Coastal Forest 3-D structure, height class distribution and productivity modeling using Radar and Lidar

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1. INTRODUCTION

Predicting forest 3-D structure, biomass and productivity is of great importance for studies of the global carbon cycle, in particular for evaluating carbon storage and emissions. Coastal mangrove forests are some of the most productive forest ecosystems globally with a primary productivity of 2.5 g carbon/m^2 per day. In addition, they store great amounts of C in the soil and biomass, provide large amounts of carbon (C) to coastal and offshore marine ecosystems and contribute over 10% of the dissolved organic C (DOC) to ocean sediments worldwide.

The mapping of vegetation structure on a regional or continental scale presents several ecological and methodological challenges. Estimating forest structure, in terms of tree height, density and biomass is particularly challenging in high biomass ecosystems, such as mangroves. Lidar measurements, such as those of the ICESat/GLAS (Geoscience Laser Altimeter System) sensor are able to measure tree height from space with several meter accuracy. The combination of GLAS and Shuttle Radar Topography Mission (SRTM) data can provide more accurate and large-scale measurements of forest structure and biomass (Fatoyinbo et al, 2008). In this study we combine and compare ICEsat/GLAS and SRTM data to derive mangrove structure and biomass maps for South and Central America, and the Gulf of Mexico. We then present recent advancements in forest 3-D structure estimation used to derive tree-height distribution and applied to individual-based modeling of forest ecosystems.

More specifically, we relate remote sensing and field data to derive ecological parameters such as height, biomass and productivity of mangrove forests.

2. METHODS AND RESULTS

We used a combination of Radar (SRTM), Lidar (IceSat/GLAS), optical (Landsat) remote sensing and field data to produce 3-D maps of mangrove forests in South and Central America and the Gulf of Mexico. Using model inversion of GLAS waveforms, we derive the height class distribution of the forest within GLAS footprints. The resulting height class distribution was combined with field data and allometric equations as input into an individual-based growth model in order to predict productivity, growth and carbon sequestration over the next 50 years in the region.

3. CONCLUSIONS

We produced biomass and structure maps of mangroves with Lidar and InSar data and incorporated the remote sensing data. We incorporated GLAS waveform information into an individual-based forest growth model validated with field data. Future studies will use these methods in combination with airborne lidar and other radar data, such as UAVSAR and ALOS/PALSAR to determine forest structure and productivity.

Fatoyinbo, T.E., Simard, M., Allen-Washington, R.A., Shugart. H.H., (2008) Landscape Scale Height, Biomass and Carbon Estimation of Mangrove Forests with Shuttle Radar Topography Mission Elevation Data - 2007. Journal for Geophysical Research-Biogeosciences Special Issue on Remote Characterization of Vegetation Structure