Diurnal and seasonal dynamic of interferometric coherence and backscattering coefficient at C-band over an olive orchard in a semi-arid area

Chakir Adnane [(1)], Frison Pierre-louis [(2)], Khabba Saïd [(1,3)], Villard ludovic [(4)], Ouaadi Nadia [(4)], Ledantec Valérie [(4)], Jarlan Lionel [(4)]

(1) LMFE, Department of Physics, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco.
(2) LaSTIG, UPEM / IGN, Champs sur Marne, Paris, France.
(3) CRSA, Centre for Remote Sensing Applications, Mohammed VI Polytechnic University (UM6P), Ben Guerir, Morocco.
(4) CESBIO, University of Toulouse, IRD/CNRS/UPS/CNES, Toulouse, France.

Corresponding Author Email: khabba@uca.ma, pierre-louis.frison@u-pem.fr

Keywords: Interferometric coherence, Backscatter coefficient, C-band, Olive, diurnal

This work aims to assess the ability of C-band radar data for monitoring the vegetation hydrological functioning in a semi-arid Mediterranean environment where up to 80-90% of water resources are used for irrigation. To support the sustainable use of water resources in agriculture, quantitative estimates of key variables such as water stress, evapotranspiration and soil moisture must be considered and radar remote sensing is a promising tool for this objective.

Within this context, an experiment was developed on a drip-irrigated olive orchard in the Chichaoua region (center of Morocco). The orchard field is about 2.4 ha, the trees are about twenty years old, 3 m high, and are planted every 5x5 m². This study focuses on the diurnal and seasonal variations of the backscattering coefficient and the interferometric coherence with a radar set composed of 7 C-band horn antennas at the top of a 20 m high tower. The setup has allowed measurements at 4 polarizations (VV, VH, HV, and HH), which provided radar acquisitions with high temporal frequency at a 15 minutes time step since March 2019. The study site is visible through three different Sentinel-1 passages, the acquisitions are available every 10 days, allowing comparison with in situ radar measurements.

The backscattering coefficient and the interferometric coherence are analyzed. The results show daily cycles correlated with the diurnal variations behavior in tree water content (sap flow) and wind speed, with daily amplitude ranging from 3 dB in winter to 5 dB in summer for the backscattering coefficient. While, at a seasonal scale, the backscattering coefficients at all polarization's show a low temporal frequency profile amplitude.

Regarding the interferometric coherence, the diurnal evolution estimated between two consecutive measurements (i.e., 15 minutes) shows a clear diurnal cycle regardless of polarization, with an amplitude of variation between 0.7 in the summer and 0.3 in winter, with a high sensitivity to rain events.

However, additional work, more in-depth with other in situ measurements, are underway to link this radar diurnal and seasonal cycle to the water content of Olive trees according to their phrenological behavior. This would bode well for water stress monitoring using radar sensors embedded in space, especially since Sentinel-1 offers, for the first time, the ability to combine radar

acquisitions at high time frequencies (6 days) in C-band with a high spatial resolution (20 m) to optimize water use and monitor crop growth and development.