BIOMASS ESTIMATION AS FUNCTION OF VERTICAL FOREST STRUCTURE AND FOREST HEIGHT. POTENTIAL AND LIMITATIONS FOR REMOTE SENSING (RADAR AND LiDAR)

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Forest biomass stock, spatial distribution and dynamics are unknown parameters for many regions of the world. Today's information is largely based on ground measurements on a plot basis without coverage in many remote regions that are fundamental for the global carbon cycle. Thus, a method capable of quantifying biomass by means of Remote Sensing (RS) could help to reduce these uncertainties and contribute to a better understanding of it. In this study the capacity to improve the estimation of above-ground biomass (AGB) with a new approach based on forest vertical structure and its potential to improve RS estimations is analyzed.

Height to biomass allometry allows biomass estimations from remote sensing systems capable to resolve forest height (LiDAR and polarimetric SAR interferometry (Pol-InSAR)). However, this approach meets its limitations for forest ecosystems under changing conditions in density and structure. To improve biomass estimation accuracy, additional parameters need to be measured. Pol-InSAR and LiDAR allow getting besides forest height vertical backscattering profiles which are connected to forest vertical structure. Thus, due to the relation between structural parameters and AGB expressed by the Structure to Biomass allometry, AGB can be potentially inverted from these systems.

The best characterization of forest vertical structure is obtained using the Legendre polynomials. Biomass profiles can be then characterized by the decomposition into a set of Legendre-Fourier basis functions. This method is able to accurately reconstruct vertical biomass profiles with low frequency features.

Vertical backscattering profiles are strongly dependent on the sensor used as the resulting profiles are very sensitive to the wavelength and system geometry. E.g. LiDAR profiles are more sensitive to leaves and crowns while Pol-InSAR tends to reconstruct more the woody compartments (stems and branches). In this study, vertical backscattering profiles from short footprint airborne LiDAR and Pol-InSAR data are evaluated for their potential to reconstruct vertical forest structure. With the Legendre decomposition it is possible to parameterize the vertical backscattering profiles and relate them to forest biomass; even though for each remote sensing system different calibration methodologies must be derived. A first step is achieved using the calibration of backscattering signal with known biomass levels showing optimum results. In order to reduce the need of known parameters a new calibration methodology that exploits height to biomass allometric relations has been derived. Inversions using this methodology are tested for LiDAR and SAR profiles showing good correlations for an optimum subset of samples. As each system (frequency) is sensitive to certain biomass components an underestimation is generally expected. Research in this area is ongoing and will be presented with special focus on each system capacity to reconstruct forest vertical biomass distribution for broader sets of samples.