Responses to Reviewer #2

The authors have largely addressed my comments and questions in the last round of review.

I have one comment and one question:

Comment: It will be great to see further research on applying the HET scheme to a global E3SM study.

We agree with the reviewer that a global E3SM study would be interesting. However, a global E3SM has a lot more degrees of freedom than a single column model, which can potentially confound physical interpretation, so we chose to use a single column model for this study to focus on improving process-level understanding and identifying the model's first-order responses to the new HET treatment. We have started to investigate the climatic impacts of accounting for surface heterogeneity in a global E3SM study and the results will be documented in a separate manuscript. We have included the following paragraph in Line 314-320:

"The patch-aggregating approach considers the subgrid variability in surface states, improving the realism of the heterogeneous land-atmosphere interactions in E3SM. This study provides an initial assessment of this treatment in a state-of-the-art ESM in a SCM configuration. This configuration allows us to improve the mechanistic understanding without being confounded by complex feedbacks in the atmosphere. The significant effects of this treatment on turbulence structure in the ABL and on low-level clouds highlight the importance of accounting for the subgrid variability in land-atmosphere coupling. Our ongoing effort is to investigate the full climatic impacts of accounting for surface heterogeneity using global E3SM simulations and results will be documented in a separate manuscript."

Question: From Figure S7 on the differences between the two simulations and the observation. Authors may comment or discuss more on this topic - it seems that the model cloud fractions are much higher than obs, which affects energy balance. Then the relative humidity is higher with a cooler modeled temperature. The precipitation phase is shifted too. What are the causes of these discrepancies? Are they related to forcing or model physics? Readers may benefit more from this discussion.

We have added a paragraph in line 152-159 to discuss Figure S7:

"We evaluated the SCM results against the ARM measurements (Fig. S7). We find the total cloud fractions in SCM simulations are much higher than the observations (Fig. S7c). The overestimation of clouds leads to decreased surface downwelling shortwave radiation (not shown). As a result, the model surface sensible heat fluxes decrease, resulting in the bias of near-surface air temperature (Fig. S7a) and the moist biases (Fig. S7b). In Fig. S7d, the observed precipitation peaks in the early morning, whereas the simulated precipitation peaks in the afternoon. This precipitation phase bias in E3SM has been attributed to the model's deficiency in the moist convective parameterization (Xie et al., 2019, Bogenschutz et al., 2020). In the next section, we investigate the impact of accounting for surface heterogeneity in land-atmosphere coupling on clouds, PBL characteristics, and precipitation by contrasting the HOM and HET model simulations."