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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cirrus cloud-temperature interactions in the tropical tropopause layer: a case study" *by* J. R. Taylor et al.

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General Comment

The authors examine Calipso lidar data and Cosmic temperature data to investigate the factors responsible for the multi-day presence of a very large area of thin cirrus cloud in the TTL above the eastern Pacific. The event and its documentation provide a unique contribution toward our understanding of thin cirrus. The paper would be suitable for publication in ACP after minor revisions.

Specific Comments

1) One major concern of the authors, that "the temperature observations do not show any indication of the expected infrared heating" appears to be misplaced. The 2D

simulations of the response to a fixed heat source similar in shape to thin cirrus in Durran et al. 2008 show that only a small part of the potential heating is actually realized as a temperature rise. In the case shown in Fig. 3b of that paper, a fixed heat source of 3 K/day produces a temperature rise of less than 1.5 K in 24 hours and that temperature rise asymptotes to only 1.85 K at infinite time.

Moreover, the 2D geometry greatly overestimates the ultimate (although not the initial) temperature rise, which in 3D is zero and therefore in perfect agreement with the authors' results. The only reference I know for this is Bretherton and Smolarkiewicz (1989), see the paragraph into which eqns (9)-(11) are embedded.

2) p. 5, 2nd paragraph: while convection can certainly lead to vertical motion, it is hard to see how such convection would sustain a cloud of this very large horizontal scale. On the other hand, heating in a stratified fluid can produce updrafts on the scale of the entire cloud and, unlike buoyant convection, this mechanism does not require weak static stability. The authors discuss Dinh et al, 2010, and I find Fig. 7 of that paper to be surprisingly similar to Fig. 4 in this manuscript. The Dinh case is certainly idealized, but not unreasonably far from scenarios considered in this paper (r= 3 microns, N=1.3 cmˆ(-3), cloud depth 500 m in Dinh, whereas r=5.6 microns, N=1 cmˆ(-3), with the same 500 m cloud depth in last case in Table 2.) Perhaps this event is an example of IR/gravity-wave-driven ascent of very small ice crystals?

3) p. 4, 2nd full paragraph: The temperature anomaly in Fig. 7 features cold over warm, which would correspond to a anticyclonic PV anomaly. However, if this is an intrusion that has been isentropically advected into the tropics from the subtropics, one would expect the PV anomaly to be cyclonic.

4) p. 3, first paragraph, righthand column: I'm not sure exactly what the authors intend to say, but "Figure 2 does not show evidence of coherent small-scale spatial structure (e.g., wave-like activity) embedded within the 3000 km cirrus cloud)" does not seem to allow for what appear to be a pair of 500-km wavelength waves centered around

tic-mark label 3000.

References

Bretherton, C. S. and P. K. Smolarkiewicz. Gravity waves, compensating subsidence and detrainment around cumulus clouds. J. Atmos. Sci., 46(6):740–759, 1989.

Dinh, P.-T, D.R. Durran and T. Ackerman, 2010: The maintenance of tropical tropopause layer cirrus. J. Geophys. Res., 115, D02104, doi:10.1029/2009JD012735. (already included in manuscript)

Durran, D.R., P.-T. Dinh, M. Ammerman, and T. Ackerman, 2009: The mesoscale dynamics of thin tropical tropopause cirrus. J. Atmos. Sci., 66, 2859-2873. (already included in manuscript)

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 15745, 2011.

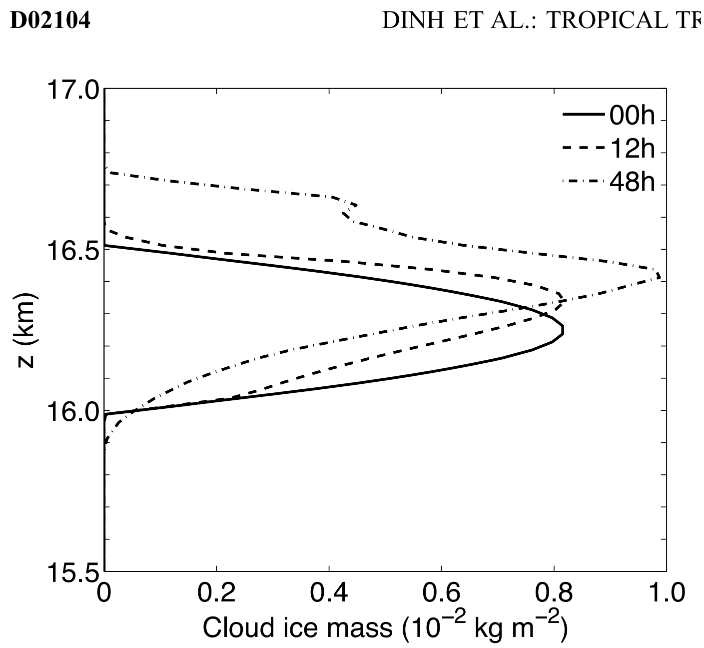

Figure 7. Vertical profiles of the horizontally integrated cloud ice mass at t = 0, 12 h, and 48 h.

Fig. 1. ascent of simulated ice mass