ANNUAL REPORT OF ISWI RELATED ACTIVITIES FOR 2016 IN KAZAKHSTAN

Olga Kryakunova, Institute of Ionosphere, Almaty, Kazakhstan, krolganik@yandex.ru

During 2016 monitoring of key parameters for space weather were carried out utilizing Kazakhstan's multi-level system measurements to provide diagnostics of the state of the near-Earth space environment and database updates. Results of space environment monitoring are accessible via the web-site of the Institute of Ionosphere (http://www.ionos.kz/?q=en/node/21) in real time. Kazakhstan's multi-level system measurements include an experimental setup for recording of cosmic ray intensity by using a neutron monitor (high mountain cosmic ray station AATB), a magnetic observatory "Alma-Ata", an optical interferometer called the Spectral Airglow Temperature Image (SATI) instrument for observing emissions of the night sky, an ionospheric sounder, a solar radio telescope for measurements of solar radio flux at frequencies of 1.078 GHz (27.8 cm) and 2.8 GHz (10.7 cm) with 1-second time resolution, and a Callisto radio spectrometer (type eC37) [Kryakunova et al., 2015].

A system for recording variations of the Earth's magnetic field at the "Alma-Ata" Geomagnetic Observatory was created. This is a system which enables remotely controlled re-start of the recording system and the measuring equipment after an interruption.. This system makes it possible to improve the quality of our geomagnetic observations at the "Alma-Ata" observatory [Sokolova et al., 2016].

Features of behavior of high-energy magnetospheric electrons in 1987-2007 were studied. The daily fluence of electrons was selected as the main characteristic of the behavior of electrons with energy > 2 MeV measured by GOES satellites in a geostationary orbit, since it is closely related to malfunctions of satellite electronics. It is shown that the increase of high-energy magnetospheric electrons begin during major interplanetary and magnetospheric disturbances, but the beginning of the electron increases lags by 1-3 days. Significantly increased solar wind speed is observed for 3 days before the beginning of the electron increase, reaching a maximum by the beginning of the electron increase. It is shown that the electron fluence was weakly linked to the level of geomagnetic activity on the same day, but was correlated with the Ap-index of geomagnetic activity observed 2-3 days before. Fluence of high-energy magnetospheric electrons is closely connected with the solar wind speed, especially measured 2 days earlier [Belov, Kryakunova et al., 2016; Belov, Kryakunova et al., 2017].

In the field of research on the ionosphere the electron concentration ($NeF2$) in the midlatitude $F2$ layer of the ionosphere was studied. If ionospheric plasma transfer processes are not taken into account, the electron concentration ($NeF2$) in the midlatitude $F2$ layer of the ionosphere should decrease gradually when there is no solar photoionization source. However, often $NeF2$ enhances at nighttime.

The analysis of the frequency of occurrence of nighttime $NeF2$ enhancements and the distributions of enhancement durations according to data from Almaty station (76°55′ E, 43°15′ N) for 2000–2014, as well as the comparison of the parameters of several very large enhancements recorded simultaneously in Irkutsk and Almaty, showed the following [Yakovets et al., 2016]: 1. There is a pronounced seasonal dependence of the frequency of occurrence of enhancements. The high probabilities of enhancement formation (up to 90%) in January, February, November and December are distribution features that are identical for high and low solar activity. In addition, the rapid decrease in the probability from February to March and the smooth increase from September to December occurs in the same manner. High solar activity is characterized by a distinct maximum frequency in the summer months, whereas low activity is characterized by a minimum frequency;

2. It was shown that, regardless of the level of solar activity, the distributions of enhancement durations have the same features. In winter and autumn, the durations are

distributed over a wide range, with most of the enhancements in the range of 1–5 hours. For the spring and summer months (April–August), the duration of the main part of the enhancement is in the range of 1–2 hours. The comparison of amplitudes of enhancements obtained at Almaty and Irkutsk for the same day showed a high probability that the source of enhancements has significant spatial dimensions.

The accuracy of the new version of the International model of the reference ionosphere (IRI2012) was estimated using seasonal daily distributions of parameters of the maximum of the *F*2 layer of the ionosphere by a comparative analysis of model data and vertical radio sounding of the ionosphere, obtained at the midllatitude station Almaty [Gordiyenko, Yakovets, 2016]. Analysis of IRI2012 model errors showed that the use of it for practical *HF* communications or satellite navigation requires the model to incorporate current data from terrestrial ionospheric soundings. The accuracy of IRI2012 model in terms of the altitude distribution of the electron concentration (*Ne*(*h*)) above the *F*2 layer maximum was estimated by a comparative analysis of model data and the satellite (Alouette-II) sensing of the ionosphere. It was revealed that all the three options provided in the model to describe the *Ne*(*h*) –profile give significant discrepancy with the observed distribution of *Ne*(*h*), which is obviously due to the insufficient description form of *Ne*(*h*).

Kazakhstan Space Weather Prediction Center works daily (http://ionos.kz/?q=en/node/21). We issue short- and long-term forecasts of the magnetic activity (Ap-indexes) and solar activity (F10.7) for 55 days, the forecast of probability of a large proton enhancement for 28 days and the forecast of fluence of magnetospheric electrons with energy> 2 MeV in a geostationary orbit for 28 days, and provide this information to all interested organizations in Kazakhstan.

During the 3rd international school for young scientists from the CIS countries (Problems of physics and astrophysics of cosmic rays, 26^{th} September – 1^{st} October 2016, Almaty, Kazakhstan), the invited talk "Methodological bases of space weather forecasting" was presented by Olga Kryakunova.

References

O.Kryakunova, A.Yakovets, C.Monstein, N.Nikolayevskiy, B.Zhumabayev, G.Gordienko, A.Andreyev, A.Malimbayev, Yu. Levin, N.Salikhov, O.Sokolova, I.Tsepakina. Space Weather Studies Using Ground-based Experimental Complex in Kazakhstan. Sun and Geosphere. 2015. N10/2. P.177-181.

Sokolova O.I., Andreev A.A., Burlakov G.V., Kachusova O.L., Kryakunova O.N., Levin Yu. N, Nikolaevskiy N.F. System of registration of magnetic field of the Earth at the "Alma-Ata" geomagnetic observatory. J. Ind. Geophys. Union. Special Volume-2. 2016. P. 76-79.

Belov A.V., Kryakunova O.N., Abunin A.A., Abunina M.A., Gaidash S.P., Tsepakina I.L. Features of behavior of high-energy magnetospheric electrons in 1987-2007. 25 European Cosmic Ray Symposum. 4-9 September 2016. Torino, Italy. Abstract ID: 49.

Belov A.V., Kryakunova O.N., Abunin A.A., Abunina M.A., Gaidash S.P., Tsepakina I.L. Features of behavior of high-energy magnetospheric electrons in 1987-2007. Bulletin of the Russian Academy of Sciences. Physics, 2017 (in press.).

Yakovets A.F., Gordienko G.I., Zhumabayev B.T., Litvinov Yu.G. Statistical Features of *NmF*2 Enhancements According to Data from the Almaty Station in Solar Cycles 23 and 24. Geomagnetism and Aeronomy, 2016. Vol. 56, No. 3, pp. 311–317.

Gordiyenko G.,_Yakovets A. (2016). Comparison of mid-latitude ionospheric *F* region peak critical frequencies, heights and topside *Ne*(*h*) profiles from IRI2012 model prediction with ground based ionosonde and Alouette II observations. Advances in Space Research (in press.).

Figure 1: Clearing the road to the high altitude cosmic ray station in Kazakhstan.