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 provided 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 satellite data validation, precision agriculture, 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) can provide sub-watershed (~km scale) coverage at very high spatial resolution (~15 m) suitable for scaling 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, respectively, using LDCR Revision A and Tempest sUAS. A semi-linear observing matrix of LDCR antenna temperature T_A at serpentine sampling grid from VSM at user-defined mapping gird (~5×5 m spatial resolution) was determined by considering the LDCR MiCo antenna radiation pattern, soil-vegetation radiative transfer (RT) model, soil dielectric mixing model, surface roughness correction, and vegetation correction. The VSM at mapping grid are then estimated using linear minimum mean square error (LMMSE) estimation method. The scientific intercomparisons of LDCR retrieved soil moisture and ground truth data will be presented.