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Nice UTLS climatologies in tropopause relative coordinates

Anonymous Referee #1

Referee comment on "Water vapour and ozone in the upper troposphere–lower stratosphere: global climatologies from three Canadian limb-viewing instruments" by Paul S. Jeffery et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-345-RC1, 2022

The manuscript presents ozone and water vapour climatologies for the upper troposphere and lower stratosphere, derived from measurements by three Canadian satellite instruments. The climatologies use special vertical and meridional coordinates - potential temperature relative to the lowest tropopause and equivalent latitude. These coordinates are chosen to reduce smearing out effects from vertical and horizontal transports, and should provide a tighter and more relevant climatology.

The manuscript is generally well written. The underlying assumptions, methods and data appear sound and plausible. Overall the manuscript is very comprehensive and detailed, but also quite long. I make a few suggestion below, to help bring out main results a bit clearer. Still, this is a good scientific paper, using a novel coordinate system, and gives a good overview of water vapor and ozone data from three Canadian satellite instruments. It is acceptable for publication in ACP with just a few minor modifications.

Suggested larger modifications:

Figs. 1, 2, 4, 5, 7: It would be good to have lines for a few isentropes (=potential temperature isolines) in these plots. That would help greatly to see where isentropic transport and/or mixing can spread water vapor and ozone, and how that is consistent with the observed climatological values.

Sections 4.2 and 5.2 compare at great length the climatologies from the different instruments / data versions. Reading this, though, I tend to get lost and/or confused. I never find a concise take-home message. I think it would be very helpful to have one table for water vapor, and one table for ozone that sums up the key differences / messages. That table could have the main latitude bands, main regions below / above the

tropopause, major differences / biases / features for each instrument / data set. Also a more concise summarizing paragraph at the end would be good.

A few minor things:

line 17, 18, 20, 21 (and possibly other places): 8% overall difference. To me it is not clear whether this means an 8% difference between the means (which one is higher then?), or if that means RMS or average absolute differences of about 8%. Please clarify / use better wording.

line 23, "consistent": I don't think two data sets are consistent when they differ by as much as 30 to 35%. Rephrase.

line 45: maybe add "and the large vertical and horizontal trace gas gradients at the tropopause" after "itself"

line 55 and 56: in both brackets, I think you need ozone and water vapor: you need ozone to generate O1D which then with water vapor generates OH. Both ozone and water vapor are radiatively important in the UTLS.

around line 78: somewhere around here you might want to say something about the difficulties for satellite measurements in the UTLS. Nadir looking instruments have wide weighting functions which do not resolve UTLS features well. LIMB looking instruments have very long path lengths, which also tend to average out finer structures.

line 113, 119: "have been shown capable of reducing" -> "can reduce", "have been shown capable of grouping" -> "can group"; there may be more places like this. Also "have been found to ..." can almost always be replaced by "are" or "can". Much less wordy, much less hedging. If it looks like a spade and handles like a spade, you might as well call it a spade.

line 123: can it really be "well constrained". I have my doubts, and suggest "constrained better"

line 358: suggest to drop "minimizes the internal variability of the model's circulation". The internal variabilty of the model is what it is. By nudging you might modify it, but more importantly you push the model towards a real observed situation (with sometimes significant side-effects, particularly if the model does not like it.)

line 363: here is an example where you can easily drop "have been found to"

line 428, Eq. 2: I am surprised to see X(i,j) in the denominator, not Y(i,j). Or, I am surprised to have X-Y in the enumerator, not Y-X. Is there a specific reason to use this unusual notation? Please clean up or explain.

line 480: might want to add "troposphere" after "hemisphere"