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Real-time cosmic ray monitoring and analysis of GLE70 from the Athens Neutron Monitor Data Processing Center

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Abstract

Within the absolute minimum phase of the 23rd solar cycle the worldwide neutron monitor network recorded unusual cosmic ray events. In specific, a series of various events took place almost from the beginning of December 2006, a sharp but yet not strong Forbush decrease appeared on the 8th of the month. It was followed by a significant ground level enhancement (GLE) on December 13, an event which is also known as GLE70 and finally the sequence of these events ended the next day (December 14) with a Forbush decrease of about 5% amplitude. In northern Europe the event was registered with big amplitudes that in some cases reached ~ 70-90%, rendering this recent enhancement in one of the greatest GLEs of the 23rd solar cycle. The Athens Neutron Monitor Data Processing (ANMODAP) Center, using the onset algorithm produced a real time alert signal concerning GLE 70 and sent it out by an email notice. This was the first real time alert signal which was produced in a worldwide level. Apart from the alert signal, the treatment of the GLE 70 was made with the application of the Neutron Monitor-Basic Anisotropic Ground Level Enhancement (NM-BANGLE) model, using data from thirty four neutron monitor stations widely distributed around the globe, resulted in the determination of some GLE-parameters such as the rigidity spectrum and the location of the anisotropy source during different moments of the event. Additionally, within the first quarter of December 2006, important radiation effects took place due to the very energetic particles that reached the Earth. A simulation on space radiation for this specific period using the Space Environment Information System (SPENVIS) tool is also being considered.

Athens NM station

(http://cosray.uoa.gr)

Super 6NM-64, Rigidity 8.53GV,

37° 53′N 23° 43′E

Altitude 260m

M.Pres. 780mbar

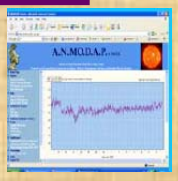
Real time data of cosmic ray measurements provided by Athens Neutron Monitor (6NM-64) since November 2000. Athens station was the sixth one to present both graphical and digital data.

Data resolution: 1hour,1min and 1sec

ANMODAP Center

(Mavromichalaki et al , Ann. Geophys. 2005)

The result of an effort during last years in order to construct an effective database of both NM and satellite data in real time regarding the necessities of Space Weather monitoring is the Neutron Monitor Network Data Processed in Athens (ANMODAP Center)



The system of the ANMODAP Center collects data in real time from twenty-three widely distributed real time cosmic ray stations using the Internet.

Graphical representation of ANMODAP data

The alert System

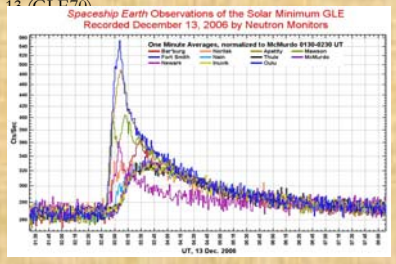
(Mavromichalaki et al , IEEE 2005)

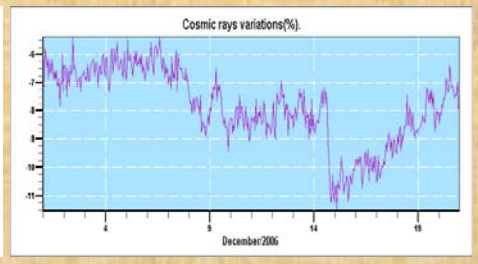
The Alert software is able to determine the onset of a forth coming Ground Level Enhancement (GLE) using the 1-min NM database of Athens station.

The Athens Neutron Monitor Data Processing (ANMODAP) Center, using the onset algorithm produced a real time alert signal concerning GLE 70 and sent it out by an email notice. This was the first real time alert signal which was produced in a worldwide level

Recent event of December 2006 - GLE70

Within the absolute minimum phase of the 23rd solar cycle the worldwide neutron monitor network recorded unusual cosmic ray events. In specific, a significant ground level enhancement (GLE) took place on December 13 (GLE70)



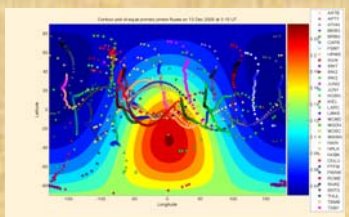


The extreme cosmic ray activity during December 2006 recorded by Athens NM

The NM Bangle Model

(Plainaki et al., JGR, 2007)

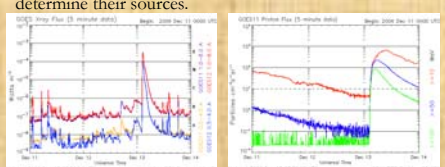
Apart from the alert signal, the treatment of the GLE 70 was made with the application of the Neutron Monitor-Basic Anisotropic Ground Level Enhancement (NM-BANGLE) model, using data from thirty four neutron monitor stations widely distributed around the globe, resulted in the determination of some GLE-parameters such as the rigidity spectrum and the location of the anisotropy source during different moments of the event.



Solar Proton Events/SXR flares

(Gerontidou et al., AIP 2006)

An extend study of the relation of Solar Proton Events and Soft X-ray flares has been done in order to determine their sources.

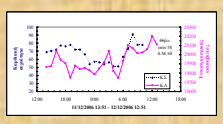


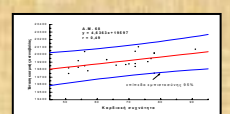
SPE of 13 December recorded from GOES

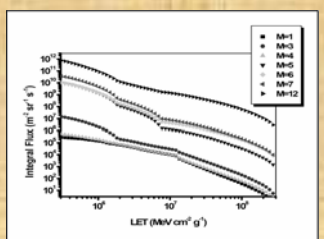
Radiation Effects

(Mavromichalaki et al, IEEE TNS 2007)

Additionally, within the first quarter of December 2006, important radiation effects took place due to the very energetic particles that reached the Earth. A simulation on space radiation for this specific period using the Space Environment Information System (SPENVIS) tool is also being considered.



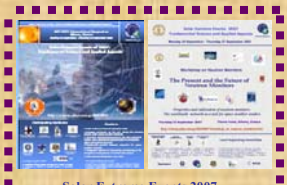




Cosmic Ray/Human Health

(Petropoulos et al, Academy of Athens, 2006)

The relationship between daily cosmic ray variations and the average daily and hourly heart frequency for the years 2002 – 2006 has been studied.



Solar Extreme Events 2007
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Workshop on Neutron Monitors
http://cosray.phys.uoa.gr/SEE2007