A multitemporal 30m land cover map for the ABoVE domain using dense Landsat time series and high resolution imagery

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Abstract

The rapid climate change in arctic and boreal ecosystems is resulting in drastic changes to land cover composition, including woody expansion in the arctic tundra, successional shifts following boreal fires, and permafrost thaw-induced wetland expansion. The impacts on physical climate and the carbon cycle of these land cover transformations are well-documented in field and modeling studies, but there have been few attempts to estimate overall rates of land cover on decadal and continental scales. Previous studies were either too coarse in spatial resolution or too limited in temporal range to analyze relevant rates of change. Here we present preliminary efforts to map land cover at 30m spatial resolution over the ABoVE core domain using time series of satellite remote sensing data from Landsat spanning 1984 – 2014. We utilize the Continuous Change Detection and Classification (CCDC) algorithm to analyze pixel-based time series of reflectance data and detect potential disturbances in land cover and distinguish relatively stable time segments. We utilize a combination of unsupervised clustering and supervised classification techniques to generate random forest models for predicting land cover over each pixel-time segment using a large suite of spectral and temporal features, digital elevation models, and other auxiliary data sources. Training and validation are performed using the considerable archive of high resolution imagery (0.5-4m) from DigitalGlobe over the ABoVE domain.

Background and Motivation

- Maps on the left indicate significant regional differences in arctic and boreal “greening” and “browning” (Top, Ju and Masek, 2016) and areas of land cover disturbances (Bottom, White et al., 2017) inferred from Landsat time series.
- Change in land cover are implied by White’s disturbance maps; land cover may explain patterns of greening and browning in Ju and Masek’s map. Land cover changes may drive recent observed enhancements in northern atmospheric CO\textsubscript{2} cycle enhancement (Graven et al., 2013).
- Land cover changes are difficult to analyze since current land cover maps are too limited in spatial, temporal, or thematic detail to answer land cover-based hypotheses regarding greening and bioge shifts in the far north.
- Landsat time series provide an opportunity to characterize land cover change at sufficient spatial resolution (30m) and temporal scale (1984 – 2014). Here we present preliminary results with maps of selected regions.

Data and Methods

- Shiny application developed for semi-automated hierarchical land cover labelling based on high-resolution (0.5 – 4m) DigitalGlobe repeat imagery spanning 1999 – 2017 and Landsat time series.
- DigitalGlobe imagery provides training and validation sites sampled from across the domain.
- High resolution imagery supplemented by photos from the field to help understand unique landscapes.
- Legend based on feature clustering, visual interpretation, accuracy, and optimal utility to the community (please provide feedback!)

Training Data and Legend

- R Shiny application developed for semi-automated hierarchical land cover labelling based on high-resolution (0.5 – 4m) DigitalGlobe repeat imagery spanning 1999 – 2017 and Landsat time series.
- DigitalGlobe imagery provides training and validation sites sampled from across the domain.
- High resolution imagery supplemented by photos from the field to help understand unique landscapes.
- Legend based on feature clustering, visual interpretation, accuracy, and optimal utility to the community (please provide feedback!)

Selected Prototype Results

- Left: Old Crow Flats in the Yukon. Top: Detail image over two time periods showing land cover change (lake drainage) in land cover map (top row), confirmed by high res. imagery (bottom row).
- Land Cover for BBR2002 in 2002
- Land Cover for BBR2010

References


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