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Interactive comment on "Long term effects on regional European boreal climate due to structural vegetation changes" *by* J. H. Rydsaa et al.

Anonymous Referee #1

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Review of "Long term effects on regional European boreal climate due to structural vegetation changes" by J. H. Rydsaa, F. Stordal, and L. M. Tallaksen

General comments:

The authors describe two WRF experiments to demonstrate the effects of northward shifts of boreal vegetation due to anticipated climate change. The experiments include the structural changes in high latitude ecosystems, which result in changes in soil moisture properties and heat fluxes.

Specific comments:

1. Are 10 years sufficient for statistical analysis? Is it possible to either increase the number of years (e.g. to 2001-2012) to have at least twelve annual samples, or to

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analyze seasonal data with taking all months into account (to have at least 30 months per season) and perform some sort of statistical analysis to show the significance of the results (see also technical comment 11)?

2. Especially sensible heat flux seems to have a strong annual cycle with observed increases especially during the growing season (Beringer et al., 2005, their Fig. 7) and warmer daytime (Beringer et al., 2001, 2005). Over Norway and Sweden, previous studies found simulated decreases in Sept.-Feb. and increases otherwise (see Snyder and Liess (2014, Climate Dyn. 42, 487–503, their Fig. 6), Jeong et al., (2014, Environ. Res. Lett. 9, 094007, doi:10.1088/1748-9326/9/9/094007, their Table 1), and Jeong et al. (2011, Climate Dyn. 37, 821-833, their Fig. 5). The present study finds a decrease in sensible heat flux with resulting decrease in 2m temperature. This should be discussed and maybe related to possible changes in simulated precipitation (see also technical comments 15, 18, and 21).

3. More emphasis should be put on spatially different seasonal changes, which can be of opposite sign between winter and summer, due to different influences from solar radiation and evapotranspiration. Maybe show maps of latent and sensible heat flux changes for all four seasons or at least the winter and summer seasons (see also technical comments 2, 15, and 17).

Technical comments:

1. Abstract: Line (L.) 2: “Arctic” not “arctic”

2. Abstract: L. 14: Is the increase in latent rather than sensible heat fluxes occurring in all seasons? Please clarify. See also Snyder and Liess (2014) and Jeong et al. (2011,2014) about their seasonal results and compare your results to these papers in the discussion.

3. Page (P.) 15509, L. 18: Delete "and"

4. P. 15509, L. 26: Are there any references for successful simulations with dynamic

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vegetation models? Some studies such as Jeong et al. (2011,2014) had difficulties representing the observed changes in vegetation, but could still be cited here.

5. P. 15511, L. 13: Discuss the influence of vegetation on ground heat flux, or cite previous work such as Yang et al. (1999, JGR 104, D16, 19505–19514).

6. P. 15512, L. 18: Mention either here or in the discussion that these model setups are not able to measure downstream effects originating from outside the WRF domain, since meteorological forcing is only modified locally.

7. P. 15513, L. 10: Typo: “choice”

8. P. 15514, L. 1: The MODIS IGBP data used in WRF include the annual cycle. The word "static" might be misleading. This should be clarified.

9. P. 15515, L. 1: "shift" should be singular here.

10. P. 15516, L. 25: Be more specific about the difference between Ex 2 and Ex 1, and state something like "in addition to the changes made for Ex 1, the second experiment ... also...". Currently, it is not clear if all Ex 1 modifications are also exactly included in Ex 2, or if only the general structure is maintained.

11. P. 15518, L. 16: Again, are these results statistically significant? The authors should perform some sort of statistical test to show the relevance of the detected changes.

12. P. 15520, L. 7: How can this cooling be explained? Please discuss the above results for sensible heat flux here.

13. P. 15520, L. 18: Fig. 8 only shows wind differences. We don’t know if there are decreased northward winds or increased southward winds. Please either show the wind field in the control experiment or rephrase to something like "reduced northward component". In general, wind fields can be represented by vectors with a reference vector in the legend to save space. However, for the present analysis it might be

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sufficient to show the change in absolute wind speed (sqrt(uˆ2+vˆ2)) in a single figure and relate the results to the heat fluxes.

14. P. 15521, L. 2: Can the authors mention if there is a change in the annual cycle of soil moisture due to the change from evergreen to deciduous forests?

15. P. 15521, L. 22: On p. 15511 l. 8-10, the authors write "Eugster et al. (2000) found that in general evergreen conifer forests have a canopy conductance half of that of deciduous forests, resulting in a higher sensible heat flux" and also Snyder and Liess (2014) and Jeong et al. (2011,2014) found an increase of sensible heat flux after evergreen forest expansion due to reduced albedo during summer. How can sensible heat flux be reduced here? Or, how is sensible heat flux defined in this study? Maybe an analysis of precipitation can shed some light on this discrepancy?

16. P. 15522, L. 1: How can 2m temperature increase with "a reduction in heat transfer to the atmosphere"? Please clarify if sensible or latent heat flux is meant, or both.

17. P. 15522, L. 24: Spring and summer are considered the seasons with strongest PBL height increase in Snyder and Liess (2014) due to strongest sensible heat flux increases. Why is summer opposite of spring in Ex 1 in this study? Again, the authors should check if the model produces excessive summer rainfall in Ex 1, which might also explain the increase in latent heat flux and 2m moisture.

18. P. 15523, L. 6: This cooling is opposite of previous findings by Liess et al. (2012), Snyder and Liess (2014), and Jeong et al. (2011, 2014) possible reasons should be discussed (sensible heat etc.)

19. P. 15524, L. 8: What does "energy limited rather than water limited" mean? Evaporation is related to temperature and kinetic energy from the low-level wind field.

20. P. 15524, L. 13: Can the authors comment on the rooting depth for forest vs. shrubs here? If forests have higher rooting depth, they are less affected by lower soil moisture in the upper layers.

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21. P. 15527, L. 2: These results by Beringer et al. (2005) are consistent with the WRF experiments by Liess et al. (2012), but Fig. 4 in the present study shows decreases. Again, the present results might show different sensible heat flux based on possible precipitation increase. Please check this and discuss a possibly different WRF setup used here.

22. P. 15529, L. 20: See comment 19.

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