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Vegetation monitoring and estimation of evapotranspiration using remote sensing-based models in heterogeneous areas with patchy natural vegetation and crops

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The integration of remotely sensed data into models for estimating evapotranspiration (ET) has increased significantly in recent years, allowing the extension of these models application from point to regional scale. Remote sensors provide distributed information about the status of vegetation and allow for a regular monitoring of water consumption.

Currently, there are two types of approaches for estimating ET based either on the soil water balance, or surface energy balance. The first one uses the reflectance of vegetated surfaces in the visible and near infrared regions of the electromagnetic spectrum (VIS / NIR) to characterize the vegetation and its role in the water balance (Gonzalez-Dugo and Mateos, 2008). On the other hand, thermal-based energy balance models use the radiometric surface temperature registered by the sensor on thermal infrared (TIR) bands as the primary boundary condition for estimating ET (Kustas and Norman, 1996).

The aim of this work is to carry out, using Landsat-8 satellite images, a continuous monitoring of growth and evapotranspiration of the different vegetation types, both natural and cultivated, in a region located in Southern Spain during the season August 2013 / September 2014. The region, with about 13800 ha, is marked by strong contrasts in the physical environment, with significant altitudinal gradient combined with a great variety of soil types and vegetation. It is characterized by a variation of grassland, scrubs, conifers, oaks and irrigated crops.

In this work, a daily soil water balance has been applied using the vegetation index-basal crop coefficient approach (RSWB). This model is based on FAO-56 methodology (Allen et al., 1998), which determines the evapotranspiration of vegetation with the concepts of crop coefficient and reference ET. The crop coefficient accounts for the influence of the plants on the evapotranspiration, considering the effect of changes in canopy biophysical properties throughout the growth cycle. It has been derived using the dual method that separates the crop transpiration from soil surface evaporation. Combining it with the spectral response of the surface provided by satellite images, a distributed basal crop coefficient is derived, which determines vegetation transpiration. There are many applications that successfully validated this approach, both in agricultural areas and heterogeneous coverage (Padilla et al., 2011; Campos et al., 2013). In this application, local meteorological data and soil properties have been used, providing daily and distributed evapotranspiration information at 30 m pixel scale during the studied period.

These results have been contrasted with that obtained from the application of a two-source energy balance model (TSEB) for the days with available thermal data. The TSEB model separates the soil and canopy contributions to the radiative temperature and to the exchange of surface energy fluxes. This model has proven to be robust in heterogeneous and incomplete covers (Timmermans et al., 2007; González-Dugo et al., 2009). The results of the comparison are used to validate the RSWB under different soil and vegetation conditions and to explore new possible applications of this approach.