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Interactive comment on "Reinitialised versus continuous regional climate simulations using ALARO-0 coupled to the land surface model SURFEX" *by* Julie Berckmans et al.

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Discussion paper

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1 Reply to the Editor

Dear Editor,

we have prepared a majorily improved version of the manuscript by incorporating all suggestions and critical comments raised by both reviewers. Please find attached our response to the referees' comments on our above mentioned manuscript, titled "Reinitialised versus continuous regional climate simulations using ALARO-0 coupled to the land surface model SURFEX". Below mentioned you will find our detailed responses to all the reviewers' comments and suggestions (put in italics and red). We have also explained where and how they were incorporated in the revised manuscipt.

2 Reply to Anonymous Referee #2

We would like to thank the Anonymous Referee #2 for the encouraging and constructive comments, which have improved the manuscript. Below is a list of modifications that we have implemented based on your comments.

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Discussion paper

The manuscript has two questions in mind: (1) Is the land surface model SURFEX better than ISBA in climate application with the modelling system ALADIN in ALARO-0 set-up? (2) Is it better to do regional climate simulations or dynamical downscaling (i.e. with re-initialization of the regional atmosphere and land surface) or some mix (e.g., continuous land surface simulation with atmosphere and sea surface temperature re-initialization)? In my opinion these questions are only weakly linked. Of course, if you want to apply continuous land surface simulation there is need to use the best available land surface model (a bad land surface model might render a regional climate simulation useless), but a better land surface model is better even in an NWP context. Therefore, I suggest to focus on one of the questions and I find the second question more interesting.

Thank you for this suggestion. Even though the comparison between SURFEX and ISBA is valid, it is only weakly linked to the question of the performance of ALARO to SURFEX in multiple downscaling approaches. The above mentioned comparison has been done in an NWP context, and the comparison for long-term climate simulations builds upon these results. However, we do not elaborate on this in the revised manuscript. We focus on the second question only, as this was the main focus of the manuscript from the onset and it is indeed more interesting.

The manuscript claims that SURFEX is better than ISBA. It has been shown in NWP context (given reference Hamdi et al., 2014), but the authors target climate time scales. They compare an available CORDEX simulation with ISBA against a new climate simulation with SURFEX which was done using a smaller simulation domain. Different domain sizes limit the comparability crucially. Both simulations were driven by the reanalysis ERA-Interim. Therefore, I would expect limited-area simulations are potentially better with a smaller domain. The presented results are not conclusive.

The reviewer's assumption is true. The domain sizes should be equal to compare well the sensitivity of the regional climate model to the different land surface model. In

the future we plan a separate study for the comparison with ISBA, but with the same model domain to make it consistent. This is not an objective any longer in the revised manuscript.

The authors cite many re-initialization vs regional climate simulation experiments. Even with ALADIN such a re-initialization experiment has been published, but for a 3-monthly period only (Beck et al. 2004). I suggest to make the manuscript more interesting and publishable by doing the list of re-initialization experiments more exhaustive by adding (a) full re-initialization (i.e. with SURFEX re initialization) and (b) blending (i.e. re-initialization of the large atmospheric scales doing "climate" for the smaller scales, see Beck et al. 2004). Finally, perhaps too much for one paper, I think the ultimate criterium will be how the set-up performs with GCM forcing.

Thank you for this valuable suggestion. We have included the full re-initialisation experiment in the revised manuscript. The new objective of the manuscript is as follows (Page 3 Lines 3-6):
"The objective of this study was to evaluate the simulation potential of three regional climate downscaling approaches with different update frequencies of the initial conditions: (1) a continuous simulation of both the atmosphere and the surface; (2) a simulation with daily reinitialisations for both the atmosphere and the surface; and (3) a simulation with daily reinitialisations of the the atmosphere while one single initialisation of the surface."

The paper of Beck et al. (2004) describes different nesting methods and concludes that for dynamical downscaling the direct nesting method is acceptable. We have used this method in the experiment, but have not explicitly mentioned it. We decided not to include a blending experiment in the revised manuscript, as the focus is on the sensitivity to the update frequency of the initial conditions. The set-up with forcing from GCM has been done as well, using ARPEGE CMIP5. We will use these results

for a separate study in the future, as the boundary conditions differ a lot and lead to different conclusions. In the conclusions, we give the recommendation of investigating this in a GCM context.
The new version (Page 12 Lines 28-31) reads:
"In conclusion, this study demonstrated that the approach of a daily reinitialised atmosphere was superior over the continuous approach. The use of a continuous surface next to a daily reinitialised atmosphere even improved the winter temperature and summer precipitation. The latter approach is highly recommended in a setup with GCM forcing, as imperfect initial and lateral boundary conditions are applied."

3 Manuscript version with highlighted changes is supplemented.