

# ***Interactive comment on “Subgrid Variations of the Cloud Water and Droplet Number Concentration Over Tropical Ocean: Satellite Observations and Implications for Warm Rain Simulation in Climate Models” by Zhibo Zhang et al.***

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I would like to thank the reviewer for the comments and suggestions. Point-to-point replies to the comments are provided below.

Comments: Authors derived the subgrid variations of liquid-phase cloud properties over the tropical ocean and investigated the autoconversion enhancement factors using MODIS product. This paper is well written, and of relevance to a broad audience. It is worthy of publication subject to the following issue.

(1) Authors assumed that subgrid variation of LWC could be inferred from the spatial variability of LWP. LWP is the vertical integrated LWC over cloud depth, so its subgrid variations include cloud depth variations. But LWC's variations do not. Please justify this assumption.

Reply: Indeed, MODIS retrievals only provide the LWP instead of the vertically resolved LWC retrieval. This is an important limitation of this study which we pointed out clearly in Section 3.

However, as we also pointed out, other techniques face more or less similar challenge. "We note here that it is the LWC  $q_C$ , instead of the LWP, that is used in the KK2000 scheme. So, the spatial variability of LWC is what is most relevant. However, the remote sensing of cloud water vertical profile from satellite sensor for liquid-phase clouds is extremely challenging even with active sensors. It is why most previous studies using the satellite observations analyzed the spatial variation of LWP, rather than LWC. In fact, even Lebsock et al. (2013), who used the level-2 CloudSat observations, had to use the vertical averaged LWC in their analysis. Airborne in situ measurement faces similar challenge. For example, Boutle et al. (2014) use the LWC observation along "horizontal flight tracks" to study the spatial variability of cloud water, which only samples the LWC at certain levels of MBL clouds. Ground-based observations are much better than satellite and airborne observation in this regard. Recently, Xie and Zhang (2015) analyzed the cloud water profiles retrieved using ground-based radars from the three ARM sites and found no obvious in-cloud vertical dependence of the spatial variability of LWC."

Comments:

Typos: (1) Lines 359 " : : any type of data quality-based data ", Should be " : : any type of quality-based data".

(2) Lines 396 " : : On the hand ", Should be " : : On the other hand".

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(3) Lines 466-467 "...Figure 6 b derived directly from the observation", Should be " : :  
:Figure 6 a derived directly from the observation."

Reply: thanks for catching these typos. They are all corrected

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2018.

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