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Estimating altimetry biomass from Sentinel-3 data

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Above Ground Biomass (AGB) has become a key variable in quantifying carbon storage and sinks as well as in understanding climate changes at global scale. Considerable research attention has been directed towards a better characterization of the amounts and the spatial distribution of AGB, integrating data from various satellite missions. In the present study, we describe the challenging results offered by the ESA ALtimetry for BIOMass (ALBIOM) project, which aims to retrieve forest AGB estimation with sufficient accuracy using low and high-resolution Copernicus Sentinel-3 SAR altimeter (S-3 SRAL) data at Ku and C bands. ALBIOM combines different qualitative and quantitative tools involving the analysis of the sensitivity of the altimetry backscattering data on land parameters, the development and the validation of an electromagnetic simulator of altimeter measurements over vegetated surfaces, and the biomass estimation using Artificial Neural Networks (ANNs). The sensitivity analysis investigates the variation of the Level 2 (L2) S-3 waveforms acquired over Africa with respect to biomass; it examines in what extent land parameters, such as soil moisture, topography, and surface roughness, affects the measurements. The analysis reveals that both the altimetric waveforms and the corresponding Normalized Radar Cross Sections (NRCSs) can be sensitive to the presence of biomass in the order of 100-400 tons/ha, although strongly influenced by the presence of topography and water bodies within the altimeter footprint. The altimetric simulator is realized through a merged modeling approach which uses simultaneously a modification of the TOVSM (Tor Vergata Vegetation Scattering Model) and SAVERS (Soil And Vegetation Reflection Simulator) simulators. TOVSM [1] is able to simulate the electromagnetic properties of vegetation elements, which are represented by simple canonical shapes. SAVERS [2] simulates the GNSS-R waveforms from land surfaces with significant topographic effects. The simulator shows promising ability to reproduce the general characteristics of the S-3 SRAL waveforms: the simulations related to forests present at least two peaks, due to the top of canopy and to the ground, although topography may introduce other peaks in the waveforms, making the identification of vegetation and topographic effects very challenging. Waveforms from G-POD SARvatore for Sentinel-3 Service are considered [3], especially for those signals which appear truncated because of a wrong positioning of the time-tracking window, mainly due to the early versions of the onboard S-3 Open Loop Tracking Command (OLTC) tables. The retrieval algorithm development using ANNs yields some interesting findings on biomass estimates over specific areas (e.g., Central Africa) but also differences in algorithm performances among different regions. The highest sensitivity to biomass is provided by the corrected "ice" backscatter coefficient, although its values are frequently invalid over land limiting the number of meaningful retrievals. The different S-3 SRAL tracking mode over different areas of the globe (i.e., open loop and closed loop) could also be liable for the differences in results.

References

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