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Interactive comment on "Stand age and species composition effects on surface albedo in a mixedwood boreal forest" *by* Mohammad Abdul Halim et al.

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We truly appreciate Editor's time to read the manuscript and make critical comments.

Editor's Comment 1: "In the introduction previous reports are cited to list possible drivers. Stand age is, however, not among the listed drivers. In the discussion the authors do a reasonable good job in focusing the discussion on the physical drivers (fraction of deciduous trees, charcoal, stand structure, ...). From this perspective it is surprising that the results section uses stand age as one of the independent variables to explain the changes in albedo (as reflected in the statistical models and the table). In my opinion, the authors should better explain that the analysis with age is simply to de-

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scribe the temporal evolution but that the additional analysis are intended to explain the physical drivers of these age trends. If this indeed reflects the thinking of the authors, the paper should be edited towards this message, e.g. no models should be fitted against age and several sentences throughout the manuscript should be rephrased. Nevertheless, if the authors interpret their results as an indication that age itself is a physical driver of albedo, it should be discussed how stand age (rather than structure) affects albedo."

Response to Editor's Comment 1: Thank you for your comment. In a sense this is a philosophical point: time is not itself a physical driver of any process (physical or biological), but all processes develop through time. There is a long history of quantifying patterns of stand development in forest science with time as the main independent variable: essentially all growth and yield models in applied forestry use this approach. Such models have then commonly been applied to understanding climate feedbacks.

In climate models, albedo has most often been treated as a constant for a land cover type; however, it has recently been argued that in forest systems stand age (time) should be treated as a "time dimension" to capture albedo dynamics, which also allows effective conversion to other time-dependent radiative processes (Bright et al. 2016). In part, this argument is that stand age is a more parsimonious predictor, and in part stand age may account for other co-occurring age-related factors that are not included in the model. Stand structure generally shows strongly non-linear relationships with stand age (Avery and Burkhart, 2015), and albedo models based on stand structure alone may not capture important system dynamics that are better captured using stand age. Incorporation of stand age as a predictor also allows examination of time-dependent interactions among different independent variables in empirical models.

We agree that it is important to note that stand age might not always be a good predictor of forest albedo; indeed, some prior studies have found important patterns of variation that are not well explained by stand age (e.g., Kuusinen et al. 2014; Lohila et al. 2010). These "null" results are also important contributions that require one to consider stand

age as a potential driver.

As noted above, stand age is a very commonly used metric in the forest science literature, and used as the main independent variable along with other stand structural and compositional properties to predict forest growth and yield. Researchers also have commonly used stand age to predict snow/wind vulnerability of forest stands along with other age-dependent variables (Kamo et al. 2016). Including stand age offers a simple and easy-to-measure tool to incorporate these models in forest management practices to help develop climate-sensitive forestry practices.

Editor's Comment 2: The importance of this study for climate modelling should be rewritten in line with the state of art of albedo modelling through canopy radiative transfer models and the simplified canopy radiative transfer schemes that are used in the land surface schemes of climate models. The authors seems not be aware of recent work (Naudts et al 2016, Luyssaert et al 2018) that does account for the effect of stand structure, tree species, and forest management on albedo and the climate (including not only albedo but also transpiration and roughness). The impact on modelling efforts of the albedo observations presented in this study is largely overstated. Canopy radiative transfer schemes combine scattering parameters and simulated canopy structures to simulate the albedo. The albedo values reported in this study can be used to evaluate existing models but are unlikely to be useful to improve existing models as claimed in the text. It may be best to delete all references to model developments and focus the discussion and conclusions on the underlying processes and the remaining unknowns.

Response to Editor's Comment 2: Thank you so much for suggesting two recent works. We will review and incorporate them in our revision to reflect the importance of albedo-stand age dynamics through canopy radiative transfer models.

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