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Interactive comment on "Land surface spinup for episodic modeling" *by* W. M. Angevine et al.

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This is our response to the comments of reviewer #1. The reviewer's comments are numbered, and our point-by-point response follows. We thank the reviewer for the positive and helpful comments, which give us an opportunity to further clarify the work. We also thank the Editor for taking on the role of second reviewer and clarifying which points to emphasize.

General comment: In this work a soil-initialization spin-up method is proposed to improve the soil moisture and the representation of the surface layer of a set of mesoscale simulations during the BLLAST experimental field campaign. The manuscript is very well orga- nized and the objectives and methodology are clearly stated. However, some issues (listed below) need some clarification to better understand the improvements of the new method. I recommend this paper for publication but considering the following

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points:

General response: Our response attempts to balance two goals, keeping the final paper clear and brief, and answering detailed questions that naturally arise. To that end, we have made changes to the manuscript, but also included here some text and figures that, in our opinion, do not need to be in the final paper.

1. section 2, first paragraph. I suggest to include some information about the length of the domains. Which area do they cover? Is the inner domain (3km) corre- sponding to the area in Figures 2, 3, 7 and 8? If this is the case, please indicate it in the text. Besides, indicate that only the results for the inner domain are used in the plots.

Text has been added indicating the latitudinal and longitudinal extent of the outer do- main, and indicating that the plots show the entire inner domain and that only results from the inner domain are used.

2. The length of the cycle is one month and the best results (when compare against available observations) are found for the cycle 2 (2 months). However, during cycle 2 the improvement is smaller than the one made using cycke 1. Therefore, it is expected that cycle 3 won't improve the results so much. Have you checked this? Are the results dependent on the duration (length) of the cycle? or in the starting of the cycle? or in the number of cycles?

We expect that the length of the cycle, the starting date, and the number of cycles all affect the results. During the analysis, we did run a third cycle, but for a different configuration than the one shown in the paper. The difference was a 10mm rather than 10cm first soil layer depth. The results are therefore not directly comparable. In that run, the third cycle was considerably too dry and warm. In other words, running the third cycle caused the system to overshoot the desired state. We did not test different starting dates or cycle lengths. Throughout the paper we have tried to be clear that we are not prescribing the choices to be made, but outlining a method that worked for us. Readers who wish to apply the method to their own uses will need to make appropriate

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choices for their specific situation.

3. The effect of using soil moisture spin-up is clearly seen in Figure 6. Without spin-up there is a larger (0.3) soil moisture than the observations (0.2) for the period of interest (end of June). Have you test if doing a mesoscale run (without cycles) but reducing the soil moisture a factor of 1.5 in every gridpoint the same results as cycle 1 or 2 are found?

We did the suggested run for 25 June. Figure R1 shows the result. The potential temperature profiles for the first two soundings are quite similar to those from the cycle2 run except that the inversion is sharper. By late afternoon, however, the results have diverged and the cycle 2 results are better. The spatial patterns of skin and near-surface air temperature, sensible and latent heat flux are rather different between cycle 2 and this test run. Figure R2 shows the sensible and latent heat fluxes and soil moisture for cycle 2 and the test run. The test run moisture field is, not surprisingly, very smooth, although it has nearly the same mean value as the cycle 2 field, which seems much more realistic. The mean sensible heat flux is about 10% larger and the mean latent heat flux about 8% smaller in cycle 2. Lacking spatially distributed measurements of heat flux, we cannot say with confidence which is more correct. On this basis, we think that cycling is a more robust method than simply reducing the soil moisture overall, but the latter could be considered. We have added a short paragraph to the Conclusions to this effect.

4. It is not clear in the text why the authors have used the soil moisture and the temperature in the second layer. Using the first layer is more linked to the surface flux (H) of Figure 7.

We show the second layer for clarity, because the thin first layer has very strong daily cycles that obscure the trends we want to highlight. This has now been explained in the text. Both the first and second layers contribute to the surface fluxes, proportionally depending on the vegetation type (root depth) in the case of soil moisture and on the

soil conductivity in the case of temperature.

5. Nothing is said about the 2m temperature or the 10m winds. Are the cycle 2 run improving these fields in the Lannemezan region?

We have shown soundings rather than surface measurements because the soundings contain more information and show our results more clearly. For a complex site like Lannemezan it is difficult to decide which surface measurement or combination of measurements best represents the model grid box. See the overview paper by Lothon et al. (2014) for more detail on the complexity of the site and distribution of measurements.

6. Figure 5 is not needed and the location of the SMOSMANIA stations can be indicated in Figure 2, for instance.

We disagree, figure 5 shows not only the site locations but the terrain, which is not shown in any other figure.

7. Are all the SMOSMANIA stations considered in Figure 6 behaving in the same way? Some of them seem that they are closer to the mountain slopes and some others at the river plain.

There is quite a bit of site-to-site variation, as mentioned in the text. The general trends are similar. The main variation is in how much the measurements at each site are affected by local rainfall.

8. Figure 7. It would be more interesting to see the temporal evolution (as in Figure 4a) of H instead of the horizontal fields and also plot the temporal evolution of LE. With this proposed new plot it is possible to evaluate how far H and LE are from the observations from Lannemezan.

We respectfully disagree. As mentioned in the text, the flux locally at Lannemezan does not change very much with cycling. Comparing with flux observations is the subject of ongoing research, because it is not trivial to construct, from the measurements over

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diverse land uses, fluxes that are representative of the model grid cell. See figure 7 of the overview paper by Lothon et al. (2014) for more detail.

9. Figure 1. Although these days were IOP, the ambient conditions were different. Is there any particular day/conditions that the model is producing better (closer to the profiles) results? If this is the case, why? From the averages in Figure 1 it is not possible to have this estimation.

All of the days included in the average have similar errors (cool and moist) in the uncycled runs. Figure R3 shows the individual comparisons for six days. BL height is less consistent, on 24 June, 30 June and 1 July the BL is lower in cycle 2 even though it is warmer (and dryer, not shown). This again highlights the four-dimensional nature of the situation. 25 June has the best agreement, which is part of the reason it was chosen for the other figures.

10. Figure 2 and 3. Please, add the topography lines to better understand these patterns. Beside, include in the text or in the caption that the cross is the Lannemezan site (right?) and the units of the fields. What is happening in the fields of Figures 2 and 3 (top) in the left side? Is there any problem related to the interpolation of these fields?

The units (or non-units, in the case of soil moisture) have been added to the caption, as has the indication that the x is Lannemezan. Elevation contours at 200 and 1000 m ASL have been added to show the topography without adding too much clutter. The odd pixels in the upper left corner are a few points of water (Bay of Biscay) in the model.

11. The improvements of the potential temperature profiles when using cycle 2 are shown in Figure 9. Do you have similar results for the rest of the simulated days (included in the plot in Figure 1)?

See figure R3 and the response to comment 9 above.

Reference: Lothon, M., Lohou, F., Pino, D., Couvreux, F., Pardyjak, E. R., Reuder, J., Vilà–Guerau de Arellano, Durand, P., Hartogensis, O., Legain, D., Augustin, P., Gioli,

B., Faloona, I., Yagüe, C., Alexander, D., Angevine, W., Bargain, E., Barrié, J., Bazile, E., Bezombes, Y., Bezombres, Y., Blay–Carreras, E., van de Boer, A., Boichard, J. L. , Bourdon, A., Butet, A., Campistron, B., de Coster, O., Cuxart, J., Dabas, A., Darbieu, C., Deboudt, K., Delbarre, H., Derrien, S., Flament, P., Fourmentin, M., Garai, A., Gibert, F., Graf, A., Groebner, J., Guichard, F., Jim'enez M. A., Jonassen, A., von Kroonenbeerg, M., Lenschow, D., Magliulo, V., Martin, S., Martínez, D., Mastrorillo, L., Moene, A., Molinos, F., Moulin, E., Pietersen, H., Piguet, B., Pique, E., Román-Gascón, C., Rufin–Soler, C., Saïd, F., Sastre–Marugán, M., Seity, Y., Steeneveld, G. J., Toscano, P., Traullé, O., Tzanos, D. ,Wacker, S., Wildmann, N., and Zaldei, A.: The BLLAST field experiment: Boundary-Layer Late Afternoon and Sunset Turbulence, Atmos. Chem. Phys. Discuss., 14, 10789-10852, 2014.

Figure captions: Figure R1: Potential temperature profiles observed by four frequent soundings at BLLAST site 2 on 25 June 2011 (black) and simulations as shown in the legend. Model results are from the nearest grid point. This is the same as figure 9 in the discussion paper, with the addition of the cyan line which is the result from initializing with ERA-Interim at 0000 UTC on 25 June but dividing the soil moisture at every point by 1.5. See response to point 3 above.

Figure R2: Sensible heat flux (top row), latent heat flux (middle row) and soil moisture in the second layer (bottom row) for cycle 2 (left column) and test run with ERA-Interim soil moisture divided by 1.5 (right column).

Figure R3: Potential temperature soundings observed (black) at ∼1700 UTC on six days (24,25,26,27,30 June, 1 July) at site 1 compared with results from uncycled (red), cycle 1 (blue), and cycle 2 (green) simulations.

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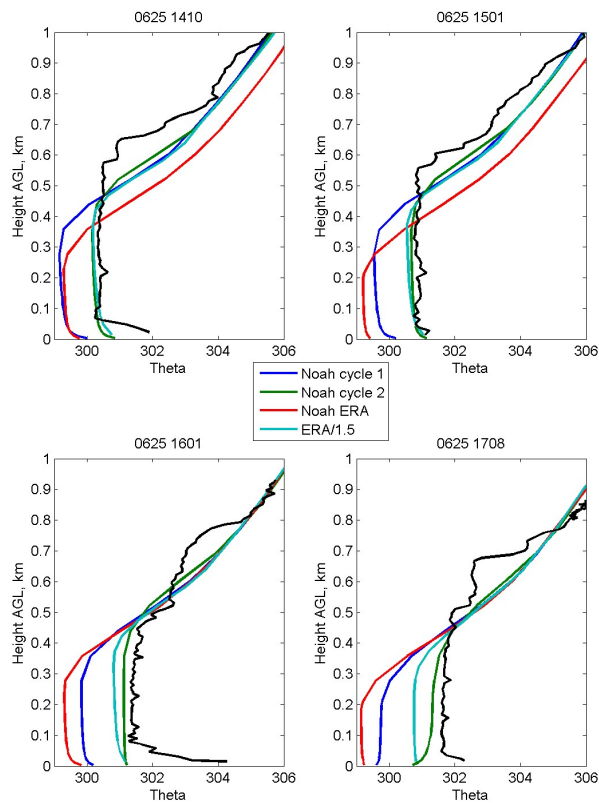Interactive Discussion

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Fig. 1. Figure R1: Potential temperature profiles observed by four frequent soundings at BLLAST site 2 on 25 June 2011 (black) and simulations as shown in the legend.
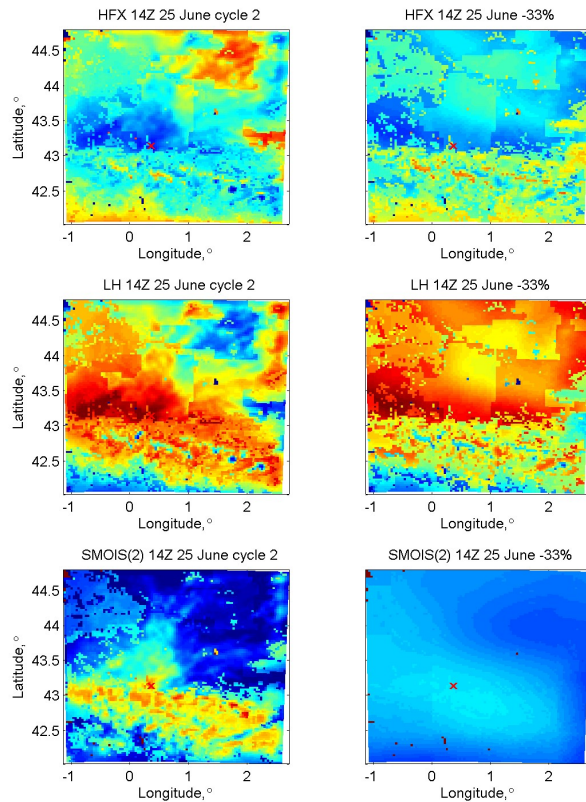
Fig. 2. Figure R2: Sensible heat flux, latent heat flux, and soil moisture in the second layer for cycle 2 and test run with ERA-Interim soil moisture divided by 1.5.
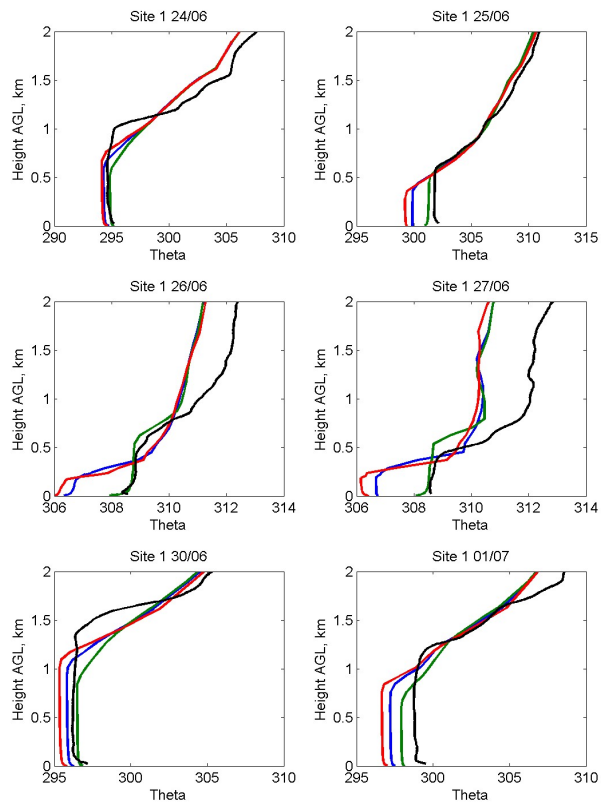
Fig. 3. Figure R3: Potential temperature soundings observed (black) at ∼1700 UTC on six days (24,25,26,27,30 June, 1 July) at site 1 compared with results from uncycled, cycle 1, and cycle 2 simulations.