

The bioclimatic extent and pattern of the cold edge of the boreal forest: the taiga-tundra ecotone

Paul M. Montesano, Christopher Neigh, Matthew Macander, Min Feng, Praveen Noojipady (2020) *Environmental Research Letters*,
<https://doi.org/10.1088/1748-9326/abb2c7>

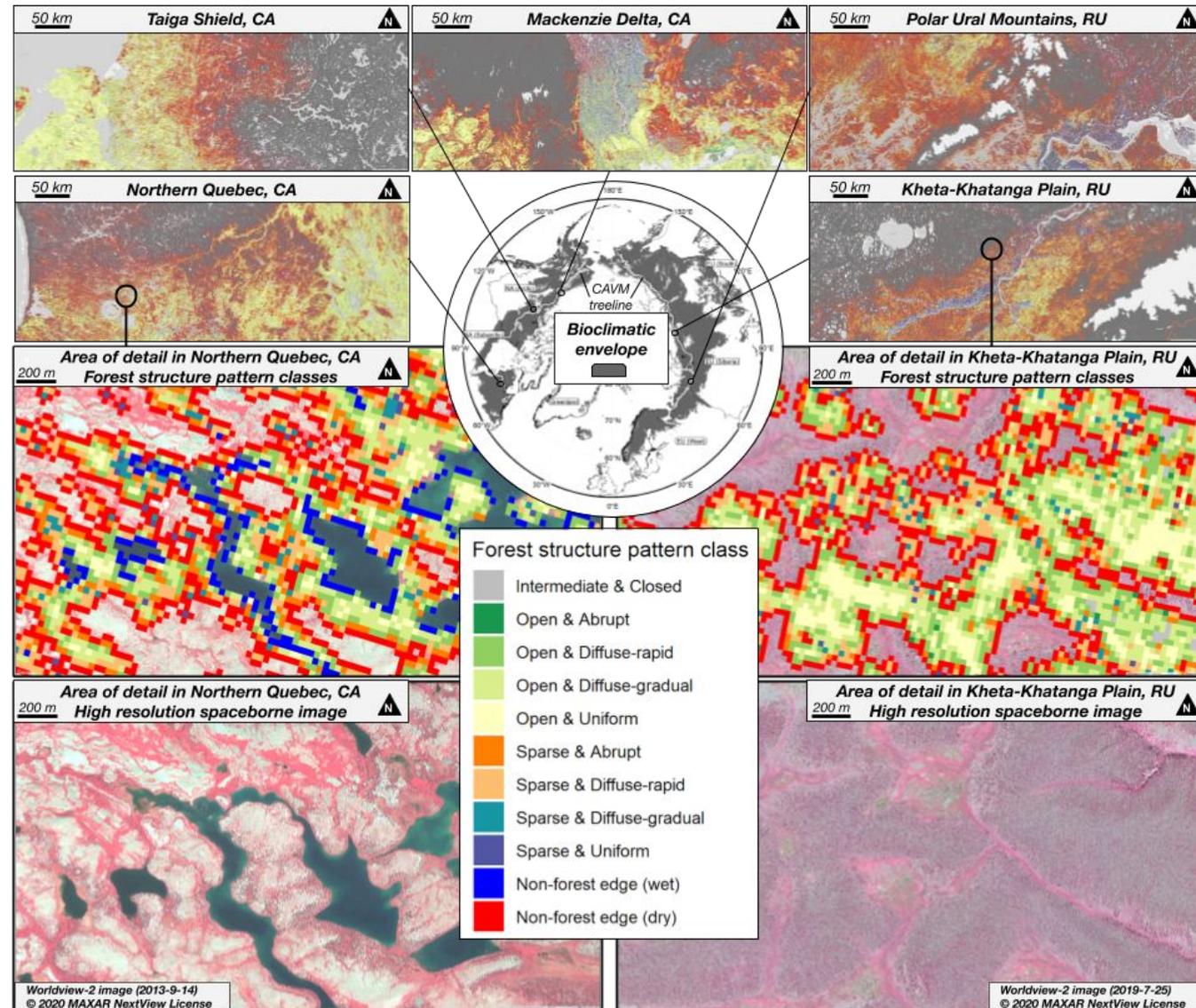
What we did

Within a broad envelope defined by climate and ecological regions, we used Landsat to:

- quantify the magnitude & the spatial gradient of tree canopy cover
- identify the extent & pattern of forest structure in the taiga-tundra ecotone

Why it matters

- These results quantify the variability of TTE forest structure, and highlight its importance for studying biome boundary changes.
- The TTE extent provides a mesoscale lens that can be used to target priority sites in greater detail.



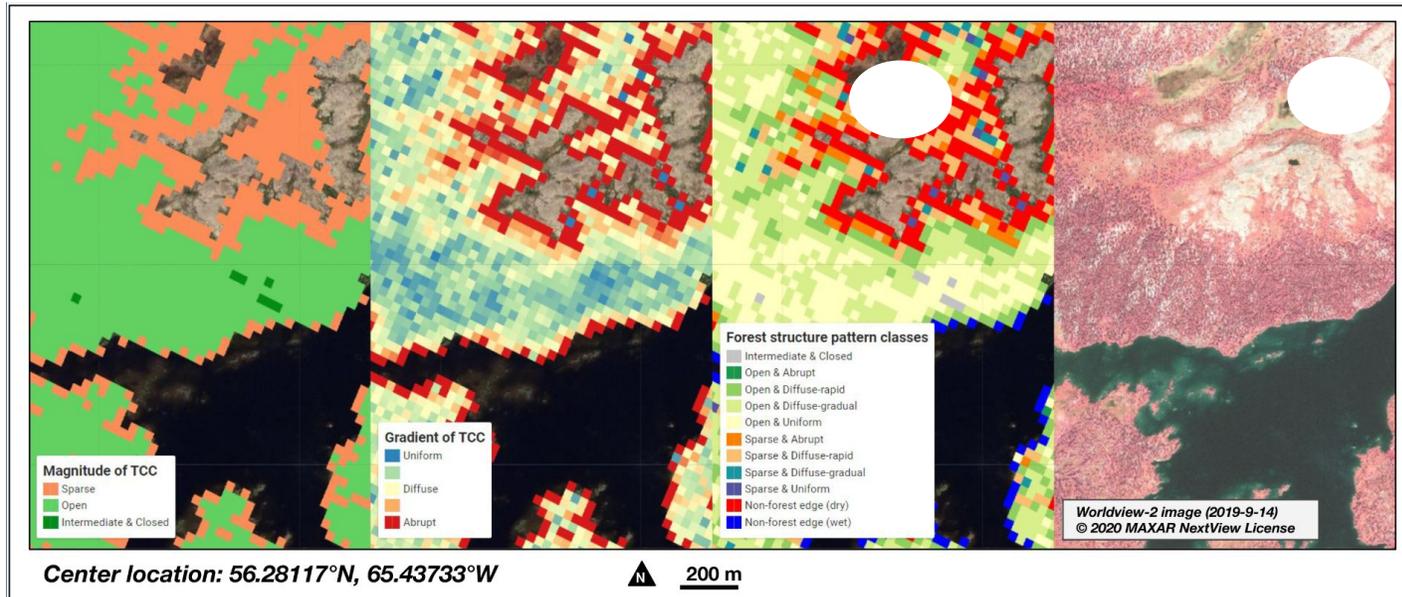
Approach

Quantifying tree cover pattern in a bioclimatic envelope

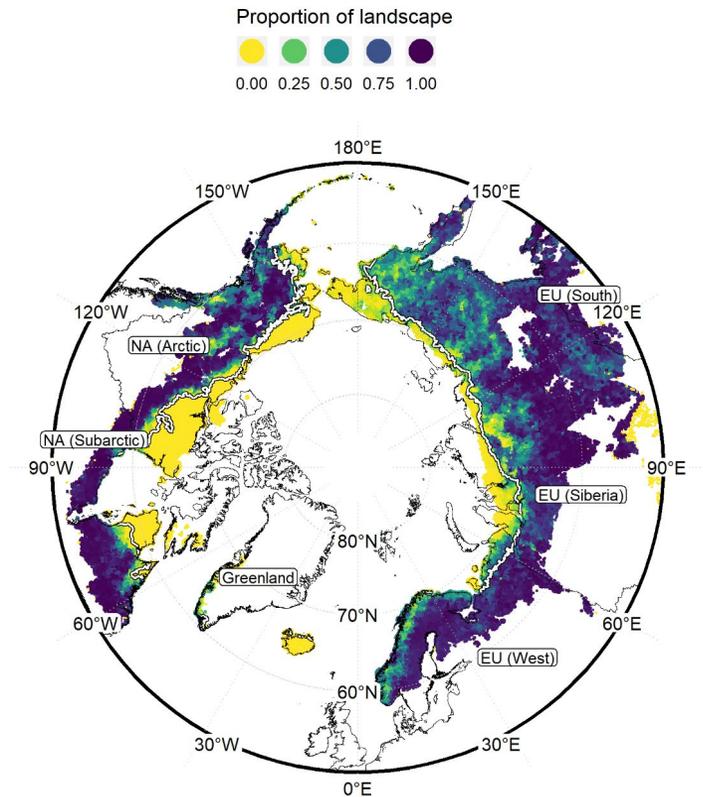
We used climate and ecological regions to derive a bioclimatic envelope within which we assembled a circumpolar tree cover composite. Using the magnitude of tree cover from this composite, and by calculating its spatial gradient (abruptness), we combined the two to classify forest structure pattern.

Assessing TTE extent

We identified TTE landscapes using the proportions of their forest structure pattern classes within spatial bounds determined by hydrological basins. These mesoscale basins helped constrain the TTE extent by quantifying their proportions of forest structure patterns.



Forest structure pattern class proportion of each landscape
Proportion is relative to the area of each landscape within the bioclimatic envelope

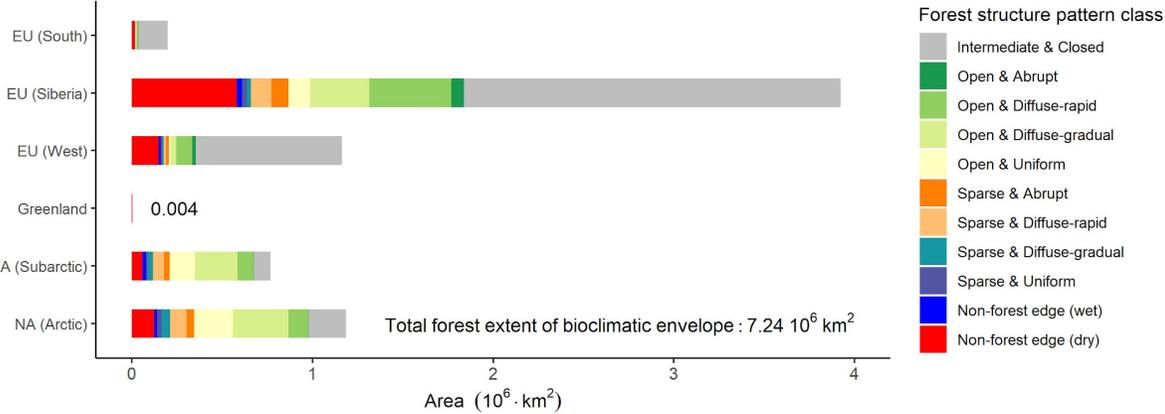


Results

The extent and pattern of the taiga-tundra ecotone

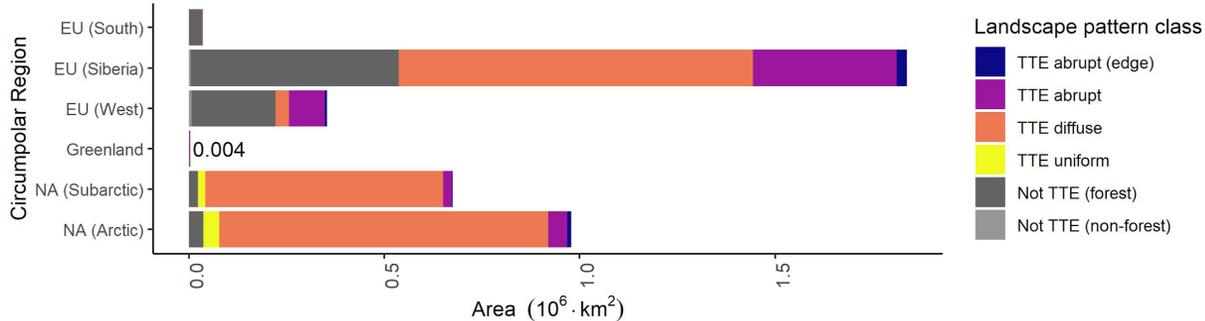
Mesoscale landscape patterns constrain the taiga-tundra ecotone

Area of forest structure pattern classes by region in the bioclimatic envelope



Landscape patterns across the bioclimatic envelope

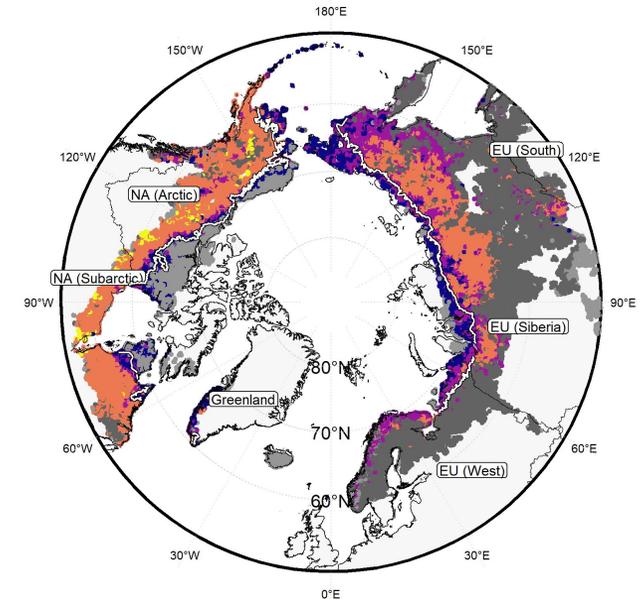
Area and landscape pattern of non-forest edge, and sparse and open canopy forest for all 26566 landscapes



Landscape patterns across the bioclimatic envelope

Colored pattern classes identify the 14594 landscapes used to define the TTE extent

Landscape pattern class



We classified 14,594 landscapes as those associated with the TTE within a circumpolar bioclimatic envelope (11.575 million km²), where 44.83% of the area of these landscapes were forest and non-forest edge, yet 36.43% contributed to the TTE extent. We report the overall extent of the TTE (3.032 million km²) across North America and Greenland (53%), and Eurasia (47%).

In TTE landscapes, 0.697 million km² is non-forest edge, 0.549 million km² is sparse forest, and 1.787 million km² is open canopy forest. Diffuse forest landscapes dominate the TTE (79%), and abrupt landscapes (~19%) indicate portions of the TTE where sparse forest and non-forest edge are the prevailing structural patterns. This account of the TTE quantifies the area of the cold edge of the boreal forest where previous global estimates show high discrepancies, and can help target monitoring and prediction of circumpolar dynamics.