AEROELECTRICAL CONSTITUENT IN THE DATABASE OF BOROK GEOPHYSICAL OBSERVATORY

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ABSTRACT: The informatization of geomagnetic and aeroelectrical researches stimulated application of digital technologies directly to data logging systems, creation of geophysical databases, with access via Internet. In the report the presentation of air electrical parameters in measuring complex and database of the mid latitude Borok Geophysical Observatory, as an example of effective application of information technologies in monitoring of air electric field and current, is considered. Now Borok Geophysical Observatory (58.03°N, 38.97°E) remains unique mid latitude geophysical observatory in Russia, leading continuous observations of geomagnetic and air electric fields, air electric current and telluric currents, atmospheric pressure pulsations, Doppler sounding of an ionosphere and some meteorological parameters. The measuring complex of an Observatory includes sensors, amplifiers, analog filters, system of a power supply and synchronization. The atmospheric electrical parameters are observable in frequency band 0÷5Hz. The Observatory “Borok” database, including the results of long-term aeroelectrical and geophysical observations, provides to researchers the easy access to the aeroelectrical and geomagnetic data via Internet. So, The Observatory “Borok” database is the effective experimental background to study the atmospheric electricity as an integral part of the Earth’s electromagnetic environment.

INTRODUCTION

The recently discoveries of new phenomena in atmosphere electricity like sprites and blue jets have shown again the need for essentially new approach to appreciate of aeroelectrical processes in the Earth’s environment. It is necessary to develop the long-term ground-based aeroelectrical and geoelectromagnetic observations parallel with satellite experiments. The creation of geophysical databases, including the aeroelectrical data and giving the Internet access to the near real time data, promotes intensification of global aeroelectrical investigations.

The mid-latitude Observatory “Borok” [58.03°N, 38.33°E; L =2.95] had equipped of geophysical facilities for the study of the Earth's electromagnetic environment, global electric circuit, solar-terrestrial relationship. Geomagnetic measurements have been continuously conducted at the Observatory for the last three decades. Aeroelectrical observations started in 1985. Actually, Borok represents a good example of a "geophysical preservation zone" with a low level of man-made electromagentic disturbances, natural background of seismic noise, absence of industrial pollution and stable water regime. The international program of geomagnetic observation (INTERMAGNET) was installed in Borok Geophysical Observatory since 2002.

The digital data logging system was developed in 1997 that allowed creating the database with CD ROM data medium. Since 1999 Borok Geophysical Observatory database is presented in the Internet. Now the Borok Geophysical Observatory database is the complex information system aimed to collect, to store and to use the digital data on geomagnetic and aeroelectrical fields as well as set of meteorological and geophysical parameters. The local data logging network and database web-server provide access to the near real time aeroelectrical and geomagnetic data via Internet.

CONFIGURATION

The Observatory is equipped with an experimental unit for the field digital recording of a wide class of electromagnetic signals. The experimental complex comprises a set of sensors, amplifiers, analog filters, time and acquisition systems (Figure 1). It gives the possibility to record variations in a wide frequency range of the following geophysical fields:

- atmospheric electric field with the help of electrostatic fluxmeter;
- vertical atmospheric electric current by the “current collector” antenna;
- atmospheric pressure by the liquid microbarograph;
- 3-component of magnetic field and total magnetic field by INTERMAGNET geomagnetic station;
- 3-component of magnetic field in network of SAMNET magnetometers;
- 3-component of ULF magnetic field by induction magnetometers;
- 3-component of telluric currents;
- riometric observations of cosmic noise absorption at frequency 32 MHz;
- radio frequency Doppler sounding.

The electrostatic fluxmeter by means “field mill” type is used as a sensor for precise measurements of the atmospheric electric field. A quasi-static electric field is transformed into AC signals by means of periodic
screening/unscreening of the sensor-based electrodes during rotation of the grounded plate. The electrostatic fluxmeter is designed according to the principle of a constant area of the sensor-based electrode. The construction enables increasing of sensitivity by a differential method of the measurement. For calibration of the device, a calibrating plate is used, which is mounted at a fixed distance from the sensor-based electrodes. The electrostatic fluxmeter are installing at flat roof of one-storied building into large equipotential plate. The fluxmeter dynamic range for DC electric field is about 800μV/m, the electric field noise is 0.1V/Hz^{1/2}.

In the atmosphere surface layer the vertical current density is measured using the method of voltage difference at a given stable resistor, connecting the sensor with the ground. The device comprises a current–collecting sensor, amplifier and a block of band–pass filters. The current collector sensitivity is about 10^{13}A/m, the dynamic range is 10^{-13}÷10^{9}A/m.

The \textit{liquid microbarograph} is suitable for the long-term recording of infrasound pressure variations with high sensitivity (~150mV/Pa). The INTERMAGNET geomagnetic station, operating in Observatory “Borok” since 2002, is equipped with fluxgate 3-component vector magnetometer and proton scalar magnetometer, measured the magnetic field with resolution 0.1nT and the sample interval of 1 sec and 1 min respectively. The geomagnetic station is a part of the INTERMAGNET global network (http://www.intermagnet.org), now joining 86 digital geomagnetic observatories in 34 countries over the world. The \textit{SUMNET fluxgate magnetometer} measures 3 components of the Earth’s magnetic field with sampling interval of 1s and resolution 0.1nT. Fluxgate magnetometer is a part of Samnet network (http://samsun.york.ac.uk), operating in the UK, Faroe Islands, Iceland, Norway, Sweden, Finland and Russia. The \textit{induction magnetometer} with linear frequency response of magnetic sensors has been developed for recording the ULF magnetic field. The transformation coefficient of the induction sensor with preamplifier is about 1V/(nT-Hz), the magnetometer frequency range is 10^{-5}÷3Hz, magnetic field noise is 0.5pT/Hz^{1/2}. Geoelectromagnetic set has been supplemented with 3 component \textit{telluric current measurements}, using 300m baseline between lead electrodes and 400m borehole. Threshold sensitivity of geovoltmeter is ~0.01μV/m, band width is 0.001÷5Hz.

\textbf{DATA LOGGING NETWORK}

The data logging local area network (Figure 1) works continuously, providing the data to database in real time. The data logging network includes the basic data logging system, data processing system, data archiving system, database server and the data logging systems of Samnet geomagnetic station and Intermagnet magnetic observatory.

The analog signals from sensors and synchronization signals from high-precision quartz clock AKV-2M come in a main data logging system, with the built-in analog-to-digital converter. Then the raw numeric data are transmitted to data processing computer to format, average, transfer in physical values, create the graphic files with data plots, transfer data and graphic files to the database server. The database server carries out a database storage and Internet access to data via the database web-site (http://geobrk.adm.yar.ru:1352) provide the near real time data to the database.

The \textit{basic data logging system} is equipped with the built-in analog-to-digital converter. The basic data logging computer software gets analog signals from sensors, makes analog to digital converting and stores data in the buffer hard disk directory. Time synchronization provides by timing pulses from the high-precision quartz clocks AKV-2M, with clock rate 10Hz.

The \textit{Intermagnet data logging system} is included to the Intermagnet geomagnetic station. The data logging software gets data from Intermagnet magnetometers and stores hourly data files on the diskette. Time synchronization provides by the separate GPS antenna, the sample rate is 1 second for vector magnetometer data and 1 min for scalar magnetometer data. Daily the stored data are copied to the database server and after that they are sent by e-mail to the Geomagnetic Information Node, located in the Institut de Physique du Globe de Paris, Paris, France.

The \textit{Samnet data logging system} gets data from Samnet magnetometer and stores the hourly data files on the hard disk. Time synchronization provides by the separate GPS antenna, the sample rate is 1 second. Daily data are sent to the database server by the data logging network and after that they are sent by e-mail to the Samnet data server, located in the York University, UK.

The \textit{data processing system} makes processing of raw data, including formatting, averaging, trasferring in physical value. The data processing software creates also the files with graphic data presentation to put them in the database web-site.

The \textit{database server} provides the database storing and access to data via Internet by Geophysical observatory "Borok" server.

The \textit{data archiving system}, equipped with CD ROM recorder, makes monthly raw dataarchiving on the CD ROM, which is the basic database medium.
Figure 1. The experimental complex and data logging network to Geoelectromagnetic monitoring.

DATABASE WEB-SITE

Database web-site (geobrk.adm.yar.ru:1352) is located on the database server. The database description, graphic data representations and the database request forms are presented on the web-site. Note, that the database inquiry processing is executed in real time by database and CGI software.

From the homepage the web visitor can go to the database help, the rules of the road, the database sections related to separate types of data. Now the data on atmosphere electric field, geomagnetic field variations and geomagnetic field ultra low frequency pulsations are open to an easy access. On each type of data the visitor can
look through the graphic data representation, request the data by filling in the interface forms. The requested data are sent to the visitor by e-mail.

The data on aeroelectric field include the hour averaged values of air electric field strength. The monthly plots of vertical air electric field strength with hour averaging are presented to preview data. The examples of aeroelectric field data plots are shown on figure 2.

The database site interface is simple and intuitively clear. Each web-site page has links to all subsections of the current section, as well as to the current section homepage and to the database website homepage. Each sections, related to the separate type of data, has help page, data description page, data request page with fill-out forms and graphic data representation pages. Note, that the graphic data representation pages are generated dynamically by CGI software.

CONCLUSIONS

The goal of aeroelectrical measurement as a part of geoelectromagnetic monitoring device is to create an extensive database for experimental investigations of the global electric circuit. The Geophysical Observatory “Borok” is equipped with the unique experimental complex for aeroelectrical, geomagnetic and radiophysics measurements with high resolution and sampling rate 10Hz. The observatory successfully works in the international networks of geomagnetic observatories (INTERMAGNET and SAMNET). The Geophysical Observatory “Borok” database provides to researchers over the world the easy access to the aeroelectrical and geomagnetic data via Internet.

ACKNOWLEDGEMENTS: The authors would like to thank Dr.D.Milling from University of York (UK) and Dr.J.Bitterly from Institut de Physique du Globe de Paris (Paris, France) for their help in progress of magnetic field measurements at the Observatory. The development of Geoelectromagnetic monitoring set and Geophysical observatory “Borok” database is supported by the Russian Foundation for Basic Research (grant # 02-07-90107).

REFERENCES

