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Identification of diabatic Rossby waves in a one-year series of ECMWF forecasts

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Condensational heating in the extra-tropics is generally associated with a material increase/decrease of potential vorticity (PV) below/above the level of maximum diabatic heating. Thereby, latent heating can lead to the generation of positive PV anomalies with substantial amplitude in the lower troposphere. Recent case studies have indicated that such cyclonic PV vortices, if produced in a baroclinic environment, can be self-sustained and rapidly propagating along the thermal wind. They have been referred to as diabatic Rossby waves (DRWs) or vortices (DRVs). In some cases these vortices may interact with tropopause PV anomalies and act as precursors for rapid cyclone intensification. So far, the frequency of DRWs, their preferred geographical occurrence and likelihood for rapid development are unknown.

This study introduces an algorithm to identify and track low-tropospheric PV anomalies in operational ECMWF forecasts. A range of criteria are applied to build several categories of positive PV anomalies that exist for a time period of at least one day. One category contains candidates for DRWS - these PV anomalies are at a certain distance to the south of the upper-level jet stream axis, there is no obvious sign of an upstream upper-level trough, they are located in a strongly baroclinic environment and propagate rapidly. A 1-year investigation in the Northern Hemisphere indicates that DRWs are more frequent in the North Pacific than the North Atlantic (by a factor of 3) and that they preferentially occur during the warm season (May to October). Their origin is located typically in the western parts of the oceans in a latitudinal belt from 20 to 50N, in regions of high sea-surface temperatures. Some of the DRWs propagate over long distances (more than 5000 km) and about 10-15% develop into intense cyclones.