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Regional drought-induced pervasive increase in tree mortality and reduction in the biomass carbon sink of Canada's boreal forests

Changhui Peng (1,2), Zhihai Ma (1), QiuAn Zhu (2), and Huai Chen (2)

(1) Institute of Environment Sciences, University of Quebec at Montreal, Canada (peng.changhui@uqam.ca), (2) Laboratory for Ecological Forecasting and Global Change, College of Forestry, Northwest A & F University, Yangling, Shaanxi 712100, China,

The Canadian boreal forests, which occupy about 30% of the boreal forests worldwide and 77% of Canada's total forested land, play a critical role in the albedo of Earth's surface and in its global carbon budget. Recent findings have suggested that terrestrial carbon sinks in northern high-latitude regions are weakening, but there has been little observational evidence to support the idea of a reduction of carbon sinks in northern terrestrial ecosystems. Here, we estimated changes in tree mortality and biomass carbon sink of natural stands throughout Canada's boreal forests using data from long-term forest permanent sampling plots. We found that tree mortality rates increased by an overall average of 4.7% yr-1 from 1963 to 2008, with higher mortality rate increases in western regions than in eastern regions (about 4.9 and 1.9 % yr-1, respectively). The water stress created by regional drought may be the dominant contributor to these widespread increases in tree mortality rates across tree species, sizes, elevations, longitudes and latitudes. Western Canada seems to have been more sensitive to drought than eastern Canada. We also found that in recent decades, the rate of biomass change decreased significantly in western Canada, but there was no significant trend for eastern Canada. Our results revealed that recent climate change, and especially drought-induced water stress, is the dominant cause of the observed reduction in the biomass carbon sink, suggesting that western Canada's boreal forests may become net carbon sources if the climate change–induced droughts continue to intensify.