United Nations Nations Unies

COSPAR Symposium

Space Weather and Small Satellites

Monday, 11 February 2019

15:00 – 18:00

Board Room D, Building C, Vienna International Centre

The sun, our powerful neighbour in space, exerts a dynamic influence on our planet and the near-Earth space environment through both radiation and the emission of charged particles in the solar wind. The influence of dynamic and eruptive events at the Sun on our environment - and even on man-made infrastructure in space and on the ground - is usually referred to as Space Weather (SWx). Over the recent years there has been an ever increasing effort to utilise major scientific space missions from space agencies around the world - and also extended ground-based networks of instruments - to advance our understanding of the Sun itself, and the most important physical processes in the coupled solar wind /geo-space system, occurring in response to the variable and highly dynamic solar output. Major breakthroughs have been made in the basic understanding of the principles of the plasma-interactions in the various coupled space plasma regimes. However, we are still far away from a sufficiently detailed understanding to be able to deliver accurate forecasts and predictions of space weather as required by the providers of infrastructure in space and on the ground, and to meet the growing demands for a sustainable highly technological society. The international SWx community is presently approaching a status of knowledge where one should begin to define a necessary global observational fleet of spacecraft, capable to deliver the data required to enable better space weather predictions in the future. This can be achieved both through improved characterisation of the solar input as well as a better understanding of how they are processed in geospace gained from targeted research and discovery. Obviously there is still an imminent and urgent need for large missions in the solar wind and in geo-space to monitor and define the overall status of the coupled system, but in order to gain a more complete picture, also on local and regional scales, the use of smaller satellites has become an interesting approach to some of the remaining open problems in space weather. This symposium will analyse some of the needs for and opportunities from using small satellites for space weather purposes.

Important Notice

Non-Delegates

In order to attend the Symposium, please register by submitting your name to the Office for Outer Space Affairs in advance and present this invitation together with an appropriate identification document at the entrance of the Vienna International Centre.

Co-ordination by the

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On the occasion of the Fifty-sixth session of the

Scientific and Technical Subcommittee of the United Nations

Committee on the Peaceful Uses of Outer Space

Monday, 11 February 201

Chair **Hermann Opgenoorth (COSPAR)**

15:00 ***A short introduction to Space Weather***

Speaker: **Hermann J. Opgenoorth**, COSPAR Space Weather Panel PSW, and Universities of Umeå, Sweden, and Leicester, UK.

15:10 ***COSPAR space weather action teams: A bottom-up component of global coordination in space weather***

Speaker: **Masha Kuznetsova**, Chair COSPAR PSW and Director Community Coordinated Modelling Center, CCMC, NASA GSFC,Washington, USA

Hermann Opgenoorth, Anna Belehaki, Mario Bisi, Sean Bruinsma, Alexi Glover, Manuel Grande, Daniel Heynderickx, Jon Linker, Ian Mann, Dibyendu Nandi, Manuela Temmer, Robert Wimmer- Schweingruber, Sharafat Gadimova

15:30 ***Heliophysics Space Weather at NASA: Research and Small Satellites***

Speaker: **James Spann**, Nicola Fox, Dan Moses, Roshanak Hakimzadeh, NASA HSD, Washington, USA

16:50 ***Space Weather with Cube Satellites in Canada: The Experimental Albertan Satellite #1 (Ex-Alta 1), the Canadian Cubesat Program, and beyond***

Speaker: **Ian R. Mann**, University of Alberta, Canada.

16:10 ***Combined small satellites and ground based instrumentation for Space Weather studies in Brazil.***

Speaker: **Clezio Marcos De Nardin**, Head of Space and Atmospheric Science - CGCEA/INPE, and the EQUARS Mission Team, SPORT Mission Team, Embrace Team, and CGCEA Research Team, Brazil

16:30 ***Space Weather Forecast Operation & Research with Small Satellites***

Speaker: **Mamoru Ishii**, National Institute of Information and Communications Technology, Japan

16:50 ***Small-satellite enabled science in Heliophysics within Italy's Roadmap towards Space Weather Science***

Speaker: **Christina Plainaki** and the ASI Space Weather Working Group,Agenzia Spaziale Italiana, Via del Politecnico snc, 00133, Rome, Italy

17:10 ***Space Weather and Small Satellites: A UK Perspective***

Speaker: **Mario M. Bisi** (RAL Space, UKRI-STFC, UK), David Jackson (Met Office, UK), Yulia Bogdanova (RAL Space, UKRI-STFC), Sean Elvidge (University of Birmingham, UK), Keith Ryden (Surrey Space Centre, UK), Jonathan Eastwood (Imperial College, London), Anasuya Aruliah (UCL, UK),

Chiara Palla (Imperial College, London), Patrick Brown (Imperial College, London), and Mike Hapgood (RAL Space, UKRI-STFC, UK).

17:30 ***Space Weather: Outreach and Capacity Building Activities***

Speaker: **Sharafat Gadimova**, The United Nations Office for Outer Space Affairs, Vienna, Austria

17:50 ***Discussion and summary of the symposium***

ABSTRACTS

COSPAR space weather action teams: A bottom-up component of global coordination in space weather

Masha Kuznetsova[1], Hermann Opgenoorth[2], Anna Belehaki[3], Mario Bisi[4], Sean Bruinsma[5], Alexi Glover[6], Manuel Grande[7], Daniel Heynderickx[8], Jon Linker[9], Ian Mann[10], Dibyendu Nandi[11], Manuela Temmer[12], Robert Wimmer- Schweingruber[13], Sharafat Gadimova [14]

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Space weather is broadly recognized as a potential global threat. Understanding and predicting space weather events is internationally acknowledged as a global challenge. The COSPAR/ILWS roadmap on space weather published in 2015 (Advances in Space Research, 2015: DOI: 10.1016/j.asr.2015.03.023) prioritizes steps to be taken to advance understanding of space environment phenomena and to improve global resilience to space weather. To facilitate progress towards roadmap goals there is a need to join forces and to maximize return on investments into advancing space weather capabilities. The COSPAR Panel on Space Weather is aiming to build upon the past successes and the roadmap recommendations and to facilitate establishment of a new international space weather research and development initiative. Keys to the success include creating flexible, collaborative, inclusive environment and engaging motivated groups and individuals committed to active participation in international space weather action teams (ISWAT) focused on topics addressing emerging needs and challenges in the rapidly growing field of space weather. The presentation will highlight recent progress that demonstrated a value of coordinated international team efforts and discuss challenges and opportunities.

Heliophysics Space Weather at NASA: Research and Small Satellites

James Spann, Nicola Fox, Dan Moses, Roshanak Hakimzadeh

NASA is a mission driven agency whose science mission is focused on discovering the secrets of the universe, looking for life elsewhere, and safeguarding and improving life on Earth. Heliophysics plays a key role in every aspect of the NASA science mission, including understanding the drivers of and enabling the prediction of space weather. The Heliophysics Division (HPD) in NASA's Science Mission Directorate has an established research program that motivates and funds solar and space physics, which is the essence and foundation of space weather research. Recently, the HPD established a Space Weather Science Applications Program, SnAP. The objective of this competed program is to enable the transition of the knowledge and understanding of space weather to operation environments, by partnering with sister agencies, the commercial sector, and academia. SnAP leverages relevant NASA capabilities to reach this objective. Furthermore, HPD has a small satellite/sounding rocket program that is relevant to space weather research, and the international space community. This talk provides an overview of space weather research, SnAP, and relevant small satellite/sounding rocket programs in the NASA Heliophysics Division.

Space Weather with Cube Satellites in Canada: The Experimental Albertan Satellite #1 (Ex-Alta 1), the Canadian Cubesat Program, and beyond

Ian R. Mann

University of Alberta, Canada.

Making low noise magnetic measurements is a significant challenge to the use of cube-satellite (CubeSat) platforms for scientific constellation class missions for studies of space weather. In May 2017, as part of the QB50 mission, the University of Alberta (UofA) in Canada launched the first ever made-in-Alberta satellite from the International Space Station. The Experimental Albertan Satellite #1 (Ex-Alta-1) was designed, built, and tested by a team of mostly undergraduate students and faculty. Until its burn-up harmlessly in the atmosphere in November 2018, it provided space qualification and test of on-board systems and payloads targeting space weather. The project, in particular, targeted a demonstration of the feasibility of making low-noise and high-accuracy science grade magnetic field measurements on CubeSats with a boom mounted, very low noise, and high accuracy miniaturised fluxgate magnetometer. We highlight the potential scientific returns and utility of using CubeSats carrying fluxgate magnetometers, such as tested on Ex-Alta 1, to constitute a magnetospheric constellation mission aimed at resolving the spatiotemporal characteristics of the coupled geospace system. Finally, we provide a brief overview of the new Canadian Space Agency funded national Canadian Cubesat Program (CCP). Fifteen student teams have been selected to participate in the CCP, one from every province and territory in Canada. Each team will build, test, launch and operate a CubeSat - aiming to elevate hands-on student training to encompass mission development from-the-cradle-to-the-grave. The CCP model could also be adopted in other nations who are seeking to develop similar hands-on training and research programs. Following the success of the QB50 mission, perhaps the UN COPUOS and COSPAR can examine the possibility of creating of a future multi-national CubeSat constellation mission. Thereby training a new generation of scientific and technical innovators, and even entrepreneurs, who can aid in the exploration, exploitation, and the peaceful uses of outer space.

Combined small satellites and ground based instrumentation for Space Weather studies in Brazil

Clezio Marcos De Nardin
Head of Space and Atmospheric Science - CGCEA/INPE

and the

EQUARS Mission Team, SPORT Mission Team, Embrace Team, and CGCEA Research Team

The present presentation provides an overview of the current small and very-small satellites under development in Brazil. The mission concept, scientific goals and related information of the Equars and SPORT Missions are provided.
In addition, ground based instrumentation needed for complementary information on space weather phenomena (over the equator) are presented and briefly discussed.
Finally, some project under development for very-small satellite linked to space weather investigation are shown.

Space Weather Forecast Operation & Research with Small Satellites

Mamoru Ishii

National Institute of Information and Communications Technology, Japan

There are two aspects in the relation between space weather and small satellites. One is that small satellites operators are customers of space weather forecast information, and another one is vice versa.
We are now proceeding a project named "Taylor made space weather" in which we connect the space environment information with specific satellite information for saving any satellites. This product is effective more for small satellites than for operational large satellites, because small satellites have not their own house keeping sensors in many cases and they need to get space environment information from third parties.
I would like to introduce another project now we plan, the atmospheric drag estimation. Our group has been developing the atmosphere-ionosphere-thermosphere model named "GAIA: Ground-to-Topside Model of Atmosphere and Ionosphere for Aeronomy" which provide useful information for estimating atmospheric drag of low orbital satellites (LEO). The main uses of this information are operators of small satellite with LEO, on the other hand the model will improve with evaluating the results with LEO trajectory information.
We discuss the both projects with operators of satellites now and hope to present fruitful results in future.

Small-satellite enabled science in Heliophysics within Italy's Roadmap towards Space Weather Science

Christina Plainaki, Agenzia Spaziale Italiana, Via del Politecnico snc, 00133, Rome, Italy
and the ASI Space Weather Working Group:
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Circum-terrestrial Space Weather has its main origins at the Sun being driven by the effects of the variability of solar activity in the Earth's magnetosphere and upper atmosphere. Space Weather is manifested through a series of phenomena including Solar Energetic Particle, geomagnetic variability, and aurorae, as well as the long term variation of the Galactic Cosmic Ray intensity. Changes of the physical conditions in the Earth's upper atmosphere often result from Space Weather. Space-based observations are of fundamental importance for addressing high priority science issues to mitigate the related risks of impacts on technology, infrastructure, and human activities. In situ measurements and remote sensing observations from small satellites or constellations of small satellites, which offer a viable alternative to single spacecraft, could provide precise information on both the space environment dynamics and global evolution of Space Weather phenomena. Moreover, the research in the different Space Weather disciplines can benefit also from the possibility of hosted payload flight opportunities.
Italian teams have been involved several times in space missions with science objectives related to Space Weather, often with lead roles. An important field for the Italian scientific community is the development of new instrumentation for future space missions, whereas different Space Weather forecasting and nowcasting modeling efforts have contributed to the overall progress, at national and international level, in the field of Space Weather. Recently, the ASI Space Weather Working Group proposed through the creation of a related Roadmap a long-term strategy for the development of Space Weather scientific activities in Italy. The entire scientific and industrial communities were also called to provide feedbacks. In the context of this strategy, the Italian Space Agency aims to assess the possibility to develop a National Scientific Space Weather Data Center to encourage synergies between different science teams with interest in the field and to motivate innovation and new mission concept development.

Space Weather: Outreach and Capacity Building Activities

Sharafat Gadimova,

The United Nations Office for Outer Space Affairs, Vienna, Austria

The International Space Weather Initiative (ISWI), launched in 2009 by the Committee on the Peaceful Uses of Outer Space, is a program of international cooperation to advance space weather science by a combination of instrument deployment, analysis and interpretation of space weather data from these instruments in conjunction with space data, and the communication of the results to the public. While the ISWI was formally concluded as an agenda item of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space in 2012, its activities continue under the framework of a new agenda item on Space Weather. A periodic ISWI newsletter is published by the International Centre for Space Weather Science and Education (ICSWSE) of Kyushu University and the ISWI website is maintained by the Bulgarian Academy of Sciences (see www.iswi-secretariat.org).

ISWI has contributed to the development of space science schools that encourage students to consider a career in space science. This project is supported by the International Committee on Global Navigation Satellite Systems' (ICG) working group on information dissemination and capacity building. In that context, the Office for Outer Space Affairs in cooperation with the Institute for Scientific Research of Boston College of the United States and the Abdus Salam International Centre for Theoretical Physics (ICTP), Italy is organizing space weather workshops to educate the public and policy-makers about space weather phenomena, as well as training courses and seminars for students and professionals in space weather data analysis and prediction. Those activities bring together a large number of experts every year, including experts from developing nations, to discuss and act on issues that are also of great relevance to ICG.

ICG, established in 2005 under the umbrella of the United Nations, promotes cooperation on matters related to civil satellite-based positioning, navigation, timing, and value-added services. ICG works to enhance coordination among providers of global navigation satellite systems (GNSS), regional systems, and augmentations in order to ensure greater compatibility, interoperability, and transparency, and to promote the greater use of GNSS capabilities to support sustainable development, particularly taking into account interests of developing nations.