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A downscaling approach for SMAP soil moisture estimates using in situ measurements and a vegetation index

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Soil moisture monitoring at a global or regional scale is nowadays achieved through remotely sensed observations which are considered as a reliable source of information for soil moisture. Due to the coarse spatial resolution of the available remotely sensed products, there is need for a downscaling approach which is usually based on other finer scale remotely sensed information along with in situ soil moisture measurements. The objective of the downscaling approach is to produce fine resolution soil moisture estimates by examining the possible relationships between optical / thermal remotely sensed data and commonly monitored in situ meteorological information. In this study a downscaling approach for remotely sensed land surface soil moisture observations from NASA's Soil Moisture Active Passive (SMAP) mission was developed. In our work we used daily global observations acquired by the L-band (1.4 GHz) operating microwave radiometer at a spatial resolution of $\sim$ 40 km, while the daily in situ soil moisture observations along with other meteorological parameters, like air temperature and precipitation, were retrieved from a six-stations network located in North Greece.

The aim of our study was to integrate SMAP passive soil moisture observations and remotely sensed environmental information in the form of the Normalized Difference Vegetation Index (NDVI) along with daily in situ measurements in order to develop a downscaling approach. In consonance with the preliminary conducted diagnostic tests, SMAP passive soil moisture retrievals, Moderated Resolution Imaging Spectroradiometer (MODIS) NDVI data, daily precipitation and daily mean air temperature were found to be possible predictors for soil moisture estimates at a daily time step with a resolution of 1 km. Thus, a multilinear regression model was established by integrating SMAP passive Level 3 soil moisture data, Moderated Resolution Imaging Spectroradiometer (MODIS) 16-day NDVI values, daily precipitation and daily mean air temperature values. During further examination of the developed regression equation, the performance of our methodology was enhanced as land use information was added to the process.

Pursuant to the initial results of the developed approach using in situ measurements for a time period of 20 months, it is argued that SMAP passive soil moisture downscaling can be effective with the utilization of supplementary environmental information. The accuracy of our results was ascertained by examining some fundamental statistical parameters, such as the Residual Standard Error (RSE) and the Multiple R squared (R^2). Our results indicated an R^2value of 0.56 and a low RSE value of 0.04 $m^3 \cdot m^{-3}$ demonstrating thus the potential of our methodology to achieve soil moisture estimates at a fine resolution.

The above described downscaling procedure was conducted with freely available remote sensing data, whilst data processing was executed within the R statistical computing environment.