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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Reassessment of causes of ozone column variability following the eruption of Mount Pinatubo using a nudged CCM" *by* P. Telford et al.

Anonymous Referee #1

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Review of "Reassessment of causes of ozone column variability following the eruption of Mount Pinatubo using a nudged CCM" by Telford et al.

GENERAL COMMENTS

This is an interesting paper that uses a nudged chemistry-climate model to attribute the sources of changes in total column ozone in response to the Mt. Pinatubo volcanic eruption. There is only one aspect of the paper that leaves me a little uneasy and that is the calculation and interpretation of the delta O3ˆdyn metric. On line 16 of pg 5430 it is stated that delta O3ˆdyn is calculated by subtracting the chemical induced ozone loss from the 'observed ozone record (delta O3ˆobs)' where delta O3ˆobs is the detrended

and deseasonalized total column ozone. It would certainly be instructive in Figures 2, 3 and 4 to see delta O3ˆobs. It is clear that any QBO signal in the observed total column ozone is not removed since only a mean annual cycle and linear trend are subtracted from the observations to generate delta O3ˆobs (bottom of pg 5249). The chemical ozone loss on the other hand has no QBO signal since that cancels out between runs A and B. So delta O3ˆdyn is not the dynamical response of ozone to the eruption; it is the dynamical response added to all other geophysical sources of variability in the original observed ozone time series (QBO, ENSO, solar cycle, noise). For me, this confounds the interpretation of the results. Why not use a regression model to remove the mean annual cycle, the trend (or EESC induced change in ozone), the QBO, the solar cycle, and ENSO from the total column ozone observations? That would leave a delta O3ˆobs that is the observed change in total column ozone as a result of the Pinatubo eruption alone (plus some noise). Then, when you subtract the chemical ozone loss, you would have the true dynamically induced ozone loss induced by the additional sulfate aerosols alone. That would make much more sense to me. Right now when you plot the delta O3ˆdyn, it displays non-zero values before the eruption and this is very confusing. You end up coming to the conclusion, as stated in your abstract, that 'the remaining variability is dominated by the QBO'. But this is already well known and it doesn't say anything about how Pinatubo affected the dynamics. You could then also make a much firmer conclusion than what you currently have as the last sentence of the paper.

The CCM simulations are good and are likely to be very instructive. If you could put some further thought into how to do the attribution of Pinatubo induced changes in ozone to chemistry and dynamics, I think that the paper would be much improved. It's really close but by dragging known non-volcano induced dynamical variability in ozone (specifically the QBO) into your delta O3ˆdyn metric, you are muddying the waters. Specifically, if you could quantify the difference in the true aerosol induced change to the effect of dynamics on ozone between the northern and southern hemispheres, that would be interesting - then again, that wouldn't actually explain WHY the hemispheres

show different dynamical responses.

SPECIFIC COMMENTS

Page 5424, line 6: Were those record lows in extra-polar ozone observed in both hemispheres or only in the northern mid-latitudes? I think that the lowest ozone over southern midlatitudes was observed in 1997.

Page 5425, line 3: I think that a more revealing paper here is that by Gleason, J.F.; Bhartia, P.K.; Herman, J.R.; McPeters, R.D.; Newman, P.A.; Stolarski, R.S.; Flynn, L.; Labow, G.; Larko, D.; Seftor, C.; Wellemeyer, C.; Komhyr, W.D.; Miller, A.J.; Planet, W. (1993). Record low global ozone in 1992. Science 260: 523-526. That was earlier than the others and showed clearly the large reductions in ozone over northern midlatitudes; more so than over southern midlatitudes.

Page 5426, line 2: Longitudinal patterns in what?

Page 5426, line 15: I was confused by this phrase 'surface aerosol density'. What exactly is that? Usually people refer to the aerosol surface area density (mˆ2/mˆ3) i.e. the aerosol SAD. You seem to have created some sort of hybrid phrase here that doesn't make sense to me and seems to be at odds with what is used elsewhere in the literature.

Page 5429, line 2: Replace ERA-40 re-analysis data' with 'ERA-40 reanalyses'.

Page 5429, line 21: It wasn't clear to me what you meant by 'simpler variability'.

Page 5429, line 22: Why not just calculate the mean annual cycle, subtract that from the time series, and then subtract the linear trend? That would be far easier. That said, if you go with my suggestion above of removing all of the variability except for the effects of Pinatubo and the unforced variability, that will all get subtracted anyway.

Page 5431, line 2: Figure 1 doesn't show 'the global average ozone column in the data and the model runs'. It shows the anomalies away from a mean value.

Page 5431, line 5: I think you need to provide some details on exactly how high this bias is.

It would be instructive to have the observations included in Figure 2, 3 and 4.

Page 5433, line 6: It wasn't clear to me what you meant by 'importance in the global residual'.

Page 5433, line 16: You state that 'After removing the variability associated with the QBO we still see low ozone at the time of the Pinatubo eruption'. But I don't see that really clearly in Figure 3. You talk about a 5 DU reduction but it's not clear to me what I should be looking at in Figure 3 to see that 5 DU. Then everything in the rest of that paragraph seems a little confusing.

Page 5434, line 15: But I thought that the depletion was quite different in the two hemispheres as described later in that paragraph.

The figure legends are confusing. The blue line should be labelled 'delta O3ˆchem' and the black line should be labelled 'delta O3ˆdyn'. Then in the figure caption say that blue is Run A minus Run B and black is detrended and deseasonalized observations minus blue.

TYPOGRAPHICAL AND GRAMMATICAL ERRORS

Page 5425, line 25: replace 'concentration' with 'concentrations'.

Page 5430, line 21: replace 'firstly' with 'first'.

Page 5431, line 8: replace 'data is' with 'data are' and please make the same correction elsewhere in the paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 5423, 2009.