Atmos. Chem. Phys. Discuss., 8, S765–S767, 2008
www.atmos-chem-phys-discuss.net/8/S765/2008/

Atmospheric Chemistry and Physics Discussions

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 #3

Received and published: 15 March 2008

General Comment:

This paper presents a new result, clearly demonstrating observationally that temperature fluctuations affect the formation of subvisible cirrus clouds at and above the tropopause. It is not a surprising result given what we have learned from the Nauru radar papers (Boehme, Comstock, Holton), but it is important(especially given the ambiguity in the stratospheric results from those papers).

I am surprised that the authors make no attempt to prove that the observed fluctuations are indeed Kelvin waves (other than to refer to previous work). This is an important omission, and ought to be remedied. I believe that they are Kelvin waves, given the

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

short wavelengths and westerly QBO phase. Still, since these observations are off the equator (where Rossby-Gravity waves may have nonzero amplitude), demonstrating the Kelvin wave character by examining the relationship with the zonal wind fluctuation (and noting the absence of meridional wind fluctuations at these time scales) is important. The short record (as compared to the period of the wave) makes for weak statistics. Showing that the dynamics of the wave (e.g., relationship of temperature to wind amplitudes, dispersion relationships etc) checks out is an important additional test.

Specific Comments:

Lines 6-8, page 2855: The radiative heating is based on the ECMWF model output, not the radiosonde data. To assert that the wave is causing the increase in potential temperature requires a demonstration that the model is, indeed, capturing the wave. This has not been done. The ACLIT case suggests that the model might indeed do this (though there is no radiosonde comparison for this case).

Lines 11-13, page 2855: The statement that "the temperature anomaly of almost 8K (left, green line) was brought about by the joint action of the Kelvin wave and the radiatively driven ascent" is wrong. The cold temperature anomaly is caused by the Kelvin wave and other dynamical fluctuations. Radiation acts to reduce the magnitude of that anomaly, not increase it.

Looking at a column of the atmosphere from an Eulerian perspective, if a portion of the column is radiatively heated, the response will either be upward vertical motion, an increase in temperature, or (most likely) some combination of the two. This follows simply from the thermodynamic equation (where horizontal advection and diffusion terms are neglected). A temperature decrease can only occur in the presence of some other external dynamical forcing (like the wave itself, but NOT from the radiative heating).

From a Langrangian perspective, an individual parcel may well experience enhanced ascent in the presence of radiative heating; and, if this ascent occurs in a region of

ACPD
8, S765–S767, 2008

negative vertical temperature gradient, the cooling of the individual parcel may be more rapid than it otherwise would have been (if the temperature of the column does not increase due to heating). I think that this is what the authors are trying to say.

On this matter, examining the Ackerman et al and Lilly papers (as the other referee has recommended) would be useful.

Figure 4: It would be appropriate to indicate with arrows which altitudes in 4a and 4b the red and pink lines in 4c refer to.

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

ACPD

8, S765–S767, 2008

Interactive Comment