

# **International Committee on Global Navigation Satellite Systems: Activities for Capacity Development**

**Training Course on Global Navigation Satellite Systems**

**14 – 18 January 2019, Asian Institute of Technology, Bangkok, Thailand**

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Office for Outer Space Affairs**



UNITED NATIONS  
Office for Outer Space Affairs



## Programme on GNSS applications

### **United Nations Regional Workshops/training courses on the use and applications of GNSS**

- Building the capacity of developing countries in using GNSS technology for sustainable development

### **United Nations/Fiji Workshop on GNSS, 24 – 28 June 2019, Suva**

- Current and Planned GNSS and Satellite-Based Augmentation Systems
- GNSS-based applications
- Natural hazards: GNSS for disaster management
- GNSS Reference Frames/Systems and Reference Station Networks

**WGS:** Seminar on GNSS Spectrum Protection and Interference Detection and Mitigation:  
*The purpose of the seminar is to educate participants on the importance of GNSS spectrum protection at the national level and explain how to reap the benefits of GNSS*

<http://www.unoosa.org/oosa/en/ourwork/psa/schedule/2019/2019-un-fiji-workshop-on-the-applications-of-gnss.html>



## Programme on GNSS applications

### United Nations/Italy Long-term Fellowship Programme, Politecnico di Torino, Turin

- **The Master in Navigation and Related Applications (MNA) Programme** provides extensive background knowledge in navigation/localization systems as well as a detailed analysis on NAV/COM integration and environmental monitoring applications
  - The II Level Specializing Master is a post graduate academic program (taken after a Master of Science program) that provides high quality training. It provides students with professional knowledge and skills needed in the navigation sector.
  - 12 months including a period ranging from 3 to 4 months for hands-on pilot project (internship)





## Promoting the use of GNSS technologies as tools for scientific applications

- **AfricaArray** is an educational initiative to support postgraduate studies and promote research into the structural detail of the Earth's crust and mantle. It has produced a number of master's and doctorate degrees in seismology, and one of its goals is to expand seismic networks in Africa
- **Reference frames and timing (WGD)** – To benefit operational geodesists or surveyors involved in positioning and measurement and potentially dealing with sea level changes. It is open to government, private sector, academic or graduate students in surveying or a related discipline (IAG, FIG, IGS)

Technical Seminars on Reference Frames in Practice, FIG Working Week 2019, 20 – 21 April, Hanoi, Vietnam

- **Training Course on GNSS (WGC)** – To create awareness on GNSS and its applications in Asia and the Pacific region (Asian Institute of Technology and the Centre for Spatial Information Science of the University of Tokyo): *General overview of signal processing in receiver, receiver performances, field survey using low-cost receiver for high-accuracy positioning*
- *Training Course on GNSS, 14 -18 January 2019, AIT, Bangkok, Thailand*

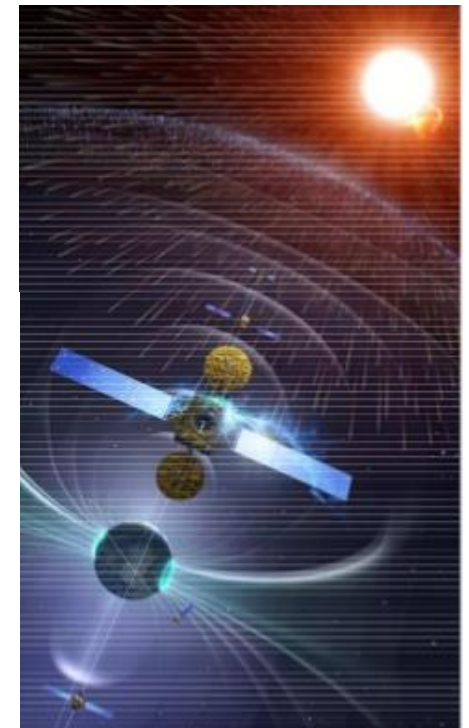


## Space Weather

**2013:** STSC agenda item “Space Weather”

**2014:** Establishment of the “Expert Group on Space Weather”

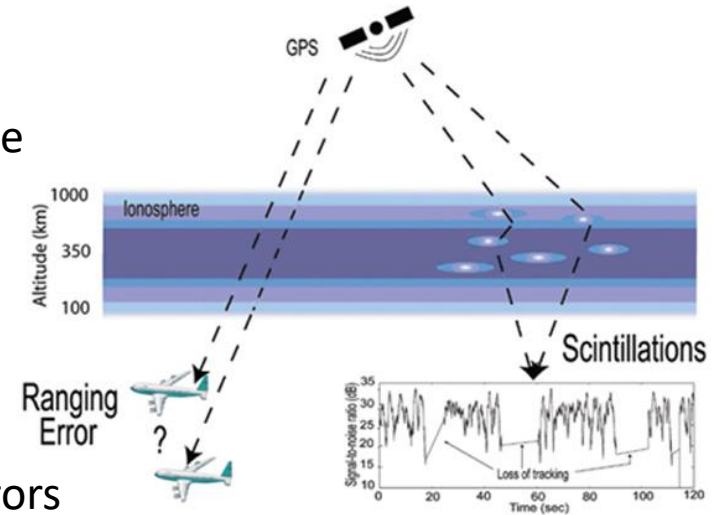
**Space weather** research and collaboration may help promote sustainable development through the prevention of catastrophic disruptions space critical infrastructure and space-based services



# Ionospheric Effects on GNSS

## ✦ Range Error - TEC

- ✦ Due to a change in the speed of the signal
  - ✦ Group Delay of the signal modulation (absolute range error)
  - ✦ Carrier Phase advance (relative range error)
- ✦ Proportional to Total Electron Content
  - ✦ Range Error =  $\pm \frac{40.3 \text{ TEC}}{f^2}$
- ✦ Varies from 1 to ~100m – can induce navigation errors
- ✦ Dual-frequency systems enable mitigation



(Picture: P. Kintner)

**Varies with location, local time, season, geomagnetic and solar activity.**

**SPACE WEATHER INCREASES IONOSPHERIC EFFECTS ON SYSTEMS**

## ✦ Scintillation

- ✦ Due to rapid fluctuations in the amplitude and phase of the signal
- ✦ May induce loss of lock – navigation errors
- ✦ Rare at mid-latitudes
- ✦ Can be severe after local sunset in the equatorial regions, especially near the peak of solar cycle

## ✦ Other Effects

- ✦ Faraday Rotation, Absorption, Doppler Shift, Waveform Distortion and Refraction, Diffraction

Source: Patricia Doherty, Boston College



# Space Weather Effects – The Big 3!

## Damage to Electric Power Grids

- Changes in the magnetic field can produce surges in power lines and transformers.
- National Academies Report 2009 – estimated the impact of a space weather induced grid collapse to be ~\$1trillion dollars

## Damage to Satellites

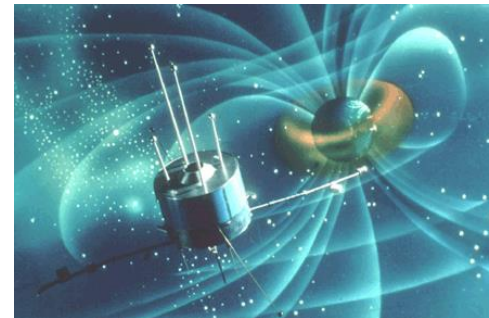
- Energetic ions can damage solar panels
- Energized plasmas can cause electrical charges that can damage the electronics
- Increase satellite drag
- Economic value of satellite enterprise >\$100Billion

## Health Risks due to Radiation Hazards

- Exposure at high altitudes
- Astronauts
- High flying jets
- Crews/passengers flying over the poles
- Redirecting these flights can cost \$100,000+
- What about space travel – mission to Mars???



Damage to power grids.



Damage to satellites.



Radiation Exposure.



## Space Weather and GNSS

- **Space Weather and GNSS (WGC)** – Promotes the use of GNSS for scientific applications and space weather in developing countries (International Centre for Theoretical Physics (ICTP), Boston Colleague)
  - Increased number of students and young scientists studying and using GNSS, including increasing participation by women, and many opportunities for research (improved imaging of the ionosphere over the equatorial region, ionospheric effects on augmentation systems...)

Workshop on Ionospheric forecasting for GNSS operations in developing countries: Findings and Challenges, 27 – 31 May 2019, ICTP, Trieste, Italy

<http://indico.ictp.it/event/8686/>







## Science, Capacity Building and Outreach

### ▪ **International Space Weather Initiative (ISWI)**

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

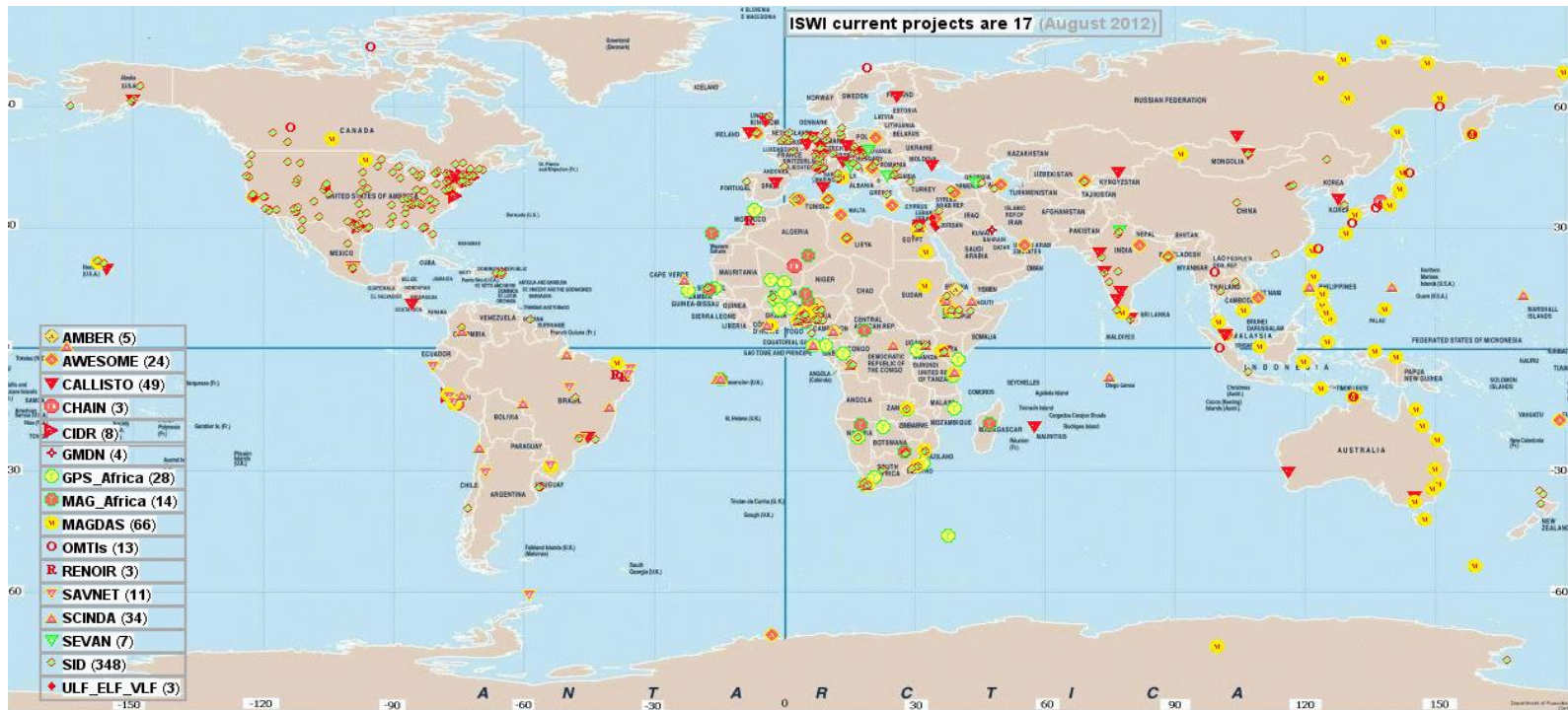
- About 80 National Coordinators from Member countries
- Grass-roots organization – *bottoms-up approach* to produce a space-weather-literate communities especially in developing countries
- Accomplished via *workshops, schools, and training courses*
- Collaboration: *SCOSTEP, COSPAR*
- **Website** (Bulgarian Academy of Sciences): <http://www.iswi-secretariat.org/>

International Space Weather Initiative Workshop, 20 – 24 May 2019, ICTP, Trieste, Italy

<http://indico.ictp.it/event/8682/>



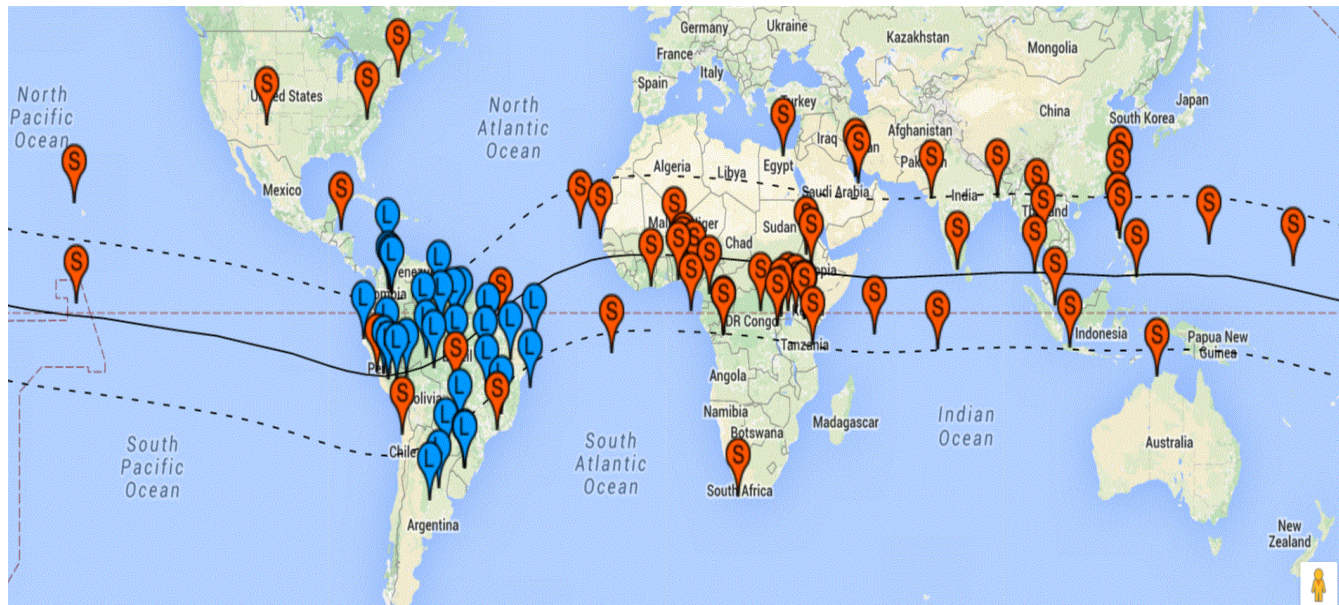
## ISWI Instrument Sites



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

# Scintillation Network Decision Aid (SCINDA)

- Provides information on ionospheric conditions (e.g., scintillation) and hence forecasts communication degradation and outage in the equatorial region.
- Radio signals up to a few GHz frequency are affected
- The region affected corresponds to about 1/3 of the surface of the globe
- Important for transequatorial flights



Red – SCINDA

Blue – LISN, another ISWI network





# ICG Information Portal



- About Us ▾
- Our Work ▾
- Benefits of Space ▾
- Information for... ▾
- Events ▾
- Space Object Register ▾
- Documents ▾
- COPUOS 2015 ▾

Our Work ▾ ICG

## 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.



International Committee on  
Global Navigation Satellite Systems

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.

### VISION STATEMENT

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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.

### Our Work

Secretariat of COPUOS

Programme on Space Applications

UN-SPIDER

#### ICG

- Members
- Providers' Forum
- Working Groups
- ICG Annual Meetings
- ICG Programme on GNSS Applications
- Resources
- ICG Documents
- Space Weather & GNSS
- Other Events
- ICG Timeline

#### UN-Space

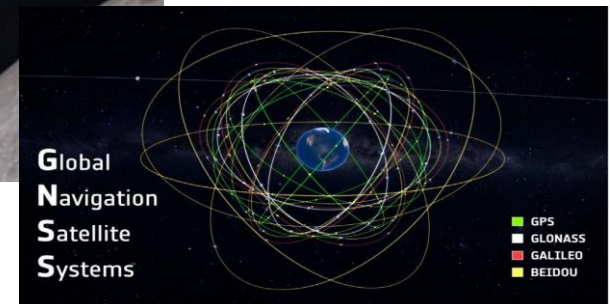
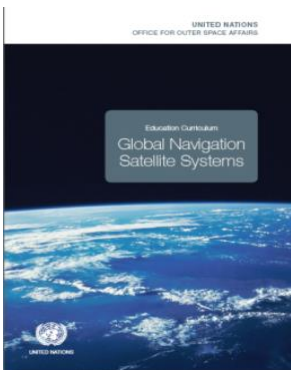
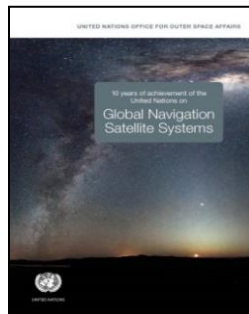
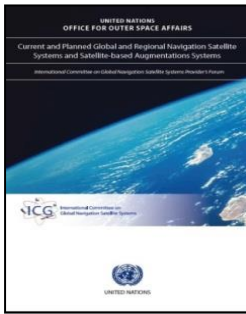
- Space Law
- Topics
- Photo Gallery

[WWW.UNOOSA.ORG](http://WWW.UNOOSA.ORG)

[WWW.UNOOSA.ORG/OOSA/EN/OURWORK/ICG/ICG.HTML](http://WWW.UNOOSA.ORG/OOSA/EN/OURWORK/ICG/ICG.HTML)



# UNOOSA Publications

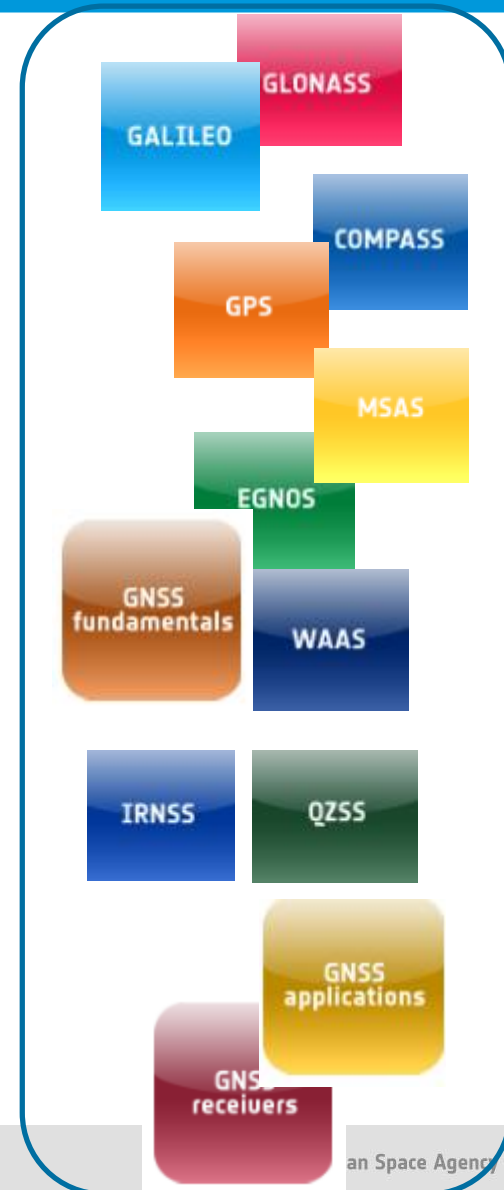


# NAVIPEDIA: Status



- In line with ICG2012 recommendation on NAVIPEDIA, ESA has been maintaining and developing further NAVIPEDIA with up-to-date information.
- NAVIPEDIA is today extensively used by universities and Galileo application developers.
- NAVIPEDIA is also used as reference as part of the European Satellite Navigation Conference (ESNC) for the GNSS application developers
- An APP version of NAVIPEDIA (for both Android and iOS operational systems) is currently under development. This should be ready by the end of 2016.

[www.navipedia.org](http://www.navipedia.org)

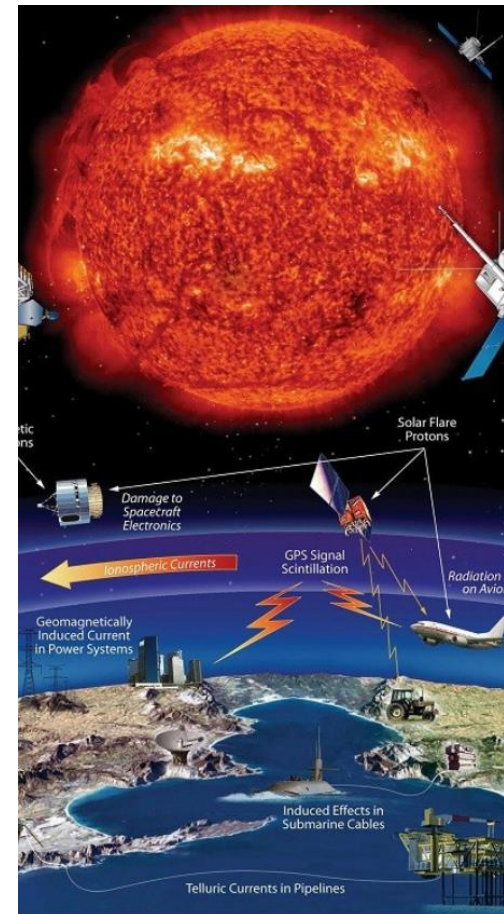






## Conclusion

- ***The activities and opportunities provided through the ICG and its Programme on GNSS applications*** 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
- ***Space weather*** is so critical because we are more dependent on space-based technology than ever before



# THANK YOU



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