

SURFACE-BASED OBSERVATIONS

(Submitted by Larisa Trichtchenko)

Summary and Purpose of Document

The surface-based observations of the space weather characteristics were divided into several categories, currently comprising of:

1. Solar:

Sunspot number
Radio bursts
Solar Magnetic field

2. Ionospheric:

Ionosondes
Riometers
TEC (combined satellite-to-ground, not part of this document)

3. Geomagnetic:

INTERMAGNET observatories
Geomagnetic chains, observatories and separate sites

4. Cosmic rays.

These observations are provided by wide variety of organizations with different capabilities and for different purposes, thus, duration of measurements, instruments characteristics, data availability etc. are governed by different "rules of the road".

Therefore, there is a need to identify the most relevant datasets and gaps in spatial coverage, identify the relevant responsible organizations and encourage them to fill the gap. Examples: spatial gap of ionospheric and magnetic coverage in South America, Africa and eastern part of Russia.

ACTIONS PROPOSED

To complete the list of ground-based observations, the participation of the ICTSW members with relevant area of expertise is requested.

Inter-Programme Coordination Team is invited to propose a procedure for evaluation of the relevant importance of different measurements for space weather operations and other services.

This procedure can also be used for identification of the services for inclusion into WMO SW portal.

IPCTSW is invited to outline the recommendations for the data availability, continuity, sampling rate etc. for each type of most important data.

IPCTSW is invited to outline the gaps in ground-based data provision and propose the recommendation for relevant organisation.

Initial lists of the observatories and measuring sites are described in Appendices as follows:
A. Solar Observations, B. Ionosphere, C. Geomagnetic Observations, D. (Cosmic Rays)

DISCUSSION /not proposed at that time

CONCLUSIONS /not proposed at that time

Recommended decision if any.

Expected benefit.

Next steps

APPENDIX A

SOLAR OBSERVATIONS FOR SPACE WEATHER

The following solar observations are the most used in space weather and other communities:

Sunspot Number (Royal Observatory Belgium),

F10.7: (Dominion Radio Astrophysical Observatory, Penticton, Canada

Radio bursts:

US Air Force Radio Solar Telescope Network (RSTN): Learmonth, Australia; San Vito, Italy;
Sagamore Hill, Massachusetts USA; Palehua, Hawaii USA

Used by WSA and ENLIL model:

GONG network: Big Bear Solar Observatory in California, USA, High Altitude Observatory at Mauna
Loa in Hawaii, USA, Learmonth Solar Observatory in Western Australia, Udaipur Solar Observatory
in India, Observatorio del Teide in the Canary Islands, Cerro Tololo Interamerican Observatory in
Chile.

Several SWx Centres use their own national solar observatories, for example:

Incheon, Korea (radio spectrograph, 2.8GHz, Radio Noise), Korean Space Weather Network

More complete list of 99 solar observatories with some details on the observations are below
(extracted from <http://www.arcetri.astro.it/~kreardon/EGSO/gbo/>).

1

Location: Narrabri, Australia Longitude: 149.8 E Latitude: 30.30 S

URL: <http://bison.ph.bham.ac.uk/sites/narrabri/narrabri.html>

Telescope: BiSON site Description: Visible, integrated sunlight

Instrument: Data Type:

2 Culgoora Solar Observatory

URL: <http://www.ips.gov.au/culgoora/>

Location: Culgoora, Australia Longitude: 149.6 E Latitude: 30.30 S

full disk H-alpha

Radio 18MHz - 1.8GHz

3

URL: <http://fourier.phys.utas.edu.au/birs/index.html>

Location: Bruny Island, Australia Longitude: 147.2 E Latitude: 42.40 S

Radio 3 - 45 MHz

4 Hiraiso Solar Terrestrial Research Center

URL: <http://sunbase.crl.go.jp/home.html>

Location: Japan Longitude: 140.6 E Latitude: 36.4 N

Full-disk and high-resolution H-alpha

Full-disk white-light

Radio Spectrograph 25-2500 MHz

5 National Astronomical Observatory,

URL: <http://solarwww.mtk.nao.ac.jp/>

Location: Mitaka, Japan

Longitude: 139.6 E Latitude: 36.1 N

Telescope: Solar Flare Telescope

Vector magnetic field, velocity, white-light, H-alpha

Solar Flare patrol

6 Nobeyama Solar Radio Observatory

URL: <http://solar.nro.nao.ac.jp/norh/index.html>

Location: Japan

Longitude: 138.2 E Latitude: 36.4 N

Full-disk images (17GHz, 10", intensity + circular polarization: 34 GHz, 5", intensity)

Total solar flux, circular polarization, 1 - 80 GHz

7 Norikura Solar Observatory

URL: <http://solarwww.mtk.nao.ac.jp/en/norikura.html>

Location: Japan

Longitude: 137.6 E Latitude: 36.1 N

530.3 nm, H-alpha, D3, He 1083.0 nm, continuum

8 Hida Observatory

URL: <http://www.kwasan.kyoto-u.ac.jp/Hida/Hida-e.html>

Location: Japan

Longitude: 137.4 E Latitude: 36.3 N

full-disk H-alpha

Flare Monitor

9 Okayama Astrophysical Observatory

URL: <http://solarwww.mtk.nao.ac.jp/en/okayama.html>

Location: Japan

Longitude: 133.6 E Latitude: 34.6 N

vector magnetic field (FOV 400 x 400", 6" res.)

10 Bohyunsan Optical Astronomy Observatory

URL: <http://www.boao.re.kr/~yjmoon/softmain.html>

Location: South Korea

Longitude: 128.9 E Latitude: 9.2 N

SOLar Flare Telescope (SOFT): White-Light, H-alpha, Vector Magnetic Field, Longitudinal Magnetic Field

11 Huairou Solar Observing Station, Beijing Astronomical Observatory

URL: <http://sun.bao.ac.cn/>

Location: Huairou, China

Longitude: 116.6 E Latitude: 40.4 N

Call, Hell, Mgl, Fel (4), Hel, and H-alpha,

Magnetic Field - Fel, H - 3.75'x5.45'

Full-Disk Vector Magnetograph

Full-Disk and High-resolution (10' x 8') H-alpha

Full-Disk Call K

Full-Disk Call K

12 Learmonth Solar Observatory

URL: <http://www.ips.gov.au/learmonth/>

Location: Australia Longitude: 114.60 E Latitude: 22.12 S
SOON site (Solar Observing Optical Network): full disk and high-resolution H-alpha, white-light + magnetogr.
GONG Site: full intensity and magnetic field
RSTN (Radio Solar Telescope Network): flux 0.2,0.4,1.4,2.7,5.0,8.8,15GHz ;
Sweep Frequency Interferometer (25-75MHz)
RIMS (Radio Interference Monitoring Sets)

13

URL: <http://bison.ph.bham.ac.uk/sites/carnarvon/carnarvon.html>
Location: Carnarvon, Australia Longitude: 113.8 E Latitude: 24.9 S
BiSON Site: integrated sunlight

14 Baikal Astrophysical Observatory

URL: <http://www.iszf.irk.ru:8101/obs/bao/bao.html>
Location: Russia Longitude: 105.0 E Latitude: 54.8 N
full-disk H-alpha
full-disk Call K
high resolution H-alpha images (9 arcminute field)

15 Radioastrophysical Observatory

URL: <http://ssrt.iszf.irk.ru/index.shtml>
Location: Siberia, Russia Longitude: 103.2 E Latitude: 51.8 N
Full-disk images at 5.2cm, 1-D scans
Radio

16 Yunnan Astronomical Observatory

URL: <http://cosmos.ynao.ac.cn/>
Location: China Longitude: 102.8 E Latitude: 25.0 N
single freq. total intensity at 1.42, 2.13, 2.84, 4.26GHz
high resolution H-alpha

17 Sayan Solar Observatory

URL: <http://www.iszf.irk.ru:8101/obs/sso/sso.html>
Location: Irkutsk, Russia Longitude: 100.8 E Latitude: 51.6 N
full-disk magnetograms (10" resolution), vector magnetograms (4" resolution)
full disk H images

18

URL:
Location: Alma-Ata, Russia Longitude: 76.9 E Latitude: 43.3 N
H + Ca K filtergrams
coronagraph

19 National Centre for Radio Astrophysics

URL: <http://www.gmrt.ncra.tifr.res.in/>
Location: Pune, India Longitude: 74.05 E Latitude: 19.1 N
Giant Meterwave Radio Telescope (GMRT) : Radio

20 Udaipur Solar Observatory

URL: <http://www.prl.ernet.in/~sushant/uso/>

Location: Udaipur, India

Longitude: 73.71 E Latitude: 24.59 N

GONG Site: helioseismology

H-alpha full disk

high resolution H-alpha

active regions

21 Ulugh Beg Astronomical Institute

URL:

Location: Parkent, Uzbekistan

Longitude: 69.97 E Latitude: 41.47 N

IRIS Site: Integrated intensity and velocity

22

URL: <http://www.astrin.uzsci.net/>

Location: Tashkent, Uzbekistan

Longitude: 69.29 E Latitude: 41.325

Full-Disk Call K images

23 Special Astrophysical Observatory

URL: <http://www.sao.ru/~sun/>

Zelenchukskaya, North Caucasus, Russia

Longitude: 41.59 E Latitude: 43.83 N

Radio, 0.9 - 18 GHz one dimensional scans with circular polarization

24 Pulkovo Observatory

URL:

Location: Kislovodsk, Russia

Longitude: 43.7 E Latitude: 43.9 N

5303, 5694, 6374, 10747, 10798 and H images

3 coronagraphs (53, 20, 10 cm)

Ca K spectroheliograms

full disk WL and H images

radio flux at .6, .8, 2, 3, 5 cm

25

URL:

Location: Abastumani, Georgia

Longitude: 42.7 E Latitude: 41.7 N

full disk WL, H, CaK

26

URL:

Location: Izmiran, Russia

Longitude: 37.7 E Latitude: 55.8 N

H images (disk)

coronagraph (53 cm) H and Ca K images (limb)

27 Solar Radio Laboratory (LaRS)

URL: <http://helios.izmiran.rssi.ru/lars/LARS.html>

ICTSW-4/Doc. 9.1

Location: Izmiran, Russia Longitude: 37.32 E Latitude: 55.47 N
Radio 169, 204, 3000 MHz, 1 sec resolution
radiospectrograph 25 - 270 Mhz, 40 / 20 msec resolution

28 Kharkov Astronomical Observatory
URL: <http://www.univer.kharkov.ua/astron/dslpp/sun/index.html>
Location: Kharkov, Ukraine Longitude: 36.23 E Latitude: 50.00 N
Multiwave Station of Solar Monitoring, spectroheliograph, full disk Ca K, H, He10830

29 Crimean Astrophysical Observatory
URL:
Location: Nauchny, Ukraine Longitude: 34.0 E Latitude: 44.7 N
He 10830 charts
coronagraph (53cm)

30
URL:
Location: Katzively, Ukraine Longitude: 34.0 E Latitude: 44.7 N

maps + solar flux (0.8-3.5cm)

31 Kandilli Observatory
URL: <http://www.koeri.boun.edu.tr/astronomy/astronomy.html/>
Location: Kandilli, Turkey Longitude: 29.1 E Latitude: 41.1 N
full disk H-alpha + CaK

32
URL:
Location: Bucuresti, Romania Longitude: 26.1 E Latitude: 44.4 N
full disk WL+H images

33 Metsähovi Radio Observatory
URL: <http://kurp-www.hut.fi/sun/>
Location: Metsähovi, Finland Longitude: 24.39 E Latitude: 60.22 N
Rado, 10-100 Ghz radio maps

34 National Astronomical Observatory Rozhen
URL: <http://www.astro.bas.bg/>
Location: Rozhen, Bulgaria Longitude: 24.74 E Latitude: 41.69 N

5303, 6374 + H images

35
URL:
Location: L'vov, Ukraine Longitude: 23.9 E Latitude: 49.8 N
full disk WL+H images

36 Debrecen Observatory
URL: http://fenyi.sci.klte.hu/~ludmany/deb_obs_en.html

Location: Debrecen, Hungary Longitude: 21.62 E Latitude: 47.56 N
full disk WL images
H-alpha flare observations

37 South African Astronomical Observatory
URL: <http://bison.ph.bham.ac.uk/new/sutherland.html>
Location: Sutherland, South Africa Longitude: 20.81 E Latitude: 32.38 S

BiSON site,integrated sunlight

38 Stara Lesna Observatory
URL: <http://www.ta3.sk/>
Tatranska Lomnica, Slovak Republic Longitude: 20.29 E Latitude: 49.15 N
Spectrograph Data Type: Visible
Sunspot observations

39 Lomnický štít Observatory
URL: <http://www.ta3.sk/>
Location: Slovak Republic Longitude: 20.22 E Latitude: 49.20 N

Fe X - XV, Ca XV photometry, H-alpha limb prominences

40 Astronomical Observatory of the Jagiellonian University
URL: <http://www.oa.uj.edu.pl/>
Location: Cracow, Poland Longitude: 19.83 E Latitude: 50.05 N

Radiospectrograph, mean fluxes in 10 channels from 275-1755 Mhz, 5 min resolution

41 Torun Centre for Astronomy
URL: <http://www.astro.uni.torun.pl/>
Location: Torun, Poland Longitude: 18.56 E Latitude: 53.10 N
daily mean flux at 127MHz

42 San Vito Air Station
URL:
Location: San Vito, Italy Longitude: 17.43 E Latitude: 40.40 N

SOON site (Solar Observing Optical Network), full disk H, WL + magnetogr.
RSTN (Radio Solar Telescope Network), flux at 0.2,0.4,1.4,2.7,5.0,8.8,15GHz
Sweep Frequency Interferometer (25-75MHz)
RIMS (Radio Interference Monitoring Sets)

43 Wroclaw Observatory
URL: <http://www.astro.uni.wroc.pl/>
Location: Wroclaw, Poland Longitude: 17.09 E Latitude: 51.11 N
H-alpha filtergr. (prominences+AR)

44 Białków Observatory

URL: <http://www.astro.uni.wroc.pl/>

Location: Wrocław, Poland

Longitude: 16.66 E Latitude: 51.48 N

H-alpha filtergrams and MSDP spectra

H-alpha filtergrams

45 Hvar Observatory

URL: <http://hvar.geof.hr/index.html>

Location: Hvar, Croatia

Longitude: 16.45 E Latitude: 43.18 N

Visible

46 Ondřejov Observatory

URL: <http://sunkl.asu.cas.cz/~sunwatch/index.html/>

Location: Ondřejov, Czech Republic

Longitude: 14.8 E Latitude: 49.9 N

full disk WL+H-alpha images

H prominences

high res. WL+H-alpha images,

magnetograms, Dopplergrams

radio flux at .24, .54, .88, 3 GHz

radio flux at 1-2 and 2-4.5 GHz

47 Astronomical Observatory of Catania

URL:

Location: Catania, Italy

Longitude: 15.1 E Latitude: 35.5 N

WL+H images (disk&limb)

48 Kanzelhöhe Solar Observatory

URL: <http://www.solobskh.ac.at/>

Location: Kanzelhöhe, Austria

Longitude: 14.9 E Latitude: 46.7 N

full disk WL+H images

49 Capodimonte Astronomical Observatory

URL: <http://www.na.astro.it/vamos/>

Location: Naples, Italy

Longitude: 14.26 E Latitude: 40.86 N

Full-Disk intensity and longitudinal magnetic and velocity field

50 Trieste Astronomical Observatory

URL: <http://radiosun.ts.astro.it/>

Location: Basovizza, Italy

Longitude: 13.8 E Latitude: 43.7 N

100-1000MHz radiopolarimeter

1-4 GHz radiopolarimeter

51 Einsteinturm Solar Observatory

URL: <http://aipsoe.aip.de/soe-e.html>

Location: Potsdam, Germany

Longitude: 13.1 E Latitude: 52.4 N

Visible

Radio burst profiles (40-800MHz), radio flux @42, ..., 775MHz

52 Rome Astronomical Observatory

URL: <http://www.mporzio.astro.it/solare/>

Location: Monte Porzio, Rome, Italy

Longitude: 12.45 E Latitude: 41.92 N

Full-disk Call K and continuum

53 Istituto Ricerche Solari Locarno

URL: <http://www.mnd-umwelttechnik.fh-wiesbaden.de/divers/irsol/shdescr.html>

Location: Locarno, Switzerland

Longitude: 8.8 E Latitude: 46.167 N

Visible

54

URL: http://www.astro.phys.ethz.ch/rapp/catalog/catalog_nf.html#phoenixII

Location: Bleien, Switzerland

Longitude: 8.7 E Latitude: 47.4 N

Radio 0.1 - 4 GHz

55

URL:

Location: Haute Provence, France

Longitude: 6 E Latitude: 44 N

full disk H images

56 Royal Observatory of Belgium

URL:

Location: Brussels, Belgium

Longitude: 5.3 E Latitude: 50.2 N

full disk maps (408MHz, 5')

600MHz integrated flux

full disk H + WL images

57 Observatory of Paris

URL: <http://mesola.obspm.fr/>

Location: Meudon, France

Longitude: 2.3 E Latitude: 48.8 N

full disk H-alpha + CaK images

58 Nançay Observatory

URL: <http://www.obs-nancay.fr/>

Location: Nançay, France

Longitude: 2.2 E Latitude: 47.4 N

maps (pol.) 150-450MHz

59 Ebre Observatory

URL: <http://www.readysoft.es/observebre/7index.htm>

Location: Roquetas, Spain

Longitude: 0.49 E Latitude: 40.82 N

Full-disk white-light images

60 Observatory of Pic du Midi

URL:

Location: Pic du Midi, France

Longitude: 0.1 E Latitude: 43.0 N

H limb images (1-2R), He 10830 images (planned)

61 Bordeaux Observatory

URL: <http://www.observ.u-bordeaux.fr/>

Location: Bordeaux, France

Longitude: 0.52 W Latitude: 44.84 N

Resonance cell velocity measurements

62

URL:

Location: Oukaimden, Morocco

Longitude: 7.5 W Latitude: 31.25 N

Integrated intensity and velocity

63 Observatório Astronómico da Universidade de Coimbra (OAUC)

URL: <http://www.astro.mat.uc.pt/obsv/index.html>

Location: Coimbra, Portugal

Longitude: 8.5 W Latitude: 40.2 N

full disk H-alpha, Call K, and continuum spectroheliograms

64 Prof. Manuel de Barros Observatory

URL: <http://www.fc.up.pt/oa>

Location: Oporto, Portugal

Longitude: 8.59 W Latitude: 41.11 N

Radio

65 Kiepenheuer Institute of Solar Physics

URL: <http://www.kis.uni-freiburg.de/kiswww2.html>

Location: Izaña, Tenerife, Spain

Longitude: 16.51 W Latitude: 28.30 N

Echelle spectrograph, Fabry-Perot Interferometer

full-disk H-alpha

66

URL: http://www.uni-sw.gwdg.de/research/exp_solar/GCT_text.html

Location: Izaña, Tenerife, Spain

Longitude: 16.51 W Latitude: 28.30 N

Visible

67

URL: http://www.kis.uni-freiburg.de/GREGOR/index_e.html

Location: Izaña, Tenerife, Spain

Longitude: 16.51 W Latitude: 28.30 N

Visible

68 THEMIS

URL: <http://www.themis.iac.es/>

Location: Izaña, Tenerife, Spain

Longitude: 16.51 W Latitude: 28.30 N

Italian Panoramic Monochromator, MSDP, MTR

69 Teide Observatory

URL:

Location: Izaña, Tenerife, Spain

Longitude: 16.51 W Latitude: 28.30 N

Vacuum Newtonian Telescope (VNT)

70 Solar Laboratory

URL: <http://bison.ph.bham.ac.uk/new/izana.html>

Location: Izaña, Tenerife, Spain Longitude: 16.51 W Latitude: 28.30 N

GONG Site, : full intensity and magnetic field

BiSON site, integrated sunlight

TON Site, Full-Disk Call K images

IRIS Site, Integrated intensity and velocity

71 Roque de los Muchachos Observatory

URL: <http://www.astro.su.se/groups/solar/>

Location: RdM, La Palma, Spain Longitude: 17.88 W Latitude: 28.76 N

Visible

72 Roque de los Muchachos Observatory

URL: <http://dot.astro.uu.nl/>

Location: RdM, La Palm, Spain Longitude: 17.88 W Latitude: 28.76 N

Visible

73

URL:

Location: Itapetinga, Brazil Longitude: 46.5 W Latitude: 23.2 S

Radio, mm-wave burst profiles

Instrument: 13.7m dish Data Type: Radio

75 OAFa - CASLEO

URL: http://www.casleo.gov.ar/Instrumentos/sst/sst_eng.html

Location: El Leoncito, San Juan, Argentina Longitude: 69.33 W Latitude: 31.8 S

Radio, 212 & 405 GHz, 1.5 & 3 arcminute field of view, 1 & 40 ms temporal resolution

76 OAFa - C.U. Cesco Station

URL: <http://www2.plasma.mpe-garching.mpg.de/hasta/site.html>

Location: El Leoncito, San Juan, Argentina Longitude: 69.33 W Latitude: 31.80 S

Full Disk H-alpha

Mirror Coronagraph - H-alpha, green and red line, 1.05 - 2 solar radii

77 Sagamore Hill RSTN Site

URL:

Location: Sagamore Hill, MA, USA Longitude: 70.82 W Latitude: 42.63 N

Radio fluxat 0.2,0.4,1.4,2.7,5.0,8.8,15GHz

Sweep Frequency Interferometer (25-75MHz)

78 Las Campanas Observatory

URL: <http://bison.ph.bham.ac.uk/new/lascampanas.html>

Location: Cerro Las Campanas, Chile Longitude: 70.7 W Latitude: 29.01 S

BiSON site, integrated sunlight

Very Large Array (VLA) Radio

88 Carl Sagan Observatory (OCS)

URL: <http://cosmos.cifus.uson.mx/Infraestructura/ocs/ocsnew.htm>

Location: Cerro Azul, Mexico Longitude: 110.57 W Latitude: 30.73 N
H-Alpha line center

89 Solar Observation Station (EOS)

URL: <http://cosmos.astro.uson.mx/Infraestructura/EOS/EOSinfrstrctr.htm>

Location: Hermosillo, Mexico Longitude: 110.96 W Latitude: 29.08 N
Full Disk H-alpha, Call K, and continuum

90 National Solar Observatory

URL: <http://nsokp.nso.edu/>

Location: Kitt Peak, AZ, USA Longitude: 111.6 W Latitude: 32.0 N
Visible
full disk magnetograms + He10830 spectroheliogr.

91 Big Bear Solar Observatory

URL: <http://www.bbso.njit.edu/>

Location: Big Bear, CA, USA Longitude: 117.0 W Latitude: 34.3 N
GONG Site vector magnetograph, Full disk WL, H-alpha, CaK, magnetograms
Full-Disk Call K images

92 Owens Valley Radio Observatory

URL: <http://www.ovsa.njit.edu/>

Location: Owens Valley, CA, USA Longitude: 117.9 W Latitude: 36.4 N
Radio

93 Mount Wilson Observatory

URL: <http://www.mtwilson.edu/Science/UCLA>

Location: Mt. Wilson, CA, USA Longitude: 118.1 W Latitude: 34.3 N
full disk magneto- + Doppler-grams (512x512), WL images

94 San Fernando Observatory

URL: <http://davinci.csun.edu/~astro/sfo.htm>

Location: Sylmar, CA, USA Longitude: 118.5 W Latitude: 34.3 N
full disk photometric images (broad band + CaK)
active region vectormagnetogr. + Dopplergrams

95 Dominion Radio Astrophysical Observatory

URL: http://www.drao.nrc.ca/icarus/www/sol_home.shtml

Location: Penticton, BC, Canada Longitude: 119.62 W Latitude: 49.32 N
Integrated 10.7cm flux

96

URL:

Location: Hat Creek, USA

Longitude: 121.5 W Latitude: 40.8 N

3mm maps (2' res.)

97 Wilcox Solar Observatory

URL: <http://quake.stanford.edu/~wso/>

Location: Wilcox, CA, USA

Longitude: 122.2 W Latitude: 37.4 N

LOS magnetic and velocity field

IRIS Network Site, Full-Disk Intensity and Velocity

98 Mees Solar Observatory

URL: <http://www.solar.ifa.hawaii.edu/mees.html>

Location: Haleakala, HI, USA

Longitude: 155.4 W Latitude: 19.6 N

Full disk Ca K images

H-alpha imaging spec. (2' FOV, 2" pix.)

vector mag. (2' FOV, 2" pix.)

vector mag. (4' FOV with 0.6" pixels)

H-alpha prominence images

99 Mauna Loa Solar Observatory

URL: <http://mlso.hao.ucar.edu/>

Location: MaunaLoa, HI, USA

Longitude: 156.6 W Latitude: 19.5 N

K-corona Images

K-corona WL images

H-Alpha Disk and Prominence

Helium-I 1083 nm Full-Disk Images

Call K and Continuum Full-Disk Images

Full Disk Potassium Images

GONG Site

APPENDIX B. IONOSPHERIC STATIONS

Many of ionosonde locations were difficult to find, for example located in Europe. The most completed list is offered by the following programs:

1. Global Ionospheric Radio Observatory (GIRO), <http://umicar.uml.edu/stationmap.html>



#	URSI	STATION NAME	LAT	LONG
1	AH223	AHMEDABAD	23.00	72.50
2	AN438	ANYANG	37.39	126.95
3	AS00Q	ASCENSION ISLAND	-7.95	345.60
4	AT138	ATHENS	38.00	23.50
5	AU930	AUSTIN	30.40	262.30
6	BP440	BEIJING	40.30	116.20
7	BJJ32	BERMUDA	32.40	295.30
8	BVJ03	BOA VISTA	2.80	299.30
9	BC840	BOULDER	40.00	254.70
10	BV53Q	BUNDOORA	-37.70	145.05
11	CXM9B	CACHIMBO	-9.50	305.20
12	CAJ2M	CACHOEIRA PAULISTA	-23.20	314.20
13	CGK21	CAMPO GRANDE	-20.50	305.00
14	RL052	CHILTON	51.50	359.40
15	CO764	COLLEGE AK	64.90	212.00
16	CS839	COLORADO_SPRINGS	39.00	255.12
17	DB049	DOURBES	50.10	4.60
18	DS932	DYESS AFB	32.40	260.20
19	EG931	EGLIN AFB	30.50	273.50

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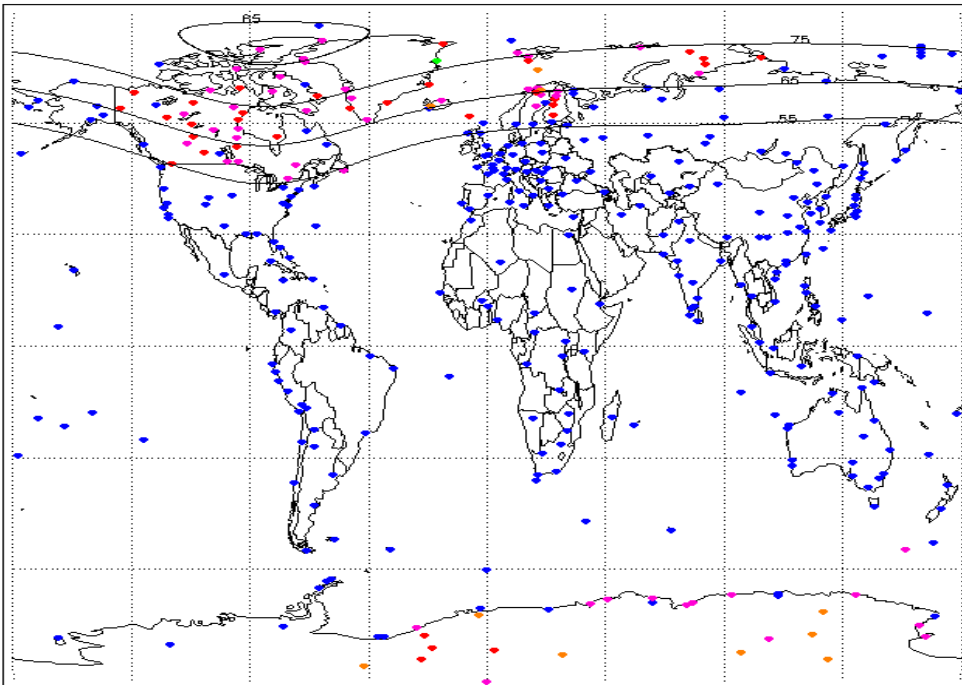
20	EI764	EIELSON	64.66	212.93
21	EA036	EL ARENOSILLO	37.10	353.30
22	FF051	FAIRFORD	51.70	358.50
23	FZA0M	FORTALEZA	-3.90	321.60
24	GA762	GAKONA	62.38	215.00
25	GM037	GIBILMANNA	37.90	14.00
26	GSJ53	GOOSE BAY	53.30	299.70
27	GR13L	GRAHAMSTOWN	-33.30	26.50
28	GU513	GUAM	13.62	144.86
29	HA419	HAINAN	19.40	109.00
30	HAJ43	HANSCOM AFB	42.50	288.70
31	HE13N	HERMANUS	-34.42	19.22
32	IC437	I-CHEON	37.14	127.54
33	AC843	IDAHO NATIONAL LAB	43.81	247.32
34	IF843	IDAHO NATIONAL LAB	43.81	247.32
35	IL008	ILORIN	8.50	4.50
36	IR352	IRKUTSK	52.40	104.30
37	JJ433	JEJU	33.43	126.30
38	JI91J	JICAMARCA	-12.00	283.20
39	JR055	JULIUSRUH	54.60	13.40
40	KS759	KING SALMON	58.40	203.60
41	TO535	KOKUBUNJI	35.70	139.50
42	KJ609	KWAJALEIN	9.00	167.20
43	LA42Q	LAVERTON	-28.30	122.80
44	LM42B	LEARMONTH	-21.80	114.10
45	LV12P	LOUISVALE	-28.50	21.20
46	MU12K	MADIMBO	-22.39	30.88
47	MHJ45	MILLSTONE HILL	42.60	288.50
48	MH453	MOHE	52.00	122.52
49	MO155	MOSCOW	55.47	37.30
50	MU230	MULTAN	33.03	72.01
51	NQJ61	NARSSARSSUAQ	61.20	314.60
52	NI135	NICOSIA	35.03	33.16
53	NO369	NORILSK	69.20	88.00
54	OK426	OKINAWA	26.68	128.15
55	SN437	OSAN AB	37.10	127.00
56	PSJ5J	PORT STANLEY	-51.60	302.10
57	PQ052	PRUHONICE	50.00	14.60
58	PA836	PT ARGUELLO	34.80	239.50
59	THJ77	QAANAAQ	77.50	290.80
60	PRJ18	RAMEY	18.50	292.90
61	RM041	ROME	41.80	12.50

62	RO041	ROME	41.90	12.50
63	EB040	ROQUETES	40.80	0.50
64	VT139	SAN VITO	40.60	17.80
65	SA418	SANYA	18.34	109.42
66	SAA0K	SAOLUIS	-2.60	315.80
67	SMJ67	SONDRESTROM	66.98	309.06
68	SH42	SOUTH HEDLAND	-20.40	118.50
69	TM308	TRIVANDRUM	8.54	76.87
70	TR169	TROMSO	69.60	19.20
71	TUJ20	TUCUMAN	-26.90	294.60
72	WP937	WALLOPS IS	37.90	284.50
73	MZ152	WARSAW	52.20	21.10
74	WU430	WUHAN	30.50	114.40
75	XI434	XINXIANG CHINA	35.30	113.92
76	YA462	YAKUTSK	62.00	129.60
77	ZH466	ZHIGANSK	66.80	123.40
78	ZS36R	ZHONG SHAN	-69.40	76.40

2. UK Solar System Data Centre provides a map with ionospheric observatories

http://www.ukssdc.ac.uk/gbdc/iono_riom.html

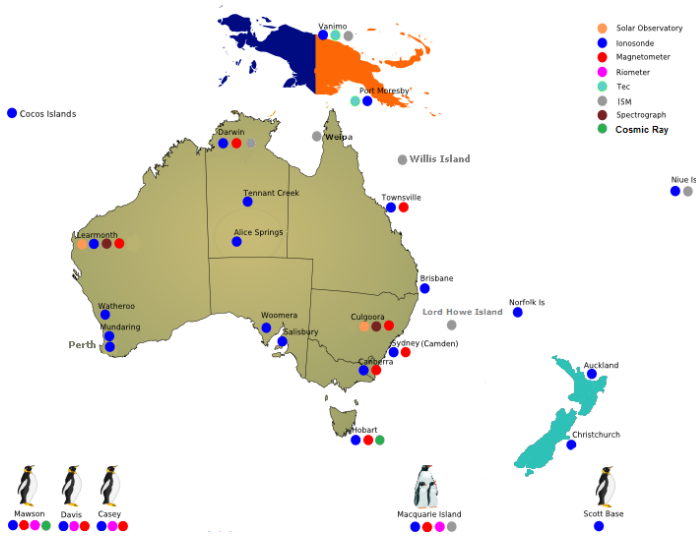
It should be noted, that provided clickable map is outdated and have errors.



Blue - Ionosonde
 Red - Riometer
 Orange - Imaging Riometer
 Magenta - Ionosonde and Riometer
 Green - Riometer and Imaging Riometer

Many forecast centres have their own networks of stations, which only partially participate in GIRO, for example:

Australian, IPS stations

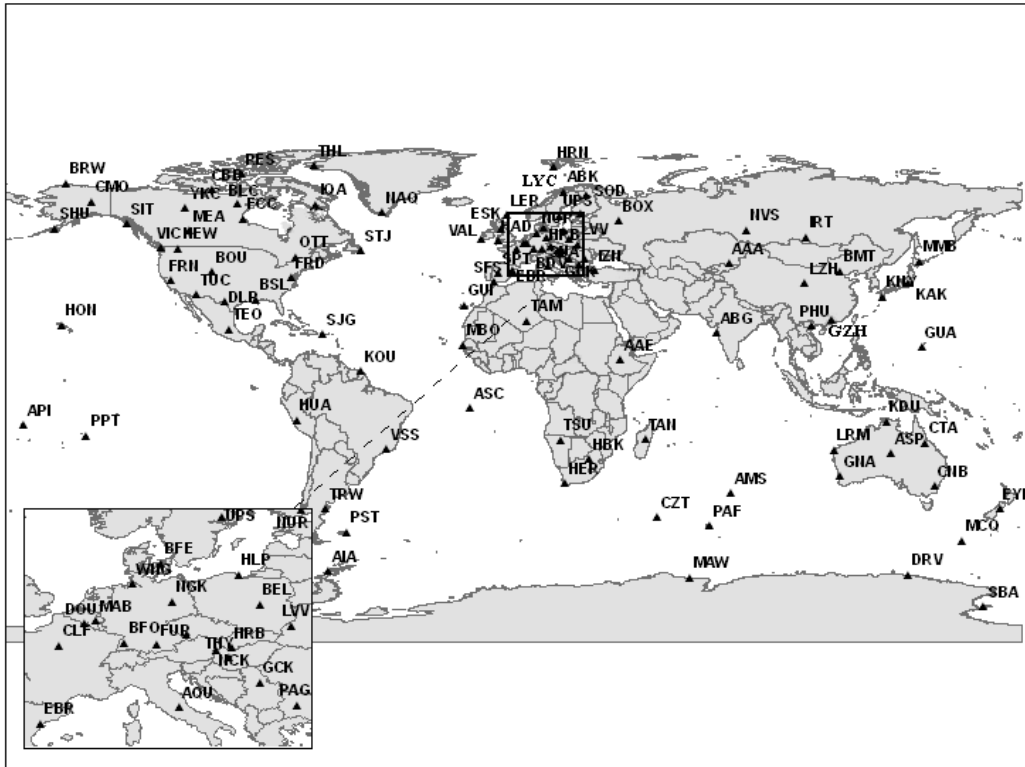


Stations are: Alice Springs, Auckland, Brisbane, Camden, Canberra, Casey, Christchurch, Cocos Islands, Culgoora, Darwin, Davis, Hobart, Learmonth, Lord Howe Island, Macquarie Island, Mawson, Mundaring, Niue, Norfolk Island, Perth, Port Moresby, Salisbury, Scott Base, Tennant Creek, Townsville, Vanimo, Watheroo, Weipa, Willis Island, Woomera. Coordinates, as well as detailed description of instruments can be found at:

http://www.ips.gov.au/World_Data_Centre/2/1/1

APPENDIX C. GEOMAGNETIC DATA

INTERMAGNET Observatories:

<http://www.intermagnet.org/index-eng.php><http://www.intermagnet.org/activitymap/activitymap-eng.php>

List of INTERMAGNET Magnetic Observatories (IMOs)

IAGA	Name	Country	Colatitude	East Longitude	Institute	GIN
AAA	Alma Ata	Kazakhstan	46.8°	76.9°	IIRK	Edi
AAE	Addis Ababa	Ethiopia	80.97°	38.77°	AAU , IPGP	Par
ABG	Alibag	India	71.38°	72.87°	IIG	Kyo
ABK	Abisko	Sweden	21.642°	18.823°	SGU	Edi
AIA	Argentine Islands (Akademik Vernadsky base)	Antarctica	155.25°	295.75°	NASC	Ott
ALE *	Alert	Canada	7.503°	297.647°	GSC	Ott
AMS	Martin de Vivies- Amsterdam Island	French Southern and Antarctic Lands	127.8°	77.57°	EOST	Par
API	Apia	Western Samoa	103.8°	188.22°	DAFFM	Edi
AQU *	L'Aquila	Italy	47.62°	13.32°	INGV	Par
ARS	Arti	Russia	33.567°	58.567°	UBRAS	Edi
ASC	Ascension Island	United Kingdom	97.95°	345.62°	BGS	Edi
ASP	Alice Springs	Australia	113.77°	133.88°	GA	Edi

List of INTERMAGNET Magnetic Observatories (IMOs)						
IAGA	Name	Country	Colatitude	East Longitude	Institute	GIN
BDV	Budkov	Czech Republic	40.92°	14.02°	ASCR	Edi
BEL	Belsk	Poland	38.16°	20.79°	PAS	Edi
BFE*	Brorfelde	Denmark	34.375°	11.672°	DTU	Kyo
BFO	Black Forest	Germany	41.669°	8.325°	GGUKS	Edi
BLC	Baker Lake	Canada	25.682°	263.988°	GSC	Ott
BMT	Beijing Ming Tombs	China	49.7°	116.2°	CHAS	Kyo
BNG*	Bangui	Central African Republic	85.67°	18.57°	IRD	Par
BOU	Boulder	United States of America	49.86°	254.76°	USGS	Gol
BOX	Borok	Russia	31.93°	38.23°	RAS, IPGP	Par
BRW	Barrow	United States of America	18.68°	203.38°	USGS	Gol
BSL	Stennis Space Center	United States of America	59.65°	270.36°	USGS	Gol
CBB	Cambridge Bay	Canada	20.877°	254.969°	GSC	Ott
CKI	Cocos-Keeling Islands	Australia	102.1875°	96.8336°	GA	Edi
CLF	Chambon la Foret	France	41.98°	2.27°	IPGP	Par
CMO	College	United States of America	25.13°	212.14°	USGS	Gol
CNB	Canberra	Australia	125.32°	149.36°	GA	Edi
CNH	Changchun	China	45.92°	124.86°	CEA	Edi
CSY	Casey Station	Antarctica	156.283°	110.533°	GA	Edi
CTA	Charters Towers	Australia	110.1°	146.3°	GA	Edi
CYG	Cheongyang	Republic of Korea	53.63°	126.854°	KMA	Kyo
CZT	Port Alfred	French Southern and Antarctic Lands	136.43°	51.87°	EOST	Par
DED	Deadhorse	United States of America	19.64°	211.21°	USGS	Gol
DLR*	Del Rio	United States of America	60.5°	259.08°	USGS	Gol
DLT	Dalat	Vietnam	78.06°	108.48°	VAST, IPGP	Par
DMC	Dome C	Antarctica	165.25°	124.167°	EOST, INGV	Par
DOU	Dourbes	Belgium	39.9°	4.6°	RMIB	Edi
DRV	Dumont d'Urville	Antarctica	156.67°	140.01°	EOST	Par
DUR	Duronio	Italy	48.61°	14.28°	INGV	Par
EBR	Ebro	Spain	49.18°	0.49°	OEB	Par
ESK	Eskdalemuir	United Kingdom	34.68°	356.8°	BGS	Edi
EYR	Eyrewell	New Zealand	133.42°	172.35°	GWS	Edi
FCC	Fort Churchill	Canada	31.241°	265.912°	GSC	Ott
FRD	Fredericksburg	United States of America	51.8°	282.63°	USGS	Gol
FRN	Fresno	United States of America	52.91°	240.28°	USGS	Gol

ICTSW-4/Doc. 9.1

List of INTERMAGNET Magnetic Observatories (IMOs)						
IAGA	Name	Country	Colatitude	East Longitude	Institute	GIN
FUR	Furstenfeldbruck	Germany	41.83°	11.28°	LMU	Edi
GAN	Gan	Maldives	89.3054°	73.1537°	ETH	Edi
GCK	Grocka	Serbia	45.6°	20.8°	GIG	Edi
GDH	Qeqertarsuaq (Godhavn)	Greenland	20.748°	306.467°	DTU	Kyo
GLN*	Glenlea	Canada	40.355°	262.880°	GSC	Ott
GNA*	Gnangara	Australia	121.8°	116.0°	GA	Edi
GNG	Gingin	Australia	121.356°	115.715°	GA	Edi
GUA	Guam	United States of America	76.41°	144.87°	USGS	Gol
GUI	Guimar-Tenerife	Spain	61.68°	343.57°	IGNS	Par
GZH	Zhaoqing	China	67°	112.5°	CEA	Edi
HAD	Hartland	United Kingdom	39°	355.52°	BGS	Edi
HBK	Hartebeesthoek	South Africa	115.88°	27.71°	SANSA	Edi
HER	Hermanus	South Africa	124.43°	19.23°	SANSA	Edi
HLP	Hel	Poland	35.39°	18.82°	PAS	Edi
HON	Honolulu	United States of America	68.68°	202.0°	USGS	Gol
HRB	Hurbanovo	Slovakia	42.14°	18.19°	SAS	Par
HRN	Hornsund	Norway	13°	15.37°	PAS	Edi
HUA	Huancayo	Peru	102.05°	284.67°	IGP	Edi
HYB	Hyderabad	India	72.6°	78.6°	NGRI	Edi
IPM	Isla de Pascua Mataveri (Easter Island)	Chile	117.2°	250.58°	DMC , IPGP	Par
IQA	Iqaluit	Canada	26.247°	291.482°	GSC	Ott
IRT	Irkutsk	Russia	37.73°	104.45°	ISTP SB RAS	Edi
ISK*	Kandilli	Turkey	48.9°	29.1°	KEORI	Edi
IZN	Izник	Turkey	49.5°	29.72°	KEORI	Edi
JAI	Jaipur	India	63.08°	75.80°	IIG	Kyo
KAK	Kakioka	Japan	53.77°	140.18°	JMA	Kyo
KDU	Kakadu	Australia	102.69°	132.47°	GA	Edi
KIV	Kiev	Ukraine	39.28°	30.3°	NASU	Edi
KMH	Keetmanshoop	Namibia	116.54°	18.110°	SANSA	Edi
KNY	Kanoya	Japan	58.58°	130.88°	JMA	Kyo
KOU	Kourou	French Guiana	84.79°	307.27°	IPGP	Par
LER	Lerwick	United Kingdom	29.87°	358.82°	BGS	Edi
LNP*	Lunping	Taiwan	65°	121.2°	DGT	Kyo
LOV*	Lovoe	Sweden	30.66°	17.82°	SGU	Edi
LRM	Learmonth	Australia	112.22°	114.1°	GA	Edi
LVV	Lviv	Ukraine	40.1°	23.75°	NASU	Edi
LYC	Lycksele	Sweden	25.4°	18.8°	SGU	Edi
LZH	Lanzhou	China	53.9°	103.84°	CEA , IPGP	Par
MAB	Manhay	Belgium	39.702°	5.682°	RMIB	Edi

List of INTERMAGNET Magnetic Observatories (IMOs)						
IAGA	Name	Country	Colatitude	East Longitude	Institute	GIN
MAW	Mawson	Antarctica	157.6°	62.88°	GA	Edi
MBC*	Mould Bay	Canada	13.685°	240.638°	GSC	Ott
MBO	Mbour	Senegal	75.62°	343.03°	IPGP, IRD	Par
MCQ	Macquarie Island	Australia	144.5°	158.95°	GA	Edi
MEA	Meanook	Canada	35.384°	246.653°	GSC	Ott
MGD	Magadan	Russia	29.949°	150.728°	IKIR	Edi
MID*	Midway Island	United States of America	61.79°	182.62°	USGS	Gol
MMB	Memambetsu	Japan	46.09°	144.19°	JMA	Kyo
NAQ	Narsarsuaq	Greenland	28.84°	314.558°	DTU	Kyo
NCK	Nagyceenk	Hungary	42.37°	16.72°	HAS	Edi
NEW	Newport	United States of America	41.73°	242.88°	USGS	Gol
NGK	Niemegk	Germany	37.93°	12.68°	GFZ	Edi
NUR	Nurmijarvi	Finland	29.49°	24.66°	FMI	Edi
NVS	Novosibirsk	Russia	35.15°	83.23°	ASB GS SB RAS	Edi
ORC	Orcadas	Argentina	150.737°	315.26°	SMN	Edi
OTT	Ottawa	Canada	44.597°	284.448°	GSC	Ott
PAF	Port-aux-Francais	French Southern and Antarctic Lands	139.35°	70.26°	EOST	Par
PAG	Panagjurishte	Bulgaria	47.5°	24.2°	BAS	Edi
PBQ*	Poste-de-la-Baleine	Canada	34.723°	282.255°	GSC	Ott
PEG	Pedeli	Greece	51.9°	23.9°	IGME	Edi
PET	Paratunka	Russia	37.029°	158.248°	IKIR	Edi
PHU	Phuthuy	Vietnam	68.97°	105.95°	VAST, IPGP	Par
PIL	Pilar	Argentina	121.4°	294.47°	SMN	Edi
PPT	Pamatai	French Polynesia	107.57°	210.42°	IPGP	Par
PST	Port Stanley	Falkland Islands	141.7°	302.11°	BGS	Edi
QSB*	Qsaybeh	Lebanon	56.1°	35.6°	NCGR, IPGP	Par
RES	Resolute Bay	Canada	15.31°	265.105°	GSC	Ott
SBA	Scott Base	Antarctica	167.85°	166.78°	GWS	Edi
SFS	San Fernando	Spain	53.333°	354.055°	RIOA	Par
SHU	Shumagin	United States of America	34.65°	199.54°	USGS	Gol
SIT	Sitka	United States of America	32.94°	224.67°	USGS	Gol
SJK	San Juan	United States of America	71.89°	293.85°	USGS	Gol
SOD	Sodankyla	Finland	22.63°	26.63°	SOD	Edi
SPT	San Pablo-Toledo	Spain	50.45°	355.65°	IGNS	Par
STJ	St John's	Canada	42.405°	307.323°	GSC	Ott
SUA	Surlari	Romania	45.32°	26.25°	GIR	Par

List of INTERMAGNET Magnetic Observatories (IMOs)						
IAGA	Name	Country	Colatitude	East Longitude	Institute	GIN
TAM	Tamanrasset	Algeria	67.21°	5.53°	CRAAG , IPGP	Par
TAN*	Antananarivo	Madagascar	108.917°	47.552°	IOGA , EOST	Par
TDC	Tristan da Cunha	Tristan da Cunha	127.067°	347.685°	DTU	Kyo
TEO*	Teoloyucan	Mexico	70.25°	260.81°	IG/UNAM	Edi
THL	Qaanaaq (Thule)	Greenland	12.53°	290.773°	DTU	Kyo
THY	Tihany	Hungary	43.1°	17.54°	ELGI	Edi
TIK*	Tixie Bay	Russia	18.4°	129.0°	IZMIRAN	NA
TRW	Trelew	Argentina	133.3°	294.7°	UNLP , RMIB	Edi
TSU	Tsumeb	Namibia	109.202°	17.584°	SANSA	Edi
TUC	Tucson	United States of America	57.82°	249.27°	USGS	Gol
UPS	Uppsala	Sweden	30.097°	17.353°	SGU	Edi
VAL	Valentia	Ireland	38.067°	349.75°	IMS	Edi
VIC	Victoria	Canada	41.48°	236.580°	GSC	Ott
VOS	Vostok	Antarctica	168.464°	106.835°	AARI	Kyo
VSS	Vassouras	Brazil	112.4°	316.35°	ON	Par
WMQ	Urumqi	China	46.19°	87.71°	CEA	Edi
WNG	Wingst	Germany	36.26°	9.07°	GFZ	Edi
YAK	Yakutsk	Russia	28.04°	129.66°	ICRA	Edi
YKC	Yellowknife	Canada	27.52°	245.518°	GSC	Ott

The geomagnetic activity map can be seen on:

<http://www.intermagnet.org/activitymap/activitymap-eng.php>

There are also many other geomagnetic sites, used for different purposes, the complete list of all of them is practically impossible to create.

APPENDIX D. COSMIC RAYS

<http://neutronm.bartol.udel.edu/>

Project Spaceship Earth

- Inuvik
- Fort Smith
- Apatity
- Norilsk
- McMurdo
- Thule

Other Stations

- Armenia
- Athens
- Lomnicky stit
- Moscow
- Newark
- Oulu
- South Pole

Muons : Nagoya

Several sites have referred to other stations, which might be not operational at this time:

South Africa: <http://www.nwu.ac.za/neutron-monitor-data>

Tsumeb (19° 12' S, 17° 35' E)

- **Potchefstroom** (26° 41.9' S, 27° 05.6' E)
- **Hermanus** (34° 25.5' S, 19° 13.5' E)
- **Sanae I, II and III** (70° 19' S, 02° 21' W) • **Sanae IV** (71° 40' S, 02° 51' W)

OLD list of stations is on:

ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/COSMIC_RAYS/STATION_DATA/docs/cosmic_ray.txt

COSMIC RAY NEUTRON MONITORS

Station	Geographic		Cutoff* GV	Alt. m	Scaling		Baro. coeff. %/mm Hg	Standard press. mm Hg
	Lat. North	Long. East			Type	Factor		
Thule	76.50	291.30	0.00	44	NM 64	100	0.99	754
Deep River	46.10	282.50	1.07	145	NM 64	300	0.987	747
Calgary	51.08	245.87	1.09	1128	NM 64	300	1.0155	671.1
Kiel	54.34	10.12	2.32	54	NM 64	100	0.961	755
Climax	39.37	253.82	2.97	3400	IGY	100	0.962	504
Beijing	40.08	116.26	9.56	47	NM 64	256	0.75%/mb	624.8
Tokyo	35.75	139.72	11.50	20	NM 64	256	0.888	760.5
Haleakala	20.71	203.07	13.30	3052	NM 64	1000	0.962	518

European site (UoA) is also listed new project on cosmic rays with mp of some stations. The availability of data and station location was not easy to extract and more time is needed.

[http://cosray.phys.uoa.gr/index.php/physics/nm-network-in-real-time,](http://cosray.phys.uoa.gr/index.php/physics/nm-network-in-real-time)

