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**A More Stable Atmosphere under Global Warming Accelerates the Hydrological Cycle of MJO**

***Abstract***

Changes in the Madden-Julian Oscillation (MJO) under global warming are analyzed using the Historical and future Rcp8.5 simulations from coupled global climate models (GCMs) in Coupled Model Intercomparison Project phase 5 (CMIP5). The spectrum of precipitation variability associated with MJO is mainly enhanced at higher frequency (period of 20-30 days) and low wavenumbers (1-2) domain across all models with warming.

Over the 10°N/S tropical belt, time-longitude diagrams of 850 hPa filtered average velocity potential (VP850) are used to estimate the MJO phase speed change, which on average increases by about 1.36 m/s in selected CMIP5 models compared to about 1.48 m/s in linear theory related to the internal variability of gross moist stability ($M$) and thermal inertia ($A^{\*}$) linked to temperature ($\hat{A}$) and moist ($\hat{αγA}$) perturbations. Among the three effects contributing to the phase speed change, we found that the positive $M$ anomaly (i.e., the atmosphere becomes more stable) is the dominant effect.

Three factors may affect $M$, including changes in convection intensity, cloud top height and MSE stratification. Stronger convection and deeper cloud top tend to increase *M*, and the latter’s contribution is especially important in area dominated by shallow convection such as the eastern Pacific ITCZ. By contrast, change in $∂\_{p}h^{'}$ tends to decrease *M*. Our result shows that the competition between dynamic and thermal dynamic results in increased 𝑀 (i.e., a more stable atmosphere) which in turn generates a faster hydrological cycle and a shorter MJO period under global warming.

**Keyword:** Madden-Julian Oscillation