

国連宇宙空間平和利用委員会宇宙天気専門家会合活動報告

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Activity Report on the Space Weather Expert Group of the Committee Of the Peaceful Use of Outer Space (COPUOS) in the United Nations (UN)

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Key Words: Space Weather, Expert Group, UN, COPUOS

Abstract

This paper describes the current activity of the expert group for space weather, which was established under the working group for the long-term sustainability in the space activity in 2011. The expert group has been working to make guidelines and recommendations for past three years. By now, five guide lines with recommendations were discussed. We like to demonstrate above issues with a hope that attendants and readers consider more about the long-term sustainability in the outer space. The final document will appear in 2014.

1. 宇宙天気専門家会合設立の背景

国連宇宙空間平和利用委員会(UN COPUOS)は、56年前に国連の宇宙活動の平和利用支援のために設立され、これまで月面の平和安全利用、宇宙ステーションの平和安全利用などについて、国際協調の視点から、技術的・法的に検討を続けて来ている。

今般、宇宙デブリの異常な増加に伴う宇宙活動の安全性への危惧が高まりつつある中で、2010年に「宇宙活動長期的持続ワーキンググループ」をスタートさせた。ワーキンググループへの付託事項は以下の通りとなっている。

- i) 地球の持続可能な開発を広義に捉え、ミレニアム開発目標の達成への貢献とすべく、宇宙活動の長期的持続可能性について、宇宙の平和利用と整合を取った検討を行う。
- ii) ミッションライフサイクルの全フェーズを通じた宇宙活動を安全に行うため、運用手順、技術標準及び政策などに関する現在のプラクティスを考慮に入れる。
- iii) 既存の宇宙条約等の法的枠組みを受入れる。

ワーキンググループの議長には、南アフリカのピーター・マルチネス博士が就任し、同議長の元で、実行計画案が策定された。

これを受けて、同ワーキンググループ傘下に、4つの専門家会合が作られたが「宇宙天気専門家会合」はその一つである。

宇宙天気専門家会合では、共同議長システムが採用され、筆者とカナダ・アルバータ大学のイアン・マン教授が宇宙天気専門家会合の共同議長に選出され、2011年後期から活動を開始した。

2. 目的と活動計画

宇宙天気専門家会合の目的は、マルチネス議長らによる実行計画に基づき、以下の4点に集約されている。

- i) Collection, sharing and dissemination of data, model and forecast tool (データ、モデル、および予報に関する情報の収集、共有、および配布)
- ii) Capabilities to provide a comprehensive and sustainable network of sources of key data in order to observe and measure phenomena related to space weather in real time or near-real time (リアルタイム・準リアルタイム観測と持続的データ交換をサポートする情報ネットワーク)
- iii) Open sharing of established practices and guidelines to mitigate the impact of space weather phenomena on operational systems (宇宙天気影響軽減するための手法およびガイドラインの非制限的共有)
- iv) Coordination among State on ground-based and space-based space weather observations in order to safeguard space activities (安全な宇宙活

動遂行を目的とした、地上と宇宙からの観測に関する各国調整)

以上の項目に対して、本専門家会合では、2種類の文書を準備する事を合意した。それらは、グループレポート(報告書)と、ガイドラインである。

(1) グループレポートは、各国ならびに国際的な範囲で活動する機関からの、最新の宇宙天気活動にかかわる情報、すなわち観測の状況、モデルの開発状況、衛星などへの影響に関する取組などについて、情報を収集し、それを統括的にまとめる。

(2) ガイドライン文書は、宇宙天気のリスクの評価と、宇宙天気影響を低減する手法、技術標準などの開発について、ベストプラクティスを紹介しつつ、統括的にまとめる。

宇宙天気専門家会合では、年に3回の会合を持ちながら、上記の成果物を2014年2月までに仕上げるスケジュールで進んでいる。

3. 基本的な考え方

すでに各国や各機関で、宇宙天気の観測、モデル開発、予報ツールの開発が行われているが、それらの状況を調査し情報を共有・公表する。世界の情報を意図的に集めるのは今回が初めてであり、宇宙天気の関連機関において有用な情報となる。

リアルタイム・準リアルタイムで、キーになるデータを継続的に提供するネットワーク機能の確立は重要である。数あるデータの中で、何がキーになるかを議論することは必要である。データ提供に関する調査を、ネットワークの特徴と合わせて調査することは、今回が初めてであり宇宙天気の関連機関において有用な情報となる。

確立されているプラクティスは、各国で異なっている。衛星設計の考え方、基礎となる設計標準(スタンダード)も違っている。事情や状況がそれぞれ異なっているので、すべての公開は難しいかもしれないが、できるところから公開を進めてもらい、共有することで、スタンダードのアップを目指す姿勢を、本専門家会合は持っている。

3.1 報告書

現在、作成を進めている報告書の章立て、各章のエディターは、下のようになっている。

1. Executive summary (Editor in chief; Ray Williamson)
2. Introduction (Jim Head, Werner Schmutz, Dalmiro Maia, Karel Kudela)
3. Identification of risks from space weather (Ken Murata, Vladimir Kuzentsov)

4. Current practices and procedures (Takahiro Obara)

5. Coordination among States on data and services to safeguard space activities (Jerome Lafeuille, Jim Head)

6. Guidelines and Recommendations for space actors (Ian Mann)

報告書は、全体で50ページになる予定で、英語で出版される。

3.2 ガイドライン

上記の考え方を確認・合意して、以下の5項目のガイドラインを議論している。

表1 現在議論されているガイドライン項目

Guideline 1	Support and promote the collection, archiving, sharing, inter-calibration and dissemination of critical space weather data (データの共有、相互利用)
Guideline 2	Support and promote further coordinated development of advanced space weather models and forecasting tools in support of user needs (モデル、予測ツール開発の情報交換)
Guideline 3	Support and promote the coordinated sharing and dissemination of space weather model outputs and forecasts (モデル出力、予測情報の共有)
Guideline 4	Support and promote the collection, sharing and dissemination of the data and access to information relating to best practices for mitigating the effects of space weather on terrestrial and space-based systems and related risk assessments (データ並びに減災技術情報へのアクセス)
Guideline 5	Promote the education, training and capacity-building required for a sustainable global space weather capability (啓蒙・教育)

現在、専門会合では上記の各項目に対して、模範例(Best Practice)を具体的に挙げる作業を行った。(詳細は次ページ以降の付録を参照されたい)

4. おわりに

先に述べたように、本専門家会合からは、ガイドラインと報告書が提出されるが、これらは、長期的宇宙活動持続ワーキンググループにて、国連の公式文書に組み込まれて、2014年に世界に公表される。

【付録】以下に、専門家会合で議論されたベストプラクティス・ガイドラインの全文を付す。

Synopsis of Candidate Guidelines and Best Practices

1. Preamble

This document represents a synopsis of the current draft of the guidelines and best practices defined through the work of Expert Group C for Long-Term Sustainability of Outer Space Activities following its meetings during the COPUOS STC in Vienna in February 2013. Specifically, it provides a snapshot of the revisions to the draft guidelines initially circulated during the STSC meeting as a conference room paper (CRP 13) and which were further developed by Expert Group C during its meetings in Vienna.

These guidelines are expected to be further revised by the Expert Group in subsequent inter-sessional work, and in the future, before their amalgamation into the report of the Working Group (WG) on the LTSSA. Where these have been determined to date, the section of the WG report where the guideline or best practice will appear as per CRP10 is indicated in parentheses. Future work from the Expert Group intends to directly associate each Expert Group guideline or best practice with a specific subsection from Sections 6 and 7 in the WG report as per CRP10.

2. Guiding Principle

Member States and their national and international agencies should take all reasonable measures to protect vulnerable space- and ground-based assets from the adverse effects of space weather in order to maintain the satellite-based services upon which human technological systems increasingly rely, including preventing the creation of related space debris.

3. Guidelines and Recommended Practices

The scope of Expert Group C is set forth in the Terms of Reference (TOR) for the Working Group on LTSSA. The topics relevant to Expert Group C are:

TOR-1. Collection, sharing, and dissemination of data, models, and forecasts;

TOR-2. Capabilities to provide a comprehensive and sustainable network of sources of key data in order to observe and measure phenomena related to space weather in real or near-real time;

TOR-3. Open sharing of established practices and guidelines to mitigate the impact of space weather phenomena on operational space systems;

TOR-4. Coordination among States on ground-based and space-based space weather observations in order to safeguard space activities.

For each guideline below we have provided traceability to the specific item in the terms of reference to which it refers in parentheses following the guideline text.

Guideline 1: Space weather entities, and member states and national and international organisations, should support and promote the collection, archiving, sharing, inter-calibration and dissemination of critical space weather data. (TOR-1; TOR-4)

Note that throughout this document the term “data” in the candidate guidelines and best practices is used to define the complete collection of information required to work with the measured data, including, but not limited to: the data itself, and any related meta-data including state-of-health and data quality indicators or other relevant information. Ideally this might also include the means to read the data, and where appropriate and feasible could include related tools for reading the data, applying calibration supplied by the instrument teams, and analysis tools, as appropriate. Note also that it is implicit that the guidelines are intended to cover all historical, current and future critical space weather datasets.

Note some of the work relating to Guideline 1 (and in fact Guideline 2) could be done in association with the WMO Inter-Programme Coordination Team on Space Weather (ICTSW).

Recommended Practices:

1.1 Member States and their national and international agencies should engage experts in identifying data sets critical for space weather services and research.

1.2 Member States and their national and international agencies should adopt policies for the free and unrestricted sharing of critical space weather data from their space- and ground- based assets. [6(b)]

1.3 All space actors and government, civilian and commercial space weather data owners are urged to allow the free and unrestricted access to and archival of such data for mutual benefit. [7.]

1.4 Member States and their national and international agencies should share real-time and near-real-time critical space weather data and data products.

1.5 Member States and their national and international agencies should:

- i Cross- and inter-calibrate critical space weather data and data products.
- ii Openly share critical space weather data and data products in a common format.
- iii Adopt common access protocols for their critical space weather data and data products.
- iv Promote the interoperability of space weather data portals promoting ease of data access by users and researchers.

1.6 Member States and their national and international agencies should undertake a co-ordinated approach to identify measurement gaps in order to meet critical space weather needs.

1.7 Member States and their national and international agencies should undertake a co-ordinated approach to maintain long-term continuity of space weather observations, and to fill key measurement gaps, in order to meet critical space weather needs.

1.8 Space actors including Member States and their national and international agencies are urged, to fly small and low power integrated payload for space weather science and monitoring whenever and wherever possible

(e.g., radiation monitors on Earth-orbiting satellite missions).

Guideline 2 : Member States and their national and international agencies should support and promote further co-ordinated development of advanced space weather models and forecast tools in support of user needs. (TOR-2)

Recommended Practices:

2.1 Member States and their national and international agencies should engage experts in a coordinated approach to document space weather research, user needs, and operational models as well as forecasting tools currently in use, and assess them in relation to space weather science, service and user needs.

2.2 Member States and their national and international agencies should undertake a co-ordinated approach to identify gaps in research and operational models and forecasting tools required to meet space weather science, service and user needs.

2.3 Member States and their national and international agencies should undertake a coordinated approach to fill gaps in models and forecasting tools needed to meet space weather needs. Where necessary this should include coordinated efforts to support and promote research and development to further advance space weather models and forecast tools.

Guideline 3: Member States and their national and international agencies should support and promote the coordinated sharing and dissemination of space weather model outputs and forecasts. (TOR-1)

Note that throughout this document the term “space weather model outputs and forecasts” in the candidate guidelines and best practices is intended to include, but not be limited to: outputs from space weather models and tools, space weather now-casts and fore-casts, space weather alerts and warnings, various space weather services and products, which can include visualizations and other relevant information as appropriate.

Recommended Practices:

3.1 Member States and their national and international agencies should identify high priority needs for space weather models, space weather model outputs, and space weather forecasts.

3.2 Member States and their national and international agencies should adopt policies for the free and unrestricted sharing of space weather model outputs and forecasts [6(b)]

3.3 All government, civilian and commercial space weather model developers and forecast providers are urged to allow the free and unrestricted access to and archival of space weather model outputs and forecasts for mutual benefit, which will promote research and development.

3.5 Member States and their national and international agencies should encourage their space weather service providers to:

i Undertake comparisons of space weather model and forecast outputs with a goal of assessing their metrics and comparative performance towards the goal of improved model and forecast accuracy.

ii Openly share and disseminate historical and future critical space weather model outputs and forecast products in a common format.

iii Adopt common access protocols for their space weather model outputs and forecast products to the extent possible, to promote their ease of use by users and researchers including through interoperability of space weather portals.

iv Undertake coordinated dissemination of space weather forecasts among space weather service providers and to operational end users.

[Guideline 4: Member States and their national and international agencies should support and promote the collection, sharing, dissemination and access to information relating to best practices for mitigating the effects of space weather on terrestrial and space-based systems and related risk assessments. (TOR-3)]

Recommended Practices:

4.1 Member States and their national and international agencies are urged to:

i Submit, to a common archive, documentation outlining best design practices, guidelines, and lessons learned relating to the mitigation of the effects of space weather on operational systems.

ii Submit, to a common archive, documentation and reports relating to space weather user needs, measurement requirements, gap analyses, cost-benefit analyses, and related space weather assessments.

4.2 Member States and their national and international agencies should provide support to enable their national agencies, satellite operators, and space weather service providers to work towards the development of international standards and best practices applicable for the mitigation of space weather effects on satellite design.

4.3 Member States and their national and international agencies should support and promote co-operation and coordination on ground-based and space-based space weather observations, forecast modelling, satellite anomaly and space weather effects reporting, in order to safeguard space activities.

This could be done in collaboration with ISES and WMO.

4.4 Member States and their national and international agencies should:

i Incorporate current, now-cast and fore-cast space weather thresholds into space launch commit criteria.

ii Provide support to enable their satellite operators to work together with space weather service providers to identify the information that would be most useful to mitigate anomalies and to derive recommended specific guidelines for best practices for on-orbit operation. For example, if the radiation environment is hazardous, this might include actions to delay the uploading of software, action maneuvers, etc.

iii incorporate the capability to recover from a debilitating space weather effect, such as including a safe mode, in satellite designs.

iv Incorporate space weather effects into satellite designs and mission planning for end of life disposal in order to ensure that the spacecraft either reach their intended graveyard orbit or de-orbit appropriately, in accordance with the UN COPUOS Space Debris Mitigation Guidelines. This should include appropriate margin analysis.

4.5 Member States and their national and international agencies should:

- i Encourage the collection, collation and sharing of information relating to ground- and space-based space weather related impacts and system anomalies, including spacecraft anomalies
- ii Encourage using a common format for reporting the information. In relation to the reporting of spacecraft anomalies, the CGMS template provides an excellent candidate approach.
- iii Encourage policies promoting the sharing of satellite anomaly data such that the satellite anomaly archive is available to all Member States.

Expert Group C acknowledges that some data may be subject to legal restrictions and/or protection of proprietary or confidential information. Note that the Coordination Group for Meteorological Satellites (CGMS) requested the WMO to recommend a template for the information to be included in satellite anomaly reports. The WMO space weather team, the Inter-Programme Coordination Team for Space Weather, has now submitted to CGMS a template that was recently recommended by The Aerospace Corp. in the United States. A process of collation of satellite anomaly information and a Satellite Anomaly Mitigation (SAM) portal for the archiving and access to this anomaly data is also in development at the NOAA National Geophysical Data Center (NGDC).

4.6 Member States should undertake an assessment of the risk and socio-economic impacts of the adverse space weather effects on the technological systems in their respective countries. The results from such studies should be published and made available to all Member States.]

Guideline 5: Member States and their national and international agencies should promote the education, training and capacity building required for a sustainable global space weather capability. (TOR-3)

Given the WMO already has extensive training programs in relation to terrestrial weather, Expert Group C considers expanding this to also include space weather training would be valuable since it would leverage their existing infrastructure and capabilities.

Recommended Practices:

5.1 Member states and their international organizations should encourage space weather training in space weather workshops.

Examples of training opportunities include US Space Weather Workshop, European Space Weather Week and AOSWA workshop, ISWI schools, and the UN Space Science and Technology Education Regional Centres.

4. Candidate Recommendations for Consideration by UN COPUOS STSC

Under the terms of reference of the LTSSA Expert Groups, areas which have been identified during the course of the work can also be highlighted and brought to the attention of STSC. Below, Expert Group C forwards two candidate Recommendations which we believe should be considered by the COPUOS STSC for potential further study and evaluation. These relate to long-term sustainability issues but which go beyond a purely space weather consideration. We propose that the Final Report from the WG for LTSSA should include such Recommendations, as well as the related practices, in the Implementation section for STSC consideration.

Candidate Recommendation 1: Member States and their agencies should work through the United Nations COPUOS and related international organizations to develop a basis for the coordination of ground and space based research and operational infrastructure to ensure the long term continuity of critical space weather observations. (TOR-2)

Related Practices:

Member States should work through the Space Weather Agenda Item for the COPUOS STSC in order to provide a mechanism for the coordination of ground and space based infrastructure to ensure the long term continuity of critical space weather observations.

Members States should work through the COPUOS STSC to implement a process to evaluate the impact and review the progress of the implementation of the guidelines including coordination of ground and space based infrastructure to ensure the long term continuity of critical space weather observations. Reviews should be completed at least every 5 years.

Candidate Recommendation 2: Member States and their national and international agencies should investigate the coordination of space weather information, including observations, analyses and forecasts, to support decision making and risk mitigation related to the operation of satellites, spacecraft, and sub-orbital vehicles including rockets and vehicles serving manned spaceflight including for space tourism. (TOR-4)

Note: In co-ordination with the considerations of the other Expert Groups, this recommendation could form the basis for a cross-cutting proposition for consideration by the LTSSA Working Group for the study of the means and feasibility of delivering a space equivalent to ICAO, including a potential role in “Space Traffic Control”.