

Interactive comment on “Interannual variability of the gravity wave drag – vertical coupling and possible climate links” by Petr Sacha et al.

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Responses to the referee’s comment on paper “ *Interannual variability of the gravity wave drag - vertical coupling and possible climate links*” by Petr Sacha, Jiri Miksovsky, and Petr Pisoft.

We would like to thank the referee for taking the time to review our manuscript. We greatly appreciate the insightful and constructive comments, which we address in our responses below.

C1

Major comments:

1) *The author solely relies on the orographic gravity wave drag parameterization scheme of the CMAM model to examine the inter-annual variability of the orographic gravity wave drag. However, the tuning procedure as mentioned in the research may potentially overestimate the role of orographic gravity wave as compared to non-orographic source such as convections. How does the choice of tuning parameters in the orographic gravity wave drag scheme affect the conclusions in this research?*

Thank you for this comment; it is a very good point. The settings of the OGWD and NOGWD parameterization scheme used in the CMAM-sd simulation are discussed in details in McLandress et al. (2013) and we will add a paragraph in the revised manuscript to make a clear summary discussing limitations connected to our results.

The tuning of OGWD consists of arbitrary choosing a value of dimensionless parameters controlling the total value of launch momentum and the vertical flux of horizontal momentum. As an indirect effect the breaking level of the waves is influenced by this setting. The nudging procedure (its influence is discussed in more detail in reply to REF1) helps to reach realistic distributions of momentum fluxes but the breaking levels and OGWD value are largely influenced by this arbitrary tuning.

As for the overestimation of the OGW relative to NOGW role, we entirely agree and it is certain that at the analyzed levels the overestimation is present. We will stress this out more in the revised version together with statement that our conclusions are directly applicable at the model atmosphere only and thus having indirect implications for the real atmosphere (as already stated in the current version of the discussion).

Let us follow with an excerpt from the reply to REF1: It would be very interesting to look at NOGWD variations connected with variability of jets, fronts

C2

etc. However, the CMAM NOGWD scheme (Scinocca, 2003) is based on launching a globally uniform isotropic NOGW spectrum in four cardinal horizontal directions at approximately 125 hPa. The aim is to produce reasonable seasonal evolution of the zonal mean zonal temperature and winds in the mesosphere and the zonal and meridional asymmetry stems from propagation effects only. Regarding NOGWD, we have produced the same analysis as for the OGWD but due to the above mentioned reasons the resulting fields are highly zonally symmetrical and weaker in magnitude compared to the OGWD and so we decided not to show them in the manuscript. However, we attach selected figures as a supplement to this response.

We expect the NOGWD interannual variability in the upper troposphere-lower stratosphere region to show highly zonally asymmetric behavior (storm track shifts, distribution of convection, etc.) and in our future research we would like to analyze a dataset that would at least roughly capture this.

2) *The QBO in this simulation is potentially affected by nudging. How is QBO represented in the simulation as compared to the observation? And how sensitive is the relationship between orographic gravity wave drag and QBO to nudging?*

The QBO representation is close to reality due to the nudging (for instance, the Pearson correlation of the CMAM-based and observational QBO index is 0.96 over the 1979-2010 period) and therefore also the modulation of the OGWD by QBO should be realistic. OGWD is very sensitive to the QBO mainly due to modulation of the background for the GW propagation. In our results we can also see some QBO influence on OGWD sourcing - probably due to polar vortex teleconnection. It would be highly interesting to look at the QBO influence on NOGW sourcing (convection etc.), but, as discussed above, we are not able to assess this in CMAM.

C3

Minor comments:

1) *The wind vectors in figure 1, 4 and 5 are too thin to see, it help vision if the wind vectors are drawn thicker.*

The figures will be adjusted in the revised version of the paper.

2) *In figure 2, it would be more concise if the standard deviation of the wind vector amplitude (norm of the wind vector) due to orographic gravity drag rather than both zonal and meridional components are shown. This is also the case for Figure 3.*

The figures will be adjusted in the revised version of the paper.

3) *In Figure 8, 9 and 10, the author mentioned the fractions are explained by “both component”, does this mean the combined norm variance of the 850-hPa wind vector?*

The value in question represents a coefficient of determination (R^2) associated with the multiple regression mapping using both components of 850 hPa wind (eastward and northward) as predictors; the captions of the figures have been updated to better explain this.

4) *Acronyms such as PW, SSW, IGW needs clarification.*

The acronyms will be correctly introduced in the revised version of the paper.

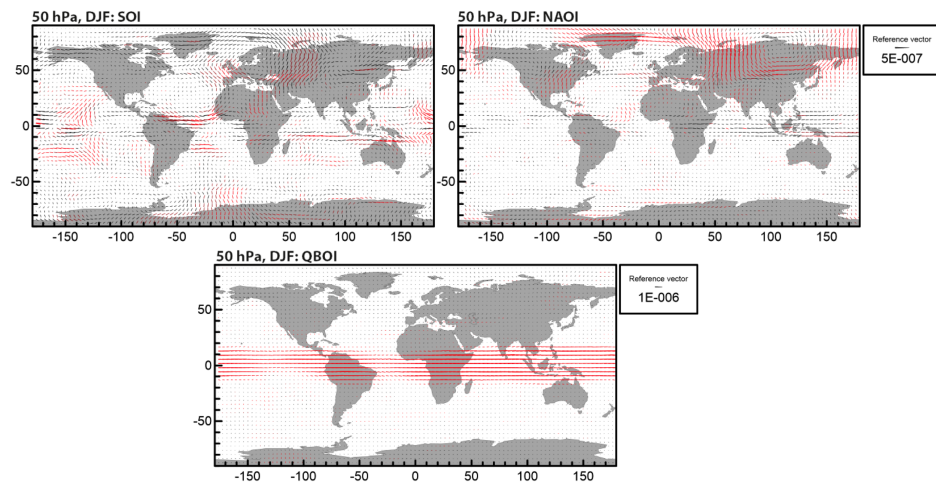


Fig. 1. Response of the non-orographic GWD [m/s/s] at the 50 hPa level related to the activity of the Southern Oscillation (left), North Atlantic Oscillation (right) and Quasi-Biennial Oscillation (bottom)