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On-Line Database of Cosmic Ray Intensities*

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*To the memory of the late NM station manager Hannu Kananen

Abstract. Cosmic ray measurements in Oulu (65.05^o N, 25.47^o E) started in 1964 with a standard 9-NM-64 neutron monitor. The 9-NM-64 neutron monitor consists of three independent units, each made of three proportional gas counters. The local vertical geomagnetic cutoff rigidity is about 0.8 GV. The neutron monitor (NM) in Oulu is one of the most stable and reliable stations of the World Neutron Monitor Network. We have recently launched a web service of the Oulu NM data. All data on cosmic ray intensity as recorded by the Oulu NM since 1964 are available in a searchable on-line database at the URL:

$$http://cosmicrays.oulu.fi$$

The database contains 1-min resolution data since 1995, 5-min resolution data since 1985, and hourly data since 1964, as well as the full information about the reliability and stability of the recorded cosmic ray intensities. Besides, 10-sec uncorrected data are available since 1990 upon special requests.

1 Introduction

Oulu neutron monitor (NM) is situated in Northern Finland (65.05^o N, 25.47^o E). The local vertical geomagnetic cutoff rigidity is about 0.8 GV. The neutron monitor in Oulu is one of the most stable and reliable stations of the World Neutron Monitor Network. The Oulu cosmic ray station belongs to Sodankylä Geophysical Observatory which is a part of the University of Oulu. Cosmic ray measurements in Oulu started in 1964 with a neutron monitor which consists of nine standard NM-64 proportional gas counters organised in three independent units (called A, B and C) of three counters each. Since the very beginning in 1963 and until December 1999, the station was managed and maintained by Hannu Kananen who untimely deceased in March 2000. Since January 2000, the Oulu NM is managed by Ilya Usoskin who substitutes in this position Kalevi Mursula.

In this paper we present a full-access on-line database of cosmic ray intensities as recorded by Oulu neutron monitor. The database and the web-page were launched in late November 2000. All data on cosmic ray intensity as recorded by Oulu NM since 1964 are available in a searchable on-line database at the URL:

$$http://cosmicrays.oulu.fi$$

The database contains 1-min resolution data since 1995, 5-min resolution data since 1985, and hourly data since 1964, as well as the full information about the reliability and stability of the recorded cosmic ray intensities. Besides, 10-sec uncorrected data are available since 1990 upon special requests.

2 Main page

Everyone visiting the above mentioned Oulu Nm database web-site sees first the main page whose screenshot is shown in Fig. 1. The main page of the database consists of six fields.

A: Header contains a menu (will be described in the following section) and links to the Oulu Cosmic Ray station, University of Oulu and Sodankylä Geophysical Observatory web pages. Similar menu is located in the bottom of the page.

B: Current data field presents Oulu NM pressure corrected count rate for the last 24 hours with 5-minute time resolution and for the last 30 days with 1-hour time resolution. This plot is automatically updated every hour.

C: Database field is an online request form for the Oulu cosmic ray database and will be discussed later in details.

D: Solar/geomagnetic status field shows the current status of solar and geomagnetic activity according to NOAA and contains a link to the NOAA current solar/geomagnetic indices web-site.

E: Links to other cosmic ray stations, world data centers and other related sites.

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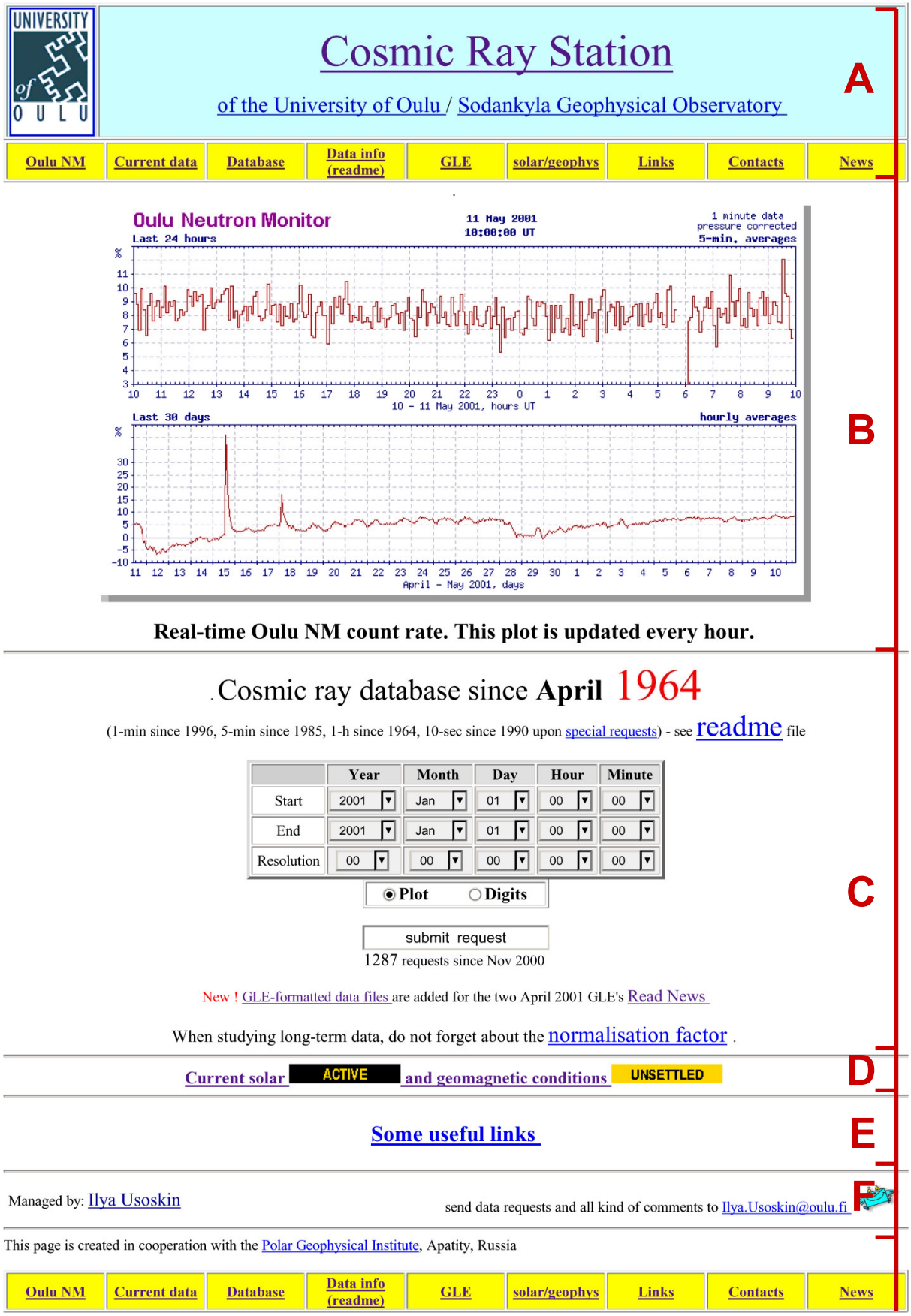

Fig. 1. A screenshot of the Oulu NM web-page with information fields indicated (see text): A - header, B - current data, C - database, D - solar/geomagnetic status, E - useful links, F - contact information.

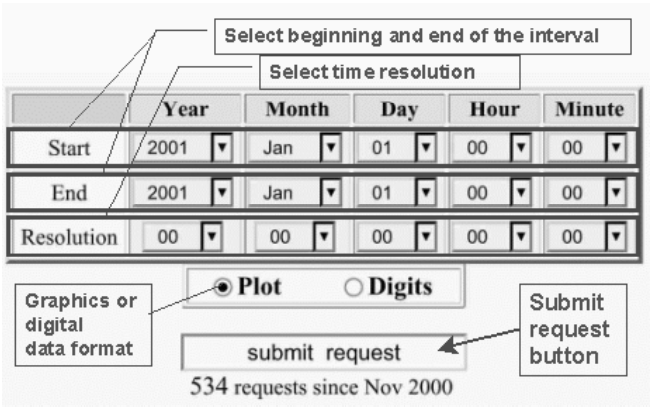

Fig. 2. Oulu NM database request form.

F: Contact information.

3 Menu

The yellow menu is situated in the top and bottom of the web-page and has nine buttons.

- "Oulu NM" refers to the Oulu NM web-page $http://spaceweb.oulu.fi/projects/crs/$ with information on the cosmic ray station.
- "Current data" refers to the current data (field B of the main page).
- "Database" refers to the database request form (field C of the main page).
- "Data info (readme)" refers to the web-page $http://cosmicrays.oulu.fi/readme.html$ containing information about the data. Following this link a user can find the list of dates with missed/ reconstructed data $http://cosmicrays.oulu.fi/bad\_data.html$
- "GLE" refers to the list of files containing data on Ground Level Enhancements $http://cosmicrays.oulu.fi/GLE.html.$ Data on GLEs of cosmic rays are available since GLE #15 (07.07.1966) in the special GLE-format.
- "solar/geophys" refers to the current status of solar and related geomagnetic state according to NOAA (field D of the main page).
- "Links" refers to to the page $http://cosmicrays.oulu.fi/Links.html$ with links to other NMs and related cosmic ray and solar information.
- "Contacts" refers to the contact information.
- "News" refers to a list of news of the Oulu NM $http://cosmicrays.oulu.fi/news.html.$

4 Cosmic Ray Intensity Database

4.1 Database request form

A database request form is shown in Fig. 2 First two lines of the form correspond to the beginning and end of the time interval data are requested for. Third line of the form lets a user to choose the desirable time resolution. The user should select the beginning and end of the time interval and the time resolution. Then he/she should choose what type of output (graphical plot or digital ASCII) is preferred, and finally press the submit request button. The line below the "submit request" button shows the number of data requests since the launch of the the database in November 2000.

4.2 Database request output

Depending on the user's choice, the output can be either a graphical plot or digital ASCII file.

A sample of graphical data output is shown in Fig. 3. The

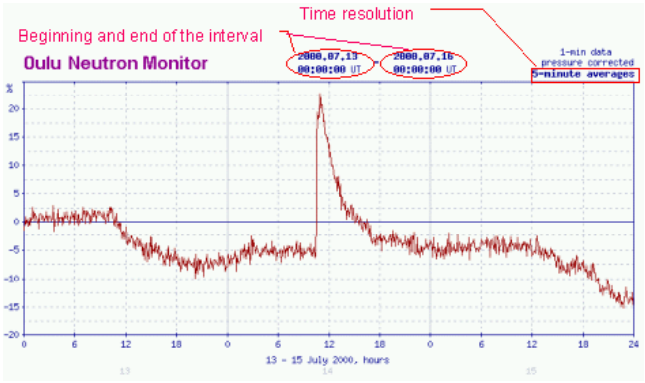

Fig. 3. A sample of the Oulu NM database graphical output.

plot shows Oulu NM pressure corrected count rate for the required period scaled. The plot is scaled as (percent-100%) where 100% is the average cosmic ray intensity level for the interval.

A sample of digital text data output is shown in Fig. 4. The output shows the following information for the required period in the ASCII text format: date, time and fractional day of year (in UT), uncorrected count rate (in counts/min), barometric pressure (in mb) and corrected count rate (in counts/min) of Oulu NM.

5 Data availability and time resolution

The database contains data since 1964. The time resolution of data was improved in time and is presented in Table 1.

During 1964-1985, only hourly data were recorded on magnetic tape (transferred later to a PC-readable information carriers). Besides the automatical recording on tapes, 5-min uncorrected counts of the NM were routinely printed out forming a paper archive of count rates since 1963. We are working now to scan and digitize this archive which will allow us

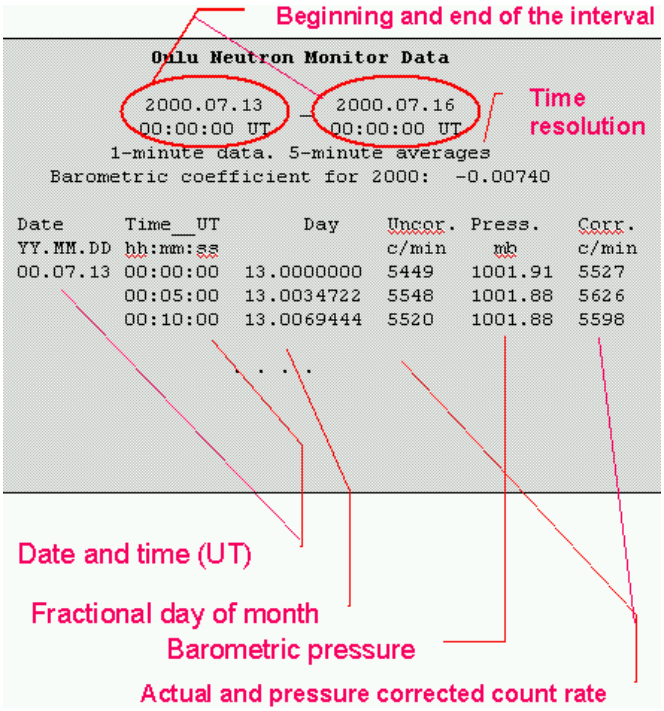

Fig. 4. A sample of the Oulu NM database digital text output.

to obtain 5-min count rates since 1963. During 1964-1985, bi-hourly pressure data were taken from the meteorological station at the Oulu airport.

In 1985, the data collecting system was updated so that it recorded 5-min data on a PC's hard disc.

In late 1995, the completely new data collecting system was implemented to collect 1-min data. This system was tested several years working in parallel with the old one.

In November 2000, the new fully automatic data collecting and pre-processing system was installed that uses, in particular, precise GPS timing and remote access control.

Since 1990 an independent data collecting system with 10-sec time resolution (built by the University of Turku, Finland) is in operation. These 10-sec (uncorrected) data are available upon special requests together with pressure data collected through the main system.

During 37 years of Oulu NM operation, there were short periods when data were lost because of various reasons. (Only about 0.5% of data are lost in total.) The full list of lost and less reliable (reconstructed) data is given at URL

$$http://cosmicrays.oulu.fi/bad\_data.html.$$

6 Normalization factor

If a long time series of cosmic ray intensities is used, one should take into account the normalization factor which is due to some changes in the absolute sensitivity of the neutron monitor. These changes are not beacuse of gradual aging of counters but arises from changes in data collecting and pre-processing system. Therefore, they can be taken into account and their effect can be estimated. The normalized count rate is calculated from the actual count rate using the correction factor, F_s:

$$I_{normalazed} = I_{actual} * F_c.$$

The values of F_c and reasons of renormalizations are given in Table 2 (and in $http://cosmicrays.oulu.fi/readme.html$).

Table 1. Time resolution and availability of Oulu NM data.

service	years	time resolution
online request	since 1996	1-min
online request	since 1985	5-min
online request	since 1964	1-hour
special request	since 1990	10-sec uncorrected
FTP or e-mail	GLE since 1964	GLE-format (300 sec)

Table 2. Correction factor of Oulu NM count rates.

Period	F_c	Reason
01/1964 - 09/1985	1.00	–
10/1985 - 12/1994	1.00674	New automatic digital barometer
01/1995 - 12/1999	1.01147	New data-collecting system
since 01/2000	1.00914	replacement of section A high voltage system

7 Concluding remarks

Concluding, we presented and described the newly launched full-access on-line searchable database of Oulu NM count rates since 1964. During first six months of operation, the database has processed about 1500 data requests. On-line data are used for a space weather forecasting and warnings as well as for long- and mid-term studies of cosmic ray intensities. In the future, we are planning to integrate our database with other cosmic ray stations over Europe and Russian Federation within a network of cosmic rays and space weather data exchange.

Acknowledgements. This work is devoted to the memory of the late NM station manager Hannu Kananen who operated the Oulu NM since its early days. Help of Polar Geophysical Institute (Apatity, Russia) in organisation of the database is greatly acknowledged. We thank the Academy of Finland for financial support. IGU acknowledges INTAS grant YSF 00-82.