REal-time COsmic Ray Database (RECORD)

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Abstract

In this paper we present a first distributed REal-time COsmic Ray Database (RECORD). The aim of the project is to develop a unified database with data from different neutron monitors collected together, in unified format and to provide a user with several commonly used data access methods. The database contains not only original cosmic ray data but also auxiliary data necessary for scientific data analysis. Currently the database includes Lomn.Stit, Moscow, Oulu; Tixie Bay, Yakutsk stations. The main database server is located in IKFIA SB RAS (Yakutsk) but there will be several mirrors of the database. The database and all its mirrors are updated on the nearly real-time (1 hour) basis. The data access software includes WWW-interface, Perl scripts and C library, which may be linked to a user program. Most of frequently used functions are implemented to make it operable to users without SQL language knowledge. A draft of the data representation standard is suggested, based on common practice of neutron monitor community. The database engine is freely distributed open-sourced PostgreSQL server coupled with a set of replication tools developed at Bioengineering division of the IRCCS E.Medea, Italy.

1. Introduction

At present data from many neutron monitors are available via Internet as real-time data plots. While graphical representation of data provides quick and convenient description of the situation for a human, it's not usable for numerical analysis. Numerical data are also presented on the Internet, but by much smaller number of stations. Present interest to space weather forecasts require cosmic ray data to be taken into consideration as far as cosmic rays themselves are treated as

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significant component of interplanetary medium. As it was stated in [1] data from several stations should be used in analysis in order to extract more information from cosmic ray data.

The Tixie Bay cosmic ray (CR) station operated by the Institute for Cosmophysical Research and Aeronomy had an automated system for data registration, processing and diagnostics of interplanetary disturbances since early 1984 [2]. Now we have a new data registration and storing system for several stations, presented on the web site of the Yakutsk Space Weather Group, where not only graphics, but also numerical data are shown and are available for downloading. The usage of data in space weather forecast tasks requires a kind of application programming interface (API) to the database in order to give researchers an instrument for data access from their programs. The first attempt to implement such a facility for our database was made during last years [3,4].

An on-line analysis of ground based cosmic ray data is of great interest nowadays for the purpose of monitoring and forecasting of the space weather conditions [5]. Currently, only data of individual cosmic ray stations are available on-line electronically. Large databases such as world data centers cannot be considered as working in on-line regime. Here we present the first distributed REal-time COsmic Ray Database (RECORD) which aims to provide an electronic database of cosmic ray data in on-line. The database includes also all auxiliary (technical, housekeeping as well as meteorological) data needed for the data analysis. Currently, the database includes five high- and mid-latitude stations: Lomnicky Stit, Moscow, Oulu, Tixie Bay and Yakutsk, and more stations will be added in the future. The main server of the database is maintained by IKFIA SB RAS (Yakutsk) but there are also mirrors of the database in Moscow and in Oulu. The RECORD database provides a user with full service including interfaces at different levels and built-in functions.

2. RECORD Database

From point of view of database theory the most "pure" way to achieve this goal would be the creation of a distributed database in the strict sense of the term [6]. However, we've choose more practical approach based on replication.
At present the database is supported by three Linux servers with PostgreSQL relational database management system located in Yakutsk, Moscow and Oulu. Each server supports it's "own" dataset, produced by contributing CR stations and a copy of "foreign" datasets, automatically replicated from the other servers. We use the replication software *pgReplicator*, developed at Bioengineering division of the IRCCS E.Medea [7]. The content of all the three database servers is synchronized once per hour, so users may choose the nearest server to work with. The standard dataset corresponding to a certain station includes 1-minute neutron monitor count rates and atmospheric pressure.

The 1-minute neutron monitor data records contain the following fields:

Name	Type	Description
dt	timestamp with time zone	The start time of measurement interval
ur	float4	Uncorrected count rate. Updated nearly in real-time regime, typically once in 5 min.
cr	float4	Automatically corrected for pressure count rate. Updated simultaneously with ur
vr	float4	Pressure corrected count rate verified by responsible investigator. Updated with significant delay after manual inspection.

Tables with 1-minute atmospheric pressure data contain the following fields:

Name	Type	Description
dt	timestamp with time zone	The start time of measurement interval
p	float4	Atmospheric pressure, mb. Updated nearly in real-time regime, typically once in 5 min.

The Moscow CR station also performs 1-min measurements of temperature, humidity and wind speed.
The averages over larger time intervals are represented by virtual tables (views) corresponding to 5-, 10-, 15-, 20-, 30- and 60-min, 1 hour, 1 day and 1 Bartel's rotation data.

3. Data access

The Web-based interface allows to browse data plots and download data in ASCII format.
We also provide a library for data access directly from programs written in different programming languages - C, Fortran and Pascal. Functions in this library implement most commonly used types of queries to the database server and return data in binary format directly into the calling program's memory. User is not supposed to be familiar to SQL language. This way of data retrieval is very useful for creating programs running automatically, for example, in monitoring and forecasting tasks.
WWW interfaces to the database and detailed information might be found at
http://ikfia.ysn.ru/ipm,

http://cosmos.izmiran.rssi.ru,
http://cosmicrays.oulu.fi.

4. Conclusion

We have presented the first distributed real-time cosmic ray database (RECORD) which provides a user with the full access to cosmic ray data from different neutron monitors. This database can be used for on-line monitoring and short-term forecasting of the space weather conditions.

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5. References

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