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Synoptic-scale zonal available potential energy increases in the Northern Hemisphere

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Available potential energy (APE), a measure of the energy available for conversion to kinetic energy, has been previously applied to examine changes in baroclinic instability as well as seasonal changes in the general circulation. Here, pathways in which the troposphere can build the reservoir of zonal available potential energy (ZAPE) on synoptic (3-10 day) time scales are explored. A climatology of ZAPE and its associated generation and conversion terms are calculated from the National Centers for Environmental Prediction (NCEP) Department of Energy (DOE) Reanalysis 2 global reanalysis dataset from 1979 to 2011 for the Northern Hemisphere (20˚-85˚ N). Applying a standardized-anomaly based identification technique, 160 ZAPE buildup events are identified during the 33-year period, which are grouped by meteorological season and the amplitude of the ZAPE anomaly at the conclusion of a buildup period.

Buildup events are analyzed from both an energetics framework and a dynamical framework to identify key processes contributing toward increases in ZAPE. Anomalously low conversion of ZAPE to eddy APE (C_A) and anomalously high generation of ZAPE (G_{ZAPE}) contribute equally to the total rate of change of ZAPE, while conversion from ZAPE to zonal kinetic energy (C_Z) contributes little across all seasons. Anomalously low C_A occurs for much of the Northern Hemisphere during buildup events with larger contributions from portions of the storm tracks, owing to changes in the jet location near high terrain, zonal elongations of the jet exit regions, and shifts in the jet stream in response to subtropical ridging. Examination of DJF buildup events reveals that the pathway toward ZAPE increase includes rapid high latitude cooling leading to increased G_{ZAPE}, high-latitude cut-off anticyclones acting to reduce C_A, mid-latitude Rossby wave trains exciting transient ridges acting to reduce C_A, and sub-tropical ridging associated with anticyclonic wave breaks acting to increase G_{ZAPE} and decrease C_A.