

Review comments (gmd-2021-243)

The authors designed multiple WRF experiments to evaluate and compare the influence of the LSM choice and horizontal resolution, on the energy and water fluxes at the surface and near-surface conditions over North America. This is a very important work as large-scale models go to finer spatial resolution with the advances in computational resources and high-resolution data availability. Also, understanding the advantage and disadvantages of different land surface models (LSMs) with different process parameterization is crucial to understand and restrict uncertainties in climate simulations. Overall, the paper is well written and within the scope of GMD. I recommend accepting this paper with a moderate revision.

Specific comments:

- L41. Besides the soil physics, other land surface processes (e.g., vegetation, groundwater) could also affect the land–atmosphere interactions. Instead of only mentioning the soil physics here, you should also mention other vital processes. As you also concluded in L280, "This suggests that the different representation of vegetation in each LSM yields to different estimates of soil properties." Please summarize more about the difference in LSMs here. Otherwise, the reader may think soil physics is the most critical determination reason for LSMs. In L430, it seems that you prefer to refer LSMs as soil schemes, which is kind of too simplified.
- The way you are explaining different results between LSMs is vague, e.g., the paragraph around L215. Which are possible major differences between LSMs cause these different simulations is not well explained. It is beneficial, but it may not be easy, to provide more information and commentary/insights, which should be very useful to guide the LSMs' development in the future.
- In section 4.2, you analyzed the difference caused by different resolutions. You explained the difference in simulated variables by using other simulated variables (e.g., its components). For example, L295, net shortwave radiation -> net total radiation. These explanations are indeed needed. However, it is not clear why net shortwave radiation is changed due to finer resolution. It is helpful to explain, from more bottom processes, how

resolution increase changes the energy or water simulations (e.g., finer resolution of DEM or LULC, and how).

- You compared 3 different resolutions (i.e., 25, 50, 100 km) in this paper. As large-scale modeling goes higher resolution or Hyperresolution, for example, NLDAS using 12.5 km, or 1 km (e.g., wood et al., 2011), it would be helpful to provide more comments on this in the discussion.

Reference

Wood, Eric F., et al. "Hyperresolution global land surface modeling: Meeting a grand challenge for monitoring Earth's terrestrial water." *Water Resources Research* 47.5 (2011).
<https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2010WR010090>