ACTIVE-PASSIVE FORWARD AND INVERSE MODELING IN SUPPORT OF SMAP AND SOIL MOISTURE REMOTE SENSING

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NASAs Soil Moisture Active Passive (SMAP) mission aims to provide the science community with unprecedented global surface soil moisture estimates to address many of the pressing and current climate dynamics questions. To achieve mission requirements and goals, SMAP will utilize an L-band Synthetic Aperture Radar (SAR) and L-band Radiometer to monitor global surface soil moisture. The cornerstone of the SMAP mission is the soil moisture data product derived from the combined Radar-Radiometer soil moisture retrieval algorithm. Improved soil moisture estimates both in terms of accuracy and spatial resolution are expected by effectively combining measurements from SMAPs radar and radiometer.

In support of SMAP and to further develop Active-Passive soil moisture remote sensing techniques for other platforms, both forward and inverse modeling issues must be addressed. Current practical forward models used for soil moisture estimation do not link emission and scattering together and neglect their underlying physical relationships. This work will highlight the possibility to obtain more accurate soil moisture estimates in a “true” Active-Passive framework by addressing these current shortcomings. Initially, an improved and physically consistent emission-scattering model will be presented and compared to established models. Then, the applicability of such models within soil moisture estimation algorithms will be demonstrated and retrieval errors examined.

By defining a shared parameter kernel and linking emission and scattering together through higher order solutions of the Radiative Transfer equation and also Peak’s Emissivity relationships, consistent modeling can be achieved. Most importantly, the complimentary sensitivities of emission and scattering, i.e., backscattering cross section and brightness temperature, to surface soil moisture and vegetation can be captured in a unified fashion. In a forward-model centric optimization algorithm a joint cost function is then defined which constrains radar backscatter and radiometer brightness temperature measurements. Minimizing model parameters are reported as soil moisture estimates of interest. By utilization of a shared parameter kernel, unified forward models, and constrained measurements through this cost function it will be demonstrated that soil moisture retrieval errors can be greatly reduced across a wide range of vegetation water content (VWC) values for various land cover types. This method does not address the SMAP spatial resolution disparity between the two instruments but is central to a truly Active-Passive estimation scheme. Applicability of this method will be highlight by applying this method to both tower-based remote sensing systems as well as airborne data. Results presented and discussed will show (1) improved soil moisture estimation by utilization of consistent forward modeling (2) reduction of estimation errors for Active-Passive retrievals compared to Radar-only or Radiometer-only soil moisture retrieval methods.