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Interactive comment on “Probability density functions of long-lived tracer observations from satellite in the subtropical barrier region: data intercomparison” by E. Palazzi et al.

Anonymous Referee #2

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This manuscript calculates PDFs from four satellite long-lived tracer datasets (N₂O from Aura/MLS, ENVISAT/MIPAS, and Odin/SMR, and CH₄ from UARS/HALOE) to identify regions of strong and weak mixing in the stratosphere and, specifically, to investigate the subtropical transport barrier. The authors have performed a comprehensive and careful analysis, and overall they have provided a clear and convincing description of it in this manuscript. I recommend publication of this work, after a few relatively minor points, detailed below, are addressed.

Note: The paper is well-written, with concepts clearly expressed. However, while the English is generally good, the manuscript is in need of extensive copyediting to improve

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the grammar and fix minor wording problems.

Substantive points:

– p18388, L10-20: A recent paper by Shuckburgh et al. [JAS 2009] that used Lyapunov diffusivity to investigate seasonal and interannual variability in mixing should also be cited in this discussion.

– p18395–18397: The various species measured by HALOE and SMR are listed, whereas for MLS and MIPAS only N₂O is mentioned. This could give the misleading impression that the latter two instruments measure only N₂O.

– Figure 2: Rather than starting in DJF for both hemispheres, it might facilitate comparisons to arrange the panels such that comparable seasons are lined up (i.e., start the bottom row with JJA). Also, "annual mean" → "multiannual mean". It should be made more clear in the figure caption (not just in the main text) that these are averages over all of the years of measurements available from each sensor.

– p18405-18406: I have a number of comments on these pages. (1) "The first impression is that there is a quite good agreement among the four sensors, especially in the Southern Hemisphere, since the satellite-to-satellite comparisons generally have many matches." I do not think that "have many matches" is quite the right wording; I believe what the authors mean to say is "agree well" or "show little scatter" or some similar phrase. (2) The authors go on to list some specific instances of disagreement, but I think that a more general statement could also be made that their analysis does not indicate consistent offsets between the various instruments in different seasons, years, hemispheres, or altitudes. (3) In Table 2, does it make sense that the differences MLS-MIP and MLS-SMR are both 0.9 (-1.1) in the NH (SH), but that the absolute values of the MIP-SMR differences are larger [-1.2 (0.9) in the NH (SH)]? (4) Since Figure 4 showed that the behavior was quite different at different potential temperatures and in different seasons, is it really meaningful to quantify the offsets in the subtropical barrier latitude between sensor pairs by grouping together data from all altitudes during

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each pair's entire overlap period? (5) Since the text discusses MLS-HAL, MIP-HAL, and SMR-HAL and notes that "the subtropical barrier latitude calculated from HALOE is always greater than that calculated from MLS, MIPAS and SMR", it might be better to show SMR-HAL in Table 2, rather than HAL-SMR. Moreover, this statement does not appear to be true for MLS-HAL in the SH (-0.3), assuming that "greater" means higher in latitude, i.e., more poleward, and not larger in absolute value. (6) MLS-HAL is characterized as "good agreement", yet the difference in the NH is nearly 3 deg (with std dev of 4.7 deg), which is only slightly better than the values for MIP-HAL or HAL-SMR.

– Figure 4: It might be better not to clip the edges of these plots, so that the results for SON 2005 can be more easily seen. The vertical dashed line should also be defined in the caption, not only in the main text. What are the horizontal grey lines – they are not explained in either the text or the caption?

– p18406 and Figures 6 and 6b: "The subtropical barrier position on average ranges from about 10N to about 40N (30N) in the NH (SH)". From what I can tell looking at these plots, values reaching as low as 10N are rare, and those reaching as high as 40N are nonexistent. What do the error bars in Fig. 6 illustrate – standard deviations, or min/max range, or ?? The grey lines, which do not appear to be the same as those in Fig. 4, should be described in the caption. Finally, it seems to me that Fig. 6b (another multi-panel figure, as is Fig. 6) would be more appropriately labelled Fig. 7, and all subsequent figures renumbered accordingly.

– p18408, L15-17: "Results shown in Fig. 7 (600 K) are also consistent with tracer fields shown in Fig. 1." It's difficult for the reader to quantitatively judge this statement, because of the lack of minor tick marks on the y-axis in Fig. 1, but to me it appears that the equatorward shift is bigger in Fig. 1 than it is in Fig. 7. In addition, it might make it easier to interpret the changes evident in Fig. 1 if the phase of the QBO could somehow be indicated on this figure.

– p18409, L5-12: First, the notion that different results are obtained for HALOE than

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for the other datasets because of its longer measurement period could be tested by repeating the HALOE analyses over a comparable (i.e., shorter) interval and seeing if the ensuing differences from the original HALOE results are in line with the inter-instrument differences. Second, is there any reason to expect inherent differences in the subtropical barrier behavior in the two time periods sampled by HALOE and the other instruments (1990s vs 2000s), as suggested in these lines? That is, have any previous studies proposed any mechanisms to cause such variations or trends (e.g., impact of climate change on QBO behavior, etc)? Perhaps small differences in the magnitude of the changes diagnosed from N₂O and CH₄ might be expected because of their slightly different vertical and horizontal gradients? In any case, I think that more discussion of these points is warranted.

– Figure 7: Since these are multiannual means (not "interannual means"), why are points for some instruments missing (e.g., only SMR data in the SH at 900 K, no HALOE data during QBO-E in SH at 830 K; many MIPAS points also missing)?

Some minor wording issues:

- p18386, L13: "barrier-to-transport regions" (i.e., add hyphens)
- p18389, L28: "Rossby-wave activity is prevented *from propagating ??* into the tropics"
- p18400, L17: "interannual average" → "multiannual average"
- p18401, L15: "interannual mean" → "multiannual mean"
- p18402, L10-11: "biased ... to each other" → "biased ... relative to each other"
- p18404, L11: "in the NH" → "in the NH during JJA"
- p18404, L16: "barrier" → "subtropical barrier"
- p18404, L24: "black shaded line" → "black dashed line"

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- p18404, L25-26: delete "exemplary" – it is not the right word
- p18405, L24: "resumes" is not the right word. "present" or "shows"
- p18405, L23: as above for "resumed"
- p18406, L25-26: I don't think that the wording "also averaged over the various QBO phases" is completely clear. I think what is meant is that the multiannual mean necessarily encompasses different QBO phases.
- p18407, L5: "We have plotted" → "In Fig. 6b, we have plotted"
- p18411, L18: delete "exemplary" – it is not the right word
- p18414, L2: "CCMs" should probably be defined (spelled out)
- p18427, Fig. 5: "filled" → "solid". Also, the x-axis labels on these plots should be fixed so that they do not overlap.
- p18431, Fig. 8: "QBO westerly (easterly)" → "QBO westerly (easterly) phase". Also "filled" → "solid".

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