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The power distribution between the symmetric and anti-symmetric components of the tropical wavenumber-frequency spectrum

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A yet unexplained feature of the tropical wavenumber-frequency spectrum is its parity distributions, i.e., the distribution of power between the meridionally symmetric and anti-symmetric components of the spectrum. Due to the linearity of the decomposition to symmetric and anti-symmetric components and the Fourier analysis, the total spectral power equals the sum of the power contained in each of these two components. However, the spectral power need not be evenly distributed between the two components. Satellite observations and reanalysis data provide ample evidence that the parity distribution of the tropical wavenumber-frequency spectrum is biased towards its symmetric component. Using an intermediate-complexity model of an idealized moist atmosphere, we find that the parity distribution of the tropical spectrum is nearly insensitive to large-scale forcing, including topography, ocean heat fluxes, and land-sea contrast. On the other hand, by adding a small-scale (stochastic) forcing, we find that the parity distribution of the tropical spectrum is sensitive to asymmetries on small spatial scales compared to the observed large-scale spectrum. Physically, such forcing can be thought of as small-scale convection, which is believed to trigger some of the Tropics' large-scale features via an upscale (inverse) turbulent energy cascade. These results are qualitatively explained by considering the effects of triad interactions on the parity distribution. According to the proposed mechanism, any small-scale asymmetry (symmetric or anti-symmetric) in the forcing leads to symmetric bias in the spectrum, regardless of the source of variability providing the forcing.