The Madden-Julian Oscillation and Atmospheric Composition

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The Madden-Julian Oscillation (MJO) is the dominant form of intra-seasonal variability in the Tropics. It is characterized by slow eastward-propagating, large-scale oscillations in tropical deep convection and the baroclinic wind field, especially over the equatorial Indian and western Pacific Oceans. To date, the MJO has been shown to have important influences on many other physical parts of the global climate system. However, the impact of the MJO on the chemical components of the global climate system has not been well documented. In this study, we explore the impact of the MJO on atmospheric composition, specifically ozone and aerosols, using the satellite remotely-sensed total ozone and aerosol products from AIRS, TOMS, MODIS, and AVHRR.

Based on these satellite data, we have found that the MJO can induce systematic and significant variations in atmospheric total ozone and aerosols, through its either convective or dynamic effect. The total ozone anomalies are mainly evident in the subtropics over the Pacific and eastern hemisphere, with a systematic relationship to the equatorial MJO convection. The subtropical positive (negative) total ozone anomalies flank or lie to the west of equatorial suppressed (enhanced) MJO convection and propagate slowly eastward (~5 m s^{-1}). The subtropical total ozone anomalies are caused by subtropical tropopause's vertical movement generated by the equatorial MJO convection. The aerosol variations are found mainly over the equatorial Indian and western Pacific Oceans as well as the tropical Africa and Atlantic Ocean. There is a strong inverse linear relationship between aerosol and rainfall anomalies in TOMS, but a weaker, less coherent positive correlation in MODIS and AVHRR. Further research is needed to fully understand this complex aerosol-rainfall relationship.