REPORT OF THE 51ST MEETING OF

The Coordination Group For Meteorological Satellites

CGMS

REPORT OF THE 51ST PLENARY SESSION OF THE COORDINATION GROUP FOR METEOROLOGICAL SATELLITES

CGMS-51
Hybrid meetings
April-June 2023

Report edited on behalf of CGMS by:

CGMS Secretariat
EUMETSAT
Eumetsat-Allee-1
64295 Darmstadt
Germany

www.cgms-info.org

CGMS MR 51 [DMT 23/1365152]

TABLE OF CONTENTS

PLENARY SESSION

1. OPENING SESSION

Welcome and opening remarks: JMA, JAXA, WMO, CGMS Secretariat

Mr. Masanori OBAYASHI, Director-General of JMA, and CGMS-51 co-host with JAXA, welcomed all participants and declared the 51st plenary session of the CGMS opened.

He highlighted that the role of the CGMS has become increasingly important in view of extreme weather events globally and on the increase in recent years. In this context, the United Nations "Early Warning for All" initiative represents an ambitious effort to address the challenges we face. Meteorological satellites are an essential component of this work and the CGMS provides the forum to share satellite status and plans, and to coordinate observational functions and products. The discussions on the CGMS future direction in the next decade is therefore of great importance. He noted that socio-economic benefits of meteorological satellite observation and future hybrid space-based observational infrastructures will play an important role going forward.

He concluded by wishing everyone a fruitful meeting.

Mr. Koji TERADA, Vice President of JAXA, welcomed all participants to Japan and the 51st CGMS plenary session including all remote participants. He added that JAXA was very pleased to co-host the CGMS-51 plenary and that in the past, JAXA had worked with JMA to develop Japanese weather satellites. Today JAXA develops various Earth observation satellites and contributes to solving social challenges by monitoring disasters and climate change using observational data.

He recalled the support provided by CGMS when JAXA prepared its next generation AMSR mission, which had been of great help in securing the programme, and the formal project development started a few weeks earlier. In cooperation with NASA, JAXA has been able to accumulate precipitation radar data for more than 20 years, continuing from TRMM and GPM. Such long-term data sets are not only essential for climate change monitoring, but maintaining data accumulation along with succeeding missions is expected to play an even more important role in the field of disaster management as well as in the monitoring of weather and climate change.

He highlighted that JAXA, together with JMA, would like to promote multi-cooperation of Earth observation satellites in the field of weather and climate change in the framework of CGMS. In this way, it is possible to link our activities to the realisation of the Paris Agreement, the Sendai Framework for Disaster Risk Reduction, and even the Societal Development Goals (SDGs), in order to solve the common challenges of humankind.

In conclusion, he looked forward to and invited CGMS to lively discussions over the coming days.

Dr. Wenjian ZHANG, Assistant Secretary-General, and on behalf of **WMO**, welcomed everyone to the CGMS 51st plenary session at the kind invitation of the Japan Government (represented by JMA and JAXA).

He expressed his sincere thanks to JMA and JAXA, the CGMS Secretariat, and all CGMS members and observers. He further thanked CGMS for its statement on the occasion of the 19th World Meteorological Congress (Cg-19) which strongly supported many Congress resolutions, including but not limited to the WMO new strategic plan, Early Warning for All (EW4ALL), Global Greenhouse Gas Watch (GGGW), data policy implementation, GBON, SOFF, and radio frequencies for Earth observations. CGMS's continued engagement and support to WMO initiatives and activities are both highly appreciated and critical.

He highlighted the importance of the CGMS-51 session: the need to strengthen the alignment of CGMS members' latest developments and plans for the implementation of the Cg-19 resolutions and new initiatives as noted above. This is essential for enhancing the global earth observation and data availability, critical for all WMO Members in order to further develop and strengthen the meteorological services for saving human life loss and minimising economic damages, and positively support the societal economic development.

He added that it would be important to take these new developments into account in the next update of the WIGOS Vision document.

He concluded by noting that the CGMS support greatly facilitates the continued success and implementation of WMO key priorities and new initiatives, ultimately leading to a win-win situation for the CGMS and user communities.

The **Head of the CGMS Secretariat, Mr Phil Evans (EUMETSAT)**, welcomed all participants to the 51st plenary session of the CGMS. He reminded CGMS of the importance of face-to-face meetings to the CGMS community in order to rebuild and strengthen the partnerships. He highlighted the many changes taking place such as new technologies in the space segment, new approaches to securing data, AI and machine learning that is expected to have a profound impact on the way satellite operators function and ultimately on the downstream users. He recalled that the work CGMS do matters in support to the monitoring of climate change and increasing severe weather events. He concluded by noting the importance of the discussions to take place on the priorities for CGMS over the next 10 years, and how to ensure that what CGMS does has the biggest impact on the societies that we serve.

Read the full addresses on page 64.

2. NEW DEVELOPMENTS AND LONG TERM PLANS BY CGMS SPACE AGENCY MEMBERS SINCE CGMS-50

Main developments since CGMS-50 and an outlook for the future

CGMS-51-CMA-WP-10: CMA updates since CGMS-50 and report on the medium to long-term future plans

Since CGMS-50, CMA successfully launched FY-3G on 16 April 2023, corresponding to the third precipitation measurement satellite in the world performing proactive measurements. FY-3E and FY-4B became operational on 1 December 2022. FY-3E and FY-4B data and products are available on the CMA NSMC official website since 1 June 2022. CMA plans to launch FY-3F in August 2023. FY-4MW is under development. Currently, eight FY satellites are operational, including four polar orbit satellites and four geostationary satellites. Before 2030, CMA will launch another eight FY satellites to support global observations.

CMA is developing a series of new application platforms:

FengYun Brain - an intelligent platform to manage the entire processing information of the FengYun satellite ground segment (internal to CMA);

FengYun Earth - a lightweight forecaster oriented platform whose main feature is convenient access to forecasters; and

FengYun Space - a third generation space weather operations system (internal to CMA).

CMA highlighted their engagement in CGMS activities. Dr. Zhen-Lin CHEN, CMA Administrator, visited EUMETSAT and the CGMS Secretariat on 30 May 2023. A CMA delegation participated in the CGMS-51 working group meetings in April at EUMETSAT.

CMA suggested that CGMS members coordinate their long-term plans, embrace new technology, and enhance space weather activities and user engagement.

NOAA appreciated the CMA considerations on large versus small platforms, and NOAA suggested that CGMS develops a consistent stakeholder communication about the relative importance of large and small platforms.

WMO echoed the comments from NOAA, emphasising the very important role of large platforms. WMO also asked for clarification of the planning for the GEO µwave satellite launch. CMA responded that some delays have incurred on the development of the GEO µwave mission due to technological challenges.

CGMS-51-CNSA-WP-02: Overview of China Earth Observation Satellites

CNSA has continuously expanded multilateral and bilateral space cooperation on behalf of the government. To date, it has signed more than 150 intergovernmental space agreements with nearly 50 countries.

Since CGMS-50, China Earth Observation Satellites are composed of three types: atmospheric, oceanographic and land satellites.

As for atmospheric observations, on 16 Apri1 2023, FY-3G was successfully launched and with the first image released on 15 May. For oceanographic observations, China has successfully launched 11 marine satellites, eight of which are in orbit.

Regarding land observations, the Terra Ecosystem Carbon Monitoring Satellite was successfully launched on 4 August 2022. It is the first satellite providing active and passive joint observations of forest carbon sink, and China's first satellite to monitor carbon storage, forest resources and forest productivity in a terrestrial ecosystem with high precision.

HJ-2E was successfully launched on 13 October 2022. The satellite obtains global 5-meter S-band image data and provides basic guarantee for disaster prevention and mitigation, and environmental protection.

0n 9 December 2022, GF-5 01A was successfully launched, marking that the construction task of the GF-series satellites space section has been fully completed, with first images released on 28 March 2023.

The operations of the CF-5B mission started on 4 April 2023.

CNSA provided its outlook for the future in three areas:

1) atmospheric observations

FY-3F is scheduled for launch in the second half of this year. FY-3H, FY-4C, DQ-2 and Geostationary Orbit Microwave Sounding Satellite are under development.

2) oceanographic observations

The new generation Ocean colour satellite is scheduled for launch by end 2023. The satellite will improve the spatial and spectral resolution of China's ocean colour observations. The mission will expand the detection spectrum, and provide rapid global coverage. The follow-on HY-4 and HY-2 E/F satellites are under development.

3) land observations

The GEO SAR Satellite and HJ-2F are scheduled for launch in the second half of this year. GF-4B and GF-7B are under development.

China will further promote the application of space information in important areas such as sustainable economic and social development addressing climate change, disaster prevention, environmental protection, carbon peak and carbon neutrality, contribute to the realisation or the United Nations 2030 Sustainable Development Goals, the peaceful use of outer space, and the building of a community with a shared future for mankind in outer space.

CGMS-51-EUMETSAT-WP-12: EUMETSAT updates since CGMS-50 and report on the medium to long-term future plans

EUMETSAT currently exploits ten satellites of which six are EUMETSAT's own (Meteosat-9 to -11, MTG-I1 and MetOp-B and –C) with the remaining in partnership (Sentinel-3A/-3B and Jason-3 and Sentinel-6 Michael Freilich missions).

Since February 2018, Meteosat-11 provides the 0° service and Meteosat-10 at 9.5°E the 5-minute rapid scanning service. Meteosat-9 remains at 45.5°E to the support, on a best effort, the multi-partner service for the continuation of the Indian Ocean Data Coverage (IODC). Dual-MetOp operations with MetOp-B and MetOp-C are planned to continue up until 2027.

The first Meteosat Third Generation (MTG) satellite, MTG-I1 (carrying the first imager in the series) was successfully launched on 13 December 2022 and is currently ongoing in-orbit commissioning. The MTG imagery mission provides 10-minute full disc imagery and also carries a lightning imager (LI).

The MTG sounding mission, MTG-S, will carry a hyperspectral infrared sounder (IRS, temperature, and water vapour, with profiles for every 30 minutes over Europe in synergy with the Copernicus Sentinel-4 mission). The MTG-S1 is currently planned for launch in 2024 with the MTG-I2 to follow in the 2026 timeframe. The operational exploitation of the Meteosat Third Generation satellite system is expected for the 2024-2040 period.

Regarding future LEO satellites: The LEO EPS-SG programme is under development and will provide a continuation and enhancement of the service from the mid-morning polar orbit in the mid-2020s to 2040s timeframe. The space segment is composed of a twin satellite in-orbit configuration with MetOp-SG A1: an optical imagery and sounding mission which also will host the Copernicus Sentinel-5 instrument currently planned for launch in 2025; and MetOp-SG B1: a microwave imaging mission, tentatively planned for launch late 2025. There will be three successive pairs of satellites with 21 years of operations.

New data access mechanisms are becoming operational to deliver the increased volume of data expected from the new satellites systems including 'pull services': the EUMETSAT Data Store, EUMETView, and a data customisation tool, the Data Tailor. EUMETSAT is also participating, along with ECMWF and the National Meteorological Services of their respective Member States, in the European Weather Cloud, which will deliver data access and cloud-based processing capabilities for the European Meteorological Infrastructure (EMI) and their users. EUMETSAT is also contributing to Destination Earth (DestinE), along with ESA and ECMWF, EUMETSAT being responsible for the Data Lake.

EUMETSAT continues to work on its AI/ML roadmap established in 2022 with initial projects, pathfinders, having started.

EUMETSAT is considering new opportunities to complement the MTG and EPS-SG programmes in the 2025-2040 timeframe in order to enhance its response to the implementation of WIGOS 2040. The following missions are under consideration with decisions expected in the 2025 timeframe:

- EPS-Aeolus, unique European technological expertise to improve Numerical Weather Forecasts

- EPS-Sterna, a constellation of micro satellites for testing new space in an operational environment

- Ocean altimetry follow-on programme highly relevant for the detection of global sea level rise and of climate change

- Procurement of commercial RO data (and if so, a global redistribution licence will be secured)

Other considerations include EUMETSAT's potential role in operational space weather data services.

EUMETSAT continues to support the EU Copernicus programme. EUMETSAT operates Copernicus Sentinels-3 and -6, and soon Sentinels-4 and -5.

The continuation of oceanography missions has now been agreed with the European Commission and ESA with the Sentinel-3 NG Topo, Sentinel-3 NG OPT and Sentinel-6 NG operations. Additionally, the ground segment development, operations, data processing and products dissemination of the future

Copernicus C02M mission and the global data processing and products dissemination of future CIMR and CRISTAL missions. Discussions are ongoing at a European level for an Arctic Weather Satellite, and a follow-on Aeolus mission potentially for the next decade.

EUMETSAT concluded by highlighting topics, which might deserve discussions in a CGMS context, namely:

- Preparation of future programmes and need for international coordination in their implementation, new architecture concepts
  - internationally coordinated response to WMO WIGOS 2040;
- Roadmap towards evolution of data services using cloud technologies, AI/ML
  - exploitation and opportunities for coordination in order to enhance accessibility and usability of satellite data by users;
- Assessment of evolution of requirements from users in preparing for the processing of vast amounts of new data, support to preparation of users
  - presentation in a future CGMS plenary;
- Evolution of relationships with commercial meteorological data providers complementary to the "CGMS backbone"
  - Secure free and open data access as per the WMO data policy Res. 1.

WMO expressed its appreciation of the advanced capabilities of MTG-I1 and asks support to the African users for exploiting these. WMO also expressed its gratitude for the Indian Ocean Data Coverage (IODC) and the need for a continuation.

EUMETSAT informed CGMS plenary that it is working closely with African users to harvest the benefits from MTG and mobilising the necessary resources. Further extensions of Indian Ocean Data Coverage will be considered on the basis of reasonable endeavours, taking into account the health of the METEOSAT constellation.

IMD expressed its gratitude for the Meteosat-9 IODC services, it has strongly benefitted the countries in the region for severe weather and nowcasting.

CGMS-51-joint-IMD-ISRO-WP-01: Joint IMD/ISRO updates since CGMS-50 and report on the medium to long-term future plans

The Government of India unleashed reforms in the space domain in 2020, opening the doors for enhanced participation of Non-Governmental Entities (NGEs) in carrying out end-to-end activities in the space domain. The "Indian Space Policy-2023" released in April 2023 gives the framework to implement the reform vision approved by the Cabinet.

As per the Indian Space Policy-2023:

- The Indian National Space Promotion & Authorization Centre (IN-SPACe) an autonomous Organisation under DOS will act as the single window agency for the authorisation of space activities by Government entities as well as NGEs.
- ISRO will focus primarily on research and development of new space technologies and applications.
- Remote sensing data of ground sampling distance (GSD) of 5 m and higher, including the archived data shall be made accessible on a 'free and open' basis to all.
- Remote sensing data of lesser than 5 m GSD will be available free of charge to all Government agencies of India and at fair and transparent pricing to all.
- DOS will ensure the availability of continuous and improved Earth observation capability and data to fulfil the national requirements.

The detailed guidelines are being worked out and the policy will be implemented very soon.

Presently, 2 satellites INSAT-3D and INSAT-3DR are operational in GEO. Sounder onboard INSAT-3D is not functioning since September 2020. EOS-06 (Oceansat-3) was successfully launched on 26 November 2022 with Ku-band scatterometer, DualBand Sea Surface Temperature Monitor (SSTM), and 13-band Ocean Color Monitor (OCM-3). In-Orbit Test (IOT) have recently been completed and the CAL/VAL phase is ongoing. Data from the Scatterometer and the OCM-3 have been released to the users. SSTM operations have stopped due to an in-orbit anomaly in its scan mechanism. EOS-07 (Microsat-2B) was launched on 10 February 2023 in low-inclination orbit with a 6-channel Microwave Humidity Sounder (MHS) onboard. ISRO-CNES joint mission SARAL/AltiKa is functioning in mispointing mode, and the mission is now extended until December 2024 provided the health of the satellite is satisfactory.

INSAT-3DS is planned for launch later this year, 2023, with many improvements to mitigate the issues related to the blackbody calibration and mid-night sun-intrusion. GISAT-1R is scheduled for launch in the first half of 2024.

Under GSICS, the inter-calibration of IR channels is in a demo phase with IASI-B/C and shortly extended to CrIS. A Ray-Matching method has been developed for inter-calibration of Vis/SWIR channels using MODIS and 6 years (2016-2021) of data have been processed for INSAT-3D/3DR VIS/SWIR channels.

CGMS-51-JMA-WP-01: JMA updates since CGMS-50 and report on the medium to long-term future plans

JMA operates two geostationary meteorological satellites, Himawari-8 and -9, equipped with Advanced Himawari Imager (AHI). JMA conducted the operational satellite switchover from Himawari-8 (in operation since July 2015) to Himawari-9 in December 2022, and for scheduled operation until FY 2029. JMA also provided parallel distribution of experimental Himawari-9 products and observation data for several months as an alternative approach before the switchover for user readiness (non-operational purposes).

JMA contracted manufacturing of the follow-on satellite Himawari-10 in March 2023, with initiation of operation scheduled for FY 2029. Himawari-10 is scheduled to carry a visible/infrared imager, an infrared sounder and a space environmental suite.

WMO congratulated JMA with the planned sounder on Himawari-10, greatly contributing to the WIGOS Vision. WMO also expressed its appreciation of HimawariRequest and encouraged other operators in the Asia-Oceanic region to implement similar mechanisms that will support EW4ALL.

CGMS-51-JAXA-WP-03: JAXA updates since CGMS-50 and report on the medium to long-term future plans

JAXA operates various kinds of satellite sensors and opens the products available to the public. JAXA keeps developing and improving the products to address climate issues.

The major updates since CGMS-50 is that the project team of the Precipitation Measuring Mission (PMM), following to the Global Precipitation Measurement (GPM) mission, was organised in JAXA on 1 June 2023. JAXA recalled its appreciation for the support provided by CGMS and IPWG, and the PMM has now been approved by the Japanese government for a launch in 2028.

GOSAT-GW, the joint mission of GOSAT-2 follow-on (TANSO-3) and GCOMW/AMSR2 follow-on (AMSR3), is scheduled for launch in JFY2024. EarthCARE, which observes clouds, aerosols, and radiation on a global scale to improve the accuracy of climate change predictions, will be launched in 2024. JAXA is developing the CPR on the EarthCARE, which will be the world's first Wband (94GHz) Doppler radar aboard a satellite.

GCOM-C has achieved the 5-year nominal mission phase and is in the post-mission phase since January 2023.

In terms of the WMO project for monitoring extremes, JAXA contributes to the WMO Space-based Weather and Climate Extremes Monitoring (SWCEM) Project by providing Global Satellite Mapping of Precipitation (GSMaP) rainfall product with climate normal. In June 2022, JAXA started to distribute the GSMaP real time data (GSMaP_NOW) to the SWCEM members, corresponding to the recommendation in the SG-SWCEM-EAWP-4 held on March 2022. JAXA is preparing the release of the reprocessed GSMaP data, as noted the above, and will re-calculate the climate normal again for the WMO project.

WMO expressed it is appreciation of JAXA's long-term support to the critical monitoring of precipitation and of the carbon cycle. WMO asked if there are plans for innovative JAXA payloads on Himawari-10. JAXA responded that this was not currently the plan but appreciated the suggestion.

CGMS-51-KMA-WP-04: **KMA Report on current status and future satellites**

KMA has been operating GEO-KOMPSAT-2A (GK2A, meteorological and space weather mission; AMI and KSEM) since 25 July 2019.

The GEO-KOMPSAT-2B (GK2B) for the oceanic and environmental mission payload, GOCI-II and GEMS, respectively, observation data are released and available since the 2nd half of 2021.

KMA is trying a new approach to support weather forecasts such as fog detection for road-hazard weather services, simulated satellite images for nowcasting and very short-term forecasting, dust peak height, AI-based proxy radar data, and drought monitoring data using GK2A and GK2B, and so on.

The follow-ons of both GK2A and GK2B are in the feasibility study.

KMA is also preparing meteorological micro-sats for the future, and is currently in a policy research phase.

WMO expressed its high appreciation of a potential Korean LEO mission contributing to the WIGOS Vision and encouraged KMA to ensure, through CGMS coordination, the maximum utilisation and impact of this mission. WMO also highly appreciated KMA's contribution and service to the ocean community who had expressed its strong interest in such a service. WMO also informed CGMS that satellite-based proxy radar data products will be very beneficial for the WMO EW4ALL initiative.

CGMS-51-NOAA-WP-01: **NOAA updates since CGMS-50 and report on the medium to long-term future plans**

NOAA provided updates on its current and future GEO, LEO and Space Weather missions, commercial weather data programme, its enterprise cloud system, as well as organisational updates.

NOAA's GOES-East (GOES-16) and GOES-West (GOES-18) satellites are operating well, and GOES-17 is the on-orbit spare. NOAA will launch and commission GOES-U, the final satellite in GOES-R Series (April 2024) which will also include a space weather instrument, the compact coronagraph (CCOR). The Geostationary Extended Observations (GeoXO) will continue and expand observations provided by the GOES-R series and add new capabilities to address emerging environmental issues and challenges.

NOAA's polar-orbiting satellites are operating well, and NOAA-21, currently providing provisional data, will be declared operational in July 2023. NOAA continues to develop JPSS-3 and JPSS-4, and its Near Earth Orbit Network (NEON) will continue and expand observations provided by the Polar Weather Satellites using instruments on small, lower-cost, proliferated satellites and partner data to improve weather forecasting, aid disaster management, and monitor climate.

NOAA's DSCOVR mission is operating well. NOAA's Space Weather Next (SW Next) will sustain, improve, and mitigate potential gaps in observations while working with partners to support NOAA's space weather forecast operation.

NOAA will foster and expand interagency, commercial, and international partnerships to complement and supplement NOAA data to meet its mission. Also, NOAA will exploit information technology, such as cloud and artificial intelligence, via Common Ground Services to expand NOAA's user community and accelerate product service delivery to meet today's customer and climate service needs.

CMA congratulated NOAA on its comprehensive programme and asked why JPSS-3 and -4 had been swapped on the launch manifest. NOAA responded that this is due to the schedule of the LIBERA instrument from NASA.

ISRO asked for elaboration of the Space Weather programme. NOAA has been benefiting from R&D capabilities for Space Weather operations, but will now establish a fully operational capability. The mission from the L-5 Lagrangian Point is a joint effort with ESA, however, a continuation is currently not guaranteed.

WMO expressed its appreciation of the space weather programme, contributing to WMO priorities such as for e.g. aviation.

WMO asked about the plans beyond JPSS-3. NOAA responded that it is not expecting that large platforms are necessary for LEO anymore, as the measurement capabilities can be provided on smaller targeted platforms, but the studies are ongoing in the context of the NEON programme. WMO requested that NOAA share the results of NEON and engage in a global discussion.

CGMS-51-NASA-WP-02: NASA updates since CGMS-50 and report on the medium to long-term future plans

NASA continues to operate more than two dozen Earth-observing satellites and instruments. Guided in its efforts by the recommendations of the decadal survey, Thriving on our Changing Planet, NASA's Earth Science Division (ESD) continues to execute a balanced and robust programme of technology development, research, and applications.

During the past year, NASA and its partners launched four missions: the Earth Surface Mineral Dust Source Investigation (EMIT) instrument to the International Space Station, the Surface Water and Ocean Topography (SWOT) satellite, the Tropospheric Emissions: Monitoring of Pollution (TEMPO) instrument hosted on a communication satellite, and four small satellites as part of Time-Resolved Observations of Precipitation structure and storm Intensity with Constellation of Smallsats (TROPICS) mission.

As of early 2023, the Earth System Observatory (ESO) comprising of the Atmospheric Observing System (AOS), Space Biology and Geology (SBG), and Mass Change (MC) missions have transitioned into the formulation phase (Phase A) with architectures at an appropriate level of maturity. These architecture concepts represent balanced acquisition strategies, leveraging unique NASA expertise, contributions from international partnerships, as well as industry capabilities by competing at least 50% of the ESO instruments and the spacecraft.

On 2 May 2023, NASA released the final Earth System Explorers (ESE) Announcement of Opportunity (AO). Consistent with the US Administration's priorities and urgent national need for understanding

and addressing climate change and reducing greenhouse gas emissions, at least one of the estimated four selected proposals will prioritise Greenhouse Gases as one of its targeted observables.

ISRO asked if there are any plans for SAR mission science. NASA responded it is conducting a very active CAL/VAL programme for the joint ISRO-NASA mission NISAR.

CMA asked about the status of TROPICS regarding the data quality and latency. NASA noted that TROPICS is a PI-led, cost-capped mission, without explicit commitments to quality and timeliness.

WMO noted that the NASA missions are increasingly supporting the new Earth System Modelling approach of WMO. An example is the ICESAT mission, which is critical for cryosphere monitoring. WMO also encouraged NASA to ensure that the new GHG Modelling and Information Center will contribute to the overall WMO GGGW initiative.

CGMS-51-joint-ROSCOSMOS-ROSHYDROMET-WP-01: ROSHYDROMET/ROSCOSMOS updates since CGMS-50 and report on the medium to long-term future

This document addressed the current status of the Russian satellite systems.

Since CGMS-50, the Russian hydrometeorological satellite constellation has been increased by geostationary meteorological satellite Electro-L N4 launched on 5 February 2023. The launch of polar-orbiting meteorological satellite Meteor-M N2-3 and highly elliptical orbit meteorological satellite Arctica-M N2 are scheduled for launch by the end of 2023. It is planned that the next generation of ELEKTRO-M will include a lightning detection instrument.

WMO observed that the HEO orbit has now become a reality, and WMO strongly hopes that there will be a mission continuity. WMO also emphasised the importance of sharing the HEO data as well as of data collection in the polar regions. Roshydromet informed CGMS that the national use of the Data Collection System on Arctica is growing.

CGMS-51-ESA-WP-08: ESA updates since CGMS-50 and report on the medium to long-term future plans

ESA informed CGM of the current status of the European Space Agency Earth observation missions currently in-orbit. Three of them, MSG, MTG and MetOp are in cooperation with EUMETSAT.

The Meteosat Third Generation, MTG-I1, was successfully launched in December 2022, with the first image revealed in May 2023.

Copernicus represents the major continuing initiative of European efforts in Earth observation. A number of Copernicus satellites have been launched, to be followed by the next generation of Sentinels and the sixth expansion missions in preparation in the coming years. Sentinel-1C, replacing Sentinel-1B, is planned for launch at the end of 2023 or in 2024.

Sentinel missions are developed, launched and operated in partnership with the European Union and EUMETSAT. The Sentinel-4 and -5 instruments developed by ESA will fly respectively on the MTG-S and Metop-SG missions also developed by ESA in cooperation with EUMETSAT.

The Earth Explorer missions SMOS, CryoSat and Swarm currently in orbit, are performing extremely well and the related data exploitation is based on continuous data of excellent quality. The three missions all feature strong elements of international collaboration and a growing synergy between them. The Earth Explorer Aeolus concluded all nominal operations on 30 April 2023 in preparation of series of end-of-life activities. The positive impact of Aeolus on the weather forecast has been seen by multiple Numerical Weather Prediction centres world-wide, and in particular by ECMWF. It will pave the way for a follow-on mission already planned in collaboration with EUMETSAT.

The Proba-V small satellite was launched on 7 May 2013. Its coarse resolution imager has, together with Sentinel-3, continued the data acquisition of the Vegetation payload on-board SPOT-4 and 5, during the reporting period. However, from July 2020, owing to its orbital drift, Proba-V Vegetation instrument ended its operations on 31 October 2021 and according to plan. The follow on to the Proba-V satellite, Proba-V Cubesat Companion (PV-CC) developed within the GSTP programme, is scheduled for launch in July/August 2023 as part of the Small Satellites Mission Service (SSMS) rideshare mission, on board the Vega flight VV23.

CGMS is further informed of the current status of the future European Space Agency Earth observation missions, and the Living Planet Programme which has three lines of implementation: Earth Explorer satellites, Earth Watch satellites plus services and applications demonstration.

The forthcoming Explorer missions, EarthCARE, Biomass, FLEX, FORUM and Harmony are under preparation. Harmony was formally selected for implementation as Earth Explorer10 (EE-10) in September 2022.

The science requirement consolidation (SciReC) studies are continuing for the four Earth Explorer 11 (EE11) candidate missions selected for Phase 0: CAIRT, Nitrosat, SEASTAR, and WIVERN. Iterative changes to the MATER (Mission Assumptions and Technical Requirements Document) have been prepared by ESA and discussed with the Mission Advisory Group for each mission. A call for ideas was issued for Earth Explorer 12 (EE12) on 20 February 2023.

Activities related to Aeolus-2 and the Arctic Weather Satellite (AWS) in cooperation with EUMETSAT, TRUTHS, SCOUTs and ALTIUS are ongoing. Each of these missions are planned to contribute to routine, operational monitoring data in order to improve our understanding of the Earth system and climate change.

Looking to the future, the six Copernicus Expansion missions are currently in phase B2/C/D/E1, addressing EU policy and gaps in Copernicus user needs, and each expanding the current capabilities of the Copernicus space component: CHIME, CIMR, CO2M, CRISTAL, LSTM, and ROSE-L. The Sentinel development activities, including Copernicus Expansion missions and Next Generation missions, continued in line with Segment 4 of the Copernicus Space Component (CSC) Programme, the Future EO Programme and the CSC Long Term Scenario. The industrial activities are progressing according to plan with system and instrument PDRs for CIMR, CHIME, LSTM and ROSE-L successfully completed.

ESA further informed CGMS of the status of the Earth Watch Programme element, Global Monitoring of Essential Climate Variables (also known as the ‘ESA Climate Change Initiative’ or CCI). The CCI has continued to progress very well since. In 2016, a second phase of the programme, CCI+ was approved

by ESA member states permitting to study and monitor 23 essential climate variables (ECV) derived from satellite data, fulfilling the GCOS objectives. Out of these 23 ECVs, 16 have been handed over to the Copernicus Climate Change Service (C3S) lead by ECMWF, for operational use. The implementation of CCI phase 2 is ongoing, with the majority of extensions to existing ECV projects, and the associated funding, being placed. The new climate initiative, CLIMATE-SPACE, was presented and oversubscribed at the Ministerial Council 2022 (CM22).

WMO expressed its appreciation for the very detailed presentation and document and asked for information about the planned launch data for CO2M. ESA confirmed that in mid-2023 the launch schedule will be available and that CO2M Critical Design Review will be performed in the second half of 2023.

CGMS-51-ECCC-WP-01: ECCC/CSA update on status and plans for the Arctic Observing Mission (AOM) and Terrestrial Snow Mass Mission (TSMM)

The Arctic Observing Mission (AOM) and the Terrestrial Snow Mass Mission (TSMM) are two satellite mission concepts currently under study by Canada. The AOM is a Canadian-led international mission that will provide authoritative data on weather, greenhouse gas, air quality and space weather over the Arctic, while TSMM is a Ku-band radar mission to inform climate services and improve environmental prediction for snow covered regions.

Both missions are aligned with Resourceful, Resilient, Ready: Canada's Strategy for Satellite Earth Observation, released in early 2022, and will enable Canada to take full advantage of the unique vantage point of space to address climate change and other key challenges of our time.

The AOM is completing pre-formulation study activities that will refine the options for mission architecture and inform what is required for the design, implementation and operational phases of the mission and scheduled for completion in late 2024, with the outputs from the study being incorporated into AOM's business case. Canada is continuing engagement activities with existing partners and is exploring new partnerships from the international community. It is anticipated that potential partner contributions will be confirmed in 2024-25, with a finalised AOM business case available to inform any budgetary decisions in 2025-2026 for an end-to-end mission implementation.

TSMM is also in its mission formulation phase. Currently Canadian industry is continuing the advancement of the Ku-band radar hardware with the CSA for potential future implementation while science studies led by ECCC continue to focus on retrieval development, including snow and radar modelling and land surface data assimilation. Outcomes of TSMM's pre-formulation study activities will support the mission's business case and inform budgetary decisions for end-to-end mission funding implementation.

WMO expressed its appreciation for the planned HEO mission and inquired about the data policy for the TSMM mission. ECCC confirmed that the Data Policy will by fully open for TSMM as per the new Canadian Space Strategy.

NOAA inquired about plans for enhanced ground infrastructure to provide NRT access to the new missions. ECCC responded that discussions are ongoing with Natural Resources Canada to identify high-bandwidth communications opportunities for repatriation of data.

3. WMO MATTERS FOR COORDINATION WITH CGMS SPACE AGENCIES

WMO matters for coordination with CGMS space agencies

CGMS-51-WMO-WP-07: WMO matters for coordination with CGMS space agencies

The WMO presented the matters needing coordination with the CGMS space agencies, including WMO strategic initiatives approved by the Nineteenth World Meteorological Congress (Cg-19): Early Warning for All (EW4All), Global Greenhouse Gas Watch (GGGW), and addressing global and regional impacts of changes in the cryosphere.

WMO will organise a stakeholder consultation/Core Satellite Data Workshop on 4-7 December 2023. The objective is to reach a common view of the core satellite data definition for Numerical Weather Prediction (NWP) and nowcasting, to develop an initial list of Earth system data to be exchanged as core data, and to finalise revised WIGOS technical regulations establishing the commitment to provide core satellite data.

WMO also introduced a plan for the next WMO Consultative Meeting on the High-level Policy on Satellite Matters, a high-level dialogue between satellite operators and WMO representatives, anticipated for February 2024.

Through its Expert Team on Radio Frequency Coordination (ET-RFC), WMO has developed a Position Statement for the World Radiocommunication Conference 2023 (WRC-23) agenda. It contains the positions on 21 agenda items of the WRC-23 that are of prime interest or concern to WMO members and as adopted by the 19th World Meteorological Congress in Geneva in May 2023.

Finally, WMO introduced the Task Team on Polar and Cryosphere Space (PCS-TT) as the Polar Space Task Group (PSTG) follow-on. PCS-TT will operate under the auspices of INFCOM, as a substructure of the Advisory Group on the Global Cryosphere Watch (AG-GCW), and with a reporting link to the Standing Committee on Earth Observing Systems and Monitoring Networks (SC-ON) through its Expert Team on Space Systems and Utilization (ET-SSU). WMO invited CGMS Members to contribute to consultations on the team.

Discussion and review of new actions

EUMETSAT pointed to the potential of GEONETCast for the provision of global distribution of warning messages in support to EW4ALL. WMO confirmed that this will be considered.

NOAA supported the core data initiative and noted that the scope of this initiative should be much broader than data for NWP.

NOAA further encouraged a consolidation of the different initiatives on Polar and High Mountains.

EUMETSAT reminded that the Polar Space Task Group had originated in an effort of CEOS and WMO to coordinate and facilitate the access to Synthetic Aperture Radar data for the arctic region and that the plan was now to broaden the mandate of the group to consider the full range of satellite data relevant to the Polar and High Mountains regions, including data that are not currently routinely collected.

WMO informed CGMS that a small team is currently working on the Terms of Reference for the polar expert team and once the terms of reference have been approved by WMO, a broader invitation for nominations for membership will be issued.

WMO reminded CGMS that the World Weather Watch was actually founded on high-level UN considerations about the use of space for meteorology, and that EW4ALL will similarly be a high-level driver for the strengthening of use of space data for disaster readiness. The support of CGMS to EW4ALL is essential.

WMO invited CGMS members to actively support and respond to the WMO strategic initiatives and resolutions, such as EW4ALL, GGGW, and the Unified Data Policy implementation on satellite data, and asked CGMS space agency members to participate in the upcoming Core Satellite Data Workshop (4-7 December 2023) and WMO Consultative Meetings on High-level Policy on Satellite Matters (Feb 2024). The CGMS-51 plenary endorsed this recommendation.

CMA expressed its strong interest to attend the WMO Consultative Meeting on High-level Policy on Satellite Matters, but pointed out that the Chinese New Year Festival in 2024 will take place from 9-15 February 2023, and asked that this be taken into account by the WMO in the scheduling of the meeting.

ISRO pointed to the need for protection of C-band frequencies for Sea Surface Temperature measurement. WMO confirmed that this is a key issue for WMO position paper for the World Radio Conference and asked that agencies would also reach out directly to the national representatives to ensure their support to the WMO position at the WRC. ISRO informed CGMS that the next meeting of the GRHSST group will take place in Ahmedabad, India, on 16-20 October 2023 and the global SST community will have the opportunity to express their concerns and their support to the WMO position.

RECOMMENDATION

Lead	Agenda item	No.	Description
CGMS members	WMO MATTERS FOR COORDINATION WITH CGMS SPACE AGENCIES	R51.01	Plenary recommended that CGMS members actively support and respond to the WMO strategic initiatives and resolutions, such as EW4ALL, GGGW, and Unified Data Policy implementation; and asks CGMS space agency members to participate in the upcoming Core Satellite Data Workshop (4-7 December 2023) and WMO Consultative Meetings on High-level Policy on Satellite Matters (Feb 2024).

4. WORKING GROUP REPORTS

4.1 Satellite systems and operations – WGI

CGMS-51-WGI-WP-10: Report on the outcome of WGI activities since last plenary

The CGMS-51 WGI meeting took place on 24 April 2023. All Task Groups presented the progress of their respective activities since CGMS-50.

The following highlights were noted:

- The topic of Radio Frequency Interference (RFI) is now well covered by the recently formed Task Group on RFI and generated a lot of discussion on passive bands spectrum protection and methods for monitoring and tracking interference issues;

- The SWOT analysis on Low Latency Data Access from LEO meteorological satellites was concluded, noting the importance of keeping the end-to-end data acquisition and provision under agency responsibility to be complemented by commercial services, and aiming to reduce the gap between global and regional services;

- Work on a new Data Collection Platform technical standard is progressing and should be ready for endorsement, along with an implementation plan at CGMS-52;

- The proposals from the CGMS future direction 2022+ project for work to be led by WGI were welcomed, many of which fitted into existing activities within the various Task Groups.

Discussion and review of new actions

In the follow-on discussion, Dr Volz (NOAA) acknowledged the importance of the Task Group on Space Debris and Collision Avoidance and the need to ensure action is taken on progressing the activities proposed by WGI. Dr Volz also highlighted the value of WGI working on the theme of Hybrid Infrastructure but noted the importance to work on this together with WGIII to address the challenge of continuity. The WGI co-chair (EUMETSAT) confirmed that WGI will indeed be working with all the CGMS Working Groups to address this activity.

Dr Zhang (WMO) noted that WMO strongly endorses the Socio Economic Benefits and Research-to-Operations themes of the CGMS future direction project, and in the scope of WGI specifically looking at the benefits of how new technologies will benefit society. Dr Zhang highlighted the need to continue engagement with the commercial sector and evaluate opportunities for cost-effective solutions in the future in order to maximise benefits for society. Dr Zhang further noted WMO's appreciation of the progress on DCS and the Smallsat, acknowledging the great benefits of DCS for collection of data from remote areas.

In conclusion, the CGMS Plenary Chair encouraged the CGMS space agency members to nominate members to the different Task Groups, especially those where no representatives of the agencies are

currently participating in the Task Group(s). It was agreed that the CGMS Secretariat opens an action on nominating additional members.

ACTION

Actionee	Agenda item	No.	Description
CGMS space agency members	WGI report	A51.01	CGMS agencies to nominate additional members for all the WGI Task Groups - by September 2023 - in particular those agencies who currently have no representatives participating in the Task Group(s). • New WGI TG: WGI TG on Radio Frequency Interference Issues • WGI TG on Satellite Data and Codes • Recent merge of two WGI TGs: WGI TG on Low Latency Data Access • WGI TG on Space Debris and Collision Avoidance • WGI TG on Data Collection Services
CGMS members	WGI report	A51.02	CGMS Members are invited to nominate candidates for WGI Co-Rapporteur and Co-Chair.

The CGMS future direction project is further addressed in the follow-on plenary discussions and combined actions opened as needed.

4.2 Satellite data and products - WGII

CGMS-51-WGII-WP-02: **Report on the outcome of WGII activities sine last plenary (including key recommendations from IPWG, IROWG, ITWG and the IWWG; proposal for the creation of a new CGMS ISWG: IESWG)**

WGII presented the status of the WGII co-chairs and rapporteurs: JV Thomas, ISRO, will remain as co-chair until CGMS-52 (mid-2024); Heikki Pohjola, WMO, current co-chair will step down following CGMS-51, and CMA has nominated Na XU as a new co-chair. The rapporteur Mitch Goldberg, NOAA, has retired and will be replaced by Andrew Heidinger, NOAA, and Paolo Ruti, EUMETSAT, will continue as co-rapporteur. Due to lack of resources, WMO is currently not in a position to fulfil the second WGII co-chair post.

Currently the WGII Terms of Reference (ToR) define that one of the co-chairs shall be nominated from WMO, and the other from a CGMS member from the Asia-Pacific region. WGII proposed to Plenary the removal of the sentence *"The other co-chair is provided by WMO*" in the current WGII ToR clause:

"WGII is co-chaired by two Chairs supported by two rapporteurs, all appointed by the CGMS Plenary. One of the two co-chairs is selected from the Asia-Pacific region. ***The other co-chair is provided by WMO.*** *NOAA and EUMETSAT provide each one of the rapporteurs. WGII representatives are nominated by each CGMS Member who shall promote continuity and foster active contribution. WGII chairs, WGII rapporteurs and CGMS Secretariat shall be informed by CGMS Members of the names of WGII representatives and any changes prior to the respective CGMS Plenary meetings. CGMS Secretariat shall maintain an updated list of WGII representatives in the corresponding WGII CGMS web page."*

WGII had held a dedicated session on a future operational carbon system and in view of the WMO Global Greenhouse Gas Watch (GGGW) initiative and as approved by the 19th WMO Congress to support the implementation of the 2015 COP-21 Paris Agreement. The GGGW initiative aims at creating a system of global, near-real time observations of CO2 from both satellite and ground-based systems. This would be coupled with the GHG model, which would provide CO2, CH4 and N2O concentrations at an (initially) 100 km grid-resolution. The aim is to bring this down to ~1 km within 10 years. Additional interactions between WMO and CGMS are needed in order to understand the operational requirements. Specifically it is expected that this initiative triggers a better coordination among ground-based measurement networks and facilitate fit for purpose solutions. As no one single constellation will be able to meet the OSCAR time resolution requirements (1 h), CGMS calls for a major coordination among operational satellite agencies for existing and future initiatives (CO2M, DQ-1/2, GF-5, OCO-2/3, GOSAT, …).

Regarding climate activities, the CEOS-CGMS Joint Working Group on Climate met in Tokyo for its 18th meeting in February 2023. The main topics addressed were:

- developing the space agency response to the 2022 GCOS Implementation Plan (IP);
- releasing an updated version of the Essential Climate Variable (ECV) Inventory; and
- releasing a merged Gap Analysis Report (v3/4.1) for the Inventory.

WGII proposed to hold a dedicated plenary session on the GEO Ring at CGMS-52 in 2024. This session will be complemented by a preliminary analysis of the GEO Ring contribution to the overall sounding capabilities.

WGII further reported on the microwave hyperspectral monitoring discussions addressed at the CGMS-51 WGII meeting in April 2024. The preliminary analyses appears to indicate that the soundings improve significantly with hyperspectral capabilities. A fairly simple hyperspectral setup at 23 GHz is very capable of detecting even small RFI signals. Hyperspectral capabilities at 183 GHz, when used during coincident overpasses with small radiometers, can significantly improve inter-calibration capabilities. Even if technical maturity is at a good level, a small satellite platform is needed. The IPWG is currently designing an OSSE framework to assess sensor capabilities (channels, resolution, sampling).

NASA informed WGII on the recently launched TROPICS, and that the commercial provider Tomorrow.IO is planning to use the TROPICS design for a future mission. CMA plans to develop a smallsat or cubesat programme in the framework of an ongoing scientific project. Whether or not the programme will become of an operational nature remains to be seen.

WGII also addressed the relevance of nowcasting applications to further exploit satellite data. The WMO Early Warning for All (EW4ALL) initiative could be an important vehicle. As an example, the African continent is difficult to cover with radar data. New techniques and methods (high-resolution satellites, e.g. MTG) coupled with new methods to process the data (e.g. AI/ML), and ways to directly communicate and integrate weather information into the lives of ordinary citizens will be a game changer. For instance, NOAA developed a new “ProbSevere LightningCast” AI/ML model which uses

visible, near-infrared, and long-wave infrared channels aboard GOES ABI to predict the probability of lightning in the next 60 minutes. NOAA/NWS uses it operationally.

WGII concluded by highlighting three key action areas to the plenary that the working group will focus on in the medium term:

1. Strengthen the scouting function for new measurement technologies emerging to have a strong trend in the technological readiness level;

2. Exploring further the applications of satellite data in emerging or new sectors – ensuring an update of use-cases for future missions; and

3. Monitoring and analysing the evolution of AI/ML technologies in the areas of retrieval methods, use of satellite data in forecasting and modelling systems, and guided exploration and exploitation of satellite data sets.

Following the presentation, plenary took note of the WGII report, and

- Endorsed the updated WGII Terms of Reference and the new co-chair and rapporteur;
- Noted the ongoing efforts by the CEOS-CGMS joint working group on climate and agreed to a dedicated plenary session on the GEO-ring at CGMS-52 plenary;
- CGMS members highlighted the important role of GSICS to support cross-calibration activities;
- Noted the importance of the WMO GGGW and EW4All initiatives and the need for the CGMS space agencies to contribute to these in a coordinated way; and
- Confirmed the three key action areas for WGII to focus on in the medium term.

Plenary further thanked the outgoing and incoming WGII co-chair.

Key recommendations from the IESWG - International Earth Surface Working Group

Since last plenary, the International Earth Surface Working Group (IESWG) has updated its Terms of Reference with the CGMS WGII. There is a clearly identified need for a group with the unique combination of data assimilation and Earth surface modelling experts in order to fully exploit existing and future observations. The IESWG has a distinct vocation towards Earth surface data assimilation, observation operators and modelling developments that can advance coupled land-atmosphere assimilation in numerical weather prediction and climate/environmental reanalyses.

The three main topical areas in the IESWG are:

1) Snow ice and cryosphere-atmosphere interaction;
2) Vegetation and land-atmosphere fluxes; and
3) Soil moisture, river-discharge and water cycle.

The IESWG will hold its 5th (IESWG-5) meeting on 26-28 September 2023 and is to this purpose conducting a survey of land surface data assimilation (DA) systems.

IESWG participants report on Earth surface-atmosphere coupling and data assimilation with particular focus on methodologies, algorithmic and modelling advances that can enhance satellite observations uptake from present missions and prepared for upcoming ones. They also focus on operational oriented product development, guaranteeing the uniqueness of the international contribution vs other international groups (i.e., CEOS Land Product Validation subgroup).

The planned activities within IESWG include modelling and assimilation to prepare for future missions such as EPS-SG, FLEX, CIMR, CRISTAL, BIOMASS, and CO2M to list but a few; as well as for existing missions like SMOS and SMAP for which data uptake has been suboptimal.

The IESWG will support the following CGMS high-level priorities:

- **CGMS HLPP 1.2.6** Work towards ensuring low frequency microwave imagery from at least 2 sun-synchronous orbits;
- **CGMS HLPP 1.2.7** Establish observational requirements for microwave observations (sounder and imager) for NWP and precipitation and perform gap analysis against the CGMS baseline;
- **CGMS HLPP 4.6.3** continue to improve microwave radiative transfer models to include complex surfaces (e.g. snow, desert, etc.) to support improved algorithm development for current and future sensors;
- **IESWG/(P)A50.01** - Create Terms of Reference and proposal to establish a new CGMS International Science Working Group [and propose Benjamin Ruston as CGMS rapporteur[1]].

Following the presentation, CGMS-51 plenary endorsed the creation of the CGMS International Science Working Group “International Earth Surface Working Group” - IESWG - for an initial fixed period of 4 years, for the group to report on progress to CGMS-53 plenary in 2025, and for plenary to decide at that stage on the continuity of the group.

ACTION

Actionee	Agenda item	No.	Description
IESWG CGMS rapporteur	WGII report	A51.03	The IESWG to report on progress to plenary CGMS-53

Further, the IESWG would need to identify a CGMS rapporteur and as far as possible by September 2023, noting that the CGMS rapporteur needs to be from a CGMS member agency involved in CGMS activities.

Key recommendations from the IROWG - International Radio Occultation Working Group

The IROWG reported on the outcome of the joint OPAC-7 and IROWG-9 meetings on 8-14 September 2022 in Austria.

[1] Comment by the CGMS Secretariat – CGMS rapporteurs need to come from one of the CGMS member agencies.

This was the first in-person IROWG meeting since the pandemic. More than 100 scientists attended, including representatives from all the major RO processing centres, space agencies, weather prediction centres, commercial data providers, and the research community. Four subgroup meetings were held, namely: Numerical Weather Prediction (NWP); Climate; Receiver Technology and Innovative Occultation Techniques; Space Weather; as well as dedicated specialist meetings focusing on BUFR format revision; level 0 data format definition; and future radio occultation observation operator development.

The IROWG-9 produced the following key recommendations to the CGMS space agencies:

- IROWG strongly supports an open data policy towards the purchase of commercial RO data and recommends that all agencies follow this model. IROWG stresses the importance of free and unrestricted access to essential RO data including archived raw or low-level data;

- IROWG recommends operational Global Navigation Satellite System (GNSS) RO missions for continuous global climate observations to be established and maintained as a backbone to ensure continuity and long-term availability of climate quality RO;

- IROWG continues to support the previous recommendations that GNSS-RO data - with at least 20,000 occultations per day - are globally distributed and provide full sampling of the diurnal cycle. IROWG also recommends further investigation of the value of increased target observation quantities, to provide a sound basis for future statements on the desirable number of observations and insights on satellite mission planning and coordination;

- IROWG recognises the importance of space weather applications of RO data, and recommends that RO and non-RO missions that use dual-frequency GNSS receivers for their orbit determination needs should make available to the operational and research communities all necessary low-level (level 0) data and metadata required to produce accurate overhead TEC data from the GNSS receiver;

- IROWG encourages technology and retrieval developments for improving planetary boundary layer profiling from GNSS-RO and their utilisation in NWP data assimilation as well as the further exploitation of RO-derived water vapour.

The IROWG initiative Radio Occultation Modeling Experiment (ROMEX) seeks to quantify the benefit of increasing the quantity of RO observations using additional observations not available to weather centres for their real time operational systems. The IROWG community has gained approval from a number of institutions to perform data assimilation experiments with the additional RO measurements over a designated time-period, currently planned to cover September-November 2022. The concept was first introduced by Dr. Richard Anthes in May 2022, in response to questions from NOAA for input on future RO needs. The resulting discussion led to a proposal for the ROMEX initiative, and endorsed by the IROWG in September 2022 (at the IROWG-9 meeting).

The experiment results will help provide guidance to the CGMS partners to answer pressing technical and programmatic questions facing the numerical weather prediction (NWP) community. This will help inform near- and long-term strategies for RO missions and acquisitions by all CGMS partners. The initial data distribution within ROMEX is planned for late 2023, followed by data quality assessment and NWP experiments in following months. The IROWG plans to present intermediate and final reports to the upcoming CGMS-52 WGII meeting in April 2024 and at IROWG-10, in September 2024.

CGMS plenary noted the recommendations by IROWG and further thanked IROWG for the efforts undertaken on the ROMEX project.

Key recommendations from the IWWG - International Winds Working Group

The IWWG elected new Co-Chairs at its meeting in May 2024:

- Iliana Genkova (Lynker@NOAA/NCEP/EMC, Task Lead Observations Processing)
- Feng Lu (CMA/NSMC/NARSSDC, Chief Designer of FY-4 GS)

They replaced Regis Borde (EUMETSAT) and Steve Wanzong (Univ. of Wisconsin). Jaime Daniels (NOAA) will continue as the CGMS rapporteur.

IWW16 took place on 8-12 May 2023 in a hybrid format at the Université du Québec a Montréal (UQAM), Canada, hosted by the Environment and Climate Change Canada (ECCC).

The workshop addressed the status of operational winds, AMV derivation and quality, use of satellite-derived winds in NWP, Ocean surface winds, Aeolus, 3D winds, and future missions, reprocessing and climate applications. The poster session was a popular addition to the winds workshop. Further the IWW16 discussed the 4th AMV intercomparison results and progress in ocean surface vector winds and the results of the Working Groups on Wind extraction methods and Data assimilation.

Plenary noted the activities by the IWWG, and thanked the outgoing and incoming IWWG co-chairs.

Key recommendations from the ITWG – International TOVS Working Group

The ITWG presented its key recommendations to CGMS plenary resulting from its meeting, ITSC-24, held on 16-22 March 2023, namely:

- Recommendation ITSC24-AS-8 to space agencies and data providers:
    - to expand the backbone system with 3 additional orbits between the current 1330, 0930, and 0530 local times;
- Recommendation ITSC24-IIFS-3 to CGMS:
    - to advance the implementation of the WIGOS Vision 2040 for passive IR and MW sounding with agency commitments beyond the established 3-orbit baseline. Noting recent assessments of expected impact, the WG recommends complementing the 3-orbit CGMS baseline with a further 3-orbit system that features at least MW sounding capabilities, with equator-crossing times between those of the 3-orbit baseline to optimize time-to-coverage of the overall system;
- Recommendation ITSC24-NWP-5 to CGMS and WMO members:

    - When commercial satellite data is purchased, ensure provision to users of the necessary data and meta-data required to make use of the data in applications, as early as possible; and
- Recommendation ITSC24-IIFS-10 to space agencies involved in reference missions (CLARREO, TRUTHS, LIBRA):
    - To work towards harmonised product definitions to make the use of these products easier for inter-calibration exercises.

Plenary noted the recommendations by the ITWG. Plenary also highlighted the need for the ITWG to be involved in future CGMS discussions on the GEO ring related to global microwave sounding and radio occultation observations, and in preparation for CGMS-52 plenary.

Key recommendations from the IPWG - International Precipitation Working Group

IPWG held its 10th meeting on 13-17 June 2022 at the Colorado State University, USA. The IPWG splits its activities between four Working Groups, with an emphasis on the first two:

1) The Baseline Surface Precipitation Network (BSPN) Working Group is drafting a strategy for a uniform quality radar/gauge database, with inputs from Quantitative Precipitation Estimation (QPE) experts;
2) The CubeSat/SmallSat Constellation Working Group has proposed an OSSE framework to benchmark existing and proposed system capabilities (sensors, channels, resolution, sampling);
3) The Multi-Satellite precipitation Working Group is soliciting user needs from global product producers, and global product producer needs from the research community; and
4) The Machine Learning Working Group is developing a standard training and independent test data set for individuals to evaluate ML algorithm capabilities in a consistent fashion.

JAXA has taken over the hosting of the IPWG website, and the IPWG e-mail list by the University of Maryland, USA. Planning is also underway for the IPWG-11 in Tokyo, Japan, in July 2024.

Plenary took note of the ongoing IPWG activities. Plenary further invited the IPWG to interact with the IESWG to further understand the use and impact of microwave measurements related to land surface.

Discussion and review of new actions

The plenary noted the status of activities by the WGII and all CGMS ISWGs and thanked the members for their work and contributions.

ACTIONS

Actionee	Agenda item	No.	Description	Deadline
CGMSSEC	WGII, WGClimate reports	A51.04	The CGMS Secretariat to secure the inclusion of an agenda item on the GEO-ring observations reprocessing for climate project at CGMS-52 plenary	spring 2024

4.3 Operational continuity and contingency planning – WGIII

CGMS-51-WGIII-WP-05: Working Group III report

The CGMS WGIII co-chair Irene Parker (NOAA) presented the WGIII report summarising the highlights of the CGMS Working Group III meeting in April including WMO's plan to organise a workshop defining 'Core' satellite data together with space agencies and users. The main updates on OSCAR/Space database and the outcomes of WMO Gap Analysis were reported. She also presented the highlights of the reported status on operational and research missions including MTG-I1 launch, Himawari-9 operations, TEMPO and TROPICS updates.

The CGMS top-level risk assessment 2023 was presented including the recognised risks on radio occultation (RO) measurements for low-inclination later part of the decade and risks on coronagraph, energetic particle sensor and plasma analyser related to space weather. A new WGIII action was raised on CMA to at look the potential for operational use of Chinese commercial RO data.

In discussion, JAXA reported that precipitation radar mission preparations have started officially. ISRO reported that OceanSat-3 was launched and INSAT-3DS is going to be launched later this year and its 4th generation follow up is under preparation.

Update from WMO on Unified Data Policy and Establishing Core Satellite Data

WMO presented their activities in the intersessional period, which were bilateral in nature. Working Group III Members welcomed the addition of a planned workshop to bring together space agencies and users representing WMO application areas with an aim to provide the proposed updates to the WIGOS Manual for core and recommend satellite data for approval of INFCOM-3 (April 2024), Executive Council and the WMO Congress.

Status of operational and research missions

EUMETSAT reported on its ongoing MTG-I1 commissioning with the first image released on 4 May 2023, EPS-Aeolus is now in Phase B, and EPS-Sterna in Phase A. EUMETSAT also noted it is investing in AI/ML to support future missions.

JMA reported that Himawari-9 became the operational mission in December 2022 and that Himawari-8 remains as back-up. JMA noted they have contracted out the manufacturing of Himawari-10, which will carry a visible/infrared imager, and infrared sounder and a space environment instrument suite.

NASA reported the Tropospheric Emissions: Monitoring of Pollution (TEMPO) mission will get powered-on in May 2023 with first light scheduled for mid-July 2023 and a public release of standard products in October 2023, and although the Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) mission lost two CubeSats in a launch attempt in 2022, NASA's new launch scheduled for 30 April 2023 is expected to allow the constellation to be ready for the 2023 Atlantic Hurricane Season, with data latency under two hours.

WMO OSCAR/Space Status

WMO presented the status of OSCAR/Space noting the addition of a milestone to develop frequency reporting to support the CGMS WGI Space Frequency Coordination Group, and to add data latency records to support the WMO gap analysis. Further, WMO noted major milestones for 2023 include adding the WIGOS station identifiers for satellites and Common Code Tables C-5/8.

WMO Gap Analysis

WMO presented their analysis of the gap between the space-based Earth and Space Weather observation capabilities recorded in OSCAR/Space and the WMO Vision for WIGOS 2040. The Gap Analysis identified 18 gaps for Earth observations (MW SST/LST, cloud radar, doppler wind lidar, altimeter lidar, wide swath radar altimeter, IR/MW limb sounder and high-temporal MW sounder) and nine (9) gaps for space weather observations (solar radio waves at L1 in the latter part of the decade).

CGMS-51-WGIII-WP-09: Review and update of the CGMS contingency plan

WGIII reviewed the proposed changes to the CGMS Contingency Plan, codifying existing practices consistent with the direction approved by CGMS-50 Plenary:

- the WMO Gap Analysis is provided annually (section 4.1), updated text regarding the help-your neighbour process (section 5.1), added use of commercially-sourced data for risk mitigation (section 5), and added text for operators to consider (without obligation) operations of satellites beyond design life if possible (section 5.1), and added text describing the CGMS Risk Assessment process (Annex).

Plenary endorsed the revised contingency plan.

Socioeconomic Benefit Studies

CMA presented its outlook for the Fengyun (FY) programme and its preliminary assessment of socioeconomic benefits, which indicated the economic benefit of the FY programme in 2019 was 31.343 RMB with a 1:30 input-output ratio.

NOAA presented two studies: The GeoXO Benefit Analysis and Economic Benefit Analysis of NOAA's Space Weather Products and Services to the Electric Power Industry.

CGMS Future Direction Project 2022+

Following a presentation on the work of the CGMS future direction 2022+ project Task Team, WGIII agreed that future execution of the themes associated with the Private Sector and Socio-Economic Benefits are appropriately placed in the framework of WGIII.

CGMS-51-WGIII-WP-07: Update of the CGMS baseline - for plenary endorsement

There were no substantial updates to the CGMS Baseline in 2023 and the CGMS-51 plenary endorsed the revised CGMS Baseline.

4.4 Data access and end user support, incl. key outcomes of the CGMS cloud technology workshop (WGIV)

CGMS-51-WGIV-WP-01: Report on the outcome of WGIV activities since last plenary, including major outcomes of the CGMS cloud technology workshop

CGMS-51 WGIV meeting took place on 25 April 2023. All Task Groups presented the progress of their activities since CGMS-50. The following highlights were noted:

- The 4th Joint Meeting of RA II and RA V satellite users was held on 18 November 2022 with two informative reports from other regions, RA I and RA III/IV. WGIV highlighted the need for increased communication between regional and global groups;
- WMO introduced its WIS 2.0 system for global data exchange and discussed its pilot phase and subsequent transition from the GTS to WIS 2.0. EUMETSAT also described its preparations for the migration from GTS to WIS 2.0;
- The CGMS Cloud Services Expert Group invited members from WGI, WGII, and WGIV to their meetings and workshops in April 2023 to discuss best practices for Cloud technology, lessons learned, and cloud interoperability;
- Plenary welcomed the proposal resulting from the CGMS future direction 2022+ project whereby WGIV would be the leading entity for the theme 'Research to operations'. WGIV welcomed and recognised the importance of this theme, whilst noting that the topic was outside the scope of the normal activities of the group. WGIV believed that the 'champion' of this theme would ideally come from one of the CGMS research & development member agencies.

WMO commended WGIV on the very active Cloud Services Expert Group.

WMO also emphasised the opportunity that WIS 2.0 offers for CGMS members to improve the access to satellite data and products. JMA noted its efforts on preparing for WIS 2.0, and urged all CGMS operators to do the same.

Since the WGIV also addresses VLab activities, WMO took the opportunity to encourage the CGMS members to continue their support to the VLab activities through the WMO trust fund.

As concerns the various WGIV task groups, plenary raised the following action on CGMS members:

ACTION

Actionee	Agenda item	No.	Description	Deadline
CGMS space agencies	WGIV report	A51.06	CGMS agencies to nominate additional members for all the WGIV Task Groups, in particular those agencies who currently have no representatives in the Task Group(s): • WGIV Task Group on Data Access/Exchange • WGIV Task Group on Metadata - CGMS members to nominate a chairperson for this TG. • WGIV Task Group on User Readiness	Sept 2023

CGMS-51-WMO-WP-10: Best Practices for Achieving User Readiness for New Satellite Systems

The proposed revision of the Best Practices (WMO-No. 1187) reflects lessons learned from the satellite systems that have become operational over the last 5-10 years, novel types of LEO missions, the increasing role of commercial satellite data providers, as well as evolutions in the user needs.

WMO emphasised the importance of the revision of these Best Practices since achieving user readiness for new satellites remains a key challenge for operators and users.

JMA informed plenary that the user readiness preparations for Himawari-10 have started and expressed its appreciation of the support provided from CGMS operators for establishing the new guidelines.

NOAA fully endorsed the best practices on user readiness and noted that the 5-year horizon for achieving user readiness is not enough for complex new systems. These efforts need to start earlier and be pursued on a continuous basis.

In conclusion, the CGMS-51 plenary endorsed the revised best practices as recommended by WGIV.

CGMS-51-EUMETSAT-WP-13: Meteosat Third Generation (MTG) user readiness preparations

The MTG User Preparation Project (MTGUP) is delivering on five themes to support users in their transition from MSG-based operational chains to MTG, and to leverage the innovation potential in enhanced or new products, mainly for nowcasting, NWP, and fire applications.

Since 2018, simulated MTG test datasets for user familiarisation have been published; product and user guidance released; data access using EUMETSAT data services upgraded; training testbeds for operational forecasters in EUMETSAT Member state NMHS fully started, with the goal of training 200-300 forecasters on MTG by 2025; and key R&D themes identified to tap the application potential of novel products fully.

Following the WMO/CGMS Guidelines on Best Practices for Achieving User Readiness for New Meteorological Satellites, readiness of the EUMETSAT Member states for MTG has been thoroughly analysed. For those lagging behind, dedicated trainings and technical assistance sessions started in 2022 and are ongoing through 2023-2024.

MTGUP is closely connected to the EUMETSAT Satellite Application Facilities getting ready for MTG. With MTG-I1 in its commissioning phase, the first image was published on 18 March 2023 and the preoperational data release schedule is now available. The degree of user interest in MTG is rapidly increasing in EUMETSAT member states and beyond.

Discussion and review of new actions

WMO expressed its deep appreciation for EUMETSAT's long-standing support, in particular for enabling the 56 WMO members in RA-I/Africa to benefit from the cutting-edge technology provided by the Meteosat satellites. WMO also emphasised the importance of EUMETSAT's support for EW4ALL activities in Africa.

Plenary took note of EUMETSAT's report on its preparation for MTG user readiness.

4.5 Space Weather Coordination Group (SWCG)

CGMS-51-SWCG-WP-01: **Report on the outcome of SWCG activities since last plenary**

Elsayed Talaat, SWCG co-chair, presented the SWCG report, supported by co-chair Tsutomu Nagatsuma and rapporteur Andrew Monham.

It was noted that there is a growing recognition of the importance of space weather awareness, forecasting and mitigation amongst CGMS members, and as highlighted in preceding plenary presentations and discussion. Contributions to the CGMS-51 SWCG dedicated session in April were correspondingly up by 35 % compared to CGMS-50, highlighting the increased activity of CGMS members to add to all elements of the value chain, be it provision of new instruments, aiding in the alignment of data provision to user needs or reacting to forecast information potentially impacting their own space assets. It is noteworthy that WMO further emphasised the need for all CGMS members to embark space weather instruments.

There has been good progress amongst CGMS member agencies since the CGMS-50 plenary on ensuring the resilience and expansion of space weather monitoring capabilities of the Sun-Earth system, in LEO, GEO, L1, L5 and most recently, lunar orbits, while working to improve the fit to operational needs. In particular:

- Hosting of ESA space weather instruments on other CGMS member (KMA, EUMETSAT) and commercial spacecraft are already implemented or planned and is seen as a positive measure for members to expand the global space weather measurement capabilities;
- CGMS member cooperation to enhance the ground segment network is also on-going in support of the NOAA SWFO L1 mission;
- Efforts to ease the path from research to operational usage (and vice-versa) were also highlighted;
- Inter-calibration efforts were featured by many members, and the transition of the previous inter-calibration task group under SWCG to a GSICS space weather subgroup was noted;
- The ICAO space weather advisories have all presented to the SWCG WG and this aviation use case is helping drive the maturity of the supporting operational services and definition of forecaster needs from CGMS members;
- The close cooperation with the WMO Expert Team on Space Weather was also highlighted, with several SWCG members supporting being active in that team;
- The growing realisation of the importance of timely and accurate space weather forecasts as input to Space Traffic Coordination was also highlighted (with reference to the 2022 Starlink loss) and this is also being captured in the recommendations from the Future Direction Project, SSA theme;
- The effort to compile a database of spacecraft anomalies potentially related to space weather events continues with significant support from the space weather community and at the level of

UN COPUOS Long Term Sustainability Guidelines. Furthermore, promising technical proposals for establishing a secure database are being evaluated. National constraints on publishing this data are being addressed by the members concerned;

- The SWCG Task Group on Ionospheric Radio Occultation System Optimisation is making good progress in close coordination with IROWG on understanding the number of required ionsopheric occultations and how to improve geolocation of plasma bubbles. In line with IROWG recommendations, efforts are being made by some members to use orbit determination GNSS receivers to deliver topside TEC data;

- CGMS-led space weather data user discussion sessions have continued to be well attended in space weather workshops in Europe and US and will take place for the first time in the Asia-Oceanic Space Weather Alliance Workshop later in October 2023. The Task Group on Improving User Data Access to Space Weather Data from Orbital Sensors helps glue together the feedback obtained and focusses the objectives of new outreach interactions and work performed within the SWCG member agencies, in particular in the area of data standardising formats and metadata;

- The ITU World Radio communications Conference 2023 (WRC-23) will consider protection of space weather sensing frequencies for the first time and CGMS members are encouraged to ensure the protection of these frequencies at national level ahead of the conference. While the Radio Occultation spectrum is already well protected, it was noted that CGMS should work with WMO-ET-SWx to protect ground-based measurements F10.7 and F30 (1-3 GHz frequencies), critical for atmospheric density models and ionospheric tomography.

Discussion and review of new actions

CGMS-51 Plenary noted:

- the SWCG Terms of Reference will be reviewed and updated, based on the CGMS Future Directions Project outcomes and inputs from the Task Groups for presentation to CGMS-52; and

- the appeal to CGMS members for the nomination of a co-rapporteur for the SWCG.

ACTION

Actionee	Agenda item	No.	Description	Deadline
CGMS members	SWCG report	A51.07	CGMS members to nominate candidates for a co-rapporteur for the SWCG	Sept 2023

5. SUPPORT TO OPERATIONAL CLIMATE AND GREENHOUSE GAS MONITORING

5.1 User perspective and plans including space agency contributions

CGMS-51-WMO-WP-09: GCOS Implementation Plan

GCOS published its Implementation Plan in 2022. It provides a set of high priority actions which if undertaken will improve global observations of the climate system and our understanding of how it is changing. This plan is mainly based on the latest 2021 GCOS Status Report, released in 2021, that identified the successes and gaps in the existing observing systems; the implications arising from the Intergovernmental Panel on Climate Change (IPCC) 6th assessment report and recent special reports; and recent scientific studies.

This plan has a different form to earlier plans. It is more targeted at observing systems (including Space Agencies), it has fewer, more focused, and integrated actions, with clearer means of assessment. The plan identifies six major themes that should be addressed: ensuring sustainability, filling data gaps (in particular for the polar regions), improving data quality, availability and utility, including reprocessing, managing data, engaging with countries and other emerging needs.

16 of the 31 actions are relevant to Space Agencies. The Joint CEOS-CGMS Working Group on Climate is now preparing the response to the GCOS Implementation Plan, which includes, additionally to a formal response, a living document that will be updated regularly and made available to GCOS panels.

The updated ECV requirements are presented in a separate document, The 2022 GCOS ECVs Requirements (GCOS 245) - which presents ECV product requirements covering all ECV products. Requirements were defined by GCOS expert panels members, informed by the wider community and underwent two public reviews. GCOS provides requirements for several of the WMO Rolling Review Requirements Application areas. Additionally, 37 out of 55 ECVs are space-based observations, making the updated requirements relevant for space agencies.

The CGMS-51 plenary took note of the WMO report on the GCOS IP.

CGMS-51-JWGCLIM-WP-02: JWGClimate (incl. JWGClimate GHG Task Team) status, plans and response to the GCOS IP

The Joint CEOS-CGMS Working Group on Climate met in Tokyo for its 18th meeting (WGClimate-18) in February 2023. The Working Group focused on developing its 2023 Work Plan, including prioritising initiatives including:

1) New approach to Space Agency Response to the 2022 GCOS Implementation Plan (IP);
2) Developing the Space Agency Statement for SBSTA delivered at COP-28;
3) Updating Essential Climate Variable (ECV) Inventory (v5; +45 CDRs);
4) Overhauling the Inventory structure and processes for simplification; and
5) Completing a merged Gap Analysis Report (v3/4.1) for the Inventory.

JWGClimate has established tighter coordination with GCOS, each GCOS IP action is assigned to dedicated teams of JGWClimate and GCOS experts.

Other activities of JWGClimate:

- Working with WMO to establish better interface with OSCAR for ECV Gap Analysis;
- Use cases for Climate Data Records have been published online;
- Work is progressing on Taxonomy for long-term ECV records;
- The GHG Task Team is preparing a document on lessons learned from the 1st Global Stocktake.

JWGClimate asked CGMS to consider the following points:

1) Preferred approach to review/approve staggered results on GCOS IP Response;
2) Path for systematizing GHG capabilities needed for Global Stocktakes 2+;
3) Guidance on engaging NewSpace entities, especially for GHGs;
4) Appropriate role complementing new WMO Global Greenhouse Gas Watch;
5) Guidance on new process for SBSTA Statement development and approval;
6) WGClimate limited by small number of active parties – seeking additional players.

NOAA raised the issue of the NewSpace engagement for GHG Emission monitoring, e.g. GHGsat or MethaneSAT. JWG Climate mentioned the recent workshop at Harvard with commercial operators and space agencies and informed that the GHG Task Team is discussing further engagement with the private sector.

WMO informed about the Congress approval of budget for the Global Greenhous Gas Watch and requested that the JWGClimate and the GHG Task Team increased the cooperation with the GGGW.

JWGClimate noted that most of the NewSpace activities on Emission Monitoring is focused on facilities, individual super-emitters and scales lower than the global 100 km scale of the GGGW and that the interrelation between the different monitoring scales needs to be considered.

CGMS WGII rapporteur noted the relevance of the GEO Ring Initiative for Long-Term Climate and activities of the International TOVS WG for the work of JWGClimate.

In conclusion, CGMS will continue its support to the JWGClimate and urges the GHG Task Team to strengthen the interface with the leading entities of CGMS Working groups I, II, III and IV.

ACTION

Actionee	Agenda item	No.	Description	Deadline
GHG TT, CGMS WGI-WGIV co-chairs and rapporteurs	Supp. to op'l GHG mtrg	A51.05	The WGClimate GHG TT chairperson (Yasjka.meijer@esa.int) and the CGMS WGI - WGIV co-chairs and rapporteurs to meet (virtual sessions) to develop an initial path forward toward a future operational GHG monitoring system, and to define priorities, and to identify the roles of each CGMS WG for the implementation that becomes part of the roadmap's work plan. (Reference is also made to the CGMS-50 WGII actions related to the GHG TT).	Autumn 2023

CGMS-51-WMO-WP-01: WMO report on its Global Greenhouse Gas Monitoring Infrastructure initiative and potential implications for the CGMS agencies

WMO recalled the background of its global greenhouse gas monitoring watch (GGGW) development and already discussed with the CGMS and CEOS communities on a number of occasions (CEOS-CGMS WGClimate, May 2022; CGMS-50, June 2022; CEOS-SIT Technical Workshop, September 2022; CEOS-SIT, March 2023; and CGMS WGII, April 2023).

The 19th World Meteorological Congress (May 2023), endorsed the concept for the WMO-coordinated Global Greenhouse Gas Monitoring Infrastructure, based on an Executive Summary developed by the Joint Study Group on Greenhouse Gas Monitoring. The Congress requested the development of a detailed, costed implementation Plan, and asked the WMO Secretary-General to allocate the necessary resources and to further strengthen close collaboration and coordination with relevant United Nations agencies and other international partners.

In order to provider authoritative data to UNFCCC Parties and other users, the GGGW estimation of GHG fluxes is based on:

- open participation from all interested parties;
- transparency with free and unrestricted access to all input and out data as well as verification results; and
- the use of documented (preferable published) methodologies and algorithms.

GGGW will organise a GHG modelling/assimilation workshop in Bonn in September 2023 and an open GHG Observing Workshop in Geneva on 3-5 October 2023.

The WMO GGGW engagement with the space community focuses on several areas:

- Development of a concept for an integrated global greenhouse gas observing system responding to GGGW requirements;
- Possibility of reducing data latency for existing and planned GHG missions;
- Improved utilization of (e.g.) hyperspectral IR sounders for GHG monitoring;
- Role of GSICS in GGGW, also w.r.t. use of surface-based measurements;
- Use of GGGW output for satellite data Quality Control.

Discussion and review of new actions

NASA asked how IG3IS fits with GGGW. WMO noted the IG3IS is mainly focussed at decision making level, that GGGW builds on IG3IS experience and that IG3IS is considered a key part of the future GGGW service component.

ISRO noted that WMO will fill a very important role in the whole value chain for GHG observations.

NOAA agreed with ISRO, noting the role of WMO for defining standards for observations and data exchange. NOAA also noted that because of the diversity of methods employed for GWG observations, open science and sharing of algorithms is crucial. NOAA also urged engagement with NewSpace working on a much faster development cycle for GHG missions that space agencies.

WMO urged CGMS members to support the GGGW development and implementation and to strengthen the national political support for the initiative.

WMO also noted the absence of proven technology for assessing negative emissions, which is a key issue for the global system.

NASA noted the importance of research programmes to ensure sustained observations. WMO gave full credit to the excellent contributions of the research community, but we are now at a point in time where focus needs to be on establishing sustained operational capabilities.

The CGMS-51 plenary endorsed the three recommendations proposed by WMO, and agreed that the CGMS High-Level Priority Plan will reflect the two last recommendations:

1) Continue engaging with the WMO Joint Study Group on Greenhouse Gas Monitoring as it is developing the draft Global Greenhouse Gas Watch Implementation;
2) Engage in the development of requirements for an integrated (i.e. both space-based and surface-based assets) global greenhouse gas observing system, via JWGClimate and WGII;
3) Support SG-GHG for the development of requirements for data latency for GHG observations, via JWGClimate, WGII, and WGIII.

Reference was also made to the action already noted above under the WGII report section:

Actionee	Agenda item	No.	Description	Deadline
CGMSSEC	WGII, WGClimate reports	A51.04	The CGMS Secretariat to secure the inclusion of an agenda item on the GEO-ring observations reprocessing for climate project at CGMS-52 plenary (plus GeoRing sounding capabilities for NWP)	Spring 2024

6. FUTURE DIRECTION OF CGMS

CGMS-51-CGMS-WP-04: Status, activities, report on the outcome and proposed way forward of the CGMS future direction 2022+ project

The Task Team Chair, Kotaro Bessho from JMA summarised the activities of the task team since it was established at CGMS-50 and in particular thanked the High-Level Meetings of CGMS delegations for providing guidance to the task team.

On behalf of the Task Team Chair, the CGMS Secretariat presented the outcome of the CGMS future direction project following the actions raised on the occasion of CGMS-50 in 2022:

This working paper proposes the recommendations from the CGMS future direction 2022+ project conducted since the CGMS-50 plenary. The proposal covers the six strategic themes:

- Socio-economic benefits
- Research to operations
- Future observing (hybrid) space infrastructure
- Future information technologies
- Relationship with the private sector
- Space situational awareness

The theme "Climate and Earth system monitoring" requires further work and is proposed to be addressed before CGMS-52 by a dedicated small task team. The Task Team identified a further topic: "Support to developing countries". This is a part of CGMS members' activities within their different individual mandates. It is proposed to establish a small task team to address the coordination aspects of this strategic theme before CGMS-52.

The position papers on each strategic theme and the recommendations were developed through a series of virtual meetings in autumn and winter 2022/23 and were reviewed in detail at the face-to-face meeting of the Task team 15-16 March 2023 at EUMETSAT. The CGMS high-level meeting on 29 March 2023 endorsed the recommendations proposed and the way forward, noting the need for the identification of concrete implementation measures in the next year (up to CGMS-52) and a stronger link as concerns the potential interfaces.

The working paper addresses the comments from the high-level meeting by identifying champions to advance the themes as pilot activities within the scope of each CGMS Working Group.

Action	Description
A50.04	CGMSSEC to invite CGMS members to nominate participants to the CGMS future direction 2022+ Task Team and review the associated draft ToRs
A50.05	The CGMS future direction Task Team to report to the final conclusion to plenary for plenary endorsement (according to the to-be-agreed Terms of Reference)

The final position papers for each of the six completed strategic themes are provided as information papers to CGMS-51:

CGMS-51-CGMS-WP-14: **Position paper: Future Information Technologies**
CGMS-51-CGMS-WP-15**: Position paper: Future Observing (hybrid) space infrastructures**
CGMS-51-CGMS-WP-16: **Position paper: Private Sector Relations**
CGMS-51-CGMS-WP-17: **Position paper: Research to Operations**
CGMS-51-CGMS-WP-18: **Position paper: Socio-Economic Benefits**
CGMS-51-CGMS-WP-19: **Position paper: Space Situational Awareness**
CGMS-51-CGMS-WP-07: **CGMS future direction 2022+ Task Team - Terms of Reference** (for information).

The CGMS Secretariat further recommended CGMS members to read each position paper in detail.

Discussion, conclusions

On Socio-Economic Benefits:

EUMETSAT noted that having reference studies available is indeed very helpful for the approval process for new satellites programmes.

WMO noted the importance of SE studies for government support for new programmes. WMO also pointed to the Early Warning for All initiative and the need for demonstrating not only socio-economic benefits, but also the benefits of the space-based observations for the protection of life. WMO informed it has created a new staff position for socio-economic benefits studies, and that contacts will be established with the CGMS activities under WGIII.

JMA confirmed that it will strive to provide a champion for the pilot activity under this theme.

On Hybrid Space Observations Architecture

NOAA appreciates the need for address the issues in cross-cutting manner but urged that it be made more explicit that also the contributions micro- and nanosatellites be considered in the study.

WMO urged that intercomparison between large and small satellites be considered.

EUMETSAT clarified that it is the intention to establish an inventory of all current and planned microwave sounding missions to support intercomparisons. This pilot will be reference for considering other observation types.

EUMETSAT confirmed the nomination of Simon Elliott as champion for the pilot activity.

On Relationship to Private Sector

NOAA confirmed the nomination of Mara Browne as champion for the pilot activity.

On Research to Operations

NOAA suggested that the activity should be co-led by the research and the operations side.

WMO would appreciate that the standardisation of specifications, e.g. for product formats, should be included in the scope of the baseline R2O process.

NOAA and NASA confirmed that they would nominate leads for this activity.

On Space Situational Awareness

ISRO suggested the activity should also cover ground sensors, e.g. telescopes, but it was confirmed that the activity should only cover the aspects related to the role of CGMS members as developers and operators of space systems.

ESA nominated Juha-Pekka Luntama as champion for the pilot activity.

On Future Information Technologies

WMO pointed out that AI/ML technology could also impact the space segment itself, not just the ground processing and that this should be considered.

It was noted that the scope of CGMS engagement in AI will be considered in a dedicated CGMS-51 session.

JMA clarified that the activity should consider the impact of new satellite constellations like StarLink.

EUMETSAT nominated Antoine Jeanjean to lead the WG-I pilot activities for the IOT aspects.

Overall conclusions

Plenary endorsed:

- The proposed way forward for each strategic theme;
- The identified champions for each strategic theme to advance the pilot activities of each CGMS working group;
- The establishment of a small, dedicated task team under the leadership of WMO and with the support of the CGMS secretariat to elaborate further the strategic theme "Earth System Monitoring and Climate";
- The establishment of a small, dedicated task team under the leadership of CMA and with the support of the CGMS secretariat to elaborate further the strategic theme "Support to Developing Countries", in coordination in particular with the WMO Education and Training programme;
- The dissolving of the Task Team;
- The CGMS working groups to ensure that their intersessional agendas reflect the need to advance the implementation of the recommendations;
- CGMS secretariat to report on the implementation at CGMS-52.

The CGMS-51 plenary further strongly encouraged CGMS members to nominate champions for the remaining themes, as this is crucial ensure the progress of the pilot activities.

ACTIONS

Actionee	Agenda item	No.	Description	Deadline
CGMS member principals	FUTURE DIRECTION	A51.08	CGMS principals are invited to nominate a representative to participate in a drafting group tasked to develop, by CGMS-52, a CGMS statement on the optimum composition of hybrid architectures (combining reference platforms, small satellites and procurement of commercial data) for fulfilling the operational observation requirements of CGMS members in the future; recognising the rapidly changing environment in small satellites and the commercial sector. In particular, the group will identify complementarity and associated merits between the three different aspects	31 July 2023, CGMS-52

Actionee	Agenda item	No.	Description	Deadline
			of a hybrid system, and will provide recommendations on an optimal mix to obtain essential observations, provided with very high reliability, or on how to fulfil the "backbone" observing requirements.	
CGMS members	FUTURE DIRECTION	A51.09	CGMS members to nominate and/or confirm representatives for the "champion" to secure the continuity of the six pilot activities and within the respective working groups (as per CGMS-51-CGMS-WP-04) Future direction project: 1 Socio Economic Benefits - WGIII / JMA to confirm by end July '23 2 Hybrid Space Observations Architectures - WGIV / Simon Elliott EUMETSAT - confirmed 3 Private Sector - WGIII / Mara Browne NOAA - confirmed 4 Research to operations - WGIV (support WGII) / • NASA, Jack Kaye - confirmed • Other agencies to provide feedback by end July '23 **5 Future Information technology** • IOT: WGI / Antoine Jeanjean EUM • AI/ML: WGII *and WGIV* / TBD • Cloud: WGIV / TBD **6 Space situational awareness** - SWCG, WGI / Juha-Pekka Luntama ESA - confirmed **7 Earth system monitoring** - WMO, Albert Fischer – confirmed **8 Support to developing countries** - CMA, XIAN Di - confirmed	31 July 2023

Based on a EUMETSAT suggestion, the CGMS plenary further agreed to establish a policy statement be developed on the optimum composition of hybrid architectures, and therefore agreed the following action:

Actionee	Agenda item	No.	Description	Deadline
CGMS member principals	FUTURE DIRECTION	A51.08	CGMS principals are invited to nominate a representative to participate in a drafting group tasked to develop, by CGMS-52, a CGMS statement on the optimum composition of hybrid architectures (combining reference platforms, small satellites and procurement of commercial data) for fulfilling the operational observation requirements of CGMS members in the future, recognizing the rapidly changing environment in small satellites and the commercial sector. In particular, the group will identify complementarity and associated merits between the three different aspects	31 July 2023, CGMS-52

			of a hybrid system, and will provide recommendations on an optimal mix to obtain essential observations, provided with very high reliability, or on how to fulfil the "backbone" observing requirements.	

7. EXPLOITATION OF ARTIFICIAL INTELLIGENCE (AI) AND MACHINE LEARNING (ML) TO ENHANCE ACCESSIBILITY AND USABILITY OF SATELLITE DATA BY USERS

7.1 Agency reports on AI/ML exploitation and opportunities for coordination

CGMS-51-CMA-WP-11: CMA plans for AI/ML exploitation and opportunities for coordination

CMA is actively integrating AI/ML technologies into their satellite data processing chain to improve weather forecasting and warnings at various administrative levels. CMA has made significant progress, including AI-based data calibration, enhanced satellite image resolution, and advanced radar estimations. Additionally, it has successfully applied AI in sea ice detection using satellite data. Future plans involve partnering with other companies to expand the use of satellite observations for societal benefits.

Discussion and review of new actions

ISRO inquired about the level of accuracy CMA has achieved in lead-time prediction using AI/ML, and whether it surpasses conventional methods for extreme event prediction. CMA clarified that they primarily utilise AI/ML for image downscaling and enhanced resolution, rather than for weather prediction.

EUMETSAT observed that some of CMA's initial applications had been initiated in the framework of Pangu, and inquired if CMA currently engages in any specific ongoing programmes or projects in order to further advance such partnerships.

CMA confirmed that they do have plans to collaborate with Huawei in developing a customised model. Additionally, they expressed their openness to cooperation in AI/ML with other satellite operators

CGMS-51-EUMETSAT-WP-09: Joint paper: EUMETSAT/NOAA plans for AI/ML exploitation

A major question for EUMETSAT revolves around the applicability and utility of AI/ML in the upstream section of the weather/climate value chain. This includes tasks like thinning of satellite data, gap analysis, and retrieval of L2 data, all aimed at enhancing the quality of products.

Simultaneously, it will be strategic to continue pursuing collaborations and studies on critical downstream applications. EUMETSAT can play a pivotal role in cooperation with its member states, international agencies, and multinational initiatives to further exploit EUMETSAT's satellite products and capitalise on synergies with the European Commission’s Copernicus programme.

Artificial intelligence is one of six key Science & Technology (S&T) Focus Areas that will advance NOAA's mission success. Cloud computing and data are two additional focus areas. The strategies for each

focus area are designed to more fully accelerate advances and serve as force multipliers to solve tough problems and set the course to strengthen NOAA's S&T path for the coming decades.

The main areas which both agencies are developing similar activities in are:

- Community driven AI ready data
    - Documentation enables users to understand the contents of a data set and should provide information and tools to increase data usability.
    - Quality information determines the dataset's "fit-for-purpose" for AI and affects the trustworthiness of AI applications.
    - Access affects the efficiency and reproducibility for the AI R&D process.
    - Preparation help identify common data services and tools to reduce the pre-processing burden for users including AI practitioners.
- Cloud AI ready data
    - Building an enterprise cloud-based ground system, including cloud data dissemination.
    - Creating teams that include a person with cloud skills.
- Operationally AI ready data
    - Proposed AI-ready data community roadmap.
    - Developing and maintaining AI ready data stand.
    - Developing automatic tools for AI-readiness assessment.
    - Developing and improving AI-ready open environmental data.
    - Sustaining the engagement with users and capacity building.

The presentation raised a number of discussion points:

- AI-ready data standards development: The current focus is on open environmental data. Will this approach differ for other types of data?
- Integration of environmental data with socioeconomic data to enhance the understanding of environmental quality.
- We welcome test users to apply the checklist to non-environmental data.
- Data access API: Take all necessary steps to ensure seamless access to the respective cloud system, promoting interoperability at the usage level.
- Identifying key training datasets to enhance nowcasting, also considering a global perspective from north to south.

Discussion and review of new actions

ISRO asked what the approach for data usage is and the split between training, testing and validation. EUMETSAT explained that there is approximately a 60/20/20 split (~60% of the data are used to train the algorithm, ~20% each for testing and validation).

EUMETSAT noted that before reaching those levels one starts off with dividing a data set into a 80/10/10 split putting 80% of the data in the training set, 10% in the validation set, and 10% in the test set. When it comes to recent applications to NWP, Huawei, deep mind google, or NVIDIA used the reanalysis where there is well-structured labelling.

Reanalysis is presently not conducted at a 1-kilometer resolution - the proper spatial scale to simulate high-impact weather events. Thus, it is imperative to expedite the utilisation of our extensive data

resources for this purpose. Naturally, it is vital for CGMS space agencies to work on how satellite data can be further exploited for training and validation purposes.

ISRO noted that many models and software are in older FORTRAN formats and have to be converted to Python or C for AI/ML implementation.

CGMS-51-JMA-WP-09: JMA plans for AI/ML exploitation

Since 2019, JMA has conducted cutting-edge research with the RIKEN Center for Advanced Intelligence Project (AIP) on AI/ML for weather observation and numerical forecasting toward related learning and application.

Against this background, JMA's Meteorological Satellite Center (MSC) and its Office of Meteorological Analysis and Application Development (OMAAD) apply AI/ML technology to develop and improve various satellite products. The MSC is improving cloud mask products, considering RGB imagery-based products and developing atmospheric profiles that will be using infrared sounder data from the Himawari 10 satellite. The OMAAD is now improving the Convective Cloud Information and has recently developed the clear air turbulence potential analysis and the Icing potential analysis. The outline of these products is in the development stage as indicated in the Working Paper.

Collaboration with the AIP Center allows JMA to assimilate cutting-edge AI/ML information on optimisation of existing and new methods, as well as related application to meteorological services. However, any new partner's limited expertise in meteorology gives rise to a need for appropriate explanation, interaction and coordination for future collaboration. Conversely, JMA's limited expertise with AI/ML technology requires ongoing development of human resources of AI/ML experts and related information sharing within JMA. Issues in actual development using this technology include a need to secure computational resources for learning and storage of teaching data, as well as identification of optimal training data.

CGMS-51-KMA-WP-03: KMA plans for AI/ML exploitation

KMA/NMSC intends to develop a strategic action plan, building on existing experience and facilitating the exploitation of satellite data (including those of the GK2A) and through the use of AI/ML in order to understand its limitations and strengths. KMA/NMSC is considering four development perspectives for AL/ML and has established a roadmap for the 2022-2024 period, which contains experimental and feasibility research projects. This might be used for the pre-phase study of the future GK5 product development (and as a follow-on of the GK2A). The paper introduces KMA's challenges when introducing AI products such as proxy data.

The paper further introduces KMA's progress on its "cloud-based data hub" to enhance the accessibility and usage of meteorological and climate data including access for external users. To this purpose, KMA is also making a "Cloud based data hub system". It is a user-customised API (Application Programming Interface), established as an open platform that can create added value by supporting the decision-making of a country and society by integrating and providing links based on climatology. It is also a data analysis platform for external users that applies cloud technology to provide users with

computing resources, meteorological and climate data, software (R, Python, etc.) required for data analysis, and visualisation analysis functions.

Discussion and review of new actions

The Chairman noted that this is the first time that information on AI and ML has been shared in the framework of the CGMS plenary. He stated it is important to continue sharing information on this matter also beyond CGMS-51. Communication with users and information sharing is important and it would be necessary to address this in CGMS in future. The plenary session ought to discuss how to move forward towards CGMS-52, also within the framework of the existing CGMS working groups.

EUMETSAT noted that there are different actions necessary in many various areas such as specific NWC radar applications, training data sets, development of L1/L2 processors, cloud aspects, AI readiness, and to facilitate user interaction and exploitation. EUMETSAT proposed to hold a lessons learned session at CGMS-52, and a working group(s) would need to be identified to address this. There are already some discussions taking place in WGII, however support of other working groups is required.

NOAA stated plenary has seen a number of good examples, with some applications more ready than others. CGMS coordination should be led by WGII, but WGIV also plays a role for utilisation, assimilation, and training with both having significant inputs on uptake of AI/ML.

WMO thanked the members for the presentations. A major event related to AI/ML took place at the WMO Meteorological Congress, where RA-VI organised a special event with global leading centres focusing on wider forecasting. The event had high visibility with a strong contribution by WMO members. Further, the 106th ECMWF Council included a session on AI/ML. In 2021, ECMWF released a roadmap on the use of AI/ML for forecasting using hybrid approaches. The big technology companies have progressed faster than expected with impressive results and low computational cost. This provides an opportunity to small meteorological services, with limited computing facilities. CGMS ought to work on maximising meteorological satellite utilisation. WMO also strongly supported the idea to task relevant CGMS working groups accordingly, and one might even consider organising a dedicated seminar. WMO concurred that a dedicated session be organised at CGMS-52.

CMA also agreed on the need for establishing a broader view by the CGMS, and to include relevant working groups, and e.g. for satellite operations. AI/ML is a very challenging area for future satellite technology and applications.

EUMETSAT informed plenary that the level of interest among European NMHSs is very high, and as mentioned by the WMO. Computational efficiency is order of magnitude better than traditional NWP and the accessibility to good quality forecast is much higher. To a certain extent, the challenges for NWP organisations are clearer, whereas for the satellite community there are multiple areas of relevance. EUMETSAT and ESA are discussing AI/ML for support to operations and it would be beneficial to address the topic within the frameworks of WII and WGIV. However, to secure that the AI/ML theme is moved forward, a focal point of contact needs to be identified. Given the speed of development, it would be essential to secure an exchange and dialogue with WGIV before CGMS-52.

JMA, as chair of the CGMS future direction project, informed plenary that some associated tasks are pre-destined for the champion to lead on AI/ML matters (nomination outstanding). The medium-term goal to identify AI/ML technology to apply to infrastructure, and the development of best practices. The "AI/ML champion" would need to secure the involvement of WGII, WGIV and possibly also WGI (satellite systems and operations).

ISRO noted that with the huge availability of data in the future, AI is going to be an important tool in meteorology. Similar to Earth observation ARD (Analysis Ready Data), it will be beneficial to the analysts to have AI-ready data, essentially meaning that the datasets could be directly used by AI/ML models. To this purpose, one might explore evolving a standard data product format. Further, the weather models which are currently in Fortran is not easily amenable to AI analysis. There are certain efforts to convert such models to newer language such as C or Python. An effort from CGMS to convert all models into newer languages will be beneficial for incorporating AI analysis in these models.

Overall conclusions

- Increasing need for monitoring the AI and ML development as it will determine how satellite data will be further exploited in the future;
- Selecting a topic that can be used to understand the preparatory work to be done at the satellite agency level to be AI ready; and
- Present an analysis of such a topic across the agencies highlighting the key AI-ready elements (i.e. data curation, partnership) that could become lesson learnt.

The following action was raised as a consequence:

ACTION

Actionee	Agenda item	No.	Description
CGMS members, CGMS WGs	AI/ML session	A51.10	AI/ML theme to be included on the plenary agenda at CGMS-52, with the CGMS WGs (WGII, WGIV, ...) to address AI/ML in their respective intersessional meetings in preparation. Focal point of contact/Coordinator: Champion of future direction AI/ML theme to be nominated (link to action A51.09)

8. EDUCATION, TRAINING AND OUTREACH ACTIVITIES

User readiness for new satellite systems

CGMS-51-VLab-WP-02: VLab progress report and a new VLab strategy 2024-2027 for endorsement

WMO presented the new strategy for the Virtual Laboratory for Education and Training in Satellite Meteorology (2024–2027) developed by the VLab Management Group (VLMG) and adopted by the WMO Executive Council at its 76th session (27 February to 3 March 2023).

The Indonesia Agency for Meteorology Climatology and Geophysics (BMKG) proposed to establish a WMO-CGMS VLab Centre of Excellence (CoE) which was supported by JMA. The application was further endorsed by the WMO Standing Committee on Earth Observing Systems and Monitoring Networks (SC-ON).

The VLab Management Group (VLMG) continued to coordinate its activities via quarterly online meetings. EUMETSAT hosted the 10th VLMG meeting as a hybrid event on 26-30 September 2022.

Since CGMS-50, VLab members have offered a variety of training opportunities. These include training efforts addressing the new generation of satellites, which continues to be a major training need identified by VLab members. Stronger collaboration and coordination of efforts between VLab members resulted in increased opportunities for training of users during the past year.

The VLab Trust Fund continues to receive yearly contributions from NOAA/NWS, EUMETSAT, and KMA. A larger number of contributing CGMS agencies is required to expand VLab activities to meet WMO-CGMS Members' requirements and needs for training and to improve the long-term sustainability of VLab activities. Regular financial contributions from CGMS Members are critical to maintain the VLab training activities.

Discussion and review of new actions

JMA confirmed its support as a satellite operator to the new CoE at the BMKG. This new CoE will provide great opportunities to improve the usage of satellite data in the RA V and the Oceanic region.

WMO expressed its appreciation of JMA's support to the proposed new CoE.

ISRO pointed to the training conducted in India in the framework of the UN training activities. WMO confirmed that it will endeavour to coordinate these training activities with the VLab.

WMO highly appreciated the contributions from NOAA, EUMETSAT and KMA to the VLab trust found however encouraged other agencies to contribute in order to sustain the VLab.

WMO also appreciated the support of the satellite operators to the regional satellite data requirements and encouraged all agencies to continue and strengthen their engagement.

Concluding the discussions, the CGMS plenary endorsed the following recommendations:

1. The updated Strategy for the Virtual Laboratory for Education and Training in Satellite Meteorology (2024–2027). The Strategy is available in the Annex I of **CGMS-51-VLab-WP-02**.

2. The application of Indonesia Agency for Meteorology Climatology and Geophysics (BMKG) as a new VLab Centre of Excellence (BMKG application and a letter of support from JMA as a supporting Satellite Operator are provided in the Annex II of the same WP).

WMO invited CGMS members to contact WMO for the provision of contributions to the WMO VLab Trust Fund to ensure the continuation of technical support to the VLab through the VLab Technical Support Officer as well as to the implementation of VLab projects.

9. CGMS HIGH LEVEL PRIORITY PLAN (HLPP)

9.1 Status of implementation of the CGMS High Level Priority Plan (HLPP) 2022-2026

CGMS-51-CGMS-WP-12: Status of implementation of CGMS High Level Priority Plan (2022-2026)

This working paper provides for information the status of implementation of CGMS High Level Priority Plan (2022-2026). It incorporates inputs from:

- WG I, II, III and IV Chairs and rapporteurs
- CGMS Space Weather Coordination Group
- International Science Working Group chairs and rapporteurs
- GSICS project
- SCOPE-CM project
- CEOS-CGMS Joint Working Group on Climate

The CGMS-51 Plenary noted the implementation of the 2022-2026 HLPP.

9.2 Revised CGMS High Level Priority Plan (HLPP) 2023-2027

CGMS-51-CGMS-WP-13: Revised HLPP 2023-2027

As part of the agreed revision cycle for the CGMS High Level Priority Plan, this document provides a proposed HLPP covering the period 2023-2027.

The plan has been updated following discussions during the CGMS inter-sessional activities, covering WGI, WGII, WGIII, WGIV and the SWCG as well as the International Science Working Groups, JWGClimate included.

The plan also reflects the outcome recommendations from the CGMS future direction 2022+ project, conducted in the 2022-2023 period by the associated CGMS Task Team, and as supported by the CGMS Secretariat.

WGI, WGII, WGIII, WGIV and the SWCG considered the draft revision at their meetings in April 2023 and proposed a number of amendments highlighted in the document.

WMO pointed out that in section 4.8 the high-level WMO priorities need to be mentioned and WMO will propose additional text in this regard.

NOAA pointed out that related to Space sustainability under 2.7, the “zero debris policy” is a specific ESA initiative and that there are similar activities by other agencies. This needs clarifying in the text.

WMO suggested that CGMS should review the HLPP in light of the anticipated revision of the WIGOS Vision. This will be discussed in the next CGMS Risk Assessment Workshop in 2024.

CGMS plenary endorsed the revision of the HLPP 2023-2027, subject to final comments from the CGMS members before the end of July. At that stage, a final version of the updated HLPP will be circulated and published on the CGMS website.

10. REVIEW OF CGMS-51 PLENARY ACTIONS AND RECOMMENDATIONS

Status of CGMS-50 actions following CGMS-51 plenary deliberations

Status of CGMS-50 plenary actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members JWGCLIM	8.2	A47.11	Climate session: CGMS members to endorse (through a written procedure) the ECV inventory gap analysis report and updated coordinated action plan	**2023 27 Jun:** Status and way forward was presented to plenary CGMS-51-JWGCLIM-WP-02. The draft Gap Analysis Report is under preparation, the previous two gap analyses exercises v3 + v4 will be merged) expected to be ready in the latter half of 2023. The HLPP will also be updated to reflect the targets. **2023 6 Jun:** Status and way forward will be presented to CGMS-51 plenary (CGMS-51-JWGCLIM-WP-02). The draft Gap Analysis Report is under preparation, the previous two gap analyses exercises v3 + v4 will be merged) expected to be ready in the latter half of 2023. **(2023 2 Jun:** CGMSSEC/WMO Considerations to link this to the outcome/next steps of the CGMS future direction project. TBD/TBC.) **2023 Apr:** WGClimate presented the status of affairs incl. that of the GHG TT and requests to the CGMS members CGMS-51-JWGCLIM-WP-01 **2023 3 Feb:** CGMSSEC has contacted Jeff Privette, Chair WGClimate, for a status update. **2022 20 May/June:** Ref. CGMS-50-JWGCLIM-WP-02 (V3 will be integrated into Gap Analysis 4 Report expected for publication end of 2022).	Nov 2023 (Dec 2022, Oct 2019)	**ONGOING**

Status of CGMS-50 plenary actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2021 29 Oct: The new version of the ECV Inventory (v4.0) is available on https://climatemonitoring.info/ecvinventory/. **2021 27 Sep:** Version 3.0 expected to be published end 2021 and will be endorsed via written/e-mail procedure. (Version 4.0 is under preparation, CGMS-49-JWGCLIM-WP-01 and CGMS-49-JWGCLIM-WP-03) **2020 Aug 17:** Further delayed due to the COVID-19 pandemic. The ECV Inventory v3 has been released on 30 July 2020. The gap analysis report is expected in September 2020. Virtual endorsement planned at time of CEOS Plenary (20-22 October 2020). **2020 Jan 22:** CGMSSEC #2: Delayed. **2019 Nov 18:** Gap analysis report and updated action plan are still being drafted due to delays in the verification of ECV entries due to slow response from agencies and subsequently delayed start of gap analysis. Report and plan should be available for review by end of November. Virtual endorsement is planned for Dec/Jan timeframe depending on review results.		
GHG TT (JWG-Climate, WGII)	8.1	To be monitored by WGII WGII/(P)A50.06	Once the new GHG TT chairperson is in place, the GHG TT to invite CGMS WG I-IV points of contact for a dedicated discussion on	**2023 28 June:** Closed on the occasion of plenary. A new updated CGMS-51 action related to the GHG TT will be raised. **2023 27 June:** To be addressed on the occasion of the meeting planned for autumn 2023 between the GHG TT Chair and the CGMS WGs I-IV (focal	autumn 2023 (Jan 2023)	**CLOSED**

Status of CGMS-50 plenary actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			specific CGMS WG contributions	points of contact, co-chairs and rapporteurs. Reference is also made to CGMS-51-JWGCLIM-WP-02). **2023 3 Feb:** CGMSSEC contacted Y. Meijer for a status update New Chairperson is Yasjka.Meijer@esa.int Representatives from CGMS WGI to WGIV: WGI sean.burns@eumetst.int WGII jeff.privette@noaa.gov,~~mitch.goldberg@noaa.gov~~ WGIII zhangp@cma.gov.cn (Peng ZHANG) WGIV sean.burns@eumetsat.int		
Chair of WGClimate/GHG TT	6.2	A48.07	WGClimate/GHG TT Chair together with the CGMS WG representatives to define priorities for CGMS WGI-IV contributions.	**2023 28 June:** Closed on the occasion of plenary. A new updated CGMS-51 action related to the GHG TT will be raised. **2023 27 Jun:** Status and way forward was presented to CGMS-51 plenary (CGMS-51-JWGCLIM-WP-02). Meetings are planned for this autumn between the GHG TT and the CGMS WG representatives. **(2023 2 Jun:** CGMSSEC/WMO Considerations to link this to the outcome/next steps of the CGMS future direction project. TBD/TBC.) **2023 3 Feb:** CGMSSEC has contacted Jeff Privette, Chair WGClimate, for a status update. **2022 20 May/June:** Ref. CGMS-50-JWGCLIM-WP-03. Ongoing, there will be a change in the Task	2nd half of 2023 (CGMS-51,(Nov 2020)	**CLOSED**

Status of CGMS-50 plenary actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				Team lead and once this is in place, the response to the action can progress. **2021 May 19:** Partially complete. Each CGMS WG has nominated a liaison who will be invited to participate in future WGClimate meetings. Before and during the next WGClimate meeting (August/September), WGClimate will work with these representatives on priorities. Expected to be addressed at CGMS-49 WGII and in the plenary climate session (and at the next GHG Task Team meeting) Representatives from CGMS: WGI sean.burns@eumetsat.int WGII jeff.privette@noaa.gov,~~mitch.goldberg@noaa.gov~~ WGIII Peng ZHANG zhangp@cma.gov.cn WGIV sean.burns@eumetsat.int		
Co-chairs of WGI, WGII, WGIII, WGIV	6.2	A48.08	CGMS WGs I-IV to reflect the operationalisation of the GHG monitoring system and to discuss with the WGClimate GHG Task Team the roles of each WG for the implementation that becomes part of the roadmap's work plan~~(deadline CGMS-49 Plenary to serve as input for next WGClimate presentation)~~	**2023 28 Jun:** Closed on the occasion of plenary. A new updated CGMS-51 action related to the GHG TT will be raised. **2023 27 Jun:** Reference is made to the WGClimate report to CGMS-51 plenary (CGMS-51-JWGCLIM-WP-02). Meetings are planned for this autumn between the GHG TT and the CGMS WG representatives. **2023 6 Jun:** Status and way forward will be presented to CGMS-51 plenary (CGMS-51-JWGCLIM-WP-02). One objective of the GHG TT in 2023 is to update the roadmap towards achieving	2nd half of 2023 (CGMS-51, CGMS-49)	**CLOSED**

Status of CGMS-50 plenary actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				an operational system. GHG TT to reach out to CGMSSEC and relevant CGMS WGs. (**2023 2 Jun:** CGMSSEC/WMO Considerations to link this to the outcome/next steps of the CGMS future direction project. TBD/TBC.) **2023 3 Feb:** CGMSSEC has contacted Jeff Privette, Chair WGClimate, and Yasjka Meijer, GHG TT Chair **2022 20 May/June:** Ref. CGMS-50-JWGCLIM-WP-03. Open, linked to A48.07 (and pending the new Task Team lead). **2021 27 Sep:** No further progress. See action Plenary A48.07 **2021 24 Feb:** To be addressed initially on the occasion of the CGMS-49 working groups in April and at the next GHG TT meeting		
IOC-UNESCO	2	A49.01	IOC-UNESCO to provide CGMS-50 guidance of the Global Ocean Observing System (GOOS) for improved IOC and WMO ocean and atmosphere predictions and other services.	**2023 27 June:** Closure proposed. IOC-UNESCO now providing inputs to the WMO Rolling Review of Requirements for operational ocean forecasting and climate applications. **2023 2 June:** WMO to contact IOC-UNESCO on a potential way forward. How CGMS (WGs I–IV) can support/close gaps in terms of operational ocean monitoring (taking CEOS marine initiatives into account). **2022 May/June:** A brief CGMS-50 plenary session was held on operational ocean monitoring. Pending feedback by IOC UNESCO + WMO to reach out to IOC.	CGMS-51 (CGMS-50)	**CLOSED**

Status of CGMS-50 plenary actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMSSEC, WMO	4.5	A50.01(a)	CGMSSEC and WMO to consider if night-time light capabilities should be covered in HLPP, the CGMS Baseline, and should be reflected in the WMO Gap Analysis.	**2023 23 Feb:** Closed on the occasion of the 5th CGMS risk assessment workshop CGMS-51 WGIII report (maintaining action A50.01(b) open).	CGMS-51	**CLOSED**
WMO	4.5	A50.01(b)	If night-time light capabilities shall be covered in the HLPP and the CGMS Baseline, WMO to reflect this in the WMO Gap Analysis.	**2023 2 Jun:** Included in the HLPP. To be reviewed anew at the 6th risk assessment workshop in 2024. **2023 23 Feb:** Addressed at the 5th CGMS risk assessment workshop (21-23 Feb 2023) to be reviewed at the 6th CGMS WGIII risk assessment workshop 2024.	CGMS-52 (CGMS-51)	**ONGOING**
CGMSSEC	5	A50.02	CGMS (SEC) to formally request the GHRSST, IOCCG, OSTST, and OSTWG to analyse the state of the current and future ocean missions by analysing and contributing to the appropriate CGMS WGs (WG III in particular for observational gaps, and WG IV for data access) with a focus on operational requirements relevant to CGMS agencies, as part of their routine ocean WG activities.	**2023 23 March:** Following discussions between CGMS members this action has been transferred to the CEOS COAST initiative (The Coastal Observations Applications Services and Tools (COAST) Ad Hoc Team). To be reported upon to CGMS-52. **2023 12 Feb:** A first analysis of the latest CGMS WGIII tables by the CEOS VC co-Chairs has not identified any gaps for the core space-one marine measurements. Two issues to be followed have been flagged: a) the delay in JAXA's AMSR-3 and the impact on high-latitude SST; and b) the potential change in technology (TBC) for the Sentinel-3NG altimeters that could lead to some disruptions in the SSH time series in the mid-2030s.	CGMS-52 (Sep 2022)	**ONGOING**

Status of CGMS-50 plenary actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				A second iteration is ongoing with the appropriate CEOS VC and consolidated findings will be reported to WGIII in April.		
EUMETSAT (CGMSSEC)	5	A50.03	The CGMS Secretariat to collate the inputs from the Ocean WGs and prepare a co-authored report on the "State of operational satellite missions" describing the state of the operational missions and identifying any potential issues for the next 20 years (in cooperation also with the IOC and the WMO).	**2023 23 March:** Following discussions between CGMS members this action has been transferred to the CEOS COAST initiative (The Coastal Observations Applications Services and Tools (COAST) Ad Hoc Team). To be reported upon to CGMS-52. **2023 22 Feb:** CGMSSEC (through EUMETSAT) proposes to address this action/topic on occasion of OSOS-3, 12-15 June, and to provide an ocean community response to/on the state of operational oceanography satellite missions. **2023 12 Feb:** Delay expected. Currently anticipated for CGMS-52 in 2024.	CGMS-52 (June 2023)	**OPEN**
CGMSSEC/ CGMS members	8	A50.04	CGMSSEC to invite CGMS members to nominate participants to the CGMS future direction 2022+ Task Team and review the associated draft ToRs	**CLOSED**. Task team and ToRs established. The representatives are: CMA: GUAN Min, XU Na ESA: Susanne Mecklenburg EUM: Sean Burns ISRO: JV Thomas JMA: Kotaro Bessho (TT Chairman) KMA: Sung-Rae Chung NOAA: Mary Ann Kutny	Sep 2022	**CLOSED**

Status of CGMS-50 plenary actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				WMO: Anthony Rea CGMSSEC: Anne Taube, Paul Counet, Mikael Rattenborg, Robert Husband, Paolo Ruti ToRs and documentation can be found under Task Team in CGMS future direction 2022		
CGMS future direction Task Team	8	A50.05	The CGMS future direction Task Team to report to the final conclusion to plenary for plenary endorsement (according to the to-be-agreed Terms of Reference)	**2023 27 Jun:** Presented to CGMS-51 plenary CGMS-51-CGMS-WP-04, CGMS-51-CGMS-WP-07. The task team to be dissolved on the occasion of CGMS-51 plenary, and associated actions and activities to be handled within the framework of the established CGMS working groups. New associated actions/recommendations have been recorded	CGMS-51	**CLOSED**

Summary of new actions resulting from CGMS-51

CGMS-51 plenary recommendations			
AGN item	**Rec #**	**Description**	**Recommendation feedback/closing document**
CGMS members	WMO MATTERS FOR COORDINATION WITH CGMS SPACE AGENCIES	R51.01	Plenary recommended that CGMS members actively support and respond to the WMO strategic initiatives and resolutions, such as EW4ALL, G3W, and Unified Data Policy implementation; and asks CGMS space agency members to participate in the upcoming Core Satellite Data Workshop (4-7 December 2023) and WMO Consultative Meetings on High-level Policy on Satellite Matters (Feb 2024).

CGMS-51 plenary actions				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS space agency members	WGI report	A51.01	CGMS agencies to nominate additional members for all the WGI Task Groups, in particular those where no representatives of the agencies are currently participating in the Task Group(s). • **New WGI TG: WGI TG on Radio Frequency Interference Issues** • **WGI TG on Satellite Data and Codes** • **Recent merge of two WGI TGs: WGI TG on Low Latency Data Access** • **WGI TG on Space Debris and Collision Avoidance** • **WGI TG on Data Collection Services**	Sep 2023
CGMS members	WGI report	A51.02	CGMS Members are invited to nominate candidates for WGI Co-Rapporteur and Co-Chair.	Sep 2023
IESWG CGMS rapporteur	WGII report	A51.03	The IESWG to report on progress to plenary CGMS-53	CGMS-53

CGMS-51 plenary actions				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMSSEC	WGII, WGClimate reports	A51.04	The CGMS Secretariat to secure the inclusion of an agenda item on the GEO-ring observations reprocessing for climate project at CGMS-52 plenary	spring 2024
	GHG TT, CGMS WGI-WGIV co-chairs and rapporteurs	A51.05	The WGClimate GHG TT chairperson (Yasjka.meijer@esa.int) and the CGMS WGI - WGIV co-chairs and rapporteurs to meet (virtual sessions) to address all operational aspects related to GHG monitoring system and to define priorities, and to identify the roles of each CGMS WG for the implementation that becomes part of the roadmap's work plan. (Reference is also made to the CGMS-50 WGII actions related to the GHG TT).	~Sept 2023
CGMS members TBD	WGIV report	A51.06	CGMS agencies to nominate additional members for all the WGIV Task Groups, in particular those where no representatives of the agencies are currently participating in the Task Group(s). WGIV Task Group on Data Access/Exchange WGIV Task Group on Metadata - CGMS members to nominate a chairperson for this TG. WGIV Task Group on User Readiness	Sept 2023
CGMS members	SWCG report	A51.07	CGMS members to nominate candidates for a co-rapporteur for SWCG	Sept 2023
CGMS member principals	FUTURE DIRECTION	A51.08	CGMS principals are invited to nominate a representative to participate in a drafting group tasked to develop, by CGMS-52, a CGMS statement on the optimum composition of hybrid architectures (combining reference platforms, small satellites and procurement of commercial data) for fulfilling the operational observation requirements of CGMS members in the future, recognizing the rapidly changing environment in small satellites and the commercial sector. In particular, the group will identify complementarity and associated merits between the three different aspects of a hybrid system, and will provide recommendations on an optimal mix to obtain essential observations, provided with very high reliability, or on how to fulfil the "backbone" observing requirements.	31 July 2023, CGMS-52

CGMS-51 plenary actions				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
CGMS members	FUTURE DIRECTION	A51.09	CGMS members to nominate and/or confirm representatives for the "champion" to secure the continuity of the six pilot activities and within the respective working groups (as per CGMS-51-CGMS-WP-04) **FUTURE DIRECTION** **1 Socio Economic Benefits** WGIII / JMA to confirm by end July '23 **2 Hybrid Space Observations Architectures** WGIV / Simon Elliott EUMETSAT - confirmed **3 Private Sector** WGIII / Mara Browne NOAA - confirmed **4 Research to operations** WGIV (support WGII) / • NOAA, NASA to confirm by end July '23 • Other agencies to provide feedback by end July '23 **5 Future Information technology** IOT: WGI / Antoine Jeanjean EUM AI/ML: WGII *and WGIV* / TBD KMA? Cloud: WGIV / TBD **6 Space situational awareness** SWCG, WGI / Juha-Pekka Luntama ESA - confirmed **7 Earth system monitoring** WMO, Albert Fischer - confirmed **8 Support to developing countries**	31 July 2023

CGMS-51 plenary actions				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
			CMA (name TBD by end July '23) - confirmed	
CGMS members, CGMS WGs	AI/ML session	A51.10	AI/ML theme to be included on the plenary agenda at CGMS-52, with the CGMS WGs (WGII, WGIV, ...) to address AI/ML in their respective intersessional meetings in preparation. Focal point of contact/Coordinator: Champion of future direction AI/ML theme to be nominated (link to action above)	CGMS-52

11. FUTURE CGMS PLENARY SESSIONS

CGMS-51-CGMS-WP-09: Tentative schedule of future CGMS plenary sessions

CGMS plenary #	Year	Location
CGMS-52	2024	North America Confirmed!
CGMS-53	2025	Europe Confirmed!
CGMS-54	2026	South Korea
CGMS-55	2027	India
CGMS-56	2028	Russian Federation
CGMS-57	2029	China
CGMS-58	2030	WMO
CGMS-59	2031	Japan
CGMS-60	2032	North America
CGMS-61	2033	Europe

CGMS-51-NOAA-WP-20: CGMS-52 Announcement

NOAA will host the CGMS-52 Plenary from June 4-6 2024 in the United States. The exact location to be decided upon in due course.

12. CONFERENCE ANNOUNCEMENTS

CGMS-51-EUMETSAT-WP-11: EUMETSAT Meteorological Satellite Conference 2023

EUMETSAT Meteorological Satellite Conference will take place in Malmö, Sweden, 11-15 September 2023. Please visit https://www.eumetsat.int/eumetsat-meteorologicalsatellite-conference-2023 for further information.

CGMS-51-KMA-WP-05: AOMSUC-13, 2023

AOMSUC-13 will be hosted by KMA in November 2023.

The preceding training event will be held at Jincheon on 3-5 November 2023, with AOMSUC-13 itself in Busan on 6-9 November 2023. A joint coordination meeting of RA II and RA V will follow immediately after on 10 November. KMA looked forward to welcoming everyone to AOMSUC-13

CGMS-51-ISRO-WP-05: GHRSST October Ahmedabad hosted by ISRO

International SST User Symposium and GHRSST International Science Team Meeting (GHRSST24), 16-20 October 2023. Please visit the meeting website for further information: https://www.ghrsst.org/ghrsst-news/24th-international-science-team-meeting-ahmedabad-india-ghrsst-xxiv-ghrsst24/)

13. CLOSING SESSION

Flag handover

Concluding the session, and according the CGMS tradition, the CGMS-51 plenary hosts, JMA and JAXA, handed over the CGMS flag to NOAA who in turn will host CGMS-52 in the USA on 4-6 June 2024.

From left to right: Mr Phil Evans, EUMETSAT DG and Head of the CGMS Secretariat; Mr Masanori OBAYASHI, JMA DG; Mr Takeshi HIRABAYASHI, Senior Chief Officer of Earth Observation Missions, JAXA; Stephen Volz, Assistant Administrator for NESDIS, NOAA.

Closing addresses

Mr Masanori OBAYASHI, Director-General, JMA, noted that the plenary session had produced fruitful discussions on satellite programmes, technological developments and data utilisation. He highlighted the rapid evolution of observational capabilities and technology and the discussions on the future direction of CGMS. The newly endorsed High Level Priority Plan now identifies strategic themes for the individual CGMS working groups to focus on, and he expected their progress reports by the time of next year's meeting. He further thanked everyone attending the plenary session for the active discussions; the CGMS Secretariat for supporting the meeting; and JAXA for co-hosting the plenary session. He expressed his thanks to NOAA who will host the 52nd plenary session in 2024. He concluded by looking forward to the future and further developments in the field of metrological satellites.

Mr Takeshi HIRABAYASHI, Senior Chief Officer of Earth Observation Missions, JAXA, recalled that Japan hosted the CGMS plenary 10 years ago. He expressed his sincere thanks to all agencies for their contributions to the meeting, the efforts of the CGMS working group, in-person and online participants, and welcomed the discussions held on the CGMS future direction.

Data and products from CGMS agencies will contribute to WMO initiatives such as Early Warning for All; help responding to global challenges such as flooding, natural disasters, and climate change; and provide support to the WMO Global Greenhouse Gas Watch. Furthermore, we need to steadily develop and operate satellites in order to provide data to the global user community on a continuous basis.

He thanked NOAA for taking on the plenary hosting responsibilities in 2024, and concluded by wishing everyone a safe journey back home and looked forward to seeing everyone at the next CGMS's plenary session.

Dr Wenjian ZHANG, Assistant Secretary-General, WMO, thanked all CGMS members for their contributions, and active support to the WMO strategic plan, education and training, the new WMO initiatives Early Warning for All and Global Greenhouse Gas Watch. He was grateful for the strong collaborative voice of the CGMS – like a big family - coupled with sincere actions, plans, and commitment.

He extended his thanks to the hosting agencies, JMA and JAXA, for their excellent hospitality, as well as to the CGMS Secretariat for its permanent support to the CGMS.

Mr Phil Evans, EUMETSAT Director-General and Head of the CGMS Secretariat, said that meetings like the CGMS plenary are at their most powerful when worthwhile from both personal and professional points of view, and that the CGMS-51 plenary could be considered as such. He highlighted that the hospitality and the organisation of the hosts, JMA and JAXA, had been absolutely exceptional.

Regarding the content of the discussions, it was incredibly impressive to see the activities of all CGMS agencies, the quality of the presentations, and having decoupled the working group meetings from plenary have helped to focus the discussions.

He noted there are many common issues, challenges and opportunities shared among the CGMS members and iterated the importance of international collaboration in order to address the changes ahead and for CGMS to continue to serve the society. The success of these CGMS events is down to the people, the passion, and professionalism that everyone brings to the discussions. He concluded by thanking the hosts, the in-room and online participants, the working groups and associated task teams, and to those behind the scenes organising the logistics aspects and in particular the staff of JMA and JAXA.

The CGMS-51 plenary adjourned at 3:00 pm.

OPENING ADDRESSES (FULL TEXT)

JMA, Mr Masanori OBAYASHI, Director-General

Good morning ladies and gentlemen. I am Obayashi Masanori, the Director-General of the Japan Meteorological Agency.

We have the great honour of working with JAXA to co-host the fifty-first session of the Coordination Group for Meteorological Satellites with the participation of related organizations. I am glad to have the opportunity to declare it open.

This is the largest international conference held by the Japan Meteorological Agency, since COVID-19 curtailed worldwide interaction. It is my great pleasure to welcome you all to our new headquarters building, to which we moved 3 years ago. In fact, this location is very close to where Japan's meteorological services began in 1875, meaning that we have come full circle after almost 150 years.

This is the first CGMS session in Japan in 10 years, and during this time, the roles of CGMS have become more and more important.

In recent years, partly due to global warming, disasters caused by torrential rains have affected Japan, and no country can escape from extreme weather. In this context, the United Nations "Early Warning for All" initiative represents an ambitious effort to address the challenges we face. Meteorological satellites are an essential component of this work, playing major roles in the monitoring of global warming and marine environments, as well as extreme meteorological conditions.

Against this background, CGMS gives the fora to share satellite status and future plans, and to coordinate observation functions and products. In particular, this year's meeting will focus on the future direction of CGMS and major strategic themes to be addressed in the future, on the basis of the discussions of the task team established after last year's plenary session. We believe that consideration of the whole field, including the socio-economic benefits of meteorological satellite observation and future hybrid space-based observation infrastructures, will play an important role going forward.

JMA relishes the opportunity to collaborate productively with other agencies to address global issues toward the future.

Finally, I would like to express my appreciation to the co-hosting agency, JAXA, to the CGMS Secretariat, and to everybody in attendance. I am sure the conference will be very fruitful.

Thank you very much.

JAXA, Mr Koji TERADA, Vice-President

Good morning, everyone. I am Koji TERADA, Vice President of JAXA. I am responsible for developing JAXA Earth observation satellites and its data use.

To all the participating CGMS Members, welcome to Japan. I would like to extend a hearty welcome to you. To those of you participating remotely, we are very sorry that we could not meet you on site this time, but I hope that you will join us for lively discussions.

We are very pleased to host the CGMS-51 Plenary Session with JMA: Japan Meteorological Agency. In the past, JAXA had worked with JMA to develop Japanese weather satellites. Currently, JAXA is developing various Earth observation satellites and is contributing to solving social challenges by monitoring disasters and climate change using observation data.

JAXA has received a lot of support from CGMS. When we launched the JAXA's next generation mission, CGMS gave us the support letter regarding precipitation radar and micro radiometer, which are important particularly in the field of weather and climate. We appreciate it so much.

Just recently, on June 1st, the next generation precipitation radar mission PMM was turned into a project and its development will begin in earnest. In cooperation with NASA, JAXA has been able to accumulate precipitation radar data for more than 20 years, continuing from TRMM and GPM. Such long-term data sets are not only essential for climate change monitoring. Maintaining data accumulation along with succeeding missions is expected to play an active role even in the field of disaster management as well as in the monitoring of weather and climate change.

JAXA would like to promote the multi-cooperation of Earth observation satellites in the field of weather and climate change for CGMS together with JMA. Through coordination by CGMS, we would like to link our activities to the realization of the Paris Agreement, the Sendai Framework for Disaster Risk Reduction, and even the SDGs, in order to solve the common challenges of humankind.

I look forward to lively discussions over the next three days, and hope you enjoy your stay in Japan.

WMO, Dr Wenjian ZHANG, the Assistant Secretary-General

Thank you Mr Chairman,

Dear Mr OBAYASHI, PR of Japan with WMO and DG of JMA,

Dear Mr TERADA, the Vice President of JAXA,

Dear Phil Evans, DG of EUMETSAT and Head of CGMS Secretariat,

Dear CGMS members and delegates, Ladies and Gentlemen,

Let me start by welcoming you all to the CGMS 51st plenary session on behalf of WMO, at the kind invitation of the Japan Government (represented by JMA and JAXA).

Taking this opportunity, I would like to express three WMO appreciations and recognitions, together with one expectation from the CGMS 51st Plenary Session:

First, WMO I would like to give a big and great thanks to JMA. As we all know, JMA is one of the earliest founding agencies for the establishment of the CGMS mechanism since 1972-1973, together with NOAA, ROSHYDROMET, and WMO. Japan's first GMS satellite was launched in 1977, and during the

past around half a century, Japan's meteorological satellites and, more broadly, Japan's Earth Observations Satellites played a key role in global earth observations and become one of the key pillars of CGMS & WMO Space Programme constellations. It is a great pleasure for WMO team to join this CGMS-51 session at the new JMA HQ with great facilities and hospitality of JMA and JAXA! Happy to learn the long history of JMA 1875, just two years younger than IMO. Thank you, both organizations, very much from WMO perspective.

My second big thank you goes to the CGMS secretariat, led by the Director-General of EUMETSAT Phil Evans, for representing the CGMS community for the active participation in the 19th World Meteorological Congress, and the great statements and comments during the Congress by the CGMS team strongly supported many Congress resolutions, including but not limited to the WMO new strategic plan, EW4ALL, GGGW (Global Greenhouse Gas Watch), Data Policy Implementation, GBON, SOFF, Radio Frequencies for Earth observations, and even a side event on Artificial Intelligence (AI) from EUMETSAT, etc. These comments represented the joint voice and support as the world's leading space community, which greatly facilitated and supported many important Cg-19 decisions.

My third big thank you and recognition go to all CGMS members and observers, for your long-standing support to WMO programs and activities, with your great meteorological satellite programs, your open data policy, and your active participation in the CGMS and WMO activities. The CGMS is a great family, and the community closest to my heart, and the world's most effective coordination mechanism with very close family collaborative spirits. The implementation of Cg-19 resolutions needs greater support from all the space agencies as members of the CGMS community! In this regard, your continued engagement and support to WMO initiatives and activities are highly appreciated and expected.

Finally, I would like to share with you all one of my BIG expectations for this CGMS Session: to strengthen the alignment of CGMS members' latest developments and future plans with WMO Congress 19th resolutions and new initiatives. The WMO team will take this CGMS plenary session, as the first chance after Cg-19, for WMO to communicate with the CGMS community the major Cg-19 resolutions, more specifically, the following WMO staff: Albert Fischer, the WMO WIGOS Branch Director who will introduce the new GCOS implementation plan with new requirements; Ms. Natalia Donoho, the new head of the WMO Space Programme, supported by Heikki Pohjola, Scientific officer, will introduce the new WMO strategic plan and new initiative EW4ALL, and Dr. Lars Peter Riishojgaard will join us online to focus on the GGGW initiative). We would like to mobilize and motivate the support from you all.

Dear colleagues, WMO thanks you all for your support and active response to the WIGOS Vision 2040. The current vision of this strategic document was approved by the 18th Congress in 2019, based on CBS recommendation (2018), and the VISION 2040 was responded to and supported by all WMO Members and CGMS members. As I mentioned before, we foresee that the implementation of Cg-19 resolutions (EW4ALL, GGGW, Hydrological strategy and Implementation plan, new elements of Polar and High Mountain in the WMO strategic plan, etc.) will greatly enhance global earth observations and data availability, which are critical for all WMO Members for further development and to strengthen their meteorological services for saving human life loss and minimizing economic damages, and positively support our national societal economic development. These new requirements have not reflected in the existing WIGOS Vision 2040; I also noted through my quick scan of the CGMS

presentations that many space agencies and satellite operators made great progress with new satellite series, which should be reflected in the updated WIGOS Vision document. I strongly believe that this CGMS plenary session will be critical for the WMO team to learn about the space agencies' great new developments and plans.

Dear colleagues, your continued support will greatly facilitate the continued success of WMO key WMO priorities and new initiatives, lead to a win-win outcome for our both communities.

Best wishes and looking forward to the fruitful outcomes of this CGMS Session.

CGMS Secretariat, Mr Phil Evans, EUMETSAT Director-General, Head of the CGMS Secretariat

Good morning, everybody.

It is of course, a huge pleasure to be here today.

I think our times during COVID reminded us how important these face-to-face meetings are to our community and to rebuild and strengthen our partnerships.

The discussions that we will be having over the next three days I think occur at quite a remarkable time for us and our wider community. There are so many changes taking place, new technologies in the space segment, new approach approaches to securing data, new technologies such as AI and machine learning that can have such a profound impact on the way satellite operators function. These are important changes that are impacting on our downstream users. Again, it is not only AI and machine learning, but increasing exploitation of other technologies as well. These, of course, are not the only issues.

The work that we do has never been so important with climate change and the consequences of climate change and increasing severe weather events. What we do matters, and it is in this context that our discussions will take place and particularly important, I think, is the discussion around the priorities for CGMS over the next 10 years.

Not only do I hope that our discussions over the next three days are fruitful, I think it is important that through these meetings, we can reinforce our international partnership. It is only through international partnership we can fully address the challenges that the world faces and, importantly, to ensure that what we do has the biggest impact on the societies that we serve.

Thank you.

LIST OF PARTICIPANTS

CGMS-51 – Plenary session List of Participants		
Firstname	**Lastname**	**Organisation**
Zhihong	Jia	CMA/NSMC
Jinsong	Wang	CMA/NSMC
Di	Xian	CMA/NSMC
Peng	Zhang	CMA/NSMC
Wei	Peng	CNSA
Bo	Lyu	CNSA
David	Harper	ECCC Environment and Climate Change Canada
Shannon	Kaya	ECCC Environment and Climate Change Canada
Mikael	Rattenborg	EUMETSAT/CGMS Sec
Anne	Taube	EUMETSAT/CGMS Sec
Joana	Betencourt	EUMETSAT/CGMS Sec
Paul	Counet	EUMETSAT/CGMS Sec
Karolina	Nikolova	EUMETSAT
Paolo	Ruti	EUMETSAT
Andrew	Monham	EUMETSAT
Sean	Burns	EUMETSAT
Simon	Elliott	EUMETSAT
Philip	Evans	EUMETSAT
Bojan	Bojkov	EUMETSAT
Mitch	Goldberg	GSICS
Joe	Turk	IPWG/Jet Propulsion Laboratory, California Institute of Technology
Ulrich	Foelsche	IROWG/University of Graz
Nilesh	Desai	ISRO
Rashmi	Sharma	ISRO
Jayaprakash V.	Thomas	ISRO
Takuji	Kubota	JAXA
Riko	Oki	JAXA
Hiroshi	Suto	JAXA
Misako	Kachi	JAXA
Osamu	Ochiai	JAXA
Akihiko	Kuze	JAXA
Mariko	Harada	JAXA
Miyuki	Miyazaki	JAXA
Toshiyuki	Kurino	JAXA
Takeshi	Hirabayashi	JAXA

CGMS-51 – Plenary session List of Participants		
Firstname	**Lastname**	**Organisation**
Koji	Terada	JAXA
Akiko	Noda	JAXA
Nao	Yoshida	JAXA EORC
Ibuki	Watanabe	JMA
Reiko	Harada	JMA
Takuya	Sakashita	JMA
Masaki	Hasegawa	JMA
Miki	Abe	JMA
Kosuke	Inoue	JMA
Yasuhiko	Sumida	JMA
Yasutaka	Hokase	JMA
Mayuko	Sakurai	JMA
Hiroshi	Suzue	JMA
Yurika	Yamada	JMA
Takumi	Maruyama	JMA
Genki	Tokairin	JMA
Akiyoshi	Andou	JMA
Toshiyuki	Kitajima	JMA
Norio	Kamekawa	JMA
Kazutaka	Yamada	JMA
Kenji	Date	JMA
Handa	Taro	JMA
Syunya	Oike	JMA
Kouki	Mouri	JMA
N.	Kawano	JMA
Masanori	Obayashi	JMA
Takashi	Mori	JMA
Ryoichi	Nomura	JMA
Gouki	Chiba	JMA
Yoshitoshi	Sakai	JMA
Osamu	Hamada	JMA
Tamaki	Yasuda	JMA
Yoshihiko	Tahara	JMA
Junichi	Hirosawa	JMA
Akihiko	Shimpo	JMA
Kazuki	Yasui	JMA
Kotaro	Bessho	JMA
Nozomu	Fukuhara	JMA
Nozomi	Hata	JMA
Masaya	Takahashi	JMA/MSC

CGMS-51 – Plenary session List of Participants		
Firstname	**Lastname**	**Organisation**
Azusa	Yota	JMA/MSC
Kazuki	Shimoji	JMA/MSC
Yuuki	Saeki	JMA/MSC
Hiroshi	Kunimatsu	JMA/MSC
Yusuke	Yogo	JMA/MSC
Kazuki	Kodera	JMA/MSC
JaeGwan	Kim	KMA
Dohyeong	Kim	KMA
Eunha	Sohn	KMA
Jack	Kaye	NASA
Tsutomu	Nagatsuma	NICT National Institute of Information and Communications Technology
Kaori	Sakaguchi	NICT National Institute of Information and Communications Technology
Jordan	Gerth	NOAA
Elsayed	Talaat	NOAA
Josh	Jankot	NOAA
Mary Ann	Kutny	NOAA
Stephen	Volz	NOAA
Irene	Parker	NOAA
Chaofei	Ma	NSOAS National Satellite Ocean Application Service
Qimao	Wang	NSOAS National Satellite Ocean Application Service
Yunfei	Lu	NSOAS National Satellite Ocean Application Service
Jeff	Privette	WGClimate/NOAA
Natalia	Donoho	WMO
Wenjian	Zhang	WMO
Heikki	Pohjola	WMO
Albert	Fisher	WMO
Vanessa	Keuck	ESA
Anthony	Mannucci	IROWG/Jet Propulsion Laboratory, California Institute of Technology
Iliana	Genkova	IWWG/NOAA EMC/NCEP (via Lynker)
Hiroshi	Murakami	JAXA
Nakayama	Ryuichiro	JMA
Kozo	Okamoto	JMA/MRI
Kotaro	Saito	MSC/JMA
Sid	Boukabara	NASA

CGMS-51 – Plenary session List of Participants		
Firstname	**Lastname**	**Organisation**
Olga	Ryzhkova	ROSHYDROMET
Konstantin	Litovchenko	ROSHYDROMET/Planeta
Andrew	Heidinger	NOAA/NESDIS GeoXO
Satya	Prakash	IMD
Chinmay	Khadke	IMD
Gianpaolo	Balsamo	ECMWF
Benjamin	Ruston	UCAR/JCSDA
Ramashray	Yadav	IMD
Rodica	Nitu	WMO
Dr. Ashim Kumar	Mitra	IMD
Shibin	Balakrishnan	IMD
Hui	Shao	IROWG/Joint Center for Satellite Data Assimilation
Christine	Mc Mahon Bognar	NASA
Steve	Wanzong	IWWG (Former co-chair)
Lars Peter	Riishojgaard	WMO
Juha-Pekka	Luntama	ESA

CGMS

WORKNG GROUP 1 (WGI)

Satellite systems and operations

WG I REPORT

Co-Chairs: *Dohyeong Kim, KMA / Sean Burns, EUMETSAT*
Rapporteur: *Karolina Nikolova, EUMETSAT*

1. WGI meeting introduction and expected outcomes

CGMS-51-WGI-WP-01 - 1 WGI Meeting Introduction by Co-Chairs/Co-Rapporteurs

The WGI Co-Chairs and Rapporteur opened the meeting with a welcome address, re-calling the role of WGI within CGMS, the objectives of WGI, its current structure, and status on WGI Co-Chairs / Co-Rapporteurs.

WGI reviewed and adopted the draft agenda proposed by the CGMS Secretariat prior to the meeting, which is in line with the Terms of Reference for WGI.

CGMS WGI was invited to make a decision on the proposed plan to present updated WGI Terms of Reference as an input to CGMS-52, based on the CGMS Future Directions Project outcomes and inputs from the Task Groups.

WGI agreed to the proposal with the following action.

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WGI Co-Chairs / Rapporteur / WGI Task Group Chairs	**1.1**	WGI/A51.01	Propose an updated WGI Terms of Reference, based on the CGMS Future Directions Project outcomes and inputs from the WGI Task Groups, to be presented for endorsement to CGMS-52. The WGI Terms of Reference will be based on inputs from the WGI Task Groups on their latest Terms of Reference.	CGMS-52	**OPEN**

WGI included representatives of the satellite operators from CMA, ESA, EUMETSAT, JMA, KMA, NOAA, ROSHYDROMET, and WMO (see CGMS report for full list of participants).

The WGI meeting was hybrid, with in-person participation at EUMETSAT and virtual attendance via MS Teams.

In view of the common items of interest in relation to Space Weather, the representatives of WGI, WGIV, and the Space Weather Coordination Group participated also in the joint WGI-WGIV-SWCG Meeting.

CGMS-51-WGI-WP-02 - WGI expected outcomes

The WGI Co-Chairs and Rapporteur summarised the expected outcomes and key objectives for the CGMS-51 WGI meeting.

It was re-called that, in line with the recommendation from CGMS-50 WGI, all Task Groups should include in their annual reports their:

- Latest Terms of Reference
- Up-to-date list of members
- Status on current and planned activities
- Latest version of Best Practices and any proposed updates
- Status of implementation of Best Practices for each agency

The CGMS-51 WGI agenda and expected outcomes have been structured accordingly.

CGMS agencies were invited to consider nominations for the roles Co-Rapporteur and Co-Chair of WGI.

2. Frequency Management

2.1 Frequency management topics including WRC-19 and WRC-23

CGMS-51-CGMS-WP-01 - SFCG report (including WRC-27 and WMO OSCAR/Space items)

The 41st annual meeting of the Space Frequency Coordination Group (SFCG) took place 19-27 July 2022.

The issues of relevance for CGMS that were discussed and progressed are:

- Update to SFCG Objectives for WRC-23 (extract in Attachment 1);
- SFCG process for gathering remote sensor information for updating the OSCAR/Space database (Attachments 2 & 3);
- Response from SFCG on CGMS activities regarding mechanisms for detection, long-term monitoring and mapping of Radio Frequency Interference (RFI).

Regarding WRC-23, the SFCG Objectives (Status: February 2023) on WRC-23 agenda items of direct interest/concern to CGMS are provided in an extract in Attachment 1. For comparison with the SFCG Objectives, the positions of WMO (Status: October 2022) are also provided in Attachment 1, which are usually largely in line with each other. Both position papers will still be updated to their final versions, WMO at the meeting of ET-RFC in its yearly meeting at 18-20 April 2023 and SFCG-42 in June 2023.

The WRC-23 agenda items of potential concern to CGMS members discussed in this paper are:

- Agenda items 1.2, 1.4, 9.1 Topic C related to IMT (5G) systems;
- Agenda items 1.16, 1.17, 1.18 and 9.1 Topic D related to new frequency usage of commercial satellite systems.

The WRC-23 agenda items of direct interest to CGMS are:

- Agenda Item 1.14: The objective of this agenda item is to ensure that passive microwave measurements in the frequency range 231.5-252 GHz are protected and the required spectrum is allocated to future passive microwave sensors, for example for the Ice Cloud Imager (ICI) instrument on Metop-SG satellites;

- Agenda Item 9.1 Topic A: The status is outlined in detail in CGMS-51-EUMETSAT-WP-06 (Frequency-related topics in support to space weather) to be presented to the Joint WGI-WGIV-SCWG session on 28 April 2023.

The paper also addressed the issues related to ITU-R Resolution 731 (Rev. WRC-19) which deals more generally with the consideration of sharing and adjacent band compatibility between passive and active services above 71 GHz such as, but not limited to, 100-102 GHz, 116-122.25 GHz, 148.5-151.5 GHz, 174.8-191.8 GHz, 226-231.5 GHz and 235-238 GHz. Unfortunately, the listed bands also include bands covered by RR footnote 5.340 (100-102 GHz, 148.5-151.5 GHz, 190-191.8 GHz and 226-231.5 GHz), stating that all emissions are prohibited, in order to protect these specific passive bands. This is interpreted by some ITU member states as if sharing could be envisaged in these purely passive bands, even against the ITU Rules of Procedure. To preserve these unique spectrum resources, it will be important that CGMS members, in response to WGI/A50.02, urge their national regulatory authorities, when establishing new regulations for use of active services and applications, to appropriately take into account the protection requirements of passive sensors and that the bands listed in RR FN 5.340 will not be opened for a shared use with active services. WRC-23 provides a mechanism to eliminate ambiguities through a revision of ITU-R Resolution 731 by means of the standing WRC agenda item 4.

WRC-23 will also determine the agenda for WRC-27. Possible new WRC-27 agenda items, supported by WMO and SFCG, were introduced. Generally, it should be noted that the proposals for WRC-27 from the individual regions/countries are still not formally finalised yet. Thus, an outlook on the WRC-27 agenda cannot be provided at this stage.

Related to the activities for updating OSCAR/Space within SFCG, this document also responds to WGI/A50.04, which calls upon the SFCG Liaison Officer and WMO to propose a process for providing accurate and timely updates on satellite frequencies recorded in OSCAR/Space database. Considering that the basic process for updating OSCAR/Space is already well established, it is proposed to complement this process with the same approach for providing updates to the remote sensor information in OSCAR/Space as established between the SFCG and WMO. The proposal is that WMO introduce the templates agreed with the SFCG, as given in Report SFCG 40-1R1 (see Attachment 3), for updating the remote sensor information in OSCAR/Space into the current procedure through the OSCAR/Space Support Team (O/SST). Each agency has to ensure that the updates provided through SFCG and CGMS are aligned in order to not to present contradicting information to WMO.

The group discussion highlighted the importance of thoroughly reviewing all existing information in the database, and filtering out outdated data. A question was raised on the potential of merging the OSCAR/Space database and SFCG database, but the group discussion concluded that while this has been discussed in the past, the databases continue to serve different purposes. The SFCG database

focuses on frequency information, while the OSCAR/Space database has a wider range of information. The importance of synchronisation between the two databases was reiterated.

The WGI/A50.04 action on proposing a process for accurate and timely updates on satellite frequencies recorded in OSCAR/Space database was closed.

WGI agreed to the following new actions.

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
WMO	**2.1**	WGI/A51.02	SFCG Representative to distribute to CGMS the final WMO position paper on WRC-23. CGMS members would then need to ensure the final WMO positions known to its members' national and international preparation processes for WRC-23.	June 2023	**OPEN**
WMO	**2.1**	WGI/A51.03	WMO to introduce the templates agreed with the SFCG for updating the remote sensor information in OSCAR/Space into the current procedure through the OSCAR/Space Support Team (O/SST).	End of 2023	**OPEN**

The report also noted that the Liaison Officer between SFCG and CGMS informed SFCG about the work of a Task Group established in the framework CGMS Working Group I, dealing with RFI detection, monitoring and mapping. SFCG noted these developments in CGMS and will provide relevant information on this subject by means of the report of the Liaison Officer back to CGMS once there is something to report. It was noted that SFCG is interested in the progress of this activity in the framework of CGMS.

CGMS was invited to provide feedback and information on its activities via the CGMS/SFCG Liaison Officer to SFCG-42 (30 May – 7 June 2023) on any frequency related matter as appropriate.

3. RFI detection, monitoring and mapping

CGMS-51-WGI-WP-03 - Report from the CGMS WGI Task Group on RFI detection, monitoring and mapping (incl. latest ToR, status on current & proposed/planned activities)

Triggered by Working Paper CGMS-49-CGMS-WP-11, CGMS-49 requested agencies to nominate participants to a Task Group to establish the initial ideas about mechanisms regarding the detection, monitoring and mapping of RFI, initially in the 24 GHz passive band. The Task Group on RFI Detection, Monitoring and Mapping (TGRFI) was established in response to this request.

Terms of Reference, consisting of the initial tasks of the group was presented. The current membership of the TGRFI was listed and includes members from CMA, EUMETSAT, KMA, NOAA and WMO.

The Task Group on RFI Detection, Monitoring and Mapping began its work in 2022, and since then has collected inputs describing how CGMS members are assessing the impact of RFI.

The activities throughout the last year included three intersessional meetings, with inputs from CMA, EUMETSAT, KMA and NOAA. In those, CMA, EUMETSAT and NOAA gave presentations on their spectrum concerns and activities on RFI detection, monitoring and mapping. KMA confirmed that no such RFI monitoring activities are undertaken by KMA, KARI (Korea Aerospace Research Institute) or KASI (Korea Astronomy and Space Science Institute).

Based on the presentations, the capability of Metop-SG Micro-Wave Imager (MWI) to monitor RFI (comparing Gaussian and non-Gaussian signals) were noted. Additionally, the impact of RFI on the MWRI instrument of FY-3D was noted, focusing on 10 and 18 GHz interference. Impact has been shown both detected in the signal (cold look calibration mode) from ~45 North over Europe and North America, and using O-B methods for 10 GHz over the oceans. TGRFI identified similar monitoring on a recurrent basis as a key approach to assessing the possible impact of 5G.

At the yearly meeting of the Space Frequency Coordination Group (SFCG) in July 2022, IEEE provided information on developments of a standard for RFI assessment in Earth Environmental Sensor Systems (EESS) frequency bands in IEEE Geoscience and Remote Sensing Society (GRSS) Frequency Allocations in Remote Sensing (FARS) Technical Committee. The TGRFI invited Paolo De Matthaeis and Roger Oliva from IEEE to join its meeting in December 2022, in order to learn about their experience developing this standard.

The TGRFI have also discussed the monitoring of RFI on the Data Collection Service (DCS). The topic has been addressed at the DCS workshop at the Meteorological Technology World Expo in Paris in October 2022, and at the CGMS WGI Task Group on Data Collection Systems. In this discussion, EUMETSAT explained the planned use of a DCS interference register used to track messages lost due to interference – NOAA also noted the use of a similar mechanism, also including the platform identification.

The Group's next tasks are to analyse the inputs provided by CMA, EUMETSAT and NOAA, and to look for common approaches. These can then be used as a basis for the establishment of a set of best practices for RFI detection, monitoring, and mapping. Once established, the best practices can be endorsed by CGMS and used to help members implement a standard approach for assessing RFI. The group discussion highlighted that this is a challenging, but important task aiming for a coordinated CGMS approach on RFI. It was recalled that the trigger of these activities within CGMS was the plans for 5G deployment in 24 GHz (not deployed as of 2023).

WGI agreed that action WGI/A50.01 on formation of the Task Group on RFI can now be closed – the TG is formed and way forward for next actions has been proposed.

WGI agreed to the following new action.

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
TGRFI	**3.1**	WGI/A51.04	Analyse the inputs provided by CMA, EUMETSAT, KMA and NOAA on spectrum concerns and activities on RFI detection, monitoring and mapping, and pursue the establishment of a draft set of best practices by CGMS-52, based on the common aspects of the approaches already adopted by members.	CGMS-52	**OPEN**

CGMS-51-NOAA-WP-05 - Active Spectrum Management with Passive Bands

The paper raised awareness on the proposals and plans for spectrum sharing that may impact meteorological and climatological data. It highlighted the risks of non-natural RF contamination, noting that years of spectrum management experience demonstrate RFI contamination will only increase in intensity and in spectrum proliferation. Resolving this type of RF contamination is not easy and may not be affordably possible. Today, it is expected the presence of anthropogenic energy can only be identified and mitigated with the aid of several different methods. A broad and continuous effort is needed, in the regulatory arena (international and national), policy (responding to changes), and technical (adding things like new robustness to future systems).

The EESS (passive) bands are at a very significant risk of increased noise levels from today's conditions. It has been calculated that low anthropogenic noise levels will be indistinguishable from natural radiation and that high levels of anthropogenic noise will simply eliminate observation data for that geographical area. It pointed to the experience observed with each generation of advanced wireless services, from 1G to tomorrow's 6G, whereby each of the generations requires a greater degree of access to the RF spectrum. The implementation of 5G and following generations of broadband are expected to affect the EESS (passive) bands. There is still no information on actual interference to a microwave sounder and it is not clear that it can easily be identified as such. As designed, MW sounders only measure the total amount of radiative power as received by the antenna. 5G signals change due to varying factors (outside temperature, usage, power). To a MW sounder, these changes look like changes in signal power and thus variations in temperature.

5G is not the only expected source of passive band degradation. Commercial non-geostationary (NGSO) satellites are being deployed in large mega-constellations and require higher data rates and volume. There is also awareness that there may be a variety of currently unknown sources of contamination that have yet to be identified as new technologies are developed and implemented.

Predominantly bands near and between 24 to 86 GHz are today's most significant risks for passive band degradation and corruption, however passive bands both below and above this range are also at or have been at risk.

With the degradation of MW sounder data, there will be an impact to weather models and forecasting accuracy. The paper recommended that there be an emphasis on the development and implementation of RFI identification and sensor robustness measures. It highlighted that if no action is taken, it will not be clear when or how much the meteorological mission has been degraded by RF contamination.

The paper highlighted areas where efforts are underway to develop methods and technologies that may reduce the risk of data corruption and loss, including flagging of data, mapping areas of contamination, determining impact on NWP, developing systems to use higher frequencies is possible (though noting these would not have the same performance as the original bands), constantly assessing and modifying product development to make maximum use of data, as well as reaching out to community to expand on mitigation approaches.

The paper recommended that CGMS members monitor WRC-23 agenda items that may affect satellite remote passive sensing, and continue to seek increased robustness in satellite passive sensors. It recommended continuation of actions by TGRFI for development of mitigation techniques for use by CGMS members.

WGI discussed that it would be of interest to explore the potential / existing uses of AI/ML and pattern recognition in the area of RFI detection.

WGI agreed to the following new action.

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
TGRFI	**3.1**	WGI/A51.05	Explore the potential / existing uses of AI/ML and pattern recognition in the area of RFI detection	CGMS-52	**OPEN**

4. Satellite Data and Codes

CGMS-51-WGI-WP-04 - Report from the CGMS WGI Task Group on Satellite Data and Codes (incl. latest ToR, status on current & proposed/planned activities)

The CGMS Task Group on Satellite Data and Codes (TGSDC) has been actively supporting the coordination of work on satellite product format issues within the CGMS community and providing support to the work of WMO's expert teams since its first meeting in 2008.

As of 2022, the activities of the CGMS WGI ad hoc team on coordination of CF-netCDF standards have been assimilated into the work of this Task Group, with no specific outcomes since CGMS-50 to report to CGMS-51.

This paper briefly summarised the status of the Task Group and its upcoming activities.

The current membership of the TGSDC was listed and includes members from CGMS, CMA, EUMETSAT, JMA, KMA, NOAA, SRC Planeta and WMO. As noted also in CGMS-50, an additional member from ISRO would complement the current composition well.

The Task Group has worked with the WMO Secretariat and the WMO Expert Team on Data Standards (ET-Data) and its Task Team on Table Driven Code Forms (TTTDCF) on the development of a number of new BUFR encoding sequences and Common Code Table entries, such as for FY-4B GIIRS, TROPICS and Metop-SG. In each case, the Task Group acts as a reference group of experts who are invited to consider and endorse relevant proposals going through WMO's approval process.

The Group continues to encourage WMO to ensure that OSCAR/Space includes references to the Common Code Table entries used for satellite identifiers (table C-5) and instruments (C-8). At the last OSCAR/Space workshop it was confirmed that these changes would be included in the forthcoming update to OSCAR/Space. The related WGIV/A49.02 action is therefore progressing, but will remain open until the changes are included.

The Task Group on Satellite Data and Codes continues to play a useful role. Between CGMS 51 and CGMS 52, the Task Group will continue to work on coordinating format standardisation for satellite data, implementation of WIGOS station identifiers for satellite platforms, and providing subject matter expertise to WMO Expert Teams. A key activity will be to ensure that the BUFR encoding sequences for the remaining Metop-SG products are introduced to the WMO approval process, targeting approval with Fast Track 2023-II in November 2023.

WGI discussed the process the Task Group follows in preparation for future systems. The preparations are normally driven by the provider of the data, and usually triggered by the release of sample / test data.

The Task Group Chair agreed to provide the Task Group's later Terms of Reference.

WGI encouraged active participation in the work of the Task Group from all satellite operators.

5. Direct Broadcast System

CGMS-51-WGI-WP-06 - Report from the CGMS WGI Task Group on Direct Broadcast Systems (incl. latest ToR, status on current & proposed/planned activities)

The core meteorological satellite systems in LEO orbits, and other operational satellite systems where applicable, should ensure low latency data access of imagery, sounding, and other real-time data of interest to users. Application areas where low latency and availability is suitable include Severe Weather Monitoring, Nowcasting and Short- and Medium-Range Numerical Weather Prediction. Other application areas could also benefit from very low latency products, e.g. ionospheric monitoring.

Today, LEO meteorological satellites have two distinct services for providing low latency data to users:

- Global service: where the full orbit data is stored on-board and served at the pole(s);
- Regional or local service: real time dissemination of instruments data to a network of direct broadcasts stations.

The historical distinction between global and regional missions could disappear in the next generation of LEO meteorological satellites, with constant data access to the satellites (internet in space concept).

The goal of this CGMS paper was to identify low latency data access solutions that could be part of the next generation of LEO meteorological satellites and assess them through a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. This SWOT analysis paper is extending the scope of the previous CGMS paper [CGMS-50-CGMS-WP-08] which focused on regional low latency data access.

Three global low latency data access solutions were studied in this paper:

- GEO Data Relay Service (GEO DRS)
- MEO/LEO Data Relay Service (LEO DRS)
- Global Network of Ground Stations Service (GNGS)

The paper compared the pros and cons of each solutions and summarised the findings. Currently, CGMS agencies retain full ownership of the data transmission chain. There are historical lessons to limit dependence on third parties to secure a timely and systematically access to data. For example, the reception points at the poles to the operating centres of the CMGS agencies have a dedicated terrestrial link to keep ownership of the transmission chain. Commercial services have risks, enterprises subject to change (new shareholder, change of group, bankruptcy, etc). Political scenario may also change and impose bans and restrictions on commercial services. Keeping ownership of the access to LEO meteorological is key, keeping full control on the end-to-end data dissemination chain. However, new market opportunities are offering innovative way of low latency data access from LEO meteorological data.

The study suggests that future LEO weather satellites systems could have a backbone of LEO meteorological satellites where the ownership of the data chain is conserved (as for the FY3/JPSS/METOP satellites of today), completed by lower cost LEO satellites constellation using innovative low latency data access mechanisms as detailed in this paper.

Timeliness is one critical aspect of a LEO weather satellite for now-casting and numerical weather applications, innovative and cost effective solutions offering global low latency data access mechanisms could be part of future LEO weather satellites programmes. The implications of this transition could result into global services (orbit data reception at the poles) and local services (direct broadcast) to be merged into a single global low latency data service. Requirements for these new types of LEO meteorological satellites would need to be assessed, for example in terms of the space segment architecture, orbit types, orbit coordination, etc.

The joint Direct Broadcast Systems and LEO Coordination tasks groups SWOT analyses, performed in response to Action WGI/A50.09, has explored the emerging technologies which can be expected to remove the historical architectural boundaries between global data access and direct broadcast systems, providing low latency data delivery for both global and local applications.

The paper proposed the merge of the Direct Broadcast Systems and LEO Coordination tasks groups into a single “Low latency Data Access from LEO Satellites” task group, with Andrew Monham and Antoine Jeanjean as Co-chairs. A preliminary draft of the merged Terms of Reference for this joint

group was provided and will be at the Kick-Off of the proposed Task Group for iteration with WGI and taking into account the specific goals from the CGMS Position Papers, in particular the "Future Information Technologies" and "Future Observing (Hybrid) Space Infrastructures".

WGI agreed to the proposed merge of the Task Groups. In view of the merge of the Task Groups, WGI encouraged review of the membership and active participation in the work of the Task Group from all satellite operators.

WGI agreed that the SWOT analysis can be considered completed, so Action WGI/A50.09 was closed. It was noted that the SWOT analysis should be kept current, as part of the routine activities of the merged Task Group. It was discussed that part of keeping the SWOT analysis current would involve realistic and current data rate scenarios. It was also agreed that a summary outcome of the SWOT analysis should be developed and disseminated to the remaining CGMS Working Groups.

WGI agreed to the proposal with the following action to continue the effort:

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
LLDA TG	**5.1**	WGI/A51.06	Merge the Direct Broadcast Systems and LEO Coordination tasks groups into a single "Low latency Data Access from LEO Satellites" task group, with Andrew Monham and Antoine Jeanjean as Co-chairs. Finalise the draft Terms of Reference with inputs from WGI and taking into account the specific goals from the CGMS Position Papers, in particular the "Future Information Technologies" and "Future Observing (Hybrid) Space Infrastructures". Present the finalised ToRs for endorsement to CGMS-52. The work of the TG should include keeping the SWOT analysis current (process to be noted in the ToRs). As part of the merge, update and present the list of members, create a new mailing list LWGI_LLDA@LISTSERV.EUMETSAT.INT, remove old mailing list.	CGMS-52	**OPEN**
LLDA TG	**5.1**	WGI/A51.07	Distribute a summary of the SWOT analysis on Low Latency Data Access from LEO meteorological satellites to the remaining CGMS Working Groups.	CGMS-52	**OPEN**

Additionally, the paper noted that during the ESA IoT for Earth Observation workshop, presentations were given on innovative concept of satellite platform as a service (SPaaS). The commercial concept is to provide a full integrated service on a satellite platform providing power, commanding, internet downlink, launch service, etc. The customer furnished item is an instrument payload.

Some SPaaS providers offers a downlink internet connection via GEO relay solutions. The ground reception points are located on directly on the rooftop of cloud providers, offering low timeliness before processing.

SPaaS are highly relevant to the topic of low latency data from LEO satellites, therefore the paper suggested it would be beneficial to further analyse SPaaS in a CGMS document memo in terms of internet connection speed, hosted instruments specifications (size/weight/power), orbit type, satellite lifetime and cost breakdown.

WGI agreed to the proposal with the following action.

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
LLDA TG	**5.1**	WGI/A51.08	Analyse potential role of satellite platform as a service (SPaaS), considering current and expected providers, internet connection speed, hosted instruments specifications (size/weight/power), orbit type, satellite lifetime and cost breakdown. Report to CGMS-52.	CGMS-52	**OPEN**

CGMS-51-CMA-WP-01 - Operational Direct Broadcast Systems status report + status of implementation of best practices (CMA)

This paper presented the status of implementation at CMA of the CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data (CGMS/DOC/18/1008274, v1B) for each of the FY-3D and FY-3E LEO satellite missions.

Working Group I took note of the status of implementation of the best practices of CMA.

CGMS-51-EUMETSAT-WP-01 - Operational Direct Broadcast Systems status report + status of implementation of best practices (EUMETSAT)

This paper presented the status of operational direct broadcast systems and implementation of the CGMS Agency Best Practices at EUMETSAT in support to Local and Regional Processing of LEO Direct Broadcast data (CGMS/DOC/18/1008274, v1B) for each of the METOP and EPS-SG LEO satellite missions. This paper also introduced available direct broadcast information about the EPS Sterna constellation, for which approval of the programme is targeted in mid-2025. The EPS-Sterna information presented in this document may evolve depending on the development of the programme.

Working Group I took note of the status of implementation of the best practices of EUMETSAT.

CGMS-51-NOAA-WP-02 - Implementation of CGMS Best Practices for Leo Direct Broadcast Data at NOAA

This paper presents status of implementation at NOAA of the CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data (CGMS/DOC/18/1008274, v1B) for NOAA-18, NOAA-19, S-NPP, NOAA-20 and NOAA-21.

Working Group I took note of the status of implementation of the best practices of NOAA.

CGMS-51-CGMS-WP-03 - Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data - latest version and new proposals

The Task Group on Direct Broadcast Systems and Task Group on the Coordination of LEO Orbits were tasked, via WGI/A50.10, with reviewing the overlap between their proposed and published Best Practices:

- The published BPs in support to local and regional processing of LEO direct broadcast data (CGMS/DOC/18/1008274)
- The BPs proposed for the Coordination of Data Acquisition for Low Earth Orbit (LEO) Satellite Systems (CGMS-50-NOAA-WP-05)

In view of the proposal for the merge of the two task groups, the paper proposed to close action WGI/A50.10 and open a new action to merge the LEO and DB best practices.

WGI agreed to the proposal with the following action.

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
LLDA TG	**5.5**	WGI/A51.09	Merge the LEO (Global) and DB (regional) best practices into a single “Low Latency Best Practices” document proposed to be structured as follow: • Common BPs for both regional and global missions • BPs specific for DB • BPs specific for global mission Present the merged BPs for endorsement to CGMS-52.	CGMS-52	**OPEN**

6. Coordination of LEO Orbits

CGMS-51-WGI-WP-05 - Report from the CGMS WGI Task Group on the Coordination of LEO Orbits (incl. latest ToR, status on current & proposed/planned activities)

This paper recalls the work performed so far by the LEO Coordination of Orbits Task Group, as well as its final Terms of Reference. This complements paper CGMS-51-WGI-WP-06 (Combined Report from the CGMS WGI Task Groups on Direct Broadcast Systems and LEO Coordination of Orbits (LCOO TG), which proposed to consolidate the existing Task Groups into a new single Low Latency Data Access Task Group (LLDA TG), such that activities may be taken into account in the new LLDA TG. Refer to CGMS-51-WGI-WP-06 for formal recommendations and proposed actions for merge of the Task Groups.

Reference is also made through this consolidated TG approach to the Best Practices formulated in the LCOO TG, while a separate Paper CGMS-51-CGMS-WP-02 formally closes the action.

CGMS-51-CGMS-WP-02 - Best Practices for the Coordination of Data Acquisition for LEO Satellite Systems - proposed way forward

The Task Group on Direct Broadcast Systems and Task Group on the Coordination of LEO Orbits were tasked, via WGI/A50.10, with reviewing the overlap between their proposed and published Best Practices:

- The published BPs in support to local and regional processing of LEO direct broadcast data (CGMS/DOC/18/1008274)
- The BPs proposed for the Coordination of Data Acquisition for Low Earth Orbit (LEO) Satellite Systems (CGMS-50-NOAA-WP-05)

The Task Groups have confirmed that the proposed Best Practices are valid as written and do not overlap with the existing Direct Broadcast Best Practices.

However, the Task Groups on LCOO and DB are proposed to be consolidated into a single TG on Low Latency Data Access. This new LLDA TG will restructure the existing Best Practices into a generic data access part and separate parts for any practices specific to the regional or global missions.

In view of the proposal for the merge of the two task groups, the paper proposed to close action WGI/A50.10 and open a new action to merge the LEO and DB best practices.

WGI agreed to the proposal to close WGI/A50.10. Refer to CGMS-51-WGI-WP-06 for formal proposed actions for merge of the Best Practices.

7. Space Debris and Collision Avoidance

CGMS-51-WGI-WP-07 - Discussion on future CGMS WGI efforts on Space Debris and Collision Avoidance

The paper recalled CGMS efforts on Space Debris and Collision Avoidance so far, from CGMS-46 until CGMS-51. In CGMS-50 WGI, the preliminary work between NOAA and EUMETSAT since CGMS-49 was outlined (CGMS-50-WGI-WP-02). Terms of Reference for a Task Group on Space Debris and Collision

Avoidance was provided, and WGI members were encouraged to nominate additional members, in order to expand the TG membership to all CGMS members. An action WGI/A50.07 was open for the Task Group to deliver a Best Practice document on collision avoidance and debris mitigation for recommendation for endorsement in CGMS-51.

The Task Group has not met since CGMS-50. In order for the Task Group to proceed with its activities, the paper proposed the following next steps:

- Identify leadership and membership of the Space Debris and Collision Avoidance TG;
- Build on the NOAA-EUM work already performed, with wider Agency participation;
- Propose to integrate agreed steps from the final SSA Position Paper with appropriate delivery dates.

The group discussion highlighted the importance of this Task Group and the need to make progress, starting with identifying the leadership. A discussion on the leadership of the Task Group took place, and WGI endorsed Andrew Monham (EUMETSAT) as interim Chair of the Task Group.

WGI encouraged active participation in the work of the Task Group from all satellite operators.

WGI agreed WGI/A50.07 on best practices on collision avoidance and debris mitigation will be kept open, and pursued by the Task Group in the lead up to CGMS-52. This should be based on previous inputs from EUMETSAT and NOAA, and seek wider participation from CGMS agencies. The future work of the Task Group will also include a review of the Terms of Reference and take into account the work already done in the scope of the Space Situational Awareness theme of the CGMS future direction 2022+ project.

8. Data Collection Services

CGMS-51-WGI-WP-08 - Report from the CGMS WGI Task Group on Data Collection Services (incl. latest ToR, status on current & proposed/planned activities)

This paper presents the status of the Task Group on DCS activities and progress since CGMS-50. The group has held regular intersessional meetings since CGMS-50 and a face-to-face DCS Workshop at the Met Tech Expo in Paris in October 2022, combined with the Satcom Forum. The DCS part focused on reports from each of the member organisations and discussions on the Enhanced DCP standard.

The discussions of the Enhanced DCP (EDCP) standard have continued to be a major topic for the Task Group (TG). The TG has developed a proposal for the way forward in developing a new IDCS/EDCP standard. The TG foresees the following plan and related schedule, which would give the agencies a common standard and would once again allow international use of DCPs:

- 2024:
  - Finalise the EDCP technical standard with the agreement of all agencies and CGMS
  - Relocate current DCPs away from the international identified channels
  - Define how the EDCP project would be funded
- 2025:
  - Produce and test a prototype transmitter
  - Modify reception sites to enable the reception of the EDCP

    - Test the system and verify the performance of the prototype and ensure it covers the transmission different modes

- 2026:
    - Certify the EDCP transmitters from the manufacturers
    - Modify the reception systems of all agencies.
    - Test the reception for all agencies and satellites
- 2027:
    - Declare the EDCP standard operational

WGI discussed and agreed with the proposed plan for development of the EDCP standard, highlighting the need to define the funding of the project, considering a prototype would need to be developed. An additional point that needs to be added to the plan is following up with users on the adoption of the EDCP standard. The plan detailed above is for the engineering timeline, and the discussion highlighted that the user implementation will take additional time.

The progress on the items part of the DCS SWOT analysis was presented, including RFI mitigation, joint DCS PR materials, DCS introduction video, and manufacturers workshop.

For addressing the threat of RFI, the Task Group is proposing to produce an RFI interference register, which would be a CGMS document populated with the history of known interferences, and kept up-to-date with any new interferences. During the DCS workshop NOAA gave a presentation on some DCS interference problems they had observed. Their investigation revealed that the interference was produced by hand held two-way radios. EUMETSAT has also in the past suffered from some external interference, which was suspected to come from ground based radars. WGI discussed and approved the proposal. The output of the DCS register will be provided to the Task Group on RFI, for input in the best practices on RFI. Additionally, WGI discussed if there are plans to create a global RFI register, with a wider scope than DCS, and concluded that agencies are invited to report on RFI issues to SFCG for knowledge exchange and are encouraged to notify ITU.

Some discussions have taken place on the joint DCS promotional materials and DCS introduction video, but these items are still a work in progress. Once the EDCP standard is finalised, a new IDCS guide standard would need to be prepared.

The manufacturers workshop took place as part of the DCS workshop during the Satcom Forum in October 2022.

WGI discussed the importance of the SWOT analysis for the future of the overall system of the CGMS members and their future plans for supporting collection of data from remote regions.

WGI discussed the threat of competing systems, opportunities for commercial support as an augmentation of DCS, and the identification of new uses of DCS, and agreed that these items should be considered as part of the SWOT analysis.

WGI agreed that the SWOT analysis should be kept current, as part of the routine activities of the merged Task Group, and presented on an annual basis. It was also agreed that a summary outcome of the SWOT analysis should be developed and disseminated to the remaining CGMS Working Groups.

WGI agreed to the proposal with the following actions:

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
TG on DCS	**8.1**	WGI/A51.10	DCS TG to complete the DCS SWOT analysis and provide current conclusions and recommendations to WGI.	CGMS-52	**OPEN**
TG on DCS	**8.1**	WGI/A51.11	As part of the routine DCS TG activities (to be reflected in the ToR), review and update DCS SWOT analysis yearly and provide to WGI – the next update, which will also take as input the outcomes of the CGMS 2022+ project.	CGMS-52	**OPEN**

Terms of Reference for a Task Group on DCS was provided. It was noted that the first three items of the proposed Terms of Reference, which are related to the EDCP standard, are rather current actions instead of responsibilities. The regular update of the SWOT analysis should be reflected in the Terms of Reference of the Task Group.

WGI members were encouraged to nominate additional members, in order to expand the Task Group membership to all CGMS members.

CGMS-51-EUMETSAT-WP-02 - Operational DCS status report + status of implementation of best practices (EUMETSAT)

This paper presents the status of the EUMETSAT Data Collection Services (DCS), currently supported by Meteosat-10 at 0° and Meteosat-9 at 45.5°E IODC (Indian Ocean Data Coverage). Meteosat-9 took over from Meteosat-8 as the prime IODC satellite 1 July 2022. Meteosat-10 took over from Meteosat-11 as the prime 0° satellite on 21 March 2023.

The paper includes details of channel utilisation, DCP allocation, geographical distribution and DCP data dissemination mechanisms. It covers also details on expected changes to the EUMETSAT DCS service in 2023. The DCS is one of the core services operated by EUMETSAT in support of meteorology and weather prediction. Noting that the EUMETSAT DCS is also embarked on the Meteosat Third Generation (MTG).

The EUMETSAT DCS currently supports both standard-rate (100bps) and high-rate (1200bps) DCPs. The prime IODC application is for the Indian Ocean Tsunami Warning Network (IOTWS). As of 31 March 2023, there are 147 DCP operators located in 78 countries (Europe, Africa, Asia). There are a total of 1691 DCPs allocated, with 455 actively transmitting. Out of those DCPs allocated, 386 are HRDCPs transmitting at 1200 bps (359 supported by Meteosat-10 at 0° and 27 by Meteosat-9 at 45.5°E). The remaining 1305 are Standard Rate DCPs (1158 supported by Meteosat-10 at 0° and 147 by Meteosat-9 at 45.5°E). Since March 2022, 66 new DCPs have been assigned (66 HRDCP and 0 SRDCP). The EUMETSAT DCS has a typical reliability greater than 99%.

The paper also included the EUMETSAT status of implementation of the CGMS Best Practices in support to DCP Transmitter Certification Process (EUM/CGMS/DOC/21/1252912) and DCP Data Access (EUM/CGMS/DOC/21/1252911).

CGMS-51-ISRO-WP-01 - Operational DCS status report + status of implementation of best practices (ISRO)

There was no report on the ISRO Data Collection Services (DCS) in CGMS-51 WGI.

CGMS-51-JMA-WP-02 - Operational DCS status report + status of implementation of best practices (JMA)

The Japan Meteorological Agency (JMA) has operated the Data Collection System (DCS) since its first Geostationary Meteorological Satellite (GMS) went into operation in 1978. The system plays important roles in collecting meteorological information as well as seismic intensity and tidal/tsunami data collaborating with the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS). In Japan, more than 400 DCPs collect seismic intensity data. Himawari-8's DCS has been operational since July 2015, and Himawari-9 took over the DCS service in 2022 and will continue in this role until 2029.

The Agency has decided that the planned Himawari-10 program set to replace Himawari-8/9 will assume the same DCS.

The paper also included the JMA status of implementation of the CGMS Best Practices in support to DCP Transmitter Certification Process (EUM/CGMS/DOC/21/1252912) and DCP Data Access (EUM/CGMS/DOC/21/1252911).

WGI discussed a comment from JMA on the DCS use on Himawari-10 and that the potential for DCS on Himawari-11 is dependent on DCS use. JMA would like to discuss this topic in the consideration of new technologies for satellite system including internet service by small satellites constellation in WGI, aligned with CGMS Future Direction project.

WGI agreed to the proposal with the following action.

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
TG on DCS	**8.4**	WGI/A51.12	DCS TG to arrange a dedicated meeting with JMA to give information from the SWOT analysis, including information from the 2022 Satcom Forum.	CGMS-52	**OPEN**

CGMS-51-NOAA-WP-03 - GOES DCS Status and Best Practice Implementation

The GOES DCS is an environmental data relay system that supports the collection of over 900,000 message per day from over 32,000 active Data Collection Platforms (DCPs) located throughout the Western Hemisphere. The GOES DCS Program has 672 different user agency agreements representing 61 countries. DCP platforms collect environmental data, transmit this information to a GOES East or West satellite. The satellites then rebroadcast this data to terrestrial receive facilities maintained by NOAA or a user's own facility. NOAA collects the complete range of DCS data, distributes it using the DCS Administrative and Data Distribution System (DADDS) or to other distribution interfaces. The DADDS is the central management for GOES DCS and provides user, DCP, and spectrum management tools.

The NOAA GOES DCS continues to be a highly reliable and highly utilized. The system continues to grow and fulfils many critical roles for many users, including use of environmental data to take action to protect life, property, and the environment. However, the growth of system usage has not had an accompanying maturation in the DCS system itself. Specific challenges include spectrum management and radio frequency interference (RFI). NOAA plans to replace the current version of DADDS, modernize DCP communication technologies, and restore a DCP Command link in order to make GOES DCS a more modern, efficient, and flexible system.

The paper also included the NOAA status of implementation of the CGMS Best Practices in support to DCP Transmitter Certification Process (EUM/CGMS/DOC/21/1252912) and DCP Data Access (EUM/CGMS/DOC/21/1252911).

CGMS-51-ROSHYDROMET-WP-01 - Operational DCS status report + status of implementation of best practices (ROSHYDROMET)

This document addresses the current status and technical specifications of the Russian data collection system and related future plans. The DCS is established to provide collection and distribution of meteorological data from the remote areas and to support natural hazards warning system.

Roshydromet has developed and deployed the national DCS based on geostationary meteorological satellites of Electro-L series (14.5W, 76E, 165.8E) with a backup option via Luch series communication satellite and highly elliptical orbit satellite Arctica-M. There are 696 DCPs currently deployed. DCPs are distributed all over the Russian territory, including 141 DCPs in hard-to-reach areas.

The Russian DCS will be further complemented with the launch of the second highly elliptical orbit satellite Arctica-M.

CGMS-51-CGMS-WP-05 - Best practices in support to DCP TX certification process - latest version and new proposals

This document covers the status of the following document "CGMS agency best practice in support to DCP TX certification process" (EUM/CGMS/DOC/21/1252912 v1, 5 November 2021). This document is still current and covers the best practices sufficiently, so WGI agreed no update is currently needed.

With the planning of a new Enhanced DCP standard it may be necessary to update this document in next meeting rounds.

CGMS-51-CGMS-WP-06 - Best Practices in support to DCP data access - latest version and new proposals

This document covers the status of the following document "CGMS agency best practice in support to DCP data access" (EUM/CGMS/DOC/21/1252911 v1, 5 November 2021). This document is still current and covers the best practices sufficiently, so WGI agreed no update is currently needed.

CGMS-51-NOAA-WP-04 - Small Satellite DCS Use as an Operational Concept

The Satellite DCS Use Concept Validation project was originally scoped to determine if satellites can successfully interface with the Data Collection System (DCS) receivers (DCPR) and thus provide a low-rate data (100, 300, or greater bps) service to satellite users.

Satellite use of the DCS fosters a new means for collecting and distributing meteorological and climatology data. This can be done using DCS equipped smallsats in polar orbits.

The initial concept has been successfully validated with TES-10. The concept is valid and DCS can be utilised to some degree by satellites. The TES-11 demonstration will be completed by the end of 2023 if the launch occurs as expected. An additional experiment involving both TES-11 and TES-12 as dual DCS hosting satellites may be possible in Q3 of 2023.

The launch and operation of TES-11 will provide a more significant validation of the operational challenges of this concept. Regulatory controls for access and protections will need to be considered by CGMS and the DCS hosting agencies once this second test is concluded. An agreement will need to be reached regarding the permitted use of DCS by satellite systems and under what conditions. It is expected that the Task Group on Data Collection Services will prepare for an initial discussion at CGMS-52.

DCS systems have come under pressure from small satellite constellation companies that seek additional usable RF spectrum and wish to increase use of this band for their space operations. It is expected that satellite use of the DCS system will alleviate some of this risk and may further strengthen the value of protecting the system.

Satellite use of the DCS also fosters a new means for collecting and distributing meteorological and climatology data. This can be done using DCS equipped smallsats in polar orbits. Additionally, should a commanding capability be implemented in GOES, this DCS equipped smallsat could also relay these commands from other DCS systems.

WGI agreed to the proposal with the following actions.

CGMS-50 ACTIONS - WGI					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**

TG on DCS	**8.9**	WGI/A51.13	Prepare a proposal on the agreed permitted Smallsat use of DCS by satellite systems and under what conditions, for discussion and endorsement at CGMS-52.	CGMS-52	**OPEN**

9. Space Weather Operational Issues

The report on usage of Space Weather products/services in support to satellite operations (each agency with experience + external speakers) will be covered in the Joint WGI-SWCG-WGIV meeting.

10. WGI Coordination Items

10.1 Status of CGMS future direction 2022+ project

CGMS-51-CGMS-WP-09 - Status of CGMS future direction 2022+ project

This working paper gave an overview of the activities undertaken on the CGMS future direction 2022+ project since CGMS-50 plenary for consideration and feedback by the CGMS-51 working groups (WGs I-IV and the SWCG). The 2nd high-level meeting on 29 March 2023 endorsed the proposed way forward, noting the need for the identification of concrete implementation measures in the next year (up to CGMS-52) and a stronger link as concerns the potential interfaces.

The basis for discussion were the agreed seven strategic themes:

- Socio-economic benefits – *proposed to be led by WGIII*
- Research to operations – *proposed to be led by WGIV*
- Future observing (hybrid) space infrastructure – *proposed to be led by WGI (Simon Elliott)*
- Future information technologies – *proposed to be led by WGI, WGIV (Cloud), WGII (AI/ML)*
- Relationship with the private sector – *proposed to be led by WGIII*
- Climate and Earth system monitoring – *proposed to be led by WGII*
- Space situational awareness – *proposed to be led by WGI and SWCG*
- + A topic for all: supporting developing countries

WGI was invited to take note of the status of CGMS future direction 2022+ project.

The proposals from the CGMS 2022+ for work to be led by WGI were welcomed. It was noted that many of them fit into existing activities within the various Task Groups. WGI agreed to the proposals for leadership of the different strategic themes.

Following CGMS-51, the concrete outcomes of the CGMS future direction 2022+ project need to be finalised, and further work to be implemented via concrete actions through the working groups.

10.2 CGMS Global Contingency Plan, as proposed by WGIII (incl. CGMS Baseline, Risk Assessment Workshop outcomes & Implementation of WGI aspects)

CGMS-51-WGIII-WP-02WGI - Status and outcome of the 5th CGMS risk assessment

The objective of the Risk Assessment Workshop is to:

- Update the CGMS Baseline based on member inputs;
- Prepare a consolidated Risk Assessment against the CGMS Baseline;
- Identify contingency actions to be taken, or actions to identify in the HLPP;
- Identify ways to integrate satellite data into the CGMS Baseline and characterise CGMS' contribution.

The Working Group III held a workshop from 21-23 February 2023, hosted by EUMETSAT.

WGI reviewed the draft update of the CGMS Risk Assessment.

CGMS-51-WGIII-WP-01WGI - CGMS Baseline - draft revision following the 5th risk assessment workshop

The 5th CGMS WGIII workshop was held on 21-23 February 2023 on whose occasion the CGMS baseline and related risk assessment was conducted. The baseline is reviewed annually instead of every 4 years. The WMO manual on WIGOS will be updated every year based on the revised CGMS Baseline. The working group reviewed the CGMS baseline and proposed revisions. The draft text of the revision of the CGMS baseline is included in the paper.

The text was reviewed by CGMS-51 WGI and other WGs in April-May 2023, in order to conclude on a final text for endorsement by CGMS-51 plenary in June 2023.

10.3 CGMS High Level Priority Plan (incl. Review, Status of implementation, Proposed Updates)

CGMS-51-CGMS-WP-07WGI - Status of implementation of CGMS High Level Priority Plan (2022-2026)

This working paper provided the status of implementation of CGMS High Level Priority Plan (2022-2026). It also listed proposals for changes to the HLPP targets. WGI reviewed and provided inputs to the current status of the HLPP.

CGMS-51-CGMS-WP-08 - Revised HLPP 2023-2027 - for plenary endorsement

WGI provided inputs for updates to the relevant sections of the HLPP. The HLPP will be updated based on inputs from the WGI meeting and the progress of the CGMS Future Direction 2022+ project, including:

- DCS – include EDCP planned timeline and further work proposals from SWOT
- RFI – include the establishment of best practices on RFI
- Low Latency Data Access – implement updates to reflect the creation of the Low Latency Data Access Task Group and its future work
- Satellite Data and Codes – add updates to reflect the coordination with WMO
- Space Debris and Collision Avoidance – include planned next steps including creation of best practices and updates according to CGMS Future Direction 2022+ project

10.4 WGI action items & recommendations (incl. review/updates of existing and proposed new action items & recommendations)

CGMS-51-WGI-WP-09WGI - WGI action items & recommendations (incl. review/updates of existing and proposed new action items & recommendations)

WGI discussed the actions and recommendations from previous CGMS plenary sessions (CGMS-50 and earlier). The status of the open actions on and recommendations for WGI were reviewed and updated as needed. The final status is provided in a table attached to this report.

10.5 Future WGI sessions (incl. dates for future plenary and intersessional meetings, proposals for new agenda items)

CGMS-51-WGI-WP-11 - Decision on dates on WGI activities in 2023-2024 (CGMS-51 to CGMS-52)

The paper guided the discussion on planning the dates and formats of the WGI activities between CGMS-51 and up to and including CGMS-52.

CGMS-51 WGI agreed on the following WGI intersessional meetings up to CGMS-52:

WGI	Proposed CGMSG-50 to CGMS-51 WGI intersessional dates
WGI Intersessional meetings	Tuesday 26 September 2023 at 12 UTC Wednesday 24 January 2024 at 12 UTC Tuesday 19 March 2024 at 12 UTC

CGMS-51 WGI agreed on the following WGI Task Group intersessional meetings up to CGMS-52:

WGI Task Group	Task Group Lead	Proposed CGMSG-50 to CGMS-51 WGI intersessional dates
Task Group on Low Latency Data Access	Antoine Jeanjean, Andrew Monham	Tuesday 12 September 2023 at 12 UTC Tuesday 7 November 2023 at 12 UTC Tuesday 23 January 2024 at 12 UTC Tuesday 12 March 2024 at 12 UTC
Task Group on Satellite Data and Codes	Simon Elliott	Thursday 28 September 2023 at 12 UTC Thursday 11 January 2024 at 12 UTC
Task Group on Data Collection Services	Nicholas Coyne	Thursday 18 May 2023 at 12 UTC Thursday 22 June 2023 at 12 UTC Thursday 20 July 2023 at 12 UTC Thursday 14 September 2023 at 12 UTC Thursday 12 October 2023 at 12 UTC Thursday 23 November 2023 at 12 UTC Thursday 25 January 2024 at 12 UTC Thursday 22 February 2024 at 12 UTC Thursday 21 March 2024 at 12 UTC
Task Group on Space Debris and Collision Avoidance	Andrew Monham	To be defined

WGI Task Group	Task Group Lead	Proposed CGMSG-50 to CGMS-51 WGI intersessional dates
Task Group on RFI detection, monitoring and mapping	Simon Elliott	Thursday 5 October 2023 at 12 UTC Thursday 18 January 2024 at 12 UTC

CGMS-51 WGI discussed and confirmed the following proposed dates of CGMS-52 plenary session:

WGI	Proposed CGMSG-50 to CGMS-51 WGI intersessional dates
CGMS-52 working group meetings	22-28 April 2024 Alternatives: 6-10 May 2024 (20-26 May 2024 - very close to plenary)
CGMS-52 plenary session In-person Host: NOAA	Week of 3-7 June 2024, USA

The confirmed schedule will be added to the online CGMS website meeting calendar.

CGMS-51-WGI-WP-10 - Status of co-chairs/rapporteurs of the CGMS working groups, CGMS International Science Working Groups, VLab, and other groups

This paper provided an overview of the co-chairs and rapporteurs in the CGMS Working Groups, rapporteurs in the CGMS international science working groups, and other CGMS related activities (VLab, JWGClimate, other task groups and teams).

The working paper provides the status of representatives and an indication of any positions that need to be filled in the near to medium-term future. CGMS members were invited to nominate candidates for co-chair and rapporteur positions (or upcoming positions) as necessary and to inform cgmssec@eumetsat.int accordingly.

Specifically for WGI, members were invited to nominate candidates for a co-chair and a co-rapporteur.

Further, the CGMS-51 working groups were requested to secure the nomination of candidates as far as is possible for recommendation to plenary for endorsement.

11. AOB

No AOB items were presented.

12. Meeting Conclusions

CGMS-51-WGI-WP-13 - Agreement on Outcomes, Conclusions & Preparations of WGI Report for Plenary (Co-Chairs / Rapporteurs)

The WGI Co-Chairs and Co-Rapporteur thanked the WGI meeting participants for their valuable contributions to a successful meeting.

The outcomes and conclusions of the meeting were reviewed against the expected outcomes presented in the beginning of the meeting. The expected outcomes were achieved, with some additional inputs on Terms of Reference and recording up-to-date membership to be provided by the Task Groups ahead of CGMS-52.

The summary list of actions is included below.

Status of CGMS-50 WGI actions following CGMS-51 plenary deliberations

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
WGI Task Group on Data Collection Services	5.1	WGI/A49.03	Analyse existing DCP standards taking into account user feedback, and propose a common standard that could be used as a future IDCS standard. This would be an evolution of an existing standard. There would also be workshops with the manufacturers to understand the best way to identify and implement this standard taking into account the SWOT analysis and the results of the survey commissioned by ESA.	***2023 24 Apr (CGMS-51 WGI): Action description updated. The plan is for the new EDCP standard to be proposed for endorsement in CGMS-52.*** Past activities: 2023 21 Mar: Progress has been made and will be presented as part of the task group report. The main topic for WGI will be how to move forward. 2023 24 Jan: DCS Workshop in October 2022, in conjunction with Satcom Forum. Some progress has been made on EDCP Standard discussions. A further Manufacturers workshop was held on 19 January to continue the EDCP Standard discussions. OTT, Microcom and Dr. Paul Crawford were present. This involved also a discussion on whether there is still the need for the EDCP standard, and the feedback was positive. Target is to have a draft outline and timeline for the EDCP standard for CGMS-51. 2022 27 Sep: The EDCP Standard will be the main topic of the DCS Workshop, which will take place on 12 October in Paris, as part of Satcom Forum 11-13 October, held in conjunction with the Met Tech Expo. WGI members are invited to join the DCS Workshop. The plan would be to have an outline of the EDCP Standard for CGMS-51 and a proposed EDCP Standard for CGMS-52. CGMS-50: WGI agreed to update action as follows “Analyse existing DCP standards taking into account user feedback, and propose a common	CGMS-52	**OPEN**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				standard that could be used as a future IDCS standard. This would be an evolution of an existing standard. There would also be workshops with the manufacturers to understand the best way to identify and implement this standard taking into account the SWOT analysis and the results of the survey commissioned by ESA." 2022 22 Mar: Discussions have been held in the DCS Task Group intersessionals. An update will be provided in the CGMS-50 WGI Task Group Report, including a proposal of approaching manufacturers. A DCS Workshop planned in the Satcom Forum. 2021 13 Sep IS: Discussions at next intersessional in December 2021/January 2022 The DCS Sub Group are working on this and plan to provide a report to CGMS 50. It was envisaged to organise a face to face meeting to discuss this topic but this has not been possible due to COVID. We are indeed looking to adapt and existing standard rather than start with a new one from scratch. It is hoped that following this path will mean existing platfors could be updated with firmware patches. Task Group lead: Nick.Coyne@eumetsat.int		
CGMS Task Force on Satellite Data and Codes, WMO	WGI V/5	WGIV/A49.02	The CGMS Task Group on Satellite Data and Codes to work closely with WMO on addressing the following points:	***2023 24 Apr (CGMS-51 WGI): Action is progressing and expected to be closed soon.*** Past activities: 2023 21 Mar: No update	CGMS-51 Plenary	**OPEN**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			i. Linking between OSCAR/Space and the WSI and/or CCT C-5 identifiers (WMO internal) ii. Potential extension of the use of the Issue Number in the WSI for satellites in order to explicitly indicate metadata which are otherwise only implicitly embedded in the Local Identifier (CGMS-50) iii. Identification of when and how the WSI should be included in the satellite products exchanges in the context of the WIGOS (CGMS-50) (ref CGMS-49-WMO-WP-08)	2023 24 Jan: Simon is in discussion with Heikki, who is working on this. Progress on this action will be reported in the TGSDC report for CGMS-51. 2022 27 Sep: First intersessional meeting was held in September 2022. Participation was very low. Broader participation in intersessional meetings is encouraged, but communication is handled also via offline email communication. CGMS-50: The Task Group is continuing to work on the use of WIGOS Station identifiers for satellite products. CGMS-50-CGMS-WP-14 includes text prepared by WMO Secretariat for the guide on the WIGOS explaining the use of WIGOS Station Identifiers for satellites. The Task Group continues to assess the best use the Issue Number (currently fixed to 0) in the future. 2022 11 Apr: Transferred to WGI. To be discussed with WMO (Simon, Chair, to follow up). WMO will first complete the ongoing WSI for satellites design and documentation in WIGOS Guide and its implementation in OSCAR/Space. CCT-C5 will be tentatively covered by that work. 2022 18 Jan: WMO to address latest on 27 October, ongoing work, done through WGI		
WGI Task Group on RFI detection, monitoring and mapping	2.1	WGI/A50.01	Continue forming the Task Group on RFI, establish and confirm the ToR for the Task Group, and investigate collectively mechanisms for	***2023 24 Apr (CGMS-51 WGI): Action closed based on the Task Group's paper to CGMS-51 WGI.*** 2023 21 Mar: No update	CGMS-51	**CLOSED**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			detection and long-term monitoring of and mapping of RFI (for example, but not limited to, from IMT-2020/5G into the 24 GHz passive band) at satellite or instrument level, or any other means, as the knowledge base for assessing the impact on the passive sensor measurements. The draft ToR is to be discussed in the intersessional meetings before CGMS-50 Plenary.	2023 24 Jan: Useful presentations from CGMS agencies in intersessionals. The report for CGMS-51 will include a proposed way forward for the future of the Task Group. Markus noted that there is now good awareness on what CGMS agencies are doing in this area. Any further action requires resources and commitment that need to be agreed by CGMS (and needs to be reflected in HLPP). 2022 27 Sep: In the intersessional meetings so far, NOAA, EUMETSAT and CMA presented their work in these areas. KMA have reached out to KARI and KASI.		
CGMS Members	2.1	WGI/A50.02	CGMS members to urge their national regulatory authorities, when establishing new regulations for use of active services and applications, to appropriately take into account the protection requirements of passive sensors and that the bands listed in RR FN 5.340 will not be opened for a shared use with active services.	***2023 24 Apr (CGMS-51 WGI): Keep action active until WRC-23 and update thereafter.*** Past activities: 2023 21 Mar: There will be a WRC preparatory meeting in next 2 weeks. This is a permanent activity. This action should remain open to increase visibility within CGMS and highlight the importance of this activity. Markus will highlight this issue again in his report. 2023 24 Jan: EUMETSAT and ESA actively provide inputs to WRC and WRC 2027 agenda.	WRC-23	**OPEN**
SFCG Rep	2.1	WGI/A50.03	SFCG rep to circulate (by the end of 2022) the updated WMO preliminary position paper on WRC-23 after being updated by ET-RFC at its August/September 2022	***2023 24 Apr (CGMS-51 WGI): Closed in favour of new action to circulate Final WMO position paper on WRC-23.***	CGMS-51	**CLOSED**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			meeting and afterwards adopted within WMO. CGMS members would then need to ensure the updated WMO positions known to its members' national and international preparation processes for WRC-23.	2023 21 Mar: Final WMO position paper on WRC-23 will be worked on 18-20 April 2023, so it would be worth re-circulating this again. Action re-opened. 2023 24 Jan: The updated WMO positions paper on WRC-23 agenda was circulated to WGI members on 4 Nov 2022. As there will be the Conference Preparatory Meeting (CPM) from 27 March to 6 April 2023, a major milestone in the ITU-R preparation for WRC-19, CGMS members are invited to make this updated WMO positions known to its members' national and international preparation processes for WRC-23. Further, this will be reported in the CGMS-51 WGI SFCG Report (in conjunction with WMO). Action closed. 2022 27 Sep: The paper has been updated and will be circulated to WGI shortly - timeline to be confirmed with Markus.		
CGMS Members	2.1	WGI/A50.04	SFCG Rep and WMO to propose a process for providing accurate and timely updates on satellite frequencies recorded in OSCAR/Space database. This process should ensure CGMS agencies inputs to the database to WMO are aligned with SFCG inputs and activities. The proposed process is to be presented by October 2022.	***2023 24 Apr (CGMS-51 WGI): Closed in favor of new action for WMO to introduce the templates agreed with the SFCG for updating the remote sensor information in OSCAR/Space into the current procedure through the OSCAR/Space Support Team (O/SST).*** 2023 21 Mar: The proposed process will be included in the report from Markus, with inputs from Heikki. 2023 24 Jan: A proposal for the process was distributed to WGI. This will be presented in the SFCG report and process can be decided in CGMS-51 WGI.	October 2022	**CLOSED**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2022 27 Sep: Heikki will follow up with Markus on documenting the process.		
WMO	2.1	WGI/A50.05	WMO to include the frequency information in their updated templates to OSCAR/Space Support Team (O/SST)	*2022 27 Sep: Completed, this is now standard procedure. Action closed.*	October 2022	**CLOSED**
WGI Task Group on Data Collection Services	4.1	WGI/A50.06	Build on the work of the SWOT analysis on the DCS from Geostationary Meteorological satellites, and particularly progress on the five proposals for further work (covering RFI Mitigation, joint DCS PR materials, DCS introduction video, manufacturer workshop, discoverable information) and present the outcome to CGMS-51.	***2023 24 Apr (CGMS-51 WGI): Manufacturer workshop was held in October 2022. DCS PR materials and DCS introduction video to be progressed. DCS RFI register to be created and passed on to TGRFI. Further work on the SWOT to be covered under new action on completing the SWOT.*** 2023 21 Mar: Progress has been made on the various SWOT areas and will be presented in the task group report. 2023 24 Jan: As part of the SWOT analysis follow-up, options for raising the profile of the DCS have been explored. Nick has been in touch with the World Bank on potential podcast on DCS. 2022 27 Sep: RFI, DCP Standard and DCS Outreach will be discussed in the DCS Workshop on 12 October.	CGMS-52	**CLOSED**
Task Group on Space Debris and Collision Avoidance	5.1	WGI/A50.07	Deliver a Best Practice document on collision avoidance and debris mitigation, with supporting presentation to CGMS WGI, for recommendation for endorsement in CGMS-52.	***2023 24 Apr (CGMS-51 WGI): Action to be kept open, and pursued by TG in the lead up to CGMS-52. This should be based on previous inputs from EUMETSAT and NOAA, and seek wider participation from CGMS agencies.*** Past activities:	CGMS-52	**OPEN**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2023 21 Mar: No updates, way forward to be discussed in CGMS-51 WGI. 2023 24 Jan: No updates. Tom will follow up with Brian Walling. 2022 27 Sep: Task Group meeting to be held		
CGMS Members	5.1	WGI/A50.08	All CGMS Members involved in spacecraft operations are strongly encouraged to nominate participants for the CGMS WGI Task Group on Space Debris and Collision Avoidance. The names of nominated participants are to be provided to the Task Group lead and CGMS WGI Co-chairs / rapporteur before CGMS-51 Plenary, so that the names of members can be reported to CGMS-51 plenary. This is to allow the formulation of the initial Best Practice on collision avoidance and debris mitigation before CGMS-52.	***2023 24 Apr (CGMS-51 WGI): Action still valid. Due date updated.*** Past activities: 2023 21 Mar: No updates, way forward to be discussed in CGMS-51 WGI. 2023 24 Jan: No updates. 2022 27 Sep: KMA have nominated a member for the task group. Reminder for further nominations to be sent.	May 2023	**OPEN**
WGI Task Group on the Coordination of LEO Orbits + WGI Task Group on Direct	5.2 / 3.1	WGI/A50.09	Build on the SWOT analysis on Low Latency Data Access from LEO meteorological satellites (CGMS-50-CGMS-WP-08) work and broaden its scope to include the following,	***2023 24 Apr (CGMS-51 WGI): The SWOT can be considered closed based on report to CGMS-50 WGI (CGMS-51-WGI-WP-06). Three ways for low latency data access were explored.*** 2023 21 Mar: SWOT is ready and extensive comments have been received from ESTEC. A draft	CGMS-51	**CLOSED**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
Broadcast Systems			thereby removing historical requirement and architectural boundaries between global data access and direct broadcast systems: • Global data coverage and access; • Temporal coverage over a given geographic area; • Low latency data delivery; Perform further study on the possible usage of emerging technologies identified by the SWOT analysis. The two Task Groups should hold meetings and agree on a proposed way forward for a consolidated SWOT analysis, and present to CGMS-51 for consideration. All CGMS agencies are encouraged to nominate participants to contribute to this activity.	SWOT will be included in the Task Group report. Integration of the comments from ESTEC will be done by CGMS-52. 2023 24 Jan: Main finding of SWOT analysis is the lack of standards for inter-satellite communication. This will be included in the group's report for CGMS-51. It can then be decided whether CGMS wants to explore this topic further and open an action for CGMS-52. 2022 27 Sep: One joint task group meeting has taken place, work ongoing.		
WGI Task Group on the Coordination of LEO Orbits	5.2	WGI/A50.10	Task Group on the Coordination of LEO Orbits and Task Group on Direct Broadcast Systems to review	***2023 24 Apr (CGMS-51 WGI): In view of the merge of the two task groups, this action was closed, in favour of a new action to merge the LEO and DB best practices.***	CGMS-51	**CLOSED**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
+ WGI Task Group on Direct Broadcast Systems			the overlap between the proposed (BP) for the Coordination of Data Acquisition for Low Earth Orbit (LEO) Satellite Systems and the already published Best practices in support to local and regional processing of LEO direct broadcast data (CGMS/DOC/18/1008274), and propose a way forward for both best practices. The updated best practices drafts should be sent for review before CGMS-51 and presented to CGMS-51.	2023 21 Mar: As a merged task group is being proposed for next year, it is proposed to make a proposal for the BP merge and provide a version ready for publishing for CGMS-52. 2023 24 Jan: Work on reviewing the overlap between the BPs has been ongoing. 2022 27 Sep: One joint task group meeting has taken place, work ongoing.		
CGMS Members	6	WGI/A50.11	CGMS agencies to consider nominating additional members for all the WGI Task Groups (listed below) by CGMS-51 Plenary, especially ones where no representatives of the agencies are currently participating in the Task Group(s). - Task Group on Low Latency Data Access - Task Group on Satellite Data and Codes - Task Group on Data Collection Services	***2023 24 Apr (CGMS-51 WGI): Members were welcome to nominate additional members, particularly for the merged Task Group on Low Latency Data Access and Task Group on Space Debris and Collision Avoidance. Additionally, participation of ISRO would complement the Task Group on DCS and Task Group on SDC. Anne to contact JV Thomas about ISRO participation.*** Past activities: 2023 21 Mar: Task Group Chairs to identify any gaps in membership and propose in CGMS-51 WGI invite for nominations as necessary. 2023 24 Jan: WGI Task Group Chairs to please create an up-to-date list of Task Group members	May 2023	**OPEN**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			- Task Group on Space Debris and Collision Avoidance - Task Group on RFI detection, monitoring and mapping	and provide to the Co-Chairs / Rapporteur + include in CGMS WGI TG reports. 2022 27 Sep: Reminder for nominations to be sent.		
All WGI Task Groups	6	WGI/A50.12	Each of the WGI Task Groups to present its latest Terms of Reference to CGMS-50, which following endorsement should be added to the CGMS Website by CGMS Secretariat. The updated Terms of Reference of the Task Groups can then be used as inputs to the review of the WGI ToRs in 2023.	***2023 24 Apr (CGMS-51 WGI): Draft ToR for the new TG on*** Low Latency Data Access ***LLDA were presented, and will be finalised for CGMS-52.*** ***There were some comments on the TG on DCS ToRs, so these would need to be revised.*** ***The TG on SDC ToRs were not presented and will be provided offline.*** ***The TG on RFI ToRs were presented and endorsed.*** ***The TG on Space Debris and CA ToRs were not presented.*** ***The ToRs that exist and are already agreed should be put on the CGMS website.*** Past activities: 2023 21 Mar: The Task Groups are preparing updated ToRs to be presented in CGMS-51 WGI. Following CGMS-51 endorsement, these should be added to the CGMS website. The ToRs should then be reviewed annually as part of the Task Group report preparation. 2023 24 Jan: Now that all Task Groups are established, we would like to ensure the Terms of Reference of the groups are consistent. WGI Task	CGMS-51 Plenary	**OPEN**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				Group Chairs to please include the TG Terms of Reference in the CGMS-51 WGI TG reports. 2022 27 Sep: Integrated in the draft CGMS-51 WGI agenda		
Plenary	2	WGIIR49 (Transferred WGI)	Working Group II recommends to CGMS Plenary the adoption of the proposed GEO baseline products presented in CGMS-49-WMO-WP-14 with the addition of SSTs, to be considered for subsequent implementation by all Agencies.	***2023 24 Apr (CGMS-51 WGI): This is being tracked by both WGII and WGIV. WGIV is waiting on WGII to confirm the GEO baseline products, in order to then proceed with discussions of the dissemination baseline. It was agreed that action will be removed from the WGI actions list.*** Past activities: 2022 10 Jan: Request sent to WGI leading group. 2022 28 Sep: To be addressed in the next WGII inter-sessional meeting 12 October. CGMSSEC to send this action to WGII lead. 2022 22 Sep MRa: Assuming that WGII has finally confirmed the GEO baseline products (unclear!), the question is how to reflect this in CGMS documentation (could be the CGMS Baseline or a self-standing doc, to be discussed in WGIII) and how to monitor the implementation in terms of production and dissemination (probably a question for WGIV). 2021 28 Sep: JV Thomas to address this with WGII co-chairs/rapporteurs. Principle endorsed by CGMS-49 plenary. WGII/Ken to send to WGIII and WGIV relevant	CGMS-50	**To be removed from WGI actions list**

Status of CGMS-50 actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				parts of WGII report. Action to WGIII to update the baseline accordingly. (WGII action to WGIV on related redistribution mechanisms).		
All WGI Task Groups	6	WGI/R50.01	Each of the WGI Task Groups to continuously present the following, starting with CGMS-51. All of the agencies are encouraged to provide inputs. - Existing / updated Best Practices - Status of implementation of Best Practices for each agency - Future work / recommendations / proposals (taking into consideration outcome of SWOT analyses)	***2023 24 Apr (CGMS-51 WGI): This is now the standard way of reporting for the TGs implemented via the new CGMS WGI agenda structure. This agenda structure should be adopted for following CGMS meetings. CLOSED.*** 2023 21 Mar: This is now the standard way of reporting for the TGs implemented via the new CGMS WGI agenda structure. This agenda structure should be adopted for following CGMS meetings. 2023 24 Jan: As per the CGMS-51 WGI agenda, each task group is expected to ensure the following inputs: • In the TG report - an up-to-date list of TG members, TG Terms of Reference, status of current and proposed activities • Latest version and new proposals for all Best Practices under the responsibility of the Task Group • Report from each Agency on the status of implementation of the Best Practices 2022 27 Sep: Integrated in the draft CGMS-51 WGI agenda	CGMS-51	**CLOSED**

Summary of WGI actions resulting from CGMS-51 discussions

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
TG on DCS	5.1	WGI/A49.03	Analyse existing DCP standards taking into account user feedback, and propose a common standard that could be used as a future IDCS standard. This would be an evolution of an existing standard. Following approval of the new EDCP standard, develop an implementation plan including prototyping, validation and outreach to users.	*2023 26 Sep: Progressing well. Microcom and Sutron have been joining DCS intersessionals, which contributes to the definition of the standard.* Past activities: 2023 24 Apr (CGMS-51 WGI): Action description updated. The plan is for the new EDCP standard to be proposed for endorsement in CGMS-52. 2023 21 Mar: Progress has been made and will be presented as part of the task group report. The main topic for WGI will be how to move forward. 2023 24 Jan: DCS Workshop in October 2022, in conjunction with Satcom Forum. Some progress has been made on EDCP Standard discussions. A further Manufacturers workshop was held on 19 January to continue the EDCP Standard discussions. OTT, Microcom and Dr. Paul Crawford were present. This involved also a discussion on whether there is still the need for the EDCP standard, and the feedback was positive. Target is to have a draft outline and timeline for the EDCP standard for CGMS-51. 2022 27 Sep: The EDCP Standard will be the main topic of the DCS Workshop, which will take place on 12 October in Paris, as part of Satcom Forum 11-13 October, held in conjunction with the Met Tech Expo. WGI members are invited to join the DCS Workshop. The plan would be to have an outline of the EDCP Standard for CGMS-51 and a proposed EDCP Standard for CGMS-52.	CGMS-52	**OPEN**

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				CGMS-50: WGI agreed to update action as follows "Analyse existing DCP standards taking into account user feedback, and propose a common standard that could be used as a future IDCS standard. This would be an evolution of an existing standard. There would also be workshops with the manufacturers to understand the best way to identify and implement this standard taking into account the SWOT analysis and the results of the survey commissioned by ESA." 2022 22 Mar: Discussions have been held in the DCS Task Group intersessionals. An update will be provided in the CGMS-50 WGI Task Group Report, including a proposal of approaching manufacturers. A DCS Workshop planned in the Satcom Forum. 2021 13 Sep IS: Discussions at next intersessional in December 2021/January 2022 The DCS Sub Group are working on this and plan to provide a report to CGMS 50. It was envisaged to organise a face to face meeting to discuss this topic but this has not been possible due to COVID. We are indeed looking to adapt and existing standard rather than start with a new one from scratch. It is hoped that following this path will mean existing platfors could be updated with firmware patches. Task Group lead: Nick.Coyne@eumetsat.int		

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
TG SDC, WMO	WGI V/5	WGIV/A49.02	The CGMS Task Group on Satellite Data and Codes to work closely with WMO on addressing the following points: i. Linking between OSCAR/Space and the WSI and/or CCT C-5 identifiers (WMO internal) ii. Potential extension of the use of the Issue Number in the WSI for satellites in order to explicitly indicate metadata which are otherwise only implicitly embedded in the Local Identifier (CGMS-50) iii. Identification of when and how the WSI should be included in the satellite products exchanges in the context of the WIGOS (CGMS-50) (ref CGMS-49-WMO-WP-08)	*2023 26 Sep: Well in progress. Should be implemented before INFCOM-3. Submission expected to INFCOM-3 in April 2024.* 2023 24 Apr (CGMS-51 WGI): Action is progressing and expected to be closed soon. Past activities: 2023 21 Mar: No update 2023 24 Jan: Simon is in discussion with Heikki, who is working on this. Progress on this action will be reported in the TGSDC report for CGMS-51. 2022 27 Sep: First intersessional meeting was held in September 2022. Participation was very low. Broader participation in intersessional meetings is encouraged, but communication is handled also via offline email communication. CGMS-50: The Task Group is continuing to work on the use of WIGOS Station identifiers for satellite products. CGMS-50-CGMS-WP-14 includes text prepared by WMO Secretariat for the guide on the WIGOS explaining the use of WIGOS Station Identifiers for satellites. The Task Group continues to assess the best use the Issue Number (currently fixed to 0) in the future. 2022 11 Apr: Transferred to WGI. To be discussed with WMO (Simon, Chair, to follow up). WMO will first complete the ongoing WSI for satellites design and documentation in WIGOS Guide and its implementation in OSCAR/Space. CCT-C5 will be tentatively covered by that work.	April 2024 (CGMS-52 WGI)	**OPEN**

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2022 18 Jan: WMO to address latest on 27 October, ongoing work, done through WGI		
CGMS Members	2.1	WGI/A50.02	CGMS members to urge their national regulatory authorities, when establishing new regulations for use of active services and applications, to appropriately take into account the protection requirements of passive sensors and that the bands listed in RR FN 5.340 will not be opened for a shared use with active services.	*2023 26 Sep: ESA and EUMETSAT have worked together to ensure this is on the WRC-27 agenda. Further work needed in other regions outside Europe.* 2023 24 Apr (CGMS-51 WGI): Keep action active until WRC-23 and update thereafter. Past activities: 2023 21 Mar: There will be a WRC preparatory meeting in next 2 weeks. This is a permanent activity. This action should remain open to increase visibility within CGMS and highlight the importance of this activity. Markus will highlight this issue again in his report. 2023 24 Jan: EUMETSAT and ESA actively provide inputs to WRC and WRC 2027 agenda.	WRC-23	**OPEN**
Task Group on Space Debris and Collision Avoidance	5.1	WGI/A50.07	Deliver a Best Practice document on collision avoidance and debris mitigation, with supporting presentation to CGMS WGI, for recommendation for endorsement in CGMS-52.	*2023 26 Sep: Action on this will be taken following first intersessional of the TG (expected November 2023).* Past activities: 2023 24 Apr (CGMS-51 WGI): Action to be kept open, and pursued by TG in the lead up to CGMS-52. This should be based on previous inputs from EUMETSAT and NOAA, and seek wider participation from CGMS agencies.	CGMS-52	**OPEN**

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2023 21 Mar: No updates, way forward to be discussed in CGMS-51 WGI. 2023 24 Jan: No updates. Tom will follow up with Brian Walling. 2022 27 Sep: Task Group meeting to be held		
CGMS Members	5.1	WGI/A50.08	All CGMS Members involved in spacecraft operations are strongly encouraged to nominate participants for the CGMS WGI Task Group on Space Debris and Collision Avoidance. The names of nominated participants are to be provided to the Task Group lead and CGMS WGI Co-chairs / rapporteur before CGMS-51 Plenary, so that the names of members can be reported to CGMS-51 plenary. This is to allow the formulation of the initial Best Practice on collision avoidance and debris mitigation before CGMS-52.	*2023 26 Sep: There is also a CGMS plenary action on this. Sean/Karolina to follow up with Anne to communicate to all CGMS members and encourage participation.* Past activities: 2023 24 Apr (CGMS-51 WGI): Action still valid. Due date updated. 2023 21 Mar: No updates, way forward to be discussed in CGMS-51 WGI. 2023 24 Jan: No updates. 2022 27 Sep: KMA have nominated a member for the task group. Reminder for further nominations to be sent.	May 2023	**OPEN**
CGMS Members	6	WGI/A50.11	CGMS agencies to consider nominating additional members for all the WGI Task Groups (listed below) by CGMS-51 Plenary, especially ones where no	*2023 26 Sep: There is also a CGMS plenary action on this. Sean/Karolina to follow up with Anne to communicate to all CGMS members and encourage participation.* Past activities:	May 2023	**OPEN**

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			representatives of the agencies are currently participating in the Task Group(s). - Task Group on Low Latency Data Access - Task Group on Satellite Data and Codes - Task Group on Data Collection Services - Task Group on Space Debris and Collision Avoidance - Task Group on RFI detection, monitoring and mapping	2023 24 Apr (CGMS-51 WGI): Members were welcome to nominate additional members, particularly for the merged Task Group on Low Latency Data Access and Task Group on Space Debris and Collision Avoidance. Additionally, participation of ISRO would complement the Task Group on DCS and Task Group on SDC. Anne to contact JV Thomas about ISRO participation. 2023 21 Mar: Task Group Chairs to identify any gaps in membership and propose in CGMS-51 WGI invite for nominations as necessary. 2023 24 Jan: WGI Task Group Chairs to please create an up-to-date list of Task Group members and provide to the Co-Chairs / Rapporteur + include in CGMS WGI TG reports. 2022 27 Sep: Reminder for nominations to be sent.		
All WGI Task Groups	6	WGI/A50.12	Each of the WGI Task Groups to present its latest Terms of Reference to CGMS-50, which following endorsement should be added to the CGMS Website by CGMS Secretariat. The updated Terms of Reference of the Task Groups can then be used as inputs to the review of the WGI ToRs in 2023.	*2023 26 Sep: ToRs of the Task Groups, taking into account comments from CMGS-51, should be presented also in CGMS-52.* Past activities: 2023 24 Apr (CGMS-51 WGI): Draft ToR for the new TG on LLDA were presented, and will be finalised for CGMS-52. There were some comments on the TG on DCS ToRs, so these would need to be revised. The TG on SDC ToRs were not presented and will be provided offline.	CGMS-51 Plenary	**OPEN**

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				The TG on RFI ToRs were presented and endorsed. The TG on Space Debris and CA ToRs were not presented. The ToRs that exist and are already agreed should be put on the CGMS website. 2023 21 Mar: The Task Groups are preparing updated ToRs to be presented in CGMS-51 WGI. Following CGMS-51 endorsement, these should be added to the CGMS website. The ToRs should then be reviewed annually as part of the Task Group report preparation. 2023 24 Jan: Now that all Task Groups are established, we would like to ensure the Terms of Reference of the groups are consistent. WGI Task Group Chairs to please include the TG Terms of Reference in the CGMS-51 WGI TG reports. 2022 27 Sep: Integrated in the draft CGMS-51 WGI agenda		
WGI Co-Chairs / Rapporteur / WGI Task Group Chairs	1.1	WGI/A51.01	Propose an updated WGI Terms of Reference, based on the CGMS Future Directions Project outcomes and inputs from the WGI Task Groups, to be presented for endorsement to CGMS-52. The WGI Terms of Reference will be based on inputs from the WGI Task Groups on their latest Terms of Reference.	*2023 26 Sep: Sean and Karolina will prepare WGI ToRs, with inputs from the TG ToRs and support from TG Chairs.*	CGMS-52	**OPEN**

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
WMO	2.1	WGI/A51.02	SFCG Representative to distribute to CGMS the final WMO position paper on WRC-23. CGMS members would then need to ensure the final WMO positions known to its members' national and international preparation processes for WRC-23.	*2023 Sep 26: WMO position paper was distributed. Action can be closed.*	June 2023	**CLOSED**
WMO	2.1	WGI/A51.03	WMO to introduce the templates agreed with the SFCG for updating the remote sensor information in OSCAR/Space into the current procedure through the OSCAR/Space Support Team (O/SST).	*2023 Sep 26: Information has been shared with O/SST. Final confirmation expected.*	End of 2023	**OPEN**
TGRFI	3.1	WGI/A51.04	Analyse the inputs provided by CMA, EUMETSAT, KMA and NOAA on spectrum concerns and activities on RFI detection, monitoring and mapping, and pursue the establishment of a draft set of best practices by CGMS-52, based on the common aspects of the approaches already adopted by members.	*2023 Sep 26: Action on this will be taken following first TG on RFI intersessional, expected in October 2023.*	CGMS-52	**OPEN**
TGRFI	3.1	WGI/A51.05	Explore the potential / existing uses of AI/ML and pattern	*2023 Sep 26: Action on this will be taken following first TG on RFI intersessional, expected in October 2023.*	CGMS-52	**OPEN**

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			recognition in the area of RFI detection			
LLDA TG Low Latency Data Access	5.1	WGI/A51.06	Merge the Direct Broadcast Systems and LEO Coordination tasks groups into a single “Low latency Data Access from LEO Satellites” task group, with Andrew Monham and Antoine Jeanjean as Co-chairs. Finalise the draft Terms of Reference with inputs from WGI and taking into account the specific goals from the CGMS Position Papers, in particular the “Future Information Technologies” and “Future Observing (Hybrid) Space Infrastructures”. Present the finalised ToRs for endorsement to CGMS-52. The work of the TG should include keeping the SWOT analysis current (process to be noted in the ToRs). As part of the merge, update and present the list of members, create a new mailing list LWGI_LLDA@LISTSERV.EU	*2023 Sep 26: ToR under preparation. Draft was presented last year, and comments from TG welcome.*	CGMS-52	**OPEN**

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			METSAT.INT, remove old mailing list.			
LLDA TG	5.1	WGI/A51.07	Distribute a summary of the SWOT analysis on Low Latency Data Access from LEO meteorological satellites to the remaining CGMS Working Groups.	*2023 Sep 26: Work underway.*	CGMS-52	**OPEN**
LLDA TG	5.1	WGI/A51.08	Analyse potential role of satellite platform as a service (SPaaS), considering current and expected providers, internet connection speed, hosted instruments specifications (size/weight/power), orbit type, satellite lifetime and cost breakdown. Report to CGMS-52.	*2023 Sep 26: Work underway. There are satellite providers that can host a small/medium instrument. NASA are looking at a Rapid Space Programme making use of an existing platform.*	CGMS-52	**OPEN**
LLDA TG	5.5	WGI/A51.09	Merge the LEO (Global) and DB (regional) best practices into a single “Low Latency Best Practices” document proposed to be structured as follow: · Common BPs for both regional and global missions · BPs specific for DB · BPs specific for global mission	*2023 Sep 26: Work underway.*	CGMS-52	**OPEN**

CGMS-51 WGI actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			Present the merged BPs for endorsement to CGMS-52.			
TG on DCS	8.1	WGI/A51.10	DCS TG to complete the DCS SWOT analysis and provide current conclusions and recommendations to WGI.	*2023 Sep 26: Work underway.*	CGMS-52	**OPEN**
TG on DCS	8.1	WGI/A51.11	As part of the routine DCS TG activities (to be reflected in the ToR), review and update DCS SWOT analysis yearly and provide to WGI – the next update, which will also take as input the outcomes of the CGMS 2022+ project.	*2023 Sep 26: This would be part of the TG on DCS reports to CGMS.*	CGMS-52	**OPEN**
TG on DCS	8.4	WGI/A51.12	DCS TG to arrange a dedicated meeting with JMA to give information from the SWOT analysis, including information from the 2022 Satcom Forum.	*2023 Sep 26: Nick and Skip will coordinate on behalf of EUMETSAT and NOAA a meeting with JMA. This would also confirm JMA's future plans for DCS on Himawari.*	CGMS-52	**OPEN**
TG on DCS	8.9	WGI/A51.13	Prepare a proposal on the agreed permitted Smallsat use of DCS by satellite systems and under what conditions, for discussion and endorsement at CGMS-52.	*2023 Sep 26: New launch opportunity under clarification. Q2/Q3 2024 launch. Smallsat use on DCS has been tested, discussions to be held on practices for use of Smallsat (what it can and cannot be used for in the frame in DCS). The proposal on agreed permitted Smallsat use of DCS would need to be a separate paper to CGMS-52. This would go to plenary for endorsement.*	CGMS-52	**OPEN**

LIST OF PARTICIPANTS

CGMS-51 - WGI List of Participants		
Organisation	**Lastname**	**Organisation**
Shuze	Jia	CMA
Wei	Zheng	CMA/NSMC
Alexis	Sarraute	ESA
Juna-Pekka	Luntama	ESA
Mikael	Rattenborg	EUMETSAT/CGMS Sec
Anne	Taube	EUMETSAT/CGMS Sec
Andrew	Monham	EUMETSAT
Antoine	Jeanjean	EUMETSAT
Karolina	Nikolova	EUMETSAT
Nicholas	Coyne	EUMETSAT
Sean	Burns	EUMETSAT
Simon	Elliott	EUMETSAT
Flavio	Murolo	EUMETSAT
Rocio	Martin Pardo	EUMETSAT
Akiyoshi	Andou	JMA
Arata	Okuyama	JMA
Harada	Reiko	JMA
Kotaro	Bessho	JMA
Kitajima	Toshiyuki	JMA
Takuya	Sakashita	JMA
Nozomi	Hata	JMA
Yasuhiko	Sumida	JMA
Yasutaka	Hokase	JMA
Yoshiaki	Takeuchi	JMA
Noriyuki	Kawano	JMA
Dohyeong	Kim	KMA
Melissa	Johnson	NOAA
William	Dronen	NOAA
Letecia	Reeves	NOAA
Thomas	Renkevens	NOAA
Beau	Backus	NOAA (JHU APL supporting)
Olga	Ryzhkova	ROSHYDROMET
Heikki	Pohjola	WMO
Zoya	Andreeva	WMO
Chang	Liu	WMO

CGMS

Working Group II (WGII)

Satellite data and products

WGII REPORT

Chair: *J. V. Thomas ISRO*
Acting Co-Chair: *H. Pohjola, WMO*
Rapporteur: *P. Ruti, EUMETSAT / M. Goldberg, NOAA*

1. Opening, objectives and expected outcomes

Morning session chaired by Natalia Donoho (NOAA). The opening session put forward the following expected outcomes:

i) Provide a scientific forum for CGMS agencies to address global issues and challenges with respect to data and products generation from their specific satellite systems;
ii) Address areas of mutual interest and advice agencies on topics related to development and use of satellite data and products, and related coordination activities, including on relevant issues for the implementation of the Vision for the WMO Integrated Global Observing System (WIGOS) in 2040;
iii) Provide guidance on questions related to satellite data and products to user communities, such as those organized in the WMO Application Areas;
iv) Act as CGMS interface, at expert level, to other groups and organisations in areas of satellite data and products, with respect to science and product development, and instrument calibration activities;
v) Promote common standards and methodologies in the area of product generation (Level-1 and -2) including calibration;
vi) Address scientific and operational aspects of the satellite data production systems at international level;
vii) Exchange and harmonise, where applicable, user requirements for satellite data and products;
viii) Address topics from the CGMS High Level Priority Plan within the scope of WGII;
ix) Arrange efficient reporting from the ISWGs and other CGMS-related international initiatives to WGII and CGMS Plenary;
x) Ensure a scientific dialogue at CGMS Member agency level on pertinent issues and high priority scientific challenges;
xi) Support the work of the ISWGs and provide actions and recommendations for this purpose;
xii) Assess recommendations from the ISWGs and provide guidance to the CGMS Plenary on issues raised;
xiii) Support the preparation of selected thematic plenary session.

WGII endorsed Heikki Pohjola (WMO) as the incoming co-chair after the retirement of Kenneth Holmlund (WMO).

2. CGMS agency reports on highlights and issues in dataset and product generation [150']

CGMS-51-CMA-WP-04 - CMA agency report on highlights and issues in dataset and products

Executive Summary

- FY Historical satellite data repossessing dataset for 13 satellites and 7 types instruments has been constructed spanning 30 years, including 7 FCDR and 4 TCDR to significantly improved quality of the dataset, and strongly supported the application research of remote sensing data in China.
- FY-3G, the first satellite of China to measure precipitation with the active dual-frequency radars in space, has been successfully launched on April 16, 2023. Four instruments have been turned on and running in good condition, and in-obit testing will be carried out in the following 6 months.
- CMA developed an automated hailstorm likelihood estimation algorithm, demonstrating the potential and advantages of Fengyun satellites in weather nowcasting.

NOAA personnel enquired whether the CMA was developing a Small- or CubeSat programme, and the CMA responded that although nothing had been decided yet operationally speaking, there was an on-going scientific project.

CGMS-51-EUMETSAT-WP-04 - EUMETSAT report on highlights and issues in dataset and product generation

Executive Summary

- MTG-I1 successfully launched on December 13, 2022 at 21:30 CET
    - The Commissioning of MTG-I1 is to be divided into two main parts: Satellite in-orbit verification (done by ESA & Industry) and System commissioning, including end-to-end processor science validation (done by EUMETSAT).
- FCI first full disk acquisition took place on 15 March. 'First image' to be published on 4th May, 2023.
- Lightning Imager (LI) full activation is to follow on the week starting 17th April.
- Future plans: MTG-S to be launched early 2023, MetOp-SG-A in mid-2024, MetOp-SG-B in mid-2025 and MTG-I2 in mid-to-late 2025.
- The operational follow-on to ESA's Aeolus DWL (EPS-Aeolus) and a new MW Sounder constellation of SmallSats (EPS-Sterna) are both in preparatory phases (0-A-B). Full scientific and socio-economic benefits analyses for both programmes are to follow shortly.
- EUMETSAT has been paying interest to the development of AI/ML, particularly on the potential to change Nowcasting and NWP.
- Next EUM Meteorological Conference to be held on Sept. 11-15th in Malmö, Sweden.

CGMS-51-IMD-WP-01 - IMD report on highlights and issues in dataset and product generation

Executive Summary

- Two GEO satellites operated by IMD (INSAT-3DR and INSAT-3D) presented.
- IMD reported on MMDRPS – A new Indian data processing system, designed to handle the data from the INSATs. Provides computing resources which enable acquisition, processing, archival and dissemination of complete meteorological data sets.
- New products Developed:
    - Storm index, Experimentally-derived detection of storms every 15 minutes by integrating OLR from INSAT and reflectivity from precipitation radar on-board TRMM
    - Climate product, gridded (0.1°) OLR product using GSICS-corrected INSAT-3D, for between 2014-2020. Tests showed broad agreement with other observation with bias of ca. 5-6 W/m^2 over continental India. Testing in the wider Indian ocean region to follow to fill the gap in CDR.
- RAPID V2: RAPID scan facility of INSAT-3DR Imager, was demonstrated on tropical cyclones in the Northern Indian Ocean during 2022.

CGMS-51-ISRO-WP-03 - ISRO report on highlights and issues in dataset and product generation

Executive Summary

- Presently, 2 satellites INSAT-3D and INSAT-3DR are operational (by IMD) in GEO. Sounder on-board INSAT-3D is not functioned since Sep 2020.
- EOS-06 (Oceansat-3) was successfully launched on 26 Nov, 2022 with K_u-band scatterometer, DualBand Sea Surface Temperature Monitor (SSTM), and a 13-band Ocean Color Monitor (OCM-3).
- In-Orbit Tests (IOT) have recently been completed and CAL/VAL phase is on-going. Data from Scatterometer and OCM-3 to be released to users very soon. SSTM operations have been stopped due to in-orbit anomaly in its scan mechanism.
- EOS-07 (Microsat-2B) was launched on 10 Feb, 2023 in low-inclination orbit with a 6-channel Microwave Humidity Sounder (MHS) on-board.
- ISRO-CNES joint mission SARAL/AltiKa is functioning in 'mispointing' mode and the mission was extended till December 2024, provided the health of the satellite remains satisfactory.
- INSAT-3DS is planned to be launched later this year, 2023, with many improvements to mitigate the issue related to the blackbody calibration and midnight sun-intrusion.
- GISAT-2 is scheduled for launch in March 2024.
- Under GSICS, inter-calibration of IR channels are in demo phase with IASI-B/C and shortly extended to CrIS. Ray-Matching method has been developed for inter-calibration of Vis/SWIR channels using MODIS and 6 years (2016-2021) data has been processed for INSAT-3D/3DR VIS/SWIR channels.

Participants requested clarification on whether the 6-Channel MHS mission EOS-07 was planned to be a SmallSat. ISRO responded affirmatively, stating that the mission should be seen broadly as a demonstrator and, if all were to go well, ISRO may consider to follow-up with a MHS constellation.

CGMS-51-JAXA-WP-01 - JAXA report on highlights and issues in dataset and product generation

Execute Summary

- JAXA's Earth Observation satellite program and data product in operation and to be launched.
- Contribution to water cycle and climate studies, disaster mitigation, and various operational applications, including weather forecast, fishery, and agriculture, is a big target of JAXA's Earth observation missions.
- To this purpose, JAXA currently operates six EO satellites/missions in orbit, and will continue those contributions by launching new satellites in near future.
    - The reprocessing during about 20 years for the new version of the GSMaP will be distributed by mid-May.
    - GCOM-C has achieved the 5-year nominal mission phase and been in the post-mission phase since Jan. 2023.
    - JAXA's Mission for Next-generation Precipitation Radar (PMM).
- In terms of the WMO project for monitoring extremes, JAXA contributes to the WMO SWCEM Project by providing GSMaP rainfall product with climate normal.
    - In June 2022, JAXA started to distribute the GSMaP real time data (GSMaP_NOW) to the SWCEM members.
    - JAXA is preparing the release of the reprocessing GSMaP data, as noted the above, and will re-calculate the climate normal again for the WMO project.
- JAXA also reaffirmed their intent to collaborate with various model communities to utilize satellite data in their models to enhance future predictions and contribute to science and society.

EUMETSAT asked JAXA representatives about the anticipated timeline for PMM, given the current planned/proposed synergies between European and American agencies for precipitation missions. JAXA responded the current timeline would fit very well into the European and American plans, as PMM is anticipated to be ready for launch in Spring 2029.

NOAA staff asked JAXA representative about whether or not JAXA had long-term plans for the continuity of AMSR. JAXA noted that AMSR3 was planned to be on-board the next JAXA EO satellite, planned to be launched in 2024, securing coverage into the 2030s. Longer-term plans are currently under discussion within JAXA and amongst the end users of AMSR data, though no plans are as-of-yet forthcoming. NOAA noted the possibility of synergy of a potential next generation AMSR with its own planned GeoXO throughout the 2030s.

CGMS-51-JMA-WP-04 - JMA report on highlights and issues in dataset and product generation

- JMA switched over from its operational Himawari-8 geostationary satellite to its Himawari-9 unit on 13 December 2022, after a period of quality monitoring for the latter's Advanced Himawari Imager (AHI) and parallel dissemination of Himawari-9 (starting on 27 September 2022). The details of this monitoring will be presented in CGMS-51-JMA-WP-03.
- Himawari-8/9 radiometric calibration bias and image-navigation biases.

  - Parameters for sensor sensitivity correction for bands 1 to 6 have been updated on annual basis. The last update was implemented for Himawari-8/AHI on 11 July 2022.
  - Calibration monitoring data for the AHI, along with information from health check observation, is available on JMA's calibration monitoring page based on the ray-matching approach commenced to support NOAA20/VIIRS from June 2022 in addition to SNPP/VIIRS.
  - The dataset for input in radiative transfer model-based calibration monitoring was updated from JRA-55 to JRA-3Q in November 2022 in relation to a JMA reanalysis project.
- Himawari-8/9 products
  - Himawari-8/9 products, including Atmospheric Motion Vectors (AMVs), Clear Sky Radiance (CSR), and High-resolution Cloud Analysis Information (HCAI), are generated at JMA/MSC and disseminated via the Global Telecommunication System (GTS) and the JMA Data Dissemination System (JDDS).
  - SST data are provided for JMA's regional SST product, aerosol data are provided for data assimilation in JMA's aerosol prediction model, and CCI and fog detection data are provided for aviation safety.
- Information on Himawari Observation
  - At around 04 UTC on 15 January 2022, a large-scale eruption occurred at the Hunga Tonga-Hunga Ha'apai volcano near Tonga. The Himawari-8 AHI observed the rapid spread of the volcanic fumes emitted and the propagation of the resulting pressure wave. Imagery relating to the event is provided on JMA's website at https://www.data.jma.go.jp/sat_info/himawari/obsimg/image_2022.html (Japanese only).

CGMS-51-JMA-WP-05 - Follow-up report on the project for enhancing utilization of Himawari-8/9 Data - Rapidly Developing Cumulus Area (RDCA) detection

- JMA has provided Convective Cloud Information, including Rapidly Developing Cumulus Area (RDCA) for aviation customers. RDCA is determined using only Himawari-8/9 observation data.
- JMA has cooperated with Malaysia (MET Malaysia), Singapore (MSS), Thailand (TMD) and Vietnam (VNMHA) as part of the ESCAP/WMO Typhoon Committee Project.
- These NMHSs and JMA exchanged letters, and JMA provided them with the source code for RDCA determination.
- Individual NMHSs installed the program on their system and ran it as an initial-test.
- JMA plans to evaluate RDCA determination and tune the program, if necessary.

EUMETSAT asked the JMA if they assimilate lightning data into NWP or nowcasting models. JMA responded that lightning data was not yet operationally assimilated, that so far it has only been used in research or validation purposes

CGMS-51-KMA-WP-02 - KMA report on highlights and issues in dataset and product generation

Executive Summary

- KMA presented their new approaches for users, noting the application of AI/ML technique(s) for weather missions:
    - The Model classifies GK2A fog into 3 types (danger, caution, attention) as a road hazard weather service according to visibility. This provides fog information to drivers through mobile navigation, and increases the use of 'visibility instruments' on highways to improve the accuracy.
    - The technique provides an AI-based 'proxy radar' using GK2A data, every 10 minutes, for a no radar observation area. This is especially useful in the pathway of typhoon and northerly-flowing convective clouds flow into the southern part of Korea.
- KMA noted an extension of scope to climate mission support, including:
    - Monitoring flash drought, due to heat wave over Korean Peninsular with satellite derived SM, EVT, LST, VHI etc. and anomaly of SM and EVT.
    - Providing various composited maps of GHGs at the global, East Asia and Korea-scales by using GOSTAT-1/2, OCO-2/3. This was compared with ground based GAW and TICCON data. It will be fundamental for GHG monitoring at KMA.
- Application of Geo-hyperspectral infrared sounder at KMA:
    - Retrieve T & q profiles from FY4B and plan for OSSEs using proxy hyperspectral infrared sounder.

NOAA asked KMA why the CO_2 measurements on TCCON are so different to in-situ measurements. KMA noted that the comparison of satellite data with observations made at the ground-level can be difficult because ground level CO_2 can be influenced by strong, local sources. This can potentially lead to positive biases when compared to satellite column-based retrievals of XCO2

CGMS-51-NASA-WP-03 - NASA report on highlights and issues in dataset and product generation

Executive Summary

NASA continues to operate a network of eight high performance differential absorption tropospheric ground-based ozone LIDAR instruments that are deployed in locations across the continental US.

- Field Campaign: The Convective Process Experiment in Cabo Verde (CPEX-CV) in summer of 2022. Follow-up to previous CPEX-AW campaign conducted in 2021. The goal was the analysing of the lifecycle and properties of convective systems in the Inter-Tropical Convergence Zone (ITCZ) and assessing the impact of assimilated CPEX data on prediction skill of tropical, Atlantic weather systems. Validation was done against similar observations from space-based platforms.
- The Airborne Visible Infrared Imaging Spectrometer (AVIRIS) and the AVIRIS – Next Generation (AVIRIS-NG) instruments flights were conducted in pursuit of a diverse set of science and applied science goals. The instruments provide measurements in the visible through shortwave infrared wavelength range at 10 and 5 nm spectral resolution respectively. The third generation AVRIS, AVIRIS-3 instrument, will begin making measurements in 2023.

Compared to AVIRIS-NG, AVIRIS-3 is a more compact instrument with 4x improved throughput and a wider field of view.

- GHG monitoring on-board the ISS: an instrument developed principally to study mineral dust as part of Earth Surface Mineral Dust Source (EMIT) investigation is also sensitive to some GHGs, i.e. CO_2 and CH_4. The instrument is another NASA contribution to climate monitoring. NASA is using EMIT observations for detecting and mapping of carbon point-sources.
- In July 2022, the Modern-Era Retrospective analysis for Research and Applications - 2 (MERRA-2) released the Stratospheric Composition Reanalysis of Aura Microwave Limb Sounder (M2-SCREAM) data product. This stratosphere-focused chemical reanalysis provides assimilated global 3D fields of ozone, water vapor, hydrogen chloride (HCl), nitric acid (HNO_3), and nitrous oxide (N_2O) mixing ratios. The assimilated fields, from 2004 to present are provided at a 50-km horizontal resolution and at a three-hourly frequency. The product assimilates Microwave Limb Sounder (MLS) profiles of the five constituents alongside total ozone column from the Ozone Monitoring Instrument.
- In September 2022, the National Snow and Ice Data Center (NSIDC) released version 2 of the Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Dataset. The product contains daily and monthly sea ice concentration (fractional area coverage) for the Arctic and Antarctic regions on NSIDC's 25 km polar stereographic grid.

EUMETSAT asked for a status update on the Earth System Observatories, a series of satellite missions which aim to provide key information to guide efforts related to climate change, disaster mitigation, fighting forest fires, and supporting agriculture. NASA responded that the scope of the project is still under discussion between NASA, NOAA and planned international partners

CGMS-51-NOAA-WP-06 - NOAA report on highlights and issues in dataset and product generation

Executive Summary

- In 2022, NOAA/NESDIS launched NOAA-21 (Nov. 10) and GOES-18 (March 1). GOES-18 entered service as GOES West on January 4, 2023. GOES-R Series satellites are planned to operate into the 2030s.
- NOAA and NASA have already begun work on the next-generation geostationary mission called Geostationary Extended Observations (GeoXO). The Department of Commerce formally approved the GeoXO Program on Dec. 14, 2022. GeoXO will continue observations provided by GOES-R and bring new capabilities to address our changing planet and the evolving needs of NOAA's data users.
- Once NOAA-21 is fully commissioned and science products are provisional, notionally a year after launch, NOAA-20 will transition a quarter orbit ahead of S-NPP. NOAA-21 will then become the primary satellite, NOAA-20 will become the backup satellite, and Suomi-NPP will become the tertiary satellite in the JPSS constellation.
- The Near Earth Orbit Network (NEON) Program will supplement and eventually replace NOAA's Joint Polar Satellite System (JPSS). JPSS will continue to operate its series of polar orbiting satellites through the late 2030's. NEON will lay the groundwork for the next generation of LEO satellites long before the final JPSS launch takes place. NEON will continue,

improve and extend NESDIS' global observations for weather forecasting, disaster management, and climate monitoring.

- Space weather is one of the largest threats to modern society and is yet the least known. It has the ability to affect national security, such as power grids, GPS, aviation, satellites, and our economic well-being. According to a recent National Research Council report [2009], geomagnetic storm-disabled electric power grids and collateral impacts could result in projected economic and societal costs of up to $2 trillion dollars per extremely large storm, and full recovery could take 4-10 years. NOAA's Space Weather Follow-On (SWFO)-L1 will maintain observational continuity of real-time solar imagery and solar-wind measurements and replace the two legacy missions - DSCOVR and SOHO. The SWFO-L1 observatory will be placed at the first Sun-Earth Lagrange point (L1) with the goal of providing images and data critical for the operations of the National Weather Service's (NWS) Space Weather Prediction Center (SWPC) alerts and forecasting.
- NOAA is transitioning all its product generation to the Cloud, including reprocessing. NOAA defines its commitments to the user community through the NESDIS Level Requirements, the Product Baseline, and the 5 Year Product Plan.

EUMETSAT and JAXA asked NOAA officials what they considered to be the product baseline for surface products. NOAA replied that they see potential in (both technologically speaking and in the ability to get through congress) flood mapping, wildfire and air quality, the so-called 'big three' environmental issues in the United States at the moment. This means NOAA is paying particular effort to developing products and services around these three areas, on top of the normal workflow

CGMS-51-ROSHYDROMET-WP-02 - ROSHYDROMET report on highlights and issues in dataset and product generation

Executive Summary

- Roshydromet launched a new Geostationary satellite, ELEKTRO-L N4, on 5th February 2023.
- Roshydromet combined seamlessly a mosaic of images from VIS and IR data from Arktika-M N1, Elektro-L N2, Elektro-L N3 and Elektro-L N4 satellites as a demonstration.
- Developed a new AI cloud masking product. Able to be used for both day- and night-time conditions. Technology uses neural networks and Roshydromet determined an average accuracy of 91%.
- New products presented:
    - Cloud parameters including: cloud top temperature and cloud top height.
    - Real-time detection of precipitation zones across Russia using GEO satellite data, combined with NWP forecast products.
    - Close to the surface wind speeds and directions in the Arctic region.
    - Regional fire monitoring / volcanic eruption product. Able to see and trace ash and smoke plumes.
    - New AMV retrievals using Elektro-L N3, verified against radiosonde winds.
    - Retrieval of CO_2 total column concentration using hyperspectral IR sounder over Russia. Shows seasonal CO_2 cycle compares well to other records (NOAA-20, OCO-2, GOSAT).

EUMETSAT enquired as to why the CO_2 seasonal cycle is not captured well by other data records. Roshydromet posited that the discrepancy may be due to the fact that other agencies and data-processing centers are adjusting their data records according to TCCON data from satellite observations, whereas Roshydromet use in-situ measurements, taken from tower in Siberia.

CGMS-51-WMO-WP-02 - WMO Data Policy and Satellite Data (core data)

The WMO provided an update of the activities undertaken to establish core satellite data, as per the new WMO Unified Policy for the International Exchange of Earth System Data (Res. 1).

- Approved by members in 2021, the new core data policy replaces the old resolutions for weather, climate and hydrology creating a single, unified policy.
- Per the policy, WMO defines both 'core' Data, which must be free and unrestricted and 'recommended' data, which the WMO believes should be exchanged.
- The policy covers only member states. It claims no authority over the activities of the private sector.
- To date, no data sets have been labelled as 'core' or 'recommended', but features of what the data sets will include has been established in WMO documentation.
- WMO recommends that agencies should nominate representatives to decide what data sets should be 'core' or 'recommended', such that a common view can be established by Q4 of 2023, and then endorsed shortly thereafter by the WMO congress.

NOAA asked the WMO to clarify whether the intentions for the core data policy should be restricted to the future, i.e. next-generation data generated by new missions, or if the WMO plans to generate also an archive of data. WMO's current plans are primarily targeting next-generation systems and that any idea to create an archive of historical data which might be considered 'core' by the standards in this policy will come later.

Lars Peter Riishøjgaard made the point that there is a need to respect the space agencies and member states' decision-making sovereignty on policy, to ensure the future of data exchange. Exchange has proven to be crucial for weather, air quality and climate applications, and suspects that exchange of data records (e.g. for climate) will become the norm in the late 2020s, after the core data policy is finalized and implemented.

3. CGMS International Science Working Groups

3.1 GSICS EP Specific topics for the attention of CGMS [15']

CGMS-51-GSICS-WP-01 - GSICS Report

Executive Summary

Global Space-based Inter-Calibration System (GSICS) is an international collaborative effort initiated in 2005 by the World Meteorological Organization (WMO) and the Coordination Group for Meteorological Satellites (CGMS) to monitor, improve and harmonize the quality of observations from operational weather and environmental satellites of the Global Observing System (GOS). GSICS aims

at ensuring consistent accuracy among space-based observations worldwide for climate monitoring, weather forecasting, and environmental applications.

This year's meeting of the GSICS Research and Data Working Groups (GRWG and GDWG) was hosted in hybrid mode by NOAA at College Park, MD, USA 27 Feb – 3 March 2023.

Relevant current topics includes expanding GSICS to provide inter-calibration for:

1. Space Weather
2. GHG constellation
3. Ocean Surface Vector Winds

and adding commercial providers as members.

3.2 ICWG Specific topics for the attention of CGMS [15']

CGMS-51-ICWG-WP-01 - ICWG activity updates and recommendations

Executive Summary

The ICWG presented the activities and relevant discussion items of the ICWG since the CGMS-50 meeting. It includes:

- An introduction to the CGMS of the new co-chairs of the ICWG (From NOAA and DWD).
- An update of ICWG-3 planning (Feb 2024).
    - A dedicated session on using lightning observations from space is planned.
    - Discussion session also planned on combining all datasets from CGMS agencies' GEO satellites into one (the so-called GEO-RING).
- A new report is set to be released by the ICWG, retailing the results of an inter-comparison of cloud properties from GEO and polar-orbiting satellites. This was focused on high impact applications such as AMW, winds, all-sky radiances, and cloud height.
- The next in the series of half-day virtual 'tag-ups' (November, 2023), a discussion of the HLPPs and related actions, and an update from the ISCCP-NG TG.

3.3 IPWG Specific topics for the attention of CGMS [15']

CGMS-51-IPWG-WP-02 - IPWG activity updates and recommendations

Executive Summary

- After postponements in 2020 and 2021, the IPWG-10 meeting took place during 13-17 June 2022 at Colorado State University (CSU), US (week of CGMS-50).
- 173 attendees (in-person and online total), 94 presentations, 22 countries represented.
- The Baseline Surface Precipitation Network (BSPN) Working Group is drafting a strategy for a uniform quality radar/gauge database, with inputs from QPE experts.
- The CubeSat/SmallSat Constellation Working Group is designing an OSSE framework to assess sensor capabilities (channels, resolution, sampling).

- The Multi-satellite precipitation Working Group is soliciting user needs from global product producers, and global product producer needs from the research community.
- The Machine Learning Working Group is developing a standard training and independent test data set for individuals to evaluate ML algorithm capabilities in a consistent fashion.
- Planning for IPWG-11 as Tokyo, Japan, in July 2024.

NOAA participants commented that precipitation product comparison and validation system NPrecipSe should be considered very useful and a very big achievement. European and Asian agencies and Met Service should consider to create their own versions of this system and, via the IPWG, work to improve further the existing system (only available in the continental United States).

EUMETSAT asked the IPWG if there exists any ideas/plans to propose a Cube- or SmallSat OSSE? The IPWG replied that plans for an OSSE are in fact currently being drafted, with an aim to be finalized at the IPWG in Tokyo, Japan in 2024.

3.4 IROWG Specific topics for the attention of CGMS [30']

CGMS-51-IROWG-WP-01 - IROWG update on recommendations and activities

Executive Summary

- Dr. Sean Healy has stepped back as the IROWG co-chair, being replaced by Dr. Hui Shao from UCAR/Joint Center for Satellite Data Assimilation, who was elected by the IROWG community. The formal handover took place at the IROWG-9 meeting in September 2022 in Leibnitz, Austria.
- The meeting was the first held in-person since the beginning of the Covid-19 pandemic, featuring over 100 participating scientists and experts from all major RO processing centers, agencies, weather prediction centres, commercial data providers and researchers. The participants were divided into 4 working subgroups: NWP, Climate, Receiver Technologies and Innovative Occultation Techniques, and finally Space weather.
- There were additional dedicated sessions to: BUFR format revisions, level-0 data format definition and future radio occultation observation operator development.
- Scientific and technical developments coming out of the meeting include the full exploitation of every GNSS satellite constellation, an acknowledgement of the impact of RO-observations from NOAA and EUMETSAT commercial data buys in NWP, developments in the use of GNSS-RO for climate applications and the acknowledgement for the creation of a RO climate data record, and presentations of the results of a GNSS-RO gap analysis, showing there exists a potential danger of a gap in the number of occultations per day, starting in ~2027 when COSMIC-2 is set to reach end-of-life.

Participants noted that the 20,000 occultations/day figure, which had recently been reaffirmed by study, is still not close to being reached; and agencies are not even meeting the WMO's recommended threshold number of 14,000 occultations/day. This comes before the COSMIC-2 gap referred to by IROWG.

A discussion about how to meet these goals followed. NOAA made the point that both it and EUMETSAT have engaged the private sector to deliver occultations, but these were expensive and only on a pilot-basis. Lars Peter Riishøjgaard suggested that agencies should attempt to 'share the burden' in acquisition of occultations, including with commercial data buys from the private sector and that a WMO framework may be helpful in ensuring both fairness and that the data which reach NWP centers are broadly similar so that they are working with the 'same sense of the truth'.

CGMS-51-IROWG-WP-02 - The RO Modeling Experiment (ROMEX)

Executive Summary

- The International Radio Occultation Working Group (IROWG) community has recently proposed a collaborative effort to explore the impact of RO observations: Radio Occultation Modeling Experiment (ROMEX).
- ROMEX seeks to quantify the benefit of increasing the quantity of RO observations using additional observations which were not available to weather centers for their real time operational systems. The IROWG community has gained approval from their respective institutions to perform data assimilation experiments with the additional RO measurements over the designated time periods.
- The effort concept, was first introduced by Dr. Richard Anthes in May 2022, in response to questions from NOAA for input on future RO needs. The resultant discussion led to a proposal for ROMEX, which was endorsed by the IROWG in September, 2022 (IROWG-9).
- The experiment results will provide guidance to the CGMS partners to answer pressing technical and programmatic questions facing the numerical weather prediction (NWP) community. This will help inform near- and long-term strategies for RO missions and acquisitions by all CGMS partners.

The IROWG additionally made the point that the orbits of commercial GNSS-RO missions are often not specifically considered which may lead to gaps in coverage, as a big determining factor for which orbit is selected may often just come down to what is available in terms of launch services. They also note that GNSS-RO satellites also have to be designed with certain orbits in mind, using the orientation of the solar panels as an example of this.

NOAA suggested that the 'backbone' number of government-owned and operated, GNSS-RO-capable satellites should be decided at both agency level and in collaborative bodies like CGMS.

3.5 ITWG Specific topics for the attention of CGMS [15']

CGMS-51-ITWG-WP-02 - ITWG activity updates and recommendations

Executive Summary

ITWG held the ITSC-23 in Tromso, Norway in March 2023. The event featured 166 participants and reports from agencies, NWP centres and from other CGMS working groups. Event working groups focused on:

- AI/Machine Learning applications

- Small- and CubeSat data assimilation
- GEO Hyperspectral Sounder data assimilation
- 'Earth System Approach'
- Potential sharing of computing resources
- There were also 2 technical sub-groups, dealing with RTTOV / CRTM (radiative transfer models) and Radio-Frequency interference.

The event generated a number of recommendations to be considered by the CGMS, GSICS, space agencies and data providers more broadly.

NOAA participants found it unrealistic for agencies to share computing resources to NWP centers, particularly internationally. A more realistic approach might involve the cost of operations being spread out amongst the various stakeholders, or sharing resources but in the specific context of an OSSE.

3.6 IWWG Specific topics for the attention of CGMS [15']

CGMS-51-IWWG-WP-01 - IWWG Report

Executive Summary

The presentation given at GCMS-51 presented the activities and relevant discussion items of the IWWG since the CGMS-50 meeting. It included:

- An introduction to the CGMS of the new co-chairs of the IWWG
- An update of IWW16 planning (May 8-12, 2023)
- An update on the 4th AMV Inter-comparison
- A discussion of the HLPPs and related actions
- An update from the OSW TG

3.7 IESWG The International Earth Surface Working Group [15']

CGMS-51-GUEST-WP-06 - IESWG activity updates including updated ToRs for an IESWG CGMS International Science Working Group for WGII review

Executive Summary

Updated IESWG ToR iterated between the CGMS WG-II, IESWG and ITWG.

The IESWG continues to work towards CGMS recognition, as there is a need for a group with the unique combination of data assimilation and Earth surface modeling experts to fully exploit existing and future observations.

The International Earth Surface Working Group (IESWG) activities began in 2006 from a sub-group on Remote Sensing and Modelling of Surface Properties (RSMSP) under the International TOVS Working Group. After four successful meetings, the final RSMSP meeting in Grenoble in March 2016 it was decided to incorporate a broader stance towards bridging the modeling gap of the Earth surface-

atmosphere interactions and fluxes in energy and water, for the purposes of improvement of NWP and advance coupled reanalyses.

The new International Earth Surface Working Group (IESWG) has convened three international meetings in 2017, 2018 and 2019 followed by 2 online meetings during the COVID-19 pandemic, aiming at gathering overviews of the surface modelling and monitoring progress in 2021, and then hosting the 4th IESWG online meeting in 2022 enlarging further the world-wide participation. In 2023 the 5th IESWG meeting is planned as a hybrid meeting hosted by the Finnish Meteorological Institute in Helsinki, Finland.

International Framework

The IESWG has had a strong connection with the CGMS-ITWG and also has interaction and close contact with the CGMS-IPWG. The IESWG has also coordinated each of the first 3 meetings to align with other specific and related meetings. IESWG-1 with a SMAP Weather Focus Session, IESWG-2 with the 8th EUMETSAT LSA-SAF Workshop, and IESWG-3 in tandem with SnowWATCH-GCW of the WMO. This has helped to raise awareness of the IESWG to a broader community and strengthened the communication with these other activities. IESWG-4 was held virtually in 2022 and again saw broad global participation.

Operational Overarching Goals

The IESWG aims at receiving operational strategic elements needed by global centers to integrate Earth Observation data (e.g. reduce emissivity uncertainty limiting DA over land/cryosphere, use new observation such GNSS-R, uptake modelling requirements to assimilate successfully) with particular focus at Land-Atmosphere interface with the overall goal to advance coupled data assimilation. The IESWG body functions to coordinate a set of actions and recommendations for current and emerging environmental observations sensitive to the Earth surface. A close connection with CGMS allows for not only advancement on scientific goals, but broader coordination that promotes faster uptake of these observations.

Linked with NOAA Science Advisory Board: A Report on Priorities for Weather Research. NOAA Science Advisory Board Report, 119 pp., 2021 https://sab.noaa.gov/wp-content/uploads/2021/12/PWR-Report_Final_12-9-21.pdf

- NOAA OD-2 Recommendation to maximize data assimilation use of Earth observations over land.
- NOAA OD-4 Recommendation Advance Coupled Earth system.

Linked with ECMWF strategy 2021. Publisher. ECMWF. URL, doi.org/10.21957/s21ec694kd and vision statement ("ECMWF will strengthen its leadership position in data assimilation by progressing in coupled assimilation, algorithmic development and integration of approaches"). Reference to:

- WMO WWRP plan (https://library.wmo.int/doc_num.php?explnum_id=10830 "Coupled data assimilation addresses two overarching goals of the World Meteorological Organization (WMO) World Weather Research Programme (WWRP) strategic plan: 1) to improve

environmental prediction and 2) develop a seamless predictive capability (Brunet et al. 2015).").

- GCOS plan (https://library.wmo.int/index.php?lvl=notice_display&id=22134#.Y9kfKhPMKhw "Theme C: Improving data quality, availability and utility, including reprocessing and Action C4: New and improved reanalysis products, point 2. Demonstrated benefits of coupled reanalysis.").

Compared to the CEOS Land Product Validation subgroup, IESWG has a different vocation towards operational aspects, such as data assimilation, observation operators and modelling developments that can advance towards coupled land-atmosphere assimilation in numerical weather prediction and climate/environmental reanalyses. The three main topical areas in the IESWG are:

1) Snow ice and cryosphere-atmosphere interaction

2) Vegetation and land-atmosphere fluxes

3) Soil moisture, river-discharge and water cycle

The IESWG participants typically report on Earth surface-atmosphere coupling and data assimilation with particular focus on methodologies, algorithmic and modelling advances that can enhance satellite observations uptake from present missions and prepared for upcoming ones. Operational centres and space agencies have provided support in the past editions of the working group meetings.

4. High Level Topics - New Horizons [60' incl. discussions]

4.1 Satellite early warning for disaster reduction

CGMS-51-GUEST-WP-04 - An African project to show case the relevance of satellite data for early warnings [30']

Executive Summary

Guest speaker, Doug Parker of NCAS, University of Leeds, gave a presentation focused the importance of satellite data for generating early warnings for extreme weather, and the effects of efforts to bring these early warnings to historically underserved communities. This focused on several case studies done in developing African nations.

The socio-economic value of improving weather forecasts in Africa, particularly as extreme weather events become more intense due to climate change, was highlighted by the HIGHWAY project on Lake Victoria, where estimates show that this single project may be responsible for up to 300 lives saved per year.

Parker presented the benefits of and challenges of implementing efficient, accurate Nowcasting systems in African nations. Nowcasting systems would save lives and property, bring economic value to local industries (e.g. agriculture, fishing) and assist greatly with disaster relief.

Attempts to implement nowcasting infrastructures (i.e. radar networks) have largely since the 1980s for a variety of reasons. New techniques and methods may be able to change this: high-resolution satellites, e.g. MTG, making observations in sparsely-observed areas in Africa will improve Nowcasting

skill. This can be coupled with new methods to process the data (e.g. AI/ML), better training for regional meteorological services, and ways directly communicate and integrate weather information into the lives of ordinary citizens (e.g. with a mobile application).

Lars Peter Riishøjgaard mentioned that NWP limited in African, due to both high convective activity, which is harder to predict, and a lack of good observations. He notes where observations are less sparse, in Northern or Southern Africa, closer to the coastal regions, weather forecasting systems have higher skill.

Participants also asked whether regional training centres had been engaged in this project. Parker responded that they had and the regional training centres in Pretoria (South Africa) and Nairobi (East Africa) had been integral to the efforts of the project. He did also note that a lack of radar networks had held back training efforts in Africa, as there are fewer products to reference.

4.2 New architectures and miniaturized instruments how will they shape the future LEO system

CGMS-51-GUEST-WP-03 - Prospects for operational implementation of MW hyperspectral measurements [30']

Execute Summary

Guest speaker Christian Kummerow presented the current state of hyper microwave measurement technology, remarking that hyperspectral MW is very close to being in reach of private industry, who may use it to make observations to be provided to agencies and NWP centres, etc.

Some problems still remain with optimization of the technology. Hyperspectral MW remains a highly power intensive method, increasing the overall size of the power source and thus the satellites carrying them. This contributes to a higher cost. Data downlink remains an issue which is not addressed by digital backend architecture.

Some capabilities of hyperspectral MW observations were also noted: improved soundings for NWP, radiofrequency interference (RFI) could be identified and possibly mitigated, and observations can be used in inter-calibrations. These three capabilities were summarized:

1. Soundings improve significantly with hyperspectral capabilities. Even greater advantages when clouds are present but still working on details.
2. A fairly simple hyperspectral setup at 23 GHz is very capable of detecting even small RFI signals.
3. Hyperspectral capabilities at 183 GHz, when used during coincident overpasses with small radiometers can significantly improve inter-calibration capabilities.

Both NOAA and EUMETSAT highlighted their own investigations into developing hyperspectral MW sounders, NOAA in the context of LEON and EUMETSAT in the context of EPS-Sterna. Both agencies agreed it would be wise to implement the lessons learned from the RFI studies into planned (or future) systems.

Ken Holmlund highlighted that the WMO had arranged an information day for commercial vendors of meteorological satellite data. He suggested that they too, might be interested in implementing Kummerow's results in their own satellite constellations.

4.3 An outlook for the future of wind observations

CGMS-51-IWWG-WP-02 - Overview of current satellite capabilities for wind observations and an outlook for the future [30']

Executive Summary

The IWWG presented the current state-of-the-art and near-future of wind observing systems. This presentation was the follow-up to an action item from GCMS-50, where a review of space-based wind observing systems was requested.

The IWWG stressed that the requirements on global winds, a critical atmospheric parameter, are not currently being met, according to requirements listed on WMO OSCAR, and are unlike to be met in the near-future of planned missions.

Several wind observing techniques were presented, along with their pros and cons:

- AMVs: Good resolution, global coverage and no gaps; but height assignment highly uncertain and only gives information and a single layer in the atmosphere;
- Surface winds from Scatterometers: Gives direct measurement of wind at high resolution and is not weather dependent; but only gives products close to the surface
- DWL gives a direct measurements of winds speed at high vertical resolution, gives products in all weather and sky conditions; but is highly complex, has only limited coverage and only measures winds in one direction. Additionally, no more DWL are planned until the 2030s;
- 3D winds from IR sounders, which are demonstrative, can be retrieved from current IR sounders and give a continuous vertical profile, works in all-sky situations and has good coverage; but is a passive tracer and possesses correlation errors due to assimilation of L1 into NWP;
- Stereo Winds are a demonstrative technology, making observations from imagers. They can accurately assign cloud heights without explicit knowledge of cloud microphysics; but are passive tracers and restricted to a single layer in the atmosphere;
- Optical flow methods are a novel technique which give dense wind coverage with excellent temporal resolution; but require a great deal of computing resources to assimilate into NWP.

NOAA claimed they have not been investigating any specific missions for 3D winds in the short time, and that NOAA considers its requirements for winds already met.

5. Review of WGII list of actions [60' incl. discussions]

WGII presented the advancement and status of the main actions through the CGMS International Science Working Group reports and the WGII report. WGII will deal with the so called “internal” actions directly.

6. Climate and greenhouse gas observations [20'] (incl. discussion)

Working papers on climate and greenhouse gas, including CEOS-Climate report (mitigation, adaptation, long-term monitoring)

CGMS-51-WMO-WP-03 - GHG observation strategy - How we should address the WMO initiative [20’]

Executive Summary

The WMO created the GHG observation strategy, to support the implementation of the 2015 COP-21 Paris Agreement, which aims to reduce anthropogenic GHG emissions.

- However, natural GHG fluxes (i.e. driven by natural processes) often not taken into account, despite interacting with anthropogenic systems in ways that are not well understood. It is also difficult to account for what the UN refers to as ‘negative emissions’, such as carbon offsets and credits, as they are often ineffectively monitored and poorly regulated. This may lead to a risk of under/overestimating the impact of carbon-mitigation efforts.
- While ‘top-level’ global CO_2 budgets are fairly well understood, individual contributions from a number of sources (e.g. land use changes) are not, and neither are the impacts of major carbon sinks. Accounting generally has two approaches: the ‘top-down’ (direct retrieval of carbon flux) and ‘bottom-up’ (adding up sources and sinks), each with their own advantages and issues.
- In response, WMO is developing the Global Greenhouse Gas Watch (G3W). This would treat GHG monitoring more operationally and regularly, similar to NWP, and less research-focused ad-hoc reporting common today. The G3W aims to create a system of global, near-real time observations of CO_2 from both satellite and ground-based systems. This would be coupled with GHG model which would output CO_2, CH_4 and N_2O concentrations at a (initially) 100 km grid-resolution, with an aim to bring this down to ~1 km within 10 years.

Participants seek clarification on why the initial target is 100 x 100 km grid when technology can already accommodate better resolution than this? Lars Peter Riishøjgaard responds that this resolution had been under discussion in the WMO and the justification is that this is ‘somewhat defensible’ when trying to build up a picture of global CO_2 (etc.) emissions, while avoiding incentivizing competition with researchers, agencies and companies that aim to do city-scale emissions tracking. This will also avoid contradicting any country’s reported emissions which may simply damage collaborative efforts between international partners.

CGMS-51-JWGCLIM-WP-01 - WGClimate status and plans and specific topics for the attention of CGMS [20’]

Executive Summary

The CEOS-CGMS Joint Working Group on Climate met in Tokyo for its 18th meeting (WGClimate-18) in February 2023. The Group focused on developing its 2023 Work Plan, including assessing and prioritizing strategies, initiatives, tasks, and partnering opportunities. For its highest priorities, the Group designated leads, schedules and paths forward. These top priorities included:

1) developing the Space Agency Response to the 2022 GCOS Implementation Plan (IP);

2) updating the Group's Coordinated Action Plan to help close addressable gaps in the GCOS IP Actions;

3) releasing an updated version of the Essential Climate Variable (ECV) Inventory;

4) restructuring (simplifying) the ECV Inventory and its maintenance processes;

5) releasing a merged Gap Analysis Report (v3/4.1) for the Inventory;

6) developing the Space Agency Statement for UNFCCC COP-28 and associated contributions for Earth Information Day.

The Group continues to publish online Use Cases for Climate Data Records, and is finalizing a robust taxonomy of definitions and best practices for multi-year time series data sets. The Group's 2023 activities are limited by the number of active representatives, and encourages all agencies to consider opportunities for active participation or other contributions.

EUMETSAT participants praised the progress made by the CEOS-JWG but commented that for many cases, climate data records are not sufficient and there is a need for real-time data sets, too.

CGMS-51-ESA-WP-07 - GHG monitoring evolution - CO2M and the ground segment [20']

Executive Summary

The European contribution (ESA, Copernicus, EUMETSAT) to global GHG monitoring, specifically the upcoming CO2M mission was presented by the European Space Agency. As per the Paris agreement, the CO2M mission will assist in the European target to make a global 5-year 'stocktake' of carbon. Besides its main target, anthropogenic CO_2, the mission will also measure CH_4 and NO_2.

- The concept allows for both monitoring over a wide area and identifying hotspots, with a variable horizontal resolution of up to 4 km^2. This allows it to give actionable information at the local, national or (wider) regional scales. Precision of single spatial samples is expected to be 0.7 ppm.
- Error sources of CO2M are aerosol and clouds. A dedicated additional instrument will allow to correct in the retrieval for aerosol scattering effects up to an Aerosol Optical Depth of (at least) 0.5, which is a step forward compared to existing missions. A cloud imager will allow to remove cloud contaminated samples.
- COM2 is currently preparing for a Critical Design Review (CDR, phase C) in 2023, with an aim for the launch of the first two satellites in early 2026.

EUMETSAT participants asked which elements of the WMO's GHG initiative ESA/the commission believed the CO2M mission could specifically fulfil. ESA responded that although one should not consider CO2M to be the only solution required to meet the WMO's initiative, it will provide them with accurate, reliable, space-based measurements to work with in addition to reports from member states, measurements from ground, air and sea-based networks, etc. WMO may also be able to contribute diplomatically when GHG satellites with high resolution are able to identity large point sources, especially of methane.

Heikki Pohjola (WMO) asked if the CO2M constellation is able to reach the OSCAR time resolution requirements (1 h). ESA replied that with the current planned set-up for CO2M, it is unlikely to meet this threshold on its own.

Ken Holmlund commented that while the CO2M has excellent potential, a much bigger constellation of (10+ satellites) would be required, along with commitments from agencies to ensure that these observations will continue to be made over the long term. He also suggested that agencies and researchers should investigate if it is feasible to retrieve CO_2 at high-time resolution by some other manner of retrieval.

CGMS-51-NASA-WP-05 - NASA Global Monitoring of Greenhouse Gas (GHG) Emissions [20']

Executive Summary

NASA presented their contributions to global GHG monitoring which is made up of several local, regional and global initiatives, making measurements of GHGs and particulates by networks of ground-based instruments, aircraft and satellite observations. Some of the ground networks have now been operating for up to 25 years.

- NASA continues to operate several airborne platforms with instruments onboard that measure GHGs. These observations significantly contribute to our understanding of the Earth system, provide the opportunity for integration and testing of instruments onboard aircraft for scientific studies, airborne campaign planning to retrieve observations from under-sampled locations, and a competitive procurement strategy for building novel or improved observations to help drive forward development of the global observing system.

- GHG modeling and analysis activities are spread through the ESD. Global Modeling and Assimilation Office (GMAO) conducts Research and Development of models and assimilation systems (e.g., GEOS, Model-E, NU-WRF) that produce quasi-operational data products that advance our understanding of the Earth and its component systems. The Carbon Cycle and Ecosystem (CCE) Focus Area continues to develop and maintain Carbon Monitoring System Flux (CMS-Flux), which is a global carbon cycle data assimilation system that quantifies the spatial and process drivers of atmospheric CO_2. The Advanced Information Systems Technology (AIST) program supports the developed of Earth System Digital Twin. Finally, the Earth Information System (EIS) is building upon and combining data acquired by NASA's Earth Science fleet and Earth System Models to create Level 5 data products that range retrospective analysis, real-time Earth science data products, seasonal to sub-seasonal forecasts, to decadal predictions.

- NASA also highlighted their inter-agency and global cooperation initiatives, which they claim is core to their GHG monitoring. These include a number of bilateral deals, including close cooperation with NOAA and NASA participation in international bodies such as the CGMS, CEOS and in the WMO's projects, such as IG3IS.

European and Asian participants were interested in whether NASA would implement AI/ML techniques into their product development in the future. NASA responded that it had 'no good answer' to this question since it was the opinion of NASA at this moment that AI was advancing rapidly and a broader agency assessment would be required first.

EUMETSAT asked how NASA structures investigations into AI/ML. NASA said nothing is official yet as these discussions about AI/ML and what it means for the agency are on-going at the directorate level, and any projects which utilize AI are currently only used in the context of other projects.

CGMS-51-CMA-WP-05 - Operational performance of FY-3E/HIRAS and FY-4B/GIIRS

Executive Summary

- Due to the sunlight on 0530 orbit, the instrument temperature field of FY-3E/HIRAS-II was reset in August 2022, and the parameters for calibration were adjusted to fit the new state of the sounder.
- The spectral calibration with respect to LBLRTM is in range of 5 ppm for three bands respectively, the radiometric calibration with respect to MetOp-B/C IASI is about 0.5 K in LWIR, 0.5 to 1 K in MWIR.
- GIIRS spectral accuracy is less than 5 ppm, radiometric accuracy is less that 1K except in some spectral channels, which are affected by noise.
- The 3rd HIRAS will be launched in the Aug, 2023 onboard FY-3F satellite.
- FY-4C/GIIRS is in the design phase and plan to be launched in 2025.

7. Selected topics of high priority to members (WPs will be pre-selected)

CGMS-51-CMA-WP-06 - Preliminary XCO2 retrieval results of ACDL on DQ-1

- CMA presented new XCO2 retrievals from the ACDL instrument on-board DQ-1 satellite. The retrieval of useful observations relies on the applying of filters (e.g. FFT, EMD or wavelet) to remove high frequency noise from the signal. Acquisition uses a pulse stacking method to improve the S/N ratio.
- Early analyses of the XCO2 retrievals from a test period in June 2022, show the data to have a low mean bias (< 1 ppm) and standard deviation, when compared to 2 test sites in Xianghe (bias: 0.48 ppm stdv: 1.48 ppm) and Sodankylä (bias: 0.8 ppm stdv: 1.99 ppm).

CGMS-51-WMO-WP-11 - Tropical Cyclone community: requirement for LEO satellite missions

Executive Summary

- Satellite data continues to be the primary tool used to estimate storm intensity, position, and structure. Approximately 90% of TCs are observed exclusively with satellite data. Monitoring

the position, intensity and structure of a TC is often a key point for subsequent decisions in the warning chain.

- The unique capabilities provided by LEO sensors allow confident operational estimates of the maximum sustained winds, radius of maximum winds, and extent of critical wind thresholds. Despite some improvements to TC monitoring over the last 4 years, significant data gaps remain. Legacy satellite missions are reaching the limits of their age and many satellites now have failed or have failing critical sensing channels. In addition, there are coverage time gaps as most LEO satellites are sun synchronous.
- It is critical to maintain the health and diversity of the LEO constellation to provide the highest quality inputs to the TC warning process.

Heikki Pohjola asked if NOAA had any plans to expand commercial data providers to assist with operations related to tropical cyclones. NOAA admit that such an idea does exist amongst NOAA operators, but no official steps have been taken to move towards, which would require approval and funding – likely through congress. NOAA also noted this would be a novel application of technologies, which comes with risks.

CGMS-51-NOAA-WP-07 - NOAA/NESDIS GeoXO Update

Executive Summary

- GeoXO has passed the USA Department of Commerce Milestone #2 and the program is proceeded with its full constellation.
- The next major decision points are the Mission Definition Review and KDP-B in 2024.
- The GeoXO Imager (GXI) contract was awarded to L3Harris in March 2023.
- The GeoXO Sounder award will be announced in September 2023.
- The Phase-A studies for the lightning mapper (LMX), ocean color sensor (OCX) and atmospheric composition sensor (ACX) will finish in late 2023.
- Spacecraft contract will be award in 2024.

CGMS-51-NOAA-WP-09 - Geostationary Reprocessing Activities at NOAA/NESDIS

Executive Summary

- NESDIS is supporting several reprocessing activities across all of the GOES series.
- Rescuing data from SMS-1 through GOES-7 that was corrupted during tape storage.
- Applying EUMETSAT developed QC and reformatting tools to GOES 8-15 GVAR data.
- Reprocessing the GOES-R ABI and GLM Records.
- Co-developing with other space agencies an application of the current GEORING of advanced imager (the next generation of the International Satellite Cloud Climatology Project - ISCCP-NG).
- Reprocessing and storage will be done in the Cloud and shared publicly.

CGMS-51-NOAA-WP-11 - NESDIS Wildland Fire Program

Executive Summary

- While existing operational satellite-derived active fire products are frequently used in a variety of operational and research applications, stakeholder engagement has identified critical gaps, such as increasing the response time for the initial attack of fires that have the potential to impact life and property, incomplete situational awareness for wildfire incident management (extended attack), and addressing science and access barriers that limit exploitation of satellites.
- In an effort to address key capability gaps, NESDIS has established a Wildland Fire Program focused on impactful service delivery. NESDIS Wildland Fire Program projects, aimed at addressing critical active fire capability gaps, are underway, with product and service demonstrations expected to begin by June 2023.
- The improved products are generated using the Next Generation Fire System (NGFS), which consists of a sensor agnostic (applicable to geostationary or low earth orbit satellites) active fire algorithm and higher order capabilities, including alerting, incident situational awareness tools that are highly tolerant of cloud cover, and an event-based data model that combines time-resolved satellite fire detections with complementary geospatial data layers.
- The active fire algorithm requirements are driven by the applications needed to achieve the desired user outcomes. For instance, in order to alert first responders to potential new wildfire starts in a timely manner, the following algorithm capabilities are needed: automated hot spot detection that is consistent with human expert interpretation of satellite imagery, tracking of previously detected hot spots, and fusion with supplemental data layers (i.e. fire weather maps, fuel type, etc.) and accurate geolocation. One of the broader implications of NESDIS Wildland Fire Program activities is an assessment of how current L2+ fire product requirements map to impact goals.

Heikki Pohjola asks if a 'false alarm rate' of the fire product(s) has been determined. NOAA say they have yet to determine a false alarm rate, but validation studies and follow-ups are currently underway following a number of verified fire events.

CGMS-51-NOAA-WP-19 - Nowcasting: Observational thresholds, objectives, and priorities for U.S. weather services

Executive Summary

Nowcasting is defined as forecasting for weather conditions within the upcoming six hours.

NOAA focused on six nowcasting application areas where satellites play a major role as an observational source: thunderstorms, heavy rain / flooding, dense fog, fire monitoring, offshore winds / sea ice, and winter precipitation.

Surveys were sent to operational meteorologists and the results of those surveys were used to develop initial observation ranges:

- Minimally useful
- Expected (2030)
- Maximum effective

Subject-matter experts subsequently reviewed the observation ranges and the ranges were adjusted for consistency and if necessary for additional considerations beyond those from the operational meteorologists originally surveyed.

In addition, Jordan Gerth (NOAA) noted that input from outside the United States would be helpful to assess global nowcasting requirements, particularly for those that might be able to be met by satellites. Paolo Ruti (EUMETSAT) suggested that the hydrology communities in Europe has worked together to create a number of useful applications of IR and MW when modelling nowcasting events (e.g. flooding).

CGMS-51-WMO-WP-17 - Terms of Reference for WMO Polar Space Task Group (PSTG) follow-on Task Team

Execute Summary

The WMO Commission for Observation, Infrastructure and Information Systems (INFCOM) at its second meeting (INFCOM2) requested: "Global Cryosphere Watch Advisory Group (GCW-AG) to prepare, in consultation with the Standing Committee on Earth Observing Systems and Monitoring Networks (SC-ON), terms of reference and a modus operandi for a task team on the coordination of space-based capabilities for advancing benefits of, and access to, space-based cryosphere observations, by evolving those of the Polar Space Task Group, for approval by INFCOM President".

The Terms of Reference (ToR) are developed for the World Meteorological Organization (WMO) Infrastructure Commission (INFCOM) Task Team on the coordination of space-based capabilities for advancing benefits of, and access to, space-based cryosphere observations, evolving those of the Polar Space Task Group (PSTG) developed in 2017 and reflect recent changes in the WMO strategic objectives, in particular embracing a holistic Earth System modelling approach and acknowledging that global Numerical Weather Prediction modelling underpins most WMO application areas.

CGMS-51-NOAA-WP-10 - Reprocessing of SNPP VIIRS Aerosol Products and their Applications

Executive Summary

The growth and decline of the economy has a bearing on air quality. The impact of changes in economic activity on air quality, like that witnessed during the lockdowns associated with the COVID-19 pandemic, were documented using tropospheric nitrogen dioxide (NO_2) column amounts observed by satellites.

Nitrogen dioxide and volatile organic compounds are precursors for formation of ozone and fine particulate matter. Air quality is typically quantified (good or bad) based on ozone and fine particulate concentrations.

In this study, we showed that when nitrogen dioxide increases or decreases, aerosol optical depth (AOD) increases or decreases commensurably. Aerosol optical depth decreased by 22% in major cities (37 of the 43 cities studied) around the world during the COVID-19 lockdowns. To achieve similar improvements in the US with targeted emissions reductions, 6 million light duty vehicles will need to be transitioned from gasoline to electricity.

- Changes in economic activity lead to decreased emissions and lead to improved air quality. Can we detect those changes in satellite aerosol optical depth (AOD) data?
- Develop long-term climatology of AOD so data for any given time period going forward is analysis ready.
- Conduct tracer-tracer correlations to attribute aerosols to different emissions sources (fires vs. urban pollution).

Some participants questioned the validity of the 6 million car vehicles claim.

Heikki Pohjola asked how long it would take to achieve this reduction of 6 million vehicles. While no specific estimate was given, NOAA project staff admitted that, looking at the rate of uptake of electrified vehicles today, it would take a very long time to achieve this.

CGMS-51-NOAA-WP-08 - NOAA's Microwave and Hyperspectral IR Workshop Outcomes

Executive Summary

NOAA presented the outcome of two recent sounder-technology workshops.

Summary from MW Sounding Workshop:

- Backbone 3-orbit constellation with sensors providing data in the 23 GHz to 183 GHz frequencies;
- Sensor Noise: New sensors should aim to achieve lower noise and striping than current sensors;
- Frequencies: 50-60 GHz frequencies have more information content than the 118 GHz for temperature sounding; 183 GHz are important for humidity soundings; 23, 31, 50, 51, and 89 GHz are also used for surface, QA/QC and Cloud clearing in DA, and precipitation;
- Legacy POES: MW sounders on older satellites that are operating beyond their mission life still provide impactful measurements and should be continued as long as technically possible;
- Mission Life: It takes 1-2 years to full test and implement new measurements in to NWP DA. Longer mission life is therefore recommended;
- RFI: Both future backbone and supplemental MW sounder missions should incorporate technology to address frequency interference (RFI);
- Robust calibration strategy is needed for inter-calibration, absolute calibration, and traceable calibration.

Summary from IR Sounding Workshop:

- Higher spatial resolution models move to 1-2 km spatial resolution, and cloud clearing;
- NEDT: low noise is necessary, consider together with spectral, and spatial resolution;
- Calibrations stability is very important;
- On-board processing like IASI for data reduction is acceptable;
- Co-location with MW sounders (and/or imagers) is desirable but not essential;
- Frequency: Frequent IR measurements of water vapour for winds (e.g. hourly coverage);
- Low latency (e.g. DBNET) for rapid refresh models that have short cut-off forecast runs;

- Atmospheric Chemistry: compliment with SWIR missions dedicated to atmospheric chemistry such as MOPITT, OMPS, SCIAMACHY, GOSAT, OCO-2, TROPOMI, GeoCarb etc.
  - The SW range of the IR sounders in future should be extended to (1.5-2.5 micrometers).
  - Morning and afternoon orbits better capture photochemical processes.
  - Fire emissions of CO, O_3, PAN and NH_3. IR sounders tracked these emissions quite well.
  - Atmospheric chemistry.

CGMS-51-JMA-WP-03 - Validation of AHI on Himawari-9, in L1 and L2 products

Executive Summary

Operational switchover from Himawari-8 to -9 was conducted on 13 December 2022 following a period of parallel data dissemination from 27 September 2022. Level-1/-2 products quality was evaluated using the Himawari-8/-9 parallel observation data and similar performance results were derived in both Himawari-8/-9 products.

- Himawari-9 Level-1 products performance
  - Image navigation: ~0.3 km
  - Inter-band co-registration: ~60 m
  - Radiometric calibration: < ~5% (B01 to B05) and 5–8% (B06), < ~0.3 K (IR bands)
- Himawari-9 Level-2 products
  - AMV, Cloud properties: Similar characteristics and qualities for H-8 and H-9.
  - CSR: No significant difference in the statistical properties for B08 (6.2 µm) and B10 (7.3 µm) , but O-B for H-9 shows slightly higher temperature for B09 (6.9 µm).
  - SST, Sunshine Duration: Calibration correction conducted.

9. High Level Topics - New Horizons [30']

9.1 New architectures and miniaturized instruments how will they shape the future LEO system

CGMS-51-NASA-WP-04 - NASA vision for future miniaturized meteorological instruments [20']

Executive Summary

- NASA has a long history of developing novel technologies, and small satellites are no exception. NASA has been building and launching SmallSats (ca. 180 kg in ca. 1 m^3 volume / the size of a kitchen fridge) and, more recently, CubeSats (which NASA defines as up 12 multiples of '1 Unit', where 1 unit = 10 x 10 x 10 cm) mostly as demonstrators;

- NASA has focused recently on integrating Small- and CubeSat technology into its Earth Venture initiative, a competitive selection of low-cost, science driven missions to develop novel technologies and support private investment in space;

- On SmallSats specifically, NASA has put in a great deal of effort recently to validate observations made by instruments in SmallSat payloads. Novel missions, such as TEMPEST-D

or CYGNSS, have been validated against operational instruments from NOAA and EUMETSAT to ensure 'science quality' observations.

Paolo Ruti (EUMETSAT) asked NASA if the push towards miniaturization was driven by user requirements. NASA claims while requirements are important, it is not the only consideration, and requires a constant understanding and reassessment of what is both technologically feasible and scientifically interesting. As a result of this technology-driven approach, NASA runs open calls for ideas and frequently hosts panel discussions in order to decide which ideas to follow through on. The philosophy, NASA said, is "How do we make the development of future technology easier?".

EUMETSAT participants also asked NASA whether they believe that Hyperspectral MW technologies are 'ready' to be used in SmallSats. NASA responded affirmatively, noting that they are currently investing efforts into hyperspectral MW and that it should be possible to deploy in SmallSats in the near-future.

10. CGMS future direction 2022+ project [30']

CGMS-51-CGMS-WP-12 - Status of the CGMS future direction 2022+ project

Executive Summary

Paolo Ruti (EUMETSAT) presented a working paper which gave an overview of the activities undertaken on the CGMS future direction 2022+ project since the CGMS-50 plenary for consideration and feedback by the CGMS-51 working groups (WGs I-IV and the SWCG). The 2nd high-level meeting on 29 March 2023 endorsed the way forward proposed, noting the need for the identification of concrete implementation measures in the next year (up to CGMS-52) and a stronger link as concerns the potential interfaces.

The basis for discussion are the agreed seven strategic themes:

- Socio-economic benefits
- Research to operations (R2O)
- Future observing (hybrid) space infrastructure
- Future information technologies
- Relationship with the private sector
- Climate and Earth system monitoring
- Space situational awareness
- A topic for all: supporting developing countries

JAXA participants noted that on research to operations, researchers and those who work in operations seemingly had a 'very different philosophy and culture' when it comes to the management of projects. This, in turn, leads to different working and funding structures, making the establishment of long-term strategic goals difficult to maintain.

EUMETSAT participants agreed with this perspective and believes the value of organizations like the CGMS can therefore be to filter out common practices to avoid redundancy or clashes of culture between either CGMS member agencies, or CGMS agencies and their member states.

NOAA participants noted that many CGMS member agencies have member states with their own met services. These met services, or consortia of met services often have their own research-to-operations initiatives. NOAA stress that the idea of 2022+ project is not to 'hijack existing structures' in R2O, but rather to add an additional layer of cooperation to influence how future satellite programmes are made as they move from research projects/demonstrators to operational system.

The WMO ask if the intention is to re-order the CGMS around these topics or if to leave the topics to be tackled by existing structures. The participants agreed that the best approach is to not alter in the existing structure in any fundamental way, but allow these topics to guide the existing structure. Participants did note however, that technology that fundamentally changes aspects of the EO or space industry (with AI/ML held up as a possible example) may result in the need to revisit the working group structure CGMS structure.

11. Review and updating of the HLPP [20']

CGMS-51-CGMS-WP-07WGII - Status of implementation of CGMS High Level Priority Plan (2022-2026)

Oral only, review of HPLL document:

https://www.cgms-info.org/Agendas/GetWpFile.ashx?wid=07bec3de-e931-46dd-b3c1-be9e0a991b4f&aid=21503bc8-0290-46b0-a559-a6e989946998

CGMS-51-CGMS-WP-08WGII - Revised HLPP 2023-2027 - for recommendation to plenary

12. Future CGMS WGII meetings [10']

CGMS-51-WGII-WP-01 - Decision on dates of WGII inter-sessional activities/meetings in 2023-2024 (CGMS-51 to CGMS-52)

TBD

CGMS-51-WGII-WP-03 - Decision on dates of CGMS-52 WGII plenary session

TBD

13. Any other business [5']

Nothing to report

14. Conclusions, preparation of the WGII report for plenary [15']

Agreement on outcomes, conclusions and preparations of the WGII report to Plenary

The summary list of WGII actions and recommendations is provided below (corresponding to i) CGMS-51 WGII high level actions and recommendations; ii) CGMS-51 WGII internal actions and recommendations; and iii) CGMS-51 WGII second level internal WGII actions.

Status of WGII actions following CGMS-51 plenary discussions

CGMS-51 WGII high level actions and recommendations						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members (WGII and SWCG)	4.5	WGII+SWCG/ (P)A50.05	CGMS WGII and SWCG members are invited to nominate candidates for a subgroup within GSICS on Space Weather Cal/Val and Intercalibration, which will be focused on providing intercalibration for Space Weather. Please provide nominations to cgmssec@eumetsat.int and mitch.goldberg@noaa.gov (left NOAA)	**2023 18 Oct:** Addressed on the occasion of the upcoming GSICS EP (after CGMS-51 plenary) and closed. **2023 8 Feb:** Current list of members of the task group on intercalibration of high energy electron sensor: **CMA** Jianguang Guo **ESA** Piers Jiggens, Hugh Evans, Melanie Heil, Juha-Pekka Luntama (from ET-SWx, WMO) **EUMETSAT** Andrew Monham, Tim Hewison **KMA** Dohyeong Kim , Jiyoung Kim, Daehyeon Oh **NASA** Jim Spann **NICT** Tsutomu Nagatsuma **NOAA** Elsayed Talaat, Terry Onsager, Brian Kress, Juan Rodriguez, and Mikayla Appell **ROSHYDROMET** Konstantin Ts. Litovchenko (TBC)	July 2023 (Dec 2022)	**CLOSED**
IESWG CGMS rapporteur	WGII report	A51.03	The IESWG to report on progress to plenary CGMS-53		CGMS-53	**OPEN**
CGMSSEC	WGII, WGClimate reports	A51.04	The CGMS Secretariat to secure the inclusion of an agenda item on the GEO-ring observations reprocessing for climate project at CGMS-52 plenary **(plus GeoRing sounding capabilities for NWP)**		CGMS-52	**OPEN**

CGMS-51 WGII high level actions and recommendations						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS members	FUTURE DIRECTION	A51.09	CGMS members to nominate and/or confirm representatives for the "champion" to secure the continuity of the six pilot activities and within the respective working groups (as per CGMS-51-CGMS-WP-04 EXT EXT) **FUTURE DIRECTION** **1 Socio Economic Benefits** WGIII / JMA to confirm by end July '23 **2 Hybrid Space Observations Architectures** WGIV / Simon Elliott EUMETSAT - confirmed **3 Private Sector** WGIII / Mara Browne NOAA - confirmed **4 Research to operations** WGIV **(support WGII)** / NOAA, NASA to confirm by end July '23 Other agencies to provide feedback by end July '23 **5 Future Information technology** IOT: WGI / Antoine Jeanjean EUM **AI/ML: WGII** *and WGIV* **/ TBD KMA?** Cloud: WGIV / TBD			**OPEN**

CGMS-51 WGII high level actions and recommendations						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			6 Space situational awareness SWCG, WGI / Juha-Pekka Luntama ESA - confirmed **7 Earth system monitoring** WMO, Albert Fischer - confirmed **8 Support to developing countries** CMA (name TBD by end July '23) - confirmed			
CGMS WGII members	2	WGIIA49.03	Define driving applications to determine the temporal coverage and spectral coverage needed as part of a LEO constellation. (For example – what temporal, spectral, and spatial resolutions needed to monitor tropical cyclones in “all sky conditions” ?)	**2023 30 April:** Closed following discussions in WGII. 2023: possible outcome a report to CGMS-51 - presentations under section 7 considering nowcasting aspects 2022 19 May: NOAA is undertaking such activity, and will compile a report and share with WGII once ready. NOAA/M. Goldberg to identify a potential focal point of contact/lead. 2022 21 Mar: A lead needs to be defined for this action to take it forward, or it will be closed. The scope needs to be narrowed down (instrument oriented) 2021 10 Dec: Action send again the request …	End 2022, CGMS-51 (CGMS-50)	**CLOSED**
CGMS WGII members	2	WGIIA49.02	Agencies to provide case studies demonstrating the benefits of additional orbital planes, beyond use of data in NWP.	**2023 30 April:** Closed following discussions in WGII. 2023: possible outcome a report to CGMS-51 - presentations under section 7 considering nowcasting aspects	CGMS-51 (CGMS-50)	**CLOSED**

CGMS-51 WGII high level actions and recommendations						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2023: something available by end of 2023 by EUMETSAT - precip and hydrology Megatropics ISRO (high inclined orbits vs polar orbit) to submit a short report - real time precip. monitoring Already available ESA study on MW sounding - different orbits - for NWP 2022 19 May: Ref. CGMS-50 NOAA-WP-19. Reminder to WGII necessary for sharing further case study demonstrations. 2021 10 Dec: Action send again the request … collect NOAA MW and Hyperspectral workshop outcome		
CGMS members (from plenary to WGII)	7	WGII/A48.19 (from Plenary A47.09)	Action transferred from plenary CGMS-48 to WGII Arctic observations: Provide product priorities for Arctic observations for a special Arctic session in WG II during CGMS-49 (Members with planned Arctic observation missions are requested to include a status report in the agency report)	**2023:** **WMO** is reinstating the polar satellite task group (PSTG) - inviting CGMS and CEOS to propose PoCs to develop ToR of this group then presenting ToR to WG2 - additional observations on land surface - cryosphere etc (a potential good point for having a CGMS Earth System Land WG) New missions: Russia, Canada ... **2022 19 May:** Postponed until CGMS-51 2021 10 Dec: Proposed action for a session at plenary (ROSHYDROMET, NOAA Arctic programme, Europe, other agencies ...) to analyse if there is a specific objective for 2022-Mitch Ken JV Paolo CGMS-49 WGII Apr 2021: CGMS-49-NASA-WP-01, CGMS-49-ECCC-WP-01 2021 11 Mar/2021 Jan: Topic on the WGII CGMS-49 agenda (and for plenary at CGMS-50).	CGMS-51 (CGMS-49)	**CLOSED**

CGMS-51 WGII high level actions and recommendations						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMSSEC & WMO		WGIIA50.01	CGMSSEC and WMO to consider if night-time light capabilities should be covered in HLPP, the CGMS Baseline, and should be reflected in the WMO Gap Analysis	Ongoing (to organize a meeting online TBC)	CGMS-52	**ONGOING**
CGMS WGII Chairs and Rapporteurs		WGIIA50.06	CGMS WGII Chairs and Rapporteurs to propose a procedure for endorsement of new co-chair / rapporteurs for the International Science Working Groups to be presented to the CGMS Plenary for approval	To prepare a draft proposal for next intersession meeting (by November - Jan ...)	GCMS-51	**CLOSED**
GCMS Plenary		WGIIA50.09	CGMS Plenary are requested to endorse the upcoming Third International Operational Satellite Oceanography Symposium (OSOS-3), planned for spring 2023 to be held in South Korea	Final check ! and close it	CGMS-50	**CLOSED**
IESWG		WGIIA50.14	IESWG to prepare a draft proposal on establishing a new CGMS International Science Working Group, adding an operational context, for review/endorsement by WG II Co-chairs and rapporteurs as well as its members and for further endorsement by Plenary	Asking IESWG to present the operational context to next Intersassional Session and then finalize it	3 June 2022	**CLOSED**
CGMS WGII members		WGIIA50.02	CGMS WGII members are invited to nominate candidates for positions of Vice-Chairs for GSICS-EP and GRWG. Please provide nominations to cgmssec@eumetsat.int and mitch.goldberg@noaa.gov	Request Mitch to report to CGMS WG2 by email and next session - EUM Moneer (Bojan discussion) plus Bojan vice chair	Sept 2022	**CLOSED**
CGMS WGII members		WGIIA50.03	CGMS WGII members are invited to nominate candidates for a Subgroup within GSICS on Space Weather Cal/Val and Intercalibration, which will be	Remind during the WMO space weather meeting (October 2022 - Ken action) - done	Sept 2022	**CLOSED**

CGMS-51 WGII high level actions and recommendations						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			focused on providing intercalibration for Space Weather. Please provide nominations to cgmssec@eumetsat.int and mitch.goldberg@noaa.gov			
WG II Co-chairs and rapporteurs		WGIIA50.12	WG II Co-chairs and rapporteurs to review the Terms of References of IESWG and agree on the way forward with respect to submitting a proposal to Plenary to establish IESWG as a new CGMS International Science Working Group	to be finalized after IESWG presentation on the operational context	3 June 2022	**CLOSED**
IESWG		WGIIA50.14	IESWG prepared a draft proposal on ToR for establishing a new CGMS International Science Working Group. Based on first outcomes, Working Group II proposes: - to finalize Terms of reference and circulate within CGMS in order to get feedback; - to be presented at CGMS-51 Plenary or endorsed off-line; - to engage IESWG in discussions on future priorities for CGMS Scientific Working Groups		3 Jun 2022	**CLOSED**
CGMS Space Agencies		WGIIR50.12	CGMS Space agencies are encouraged to maintain space-based assets beyond the design lifetime as long as they provide value added observations on a safe and affordable basis as determined by the operating agency	**2023 18 Oct:** Closed following CGMS-51 plenary. At NASA we are starting the new (triennial) senior review process to inform our plans for how to move forward with mission extensions! Similarly EUMETSAT		**CLOSED**

CGMS-51 WGII high level actions and recommendations						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS Members		WGIIR50.04	(IROWG) All providers of RO observations are encouraged to classify RO data as core data in the sense of the WMO Unified Data Policy (Res. 1). Therefore, free, timely and unrestricted access shall be provided to NRT RO data and free and unrestricted access shall be provided to archived raw data (including auxiliary data)	**2023**: IROWG is preparing a best-practice document Acknowledge the new data buy approach implemented by NOAA (for Jan2023 to Jun2023) - towards free data access - continue to be IROWG recommendation - risk of losing data for climate monitoring (data that are not freely provided) - obj to maintain a consistent record in collaboration with private sector (23 Nov 2022)	CGMS-52	**OPEN**
WMO and CGMS Members		WGIIR50.05	(IROWG) WMO and CGMS are encouraged to coordinate any GNSS-RO data purchases to ensure the current 20000 daily target identified in HLPP is met with global and full local time coverage	**2023**: ROMEX to provide new advice by 2024. 2023: IROWG continues to recommend 20000 ROs. However, ROMEX will maybe update this number. Cross organizational collaboration - providers and global centers to re-evaluate this limit of 20000 through an international collaboration - NWP centers working with data providers (steering meeting in Nov-Dec 2022) (23 Nov 2022)	CGMS-52	**OPEN**

CGMS-51 WGII internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
GSICS, WGClim, SCOPE-CM	WGII/8	A47.21	GSICS, WGClimate and SCOPE-CM to organise a workshop on calibration supporting reprocessing.	**2023 - to be analysed at EP meeting if still needed** 2022 19 May: WGII discussions (initial request coming from CMA). Delayed due to COVID. 2021 10 Dec: It will not happen before GCMS-50 - so it would be good to present at the Plenary in order to get support from agencies ang gathering involvement from other WGs 2021 27 Sep: No update, pending. CGMS-49 WGII Apr 2021: Workshop to be planned (delayed due to the pandemic). 2121 11 Mar: JWGC to discuss in March and GSICS at Annual meeting 2021 Jan: WGClimate to meet in February 2020 May CGMS-48 WGII session: Postponed due to Covid-19 situation. 2020 Mar 12 WGII IS #2: To be discussed on 17 March within GSICS community. 2020 Jan 9 WGII IS #1: - (First review to take place at GSICS meeting in March 2020, Korea - meeting cancelled).	CGMS-52 (Mar 2020, CGMS-48)	**OPEN**
GSICS			Establish a common reference solar spectrum with appropriate spectral coverage and spectral resolution and develop common methods and tools for on-ground calibration and characterisation and inter-calibration of UV-Vis- NIR SWIR spectrometers		CGMS-52	**OPEN**

CGMS-51 WGII internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
GSICS			Establish a methodology to characterise microwave instruments for O2 absorption channels through the SNO and RTM modelling. The implementation will be done successively by the individual satellite operators;		CGMS-52	**OPEN**
GSICS			Establish mechanisms for cross-calibrating scatterometers across the constellation.		CGMS-52	**OPEN**
IWWG	WGII/5	A46.07	IWWG to consider developing climate projects from Atmospheric Motion Vectors (AMVs) and to report to the CEOS/CGMS WGClimate with a potential pilot project. (Ref. CGMS-46-IWWG-WP-01)	**2023 18 Oct: Closed following CGMS-51 plenary** 2022 19 May: WGII noted the NOAA activities . IWWG is requested to report on progress to CGMS WGII. At CGMS-51 NOAA will provide a WP on geostationary processing. 2021 10 Dec: Ongoing. 2021 27 Sep: IWWG has joined JWGClimate. CGMS-49 WGII Apr 2021: Progress on reprocessing activities, however, further discussions needed between the IWWG and the JWGClimate. 2121 11 Mar/2020 Mar 6: IWW15 postponed until 14-18 April 2021 2020 Jan 9 WGII IS #1: To be reviewed at the IWWG meeting in April 2020. (Régis Borde, Steve Wanzong) CGMS-47: IWWG has reviewed the gaps identified by the last Essential Climate Variables (ECV) inventory. • The international status of polar and geostationary	CGMS-50 (CGMS-48/-47)	**CLOSED**

CGMS-51 WGII internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				AMV reprocessing has been updated and is presented in Annexe 1 of the IWWG Working Paper. • This topic will be discussed in a specific session at the next at IWW15. WGII IS#2 2019: no update		
CGMS members	WGII/5	A46.03	AMV producers to adopt the new AMV BUFR template.	2023 **IWWG in May where HLPP topics will be addressed** 2022 no updates - to produce a short document to be presented to IWWG and then having a best practices doc (IWWG) 2022 to be discussed by next IWWG meeting 2021 10 Dec: No progress 2021 27 Sep: Two centers ongoing (IMD, JMA and CMA), others completed, JMA postponed until March 2022. JMA is working on a thinning process because of GTS size limits. CGMS-49 WGII Apr 2021: CGMS-49-IWWG-WP-01 EUM / NWP SAF, NOAA have implemented, CMA to implement, other agencies invited to adopt template. 2021 11 Mar/Jan: IWW15 takes place mid April 2020 May CGMS-48 WGII: to be reviewed at the next IWWG. 2020 May 22: KMA is working on the production of the new bufr data with the sequence 3.10.077 and will release in June 2020. 2020 Mar 6: IWW15 postponed until 14-18 Sept 2020 Jan 9 WGII IS #1: To be reviewed at the IWWG meeting in April 2020. (Régis Borde, Steve Wanzong) CGMS-47: The AMV sequence 3.10.067 endorsed by the WMO in November 2017 has been rejected by some users in early 2018 because it could not	By IWW15, CGMS-48	**CLOSED**

CGMS-51 WGII internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				be used in automated framework. • The WMO corrected the sequence appropriately and endorsed the new AMV BUFR sequence 3.10.077 in November 2018. • NOAA, EUMETSAT and JMA are working on the production of the test data, planning an operational change early 2020. The NWCSAF will release a software patch later in 2019 which includes the new BUFR sequence. A new deadline to IWW15 (spring 2020) has been set to agencies to change their AMV BUFR sequence. • AMV producers to provide their users with a small test dataset (a few hours of data) encoded in the new BUFR format as soon as possible. • Nine months later, AMV producers will provide parallel dissemination of their AMV data in the new and old BUFR sequence over a 2-3 month period of time to allow the switch to take place.		
NWP community	WGII/5	A46.04	NWP community to define the best configuration to be used by the AMV producers, for use in global and regional NWP models.	**2023 Oct: Closed following CGMS-51 plenary** 2022 no updates - to produce a short document to be presented to IWWG and then having a best practices doc (IWWG) - 2021 10 Dec: No progress CGMS-49 WGII Apr 2021: A requirements document to be prepared, experiments ongoing expected to continue until IWWS-16 (~2023). Requirements document has been prepared for IWWG review. 2121 11 Mar/2020 Mar 6: Pending IWW15, postponed until mid April 2021, deadline may have to shift. 2020 Jan 9 WGII IS #1: To be reviewed at the	CGMS-51 (By IWW15, CGMS-48)	**CLOSED**

CGMS-51 WGII internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				IWWG meeting in April 2020. (Régis Borde, Steve Wanzong) CGMS-47: The Met Office and Met Norway is planning to test various configurations of AMVs, via the NWC SAF software, to work towards optimal configurations. • There are no updates to report at this time. • We expect more discussion at the IWW15. • No results to report yet. • This topic and results will be re-visited at IWW15. WGII IS#1 Dec 2018: The two NWP contacts that will help with this action are: Mary Forsythe mary.forsythe@metoffice.gov.uk and Roger Randriamampianina rogerr@met.no (Steve Wanzong, Co-Chair, IWWG)		
IWWG	WGII/5	A46.06	IWWG to look at improving quality indicators for high resolution wind derivation for mesoscale and regional applications. (Ref. CGMS-46-IWWG-WP-01)	**2023 remains open following CGMS-51 discussions.** to be addressed in May 2022 no updates - to produce a short document to be presented to IWWG and then having a best practices doc (IWWG) 2021 27 Sep: Ongoing, preliminary results provided by UKMO and CIMSS. 2021 May 16: CGMS-49-IWWG-WP-02 CGMS-49 WGII Apr 2021 2121 11 Mar/2020 Mar 6: IWW15 postponed until 14-18 Sept 2020 Jan 9 WGII IS #1: To be reviewed at the IWWG meeting in April 2020. (Régis Borde, Steve Wanzong) CGMS-47: Research activities continue that aim to	CGMS-52 (CGMS-48/-47)	**ONGOING**

CGMS-51 WGII internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				identify additional quality information from the AMV derivation that could be used to filter out poor quality AMVs and/or set observation errors for the AMV height assignment. • Quality measure associated with the correlation surface (addresses feature tracking) • Optimal estimation cost associated with cloud top temperature retrieval (addresses AMV height assignment) • Cloud top pressure error estimates (addresses AMV height assignment) • No results to report at this time. • We expect that some useful information relevant to this action may be extracted from work associated with A46.04. • This topic will be re-visited at IWW15. WGII IS#2 2019: no update		
CMA, EUM, NOAA (Space agencies)	WGI I/3	WGII/A48.02	Data providers to document data processing QC processes (including a month of QC statistics, e.g. rejection percentage at each QC step) and space sampling information and provide to IROWG.	**2023 to become a best practice document (closed and moved to WGII best practice list, action on Co-chairs for Best Practices repository)** 2022 - prepare a short doc as best practices, from IROWG - updates 2022 - final report of the workshop will provide best practices input 2021 10 Dec: No progress. 2021 27 Sep. No progress to date. Action on NOAA and EUMETSAT to request information on QC information on procured data and report back. Further discussions foreseen for IROWG September 2022, Addressed in CGMS-49 WGII Apr 2021. For further discussion.	Apr-21	**CLOSED**

CGMS-51 WGII internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2021 11 Mar: Waiting for IROWG meeting. 2021 Jan: CMA, EUM, NOAA to consider and implement as far as is possible. IROWG noted that RO data from KOMPSAT-5 are also of interested. 2020 Dec from IROWG: Reference is made to previous WGII action A46.08: IROWG to develop process and principles for RO data quality control to ease intercomparison of data from different providers. ○ IROWG acknowledges there are about 10-30% observations rejected during the data processing and retrieval procedures for current missions. However, the quality control (QC) procedures are not consistent among different data providers and processing centers. They are very likely to differ between the current and future missions as well. Providers should document their QC procedures (e.g., QC pertains to orbits, space sampling/ inhomogeneity, neutral atmosphere or space weather products, etc.) and share with IROWG. ○ IROWG recommends an action to data providers to document data processing QC processes (including a month of QC statistics, e.g. rejection percentage at each QC step) and space sampling information and provide to IROWG.		
CGMS members - WMO oscar	WGII/8	WGII/A48.15	CGMS Members shall make available their validated instrument SRFs together with uncertainty information through their instrument calibration landing pages. In addition, a document summarising the currently available SRFs and their	**2023 - each agency providing a link to the related web pages** 2022 Request WMO to report the status - so we can have an update at WG2 - 2021 10 Dec: ?to be part of OSCAR 2022 - SRF ongoing 2021 27 Sep: Ongoing. CGMS-49 WGII Apr 2021: ISRO & IMD have held a coordination meeting and implementation is	CGMS-52	**ONGOING**

CGMS-51 WGII internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			status (accurate/inaccurate) as well as identifying any missing information shall be provided through the landing pages.	ongoing. 2021 Feb: Some space-agencies may already provide SRFs on separate websites, but do not link this webpage to their landing pages. In order to complete the action would, thus, be to add links to your SRF subpages on your space agency instrument landing pages. 2021 Jan: EUM, JMA, have included such information. A reminder will be sent (by Rob Roebling, EUMETSAT) CMA information is included on the GSICS web page. http://gsics.nsmc.org.cn/portal/en/fycv/srf.html		
WMO	2	WGII/A49.12	WMO conduct a survey on baseline Level-2 product requirements for LEO satellites.	**2023 Oct: Remains open following CGMS-51 plenary** **2022 19 May:** Open. No progress. 2022 21 Mar: WMO to report to WGII CGMS-50 2021 10 Dec: ?	CGMS-52 (CGMS-51)	**OPEN**
WMO	2	WGII/A49.09	SST – review specification involving key users	2023 no update. WMO to provide baseline (GHRSST to review it). 2021 10 Dec: CEOS plenary there was a proposal to support oceanography - SST GEO baseline, what time and spatial coverage = WG2 to contact Virtual Constellation Initiative	CGMS-52 (Dec-21)	**OPEN**
WMO	2	WGII/A49.10	Review the baseline dissemination strategy for volcanic ash product	2023 No update.WMO to provide baseline 2021 10 Dec: Need for WGII and WGIV to set up a dedicated meeting?	CGMS-52 (Dec-21)	**OPEN**
WG II	2	WGII/A49.11	The dissemination strategy for the baseline products presented in CGMS-49-WMO-WP-14, including SST, should	**2023 Oct: Closed following CGMS-51 plenary** 2022 ensuring it is under WGIV - 2021 10 Dec: Need for WGII and WGIV to set up a dedicated meeting?	CGMS-52 (CGMS-50)	**CLOSED**

CGMS-51 WGII internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			be presented to and discussed with CGMS WG IV.			

CGMS-51 WGII second level internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
SCOPE-CM	WGII/4	A47.08	SCOPE-CM to report back on the conclusion of the 9 pilot projects	2022 Oct: updated only one use case (from EUMETSAT) the rest was outdated. Partly addressed. 2021 10 Dec: WMO to finalise -no need for WGII to review as an outcome of a presentation so already assessed 2021 27 Sep: Report to be published CGMS-49 WGII Apr 2021: WMO Secretariat to publish the related report. 2121 11 Mar: Still open, WMO to finalize 2021 Jan: Draft report under preparation. 2020 May CGMS-48 WGII: SCOPE-CM leads have been contacted by WMO on 22 May 2020 to provide feedback on outcome of projects before 30 June 2020. Plan to publish results in WMO Bulletin. New deadline. 2020 Mar 12 WGII IS #2: WMO to report in May 2020 2020 Mar 6: Changes with SCOPE-CM ongoing? Chair stepping down? 2020 Jan 9 WGII IS #1: No further information available	CGMS-52 (CGMS-48)	**ONGOING**

CGMS-51 WGII second level internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
ITWG	WGII/3	WGII/A48.03	ITWG to send a report demonstrating the value of temperature sounding of the upper stratosphere and mesosphere (as for the SSMIS UAS channels).	**2023 Oct: Remains open following CGMS-51 plenary** 2021 10 Dec: No clear way forward. To be addressed at the next WGII intersessional meeting. 2021 27 Sep. Work completed, report to be provided to WG II for review, CGMS-49 WGII Apr 2021: To be addressed at the upcoming ITWG meeting in June 2021. 2021 11 Mar/2021 Jan: ITWG meeting to be held in June 2021. Mitch to provide progress information. Some reports expected at ITWG.	CGMS-52 (CGMS-48)	**OPEN**
GSICS, OSVW	WGII/4	WGII/A48.10	OSVW to present at next GSICS meeting the potential and potential benefits and issues of crosscalibration of scatterometer data (at the GSICS annual meeting).	2021 10 Dec: No progress - Depending on GSICS outcome it could find a solution or to be discussed and be considered as a green category (colour scheme) 2021 27 Sep: No progress 2021 11 Mar: OSVW have been invited? 2021 Jan: OSVW group to be invited to the next GSICS meeting.	CGMS-52 (Mar 2021)	**OPEN**
IWWG	3	WGII/A49.13	To clarify approach for 3D wind profile measuring constellation in recommendation	2022: EUMETSAT 3D wind profiling. other than EUMETSAT at the moment not much going on 2021 27 Sep: IWWG to follow up at their next meeting	CGMS-52 (Mid-May 2021)	**OPEN**
WGClimate, GCOS (WMO)	5	WGII/A49.19	GCOS and JWGClimate to develop a proposal for a formal approach for the translation of GCOS technology free requirements to requirements for space-based observations.	2023: WMO to clarify 2022 21 Mar: Who is taking the lead to move this activity forward?	CGMS-52 (CGMS-50)	**OPEN**

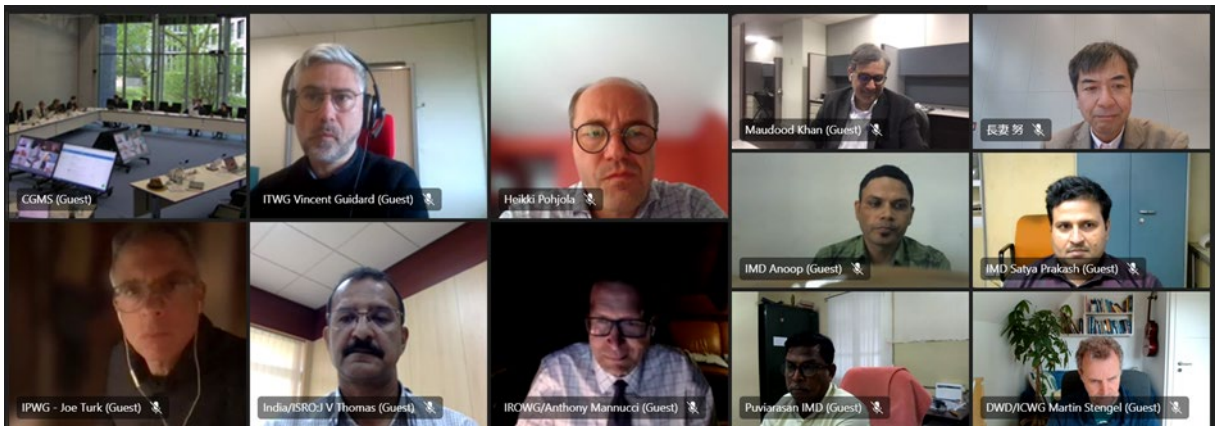
CGMS-51 WGII second level internal actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
JWGClimate	6	WGII/A49.23	JWGClimate GHG task team to provide a report on the progress of the evolution of ground-based/in-situ GHG observations to CGMS.	2021 10 Dec: No progress reported. 2021 27 Sep: Work is ongoing. GHG TT, and others, preparing a synthesis report on requirements for observations, including ground-based/insitu observations.	CGMS-52 (CGMS-50)	**OPEN**
IWWG (& WGII)	4.1		Report on status of the IWWG OSW Task Group	**2023 Oct: Closed following CGMS-51 plenary** 2022: an update after next IWWG meeting (May 2023) Addressed in CGMS-49 plenary for WGII to follow/prepare feedback to CGMS-51 plenary)	CGMS-51	**CLOSED**

LIST OF PARTICIPANTS

CGMS-51 - WGII List of Participants		
Organisation	**Lastname**	**Organisation**
Guan	Min	CMA
Wei	Zheng	CMA/NSMC
Na	Xu	CMA/NSMC
Lu	Zhang	CMA/NSMC
Chengli	Qi	CMA/NSMC
Christian	Kummerow	IPWG/Colorado State University
Yasjka	Meijer	ESA
Juha-Pekka	Luntama	ESA
Alexis	Sarraute	ESA
Mikael	Rattenborg	EUMETSAT/CGMS Sec
Anne	Taube	EUMETSAT/CGMS Sec
Jenny	Rourke	EUMETSAT
Jörg	Schulz	EUMETSAT
Christian	Marquardt	EUMETSAT
Stephan	Bojinski	EUMETSAT
Justin	Shenolikar	EUMETSAT
Ruediger	Lang	EUMETSAT
Joachim	Saalmueller	EUMETSAT
Paolo	Ruti	EUMETSAT
Christophe	Accadia	EUMETSAT
Viju	John	EUMETSAT
Martin	Stengel	ICWG/DWD
Benjamin	Ruston	IESWG/UCAR
Anoop	Kumar Mishra	IMD
Chinmay	Khadke	IMD
Puviarasan	Narayanasamy	IMD
Satya	Prakash	IMD
Joe	Turk	IPWG/JPL/Caltech
Vincent	Guidard	IPWG/Météo-France
Anthony	Mannucci	IROWG
Ulrich	Foelsche	IROWG / University of Graz
Hui	Shao	IROWG/JCSDA
Pradeep	Thapliyal	ISRO
Rashmi	Sharma	ISRO
Jayaprakash V	Thomas	ISRO HQ
Bipasha	Shukla	ISRO SAC
Régis	Borde	IWWG/EUMETSAT
Steve	Wanzong	IWWG/UW-Madison/CIMSS
Kachi	Misako	JAXA

CGMS-51 - WGII List of Participants		
Organisation	Lastname	Organisation
Toshiyuki	Kurino	JAXA
Takuji	Kubota	JAXA
Ayako	Yamane	JMA
Date	Kenji	JMA
Hiroshi	Suzue	JMA
Kazuki	Shimoji	JMA
Kazutaka	Yamada	JMA
Miki	Abe	JMA
Kotaro	Saito	JMA
Masaya	Takahashi	JMA
Masayuki	Sasaki	JMA
Mayu	Sumita	JMA
Mayuko	Sakurai	JMA
Mayuko	Kasai	JMA
Misaki	Eiki	JMA
Mouri	Kouki	JMA
Nakayama	Ryuichiro	JMA
Norio	Kamekawa	JMA
Shiho	Naiki	JMA
Shiro	Omori	JMA
Takahito	Imai	JMA
Takumi	Maruyama	JMA
Taro	Handa	JMA
Yoshiaki	Takeuchi	JMA
Yusuke	Yogo	JMA
Kaziki	Kodera	JMA
Nakayama	Ryuichiro	JMA
Noriyuki	Kawano	JMA
Shin	Koyama	JMA
Nozomu	Fukuhara	JMA MSC
Hiroshi	Kunimatsu	JMA/MSC
Kazuki	Kodera	JMA/MSC
Oike	Syunya	JMA/MSC
Saeki	Yuuki	JMA/MSC
Yurika	Yamada	JMA/MSC
Wenying	Su	JWGCLIMATE/NASA
Eunha	Sohn	KMA
Khan	Maudood	NASA
Sachidananda	Babu	NASA
Jack	Kaye	NASA
Douglas	Parker	NCAS/University of Leeds

CGMS-51 - WGII List of Participants		
Organisation	**Lastname**	**Organisation**
Tsutomu	Nagatsuma	NICT
Jaime	Daniels	NOAA
Jordan	Gerth	NOAA
Mitch	Goldberg	NOAA
Shobha	Kondragunta	NOAA
Jeff	Privette	NOAA
Melissa	Johnson	NOAA
Zhou	Lihang	NOAA
Veronica	Lance	NOAA
Andrew	Heidinger	NOAA/NESDIS
Elsayed	Talaat	NOAA/NESDIS/SWO
Alexander	Uspensky	ROSHYDROMET
Anne-Claire	Fontan	WMO
Kenneth	Holmlund	WMO
Natalia	Donoho	WMO
Lars Peter	Riishojgaard	WMO
Chang	Liu	WMO
Sebastien	Langlade	WMO/Meteo France
Herndon	Derrick	WMO/University of Wisconsin-CIMSS
Heikki	Pohjola	WMO/WGII co-chair


CGMS (Guest)
ITWG Vincent Guidard (Guest)
Heikki Pohjola
Maudood Khan (Guest)
長妻努
IMD Anoop (Guest)
IMD Satya Prakash (Guest)
IPWG - Joe Turk (Guest)
India/ISRO:J V Thomas (Guest)
IROWG/Anthony Mannucci (Guest)
Puviarasan IMD (Guest)
DWD/ICWG Martin Stengel (Guest)


CGMS-51 WGII, 24 April 2023 - Connection details
Chat
People
Raise
React
View
Rooms
Slido
Apps
More
Camera
Mic
Share
Leave
Sylwia Mie...
Roshydrom...
BenR (Guest)
IROWG (Uli...
Recording and transcription
Started by Joana Betencourt. By attending this meeting, you consent to being included.
Privacy policy
JMA Takum...
Participants
CGMS (Guest)
ITWG Vincent Guidard (Guest)
Heikki Pohjola
IMD Satya Prakash (Guest)
Puviarasan IMD (Guest)
DWD/ICWG Martin Stengel (Guest)
IMD Anoop (Guest)
India/ISRO:J V Thomas (Guest)
IROWG/Anthony Mannucci (Guest)
Maudood Khan (Guest)
Kaye, Jack (HQ-DK000)
Type here to search
13:32
24/04/2023

CGMS

Working Group III (WGIII)

Contingency and continuity planning

WGIII REPORT

Chair: *Irene Parker, NOAA / Peng Zhang, CMA (absent)*
Rapporteur: *Heikki Pohjola, WMO*

1. Opening, objectives

Co-Chair Irene Parker (NOAA) opened the meeting and welcomed all participants to the WGIII session of CGMS-51 working groups. She presented the meeting agenda and the objectives of the meeting related to the role of WGIII with regards to the CGMS baseline and the CGMS risk assessment. The meeting participants were introducing themselves onsite and online. The list of participants can be found in the Annex 1.

2. Review of current WGIII list of actions

CGMS-51-WGIII-WP-10 - Status of CGMS-50 WGIII list of actions

Anne Taube (EUMETSAT) presented the status of the list of actions. Actions were reviewed and updated accordingly in the list of actions (Annex 2).

CGMS-51-CGMS-WP-14WGIII - Status of co-chairs/rapporteurs of the CGMS working groups, CGMS International Science Working Groups, VLab, and other groups

Anne Taube (EUMETSAT) presented the status of the nominations and representatives of the co-chairs and rapporteurs. It was noted that situation related to WGIII is good.

3. Status of and way forward for establishing core satellite data as per new WMO unified Data Policy [20']

WMO Unified Data Policy

CGMS-51-WMO-WP-12 - WMO Unified Data Policy and satellite data

Heikki Pohjola (WMO) presented the WMO activities on defining Core satellite data under WMO Unified Policy for International Exchange of Earth System Data. He explained the major changes compared to old WMO Data Policy resolutions 40, 25 and 60. The important change is that with the new data policy WMO commits itself to broadening and enhancing the free and unrestricted international exchange of Earth system data. Thus, new data policy resolution emphasis on the Earth System and not only weather, hydrology and climate alone. New data policy has two categories: Core (data *shall* be exchanged) and Recommended (data *should* be exchanged).

The invitation letters, together with WMO preliminary analysis of current space-based observation capabilities, were sent out requesting space agencies to contact WMO to facilitate bilateral discussion. Now WMO has completed bilateral discussions with most of the space agencies to define possible Core and Recommended satellite data provided by space agencies. In general space agencies are very much willing to define most of their data Core. Some exceptions are for example certain space weather data, which cannot be exchanged without restrictions. Also, some concerns were raised that more user consultation is needed before Core data is defined and documented in WIGOS manual, which is referred to the data policy related to the data exchange. Therefore, WMO is organizing a workshop

for the consultation of space agencies and WMO application areas. The aim is to document the outcome in WMO WIGOS Manual and presented for INFCOM 3, WMO Executive Council and again for WMO Congress for the final approval by WMO members.

4. Updates on significant observational missions (in response to/from a CGMS baseline/risk assessment point of view)

4.1 Operational missions

CGMS-51-EUMETSAT-WP-10 - MTG status report

Paolo Ruti (EUMETSAT) gave an update of MTG-I status and other EUMETSAT´s mandatory satellite programs. MTG-I1 commissioning is ongoing, and it is divided into two main parts: Satellite in-orbit verification (ESA & Industry) and System commissioning, including end-to-end processor science validation (EUMETSAT). In practice, these two phases are highly interleaved. He reported that FCI first full disc measurement took place 15 March 2023, and the first image is going to be released 4 May 2023. LI instrument operations, after the first power on test taken place already, is going to be activated later during H1 2023. He also presented the status of EPS-Aeolus mission with Doppler wind lidar, which is now in Phase B. EUMETSAT´s MW sounder missions EPS-Sterna is in Phase A. He also emphasized the importance the role of AI/ML in the future applications of NWP and nowcasting, where EUMETSAT is also investing within new missions. Finally, he wanted to remind EUMETSAT Meteorological Satellite Conference 2023 to be organised in Malmo, Sweden.

CGMS-51-JMA-WP-06 - Status of Himawari-8/9 and their follow-on satellite Himawari-10

Kotaro Bessho (JMA) reported on the status of Himawari-8/9 operations and their follow-on satellite Himawari-10 planning. Satellite Operation by the Japan Meteorological Agency (JMA) was switched over from Himawari-8 (in operation since July 2015) to Himawari-9 in December 2022 for scheduled operation until FY 2029. JMA implemented a largely seamless switchover to Himawari-9 with Himawari-8 providing back-up in the event of a critical malfunction, with no changes on data format or data dissemination system. Himawari satellites are also covering the Himawari Request service started in January 2018. It is covering the target area 1000 km x 1000 km with 2.5-minute time resolution supporting disaster risk reduction activities in the Asia Oceanic region. It has 22 registered NHMS users and all together 176 support requests for tropical cyclones, volcanic eruption and wildfires observing support.

JMA contracted manufacturing of the follow-on satellite Himawari-10 in March 2023, with initiation of operation scheduled for FY 2029. Himawari-10 is scheduled to carry a visible/infrared imager as well as an infrared sounder and a space environmental suite completing hyperspectral IR sounder request by WMO WIGOS Vision 2040. It will have L3Harris´s new 18-band imager based on the GeoXO Imager concept. As well as L3Harris's new infrared FTS sounder based on the GeoXO Sounder concept. Its design lifetime will be 15 years.

4.2 Research missions

CGMS-51-NASA-WP-06 - Overview of NASA TEMPO and TROPICS missions

Maudood Khan (NASA) gave a presentation on NASA´s TEMPO and TROPICS missions. Tropospheric Emissions: Monitoring of Pollution (TEMPO) is a grating spectrometer, sensitive to visible and ultraviolet wavelengths of light. It is attached to the Earth-facing side of a commercial telecommunications satellite that is stationed in a geostationary orbit. It will collect high-resolution measurements of ozone, nitrogen dioxide and other pollutants, data which will revolutionize air quality forecasts. It is building on a legacy of monitoring atmospheric composition from Satellites: Ozone Monitoring Instrument aboard Aura spacecraft launched in 2004. The instrument is integrated onto a Maxar 1300 Series Spacecraft Bus hosted on an Intelsat Commercial Satcom mission (IS40e) stationed at 91 deg W. Instrument will get powered on in May 2023. First light in mid-July 2023 and then a public release of standard products in October 2023.

Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS). TROPICS will provide rapid-refresh microwave measurements over the tropics using a constellation of Cubesats. Each member of the constellation will host a radiometer will scan across the satellite track and provide: Temperature profile using seven channels near the 118.75 GHz O2 absorption line; Water vapor using three channels near the 183 GHz water vapor absorption line; Precipitation using a single channel near 90 GHz; and Cloud-ice measurements using a single channel at 205 GHz.

The TROPICS constellation initially comprised of two CubeSats in each of three orbital planes with the following launch parameters: equally spaced RAAN (±10° tolerance), 550 km altitude (±50 km tolerance), 30° inclination (±3° tolerance). The configuration was to provide better than 60-minute median revisit rates with spatial resolution and swath width comparable to current state-of-the-art sensors. Unfortunately, last summer two Spacecraft were lost in a launch attempt. However, they were successful in launching TROPICS-01 (TROPICS Pathfinder was launched on June 30, 2021, on SpaceX Transporter 2) which was identical to the other TROPICS satellites and was intended to enable full testing of the technology, communication systems, data processing, and data flow to application users in advance of the constellation's launch. Recognizing the urgent science need to allow researchers to study tropical cyclones through more frequent observations as well as the strong potential applications benefits to protect life and property, NASA awarded a new launch contract to Rocket Lab to ensure that the constellation could meet the need for the 2023 Atlantic Hurricane Season. The remaining four spacecraft are currently in New Zealand for integration onto the two dedicated launch vehicles. The first launch is scheduled no earlier than May 1st UTC (April 30th in the United States) (https://www.rocketlabusa.com/missions/next-mission/). The second launch window will be defined by the actual launch time of the first launch to ensure the RAAN spacing required for the mission.

Paolo Ruti asked about the evaluation of the TROPICS humidity channels, and if they based on impact analysis in data assimilation of NWP system. It was confirmed that channel selection is a legacy after GPM and then based on related OSES. The real benefit could come if cubesats operate without degradation of performance.

Also, real time data latency performance was discussed and it was concluded it will be less than 2 hours, which **is generally good considering Cubesat limitation.**

5. CGMS baseline and risk assessment

5.1 CGMS baseline and risk assessment

CGMS-51-WMO-WP-13 - WMO Gap Analysis

Heikki Pohjola (WMO) presented WMO Gap Analysis prepared for the 5th CGMS WG III Risk Assessment Workshop organized earlier this year. WMO gap analysis for Earth observation and space weather observation capabilities against the WMO Vision for WIGOS 2040 covering the next decade was provided. He explained the objectives of the work related to WMO WIGOS Vision 2040 and WMO Rolling Review of Requirement, and the content of the WIGOS subcomponents 1 and 2 used for the gap analysis on LEO and GEO orbits. It compares space-based observation capabilities recorded in OSCAR/Space to the WMO WIGOS Vision for 2040 requirements detailing the missing observations capabilities related to the specific observation types in WIGOS subcomponent 1 and 2. The work summarises totally 18 gaps for Earth observation types and 9 gaps for space weather observation types as main concerns non-compliant with WIGOS Vision 2040 requirements. Seven out of all the gaps are including periodic totally missing observation capabilities. These are for Earth observations: MW SST/LST, cloud radar, Doppler wind lidar, altimeter lidar, wide swath radar altimeter, IR/MW limb sounder and high temporal MW sounder. In addition, total gap for space weather is identified for solar radio waves measurements at L1 later part of the decade.

CGMS-51-WGIII-WP-02WGIII - Outcome of the 5th CGMS risk assessment workshop

Melissa Johnson (NOAA) presented the CGMS risk assessment prepared by the 5th CGMS Risk Assessment Workshop together with NOAA. She introduced objectives, background, and the preparation procedure of the risk assessment. She explained how space agencies are first consulted to receive the latest information on their missions. The agency feedback is also submitted to WMO for OSCAR/Space input reconciliation. Related to high level risk assessment she introduced the identified gaps on radio occultation, and on L1 for coronagraph, magnetometer and plasma analyser. Related to the risk assessment there are following associated open actions (existing):

- ISRO to confirm plans beyond OceanSat-3.
- ISRO to provide update on their plans for a geostationary hyperspectral infrared sounder.
- NASA and JAXA to confirm plans to fly a precipitation radar beyond the GPM Core.
- KMA to report on plans beyond GK2B for visible/UV spectrometer and Narrow Band imager.
- WGII to consider whether observations from geostationary orbit should be added to the CGMS baseline requirements for the broadband short/long wave radiometer.
- WMO to implement energy ranges for high energy particle classification to OSCAR/Space as defined in the CGMS Baseline (closed in the meeting).
- WMO to implement the feature of SunEarth line instrument filtering for the OSCAR/Space Gap Analysis (closed in the meeting).
- NOAA should review additional ground resources needed to track STEREO-A and PUNCH to provide additional coverage in the near-term.

All the flight out charts were reviewed during the meeting. Several updates were made:

- FY4D-4F - remove and update assessment to note risk in later part of the decade.
- Change no long term plans to no long term commitment on last SWx slide.
- Change GeoXO to GeoXO I1 to reflect imager v sounder.
- Ensure FY-3G is in drifting orbit.
- FY-3G to be included on the microwave imager chart.
- FY-3F and 3H to be included on the narrow band visible imager chart.
- Update RO assessment to reflect that CGMS is not meeting the baseline commitment but will include commercial providers as a risk mitigation measure as long as agencies ensure provider commits to providing data free and open basis/as long as they meet qualifications for those measurements.

Update RO assessment to reflect that CGMS is not meeting the baseline commitment but will include commercial providers as a risk mitigation measure as long as agencies ensure provider commits to providing data free and open basis/as long as they meet qualifications for those measurements. Radio occultation (RO) data use and requirements were discussed. Mikael Rattenborg (CGMSSEC) was asking about the difference between IROWG target (20000) and CGMS baseline target (14600). Elsayed Talaat (NOAA) was explaining that CGMS baseline target is the total maximum number of RO soundings available from the current baseline capabilities including data buys by NOAA and EUMETSAT. IROWG target of 20000 ROs is based on the scientific analysis. The CGMS Baseline commitment of 14,600 occultations is not being met until 2025 until Metop-SG launches, and there is a high risk of not meeting the commitment from low inclination orbits in the later part of the decade as there are no plans for a follow-on to COSMIC-2. There is inconsistent coverage from polar and high inclination orbits throughout the period. Commercial operators could offer some risk mitigation (would need to ensure compliance with national and international mandates and policies). An HLPP objective (1.2) already exists to advance the atmospheric Radio Occultation constellation, with the long-term goal of providing 20000 occultations per day on a sustained basis; consider an additional recommendation for tropical missions to carry RO sensors.

Christian Marquardt was pointing out that so far NOAA and EUMETSAT have had an excellent cooperation on commercial data buys of RO data. He was asking about the potential use of Chinese commercial RO data to be used in the future. An action was placed on CMA to look into future commercial RO.

As a summary of the discussion Irene Parker stated that for this risk mitigation we should consider EUMETSAT´s and NOAA's RO commercial data buy and reevaluate annually how to incorporate commercial data in the risk mitigation. Also, as a part of WGIII we can stress the potential gap in out years at CGMS 51 and how this can be addressed in the future. The RO risk was updated according to discussion.

Jordan Gerth (NOAA) was pointing out that GOES-17 is not anymore on 137 W and the LI gap on the pacific should be recognized like pointed out in WMO Gap Analysis.

Mitch Goldberg (NOAA) was asking about the definition of ocean color. VIRS can be used also, but it is limited. Mikael Rattenborg (CGMSSEC) commented that we need to add specific definition what narrow band means. It was agreed to have that in the risk assessment in 2024.

Andrew Monham (EUMETSAT) was asking about NOAA´s plans to mitigate coronagraph gap and if plan exist why it is indicated as a gap. Elsayed Talaat (NOAA) confirmed that long-term plan will be confirmed until the end of the year. The gap is indicated due to the missing confirmation of the mitigation plan. Also, it was asked about the long-term commitment on plasma analyser. Irene Parker (NOAA) explained that situation is the same due to SWFO-L1 continuation is not approved yet. It was agreed that related wording will be changed from "plan" to "commitment", because the plan exist, Melissa to provide updated charts week after the meeting.

CGMS-51 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CMA	6.1		CMA to look into the potential of the operational use of Chinese commercial RO data.	CGMS-52	**OPEN**

CGMS-51-WGIII-WP-01WGIII - CGMS Baseline - draft revision following the 5th risk assessment workshop

Anne Taube (EUMETSAT) presented CGMS baseline document. She concluded that it includes some editorial changes only: references list updated, GEO slots updated for Space weather observations. Anne was requesting the meeting participants to send any additional comments to her.

5.2 Any outstanding items on the baseline and risk assessment

5.3 CGMS Contingency Plan

CGMS-51-WGIII-WP-04 - Review and update of the CGMS Contingency Plan

Mikael Rattenborg (CGMSSEC) presented CGMS contingency plan document. He went through the changes of the document compared to last´s year: WMO gap analysis edited to be provided every year instead of every 4-year; in section 4.1, hosted payloads added to the texts as reflected also in the CGMS baseline and other documents; in section 5.1, included the text about help your neighbour-process, which it was already applied in many cases already e.g. IOCD etc. Under section 5, added a paragraph about the commercial sourced data included in the risk assessment. In section 5.1, added text about the satellites operated beyond their design lifetime. It does not obligate operators to do this, but it encourages them to apply if possible. In section 6, the graph about CGMS risk assessment was added.

6. Socio-economic benefit studies

Reports on performed or ongoing SEB studies

CGMS-51-CMA-WP-02 - Preliminary assessment of socio-economic benefits from CMA Meteorological Satellite Programmes

Min Guan (CMA) presented the outlook of Fengyun (FY) programme and its preliminary assessment of socio-economic benefits. A scientific and accurate analysis of the socio-economic benefits of FY Meteorological Satellite programme will help to improve the application development and satellite

meteorological services. By analyzing the application of FY meteorological satellite data in meteorological disaster prevention and mitigation, climate application, ecological civilization construction, atmospheric environment application and space weather monitoring, the information value chain of FY meteorological satellite was understood. Based on the information value chain, the FY meteorological satellites socio-economic benefit analysis model was established and combined with the Analytic Hierarchy Process (AHP) with the survey questionnaire. Data access has the lowest score in the survey, which means that training and publicity should be strengthened. Based on the benefits of meteorological services in 2019, it is quantitatively calculated that the economic benefit of the FY meteorological satellite in 2019 was 31.343 billion RMB, and the input-output ratio of the FY meteorological satellite programme was 1:30.

CGMS-51-NOAA-WP-12 - Report on NOAA SEB Studies

Charles Wooldridge (NOAA) presented the two relevant studies:

GeoXO Benefit Analysis and Economic Benefit Analysis of NOAA's Space Weather Products and Servic es to the Electric Power Industry.

GeoXO Benefit Analysis study purpose is to conduct an economic benefit analysis of NOAA´s future Geostationary Extended Observation (GeoXO) satellite contellation and the manner in which those benefits are produced. The report also provides estimates of the magnitude of a subset of the anticipated societal benefits for comparison with the anticipated cost of the constellation during its development and throughout its operational life. GeoXO includes five distinct instruments but is designed as a system. Although each instrument provides unique and economically valuable observations, realizing the full value of GeoXO depends on multiple instruments working in combination. Even where benefits can be traced primarily to a single instrument, the magnitude of benefits is frequently increased by information provided by other instruments on GeoXO. The five instruments included in recommended GeoXO constellation are: VIS/IR Imager (imager), Geostationary Lightning Mapper (lightning mapper), Ocean Color, Atmospheric Composition, and IR Sounder (sounder).

Economic Benefit Analysis of NOAA's Space Weather Products and Services to the Electric Power Industry study looks at potential economic impact of a solar storm. More specifically it addresses the economic loss from a space weather induced electricity blackout.

NOAA continues to pursue socioeconomic benefit analyses to better understand the value of our satellite programs and data. These analyses help us communicate effectively with funding agencies and to prioritize among potential program capabilities.

7. WMO OSCAR/Space database status update

WMO OSCAR/Space database

CGMS-51-WMO-WP-14 - Current Status of WMO OSCAR/Space

Heikki Pohjola presented the current status of WMO maintained OSCAR/Space (Observing System Capability Analysis and Review Tool for Space-based capabilities) database. He introduced the structure of the database consisting of three connected databases: OSCAR/Requirements, OSCAR/Space and OSCAR/Surface.

OSCAR/Space is a key tool and information source to support the WMO Rolling Review of Requirements (RRR) process and WMO Gap Analysis (CGMS-51-WMO-WP-14), which are used to monitor the compliance of satellite programmes in the implementation of the CGMS Baseline and the space-based component of the Vision for WIGOS in 2040 (WMO-No. 1243). WMO Space Programme Office continued a successful development framework with a contractor for the OSCAR/Space technical maintenance. The recent development plan in 2022 resulted software release including a milestone to develop OSCAR/Space frequency recording to support Space Frequency Coordination Group (SFCG) in their interest of using OSCAR/Space as an information source. Also, data latency records are implemented in OSCAR/Space to support gap analysis especially for Space Weather application.

The major miles stones in 2023 are to implement the WIGOS station identifiers for satellites and Common Code Tables C-5/8 recorded in OSCAR/Space. The main mechanism for the WMO Space Programme Office to collect the relevant information for the database content updating is through templates submitted to the OSCAR/Space Support Team (O/SST) members, usually two to three times per year. In addition, the similar request was sent to some non-CGMS members having their satellites in OSCAR/Space.

8. Review of CGMS-51 WGIII actions

9. CGMS future direction project 2022+

CGMS-51-CGMS-WP-09WGIII - Status of CGMS future direction 2022+ project

Paolo Ruti (EUMETSAT) presented the status and way forward of the CGMS future direction 2022+ project. CGMS tasked the project to review CGMS activities in small groups with different themes. The basis for discussion is the agreed seven strategic themes: Socio-economic benefits, Research to operations, Future observing (hybrid) space infrastructure, Future information technologies, Relationship with the private sector, Climate and Earth system monitoring and Space situational awareness. In addition, there is a topic for supporting developing countries. The 2nd high-level meeting on 29 March 2023 endorsed the way forward proposed, noting the need for the identification of concrete implementation measures in the next year (up to CGMS-52) and a stronger link as concerns the potential interfaces. It was concluded that the goals related to different themes are translated to deliverables and implemented into work of the working groups.

Commercial data and SEB topics were discussed. It was concluded that the concreate outcome related to commercial data is the best practice guide for commercial data buy.

CGMS-51 actions - WGII					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
CGMS WGs	8		The CGMS working groups are requested to consider and identify the implications/impact/activities in each working group and to give feedback as necessary. This includes implementation measures and interface considerations. - Do you agree on lead designation to Working Groups. (Note: no new WGs are proposed). - Additional questions and proposals to be discussed? - Support to developing countries - Interface considerations, other to be considered? - Implementation measures (short and long term) - For recommendation to plenary	CGMS-51 plenary	**OPEN**

10. CGMS High Level Priority Plan (HLPP)

Review and updating of the HLPP

CGMS-51-CGMS-WP-07WGIII - Status of implementation of CGMS High Level Priority Plan (2022-2026)

Mikael Rattenborg presented the current status of the CGMS High Level Priority Plan (2022-2026). He presented the status of implementation incorporated to WG III and pointed out the following outcomes:

1.1.1: Continuity of passive MW imager: Action on ESA to confirm CIMR mission (exists already).

1.1.2: Continuity of precipitation radar: Action on NASA and JAXA to confirm plans after GPM core (exists already).

1.1.4: Continuity of RO: Action on IROWG to review the number of RO soundings (exists already).

1.1.5: SWCG asks to include L1 magnetometer and plasma analyser in the description of the gap, noting that there are limited opportunities for gap-filling in-situ measurements from L1 (currently provided by DSCOVR and ACE).

1.2.1: Related to SW IR spectrometer for GHG monitoring, multi viewing/polarization imaging for aerosols and UV limb sounding for ozone and trace gases: Further concreate actions to be discussed

related to short wave spectrometer and other aerosol measurements, and limb sounding. The CGMS Secretariat reminded WGII to consider this.

1.2.2: When hyper spectral IR sounder is now more advanced and common, it was agreed to replace IR by hyperspectral IR for clarification.

1.2.3: Work towards operational hourly daytime UV/VIS mapping of air quality from geostationary orbit to improve time sampling, spatial and spectral resolution and timeliness of observations, including the deployment of HSIR instruments across the GEO ring as per WIGOS vision 2040; Complete understanding on new missions needed, will be kept as a target.

1.2.4. Work towards ensuring optimised High Spectral resolution IR measurements from LEO and GEO orbits to improve time sampling, spatial and spectral resolution and timeliness of observations, including the deployment of HSIR instruments across the GEO ring as per WIGOS Vision 2040: Demonstrate the complementarity of the measurements. Action on WGII (exists already).

1.2.5. Work towards optimising the distribution of planned scatterometer missions across different polar and inclined non synchronous orbits to achieve the 6-hour sampling requirement of the WIGOS and resolve diurnal variations; No information on progress of scatterometer missions. It is not foreseen multiple orbits coming.

1.2.7. Establish observational requirements for microwave observations (sounder and imager) for NWP and precipitation and perform gap analysis against CGMS baseline: IPWG proposed addition for precipitation, develop a benchmark to conduct comprehensive assessments of current and future scenarios for the CGMS baseline.

1.2.8: Work towards increasing geographical resolution and coverage for altimetry measurements, including very high latitudes: CGMS-51 action for ESA to present plans for the operational Copernicus mission CRISTAL.

1.2.11: Work towards operational infrared/µwave limb sounding for climate monitoring and NWP applications: Decided to remove IR limb sounding requirement, because there is not foreseen operational continuation and application for that measurement.

1.4.1: Support satellite impact studies, including in particular impact of data latency and the impact of the Early Morning orbit: WMO impact workshop in 2024 preparations started. It will be now more continuous project where CGMS gives input for important science questions.

Kenneth Holmlund (WMO) pointed out the importance of the critical assessment to support polar space task related measurements. Meeting took a note on this to be added in HLPP.

Mikael Rattenborg further proposed the revised HLPP 2023-2027 to be presented to plenary for endorsement.

11. Future CGMS WGIII meetings

CGMS-51-WGIII-WP-08 - Decision on dates of inter-sessional activities/meetings in 2023-2024 (CGMS-51 to CGMS-52) and dates of the CGMS-52 WGIII plenary session

Anne Taube (EUMETSAT) presented the proposal for the dates of intersessional meetings and CGMS-51 as follows:

WGIII activity, format	Proposed dates
Intersessional #1 Intersessional #2 Intersessional #3 *(6th risk assessment workshop, in-person)* Intersessional #4 Intersessional #5, final prep meeting before plenary	27 September 2023, 12 UTC 22 November 2023, 12 UTC 17 January 2024, 12 UTC *(21-22 February 2024, 6th risk assessment WS)* 20 March 2024, 12 UTC 15 April 2024, 12 UTC
CGMS-52 working group meetings In-person Host?	22-28 April 2024 Alternatives: 6-10 May 2024 (20-26 May 2024 - very close to plenary)
CGMS-52 plenary session In-person Host: NOAA	Week of 3-7 June 2024, USA

It was agreed with the option 22-28 April for working group meetings. Anne Taube commented that EUMETSAT is a backup host for the working group meetings if there is not any other host available. CGMS member agencies to contact CGMSSEC, if they would be willing to host CGMS-52 working group meetings in April 2024.

It was asked if the plan is to keep working group meetings and plenary separated as this year. Anne Taube was commenting that this is the plan, and all working groups are supporting that option even if there will be extra travelling then. Mikael Rattenborg commented that there nowadays so many topics to be prepared for plenary that it is not feasible to keep meetings together anymore. Irene Parker (NOAA) was commenting that we should also provide virtual meeting option like this year.

12. Any other business

None.

13. Conclusions, preparation of the WGIII report for plenary

Irene Parker (NOAA) as a chair concluded the good work of the meeting supporting many activities and thanked the great support by CGMS secretariat. She was very happy with the outcomes of the meeting without no boundaries and admitted learning a lot by herself as well.

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
EUM (NSOAS)	WGIII/3.2 & 4.1	WGIII/A48.02	CGMS-48 WGIII discussions May 2020 (and the now closed 1RAWS2019.4): WGIII recognised the need for a long term plan for ~6Ghz frequency microwave imaging in at least one LEO orbit for all weather Sea Surface Temperature observations. Recommended Mitigating Action #4: [EUM and SOA] to ensure data availability for HY-2B MWI.	**CLOSED** **2023 22 Feb:** NSOAS and WMO are in the process of setting up an MoU, once it enters into force, it is expected that the NSOAS data can be added to the CGMS baseline/risk assessment review. It is expected that the HY-2 data will be included in the 6th CGMS WGIII risk assessment and the CGMS Baseline. **2023 9 Jan:** Discussions have taken place between WMO and NSOAS whereby it appears as if NSOAS will identify some of their data as "Core" (as per WMO Res. 1) **2022 20 Dec, 21 Sep:** Still under discussion, no further feedback from NSOAS. New status request sent 10 Jan 2023. **2022 17 May:** EUM in contact with NSOAS. NSOAS is currently positive that this will concretise but requires confirmation by its ministry. **2021 27 Sep:** Currently the data policy is not fully free and open. EUMETSAT is addressing this with NSOAS and expecting final confirmation by end 2021. 2021 Jan: No progress, action on CGMSSEC. 2020 May 28, CGMS-48 WGIII (CGMS-48-CGMS-WP-10): EUMETSAT to reach out to NSOAS (SOA/MNR) to confirm if the HY missions can be included in the CGMS baseline and risk assessment.	Dec 2022 (Feb 2021)	**CLOSED**	1.1.1

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
EUM (NSOAS)	WGIII/3.2 & 4.1	WGIII/A48.03	CGMS-48 WGIII discussions May 2020 (and the now closed 1RAWS2019.8): WG III recognised that there is no radar altimetry data availability in the early morning orbit in the short term and that there are no plans in the long term for coverage. Recommended Mitigating Action #8: [EUM and SOA] to ensure data availability for HY-2B ALT.	**CLOSED** **2023 22 Feb:** NSOAS and WMO are in the process of setting up an MoU, once it enters into force, it is expected that the NSOAS data can be added to the CGMS baseline/risk assessment review. It is expected that the HY-2 data will be included in the 6th CGMS WGIII risk assessment and the CGMS Baseline. **2023 9 Jan:** Discussions have taken place between WMO and NSOAS whereby it appears as if NSOAS will identify some of their data as "Core" (as per WMO Res. 1) **2022 20 Dec, 21 Sep:** Still under discussion, no further feedback from NSOAS. New status request sent 10 Jan 2023. **2022 17 May:** EUM in contact with NSOAS. NSOAS is currently positive that this will concretise but requires confirmation by its **2021 27 Sep:** Currently the data policy is not fully free and open. EUMETSAT is addressing this with NSOAS and expecting final confirmation by end 2021. 2021 Jan: No progress, action on CGMSSEC. 2020 May 28, CGMS-48 WGIII (CGMS-48-CGMS-WP-10): EUMETSAT to reach out to NSOAS (SOA/MNR) to confirm if the HY missions can be included in the CGMS baseline and risk assessment.	Dec 2022 (Feb 2021)	**CLOSED**	1.2.8

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
☐ EUM ☐ KMA (NIER)	WGIII/3.2 & 4.1	WGIII/A48.04	EUMETSAT to explore with NIER of GEO KOMPSAT 2B GEMS observations can be considered for the CGMS baseline and risk assessment.	**CLOSED** **2023 21 Feb:** Presentation provided by NIER at the 5th risk assessment workshop. Data are available online, however, it is limited for operational NRT purposes, and redistribution currently not granted. It is therefore proposed to close the action and revisit it in the future. (If KMA agrees, KMA is invited to provide verbal updates if there are changes to the data policy). **2023 12/17 Jan**: NIER has agreed to provide a brief status report at the 5th risk assessment workshop. Following interaction between CGMSSEC and KMA, and KMA and NIER, it appears somewhat unlikely that NRT data will be available in the near/medium term future. KMA is kindly invited to inform CGMS in case of any new developments → Closure of action will be confirmed after NIER presentation at 5th risk assessment workshop **2022 28 Sep:** Follow-on GEMS (satellite) under discussion, potential kick off in 2024 timeframe. (GEMS data available on ftp site. Some restrictions apply to GEMS data redistribution). Pending outcome of NIER data policy discussions. KMA to contact NIER to consider attending the 5th CGMS risk assessment WS. **2022 21 Sep:** Still under discussion, no further feedback from GEMS **2022 17 May:** EUM and KMA in contact with NIER. Data expected to become	Dec 2022	**CLOSED**	1.2.3

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
				available in second half of 2022. GEO KOMPSAT 2B GEMS observations already included in the CGMS baseline and risk assessment. **2021 29 Nov**: Some data available via NIER's website. Further data expected to be available end of 2021. Data policy TBC. KMA and EUMETSAT to continue to reach out to NIER. 2021 16 Apr: KMA to reach out to NIER 2021 1-3 Mar: EUMETSAT to continue reaching out to NIER (NIER expected to provide a status presentation to WGII at CGMS-49). 2021 Jan: No progress, action on CGMSSEC.			
ISRO	3.1	WGIII/A49.02	ISRO to update CGMS-50 on their plans for a geostationary hyperspectral infrared sounder.	**2023 21 Feb:** The action will be maintained and ISRO is requested to report to upcoming CGMS sessions. **2022 20 Dec, 28 Sep**: INSAT 4th generation consideration, TBC if an HSIR will be included. ISRO will provide the latest status to the 5th CGMS risk assessment workshop. **2022 May**: Plans still unclear related to HIRS. **2022 24 Feb**: Review ongoing. Update to be provided to plenary in June. **2021 Sep 27**: Unclear if ISRO will have confirmed plans by CGMS-50. TBC.	CGMS-52	**OPEN**	1.2.2
☐ JAXA ☐ NASA	4	WGIII/A49.06	NASA and JAXA to confirm plans to fly a precipitation radar beyond the GPM Core.	**2023 21 Feb**: Status provided at the 5th CGMS WGIII risk assessment by JAXA.	CGMS-52 (Feb-24)	**ONGOING**	1,1,2

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
				JAXA (and/or NASA) to provide updates at the 6th risk assessment. **2022 May:** NASA and JAXA confirmed that this is ongoing. JAXA and NASA are kindly requested to provide the latest status to the 5th CGMS risk assessment workshop **2022 24 Feb:** Discussions ongoing between NASA and JAXA. Report to be provided to CGMS-50 plenary session. **2021 Sep 27:** To be addressed within the framework of the 4th risk assessment WS			
ESA	4	WGIII/A49.07	ESA to report on plans for the CIMR (Copernicus Imaging Microwave Radiometer) and CRISTAL (Copernicus Polar Ice and Snow Topography Altimeter) missions	**2023 26 Apr:** ESA to report to the 6th risk assessment WS in Feb 2024. **2022 17 Feb**: The programme is not yet approved. ESA expects to be in a position to report at the 5th risk assessment workshop in 2023. **2021 Sep 27**: To be addressed within the framework of the 4th risk assessment WS	Feb 2024, CGMS-52	**OPEN**	
ISRO	4	WGIII/A49.08	ISRO to confirm plans beyond Oceansat 3 series	**2023 26 April: CLOSED** on the occasion of CGMS-51 WGIII meeting **2023 12 April:** CLOSURE PROPOSED. ISRO and IMD acknowledges the importance of Oceansat- 3 series continuation and and geostationary Hyperspectral infrared sounder. While the agencies are making earnest efforts to include these in the future mission plans, with the new reforms in Indian space sector, it is anticipated to take an year or more to confirm the plans, the action items are temporarily withdrawn till next	CGMS-51	**CLOSED**	1.1.3

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
				announcement from India regarding the continuity plan **2023 21 Feb:** The action will be maintained and ISRO is requested to report to upcoming CGMS sessions. **2022 20 Dec, 17 May:** Plans still to be confirmed. ISRO will provide the latest status to the 5th CGMS risk assessment workshop **2021 Sep 27:** To be addressed within the framework of the 4th risk assessment WS			
WGIII	4.1	WGIII/A49.12	CGMS Baseline Calibration and Validation section to be updated according to NWP position paper outcome.	**CLOSED** **2022 28 Sep:** Action CLOSED and new action created. **2022 21 Sep:** Who is taking the lead on this action? **2022 17 May:** NWP paper needs to be considered in the WMO regulatory update. **2022 24 Feb:** Pending WMO regulatory update **2021 Sep 27:** To be addressed within the framework of the 4th risk assessment WS	End Oct 2022 (Feb-22)	**CLOSED**	
WMO + WGIII	*WGIII IS #1 28 Sep 2022*	n/a	Following the update of the WIGOS Manual, update the CGMS baseline accordingly.	**2023 23 Feb:** The update of the WIGOS Manual has been postponed. A major update is expected in the 2023/2024 timeframe. Potentially to be addressed at the 6th CGMS WGIII risk assessment workshop in 2024. ***2022 28 Sep:*** *CGMS to update the baseline following WMO's regulatory update of the WIGOS manual (raised on the occasion of the CGMS WGIII inter-sessional meeting)*	Feb 2024	**OPEN**	

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WGII	4.1	WGIII/A49.14	The list of CGMS baseline sensor observations should be reviewed against the list of products required for NWP in the WMO's Position paper on Satellite data Requirements for Global NWP.	**CLOSED** **2022 28 Sep:** CLOSED following discussions in WGIII intersessional. **2022 21 Sep:** Who is taking the lead on this action? It is for WGII, however, someone needs to bring this up/take it to WGII. 2022 17 May: Open following discussion in WGIII 2022 25 Mar: For WMO consideration (link to gap analysis/high level paper) 2022 24 Feb: Reminder to WGII by CGMSSEC when circulating the updated draft baseline and 4th RA 2021 Sep 27: To be addressed within the framework of the 4th risk assessment WS	26 Sep-22	**CLOSED**	
☐ WGI ☐ WGII ☐ WGIV ☐ Click to add a new task...	4.1	WGIII/A49.15	Review of CGMS baseline Section 3. against the WMO's Position paper on Satellite data Requirements for Global NWP.	**CLOSED** **2022 28 Sep:** CLOSED following discussions in WGIII inter-sessional meeting #1 **2022 21 Sep:** Who is taking the lead on this action? It is for WGI, WGII and WGIV, however, someone needs to bring this up/take it up with these WGs. **2022 17 May:** Open following discussion in WGIII 2022 25 Mar: For WMO consideration (link to gap analysis/high level paper) 2022 24 Feb: Reminder to WGII by CGMSSEC when circulating the updated draft baseline and 4th RA 2021 Sep 27: To be addressed within the	Oct 2022 (Feb-22)	**CLOSED**	

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
				framework of the 4th risk assessment WS (and in WGI, WGII, WGIV)			
WMO	6	WGIII/A49.17	Continue preparing and submitting to O/SST templates on OSCAR/Space data that needs to be updated, approximately 2-3 times a year.	**2023 26 April:** CGMS-51 WGIII meeting (action updated from 3-4 times/year to 2-3 times/year **2023 23 Feb:** Currently taking place approx. twice/year. **2022 17 May**, 24 Feb: Ongoing	CGMS-51 (CGMS-50)	**ONGOING**	
NOAA	WGIII/4.1	WGIII/A50.01	NOAA to review additional ground resources needed to track STEREO-A and PUNCH to provide additional coverage in the near-term.	**2023 21 Feb:** Presentation made to the 5th risk assessment. Update on STEREO-A to be made at the 6th CGMS WGIII risk assessment workshop in 2024. (On PUNCH - concluded). **2022 28 Sep:** Ongoing. NOAA will include status in its input to the 5th risk assessment.	CGMS-52 (CGMS-51)	**ONGOING**	1.1.5
KMA	WGIII/4.1	WGIII/A50.02	KMA to report on plans beyond GK-2B for visible/UV spectrometer and Narrow Band imager.	**2023 23 Feb:** KMA to confirm: KMA to report on any progress at the 6th CGMS WGIII risk assessment workshop in 2024 **2022 28 Sep:** Feasibility studies ongoing (results together with special feasibility test expected to take +/-2 years overall)	CGMS-52 (CGMS-51)	**OPEN**	1.2.3
WGIII lead (CGMSSEC)	WGIII/4.2	WGIII/A50.03	To add characteristics/definitions of the new energy ranges related to the high energy particles in the Sensor Type table of the CGMS Baseline document.	**CLOSED** **2023 23 Feb:** Input provided on the occasion of the 5th CGMS risk assessment. CGMS Baseline updated accordingly. CLOSURE expected. **2022 28 Sep:** Information from SWCG to be included in the next version of the baseline. Comment added to draft v5 document [*ACTION CGMSSEC to include the information in the baseline document*] **2022 10 Jan:** Request sent to SWCG	RA workshop 2023	**CLOSED**	

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
WMO	WGIII/4.2	WGIII/A50.04	To implement energy ranges for high energy particle classification to OSCAR/Space as defined in the CGMS Baseline.	**2023 26 April:** Presented to CGMS-51 WGIII. CGMS-51-WMO-WP-14 **2023 23 Feb:** Development ongoing. Likely delivery around June 2023. WMO to report on status in April 2023 at the CGMS-51 WGIII meeting	CGMS-51 WGIII (RA workshop 2023)	**ONGOING**	
WMO	WGIII/4.2	WGIII/A50.05	To implement the feature of Sun-Earth line instrument filtering for the OSCAR/Space Gap Analysis.	**CLOSED** CGMS-51-WMO-WP-13 **2023 26 April:** The capability exists in OSCAR Space database. Action closed on the occasion of CGMS-51 WGIII meeting. **2023 23 Feb:** Development ongoing. Likely delivery around June 2023. WMO to report on status in April 2023 at the CGMS-51 WGIII meeting	CGMS-51 WGIII (RA workshop 2023)	**CLOSED**	
CGMSSEC	WGIII/4.4	WGIII/A50.06	CGMS Global Contingency Plan to be updated according to the findings in the working paper CGMS-50-CGMS-WP-25 in WG III (presentation).	**CLOSED** CGMS-51-WGIII-WP-04 **2023 23 Feb:** Paper to be submitted to CGMS-51 WGIII meeting in April 2023 (presented at the 5th CGMS risk assessment workshop. **2022 28 Sep:** CGMSSEC will provide an update and present it to the 5th risk assessment workshop. WGIII members are invited to point out further areas for revision before the workshop.	RA workshop 2023	**CLOSED**	
☑ EUM ☑ NOAA ☑ CMA	WGIII/6	WGIII/A50.07	To present outcomes of the undertakings on socio-economic benefits and impact studies.	**2023 26 Apr:** CGMS-51-NOAA-WP-12 PPT, CGMS-51-CMA-WP-02 **2023 18 Jan:** CMA will provide SEB report at WGIII session in April 2023. EUMETSAT expects to be able to share the outcome of a currently ongoing SEB study in 2024.	CGMS-52, (CGMS-51)	**ONGOING**	1.4.2

CGMS-50 WGIII action status							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
				2022 28 Sep: NOAA expect to have a study available for the GEO XO mission (ongoing). (SEB studies to be addressed in the CGMS WGIII CGMS-51 plenary session in April 2023)			
CGMSSEC	WGIII/9	WGIII/A50.08	To add proposed HLPP target for the work towards operational IR/MW limb sounding capability for climate monitoring and NWP application.	**CLOSED** (published)	CGMS-50 plenary	**CLOSED**	
CGMSSEC	WGIII/9	WGIII/A50.09	To add proposed HLPP target to coordinate the evaluation of small satellite constellations capability to provide sufficient µwave sounding performance for the radiance data assimilation.	**CLOSED** (published)	CGMS-50 plenary	**CLOSED**	

PLENARY ACTIONS FOR WGIII						
CGMSSEC, WMO	4.5	A50.01(a)	CGMSSEC and WMO to consider if night-time light capabilities should be covered in HLPP, the CGMS Baseline, and should be reflected in the WMO Gap Analysis.	**CLOSED** **2023 23 Feb:** Closed on the occasion of the 5th CGMS risk assessment workshop (maintaining action A50.01(b) open). To be addressed at the 5th CGMS risk assessment workshop (21-23 Feb 2023)	CGMS-51	**CLOSED**
WMO	4.5	A50.01(b)	If night-time light capabilities shall be covered in the HLPP and the CGMS Baseline, WMO to reflect this in the WMO Gap Analysis.	**2023 23 Feb:** Addressed at the 5th CGMS risk assessment workshop (21-23 Feb 2023) to be reviewed at the 6th CGMS WGIII risk assessment workshop 2024.	CGMS-52 (CGMS-51)	**OPEN**

Other related actions (will not be translated into a new WGIII action - 23 Feb 2023)					
Plenary	2	WGIIR49.	Working Group II recommends to CGMS Plenary the adoption of the proposed GEO baseline products presented in CGMS-49-WMO-WP-14 with the addition of SSTs, to be considered for subsequent implementation by all Agencies.	**CLOSED FOR WGIII** **2023 23 Feb:** This is a WGII action and will therefore be "closed" in the framework of WGIII. **2022 10 Jan:** Request sent to WGII leading group. **2022 28 Sep:** To be addressed in the next WGII inter-sessional meeting 12 October. CGMSSEC to send this action to WGII lead. **2022 22 Sep** MRa: Assuming that WGII has finally confirmed the GEO baseline products (unclear!), the question is how to reflect this in CGMS documentation (could be the CGMS Baseline or a self-standing doc, to be discussed in WGIII) and how to monitor the implementation in terms of production and dissemination (probably a question for WGIV). **2021 28 Sep:** JV Thomas to address this with WGII co-chairs/rapporteurs. Principle endorsed by CGMS-49 plenary. WGII/Ken to send to WGIII and WGIV relevant parts of WGII report. Action to WGIII to update the baseline accordingly. (WGII action to WGIV on related redistribution mechanisms).	**CLOSED for WGIII**

CGMS-51 WGIII actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
CMA	6.1		CMA to look into the potential of the operational use of Chinese commercial RO data.	**2023 27 Sept:** WGIII IS: CMA hopes to report to the 6th risk assessment.	CGMS-52	**OPEN**	
CGMS WGs	8		The CGMS working groups are requested to consider and identify the implications/impact/activities in each working group and to give feedback as necessary. This includes implementation measures and interface considerations. - Do you agree on lead designation to Working Groups. (Note: no new WGs are proposed). - Additional questions and proposals to be discussed? - Support to developing countries - Interface considerations, other to be considered? - Implementation measures (short and long term) - For recommendation to plenary	**2023 27 Sept:** WGIII IS: Closed following CGMS-51 plenary session and endorsement of the CGMS future direction themes and proposed way forward.	CGMS-51 plenary	**CLOSED**	

LIST OF PARTICIPANTS

CGMS-51 - WGIII List of Participants		
Organisation	**Lastname**	**Organisation**
Min	Guan	CMA/NSMC
Wei	Zheng	CMA/NSMC
Alexis	Sarraute	ESA
Mikael	Rattenborg	EUMETSAT/CGMS Sec
Anne	Taube	EUMETSAT/CGMS Sec
Andrew	Monham	EUMETSAT
Karolina	Nikolova	EUMETSAT
Flavio	Murolo	EUMETSAT
Knut	Dammann	EUMETSAT
Rocio	Martin Pardo	EUMETSAT
Robert	Husband	EUMETSAT
Christian	Marquardt	EUMETSAT
Puviarasan	Narayanasamy	IMD
Satya	Prakash	IMD
Jayaprakash V	Thomas	ISRO HQ
Toshiyuki	Kurino	JAXA
Takuji	Kubota	JAXA
Hiroshi	Suto	JAXA
Harada	Reiko	JMA
Kazutaka	Yamada	JMA
Miki	Abe	JMA
Takuya	Sakashita	JMA
Yasuhiko	Sumida	JMA
Dohyeong	Kim	KMA
Khan	Maudood	NASA
Tsutomu	Nagatsuma	NICT
Charles	Wooldridge	NOAA
Elsayed	Talaat	NOAA/NESDIS/SWO
Alexander	Uspensky	ROSHYDROMET
Heikki	Pohjola	WMO
Zoya	Andreeva	WMO
Chang	Liu	WMO

CGMS

Working Group IV (WGIV)

Data access and end user support

WGIV REPORT

Co-Chairs: *Kotaro Bessho, JMA / Vasily Asmus, ROSHYDROMET*
Rapporteurs: *Natalia Donoho, WMO / Simon Elliott, EUMETSAT*

1. Opening, objectives and expected outcomes / WGIV co-chairs and rapporteur status

- CGMS WG IV handles various topics related to data access and user support.
- It is expected that the outcomes from the discussion of this WG will contribute the upgrades of satellite data dissemination systems, data formats and metadata exchange, and support the user-provider dialogue on regional/global scales and the user readiness for new satellite systems.
- In the last meeting on April 2023, the WG had the fruitful discussion results including user communication between multi regions, WIS 2.0, Cloud Services Expert Group activities and the CGMS Future Direction.

2. Review of actions and recommendations from previous meetings and status update

3. User-provider dialogue on regional/global scales

3.1 User-provider dialogue on regional/global scales

CGMS-51-joint-JMA-KMA-WP-01 - Progress Report on the RAII WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training in 2022

The WMO Regional Association (RA) II WIGOS Project to develop support for National Meteorological and Hydrological Services (NMHSs) in Satellite Data, Products, and Training is a regional framework formed to assist NMHSs in RA II for better use of satellite-related information in collaboration with relevant satellite operators, users and WMO. The 4th Joint Meeting of RA II WIGOS Project and RA V TT-SU for RA II and RA V NMHSs was held in Tokyo, Japan, and also online on 18 November 2022. The meeting was hosted by the Japan Meteorological Agency (JMA). In the Joint Meeting, they had useful reports for regional community such as WMO's report for the global survey from ET-SSU, three training activity reports from the BOM, CMA, KMA, and the BMKG, two informative reports from other regions, RA I and RA III/IV. As a result, at the 4th Joint Meeting of RA II WIGOS Project and RA V TT-SU, we realized we need to communicate more between global and regional group.

KMA proposed the following recommendation.

CGMS-51 RECOMMENDATIONS – WGIV		
item	**Recommendation#**	**Description**
WGIV 3.1		AOMSUC-13 in 2023 will be held in Busan, Korea hosted by KMA together with VLab training, and a RA II/V joint coordination meeting. RA II/V Joint Coordination Group ask for CGMS's support and encouragement to attend.

3.2 Implementation and evolution of sustained and coordinated communication satellite broadcast systems

CGMS-51-CMA-WP-07 - The report on CMACast services and upgrade

CMA provided the status of the CMACast system services and upgrade. In the framework of GEONETCast, CMACast distributes data to Asia-Pacific users who use the Integrated CMACast system to receive, process data and make weather forecast in last 2022. In order to better offer more users services, CMACast system had updated in 2022. After upgrade, the coverage of CMACast includes the Asia-pacific region, the middle East region and most area of Africa. And most of users of CMACast had pointed to the new communication satellite and upgraded the new version receive software of CMACast. In addition, some parts of FY4B and FY3E products have been broadcasted by CMACast to users. CMACast will keep providing meteorological data dissemination service for the users.

CGMS-51-CMA-WP-08 - The update of FENGYUN satellite data and application services

CMA provided an overview of FENGYUN satellite data, the status and the future plan of the FENGYUN satellite data distribution and services. FY-3E and FY-4B data distribution information was updated. FENGYUN satellite data are open to NMSs and other international organizations and users for free charge via many ways. For real-time users, FENGYUN satellite data can be accessed via direct broadcasting station, CMA data broadcasting system (CMACast), GTS, WIS and public cloud. For non-real-time users, FENGYUN satellite data can be accessed from the FENGYUN satellite data center website, downloading toolkits and offline data services. For emergency users, FENGYUN satellite emergency support mechanism FY_ESM is useful to The National Meteorological Services (NMSs). The software platform of FENGYUN Earth will be provided to the international user for enhancing FENGYUN satellite data application this year.

CGMS-51-JMA-WP-07 - JMA report on usage of cloud services / data dissemination and distribution of Himawari-8/9 and their recent updates

JMA presented an overview of Himawari-8/9 data dissemination and distribution in JMA and reported their recent updates.

Himawari-8/9 data distribution services include:

- HimawariCloud;
- HimawariCast;
- JMA Data Dissemination System (JDDS), a terrestrial service using HTTP, which facilitates users' transition from MTSAT to Himawari-8/9 data.

Additional Japanese institutions operate archival and redistribution services for Himawari-8/9 data in support of the research, development and education communities. The Japan Meteorological Business Support Center (JMBSC) provides Himawari data to private sector companies (37, as of March 2022).

Lastly, JMA reported that the switch over from Himawari-8 to Himawari-9 was successful.

3.3 Global or inter-regional data circulation and access, WIS

CGMS-51-ROSHYDROMET-WP-03 - Satellite data exchange in Roshydromet

Roshydromet presented an overview of their satellite data exchange. Roshydromet is sharing satellite data with international community in accordance with WMO Unified Data Policy.

Data from Russian geostationary satellites of Electro-L series (Electro-L N3,76E, and Electro-L N2, 14,5W) is being distributed in HRIT/LRIT format every 3 hours. The 15-minute HRIT data is provided to local users via land channels. Electro-L N4 satellite was launched on February 05, 2023 and placed at 165,8 E position.

The data in HRIT/LRIT format will be available to users after the commissioning phase completion.

Data from Russian polar meteorological satellite Meteor-M N2-2 is provided to users worldwide in direct broadcast via HRPT downlink (1700 MHz). It currently includes MSU-MR scanning radiometer data. Next satellite of Meteor-M series, Meteor-M N2-3, is planned for launch on June, 27, 2023. After the commissioning phase, the data will be distributed to users via HRPT downlink. It will contain MSUMR scanning radiometer data together with microwave sounder MTVZA-GY data.

Data from infrared sounder IKFS-2 from Meteor-M N2-3 will be available on Roshydromet GSICS Processing and Research Centre website http://planet.rssi.ru/calval/portal-main-en?setlang=en_US

CGMS-51-WMO-WP-15 - WIS 2.0 introduction, pilot phase and transition.

In the coming years, WMO's WIS 2.0 will gradually replace the GTS. WMO gave an overview of the background for this migration, what it entails and how it is being carried out. The focus of the initiative is opening up data access to the widest community by reducing technical barriers and costs, and leveraging well understood and freely available technologies. The "WIS 2-0 in a box" solution was highlighted as a reference implementation of a WIS 2.0 node.

CGMS-51 RECOMMENDATIONS – WGIV		
item	**Recommendation#**	**Description**
WGIV 3.3		Given that GTS operational availability is not guaranteed beyond 2030, CGMS Members are recommended to develop plans for the adoption of the WMO Information System WIS 2.0 in support of international data exchange.

CGMS-51-EUMETSAT-WP-08 - EUMETSAT report on preparations for the migration from GTS to the WIS 2.0

In the coming years WMO will perform a phased introduction of its next generation information system (WIS 2.0). This brings with it a change of paradigm for both data providers and consumers; it also presents a number of opportunities for CGMS Members. EUMETSAT provided a brief summary of the WIS 2.0 architecture and describes how EUMETSAT is preparing for its migration to WIS 2.

CGMS-51-NOAA-WP-13 - NOAA Report on GEONETCast Americas (GNC-A)

GEONETcast (GNC) is a worldwide, near real time, network of satellite-based data dissemination systems designed to distribute weather products to diverse communities. NOAA presented an introduction to GNC-A, some news about their program, and an introduction to new GNC-A Program Manager.

3.4 Widening of data access, to new missions/providers as well as for other user communities

No specific topics were addressed under this item in the agenda.

3.5 Disaster support

CGMS-51-JMA-WP-08 - Status of JMA Himawari Request service

In January 2018, the Japan Meteorological Agency (JMA) launched a new international service "HimawariRequest", in collaboration with the Australian Bureau of Meteorology. The service allows NMHS users in Himawari8/9 coverage area to request Target Area observation covering a 1,000km x 1,000km area every 2.5 minutes.

Target Area observation supports JMA's national/international services including the RSMC Tokyo - Typhoon Center and the Tokyo VAAC. In response to a recommendation made at the 2015 Joint RA II/RA V Workshop on WIGOS for Disaster Risk Reduction, JMA developed the service through the RA II WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training. As of 12 April 2023, JMA had taken registrations from 22 NMHSs in RA II and RA V, and 19 have completed preparation for their requests.

There have been 202 international requests since the commencement of the service, among which 182 have been approved. Targets have included tropical cyclones in the South Pacific, extreme weather and bushfires in Australia, and volcanic activity in Indonesia.

JMA expects the HimawariRequest service to support disaster risk reduction activities in the Asia Oceania region based on the regional monitoring of extreme events such as tropical cyclones and volcanic eruptions using the Target Area observation.

As part of the RA II WIGOS Project, JMA is currently considering the creation of a web resource that displays the location of request-based rapid scan observations conducted by CMA, JMA and KMA in map form for at-a-glance viewing and ease of use.

3.6 Support to the Ocean user community

CGMS-51-NOAA-WP-14 - NOAA's CoastWatch/PolarWatch Support to the Ocean User Community

Ocean observations from space provide essential information for weather forecasting, ecological forecasting, climate forecasting, marine resource management, safety and navigation, research, blue economy, and other applications. Many ocean observations from satellites are now operational: mature, robust, validated, documented, and routinely available. Potential users remain, who are not aware of or perceive barriers to using satellite ocean remote sensing data in their operational applications. At NOAA CoastWatch, our data are "free and open" and we effectively do the research and development and build the relationships and user-confidence to get from satellite observations

and data products to tools for decision making (such as Sargassum bulletins; by-catch avoidance tools; probability maps for harmful algae). And we collaborate internationally to use global satellite data to extend environmental monitoring and indicators to benefit the global community. Within NOAA, we lead and champion for the prioritization of innovative projects to support user needs. CGMS has a role to promote the optimal exploitation of satellite mission investments. CGMS should appreciate and acknowledge the importance of the need for (and support the development of, where appropriate) consistently-processed, long term time series which link to NRT (similar to but different and separate from conventional Climate Data Records); consistently-processed multi-mission data (e.g., "super-collated", fused, etc.); and multiple geophysical parameter satellite data combined with other observation types to produce relevant 4-dimensional ocean knowledge. CGMS has endorsed the Third International Operational Satellite Oceanography Symposium (OSOS-3) will be held in Busan, South Korea, 12-15 June 2023, with an optional training day on 16th June 2023. We suggest CGMS continue to support activities which aim to bridge gaps between data products and applications for decision making (e.g., OSOS-3, etc.) in the operational ocean, coastal, and freshwater communities.

NOAA asked CGMS WGIV to appreciate and acknowledge the importance of the need for (and support for the development of, where appropriate) the following: especially for the ocean user community:

- Consistently-processed, long term time series which link to NRT (similar to but different and separate from conventional Climate Data Records);
- Consistently-processed multi-mission data (e.g., "super-collated", fused, etc.);
- Multiple geophysical parameter satellite data combined with other observation types to produce relevant 4-dimensional ocean knowledge in applications that enable decision-making.

3.7 Support for Arctic observations

CGMS-51-NOAA-WP-15 - NOAA's sea ice innovation plan and Arctic observation priorities

Changes in sea-ice cover come with increased hazards and notable societal impacts (e.g., on stability of Arctic communities, fisheries, national security, polar maritime transportation, coastal resilience).

NOAA/NESDIS sea ice innovation plan aims to advance the monitoring of the integrated Earth system to meet the challenges of climate and environmental change in the polar oceans, increase accessibility to analysis-ready information products.

The plan was co-developed through user engagement and using recommendations in NOAA strategic documents and other governmental organizations' reports on the polar regions.

Five recurrent gaps were identified:

- Sea ice dynamics;
- Sea ice long-term records;
- Information product enhancements;
- Product tailoring;
- Novel sea ice information products.

Addressing these gaps will lead to innovation demonstrations and fit-for-purpose products enabling NOAA to deliver U.S. Government's authoritative climate products and services of the highest quality.

3.8 Support for Hyperspectral infrared instruments

CGMS-51-EUMETSAT-WP-03 - Availability of MTG IRS products via EUMETSAT data access services

EUMETSAT's Meteosat Third Generation (MTG) mission will include both an imaging and a sounding satellite embarking different instrument suites. MTG-S, the sounder satellites, will fly with the InfraRed Sounder (IRS) on board. This instrument will provide substantial benefit to weather forecasting by tracking the three-dimensional structure of atmospheric water vapour and temperature operationally.

EUMETSAT operates a portfolio of data access services that will provide users with MTG-S IRS data products. This paper provides an overview of how users can access these products using these data access services.

Users were invited to take note and familiarise themselves with the data services that are most appropriate for their use of MTG-S IRS products.

CGMS-51-CMA-WP-09 - FY4 satellite series GIIRS L1 Data Introduction and access services

CMA provided an overview of the Geostationary Interferometric Infrared Sounder (GIIRS) data information of FY-4A and FY-4B, the status and access services. The daily schedule, observation region, L1 data volume and L1 file name of GIIRS were introduced.

GIIRS data are open to NMSs and other international organizations and users for free charge via many ways. For real-time users, the data can be accessed via public cloud. For non-real-time users, the data can be accessed from the FENGYUN satellite data center website, downloading toolkits and offline data services.

4. Coordination of Metadata (incl. standards within ocean communities)

The Working Group noted the ongoing efforts to initiate the activities of the Task Group on Metadata. A number CGMS Members have nominated members of the Task Group, but efforts are continuing to find a chairperson and to consolidate the terms of reference.

5. User readiness for new satellite systems

5.1 User readiness for new satellite systems

CGMS-51-VLab-WP-01 - VLab progress report and a new VLab strategy 2024-2027 for endorsement

The VLab Strategy (2024–2027) was updated by the VLab Management Group (VLMG) and adopted by the WMO Executive Council at its 76th session (27 February to 3 March 2023, Geneva). CGMS WGIV was invited to recommend the updated VLab Strategy, as provided in the Annex of the working paper, to CGMS Plenary for endorsement.

The VLab Management Group (VLMG) held quarterly online meetings. The Tenth meeting of VLMG was hosted by EUMETSAT at EUMETSAT HQ as a hybrid event on September 26-30, 2022.

Since CGMS-50, VLab members have offered a variety of training opportunities. The training topics address both current and new generation of satellites. Strong collaboration and coordination among VLab members build capacity regionally.

The VLab Trust Fund continues to receive yearly contributions from NOAA/NWS, EUMETSAT, and KMA. Regular and increased contributions from CGMS agencies is required to expand VLab activities to meet WMO-CGMS Members' requirements and user needs and to improve the long-term sustainability of VLab activities.

CGMS WG-IV recommends to plenary to endorse the updated Strategy for the Virtual Laboratory for Education and Training in Satellite Meteorology (2024–2027).

CGMS-51 RECOMMENDATIONS – WGIV		
item	**Recommendation#**	**Description**
WGIV 5.1		CGMS WG-IV recommends to plenary to endorse the updated Strategy for the Virtual Laboratory for Education and Training in Satellite Meteorology (2024–2027).

CGMS members are invited to contact WMO to provide contributions to the WMO VLab Trust Fund to ensure the continuation of technical support to the VLab through the VLab Technical Support Officer as well as to the implementation of VLab projects.

CGMS members are invited to contact their supported VLab Centres of Excellence to discuss training needs and requirements.

CGMS-51-WMO-WP-16 - Best Practices for Achieving User Readiness for New Satellite Systems for recommendation to plenary

The CGMS/WMO Best Practices for Achieving User Readiness for New Meteorological Systems was endorsed by CGMS-44 plenary, June 2016, and it is aimed to support and guide satellite operators and users in their respective preparation activities.

The Best Practices provide a typical breakdown of user readiness activities and a timeline of deliverables from satellite operators to support user readiness. The Best Practices cover activities performed by both User Organizations and Satellite Operators.

The proposed revision of the document published in 2017 (WMO-No. 1187) reflects lessons learned from the satellite systems that have become operational over the last 5-10 years (such as Himawari-8/9, GOES-R, GEO-Kompsat-2, FY-4, FY-3 and JPSS), novel types of LEO missions, the increasing role of commercial satellite data providers, as well as evolutions in the user needs.

CGMS WG-IV recommends to plenary to endorse CGMS/WMO Best Practices for Achieving User Readiness for New Satellite Systems.

CGMS-51 RECOMMENDATIONS – WGIV		
item	**Recommendation#**	**Description**
WGIV 5.1		CGMS WG-IV recommends to plenary to endorse CGMS/WMO Best Practices for Achieving User Readiness for New Satellite Systems.

5.2 Notification of changes (and alerts) in satellite data and/or products impacting users

No specific topics were addressed under this item in the agenda.

6. Cyber security towards end users

The activities of the Task Group on Cyber Security were suspended following the end of CGMS 50. As such, there was nothing reported under this agenda item.

7. Cloud Services interoperability

CGMS-51-NOAA-WP-16 - Summary and Highlights from CGMS WGIV Cloud Service Expert Group (2022-2023)

The CGMS Cloud Services Expert Group was established in July 2020 and is comprised of members from the National Oceanic and Atmospheric Administration (NOAA), European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), Korea Meteorological Administration (KMA), China Meteorological Administration (CMA), Japan Meteorological Agency (JMA), Indian Space Research Organisation (ISRO), and the World Meteorological Organization (WMO). The group hosts an annual CGMS Cloud Workshop and develops best practices and lessons learned based on the information exchange in the workshops. Over the past year (2022-2023), the group has focused on planning the 2023 annual Cloud workshop and finalizing the best practices document for CGMS publication.

The Group invited members from WGs I, II, and IV to their meetings and workshops to discuss Cloud best practices, lessons learned, and cloud interoperability.

8. Long term data preservation

At the time of the Working Group IV meeting, there was nothing specific to report.

Since the meeting, however, and in response to action WGIV/A50.02 ("*WGISS and WGIV to hold a joint meeting to discuss modalities and areas of common activities between WGISS and WGIV. This should include a report on the implementation of the adopted guidelines.*"), a joint meeting between WGIV and CEOS-WGISS was help on 07/06/2023. The meeting was well supported and identified possible areas for collaboration both in terms of data management and in the use of cloud computing.

9. Aspects on the implementation of the global contingency plan from Plenary (as proposed by WGIII)

CGMS-51-WGIII-WP-02 - Status and outcome of the 5th CGMS risk assessment.

The objective of the Risk Assessment Workshop is to:

- Update the CGMS Baseline based on member inputs;
- Prepare a consolidated Risk Assessment against the CGMS Baseline;
- Identify contingency actions to be taken, or actions to identify in the HLPP;
- Identify ways to integrate satellite data into the CGMS Baseline and characterise CGMS' contribution.

The Working Group III held a workshop from 21-23 February 2023, hosted by EUMETSAT.

WGIV reviewed the draft update of the CGMS Risk Assessment.

10. Review of WGIV list of actions (incl. review/updates of existing and proposed new action items & recommendations)

CGMS-51-WGIV-WP-02 - Status of CGMS-50 WGIV list of actions, and

CGMS-51-CGMS-WP-14WGIV - Status of co-chairs/rapporteurs of the CGMS working groups, CGMS International Science Working Groups, VLab, and other groups

WGIV discussed the actions and recommendations from previous CGMS plenary sessions (CGMS-50 and earlier). The status of the open actions on and recommendations for WGIV were reviewed and updated as needed. The final status is provided in a table attached to this report.

11. Report on CGMS future direction 2022+ project

11.1 Status of CGMS future direction 2022+ project

CGMS-51-CGMS-WP-09WGIV - Status of CGMS future direction 2022+ project

CGMS Secretariat gave an overview of the activities undertaken on the CGMS future direction 2022+ project since CGMS-50 plenary for consideration and feedback by the CGMS-51 working groups (WGs I-IV and the SWCG). The 2nd high-level meeting on 29 March 2023 endorsed the proposed way forward, noting the need for the identification of concrete implementation measures in the next year (up to CGMS-52) and a stronger link as concerns the potential interfaces.

The basis for discussion were the agreed seven strategic themes:

- Socio-economic benefits – *proposed to be led by WGIII*
- Research to operations – *proposed to be led by WGIV*
- Future observing (hybrid) space infrastructure – *proposed to be led by WGI (Simon Elliott)*
- Future information technologies – *proposed to be led by WGI, WGIV (Cloud), WGII (AI/ML)*
- Relationship with the private sector – *proposed to be led by WGIII*
- Climate and Earth system monitoring – *proposed to be led by WGII*
- Space situational awareness – *proposed to be led by WGI and SWCG*
- + A topic for all: supporting developing countries

WGIV was invited to take note of the status of CGMS future direction 2022+ project.

Following CGMS-51, the concrete outcomes of the CGMS future direction 2022+ project need to be finalised, and further work to be implemented via concrete actions through the working groups.

12. CGMS High Level Priority Plan (incl. Review, Status of implementation, Proposed Updates)

CGMS-51-CGMS-WP-08WGIV – Revised HLPP 2023-2027 - for plenary endorsement

This working paper provided the status of implementation of CGMS High Level Priority Plan (2022-2026). It also listed proposals for changes to the HLPP targets. WGI reviewed and provided inputs to the current status of the HLPP.

CGMS-51-CGMS-WP-07WGIV - Status of implementation of CGMS High Level Priority Plan (2022-2026)

The Working Group noted the status of those parts of the CGMS High Level Priority Plan (2022-2026) relating to its activities and confirmed their validity.

13. Future WGIV sessions (incl. dates for future plenary and intersessional meetings, proposals for new agenda items)

CGMS-51-WGIV-WP-03- Decision on dates on WGIV activities in 2023-2024 (CGMS-51 to CGMS-52)

The paper guided the discussion on planning the dates and formats of the WGIV activities between CGMS-51 and up to and including CGMS-52.

CGMS-51 WGIV agreed on the following WGIV intersessional meetings up to CGMS-52:

WGIV	Proposed CGMSG-50 to CGMS-51 WGI intersessional dates
WGIV Intersessional meeting #1	12/10/2023, 12 UTC
WGIV Intersessional meeting #2	25/01/2024, 12 UTC
WGIV Intersessional meeting #3	04/04/2024, 12 UTC

CGMS-51 WGV discussed and confirmed the following proposed dates of CGMS-52 plenary session:

WGIV	Proposed CGMSG-51 to CGMS-52 WGIV intersessional dates
CGMS-52 working group meetings	22-28 April 2024 Alternatives: 6-10 May 2024 (20-26 May 2024 - very close to plenary)
CGMS-52 plenary session In-person Host: NOAA	Week of 3-7 June 2024, USA

The confirmed schedule will be added to the online CGMS website meeting calendar.

CGMS-51-WGIV-WP-10 - Status of co-chairs/rapporteurs of the CGMS working groups, CGMS International Science Working Groups, VLab, and other groups

This paper provided an overview of the co-chairs and rapporteurs in the CGMS Working Groups, rapporteurs in the CGMS international science working groups, and other CGMS related activities (VLab, JWGClimate, other task groups and teams).

The working paper provides the status of representatives and an indication of any positions that need to be filled in the near to medium-term future. CGMS members were invited to nominate candidates for co-chair and rapporteur positions (or upcoming positions) as necessary and to inform cgmssec@eumetsat.int accordingly.

14. AOB

No AOB items were presented.

15. Meeting Conclusions

The WGIV Co-Chair and Co-Rapporteurs thanked the WGIV meeting participants for their valuable contributions to a successful meeting.

The outcomes and conclusions of the meeting were reviewed against the expected outcomes presented in the beginning of the meeting. The expected outcomes were achieved, with some additional inputs on Terms of Reference and recording up-to-date membership to be provided by the Task Groups ahead of CGMS-52.

The summary list of WGIV actions is included below.

Status of CGMS-50 WGIV actions following CGMS-51 plenary discussions

Status of CGMS-50 WGIV actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
WGIV	WGII/4	A45.05	Action from WGII: Ensure timely (< 1 hr) and free access to all geostationary visible, IR and water vapour data that is required to improve global hydrological prediction.	WGIV 11 Oct 2023 : Natalia to follow up with WGII WGIV 26 Jan 2023 : Natalia to follow up with WGII WGIV Apr 2022: needs update after IPWG meeting in June 2022. Due to potential schedule conflict this may not be possible until after CGMS-50 plenary 2022 18 Jan: needs an update from WGII and is still open waiting for input from the IPWG 2021 9 Nov: await the work from WGII on (WGII49.??) , then follow up CGMS-49: A common minimum baseline for Level-2 products generated from geostationary imagery data is proposed in CGMS-49-WMO-WP-14 2021 2 Feb: On hold At CGMS-48/47: Pending response from WGIV/A46.02 Put on hold until requirements are clarified (see new action A46.02) 29 May 2018: NOAA provides this data at the requested latency. 14 Mar 2018: IPWG recognises it is not feasible having all channel data from the new era of GEO satellites, however: a) At a minimum, sustained 30-min refresh full disk longwave IR (10 to 15-min desired), near realtime access; b) Given the expanded spectral bands of the operational global geo constellation, additional 6.2 um water vapor channel data, at the same refresh	CGMS-52 (CGMS-49)	**ONGOING**

Status of CGMS-50 WGIV actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				as IR c) Finally, visible channel data desired 25 Oct '17: CGMSSEC has sent a message to IPWG co-chairs to this purpose asking for more details to enable WGIV to react. [enquiry sent to R Ferraro 19 Feb 2018] WGIV IS 11 Oct '17: This action was discussed and WGIV concluded the request is too open and would have a significant impact on the data access in this form. The following clarification was formulated and CGMSSEC is asked to pass this on to the IPWG: The precipitation community to clarify what data are needed, in terms of time/spatial resolution, spectral channel selection, and sub-setting. CGMSSEC to follow this up with IPWG.		
CMA, EUMETSAT	WGIV/3	WGIV/A48.01	To report on the status of data dissemination from Indian Ocean Data Coverage partners, as identified in CGMS-43-EUM-14 roadmap	WGIV 11 Oct 2023 : EUMETSAT to present a summary report at the WGIV meeting for CGMS-52 WGIV 26 Jan 2023 : EUMETSAT to present a summary report at the WGIV meeting for CGMS-51 WGIV Apr 2022: EUMETSAT verbally summarised the ongoing MET8→ MET9 transition. MET9 will operate at 40.5E. MET9 will become EUMETSAT primary IODC satellite from 01 Jun 2022 and will operate in parallel with MET8 until 01 Jul 2022 , at which point MET8 will stop. EUMETSAT confirmed that although there is a 4 degree longitude difference, the EUMETCast dissemination and data policy will not change. CMA stated that its Indian Ocean Data Coverage support remains unchanged,	CGMS-52	**ONGOING**

Status of CGMS-50 WGIV actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				and is based upon FY-2H at 79E. EUMETSAT will present a summary report at a WGIV intersessional meeting before CGMS-51 2022 29 Apr: EUMETSAT to provide updates - proposed to close 2022 18 Jan: Ongoing CGMS-49: several related WP CGMS-49-CMA-WP-12, CGMS-49-ISRO-WP-01, CGMS-49-EUMETSAT-WP-10 EUMETSAT will compile a consolidated report summarising the status, taking into account changes in data access and data policy 2021 2 Feb: Report to be provided to CGMS-49		
CGMS members	WGIV/17	WGIV/A48.08	To provide a point of contact for participation in regular inter-sessional teleconferences to convert identified WGIV recommendations into Best Practises.	WGIV Apr 2023: Confirm closure WGIV 26 Jan 2023 : this has been done for User Readiness. To be handled on a Task Group by Task Group basis for other cases, Proposed for CLOSURE WGIV Apr 2022: Suggestion made to exploit existing group used for review of user readiness 2022 11 Apr: NOAA has named Vanessa Escobar, Jason Taylor, Satya Kalluri as Task Group on User Readiness members. Task Group has not yet started. Plan to hold an initial organizational meeting prior to CGMS 50 2022 7 Feb: Email sent from CGMS Sec seeking nominations for TG-UR by 28/02/2022 2022 18 Jan: Task group on user readiness	CGMS-50	**CLOSED**

Status of CGMS-50 WGIV actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2021 9 Nov: dedicated task teams agreed to be established per topic and recommendations to be addressed there CGMS-49: will be addressed in intersessional meetings, starting 15 Sep 2021 2021 2 Feb: CGMS members to provide pocs ISRO: Nitant Dube (nitant@sac.isro.gov.in)		
WMO + EUM (CGMS space agencies)	WGIV/	WGIV/A48.09	Noting the recent conclusions of the WMO IPET-DRMM and the concurrence expressed in CGMS WG III, WMO is encouraged to add the satellite identifier (from Common Code Table C5) and satellite instrument identifier (from Common Code Table C8) to OSCAR Space. (This action originates from WGIII discussions at CGMS-44, WGIII R44.02 and WGIII/A47.05 and discussions at CGMS-48 WGIII, May 2020)	WGIV 11 Oct 2023 : Going to be implemented as a part of next OSCAR/Space development work package together with WIGOS Station Identifier implementation WGIV 26 Jan 2023 : Implementation plan drafted with WMO WIGOS team and Task Group on Satellite Data and Codes. Going to be implemented as a part of next OSCAR/Space development work package together with WIGOS Station Identifier implementation 2022 11 Apr: Ongoing. To be clarified if OSCAR update is in progress (WMO) 2022 4 Feb: deadline changed to CGMS-50 (for CCT-C8) 2022 18 Jan: Wait until WIGOS Station Identifier discussions re CCT C-5 are concluded before addressing C-5 in OSCAR. Action can be addressed for CCT-C8 2021 9 Nov: not yet implemented (WMO) 2021 27 Apr: WMO to confirm 2021 22 Feb: EUMETSAT has addressed this with WMO. To be incorporated in the OSCAR space database. Action recommended for closure.	CGMS-52 CGMS-49 (CGMS-48)	**ONGOING**

Status of CGMS-50 WGIV actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2020 May 29: Action transferred to WGIV (lead EUM/Simon.Elliott@eumetsat.int). 2020 Feb 19: WMO now focuses on the NWP station identifiers.		
Satellite operators who launched new satellites since 2016	WGIV/2	WGIV/A49.01	To provide updates for WMO "Guidelines on Best Practices for Achieving User Readiness for New Meteorological Satellites" https://library.wmo.int/doc_num.php?explnum_id=3553	WGIV 26 Jan 2023 : Can be CLOSED 2022 29 Apr: work is ongoing: ET-SSU and CGMS WG IV (to be endorsed by CGMS-51) 2022 11 Apr: To be addressed by the Task Group on User Readiness once established 2022 1 Mar: NOAA representatives: vanessa.escobar@noaa.gov; Jason.Taylor@noaa.gov; Satya.Kalluri@noaa.gov 2022 7 Feb: To be addressed by TG-UR (see action A48.08) 2022 18 Jan: Needs updating based on new satellite launch dates 2021 9 Nov: will be a key subject for the new task team on user readiness Relevant agencies: JMA, NOAA, EUMETSAT, KMA, CMA, IMD, ROSHYDROMET	CGMS-51	**CLOSED**
CGMS members	WGIV/8	WGIV/A49.04	to propose a candidate for the TFMI chair.	WGIV 11 Oct 2023 potential chairperson identified - final confirmation from reporting line pending WGIV 26 Jan 2023 : to be followed up at meeting of rapporteurs and co-chairs before WGIV meeting in April 2023 2022 29 Apr: no much progress 2022 4 Feb: To be addressed at TG-M KOM on 17 Feb 2022 - outcome? 2022 18 Jan: No progress	Nov 2023	**ONGOING**

Status of CGMS-50 WGIV actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
				2021 9 Nov: will be address as part of (re-) establishing the Task Group on MetaData, and other Task Groups		
CGMS members	WGIV/16	A47.06	CGMS members, through WGIV, to review CGMS members' adherence levels to the CEOS Data Preservation Guidelines on a regular basis (every 2-5 years). For review at CGMS in the 2023-2024 timeframe.	12 Oct 2023 to be taken up at intersessional meeting #2 on 25 Jan 2024 2022 18 Jan: 2019, 10 Dec, IS WGIV: CGMSSEC/Anne to raise it with MRa if this should be covered by the HLPP. ISRO/Nitant Dube will secure that CGMS is informed once new version(s) of the CEOS DP guidelines are available. (The related recommendation was endorsed by CGMS-47 plenary).	2024	**OPEN**
			The Terms of Reference of the CGMS Working Groups to be reviewed every 5 years. WGIV to review its ToRs in 2023.	12 Oct 2023 to be taken up at intersessional meeting #2 on 25 Jan 2024	2024	**OPEN**
CGMS Members	§3.4	WGIV/A50.01	CGMS members continue to foster the growth of EOTEC DevNet by, for example: joining the CoPs, identifying other experts for the CoPs, contributing to EOTEC DevNet products, and sharing EOTEC DevNet information within their network.	Ongoing action		**ONGOING**
CGMS Sec and CEOSS WGISS	§4.3	WGIV/A50.02	WGISS and WGIV to hold a joint meeting to discuss	12 Oct 2023 WGIV and CEOSS WGISS are in contact on issues relating to cloud activiteis and	CGMS 51	**CLOSED**

Status of CGMS-50 WGIV actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
			modalities and areas of common activities between WGISS and WGIV. This should include a report on the implementation of the adopted guidelines.	WIS 2.0. WIV will present at CEOS WGISS in October 2023		
WGIV	§12	WGIV/A50.03	WGIV recommends Plenary to endorse Natalia Donoho (NOAA) and Simon Elliott (EUMETSAT) as WGIV co-rapporteurs.	12 Oct 2023 Approved at CGMS 50 plenary	CGMS 50 Plenray	**CLOSED**
CGMS members	6	WGIV/(P)A50.01	(Action to be monitored by WGIV) CGMS members are invited to contact WMO to provide contributions to the WMO VLab Trust Fund to ensure the continuation of technical support to the VLab through the VLab Technical Support Officer as well as to the implementation of VLab projects.	Monitoring action only		**ONGOING**

CGMS-50 WGIV recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
CGMS space agencies	4.1	(R49.02)	Transferred from CGMS-49 plenary When pursuing data purchasing, CGMS recommends CGMS space agencies to consider an option for redistributing data to global NWP centres	2022 11 Apr: NOAA is currently distributing the Radio Occultation data we are purchasing under our current delivery order to National Meteorological and Hydrological Centers for non-commercial use WGIV to consider adding this to the WGIV CGMS-50 agenda. WGIV to collect input from CGMS space agencies on the data buy redistribution options to global NWP centres by end 2021. Feedback to WGIV to WGIII on the baseline/risk assessment (Feb 2022) for inclusion or not - TBD.
Plenary	2	(WGIIR49.)	Transferred from CGMS-49 WGII and plenary Working Group II recommends to CGMS Plenary the adoption of the proposed baseline products for geostationary satellites presented in CGMS-49-WMO-WP-14 with the addition of SSTs, to be considered for subsequent implementation by all Agencies.	2022 18 Jan: 2021 9 Nov: await the work from WGII, then follow up Endorsed by CGMS-49 plenary. WGII/Ken to send to WGIII and WGIV relevant parts of WGII report. Action to WGIII to update the baseline accordingly. (WGII action to WGIV on related redistribution mechanisms).
CGMS members	2	WGIV/R49.01	To consider an enhancement of advance notifications of processing changes as specified below and provide feedback to WG-IV. If a planned change to data processing results in a change in brightness temperature of 0.1K or 20% of NEdT (whichever is smaller), this should be made clear in notifications to users. These notifications should be made no later than 8 weeks before the change and test data	2022 11 Apr: NOAA: To be addressed by the Task Group on User Readiness once established 2021 9 Nov: to be addressed by the Task Group on User Readiness once established To be converted into a good practice document.

CGMS-50 WGIV recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
			should be provided if possible. [From the ITWG ITSC-21 Report]	
CGMS members	12	WGIV/R49.02	The WGIV Cyber Security Expert Group welcomes any other members who are not yet represented in the group, and to propose new security related topics to be addressed by the group	2022 11 Apr: NOAA: So far the cyber security group met only once, for establishing the terms of reference. They should have met in December 2021; however, the attendance was too low and all experts were busy. 2021 9 Nov: standing recommendation to support Task Group, outreach to be addressed
CGMS members	12	WGIV/R49.03	The Cloud Expert Group welcomes any other members who are adopting cloud services to discuss best practices, exchange information, and identify emerging coordination opportunities.	2022 11 Apr: NOAA: Ongoing 2021 9 Nov: standing recommendation to support Task Group, outreach is planned via a flyer by end of November
CGMS members	WGIV/ (PI 9.1)	WGIV/R48.01 (PI R47.10)	On training and education: CGMS members to provide contributions into the WMO VLab Trust Fund to ensure the continuation of technical support to the VLab. CGMS members considering to provide additional support should contact the WMO Space Programme Secretariat	2022 11 Apr: NOAA: WMO has confirmed that NOAA contributed to the Trust Fund and the money was transferred in December 2021. 2020 Aug: Transferred to WGIV 2020 May CGMS-48 WG discussions: VLab will in future be addressed in WGIV, user preparedness. The plenary recommendation is critical! 2020 Jan 22, CGMSSEC IS#2: To be addressed within the framework of Vlab, WMO, CGMSSEC plus communication to CGMS agencies
CGMS space agencies	WGIV/7	R42.01	Satellite operators to provide WIS Discovery Metadata Records, compliant to WIS requirements and following the guidance to be provided by the CGMS-WMO Task Force on metadata implementation, in order to	2022 11 Apr: NOAA: To be addressed by the Task Group on Metadata once established 2021 9 Nov: to be addressed by the Task Group on MetaData once re-established CGMS-48: to be converted into Best Practise by IS sub-

CGMS-50 WGIV recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
			facilitate satellite information discovery and access	group (NOAA: NCEI? See also WGIV/A48.02) at CGMS-47: consider conversion into best practise during inter-sessional meeting
CGMS space agencies	WGII/10	R43.07	CGMS agencies to make available a non real-time cache of satellite level 1 data over the previous 2-3 months, similar to the NOAA CLASS system.	2022 18 Jan: 2021 9 Nov: to be addressed by the Task Group on Data Access/Exchange once established CGMS-48: to be converted into Best Practise by IS sub-group at CGMS-47: consider conversion into best practise during inter-sessional meeting
CGMS members	WGIV/6		On training and education: CGMS members to participate in the EOTEC DevNet regional discussions planned in the future, held online across time zone". Information for the upcoming regional meetings is available at https://ceos.org/ourwork/other-ceos-activities/eotec-devnet/ and more detailed information for the most recent regional meetings at https://ceos.org/meetings/eotec-devnet-regional-meetings/.	2022 18 Jan: 2021 9 Nov: WGIV proposed to create a recommendation for ongoing meetings, to strengthen cooperation between CEOS and CGMS-WMO VLab communities.
CGMS Plenary	§4.3	WGIV/R50.01	CGMS WGIV recommends to the Plenary Session of CGMS 50 to suspend the activities of the Task Group on Cyber Security, and to revisit the role of the Task Group for CGMS 52.	
WGIV Cloud Service Expert Group	§4.3	WGIV/R50.02	WG IV recommends that Cloud Service Workshops are organised on an annual	

CGMS-50 WGIV recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
			basis, the schedule being shortened to take advantage of the consequent recurrence.	
	WGIV §5.1		CGMS WG-IV recommends to plenary to endorse the updated Strategy for the Virtual Laboratory for Education and Training in Satellite Meteorology (2024–2027).	CONCLUDED This was done
	WGIV §5.1		CGMS WG-IV recommends to plenary to endorse CGMS/WMO Best Practices for Achieving User Readiness for New Satellite Systems.	CONCLUDED This was done

Summary of WGIV actions resulting from CGMS-51

CGMS-51 WGIV actions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
CGMS space agencies	WGIV report	A51.06	CGMS agencies to nominate additional members for all the WGIV Task Groups, in particular those agencies who currently have no representatives in the Task Group(s): · WGIV Task Group on Data Access/Exchange · WGIV Task Group on Metadata - CGMS members to nominate a chairperson for this TG. · WGIV Task Group on User Readiness	11 Oct 2023 Call to be sent by CGMS Sec in liaison with WGIV rapporteurs during October 2023		

CGMS-51 WGIV recommendations				
Lead	**AGN item**	**Rec #**	**Description**	**Recommendation feedback/closing document**
CGMS members	WGIV/6	new recommend-ation	On training and education: CGMS members to participate in the EOTEC DevNet regional discussions planned in the future, held online across time zone". Information for the upcoming regional meetings is available at https://ceos.org/ourwork/other-ceos-activities/eotec-devnet/ and more detailed information for the most recent regional meetings at https://ceos.org/meetings/eotec-devnet-regional-meetings/.	2022 18 Jan: 2021 9 Nov: WGIV proposed to create a recommendation for ongoing meetings, to strengthen cooperation between CEOS and CGMS-WMO VLab communities.

LIST OF PARTICIPANTS

CGMS-51 - WGIV List of Participants		
Organisation	Lastname	Organisation
Li	Xiaoru	CMA
Zhe	Xu	CMA/NSMC
Peng	Zhang	CMA/NSMC
Wei	Zheng	CMA/NSMC
Mikael	Rattenborg	CGMS Sec
Sean	Burns	EUMETSAT
Simon	Elliott	EUMETSAT
Mark	Higgins	EUMETSAT
Andrew	Monham	EUMETSAT
Karolina	Nikolova	EUMETSAT
Edmund	Henley	EUMETSAT (MET OFFICE UK)
Anoop Kumar	Mishra	IMD
Nitant	Dube	ISRO
Miki	Abe	JMA
Akiyoshi	Andou	JMA
Kotaro	Bessho	JMA
Taro	Handa	JMA
Yasutaka	Hokase	JMA
Kosuke	Inoue	JMA
Shin	Koyamatsu	JMA
Harada	Reiko	JMA
Takuya	Sakashita	JMA
Kazuki	Shimoji	JMA
Yasuhiko	Sumida	JMA
Ibuki	Watanabe	JMA
Ayako	Yamane	JMA
Dohyeong	Kim	KMA
Jaegwan	Kim	KMA
Mitch	Goldberg	NOAA
Josh	Jankot	NOAA
Veronica	Lance	NOAA
Thomas	Renkevens	NOAA
Kathryn	Shontz	NOAA
Jessica	Wieman	NOAA
Beau	Backus	NOAA/JHU APL supporting
Elsayed	Talaat	NOAA/NESDIS/SWO
Bernadette	Connell	VLab/CIRA/CSU & WMO VLab
Zoya	Andreeva	WMO
Natalia	Donoho	WMO

CGMS-51 - WGIV List of Participants		
Organisation	**Lastname**	**Organisation**
Hassan	Haddouch	WMO
Chang	Liu	WMO

CGMS

(SWCG)

Space Weather Coordination Group

SWCG REPORT

Chair: *Tsutomu Nagatsuma, NICT/Elsayed Talaat, NOAA*
Rapporteur: *Andrew Monham, EUMETSAT*

1. Welcome, objectives and review of agenda

SWCG Co-Chairs, Dr. Elsayed Talaat and Dr. Tsutomu Nagatsuma, supported by Rapporteur Mr. Andrew Monham, welcomed the participants, consisting of representatives from CMA, ESA, EUMETSAT, ISRO, JMA, JAXA, KARI, KMA, NICT, NOAA, ROSCOSMOS, ROSHYDROMET and WMO (see Annex 1 for full list of participants).

SWCG reviewed and adopted the draft agenda proposed by the CGMS Secretariat prior to the meeting which is in line with the Terms of Reference for SWCG.

2. 5th CGMS risk assessment and baseline update

CGMS-51-WGIII-WP-02SWCG - Status and outcome of the 5th CGMS risk assessment (Melissa Johnson)

The Risk Assessment highlights the following:

a. The short-term risks associated to measurements at L1 relying on ageing spacecraft DSCOVR, ACE and SOHO, prior to the entry into operations of the NOAA SWFO mission. Note that the ISRO Aditya L1 mission will not support real-time data flows. Mitigation actions to improve ground segment data latency from the STEREO mission are on-going, but it is noted that for magnetometer and solar wind measurements, it will only be close enough to the sun-earth line for a few months this year. Punch will not be launched in advance of SWFO. Closes Action WGIII/A50.01.

b. Longer-term risks associated to the end of programmes are identified for:
   i) L1 measurements (end of SWFO)
   ii) Low and high energy particle measurements in the GEO 86.5°-123°E range (end of FY-4B)

It is noted that in both cases above, plans for follow-on missions are being proposed in the respective agencies and awaiting approval.

CGMS-51-WGIII-WP-01 - CGMS Baseline - draft revision following the 5th risk assessment workshop (Melissa Johnson)

The CGMS Baseline document has been updated and was confirmed as correctly addressing the space weather aspects, in particular the characteristics/definitions of the new energy ranges related to the high energy particles in the Sensor Type table, closing the Action WGIII/A50.03.

CGMS-51 actions - SWCG					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
NOAA	SWCG/2	SWCG/A51.07	Report on the STEREO-A coverage implementation	RA Workshop 2024	

3. Updates on space-based observational capabilities

CGMS-51-CMA-WP-03 - The capabilities of FY-3E on monitoring space weather events (WeiGuo Zhong)

The CMA FY-3E LEO satellite space weather observation package consists of:

a. The solar X-ray and Extreme Ultraviolet Imager (XEUVI) for the solar X-ray and EUV images;
b. The Triple Ionospheric Photometer (Tri-IPM) for imaging the earth's far-ultraviolet (FUV);
c. The Space Environment Monitor-II (SEM-II) for measuring the charged particles flux, the satellite surface potential, the radiation dose in sensors, and the geomagnetic field variations;
d. Global Navigation satellite system Occultation Sounder-II (GNOS-II) for the electron density profile.

CMA described the successful inter-calibration activity with other agency sensors.

CGMS-51-ESA-WP-01 - ESA Vigil (L5) and D3S missions update (J-P. Luntama)

A broad range of ESA activities was presented:

a. The ESA Vigil (Lagrange 5) mission is on track for launch in 2029, following strong support at the ESA Ministerial in 2022. It will embark a NOAA Coronagraph (CCOR) and a NASA EUV imager. Some further payload de-scoping (X-ray and radiation monitors) has taken place to reduce cost in coordination with the user representatives. ESA foresee this to be the first in a series of operational missions to L5 with open data policy and data latencies expected between 15 minutes to 1 hour;
b. Particle sensors and are embarked in LEO and GEO on EUMETSAT satellites as well as commercial satellites as hosted payloads and the SOSMAG magnetometer is on the KMA GK2A with NRT data available from ESA. A trial availability of this data from the WMO WIS 2.0 is also being initiated;
c. Lunar hosted payloads are also planned on the ESA Lunar Pathfinder and in cooperation with NASA on Lunar Gateway;
d. Support to a commercial nanosat mission carrying particle sensors, magnetometers, radio beacons and ions and neutron spectrometers is under definition, with launch foreseen for 2026;
e. The planned auroral monitoring mission foresees a demonstration satellite in polar orbit at 7000km in 2027, with the possibility of an operational 4-satellite constellation in 2030.

CGMS-51-KMA-WP-01 - KMA Report on the update of space weather activities

The Korea Meteorological Administration KMA GK2A KSEM environmental package has been delivering data since 25 July 2019. GK2A has two payloads, one is Advanced Meteorological Imager (AMI) and the other is the Korean Space wEather Monitor (KSEM). The GK2A's space weather payload, KSEM consists of Particle Detector (PD), Magnetometer (MG), and Charging Monitor (CM). A query by UK Met Office as to availability of NRT space weather data via EUMETSAT is being followed up.

Plans are in place to continue and improve the space weather payload on GK2A successor GK5 satellite to be operational from end-2031.

KMA analysed electron particle flux inter-comparison between GK2A/KSEM PD and GOESR/MPS-HI data for 2 years (2020-2021). As a result, overall response of KSEM PD and MPSHI to the electron flux detection phases show a good correspondence.

CGMS-51-NOAA-WP-17 - NOAA Space Weather Observations Update (Elsayed Talaat)

a. GOES-R series: GOES-18 transitioned to GOES West; GOES-17 transitioned to storage mode.
b. GOES-U: Planned for launch in 2024 will feature the Compact CORonagraph CCOR as part of its extensive space weather package.
c. Establishment of NOAA-NASA Space Weather Observations Programs Division (SWO)
d. Ongoing development of SWFO-L1 Observatory, instruments, and ground segment with launch planned for 2025 (rideshare with NASA IMAP mission).
e. Continued progress in formulation of the Space Weather Next program; System Definition Review held in February 2023 with program approval decision late 2023.
f. Awarded contracts for the first Space Weather Data Pilot; entered data receiving phase in November and evaluation phase in January. Following an evaluation phase, it is anticipated to negotiate free and open use of data.

CGMS-51-ISRO-WP-02 - Near Lunar particle Environment from CLASS payload on Chandrayan-2 mission (Shyama Narendranath)

ISRO presented particle observations from Chandrayan-2 relevant for lunar space weather in support of international exploration activities and recommend a dedicated “space weather index” for the Moon.

CGMS-51-ISRO-WP-04 - Solar X-ray Spectral monitoring with XSM payload on-board Chandrayan-2 mission. (Santosh Vadawale)

ISRO also presented the X-ray spectral monitoring XSM instrument on Chandrayan-2, which provides high quality data within an availability time of 1 to 3 days.

4. Updates on space weather activities - Agency reports

CGMS-51-EUMETSAT-WP-07 - EUMETSAT Space weather activity status and planning update (Andrew Monham)

EUMETSAT presented their on-going space weather activities and highlighted the cooperation with ESA to ensure the delivery of operational space weather data in support of European forecasting service users, together with the status and plans for the European Space Weather Network, where a model based on Satellite Application Facilities (SAFs) is being considered.

CGMS-51-ESA-WP-03 - ESA space weather service network: progress and next steps (Alexi Glover)

ESA presented the status and plans for the ESA space weather service network. In answer to questions, surveys are being made to better understand the profiles of existing users of these services (e.g. space

weather experts, operators etc.) It was also noted that the service is separate to the European Weather Cloud.

CGMS-51-NASA-WP-01 - NASA space weather activities (Jim Spann)

NASA presented the broad scope of their Heliophysics System Observatory, together with the heliophysics objectives, vision, overview of the space weather program and latest information on the GDC constellation and DYNAMIC missions, the development of which are currently suspended due to financial reasons.

Question on whether international coordination of R2O feasibility assessments could take place in order to avoid duplications and allow international partners to focus their resources on different promising candidates for operationalisation with sharing of outcomes. It was noted this is not currently happening, but could be addressed in CGMS.

CGMS-51-NICT-WP-01 - NICT Space Weather Activities (T. Nagatsuma)

The NICT Space Environment Laboratory continues to operate space weather services on a 24/7 basis as a part of ICAO's global centers, ACFJ and also serves domestic users. A 7.3m diameter parabolic antenna was constructed at Kashima Space Technology Center, NICT in March 2023 for reception of SWFO-L1 data. New space weather applications have been developed including AI-based radiation belt electron forecast models and new releases of WASAVIES and SECURES. For the operational space environment monitoring at the Japanese meridian of geostationary orbit, NICT have been developing engineering model of new space weather sensors, RMS (Radiation Monitors for Space weather) –e (electron) and –p (proton), and internal charging monitor, CHARMS(Charging And Radiation Monitors for Space weather)-c.

In answer to questions, it was noted that Himawari 10 is a future satellite and is planned for launch around 2028-2029.

CGMS-51-NOAA-WP-18 - NOAA Space Weather Activities (Brent Gordon)

NOAA Space Weather Prediction Center highlighted that Solar Cycle 25 continues to be very active and SWPC are focusing on bringing intelligent Impact Based Decision Support Services (IDSS) to customers to ensure they have the right information at the right time in order to make the right decisions. Support for Aviation, Spaceflight, and Space Situational Awareness is increasing and SWPC continues to move forward with several modeling enhancements as well. These are all driven, and improved by the satellite-based observations partners in CGMS provide. Via the Space Weather Prediction Testbed, SWPC have launched upon a new era of interactions with customers, scientists, operational data providers, industry, and operational forecasts to improve our services. Finally, SWPC are launching an international effort to bring a much needed update to the NOAA Space Weather Scales used worldwide.

Questions and discussion points:

- social science experience from climate services could be used to aid user engagement/insight gathering.
- Discussion on alert thresholds for aviation users: is it I better to alert too often or miss something?
- A report on the space weather prediction testbed outcomes will be published.

- Remark made that the evolution of the space weather scales should have input from the international community.

CGMS-51-WMO-WP-04 - WMO report on the Space Weather Expert Team priorities and activities (Kirsti Kauristie).

The WMO Space Weather Expert Team kicked off in 2022, following on the work of IPT SWeISS which ended in 2020. WMO ET-SWx comprises 32 expert from 20 countries and 7 international organisations and involves significant collaboration with CGMS, as well as ISES and COSPAR. An important overarching goal is identified as facilitating integration through data standards.

Questions and discussion points:

- Regarding the WMO-ISES-COSPAR Coordination Team, (WICCT), which integrates operations and research needs, coordination with CGMS activities is required.
- Consensus in API, formats needed.
- CGMS is holding user engagement sessions for formats and metadata. CGMS caters first to operational community…need ISES to feedback on what is the data they need in their models.
- NOAA point out that they are designing product generation systems right now, so time critical.
- Need is for a unified data standard (whether 1D or 3 D) is most important.
- Global multi-hazard early warning overlaps with communications system between ISES systems presented by Ishii-san. Definition of what constitutes an extreme space weather event where communication is required requires clarifying.
- An EGU town hall meeting on ground-based measurements is planned at the Space Weather Coordination Forum (ISWCF), Roundtable on 17 November 2023 at WMO.

CGMS-51-JAXA-WP-02 - JAXA activities on sun and solar terrestrial science (Prof. Iku Shinohara)

JAXA has 5 spacecraft missions in operation targeting Sun and Solar-Terrestrial Sciences comprising:

- “In-situ" observations of space plasma environment
    - In geospace: Arase (ERG)
        - All data acquired by Arase is made fully available to the international research community 1-year after observations. Real-time data from HEP, XEP, and MGF instruments is available (although temporarily suspended due to system upgrade).
        - The extended mission covering whole of 25th solar cycle (until the end of March 2033) has been approved.
        - Note that the Geotail mission was terminated at the end of November 2022 after 30-year observation.
    - In planetary space: Mio (MMO)/BepiColombo
- “Imaging” observations of solar and planetary atmosphere
    - Hinode (Solar-B) Sun from Earth
        - All data acquired by HINODE is made fully available to the international research community immediately after observations.

        - JAXA has confirmed the continuation of HINODE operations until March 2024; a further extension plan is now under the review.
    - Akatsuki (Planet-C) Venus
    - Hisaki Jupiter, Mars and Venus from Earth
        - The Hisaki operation will be terminated in 2023 due to the degrade of the star-tracker.

The following future missions are planned:

- GEO-X (GEOspace X-ray imager)
    - CubeSat X-ray imaging of the Earth's magnetosphere from the vicinity of the Moon for launch 2023-2025
- Solar-C (EUVST) to provide EUV sun imaging spectrometer (development about to start)

Questions and Discussion:

- The extension of Arase is welcomed. JAXA are very interested in cross-calibration of the sensors.

5. International space weather data user activities

CGMS-51-GUEST-WP-01 - Status update of the International Space Environment Service (ISES), (Mamoru Ishii)

The International Space Environment Service (ISES) has been the primary organization engaged in the coordination of space weather services since 1962. Space weather is not new, but space weather services are becoming increasingly important as our technologies and national/international infrastructures become more vulnerable to storms in space. The growing demand for space weather services to protect our space-based and ground-based assets requires the worldwide coordination of strong partners. The ISES network of Members, Associate Warning Centers, and Collaborative Expert Centers (CEC) provides space weather forecasts, warning, alerts, and environmental data to government and private-industry users around the globe. It was noted that Germany joined as a CEC in 2023.

The "Coimbra Declaration" reflects the agreement for COSPAR-ISES-WMO to lead space weather related activities in response to the UN COPUOS STSC February 2022 recommendations. The first International Space Weather Coordination Forum (ISWCF (former round table)) will be held in Nov. 2023.

CGMS-51-ESA-WP-02 - Space Traffic coordination needs for space weather inputs, (J.-P. Luntama)

The importance of space weather services to space traffic coordination has been recently exemplified by the loss of Starlink satellites from low orbit in February 2022. ESA space weather service requirements have been updated in 2023 to better reflect the needs, in particular:

- Atmospheric Estimates for Drag Calculation
- Forecast of geomagnetic and solar indices for drag calculation
- Archive of geomagnetic and solar indices for drag calculation

It is noted that the CGMS Future Directions already foresees effort to cooperate on space traffic coordination within CGMS and there is the potential for a new Space Weather goal within the SSA Theme to produce a report of space weather observation requirements for improved STC services and space sustainability and suggestions are included in the presentation for consideration.

Questions and Discussion:

- Further HLPP discussion on the needs for thermospheric measurements is required.
- Discussion about SpaceX satellite loss. SWPC did forecast it but not shared as a launch constraint.
- Reentry can take days with closure of airspace.
- Economies of scale… pushing edge of technology to cut costs and to improve efficiency, going to be more susceptible to space weather affects, operating towards the margins.
- Warnings have to be heeded for minor effects.
- Discussion took place about commercial operator autonomous decisions on when to go to higher orbits with on-board models. Currently Space-X coordinates closely with SWPC. Also more calls from launch companies being received.

CGMS-51-ROSHYDROMET-WP-05 - Updates to China-Russia Consortium advances towards scheduled duty operations, (K. Kholodkov)

CRC is an established space weather center that works in the framework of ICAO-designated space weather centers for civil aviation. Agencies comprising CRC are continuing to integrate new data from new satellites, such as Fengyun-3G and Elektro-L N4, for the benefit of civil aviation safety, in particular RO occultation data.

CGMS-51-WMO-WP-06 - Space-based observations supporting space weather services for civil aviation - PECASUS view (Kirsti Kauristie (FMI))

The PECASUS Consortium is one of the four centers providing space weather (SWx) advisories to civil aviation according to the ICAO regulations, in particular: GNSS, HFCOM and Radiation at flight levels. ICAO SWx advisories are mostly composed from the basis of ground-based observations, but space-based observations give crucial support in monitoring solar activity and ionospheric electron density assessments by GNSS. Radio Occultation data collected by LEO GNSS receivers for supporting TEC products and ionospheric tomography from one shopping point would be a significant step forward. Further examples of spaced based observations that would open pathways for improved services include energetic (tens of keV) electron precipitation fluxes from polar LEO orbits (D-layer absorption) and SEP flux spectra (from some hundreds of MeV to GeV) measurements. User community would like to know about space weather storms with lead times of 6-18 hours. All missions that push forward our forecasting capabilities are welcome, such as: versatile solar observations from L1 and L5, missions monitoring the state of magnetosphere and physics based and empirical models describing ionospheric conditions.

Questions and Discussion:

- the spectral requirements in the stated wide energy range would need to be defined.

- It was suggested it could be useful for users to take in forecasts with iterations as lead time reduces, rather than just one shot.
- It was noted that space weather services from FMI benefit from the same quality arrangements as used for meteorological services.

CGMS-51 actions - SWCG					
Actionee	**AGN item**	**Action**	**Description**	**Deadline**	**Status**
SWCG	SWCG/5	SWCG/A51.09	Members to document any plans for NRT, operational thermospheric density measurements with consideration of observation requirements from atmospheric density models.	CGMS-52	
SWCG/data access + RO TGs	SWCG/5	SWCG/A51.10	Consider ICAO PECASUS requirements for improved LEO RO observation, energetic (tens of Kev) electron precipitation flux from LEO orbit , SEP flux spectra (100s MeV to GeV)	CGMS-52	

6. OSCAR review for space weather - Completeness and suitability of space weather related content

CGMS-51-WMO-WP-05 - Updates on Space Weather information in OSCAR/Space and WMO Gap Analysis (Heikki Pohjola)

OSCAR/Space is a key tool and information source to support the WMO Rolling Review of Requirements (RRR) process and WMO Gap Analysis (CGMS-51-WMO-WP-14), which are used to monitor the compliance of satellite programmes in the implementation of the CGMS Baseline and the space-based component of the Vision for WIGOS in 2040 (WMO-No. 1243).

WMO Space Programme Office continued a successful development framework with a contractor for the OSCAR/Space technical maintenance. The recent development plan in 2022 resulted software release including a milestone to develop OSCAR/Space frequency recording to support Space Frequency Coordination Group (SFCG) in their interest of using OSCAR/Space as an information source. Also, data latency records are implemented in OSCAR/Space to support gap analysis especially for Space Weather application.

The major miles stones in 2023 are to implement the WIGOS station identifiers for satellites and Common Code Tables C-5/8 recorded in OSCAR/Space.

The main mechanism for the WMO Space Programme Office to collect the relevant information for the database content updating is through templates submitted to the OSCAR/Space Support Team (O/SST) members, usually two to three times per year. In addition, the similar request was sent to some non-CGMS members having their satellites in OSCAR/Space.

The WMO gap analysis for Earth observation and space weather observation capabilities against the requirements presented in WMO Vision for WIGOS 2040 was provided. It compares space-based

observation capabilities recorded in OSCAR/Space to the WMO WIGOS Vision for 2040 requirements for the period of next decade. In this working paper detailed descriptions of the missing observations capabilities related to the specific observation types in WIGOS subcomponent 1 and 2 were given. The work summarises totally 18 gaps for Earth observation types and 9 gaps for space weather observation types as main concerns non-compliant with WIGOS Vision 2040 requirements. Out of these gaps totally seven are including periodic totally missing observation capabilities. These are for Earth observations: MW SST/LST, cloud radar, Doppler wind lidar, altimeter lidar, wide swath radar altimeter, IR/MW limb sounder and high temporal MW sounder. In addition, total gap for space weather is identified for solar radio waves measurements at L1 later part of the decade.

Questions and discussion:

- Ways to manage commercial small satellite constellation information are to be considered.
- It is stressed that the latency information requested under action SWCG/A50.01 is not complete and CGMS members need to supply this.
- Is online source accurate for data collection It was noted that an official agency input overrules information sourced online.

7. Briefings on next steps by the SWCG Task Groups

CGMS-51-SWCG-WP-10 - Task Group Report on Intercalibration of High Energy Electron Sensor (Tsutomu NAGATSUMA)

The cross-calibration of high energy electron sensor at GEO have been discussed at the task group within CGMS/SWCG since Feb. 2019. The Task Group submitted a white paper about the cross-calibration of high energy electron sensor to Executive Panel of Global Spacebased Inter-Calibration System (GSICS-EP). GSICS-EP endorsed to establish GRWG space weather subgroup in 2022. The kick-off meeting of GSICS GRWG space weather subgroup was held on Dec. 14, 2022. A breakout session in the GSICS Annual meeting 2023 has also held by the subgroup. The scope of the subgroup was proposed in the session.

The operational framework of SW sensor's intercalibration is being prepared, and the activities of the task group are being transferred to the activities of subgroups under GSICS.

It is recommended that CGMS/SWCG continue to collaborate with the GSICS GRWG Space.

Weather subgroup to share information and have discussions.

Further nominations for membership of the GSICS GRWC Space Weather subgroup are encouraged, especially from WGII.

8. Review of SWCG list of actions

CGMS-51-SWCG-WP-02 - Status of CGMS-50 SWCG list of actions (Andrew Monham)

Note this action list includes entries discussed in the Joint WGI-WG-IV, SWCG report.

SWCG actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/3	SWCG/A49.05	Poll CGMS Members on reasons for sparse anomaly data supply to CGMS.	Proposed for closure. SWCG IS#2: Awaiting TG meeting in Jan 23. SWCG IS#1: No further inputs made at Plenary Propose to discuss / close at Anomaly TG meeting 18 February 2022: Poll issued -No responses received – invited until CGMS-50 Plenary 2021 20 Oct IS#9: Poll not yet performed.	Jan. 2023	**CLOSED**	
CGMS Members	SWCG/6	SWCG/A50.01	Supply latency information to OSCAR DB with granularity of each relevant space weather sensor on their space missions.	Some latency info added, but further inputs still required by WMO - proposed to keep OPEN SWCG IS#2: Inputs needed before the CGMS Risk Assessment in February SWCG IS#1: CGMS Members to provide inputs on SWCG/A50.01 by IS#3 (26 January 2023)	Feb. 2024	**OPEN**	
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/3	SWCG/A50.02	TG to Review Terms of Reference to: - Agree additional activities related to Best Practices on spacecraft operators usage of space weather data	3 TG meetings held.Action proposed for closure (see Anomaly TG report).	CGMS-51	**CLOSED**	6.1

SWCG actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
			- Agree on updates to required anomaly input data content and formats - Recommend to CGMS-51 whether to continue TG activities based on progress made.				
SWCG (RO TG)	Joint WGI-WG-IV-SWCG/4	SWCG/A50.03	Establish requirements for and recommend an implementation of an optimised system for radio occultation observations for ionosphere monitoring	5 TG meetings taken place. Next steps identified in TG report	CGMS-51	**OPEN**	6.4
SWCG (Data Access TG)	Joint WGI-WG-IV-SWCG/5	SWCG/A50.04	Task Group on Improving User Data Access to Space Weather Data from Orbital Sensors to identify work priorities and report on achievements	5 TG meetings held. TG report proposes to close action with new action(s).	CGMS-51	**CLOSED**	2.4
CGMS Members	Joint WGI-WG-IV-SWCG/6	SWCG/A50.05	CGMS members are invited to support the WRC-23 preparatory process on agenda item 9.1 Topic A (space weather) through its national regulatory authorities, regional WRC-23 preparations or directly in the relevant ITU fora, as appropriate, i.e. identification of frequency bands requiring protection, with coordination with WMO-ET-SWx/WMO-ET-RFC	Proposed to keep action OPEN SWCG IS#2: Markus Dreis invited to SWCG IS#3 26 Jan 2023. o Action: Heikki (WMO) to send input from WMO-ET-SWx RF subgroup. SWCG IS#1: - WRC takes place 20 Nov-15 Dec. 2023. - Markus Dreis (EUMETSAT) to be invited to report latest developments and needs at SWCG IS#2, 30 November.	30 October 2023	**OPEN**	6.1
NOAA	WGIII/4.1	WGIII/A50.01	NOAA to review additional ground resources needed to track STEREO-A and PUNCH to provide additional coverage in the near-term in case of unavailability of SOHO data	Review COMpleted Proposed to close vs RA Workshop input	RA workshop 2023	**CLOSED**	6.1

SWCG actions							
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**	**HLPP ref**
				SWCG#2: NOAA input sent (again) 6-Dec - to be forwarded to WGIII) SWCG IS#1: NOAA working with NASA on response (target report at SWCG IS#2, 30 November)			
CGMSSEC	WGIII/4.2	WGIII/A50.03	To add characteristics/definitions of the new energy ranges related to the high energy particles in the Sensor Type table of the CGMS Baseline document.	CGMS Baseline input added. Proposed to close SWCG IS#2: Christian Naylor (NOAA) provided final input on 6 Dec. All SWCG to review for IS#3 SWCG IS#1: - E.Talaat inputs made to the March 2022 Risk Assessment (File on Is#1 MoM). Proposed to update Baseline using this input.	RA workshop 2023	**CLOSED**	6.1
GMS members (WGII and SWCG)	4.5	WGII+SWCG/ (P)A50.05	CGMS WGII and SWCG members are invited to nominate candidates for a subgroup within GSICS on Space Weather Cal/Val and Intercalibration, which will be focused on providing intercalibration for Space Weather. Please provide nominations to cgmssec@eumetsat.int	Discussion on membership / Action status to take place under SWCG agenda point 7. **2023 3 Feb:** CGMSSEC contacted M Goldberg for a status update.	Dec 2023	**OPEN**	

CGMS-51-CGMS-WP-14SWCG - Nominations and representatives at meetings (CGMS, ISWGs, VLAB - Co-chairs and rapporteurs) (Anne Taube)

It was noted that the SWCG required a co-rapporteur as the current rapporteur is currently leading 5 Task Groups in SWCG and WGI in addition to the extensive rapporteur tasks of SWCG and this will be raised in the Plenary Meeting.

9. Status report on CGMS future direction 2022+ project

CGMS-51-CGMS-WP-09SWCG - Status report on the CGMS future direction 2022+ project (Mikael Rattenborg / J-P Luntama)

This working paper gives an overview of the activities undertaken on the CGMS future direction 2022+ project since CGMS-50 plenary for consideration and feedback by the CGMS-51 working groups (WGs I-IV and the SWCG). The 2nd high-level meeting on 29 March 2023 endorsed the way forward proposed, noting the need for the identification of concrete implementation measures in the next year (up to CGMS-52) and a stronger link as concerns the potential interfaces.

The basis for discussion are the agreed seven strategic themes (and as illustrated by the presentation slides):

- Socio-economic benefits
- Research to operations
- Future observing (hybrid) space infrastructure
- Future information technologies
- Relationship with the private sector
- Climate and Earth system monitoring
- Space situational awareness

+ A topic for all: supporting developing countries.

ACTION: The CGMS working groups are requested to consider and identify the implications / impact / activities in each working group and to give feedback as necessary. This includes implementation measures and interface considerations.

It was agreed that SWCG can take full responsibility for the related space weather proposals under the SSA future direction input, noting that much of this is already in scope of current activities. The following specific additional items were noted:

- Produce a report of space weather observation requirements for improved STC services and space sustainability;
- Identification of synergies with other CGMS Themes.

10. Review and updating of the HLPP

CGMS-51-CGMS-WP-07SWCG - Status of implementation of CGMS High Level Priority Plan (2022-2026) (Mikael Rattenborg)

This working paper provides the status of implementation of CGMS High Level Priority Plan (2022-2026). It incorporates inputs from: - WG I, II, III and IV Chairs and rapporteurs - CGMS Space Weather Coordination Group - International Science Working Group chairs and rapporteurs - GSICS project - SCOPE-CM project - CEOS-CGMS Joint Working Group on Climate.

CGMS-51-CGMS-WP-08SWCG - Proposed update to the CGMS High-Level Priority Plan (HLPP) for the period 2020-2026 (Mikael Rattenborg)

SWCG provided inputs which will lead to further refinement of the HLPP to be presented at Plenary.

11. Future CGMS SWCG meetings

Decision on dates on SWCG activities in 2023-2024 (CGMS-51 to CGMS-52) (Anne Taube)

Dates were discussed and agreed for SWCG Intersessionals.

SWCG activity	Proposed dates
Intersessional #1	28 September 2023, 12 UTC
Intersessional #2	30 November 2023, 12 UTC
Intersessional #3	25 January 2024, 12 UTC
Intersessional #4	21 March 2024, 12 UTC
Intersessional #5	11 April 2024, 12 UTC

12. Any other business

None.

13. Conclusions, preparation of the SWCG report for plenary

The SWCG Chairs and Rapporteur thanked the SWCG members and external presenters for their active participation in the meeting and efforts throughout the year.

The summary list of actions is provided below.

Status of CGMS-50 SWCG actions following CGMS-51 plenary discussions

Status of CGMS-50 SWCG actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
SWCG (Anomaly TG)	Joint WGI - WG-IV-SWCG/3	SWCG/A49.05	Poll CGMS Members on reasons for sparse anomaly data supply to CGMS.	Proposed for closure. SWCG IS#2: Awaiting TG meeting in Jan 23. SWCG IS#1: No further inputs made at Plenary Propose to discuss / close at Anomaly TG meeting 18 February 2022: Poll issued -No responses received – invited until CGMS-50 Plenary 2021 20 Oct IS#9: Poll not yet performed.	Jan. 2023	**CLOSED**
CGMS Members	SWCG/6	SWCG/A50.01	Supply latency information to OSCAR DB with granularity of each relevant space weather sensor on their space missions.	Some latency info added, but further inputs still required by WMO - proposed to keep OPEN SWCG IS#2: Inputs needed before the CGMS Risk Assessment in February SWCG IS#1: CGMS Members to provide inputs on SWCG/A50.01 by IS#3 (26 January 2023)	Feb. 2024	**OPEN**
SWCG (Anomaly TG)	Joint WGI - WG-IV-SWCG/3	SWCG/A50.02	TG to Review Terms of Reference to: - Agree additional activities related to Best Practices on spacecraft operators usage of space weather data - Agree on updates to required anomaly input data content and formats - Recommend to CGMS-51 whether to continue TG activities based on progress made.	3 TG meetings held. Action proposed for closure (see Anomaly TG report).	CGMS-51	**CLOSED**

Status of CGMS-50 SWCG actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
SWCG (RO TG)	Joint WGI - WG-IV-SWCG/4	SWCG/A50.03	Establish requirements for and recommend an implementation of an optimised system for radio occultation observations for ionosphere monitoring	5 TG meetings taken place. Next steps identified in TG report	CGMS-52	**OPEN**
SWCG (Data Access TG)	Joint WGI - WG-IV-SWCG/5	SWCG/A50.04	Task Group on Improving User Data Access to Space Weather Data from Orbital Sensors to identify work priorities and report on achievements	5 TG meetings held. TG report proposes to close action with new action(s).	CGMS-51	**CLOSED**
CGMS Members	Joint WGI - WG-IV-SWCG/6	SWCG/A50.05	CGMS members are invited to support the WRC-23 preparatory process on agenda item 9.1 Topic A (space weather) through its national regulatory authorities, regional WRC-23 preparations or directly in the relevant ITU fora, as appropriate, i.e. identification of frequency bands requiring protection, with coordination with WMO-ET-SWx/WMO-ET-RFC	Proposed to keep action OPEN SWCG IS#2: Markus Dreis invited to SWCG IS#3 26 Jan 2023. o Action: Heikki (WMO) to send input from WMO-ET-SWx RF subgroup. SWCG IS#1: - WRC takes place 20 Nov-15 Dec. 2023. - Markus Dreis (EUMETSAT) to be invited to report latest developments and needs at SWCG IS#2, 30 November.	CGMS-51	**OPEN**

Status of CGMS-50 SWCG actions following CGMS-51 discussions						
Actionee	**AGN item**	**Action #**	**Description**	**Action feedback/closing document**	**Deadline**	**Status**
NOAA	WGIII/4.1	WGIII/A50.01	NOAA to review additional ground resources needed to track STEREO-A and PUNCH to provide additional coverage in the near-term in case of unavailability of SOHO data	Review Completed Proposed to close vs RA Workshop input SWCG#2: NOAA input sent (again) 6-Dec - to be forwarded to WGIII) SWCG IS#1: NOAA working with NASA on response (target report at SWCG IS#2, 30 November)	RA workshop 2023	**CLOSED**
CGMSSEC	WGIII/4.2	WGIII/A50.03	To add characteristics/definitions of the new energy ranges related to the high energy particles in the Sensor Type table of the CGMS Base line document.	CGMS Baseline input added. Proposed to close SWCG IS#2: Christian Naylor (NOAA) provided final input on 6 Dec. All SWCG to review for IS#3 SWCG IS#1: - E.Talaat inputs made to the March 2022 Risk Assessment (File on Is#1 MoM). Proposed to update Baseline using this input.	RA workshop 2023	**CLOSED**
GMS members (WGII and SWCG)	4.5	WGII+SWCG/ (P)A50.05	CGMS WGII and SWCG members are invited to nominate candidates for a subgroup within GSICS on Space Weather Cal/Val and Intercalibration, which will be focused on providing intercalibration for Space Weather. Please provide nominations to cgmssec@eumetsat.int	Discussion on membership / Action status to take place under SWCG agenda point 7. 2023 3 Feb: CGMSSEC contacted M Goldberg for a status update.	Dec 2022	**OPEN**

Summary of SWCG actions resulting from CGMS-51

CGMS-51 SWCG actions				
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/2	SWCG/A51.01	Expand extent of anomaly data feedback	CGMS-52
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/2	SWCG/A51.02	Review current usage of space weather data for spacecraft operations and goals for improvement.	CGMS-52
SWCG (Data Access TG)	Joint WGI-WG-IV-SWCG/4	SWCG/A51.03	Report Space Weather data gaps & discrepancies between providers and user surveys and OSCAR DB and related priorities for resolution.	CGMS-52
SWCG (Data Access TG)	Joint WGI-WG-IV-SWCG/4	SWCG/A51.04	Propose standardised Space Weather operational formats and CF convention metadata examples.	CGMS-52
SWCG (Data Access TG)	Joint WGI-WG-IV-SWCG/4	SWCG/A51.05	Implement improved data access through existing mechanism infrastructure	CGMS-52
SWCG (Data Access TG)	Joint WGI-WG-IV-SWCG/4	SWCG/A51.06	Review future landscape of operational data delivery mechanisms and coordination taking into account WIS 2.0 and other cloud-based data access mechanisms.	CGMS-52
NOAA	SWCG/2	SWCG/A51.07	Report on the STEREO-A coverage implementation	RA Workshop 2024
NOAA	SWCG/4	SWCG/A51.08	Provide NOAA aviation and satellite industry testbed reports to SWCG when available	CGMS-52
SWCG	SWCG/5	SWCG/A51.09	Members to document any plans for NRT, operational thermospheric density measurements with consideration of observation requirements from atmospheric density models.	CGMS-52
SWCG/data access + RO TGs	SWCG/5	SWCG/A51.10	Consider ICAO PECASUS requirements for improved LEO RO observation, energetic (tens of Kev) electron precipitation flux from LEO orbit , SEP flux spectra (100s MeV to GeV)	CGMS-52
SWCG	SWCG/9	SWCG/A51.11	Produce a report of space weather observation requirements for improved STC services and space sustainability	CGMS-52

LIST OF PARTICIPANTS

CGMS-51 –SWCG List of Participants		
Organisation	Lastname	Organisation
Weiguo	Zong	CMA/NSMC
Min	Guan	CMA/NSMC
Wei	Zheng	CMA/NSMC
Shuze	Jia	CMA/NSMC
Na	Xu	CMA/NSMC
Alexi	Glover	ESA
Louise	Fischer	ESA
Juha-Pekka	Luntama	ESA
Mikael	Rattenborg	EUMETSAT/CGMS Sec
Anne	Taube	EUMETSAT/CGMS Sec
Andrew	Monham	EUMETSAT
Karolina	Nikolova	EUMETSAT
Simon	Elliott	EUMETSAT
Jenny	Rourke	EUMETSAT
Kirsti	Kauristie	FMI
Puviarasan	Narayanasamy	IMD
Satya	Prakash	IMD
Mohammad	Hasan	ISRO
Shyama	Narendranath	ISRO
Santosh	Vadawale	ISRO/PRL
Jayaprakash V	Thomas	ISRO HQ
Shyama	Narendranath	ISRO
Santosh	Vadawale	ISRO
Iku	Shinohara	JAXA
Osamu	Ochiai	JAXA
Hiroshi	Suto	JAXA
Harada	Reiko	JMA
Kazutaka	Yamada	JMA
Kotaro	Bessho	JMA
Miki	Abe	JMA
Takuya	Sakashita	JMA
Ibuki	Watanabe	JMA
Yasuhiko	Sumida	JMA
Dohyeong	Kim	KMA
Jaegwan	Kim	KMA
Eunha	Sohn	KMA
Edmund	Henley	MET OFFICE
James	Spann	NASA
Tsutomu	Nagatsuma	NICT

CGMS-51 –SWCG List of Participants		
Organisation	**Lastname**	**Organisation**
Mamoru	Ishii	NICT
Josh	Jankot	NOAA
Melissa	Johnson	NOAA
Thomas	Renkevens	NOAA
Beau	Backus	NOAA/JHU APL supporting
Elsayed	Talaat	NOAA/NESDIS/SWO
Brent	Gordon	NOAA/Space Weather Prediction Center
Kirill	Kholodkov	ROSHYDROMET (IAG)
Alexander	Uspensky	ROSHYDROMET
Bernadette	Connell	VLab/CIRA/CSU & WMO VLab
Suzy	Bingham	WMO
Heikki	Pohjola	WMO
Natalia	Donoho	WMO
Zoya	Andreeva	WMO
Roger	Saunders	WMO

CGMS

(WGI-WGIV-SWCG)

Joint working group WGI-WGIV-SWCG

JOINT WGI-WGIV-SWCG REPORT

Co-chairs: Tsutomu Nagatsuma, NICT/Dohyeong Kim, KMA
Rapporteur: Karolina Nikolova, Andrew Monham, EUMETSAT

1. Introduction, objectives

The meeting co-chairs, Dr. Tsutomu Nagatsuma and Dr. Dohyeong Kim supported by Rapporteurs Mr. Andrew Monham and Karolina Nikolova, welcomed the participants, consisting of representatives from CMA, ESA, EUMETSAT, IMD, JMA, JAXA, KMA, NASA, NCMRWF, NICT, NOAA, ROSHYDROMET VLab, WMO, Met Office UK (see Annex 1 for full list of participants).

The draft agenda proposed by the CGMS Secretariat prior to the meeting was reviewed and adopted.

Andrew Monham presented the objectives of the meeting.

2. Benefits of space weather data usage for satellite operators and role of anomaly report database

CGMS-51-SWCG-WP-05 - Report on progress of the Space Weather Spacecraft Anomaly Database Task Group. (Andrew Monham)

The Space Weather Spacecraft Anomaly Database Task Group objective is to promote the collection of spacecraft anomaly data as the data source for space weather actors to analyse the impact of space weather on satellite systems, in order to improve:

- spacecraft design robustness;
- support the spacecraft operations community with space weather warnings and improved post-event anomaly analysis;
- tools modelling space weather effects.

The Task Group has been active in promoting the sharing of anomaly data in various fora involving the spacecraft operations community and has established strong links to similar activities on-going in NASA. Outreach to commercial operators is also on-going.

Strong backing for this activity is received from representatives of UN COPUOS with the Long Term Sustainability Guidelines specifically encouraging support to this CGMS activity.

The data provision template and guidelines have been improved to support more automated data collection and extraction and anomaly data is currently being received from CGMS members with a target for completion of the compilation before CGMS-51 Plenary.

The Task Group has also initiated steps to identify best practices in usage of space weather data by spacecraft operators and their goals for improvement.

Finally, the Task Group recommends to continue activities based on encouraging progress made since CGMS-50.

The Joint meeting agreed that TG activities should be continued.

NOAA made the following statement:

NOAA is ensuring that applicable U.S. law, regulations, and government-wide policies are adhered to before sharing potential satellite-sensitive information with an external community. Specifically, NOAA is required to comply with the DOC/NOAA Controlled Unclassified Information (CUI) policy when sharing information that includes specific satellite or payload fault details to international members, some of whom NOAA has no affiliation with. NOAA can not contribute to this effort until internal procedures are fully developed that ensure that we comply with stipulated rules as it pertains to handling and distributing CUI information.

CGMS-51-SWCG-WP-09 - Revised Anomaly Data Collection Template and Guidelines (Andrew Monham)

An overview of the revised spacecraft anomaly reporting template is provided to complement the response to the Action SWCG/A50.02 "Agree on updates to required anomaly input data content and formats" to help guide CGMS members in their support to the anomaly collection process.

The presentation also provides further information on the potential for EDAC scrubbing events collection with examples from Metop in EUMETSAT.

CGMS-51-SWCG-WP-06 - CGMS agency spacecraft space weather anomaly reports compilation (Andrew Monham)

Andrew Monham presented highlights from the anomaly reports compilation. He presented the new template used for inputs to the anomaly database. Examples of Error Detection and Correction (EDAC) Scrubbing Events data were provided, with the note that these are very useful for correlation purposes.

Data collection process is ongoing using new template and will be refined based on user feedback.

Thomas Renkevens asked if the inputs provided from Operator be published publicly. Andrew Monham explained the Operator inputs will not be published directly, but the purpose is to publish compilation of the input data. Andrew Monham highlighted the importance of clarifying which information is confidential, in order to ensure this is taken into account in the publishing of data. Andrew Monham and Elsayed Talaat noted that feedback on the process of publishing and collection is welcome, in order to accommodate any concerns.

Tsutomu Nagatsuma that anomaly data should be analysed statistically by the different organisations, and suggested to consider this type of data collection.

CGMS-51-ESA-WP-05 - Space Weather for Spacecraft Operators: End User Interaction within ESA's Space Safety Programme (Alexi Glover)

This presentation focused on the type of end user interaction within ESA's Space Safety Programme. There are 29 user driven services in demonstration & testing available via the Space Weather SWE Portal, with over 3000 registered users and over 50 institutes and organisations involved in service development and provision. There is ongoing engagement with users on several levels, including online service provision supported by SWE helpdesk, second line support from Expert Groups, training course and webinars. A major release of the SWE Service Portal is in preparation for July 2023.

CGMS-51 actions - J-WGI-WGIV-SWCG				
Actionee	**AGN item**	**Action**	**Description**	**Deadline**
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/2	SWCG/A51.01	Expand extent of anomaly data feedback	CGMS-52
SWCG (Anomaly TG)	Joint WGI-WG-IV-SWCG/2	SWCG/A51.02	Review current usage of space weather data for spacecraft operations and goals for improvement.	CGMS-52

3. Requirements and feasibility of low latency RO data dissemination for space weather data users through direct broadcast

CGMS-51-EUMETSAT-WP-05 - Requirements and feasibility of low latency RO data dissemination for space weather data users through direct broadcast (Andrew Monham)

The Task Group on Ionospheric Radio Occultation System Optimisation was formed at CGMS50 to:

- Address the full scope of HLPP (6.4);
- In coordination with IROWG establish requirements for and recommend an implementation of an optimised system for radio occultation observations for ionosphere monitoring.

All documentation is available on the Google Drive along with the Data Access Task Group information.

The Task Group benefits from expert ionospheric RO experts along with representatives of the CGMS RO data providers and 5 meetings were actively supported.

Among the aspects identified within the scope of the group are data latency, number of ionospheric measurement counts for the whole system, geographic and local-time coverage, observing System Experiments to address sensitivity of operational applications to changes in latency / counts in order to establish requirements, potential improvements in CGMS Member RO measurement capabilities and / or data access in support of the requirements, and access to commercial RO in support of the requirements.

Significant progress has been made in developing the capability table of ionospheric RO missions, reviewing methods to geolocate plasma bubble scintillation, initiating Observing System Simulation Experiments (OSSE) such that it can be expected significant further progress to meet the high level aim of the group can be made prior to CGMS-52.

Next steps before CGMS-52 will include finalisation of the RO capability table, including commercial providers and resolving discrepancies / gaps found with respect to the OSCAR DB comparison, continuing OSSEs to determine the number of required occultation's and to sensitivity of operational applications to changes in latency / counts and optimal distribution of orbital planes and measurements along those planes, further analysing the geolocation of scintillations taking advantage of above mentioned OSSEs and further studies, and consideration of readiness to propose potential improvements in CGMS Member RO measurement capabilities and / or data access in support of the requirements.

SWCG/A50.03 - remains open, with the note that significant progress has been made.

4. Space Weather Data Access (outcome of User Survey)

CGMS-51-SWCG-WP-07 - Report from the CGMS SWCG Task Group on Improving User Data Access to Space Weather Data from Orbital Sensors (Andrew Monham)

The Task Group on Improving User Data Access to Space Weather Data from Orbital Sensors helps glue together the feedback obtained from the various outreach activities of SWCG:

- Data Provider and User Surveys conducted 2017-2019;
- CGMS-User meetings held in space weather workshops in Europe and USA identifies the priorities for improving the provision of CGMS Agency space weather sensor data to operational users.

The Task Group has been very active with wide participation of all representing relevant roles of data providers and users, holding 5 meetings and a number of outreach events to external parties in workshops in Europe and the USA. Furthermore the group is cooperating closely with the recently formed WMO Expert Team on Space Weather.

Based on identification of priorities, the group has made significant strides in:

- updating the baseline of data provision to user needs and gap identification and correlating this with the OSCAR DB;
- working on improving data access reliability through leveraging of existing cooperation agreements for meteorological data exchange;
- Initiating prototype format standardisation and metadata definition activities in coordination with the related WMO activity.

Work is set to continue to complete these initial tasks before CGMS-52.

The joint meeting agreed that SWCG/A50.05 on forming the Task Group was closed.

In relation to ESA's SWx missions and related pilots, a discussion was held on the possibility of using WIS 2.0. It was confirmed that the use of WIS 2.0 will be explored and experience shared.

CGMS-51 actions - J-WGI-WGIV-SWCG				
Actionee	**AGN item**	**Action**	**Description**	**Deadline**
SWCG (Data Access TG)	Joint WGI-WG-IV-SWCG/4	SWCG/A51.03	Report Space Weather data gaps & discrepancies between providers and user surveys and OSCAR DB and related priorities for resolution.	CGMS-52
SWCG (Data Access TG)	Joint WGI-WG-IV-SWCG/4	SWCG/A51.04	Propose standardised Space Weather operational formats and CF convention metadata examples.	CGMS-52
SWCG (Data Access TG)	Joint WGI-WG-IV-	SWCG/A51.05	Implement improved data access through existing mechanism infrastructure	CGMS-52

CGMS-51 actions - J-WGI-WGIV-SWCG				
Actionee	**AGN item**	**Action**	**Description**	**Deadline**
	SWCG/4			
SWCG (Data Access TG)	Joint WGI-WG-IV-SWCG/4	SWCG/A51.06	Review future landscape of operational data delivery mechanisms and coordination taking into account WIS 2.0 and other cloud-based data access mechanisms.	CGMS-52

5. Frequency-related topics in support to space weather

CGMS-51-EUMETSAT-WP-06 - SFGC Frequency-related topics in support to space weather (M.Dreis)

The international regulatory framework, the ITU Radio Regulations (RR), so far do not contain any recognition or provisions related to space weather observations using radio frequencies.

The World Radiocommunications Conference 2023 (WRC-23) will now deal with space weather frequency related issues under agenda item 9.1 Topic A.

This agenda item is actually twofold with preparatory studies, with no regulatory actions at WRC-23, followed by a WRC-27 agenda item with the aim to actually establish regulatory conditions in the Radio Regulations in support of space weather observations.

The ultimate goal under these agenda items at two consecutive WRCs is to:

- define space weather in the context of ITU Radio Regulations;
- determine the appropriate “radio communication service” under which space weather should be considered (Meteorological Aids Service or Radio Astronomy Service);
- identify space weather sensors/stations and frequency bands, that need to be protected by appropriate regulations;
- conduct necessary sharing studies with incumbent services for active and receive only usage of space weather sensors/stations, as appropriate;
- finally establish at WRC-27 appropriate recognition of space weather in the ITU Radio Regulations through regulatory provisions to protect space weather observations while not placing undue constraints on incumbent services.

Resolution 657 (Rev. WRC-19) determines what has to be studied in preparation for WRC-23 under agenda item 9.1 Topic A. Actually, there is a different interpretation regarding the possibility to introduce some regulatory elements into the Radio Regulations already at WRC-23. While Europe and some countries around the world support this view, others are not supporting such action already at WRC-23.

This document provides an overview of the status of discussions in the framework of the WRC-23 preparations after the two weeks of ITU-R Conference Preparatory Meeting (CPM), 26 March – 6 April 2023, where the so-called CPM-Report was finalised, summarising the results of all preparatory studies on WRC-23 agenda items.

Elsayed Talaat noted that the highest priority spectrum protection is the same as the one for RO spectrum, so it is important that these frequencies are protected. Markus confirmed the RO spectrum is already very well-protected through the frequency allocation for Radio Navigation Satellite Service (RNSS) systems.

Beau Backus asked if there is a request to expand beyond these well-protected frequencies. It would appear not at the moment.

Edmund Healy enquired on whether ground-based radio telescopes are considered and if Met Aid space weather be higher priority? There is a concern that ground-based radio telescopes (future use for operational interplanetary scintillation) may suffer with lower priority.

Jussi Luntama noted that there will be radio beacons on satellites, so that is a potential future application, which needs to be considered in future frequency protection plans. Jussi also noted that ground-based measurements F10.7 and F30 (1-3 GHz frequencies) are critical for atmospheric density models and ionospheric tomography. It is important that CGMS supports protection of these frequencies and works with WMO-ET-SWx to achieve this.

Elsayed Talaat said that there is a list of prioritised frequencies used for operations, and invited members to work with their national authorities to work on a narrower list of frequencies for protection. Markus agreed and welcomed CGMS agencies to highlight important frequencies for protection ahead of the upcoming WRC-23. This is already covered by an open action and this should form part of the standard SWCG agenda. It was noted that is it too late to make a coordinated input to WRC-23 – inputs should be made at national level.

Beau asked if space weather has the need of frequency protection in the passive bands. Markus responded that most of the space weather sensors observe at lower frequencies and if there would be an overlap, those observations would already be protected by existing regulations and allocations to the Earth-Exploration Satellite Service (passive).

6. Review of actions

The action items were reviewed and updated. See further below for the status and summary list of actions.

7. AOB

None.

8. Next steps, conclusions and reporting to plenary

The Chair noted the satisfactory progress on the issues covered and that continuation of the activities is foreseen through the Task Groups and recorded actions.

Reporting to plenary will be performed as part of the Space Weather Coordination Group report.

The associated and summary list of actions is included in the SWCG list of actions.

LIST OF PARTICIPANTS

CGMS-51 – J-WGI-WGIV-SWCG List of Participants		
Organisation	**Lastname**	**Organisation**
Fang	Meng	CMA/NSMC
Peng	Zhang	CMA/NSMC
ZHE	Xu	CMA/NSMC
Alexi	Glover	ESA
Louise	Fischer	ESA
Mikael	Rattenborg	EUMETSAT/CGMS Sec
Anne	Taube	EUMETSAT/CGMS Sec
Andrew	Monham	EUMETSAT
Edmund	Henley	EUMETSAT (MET OFFICE UK)
Jenny	Rourke	EUMETSAT
Karolina	Nikolova	EUMETSAT
Markus	Dreis	EUMETSAT
Sean	Burns	EUMETSAT
Simon	Elliott	EUMETSAT
Puviarasan	Narayanasamy	IMD
Osamu	Ochiai	JAXA
Ibuki	Watanabe	JMA
Mayuko	Sakurai	JMA
Mayuko	Kasai	JMA
Harada	Reiko	JMA
Kazutaka	Yamada	JMA
Kotaro	Bessho	JMA
Miki	Abe	JMA
Kosuke	Inoue	JMA
Takuya	Sakashita	JMA
Akiyoshi	Andou	JMA
Arata	Okuyama	JMA
Azusa	Yota	JMA
Misaki	Eiki	JMA
Taro	Handa	JMA
Yasuhiko	Sumida	JMA
Yasutaka	Hokase	JMA
Dohyeong	Kim	KMA
Sachidananda	Babu	NASA
Srinivasa Prasad	Vijapurapu	NCMRWF
Tsutomu	Nagatsuma	NICT
Thomas	Renkevens	NOAA
Josh	Jankot	NOAA
Beau	Backus	NOAA/JHU APL supporting
Elsayed	Talaat	NOAA/NESDIS/SWO

CGMS-51 – J-WGI-WGIV-SWCG List of Participants		
Organisation	**Lastname**	**Organisation**
Olga	Ryzhkova	ROSHYDROMET
Bernadette	Connell	VLab/CIRA/CSU & WMO VLab
Heikki	Pohjola	WMO
Natalia	Donoho	WMO
Zoya	Andreeva	WMO

GENERAL CGMS INFORMATION

CGMS Agenda and Working Papers

The agenda and Working Papers (WPs) are available as follows:

→ **CGMS-51 Working Groups:** https://www.cgms-info.org/agendas/agendas/CGMS-51

→ **CGMS-51 Plenary Session:** https://www.cgms-info.org/agendas/agendas/CGMS-51-Plenary

List of actions and recommendations

The working group actions and recommendations are maintained on dedicated confluence pages currently accessible to the five CGMS working group co-chairs and rapporteurs. The plenary actions and recommendations are maintained by the CGMS Secretariat.

CGMS members, observers and relevant actionees are requested to provide feedback as necessary to the working groups (L-WGI [at] LISTSERV.EUMETSAT.INT; L-WGII [at] LISTSERV.EUMETSAT.INT; L-WGIII [at] LISTSERV.EUMETSAT.INT; LWGIV[at] LISTSERV.EUMETSAT.INT; L-SWCG [at] LISTSERV.EUMETSAT.INT) and the CGMS Secretariat (CGMSSec [at] eumetsat.int), and when preparing Working Papers to refer to relevant actions and recommendations if needed.

CGMS List Servers

There are currently eight CGMS list servers:

- Plenary;
- WGI, WII, WGIII, WGIV, and SWCG; and
- WGI Low Latency Data Access (LLDA) Task Group, and Task Group on data collection services (DCS).

Information on points of contact and list servers is available upon request from the CGMS Secretariat at CGMSSEC [at] eumetsat.int.

CGMS Charter, members and observers

Other information such as the CGMS Charter and the current list of members and observers are available at https://cgms-info.org/about-cgms/ .

General enquiries

Please contact the CGMS Secretariat at CGMSSEC [at] eumetsat.int in case of any enquiries related to CGMS.

CGMS

Report of the 51st Meeting of CGMS

Annexes

ANNEX I: ABBREVIATIONS

Abbreviation	Meaning
ACE	Advanced Composition Explorer
AMV	Atmospheric Motion Vector
AOD	Aerosol Optical Depth
AWS	Automatic Weather Station
CAMS	Copernicus Atmosphere Monitoring Service
CCI	Convective Cloud Information
CCOR	Compact Coronagraph
CDR	Climate Data Records
CFOSAT	Chinese-French Oceanography Satellite
CRC	China-Russia Consortium
CSR	Clear Sky Radiance
D3S	Distributed Space Weather Sensor System
DCP	data collection platform
DCS	Data Collection Service
DRS	Direct Relay Satellite
DRT	Data Relay Transponder
DWL	Doppler Wind Lidar
E-DCP	Enhanced DCP
EARS	EUMETSAT Advanced Retransmission Service
ECV	essential climate variables
EO	Earth Observation
EORC	JAXA Earth Observing Research CenteR
EOSC	Earth-observing satellite constellation
EOTEC DevNet	Earth Observation Training, Education, and Capacity Development Network
ERSA	ESA Radiation Sensor Array
ESA PB-EO	ESA Programme Board for Earth Observation
ESC	Expert Service Centres
ESD	NASA's Earth Science Division
ET-SWx	Expert Team on Space Weather
EUVST	Extreme Ultraviolet HighThroughput Spectroscopic Telescope
EZIE	Electrojet Zeeman Imaging Explorer
FCDR	fundamental climate data record
FDR	Fundamental Data Records
FOC	Full Operational Capability
FRP	Fire Radiative Power
FY	FengYun
FY_ESC	Emergency Support Mechanism of FY Satellite
GAW	WMO Global Atmospheric Watch
GBON	Global Basic Observation Network
GEO-XO	Geostationary and Extended Orbits
GeoHSS	Hyper Spectral Sounding instrument on a geostationary satellite
GNC-A	GEONETCast Americas broadcast
GNSS	Global Navigation Satellite System
GOES	Geostationary Operational Environmental Satellites
GOLD	Global-scale Observations of the Limb and Disk
GSICS	Global Space-based Inter-Calibration System

Abbreviation	Meaning
GST	2023 Global Stocktake
GTS	Global Telecommunication system
HAPS	High Altitude Platform Systems
HERMES	Heliophysics Environmental and Radiation Measurement Experiment Suite
HSS	Hyperspectral IR Sounder
ICON	Ionospheric and Connection Explorer
IDA	Internal Dosimeter Array
IDCS	international DCS channels
INFCOM	WMO Commission for Observation, Infrastructure and Information Systems
INPE	Brazilian Ministry of Science, Technology, and Innovations
IOC	Initial Operational Capability
IODC	Indian Ocean Data Coverage
IPWV	Integrated Precipitable Water Vapour
IS40e	Intelsat Commercial Satcom mission
ISCCP-NG	Next Generation of the International Satellite Cloud Climatology Project
ISES	International Space Environment Service
KSEM	Korean Space wEather Monitor
MAP	Multi-mission Aerosol product
MMDRPS	Multi-Mission Meteorological Data Receiving and Processing System
MODIS	Moderate Resolution Imaging Radiometer Suite
MOSDAC	Meteorological and Oceanographic Satellite Data Archival Center
MTG-S	Meteosat Third Generation Sounding
NCMRWF	National Centre for Medium Range Weather Forecast (India)
NGRM	Next Generation Radiation Monitor
NKN	National Knowledge Network
NREN	National Research and Education Network
NSF	National Science Foundation (USA)
NWP	Numerical weather prediction
OGC	Open Geospatial Consortium
OMI	Ozone Monitoring Instrument
OSOS	First International Operational Satellite Oceanography Symposium
OSSEs	Observing System Simulation Experiment
OSW TG	Ocean Surface Wind Task Group
OVW	ocean vector winds
PMAp	Polar Multi-mission Aerosol product
PSTEP	Project for SolarTerrestrial Environment Prediction
RDCA	rapidly developing cumulus areas
RO	radio occultation
ROSES	Research Opportunities in Space and Earth Science
RRR	Rolling Requirements Review
RTSWnet	Real-Time Solar Wind network
S2P	Space Safety Programme
SAN	SWFO Antenna Network
SAS & R	satellite aided search and rescue
SBIR	Small Business Innovation Research
SCO	Space Climate Observatory
SDR	sensor data records

Abbreviation	Meaning
SETT	Socio Economic Tiger Team
SOHO	Solar and Heliospheric Observatory
SOSMAG	Service Oriented Spacecraft Magnetometer
SSA	single scattering albedo
SST	Sea Surface Temperature
STEREO	Solar Terrestrial Relations Observatory
SWCEM	WMO Space-based Weather and Climate Extremes Monitoring
SWFO	Space Weather Follow-On
SWO	Space Weather Observations
SWORM	the Space Weather Operations, Research and Mitigation team
SWOT	Strengths, Weaknesses, Opportunities, and Threats
SWxSA	Space Weather Science Application
TANSO-FTS	Thermal And Near-infrared Sensor for carbon Observation Fourier-Transform Spectrometer
TEMPO	Tropospheric Emissions: Monitoring of Pollution
ToR	Terms of Reference
VLab	WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology
VLMG	VLab Management Group
WIS	WMO's Information System
WSI	WIGOS Station Identifiers

ANNEX II: PHOTOGRAPHS FROM THE PLENARY SESSION …


CGMS-51 Plenary Session
26 - 28 June 2023, Tokyo, Japan
CGMS
JAXA
Successful launch of
MTG-I1 on 13 Dec
2022, commissioning
ongoing


CGMS-51 Plenary Session


EUMETSAT
ISRO


CGMS-51 Plenary Session

CGMS

Report edited on behalf of CGMS by:

CGMS Secretariat, EUMETSAT

Eumetsat-Allee 1
D-64295 Darmstadt Germany

www.cgms-info.org
CGMS MR 51