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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 #2

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This paper addresses a question of interest to the community, and it utilizes a new data set. However, this paper has several major problems that need to be solved before it is publishable.

First, I cannot follow the scientific argument being made in this paper. I think the key argument in the paper can be found in the discussion on page 8941 — where they argue that the cooling above convection cannot be explained by adiabatic lifting, and irreversible mixing must be invoked. I have read this section many, many times, and I simply cannot follow the logic of their argument. Thus, it is impossible for me to evaluate the main scientific claims in this paper. That said, I find the conclusion of the reversible mixing above the tropopause to be reasonable.

Overall, I find this paper to be poorly written. Many of the arguments the authors make are extremely difficult to follow. If I had not been reviewing this paper and therefore

required to read it, I would've quickly given up and moved on to the next paper. Owing to the subtlety of many of the arguments, good writing for this paper is absolutely necessary. I recommend the authors spend quite a bit of time tightening up the prose.

Second, the paper overreaches in its conclusions. The authors have about one month of data from Brazil. From this, they extrapolate that convective overshoots are common features of all continental convection at all times. In my opinion, it is impossible to make that conclusion based on such a limited data set.

Third, the impression given in this paper is that everyone dismisses convection being important for mass transport in the TTL, and in this paper the authors show that it is indeed important. I believe this is a mischaracterization. Most of the scientists studying the TTL would agree that deep convection does, at least some times, transport mass throughout the TTL. The real question is how important such transport is compared to slow ascent. Some would argue that it's not very important, while others would argue that it is very important. This paper only shows that deep convective transport through the TTL is occurring — it does not help us resolve the fundamental question about the importance of convective versus slow ascent. I suppose additional evidence demonstrating irreversible transport by convection high into the TTL is publishable, but overall this is an extremely minor contribution to TTL science.

Fourth, the authors claim in the abstract that their analysis can explain the chemical, moisture, and thermal properties of the stratosphere. This is again an overreach. All they've shown is that some mass is irreversibly mixed into the stratosphere by convection. They show in no way that this can explain the chemical composition of the lower stratosphere, in particular water vapor.

Overall, it seems to me that the authors think this paper is a lot more significant than I do. If the authors continue to believe this is groundbreaking work, then they need to rewrite the paper to clearly articulate what's new and how this work advances our knowledge. This requires a far better and sharper discussion of how this work fits into

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our present view of TTL science.

A few other comments: I agree with another reviewer that categorizing this work in terms of Newell and Gould-Stewart's stratospheric fountain is a mistake. That concept is past its prime and should be allowed to die with dignity. The better way to characterize the debate is between fast ascent and slow ascent in the TTL.

Most, perhaps all, of the figures in this paper could be black and white. I recommend the authors modify the figures to remove color in as many figures as possible. That way, readers do not have to seek out color printers in order to print out the paper.

I might also recommend a few additional references: Holloway, C.E., and J.D. Neelin (2007), The convective cold top and quasi equilibrium, J. Atmos. Sci., 64, 1467-1487. This paper makes a strong case that the cooling above convection is adiabatic. Dessler, A.E., S.P. Palm, and J.D. Spinhirne (2006), Tropical cloud-top height distributions revealed by the Ice, Cloud, and Land Elevation Satellite (ICESat)/Geoscience Laser Altimeter System (GLAS), J. Geophys. Res., 111, D12215, DOI: 10.1029/2005JD006705. This paper shows that clouds go quite high quite frequently. Rossow, W.B., and C. Pearl (2007), 22-Year survey of tropical convection penetrating into the lower stratosphere, Geophys. Res. Lett., 34, L04803, DOI: 10.1029/2006GL028635. Another paper demonstrating the great frequency of deep convection.

If convection is indeed mixing cold air into the TTL, then wouldn't that be driving diabatic descent? This is what Sherwood argued, that there was a drain rather than a fountain above convective regions. The authors seem to be implicitly rejecting this argument, but provide no reason why. This needs to be explicitly discussed.

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