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Reply on EC1

Jacopo Riboldi et al.

Author comment on "Circumglobal Rossby wave patterns during boreal winter highlighted by space–time spectral analysis" by Jacopo Riboldi et al., Weather Clim. Dynam. Discuss., https://doi.org/10.5194/wcd-2021-59-AC1, 2022

Reply to Editor's comment (https://doi.org/10.5194/wcd-2021-59-EC1)

First of all, we would like to thank the editor for the comment and for the interest shown in the study. The comment inspired two thoughts, which will result in consequent modifications of the manuscript:

- We do not think that excluding the c_p=0m/s line would substantially affect the results, as even stationary features such as atmospheric blocking often exhibit a slow eastward or westward propagation, especially in winter when the background flow is particularly strong. The fact that periodograms are computed over a broad range of latitudes before averaging can attenuate the loss of information due to wind anomalies that happen to be moving with c_p< 1m/s on selected latitude circles (we describe in the newly added Supplementary text S2 why this is the case). Also, it is possible for waves with non-zero phase speed to still yield a circumglobal wave-like anomaly in the monthly mean: an example are recurring Rossby wave patterns (which propagate, but tend to occur at fixed longitudes; *Roethlisberger et al. 2019*). Instantaneous but strong wave-shaped anomalies occurring over a few days in a month can also be highlighted by the monthly mean. However, the absence of an explicit treatment of stationary waves is definitely a limitation of the employed methodology and we will comment on that in detail in a new Discussion section, added during the revision.
- More in general, the degree of zonal propagation of Circumglobal Rossby Wave Patterns (CRWPs) is difficult to quantify and the literature does not provide many hints in this regard. Branstator (2002), for instance, did not explicitly comment on the stationarity or propagation of their wave pattern, which is retrieved from an EOF analysis of monthly mean fields. Watanabe (2004) based their conclusions on low-pass filtered wind anomalies to remove transient disturbances although they pointed out the presence of rapid transient in the daily fields ("*Propagation of wave packets, but not the wave itself, on the Asian jet is quite evident in the daily anomalies, indicating that the Rossby wave argument appears relevant for individual NAO events as well, although the anomalies are not stationary anymore*", from the same paper). The work by Feldstein and Dayan (2008) and Harnik et al. (2016) did not quantify explicitly the phase speed of the wave patterns thereby identified. Their observation of near-zero phase speed was actually derived from the visual inspection of lagged composites computed by averaging over several events. However, the compositing procedure can

implicitly act as a low-pass filter for the transients and small scales, making difficult to ascertain the full range of phase speeds involved. The final section of Fragkoulidis et al. (2018) features an extended discussion of the problems that temporal and spatial averaging can originate when trying to diagnose CRWPs and circumglobal waveguides. On the other hand, the spectral approach adopted in the paper does not involve any filtering and allows to obtain a global fingerprint of the slowly- as well as of the rapidly-propagating harmonics involved in each wave pattern. This methodological difference can explain, at least partly, the not-so-slow phase speeds involved in CRWP1 and CRWP2 events. A discussion of these methodological issues and a broader comparison of the results will be added to the revised manuscript to clarify analogies and differences of the identified CRWPs with others discussed in previous studies.

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