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Incorporating fire severity into estimates of carbon losses from wildfires in Ontario

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Forest fires exhibit considerable spatial heterogeneity with respect to fire severity with obvious implications for carbon losses to the atmosphere, and yet fire severity is poorly quantified at the landscape level. In this study we evaluate the impacts of including estimates of fire severity on carbon losses in north western Ontario, Canada. Field studies from 162 plots were used to characterize carbon losses and transfer among the major carbon pools from four fire severity classes that were identified based on losses of above ground live biomass. Carbon losses to the atmosphere were dominated by above ground live biomass and forest floor pools, with percentage losses from each pool increasing with fire severity class. Carbon losses from coarse woody debris and standing dead biomass exhibited no relationship with fire severity. For application to the landscape level, pre-fire carbon above ground pools were obtained using Landsat images and a multiple regression equation using three vegetation indices that was derived from data from 129 forest plots in Ontario. This equation did not require prior species classification and based on 42 independent sampling plots had a RMSE of 24.2 Mg C ha-1. Forest floor carbon exhibited no relationship with above ground biomass and a median C pool obtained from field data was used for all sites. The fire severity classes that we developed could be identified by remote sensing with an overall accuracy of 75%. Based upon the evaluation of 13 fires (> 5 ha) that occurred in 2005, only 37.5 % of the area burned was classified as stand replacing. Estimated carbon losses that incorporate fire severity were therefore approximately 30% lower than if stand replacing fires had been assumed. Fire severity information can be incorporated into the CBM-CFS3 model and carbon losses obtained using both approaches were comparable indicating the potential for fire severity to be incorporated into hindcast and forecast modelling.