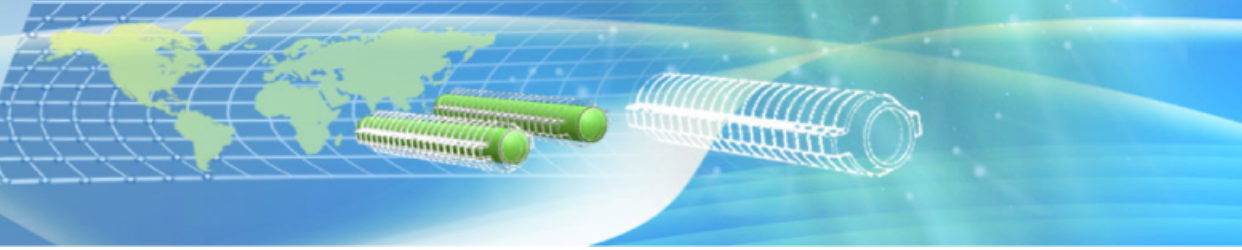




Real Time Database
for High-Resolution
Neutron Monitor
Measurements



Potential use of NMDB for the real-time Observation and Specification of the near-Earth Radiation environment

<http://nmdb.eu> mail@nmdb.eu

EU FP7 project Contract No RI-213007

Christian T. Steigies for the NMDB consortium

Institut für Experimentelle und Angewandte Physik

Abteilung Extraterrestrische Physik

Christian-Albrechts-Universität zu Kiel

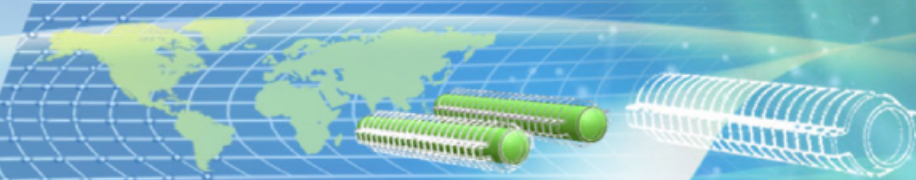
Germany



e-infrastructure



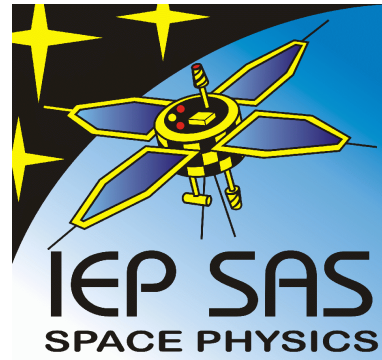
Real Time Database for High-Resolution Neutron Monitor Measurements



C | A | U

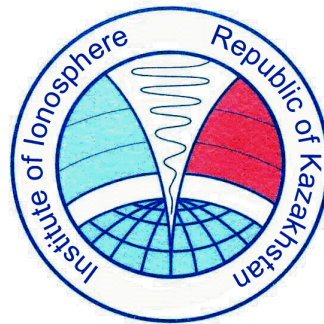
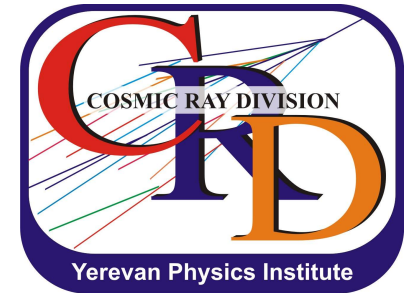
Christian-Albrechts-Universität zu Kiel

UNIVERSITY of OULU
OULUN YLIOPISTO

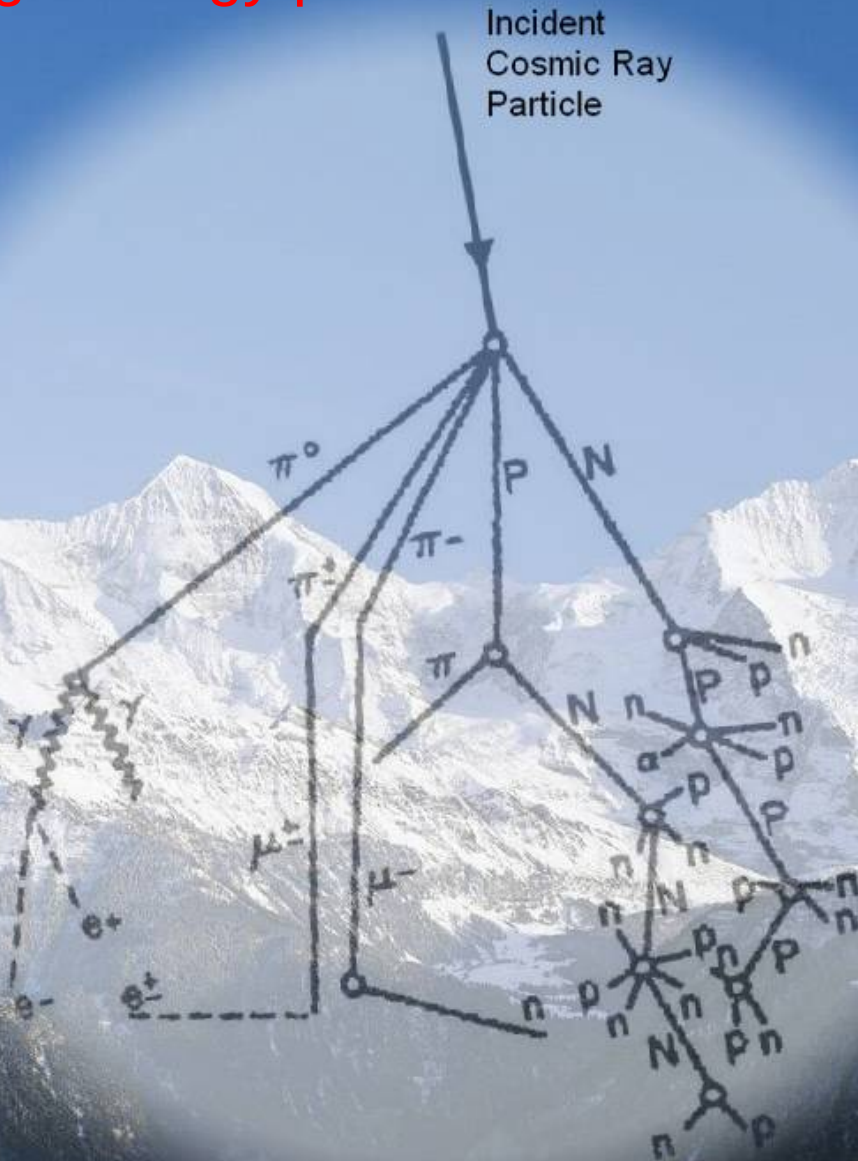


u^b

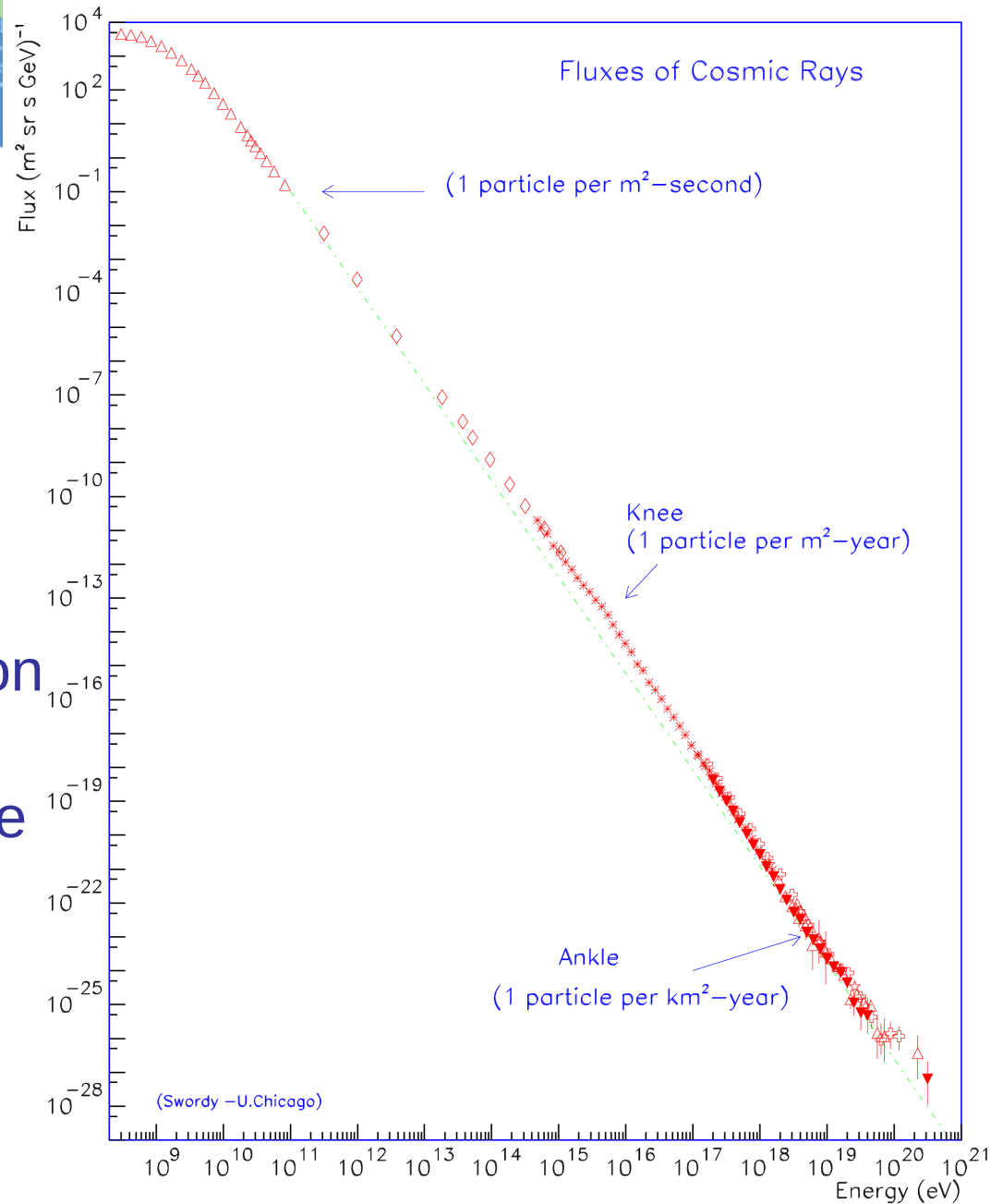
^b
UNIVERSITÄT
BERN

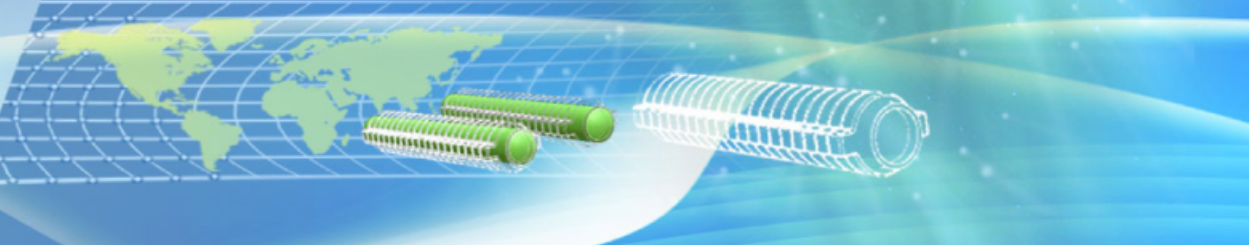


Cosmic Rays: high energy particles from the Universe

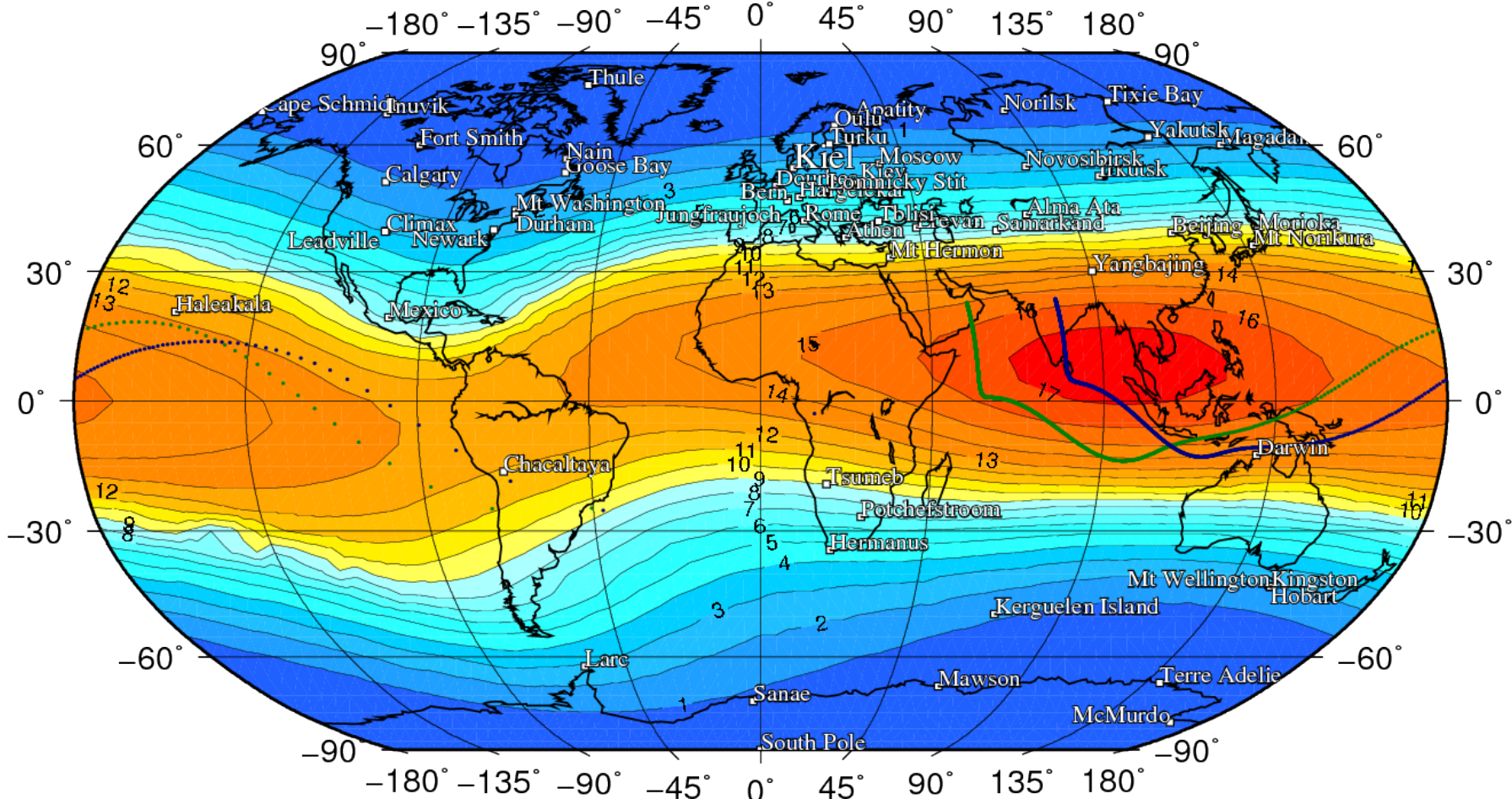


- Cosmic Ray energies and intensities cover many orders of magnitude
- Higher energies require larger detectors
- Detection range for Neutron Monitors: 0.5-20GeV
- Energies above 10GeV are not affected by the solar magnetic field



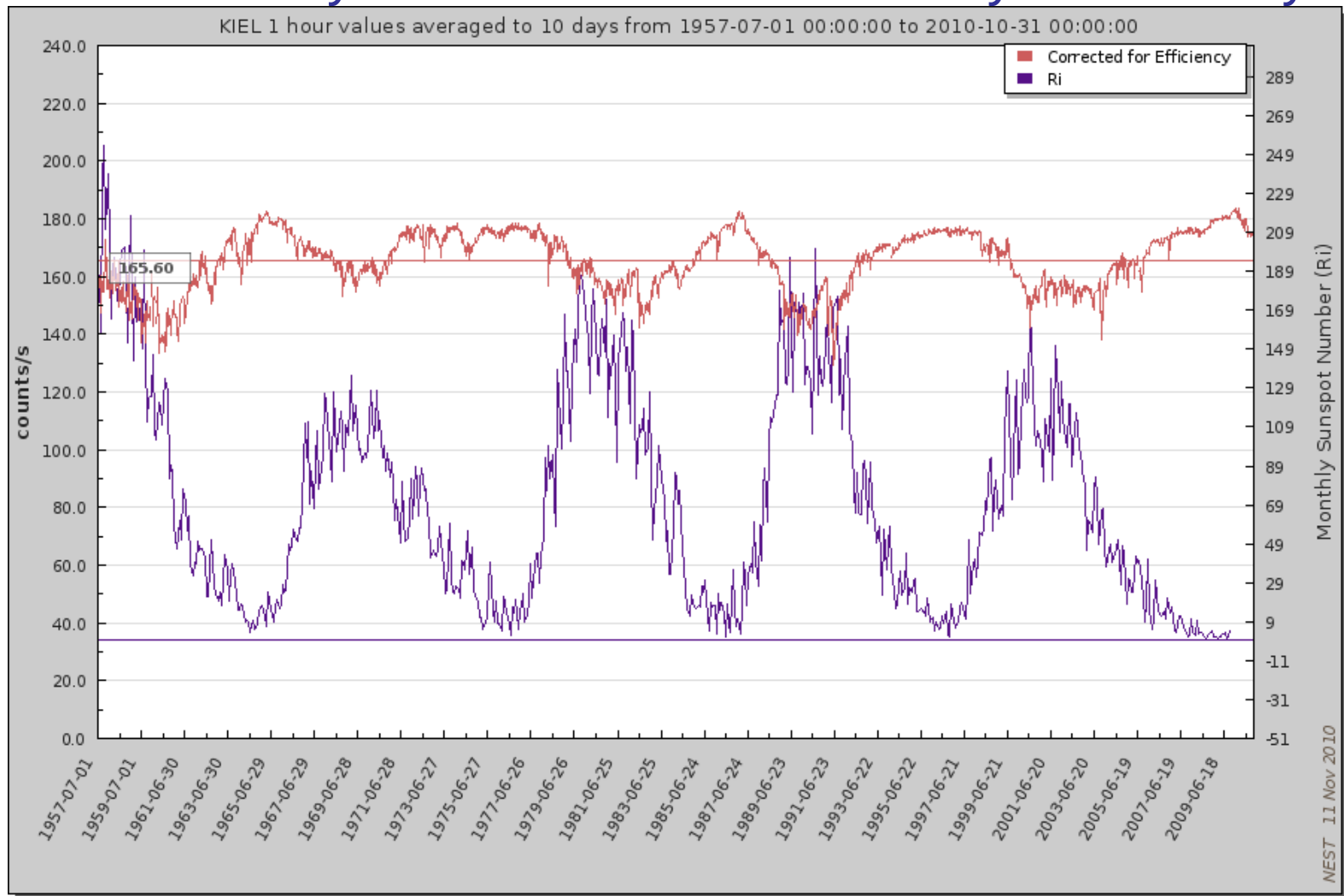


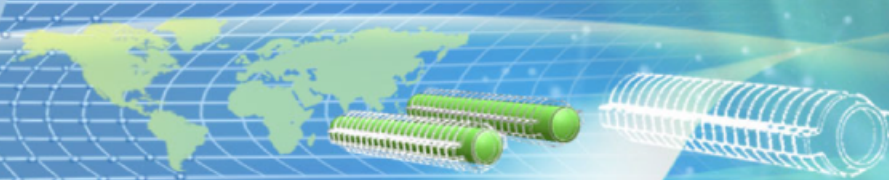
Worldwide Neutron Monitor network



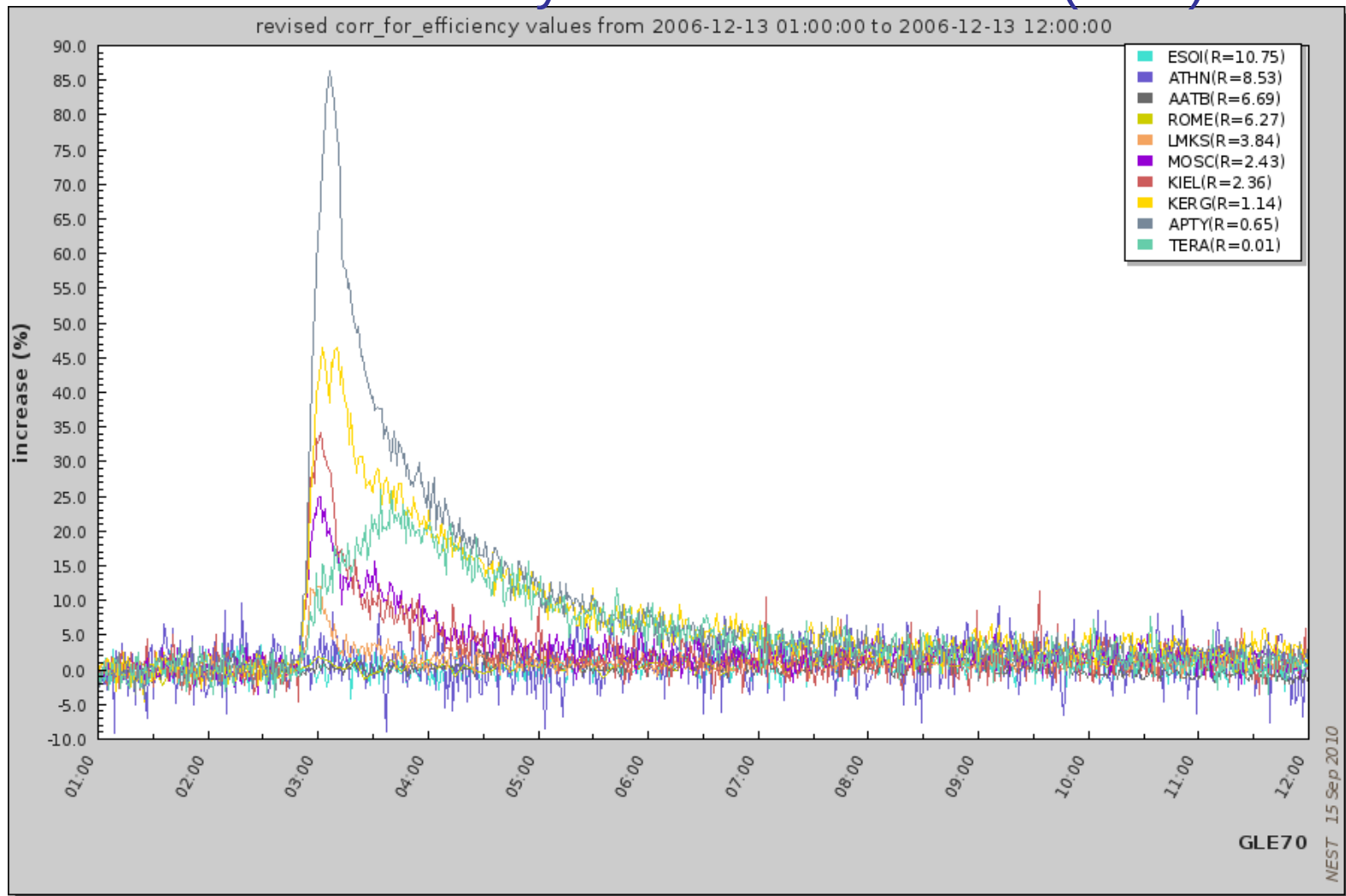


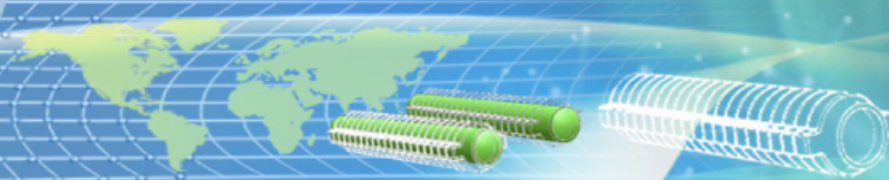
More than 50 years of data: modulation by the solar cycle



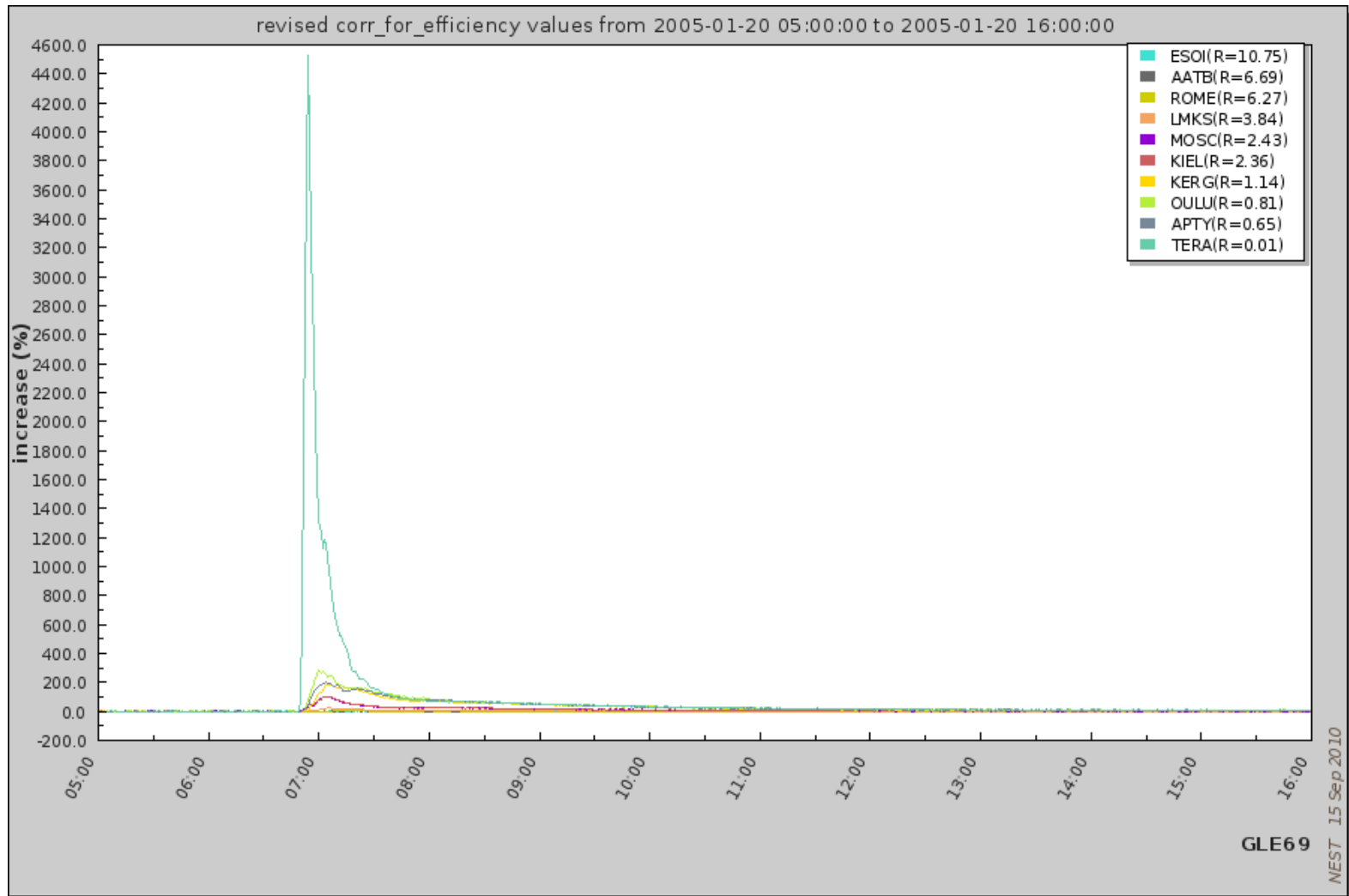


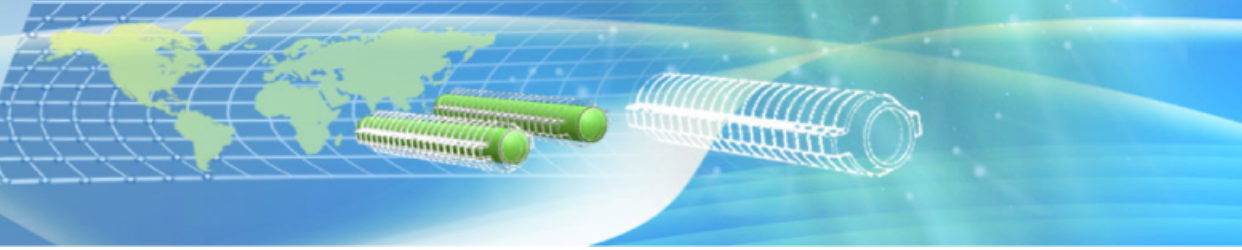
Solar Cosmic Rays: short term events (GLE)





Increase is strongly dependent on location and altitude





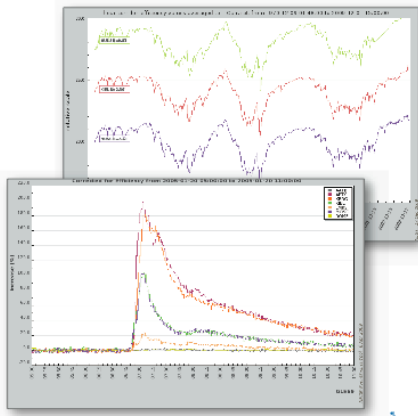
Status in 2007

- Data in 1h resolution and common format available at World Data Center (WDC)
- No real-time data
- No high-resolution data
- Not suitable for Space Weather applications

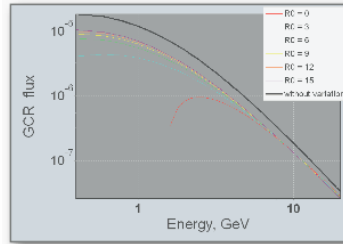
NMDB goals

- Provide data in standard format
- Provide high resolution data
- Provide real-time data (< 5 min delay)
- Make data easily accessible
- Provide designs for modern registration systems
- Applications

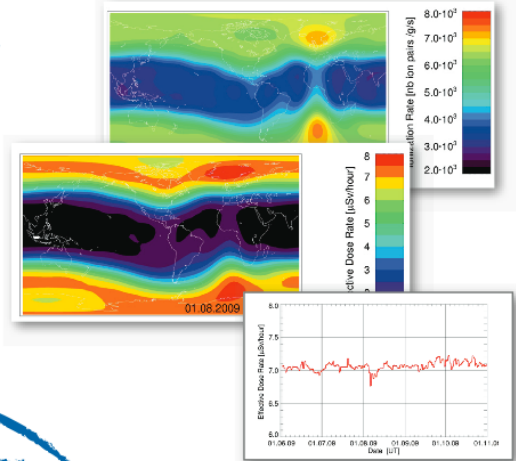
NEST TOOL TO PLOT AND RETRIEVE DATA



SPECTRUM OF GCR



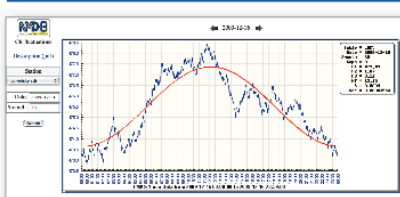
IONISATION RATES AND DOSE RATES IN THE ATMOSPHERE (every 6 hrs)



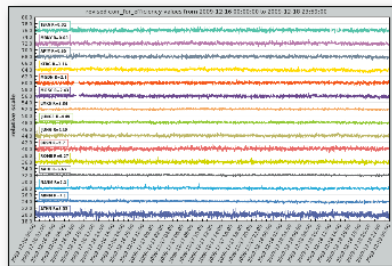
GLE ALERT IN REAL TIME



DAILY CR VARIATION



COSMIC RAYS NOW!



TRAINING AND PUBLIC OUTREACH

BOOK NAVIGATION

- NMDB Stations
- NMDB Online Access Tools and Data Products
- NMDB Data Products
- NMDB Documentation
- Public Outreach
 - English
 - What are cosmic rays?

What we see at the sky, we see bright objects: the Sun of course, planets, stars, nebulae... All this is light, electromagnetic waves. When operational telescopes, we can also detect electromagnetic waves that are invisible to the human eye, such as infrared or ultraviolet or x-rays, gamma rays.

Since the early 20th century, we know that the Earth is not only lit by such waves, but also bombarded by charged energetic particles: protons, ions, electrons that come in at nearly the speed of light. These particles are called cosmic rays, and they tell us a story about the Universe that we would not learn from light alone.

Where do they come from?

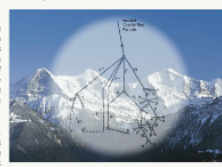
Cosmic rays come from across the Universe where some kind of explosion occurs: the remnants of stellar explosions (supernovae), active galaxies, and also from the Sun.

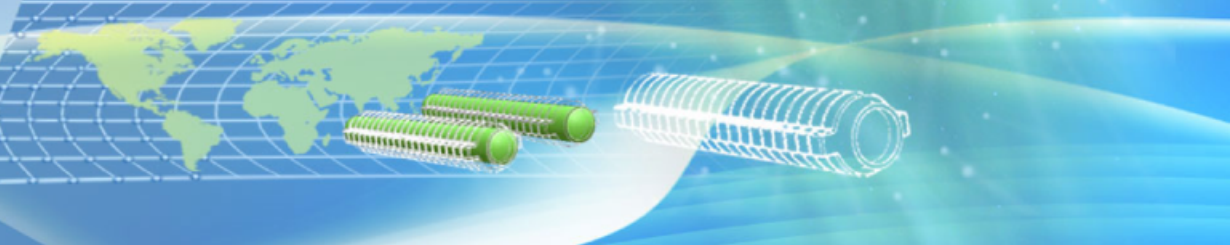
Cosmic rays come in permanently, although their intensity is modulated by the Sun. Particles accelerated at the Sun, solar cosmic rays, are more sporadic. They come as individual events, on top of the usual particle flux from the remote Universe.

How can we observe them?

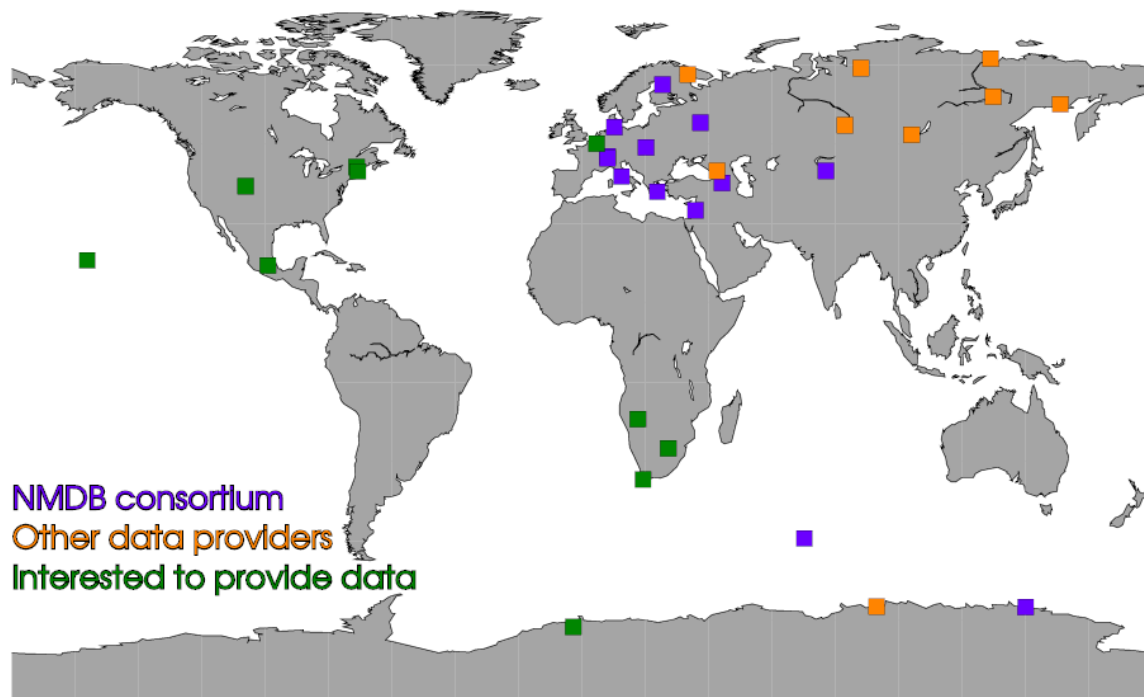
Cosmic rays do not directly hit the ground, but collide with the atoms of the high atmosphere. This creates lots of secondary particles: protons, neutrons, muons and electrons. Because the primary particle has a maximum speed of about 300,000 km/s, two thirds of the speed of light, a significant number of secondary neutrons, muons and other particles can be detected by ground-based particle counters near the magnetic poles.

The magnetic field of the Earth is another filter, although it plays no role at the magnetic poles of the Earth. But the closer one comes to the equator, the faster the primary charged particle must be to get

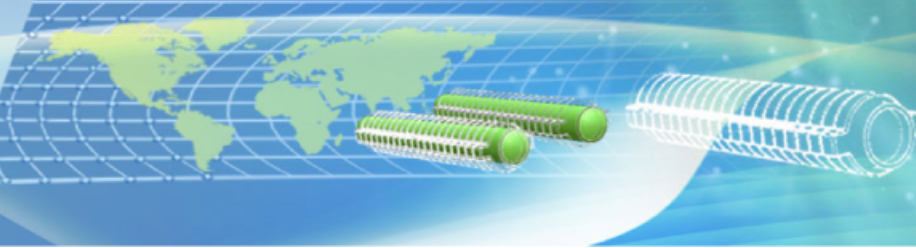




NMDB data providers



- 26 stations
- 19 real-time
- Future stations:
 - New Hampshire
 - Delaware
 - Mexico
 - South Africa
 - Austria
 - Belgium
 - Spain
 - Thailand
 - ...



Quick Plots

Last Data GLE70 GLE69

3 ways 2 use NEST

Stations

<input type="checkbox"/> AATB	<input type="checkbox"/> APTY	<input type="checkbox"/> ATHN	<input type="checkbox"/> ARNM	<input type="checkbox"/> NANM
<input type="checkbox"/> BKSJN	<input type="checkbox"/> ESOI	<input type="checkbox"/> IRKT	<input type="checkbox"/> IRK2	<input type="checkbox"/> JUNG1
<input type="checkbox"/> JUNG	<input type="checkbox"/> KERG	<input type="checkbox"/> KIEL	<input type="checkbox"/> LMKS	<input type="checkbox"/> MCRL
<input type="checkbox"/> MGDN	<input type="checkbox"/> MOSC	<input type="checkbox"/> MRNY	<input type="checkbox"/> NRLK	<input type="checkbox"/> NVEK
<input type="checkbox"/> OULU	<input type="checkbox"/> ROME	<input type="checkbox"/> TERA	<input type="checkbox"/> TXBY	<input type="checkbox"/> YKTK

All stations one color

Date Selection

Last 1 days

From 20 Jan 2010 0h 0mn

To 20 Jan 2010 23h 59mn

GLE number/date 70 (13 Dec 2006)

FD number/date 52 (2006 Dec 14)

Data type

Pressure & efficiency corr.

Pressure corrected

Uncorrected

Pressure

Scale

Relative scale

Counts/s (or mbar)

Log scale

Output

Plot

Ascii

Plot & ascii

Fits



Real-time plot examples

Event plot examples

Overplot option

optional / select only 1 station

Corrected for efficiency

Corrected for pressure

Uncorrected

Pressure_mbar

Smoothed sunspot number

Monthly sunspot number

No Sunspot Number display

NMDB tables

Environmental data

Scaling Options

Event Options

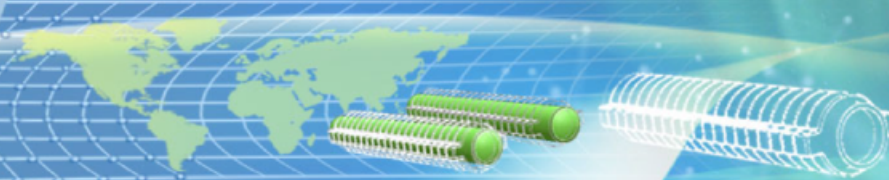
Ascii Options

Style Options

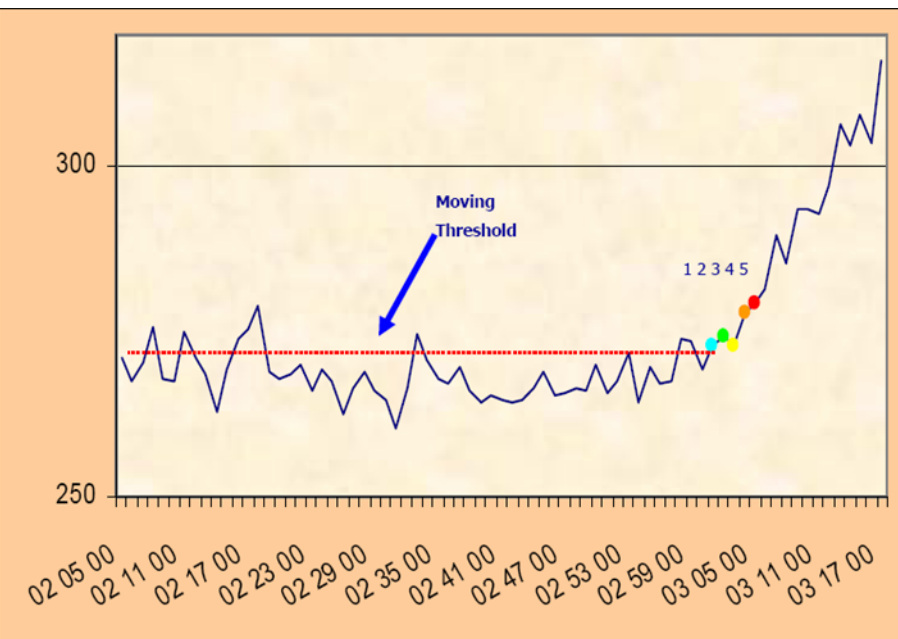
OBSParis: NEST

- Main interface to NMDB data
- Plots countrate, pressure, sunspot index, ...
- Performs averaging and merging (ori+rev) in MySQL
- Generates plots and ascii
- Customize plots
- Can be used in scripts (wget)
- “Very easy to get to the data” (comment by NOAA user)

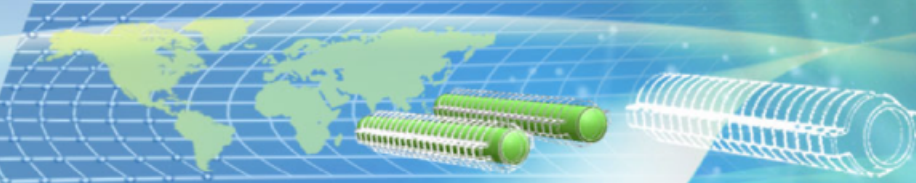
<http://nest.nmdb.eu>



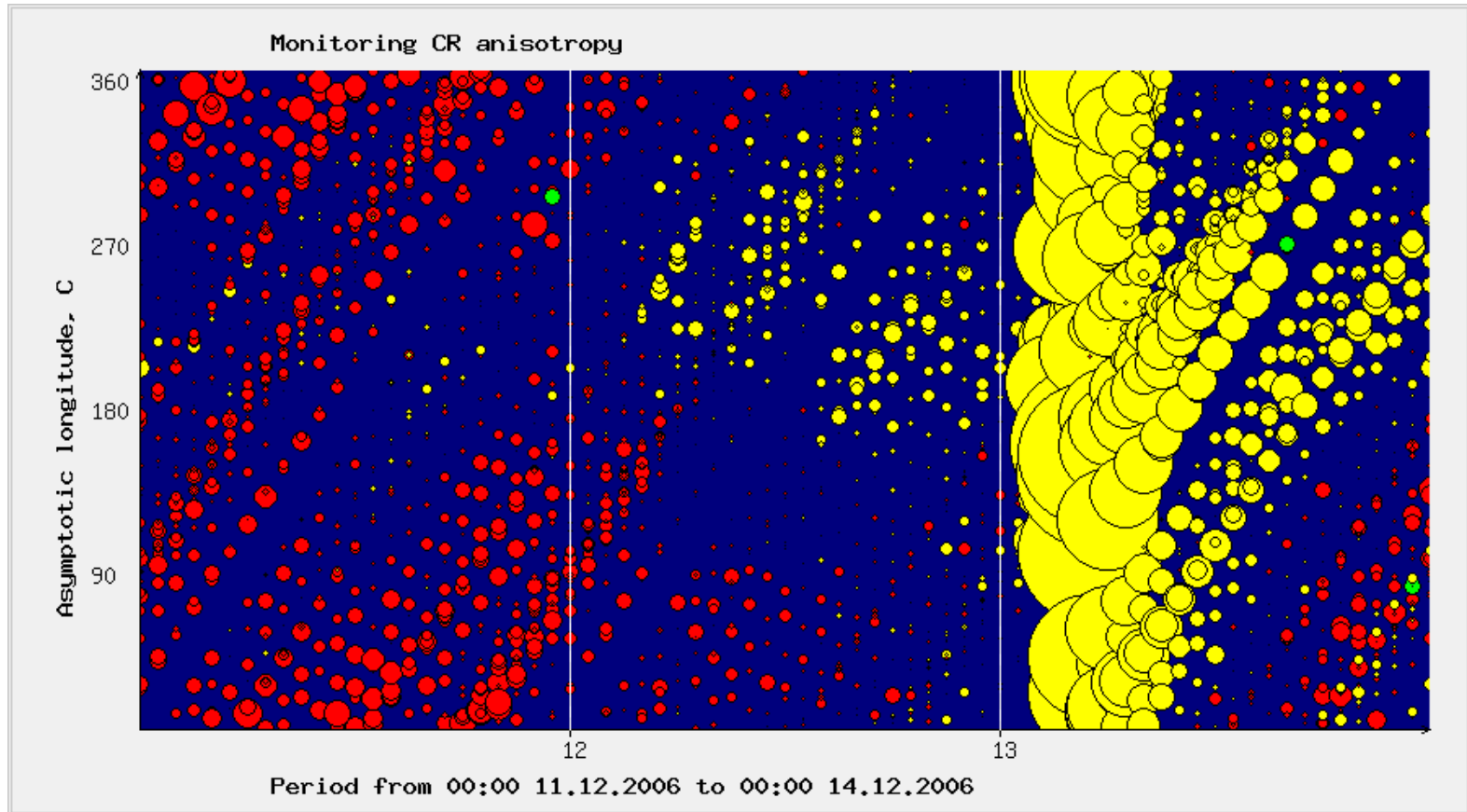
NKUA: GLE ALERT



- Determine moving threshold M (last 60 minutes) and standard deviation σ
- Pre-alert if $\text{count rate} > M + N \cdot \sigma$
- 5 pre-alerts \rightarrow Station Alert
- 3 Stations in Station Alert \rightarrow General Alert

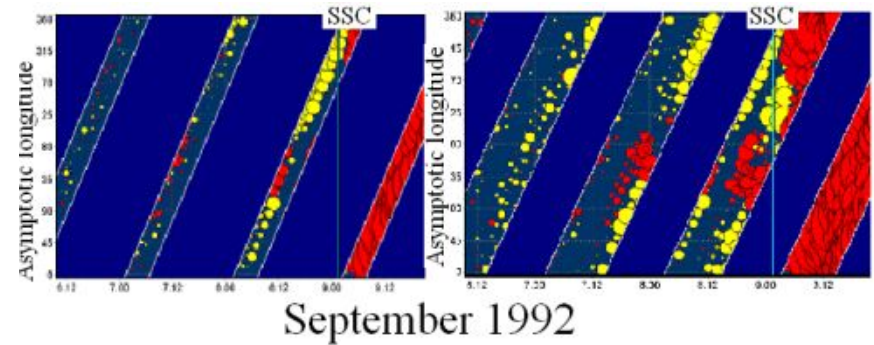
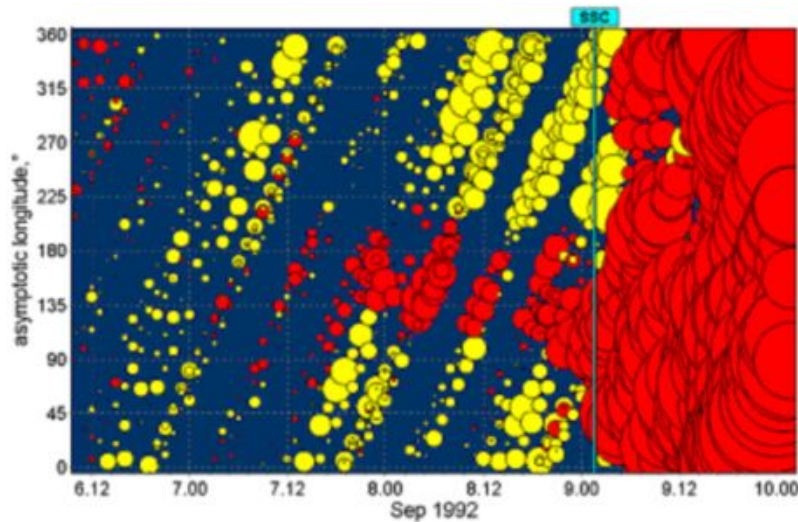


IZMIRAN: Monitoring of CR anisotropy



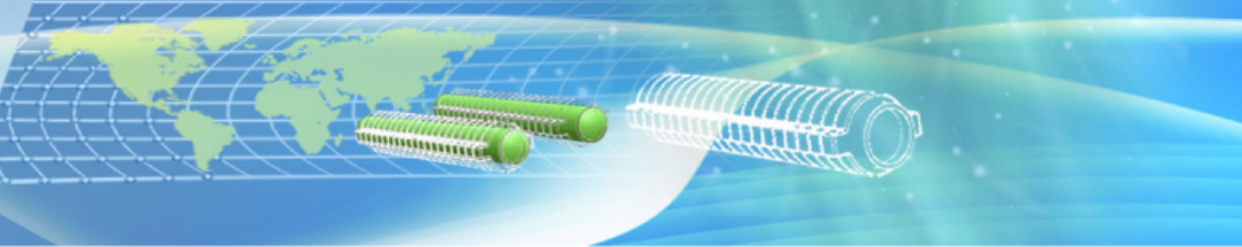


Anisotropy monitoring requires whole Earth coverage



Calculation using only:
European stations / +Russian stations

Calculation using all available stations

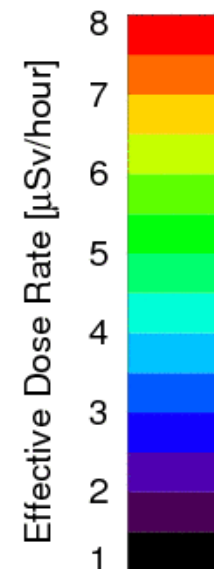
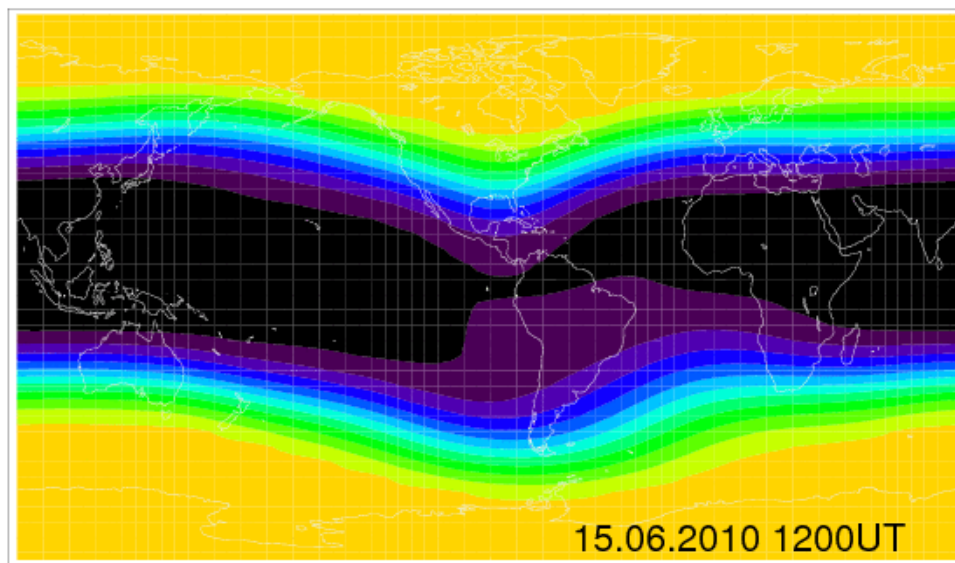


UBern: Ionization and Radiation Dose Rates

Effective Dose Rate vs. Position

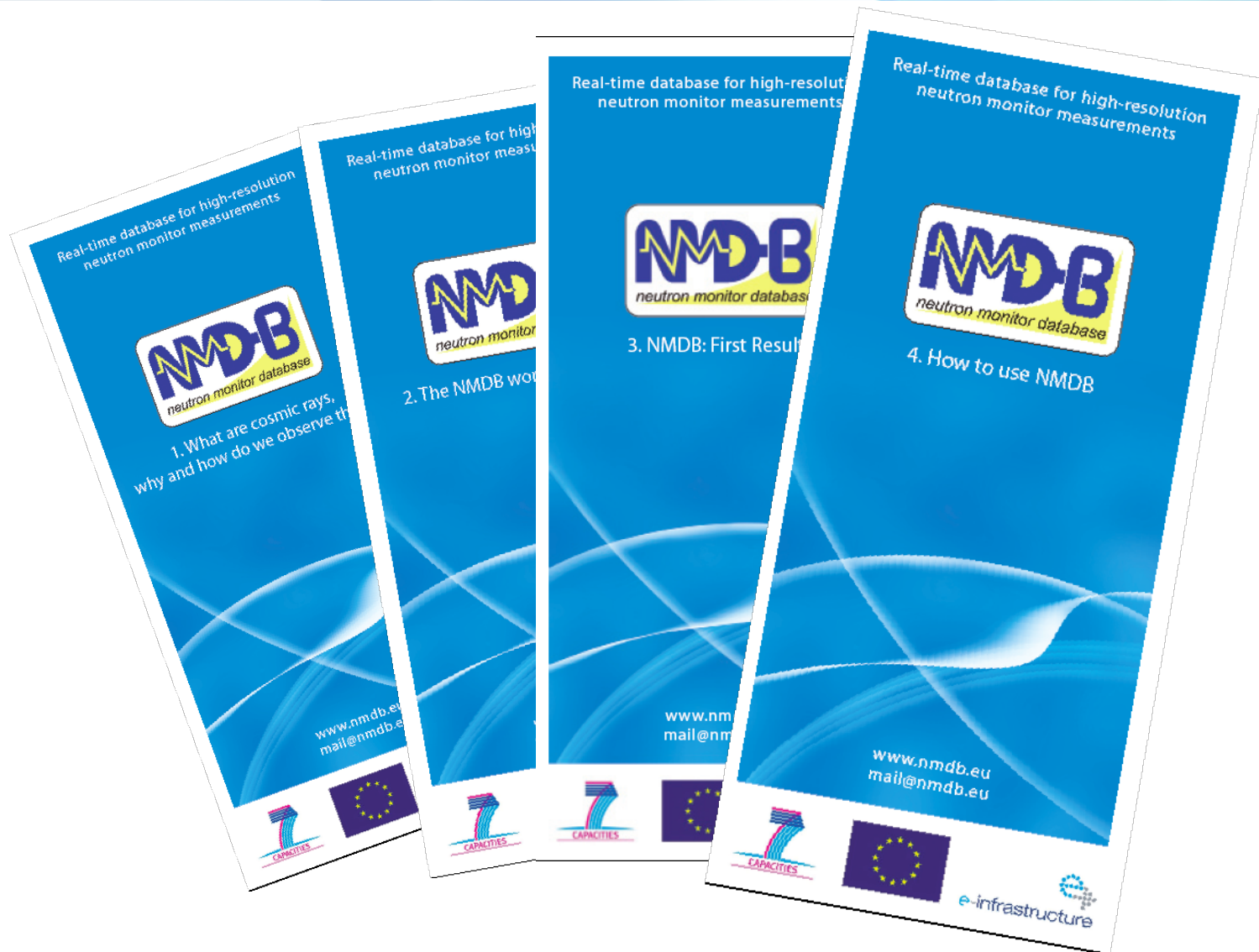
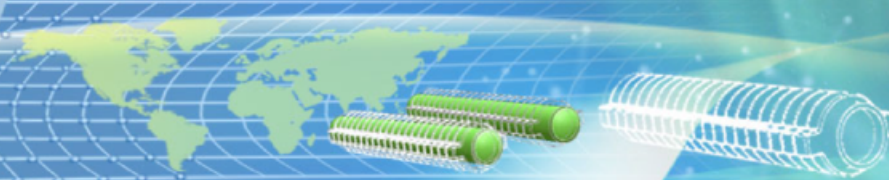
Altitude: ~10.5 km asl

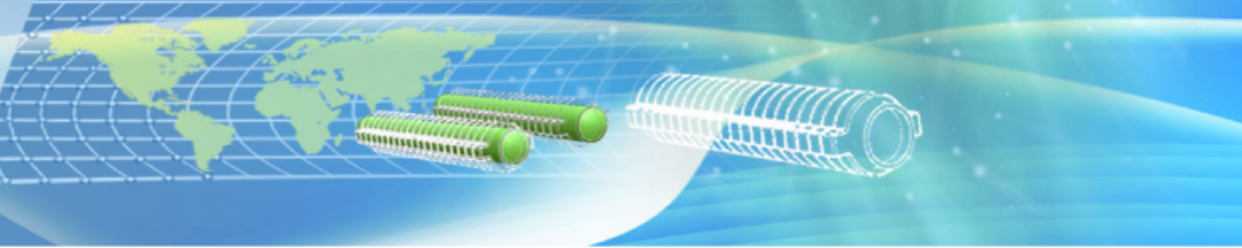
At time: 2010-06-15 12:00 UT





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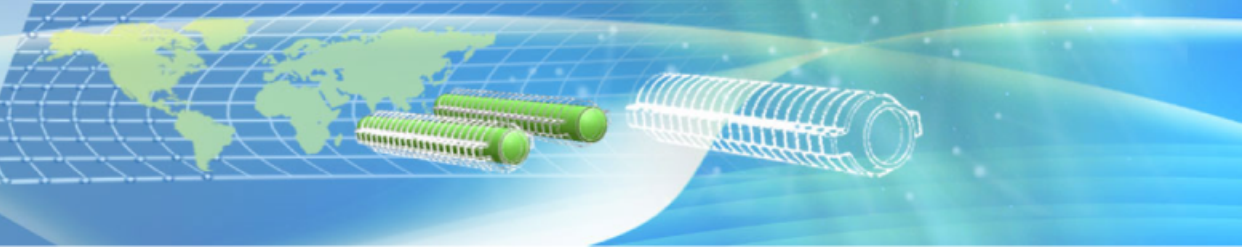


NMDB: one stop shop for...

- real-time cosmic ray data
- historical cosmic ray data
- GLE alerts, CR and GLE spectra
- background information on cosmic rays
- training for cosmic ray science
- information on registration systems and components

questions@nmdb.eu

<http://nmdb.eu>



Acknowledgements

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP/2007-2013) under grant agreement no 213007.

Data retrieved via NMDB are the property of the individual data providers. We acknowledge the PIs of individual neutron monitors for providing data.