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Antecedent Synoptic Environments Most Conducive to North American Polar/Subtropical Jet Superpositions

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The atmosphere often exhibits a three-step pole-to-equator tropopause structure, with each break in the tropopause associated with a jet stream. The polar jet stream (PJ) typically resides in the break between the polar and subtropical tropopause and is positioned atop the strongly baroclinic, tropospheric-deep polar front around 50°N. The subtropical jet stream (STJ) resides in the break between the subtropical and the tropical tropopause and is situated on the poleward edge of the Hadley cell around 30°N. On occasion, the latitudinal separation between the PJ and the STJ can vanish, resulting in a vertical jet superposition. Prior case study work indicates that jet superpositions are often attended by a vigorous transverse vertical circulation that can directly impact the production of extreme weather. Furthermore, this prior work suggests that there is considerable variability among antecedent environments conducive to the production of jet superpositions. These considerations motivate a comprehensive study to examine the synoptic-dynamic mechanisms that operate within the double-jet environment to produce jet superpositions.

This study focuses on the identification of North American jet superposition events in the Climate Forecast System Reanalysis (CFSR) dataset during November–March 1979–2010. Superposition events are classified into three characteristic types: “Polar Dominant” events consist of events during which only the PJ is characterized by a substantial excursion from its climatological latitude band; “Subtropical Dominant” events consist of events during which only the STJ is characterized by a substantial excursion from its climatological latitude band; and “Hybrid” events consist of those events characterized by an excursion of both the PJ and STJ from their climatological latitude bands. Following their classification, frequency distributions of jet superpositions are constructed to highlight the geographical locations most often associated with jet superpositions for each event type. Potential vorticity inversion and composite analysis are also performed on each event type in an effort to illustrate the antecedent environments and the dominant synoptic-dynamic mechanisms that favor the production of North American jet superpositions for each event type.