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

Sharafat Gadimova
Office for Outer Space Affairs

UNITED NATIONS
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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

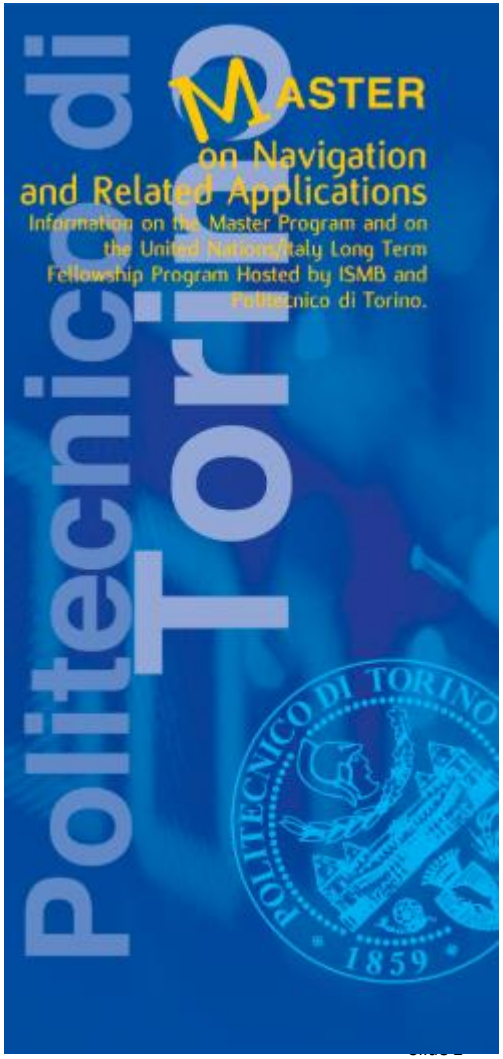
WGS: Seminar on GNSS Spectrum Protection and Interference Detection and Mitigation:
The purpose of the seminar is to educate participants on the importance of GNSS spectrum protection at the national level and explain how to reap the benefits of GNSS

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

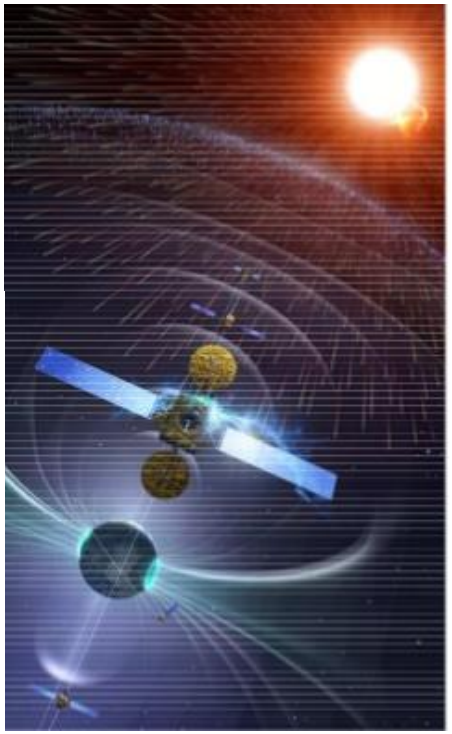
- **Training Course on GNSS (WGC) –** To create awareness on GNSS and its applications in Asia and the Pacific region (Asian Institute of Technology and the Centre for Spatial Information Science of the University of Tokyo): *General overview of signal processing in receiver, receiver performances, field 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”

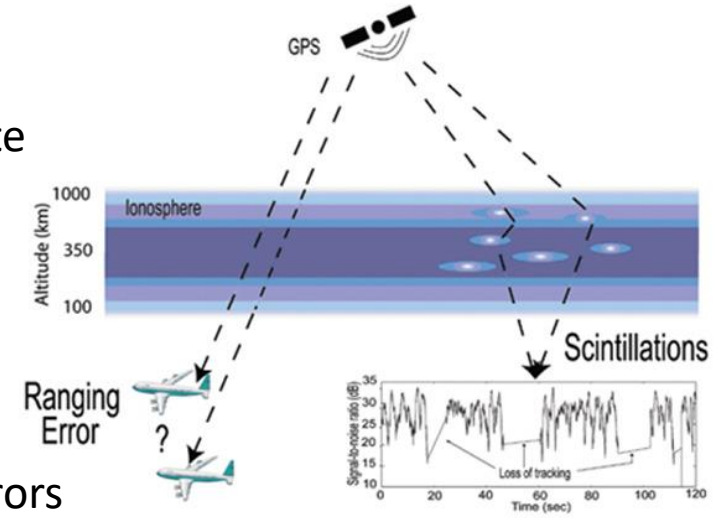
2014: Establishment of the “Expert Group on Space Weather”

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 $= {}_{+/-} \frac{40.3\ TEC}{f^2}$
  - Varies from 1 to ~100m – can induce navigation errors
  - Dual-frequency systems enable mitigation
- **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



(Picture: P. Kintner)

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

SPACE WEATHER INCREASES IONOSPHERIC EFFECTS ON SYSTEMS

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

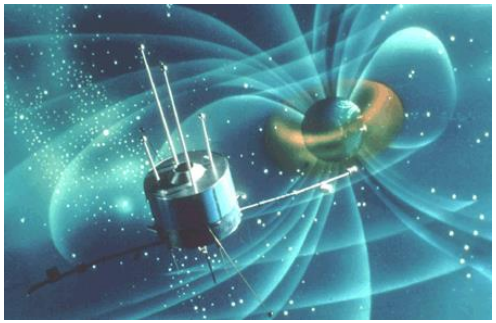
Damage to Satellites

- 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.

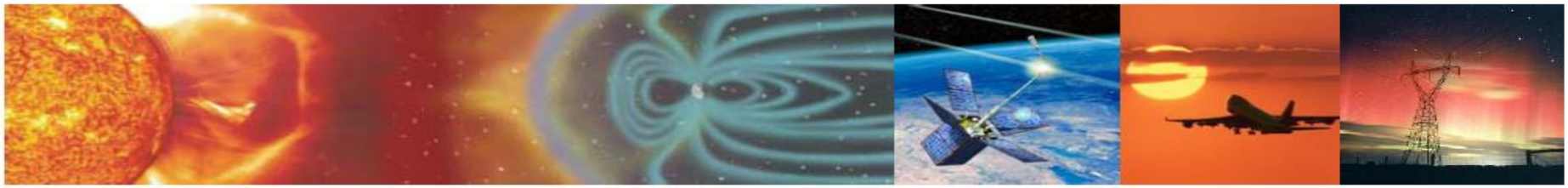
Source: Patricia Doherty, Boston College

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

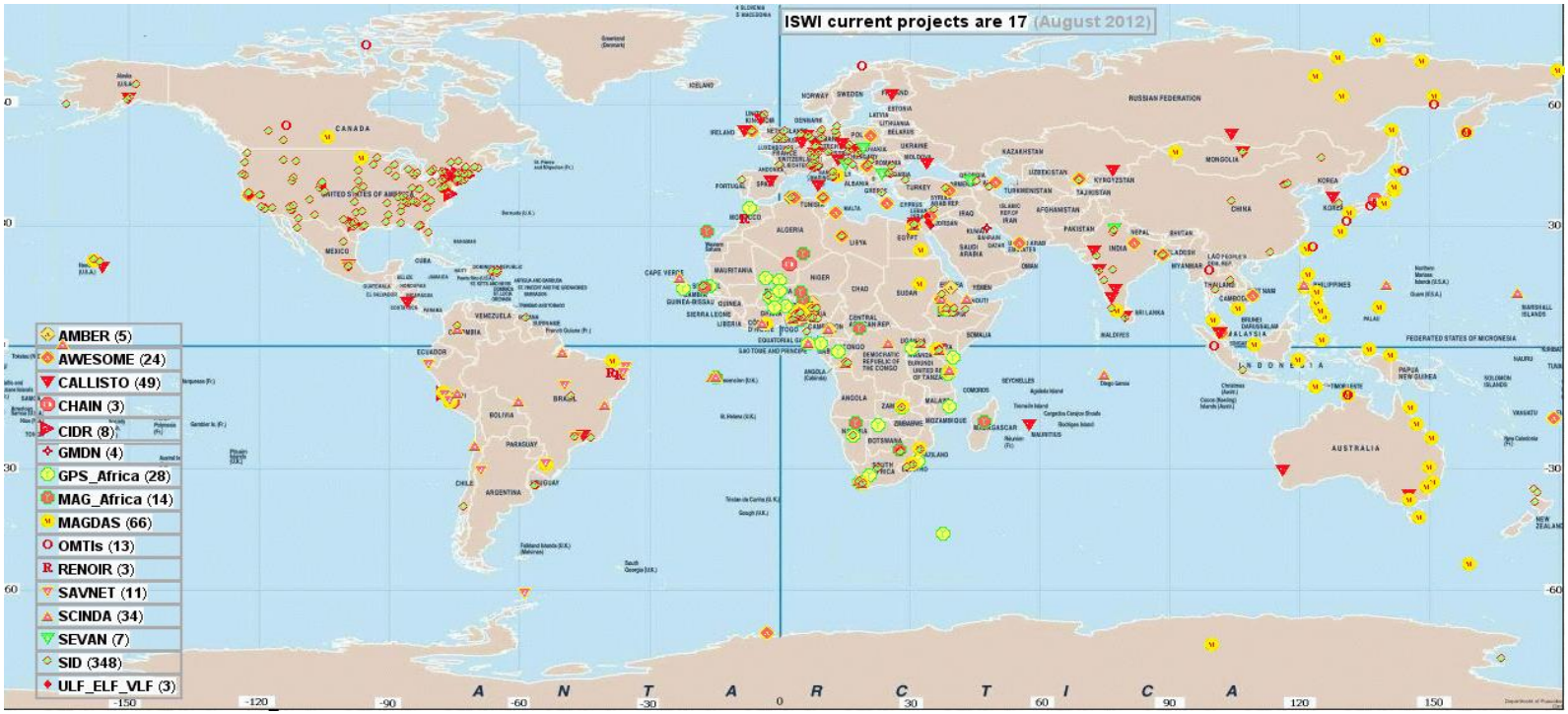
  - About 80 National Coordinators from Member countries

- 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/

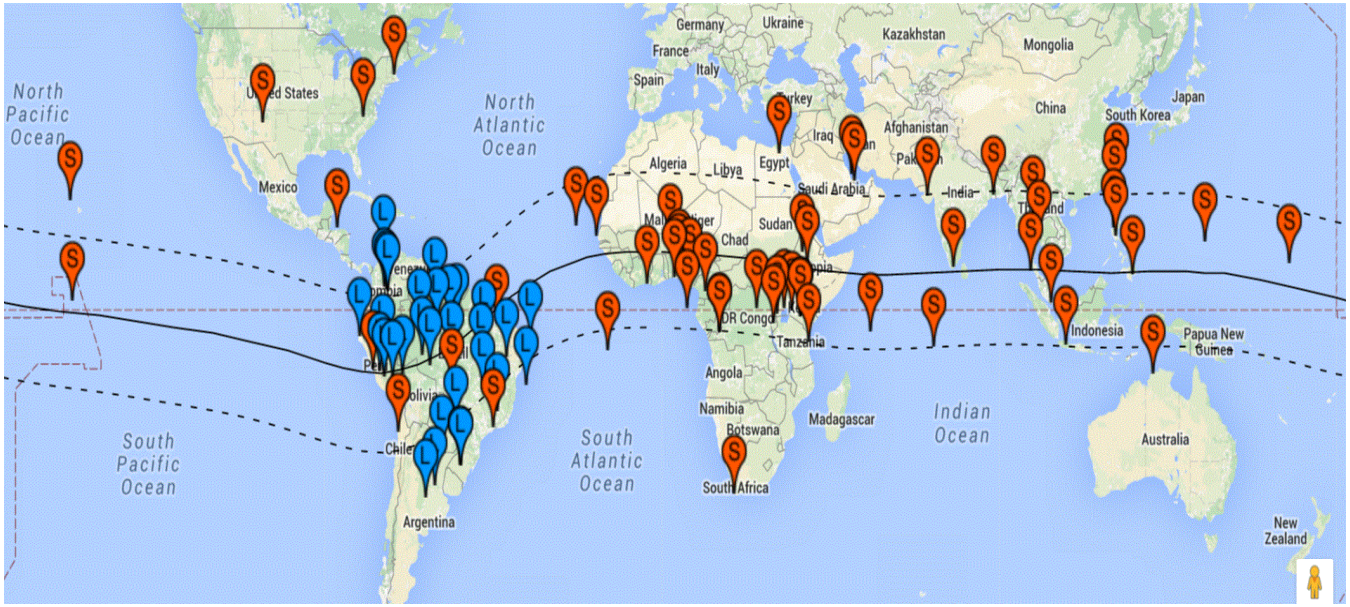
ISWI Instrument Sites



- 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

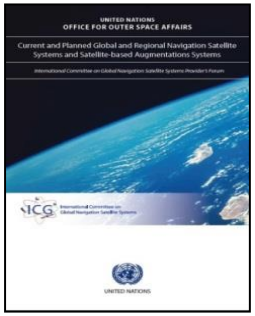
K. Groves, C. Carrano, C. Bridgwood, P. Doherty ***(Boston College)***

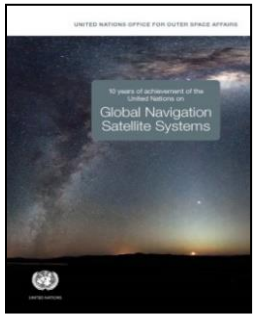
ICG Information Portal

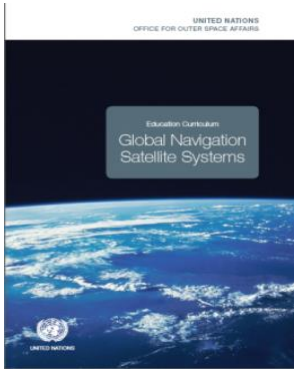
WWW.UNOOSA.ORG

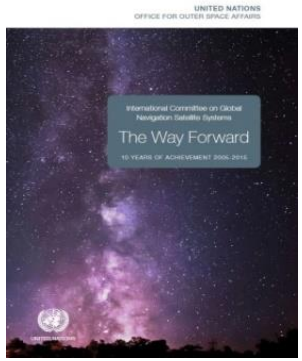
WWW.UNOOSA.ORG/OOSA/EN/OURWORK/ICG/ICG.HTML

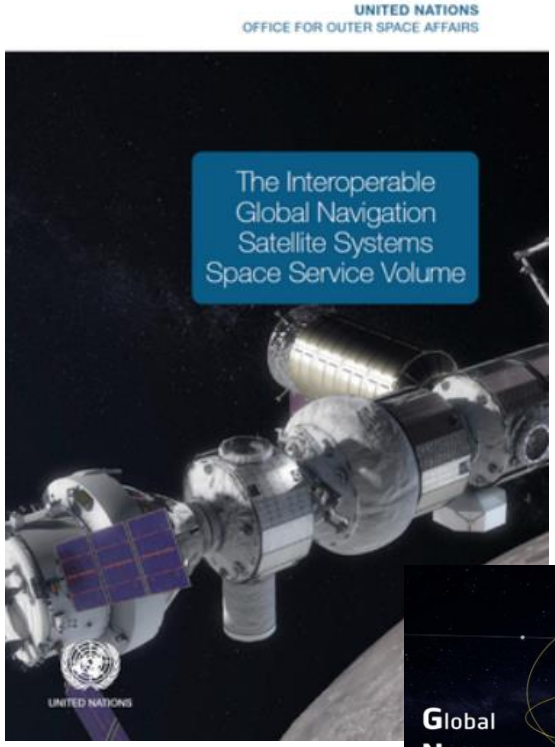
UNOOSA Publications

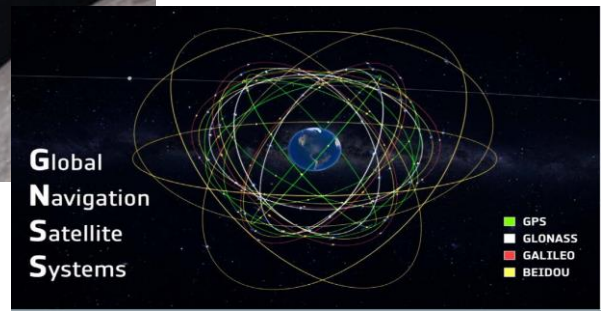








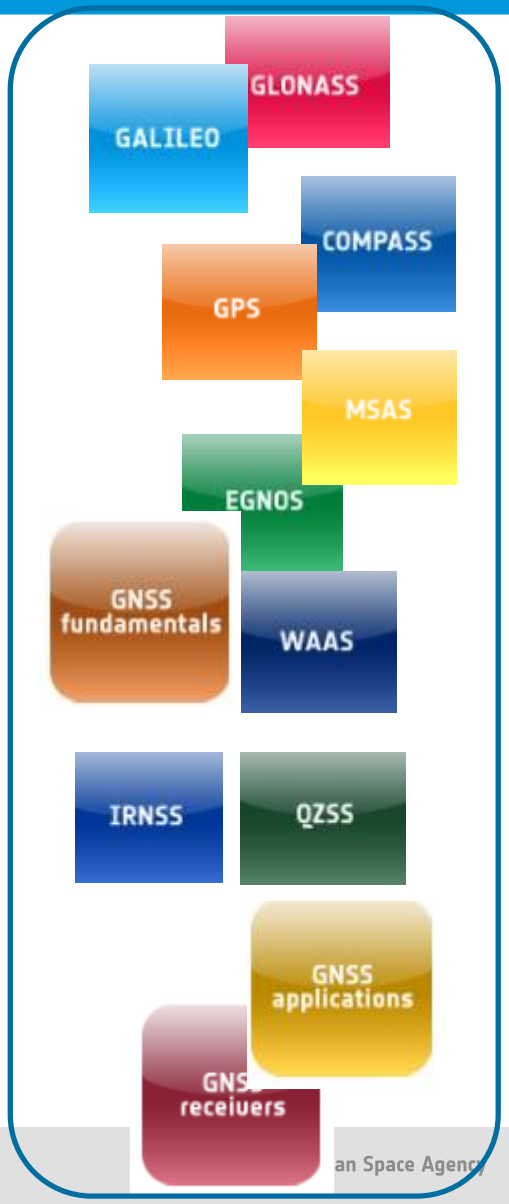




NAVIPEDIA: Status

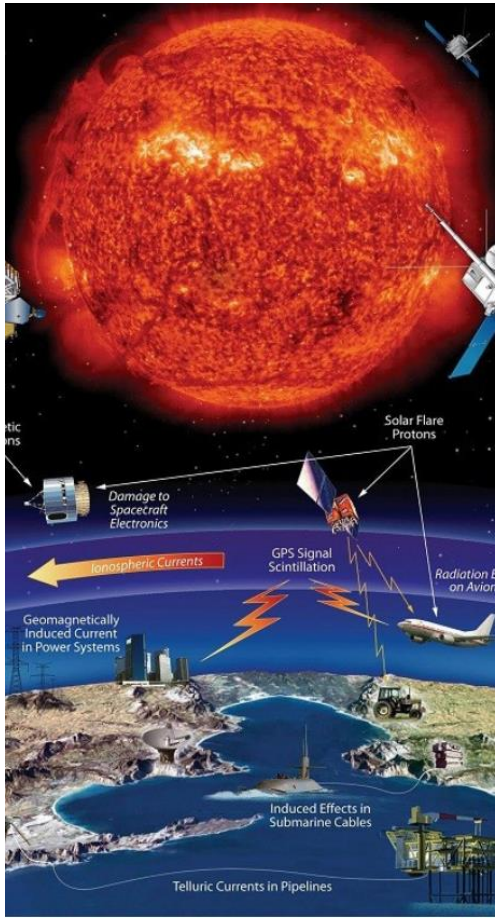
- In line with ICG2012 recommendation on NAVIPEDIA, ESA has been maintaining and developing further NAVIPEDIA with up-to-date information.
- NAVIPEDIA is today extensively used by universities and Galileo application developers.
- NAVIPEDIA is also used as reference as part of the European Satellite 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



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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