題名 [See] ISWI Newsletter - Vol. 4 No. 55
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* ISWI Newsletter - Vol. 4 No. 55                              21 May 2012 *
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*           I S W I  =  International Space Weather Initiative            *
*                            (www.iswi-secretariat.org)                    *
*                                                                          *
* Publisher:        Professor K. Yumoto, ICSWSE, Kyushu University, Japan  *
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* Archive location: www.iswi-secretariat.org  (maintained by Bulgaria)     *
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Attachment(s):
(1) "Abuja 55COPUOS-1018 E, 600 KB pdf, 10 pages.
(2) "Cairo 49STSC-994 E, 800 KB pdf, 15 pages.

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:                       Re:
:                       UN reports for
:                         UN/Nigeria Workshop on ISWI (2011)
:                                         and
:                         UN/Egypt Workshop on ISWI   (2010)
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Dear ISWI Participant:

The flagship event of ISWI is the annual ISWI workshop, as you are well aware of.

So far, with ISWI, we have had workshops in Cairo and Abuja. The English version for the UN report for the workshop held in Abuja has just come out and I attach it to this email. (The other five language versions will come out after the COPUOS session in June.) For ISWI, this is a very important document as it becomes part of the permanent record of our space weather activities.

The report for Cairo is also attached. This was originally circulated in Volume 3, Number 83, of this newsletter, and I attach it again for the benefit of recent subscribers to this newsletter.

The next workshop, "UN/Ecuador Workshop on ISWI", will take place in Quito later this year. Stay tuned to this newsletter for details concerning this last workshop in a series of three ISWI workshops, Cairo/Abuja/Quito.

Always faithfully in the service of ISWI,
: George Maeda
: The Editor
: ISWI Newsletter

United Nations A/AC.105/1018

General Assembly

Distr.: General
4 April 2012

Original: English

Committee on the Peaceful Uses of Outer Space

Report on the United Nations/Nigeria Workshop on the International Space Weather Initiative

(Abuja, 17-21 October 2011)

I. Introduction

A. Background and objectives

1. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), in particular through its resolution entitled "The Space Millennium: Vienna Declaration on Space and Human Development", recommended that activities of the United Nations Programme on Space Applications should promote collaborative participation among Member States, at both the regional and international levels, in a variety of space science and technology activities, by emphasizing the development and transfer of knowledge and skills to developing countries and countries with economies in transition.[1]

2. At its fifty-third session, in 2010, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums and expert meetings related to socio-economic benefits of space activities, small satellites, basic space technology, human space technology, space weather, global navigation satellite systems and search and rescue planned to be held in 2011.[2] Subsequently, the General Assembly, in its resolution 65/97, endorsed the report of the Committee on the work of its fifty-third session.

3. Pursuant to General Assembly resolution 65/97 and in accordance with the recommendations of UNISPACE III, the United Nations/Nigeria Workshop on the

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[1] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3), chap. I, resolution 1, sect. I, para. 1 (e)(ii), and chap. II, para. 409 (d)(i).

[2] *Official Records of the General Assembly, Sixty-fifth Session, Supplement No. 20* (A/65/20), para. 79.

V.12-52266 (E) 190412 200412

International Space Weather Initiative was held in Abuja from 17 to 21 October 2011. The National Space Research and Development Agency (NASRDA) of Nigeria hosted the Workshop on behalf of the Government of Nigeria.

4. Organized by the United Nations, the European Space Agency, the National Aeronautics and Space Administration (NASA) of the United States of America and the Japan Aerospace Exploration Agency (JAXA), the Workshop was the nineteenth in a series of workshops on basic space science, the International Heliophysical Year 2007 and the International Space Weather Initiative proposed by the Committee on the Peaceful Uses of Outer Space on the basis of discussions of its Scientific and Technical Subcommittee, as reflected in the report of the Subcommittee on its forty-seventh session (A/AC.105/958, paras. 162-173). A previous workshop in the series had been hosted by the Government of Egypt in November 2010 (see A/AC.105/994). The workshops were a continuation of the series of workshops on the International Heliophysical Year 2007 that had been held between 2005 and 2009 and that had been hosted by 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).[3] Those workshops were a continuation of the series of workshops on basic space science held between 1991 and 2004 and hosted by the Governments of India (see A/AC.105/489), Costa Rica and Colombia (see A/AC.105/530), Nigeria (see A/AC.105/560/Add.1), Egypt (see A/AC.105/580), Sri Lanka (see A/AC.105/640), Germany (see A/AC.105/657), Honduras (see A/AC.105/682), Jordan (see A/AC.105/723), France (see A/AC.105/742), Mauritius (see A/AC.105/766), Argentina (see A/AC.105/784) and China (see A/AC.105/829).[4] All workshops were co-organized by the International Astronomical Union and the Committee on Space Research (COSPAR).

5. The main objective of the Workshop was to provide a forum in which participants could comprehensively review achievements of the International Space Weather Initiative, in terms of the status of deployment of low-cost, ground-based, worldwide space weather instruments, and further plans for the Initiative, as well as assess recent scientific and technical results in the field of solar-terrestrial interaction. Further, the Workshop was to recommend ways and means of updating and upgrading the website (www.iswi-secretariat.org) and newsletter (beta.iswi-secretariat.org/2009/11/24/newsletter) of the Initiative.

B. Programme

6. At the opening of the Workshop, statements were made by a senator of Nigeria, the Chair of the Senate Committee on Science and Technology, a representative of the Minister of Science and Technology on behalf of the Government of Nigeria, the Director General of NASRDA, the Director of the Centre for Basic Space Science at the University of Nigeria, and representatives of

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[3] Information on the International Heliophysical Year 2007 and the United Nations Basic Space Science Initiative is available on the website of the Office for Outer Space Affairs of the Secretariat at www.unoosa.org/oosa/SAP/bss/ihy2007/index.html.

[4] Details of all the workshops of the United Nations Basic Space Science Initiative organized jointly with the European Space Agency have been made available at neutrino.aquaphoenix.com/un-esa.

JAXA and the Office for Outer Space Affairs of the Secretariat. The Workshop was divided into plenary sessions and working group sessions. Presentations by invited speakers, describing their achievements with regard to organizing events and carrying out research, education and outreach activities related to the International Space Weather Initiative and its instrument arrays, were followed by brief discussions. Invited speakers, who came from both developed and developing countries, presented 130 papers and posters. Poster presentation sessions and working groups provided participants with an opportunity to focus on specific problems and projects related to the International Space Weather Initiative, particularly its instrument arrays and their status of operation and coordination.

7. The Workshop focused on the following topics: national coordination of the International Space Weather Initiative, operational instrument arrays of the Initiative and distribution of Initiative instruments by countries. A case study was presented on the development and operation by Japan of five instrument arrays as part of the Initiative, in particular for the benefit of developing countries and countries with economies in transition. In that regard, the Workshop was to develop elements of a resolution for the establishment of an international centre for space weather science and education. The Workshop was also to consolidate the large number of International Space Weather Initiative instrument arrays as reported at a previous workshop on the Initiative hosted by the Government of Egypt in 2010 (see A/AC.105/994).

8. In brief statements, organizers of and other participants in the Workshop expressed their appreciation for the long-term, substantive contributions made to the development of the International Space Weather Initiative, in particular for the benefit of developing countries, by a number of distinguished scientists.

C. Attendance

9. Scientists, engineers and educators from developing and industrialized countries from all economic regions were invited by the United Nations, NASA, JAXA, the International Committee on Global Navigation Satellite Systems (ICG), the Space Environment Research Center of Kyushu University in Fukuoka, Japan, NASRDA and the Centre for Basic Space Science of the University of Nigeria to participate in and contribute to the Workshop. Workshop participants, who held positions at universities, research institutions, national space agencies and international organizations, were involved in the implementing activities of the International Space Weather Initiative covered by 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 Initiative played a leading role. The preparations for the Workshop were carried out by an international scientific organizing committee and a local organizing committee.

10. Funds provided by the United Nations, NASA, JAXA, ICG, the Space Environment Research Center and the Government of Nigeria were used to cover the travel, accommodation and other costs of participants from developing countries. More than 100 specialists in the International Space Weather Initiative attended the Workshop.

11. The following 20 Member States were represented at the Workshop: Austria, Brazil, Bulgaria, Côte d'Ivoire, Croatia, Democratic Republic of the Congo, Ecuador, Egypt, Ethiopia, Ghana, India, Indonesia, Iraq, Japan, Niger, Nigeria, Peru, Slovakia, Turkey and Zambia.

II. Current status of International Space Weather Initiative instrument arrays in operation

Observations and findings

1. Atmospheric Weather Electromagnetic System for Observation Modeling and Education and the sudden ionospheric disturbance monitor

12. The Workshop recalled that the Atmospheric Weather Electromagnetic System for Observation Modeling and Education (AWESOME)[5] and the sudden ionospheric disturbance monitor[6] instrument arrays consisted of extreme low-frequency and very-low-frequency receivers recording radio signals between 300 Hz and 50 kHz. Monitoring the strength of those signals served as an ionospheric diagnostic tool, since the propagation of the radio signals from transmitter to receiver relied on the conditions of the lower ionosphere.

13. The AWESOME instruments recorded a number of single-frequency radio stations and also recorded broadband natural radio signals, such as those emitted by lightning and wave-particle interactions in the magnetosphere of the Earth. AWESOME monitored the amplitude and phase of very-low-frequency transmitter signals with 50 Hz time resolution and allowed the entire radio spectrum between 300 Hz and 50 kHz to detect natural signals such as those coming from sferics, whistlers, chorus and hiss. The sudden ionospheric disturbance monitor instruments were a simpler version of the AWESOME instruments, used for educational purposes, and primarily recorded single-frequency stations with an amplitude of very-low-frequency transmitter signals with 0.2 Hz time resolution.

2. Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory

14. The Workshop noted that the Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO)[7] spectrometer was a heterodyne receiver. It operated between 45 and 870 MHz, using modern commercially available broadband cable television tuners with a frequency resolution of 62.5 kHz. The data recorded by the CALLISTO instrument array were flexible image transport system files with up to 400 frequencies per weep. The data were transferred via an R232 cable to a computer and saved locally. Time resolution was about 0.25 seconds, depending on the number of channels. The integration time was 1 millisecond and the radiometric bandwidth about 300 kHz. The overall dynamic range was larger than 50 decibels.

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[5] http://nova.stanford.edu/~vlf/IHY_Test/pmwiki/pmwiki.php.

[6] http://solar-center.stanford.edu/SID/sidmonitor.

[7] www.astro.phys.ethz.ch/astro1/Users/cmonstei/instrument/callisto/index.htm.

3. Remote Equatorial Nighttime Observatory of Ionospheric Regions

15. The Workshop noted that Remote Equatorial Nighttime Observatory of Ionospheric Regions (RENOIR)[8] stations operated in order to improve understanding of the variability in the night-time ionosphere and the effects of that variability on critical satellite navigation and communication systems. RENOIR instruments were dedicated to studying the equatorial, low-latitude ionosphere and thermosphere system, its response to storms and the irregularities that appeared on a daily basis. A RENOIR station consisted of the following: (a) one wide-field ionospheric imaging system; (b) two miniaturized Fabry-Perot interferometers; (c) a dual-frequency global positioning system (GPS) receiver; and (d) an array of five single-frequency GPS scintillation monitors. The array of single-frequency GPS scintillation monitors provided measurements of the irregularities, as well as their size and speed. The dual-frequency GPS receiver measured the total electron content of the ionosphere. If available, an all-sky imaging system measured two different thermosphere/ionosphere emissions from which the two-dimensional structure and motion of irregularities was observed. Those observations were used to calculate the density and height of the ionosphere. Two miniaturized Fabry-Perot interferometers measured the thermospheric-neutral winds and temperatures. The two interferometers were separated by 300 km, allowing bistatic, common-volume measurements. Those measurements were useful for studying the response of the thermosphere to storms as well as for looking for the possible connection of gravity waves to the seeding of equatorial instabilities.

4. South America Very Low Frequency Network

16. The Workshop observed that the South America Very Low Frequency Network (SAVNET)[9] used the properties of very-low-frequency wave propagation on long distances between a transmitter and a receiver in the Earth-ionosphere waveguide. The waveguide was formed by the Earth’s surface, which was an electrical conductor, and by the low ionosphere D-region at an altitude of approximately 70 km during diurnal conditions and the E-region at an altitude of approximately 90 km at night without the presence of solar radiation. The characteristics of very-low-frequency propagating waves (amplitude and phase velocity) in the waveguide depended on the geometry of the waveguide, the electrical conductivity of its borders and the geomagnetic field. All phenomena capable of changing those waveguide properties affected the characteristics of very-low-frequency propagation.

17. SAVNET had two main objectives: the indirect long-term monitoring of solar radiation; and the provision of a diagnostic tool to study the ionosphere above the South Atlantic Magnetic Anomaly region during quiescent and geomagnetically disturbed periods. Further objectives of SAVNET were: the study of ionospheric D-region properties during transient perturbations such as solar flares; the diagnosis of extrasolar sources of ionospheric perturbations; the observation of atmospheric phenomena producing ionospheric perturbations such as sprites, terrestrial gamma-ray flashes and seismo-electromagnetic processes; the provision of experimental data sets to feed computational propagation codes in order to obtain

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[8] http://airglow.csl.illinois.edu/Research/RENOIR.
[9] www.craam.mackenzie.br/SAVNET/savnet2.htm.

daily templates of very-low-frequency wave properties on a given transmitter-receiver path; and the study of peculiar properties of the ionosphere at high (southern) latitudes.

18. The SAVNET base receiver was composed of two directional squared (3 m × 3 m) loop antennas and an isotopic vertical (6 m) antenna. The sensor signals were amplified and transported to an A/D audio card. The wave characteristics were provided by a Software Phase and Amplitude Logger computer code.

5. Space Environmental Viewing and Analysis Network

19. The Workshop noted that the Space Environmental Viewing and Analysis Network (SEVAN)[10] was an array of particle detectors located at middle and low latitudes that aimed to improve fundamental research into space weather conditions and to provide short- and long-term forecasts of the dangerous consequences of space storms. SEVAN detected changing fluxes of different species of secondary cosmic rays at different altitudes and latitudes; it was a powerful integrated device used to explore solar modulation effects.

6. International Space Weather Initiative instrument arrays of Japan

20. The workshop noted that, in Japan, the Solar Terrestrial Physics Programme subcommittee of the Science Council was participating in the International Space Weather Initiative as a follow-up programme of the International Heliophysical Year. The subcommittee continued their instrument deployment plans and developed database systems for public access. The leading space weather instrument programmes — the Continuous H-alpha Imaging Network (CHAIN), the Global Muon Detector Network (GMDN), the Magnetic Data Acquisition System (MAGDAS), Optical Mesosphere Thermosphere Imagers (OMTIs) and the South-East Asia Low-latitude Ionosonde Network (SEALION) had expanded their operations since 2010. In addition, the National Institute of Information and Communications Technology of Japan had expanded its space weather outreach activities.

21. To create awareness of the International Space Weather Initiative in Japan and beyond, the Solar Terrestrial Physics Programme subcommittee had organized a meeting at Kyushu University in March 2010. Subsequently, a session dedicated to the Initiative was held during the international symposium of the Japan Geoscience Union, on 25 and 26 May 2010. In 2011, the subcommittee organized another session on the Initiative during the international symposium of the Japan Geoscience Union, on 25 May 2011. During that session, scientists and engineers in charge of the operation of space weather instruments, and contributors who provided their own data to the Initiative presented their achievements and plans for the future. Several foreign researchers were invited to present their activities, with particular emphasis on international collaboration. The session was highly successful, and another one will be held in 2012, which will be the last time during the International Space Weather Initiative 2010-2012.

22. During the Workshop, several instrument array sessions were scheduled. Among them was the MAGDAS session, during which 31 individuals (mainly

[10] http://sevan.crd.yerphi.am.

MAGDAS hosts from all over the world, in particular Africa) delivered their presentations. The presentations are available on the website of the Space Environment Research Center of Kyushu University (www.serc.kyushu-u.ac.jp).

23. The general theme of the MAGDAS session was capacity-building, which consisted of three phases: (a) development of instrument capacity; (b) development of data-analysis capacity; and (c) development of science capacity. Capacity-building was one of the major goals of the International Heliophysical Year and the International Space Weather Initiative, as specified by the organizers of those initiatives. All MAGDAS hosts are members and partners in the capacity-building under the MAGDAS project of the Space Environment Research Center. Thanks to the MAGDAS hosts, the Space Environment Research Center is able to operate ground observatories all over the world.

24. In 2011, under the MAGDAS project, the first MAGDAS school in Africa, the ISWI/MAGDAS School on Litho-Space Weather, was launched. A 264-page textbook entitled *Selected Papers of MAGDAS* was published prior to the School, containing MAGDAS-related papers that had been published in peer-reviewed journals. The book enabled the School's students to understand the purpose of the MAGDAS project, which now has 64 real-time magnetometers operating around the world. The School, located near Lagos, Nigeria, on the campus of Redeemer's University, was highly successful. It attracted 59 participants, of whom 8 were instructors, mainly from Kyushu University. The remaining participants were Nigerian students and representatives of MAGDAS host stations in Africa.

25. During the Workshop, representatives from all five space weather instrument arrays provided detailed reports on their operation and capacity-building activities (see below).

Reports to the Workshop on the status of the five instrument arrays of Japan

1. Flare-monitoring telescopes under the Continuous H-alpha Imaging Network project, Kwasan and Hida Observatories, Kyoto University

26. In March 2010, the Flare Monitoring Telescope was installed at the National Ica University of Peru under the CHAIN project to observe the full-disk sun. The Telescope achieved results such as the observation of important solar flares that occurred during the night in Japan.

27. As part of the project, the Japan-Peru Flare Monitoring Telescope Summer School and Data Analysis Workshop was held in Japan in July 2011, and was attended by Peruvian, British, Egyptian and Japanese researchers. Participants advanced data analysis and scientific investigation of the aforementioned solar active phenomena and held productive discussions.

28. Kyoto University had planned to install a new Flare Monitoring Telescope in Algeria in collaboration with the Centre de Recherche en Astronomie, Astrophysique et Géophysique (Centre for Astronomical, Astrophysical and Geophysical Research) but it was postponed for logistical reasons. In 2011, a number of institutes from outside Japan offered to participate in the CHAIN project, including the Center of Astronomy and Geophysics of the Mongolian Academy of Sciences, the King Saud University and the King Abdulaziz University in

Saudi Arabia, and the Bosscha Observatory in Indonesia, which allowed the exchange of technical and scientific information with those institutes.

2. Global Muon Detector Network, Shinshu University

29. A gap had existed in the viewing directions of GMDN but it was overcome by adding a new detector at Sierra Negra, a mountain in Mexico 4,600 metres above sea level. The detector (SciBar) was installed in 2012, primarily for observing solar neutrons, but also as a muon detector. The detector, consisting of ~15,000 scintillator strips ($2.5 \times 1.3 \times 300$ cm^{3} each) viewed by ~250 multi-anode photomultipliers, is capable of producing precise measurements of the particles produced by various interactions of the primary cosmic rays with atmospheric nuclei. Preliminary experiments, using a small prototype detector, have been undertaken.

3. Magnetic Data Acquisition System project, Space Environment Research Center, Kyushu University

30. The MAGDAS project operates 64 real-time magnetometers around the world, which is the largest real-time magnetometer array in the world. In 2011, three new MAGDAS stations were activated: ICA station in Ica, Peru; HVD station in Khovd, Mongolia; and CAN in Canberra. Data from each MAGDAS station are transferred in real time via the Internet to the Space Environment Research Center of Kyushu University. At the Center, the data are processed, distributed and stored. Under the supervision of the Director of the Center, five students from Egypt, Malaysia, the Philippines and the Sudan participated in the MAGDAS project and worked on their doctoral degrees.

4. Optical Mesosphere Thermosphere Imagers, Solar-Terrestrial Environment Laboratory, Nagoya University

31. The OMTI array started taking automated measurements of gravity waves, winds and temperatures of the upper atmosphere in Darwin, Australia, in March 2011, using an all-sky airglow imager and a Fabry-Perot interferometer. Darwin is located at a geomagnetically conjugate point of Japan, giving an opportunity for new simultaneous measurements of hemispheric coupling of the upper atmosphere and ionosphere at middle latitudes. The automated measurements of the upper atmosphere, including the measurements at Darwin, were carried out worldwide in 2011 by using 12 airglow imagers and 5 Fabry-Perot interferometers.

5. South-East Asia Low-latitude Ionosonde Network project, Space Weather and Environment Informatics Laboratory, Applied Electromagnetic Research Institute, National Institute of Information and Communications Technology

32. The SEALION project operated six ionosondes, four GPS receivers, two GPS scintillation monitors, two magnetometers, and one all-sky airglow imager. In addition, the project installed a meteor radar on Biak Island, Indonesia, for monitoring lower thermospheric and mesospheric winds. To expand the capability of monitoring ionospheric and thermospheric conditions in East Asia (which includes Japan and South-East Asia), collaboration with a number of institutes in South-East Asia was established to share ionospheric total electron content data derived from GPS receiver networks operating in each country of the subregion. For

example, the King Mongkut's Institute of Technology Ladkrabang in Thailand developed the Thai GPS and Ionospheric Data Center, partly using support from the SEALION project. They collected data from more than 20 GPS receivers in Thailand. In Indonesia, the National Institute of Aeronautics and Space collected data from more than 100 GPS receivers to produce two-dimensional GPS-total electron content maps throughout Indonesia. Those data acquisition activities were important not only for each country but also for the entire region of East Asia, including Japan, because severe ionospheric disturbances such as plasma bubbles are generated at low latitudes and often reach mid-latitudes during high solar activity.

III. Summary of presentations

33. Copies of the presentations made during the Workshop were made available to participants and posted on the website (www.iswinigeria.org.ng).

IV. Abuja International Space Weather Initiative resolution

34. The following resolution was developed during the deliberations of the Workshop and was unanimously adopted by the participants.

35. The United Nations should lead, with the active support of Japan and relevant scientific organizations, an international effort to establish an international centre for space weather science and education in an existing national educational and research institution. The Space Environment Research Center at Kyushu University, Japan, has offered to host such a centre.

36. The centre should grow into a network of centres, focusing on space weather around the world, dedicated to the advancement of space weather research and education.

37. The centre should provide capacity-building and technical guidance to nations that wish to engage in space weather science and education. Capacity-building consists of three main components:

(a) Training on and deployment of space weather instrumentation. Space weather monitoring, for either operations or research, requires continuous data recording. Such data come from precision instruments, either on the ground or in space, which require proper maintenance. Recent research has shown that the number of individuals with the skills to operate and maintain those specialized instruments is declining around the world.

(b) Training on data analysis. Raw data must be inspected, corrected, calibrated, interpreted, transformed and archived. Most of those activities require sophisticated software and long-term experience in handling the data. Using such software means that advanced training is required for users of the data.

(c) Education and training in space weather science. With processed and archived data available, the final process is to perform scientific investigations based on the data, and to publish the research findings in international scientific literature. The ability to perform that final process generally requires a PhD or MSc-level education, which can be provided only by experts in space sciences.

38. Space weather work is roughly divided into two spheres: operational activities; and research and educational activities.

39. Operational work is handled by existing national space institutions. Research and education are the domains of advanced research institutions and universities. The proposed centre must be part of an advanced research institution or university. Additionally, a proven record of capacity-building is an essential prerequisite for the centre.

40. The centre must be an institution with a proven record in organizing international activities such as space weather schools, workshops, observation campaigns, installation of instruments in different regions of the world, training of instrument host staff and students, and international outreach programmes. The centre staff must possess experience in promoting and supporting international programmes such as the International Space Weather Initiative.

41. The centre will cooperate with the regional centres for space science and technology education, affiliated to the United Nations, which are located in Brazil, India, Mexico, Morocco and Nigeria, and with other centres of excellence in space science and technology education.

42. The Centre for Basic Space Science at the University of Nigeria has offered to act as a regional centre for space weather science and education.

United Nations

A/AC.105/994

General Assembly

Distr.: General
20 June 2011

Original: English

Committee on the Peaceful Uses of Outer Space

Report on the United Nations/National Aeronautics and Space Administration/Japan Aerospace Exploration Agency Workshop on the International Space Weather Initiative

(Cairo, 6-10 November 2010)

I. Introduction

A. Background and objectives

1. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), in particular through its resolution entitled "The Space Millennium: Vienna Declaration on Space and Human Development", recommended that activities of the United Nations Programme on Space Applications should promote collaborative participation among Member States, at both the regional and international levels, in a variety of space science and technology activities, by emphasizing the development and transfer of knowledge and skills to developing countries and countries with economies in transition.[1]

2. At its fifty-second session, in 2009, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums and conferences planned for 2010.[2] Subsequently, the General Assembly, in its resolution 64/86, endorsed the report of the Committee on the work of its fifty-second session.

3. Pursuant to General Assembly resolution 64/86 and in accordance with the recommendations of UNISPACE III, the United Nations/National Aeronautics and Space Administration/Japan Aerospace Exploration Agency Workshop on

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[1] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3), chap. I, resolution 1, sect. I, para. 1 (e)(ii), and chap. II, para. 409 (d)(i).

[2] *Official Records of the General Assembly, Sixty-fourth Session, Supplement No. 20* (A/64/20), para. 82.

the International Space Weather Initiative was held in Cairo from 6 to 10 November 2010. Helwan University hosted the Workshop on behalf of the Government of Egypt.

4. Organized by the United Nations, the European Space Agency (ESA), the National Aeronautics and Space Administration (NASA) of the United States of America and the Japan Aerospace Exploration Agency (JAXA), the Workshop was the eighteenth in a series of workshops on basic space science, the International Heliophysical Year 2007 and the International Space Weather Initiative proposed by the Committee on the Peaceful Uses of Outer Space on the basis of discussions of its Scientific and Technical Subcommittee, as reflected in the report of the Subcommittee (A/AC.105/958, paras. 162-173). Previous workshops in the series were hosted by the Governments of the United Arab Emirates in 2005 (A/AC.105/856), India in 2006 (A/AC.105/882), Japan in 2007 (A/AC.105/902), Bulgaria in 2008 (A/AC.105/919) and the Republic of Korea in 2009 (A/AC.105/964).[3] Those workshops were a continuation of the series of workshops on basic space science that were held between 1991 and 2004 and that were hosted by the Governments of India (A/AC.105/489), Costa Rica and Colombia (A/AC.105/530), Nigeria (A/AC.105/560/Add.1), Egypt (A/AC.105/580), Sri Lanka (A/AC.105/640), Germany (A/AC.105/657), Honduras (A/AC.105/682), Jordan (A/AC.105/723), France (A/AC.105/742), Mauritius (A/AC.105/766), Argentina (A/AC.105/784) and China (A/AC.105/829).[4]

5. The main objective of the Workshop was to provide a forum in which participants could comprehensively review achievements of the International Heliophysical Year 2007 in terms of the deployment of low-cost, ground-based, worldwide space weather instruments and plans for the International Space Weather Initiative and assess recent scientific and technical results in the field of solar-terrestrial interaction.

B. Programme

6. At the opening of the Workshop, statements were made by the representative of the Ministry of Higher Education and Scientific Research on behalf of the Government of Egypt, by the President of Helwan University and by representatives of NASA, JAXA and the Office for Outer Space Affairs of the Secretariat. The Workshop was divided into plenary sessions. Presentations by invited speakers, describing their achievements with regard to organizing events and carrying out research, education and outreach activities related to the International Space Weather Initiative and its instrument arrays, were followed by brief discussions. Invited speakers, who came from both developed and developing countries, presented 110 papers and posters. Poster presentation sessions and working groups provided participants with an opportunity to focus on specific problems and projects

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[3] Information on the International Heliophysical Year 2007 and the United Nations Basic Space Science Initiative is available on the website of the Office for Outer Space Affairs at www.unoosa.org/oosa/SAP/bss/ihy2007/index.html.

[4] Details of all the workshops of the United Nations Basic Space Science Initiative organized jointly with the European Space Agency have been made available on the Internet at www.seas.columbia.edu/~ah297/un-esa.

related to the International Space Weather Initiative, particularly its instrument arrays and their operation and coordination.

7. The Workshop focused on the following topics: national coordination of the International Space Weather Initiative, instrument arrays of the Initiative in operation and distribution of Initiative instruments by countries.

8. In a ceremony that was part of the Workshop, organizers and participants of the workshops expressed their appreciation for the long-term, substantive contributions made to the development of the Initiative, particularly for the benefit of developing countries, by a number of distinguished scientists.

C. Attendance

9. Scientists, engineers and educators from developing and industrialized countries from all economic regions were invited by the United Nations, NASA, JAXA, the International Committee on Global Navigation Satellite Systems (ICG), the Space Environment Research Centre (SERC) of Kyushu University in Fukuoka, Japan, Helwan University and the Space Weather Monitoring Center of Egypt to participate at and contribute to the Workshop. Workshop participants, who held positions at universities, research institutions, national space agencies and international organizations, were involved in implementing activities of the International Space Weather Initiative covered by 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 Initiative played a leading role. The preparations for the Workshop were carried out by an international scientific organizing committee, a national advisory committee and a local organizing committee.

10. Funds provided by the United Nations, NASA, JAXA, ICG, SERC, Helwan University and the Space Weather Monitoring Center of Egypt were used to cover the travel, accommodation and other costs of participants from developing countries. A total of 120 specialists in the International Space Weather Initiative attended the Workshop.

11. The following 29 Member States were represented at the Workshop: Austria, Brazil, Bulgaria, Cameroon, Congo, Côte d'Ivoire, Egypt, Ethiopia, France, India, Indonesia, Italy, Japan, Kenya, Malaysia, Mozambique, Niger, Nigeria, Peru, Philippines, Republic of Korea, Senegal, Slovakia, Sudan, Switzerland, Turkey, United Republic of Tanzania, United States of America and Viet Nam.

12. A list of designated national and area coordinators of the International Space Weather Initiative is provided in annex I to the present document. A table summarizing the type and number of International Space Weather Initiative instruments by country or area is provided in annex II.

II. Summary of presentations

A. International Space Weather Initiative instrument arrays in operation

1. African Global Positioning System Receivers for Equatorial Electrodynamics Studies

13. It was recalled that the African Global Positioning System Receivers for Equatorial Electrodynamics Studies (AGREES) instrument array was deployed to:

(a) To understand the unique structures of the equatorial ionosphere that had been reported from satellite observation data in the African region, which data had not been confirmed, validated or studied in detail by observations from the ground owing to a lack of suitable ground-based instrumentation in the region;

(b) To monitor and understand the processes governing electrodynamics and plasma production and loss in the lower and middle latitudes as a function of local time, season and magnetic activity;

(c) To estimate the contribution of ionospheric and plasma spherical irregularities and their effect on global navigation satellite systems (GNSS) and communications systems in the African region, where significant signal degradation (scintillation) had become a challenging problem.

2. African Dual Frequency Global Positioning System Network

14. It was noted that the Global Positioning System (GPS) consisted of a minimum of 24 satellites orbiting the Earth at an altitude of approximately 20,000 km. Each satellite transmitted a radio-wave signal to GPS receivers. By determining the time that the GPS signal reached a GPS receiver, one calculated the distance to the satellite in order to determine the exact position of the GPS receiver on Earth. Different errors in the determination of the distance between satellite and GPS receiver were introduced while the signal traversed the ionosphere and troposphere. The analysis of the satellite signal errors led to the determination of geophysical parameters such as the total electron content in the ionosphere or atmospheric water vapour distribution in the troposphere. The African Dual Frequency Global Positioning System Network (GPS-Africa) instrument array consisted of a number of different networks of GPS receivers: the International GPS Service (IGS), the Analyse multidisciplinaire de la mousson africaine (AMMA), the Scintillation Network Decision Aid (SCINDA) and AGREES.

3. African Meridian B-field Education and Research

15. It was observed that the African Meridian B-field Education and Research (AMBER) instrument array was deployed to: (a) monitor the electrodynamics that governed the motion of plasma in the lower and middle latitudes as a function of local time, season and magnetic activity; (b) understand ultra-low-frequency pulsation strength into low- and mid-latitudes and its connection with equatorial electrojets and the auroral electrojet index; and (c) support studies about the effects of Pc5 ultra-low-frequency waves on the mega electron volt electron population in the inner parts of the Van Allen radiation belts.

16. In addition, to cover the largest land-based gap in global magnetometer coverage, the AMBER instrument array addressed two fundamental areas of space physics: (a) the processes governing the electrodynamics of the equatorial ionosphere as a function of latitude (or L-shell), local time, longitude, magnetic activity and season; and (b) ultra-low-frequency pulsation strength and its connection with equatorial electrojet strength at low- and mid-latitude regions.

17. Space-based observations showed unique equatorial ionospheric structures in the African region, although those had not been confirmed by ground-based observations, owing to a lack of ground-based instruments in the region. The AMBER magnetometer array, in partnership with GPS receiver arrays (GPS-Africa, SCINDA and CIDR), would allow the understanding of the electrodynamics that governed equatorial ionospheric motions.

4. Atmospheric Weather Electromagnetic System for Observation Modeling and Education and the sudden ionospheric disturbance monitor

18. It was recalled that the Atmospheric Weather Electromagnetic System for Observation Modeling and Education (AWESOME) and the sudden ionospheric disturbance monitor instrument arrays consisted of extreme low frequency and very low frequency receivers recording radio signals between 300 Hz and 50 kHz. Monitoring the strength of those signals served as an ionospheric diagnostic tool, since the propagation of the radio signals from transmitter to receiver relied on the conditions of the lower ionosphere.

19. The AWESOME instruments recorded a number of single-frequency radio stations and also recorded broadband natural radio signals, such as those which were emitted by lightning and wave-particle interactions in the Earth's magnetosphere. AWESOME monitored the amplitude and phase of very low frequency transmitter signals with 50 Hz time resolution and allowed the entire radio spectrum between 300 Hz and 50 kHz to detect natural signals such as those coming from sferics, whistlers, chorus and hiss. The sudden ionospheric disturbance monitor instruments were a simpler version of the AWESOME instruments for educational purposes and recorded primarily single-frequency stations with an amplitude of very low frequency transmitter signals with 0.2 Hz time resolution.

5. Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory

20. It was noted that the Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO) spectrometer was a heterodyne receiver. It operated between 45 and 870 MHz, using modern commercially available broadband cable-TV tuners with a frequency resolution of 62.5 kHz. The data recorded by the CALLISTO instrument array were flexible image transport system (FITS) files with up to 400 frequencies per weep. The data were transferred via a R232 cable to a computer and saved locally. Time resolution was of the order of 0.25 second, depending on the number of channels. The integration time was 1 millisecond and the radiometric bandwidth about 300 kHz. The overall dynamic range was larger than 50 decibels.

6. Continuous H-alpha Imaging Network

21. It was observed that, in order to understand and predict the space weather situation, it was critical to observe erupting phenomena on the solar surface that were initial boundary conditions for all processes. The Continuous H-alpha Imaging Network (CHAIN) instrument array is an observational network with ground-based solar flare monitoring telescopes.

7. Coherent Ionospheric Doppler Receiver

22. It was recalled that the Coherent Ionospheric Doppler Receiver (CIDR) instrument array consisted of systems of ultra high frequency/very high frequency radio receivers, a control computer and two antennas (one for CIDR and one for GPS). CIDR data were used to tomographically reconstruct the ionosphere along the respective satellite track. Depending on the number of ground installations (no less than three) and the baseline, the tomography could reveal the large-scale structure of the ionosphere, medium-sized structures such as plumes and patches and very fine structures, using a short baseline configuration. In addition, CIDR data were used as an input to data assimilation models for reconstructing the ionosphere on a global or local scale.

8. Global Muon Detector Network

23. It was noted that the Global Muon Detector Network (GMDN) was a network of multidirectional muon telescopes distributed on three different continents, covering a global range of asymptotic telescope views. As a test case, using GMDN data, it was possible to observe a cosmic ray precursor for the magnetic storm that had occurred in December 2006.

9. Magnetic Data Acquisition System

24. It was observed that the Magnetic Data Acquisition System (MAGDAS) was deployed for space weather studies during the period 2005-2008, overlapping with the development of the United Nations Basic Space Science Initiative and International Heliophysical Year campaign. MAGDAS aided the study of the dynamics of geospace plasma changes during magnetic storms and aurora substorms, the electromagnetic response of the ionosphere-magnetosphere to various solar wind changes and the penetration and propagation mechanisms of DP2-ULF range disturbances from the solar wind region into the equatorial ionosphere. MAGDAS conducted real-time monitoring and modelling of the global three-dimensional current system and the ambient plasma density for understanding changes in the electromagnetic and plasma environment in the geospace.

10. Optical Mesosphere Thermosphere Imager

25. It was recalled that the Optical Mesosphere Thermosphere Imager (OMTI) instrument array observed the Earth's upper atmosphere through nocturnal airglow emissions from oxygen and hydroxyl in the mesopause region (at an altitude 80-100 km) and from oxygen in the thermosphere/ionosphere (at altitude of 200-300 km). OMTI consisted of all-sky cooled charge-coupled device imagers, Fabry-Perot interferometers, meridian scanning photometers and airglow

temperature photometers, in order to measure two-dimensional images of upper atmospheric disturbances and their Doppler wind and temperature.

11. Remote Equatorial Nighttime Observatory for Ionospheric Regions

26. It was noted that Remote Equatorial Nighttime Observatory for Ionospheric Regions (RENOIR) stations operated in order to improve understanding of the variability in the night-time ionosphere and the effects of that variability on critical satellite navigation and communication systems. RENOIR instruments were dedicated to studying the equatorial/low-latitude ionosphere/thermosphere system, its response to storms and the irregularities that appeared on a daily basis. A RENOIR station consisted of the following: (a) one wide-field ionospheric imaging system; (b) two miniaturized Fabry-Perot interferometers; (c) a dual-frequency GPS receiver; and (d) an array of five single-frequency GPS scintillation monitors. The array of single-frequency GPS scintillation monitors provided measurements of the irregularities, as well as their size and speed. The dual-frequency GPS receiver measured the total electron content of the ionosphere. If available, an all-sky imaging system measured two different thermosphere/ionosphere emissions from which the two-dimensional structure/motion of irregularities was observed. Those observations were used to calculate the density and height of the ionosphere. Two miniaturized Fabry-Perot interferometers measured the thermospheric neutral winds and temperatures. The two interferometers were separated by 300 km, allowing bistatic, common-volume measurements. Those measurements were useful for studying the response of the thermosphere to storms as well as for looking for the possible connection of gravity waves to the seeding of equatorial instabilities.

12. South Atlantic Very Low Frequency Network

27. It was observed that the South Atlantic Very Low frequency Network (SAVNET) used the properties of very low frequency wave propagation on long distances between a transmitter and a receiver in the Earth-ionosphere waveguide. The waveguide was formed by the Earth’s surface, which was an electrical conductor, and by the low ionosphere D-region at an altitude of approximately 70 km of altitude during diurnal conditions and the E-region at an altitude of approximately 90 km at night without the presence of solar radiation. The characteristics of very low frequency propagating waves (amplitude and phase velocity) in the waveguide critically depended on the geometry of the waveguide, the electrical conductivity of its borders and the geomagnetic field. All phenomena capable of changing those waveguide properties affected the characteristics of very low frequency propagation.

28. SAVNET had two main objectives: (a) the indirect long-term monitoring of solar radiation; and (b) providing a diagnostic tool to study the ionosphere above the South Atlantic Magnetic Anomaly (SAMA) region during quiescent and geomagnetically disturbed periods. Further objectives of SAVNET were: (c) the study of ionospheric D-region properties during transient perturbations such as solar flares; (d) the diagnosis of extrasolar sources of ionospheric perturbations; (e) the observation of atmospheric phenomena producing ionospheric perturbations, like sprites, terrestrial gamma-ray flashes and seismo-electromagnetic processes; (f) the provision of experimental data sets to feed computational propagation codes in order to obtain daily templates of very-low-frequency wave properties on a given

transmitter-receiver path; and (g) the study of peculiar properties of the ionosphere at high (southern) latitudes.

29. The SAVNET base receiver was composed of two directional squared (3m x 3m) loop antennas and an isotopic vertical (6 m) antenna. The sensor signals were amplified and transported to an A/D audio card. The wave characteristics were provided by a Software Phase and Amplitude Logger computer code.

13. Scintillation Network Decision Aid

30. It was recalled that SCINDA was a real-time, data-driven communication outage forecast and alert system. It aided in the specification and prediction of satellite communication degradation resulting from ionospheric scintillation in the equatorial region. Ionospheric disturbances caused rapid phase and amplitude fluctuations of satellite signals observed at or near the Earth's surface; those fluctuations were known as scintillation. The most intense natural scintillation events occurred during night-time hours within 20 degrees of the Earth's magnetic equator, a region encompassing more than one third of the Earth's surface. Scintillation affected radio signals up to a few GHz frequencies and seriously degraded and disrupted satellite-based navigation and communication systems. SCINDA was designed to provide regional specification and short-term forecasts of scintillation activity to operational users in real time.

14. Space Environmental Viewing and Analysis Network

31. It was noted that the Space Environmental Viewing and Analysis Network (SEVAN) was an array of particle detectors located at middle and low latitudes which aimed to improve fundamental research of space weather conditions and to provide short- and long-term forecasts of the dangerous consequences of space storms. SEVAN detected changing fluxes of different species of secondary cosmic rays at different altitudes and latitudes, thus turning SEVAN into a powerful integrated device used to explore solar modulation effects.

Annex I

National and area coordinators of the International Space Weather Initiative

Country or area	*Coordinator*	*Affiliation*
Algeria	N. Zaourar	Geophysical Laboratory, University of Sciences and Technology, Algiers
Argentina	C. Mandrini	Instituto de Astronomía y Física del Espacio, Buenos Aires
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Belgium	G. Lapenta	Afdeling Plasma-astrofysica, Katholieke Universiteit Leuven
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	J.P. Raulin[b]	Presbyterian Mackenzie University, Sao Paulo[b]
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Canada	I. Mann	Department of Physics, University of Canada, Alberta
Cape Verde	J. Pimenta Lima	Instituto Nacional de Metereologica e Geofisica
China	W. Jing-Song	National Center for Space Weather, China Meteorological Administration
Congo	B. Dinga	Ministère de la recherche, Groupe de recherches en sciences exactes et naturelles, Brazzaville
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Denmark	K. Galsgaard	The Niels Bohr Institute, Computational Astrophysics, Copenhagen
Ecuador	E. Lopez	Observatorio Astronómico de Quito, Interior del Parque La Alameda, Quito

Country or area	*Coordinator*	*Affiliation*
Egypt	A. Mahrous	Space Weather Monitoring Center, Helwan
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Finland	R. Vainio	Department of Physical Sciences, University of Helsinki
France	N. Vilmer	Laboratoire d'études spatiales et d'instrumentation en astrophysique, Observatoire de Paris
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Italy	M. Messerotti	Department of Physics, University of Trieste
Japan	T. Obara	Japan Aerospace Exploration Agency
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Country or area	*Coordinator*	*Affiliation*
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Poland	M. Tomczak	Astronomical Institute, University of Wroclaw, Wroclaw
Portugal	D. Maia	University of Lisbon
Puerto Rico	S. Gonzalez	Arecibo University, Arecibo
Qatar	S.S. Bin Jabor Althani	Astronomy Department, Qatar Science Club
Republic of Korea	Y.D. Park	Korea Astronomy and Space Science Institute, Daejeon
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Rwanda	J. de Dieu Baziruwiha	Institut supérieur pedagogique, Kigali
Saudi Arabia	H. Basurah	Department of Astronomy, King Abdul Aziz University, Jeddah
Senegal	G. Sissoko	Groupe modelisation et simulation en energie solaire, Departement de physique, Universite Cheikh Anta Diop, Dakar
Serbia	I. Vince	Astronomical Observatory, Belgrade
Slovakia	I. Dorotovic	Slovak Central Observatory, Hurbanovo
South Africa	L.A. MacKinnel	Rhodes University, Grahamstown
Spain	J.R. Pacheco	Universidad de Alcalá
Sweden	H. Lundstedt	Swedish Institute of Space Physics, Lund
Switzerland	A. Csillaghy	University of Applied Sciences, Campus Brugg-Windisch
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	D. Ruffolo[b]	Bandung Institute of Technology[b]
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Ukraine	O. Litvinenko	Institute of Radio Astronomy NASU
United Arab Emirates	H.M.k. Al-Naimiy	United Arab Emirates University, Sharjah
United States	R. Smith	Geophysical Institute, University of Alaska
Uruguay	G. Tancredi	Observatorio Astronómico Los Molinos
Uzbekistan	S. Egamberdiev	Ulugbek Astronomical Institute
Viet Nam	H.T. Lan	Department of Atmosphere and Space Physics, Institute of Physics, Ho Chi Minh City
Yemen	A. Haq Sultan	Physics Department, Faculty of Science, Sanaa University

Country or area	*Coordinator*	*Affiliation*
Zambia	N. Mwiinga	Department of Physics, School of Natural Sciences, University of Zambia, Lusaka
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[b] Secondary contact.

Annex II

International Space Weather Initiative instrument distribution by country or area

Country or area	*Number of instruments*	*Type of instrument(s)*
Algeria	7	AMBER (1), AWESOME (1), CHAIN (1), GPS-Africa (1), MAG-Africa (1), SID (2)
Antarctica	2	AWESOME (1), SID (1)
Argentina	1	SAVNET (1)
Armenia	1	SEVAN (1)
Australia	14	CALLISTO (2), GMDN (1), MAGDAS (10), OMTI (1)
Austria	2	AWESOME (1), SID (1)
Azerbaijan	3	AWESOME (1), SID (2)
Belgium	1	CALLISTO (1)
Benin	1	GPS-Africa (1)
Bosnia and Herzegovina	1	SID (1)
Botswana	1	GPS-Africa (1)
Brazil	16	CALLISTO (1), GMDN (1), MAGDAS (2), RENOIR (2), SAVNET (4), SCINDA (3), SID (3)
Bulgaria	3	SEVAN (1), SID (2)
Burkina Faso	3	GPS-Africa (2), SID (1)
Cameroon	2	AMBER (1), SCINDA (1)
Canada	10	MAGDAS (1), OMTI (2), SID (7)
Cape Verde	1	GPS-Africa (1)
Central African Republic	1	MAG-Africa (1)
Chile	2	SCINDA (1), SID (1)
China	10	SID (9), SEVAN (1)
Colombia	3	SCINDA (1), SID (2)
Cong	4	SCINDA (1), SID (3)
Costa Rica	2	CALLISTO (1), SEVAN (1)
Côte d’Ivoire	4	MAGDAS (1), MAG-Africa (2), SCINDA (1)
Croatia	2	SEVAN (1), SID (1)
Cyprus	1	AWESOME (1)
Czech Republic	2	CALLISTO (1), SID (1)
Democratic Republic of the Congo	2	SID (2)
Ecuador	1	AWESOME (1)
Egypt	7	AWESOME (1), CALLISTO (1), CIDR (1), MAGDAS (2), SID (2)

Country or area	*Number of instruments*	*Type of instrument(s)*
Ethiopia	11	AMBER (1), AWESOME (1), MAGDAS (1), MAG-Africa (1), SCINDA (2), SID (5)
Fiji	1	AWESOME (1)
Finland	1	CALLISTO (1)
France	4	SID (4)
Gabon	2	GPS-Africa (2)
Germany	21	CALLISTO (1), SEVAN (1), SID (19)
Ghana	1	GPS-Africa (1)
Greece	2	AWESOME (1), SID (1)
Guyana	1	SID (1)
India	19	AWESOME (4), CALLISTO (2), MAGDAS (1), SEVAN (1), SID (11)
Indonesia	5	MAGDAS (3), SEVAN (1), SID (1)
Ireland	8	AWESOME (1), CALLISTO (1), SID (6)
Israel	2	AWESOME (1), SEVAN (1)
Italy	32	MAGDAS (1), SID (31)
Japan	12	CHAIN (1), GMDN (1), MAGDAS (6), OMTI (4)
Jordan	1	AWESOME (1)
Kenya	6	GPS-Africa (1), MAGDAS (1), SCINDA (1), SID (3)
Kuwait	1	GMDN (1)
Lebanon	6	SID (6)
Libyan Arab Jamahiriya	2	AWESOME (1), SID (1)
Madagascar	1	MAG-Africa (1)
Malaysia	3	AWESOME (1), MAGDAS (1), OMTI (1)
Mali	4	GPS-Africa (2), MAG-Africa (2)
Mauritius	1	CALLISTO (1)
Mexico	5	CALLISTO (1), SID (4)
Micronesia, Federated States of	1	MAGDAS (1)
Mongolia	12	AWESOME (1), CALLISTO (1), SID (10)
Morocco	2	AWESOME (1), GPS-Africa (1)
Mozambique	3	GPS-Africa (1), MAGDAS (1), SID (1)
Namibia	4	AMBER (1), GPS-Africa (1), MAG-Africa (1), SID (1)
Netherlands	1	SID (1)
New Zealand	3	SID (3)
Niger	1	GPS-Africa (1)
Nigeria	32	AMBER (1), MAGDAS (3), SCINDA (2), SID (26)
Norway	1	OMTI (1)

Country or area	*Number of instruments*	*Type of instrument(s)*
Peru	8	AWESOME (1), CHAIN (1), CIDR (1), MAGDAS (1), SAVNET (3), SCINDA (1)
Philippines	7	MAGDAS (6), SCINDA (1)
Poland	1	AWESOME (1)
Portugal	1	SID (1)
Republic of Korea	2	SID (1), CALLISTO (1)
Romania	2	SID (2)
Russian Federation	6	CALLISTO (1), MAGDAS (3), OMTI (2)
Sao Tome and Principe	1	GPS-Africa (1)
Saudi Arabia	2	AWESOME (1), SCINDA (1)
Senegal	3	GPS-Africa (1), MAG-Africa (1), SID (1)
Serbia	2	AWESOME (1), SID (1)
Slovakia	2	SEVAN (1), SID (1)
South Africa	20	GPS-Africa (7), MAGDAS (2), MAG-Africa (2), SID (9)
Spain	1	MAG-Africa (1)
Sri Lanka	1	SID (1)
Sudan	1	MAGDAS (1)
Switzerland	4	CALLISTO (3), SID (1)
Thailand	4	OMTI (1), SID (3)
Tunisia	4	AWESOME (1), SID (3)
Turkey	3	AWESOME (1), SID (2)
United Arab Emirates	1	AWESOME (1)
United Kingdom of Great Britain and Northern Ireland	8	MAG-Africa (1), SID (7)
United Republic of Tanzania	2	GPS-Africa (1), MAGDAS (1)
United States of America	172	AWESOME (2), CALLISTO (1), CIDR (6), MAGDAS (2), OMTI (1), SID (160)
Uganda	3	GPS-Africa (1), SID (2)
Uruguay	3	SID (3)
Uzbekistan	2	AWESOME (1), SID (1)
Viet Nam	2	AWESOME (1), MAGDAS (1)
Zambia	4	GPS-Africa (1), MAGDAS (1), SID (2)
Taiwan Province of China	1	MAGDAS (1)