QBO/Solar Influence on the Madden-Julian Oscillation: Midlatitude Impacts

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It has been shown that the QBO modulates the intraseasonal Madden-Julian climate Oscillation (MJO) in boreal winter such that a larger number of days with higher MJO amplitudes occur during the easterly phase (QBOE) than during the westerly phase (QBOW) (Son et al., 2017, Zhang & Zhang, 2018, and references therein). In addition, evidence for a secondary modulation of MJO amplitudes during boreal winter by solar UV variability on both the 11-year and 27-day time scales has been reported (Hood, 2017; 2018). Although only ~ 3.5 solar cycles of good quality data exist, the available data indicate that the difference between the two QBO phases is amplified by minima and maxima of the solar cycle. The short-term modulation is such that, under solar maximum conditions, the number of days when MJO amplitudes exceed a given threshold is reduced at lags of several days after 27-day solar UV maxima and is increased at lags of several days after UV minima. A possible mechanism for producing these modulations involves QBO- and solar-induced changes in the tropical upwelling rate, which affects temperature and static stability in the lowermost stratosphere.

Here, the above analyses are extended by investigating derivative effects on the North Pacific winter storm track (NPST) and associated temperature/precipitation anomalies over North America using ERA Interim data. It is well documented that the NPST strengthens and shifts northward during early MJO phases as compared to later phases (e.g., Guo et al. [2017]). One consequence is that cold air outbreaks during Nov-Apr are 1.5-2 times more likely in the western U.S. during MJO phases 2 and 3 as compared to later phases or when MJO is inactive. The cold air outbreaks occur in conjunction with an anomalous trough over the western U.S. positioned east of a blocking anticyclone over the central Pacific. Compositing the data according to QBO phase shows that these cold air outbreaks during MJO phase 2 are ~ 1.7 times more likely in QBOE than in QBOW. This may be related to an observed northward shift of the time-averaged NPST during QBOE relative to that in QBOW (Wang et al., 2018). Results of further compositing according to solar cycle phase and lags relative to short-term solar maxima and minima will be presented.

Key words: MJO, QBO, solar UV, storm tracks

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