

The Cryosphere Discuss., referee comment RC2  
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## Comment on tc-2021-290

Anonymous Referee #2

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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 1: Evaluation of the snow-albedo effect " by Anne Sophie Daloz et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-290-RC2>, 2021

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General comments:

In this paper snow albedo effect is studied in the Europe in winter and spring time. Simulations from Regional Climate Models are used to produce Snow Albedo Sensitivity Index (SASI) and these RCM based SASI values are compared to the SASI values derived from reanalysis and satellite observations. Conclusions are that accurate retrieval of SASI is more dependent of correct snow cover simulations than chosen atmospheric models. This leads to the observation that choosing correct Land Surface Model have an important role in simulating snow albedo effect. The subject itself is very interesting, and this study would be a good fit to The Cryosphere journal. However, I have some concerns.

Specific comments:

- I have some difficulties to understand how the satellite based SASI is formed. First, where the SW data is from? Secondly, if snow cover extent from MODIS is used, and that covers years 2003-2015, then I assume that satellite based SASI is covering years 2003-2015. Therefore, satellite based SASI cannot be used to verify/compare RCMs based SASI covering year 1986-2015. Due to the climate change, snow cover extent is vastly different in 2000s than in 1980s or 1990s (e.g. <https://www.ncdc.noaa.gov/snow-and-ice/extent/snow-cover/nhland/4>). I have doubts that weighting every grid point by the amount of MODIS data is enough to make satellite based SASI comparable to reanalysis and model based SASI.
- The value 0.4 as the average albedo difference between a snow-covered and snow-free surfaces is problematic. First, chosen three areas have different vegetation. The Scandinavian area are mostly boreal forest (needleleaved evergreen forest) whereas the East Baltic and the East Europe have more deciduous trees. Throughout the year needleleaved evergreen trees have their "leaves" on, but deciduous trees don't. So difference between snow-covered and snow-free surface albedo should be different in

the Scandinavian area (high-latitudes) compared to the two other regions (mid-latitudes). Also, the difference depends on whether snow is new or old. Old snow can have impurities, which lowers albedo (Warren and Wiscombe, 1980)). And, in winter snow can sporadically accumulate on trees, which itself increases albedo. I suggest that authors modify  $\alpha$  corresponding better different scenarios.

- I am not sure that mean value alone is adequate quantity to describe SASI results based on different models, reanalysis, and satellite observations (Sections 3.1, 3.2; Figures 2, 3 and 4). Standard deviation provides more information about the distributions of the SASI values, and therefore can indicate how well some simulations compare with reanalysis or satellite based SASI. I suggest that authors add standard deviation information to the comparisons, if not as figures, then at least say something about it in the text.
- I would have hoped to see some concrete ideas about the usefulness of different LSMs. Are there some overlapping features in simulations which agree with reanalysis and satellite based SASI, and how about those which performed more poorly?

Minor comments:

The description of LUCAS experiments will need some clarifications and more details. It is of course allowed to specify manuscript to people with certain scientific knowledge, but as not every reader is familiar with climate models, it would be reader-friendly to provide more explanations.

- What is a rotated coordinate system, could that term be explained?
- What is the time resolution of the simulations? Hourly, daily, monthly?
- In line 121 is said that "outputs from ten ... RCM simulations", are there more than those chosen ten? If yes, why those specific ten simulations are chosen?
- Table 1, could you open the used acronyms in Table 1 caption?
- Are RCMs WRF 3.8.1 and WRF 3.8.1D the same? If not, what is the difference?

Lines 158-168: snow schemes of CLM versions, Noah-MP and RCA4 system are described, but what about iMOVE, VEG3D and TERRA-ML?

Lines 180-181: the two thresholds for cloud cover are used. 50% of cloud cover is quite a lot of clouds in one cell, why this threshold was chosen? How were these thresholds used?

Line 182: why also "good" and "ok" flagged data was used?

Line 209: mention that the Scandinavian region have mostly needleleaved evergreen forest, whereas other two regions have more deciduous trees.

line 277: The peaks are quite pronounced in the East Europe and the East Baltic regions, but I think they are less pronounced in the Scandinavian region. Could it be due to the illumination conditions?

line 312: based on Figure 5, the snow cover for MODIS is from MODIS-TERRA, is that correct? Why MODIS-TERRA, if you also have MODIS-AQUA data?

line 314: what are those limitations and biases that are referenced to in this sentence?

line 328: also WRFb-CLM4.0 have high values during the ablation period. Should that model also be added?

lines 322-334: would it be more informative to add different markers whether models are over or under the range of reference datasets? For example, black dots when over and (red?) x when under?

line 346- 349: I would argue that REMO-iMOVE and WRFa-NoahMP have very different results, not REMO-iMOVE and CCLM-VEG3D, if these results are based on Figure 5. But also, based on Figure 3, CCLM-VEG3D do not reproduce SASI well at all.

Figure2: colorbar ticks and color limits do not match, could it be modified?

Figure 3 and 4: can horizontal lines be added? It would make reading of the figures much easier. Also, it would be more informative to draw ERA5 and SATELLITE lines last so they would be top of everything.

Figure 5: black color of MODIS-TERRA, especially black median line in the very dark grey bar is difficult to see. Can bar be made more lighter grey?

Table 1: Can table rows be listed based on RCM (as in Figure 2), not institute? It would be easier to read.

Technical corrections:

lines 46-47: word "it" is ambiguous, could this sentence be modified to be easier to read?

line 80: open the "RCMs" acronym

line 107: "Section4 the last sections" -> remove "the last section"

line 175: add MODIS product names (for TERRA: MOD10C1 and for AQUA: MYD10C1)

line 176: reference to the same section 2.2 is not necessary, remove it or change it

line 225: "The model data.." -> change it to "Most of the model data ..."

line 319: ".. snow cover varies between..." -> "..snow cover mean varies between..."

References:

Warren, S. G., & Wiscombe, W. J. (1980). A Model for the Spectral Albedo of Snow. II: Snow Containing Atmospheric Aerosols, *Journal of Atmospheric Sciences*, 37(12), 2734-2745. Retrieved Nov 15, 2021, from [https://journals.ametsoc.org/view/journals/atsc/37/12/1520-0469\\_1980\\_037\\_2734\\_amftsa\\_2\\_0\\_co\\_2.xml](https://journals.ametsoc.org/view/journals/atsc/37/12/1520-0469_1980_037_2734_amftsa_2_0_co_2.xml)