

***Interactive comment on “Overshooting of clean tropospheric air in the tropical lower stratosphere as seen by the CALIPSO lidar” by J. P. Vernier et al.***

**Anonymous Referee #4**

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**General Comments**

This paper presents temporal and spatial variabilities of aerosols measured by CALIOP lidar in the tropical Upper Troposphere and Lower Stratosphere from 2006 to 2009. The evolution of aerosols includes fast cleansing events between 14–20 km as well as volcanic eruptions and convective events over the Asian monsoon. The aerosol cleansing events are explored in depth in connection with tropical convection and flux calculations in the Tropical Tropopause Layer (TTL). It is noteworthy that the recalibrated aerosol products used in this study (as shown in Vernier et al., 2009) show the details of transport processes in the TTL, which has not been shown from other tracers. And

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the amount of mass flux from the troposphere to the lower stratosphere is significant based on this study. However, apart from all the numbers presented in this study, the large mass flux contribution by overshooting deep convection in the tropics is still puzzling to me. According to Liu and Zipser (2005), only 1% of deep convection reaches as high as 14 km and 0.1% penetrates 380 K isentropic surface. And the cleansing events reach up to 20 km well above the tropopause. The results in this study will be more convincing if the authors can include any evidence of convection reaches up to higher altitudes.

**Specific Comments**

1. The aerosol layers related to the monsoon convection (May–Nov?) are not clearly shown and hard to separate from the volcanic plumes in Fig. 2 (the last paragraph on page 168). It would be helpful to indicate volcanic eruptions and the monsoon events as separate symbols. Or if the monsoon convective events are annually repeated, the annual cycle can be extracted from the variability.
2. In Fig. 2, CALIOP SR has the minimum at 400–440 K layer in early 2008. If this clean air is originated from the troposphere, the minimum should be located at lower levels? Also the maxima in the summers of 2008 and 2009 are located at the same layer (400–440 K).
3. 1st sentence on Page 170 – The reason for 2 months' averaging is not clear to me. The authors used 16-day average in the previous figures and the effect of QBO in the zonal asymmetry should be small at this altitude.
4. It is shown in Liu & Zipser (2005) that tropical convection has prominent semiannual cycle with maximum intensities in spring of both hemispheres (Apr and Sep). It is hard to reconcile this with convective time series in Fig. 5.
5. In section 4.2, the unit of the flux is shown as kg/s instead of kg/m<sup>2</sup>/s (Yang et al., 2008). And Yang et al. (2008) have shown fluxes in layers not every 1-km level as

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shown in Table 1. I am wondering about how the comparisons in Table 1 are made.

#### Technical Comments

1. Page 170, line 16 – Mote et al. (2008) should be Mote et al. (1998).
2. Page 171, line 16 – times series should be time series
3. Using different color scales in Fig. 4 and increasing the size of the figure might help to follow the events details.
4. The lines in Figure 5 would be more recognizable if the legend is put outside of the frame.
5. Page 172, line 18 – WV water vapor (WV) should be water vapor?
6. Overlaying PDF of the TRMM OPFs on top of the white dots (or replace them) in Fig. 6 will help to quantify the convective activities.
7. Page 173, line 17 – 14-17 km?
8. Page 175, line 5 – Halogen Occultation Experiment
9. Page 175, line 29 – Numerical Weather Prediction (NWP) models
10. Page 176, line 10 – by radiative heating

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