The Impact on the Sound Speed Field of Internal Bores and Large Amplitude Internal Waves in the Continental Shelf/Slope Region

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Abstract

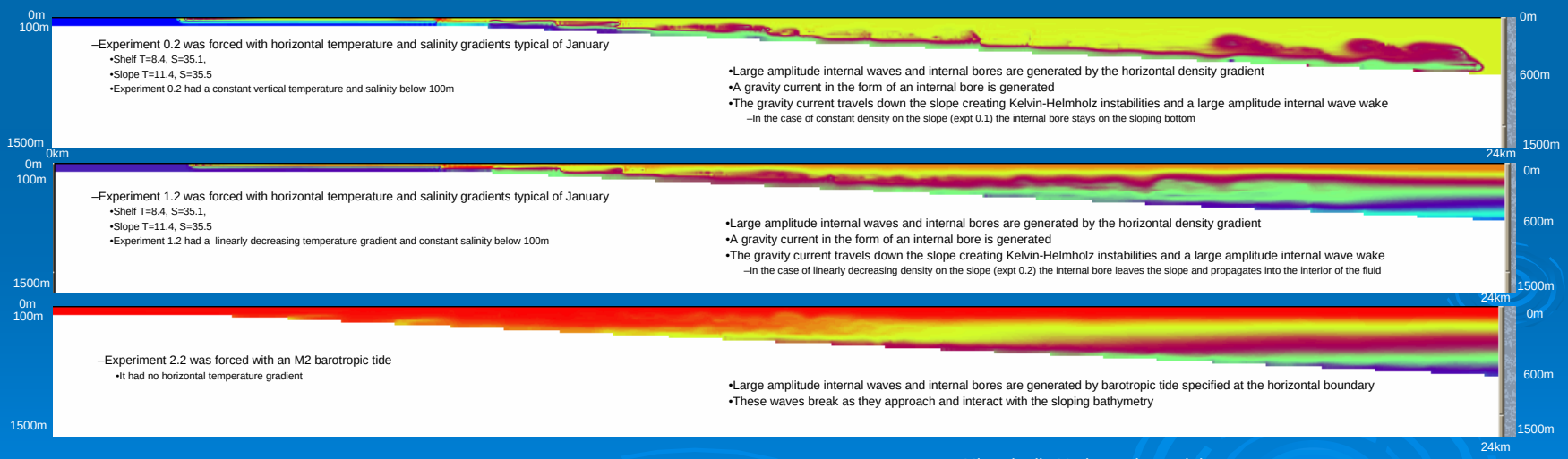
Barotropic tides can generate internal waves that propagate up the continental slope and force deep water onto the continental shelf. Also dense water formed by winter cooling on the shelf flows down the continental slope to the deep ocean. Canyons are preferred locations for these cross-slope flows because the slopes are steeper than the average, thus accelerating the flows. Since cross-slope flows have an inherent vertical acceleration, they are nonhydrostatic. These flows produce large amplitude internal waves and internal bores. Previous simulations of internal bores over flat topography have demonstrated that nonhydrostatic models are required to obtain the correct dynamics of the head, the mixing region and the large amplitude internal waves of the bore. The organization of the temperature field generated by these dynamics significantly affects the propagation and coherence of acoustical signals. The sound speed field will be constructed from simulations of internal bores on slopes. The effect of the sound speed field on acoustical signals will be assessed particularly with respect to propagation and coherence.

Nonhydrostatic Model Description

- 2D, z level, finite difference
- 51 vertical levels, 2000 horiz. grid points
- dx=dz=30m, dt=10sec
- 4th order finite difference methods for advection
- Adams-Bashforth time advancement scheme
- eddy diffusivity is split into a horizontal and vertical component
  - a constant background value and a part that varies to maintain the horizontal and vertical grid cell Reynolds numbers at a defined value.
- The Poisson equation for the pressure is solved using Successive Over Relaxation (SOR).

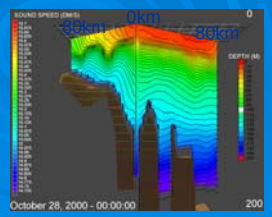
Description of Simulations

- Domain is an idealization of the Hudson canyon and outer New Jersey shelf
  - Shelf depth 100m
  - Maximum canyon depth 1500m
  - Slope 0.05
  - Length of slope 30km
- No Coriolis force



Conclusions

- Only Nonhydrostatic models can simulate Kelvin-Helmholz instabilities and the large amplitude internal waves
- The Kelvin-Helmholz instabilities and the large amplitude internal waves SIGNIFICANTLY affect the acoustical field, both the spatial coherence and the temporal structure (previous and on-going studies).

- Historically Hydrostatic models have simulated
  - The propagation of gravity currents down the slope and into the interior
  - The breakdown of barotropic tides into internal waves (baroclinic tides)

  (From a simulation of the MidAtlantic Bight using NCOM see also poster 20 in SS 1.04)