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Long-term energy balance and vegetation water stress monitoring of Mediterranean oak savanna using satellite thermal data

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Drought is one of the major hazards faced by natural and cropped vegetation in the Mediterranean Sea Basin. Water scarcity is likely to be worsened under the predicted conditions of climate change, which is expected to make this region both warmer and drier. A Holm oak savanna, known as dehesa in Spain and montado in Portugal, is an agro-silvo-pastoral system occupying more than 3 million hectares the Iberian Peninsula and Greece. It consists of widely-spaced oak trees (mostly Quercus ilex L.), combined with crops, pasture and Mediterranean shrubs. This ecosystem is considered an example of sustainable land use, supporting a large number of species and diversity of habitats and for its importance in rural economy. A similar ecosystem is worldwide distributed in areas with Mediterranean climate (as California or South Africa) and shares structural and functional properties with tropical savannas in Africa, Australia and South America. Remote sensing time series can assist the monitoring of the energy balance components, with special attention to the evapotranspiration and vegetation water stress over these areas. Long-term data analysis may improve our understanding of the functioning of the system, helping to assess drought impacts and leading to reduce the economic and environmental vulnerability of this ecosystem.

This work analyzes the evolution the surface energy balance components, mapping the evapotranspiration and moisture stress of holm oak woodlands of Spain and Portugal during the last 15 years (2001-2015). The surface energy balance model (SEBS) has been applied over the Iberian Peninsula on a monthly time scale and 0.05° spatial resolution, using multi-satellite and meteorological forcing data. Modelled energy and water fluxes have been validated using ground measurements of two eddy covariance towers located in oak savanna sites during 3 years, resulting in moderate deviations from observations (10-25 W/m2).

The departure of actual ET from the potential rate, expected under optimum soil water conditions, has been used to assess the water stress of the system. An annual drought index has been calculated based on this relative ET, in order to compare the main drought events occurred during the study period. Two generalised events (2005 and 2012) and a partial one (2009) have been characterised by analysing the evaporative stress time series, performing a detailed comparison over the two eddy covariance tower sites and a general one over the entire oak savanna area of the Peninsula.