EGU2020-10378
https://doi.org/10.5194/egusphere-egu2020-10378
EGU General Assembly 2020

Simulation of streamflow in two Mediterranean catchments using a process-based model and remote sensing products

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Watershed modelling is one of the most important assessment tools in watershed planning and management. Nonetheless, the classic calibration of watershed models, in which a few discharge gauges near the outlet of a catchment are used to compare measured and simulated streamflow, is often criticized by not assuring that relevant processes such as evapotranspiration, soil moisture, crop growth, and groundwater recharge are well represented in the catchment area. This study aimed to simulate streamflow in two Mediterranean catchments, Orba (778km^2) in Italy and Segre (1286km^2) in Spain, using the physically-based, fully distributed MOHID-Land model. Model calibration/validation of streamflow was first performed following a classical approach. Different products derived from remote sensing platforms were then used to evaluate the adequacy of model simulations of crop growth and soil moisture in the catchment area.

The MOHID-Land model considers four compartments or mediums (atmosphere, porous media, soil surface and river network), computing water dynamics through the different mediums using mass and momentum conservation equations. The model was implemented in the two simulated catchments with a resolution of 1 km. Data inputs included the Digital Elevation Model over Europe (EU-DEM) with a resolution of 30 m; the soil hydraulic properties map from EU-SoilHydroGrids ver1.0 with a resolution of 250 m; the CORINE land cover map from 2012 with a resolution of 100 m; the hourly weather data (precipitation, wind velocity, relative air humidity, solar radiation and surface air temperature) from local weather stations; and the reservoir discharge data from governmental and/or regional agencies. Simulations were run from 2006-2014 for Orba and from 2008-2018 for Segre, and included a model warm-up, a calibration, and a validation period. Comparison between simulated and measured flows were performed in 2 and 10 hydrometric stations located in the Orba and Segre catchments, respectively. Four statistical parameters (R^2, RMSE, PBIAS and NSE) were used to evaluate model performance, confirming the good fitting of model simulations to measured data.

Model simulations of leaf area index (LAI) were then compared with LAI maps at 30 m resolution derived from ATCOR and Landsat 8 imagery data using the Normalized Difference Vegetation Index (NDVI) and the Soil Adjusted Vegetation Index (SAVI). Furthermore, model simulation of soil moisture were also compared at the surface depth (0-5 cm) with soil moisture maps at 1 km resolution created with the DISaggregation based on a Physical And Theoretical scale CHange (DISPATCH) algorithm for the downscaling of the 40 km SMOS (Soil Moisture and Ocean Salinity) soil moisture data using land surface temperature (LST) and NDVI data. Results showed the fundamental differences between the MOHID-Land and remote sensing outputs, with major differences being analyzed by soil units and land use classes.