

## ***Interactive comment on “Hydration or dehydration: competing effects of upper tropospheric cloud radiation on the TTL water vapor” by L. Wu et al.***

**Anonymous Referee #1**

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Reviewer's comments on “Hydration or dehydration: competing effect of upper tropospheric cloud radiation on the TTL water vapor” by Wu, Su, Jiang and Read

General comments:

This is a modeling study of the radiative effect of upper-tropospheric (UT) clouds on TTL temperature and moisture. Different from most previous studies of the same topic that used 1D model, the authors employed a full-fledged 3D WRF model in “tropical channel” configuration. They first showed that the WRF model in this setting can reasonably simulate the TTL water vapor distribution and cloud radiative effect (CRE). Then, they compared the control run with an experiment in which UT cloud radiative

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effects (UTCRES) are turned off. It was found that in the UT below TTL (from 215 - 150 hPa), UTCRE induces warming and moistening; inside the TTL (150-80 hPa), however, UTCRE leads to cooling and dehydration. The authors diagnosed the causes of these different responses. Overall, this is a solid study and a comprehensive analysis. I only have a few points to contend.

1. “Tropical channel” configuration: I don't quite understand the advantage of this approach. Saving computer time? Minimizing extratropical influence? I think the authors should cite some previous publications using a similar approach to back them up.
2. Simulated LWCF (Fig. 3): based on Fig. 3, I am a little concerned that this model configuration may not capture the cloud field very well. Besides, they are supposed to evaluate the model performance in simulating UT clouds, not all clouds as done in Fig. 3.
3. A quick comparison with CALIPSO UT cloudiness may help.

In balance, the manuscript appears to me as acceptable for publication after some minor revisions. Specific comments are given below.

Specific comments:

1. (p4662, Line 26) Clarify which months are “moist phase” and which are “dry phase”.
2. (p4664, 1st paragraph) Equation 1 shows that UTCRE will lead to changes in both temperature and vertical velocity. But how it is partitioned between the two is not obvious. The authors go through some hand-waving arguments to explain the observed changes in Fig. 5. It may work better to simply plot the three terms individually as a function of height, which is worth a thousand words.
3. (p4664, 1st paragraph) There should also be a water vapor budget equation to accompany the discussion. And it would be nice to plot various budget terms for water vapor to show how the hydration are dehydration are maintained.
4. Vertical water vapor transport in Fig. 6: is it total transport or transport by mean vertical motion? Note that total transport = transport by mean motion + transport by

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eddies. Fig. 7 seems to be discussing eddy effects.

5. (p4665, lines 4-7) I don't see any contradiction between sign change in vertical velocity and persistently enhanced vertical transport. Note that the budget term corresponding to the vertical transport measures the vertical gradient of the product of  $q$  and  $w$ :  $-d(qw)/dz$ .  $w$  could change sign but  $d(qw)/dz$  could still stay the same sign.

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