Recurving TC–Jet Stream Interactions over the Western North Pacific

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Background

Case studies and idealized modeling studies have shown that episodes of recurving tropical cyclones (TCs) can substantially modulate the midlatitude circulation. While some recurving TCs excite or amplify Rossby wave trains that produce significant midlatitude circulation anomalies and high-impact weather downstream, others exert little influence on the midlatitude circulation. The hierarchy of factors governing this difference in behavior is not well understood, although characteristics of the large-scale flow pattern and the phasing between the TC and the midlatitude flow are believed to be important. The aim of ongoing research at the University at Albany is to understand the factors modulating the influence of western North Pacific (WNP) TCs on the midlatitude circulation.

Part 1: A Climatology and Composite Analysis (presented by Archambault)

In Part 1 of this study, we present a climatology and composite analysis of TC–jet stream interactions associated with 292 recurving WNP TCs identified for 1979–2009. The recurving WNP TCs are objectively ranked by the strength of the TC–jet stream interaction (i.e., the magnitude of the negative 250–150-hPa layer-averaged PV advection by the irrotational wind associated with the TC outflow). The top and bottom quintiles of the ranked cases are categorized as strong and weak TC–jet stream interaction cases, respectively. Climatologies of each category are constructed to assess factors that are hypothesized to modulate the strength of TC–jet stream interaction during WNP TC recurvature (e.g., time of year, characteristics of the large-scale flow pattern, TC strength, extent of TC wind field). Interaction-relative composite analyses are created for each category to allow for a comparison of the flow response to recurving WNP TCs associated with strong and weak TC–jet stream interactions. The interaction-relative compositing is performed by shifting the reanalysis grids such that the point of the maximum TC–jet stream interaction for each case is collocated with the composite mean.

Results indicate that relative to the weak TC–jet stream interaction cases, the strong TC–jet stream interaction cases feature stronger midtropospheric ascent and broader divergent outflow associated with the TC, a more amplified trough–ridge flow pattern, and a more distinct downstream jet streak embedded within a stronger waveguide. A comparison of the downstream large-scale flow evolution for the two categories suggests that the strong interaction cases are associated with the development of higher-amplitude, longer-lived Rossby wave trains over the eastern Pacific and North America.

Part 2: Case Studies and the Influence on the General Circulation (presented by Cordeira)

In Part 2 of this study, we present examples of strong and weak TC–jet stream interactions over the WNP as motivation for an investigation of the influence of TC–jet stream interactions on the Northern Hemisphere (NH) general circulation. The influence of these interactions on the NH general circulation is subsequently diagnosed using NH derived quantities of the zonal available potential energy (A_Z) and eddy kinetic energy (K_E). Overall, WNP TC recurvature is found to be associated with a statistically significant decrease (increase) in NH A_Z (K_E) relative to climatology. A transition from relatively zonal flow to meridional flow across the North Pacific in associated with Rossby wave train propagation and downstream baroclinic development subsequent to WNP TC recurvature suggests that NH A_Z is being converted into NH K_E.

The results from Part 1 suggest that WNP TCs that recurve into the midlatitudes and interact favorably with the jet stream (i.e., a strong TC–jet interaction) tend to be associated with the development of higher-amplitude, longer-lived Rossby wave trains over the eastern Pacific and North America. These strong interactions cases are associated with significant decreases (increases) in NH A_Z (K_E) relative to climatology, whereas weak interaction cases are associated with insignificant NH A_Z and K_E variability. The results herein indicate a positive association between the strength of recurving TC–jet stream interactions over the WNP and the magnitude of the perturbation to the NH general circulation.