Supplementary Information

Zonal Wave 3 Pattern in the Southern Hemisphere generated by tropical convection

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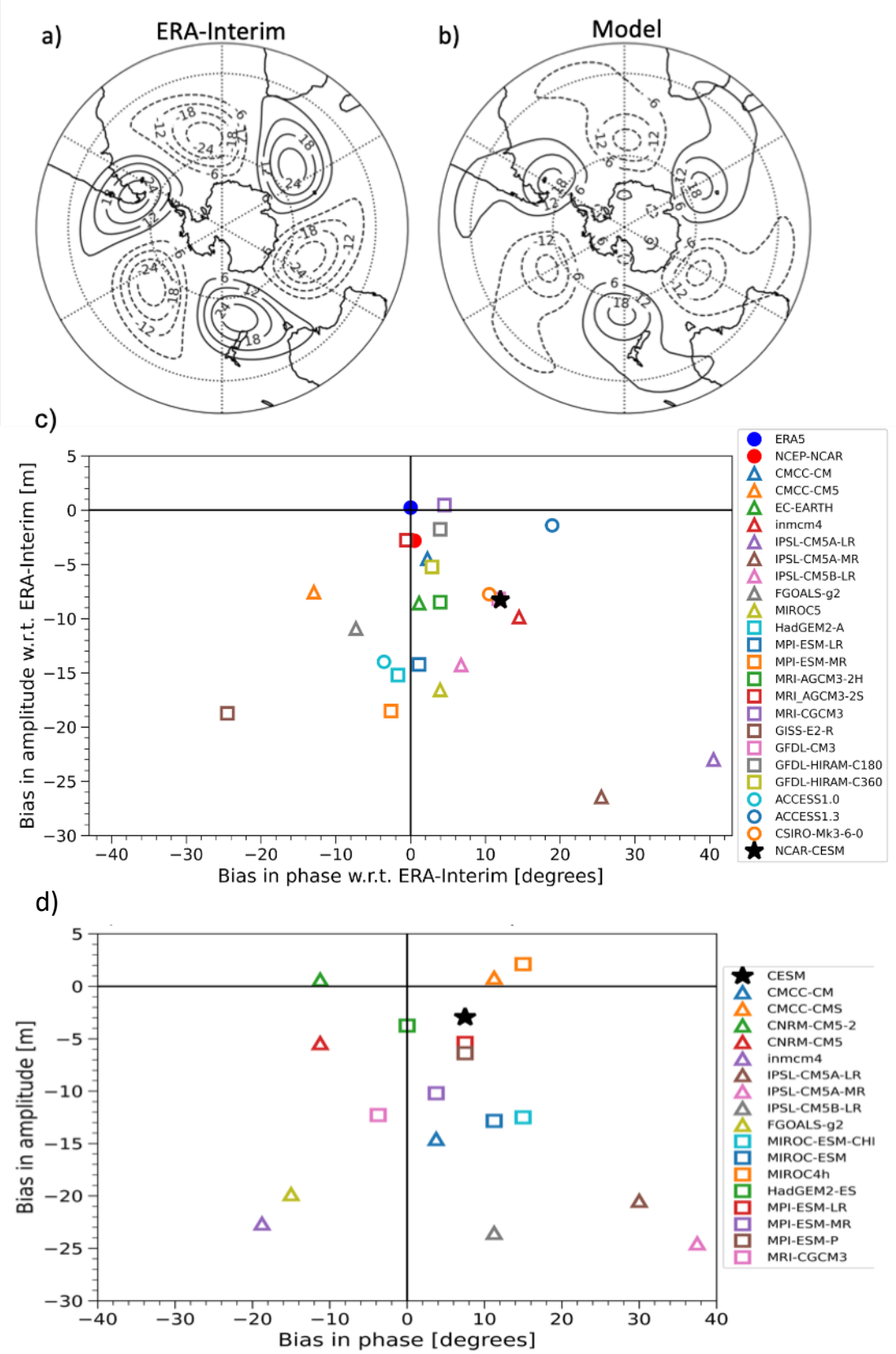

Figure S1 | Fourier filtered zonal wavenumber 3 in a) reanalysis (ERA-Interim) and b) model control (*CTRL*). Panel c) shows the comparison between three reanalysis (ERA-Interim, ERA-5 and NCEP-NCAR) products and different Atmospheric Model Intercomparison Project (AMIP) model simulations on their ability to represent the ZW3 pattern in the SH extratropics and panel d) shows the comparison between

different coupled model simulations from the Coupled Model Intercomparison Project 5 (CMIP5). 30-year long simulations from 1979-2008 are considered from all three reanalysis and for AMIP simulations from CMIP models. 100-year long simulations are used for coupled pre-industrial control simulations from CMIP models Fourier transforms are used to calculate the amplitude and the phase (location of the first maximum) of the climatological mean ZW3 pattern. Bias is calculated by subtracting the mean amplitude and phase of reanalysis and modeled ZW3 from the ZW3 obtained from ERA-Interim reanalysis. CESM is marked as black star.

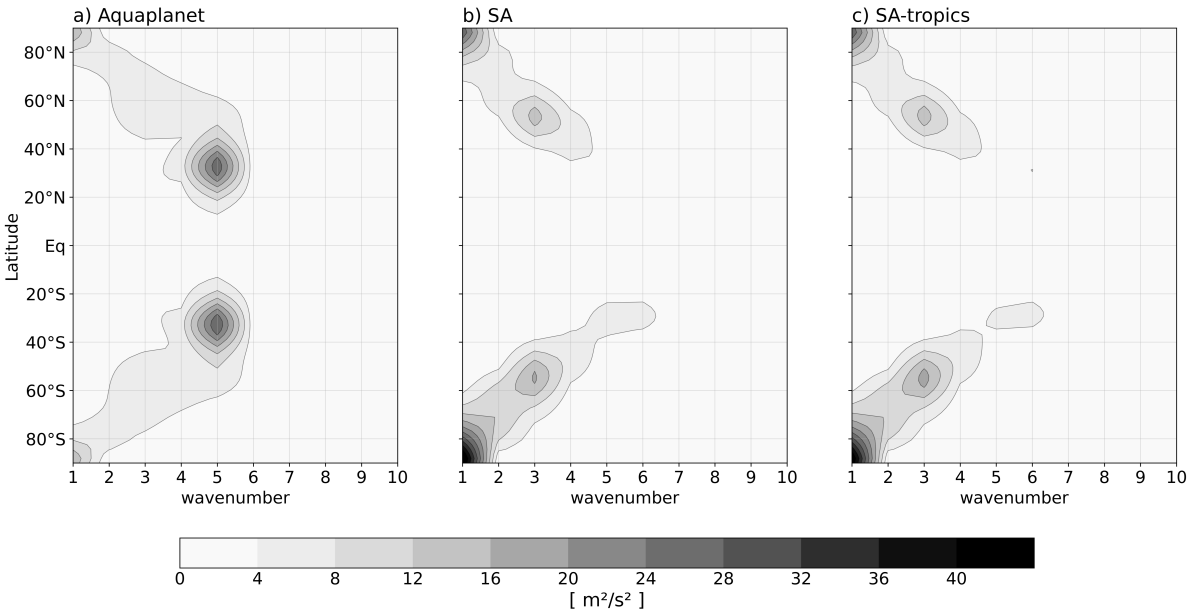

Figure S2 | Total wave energy (m^2/s^2) computed from meridional winds at 300 hPa as a function of wavenumber and latitude in a) aquaplanet, b) SA-only and c) SA-tropics simulations.

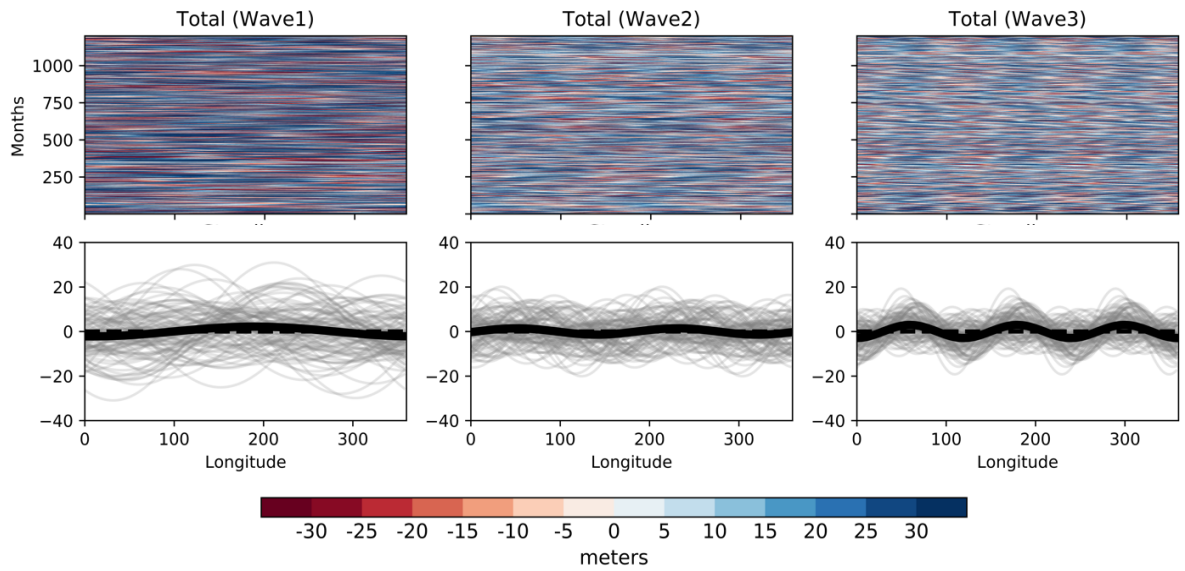

Figure S3 | Waves in the Aquaplanet simulation. Zonal waves 1, 2 and 3 are shown in first, second and third column respectively. Zonal waves are filtered using 300 hPa geopotential height field at 55°S. Top row shows the total amplitude of each zonal wave. Thick black line in the second row shows the mean amplitude of the wave and the thin grey lines represent the mean amplitude in each year for 100 years of simulation. Dashed black line in the bottom row represents the zero line.

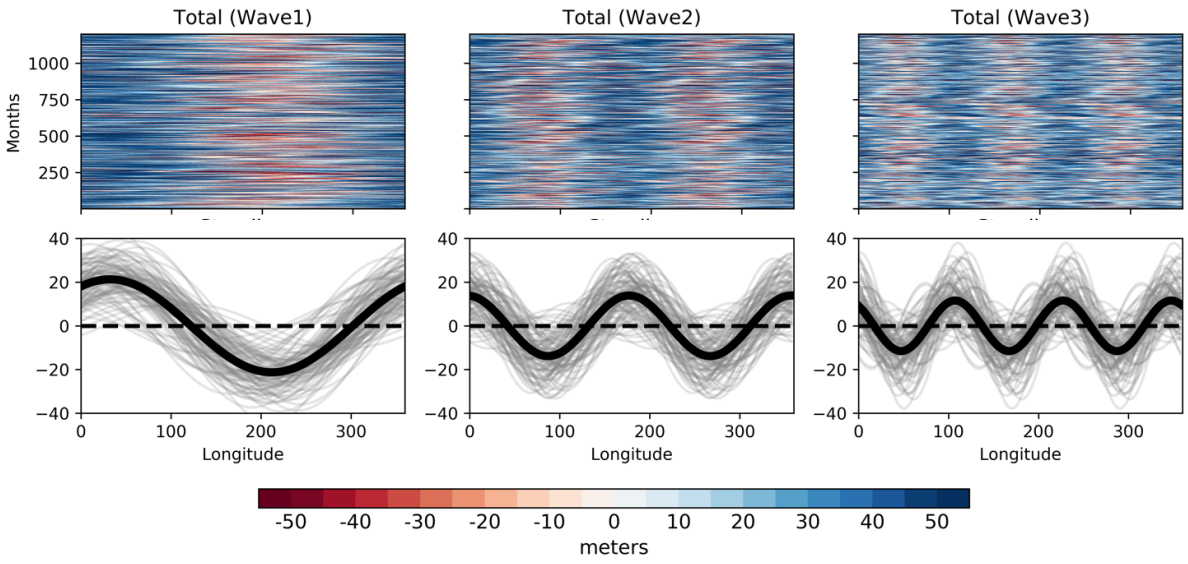

Figure S4 | Waves in South America only simulation. Zonal waves 1, 2 and 3 are shown in first, second and third column respectively. Zonal waves are filtered using 300 hPa geopotential height field at 55°S. Top row shows the total amplitude of each zonal wave. Thick black line in the second row shows the mean amplitude of the wave and the thin grey lines represent the mean amplitude in each year for 100 years of simulation. Dashed black line in the bottom row represents the zero line.

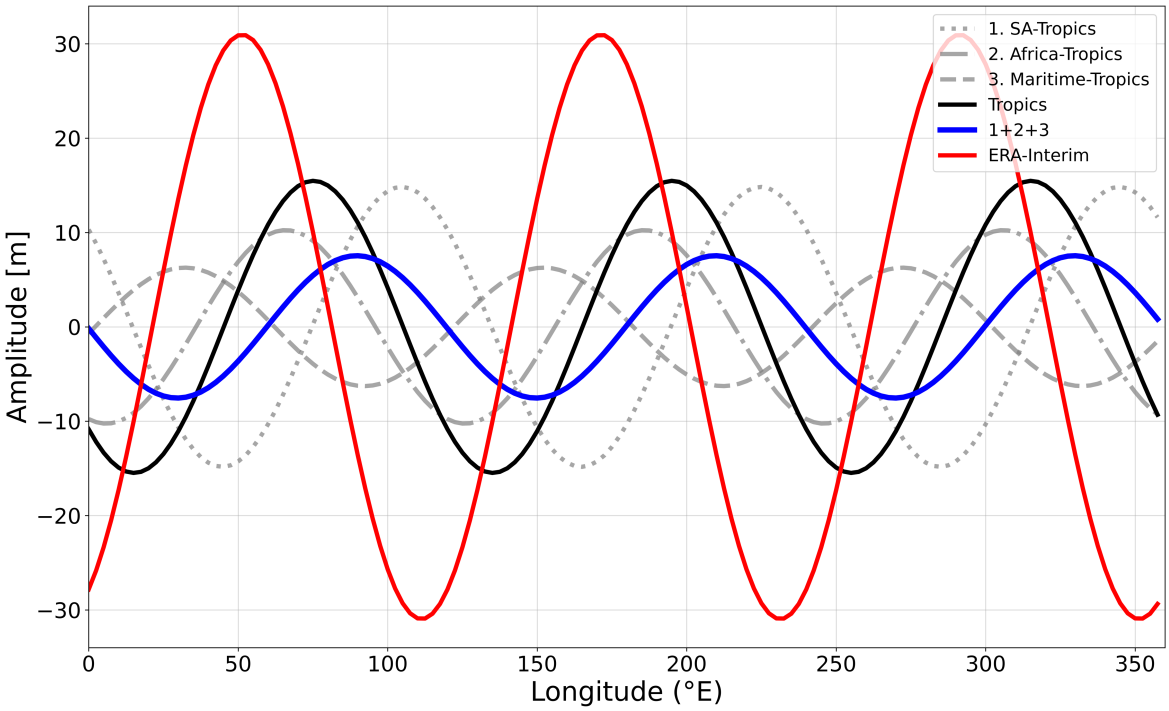

Figure S5 | Amplitude of ZW3 in different arrangements of landmasses in the tropics. Grey lines represent simulations with individual landmasses in the tropics with dotted, solid and dashed grey lines respectively for tropical South America, tropical Africa and tropical Maritime continent simulations. Solid blue line is the linear sum of the three grey lines. Black line represents *Tropics* simulation in which all three tropical landmasses are present.

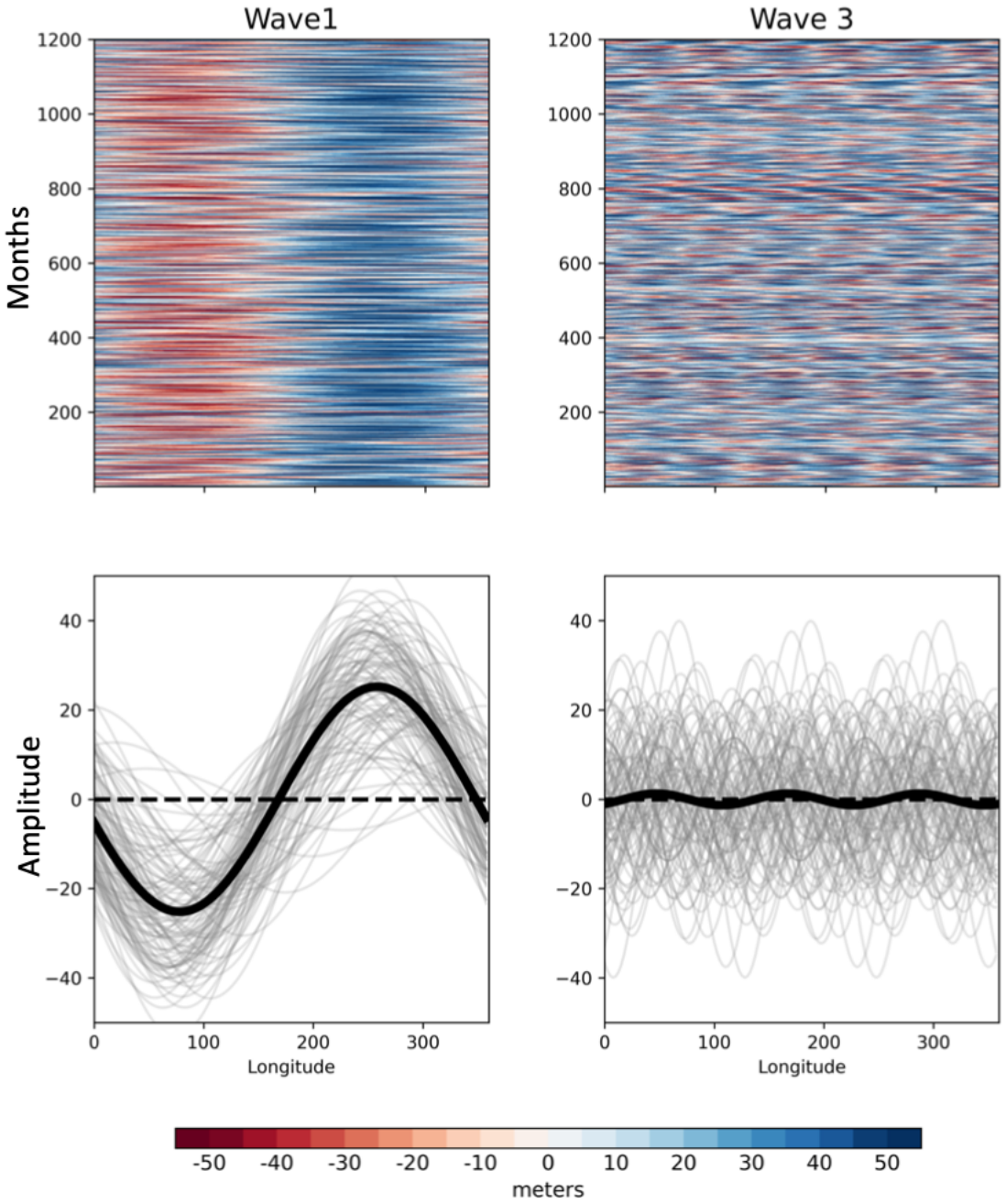

Figure S6 | Zonal wave 3 amplitude and phase in the simulation in which only Antarctica (with orography) is present in the model. First row shows a longitude-time plot of ZW3 at 55°S in each month for 100 years showing the time evolution of ZW3 phase and amplitude. Thick black line in the second row shows the time mean amplitude of the wave and the thin grey lines represent the time mean amplitude in each year for 100 years of simulation. Dashed black line in the bottom row represents the zero line.

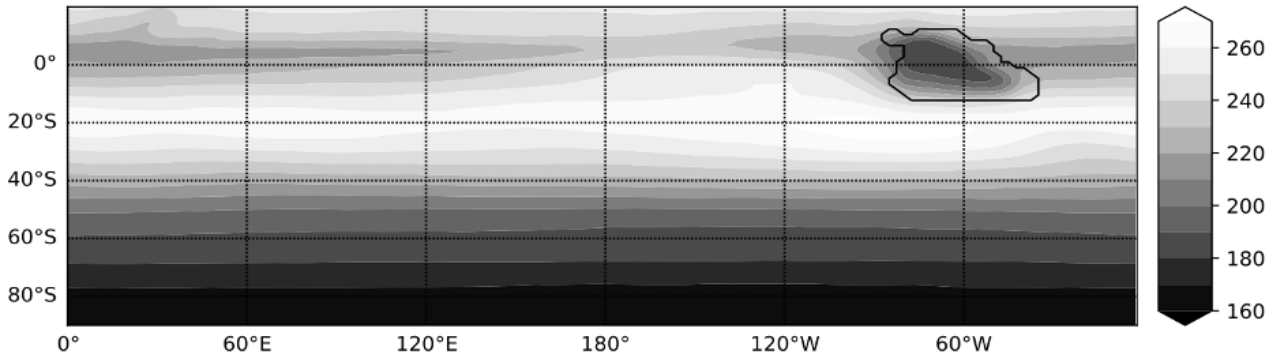

Figure S7 | Outgoing Longwave Radiation (OLR) for the tropical South America simulation.

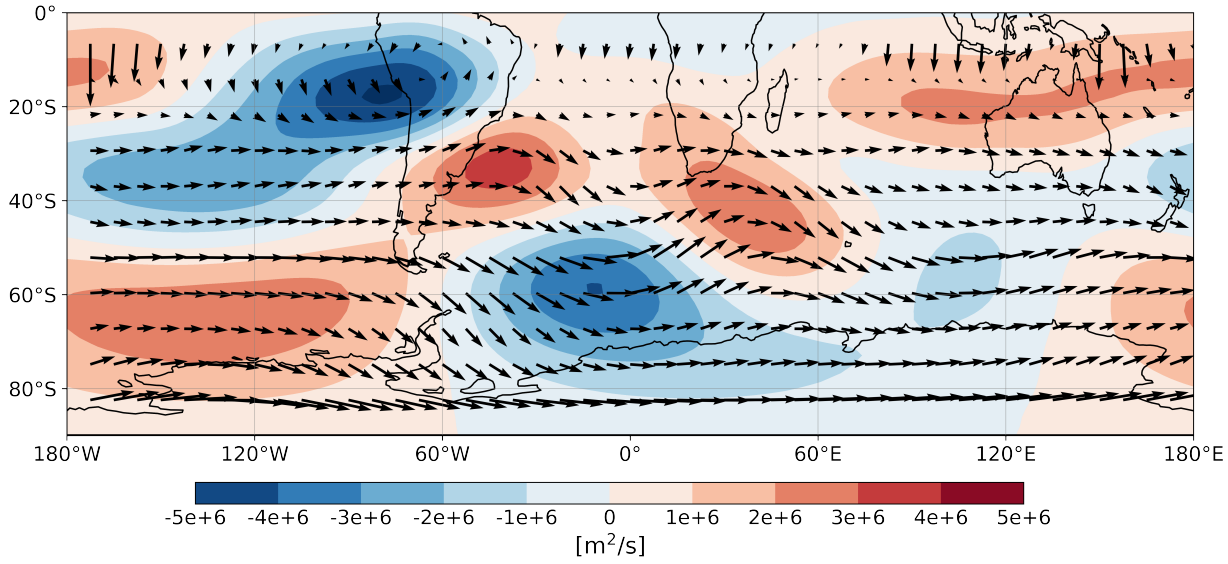

Figure S8 | Streamfunction and wave propagation in the *SA-tropics* simulation. Shading represents streamfunction at 300 hPa calculated from the perturbation zonal and meridional velocities (zonal mean removed) and vectors represent wave activity flux calculated using Takaya and Nakamura (2001) for the *SA-tropics* simulation.

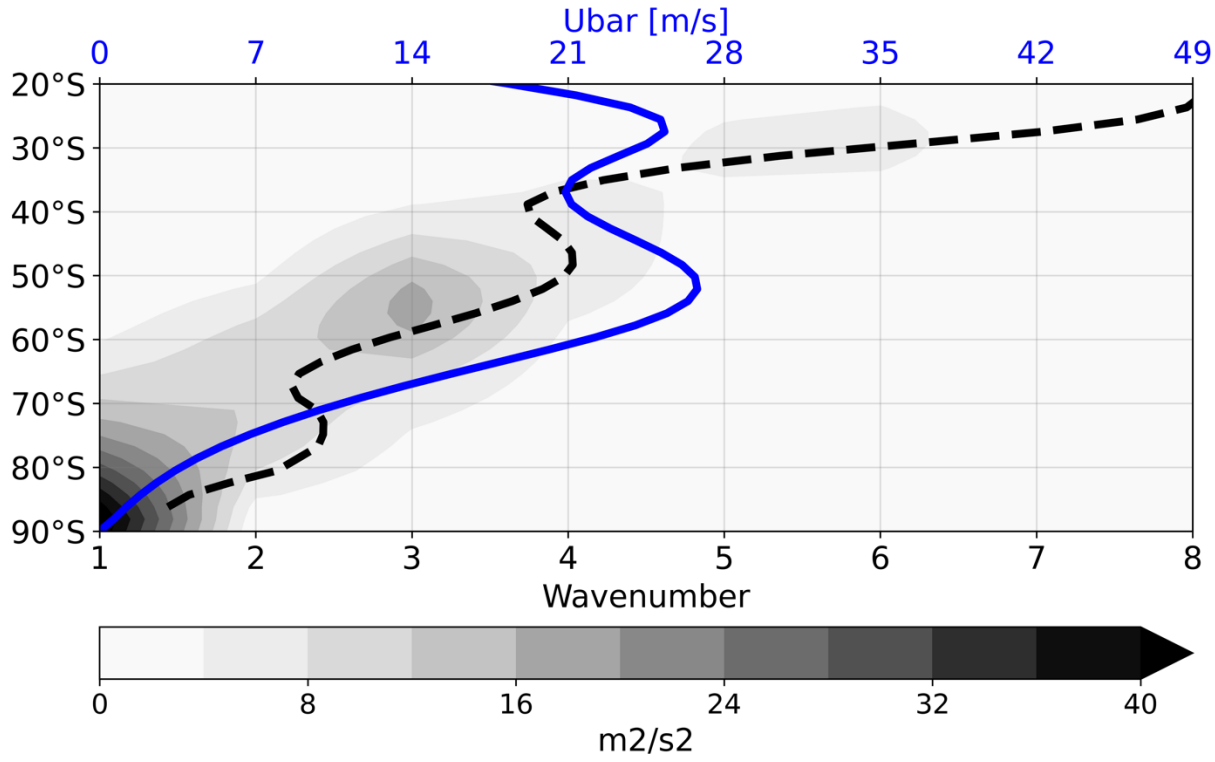

Figure S9 | Shading shows the total wave energy (m^2/s^2) computed from 300 hPa meridional winds in the tropical South America Simulation. Dashed black line represents the stationary wavenumber (Ks) computed from Hoskins and Karoly (1981)[8] and blue solid line shows zonal mean zonal wind profile in the tropical South America Simulation.

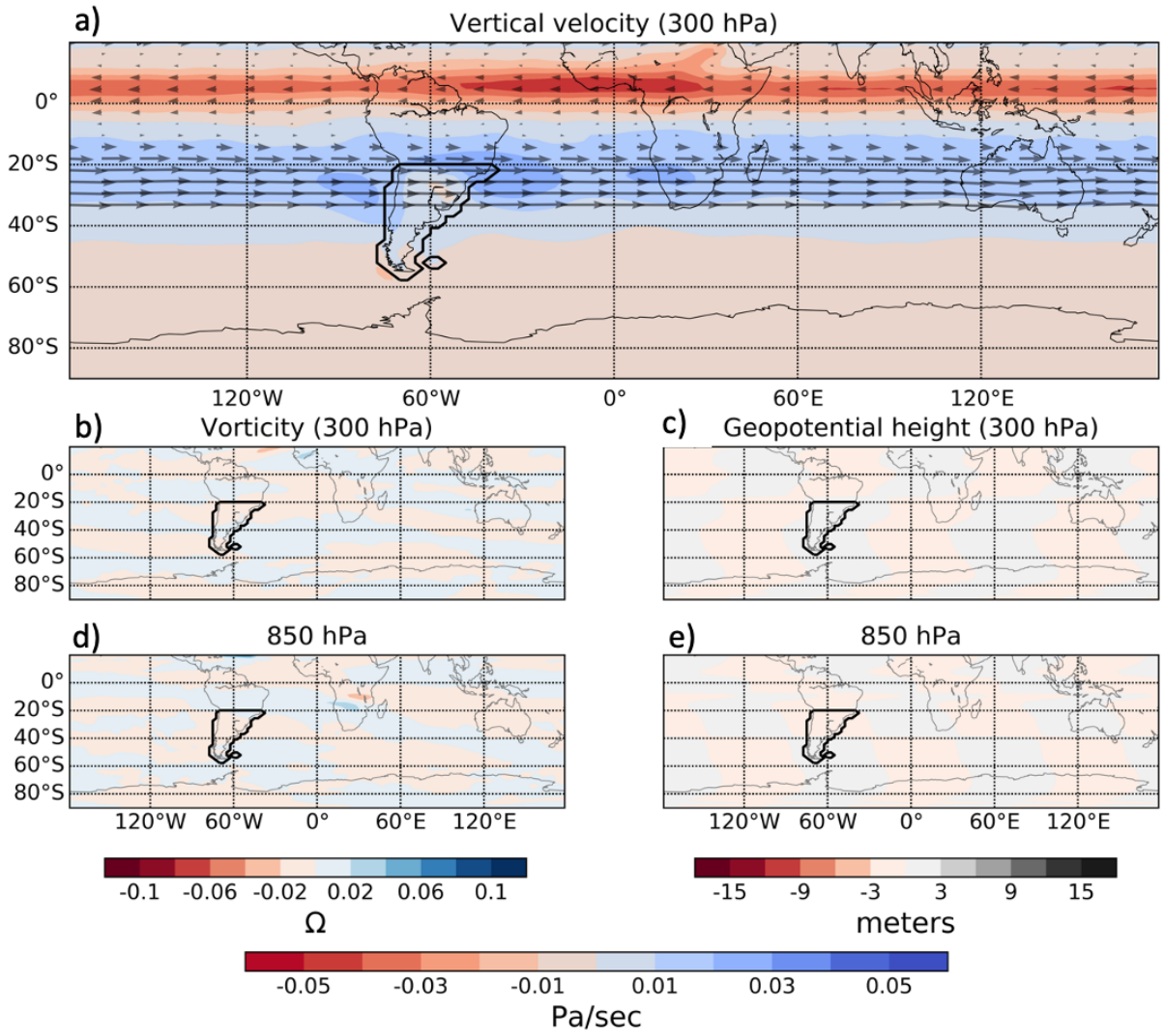

Figure S10 | Vertical Velocity, Perturbation vorticity and eddy geopotential height for midlatitude South America simulation. Panel a) shows vertical velocity at 300 hPa (Pascals/sec). Panels b) and c) represent the perturbation vorticity (units are W, where W =7.29x10^{-5} rad/sec, is rotational rate of earth) at 300 hPa and 850 hPa respectively. Panels d) and e) represent eddy geopotential height corresponding to wavenumber 3 (shading, in meters) at 300 hPa and 850 hPa respectively.

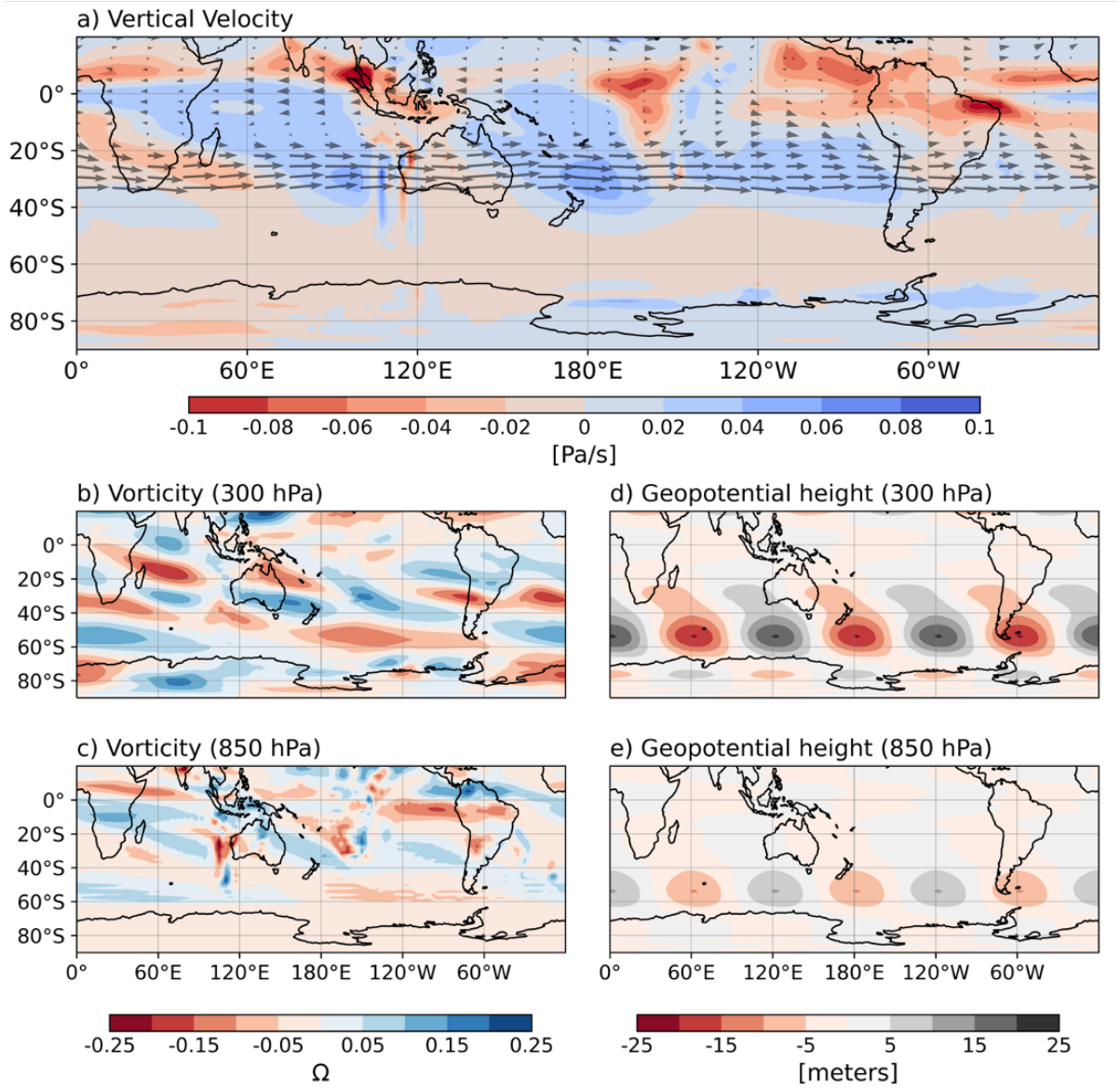

Figure S11 | Vertical Velocity, Perturbation vorticity and eddy geopotential height for Control *(CTRL)* simulation. Panel a) shows vertical velocity at 300 hPa (Pascals/sec). Panels b) and c) represent the perturbation vorticity (units are W, where W =7.29x10^{-5} rad/sec, is rotational rate of earth) at 300 hPa and 850 hPa respectively. Panels d) and e) represent eddy geopotential height corresponding to wavenumber 3 (shading, in meters) at 300 hPa and 850 hPa respectively.