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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Variability in upwelling across the tropical tropopause and correlations with tracers in the lower stratosphere" *by* M. Abalos et al.

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We thank the Anonymous Referee #1 for the careful reading of the manuscript and the valuable comments. We answer to each point below.

Minor Comments:

"I would like the authors to speculate on the reasons why ozone appears to require a meridional eddy mixing source, but CO does not. Presumably, if it exists for one, it would exist for the other, unless there is something about the meridional gradients of the two species that makes the transports substantially different. Ploeger (2012) has some discussion of this."

The magnitude and seasonality of the eddy mixing term is actually a very interesting issue, and we agree that we can speculate on the reason why the effect of horizontal in-mixing should be smaller for CO than for ozone. One possible reason, as the referee suggests, could be the smaller relative meridional gradients in this variable (as pointed out in Ploeger et al. 2012). We have included this in the revised version of the manuscript on page 18830, line 16.

"page 18829, line lines 7-10: The authors state: "The presence of a significant residual in these calculations is consistent with the importance of eddy transport into the tropics (in-mixing) for the ozone budget, as suggested previously by Avallone and Prather (1996) using a one-dimensional 1D model, ..". In my reading of the Avallone paper, they did not require an additional ozone source to explain the mean vertical profile (of ozone). E.g. a sentence in the discussions says: "Thus we conclude like Kinne el al. [1992], that primary production of O3, through reaction (1) alone, can explain the observed vertical distribution over this scale height." They did need mixing for other gases, but not for ozone."

One key point of the cited paper is that, while the CO-O3 tracer correlation can be explained only by photochemistry and vertical transport, the combination of CO-O3 and O3-NOy relations can only be explained if there is an in-mixing of air from the extratropics into the tropics. In the Discussion the authors say: “It does not seem possible to generate the observed O3-NOy and O3-NO2 relationships with known photochemistry”, and then “The most compelling explanation of the tropical data is the inclusion of NO2-rich (N2O-poor) air from mid-latitudes”. Thus, it is true that the authors do not specifically require in-mixing of ozone into the tropics, but only claim more generally the need of including “a small amount of mixing of much older photochemically aged air from the midlatitude stratosphere into this tropical plume”. Consequently, we have removed the reference from the manuscript.

"Figure 8: explain the reasons for the jumps in the power spectra around 120 days and 180 days."

ACPD

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This is just an effect of the 11-points running mean that has been applied to the spectra, averaging over a number of points gives “jumps” at different frequencies. The smoothing is necessary in this figure given the wide range of timescales included. We tried to minimize these effects by plotting the x-axis on a log-frequency scale, but still some inevitable issues at the extremes of the spectrum. However, the purpose of Figure 8 is just to highlight the behavior at very fast timescales and justify the high-frequency cut-off (<6 days), and we believe it is not relevant to describe the spectrum in detail in the manuscript.

"page 18828, line 10: should also mention longwave forcing of ozone near the tropical tropopause (not just CO2)."

We agree and we will add it.

Technical Comments:

"They are various places where the authors use "associated to" rather than "associated with", which would be more appropriate."

We agree and we will change it.

"page 18834, line 19: "accuracy" would be better than "reality""

We also agree and will change it.

References

Avallone, L. M. and Prather, M. J.: Photochemical evolution of ozone in the lower tropical stratosphere, J. Geophys. Res., 101, 1457–1461, 1996. Ploeger, F., Konopka, P., Müller, R., Fueglistaler, S., Schmidt, T., Manners, J. C., Grooß, J.-U., Günther, G., Forster, P. M. and Riese, M.: Horizontal transport affecting trace gas seasonality in the Tropical Tropopause Layer (TTL), J. Geophys. Res., 117, D09303, doi:10.1029/2011JD017267, 2012.