Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-870-RC4, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Stratospheric Variability at a glance – Analysis of the intra decadal timescale and the QBO" *by* Duy Cai et al.

Anonymous Referee #3

Received and published: 3 January 2017

Thank you to the authors for their quick response to my comments. I'm replying in order to add some further details re. my two main criticisms of the paper.

1) Re. the intradecadal timescale, the Authors replied: "To our knowledge this is the first time that the relevance of the QBO has been addressed by power spectral analysis for the intra decadal time scale."

The QBO's timescale is intradecadal, since it has a period of roughly

2.4 years. The QBO period is variable, and the QBO may be influenced by other low-frequency phenomena (e.g. ENSO) and so the QBO peak will appear somewhat smeared out in a power spectrum. So I do not understand what is novel about Fig. 1 and 2, since it seems to me that the power spectra show exactly what you would expect to see. Power spectra have of course been shown in previous studies (e.g. Pascoe et

al. 2005, Fig 3).

I do not understand why you emphasize "for the intra decadal time scale"

- I presume this means simply that your power spectrum covers periods up to about 10 years. But if there is something special about this approach that I have misunderstood, please explain (if I have missed it, perhaps other readers may also miss it). Finally, re. Fig 2, I don't understand what is the null hypothesis for this statistical test. If the null hypothesis is that there is no QBO, it doesn't seem a very useful test since this existence of the QBO is established beyond any reasonable doubt. The way the paragraph at lines 151-158 is written suggests that your null hypothesis is that there is no QBO. But if this is not what you meant then you need to more clearly describe your null hypothesis.

2) Re. the MRG waves, I agree that you have demonstrated clearly that the representation of these waves in your model differs substantially between the high-vertical resolution and low-vertical resolution model versions. The calculation from linear wave theory (Fig. 6) is useful to explain this result, but it is not in itself new. Boville and Randel 1992, which you cite, already showed this. More importantly, though, your results don't demonstrate that the MRG wave is very important for the QBO in your model or in ERA-Interim. Without determining this, you cannot claim that inadequate resolution of the MRG wave is the key factor determining why vertical resolution is important for modelling the QBO. It has been well known for some time that realistic levels of Kelvin and MRG wave activity are insufficient to drive the QBO by themselves, and substantial forcing from gravity waves is also required.

The forcing by the MRG tends to be smaller than that due to Kelvin waves, e.g. Kim and Chun 2015, Fig 2. To determine how important is the MRG forcing, you need to calculate the terms in the zonal momentum budget. If the MRG turns out to provide a substantial fraction of the wave forcing in your model, then it might be an important factor determining why a QBO occurs at high vertical resolution but not at low vertical

resolution. Note, however, that since changing the vertical resolution of the model also changes the background zonal wind state, in comparing the two model versions you are not only comparing the effects of changed vertical resolution on the waves, but also the effect of a changed background state.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-870, 2016.