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Role of thermodynamic processes in driving Monsoon Intraseasonal Oscillations (MISO) away from the Equator

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Monsoon intraseasonal oscillation (MISO) is an important aspect of the monsoon variability on various timescales, accounting for short-term variability as well as about 40% of total seasonal rainfall variance. MISO plays an important role in modulating the active (wet) and break (dry) spells of monsoon, and its low-frequency component has a time period of 30-60 days and exhibits northward propagation from the equatorial Indian Ocean to the Himalayan foothills. This northward propagation is generally attributed to generation of positive barotropic vorticity to the north of the previous convection centre. However, using ERA5 reanalysis composites we show that the relation between convection centre and positive barotropic vorticity undergoes significant change as MISO propagates away from the equator. Close to the equator (0-15°N), barotropic voriticty is either in-phase or leads rainfall, whereas further poleward (15°N-25°N), this relationship reverses and rainfall leads vorticity by 1-2 days. This contrast is closely tied to changes in the vertical structure of vorticity: near the equator, the vorticity maximum lies in the middle troposphere, while poleward of 15°N it is in the lower troposphere. The vorticity budget at each pressure level reveals the importance of vertical advection of vorticity for its near-barotropic structure, together with the importance of thermodynamic influences on vorticity, especially poleward where the vortex stretching term grows. Such findings point to the central role of feedback on the dynamics from the thermodynamic processes away from the equator. Furthermore, it closely ties the ability of models to reproduce MISO to their ability to represent convective processes.