Atmospheric
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Discussions

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Interactive comment on "Attribution of recent ozone changes in the Southern Hemisphere mid-latitudes using statistical analysis and chemistry-climate model simulations" *by* Guang Zeng et al.

Anonymous Referee #1

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This paper presents an interesting analysis of ozone variability above the observation site of Lauder in New Zealand. The objective is to identify and quantify the main drivers of ozone variability and trend at different altitudes as monitored with ozone sondes. The attribution is carried out using multivariate regression analysis and sensitivity simulations from a chemistry-climate model. A large part of the ozone variability is found to be driven by dynamical/climate variability. Some of it is also linked to changes in O3 precursors emissions. The results suggest that ozone long-term monitoring at specific sites contains valuable information in terms of the causes of ozone changes. This study illustrates how to extract information about atmospheric composition changes from ob-

servational time series. The results will be useful to scientists running monitoring sites. The paper is reasonably clear and well written. Its scope fits perfectly with those of ACP. Therefore, I recommend publication with minor corrections that the authors may consider.

l19, p2 : 'where climate change accelerates the export of O3 to higher latitudes, reducing O3' I think the impact of climate change on tropical ozone in the stratosphere is more about enhanced tropical uplift and hence reduced time for ozone production in rising air.

l5, p3: for more clarity, I would suggest to have: 2.1 ozone record 2.2 statistical method 2.3 chemistry-climate model simulations

l21, p3: 'Tropopause height is calculated using the 150 ppbv O3 chemical tropopause'. Why 150 pbbv ? Prather et al., 2011, recommended the 100 ppbv O3 contour. Prather, M. J., et al. (2011), An atmospheric chemist in search of the tropopause, J. Geophys. Res., 116, D04306, doi:10.1029/2010JD014939.

l24, p3: The different model simulations are forced by different scenarios in CH4 and other O3 precursors, greenhouse gases (GHGs), and ozone depleting substances (ODSs) over the period of the time series. There does not seem to be any forcing that is characteristic of the effect of tropospheric O3 precursors.

l24, p3: The effect of surface temperature is discussed in the text and appears in Table 3 (correlation coefficient). It seems to be the dominant factor in O3 variability at the surface. Why wasn't it included in the regression?

l20, p3: What is Cly? 'effective equivalent chlorine loading (Cly)'. and 2 lines down : 'Cly is the total chlorine loading'.

l27, p3 : 'We note that interdependencies and correlations, e.g., between stratospheric temperature, relative humidity at surface, and tropopause height as regression functions, cannot be excluded'. There is no need to speculate here. For example, the ef-

fective equivalent chlorine loading, a regression function, impacts O3 and stratospheric temperature, one of the regression function. Furthermore, correlations between regression functions can be calculated. It is a significant source of uncertainties and should be discussed.

l24, p4: 'CH4 mixing ratios are prescribed at the surface, and the same CH4 scenario is used in both chemistry and radiation.' The wording is a bit confusing. Isn't the model-calculated CH4 fed into the radiation scheme, like O3?

l32, p4: This paragraph would greatly gain in clarity and usefulness if the different simulations were described and contrasted instead of just referring to the Table 1.

l10, p5: 'Fig. 2 shows the deseasonalised O3 anomalies at the eight layers from the surface to the lower stratosphere, and the respective regressed O3 anomalies'. Please, could you indicate when a figure is about observed or model-calculated variables? Also, is it monthly means for all the analysis (as indicated in one figure)? Give more information about the time resolution and data processing/filtering of the different analyses.

l11, p5: Can be quantitative about the amount of variability captured by the regression? just provide the values of the determination coefficient $R2$.

l19, p5: "project onto" ? replace by "are mostly driven by"

l26, p5: se comment above about Tsurf missing from the regression.

l29, p6: it's very unlikely that temperature is the driver of O3 variability in the lower stratosphere. The slowing down of O3 destruction by stratospheric cooling (via Chapman cycle) occurs in the upper stratosphere. The ozone budget and variability in the mid-latitude lower stratosphere is dominating by dynamics. I think temperature changes simply reflect dynamical changes that drive O3 variability.

l9, p8: Difficult to expect a CCM to reproduce specific short-term O3 anomalies. Those anomalies are often driven by specific dynamical variations. Comparisons between

CCM simulations and observational time series make more sense when considering long term trends. I would suggest to add the analysis of a REF-C1SD simulation (wind/temperature forced by meteorological analyses instead of being calculated by the model) and compare to REF-C1. It would give an estimate about the effect of model-calculated dynamics/meteorology and biases (yes, there are some) on O3 variability, including trend, for the considered site. Even on long-time series, this could be significant. The authors would be in a stronger position in their attribution analysis. It is less of a problem when considering large-scale averages or multiple sites but here the analysis is limited to a specific site.

Figures : Can the authors add in all the figure captions which curves are what?