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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Sensitivity of stratospheric water vapour to variability in tropical tropopause temperatures and large-scale transport" *by* Jacob W. Smith et al.

Anonymous Referee #2

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General:
This a very important and well-written paper and should be published by ACP. It describes and uses the novel method of separation of transport and temperature histories on the formation of stratospheric water vapor. Although there are some limitations of this method (e.g. diabatic vertical velocities which are a part of transport strongly depend on temperatures), the obtained results are of great value. Similarly, the timescale-dependent analysis of Eulerian temperature variations give very interesting insights into their importance on stratospheric entry values of water vapor. Thus, I have only few minor comments.

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Major points

- Maybe one additional sentence in the abstract stressing the importance of the sampling effect of the Lagrangian dry point reconstruction which can lead to so different values and patterns of water vapor entering the stratosphere if compared with Eulerian estimates...

Minor comments:

- P2L26
  ...impact of water vapor on ozone is also related to the impact on the formation of the polar stratospheric clouds (PSCs)...more PSCs, more catalytic ozone depletion... maybe you can mention it
- P4L122
  The sentence starting with "This value could be regarded..." is very difficult to understand and probably not necessary. Fig 1, its caption and the other parts of text explain fully sufficient the applied method...Maybe you can replace "hot" by "warm" in the color bar of Fig 1 (hot TTL sounds strange for me).
- P6L170
  In the description of the UM-UKCA simulation it is not clear for me how the inter-annual variability was realized in the time-slice simulation. Because of the perpetual year 2000 boundary condition, it is not clear if you run year 2000 many times (perpetuum run) and get in this way an ensemble of "different" years 2000 which mimic the inter-annual variability of the real atmosphere?
- P6L183
  The 11 orange lines are obtained by using the transport of each particular

year between 1999-2009 (11 cases) for all years between 1999 and 2009, isn't it?...maybe you would like to add this or a similar sentence to your text or to the caption of Fig 3a.

- P7L193-203
  To be honest I do not understand your explanation in this paragraph. For me every orange line in Fig 3a is calculated with always "true" temperature and "false" winds with exception of only one year when also the wind is correct (e.g. if you take the winds from 2003 for all other years between 1999 and 2009 than only for 2003 both temperature and winds are correct). Then, to get the purple line in Fig 4a you have to calculate the in-year average, i.e. an average over 10 orange lines from Fig 3a ....same with the orange line in Fig 4b resulting from 11 purple lines in Fig 3b. However, I do not understand why did you flip the colors? You also write in the caption of Fig 4 "....of (orange) time-shifted-temperatures and (purple) time-shifted-transport" Maybe you would like to clarify and reformulate this paragraph.

- P8L235
  The results presented in 3.1 are very interesting and important. One additional point: In Fig 4b the positive anomalies of the purple line are always between late spring and fall indicating the also the summer monsoons and their dynamical inter-annual variability may be an important factor...

- P8L249
  The dry bias and reduced annual cycle amplitude due to non-linearity of the Clausius-Clapeyron equation with respect to temperature...

- P9L255, Figure 5
  In the caption you should shortly denote the red dotted line as an Eularian estimation of the tropical H2O in the lower stratosphere..

- P9283-288
  Similar problem like in the previous chapter. I think that you repeat the transport of January for all month of a given year, the same for February, March, etc... and the same for temperature?

- P9L320
  Section 3.2 is also very interesting and has very valuable results. Still two remarks (1) In boreal summer the monsoon circulations are very strong and unique. I also expect some influence on your results if compared with the winter transport, i.e. meridional “wide” (summer) versus meridional “narrow” (winter) tropics. (2) Vertical velocities, i.e. diabatic heating rates you are using depend strongly on the lowest temperatures in the TTL, i.e. cold TTL is related to a strong upwelling (winter) and warm TTL is related to a weak upwelling (summer). Because of this, the separation between transport and temperature has a clear limitation...

- P13L395
  “Eulerian methods to estimate stratospheric water vapour”– in this context I can only imagine Eulerian methods to estimate temperature fluctuations which are compared here with the Lagrangian dry point estimation...how do you apply it for water vapor?... maybe you wish to clarify it

- P13L420
  You should mention here that the zonally averaged values are marked as stars in Fig 9.

- P14L433
  Why is the modeled tropical mean Eulerian water vapor (Fig 11 a, dotted line) higher than the H2O obtained from the Lagrangian reconstruction? Is the transport scheme of the chemistry-climate model too diffusive?

- P14L454

...for which the LDP in the first month or two - something wrong with the sentence

- P14L558
  “The seasonal variation of transport...” Do you mean the seasonal variation of vertical transport (different upwelling in winter and summer) or of horizontal transport (narrow tropics during winter and wider tropics including Asian and American monsoon during summer)?

- P18L564 The general stronger role of transport during boreal summer and fall can be due to the inter-annual variability of monsoons

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