INTERNATIONAL UNION OF RADIO SCIENCE
UNION RADIO-SCIENTIFIQUE INTERNATIONALE
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**Commission GASS 2021 Report**

**Commission G**

The Coordinating activities meetings for Commission G were held on Monday, Wednesday and Friday – August 30, September 01 and September 03, from 15.00 to 16.00 Rome CEST.

Prof. Patricia Doherty, Chair of Commission G 2017-2021, led the first two meetings and turned over the last meeting to Giorgiana De Franceschi, Chair for the 2021-2023 biennium. It is important to note that, because the hybrid format of the GASS2021, part of the members was on site and part on line, reaching however a high number of attendees of more than 50 in total for each of the three meetings.

The Commission G Coordinating activities meeting n.1 commenced with a brief remembrance and moment of silence for the following friends and colleagues who passed away during the triennium:

- William Burke, 1935-2020, USA
- Don Farley, 1933-2018, USA
- Bengt Hultqvist, 1927-2018, Sweden
- Edward S. Kazimirovsky, 1937-2018, Russia
- Leo McNamara, 1940–2021, USA
- Aleksandr P. Potekhin, 1951 – 2019, Russia
- Karl Rawer, 1913-2018, Germany
- Alan Rodger, 1951-2020, UK
- Charlie Rush, 1942-2020, USA
- Yuri Ruzhin, passed away in 2021, Russia
- Bill Wright, 1929-2018 USA

## 1. Results of Election of Vice-Chair

Commission G held the election for Vice Chair during the 1nd meeting. Three eminent scientists were nominated including:

Keith Groves, Boston College, USA

Ivan Galkin, UML, USA

John Bosco Habarulema, SANSA, South Africa

We are pleased to announce that Dr. Keith Groves was elected Vice Chair of Commission G for the 2021-2023 biennium. We thank all of the candidates for their generous offer to lead the Commission.

## 2. Results of Election of Early Career Representative

Commission G also held the election for Early Career Representative. Three dynamic and enthusiastic young scientists were nominated including:

Dario Sabbagh, INGV, Italy

Bruce Fritz, US Naval Research Lab., USA

Kshitija Deshpande, ERAU. USA

Because the resulting ex aequo between Sabbagh and Fritz, both have been elected as ECR of Commission G 2021-2026 together with Sean Elvidge that will finish his action in 2023.

## 3. Appointment of Associate Editor for *Radio Science Bulletin*

Dr. Iwona Stanislawska, past Chair of Commission G 2014-2017, will serve as the Associate Editor for the RSB.

## 4. Updates/Status of Working Groups

The full WG's status is included in the report by Patricia Doherty (2017-2021).

Summarizing, the following WGs will continue their activities:

**G1: Ionosonde Network Advisory Group (INAG)**

Chair: I.A. Galkin (USA); Vice-Chairs: J.B. Habarulema (RSA), Baiqi Ning (China); INAG Bulletin Editor: K. Wang (Australia).

INAG deals with the monitoring of the ionosphere by means of High-Frequency (HF) radio sounding. Recognizing the accomplishments over the past 90 years, INAG notes strengthening role of the HF ionosonde as a fully autonomous instrument for accurate and prompt specification of the ionospheric weather.

**G2: Studies of the ionosphere using beacon satellites**

Chair: P. Doherty (USA); Vice Chairs: B. Nava (Italy), A. Krankowski (Poland)

The Beacon Satellite Group (BSG) is interdisciplinary, servicing science, research, applications, and engineering interests. The prime objective is to study the ionosphere using beacon satellite signals.

**G3: Incoherent Scatter**

Chair: A. J. Kavanagh (UK); Vice Chair: TBD[2021- ]

ISWG main task is coordinating the combined "World Day" operations of all the global incoherent scatter radar facilities around the world.

**GEH: Seismo Electromagnetics (Lithosphere-Atmosphere-Ionosphere Coupling)**

Co-chairs: S. Pulinets (Russia), M.Y. Hobara (Japan), H. Rothkaehl (Poland)

The main activity would include:

1. Further development of the physical mechanisms of pre-earthquakes ionospheric anomalies generation
2. Statistical confirmation of the pre-earthquake ionospheric anomalies existence
3. Development of the technologies of automatic identification of the pre-earthquake ionospheric anomalies

**GJFEH: Interdisciplinary Space Weather**

Co-chairs: I. Stanislawska (Poland), R. Fallows (Netherlands), Patricia Doherty (USA)

This inter commission group is devoted to advancements on monitoring, studying, modelling, forecasting, mitigating space weather phenomena and impacts on the near-Earth. The activity foreseen efforts in investigating planetary ionospheres.

**IRI task force (URSI/COSPAR).**

The task force will continue the international efforts on models for the International Reference Ionospehere.

The **WG: Middle Atmosphere** is inactive and Commission G decided to close this group. Moreover, the past chair J. Roetteger passed away, Paul Cannon gave to the community this info during the third meeting.

**There have been proposals, accepted, of new WGs as follows:**

**G4 Capacity Building and training**

Chair C. Cesaroni (Claudio.cesaroni@ingv.it , Italy), co-Chairs J. Owlendo (j.olwendo@pu.ac.ke, Kenya), B. Nava (bnava@ictp.it), P. Doherty (patricia.Doherty@bc.edu)

The "Capacity building and training" working group deals with the activities related to the training of students and young scientists especially from developing countries. The main objectives of the working group are:

- Organize international workshops especially for young scientists from developing countries

- Facilitate visits exchange for young scientists by spreading news about opportunities and by putting in place action for funds raising

- Organize periodical webinar for sharing new research among the commission G community

**FCGEH- Risk and Disaster Management** (Inter URSI Commissions)

Chair (T. Tanzi, France, COMM F),…co-chairs Commission G (C. Cesaroni, Italy; A. Ippolito, Italy)

The suggested scientific topics are:

•Identifying precursors based on seismic events, lightening events.

•Application of weather radars (fast scans…).

•Space-weather with regard to its impacts on satellite communications and high-latitude power transmission (Geomagnetically Induced Currents)

**HGE Radio Diagnostics of Space Weather Plasma Processes**

Chair: M. Messerotti (INAF, Italy), co-chair Commission G (David Themens, Canada), Commision E ( Y. Hobara (Japan)

The activities range from Solar and Heliospheric Weather to Interplanetary and Planetary Space Weather.

This Working Group is aimed at constituting a forum for the community of radio physics theoreticians and radio emission observers from space and ground, in order to promote the joint study of plasma processes in the framework of Space Weather. The main role of this forum consists of synergising the establishment of robust theoretical and observational frameworks by fostering the refinement of existing radio physics models and radio observation techniques as well as the development of new ones

## 5. Updates to Terms of Reference of Commission

The Terms of Reference of Commission G have been slightly modified as described below:

The Commission deals with the study of the ionosphere in order to provide the broad understanding necessary to support space and ground-based radio systems. Specifically, the Commission addresses the following areas:

- Global morphology and modelling of the ionosphere;
- Ionospheric space-time variations and the impacts of space weather on systems;
- Development of tools and networks needed to measure ionospheric properties and trends;
- Theory and practice of radio propagation in and through the ionosphere;
- Application of ionospheric information to radio systems.

To achieve these objectives, the Commission co-operates with other URSI Commissions, corresponding bodies of the ISC family (IUGG, IAU, COSPAR, SCOSTEP, SCAR, etc.) and other organisations (ITU, IEEE, etc.).

## 6. Meetings proposed to be supported in the coming triennium

The Commission anticipates providing support to URSI centered meetings in the coming biennium. As funds permit, this includes young scientist support to attend the flagship meetings AT-AP-RASC2022 and GASS2023. Funds permitting, we may also support the Beacon Satellite Symposium in August 2022 (Boston, USA), IRI meetings, RFI (URSI Inter-commission), in February 2022, UK, Eastern Africa GNSS and Space Weather capacity building workshops" in Kenya (or at ICTP-Italy) 2022, 2023.

## 7. Report and comments on the scientific program of the Commission for the current GASS

Commission G organized 16 scientific sessions, 5 joint sessions leaded by Commission G and a workshop for a total of 311 papers submitted, 13% of them as “invited presentation”.

This list of GASS sessions include:

G01: Data Assimilation for Space Weather

G02: Advances on High Accuracy GNSS solution

G03: International Reference Ionosphere: Improvement, Validation and Usage

G04: Science with Modern Ionosondes and Associated Instrumentation and Models

G05: Advances in Irregularities and Scintillation Studies

G06: Innovations in Geospace Science Using Incoherent Scatter Radar Techniques

G07: Design and Application of HF and OTH Radar Systems

G08: Ionospheric Space Weather

G09: Radio Occultation and Reflectometry: ionosphere compensation, monitoring and modelling

G10: Radio Studies of Mid and Low Latitude Aeronomy

G11: International Beacon Satellite Studies

G12: Long-term Ionosphere Forecasting: State of the Art and Recent Advances

G13: Open Session

G14: Predictability of the Earth’s Ionosphere and Space Weather Dynamics

G15: PRESTO: The New SCOSTEP Space Weather and Space Climate Program

G16: Space Weather impacts on GNSS

GH1: Meteors, Collisional EMPs & other Highly-transient Space Plasma Events

GH2: Plasma Instabilities in the Ionosphere

GH3: Lessons learned from Ground-based Active Ionospheric Experiments

GHE1: Seismo Electromagnetics (Lithosphere-Atmosphere-Ionosphere Coupling)

GHJ1: The Polar Environment and Geospace

WS3: Radio Science in Space Weather

The Commission G congratulates with the LOC of GASS2021 for the successful organization of the Conference in the hybrid form. The virtual platform was well working and intuitive, allowing papers and FIPs presentation and, most important, the platform offered the same opportunity to on site and on line attendees to actively participate, although some difficulties for the not optimal time zone in some part of the globe, depending on the scheduled CEST time sessions, that however cannot be avoid in case of hybrid form. Moreover, there were comfortable rooms on site and technical assistants able to solve rapidly eventual difficulties arising sometime with the on line speakers.

Most of the sessions were well attended. There was considerable interest in the Workshop on Radio Science in Space Weather. Unfortunately, some of the conveners were not able to attend but chair and vice chair were able to replace them in time.

The Commission thanks Ivan Galkin for the impressive tutorial offered "Ionospheric Imaging with Assimilative IRI".

The Commission also would suggest the following for the future events: FIP's should be organized as flash sessions with 3 min presentation for each FIP, followed by discussion moderated by a chair. Oral slot could be reduced to 10 min presentation + 2 minute for question in order to decrease the number of parallel sessions. It is suggested to increase FIP's (flash oral) sessions, much more dynamic than oral slots.

## 8. Proposed sessions for the next GASS 2023

All agreed that it was too early to consider program development for special sessions, considering the urgent need to consolidate sessions for AT-AP RASC 2022. Thus, we will simply hold the discussion later and within the next AT-AP-RASC 2022. Meanwhile, for a placeholder we will use our general interest sessions listed below for the AT-AP RASC 2022 under G1 – G6, and some special sessions (S-G) particularly in case that some of them will be postponed to GASS2023.

## 9. Proposed sessions for the AT-AP-RASC 2022

The sessions planned for the AT-AP RASC 2022 include historical topics related to the Commission G terms of reference and special sessions focusing on selected aspects in the field of the ionosphere and radio propagation. Commission G Officers (Chair, V-Chair, ECRs) will act as chairs of the historical sessions (G1-G6).

G1 - Global morphology and modelling of the ionosphere

G2 – Ionospheric modelling, imaging and data assimilation

G3 - Ionospheric effects of Space Weather

G4 – Radar and radio techniques for ionospheric diagnostics

G5 –Transionospheric radio propagation and systems effects

G6- Open Session - This session welcomes all papers related to the Commission G terms of reference, particularly those not covered by the G special sessions.

To date (September 7 2021), the list of special sessions to be consolidated within September 20 include:

- S-G1 OTHR/HF Radar (including SuperDarn), Paul Cannon, Todd Parris, Trevor Harris
- S-G2 GNSS Radio Occultation: Measurements, data assimilation and models, Riccardo Notarpietro, Mainul Hoque, Manuel Hernandez-Pajares
- S-G3 Novel radio instruments and techniques for Space Weather model validation and testing, David Themens, Alessio Pignalberi, Fabricio Dos Santos Prol.
- S-G4 Ionospheric Space Weather: effects on navigation and communication (I. Stanislawska, V. Romano…..)
- S-G5 Recent advances on ionospheric perturbation indices and scales, Luca Spogli, et al

- S-G6 Machine Learning methods for ionospheric modelling: state of the art and future actions, Claudio Cesaroni, Ryan McGranaghan, Enrico Camporeale,…
- S-G7 Advances in Incoherent Scatter Radars and its techniques, Ingemar Häggström, Yue Xinan, Yin Chen yin.chen@egi.eu
- S-G8 Data Assimilation and Modelling, S. Elvidge….
- S-G9 Space weather risks, mitigation, services, predictions, P. Doherty, G. De Franceschi,….
- S-G10 Modern ionosonde research and weather operations, Ivan Galkin, John Bosco Habarulema

## 10. Other business

**Commission G Officers for the 2021-2023**

Chair: Giorgiana De Franceschi, INGV, Italy, Email: giorgiana.defranceschi@ingv.it

Vice-Chair: Keith Groves, Boston College, USA, Email: keith.groves@bs.edu

ECR (2nd term): Sean Elvidge, University of Birmingham, UK, Email: s.elvidge@bham.ac.uk

ECR (1st term): Dario Sabbagh, INGV, Italy, Email: Dario.sabbagh@ingv.it

ECR (1st term): Bruce Fritz, US Naval Research Lab., USA, Email: bruce.fritz@nrl.navy.mil

**Technical Advisory Committee (TAC)**

The following people have agreed to support Commission G as part of the technical advisory committee (TAC). Commission G members are welcome to advise the Chair, Vice Chair and ECRS at any time.

The TAC includes:

Giorgiana De Franceschi, Chair

Keith Groves, Vice Chair

Sean Elvidge, ECR

Dario Sabbagh, ECR

Bruce Fritz, ECR

Luca Spogli (Italy), luca.spogli@ingv.it

Paul Cannon (UK), P.Cannon@bham.ac.uk

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Prepared by Giorgiana De Franceschi, Commission G Chair (2021-2023)