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Crop coefficients parametrization using remote sensing in basin-scale hydrological modelling

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Satellite-based vegetation indices as Normalized Difference Vegetation Index (NDVI) are increasingly used to derive crop coefficients (kc) for field-scale soil water balance modelling, and for operational monitoring of evapotranspiration (ET). However, for basin-scale hydrological modelling, kc values are traditionally based on literature values, crop and management specific (e.g. FAO-56). For basin-scale analysis, these tabular kc-values are prone to misinterpretations, such as, site specific crop seasons and climate variability within the catchment. Compared to the traditional approach, the advantage of using an NDVI-based method is that observed information on current vegetative status is captured, from which "real" crop coefficients may be derived. However, for future scenario analysis, no satellite-based data are available, hence, crop coefficients need to be estimated either from literature values that are not site-specific, or based on historic NDVI observations.

The aim of this study is to evaluate the impacts of various crop coefficient parameterization methods on the performance of a basin-scale hydrological model. We assume actual NDVI as the best available proxy for the crop coefficient and calibrate a hydrological model (SPHY) with monthly reservoir inflows: the reference model. Then, we change the crop coefficient parameterizations of this model with three different parameterizations and compare outputs for a validation period. The study is performed in the sub-humid to semi-arid Upper Segura basin (2592 km2) in SE Spain.

The three parameterization methods we evaluate are: (1) land-cover specific kc values using traditional approach from reference tables (FAO-56), (2) land-cover specific kc values obtained from seasonal trajectories of NDVI, (3) pixel-specific seasonal kc values from NDVI trajectories of each pixel. To evaluate the performance of the three methods, spatial and temporal patterns of simulated streamflow, evapotranspiration, and soil moisture are compared to the reference model. Overall, deviations compared to the reference model were highest for the tabular-based method. For the two NDVI-based methods spatial and temporal differences in outputs can be significant while, surprisingly, streamflow-based performance indicators at the basin outlet were hardly sensitive to the method chosen. Our results demonstrate the sensitivity of model outcomes to different methods to derive crop coefficients parameterizations and provide insight in how to use satellite-based vegetation indices in basin-scale hydrological modelling.