

With this cover letter, we will submit the revised manuscript (acp-2010-399) entitled, “*Relating tropical ocean clouds to moist processes using water vapor isotope measurements*” for publication in Atmospheric Chemistry and Physics. We would like to thank referees for the careful and constructive reviews. Based the comments from the referees, we have made changes of the manuscript, which are detailed below.

### **Reply to the evaluation by the second referee**

This reviewer pointed out two things. We believe these two points are relevant to comments from first reviewer and following his/her minor comments.

**1. Table 1: Is it valid to show the number of lower sensitivity data? (Specifically, BLC and PC data for 850-500 hPa)**

**Answer:** This point is related to our answer to the first referee. Please see our responses and Appendix to the first reviewer above.

**2. Figure 1: What are the multiple lines in the same colors?**

**Answer:** The multiple lines in the same color are multiple profile observations in one TES Run ID (5889) except precipitating clouds (Three Run IDs, 5889, 5918 and 5948 were need to plot multiple profile observations).

**3. Figure 2: Latitude/Longitude information should be added. Is this a snapshot? If so, the date should be specified.**

**Answer:** We add the date in the figure caption. The geographical information was already presented in the original manuscript.

**4. Figure 3: Time information should be specified in the caption. Why COD/CTP and H<sub>2</sub>O/dD have different sampling frequencies? How can the reader know about the cloud types during this time series?**

**Answer:** In Fig. 3, cloud properties (a and b) and water vapor (c and d) have different sampling frequencies because we sampled cloudy conditions for Fig. 3 (a) and (b). We add a sentence in figure caption.

**5. Figure 4: Is it a snapshot? Seasonal mean for a single year? Climatology? Please clarify.**

**Answer:** We mentioned sampling period in *Section 2.2. Isotopic composition of water vapor ( $\delta D$ )*. It is not a snapshot. It is a seasonal mean value (June to August, JJA) from June 2005 to August 2008.

**6. Abstract: It has been told by many that the vapor-dD relationship is controlled by not only Rayleigh process but also other non-Rayleigh processes, but none of them has quantified the significance. Is it still impossible in this study?**

**Answer:** It is a good point. One of the simplest models for atmospheric water vapor isotope is based on the Rayleigh distillation equation. Several processes could potentially change the isotopic composition of water vapor, such as mixing, subsidence and re-evaporation (non-Rayleigh processes) as we described in our manuscript. Quantifying the significance is beyond our scope of the study. However, some studies using remotely sensed data and/or *in-situ* measurements have been used to constrain humidity dynamics of lower troposphere. For example, Worden et al. (2007) quantitatively showed the contribution of rainfall evaporation to lower tropospheric humidity. Galewsky et al. (2007) reproduced the clear-sky free troposphere relative humidity and D/H ratios using a model that accounts for large-scale condensation, fractionation, mixing and transport of water vapor, which Rayleigh distillation model underpredicted.

Galewsky, J., Strong, M., and Sharp, Z. D.: Measurements of water vapor D/H ratios from Mauna Kea, Hawaii, and implications for subtropical humidity dynamics, *Geophys. Res. Lett.*, 34, L22808, doi:10.1029/2007GL031330, 2007.

**7. P17412 top: What is the unit of COD?**

**Answer:** Cloud Optical Depth is unit-less.

**8. P17414 bottom: Why do the ranges of the lines in Fig 1e-h link to the sensitivity? What is the each single line in the figure 1e-h? What is difference between error and sensitivity in this context?**

**Answer:** If there is little sensitivity, there would be no difference between TES *a priori* constraint and an estimate. Each line represents a single observation measured by TES in Fig. 1e-h.

**9. P17415 middle: What is “step-and-stare”? Describe.**

**Answer:** “Step-and Stare” is a TES observation mode in which 60 measurements are made spaced about 35km apart. “Stare” means point at a specific latitude and longitude for up to 210 seconds. “Transect” means a set of exactly contiguous latitudes and longitudes in a line up to 885 km long. We added the definition of “step and stare” in the manuscript. Now it becomes “A TES “step-and-stare”, which is a set of nadir footprint spaced about 35 km apart, was conducted during this same time and the approximate orbit location of this set of observations is shown as a vertical red line over the MODIS imagery.”.

**10. P17416 middle: “less than 0.1” -> No COD data is less than 0.1 in Figure 3.**

**Answer:** Fixed. Now the sentence is “Near  $-3^{\circ}$ , the air is relatively dry, approximately 1 g/kg but also very isotopically depleted underneath high cirrus (cloud-top pressure near 200 hPa, but cloud optical depth less than 1.0).”.

**11. P17419 bottom: “The first distribution is for comparison against...” -> I don’t see any clear sky and non-precipitation cloud distributions in the figure 6.**

**Answer:** The sentence in Page 17419, lines 28 and 29 seems to be confusing such that we have added more information. Now it becomes “The first distribution (850-500hPa) is for comparison against the clear sky and nonprecipitating cloud distributions shown in Fig. 5 and shows that the air above boundary layer clouds is more isotopically depleted than air parcels associated with clear sky and nonprecipitating clouds.”.

**12. P17420: *This explanation is particularly hard to follow. At top, it reads “well explained by local mixing”, but at middle, it reads “due to less frequent mixing”. Which is true? I may misunderstand it, but to avoid such misunderstanding, it’d be better for the authors to make the explanation easier. Using schematic figures is absolutely necessary.***

**Answer:** The TES observations show that the air above boundary layer clouds is constrained by the two theoretical lines. However, compared to the clear and nonprecipitating clouds, the overall isotopic composition of water vapor for boundary layers are more depleted in heavy isotope (Table 1). We tried to explain this isotopic depletion in the sentence in page 17420, line 5. To address the criticism of this reviewer, we reworded the paragraph in Page 17420, lines 3 to 11 to make that clearer. Now the paragraph becomes “We can conclude from either distribution that the TES observations above boundary layer clouds are well constrained by local mixing and Rayleigh condensation.”. Since Steven (2005) described each type of clouds in detail using cartoons, we believe it is not necessary to add a cartoon in this manuscript.

We appreciate the comments from the reviewers. Thank you for reviewing our manuscript.

Sincerely,

Jeonghoon Lee