The impact of tropospheric and stratospheric tropical variability on the location, frequency, and duration of cool-season extratropical weather systems

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Abstract
The variability in the tropical atmosphere has the potential to shift the midlatitude flow into preferred states, which can influence the life cycles of extratropical weather systems. Using the National Aeronautics and Space Administration’s Modern-Era Retrospective Analysis for Research and Applications Version 2 data, this analysis evaluates the impact of tropospheric and stratospheric tropical variability on the location, frequency, and duration of cool-season extratropical weather systems in the Northern Hemisphere. The analysis considers cool season occurrences of blocks, extratropical cyclones that meet the bomb criteria, and tropical cyclones (TCs) that undergo extratropical transition (ET) from 1980-2015. Additionally, the analysis is motivated to consider tropical variability that occurs with phenomena known to impact the atmosphere on subseasonal–to–seasonal (S2S) timescales. The synoptic events are investigated in the context of both tropospheric variability, from the Madden-Julian Oscillation (MJO) and El Nino-Southern Oscillation (ENSO), and stratospheric variability from the Quasi-Biennial Oscillation (QBO). It is hypothesized that stratospheric variability impacts extratropical weather systems to the same level of significance as tropospheric variability.

The results show that both tropospheric and stratospheric tropical modes of variability can have statistically significant associations with extratropical synoptic events. Our analysis suggests that Northern Hemisphere cool-season block and ET events are associated with a statistically significant frequency minimum in phases 7 and 3 of the MJO, respectively. With respect to the QBO, bomb cyclones have a statistically significant maximum in neutral QBO conditions and ET events have a minimum in neutral QBO. An analysis of bomb cyclone locations reveals that the frequency of bomb occurrence in the subtropical-to-midlatitudes is significantly impacted by the MJO while the frequency of bomb cyclones in Arctic latitudes is impacted by the phase of the QBO. The results are discussed in the context of the potential dynamical mechanisms that lead to these shifts in frequency and location from climatology.