

Annual Progress Report Form - Oil Spill Recovery Institute

Today's date: 27 July 2004

Name of awardee/grantee: University of Miami, Rosenstiel School of Marine and Atmospheric Science, PI: Professor Christopher N.K. Mooers

OSRI Contract Number: 03-10-14

Project title: Nowcast/Forecast Ocean Circulation System

Dates this progress report covers: 05/01/03-4/30/04

PART I - Progress Report on Activities

ABSTRACT. The purpose of this project is to design, develop, test, and implement a real-time ocean nowcast/forecast system (NFS) for Prince William Sound (PWS). The 4D ocean circulation and stratification model implemented as the backbone (PWS-POM) for PWS/NFS is the Princeton Ocean Model (POM), which is the most widely utilized ocean model in the world, especially for the coastal ocean, and which continues to be upgraded year-by-year by colleagues at Princeton University. PWS-POM covers PWS and depends upon specification of the inflow/outflow and water mass properties at Hinchinbrook Entrance (HE) and Montague Strait (MS). PWS/NFS utilizes a comprehensive set of forcing functions: high resolution bottom topography and coastline, tides, synoptic winds and atmospheric pressure with mesoscale space-time resolution from RAMS, seasonal heating and cooling from climatology, distributed runoff from climatology and a terrain model, precipitation, and throughflow from HE and to MS, linking PWS and the Alaska Shelf, from historical data. Emphasis has been placed on model validation with SEA Program, EVOS, and OSRI data, while real-time verification is performed with NOS tide gauge coastal sea level (CSL) data and NDBC buoy and C-MAN station wind and temperature data. The backbone model PWS-POM, and its upgrade EPWS-POM, have proven effective in process studies and are ready for ecosystem models to be nested in them. At the computational price of covering a larger domain, EPWS-POM has the advantage of allowing for unconstrained exchange between PWS and the Alaska Shelf. PWS/NFS (and soon EPWS/NFS) provides a real-time capability to estimate Lagrangian trajectories for spills, larval transport, etc. in a highly automated fashion.

STATUS OF OBJECTIVES. Our fifth-year objectives, and their status, are summarized below:

Make further upgrades to PWS/NFS. (Accomplished; see list below.)

Document PWS/NFS to make it transferable to OSRI. (Deferred due to all the changes in progress with OSRI and its programs.)

Implement fully EPWS/NFS as soon as possible and conduct several tests to evaluate and upgrade it. Anticipate that EPWS/NFS will replace PWS/NFS within a year or so. (Deferred; see the note below on the delay in availability of Global-NCOM fields for synoptic open boundary conditions.)

Continue interactions with SINTEF on its OSCAR model project by providing our model output for input to their model. (Accomplished.)

Continue to expand our interactions with UAA on its RAMS model project, as they will be providing us with model output in real-time for forcing our models. (Accomplished.)

Utilize the OSRI CTD and ADCP data for model evaluation purposes. (Accomplished, but there are more data yet to be utilized.)

Hope to hindcast the EXXON Valdez oil spill scenario, if the atmospheric forcing data can be found. (Deferred until appropriate data are found.)

Prepare and submit a few mss (e.g., description of PWS/NFS, more model PWS-POM evaluation, and PWS response to atmospheric forcing) to refereed journals. (Partially accomplished; see discussion below.)

ROADBLOCKS ENCOUNTERED. The lack of real-time, continuous ocean data, especially velocity and temperature/salinity profiles over the water column within PWS, as well as at HE and MS, is a limiting factor for on-going PWS/NFS, and future EPWS/NFS, verification and possible data assimilation. Though such observing system elements have been slow to materialize, there is hope that the situation will change with near-future implementation of the Coastal-Integrated Ocean Observing System (IOOS), perhaps by augmenting NDBC buoys with ocean sensors as part of the “national backbone”.

The lack of synoptic open boundary condition data is a limiting factor for PWS/NFS and EPWS/NFS due to the high degree of spatial and temporal variability at HE and MS. The solution has been in sight for over a year. The quasi-operational global version, with 1/8 deg resolution, of the Navy Coastal Ocean Model (Global-NCOM), a Navy variant of POM, developed by the Naval Research Laboratory (NRL) has appeared very promising. It has been undergoing, and passing, various technical and operational tests this past year as part of the technology transfer involved in transitioning it to operational use by the Naval Oceanographic Office (NAVO). The Navy and NOAA have signed a MOU committing to the transfer of Global-NCOM fields from NAVO to the NOAA Coastal Data Development Center (NCDDC) for real-time access by the civil sector via a server. (We are slated to be a “beta tester”.) This capability had been scheduled to be available by early summer but has now slipped to late summer because of a major upgrade of NAVO’s supercomputer center that is in progress.

HIGHLIGHTS OF ACCOMPLISHMENTS. A presentation was made at the OSRI Workshop in Anchorage, 16 to 18 June 2003, which was devoted to reviewing progress and planning future efforts, including ecosystem modeling. In coordination with proposals from other OSRI P.I.'s, a proposal was prepared and submitted for the next three years of research by the 15 July 2003 deadline.

The PWS/NFS continued in operation with various upgrades (see below), especially involving the use of PWS/RAMS for atmospheric forcing and the evaluation of the benefits of so doing. The implementation and evaluation of EPWS/POM continued. For garnering further insights into system performance, four parallel runs were maintained:

- w/RAMS (UAA) wind-forcing and tidal-forcing (this is the run placed on the Website daily)
- as above but w/ETA(NCEP)atmospheric pressure-forcing
- as above but w/throughflow-forcing provided by velocity open boundary conditions at HE & MS based on "climatological" monthly transport
- as above but w/sea level adjusted daily based on model-observed coastal sea level difference at Valdez.

Mr. Xinglong Wu, OSRI Student Fellow, defended his Masters thesis successfully in summer 2003. It is entitled "Assessment of a North Pacific Data-Assimilating Ocean Circulation Model as a Means for Down-Scaling to a Higher-Resolution, Extended Prince William Sound Circulation Model". Plans were made for Mr. Wu to move ahead with his PhD program and derive a ms for peer-reviewed journal publication. This effort has required extending his analysis of atmospheric forcing data, ocean model output, and CSL observations and a more thorough analysis of remote forcing affecting open boundary conditions for EPWS/POM. He progressed with refining and extending his analysis of NPAC/POM and CSL and wind data for the Gulf of Alaska. A ms has been drafted on coastally trapped waves, observed and simulated, along the GOA coast. The results of this study have implications for open boundary conditions to be applied to EPWS/POM and, eventually, EPWS/NFS.

Coordination with Dr. Shari Vaughan was conducted, upon her departure from PWSSC, to ensure that a complete copy of her SEA Program, EVOS, and OSRI/PWS physical oceanographic observations was available for model evaluation.

Prof. Mooers prepared for, and participated in, the OSRI/HAZMAT Workshop held in Seattle, 27 to 29 October 2003 to design (with surface advection and turbulent transport) a simulated particle trajectory field experiment for PWS. The workshop focused on the design of Lagrangian field experiments for PWS. The intent is to compare simulated particle trajectories and dispersion with observed values. Hence, plans were made for coordinating modeling efforts between NOAA/HAZMAT, RSMAS/OPEL, UAA/AEFF, and SINTEF. Communications were held with Peter Olsson and Walter Cox on plans for the summer dispersal experiment and the "table top exercise". Also, data transport to NOAA/HAZMAT (Seattle) was established for PWS/NFS fields in advance of the "table top" exercise, which Dr. Bang facilitated actively and successfully.

Dr. Inkweon Bang, Research Scientist/Co-PI, continued efforts with PWS/NFS upgrades and

testing with PWS/RAMS forcing. He also continued work on revising the PWS/POM validation ms and with implementing and testing EPWS/POM. Dr. Bang commenced interactions with NOAA/HAZMAT through transmittal of test datasets. He also commenced high-resolution tidal predictions for PWS in collaboration with NOAA/PMEL investigators. This effort is a mutually beneficial transaction; they need better tidal estimates for tsunami prediction research at PMEL, and we obtain an improved bottom topography and receive QC feedback.

ATTRIBUTES OF FIRST GENERATION PWS/NFS (<http://PWS-NFS-OSRI.RSMAS.MIAMLEDU/>)
RESOLUTION

- HORIZONTAL: 1.1 KM
- VERTICAL: 15 SIGMA LEVELS
- TEMPORAL: EXTERNAL (INTERNAL) MODE = 4 SEC (2 MIN)

FORCING

- EIGHT TIDAL CONSTITUENTS, FROM MIKE FOREMAN
- SNOWMELT RUN-OFF, FROM HARPER SIMMONS
- ATMOSPHERIC
 - WINDS FROM RAMS, WITH ETA AND NDBC BUOYS AS BACKUP
 - ATMOSPHERIC PRESSURE FROM SAME SOURCES
 - HEATING/COOLING FROM COADS MONTHLY CLIMATOLOGY AND POTENTIALLY RAMS
 - PRECIPITATION FROM HARPER SIMMONS
- THROUGHFLOW AT HE/MS
 - FROM "1996" HE MOORED ADCP
- TEMPERATURE AND SALINITY AT HE/MS
 - FROM IMS ARCHIVES PLUS SEA OBSERVATIONS

VERIFICATION

- THREE (46060, 46061, 46081) NDBC MET BUOYS (SST, SSW, ETC.)
- THREE NDBC C-MAN STATIONS (Valdez Arm: Bligh Reef Light, Middle Rock Light, Potato Point) (CST, CSW, ETC.)
- CORDOVA AND VALDEZ NOS TIDE GAUGES (CSL, CST)

UPGRADES (DONE = ACCOMPLISHED IN 03/04)

- FULL DEPTH FOR BLACK HOLE (DONE)
- SWITCH FROM NDBC WINDS TO RAMS WINDS (DONE)
- THROUGHFLOW AND TIDAL FORCING AS OBC (DONE)
- ADD ATMOSPHERIC PRESSURE FORCING (DONE)
- AUGMENT UPPER LAYER PHYSICS FOR ESTIMATING SURFACE CURRENTS MORE COMPLETELY (DONE)
- INCREASE VERTICAL RESOLUTION TO 26 SIGMA LEVELS
- UPGRADE THROUGHFLOW ANNUAL CYCLE WITH ALL SEA/EVOS HE MOORED ADCP DATA
- POSSIBLY ADD EVAPORATION AFTER INVESTIGATION OF INFORMATION SOURCES AND SIGNIFICANCE OF MAGNITUDE
- BEAUTIFICATION OF WEBSITE (FIRST STEPS TAKEN WITH ANIMATION OF SIMULATED PARTICLE TRAJECTORIES)
- DOCUMENTATION

FAILURE MODES (PRELIMINARY ASSESSMENT)

- NDBC OUTAGES
- RAMS OUTAGES
- RSMAS POWER OUTAGES (SEVERAL PER YEAR FOR CA. 10 MIN)
- RSMAS HARD DISC CRASHES (ONCE PER SEVERAL YEARS FOR CA. 1 TO 2 DAYS)

The Inkweon Bang, Shari Vaughan, and Chris Mooers ms, entitled “ Initial Steps toward Validation of a Seasonal Cycle Simulation for Prince William Sound Circulation (Flow and Mass) Fields” validation ms was revised, upgraded, and submitted to Continental Shelf Research. It has been accepted subject to minor revisions, due late September, for a special volume (II) on coastal ocean model skill assessment.

The Xinglong Wu, Christopher N. K. Mooers, George R. Halliwell and Dong-Shan Ko ms, tentatively entitled “Coastally-Trapped Waves in the Northern Gulf of Alaska: Observed and Predicted”, is undergoing careful revision and upgrading prior to submission to (probably) Journal of Geophysical Research.

Papers were presented at -

AMS Conference on Coastal Oceanic and Atmospheric and Oceanic Prediction and Processes, 6 to 8 August 2003, Seattle, WA (entitled “A First Assessment of the Response of a Mesoscale Coastal Ocean Model to Forcing by a Mesoscale Coastal Atmospheric Model” by Chris Mooers, Inkweon Bang, and Peter Olsson).

AGU Ocean Sciences Meeting, 26 to 30 January 2004, Portland, OR (entitled “An Assessment of the Response of a Coastal Ocean Model (EPWS-POM) to Forcing by a Regional Atmospheric Model (PWS-RAMS)” by Chris Mooers, Inkweon Bang, and Peter Olsson and “Influence of Velocity Structure at Hinchinbrook Entrance on Circulation and Stratification in Prince William Sound, Alaska” by Inkweon Bang and Chris Mooers).

TOS/ASLO Ocean Research Conference, 15 to 20 February 2004, Honolulu, HI (entitled “Towards Data Assimilation for Prince William Sound, Alaska Ocean Circulation Nowcast/Forecast System” by Chris Mooers and Inkweon Bang).

An abstract entitled “Comparisons of Numerical Simulations of the Circulation and Stratification of Prince William Sound with Observations” by Chris Mooers, Inkweon Bang, and Xinglong Wu) has been accepted for presentation at the 51st Eastern Pacific Oceanic Conference, 22 to 25 September 2004 on Vancouver Is., BC, Canada.

An abstract (entitled “The Coupled Meoscale Ocean-Atmosphere Nowcast/Forecast System for Prince William Sound, Alaska” by Chris Mooers, Inkweon Bang, and Peter Olsson) has been accepted for presentation at the 7th International Marine Environmental Modeling Seminar, 19 to 21 October 2004, Washington, DC.

CONCLUSIONS TO DATE. PWS/POM has been validated against SEA Program data for 1996. PWS/NFS is a working first-generation nowcast/forecast system in the spirit of the Coastal-Integrated Ocean Observing System (C-IOOS or COOS). The impact of PWS-RAMS on PWS/NFS is encouraging. PWS/NFS is almost as complete as it can be made without additional real-time observing system elements in PWS and in the proximity of HE and MS, and until the Global-NCOM fields become available for use as open boundary conditions. The promising validation results suggest that PWS-POM and EPWS-POM are ready to have ecosystem and

other applications models embedded in them.

Part II - Annual Financial Statement

<u>Budget Category</u>	<u>Budget</u>	<u>Year-to-date Expenses</u>	<u>Balance Remaining</u>
Direct Costs			
Personnel	98,045	97,016.15	1,028.85
Travel	16,130	17,785.72	-1,655.72
Contractual	0	0	0
Commodities	5,825	5,198.13	655.04
Equipment	0	0	0
Subtotal Direct Costs	120,000	120,000.00	0
Indirect	30,000	30,000.00	0
Project Total	150,000	150,000.00	0