

Circumglobal Rossby wave patterns during boreal winter highlighted by wavenumber/phase speed spectral analysis

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Recommendation: Accept with minor revision

This study systematically identifies two circumglobal Rossby wave packets (CRWPs) using diagnostic analyses with Reanalysis data. The CRWPs were identified with an EOF analysis in wavenumber/phase speed space applied to the daily spectral amplitude of the meridional wind. The authors diagnosed many interesting features of these wave packets, including spatial structure, blocking frequency, and most interestingly a possible driving mechanism via MJO phase 3 tropical convection (for CRWP1) and the generation within the extratropics for CRWP2. The authors also found linkages to the MJO, meridional heat flux, and baroclinicity, connections of the CRWPs to the North Pacific and North Atlantic storm track regions at different time lags, and even to wave packet propagation from the North Atlantic, followed by anticyclonic wave breaking and then propagation across the Mediterranean to the Middle East. This manuscript was a pleasure to read, and I learned a lot.

I recommend accepting this manuscript with minor revisions and suggest that the authors consider all my comments below.

Minor Comments

1. Line 88. It would be helpful to state here that the seasons will be examined separately, even though it is stated later.
2. Line 112. The spectra are averaged over a very broad range of latitudes. How do the spectra vary if separate averages are performed for more narrow latitudinal bands? In other words, what would the spectra look like if there were four separate latitudinal bands that are 10 degrees latitudes wide, e.g., 35-45N, 45-55N, etc? Stated slightly differently, how sensitive are the results shown in Fig. 1 to choices of different latitudinal bands. Note that I am only asking this about Fig. 1. I don't expect that the authors redo their entire analysis for these four bands, since the results presented in this manuscript are very interesting with this average over more than 40 degrees latitude.
3. Line 113-114. It is not clear to me how this method gets around the issue of non-zonal propagation. To me, this just a limitation of the method. Since no method can address all questions, it is sufficient to simply acknowledge this limitation. Also, another advantage for not first averaging the meridional wind anomalies is that the meridional wind can sometimes be in the opposite direction at different latitudes for the same longitude, which would lead to the cancellation of the signal. Wave breaking and blocks are just two examples when this can happen. The authors may wish to mention this point.
4. Line 117. I don't see how the vertical stacking, i.e., an equivalent barotropic vertical structure, is linked to the need for performing a latitudinal average. The authors may

wish to explain this more carefully.

5. Line 121. I suggest that “precise” be replaced by “state” or a similar word.
6. Line 136. It would be clearer to write “The circulation patterns associated with modes of spectral variability...”.
7. Figure 1. Westward phase speeds for all wavenumbers less than 8 is a little surprising to me, especially for the larger wavenumbers within this group. Since the Rossby wave dispersion relation depends on the background zonal-mean zonal wind and beta, or even better, the meridional potential vorticity gradient, are the westward phase speeds related to a small zonal-mean zonal wind within some latitudinal bands (see comment #2 above). Also, does the phase speed in the top left corner of each panel indicate the average phase speed. This isn’t stated in the caption.
8. Lines 153. “Propagation is misspelled.
9. Line 155. “or” -> “of”.
10. Lines 190-191. The authors should provide greater justification for using the meridional component of the E-vector (E_y) as a proxy for wave breaking. After all, any horizontal tilt of eddies, no matter how small, will have a non-zero E_y . By looking at observational data, it is very easy to find many days with a fairly large E_y without wave breaking. On the other hand, when there is wave breaking, I would expect E_y to be quite large. It would be helpful for the authors to show some correspondence between large E_y and wave breaking.
11. Line 226. Where is the reduced meridional gradient of geopotential that is being referred to?
12. Line 268. The process described with enhanced tropical convection and a negative vorticity anomaly matches that described by Sardeshmukh and Hoskins (1988, J. Atmos. Sci.) for the so-called Rossby wave source. It would be good to cite that paper.
13. Line 300. I assume that the authors are referring to Fig. 3d not Fig. 3e.
14. Figure 7. Since a statistically significant MJO is found at positive lags, and CRWP2 shows anomalies in geopotential height at lower latitudes, it is possible that CRWP2 is exciting the MJO. This isn’t surprising since many papers have shown results suggesting that the MJO can be triggered by midlatitude disturbances.