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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 #1

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This paper discusses the well known link between ENSO and the extratropical stratosphere. In El Nino years, greater planetary wave generation in the troposphere, and subsequent propagation into the stratosphere, leads to an enhanced Brewer-Dobson-Circulation and a more disturbed polar vortex. As in

Impact of prescribed SSTs on climatologies and long-term trends in CCM simulations, H. Garny, M. Dameris, and A. Stenke, Atmos. Chem. Phys. Discuss., 9, 4489-4524, 2009

a further link is drawn between ENSO and extratropical stratospheric ozone

concentrations (increased primarily due to an enhanced Brewer-Dobson-Circulation). The new work of this paper is to define an index to quantify the tropospheric stationary wave anomaly of El Nino years, and to demonstrate that this correlates well with anomalous temperature and ozone in the extratropical stratosphere in El Nino years using the CCM 21st century integrations carried out for CCMVal.

Major comments:

1) One of the key results of this paper is the definition of a ΔZ index which quantifies the enhanced tropospheric planetary wave anomaly in El Nino years. The way in which this enhanced planetary wave anomaly will affect the extratropical stratosphere is through planetary wave propagation from troposphere to stratosphere. It is thus an important link in the argument of this paper to check that ΔZ correlates well with the vertical EP flux across the tropopause (i.e. - planetary wave flux from the troposphere to the stratosphere). Please consider carrying out this analysis and adding a scatter plot to show the results.

2) Another key result of this work is Figure 5. This Figure shows the very high correlation between $\Delta O3$ and ΔT. These indicies are both formed by taking the difference [(El Nino years) - (Neutral years)], in other words the same sets of years. What the Figure shows, therefore, is that anomalously high ozone concentrations in the polar stratosphere are well correlated to anomalously high temperatures in the same region. This high correlation would be expected due to

i) an increased Brewer-Dobson-Circulation (which will lead to both increased ozone concentrations and temperature)

ii) enhanced diabatic heating, due to increased ozone, leading to enhanced temperatures

I think the authors need to provide good justification that a link to ENSO is needed to explain this high correlation – I don't think it is.

Minor comments:

1) In the Introduction, after "can favour the enhancement of mid-latitude planetary waves" please add a relevant reference. Perhaps:

Manzini, E., M. A. Giorgetta, M. Esch, L. Kornblueh, and E. Roeckner (2006), The influence of sea surface temperatures on the Northern winter stratosphere: Ensemble simulations with the MAECHAM5 model, J. Clim., 19, 3863–3881

2) Page 7, line 10: "found that the change of ozone during one year is directly related to the ozone change during the same year" This statement is trivial. I assume you mean the following year rather than the same year?

3) Page 8, line 1: I'd suggest "but it is about the double for ERA40 above." → "but it is about double for ERA40 above this height."

4) Page 8, lines -4 – -2: I do not agree that the presence of internal stratospheric variability is enough to claim that the ERA40, SSU and model results are consistent. The multi-model mean will remove much of this internal variability and so should look similar to the ERA40 and SSU data. However it is clear from Figure 2 that the multi-model mean is qualitatively different from the ERA40 and SSU data. Please, instead, comment on the nature of the differences.

5) Page 9, lines -6 – -4: "This result shows that the ENSO tropospheric stationary wave anomalies are stronger for ERA40 that for the majority of the models". This is an

important point – you have shown that most models under-represent an important mechanism. You might consider making more of this point. (This relates to your point 4 on Page 14).

6) Page 9, line -3: You might comment that a correlation of 0.31 is a bit low (it explains less than 0.1 of the variance, and 86% significance is below the usual 90% or 95% confidence intervals usually quoted).

7) Page 12, Figure 6: The authors might consider adding a reference to

Impact of prescribed SSTs on climatologies and long-term trends in CCM simulations, H. Garny, M. Dameris, and A. Stenke, Atmos. Chem. Phys. Discuss., 9, 4489-4524, 2009

who also considered the effect of SSTs on polar stratospheric ozone concentrations.

8) Page 20: References to Hamilton and to Hadjinicolaou should be swapped around to maintain alphabetical order.

Typographical errors:

1) Page 3, line -7: "participated to" → "participated in" or "contributed to"

2) Page 3, line -3: "necessary similarly" → "necessarily similarly"

3) Page 4, line 9: "may be in partly due to the smaller SSTs anomalies occurred"→ "may be partly due to the smaller SST anomalies that occurred"

4) Page 5, line 5: "consists" → "consist"

5) Page 5, line 12: “heights" → “height"

6) Page 6, line 3: “In this analysis, no distinction between models including or not the QBO or the solar cycle is performed" → “In this analysis, no distinction is made between models that include the QBO or the solar cycle and those that do not."

7) Page 7, line 12: “Therefore it interesting" → “Therefore it is interesting"

8) Page 10, line -2: “demonstrate" → “demonstrates"

9) Page 11, line 5: “)" has no corresponding (

10) Page 13, line -2: “depends by" → “depends on"