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Analysis of time-series of total and plant water stress levels using a dual-source energy balance model over agricultural crops and medium to low resolution thermal infra red remote sensing data

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Detecting, monitoring and mapping plant water stress with remote sensing data is a crucial component of modern agricultural water management, especially in areas with scarce water resources such as the south and the eastern parts of the Mediterranean region. Developing efficient operational methods dedicated to those three actions is thus necessary to design observing systems for areas with a mixture of irrigated, rainfed and deficit irrigation agriculture. Those systems can assist managers in tasks such as early warning of drought, real time irrigated area mapping etc. A way to quantify plant and total water stress levels is to exploit the available surface temperature data from remote sensing as a signature of the surface energy balance, including the latent heat flux. Remotely sensed energy balance models enable to estimate evapotranspiration and the water status of continental surfaces. Two-source models, such as TSEB (Norman et al., 1995) allow deriving a rough estimate of the water stress of the vegetation instead of that of a soil-vegetation composite. For the latter, a realistic underlying assumption enables to invert two unknowns (evaporation and transpiration) from a single piece of information. This assumption states that, in most cases, vegetation is unstressed, and that if vegetation is stressed, evaporation is negligible. In the latter case, if vegetation stress is not properly accounted for, the resulting evaporation will decrease to unrealistic levels (negative fluxes) in order to maintain the same total surface temperature. Actual and potential transpiration rates are combined to derive an index of plant water stress applicable to low resolution data. Here, we evaluate time series of plant water stress indices in the Kairouan area in Central Tunisia in the last few years by comparing them with 1- maps of the irrigation sectors as well as rainfall data and 2- turbulent heat flux measurements obtained at low resolution (scintillometer, eddy-covariance over homogeneous areas) and 3- outputs of a distributed hydrological model (SAMIR).