Russian Dolls: Nesting a turbulent Large Eddy Simulation within a nonhydrostatic Adaptive Grid Model within a 1/25 HYCOM model

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https://github.com/UNC-CFD/somar

with Sutanu Sarkar (UCSD) and Maarten Buijsman (USM) Co-PIs

LONG-TERM GOALS

To create a modeling framework that can span a wide range of dynamically active scales, with particular emphasis to the hydrostatic-nonhydrostatic divide.

OBJECTIVES

The project has a technological goal and several scientific goals. The technological objective is to integrate in a seamless way three ocean models, each optimized for the physics on a particular range of scales: HYCOM for the large hydrostatic scales down to O(10 km) scales; SOMAR to bridge the hydrostatic-nonhydrostatic divide from O(10 km) to O(100 m) scales; and finally a LES model to handle the turbulent scales O(<100 m). Once the integration is achieved, we intend to apply the framework to aid the interpretation of ASIRI data.

APPROACH

The work is distributed between UNC (the lead institution) and UCSD and USM (the subcontractors). Vamsi Chalamalla, a postdoc working at UNC under the supervision of the PI is responsible for integrating SOMAR with LES; Masul Jalali, a student at UCSD is working under the supervision of prof. Sarkar to create high-resolution runs to check the SOMAR-LES integration; finally Gordon Stephenson, a postdoc under the supervision of Dr. Buijsman is developing the software framework to exchange data between HYCOM and SOMAR-LES. Dr. E. Santilli (the original developer of SOMAR) is an external collaborator.

WORK COMPLETED

During the first year of the project we

1. Completed the two-way integration of SOMAR with LES.
2. Tested the SOMAR-LES model against known datasets to ensure consistency and accuracy.
3. Zeroed in a testbed problem for the HYCOM-SOMAR integration: an internal wave hands-off between HYCOM and SOMAR.

RESULTS

The LES model is now fully implemented in SOMAR. The LES is two way coupled to SOMAR, and initial testing with high resolution runs indicates good agreement. Figure 1 shows a schematic of how the models are nested. SOMAR is statically nested within HYCOM, whereas the areas covered by LES can be dynamically adjusted. We have learned that information need to be upscaled to HYCOM from SOMAR in order not to introduce errors at the HYCOM-SOMAR interface.

IMPACT/APPLICATIONS

We plan to apply the HYCOM-SOMAR-LES framework to interpret ASIRI observations of sharp salinity fronts.

RELATED PROJECTS

One of the Co-Pis (Prof. S. Sarkar) is also involved in ASIRI. We plan to apply our model to study the evolution of salinity fronts, especially with regard to mixing at the front edge.

PUBLICATIONS

Chalamalla, V. K., E. Santilli, A. Scotti and S. Sarkar, "SOMAR-LES for multiscale modeling of internal tide generation", VIII Int. Symp. on Stratified Flows, San Diego, CA, 2016. (https://joss.ucar.edu/sites/default/files/meetings/2016/issf/papers/chalamalla-vamsi-article.pdf)

Santilli, E., V. K. Chalamalla, A. Scotti and S. Sarkar, "Capturing remote mixing due to internal tides using multi-scale modeling tool: SOMAR-LES

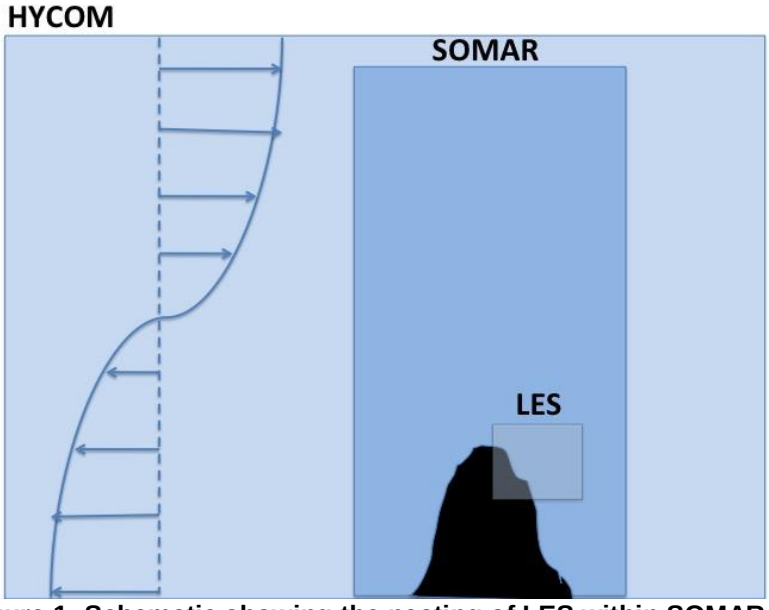

Figure 1: Schematic showing the nesting of LES within SOMAR within HYCOM. SOMAR is statically nested within HYCOM, whereas areas where the LES is applied can change dynamically as the the flow evolve.