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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Aircraft measurements of gravity waves in the upper troposphere and lower stratosphere during the START08 Field Experiment" *by* F. Zhang et al.

**Anonymous Referee #1**

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This study presents some detailed observations and complex spectral/wavelet analysis of research aircraft measurements of gravity waves. The waves were observed during START08 and represent a unique dataset to study gravity waves associated with jets. The paper is well structured and provides new insight by quantifying the observed waves – it should be published in ACP. However, I feel that a little extra analysis could make this study more useful, both for quantifying the mesoscale signals and for understanding the wave generation. I suggest the authors consider these extra analyses, which shouldn't be too onerous, in their revised manuscript.

1. Spectral analysis (Figs. 4 and 5).

The authors claim that the spectra reproduce the -5/3 slope, which they do in many cases. However, because of the inherent properties of the spectra this slope is not entirely obvious in many cases, mostly because of the change in slope with scale. I suggest that the authors also complete spectra of kinetic energy (which includes horizontal and vertical velocities), which should show a -5/3 slope extending over more decades (especially in Fig. 5).

I can't determine the units of the spectra that are labelled as 'variance' but I assume they are in mˆ2/sˆ2 for the velocity components. It would be advantageous to plot the energy density (units of mˆ3/sˆ2) instead, which would allow direct comparisons to the cited studies (e.g., Nastrom and Gage 1985, Skamarock 2004).

2. Inferences about propagation direction

I think the manuscript would benefit from enhanced discussion about what can be inferred about horizontal propagation direction and how the superposition of gravity waves propagating in opposing directions can complicate the analysis. In particular, around line 20 on p 4739, there is discussion of cospectra varying sign. For example as shown in Fig. 7 (leg J3), the cospectra of w and p suggest upward propagating waves (almost exclusively). Thus, the variations in sign of the cospectra of u and w imply that this track is sampling waves propagating in both the forward and backward direction. As argued by the authors (p4740 line $\sim$5) this highlights a difficulty in interpreting the waves observed by aircraft, but it does tell us something useful about the wave field nonetheless.

For such legs it would be useful to obtain estimates of the net momentum flux. The analysis presented could readily separate the averages into positive and negative components, which should give a good indication of the dominance of which particular propagation direction as a function of scale.

Similarly, in section 5 – the authors provide detailed analysis of specific example of waves and their scales. From this analysis they should be able to infer the (intrinsic)



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propagation direction for each case considered, based on the sign of the cospectra of u and w, and the vertical propagation direction. This could be used to comment on the direction of propagation of the waves away from any key synoptic features presented in Fig. 2, and whether there is broad consistency between these sampled waves and those seen in WRF.

Minor comments:

1. p. 4727 line 15. Suggest changing to: “dominated by signals with sampled periods..” to be clear that this isn’t the wave period.

2. p. 4730 line 19. I don’t think this claim to be the ‘first’ is entirely correct. It may be the first such flight to actually aim to find the mesoscale gravity waves from jet/fronts, but previous studies/flights have measured them and analyzed them (e.g., Shapiro and Kennedy 1975; Koch et al. 2005).

3. To be clear: Do the authors ascertain that the small-scale signals represented in the data are entirely fictitious? Or is it that these signals do exist, but the sampling errors (associated with the violation of the assumptions about pressure) are very large making the spectral estimates unreliable?

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 4725, 2015.