

The manuscript titled “Characterising the Seasonal and Geographical Variability of Tropospheric Ozone, Stratospheric Influence and Recent Changes” presents a very interesting analysis on the stratospheric influence on tropospheric ozone using two chemistry-climate models CMAM and EMAC, as part of the IGAC/SPARC CCMi activity. The manuscript first shows that both models agree quite well with the observations from Satellite with the Ozone Monitoring Instrument (OMI) and from ozonesondes. Then the manuscript focuses on the models to study the variability of tropospheric ozone, stratospheric ozone and the stratospheric intrusions in order to assess how much stratospheric ozone impact tropospheric ozone. A statistically significant increase in tropospheric ozone is found across much of the world. The role of the stratosphere-troposphere exchange to such ozone changes ranges from 25-30% at the surface and 50-80% in the upper troposphere-lower stratosphere.

Although the manuscript is not so easy to read and follow, it is well structured; in particular, the summaries of each main section are very much appreciated.

I would suggest minor revisions, mainly clarifications, before the manuscript could be published.

#### General comments:

I found one general information missing about the models. It is the inferred stratospheric influx as mentioned in Young et al., 2013 (Table 2) for other CCMi models. Could the authors add this information?

Young, P. J., Archibald, A. T., Bowman, K. W., Lamarque, J. F., Naik, V., Stevenson, D. S. et al.: Pre-industrial to end 21st century projections of tropospheric ozone from the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP). *Atmos. Chem. Phys.*, 13(4), 2063-2090, doi:10.5194/acp-13-2063-2013, 2013.

#### Specific comments:

Line 1 p. 2: Could the authors give the period of time on which the change in ozone was calculated: 4-6 ppbv (5-10%).

Line 24 p.2: “background ozone” is used here, when I think it refers to “baseline ozone”. According to the Hemispheric Transport of Air Pollution 2010 Part A paper and Cooper et al. (2014), “Baseline concentrations refer to observations made at a site when it is not influenced by recent, locally emitted or produced anthropogenic pollution. The term global or hemispheric background concentration is a model construct that estimates the atmospheric concentration of a pollutant due to natural sources only.”

Cooper, O. R., Parrish, D. D., Ziemke, J., Cupeiro, M., Galbally, I. E., Gilge, S., ... & Oltmans, S. J. (2014). Global distribution and trends of tropospheric ozone: An observation-based review.

HTAP, T., 2010. Hemispheric Transport of Air Pollution 2010 Part A: Ozone And Particulate Matter, Air Pollution Studies No. 17.

Line 12-14 p. 3: I am not sure to understand where “seasonal minimum’ comes from. According to Tang et al. (2016), the STE ozone flux in the Northern Hemisphere shows a maximum in late spring and early summer as well. Could the authors clarify the sentence?

Line 9 p. 5: [Typo] In “24, 6, 48 and 24 h”, “24” is written twice.

Line 26 p. 5: [Typo] Change “Langrangian” to “Lagrangian”

Line 1 p. 9: Could the authors add references about the intercomparison campaigns between 1970 and 1990, for example Beekman et al. (1994).

I would have the same comment for the “evidence that the ECC sondes have greater precision [...]”.

Beekmann, M., Ancellet, G., Megie, G., Smit, H., Kley, D., 1994b. Intercomparison campaign of vertical ozone profiles including electrochemical sondes of ecc and brewer-mast type and a ground based uv-differential absorption lidar. *J. Atmos. Chem.* 19, 259e288.

Line 18 p. 9: The authors wrote, “A seasonal maximum in tropospheric ozone is evident in each hemisphere during spring, which is more pronounced in the Northern Hemisphere and extended in many regions through summer”. According to Figure 1a, the Northern Hemisphere shows a seasonal maximum in spring and summer. In spring the maximum is rather seen above 80N.

How confident are you on the retrieval of tropospheric ozone above 80N? Wouldn't be rather a stratospheric signal?

Could the authors add this particular polar region (>80N) where the spring maximum is seen?

Line 21 p. 9: Use of the parenthesis: “northward (southward)”. This is not really a good structure and the authors tend to overuse it through the manuscript. I would suggest writing it without the parenthesis. That would be better English and more fluent for the reader.

Figure 1 (p. 10): I would suggest to change the maximum limit of the colorbar. Tropospheric ozone (1000-450 hPa sub-column) barely reach 35 DU at a maximum. I would suggest to change 50 DU to 35 DU. The geographical variability of tropospheric ozone will then be easier to see. Would the authors know what is happening above South Africa for JJA and SON? There is ozone values around 30 DU on the coast and above the ocean around but rather 20 DU on the continent, as there would be a continent/ocean barrier. It does not seem real.

Line 23 p. 12: Could the authors explain more, maybe with an equation, how they link the “interannual variability” and the “seasonal aggregates of the computed relative standard deviation (RSD) of the monthly mean O<sub>3</sub>”. It is not obvious. The interannual variability seems to be the variability year to year. Why would the authors study seasonal composites of RSD as a metric for the interannual variability?

Line 14 p. 17: Section 4. Could the authors explain more the difference between O<sub>3</sub>S and O<sub>3</sub>F? If there is any equation used, I would suggest adding them to the text. It is not so clear.

Line 18 p. 33: “RSD values of over 10%”. How does 10% compare with other values? It is not a clear evidence for the reader that it shows an influence of ENSO and QBO.

Line 24 p. 33: “Taking this information into account”. To which information do the authors refer?

Line 33 p. 33: The sentence started at this line and finishes line 2 p. 34, I think the sentence could be shortened.

Line 34 p.33: “(no larger than 20%)”, I would suggest removing the parenthesis and writing “with biases no larger than 20%”.

Line 13 p. 34: What does “high sensitivity to the tropopause” mean?

Figure S4 p. 6: [TYPO] in the caption change “CMAN” to “CMAM”