Description of Soil Moisture Animation

The animation depict soil moisture patterns of a drying period between 27/2/2011 and 08/06/2011 at 5 cm below the litter layer. The figures patterns are kriging interpolations done with MATLAB that are based on 105 soil moisture measurements (black dots) and 105, 71 simulation nodes (black dots) for the 25 m, 100 m model resolution respectively. In this context, it is helpful to note that the model HydroGeoSphere is a node based model using a triangulated instead of a rectangular grid. The white pixels in the figures represent the river (flowing from south to north).

The top figures give the kriging interpolations for measured soil moisture values; the middle rows give interpolated soil moisture values for a simulation with no flow lower boundary condition at 1.5 m depth for the 25 m (left column) and the 100 m model resolution (right column); the lower rows give interpolated soil moisture values for simulation with a bedrock of 18.5 m thickness below the 1.5 m mineral soil at 25 m (left column) and 100 m model resolution (right column).

For detailed information about the model setups, please refer to Cornelissen (2016) or Cornelissen et al. (2014).

The following descriptions and explanations are taken from Cornelissen (2016, p. 128-135) but can also be found in Cornelissen et al. (2014):

The measured pattern clearly followed the course and the source area of the river in the southeastern part of the catchment. In the western area, the measured pattern had a patchy structure. The simulation at 25 m resolution (without bedrock) closely resembled the measured pattern in the eastern part of the catchment, but missed a great part of the pattern in the western part. As expected, the spatial differentiation was smaller for the simulation at 100 m resolution, but the source area of the river was still well represented. The bedrock simulations only marginally affected soil moisture simulation at both scales, and as such were not able to add additional insights in the model's capability to simulate spatial dynamics and their variability. With decreasing soil moisture, the spatial patterns of the bedrock setups increasingly differed from the patterns of the non-bedrock setups.

A Spearman correlation analysis between measured/simulated soil moisture patterns and topographic variables/porosity distributions was performed. Correlation strengths of simulated soil moisture patterns to relative elevation and porosity were higher but correlation strengths to slope were lower compared to measured soil moisture patterns. In addition, measured soil moisture patterns were not clearly correlated to either a topographic or porosity pattern which could have resulted from the simple linear correlation approach applied in this study and/or from the fact that an important pattern controlling soil moisture variability was not included in the analysis. The results generally indicated that the simulation underestimated the complexity of the soil moisture pattern. Famiglietti et al. (1998) found that the influence of topographic attributes on the soil moisture pattern and its variability increased with further drying of the catchment. In my study, the correlation between soil moisture and relative elevation increased, but the correlation with slope decreased with drying. This pattern was observed for both the measurements and the simulations.

References

Cornelissen, T., Diekkrüger, B., Bogena, H.R. (2014): Significance of scale and lower boundary condition in the 3D simulation of hydrological processes and soil moisture variability in a forested head water catchment. Journal of Hydrology 516: 140-153. doi: 10.1016/j.jhydrol.2014.01.060.

Cornelissen, T. (2016): 3D-Modeling of unsaturated flow dynamics and patterns: Potentials and Limitations at different spatial and temporal scales. University of Bonn, Bonn. http://hss.ulb.uni-bonn.de/2016/4396/4396-index.pdf.

Famiglietti, J.S., Rudnicki, J.W., Rodell, M. (1998): Variability in surface moisture content along a hillslope transect: Rattlesnake Hill, Texas. J. Hydrol. 210, 259–281. doi: 10.1016/S0022-1694(98)00187-5.