Perpetual year simulation with the IAS-South Florida regional HYCOM nest

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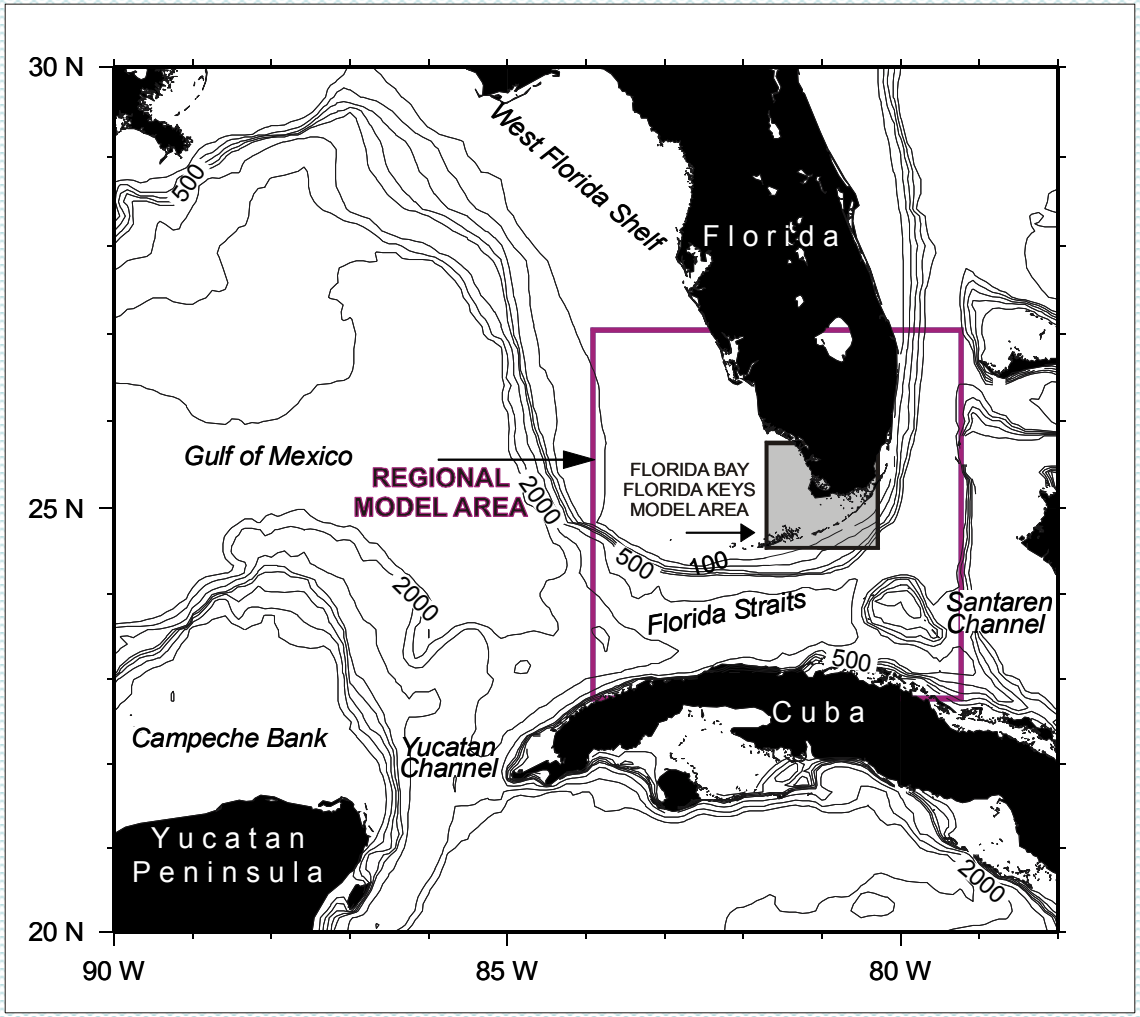
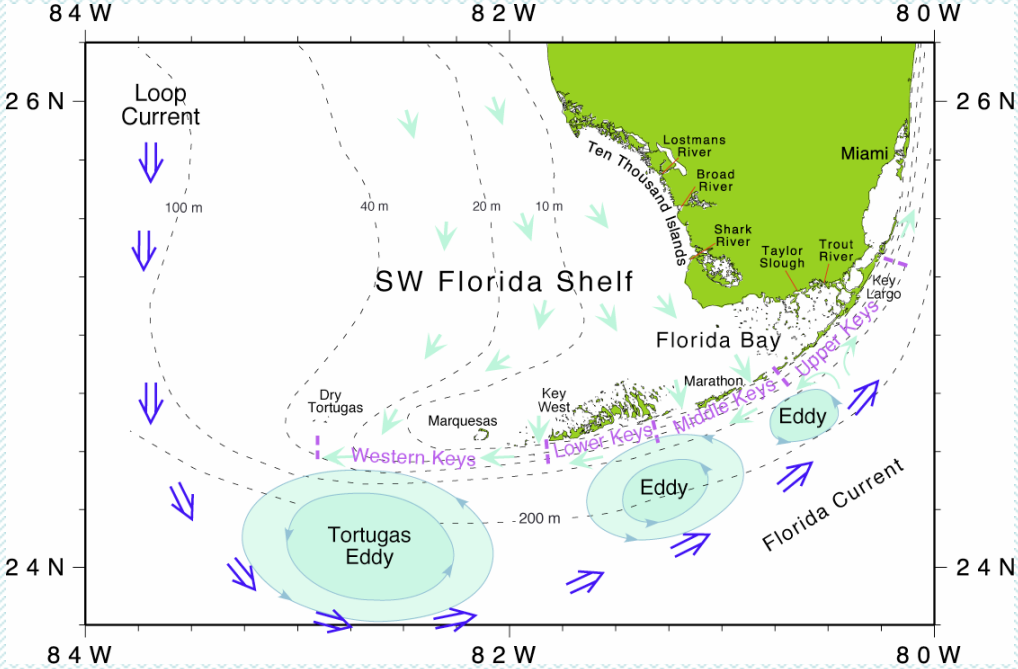
GODAE-HYCOM Workshop, October 27-29, 2004

HYCOM application for coastal seas adjacent to Florida Bay/Florida Keys

- physical transport processes impose strong hydrodynamic links between Florida Bay and the adjacent coastal seas.
- significant transient inputs can reach Florida Bay and the Florida Keys from remote regions of the Gulf of Mexico.

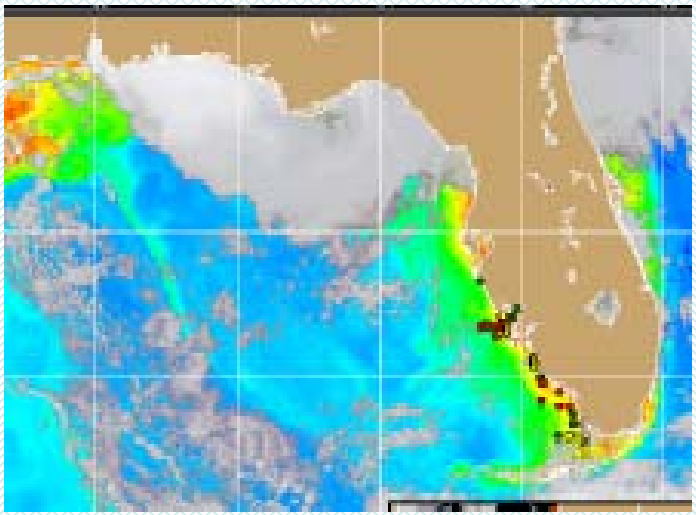


Funded by NOAA, the SFWMD and the EPA



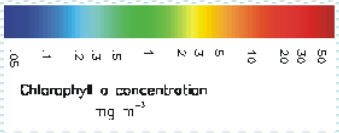
Ongoing observational monitoring studies provide evidence of **transport processes linking south Florida coastal ecosystems**

Lee et al., 2001



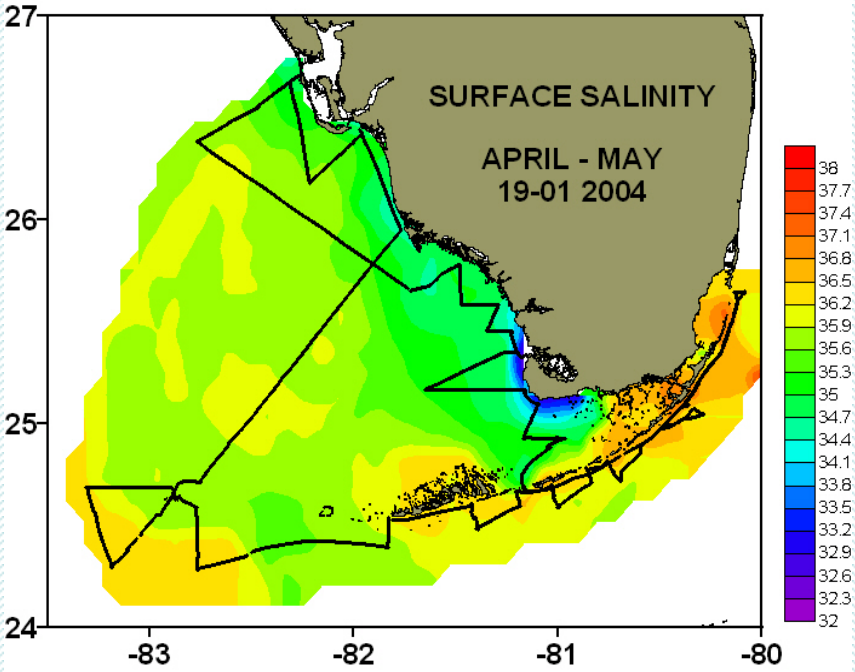
May 1, 2003

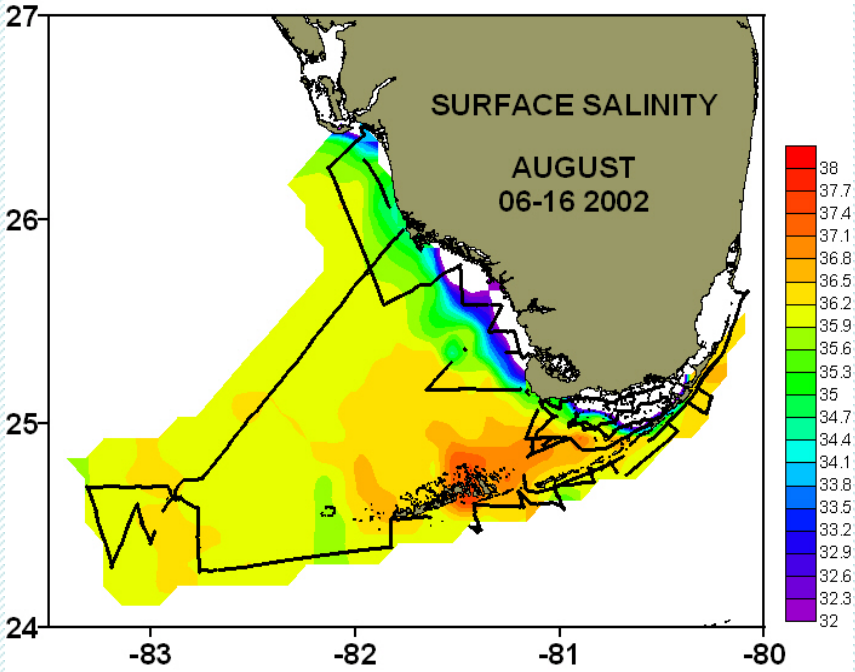
Coastal areas in SW Florida can be influenced by the Mississippi and west Florida shelf rivers.



NOAA CoastWatch Harmful Algal Blooms (HAB) bulletin
http://coastwatch.noaa.gov/hab/bulletins_ms.htm

Salinity data (Walton Smith bi-monthly cruises)





Coastal HYCOM application issues

- Nesting / larger scale model set-up
- Topography
- Continental shelf processes
- Relaxation to climatology
- High frequency forcing
- Validation
- Interdisciplinary capabilities

A 2 ½ year simulation has been completed with a 1/25 degree IAS configuration and 10m coastline nested the 1/12 degree North Atlantic (NA) HYCOM with a 20m coastline
(initialized from the 20m coastline climatological NA HYCOM and forced with monthly mean fluxes and winds plus 6-hourly anomalies).

The regional model (1/25 degree with improved shallow water topography) has been run for the same period with nested boundary conditions, with the same atmospheric forcing and with the addition of rivers.

Nesting

❖Domain is nested in IASd0.04 which in turn is nested in ATLd0.08

❖IAsd0.04 provided 3D nested archive files for 2.5 years covering a period from 8th to 10th year of nested run with ATLd0.08

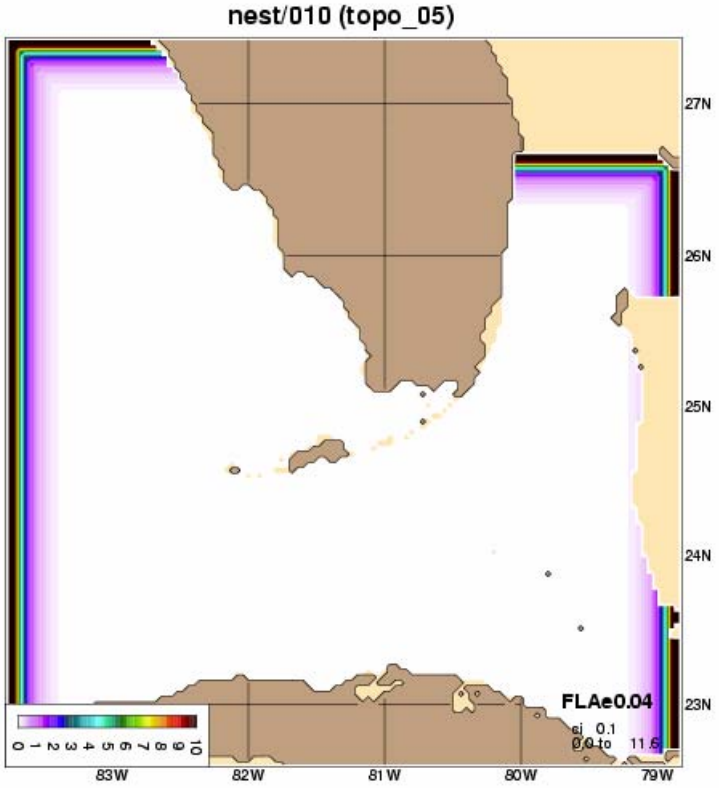
❖The regional FLAe0.04 model has been run for the same period with nested open boundary conditions (archv_008.tar to archv_010l.tar) using the same forcing but with addition of rivers as bogus precipitation to enhance coastal features

❖Four distinct nesting regions/buffer zones.

Forcing

- Monthly ECMWF plus 6-hourly anomaly winds.
- Monthly ECMWF heat fluxes.
- Monthly ECMWF Precipitation.
- Rivers with constant monthly discharge

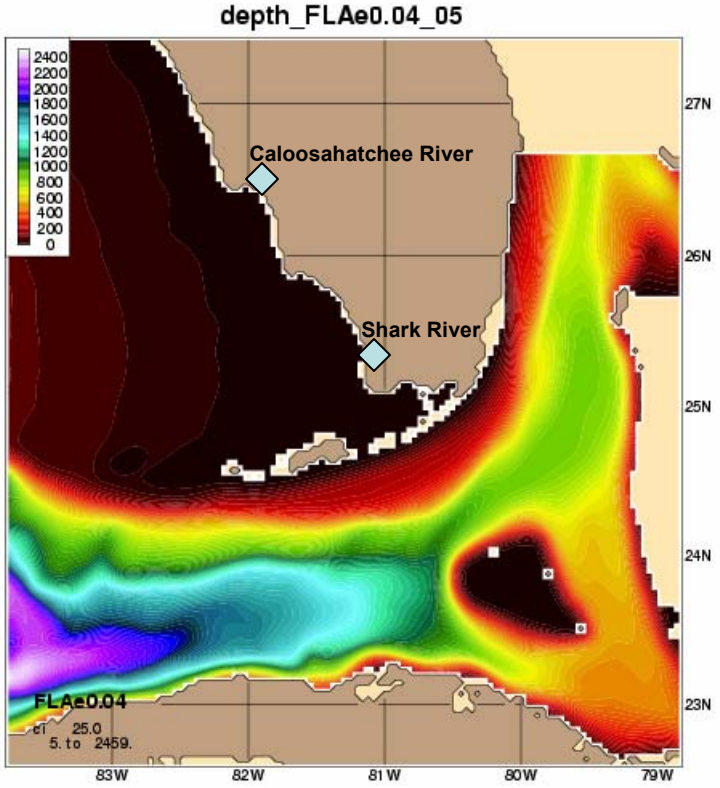
Nesting

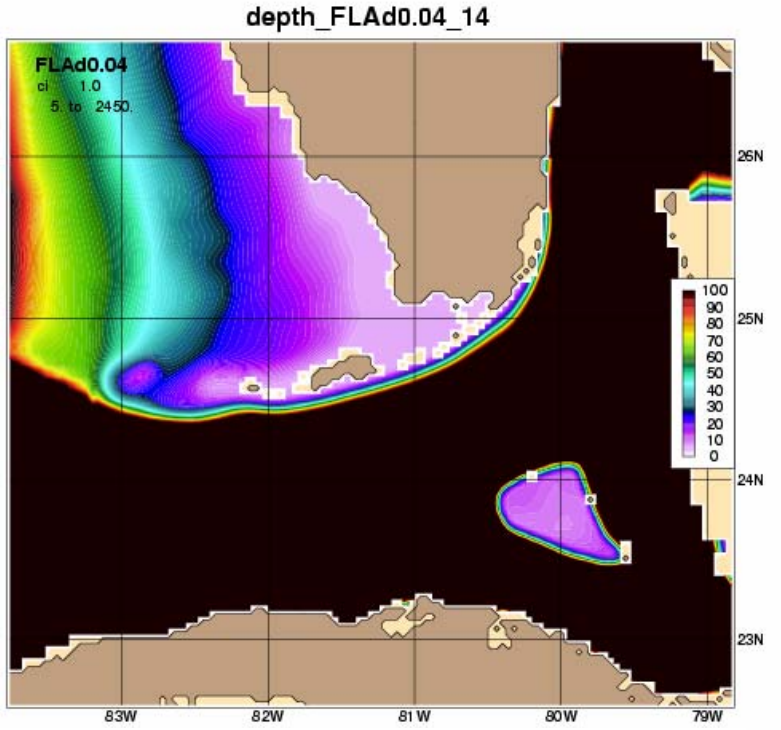


Open boundaries where FLAe0.04 is nested in IASd0.04. The lighter regions are landmasked. The scale refers to the weighting of merging the boundaries of the outer and inner topography.

Bathymetry

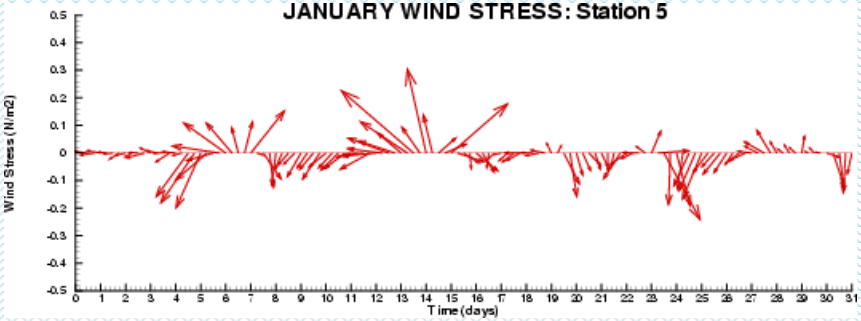
- Derived from 2-minute NAVO/NRL DBDB2 global dataset.
- 1/25 degree grid resolution
- 1 m coastline, 5m Hmin
- Extended North of 27N

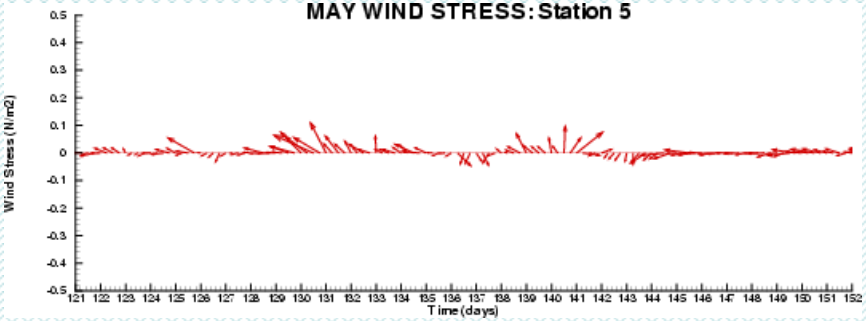


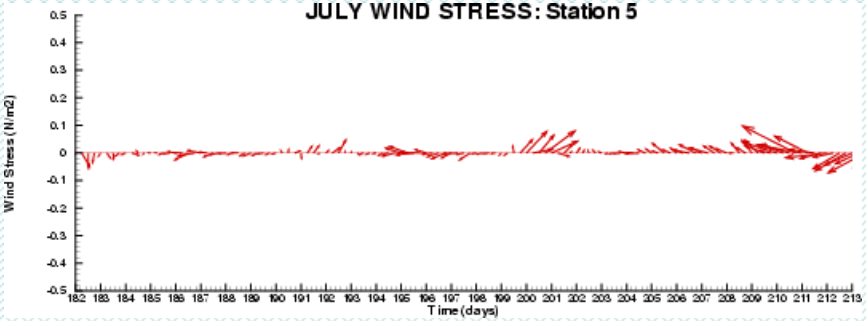


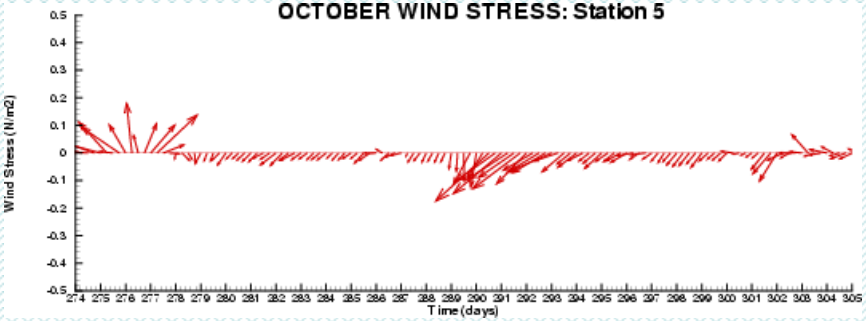
Regional FLAe0.04 Bathymetry,
1m coastline 5m minimum depth
1/25 degree resolution

Atmospheric Forcing









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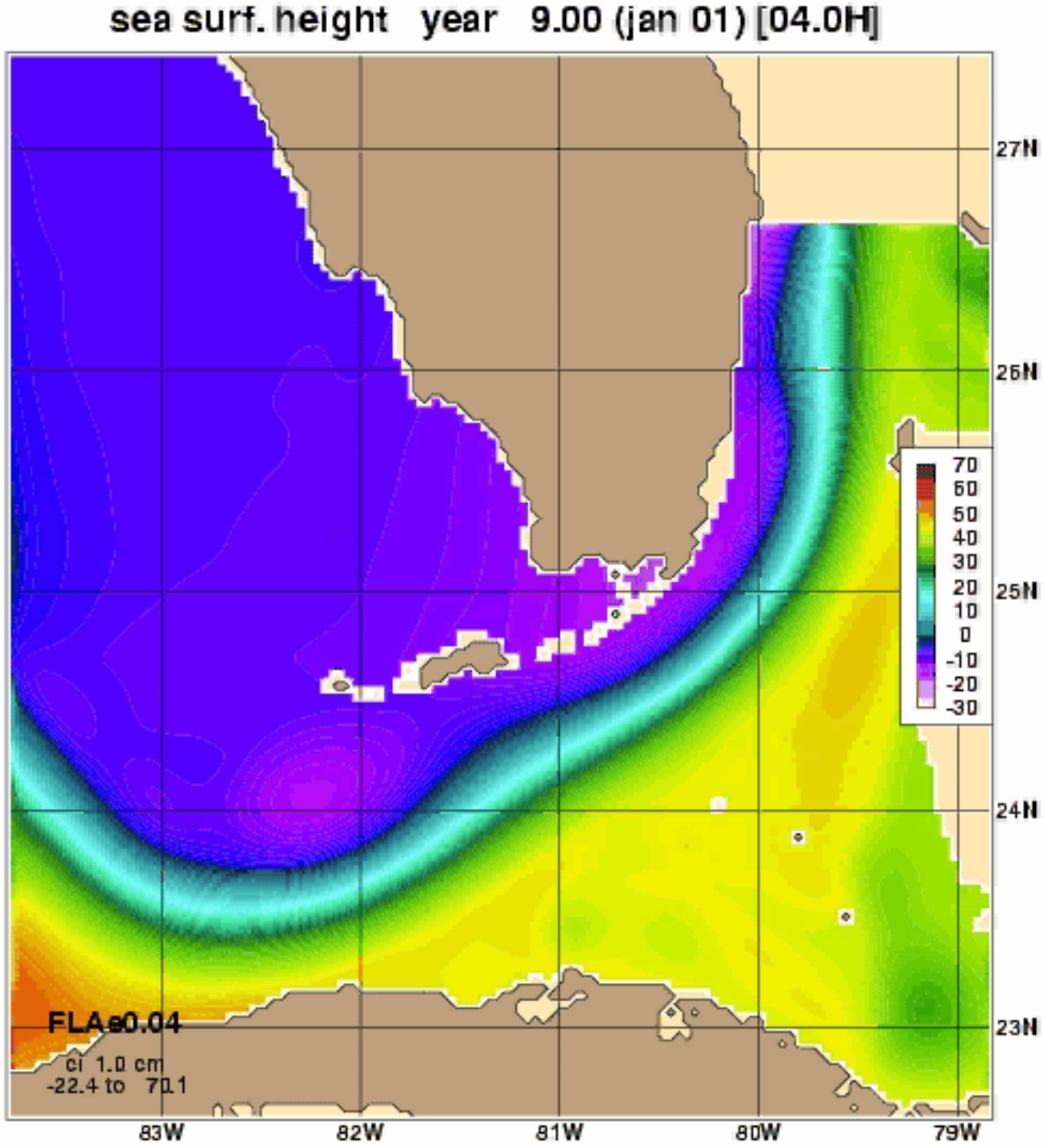
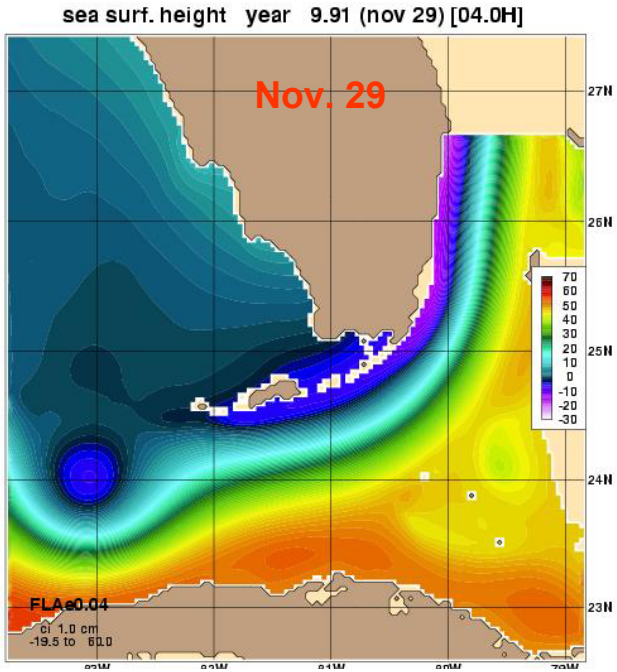
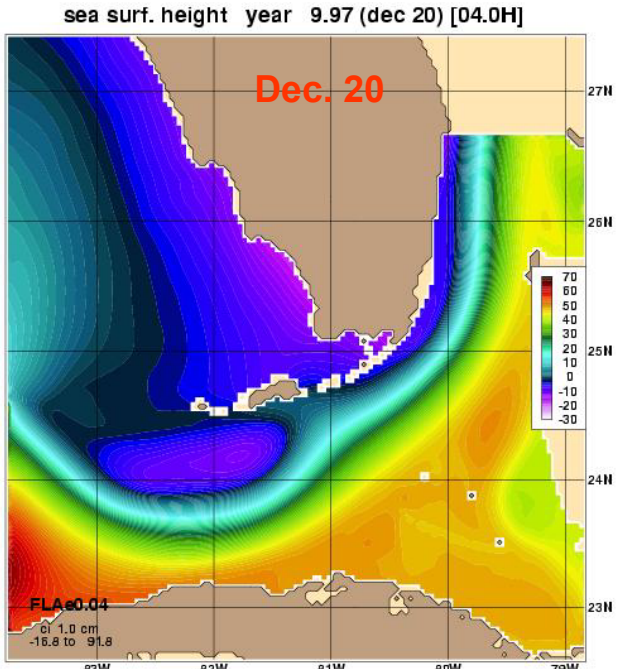
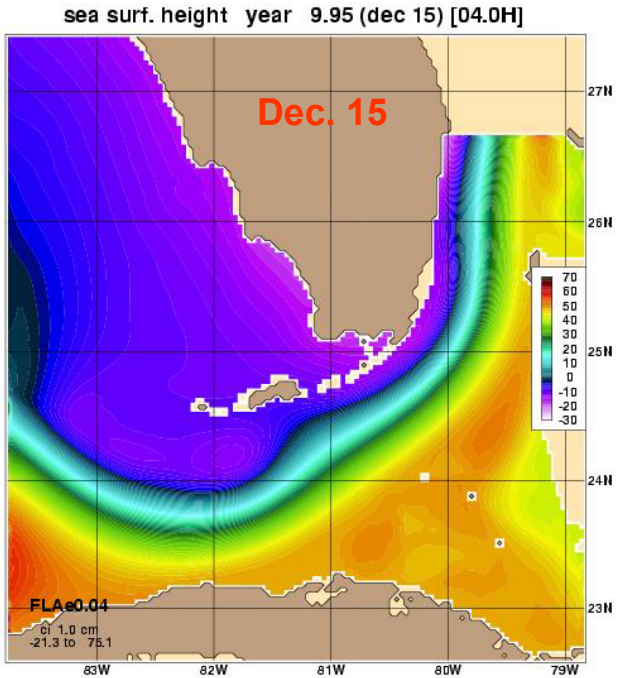
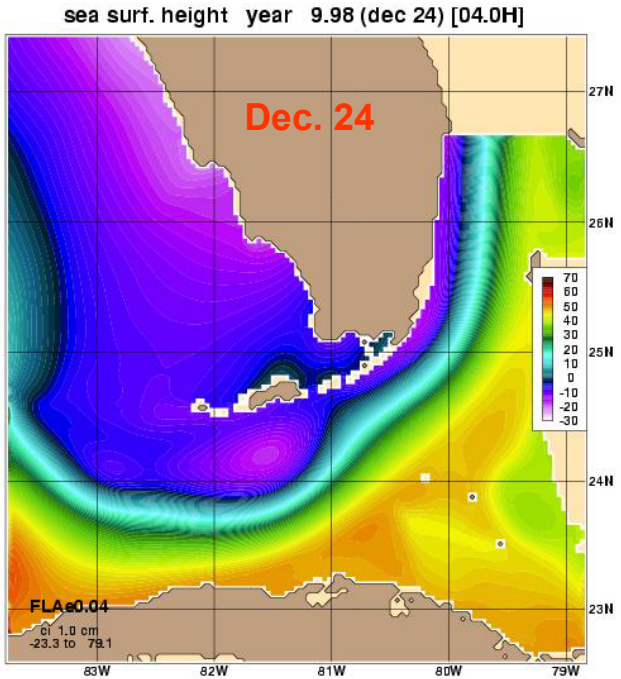


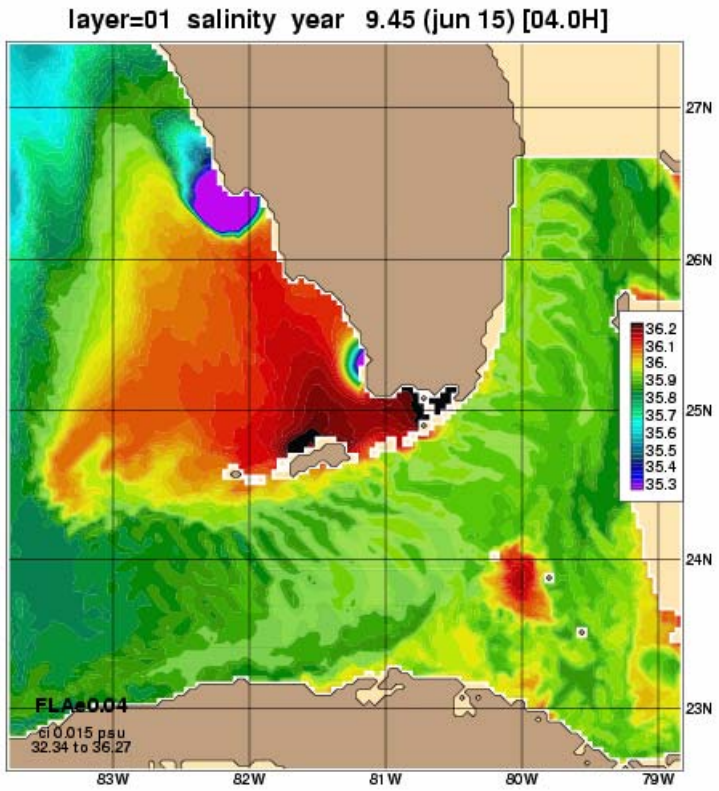

sea surf. height year 9.91 (nov 29) [04.0H]
Nov. 29
27N
26N
25N
24N
23N
70
60
50
40
30
20
10
0
-10
-20
-30
FLAe0.04
CI 1.0 cm
-19.5 to 60.0

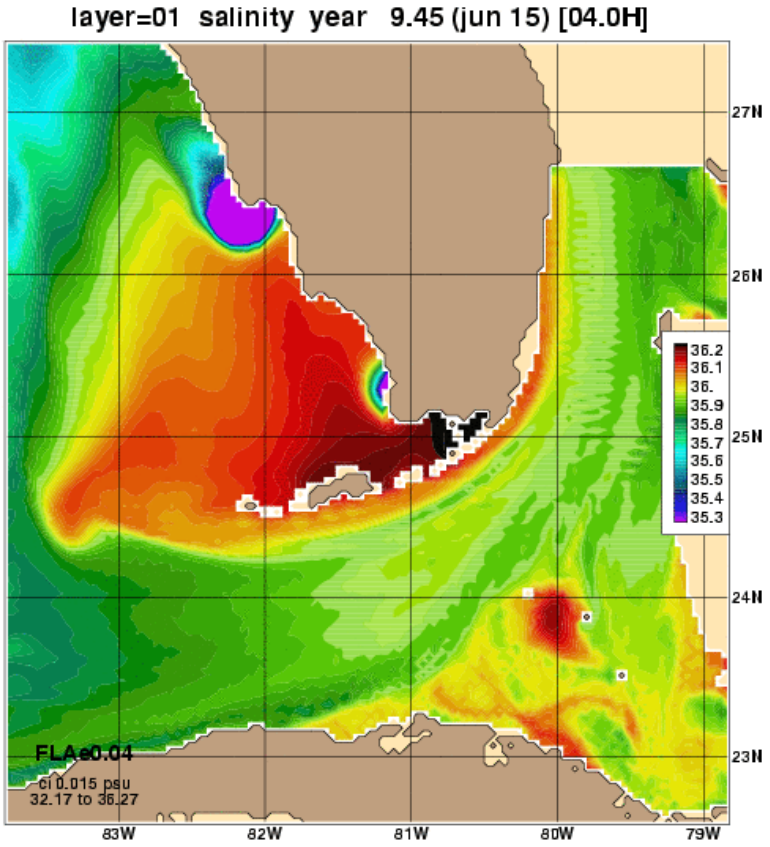

sea surf. height year 9.97 (dec 20) [04.0H]
Dec. 20
27N
26N
25N
24N
23N
70
60
50
40
30
20
10
0
-10
-20
-30
FLAe0.04
CI 1.0 cm
-16.8 to 91.8


sea surf. height year 9.95 (dec 15) [04.0H]
Dec. 15
27N
26N
25N
24N
23N
70
60
50
40
30
20
10
0
-10
-20
-30
FLAe0.04
CI 1.0 cm
-21.3 to 75.1
83W
82W
81W
80W
79W


sea surf. height year 9.98 (dec 24) [04.0H]
Dec. 24
27N
26N
25N
24N
23N
70
60
50
40
30
20
10
0
-10
-20
-30
FLAe0.04
CI 1.0 cm
-23.3 to 79.1
83W
82W
81W
80W
79W

Surface Salinity: JUNE 15



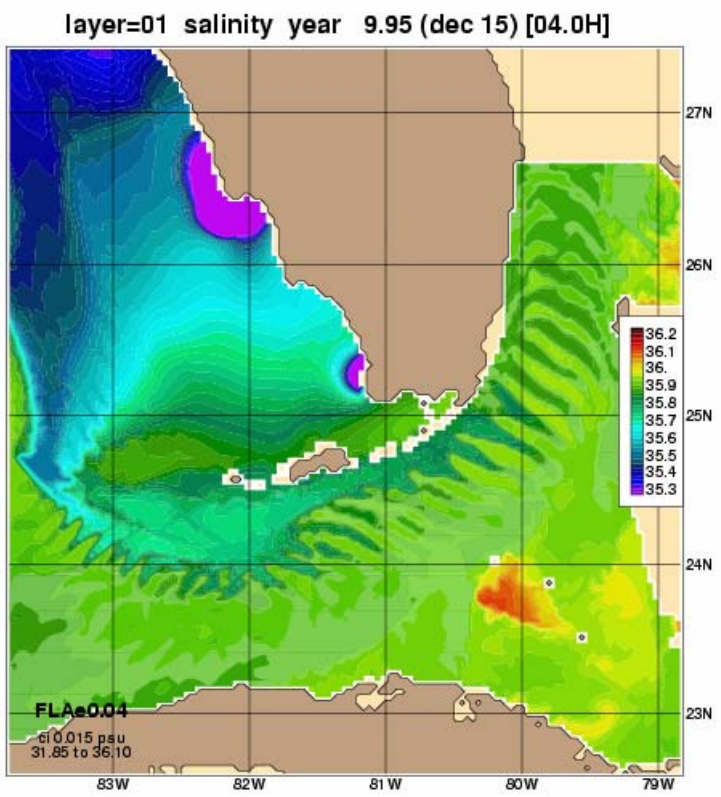


FLAe0.04

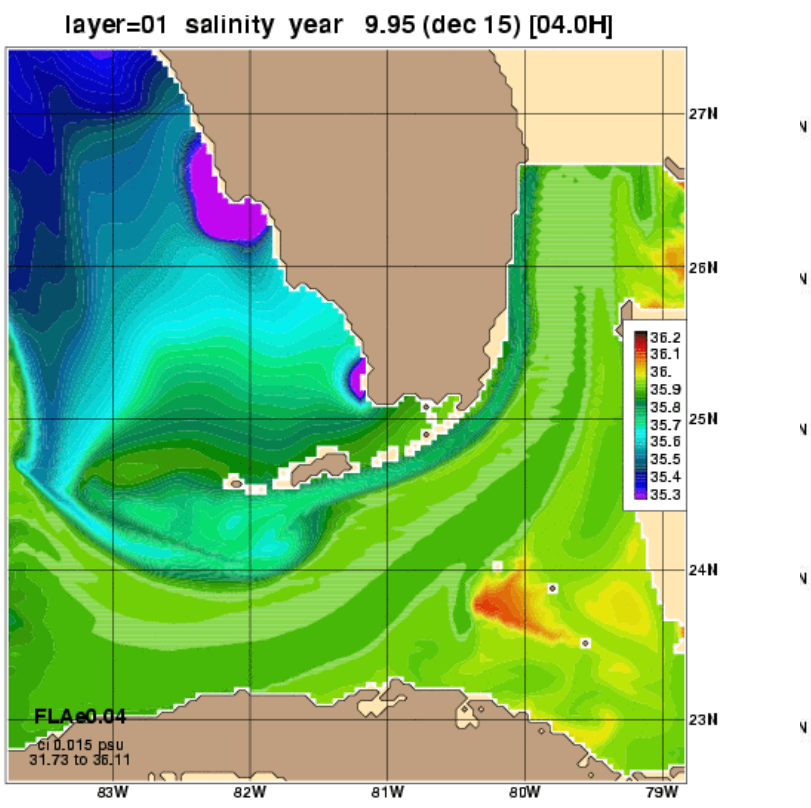
FLAe only:

- River plumes from Caloosahatchee and Shark River
- Formation of hypersaline water in Florida Bay

Surface Salinity: DECEMBER 15

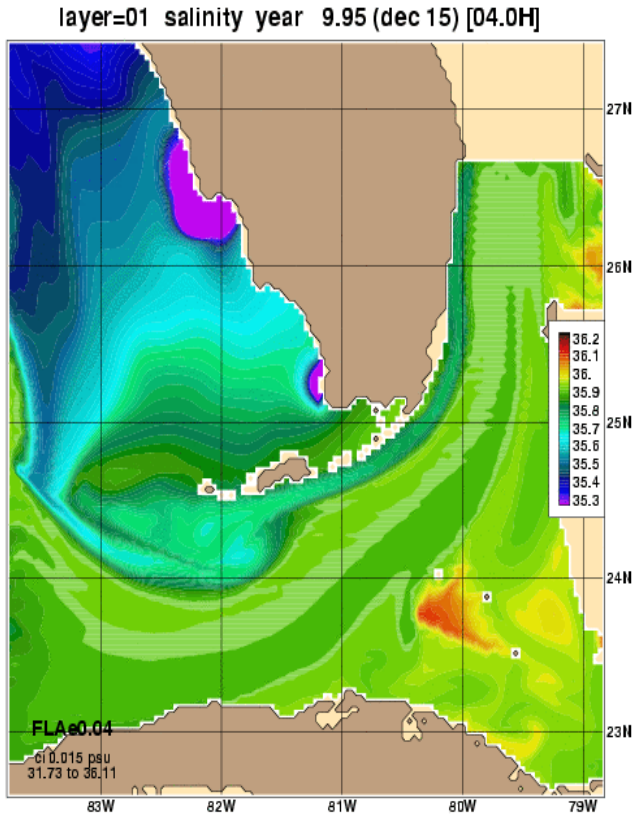


FLAe0.04

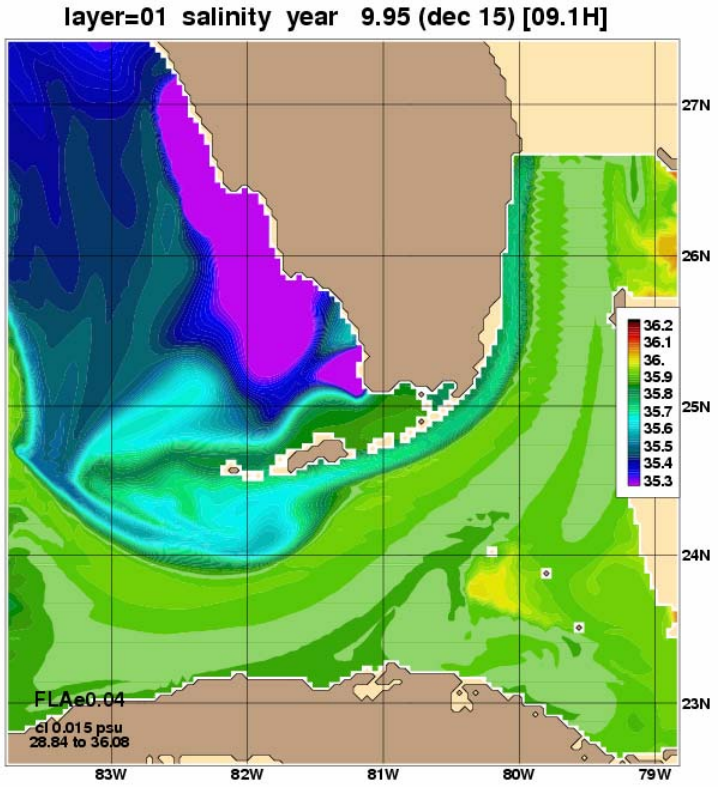


- Retention of high salinity water in Cay Sal Bank
- Smaller intrusion of low S waters from the NW in the FLAe simulation

Surface Salinity (“improved” rivers)

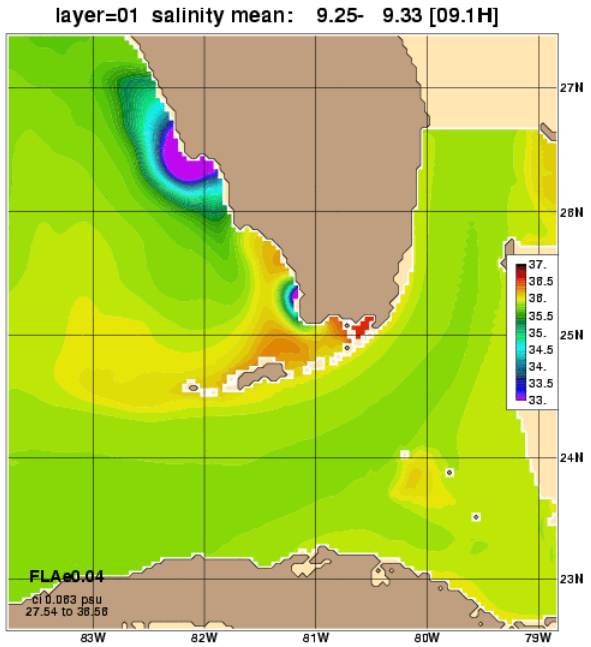


December 15

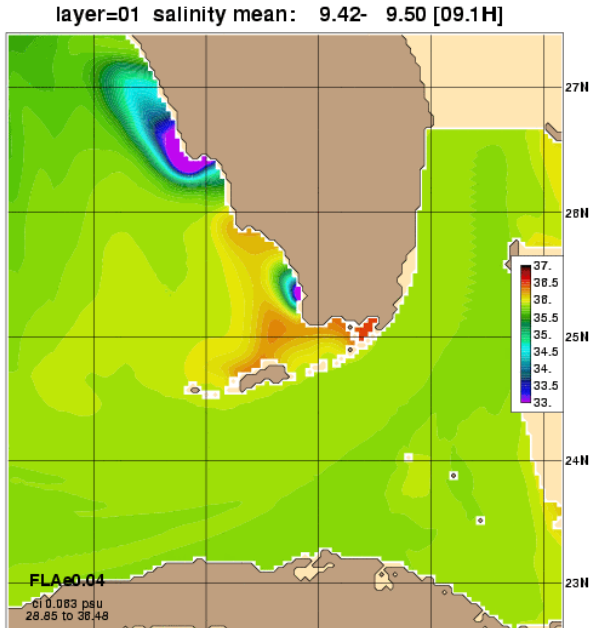


Low relaxation
River “thickness”
No river “smoothing”

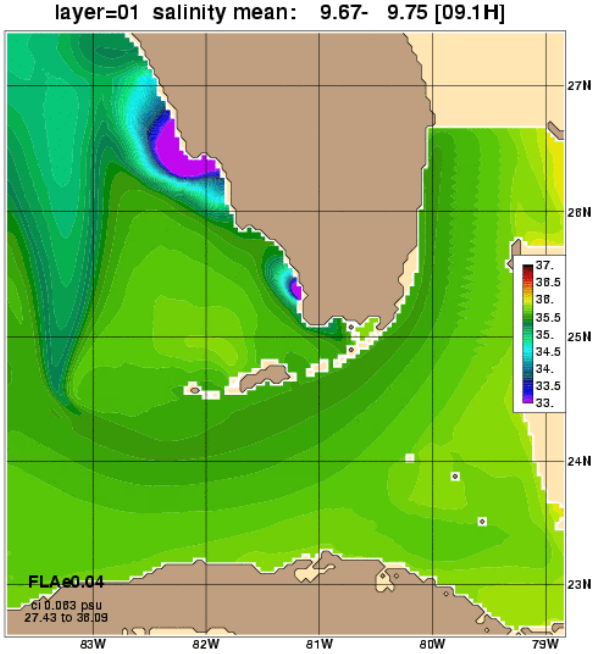
Monthly mean surface salinity



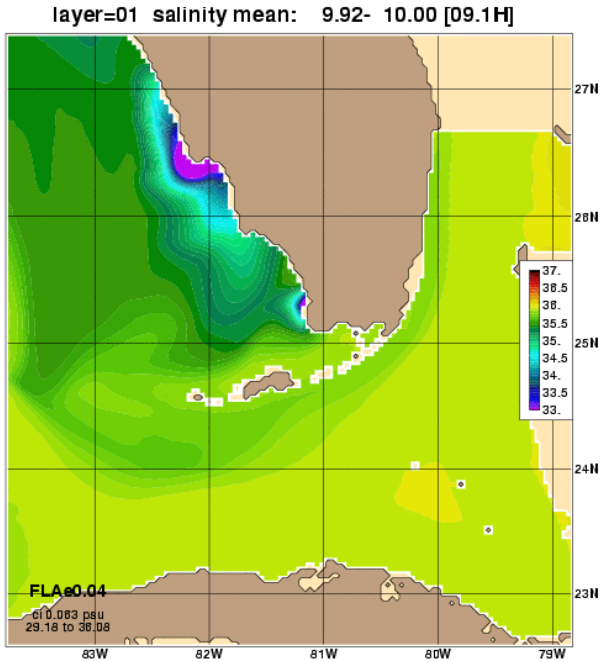
April



June



Sept.

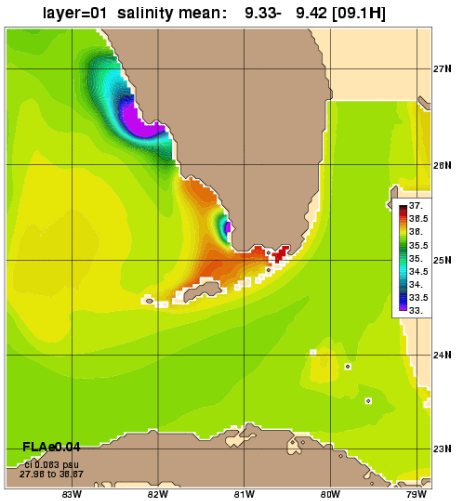


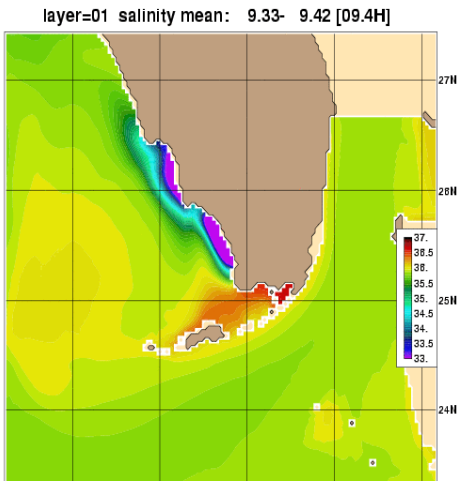
Dec.

Point sources

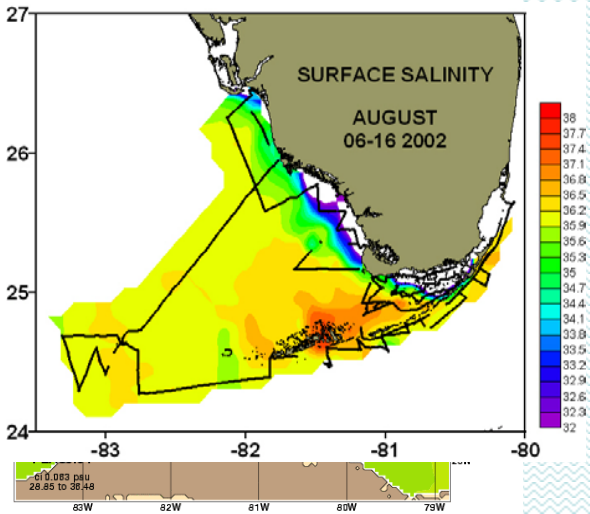
Line source

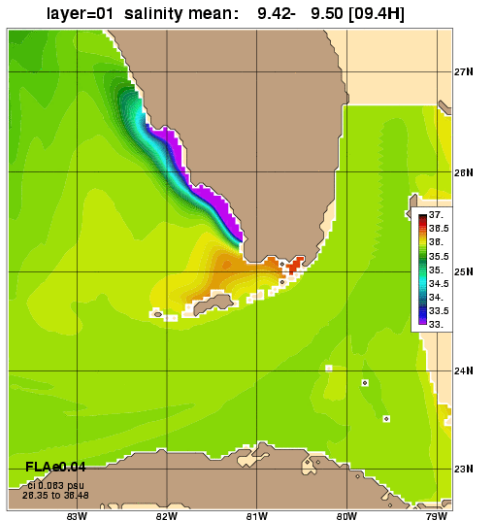
May





June



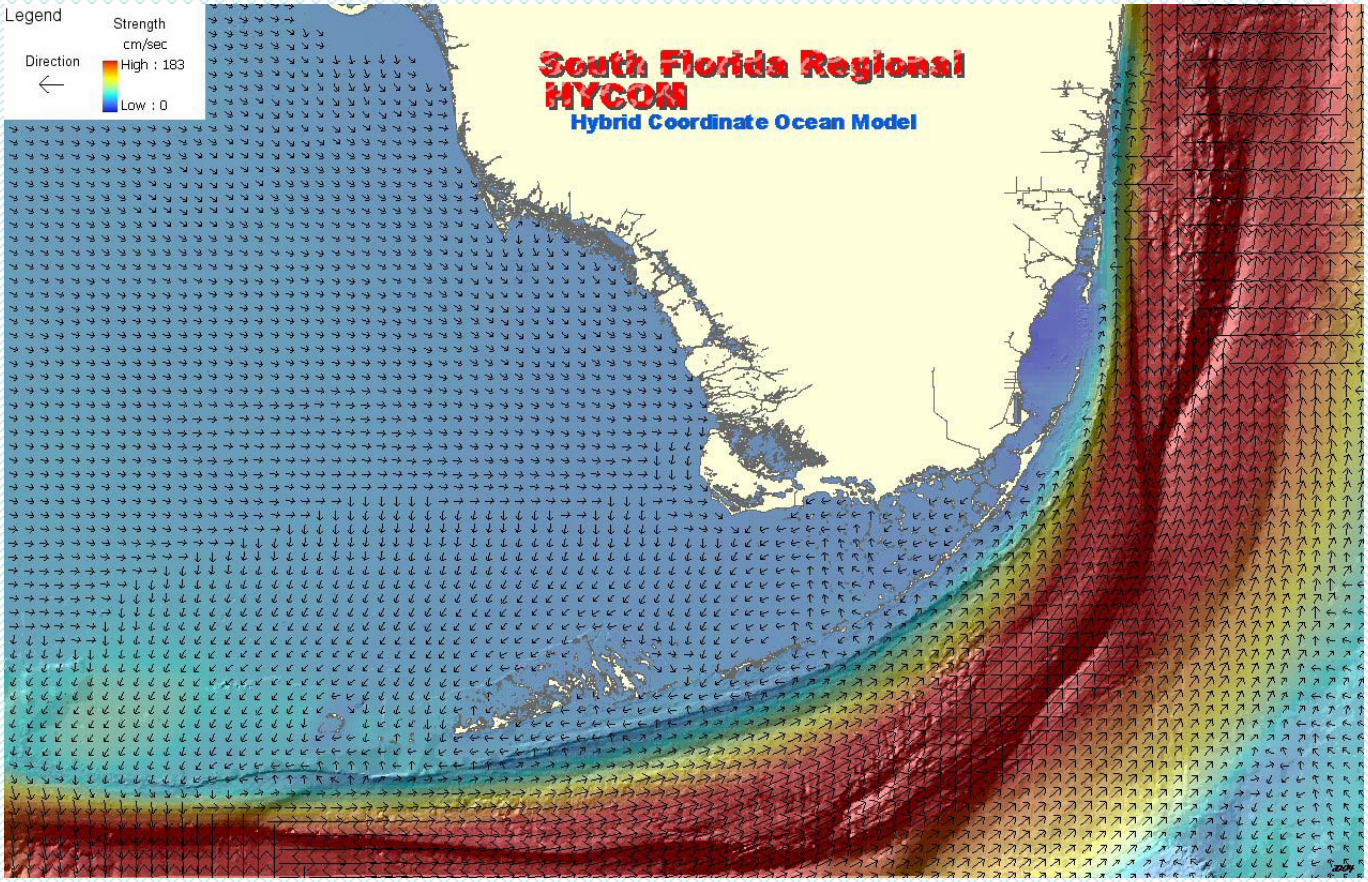


Future plans:

- New nest in ATL 1/12
- Inter-annual simulation
- Improved coastal dynamics: river plumes, tides, high resolution winds…
- Comparison to data
- Biological and socioeconomic applications

Toward an operational management tool for the Florida Keys Reef Tract

Monthly mean currents for December overlaid on topography; current direction in arrows, current strength in color.



Model results are being incorporated in a multi-layer management tool for the Florida Keys, developed by the National Center for Caribbean Coral Reef Research (NCORE): http://ncore.rsmas.miami.edu.

The GIS model includes layers on circulation, atmospheric parameters, socioeconomic parameters, vegetation and habitat, legal and administrative boundaries etc.

"BOX" model domain:
An idealized basin has been set up
for the study of river plume dynamics

- periodic f-plane
- 20m deep flat bottom
- 10 equally spaced z-levels (or hybrid)
- initial 35 psu and 35 ^{o}C
- river forcing 900 m^3/s
- Buoyancy due to river is the only sfc forcing

WORK IN PROGRESS!!!

River plume dynamics:

- E-P treated as salt flux (standard “rivers are rain” approach): the river inflow is balanced by a small const. evaporation term in the “precip” input file

  Free surface changes due to the density change

- E-P treated as mass flux (“coastal mound” approach): update the pbaro component of SSH

  Free surface changes due to the change in total mass

- River “smoothing” : spreads the river-rain input horizontally around the source

- River “thickness”: specify a depth to mix the riverine input vertically below the source (reduce the need for horizontal smoothing)

- Selected hybrid layers: specify a number of near surface layers to be always fixed (z- or sigma or sigma-z) levels (specify a minimum density for hybrid layers)

Case 1: With Channel (3-grid point wide)

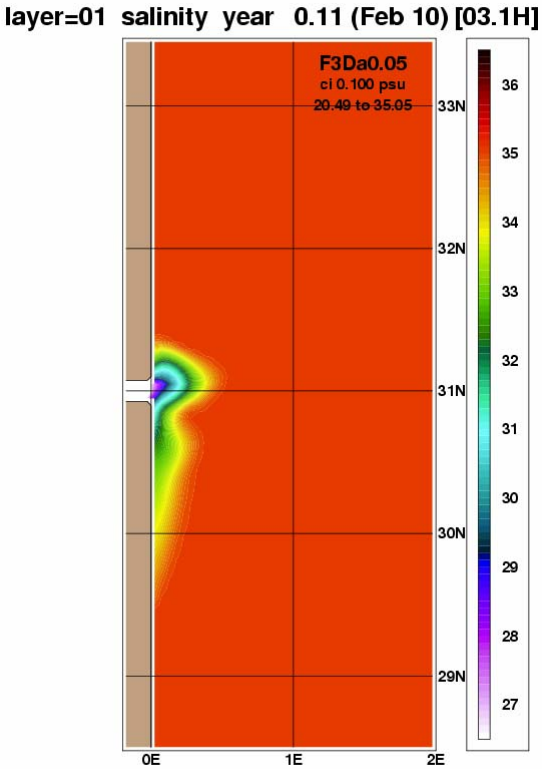
- exp #3.1 E-P as salt flux, thkriv=0
- exp #3.2 E-P as mass flux, thkriv=0
- exp #3.3 E-P as mass flux, thkriv=5
- exp #3.4 E-P as mass flux, thkriv=5, nsmooth=0
- exp #3.5 E-P as mass flux, thkriv=5, nsmooth=0, hybrid layers

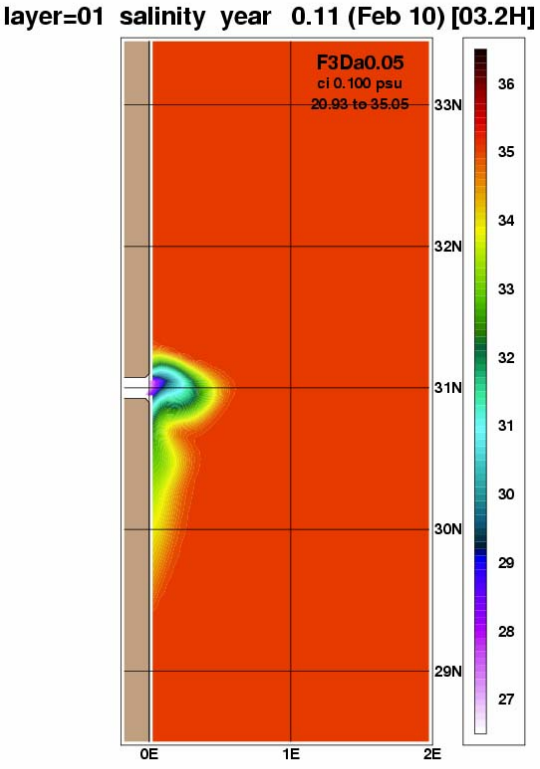
Case 2: Without Channel (1-grid point source)

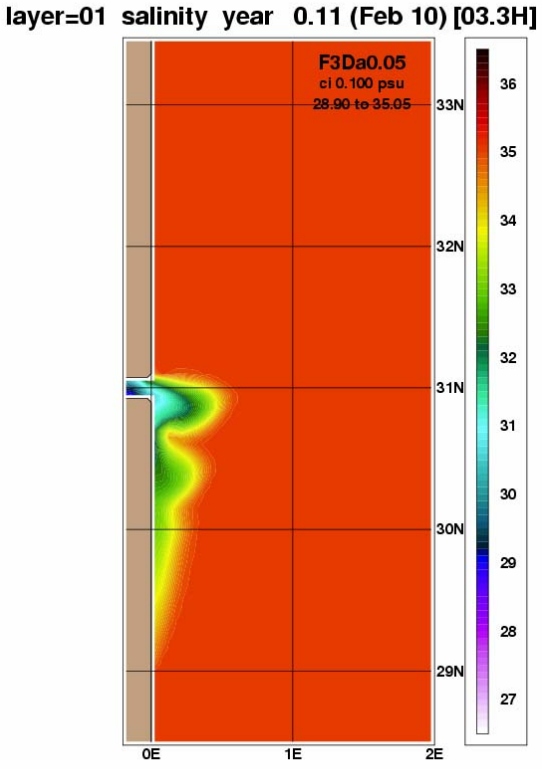
- expt_06.5 E-P as mass flux, thkriv=5 , nsmooth=0, hybrid layers

Case 3: Without Channel (3-grid point source)

- expt_07.5 E-P as mass flux, thkriv=5 ,nsmooth=0, hybrid layers







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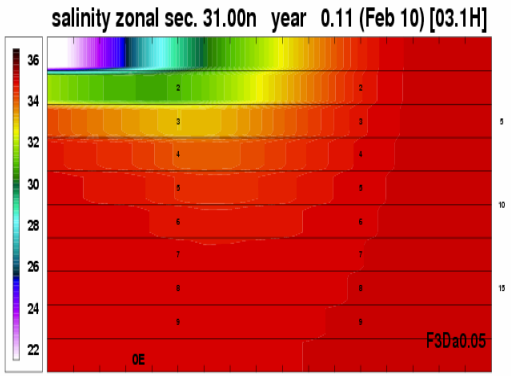

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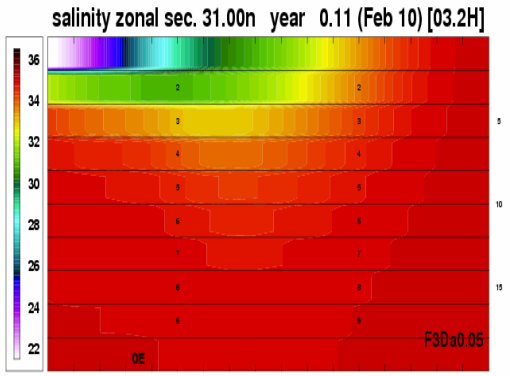

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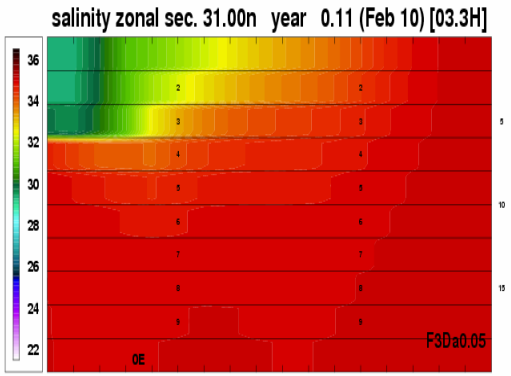
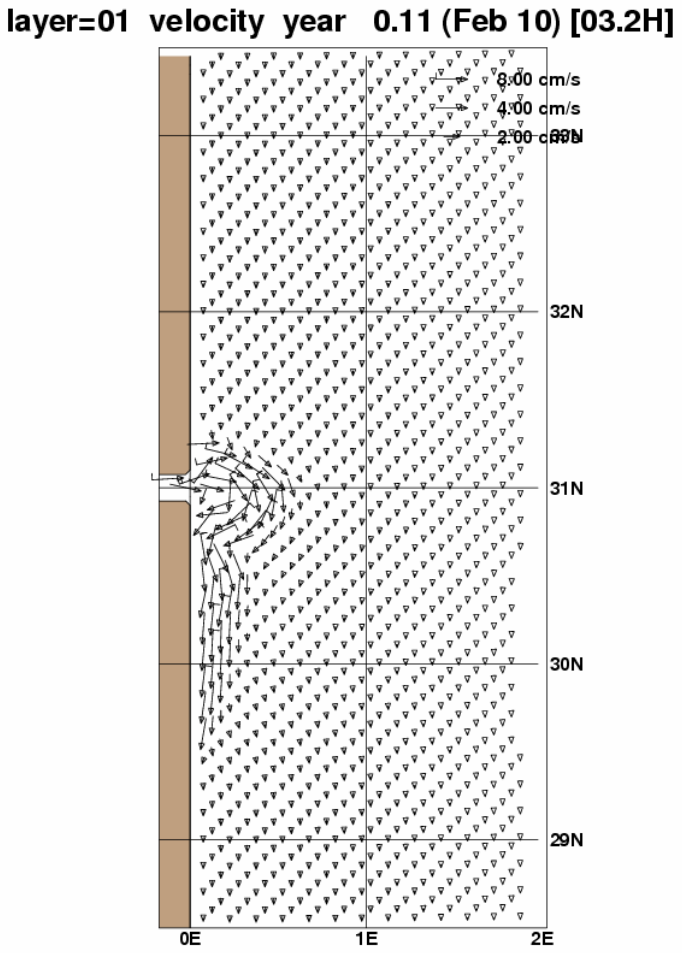


Salt flux

Mass flux

Mass flux + thkriv



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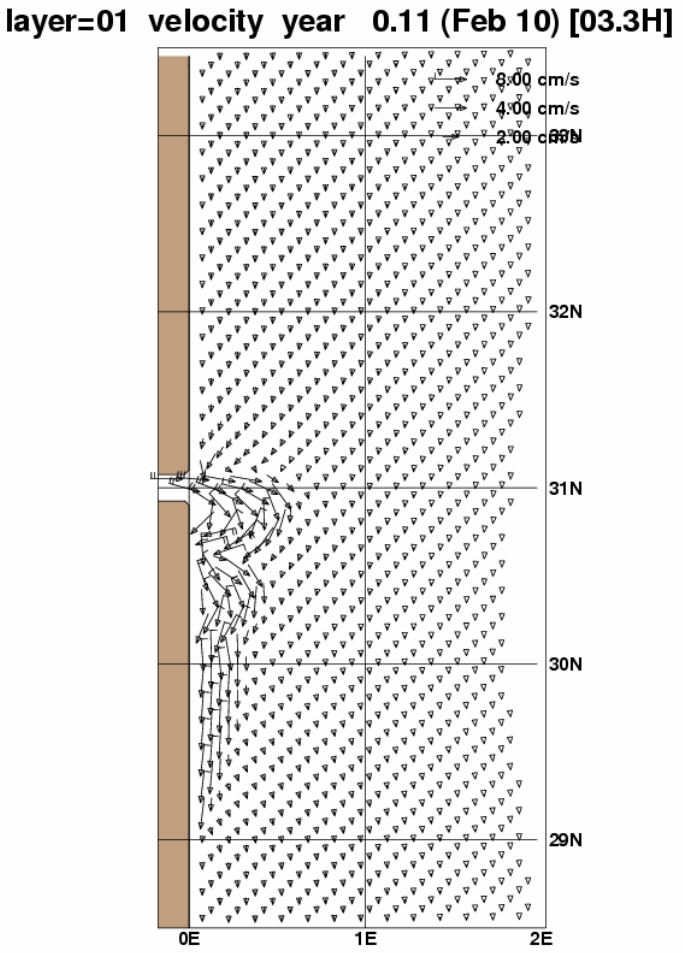
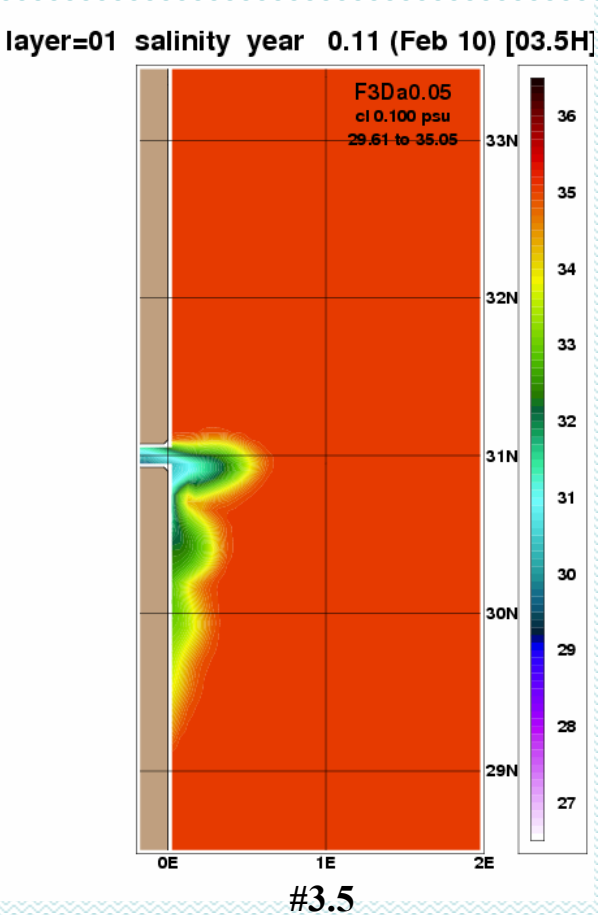
Mass flux



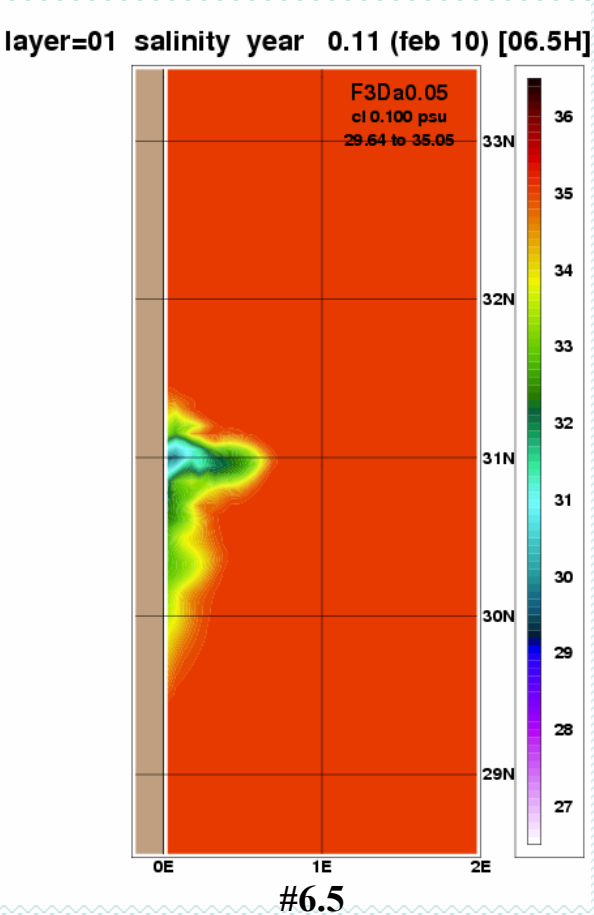
#3.3

Mass flux + thkriv



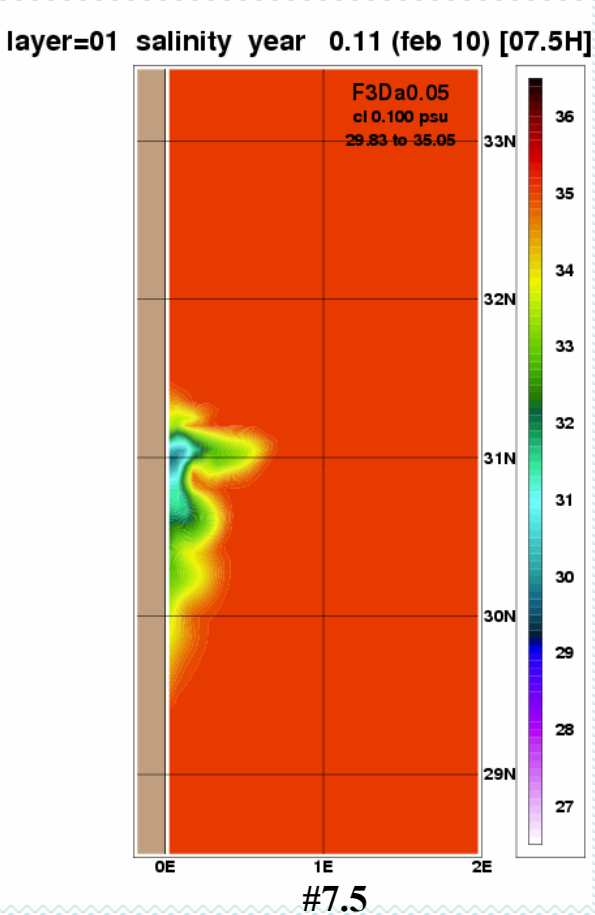
#3.5

Channel (3 sources)



#6.5

No channel (1 source)



#7.5

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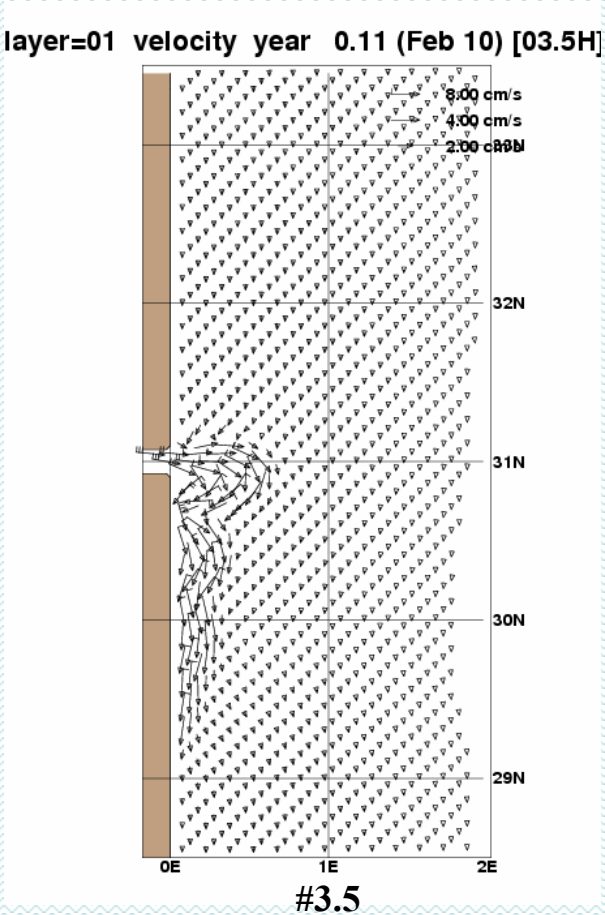

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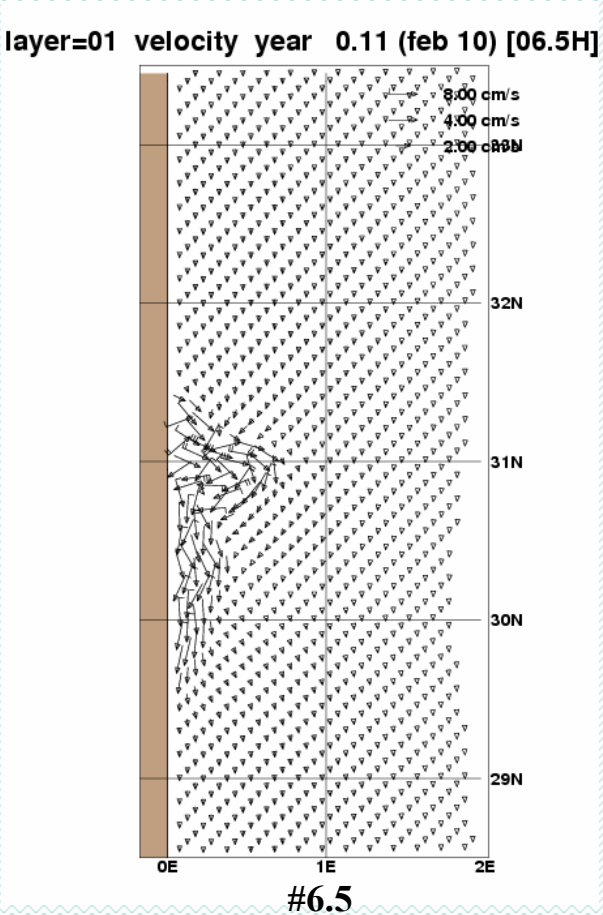
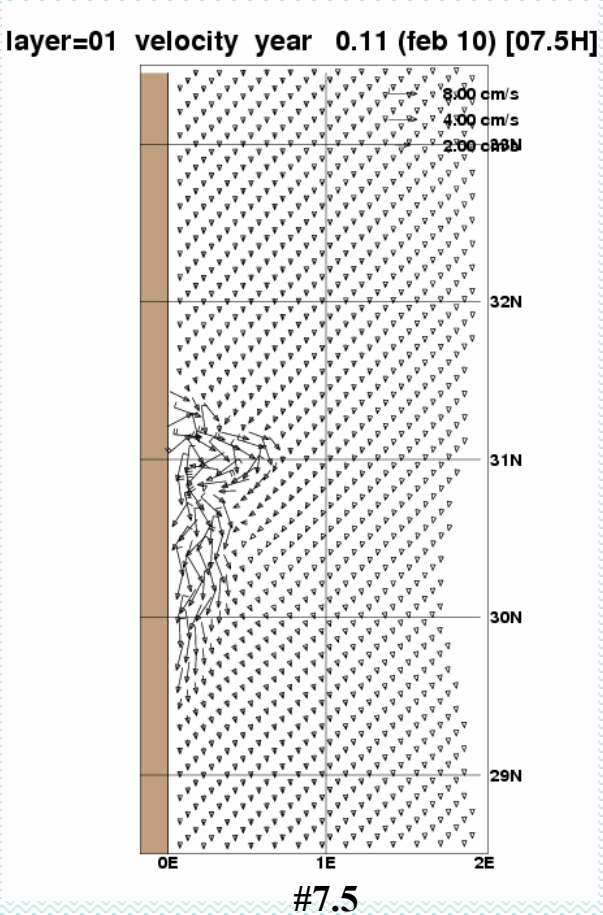


#6.5



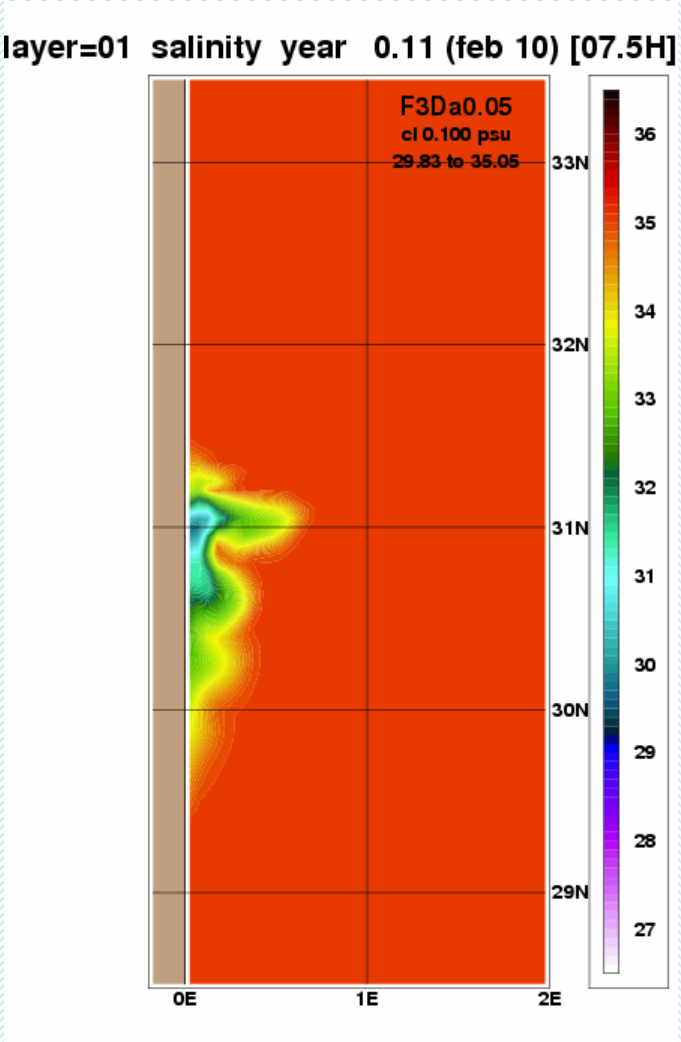
#7.5

Channel (3 sources)

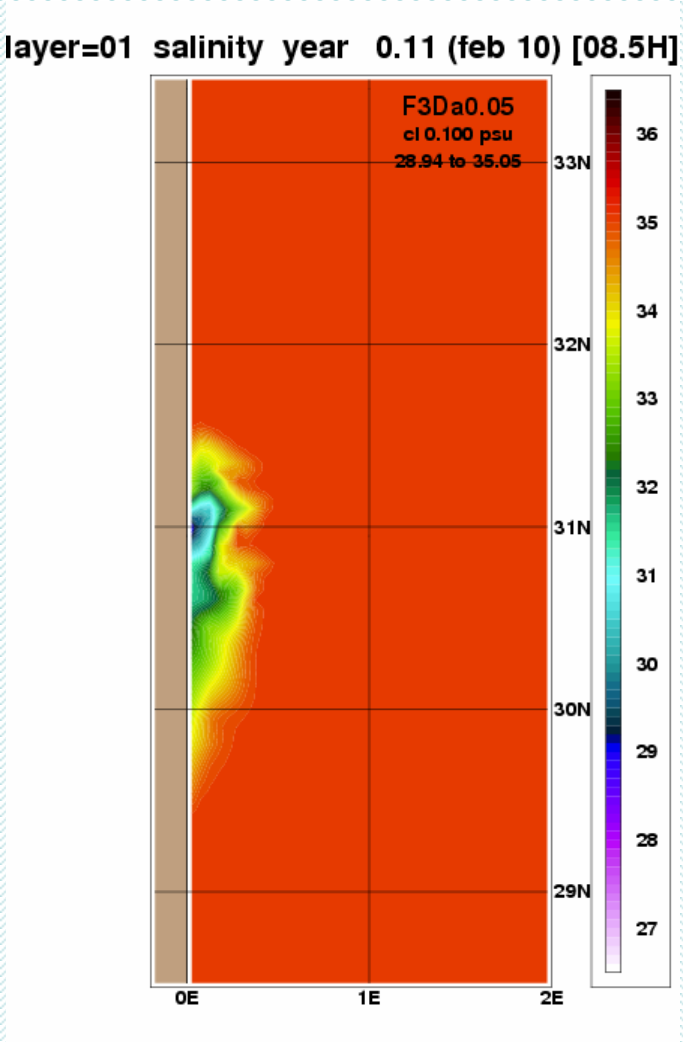
No channel (1 source)

No channel (3 sources)

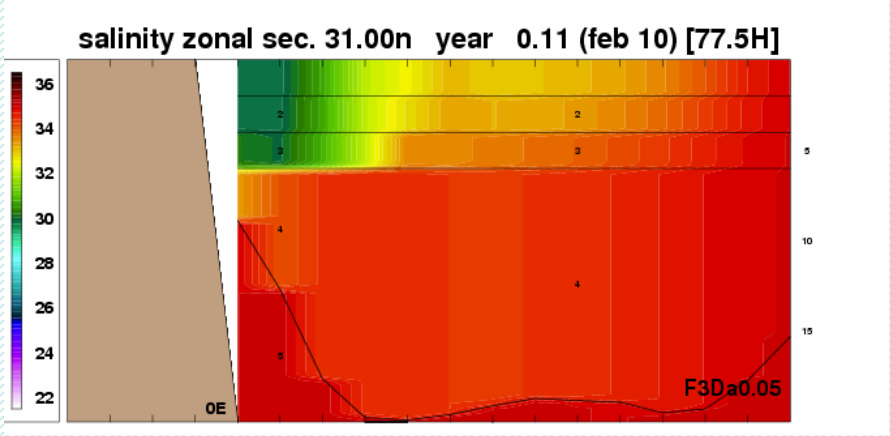
KPP


layer=01 salinity year 0.11 (feb 10) [07.5H]
F3Da0.05
cl 0.100 psu
29.83 to 35.05
33N
32N
31N
30N
29N
0E
1E
2E
36
35
34
33
32
31
30
29
28
27

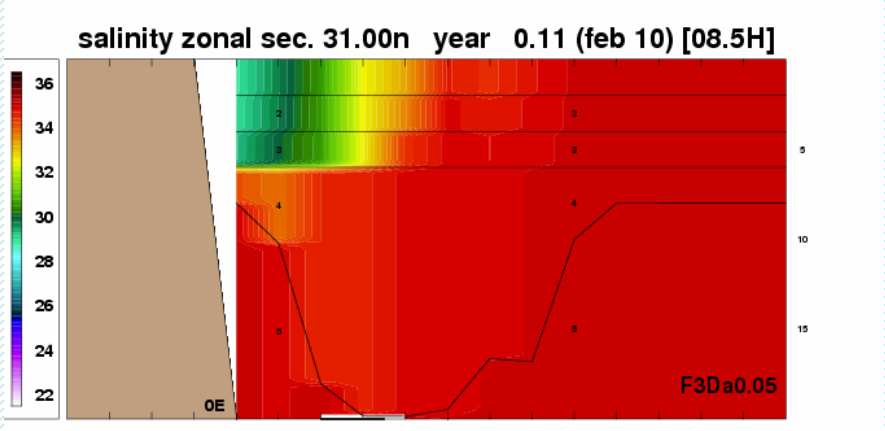
M-Y 2.5

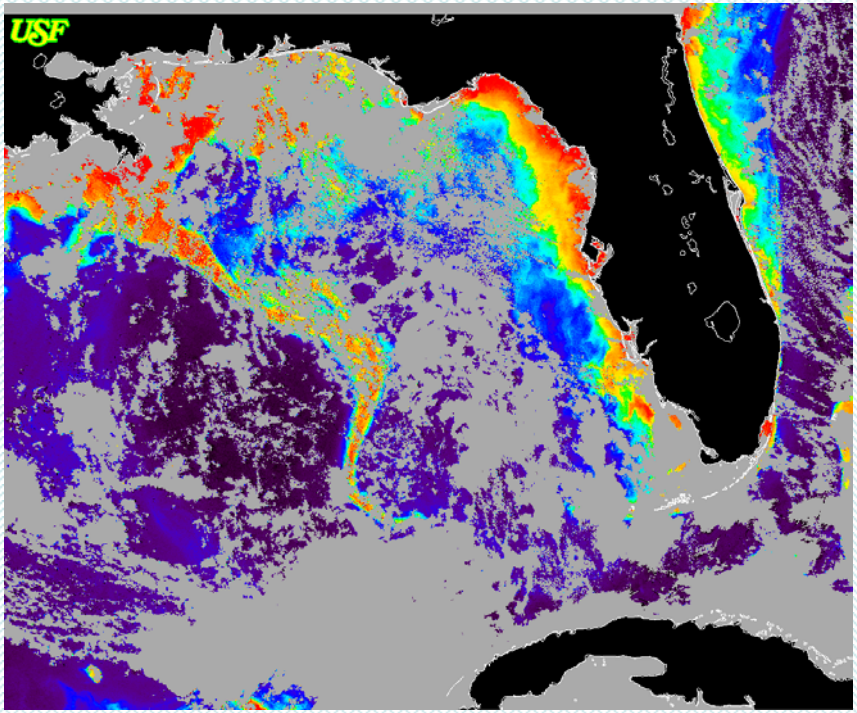

layer=01 salinity year 0.11 (feb 10) [08.5H]
F3Da0.05
cl 0.100 psu
28.94 to 35.05
33N
32N
31N
30N
29N
0E
1E
2E
36
35
34
33
32
31
30
29
28
27

KPP

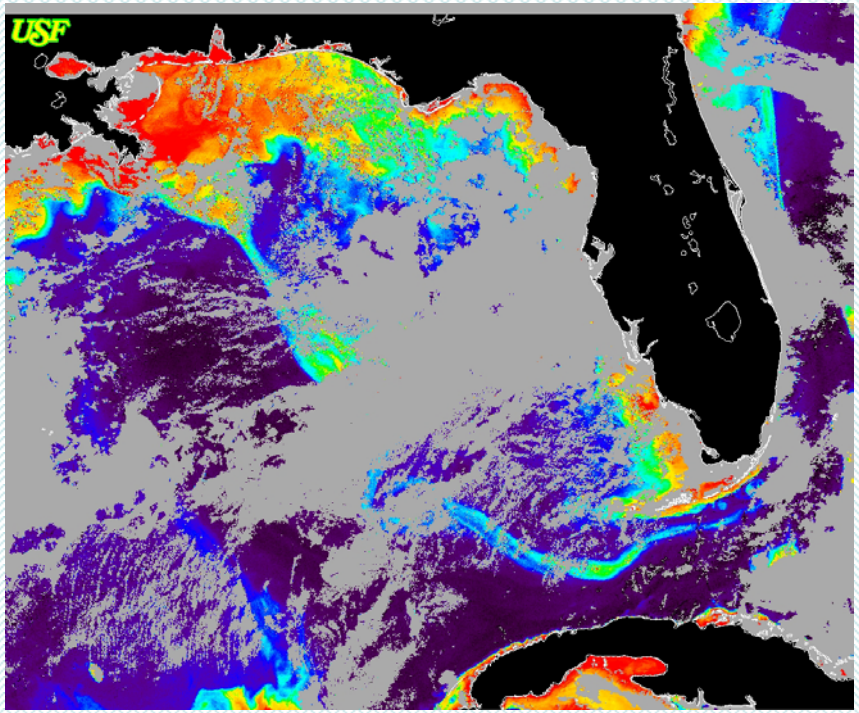

salinity zonal sec. 31.00n year 0.11 (feb 10) [77.5H]
36
34
32
30
28
26
24
22
0E
F3Da0.05

MY

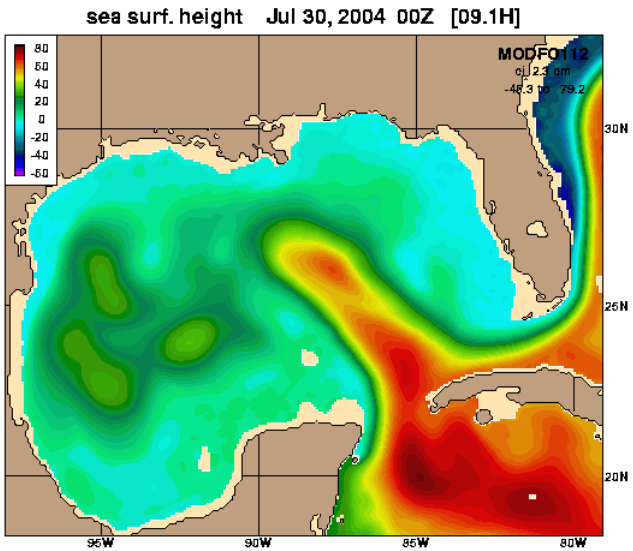

salinity zonal sec. 31.00n year 0.11 (feb 10) [08.5H]
36
34
32
30
28
26
24
22
0E
F3Da0.05



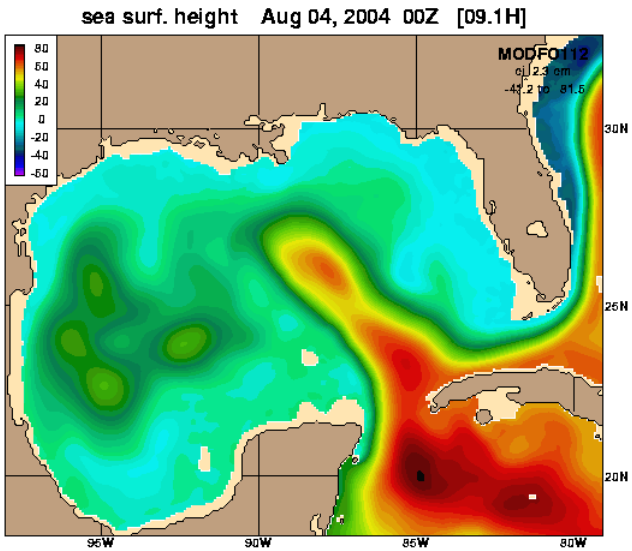
07/30/2004



08/04/2004



HYCOM SSH 07/30/2004



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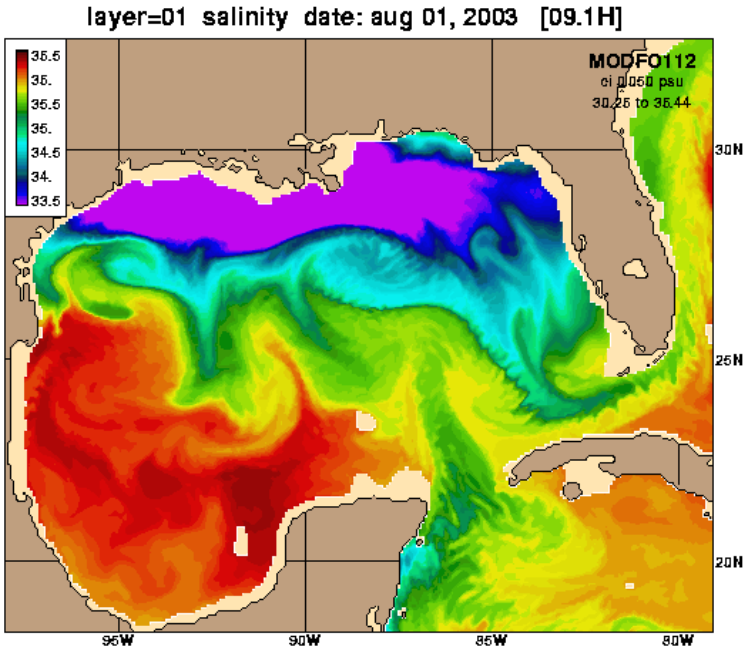
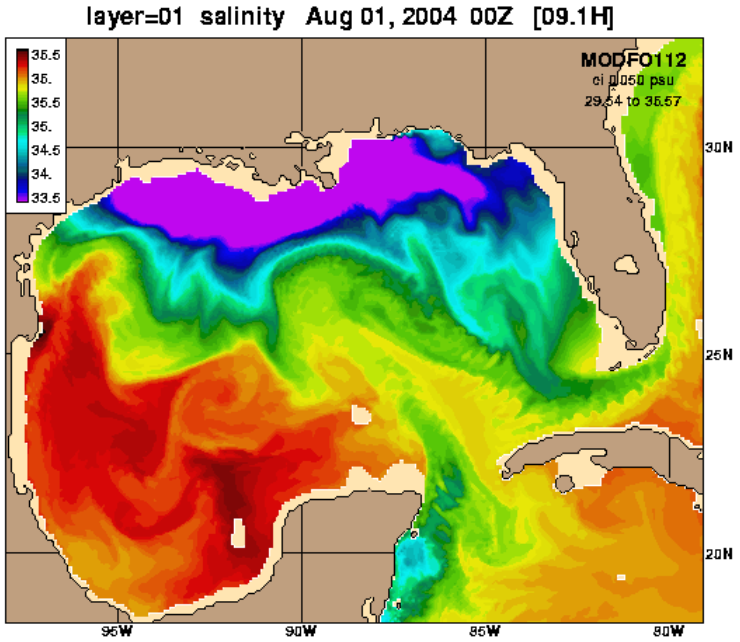


HYCOM SSS 08/01/2003



HYCOM SSS 08/01/2004