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Albedo changes generate a net negative radiative forcing when closed-canopy boreal forest stands are converted to open lichen woodlands

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We have investigated the radiative forcing caused by natural deforestation in Canada's Eastern boreal forest. In this region, repeated forest fires can cause a change from closed-canopy coniferous forests to lichen woodlands of various residual forest cover densities. We used albedo estimates from MODIS imagery, incoming solar radiation measurements and forest biomass estimates from field plots to estimate 1) CO_2-driven radiative forcing related to the loss of forest biomass carbon to the atmosphere, and 2) albedo-driven radiative forcing related to changes in land cover properties.

We have estimated that the conversion of closed-canopy coniferous forests to open lichen woodlands of low residual cover density generates a net radiative forcing of about $-0.12 \mathrm{nWm}-2\ \mathrm{ha}^{-1}$, therefore generating a net cooling effect to the atmosphere. In stands that were only partially converted to open lichen woodlands, up to a 60% removal of initial cover density, the net radiative forcing was not significantly different from zero.

We initially hypothesized that the change from the dark conifer canopies to a light lichen cover would generate the bulk of the albedo radiative forcing. Result show, however, that albedo radiative forcing is driven by the changes in snow cover exposure, especially in early spring when the sun is high and the snow cover is still complete. The summertime differences in land cover properties generate a much smaller differences in albedo and radiative forcing. These results therefore suggest that it is the exposure of snow cover and not the summer surface properties that dominates the albedo effect, therefore extending the inference to all open woodland types.

Although this study focussed on deforestation impacts, the results also suggest that increasing coniferous forest carbon stocks in areas of significant snow cover may not provide expected climate change mitigation benefits. They also suggest that conversion of conifers to deciduous tree cover could increase the albedo and provide a cooling effect.