The worldwide neutron monitor network: at present and in future.

E. Eroshenko

1. Short overview the history of the NMN creation and CR data accumulation;

 Existing archives and CR data bases. Modern tendencies of geophysical data base creating.
 Different ways of data presentation.;
 Requirements TO and FOR distributed infrastructures. New possibilities.

# History of the neutron monitor network

2						
	What?	When?				
	e basis for the NM network	Very long ago				
	Invention of the NM by Sympson	1948				
	The first standard NM appearance	1951-1953				
	The first NM network (IGY)	1957-1958				
	Creation of the NM64 and second NM network	1963-1968				
	First Internet presentation of the CR variation in real time	1997				
	NM Network in real time	2000 -				

## Deployment of the neutron monitor network





090W

060W

030W

150W

120W

## All neutron monitors IGY (Simpson) NM – 5-6 now (mountains)

NM64 Super NM 55 operating now 46 of them operatively present data 26- real time data



000

030E

060E

090E

120E

150E



### Presentation of NM data in the Internet in real time



# Real time data publication



# Sub infrastructures

Europe	USA	Euro-Asia	SA
Athens	McMurdo	Alma-Ata	Hermanus
ESOI	Inuvik	Apatity	Potchefstrom
Junafrau1	Newark	Barenzburg	Sanae
Junafrau	Fort Smith	Baksan	Tsumeb
Kergeluen	South Pole	Cape Shmidt	OTHERS
Terra Adelie	Thule	Irkutsk,	Erevan 2000,
Kiel	Peawanuck	2000, 3000	3000
Lom Stit	Nain	Magadan	Tbilisi
Oulu	Climax	Moscow	Beijing
Rome	Haleakala	Novosibirsk	Tibet
Santiago	Calgary	Norilsk	Mexico
larc	wasnington	Tixie Bay	Mawson
Dourbus 2	Durham	Yakutsk	Kingston
			AA+ \A/allin at an

# **DOURBES** CR stations EC + Some words about forgotten station Dourbes



Monitor 18NM64 In 2002 year worked in Real Time. Resolution and updating 1-minute http://digisonde.oma.be/ Contact personnen Dr. Sc. Ir Jean-Claude JODOGNE Tel: 02/373 05 55 E-mail: jodogne@oma.be

•Dr. Sc. Hamid NEBDI Tel: 02/373 67 58 E-mail: nebdi@oma.be

## Solar and galactic cosmic rays

 There are two types of space phenomena for which monitoring and forecasting the CR data are very important. The first one is the strong space radiation storms caused by the solar cosmic rays accelerated to energy > 1 GeV during the great solar flares. The second one are the great interplanetary disturbances producing large geomagnetic storms in the Earth magnetosphere.

#### solar and galactic cosmic ray variations





GLE profile finished much earlier than max flux in low energies occurred An example of the interplanetary disturbances created giant Forbush effects and severe magnetic storms in November 2004.

#### Precursor of the shock arrival in the CR variations Longitudinal distribution of CR variations

#### Derived only from European stations



#### Derived from European + Russian stations





## Existing archives and data bases

#### Archives and data bases on GLE and 5/or 1minute data

•GLE data - Australian Antarctic Data Center <u>http://aadc-</u>

<u>maps.aad.gov.au/aadc/gle/index.cfm</u> (58).

•Archive of GLE data on the server <u>ftp://cr0.izmiran.ru/COSRAY!/FTP\_GLE/</u> (70).

•Archive of the minute data on the server <u>ftp://cr0.izmiran.rssi.ru/COSRAY!/FTP\_NM1/</u> (3800 monthly writing).

•But mainly, 1- and 5- minute data are stored on the station (or small center) servers, for example, SpeceShipEarth data- on the server of Bartol Reseach Institute http://neutronm.bartol.udel.edu/.

## Hourly, monthly, yearly NM DATA

#### WDC-A (Boulder, Colorado, USA) <a href="mailto:ftp://ftp.ngdc.noaa.gov/STP/SOLAR\_DATA/COSMIC\_RAYS/">ftp://ftp.ngdc.noaa.gov/STP/SOLAR\_DATA/COSMIC\_RAYS/</a>

WDC-B (Moscow, Russia) http://www.wdcb.ru/stp/data/cosmic.ray/

#### WDC-C Ibaraki, Japan

http://www.env.sci.ibaraki.ac.jp/database/html/WDCCR/data\_e.h

#### <u>tml</u>

The most complete data base (since 1953 from 98 st) is on the **IZMIRAN Data Base** <u>http://cr0.izmiran.ru/common/links.htm</u>

Data from individual stations are accumulated at their servers or at separate small Centers (Bartol, Jungfraujoch, Rome, South Africa).

## Existing database in IZMIRAN • Data from 20 stations are updated in real time (every hour) and accessible in graphic and digital form.

cow Neutron Monitor - Microsoft Internet Explore

	Nerwork of Cosmic ray Station
tron N	Ionitors, operated
All Co	osmic Ray Stations + InterPlanetary Data: WorldNet
<b>I</b> dB	& Alma-AtaB (Mt Tien Shan) & DataBase of Kazaki
<b>IdB</b>	i & Apatity
<b>IdB</b>	& Athens
<b>IdB</b>	& Baksan
<b>IdB</b>	& Barentzhurg
IdB	& Beijing
IdB.	& Calgary
IdR	& Cono Shmidt
IdB	A Climan
	6 Cumax
IUD.	a Erevanzooo (MIt. Nor-Amberd 2000 m)
• •	•
<b>I</b> dB	& Tibet (Vanghajing)
IdB	& Turneh South Africa
	a Tsumeo, Soum Anica
IUB	t & Thule
TdB.	& Yakutsk or Yakutsk=>Forecast

59 stations



\_ 🗗 ×

Real time data publication The samples of good organized http publications:

<u>http://cosmicrays.oulu.fi/</u> Or

http://pgi.kolasc.net.ru/CosmicRay/ Or

http://cr0.izmiran.rssi.ru/mosc/main.htm;

http://cosray.phys.uoa.gr/

http://134.245.132.179/kiel/main.htm

http://neutronmonitor.ta3.sk/realtime.php

# Real time data publication

#### Index of /ftpdir/lists/xray

	Name	Last modifie	<u>ed</u>	<u>Size</u>
2	Parent Directory	18-Mar-2004	22:57	-
ľ	20061224 G11xr 1m.txt	25-Dec-2006	00:10	81k
ľ	20061224_G11xr_5m.txt	25-Dec-2006	00:15	20k
Đ	20061224 G12xr 1m.txt	25-Dec-2006	00:10	81k
Đ	20061224 G12xr 5m.txt	25-Dec-2006	00:15	20k
Đ	20061225 G11xr 1m.txt	26-Dec-2006	00:10	81k
••	•			
ľ	20070323_G11xr_1m.txt	23-Mar-2007	15:01	51k
	20070323_G11xr_5m.txt	23-Mar-2007	15:05	13k
ľ	20070323_G12xr_1m.txt	23-Mar-2007	15:01	51k
Đ	20070323_G12xr_5m.txt	23-Mar-2007	15:05	13k
Đ	G11xr 1m.txt	23-Mar-2007	15:09	7k
Ð	G11xr 5m.txt	23-Mar-2007	15:05	2k
Đ	G12xr 1m.txt	23-Mar-2007	15:09	7k
ľ	<u>G12xr_5m.txt</u>	23-Mar-2007	15:05	2 k

File structure of GOES project

Sample of unsuccessfully elaborated database: it takes 12 sec to get data for 1 minute . The whole table is transferred, by request, but it contains only 5% of useful information.

Last Data !							📕 Getl	Data1x -	Блокнот													
						_	Файл Правка Формат Вид Справка															
	IP ADDRESS 192.168.24.140					<pre>ktitle&gt;Show<body background="/image^&lt;br">C56C57C58C59</body></pre>																
Date Time C1		Cl	C2	68	Κ	$\mathbf{b}^{\mathrm{I}}$	Ce	07	C	38td>27	h> <tl 68<th>58</th><th>Kb</th><th>&gt;C140&lt; d&gt;</th><th>/th&gt;<t 2848<!--</th--><th>h&gt;C141 td&gt;<td< th=""><th></th><th>2</th><th>C18</th><th>C19</th><th></th></td<></th></t </th></tl 	58	Kb	>C140< d>	/th> <t 2848<!--</th--><th>h&gt;C141 td&gt;<td< th=""><th></th><th>2</th><th>C18</th><th>C19</th><th></th></td<></th></t 	h>C141 td> <td< th=""><th></th><th>2</th><th>C18</th><th>C19</th><th></th></td<>		2	C18	C19		
	det1	2007- 03-21 23:59:39	3049	2978	2876	2697	2949	2793	2915	28	d> <fo &gt;<fon <font font</font </fon </fo 	nt col t colo color	lor=red pr= <mark>red</mark> r=red>0 =red>0	d>OOO(/font>	ont>it>it>	d> d> d> d> d> d> d d d d d d d d d d d d	<font of<br="">font co ont co ont colu</font>	col olc lor or=	1	3092	3028	
IP ADDRESS 192.168.24.136						1	C >C > 4 <th>46C129&gt;3</th> <th>n&gt;&lt;<mark>t</mark>h&gt; /th&gt; 3210<!--</th--><th>C47h&gt;C130&lt; td&gt;</th><th>&gt;C /th&gt;C</th><th>48h&gt;C131 td&gt;<td< th=""><th>&gt;C C &gt;3065</th><th>49&lt; th&gt; ⁄td</th><th></th><th></th><th></th><th></th></td<></th></th>	46C129>3	n>< <mark>t</mark> h> /th> 3210 </th <th>C47h&gt;C130&lt; td&gt;</th> <th>&gt;C /th&gt;C</th> <th>48h&gt;C131 td&gt;<td< th=""><th>&gt;C C &gt;3065</th><th>49&lt; th&gt; ⁄td</th><th></th><th></th><th></th><th></th></td<></th>	C47h>C130< td>	>C /th>C	48h>C131 td> <td< th=""><th>&gt;C C &gt;3065</th><th>49&lt; th&gt; ⁄td</th><th></th><th></th><th></th><th></th></td<>	>C C >3065	49< th> ⁄td								
	Date	e Time	C1	C2	C3	C4	C5	C6	C7	С	<pre>&gt;<font color="red">0</font>00<th>&lt; /td&gt;&lt;</th><th>td&gt;<for d&gt;<for< th=""><th>nt t c</th><th>2</th><th>C18</th><th>C19</th><th></th></for<></for </th></pre>					< /td><	td> <for d&gt;<for< th=""><th>nt t c</th><th>2</th><th>C18</th><th>C19</th><th></th></for<></for 	nt t c	2	C18	C19	
	4.42	2007-	LastData - Блокнот												cc ol							
det2	detz	03-21 16:48:00	Файл (	Правка	Формат	Вид С	правка	<b>FO</b> - 22	201	1.0	25.05	2042	07	2007	2772	2701		1c </td <td>7</td> <td>3058</td> <td>2704</td> <td></td>	7	3058	2704	
detector1 2007-03-22 2 detectcr2 2007-03-22 1 detector3 2007-03-22 1						2 23: 2 17: 2 16:	59:32 20:00 39:00	293	16 34 64	3025	2943 3176 667	2873	3018	3037	2885	204 m 295 69	h> 🗸	F		_		
			detector4 20		2006	06-12-14 14:15		15:59	5:59 2		170	447	3 5		h		0,0	i1 .	:			
	Date	e Time	detec detec	tor5	2007	-03-2	2 17:	32:00	3212	22 3 60 8	0621	34542	28128	15509	3258	19332	1607 = 309	219	C2	0 C21	C2:	
ſ	det3	2007- 03-21	detec detec detec	tor7 tor8	2007 2007 2007	-02-1 -02-1 -03-2	4 11: 4 11: 2 17:	36:00 37:00 40:00	1580 1546 144	01 1 56 1 44	5667 4837 587	15157 13543 990	14621 14698 1558	14207 15714 1535	15353 15428 1299	9243 9571 1447	980 972 154	559	0	0	0	
L		16:23:00	<														>					
															Стр 9, стлб	510						
:	Ш																				>	~
🖥 Готово 🤤 Мой компьютер									Ĩ													
4	и пуск		ک 🖸	» 🖻	2 Провод	ник 👻	<b>W</b> 2 M	icrosoft	- 18	plot		ø	3 Internet	🍞	Безымянн	ы	🦉 not - Pai		E	V 🔇	20:11	

## From present -- to future

- The ways of improving:
- Upgrading of NM registration system with 1-min data acuisition;
- The new NMs opened:
- Station Mirny is operating from January 2007;
- The new Plateau de Bure NM started to operate (J.-L. Autran);
- China intends to open new NM (Antarctida);
- This is good, but we should also try to keep the old, long time operated stations.

## Station MIRNY





# ANTARCTIDA

#### SUMMARY

A World wide Network of cosmic ray stations is a steady structure successfully operating more than 50 years, which proved its vital capacity and necessity;

The NM network is an unique TOOL for scanning the inner heliosphere, but...

The "product" of CR presentation in real time exists 10 years already, but its possibilities are used insufficiently Our task – to make NMN stable, more reliable and efficient for usage in different aspects The FP7 project (MNDB) initiated and prepared by European and some other groups can give an additional impuls to improve an efficiency of usage of the CR observations. We hope it will attract more other providers to this Database.

- To implement the full or partly unification of the world wide CR station network this net should correspond to some basically requirements. The project has to:
- Promote further obtaining data at the stations and improving their quality. The people directly responsible for data obtaining have to be interesting in the project fulfillment.
- Promote an improving exchange by the data on the CR variations and facilitation of access to data (including real time data).
- Increase an interest to CR variation data from the crossdisciplinary scientists and from the organizations attended with applied tasks.
- Use the global character of the world wide net and focus on solving of the global objects;
- Be guided on the previous experience and already existing Net structures.

# • THANK YOU