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Signal contribution of remote areas to cosmic-ray neutron sensors based on distance and sensitivity

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Cosmic-Ray Neutron Sensing (CRNS) is an established measurement technique for water content in soils and snow. The high integration depth and the large measurement footprint is an important advantage compared to conventional point-scale sensors. However, the radial-symmetrical footprint definition based on the 86% quantile of detected neutrons is often not helpful to explain the influence of certain areas in complex fields. Many natural sites are highly heterogeneous and thus knowledge of the contribution of distant areas to the measurement signal would be very useful, e.g. to support calibration sampling, sensor location design, data interpretation, and uncertainty assessment. Here, CRNS calibration and validation remains a challenge, since the influence of the different fields and structures to the signal is usually not known.

In this presentation, we proposes a generalized analytical procedure to estimate the contribution of patches or fields in the footprint of a cosmic-ray neutron detector to its signal using the radial intensity functions. The proposed method could greatly support calibration sampling, sensor location design, and uncertainty assessment, e.g. in complex or vegetated terrain, without the need of computationally expensive neutron modeling. Furthermore, a new concept for a more practical definition of the sensor footprint is proposed, which represents the maximal distance to a field such that its soil moisture change is still sensible in terms of measurement precision.