Answers to the comments by reviewer RC1:

This is an interesting and thorough study, but some of the methods are hard to follow.
In particular, I recommend some effort on simplifying and clarifying the descriptions of
sigmoid fits in sections 2.2.1 and 2.2.2; figures of example fits might help.
The authors are grateful for the encouraging comment. The sigmoid fitting is described now in more
detail and related images are included. The method sounds complicated, because one has to take into
account also rare, but possible complications (such as marked snowfall after melt onset). However,
the main complication really to take into account is the greening up of vegetation. This is
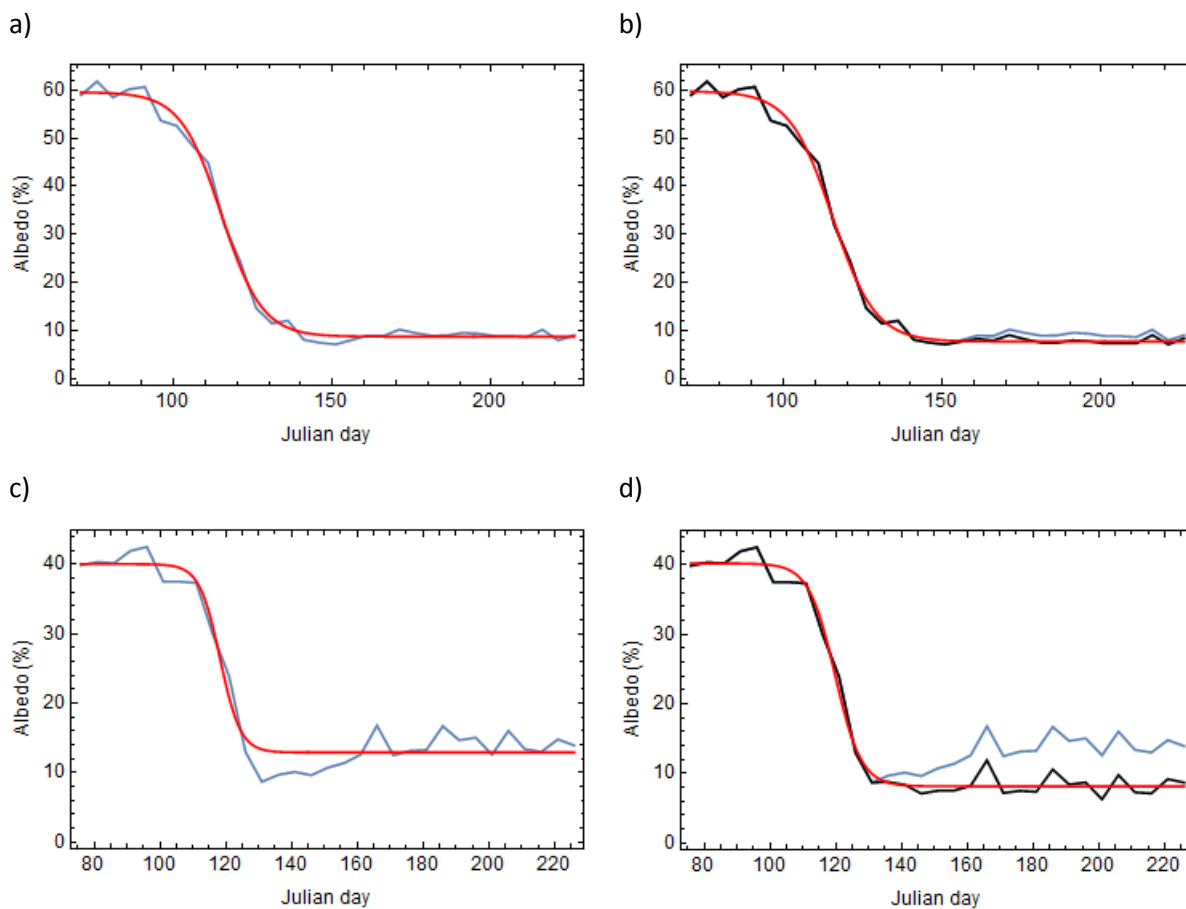demonstrated in the added Figure 2.

a)

b)

c)

d)

Figure 2. Examples of sigmoid fitting. Original data points are shown in blue, the fit in red and the data points from which vegetation greening effect has been removed in black. a) initial fit of an easy case, b) final fit of the easy case, c) initial fit of a case with strong influence of vegetation greening on albedo, d) final fit of the case with strong influence of vegetation greening on albedo.

Minor comments:

page 1, line 26.
Forest cover having a significant influence on albedo does not follow from it being an important component of the carbon budget.
This sentence is now edited according to the comment.

page 2, line 11.
"by in" – delete one
"in" is deleted as requested.

page 2, line 24
"since 200" is sufficient
"Year" is removed as suggested.

page 3, line 3
I think that standalone forcing of land models with climate model outputs is being discussed here, but it is not clear.
The text is edited (page 3, line 6).

page 4, line 6
Delete "only"
"Only" is deleted as requested.

page 5, line 21
"using in-situ FSC observations" Is FSC %-units simply %?
Yes, the FSC units is %. There was an extra confusing FSC that is now removed. The FSC unit is defined to be in % on page 5, line 21.

page 6, line 11
What is being iterated here?
The sigmoid fitting is iterated means that the nonlinear fitting is made iteratively as usual. The reason for this is that the nonlinear fit result depends much on the initial values of the parameters of the function to be fitted. As there is no absolute method to find the best possible initial values, it is useful to iterate the results so that the next fit uses as initial parameter values the outcome of the previous iteration. This section (page 6, lines 12 – 26) is now described in more detail as suggested and Figure 2 is added.

page 8, line 3
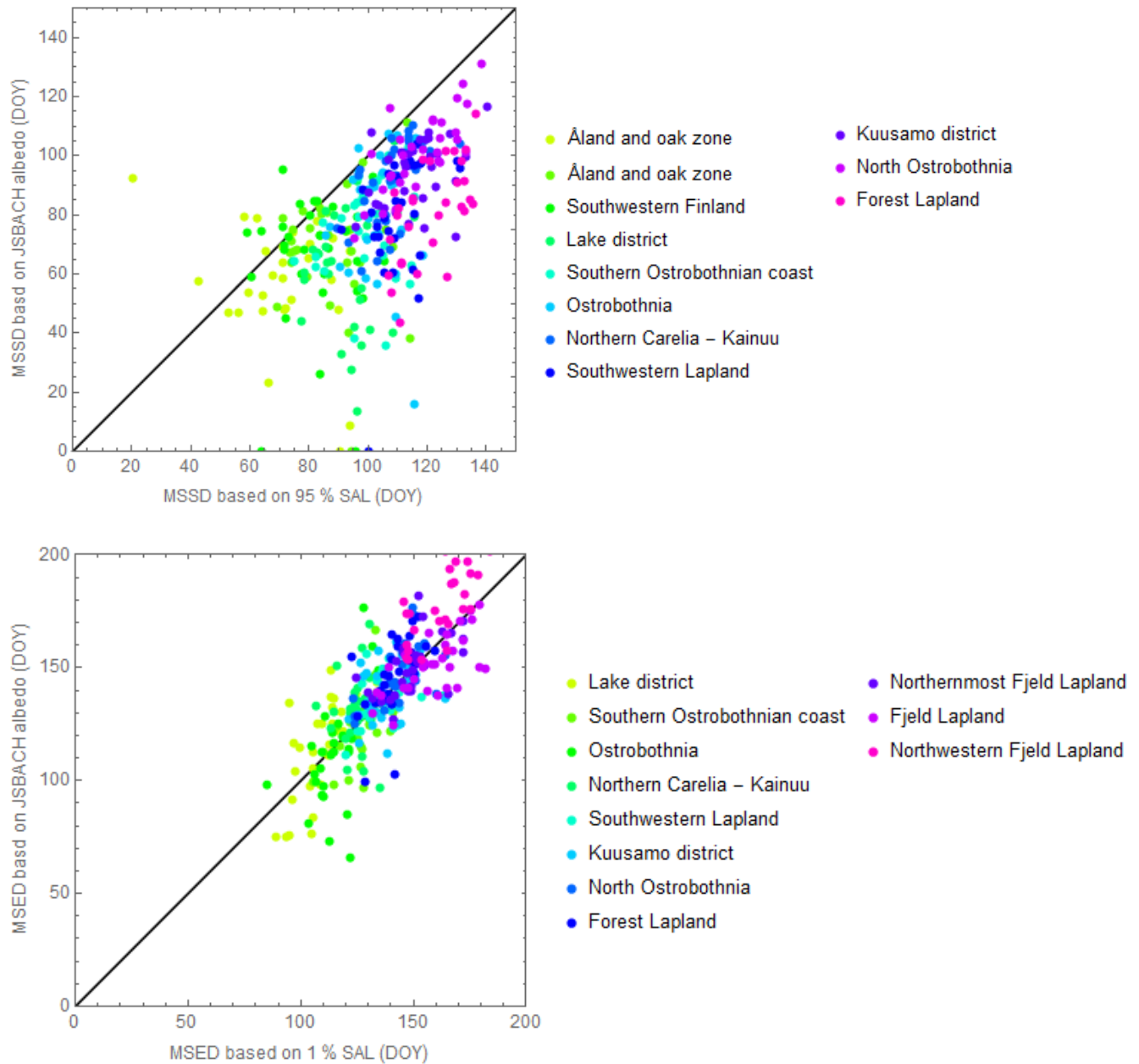Roesch et al. (2001) is missing from the reference list
The missing reference has been added.

page 9, section 2.2.5
JSBACH should produce an albedo. Has this been examined and rejected for compar-

ison with satellite measurements?

Yes, the albedo was also compared and the results were the same as using the snow depth. Here we chose the snow depth, because the model provides it and our main 'ground truth' was the operational snow depth. In addition, snow depth that accumulates throughout the seasonal cold period is a better indicator of winter-time climate than snow albedo, which is sensitive to prevailing weather conditions before the melt onset. Hence the scatter between the model and satellite data based albedo is larger than that of the end of melt season. Below the comparison between the albedo values at the beginning and end of snow melt are shown.

MSSD basd on JSBACH albedo (DOY) vs MSSD based on 95 % SAL (DOY)

- Åland and oak zone
- Åland and oak zone
- Southwestern Finland
- Lake district
- Southern Ostrobothnian coast
- Ostrobothnia
- Northern Carelia – Kainuu
- Southwestern Lapland
- Kuusamo district
- North Ostrobothnia
- Forest Lapland

MSED basd on JSBACH albedo (DOY) vs MSED based on 1 % SAL (DOY)

- Lake district
- Southern Ostrobothnian coast
- Ostrobothnia
- Northern Carelia – Kainuu
- Southwestern Lapland
- Kuusamo district
- North Ostrobothnia
- Forest Lapland
- Northernmost Fjeld Lapland
- Fjeld Lapland
- Northwestern Fjeld Lapland

page 9, line 30

Same comment again – can the same variable (albedo) be used for melt onset in data and model?

Yes, the albedo of the model can be used also for the melt onset observation. The scatter is slightly larger in that case than for the end of snow melt, because the true albedo right before the melt onset is very sensitive to prevailing weather conditions. Related text is added on page 10, lines 9-11.

page 9, line 6
"areal trends"
Now page 10, line 18. Edited as requested.

page 10, line 20
"areas being half"
This sentence is reworded (page 11, line 2).

page 11, section 3.1.3
So is this saying that the snow is starting to melt earlier but is not disappearing any earlier?
Yes, that's right. The end of melt season is very sensitive to the weather conditions at that time and has no clear trend, whereas the onset of melt is related to the weather conditions during a longer time period and has a decreasing trend.

page 11, line 29
"as snow or water" (or "as snow or rain")
Edited as suggested.

page 12, line 3
Carelia or Karelia?
The authors use the official English forms of the names, however odd they seem. Hence, Carelia but Kainuu. Häme – Uusimaa (in Finnish), but Ostrobothnia (Latin version of Etelä-Pohjanmaa)!

page 13, line 11
"also agreed well"
Edited as suggested.

page 13, line 18
"has increased"
Edited accordingly.

Tables 3 to 6
Values in bold font are not explained
The idea was to emphasize the cases for which the moving average of five years shows a significant coefficient of determination (>0.5). This information is now added to the table captions.

Figure 7
Remove Out[151]=

Figure 9
The colours used do not clearly relate to anything
The colours are related to the map of Figure 1b. This information is added to the Figure caption 10. As the whole Lapland is treated as one, the colour is a random choice.

One co-author from the FMI model team should be added:
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