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Atmospheric Chemistry and Physics Discussions

Interactive comment on "First tomographic observations of gravity waves by the infrared limb imager GLORIA" *by* Isabell Krisch et al.

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Discussion paper

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The manuscript describes a very interesting case study of atmospheric gravity waves using data from the limb imager onboard the aircraft. The tomographic method reveals the 3D propatgation of a gravity wave packet, the 3D ray-tracing simulation locates the potential wave sources and clearly reveals the horizontal propagation of GWs under the influence of background winds. The paper is overall well written and organized. It is suitable for publication after making the some revisions. Most of my comments are minor but some of them require more clarification and explanation.

1. Page 1, Line 2-3, the term ‘global atmospheric models’ see 6.
2. Page 1, Line 5, measured - observed/revealed.
3. Page 1, Line 12-13, the last sentence should be reworded
4. Page 1, Line 17, I donot see a good logic relation when using ’Thereby’.
5. Page 1, Line 20, add abbreviation QBO for quasi-biennial oscillation.
6. Page 2, Line 5, the term ‘global atmospheric circulation models’. Even there are more than one options, mostly GCM refers to ‘general circulation model’.

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7. Page 2, Line 14, there are more published papers about the gravity wave parameterization schemes such as Alexander and Dunkerton 1999, Beres et al. 2004 and 2005, Richter et al. 2010.

8. Page 2, Line 15, besides the source distribution, the launched wave propagation direction is another simplification.

9. Page 2, Line 24, polarization - polarisation, analyzed - analysed, you may skip this since they are just differences between American and Bristish English.

10. Page 2, Line 25, there are several published papers using multiple instruments (colocated or network) to study the 3D strucuture of gravity waves such as Lu et al. 2016 (two lidar and imager), Cao et al. 2016 (lidar and imager), Bossert et al. 2015 (lidar and imager).

11. Page 3, Line 5, remove 'measurement',

12. Page 3, Line 7, the title of this section could better be 'Data and Methodolody'.

13. Page 3, Line 18, I suppose less pixels are used thus the readout time is reduced.

14. Page 3, Line 23, what is the aircraft flight altitude? what is the altitude range the measurements are taken?

15. Page 4, table 1 caption, the second sentence: The last column indicates the retrieved quantity for each spectral range.

16. Page 4, Line 10, structure - signatures.

17. Page 4, Line 12, this part - which part? the altitude range?

18. Page 5, Line 7, what is the temporal resolution, such as the integration time or exposure time?

19. Page 5, Line 9-10, what is the evidence that this is a mountain wave? This is important because this is the prerequisite of fitting. Is it stationary or near-stationary during your 2 hour observation window?

20. Page 5, Line 12, remove 'as discussed in Sec. 3.2'. It is not proper to refer to something in latter discussions.

21. Page 5, Line 17, 'GW'-'GWs'.

22. Page 5, Line 18-19, what is the relation between S-G filter and the polynomial fitting?

23. Page 6, Line 1, 'direction'-'directions', 'taken'-'treated'.

24. Page 6, Line 2, 'can be seen' - 'is demonstrated'.

25. Page 6, Figure 2, I feel Fig. 2 could be improved for better visulization. Add $x - y - z$ coordinate to show the scale of wave structures. The colorbar for positive and negative temperature perturbation should be properly chosen (red-white-blue) to clearly demonstrate the wave pattern. Figure 3 of Wright et al. 2017 is a good example.

26. Page 7, Figure 3, the x-coordinate of bottom sub-figures could be just the distance, which is more straightforward to compare the scales of GWs.

27. Page 7, Section 3 title 'Analysis'-'Results'.

28. Page 7, Line 8, and the data plotted in Fig. 2 and Fig. 3, what is the horizontal resolution of the raw temperature measurements? You may clarify these basic information in the text.

29. Page 7, Line 9, '3D direction'- please clarify this direction, is this direction the wave 'propagation direction' or the orientation of the wave front? You assume it is

a mounain wave, so the wave is not really 'propagating'. So if it is the orientation of the wave front, is there a relationship between the wave front orientation and the mountain ridge orientation?

30. Page 7, Line 14, 'the strength of the coupling of a GW with the background', what does this mean? Does it mean the same as the forcing/drag of GW.

31. Page 7, Line 15, at the end add 'when they dissipate.'

32. Page 8, Line 1, since those wave parameters are derived from fitting, are there confidence intervals that can describe the robustness of the fitting, say the uncertainties of those fitted parameters.

33. Page 8, Line 5-6, the total momentum in the order of GN (10^9N) seems to be a gigantic number, what is the physical meaning of this total momentum? The force the wave exerts on atmosphere? And how do you distinguish these two waves spatially?

34. Page 8, Line 7, how do you quantify the GW and calculate MF from ECWMF model?

35. Page 8, Line 8, how do you calculate this 0.14%? Do you mean the largest 0.14% of the all GWs?

36. Page 8, Line 14, 'characterize'-locate or identify.

37. Page 8, Line 15, 'advance'-'advantage'.

38. Page 8, Line 17, in this condition, when ray-tracing is discussed, GW intrinsic parameters rather than MF matter here.

39. Page 9, Figure 5, this is the intermittency of the gravity waves, which is mainly described by this probability distribution. I suppose you can make a similar plot

using the MF derived from your observations, which I think makes more sense to quantify the intermittency of the gravity waves retrieved from your observations. If go further, the log-normal distribution can also be fitted in the probability distributions.

40. Page 9, Line 9-10, for each dot of different size, it could be better visualization if you add a white edge for each dot, then they can be still visible when overlapped with dense trajectories.

41. Page 9, Line 10-11, 'according to the GWMF at the source location', so here you implicitly assume the GWs do not undergo any dissipation when they propagate from source to measurement locations?

42. Page 9, Line 13-14, what is the point of this 6 hour, in your Figure 6A, you indicate it is a 1-day backward simulation. So is there any conflict between these two? Then, can we understand this time is related to the propagating speed of the wave packet, say how much time it takes to propagate from source to measurement location. If so, a speed (group speed?) could be estimated.

43. Page 10, Line 1-2, the turning of the wave vectors could be explained by the wave refraction.

44. Page 11, the ray-tracing simulation (backward and forward) of GW propagation and the comparsion between 1D vs. 4D run are dramatically interesting and important. I expect more discussions about the ray-tracing results, especially on how this study can advance our understanding of the horizontal propagation of GWs and insights into GW parameterization.

45. Page 14, Line 16, 60°.

46. Page 17, please skip the questions regarding the uncertainties of fitted GW parameters.