The Effects of Canopy Structure and Topography on Seasonal Changes in Surface Reflectance Pattern in the Boreal Region of Alaska – Implication for Surface Radiation Budget

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ABSTRACT

Forests play a critical role in regulating the world's climate. They sequester atmospheric carbon and maintain a nice energy balance of incoming and outgoing solar radiation. The variability in forest canopy characteristics create uncertainty in the estimation and modelling of Earth's radiation budget and understanding surface radiative processes within canopies. Accurate knowledge of energy balance helps better quantification of surface radiation budget and modelling prediction of climate. We studied the small-scale variability (at 30-m resolution) in land cover classes, canopy characteristics, and terrain conditions and its relationship to seasonal changes in surface reflectance pattern in the boreal regions of Alaska. We combined Landsat 8 surface reflectance and LiDAR-derived canopy matrices to examine the existence of any relationships.

The canopy characteristics and canopy structural complexity (rugosity) varies with land cover classes. Tree heights and rugosity are positively correlated. However, tree heights and rugosity are higher in deciduous forests in comparison with evergreen forests. Our exploratory data analysis suggests that the presence of snow during winter months increases visible and near-infrared reflectance in forested areas, however no significant variation in visible and near-infrared reflectance was observed during summer months (May and August). The results further suggest that the surface reflectance from visible, near-infrared, and shortwave-infrared wavelength changes with seasons, topography, canopy characteristics, and land cover classes. Large variability and decreasing visible and near-infrared reflectance in relation to increasing canopy cover, tree heights and rugosity during March could be associated with the creation of high surface heterogeneity due to snow accumulation, especially in the region dominated by evergreen forests. Higher rugosity creates surface heterogeneity because of uneven tree heights and consequently greater absorption of lights due to canopy shades.

The detailed understanding of canopy characteristics and terrain conditions and its relationship to surface reflectance patterns at a small spatial scale could help parametrization of climate change models.

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