# A COASTAL CIRCULATION NOW/FORECAST SYSTEM FOR TEXAS-LOUISIANA CONTINENTAL SHELF

K.-J. JOSEPH YIP*, MATTHEW K. HOWARD and ROBERT O. REID
DEPARTMENT OF OCEANOGRAPHY, TEXAS A&M UNIVERSITY, TAMU 3146
COLLEGE STATION, TX 77843-3146
PHONE: 979-862-1282; EMAIL: JYIP@POINCARE.TAMU.EDU

**ABSTRACT** - An automatized continental shelf circulation forecast system will be presented. This system has been providing predicted surface current on Louisiana-Texas continental shelf since May 1, 1999 for oil spill prevention project sponsored by Texas General Land Office (TGLO). The predicted surface currents then transferred by Internet to TGLO for driving a dynamic trajectory model. There are 4 major components in this system: (1) forecast wind field retrieving and preparation module, (2) shelf circulation model module, (3) simulation plotting module and (4) web display and file transfer module. The wind field used in this system is a 3-hour interval ETA-32 forecast gridded wind from NCEP based on 00Z, 03Z, 12Z and 18Z model runs. The model used in this system is a spectral model developed to simulate time dependent, wind-driven circulation on the inner Texas-Louisiana continental shelf, which is formulated with a boundary fitted curvilinear coordinate system. Computational domain of the model is from 90.5°W to 25°N and from coastline to 200m-isobath offshore. Modeled surface currents compared with observations from Texas Automated Buoy System (TABS) at near shore current moorings will be presented in the conference. An implementation of the barotropic version of the 3-D predictive Princeton Ocean Model (POM) with a larger model domain which includes most of the northern Gulf of Mexico shelf and slope region, is underway. Tests conducted using a DEC Alpha workstation demonstrate that this system is sufficiently powerful to employ the POM model and the larger domain in an operational system. This model also allows assimilation of velocity fields. The system so far delivers reasonable qualitative near real time as well as predicted products.

An ocean circulation forecast system has been developed for the Texas-Louisiana continental shelf with support from the Texas General Land Office (TGLO) Oil Spill Prevention and Response Program. The system has been in operation since May 1999. Nowcast current fields are produced hourly based on observed winds. Forecast currents, hourly out to 24 hours, are produced once per day based on forecast wind fields. The modeled current fields are made available to the TGLO via the Internet for use in driving a particle trajectory model in the event of an oil spill. There are four major components to the system: wind field acquisition, model runs, product delivery, and website display.

## 1. NOW/FORECAST WIND FIELD

### 1.1 Nowcast winds

The gridded wind fields used to drive the nowcast model are based on observations made at marine and coastal marine meteorological stations located in the northwest Gulf of Mexico. Hourly observations made at these stations are injected into the weather network operated by the National Weather Service (NWS) and redistributed to researchers through the Internet using software provided to us by the University Consortium for Atmospheric Research. We wrote programs which identify, extract, and reformat the observations on a continuous and unattended basis. The data are gridded and used to drive a nowcast version of the Texas-Louisiana coastal current model. The nowcast currents appear about an hour and 15 minutes after the observations are made.

### 1.2 Forecast winds

The NWS initiates runs of their ETA-32 numerical weather model at 00Z, 03Z, 12Z, 18Z. Each run takes about three hours to complete and produces an analysis field (zero hour forecast) and a series of 3-hourly forecasts. The runs at 00Z and 12Z produce forecasts out to a 48-hr horizon while the runs at 03Z and 18Z produce forecast fields out to a 33-hr horizon. We run an automated script to download the surface fields as soon as they become available. The script can accommodate long network delays and will resubmit itself if the data are late in being deposited on the NWS server.

For our purposes, analysis and forecast fields out to 33 hours are downloaded from each of the four ETA runs. This allows us to have forecasts which are 24 hours beyond the time we receive them. The files are large and disk space is a consideration. As new fields are retrieved, old forecasts valid for the same time are replaced. The goal is to retain the analysis fields and the youngest forecasts in our archive while providing the most up-to-date fields for display and use in driving the current forecast model. After each suite of fields are retrieved, the Gulf of Mexico subset is extracted, converted to appropriate units and formats, plotted, and posted to the website. ETA fields in tabular form are passed to the circulation forecast model.

## 2. SHELF CIRCULATION MODEL

### 2.1 Spectral Model (2-dimensional)

The model presently employed in the system is an

* *Corresponding author address*:
K.-J. Joseph Yip, Department of Oceanography, Texas A&M University, TAMU 3146, College Station, TX 77843-3146. email: jyip@poincare.tamu.edu.

operational version of the wind-driven spectral model developed during the Louisiana-Texas Shelf Physical Oceanography Program (LATEX) (Current (1996)) (Fig. 1) and is improved to allow for Ekman shear in the near surface and near bottom regions of the water column. It is a time dependent, boundary fitted curvilinear coordinate system model with a quadratic bottom friction. The computational domain of the model extends from shore to the 200m isobath, and from 90.5°W to 25°N. A wall exists at the 90.5°W lateral boundary and the along-shelf current is taken as zero along the seaward boundary. At present no assimilation of TABS current information is employed.

### 2.2 Princeton Ocean Model (3-dimensional)

Early this year a modified version of Princeton Ocean Model (POM) (Blumberg et al (1987); Lo (1999)) to cover larger area which includes most of the Northern Gulf of Mexico (GOM) (Fig. 2) is in experimental mode for a preparation of shelf circulation model module changeover. POM simulations, in the meantime, have focused on the use of realistic wind forcing, mixing and diffusion parameters, high resolution bathymetry, and climatological temperature and salinity for model initializations. Parameter tuning is also performed to optimize the wind-driven circulation simulation over the shelf. A series of POM nowcast simulations holding temperature (T) and salinity (S) fixed throughout the model runs, using realistic wind fields as driving force, and without data assimilation was carried out. Comparisons of the results for April to July of 1999 to the observation from TABS current meters were carried out as well. The TABS moorings chosen for the comparison are P, B, D, J and K. (see Fig. 1) The wind-driven simulations show reasonable qualitative agreement between TABS measurement and modeled currents at locations D, J, and K in April-May period (Fig. 3 and 4), and at P, B and J in June-July period (Fig. 5 and 6). These show noticeably strong inertial motions throughout the experimental period likely produced by onset of frontal events during April and May, and by diurnal wind event during June and July. From the experiments conducted demonstrate the feasibility of using POM for prediction of the shelf circulation.

## 3. POSTED FIELDS ON THE WEB

Plotted fields are available through our website at http://www.seawater.tamu.edu/tglo. This web page is designed primarily for access by the oil spill response team working in the field. Graphical content on the page itself is kept to a minimum. Gridded wind and current fields are provided in Adobe PDF format which allows high-quality prints and the ability to zoom in without loss of detail. Tabular data for input into the TGLO trajectory model and hydrodynamic bay models is also available through the page.

## 4. SUMMARY

At present, the forecast currents are based on the analysis and forecast fields of the 00Z model run only. In the near future we will update our computer systems so that current forecasts will be produced four times a day using ETA fields from the 03Z, 12Z and 18Z runs. Gridded wind stress fields and simulated wind-driven currents from the model at 1200 UTC of August 10, 1999 are shown in Figures 7 and 8, respectively. The surface currents are upcoast for the entire sector of the shelf, which is consistent with the wind stress field for the region. However, this model is not aware of the anticyclonic Loop Current eddies at the shelf break. Nor does it sense the current at the eastern cross-shelf boundary. These factors contribute to large discrepancies between the simulated and observed currents on the outer shelf and in the eastern section. It indicates the need for data assimilation. An implementation of the barotropic version of the 3-D predictive POM with a larger model domain which includes most of the northern Gulf of Mexico shelf and slope region, is underway. Tests conducted using a DEC Alpha workstation demonstrate that this system is sufficiently powerful to employ the POM model and the larger domain in an operational system. This model also allows assimilation of velocity fields (Horton et al (1997); Oke et al (1999)).

## 5. REFERENCES


Blumberg, A., and G. Moller, 1987: A description of a three-dimensional ocean circulation model in *Three-dimensional Coastal Ocean Circulation Models, Coastal Estuarine Sci.*, 4, 1-16.

Current, C. L., 1996: Spectral model simulation of wind driven subinertial circulation on the inner Texas-Louisiana shelf. Dissertation, Texas A&M University.

Horton, C., M. Clifford, J. Schmitz and L. H. Kantha, 1997: A real-time oceanographic nowcast/forecast system for the Mediterranean Sea. *J. G. R.*, **102**, 25,123-25,156.

Lo, Y.-T., 1999: Modeling the buoyancy-driven flow due to river discharge on the Texas-Louisiana continental shelf of the Gulf of Mexico. Dissertation, Texas A&M University.

Oke, P. R., 1999: Personal communication, Oregon State University.

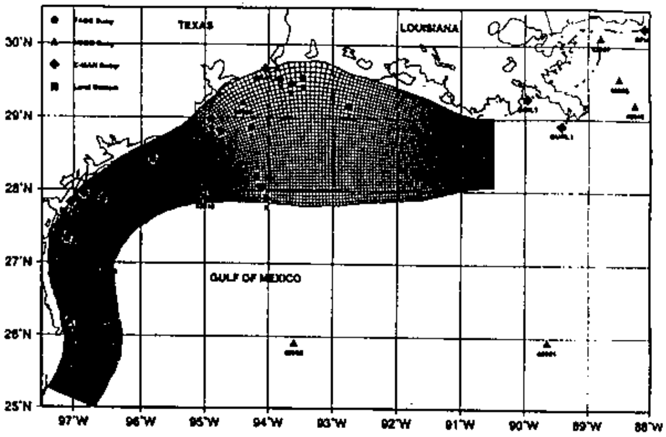


Fig. 1. LATEX Spectral model grid system with locations of TABS observation sites (solid circles) and meteorological stations (diamonds and triangles)

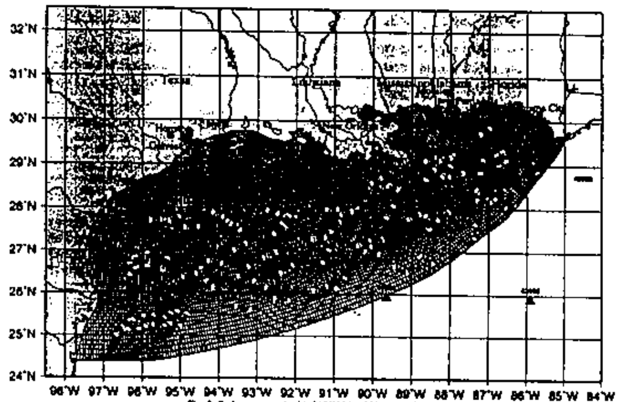


Fig. 2. Bathymetry and grid (210X104) of Northern Gulf of Mexico.
Locations of NDBC (triangle) and TABS (circle) stations indicated by symbols.

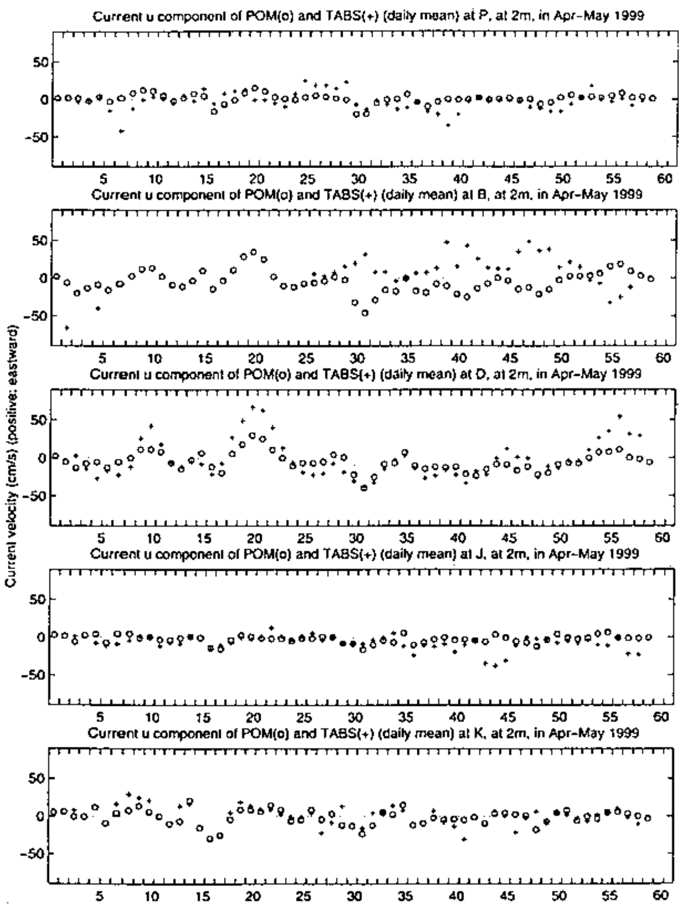


Fig. 3. Simulated vs. observed current u components of Apr–May 1999, and x-axis is day in simulation

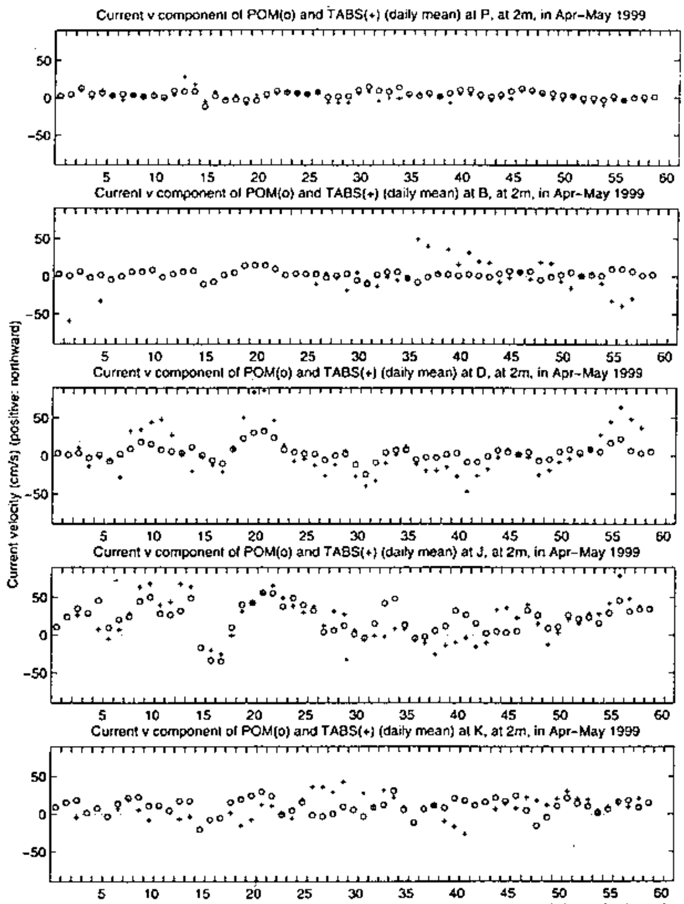


Fig. 4. Simulated vs. observed current v components of Apr–May 1999, and x-axis is day in simulation

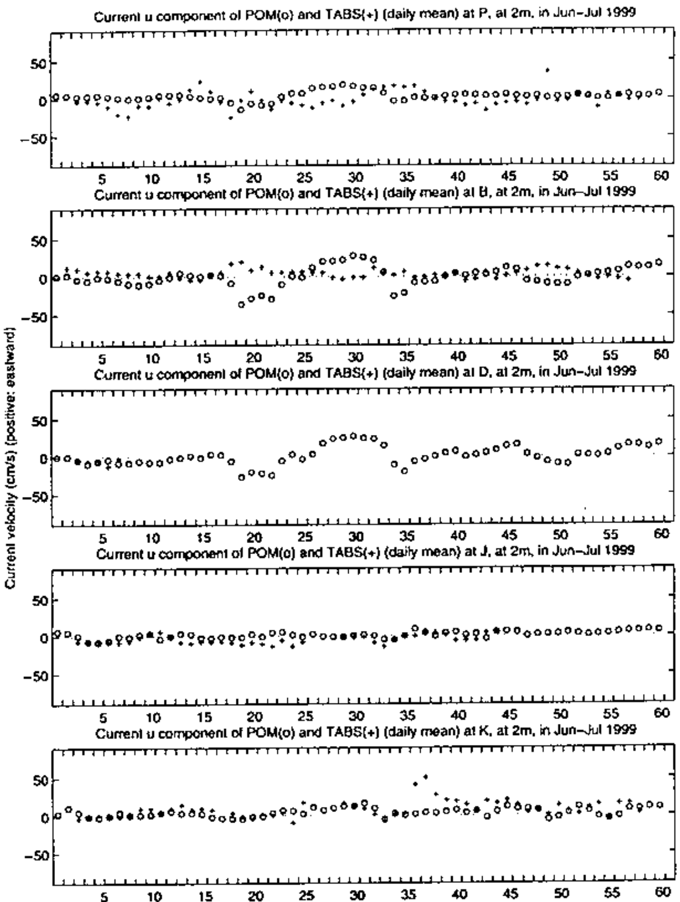


Fig. 5. Simulated vs. observed current u components of Jun–Jul 1999, and x-axis is day in simulation

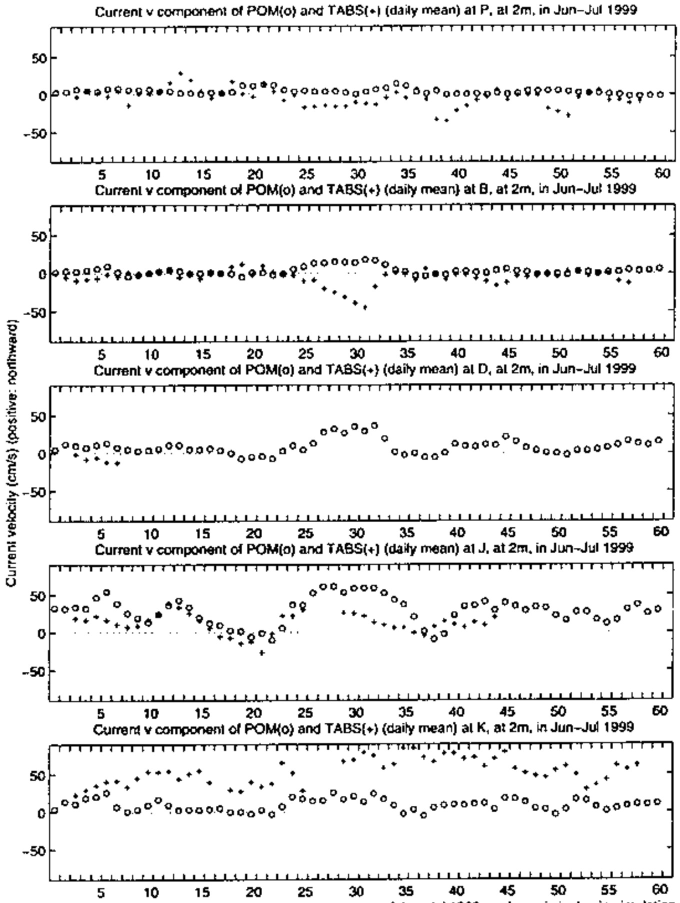


Fig. 6. Simulated vs. observed current v components of Jun–Jul 1999, and x-axis is day in simulation

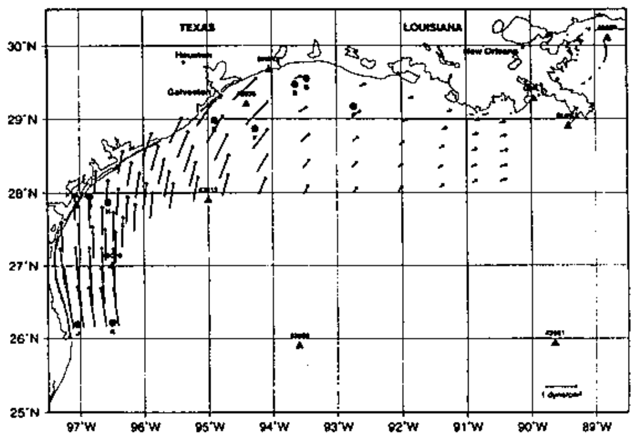


Fig. 7. Hourly wind stress from LATEX regional model for 1200 (UTC) August 10, 1999.
Locations of NDBC (triangle) and TABS (circle) stations indicated by symbols.
Vector length is indicated at lower right hand corner.

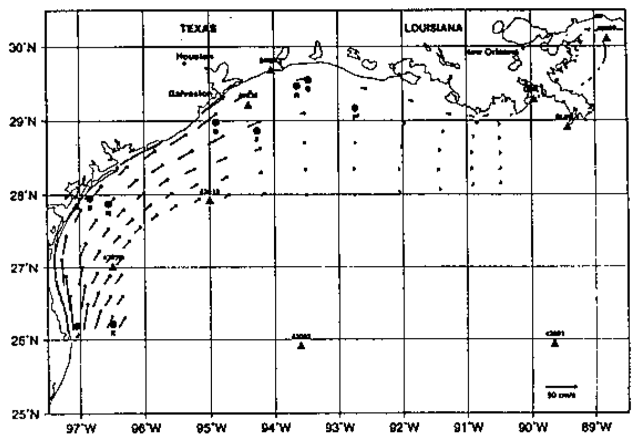


Fig. 8. Hourly current vector field at 1200 (UTC) August 10, 1999.
Locations of NDBC (triangle) and TABS (circle) stations indicated by symbols.
Vector length is indicated at lower right hand corner.