Toward the real-time South Florida and Florida Straits (SFFS) system

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OUTLINE

- The complex South Florida Coastal System
- FKEYS-HYCOM nested in GOM-HYCOM
- > Improved eddy representation in the nested model
- > Validation of eddy fields with SeaWiFS chlorophyll-a images

with high frequency rada data (WERA)

- Eddy evolution in the Florida Straits
- Eddy induced upwelling in the Dry Tortugas
- > Tide implementation
- > Tidal effects on the flow through the middle Keys
- Real-time South Florida and Florida Straits (SFFS) System
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The Complex South Florida Coastal System



Adapted from Lee et al. (2002)

Broad SW Florida shelf Narrow Atlantic Florida Keys shelf Shallow Florida Bay Deep Straits of Florida

COMPLEX DYNAMICS

Wind-driven shelf flows Buoyancy-driven shelf flows (river runoffs) Intense coastal to offshore interactions (Loop Current /Florida Current front and eddies) Flows coming from Caribbean Sea

FKEYS-HYCOM nested in **GOM-HYCOM**



Simulation from 2004 to present

GOM-HYCOM from Ole Martin Smedstad

GOM-HYCOM <u>With</u> DATA ASSIMILATION <u>With</u> 20 layers Resolution ~ 3-4 km 0.5 deg NOGAPS

FKEYS-HYCOM <u>With</u> desired topographic details in shallow Florida Keys areas <u>With</u> river line source along the Ten Thousand Islands <u>With</u> 26 layers Resolution ~ 1km COAMPS-27km

minimum water depth: 2m

The FKEYS-HYCOM is capable of simulating

(i) the **spontaneous formation** of frontal eddies with realistic bottom topography and

(ii) their subsequent evolution as they interact with coastal boundaries and varying shelf width.

Improved eddy representation in the nested model







0

33

H

.20

50

8

q/m3

5.00

8

Okubo-Weiss Parameter (Q)

$$Q = d^2 - \zeta^2$$

Where ζ is the relative vorticity, d is the deformation rate

$$\zeta = \frac{\partial v_E}{\partial x} - \frac{\partial u_E}{\partial y} \frac{\partial v_E}{\partial x} + \frac{\partial u_E}{\partial y} \frac{\partial v_E}{\partial y} + \frac{\partial u_E}{\partial y} + \frac{\partial u_$$

Black lines: 100m, 200m, 500m isobaths

Green lines: The Florida Current front (20°C isotherm at 150m)

FKEYS-HYCOM vs. WERA



WERA : http://iwave.rsmas.miami.edu/wera/ (Nick Shay, RSMAS)



Eddy induced upwelling in the Dry Tortugas



Tide Implementation

Eight Constituents are included:

Semi-diurnal - M2 (12.42), S2 (12.0), N2(12.66), K2(11.97) Diurnal - K1(23.93), O1(25.82), P1(24.07) Q1(26.87)

Tide comes from

- (i) a local tidal potential directly computed in HYCOM and
- (ii) the remote tide coming from outside the domain
 - through the open boundaries

Sea surface height and barotropic velocities were extracted from the Egbert TXPO tidal model

FKEYS-HYCOM domain with Topography



It covers:

- SWFS: Southwest Florida Shelf SEFS: Southeast Florida Shelf
- AFKS: Atlantic Florida Keys Shelf
- FB: Florida Bay
- FK: Florida Keys National Marine Sanctuary
- DT: Dry Tortugas Ecological Reserve

Tidal effects on the flow through the middle Keys



Tidal effects on the flow through the middle Keys



Tidal effects on the flow through the middle Keys



More detail analyses will be done to answer the following questions about the flow through the Keys;

Seasonal dependences ? Low-frequency flow reversal ? Any relation to local wind forcing ? Any relation to the variations of the Loop Current ? Any relation to the eddy propagation ?

Real-time South Florida and Florida Strait (SFFS) System

Atmospheric Forcing:

NCEP GFS (Global Forecast System) horizontal resolution of ~35km forecast out to 180 hours

Boundary conditions (nesting): NRL's real-time GOM-HYCOM archives horizontal resolution of ~0.04deg

<u>Restart from a hindcast simulation with coamps-27km</u>

6 days forecast

<u>**Results</u>** http://coastalmodeling.rsmas.miami.edu/ Models/View/ SOUTH_FLORIDA_AND_FLORIDA_STRAITS</u>

6days forecast from Feb 05 00Z, 2011: SSH & Surface Currents



6days forecast from Feb 05 00Z, 2011: Sea Surface Temperature (SST)



6days forecast from Feb 05 00Z, 2011: Temperature at 50m



Summary

Ongoing (2004-present) high resolution FKEYS-HYCOM simulations (with/without tides)

Topics and Studies:

- -> Mesoscale and submesoscale eddy interaction (made possible due to high resolution)
- -> Eddy driven cross-shelf and shelf to offshore marginal transport (upwelling etc.)
- -> Eddy "statistics" (spatial, temporal; C. Morais MS thesis)
- -> larval transport: coupling to the Connectivity Modeling System (C. Paris and A. Srinivasan)

Near real time SFFS system

Plans:

-> automate and transfer to UM's Center for Computational Science (CCS)
-> part of GOM prediction model network (applications: oil spill, fisheries etc.)