CGMS-52-CGMS-WP-07
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Prepared by
CGMSSEC
Agenda Item: Plenary
(Information docs)

Provided for
information to Plenary

Status of implementation of CGMS High Level Priority Plan (2023-2027)

This working paper provides the status of implementation of CGMS High Level Priority Plan (2023-2027). It incorporates inputs from:

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

The colour coding in the table corresponds to the following:

Green: Priority is reflected in ongoing CGMS actions
Yellow: Actions have been defined associated to the priority, but progress is limited
Red: No actions associated with the priority can be identified or major obstacles is hindering progress

Action/Recommendation proposed:

This is an information document, supporting the annual process for revision of the HLPP

Plenary is invited to note the status of implementation of the HLPP 2023-2027.

This document presents the status of implementation of the CGMS High-Level Priority Plan (2022-2026), as agreed by CGMS at its 50th Plenary Session 26-28 June 2023 at JMA Headquarter, Tokyo, Japan. The document was submitted to review on the occasion of the CGMS-52 working group meetings 22-26 April 2024 at EUMETSAT, Darmstadt, Germany.

Inputs have also been provided by International Science Working Groups (through WG-II) and the joint CEOS-CGMS Working Group on Climate.

The table present the targets according to the logic of the CGMS end-to-end systems. A colour coding indicates the overall progress of achievement of the target:

ACHIEVED	Target has been achieved, will be proposed for removal from HLPP
	Priority is reflected in ongoing CGMS actions
	Actions have been defined associated to the priority, but progress is limited
	No actions associated with the priority can be identified or major obstacles is hindering progress

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1	**Operational Continuity and Contingency Planning**	**WG-III**		
1.1	Mitigate the impact of identified degradation or loss of capabilities of the CGMS baseline and ensure appropriate contingency measures are in place	WG-III	WG-III at its Risk Assessment Workshop in February identified mitigating actions to address loss of CGMS baseline capabilities. The outcome of the Risk Assessment was presented to all CGMS WGs to consider opportunities to mitigate identified risks. (Associated actions are recorded).	

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.1.1	Ensure continuity of passive microwave imager measurements		CGMS recognizes the need for a long-term plan for ~6 GHz frequency microwave imaging in at least one LEO orbit for all weather sea surface temperatures. Recommended mitigating actions included ensuring data availability from HY-2B, continue to work towards having 6 GHz data from two orbits (consistent with section 1.2.2), and NOAA to provide an update on SSMI status and possible follow-on. Europe to confirm plans for the Copernicus CIMR (Copernicus Imaging Microwave Radiometer) mission. It will be investigated by IPWG whether the current and planned µwave constellation provides adequate support for precipitation measurements, as these measurements depend mainly on frequencies around 90 GHz. As of 2024 there is low risk of not meeting the CGMS Baseline commitment; however, sensor performance requirements for different environmental parameters vary; ~6 GHz frequency microwave imaging critical for all weather SSTs, and >90 GHz frequency critical for precipitation.	

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			CIMR Mission confirmed by ESA at RA WS 2024, subject to EU Funding Gate Milestone in June 2024.	
1.1.2	Ensure continuity of Precipitation Radar measurements;		2024 Risk assessment: Low risk of not meeting the CGMS Baseline commitment. FY-3I now provides continuity beyond FY-3G. After orbit boost GPM-Core Observatory EOL is now early 2030s. NASA and JAXA action to confirm plans beyond the GPM Core. Plans for PMM confirmed at RA WAS Feb 2024 **WG-III recommends that the target be considered completed**	**Achieved**

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.1.3	Ensure continuity of Scatterometer measurements		2023 Risk Assessment: Low risk of not meeting the CGMS Baseline commitment. FY-3J now provides coverage beyond FY-3E in the early morning orbit. Oceansat-3A confirmed at RA WS 2024 ISRO to confirm plans beyond OceanSat-3A.	

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.1.4	Ensure continuity of Radio Occultation Measurements with required quantity, geographical coverage and temporal sampling for numerical weather prediction and for ionospheric monitoring		2023 risk assessment: The CGMS Baseline commitment (14600 occultations per day) will not be met even with Metop-SG A1 and B1 (2025-26), and there is also 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 (commitment for number of occultations can be met, but not the geographic distribution or performance to meet NWP requirements). Commercial operators offer some risk mitigation (assuming compliance with national and international mandates and policies). An HLPP objective 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. Action on IROWG to review # of occultations provided by the planned missions in the CGMS baseline.	

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Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.1.5	Ensure continuity of Coronagraph Plasma Analyser and Magnetometer observations from L-1 through exploitation of scientific space weather missions for operational gap filling		Increasing risk of a gap in the early part of the decade and long term continuity at L1. Increasing risk of a gap until GOES-U and SWFO-L1 are launched as SOHO operating well past design life, but additional ground resources used to track STEREO-A may mitigate that risk in the event of SOHO loss before 2024. GOES-U launch will take place June 2024. Jan-23 to June 24 STEREO will provide a SOHO/LASCO equivalent view. Wallops and FBK large antennas have been prepared for NRT data and will be activated in case of SOHO failure. Additional resiliency can be provided by PUNCH, if needed as a gap filler. **SWCG and WG-III recommends that this target should be considered achieved**	Achieved

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.2	Advance the response to the WIGOS 2040 vision for space, by the implementation of new capabilities beyond the CGMS baseline	WG-III	CGMS reviews its response to the WIGOS vision annually, based on the WMO Gap Analysis. This review is conducted in the CGMS Risk Assessment Workshop and by WG-III.	

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.2.1	Work towards establishing optimum constellations for new observations introduced in the CGMS baseline: - Short Wave IR Spectrometers for monitoring of Greenhouse Gases (CO2 and CH4); - Multi-viewing, multi-channel, multi- polarisation imaging for aerosols;		- CGMS contribution to SWIR spectrometer constellation for emission monitoring is being coordinated by the JWGClimate and its GHG Task Team. - The capabilities of the CGMS baseline for aerosol measurements has been assessed and added to the baseline document. Further concrete actions to be discussed with WG-II. - The capabilities of the CGMS baseline for monitoring of minor trace gases have been assessed and added to the baseline document.	

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	- UV limb sounding spectrometry for profiles of Ozone and trace gases;		Further concrete actions to be discussed with WG-II.	
1.2.2	Advance the new generation of GEO satellites, including advanced imaging, lightning mapping and hyperspectral IR sounding for the whole geostationary ring;		It is now confirmed that both GEO-XO and Himawari-10 will be manifesting IR sounders Action on ISRO to confirm HSIR plans for INSAT	
1.2.3	Work towards operational hourly daytime UV/VIS mapping of air quality from geostationary orbit;		Sentinel-4 planned for launch in 2025. TEMPO has been launched and ACX is now planned for GEO-XO, with an instrument specification very similar to TEMPO. To be addressed with WG-II.	

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.2.4	Work towards ensuring optimised *Hyperspectral* 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;	WG-III, support from WG-II and ITWG	Analysis of the current plans and gaps required. Propose action on WG-II and ITWG Presentation by EUMETSAT at CGMS-52 WG-II, proposing a set of questions to be addressed by ITWG	
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 plans exist to provide additional scatterometer orbits. **Propose to remove from HLPP**	

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.2.6	Work towards ensuring low frequency microwave imagery for all-weather SST and ice monitoring from at least 2 sun-synchronous orbits		Action on ESA to confirm CIMR mission under Copernicus (EU Funding Gate Milestone in June 2024)	

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1.2.7	Establish observational requirements for microwave observations (sounder and imager) for NWP and precipitation and perform gap analysis against CGMS baseline. For precipitation, develop a benchmark to conduct comprehensive assessments of current and future scenarios for the CGMS baseline;	WG-III,-II, IPWG, ITWG. IESWG	**IPWG:** The quantitative precipitation community currently lacks a methodology to quantify the impact of a change to the satellite observing system (whether it be the current CGMS baseline, or some expansion of this in the future) upon the resultant global precipitation products. While the NWP community has established OSSE methodologies for quantifying the net +/- impact upon various forecast metrics, resulting from a loss of a satellite system or impacts expected from a new system, the precipitation community has no equivalent method to assess how satellites with varying quality and resampling rates would affect the overall accuracy of weather or climate products. Several IPWG members have started to outline the steps needed to formalize such OSSE-like capability for global precipitation products. NASA and the US Dept. of Energy have proposed a simulation experiment to DOE that if funded, would create a prototype of the model output needed to support the satellite simulator and retrieval	

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			package. However, AI tools to perform fast radiative transfer simulations as well as generalized retrievals that use these simulations to train algorithms still need to be developed and require support from CGMS members. More importantly, it would be useful to assess which CGMS agencies would be interested in such a tool, as their application would be of the order of complexity of running OSSEs – which are neither free nor trivial to implement. **ITWG:** The observational requirements for microwave observations from the ITWG perspective have been outlined in a document provided as input to the CGMS Future Directions initiative, as requested by Simon Elliot. There has been a lot of activity in this area within ITWG, and the document summarises a wide range of OSEs and simulation studies that establish the requirements for a constellation of MW sounders. It highlights the benefit of complementary orbits with different overpass times and the continued significant	

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			benefit expected in NWP from further MW sounders beyond the 3-orbit baseline.	
1.2.8	Work towards increasing geographical resolution and coverage for altimetry measurements, including very high latitudes;		Altimetry coverage for arctic sea-ice at very high latitudes is currently provided by R&D missions (CRYOSAT-2 and ICESAT) for which continuity is not currently assured. Action on ESA to confirm plans for the operational Copernicus mission CRISTAL (EU Funding Gate Milestone in June 2024).	

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1.2.9	Advance the atmospheric Radio Occultation constellation, with the long-term goal of providing 20000 occultations per day on a sustained basis	WG-III,-II, IROWG	**IROWG** recommends targeting 20,000 globally distributed observations per day with uniform spatial and local time coverage, noting that both the equatorial and polar components of the COSMIC-2 mission are required for operational NWP. Recent studies show that substantial increases in NWP accuracy and climate monitoring utility are obtained for increases in the number of RO profiles to at least 20,000/day (corresponding to around 4 M bending angles per day), and beyond, not approaching saturation at 20,000 per day. The status remains unchanged: the target number of occultations will not be met with existing operational missions or those in the implementation stage. Current estimates for operational missions, including the COSMIC-2 equatorial mission, are for approximately 12,000 occultation profiles per day starting in 2022 with the launch of EPS-SG. However, only 5,500 are from satellites providing global coverage (EPS, EPS-SG, Feng-Yun and JASON-CS/Sentinel-6). The COSMIC-2 mission profiles are all	

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			below about 40 degrees latitude. Source: WMO/OSCAR (courtesy of C. Marquardt, EUMETSAT). **IROWG: suggests adding the words "with uniform spatial and local time coverage" after "providing 20000 occultations per day".** Given the prevalence of commercial data, simply recommending 20000 occultations per day is not sufficient. The distribution has to be considered.	
1.2.10	Work towards operational 3D wind profile observations from space-based lidar;		EPS-AEOLUS follow-on planned by ESA and EUMETSAT	

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.2.11	Work towards operational infrared/µwave limb sounding for climate monitoring and NWP applications		No progress reported	
1.2.12	Move towards an operational space weather monitoring capability from the Lagrangian Point L-5	SWCG	The need to expand to the L-5 orbit has been established by NOAA's NSOSA study, which noted the benefit of off-Sun-Earth axis solar observations. Space Weather cooperation between NOAA and ESA has been assigned, including instrument exchanges for Vigil and SWFO. Vigil is now approved, Phase C/D has started **Propose to reflect L-5 Vigil in CGMS Baseline and consider priority achieved**	Achieved

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1.2.13	Establish the operational framework for the provision of magnetometer data from LEO orbit;	SWCG	Operational need has not yet been demonstrated, but a clear interest has been stated in survey and from scientific community.	
1.2.14	Investigate continuous space weather observations from lunar orbit for terrestrial and future lunar space weather services as well as for heliophysics research, complementing the geostationary and L1 measurements.	SWCG	Lunar Gateway demonstration mission with ESA and NASA payloads under development for launch in 2024. NOAA MoA with NASA has been signed on SW services in support to future lunar operations. Service requirements to be assessed in the context of Lunar Pathfinder and Lunar Gateway missions	

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1.2.15	Work towards auroral monitoring capabilities	SWCG	ESA Aurora-D concept demonstration mission planned for 2027 launch, to be followed by a 4-satellite operational constellation for 2030 (TBC) CMA confirmed that Aurora monitoring observations are provided by the WAI instrument on FY-3D and -H **WG-III and SWCG recommends to consider the target achieved (subject to data availability from WAI)**	Achieved

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.3	**Ensure long-term continuity of OSCAR/Space as a primary tool to support the CGMS Risk assessment and the WMO Rolling Review of Requirements including gap analysis against observing system requirements for satellite data and make OSCAR/Space the primary repository for WIGOS satellite metadata records generated by CGMS operators**	**WG-III**	WMO Space Programme Office continued a successful developmet 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	

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			satellites in OSCAR/Space	
1.4	**Assess impact and benefits of CGMS satellite missions**	**WG-III**		
1.4.1	Support satellite impact studies, including in particular impact of data latency and the impact of the Early Morning orbit;		The preparation process for the next WMO impact workshop in May 2024 has started and CGMS has provided inputs to the science questions for the workshop, to ensure that impact of data latency is adequately addressed, but it is unclear how these questions have been taken into account in the workshop preparations.	
1.4.2	Develop capacity to assess socio-economic benefits of CGMS satellite missions;		To be discussed **Remove from HLPP, SEB targets have (see below) been revised in the CGMS Future activity.**	Remove

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.4.3	Collect and make available to CGMS members SEB case studies of relevant satellite systems for the purpose of identifying common practices in the next phase.	SEB Champion		
1.4.4	Explore with WMO and other agencies the possibility to develop a study on the SEB value of the space-based observing system responding to WIGOS 2040 in cooperation with CGMS, and to trigger collaboration with CGMS members;	SEB Champion		

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1.5	**Identifying partnership opportunities on space and ground segments and establish CGMS coordinated mechanisms;**		Partnership on LEO ground segments being implemented by EUMETSAT and NOAA for Metop-SG and JPSS. It should be noted that this target applies strongly to the CGMS engagement in Space Weather and NOAA is actively pursuing Ground Segment partnerships for the SWFO-L1 mission.	
1.6	**Relationship with the Private Sector**	**Private Sector Relations Champion**		
1.6.1	Identify/evaluate potential or future commercial Earth observation technologies – and share information on pilots/testbeds etc. to evaluate new commercial Earth observation technologies.			

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
1.6.2	Assess the operational maturity of commercial observation technology.			
1.6.3	Develop best practices/templates for end user license agreements/procurements, for considering the value of public access and the additional costs of data sharing rights, including quality control considerations;			

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2	**COORDINATION OF SATELLITE SYSTEMS AND OPERATIONS**	**WG-I**		
2.1	**Coordination/Optimisation of data collection systems**	**WG-I**		
2.1.1	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 including creation of an RFI DCS register, joint DCS PR materials, DCS introduction video, manufacturer workshop, discoverable information);		The SWOT analysis has been completed. Further work building on the SWOT analysis outcomes is to be carried out, specifically work on the five proposals for DCS improvements based on the SWOT analysis, including work with RFI Task Group and DCS RFI register, DCS promotional materials presenting global view of DCS, improved DCS outreach via DCS introduction video, further work on EDCP standard, improvements to DCS user information across agencies.	

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2.1.3	Establish an enhanced DCP standard, taking into account requirements of tsunami alert systems and in-situ ocean observations (e.g. buoys) and lessons learned from the development of high-rate DCP. This would give agencies a common standard and would once again allow international use of DCPs. It is foreseen that this would be covered under a project with engineering work spanning 2024-2027, which would include the production and testing of a prototype transmitter;		An EDCP standard proposal has been prepared for presentation to CGMS-52 WGI and Plenary. This includes a proposed implementation plan 2024 – 2027 and funding requirements. If endorsed by CGMS-52 WGI and Plenary, the group will proceed as per the implementation plan.	
2.2	**Radio Frequency (RF) Protection**	**WG-I**		

Commented [KN1]: Under DCS, a point should be added on developing the use case for Smallsat.

Commented [KN2]: Reviewed/updated by Markus and Beau

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2.2.1	Facilitate an effective preparation of national and ITU-R regional groups' positions for the World Radiocommunication Conference (WRC) 2027 favourable for the CGMS-related issues, in particular but not exclusively with regard to the: - Establishment of protection for passive microwave sensors in the bands 50.2-50.4 GHz, 52.6-54.25 GHz and in bands above 86 GHz from unwanted emissions from active services in neighbouring frequency bands (WRC-27 agenda items 1.1, 1.3, 1.8 and 1.18);		This topic needs to be kept in the HLPP for securing adequate information flow inside CGMS on national and regional level preparatory activities (as well as the dedicated report from SFCG activities provided by CGMS Liaison representative in SFCG) **WG-I proposes this rewording to better reflect the situation after WRC** WG-I at CGMS-52 to confirm that the text reflects well the CGMS priorities for WRC 27.	Reworded

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
	- Possible new primary frequency allocations to EESS (passive) in the bands 4200-4400 MHZ and 8400-8500 MHz for Sea Surface Temperature (SST) measurements to complement the SST measurements in the 6/7 GHz range (WRC-27 agenda item 1.19); - Protection of the frequency bands 7450-7550 MHz, 7750-7900 MHz and 8025-8400 MHz, used for the downlink from MetSat and EO satellites, from possible future frequency usage by International Mobile Telecommunications (IMT) (WRC-27 agenda item 1.7);			

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2.2.2	Within the general ITU framework, ITU-R Resolution 731 deals with the establishment of sharing conditions between active and passive services in bands above 71 GHz.		WRC-23 corrected the inconsistencies in Resolution 731, by eliminating the possibility to study bands subject to RR footnote 5.340 (all emissions are prohibited) for sharing with active services. Subject to contributions to the relevant groups in ITU-R, responsible for the active and passive radiocommunication services involved, studies can now be put forward under this corrected Resolution 731 for any bands above 71 GHz, either for sharing in bands not subject to RR FN 5.340, or to determine the unwanted emissions to neighbouring 5.340 bands, that are not already covered by WRC-27 agenda items 1.1, 1.3, 1.8 or 1.18, see 2.2.1 above. **WG-I proposes this rewording to better reflect the situation after WRC**	Reworded

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2.2.3	Pursue the establishment of a set of best practices for the RFI detection, monitoring, and mapping based on the common aspects of the approaches already adopted by CGMS members;		The recently formed Task Group on RFI has proposed a set of draft Best Practices on RFI detection, monitoring, and mapping for review by CGMS-52 WGI. Further work on the Best Practices is planned in the lead up to CGMS-53.	
2.3	**Data acquisition and data processing, including low latency data access**	**WG-I**		

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2.3.1	Ensure the ease of use of satellite-derived data and products, disseminate in one of the standard formats, as specified in the CGMS LRIT/HRIT Global Specification and the WMO Manual on Codes. Once the use of netCDF with the CF convention are captured in the WMO Manual on Codes, ensure compliance with this for satellite-derived data and products disseminated in netCDF.		Work has progressed, see the status report provided by EUMETSAT on dedicated paper for CGMS-48, containing also the outcome of specific work achieved by the WG-I participants through dedicated Inter-Sessional meetings. A dedicated CGMS "liaison officer" agreed at CGMS-47. The role is to coordinate with the CF community to concentrate efforts and views of the different CGMS members aiming at contributing to the evolution of these standards by actively participating in the related CF meetings. Topic is proposed to be further developed through the Task Group of Satellite Data and Codes (TGSDC), which will interact with the CF Conventions Committee, the CF Standard Names Committee, and the CF Governance Panel	

Commented [KN3]: Simon will provide proposed updates to Mikael/Karolina

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2.3.2	To address technical and operational aspects of direct low latency data access (present and future) of mutual or global interest for the CGMS agencies, including facilitating transition to new LEO systems.		The LLDA Task Group has performed and distributed a "Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis of Low Latency Data Access from LEO Meteorological Satellites. This SWOT analysis also contains an analysis on the potential role of satellite platform as a service (SPaaS). This SWOT analysis is planned to be maintained on a yearly basis by the LLDA task group to keep up to date with the space sector context.	
2.3.3	Merge the LEO (global) and DB (regional) best practices into a consolidated "Low latency best practices" containing common best practices for both regional and global missions, as well as specific best practices for direct broadcast and global missions.		A "Merge of LEO Direct Broadcast and Coordination of LEO Orbits Best Practices proposal" [CGMS-52-CGMS-WP-03] was produced for review by CGMS-52 WGI. The document would benefit from one further round of iteration inside the LLDA Task Group. Proposal is to publish the document by CGMS-53.	

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2.3.4	Develop efficient standardized data handling for high-resolution imaging and hyperspectral instruments		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. 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. Between CGMS 52 and CGMS 53, the Task Group on Satellite Data and Codes will continue work on coordinating format standardisation for satellite data.	
2.4	**Coordination with WMO Information Systems (WIS)**	**WG-I**		

Commented [KN4]: Simon will have a look offline and propose updates

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2.4.1	Actively ensure the WIS 2.0 usage for satellite data provision and discovery.		Ongoing.	
2.4.2	Support WIS and WIGOS in the definition of harmonised product metadata for satellite data and implement these for CGMS missions.			

Commented [KN6]: This will be updated by Simon after WGIV takes place.

Commented [KN5]: This should be moved to WGIV

Commented [KN7]: This should be moved to WGIV

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2.4.3	Provide coordinated CGMS inputs to WMO on satellite and instrument identifiers for data representation and metadata within the WIS		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. Between CGMS 52 and CGMS 53, the Task Group on Satellite Data and Codes will continue work on implementation of WIGOS station identifiers for satellite platforms, and providing subject matter expertise to WMO Expert Teams.	

Commented [KN8]: Done for C-5. Continuing for C-8.

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2.5	**Operational issues related to Space Weather**			
2.5.1	Evaluate existing operational space weather products and services in support of CGMS members' spacecraft operations and recommend additional services as appropriate	WG-I, SWCG	The WGI Space Environment Sustainability Task Group (with support from SWCG) has initiated steps to identify best practices in usage of space weather data by spacecraft operators and their goals for improvement. Outreach activities are being supported at space weather and operations workshops and specific user engagement / test-bed activities are on-going at ESA and NOAA.	
2.6	**Space Traffic Coordination**	**SSA Champion**		
2.6.1	Review of CGMS member agencies' satellite operations for collision avoidance and re-entry prediction.			

Commented [KN9]: We need to add an entry on Space Environment Sustainability.

The inputs can be taken from the WGI ToR, which has objectives for SES listed.

This is aligned with the SSA Champion on STG Coordination points below.

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2.6.2	Perform a gap analysis between the needs and the available/used space traffic coordination (STC) services, carry out an assessment of service development prospects and prepare a proposal for best practises to support improvement.			
2.6.3	Engage with UN-COPUOS to achieve a global standardised approach for STC based on a CGMS proposal;			
2.7	**Space sustainability**	**SSA Champion**		
2.7.1	Share space sustainability rating methodologies and carry out a pilot project where some operational mission plannings are evaluated.			

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2.7.2	Follow efforts to establish an international agency policy on "zero debris" and based on the outcome, carry out an assessment of impacts of such policy on operational missions of CGMS members and the private sector.			
2.7.3	Prepare a CGMS best practises document for long term space sustainability;			
2.8	**CGMS satellite missions in hybrid space infrastructures**	**Hybrid Space Infrastructure Champion**		

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2.8.1	Taking passive µwave sensing as an initial case, identify all current constellations, and those planned for the next few years (CGMS baseline, complementary systems, and potential data buys) and demonstrate the impact of CGMS contributions, as part of the integrated system.			
2.8.2	Address such aspects as orbit coordination and harmonised data access to ensure the different components of the hybrid space infrastructures provide a seamless operational service to the users.			
2.8.3	Conduct a critical review of WIGOS 2040 with respect to hybrid systems;			

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress	Overall Status
2.9	**New technologies for satellite systems**	**IOT Champion**		
2.9.1	Assess the internet-of-things (IOT) technology for inter- and intra-connections between satellite and ground network.	..	The internet-of-things (IOT) technology study found that IoT applications for LEO services and ground-based systems provide opportunities for CGMS agencies: • GEO IoT can open new mode of operations for LEO meteorological satellites, such as TTMC • LEO relay IoT can complement DCS in polar locations • Direct broadcast remains a better value for money solution to GEO IoT for instrument payload downlink	
2.9.2	Explore improvements to LEO satellite systems low latency data access from both a global and regional perspective, harnessing common emerging technologies and taking account of the evolution of the commercial and agency space systems;	..		

3	**COORDINATED DATA ACCESS AND DIALOGUE WITH USER COMMUNITY**	**WG-IV**		

3.1	**Support the user-provider dialogue on regional/continental scales through regional coordination groups maintaining requirements for dissemination of satellite data and products through the various broadcast services;**		To be addressed by TG on User Readiness Regional coordination groups on data requirements are now established in and recognized by WMO regions and those groups are very active: - RA I Dissemination Expert Group (RAIDEG) - RA II WG-I Expert Team on Satellite Observations and Applications (ET-SOA) - RA III/IV Satellite Data Requirements (SDR) Group - RA V WG-I Expert Team on Satellite Utilization (ET-SAT) - RA VI, TBD The results from joint meetings and user surveys in the Regions continue to useful for policy makers and CGMS members for satellite product development, data dissemination and user training.	

3.1.1	Establish a sustained interaction with the operational nowcasting communities with a view to fully utilise the commonality of the future geostationary imagers and sounders.		The responsibility for the priority is between agencies and nowcasting communities, not between Agencies. However, it is recognized that Agency interaction would facilitate further progress and some activities are happening here as well. Looking at some the key players with key current and future capabilities it seems this is progressing reasonably. Whilst some interactions exist, also in the context of the EUMETSAT MTG IRS Mission Advisory Group, a sustained regular interaction across all CGMS members planning to launch geo-satellites with hyperspectral infrared capabilities has not yet been established. Focus of SCOPE-Nowcasting Pilot Project 1 in RA II (Asia) and RA V (South-West Pacific) Note however that SCOPE-Nowcasting has been inactive since 2019.	

			Activity to be coordinated with WGII, no progress so far.	
3.2	**Prepare operational users for new generation of meteorological satellites through user readiness programmes, with coordinated contributions from CGMS members**		To be addressed by TG on User Readiness (not yet established)	

3.2.1	Consider the full range of user capabilities (ranging from advanced Short-range NWP to more conventional nowcasting) when planning data utilisation, products generation and dissemination strategies, in particular for the new geostationary satellites			
3.2.2	Improve the provision to users of characterisation data (including apodization) for geostationary and low Earth orbit hyperspectral infrared instruments.			
3.2.3	Develop Best Practices for Operational User Notifications			
3.3	**Coordinated global data exchange**		To be addressed by Task Group on Data Access/Exchange (not yet established)	

3.3.1	Develop Best Practices for Global Data Exchange			
3.3.2	Explore options for optimal data exchange of advanced data from new generation GEOs, in consultation with the global NWP centres through GODEX-NWP			
3.3.3	Support the coordination of the operational Digital Video Broadcast (DVB) satellite services for the Americas, Africa, Europe and the Asia Pacific regions;		The communication satellite broadcast systems GEONETCast Americas, EUMETCast, CMACast and HimawariCast are well established and coordinated systems, and no significant issues are observed. Reporting on the broadcast systems were provided in CGMS-51 WG-IV meeting.	

3.4	**Increase access to, and use of, data from R&D and pre-operational missions**		To be addressed by TG on Data Access/Exchange (not yet established) EUMETSAT, supported by CGMS members, is actively increasing access of such data to its member states, and to other CGMS members through bilateral arrangements. It should however be noted, that the bilateral agreements for R&D satellites do not always allow unrestricted re-distribution for operational use. There are ongoing activities, no specific issues reported.	

3.5	**Investigate the feasibility of utilizing existing dissemination systems for meteorological information in helping to mitigate disasters;**		Could be addressed by TG on Data Access/Exchange (not yet established) The utilization of existing dissemination systems for disaster mitigation purpose is well established but still has room for expansion. The on-demand Rapid Scanning services of CMA, JMA and KMA are using existing dissemination systems for supporting disaster preparedness.	

3.5	**Increase operational access to data and products in support to the ocean user community;**		Ocean is addressed in the regional dialogues, but there is a need for a better dialogue with the global ocean community. The future mechanism for structured dialogue between CGMS and the ocean community is still to be defined. KMA has implemented an L-band Direct Broadcast service on GEO-KOMPSAT-2A, providing meteorological and marine data for reception by ships. Even though there is still no coordinated interaction with this community in place, the ocean user community benefits from evolutions in existing data access mechanisms. To be addressed by TG on Data Access/Exchange (not yet established)	

3.6.1	Ensure the timely access to and exchange of near-real-time scatterometer data, share access to calibration and validation information across CGMS agencies		To be addressed by TG on Data Access/Exchange (not yet established)	
3.6.2	Promote the product metadata standards within ocean communities, such as on SST, ocean colour, ocean vector surface wind and ocean surface topography, to facilitate common data representation and near-real time exchange. This must be done in dialogue with the relevant CEOS Virtual Constellations.		Could be addressed by the WG-I Task Group on Satellite Data and Codes?	

3.7	**Application of Cloud Technologies**	**Cloud Champion**	**Cloud Services Expert Group established and working well.**	
3.7.1	Develop best practices for cloud services interoperability.			
3.7.2	One or more CGMS members to prepare demonstration of collaboration with private sector regarding satellite data distribution;			
3.8	**Research to operations**	**R2O Champion**		
3.8.1	Collect the experience of each agency by carrying out a research-to-operations method survey with each agency including identification of research missions with a potential transfer to operations.			
3.8.2	Based on the results of the method survey, propose a consistent CGMS research-to-operations baseline process that includes flexibility and adaptability and facilitates the participation of R&D agencies;			

4	**ENHANCE THE QUALITY OF SATELLITE-DERIVED DATA AND PRODUCTS**	**WG-II (Supported as appropriate by ISWGs and GSICS project)**	**Status below is provided based on information from the ISWGs that have met since last CGMS. A complete status of implementation of the proposed targets in the product area will be gradually established by WG-II, the ISWGs (during their cycle of meetings) and the GSICS project.**	
4.1	**Establish within GSICS a fully consistent calibration of relevant satellite instruments across CGMS agencies, recognising the importance of collaboration between operational and research CGMS agencies;**			

4.1.1	Maintain within GSICS a framework for inter-calibration of hyper-spectral sounders;	GSICS	Implemented and provides input to the annual GSICS. observing system report. Interoperability within GSICS framework ongoing. **GSICS to provide status**	
4.1.2	Establish within GSICS a consistent inter-calibration for thermal IR channels using hyper-spectral sounders as reference. The implementation will be done successively by the individual satellite operators	GSICS	**GSICS to provide update**	

4.1.3	Establish a consistent inter-calibration for solar channels using instruments with adequate in-orbit calibration and vicarious methods as reference. The implementation will be done successively by the individual satellite operators.	GSICS	The lunar irradiance and DCC (Deep Convective Cloud) have been suggested by GRWG as targets to transfer the NPP-VIIRS reference calibration for the solar reflective bands. The results have been demonstrated by most satellite agencies, the approach for implementation is still under discussion. It is imperative to stress the need to use the same solar spectrum for inter-comparing sensors based on radiance units. The MODIS, NPP-VIIRS, and N20-VIIRS sensors use the Neckel&Labs, MODTRAN 4.3, and Thuillier 2003 solar spectra, respectively. The GSICS-recommended NOAA NPP-VIIRS V2 calibration reference will use the Thuillier solar spectrum. This multiplicity is confusing. The GSICS VIS/NIR and UV groups have tasked the CU/LASP solar group to prepare a paper (contact: Peter Pilewskie peter.pilewskie@lasp.colorado.edu) to establish a high resolution solar reference spectrum anchored to the newly launched ISS/TSIS-1 sensor. This will be in coordination CEOS WGCV IVOS group.	

4.1.4	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	GSICS	Ongoing	

4.1.5	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;	GSICS	IPWG asked for confirmation that GSICS also addresses µwave imagers. GSICS has confirmed this and is discussing to invite JAXA for a discussion on µwave intercalibration.	
4.1.6	Establish mechanisms for cross-calibrating scatterometers across the constellation.	GSICS	There have been discussions in MW Subgroup on scatterometer inter-comparison and Xiaolong Dong summarized these in http://gsics.atmos.umd.edu/pub/Development/Annualmeeting2022/CEOS_MW_Activities_GSICS20220317.pptx	

4.2	**Establish commonality in the derivation of satellite products for global users where appropriate (e.g., through sharing of prototype algorithms);**			

4.2.1	Establish commonality in the derivation of AMV products for global users where appropriate (e.g., through sharing of prototype algorithms) and consider backwards compatibility when designing AMV algorithms for the 16-channel imagers, so that present state-of-the-art algorithms can be applied to old imagery.	IWWG	Implementation of new AMV BUFR sequence and Common QI by space agencies is partially completed. . NOAA, EUMETSAT, KMA and the NWCSAF/HRW have implemented the use of a new AMV BUFR sequence. EUMETSAT, NOAA, KMA, JMA and the NWCSAF/HRW have included the Common QI into their algorithm repositories 4th AMV Intercomparison was completed and results were presented at IWW16. Brazilian Weather Forecast and Climatic Studies Centre (CPTEC/INPE), EUMETSAT, Japan Meteorological Agency (JMA), Korea Meteorological Administration (KMA), National Oceanic and Atmospheric Administration (NOAA) and NWCSAF participated and contributed AMVs datasets. UW-Madison/CIMSS (Dave Santek) and NWCSAF (Javier Garcia-Perreda) performed the analysis and reported to IWWG. The 5th AMV Intercomparison is yet to be coordinated and planned in time for the 17th IWW in Spring 2025	

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<td>4.2.2</td>
<td>Investigate the best configurations to be used by the AMV producers for use in global and regional NWP models respectively, and clearly define the appropriate requirements for each of them;</td>
<td>IWWG</td>
<td>
A document created by Mary Forsythe (Met Office) distributed to the IWWG NWP community was discus during the 16th IWW. No changes were proposed to the tab with Global and Regional NWP recommendations. document remains a living document and will be periodica updated based on the latest scientific information received discussed at each IWW.

The 16th IWW discussion recognised the merits of a centrali NWC SAF AMV production to support regional models.

Global NWP

<table>
<tr><td>Timeliness</td><td>Important as data later in the window has the most impact.</td></tr>
<tr><td>Target size and image interval</td><td>Best to generate AMVs with target size and interval whi is optimal for the best AMV product. NWP centres can superob data, if necessary, to the resolution which is optimal for NWP. Based on recent studies this might be ~ 16x16 pixels with ~10 min interval (where available)</td></tr>
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			Grid size	Should **avoid overlapping targets** (to reduce correlate error). There is an open question as to whether NWP centres might benefit from maximising density after allowing for this constraint as it gives flexibility to use da at higher density in regions of interest and the potential reduce random error through superobbing. However, there is a *cost/benefit trade-off: the cost of production/storage/processing of increased volumes versus the currently unknown benefit to NWP*.	
			Temporal frequenc y	Many centres assimilate data **hourly** in NWP so this seems like a sensible target, however, increased frequency can help to fill the spatial gaps. *It may be use to have the data every half hour*, perhaps even more often. However, note caveats re cost/benefit trade-off above. May benefit from enhanced spatial/temporal products for critical events such as storms.	
			Derivatio n settings	Are there any other changes that could help to improve the spatial coverage without impacting too much the quality of the winds? Novel optical flow retrieval is potentially one option.	
			Derivatio n informati on	Access to information from the derivation that might hav skill for NWP quality control. This might include information on the correlation surface (for confidence in tracking) as well as information from the cloud analysis and height assignment steps. Request made for standardised cloud type to be made available.	

Regional NWP

Timeliness	**Critical**. Some regional models cannot use data old
Target size and image interval	Likely want a higher resolution product than for glob r what will be optimal. **Might be worth trying 16x16 and s** with both **10 min and 5 min intervals** (where available) approaches to reduce noise (averaging correlation ring, filtering). Produce AMVs from high resolution chann m).
Grid size	Ideally set grid size to avoid overlapping targets, bu more the better. TBC if density is sufficient without overla NWC SAF / HRW could be used to explore. May want to on.
Temporal frequency	Probably want winds produced every **10/15 min** – s nprove the spatial coverage even if we thin or superob to o e to correlated error. May benefit from enhanced spatial ucts for critical events such as storms. May be useful for N sters.
Derivation settings	Are there any other changes that could help to impr coverage without impacting too much on the quality
Derivation information	Access to information from the derivation that might ll for NWP quality control. This might include information tion surface (for confidence in tracking) as well as inform cloud analysis and height assignment steps. Request ma sed

					cloud type to be made available. Improving the erro particularly important for initialising the smaller scal	
				NWP usage	A particular challenge is how to benefit from the hig information without hitting the system too hard due We may want to consider back-and-forth nudging a approaches in NWP.	rors. onal

4.2.3	Assess value of derivation of winds from GEO Hyperspectral IR	IWWG	The potential of 3D winds extracted from Hyperspectral IR sounders can be estimated from existing demonstration 3D AIRS/CrIS (CIMSS/NOAA/NASA) and 3D IASI winds (EUMETSAT) that can be made available to the user community. For a better estimation of 3D winds from a Geostationary Hyperspectral IR sounder instrument, NOAA is discussing the possibility of generating 3D AMVs from GEOS-5 for use in OSSEs. Feng Lu (CMA) will update the community at the IWW16 on the status of 3D AMVs from the Geostationary Interferometric Infrared Sounder-2 (GIIRS-2) on FY-4B. EUMETSAT's 3D IASI AMV processor is fully developed. Production of a demonstration dataset is ongoing. Three months of data (Jan-Mar 2023) covering both North and South high latitude regions (poleward +/- 45 degrees) can be made available to the user community upon request. While not a GEO application, CIMSS, University of Wisconsin - Madison has a new funding start that will demonstrate the feasibility of tracking features in global profile of retrievals of humidity and ozone derived from AIRS and CrIS radiances on Aqua, NOAA-20, and NOAA-21 (and possible SNPP). Retrieval products will be generated using	

			the Dual Regression (DR) method that derives atmospheric profiles, surface parameters, and cloud properties simultaneously under clear and cloudy conditions from any of the current hyperspectral infrared (IR) sounders at single field-of-view (SFOV) resolution. With three CrIS and one AIRS instrument flying in the afternoon orbit, time sequences of these global humidity and ozone profile fields enable feature tracking to determine atmospheric motion vectors (AMVs). Tracking features in retrieval fields rather than in the radiance images enables estimation of wind profiles at retrieval determined heights. This approach has been demonstrated from the successive AIRS overpasses in polar regions, but now can be tested globally.	
4.2.4	Establish a coherent development of volcanic ash products and applications with close user community coordination;	WG II	WG II will discuss the way forward for Ash Product development, updated intercomparisons and definition of suitable parameters for end user applications with SCOPE-NWC, IAW and ICAO.” Action on WMO. **WG-II to comment**	

4.2.5	Assess the cloud properties generated from the geostationary and polar orbiting imagers and pursue best practices that lead to improved consistency and accuracy across the globe and the Geostationary ring;	ICWG	**ICWG:** While ICWG-3 did not include a cloud property intercomparison effort as was done in past meetings, it was agreed that an intercomparison/assessment of contributed cloud products is a high priority for the next ICWG-4. Moreover, it was decided that this effort will use the new ISCCP-NG L1G dataset as the common input for all participating algorithms. The use of the ISCCP-NG L1G serves a two-fold purpose – it provides a common framework for evaluating a variety of cloud algorithms, and it enables an evaluation of the L1G datasets themselves via assessments of retrieval performance on these inputs. The latter provides a pathway for ICWG to provide feedback to the ISCCPNG/GeoRing development effort. The ICWG ISCCP-NG Topical Group will coordinate these intercomparison efforts and liaise with the L1G development community.	

4.2.6	Establish together with the user community a commonly agreed approach for retrieval of Principal Component scores and associated parameters from hyperspectral infrared data, minimizing information loss including the mutually acceptable update strategy for the principal component basis and to implement such an approach in a coordinated manner.	ITWG	**ITWG status:** After ITSC-24, the following statement was received from Tim Hultberg (EUMETSAT) on the Hybrid compression of IASI spectra: - As for "feedback from users" we did two parallel studies: https://www.eumetsat.int/use-iasi-reconstructed-radiances-acaq-retrievals (only one of the two "final reports" is currently available from this page, but we have the other and it should be added to the web soon) - The local part of the hybrid is only relevant for very unusual situations and small trends in the bias from reconstruction; we don't use it in EUMETSAT product generation. But we do (since 30th of March 2023) use the global PC scores from the new PC basis (v2.01) with full noise normalisation matrix. Dave Tobin (NOAA/SSEC) reported the following: On the CrIS side of things, we developed the PC product and did internal (internal to the CrIS SDR calibration team) assessments, but when it came time to make it into an	

			official product, the JPSS project decided that they did not have any “user requirement” or user requests for the CrIS PC product, and so we did not proceed to making an official product supplied to users. So, no real user feedback. More recently, we have some interest in the CrIS product from the GeoXO GXS project, and will continue with the project and provide products. So, maybe some feedback in the ~1 year time frame. At the conference, users were encouraged to get in touch with Dave if they were interested to test the data. Update as of March 2024: - NOAA is considering a proposal to continue development and demonstration of PC products for JPSS CrIS SDR radiance data, as well as for future hyperspectral microwave data. - Sample Hybrid PC data based on the NASA CrIS L1B radiance data will be available in the next weeks via the NASA GES DISC. - The GeoXO GXS project is currently planning for a PC product, with details to be defined, to be the primary product (opposed to raw radiances), similar to the path used for MTG-IRS.	

4.3	**Foster the continuous improvement of products through validation and inter-comparison through international working groups and SCOPE-type mechanisms;**			

4.3.1	Apply the IPWG validation protocol (as defined on its web page) to precipitation combination datasets generated using multiple satellite and in-situ data sources, and expand the number of participating agencies to broaden the validation domain. The IPWG website is currently being transitioned, and will be updated to reflect the status of previous, current and newly added operating validation regions	IPWG	The South Korean validation website is up and running. It has been presented to the IPWG community during one of the virtual sessions IPWG did hold in 2021. The sites, some of which are still operational, see relatively little traffic because validation statistics are not uniform across sites, and it is nearly impossible to distinguish differences due to weather regimes from differences in the quality of validation data. IPWG thus focusing on Baseline Surface precipitation Network. Working with WMO their Inter-Program Expert Team on Operational Weather Radars. Pekka Rossi is the coordinator. Daniel Michaelson is the current chair. Already, the US, Korea and Japan appear ready to contribute data. Will focus on this at IPWG-11 to increase participating sites. Requirements are: • Radar with rain gauges for approx. 1 year • A PI willing to verify quality of the product	

4.3.2	Provide a SCOPE-CM Implementation Plan following the agreed new concept;	WG II	WP on SCOPE-CM phase III will be discussed at CGMS-48. A small task team composed of representatives from NOAA, EUMETSAT and WMO have considered the way forward for SCOPE-CM and proposes to conclude all Phase-II activities and then adopt a new approach for SCOPE-CM, i.e, to focus on production of CDRs responding to gaps identified by JWGClimate. WG-II supported this proposal, which then will be detailed with updated strategy, Agenda and Terms of Reference for SCOPE-CM. **Remove from HLPP** **WG-II to comment**	

4.3.3	Conduct an inter-comparison study between the different methods to derive level 2 data from infrared hyperspectral sounders, recognising that there are several software packages available utilizing AIRS/IASI/CrIS data.	ITWG	At ITSC-23 NOAA (Tony Reale) presented "Enterprise Comparison of Atmospheric Profiles Derived Polar Satellite and GNSS Constellations ". The presentation described the features of the NOAA Products Validation System (NPROVS). NPROVS routinely compiles daily datasets of collocated radiosonde, dropsonde, numerical weather prediction (NWP) and satellite sounding product observations. These datasets are sub-divided for Conventional and Special radiosonde observations. These collocations are primarily used to monitor satellite derived soundings from multiple product suites and support of scientific algorithm development. NPROVS supported satellites, sensors, and products relevant to this comparison include: S-NPP and NOAA-20: CrIS/ATMS NUCAPS/HEAP from NOAA MetOp-B/C: IASI/AMSU NUCAPS/HEAP from NOAA; IASI Level 2 from EUMETSAT Aqua: AIRS Level 2 from NASA • Results comparing NOAA (NUCAPS), EUMETSAT IASI L2, and NOAA (MiRS) MW-only soundings	

			from MetOp-B were provided; mismatch among these data are minimal lending high confidence. • Results comparing GNSS COSMIC-2 versus GRAS retrievals were provided; mismatch among these data is larger (than for polar satellites) lending moderate confidence. • Overall, enterprise assessment differences among polar satellites appear larger (despite smaller mismatch) than for GNSS. NPROVS data, results, and documentation are available at https://www.star.nesdis.noaa.gov/smcd/opdb/nprovs/ No updates from ITSC-24	

4.3.4	Coordinate and improve the use of cloud properties in the high impact applications, in particular Atmospheric Motion Vectors and All-Sky Radiance Products .	ICWG	Link between ICWG and SCOPE-Nowcasting has now been established, through the SCOPE-NWC lead Mike Pavolonis/NOAA **ICWG:** A representative from the IWWG attended ICWG-3 and presented an update on IWWG activities. ICWG agreed to coordinate with IWWG on the ISCCP-NG cloud property intercomparison planned for ICWG-4, specifically to include in the intercomparison IWWG golden days such that cloud-top properties can be provided to the AMV community for evaluation.	

4.3.5	Support the continued analysis and growth of the cloud climatology assessment data archive initiated by GEWEX and the coordinate the development and assessment of cloud climate products for the next generation of the International Cloud Climatology Project (ISCCP-NG)	ICWG	**ICWG to comment**	
4.4	**Maintain, enhance and improve the methods to describe the error characteristics of satellite data and products.**			

4.4.1	Establish a common vocabulary and methodology with appropriate error propagation to include the errors associated with validation data (e.g. radiosonde temperature, water vapour, precipitation and winds).	ITWG, ICWG	**ITWG:** From the ITWG International Issues and Future Systems Working Group, the last action on this topic was for Christoforos Tsamalis (Met Office) to provide input to Mikael Rattenborg. This was completed and reported at ITSC-22. No updates are available following ITSC-23. From the ITWG Climate Working Group, this topic was discussed at ITSC-23 in the context of allowing users to better understand and trace uncertainties when interpreting long time series (e.g., ECVs). It was noted that when reporting climate trends, the climate community addresses statistical uncertainties in trends associated with the lengths of observations and magnitudes of variability in time series. On the other hand, the satellite CDR community addresses calibration uncertainty, or stability, of time series in trend detection. This led to a new recommendation from the Climate Working Group as shown below. Recommendation Climate-11 to satellite data product developers: Report statistical uncertainties of the CDR trends together with the calibration uncertainties No updates from ITSC-24 **ICWG:**	

			ICWG recognizes the challenges associated with validating/evaluating remote sensing retrievals, particularly those retrievals of cloud properties for which no direct ground truth is available. ICWG-3 featured discussions on such validation efforts, including presentations on, e.g., liquid cloud microphysics retrieval evaluation using different in situ cloud probes that provide differing information on droplet size distributions. While no consensus was achieved, it is expected that discussion on validation efforts and associated errors will continue at ICWG-4.	

4.4.2	Agree on standardized procedures to derive NedT estimates for microwave sounders, and include such estimates in the disseminated BUFR data.	ITWG, ICWG	**ITWG:** At ITSC-23 the ITWG International Issues and Future Systems working group noted that a recent paper by Yang and Yang is currently under review, and this includes comparisons of different NedT algorithms (Yang and Yang, 2021, "A New Algorithm for Determining the Noise Equivalent Delta Temperature of In-orbit Microwave Radiometers", IEEE Transaction on Geoscience and Remote Sensing). The group reiterated that websites with timeseries of instrument performance indicators such as the NOAA/NESDIS ICVS (Integrated Calibration/Validation System) monitoring are an invaluable resource for data users, including for NWP and reanalysis applications. The group would greatly appreciate such monitoring to be available from other space agencies. The view from the NWP/DA working group was this: There was a general feeling in the WG that the timeseries of NedT estimates is very useful, as it allows users to identify when changes to the instrument occur. In particular websites showing the time series can be very helpful in making decisions on instrument/channel rejection. This is not just a requirement for short-range NWP; timeseries spanning the	

			lifetime of instruments can be useful to reanalysis applications. With regards to consistency in the method used to estimate NedT, it was pointed out that it is not always possible to perform the calculation in the same way for all instrument types. Consequently it was felt that we modify the recommendation previously DA/NWP 23-8 to reflect this. The following two new standing recommendations were made. Recommendation DA/NWP - Standing 13 to Data Providers: Provide NedT estimates for inclusion within BUFR for microwave data. Recommendation DA/NWP- Standing 14 to Data Providers: Make NedT estimates from microwave instruments available as time series on publicly available websites to enable monitoring of instrument health in near real time. Joerg Ackermann who was unable to attend the meeting requested that the WG make the following additional recommendation, to aid instrument characterisation: Recommendation DA/NWP- Standing 15 to Instrument Developers: Pre-launch calculation of NEdT should use the same algorithm as will be used in-orbit using warm target counts variability divided by the instrument gain	

			In general, this has been discussed for a long time by the DA/NWP Working Group now; we have the standing recommendations and given the long list of items needing discussion there is unlikely to be any further input from that working group. Based on the standing recommendations, it is proposed to consider this HLPP item for closure	
4.5	**Strengthen interaction with users in selected thematic areas by establishing a close relation with them as beta-testers and foster optimum use of satellite data.**			

4.5.1	Report on the progress within the Nowcasting community toward the use of hyperspectral sounders and work toward common products to serve the requirements of the global community.	WG II	The value of hyperspectral infrared has been discussed at the EUMETSAT Nowcasting Workshop in 2017 follow up with a report that was prepared in 2018 and update in 2019 by Hazardous Weather Testbed group. In addition, FY-4A/GIIRS has been launched and data is now available routinely and with sufficient quality to explore the value of the data in Nowcasting. At the joint WG II/III session OSSEs for Assessment of Hyperspectral Infrared Measurements from Geostationary Orbit was presented by NOAA. In addition, EUMETSAT has been using polar orbiting data to demonstrate the potential value of hyperspectral IR from GEO. Report from NOAA will be provided at WG-II. EUMETSAT relevant reports at https://www.eumetsat.int/severe-storm-forecasting-lab **WG-II to comment**	

4.5.2	Enhance the use of satellite precipitation datasets through an IPWG-led user workshop where training on visualization and analysis tools will be one of the topics.	IPWG	A session on "Training and outreach on satellite-based products to monitor weather, climate, and extreme events" was successfully coordinated at CSU/CIRA in Fort Collins, CO US in June 2022 during the IPWG-10 workshop. In addition, IPWG members have actively participated in the online Satellite Precipitation Applications Workshops co-organized with the GPM application group, and with the GPM Mentorship Program. Further training events are planned during the IPWG-11 workshop, to take place in Tokyo, Japan in July 2024.	
4.6	**Foster and support research regarding enhanced radiative transfer capabilities, recognising the paramount importance of radiative transfer developments for satellite products**			

4.6.1	Continue support for line-by-line (LBL) reference model development and enhanced characterization of spectroscopy to ensure that product development teams and users of level 1 data have access to the latest updates in LBL forward modelling and the uncertainties involved.	ITWG	Following ITSC-23 the ITWG Radiative Transfer and Surface Modeling Working Group provided the following information about specific requests for support. **LBL modeling** 1. Continuous support for line-by-line modeling should be guaranteed. The community needs the development of competing line-by-line codes. There are concerns that line- by-line models are not flexible enough to accommodate the use of line parameters from alternative databases. For instance, LBLRTM uses line mixing coefficients that are not compatible with the GEISA line parameters because the LBLRTM line mixing coefficients are based on HITRAN line data. 2. Although the semi-empirical MTK_CKD model is perhaps adequate for many applications, there is still the need for a physically based representation of the water vapour continuum absorption which should eventually be implemented in state-of- the-art LBL models. 3. Further research is needed into the modeling of line mixing processes for CO2, CH4, N2O and to a lesser extent water vapor. This is especially true for the 4μm absorption band of CO2.	

			4. The effects of pressure and Doppler line broadening should be modelled using a better representation of the line shape than the Voigt profile. Proposed replacements to the Voigt profile will require different broadening coefficients for all the molecules and consequently the need for significant updates to LBL models. 5. To allow the exploitation of spectral regions affected by non-LTE effects, it is important that these effects are accurately represented in LBL codes. In parallel, efficient representations of non-LTE effects should also be sought for implementation in fast RT models. **Spectroscopy** 1. A strong emphasis should put on the continuous support of theoretical and laboratory spectroscopic studies. It is crucial that a compilation of basic line parameters is maintained. 2. It should be assessed if there is a requirement to introduce more molecular species, including isotopes, and understand what accuracies are required. 3. It should be assessed if there is any requirement regarding the precision of the spectroscopic parameters	

			4. Using the synergy between the IR and the UV/Vis some inconsistencies have been observed in the retrieval of ozone profiles which could attributed to an inconsistency of the precision of the spectroscopic parameters between the 2 spectral ranges. Inconsistency problems have also been observed for SO2. 5. Promote research into spectroscopy of higher frequency microwave channels up to 664GHz. 6. Line shapes of water vapor broadening for trace gases need improvement. 7. Regarding the database of cross sections, in general, we have access to the absorption coefficients for a set of pressure and temperature. The experience gained with IASI suggests that we should address the following points: a) The number of temperature and pressure values available in databases may not be sufficient to ensure that the error made when interpolating to the actual temperature and pressure is smaller than the noise of the instrument. b) Even if the spectral variation is low, cross section measurement have not been done using the best spectral resolution (especially in the center of the absorption band).	

			• Some measurements have been done with an instrumental noise which was too high resulting in negative absorption coefficients. **Spectroscopic databases** The present status of the atmospheric databases is the result of numerous studies performed during the last 20 years in several dedicated spectroscopic laboratories all over the world. International cooperation contributed to the establishment of a number of spectroscopic databases for atmospheric applications. These include: • GEISA under the responsibility of N. Jacquinet-Husson and R. Armante from LMD, Palaiseau, France. The last update has been done in 2011 (Jacquinet-Husson, N. and others, 2011), the next one is planned for the end of 2015. • HITRAN under the responsibility of Phillips Laboratory, Cambridge, USA (Rothman et al., 2013). • MIPAS specifically dedicated to satellite experiments in the Earth's atmosphere (Flaud, 2003). • BEAMCAT, for millimeter and sub-millimeter wave propagation in the Earth's atmosphere (Feist, 2004). • JPL Catalog (Pickett et al., 1998) of microwave to sub-millimeter transitions. It mostly contains rotational transitions of a few hundred molecules	

			which can be potentially observed in the Earth's atmosphere or in the atmosphere of other planets. It also features molecules present in the Inter Stellar Medium (ISM) or in Circum Stellar Envelopes (CSE) of late type stars. It comprises a small, but increasing, number of entries for infrared transitions. • CDMS Catalog (Müller et al., 2001, 2005). Like the JPL catalogue, it mostly contains rotational transitions of molecules important for the ISM or CSEs. Some of the molecules are of course also relevant for application in Earth's atmosphere or in the atmosphere of other planets and a number of entries are for infrared transitions of such molecules. Of all the databases listed above, GEISA and HITRAN are of primary importance for data assimilation. Finally, the VAMDC consortium (http://www.vamdc.eu/) aims at being an interoperable e- infrastructure that provides the international research community with access to a broad range of atomic and molecular data. **Overall status at ITWG in Q1/2024**	

			Following ITSC-24, the ITWG Radiative Transfer and Surface Modeling Working Group reported: 1. The NWPSAF Technical report "Literature Review on Microwave and Sub-millimetre Spectroscopy for MetOp Second Generation" (2022) by Turner, E., Fox, F., Mattiolo, V. and Cimini, D was highlighted to be an important reference material (https://nwp-saf.eumetsat.int/site/download/members_docs/cdop-3_reference_documents/NWPSAF_report_submm_litrev.pdf). 2. The need for a characterization of model biases and uncertainties in key spectroscopic parameters. 3. The need to map spectroscopic uncertainties into radiance uncertainties. 4. Encourage comparison studies in model and/or laboratory spectroscopic measurements. In this regard, it is recommended to work more closely with the planetary/astronomy community for knowledge of LBL / spectroscopy information. 5. Continuous support of theoretical and laboratory spectroscopic studies. A compilation of basic line parameters must be maintained. 6. Recommends promoting research regarding the spectroscopy of higher frequency microwave channels up to 1000 GHz (specially the H2O lines in the sub-mm range of	

			particular importance for the upcoming launch of ICI onboard Metop-SG). 7. Continuous support of FAR-IR model developments in preparation for future missions (sigma-IASI - FORUM model, or FIREX requirements). 8. The importance of maintaining the Rosenkranz MW/sub-mm model as there are concerns it might become discontinued. 9. There are raised concerns regarding the LBL needs in hyperspectral MW missions. 10. Recommends maintaining the last LBLRTM version upon the release of the Community LBLM (CLBLM) model.	

4.6.2	Perform validation and intercomparison of LBL models/spectroscopy to assess the impact of spectroscopic uncertainties and the differences between line-by-line and fast radiative transfer models.	ITWG	At ITSC-23 a presentation was given by Thibault Delahaye (Laboratoire de Météorologie Dynamique/IPSL) et al. titled "*CO2 spectroscopy in 4A/OP: new developments and applications to satellite missions*". This presentation described the development and validation of a new CO2 full line-mixing algorithm and software package. This is required by missions including IASI in order to retrieve CO2 concentration by inversion of infrared spectra using radiative transfer-based algorithms. This method fundamentally relies on the precision of CO2 molecular spectroscopy knowledge. The authors presented the status of the CO2 spectroscopy and its implementation and validation in the radiative transfer software 4A/OP. Following ITSC-24, the RTSP Working Group emphasizes the significance of intercomparison studies to refine the accuracy and reliability of fast atmospheric radiative transfer models. In this context, the Community Radiative Transfer Model (CRTM), Radiative Transfer for TOVS (RTTOV), and Advanced Radiative Transfer Modeling System (ARMS) are highlighted as crucial components in the broader effort to advance atmospheric modeling capabilities.	

			The RTSP Working Group advocates for a strategic inclusion of these models in benchmarking exercises against more accurate (but much slower) counterparts like kCARTA, LBLRTM, and CNR/Florence Klima LBL. By engaging in such comparative analyses, the aim is to leverage insights gained to drive enhancements in these fast models, ensuring they remain at the forefront of radiative transfer modeling capabilities for operational and time-constrained applications.	

4.6.3	Through coordination between IPWG, ITWG and ICWG, continue to improve microwave radiative transfer models to include complex surfaces (e.g., snow, desert, etc.) and scattering atmospheres (e.g., frozen hydrometeors) to support improved algorithm development for current and future sensors.	IPWG, ICWG, ITWG, IESWG	**IPWG comments:** This is always an ongoing topic and challenge, but we are pleased to report some headway. IPWG has established a Focus Group on Particle scattering led by Guosheng Liu (FSU). The goals of the group is to create greater community understanding of the state-of-the-art research and to communicate available tools to the broader precipitation community. It has also created a Land Surface FG led by Sarah Ringerud (GSFC) and Joe Turk (JPL) The goals of the group is to create greater community understanding of the state-of-the-art research in this area to facilitate future improvements. These focus groups should be inter-disciplinary. **Overall status at ITWG in Q1/2024** Following ITSC-24, the ITWG Radiative Transfer and Surface Modeling Working Group reported the following notes regarding aerosols, clouds, complex surfaces and radiative transfer modeling in general. Aerosols	

			1. The working group discusses the existence of a new UV optical database: the Super-spheroid model (Lei Bi, oral presentation 11.05 ITSC-2024). Kong, S., Sato, K. and Bi, L., 2022. Lidar Ratio-Depolarization Ratio Relations of Atmospheric Dust Aerosols: The Super-Spheroid Model and High Spectral Resolution Lidar Observations. Journal of Geophysical Research: Atmospheres, 127(4), p.e2021JD035629 and the development of ML approaches to parameterize the database and its jacobians Yu, J., Bi, L., Han, W. and Zhang, X., 2022. Application of a neural network to store and compute the optical properties of non-spherical particles. Advances in Atmospheric Sciences, 39(12), pp. 2024-2039. 2. It was reported that the fast RT model RTTOV OPAC/CAMS database now includes new species (volcanic ash, Asian dust and the ICON-ARTS species). It was recommended that RTTOV developers reach out to the aerosol community and survey their aerosol (physical) needs. 3. It was encouraged that the aerosol community publish a literature review that includes new aerosol studies and challenges regarding VIS/near-IR aerosol sensitivities and spectral dependencies.	

			4. Continuous support for field campaigns and the community to use field campaign data for validation studies. 5. Recommendation to connect aerosol Fcs to RT evaluation studies. Clouds 1. Continue support for refractive index dependence studies on temperature in the far-IR. 2. Continue support to exploit synergy (i.e., FORUM+IASI-NG) in studies of cloud properties and retrievals. 3. The development/evaluation of fast scattering solvers such as the Chou/Tang phase function scaling methods (i.e., poster 1p.12 ITSC-24 presented by Vidot et al.) 4. The continuous support for the development of cloudy RT model validation datasets. 5. Continuous support to address the discussion as to whether physical consistency is important: “true” hydrometeor size/shape or spectral “significant” parameters are enough. In this regard it is important to mention the recent work presented at ITSC-24 (Ether Villeneuve’s work, presentation 1.05) that indicated that perturbations of NWP model parameterizations have a larger impact than hydrometeor habit assumptions. In radar sensitivity (Ku): convective parameterization / cloud fraction has a larger impact than changing shape / PSD parameters. In radiance	

			space: representation of the cloud overlap scheme also has a large impact. 6. Continuous support of sub-grid variability studies (NUBF effects / cloud fraction impact) studies. 7. Support studies that can assess the impact/importance of habit/PSD parameter on radiance space. 8. Continuous the ongoing recommendation of model inter-comparison. Surface properties 1. The working group discusses that microwave observations over land are a problem for data assimilation (DA), and recognizes the importance of improved land surface emissivity models with the explicit intent of improving data assimilation over land (possibly to research into AI approaches). **IESWG:** The IESWG continues to support these efforts, and radiative transfer particularly in snow, soil and vegetation and at lower microwave frequencies would help in the uptake and use of this data in land data assimilation. The ability to work with mixed surface types is also of high importance to our group.	

4.7	**Stimulate trade-off analyses for the development of future passive sounding instruments**			

4.7.1	Conduct studies to investigate the technical feasibility to reduce the field of view sizes for future microwave sounders to keep in line with the spatial resolution expected for future global NWP models.		For EPS-SG, EUMETSAT has concluded that no major improvements for MWS can be anticipated (over current microwave state-of-the-art sounders) within known technical limitations. For the foreseeable future, no significant improvements are expected for the CGMS baseline." However, it should also be noted, that for ongoing considerations of microwave constellations and miniaturisation of microwave instruments, the continued trade-off studies are essential. EUM to check with Christophe Accadia on studies for EPS-Sterna Discussions foreseen at WG-II on Hyperspectral µwave WG-II to comment	

4.7.2	Conduct trade-off studies regarding the benefits of spectral, radiometric, and spatial resolution of infrared sounders, taking into account aspects such as scene inhomogeneity and uncertainties in spectroscopy;		NOAA to check whether GEO-XO trade-off studies can be shared WG-II to comment	
4.8	**Support to emerging application areas**			

4.8.1	Foster the coordinated development of novel products and applications of the new generation of imagers, initially for the areas of fire, aerosols, flood-mapping and river ice break-up.	WG-II	Collaboration on flood mapping is progressing well between NOAA and CMA. In addition the flood mapping was discussed at CGMS-48 WG-II meeting establishing links with CEOS and the WMO Flood Forecasting Initiative. Roshydromet also presented promising high resolution flood mapping results that could be used as independent validation. Hence, in summary flood mapping is progressing well. Limited progress and collaboration was presented in other areas. Fires covered by GOFC-GOLD **WG-II to comments**	

4.8.2	Provide support to users in the WMO application areas, including for agricultural, hydrology, cryosphere, marine/ocean and other applications, with a focus on the WMO co-led UN Early Warnings for All (EW4ALL) identified priority hazards (heat, drought, flood, and tropical cyclones); and, where appropriate, identify and follow-up on opportunities by other entities (e.g. CEOS led activities).	WG-II	**WG-II to comment**	

4.8.3	Review capabilities of and identify critical gaps in the CGMS constellation for the provision of physical snow and ice products in support of operational cryosphere, polar and high-mountain monitoring, and reflecting WMO priorities to address global and regional impacts of changes in the cryosphere (2024-2027).	WG-II, IESWG	**IESWG:** IESWG has identified Snow Water Equivalent (SWE) measurements as a gap in space-borne products. There is an additional need for a continuous purpose-designed record of soil moisture relevant observations. We note HLPP item 4.2.4 as a similar gap item, and wonder if a similar statement could be made regarding SWE? (4.2.4 Establish a coherent development of volcanic ash products and applications with close user community coordination.). Such a product would be based on a number of operational µwave sensors, in particular AMSR and CIMR, as well as contributions from R&D sensors. **Proposed new target for HLPP: Establish a coherent development of a Snow Water Equivalent (SWE) product and applications with close user community coordination.**	

4.8.4	Establish product development priorities including synergistic products for operational monitoring of cryosphere, polar and high-mountain regions;	WG-II	**WG-II to comment**	

4.9	**Identify AI/ML technologies for applying to the product processing and data management infrastructure and develop best practices**	**AI/ML Champion, WG-II, supported by all ISWGs, WG-I and WG-IV**	Comments from International Science Working Groups: **IPWG** has created a Machine Learning WG with the explicit purpose of setting up a common evaluation tool for individual investigators. The tool will provide the same training data to each participant and then assess the quality of the ML learning algorithm by testing against and independent but similar dataset and a dataset from a different region that the algorithm has never encountered **ITWG:** Following ITSC-24, the ITWG Radiative Transfer and Surface Modeling Working Group identifies areas where AI is being used effectively. For example: ● Neural network-based methods for simulating cloud- and aerosol-affected solar satellite channels (Leonhard Scheck, presentation 11.06 on ITSC-2024): MFASIS in vis/near-IR/IR 0.4 – 2.2 micron ● Hatfield, Sam, et al. "Building tangent-linear and adjoint models for data assimilation with neural networks." Journal of advances in Modeling Earth Systems 13.9 (2021). The working group further identified areas that could benefit from AI approaches. For example: ● Cloud and precipitation. parameter tuning to decide the best configuration based on a large training dataset for DA. i.e., Geer, A.J.: Physical characteristics of frozen	

			hydrometeors inferred with parameter estimation, Atmos. Meas. Tech., 14, 5369-5395, https://doi.org/10.5194/amt-14-5369-2021, 2021 ● Land surface emissivity methods The EUMETSAT "AI roadmap" was mentioned as being the only "coordinated" effort at operator level that was known in the working group. The general consensus was recommending funding agencies to fund 3+ years for AI research into replacing or developing components that get used in operational context (e.g., fast models). **IWWG:** Jascon Apke (CIRA) presented the Optical flow Code for Tracking, AMV, and Nowcasting Experiments (OCTANE), an open-source toolkit that could be used for AMVs derivation for NWP DA and early signals of deep convection development. **ICWG:** While no formal ICWG activity to date has focused on AI/ML approaches, ICWG recognizes the potential impact of such approaches on cloud property retrievals.	

			Many ICWG-3 presentations featured AI/ML algorithm approaches for cloud property retrievals, including for scene classification and retrievals of multilayer clouds Moreover, AI/ML was proffered as a potential new Topical Group for ICWG-4, and many contributions to the ISCCP-NG cloud product assessment are expected to leverage AI/ML techniques, thus enabling their evaluation against heritage approaches and common benchmark datasets. ICWG therefore will continue efforts to coordinate and evaluate AI/ML technologies.	

5	**ADVANCING THE ARCHITECTURE FOR CLIMATE MONITORING FROM SPACE (THROUGH THE JOINT CEOS-CGMS WORKING GROUP ON CLIMATE)**	**Joint CEOS-CGMS Working Group Climate (WG Climate)**		
5.1	Update ECV Inventory of Climate Data Records, Gap Analysis and Coordinated Action Plan (CAP) of CEOS and CGMS and report on status of the implementation of the CAP (This target is cyclic and all three parts are covered every year including endorsement by CEOS and CGMS);		The ECV Inventory v4.1 will be updated to v5.0 by incorporating the ~45 CDRs previously submitted to the activity (just after the window closed in the last update). We expect to release v5.0 by 30 December 2024. The Gap Analysis Report and updated CAP have not been released (and hence no update on implementation), however we expect release by Autumn 2024. All three of these activities were impacted by the pandemic backlog, and additionally be a contract lapse for the Inventory work. 2021,	

5.2	Report to and interact with the UNFCCC Subsidiary Body for Scientific and Technological Advice – Research and Systematic Observation (SBSTA-RSO) to foster the usage of satellite data in the context of the Paris Agreement, in particular results from the operational GHG monitoring system. (This target is also part of the cyclic regular annual reporting);		Despite the lack of an operational GHG monitoring system as referenced in this Action, WGClimate coordinated a set of research-grade GHG fluxes and related data sets through a tailored GST data portal to support GST1. We have no indications these data were reviewed or leveraged in the GST Reports. Interactions with UNFCCC SBSTA have been very limited and less-than-productive following Joanna Post's departure and the absence of a permanent backfill for her position. The interactions primarily only concerned COP Earth Information Day activities, in which case WGClimate (via Susanne Mechlenburg) provided a briefing to delegates and guests in attendance. WGClimate is actively working with CEOS partners to identify opportunities -- first finding points-of-contact -- to improve the communication with SBSTA, UNFCCC and other bodies (e.g., GEO) to foster greater use of satellite data.	

5.3	Respond to the GCOS IP after new versions of it issued by GCOS (every 5 years). Provide support to GCOS for the GCOS status report (one year prior to the new GCOS IP);		Per last year's report, WGClimate in working progressively through development of the Space Agency Response via a planned 2-year stratified and prioritized approach. This activity includes regular meetings with GCOS Secretariat, and is currently tracking well. We expect completion in time for endorsement at the CGMS Plenary in 2025.	
5.4	JWGClimate Task Team on GHG monitoring to coordinate the specific CGMS contributions to the operational GHG constellation, covering activities on mission coordination, inter-calibration, product prototyping, data distribution, exchange, formatting, and on training and outreach;		This activity formally commenced on 3 June 2024 in a first-ever meeting of leadership from the CGMS Standing WGs, WGClimate and its GHG TT. The meeting resulted in alignment on shared purpose and a high level path forward, including stratification and assignment of issues to address, and will use the imminent GHG Roadmap activity in part as a vehicle to begin addressing issues. Meeting participants plan to meet periodically (e.g., semi-annually) going forward. CGMS identified an inter-WG liaison (Simon Elliott) to WGClimate to facilitate coordination and co-author the Roadmap.	

5.5	Foster the implementation of the architecture for climate monitoring from space by strengthening the analysis of use cases for climate data records to increase usage in climate services and science.		The primary work on this Use Case activity is complete, and results have been posted online. WGClimate is no longer soliciting new use cases, however it will consider additional cases if and when offered.	
5.6	JWGClimate to publish updated definitions for the Fundamental, Thematic, and Interim Climate Data Record.		WGClimate has developed a mature set of definitions, solicited some community feedback, and plans to submit a peer-reviewed journal article on this by 31 December 2024.	

5.7	Engage in the development of requirements for an integrated global greenhouse gas observing system (i.e. both space-based and surface-based assets).		This work partially began via WGClimate participation in the G3W Study Group, which ultimately led to the G3W Implementation Plan. As part of the GHG Roadmap update and initial work with CGMS WGs in 2024, WGClimate will engage further with G3W and other user programs (e.g., UNEP IMEO, Methane Pledge) as possible to ascertain further requirements on the system.	
5.8	Support the WMO joint study group on greenhouse gas (GHG) monitoring for the development of requirements for data latency of GHG observations;		WGClimate participated in the Study Group, including via the Study Group Co-Chair Vincent-Henri Peuch from WGClimate. Initial G3W requirements were defined.	

6	**ADVANCE OPERATIONAL SPACE WEATHER MONITORING FROM SPACE**	**SWCG**		

6.1	Coordinate CGMS activities and align priorities with the space weather user community, in particular the ICAO Space Weather Centres, ISES, WMO ET-SWx and the UNCOPUOS STSC		Several ICAO SWC members are participating in SWCG and are also members of ISES. ISES is invited to give presentation at SWCG. The SWCG Task Group on Improving Data Access objective is directly related to this coordination activity and includes ISES representation. 5 teleconferences have been held. A dedicated CGMS-ISES meeting took place as part of the ISES annual meeting on 21 April 2023 with future feedback process defined. The UNCOPUOS STSC ET on SWx recommendation for WMO, ISES and COSPAR to initiate an activity to improve coordination has been followed up with the creation of the WMO Expert Team which includes CGMS representation from SWCG, together with ISES and COSPAR members. The published UNCOPOUS STSC Long Term Sustainability Guidelines covering space weather and reporting of spacecraft anomalies are being considered within CGMS and WMO-ET-SWx.	

6.2	Establish a consistent inter-calibration framework in GSICS for energetic particle measurements using instruments with adequate in-orbit calibration and vicarious methods;		The task group on inter-calibration of high energy particle sensor has successfully transitioned to a GSICS space weather subgroup which reports progress to the CGMS SWCG.	
6.3	Advance the integration of Space Weather coordination activities into the relevant CGMS working groups;		The integration of Space Weather activities in relevant CGMS WGs is continuing. SWCG Chairs and rapporteur participate in relevant Intersessional activities to ensure coordination: Joint session with WG-I and -IV, GSICS discussions, participation in annual CGMS Risk Assessment workshop.	

6.4	In coordination with IROWG establish requirements for and recommend an implementation of an optimised system for radio occultation observations for ionosphere monitoring.		Progress is being made in the development of advanced methods to reduce residual effects of the ionosphere on atmospheric retrievals and an increasing number of receivers are able to collect ionospheric data, for example, the extension of GRAS RO profiles into the ionosphere under testhas been implemented for on Metop first generation satellites, soon later to be complemented by Metop second generation ionospheric RO data. End-user utilization of ionospheric RO is increasing, with COSMIC-2 ionospheric data starting to be integrated into SWPC models. The SWCG Task Group on Radio Occultation system optimisation has been established, including IROWG leadership to reduce end-to-end data and product median latencies to at or below 30 minutes and perform Observation System Simulation Experiments to determine the optimal orbital configurations and necessary measurement counts.	

6.5	Ensure the timely access to and global exchange of space weather data of CGMS Members, including instruments hosted on third-party satellites		WMO is in the process of establishing the definition of space weather data types as “core” or “recommended”, with core data enjoying free and open distribution. EUMETSAT is enhancing existing partner cooperation agreements to encompass space weather exchange. NOAA and EUMETSAT are discussing the expansion of currently exchanged data sets, as are CMA and EUMETSAT.	

6.6	Document current data formats for space weather observations		The SWCG surveys of data providers and data users include information on formats used for operational space weather purposes. The SWCG Task Group on improving data access is working towards standardised data formats and meta data using CF conventions, with prototype NetCDF formats under development. Coordination with WMO-ET-SWx is also on-going in this respect.	

6.7	Investigate impact on future SW observations due to increased demand on SW services by Space Situational Awareness and Space Traffic Coordination	SSA Champion	Discussions are on-going between CGMS members and their regional SSA / space traffic coordination responsible entities regarding the prediction of the thermospheric drag environment. An ESA presentation on the status of their activities was made at CGMS-51 SWCG.	

7	**OUTREACH AND TRAINING**		**Vlab proposes to add priority:** **"Ensure availability and training in usage of satellite data and products in monitoring regional priority hazards in addressing the UN Early Warnings for All initiative."**	

7.1	**Engage in communication and outreach activities to promote EO and Space Weather observations benefits.**	**Plenary**	VLab participates in the CEOS Earth Observation Training, Education, and Capacity Development Network (EOTEC DevNet) activities. Many VLab members join the quarterly Regional Flood Working Groups Meetings. EOTEC DevNet is initiating a Drought Working Group that will be of interest for collaboration. During this past year, the Kenya CoE organized an Aviation Space Weather Course and the CoE Costa Rica published a GOES-R Satellite Space Weather Receiver Tutorial. VLab supports promising and early career personnel to attend training events, conferences, or conduct scientific activities that contribute towards satellite product development, evaluation, and implementation. Maybe 7.1 need to be clarified or expanded? EO is often interpreted as activity under CEOS and GEO. In reality, we use the best available data/information to assess the situation. Vegetation health, precipitation, temperature and extremes are used to assess agriculture production and are also used to assess forest health in relation to wildfire hazard. The products for each share similar goals although are often produced by different organizations and groups. How do we better leverage information and efforts across disciplines and sub-disciplines?	

7.2	**Training**	**Plenary /VLab**		

7.2.1	Continue to foster optimum use of satellite data for weather forecasting, climate applications, and environmental assessments including hazardous events such as volcanic ash and flooding;		VLab members conducted monthly Regional Focus Group/Monthly Weather and Climate Meetings (Americas and the Caribbean, Australian and Indonesia CoEs, EUMETSAT, and Oman CoE) which highlight recent significant events. Many VLab members reported delivering training on multi-hazard events and particularly training for the Early Warning for All (EW4ALL) initiative. To be noted is that priorities change in importance depending on exposure to events. For example, there is higher interest in the Earth Observation (here related to vegetation health and wildfire risk, drought, flooding, direct impacts on communities and agriculture production) component to address EW4ALL and Climate initiatives in general. The recent Geomagnetic Storms also pushed interest up.	

7.2.2	Update and develop new training material where necessary, and in collaboration with other training and education programmes in the subject of meteorology, including the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab), the Community for the Advancement of Learning in Meteorology and related disciplines (CALMet), and the WMO Training and Education Programme. It will also include partnerships with the Committee on Space Research (COSPAR), the CEOS Working Group on Capacity Building and Data Democracy (WGCapD), CEOS-CGMS Joint Working Group on Climate, and with other programmes in areas of		Significant progress in the training material provided by the VLab. View the VLab working paper for a summary of events. In developing satellite skills for climatologists, Vlab worked closely with experts. Since climate is a rapidly changing area, CGMS members are invited to improve communications with the CEOS-CGMS Joint Working Group on Climate and training priorities.	

	common or complementary interest.			
7.2.3	Provide shared, regular support to funding the VLab Technical Support Officer function through the WMO VLab Trust Fund, and to the VLab Centres of Excellence as per agreed expectations.		The Centres of Excellence appreciate the opportunities and collaborations provided by CGMS partners. Current WMO Trust funding supports the part-time TSO and travel for VLab personnel to attend meetings and conferences.	

7.3	**User Conferences** Conduct regional satellite users conferences to (i) share experience and foster the exchange of ideas; (ii) promote better access, and improve the utilisation of, existing satellite data and products; (iii) prepare the user community on new satellite systems' data products and services; (iv) engage with the user community on the application of new Climate Data Records, supported by the CEOS-CGMS Joint Working Group on Climate;	**Plenary**	Series of Asia-Oceanic conferences and NOAA satellite users' conferences are continuing. In spite of COVID-19, the 11th Asia-Oceanic Conference was held in Beijing Oct 2021 as a hybrid event and conducted a series of virtual Community Meetings in Oct 2020.	

	(v) gain user feedback on data, product and system real-world application; (vi) engage young people entering the field; (vii) other items as appropriate.			