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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characteristics of gravity waves generated in a baroclinic instability simulation" *by* Y.-H. Kim et al.

Anonymous Referee #1

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General Comments

Overall I found this paper to be well written. The results presented are notable, and the authors invoke some novel analysis techniques to describe the waves generated in the simulations. This paper will be a useful contribution to the literature on wave generation at jet/front systems. I therefore recommend acceptance subject to the authors addressing my comments below.

Specific Comments

Page 32640

1. Title. The title seems to be a bit generic. It could be a good idea to include something about jets/fronts in the title, since this appears to be the focus of the paper.

2. Abstract L4,11: The shortened labels for the waves (W1,W2,W3,...) while useful in the main body of the paper should not appear in the abstract.

3. L8 "...eastward, which is difficult for the waves to propagate..." This sentence doesn't make sense. Perhaps split into two sentences e.g. "...eastward. These waves have difficulty propagating upward..."

4. L13 "The generation mechanism ... is discussed". Please state your results as to what this generation mechanism actually is, i.e. generation at the surface front.

5. L4,13 It would be better to not use the acronym (GW) in the abstract.

Page 32641

1. L5/6. Presumably your simulations are initialised in a balanced state, so any mechanism of generation is going to be "spontaneous" — therefore, is geostrophic adjustment (which is the system adjusting to unbalanced initial conditions, e.g. Rossby 1938) actually relevant here? I suggest removing "geostrophic adjustment" and just retaining "spontaneous balance adjustment" – also sometimes called spontaneous adjustment emission (SAE).

2. L6/7 What is the difference between unbalanced instabilities and shear instability, or is shear instability a class of unbalanced instability?

Page 32644

1. L8. "Considerably small amplitudes" – I think you mean "negligibly small amplitudes".

2. L10. Please define "Running average" a little more carefully. Does this have a time window over which averaging occurs (i.e. a moving average) or is it an average over all time from initialisation to the present instant? Why/how did you make this choice? A mathematical expression defining the background flow field would be helpful.

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1. Just a comment. I really like the idea of separating out the wave packets via decomposing the spectral domain into various sectors. I haven't seen this done before but it seems a very useful technique.

Page 32650

1. L16. "...the isoline of c corresponds to an isoline of the vertical wavenumber m for a given background state, as mˆ2=Nˆ2/cˆ2". I don't understand where this formula came from. I get cˆ2=wˆ2/Kˆ2 where wˆ2= fˆ2+Nˆ2 Kˆ2/mˆ2 for hydrostatic waves. This only reduces to your result if you are assuming that Kˆ2/mˆ2»fˆ2/Nˆ2. Are you making this assumption? In either case, please state where the formula comes from and any assumptions involved.

2. L26. "Resonant generation of waves". Is this really a mechanism of generation? I agree that the vertical flow structure can be responsible for selecting the dominant scale of the waves. However, I don't see how resonance (which is a scale selection and amplification process) can be responsible for the initial generation of the wave. Surely the generation still requires some sort of flow imbalance, e.g. a sharp front?

3. L29 and following page L1: The formula from previous is stated again here c=Nˆ2/mˆ2. Note that a power-of-2 is missing on the c. Also refer to my comments above regarding where this formula comes from? Further, please explain why this formula leads to an arc-shaped spectrum in the c-phi domain (as stated on L1 of the next page). Its not clear to me why this must be the case.

Page 32652

1. L3-5. What wavelet function are you using? I don't understand the reasoning for the multiplication by exp(-z/(2H)). Why is this done?

Page 32654

1. L13,17. Here you discuss that the waves might be damped by model diffusion. What are the values of the model diffusivity and viscosity used in these simulations?

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Page 32658

1. L12-14. You state that the “GWs are generated by the surface front”. However, there are many mechanisms of surface front generation; e.g. strain flow acting over a front (Shakespeare 2015, JAS) — this is a linear process — and where the front behaves as an obstacle to the surrounding flow (Snyder et al, 1993, JAS, also seen in Shakespeare 2015) — this is a non-linear process. Note that both mechanisms give waves that are stationary relative to the front. From your results, it seems that the second mechanism is the one operating in your simulations, but you could check this by evaluating the magnitude of the large-scale confluence (needs to O(0.2f) or greater for the first mechanism).

Page 32660

1. I like the analysis using the frontogenesis function. However, it would be useful to label the packets (W1,W2, etc) on figure 11 to avoid the need for complicated descriptions of their locations e.g. “58-65 deg N west of 30 deg E”.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 32639, 2015.