UNITED NATIONS
Office for Outer Space Affairs

International Committee on
Global Navigation Satellite Systems

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International Committee on Global Navigation Satellite Systems (ICG): SPACE WEATHER

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Background

- 2001 – 2004: Action Team on GNSS (Italy and the United States) – *in implementation of the recommendations of UNISPACE-III, 1999, Vienna*
  - An international framework to support operational coordination and exchange of information among system operators and national and international user communities would be important
  - The assumption was that current and future system operators would soon move from a competitive to a collaborative mode where there is a shared interest in the universal use of GNSS services regardless of the system
- 2005: Establishment of the ICG (noted by UNGA 61/111 of 14 December 2006)
  - Promote the use of GNSS and its integration into infrastructure, particularly in developing countries;
  - Encourage compatibility and interoperability among global and regional systems
- Main challenge is to provide assistance and information for those countries seeking to integrate GNSS into their basic infrastructure, including at governmental, scientific and commercial levels

Membership

- Members: 9 nations and the European Union

Current and future core, regional or augmentation systems providers: China (BeiDou), EU (Galileo/EGNOS), Russia (GLONASS/SDCM), United States (GPS/WAAS), India (IRNSS/GAGAN), and Japan (QZSS/MSAS)

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

- Associate Members and Observers: 21 organizations

International & regional organizations and associations dealing with GNSS services and applications: UN system entities (ITU, BIPM, ICAO, IMO), 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 (2007), United States (2008), Russian Federation (2009), Italy & European Union (2010), Japan (2011), China (2012), United Arab Emirates (2013), European Union (2014), United States (2015), Russian Federation (2016), **Japan (2017),** China (2018), India (2019), Vienna (2020)
- 2006: Terms of Reference and Workplan
- **Systems, Signals and Services (United States & Russian Federation):** Focused discussion on compatibility and interoperability, encouraging development of complimentary systems; Exchange detailed information on systems and service provision plans
- **Enhancement of GNSS Performance, New Services and Capabilities (India, China and European Space Agency):** Focused discussion on system enhancements (multipath, integrity, interference, etc.) to meet future needs
- **Information Dissemination and Capacity Building (UNOOSA):** Focused on education and training programmes, promoting GNSS for scientific exploration (space weather specifically)
- **Reference Frames, Timing and Applications (IAG, IGS & FIG):** Focused on monitoring and reference station networks

Providers' Forum

- **2007: Establishment**
- Members: Current and future global and regional satellite navigation systems and Satellite-based Augmentation Systems (SBAS) providers

PF provides ways and means of promoting communication among system providers on key technical issues and operational concepts such as the GNSS spectrum protection, orbital debris, and orbit de-confliction

- Scientific and Technical Subcommittee of UNCOPUOS (UN GA Res. 62/217 of 1 February 2008) started consideration of an agenda item "Recent developments in GNSS"
- **2008: Terms of Reference and Workplan**
- Agreement that all GNSS signals and services must be compatible and open signals and services should be interoperable to the maximum extent possible in order to maximize benefit to all GNSS users;
- Consensus reached on Principle of transparency - *every GNSS provider should publish documentation that describes the signal and system information, the policies of provision and the minimum levels of performance offered for its open services*
- **2017: Eighteenth Meeting, 6 June 2017, Vienna, Austria**
- Open Service Information Dissemination, Open Service Performance, Spectrum Protection (interference detection and mitigation)

UNOOSA: Executive Secretariat (ICG and Providers' Forum)

Working Groups: Recommendations/Observations

- **Interference Detection and Mitigation (IDM)**
  - To continue addressing the need for worldwide GNSS spectrum protection
  - To establish a multi-year agenda item focused on national efforts to protect RNSS spectrum, and pursue GNSS IDM in member states
- **Request for voluntary reporting on national RNSS spectrum protection practices and GNSS IDM capabilities (A/AC.105/C.1/2017/CRP.18):**

STSC agreed that, a general exchange of information should be included on issues related to GNSS IDM, with a view to raising awareness of efforts to achieve the overall goal of promoting effective use of GNSS open services by the global community.

http://www.unoosa.org/res/oosadoc/data/documents/2017/aac_105c_12017crp/aac_105c_12017crp_18_0_html/AC105_C1_2017_CRP18E.pdf

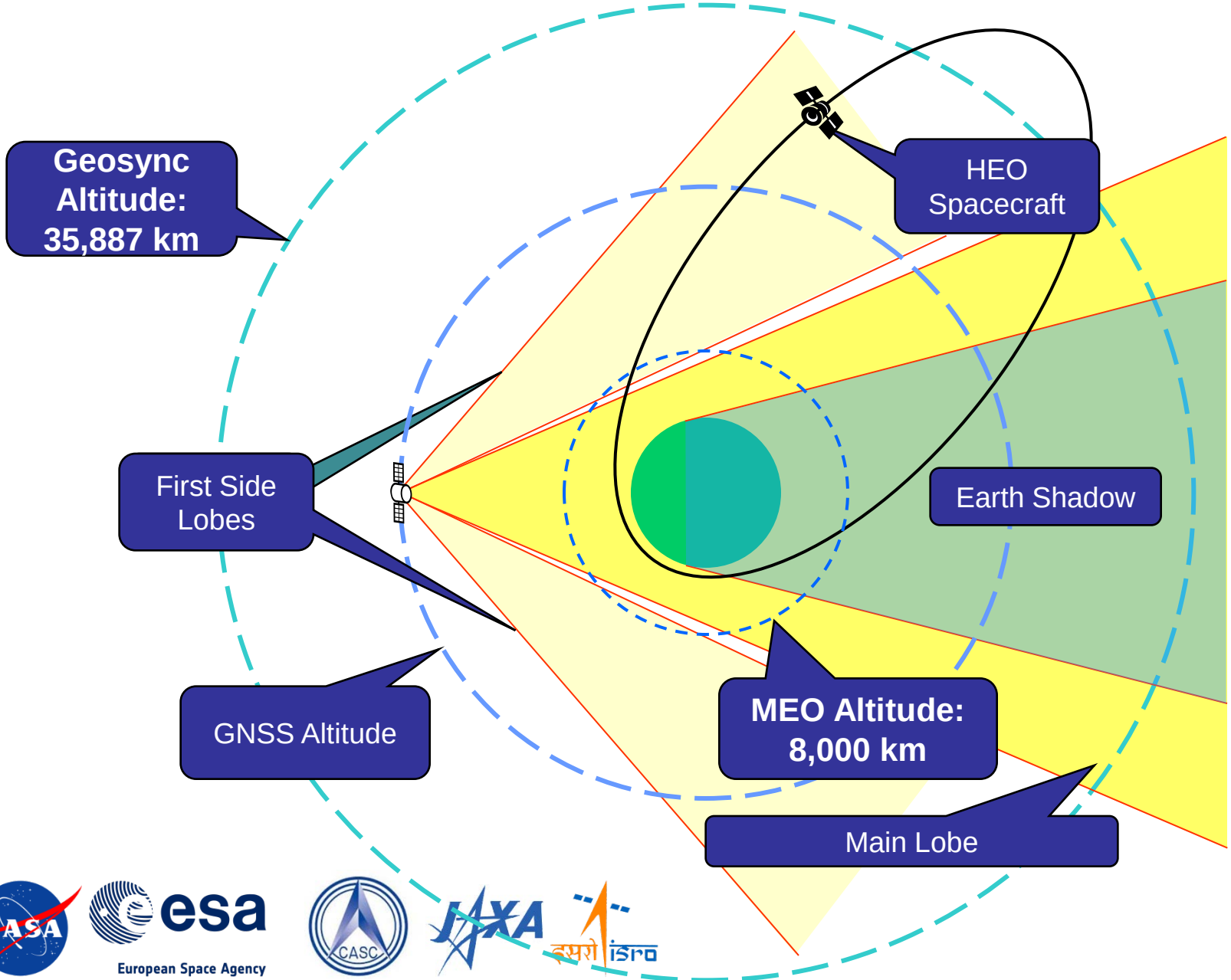
Working Groups: Recommendations/Observations

- **Interoperable GNSS Service Volume (SSV)**
  - Providers will develop a booklet defining the characteristics of a fully **interoperable space service volume**

The GNSS Space Service Volume (SSV) is the region of space extending to approximately the geostationary altitude or even beyond where terrestrial GNSS performance standards may not be applicable. The SSV defines GNSS system performance for space users by specifying at least three parameters:

1. Pseudorange Accuracy
2. Received Power and
3. Signal Availability

Reception Geometry for GNSS Signals in Space



Working Groups: Recommendations/Observations

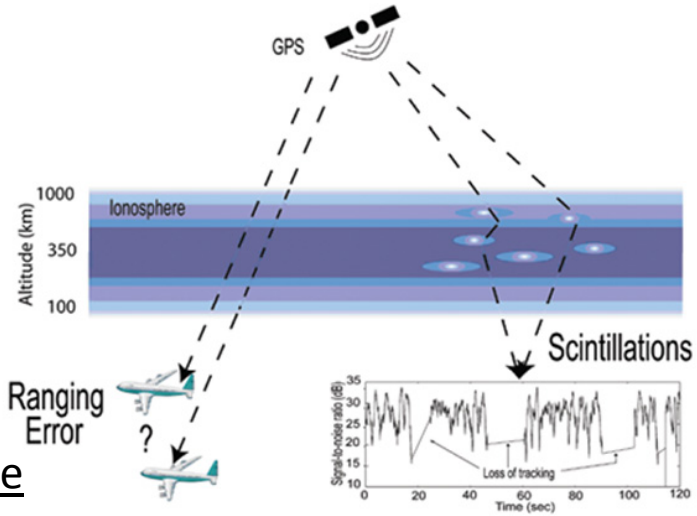
- **Advanced Receiver Autonomous Integrity Monitoring (ARAIM)**
  - Future integrity concepts based on Advanced Receiver Autonomous Integrity Monitoring (ARAIM) will continue to be studied with the objective of exploiting the interoperability between the different systems for safety of life applications.
- **Space Weather**
  - Space Weather aspects will continue to be addressed showing improvements that are achievable by advanced ionospheric modelling and receiver technologies

ICG Information Portal: http://www.unoosa.org/oosa/en/ourwork/icg/working-groups.html

ICG-11 Meeting, 2016, Sochi, Russian Federation: Joint Statement

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
- **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



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

UNOOSA: Programme on GNSS applications

- **United Nations Regional Workshops/training courses on the use and applications of GNSS**
  - These activities increase awareness among decision and policy makers of the benefits of GNSS, space weather effects, and develop regional and national pilot projects on GNSS applications, space weather reserach
- **United Nations/United States of America Workshop on the International Space Weather Initiative: The Decade after the International Heliophysical Year 2007, 31 July – 4 August 2017, Boston**
- In-line with COPUOS' Thematic Priority Area: **International framework for space weather services** and flagship event for UNISPACE+50
- A high level International Forum on the economic and societal effects of extreme space weather
- 10th anniversary of IHY, a mission to advance space weather science through instrument deployment, analysis of data, and communication of results to the public.

2007 – 2008: IHY - to understand planetary environments; 2009 – 2012: ISWI – to focus on space weather (Instrument deployments, data analysis); 2012 : Space Weather Agenda item at STSC

ISWI Instrument Sites: 1000s trained

- Scientists from developing and developed nations work together in deploying and operating space weather instruments (currently there are more than 1000 deployments in more than 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)

www.iswi-secretariat.org

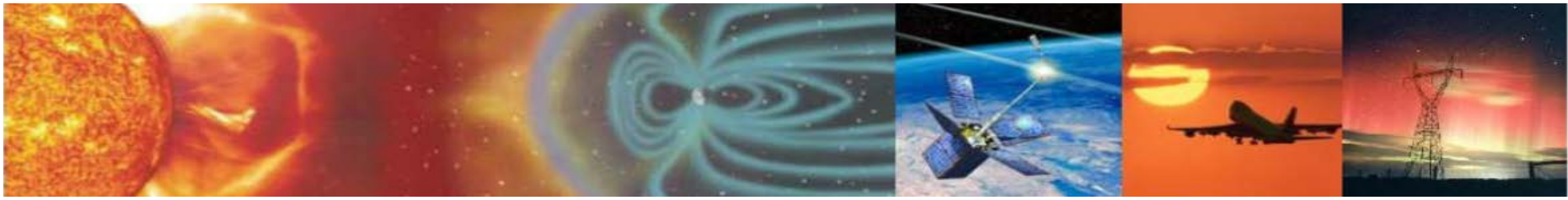
Workshop: Recommendations/Observations

I. International Cooperation on the impacts of space weather – the importance of the coordination body concept

- Increased collaboration between national and international space weather stakeholders is essential to meet current and future needs for space weather services

II. Recognizing, and building, on prior and continuing work by space weather stakeholders

- The increasing dependency on technology supports a renewed international effort to enhance space weather services and mitigation efforts by Member States
- Ground- and space-based instrument data critical for supporting space weather research and services are distributed across the globe involving different Member States and organizations. In order to enable effective international coordination and collaborations in space weather research and services, there should be absence of barriers against data flows and communications. To that end, an open data policy should be developed.



Workshop: Recommendations/Observations

III. UNISPACE+50 and Thematic Priority 4: International framework for Space Weather Services

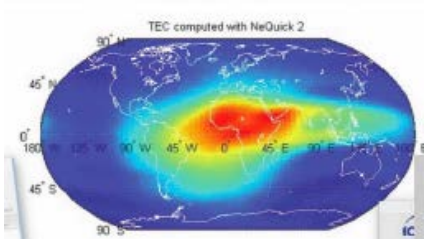
- Use the UNISPACE+50 process to promote enhanced cooperation that would meet the identified needs of Member States for future space weather services (Space2030). Outcomes and recommendations of this process will be reported under the UN COPOUS framework in the timeframe 2018 – 2030.
  - The workshop contributes to the goals and targets set within the framework of the Sustainable Development Goals (SDGs), and due to the fact that space technology supports our common goals to address global challenges, space weather research and global collaboration will promote sustainable development through the prevention of catastrophic disruptions of critical infrastructure and services.

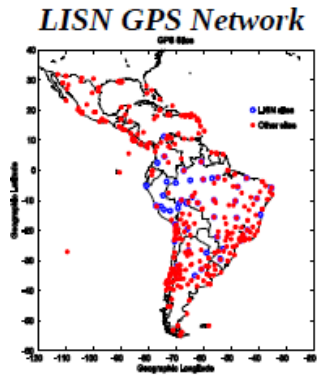
IV. Capacity Building and Outreach

- Given the importance of ISWI to capacity building, training, and their potential contribution to enhanced provision of improved space weather service, a process should be identified and adopted whereby ISWI activities are recognized by, and report to STSC through the STSC Space Weather agenda item.
- Continue the public-lecture and teacher-workshop activities in the margins of workshops and space science schools, and in other space weather activity venues.

UNOOSA: Programme on GNSS applications

- **Space Weather and its effects on GNSS**
  - 2009 – 2015: Workshops organized in cooperation with the International Centre for Theoretical Physics (ICTP) and Boston College
  - Encourage the use of GNSS for societal and economic development
  - Build GNSS infrastructure
  - Establish international scientific collaborations
- **Many opportunities for training courses/regional workshops and research**
  - ICTP and Boston College: Workshops on Ionospheric Effects on SBAS and GBAS Applications at Low Latitudes, May 2017, Trieste, Italy
  - Improved imaging of the ionosphere over the equatorial region
  - Increased number of young scientists, including participation by women





ICG Information Portal

WWW.UNOOSA.ORG

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

Conclusion

- ICG has encouraged tangible international cooperation, and leading global satellite operators have coordinated their GNSS services to provide global coverage in satellite-based positioning, navigation and timing, for the benefit of all.
- The establishment of ICG serves as a model for how the United Nations can undertake action to follow up on global conferences and yield tangible results within a fixed time frame.

2018: UNISPACE+50 years of space cooperation and development

UNISPACE+50 will take stock of the contributions of the three UNISPACE conferences (UNISPACE I, held in 1968, UNISPACE II, held in 1982 and UNISPACE III, held in 1999) to global space governance

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THANK YOU

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