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Measurement and simulation of neutron monitors count rate dependence on surrounding structure

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Neutron monitors are the premier instruments for precise measurements of time variations (e.g., of solar origin) in the Galactic cosmic ray (GCR) flux in the range of ~1-100 GeV. However, it has proven challenging to accurately determine the yield function (efficiency) vs. rigidity in order to relate a neutron monitor's count rate with those of other monitors in the worldwide network and the underlying GCR spectrum. Monte Carlo simulations of the yield function have been developed but there have been few opportunities to validate these models observationally, especially with regard to the particular environment surrounding each monitor. Here we have precisely measured the count rate of a calibration neutron monitor ("calmon") near the Princess Sirindhorn Neutron Monitor (PSNM) at Doi Inthanon, Thailand, which provides a basis for comparison with count rates of other neutron monitors worldwide that are similarly calibrated. We directly measured the effect of the surrounding structure by operating the calmon both outside and inside the building. Using Monte Carlo simulations, we can clarify differences in response of the calmon and PSNM, as well as the calmon outside and inside the building. The dependence of the calmon count rate on surrounding structure can be attributed to its sensitivity to neutrons of 0.5-10 MeV and a shift of sensitivity to nucleons of higher energy when placed inside the building. Simulation results for the calmon to PSNM count rate ratio are in agreement to within a few percent, providing a useful validation and improving confidence in our ability to model the yield function for a neutron monitor station. Partially supported by the Thailand Research Fund, a Mahidol University postdoctoral fellowship, the South African National Antarctic Programme of the National Research Foundation, and the United States National Science Foundation (PLR-1341562, PLR-1245939, and their predecessors).

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