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Labstracts

Over 80 years of progress through research — for the Navy and the Nation

News from the Naval Research Laboratory, Washington, DC

First global ocean model developed at NRL Stennis

Becky Rotundo
NRL Stennis Space Center, Code 7030.4

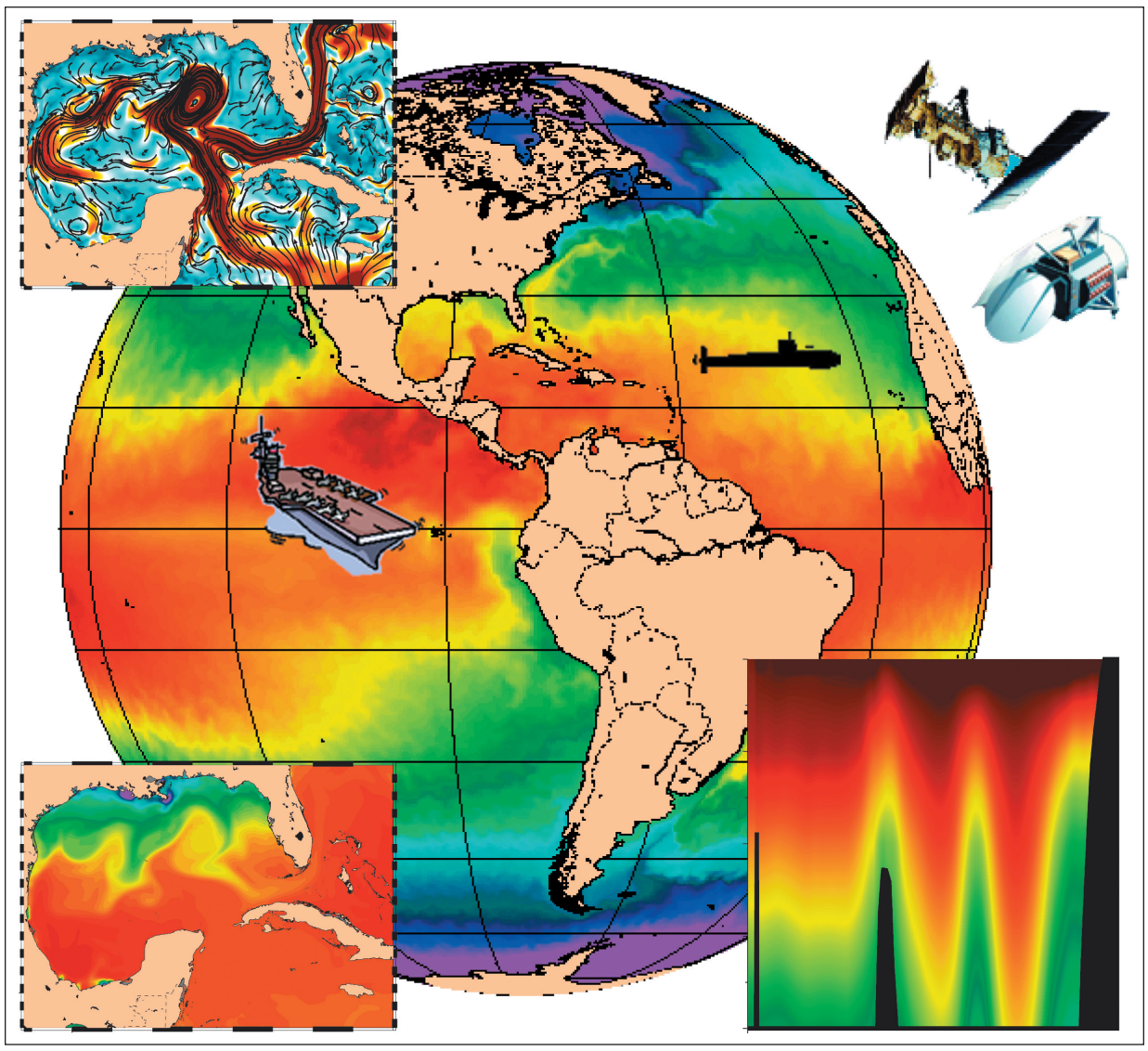
A fully global ocean circulation model**,** developed by scientists at NRL, Stennis Space Center, and transitioned to the Naval Oceanographic Office (NAVOCEANO) for operational evaluation, was declared operational by the Navy's Administrative Modeling Oversight Panel earlier this year.

The global Navy Coastal Ocean Model (NCOM) provides a real-time representation of the global oceans – from coastal regions to the Arctic – predicting the temperature, salinity, currents and sound velocity structure in the ocean with relatively high vertical resolution.

"Our intent was to provide a system where anyone in the Navy can ask 'what's the ocean going to be like here, today'," said **Dr. Charlie Barron**, Oceanography Division, "and NCOM helps NAVOCEANO provide that information."

NCOM is part of a two-model first-generation global capability that makes best use of our present satellite, observational and computational resources to support the global ocean solution. The first part is the near global Navy Layered Ocean Model (NLOM), a deep water ocean model with high horizontal resolution that assimilates altimeter data to produce detailed forecasts of front and eddy position. NCOM supports less horizontal detail in deep water, but bridges the gap between the deep and coastal waters to provide a capability for nesting even higher resolution coastal

(See Global ocean model developed at Stennis, page 4.)



Global NCOM assimilates satellite measurements of sea surface temperature and elevation to produce forecasts of temperature, salinity, elevation and currents that support Navy operations.

Commanding Officer's annual secretarial award presented to Ms. Mandy Walters

Janice Schultz
Public Affairs Office, Code 1030

Ms. Mandy Walters of NRL's Chemistry Division was presented the Commanding Officer's Award for Excellence in Secretarial Support by **CAPT Daniel Gahagan** in a recent ceremony held at the Lab. Ms. Walters is the Branch Secretary for the Center for Corrosion Science (Code 6130), collocated in Washington, DC, and Key West, Florida, with additional staff in San Diego, California; Norfolk, Virginia; and the Washington Navy Yard. The citation reads:

> *… Apart from her efficient handling of usual branch secretary tasks, which alone deserve praise, Ms. Walters has been the focal point for Key West recovery from the four hurricanes, which greatly impacted the facility last year. Her handling of the significant administrative workload increase has been executed most effectively and efficiently, with added collateral benefit to other NRL staff, some also burdened with additional workload from the hurricanes. It is with both respect and pleasure that Ms. Walters is awarded the Secretarial Support award.*

In addition to daily administrative duties, Ms. Walters has considerable collateral duties and must coordinate most administrative tasks between the various locations. The branch also coordinates

(See Ms. Walters is recognized for extraordinary service, page 5.)

Highlights in this issue . . .

Global ocean model developed at Stennis

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models within it. NCOM and NLOM work together to produce daily estimated profiles of temperature and salinity for use by Navy operational acoustic systems. To take advantage of the high horizontal detail in NLOM, a third component, the Modular Ocean Data Assimilation System (MODAS), combines daily NLOM sea surface height with satellite observations of sea surface temperature to derive synthetic temperature and salinity profiles based on statistics derived from historical observations. MODAS is an earlier system developed by NRL that has been used operationally by NAVOCEANO since 1999. Assimilating these temperature and salinity profiles to keep its deep-water solution on track, global NCOM provides an immediate best estimate of global 3-D ocean characteristics at a high resolution.

"… *From the Sea* was the document that stated the Navy was to shift its focus from deep water to coastal regions," said **Mr. Bob Rhodes**, Associate Superintendent, Oceanography Division. "When that happened, the need for a model capable of resolving the entire global ocean, including the coastal areas, became apparent. However, we were constrained by computer power." At the time NLOM was transitioned to NAVOCEANO, NLOM used a large portion of the operational computer capability that was available. A combination of expanding computer power and a new focus led the researchers to conclude that higher resolution coastal models were needed and feasible.

The availability of faster and more capable operational computers played an important role in NCOM's development. The overall global solution is very computer intensive, and reducing the problem to fit within available resources required tradeoffs between horizontal resolution, vertical resolution, sampling rate, and total area covered. To better represent upper-ocean and coastal dynamics for nesting with coastal ocean models, NCOM requires relatively high vertical resolution. But to afford this high vertical resolution, the NCOM uses lower horizontal resolution, limited to about 15 km in mid-latitudes. NLOM, in contrast, focuses on the deep-water dynamics controlling the positions of fronts and eddies. By excluding the Arctic Ocean and relatively shallow shelf regions, NLOM is able to run with coarse vertical resolution but ~3.5 km horizontal resolution, more properly resolving the dynamics of the open-ocean features that can affect Navy systems. This information from the real-time NLOM model is critical for properly maintaining the deep-water ocean features in NCOM. Using NLOM to compensate where its horizontal resolution is lacking allows NCOM to provide accurate boundary information to higher resolution coastal models that are currently under development at NRL for future Navy operational systems.

Just what does the model provide? There are almost 1000 representations of rivers in global NCOM providing an important first estimate of salinity in coastal regions. Search and rescue may use surface current information to determine where to look for survivors or wreckage, or for navigation purposes. Surface current information can be used to predict where contamination may travel, as in the event of an oil spill. Sea surface height, optionally including tidal variations, is useful in storm surge prediction. Temperature, salinity, sound speed and current profiles provide measurements throughout the water column, from surface to the ocean bottom, for a variety of other Navy applications.

Many people were involved in this process. "The development, validation and transition of global NCOM were a team achievement with important contributions from many NRL researchers," said Rhodes. Dr. Barron was the lead researcher for the development/transition process with key roles in model and system development, experiment and validation design. He was the lead author of the validation test report (VTR), patent application and lead and co-author on journal articles related to global NCOM, and a member of the transition validation test panel and operational test panel.

Mr. Rhodes, project manager and lead of the transition panel, was responsible for maintaining the 6.4 transition support and was responsible for the oversight of the transition process. He contributed to the development of the data assimilation procedure.

Model runs, operational system design and porting the system to various pre-operational and operational HPC platforms was coordinated by **Ms. Lucy Smedstad** who took the lead in data management and training for NAVOCEANO personnel who would be responsible for the operational run. She was instrumental in the analysis of results and web page updates, responsible for responding to preoperational NCOM data requests from NAVOCEANO and other navy and academic users.

Dr. Clark Rowley developed and implemented the methodology to provide full tidal+non-tidal boundary conditions from global NCOM. He provided the capability and initial evaluation of nesting NAVOCEANO's Shallow Water Analysis and Forecast System (SWAFS) domains into global NCOM, which was a key requirement from NAVOCEANO.

Postdoctoral researcher, **Dr. Birol Kara**, performed extensive global NCOM evaluation, especially of SST, mixed layer depth and subsurface thermal structure. His work on air-sea exchange led to a new formulation of the heat flux incorporated into global NCOM.

Dr. Paul Martin was the primary developer of the NCOM model code. Martin and **Dr. Alan Wallcraft** converted NCOM into a scalable, portable computer code suitable for use on the high-performance computing (HPC) systems required for daily global integration at these spatial scales. Dr. Wallcraft's HPC projects provided the NRL computational resource allocations used in developing global NCOM.

Dr. Harley Hurlburt served as technical advisor on experiment design, evaluation planning, interpretation and result reporting. Hurlburt also assisted with writing the development and evaluation plan.

Global grid generation, bathymetry refinement and guidance on data assimilation weighting were contributed by **Dr. Dong Shan Ko**. He also implemented and tested schemes to use global NCOM boundary conditions in higher resolution nested NCOM East Asian Seas and Intra-Americas Seas domains.

Navy reservists**, LCDR Karen Ebersol** and **CDR Stuart Walker**, provided various evaluations of the system. **Dr. John Kindle** evaluated boundary conditions from global NCOM using a nested U.S. Pacific coast model**; Dr. Steve Piacsek** evaluated global NCOM results for the Greenland-Iceland-Norwegian Sea region; and **Dr. Ruth Preller** evaluated global NCOM in high latitudes and in supporting initial work toward coupling with an Arctic ice model.

Ms. Jan Dastugue was responsible for web page development and graphics support for model validation and public view, and **Mr. Peter Flynn** assisted with visualization of model results. **Dr. Gregg Jacobs** provided support in comparing NCOM sea surface height variability with altimeter measurements, and **Dr. Bill Schmitz**, formerly of Woods Hole Oceanographic Institute, served as an external member of the validation test panel. ◆

NRL Exhibits

October 4 - 5

NRL to exhibit at SPIE Optics East

Linda Greenway
NRL Exhibits Office, Code 1004.1

Optics East 2006 will be held at the Hynes Convention Center in the Back Bay of Boston, Massachusetts. This multidisciplinary event consists of 30 technical sessions, 15 short courses and an exhibition of over 65 exhibitors focusing on:

- Sensors and industry applications,
- Life sciences,
- Communications/ITCom, and
- Core technologies such as optomechatronics, photonic crystals, and nanotechnology.

A poster session will take place on October 3, from 6:00 p.m. to 7:30 p.m.

NRL will be in Booth 429, highlighting NRL's Institute for Nanoscience and its recent accomplishments. The exhibition hours are:

Tuesday, October 4, 10 a.m. – 5 p.m
Wednesday, October 5, 10 a.m. – 4 p.m.

If you have any recruitment needs and want to display announcements, please email **Linda Greenway** at **exhibits@utopia.nrl.navy.mil** and copies will be made available in the booth. If you have cleared papers you want to make available to the attendees, please email a pdf version to the same address.

For more information and to register for this conference and exhibition, please visit: **http://www.nrl.navy.mil/techtransfer/exhibits/2007ExSched.html**.

If you have any further questions, please don't hesitate to contact Linda at **(202) 404-2307**. ◆