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Committee on the Peaceful Uses of Outer Space
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Basic Space Science Initiative 1991 - 2012

Note by the Secretariat

1. The present document contains an overview and summary on the achievements of the basic space science initiative in terms of donated and provided planeteriums, astronomical instruments, and space weather instruments, particularly operating in developing nations. These instruments have been made available to respective host countries, particularly developing nations, through the series of twenty basic space science workshops, organized through the United Nations Programme on Space Applications since 1991.

2. 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 basic space science workshops were organized as a series of workshops that focused on basic space science (1991-2004), the International Heliophysical Year 2007 (2005-2009), and the International Space Weather Initiative (2010-2012) 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 reports of the Subcommittee. Workshops on the International Space Weather Initiative in the series were hosted by the Government of Egypt in 2010 (see A/AC.105/994), the Government of Nigeria in 2011, and the Government of Ecuador in 2012 (see A/AC.105/1030). Workshops on the International Heliophysical Year 2007 were 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). Workshops on basic space science were 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).

3. All workshops were co-organized by the International Astronomical Union (IAU) and the Committee on Space Research (COSPAR).

Basic Space Science Initiative

1991 - 2012

DRAFT

1. Introduction

The basic space science initiative was a long-term effort for the development of astronomy and space science through regional and international cooperation in this field on a worldwide basis, particularly in developing nations. Basic space science workshops were co-sponsored and co-organized by ESA, JAXA, and NASA.

A series of workshops on basic space science was held from 1991 to 2004 (India 1991, Costa Rica and Colombia 1992, Nigeria 1993, Egypt 1994, Sri Lanka 1995, Germany 1996, Honduras 1997, Jordan 1999, France 2000, Mauritius 2001, Argentina 2002, and China 2004; http://neutrino.aquaphoenix.com/un-esa/) and addressed the status of astronomy in Asia and the Pacific, Latin America and the Caribbean, Africa, and Western Asia. Through the lead of Professor Dr. Masatoshi Kitamura (1926-2012) from the National Astronomical Observatory Japan, astronomical telescope facilities were inaugurated in seven developing nations and planetariums were established in twenty developing nations based on the donation of respective equipment by Japan.

Pursuant to resolutions of the Committee on the Peaceful Uses of Outer Space of the United Nations (COPUOS) and its Scientific and Technical Subcommittee, since 2005, these workshops focused on the preparations for and the follow-ups to the International Heliophysical Year 2007 (UAE 2005, India 2006, Japan 2007, Bulgaria 2008, South Korea 2009; http://www.unoosa.org/oosa/SAP/bss/ihy2007/index.html). IHY's legacy is the current operation of 16 worldwide instrument arrays with close to 1000 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 of Armenia, Brazil, France, Israel, Japan, Switzerland, and the United States.

Starting in 2010, the workshops focused on the International Space Weather Initiative (ISWI) as mandated in a three-year-work plan as part of the deliberations of COPUOS. Workshops on ISWI were scheduled for Egypt in 2010 for Western Asia, Nigeria in 2011 for Africa, and Ecuador in 2012 for Latin America and the Caribbean.

The International Center for Space Weather Science and Education at Kyushu University, Fukuoka, Japan (http://www.serc.kyushu-u.ac.jp/index_e.html), was established through the basic space science initiative in 2012. Similar research and education centers were also established in Nigeria (http://www.cbssonline.com/aboutus.html) and India (http://www.cmsintl.org/).

Activities of basic space science initiative were also coordinated with the Regional Centres for Space Science and Technology Education, affiliated to the United Nations (http://www.unoosa.org/oosa/en/SAP/centres/index.html) and the International Committee on Global Navigation Satellite Systems (http://www.unoosa.org/oosa/en/SAP/gnss/icg.html).

2. Astronomical telescopes donated to developing countries through the Official Development Assistance programme of Japan

In order to promote education and research in developing nations, the Government of Japan has provided developing nations with high-grade equipment under the framework of the Official Development Assistance (ODA) cooperation programme since 1982 (see Table 1.). Under this cooperation programme, astronomical instruments have been donated to seven developing nations. The instruments donated included university-level reflecting telescopes together with various accessories. Table 2 describes ODA donations with the assistance of the Japan International Cooperation Agency (JICA) and the cooperation with the Programme on Space Applications of the Office for Outer Space Affairs of the United Nations (OOSA).

The number of science students in developing nations is rapidly increasing. In addition, selected students attend Ph.D. courses at universities or science institutes in order to further pursue higher education and research. Many of these scholars are aware of the fact that the present age is called the “space age” and become therefore interested in the subject of space science and technology.

Similarly, the number of highly educated professionals in astronomy is also steadily increasing in developing nations; however, many developing nations do not have the adequate astronomical equipment so urgently needed for education and research purposes that such professionals could use. One example of the need to support cooperation programmes providing adequate astronomical equipment to developing nations is that old-fashioned refracting telescopes are still used in a good number of nations. There is still a great lack of modern high-grade reflecting telescopes of higher quality and better resolution that could be used to better observe astronomical phenomena.

Table 1.

	Receiving Institution	*Location*	*Model*	*Option*	*Country*	*Year*
1.	Science Centre	Singapore	40-cm Reflector	..	Singapore	1987
2.	Bosscha Observatory Institute of Technology	Bandung, Lembang, 40391 Java, Indonesia	45-cm Cassegrain	Photoelectric photometer, spectrograph	Indonesia	1988
3.	Chulalongkorn University	Physics Department Faculty of Science Bangkok 10330, Thailand	45-cm Cassegrain	Photoelectric photometer, spectrograph	Thailand	1989
4.	Arthur C. Clark Center for Modern Technologies	Colombo, Katubedda Moratuwa, Sri Lanka	45-cm Cassegrain	Photoelectric photometer, spectrograph	Sri Lanka	1995
5.	Facultad Politecnica Asuncion University	Campus Universitario, Observatorio, Astronomico, San Lorenzo Asunción, Paraguay	45-cm Cassegrain	Photoelectric photometer, charge-coupled device	Paraguay	1999
6.	Philippine Atmoshperic, Geophysical and Astronomical Services	1424 ATB Bldg., Quezon Avenue, 1104 Quezon City,	45-cm Cassegrain	Photoelectric photometer,	Philippines	2000

	Receiving Institution	*Location*	*Model*	*Option*	*Country*	*Year*
	Administration	Philippines		spectrograph		
7.	Cerro Calan Astronomical Observatory Universidad de Chile Departamento de Astronomia	Casilla 36-D, Santiago, Chile	45-cm Cassegrain	Charge-coupled device	Chile	2001

3. Planetarium equipment donated to developing countries through the Official Development Assistance programme of Japan

Planetariums are important tools for education in astronomy. Nevertheless, only a limited number of developing nations have available planetariums located in their capital cities. On the other hand, industrialized nations have built a considerable number of planetariums that are used for space education not only in their capital cities, but also in villages, schools, and other places.

In order to promote education in developing nations, the Government of Japan has provided developing nations with equipment under the framework of the Official Development Assistance (ODA) cooperation programme since 1982 (see Table 2.). Under cooperation programme, planetarium instruments have been donated to 20 developing nations. The instruments donated included complete planetariums used for educational purposes together with various accessories. Table 1 describes the ODA donations provided with the assistance of the Japan International Cooperation Agency (JICA) and the cooperation with the Programme on Space Applications of the Office for Outer Space Affairs of the United Nations (OOSA).

Table 2.

	Receiving Institution	*Location*	*Model*	*Dome diameter (metres)*	*Seats*	*Country*	*Year*
1.	Pagoda Cultural Center	Yangon, Myanmar	GX	12	..	Myanmar	1986
2.	Haya Cultural Centre for Child Development	Post. B. 35022, Amman, Jordan	GEII-T	6.5	..	Jordan	1989
3.	National Planetarium Space Science Education Center	53 Jalan Perdana, 50480 Kuala Lumpur, Malaysia	Minolta Infinium β	20	213	Malaysia	1989
4.	Planetarium	Padre Burgos St., Ermita, Rizal Park, 2801 Manila, Philippines	GM-15s auxiliary projectors	16	310	Philippines	1990
5.	Meghnand Saha Planetarium	University of Burdwan, Golapbag Burdwan-713104, West Bengal, India	GS-AT	8.5	90	India	1993
6.	Planetario de la Ciudad de Buenos Aires “Galileo Galilei”	Av. Sarmiento y Belisario Roldán, s/n C1425FHA, Buenos Aires, Argentina	Auxiliary projectors	..	345	Argentina	1993
7.	Planetario de la Ciudad	Intendencia Municipal de Montevideo, Rivera 3245, 11600 Montevideo, Uruguay	Auxiliary projectors	..	..	Uruguay	1994
8.	Ho-Chi Minh Memorial Culture Hall Vinh City Planetarium	Vinh University, No. 6 Le Mao Street, Vinh City, Nghee An Province, Viet Nam	GS	8.5	80	Viet Nam	1998
9.	Planetarium	Science Center for Education, 928 Sukhumvit Road, Klong toey, Bangkok, 10110 Thailand	Auxiliary projectors	..	..	Thailand	1998
10.	Planetarium	Ministry of Science and Technology, 255 Stanley Wijesundara, Mawatha, Colombo 7, Sri Lanka	Auxiliary projectors	..	..	Sri Lanka	1998

	Receiving Institution	*Location*	*Model*	*Dome diameter (metres)*	*Seats*	*Country*	*Year*
11.	Tamilnadu Science and Technology Centre Anna Science Centre Planetarium	Pudukkottai National Highway, Near Tiruchirappalli Airport, Tiruchirappalli 620 007, India	GS	8.5	90	India	1998
12.	Planetarium	City Park, ul. Chamzy 6, Tashkent, Uzbekistan	..	..	..	Uzbekistan	2000
13.	Planetario Padre Buenaventura Suárez S.J.	Oliva No. 479, Asunción, Paraguay	EX-3	5	23	Paraguay	2001
14.	Planetario Municipal	Florencia Astudillo y Alfonso Cordero, Parque de la Madre, Cuenca, Ecuador	..	..	70	Equador	2002
15.	El Pequeño Sula, Museo para la Infancia of the City Hall of San Pedro Sula	Bulevar del Sur, Contiguo al Gimnasio Municipal, San Pedro Sula, Honduras C.A.	GS-T	8.5	..	Honduras	2003
16.	National Costa Rica University	San José, Costa Rica	GS-S	8.5	40	Costa Rica	2003
17.	Laboratorio Central del Instituto Geofisico	Calle Badajoz 169-171, IV Etapa Mayorazgo, ATE, Lima 03, Perú	GS-T	7.5	..	Perú	Scheduled for 2007
18.	National Astronomical Observatory of Tarija	Loc. Santa Ana Tarija, P.O. Box 346, Bolivia	GS-S	8.5	..	Bolivia	Scheduled for 2008
19.	National History Museum	Havana, Cuba	..	..	..	Cuba	Scheduled for 2007
20.	Tin Marín Children's Museum	Sexta Decima Calle Poniente, Centro Gimnacio Nacional y Parque Cuscatlan, San Salvador, El Salvador	GE-II	6.5	..	El Salvador	2007

4. Countries hosting istruments of the International Space Weather Initiative

Table 3.

01. **Algeria** (7) *AMBER(1), AWESOME(1), CHAIN(1), GPS_Africa(1), MAG_Africa(1), SID(2)*
02. **Antarctica** (2) *AWESOME(1), SID(1)*
03. **Argentina** (1) *SAVNET(1)*
04. **Armenia** (3) *SEVAN(3)*
05. **Australia** (18) *CALLISTO(2), GMDN(1), MAGDAS(11), OMTIs(1), SID(3)*
06. **Austria** (3) *CALLISTO(1), SID(2)*
07. **Azerbaijan** (3) *AWESOME(1), SID(2)*
08. **Bangladesh** (1) *SID(1)*
09. **Belgium** (1) *CALLISTO(1)*
10. **Benin** (1) *GPS_Africa(1)*
11. **Bosnia-Herzegovina** (1) *SID(1)*
12. **Botswana** (1) *GPS_Africa(1)*
13. **Brazil** (24) *CALLISTO(2), CSSTE(1), GMDN(1), MAGDAS(2), RENOIR(2), SAVNET(6), SCINDA(3), SID(7)*
14. **British Virgin Islands** (1) *SID(1)*
15. **Bulgaria** (2) *SEVAN(1), SID(1)*
16. **Burkina Faso** (3) *GPS_Africa(2), SID(1)*
17. **CHINA** (3) *SID(3)*
18. **Cameroon** (2) *AMBER(1), SCINDA(1)*
19. **Canada** (20) *MAGDAS(1), OMTIs(2), SID(17)*
20. **Cape Verde** (2) *GPS_Africa(1), SCINDA(1)*
21. **Central African Republic** (1) *MAG_Africa(1)*
22. **Chile** (1) *SCINDA(1)*
23. **China** (26) *SID(26)*
24. **Colombia** (8) *SCINDA(1), SID(7)*
25. **Congo** (7) *SCINDA(3), SID(4)*
26. **Costa Rica** (1) *CALLISTO(1)*
27. **Cote d'Ivoire** (4) *MAGDAS(1), MAG_Africa(2), SCINDA(1)*
28. **Croatia** (6) *SEVAN(1), SID(5)*
29. **Cypress** (1) *SID(1)*
30. **Czech Republic** (2) *CALLISTO(1), SID(1)*
31. **D Rep of Congo** (2) *SID(2)*
32. **Denmark** (2) *SID(2)*
33. **Djibouti** (1) *SCINDA(1)*
34. **Ecuador** (1) *MAGDAS(1)*
35. **Egypt** (9) *AWESOME(1), CALLISTO(1), CIDR(1), MAGDAS(2), SCINDA(1), SID(3)*
36. **England** (1) *SID(1)*
37. **Ethiopia** (20) *AMBER(1), AWESOME(1), MAGDAS(1), MAG_Africa(1), SCINDA(2), SID(14)*
38. **Fiji** (1) *AWESOME(1)*
39. **Finland** (2) *CALLISTO(2)*
40. **France** (4) *SID(4)*
41. **Gabon** (2) *GPS_Africa(2)*
42. **Germany** (26) *CALLISTO(2), SID(24)*
43. **Ghana** (1) *GPS_Africa(1)*
44. **Greece** (6) *AWESOME(1), SID(5)*

45. **Guyana** (2) *SCINDA(1), SID(1)*
46. **India** (25) *AWESOME(2), CALLISTO(4), CSSTE(1), MAGDAS(1), SEVAN(1), SID(16)*
47. **Indonesia** (10) *MAGDAS(8), SID(2)*
48. **Ireland** (14) *AWESOME(1), CALLISTO(4), SID(9)*
49. **Israel** (4) *AWESOME(1), ULF_ELF_VLF(3)*
50. **Italy** (41) *CALLISTO(2), MAGDAS(1), SID(38)*
51. **Japan** (13) *CHAIN(1), GMDN(1), MAGDAS(7), OMTIs(4)*
52. **Jordan** (1) *CSSTE(1)*
53. **Kazakhstan** (1) *CALLISTO(1)*
54. **Kenya** (8) *CALLISTO(1), GPS_Africa(1), MAGDAS(1), SCINDA(2), SID(3)*
55. **Korea** (2) *SID(2)*
56. **Kuwait** (1) *GMDN(1)*
57. **Lebanon** (11) *SID(11)*
58. **Libya** (3) *AWESOME(2), SID(1)*
59. **Madagascar** (1) *MAG_Africa(1)*
60. **Malaysia** (23) *AWESOME(1), CALLISTO(3), MAGDAS(2), OMTIs(1), SID(16)*
61. **Mali** (4) *GPS_Africa(2), MAG_Africa(2)*
62. **Mauritius** (3) *CALLISTO(3)*
63. **Mexico** (17) *CALLISTO(1), CSSTE(1), SAVNET(1), SID(14)*
64. **Micronesia** (1) *MAGDAS(1)*
65. **Mongolia** (13) *CALLISTO(2), MAGDAS(1), SID(10)*
66. **Morocco** (22) *AWESOME(1), CSSTE(1), GPS_Africa(19), RENOIR(1)*
67. **Mozambic** (4) *GPS_Africa(1), MAGDAS(1), SID(2)*
68. **Namibia** (4) *AMBER(1), GPS_Africa(1), MAG_Africa(1), SID(1)*
69. **Netherlands** (2) *SID(2)*
70. **New Zealand** (4) *SID(4)*
71. **Niger** (1) *GPS_Africa(1)*
72. **Nigeria** (47) *AMBER(1), CSSTE(1), MAGDAS(3), SCINDA(4), SID(38)*
73. **Norway** (1) *OMTIs(1)*
74. **Pakistan** (3) *SID(3)*
75. **Peru** (8) *CHAIN(1), CIDR(1), MAGDAS(2), SAVNET(3), SCINDA(1)*
76. **Philippines** (8) *MAGDAS(6), SCINDA(1), SID(1)*
77. **Poland** (1) *AWESOME(1)*
78. **Portugal** (3) *SID(3)*
79. **Rep of Congo** (1) *SID(1)*
80. **Republic of the Marshal Islands** (1) *SCINDA(1)*
81. **Romania** (3) *SID(3)*
82. **Russia** (13) *CALLISTO(1), MAGDAS(9), OMTIs(2), SID(1)*
83. **Sao Tome and Principe** (2) *GPS_Africa(1), SCINDA(1)*
84. **Scotland** (1) *SID(1)*
85. **Senegal** (3) *GPS_Africa(1), MAG_Africa(1), SID(1)*
86. **Serbia** (2) *AWESOME(1), SID(1)*
87. **Slovakia** (4) *CALLISTO(1), SEVAN(1), SID(2)*
88. **Slovenia** (1) *SID(1)*
89. **South Africa** (26) *GPS_Africa(7), MAGDAS(2), MAG_Africa(2), SCINDA(2), SID(13)*
90. **South Korea** (2) *CALLISTO(2)*
91. **Spain** (4) *CALLISTO(2), MAG_Africa(1), SID(1)*
92. **Sri Lanka** (2) *CALLISTO(1), SID(1)*
93. **Sudan** (1) *MAGDAS(1)*
94. **Sweden** (3) *SID(3)*
95. **Switzerland** (8) *CALLISTO(5), SID(3)*
96. **Taiwan** (4) *MAGDAS(1), SID(3)*

97. **Tanzania** (2) *MAGDAS(1), SCINDA(1)*
98. **Thailand** (6) *OMTIs(1), SID(5)*
99. **Tunisia** (8) *AWESOME(1), SID(9)*
100. **Turkey** (3) *AWESOME(1), SID(2)*
101. **UAE** (1) *AWESOME(1)*
102. **UK** (20) *CALLISTO(1), MAG_Africa(1), SCINDA(2), SID(16)*
103. **URUGUAY** (4) *SID(4)*
104. **USA** (270) *AWESOME(2), CALLISTO(3), CIDR(9), MAGDAS(2), SCINDA(2), SID(252)*
105. **US Virgin Islands** (2) *SID(2)*
106. **Uganda** (5) *SCINDA(1), SID(4)*
107. **Ukraine** (1) *CALLISTO(1)*
108. **Uruguay** (3) *SID(3)*
109. **Uzbekistan** (3) *AWESOME(1), SID(2)*
110. **Venezuela** (2) *SID(2)*
112. **Vietnam** (3) *AWESOME(1), MAGDAS(1), SID(1)*
112. **Zambia** (3) *MAGDAS(1), SID(2)*

LEGEND

AMBER African Meridian B-field Education and Research
AWESOME Atmospheric Weather Education System for Observation and Modeling of Effects
CALLISTO Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory
CHAIN Continuous H-alpha Imaging Network
CIDR Coherent Ionospheric Doppler Radar
CSSTE Centres for Space Science and Technology Education
GMDN Global Muon Detector Network
GPS Africa African Dual Frequency GPS Network
MAGDAS Magnetic Data Acquisition System
MAG Africa Magnetometers in Africa
OMTIs Optical Mesosphere Thermosphere Imager
RENOIR Remote Equatorial Nighttime Observatory for Ionospheric Regions
SAVNET South America Very Low frequency Network
SCINDA Scintillation Network Decision Aid
SEVAN Space Environment Viewing and Analysis Network
SID Sudden Ionospheric Disturbance Monitor
ULF_ELF_VLF ULF/ELF/VLF network

Current distribution of the International Space Weather Initiative instrument arrays as operational data sources

Distribution of instruments by country

Centres for Space Science and Technology Education (**CSSTE**)
6 centers, hosted in 6 coutries
Brazil (1), India (1), Jordan (1), Mexico (1), Morocco (1), Nigeria (1),

African Meridian B-field Education and Research (**AMBER**)
5 instruments, hosted in 5 coutries
Algeria (1), Cameroon (1), Ethiopia (1), Namibia (1), Nigeria (1),

Atmospheric Weather Education System for Observation and Modeling of Effects (**AWESOME**)
24 instruments, hosted in 21 coutries
Algeria (1), Antarctica (1), Azerbaijan (1), Egypt (1), Ethiopia (1), Fiji (1), Greece (1), India (2), Ireland (1), Israel (1), Libya (2), Malaysia (1), Morocco (1), Poland (1), Serbia (1), Tunisia (1), Turkey (1), UAE (1), USA (2), Uzbekistan (1), Vietnam (1),

Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory (**CALLISTO**)
51 instruments, hosted in 27 coutries
Australia (2), Austria (1), Belgium (1), Brazil (2), Costa Rica (1), Czech Republic (1), Egypt (1), Finland (2), Germany (2), India (4), Ireland (4), Italy (2), Kazakhstan (1), Kenya (1), Malaysia (3), Mauritius (3), Mexico (1), Mongolia (2), Russia (1), Slovakia (1), South Korea (2), Spain (2), Sri Lanka (1), Switzerland (5), UK (1), USA (3), Ukraine (1),

Continuous H-alpha Imaging Network (**CHAIN**)
3 instruments, hosted in 3 coutries
Algeria (1), Japan (1), Peru (1),

Coherent Ionospheric Doppler Receivers (**CIDR**)
11 instruments, hosted in 3 coutries
Egypt (1), Peru (1), USA (9),

Global Muon Detector Network (**GMDN**)
4 instruments, hosted in 4 coutries
Australia (1), Brazil (1), Japan (1), Kuwait (1),

African Dual Frequency GPS Network (**GPS_Africa**)
43 instruments, hosted in 16 coutries
Algeria (1), Benin (1), Botswana (1), Burkina Faso (2), Cape Verde (1), Gabon (2), Ghana (1), Kenya (1), Mali (2), Morocco (19), Mozambic (1), Namibia (1), Niger (1), Sao Tome (1), Senegal (1), South Africa (7),

Magnetic Data Acquisition System (**MAGDAS**)
71 instruments, hosted in 27 coutries
Australia (11), Brazil (2), Canada (1), Cote d'Ivoire (1), Ecuador (1), Egypt (2), Ethiopia (1), India (1), Indonesia (8), Italy (1), Japan (7), Kenya (1), Malaysia (2), Micronesia (1), Mongolia (1), Mozambic (1), Nigeria (3), Peru (2), Philippines (6),

Russia (9), South Africa (2), Sudan (1), Taiwan (1), Tanzania (1), USA (2), Vietnam (1), Zambia (1),

Magnetometers in Africa (**MAG_Africa**)

14 instruments, hosted in 11 coutries

Algeria (1), Central African Rep. (1), Cote d'Ivoire (2), Ethiopia (1), Madagascar (1), Mali (2), Namibia (1), Senegal (1), South Africa (2), Spain (1), UK (1),

Optical Mesosphere Thermosphere Imager (**OMTIs**)

12 instruments, hosted in 7 coutries

Australia (1), Canada (2), Japan (4), Malaysia (1), Norway (1), Russia (2), Thailand (1),

Remote Equatorial Nighttime Observatory for Ionospheric Regions (**RENOIR**)

3 instruments, hosted in 2 coutries

Brazil (2), Morocco (1),

South America Very Low frequency Network (**SAVNET**)

11 instruments, hosted in 4 coutries

Argentina (1), Brazil (6), Mexico (1), Peru (3),

Scintillation Network Decision Aid (**SCINDA**)

34 instruments, hosted in 22 coutries

Brazil (3), Cameroon (1), Cape Verde (1), Chile (1), Colombia (1), Congo (3), Cote d'Ivoire (1), Djibouti (1), Egypt (1), Ethiopia (2), Guyana (1), Kenya (2), Nigeria (4), Peru (1), Philippines (1), Rep. of Marshal Islands (1), Sao Tome and Principe (1), South Africa (2), Tanzania (1), UK (2), USA (2), Uganda (1),

Space Environment Viewing and Analysis Network (**SEVAN**)

7 instruments, hosted in 5 coutries

Armenia (3), Bulgaria (1), Croatia (1), India (1), Slovakia (1),

Sudden Ionospheric Disturbance Monitor (**SID**)

657 instruments, hosted in 75 coutries

Algeria (2), Antarctica (1), Australia (3), Austria (2), Azerbaijan (2), Bangladesh (1), Bosnia-Herzegovina (1), Brazil (7), British Virgin Islands (1), Bulgaria (1), Burkina Faso (1), CHINA (3), Canada (17), China (26), Colombia (7), Congo (4), Croatia (5), Cypress (1), Czech Republic (1), D Rep of Congo (2), Denmark (2), Egypt (3), England (1), Ethiopia (14), France (4), Germany (24), Greece (5), Guyana (1), India (16), Indonesia (2), Ireland (9), Italy (38), Kenya (3), Korea (2), Lebanon (11), Libya (1), Malaysia (16), Mexico (14), Mongolia (10), Mozambique (2), Namibia (1), Netherlands (2), New Zealand (4), Nigeria (38), Pakistan (3), Philippines (1), Portugal (3), Rep of Congo (1), Romania (3), Russia (1), Scotland (1), Senegal (1), Serbia (1), Slovakia (2), Slovenia (1), South Africa (13), Spain (1), Sri Lanka (1), Sweden (3), Switzerland (3), Taiwan (3), Thailand (5), Tunisia (7), Tunisiaia (2), Turkey (2), UK (16), URUGUAY (4), USA (252), US Virgin Islands (2), Uganda (4), Uruguay (3), Uzbekistan (2), Venezuela (2), Vietnam (1), Zambia (2),

ULF/ELF/VLF network (**ULF_ELF_VLF**)

3 instruments, hosted in 1 coutries

Israel (3),

Published scientific papers based on results of the International Space Weather Initiative in the period of time from 2009 - 2013

Table 4.

2013

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5. Prospective Continuation of the Basic Space Science Initiative Beyond 2012

The Basic Space Science Initiative will continue providing support to operators of planetariums, astronomical telescopes, and ISWI instruments.

Astronomical telescopes

The International Scientific Optical Network (ISON) is an open international non-government project mainly aimed at being a free source of information on space objects for scientific analysis and other applications. It was initiated in the framework of the programme of the GEO region investigations started by the Keldysh Institute of Applied Mathematics (KIAM) of the Russian Academy of Sciences in 2001 and in order to support space debris radar experiments with additional tracking data used for determination of orbital parameters precise enough to properly point narrow radar beams of selected objects.

ISON is one of the largest observation systems and it is one of two existing systems in the world, capable to observe the sky globally from both – Eastern and Western - hemispheres. At present, there are more than 30 telescopes operating in 20 observatories in eight nations: Bolivia, Georgia, Italy, Moldova, Russia, Tajikistan, Ukraine, Uzbekistan. All these telescopes participate in a coordinated observation programme under the ISON project.

ISON telescopes are grouped in three subsets dedicated to tracking of different classes of the space objects – bright GEO-objects, faint fragments at GEO region, bright objects at highly elliptical (HEO), and low orbits (LEO). ISON activities are arranged with four supporting groups such as (i) electric and software engineering, (ii) optical and mount engineering, (iii) observation planning and data processing, and (iv) network development. The obtained data are collected and stored at the KIAM Centre for Processing and Analysis of Information on Space Debris (CCPAISD), Russian Academy of Sciences.

The goal of the ISON observations of faint space debris fragments at high orbits was formulated from the beginning of the establishment of ISON in 2004. First experiments arranged with a 64 cm telescope AT-64 in Nauchny, Crimea, in October 2004 were devoted to adjusting of a method of the fragments discovering and checking of the Pulkovo theory on orbital evolution of the GEO object explosion fragments. These successful attempts, discovering seven not catalogued fragments and obtaining 1240 measurements in 18 tracks, initiated also the cooperation with a team at the Astronomical Institute of the University of Bern (AIUB), Switzerland. The regularly coordinated AIUB-ISON observing campaigns were carried out during 2005 and the ISON subsystem for the tracking of the faint fragments at GEO region started operations in 2006. ISON news are regularly published in a dedicated website: http://www.lfvn.astronomer.ru.

Planetariums

The recently published book titled Max Goes to the Moon has been donated by author Jeffrey Bennett (www.jeffreybennett.com) and provided to public educational institutions by the Office for Outer Space Affairs of the United Nations (www.unoosa.org). Max Goes to the Moon was the first children's book selected to be read aloud in space, by Astronaut Alvin Drew aboard the final mission of the Space Shuttle Discovery. To see a video of the reading, go to http://www.bigkidscience.com/max_in_space. Planetariums in your region can obtain materials for a Max Goes to the Moon planetarium show *at no cost*. A variety of other free educational resources related to this and other books in the Max series are available at www.BigKidScience.com. Jeffrey Bennett also distributes e-mails with educational information about space science. Educational institutions that are using the book are invited to provide brief information on ways and means to incorporate the book into their educational activities to the Office for Outer Space Affairs of the United Nations.

Space weather instruments

In 2012, the Scientific and Technical Subcommittee of COPUOS, at its forty-ninth session, agreed that an agenda item entitled "Space Weather" should be introduced as a regular item on the agenda of the Subcommittee, in order to allow member States of COPUOS and international organizations having permanent observer status with COPUOS to exchange views on national, regional, and international activities related to space weather research with a view to promoting greater international cooperation in that area. The Subcommittee noted that it could, through that item, serve as an important advocate for efforts to close existing gaps in the space weather research field (A/AC.105/1001, para. 226).

Space weather is important to society, which increasingly relies on technology for education, business, transportation and communication. Space storms can disrupt GPS/GNSS reception and long distance radio transmission. Modern oil and gas drilling frequently involve directional drilling to tap oil and gas reservoirs deep in the Earth, thus depending on accurate positioning using GPS systems. Energetic particles at the magnetic poles can force re-routing of polar airline flights resulting in delays and increased fuel consumption. Ground induced currents generated by magnetic storms can cause extended power blackouts and increased corrosion in critical energy pipelines.
In addition, space weather likely affects Earth's climate. The amount of energy entering the troposphere and stratosphere from all space weather phenomena is trivial compared to the solar insolation in the visible and infrared portions of the solar electromagnetic spectrum. However, there does seem to be some linkage between the 11-year sunspot cycle and Earth's climate. For example, the Maunder minimum, a 70 year period almost devoid of sunspots, correlates with a cooling of Earth's climate.
Space weather is inherently an international enterprise. Solar and magnetic storms can affect large regions of the Earth simultaneously, and equatorial ionospheric disturbances occur routinely around the globe. It is therefore appropriate for the United Nations to promote improvement in space weather modelling and forecasting for the benefit of all nations.

There has been significant scientific progress over the past decade in developing physics-based space weather models, and large-scale coupled (real-time) space plasma simulations. However, these models are limited by still being data starved in various spatial space weather domains. Thus, there is a crucial need for guaranteed continuous space weather data streams.

In 2007, the International Heliophysical Year (IHY) and International Space Weather Initiative (ISWI) have made significant progress in the installation of new instrumentation for the understanding of space weather impacts on Earth's upper atmosphere, generating new data streams useful for space weather in regions unobserved before. With the support of the United Nations Office of Outer Space Affairs (OOSA), the ISWI has facilitated the operation of nearly 1000 instruments operating in 100 of the UN's 194 Member States. The data from these instrument arrays is a unique resource for the study of space weather influences on Earth's atmosphere. The IHY and ISWI schools have trained several hundred graduate students and young scientists, many of whom are maturing as fine scientists as evidenced by their publications.
ISWI Scientific Objectives and Programme

At the 2011 UN/Nigeria Workshop on ISWI (A/AC.105/1018), the desire for a programme to enhance the science from ISWI was announced. The announcement also appeared at that time in the ISWI Newsletter (http://iswi-secretariat.org/) . This was followed up by a presentation and subsequent discussion of an ISWI science plan at the 2012 UN/Ecuador Workshop on ISWI (A/AC.105/1030), resulting in the following observations and recommendations.

The overall ISWI objective is to develop the scientific insight necessary to understand the science, and reconstruct and forecast near-Earth space weather. Steps in this process include: (i) Expanding and continuing the deployment of the existing ISWI instrument arrays and add new arrays as appropriate. (ii) For the data being obtained by the arrays, expanding the data analysis effort for array data and using existing data bases. (iii) Coordinating the data products to provide inputs for physical modeling, input instrument array data into physical models of heliospheric processes, and developing data products that reconstruct past conditions in order to facilitate assessment of problems attributed to space weather effects. (iv) Coordinating the data products to permit predictive relationships to be developed, to develop data products yielding predictive relationships that enable the forecasting of Space Weather, and to develop data products that can easily be assimilated into real-time or near real-time predictive models.

Fundamental aspects of ISWI include education and training, and public outreach activities. The concept is to encourage and support space science courses, workshops and curricula in university and graduate schools that provide instrument support. There has been much success in these areas, but there is a strong need to continue the education and training, develop public outreach materials that are unique to ISWI, and coordinate their distribution. It is important to provide information on ISWI instruments and results to the media, especially to local media.

The overall goal of an ISWI science programme should be to gain a more complete understanding of the universal processes that govern the Sun, Earth, planets, and heliosphere. This must involve scientists from a variety of disciplines, such as Solar Physics, Planetary Magnetospheres, Heliosphere and Cosmic Rays, Planetary Ionospheres, Thermospheres and Mesospheres, and Climate Studies. ISWI science projects should focus on the fundamental underlying physics of each phenomenon. They should facilitate discussions between different disciplines by focusing on relationships between these phenomena and commonalities in the physical processes. This allows researchers to plan and participate in cross-disciplinary studies, culminating in a greater understanding of fundamental universal processes.

What are the science benefits? This question is informed by recognizing what is unique about the ISWI data sets: (i) By observing in new geographical regions, a more global picture of Earth's response to solar wind inputs can be obtained; (ii) 24/7 solar observing is obtained in the radio and H-alpha wavelength regimes; (iii) Arrays provide global, 3-D information that can be used in tomographic reconstructions; (iv) Over the long term, these arrays will provide real-time data valuable for forecasting and now casting; and (v) Modeling improvements will allow better exploitation of existing data sets.

Enhancing the Science from ISWI

The primary data sets for ISWI science should come from the ISWI (IHY Legacy) Instrument Projects/Arrays. There are currently 16 operational instrument arrays hosted by ~100 nations. Current scientific activities sponsored by ISWI will continue. Specific recommendations are:

1. The ISWI will continue the deployment of instruments both for existing instrument arrays and for new instrument arrays on a perpetual basis.

2. The ISWI will undertake a process to use ISWI instrument data sets to determine data utility, to develop connections with virtual observatories to make data more readily available, and to facilitate collaborative modelling of regions of interest (e.g., the equatorial ionosphere) in collaboration with modelling centers of the ESA JAXA, NASA and others.

3. Data from ISWI instrument arrays will be combined with space-based data to advance space weather science leading to quality papers in international journals.

4. Space Science Schools are an integral part of ISWI, providing training for young and new researchers in instrument operation and the science of heliophysics. ISWI Space Science Schools will continue, and partnerships with organizations such as SCOSTEP and the International Astronomical Union will be established or strengthened to assure that these capacity building activities are accomplished efficiently and for the benefit of all member states.

Another new aspect of ISWI might include coordinated programmes or campaigns modeled on the Coordinated Investigation Programmes (CIPs) established under the International Heliophysical Year (IHY). These could use the same principles as the IHY scientific activities, but need not be as formal as the CIPs were. General CIP science topics included cosmic rays, solar filaments, CME onset and propagation, incoherent scatter radar data and comparative aeronomy.

The main communication interface for ISWI science should be an internet site set up either directly through or via a link to the main ISWI website at http://www.iswi-secretariat.org/. The science program can aid in establishing space weather modeling centers around the world, e.g., in collaboration with NASA's Coordinated Community Modeling Center (CCMC) at http://ccmc.gsfc.nasa.gov/. It would provide an interface for ISWI science results with the ISWI Space Science Schools and Public Outreach projects. Specific details on developments of the ISWI science programme will be made available through the ISWI Newsletter.

One way of developing and promoting scientific results from ISWI could be to have one or more ISWI science workshops, the first possibly as early as next year, 2013. The workshop would focus on scientific results. This or a follow on workshop could be like a NASA Coordinated Data Analysis Workshop (CDAW) in which the data interfaces and analysis tools are prepared in advance, and the results are presented at one or more later meetings and then published together in one volume.

Developing Data Analysis Links between ISWI Projects and/or with Outside Projects

In the following, some recent examples of cooperative science projects already underway or planned that involve ISWI array data. These include some examples of combining data from several ISWI arrays and with other “outside” data sources.

The Continuous H-alpha Imaging Network (CHAIN) project, with PIs K. Shibata and S.Ueno of Japan, has the goal of forming an worldwide H-alpha observing network for understanding and predicting space weather by accurately observing erupting phenomena on the solar surface that are initial boundary conditions of all eruptive processes. Its scientific goals are determination of the 3-D velocity field of eruptive phenomena on the solar surface, detection of shock waves (Moreton waves) generated by solar explosive phenomena, and estimation of solar UV radiation and comparison with ionospheric variation. The CHAIN group is seeking partnerships for using these data in international cooperative studies. For example, this year they plan to work with the Pakistan Space and Upper Atmosphere Research Commission (SUPARCO) to study F2 ionospheric density variations during solar minimum and maximum conditions, ionospheric variability at low and mid latitudes for solar cycles 22and 23, and solar cycle effects on coupling of neutral and ionized species at F2 altitude.

The Compact Astronomical Low-cost Low-frequency Instrument for Spectroscopy in Transportable Observatories (CALLISTO), PIs A. Benz and C. Monstein (ETHZ, Switzerland), is a radio spectrometer using a heterodyne receiver build by the ETH Zürich Radio and Plasma Physics Group. CALLISTO is able to continuously cover the solar radio spectrum from 45 to 870 MHz, using modern, commercially available broadband cable-TV tuners having frequency resolution of 62.5 KHz. CALLISTO has now deployed ~56 instruments in more than 30 locations with users from more than 74 countries. It produces science quality data and detects even tiny eruptions from the Sun. The spectral data on solar radio bursts is being used by the solar community but needs wider distribution. CALLISTO data is now being utilized for an Indo-US project on solar eruptive events. With this large network CALLISTO provides 24/7 coverage of radio bursts. Future plans include identifying sets of similar instruments to provide more continuous coverage over the whole frequency range.

The African Meridian B-Field Education and Research (AMBER), PI’s E. Yizengaw (Boston College, USA) and M. Moldwin (University of Michigan, USA), is a magnetometer array comprised of four magnetometers stationed in Ethiopia, Algeria, Cameroon, and in Namibia. AMBER’s data are being combined with other related arrays to provide important new observations for these objectives: (i) To monitor the electrodynamics governing the motion of plasma in the low/mid-latitude as function of LT, season, and magnetic activity; (ii) To understand ULF pulsation strength into low/mid-latitudes and its connection with EEJ and EA; (iii) To support studies about the effects of Pc5 ULF waves on the MeV electron population in the inner parts of the Van Allen belts. Recently, in collaboration with the SAMBA (E. Zesta, AFRL, USA) project, a fifth magnetometer was deployed in Nigeria. Other non-ISWI networks that are being used with AMBER are LISN (C. Valladares, Boston College, USA) in South America and MEASURE (M. Moldwin) in North America. AMBER is working to coordinate with other ground-based magnetometer arrays to provide a worldwide network to understand the electrodynamics that governs equatorial ionosphere motions. Data from the AMBER and related magnetometer arrays will be made accessible to space weather forecasters and the space science community at large.

There are several international programmes for which the use of ISWI data is planned. The International Study of Earth-Effecting Solar Transients (ISEST) is coordinated by Jie Zhang of George Mason University, USA, and is being implemented in 2012 - 2013 under the framework of Task Group 3 of SCOSTEP/CAWSES II. Its goals are: (i) To organize three international workshops; (ii) To promote an international effort to create a comprehensive database of Earth-effecting solar and heliospheric transient events in solar cycle 23 and 24, to develop advanced theoretical models of heliospheric transients, and to develop prediction tools for heliospheric transients. Another program is an ISWI Study of Radio Transients coordinated by N. Gopalswamy of the ISWI Secretariat. Two other international programmes that D. Webb coordinates are the IAU Working Group on International Collaboration on Space Weather and the STEREO mission Space Weather Group. Both of these could utilize ISWI data.

Table 4. lists published scientific papers that used ISWI array data using the Astrophysics Data System (ADS).

Conclusions

Space weather research is beneficial to the technological society. The ISWI makes an important and unique contribution by developing new data sources necessary for improved space weather understanding and prediction. The initial emphasis in ISWI has been on studies with analyses of data from individual ISWI instrument arrays. It is now time to expand these studies and it is recommended that, where possible and scientifically justified, these projects include cooperative studies with data sets from other ISWI arrays and other "outside" data sets to best address and expand the science results. Above a few examples of such expanded projects utilizing data from the ISWI arrays are given. It is recommended that these projects continue to interface with the ISWI Space Science Schools, Public Outreach projects and other educational science programmes. The ISWI community at large also would like to receive feedback from the PI groups of the instrument arrays and projects on how best to proceed on enhancing ISWI science. It is expected that any new data plan or procedures will be part of the proposed new permanent agenda item "Space Weather" for the Scientific and Technical Subcommittee of COPUOS.

Further Rading

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