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Very High Resolution Mapping of Tree Cover Using Scalable Deep Learning Architectures

sangram ganguly (1), saikat basu (2), ramakrishna nemani (1), supratik mukhopadhyay (2), andrew michaelis (1), petr votava (1), and sassan saatchi (3)

(1) NASA Ames, Moffett Field, CA, United States (sangram.ganguly@nasa.gov), (2) Louisiana State University, Baton Rouge, LA, United States (sbasu8@tigers.lsu.edu), (3) NASA JPL, Pasadena, CA, United States (Sasan.S.Saatchi@jpl.nasa.gov)

Several studies to date have provided an extensive knowledge base for estimating forest aboveground biomass (AGB) and recent advances in space-based modeling of the 3-D canopy structure, combined with canopy reflectance measured by passive optical sensors and radar backscatter, are providing improved satellite-derived AGB density mapping for large scale carbon monitoring applications. A key limitation in forest AGB estimation from remote sensing, however, is the large uncertainty in forest cover estimates from the coarse-to-medium resolution satellite-derived land cover maps (present resolution is limited to 30-m of the USGS NLCD Program). As part of our NASA Carbon Monitoring System Phase II activities, we have demonstrated that uncertainties in forest cover estimates at the Landsat scale result in high uncertainties in AGB estimation, predominantly in heterogeneous forest and urban landscapes. We have successfully tested an approach using scalable deep learning architectures (Feature-enhanced Deep Belief Networks and Semantic Segmentation using Convolutional Neural Networks) and High-Performance Computing with NAIP air-borne imagery data for mapping tree cover at 1-m over California and Maryland. Our first high resolution satellite training label dataset from the NAIP data can be found here at http://csc.lsu.edu/∼saikat/deepsat/ . In a comparison with high resolution LiDAR data available over selected regions in the two states, we found our results to be promising both in terms of accuracy as well as our ability to scale nationally. In this project, we propose to estimate very high resolution forest cover for the continental US at spatial resolution of 1-m in support of reducing uncertainties in the AGB estimation. The proposed work will substantially contribute to filling the gaps in ongoing carbon monitoring research and help quantifying the errors and uncertainties in related carbon products.