Atmos. Chem. Phys. Discuss., 9, C2452–C2455, 2009
www.atmos-chem-phys-discuss.net/9/C2452/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Northern winter stratospheric temperature and ozone responses to ENSO inferred from an ensemble of Chemistry Climate Models" *by* C. Cagnazzo et al.

Anonymous Referee #2

Received and published: 3 July 2009

Northern winter stratospheric temperature and ozone responses to ENSO inferred from an ensemble of Chemistry Climate Models by Cagnazzo et al.

This paper attempts to link ENSO and the northern polar stratosphere using a multi-model ensemble of Chemistry-Climate models as well as in observation and reanalysis products. They find anomalous winter warming being associated with a dynamical increase in total column ozone north of 70°N. This is found in a combination of observations, reanalysis products, and indicated by a multi-model mean of Chemistry-climate models. I think this paper should be accepted for publications if the authors consider and address the comments below.

Major comments:

1. I am concerned about the impact of having 9 realizations (SOCOL) from a single model out of a total of either 24 or 30 simulations. In this instance a single model could represent 30-40% of the total multi-model weighting. Even though you have 12 models, SOCOL and MRI (5 realizations) represent 47-60% of the weighting for the multi-model average. Could you test if your relationships remain as significant if you for example randomly selected 1 or up to 3 SOCOL simulation instead of all 9.

2. By using the 500 hPa, 50°N geopotential height anomaly you do get a sense of the vertically propagating planetary waves emerging from the troposphere but you might be missing out on another important aspect. ENSO warms the tropical troposphere which has been shown to increase the strength of the subtropical jet and this can impact the amount of wave energy propagating into the stratosphere so even in the absence of increases in the formation of waves at 500 hPa you could still get more wave flux into the stratosphere driving a stronger B-D circulation. Looking at meridional eddy heat flux at 100 hPa at say 40-80°N if it was archived could give you a more complete picture of the impacts that ENSO can have on the circulation of the stratosphere.

3. For figure 5 it is not clear from what the authors showed that the strong positive relationship between total ozone and temperature anomalies are from ENSO, if this is what the authors are implying. I think you do make the case in this paper that the positive offsets from zero for temperature and ozone seem to be influenced by ENSO, but it is not shown that the close coupling between polar temperature and ozone are enhanced by ENSO. I think it would be useful for the authors to plot a similar figure for all the Neutral years, I would expect to see a similar significantly positive correlation without the offset from zero. If you find something different from this it could strengthen your case that ENSO strengthens this relationship, if not it would best to reword the section that describes figure 5 and in the conclusion section at top of page 15.

Minor comments:

Page 4 bottom of 1st paragraph not clear what is meant by simulation designs?

Page 4 par. 2 the comment about the impact of cold ENSO, did the authors check this in these simulations or just assume this is the case based on previous studies.

Page 4 section 2.1 It might be useful to add a couple columns to table 1 which states which models included solar variability and aerosols impacts from volcanic eruptions. The authors seem to indicate it is included in all models and I know this is not the case.

Page 7 section 3 "In the upper stratosphere . . .circulation in the mesosphere." Have the authors looked at the frequency of sudden stratospheric warmings in the warm ENSO vs. neutral years. If the response you are seeing is from more frequent mid-winter warmings planetary waves can't propagate into the upper stratosphere/lower mesosphere which could cause the cooling response seen there.

Page 7 section 3 when you go to looking at 6 cases you mention that the response is smaller in the 2 additional cases with smaller ENSO anomalies. If the response you are seeing is robust you should be able to normalize the stratospheric temperature anomalies to some form of the ENSO index, so all cases could be compared to say a 1 or 2 SD warm ENSO anomaly.

Page 11 is it not clear what is meant in the last sentence by "non-linearity of the system".

Page 12 bottom of 1st par. you state there is a negligible contribution of the dynamically-induced chemical effects but it is not clear to me how this is shown. Wouldn't you expect that when polar stratospheric temperatures are anomalously warm from ENSO that less PSC formation would likely take place and that could impact ozone in February and March. It would be helpful if you state clearer why this does not appear to be the case.

Page 15 last sentence 1st par. Please see comment 3 in major comments section and reword unless you can show no significant relationship between delta T and delta O3

in neutral years.

Technical corrections:

Page 10 second line form the bottom change "demonstrate" to "demonstrates".

Page 13 point 3 line 3 I think you mean "trough" instead of "through".

Page 13 point 3 line 4 change "tropospheirc" to "tropospheric".

Page 13 second line from bottom change "depends by" to "depends on"

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 12141, 2009.