Forest composition change and biophysical climate feedbacks across boreal North America

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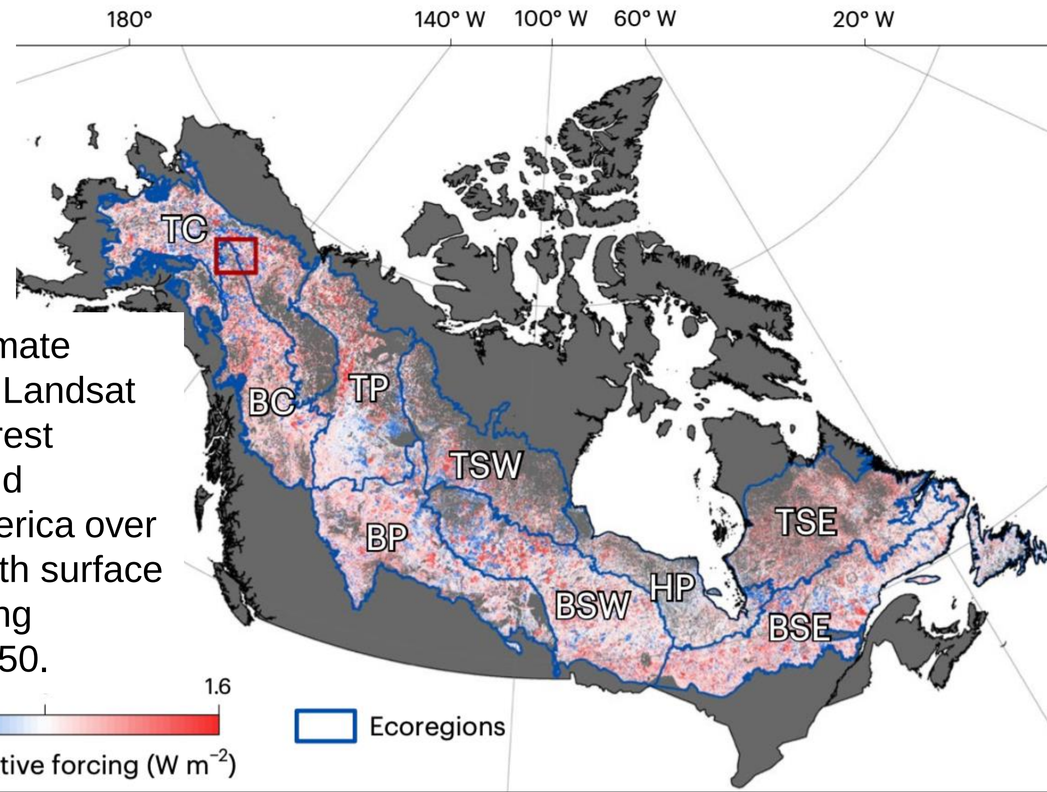
Background: In boreal forests shaped by fire, deciduous trees that dominate post-fire have the potential to mitigate climate warming because they are faster growing, take up more carbon and reflect more light, leading to cooling of the climate and decreased likelihood of additional fire.

Analysis: To assess the extent to which these climate feedbacks were under way we used multi-season Landsat imagery and field measurements from 27,000+ forest inventory sites to map per-pixel total tree cover and deciduous : evergreen cover across boreal N. America over the past 3 decades. We combined these maps with surface albedo from MODIS and calculated radiative forcing feedbacks for areas that burned as far back as 1950.



Findings: Despite tremendous dynamics both spatially and temporally, when we tallied up all the changes in composition, the net biophysical forcing feedbacks were relatively small. This indicates that intensifying fire regimes have not yet resulted in large-scale increases in deciduous trees and associated radiative cooling.

Significance: Past work at local to regional extents has indicated shifts in boreal forest composition arising from more intense fires and more severe burning of forests and organic soils, but when climate feedbacks from fire disturbance were assessed across this vast spatial domain and fires over some 7 decades, the net changes in climate feedbacks were small. It is very possible our findings will change in future decades due to the increasingly extreme fire events of the past few years.

Full Citation & Abstract

Article citation:

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Abstract:. Deciduous tree cover is expected to increase in North American boreal forests with climate warming and wildfire. This shift in composition has the potential to generate biophysical cooling via increased land surface albedo. Here we use Landsat-derived maps of continuous tree canopy cover and deciduous fractional composition to assess albedo change over recent decades. We find, on average, a small net decrease in deciduous fraction from 2000 to 2015 across boreal North America and from 1992 to 2015 across Canada, despite extensive fire disturbance that locally increased deciduous vegetation. We further find near-neutral net biophysical change in radiative forcing associated with albedo when aggregated across the domain. Thus, while there have been widespread changes in forest composition over the past several decades, the net changes in composition and associated post-fire radiative forcing have not induced systematic negative feedbacks to climate warming over the spatial and temporal scope of our study.

Key datasets used: Landsat Surface Reflectance data were provided by the US Geological Survey. Forest inventory data were provided by Canadian provinces as well as our fieldwork collections. Computing resources include the Google Earth Engine cloud computing platform, the NASA ABoVE Science Cloud, and Northern Arizona University's high-performance computing cluster Monsoon. Data sets derived from the analysis are available via the ORNL DAAC.

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