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Monitoring Evaporation/Transpiration in a Vineyard from Two-Source Energy Balance and Radiometric Temperatures

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Water management and understanding of irrigation efficiency could be significantly improved if the components of evapotranspiration (ET) in row-crop systems (plants and soil interrows) could be quantified separately. This evaporation/transpiration (E/T) partition, and its daily and seasonal evolution, depends on a variety of biophysical and environmental factors. In this work we present an operational method to provide continuous E/T results avoiding soil or canopy disturbance. This technique is based on the combination of the surface-atmosphere energy exchange modeling together with an accurate remote thermal characterization of the crop elements.
An experiment was carried out in a row-crop vineyard in Mallorca, Spain, from June 2012 to May 2013. A set of 6 thermal-infrared radiometers (IRTs) were mounted in a mast placed in the middle of a vineyard N-S row. Two IRTs pointed to the soil between rows and other two pointed to the plants from a frontal view, measuring both east and west sides of the row. A fifth IRT pointed upward to collect the downwelling sky radiance and the remaining IRT was mounted at 4.5-m height over the canopy measuring the composed soil-canopy temperature. Measurements of the four components of the net radiation over the canopy and soil heat fluxes, as well as air temperature, humidity, wind speed, and soil moisture, were collected and stored in 15-min averages.
A two-source energy balance approach was applied to the vineyard from its appropriate thermal characterization. Total and separate soil/canopy components of net radiation, soil, sensible and latent heat fluxes were obtained every 15 minutes and averaged at hourly and daily scales. Comparison between observed and modeled values of available surface energy showed relative errors below 15%. An analysis of the partition E/T was conducted along the vineyard growing season and the different phenological stages. In this experiment, interrow soil evaporation reached as much as 1/3 of the total cumulative evapotranspiration from floration to harvest.
This technique can be useful for scientists and land managers interested in improving water use efficiency, not only because it is shown as an alternative to traditional weighing lysimeters, but also because the presented method allows the continuous monitoring of the E/T partition under a variety of meteorological conditions and covering the different stages of the crop development.