J. Ind. Geophys. Union (January 2016)
Special Volume-2/ 2016 pp: 76-79

System for Recording Variations of Earth's Magnetic Field at the "ALMA-ATA" Geomagnetic Observatory

O.I. Sokolova, A.A Andreev, G.V. Burlakov, O.L. Kachusova, O.N Kryakunova, Yu. N Levin, N.F. Nikolaevskiy

Institute of the Ionosphere, National Center for Space Research and Technology
Kamenskoe plato, Almaty, Republic of Kazakhstan
olgsokolova@yandex.ru

ABSTRACT

Modern equipment allows recording and monitoring of the geomagnetic field variations in INTERMAGNET Magnetic Observatories with high quality and resolution. However, many INTERMAGNET Magnetic Observatories have various problems of man-made origin that have negative effects on geomagnetic observation: noise in the recorded data or breaks in the record because of hardware or software failures, etc. We present a system, which enables remotely controlled re-start of the recording system after an interruption, applied to the measuring equipment and parameters of measurement of variations of Earth's magnetic field at the "Alma-Ata" geomagnetic observatory. This system makes it possible to improve the quality of our geomagnetic observations.

Key words: Geomagnetic field, Measurement, Recording, Monitoring.

INTRODUCTION

Kazakhstan's first geomagnetic observatory was put into operation in 1963, near Almaty city. From this time the "Alma-Ata" geomagnetic observatory (code IAGA – AAA; geographical coordinates: 43.25ºN, 76.95ºE; geomagnetic coordinates: 34.3ºN, 152.7ºE) began to measure the geomagnetic activity in the Republic of Kazakhstan. At present the observatory produces regular observations of the geomagnetic field in near real time. The observatory uses the following devices: two fluxgate magnetometers (LEMI-008 and LEMI-018) for continuous recording of variations of X, Y, Z components of the geomagnetic field; the DI-flux magnetometer LEMI-203 for absolute measurements of the magnetic declination D and magnetic inclination I; the scalar Overhauser proton magnetometer POS-1 for absolute measurements of total intensity F of the geomagnetic field. The observatory also calculates in real time the local K-index of geomagnetic activity for a quantified description of the disturbances of the geomagnetic field. At present the database of the "Alma-Ata" geomagnetic observatory include: hourly mean values of (H, D, Z) from 1963 to 2009; 1- second data files of (X, Y, Z, F) from November, 2003 up to the present; one-minute data files of (X, Y, Z, F) from November, 2003 up to the present; a local K-index of geomagnetic activity from 1996 up to the present. These data are submitted to the website (http://geomag.ionos.kz) of "Alma-Ata" geomagnetic observatory. In November, 2005 the observatory became a full member of the INTERMAGNET. The INTERMAGNET imposes the strict requirements of quality on each member INTERMAGNET Observatory (IMO) [*Nechaev, 2006, Benoît, 2011, Jankovski and Sucksdorff, 1996*]. Modern equipment allows recording and monitoring of the geomagnetic field variations in IMO with high quality and resolution. However, many IMO have various problems of man-made origin that have negative effects on geomagnetic observation [*Okawa et al, 2007*]. At present AAA commonly faces the problem of noise in the recorded data or breaks in record because of hardware or software failure. We present a newly devised system allowing remote start and control of the measuring equipment and parameters of measurement. We find that this system has improved quality of our geomagnetic observation and minimized data gaps.

REMOVAL OF NOISE IN TOTAL INTENSITY F MEASUREMENTS AT THE "ALMA-ATA" GEOMAGNETIC OBSERVATORY

For measurement and recording of total intensity F of geomagnetic field in the "Alma-Ata" geomagnetic observatory, we have used the POS-1 Overhauser magnetometer. It consists of a sensor and the electronic block, which is connected with the recording personal computer (PC) via the RS-232 interface (Figure 1). The computer is configured to continuously measure the total field intensity, F, at five second sampling rate in automatic mode. The obtained data are processed and transferred to the database for storage.

Longtime use of magnetometer POS-1 has shown that significant noise, commonly of man made origin are also recorded along with signal. The noise is produced from various sources of electromagnetic radiation surrounding the observatory, which interfere with the sensor and power-supply circuits. The main part of noise is due to defects in uninterrupted power supply and electric grounding of the

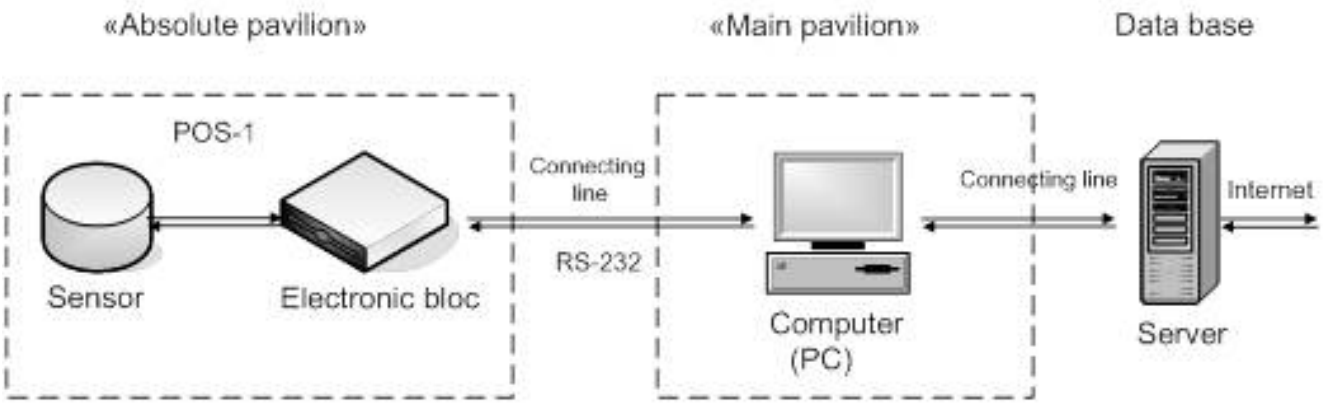

Figure 1. Scheme of equipment connection: distance about 10 m between "Absolute pavilion" and "Main pavilion"; distance about 100 m to Server with data base

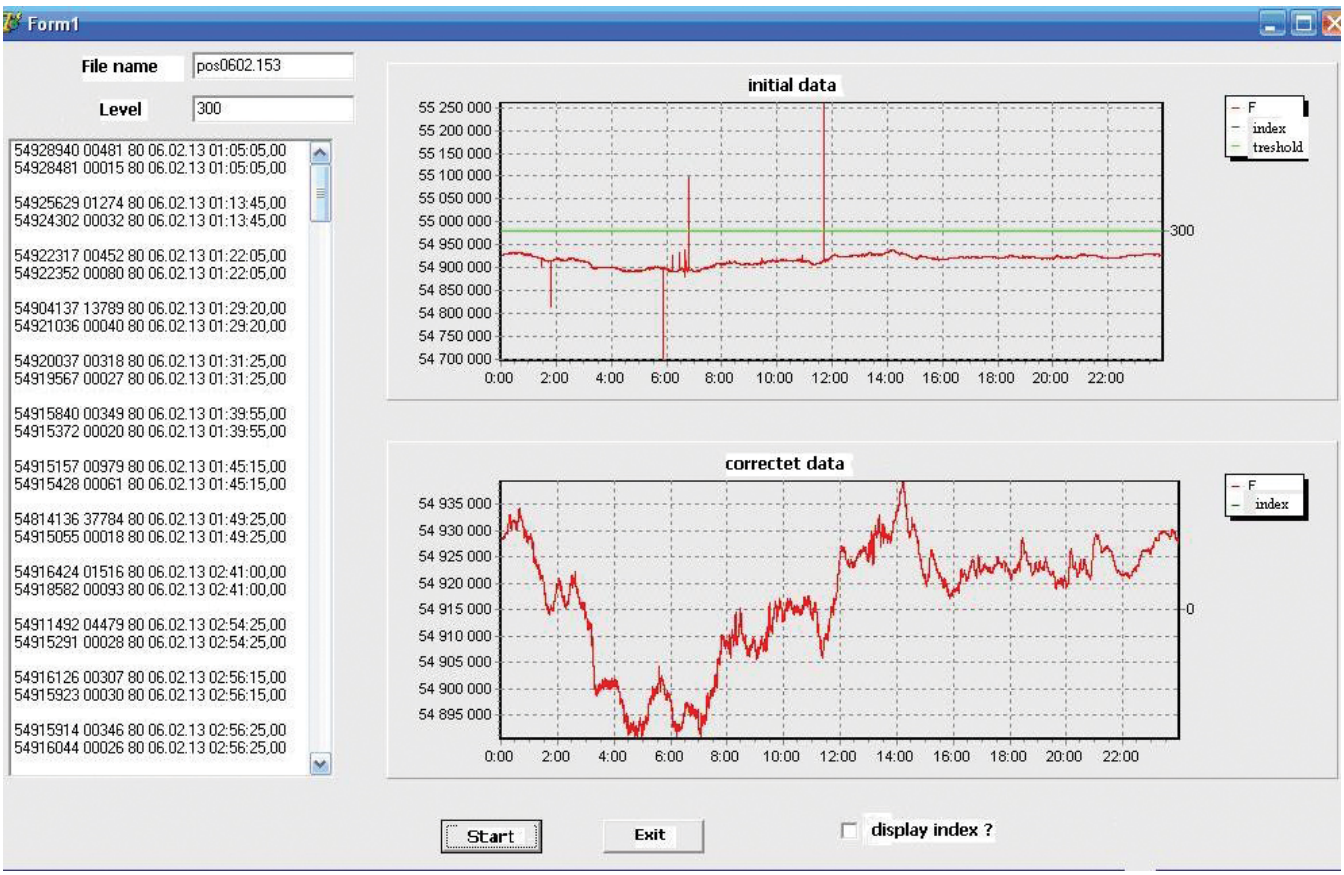

Figure 2. Graphic interface of the program of filtration of pulse noise

equipment, which affect the equipment and cause pollution of recorded data. A program to filter the data is used to remove spikes in the data set. Additionally, the POS-1 calculates the QMC as well. QMC (quality of measurement condition) is a root-mean-square error of determination of frequency of a signal precision, expressed in nT. The magnitude of QMC strongly depends on external noise during measurement. If QMC is a minimum and its value lies within 10-50 pT, noise is practically absent. If QMC is greater than 50 pT, the interferences are non-trivial. If this value is more, the interference is considerable. The filtering program uses QMC values for the analysis of spikes in geomagnetic data. If a spike is detected, the program eliminates it from a dataset and replaces it by the average value. The program works in the semi-automatic mode and is started manually after the process of recording of the daily data file is completed. Then the file with corrected values is saved automatically to the database of the observatory server. The graphic interface for program that filters the data is presented in Figure 2.

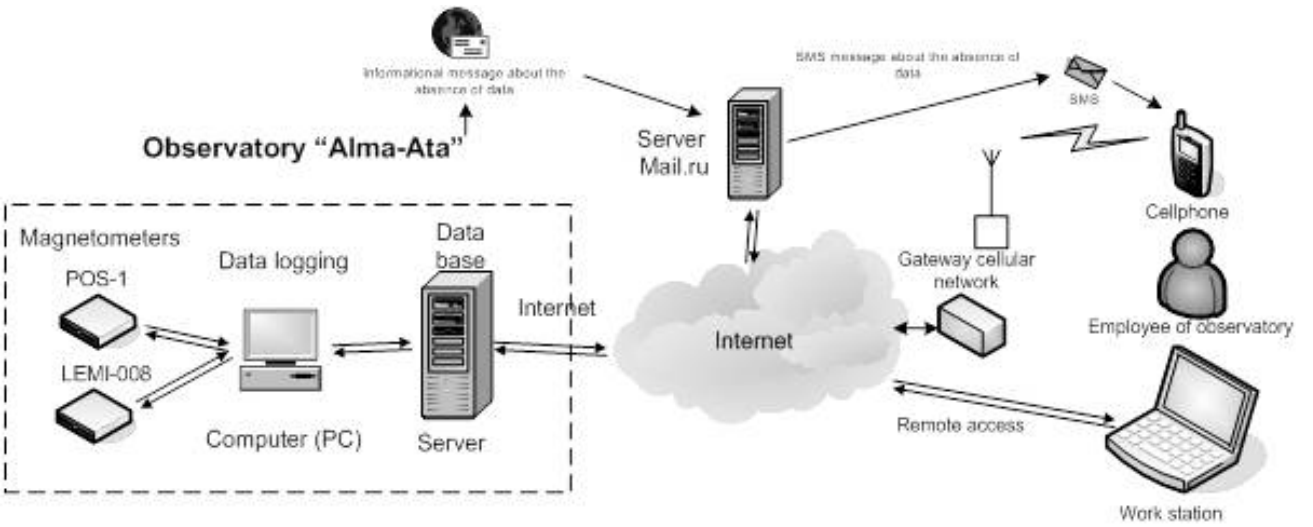

Figure 3. Remote control system

In the upper panel of Figure 2, a daily data array with noise is presented. The lower panel shows the view of the data array, after removal of the spikes. It is possible to filter and process data by starting the program directly on the recording personal computer. Additionally protected remote access to this computer from any other computer is ensured through Internet, which allows initiating the program of filtering remotely for a more efficient data recording process. In case of "hangup" of the software there is also an opportunity to reboot it remotely.

REMOTE STARTING OF DIGITAL MAGNETOVARIATION STATION OF THE "ALMA-ATA" GEOMAGNETIC OBSERVATORY

In the "Alma-Ata" geomagnetic observatory the digital three-component fluxgate magnetometer LEMI-008 is used to record the X, Y, and Z components of magnetic field variations. It consists of the fluxgate sensor and the electronic block, which provide transformation, processing and accumulation of information on variations of geomagnetic field, and, also transfers this information to the recording computer via the RS232 interface. The built-in GPS receiver corrects the time of internal clock. On the recording computer, one-second data of X, Y, Z components of measured geomagnetic field are acquired in the automatic and continuous mode. The obtained data are sent to the server for storage. During operation it became clear that periodically in recording data there are gaps because of hardware failure in the electronic block or owing to "hangup" of the recording software "Lemi Manager". It is possible to restore recording by restarting of the program or the electronic block. It was also noticed that the built-in GPS receiver sometimes loses connection with the satellite, which leads to loss of synchronization with UTC.

To restart the electronic block of LEMI-008, short-term shutdown of the supply voltage (12 volts) is reinstated by triggering a special program written on Delphi 7. The protection program prevents casual starting of reset process of electronic LEMI-008 block. For authorized starting of reset program, the corresponding code is entered in the window of the restarting program by pressing "START" button. This initiates the restarting process of LEMI-008 .

REMOTE CONTROL OF MAGNETOMETERS AND RECORDING SYSTEM AT THE "ALMA-ATA" GEOMAGNETIC OBSERVATORY

The proposed method of remote control of functioning of the equipment of the "Almaty" geomagnetic observatory is based on the information communicated to observatory staff about a break in the geomagnetic data record by means of SMS messages. If the data from the magnetometers POS-1 or LEMI-008 does not come to the database of observatory for more than 10 minutes, the server displays the corresponding information message. The special imagAllert.exe program (written on Delphi7) forms and sends this information message in the form of an e-mail to the special e-mail address on the Mail.ru e-mail server, as in Figure 3.

On the "mailbox" of this address, special settings are made, which allow the Mail.ru resource to form the SMS

message about receipt of the e-mail to this address. SMS comes to the cell phone of the employee of the observatory, who after obtaining the notification about a problem with the data transmission, can remotely access the protected server, using the internet server or the recording personal computer. Further, the staff, in online mode, can find out the reason of the data transmission stop and, if necessary, restart the magnetometer or the software (POS_manager or LEMI_manager). Besides, the software "Remote access" enables restart of the recording computer.

CONCLUSION

The newly designed system allows not only deletion of noise, but also enables continuous recording of the geomagnetic data at the "Alma-Ata" observatory. This process was successfully applied several times during the past year at AAA. Remote restarting also allows operation without coming close to the sensor logger that reduces quantity of electromagnetic interferences and accelerates a restarting process. This ensures reduction of total number of days of lost data. The created system allows re-start and control of the measuring equipment and parameters of measurement of variations of Earth's magnetic field at the "Alma-Ata" geomagnetic observatory.

ACKNOWLEDGMENTS:

This work was performed under the Republican Budgetary Program 055 "Scientific and (or) scientific - technical activity", the subprogramme 101 "Grant financing of scientific researches" within the "Creation of Collecting System of Experimental Geophysical Data on the basis of Modern Information Technologies and Its Use in Research of the Near-the-Earth Space".

REFERENCES

Benoît St-L, 2011. INTERMAGNET Technical Reference Manual. Ver4.6. Edinburg. UK. 2011. pp. 23-26

Jankovski, J. and Sucksdorff, C., 1996. Guide for magnetic measurements and observatory practice// 1996, Warsaw, pp. 87-157.

Nechaev, S., 2006. Guide to stationary geomagnetic observations. Irkutsk: Publishing House of the Institute of Geography SB RAS, 2006, pp. 98-122

Okawa, T., Tokumoto, T., Nakajima, S., Owada, T., Toya T, Muromatsu, F., Kumasaka, N. and Koike, T., 2007. Development of artificial Geomagnetic disturbances monitoring system. Publ. Inst. Geophys. Pol. Acad. Sc., C-99 (398), Warsaw, 2007, pp. 183-188