Influence of soil variables at the L Band

Backscattering coefficient simulations for sunflower in early stages

Mieza, M. Soledad [1], Ferrazzoli, Paolo[2], Cravero Walter R.[3] , Kovac, Federico D.[1]

[1] Facultad de Ingeniería, UNLPam, (6360) General Pico-La Pampa, Argentina
[2] Università di Roma Tor Vergata – DICII - Roma, Italia
[3] IFISUR, UNS y CONICET, Alem 1253, Bahía Blanca, Argentina
smieza@ing.unlpam.edu.ar - ageo@ing.unlpam.edu.ar

Extended Abstract

SAR backscattering coefficient (***σ^0***) of crops depends on the operational frequency, polarization and incidence angle of the acquisition system, the dielectric behaviour of crops, and soil-related variables such as the volumetric moisture **(m_v)** [1] and its roughness. In SAR applications, surface roughness is usually characterized by two parameters: the standard deviation of the surface height to a reference height or *rms* height **(*s*)** and the autocorrelation length **(*l*).** The autocorrelation length, defined as the distance at which the correlation function drops to 1/e, describes the surface periodicity and indicates to what extent two separate points can be considered correlated [2].

For crops in their early stages, soil characteristics play a crucial role in ***σ^0*** due to the low vegetation development**.** In this work, we present ***σ^0*** simulations for sunflower (early stages) using a model proposed by [3] for the L Band; specifically, the frequency was set to that of the SAOCOM instruments (1.275 GHz).

The simulations were performed for typical conditions in NE La Pampa in central Argentina, where crops are mainly grown under no-tillage practices. Representative values for the area were used as input for all the variables required by the model: the soil composition (65% sand, 8% clay), that for the expanse of a crop season is invariable, a plant density of 4 plants/m^2, the volumetric moisture from 0.05 to 0.3 (0.05 steps), and for the roughness-associated variables, the correlation length ranging from 5 cm to 30 cm (5 cm steps), and ***s*** from 0.5 cm to 2.5 cm (0.5 cm steps). Sunflower morphometric evolution was simulated using a model developed for the same geographical area [4].

The results for ***σ^0*** = f(***s***, ***l***, **m_v**), HV polarization and an incidence angle of 32.5º, for the minimum crop height simulated (10cm), are shown in Fig. 1. The chosen incidence angle and polarization mode are within the recommended for SAR crop monitoring [5]. At the L band, the highest values of *σ^0*, for the ranges of the variables analyzed, are associated with the lowest correlation length (5 cm), maximum "***s***" **(**2.5 cm***)***, and high volumetric moisture. As the crop develops, the influence of the soil characteristics diminishes, and for crop heights greater than 80 cm, the maximum **$\Delta\sigma^0$** is of approximately 2 dB, also shown in the figure (on the right).

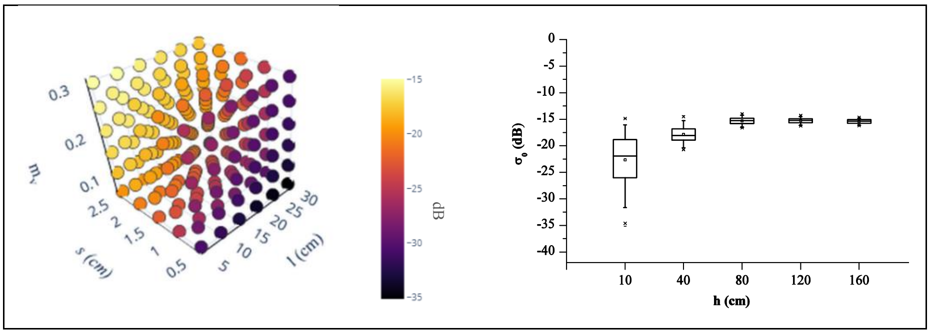

Fig. 1. 3D Scatter plot showing $\boldsymbol{\sigma^0} = \mathrm{f}(\boldsymbol{s}, \boldsymbol{l}, \mathbf{m_v})$ for HV, θ=32.5°, for the L band for the minimum crop height simulated (10 cm), on the left, and to the right boxplots showing $\boldsymbol{\sigma^0}$ variability as a function of the crop height for the ranges selected for all soil variables.

In the co-polarization modes (HH and VV), for the minimum crop height (10 cm), $\boldsymbol{\Delta\sigma^0}$ is also around 20 dB.

The results obtained point to the necessity, mainly when working throughout crops early vegetative stages or with low plant density, to adequately characterize the soil conditions. Even though we tested the model for sunflower, it is estimated that the soil effect is similar for other crops at early stages, like maize and soybeans, also grown in the area. Furthermore, these simulations could enhance methodologies oriented to de-couple soil roughness and moisture or improve roughness characterization.

Keywords: soil, backscattering, sunflower, SAOCOM, L Band

References

1. Gardner, W.: 21. Water Content. In: Klute, A. (ed.) METHODS OF SOIL ANALYSIS Part 1 Physical and Mineralogical Methods (1986).
2. Ulaby, F., Long, D.: chapter10. In: Microwave Radar and Radiometric Remote Sensing. pp. 420–458. The University of Michigan Press (2014).
3. Bracaglia, M., Ferrazzoli, P., Guerriero, L.: A fully polarimetric multiple scattering model for crops. Remote Sens. Environ. 54, 170–179 (1995). https://doi.org/10.1016/0034-4257(95)00151-4.
4. Mieza, M.S., Cravero, W.R., Kovac, F.D.: Girasol: modelado morfométrico para aplicaciones SAR En condiciones locales para La Pampa. In: CAI 49 JAIIO. , Buenos Aires (2020).
5. Ferrazzoli, P.: SAR for agriculture: Advances, problems and prospects. In: 3rd International Symposium on Retrieval of Bio and Geophysical Parameters from SAR Data for Land Applications. pp. 47–56 (2002).