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# Improved soil moisture-atmospheric boundary layer interactions by assimilation of Cosmic-Ray Neutron counts

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The Cosmic-Ray Neutron Sensing (CRNS) technology determines soil moisture for a few tens of hectares in a non-invasive way. These measurements, however, can be used to extend soil moisture characterization at regional scales using data assimilation. In the present study, we deployed the Ensemble Adjustment Kalman Filter (EAKF) to assimilate the CRNS neutron counts in order to update the spatial soil moisture, soil infiltration, and evapotranspiration parameters of the Noah-MP land surface model witch is also part of the WRF-Hydro modelling system. The study was conducted in the southern part of Germany, which includes the Rott and Ammer catchments within the TERENO Pre-Alpine observatory. The assimilation was carried out for both, a Noah-MP standalone scenario with observed rainfall as input and a coupled WRF-Hydro scenario with simulated rainfall to fully evaluate the added value of the assimilation. The assimilation performance was analysed at local and regional scale using independent soil moisture observations across the modelling domain. During the assimilation period, the Noah-MP standalone findings demonstrate a significant improvement in field scale soil moisture characterisation. The RMSE of simulated soil moisture was decreased by up to 66 % at field scale and up to 23 % at catchment scale. Additionally, the spatial patterns in the field scale soil moisture have showed improvement with reduction in spatial Bias by 0.025 $cm^3/cm^3$. The initial results from coupled WRF-Hydro scenario demonstrate that the soil moisture and parameter estimation experiment had a significant impact on estimated soil moisture and, humidity and evapotranspiration at regional scale. These findings support the use of the CRNS technique to improve the land surface and coupled hydro-atmospheric modelling.