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Application of the two-source energy balance model to partition evapotranspiration in an arid wine vineyard

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The partitioning of evapotranspiration (ET) into transpiration (T), a productive water use, and soil water evaporation (E), which is generally considered a water loss, is highly relevant to agriculture in the light of increasing desertification and water scarcity. This task is challenged by the complexity of soil and plant interactions, coupled with changes in atmospheric and soil water content conditions. Many of the processes controlling water/energy exchange are not adequately modeled.

The two-source energy balance model (TSEB) was evaluated and adapted for independent E and T estimations in an isolated drip-irrigated wine vineyard in the arid Negev desert. The TSEB model estimates ET by computing vegetation and soil energy fluxes using remotely sensed composite surface temperature, local weather data (solar radiation, air temperature and humidity, and wind speed), and vegetation metrics (row spacing, canopy height and width, and leaf area). The soil and vegetation energy fluxes are computed numerically using a system of temperature gradient and resistance equations; where soil and canopy temperatures are derived from the composite surface temperature. For estimation of ET, the TSEB model has been shown to perform well for various agricultural crops under a wide range of environmental conditions, but validation of T and E fluxes is limited to one study in a well-watered cotton crop. Extending the TSEB approach to water-limited vineyards demands careful consideration regarding how the complex canopy structure of vineyards will influence the accuracy of the partitioning between E and T.

Data for evaluation of the TSEB model were collected over a season (bud break till harvest). Composite, canopy, and soil surface temperatures were measured using infrared thermometers. The composite vegetation and soil surface energy fluxes were assessed using independent measurements of net radiation, and soil, sensible and latent heat flux. The below canopy energy balance was assessed at the dry midrow position as well as the wet irrigated position directly underneath the vine row, where net radiation and soil heat flux were measured, sensible heat flux was computed indirectly, and E was calculated as the residual. While the below canopy energy balance approach used in this study allowed continuous assessment of E at daily intervals, instantaneous E fluxes could not be assessed due to vertical variability in shading below the canopy. Seasonal partitioning indicated that total E amounted to 9-11% of ET.

Initial evaluation of the TSEB model indicated that discrepancies between modeled and measured fluxes can largely be attributed to net radiation partitioning. In addition, large diurnal variation at the soil surface requires adaptation of the soil heat flux formulations. Improved estimation of energy fluxes by accounting for the relatively complex canopy structure of vineyards will be highlighted.