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Atmospheric Chemistry and Physics
Discussions

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Interactive comment

Interactive comment on “Spatial and Temporal Variability of Interhemispheric Transport Times” *by* Xiaokang Wu et al.

Anonymous Referee #2

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In this study, the authors analyze the seasonal and interannual variability of transport times from northern hemisphere midlatitudes to the southern hemisphere for 3 different idealized age tracers emitted over North Hemisphere midlatitudes (one for mean age, and two decay tracers with 5- and 50-day decay times). The authors relate seasonal variability to (largely) to the seasonal migration of the ITCZ and interannual variability (largely) to ENSO, but point out some differences among the tracers. For example, the authors note that the largest variability for the mean age tracer is close to the location of the ITCZ, while the decay tracers have peak variability south of the ITCZ.

Overall, the results of the study are broadly consistent with findings of previous work regarding seasonal and interannual variability of tracer transport, and the explanations are qualitatively plausible. I do think, however, that the study could benefit from more

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detailed discussion of the interplay of tracer transport and dynamics and convection.

For the discussion of interannual variability (ENSO) in particular, the authors could do much more. For example, prior work on the SPCZ-ENSO relationship points to the axis of the SPCZ "diagonal" shifting generally northeastward during El Niño and southwestward during La Niña (see, for example, Vincent et al. 2011; reference appended below). The authors may want to consider placing their results in the context of such spatial displacements of the SPCZ. More generally, I wonder about the relative role of changes in intensity of convection are relative to changes in its location (as discussed in a two-box model interhemispheric exchange time in Lintner et al. 2004)?

It may also be worth noting that the 1997-1998 El Niño event represented what Cai et al. (2012) have described as a "zonal SPCZ" event, with the SPCZ and eastern Pacific ITCZ effectively merging into a single convection zone near the equator. During other El Niño years, the SPCZ does not experience such an extreme response to ENSO forcing. (Whether zonal SPCZs occur appears to be tied to the flavor of ENSO forcing, as these events are more common during so-called "eastern Pacific El Niños" relative to "central Pacific El Niños".)

Given the consideration of 5-day and 50-day loss tracers, it also seems that performing some analysis with respect to intraseasonal variability, especially the Madden Julian Oscillation (MJO), could be of value.

Other Comments P1, L1: "a ideal age"→"an ideal age"

P1, L18: subject/verb agreement: "majority…have used". Suggest changing "The majority of previous studies" to "Most previous studies"

P1, L21: "into single parameter"→"into a single parameter"

P1, L22: "model-data"→"model-observation"

P2, L11: "from NH surface"→"from the NH surface"

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P2, L13: It may be helpful to include a brief description of the TTD, for readers who may not be familiar with what this is.

P4, L1: “time T is much larger”→”time T much larger”

P5, L4: subject/verb agreement: “spatial distribution. . .are”→”spatial distribution. . .is”

P5, Last Paragraph: I think it would be worthwhile to develop a bit more in the way of mechanistic explanation for the zonal variations of age in the tropics. For example, for the relatively high values over the northern Indian Ocean in summer, presumably this is related to the South Asian monsoon, which (relative to winter) has the “ITCZ” located far to the north and relatively strong cross-equatorial flow, particularly over the western portion of the Indian Ocean (with the Findlater/Somali jet). This does seem to be touched on later.

P6, L23-24: The part of the sentence “see surface winds. . .” should probably be enclosed with parentheses.

P7, L1: “round”→”around”

P7, L1: I suggest replacing “where” with “while”

P7, L2: remove “moderate to”

P7, L21: what exactly does “more compact” mean here?

P8, L17: “with both occurring either side”→”with both occurring on either side”

P8, L29: subject/verb agreement: “precipitation. . .that extend. . .”→” precipitation. . .that extends. . .”

P9, L9: “in northern tropical”→”in the northern tropical”

P9, L12: “during El Niño year”→”during El Niño years”

P9, L20: “correlations either side”→”correlations on either side”

P9, L23: subject/verb agreement: “characteristics . . .is. . .”→”characteristics. . .are. . .”

P10, L28: “with more strongly influenced by the trail of the TTD”→”which is more strongly influenced by the tail of the TTD”

P11, L3: subject/verb agreement: “variability. . .suggest. . .”→”variability. . .suggests. . .”

Figure 1: The use of the same color scale with different ranges of age of air makes the direct comparison across the panels challenging. While a single scale over the full range is probably not optimal, perhaps the authors could highlight a few common contours across the panels. Also, including a DJF - JJA difference plot could be useful for discussing contrasts between these two seasons.

Figure 2, caption: “approximation location”→”approximate location”

Figure 4, caption: spelling: “variatiability”→”variability”

Figure 4 also seems ripe for further discussion. For example, the structure of the standard deviation for the 5-day loss tracer in subtropical to mid-latitudes of the South Hemisphere exhibits relatively high variability co-located with not only the SPCZ but also the South Atlantic Convergence Zone and the South Indian Convergence Zone. While I realize that this might be beyond the scope of the present study, I’d be curious to see how the tracers reflect observed synoptic-scale interactions in these convection zones (see, e.g., Matthews 2012 or Niznik and Lintner 2013).

References: Cai, W., et al., 2012: More extreme swings of the South Pacific Convergence Zone due to greenhouse warming, Nature, 488, 365–369, doi:10.1038/nature11358.

Matthews, A. J., 2012: A multiscale framework for the origin and variability of the South Pacific Convergence Zone. Q. J. Roy. Meteor. Soc., 138, 1165-1178, doi: 10.1002/qj.1870.

Niznik, M. J. and B. R. Lintner, 2013: Circulation, Moisture, and Precipitation Relationships along the South Pacific Convergence Zone in Reanalyses and CMIP5 models. J. Clim., 26, 10174–10192, doi:10.1175/JCLI-D-13-00263.1.

Vincent, E. M., M. Lengaigne, C. E. Menkes, N. C. Jourdain, P. Marchesiello, and G. Madec, 2011: Interannual variability of the South Pacific Convergence Zone and implications for tropical cyclone genesis, Clim. Dyn., 36, 1881–1896.

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