L-BAND HIGH SPATIAL RESOLUTION SOIL MOISTURE MAPPING USING SMALL UNMANNED AERIAL SYSTEMS

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Soil moisture is of fundamental importance to many hydrological, biological and biogeochemical processes, plays an important role in the development and evolution of convective weather and precipitation, water resource management, agriculture, and flood runoff prediction. The launch of NASA's Soil Moisture Active/Passive (SMAP) mission in 2015 provide new passive global measurements of soil moisture and surface freeze/thaw state at fixed crossing times and spatial resolutions of 36 km. However, there exists a need for measurements of soil moisture on smaller spatial scales and arbitrary diurnal times for SMAP validation, precision agriculture and evaporation and transpiration studies of boundary layer heat transport. The Lobe Differencing Correlation Radiometer (LDCR) provides a means of mapping soil moisture on spatial scales as small as several meters. Compared with other methods of validation based on either in-situ measurements or existing airborne sensors suitable for manned aircraft deployment, the integrated design of the LDCR on a lightweight small UAS (sUAS) is capable of providing sub-watershed (~km scale) coverage at very high spatial resolution (~15 m) suitable for scale studies, and at comparatively low operator cost. To demonstrate the LDCR several flights had been performed during field experiments at the Canton Oklahoma Soilscape site and Yuma Colorado Irrigation Research Foundation (IRF) site in 2015 and 2016 separately using LDCR Rev A and Tempest sUAS. The scientific intercomparisons of LDCR retrieved soil moisture and in-situ measurements will be presented. The next revision of the sensor – LDCR Rev B - has been built and integrated into SuperSwift sUAS. In Rev B, besides analog correlator data, a digital backend is also implemented. The IF signal is sampled at 80 MS/s to enable digital correlation, RFI detection and mitigation capability. The Rev B architecture and hardware implementation is discussed along with the challenges involved in integrating the sensor with the SuperSwift airframe. The dual analog and digital backend implementation enables comparison of the two approaches in terms of RFI detection, RFI mitigation, thermal drift etc. Time/frequency blanking, cross frequency detection and spectral kurtosis tests are implemented in individual channels for RFI detection. A study of the spectral kurtosis of the cross spectra in correlating radiometers and its application in RFI detection is carried out.