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Surface soil moisture scaling: Model and remote sensing results

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This study is focusing on spatial surface soil moisture scaling at a mesoscale catchment using Electronically Scanned Thinned Array Radiometer (ESTAR) and modeled soil moistures. The physically based distributed hydrological model, GEOtop (Rigon et al., 2006), was applied to the Little Washita basin [611km2], Oklahoma, USA, using the field observations from the Southern Great Plain -1997 (SGP97) and SGP 99 Hydrology Experiments. The model is well reproducing the diurnal cycles of soil moistures and soil temperatures at different sites in the basin. The discharges time series at the basin outlet were well simulated. The heat fluxes including net radiation, latent heat, sensible heat and ground heat fluxes were well reproduced by the model. During the experiments, about daily ESTAR soil moisture maps of 800 m resolution were derived from the brightness temperature measurements obtained with L-band ESTAR microwave radiometer. The modeled spatial soil moisture maps, 200m resolution, for the top 5 cm soil layer for the whole basin were produced for the same time when the ESTAR brightness temperatures were measured. The model showed that the soil type is the main controlling factor of soil moisture distribution in the basin. The basin has 18 soil types. Since the soil type is the main controlling factor of soil moisture distribution in the basin, scaling analyses for both model and ESTAR soil moistures were performed along the longest transect that crosses many soil types. During the SGP 97 the basin was moderately wet while during the SGP 99 the basin was very dry.

For the SGP 97, both ESTAR and model showed that surface soil moisture variance versus the support area follows an increasing power law for scale ranges from 0.2 km to 10 km. While for very dry condition; SGP 99, the soil moisture variance is spatially uniform and is independent of scale.

In agreement with Rodriguez et al., 1995 and for both moderately wet and dry conditions, the model showed that the spatial correlation of surface soil moisture follows power law decay up to about 1 km. For scales larger than 1 km and for moderately wet condition, the model showed that the surface soil moisture have multiscaling behaviour, while for the dry condition, the model showed that there is no spatial correlation.

On the other hand, for both conditions, ESTAR showed that the surface soil moistures have multiscaling behaviour and the average surface soil moisture correlation range is about 7 km but some cases showed that surface soil moistures correlate well up to about 34.5 km (transect length). Furthermore, the spatial correlation of surface soil moisture in the basin is investigated using soil moisture variograms. The soil moisture correlation range along the transect corresponds well with the surface soil moisture range estimated with variograms .The variogram of the modeled soil moisture for the SGP 97 and SGP 99 showed that the soil moistures correlate well for scale ranges from 5 km to 10.5 km and for scale ranges from 2.5 km to 5 km, respectively. Similarly, the variogram of the ESTAR soil moisture for the SGP 97 and SGP 99 showed that the soil moistures correlate well for scale ranges from 4 km to 9.5 km and for scale ranges from 8 km to 15 km, respectively.