Monitoring and prediction in the dynamically and topographically complex South Florida Coastal Seas System

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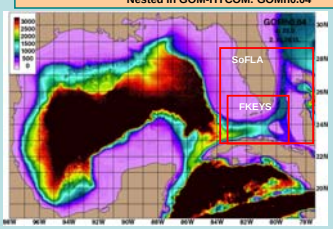
Summary

The South Florida Coastal Seas System is characterized by complex topography and strong interactions with large scale flows. The 3.5km resolution South Florida Hybrid Coordinate Ocean Model (SoFLA-HYCOM) and the 900m resolution Florida Keys Hybrid Coordinate Ocean Model (FKEYS-HYCOM) encompass both the coastal regions (the broad Southwest Florida shelf, the narrow Atlantic Keys shelf, the shallow Florida Bay and Biscayne Bay) and adjacent deep regions (the Straits of Florida), including Marine Protected Areas (the Florida Keys Marine Sanctuary and the Dry Tortugas Ecological Reserve). The presence of the strong Loop Current/Florida Current system and associated eddies connects the local and basin-wide dynamics. A multi-nested approach has been developed to ensure resolution of coastal scale processes and proper interaction with the large scale flows. Issues associated with environmental prediction challenges are evaluated, such as different strategies of nesting to HYCOM GODAE products and the impact of resolution adopted by the atmospheric forcing and the model grid size. Comparisons to data provided by the observational monitoring network include time series from moored ADCP currents and from Florida Current transport at 27°N (NOAA cable data).

The model simulations depict the dominance of wind-driven and buoyancy-driven flows (which are controlled by river inputs) on the inner- and mid- SW Florida shelf, while a wind-driven current opposing the mean Florida Current flow is evident on the Atlantic Keys shelf. Loop Current variability influences the outer- SW Florida shelf currents. Eddy passages along the Loop Current/Florida Current front depict strong interactions with coastal flows and improvements in the timing of these passages are observed when nesting to a data assimilative Gulf of Mexico HYCOM model. The mean Florida Current transport is captured in most model simulations; however, the best agreement to observed fluctuations is seen when nesting to a full North Atlantic basin HYCOM model. High resolution around Florida Bay and the Florida Keys is essential to capture changes in shallow hypersalinity conditions due to intrusions of regional riverine waters. The modeling activities and the observational network are part of the South Florida pre-operational monitoring and prediction system.

SOUTH FLORIDA NESTED MODELS

Nested in GOM-HYCOM: GOMh0.04



SoFLA-HYCOM
1/25° resolution:
idm=161
jdm=163
kdm=20
83.76°W–77.36°W
22.78°N–28.61°N

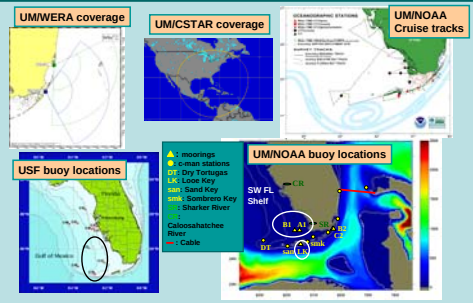
FKEYS-HYCOM
1/100° resolution
idm=437
jdm=361
kdm=26
83.36°W–79.00°W
22.78°N–26.05°N

GOMh0.04 1/25° resolution: Idm=517 jdm=349 kdm=20; 98°W-77.36°W; 18.90°N–30.71°N; 2 m minimum water depth

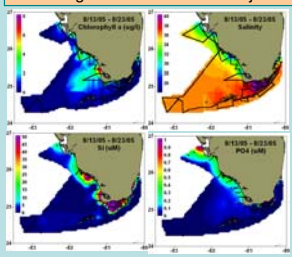
The complex South Florida coastal system

Lee et al., 2002

Local Observational Data Coverage in the SoFLA Domain



Interdisciplinary monitoring around the river influenced areas in support of the Everglades Restoration Project

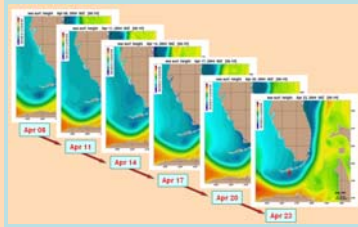


SoFLA-HYCOM: FLAh0.04 Run Numbers and Attributes

RunID	Layers	Atm. Forcing	Nesting BC	Simulation period
09.1	20	fnmoc-1.0	Free GOMh0.04	2004, 2005
29.1	20	fnmoc-1.0	HCODA GOMh0.04	2004, 2005
39.1	20	fnmoc-1.0	ATLd0.08	2004
67.1	20	coamps 27km	Free GOMh0.04	2004
27.1	20	coamps 27km	HCODA GOMh0.04	2004, 2005
04.1	20	Fnmoc-0.50	Free GOMh0.04	2004
02.1	26	Fnmoc-1.0	Free GOMh0.04	2004
01.5	26	coamps 27km	Free GOMh0.04	2004 2005
02.5	26	coamps 27km	HCODA GOMh0.04	2004 2005
03.5	26	coamps 27km	ATLd0.08	2004 2005

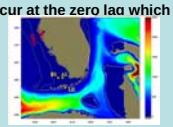
HYCOM v. 2.1.34, 2.1.35

Simulation of coastal to offshore interactions during an eddy passage April 2004

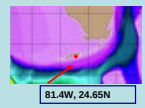


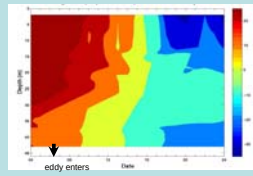
Model-Data Comparison: inner shelf

- Energy peaks are in phase over all
- For the SW Florida shelf shallow moorings (#A1 and #B1):
  - No obvious phase bias between model and data
  - The maximum cross-correlations occur at the zero lag which are above the 99% significance level
  - Model currents larger in amplitude
  - Wind-driven circulation dominates
  - Free and NCODA runs very similar
- For the Florida Keys shelf mooring at Looe Key:
  - Model currents have energy comparable to observations in the low-frequency band but are less energetic for the synoptic bands, suggesting FC influence

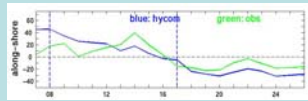


Along-Shore Current reversal at Looe Key during the eddy passage





Model to Data comparison

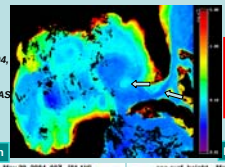


•40 HLP data (rd. 73 deg.) Prepared by Ryan Smith, NOAA/AOML

April 2004

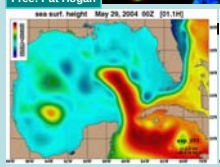
Model-Data Comparison: mid- and outer- shelf (COAMPS 27 km winds)

7-days, 5/24-31/2004, Aqua-chla Provided by Vive Banzon, RSMAS Satellite group

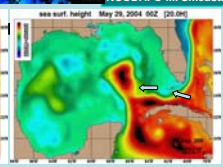


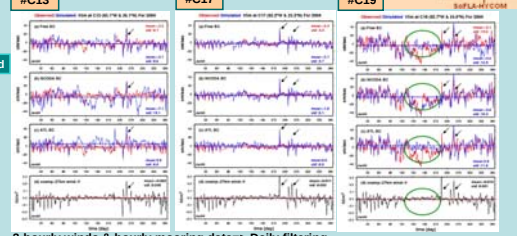
Noticeable improvement on positions of Loop Current and eddies

Free: Pat Hogan



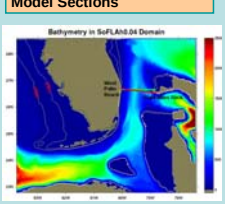
NCODA: O-M. Smedstad





3-hourly winds & hourly mooring data=> Daily filtering

Locations of the Cable and Model Sections



Cable

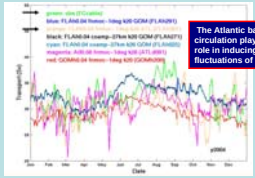
SoFLAh0.04

Statistical Characteristics: SoFLAh0.04 vs. Florida Current Transport: 2004 and 2005

	Free	NCODA	Cable	Free	NCODA	Cable
Mean	31.85	32.46	31.81	32.02	32.62	31.38
STD	1.89	1.96	3.00	1.66	1.88	3.37
	Year 2004			Year 2005		

Missing Cable data:
2004: 9/04-10/28; 12/26-12/28
2005: 7/26-8/03; 10/25-10/26; 12/08
Model data for those days are removed before computing the means and stds.

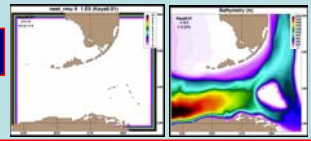
Cable Data and HYCOM: FC Transport at 26.7N Year 2004



The Atlantic basin-wide circulation plays an important role in inducing larger fluctuations of the FC transport

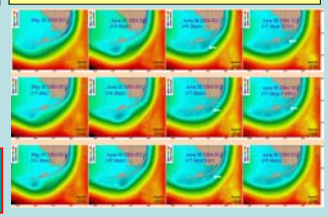
FC transport at 27°N is not sensitive to the current changes in resolution of the local atmospheric forcing or the adopted increase in vertical layers

High resolution FKEYS domain: nested open boundaries and topography



20 grids relaxation zone along boundaries (e-folding scale of 0.1 to 5-days) Daily updating for barotrophic & baroclinic BC's
NRL DBDB2 topo with 2m minimum water depth
More realistic passages between the Keys and Florida Bay

FKEYS-HYCOM SSH: high resolution enhances mesoscale and submesoscale eddy activity



Acknowledgments:
Data were provided by Tom Lee (UM/RSMAS), Peter Ortner and Libby Johns (NOAA/AOML) and Bob Weisberg (USF)
FC transport of ATLd091 and archive files of GOMh200 were provided by Ole Martin Smedstad, NRLSSC.