The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
https://doi.org/10.5194/tc-2021-291-RC2, 2021

Comment on tc-2021-291

Anonymous Referee #2

Referee comment on "Land–atmosphere interactions in sub-polar and alpine climates in the CORDEX Flagship Pilot Study Land Use and Climate Across Scales (LUCAS) models – Part 2: The role of changing vegetation" by Priscilla A. Mooney et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-291-RC2, 2021

Major comments:
This paper aims to analyze the impacts of afforestation/reforestation on snow and the snow-albedo effect and identify the major pathways to improve the model in representing grass-snow and forest-snow interactions. Based on a comparison between nine regional climate models with different combinations of regional atmosphere model and land surface scheme, the results show that there is large uncertainty in the magnitude for the changes in the snow-albedo sensitivity index, even though the sign of the change direction is robustly modeled by all the models. The greatest differences between models emerge in the snowmelt season, which is also seen in one regional model using different land surface models. In general, the manuscript touches upon very interesting scientific questions and has many potential merits on improving regional climate model or Earth system model to represent biophysical effects from land-use change or potential natural vegetation change. It falls well within the scope of the journal "the Cryosphere". However, this paper lacks detailed demonstration and interpretation of how different forests and grass regulates land surface albedo and energy balance. For vegetation-snow interaction, there are both positive and negative responses for forest displacement of grasslands to near-surface warming. A positive response means the decreased albedo enhances the net incoming shortwave radiation, while a negative response means the shading effects of taller woody species may delay the snowmelt in certain circumstances. Therefore, I look forward to seeing (1) the effects of afforestation (forest run – minus run) on SASI (spatially and seasonally) (2) how the effects of afforestation on near-surface temperature, latent and sensible heat fluxes, and downward shortwave radiation (3) why is the impact of afforestation (FOREST-GRASS) on the number of snow days in the season so different among the models, if they prescribe the same forest and grassland land cover (4) is dynamic vegetation and static vegetation (prescribe phenology or no phenology) important for snow-albedo feedback?

Minor comments:
Table 1.1. I hope the authors could mention more details about how snow-vegetation interaction is described by different land surface models.
Line 155. Do the deciduous and evergreen forests use the same albedo for free-snow surface and snow cover surface? These two types of forests have a big difference for the winter albedo.

Figure 2. It would be nice to see the effects of afforestation by illustrating the difference between the forest run and grassland run.
Figure 3. How to explain the impact of afforestation (FOREST-GRASS) on snow water equivalent (SWE) also differs the sign among regional climate models.
In the discussion part, it is worth mentioning the importance of surface roughness length and windblown snowdrift in the regional climate model to quantify snow-albedo effects of afforestation.