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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A study of the dynamical characteristics of inertia–gravity waves in the Antarctic mesosphere combining the PANSY radar and a non-hydrostatic general circulation model" *by* Ryosuke Shibuya and Kaoru Sato

Anonymous Referee #2

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The propagation of gravity waves through the midle atmosphere is studied with PANSY and MERRA observations in comparison with NICAM simulations. The analysis is done carefully including a novel method for the estimation of vertical phase velocity. The validation of NICAM is interesting but still deserves some discussion (sse major comment 1). NICAM-derived frequency spectra are presented (to which relates major comment 2) and are further complemented with the identification of two pathways of gravity waves in the southern hemisphere. The interpretation of these features in terms of momentum fluxes and group velocities is instructive, although the physical processes

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Discussion paper

could be masked by the Doppler shift (see major commment 3). The work is presented scientifically and technically correct and provides an ineresting contribution to the field of middle atmosphere research. With an extended discussion of selected issues and some technical improvements I recommend: accept with minor revisions.

MAJOR COMMENTS

1) NICAM validation: NICAM-derived gravity wave amplitudes are found to be too large in comparison with PANSY (discussed at P15-16). The explanation you give at page 16 / line 2 is counterintuitive. Either you explain in depth how a diffusive process, which dissipates energy, leads to stronger waves, or you give another argument or hypothesis... May be related to this issue is the too-strong polar vortex in NICAM as shown in Figure 6b in comparison with MERRA (Figure 6a). Possibly, there are breaking too few gravity waves in the stratosphere which appear then too strong in the mesosphere? A good place for such a discussion could be the end of section 5 at page 30.

2) Flat vertical-velocity spectrum: Perhaps it could help the explanation of the flat vertical-velocity spectrum when you include dispersion relations. These imply that the vertical velocity is proportional to the frequency w $\sim$ \hat{\omega} / N b where b is the buoyancy. Consequently, its variance is proportional to \hat{\omega}^2. Given a buoyancy / temperature spectrum with an frequency exponent between -1 and -5/3, an exponent between 1 and 1/3 could be expected for the verical velocity spectrum.

3) Doppler shift: An important element of your study is the consideration of critical latitudes where the intrinsic frequency \hat{\omega} equals the Coriolis frequency f. Your radar and model data are analysed, at the other hand, for the ground-based frequency \omega. The missing information on the intrinsic frequency is also critical for the identification in long-periodic and mid-periodic waves. One consequence is the population of lower-than-f frequencies by gravity waves which is seen in some figures. Although your physical interpretation is basically correct, the issue of Doppler shift deserves a

more detailed discussion.

MINOR COMMENTS

1) Arrangement of formulae: Please, introduce Doppler shift and dispersion relation earlier, for example right after equations (3) where \bar{\omega} appears first.

2) Notation of temperature spectrum as P_{tem} - why dont you use the more common P_{T}? But this is a matter of taste, your notation is mathematically correct.

P9L11: For my taste, you do not need ", respectively," here.

P9L12: Again, ", respectively," might be deleted.

P10L9: "which IS a global"

P10L24: targeted –> target

P12L8: "one IS produced..."

P12L10: "pertaining" –> "pertains"

P12L17: Suggest to substitute the sentence "included. The vertical... zero." with "included, and thus have been set to zero."

P14L13: You might delete "with a vertical phase velocity V_1" without loss of information.

P15L19: The imaginary nuber "i" is twice too much in the argument of cosine.

P14L21: You might delete "via the factor of 2.0 introduced on the right hand side of the equation" because if you are exactly on a phase line you have exactly A = a provided you sample enough waves.

P17L3: I suggest to write "as strong" instead of "strongly" because the jets tilt equatorward in both datasets, more or less.

P17L19: May be, you replace "that assumes.. form" with "as noted in the form" makes

this long sentence slightly better to read.

P17E2: The imagaginary number "i" is missing in the exponential function.

P26L19: Please specify you mean the austral summer. Inhabitants of the Northern hemisphere could think of JJA when they read "summer"...

P28L11: Please, give a proper reference for the WKB theory. In order to reduce the number of formulae I suggest not to use the frequency function \Omega because it is not used in any formulae.

P29L14: Please, add a "hat" to the frequency –> \hat{\omega}.

P32L20: Please, change "tsutsumi" to "Tsutsumi".

P34L23: The year of publication appears after the author and not at the end of the record, as with the others.

P42L20: The year of publication appears after the author and not at the end of the record, as with the others.

P51F6: There seems to be a minus sign in front of 30 °S at the lower axis of Fig. 6b which does not belong there.

P57F12: Please add "Latitude [S]" to the lower axes.

P58F13: Please, add an information on the height (25 km?) to the caption.

P59F14: Please add "Period [h]" to the lower axes.

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