Modeling the Annual Soil-Water Balance with a Statistical-Dynamical Eco-hydrology Model over the Conterminous U.S.

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Abstract. The statistical-dynamical annual water balance model of Eagleson (Eagleson 1978a-g) is a pioneering work in the analysis of climate, soil and vegetation interactions. It is a one-dimensional representation of soil moisture dynamics as forced by a stochastic climate and describes the relationships between the annual amounts of precipitation, runoff infiltration and evapotranspiration as a function of volumetric soil moisture and soil and vegetation characteristics. The description is physically based and only accounts for processes operating in the vertical direction, across the soil-atmosphere interface.

In this framework we apply this model to investigate water fluxes at a 5x5 km grid of study covering the entire conterminous U.S. in order to determine the vulnerability of water supply to droughts under scenarios of future population, economic and climate changes.

In the current implementation of the model, soil parameters have been retrieved from the VEMAP datasets and evaluated at the study grid resolution by using simple kriging procedures, while PRISM datasets (already available at the 5x5 km resolution) have been used to obtain annual values of precipitation. Storm statistics, such as annual mean values of inter-arrival time, storm intensity, storm duration and storm depth have been evaluated by analyzing hourly data provided by NCDC for about 3000 stations distributed over the U.S. and then estimated at each cell of our study grid by using regional, weighted linear regressions of parameter values on total annual precipitation.

The model has been calibrated at a basin scale, by comparing predicted values for long term means of total annual yield with averaged streamflow measurements at 655 gaged basins distributed over the U.S. Transpiration efficiency and vegetal canopy coverage have been selected as calibration knobs.

The model, in its current implementation, provided good fit for most of the test basins used for calibration and, once it has been extended to the entire conterminous U.S., showed a rather good match with current estimation of water availability.