Geophysical Research Abstracts
Vol. 15, EGU2013-977, 2013
EGU General Assembly 2013
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Modelling surface energy fluxes over a Dehesa ecosystem using a two-source energy balance model.

Ana Andreu (1), William. P. Kustas (2), Martha C. Anderson (3), Arnaud Carrara (4), and Maria Patrocinio Gonzalez-Dugo (5)

(1) IFAPA. Avd. Alameda del Obispo. Apdo. 3048-14071, Cordoba, Spain. (ana.andreu.ext@juntadeandalucia.es), (2) Hydrology and Remote Sensing Laboratory, USDA ARS, Bldg. 007. BAR West Beltsville, MD 20750, United States (Bill.Kustas@ars.usda.gov), (3) Hydrology and Remote Sensing Laboratory, USDA ARS, Bldg. 007. BAR West Beltsville, MD 20750, United States (Martha.Anderson@ars.usda.gov), (4) Fundacion CEAM, Parque Tecnologico, Calle Charles R. Darwin, 14. 46980 Paterna, Valencia, Spain (arnaud@ceam.es), (5) IFAPA. Avd. Alameda del Obispo. Apdo. 3048-14071, Cordoba, Spain. (mariap.gonzalez.d@juntadeandalucia.es

The Dehesa is the most widespread agroforestry land-use system in Europe, covering more than 3 million hectares in the Iberian Peninsula and Greece (Grove and Rackham, 2001; Papanastasis, 2004). It is an agro-silvo-pastural ecosystem consisting of widely-spaced oak trees (mostly Quercus ilex L.), combined with crops, pasture and Mediterranean shrubs, and it is recognized as an example of sustainable land use and for his importance in the rural economy (Diaz et al., 1997; Plieninger and Wilbrand, 2001). The ecosystem is influenced by a Mediterranean climate, with recurrent and severe droughts. Over the last decades the Dehesa has faced multiple environmental threats, derived from intensive agricultural use and socio-economic changes, which have caused environmental degradation of the area, namely reduction in tree density and stocking rates, changes in soil properties and hydrological processes and an increase of soil erosion (Coelho et al. 2004; Schnabel and Ferreira, 2004; Montoya 1998; Pulido and Díaz, 2005). Understanding the hydrological, atmospheric and physiological processes that affect the functioning of the ecosystem will improve the management and conservation of the Dehesa. One of the key metrics in assessing ecosystem health, particularly in this water-limited environment, is the capability of monitoring evaporation (ET). To make large area assessments requires the use of remote sensing.

Thermal-based energy balance techniques that distinguish soil/substrate and vegetation contributions to the radiative temperature and radiation/turbulent fluxes have proven to be reliable in such semi-arid sparse canopy-cover landscapes. In particular, the two-source energy balance (TSEB) model of Norman et al. (1995) and Kustas and Norman (1999) has shown to be robust for a wide range of partially-vegetated landscapes. The TSEB formulation is evaluated at a flux tower site located in center Spain (Majadas del Tietar, Caceres). Its application in this environment is challenging due to the complexity of the canopy structure, having sparse tree cover, with large areas of grass and bare soil substrate strongly influencing the radiative and turbulent exchanges, and their interactions. The TSEB model was evaluated for all seasons in 2008 and 2009. Model input, local meteorological and tower-based longwave radiation observations, come from the Fluxnet eddy covariance tower located at the study site (ES-LMa, 39°56′ N; 5°46′ W, 260 m a.s.l). A reduction to the nominal value typically assigned to the Priestley-Taylor coefficient for the oak trees (α = 1.3) was necessary in order to achieve good agreement with the measurements. This is consistent with a higher stomatal resistance observed for woody vegetation that is well adapted to semiarid climates. The half-hourly estimates were compared with the flux tower measurements over the different seasons and years. The average root-mean-square-difference (RMSD) between modeled and measured sensible and latent heat fluxes was 30 Wm-2 yielding a percentage error of approximately 15% for latent heat and 30% for sensible heat. Further investigations are planned for improving TSEB algorithms for the soil/substrate resistance formulations and radiation partitioning for this particular canopy structure condition. In addition, large scale application of the TSEB model over the Dehesa ecosystem using satellite observations will also be evaluated.