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Soil water content maps by remotely-sensed thermal inertia data: Calibration and validation procedures

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Remote sensing of soil water content from air- or space-borne platforms offers the possibility to provide large spatial coverage and temporal continuity.

The procedure herein applied allows to assess surface water contents from thermal inertia data, which in turn is function of the amplitude of diurnal surface temperature and the corresponding soil heat flux variation.

The surface temperature was provided by the FLIR A40-M thermal camera and the soil heat flux by CIR MS4100 multi-spectral camera, both carried on board the Sky Arrow aircraft. The water content map was calculated by using empirical relationships among volumetric water content, volumetric heat capacity and thermal conductivity, once clay mass fraction and bulk density are known.

The procedure was applied on a 4 ha bare soil located in the Sele plain, South of Italy, and the surface soil water content map validate by ground TDR-based measurements.

The first results were promising because we observed (i) a very close average of the measured (0.165 cm^3 cm^{-3}) and estimated (0.181 cm^3 cm^{-3}) soil water content, (ii) a very close standard deviation (0.025 vs 0.019 cm^3 cm^{-3}) for measured and estimated

soil water content, respectively, (iii) a similar range of experimental semivariogram (73 vs 45 m), and (iv) a similar pattern of variability.

After these promising results, the procedure was validated on 3 days at decreasing soil water contents measured at ground by TDR. A sensitivity analysis of the main applied algorithms was performed and the remote sensed images were better corrected for the influence of the atmosphere. The influence of the clay content was crucial. The validation gave similar results of the first test, both in average and standard deviation. Moreover, the same spatial patterns of variability were found also at different soil water contents.

With these promising results at hand, the next step will be developing a practical and robust procedure for estimating water contents throughout the entire soil profile in the perspective of predicting the crucial vadose zone processes at large scale.