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Multifrequency and multiplatform retrieval of soil moisture in vegetated terrains

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The future ROSE-L mission, planned to be launched in 2028, will offer the unprecedented opportunity to form with Sentinel-1 a multiplatform radar observatory with very high sampling capability in space and time as well as in the electromagnetic spectrum, thanks to the large swath and short revisit of the two platforms. A requirement to cover the same swath at L and C band has already been specified, with the scope of achieving an optimal superimposition in space of the images and foster multifrequency applications. Nevertheless, as for the specific soil moisture application, it is not yet assessed whether it is preferable flying the two sensors very close each other to improve the thematic accuracy of the product, or alternatively phasing the orbits to achieve three days revisit of the constellation. Moreover, ROSE-L is expected to have polarimetric capability in addition to the standard dual-pol capability of Sentinel-1.

Within the frame of the Italian Space Agency's "SAR-L: consolidamento della scienza" Project, the potential of a synergic use of C- and L-band SAR data to improve the soil moisture retrieval over bare soil and vegetated areas is being analyzed. In particular, the simulation study here presented aims at offering an answer to which is the best orbital phasing for the "System of Systems" formed by ROSE-L and Sentinel-1. Images over a fictious agricultural area are simulated using the soil scattering semi-empirical model in (1) and the Water Cloud Model in (2). The multitemporal algorithm in (3) has been extended to the multifrequency case and tested on the simulated dataset comparing different acquisition timing and polarization configurations.

The performances of the dual-frequency algorithm generating the soil moisture map every 6 days were found generally better with respect to the case in which a single frequency is considered. However, the alternated 3-day acquisitions achieve the same performances when C-band is acquired, whereas it keeps the performances of L-band in the other cases. Halving the temporal resolution of the soil moisture product is deemed a very important achievement in many applications' domain, although at the expense of a minor loss in accuracy.

Note that the good performances when acquiring C-band are mainly due to the information about soil roughness gathered from the previous L-band acquisitions that, accordingly to the forward model, are more sensitive to the range of considered roughness. This mechanism can be only exploited thanks to the power of the multitemporal approach.

The work has also considered the case of a vegetated soil. Vegetation attenuation and scattering is introduced in the forward simulations, and the inversion of the Water Cloud Model within the retrieval algorithm partially mitigate the vegetation effects. As the removal of the vegetation effect is a major issue in soil moisture retrieval and subject to errors, the larger penetration of L-band signal highlights the performances of ROSE-L.

1. Oh, Y., K. Sarabandi, and F. T. Ulaby, "Semi-empirical model of the ensemble-averaged differential Mueller matrix for microwave backscattering from bare soil surfaces," Trans. Geosci. Remote Sens. IEEE. Vol. 40, pp. 1348-1355. 2002.C. R. Mannix, D. P. Belcher, P. S. Cannon, and M. J. Angling, "Using GNSS Signals as a Proxy for SAR Signals: Correcting Ionospheric Defocusing," *Radio Science*, **51**, 2, February 2016, pp. 60-70.
2. Attema, E.P.W. and Ulaby, F.T., 1978. Vegetation modeled as a water cloud. Radio Science Journal, 13, 357–364.
3. N. Pierdicca, L. Pulvirenti and G. Pace, "A prototype software package to retrieve soil moisture from Sentinel-1 data by using a bayesian multitemporal algorithm," Journal of Selected Topics in Applied Earth Observations and Remote Sensing. IEEE. Vol. 7, no. 1, pp. 153-166. Jan. 2014.