At last it is possible to measure area-average soil moisture!

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Abstract. When a hitherto impossible measurement becomes possible, there are transformational changes in understanding. But measuring soil moisture using cosmic rays? It sounds like 1950s science fiction, doesn't it. However, the non-invasive measurement of soil moisture at a horizontal scale of ~700m and depths of 15-70 cm is now feasible, by counting cosmic-ray neutrons that are generated within soil, moderated mainly by the hydrogen atoms, and emitted back to the atmosphere. The number of neutrons counted is sensitive to water content changes, largely insensitive to soil chemistry, and their intensity is inversely correlated with the hydrogen (i.e., water) content of the soil. Neither the basis of this measurement method nor the sensor technology used are new, they have been around for decades. However, the systematic understanding of cosmic-ray interactions at the ground-atmosphere interface and resulting knowledge of the source "footprint" of above ground neutron detectors and recognition of their lack of sensitivity to soil type in selected neutron energy bands is new, as is the low power electronics used for remote signal conditioning, counting and data capture. The measurement with a portable neutron detector placed above the ground takes minutes to hours, permitting high-resolution, long-term monitoring of undisturbed soil moisture. The large footprint makes the method suitable for weather and short-term climate forecast initialization and satellite validation, while the measurement depth makes the probe ideal for studying plant/soil/atmosphere interactions. Inclusion of a second detector that is sensitive to neutrons with lower energy shows promise as a means for detecting snow cover. This talk briefly overviews evidence that soil moisture status can potentially influence weather and seasonal climate and describe the COsmic-ray Soil Moisture Observing System (COSMOS), which observing program will install initially a network of 50 probes (to provide a proof of concept) and subsequently 500 probes distributed across the contiguous USA. The nature, scope, and scientific focus of the COSMOS program is described together with deployment strategies and potential probe locations. Proposed redevelopment of the cosmic ray method to allow calibration of upcoming remote sensing missions is also discussed, and some early results obtained at COSMOS probe sites presented.