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Merging raster meteorological data with low resolution satellite images for improved estimation of actual evapotranspiration

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Actual evapotranspiration (ETa) can be estimated using Energy Balance models and remotely sensed data. In particular, satellite images acquired in visible, near and thermal infrared parts of the spectrum have been used with the Surface Energy Balance Algorithm for Land (SEBAL) to estimate actual evapotranspiration. This algorithm is solving the Energy Balance Equation using data from a meteorological station present in the vicinity, and assumes the meteorological conditions homogeneous over the study area. Most often, data from a representative weather station are used. This assumption may lead to substantial errors in areas with high spatial variability in weather parameters. In this paper, the ITA-MyWater algorithms (Integrated Thermodynamic Algorithms for MyWater project), an adaptation of SEBAL was merged together with spatially distributed meteorological data to increase the accuracy of ETa estimations at regional scale using MODIS satellite images.
The major changes introduced to migrate from point to raster are that (i) air temperature and relative humidity maps are used for the estimation of the Energy Balance terms, including instantaneous net radiation and soil heat flux and (ii) the variability of wind speed is taken into account to generate maps of the aerodynamic resistance, sensible heat flux and difference between soil and air temperature at the boundary conditions (at dry and wet pixels).
The approach was applied in the river basin of Tamega in Portugal, where actual evapotranspiration was estimated for several MODIS 8-day periods from spring to winter of the same year. The raster meteorological maps were produced by the MM5 weather forecast model. Daily reference evapotranspiration was calculated with MOHID LAND model. Using a temporal integration technique and the daily reference evapotranspiration maps, the cumulative evapotranspiration over the MODIS 8-day period was estimated and compared to the global evapotranspiration MODIS product (MOD16A2). A correlation analysis was performed at the common spatial resolution of 1km using selected homogeneous pixels (from the land cover point of view). A statistically significant correlation factor of 0.6 was found, and the RMSE was 0.92 mm/day. Using raster meteorological data the ITA-MyWater algorithms were able to catch the variability of weather patterns over the river basin and thus improved the spatial distribution of evapotranpiration estimations at low resolution.

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