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On the energetics of convectively coupled Kelvin Waves: contrast between Indian and Pacific Basins

Abstract

Utilizing ERA5 reanalysis data, this study provides a comprehensive examination of Convectively Coupled Kelvin Waves (CCKWs) over the Indian and Pacific basins, highlighting a distinct contrast where Indian CCKWs align with theoretical equatorial wave structures while Pacific CCKWs exhibit a significant northward shift of the convective center, accompanied by enhanced meridional winds and a more robust wave response.

To understand the underlying energetics, a Moist Static Energy (MSE) budget analysis was performed, revealing that despite these structural differences, both basins share a consistent energy cycle governed by similar physical factors, during the recharge phase on days -2 and -1, column processes, comprising vertical MSE advection, the apparent heat source, and the moisture sink destabilize the atmosphere by importing MSE, while horizontal MSE advection provides early destabilization on day -2 before beginning to stabilize the environment by day -1. In the subsequent discharge and transition period from days 0 to +2, the column process shifts to exporting MSE to stabilize the atmosphere, while horizontal MSE advection maintains this stabilizing role through day +1 until it prematurely triggers destabilization again on day +2. The finding that horizontal MSE advection consistently leads the recharge-discharge cycle underscores its critical role in driving the eastward propagation of CCKWs, demonstrating that both horizontal advection and column processes are indispensable in maintaining the wave's energy cycle as they take alternating roles in recharging and discharging the tropical region.

Keyword

CCKW (Convectively coupled Kelvin wave), MSE (Moist static energy) budget

Reference

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