

Interactive comment on “Quantifying the missing link between forest albedo and productivity in the boreal zone” by Aarne Hovi et al.

Anonymous Referee #2

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The study by Hovi et al. is addressing the important topic of how forest management and composition is influencing albedo and fapar. The understanding and quantification of the relation of albedo and fapar are prerequisites for assessing the effectiveness of forest management for climate mitigation, while including the radiative forcing effect through the energy budget. The study complements observational studies through radiative transfer modelling. Results reveal that radiative forcing can be reduced through increased albedo by increasing the abundance of deciduous species. The study is an important contribution towards a better understanding of forest structure on albedo and FAPAR, thus linking two main components of the climate, i.e. the energy and carbon cycle.

While the topic is interesting and important, the study has major shortcomings.

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1. The study is based on bidirectional radiation quantities for albedo (black sky albedo), no diffuse irradiance is taken into account. At the high latitudes of the test sites, the fraction of diffuse radiation cannot be neglected. The effect of varying leaf angles might significantly decrease under a scenario with diffuse irradiance. I expect that the results (difference between broadleaf and needleleaf) might be much less significant when introducing a realistic diffuse fraction. If the study is supposed to serve as a baseline for future management, it needs to quantify differences under realistic irradiance scenarios for the given latitudes.

2. The study assumes that fapar is a proxy for productivity. This assumption (and related study title) is too simplistic as light is only one of several growth limiting factors, and light use efficiency needs to be accounted for at the species or plant functional type level. Also other limiting factors such as temperature, soil water, and vapor pressure deficit would need to be accounted for at the species or plant functional type level for the conversion of fapar to GPP. Further, productivity in sunlit and shaded leaves is not linearly scaling with APAR (see light saturation curve).

3. The definition and usage of fapar is unclear – when using fapar for GPP estimation, only fapar absorbed by leaves is relevant. Forest canopy fapar is not mainly determined by leaf area index and directionality of incoming solar radiation (as stated in line 64), but – depending on the fraction of leaf to plant area, very much by stems, branches, and the understory. It is mentioned that no correction was done for litter, but it is unclear if the same is true for stems, branches, and understory (which might contain open soils, lichen, etc.).

4. Equations section of albedo and fapar – both quantities are not fluxes (of radiation), but ratios! Review definitions and revise equations. Also, explain how spectral weighting based on TOA spectral distribution is influencing results compared to weighting by top of canopy irradiance spectral distribution.