Simulating the variability of Florida Current frontal eddies

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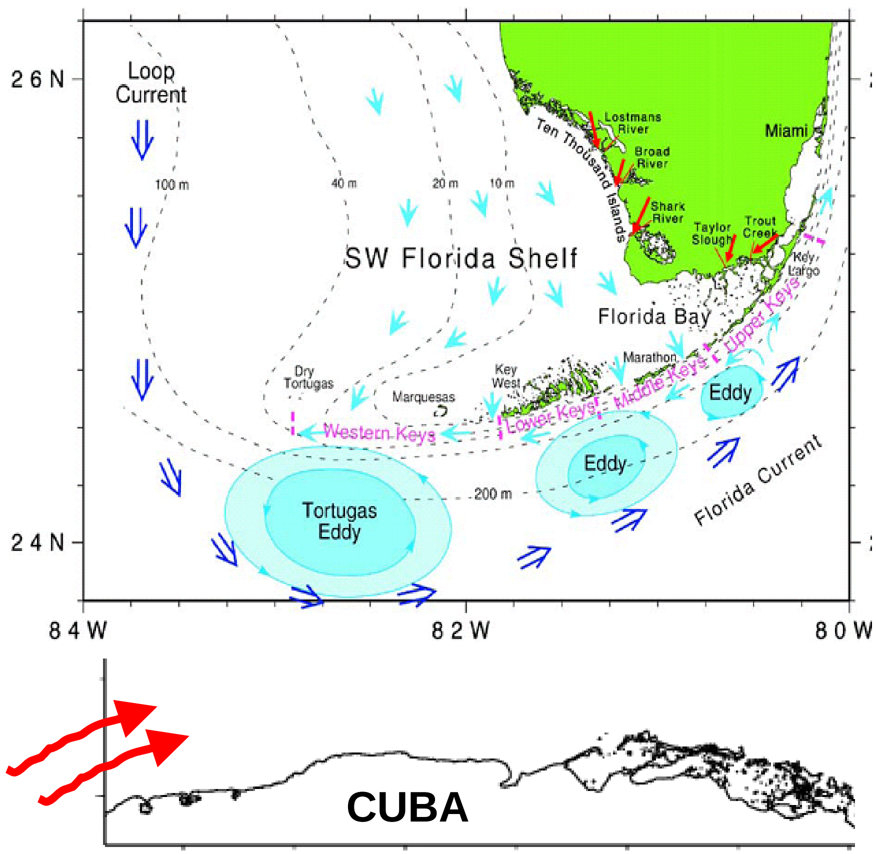
LOM09

The Complex South Florida Coastal System



Adapted from Lee et al. (2002)

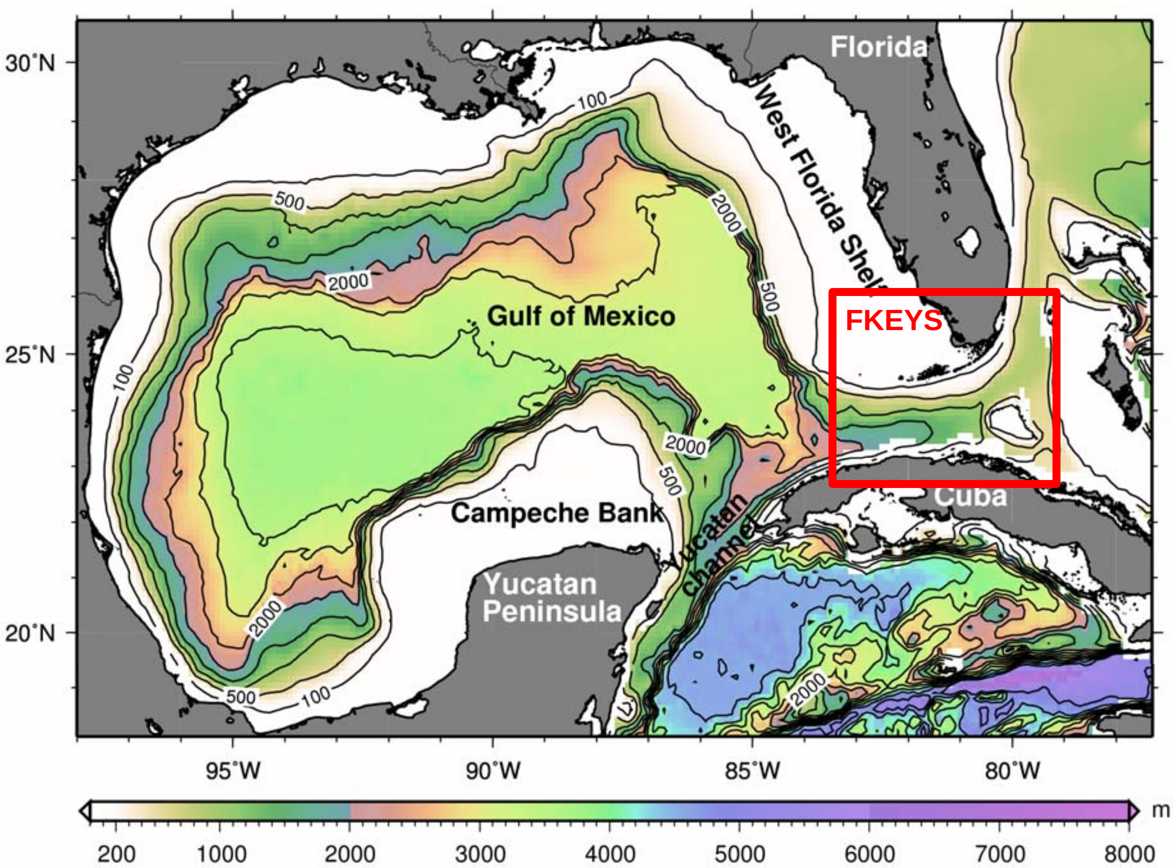
COMPLEX TOPOGRAPHY

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)

FKEYS-HYCOM nested in GOM-HYCOM



Simulation for 5 years from 2004 to 2008

GOM-HYCOM from Ole Martin Smedstad

GOM-HYCOM

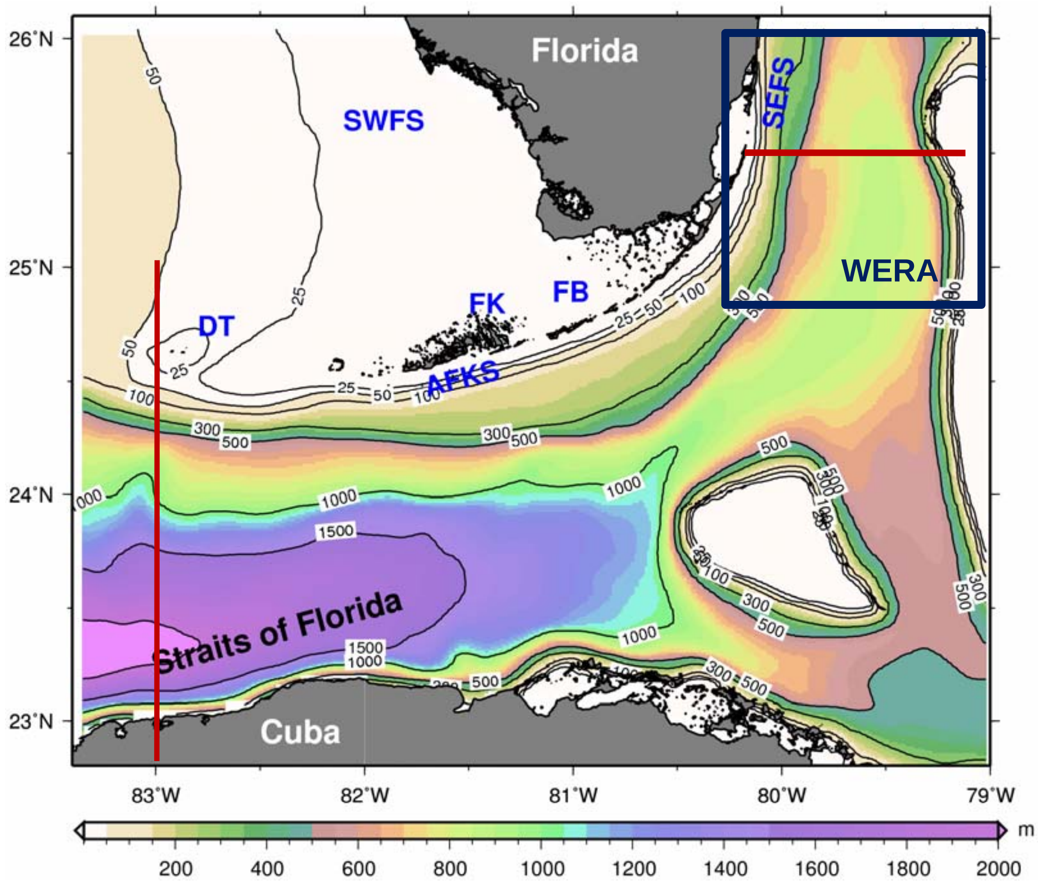
- **With DATA ASSIMILATION**
- **With 20 layers**
- **Resolution ~ 3-4 km**
- **1 deg NOGAPS**

FKEYS-HYCOM

- **With desired topographic details in shallow Florida Keys areas**
- **With river line source along the Ten Thousand Islands**
- **With 26 layers**
- **Resolution ~ 1km**
- **COAMPS-27km**

minimum water depth: 2m

FKEYS-HYCOM domain with Topography



It covers:

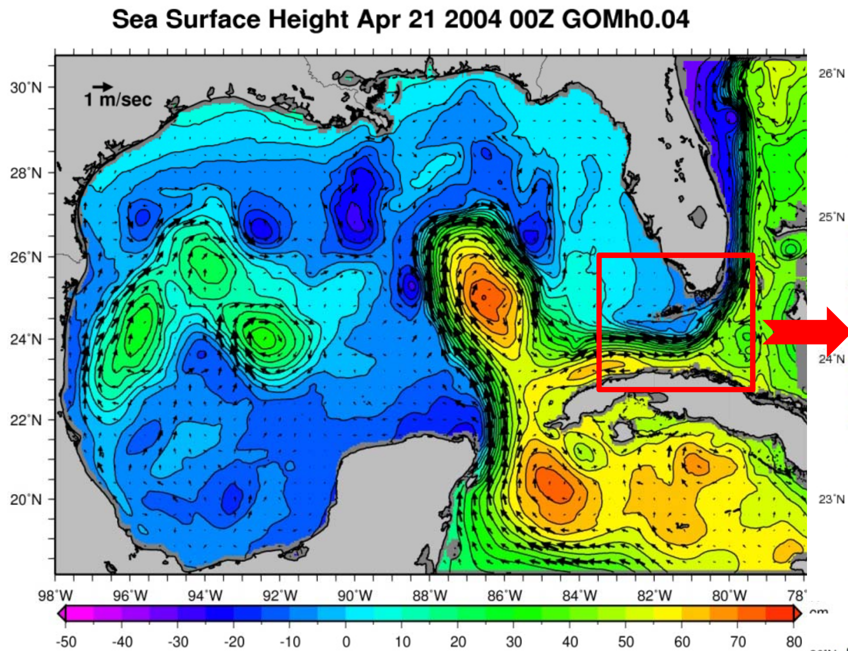
SWFS: Southwest Florida Shelf
SEFS: Southeast Florida Shelf
AFKS: Atlantic Florida Keys Shelf
FB: Florida Bay
FK: Florida Keys National Marine Sanctuary
DT: Dry Tortugas Ecological Reserve

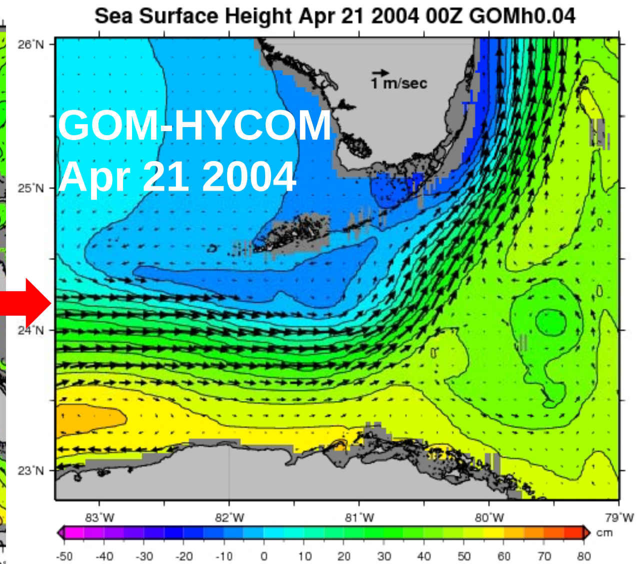
The FKEYS-HYCOM can simulate

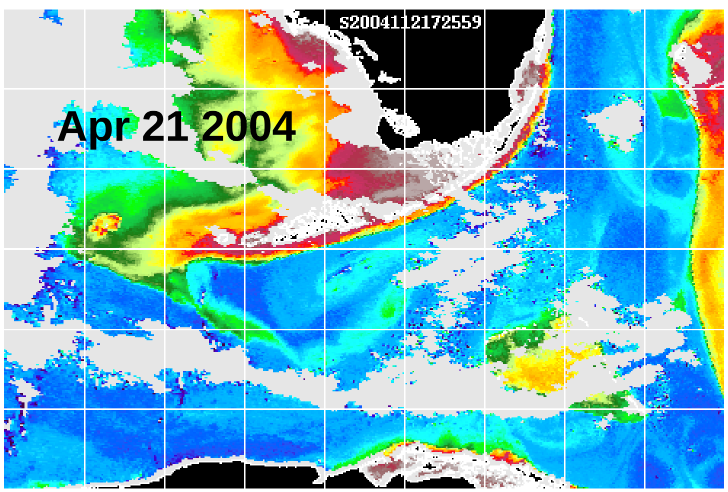
(i) the **spontaneous formation** of frontal eddies with realistic bottom topography and

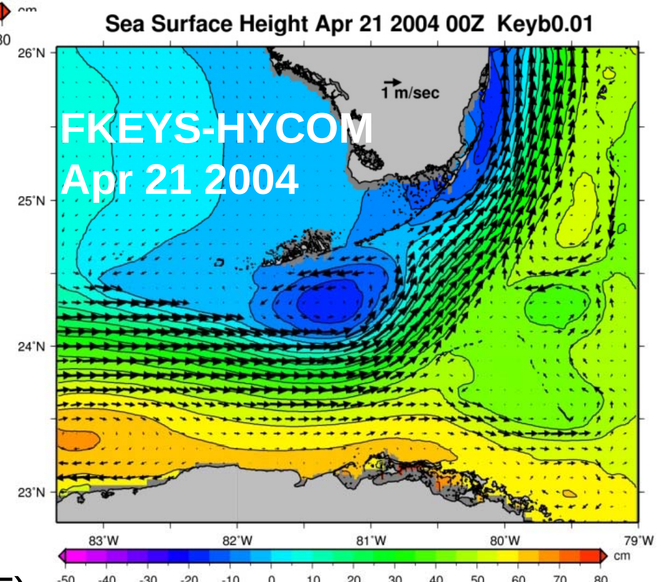
(ii) their **subsequent evolution** as they interact with coastal boundaries and varying shelf width.

GOM-HYCOM vs. SeaWiFs vs. FKEYS-HYCOM



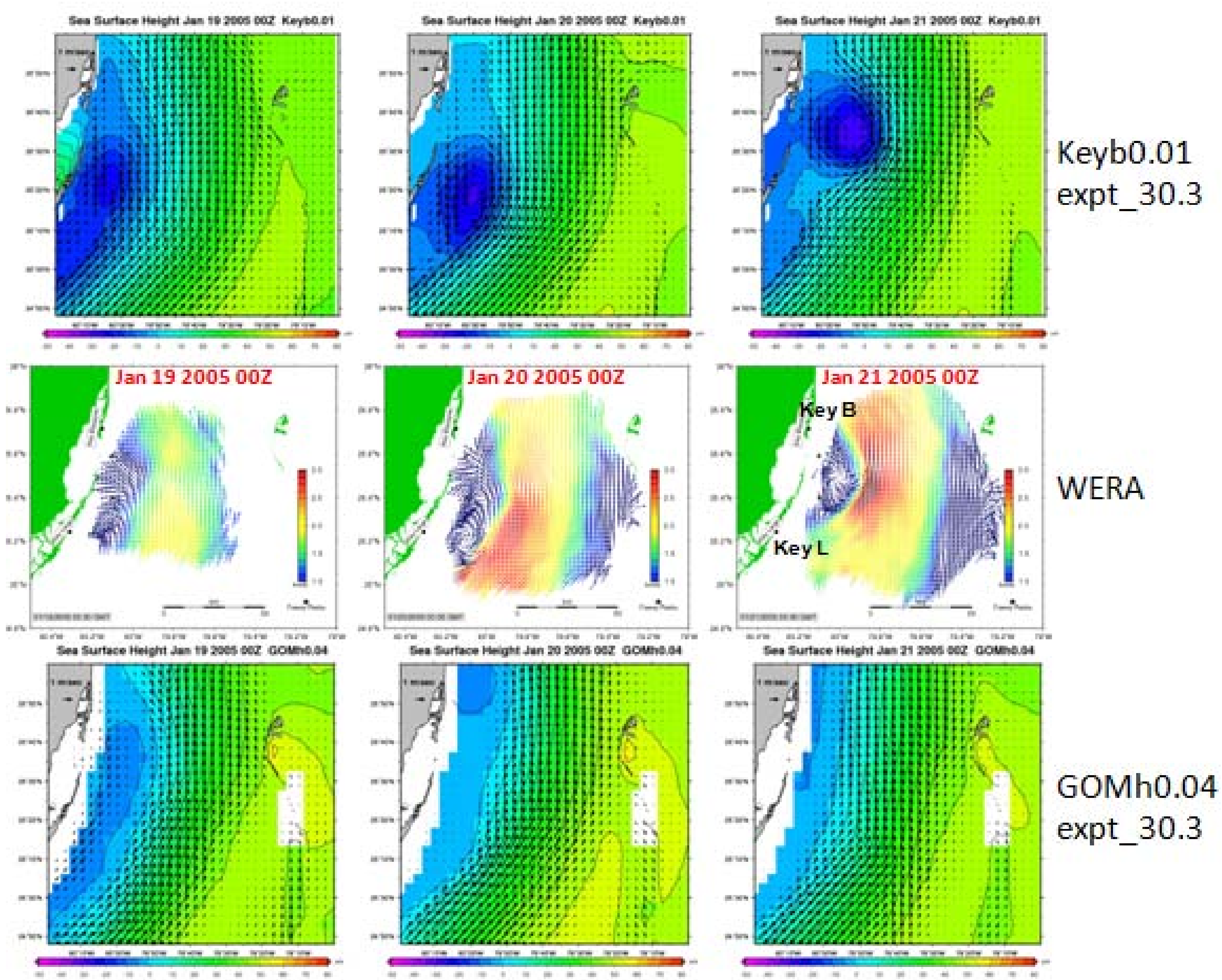






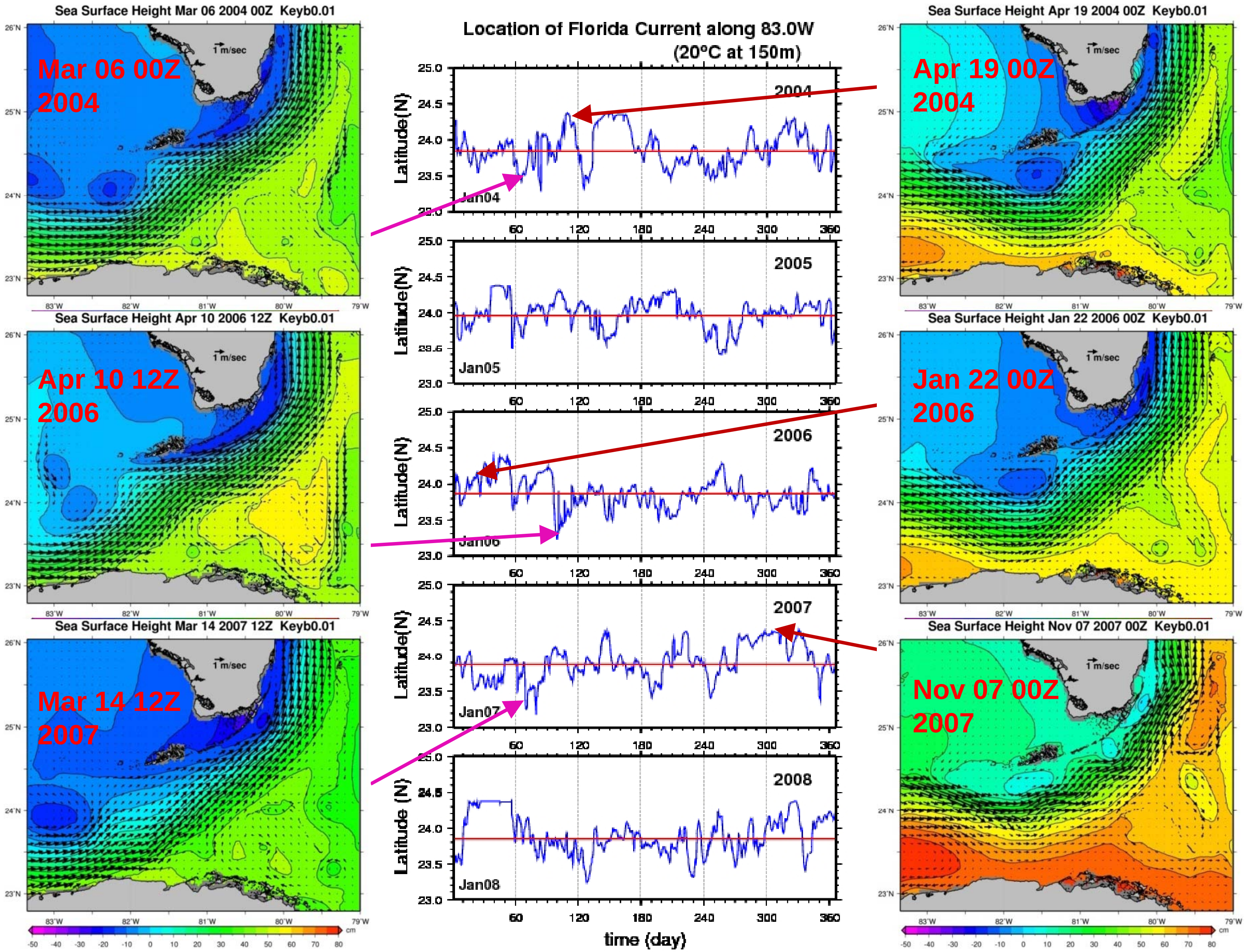
SeaWiFs:http://imars.usf.edu/ (Chuanmin Hu, USF)

FKEYS-HYCOM vs. WERA vs. GOM-HYCOM

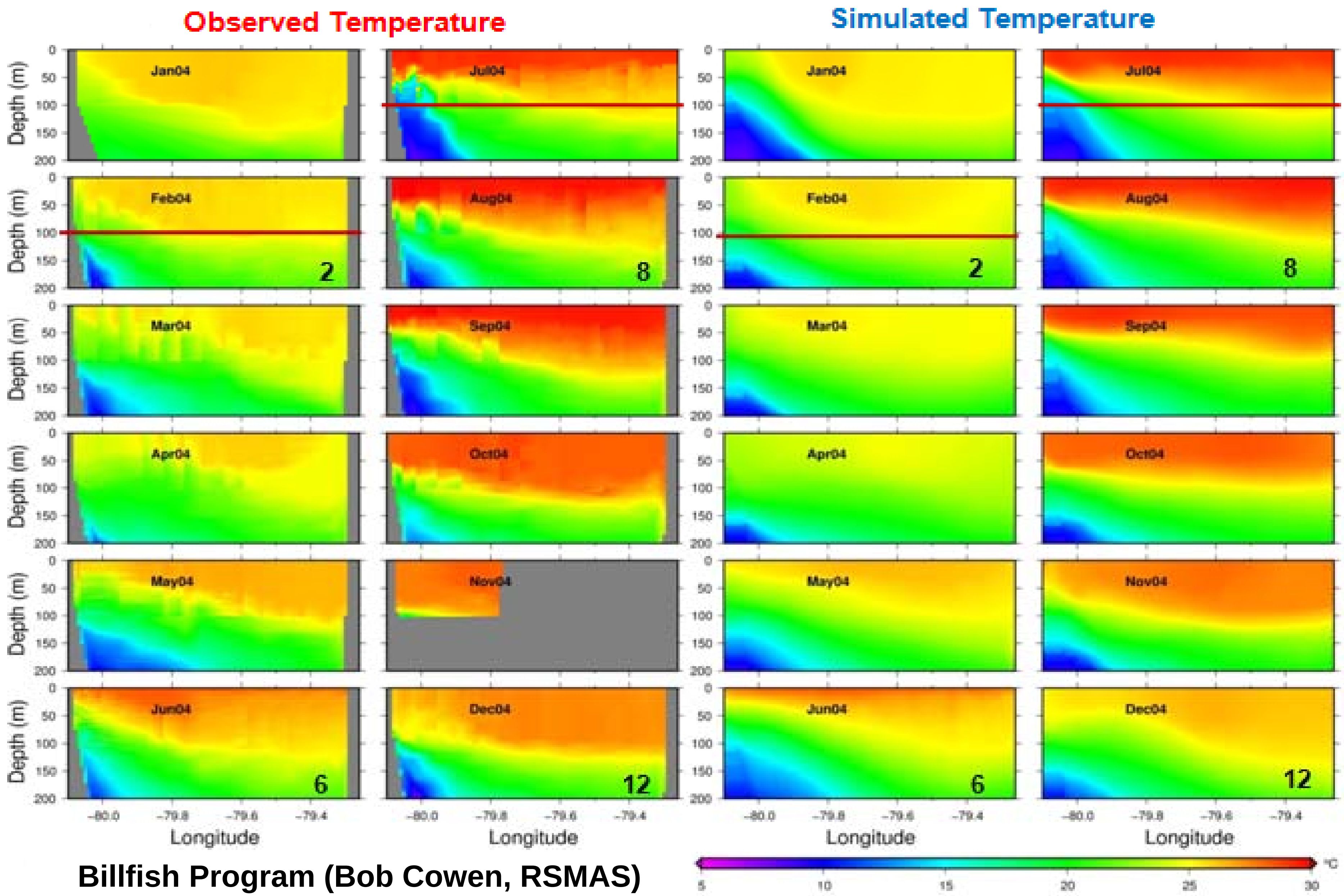


WERA : http://iwave.rsmas.miami.edu/wera/ (Nick Shay, RSMAS)

Florida Current Meander & Eddies (SSH + Currents)

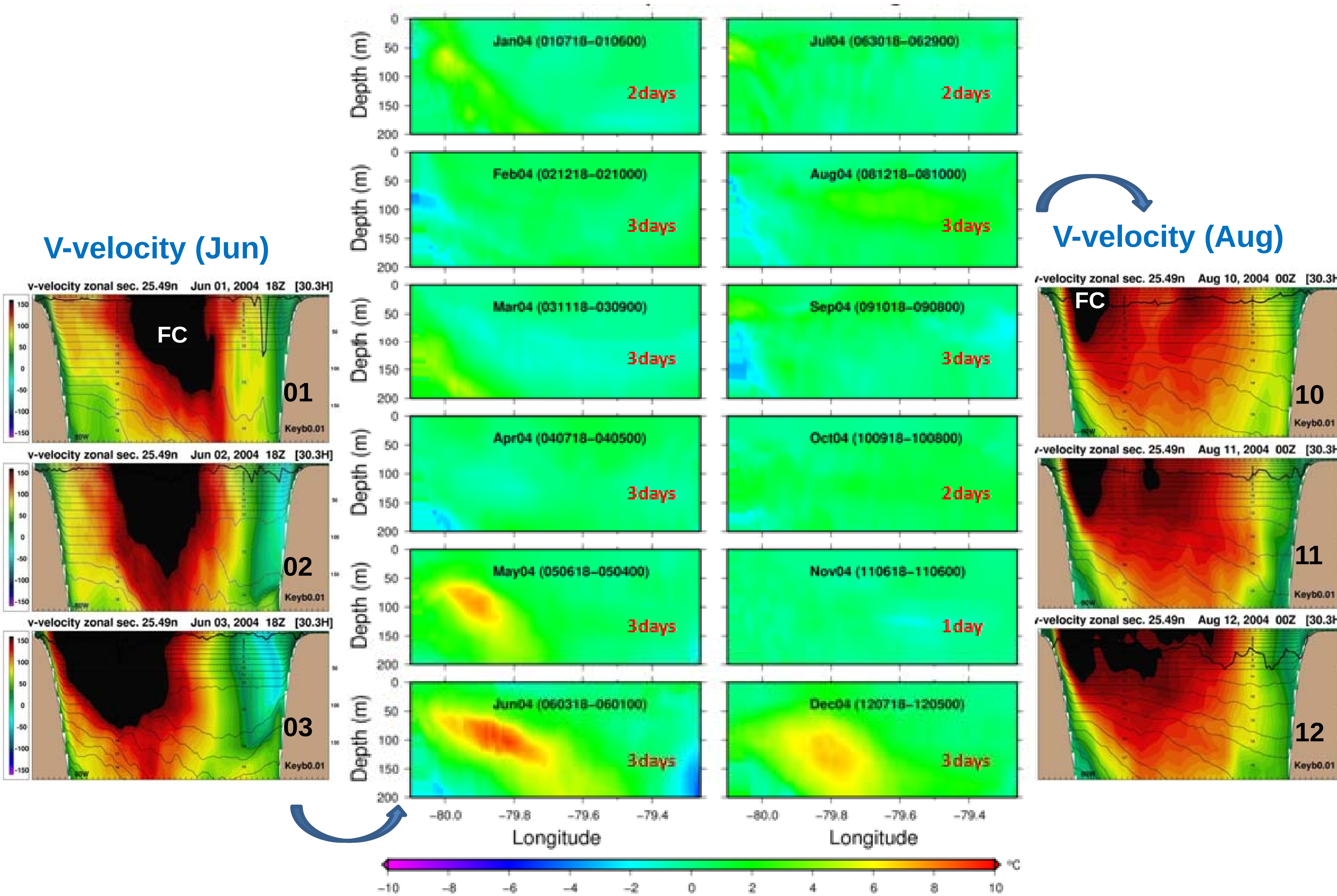


Cross-sectional Temperature @ 25.5ºN (2004)



Billfish Program (Bob Cowen, RSMAS)

Temperature change over the period of Observation



Okubo-Weiss Parameter (Q)

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

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

$$\zeta = \partial v_E / \partial x - \partial u_E / \partial y$$

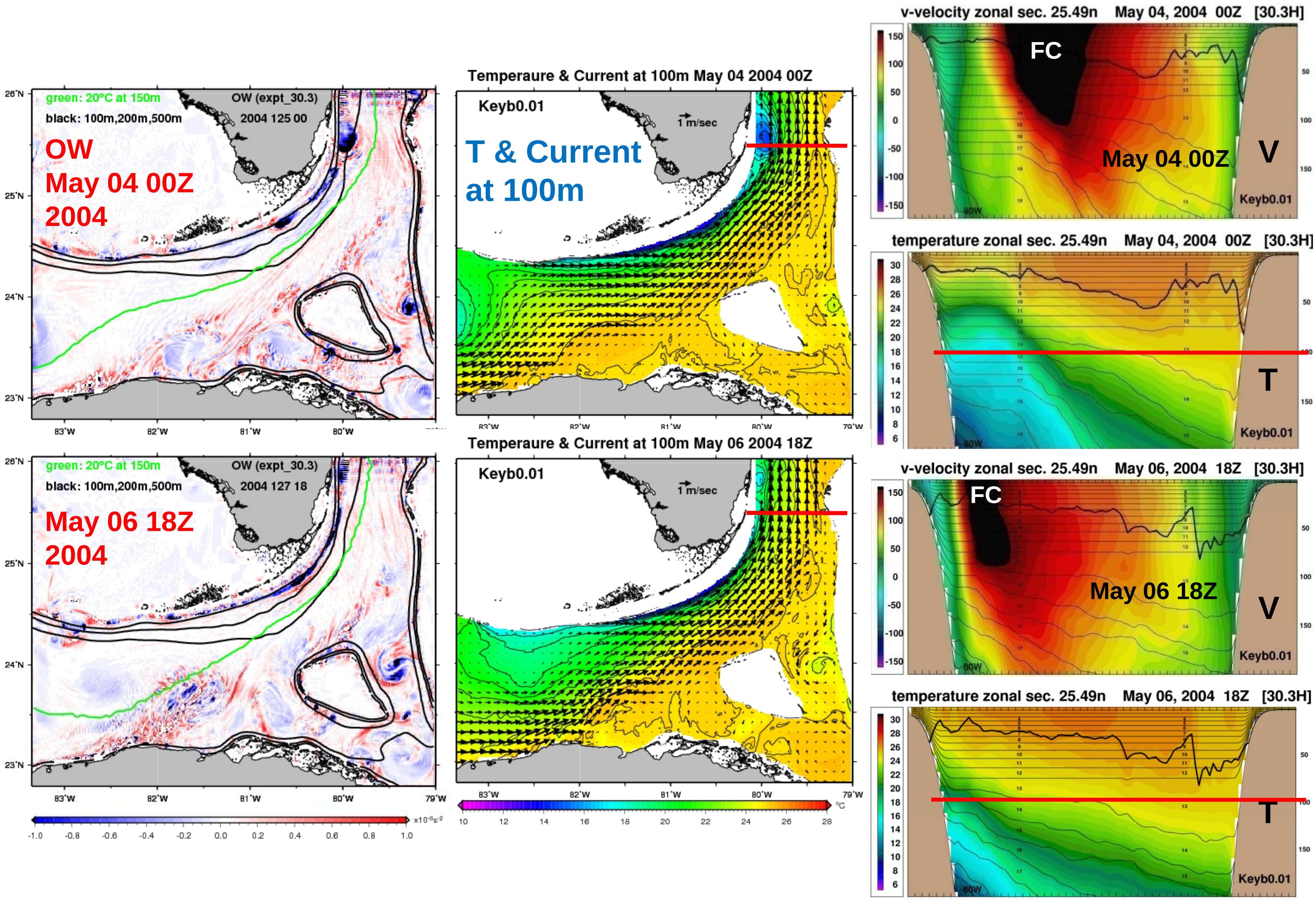
$$d^2 = \left(\frac{\partial u_E}{\partial x} - \frac{\partial v_E}{\partial y}\right)^2 + \left(\frac{\partial v_E}{\partial x} + \frac{\partial u_E}{\partial y}\right)^2.$$

$$|\mathbf{u_E}| = \sqrt{u_E^2 + v_E^2}$$ Eulerian Flow

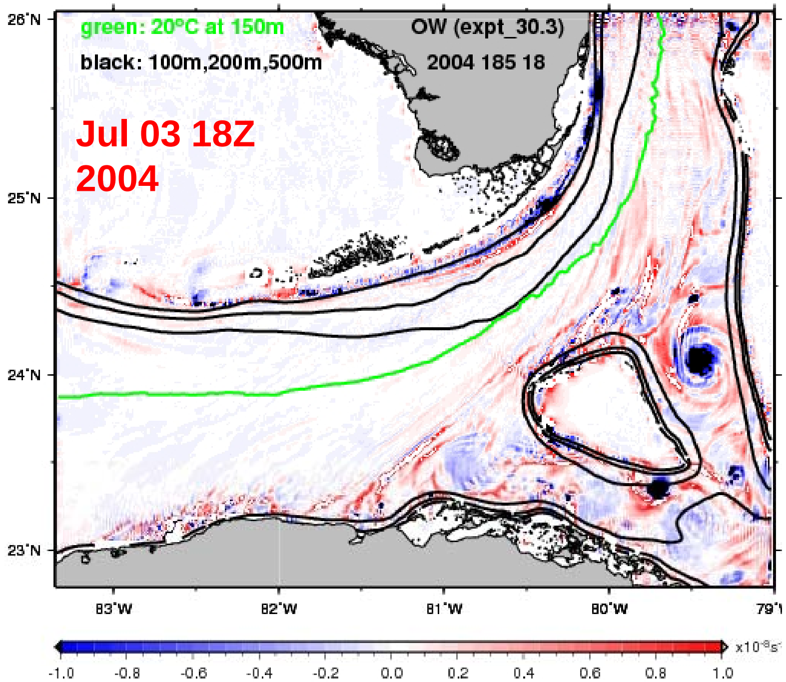
Okubo-Weiss parameter (Q) represents a balance between the magnitude of vorticity and deformation (*Veneziani et al.,* 2005).

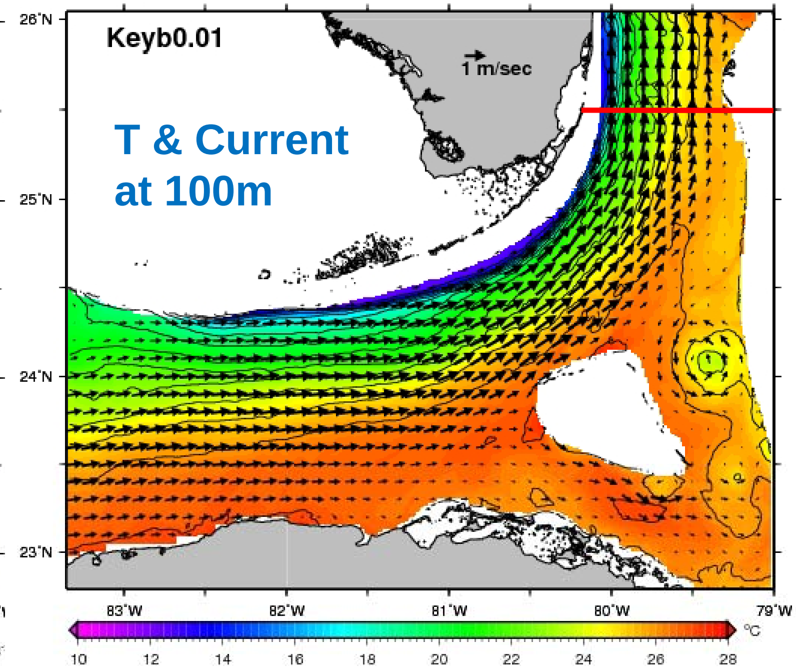
Since this parameter typically assumes high negative values inside coherent vortex cores while it becomes highly positive in the area immediately surrounding the vortex cores, it is very useful in identifying vortice and rotating structures, like eddies in ocean.

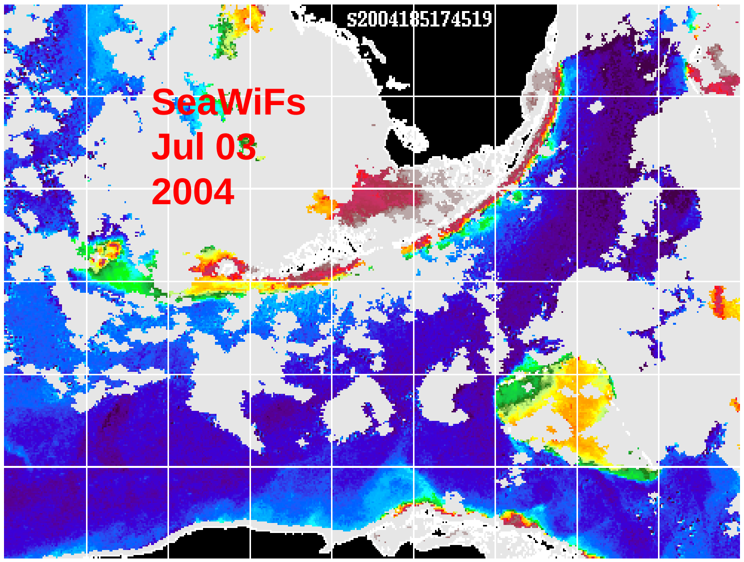
Florida Current Meander & Eddies & Upwelled Cool Water

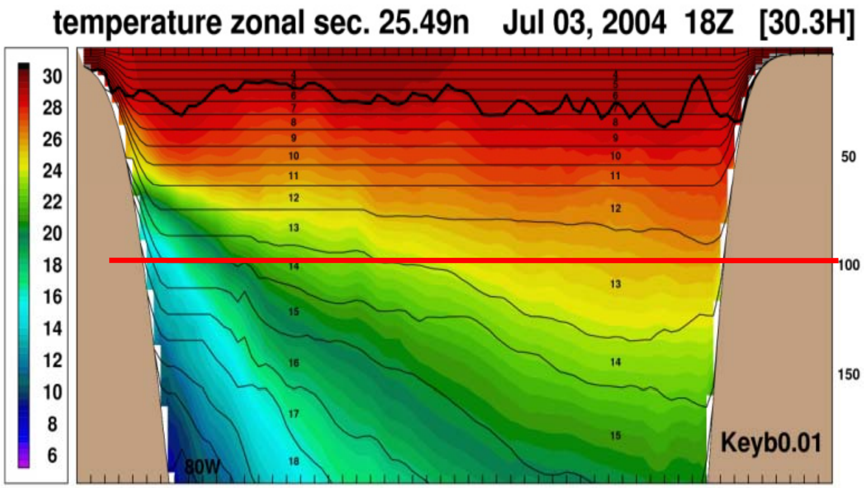


Eddies in cluster & Upwelled Cool Water along the 100m isobath

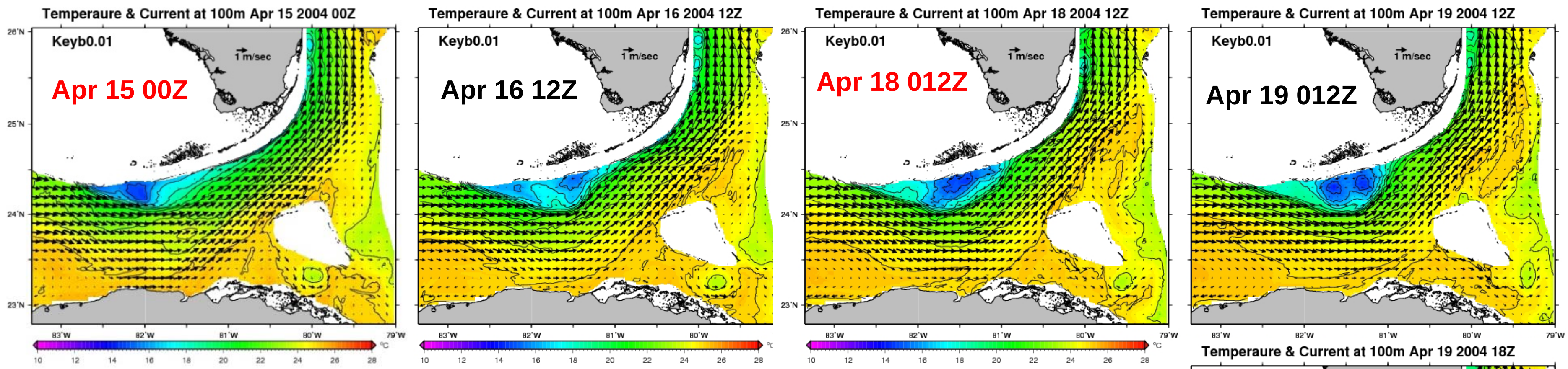


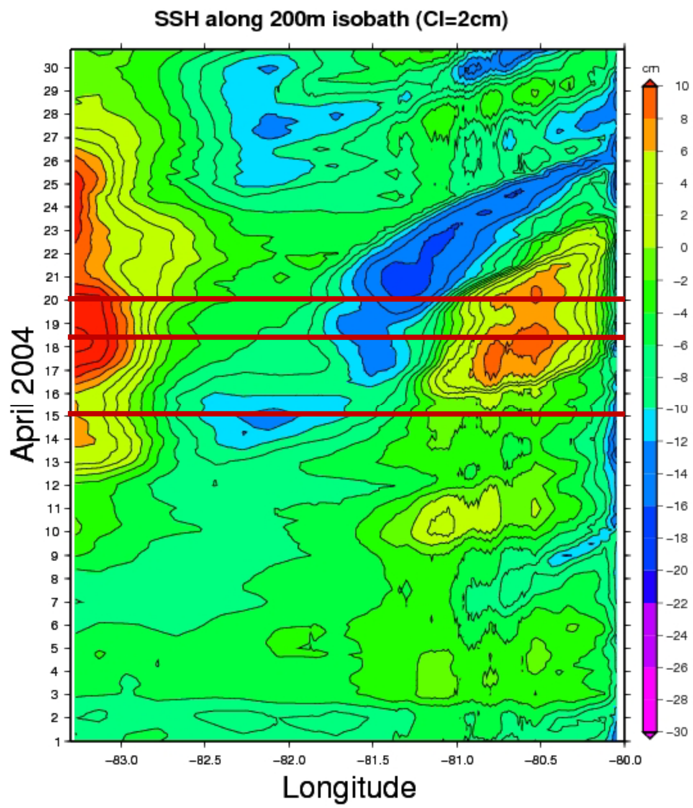


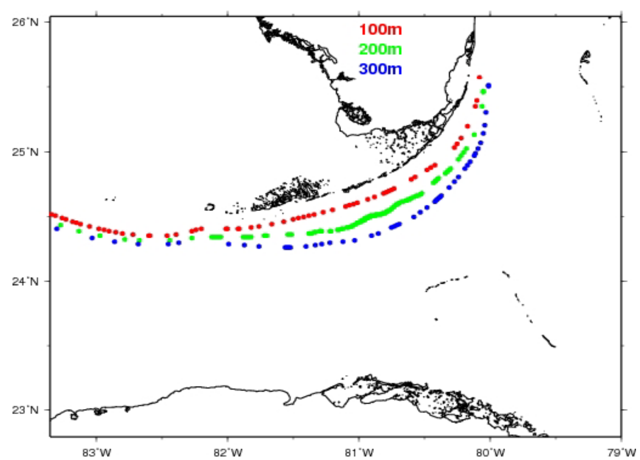


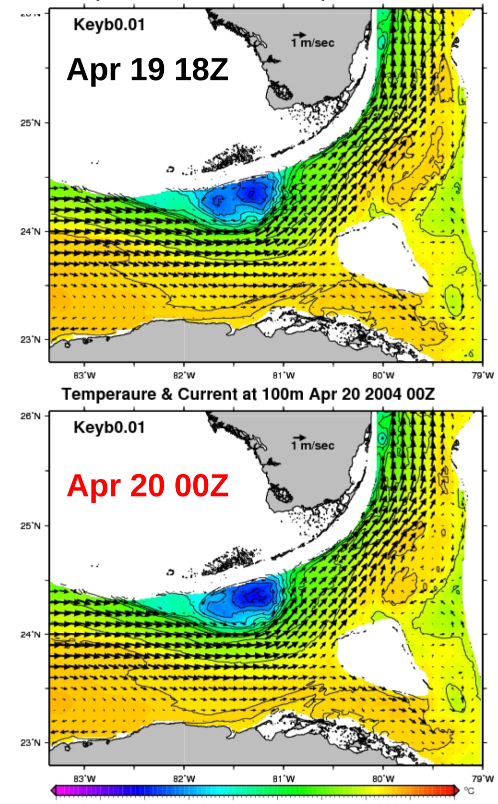


Eddy evolution (T & Current at 100m)

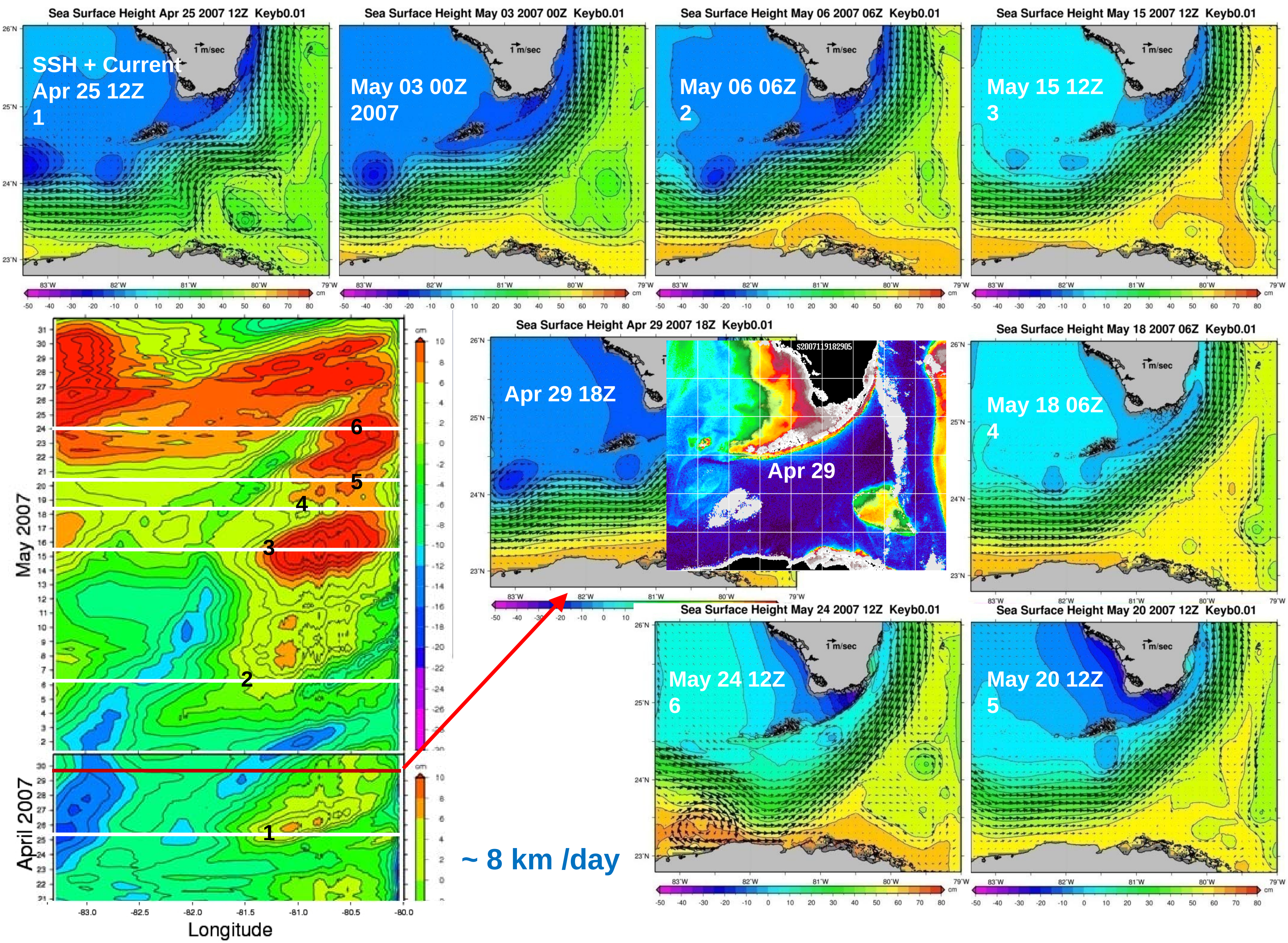








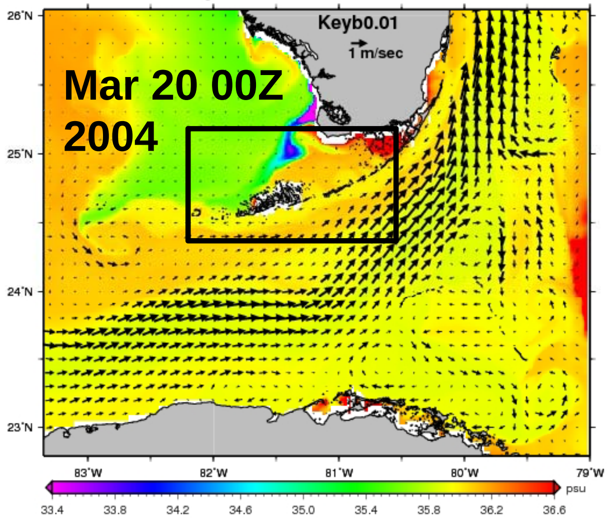
~ 20 km /day


Sea Surface Height Apr 25 2007 12Z Keyb0.01
SSH + Current
Apr 25 12Z
1
Sea Surface Height May 03 2007 00Z Keyb0.01
May 03 00Z
2007
Sea Surface Height May 06 2007 06Z Keyb0.01
May 06 06Z
2
Sea Surface Height May 15 2007 12Z Keyb0.01
May 15 12Z
3
Sea Surface Height Apr 29 2007 18Z Keyb0.01
Apr 29 18Z
Apr 29
Sea Surface Height May 18 2007 06Z Keyb0.01
May 18 06Z
4
Sea Surface Height May 24 2007 12Z Keyb0.01
May 24 12Z
6
Sea Surface Height May 20 2007 12Z Keyb0.01
May 20 12Z
5
May 2007
April 2007
Longitude
~ 8 km /day

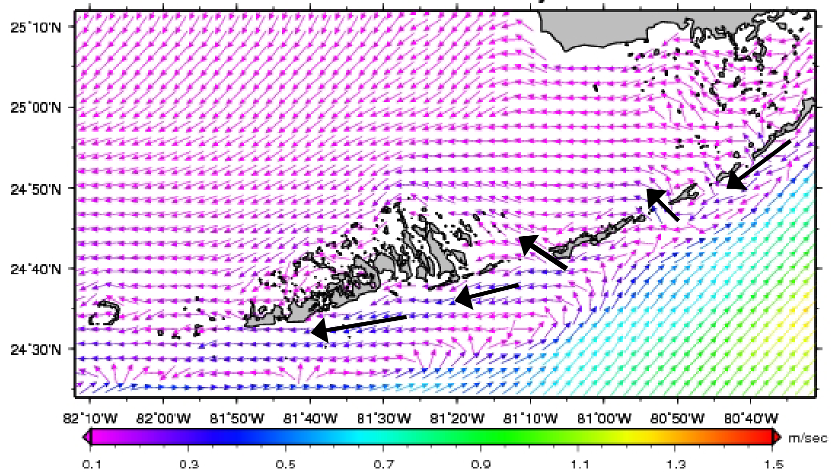
Exchanging water properties through Key Passages

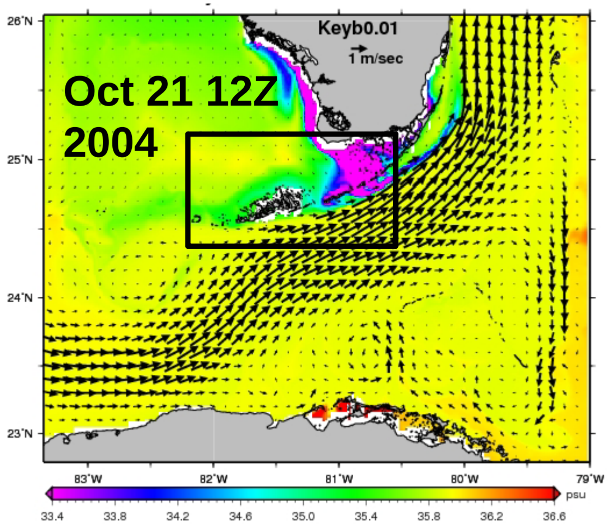
Surface Salinity & Current

Surface Salinity & Current Mar 20 2004 00Z

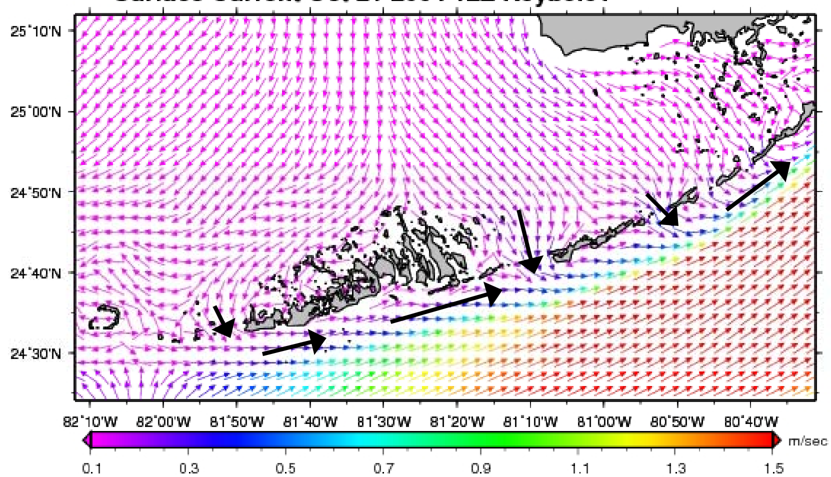


Surface Current Mar 20 2004 00Z Keyb0.01





Surface Current Oct 21 2004 12Z Keyb0.01



SUMMARY

The FKYES-HYCOM is capable of simulating submesoscale eddies off the Biscayne Bay which can be captured with high frequency radar and cannot be captured by the outer lower resolution model.

Mesoscale features are mostly associated with onshore-offshore meandering of the Florida Current. The meanders are northward travelling waves with upwelling occurring in the troughs between the offshore meander and the shelf break.

The passage of a frontal eddy can produce large current variations and even current reversals on the shoreward side of the Florida Current, coupled to cold anomalies from upwelling in the core of the features.

The decay of the eddy occurs with the approach of an onshore Florida meander crest that sends the eddy toward the east and causes a rapid decrease in size. Presumably, the decrease of size is due to the narrowing of channel (topographic constraint).


THANKS !
2004 2 11