Review comments for "A comprehensive observational filter for satellite infrared limb sounding of gravity waves" by Trinh et al.

This manuscript extensively studied the effects of observational filter for limb sounders on retrieving the gravity wave momentum flux (GWMF) spectrum. Four aspects that impact the spectrum are thoroughly discussed: (1) visibility filter, (2) projection along tangent-point track, (3) aliasing effect, and (4) the slant profiling impact. Using SABER and HIRDLS instruments as two examples for exercise, and three source momentum spectra (MF1, MF2 and MF3) offline calculated from GCM simulations as the input, the filtered GWMF spectra are then demonstrated for the two instruments respectively. Instrument visibility and aliasing effect are found to be the most important two factors that skew the spectrum, and the other two factors are minor.

This is the first comprehensive study of the observational filter for GWs that is not limited to one specific instrument and/or one specific method to the reviewer's best knowledge. Although only SABER and HIRDLS are considered in the manuscript, the general strategy discussed in this paper is also applicable to other current and future satellite limb sounders, and not only suitable for infrared spectrum, but also applicable to microwave sounders, e.g., Microwave Limb Sounder (MLS), as long as the approach of retrieving GWMF is consistent with Ern et al. [2004; 2011]. Therefore, this work is novel and significant. The presentation is mostly clear, and the work is done with critical thinking. Therefore, it definitely worth a publication eventually after the following questions are addressed properly in the revised manuscript:

(1) my major concern is that this work is still too specific, as the factors #2 and #3 are only valid with Ern et al. [2004; 2011]'s methodology. If other methods, e.g., multiple collocated and coincident obs., are used, #2 and #3 need to be justified. Also, factor #1 only works for limb sounders. That's completely a different story for nadir sounder such as Atmospheric Infrared Sounder (AIRS). For nadir sounder, since the phase front information can be directly inferred from the cross-track scanning image, MF1 and MF2 may be much less weakened compared with limb sounder results.
    I do not intend to ask the authors to consider every situation. That's too complicated and not the aim of the current study either. My suggestion is to give a fair discussion of other methodology/observational technique, and possible impact therein.
(2) It is not surprise at all to see that MF3 is weakened the least by the observational filter. In general limb sounder is more suitable for studying slantwisely propagating GWs, while nadir sounder is more suitable for observing vertically propagating deep GWs (e.g., mountain GWs). As MF1+MF2 are designed to reach best-fit against AIRS observation, a justification of why using them here is needed. Choi et al. [2010, JGR] found the best-fit ray-based source spectrum with comparison against Aura MLS. As MLS is also a limb sounder, the spectrum found in their paper might make

more sense to be used in your study. If not too much work, I'd like to see what the performance would be.

(3) The authors claimed in the conclusion part that this work could aid on improving GWD parameterization in GCMs that are used for weather and future climate study. But how? Is there a strategy that you could roughly describe? In Preusse et al. [2014, ACP]'s paper, they sort of applied traditional step-by-step filter on the model simulations (i.e., instrument filter, and then retrieval method filter). This is also the way most model-obs. comparison works do at the current stage. Could you generalized filter be more efficiently applicable to model simulations?

(4) Some symbols have multiple meanings, e.g., beta in Fig. 5 and Fig. 8. This causes some confusion that should be avoided in the revised manuscript. Please refer to my suggestions on combining/changing some of your figures in the detailed comments below.

(5) How to correct or avoid the aliasing effect? It's not explicitly discussed in this paper, and this effect seems to be very disturbing.

Detailed comments:

P10773, L15: add "mostly" before treated. A great portion of GW spectrum can now be resolved in GCMs owning to the rapid improvement of model resolution.

P10773, L16: add "fully" before "resolved".

P10774, L16: I don't have the memory that Allen and Vincent [1995] did such a comparison with model. Please double check; I might have a wrong memory but I can't find a copy of their paper at this moment.

P10775, L23: Wu and Eckermann [2008] talked about MLS. It is Gong et al. [2012] that discussed about observational filter of AIRS.

P10776, paragraph 2: As I posed my concern in my major comment (2), please justify the appropriateness and/or shortcomings of using MF1 and MF2 in this study here or somewhere else.

P10779, L1-2: Delete "Figure 2… patterns." Redundant.

P10780, L4-9: Please cite 1-2 references about MERRA convection climatology. Also, as MERRA's topmost data assimilation level is the top of stratosphere (from AMSU-A), MERRA mesosphere is basically model output without observation nagging in. How reliable MERRA mesosphere is? Anyway, this should not affect your results, but may affect future instruments that may design to observe mesosphere GWs.

P10781, L21: change "we generated…spectrum")." to ""truth" is generated".

P10781, L25: change "for" to "from".

P10783, L3: add “(sigma)” after “GWMF”. It makes it easier to understand your Eqn. (3).

P10785, L9: Is there a way to see lumbda_$_{h,LOS}$ directly from Fig. 6?

P10788, Eqn (13): Maybe using the symbol k_N is better. kν may get the impression of Boltzmann constant and wave frequency is the reader happens to be from the remote sensing side.

P10788, Eqn. (15): right arrow is usually used in presentations, not in formal scientific paper. Please separate Eqn. (15) into two equations.

P10789, L1-4: How to correct/avoid this aliasing effect?

P10789, L23: are the red dots in your Fig. 1 corresponding to O1 and O2 in your Fig. 11? If yes, it’s good to put O1 and O2 in Fig. 1 as well and mention the correspondence here.

P10792, L13: The sharp discontinuities in MF1 and MF2 “true spectrum” making me wonder whether model has some issue on sub-grid scale treatment. Also, I’m wondering why there’s a dip of “true” spectrum in Fig. 17 for all three inputs around lumbda_z=10 km?

P10796, L5: add “s” after “wavelength”.

P10796, L8: change “effected” to “affected”.

P10797, L20, 21: change “and” to “with” in both lines.

P10798, L1: change “sub plots” to “panels”.

P10799, L5: add “the” before “largest”.

P10799, conclusions: You seem not consider instrument noise anywhere in your current study. Could you clarify? Even if your instrument scan is perfect to capture the entire 3D structures, the signal-to-noise ratio is still critically important.

P10801, L3-5: Please break this super long sentence into several short sentences.

P10801, paragraph 2: Interesting… It’s always puzzling me why MLS and AIRS have diurnal difference in GW variances. I’d suppose it’s partly due to the diurnal cycle of convective source, but your results seem not to support this assumption.

P10801, L17: “In the first instance”: what instance? Please be specific.

P10801, L18: “these”: which ones? Please be specific.

P10801, L27: “we still may… also” -> “we may still …” and delete “also”.

P10802, L1: “to” -> “too”; add “be” after “not”.

Figure suggestions:

Fig. 5, 8 and 9 can be combined by overlaying the wave front on Fig. 5. Since you already have LOS and tangent point track in Fig. 5, you can name the three angles there (phi, beta and gamma), and the projections are easier to be understood.

Put lumbda_h=185 km line on (a) and (f) for easier comparison. Same suggestions also for Fig. 14 and 15.

Fig. 11 and 12 can be combined by overlaying all Fig. 12 symbols on Fig. 11. That’s also easier for understanding and for the sake of conciseness of your paper.

Fig. 11: O1 and O2 should also be marked in Fig. 1 for clarity.

References:
Choi, H.-J., H.-Y. Chun, *and* I.-S. Song (2009), Gravity wave temperature variance calculated using the ray-based spectral parameterization of convective gravity waves and its comparison with Microwave Limb Sounder observations, J. Geophys. Res., 114, *D08111, doi:*10.1029/2008JD011330.

Gong, J., Wu, D. L., and Eckermann, S. D.: Gravity wave variances and propagation derived from AIRS radiances, Atmos. Chem. Phys., 12, 1701-1720, doi:10.5194/acp-12-1701-2012, 2012.