Geophysical Research Abstracts
Vol. 19, EGU2017-13132, 2017
EGU General Assembly 2017

Global sensitivity analysis of a local water balance model predicting evaporation, water yield and drought

Matthias Speich, Massimiliano Zappa, and Heike Lischke
Swiss Federal Research Institute WSL, Landscape Dynamics, Birmensdorf, Switzerland (matthias.speich@wsl.ch)

Evaporation and transpiration affect both catchment water yield and the growing conditions for vegetation. They are driven by climate, but also depend on vegetation, soil and land surface properties. In hydrological and land surface models, these properties may be included as constant parameters, or as state variables. Often, little is known about the effect of these variables on model outputs.

In the present study, the effect of surface properties on evaporation was assessed in a global sensitivity analysis. To this effect, we developed a simple local water balance model combining state-of-the-art process formulations for evaporation, transpiration and soil water balance. The model is vertically one-dimensional, and the relative simplicity of its process formulations makes it suitable for integration in a spatially distributed model at regional scale. The main model outputs are annual total evaporation (TE, i.e. the sum of transpiration, soil evaporation and interception), and a drought index (DI), which is based on the ratio of actual and potential transpiration. This index represents the growing conditions for forest trees.

The sensitivity analysis was conducted in two steps. First, a screening analysis was applied to identify unimportant parameters out of an initial set of 19 parameters. In a second step, a statistical meta-model was applied to a sample of 800 model runs, in which the values of the important parameters were varied. Parameter effect and interactions were analyzed with effects plots. The model was driven with forcing data from ten meteorological stations in Switzerland, representing a wide range of precipitation regimes across a strong temperature gradient.

Of the 19 original parameters, eight were identified as important in the screening analysis. Both steps highlighted the importance of Plant Available Water Capacity (AWC) and Leaf Area Index (LAI). However, their effect varies greatly across stations. For example, while a transition from a sparse to a closed forest canopy has almost no effect on annual TE at warm and dry sites, it increases TE by up to 100 mm/year at cold-humid and warm-humid sites. Further parameters of importance describe infiltration, as well as canopy resistance and its response to environmental variables.

This study offers insights for future development of hydrological and ecohydrological models. First, it shows that although local water balance is primarily controlled by climate, the vegetation and soil parameters may have a large impact on the outputs. Second, it indicates that modeling studies should prioritize a realistic parameterization of LAI and AWC, while other parameters may be set to fixed values. Third, it illustrates to which extent parameter effect and interactions depend on local climate.