

IMPACT OF GODAE PRODUCTS ON NESTED SIMULATIONS OF THE FLORIDA AND NORTHERN GULF OF MEXICO COASTAL OCEAN

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1. Project Overview

This poster summarizes results from a National Oceanographic Partnership Program CODAE project entitled "HYCOM Coastal Ocean Hindcasts and Predictions: Impact of Nesting in HYCOM GODAE Assimilative Hindcasts". It is designed to evaluate the impact of nesting coastal ocean models over the northern and eastern Gulf of Mexico (GoM) and over the Florida Straits within GODAE ocean hindcasts. The GODAE products and the nested simulations all use the HYBRID Coordinate Ocean Model (HYCOM). The impact of initial and boundary conditions on the coastal simulations are evaluated, then results are used to provide feedback to the operational centers producing the products. Three regions are emphasized: (1) the West Florida Shelf (WFS), (2) the South Florida coastal region (SoFLA) including Florida Bay and the Florida Straits, and (3) the northern GOM shelf (NGoM). This poster briefly summarizes some results from the WFS and SoFLA regions. The following posters presented at this symposium contain additional results from this project:

- S4.8-23, Barth *et al.*, nesting ROMS WFS simulations within HYCOM-based GODAE products
- S4.23-52, Hogan, the GoM data assimilation system used as the outer model
- S5.14-9, Kourafalou *et al.*, impact of GODAE products on nested SoFLA biophysical modeling
- S5.25-13, Schiller *et al.*, impact of GODAE products on NGoM simulations

2. West Florida Shelf Simulations

WFS simulations (Figure 1) are nested within four HYCOM-based outer models. Three of these models are data assimilative and represent different stages in the development of the U. S. Navy ocean nowcast/forecast system. They include an Atlantic basin hindcast using optimum interpolation (ATL-OI), the first regional test of the NCODA assimilation system performed in the GoM (GoM-NCODA), and the first global test of the NCODA system (GLB-NCODA). The fourth WFS simulation is nested in a free-running (non-assimilative) GoM simulation (GoM-free). The locations of the six moorings used in the Taylor diagram analysis (Figure 3) are shown with black dots. The three northern moorings are, from offshore to coast, C16, C12, and C15. The three southern moorings are, from offshore to coast, C18, C13, and C17.

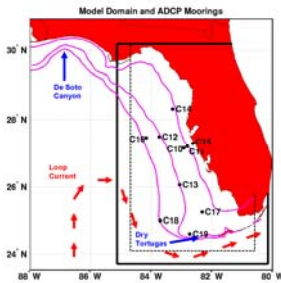


Figure 1. Locations of the West Florida Shelf Coastal Ocean Monitoring and Prediction System (COMPS) ADCP Moorings C10 to C19 along with the boundaries of the nested model domain. Dashed lines outline the nesting relaxation boundary zones. The 20, 50, and 100m isobaths are shown as a schematic of the Loop Current path.

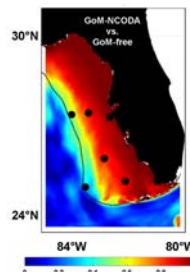


Figure 2. Map of vector correlation magnitude between 3-hourly surface velocity fields from nested experiments GoM-NCODA and GoM-free. Locations of the six moorings used in the Taylor diagram analysis (Figure 3) are shown with black dots. The three northern moorings are, from offshore to coast, C16, C12, and C15. The three southern moorings are, from offshore to coast, C18, C13, and C17.

Key results are:

- (Figure 2) Vector velocity correlation between the two simulations nested in GoM-NCODA and GoM-free demonstrate very high correlation over the inner shelf where the deterministic response to wind forcing dominates. The offshore BC have virtually no influence on inner-shelf velocity fluctuations.
- (Figure 3) Taylor diagrams comparing simulated to observed alongshore velocity fluctuations demonstrate that fluctuations over the inner shelf are nearly identical among all four nested experiments. Resemblance among the experiments decreases with increasing distance offshore. At the outer shelf moorings C16 and C18, the simulation nested in GLB-NCODA produces velocity fluctuations that most closely resemble the observations.
- (Figure 4) Two events where persistent northward and southward velocity occurred at both C16 and C18 are compared to mean surface velocity maps over the same time intervals from nested simulation GLB-NCODA. Alongshore flow at the SW corner of the WFS associated with a cyclone (northward flow) followed by the Loop Current (southward flow) force alongshore flow with similar direction along most of the outer WFS. Boundary conditions provided by GLB-NCODA produce the most accurate behavior of the Loop Current and eddy, and hence of the alongshore flow over the outer WFS.

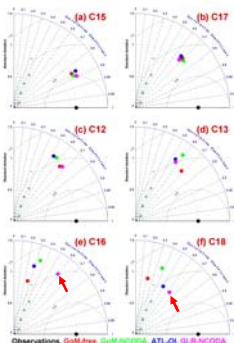


Figure 3. Taylor diagrams comparing the four nested experiments at six ADCP moorings (Figure 1). The moorings in panels (a) through (f) are arranged in order of increasing distance from the coast. The color legend for the points plotted in each panel is shown at the bottom. At outer shelf moorings C16 and C18, the simulation nested in GLB-NCODA (marked by red arrows in the bottom panels) resulted in the most accurate velocity fluctuations.

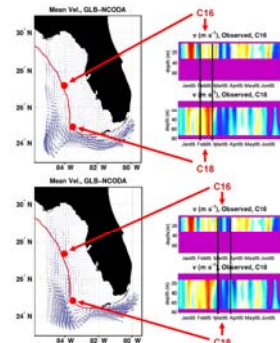


Figure 4. Mean surface velocity maps from experiment GLB-NCODA (upper-left) over 26 January to 14 February 2005 when persistent northward flow was observed over the outer shelf at both moorings C16 and C18 (upper right). Mean surface velocity maps from experiment GLB-NCODA over 26 February 2005 to 17 March 2005 (lower left) when southward flow was observed at the same two moorings (lower right). The 100m isobath is shown in the velocity maps.

3. SoFLA Simulations

The SoFLA region including Florida Bay and the Florida Keys is important for its coral reefs, seafood industry, and recreation. Oceanographic conditions are strongly influenced by the Florida Current and associated eddies such as the "Tortugas Gyre" (Figure 4). Flow variability associated with these features is especially important for larval recruitment and the retention of important marine species such as the Florida lobster. To successfully simulate or hindcast these features in a regional coastal domain requires accurate boundary conditions from a GODAE product to correctly reproduce the flow pattern associated with these energetic ocean features.

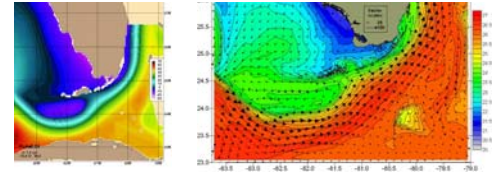


Figure 5. The Florida Current and associated Tortugas gyre in a HYCOM simulation illustrated by an SSH map (left) and a temperature-velocity map (right). The cyclonic flow around the Tortugas gyre is associated with flow reversal over the shelf south of the Florida Keys which has an important impacts on marine species.

SoFLA simulations nested within GoM-NCODA and GoM-free are compared in Figure 6 to each other and to satellite temperature and color observations. The path of the Florida Current and the presence of a Tortugas gyre is correctly reproduced by the simulation nested in GoM-NCODA and not by the one nested in GoM-free. The boundary conditions provided by GoM-NCODA are responsible for the correct representation of these ocean features within the nested domain.

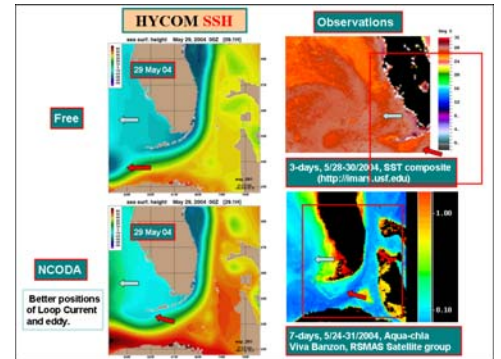


Figure 6. SSH maps from the SoFLA simulations nested in GoM-free (top left) and GoM-NCODA (bottom left) compared to observed maps of SST (top right) and ocean color (bottom right). Nesting within the data-assimilative GODAE product produces realistic positions of the Florida Current and associated eddies.

4. Conclusions

1. In nested WFS simulations, modest improvement in the representation of velocity fluctuations over the outer shelf was achieved by nesting in a GODAE product that more accurately reproduced the Loop Current path and the location of associated eddies. No significant improvement could be detected over the inner shelf. The outer model choice was found to influence the simulated temperature over both the middle and outer shelf (not shown here).
2. In simulations nested within the SoFLA domain, accurate boundary conditions provided by GODAE products are required to reproduce the Loop Current path and transport, along with Tortugas Gyre events, within the nested domain.
3. Other results from this project are contained in other posters presented at this symposium – see the list presented in section (1) of this poster.

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