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Title: Nonhydrostatic Effects in Numerical Modeling of Mesoscale Convective Systems and Baroclinic Waves

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Background:

The present investigation is concerned with the role of convection upon mesoscale modeling results, particularly when the grid resolution becomes small enough that there is not a clear scale separation between the explicitly resolved circulations and the parameterized clouds. In those situations, the vertical accelerations in explicitly resolved circulations become strong enough that the hydrostatic assumption may no longer be valid. These concerns arise from interests in improving mesoscale modeling *per se* and in improving the subgrid-scale parameterizations in global models.

Significant accomplishments in the past year:

The hydrostatic and the nonhydrostatic options of the Colorado State University Regional Atmospheric Modeling System were used to simulate dry gravity currents in two dimensions, using several different horizontal grid sizes. With horizontal grid intervals of 10 km or less, nonhydrostatic simulations produce wider and colder heads and weaker but wider forced updrafts than do the hydrostatic simulations. Comparing the hydrostatic and nonhydrostatic models shows that the difference between the vertical mass fluxes is much less than the difference between the vertical velocities.

When the grid is fine enough to resolve the head of the gravity current, horizontal convergence at the gust front extends upwards almost to the head of the cold air. Vertical mass flux in the forced updraft at the front varies with horizontal grid size mainly as a function of the height of the simulated head. For coarser grids, which do not resolve the head, vertical mass flux at all heights decreases with increasing horizontal grid size.

A comparison of nonhydrostatic simulations with horizontal grid intervals of 1 km and 2 km illustrates how decreasing the grid size does not necessarily increase the intensity of the resolved circulation. The smaller grid enables the simulated gravity current to entrain a bubble of warm air behind the head, which results in a weaker circulation with a shorter head and a weaker updraft.

Focus of current research:

The hydrostatic and nonhydrostatic versions of the RAMS model will be used to simulate deep moist convection using horizontal grid intervals between 20 km and 50 km, with parameterized cumulus convection. The magnitudes of the vertical velocities will be compared for the hydrostatic and nonhydrostatic models and the individual terms in the vertical momentum equation will be examined in the nonhydrostatic model, in order to document the effects of relaxing the hydrostatic assumption in numerical modeling of mesoscale circulations.

The nonhydrostatic model will be used, with a horizontal grid interval of 1 km, to simulate the formation of mesoscale convective systems which include nimbostratus anvils. By alternatively including and excluding ice processes, an examination of the role of mesoscale downdrafts in forming and organizing mesoscale convective systems will be made.

Publication:

Cohen, C., 1992: The effects of the hydrostatic assumption and of horizontal grid size on numerical simulations of low-level mass convergence. Submitted to *J. Atmos. Sci.*