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Impact of the cultural practices on the spatial variability of surface fluxes and microclimate at the regional scale

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Describing soil - vegetation - atmosphere transfers is of prime interest for understanding interactions and feedback between vegetation and boundary layer, and assessing plant water status. It became particularly important these last years in the context of climatic changes because landuse evolution can induce significant modifications of surface fluxes like evapotranspiration and therefore, for example, different irrigation strategies. The current study focussed on linking micrometeorological conditions to cultural practices at local and regional scales. We considered both observation and modelling tools designed for capturing and characterizing the spatial variability of land surfaces. We have used different models simulating the transfers between soil-vegetation and atmosphere (the SEBAL spatialised energy balance model, (Bastiaanssen et al, 1998) and the 'Planetary Boundary Layer Model (described in Brunet et al, 1991). They were applied over a small agricultural region in the South East of France called "The Crau Camargue", where an experimentation took place in 2006 including intensive ground measurements on different types of crops, in parallel to airborne and satellite data collection. This region was flat and presented high contrasted areas with various cultural practices. Thermal data were collected at different spatial resolutions using spaceborne (ASTER) and airborne (thermal Infra Red camera) sensors. Micrometeorological measurements were performed on 5 fields (rice,

2 wheat, grassland, corn). The main characteristics of the vegetation (LAI, height, biomass) were measured all along the cultural cycles of each crop. Atmospheric profiles were acquired for several clear days with a tethered balloon over the studied site. The main land surface properties were derived from remote sensing data acquired at different spatial resolutions: LAI and albedo were estimated from ASTER(15m) and FORMOSAT (8m) images for several dates. Albedos were estimated by a linear combination of reflectances in the visible and near-infrared ranges. We have compared various coefficient sets proposed in the literature (Jacob et al, 2002) and have adjusted a new set for FORMOSAT data. We will show the validation. LAI and vegetation fraction *(FCOVER)* were computed by feeding a Neural Network (NN) with reflectances estimated both in the ASTER and FORMOSAT channels. The NN was previously calibrated over a database simulated with the radiative transfert model (SAIL, Verhoef, 1984) for a wide variety of crops and LAI (Weiss and Baret, 2002). The other surface parameters such as emissivity, minimum stomatal resistance (r_{smin}), roughness lengths took constant values according to the vegetation type of the landuse map derived from image classifications.

Maps of the main energy fluxes and temperatures were simulated with the 2 models for contrasted dates at different spatial resolution according to the remote sensing data used. A disaggregation method was used to reduce spatial resolution of surface temperature obtained from ASTER from 90 m to 30m, in order to better identify each field. The validation of this methodology was done by comparing the results with the airborne thermal images acquired at fine resolution (3.5m). The simulated surface fluxes showed great spatial variations due to differences in soil moisture and surface roughness, which is highly dependant on cultural practices. Comparisons between simulations and measurements gave satisfactory results for the SEBAL model. Thermal images acquired by the infrared airborne camera were in good agreement with the surface temperatures estimated by the PBL model. The spatial variations of air temperature at 2m above the ground were not negligible (up to 3 degrees for some dates). These temperature variations have a significant effect on crop development and could explain the yield differences observed (Courault and Ruget, 2001). Irrigation appeared as the main factor explaining the great micrometeorological variability.

It appears that even at a small scale, the crop types and the various cultural practices induced significant variations both on temperature and surface fluxes. Remote sensing data at high spatial and temporal resolution (such as FORMOSAT@SPOT data) were also an indispensable tool to provide accurate inputs to the transfer models. Indeed, identification of each crop type associated with its main cultural practices (such as sowing date, irrigation, cut date of meadow for example) is possible. The main surface parameters characterising the vegetation development can be extracted from these data using efficient methodologies (such as the neural network for LAI and vegetation fraction) or using adequate coefficient sets for the albedo estimation.

We can expect that through increasing spatial resolution and sensor profusion remote sensing will continue to play an essential role providing information at a low cost. Such information will be useful for improving assessment of crop water status, either for irrigation scheduling or for global assessment of crop water use and its spatial variations within an irrigated area.

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