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Using downward-looking cosmogenic neutron sensor to calibrate wide-area sensor and to measure snow water equivalent

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Cosmogenic (or cosmic-ray) neutron sensors used for soil moisture monitoring have a horizontal footprint of hectometers, with higher sensitivity to the nearest few meters and lower sensitivity to distances up to 250 m. The instruments are called “standard COSMOS sensors” or wide-area sensors. In the last two years we have developed a new sensor with a more focused horizontal footprint. The downward-looking or local-area sensor can measure soil moisture in an area that is more consistent with the physical dimension of the sensor. It has neutron shields on all sides except the bottom that reduce the contribution of neutrons coming from afar, while allowing those neutrons that come from below to enter the detector. We showed that our particular sensor has a footprint of ca. 1 m and that it can be calibrated on independent in-situ soil moisture measurements.

Here, we propose two ways in which local-area sensors can be used in hydrology. One is the non-invasive calibration of wide-area sensors. Conventionally, calibration is performed by taking numerous samples within the hectometer footprint, measuring soil moisture by the oven drying method, computing representative averages, and comparing it to the simultaneously measured neutron intensity of a standard COSMOS sensor. In the method discussed here this procedure is replaced by measuring the local neutron intensity at the same sampling locations within the footprint instead.

The second application is the non-invasive measurement of snow-water equivalent with the local-area sensor placed on top of snow pack (stationary sensing) or on a moving sled (roving). Preliminary data are promising, showing consistent decrease in the neutron intensity with increasing snow-water equivalent. We are collecting additional experimental data and comparing them with results from neutron transport models.