Uncertainties associated with forest resource inventory predictions over large geographies in northern Canada

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ABSTRACT

The consequences of climate change have been reported as most severe and rapid in the northern regions of the globe, however, little data are available in such regions to provide information on ecosystem development under such conditions. As a result, accurate large-scale contemporary forest resource inventory (FRI) products are needed in such regions not only to track ecosystem health, but to aid policy makers in making informed sustainable forest management strategy decisions. However, the utility of such products is often restricted as data availability and quality limitations propagate uncertainties to FRI products, many of which are overlooked and/or poorly understood. The current study attempts to quantify and evaluate the contribution of six sources of uncertainty within a stand height inventory product over a 225,000 km\(^2\) in the Northwest Territories (NWT), Canada. This product is derived from field plot data integrated with Geoscience Laser Altimeter System (GLAS) spaceborne laser altimetry data and supplementary predictor data within the random forest algorithm. The effect of numerous sources of uncertainty are evaluated using state-of-the art airborne laser scanning (ALS) data. Sources of uncertainty are stratified according to: spatially restricted source data and associated temporal disparities, data quality degradation (GLAS laser energy), geographic location (latitude), environmental factors (e.g. terrain complexity), and model transfer between data sources. The magnitude and contribution of each source of uncertainty with respect to data product accuracy will be presented. Results suggest that model transfer is of key importance, and also demonstrates the significance of spatial sampling. Surprisingly temporal disparity does not play such a significant role, however, the influence of other more prominent uncertainty sources likely diminish the effects of temporal disparity. The quantification, and understanding of such uncertainties within FRI products is important given upcoming launch dates for Earth Observation (EO) missions such as ICESat-2 and the Global Ecosystem Dynamics Investigation (GEDI) LiDAR system. The minimization and resolution of uncertainties will allow the more accurate quantification of forest structure change whilst allowing the evaluation of currently implemented forest sustainability strategies.