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Investigation of the Scaling Properties of Simulated Soil Moisture Fields

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Soil moisture is of major importance to land surface processes, since it controls the partitioning of available net radiation into sensible and latent heat flux, and of precipitation into infiltration and runoff. Previous studies have identified the existence of scaling properties in observed soil moisture field and related these to land surface characteristics and the spatiotemporal precipitation patterns. Identifying the capability of a hydrological model to accurately represent soil moisture scaling would serve as a means for model testing and to provide confidence in the simulated spatial patterns. In this study, we use a physically-based, fully-distributed hydrologic model, known as the TIN-based Real-time Integrated Basin Simulator (tRIBS), to assess the capability of the dynamic simulations to retrieve the observed scaling properties of the soil moisture field. The assessment is performed against high resolution, soil moisture retrievals based on brightness temperature measurements from an aircraft sensor. We focus our work on the Little Washita watershed in central Oklahoma using the data sets gathered in the Southern Great Plains 1997 (SGP97) field experiment. In the first part of the study, we describe the model setup and performance relative to traditional hydrological metrics, such as streamflow statistics at multiple, nested gauges and soil moisture statistics at available point observations. Subsequently, we test the model performance with respect to reproducing the observed scaling properties of the soil moisture field for available sampling dates. We discuss the potential errors introduced in both the soil moisture retrievals from remote sensing and the hydrological model simulations and their manifestation in the scaling analysis. The results of this study will be useful for assessing the utility of distributed hydrologic models to examine the scaling properties of hydrologic response fields.