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Surface soil moisture mapping at high spatial resolution over agricultural bare soils by using TERRASAR-X and FORMOSAT-2 data.

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This work aims to investigate the capabilities of TERRASAR-X SAR (Synthetic Aperture Radar) and FORMOSAT-2 high resolution and multi-spectral data to estimate the surface soil moisture content of bare agricultural soils. Emphasis is put on the use of time series of TerraSAR Strip Map mode images acquired during the autumn 2009, between the 28 of September and the 11 of November, that matches with the period where agricultural fields are mainly bare (more than 40% of the area is composed of bare soils).

The analysis is firstly performed by extracting the bare soil surfaces from FORMOSAT-2 NDVI data. Then, X-band backscattering coefficients acquired at high incidence angle (43˚) over bare soils are compared with field measurements collected over local sites located in the south-west of Toulouse (43˚29'36"N, 01˚14'14"E) in France. Field data consists of Surface Soil Moisture (SSM) and surface soil roughness respectively recorded by a Theta Probe sensor and a 2-meters long profilometer. Measurements are performed along several meters transects depending of the field size (at least several hectares). Changes in soil practices (plough, sown…) and spatial tillage orientation are also monitored in time.

Results show the low sensitivity of the radar backscattering coefficient (43˚) to the tillage orientation. Signal variation lower than 0.5dB is observed when considering a relative angle view ranged between 0 and 90˚ ($\theta_{satellite\ view\ angle} - \theta_{field\ tillage\ orientation}$). A well marked correlation between radar data and SSM measurements (r^2 *=0.75*) is then observed whatever the soil practices, which is strongly important since C-band or L-band data do not allow significant SSM estimations without considering soil roughness corrections. Surface soil moisture is accurately estimated at local scale (rmse about 5%) thanks to the high spatial resolution images and to the small wavelength data (about 3 cm) less sensitive to soil roughness changes. Finally, soil moisture maps are processed, and well indicate the spatial variability of soil moisture over bare agricultural fields. Spatial analyses are performed by considering soil practices and soil properties.

These results suggest that high resolution X-band images could be used to derive multi-temporal SSM maps over agricultural bare soils, by neglecting the tillage orientation contrary to analyses performed by C- and L-band data.

The following work consists to 1) assimilate the high resolution soil moisture maps in physical models to improve evapotranspiration estimates at regional scale 2) combine X-band data with C- and L-band data in order to estimate soil moisture over vegetated fields.