**COMMISSION G**

**G01 : GNSS Radio Occultation: advancements on measurements, data assimilation and models**

**Conveners:**

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**Session Description:**

Nowadays hundreds of core CGMS coordinated and commercial satellites host GNSS receivers for collecting radio occultation and POD observations. The assimilation of such GNSS dual frequency measurements, collected either in a limb or in an almost vertical sounding links, into numerical models, has the potential to contribute significantly to the improvement of the ionosphere and plasmasphere monitoring and prediction, with enormous benefits for a better understanding of the space weather. However, different space-based measurements or products can be assimilated, spanning from the standard dual frequency carrier phases and pseudoranges, to the slant TECs or to the topside TEC derived from zenith data, to the dual frequency bending angles, to the electron densities profiles. And such measurements can then be assimilated on top of other in-situ observations, iono-soundings and ground-based GNSS measurements.

Aim of this session is to provide a comprehensive overview and discuss about recent advancements on the impact of the GNSS radio occultation and zenith data collected from satellite platforms, for the ionosphere and plasmasphere monitoring and modelling. Contributions on the topics of new data assimilation models, data assimilation trials and validation, ionosphere models improvements, as well as contributions on new ionospheric radio occultation data provision are definitely welcome.

**G02 : Novel radio instruments and techniques for Space Weather model validation and testing**

**Conveners:**

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**Session Description:**

Radio propagation in bands ranging from VLF to UHF is crucially reliant or affected by the state of the ionosphere; as such, modeling of this propagation is subsequently highly sensitive to the choice of ionospheric representation. There are now dozens of ionospheric models that have been developed by the community with varying degrees of maturity and availability; however, we still lack an understanding of whether these models meet the basic needs of radio propagation modellers and users.

This session seeks to open a dialogue between experimentalists, users, and model developers on approaches and metrics that can be used to validate ionospheric models, with focus on radio propagation and Space Weather applications.

This session encourages submissions on topics including, but not limited to:

1. Radio propagation experimentation;
2. experiments validating radio propagation models;
3. efforts or ideas to establish community ionospheric model validation testbeds;
4. novel ionospheric and radio propagation model validation metrics;
5. new radio propagation observations;
6. user-defined and user-focused model validation metrics, such as those relevant to GNSS and Over-the-Horizon Radar (OTHR).

**G03 : Ionospheric Space Weather and Impacts on Technological Systems**

**Conveners:**

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Yury Yasyukevich, Institute of solar-terrestrial physics SB RAS, yasukevich@iszf.irk.ru

**Session Description:**

This session will focus on ionospheric and space weather events that may impact telecommunications and navigation systems. Studies on the impact of ionospheric effects on technological systems and services are welcome. The session will also cover all areas of ionospheric space weather research including modeling, data assimilation, and novel observations, especially those using radio wave techniques. Of special interest are papers describing the assessment and validation of space weather models, and the justification of the need for new ground and space-borne measurements. Studies and investigations addressing the modeling, forecasting and/or mitigation of ionospheric phenomena due to space weather events, such as large scale ionospheric gradients or medium- and small-scale irregularities, are also welcome.

**G04 : Recent advances on ionospheric perturbation indices and scales**

**Conveners:**

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**Session description:**

The formation of ionospheric irregularities results from dynamical processes in the ionosphere including transport processes, instabilities, and turbulence, being driven and modulated by Space Weather phenomena and by the forcing from the neutral atmosphere. Ionospheric irregularities affect the propagation of radio waves (e.g., scintillation), posing a threat on modern radio systems. Among these, Global Navigation Satellite Systems (GNSS) critical applications, for which accuracy, availability, continuity, and integrity are mandatory, and HF/VHF/UHF radio communications that exploit reflection and refraction by the ionosphere. The session welcomes papers addressing recent developments in definition, implementation, standardization, modelling and predictability of ionospheric perturbation indices and activity scales. The session is also willing to ease the dialog with the user community (e.g., aviation, farming, safety of life) by accepting contributions addressing how the use of indices and scale can support specific operations and services. Papers addressing data standardization, preservation and access are also welcome.

**G05 : Machine Learning methods for ionospheric modelling: state of the art and future actions**

**Conveners:**

Claudio Cesaroni, Istituto Nazionale di Geofisica e Vulcanologia (Italy), claudio.cesaroni@ingv.it

Ivan Galkin, UML, ivan\_galkin@uml.edu

**Session Description:**

In the last decades, several ground-breaking results were reached in Artificial Intelligence (AI), such as image recognition at super-human accuracy. On other hand, people are using AI technologies in their everyday lives, and somehow it has become an integral part of their daily rituals. AI in ionospheric physics have been boosted by the growth of available data from ground based and spaceborne instruments becoming a useful tool for modelling and forecasting.

The session welcomes result on applications of AI technique for ionospheric forecasting, modelling of the Space Weather effects on the ionosphere and ionosphere-neutral atmosphere coupling. Expected contributions span from black-box models to data-driven physics-based simulations exploiting regression and classification algorithms, automatic event identification, feature extraction and deep learning.

**G06 : Advances in Incoherent Scatter Radars and Global Open Science Cloud services**

**Conveners:**

Ingemar Häggström, EISCAT Scientific Association, ingemar.haggstrom@eiscat.se

Yue Xinan, Institute of Geology and Geophysics, Chinese Academy of Sciences, yuexinan@mail.iggcas.ac.cn

Yin Chen, EGI Foundation, yin.chen@egi.eu

**Session Description:**

This session will focus on advances in the field of incoherent scatter radar measurement of the Geospace environment. Incoherent scatter radar provides powerful measurement capabilities for study of the ionosphere and its coupling to the lower atmosphere and magnetosphere. Instrument capabilities are rapidly evolving with new radars, operational modes, and measurement techniques. Papers which focus on new developments in incoherent scatter radar systems, analysis techniques, technology, and science applications are welcome. This session will also foster collaboration among the global community of Geospace Radar systems to encourage coordinated scientific and technical efforts. Submissions related to Global Open Science Cloud services solutions that enable cross country/region/continent data access, federated data processing and big data handling are especially in the scope.

**G07 : (Ionospheric) Space Weather operational services**

Conveners:

Patricia Doherty, Boston College Institute for Scientific Research, patricia.doherty@bc.edu

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Keith Groves**,** Boston College Institute for Scientific Research, keith.groves@bc.edu

**Session Description:**

Space Weather is driven by changes starting at the Sun that may impact the Earth’s magnetic field and the upper atmosphere producing their variability. This results in a variety of manifestations, depending on the severity of the Space Weather event, that can affect society’s technological infrastructures in different ways. Therefore, the societal interest on Space Weather information and services is growing rapidly as well the demand of solutions against the ionospheric threats to technological systems.

The session aims to solicit contributions focusing on:

* past and recent ionospheric space weather events and societal/economic impacts.
* mitigation strategies adopted against the ionospheric effects on technological infrastructures.
* existing local, regional, global ionospheric space weathers operational services.

**G08 : Modern ionosonde research and weather operations**

**Session conveners:**

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Pornchai Supnithi, King Mongkut's Institute of Technology Ladkrabang (KMITL), pornchai.su@kmitl.ac.th

**Session Description:**

Modern ionosonde continues to be a strong performer on the rapidly advancing space weather theater. As growing practical demands refocus research-to-operations transition on the sensors of high accuracy and prompt delivery, ionosondes offer a few minutes latency of global data acquisition and a suite of solutions for extracting and assimilating the actionable information. This session welcomes reports on state-of-the-art ionosonde-related science and engineering that further enhance this capability and reach over to other domains of remote ionospheric sensing for cooperative data fusion. Traditionally, session topics will include new digital ionosonde technologies, intelligent systems for interpretation of acquired data, detection, and evaluation of traveling ionospheric disturbances (TID), information science for timely network data acquisition and dissemination, assimilative modeling of 3D plasma-distribution in the ionosphere, sensing the vertical and horizontal plasma transport, concepts and designs for topside ionospheric sounding, and other relevant topics.

**G09 : Limits of predictability of ionosphere behavior**

**Conveners:**

Yenca Migoya-Oruè, STI, The Abdus Salam International Centre for Theoretical Physics (ICTP),Trieste, Italy) yenca@ictp.it

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Sandro Radicella, former Head of T/ICT4D Laboratory, The Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy sandro.radicella@gmail.com

**Session Description :**

The topic of this Special Session, very relevant for Ionosphere and Space Weather modelling and applications, is to which extent the near-Earth plasma is predictable in terms of the physics of dynamical systems and statistical results. Ionospheric models attempt to predict ionospheric parameters variations, but there has been always a mismatch between modelled quantities and real measurements. To determine and understand such mismatch is essential to define the predictability of the ionospheric parameters making use also of modern techniques like big data and machine learning. It has to be considered too that near-Earth plasma is highly non-linear. The Session intends to have invited and contributed papers dealing with recent results of prediction models, numerical simulations, case studies and theoretical aspects of the problem.

**G10 : Open Session**

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Bruce Fritz, bruce.fritz@nrl.navy.mil

Dario Sabbagh, dario.sabbagh@ingv.it

**Session Description:**

This session welcomes all papers related to the Commission G terms of reference, particularly those not covered by the other G and G/H sessions.

This session welcomes all papers related to the Commission G terms of reference:

• Ionospheric imaging

• Global Morfology and modelling of the ionosphere

• Ionospheric modelling and data assimilation

• Ionospheric effects of Space Weather

• Radar and radio techniques for ionospheric diagnostics

• Transionospheric radio propagation and systems effects

**GBC-1 : HF Radars for Science and Surveillance**

**Conveners**
Paul S Cannon, University of Birmingham, UK P.Cannon@bham.ac.uk

Trevor Harris, University of Adelaide, Australia, trevor.harris@adelaide.edu.au

Todd Parris, Air Force Research Laboratory, Albuquerque, USA, richard.parris.1@spaceforce.mil, toddparris@gmail.com

Levent Sevgi, lsevgi58@gmail.com

Kumar Vijay Mishra, vizziee@gmail.com

**Session description :**

Contributions are welcomed addressing the design and performance of all HF scientific and surveillance radars with a focus on ionospheric aspects. Contributions might include ray tracing and planning tools, frequency management, coordinate registration, antennas, technologies and architectures, new modes of operation and new observations. The latter may include observations from both scientific HF radars such as SuperDARN and surveillance radars, such as Over the Horizon Radars (OTHR).

**(Special section) Ionospheric effects of the Hunga Tonga volcanic eruption of 15 January 2022 (only for invited authors !)**

**Conveners**
Giorgiana De Franceschi (giorgiana.defranceschi@ingv.it)
Claudio Cesaroni (claudio.cesaroni@ingv.it).

**Session Description**

On January 15 2022, Hunga-Tonga-Hunga-Ha’apai, an uninhabited volcanic island on the Tongan archipelago in the South Pacific Ocean, erupted with spectacular force. This event triggerred travelling waves in the atomosphere-ionosphere system detected all over the world. This special session aims at convening scientists working on Litosphere-Atmosphere-Ionosphere coupling processes in order to share the first results about the occurred phenomena. The session wants to promote an open discussion on international efforts and future capabilities for real time detection of ionospheric effects driven by natural hazards. This "extra" session has been organized thanks to the prompt support of the URSI Board and the facilities they made available.