RSHS18-35
Remote Sensing and Hydrology Symposium (ICRS-IAHS)

Evapotranspiration and crop stress in two Californian vineyards using recent modelling in a two source energy balance framework

Hector Nieto (1), William P. Kustas (2), Joseph G. Alfieri (2), and Omar García-Tejera (1)

(1) IRTA, Efficient Use of Water in Agriculture, Lleida, SPAIN, (2) USDA ARS, Hydrology and Remote Sensing Laboratory, Beltsville, MD, USA

Thermal-infrared remote sensing of land surface temperature (LST) provides valuable information for quantifying root-zone water availability, evapotranspiration (ET) and crop stress. For precision farming applications, it is crucial to assess the impacts of within variability in soil texture, water availability and other stress factors on plant condition and productivity. For that purpose, crops stress is usually expressed as the ratio between actual and potential ET or, more convenient, the ratio between actual and potential plant transpiration. Two-source energy balance models can solve the soil/substrate and canopy fluxes by achieving a balance in the radiation and turbulent flux exchange with the lower atmosphere for the soil/substrate and vegetation elements. However, the unique vertical canopy structure and the strongly clumped plant distribution/row structure of vineyards and orchards creates an environment that is likely to cause that both the wind profile inside the canopy air space, and the radiation partitioning between canopy and soil, deviate from how they are typically modelled for most crops.

This study evaluates the impact of using a new wind profile formulation in the canopy air space, which explicitly considers the unique vertical variation in plant biomass of vineyards, as well as a simple geometrical-optical model to evaluate the radiation transmission in row crops. The LST-based two-source energy balance (TSEB) model, which uses land surface temperature as the key boundary condition for flux estimation, is evaluated to estimate actual evapotranspiration in two adjacent vineyards in California. On the other hand, this new modelling framework for row crops is also implemented into the Shuttleworth and Wallace energy-combination model, in order to estimate the vineyard potential evapotranspiration rates and hence actual crop stress. This is done under the assumption that both actual and potential ET need to be estimated under the same modelling structure/framework in order to avoid producing biased crop stress estimates. Results show the improvement that the new wind attenuation and radiation partitioning model have on the LST-based ET estimates when using continuous radiometer-based LST measurements. In addition, it is shown how long time series of LST observations under varying soil moisture and atmospheric conditions can be used to evaluate the dependence of vapour pressure deficit on maximum stomatal conductance and its implementation into the Shuttleworth and Wallance potential ET. Finally, differences in potential ET and crop stress between Shuttleworth and Wallace and the Penman-Monteith "big leaf" models are discussed with rainfall and irrigation data.