

## Response to Reviewer #2

**We thank this anonymous reviewer for her/his insightful comments, which have been very helpful in the further revision of our manuscript. We have made every effort to address all the concerns raised by this review. Our point-by-point response is given below.**

### **General Comments:**

1. *CNTL is a 15-day continuously running simulation, while the sensitivity studies designed to test the effect of eliminating various moist processes are much shorter (24-h) simulations that use initial conditions from CNTL (which includes moist processes). The authors argue that this experiment design is necessary in order to preserve large-scale conditions found in CNTL for the sensitivity experiments. This is a legitimate concern and perhaps a valid reason for the current design. However, such a design may obscure the overall (e.g., climatological) effects of the withheld moist processes on the MPS circulations. For instance, it is very well known that vertical circulations are stronger in deep, moist convection than in the surrounding dry air. I would argue that this effect largely explains the stronger vertical motions in the CNTL MPS than it's analog in FAKE-DRY - a point hinted at by reviewer Dr. C. C. Wang in his comments concerning what is the MPS and what is convection?*

*To assess the overall effect of latent heating processes, analysis of a 15-day continuously running FAKE-DRY simulation should also be included. The longer-term elimination of atmospheric temperature changes due to convection would favor a dry-adiabatic stratification in the interior of the domain. In that situation, one might imagine a very different result with a stronger MPS than that occurring in CNTL, since there would be less resistance to vertical displacements in an environment with much lower static stability. At the very least, the authors need to discuss this possibly in the revised version of the paper.*

**Reply: The reviewer is right the Fake-Dry sensitivity experiments so designed in the current study is to maintain similar larger-scale circulations to that of CNTL, not to assess the overall climatological effect of moist convection in this area. We indeed performed another sensitivity experiment that completely eliminates**

**moist convection during the entire 15-day simulation. As expected, the larger-scale circulation is drastically different from that in the CNTL that it will not serve the purpose of understanding the effect of moist convection on the updraft strength or the propagation. Moreover, there is an apparent inconsistency in this 15-day continuous simulation because the boundary conditions still come directly from the reanalysis that is not dry. In other words, this continuous dry simulation will be addressing a very different set of questions that is beyond the goals of the current manuscript. Nevertheless, we found no evidence that the MPS in this longer- term continuous longer-term simulation is stronger than that in the current Fake-Dry experiment. We have added a brief summary of the above discussion in the revised manuscript.**

*2. The “no evaporation” (NOVAP) experiment produces the interesting result of more precipitation and a stronger MPS than in CNTL. However, there is very limited discussion of why this might be true, which I found somewhat dissatisfying. In fact, other than to show that evaporation influences the movement of both the precipitation and the vertical motion pattern, it is not clear why this experiment was even presented in the paper. The authors argue that there would be stronger mountain-plains temperature gradients (on a constant pressure surface), and thus a stronger MPS, during the day when evaporation is not included, due to less local cooling from mountain convection. I agree with this conclusion. However, there are factors independent of the MPS that might be influencing the heavier precipitation in the NOVAP experiment. First, evaporatively cooled downdrafts have been shown in some situations to have negative effects on the strength of the convection and amount of precipitation (e.g., Schumacher 2009, Trier et al. 2011). This is not mentioned. The authors emphasize only the positive effects of cold pools on sustaining precipitation systems instead of the possible negative ones. Second, a more obvious effect of excluding evaporation is that for convection of a given strength, more precipitation reaches the ground when evaporation is withheld. These aspects should be quantified (or at least discussed) when NOVAP is presented.*

**Reply:** Please refer to our response to the major comments #2 and #4 of the reviewer Dr. C. C. Wang. The larger precipitation in NOVAP than CNTL may be due to (1) a stronger updraft due to less energy loss by evaporative cooling despite similar in CAPE, (2) a slowed moving speed without the cold pool by turning off evaporative cooling, and (3) more precipitation reaching the ground without evaporative cooling. We have added discussions on the negative and positive influences of the cold pool in the revised manuscript, and add the following references:

Schumacher, R. S.: Mechanisms for quasi-stationary behavior in simulated heavy-rain-producing convective systems. *J. Atmos. Sci.*, 66, 1543-1568, 2009.

Trier, S. B., Marsham, J. H., Davis, C. A., and Ahijevych, D. A.: Numerical simulations of the postsunrise reorganization of a nocturnal mesoscale convective system during 13 June IHOP\_2002, *J. Atmos. Sci.*, 68, 2988-3011, 2011.

**Specific Comments:**

1. P. 27893, lines 9-25. *This comment concerns this literature review of propagating convection in the lee of major mountain ranges. Here, the authors have failed to mention recent work on observed (Laing et al. 2008) and simulated (Laing et al. 2012) propagating convection in the lee of mountains in tropical northern Africa. Given that such propagating convection is global in nature, the authors should consider referencing these studies, since most of the current references are limited to the midlatitudes.*

**Reply:** We will add the following references in the revised manuscript:

Laing, A. G., Carbone, R. E., Levizzani, V., and Tuttle, J.: The propagation and diurnal cycles of deep convection in northern tropical Africa. *Quart. J. Roy. Meteor. Soc.*, 134, 93-109, 2008.

Laing, A. G., Trier, S. B., and Davis, C. A.: Numerical simulations of organized convection in tropical northern Africa. *Mon. Wea. Rev.*, 140, 2874-2886, 2012.

2. P. 27896, lines 26-29. *Why is only evaporation neglected in experiment NOVAP? If you are testing the effects of latent cooling, it seems you'd want to eliminate all such physical processes including melting.*

**Reply:** We believe that the evaporation cooling is the main part of latent cooling that directly controls the cool pool strength, and the current NOVAP experiment already serves the goal of understanding the impact of cold pool dynamics. In the meantime, technically it is not straightforward to turn off all other cooling processes in the microphysics of the model besides melting.

3. P. 27901, lines 9-12. *I would argue that vertical motions of order 1 m/s are still quite strong given that scales less than  $L \sim 200$  km have apparently been removed.*

**Reply:** We re-plotted Figs. 8, 10, 11 and added -0.5 and -0.5 into the bar of vertical motion. The units of the vertical motion should be in “cm/s” instead of “m/s”. We also changed the smallest contour level from “-1 to 1” to “-0.5 to 0.5” in these figures.

4. *Figs. 8, 10, 11 and related discussion. Please consider enlarging or reorganizing these figures in some other fashion. The circulation vectors were very hard to read on my copy, which made it more difficult to follow the related discussion.*

**Reply:** We reorganized Figs. 8, 10, 11 to be more readable, along with other changes in the reply to specific comment #3.

5. P. 27905, lines 4-7. *This statement of evaporation providing convective enhancement appears somewhat at odds with results from the NOVAP run shown in Figs. 4 and 6 (see general comment 2).*

**Reply:** Good point. Wording is changed in the text to avoid the inconsistency.

6. P. 27098, lines 8-10. *Similar to the previous comment, it is not clear to me from the figures presented that the NOVAP MPS is weaker than the CNTL MPS.*

**Reply: This was a typo. We changed "much weaker" to "much stronger".**