Discussion of numerical methods to respect asymptotic limit solutions

Mike Cullen (Met Office)

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Possible asymptotic limits- shallow water

As Fr-->0, solution converges to 2d Euler as $O(Fr^2)$. Do explicit methods achieve this as well as semi-implicit methods? Is the C grid (or equivalent) essential? Is curl(grad)=0 essential?

As the Earth's rotation rate-->infinity, solution converges to semi-geostrophic as $O(Ro^2)$, but becomes degenerate near equator. Do explicit methods achieve this as well as semi-implicit methods? Is the C grid an obstacle (bad for representing geostrophic balance)?

Possible asymptotic limits- vertical slice

SG limit of Eady problem, both frontal development and correct subsequent evolution.

Limit solution is Lagrangian, there is no Eulerian solution of SG in this case.

Are semi-Lagrangian, or clever upwind methods necessary?

The SG equations are a set of Lagrangian conservation laws. Are conservative SL methods or cleverly upwinded FV methods necessary?

Vertical slice II

Breakdown into stratified turbulence as stratification increases using initial data with vertical shear. What vertical resolution is required?

Vertical slice III

Flow over ridge converges to SG as Ro-->0 with fixed orographic height and thermal structure. Can standard schemes in terrain following coordinates represent geostrophic balance well enough?

Flow over ridge as Fr-->0 achieved by increasing stratification with same ambient flow and ridge height. Can standard schemes in terrain-following coordinates represent a state of rest in hydrostatic balance well enough- espicially for non-constant stratification?

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3d limit

Convergence to anelastic balance as speed of sound $\rightarrow$ infinity (use isothermal profile with T increasing).

Do explicit or vertically implicit, horizontally explicit methods do as well as semi-implicit methods? Are SL discretisations of the continuity equation OK?