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Estimating the spatial distribution of daily air temperature by Time Series Analysis of MODIS Land Surface Temperature

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The lack of information about air temperature (Ta) spatial distribution is a central problem in agro-environmental studies at all scales. Air temperature is in fact the most important variable, along with radiation, to influence crop development and its spatial distribution. It is used as input in a large variety of models ranging from prediction of potential evapotranspiration and crop yields to climatic impact studies.

The aim of the Italian project Agroscenari is to determine future adaptation of crops to climate change by studying relatively small areas representative of specific production systems. This requires knowledge of climate at much higher spatial resolution than GCM-based scenarios. This applies particularly to areas, such as the Valle Telesina (Italy), one of our study areas, characterized by complex relief (Alfieri et al, 2010). We have down-scaled GCM-scenarios in two steps: a) statistical downscaling by relating GCM-fields of air temperature to observations gridded at a 35 km x 35 km resolution; b) by using MODIS Land Surface Temperature to characterize sub-grid spatial variability of time series of air temperature. We describe here the step (b).

*Relation between air temperature and surface temperature***.** Near surface air temperature and Land Surface Temperature (LST) observed from satellites are correlated. Daily land surface temperature (LST) of Terra Moderate Resolution Imaging Spectrometer (MODIS) sensor was used for the analysis. We have established a regression equation for all available stations relating daily observations of air temperature with LST observations for the period 2000 – 2006.

*Characterization of spatial and temporal patterns***.** We have calculated for each MODIS pixel time series of the ratio of LST at each pixel-location to the LST at the location of a reference node of the 35 km x 35 km grid. Removal of cloud affected pixel values and gapfilling was performed by HANTS algorithm (Menenti et al, 1993) producing continuous time series of maximum and minimum LST. Fourier analysis of the time series of LST ratios was performed for each year, showing three main periodical components (yearly, half yearly and seasonal). We have evaluated the interannual variability of amplitude and phase values to conclude that we could use their mean values to characterize the annual temporal profile of the pixel-wise ratio.

*Estimation of the spatial pattern of daily air temperature***.** Daily maximum air temperature at each pixel location was estimated by combining the spatial and temporal pattern of the ratio with the regression equation giving air temperature as function of surface temperature. This gives maximum air temperature at any location as function of maximum air temperature at the reference node.

Estimated maximum air temperature was compared with observation at four stations in Valle Telesina area giving a RMSE between 2.9 and 4.2 k.

Keywords: Time series analysis, Land Surface Temperature, HANTS algorithm, temperature spatial patterns