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Effects of species selection and management on forest canopy albedo

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Forest management is considered to be one of the more easy to implement instruments available to mitigate climate change as it can lead to increased sequestration of atmospheric carbon dioxide. However, the changes in canopy albedo, and hence surface energy balance, may neutralise or offset the climate benefits of carbon sequestration. Although there is an emerging body of literature linking canopy albedo to management, understanding is still fragmented.

We here make use of a generally applicable approach: we combine a stand-level forest gap model with a canopy radiation transfer model and satellite-derived model parameters in order to quantify the effects of forest management on canopy albedo for different forest species and management strategies.

The structural changes associated with forest management can be described by the change in LAI in combination with crown volume. However, not only the removal of trees but also the type of understorey affects the canopy albedo. The relationship between the canopy cover and the canopy albedo is explained by the influence of the albedo of the forest floor. A low canopy cover allows more light to penetrate to the forest floor and is more likely to support an abundant understorey vegetation. When the albedo of the understorey vegetation exceeds the albedo of the overstorey canopy, a low canopy cover is likely to result in a high albedo.

We find that the most intensive management measures lead to the largest albedo change, which can reach up to 9% compared to unmanaged forest. The choice of species, in combination with thinning, dominates the variation in canopy albedo. During stand establishment, albedo is driven by tree species. Following canopy closure, the effect of tree species on albedo decreases in favour of an increasing importance of forest management on albedo. These trends continue until the end of the rotation where management finally explains up to 80% of the variance in canopy albedo. In summary, forest albedo, and hence surface energy balance, is strongly altered by humans.