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Interactive comment on "Biogeophysical impacts of peatland forestation on regional climate changes in Finland" *by* Y. Gao et al.

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General comments:

The authors provide an analysis on the biogeophysical effects of the dominant land cover change on regional climate in Finland. They found a spring warming due to the conversation of peatlands to coniferous forests that can be mostly related to the modification of the corresponding albedo values. The slight cooling in the growing season is explained with the increased evapotranspiration. The spatial distribution of the climate impacts are introduced for the whole country, furthermore the local scale effects are investigated more in detail for 5 selected subregions.

It is a very recent and important topic, with several practical aspects, especially regarding to the projected climate change and land cover change. The concepts of the manuscript are understandable, the results are interpreted correctly. The novelty of the presented work as well as the need of the regional scale and the use of a regional climate model is clearly explained.

The abstract of the discussion paper provide a concise summary of the paper but I would suggest referring to the practical application also in this place.

AR: We will add descriptions of practical application at the end of abstract as follows.

“The results from this study can be further integrally analysed together with biogeochemical effects of peatland forestation to provide background information for adapting future forest management to climate change mitigation. Moreover, they provide insights about the impacts of projected forestation of tundra in high latitudes due to climate change.”

The Methodology chapter contains a very detailed and complete introduction and evaluation of the applied land cover maps and the land surface scheme and parameterization of the regional climate model. It underlines the importance of the appropriate representation of the land cover in climate models that has been improved by the corresponding author. I suggest keeping sect. 2 shorter and including the technical details in the Appendix.

AR: We will move Section 2.3 (Modifications in REMO LSS in this study) to Appendix.

The uncertainties and the limitations of the applied methods are well discussed at the end of the work.

Specific comments:

Following are few comments and questions that the authors should consider clarifying:

(1) The simulated changes of temperature, evapotranspiration, . . . and their magnitude are closely related to the modification of the corresponding main land surface

parameters in the climate model. Therefore for the better representation and interpretation of the process chain, I would suggest to include some maps about the changes (2000s vs. 1920s) of albedo, leaf area index and fractional vegetation cover for the whole domain (e.g. on monthly timescale, next to figure 3).

AR: We agree that to show the monthly changes in land surface parameters together with the changes in climate variables is helpful for representation and interpretation of the process chain. For this purpose, we adopted the approach suggested by reviewer #3 in general comment 3 to show correlation relationships. Moreover, we want to keep the length of the manuscript not too long as suggested by Reviewer #3 in general comment 1 to cut down the number of figures. Therefore, please refer to the response to general comment 3 of Reviewer #3 about this comment.

(2) In order to support the better understanding of the main outcome and to make possible to compare the results of the 5 subregions, please add a summary-table that includes the modification of the land cover types (in %), the corresponding change of the albedo, leaf area index and fractional vegetation cover as well as the impacts on the analysed climatic variables for each subregions (complete table 1 with the above mentioned information).

AR: The impacts on analyzed climatic variables for each subregion with daily time resolution have been shown in Fig. 8 in the original manuscript. The change of surface parameters of five subregions for the most interesting periods will be shown in the correlation figures as mentioned in the above specific comment 1. Thus, we believe that there is no longer necessary to add this table anymore.

(3) I would suggest preparing a sensitivity study with unchanged vegetation cover for the same time periods. In this way the contribution of the GHG emission and land cover change to the observed climate tendency could be separately assessed.

AR: The two simulations in this study were conducted over the same time period (1979.1.1 - 1996.12.31) with two different land cover maps. ERA-interim is used as

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our boundary forcing data. The GHG concentrations for the two simulations are the same. Therefore, the impacts on climate conditions are only from the changes in land cover.

To estimate the contributions of increased GHG concentrations to the observed climate tendency, we cannot simply use our boundary forcing data over the same time period to do the simulations with two levels of GHG concentrations. It is because that ERA-interim reanalysis data is based on observational data. For complete consideration, a global model is needed. Additionally, in response to the general comment 1 from Reviewer #3, the trend maps for monthly mean daily maximum temperature and daily minimum temperature are investigated for March and April. We consider that the trend of daily maximum temperature is influenced by albedo-mediated temperature changes locally, while the trend of daily minimum temperature is more closely related to general climate change caused by global GHGs increases. The local effects in the trends of daily maximum temperature suggest that our modeled results show qualitatively a good correspondence to observational data.

(4) Outlook: How does projected climate change affect the existing land cover (primarily forests and peatlands) in Finland? How could these changes alter the regional climate?

AR: The land cover in Finland is strongly managed. Therefore, we will generally discuss the potential land cover change under the projected climate for high latitudes, and its influence on climate. The content below will be added in discussion part.

"The biogeophysical impacts of vegetation-climate feedbacks on climate are modest in comparion to the effects of increased GHGs for Europe, but local, regional and seasonal effects can be significant (Wramneby et al., 2010). However, studies with dynamic vegetation models under climate projections with increased GHGs indicate that more carbon will be gained to terrestrial ecosystems in high-latitudes by the end of this century (Fallon et al., 2012; Zhang et al., 2014). This is due to increase in woody plants that induce biogeophysical feedbacks with an earlier onset of growing season."

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(5) Please refer short in the discussion part also to the possible biogeochemical feedbacks: how are the carbon sequestration and methane concentrations altered by the forest cover increase/peatland decrease? What are the climatic impacts of these changes?

AR: The discussion about biogeochemical aspects will be added as follows.

"Peatland is a significant source of CH4 emissions, and the amount of CH4 emission is sensitive to temperature, water table level, plant root depth and soil nutriention level, etc. (Melton et al. 2013; Turetsky et al., 2014; Lohila et al., 2010). After peatland forestation, the soil water table level goes down leading to increased CO2 release at the expense of CH4 release (Minkkinen and Laine, 2006). As time goes by, carbon sequestration by the tree growth and the formation of a new litter layer could compensate the carbon loss from peatland. Lohila et al. (2010) combined the radiative forcing effects from the differences of albedo and GHG fluxes due to peatland forestation at site-level, and showed net cooling at two soil nutrient-rich sites in the south and north and one soil nutrient-poor site in the south of Finland. Accounting for such local impacts in a regional climate model requires very sophisticated process descriptions and detailed parameterisation of soil properties."

Please also note the supplement to this comment: http://www.biogeosciences-discuss.net/11/C4689/2014/bgd-11-C4689-2014- supplement.pdfSpecific comments (in supplement):

(1) Page 11253, Line 5: Suggestion: keep shorter sect. 2.1, 2.2 and 2.3, and include the technical details in an Appendix.

AR: Answered in the response to general comments.

(2) Page 11256, Line 2: Where exactly? Figure 2 should be mentioned here.

AR: Fig.2 is mentioned in the following sentence for the regional differences, where the total fractional changes over Finland is shown.

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(3) Page 11263, Line 14: This kind of information is hard to follow in this form (i.e. long paragraphs), please add a table that summarizes the main outcome for the 5 regions.

AR: Answered in specific comment 2.

(4) Page 11265, Line 23: Please show the corresponding LAI and fractional vegetation cover changes on figures for the whole domain.

AR: Answered in specific comment 1.

(5) Page 11266, Line 19: It would be interesting to have some information on the effect of the GHG concentration increase on the observed temperature tendency (i. e. without any land cover change)

AR: Answered in specific comment 3.

(6) Page 11288, Figure 8: the ET values with negative signs are confusing.

AR: Agreed. ET values in Fig.8 will be changed to be with normal signs.

Interactive comment on Biogeosciences Discuss., 11, 11249, 2014.