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Atmospheric Chemistry and Physics Discussions

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8, S617–S620, 2008

Interactive Comment

Interactive comment on "Correlation between equatorial Kelvin waves and the occurrence of extremely thin ice clouds at the tropical tropopause" *by* F. Immler et al.

Anonymous Referee #2

Received and published: 7 March 2008

[Note: This comment replaces an early version that has been submitted by mistake. My apologies!]

General comments

The manuscript contains an analysis of tropical cirrus cloud observations, relating them to equatorial Kelvin waves. The authors present a relevant, novel study. However, the conclusions should be improved upon. I suggest publishing the paper after consideration of the comments below.

Specific comments

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Interactive Discussion

Discussion Paper

1. Main concern

   The authors present valuable new observations, but miss the opportunity to draw one of the most substantial conclusion (p.2855, 1-14). Specifically, I would like to propose an extended interpretation of the upper cloud in Figure 4b, and the corresponding trajectories in Fig. 4c (red lines):

   The red back trajectory in Fig. 4c shows a steep increase in potential temperature up to 365 K (at < -7 days), possibly related to convective activity, and subsequently rising potential temperatures with a rate of about 1 K potential temperature per day. The authors attempt to explain this rate by clear air radiative heating due to the cold anomaly of up to -8 K. Because of the long relaxation time scale in the tropical upper troposphere however [Hartmann et al 2001], a temperature difference of -8 K translates only into a heating rate of about +0.5 K potential temperature per day. Moreover, it is very unlikely that the air parcel has stayed in such a negative temperature anomaly for several days and I don't think that the authors claim that.

   The rising potential temperatures can therefore not be explained by radiative heating, unless one brings cirrus clouds into play. The crucial point is: A cold temperature anomaly induces a cirrus cloud, leading to substantial radiative heating [cp. Corti et al. 2006], leading to lofting of the cloud, fostering the cloud persistence due to adiabatic cooling. I strongly recommend including a discussion on "cloud lofting" [Lilly 1988, Ackerman et al. 1988]. The chances are high that the present study is the first observational evidence for cloud lofting.

2. dehydration pump (p.2851, 27-29)

   The authors seem to claim that cirrus clouds dry the lowermost tropical stratosphere. The observations however give no evidence for substantial dehydration above the (cold point) tropopause. Rather, dehydration seems to be restricted to the troposphere.

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3. cloud range (p. 2854, 11)

   How is the cloud range determined? From a cloud mask based on backscatter ratio? The authors should clarify this.

4. Variability Figure 3.

   It might be a good idea to show percentiles (25/75 or 5/95) instead of standard deviations here, as the distribution in temperature anomalies may be substantially skewed.

Technical corrections

- - p2850, 23: evapouration > evaporation
- - p2852, 16: informations > information (no plural)
- - p2854, 2: levelas > levels
- - p2855, 3: Fig. 4 (right) > Fig. 4c
- - p2855, 21: obseravtions > observations
- - Fig. 1b: Please consider replacing the black color for indicating temperature anomalies above 6 K as it encumbers spotting the black symbols.
- - Fig. 4c: Units are missing (T and theta)
- - Fig. 4, caption: Replace ”Left”, ”Middle”, ”Right’ by ”(a)”, ”(b)”, ”(c)”
- - Fig. 4c, figure caption: Magenta lines are not discussed

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References:

Ackerman, T. P., K. N. Liou, F. P. J. Valero, and L. Pfister, 1988: Heating Rates in Tropical Anvils. Journal of the Atmospheric Sciences, 45, 1606-1623.

Corti, T., B. P. Luo, Q. Fu, H. Vomel, and T. Peter, 2006: The impact of cirrus clouds on tropical troposphere-to-stratosphere transport. Atmospheric Chemistry and Physics, 6, 2539-2547.

Hartmann, D. L., J. R. Holton, and Q. Fu, 2001: The heat balance of the tropical tropopause, cirrus, and stratospheric dehydration. Geophysical Research Letters, 28, 1969-1972.

Lilly, D. K., 1988: Cirrus Outflow Dynamics. Journal of the Atmospheric Sciences, 45, 1594-1605.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 2849, 2008.

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