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The impact of observed cosmic-ray neutrons on simulated soil moisture and land energy partitioning

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Characterizing the influence that the land surface exerts to the atmosphere is of extreme importance in order to improve the realism of numerical weather and climate predictions under a changing world. Not surprisingly, the soil moisture is considered to be one of the most important components associated with land-atmosphere coupling but its measurement at intermediate scales can be difficult given the inherent heterogeneity in soil water processes. Global coverage soil moisture estimates are provided via satellite remote sensing technology and its continuing success also depend on the availability of ground-based hydrometeorological measurements for calibration and validation applications. Here, we investigate the benefits and limitations of a new innovative technology that measures cosmic-ray neutron intensity to estimate integrated soil moisture at unprecedented spatial scales (i.e. sub-kilometer), which can potentially fill the gap between traditional point-scale measurements and satellite remote sensing products. To better understand the impact of those measurements on land surface processes, we combine the uncertainties from a land surface model and from the cosmic-ray soil moisture sensor using parameter estimation techniques and an ensemble data assimilation framework. The ability of the Noah land surface model to reproduce soil moisture dynamics and surface energy fluxes is evaluated at three sites from the COsmic-ray Soil Moisture Observing System (COSMOS) in the USA, characterized by different climatological and land cover aspects, and using both "synthetic" and "real observation" experiments.