Supporting Information for "Rossby Wave Phase Speed Influences Heatwave Location through a Shift in Storm Track Position"

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Introduction

The main manuscript introduces a categorical phase speed estimate based on spectral analysis. Technical details about the two-dimensional Fourier transform and the choice of the 30-day window length are presented in Text S1 and Figure S1. The analysis that follows in the main manuscript uses a composite criterion on meridional wind variance

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aggregated for zonal wavenumbers 5-8. The results are qualitatively similar when focusing on individual wavenumbers as shown in Figure S2. In order to very briefly address potential waveguideability aspects, Figure S3 depicts a composite analysis of zonal wind anomalies.

Text S1.

The Fourier coefficients $B_{k,\omega}$ with zonal wavenumber $k \geq 0$ and angular frequency ω for the transformation of gridded meridional wind anomalies $v_{m,n}$ with M time steps Δt and N points in longitude are given by

$$B_{k,\omega} = \frac{\sqrt{2\Delta t}}{N\sqrt{M}} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} v_{m,n} e^{-i[\omega m \Delta t + 2\pi k n/N]} \tag{1}$$

Power spectral density ρ_{k,c_p} at latitude ϕ and phase speed $c_p = a\cos\phi(\omega/k)$, where a denotes the Earth's radius, can be computed as

$$\rho_{k,c_p} = B_{k,\omega} B^*_{k,\omega} \frac{k}{2\pi a \cos\phi} \tag{2}$$

The centroid C_k of a phase speed spectrum is defined as

$$C_k = \sum^{S} \rho_{k,c_p}\, c_p \Big/ \sum^{S} \rho_{k,c_p} \tag{3}$$

The time series of extratropical meridional wind variance V_k in the respective phase speed bin S are obtained by integration of power spectral density ρ_{k,c_p} using the centroid C_k as the lower bound for the "fast" and the upper bound for the "slow" phase speed bin. The correlation of meridional wind variance between the two phase speed bins is sensitive to the time window length used for the Fourier transformation of meridional wind anomalies (Fig. S1). As stated in the main manuscript, a 30-day window is chosen

to obtain two time series that are uncorrelated while maintaining a sufficiently large sample size. For shorter windows, the reduced phase speed resolution results in a positive correlation of meridional wind variance, whereas for longer windows the spectra suffer from increased noisiness. The resulting correlation coefficients, shown in bold letters on the main diagonal of the upper right and lower left quadrant of Figure S1, are close to zero and statistically insignificant. A positive correlation for adjacent wavenumbers in the same phase speed bin is the signature of localized Rossby wave packets. The statistical significance of these correlation coefficients is indicated by the red shading of the boxes next to the main diagonal of Figure S1 and caused by spectral leakage during the Fourier transformation along the zonal dimension.

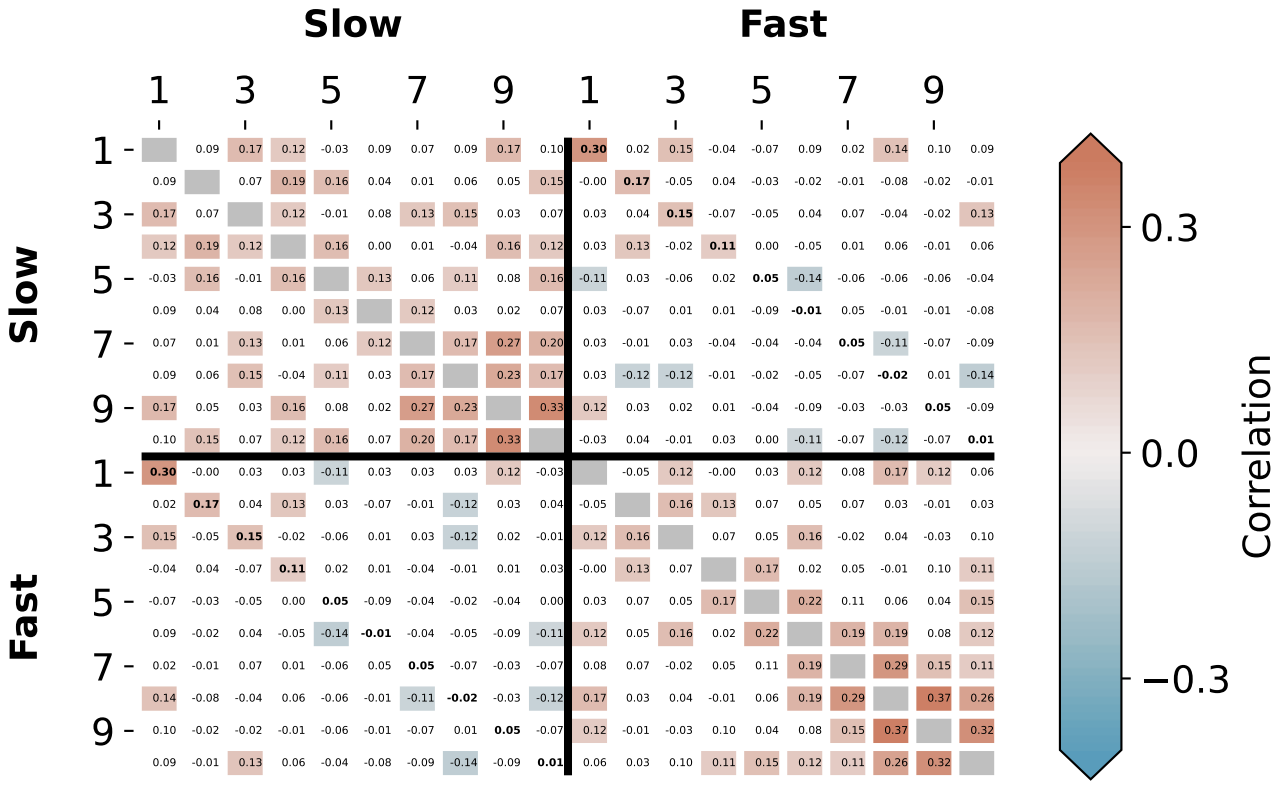

Figure S1. Pearson correlation coefficients between time series of meridional wind variance for different zonal wavenumbers in the 'slow' and 'fast' phase speed bins, respectively, color shaded where statistically significant at the 95% confidence level.

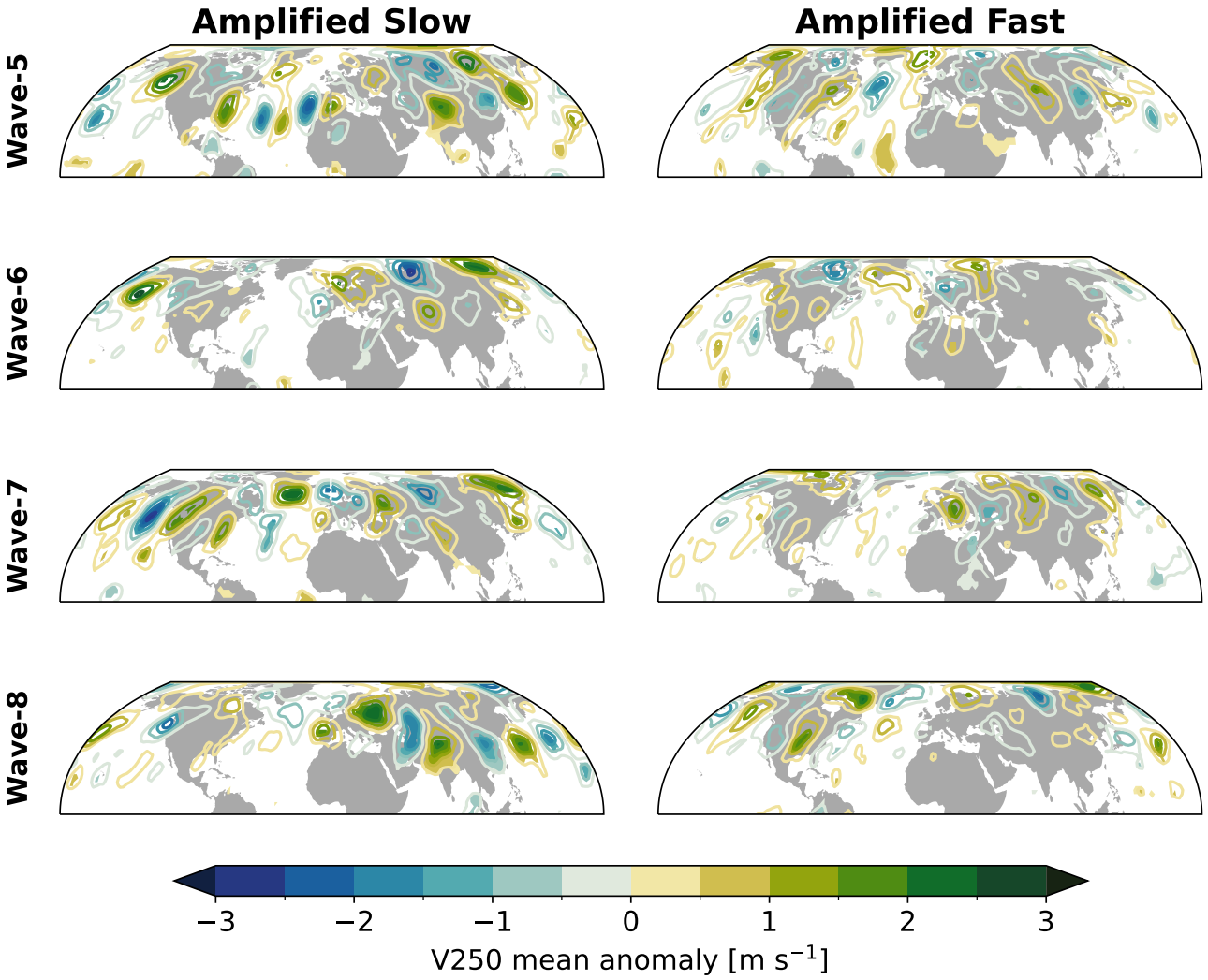

Figure S2. Composite mean of 30-day mean upper-tropospheric meridional wind anomalies during episodes when the meridional wind variance for individual zonal wavenumbers exceeds the 90th percentile in the respective phase speed bin; color shading indicates a statistically significant increase in variance or a composite mean significantly different from zero at the 95% confidence level.

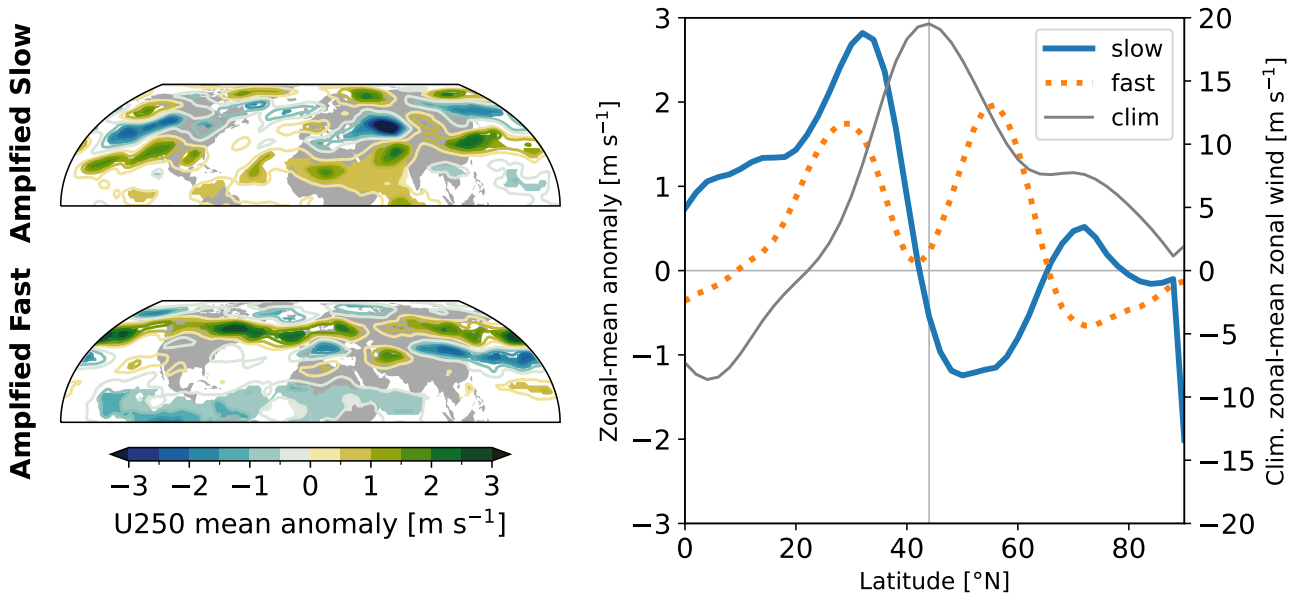

Figure S3. Composite mean of 30-day mean upper tropospheric wind anomalies as in Figure 2 but for zonal wind (left column), as well as, zonal-mean zonal wind climatology and zonal-mean composite-mean anomalies at 250hPa (right column). Note that the horizontal maps use a sub-seaonally varying climatology whereas the zonal-mean anomalies are computed with respect to a fixed JJA mean.