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COsmic-ray Soil Moisture Observing System (COSMOS): an overview and recent progress

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Area-average soil moisture at the horizontal scale of hectometers and vertical scale of decimeters can be inferred from measurements of cosmic-ray fast neutron intensity in air above the ground surface. Hydrogen is very efficient at moderating (or removing) fast neutrons, and therefore emission of neutrons from soil and their concentration in the atmosphere are inversely correlated with the soil moisture content. Fast neutrons are measured using a gas-filled thermal neutron detector surrounded by plastic. Such detectors can be stationary or mobile. Stationary cosmic-ray detectors are being used to form the COsmic-ray Soil Moisture Observing System (COSMOS) that provides continental-scale soil moisture data in the USA. Mobile detector, called the COSMOS rover, can be used to map neutrons and infer soil moisture content over large areas or along long lines. Recent advances have been made on calibration of COSMOS probes, conversion of neutron intensity to soil moisture, and mobile measurements. Correction factors have been developed to account for variations in the incoming cosmic-ray intensity, soil mineral chemistry and atmospheric water content; additional corrections, for example for topography and surface water, need to be developed. With these corrections a "universal" calibration function can be developed. Mobile measurements using the car-mounted COSMOS rover have previously been shown to produce reasonable soil moisture fields. New simultaneous measurements using car-mounted and helicopter-mounted rovers gave comparable results, extending the rover capability to low-flying aircraft and permitting rapid measurements over difficult areas that are inaccessible to ground vehicles.

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