



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

New Space Weather Expert Group

Prof. Ian R. Mann

Chairman and Rapporteur

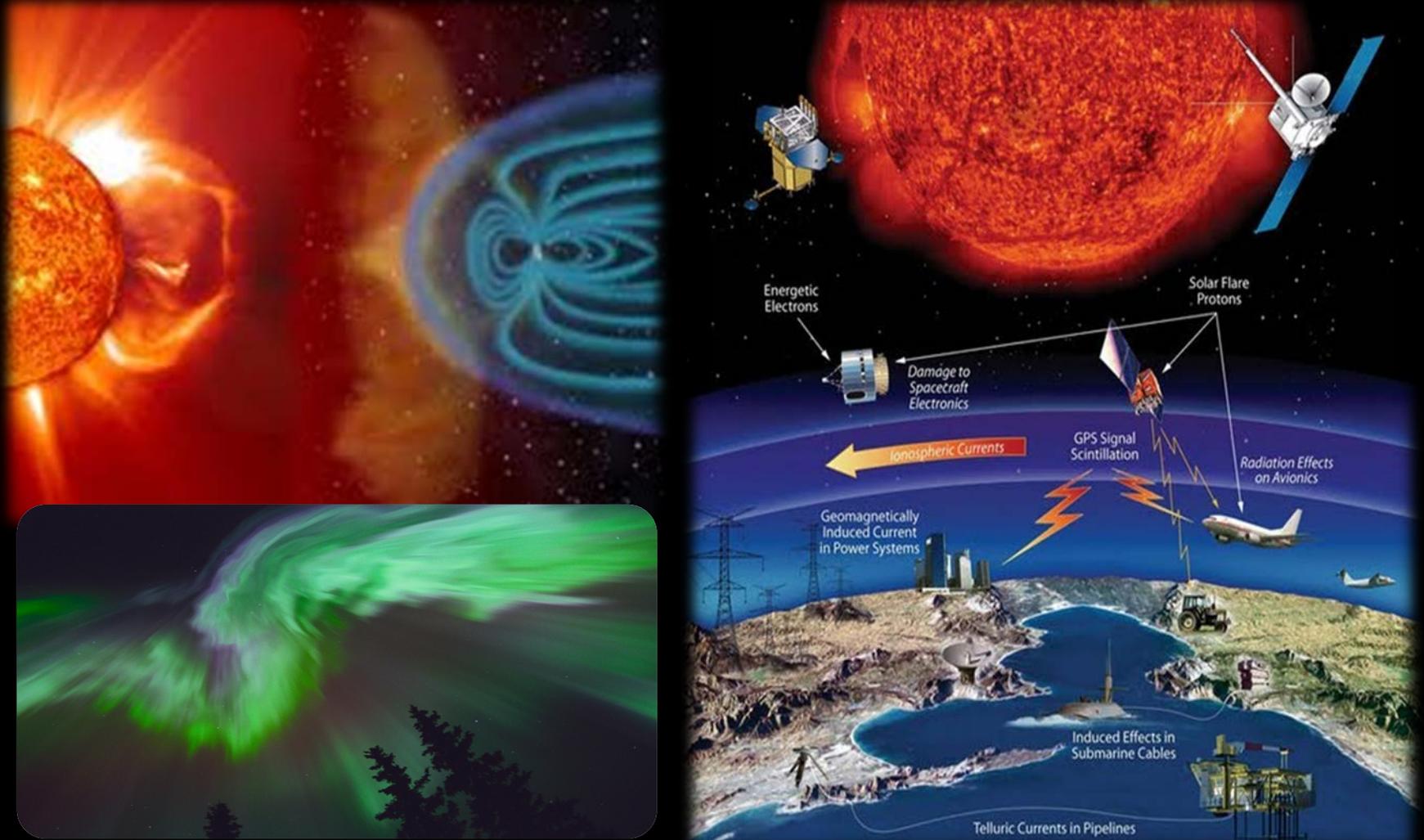
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Thanks to Karel Schrijver, Chair of COSPAR-ILWS Space Weather Roadmap Team.

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*.



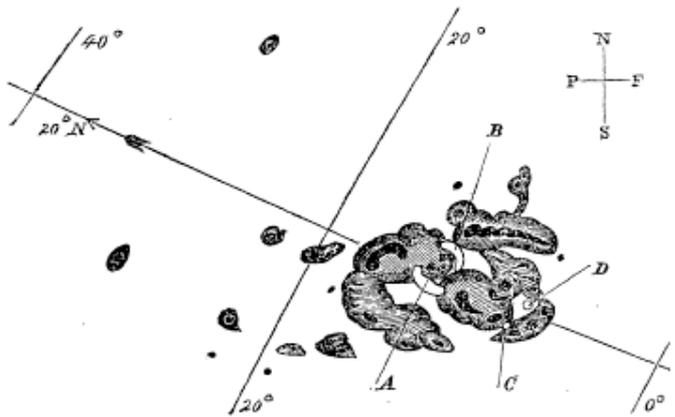
Solar flaring and the connection to geospace: discovered in 1859

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

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

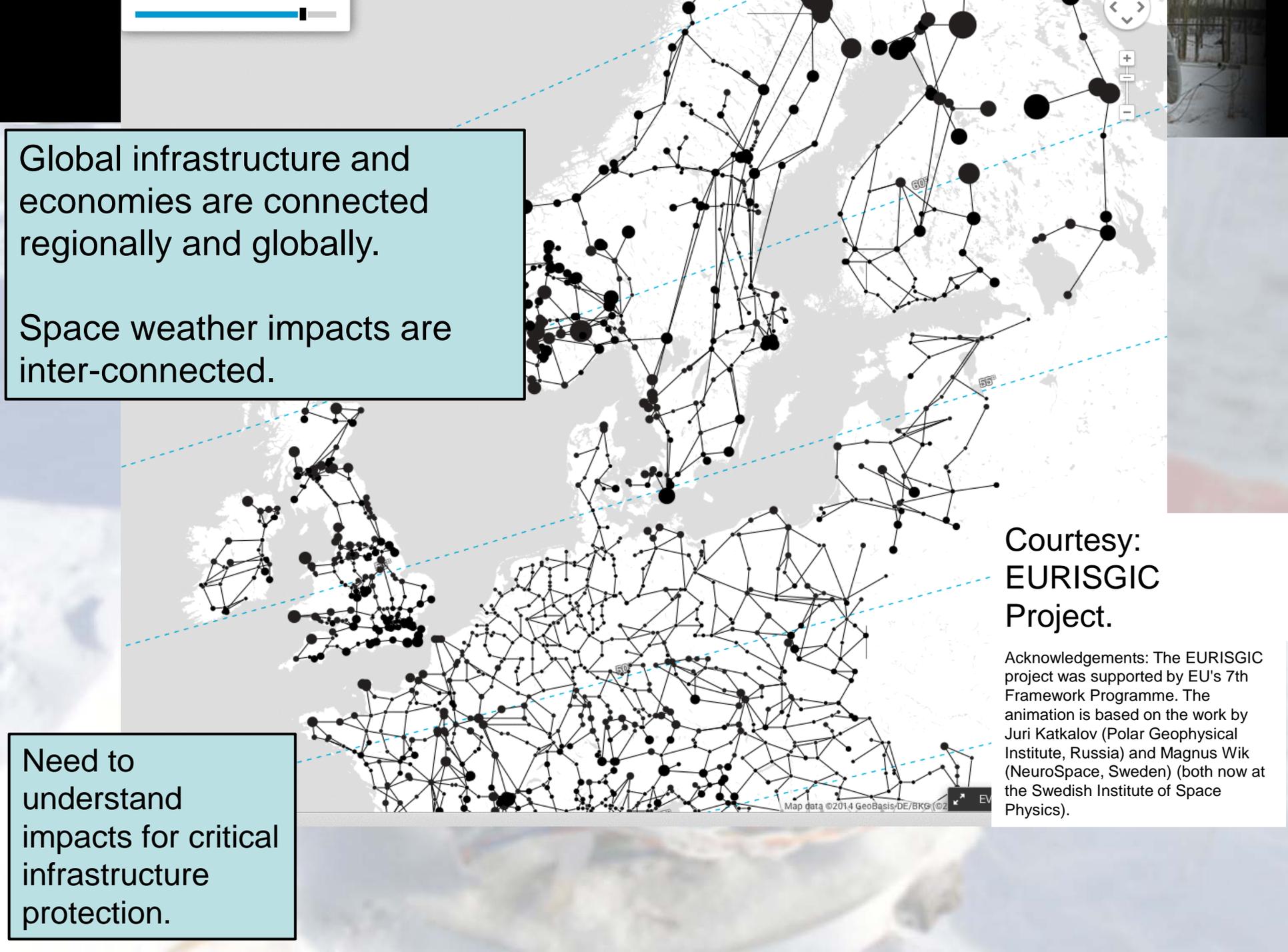


first impression was that by some chance a ray of light had penetrated a hole in the screen attached to the object-glass, by

ing brilliancy of the
ge telescope with
es, and disappeared
pe used, an equa-



eol.jsc.nasa.gov



Global infrastructure and economies are connected regionally and globally.

Space weather impacts are inter-connected.

Need to understand impacts for critical infrastructure protection.

Courtesy:
EURISGIC
Project.

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.



...laws and institutions must go hand in hand with the progress of the human mind. As that becomes more developed, more enlightened, as new discoveries are made, new truths discovered and manners and opinions change, with the change of circumstances, institutions must advance also to keep pace with the times.

Thomas Jefferson.



UN Space Weather Expert Group

- 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.



Heritage

- 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 future as 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 new Space Weather Expert Group to meet needs of international community.



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 (cf. 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: A/AC.105/C.1/2016/CRP.17.

15-17 February 2016 Space Weather Workshop and UN Expert Group findings.

Advancing space weather science to protect society's technological infrastructure: a COSPAR/ILWS roadmap

chaired by

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and

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

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- Hermann Opgenoorth; Swedish Institute of Space Physics, Sweden
- Karel Schrijver, chair; Lockheed Martin ATC, USA
- Michael Terkildsen; IPS Radio and Space Services, Australia
- Cesar Valladares; Boston College, USA
- Nicole Vilmer; LESIA Observatoire de Paris, France

Highest-priority recommendations in brief

In a collaborative international effort:

Research: observational, computational, and theoretical needs

1. “Augment the system observatory”
2. “Initial focus: Know what \bar{B} is coming”
3. “Initial focus: Establish the GDM-GIC response”
4. “Quantify conditions to expect”

Teaming: coordinated collaborative research environment

- I. “Uncover susceptibility”
- II. “Focus resources”
- III. “Ease access to data”
- IV. “Grow coverage affordably”

Bridging communities: collaboration between agencies and communities

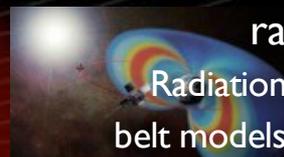
- A. “Trust partners”
- B. “Learn about SWx and its impacts”
- C. “Evolve priorities and coordinate”
- D. “Make use of advancing knowledge”
- E. “Avoid duplication and mistakes”

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



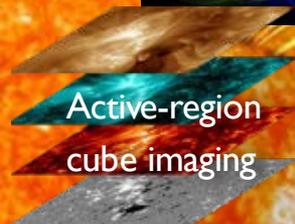
Binocular vision for the solar corona

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



II: Data-driven dynamic radiation-belt modeling

Radiation belt models



Active-region cube imaging



In-situ SEP measurements in inner heliosphere

III: Solar energetic particles in the Sun-Earth system

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



Global solar field models & observations

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

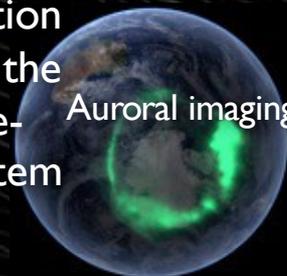


Magnetotail-to-ionosphere probes

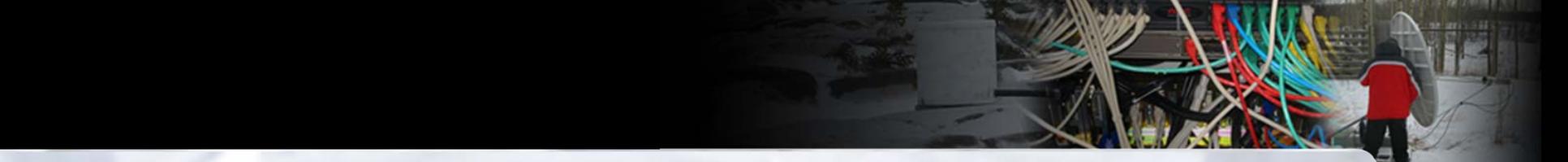


Coordinated ground-based networks.

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



Auroral imaging



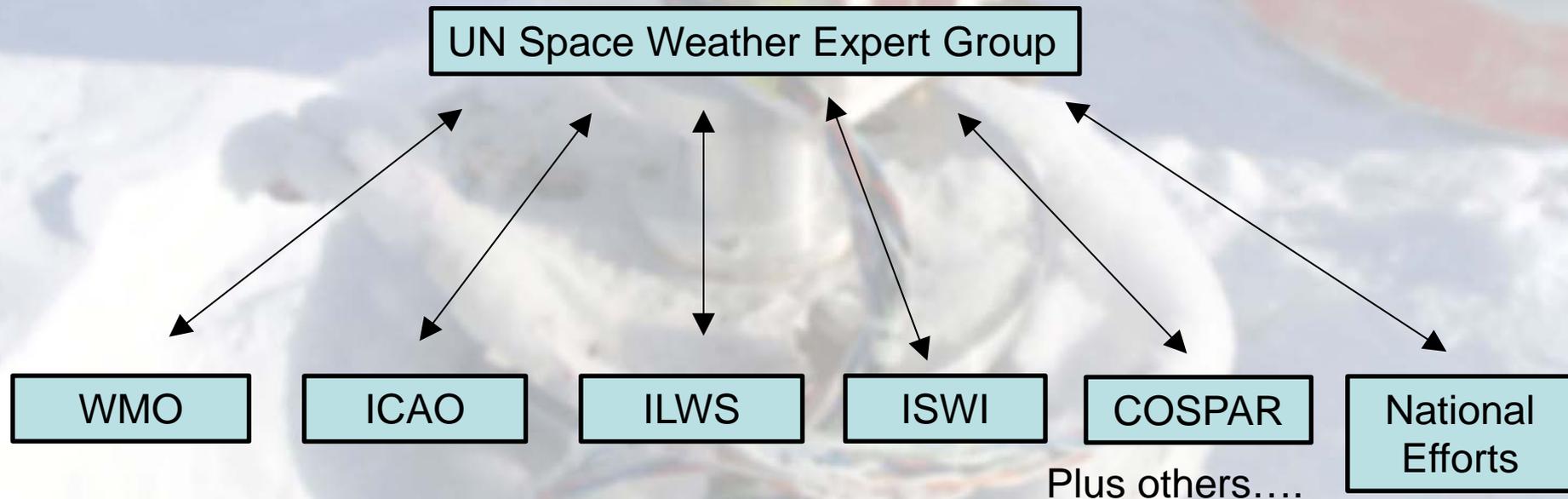
Expert Group Foci and Priorities:

- ***Geomagnetically Induced Currents (GICs) (Pathway I) be pursued as a first priority.*** Targets of space radiation and ionospheric impacts (Roadmap Pathways II and III) including GNSS to be examined later.
- New ***science research***, and maintaining and expanding ***observational and modelling capabilities*** is key.
- UN Expert Group efforts underway to promote national and international efforts to assess ***GIC impacts on national and regional scales***. Define ***worst case space environment***.
- Significant value in national ***space weather risk and socio-economic impact assessments*** and ***action plans*** in relation to ***critical infrastructure protection***, and space weather entries in national risk registers. Increasing recognition ***impacts are non-uniform and differ geographically***.
- National economies are connected both regionally and globally, so ***even countries with a perceived low domestic space weather risk can benefit*** from a global approach to mitigating space weather risks.

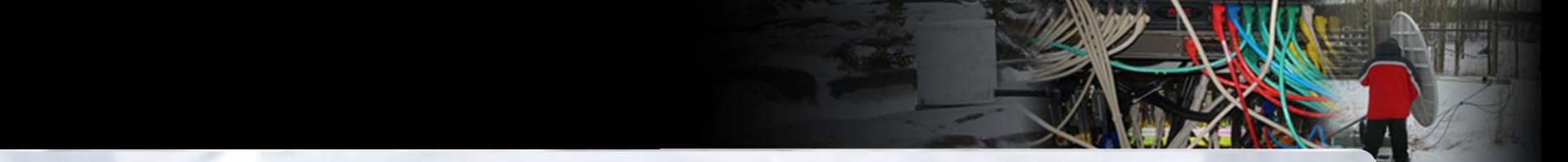


Active International Space Weather Efforts

Communication and ***Implementation*** of Best Practices?



With new understanding of both increased likelihood and impact of space weather, international coordination is essential.



Next Steps?

- Clear need for a forum to promote international coordination on space weather.
- Important question is how?
- Action team within UN COPUOS Space Weather agenda item perhaps utilising Space Weather Expert Group?
- Model on Near Earth Objects (NEO) Action Team 14 (international warning network etc)? Or an activity modelled on Inter-Agency Space Debris Coordination Committee (IADC) type activity for space debris? Or something else?

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