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Cosmic-ray neutron sensing based monitoring of snowpack dynamics: A comparison of four conversion methods

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Snow monitoring instruments like snow pillows are influenced by disturbances such as energy transport into the snowpack, influences from wind fields or varying snow properties within the snowpack (e.g. ice layers). The intensity of epithermal neutrons that are produced in the soil by cosmic radiation and measured above the ground surface is sensitive to soil moisture in the upper decimetres of the ground within a radius of hectometres. Recently, it has been shown that aboveground cosmic ray neutron sensors (CRNS) are also a promising technique to monitor snow pack development thanks to the larger support that they provide and to the lower need for maintenance compared to conventional sensor systems. The basic principle is that snow water moderates neutron intensity in the footprint of the CRNS probe. The epithermal neutrons originating from the soil become increasingly attenuated with increasing depth of the snow cover, so that the neutron intensity measured by the CRN probe above the snow cover is directly related to the snow water equivalent.

In this paper, we use long-term CRNS measurements in the Pinios Hydrologic Observatory, Greece, to test different methods for the conversion from neutron count rates to snow pack characteristics, namely: i) linear regression, ii) the standard N_0-calibration function, iii) a physically-based calibration approach and iv) the thermal to epithermal neutron ratio. The latter was also tested for its reliability in determining the start and end of snowpack development, respectively. The CRNS-derived snow pack dynamics are compared with snow depth measurements by a sonic sensor located near the CRNS probe. In the presentation, we will discuss the accuracy of the four conversion methods and provide recommendations for the application of CRNS-based snow pack measurements.