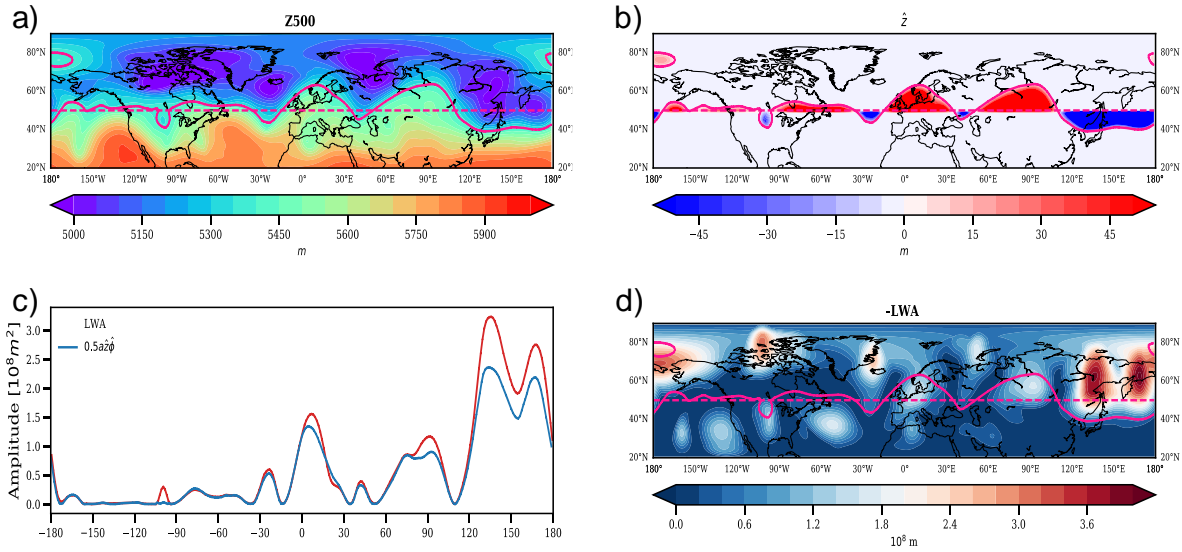


Supplementary Text 1: Recipe for the calculation of local wave activity (LWA)

We illustrate the calculation of LWA using the weather map on 1200 UTC 13 Feb 1983. The calculation is performed for the latitudes of 20N-90N. The detailed calculation procedure is listed below.

1. Choose a latitude of interest, ϕ . Use 50 N as an example here.
2. Determine the corresponding Z_{500} contour such that the equivalent latitude of the contour satisfies $\phi_e = \phi$. The equivalent latitude is obtained from the area from the Z_{500} contour to the North Pole via box counting and converting the area to a hypothetical equivalent latitude such that the contour is zonally symmetric. SI Fig. 7a gives the Z_{500} contour (solid red) with the equivalent latitude of 50N (dashed red).
3. Compute the eddy term $\hat{z} = z - Z_{500}$. For the calculation at each latitude, only the values between the latitude ϕ and contour Z_{500} will be used. See SI Fig. 7b. Note that z is the actual geopotential height, and \hat{z} is the difference between the actual geopotential height and the Z_{500} for the equivalent latitude.
4. The line integral for the southern cyclonic LWA is computed at the longitude λ by box-counting \hat{z} in the southern grid boxes relative to the latitude ϕ_e that satisfy $\hat{z} \leq 0$. Similarly, the northern anticyclonic LWA is calculated for the northern grid boxes satisfying $\hat{z} \geq 0$. LWA at $\phi = 50\text{N}$ is shown in SI Fig. 7c. This is compared with the product of the zonal amplitude \hat{z} and meridional amplitude $\hat{\phi}$ of a planetary wave described in ref 1, where \hat{z} is the deviation of the geopotential height from the zonal mean, and $\hat{\phi}$ is the meridional displacement of the contour. In the small amplitude limit, $\text{LWA} = -0.5a\hat{z}\hat{\phi}^2$, where a is Earth's radius.
5. Repeat steps 1-4 for all the other latitudes. The longitude by latitude map of LWA is shown in SI Fig. 7d.



SI Figure 7. (a) Z_{500} as a function of longitude and latitude. (b) The eddy term \hat{z} plotted between the latitude 50N and the contour with the equivalent latitude $\phi_e = 50N$. (c) LWA at 50N as a function of longitude (red). The product of the zonal amplitude \hat{z} and meridional amplitude $\hat{\phi}$ of a planetary wave (blue). In the small amplitude limit, $|LWA| = 0.5a\hat{z}\hat{\phi}$. (d) -LWA as a function of longitude and latitude. In (a), (b) and (d), the contour with the equivalent latitude $\phi_e = 50N$ is shown in solid red, and the latitude 50N is in dashed red.