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Geoscientific Model Development Discussions

Interactive comment on "Vertical resolution dependence of gravity wave momentum flux simulated by an atmospheric general circulation model" *by* S. Watanabe et al.

Anonymous Referee #2

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Review of "Vertical resolution dependence of gravity wave momentum flux simulated by an atmospheric general circulation model" by Watanabe et al.

Summary:

This paper examines the impact of a model's vertical resolution on the gravity wave (GW) momentum flux (GWMF) in the stratosphere. Since the model has high horizontal resolution (∼0.5 deg), only very short (one-week) simulations could be performed. The authors find that when the vertical resolution in the stratosphere is increased from 1 km to 0.2 km the (eastward) GWMF in the stratosphere is significantly reduced, which is contrary to what happens when horizontal resolution is increased. They attribute

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the reduced GWMF in the stratosphere in the high-vertical resolution simulation to the presence of short vertical wavelength GWs near the tropopause.

General comments:

This is an interesting study, which could have important implications for GW parameterizations used in coarse horizontal resolution models. My major concern is that the experimental set up the authors have used has somehow strongly impacted on the results by causing the spurious generation or supression of the longer vertical wavelength GWs that propagate into the stratosphere. There are a number of questions concerning the experimental set up that are unaddressed. To generate the initial conditions for the high resolution run they simply interpolate the initial conditions of the low resolution simulation to the finer grid. Is it possible that this could have somehow changed the longer GWs? The authors consider the possibility that the different initial conditions have resulted in changes in the evolution of the tropospheric circulation, but the figure they show to demonstrate that this does not impact on the stratospheric GWs (Figure 2) is highly qualitative. Is it possible that the tropospheric circulation (or perhaps the region of deep convection) has changed so that the generation of the longer GWs generated by the convection is different?

The authors therefore need to more deeply examine the possible impact of their experimental set up on the results. They need to demonstrate that the longer vertical wavelength GWs propagating up from the lower troposphere (i.e., the region below 8 km where the model resolution is the same for all simulations) is largely unchanged for the different simulations. They also need to tone down their statements regarding cause and effect that appear in the abstract and conclusions. Based on the scanty evidence that they provide, statements like “GWs with short vertical wavelengths likely play an important role in determining the GWMF in the stratosphere and mesosphere since they are unjustified and misleading.

Recommendation: Major revision

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Specific points:

Abstract (l.10-12); “found that inertial GWs with short vertical simulated at higher vertical resolutions likely play an important role in determining the GWMF in the stratosphere and mesosphere.” – the word “likely” is far too strong based on the scanty evidence that is provided.

p.7560 l.16: “deep individual convections” –> “convective systems”

p.7560 l.22: “studied in great depth” – change “great” to “considerable” since there hasn’t really been that many studies of the effects of horizontal resolution on GWs.

p.7561 l.5: “covering” –> “coverage”

p.7561 l.20: “horizontal wavelengths from 188 to 40000 km”. This is true at the equator, but due to the convergence of meridians shorter wavelengths are resolvable at higher latitudes.

p.7562 l.22: “meteorological” is mispelt

p.7562 l.23: What is a “spherical” filter?

p.7562 l.26: Explain why only the eastward component of the GWMF is discussed (i.e., easterly background winds in stratosphere filter out westward propagating GWs).

p.7564 l.17: Explain why the GWs in the lower stratosphere are found to the east of the strong precipitation. This is presumably a result of filtering by the background winds, since near the convective source region I would expect that the forced GWs would be propagating in all directions.

p.7566 l.11-14: The existence of low-frequency thin GWs in the lower stratosphere likely causes . . .” – the word “likely” is far too strong based on the scanty evidence that is provided.

Figure 3: The purple contours are difficult to see, and the contour labels impossible to

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read. Since the point of plotting the heating is presumably to show where the strongest convection is, I suggest plotting only a single but thick contour for a value of large heating.

Interactive comment on Geosci. Model Dev. Discuss., 7, 7559, 2014.