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The Art of Identifying Equatorial Waves

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Equatorial waves are synoptic- to planetary-scale propagating disturbances at low latitudes with frequencies from a few days to several weeks. Here this term includes Kelvin waves, equatorial Rossby waves, mixed-Rossby gravity waves, and inertio-gravity waves, which are closely related to linear wave theory, but also tropical disturbances, African easterly waves, and the intraseasonal Madden-Julian Oscillation. These waves can couple with deep convection, leading to a substantial modulation of rainfall. Recent work has shown that equatorial waves are amongst the dynamical features internal to the troposphere with the longest intrinsic predictability and that some models forecast them with an exploitable level of skill at lead times of up to a few weeks.

A number of methods have been developed to identify and objectively isolate equatorial waves, both in (usually satellite) observations and in model fields. Most of these rely on (or at least refer to) the adiabatic, frictionless linearized primitive equations or shallow water system on the tropical beta plane. Common ingredients to these methods are longitude-time filtering (Fourier or wavelet) and/or projections onto predefined empirical or theoretical dynamical patterns. This paper aims to give an overview of the different methods to isolate the waves and their structures, to discuss underlying assumptions, to provide a systematic comparison, and to reveal advantages and disadvantages of each method. This way this study helps to optimally choose an approach suited to a given problem at hand and to avoid misuse and misinterpretation of the results.