Geophysical Research Abstracts
Vol. 16, EGU2014-7370, 2014
EGU General Assembly 2014

Classification of extratropical cyclogenesis events based on a set of precursors

Michael Graf, Michael Sprenger, and Heini Wernli

ETH Zurich, Inst. for Atmos. and Climate Science, Dep. of Env. Sciences, Zürich, Switzerland
(michael_arthur_graf@bluewin.ch)

Many studies indicate a large variability of the relevant physical processes (so-called precursors) responsible for cyclogenesis. In this study, potential precursors for cyclogenesis are systematically and comprehensibly investigated on a statistical basis. For this reason, cyclones are objectively identified during the time period 2000-2011 in the ERA-interim dataset and then tracked along their life cycle. The starting points of these tracks are considered as the points of cyclogenesis.

In the environment of these cyclogenesis locations a set of about 30 potential precursors is determined. The set includes the following parameters: (a) the surface conditions and fluxes (e.g., sensible and latent heat fluxes, sea surface temperature); (b) characteristic conditions in the troposphere (e.g., vertically integrated water vapor, amplitude of low-level potential vorticity); (c) measures of baroclinic and convective stability (e.g., horizontal temperature gradients, convective available potential energy, Eady growth rate); and (d) flow patterns and forcings from upper-tropospheric and stratospheric levels (e.g., jet streams and streaks, potential vorticity anomalies). In addition to simple Eulerian characterisations, more advanced diagnostic approaches are applied: Lagrangian backward trajectories, averaged time since oceanic moisture uptake of involved low-level air parcels, and layerwise quasi-geostrophic forcing for vertical motion.

In the phase space of these potential precursors - determined for a multitude of cyclones and suitably normalized - a principal component analysis is performed. The first two principal components are used subsequently for the separation of the cyclogenesis events in nine classes. Composites of each class are constructed in order to represent the averaged spatial pattern of the precursors. This statistical approach reveals that the most important separating mechanisms are upper-level forcing and moist processes. They are to a large extent represented by the low-level and upper-level potential vorticity. Weak (strong) upper-level forcing is associated with a zonal (meridional) flow pattern. The classification of Petterssen and Smebye is reproduced, if enhanced moisture values are present. But also other physical mechanisms can be detected (e.g., diabatic Rossby waves). The classification approach is additionally applied to a selection of cyclones, which caused high-impact weather during their lifecycle.