Interpreting Cosmic Ray Neutron-Based Snow Water Equivalent Estimates from Heterogenous Snow Distributions

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ABSTRACT

Conventional methods of snow water equivalent (SWE) methods are questionable in the spatially heterogenous snow of prairie environments. Despite low annual snowfall, snowpacks on North American prairies are extensively redistributed by wind, leading to scouring of open areas, and accumulation behind barriers (e.g., trees and fences) or topographically low areas. Cosmic ray neutron sensing (CRNS) techniques are capable of making SWE estimates that are more representative of the areal average than conventional methods due to their large areal footprint, approximately 200-300 meters radius. A CRNS instrument was deployed at the Central Agricultural Research Center in central Montana, USA as a part of the NASA SnowEx field campaign during winter 2020-2021. CRNS has shown to be sensitive to areal average SWE within its footprint in a prairie environment. However, the moderated neutron flux from varying spatial distributions of shallow snowpack within the sensor's footprint remains a source of uncertainty in SWE estimates. To address this uncertainty, we use a Monte Carlo neutron transport model to simulate the CRNS response under varying spatial distribution patterns of snowpack. Preliminary results showed that bare field conditions near the CRNS can yield larger neutron counts, and thus depressed SWE estimates. Once the effects are known, we hope to be able to correct SWE measurements for changes in the snow distribution. These results aid in the interpretation of CRNS SWE estimates in the prairie and demonstrate the value of CRNS observations in highly variable shallow snow environments.

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