Annual 21st Century Land Cover, Land Use, and Change in the NASA ABoVE Region

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Background

Satellite-based remote sensing in the Arctic, subarctic, and boreal zones

Due to the inaccessibility, size, and harsh conditions of high-latitude regions, ground-based data collection efforts are sparse. Earth-observing satellites enable consistent and reliable monitoring of Arctic and boreal ecosystems where field conditions are challenging. Satellite-based remote sensing also supports the application of standardized indices of change and change detection algorithms, as well as upscaling, allowing discoveries and progress made in study regions like the ABoVE domain to be expanded to other similar environments.

Land cover dynamics and disturbance

Disturbances in Arctic and boreal ecosystems alter land cover both directly, like in the case of wildfires or harvesting events, causing tree-covered areas be converted to other land cover types, and indirectly, through climate change affecting the species composition of vegetation. Understanding the ways that land cover is changing across both space and time in high-latitude ecosystems is therefore an important global change science challenge.

Methods

- Global Land Cover mapping and Estimation (GLanCE), a NASA MEaSURES project, will provide a data record of 21st century global land cover and disturbance at 30-meter resolution.
- The classification scheme contains 20 land cover types divided into two levels; currently, products use the "Level I" classification scheme — water, snow/ice, developed, barren, trees, shrubs, and herbaceous (figure 3).
- Training data is collected through a variety of sources and classifications are performed using the Continuous Change Detection and Classification algorithm (CCDC), which includes identification of change points and modeling of stable time segments, followed by assignment of class labels to time segments (fig. 1).

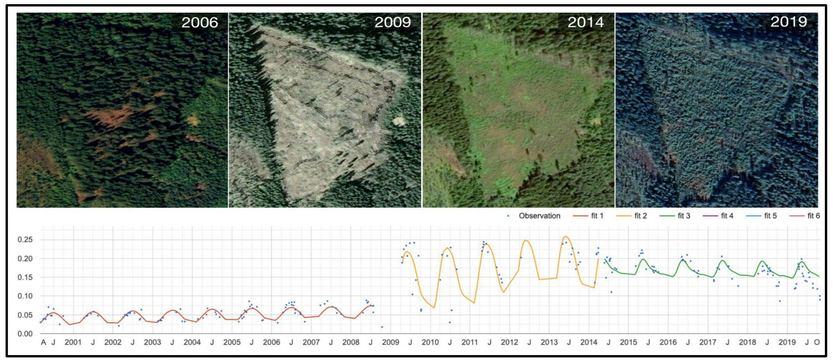


Figure 1 (above). An example of CCDC algorithm results for a pixel that was converted from forest to grassland, then began to recover. The time series plots show all Landsat observations (points) in the SWIR1 band and the CCDC model fits (lines). The high resolution images demonstrate what the land cover changed looked like on the ground.

Figure 2 (right). Time series plot of the total change area that the GLanCE data set identified in the ABoVE region from 2001 to 2019.

Results

Overall, GLanCE detected 266,280.20 square kilometers of land cover change in the ABoVE core domain between 2001 and 2019 (figure 3). Most change was located south of the treeline. The land cover types with the highest area change between 2001 and 2019 were tree cover (-58,461 km^2) and herbaceous (+75,267 km^2). Of these two changes, the majority is conversion directly from tree cover to herbaceous cover; in fact, this change was the largest difference between any two classes over the time period (table 1, figure 5). Annually, the largest change was detected in 2019, the most recent year in the results (figure 2).

2001 \ 2019	Water	Snow/ice	Dev.	Barren	Trees	Shrubs	Herb.
Water	367,660.01	4.34	0.37	977.96	949.26	71.33	3,103.04
Snow/ice	7.95	17,650.02	0.02	10.88	6.4	1.2	2.91
Dev.	0.11	0.01	285.5	1.7	0.22	0.28	4.99
Barren	412.94	30.51	1.85	148,337.51	747.77	6,678.66	2,304.00
Trees	922.21	2.76	27.43	504.28	1,529,449.88	17,365.23	123,853.54
Shrubs	81.57	2.06	0.45	406.27	30,008.48	260,456.77	9,619.02
Herb.	1,805.50	3.60	39.42	975.01	52,502.38	8,294.10	1,498,549.04

Table 1. Area in square kilometers of each GLanCE land cover class in 2001 and 2019. Light grey cells represent unchanged area. The largest change by area was from trees in 2001 to herbaceous in 2019, at over 120,000 square kilometers (highlighted).

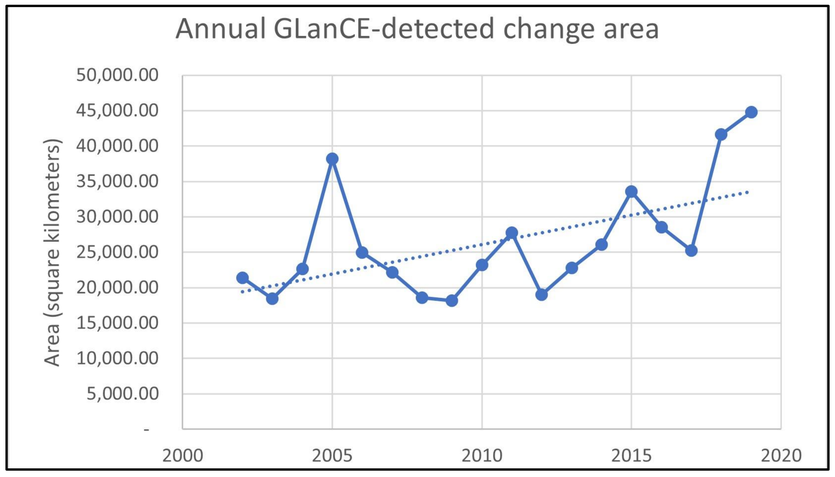
Discussion

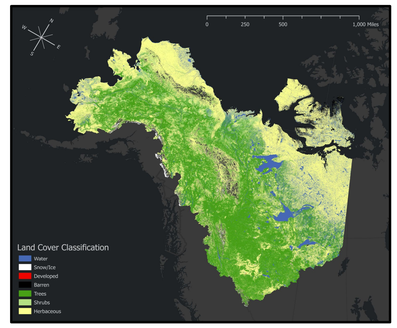
Summary

This work presents a preliminary assessment of the GLanCE land cover and disturbance modeling methods and results in the ABoVE region.

Future work

- Accuracy assessment of GLanCE results in the core ABoVE domain
- Potential inclusion of GLanCE "Level-II" land cover classifications
  - E.g. leaf type (broadleaf and needleleaf) and tree phenology (deciduous and evergreen)





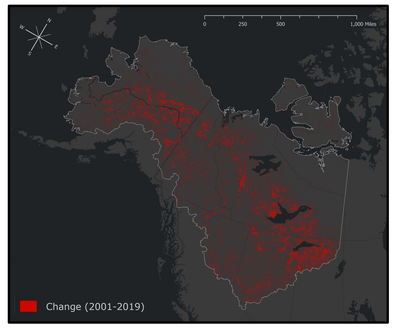


Figure 3 (above, left). GLanCE land cover product for the year 2019 in the ABoVE core domain. Land cover classifications are annual, at 30-meter spatial resolution, and currently contain seven land cover types.

Figure 4 (above, right). Distribution of all changes detected by GLanCE in the ABoVE domain between 2001 and 2019.

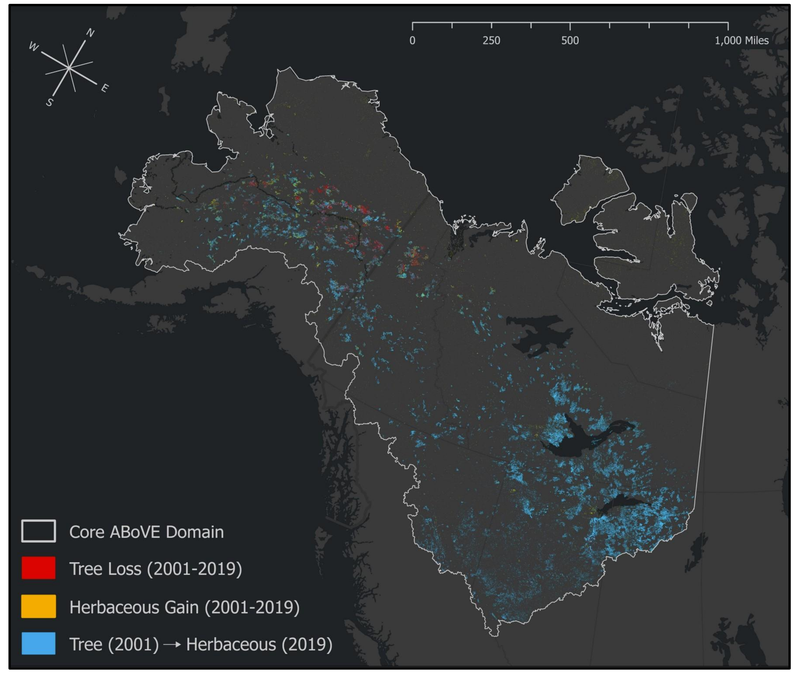


Figure 5. Map of tree loss (conversion to non-herbaceous), herbaceous gain (conversion to non-trees), and conversion from trees to herbaceous detected by GLanCE in the core ABoVE domain.

Scan the QR code to see more from GLanCE and access the data!