

# ***Interactive comment on “Stratospheric impact on the Northern Hemisphere winter and spring ozone interannual variability in the troposphere” by Junhua Liu et al.***

## **Anonymous Referee #3**

Received and published: 18 December 2019

The paper compares the 1990-2015 ozonesonde observations at 8 North American and 9 European sites with CCM output of tropospheric ozone levels to study the stratospheric impact on the observed tropospheric ozone concentration time series. The (total + tropospheric) ozone output of the model is first validated by comparison with satellite ozone retrievals. Making use of a model stratospheric ozone tracer, the impact of STE on tropospheric ozone is assessed, together with the analysis of model wind patterns and air mass fluxes.

## GENERAL COMMENTS

The study is scientifically sound and takes into account all relevant literature. The

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analysis is detailed and all relevant aspects are considered. The presentation is clear, although somewhat verbose at some locations, and follows a very logical structure. It therefore deserves publication in ACP, if some remaining issues can be described better or clarified. These are summed up here below.

## SPECIFIC COMMENTS

\* From the text (page 4, lines 114-120), it is not clear how the stratospheric ozone tracer (StratO3) is defined. Please be more specific on this important variable of your analysis.

\* On page 5, lines 147-150: please, be more quantitative when comparing the magnitude, IAV and trend of the tropospheric ozone satellite retrieval and model replay simulation. More in general, I agree with reviewer 1 that, throughout the entire manuscript, you should quantify the comparison of “IAV” between two datasets.

\*On Page 5, lines 154-156, please describe more clearly how the ozone anomalies are calculated. For instance, for every ozonesonde site, you first calculate the monthly anomalies, and then you calculate the monthly mean of those monthly anomalies for all sites together? What does the 95% confidence interval represents ? The site to site variability with or without the variability within one month at a given site?

\*Coming back to the previous point: quantify the statements on page 6, lines 168-169: “Both observations and simulations show the largest interannual variations in the winter and spring, when the strongest IAVs occur” and on page 6, lines 176-177: “The IAV of ozone is larger over North America then over Europe, and larger in spring than in winter”.

\* In sect 4.1, in which you describe Fig. 4, it should be mentioned that the comparison between ozonesonde data and model simulation decrease with increasing pressure and why this is the case.

\* Page 6, lines 184-188: I do not understand the link between the winter polar 150 hPa

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AVERAGED temperature – 200 hPa O3 IAV correlation and PSC formation, which only happens at very low stratospheric temperatures ( $< -80^{\circ}\text{C}$ ).

\* Page 7, lines 206-209: where do these explained variances come from (in Table 3, only correlations are shown)? Please explain. Same comment for the percentages for the explained variations, mentioned on Page 8, line 234, and page 9, lines 265-267.

\* Page 9: why are you using the alternative definition of tropopause pressure by Browell et al. (1996)? Is this tropopause identical to the ozonopause? What is the effect of this choice for the tropopause (compared to the thermal tropopause, as defined by the WMO) on the mentioned correlations with the IAV of O3 and stratO3?

\* Page 12, lines 372-388: the analysis of the correlations between AO and ozone is not very convincing. First of all, please mention the months for which Fig. 12 is constructed (DJF and/or MAM?). Secondly, on which ground do you classify the correlation profiles (with low correlation coefficients after all) in Fig. 12 as significantly different between North America and Europe? And similar between sonde and model data in Figure S2?

#### TECHNICAL CORRECTIONS

\* Pag 1, line 29: remove the ‘ after ozonesondes

\* Page 2, line 46-47: replace “In so doing” with “In doing so”.

\* Page 5, before Section 4: Here, you can add that some features in tropospheric ozone are well reproduced (e.g. 2015), while others not (e.g. 2013) and that those differences will be analyzed further in the paper.

\* Page 9, after line 269: please mention here that the longitudinal difference in dynamics between North America and Europe will be further analyzed in Sect. 5.2.

\* Page 10, line 310: replace “asterisks” by “lines” (referring to Fig. 8).

\* Page 13, line401: replace “resulting” with “result”.

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\* Please remove the : in the section titles (e.g. 6: Conclusions and discussion)

\* Please acknowledge the data repositories properly for the ozone data used (ozonesondes: WOUDC, SBUV, OMI, etc.).

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