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Atmospheric Chemistry and Physics Discussions

Interactive comment on "How Does Downward Planetary Wave Coupling Affect Polar Stratospheric Ozone in the Arctic Winter Stratosphere?" *by* Sandro W. Lubis et al.

Anonymous Referee #4

Received and published: 15 September 2016

The manuscript analysis the instantaneous and cumulative impact of (Downward Wave Coupling) DWC events on Arctic ozone. While it is well known that planetary waves impact polar ozone through modulations of the residual circulation and stratospheric temperatures, the study adds new aspects by explicitly investigating the impact of DWC events on ozone via vertical advection and eddy transport. The analysis is convincing and highlights the role of wave reflection for high latitude ozone field. I recommend publication after addressing the following comments.

1) Directly comparing the impact of DWC events on ozone with the impact of upward wave events somehow implies that positive wave activity (as seen before the DWC) without the occurrence of wave reflection would turn into such strong upward wave

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events. The line of argumentation (and in particular the wording '. . . prevents ...') reinforces this impression (e.g., line 265). Please clarify if DWC events indeed prevent large positive ozone anomalies as shown in Figure 4 and 8. If this cannot be clearly concluded revise the text accordingly.

2) Some aspects of Figures 2 and 6 are not discussed in the text. Why does the vertical advection imply negative ozone tendencies in the upper stratosphere in case of upward wave events? This can be discussed by using the shape of the ozone VMR profile. What about the instantaneous chemical response in the upper stratosphere? Why does the upper stratospheric signal of the eddy transport from upward wave events last much longer in the model simulation?

3) It is not at all clear why at the end of the winter the dynamical composite gives positive ozone anomalies for reflective winters (Figure 12e). This needs to be clearly explained and related to the weaker or reversed ozone transport. The argument from line 413 is confusing since sharpened meridional gradients should even more so result in negative anomalies in case of less transport.

4) The positive chemical ozone anomaly in reflective year's midwinter (Figure 12c) is not mentioned or explained in the text.

5) Please explain if Figure 1 is based on a DWC composite or a single DWC event?

6) Line 190: Deceleration doesn't necessarily result in adiabatic cooling.

7) Line 211-212: The negative and positive values seemed to be almost at the same level (instead of in the 'upper' and 'lower' stratosphere.)

8) Line 216: Or transport out of the polar vortex?

9) How were the terms in Figure 2 calculated? Are the DYN and CHM+ANA composites MERRA-2 output? Are the composites in 2d-2f calculated with equation 2? Are the terms consistent (i.e. is the sum of 2d-2f the same as DYN)?

10) Line 395: Is the direct effect mentioned here the effect over the DWC life cycle? This was shown to be nearly zero and not a 'weak increase'.

Minor comments:

1) Line 95: AURA -> Aura

2) Line 169: Please explain the minimum ozone term in Table 1. Is this the ozone tendency related to the date of the DWC (and this not necessarily a temporal minimum)?

3) Line 222: 2e -> 2d

4) Caption Figure 1: a-d -> a-b

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