Scaling, Physical Controls, and Effective Parameters in Multi-Scale Soil Hydrology – Current Understanding and Future Opportunities!

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Soil moisture is the natural state variable of the land surface critical to climate feedback, hydrology, and agriculture. Its temporal and spatial variability over catchment areas affects surface and subsurface runoff, modulates evaporation and transpiration, determines the extent of groundwater recharge and contaminant transport, and initiates or sustains feedback between the land surface and the atmosphere. At a particular point in time soil moisture content is influenced by: (1) the precipitation history, (2) the texture of the soil, which determines the water-holding capacity, (3) the slope of the land surface, which affects runoff and infiltration, and (4) the vegetation and land cover, which influences evapotranspiration and deep percolation. In other terms the partitioning of soil moisture to recharge to the groundwater, evapotranspiration to the atmosphere, and surface/subsurface runoff to the streams at different spatio-temporal scales and under different hydro-climatic conditions pose one of the greatest challenges to weather and climate prediction, water resources availability, sustainability, quality, and variability in agricultural, range and forested watersheds and hydro-climatic conditions. To date very few studies have been made to quantitatively understand the multi-scale dynamics of soil moisture in land-surface hydrologic systems. In this context we hypothesize that: 1) soil moisture variability is dominated by soil properties at the field scale, topographic features at the catchment/watershed scale, and vegetation characteristics and precipitation patterns at the regional scale and beyond; and 2) ensemble hydrologic fluxes (evapotranspiration, infiltration, and shallow ground water recharge) across the vadose zone at the corresponding scale can be effectively represented by one or more soil, topography, vegetation, or climate scale factors. Using ground-based and various active and passive microwave remote sensing measurements during the NASA field campaigns in the past decade including Southern Great Plains Experiments (SGP97, SGP99), Soil Moisture Experiment (SMEX02, SMEX05), and Cloud Land Atmosphere Interaction Study (CLASIC 2007), we test these hypotheses. Results of our ongoing study and the future need related to the better understanding of soil moisture controls, scaling properties, and effective soil hydraulic parameters at different scales will be presented.