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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ultrathin Tropical Tropopause Clouds (UTTCs): I. Cloud morphology and occurrence" *by* Th. Peter et al.

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General Evaluation:

This well written paper introduces a new and fascinating phenomenon that is apparently relevant to the dehydration of the stratosphere: namely ultrathin cirrus clouds (UTTCs) near the tropical tropopause. The first part, which is the subject of this review, describes the observational evidence characterizing the UTTCs as obtained in an airborne field program. The second part (to be evaluated separately by another reviewer) describes a plausible mechanism to explain the occurrence of such clouds. It is strongly recommended that the two parts be read as a unit since they are highly interdependent.

The authors are to be congratulated on an excellent experimental design, which en-

abled them to locate and define the physical characteristics of the UTTCs. Although it seems clear that these clouds must play only a minor role in the overall dehydration of air entering the stratosphere, their possible role in explaining the final few tenths of a ppm of dehydration may well be the key to understanding why the stratospheric humidity appears to be less than that given by ice saturation at the mean tropical tropopause temperature. An understanding of these UTTCs, may also offer clues in our continuing efforts to understand the role of the more commonly observed thicker subvisible cirrus that appear to be major players in the dehydration process.

Specific Comments:

1. The introduction refers to various previous works concerning the role of cirrus in dehydration. An additional reference not mentioned is the following:

Holton, J. R. and A. Gettelman, Horizontal transport and the dehydration of the stratosphere, Geophys. Res. Letts., 28, 2799-2802, 2001.

A major point of the above reference d paper is that horizontal velocities are typically orders of magnitude greater than vertical velocities near the tropical tropopause so that horizontal advection through "cold pools" near the tropopause must be considered in any discussion of dehydration. This seems consistent with the UTTCs discussed by Peter et al. since the enhanced vertical motions that they require to explain the stabilization of the UTTCs are most likely associated with inertia-gravity waves of short vertical and long horizontal scale (and hence large horizontal and weak vertical velocities).

2. On page 1565, line 11, The "oversampling" by the FISH is stated quite casually, and not really explained. One is left wondering why we should believe results that must be corrected by a factor of five. The multiple checks on water content of the UTTCs, are however a nice aspect, and make the final results more convincing.

3. Instrumentation: It would be useful to include a table summarizing the instrumenta-

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tion for the Geophysica. Some of the instruments (e. g. OLEX and MAS) appear to be only mentioned in the text by their acronyms. A more descriptive summary would help those of us who are not airborne experimenters.

4. Linkage of this paper with part II:

In the second part a 1-d particle model is reported that appears to provide a good explanation for the existence and duration of the observed UTTCs, but the justification for the vertical velocity profile is based on reference to the ECMWF analysis relevant to the flight of 27 February, 1999, while most of the discussion in diagrams of part 1 refer to the flight of 24 February, 1999. It would be better to use the same day so that readers could make a direct comparison. One is left wondering whether the ECMWF analysis for 24 February perhaps does not support the model hypothesis so well.

In part II, page 1581, line22 we read "... slow radiatively driven cooling and upwelling". It is now generally accepted that radiation doesn't "drive" the upwelling near the tropical tropopause. Rather this is driven remotely from the stratosphere by dynamical forcing which pulls the air parcels upward, and thus cools the air below its radiative equilibrium temperature, hence leading to radiative heating that raises the potential temperature for the parcels so that the upward drift is irreversible. Please see the review cited below for details:

Holton, J. R., P. H. Haynes, M. E. McIntyre, A. R. Douglass, R. B. Rood and L. Pfister, Stratosphere-troposphere exchange, Reviews of Geophysics, 33, 403-439, 1995.

Minor Comments:

1. In the legends for Figs. 4 and 5 it would be useful to state which curves refer to the left hand and right hand ordinate scales, respectively.

2. page 1561, line 1 "allows to detect" is not grammatically correct. Reword as either "allows us to detect" or "allows the detection of".

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Interactive comment on Atmos. Chem. Phys. Discuss., 3, 1557, 2003.