

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 #2

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Liu et al. use model simulations of ozone and a stratospheric ozone tracer together with observations from ozonesondes to investigate the interannual variation of ozone and the vertical extent of the impact of stratospheric ozone on tropospheric ozone. Before the simulations are used for the analyses their quality is checked by first comparing the simulations to measurements.

I am confident that the study itself is important and deserves to be published, however, I am not happy with how the result from these study are presented. The manuscript in its present form is confusing and needs thorough structuring and a clear line. From the current manuscript is not clear what the major focus of this study is: Do you want

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to evaluate the model or do you want to investigate the stratospheric impact on the NH winter and spring interannual variability in the troposphere as it is stated in the title. The manuscript in its current form has a stronger focus on the evaluation of the model than on the analyses of the interannual variability.

Further, a lot of information is packed into the figures and thus makes it quite hard to follow and get the major results through. I would suggest major revisions before the manuscript can be published.

Specific comments: P1, general: Why is it important to look at the interannual variation? What are the unanswered questions? The motivation for this study is not clear. In the introduction (P2, 58-59) a motivation is given. Something like this could be repeated in the abstract.

P1, L1: How long is the model run? That should be mentioned here.

P1, L29-30: Why should ozone sondes be closer to the polar vortex? This sentence is somewhat weird and misleading and thus should be rephrased.

P2, L44: What exactly are these “replay” simulations? This should be explained. What atmospheric conditions or initial conditions have been assumed for this simulation?

P2, L48: Which parameters exactly? Can you give some examples?

P3, L75ff: Here you give a better description of the aim of this study. Something like this should be also added in the abstract, so that it also there becomes more clear why it is important to investigate these processes.

P3, Section: A comparison for each station would also be quite useful to understand local differences and which stations/locations maybe mess up the mean.

P5, L135ff: The comparison to the satellite data has not been mentioned in the abstract or introduction. Why? If it is a part of this study it should be mentioned there. Why do you this comparison in the first place? Is this really necessary? You anyway compare

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the model simulations to sonde data so. Therefore, I do not understand what additional information is gained by doing an additional comparison. Especially, if your focus is not on the evaluation of the model but on the investigation of the impact of stratospheric ozone on tropospheric ozone.

P5, L154ff: Reference to the figure is missing.

P7, L205ff: I cannot follow how you derive this conclusion. Which season and time periods are you referring to? How have the numbers in percent been derived?

P8, L228: What exactly is the StratO3 tracer? What is included in the diagnostic? How is it calculated? Is this simply the stratospheric O3 flux?

P8, L234: Where exactly do we see this in Figure 6?

P9, L266ff: Also here it is not clear how the numbers in percent have been derived.

P9, L267-267: Here an important result is given, but it gets somehow lost in the discussion of the differences between the model simulations and observations.

P9, L269: Reference? Has this relations seen before? Has this relation already been discussed somewhere else?

P10, L298-299: This sentence is too complicated and should be rephrased. Maybe it would be better to split this sentence also into two sentences.

P10, L308: It would be worth to more clearly state that because of the different tropopause heights different pressure levels are shown in the figures.

P10, L315: How it the air mass flux derived/calculated?

P10, L320: not shown? Or is this shown? Can this be seen when comparing 1993 to 1998?

P10, general: In the introductory part of this section StratO3/O3 distinction based on PV is mentioned, but in the analyses the air mass flux is used.

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P11, L327: Here four panels are given, but only 2 panels show the 400 hPa level.

P11, L330: Why is there less dynamic perturbation?

P12, L363: Why are these three parameters used? What is the connection between these? This is not really discussed. Wouldn't it then be easier to just show StratO3/O3?

P12, L383: maximum? Shouldn't it read minimum? Generally, I have the feeling that in this paragraph the description does not agree with the figure shown.

P13, L396: This is not clear. How does the Pinatubo eruption deplete ozone? Do you mean in the troposphere or the stratosphere and by which process?

P13, L410-411: This does not become comprehensible from what is shown in the manuscript.

Figure 2 and 3: Are these figures really useful? Especially, since later anyway the simulations are compared to ozone sonde data. This part of the study could (if required) be provided in the supplement.

Figure 4: What does the reader gain from this Figure? Is there any more information gained when comparing observations from all stations with the model simulation?

Figure 5, 6, and 7: I would suggest to split these by North America and Europe and discuss the regions separately. As you do it now, you compare different pressure levels, seasons and regions and it gets really hard to follow since you also above all that additionally discuss the differences between model simulation and observations.

Figure 8, 9: Again too many panels and too many things discussed at the same time. I would suggest to solely show the anomalies in the figure and to provide the air mass flux in the supplement.

Technical comments: P2, L18: add "of O3" after input and maybe use a different wording for "input", e.g. entrainment.

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P2, L47: “in so doing” → “in doing so”?

P4, L99: present = 2019? It would be better to clearly state the year here.

P4, Section 4 header: remove colon.

P4, Section 4.1 header: remove full stop after title.

P7, L219: space between “correlation” and reference of “Terao” missing.

P7, Section 4.3 header: Remove colon.

P12, L360: “impact on tropospheric O₃ from the upper to lower troposphere” → not clear. Please rephrase the sentence.

P13, Section 6 header: remove colon.

Figure 8 and 9: Panel labelling with a,b,c. is missing.

Figure 8: Adjust both columns so that they are next to each other at the same height. At the moment there is a shift between the columns.

Figure 10 and 11: 180 W on the right side of the x-axes should read 180 E.

Figure 10 and 11: To use white dashed lines instead of black dashed lines would increase the readability.

Figure 12: Also here North America and Europe should be marked.

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