INTERNATIONAL UNION OF RADIO SCIENCE
UNION RADIO-SCIENTIFIQUE INTERNATIONALE
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Commission Report
2017-2021

Commission Triennial Report

Commission E

1. Terms of Reference

There were no updates to the Terms of Reference. The current Terms of Reference are as follows:

Commission E promotes research and development in:

- Terrestrial and planetary noise of natural origin, seismo- electromagnetic fields;
- Man-made electromagnetic environment;
- The composite noise environment;
- The effects of noise on system performance;
- The effects of natural and intentional emissions on equipment performance;
- The scientific basis of noise and interference control, electromagnetic compatibility;
- Spectrum management

2. Commission E Working Groups

A number of Working Groups have been established to provide a focus for a number of activities relevant to the theme of Commission E. These are outlined below, together with the relevant contact persons

2.1 Overview Commission E Working Groups

WG Name	Title	Co-Chairs / Chairs
E1	Terrestrial and Planetary Electromagnetic Noise Environment and seismo-electromagnetic fields	C. Price (Israel), Y. Hobara (Japan), A.P. Nickolaenko and K. Hattori (Japan)
E2	Intentional Electromagnetic Interference	M. Bäckström (Sweden), and W. Radasky (U.S.A)
E3	High-Power Electromagnetics	R.L. Gardner (U.S.A) and F. Sabath (Germany)

E4	Lightning Discharges and Related Phenomena	V. A. Rakov (USA) and S. Yoshida (Japan)
E5	Interaction with, and Protection of, Complex Electronic Systems	F. Gronwald (Germany), J-P. Parmantier (France)
E6	Spectrum Management	J. P. Borrego (Portugal) and R. Struzak (Poland)
E7	Electromagnetic Compatibility in Wired and Wireless Systems	F. Rachidi (Switzerland), A. Zeddam (France), and F. Gronwald (Germany)
E8	Stochastic Techniques in EMC	L. Arnaut (UK), S. Pignari (Italy), and R. Serra (Netherlands
EB	Chaos and Complexity in EM	G. Gradoni (UK), and A. Sihvola (Finland)
EHG	Solar Power Satellite	Chair: H. Matsumoto (Japan), Co-Chair for Commission E: J. Gavan (Israel), Co-Chair for Commission H: K. Hashimoto (Japan);
GEH	Seismo Electromagnetics (Lithosphere-Atmosphere-Ionosphere Coupling)	Co-Chair for Commission E: M. Y. Hobara (Japan), Co-Chair for Commission G: S. Pulinets (Russia), Co-Chair for Commission H: H.Rothkaehl (Poland)
GJFEH	Interdisciplinary Space Weather	Co-Chair for G: I. Stanislawska (Poland) Co-Chair for J: R. Fallows (Netherlands)
URSI/IAGA	URSI/IAGA VLF/ELF Remote Sensing of the Ionosphere and Magnetosphere (VERSIM)	Chair for URSI (Commissions E,G,H): M. Clilverd (UK), IAGA Chair: J. Bortnik (USA)

E1. Terrestrial and Planetary Electromagnetic Noise Environment

Co-Chairs: C. Price (Israel), Y. Hobara (Japan), A.P. Nickolaenko (Ukraine), and K. Hattori (Japan)

This WG deals with the study on the characteristics of natural electromagnetic noise taking place not only in the terrestrial, but also in the planetary environment. The most well-known EM noise is the atmospheric radio noise from the lightning discharges (so-called sferics in a wide frequency range from DC to VHF). Some examples of topical subjects on sferics are (1) monitoring of global lightning activity as studied by high frequency noise and Shumann resonance phenomena in the ELF band and (2) ELF transients related with the optical emissions in the mesosphere due

to the lightning. Higher frequency lightning emission provides us with the information on the fine structure of lightning electrical structure, while lower frequency noise provides us with the macroscopic nature of lightning. The noise coming from the ionosphere/magnetosphere will be discussed as well; micro pulsations in the ULF range, VLF/ELF emissions and HF emissions due to the plasma instabilities in the space. The radio noise environment on other planets is also of interest to this group. We are particularly interested in using natural EM observations in monitoring, detecting and forecasting natural hazards, such as thunderstorms, severe weather, space weather and seismic events.

E2. Intentional Electromagnetic Interference

Co-Chairs: M. Bäckström (Sweden), and W. Radasky (U.S.A)

This working group studies the area of intentional electromagnetic interference (IEMI), which is defined by the IEC as the "Intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes." In particular, this working group focuses on the electromagnetic threat weapons, the coupling to electronic systems, the vulnerability of systems to these types of transients and the protection of systems from the IEMI threat.

E3. High Power Electromagnetics

Co-Chairs: R.L. Gardner (U.S.A) and F. Sabath (Germany)

The objective is to encourage research in high power electromagnetics (HPE). The technical area of HPE consists of the physics and engineering associated with electromagnetic sources where nonlinear effects associated with high-field regions (and air breakdown) must be included in the analysis and design. This includes (but is not limited to) EMP simulators, high-power narrowband and meso-band sources and antennas, and hyperband (impulse) sources and antennas. It also includes the environment near lightning channels and in nuclear EMP source regions. In some cases it includes the high field regions on, or in targets because of local field enhancement.

E4. Lightning Discharges and Related Phenomena

Chair: V. A. Rakov (USA) and S. Yoshida (Japan)

The lightning discharge is one of the two natural sources of electromagnetic interference (EMI), the other one being the electrostatic discharge. Electric and magnetic fields generated by lightning represent a serious hazard to various systems, particularly those containing sensitive electronics. This WG focuses on the characterization of lightning and its interaction with engineering systems and with the environment, as well as on lightning detection and testing. It covers all aspects of lightning research, including observations, field and laboratory experiments, theoretical studies, and modeling.

E5. Interaction with, and Protection of, Complex Electronic Systems

Co-Chairs: F. Gronwald (Germany), J-P. Parmantier (France)

This working group studies the various electronic and electromagnetic aspects related to the interaction with, and protection of, complex electronic systems. The focus is the analysis of the various coupling paths and their associated transfer functions into complex electronic systems, as formalized in the framework of electromagnetic topology. Analytical, numerical, and measurement techniques are used to characterize the electromagnetic fields and currents

in a complex environment. In the analysis, special attention is placed on the emergence of new technologies, and the inclusion of advanced materials and communication systems.

E6. Spectrum Management

Co-Chairs: J.P. Borrego (Portugal) and R. Struzak (Poland).

The E6 focus is on sound scientific spectrum management for improved utilization of the radio frequencies for protection wireless communications service and radio sciences. The goal is to assure further development of radio sciences and communication services, unobstructed by potential radio interference due to unwanted energy in the form of out-of-band and in-band encroaching and deleterious in-band and out-of-band emissions. The electromagnetic spectrum is treated as a limited natural resource with a multitude of competing demands for access to it and use of it. Spectrum management seeks innovative means and technologies for adequate co-existence of all of them taking into account the need of protection of new and incumbent wireless and wired communication services, systems and equipment, with special focus on science services and those that use passive technologies.

E7. Electromagnetic Compatibility in Wired and Wireless Systems

Co-Chairs: F. Rachidi (Switzerland), A. Zeddam (France), and F. Gronwald (Germany)

The intensive use of the electromagnetic spectrum for communications has resulted in issues of compatibility and interoperability between different users. In addition the continual increase in operating frequency of products and higher frequency sources of disturbances (such as Ultra-Wide Band systems) resulted in an increase of potential EMC problems in communication systems and the use of power lines for carrying data is adding to interference problems. Potential remedies are also addressed.

E8. Stochastic Techniques in EMC

Co-Chairs: L. Arnaut (UK), S. Pignari (Italy), and R. Serra (Netherlands)

2.2 Overview Commission E Joint Working groups

EB Chaos and Complexity in EM

Co-Chairs: G. Gradoni (UK), and A. Sihvola (Finland)

Wave complexity underpinned by fully developed, partial and transient chaos is becoming permanent in multi-component electromagnetic systems operating at electrically large scales. Statistical methods have been developed to tackle those systems and their specific engineering structures occurring in electromagnetic compatibility, electronics circuits as complex sources of radiated emissions, wireless communications including massive MIMO systems, etc. Recent studies in wave chaos have attracted researchers in electromagnetic theory and universal statistical properties have been used to study large electromagnetic systems without solving the full-wave problem. Hybrid methods combining full wave algorithms with newborn statistical methods are emerging in the EM wave modeling arena. System specific components need detailed treatment while deformed and irregular parts of EM environments can be treated statistically because of their mixing behavior. Furthermore, statistical sources can be treated through semi-classical as well as random matrix theories. Novel theoretical models have been developed describing fields through complicated electromagnetic environments – including

electromagnetic reverberation chambers - also accounting for coupling through apertures and including losses at both microwave and mmWave regimes, as well as complex placement of wires and cables within EM environments. Uncertainties arising within cabling and radiating systems can be described through the polynomial chaos method.

EHG Solar Power Satellite

Chair: H. Matsumoto (Japan), Co-Chair for Commission E: J. Gavan (Israel), Co-Chair for Commission H: K. Hashimoto (Japan)

GEH Seismo Electromagnetics (Lithosphere-Atmosphere-Ionosphere Coupling)

Co-Chair for Commission G: S. Pulinets (Russia), Co-Chair for Commission E: M. Y. Hobara (Japan), Co-Chair for Commission H: H.Rothkaehl (Poland)

GJFEH Interdisciplinary Space Weather

Co-Chair for G: I. Stanislawska (Poland), Co-Chair for J: R. Fallows (Netherlands)

URSI/IAGA VLF/ELF Remote Sensing of the Ionosphere and Magnetosphere (VERSIM)

Chair for URSI (Commissions E,G,H): M. Clilverd (UK), IAGA Chair: J. Bortnik (USA)

3. Commission E Related International Activities – Flagship Conferences

Besides the various national URSI activities, main focus of Commission E is put on the URSI flagship conferences.

3.1 URSI GASS 2017, Montreal, Canada, August 19-26, 2017

Commission E offered 11 sessions at the URSI GASS in Montreal (2017), most of them consisting of several parts. In addition, there were seven more sessions, organized and coorganized with other Commissions. All of the sessions were well attended. It was intended to have a similar session structure for the next GASS. Commission E also offered a “Short Course on IEMI and Cyber threats for Wireless Communications”, an “ECR Tutorial on Wave Chaos and Complexity in Electromagnetic Environments”, and a “Tutorial on EMC Aspects in Smart Grids”. Commission E also was involved in the well-received “One-Day Workshop on RFI Mitigation and Characterization”.

3.2 URSI AT-RASC 2018, Gran Canaria, Spain, May 28 – June 1, 2018

Unexpectedly, Commission E only received a comparatively small number of paper submissions for this conference. It was not possible to fill all sessions as previously planned. As a consequence, the initially planned session structure was changed to form three larger sessions, two of them being held in two parts, and three special joint sessions. The reason for the low submission rate was seen in competitive events centering on Electromagnetic Compatibility and a too large number of Commission E related conferences in general.

3.3 URSI AP-RASC 2019, New Delhi, India, March 9 - 15, 2019

The situation of low submission rates still persisted in this conference but slightly improved, such that five oral sessions and one poster session could be offered, covering an interesting variety of Commission E topics.

3.3 URSI GASS 2020, Rome, Italy, August 29 – September 5, 2020 (fully virtual)

For the URSI GASS 2020, the well-established session structure of the URSI GASS 2017 was taken over and updated, leading to a very good number of papers submissions that resulted in a highly attractive collection of 16 Commission E related sessions. Unfortunately, due to the worldwide COVID pandemic, the URSI GASS 2020 could only take place in a virtual format. Some authors postponed their contribution to the next URSI GASS 2021, resulting in gaps of the initial program. Nevertheless, most sessions could take place, at least in a reduced and virtual setting, with most scientists hoping for a regular URSI GASS in 2021.

3.4 URSI GASS 2021, Rome, Italy, August 28 – September 4, 2021 (planned as hybrid event)

At the time of writing this report, the COVID pandemic still persists. The URSI GASS 2021 has been organized in a similar was as the URSI GASS 2020, resulting in a similar session structure with a very satisfying number of paper submissions, distributed to 15 Commission E related sessions, together with one tutorial. The URSI GASS 2021 is planned as a hybrid event, allowing for both on-site and remote attendance.

4. Reviews of Radio Science

In the March 2020 and June 2020 issue of the Radio Science Bulletin, a Commission E corner was announced. It is the intent of this corner to showcase latest research, news, updates, and announcements from different geographical regions. Concise reports, editorially in line with the RSB and subsequent to a review process, are requested to appear in this corner.

5. Website

Further information about Commission E may be found via the web link below:

https://www.ursi.org/commission.php?id=E