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A composite diagnosis of synoptic-scale extratropical cyclone over North Atlantic

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This study examines the role of synoptic-scale dynamic and thermodynamic forcing mechanisms that underlie the development of Extratropical cyclones over North Atlantic. In spite of different analysis and classifications of dynamics of mid-latitude storms, less attention has been paid to the development of warm-core against cold-core cyclones. Tropical cyclones that have undergone extratropical transition and rapidly re-intensified to extratropical cyclones are typical warm-core cyclones while most marine mid-latitude cyclones show a shallow warm-core at lower troposphere.

The vertical profile of laplacian of temperature at cyclone centre and over cyclone area is used to discrete separation between warm-core and cold-core cyclone. Also, a phase diagram is constructed to follow cyclone thermal characteristic, cyclone phase evolution, cyclone phase transition and especially to improve the composite process. To investigate the dynamics of cyclone regarding the vertical thermal structure, one needs to employ a suitable diagnostic tool which permits explicit consideration of all dynamic and thermodynamic forcing mechanisms at all atmospheric levels including troposphere and lower stratosphere. In this study, the extended form of Zwack-Okossi (Z-O) equation is used to examine different forcing contributions by calculating near-surface geostrophic vorticity tendency at 925 hPa.

The first part of diagnostic results consists of verifying accuracy of calculated Z-O geostrophic vorticity tendency by comparing with the observed values for each composite and focusing on horizontal distribution of synoptic-scale forcing mechanisms contributed to the total near-surface geostrophic vorticity tendency in cyclone area. Vorticity advection (adiabatic cooling) term shows positive (negative) and large contribution in all composites. Also, contribution of all forcing terms at maximum geostrophic vorticity tendency ahead of cyclone centre is investigated to determine the role of each mechanism in cyclone displacement. Furthermore, The vertical profiles and vertical cross section prepared in second part are examined to achieve a better insight to the dynamic and thermodynamic mechanisms responsible for developing each composite.