The identification and EP flux anomalies of several types of synoptic events
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Rossby waves excited within the extratropical waveguide can disperse and propagate horizontally, potentially impacting the downstream weather, and vertically, potentially inducing extreme stratospheric conditions (e.g., sudden stratospheric warming events). Previous work has shown that several categories of synoptic events can excite tropopause waveguide perturbations that are associated with horizontal Rossby wave dispersion and propagation. This research expands upon our understanding of horizontal Rossby wave processes by utilizing NASA’s MERRA-2 dataset to examine the role of several types of synoptic events in producing vertically propagating Rossby waves.

This analysis is based on case lists of three types of synoptic events: extratropical blocking, bombing extratropical cyclones, and the extratropical transition (ET) of tropical cyclones for the winter months of 1980-2015. Along with analyzing the spatial distribution and structure of these individual events, this study also created case-lists of “consecutive” synoptic events, namely blocking events that occurred within 5 days and 60° downstream of a point on the track of bombing cyclones or ET events. These consecutive case-lists show that half of the blocks that were identified in Europe occurred downstream of a point on a bombing cyclone track. Although more ET events occurred in the Western Pacific than the Atlantic, more blocking events occurred downstream of North Atlantic ETs than Western Pacific ETs.

To quantify the impact of these synoptic events in producing vertically propagating Rossby waves and/or inducing extreme stratospheric conditions, the tropopause-level zonal-mean meridional eddy heat flux anomaly was calculated with respect to the climatological mean for all of the synoptic events. The zonal mean meridional eddy heat flux is directly proportional to the vertical component of the Eliassen-Palm (EP) flux vector, which describes the vertical component of Rossby wave propagation. The results show that each type of synoptic event can be associated with upward EP flux but there is variability in the magnitude of upward EP flux anomaly between and within the synoptic event types. In a composite sense, blocking events that occurred in Europe (West Pacific) were followed by a statistically significant maximum (minimum) in the 100-hPa zonal-mean meridional eddy heat flux anomaly. Bombing events that occurred in the West Pacific (Atlantic) were followed by a statistically significant maximum (minimum) in the 100-hPa zonal-mean meridional eddy heat flux anomaly.

The presented results explore the variability in the synoptic events location, downstream impacts, and associated tropopause zonal-mean meridional eddy heat flux anomaly from a climatological and composite perspective.