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Geoscientific Model Development Discussions

Interactive comment on "Experiments on sensitivity of meridional circulation and ozone flux to parameterizations of orographic gravity waves and QBO phases in a general circulation model of the middle atmosphere" *by* A. V. Koval et al.

Anonymous Referee #2

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This paper uses a simple model to look at the influence of orographic gravity waves (OGWs), and the QBO phase, on the stratospheric circulation and, therefore, on ozone fluxes in the middle atmosphere.

The use of simple models to study the effects of a single physical process can be very useful. Indeed, there are a number of comprehensive General Circulation Models (GCMs) which still do not include internally generated QBOs, and the necessity of Earth System models performing climate change simulations to be built on a GCM which does simulate a QBO could be a conclusion of this paper.

However, the analysis in this paper is quite simple - OGWs and the QBO have an influence on the simulated vertical velocity and this has a direct impact on the vertical flux of ozone. The impact of the QBO on the residual circulation is well known (Baldwin et al., 2001: The quasi-biennial oscillation). The impacts of planetary wave drag, orographic wave drag, and non-orographic wave drag, on the stratospheric meridional circulation have been studied and quantified for several GCMs (Butchart et al., 2006: Simulations of anthropogenic change in the strength of the Brewer–Dobson circulation; Butchart et al., 2011: Multimodel climate and variability of the stratosphere). Indeed, the idea that, unless the mean winds are altered, changes in OGW will be compensated for (and cancelled out) by changes in planetary waves has been suggested (Cohen et al., 2013: Compensation between resolved and unresolved wave driving in the Stratosphere: Implications for downward control; Cohen et al., 2014: What drives the Brewer-Dobson Circulation?) such that the impact of OGW described in this paper may not even be realised in GCMs. The effect of transport on ozone is also not the whole story, as ozone concentrations will depend on local sources and sinks as well as fluxes. A method to split these two effects in chemistry-climate models has also already been considered (Garny et al., 2011: Attribution of ozone changes to dynamical and chemical processes in CCMs and CTMs).

As such, I feel that this paper adds little to our current scientific understanding. More in depth analysis of the effects of OGW and the QBO needs to be included, and proper reference should be made to the existing literature. Further, it is not clear why OGW has been focused on, and not planetary waves and non-orographic gravity waves also.

In general, the use of English in this paper needs improving. I would recommend that any revisions be proof read by a native English speaker before submission.

MINOR COMMENTS

Section 2.1: The ozone distribution used in MUAM is compared to Randel and Wu (2005). How does this compare to the newer AC&C/SPARC ozone (Cionni et al., 2011:

Ozone database in support of CMIP5 simulations: results and corresponding radiative forcing) and BDBP ozone (Hassler et al., 2008: Technical Note: A new global database of trace gases and aerosols from multiple sources of high vertical resolution measurements; Hassler et al., 2009: A vertically resolved, monthly mean, ozone database from 1979 to 2100 for constraining global climate model simulations) climatologies?

Section 4.1: If differences greater than 0.1m/s are significant (at the 95% level), it would be useful to include the 0.1m/s contour in Figure 2. Further, you refer to differences as a percentage of the total meridional velocity. It might be useful to add additional panels to this Figure, plotting these percentages.

Section 4.1: Add more detail on the physical reasons why the patterns in Figures 3(b) and 3(c) (and also Figures 4(b) and 4(c)) look so similar.

VERY MINOR COMMENTS AND TYPOGRAPHICAL ERRORS

Equation 1: Two different Greek symbols are used for latitude. Please use one or the other.

Section 4.1: Figures should be referred to in numerical order. Currently Figure 2 is referenced before Figure 1.

Equation 5: Need to define rho_i.

Interactive comment on Geosci. Model Dev. Discuss., 8, 5643, 2015.