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Evapotranspiration and evaporation/transpiration partitioning with dual source energy balance models in agricultural lands

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Evapotranspiration is an important component of the water cycle, especially in semi-arid lands. Its quantification is crucial for a sustainable management of scarce water resources. Evapotranspiration at large scales is often estimated through integrated water balance models forced by distributed meteorological forcing. This forcing includes irrigation inputs from surface and groundwater uptakes. Those amounts are largely unknown at most scales, including the regional scale, i.e. the working scale of institutional stakeholders. An alternative way to quantify evapotranspiration is to exploit the available surface temperature data from remote sensing as a signature of the surface energy balance.

As important as evapotranspiration itself is the estimation of its components, transpiration and evaporation, at least for agronomical management and ecosystem health monitoring. Single temperatures can be used with dual source energy balance models but rely on specific assumptions on raw levels of plant water stress to get both components out of a single source of information. Additional information from remote sensing data are thus required, either something specifically related to evaporation (such as surface water content) or transpiration (such as PRI or fluorescence).

This works evaluates the SPARSE dual source energy balance model ability to compute not only total evapotranspiration, but also water stress and transpiration/evaporation components. The model can be run in two modes: a retrieval mode to simulate evaporation and transpiration from TIR data, and a prescribed mode which simulates potential evaporation and transpiration rates. This enables to simulate not only actual fluxes but also surface and plant water stress. It ensures also an increased robustness through bounding the actual fluxes by the corresponding potential rates.

First, the theoretical limits of the evapotranspiration component retrieval are assessed through a simulation experiment using both retrieval and prescribed modes of SPARSE with the sole surface temperature. A similar work is performed with an additional constraint, the topsoil surface soil moisture level, showing the significant improvement on the retrieval.

Then, a wide range of flux datasets acquired over rainfed and irrigated crops in temperate, Mediterranean and semi-arid regions are used to check the robustness of both stress levels and evapotranspiration retrievals. In particular, retrieval of the evaporation and transpiration components is assessed in both conditions (forcing by the sole temperature or the combination of temperature and soil moisture).

Finally, two flux datasets relevant for assessing the performance of evapotranspiration retrievals at the MODIS scale are studied. One is an extensive rainfed oliveyard with very low vegetation cover. A second dataset has been acquired over a complex agricultural landscape with an eXtra-Large Aperture Scintillometer set-up over a 4 km transect.