Multi-scale behavior in vortical flows

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In this project we study intense vortical flows in the atmosphere with a focus on the spin-up from a tropical storm to hurricane strength. Paeschke *et al.* (2012) developed a theory describing a new mechanism for the transfer of convectively available potential energy (CAPE) to the primary vortex circulation that involves an interplay of strong vortex tilt with non-axisymmetric patterns of the release of CAPE or other of diabatic heating effects. Strong vortex tilt during early stages of hurricane development is corroborated by observational data presented by Dunkerton *et al.* (2009). We intend to test the theoretical hypotheses of Paeschke *et al.* (2012) against numerical simulations based on EULAG. EULAG has been successfully used to simulate a wealth of atmospheric systems and has a successful project record on the DKRZ infrastructure. Our aim for the first phase of this project is to reproduce certain "precessing quasi-modes" of vortices with large tilt in three-dimensional numerical simulations of adiabatic flows. Such quasi-modes, which are at the core of the hypothesized spin-up mechanism, have been theoretically predicted in a linearized small-displacement theory by Reasor *et al.* (2004), and a large-tilt analogue has been identified in the nonlinear matched asymptotic analysis of Paeschke *et al.* (2012). If these adiabatic tests are successful we plan to supplement the model with prescribed asymmetric heating to verify its effect on the primary circulation as predicted by the theory. In future project phases we intend to increase model complexity and realism step by step to include a bulk microphysics moisture model as well as surface sensitive and latent heat addition.

Key words: atmospheric vortex intensification, multi-scale analysis, testing of established theoretical hypotheses by numerical simulation.

References

Dunkerton, Timothy J., Montgomery, M. T. & Wang, Z. 2009 Tropical cyclogenesis in a tropical wave critical layer: easterly waves. *Atmos. Chem. Phys.* **9** (15), 5587–5646.

Paeschke, Eileen, Marschalik, Patrik, Owinoh, Antony Z. & Klein, Rupert 2012 Motion and structure of atmospheric mesoscale baroclinic vortices: dry air and weak environmental shear. *J. Fluid Mech.* **701**, 137–170.

Reasor, Paul D., Montgomery, Michael T. & Grasso, Lewis D. 2004 A new look at the problem of tropical cyclones in vertical shear flow: Vortex resiliency. *J. Atmos. Sci.* **61** (1), 3–22.