

A reanalysis of extreme cyclone processes: Tropical, extratropical, and otherwise

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The purpose of this research is to analyze historically extreme cyclogenesis cases in the context of synthesizing crucial dynamic and thermodynamic processes occurring on planetary-, synoptic-, and mesoscales. Our analysis includes diagnoses from both the classical Sutcliffe quasi-geostrophic, and the potential vorticity perspectives.

The particular foundational analysis is that of two exceptional meteorological ‘bombs’ occurring in the western North Atlantic Ocean during 28 January through 7 February 1972, with one cyclone’s intensification approaching 2.6 bergerons. Among the planetary-scale consequences of these cyclogenesis includes the Arctic Oscillation index changing from strongly positive to strongly negative. The individual cyclones intensified explosively from their genesis stages as mesoscale frontal waves along the US east coast in the presence of an unusually strong zonal jet at the dynamic tropopause. The subsequent explosive intensifications were associated with an upscale expansion of cyclonic vorticity that encompassed virtually the entire North Atlantic basin.

In turn, we employ similar analyses to both historically extreme named tropical cyclones, and to the most explosive of cyclogenesis cases occurring in the extratropical North Pacific basin. Our analysis of extratropical cyclones’ dynamic and thermodynamic structures throughout their full life cycles reveals similarities to several named tropical cyclones.

Our results suggest that dynamic and thermodynamic similarities, among our investigated set of cyclones, are sufficiently strong to warrant the development of a unified dynamical classifier for cyclogenesis, regardless of whether they appear in the extratropical or tropical latitudes.