Neutron Monitors

Neutron Monitors are ground-based instruments used to detect cosmic rays on a global scale. Cosmic rays will interact with air molecules in the upper atmosphere and produce high energy secondary particles. These particles will then interact with other air molecules, creating a cascade of energetic particles through the atmosphere. Once this cascade reaches a surface neutron monitor, the particles will interact with the heavy metal producer in the neutron monitor to produce neutrons, which are then detected by the gas detector tube.

Neutron monitors were first used experimentally by John Simpson in 1947. Since then, they have been installed and operated by many institutions around the world. The University of New Hampshire currently operates two functional neutron monitors—one in Durham, NH, and one in Leadville, CO. In addition, the university is the custodian of historical data from three other neutron monitors—Mount Washington, NH (operational from 1955 to 2006), Climax, CO (operational from 1951 to 2006), and Haleakala, HI (operational from 1991 to 2006). Currently, none of the data from any of these monitors has been contributed to the neutron monitor database.

Cosmic Rays

Cosmic rays consist of high energy subatomic particles, primarily protons or α particles. They generally originate from stars, supernova, or are particles in the interplanetary medium that have been accelerated in some way (shocks or magnetic fields, for instance). Typically, these particles have energies that range from about 100 MeV to about 10 GeV. This wide range is measured from detectors on satellites above Earth’s atmosphere. Due to attenuation in the atmosphere, only particles with a high enough incident energy (above 1 GeV) will ever reach the surface of the earth to be detected by neutron monitors. The magnetic field also plays a role in what the minimum energy a particle must have for it to be detected at ground level. At lower latitudes, the magnetic field impedes the motion of charged particles more, so particles must have more energy to create a cascade that will reach the ground.

Current Work

To include the UNH operated neutron monitors in the NMDB, the original data had to be reformatted to match the required format. This included:
- finding the total count rate of the whole monitor and correcting it for any tubes that did not report a value correcting the total count rate for the pressure conditions and the detector’s efficiency
- changing the time stamp to YYYY-MM-DD HH:MM:SS format
- finding the hour average of the count rates

The NMDB has three tables for each set of maximum resolution data submitted: STATION_ori, which lists the original and pressure and efficiency corrected measurements, STATION_rev, which has the same categories as STATION_ori, but is only used if a revision has been made to the data at a later date, and STATION_env, which lists the environmental conditions for each measurement. In addition, there are three additional tables: STATION_1h, which is a one hour average of the measurements; STATION_meta, which is a human generated record of the station; and station_information, which contains information about the monitor and station.

Figure 6 shows sample input data from Climax, CO, Leadville, CO, and Durham, NH (below). Variability in data file formats can make data processing difficult.

References

Neutron Monitor Database. European Commission, Seventh Frameworks Programme. <www.nmdb.eu>

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