A feasibility study to retrieve deep soil moisture using a temporal variational data assimilation method and WindSat data

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Abstract. A variational data assimilation methodology is used to derive temporal deep soil moisture profile sensitivities for use with future satellite data. Several case study data sets were selected for analysis and WindSat satellite data were used as a surrogate for future microwave imager/sounder sensor data. The framework for a full 4-dimensional variational (4DVAR) data assimilation system has been developed. Soil moisture sensitivity results using 2-dimensional components of the 4DVAR Regional Atmospheric Mesoscale Data Assimilation System (RAMDAS) are presented. Our goal is to identify paths to soil moisture performance objective (soil moisture at depths between 0-80 cm) for US Army use, and to identify and mitigate algorithm impediments to its potential performance. The validation aspects of this work will also enable the Army to more accurately determine the Soil Moisture EDR impacts upon DoD-related trafficability, off-road mobility, counter-mine operations, and hydrological streamflow estimation. Our results indicate that the depth penetration of the soil moisture information with time is dependent on soil texture information, and in particular, the soil hydraulic conductivity parameter. A majority of soils show very deep soil moisture sensitivity penetration (>100 cm soil depths) after approximately 7-14 days of temporal data assimilation. Some soils require longer integration times. Examples of the deep soil moisture signal from the temporal adjoint sensitivity studies will be presented. This research was supported in part by the DoD Center for Geosciences/Atmospheric Research at Colorado State University under Cooperative Agreement W911NF-06-2-0015 with the Army Research Laboratory.