SWCG report and key recommendations to CGMS plenary

Presented to CGMS-53 Plenary, agenda item 5

Coordination Group for Meteorological Satellites

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SWCG and its role within CGMS

The CGMS Space Weather Coordination Group (SWCG) was established by the 46th CGMS plenary on 8 June 2018, building upon the work performed by the former Space Weather Task Team, created in 2015 during CGMS-43.

SWCG co-chairs: Tsutomu Nagatsuma, NICT/JMA, Vacant position (Jim Spann, NOAA nominated)
SWCG co-rapporteurs: Andrew Monham, EUMETSAT, Jesse Andries, WMO

Terms of Reference: Objectives (not updated since CGMS-51)

- Coordinate space weather activities within and across CGMS working groups including space weather data, ensuring space weather operational measurements are incorporated into the CGMS baseline, relevant frequencies, anomaly resolution, products, knowledge, policy, etc.;
- Address space weather topics relevant to CGMS that are not currently within the purview of other CGMS WGs;
- Facilitate dialogue between CGMS members and space weather communities;
- Identify which space weather organizations/forums the SWCG should interact with both as an active participant and/or engaging them within CGMS activities;
- Identify needs and requirements from space weather communities that should be managed and coordinated by CGMS or its members;
- Follow current and future international and domestic space weather policies which may have an effect on CGMS or its members; and
- Review the CGMS high level priorities related to space weather.

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Current SWCG structure and related activities

WG1
Satellite Systems and Operations

SWCG
Space Weather Coordination

SWCG Co-Chairs:
- ***Tsutomu Nagatsuma (NICT)***
- ***Vacant***

SWCG Co-Rapporteurs:
- ***Andrew Monham (EUMETSAT)***
- ***Jesse Andries (WMO)***

Task Group on
Space Environment Sustainability

TG Co-Chairs: ***Andrew Monham (EUMETSAT)***
Juha-Pekka Luntama (ESA)

Task Group on
Spacecraft Anomaly Database

TG Chair: ***Andrew Monham (EUMETSAT)***

Task Group on the
Improving Data Access

TG Chair: ***Andrew Monham (EUMETSAT)***

Task Group on
Ionospheric RO optimisation

TG Chair: ***Erin Lynch (NOAA)***

GSICS GRWG
Space Weather Subgroup

Subgroup Chair:
Tsutomu Nagatsuma (NICT)

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Main outcomes and future work

- CGMS risk assessment
  - Risk posture has improved.
    - high risk for gap after 2031 for energetic particles, plasma analyser and magnetometer at L1 has been removed.
    - Remaining risks are a moderate risk for gap or performance degradation towards the middle of next decade for coronagraphy from GEO and energetic particle sensors in LEO.
  - Dedicated Risk Assessment for Ionospheric RO is needed in 2026.
    - **SWCG/A53-XX**: SWCG to recommend to WGIII how to separate RO and Ionospheric Electron Density profiles in the CGMS Baseline and Risk Assessment.

- CGMS baseline update
  - Off Sun-Earth-line observations (both remote-sensing and in situ) added to the baseline with the L5 Vigil mission
  - Improved clarity in the baseline wrt. on and off Sun-Earth-line contributions
  - **SWCG/A53-XX**: Decide which NASA missions have sufficient commitment to include in the CGMS baseline (e.g. JEDI, PUNCH, SDO)

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Main outcomes and future work

- Unique opportunity of a suite of L1 missions
  - By the end of 2025 a total of six spacecraft (SWFO-L1, IMAP, Aditya-L1 and the legacy ACE, DSCOVR, and Wind missions) in the same location of space and measuring the solar wind plasma, particle, and magnetic parameters simultaneously
  - Opportunity to assess both:
    - Cross-calibration issues
    - Variability scales of heliospheric structures and model sensitivity to these variations
  - **SWCG/A53-XX**: SWCG to consider how to harness the suite of L1 constellation missions for operational space weather usage

- Data requirements for Aviation services
  - Inputs on requirements were received from a survey with the ICAO centres
  - From the review of the survey, improved auroral observations were identified as needed by the aviation users
  - **SWCG/A53-XX**: SWCG to analyse and respond to the needs identified by the ICAO space weather service centres

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Main outcomes and future work

- OSCAR review and GAP analysis
  - Improved presentation in terms of orbit requirements (esp. Solar and heliospheric)
  - Further improvements needed to OSCAR/Space and Gap analysis tools
    - Recording latency information
      SWCG/A50.01: Supply latency information to OSCAR DB with granularity of each relevant space weather sensor on their space missions.
    - Recording data availability
    - Improvements needed to filters for analysis in OSCAR/Space
      - energetic particles
      - ionospheric RO

- GSICS activities (HLPP 6.2) in SWx
  - A meeting was held with COSPAR/PRBEM members to discuss revisions to the PRBEM Data Analysis Procedure document for standardization of Cross-Calibration.
  - In addition to cross-calibration of high-energy electrons, it was decided to address cross-calibration of solar wind observations (particle and magnetic field observations) at L1 point.

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Main outcomes and future work

- Spacecraft Anomaly Database Task Group
  - The compiled anomaly database since 2015 is available on the CGMS website on the SWCG page.
  - The compilation of new data covering 2024 has so far only been achieved for EUMETSAT satellites. Especially in view of the significant space weather events of 2024, CGMS members operating satellites are encouraged to provide their anomaly lists
    SWCG/A51.01: Expand extent of anomaly data feedback
  - EDAC data collected by EUMETSAT has been proven to be useful for analysis and assessment by SWx scientists
    - **SWCG/A53.XX**: CGMS Members operating satellites to produce EDAC data covering 2024 and report on ability to supply historical and future data.
  - SPARK tool developed by NASA as repository for CGMS anomalies
    - **SWCG/A53.XX**: Assess suitability of SPARK database tool as repository for CGMS anomalies, including data access criteria, metadata needs and standardisation.

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Main outcomes and future work

- Data Access Task Group (HLPP 6.5-6.6)
  - Work by the group in collaboration with WMO ET-SWx clarified different aspects to be handled distinctly:
    - Data access mechanisms
      - **SWCG/A53.XX**: Review usage plans and implementation status for improved data access through heritage, new and future mechanism infrastructures, learning lessons from terrestrial data access approaches
    - Data formats
      - **SWCG/A53.XX**: Draft WMO-CF profiles with improved metadata in coordination with WMO ET-SWx, ISES, COSPAR and research community and proposed follow-up activities

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Main outcomes and future work

- Ionospheric Radio Occultation Task Group (HLPP 6.4 and 1.1.4)
  - Refined the capability table of ionospheric RO missions
  - Developing a capability table of antenna assets that can support reduction of ionospheric RO latency
  - Continuing Observing System Simulation Experiments (OSSEs) in support of requirement definition
  - Enhancing coordination with the IROWG Space Weather Subgroup
  - Continuing assessment of OSEs/OSSEs, including potential Space Weather ROMEX-like experiment
    - **SWCG/A50.03**: Establish requirements for and recommend an implementation of an optimised system for radio occultation observations for ionosphere monitoring

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Main outcomes and future work

- Space Environment Sustainability (HLPP 6.7)
  - Related actions have been transferred to dedicated Task Group under WGI
  - Currently, there is a gap in (near real-time) thermospheric density observations for operational users
  - GNSS Precise Orbit Determinations are valuable in that respect
    - Advance GNSS POD applications to atmospheric density estimation
    - Global collaboration among space agencies, research groups, and satellite operators for cross-verification and data sharing.
    - Open-source software and databases supporting POD-based thermospheric density retrievals.
    - Expand POD-equipped LEO satellite constellations for continuous global coverage of the thermosphere
    - **SWCG/A53.XX**: Assess possibility to share satellite orbit data to estimate atmospheric drag.

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Key recommendations to plenary

- Operational thermospheric density measurements are crucial to effective space traffic coordination and collision avoidance. Specific items are proposed to be added to HLPP with associated actions to improve observations and modelling and establish this as a baseline activity within 1 to 2 years.
- Improved auroral observations were identified as needed by the aviation users and new operational satellite systems are planned by CMA and ESA and foreseen to become part of the baseline.
- Ionospheric RO is recommended to undergo a dedicated risk assessment in 2026 as distinct needs become better defined.
- CGMS satellite anomalies compiled since 2015 is published on the CGMS website on the SWCG page.
  However, only a few CGMS members are currently providing data and the objectives of the database cannot be achieved without more data from CGMS members and other operators.
  A new anomaly database tool "SPARK", developed under NASA contract, containing advanced analysis features allowing correlation with space weather effects and allowing protection of sensitive data is ready for evaluation by the CGMS agencies.
- SWCG Terms of Reference will be reviewed and updated, based on the CGMS Future Directions Project outcomes and inputs from the Task Groups for presentation to CGMS-54.
- Due to the increasing importance to CGMS members of operational space weather observational systems, the maturing of capabilities and future expansion plans, it is recommended to plan for a dedicated space weather coordination agenda point as part of the CGMS-54 plenary.
- Plenary invited to endorse Jim Spann (NOAA) as co-chair of SWCG, following departure of Elsayed Talaat (NOAA).

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Review of HLPP

➢ New item proposed for addition to HLPP

Ref	Target	Primary responsible for target in CGMS	Summary/highlights of progress (as reported at last CGMS)	Overall Status
6.8	Work on comparing different measurement strategies/techniques for characterising thermospheric environment.	SWCG	New actions have been raised regarding the use of POD data for determination of thermospheric environment at satellite altitudes. CMA plans inclusion of mass spectrometer on FY3-J.	

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