LONG-TERM MONITORING OF SOIL MOISTURE CONTENT USING PORTABLE NMR INSTRUMENTS

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Nuclear magnetic resonance (NMR) has been previously proposed and demonstrated as viable method for measuring water content in unsaturated soils and sediments. Man-portable NMR logging tools and non-invasive NMR instruments have recently become available. These portable NMR geophysical tools provide several potential advantages over existing soil moisture sensors including:

a) direct detection of water,
b) no radioactive source,
c) theoretical independence from soil type,
d) providing information on the water-filled pore size distribution, and
e) not requiring contact with or disturbance of the native soil under investigation.

A series of laboratory and field experiments were performed to test the ability of portable NMR instruments to accurately measure total water content in-situ across a wide range of soils and saturation states, and yield unique information relating to water-filled pore size distributions. Controlled laboratory measurements used a portable NMR probe, capacitance, frequency-domain and time-domain reflectometry sensors to measure water content over a several-month long cycle of saturation, draining and drying, in three contrasting sample soils. These experiments showed that the NMR sensor and the other soil moisture sensors exhibited small biases in total water content estimation, while the NMR sensor data also exhibited small variance due to random noise. The NMR data also showed clear trends in the quantification of mobile, capillary and clay bound water as the samples dried over time. Concurrent long-term monitoring experiments were performed in shallow access tubes installed at field sites in Crested Butte, Colorado and Blodgett Forest, California. These field experiments spanned one full annual precipitation cycle and the NMR data yielded unique insight into the water storage in different apparent pore sizes. The field data are presently being correlated with concurrently sampled soil CO_2 flux measurements to assess the potential for NMR-measured water content distributions to improve the understanding of carbon cycling in soils.