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Simulated meridional propagation in the Asian monsoon: Relationship to physical mechanisms and convectively coupled Equatorial waves

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Boreal summer monsoon rainfall over subtropical Asia is characterized by onset and break periods on intraseasonal timescales, which result from intermittent northward-propagating convective systems. The northward-propagation is generally understood to result from the interactions of convectively-generated vorticity anomalies with the seasonal easterly shear of the zonal wind. Several mechanisms have been proposed to explain this interaction, but which of them is dominant remains unclear. Observations suggest that the northward propagation is frequently associated with the Madden-Julian oscillation (MJO), convectively-coupled equatorial Rossby (ER) waves, and sometimes mixed Rossby-gravity (MRG, or Yanai) waves, suggesting that convective-scale processes also play a role in northward propagation. In this study, we analyze the simulation of the NPISO and ER and MRG waves in the super-parameterized Community Climate System Model (SP-CCSM), which computes convective tendencies of moisture and temperature via an embedded cloud-resolving model at each GCM grid column, rather than via a traditional cumulus parameterization. Previous studies have shown that this convective treatment improves the simulation of the Asian monsoon. Horizontal and vertical composites of ER and MRG waves in SP-CCSM show excellent agreement with composites based on radiosonde and reanalysis data, whereas composites from the traditionally-parameterized CCSM show only weak agreement. In particular, SP-CCSM successfully simulates the low-level build up of specific humidity prior to maximum convection, while CCSM does not. Mechanisms for northward propagation of both the NPISO, and the observed northward propagation of ER and MRG waves will be presented. These mechanisms will include: surface latent heat flux, vorticity advection, vertical wind shear effect, and moisture advection, as recently summarized in Chou et al. (2011). Emphasis will be placed on determining if certain mechanism are more prominent in different wave types, and how the different convective treatments improve the representation of the studied mechanisms.