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Parameterization of potential evapotranspiration approaches for distributed hydrologic modeling

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Reliable soil moisture products are needed for the estimation of plant available water or agricultural droughts. For the simulation of hydrological states, e.g. soil moisture, the estimation of evapotranspiration is crucial since it has the largest contribution to the water balance besides precipitation. In hydrological modeling the evapotranspiration is usually estimated based on potential evapotranspiration (PET). The common approaches for PET estimation and their parameterization are sufficient at the point or field scale for which they have been developed. But for spatially distributed estimations on the mesoscale, e.g. 4 km, their robust parameterization is still a challenge in current research.

The aim of this study is to find scale and location independent parameters for three different potential evapotranspiration formulations, which are applied in the mesoscale Hydrologic Model (mHM). PET is estimated using the 1) Hargreaves-Samani, 2) Priestley-Taylor, and 3) Penman-Monteith equations. The Hargreaves-Samani method is a temperature driven approach, whereas the other two methods are based on radiation. For estimating the parameters of the above mentioned PET formulations, the Multiscale Parameter Regionalization technique is used. This technique accounts for subgrid variabilities by connecting morphological terrain properties, which are available in a higher resolution than the model resolution, with the parameters for the particular PET approach. The parameters, which needed to be estimated, are the coefficient of the Hargreaves-Samani equation, the Priestley-Taylor coefficient, and the aerodynamic and bulk surface resistance for the Penman-Monteith equation. The Hargreaves-Samani coefficient is regionalized based on the aspect of the terrain. The Priestley-Taylor coefficient as well as the aerodynamic and bulk surface resistance have been estimated using static land cover information combined with leaf area index (LAI) development curves and thus an approximation for vegetation information.

This new parameterized PET approaches are evaluated in six different German river basins ranging from 6,000 km^2 to 38,000 km^2 including a spatial variety from catchments in the northern German lowlands to alpine catchments in the south.

The comparison of the results is focusing on evapotranspiration, soil moisture and discharge. Whereas only slight changes in the discharge hydrograph have been observed in the comparison of the three PET equations, the impact on soil moisture is significant. Especially during the summer period the soil moisture is lower for the Priestley-Taylor and Penman-Monteith formulation compared to the Hargreaves-Samani equation. This effect is due to higher estimates in PET for those two methods. Furthermore a validation against eddy covariance measurements showed that the dynamics of evapotranspiration is captured well by the three methods.