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Empirical models of monthly and annual surface albedo in managed boreal forests of Norway

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As forest management activities play an increasingly important role in climate change mitigation strategies of Nordic regions such as Norway, Sweden, and Finland – the need for a more comprehensive understanding of the types and magnitude of biogeophysical climate effects and their various tradeoffs with the global carbon cycle becomes essential to avoid implementation of sub-optimal policy. Forest harvest in these regions reduces the albedo “masking effect” and impacts Earth’s radiation budget in opposing ways to that of concomitant carbon cycle perturbations; thus, policies based solely on biogeochemical considerations in these regions risk being counterproductive. There is therefore a need to better understand how human disturbances (i.e. forest management activities) affect important biophysical factors like surface albedo.

An 11-year remotely sensed surface albedo dataset coupled with stand-level forest management data for a variety of stands in Norway’s most productive logging region are used to develop regression models describing temporal changes in monthly and annual forest albedo following clear-cut harvest disturbance events. Datasets are grouped by dominant tree species and site indices (productivity), and two alternate multiple regression models are developed and tested following a potential plus modifier approach. This resulted in an annual albedo model with statistically significant parameters that explains a large proportion of the observed variation, requiring as few as two predictor variables: i) average stand age – a canopy modifier predictor of albedo, and ii) stand elevation – a local climate predictor of a forest’s potential albedo. The same model structure is used to derive monthly albedo models, with models for winter months generally found superior to summer models, and conifer models generally outperforming deciduous.

We demonstrate how these statistical models can be applied to routine forest inventory data to predict the albedo temporal evolution in managed forests throughout the region, which in turn can be used to estimate the contribution from albedo changes across alternative management scenarios to seasonal and inter-annual radiative forcings. Incorporating temporal descriptions of albedo into regional assessments of the climatic effects of alternative forest management strategies would serve to better inform the development of climate protection policy, and furthermore, help to improve albedo parameterizations of forest (and other land use) management in land-surface components of earth system models that currently suffer from poor representations of temporal transitions.