MODELING MANGROVE FOREST PRODUCTIVITY AT THE LANDSCAPE SCALE WITH REMOTE SENSING

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1. INTRODUCTION

Mapping mangrove mean canopy height with radar interferometry (inSAR) is relatively simple as mangroves grow in tidally inundated areas, at sea level, where the underlying topography does not significantly impact the inSAR measurement. These height maps show the variability of the canopy structure at spatial scales larger than the pixel size (i.e. 30m) and implicitly indicate the spatial distribution of environmental forcings and stressors (tide, topography, salinity and nutrients). Within ecosystems there are two dominant scales: a large scale that is driven by environmental factors such as temperature, topography, moisture etc. and a small scale that is driven by competition between individual trees. To characterize the small scale canopy structure, we use ICEsat/Geoscience Laser Altimeter System (GLAS) and estimate tree size class distribution. Finally, the distribution is combined to an ecological model to build a spatially explicit model of ecosystem productivity.

2. METHODOLOGY

We used Shuttle Radar Topography Mission (SRTM) data calibrated with lidar and field data to map mangrove forest canopy height at the landscape scale with a 2 m rms accuracy and a spatial resolution of 30m [1]. To study small scale canopy structure, we use ICEsat/GLAS waveforms to obtain the tree size class distribution. GLAS is a large footprint lidar with a size of about 70m. The returned signal (i.e. the waveform) is caused by the light reflection of all forest components within the footprint considering light occlusion by upper canopy layers. In fact, the lidar waveform is the histogram distribution of the scattering surfaces height that very closely follows the canopy top within the footprint. Assuming the laser energy reflected at a given height H is proportional to the canopy surface area at H, we used allometric equations relating tree height H and crown extent a_c to infer the number of trees of height H within each footprint. We obtained the size class distribution with the footprint by performing this inversion for all heights. Relating the distribution to mean canopy height, we built a look up table that is used for spatial interpolation with the inSAR map of mean canopy height.

Since the spatial density of trees of height H is known, we can apply the FORMAN productivity model [2] assuming local values of salinity, nutrient availability and specie distribution (3 for the Everglades). The output is the annual growth in basal area within each footprint. These estimates are interpolated by matching mean canopy height with expected productivity.

3. CONCLUSION

We developed methodologies to quantify the canopy structure at the scale of environmental factors regulating the mangrove ecosystems as well as individual trees competing for resources. The method was applied to the Everglades National Park and an interactive web tool is provided at www-radar.jpl.nasa.gov/coastal. This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, and was sponsored by the National Aeronautics and Space Administration.

4. REFERENCES

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