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Upscaling runoff and evapotranspiration fluxes in the Little Washita watershed using physically-based hillslope models

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Several authors in the literature, such as Khan (2014) and Loritz (2017), have previously suggested that 3D catchment hydrology can be predicted from 2D hillslope simulations. Following this idea, we propose an upscaling methodology for runoff and evapotranspiration fluxes. The first step consists of a geomorphic analysis of the studied watershed. The average mean slope and hillslope length are then used to build a 2D equivalent-hillslope model. The validity of the methodology is tested by comparing the resulting water balance with a 3D physically-based distributed model. 2D fluxes of the equivalent hillslope are converted into 3D by using the drainage density. This upscaling methodology is applied to the Little Washita (LW) watershed (Oklahoma, USA). Both the 3D reference model and the 2D equivalent model are built with the physically-based distributed code HydroGeoSphere, which is forced by LW reanalysis climatic data. Two decades are simulated. Regarding the evapotranspiration, the upscaling methodology with only one equivalent hillslope gives a good prediction of 3D fluxes. However, a combination of several hillslopes is needed for simulating the 3D flow rate at the basin's outlet. This work on the decrease of model dimensionality is a first step in the upscaling process from 3D physically-based models to 1D column models used in global Land Surface Models.