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The Madden-Julian-Oscillation as simulated in ECHAM6: Multivariate assessment of AMIP and coupled experiments

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This study presents a quantitative analysis of the Madden-Julian Oscillation (MJO) as simulated in an ensemble of ECHAM6 experiments. The ensemble members differ in their parameter settings, resolution and whether the atmosphere is coupled to an ocean or not. We concentrate on the main characteristic features of the MJO, namely the convective strength of the convectively coupled circulation system around the Equator and the eastward propagation strength of outgoing longwave radiation (OLR) and 850 and 200 hPa zonal winds in the Tropics within the MJO related frequency-wavenumber range.

Almost all experiments show MJO-like variability, however, to different degrees and in different aspects, so that a sound assessment requires a multivariate approach. By focusing on only a single MJO-characteristic, it is possible to be misled as to the quality of simulated MJO-like variability. Especially the convective signature is decoupled from the dynamic MJO-like variability in our simulations. The importance of the convection scheme is confirmed: The Nordeng modifications of the Tiedtke scheme are a necessary condition to simulate realistic MJO features. High-resolution coupled experiments better represent the MJO as compared to low-resolution AMIP experiments. This is shown to follow from two more general findings, namely that: 1.) air-sea interaction strengthens the convective signature, and 2.) increased resolution enhances eastward propagation. Our quantitative assessment also shows that the simulated MJO improves with a more realistic mean state of SST, precipitation and the winds in 850 hPa height.