

Interactive comment on “Global large-scale stratosphere-troposphere exchange in modern reanalyses” by Alexander C. Boothe and Cameron R. Homeyer

Anonymous Referee #2

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The paper presents a climatology of stratosphere-troposphere exchange (STE) in four modern reanalyses. The results show coherence in the overall spatial structure but also reveal interesting differences among the reanalyses. The study is based on the lapse rate tropopause, which provides a picture of UTLS transport more consistent with the stratospheric global overturning circulation as compared to previous works using a PV contour. Perhaps the most relevant difference is that over the extratropics troposphere-to-stratosphere transport is larger than stratosphere-to-troposphere in the MERRA reanalyses, while in the other two downward transport dominates. The analyses presented are comprehensive and novel, and the paper is well written and generally easy to follow. This work contributes to advance in understanding the

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UTLS transport processes, and I recommend its publication after the following minor comments and suggestions have been addressed.

General comments

- P6 L19-20: Since you include tropical upwelling as part of the TST, I would suggest including extratropical downwelling as part of the STT. You actually include it in the classification in Section 4.5 when referring to trends in the time series, so why not explicitly include it from the beginning?

- P10 L19: In the analyses of the annual cycle, I would suggest separating three regions: tropics, NH extratropics, SH extratropics. As it is, the annual cycle is mixing several different mechanisms and perhaps this alternative separation would provide clearer insights on the causes of the differences among reanalyses.

Specific comments

- P12 L21-26: How do the results in this study compare to previous studies explicitly looking at the BDC in reanalyses (Abalos et al. 2015 JRG-A, Miyazaki et al. 2016, ACP)?

- Section 4.6.2. Diagnostics: I am missing some discussion at the end of the Section connecting these diagnostics to the previous results shown in the paper. For instance, are the differences in tropopause height and/or jet location consistent with more extratropical TST in MERRA?

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- Section 5.2. Discussion: Please add some discussion on how your estimates compare quantitatively with previous works highlighted in the Introduction.

Technical corrections/suggestions

- P1 L15: “has important and significant”: perhaps redundant?
- P1 L20: although water vapor is a greenhouse gas, is it considered a pollutant?
- P5 L13: “pvu” should be PVU
- P5 L16: “about 750 m in the extratropical UTLS to about 1100 m in the tropical UTLS”. You could specify an approximate range of altitudes corresponding to the extratropical and tropical UTLS
- P5 L23: “6 billion”. It is better to write $6 \cdot 10^9$, to avoid confusion with the world billion
- P6 L4: “affects” should be effects
- P8 L17: “East pacific” should be West Pacific, right?
- P9L31: “... STE mass flux” I suggest adding the clarification (TST-dominant)
- P11 L28: “normalize” usually refers to dividing by the time mean, while what you did was compute the anomalies with respect to the mean
- P12 L17: suggestion for clarity: “... show increasing vertical STT in the extratropics and TST in the tropics, whereas ...”
- P15 L27: suggestion: remove “there to be”
- P15 L29-30: sentence not clear, rephrase.

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