Review of: "Propagation paths and source distributions of resolved gravity waves in ECMWF-IFS analysis fields around the southern polar night jet" (revised)

by C. Strube et al.

Recommendation: Accept with minor revisions

The authors have responded satisfactorily to almost all of my comments. The paper is now acceptable for publication, subject to addressing the comments (plus a few editorial suggestions) listed below. The line numbers refer to the tracked-changes version of the revised paper.

Specific Comments:

(304) "Various sources excite gravity waves of scales typical...": This strikes me as opaque. The point is that the wavenumber spectrum generated by a source depends on the spatial scale of the source. How about something like "Sources of gravity waves generate a wavenumber spectrum that depends on the physical dimensions of the source"?

(307) "the spectral distribution": Do you mean the wavenumber spectrum? Spectral distribution could also refer to the frequency spectrum.

(308) "descried [sic] by the spectral distribution gained from the monochromatic waves in this region": I believe you meant "described" instead of "descried". That aside, I do not understand what you mean by "the distribution gained from the monochromatic waves". What monochromatic waves are you referring to?

Note that all of this confusion appears to have arisen following my original comment that any real-world topographic source will excite a spectrum in wavenumber: For the very simple example of a Gaussian source, the wavenumber spectrum is a Gaussian red spectrum, not a spectrum "centered at the main carrying frequency" [sic—I presume you meant wavenumber here]. That is, the Gaussian width, L, of an obstacle in physical space, $h' = \exp[-x^2/(2\,L^2)]$, is inversely related to the Gaussian width of its spectrum in wavenumber space, $\sim \exp[-k^2/(2\,\kappa^2])$, with $\kappa = L^{-1}$.

Now, I presume all that you mean is that the physical appearance of the wavepacket excited by orography is dominated by wavelength $\kappa^{-1} \sim L$, which is fine. But it would be useful to state things more clearly.

(469) "broad an apparent contradiction forward": I think you mean "brought forward an apparent contradiction", or more simply "highlighted an apparent contradiction".

(477) "require a modeling study upwards from relevant sources": It might be clearer to write "require a modeling study of upward propagation from relevant sources".

(488) "wind and intrinsic phase speed are of the same magnitude but opposite to each other ($(U - \hat{c}) = c_{gb} \approx 0$)": This does not make sense because $(U - \hat{c})$ *is* the intrinsic phase speed. I

think the source of the confusion is in the use of the word “intrinsic”. The common use of the term refers to the value relative to the background flow. See for example:

https://glossary.ametsoc.org/wiki/Intrinsic_wave_frequency

In any event, for mountain waves the phase speed relative to the ground is (using your symbol) $\hat{c}$, and $\hat{c} \sim 0$ because the waves are generated by wind blowing over fixed topography (a non-steady wind can still generate a spectrum in frequency/phase velocity, but that is another matter). Insofar as $\hat{c} \sim 0$, the waves do not propagate with respect to the ground, but do so with respect to the background flow, with intrinsic phase velocity U and intrinsic frequency kU. The slope of the wave ray with respect to the source (for the limiting case of hydrostatic, plane-parallel waves, $(k/m)^2 << 1$) is $\Delta x/\Delta z = c_{gx}/c_{gz} \sim -m / k$; thus, for positive U the ray tilts toward negative x with increasing altitude.

Nothing stated here invalidates any of your conclusions, but it is important to get these explanations straight and set them down clearly.

(488) “intrinsic group velocity”: Note that this is redundant. Group velocity is defined in terms of intrinsic frequency, $k\,(U - c)$.

(561) “that is only” => that is, only

(563) “discerns”: I think you mean “distinguishes”.

(643) “This would mark a paradigm shift ... from waves that are horizontally refracted ... to waves that feature southward orientation already at source altitude”: A minor comment here is that this statement strikes me as overly dramatic. The fact that there may be sources that produce wavetrains with group velocity oriented in a non-zonal direction is hardly a paradigm shift. In some regions, such waves might dominate, whereas in other situations the refraction mechanism might be important. Note, by the way, that in studies such as Sato (2009) refraction into the core of the SH polar night jet occurs over large vertical distances, and the mechanism was proposed to explain forcing at 0.1-1 hPa, i.e., in the upper stratosphere and lower mesosphere.