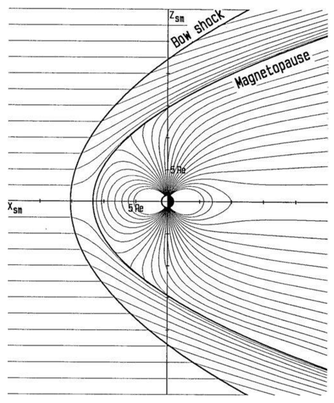
Cosmic Rays: Observation

Geomagnetic transmission

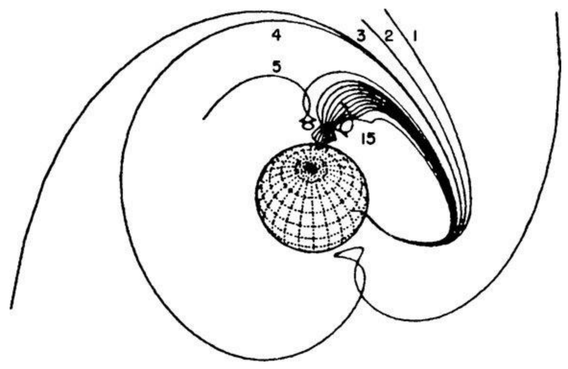
Geomagnetic rigidity cutoff – energy screening – The Earth as Magnetic Spectrometer :

$$R = \rho Bc = pc/q$$

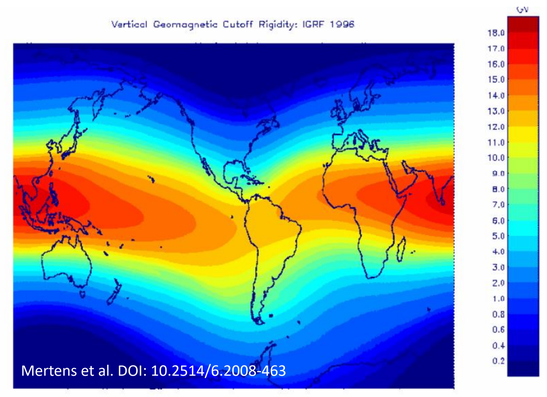
Higher momentum – higher resistance to deflection in B.

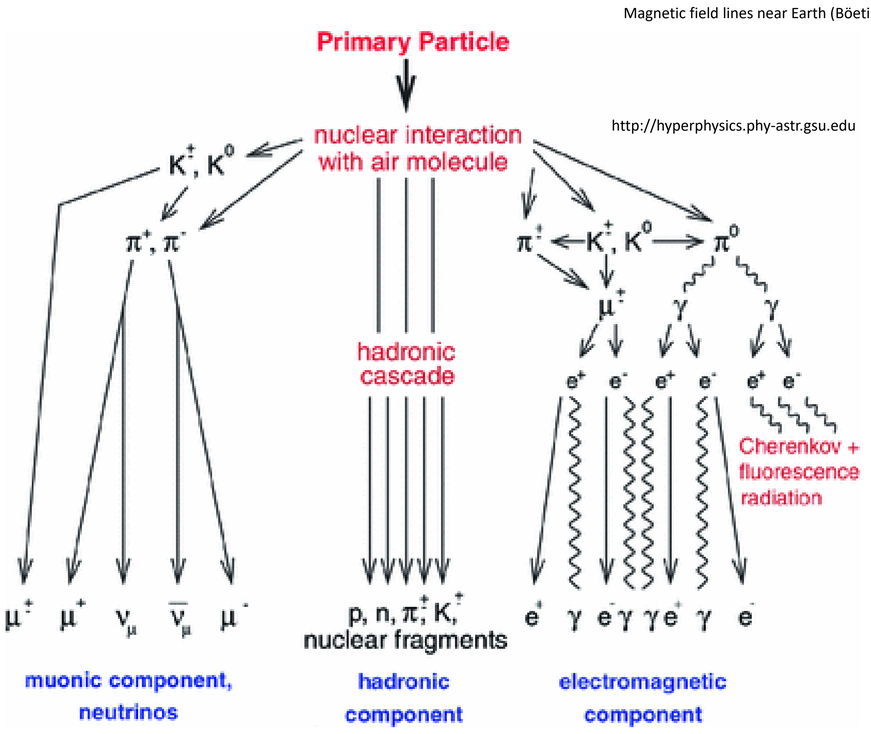


Magnetic field lines near Earth (Böetikofer et al. 1995)



Trajectory tracing in the magnetosphere (Smart2000)





http://hyperphysics.phy-astr.gsu.edu

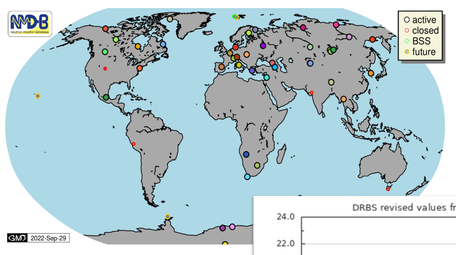
Atmospheric transmission – Extended Air Showers(EAS):

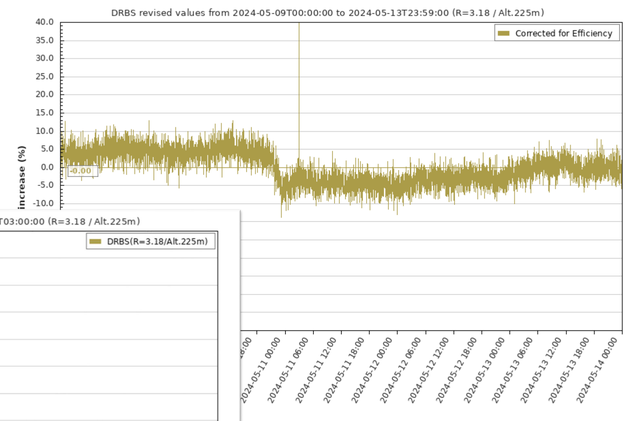
primary cosmic rays collide with the nuclei of atmospheric atoms (15-35 km altitude) and initiate particle cascades that last several generations and produce a large number of secondary particles that may or may not reach sea level:

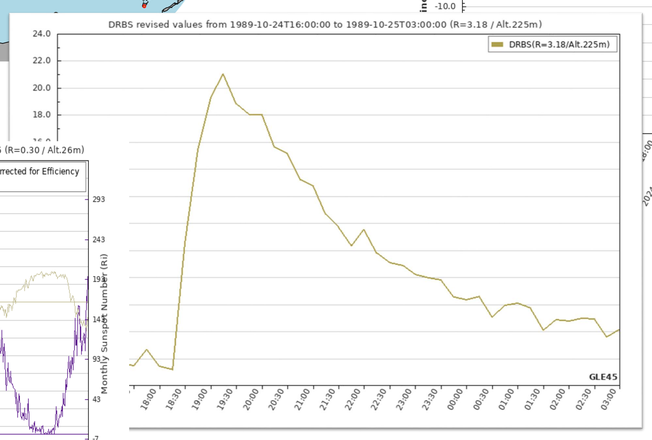
***Muons**, <E> 4 GeV, ~70 m^{-2} sr^{-1} s^{-1}*

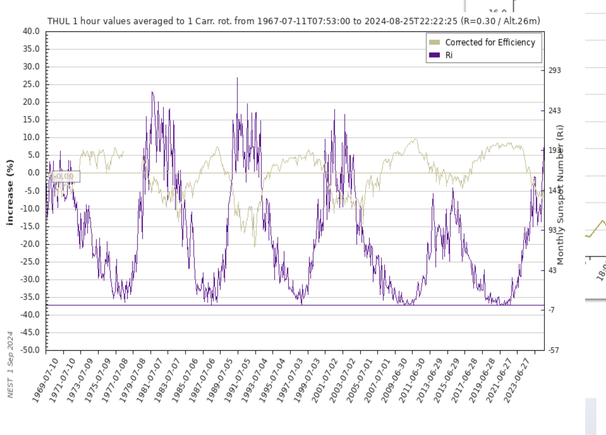
***Electro Magnetic Component** (electrons, photons, positrons); intensity varies strongly*

***Nucleonic component** neutrons, protons ~3 m^{-2} sr^{-1} s^{-1}*







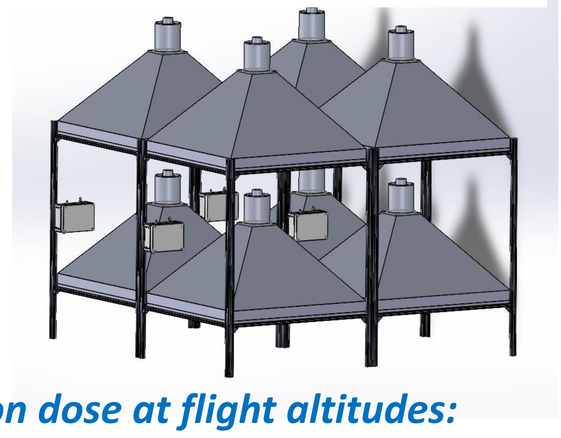


Neutron Monitors – long time stability

Operating continuously for more than 70 years to monitor the hadronic component. Working in a network they provide valuable information about the energetic properties of Solar Particle Events.

Cosmic Rays as a Tool for advanced Space Weather warning

*Due to their high energies (and therefore velocities) cosmic rays that interact with high energy matter ejected from the Sun can be modulated and produce anisotropies in the Neutron Monitors and Muon Telescope observations – **precursors.***

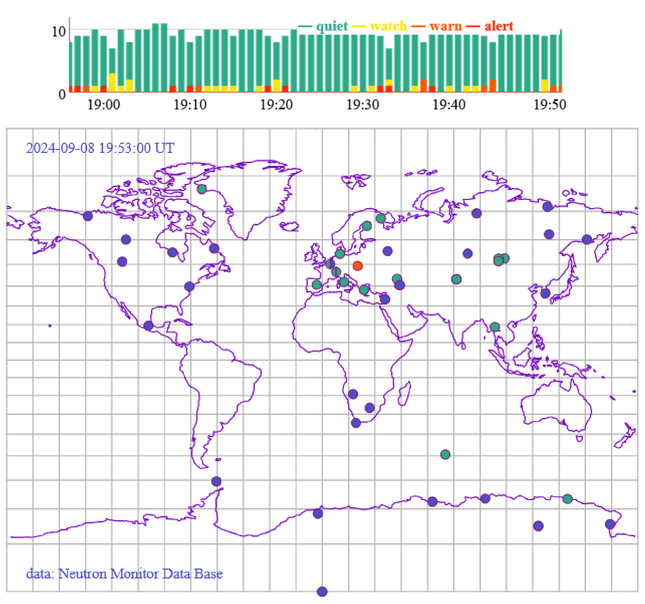


Muon Telescopes – directivity

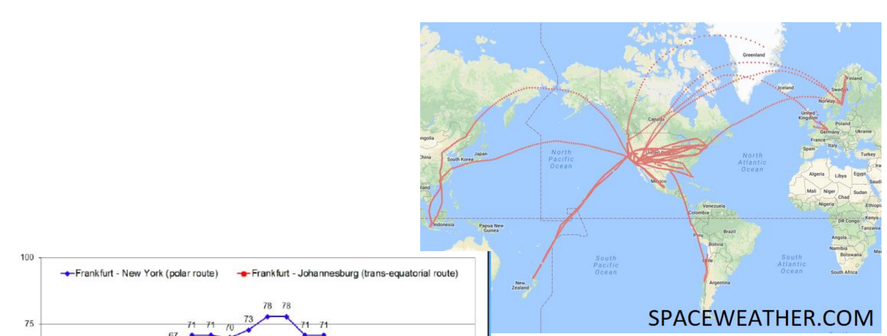
*Advanced instrument allowing observation of real-time anisotropies in the interplanetary space **. Indispensable tool for space weather services and forecast.***

Data and Services

Ground level enhancement (GLE) Alert:

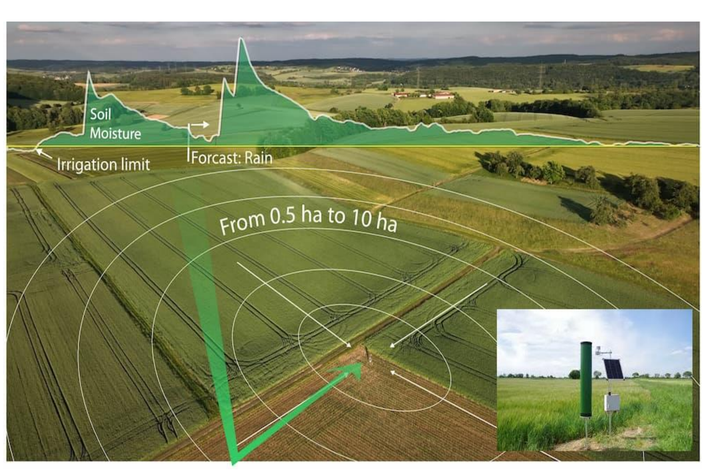


Radiation dose at flight altitudes:



Gerhard Fracsh, 2014

Soil Humidity measurements:



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