

Boreal Forest Fire Biomass Consumption for Carbon Emission Estimation: Measurement Requirements and Current Research

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Quantification of carbon emissions from boreal fire includes measuring both spatial extent and the biomass consumed during the fire and converted to atmospheric carbon. Based on previous research, it is hypothesized that the variability in biomass consumed during fire is the main driver of uncertainty in carbon emission from wildfires. In boreal systems, consumption of both aboveground biomass and carbon held in the forest floor and upper soil layers needs to be assessed.

Current emissions models use consumption values based on a few direct measurements and some modeled estimates. For the North American boreal region these values are typically in the range of 20-25% of aboveground biomass consumed under average fire conditions. Values range from 5-40% of ground-layer carbon consumed. While these values have been used by many researchers to make emissions estimates, they have not been scrutinized, and the variability in consumption has not been fully assessed. Better measures are needed to define both the typical levels of consumption and describe the variability in consumption possible as a function of vegetation type, biomass density, ground-layer carbon depth, and burn severity.

Approaches to quantifying biomass consumption and results of measurement activities are presented in this paper. Direct, field-based measures, requiring measurement from before and after burning, are collected on a limited level. Post-fire field studies, measuring ground-layer depth within and outside of recent burn sites and determining burn depth from analysis of remaining material, have shown a high level of variability in ground-layer burning. Indirect measures include remote sensing; a technique developed to assess ecological burn severity using field data (Composite Burn Index) and pre- and post-fire Landsat images (Normalized Burn Ratio) is being assessed. The Canadian forest fire behavior prediction (FBP) system was developed to predict fire behavior at the fireline. Recently it has been used to estimate the amount of carbon released from fires. This application, while promising, is being validated to confirm whether the FBP consumption levels are correct for carbon emissions estimates.

In this paper, we present the work of several groups finding ways to better quantify biomass consumption in boreal fires. We review issues in terminology used by scientists and managers as well as problems of using measurements developed for fire management or ecological studies for the study of carbon emissions. We review how various measurement methods may or may not be useful in estimating biomass consumption and carbon emissions from boreal wildfire.