Forest Height, Cover, and Biomass Mapping using Passive Multiscale Data

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The Simple Geometric-optical Model (SGM) predicts top-of-canopy bidirectional reflectance as a function of viewing and illumination angles and important canopy parameters: plant number density, mean crown radius, mean crown aspect ratio, mean crown center height ratio, and background reflectance magnitude and anisotropy. The model was adjusted against red band data in nine views from the Multiangle Imaging Spectroradiometer (MISR) on the NASA Earth Observing System Terra satellite to retrieve estimates of crown cover, mean canopy height, and woody biomass (via regression) on a 250 m grid for large parts of Arizona and New Mexico. A first test of the applicability of this method to northeastern forests was also examined at two scales: at Howland Forest and for a large part of the state of Maine (Terra orbit D13824). For the SW forests, the background angular response in the MISR viewing plane was estimated prior to model inversion using the isotropic, geometric, and volume scattering weights of a US PAS-RossThin kernel-driven model, plus nadir camera blue, green and near-infrared reflectance, with calibration obtained using the SGM with plant mean radius and number density estimates obtained from Ikonos panchractic imagery. For the NE forests, a fixed background bidirectional reflectance distribution function was used owing to lack of calibration data. In both cases, the mean crown center height ratio, crown foliage density, leaf reflectance, and tree number density were fixed at typical values and fractional crown cover and canopy height calculated by adjusting crown radius (exploiting sensitivity to brightness) and crown aspect ratio (exploiting sensitivity to BRF shape).

MISR/SGM canopy height and crown cover retrievals for Howland Forest show a spatial match with H100 heights from the Lidar Vegetation Imaging Sensor (LVIS) in the range 10.0 - 30.0, although there is a compression of the MISR height estimates to a range of 7 - 29 m (Fig. 1). The relationship is relatively weak (R=0.21) but positive. The cover estimates (range: 0.0 - 0.8) are more noisy than the height estimates. Height and cover estimates are lower for roads and areas with few trees. In view of the lack of background calibration, the heterogeneity of the landscape, and the fixing of model parameters, these results are deemed promising.

Howland Forest, Maine

Arizona and New Mexico