

Interactive comment on “Evaluating the Met Office Unified Model Global Atmosphere/Land 3.1 (GA/L3.1) and Global Atmosphere/Land 6.1 (GA/L6.1) land surface temperature. Outcomes of the SALSTICE campaign” by Jennifer K. Brooke et al.

Anonymous Referee #1

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The manuscript provides an assessment of land surface temperature (LST) simulated with different configurations of the UK Met Office Unified model. The exercise is made for a small area in the US (Arizona) taking advantage of simulations and data gathered for a particular experiment (SALSTICE), which was focused on model LST bias with respect to IASI retrievals. Model LST simulations are compared with IASI and MODIS products, as well as with in situ estimates. Model net radiation, turbulent heat fluxes at the surface and ground flux are also compared with ground observations.

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The manuscript is very well written and the subject is of interest, given the limitation in the assimilation of radiances sensitive to lower troposphere over land due to the large model skin temperature biases. However, it is difficult to draw solid conclusions when different model configurations (in terms of dynamics, resolution, approach to bias correction, surface parameters) are not run for a common period. I suggest the article to be accepted subject to revisions in line with my comments below.

1) On local estimates of LST (section 2.2.2): I fully agree with the need to account for the uncertainty in local emissivity for the LST ground estimates. From the description provided in this section, it seems you do not correct the surface leaving radiance for the downward radiation that is reflected by the surface. This may be the same order of emissivity uncertainty for the 8-14 micro-m band. Please check and modify the data and model versus in situ comparisons in the manuscript as needed.

2) End of section 2.3 (page 6): The angular dependence of LST estimates should not be linked to atmospheric effects, as these should have been corrected during the retrieval process. Although insufficient correction for the optical path may still persist, the effects described in the text are more frequently a consequence of spatial heterogeneity (i.e., different viewing perspectives may actually yield different scenes, even if matching in time and space) and therefore are essentially dependent on the viewing & illumination geometry. That is why angular-dependent biases are mostly inexistent for night-time observations.

3) Lines 3-8 (page 8): Indicate how the change in the emissivity attributed to each tile (bare ground, grasses, ...) change the emissivity map over the study area. I'd say that overall you have a slight decrease for GA/L6.1 and US2.2(A to D) and an increase in US2.2E due to the drastic reduction of bare ground fraction.

4) Lines 10-15 (page 8): Please include a short justification for the use of different ZoH/ZoM ratios in the global and limited area model versions.

5) On the overall analysis of model simulations: As referred above in my general com-

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ment, the results of different model configurations correspond to the same period of the year (May), but for model runs performed for different years. You must ensure that when comparing these results, they are not affected by inter-annual variability. In order words, please show that the conditions observed in each May of the 2013-2018 period do not deviate greatly from the average. In the case they do, please check how that may have affected your results. This is relevant, since a dryer or rainier than usual year may lead to a significant change in vegetation cover (and therefore in surface parameters such as surface albedo and emissivity, and even ZoM), soil moisture availability (and likely in the partition between latent and sensible heat fluxes), which will certainly impact your model performance.

6) Last line of page 9 – line 7 of page 10: I'm not sure I follow what is meant here, especially with what respects the degradation in the representation of the grassland fractions. In contrast to the latter, when use a higher resolution landcover, you get better representation for bare soils: is this so? Why? Please clarify (or just rephrase).

7) When discussing the statistics between the various model configurations and MODIS LST products (collections 5 and 6), it would be useful to have an idea how both compare with the in situ estimates (please make sure these are properly estimated, as commented above). You may consider adding a table with a summary of all these, including an average of the in situ (or MODIS) LST per site, which would somehow answer my question above on stable the conditions are among the studied years. This may also help you check if there are years/sites for which MODIS (Aqua or Terra) presents higher biases, and therefore help you analysing your model comparisons with MODIS LST.

8) On the assessment of model biases and terrain slope: The impact of slope, especially the x-component) surely differs for Terra (morning overpass) and Aqua (afternoon overpass), if this is essentially related to the LST contrast between slopes facing/hiding from the sun. Maybe this effect is more noticeable in the afternoon, and in that case the "Aqua signature" prevails. In any case, the illumination geometry is obviously very

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relevant for this, and therefore results should be assessed for the two platforms separately.

9) Lines 15-16 of page 14 "Our findings suggest that the daytime model LST bias could be minimised by increasing the bare soil cover fraction in the study regions". I don't think you can say this, as you are suggesting that you should change the fraction of bare soil, instead e.g., correcting, e.g., model parameters where the fraction of bare soil is low.

10) The comparisons between model and observed net radiation and surface energy fluxes are only discussed for a single site/year. Although the issue of different models run for different periods could make the discussion difficult, it would be interesting to know how the comparison between simulations and observations evolved as the model land surface temperature changed.

11) Editorial:

- Abstract: "The diurnal cycle of LST in Global Atmosphere/Land 6.1 (GA/L6.1) showed a significant improvement relative to GA/L3.1": Please be more specific (meaning quantitative) here.

- lines 5-6 (page 6): Suggest replacing "to give site-specific LST for each site." by "to give site-specific LST."

- Figures 4 and 5: suggest the authors include a short title for each panel (e.g., LST bias – US2.2A), to facilitate their interpretation.

- line 23 (page 12): "IASI"

- Figure 7: Please ensure each individual scatter-plot has the same range in the y- and x-axes, since we are comparing the same variable (model versus observations). For the same reason, please resize the diagrams so that they are closer to a square, i.e., so that the length in the y-axis corresponding to, say, 10 Wm^{-2} roughly matches the same length for 10 Wm^{-2} in the x-axis.

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- Line 12 page 18: Please rephrase sentence.

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