Geophysical Research Abstracts, Vol. 7, 02774, 2005
SRef-ID: 1607-7962/gra/EGU05-A-02774

Vortex Rossby waves in hurricanes: their importance for numerical weather prediction

G. Brunet (1), Y. Martinez (2), Y. Chen (3), P. Yau (2), M. Desgagné (1) and W. Ohfuchi (4)

(1) Recherche en Prévision Numérique, Environment Canada, Canada, (2)

Department of Atmospheric and Oceanic Science, McGill University, Canada, (3) Mesoscale and Microscale Meteorology, National Center for Atmospheric Research, USA, (4) Atmosphere and Ocean Simulation Research Group, Earth Simulator Center, Japan (gilbert.brunet@ec.gc.ca/ Fax: 514 421-2106/ Phone: 514 421-4617)

An innovative potential vorticity diagnostic tool called Empricical Normal Modes (ENMs) was applied to diagnose inner spiral bands formed in an explicitly simulated hurricane using the high-resolution PSU-NCAR nonhydrostatic mesoscale model MM5 in Chen et al. 2003 (J. Atmos. Sci. - JAS). The ENM method has the capability to decompose simultaneously wind and thermal fields into dynamical consistent and orthogonal modes with respect to wave-activities (Brunet 1994 JAS; Brunet and Vautard 1996 JAS; Charron and Brunet 1999 JAS; Zadra et al. 2002 JAS).

For wavenumber one and two anomalies, it was found that the leading modes are vortex Rossby waves that explain 40% to 50% of the wave activity in a period of 24 hours. The Eliassen-Palm (EP) flux and its divergence show that the vortex Rossby waves are concentrated in the inner-core region where the radial gradient of the basic state potential vorticity is large. In general, these waves propagate outward in the lower troposphere and inward in the upper troposphere. The vortex Rossby waves lead to significant wave-mean-flow interaction, as indicated by the divergence of the EP flux, with tangential wind acceleration or acceleration of order 1-2 m/s per hour in the vicinity of the eyewall region. The vortex Rossby waves show also characteristics typical of flow with critical level and sheared disturbances. Hence these mesovortices are responsible for the dynamical processes controlling the redistribution of angular momentum in the inner core.

A proposed follow-up study will apply the ENM diagnostics to tropical cyclones with higher resolution simulations, using the Meteorological Service of Canada MC2 non-hydrostatic LAM, which resolves the convective scale and the critical level. A collaborative effort between the Earth Simulator Center (ESC), Recherche en Prévision Numérique and McGill University is now focusing on simulating the full life cycle of hurricane Earl (September 1998). The goal is to produce a 1 km horizontal resolution forecast over a very large domain which covers the tropical and extra-tropical re-development of Earl. It will produce 8-9 days of simulation on a fine-resolution domain of size 11000 x 8640 x 67. This simulation and others with lower resolution will be used to comment the role of these vortex Rossby waves in the tropical and extra-tropical transition phases. We will point out the expected implication of these results in the context of numerical weather prediction at different space-time resolutions.

References:

Brunet, G., 1994: Empirical normal mode analysis of atmospheric data. J. Atmos. Sci., 51, 932-952.

Brunet, G. and R. Vautard, 1996: Empirical normal modes versus empirical orthogonal functions for statistical prediction. J. Atmos. Sci., 53, 3468-3489.

Charron, M. and G. Brunet, 1999: Gravity Wave Diagnosis Using Empirical Normal Modes. J. Atmos. Sci., 56, 2706-2727.