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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Seventeen years of ozone sounding at L'Aquila, Italy: evidence of mid-latitude stratospheric ozone recovery and tropospheric profile changes" *by* Daniele Visioni et al.

Anonymous Referee #1

Received and published: 22 July 2020

GENERAL COMMENTS

This paper presents an analysis of trends in vertical ozone profiles obtained from 295 ozonesonde flights made at L-Aquila, Italy from 2000 to 2016. A partial attribution of the drivers of observed changes is then made through a diagnosis of transient simulations of several chemistry-climate models (CCMs) made available through the SPARC CCMI project. Simulations with GHG concentrations fixed at 1960 levels (fGHG) and with ozone depleting substance concentrations fixed at 1960 levels (fODS) are used together with the reference simulations (refC2) to understand how different chemical and

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dynamical drivers of ozone changes at Northern mid-latitudes have affected ozone over L'Aquila this century.

In its current state the paper is not suitable for publication in ACP for the reasons outlined below. I would, however, strongly encourage the authors to revise the paper taking into consideration my suggested changes because I believe that this analysis does have merit and value. It may only be that some key information is missing in a few places.

SPECIFIC COMMENTS

Line 61: Tropospheric influx of what? Similarly on line 64 you mention 'enhanced stratospheric input'. Input of what? Water vapour, ozone?

Line 72: But ozone recovery is a very different thing to ozone increases. Let me give you an example: even though ozone in the tropical lower stratosphere is decreasing, it is recovering from the effects of ODSs. I have had to make this point in reviewing several papers. Here is, verbatim, what I said in response to an earlier different paper I reviewed:

"Could I put it to you that the Montreal Protocol has been effective in reducing ODS concentrations, and thereby concentrations of Cly and Bry throughout the atmosphere, and that, as a result, ozone throughout the atmosphere, including the lower stratosphere, is recovering from the effects of those ODSs. Is this recovery apparent in observations in the upper stratosphere? Apparently yes. I say apparently only in that (at least in this paper) a thorough attribution of the drivers of those ozone increases has not been done. Is this recovery apparent in observations in the lower stratosphere? No, clearly not. Why not? Well because other factors have been affecting ozone (not diagnosed in this paper) that are likely (we cannot be sure since a thorough attribution has not been done) overwhelming the increases brought about by reductions in concentrations of Cly and Bry. Wouldn't that be a more accurate picture to communicate to policy-makers?"

The point I need to make here is that ozone increases are not indicative of recovery (from the effects of ODSs). Ozone increases aren't even a prerequisite for ozone to be recovering. What is an imperative for detecting ozone recovery is an *attribution* of ozone increases to decreases in concentrations of ODSs, even if those ozone increases are offset by other factors. That attribution can be done, in large part, by comparing the fODS and refC2 CCMI simulations as you have done. So all I am saying is be careful of the word 'recovery'. Use it when you really do mean recovery from the effects of ODSs, but don't use it as a synonym for ozone increases.

Line 125: This is the entire *mean* profile, averaged over all 295 flights right?

Figure 1: Rather than having two panels couldn't you just plot the ozone mixing ratios on a log scale?

Table 1: Why not just use the GPS altitude from the radiosondes instead of calculating a pressure altitude? If you are going to calculate a pressure altitude, shouldn't you at least use H=RT/g so that you have a temperature dependent scale height.

Line 165: In calculating the uncertainties on the trends, did you account for the effects of autocorrelation in the regression residuals? If not, why not?

Figure 4: Has the seasonal cycle been removed from these data? If so, then please say so and describe how. If not, then why do I not see a seasonal cycle in the partial columns? It is not clear from the figure caption whether the MLR has been used to remove the variability from the measurements or from the regression mode fit. This needs to be explained much more clearly. I would like to see the formula for the MLR, a description of how the annual cycle was removed (fitting a Fourier expansion?), how seasonality in the fit coefficients was handled (e.g. the QBO affects ozone more in some seasons than in others) and how autocorrelation in the residuals was accounted for in the calculation of the trend uncertainties. No explanation is provided as to how the uncertainties were calculated.

Lines 178-181: There are two things that confuse me here: 1) Over what period are these trends calculated? You state that the trends are from 1997 but you give no end year. 2) I am very surprised that the trends are all negative. From everything I have read, since 1997 ozone has been increasing in the northern mid-latitude middle and upper stratosphere. The values that you quote also seem to not correspond at all to the values plotted in Figure 5 (blue line).

Line 194: But the values for 'all observations' are also just for 35N-60N right?

Line 194: Why only 'seem to agree'? Surely you can calculate the degree of statistical agreement and provide a quantitative value that describes the level of agreement and don't have to resort to vague statements such as 'seem to agree'?

Line 209: You need to define the TTL acronym.

Figure 6: Previously you were taking 35N-60N to be the northern mid-latitudes but now you are taking 35N-55N. Why the change?

Line 235: Injection of what from the stratosphere? Ozone I presume, but you need to avoid the reader having to presume.

Line 243: Again, I assume you are referring to ozone fluxes here?

Figure 8: Somewhere, either in the figure or in the figure caption it needs to be stated over what period these trends were calculated.

Figure 9: No reference is made in the figure caption as to what is shown in panel (f) - I think that you mistakenly refer to panel (e) rather than (f).

Line 287: You need to expand on what the 'e90, O3, PV-theta' refer to. Do you really want readers to have to guess what e90 is?

GRAMMAR AND TYPOGRAPHICAL ERRORS

I understand that the first author's first language may not be English and, as a result,

there will possibly be some grammatical errors in the paper. This should not detract from the scientific quality of the research. I have made some suggestions in places for where these might be corrected but feel it is not my role to copy edit the paper. What does annoy me somewhat is that there are many co-authors on this paper whose first language is English and it is clear that they didn't even bother to proof read this paper and suggest corrections to the grammatical errors. My advice to the lead author would be to get some of the co-authors to at least do that much.

Line 40: Replace 'associated to higher' with 'associated with higher'.

Line 42: Replace 'do not result to be statistically significant in our analyses' with 'are not statistically significant in our analyses'.

Line 48: Replace 'emerging evidences' with 'emerging evidence'.

Line 50: Replace 'as SPARC-CCMVal' with 'such as SPARC-CCMVal'.

Line 56: Replace 'greenhouse gases (GHGs)' with 'greenhouse gas (GHG) concentrations'.

Line 60: Replace 'increase out of the tropics' with 'increase poleward of the tropics'.

Line 63: Replace 'for year 2030' with 'for 2030'.

Line 68: Replace 'year 2000 to the year 2016' with '2000 to 2016'.

Line 85: Replace 'coupled' with 'ozonesonde coupled'.

Line 89: Replace 'preparation's procedure' with 'preparation procedures'.

Line 117: Shouldn't this be 'Wallops Island' rather than 'Wallop'? Likewise on line 122.

Line 122: Replace 'ozonosondes data' with 'ozonesonde data'.

Line 135: Replace 'errorbar' with 'error bar' throughout.

Line 136: Replace 'single sondes location' with 'single sonde location'.

Line 213: Replace ’catalytic cycle’ with ’catalytic cycles’.

Line 250: Replace ’is not influent to our overall’ with ’does not influence our overall’.

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