

Supporting Information to "On the role of downstream-developing Rossby waves in concurrent heat extremes"

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Supplementary Figures

This document contains supplementary Figures that are explained and referenced in the manuscript.

- Figure S1 illustrates the zonal-mean profile of the idealized experiment.
- Figure S2 illustrates different steps in the Rossby wave packet algorithm.
- 5 – Figure S3 depicts the climatological-mean Rossby wave packet properties in the idealized experiments.
- Figure S4 depicts the mid-latitude power spectra of meridional wind at 250hPa for ERA5 data.
- Figures S5-S8 show composite-mean Rossby wave packet properties for ERA5 data.

Supplementary Text

A Markov chain with a transition matrix between non-hot days and hot days

$$10 \quad P = \begin{pmatrix} 0.94 & 0.06 \\ 0.54 & 0.46 \end{pmatrix} \quad (1)$$

has a stationary distribution of $[0.9, 0.1]$. A sufficiently long sequence of days created by this Markov chain contains 10% hot days. A heatwave criterion of at least 3 consecutive hot days yields a heatwave frequency of about one event per 90 days. Two independent sequences show approximately 0.15 concurrent events per 90 days.

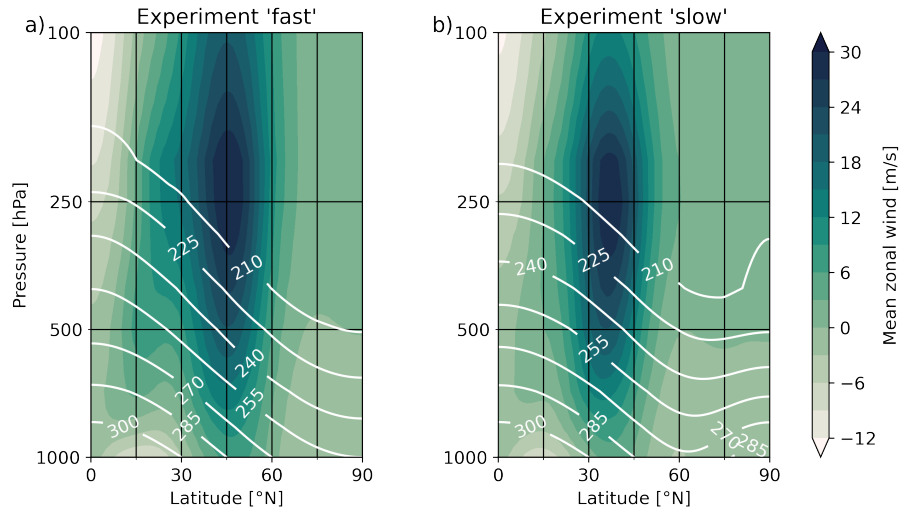


Figure S1. A color shading of climatological-mean zonal-mean zonal wind with contours of the equilibrium temperature profile in units of K for the idealized numerical experiment with (a) high phase speed and (b) low phase speed.

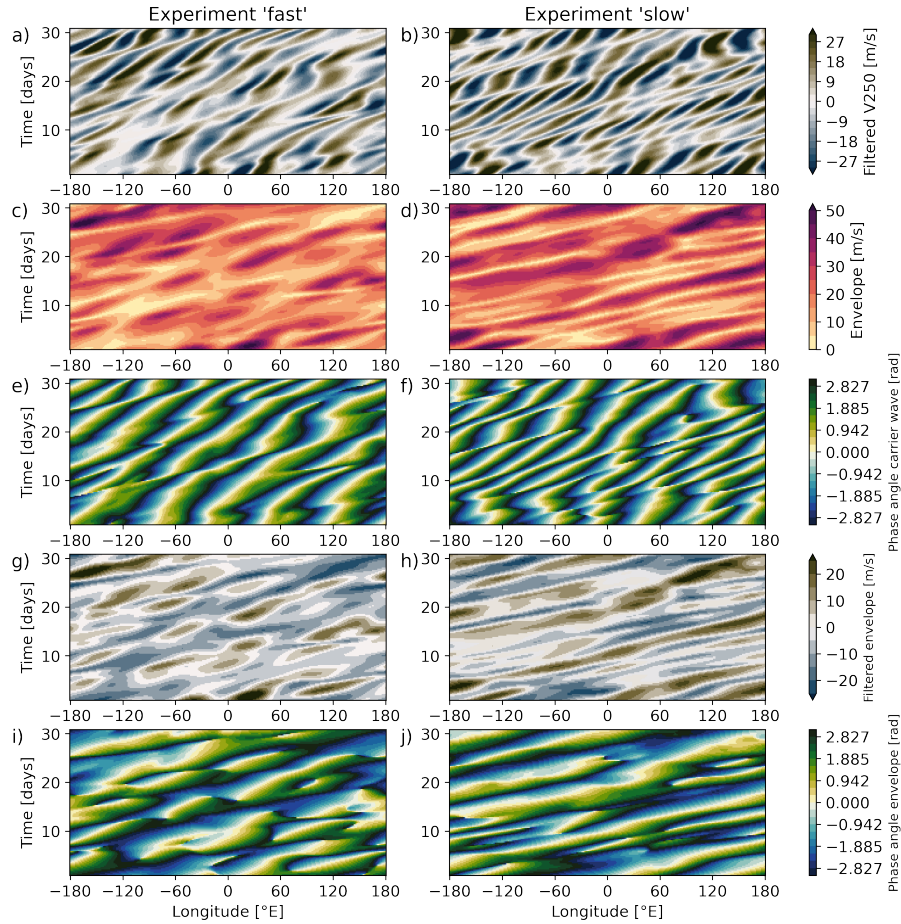


Figure S2. The wave packet envelope (c, d) is computed as the absolute value of the Hilbert transform of horizontally filtered meridional wind anomalies at 250 hPa (a, b). The argument of the Hilbert transform (e, f) is the basis from computing the local frequency, the local zonal wavenumber, and the local phase speed. A Hilbert transform in longitude of the low-pass filtered wave packet envelope anomalies (g, h) from the zonal mean yields a phase angle (i, j) which is used for the computation of the zonal group velocity. A Hilbert transform in latitude of wave packet envelope anomalies from the meridional mean is used for the computation of the meridional wavenumber and the meridional group velocity (not shown).

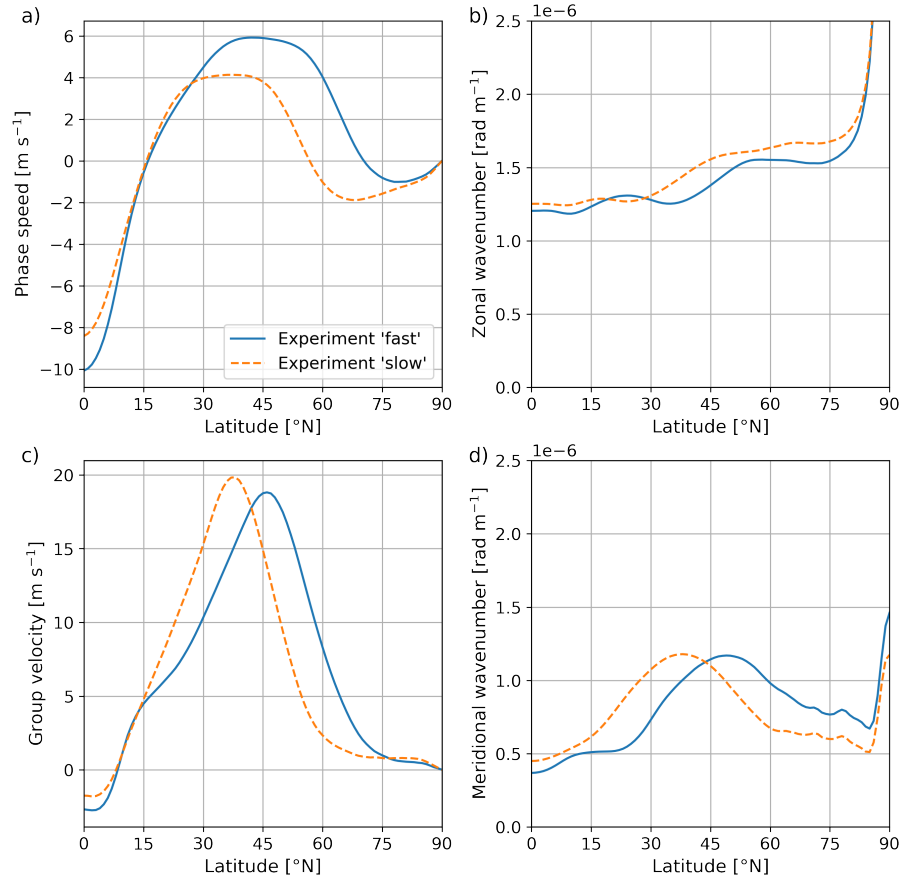


Figure S3. Climatological-mean Rossby wave packet properties in the idealized experiments that are relaxed to the equilibrium temperature profiles in Figure S1 and that show a high or a low phase speed, respectively.

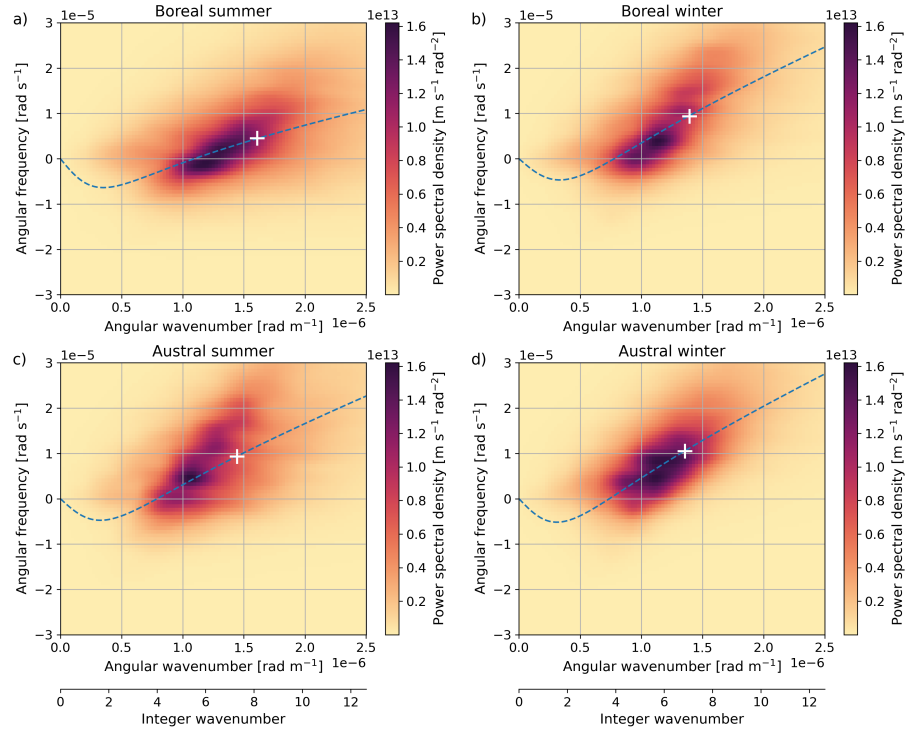


Figure S4. Mid-latitude meridional-mean power spectra of meridional wind at 250 hPa as in Figure 2 but from ERA5 data in the Northern (panel a-b) and Southern Hemisphere (panel c-d) for December-February (panel a, d) and for June-August (panel b-c), respectively.

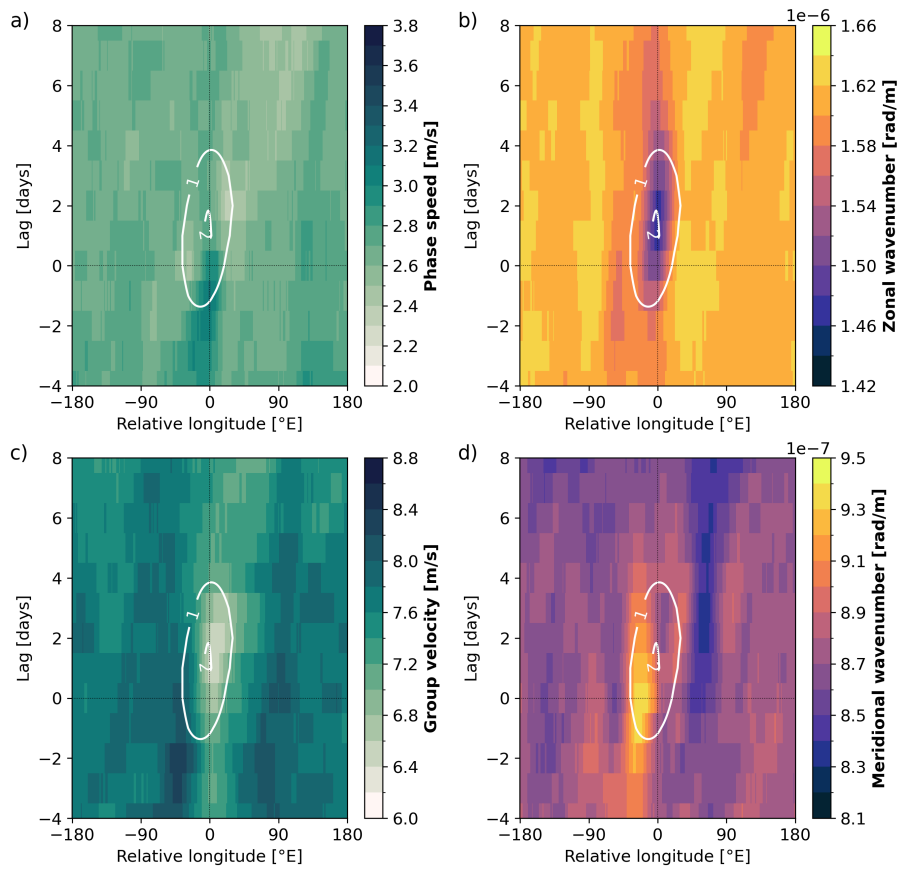


Figure S5. Composite-mean Rossby wave packet diagnostics as in Figure 5 and 6 but relative to heatwave onsets from June-August between 30°N-45°N in ERA5.

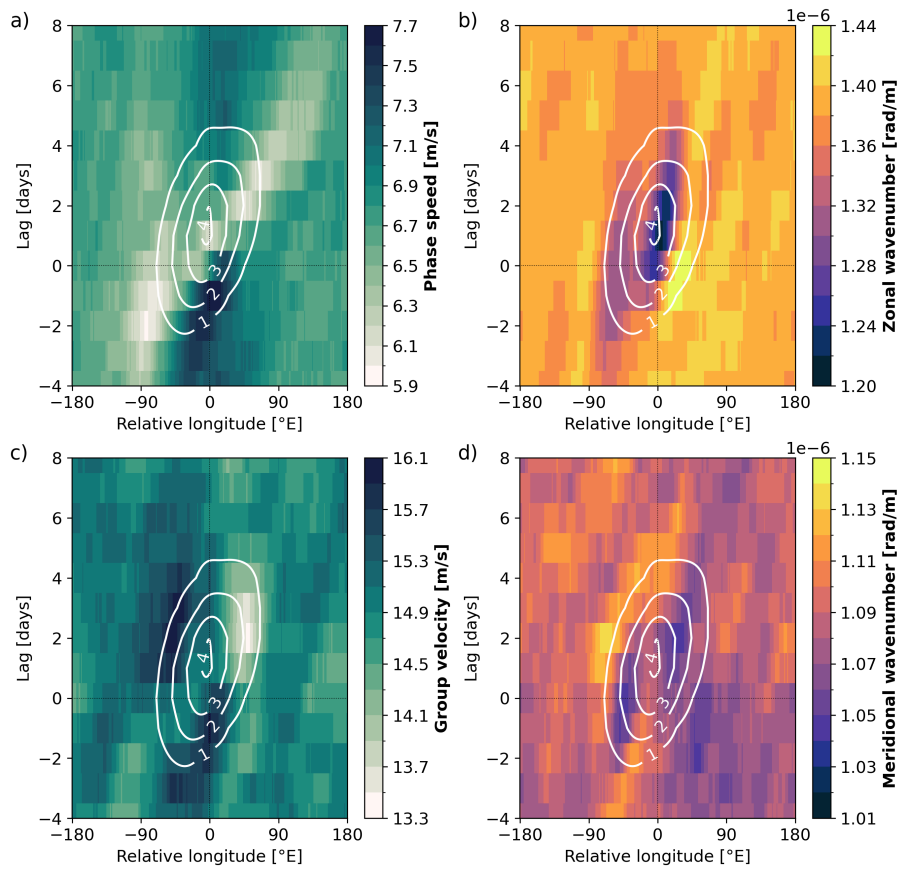


Figure S6. Composite-mean Rossby wave packet diagnostics as in Figure 5 and 6 but relative to heatwave onsets from December-February between 30°N-45°N in ERA5.

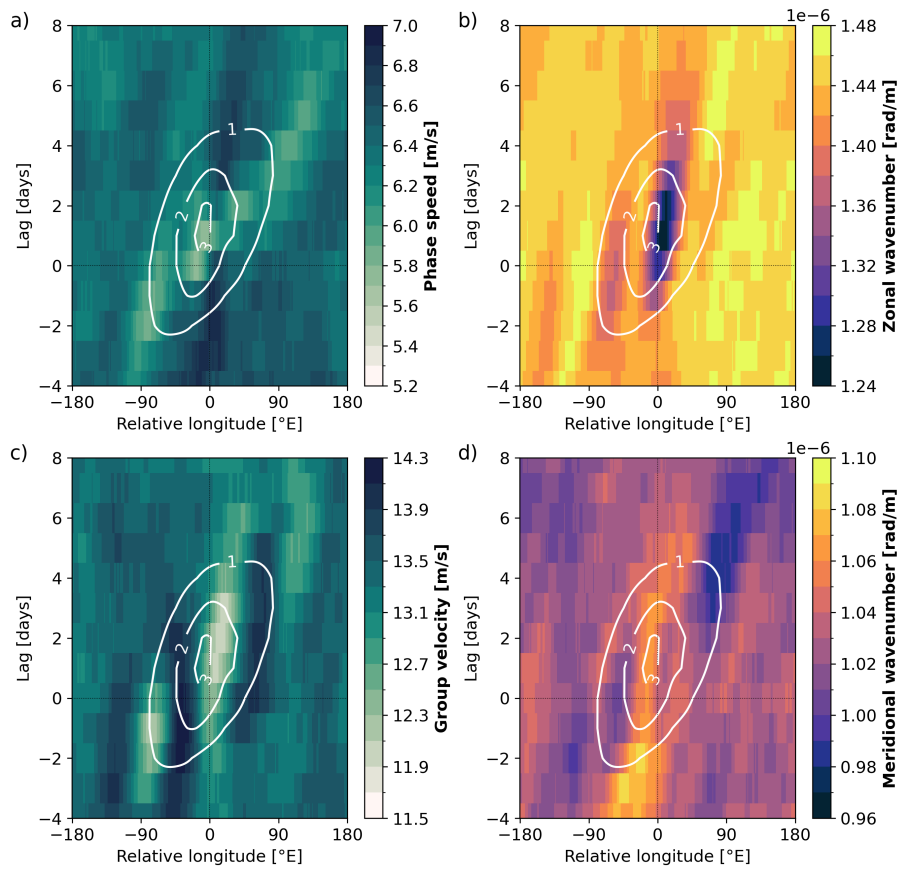


Figure S7. Composite-mean Rossby wave packet diagnostics as in Figure 5 and 6 but relative to heatwave onsets from December-February between 30°S-45°S in ERA5.

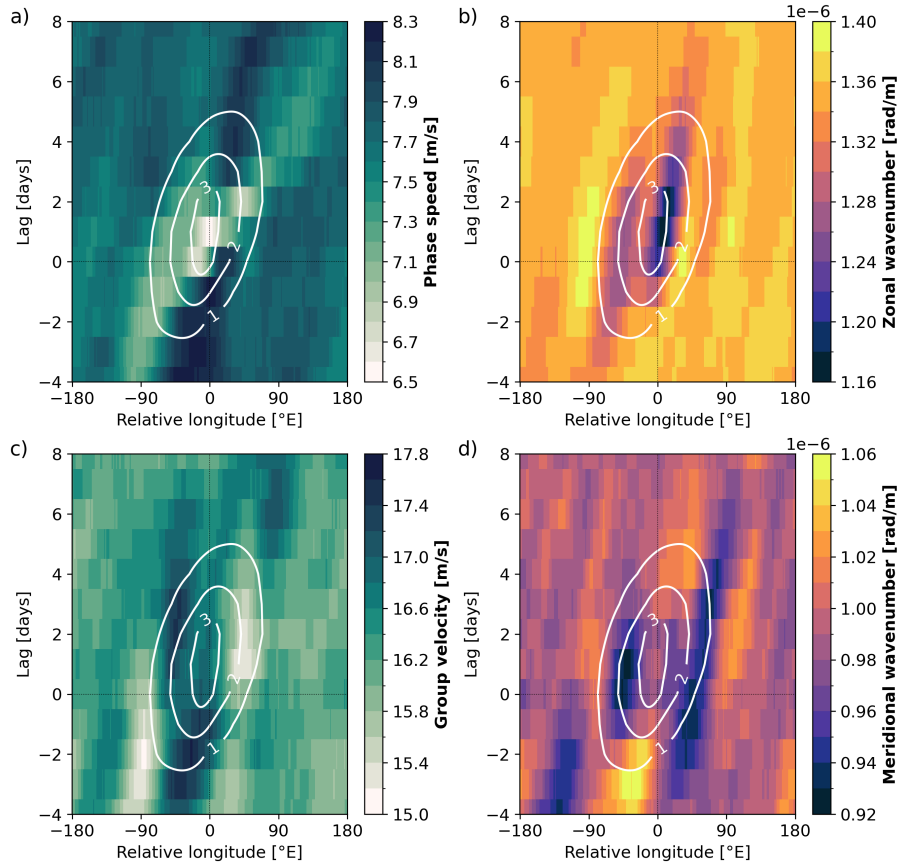


Figure S8. Composite-mean Rossby wave packet diagnostics as in Figure 5 and 6 but relative to heatwave onsets from June-August between 30°S-45°S in ERA5.