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Diabatic Rossby Waves: Aspects of their Dynamics and Climatology

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Diabatic Rossby waves (DRWs) are low-tropospheric positive potential vorticity (PV) anomalies that are continuously regenerated through diabatic processes, leading to a rapid propagation often along an intense baroclinic zone. It has been hypothesized that DRWs can be important precursors for rapid bottom-up cyclone development. Previously, the mechanism of DRWs has been studied in idealized channel flows - in this study ECMWF analyses, satellite imagery and mesoscale model simulations are used to further investigate open questions of the complex DRW phenomenon.

First, for a selected case of a DRW that originated near Florida and later became part of an intense cyclone over the central North Atlantic, mesoscale model simulations are performed in order to study the DRW with high spatial and temporal resolution. To this end, the non-hydrostatic model COSMO is used which is able to simulate the genesis and propagation of the DRW. Trajectory calculations help identify the air flows associated with the diabatic PV generation leading to the formation of the DRW and the subsequent diabatic PV destruction as the air parcels rise to the middle troposphere. Satellite pictures are used to qualitatively compare the model simulation with observed processes, in particular during the DRW genesis phase where an oceanic mesoscale convective system occurs at the time and location of the first occurrence of the low-tropospheric PV anomaly.

In a second part, in order to put the case study results into a more general context, selected results will be shown from a preliminary climatology of DRWs in the Northern Hemisphere. The climatological analysis is based upon a refined tracking algorithm that objectively identifies rapidly propagating low-tropospheric PV anomalies far to

the south of the mid-latitude jet stream. The results indicate that DRWs are more frequent in the North Pacific than the North Atlantic (by a factor of 2-3) 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 temperature. Some of the DRWs propagate over long distances (more than 5000 km) and about 10-15% develop into intense cyclones.