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Parameterizing water status models within heterogeneous Mediterranean vineyard watershed

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Knowledge of evapotranspiration and water status in a spatially distributed manner is of interest for the monitoring of vine activity throughout the cultural cycle, and for the acquainting of hydrological modeling as upper boundary conditions. Prior works aim at assessing the performances, over the 70 km-sq Mediterranean vineyard La Peyne watershed (Southern France), of two spatialized approaches devoted to the mapping of instantaneous surface energy fluxes from optical remote sensing (Galleguillos et al., 2009). Considering high spatial resolution ASTER data, we select the S-SEBI and WDI methods characterized by their simplicities and feasibilities, in terms of implementation and input requirements. They differ by the way they use the spatial information captured over the solar and thermal domains, for the differentiating based retrieving of water status and evapotranspiration. Intercomparison exercises over the vineyard fields within the watershed show the consistencies of the considered methods. Validation exercises are performed over several contrasted sites, by considering ground based references obtained directly (eddy covariance measurements) or indirectly (neutron probe data along with the 1-D HYDRUS model). They show the quantitative relevances of the methods, with performances on evapotranspiration and water status retrievals that are comparable to results currently reported in the literature.

Beyond the satisfactory results we obtained when assessing method performances, difficulties raise when implementing these methods over the Mediterranean vineyard La Peyne watershed, either when acquainting several variables that allow theoretically defining the evaporative extremes (WDI), or when empirically setting these extremes according to the spatial variabilities captured through thermal infrared observations (S-SEBI). When dealing with the WDI method, questions raise about the spatial representativeness of micro-meteorological variables, about the relevance of nominal values proposed in the literature for stomatal resistance, about the quantification of aerodynamic resistance from either micro-meteorological measurements or nominal values proposed in the literature, as well as about the derivation of evaporative extremes on a pixel-by-pixel basis or not. When dealing with the S-SEBI method, questions raise about the spatial extension of the remote sensing images that capture the spatial variabilities, as well as about the pixel selections within the temperature – albedo diagram for determining evaporative extremes.

A relevant characterization of these factors can only be obtained through a better comprehension of the interactions among the vegetation cover, the atmosphere and the soil surface. The raising questions are therefore handled through sensitivity analysis. The latter are performed by assessing water status and evapotranspiration variations according to the tuning of the aforementioned factors. Several retrievals are intercompared, and the considered factors are hierarchically classified according to their influence on the recovering of water status and evapotranspiration. The sensitivities underlined through these analysis are confronted to the accuracies of the ground based references, and especially to those derived from neutron probe data through the 1-D HYDRUS model. Overall, these sensitivity analysis allow providing recommendations when parameterizing the remote sensing based methods we consider here.

The main results obtained from the sensitivity analysis are the following. The parameters used in WDI calculation that do not significantly influence the retrieval of water status and evapotranspiration (less than 10% in relative) are air temperature, canopy resistance at potential evapotranspiration, canopy resistance associated with

nearly complete stomatal closure, relative humidity, air atmospheric pressure and soil heat flux. WDI calculations are sensitive (variation in calculation of water status and evapotranspiration ranging between 10 and 40% in relative) to net radiation, and especially aerodynamic resistances over bare soil and vegetation. The estimates derived from S-SEBI are significantly sensitive to spatial extension, with variations of about 25% in relative when considering a larger spatial extension within the remotely sensed images (a 1000 sq-km size region that includes a larger panel of vegetation types and soil conditions, as compared to the 70 sq-km size La Peyne watershed that includes vineyards by 70%). Non negligible differences were also observed (around 20% in relative), when tuning the pixel selections for the determination of evaporative extremes.

References

M. Galleguillos, F. Jacob, L. Prévot, P. Lagacherie, 2009. Spatializing vineyard hydric status within heterogeneous Mediterranean watershed from high spatial resolution optical remote sensing. 2009 IEEE International Geoscience & Remote Sensing Symposium, Cape Town, Africa, July, 13-17 2009.