REPORT OF THE 54th PLENARY SESSION OF THE COORDINATION GROUP FOR METEOROLOGICAL SATELLITES

EXTRACT
Joint WGI-WGIV-SWCG

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Report prepared by the WGI, WGIV and SWCG rapporteurs

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CGMS MR 54

PARALLEL WORKING GROUP SESSIONS

JOINT WGI, WGIV AND SWCG REPORT

Co-Chairs:
Rapporteur: *WGI / Karolina Nikolova & SWCG / Andrew Monham*

1. Welcome, objectives and review of agenda

SWCG Acting Chairs Dr. Zong Weigou and Dr. Juha-Pekka Luntama, supported by Rapporteurs Ms. Karolina Nikolova and Simon Elliott, welcomed the participants, consisting of representatives from CMA, ESA, EUMETSAT, IROWG/JCSDA, ISRO, JAXA, JMA, KARI, KMA, NASA, NICT, NOAA and WMO (see Annex 1 for full list of participants).

Apologies were received from SWCG Co-Chair, James Spann for not being able to attend on-site, due to family reasons and also from SWCG Co-Chair, Tsutomu Nagatsuma who has announced he will be stepping down as Co-Chair following the CGMS-54 WG meetings.

The participants reviewed and adopted the draft agenda proposed by the CGMS Secretariat prior to the meeting.

1.1 Item 8.1 from WGI: International cooperation

Highlights of the outcome of the International Conference on Spacecraft Mission Operations (SMOPS-2026), (Nandini Harinath (virtually))

ISRO/ISTRAC provided a short report on the outcome of the SMOPS-2026 conference (instead of in WGI due to time constraints)

Nandini extended thanks and greetings from Benguluru. The presentation provided a brief overview of the International Conference on Spacecraft Mission Operations (SMOPS-2026). The technical programme of the conference was presented. It spanned over 4 technical sessions and included 120 oral presentations, 80 poster presentations. Three panel discussions were held with over 1000 attendees. Three plenary sessions were held on the topics of “Turning Design into Achievement”, “Mission OPS Strategy & Future Roadmap” and “Ground Segment and Constellations”. 15 best paper awards were given. There were 18 key talks and 7 interactive sessions. There were 23 Indian industries participating. Proceedings are to be published in Acta Astronautica.
EUMETSAT D/OPS was present at the conference, CGMS Secretariat extended thanks on his behalf.

2. Space weather spacecraft anomaly report database [40']

CGMS-54-SWCG-WP-03 Report on progress of the Space Weather Spacecraft Anomaly Database Task Group (Andrew Monham)

The Space Weather Spacecraft Anomaly Database Task Group objective is to promote the collection of spacecraft anomaly data as the data source for space weather actors, to analyse the impact of space weather on satellite systems. Particularly to improve:

- spacecraft design robustness
- support the spacecraft operations community with space weather warnings and improved post-event anomaly analysis
- tools modelling space weather effects

Data collection from CGMS agencies and other sources remains problematic, although NOAA have provided some (GEO) data for the first time, along with the more regular inputs from ESA and EUMETSAT.

CGMS needs to establish what measures can be taken to overcome barriers in supplying the data. It is suggested that historical anomaly data might be considered to be supplied from these operators (which may be considered less sensitive?) such that value assessment can be made against archived space weather data.

The compiled anomaly database since 2015 is available on the CGMS website on the SWCG page: Space weather coordination group – CGMS – Website.

Strong backing for this activity is received from UN COPUOUS with the published Long-Term Sustainability Guidelines specifically encouraging support to this CGMS activity. The CGMS/WMO compliance matrix has been published on the CGMS website.

Study work on the SPARK tool under NASA/NOAA contract is now being finalised. This provides an excellent anomaly database structure with strong security and data analysis features. CGMS must now decide whether this platform can be supported, both conceptually and financially. A dedicated presentation from the developer on the latest status is provided separately.

Following the recommendation from the CGMS-53 NICT analysis of 2023 EUMETSAT EDAC, further, more expansive collection of EDAC data in EUMETSAT has been performed and it is confirmed that EUMETSAT tools should allow a systematic collection, if desired, in the future. NICT is presenting a new analysis of the latest data separately (see below). ESA could collect data if requested on specific adhoc events. With no response from other agencies, it is recommended to define historical reference periods for collection and analysis (assuming agreed participation of further agencies).

Discussion

- It was stressed in the discussion that feedback is needed to get a sense of what is needed in order to be able to provide data. When looking at historical data, how far back in do we need to go to overcome the barriers to sending more recent data? There have been indications that sharing data from instruments rather than satellite platforms may be easier to access (components not shared with other satellites involved in national security for instance. If there is no way to get the data, we should just admit that.

- It was agreed to close the general action SWCG/A51.01 on expanding the extent of anomaly feedback with the more specific proposed actions. Some rewording / combination of functional anomaly and EDAC analysis was made – please refer to the action list below. Note that for the historical analysis, it was proposed that 3 periods should be considered:
    - Quiet conditions at solar min
    - Quiet conditions at solar max
    - Active conditions at solar max
- It was agreed to close the action SWCG/A53.06 "Assess suitability of SPARK database tool as repository for CGMS anomalies, including data access criteria, metadata needs and standardisation", based on the positive feedback made from the Task group. New, specific actions on the way forward are proposed (see below). Regarding the funding, it was estimated that about 50% FTE would be needed to secure maintenance of the tool, without further expansion of functionality.

CGMS-54-NICT-WP-03 Trend analysis of satellite anomalies using EDAC data (Tsutomu Nagatsuma)

Space environment effects such as single event upsets (SEUs), surface charging, and deep dielectric charging are major causes of satellite anomalies. These effects are driven by solar energetic particles, galactic cosmic rays, and variations in magnetospheric energetic particles associated with substorms and geomagnetic storms. To mitigate minor anomalies, spacecraft commonly implement error detection and correction (EDAC) techniques, which provide a valuable record of space environment–induced disturbances.

This study analysed long-term trends of EDAC events observed by LEO satellites, Sentinel-3B and Metop-C, using EDAC data provided by EUMETSAT. EDAC occurrences were examined separately inside and outside the South Atlantic Anomaly (SAA). For Sentinel-3B, EDAC events outside the SAA showed a decreasing trend from 2023 to 2025, potentially reflecting reduced galactic cosmic ray flux during the current solar maximum. Within the SAA, EDAC events also exhibited a slight decline, which may be associated with a contraction of the high-flux region of the SAA.

For Metop-C, EDAC events were compared with onboard space environment monitor data. A clear log-linear relationship was identified between EDAC occurrence and proton flux, with the strongest correlation observed for protons above 16 MeV. Notably, the EDAC event rate in 2025 was higher than in 2023, suggesting a possible contribution from material degradation.

These results demonstrate that combining long-term EDAC records with space environment data enables the separation of environmental effects from aging-related instrument degradation, supporting improved satellite risk assessment and spacecraft design validation.

Discussion

- Concerning material degradation, noting extent of SAA might have been changing, it was discussed whether a multiple linear regression to disentangle the multiple potential sources of change had been considered. This was agreed to be an interesting idea, noting also that the

spectral shape of SAA is changing and should be analysed before drawing a conclusion. ESA are making a mission which will monitor component sensitivity to space environment effects (launch after 2028).

- See overall discussion of EDAC from the TG report and related actions below.

CGMS-54-GUEST-WP-02 Spacecraft Anomaly Resolution Knowledgebase SPARK, exploring and analysing CGMS anomalies (Alec Engell (NextGen) (virtually))

The SPARK tool has been developed under a NASA/NOAA study contract in the US. This tool provides powerful data analysis capabilities both within the tool and allows additional private data analyses with external data in the NASA Heliocloud. CGMS anomalies, as well as NASA anomalies have been ingested (although CGMS currently do not have access to the NASA data). On-boarding / demonstration sessions can be arranged.

Discussion

- See overall discussion of SPARK from the TG report and related actions below.
- Link to tool is here: Space Weather Analyst™ Space Weather Analyst™

Joint WGI, WGIV and SWCG agreed the following actions.

CGMS-54 ACTIONS - Joint WGI, WGIV and SWCG					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
SWCG Anomaly TG	Joint-WGI-WGIV-SWCG/2		CGMS Members operating satellites to suggest measures to enable satellite anomaly data supply.	SWCG-IS#1 (24 Sept. 2026)	
SWCG Anomaly TG	Joint-WGI-WGIV-SWCG/2		CGMS Members operating satellites to supply Functional anomalies and EDAC events over two/three historical time periods to be defined within the Task Group and organise analysis.	SWCG-IS#1 (24 Sept. 2026)	
SWCG Anomaly TG	Joint-WGI-WGIV-SWCG/2		CGMS Members to decide whether SPARK should become the baseline repository of CGMS anomalies, define access preferences (centralised vs federated)	SWCG-IS#1 (24 Sept. 2026)	
SWCG Anomaly TG	Joint-WGI-WGIV-SWCG/2		CGMS Members to identify source of further SPARK funding.	SWCG-IS#1 (24 Sept. 2026)	

3. Space weather data access

CGMS-54-SWCG-WP-05 Report from the CGMS SWCG Task Group on improving user data access to space weather data from orbital sensors (Andrew Monham)

The Task Group on Improving User Data Access to Space Weather Data from Orbital Sensors helps glue together the feedback obtained from the various outreach activities of SWCG:

- Data Provider and User Surveys conducted 2017-2019
- CGMS-User meetings held in space weather workshops in Europe, USA and Asia
- CGMS-International Space Environment Service coordination meetings (http://www.spaceweather.org/)

And identifies the priorities for improving the provision of CGMS Agency space weather sensor data to operational users.

The Task Group has been active with wide participation of all representing relevant roles of data providers and users, holding 3 meetings and a number of outreach events to external parties in workshops in Europe, USA.

Furthermore the group is cooperating closely with the WMO Expert Team on Space Weather.
Based on identification of priorities, the group has made progress in:

- Analysing the needs for space-based observational data to support the ICAO mission
- Assessing the suitability and usage of current and planned data access mechanisms available to the agencies
- Further developing the approach to format and metadata usage in coordination with the WMO-ET-SWx

Work is set to continue to mature these tasks before CGMS-55.

CGMS-54-WMO-WP-20 Report on the work of the WMO ET-SWx Task Team on Latency Assessment (Simon Elliott)

The WMO Expert Team on Space Weather is interested in the scope for timely exchange of small data sets. WIS 2.0 is being considered as a candidate architecture to support this. A Task Team on Data Latency has been set up comprising Simon Elliott (EUMETSAT), Kirill Kholodkov (RAS), Joaquim Eduardo Rezende Costa (INPE), and Kasper van Dam (KNMI) with support from Zoya Andreeva and Heikki Pohjola from WMO. Work is well underway preparing for the assessment campaign. It is planned for the second quarter of 2026. The outcome of the latency assessment will be provided as input to the Expert Team on Space Weather.

The current status of WIS 2.0 was presented. The dataflow in WIS 2.0 and interaction between consumer, supplier, global broker and global cache was provided. Assessment campaign to start soon. The assessments will offer an objective measure of the time to get small data sets from a supplier to multiple consumers world-wide using the existing WIS 2.0 infrastructure. Due to regulatory constraints, the approach is only valid for payloads less than 4096 bytes. Timeliness in the order of 1 second is expected. The Space Weather community (through WMO ET-SWx) can use this information

when considering options for data exchange. Results from first campaign were presented for 40 hours, during which 2106 messages were transferred with no losses with a mean time delay of 0.197s and standard deviation of 0.014s.

Discussion

- It was discussed whether this timeliness would hold true where a large number of simultaneous requests for data are being processed. Due to the use of MQTT, it was expected that this should not impact performance.

CGMS-54-GUEST-WP-03 Formats and Metadata for operational space weather data: progress on clarifying scopes and next steps (Edmund Henley (virtually))

As a discipline, space weather lacks some key standards on variable naming and coordinate reference frame identification which have helped terrestrial weather advance, and build ecosystem of tools able to automagically use & combine observation and model data from many sources. The lack of standardised formats and metadata in operational space weather data from space incurs friction penalties on users, hidden from providers. See CGMS-52 for details, CGMS-53 for big-picture.

This presentation details progress on discussing with space weather research community. As more countries address space weather operationally, CGMS providers should consider what can be done to make their observation data more intercomparable. And how to balance aiming for compatibility with standards & practices in terrestrial weather, and the space weather research community (a key user).

Since CGMS-53, progress has been made to engage with those in the research community who we in the operational world rely on disproportionately in space weather (compared to terrestrial weather):

- Discussions on metadata + data at IHDEA 2025
- Getting some of this into the literature – notably via COSPAR-PSW ISWAT roadmap papers.

Recommended scope for any CGMS work: focus on operations layer (ISES, WMO ET-SWx) – get needs for this. Also: consider resuming cheap strawperson trial on datafile layer, continue engaging with research community.

Discussion

- The complexity of the problem is recognised. ISES and other users have been asked for their input in the past, and SWCG will do again. But experts always muddle through somehow, and ISES and most other users consulted are experts so may not give the answer needed. Is really about seeking funding. HAPI for 1-dimensional data and SPASE for higher dimensional data sets seems to have potential, within a NetCDF format. It is recommended to keep the current action open and discussion to converge on a solution will continue at forthcoming US SWW in Boulder and at the next Task group meeting.

Commented [AM1]: Please check this makes sense, in particular that a NetCDF format can contain the HAPI and SPASE data

CGMS-54-NOAA-WP-23 Analysis and next steps in meeting needs of ICAO space weather service (Erin Lynch (virtually))

The results of an ICAO Space Weather Centres poll on their needs for space-based observations were presented. An analysis of the data needed to support the ICAO mission was conducted within the SWCG Data Access Task Group was conducted to assess:

- How the needs are currently being met
- Plans for ensuring continuity in the future
- Potential gaps.

Discussion

- The rationale for ICAO requiring space-based radio burst measurements, rather than a ground-based solution was not understood. It was noted that there are no plans for a space-based system. Reference is made to the action raised in the SWCG meeting: *"Review OSCAR space-based gaps and identify which ones may be covered by ground-based sensors."*. Needs of ICAO will be assessed in this context. It was also noted in this respect that Europe has inaugurated a new radio telescope, but ground-based coordination is needed for the global network. It was agreed that the ICAO requirements should not need to specify the source of measurement data, but specify the needs which CGMS and ISES can attribute to space and ground sensor requirements.
- Concerning purchase of commercial Radio Occultation data, it is needed to avoid duplication through agency coordination. This is done for the neutral atmosphere RO data. It was noted that the CGMS-52 endorsed a Best Practice on "Relationship with the private sector Commercial data purchases" which includes the issue of avoiding data buy duplication: CGMS-best-practice-document-Relationship-with-the-private-sector-for-commercial-data-purchases.pdf
- SWCG will meet with ISES in the upcoming US SWW and discuss with ICAO SWx representative about what is there, not there, planned, not planned, in order to manage expectations.
- The current action can be closed.

4. Ionospheric Radio Occultation system optimisation

CGMS-54-SWCG-WP-14 Report from the CGMS SWCG Task Group on Ionospheric Radio Occultation System Optimisation (Erin Lynch (virtually))

The Task Group on Ionospheric Radio Occultation System Optimisation was formed at CGMS-50 to address the full scope of HLPP (6.4):

- In coordination with IROWG establish requirements for and recommend an implementation of an optimised system for radio occultation observations for ionospheric monitoring. All documentation is available on the Google Drive

The task group benefits from the participation of ionospheric RO experts along with representatives of the CGMS RO data providers. Three meetings were actively supported. Progress has been made in:

- Refining the capability table of ionospheric RO missions

- Developing a recommendation for the GNSS RO baseline for ionospheric observations
- Assessing NOAA's OSSE and architecture study to understand requirements

Discussion

- The long-standing action: "Establish requirements for and recommend an implementation of an optimised system for radio occultation observations for ionosphere monitoring" can be closed, as it is both the Terms of Reference for the Task Group and the HLPP. Work to fulfil this is the key objective of the Task Group.
- The TG also addressed the existing action coming from the Risk Assessment Workshop; "The SWCG to make a recommendation to WGIII how to separate RO and Ionospheric Electron Density profiles in the CGMS Baseline and the risk assessment documents". The action is closed with the proposed update to the CGMS Baseline.

5. Space environment sustainability Space Weather aspects

CGMS-54-SWCG-WP-08 Space weather issued addressed by the Space Environment Sustainability Task Group (Juha-Pekka Luntama)

The presentation was deferred from the Joint meeting due to time-pressure and instead held within the SWCG meeting. It provides a summary of the ongoing space weather related actions in the Space Environment Sustainability Task Group:

- WGI/A53.08: Review current usage of space weather data for spacecraft operations and goals for improvement
    - Specific request made for CGMS Member agencies to provide inputs to the ESA-provided space weather SESTG STC approaches Excel sheets.
    - ESA was requested to provide more details in these SWx Excel sheets to facilitate comparison with other agencies' approaches and achieved accuracies.
- WGI/A53.09: Produce a report of space weather observation requirements for improved STC services and space sustainability
    - To be produced following delivery and analysis of inputs from WGI/A53.08
        - Identification of services where performance is not sufficient
        - Identification of missing or insufficient observations
        - Identification of existing data sources that are not utilised effectively
    - Outputs:
        - Report allowing CGMS members to identify means to provide missing or better observation data
        - Establishing access or sharing existing data that are not utilised

CGMS-54-ESA-WP-06 Use of GNSS for thermospheric density determination (Myrto Tzmali)

Dedicated electrostatic accelerometers have flown on four geodetic missions (CHAMP, GRACE, GRACE-FO, Swarm). These instruments measure all non-gravitational surface forces: atmospheric drag, solar radiation pressure, Earth albedo, and thruster firings. Accelerometer-derived densities are

the observational gold standard: accuracy of ~2–5% under nominal conditions. They have underpinned all major empirical density models (DTM, NRLMSISE, JB2008).

The challenges on accelerometers were presented. Despite the challenges, accelerometer-derived densities at 400–550 km remain irreplaceable for orbit prediction, reentry forecasting, and space weather research. There is an observational gap as only a handful of satellites carry dedicated accelerometers - severely limiting global coverage in local time and latitude.

Discussion

- No comments.

CGMS-54-NOAA-WP-11 Update on thermospheric density measurements from satellites with GNSS Precise Orbit Determination (POD) (Irfan Azeem (virtually))

The thermosphere, extending from approximately 80 to 600 kilometers above the surface influences various space-based activities, including satellite operations and space traffic management. Global Navigation Satellite System (GNSS) Precise Orbit Determination (POD) is an innovative solution for monitoring thermospheric density, improving understanding of upper atmospheric variability and space weather. An increasing number of LEO satellites are now being equipped with POD antennas for navigation, highlighting the growing importance of precise orbital tracking. To fully realize the benefits of this technology, international collaboration is essential to proliferate thermospheric density data ,enhance data reliability, and enable standardization and interoperability of data across international missions and platforms.

Discussion

- It was suggested this could be challenging, noting data could come from fleets, individual providers, with heterogeneous inputs. The preference is to get data through the GNSS measurements: ranges, pseudo-ranges and phase offsets.
- Consensus on what to include in radiation models is needed, potentially through another workshop.
- NOAA would like to do another pilot study with some data from the commercial sector and a bigger team looking at those data.
- It was agreed to raise an action to coordinate the cross verification and data sharing of POD for thermospheric density verification and to advocate for a workshop.

Joint WGI, WGIV and SWCG agreed the following actions.

CGMS-54 ACTIONS - Joint WGI, WGIV and SWCG					
Actionee	**AGN item**	**Action #**	**Description**	**Deadline**	**Status**
SWCG	Joint-WGI-		SWCG to coordinate for cross-verification and data sharing of	CGMS-55	

	WGIV-SWCG/5		POD for thermospheric density application		

6. 6 AI/ML [15']

CGMS-54-CGMS-WP-38 Report on preliminary outcome of the survey on AI/ML (Paolo Ruti) 53.07

It was noted that this presentation is from WGII and this joint session is used to expand the audience.

There is a strong community interest in making EO data and services more AI-ready, but maturity remains uneven across agencies: Few agencies are already advancing with roadmaps, pilot services, Spatio-Temporal Asset Catalogues (STAC) adoption, cloud-native formats, and AI-oriented access approaches, while others remain in planning or early exploration phases.

Agencies consistently highlight that users need a usable access for efficient implementation into ML workflows (efficient data filtering and extraction, chunking, machine-readable metadata, provenance, and practical tooling). There is demand for a shared AI/ML catalogue, mainly to avoid duplication, accelerate uptake, improve benchmarking, and strengthen collaboration.

Challenges reported by users remain concentrated around data access speed, preprocessing burden, interoperability across sources, standards maturity, and platform or usage constraints. There is clear interest in a community coordination on best “AI-ready” EO practices under a CGMS–WMO framework, with respondents indicating that joint guidance, shared practices, and lightweight coordination mechanisms would be useful next steps.

Discussion

- ESA commented that in space weather applications, different AI/ML models are used for different observations, such as F10.7 for orbit predictions compared with sun spot identification. It may not be feasible to use a common approach.
- Results are considered to be the first steps. Use cases can be identified and feedback provided and shared with the space weather community.
- It was noted that the survey focussed on AI/ML pipelines for discoverability of different fields.

7. Review of actions

The status of all actions emanating from this Joint WG meeting is presented in the CGMS-54 SWCG Report.

8. AOB

It was noted that topics presented were mainly of concern to both SWCG and WGI, whereas WGIV interest was limited to the data access agenda point. It was therefore recommended to consider structuring the Joint meeting differently for the CGMS-55 WG sessions.

9. Next steps and conclusions

The Chairs thanked the participants for their contributions and productive discussions.

LIST OF WORKING GROUP PARTICIPANTS

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