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Numerical modeling of polar mesocyclones generation mechanisms

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Polar mesocyclones, commonly referred to as polar lows, remain of great interest due to their complicated dynamics. These mesoscale vortices are small short-living objects that are formed over the observation-sparse high-latitude oceans, and therefore, their evolution can hardly be observed and predicted numerically. The origin of polar mesoscale cyclones is still a matter of uncertainty, though the recent numerical investigations [3] have exposed a strong dependence of the polar mesocyclone development upon the magnitude of baroclinicity. Nevertheless, most of the previous studies focused on the individual polar low (the so-called case studies), with too many factors affecting it simultaneously. None of the earlier studies suggested a clear picture of polar mesocyclone generation within an idealized experiment, where it is possible to look deeper into each single physical process.

The present paper concentrates on the initial triggering mechanism of the polar mesocyclone. As it is reported by many researchers, some mesocyclones are formed by the surface forcing, namely the uneven distribution of heat fluxes. That feature is common on the ice boundaries [2], where intense air stream flows from the cold ice surface to the warm sea surface. Hence, the resulting conditions are shallow baroclinicity and strong surface heat fluxes, which provide an arising polar mesocyclone with potential energy source converting it to the kinetic energy of the vortex. It is shown in this paper that different surface characteristics, including thermal parameters and, for example, the shape of an ice edge, determine an initial phase of a polar low life cycle. Moreover, it is shown what initial atmospheric state is most preferable for the formation of a new polar mesocyclone or in maintaining and reinforcing the existing one.

The study is based on idealized high-resolution ($\sim$2 km) numerical experiment in which baroclinicity, stratification, initial wind profile and disturbance, surface parameters, lateral boundary conditions are varied in the typically observed range. The approach is fully nonlinear: we use a three-dimensional non-hydrostatic mesoscale model NH3D_MPI [1] coupled with one-dimensional water body model LAKE. A key method used in the present study is the analysis of eddy kinetic and available potential energy budgets.

References

1. Mikushin, D.N., and Stepanenko, V.M., The implementation of regional atmospheric model numerical algorithms for CBEA-based clusters. Lecture Notes in Computer Science, Parallel Processing and Applied Mathematics, 2010, vol. 6067, p. 525-534.

2. Rasmussen, E., and Turner, J. (eds), Polar Lows: Mesoscale Weather Systems in the Polar Regions. Cambridge: Cambridge University Press, 2003, 612 pp.

3. Yanase, W., and Niino, H., Dependence of Polar Low Development on Baroclinicity and Physical Processes: An Idealized High-Resolution Experiment, J. Atmos. Sci., 2006, vol. 64, p. 3044-3067.