Numerical and Experimental Comparisons of Oceanic Overflow

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ABSTRACT.

Overflows in the ocean occur when dense water flows down a continental slope into less dense ambient water. These density driven plumes occur naturally in various locations in the global ocean, but it is important to study idealized and small-scale models which allow for stronger confidence and control of parameters.

The work presented here is a direct qualitative and quantitative comparison between physical laboratory experiments and large-scale numerical simulations.

Physical parameters are varied, including the Coriolis parameter, the inflow density anomaly, and the inflow volumetric flow rate. Laboratory experiments are conducted using a rotating square tank and high resolution camera mounted on the table in the rotating reference frame. Video results are digitized in order to compare directly to numerical simulations. The MIT General Circulation Model (MITgcm), a three dimensional, full physics ocean model, is used for the numerical simulations. These simulations are run under the full range of physical parameters corresponding to the specific laboratory experiments.

EXPERIMENTAL METHODS.

High-quality video is obtained to use as qualitative data to compare to numerical simulations. Our experiment is modular in that we can vary relevant parameters to observe different effects on the dense water plume.

RESULTS.

Two different physical cases are presented here, compared directly to numerical simulations at five different resolutions (25, 50, 100, 200, 400). Figures 3 (more eddies) and 4 (less eddies) show a snap shot at the same time for all five resolutions and the experimental results are in the bottom right corner. Figure 5 shows plume path and final plume area for both cases.

CONCLUSIONS.

A resolution of 200x200x200 is adequate. Results show that the MITgcm results match experiments better for cases that are more laminar with less eddies. Overall, the MITgcm is under predicting the plume area. For cases with eddying behavior, the MITgcm does not have enough mixing so plume descends too far down slope.

REFERENCES.