

# Using models to understand ocean current variability and fisheries links

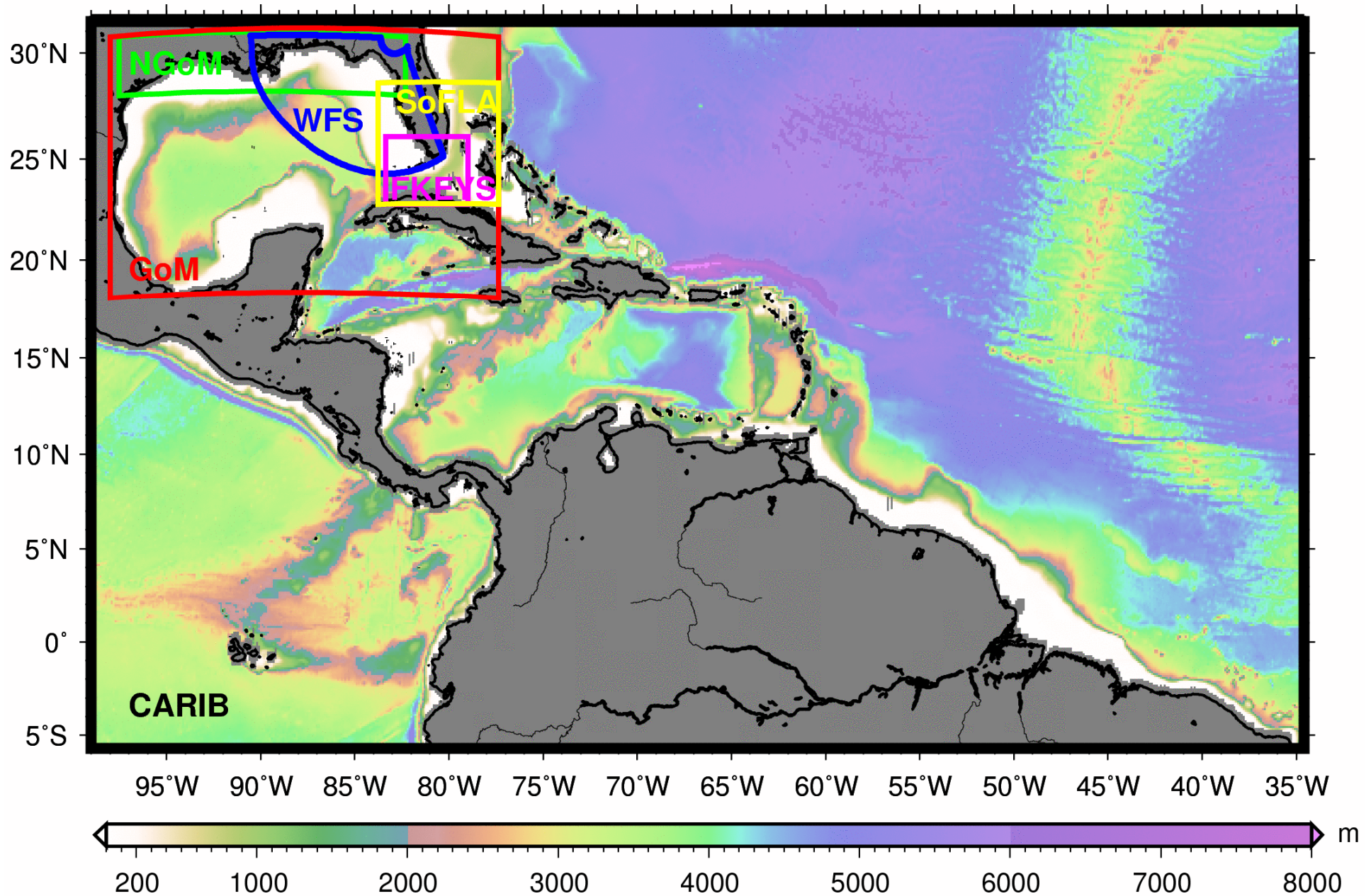
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*Contributions: C. Paris, A. Srinivasan, H. Kang, M. LeHennaff (UM/RSMAS)  
R. Atlas, G. Halliwell, G. Goni, F. Bringas (NOAA/AOML)  
P. Hogan, O.M. Smedstad (NRL-SSC)*

<http://coastalmodeling.rsmas.miami.edu>

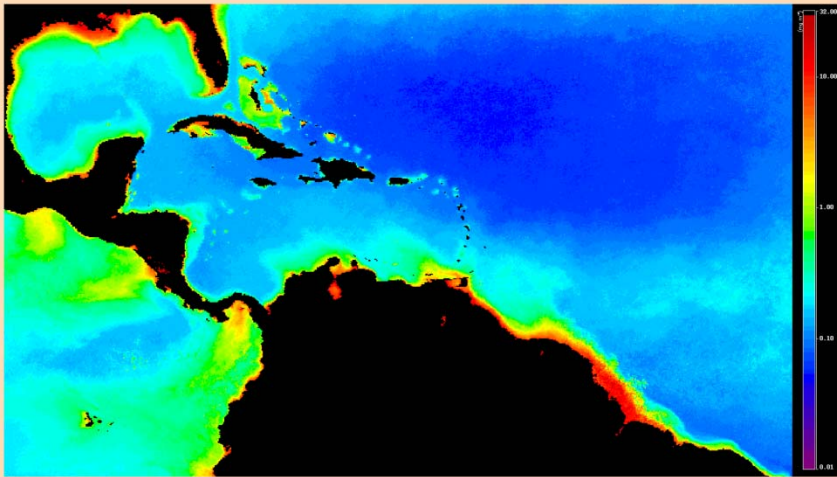


# Regional and coastal modeling at UM/RSMAS with the Hybrid Coordinate Ocean Model



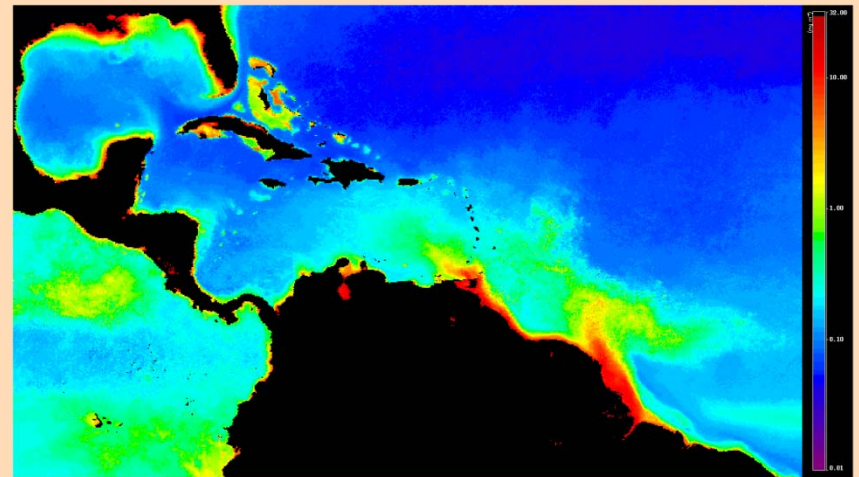
# Chl-a: seasonal variability (MODIS climatology)

MODIS climatology – February (monthly mean)



*Provided by Viva Benzon, RSMAS satellite group*

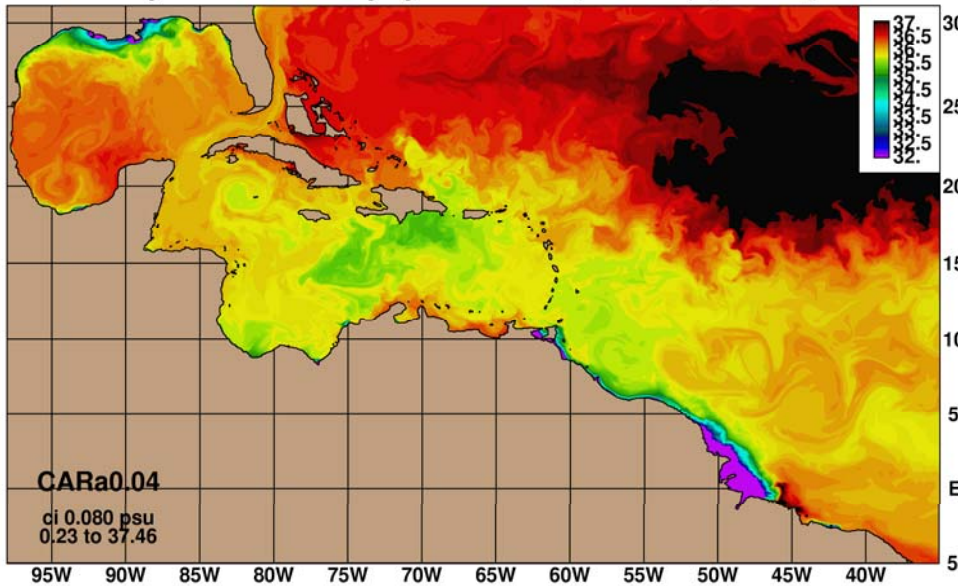
MODIS climatology – August (monthly mean)



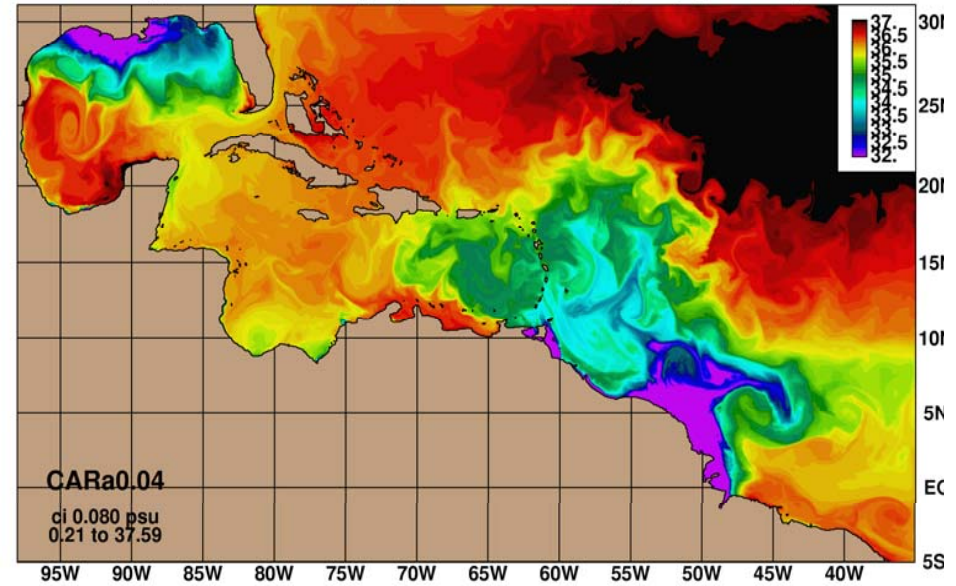
*Provided by Viva Benzon, RSMAS satellite group*

## Salinity: seasonal variability (CARIB-HYCOM SSS climatology)

layer=01 salinity year 5.08 (Feb 01) [01.0H]



layer=01 salinity year 5.58 (Aug 01) [01.0H]



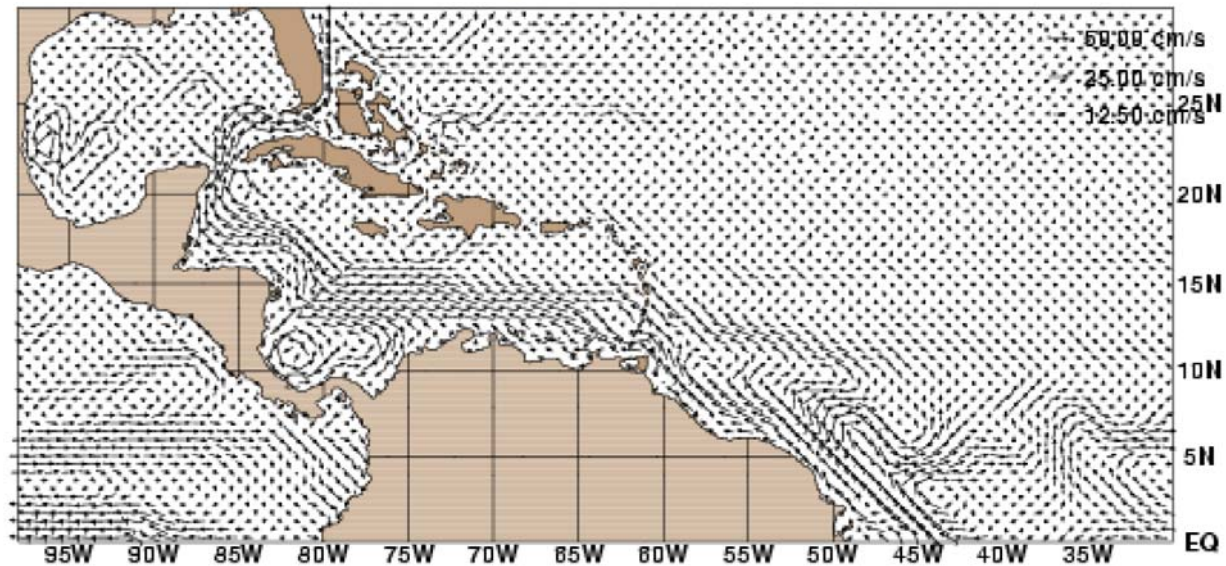
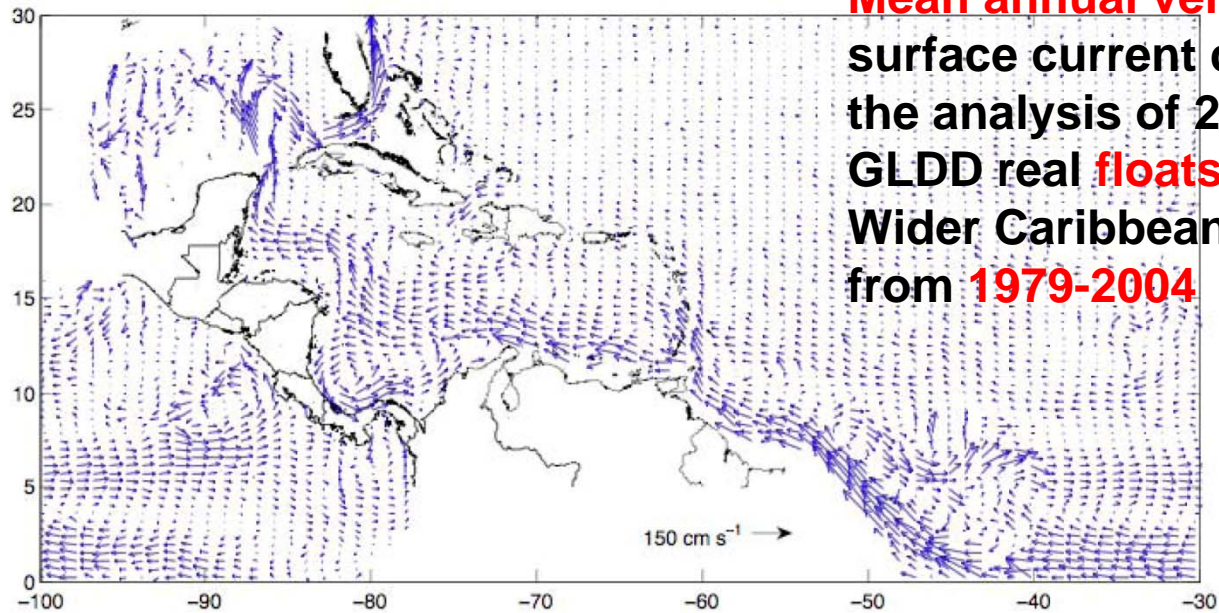
### Climatology from ERA 40, 1979-2002

- Wind stress and speed
  - Climatology corrected by scatterometer
  - Representative NOGAPS 6-hr anomalies (year 2003) added
- Precipitation
  - Climatology corrected by regression (GPCP)

Model resolution: ~4 km

# CARIB-HYCOM: Obs. vs. model Mean Flow

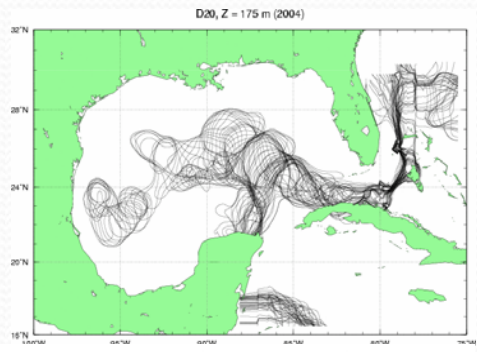
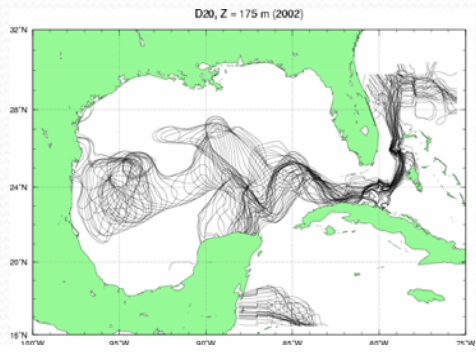
Mean annual velocity of surface current derived from the analysis of 2646 GLDD real floats entering the Wider Caribbean from 1979-2004



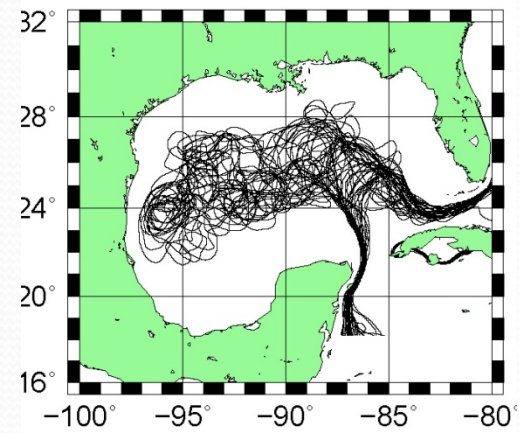
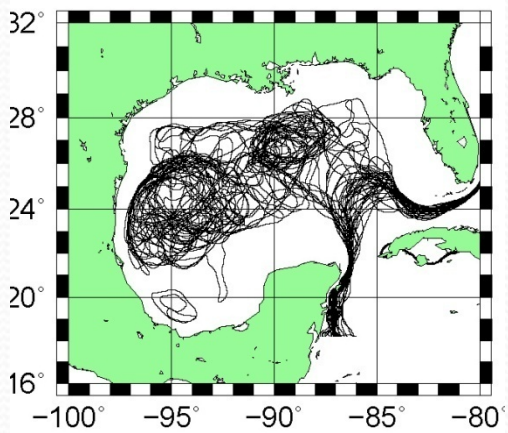
*In collaboration with A. Griffo and Z. Garraffo*

## GoM-HYCOM: Model to data comparison: 20° isotherm at 175m depth

DATA



MODEL

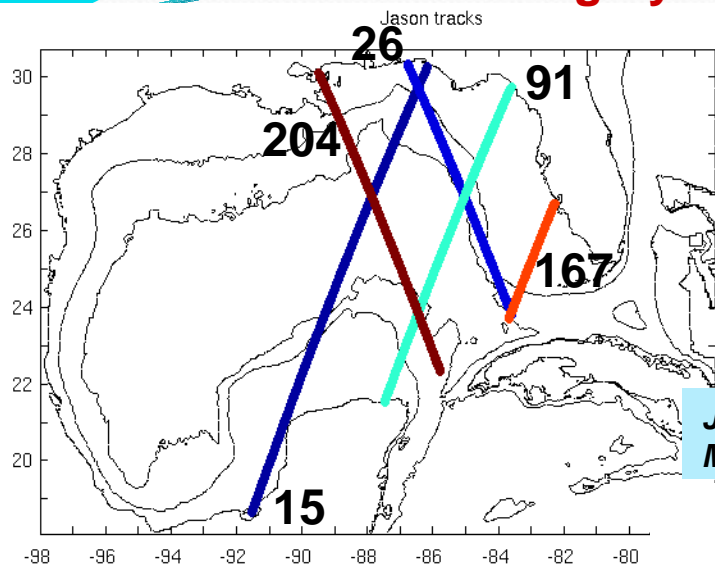


2002

2004

- *Good representation of the northward penetration of the Loop Current by the model*
- *Analysis tool for OSSEs*

# Observing System Simulation Experiments in the Gulf of Mexico



- Altimetry data :
- X-track data (CTOH, LEGOS, Toulouse)
  - 1 Hz Jason data
  - HF tidal and atmospheric barotropic signals retrieved

Jason 1 tracks in the Gulf of Mexico

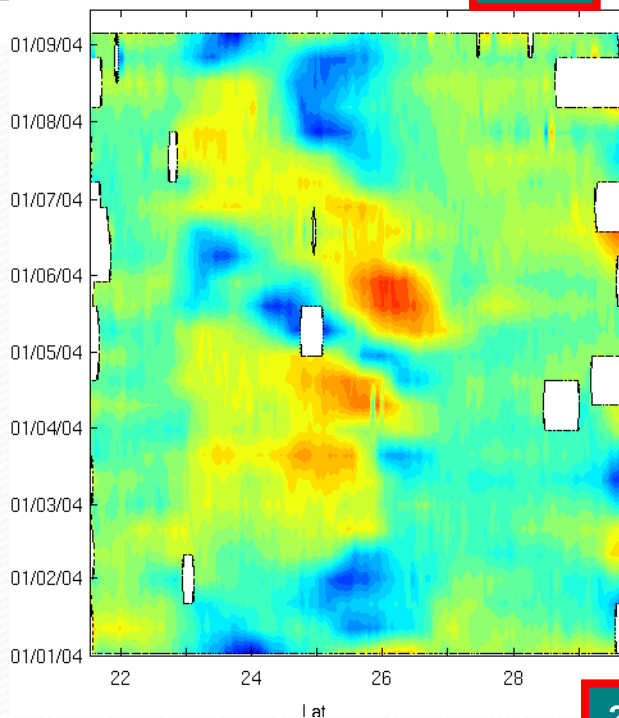
## Model configuration:

- 1/25 deg Hycom, year 2004
- COAMPS 27km, 3h forcing
- BC : cyclic from 4 years larger domain simulation
- IC : NOGAPS assimilated run

*Time-space comparison of Sea Level Anomaly between the model and the observations (local time average retrieved from both), for track 91 in 2004*

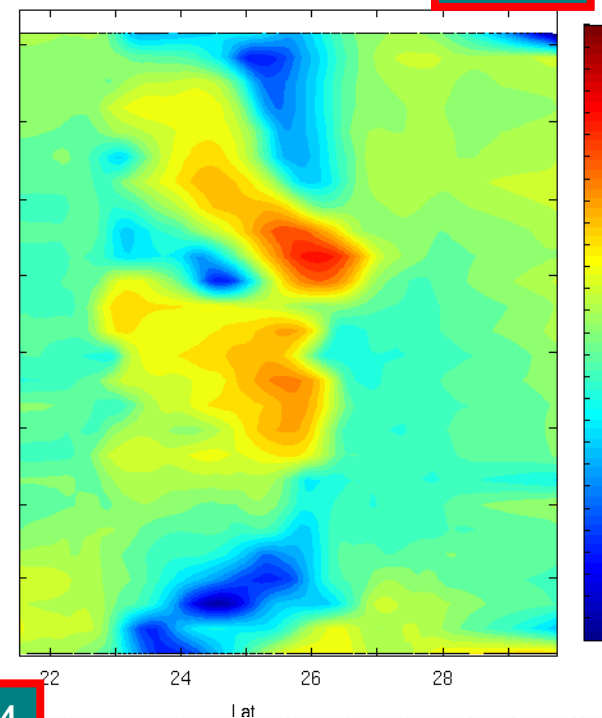
SLA by Jason 1 track 91 (cm)

DATA



Model SLA along Jason 1 track 91 (cm)

MODEL

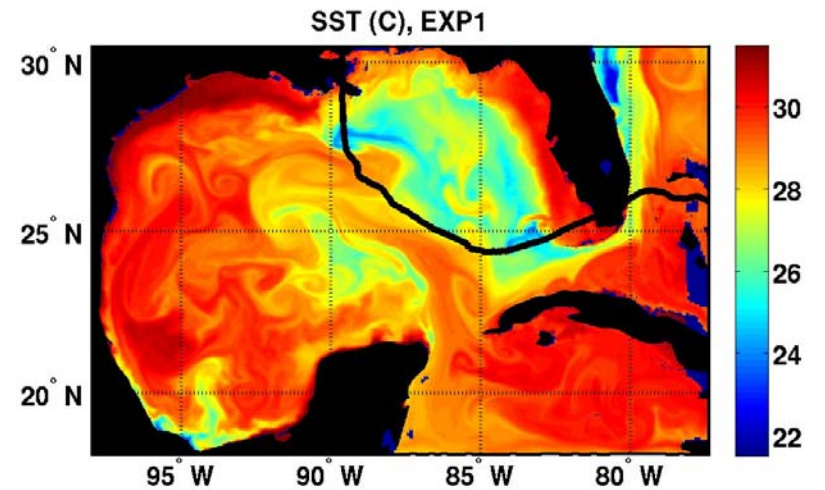
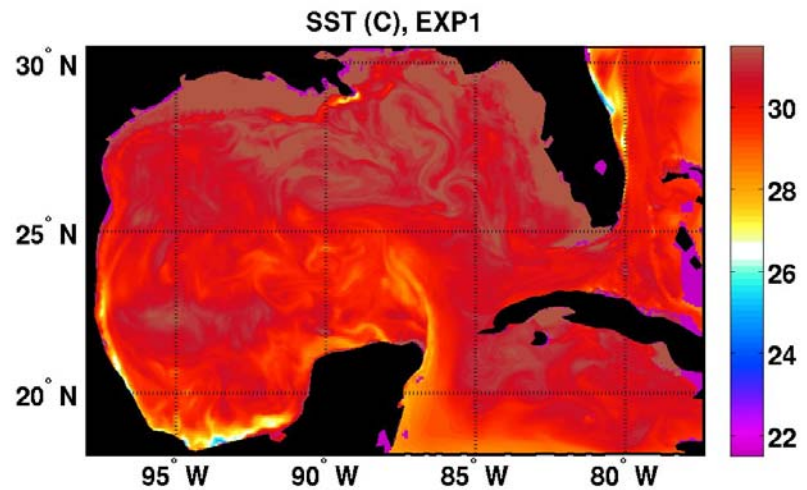
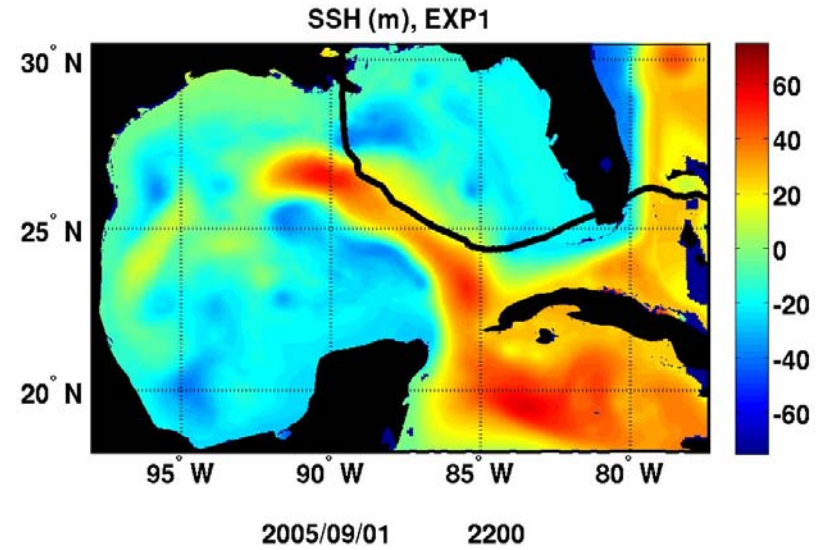
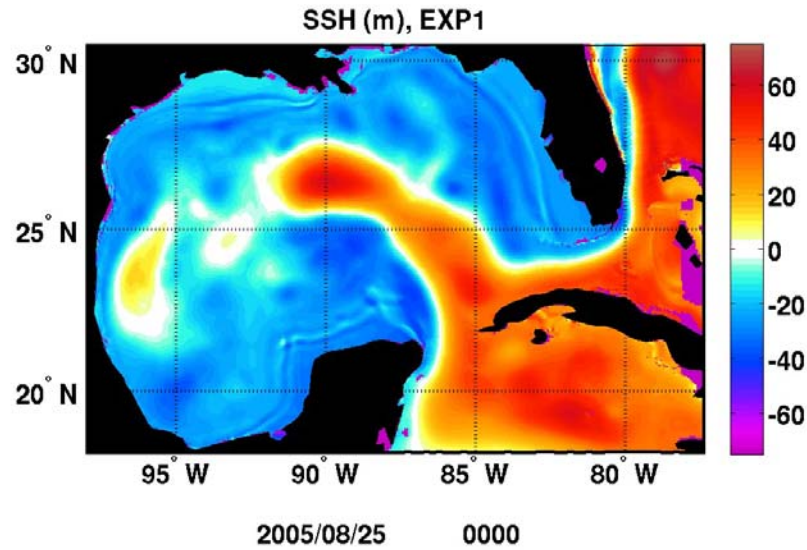


2004

➤ **Simulation of dramatic SSH and SST changes during extreme events:  
hurricane Katrina example**

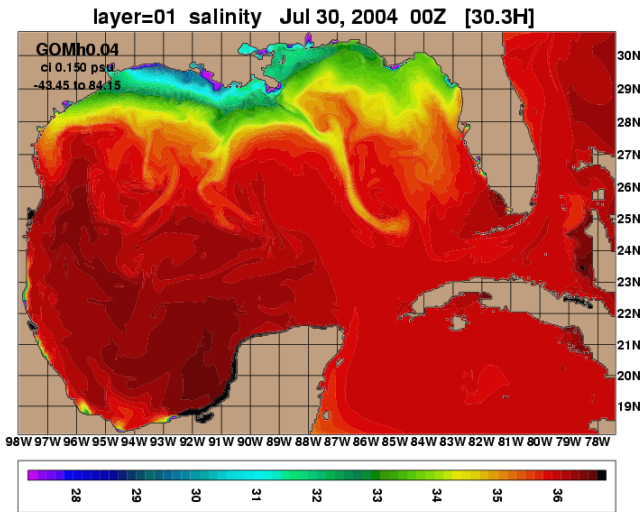
**pre-Katrina**

**post-Katrina**

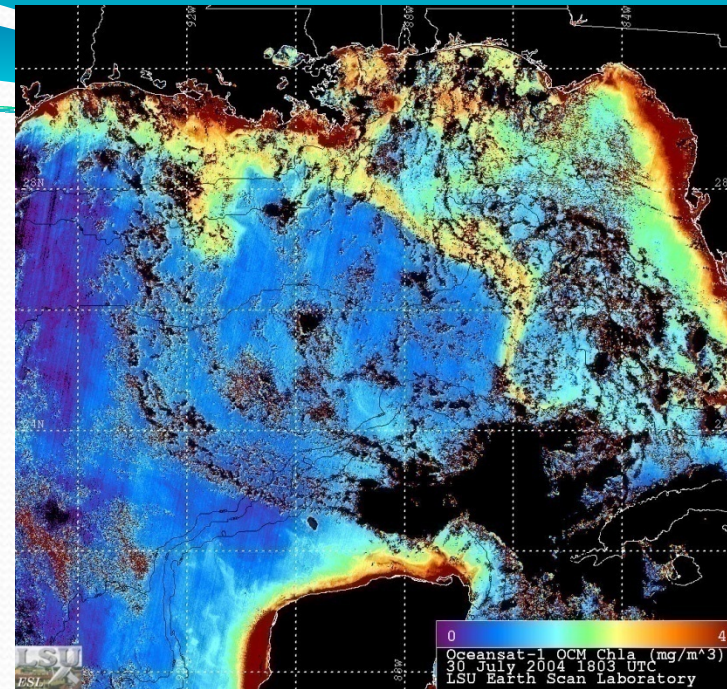




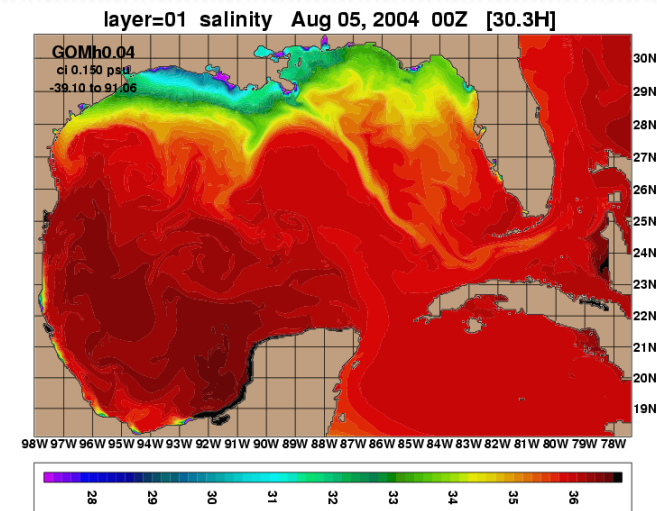
# Loop Current influence on offshore removal of Mississippi River waters



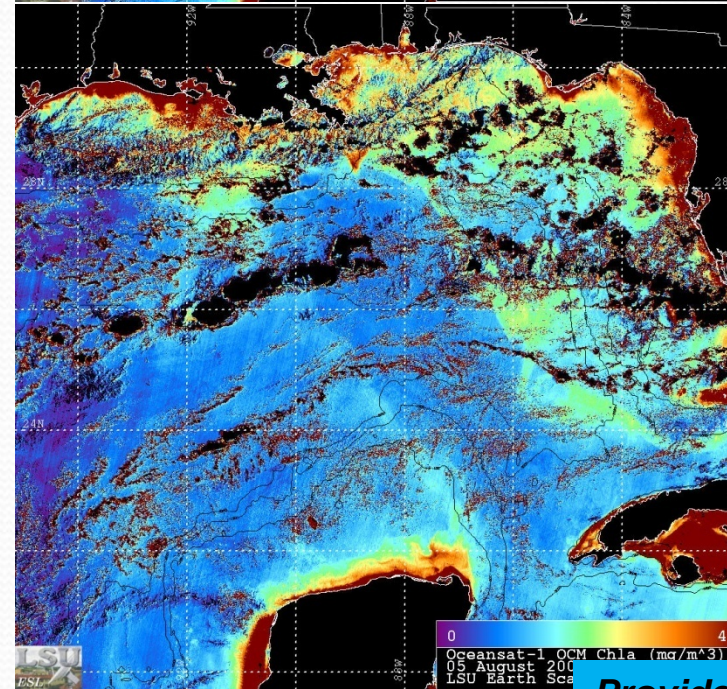
7/30/04



## ➤ Connectivity of remote ecosystems



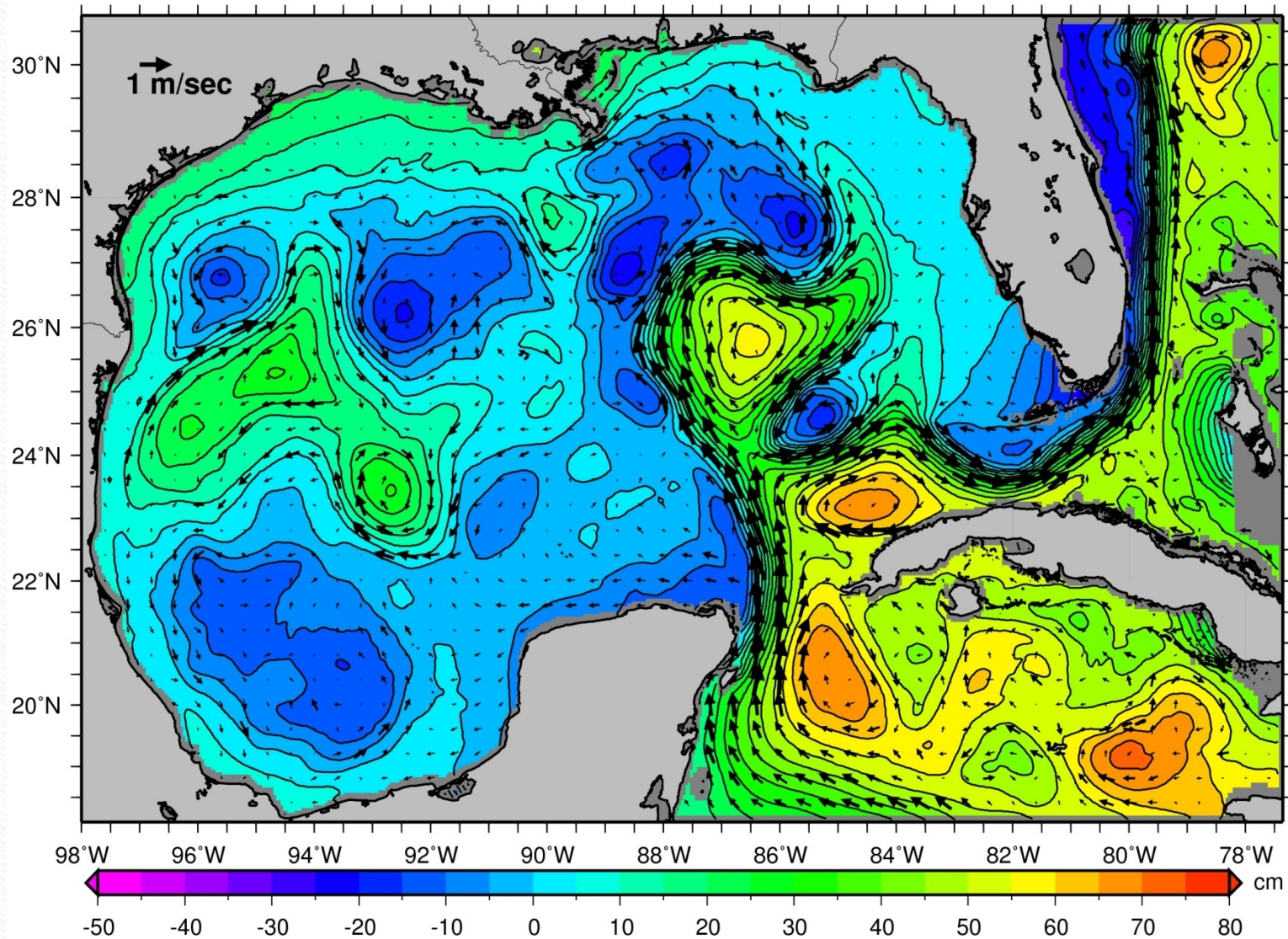
8/05/04



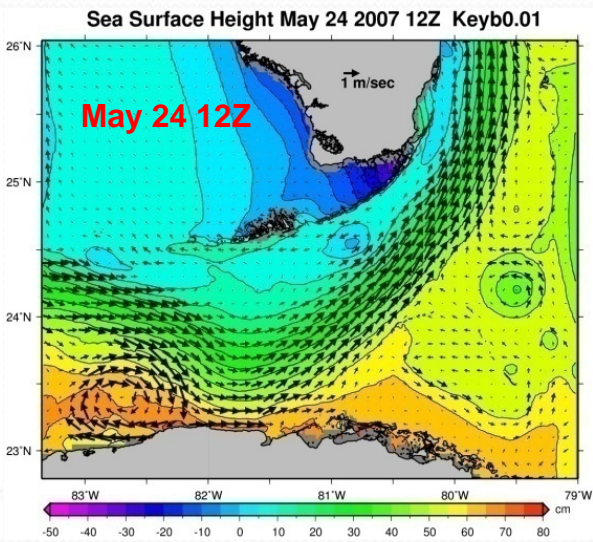
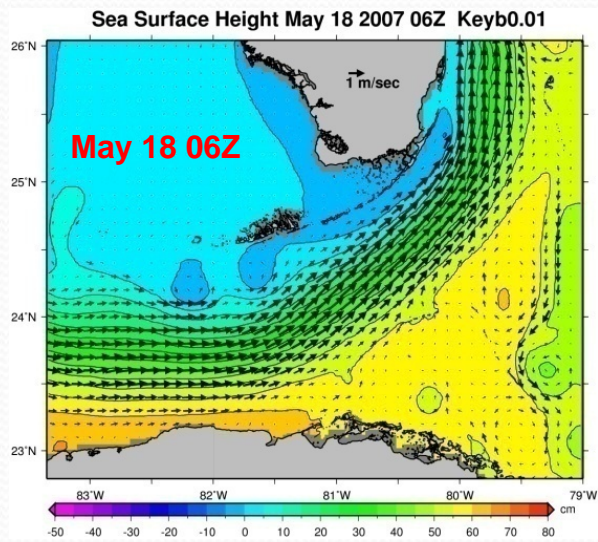
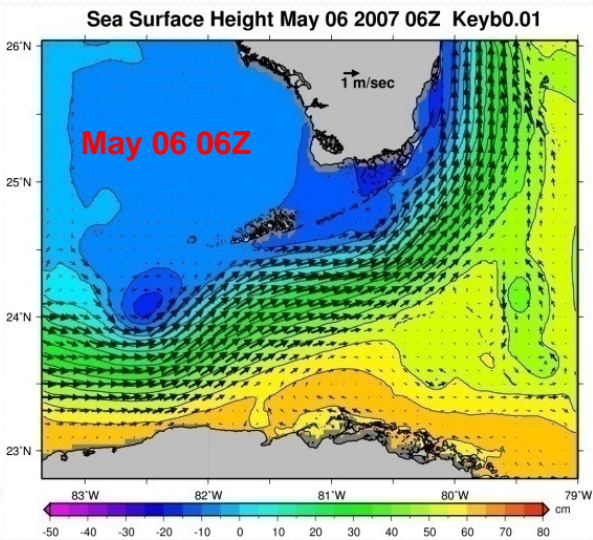
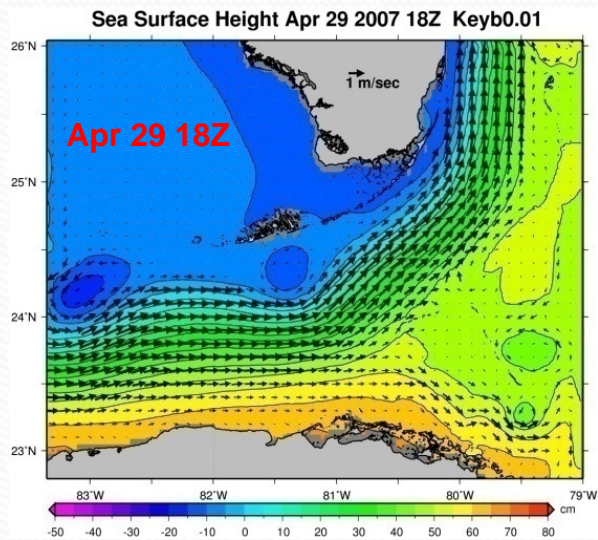
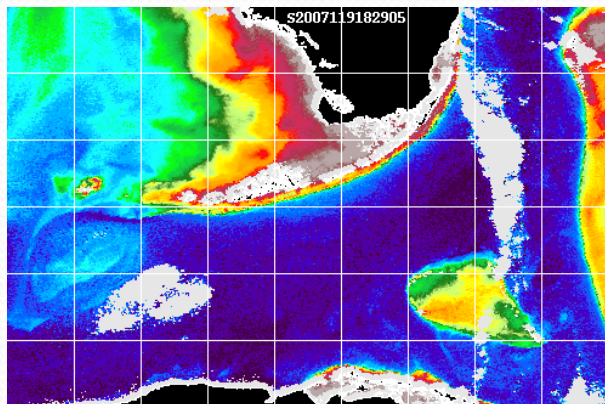
Provided by LSU

## Eddy activity and fronts in the Gulf of Mexico

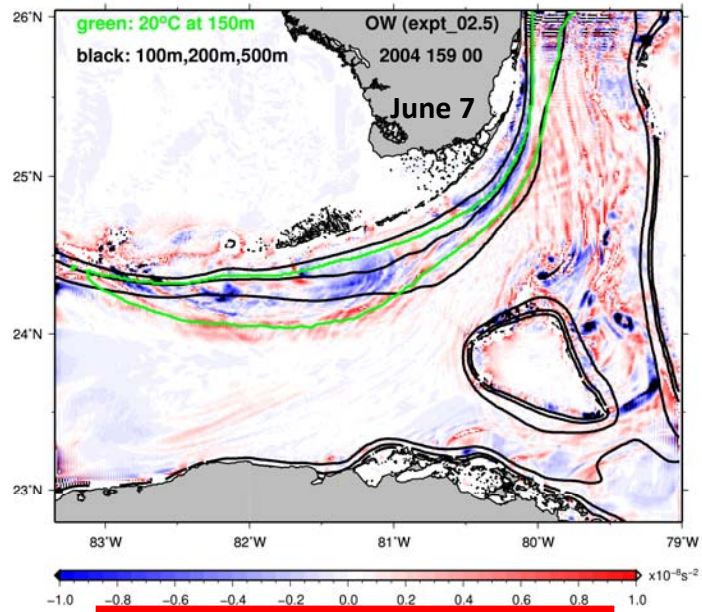
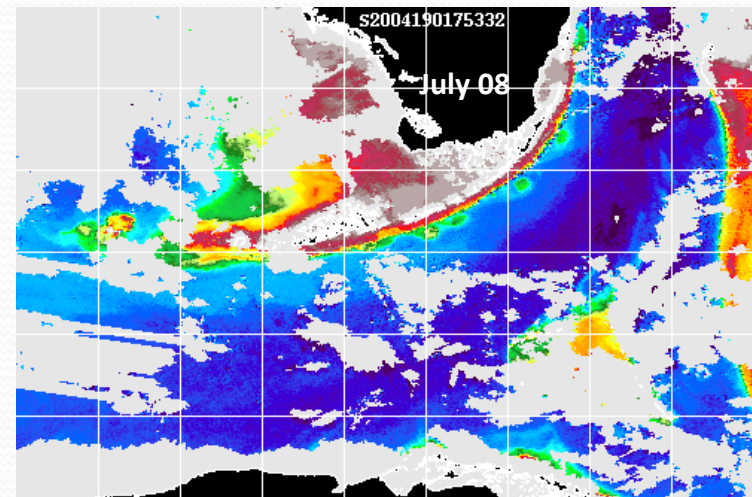
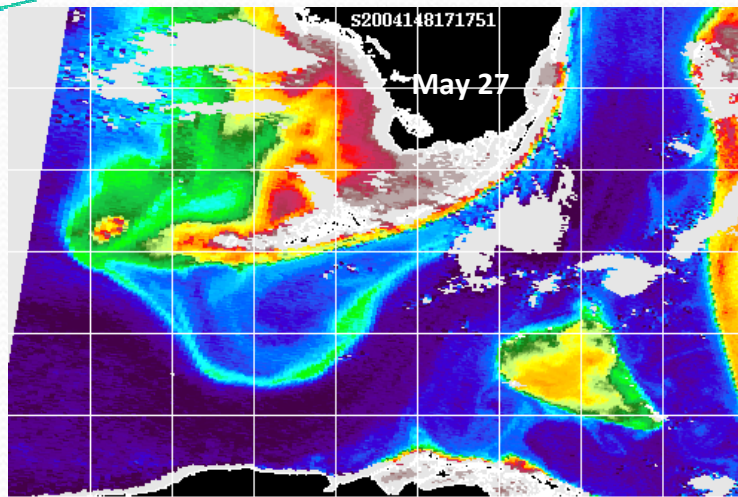
Sea Surface Height May 18 2004 00Z GOMh0.04



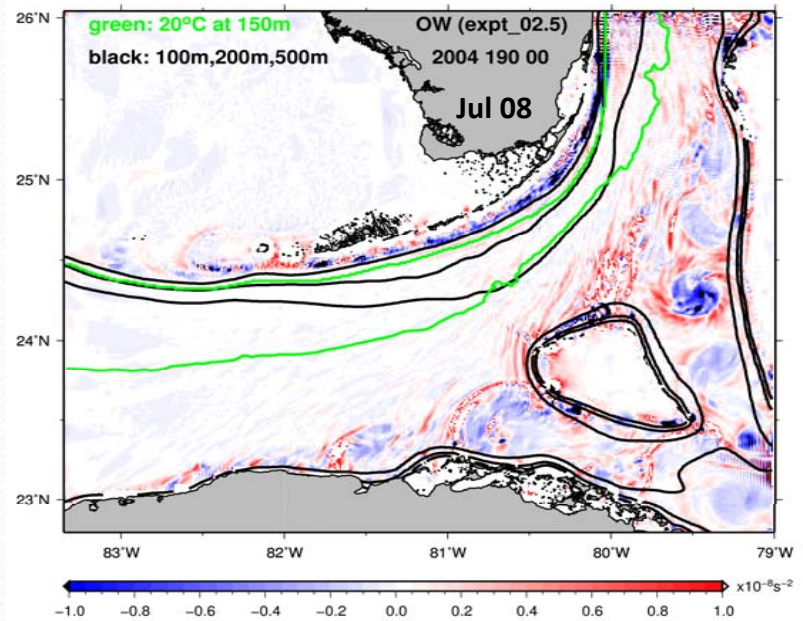
# Eddy evolution in the Straits of Florida



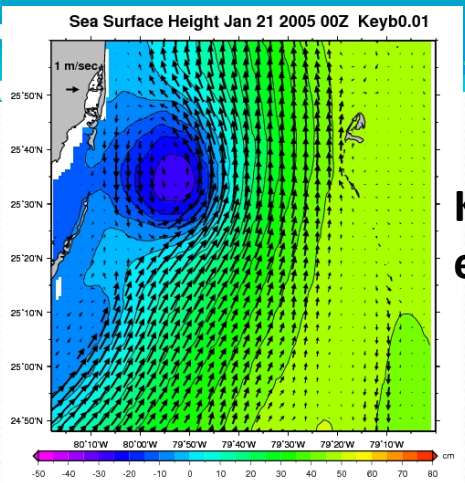
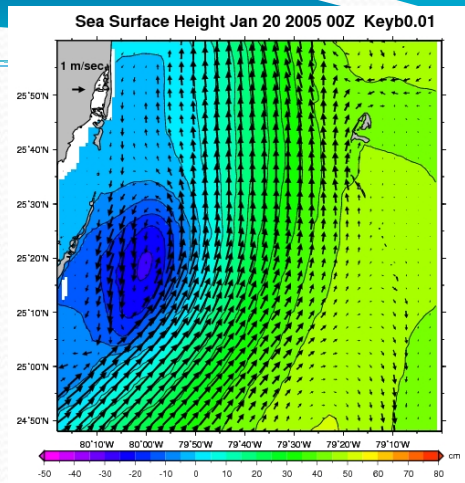
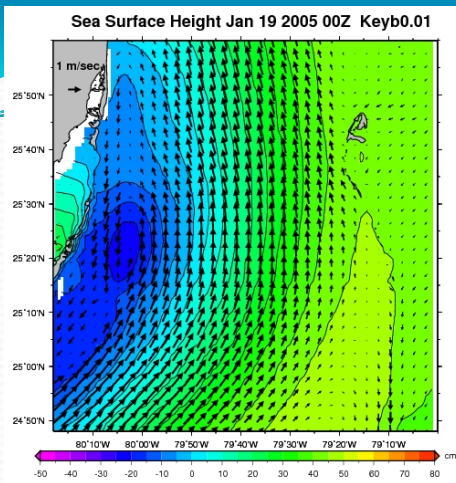
# Eddy evolution in the Straits of Florida



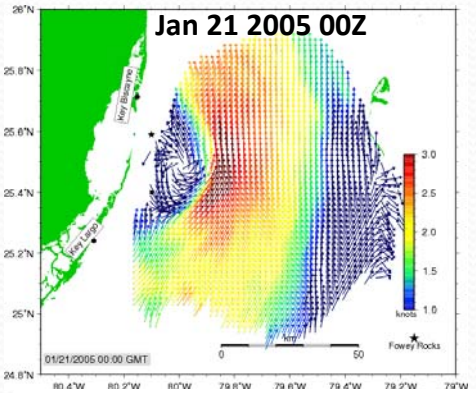
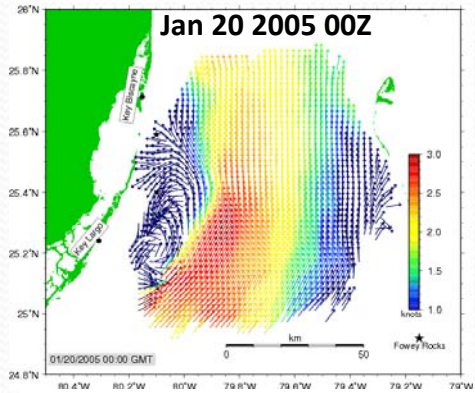
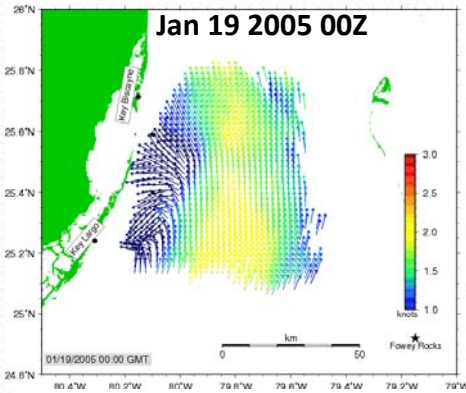
**Okubo-Weiss parameter**  
 $Q = d^2 - \zeta^2$



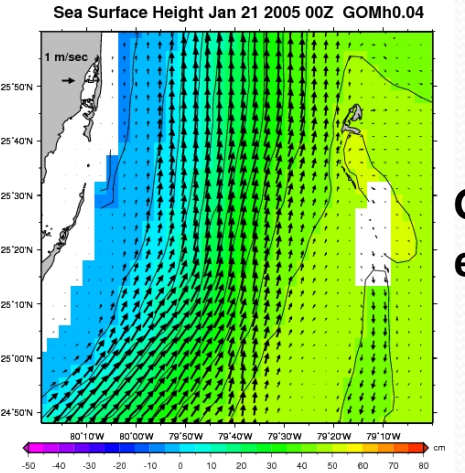
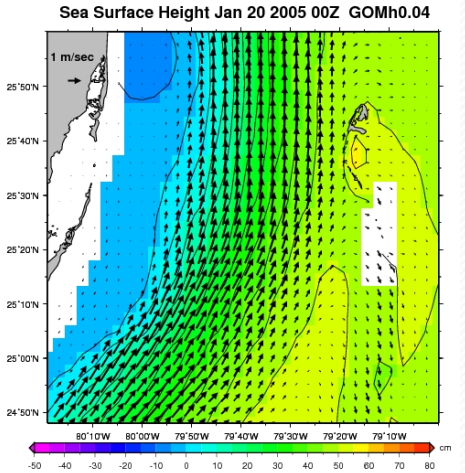
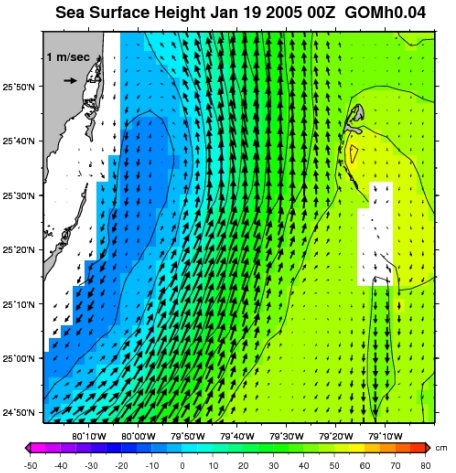
SeaWiFS images provided by Chuanmin Hu, USF



Keyb0.01  
expt\_30.3



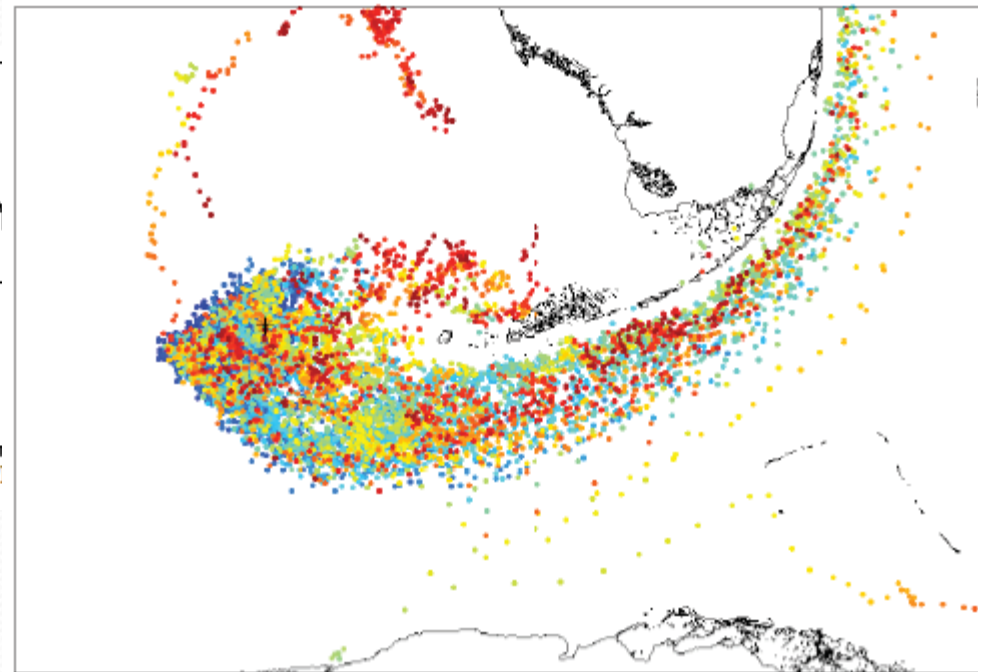
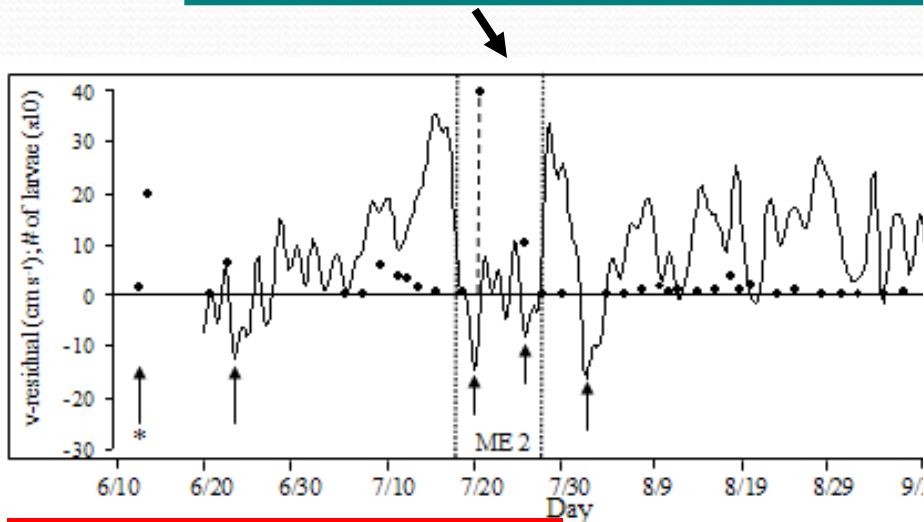
WERA



GOMh0.04  
expt\_30.3

➤ Eddy prediction is crucial for biophysical connectivity studies

Alongshore current and larval counts during an eddy passage (2001 data)



*Sponaugle et al., 2005*

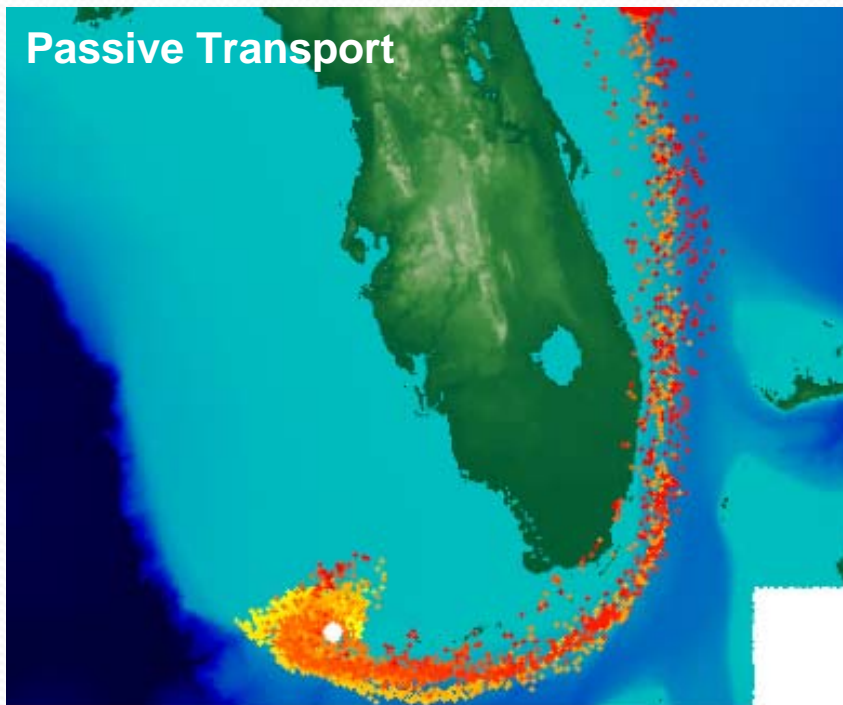
BiOlogical Lagrangian Transport System (BOLTS)  
coupled with HYCOM

Blue: early larvae  
Red: late larvae

part of the **Connectivity Modeling System (CMS)**  
<http://www.rsmas.miami.edu/personal/cparis/cms/description.htm>

## Biophysical Lagrangian Tracking System (BOLTS)

Transport and recruitment of Coral reef Larvae

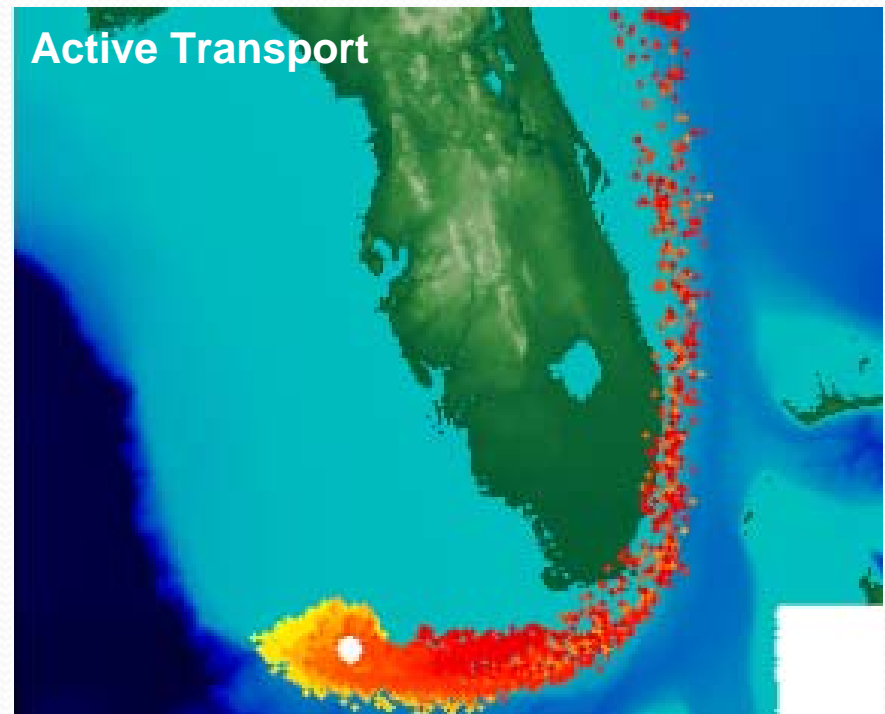


Dry Tortugas - Release April 1, 2004  
Daily position of particles during a  
30-day passive transport in the  
Florida Current

**Recruitment to coral reef = 2%**



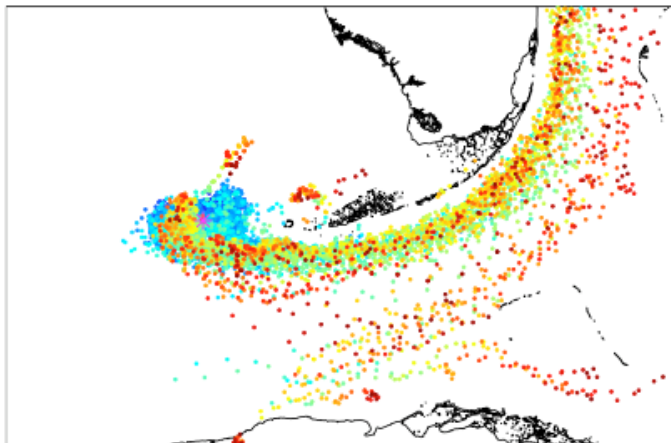
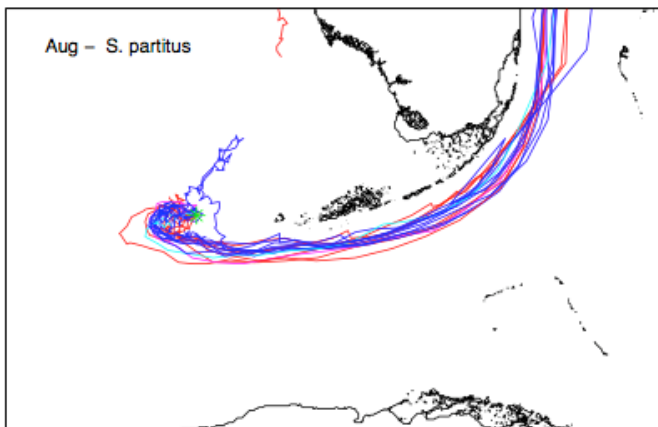
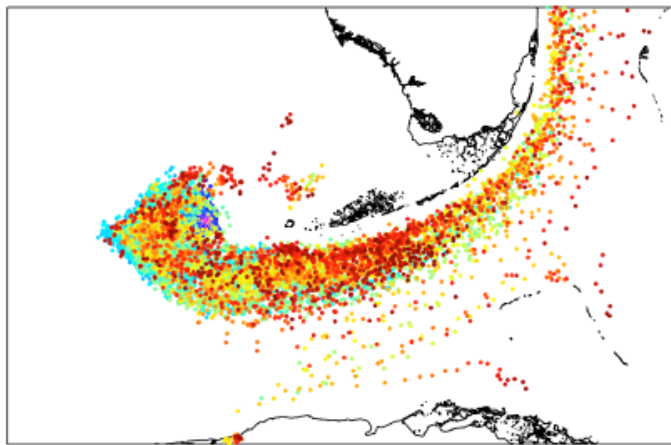
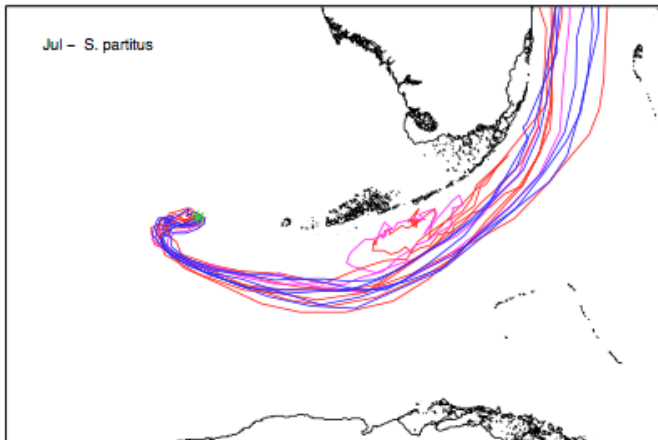
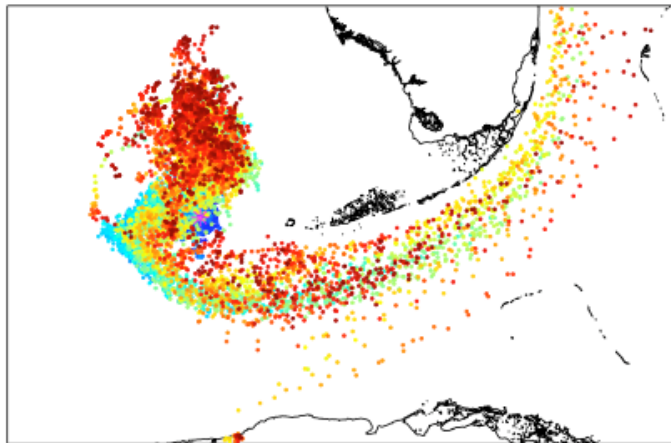
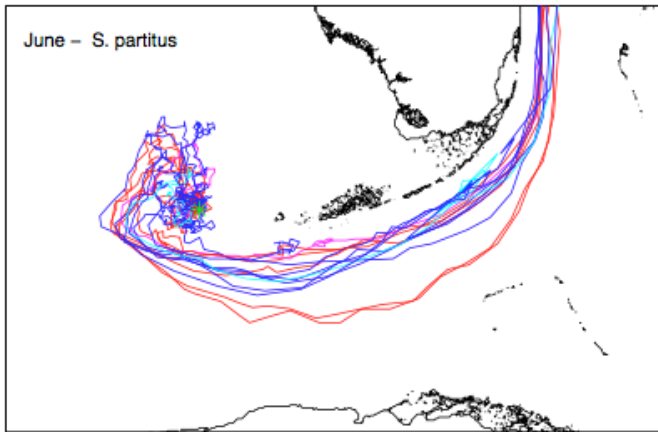
Photo: C Guigand



Dry Tortugas - Release April 1, 2004  
30-day active transport with OVM  
(Ontogenetic Vertical Migration) observed  
from the bicolor damselfish larvae

**Recruitment to coral reef = 38%**

- *population connectivity models need to include physical-biological interactions*
- *CMS efficiently performs sensitivity analyses on the influence of biophysical parameters*



**Monthly 30-day trajectories (2004)**

**Coupled FKEYS-HYCOM and  
CSM/BOLTS with  
Ontogenetic Vertical Migration**

**Trajectory depth : red at 0-10  
m to dark blue at 40-50 m**

**Transport of 100 individual  
particles integrated over 30  
days released in the upper 5  
m at a single location in the  
Dry Tortugas Ecological  
Reserve**

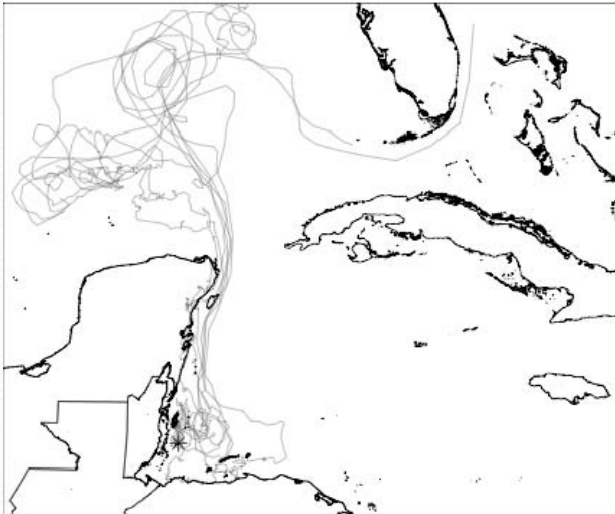
**Particle age from day 1  
(blue) to day 30 (red)**

**Concentration of blue and  
cyan particles (early stage)  
indicates the spawning area  
while areas with red  
particles (late larvae)  
indicate larval retention  
and/or the end of the 30-day  
advection**

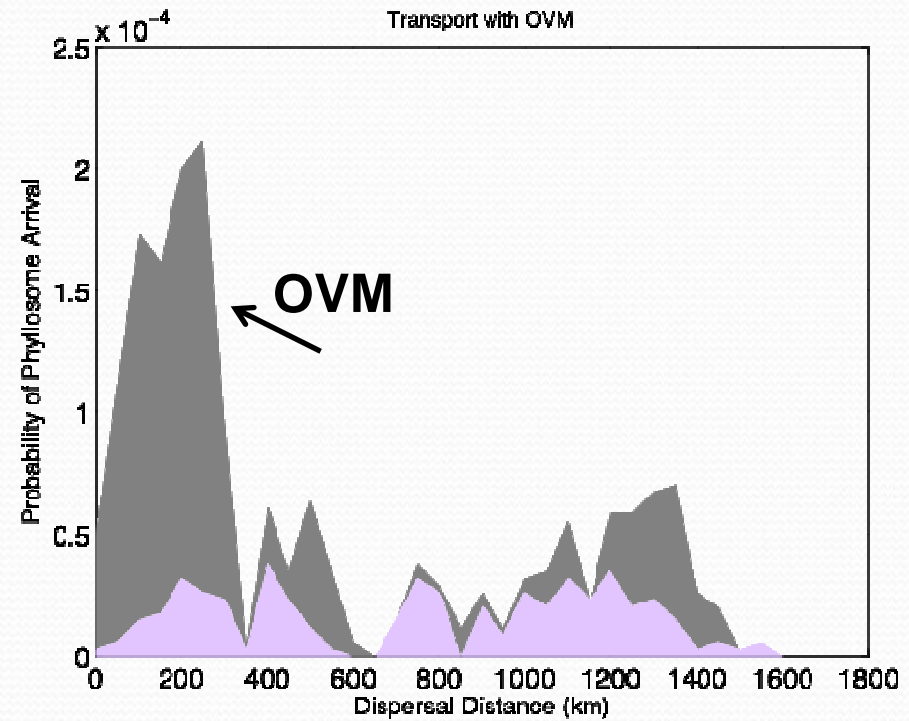
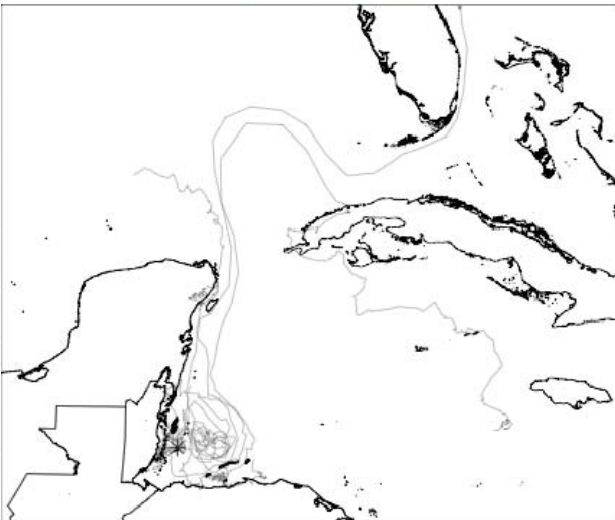


# Modeling lobster transport and recruitment

Glovers Reef Passive



Glovers Reef OVM



phyllosoma

passive particles

(Paris et al. unpubl.)