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Committee on the Peaceful Uses of Outer Space

Report of the United Nations/United States of America Workshop on the International Space Weather Initiative: the decade after the International Heliophysical Year 2007

(Boston, United States, 31 July-4 August 2017)

I. Introduction

1. The year 2018, which marks the fiftieth anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE+50), will represent a milestone opportunity to demonstrate the broad societal benefits of space and chart the future role of international collaboration in the peaceful uses of outer space.
2. There are a total of seven UNISPACE+50 thematic priorities, endorsed by the Committee on the Peaceful Uses of Outer Space in 2016 ([A/71/20](#), para. 296). One of those priorities is the international framework for space weather services. The Expert Group on Space Weather of the Scientific and Technical Subcommittee is the mechanism for the implementation of objectives under that priority, with substantive support to be provided by the Office for Outer Space Affairs. Considerable work will be carried out on developing a mechanism for international coordination, under such a framework so that a set of recommendations, as well as information on all the thematic priorities, can be submitted to the Committee for consideration at its sixty-first session, to be held in Vienna in June 2018.
3. As agreed by the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee, a series of workshops, held between 2005 and 2009, focused on the preparations for and the follow-up to the International Heliophysical Year 2007. Those workshops were hosted by the Governments of the United Arab Emirates in 2005 (see [A/AC.105/856](#)), India in 2006 (see [A/AC.105/882](#)), Japan in 2007 (see [A/AC.105/902](#)), Bulgaria in 2008 (see [A/AC.105/919](#)) and the Republic of Korea in 2009 (see [A/AC.105/964](#)).
4. The legacy of the International Heliophysical Year 2007 is the current operation of 18 worldwide instrument arrays, with close to 1,000 instruments recording data on solar terrestrial interaction from coronal mass ejections to variations of the total electron content in the ionosphere (<http://iswi-secretariat.org>). Instruments are provided to hosting institutions by entities in Armenia, Brazil, France, Germany, Israel, Japan, Switzerland and the United States of America. The International Heliophysical Year 2007 is a successful model for the deployment of arrays of small instruments in scientifically interesting geographical locations, and it drew scientists



and engineers from around the globe in a coordinated observing campaign of the heliosphere and its effects on planet Earth.

5. Consequently, in 2009, the Committee launched the International Space Weather Initiative (ISWI), to be dealt with by its Scientific and Technical Subcommittee ([A/AC.105/933](#), para. 168). Workshops on ISWI in the series were hosted by the Governments of Egypt in 2010 (see [A/AC.105/994](#)), Nigeria in 2011 (see [A/AC.105/1018](#)) and Ecuador in 2012 (see [A/AC.105/1030](#)).

6. ISWI is an international cooperation programme to advance space weather science that combines the deployment of instruments with the analysis and interpretation of space weather data obtained from those instruments in conjunction with space data, and communicates the results to the public.

7. Although ISWI was formally concluded in 2012 as an agenda item of the Scientific and Technical Subcommittee of the Committee, its activities continue under the framework of a new agenda item on space weather ([A/AC.105/1001](#), para. 226). At its fifty-seventh session, the Committee endorsed the establishment of an expert group on space weather under the agenda item that would take stock of relevant technology, information and observation systems around the world and propose recommendations, including areas for future study ([A/69/20](#), para. 146).

8. As part of the United Nations Programme on Space Applications, the United Nations/United States of America Workshop on the International Space Weather Initiative: the decade after the International Heliophysical Year 2007 was organized jointly by the Office for Outer Space Affairs and the National Aeronautics and Space Administration (NASA) on behalf of the Government of the United States. The Workshop was co-organized and co-sponsored by the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP), the International Committee on Global Navigation Satellite Systems (ICG), National Science Foundation and Universities Space Research Association of the United States. The Workshop was hosted by Boston College and held in Boston, United States, from 31 July to 4 August 2017.

9. The present report describes the background, objectives and programme of the Workshop and provides a summary of the observations and recommendations made by the participants.

A. Background and objectives

10. Space weather monitoring, prediction and research have become essential pillars of the global response to advance space weather science, thereby advancing the development of improved operational space weather services and improving resilience against adverse space weather effects and impacts. A major thrust of the International Heliophysical Year 2007 and ISWI was to deploy arrays of small, inexpensive instruments, including magnetometers, radio telescopes, global positioning satellite (GPS) receivers and all-sky cameras, around the world to allow global measurements of ionospheric and heliospheric phenomena. The ISWI programme was envisioned as a partnership between instrument providers and instrument hosts in respective countries. The goal was to provide an expanded and unique viewpoints of space weather on a continental scale.

11. The United Nations/United States Workshop marked the tenth anniversary of the International Heliophysical Year 2007 and provided a forum to discuss the creation of common warning and observation systems; strategies to improve the collection, exchange and delivery of space weather data; modelling and forecasting methods; and the improvement of accuracy, reliability and interoperability. Furthermore, the Workshop considered a road map to design a user platform in order to identify user requirements and to promote synergies between the various communities addressing space weather impacts. The road map served the goal of supporting capacity-building, training and awareness-raising initiatives, and provided information on cutting edge/up-to-date space weather research.

12. The discussions at the Workshop were also linked to the 2030 Agenda for Sustainable Development and the targets set out in the Sustainable Development Goals. The topics of discussion and the related Goals were as follows:

(a) Continuation of the efforts in space weather education in order to better define and characterize severe space weather events and their probability of occurrence and assess their impacts on technological systems (Goal 4: Quality education);

(b) Space weather research helps to promote sustainable development through the prevention of catastrophic disruptions of both ground- and space-based critical infrastructure as well as space-based services, especially during severe space weather events (Goal 9: Industry, innovation and infrastructure);

(c) International coordination of operational space weather services, including monitoring, forecasting, and awareness-raising, with the overall goal of protecting life, property and critical infrastructure (Goal 17: Partnerships for the Goals).

13. In order to strengthen the ongoing processes in the lead-up to UNISPACE+50, the Workshop had the following specific objectives:

(a) Strengthen international coordination and cooperation on space weather products and services, contributing to the following UNISPACE+50 thematic priorities:

(i) Global partnership in space exploration and innovation (thematic priority 1);

(ii) International framework for space weather services (thematic priority 4);

(iii) Capacity-building for the twenty-first century (thematic priority 7);

(b) Continue efforts in space weather education, especially for students from developing nations, recognizing that the International Heliophysical Year 2007 and ISWI had contributed to significant progress in the development of space science schools that encouraged students to consider a career in space science;

(c) Develop a coherent international policy towards an appropriate response to space weather.

B. Programme

14. At the opening of the Workshop, chaired by the Director of the Institute for Scientific Research at Boston College, inspiring welcome remarks and keynote speeches were delivered by the Vice-Provost for Research of Boston College, the Director of the Office of Space and Advanced Technology in the Bureau of Oceans, Environment and Science of the United States Department of State, the representatives of NASA and the National Weather Service of the United States, and the Chair of the Committee on the Peaceful Uses of Outer Space. The Director of the Office for Outer Space Affairs also made opening remarks and delivered a keynote presentation.

15. Speakers emphasized that severe space weather, induced by large solar flares and coronal mass ejections from the sun, can potentially cause damage to critical infrastructure, including, but not limited to, the power grid, as well as systems for aviation, communication, Earth observation and navigation (for both position and timing). Consequently, the potential failure of critical infrastructure can lead to cascading effects impacting other sectors. Noting the increasing reliance of modern society on an interdependent communications infrastructure, the importance of international cooperation in monitoring and preparing for hazardous space weather activity was underlined.

16. Furthermore, it was noted that a special segment of the sixty-first session of the Committee would be dedicated to UNISPACE+50. That event would represent a

milestone opportunity to demonstrate the broad societal benefits of space and chart the future role of international collaboration on the peaceful uses of outer space. It was also noted that the Workshop's outcomes, as a flagship activity under UNISPACE+50 thematic priority 4 (International framework for space weather services), would feed into the preparation process towards the final recommendations for UNISPACE+50.

17. A high-level international forum on the economic and societal effects of severe space weather was held on 31 July and 1 August. The forum brought together speakers from major international organizations, followed by a panel session to discuss issues and policies for acknowledging space weather as a global challenge. The forum helped to focus on the level of international collaboration needed to meet the challenges of understanding and mitigating the impacts of severe space weather for the benefit of all of humankind.

18. On 1 August, the forum featured a flagship activity for the discussion of issues related to UNISPACE+50, including the relevant inputs for the development of objectives under one of its seven thematic priorities directed specifically at space weather services.

19. From 2 to 4 August, the Workshop programme featured technical sessions focusing on the following topics: scientific results on the ionosphere and thermosphere; space weather instruments; space weather modelling, including from the sun to geospace, and severe space weather; and near-Earth radiation and plasma environment, and ionosphere-thermosphere variability; international outreach and capacity-building; coordination of space- and ground-based data resources and ISWI. Invited speakers, who came from both developed and developing nations, presented papers and posters. Poster and discussion sessions provided participants with an opportunity to focus on specific problems and projects related to ISWI, particularly its instrument arrays and their status of operation and coordination, and operational use of space weather data.

20. The presentations made at the Workshop, as well as abstracts of the papers given, the Workshop programme and background materials, are available on the website of the Office for Outer Space Affairs (www.unoosa.org).

C. Attendance

21. Scientists, engineers and educators from developing and industrialized countries from all economic regions were invited by the United Nations, Boston College and NASA to participate in and contribute to the workshop. Participants were selected on the basis of their scientific, engineering and educational backgrounds and their experience in implementing programmes and projects in which the International Heliophysical Year 2007 and ISWI played a leading role. The preparations for the Workshop were carried out by the United Nations in cooperation with an international scientific organizing committee and a local organizing committee.

22. Funds provided by the United Nations, the Government of the United States and co-sponsors were used to cover the travel, accommodation and other costs of 42 participants from 35 countries. A total of 146 specialists in space weather attended the Workshop.

23. The following 44 Member States were represented at the Workshop: Argentina, Australia, Brazil, Bulgaria, Cameroon, Canada, China, Congo, Côte d'Ivoire, Croatia, Ecuador, Egypt, Ethiopia, Finland, France, Georgia, Germany, Greece, Hungary, India, Indonesia, Italy, Japan, Kenya, Malaysia, Mexico, Morocco, Nepal, Nigeria, Norway, Pakistan, Peru, Philippines, Poland, Rwanda, Slovakia, Sri Lanka, Tunisia, Uganda, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States, Uruguay and Viet Nam. Representatives of the Committee on Space Research (COSPAR), the European Space Agency, the International Civil Aviation

Organization (ICAO), the Office for Outer Space Affairs and the World Meteorological Organization (WMO) attended the Workshop.

II. Observations and recommendations

24. Space weather is increasingly becoming a central topic that requires improved and sustained international coordination to respond to severe space weather events, including improved international data-sharing. There is also a need for more advanced space weather models and forecast tools in support of user requirements, and for the coordinated sharing and dissemination of space weather model outputs and forecasts.

25. Recognizing that space weather is a global challenge, participants in the Workshop made the general observations and recommendations set out below.

A. Important role of a coordinating body to prepare for severe space weather events and mitigate their impacts

26. Presentations and discussions by a wide range of space weather stakeholders, service providers and users illuminated an extensive network of space weather services and capabilities, underpinned by an increased understanding of space weather science, impact and risks. Workshop participants agreed, however, that international coordination was essential to mitigate the threat posed by space weather to the modern interconnected and interdependent society.

27. Participants in the Workshop noted the success of ICG as a model for targeted cooperation and interoperability, and for the avoidance of the duplication of efforts at the global intergovernmental level.

28. Participants also noted that, in the face of increased understanding of the impacts of adverse space weather, the Office for Outer Space Affairs played an important role in fostering greater synergy and in promoting the convergence of common interest among States members of the Committee, as well as related national and international organizations, in space weather efforts.

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

29. Participants recognized that there were many steps that could be taken to develop improved international space weather coordination. The guidelines for the long-term sustainability of outer space activities relating to space weather, namely, guidelines 16 (Share operational space weather data and forecasts) and 17 (Develop space weather models and tools and collect established practices on the mitigation of space weather effects), provided the initial basis for examining the implementation of some of the necessary coordination and actions within Member States and their national and international organizations.

30. Consistent with the guidelines for the long-term sustainability of outer space activities relating to space weather, the coordination effort could include the following:

- Awareness-raising among policymakers on the potential impact of severe space weather, including its confluence with other natural hazards (guideline 26)
- Efforts to improve ground- and space-based observation infrastructure for both research and operations
- Support for open data-sharing policy and real-time data accessibility
- Avoidance of duplication of measurement systems as appropriate
- Increased coordination on space weather forecasting services

- Advocacy for new scientific research, and support for ground- and space-based observation infrastructure and related development of improved modelling capability (guideline 27)
- Renewed focus on research-to-operations and operations-to-research for improved space weather services
- Consideration of socioeconomic impact studies for space weather, taking into account that different nations have different space weather vulnerabilities and needs, but also recognizing that all nations are vulnerable to impacts on technological systems and the global economy
- Sharing of best practices for space weather risk assessment and mitigation
- Communication and coordination regarding the design and engineering of systems in order to avoid or mitigate space weather effects

31. In connection with the guidelines for the long-term sustainability of outer space activities relating to space weather, the participants in the Workshop noted that the ground- and space-based instrument data that are critical for supporting space weather research and services are distributed across the globe and involve a number of Member States and organizations.

32. In addition to the established guidelines for the long-term sustainability of outer space activities relating to space weather, and best practice, the Workshop participants also highlighted the importance of a number of additional specific items that needed to be addressed in future coordination activities. Those items included the identification of the most important data to be shared; joint efforts of the international entities, including COSPAR, ICAO, the International Geographical Union, the International Global Navigation Satellite System Service, the International Union of Radio Science, SCOSTEP and WMO, among others; and increasing awareness on impacts of space weather phenomenon.

33. It was noted that the increasing dependency on technology required a renewed international effort to enhance space weather services and mitigation efforts by Member States.

34. In addition, it was highlighted that countries should work together in order to improve predictions and preparedness for space weather events. The main points raised in the Workshop discussion are set out below:

- Vulnerability research and risk assessments would be essential tools to raise awareness among policymakers, designers and engineers
- A benefit and gap analysis, particularly in developing nations, should be carried out
- The working of mitigation plans and their integration in a comprehensive contingency planning in disaster management should be elaborated
- A better understanding of the needs of end users would be necessary (science and engineering are key stakeholders in formulating the needs)
- Global prediction, forecast, nowcast and space weather warning capabilities should be developed and improved to enable decision makers to act accordingly. Such capabilities might include a global space weather warning network
- Lessons could be learned from risk analyses relating to critical infrastructure protection and applied to space weather, with due consideration of mitigation versus system resiliency as the basis for protecting against space weather impacts. Such lessons learned should be shared among member States and the appropriate national space weather stakeholders
- Regional nature of severe space weather events and their impact on the economy and technological infrastructure of member States should be studied

- Increasingly critical reliance on space systems (for example, global navigation satellite systems for drivers, autonomous vehicles, positive train control, etc.), and potentially extensive effects of even lesser space weather events

35. With the expansion in the development of private and commercial space weather services, the private sector was recognized as an additional important component and stakeholder in many ways, including in supporting research and science, and in protecting critical infrastructure.

36. Participants reiterated that the International Heliophysical Year 2007 and ISWI facilitated the deployment of several of the instrument networks worldwide. Existing databases and relevant software tools were identified to promote space science activities in developing nations. Extensive data on space science had been accumulated by a number of space missions. Similarly, long-term databases are available from ground-based observations.

37. The participants in the Workshop noted that capacity-building and technical guidance should continue to be provided to countries that wish to be engaged in space weather science and education. Opportunities for continued partnerships with capacity-building entities and activities within the United Nations should be further developed.

38. The activities of ISWI were also coordinated with the regional centres for space science and technology education, affiliated to the United Nations, and the programme of ICG on global navigation satellite system applications.

39. The Workshop noted the significant expansion of the level of activities and international participation within ISWI, as well as the recent adoption of an open data policy (see [A/AC.105/C.1/2017/CRP.8](#)). It also noted the recent decision to focus on the contribution that ISWI instrument arrays bring to operational space weather products, including the promotion of the availability of real-time data within the ISWI networks.

40. The education and training activities of ISWI were highlighted. Instrumentation training, data-analysis training and space weather science education were the key components of those activities.

C. UNISPACE+50 and the international framework for space weather services (thematic priority 4)

41. The participants in the Workshop noted that space weather has a global impact, which necessitates a global response through improved coordination. The Workshop therefore agreed that additional coordination was essential at the Member State level, with a view to promoting international coordination and cooperation towards meeting future needs for space weather services.

42. It was noted that UNISPACE+50 represented a unique opportunity to provide input to the Committee on the Peaceful Uses of Outer Space in relation to future requirements for improved space weather services through ISWI. The aim was to build on the current three-dimensional focus (science, capacity-building and outreach) with the addition of “services”, thereby creating a four-dimensional focus. It was also noted that science involves instrument deployment, data collection, data analysis and the interpretation of results. Capacity-building involves training students and young scientists to handle instruments and data and scientific research.

43. It was noted that outreach involves explaining the relevance of space weather to the general public, designers and engineers, schoolchildren and policymakers, and also involves innovative hands-on approaches, including citizen science and the training of educators. Progress toward meeting those needs would be monitored, with implementation expected to be delivered through the coordinated actions of existing space weather stakeholders, including COSPAR, ICAO, the International

Astronomical Union, the International Space Environment Service, SCOSTEP and WMO, among others.

44. Contribution to the goals and targets set within the framework of the Sustainable Development Goals was underlined, and due to the fact that space technology supports our common goals to address global challenges, it was noted that space weather research and global collaboration would therefore promote sustainable development through the prevention of catastrophic disruptions of critical infrastructure and services.

45. The participants in the Workshop made the following recommendations:

(a) Increased international cooperation should be promoted in order to meet current and future needs for space weather services, and a coordination mechanism should be established, with participation on a voluntary basis, and which would be substantially supported by the Office for Outer Space Affairs and guided under the framework of the Committee;

(b) In order to enable effective international coordination and collaborations in space weather research and services, there should not be any barriers to data flows and communications. To that end, an open data policy, complete with rules of operation and data standards, should be promoted at the national level;

(c) A process should be identified and adopted whereby ISWI activities are recognized by and reported to the Scientific and Technical Subcommittee through its space weather agenda item;

(d) In addition to ISWI coordination, the partnerships already established with other international scientific organizations, as well as grass-roots and emerging initiatives, need to be strengthened to ensure that capacity-building activities are accomplished efficiently and for the benefit of all Member States;

(e) New knowledge generated by ISWI activities should be effectively communicated to the public and the scientific community at large by means of ISWI newsletters, its website and other media;

(f) The UNISPACE+50 process should be used to promote enhanced cooperation that would meet the identified needs of Member States for future space weather services.

46. The participants in the Workshop expressed their appreciation to the United Nations, the Government of the United States and the co-sponsors for the substance and the excellent organization of the Workshop.