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Classification of cyclogenesis events based on a comprehensive set of potential precursors

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Case studies indicate a large variability of the involved atmospheric structures and physical processes responsible for cyclogenesis. Historical classifications focus on the relative importance of low-level baroclinicity and upper-level disturbances, and a more recent threefold classification also considers the role of diabatically produced low [U+2010] tropospheric potential vorticity. In this study, a large set of potential precursors for cyclogenesis will be systematically investigated on a statistical basis. Cyclones are objectively identified during 2010 in the operational analyses and deterministic forecasts from the European Centre for Medium [U+2010] Range Weather Forecasts (ECMWF) and then tracked along their life cycle. The starting points of these tracks are considered as the location of cyclogenesis. In the environment of these locations a set of about 20 precursors is determined. The set includes the following parameters: (a) temperature and heat fluxes at the surface; (b) characteristic conditions in the troposphere (e.g., integrated water vapor, amplitude of low [U+2010] level potential vorticity); (c) measures of baroclinic and convective stability (e.g., Eady growth rate and CAPE); and (d) flow patterns at and forcing from the tropopause level (e.g., jet streams and streaks, potential vorticity anomalies, height of the tropopause). In addition to these relatively simple Eulerian characteristics, more advanced diagnostic approaches will be applied, including a Lagrangian moisture source diagnostic and quasigeostrophic omega forcing.

These parameters will be determined for a multitude of cyclones and build the basis for an in [U+2010] depth statistical analysis in this precursor phase space. A clustering approach will be applied to this precursor phase space in order to determine the main categories of cyclogenesis, and their geographical and seasonal variability.