

## ***Interactive comment on “Mixing and ageing in the polar lower stratosphere in winter 2015/2016” by Jens Krause et al.***

**E. Ray (Referee)**

eric.ray@noaa.gov

Received and published: 21 November 2017

This paper uses in situ aircraft measurements and the CLaMS model to investigate the transport characteristics responsible for observed trace gas correlations in the polar lower stratosphere. This is nice work and really highlights the power of using model age spectra to better understand the causes of measured trace gas distributions in the stratosphere. The model does a reasonable job of reproducing the general features of the observed trace gases but the age spectra is what really explains why the features exist. The data and techniques are well described and the conclusion are well supported. My main comments are around the discussion of the tracer-tracer curves and the grammar, which could have used more work before submission. I suggest publication with consideration of the comments below.

C1

Main comments:

Figures 3-5 and 8b: I suggest changing the x and y axis ranges to eliminate white space and make the features more visible. You could change the theta minimum to 290 K for instance.

Pg. 13: I think this discussion of mixing and Figure 6 needs to be clearer. In Line 7 it is stated that “stratospheric CO will relax towards its stratospheric equilibrium value”. But that’s not really how it works. CO has a chemical lifetime in the stratosphere so it’s destroyed at a certain rate. In the absence of mixing or transport it will be completely destroyed. You should cite Minschwaner et al. (2010) here for the CO chemical lifetime discussion.

In panel (d) I would recommend extending the blue curve up to the Chi\_meso point since there is a background correlation curve that connects the stratospheric to the mesospheric values.

Lines 23-24: In the discussion of Figure 7 it’s not clear that it’s remarkable CO is higher relative to N<sub>2</sub>O in phase 2 compared to phase 1. The old air in the vortex that has come from high altitudes is expected to have relatively low N<sub>2</sub>O and CO but is it expected that the correlation will remain constant, or that CO will be lower relative to N<sub>2</sub>O? I just don’t think it’s well established what the correlation should be and if it is that should be justified by prior work.

Lines 24-25: This sentence is too vague to understand what it is referring to.

Lines 26-28: What does the “direct tropospheric impact” mean? This sentence should also be clarified.

Figure 14: I’d suggest making these plots NH only to see the features and differences in the region of interest more clearly. It would also be interesting to see line plots at 350K and 400K for example of mass fraction vs. latitude for climatology and 2016.

Grammar comments:

C2

Pg. 2, line 6: “these air masses”, what air masses are you referring to? Be more specific.

Pg. 2, line 23: comma needed after “vortex”

Pg. 2, line 24: comma needed after “result”

Pg. 2, line 25: “. . .establishes a relatively tropospheric. . .”

Pg. 3, line 9: “. . .conditions existed due to. . .”

Pg. 3, line 11: replace “was” with “were”

Pg. 3, line 13: replace “to” with “on”

Pg. 3, line 15: comma after second “warming”

Pg. 3, lines 19-21: be consistent with use of either “eastward” and “westward” or “easterly” and “westerly”

Pg. 3, line 24: “. . .El Nino could have accounted for a. . .”

Pg. 3, line 28: comma after “TTL”

Pg. 4, line 12: remove “the”

Pg. 4, line 13: remove “the aim of”

Pg. 4, line 16: remove “about”

Pg. 4, line 18: replace “of” with “that measured”

Pg. 4, line 22: add “and” between N<sub>2</sub>O and CO

Pg. 8, line 1: change “take” to “taken”

Pg. 8, line 2: change to “Green’s”

Pg. 8, line 4: “. . .allows the calculation of time. . .”

### C3

Pg. 8, line 9: change “formation” to “formulation”

Pg. 8, line 10: “box model”

Pg. 8, line 21: remove “respective”

Pg. 8, line 27: change “constitute” to “contribute” and remove “, respectively”

Pg. 8, lines 30-31: “. . .mean age from long-lived tracer measurements, the tracer must have a. . .”

Pg. 9, line 26: change “the last” to “recent”

Pg. 9, line 27: remove “an”

Pg. 11, line 9: change “to” to “with”

Pg. 11, line 15: not all of the CO decreases below 360 K.

Pg. 11, line 16: change “rise” to “make”

Pg. 11, line 17: add “the” before “winter”

Pg. 12, line 5: “. . .with air from the tropical lower stratosphere.”

Pg. 12, line 9: change “of” to “the” and “as” to “of”, “. . .this increase originated. . .”

Pg. 12, line 10: “. . .TTL, into the extratropical lower stratosphere.”

Pg. 12, line 11: add comma after “tropopause”

Pg. 12, line 13: “. . .as a stratospheric. . .”, “used here as a tropospheric. . .”

Pg. 12, line 17: “effects”

Pg. 13, line 5: remove “actual”

Pg. 13, line 6: “. . .correlation is established. . .”

Pg. 13, line 26: remove “to” before “the”

### C4

Pg. 13, line 32: add a comma after “before”  
Pg. 13, line 35: “. . .is the main source. . .”  
Pg. 16, line 18: change “by” to “in”  
Pg. 16, line 19: does the (3.7) refer to the uncertainty?  
Pg. 16, line 30-31: “. . .information on the. . .”  
Pg. 17, line 12: solid lines, not dotted lines Pg. 18, line 4: add “the” after “as”, change “by” to “in”  
Pg. 22, line 5: “. . .average profiles throughout. . .”  
Pg. 22, line 6: change “from” to “of”  
Pg. 22, line 14: remove “to”, add comma after “(Fig. 5)”  
Pg. 22, line 27: “even though”  
Pg. 22, line 28: change “potentially” to “potential”  
Pg. 22, line 30: add comma after “Therefore”  
Pg. 22, line 32: “box model”  
Pg. 22, line 34: “calculated”  
Pg. 23, line 1: add “a” after “as”  
Pg. 25, line 3: “decreased”  
Pg. 25, line 4: “denoted”  
Pg. 25, line 17: “observed”

---

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2017-955>, 2017.