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Relationships between the MJO and the Extratropical Stratospheric Circulation in the Subseasonal to Seasonal (S2S) Prediction Models

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There is increasing evidence that the Madden Julian Oscillation (MJO), the leading mode of instraseasonal variability in the tropics, may be a source of predictability for the extratropical Northern Hemisphere (NH) atmospheric circulation during the boreal winter. This study explores the interplay between the wintertime NH stratospheric circulation, MJO, and the Arctic Oscillation (AO) in observations and subseasonal-to-seasonal (S2S) prediction models. Consistent with previous studies, observed MJO phases 2-4 are associated with the positive surface AO but also with the stratospheric AO/stratospheric polar vortex (SPV). MJO phases 7-8 are linked with the negative surface AO but not the negative/weak SPV. However, in the presence of a strong or weak SPV, the polarity of the surface AO is dominated by the SPV not the MJO. Analysis of the spatial signatures associated with the combined SPV/MJO signals shows that the Pacific is dominated by the MJO while the Atlantic is dominated by the SPV. Consequently, the constructive /destructive interference between the combined signals influences 2-m temperature anomalies differently than if the MJO alone were considered.

Nearly all analyzed S2S models confirm the observed tropospheric MJO-AO relationships, particularly during phases 4 and 7. However, the models cannot clearly reproduce the relationship between the stratospheric circulation and the MJO-AO teleconnections. Under strong or weak SPV conditions, the ECMWF and BOM simulations exhibit strong agreement with the observations, capturing the dominance of the SPV on the AO polarity over the MJO. Little agreement exists between the observations and these models, including the NCEP simulations, during phases 7-8 suggesting that the MJO teleconnections in those phases are more difficult to reproduce. Observed T2m temperature patterns during MJO phases 2-4 exhibit stronger agreement with the S2S models.