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Systematic Decomposition of the MJO and its Northern Hemispheric Extra-Tropical Response into Rossby and Inertio-Gravity Components

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The Madden-Julian Oscillation (MJO) is the dominant form of intra-seasonal variability in the tropics. The MJO is a complex convectively coupled phenomenom which is still poorly represented in the current generation of climate models and our understanding of its essential dynamics and its influence on the mid-latitude circulation is still incomplete. Here, we use a normal mode decomposition method to systematically decompose the MJO into Kelvin, inertio-gravity (IG) and Rossby wave components in the ERA-Interim reanalysis data for the period 1980-2015 to provide a climatology of the 8 MJO phases for the Kelvin, IG and Rossby wave components.

Our analysis shows that the Rossby modes provide a larger contribution to the magnitude of the MJO in terms of geopotential height and winds than the Kelvin wave and IG modes. Moreover, the kinetic energy associated with the Rossby modes of the MJO accounts for about 93% of the kinetic energy. Our decomposition also shows that the Kelvin wave is the dominant mode in the unbalanced wave part which is flanked by Rossby waves on both sides of the equator, consistent with previous studies. The extra-tropical response to the MJO consists also of both IG and Rossby wave components in the Northern Hemisphere (NH). The mid-latitude MJO response is also linked to well-known teleconnection patterns like the North Atlantic Oscillation and the Pacific-North American pattern. The transient NH atmospheric response is fast, on the order of 5 days. While the extra-tropical response is dominated by Rossby waves, IG waves show also a prominent response in the NH.