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QBO/Solar Modulation of the Boreal Winter Madden-Julian Oscillation: The Role of Extratropical Wave Forcing in Late Fall / Early Winter

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The tropical Madden-Julian oscillation (MJO) is the strongest of the intraseasonal climate oscillations. It generates a Rossby wave train that can be associated with high-impact weather events at northern midlatitudes in winter and spring. Here, we investigate using 41 years of ECMWF reanalysis data (1979-2019) why static stabilities in the tropical lower stratosphere are unusually low under easterly QBO and solar minimum conditions, leading to stronger MJO episodes. Results indicate an important role for extratropical wave forcing events, including stratospheric warmings, occurring preferentially in late fall and early winter during QBOE and SMIN. This increases the tropical upwelling rate beyond that caused by the QBO induced meridional circulation alone, further reducing lower stratospheric temperatures and static stability during northern winter. In many but not all years, major sudden stratospheric warmings (SSWs) contribute significantly to the results obtained here. Of the 11 clear QBOE years in the study period, six had SSWs in early winter prior to Jan. 15. Of the 12 clear QBOW years, none had early winter SSWs while six had SSWs in late winter after Jan. 15. There are two main implications of these results: (1) Observations of wave forcing and tropical static stabilities in late fall / early winter, combined with the known QBO and solar phases, may provide a means of projecting the likely strength of the MJO in a given winter; (2) A necessary prerequisite for a successful simulation of the QBO/solar - MJO connection in a global climate model may be the ability to simulate a preferred occurrence of extratropical wave forcing events, including SSWs, in early winter under QBOE and SMIN conditions.