

Hydrostatic and Nonhydrostatic Nested Modeling of Straits in the Philippines Archipelago

Dr. Patrick C. Gallacher
Naval Research Laboratory, Ocean Sciences Branch
Stennis Space Center, MS 39529
phone: (228) 688-5315 fax: (228) 688-4149 e-mail: gallacher@nrlssc.navy.mil

Award Number: N00014-07-WX-20528

LONG-TERM GOALS

This study utilizes nested nonhydrostatic models embedded in hydrostatic models to simulate and predict the submesoscale dynamics of straits at high spatial and temporal resolutions. The goal of this work is to understand the submesoscale dynamics of straits and the impact of these dynamics on the throughflow in the straits. The Navy requires the ability to forecast features and circulations forced by these dynamics on scales that impact naval operations, kilometers to meters.

OBJECTIVES

The primary objective is to understand the submesoscale dynamics in straits using nested nonhydrostatic models embedded in hydrostatic models. Specifically we will work

- To understand the effects and interactions of the primary forcing components:
 - Tides, especially the spring-neap tidal cycle and remotely versus locally generated tides,
 - Large scale circulation, particularly the Pacific to Indian ocean throughflow and it's seasonal variability,
 - Winds, especially the Southeast Asian monsoon cycle,
- To establish the resolution (dx and dz) and the aspect ratio (dx/dz) required to accurately simulate submesoscale physics and structures,
- To determine the importance of accurate and detailed representation of topography and forcing, especially at open boundaries,
- To understand the impact of rotation on the flow in straits, this is particularly important to nonhydrostatic physics,
- To explore the impact of data assimilation in a nonhydrostatic model, especially for sparse and irregular data,
- To compare model and field observations both for planning and for assessment.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 30 SEP 2007		2. REPORT TYPE Annual		3. DATES COVERED 00-00-2007 to 00-00-2007	
4. TITLE AND SUBTITLE Hydrostatic And Nonhydrostatic Nested Modeling Of Straits In The Philippines Archipelago				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Research Laboratory, Ocean Sciences Branch,Stennis Space Center,MS,39529				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES code 1 only					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 5	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

APPROACH

We use a system of multiply nested nonhydrostatic model (NRL-MIT) domains which utilize hydrostatic models (NCOM and/or HYCOM) to provide open boundary conditions for the coarsest NRL-MIT domain. The NRL-MIT domains consist of the nonhydrostatic version of the MITgcm model wrapped in a suite of scripts that provide initial/restart fields, open boundary values and handle output in a series of segmented, parallel integrations that maximize cpu usage and the ratio of system to wall clock time. The forcing consists of surface fluxes from the NOGAPS and COAMPS operational nowcast/forecast systems and open boundary conditions from the NCOM and/or HYCOM nowcast/forecast systems. HYCOM forecasts with resolutions of up to 4 km may be available in the region in the next year or two (Harley Hurlburt, personal communication). The basic bathymetry will be the NRL DBDB2 (2 minute) bathymetry which we hope will be enhanced and improved with several additional bathymetry databases obtained during the DRI.

WORK COMPLETED

We have designed the NRL-MIT domain for the Surigao Strait (Figure 1) which will be our initial hindcast domain. Code has been added to the nonhydrostatic MITgcm model to allow the coordinate system of the model domain to be rotated relative to the earth-centered spherical polar latitude/longitude grid. The changes were tested successfully. The transports from the EAS16NFS have been collected for analysis (Figure 2). These were provided by Ms. Shelley Riedlinger.

RESULTS

Although the transport into the Surigao strait is highly variable, monthly and interannually, the mean is 1 to 2 Sv into the strait at the 100 m isobath where the NCOM transports were calculated. Also tidal flow measured in the Surigao strait during the exploratory cruise showed tidal speeds of up to 6 m/s through the Surigao strait into the Bohol Sea. Flow up a steep slope from deep water, such as up the slope immediately on the Pacific side of Surigao strait can generate NLIWs with large amplitudes. These are the waves we are studying in the Surigao strait.

IMPACT/APPLICATIONS

Tactical scale or submesoscale forecasting in domains of 100 to 200 km will require nonhydrostatic modeling systems with resolutions of 100s of meters or less to correctly predict the NLIWs, turbulent regions, fronts, boils and small scale eddies. This project studies the dynamics of NLIWs, their interactions and their impact on the tactical environment. This work furthers the basic understanding of NLIWs and lays the foundation for future nonhydrostatic forecast systems.

RELATED PROJECTS

This project is synergistic with the following projects:

NonLinear Internal Wave Initiative (NLIWI) ONR DRI,

Integrated Sub-Mesoscale/Acoustic Modeling, NRL 6.2 core

Effects of Non-Acoustic Noise on Multi-Sensor USW Networks, NRL 6.2 core

Horizontal Array-Gain Variability due to Transverse Shelf-break Dynamics, NRL 6.2 core

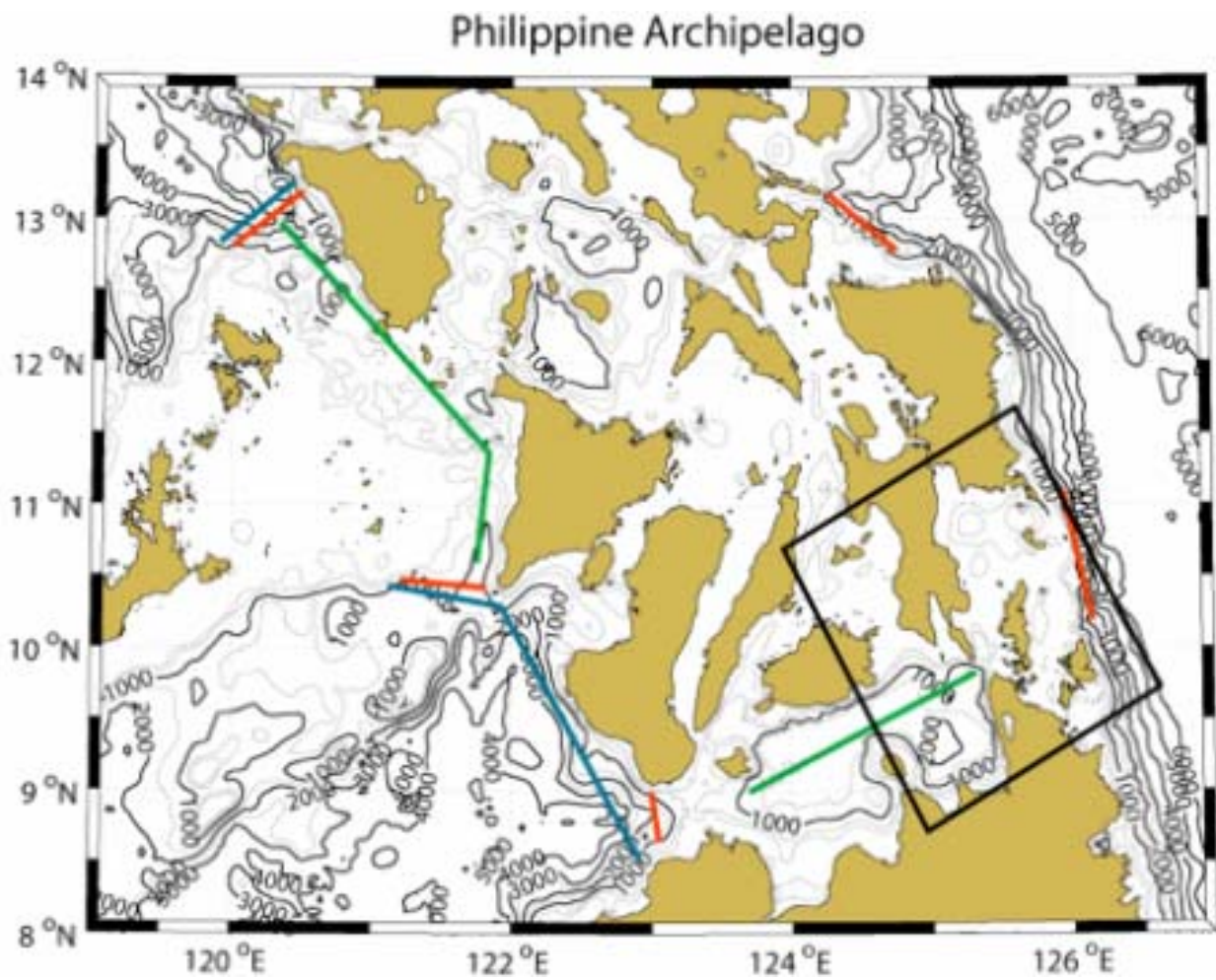


Figure 1. Philippines Archipelago showing the placement of the NRL-MIT Surigao Strait domain. The domain is rotated and sized to minimize extraneous land points and to place the northeast side nearly parallel to the steep slope of the Pacific basin.

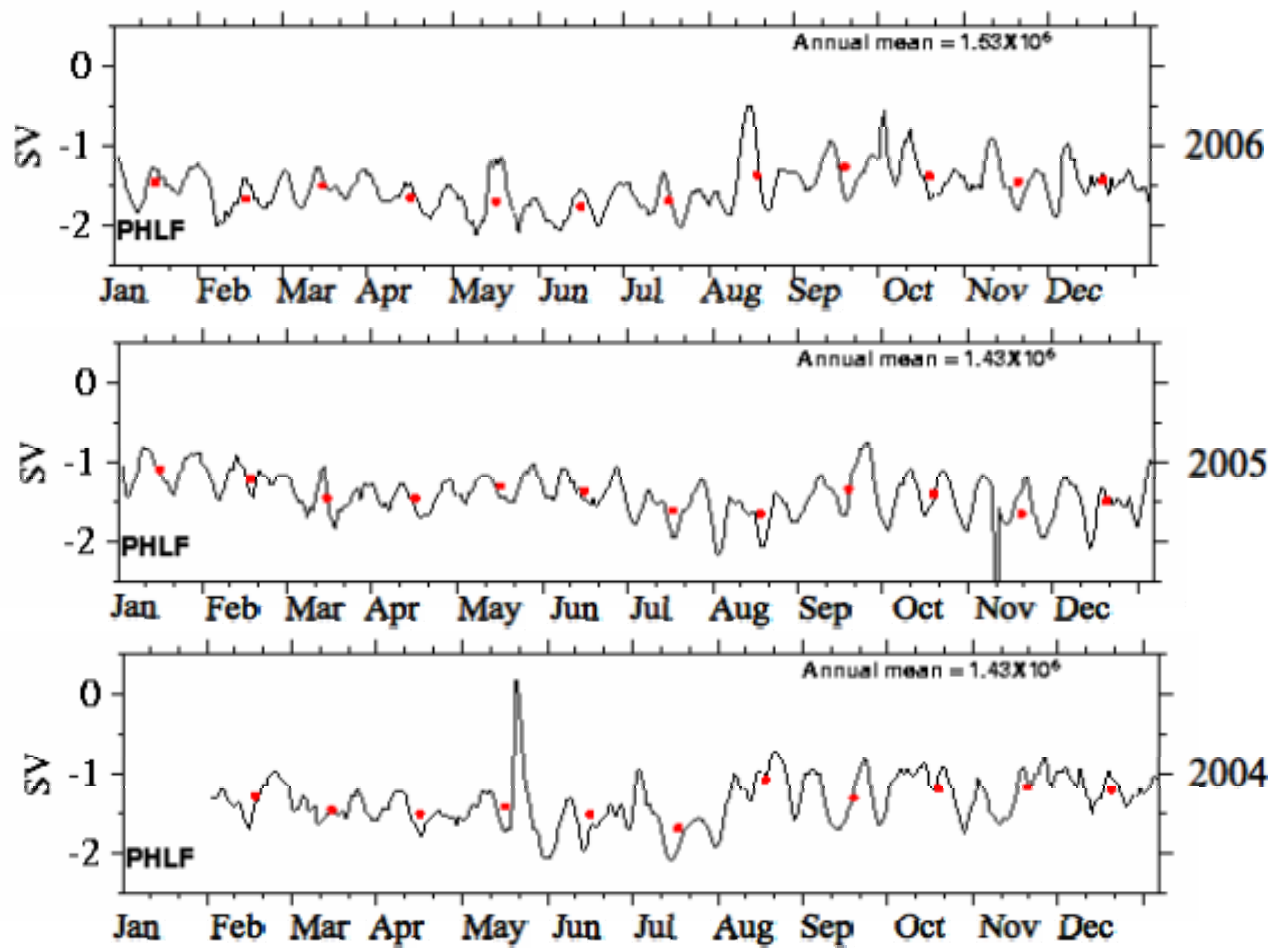


Figure 2. Daily transport through the eastern boundary of the Surigao Strait at the 100 m isobath. Red dots are the monthly average transport. Although there is significant monthly and interannual variation the average transport is into the strait at between 1-2 Sv. Data is from the EAS16NFS courtesy of Ms. Shelley Riedlinger.