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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Is there a stratospheric fountain?" *by* J.-P. Pommereau and G. Held

Anonymous Referee #3

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Review of "Is there a stratospheric Fountain?" by Pommereau and Held

This manuscript uses radiosonde temperatures over Brazil with information on clouds from a radar to discuss deep convection and the entry of air into the stratosphere. The paper is interesting, but some of the conclusions are not well supported. The grammar needs significant improvement in many places. The paper needs major revisions if it is to be publishable in ACP.

In general, I think that the analysis and data is new and appropriate for ACP. There should be a bit more discussion of the actual location of the radar observations relative to tropopause temperatures. How far apart in space and time are they? It would also be good to show some PDFs of cloud top height, perhaps as a function of local time.

I do not think that the discussion of irreversible mixing however is useful or appropriate, and is not well justified in the current manuscript. It is simply done as a reductive

process: it cannot be anything else, therefore it is irreversible mixing. More caveats need to be placed on it, in the absence of presenting any in-situ observations.

In particular, the gravity wave analysis is a bit cursory based on profiles which are fairly widely spaced in time. I am interested in how an upper tropospheric heating of 1C (mean) up to 4C (max in Fig 2) would be manifested at higher altitudes (requiring a cooling for hydrostatic balance) and if this process might also contribute rather than mixing. Gravity waves are only analyzed by variations in the profiles for certain vertical wavelengths.

The role of large scale waves should also be discussed: Note that in Figure 1 there is evidence of downward propagating temperature anomalies, which are very similar to those noted by Boehm & Verlinde (2000) and Fujiwara et al (2003) for Kelvin waves: but this is too far from the equator to be Kelvin waves. Perhaps these are sub-tropical Rossby waves which modify the temperatures near the tropopause.

I think some serious clarification of the conclusions is in order. There is some very interesting analysis here with the frequency of deep convection, as well as the discussion of in-situ data from TROCCINOX (which could be made more specific, but is done so in the referenced papers).

The biggest problem of interpretation is that the papers by Danielsen and Sherwood are basically focused on tropical convection as a dehydration mechanism. However, the TROCCINOX data show hydration resulting from this convection. Recall that this sub-tropical data (22S) shows tropopause temperatures of -73C (200K) in non-convective conditions, with cooling to -81C (192K) associated with convection. Even at 192Ke the saturation vapor mixing ratio is close to 5ppmv. And then there is any lofted ice. Since the tropical entry mixing ratio of water vapor is something like 2-4ppmv depending on region in January-March, this convection is hydrating the stratosphere. It should be clarified that this refers to a convective hydration mechanism for the stratosphere (backed up by tracer mechanisms from TROCCINOX), not the dehydration postulated

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by Danielsen and Sherwood. That clarification of the conclusions would be a useful contribution from this work.

Also, the statements in the abstract and conclusions that deep convective penetration above the tropopause is 'widespread' based on a few events sampled in a region and season specifically selected for convection is misleading (This is on p8934, L25 of the abstract).

This entire paragraph in the abstract is repeated from the conclusions: this is not really appropriate and it should be excerpted in the abstract.

Specific comments: The introduction in particular has several grammar mistakes which make it difficult to read. P8936, L22: 'TRMM' is missing the 'T'.

There are other grammar mistakes I have not commented on

P8937, L22-24: Why is the difference in altitude between 340-370K a measure of convective intensity? This is an interesting point, but needs more explanation.

P8942, L9: It would be interesting and useful to show a PDF of cloud counts

References:

M. T. Boehm and J. Verlinde. Stratospheric influence on upper tropospheric tropical cirrus. Geophys. Res. Lett., 27(19):3209-3212, 2000

M. Fujiwara, M. K. Yamamoto, H. Hashiguchi, T. Horinouchi, and S. Fukao. Turbulence at the tropopause due to breaking Kelvin waves observed by the Equatorial Atmosphere Radar. Geophys. Res. Lett., 30(4), 2003. 1171.

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