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Using OIFS to assess the intraseasonal multiscale model of tropical dynamics

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In a series of papers during the last fifteen years Majda, Klein, and Biello developed a multi scale asymptotic theory of the tropical troposphere named Intraseasonal Planetary Equatorial Synoptic Dynamics (IPESD) and Intraseasonal Multiscale Moist Dynamics (IMMD). The theory is derived by exploiting a fundamental separation of scales which occurs in the tropics; diabatic heating due to the release of latent heat of condensation as resolved on planetary scales is at least one order of magnitude smaller than the fluctuations, as resolved on equatorial synoptic scales and smaller. In the multiscale theory, the synoptic scale resolved fluctuations are linearly forced by diabatic heating directly applied on the synoptic scales. However, the planetary scale resolved circulations evolve over intraseasonal time scales and are driven by upscale forcing from the synoptic scales. Effectively, this means that the synoptic scale circulations respond linearly to synoptic scale diabatic heating, while their accumulated Reynolds stresses drive the planetary flows on the slower, intraseasonal time scale. The IMMD theory has been used to construct a set of models for the planetary scale Madden-Julian Oscillation (MJO). In those models, it has been discovered that organized diabatic heating on the synoptic scales made the vertical flux of zonal momentum the dominant forcing in the MJO.

In this study we use the Open Integrated Forecasting System, run in an aquaplanet with perpetual equinoctial conditions, at a spectral truncation of T159, to study the predictions of the IMMD theory. We isolate organized tropical structures, as are found in the MJO, and lag correlate them to upscale fluxes from the synoptic scales. We show that indeed, the vertical transport of zonal momentum is the dominant up-scale flux term which drives organized planetary scale flows in a high-complexity model.