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Enhancement of Penman-Monteith equation for monitoring evapotranspiration: relationship between the surface resistance and remotely sensed stress index in semi-arid region

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Evapotranspiration (ET) plays an essential role for detecting plant water status, estimating crop water needs and optimizing irrigation management. Accurate estimates of ET at field scale are therefore critical. The present paper investigates a remote sensing and modelling coupled approach for monitoring actual ET of irrigated wheat crops in the semi-arid region of Tensift Al Haouz (Morocco). The ET modelling is based on a modified Penman-Monteith equation obtained by introducing a simple empirical relationship between surface resistance (rc) and a stress index (SI). SI is estimated from Landsat-derived land surface temperature (LST) combined with the LST endmembers (in wet and dry conditions) simulated by a surface energy balance model driven by meteorological forcing and Landsat-derived fractional vegetation cover. The proposed model is first calibrated using eddy covariance measurements of ET during one growing season (2015-2016) over an experimental flood irrigated wheat field located within the irrigated perimeter named R3. It is then validated during the same growing season over another drip-irrigated wheat field located in the same perimeter. Next, the proposed ET model is implemented over a 10x10 km2 area in R3 using a time series of Landsat-7/8 reflectance and LST data. The comparison between modeled and measured ET fluxes indicates that the model works well. The Root Mean Square Error (RMSE) values over drip and flood sites were 13 and 12 W/m2, respectively. The proposed approach has a great potential for detecting crop water stress and estimating crop water requirements over large areas along the agricultural season.