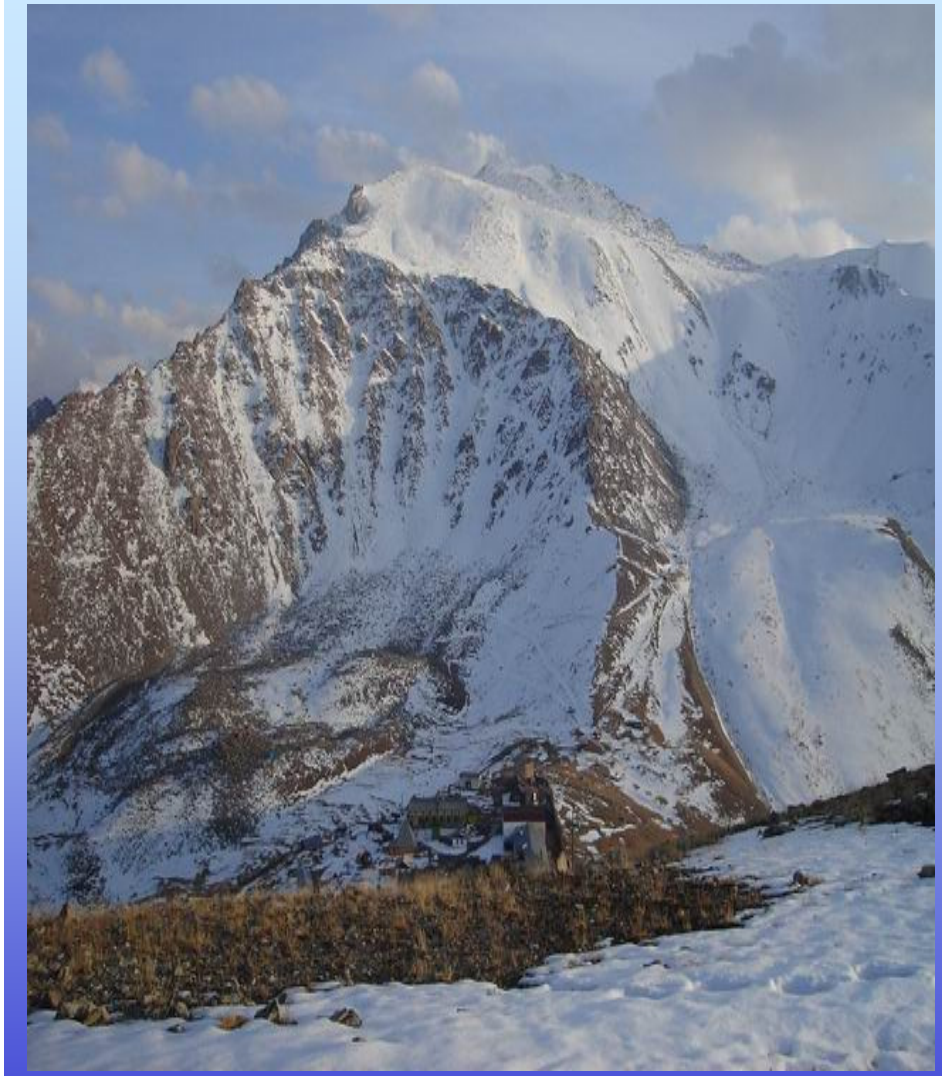

Space Weather Research in Kazakhstan

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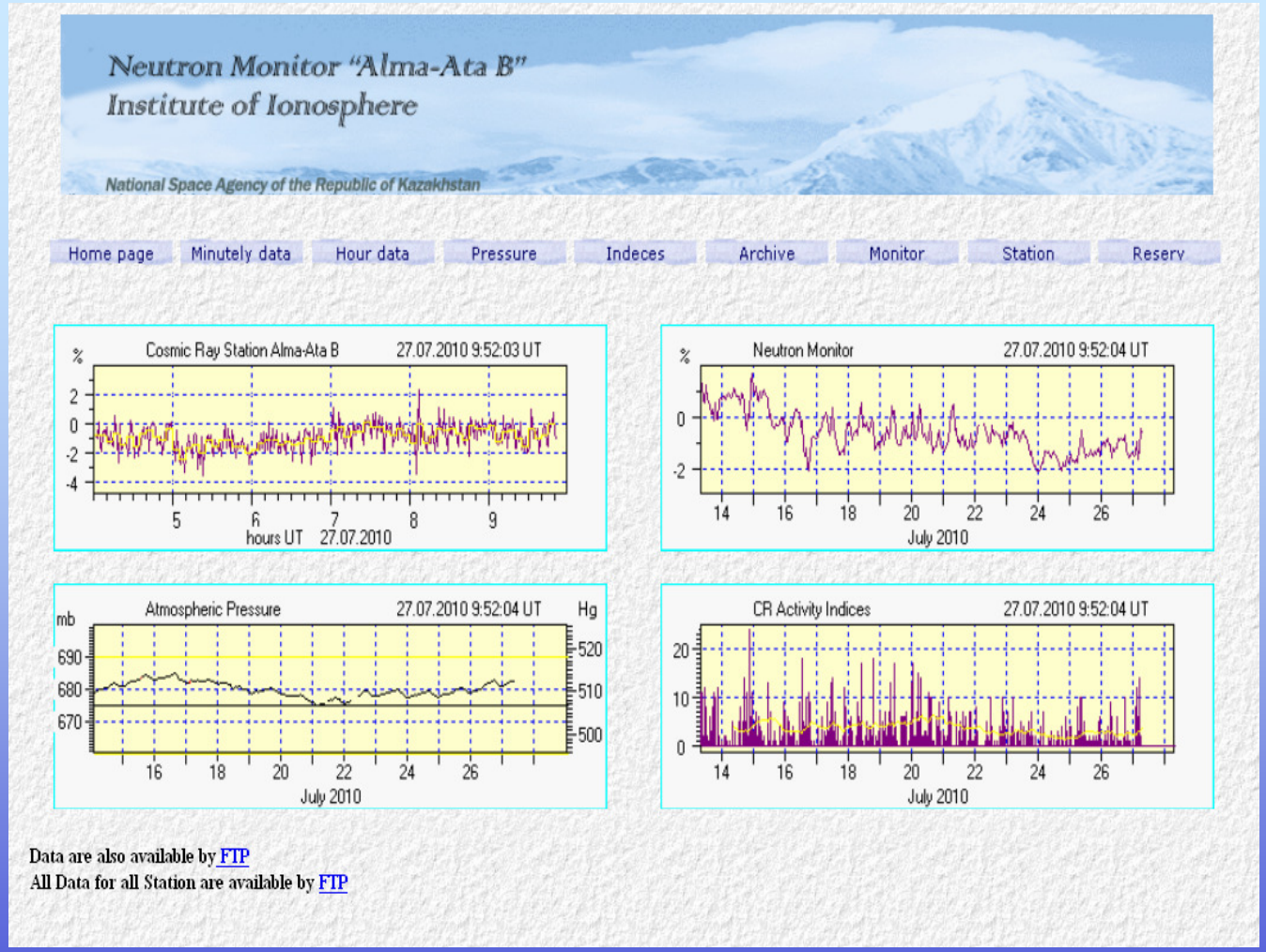
Almaty, Kazakhstan

Workshop on the International Space Weather Initiative
8-12 October 2012, Quito, Ecuador

In Kazakhstan there is an experimental complex for space weather study and forecasting. This complex is situated near Almaty (Kazakhstan). It includes an experimental setup for records of cosmic ray intensity (neutron monitor) at the altitude of 3340 m above sea level, the magnetic observatory «Alma-Ata», an optical interferometer SATI for recording the emission of night sky, an ionospheric sounder and solar radio telescope. Nowadays the measurements of the solar radio flux at frequencies of 1.078 GHz and 2.8 GHz (10.7 cm) are carries out on the regular basis with 1 second time resolution. Type II solar radio bursts are currently one of the main observable precursors of CMEs that will arrive at Earth within a few days after bursts. In view of future upgrade of the «Orbita» ground regarding new radio astronomical instruments, a measurement campaign was planned and organized between Institute of ionosphere, «NCSRT» and ETH Zurich, supported by SSAA. A new Callisto radio spectrometer (eC37) was installed and configured while the «Orbita» ground station. Results of space environment monitoring in real time are accessible via Internet.

Almaty High Mountain Cosmic Ray Station *(cosmic ray station Alma-Ata B) is situated near Almaty city on distance of 28 kilometers at the mountain and* ***50 km from the Institute of Ionosphere.*** *It has been operated since 1973.*
Location of Cosmic Ray Station Alma-Ata B:
Latitude 43.25 N
Longitude 76.92 E
Altitude 3340 m above sea level

Present high mountain Alma-Ata neutron supermonitor (Alma-Ata B**,** 43.1 N latitude, 76.6 E longitude, geomagnetic rigidity cutoff 6.69 GV) consists of the 18 SNM15 type neutron counters, which are divided between three standard 6-counter units. The sum rate of the monitor count is ~ 4.5-5.0 10^6 pulse per hour (depending on the solar activity phase).

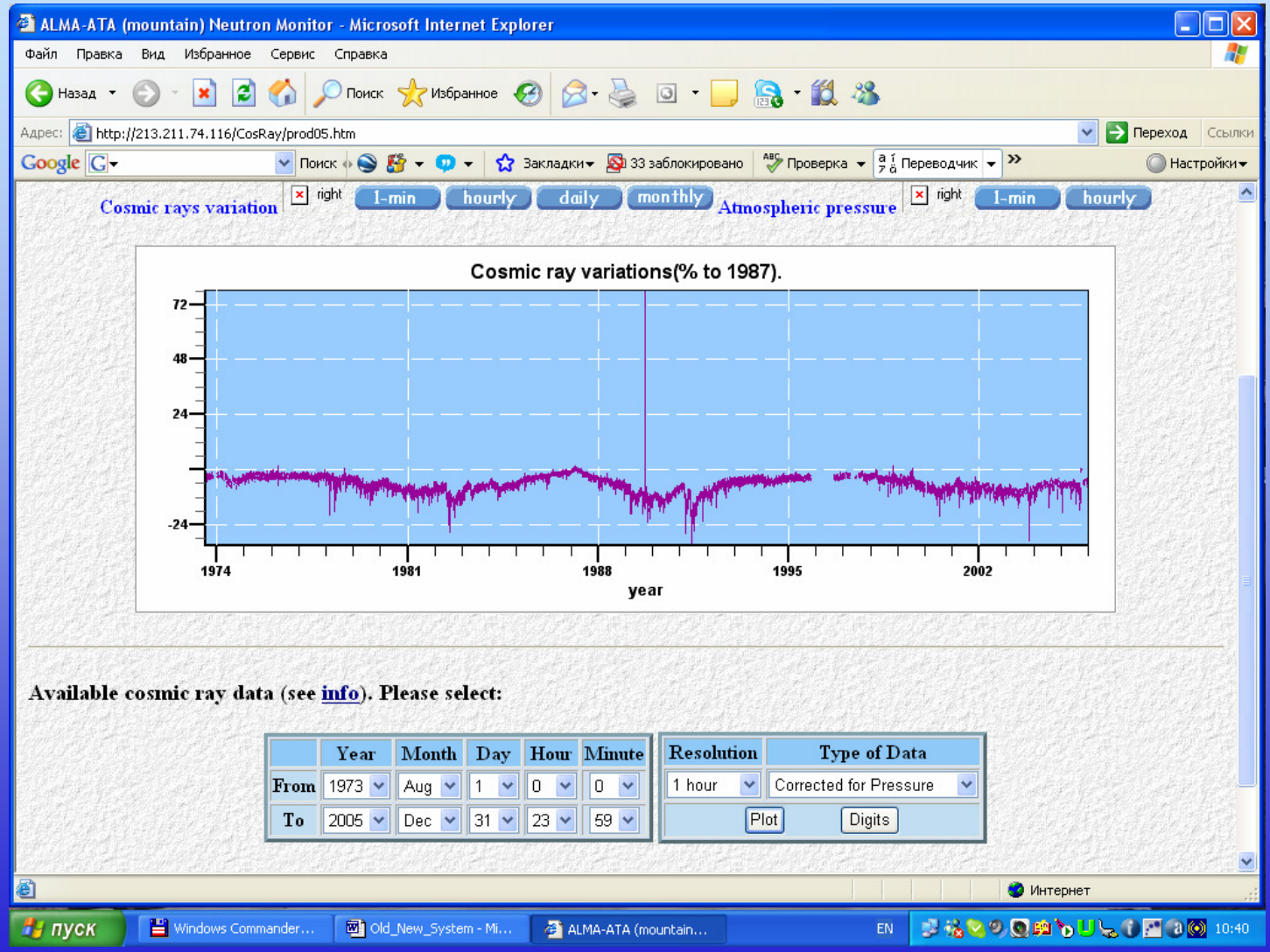


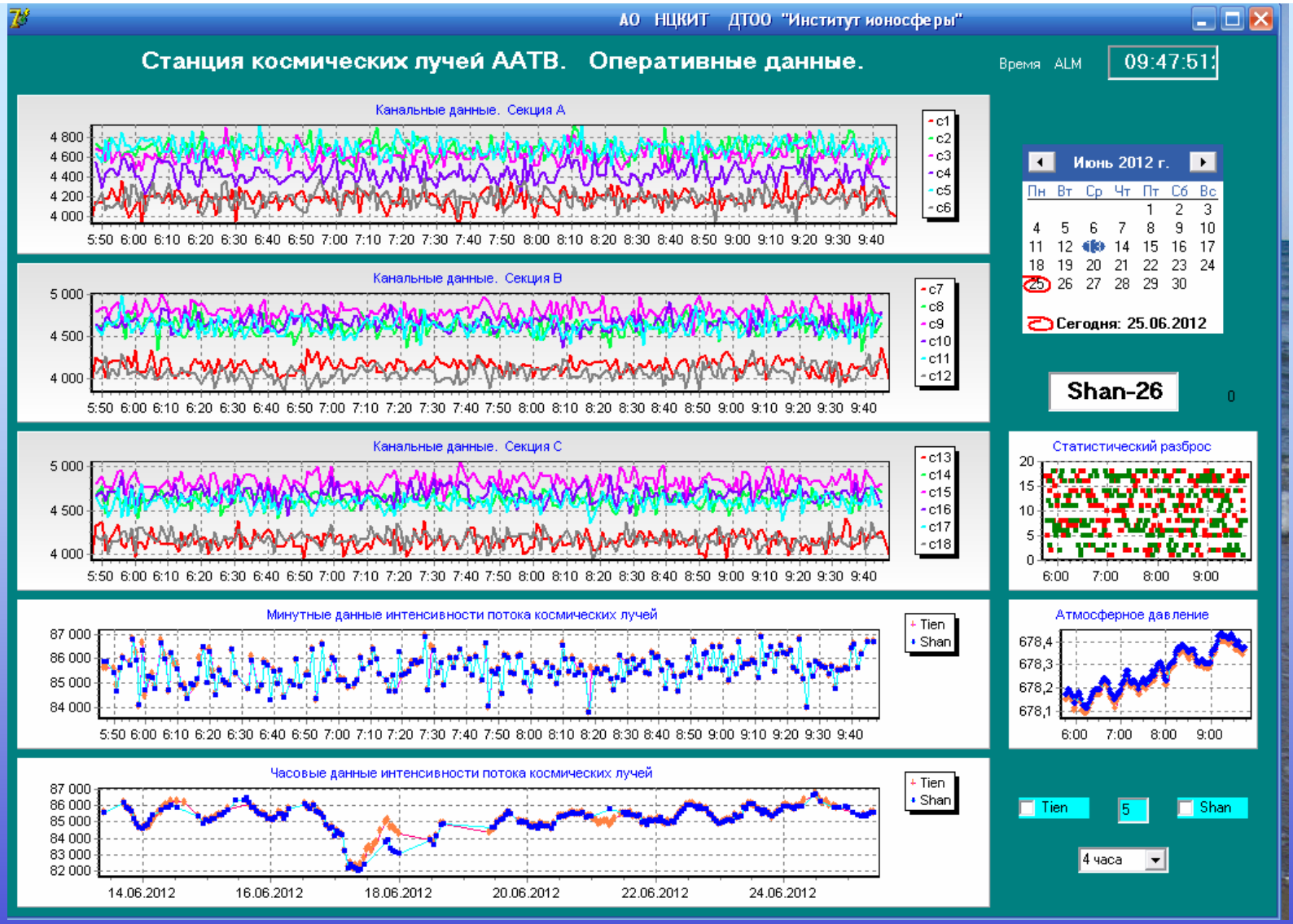
The neutron monitor data are presented in the graphic and text form with a minutely updating in a real time.

http://cosray.ionos.kz/CosRay/index.htm

The interface with cosmic ray intensity data in real time obtained by means of high-altitude neutron monitor has been realized on Institute of Ionosphere web-site.

Control panel allows to select a time interval, type of the data and the form of data presentation.





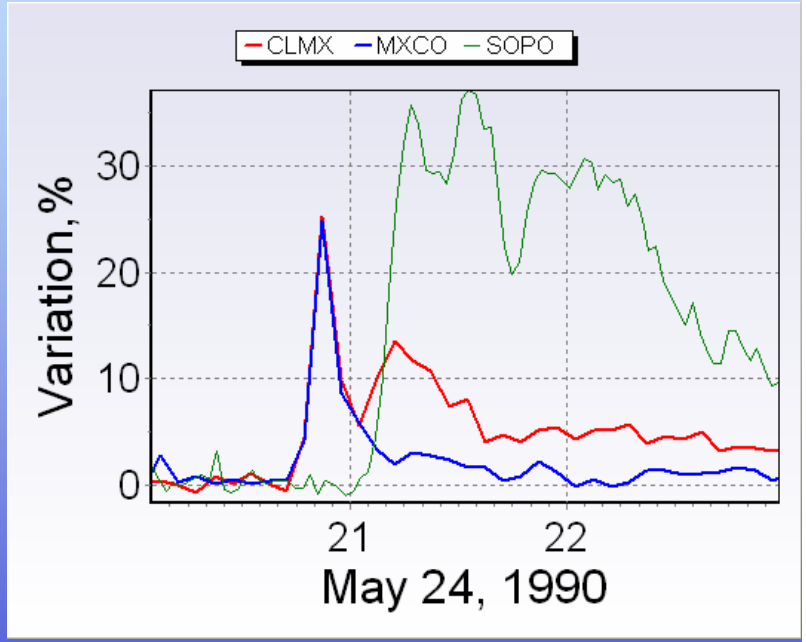
New online system with 1-minute update for visual control of Neutron Monitor data quality and MySQL database were created. This database was set up at the institute where we can see 1-min canal data of intensity and atmospheric pressure. Now the intensities of neutron pulses are recorded with a 1-minute temporal resolution separately for the each neutron counter.

Monitoring of solar neutrons by the observations with ground level neutron monitors.

The observation at the Earth of solar protons and neutrons, generated during powerful solar flares (in combination with X-ray and gamma-ray data) allows us to obtain unique information on the Sun's flare process and particle acceleration mechanisms.

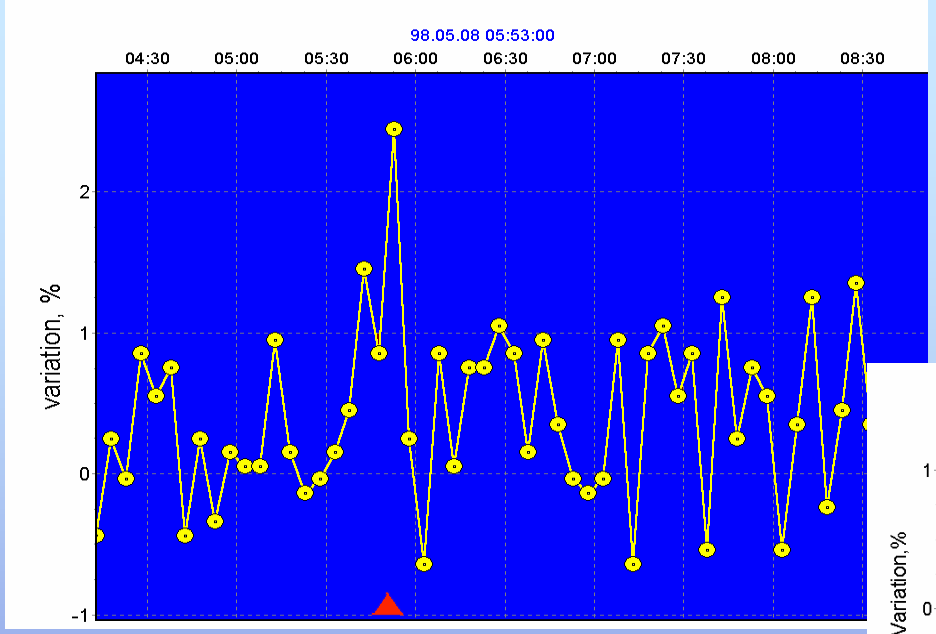
The detection of solar neutrons is mostly probable near local noon at mid- and low-latitude mountain neutron monitors. There are only a few such cosmic ray stations in the world network (about 10), and high mountain (3340 m) neutron monitor at Alma-Ata (Institute of Ionosphere) is among them. The combination of its geomagnetic cutoff rigidity (6.7 GV), altitude (3340 m) and high statistical accuracy makes this station enable to record solar neutrons of the energy order of 300 MeV.

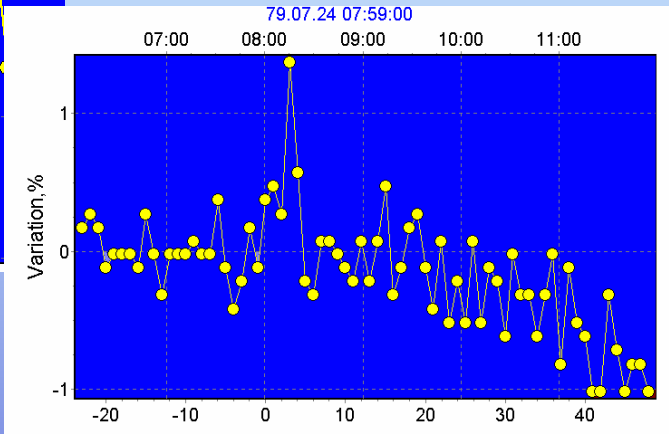
Two types of the ground-level enhancements of the solar cosmic ray: neutron and proton enhancements, but neutron enhancement can be registered before neutron enhancement.



The count rate variations at the neutron monitors Mexico (MXCO), Climax (CLMX), and South Pole (SOPO) during the GLE on May 24, 1990.

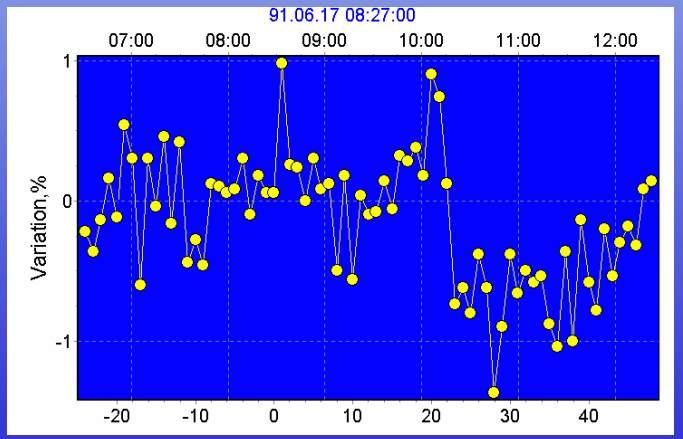
Belov A. et al. A real-time search for solar neutron events in the data of high-altitude neutron monitors. Proc. 31 ICRC, 2009, 1107.





flare onset

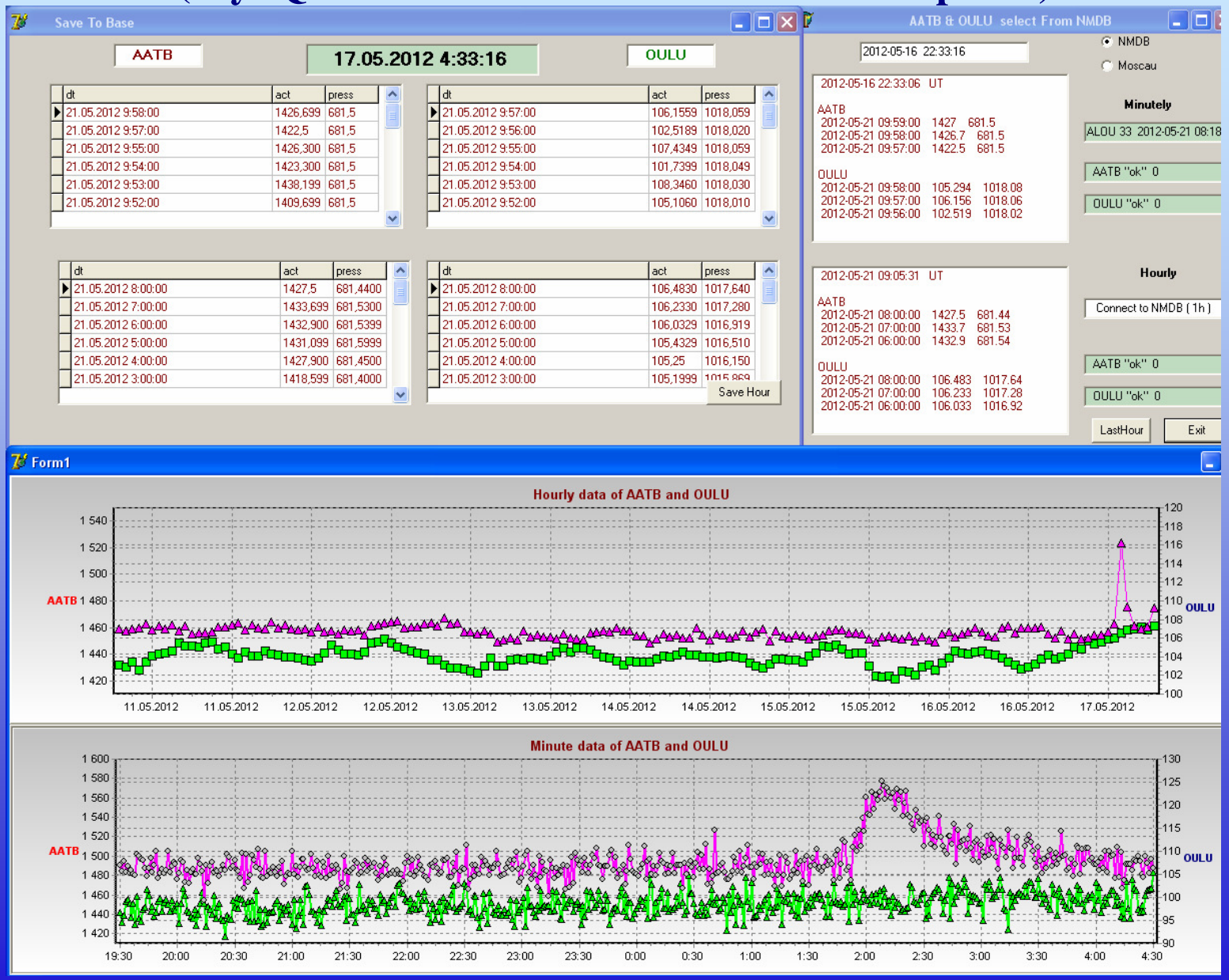
Variations of the Alma-Ata NM 1-min count rate 8 May 1998.

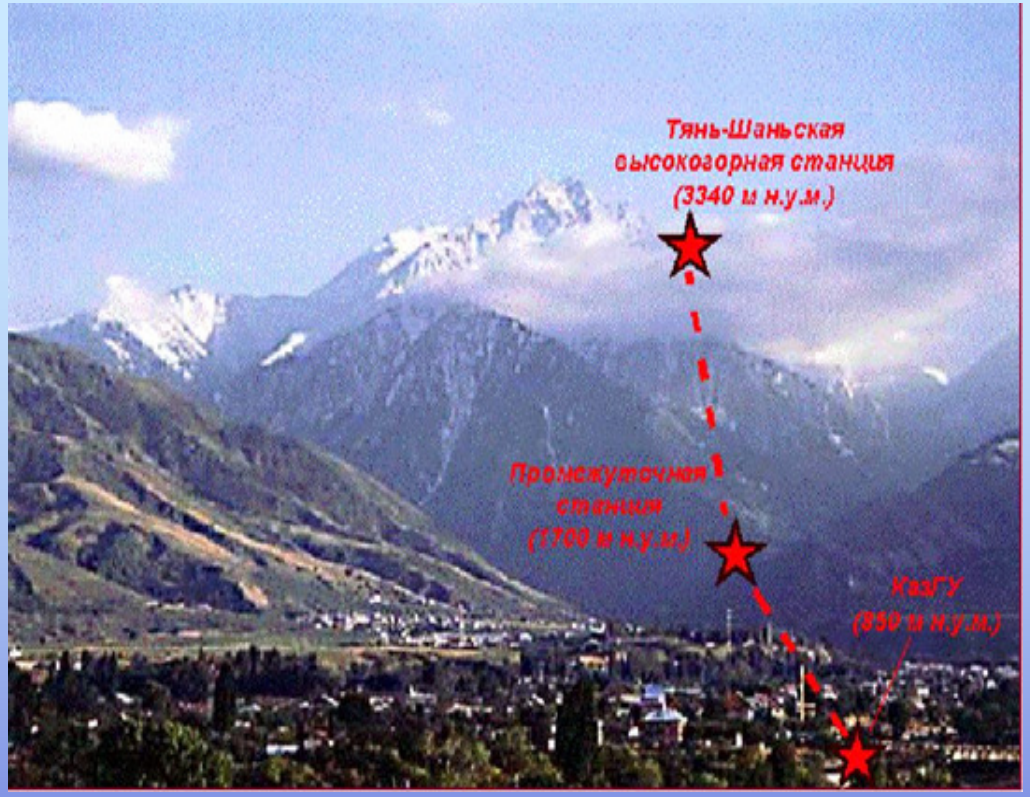


SEARCH FOR SOLAR NEUTRON EVENTS IN ALMA-ATA NEUTRON MONITOR DATA

Proceeding of ICRC, 1999, SH 1.3.05

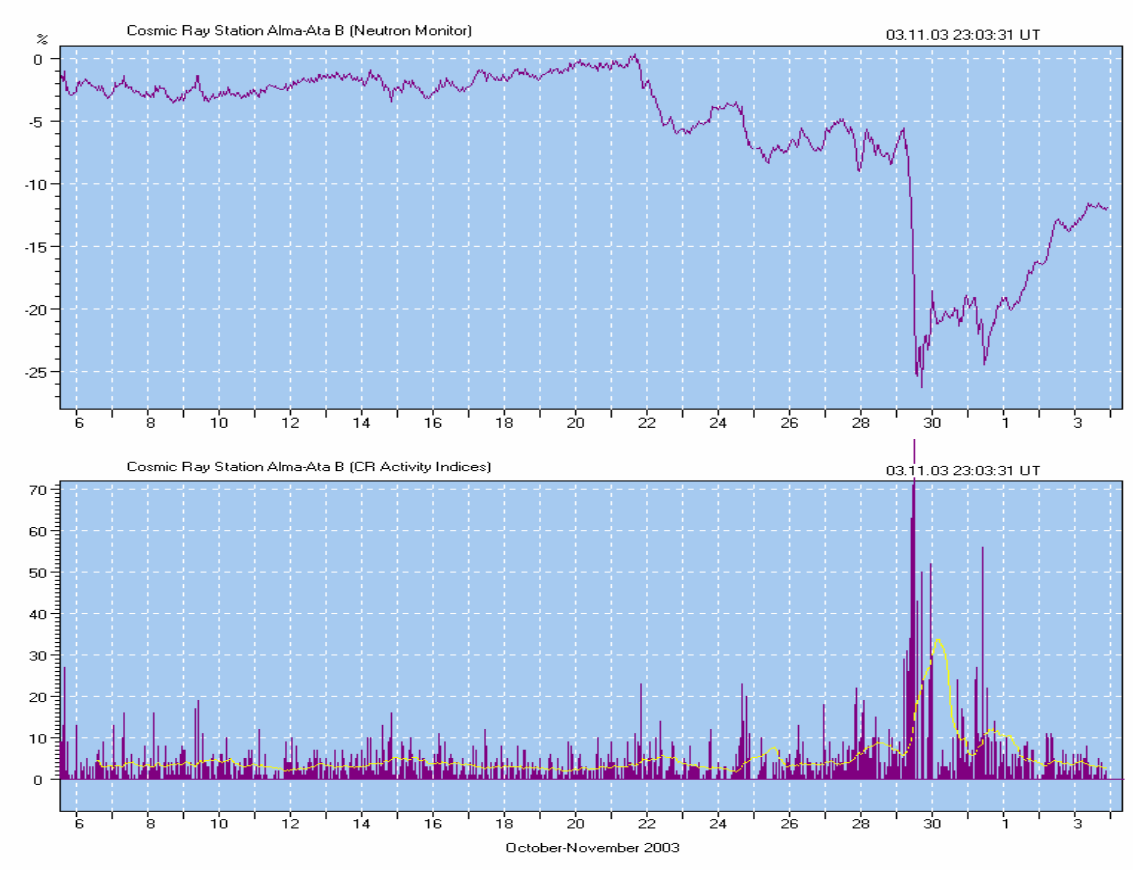
AATB + OULU neutron monitors 1-min data in real time (MySQL database at the Institute of Ionosphere)





In the frame of cooperation between the Institute of Ionosphere (Almaty), the Lebedev Physical Institute of Russian Academy of Sciences (Moscow), the Institute for Physics and Technology (IPT, Almaty) and the Physics Department of the Kazakh National University (KNU) three experimental setups for registration of cosmic ray intensity (neutron monitors) at altitude of 3340, 1750 and 850 m above sea level were integrated in common experimental copmlex, the ATHLET collaboration (Amurina et al., 2005) (http://www.tien-shan.org/she/vardbaccess/index.html) *ATHLET (Almaty THree Level Experimental Technique)*

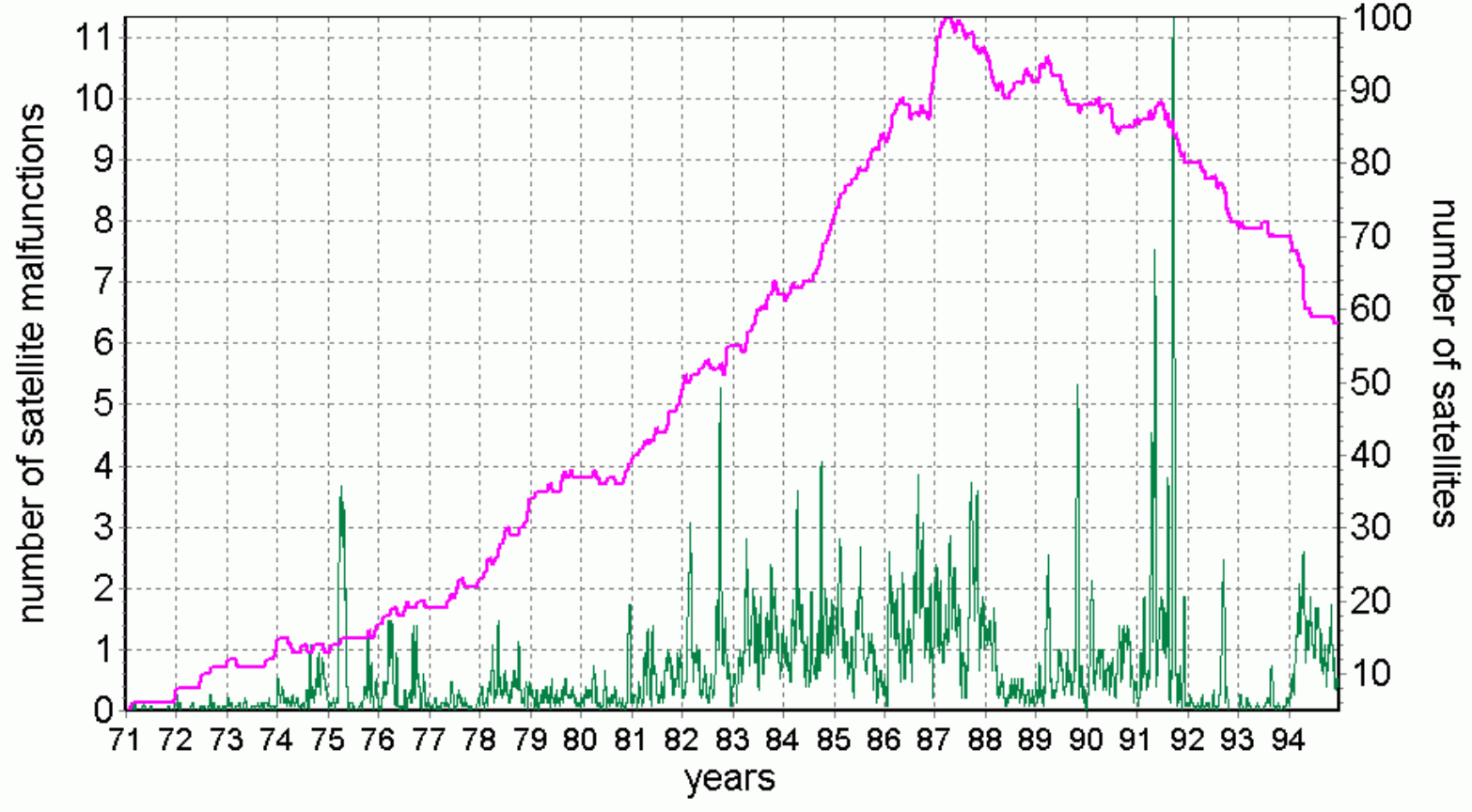
We propose to input cosmic ray activity indices for investigation of space weather disturbances in real time



Variations of cosmic ray intensity.

Cosmic ray activity indices.

Satellite and Anomaly Number



~300 satellites
~6000 satellite malfunctions

INTAS-00-0810 "Improvement of the control and prognosis methods of the periods of dangerous influence of the space weather on satellite electronics".

Satellite malfunction data

The main contribution was from NGDC satellite anomaly database, created by Daniel Wilkinson.

+

"Kosmos" data (circular orbit at 800 km altitude and 74º inclination)

+

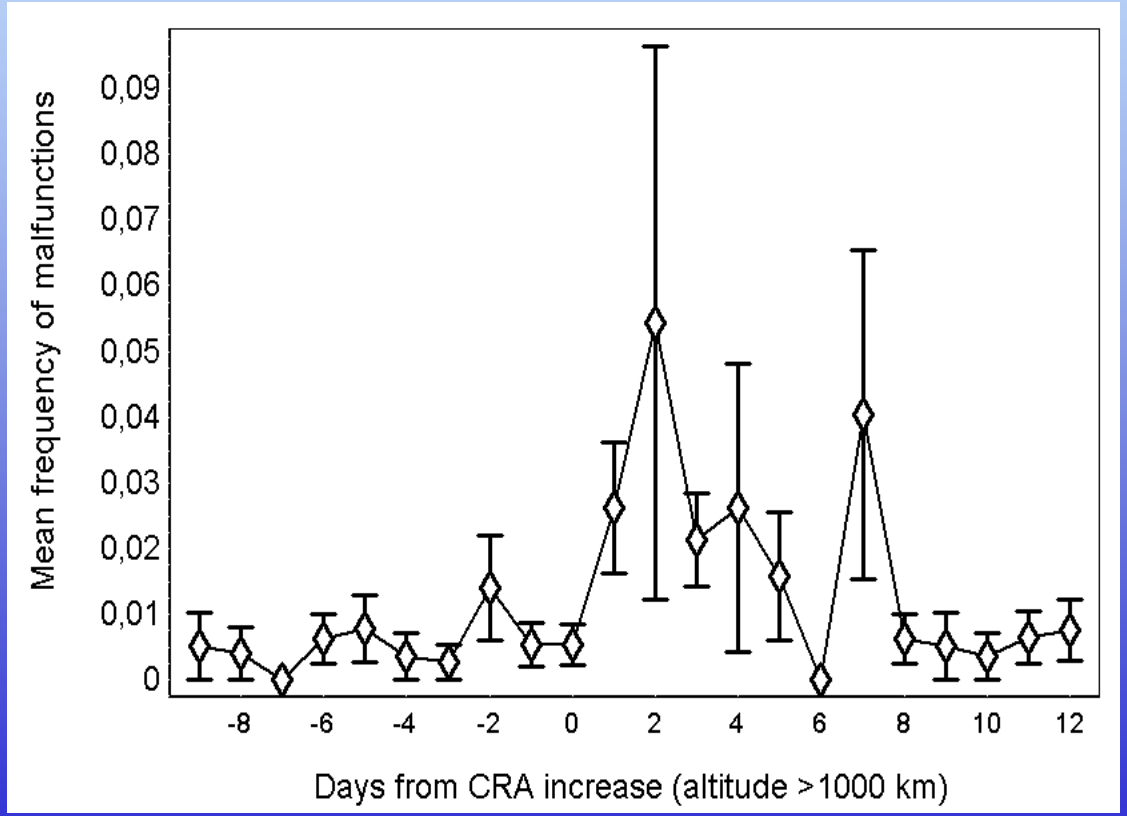
1994 year anomalies - Walter Thomas report (Thomas, 1995).

+ ε

The satellites characteristics - from different Internet sources:
http://spacescience.nasa.gov/missions/index.htm
http://www.skyrocket.de/space/index2.htm
http://hea-www.harvard.edu/QEDT/jcm/space/jsr/jsr.html
http://www.astronautix.com/index.htm

INTAS project 00810, Belov A., Dorman L., Iucci N., Kryakunova O., Ptitsyna N. The relation of high- and low-orbit satellite anomalies to different geophysical parameters.// in "Effects of Space Weather on Technology Infrastructure" edited by I.A. Daglis, Kluwer Academic Publishers, Dordrecht, The Netherlands, NATO Science Series II, 2004, Vol.176, pp. 147-163.

The relation of satellite malfunctions to the behavior of cosmic ray activity indices for Alma-Ata station. We applied the epoch method to our data, choosing day with each of satellite anomalies as zero-day. This figure demonstrates that at the high altitude, just after CRA-index increase, a significant rise of the satellite malfunctions frequency is observed.



Belov A.V., Eroshenko E.A., Yanke V.G., Kryakunova O.N., Nikolaevskiy N.F. International Journal of Modern Physics A.–2005.

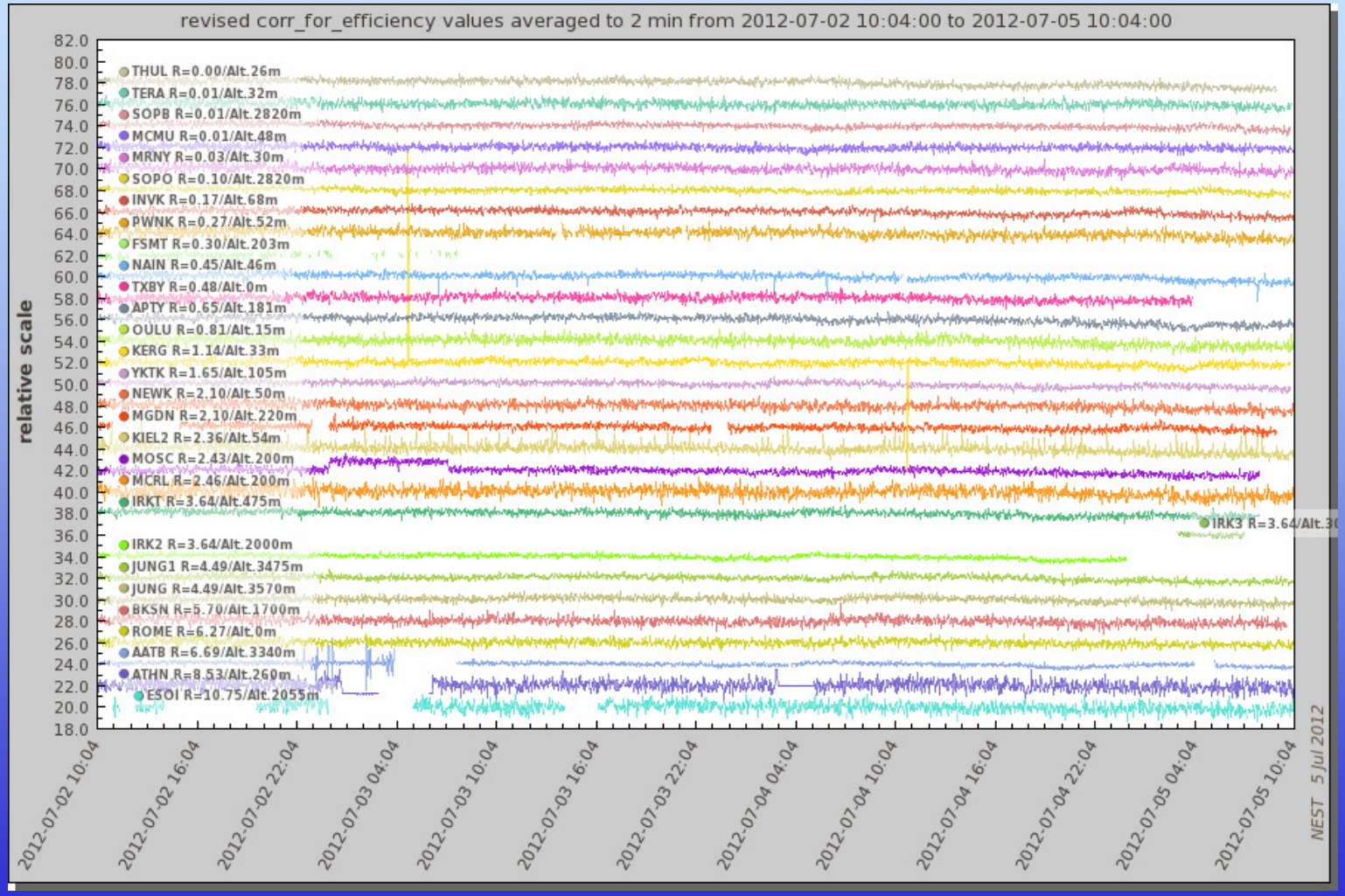
Real Time Neutron Monitor Data-Base (NMDB)

http://www.nmdb.eu

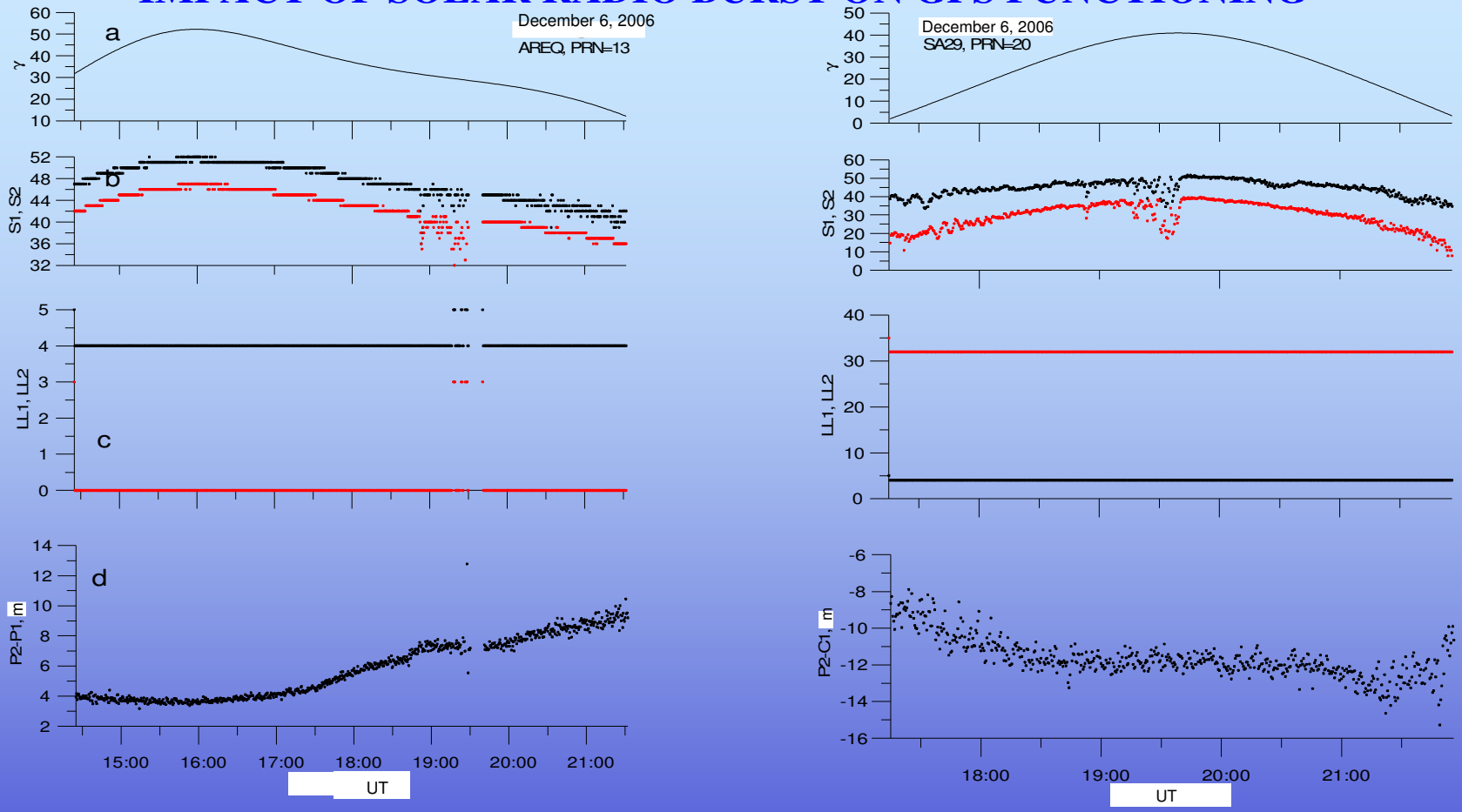
- 12 partners
- 28 NM stations in real-time

Almaty Cosmic Ray station is included in the world-wide neutron monitor network for the real-time monitoring of the space weather conditions and European database NMDB

http://www.nmdb.eu

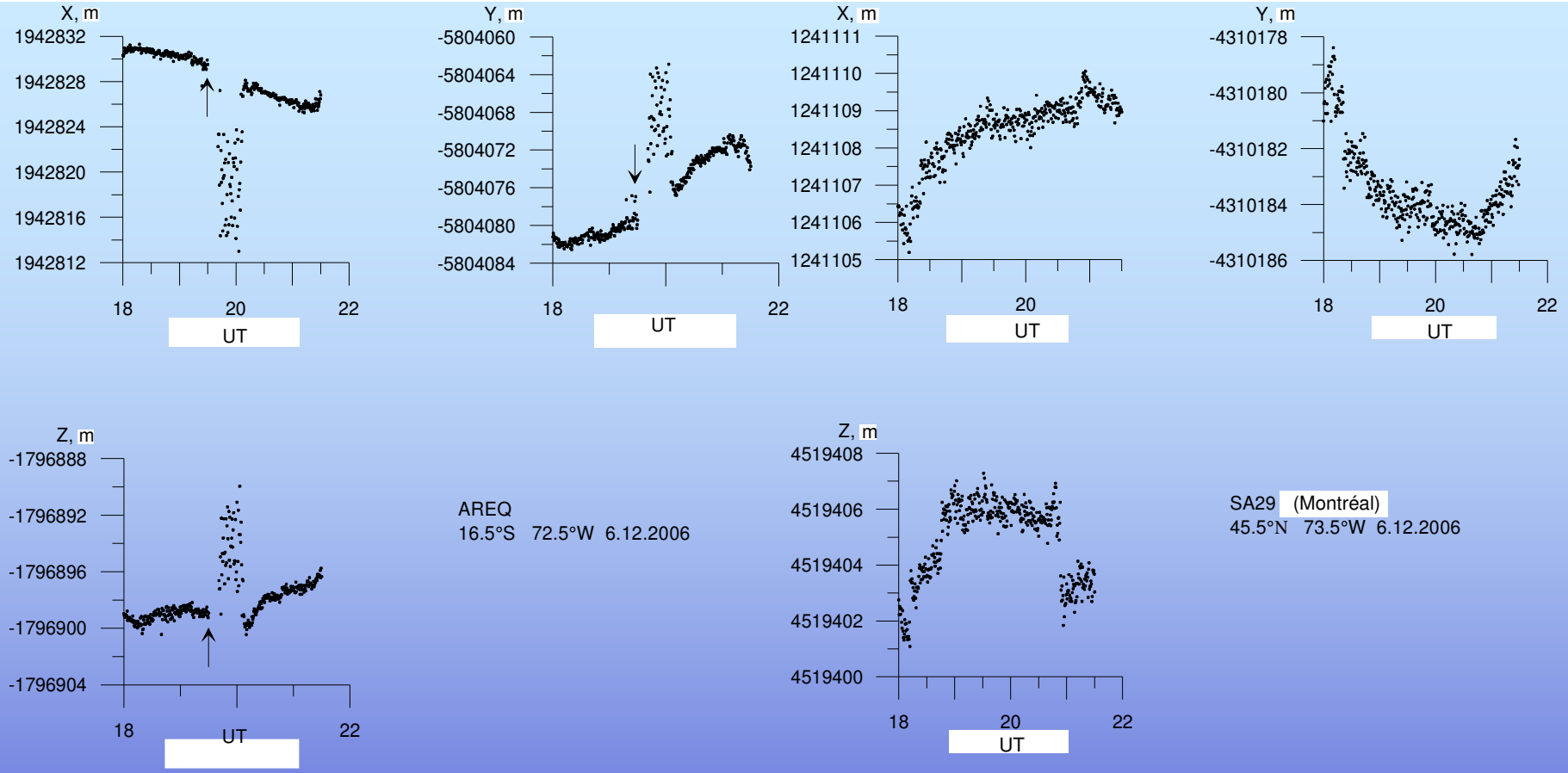


IMPACT OF SOLAR RADIO BURST ON GPS FUNCTIONING

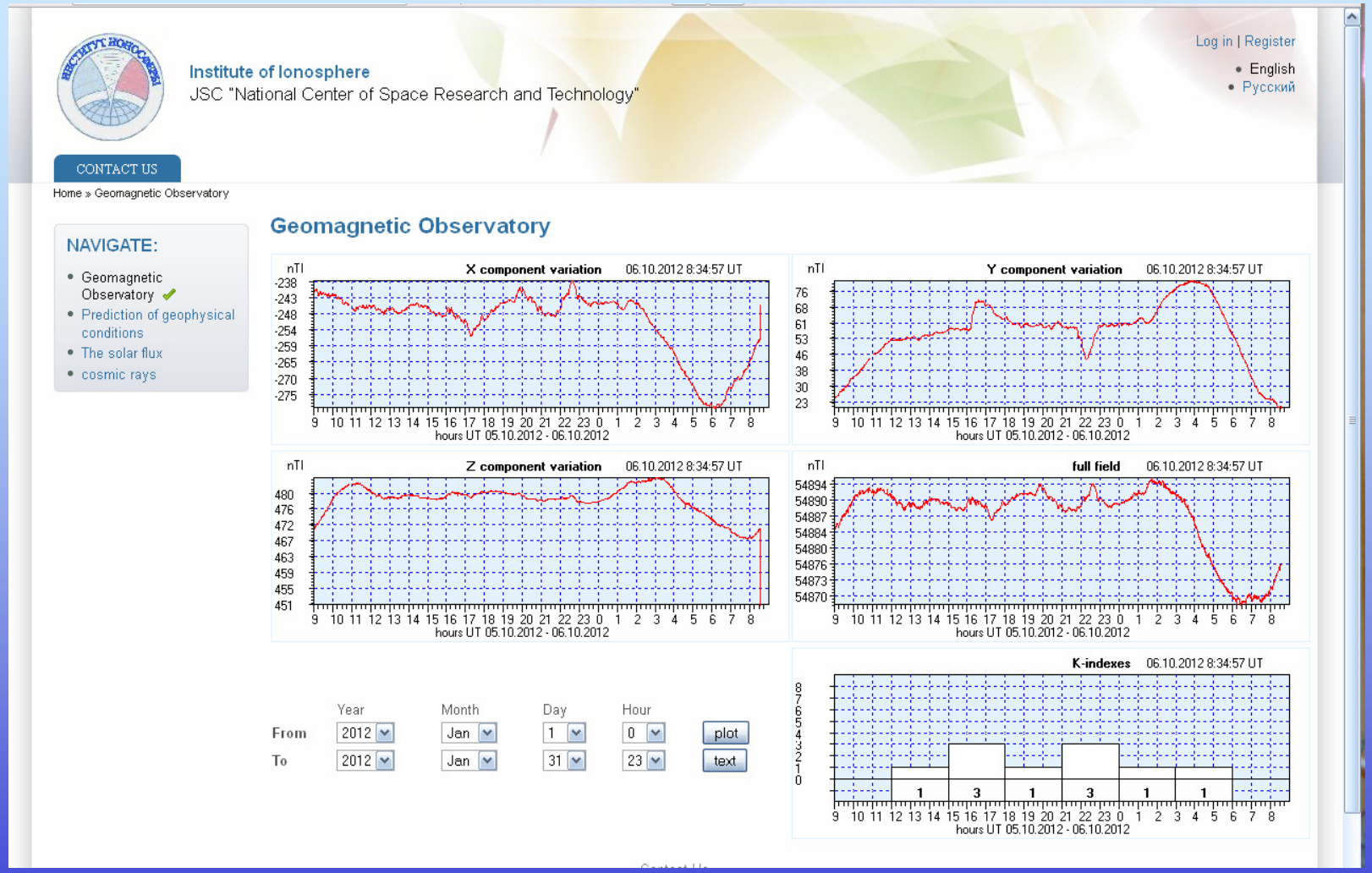


Temporal dependence of the satellites elevation (a), signal strength S1 and S2 for frequencies L1 (black) and L2 (red) (b), Cycle Slips (LL1 and LL2 for frequencies L1 and L2, respectively) (c), and difference of the pseudoranges (P2-P1) (d) for Arequipa (Peru) (left panels) and Montreal (Canada) (right panel).

A. Yakovets, C. Monstein et al. Solar radio burst on December 06, 2006 and GPS functioning. Izvestia of Academy of Science, Kazakhstan, Physics and mathematics, 2012, in print.

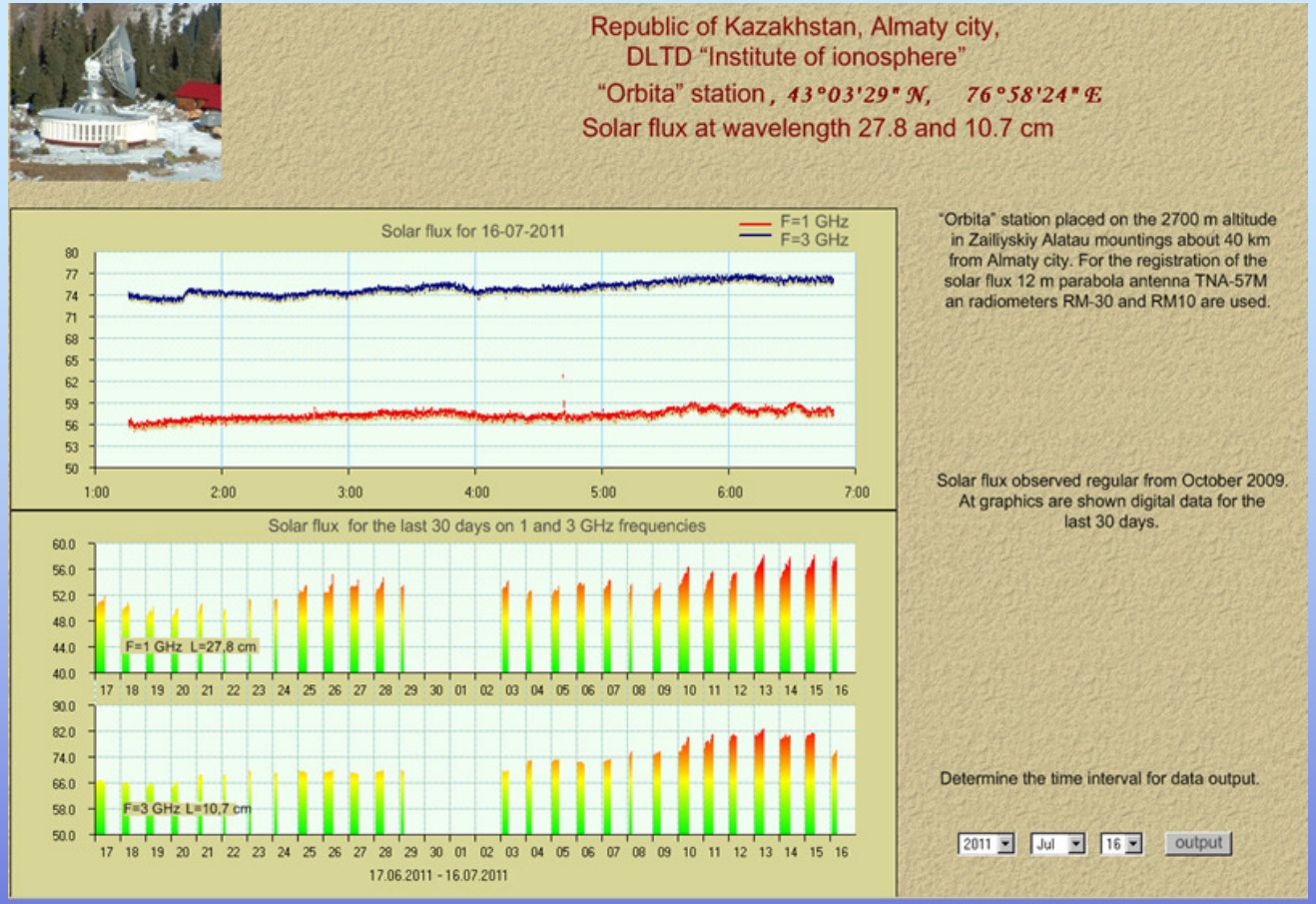


Calculated current coordinates of receivers in the geocentric Cartesian coordinate system for Arequipa (left panels) and Montreal (right panel). Arrows show the beginning of a position outage at 19:30 UT for Arequipa. There is a significant difference in functioning GPS receivers located at sites with the same longitudes but different latitudes during solar radio bursts. A magnitude of the solar radio flux is modulated by the gain of a GPS antenna used. The gain of the antenna for a low elevation of the Sun may be on 9 DB lower compared with the Sun located at zenith. Therefore, the depth of C/No fading during solar radio bursts has to depend on solar zenith angle. For the solar radio burst considered solar zenith angles were 830 and 220 for Arequipa and Montreal respectively. Therefore, a significant difference in functioning GPS receivers located at these sites can be explained on the basis of this reason.



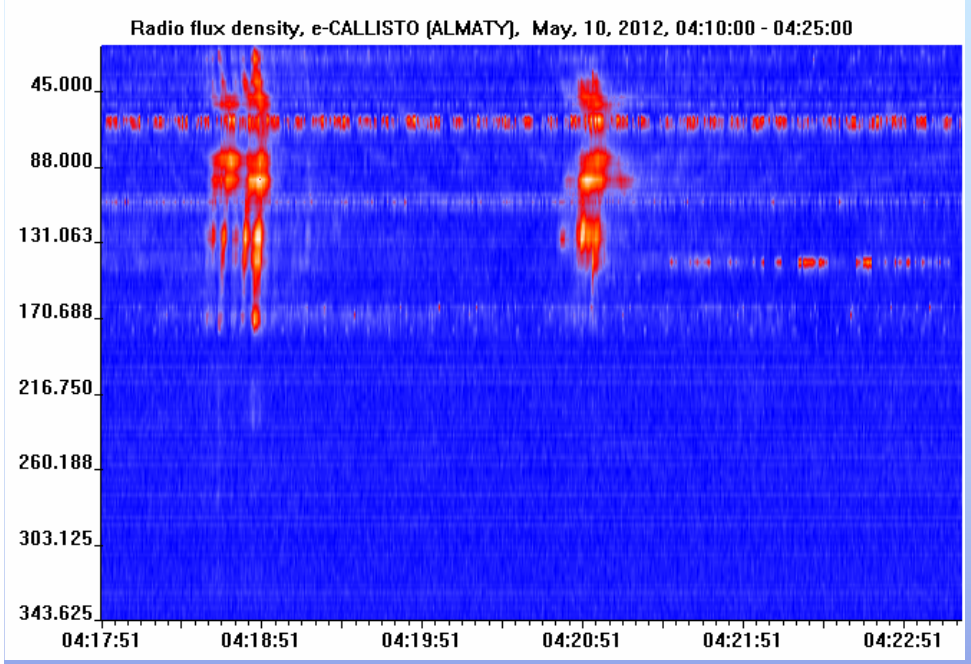
Geomagnetic observatory «Alma-Ata» is included in INTERMAGNET

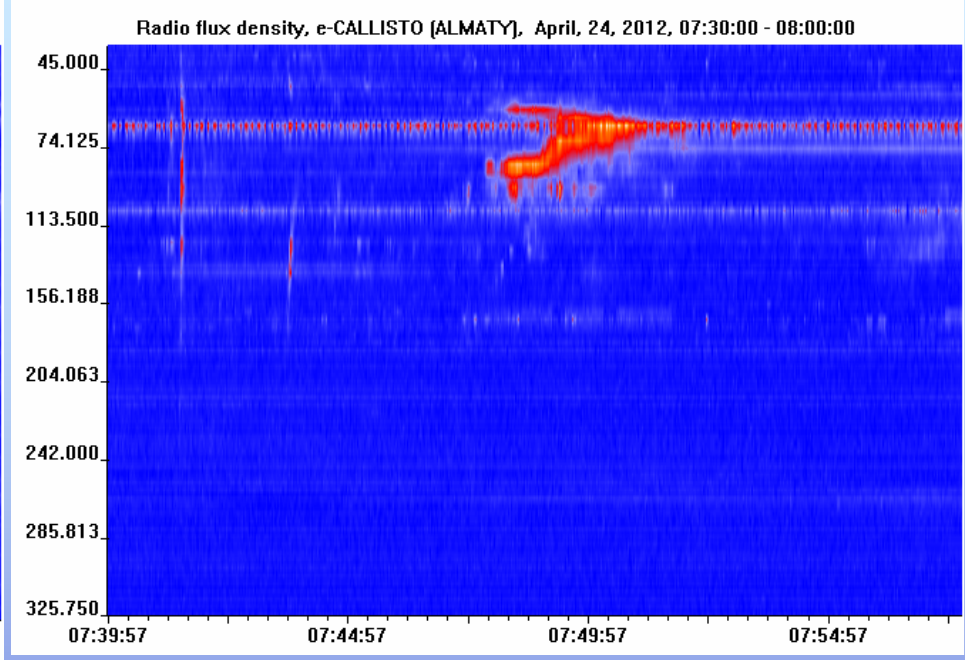
“Orbita” station is situated on the 2700 m altitude in Zailiyskiy Alatau mountings about 40 km from Almaty city at the altitude of 2700 m a.s.l.



The solar flux density at 10.7cm and 27.8 cm wavelengths is measured using fully automated radio telescope. A 12-meter parabolic antenna and radiometers RM-10 and RM-30 are used for measurements.

The two radiometers record solar flux density at 10.7cm and 27.8 cm wavelengths each day for as long as the Sun is above the local horizon. Real time and archival data of solar flux on 1 GHz and 3 GHz are presented on web-site (http://www.ionos.kz/?q=orbita).

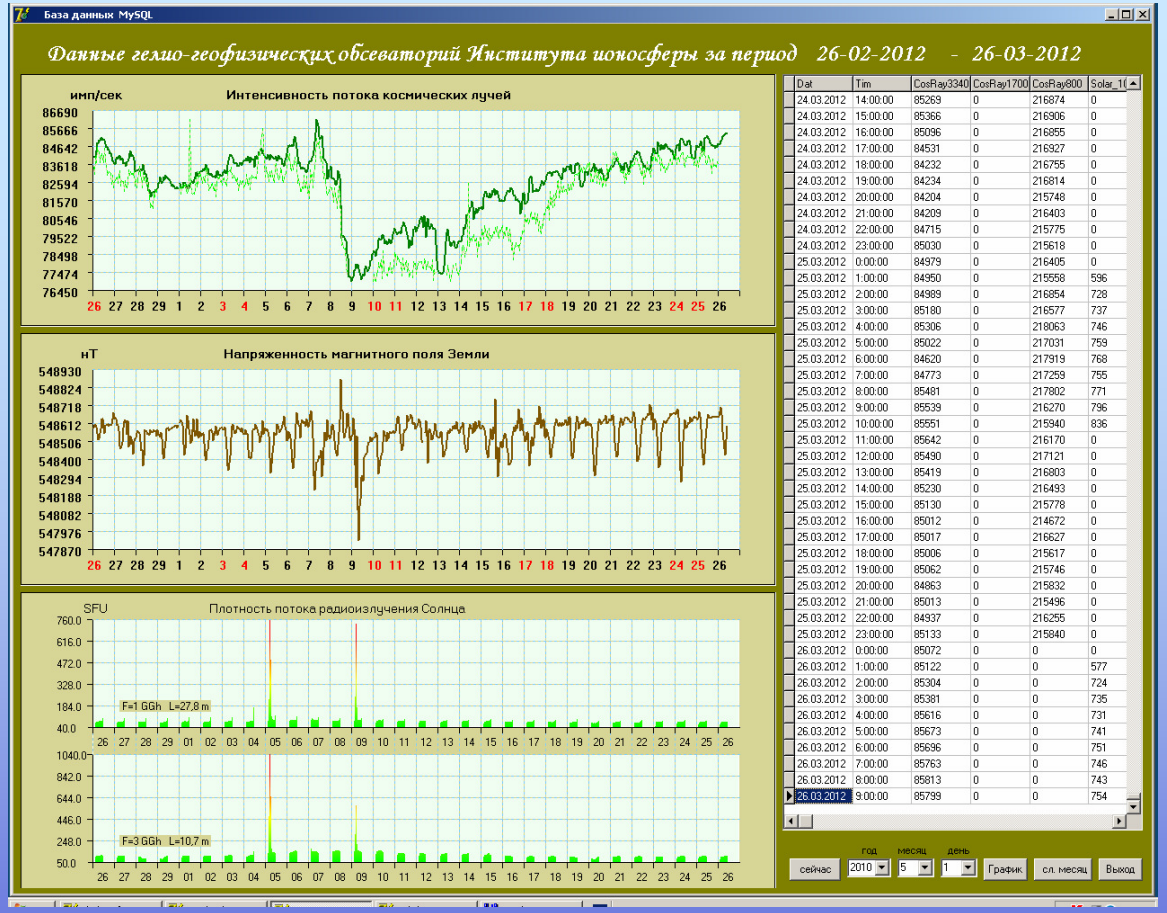




Radio burst of type III recorded on the 10 of May, 2012.

Radio burst of type II recorded on the 24 of April, 2012.

In view of upgrade of the «Orbita» ground regarding new radio astronomical instruments, a measurement campaign was planned and organized between Institute of Ionosphere and ETH Zurich, supported by SSAA. A new Callisto radio spectrometer (eC37) was installed and configured while the «Orbita» ground station.

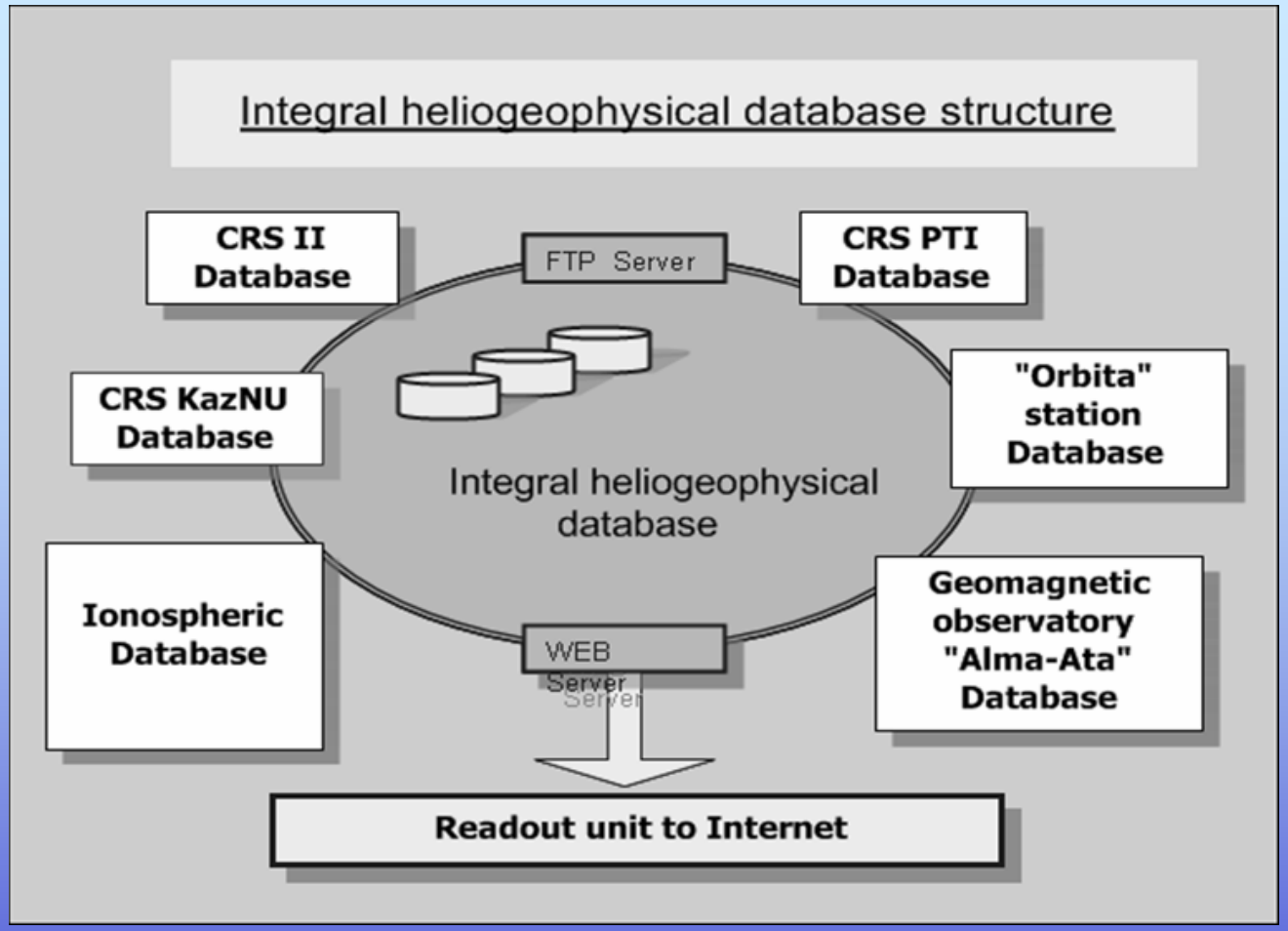


All data are represented on the web-site of the Institute of Ionosphere (www.ionos.kz) in real time.

March, 2012.

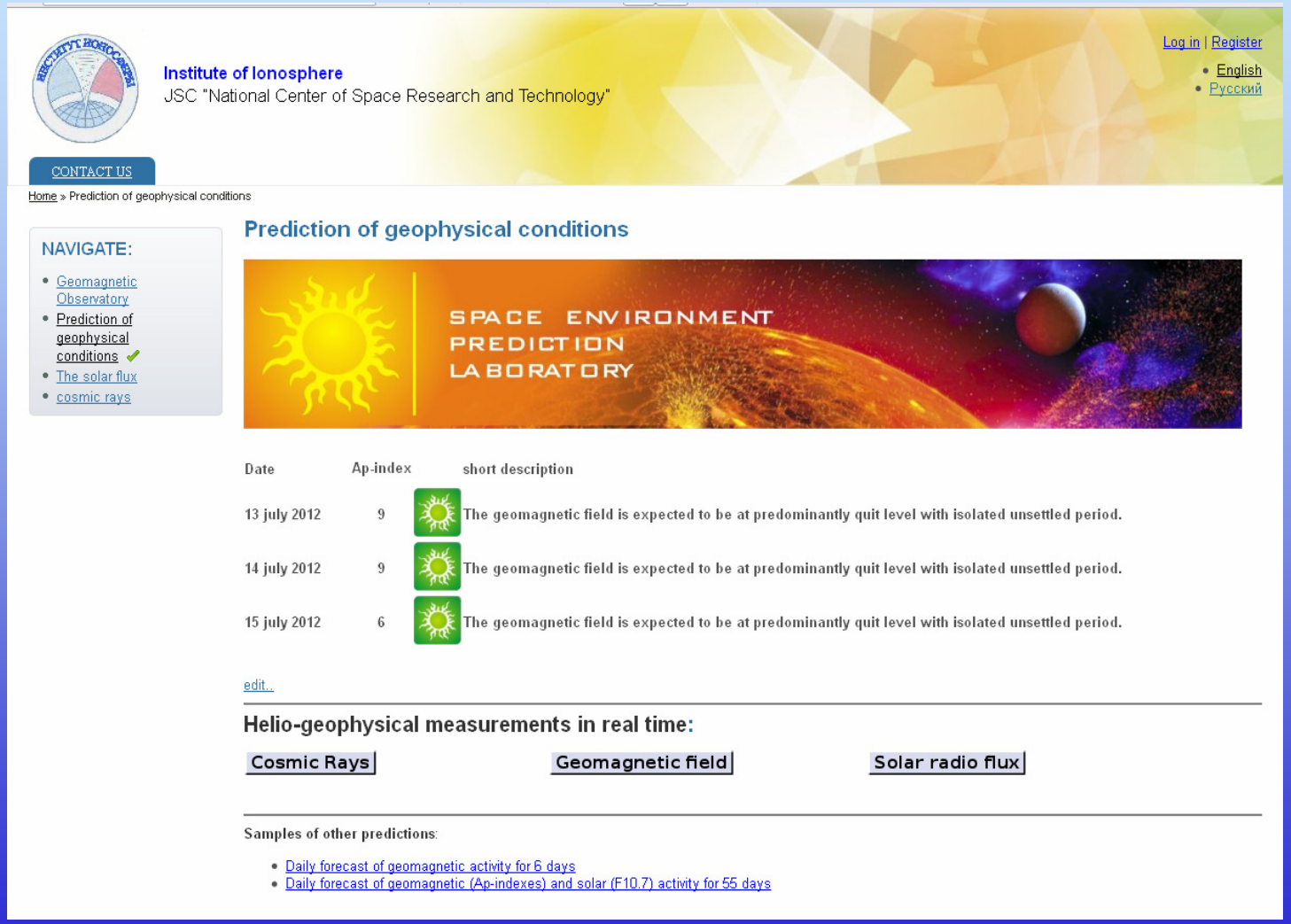
The measurements by means of Kazakhstan experimental complex.

The fine structure of solar flare on 9 of March, 2012 (5-second data)

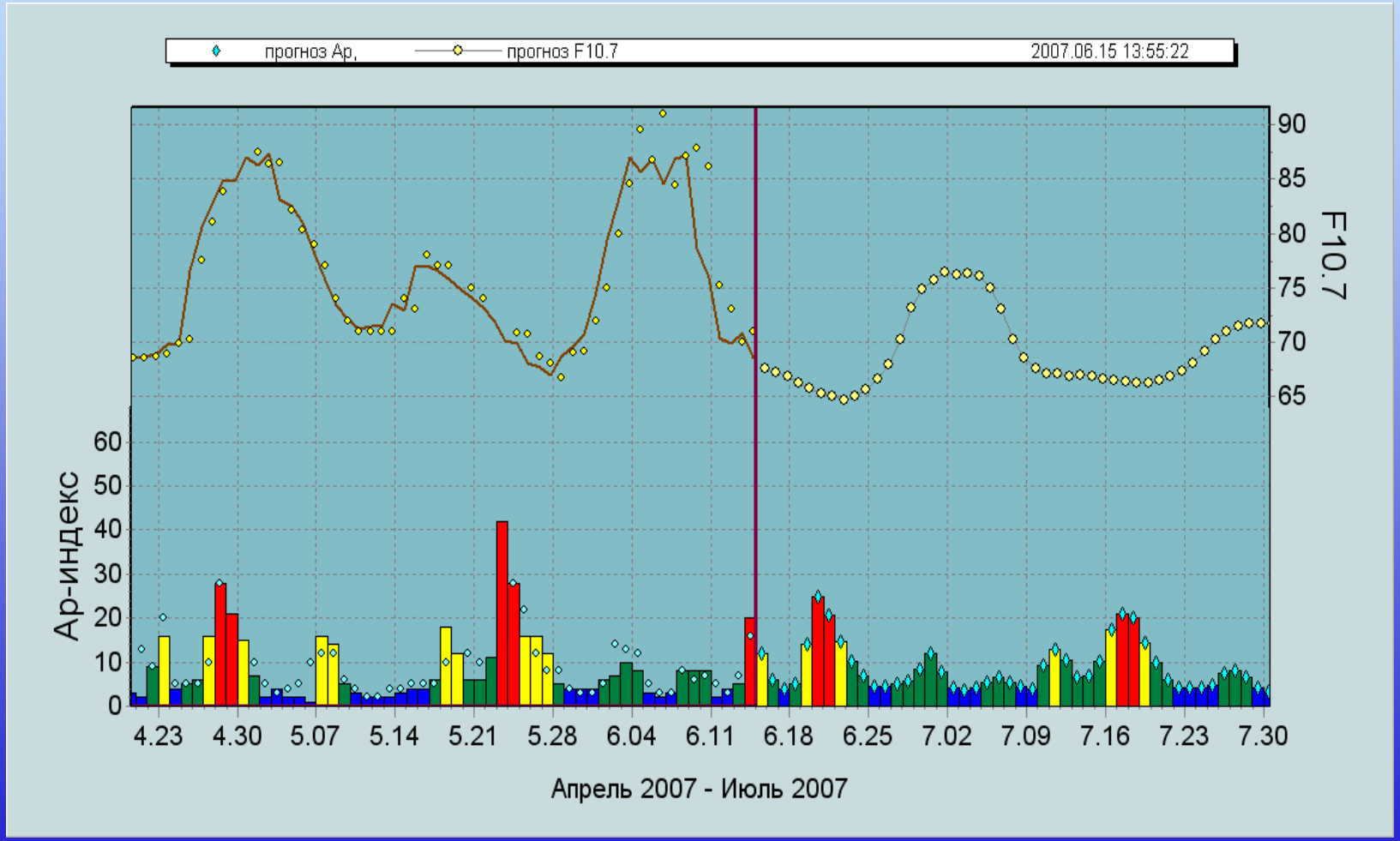


The integral database joints the databases of six geliogeophysical stations. All distributed information system works continuously in an automatic mode.
In the database the information from following installations: the high-mountainous neutron supermonitor 18NM64, (3340 m above see level); the neutron monitor located in KNU (800 m above see level); the neutron monitor located in IPT (1700 m above see level); a geomagnetic observatory "Alma-Ata" located in 10 km from city Almaty; the "Orbita" station located in mountains at height of 2700 m is collected.

Since July, 2006 the space environment prediction laboratory represents the forecast of geomagnetic activity every day on the site (www.ionos.kz/?q=en/node/21).

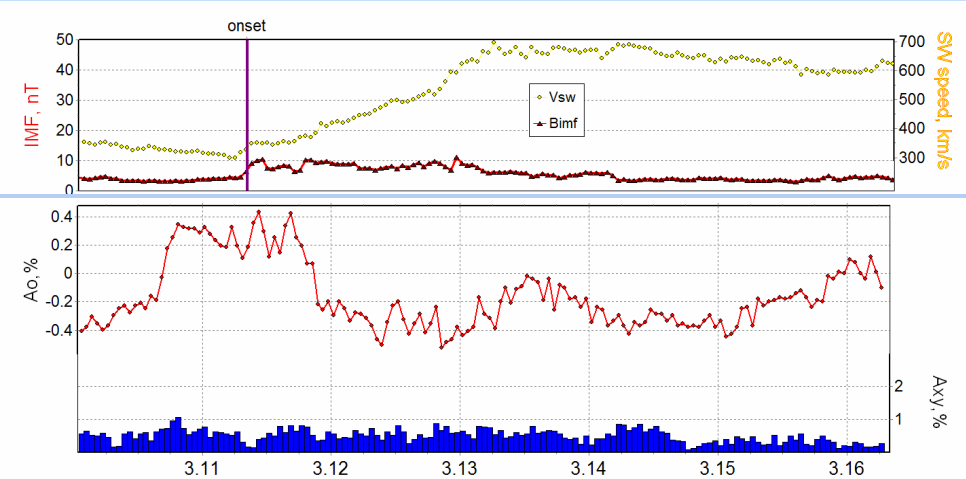


Since July, 2006 the space environment prediction laboratory represents the every day forecast of geomagnetic activity and the solar flux density at 10.7 cm for 55 days.

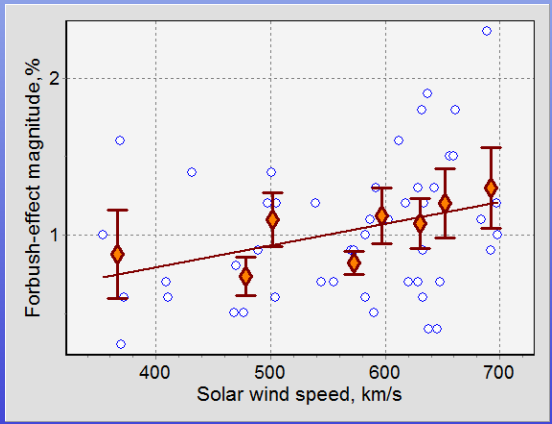


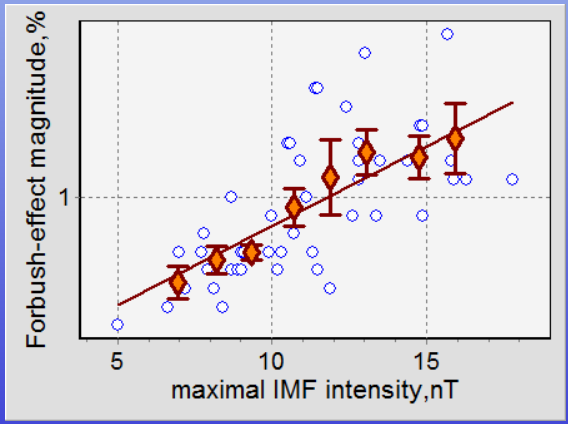
Influence of high-speed streams

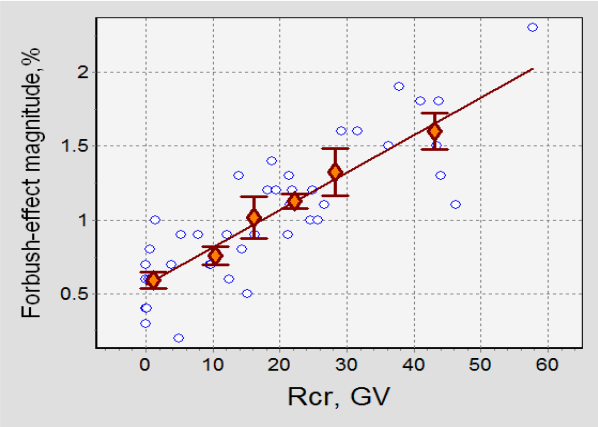
from coronal holes on cosmic ray intensity



Behavior of 10 GV cosmic ray density (A0) and equatorial component Axy of the vector CR anisotropy, and relevant parameters of the interplanetary magnetic field: (IMF) intensity and solar wind velocity, during the March 10-16, 2007.







Dependence of FE magnitude on the maximum solar wind speed, maximum IMF intensity and CR critical rigidity in 2007.

See poster presentation!

Thank you for your attention!

The Big Almaty lake nearby Cosmic Ray Station

and "Orbita" station