Supporting Information for "Regional Features of the 20-30 Day Periodic Behavior in the Southern Hemisphere Circulation"

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Contents

QGPV-based local finite-amplitude activity

As mentioned in the main text, another way to calculate the local finite-amplitude wave activity is based on quasi-geostrophic potential vorticity (QGPV), given the fact that QGPV is a material conserved quantity. Following Huang and Nakamura (2016), the equation for QGPV based local finite-amplitude is showed below:

$$A_q(\phi_e,\lambda,z,t) = \frac{a}{cos\phi_e}\left(\int_{q'\geq 0,\phi\leq\phi_e,\lambda=const} q' cos\phi d\phi - \int_{q'\leq 0,\phi\geq\phi_e,\lambda=const} q' cos\phi d\phi\right), \quad (1)$$

where a is the earth radius, ϕ, λ, represents the latitude and longitude respectively, z is the pressure pseudoheight defined by $z = -Hln(p/1000hPa)$ with $H = 7km$, the QGPV $q(\phi,\lambda,z,t) = f + \zeta + \frac{f}{\rho_0}\frac{\partial}{\partial z}[\frac{\rho_0(\theta-\widetilde{\theta})}{\partial\widetilde{\theta}/\partial z}]$, in which $f = 2\Omega sin\phi$ is the Coriolis parameter, ζ is relative vorticity, θ is the potential temperature ($\widetilde{\theta}$ is the hemispheric averaged basic state), and $q' = q - Q(\phi_e)$ denotes the deviation from the reference QGPV at the equivalent latitudes. A monotonic relationship between ϕ_e and Q lies below:

$$\phi_e(Q) = arcsin[1 - \frac{S(Q)}{2\pi a^2}], \tag{2}$$

where $S(Q)$ is the area bounded by the Q contour. Additionally, to consider the LWA at all pseudo-height levels, the density weighted LWA along the whole column is defined following Wang and Nakamura (2015):

$$\langle A_q \rangle = \int_0^\infty e^{-z/H} A(\phi_e, \lambda, z, t) dz \bigg/ \int_0^\infty e^{-z/H} dz. \tag{3}$$

References

Huang, C. S. Y., & Nakamura, N. (2016, January). Local Finite-Amplitude Wave Activity as a Diagnostic of Anomalous Weather Events. *Journal of the Atmospheric Sciences*, *73*(1), 211–229. Retrieved 2023-03-24, from `https://journals.ametsoc.org/view/journals/atsc/73/1/jas-d-15-0194.1.xml` (Publisher: American Meteorological Society Section: Journal of the Atmospheric Sciences) doi: 10.1175/JAS-D-15-0194.1

Wang, L., & Nakamura, N. (2015). Covariation of finite-amplitude wave activity and the zonal mean flow in the midlatitude troposphere: 1. Theory and application to the Southern Hemisphere summer. *Geophysical Research Letters*, *42*(19), 8192–8200. Retrieved 2023-04-16, from `https://onlinelibrary.wiley.com/doi/abs/10.1002/2015GL065830` (_eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/2015GL065830) doi: 10.1002/2015GL065830

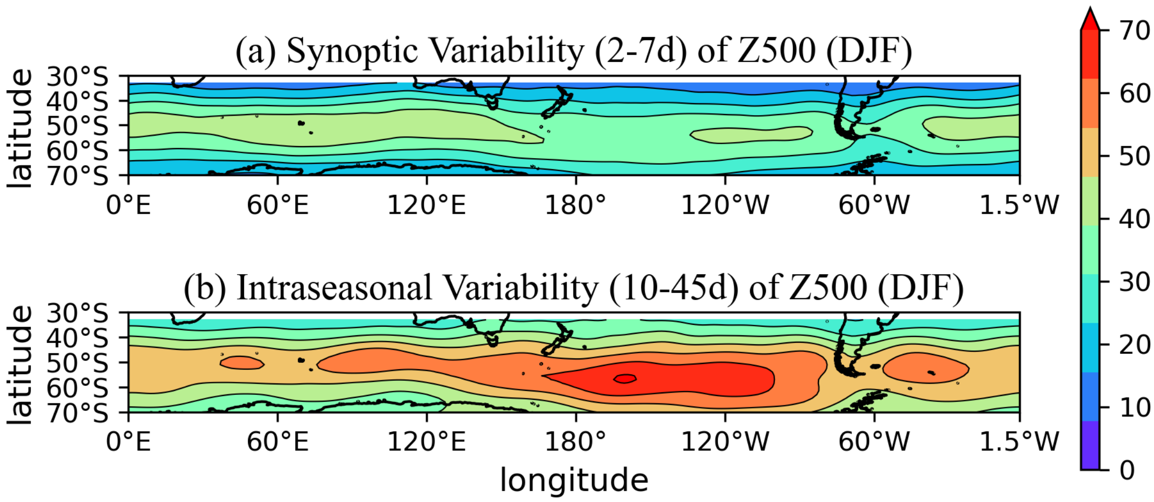

Figure S1. Bandpass-filtered variance converted to standard deviation for 500hPa geopotential height in austral summer(DJF): (a)synoptic variability(2-7 days), and (b)intraseasonal variability(10-45 days). The shading represents values between 0*gpm* and 70*gpm*.

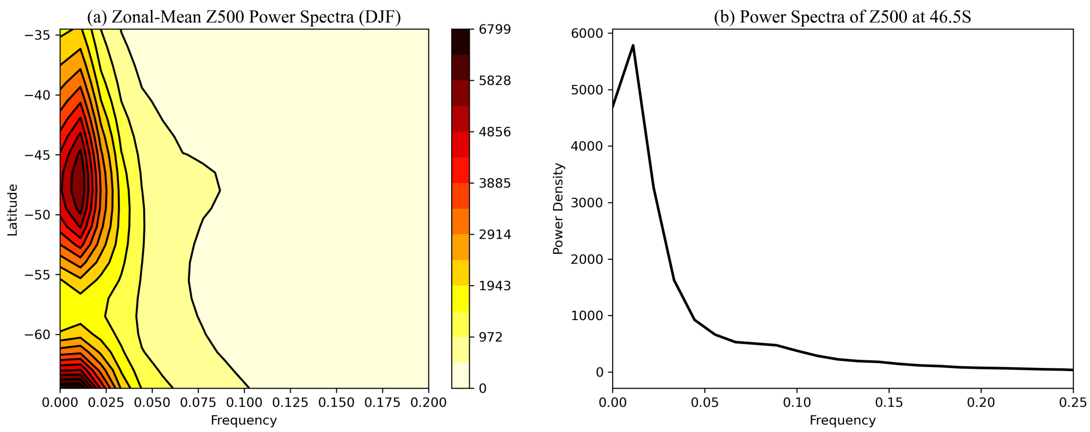

Figure S2. Power spectra in austral summer(DJF) of (a)zonal-mean Z500, and (b)zonal-mean Z500 at 46.5°S.

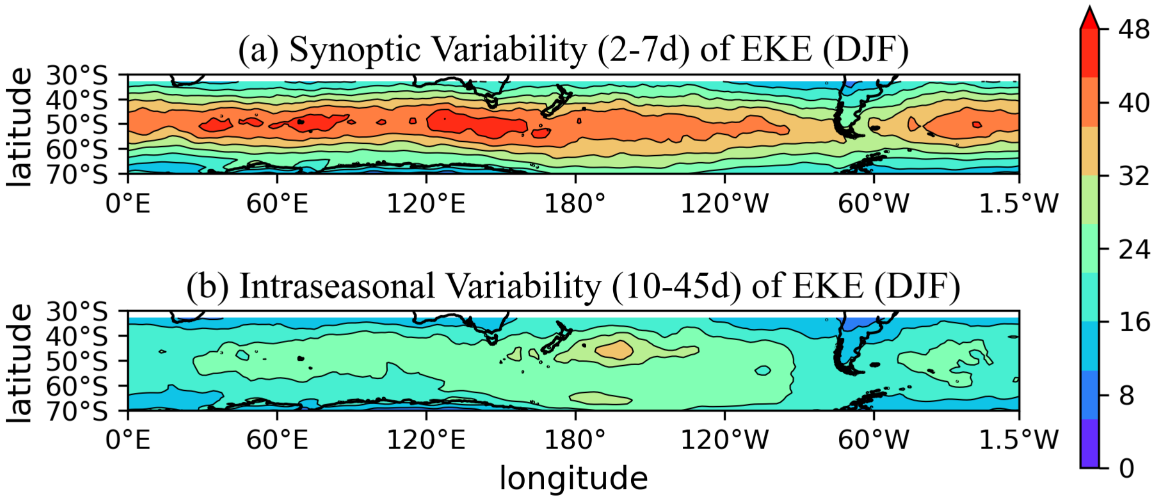

Figure S3. Bandpass-filtered variance converted to standard deviation for vertical averaged eddy kinetic energy (EKE) in austral summer(DJF): (a)synoptic variability(2-7 days), and (b)intraseasonal variability(10-45 days). The shading represents values between $0m^2/s^2$ and $48m^2/s^2$.

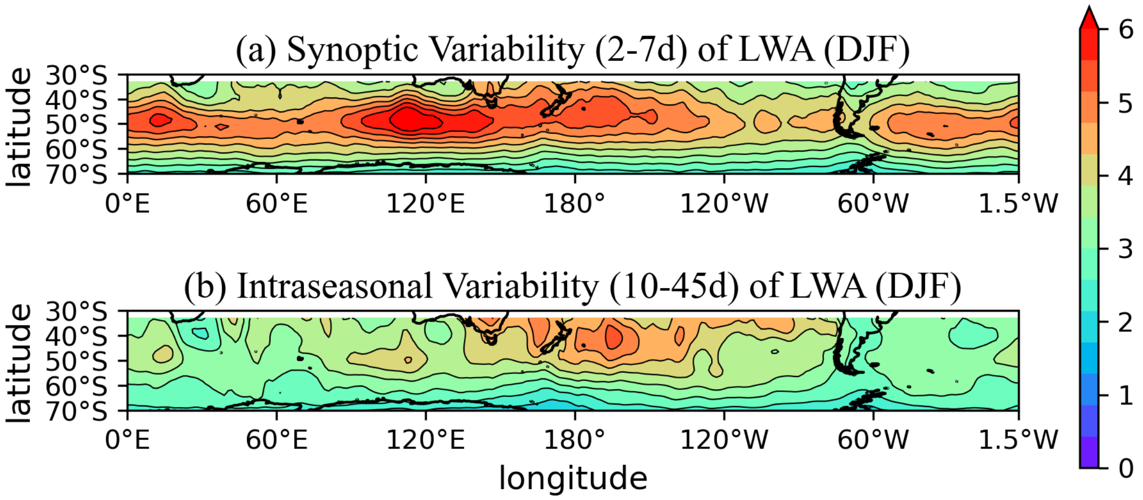

Figure S4. Bandpass-filtered variance converted to standard deviation for QGPV-based local wave activity in austral summer(DJF): (a)synoptic variability(2-7 days), and (b)intraseasonal variability(10-45 days). The shading represents values between $0 m/s$ and $6 m/s$.

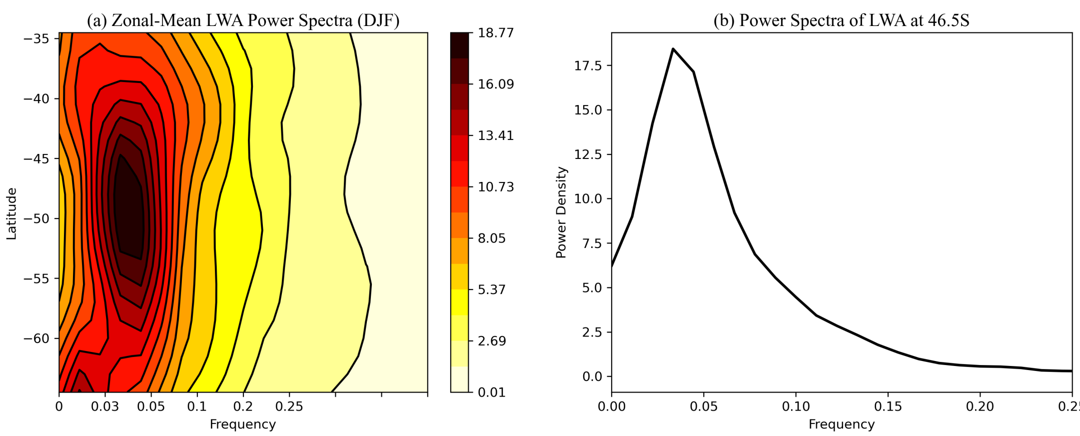

Figure S5. Power spectra in austral summer(DJF) of (a)zonal-mean QGPV-based LWA, and (b)zonal-mean QGPV-based LWA at 46.5°S.

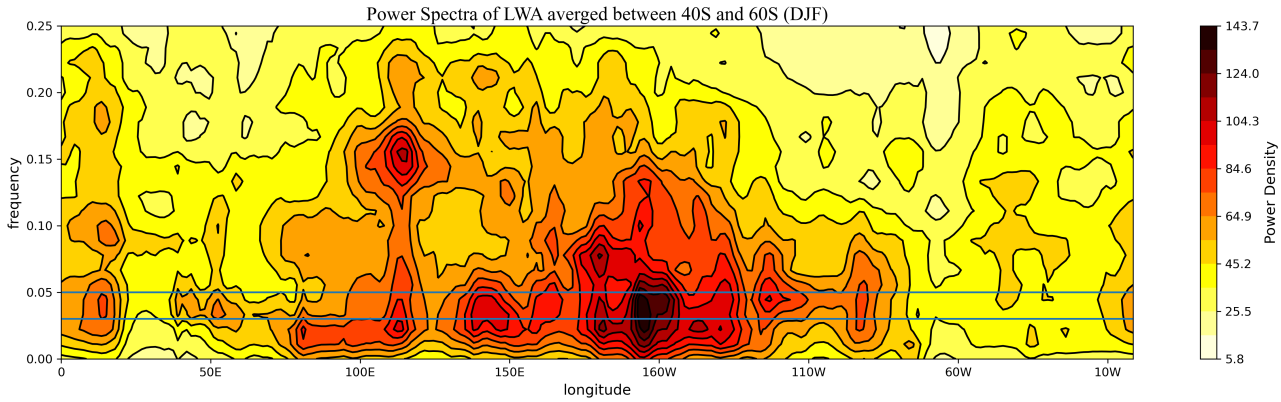

Figure S6. Power spectra of QGPV-based LWA averged between 40°S and 60°S as functions of longitude and frequency.

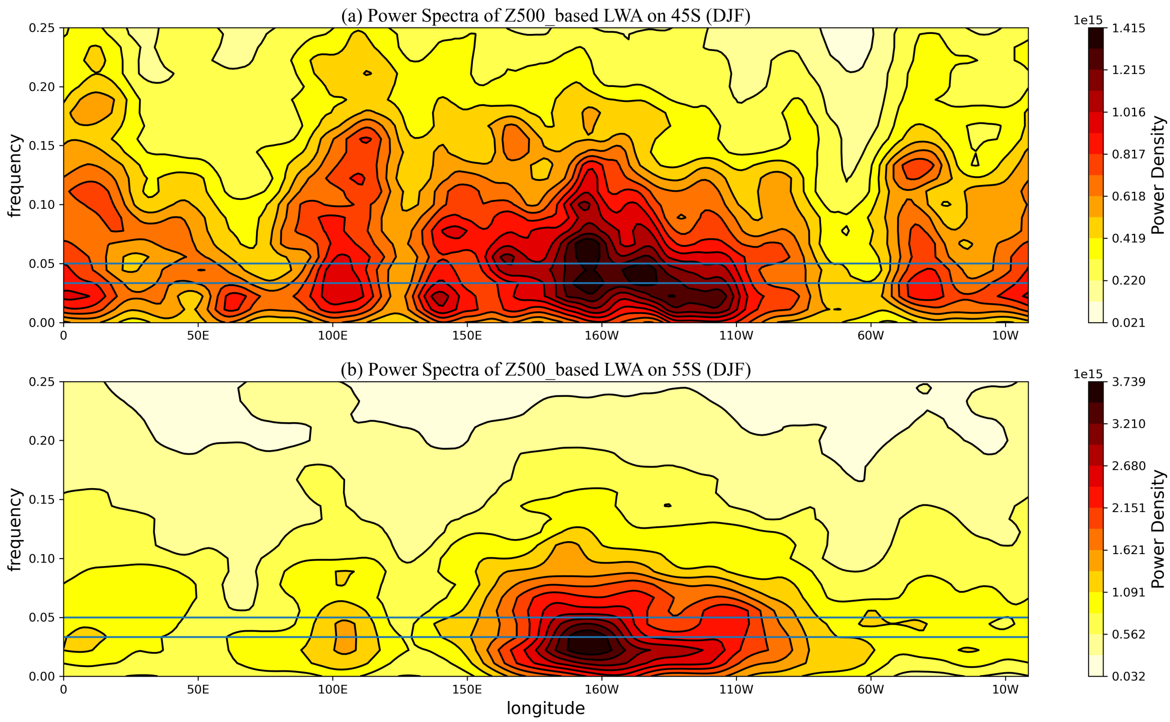

Figure S7. Power spectra of Z500-based LWA as functions of longitude and frequency at two representative latitudes 45°S (upper panel) and 55°S (lower panel), respectively.

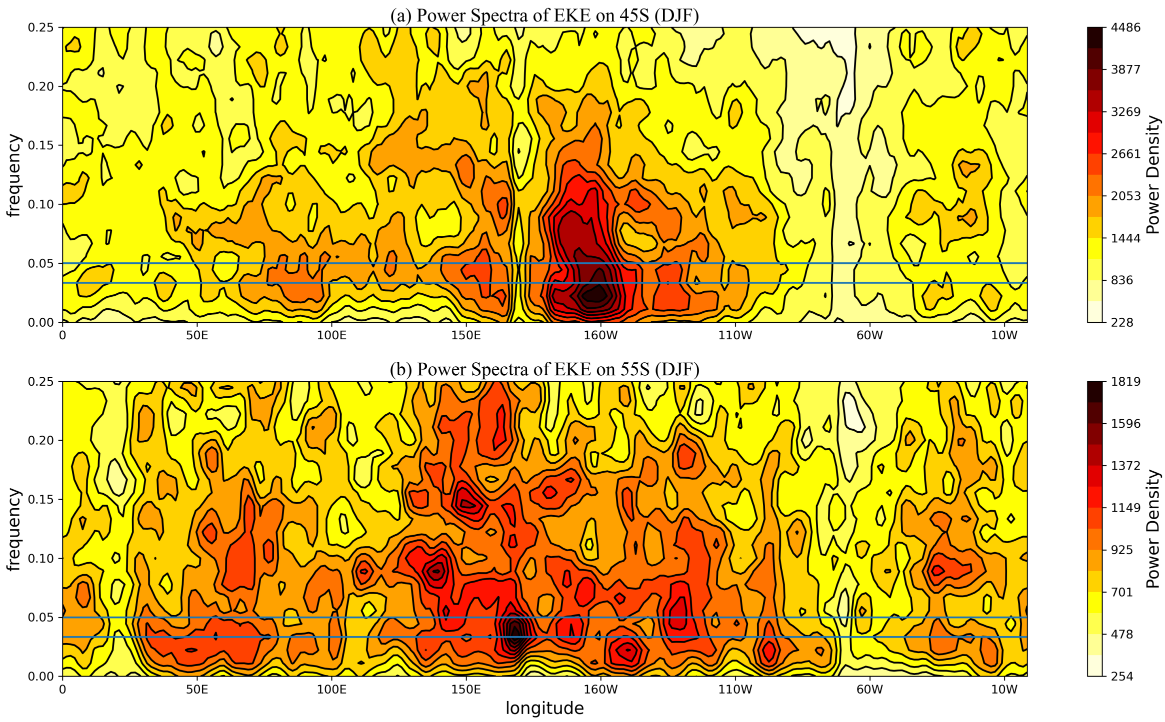

Figure S8. Power spectra of vertical averaged EKE as functions of longitude and frequency at two representative latitudes 45°S (upper panel) and 55°S (lower panel), respectively.

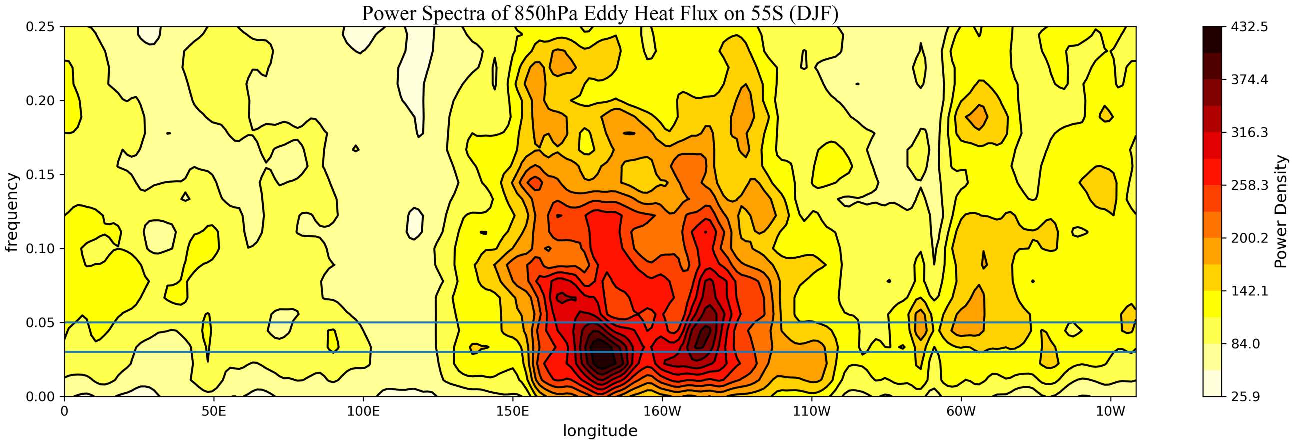

Figure S9. Power spectra of 850hPa eddy heat flux as functions of longitude and frequency at 55°S.