United Nations Committee on Peaceful Uses of Outer Space (COPOUS):

Space Weather Expert Group


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Thanks to Karel Schrijver, Chair of COSPAR-ILWS Space Weather Roadmap Team.
United Nations COPUOS

• UN Committee on Peaceful Uses of Outer Space (COPUOS) formed in 1959, and was responsible for 5 space treaties, and was set up by and reports to UN General Assembly.

• COPUOS now has 84 member states with interests in space, and around 30 permanent observers (intergovernmental and non-governmental organizations including WMO, SCOSTEP, etc).

• Works on basis of consensus to:
  – Promote information sharing and international cooperation in peaceful uses and exploration of outer space under UN auspices
  – Study legal matters related to the use and exploration of outer space.

• COPUOUS has two Subcommittees: Scientific and Technical Subcommittee (STSC) and the Legal Subcommittee.

• STSC approved regular Space Weather agenda item in 2013.
Heritage of Space Weather in COPUOS

• Builds on work of Expert Group C (Space Weather) in Long-Term Sustainability of Outer Space Activities (LTS) in UN Committee on Peaceful Uses of Outer Space (COPUOS). 2011-2015.

• New Space Weather Expert Group with Rapporteur, reporting to UN COPUOS under permanent agenda item approved Feb. 2015 in Vienna.

Opportunity to define activities of the Space Weather Expert Group to meet needs of international community for 2018-2030.
*Space Weather* has a wide range of impacts on terrestrial and space-based infrastructure. International co-ordination and collaboration is critical to understand and quantify impacts and for *future critical infrastructure protection*.

UN – Long-Term Sustainability of Outer Space Activities program resulted in approval of new space weather guidelines by COPUOS in 2016.
On a curious Appearance seen in the Sun.
By R. Hodgson, Esq.

“While observing a group of solar spots on the 1st September, I was suddenly surprised at the appearance of a very brilliant star of light, much brighter than the sun’s surface, most dazzling to the protected eye, illuminating the upper edges of the adjacent spots and streaks, not unlike in effect the edging of the clouds at sunset; the rays extended in all directions; and the surrounding brilliancy of the image telescope with its glass and lenses, and disappeared when the glass was removed, an equa-

Description of a Singular Appearance seen in the Sun on September 1, 1859. By R. C. Carrington, Esq.

While engaged in the forenoon of Thursday, Sept. 1, in taking my customary observation of the forms and positions of the solar spots, an appearance was witnessed which I believe to be exceedingly rare. The image of the sun’s disk was, as usual with me, projected on to a plate of glass coated with distemper of a pale straw colour, and at a distance and under a power which presented a picture of about 11 inches diameter. I had secured diagrams of all the groups and detached spots, and was engaged at the time in counting from a chronometer and recording the contacts of the spots with the cross-wires used in the observation, when within the area of the great north group (the size of which had previously excited general remark), two patches of intensely bright and white light broke out, in the positions indicated in the appended diagram by the letters A and B, and of the forms of the spaces left white. My first impression was that by some chance a ray of light had penetrated a hole in the screen attached to the object-glass, by
Global infrastructure and economies are connected regionally and globally.

Space weather impacts are inter-connected.

Need to understand impacts for critical infrastructure protection.

Acknowledgements: The EURISGIC project was supported by EU’s 7th Framework Programme. The animation is based on the work by Juri Katkalov (Polar Geophysical Institute, Russia) and Magnus Wik (NeuroSpace, Sweden) (both now at the Swedish Institute of Space Physics).
Space Weather Risks

- **High Impact:** Can have very high socio-economic impact on wide range of ground and space-based technological infrastructure (~$10s B to perhaps upto ~$1-2 Trillion; Baker et al., 2008).

- **High Likelihood of Extreme Event:** Comparatively high likelihood of extreme event (e.g., 23 July 2012 event – Baker et al., 2013). According to Riley (2012) probability of extreme event happening in the next decade might be as high as ~12%.

- **Impacts span all Space Weather Activity Levels:** Even modest space weather can have significant impacts (e.g., Schrijver et al., 2014; Schrijver and Mitchell, 2013).

- **Impacts are Regional:** Different geographical regions are vulnerable to different space weather; these need to be understood.

- **New Science and Applications Research:** Advances require both increased scientific understanding of the space weather processes as well as better applied research of impacts and mitigation.
Advancing space weather science to protect society's technological infrastructure: a COSPAR/ILWS roadmap

chaired by

Karel Schrijver and Kirsti Kauristie

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COSPAR site: http://tinyurl.com/swxrm

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Tracing impacts & predicting space weather

Electrical systems

Geomagnetic variability
Most significant use: protection of power transmission networks
Focus on post-eruption

Navigation/Comm.

Ionospheric variability
Most significant use: Adv. knowledge of navigation & communication
Focus on post-eruption

(Aero)Space assets

Particle environment
Most significant use: post-eruption NRT satellite anomaly resolution, and design specs
Focus on post-eruption & pre-flare

2-day forecast

Initiation of severe space weather: observations of coronal images and coronagraphic observations
multi-height pre-eruption (vector-) magnetic field and flows, (including off Sun-Earth line) measure/validate initial direction, velocity, and magnetic field

Magnetohydrodynamic propagation model through background solar wind, based on global coronal field knowledge

L1 in situ measurements; validation of model magnetic field

1/2 hour forecast

Model for the reconfiguration of the magnetosphere/ ionosphere system driving strong GICs,
based on multi-point in-situ measurements in the transition region from dipolar to stretched field and the connected regions below, supported by coordinated ground-based networks.

Model for ionospheric storms driven by geomagnetic and magnetospheric field measurements, neutral-atmosphere measurements and (regional) assimilative modeling, including plasma bubbles

High-res. nowcast of electron density and near-term forecast based on NRT data assimilation and NRT model result distribution

SEP, RB, GCR
In situ SEP measurements of energy spectra and composition at L1 and elsewhere in the inner heliosphere.

Model for location-specific particle populations (supported by X/EUV and radio observations)

(calibrated) SEP, RB, substorm energetic particle properties

archive of past conditions
Geomagnetic field measurements
Ionospheric conditions

extreme-event properties
Geomagnetic & ionospheric models combined with flare/CME observations and models, combined with observed statistics of flaring on Sun-like stars
Terrestrial/lunar radionuclide data with

Domain: solar, heliospheric, geospace
Deployment of new/additional instrumentation, to add to existing observational resources and to modeling capabilities to be developed soon:

I-1: Quantify active-region magnetic structure for nascent coronal ejections

I-2: Solar wind-magnetosphere-ionosphere coupling inducing strong GICs

I-3: Global corona to drive models for the solar-wind plasma and field

I-4: Quantification of the state of the magnetosphere-ionosphere system

II: Data-driven dynamic radiation-belt modeling

III: Solar energetic particles in the Sun-Earth system

Binocular vision for the solar corona

Active-region cube imaging

In-situ SEP measurements in inner heliosphere

Radiation belt models

Magnetotail-to-ionosphere probes

Coordinated ground-based networks

Global solar field models & observations

Auroral imaging

artist’s impression

www.nasa.gov
UN Space Weather Expert Group
(UN COPUOS STSC)

• **Mandate:** Promote awareness, provide guidance, and enable communication and cooperation in space weather related activities among Member States and related national and international organisations.

• **Focus:** To promote awareness, communication, and provide guidance and enable cooperation in space weather related activities.

• **Specific actions and definite outcomes:** Ensure that the work is complementary to other space weather coordination activities such as those within the WMO, ISES, COSPAR, ILWS, ICAO etc.
With new understanding of both increased likelihood and impact of space weather, international coordination is essential.
Potential Prioritisation of Space Weather in UN COPUOS for 2018-30

• UN COPUOS defining Thematic Priorities for 2018-2030.

• Space Weather under consideration as Thematic Priority 4: Developing an International Framework for Space Weather Services. (TP-4 report available for download from UN).

• Priorities discussed at June 2018 COPUOS meeting at UNISPACE+50. To be defined further over next 2 years.

EG seeks feedback and input to this process
Potential COPUOS SW Foci (2018-30)

- **WHEN:** *Important to know when to act.*
  - *International Space Weather Warning Network?* Cf. UN International Asteroid Warning Network (IAWN)?

- **WHAT:** *Important to know what to do.*
  - Promote study of *socio-economic and risk impact studies* in member states.
  - Promote engagement of *Critical Infrastructure Protection* administrations in Member States.
  - Promote definition of *actionable operational responses*.
  - Improve modeling and R2O – action teams under UN/COSPAR via CCMC SWAT.

- **HOW:** *Define appropriate mechanism/administration to meet space weather needs in UN context.*
  - Suggesting a potential *International Meeting/Workshop on Space Weather in 2019* to kick-off of the post-2018 Space Weather actions.
  - Define future administration in UN context – proposal to form an *International Coordination Group on Space Weather (ICGSW)* in 2020.

- **SCIENCE:** New science research needs to be prioritized at UN Member State and international agency level. How best to promote and achieve this?

UN COPUOS has political influence for communication and coordination with and between Member States; implementation expected to be delivered by other entities (WMO, ISES, national space weather plans etc).
Future UN Focus for 2018-30

- Space Weather Expert Group via TP-4 proposes formation of potential new "International Coordination Group for Space Weather" (ICGSW).

- Could provide forum for space weather stakeholders to promote improved international communication and collaboration, incorporating formal membership of appropriate space weather stakeholder organisations.

- If approved, the ICGSW could replace the UN Space Weather Expert Group with appropriately modified Terms of Reference and Mandate etc.


UN COPUOS has political influence for communication and coordination with and between Member States; implementation expected to be delivered by other entities (WMO, ISES, national space weather plans etc).
Contacts:

Provide discussion and feedback here (e.g., to Ishii-san), to member(s) of the Expert Group, or by email (for example to):

- Prof. Ian R. Mann, University of Alberta (Canada). Chair and Rapporteur for the UN COPUOS Expert Group on Space Weather. (imann@ualberta.ca)

- Prof. Hermann Opgenoorth, Swedish Institute of Space Physics (Sweden).

- Dr. Terrance Onsager, NOAA/NWS/Space Weather Prediction Center (USA)

- Dr. Mamoru Ishii, NICT(Japan), etc.
Back-up Slides
Early UN COPUOS Space Weather Expert Group Recommendations:

• Make better use of existing data and models for space situational awareness, now-casting, and forecasting;

• New scientific research need for improved space weather forecasting: endorsed COSPAR-ILWS Space Weather Roadmap 2015-2025;

• For improved fidelity of severe space weather scales and indicators in forecast products, identified the need for regional forecast products, and (as appropriate) ongoing or increased access to real-time data;

• Promote increased collaboration between research and operational communities to transition new research findings into improved space weather products including situational awareness, now-casting, and forecast products.
UN COPUOS Space Weather Expert Group Work Plan

- Examine the report and conclusions of the **LTS Expert Group C** on space weather ([A/AC.105/C.1/2014/CRP.15](http://example.com)) and other information related to space weather including the recent report from the **COSPAR-ILWS Roadmap team “Understanding Space Weather to Shield Society”**. The group will examine the guidelines, recommendations and best practices to **identify mechanisms to promote their implementation, including an assessment of prioritization**. [year 1]

- **Complete an inventory of relevant United Nations organisations**, including the World Meteorological Organisation (WMO) and International Civil Aviation Authority (ICAO) and others, **and those within Member States and national and international organisations**. Identify and assess their role in the global space weather effort, **promote coordination and communication between them**, and ensure that the efforts of STSC are complementary. [years 1-2]

- **Promote increased and expanded member State involvement** in providing **space weather monitoring**, from the ground and in space, and in **developing, advancing, and sharing and delivering space weather services**. [years 2-4]

- **Report yearly to the COPUOS STSC** on its progress.