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VHF SoOp (Signal of Opportunity) Technology Demonstration for Soil Moisture Measurement Using Microwave Hydraulic Boom Truck Platform

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A goal of this research is to test deployable VHF antennas for 6U Cubesat platforms to enable validation of root zone soil moisture (RZSM) estimation algorithms for signal of opportunity (SoOp) remote sensing over the 240-270 MHz frequency band. The proposed work provides a strong foundation for establishing a technology development path for maturing a global direct surface soil moisture (SM) and RZSM measurement system over a variety of land covers. Knowledge of RZSM up to a depth of 1 meter and surface SM up to a depth of 0.05 meter on a global scale, at a spatial resolution of 1-10 km through moderate-to-heavy vegetation, is critical to understanding global water resources and the vertical moisture gradient in the Earth's surface layer which controls moisture interactions between the soil, vegetation, and atmosphere. Current observations of surface SM from space by L-band radiometers (1.4 GHz) and radars (1.26 GHz) are limited to measurements of surface SM up to a depth of $\sim$0.05 meter through moderate amounts of vegetation. This limitation is mainly due to the inability of L-band signals to penetrate through dense vegetation and deep into the soil column. Satellite observations of the surface moisture conditions are coupled to sophisticated models which extrapolate the surface SM into the root zone, thus providing an indirect estimate rather than a direct measurement of RZSM. To overcome this limitation, low-frequency airborne radars operating at 435 MHz and 118 MHz have been investigated, since these lower frequencies should penetrate denser vegetation and respond to conditions deeper in the soil.
This presentation describes a new and less expensive technique for SM as well as RZSM direct measurement using Signal of Opportunity transmitters. Being less expensive and needing only passive simple RF receiver, the SoOp concept has the potential for being used for space borne applications, thus providing global SM and RZSM measurements. This study will describe current efforts in developing necessary RF hardware to demonstrate and validate the SoOp concept. To receive direct signal from this satellite and also its reflected signal from ground, we developed 4 channel VHF digital receiver.