Geophysical Research Abstracts,
Vol. 11, EGU2009-6971, 2009
EGU General Assembly 2009
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# Spatializing vineyard hydric status within heterogeneous Mediterranean watershed from high spatial resolution optical remote sensing.

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Land surface evapotranspiration is one of key hydrological inputs that determine hydric status within Mediterranean vineyards. Its knowledge 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. Due to vineyard landscape structures, mostly including small fields, the use of remote sensing has not been extensively investigated, apart from airborne observations. Spaceborne ASTER data, collected over the optical domain at high spatial resolution, are of strong interest for the mapping of vineyard hydric status in relation with surface and soil properties, provided vine thermal and hydric status are strongly linked. The objective of this study is to assess the performances of two spatialized approaches devoted to the mapping of instantaneous surface energy fluxes from optical remote sensing.

Amongst the candidate methods to be foreseen for the mapping of vineyard water status from remote sensing, we consider two single layer methods characterized by their simplicities and feasibilities, in terms of implementation and input requirements. The first method is the Simplified Surface Energy Balance Index (S-SEBI, proposed by Roerink et al., 2000) and the second is the Water Deficit Index (WDI, designed by Moran et al., 1994). 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. First, the spatial information can be characterized through the temperature – vegetation index triangle that is controlled by soil moisture (WDI), or through the temperature – albedo diagram that is controlled by radiative and evaporative processes (S-SEBI). Second, evaporative extremes can be determined according to theoretical considerations and related formalisms (WDI), or assigned according to variabilities captured through thermal infrared observations (S-SEBI).

These two remote sensing based single layer approaches are selected since input requirements are reduced, as compared to more detailed double layer models that distinguish soil and vegetation (Campbell and Norman, 1998 ; Norman et al., 1995 ; French et al., 2005). They have been widely over various landscapes, and mainly over full canopy cultures like cereals, because of simplicity in terms of canopy structure and related homogeneity. However, little information is available for heterogeneous vineyard crops characterized by row-based two-dimension structures, the latter inducing significant soil exposition to sunlight and air turbulence within the canopy. Further, the consideration of these two spatialized approaches allows intercomparing their potential and limitations, in terms of feasibility and accuracy, especially according to the theoretical or empirical determination of evaporative extremes that are used for the differentiating based retrieving of water status and evapotranspiration.

The current study is conducted within the La Peyne basin, a 70 sq-km watershed located in southern France which includes vineyards by more than 70%. For each ASTER data acquisition in 2007 and 2008, maps of water status indicators are computed: water deficit from WDI and evaporative fraction from S-SEBI. They are next normalized through actual evapotranspiration, where the latter is derived from potential evapotranspiration and water deficit on the one hand, and from available energy and evaporative fraction on the other hand. Retrievals of water status and evapotranspiration are intercompared and validated against ground based references. Intercomparison exercises are performed over all vineyard fields within the La Peyne watershed. Validation exercises are performed over several contrasted sites, where the contrasts are related to vegetation height, inter-row distance, hydrodynamic soil properties, and distance to the water table. Ground based references are either direct estimates based on eddy covariance measurements, or indirect estimates deduced from neutron probe data through the 1-D HYDRUS model that simulates water transfers within the vadose zone and up to the surface (Simunek and van Genuchten, 2008).

The main results obtained from the intercomparison and validation exercises are the following. HYDRUS simulations over the several locations selected for ground based references provide contrasted values. Mean daily evapotranspiration can vary from 0 to 4.5 mm for a given site. It also varies significantly from one site another, with cumulative values ranging from 760 mm to 1150 mm during the 2007-2008 period. Under conditions of large evaporation rates, if varies from 4.5 mm for the wettest site to 2.5 mm for driest site, when selecting full vegetation cover only. These results illustrate the significant differences in evaporative regime, despite similar surface conditions. This is ascribed to the differences in pedological properties, as well as to the differences in soil water conditions induced by variations in distance to water table. Finally, intercomparison of WDI and S-SEBI evapotranspiration maps for several ASTER overpasses indicates the consistencies of both methods. It shows systematic differences, with an averaged coefficient of determination close to 80%, and an averaged quadratic difference of 50 W/sq-m. Validation against eddy covariance measurements show errors within the range of similar studies reported in the literature, with 20 W/sq-m for S-SEBI and 25 W/sq-m for WDI.

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