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

by C. Strube et al.

Recommendation: Minor revision

This is an interesting and well-written paper that illustrates by means of ray tracing that gravity waves excited in the troposphere over SE Australia and New Zealand can propagate over 1000 km in the meridional direction by the time they reach the middle stratosphere. The results lend support to the idea that GW meridional propagation can explain the "forcing gap" at high southern latitudes that has been implicated in the cold-pole problem of current GCMs and climate models.

Publication is recommended after the authors address the specific comments listed below.

Specific Comments (line number):

(19) "to account for lateral propagation": More precisely, to account for *meridional* propagation, which is the major deficiency in current column-based GW parameterizations.

(48) "gravity waves propagate along their phase lines": It would be clearer to write that the *group* propagation of gravity waves occurs along their phase lines.

(257) "Figure 3": Please state explicitly here that these maps are for an altitude of 25 km. This information is given in the figure caption, but it is important enough to include also in the text.

(294) "clear source attribution … and hence can be described by … a single monochromatic wave": I am not sure how it follows that a well-defined source implies a monochromatic wave. For example, the horizontal wavenumber spectrum of GW waves excited by wind blowing over a Gaussian obstacle will itself be a Gaussian, not a monochromatic wave. Perhaps I am misunderstanding what the authors are saying here?

(331) "group velocity falls below a specified threshold": What is the threshold?

(339) "The ray launch and termination points … in Figure 4": Please state explicitly here that the ray launch points (left column of Fig 4) are all at 25 km. The figure caption states this, but this is important information that should be mentioned in the text here, when the reader first encounters Fig. 4.

(371) "The grey dots … are scaled": It might be clearer to write that the size of the gray dots is proportional to the GW momentum flux at the location of each launch point.

(402) "The majority of these waves": More accurately, "the majority of these rays".

(403) “the tropospheric jet upwind of New Zealand”: It would be useful to refer here to Fig. 1, where the synoptic situation is shown.

(415) “‘mountain’ rays travel short [horizontal] distances”: Is this because the ratio of horizontal to vertical group velocities $c_{gx}/c_{gz} \sim [k(U - c)]^{-1}$, where U is the background wind, $c \sim 0$, and U is strong in the generation region of the mountain waves and at higher altitudes as they propagate upward?

(453) “contradiction between”: It would be useful to explain here, in a sentence or so, what the contradiction is.

(465) “wind and intrinsic phase speed cancel each other”: I am not sure what this means. The intrinsic phase speed is $(U - c)$, where c is the ground-based phase speed, so I do not understand in what sense the wind and the intrinsic phase speed “cancel each other”. Do you mean to say that certain values of c can reduce the intrinsic phase speed $(U - c)$? Note also that, for mountain waves, $c \sim 0$, so it is not clear how much effect c can have on the intrinsic phase speed.

(466) “the wave drifts with the wind”: What does this mean?

(482) “Figure 8 … relative propagation direction”: How is the relative angle measured? Clockwise or counterclockwise from the direction of the wind? This needs to be noted here.

(501) “Here 0° represents a direction to the East …”: Note that only the left and middle column show directions with respect to the ground. The right column is the direction of the wave vector relative to the wind. That aside, it would be less confusing to state that 0° points East, 90° points North, and so on; and that the plots in the first two columns show the direction of the wave vector and the direction of air flow, respectively. Finally, the right column of the figure shows the angle between the wave vector and the wind direction, measured counter-clockwise. The latter should be noted explicitly in the text.

(522) “all directions … are present (panel i)”: The spread of angles with respect to the wind in Fig. 9i is somewhat broader than in the other cases, especially that of “mountain” waves (Fig. 9c), but it does not appear to me qualitatively different. In particular, it is not the case that in Fig. 9i “all directions relative to the wind are present”. There are virtually no rays with directions between 270° and 90° relative to the wind in Fig. 9i.

Grammar, syntax, typos:

(371) “The grey dots, that are marking the launch locations, …” → The grey dots that mark the launch locations… (no commas, since this is a “restrictive” relative clause)

(381) “non” → none

(383) “Australia, however, …” → Australia; however, …

(425) “large amount … of rays travels” → large number … of rays travel

(532) “for at 8 km altitude” → at 8 km altitude

(533) “aligns form the Australian East coast” → extends SE from the East coast of Australia

(538) “for the stratosphere most relevant” → the waves most relevant for the stratosphere

(Fig. 11 caption) “direction where the wave vector is pointing to” → direction of the wave vector