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Response Functions of a Semi-Leaded Neutron Monitor from Latitude Surveys during 2018 - 2020

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We have developed a mobile neutron monitor (“Changvan”) with three neutron counters to investigate cosmic ray spectral variations via ship-borne latitude surveys. Because Earth’s magnetic field excludes cosmic rays below the local geomagnetic cutoff rigidity, which depends on magnetic latitude, the count rate due to atmospheric neutrons from cosmic ray showers vs. cutoff rigidity (i.e., the response function) is directly related to the cosmic ray spectrum. Repeated measurements with the same detector over different solar cycle phases can provide precise information about cosmic ray spectral variations. The Changvan uses the NM64 design, except that the central counter lacks the lead producer, so we call this a “semi-leaded” neutron monitor. The Changvan was operated on two voyages on the Chinese icebreaker “Xue Long” between Shanghai and Antarctica during 2018 – 2020, from which we have measured the response function of each counter. We present a preliminary comparison of response functions from Monte Carlo simulation and Changvan measurements. We find that the leaded/unleaded count rate ratio is sensitive to the cutoff rigidity, and the maximum difference between simulated and experimental ratios was less than 8%. This leads to a promising spectral indicator that could be used to determine the spectral index of relativistic solar ions or Galactic cosmic rays with a single detector. The research is supported in part by Thailand Science Research and Innovation via Research Team Promotion Grant RTA6280002.

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