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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Observation and a numerical study of gravity waves during tropical cyclone Ivan (2008)" *by* F. Chane Ming et al.

Anonymous Referee #1

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The paper describes a case study of waves generated by a tropical cyclone (TC) using several observational datasets, ECMWF analyses and mesoscale numerical simulations. Multiple analyses of the gravity wave field are carried out, and the evolution and role of spiral rainbands are also briefly addressed. The emphasis is on waves with moderate to large horizontal wavelengths (larger than $\sim$ 40 km). The paper describes many results and brings interesting and useful material. Nonetheless, it could be improved regarding the following issues:

1. The presentation of results could be improved; many aspects of the gravity waves are quantified, many numbers are given, but it is sometimes hard to follow why such or such characteristics are emphasized, or what relevance such or such

numbers have. A critical and quantitative assessment of the gravity waves encountered is lacking. For example, in the abstract (lines 12-14), a dominant wave packet and its characteristics are described. No estimate of its amplitude (temperature and/or wind fluctuations, momentum or Eliassen-Palm flux) is provided. There are a number of ways to quantify gravity waves, depending on the context, but it is essential that some quantitative assessment be included. In particular, in the conclusion, the authors should discuss which wave packets have largest amplitudes, and include a discussion of the observational filters of their different datasets and what that implies for their conclusions.

2. The paper focuses on rather large-scale gravity waves, for several reasons:

   - observations such as radiosondes tend to emphasize large-scale waves,
   - the altitude interval over which anomalies are investigated (10-15km for the Upper Troposphere (UT), 18-22 km for the lower stratosphere) implies that only waves with fairly short vertical wavelengths ($<$ 5km) are analyzed in the radiosondes;
   - the ECMWF analyses, by construction and by limitations of the resolution, describe mostly the low-frequency part of the GW spectrum.
   - the mesoscale model resolution ($\Delta x = 4$km) will allow description of waves with wavelengths larger than 40 km. In the vicinity of strong convection, high-frequency waves with wavelengths closer to the size of individual convective cells, hence shorter than 40 km, are expected.

   This is fine and important waves (e.g. figure 8a) are described.

3. Much analysis is carried out, using several methods. In serveral places, the manuscript tends to describe too much the results from those methods (e.g. lists of peaks of FFT spectra), rather than extracting in a clear, simple way the main conclusion to retain from this analysis. As a result, it is difficult to identify what is

the main message, the main conclusion coming out of this study. For example, in Figure 8 one might prefer a fuller description of the large-scale wavepacket in physical space (vertical cross section), rather than the multiple analyses, using Fourier transforms and wavelets.

Minor points:

p10765: add 'the': useful for the simulation

p10766: it should be commented and emphasized that the chosen resolution ($\Delta x = 4$ km) is in the 'gray zone' regarding the representation of convection: it is not yet simulated, but parameterizations are no longer quite appropriate either at that scale.

p10768: it is chosen to analyze the radiosondes in a truly narrow range (5km in the upper troposphere and 4 km in the stratosphere. This seriously biases the analyses of GWs. Radiosondes favor the analysis of low-frequency waves. The choice of this altitude range reinforces the emphasis on short vertical scale waves, hence most probably on low-frequency waves.

p10768, line 23: why 'on the other hand'? This (58-70

p10769, line 9: 'It is consistent...' What does 'it' refer to here? The contrast between troposphere and stratosphere? The 'opposite'?

p10770, line 6: what method for the bi-directional 2D filter?

p10771, line 18: what is the vertical wavelength in the ECMWF? Is it consistent? As presented here in the text, the vertical wavelength is estimated from the other charac-

teristics, not diagnosed from the analyses. A vertical wavelength of 1-2 km is probably not resolved by the ECMWF. It is of interest to mention what the estimated wavelength is, what the simulated wavelength is, and explain the discrepancy if there is one.

p10773, lines 15-16: you assume that some eastward waves are absorbed. What is the reasoning? The wind increases, so waves with phase speeds within the interval of values taken by the wind speed will likely dissipate at critical layers? Or do you assume that the acceleration is the result of wave absorption in that layer? I would agree with the former, but not the latter (there are many other possible reasons for the wind to have variations in the vertical, regardless of gravity waves). (p10779 line 10-12 suggests that the authors had the second explanation in mind).

p10774, lines 21-23: what about the amplitudes of the waves? Here as in many other places in the text, the only focus is on wave characteristics, leaving aside whehter the amplitudes of the waves. Yet it is the latter that will largley determine if such or such waves are of importance.

p10775, in this part the amplitudes of the waves are discussed, using momentum fluxes to quantify them. This is good. Could the authors say more about the method to calculate the momentum fluxes?

p10775, line 11: what do you call a binary image?

p10775, lines 20-23: there are so many peaks in this FFT spectrum that the information is no longer useful.

p10776, lines 10-12: this part (comparison of the amplitudes in the mesoscale simulations and in the ECMWF) would need to be detailed furhter. How much larger are the waves in the mesoscale simulations (wind perturbations? momentum fluxes?). How is the comparison at different scales?

p10776, line 12: it is only 'suggested' 'that the GWs are better represented in Meso-NH simulations' than in the ECMWF. Given the resolution in the mesoscale model (dx=4

km), why is the difference not more striking?

p10777, lines 5-8: separate the sentence on E-W intensity and eye size into two sentences; as such it is too difficult to read.

p10777, lines 21-22: is this the main message here (that TC rainbands contribute to the energy dissipation)?

p10778, line 1: there should be one 'mean size', not four values. Or else the authors should state that the rainbands have widths varying between 15 and 60km.

p10779, lines 10-15: does the enhancement during landfall involve orographic waves?

p10780, line 1: plural, singular for TC? (a ... TCs)

p10780, lines 1-12: all this discussion of different numerical results can only make sense if the resolution of these different simulations are also critically taken into account.

p10780, lines 13-24: this paragraph would have its place in the introduction

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 10757, 2013.