

International Committee on Global Navigation Satellite Systems (ICG): Space Weather and GNSS

**The ISWI Workshop on Space Weather: Science and Applications
2 – 3 November 2021**

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Office for Outer Space Affairs**



Global Navigation Satellite Systems

Global Constellations

- Global Positioning System (GPS, 24+3) of the United States,
- Global'naya Navigatsionnaya Sputnikovaya Sistema (GLONASS, 24+) of the Russian Federation,
- GALILEO (24+3) of the European Union, and
- BeiDou Navigation Satellite System (BDS, 27+3IGSO+5GEO) of China
- ***Satellite-based Augmentations:*** WAAS (3), SDCM (3), EGNOS (3), BDSBAS (3), GAGAN (3), MSAS (2), Australia SBAS (2)

Regional Constellations

- Indian Regional Navigation System/"Navigation with Indian constellation" (NavIC, 7) of India
- The Quasi-Zenith Satellite System (QZSS, 4+3) of Japan



International Committee on GNSS (ICG)

- UNOOSA serves as the executive secretariat of ICG
- Established in 2005, ICG provides a mechanism for multilateral discussion and coordination on GNSS issues of concern
- Encourages **coordination** among GNSS providers
- **Promotes** the introduction and utilization of GNSS services in developing countries
- **Assists** GNSS users with their development plans and applications
- Contributes to the **sustainable development** of the world
- Assure GNSS **interoperability and compatibility** among providers and users globally for enhanced services and applications





Membership

- **Members:** Current and future core, regional or augmentation systems providers:
 - **State Members of the United Nations** with an active programme in implementing or promoting a wide range of GNSS services and applications: Italy, Malaysia, United Arab Emirates, Australia, *New Zealand*
- **Associate Members and Observers:** 21 organizations
 - International & regional organizations and associations dealing with GNSS services and applications: UN system entities, IGOs, NGOs
- *ICG participation is open to all countries and entities that are either GNSS providers or users of GNSS services, and are interested and willing to actively be engaged in ICG work*
- **Annual Meetings:** UNOOSA (2006), ... India (2019), **Vienna (2021)**, UAE (2022), European Commission (2023)
 - *ICG-15 meeting, Vienna, AUSTRIA, 27 September – 1 October 2021*



ICG: Working Groups

- **Systems, Signals and Services (*United States & Russian Federation*):** Compatibility and spectrum protection; interoperability and service standards; system-of-system operations
- **Enhancement of GNSS Performance, New Services and Capabilities (*India, China & ESA*):** Future & novel integrity solutions; implementation of interoperable GNSS Space Service Volume (SSV) and its evolution; *examination of performance of atmospheric models, establish dialogue with space weather/RS community*
- **Information Dissemination and Capacity Building (*UNOOSA*):** Focused on education and training programmes, *promoting GNSS for scientific exploration (incl., space weather and its effects on GNSS)*
- **Reference Frames, Timing and Applications (*IAG, IGS & FIG*):** Focused on monitoring and reference station networks



Working Group Systems, Signals and Services (S)

The subgroup on compatibility and spectrum protection:

- continued its campaign to promote adequate protection of GNSS spectrum through education and outreach;

<http://www.unoosa.org/oosa/en/ourwork/icg/working-groups/s/IDMIndex.html>

- continued to investigate methods of implementing interference detection and mitigation capabilities through permanent network-based solutions and through crowdsourcing techniques

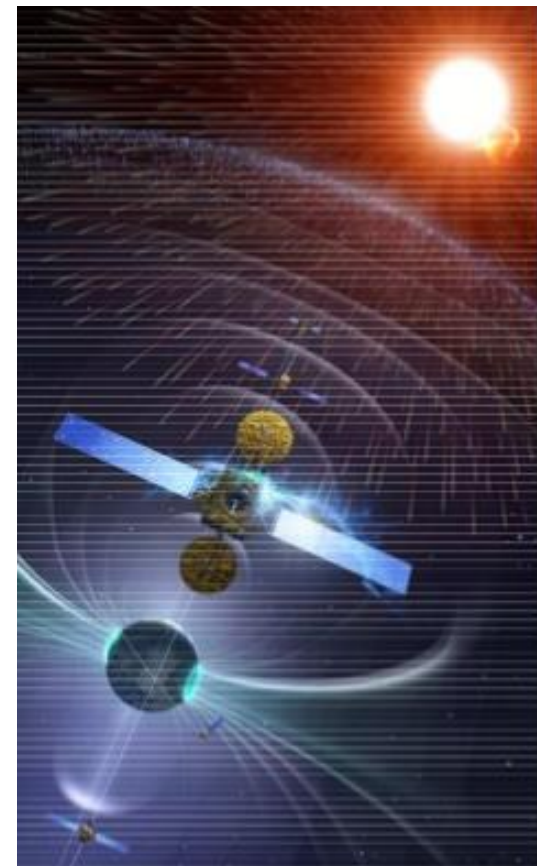
GNSS Spectrum Protection Booklet

- *Fundamentals of GNSS; Interference and Spectrum Management; Interference Threats; Methods of Interference Detection and Mitigation; Current Interference Challenges*



Working Group Enhancement of GNSS Performance, New Services and Capabilities (B)

- The importance of exploiting the multitude of signals broadcast by GNSS enabling better monitoring of **space weather phenomena** and progressing the understanding of the ionosphere
 - Examine the performance of atmospheric models to correct single frequency measurements and recommend models for implementation to Service Providers;
 - Establish a dialogue with Space Weather/Remote Sensing community in order to identify how GNSS can better support the advancement of Space Weather/Remote Sensing products and vice versa.





Working Group Enhancement of GNSS Performance, New Services and Capabilities (B)

- This publication, and the work of WGB, show the significant value of GNSS SSV for a much wider scope of future space exploration activities for countries all over the world.
- GNSS SSV and its potential augmentations can enable ambitious future missions and activities in the context of space exploration going beyond low-Earth orbit to the Moon, Mars and other celestial bodies.



https://www.unoosa.org/res/oosadoc/data/documents/2021/stspace/stspace75rev_1_0.html/st_space_75rev01E.pdf



Working Group Reference Frames, Timing and Applications (D)

- Studies have been conducted by some Providers and the timing community identifying several methods to improve their time offset determination and impact on positioning;
- Additional work is necessary for the Providers to assess the accuracy goals in the determination of the GNSS time offsets and impact on positioning, so as to specify a recommended method to determine and monitor them;
- To continue to work together (WG C and D) and contribute to capacity building on GNSS and utilization of GNSS in Geodesy and Reference Frames;



ICG: Programme on GNSS applications

- ❖ **United Nations Regional Workshops/training courses on the use and applications of GNSS**
 - to reinforce the exchange of information between countries and scale up the capacities in the region for pursuing the application of GNSS solutions;
 - to share information on the national, regional and global projects and initiatives, which could benefit the regions; and
 - to enhance cross-fertilization among them



ICG: Programme on GNSS applications

- **GNSS spectrum protection and interference detection and mitigation (WGS):** to engage with spectrum regulators and decision makers within their respective countries in order to do the following:
 - Ensure that there is a solid understanding of the processes and organizations involved in the regulation of the GNSS spectrum in respective countries;
 - Develop actions to ensure that there is adequate protection for the GNSS spectrum.
- **Standards and interoperability of precise point positioning services (WGS&B&D):** to increase the user benefits and opportunities to support PNT applications in developing countries.



ICG: Programme on GNSS applications

- **Sustainability and modernization of GNSS continuously operating reference stations and geospatial infrastructure through capacity development (WGD):** to provide information on the importance of planning and its link to the “why, what and how” of developing long-term capability with respect to GNSS and geospatial infrastructure and related activities:
- There was a need for standards and procedures that were “fit for purpose” , including consolidated checklists that would serve to ensure consistent and sustainable use of GNSS, and related activities in the regions;
- Engagement with the private sector, especially for training, data provision and processing, was encouraged.



Space Weather and GNSS

- *In cooperation with the Institute for Scientific Research at Boston College, in the United States, and the Abdus Salam International Centre for Theoretical Physics, Italy*
 - A series of outreach workshops on space weather effects on GNSS operations.
 - The lectures designed to give both theoretical and practical training on the physics of space weather and its effects on GNSS, through, for example, equatorial electrodynamics, scintillations and other ionospheric irregularities.





ICG: Programme on GNSS applications

2022: African Workshop on GNSS and Space Weather, Rabat, Morocco

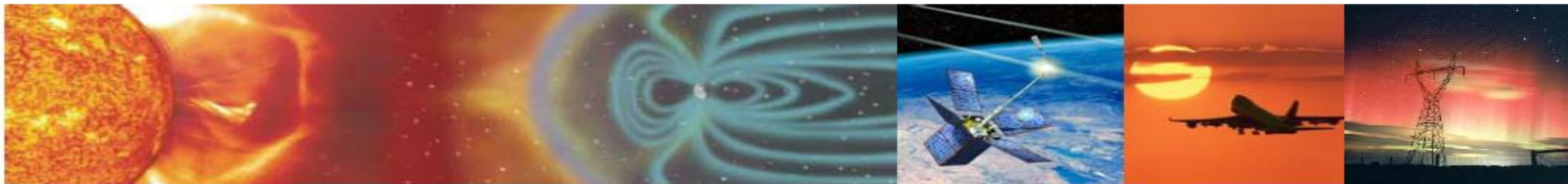
- To provide updated knowledge of how GNSS operate and their applications; to describe the science of SW; and how to perform ionospheric and SW research with GNSS data
 - Introduction to GNSS
 - GNSS Applications
 - Ionospheric Total Electron Content
 - Scintillation
 - Ionospheric Modeling
 - Space Weather
 - The Sun-Earth Connection
 - Hands-on laboratories





UNOOSA: Space Weather

- **2004:** Session of the Committee on the Peaceful Uses of Outer Space (COPUOS) called for addressing solar-terrestrial interaction: global climate, **space weather**, Sun-Earth-heliosphere-system
- **2005 - 2009:** Workshops and Follow-up projects: low-cost, ground-based world-wide instrument arrays, GNSS on board of instrument arrays (IHY: Instrument Array, Data, Teaching)
- **2010 - 2012:** STSC agenda item “International Space Weather Initiative” & ISWI Workshops (Egypt, Nigeria, Ecuador)
- **2013:** STSC agenda item “Space Weather”





Space Weather: A global challenge

- Space weather is increasingly becoming a central topic that requires
 - improved international coordination to respond to extreme space weather events, including an improved international data sharing.
- Space weather research and collaboration may help to
 - promote sustainable development through the prevention of catastrophic disruptions space critical infrastructure and space-based services





Space Weather: A global challenge

- There is a need to
 - Develop an improved basis for international monitoring, forecasting and warning procedures, especially in the form of more coordinated international communication and coordination of warnings of extreme space weather events
 - Define a set of best practices, operating procedures and actions to mitigate the adverse impacts of extreme space weather, which required a prior assessment in each Member States of its exposure to risks from space weather and related socioeconomic impacts, as well as defined operating procedures, developed in partnership with administrations responsible for critical infrastructure and civil protection



Space Weather: Capacity Building and Outreach

▪ **ISWI and ISWI Steering Committee**

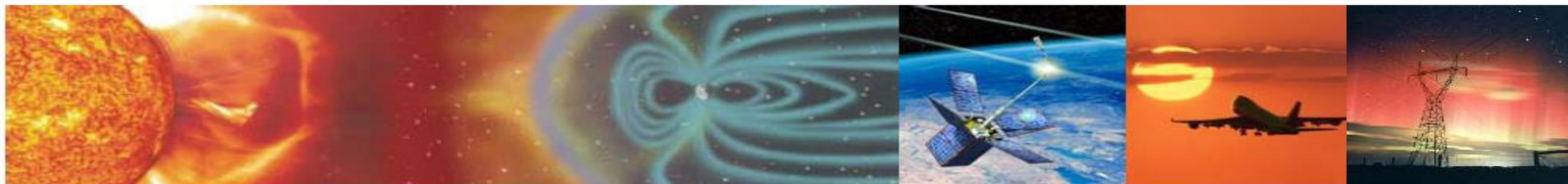
A programme of international cooperation to advance the space weather science by a combination of instrument deployment, analysis and interpretation of space weather data

- About 80 National Coordinators from Member countries
- Accomplished via *workshops, schools, and training courses*
- Collaboration: *SCOSTEP, COSPAR*
- **Website** (Bulgarian Academy of Sciences): <http://www.iswi-secretariat.org/>
- ISWI Newspaper



Space Weather: Capacity Building and Outreach

- Training in handling space-weather instruments; data handling; data analysis and interpretation
- Running advanced schools introducing topics from the solar interior to surface of Earth
- Hands-on experience to handle instruments and data sets
- Running ISWI workshops to enhance the general background in space weather, including Space Weather and its effects on GNSS
- Instrumentations, Solar Physics, SW effects on GNSS, New SW Scientific results





ISWI Instrument Sites

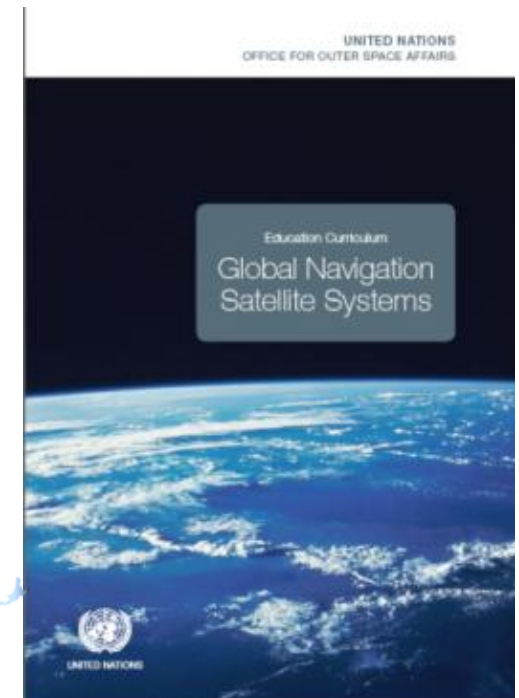


- Scientists from developing/developed nations work together in deploying and operating SW instruments: > 1000 deployments in >100 sites;
- Students and faculty participate at all levels of the instrument project and science;
- 19 instrument networks from 8 countries (USA, Germany, Japan, Brazil, France, Israel, Armenia, Switzerland)



Information Centres for ICG

The Programme of Space Applications established regional centres (**also acting as the ICG information centres**) in each region covered by the United Nations Economic Commissions: Africa, Asia and the Pacific, Latin America and the Caribbean, and Western Asia





ICG Information Portal



International Committee on Global Navigation Satellite Systems (ICG)

MISSION STATEMENT

The International Committee on Global Navigation Satellite Systems (ICG), established in 2005 under the umbrella of the United Nations, promotes voluntary cooperation on matters of mutual interest related to civil satellite-based positioning, navigation, timing, and value-added services. The ICG contributes to the sustainable development of the world. Among the core missions of the ICG are to encourage coordination among providers of global navigation satellite systems (GNSS), regional systems, and augmentations in order to ensure greater compatibility, interoperability, and transparency, and to promote the introduction and utilization of these services and their future enhancements, including in developing countries, through assistance, if necessary, with the integration into their infrastructures. The ICG also serves to assist GNSS users with their development plans and applications, by encouraging coordination and serving as a focal point for information exchange.

VISION STATEMENT

The International Committee on Global Navigation Satellite Systems (ICG) strives to encourage and facilitate compatibility, interoperability and transparency between all the satellite navigation systems, to promote and protect the use of their open service applications and thereby benefit the global community. Our vision is to ensure the best satellite-based positioning, navigation and timing for peaceful uses for everybody, anywhere, any time.

At the "United Nations International Meeting for the Establishment of the International Committee on Global Navigation Satellite Systems (ICG)" held on 1-2 December 2005 in Vienna, Austria, the ICG was established on a voluntary basis as an informal body for the purpose of promoting cooperation, as appropriate, on matters of mutual interest related to civil satellite-based positioning, navigation, timing, and value-added services, as well as compatibility and interoperability among the GNSS systems, while increasing their use to support sustainable development, particularly in the developing countries. The participants in the meeting agreed on an establishment of the ICG information portal, to be hosted by UNOOSA, as a portal for users of GNSS services.



International Committee on
Global Navigation Satellite Systems



ISWAT - International Space Weather Action Teams

Join forces to advance space weather understanding and capabilities to alert and shield society!

The COSPAR ISWAT initiative is a global hub for collaborations addressing challenges across the field of space weather.

HOME

JOIN ISWAT

HOW WE WORK

S: Space weather origins at the Sun

H: Heliosphere variability

G: Coupled geospace system

Impacts

LATEST NEWS:

COSPAR SPACE WEATHER ROADMAP

- Announcements of Special Issues of COSPAR Space Weather Roadmap
- COSPAR Space Weather Roadmap

ISWAT WORKING MEETINGS (upcoming)

S1: Long-term solar variability

H1: Heliospheric magnetic field and solar wind

G1: Geomagnetic environment

Climate

S2: Ambient solar magnetic field, heating and spectral irradiance

H2: CME structure, evolution and propagation through heliosphere

G2a: Atmosphere variability

Electric power systems/GICs

S3: Solar eruptions

H3: Radiation environment in heliosphere

G2b: Ionosphere variability

Satellite/debris drag

H4: Space weather at other planets/planetary bodies

G3: Near-Earth radiation and plasma environment

Navigation/Communications

(Aero)space assets functions

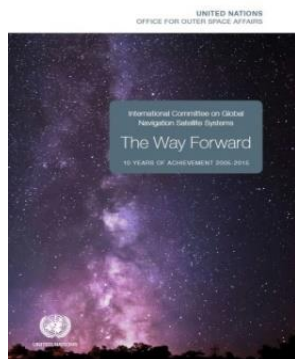
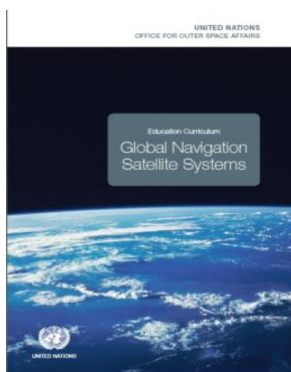
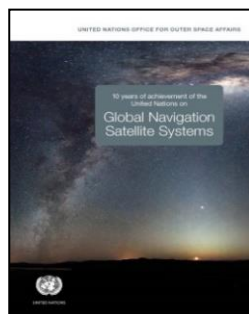
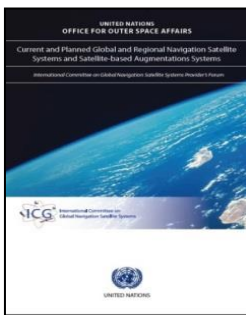
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UNOOSA Publications



<http://www.unoosa.org/oosa/en/ourwork/icg/documents/publications.html>



Conclusion

- The activities and opportunities provided through the ICG result in the development and growth of capacities that will enable each country to enhance its knowledge, understanding and practical experience in those aspects of GNSS technology that have the potential for a greater impact on its economic and social development, including the preservation of its environment
- The ICG is an important vehicle in the multi-lateral arena, as satellite-based positioning, navigation and timing becomes more and more a genuine multinational cooperative venture
- With increasing dependence on space-based infrastructure in our society – Space Weather is important for general understanding, and to define, model, predict and mitigate very large events

THANK YOU



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