Geophysical Research Abstracts
Vol. 19, EGU2017-18955, 2017
EGU General Assembly 2017

Scale effects on the evapotranspiration estimation over a water-controlled Mediterranean ecosystem and its influence on hydrological modelling

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The integration of currently available satellite data into surface energy balance models can provide estimates of evapotranspiration (ET) with spatial and temporal resolutions determined by sensor characteristics. The use of data fusion techniques may increase the temporal resolution of these estimates using multiple satellites, providing a more frequent ET monitoring for hydrological purposes. The objective of this work is to analyze the effects of pixel resolution on the estimation of evapotranspiration using different remote sensing platforms, and to provide continuous monitoring of ET over a water-controlled ecosystem, the Holm oak savanna woodland known as dehesa. It is an agroforestry system with a complex canopy structure characterized by widely-spaced oak trees combined with crops, pasture and shrubs. The study was carried out during two years, 2013 and 2014, combining ET estimates at different spatial and temporal resolutions and applying data fusion techniques for a frequent monitoring of water use at fine spatial resolution.

A global and daily ET product at 5 km resolution, developed with the ALEXI model using MODIS day-night temperature difference (Anderson et al., 2015a) was used as a starting point. The associated flux disaggregation scheme, DisALEXI (Norman et al., 2003), was later applied to constrain higher resolution ET from both MODIS and Landsat 7/8 images. The Climate Forecast System Reanalysis (CFSR) provided the meteorological data. Finally, a data fusion technique, the STARFM model (Gao et al., 2006), was applied to fuse MODIS and Landsat ET maps in order to obtain daily ET at 30 m resolution.

These estimates were validated and analyzed at two different scales: at local scale over a dehesa experimental site and at watershed scale with a predominant Mediterranean oak savanna landscape, both located in Southern Spain. Local ET estimates from the modeling system were validated with measurements provided by an eddy covariance tower installed in the dehesa (38 ° 12 'N, 4 ° 17' W, 736 m a.s.l.). The results supported the ability of ALEXI/DisALEXI model to accurately estimate turbulent and radiative fluxes over this complex landscape, both at 1 Km and at 30 m spatial resolution. The application of the STARFM model gave significant improvement in capturing the spatio-temporal heterogeneity of ET over the different seasons, compared with traditional interpolation methods using MODIS and Landsat ET data.

At basin scale, the physically-based distributed hydrological model WiMMed has been applied to evaluate ET estimates. This model focuses on the spatial interpolation of the meteorological variables and the physical modelling of the daily water balance at the cell and watershed scale, using daily streamflow rates measured at the watershed outlet for final comparison.