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Intercomparison between model and ESTAR soil moistures during the Southern Great Plain Hydrology Experiments - 1997 and 1999

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In this study, the field data collected during the Southern Great Plain Hydrology Experiments-1997 (SGP97) and SGP99 over the Little Washita basin [611km2], Oklahoma, USA, were used to calibrate and validate the physically based distributed hydrological model, GEOtop (Rigon et al., 2006), over the basin. GEOtop includes solution of Richards equation (Richards, 1931) in three dimensions for evolution of soil water content and pressure, coupled with one dimensional simulation of soil heat transport. The model based on discretization of land features based on digital elevation data. The model is initialized for soil moisture, soil temperature, soil thermal properties, and soil hydraulic properties profiles and for land use properties. The model is driven by meteorological forcing taken at an hourly time step from 45 stations [ARS and MESONET networks]. Each station measures precipitation, relative humidity, air temperature, downward solar radiation, wind speed, wind direction and air pressure. The model was calibrated and validated for SGP97 and SGP99 experiments, respectively, against the measured volumetric soil moistures and the measured gravimetric soil moistures. For both experiments, the model is capable of reproducing the water and energy budgets at the basin scale. For both SGP97 and SGP99, the model well reproduces the soil moisture profiles, up to 0.6 m depth from the ground surface, at 4 and 10 sites, respectively. Similarly, for both SGP97 and SGP99, the model well reproduces the soil temperature profiles, up to 0.6 m depth from the ground surface, at 7 and 5 sites, respectively. The net radiation, latent heat, sensible heat and ground heat fluxes were well reproduced by the model. In addition, the model well reproduces the base flows as well as the peak flows at the basin outlet. Thus, the modeled spatial soil moistures for the top 5 cm soil layer for the whole basin and for both experiments were produced and compared to the corresponding Electronically Scanned Thinned Array Radiometer (ESTAR) soil moistures obtained during the experiments. The resolution of the modeled soil moisture is 200m, same as the model input maps, while the resolution of ESTAR derived soil moisture is 800m. Unfortunately, the model and ESTAR shows completely different spatial soil moisture patterns. In order to understand where the differences originate, the effect of vegetation, surface roughness and topography were investigated. The result of the analysis showed that vegetation, surface roughness and topography have little effects on ESTAR soil moisture estimates. To the contrary of what happens in GEOtop, ESTAR soil moistures are influenced by runoff depth and to some extent by vegetation intercepted water depth, and are higher compared to the modeled soil moistures, especially under wet conditions. This is supposed to say that there are two conclusions: (1) the blurring due to ESTAR resolution, and (2) the need for a different assimilation method because of uncertainties in the present method.