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Recent Results from the ALBIOM Project on Biomass Estimates from Sentinel-3 Altimetry Data

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The ALtimetry for BIOMass (ALBIOM) project is an ESA-funded Permanent Open Call Project that aims to retrieve forest biomass using Copernicus Sentinel-3 (S3) altimeter data. The overall goal of ALBIOM is to estimate biomass with sufficient accuracy to be able to increase existing satellite data for biomass retrieval, as well as to improve the global mapping and monitoring of this fundamental variable.

The project core tasks consist of 1) an analysis of the sensitivity of altimetry backscatter data on land parameters; 2) the development and validation of a Sentinel-3 altimeter backscatter simulator, including the effect of both topography and vegetation and 3) the development and validation of a machine-learning biomass estimation algorithm.

Here we present a summary of the results obtained from the project. The sensitivity analysis reveals that both the altimetric waveforms and the corresponding Normalised Radar Cross Sections (NRCSs) can be sensitive to the presence of biomass in the order of 100-400 tons/ha, but they are also influenced by topography and water bodies. Different sensitivities with respect to the different frequencies and resolution modes are observed, highlighting non-linear behaviours of the NRCSs. The use of differential NRCSs, defined as the difference among those calculated over two different bandwidths, was demonstrated to be not necessarily more sensitive to vegetation, as it was instead highlighted by previous studies like [Papa et al., 2003].

The tracking window often appears partly or completely misplaced, when the tracking mode is in open-loop mode prescribing a predetermined range, and its size is often not long enough when collecting data over land, especially over regions with complex topography. The length and correct positioning of the tracking window over land represent therefore critical aspects for a study like ALBIOM.

The modelling work has been focused on the development of a merged model approach to simulate altimeter waveforms over vegetated areas. The merging is obtained via the simultaneous

use of the modifiedTor Vergata Scattering Model (TOVSM) [Ferrazzoli and Guerriero, 1995, 1996] to simulate the waveform of a flat surface covered by forest vegetation, and the use of the Soil And Vegetation Reflection Simulator (SAVERS) [Pierdicca et al., 2014], originally conceived for GNSS-Reflectometry, and here adapted to the Altimetry system. The simulator developed within ALBIOM shows promising ability to reproduce the general characteristics of the S3 waveforms. The simulations related to forested surfaces present at least two peaks, due to the top of canopy and to the ground, but the presence of topography may introduce other peaks in the waveforms, making the identification of vegetation and topographic effects challenging.

Initial results on the algorithm development using Artificial Neural Networks (ANN) highlight some promising biomass estimates over specific areas (e.g. Central Africa) but also differences in algorithm performances among different regions. The corrected “ice” backscatter coefficient showed the highest sensitivity to biomass, but its values are often invalid over land, which limits the number of meaningful retrievals. The different altimeter tracking mode of Sentinel-3 over different areas of the globe (i.e., open loop and closed loop) could also be responsible for the differences in results.