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# Radar data sensitivity to crops using TerraSAR-X, Radarsat-2 and Alos satellite data

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In a changing climate context, the understanding of the different processes involved in the surface-atmosphere interactions in anthropized area is fundamental. On agricultural ecosystems, this issue is reinforced by the obligation to combine sufficient productivity and durability of the resources from local to regional scales.

The objective of this study is to investigate the sensitivity of multi-frequency (at X-, C- and L-bands) and multi-polarization (HH, VV, HV and VH at C-band) radar backscatter signatures during the growing season (i.e. from sowing to harvest) of different crops (e.g. corn, rapeseed, soybean, sunflower and wheat). Optical data are used as references for the analyses.

The study is in the framework of the MCM'10 experiment (http://www.cesbio.ups-tlse.fr/fr/mcm.html), carried out over an agricultural area located in the South West of France, in Midi-Pyrénées region. The aim of the experiment is to improve knowledge on agrosystems functioning, combining ground measurements and high resolution satellite images acquired in optical, thermal and radar domains. In microwave domain acquisitions are performed quasi-synchronously by TerraSAR-X, Radarsat-2 and Alos. Optical images are acquired by Formosat-2 and Spot 4/5 satellites. In addition to meteorological stations, ground measurements are collected the closest to each satellite acquisitions. They consist in qualitative (e.g. observations upon land use, agricultural practices...) and quantitative (e.g. crop height, crop biomass...) measurements. Overview of the experiment is given in Baup et al., 2012 presented in this conference.

The Normalized Difference Vegetation Index (NDVI) and the Leaf Area Index (LAI) are computed from optical data. Backscattering coefficients are derived from microwave data following different steps: (i) a radiometric calibration is applied, (ii) all images are geo-referenced using aerial ortho-photos, (iii) an angular correction is performed at X- and C-bands (at L-band, all images are acquired with the same incidence angle). The angular correction is based on empirical relationships between the NDVI and the difference of backscattering coefficients between two successive images acquired at high and low incidence angles. Higher sensitivity is observed at C-band (compared to X-band) with an exponential decrease as NDVI increases. Sensitivity is around 0.3 dB/° for low NDVI ($\sim$0.2) and values saturate under 0.1 dB/° for NDVI higher than 0.4.

At X-band, the temporal behaviors appear comparable for the summer crops (i.e. corn, soybean and sunflower) with an increase of several dB (3 to 6 dB) during the first phenological stages and a saturation period (around -8 dB). At C-band full-polarization data show different behavior depending on the considered crop and polarization, for examples: VH backscatters increase of about 9 dB during the whole soybean growth period, on sunflower two periods are observed (an increase and a decrease) with a dynamic of about 6 dB with co-polarized backscatters. At L-band backscattering coefficients appear sensitive to winter crop height (i.e. rapeseed, wheat).

This work show that multi-frequency approaches (microwave and optical) appear useful and complementary to monitor crop cycles and vegetation parameters.

This approach is in the framework of the next generation of satellite mission: COSMO-SkyMed, TamDEM-X, Radarsat constellation, Sentinelle Mission, TamDEM-L, Alos-2...