

## **Top-down Solar Influences on the Madden-Julian Short-Term Climate Oscillation**

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The tropical Madden-Julian Oscillation (MJO) is the strongest of the intra-seasonal climate oscillations and has important effects on extratropical circulation, including effects on storminess and temperature in the United States and Europe. Beginning about three years ago, it was realized that the stratospheric quasi-biennial oscillation (QBO) exerts a significant influence on the amplitude and occurrence rate of MJO events during boreal winter (DJF). More events occur in the easterly QBO phase (QBOE) than in the westerly phase (QBOW). The main candidate mechanism is the decrease in static stability in the tropical upper troposphere / lower stratosphere (UTLS) resulting from relative upwelling and adiabatic cooling under QBOE conditions.

In this work, we examine whether strong MJO occurrence rates are also influenced by solar variability on the 27-day and 11-year time scales. On both time scales, there is observational evidence that increased solar UV heating in the tropical upper stratosphere accelerates the lower mesospheric subtropical jet, which modifies wave propagation such that the stratospheric meridional circulation is slowed. The net effect is that temperatures in the tropical UTLS are reduced under 27-day or 11-year solar minimum (SMIN) conditions relative to those under SMAX conditions.

It was found that, under 11-year SMAX conditions when 27-day UV variations are largest, the mean occurrence rate of strong winter-spring MJO events is increased and tropical UTLS static stabilities are decreased following 27-day solar UV minima; the opposite occurs after 27-day solar UV maxima (Hood, *J. Atmos. Sci.*, 75, 857, 2018). Although only 3-4 solar cycles of high-quality MJO data are available, there is also evidence for an increase in strong MJO events and decreased static stabilities under 11-year SMIN conditions ([Hood, *GRL*, 44, 3849, 2017). Occurrence rates are largest under combined QBOE/SMIN conditions and are smallest under QBOW/SMAX conditions.