Convective Gravity Waves during the Madden-Julian-Oscillation –results of numerical modeling

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Weather systems in the tropical Indian Ocean region are prominently influenced by the Madden-Julian-Oscillation (MJO) (Madden and Julian, 1972). Once an MJO active cycle is established, it can drive surface weather for several months, forcing heavy rainfall and droughts on the Indian Subcontinent. Although understanding of the MJO has improved over the last decade, MJO still considerably degrades forecasting skill, particularly in the Asian Monsoon region (Kim et al. 2014). This is especially true for seasonal prediction. The interaction of gravity waves (GW) from convection during MJO active phases is one of the various sources of uncertainties in MJO modeling. We developed a coupled model of convective gravity wave (CGW) forcing and propagation to evaluate the entire life-cycle of GWs from their convective excitation to their dissipation in the upper stratosphere / lower mesosphere region. CGW forcing at source level was calculated using the Song & Chun (2005) model. GW trajectories were calculated using GROGRAT (Marks & Eckermann 1995). Simulations were performed for all respective MJO phases for MJO cycles during a 30 years period using CFSR3 data for the full spectrum of CGWs. Our results show a strong correlation between momentum flux at cloud top height and 850 hPa zonal wind anomalies. Maximum momentum flux is prominently found in the inner tropics at altitudes between 20 km and 45 km. Horizontal and vertical wavelength spectra show maximum momentum flux for rather short wavelengths (~15-20 km) –a challenge for limb- and nadir-sounding satellite instruments. Maximums in GW drag are consistently found at altitudes higher than 45 km. We therefore conclude that convective GWs during MJO are an important contribution to the middle atmosphere momentum and energy balance and have significant effect on large-scale middle atmosphere circulations like the Brewer-Dobson circulation.

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