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Changes in radiative forcing due to clear-cutting in Sweden

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Land cover conversion affects climate by imposing perturbations in the surface properties and greenhouse gas fluxes. Forest management systems often disregard that modification in surface albedo influences the exchange of energy and greenhouse gases. In this study, we examine the net climatic effect of clear-cutting in high-latitude regions by comparing the importance of biogeophysical (albedo) and biogeochemical (carbon dioxide release) changes in Sweden. The hypothesis is that the albedo effect of high-latitude clear-cutting can reduce climate warming.

Data on incoming and reflected shortwave radiation was obtained from four-component net radiometers installed in the forest and neighbouring clear-cut sites, in southern (56°N), central (60°N) and northern (64°N) Sweden. The study site pairs along a latitudinal gradient were chosen to account for different climatic conditions. Data at these station pairs covered a continuous period of three (2016-2018), five (2014-2018) and one year (2014), respectively. Due to lack of clear-cut measurement stations in close vicinity to the northernmost forest site, the shortwave radiation data was retrieved from an open mire, where albedo and its temporal dynamics are similar to a clear-cut. All the forest stations and the mire station are part of ICOS Sweden network. Data on carbon dioxide release from clear-cutting was estimated as a difference in the aboveground carbon stock of the standing biomass between forest and clear-cut sites. The estimated carbon dioxide release was translated into an equivalent change in absorbed shortwave radiation and compared to the radiative forcing by albedo difference between forest and clear-cut sites.

Our results underline results from previous studies showing that the magnitude of the net radiative forcing by clear-cutting varies considerably depending on the latitudinal position of the examined sites. Based on available data, clear-cutting in southern and central Sweden had a warming effect on the climate while in northern Sweden clear-cutting had a net cooling effect. However, large inter-annual variability (central Sweden) and lack of available continuous data (northern Sweden) resulted in high uncertainty of the climatic effects of changes in net radiative forcing due to clear-cutting. Our study indicates that the albedo effect has an essential role in the estimation of the climatic effect of clear-cutting and should thus be incorporated in future forest management strategies.