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Accuracy and precision of cosmic-ray neutron sensors at humid environments

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The accuracy and precision of the Cosmic-Ray Neutron Sensor (CRNS) counting rate and its soil moisture estimate are affected differently by distinct neutron mitigating factors. On one hand, the accuracy of the sensor can be improved by correcting for different hydrogen pools but the precision can only be improved by increasing the surface area of the sensor or by increasing the integration time. Most past studies had not investigated the effects of different neutron mitigating factors on the accuracy and precision separately, and often use these terms interchangeably. Here, we used data from three agricultural sites located in Southern England to investigate this issue. We developed an extended version of the COsmic-ray Soil Moisture Interaction Code (COSMIC) which includes additional effects of relevant neutron mitigating factors on the neutron counts. We incorporate a sensitivity analysis framework to the extended version of COSMIC to test the contribution of individual mitigating factors. With regards to the accuracy and precision of measured neutron counts, we found atmospheric pressure and soil water content to be most influential contributing to 35% and 20% of the signal variability, respectively. When analyzing the precision of the derived soil moisture content from CRNS, our results suggest that the soil water content itself contributes to approximately 60% of the signal variability while soil bulk density, lattice water, and soil organic matter have low contributions on the order of 5% each. All other signals are found to be below our sensitivity threshold. As the use of CRNS continues to expand, we recommend that a detailed assessment of signal uncertainty and its propagation from measured neutron count to derived soil moisture to be included in the future.