

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 #1

Received and published: 15 December 2014

The paper is concise and describes sensitivity experiments with an atmospheric general circulation model investigating the effect on gravity wave momentum fluxes of increasing the vertical resolution. A global model with a high model top (150 km) and with high horizontal resolution (0.56°) is used. Five runs with different vertical resolutions above 8 km are carried out. The authors show that the GW momentum fluxes are much stronger (by a factor 2-3) in the simulation with the poorest vertical resolution ($dz=1000\text{m}$), and that they decrease as vertical resolution increases. This is a surprising result, contrary to what is expected based on sensitivity experiments on the horizontal resolution (GW momentum fluxes increase with resolution). The authors illustrate that this is likely due to a lack of filtering in the simulation with poor vertical

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resolution, resulting in too many waves present in the stratosphere and mesosphere. They use this short paper as a means to open a discussion on possible mechanisms that could lead to this surprising behavior.

On one hand, the paper is well-written and present stimulating results. On the other hand, it is perhaps shorter than it should be, even if the purpose is only to start a discussion by a stimulating, counter-intuitive result. Indeed, with the simulations that are obtained, it seems that it should be possible to explore a bit more the behavior of the gravity waves, especially how the sensitivity to vertical resolution varies with latitude. Hence I recommend to accept the paper after major revision, addressing the points below.

Major points:

1. All the figures are for latitudes between 35 and 40°N. Is this behavior also observed at other latitudes?
2. There is significant orography in these latitudes, but the authors only insist on convectively generated waves; are there occurrences of orographic waves? In other latitude bands (e.g. in the winter hemisphere, near the Andes) what is the sensitivity to the vertical resolution? It would be expected that the GW generated there are higher frequency, with deeper wavelengths, and so that there is less sensitivity, is this right? On the other hand, non-orographic gravity waves from jets and fronts presumably have near-inertial frequencies, so that there should here again be significant sensitivity. Is this right?
3. In locations where deep gravity waves are present (with wavelengths in the vertical of 6 km or more), how comparable are the different simulations?
4. Figure 4 is obscure and hardly referenced in the text (p7565). The authors should either remove it or make a more significant use of it and improve considerably the figure.

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Minor points:

p7561, line 20: 'wavelengths from 188 to 40 000km': awkward; please rephrase, e.g. 'wavelengths larger than ~ 190 km'.

p7561, lines 23-25: the sentence is mysterious, I do not understand what the meaning is. What are the 'observed phenomena'? In what sense fo explicitly resolved GWs explain these?

p7562, line 22: typo: Metrological

p7562, line 25: again, why such a precise lower bound (188 km)? Would 'shorter than 950 km' be sufficient? (Same for the caption of figure 1, and in the conclusion...).

p7565, lines 1-2: please provide one or more references to illustrate the observational evidence confirming the existence of a peak at near-inertial frequencies.

p7565, line 2: 'the lowest inertial frequency': do the authors mean 'lowest intrinsic frequency'?

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

GMDD

7, C2659–C2661, 2014

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