

Modeling the pathways of particles related to the Deepwater Horizon oil spill accident toward the Florida Keys

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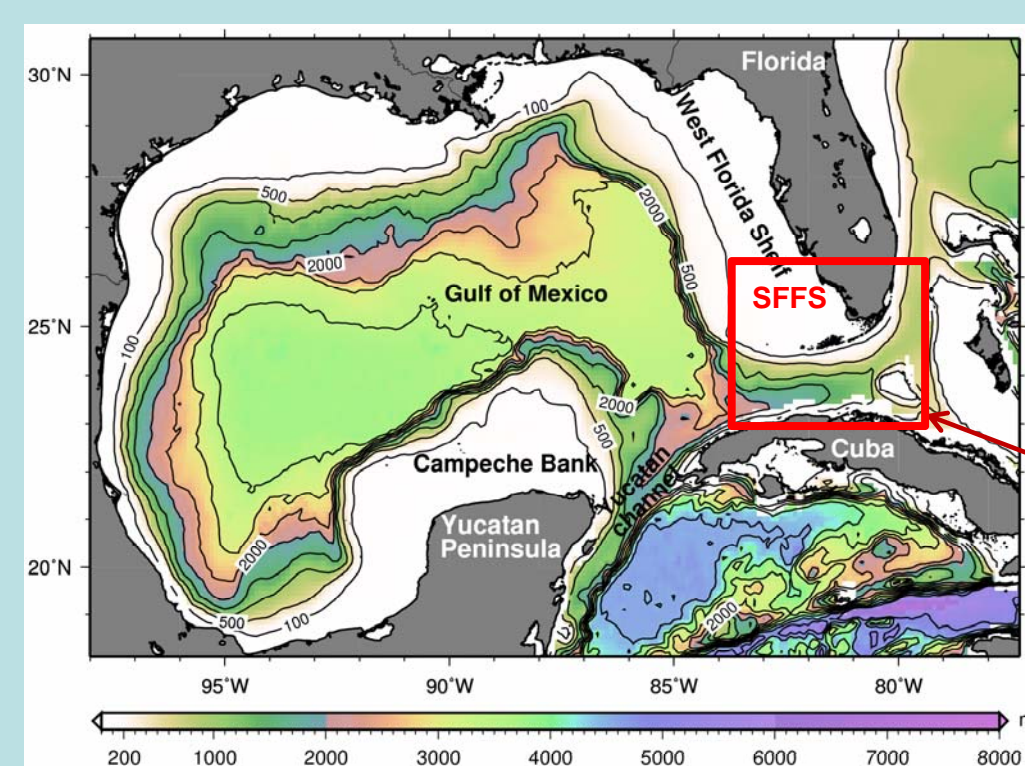
Summary

The oil spill accident in the Northern Gulf Mexico during the spring-summer of 2010 has been an event of historic proportions, expected to have long term ecological impacts. Although the Northern Gulf has been in the immediate vicinity of the spill and under direct threat, the South Florida coastal areas have also been under consideration for possible influence of oil related substances. Given the environmental and socioeconomic importance and the fragile conditions of the Florida Keys National Marine Sanctuary and Dry Tortugas Ecological Reserve, this study examines the probability and variability in the pathways connecting these remote ecosystems to the Deepwater Horizon (DH) oil spill site.

A high resolution (~3.7 km) numerical model has been employed to provide the circulation needed for the calculation of particle pathways. The model covers the entire Gulf of Mexico (GoM) and the Florida Straits, encompassing the Florida Keys and Florida Bay; it is based on the Hybrid Coordinate Ocean Model (HYCOM) and hence called GoM-HYCOM. The model assimilates all available data, including observations that were reported in real time as part of the NOAA response to the DH oil spill. Particle trajectories were simulated using the HYCOM model Lagrangian particle package with additional oil attributes. Initial conditions were updated frequently, using the oil patch observed through satellite imagery. Both surface and sub-surface particle trajectories were calculated, using the GoM-HYCOM velocity fields at appropriate depths.

Particles were released at all model grid points that contained oil data. The hydrodynamic model forecasts were then used to project particle pathways in time. The probability of particles reaching the various interior and shelf areas in the Gulf and South Florida were also calculated. We demonstrate the variability in the large scale Loop Current/Florida Current system and the associated frontal eddies that controlled the pathways toward the Florida Keys. In particular, we show the various stages of formation and detachment of the Loop Current eddy Franklin, which had a large impact on the connectivity pathways. Results from this study aim towards showcasing a methodology that connects local and remote environmental impacts, thus enhancing the efforts of a sustainable ecosystem management approach for the Florida Keys.

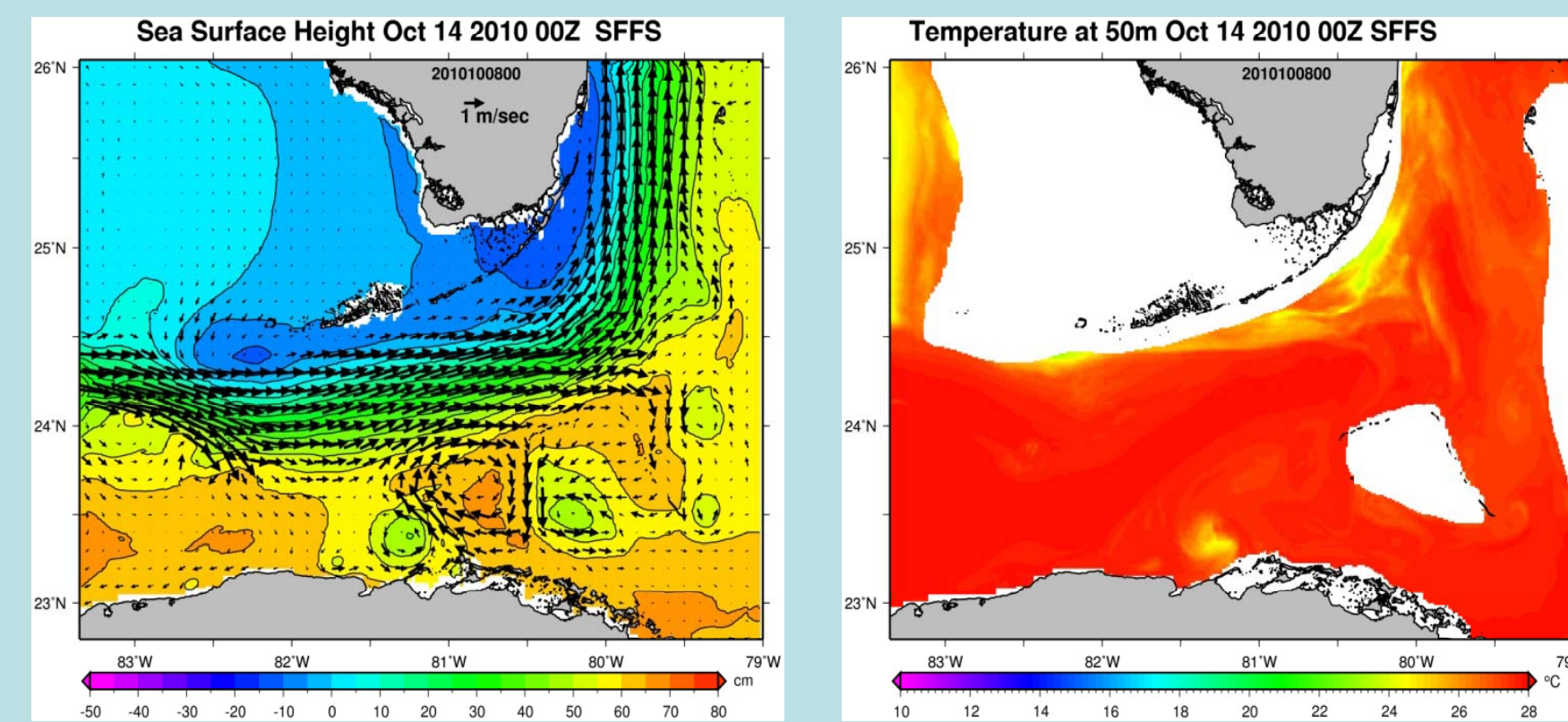
Regional and coastal modeling at UM/RSMAS with the Hybrid Coordinate Ocean Model
<http://coastalmodeling.rsmas.miami.edu>



- Regional GoM-HYCOM model (domain and topography)
- Resolution ~ 3-4 km
- Long term data assimilative simulations (performed at NRL with the Navy Coupled Ocean Data Assimilation)
- Atm. Forcing: NOGAPS 0.5-1 deg
- SOUTH FLORIDA and FLORIDA STRAITS - HYCOM (SFFS)
- Resolution ~ 900 m
- Topographic details in shallow Florida Keys areas; tides included
- Atm. Forcing: COAMPS 27km
- (REAL TIME forecasting: GFS forcing)

South Florida and Florida Straits Hybrid Coordinate Ocean Model (SFFS-HYCOM)

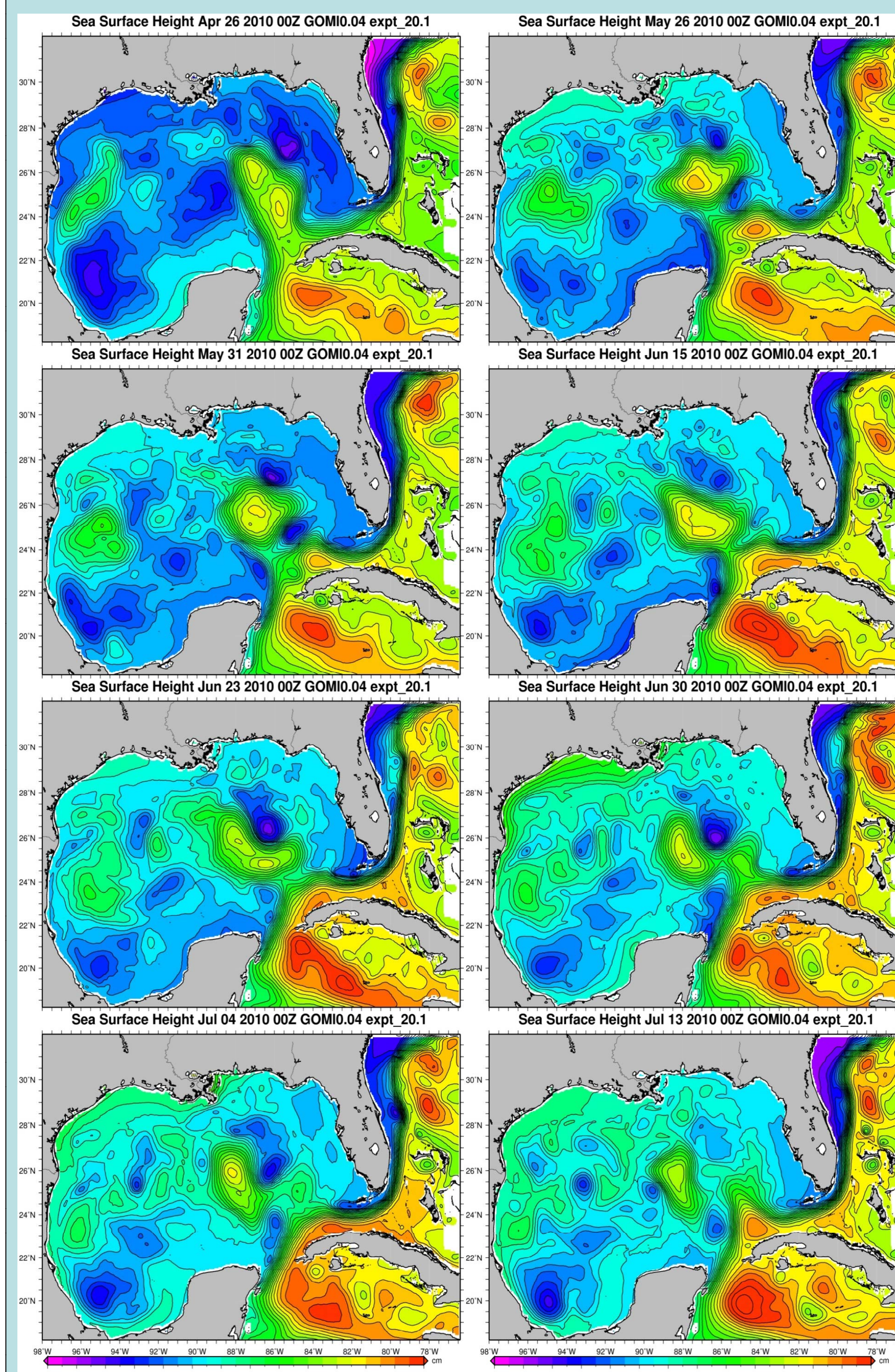
- Now running in near real time
- Examples from a recent forecast for Oct. 8, 2010



- The Loop Current/Florida Current (LC/FC) system evolution is largely influenced by the rich eddy field
- The connectivity between South Florida, the Gulf interior and remote Gulf ecosystems is influenced by cyclones traveling around the LC and north of the FC

Evolution of Eddy Franklin detachment

GoM-HYCOM Sea Surface Height maps during the DH oil spill period (April-July 2010)



The connectivity of South Florida and the DH oil spill site was effectively closed in early July, after the LC ring detached completely (following a temporary detachment and reattachment in late May)

The Deepwater Horizon oil Spill

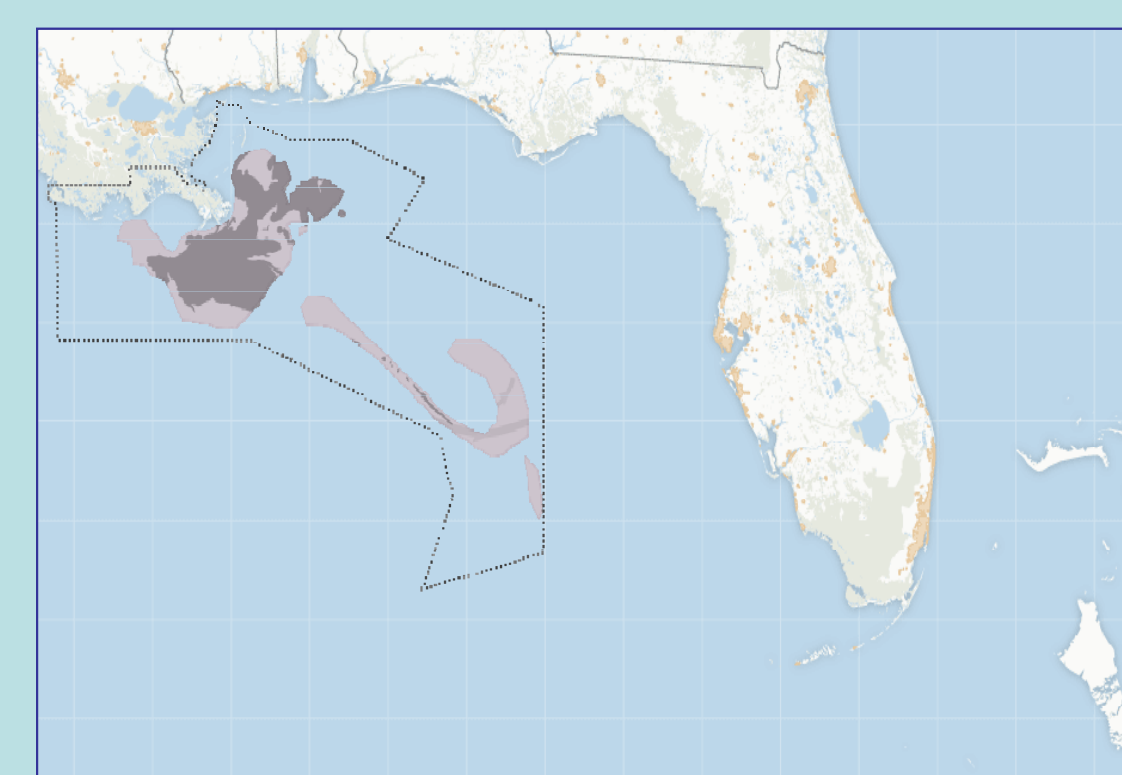
A challenge of historical proportions for the management of the Florida Keys

- Did we understand and could we predict the oil particle pathways?

➢ Need for an integrated, real time, regional modeling and observing system

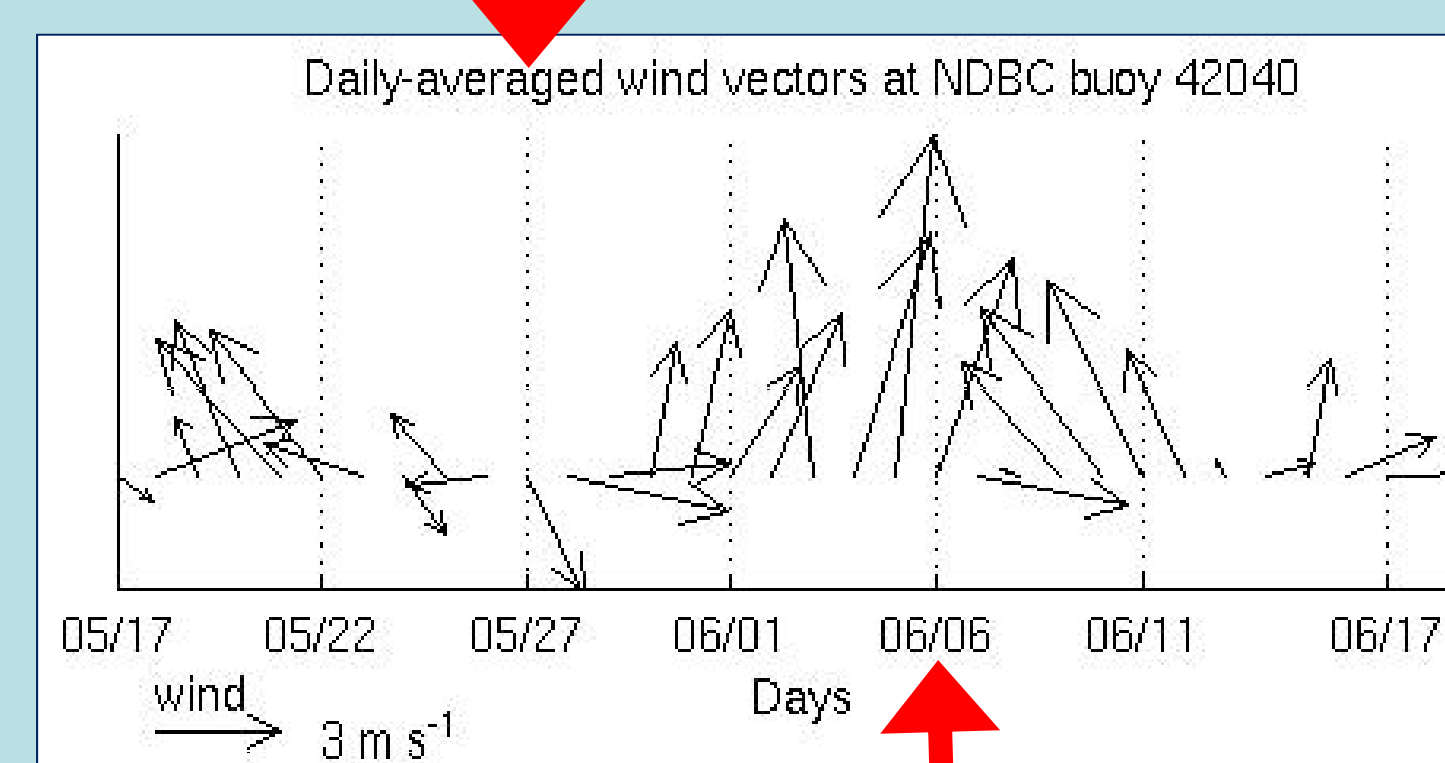


Evolution of oil patch spreading

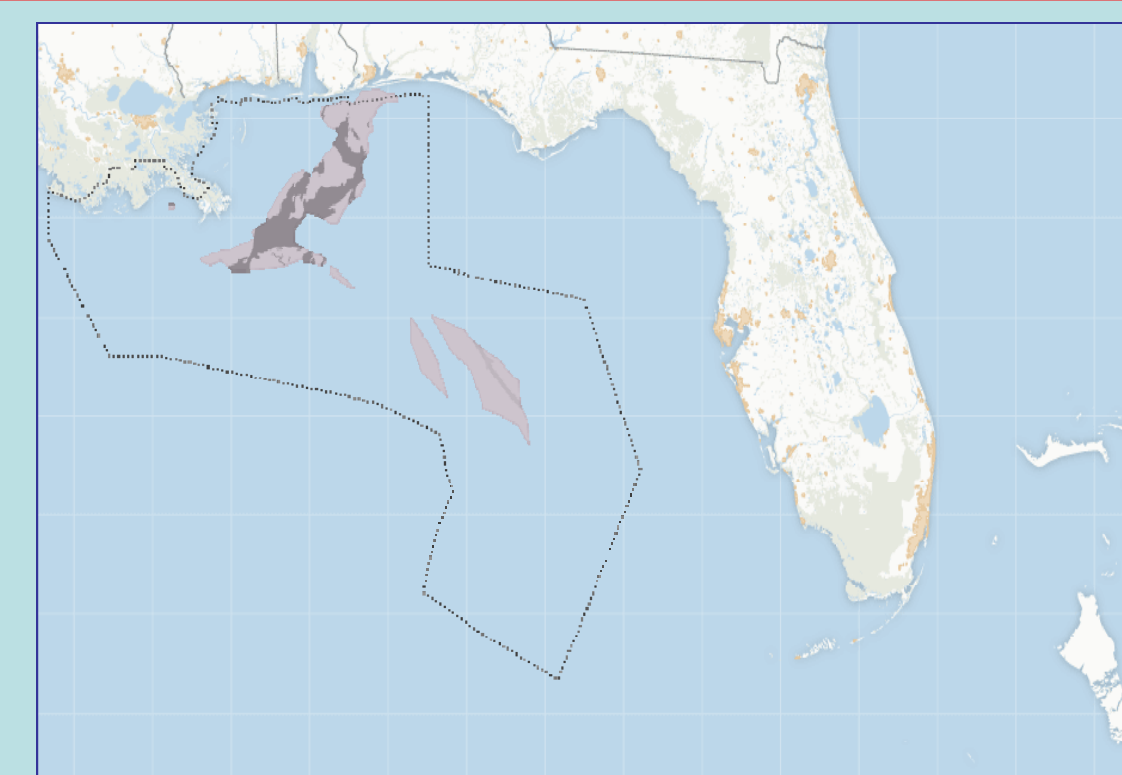


05/27/2010
 (source: the New York Times)

Observed oil patch after light southward winds



Observed oil patch after strong northward winds



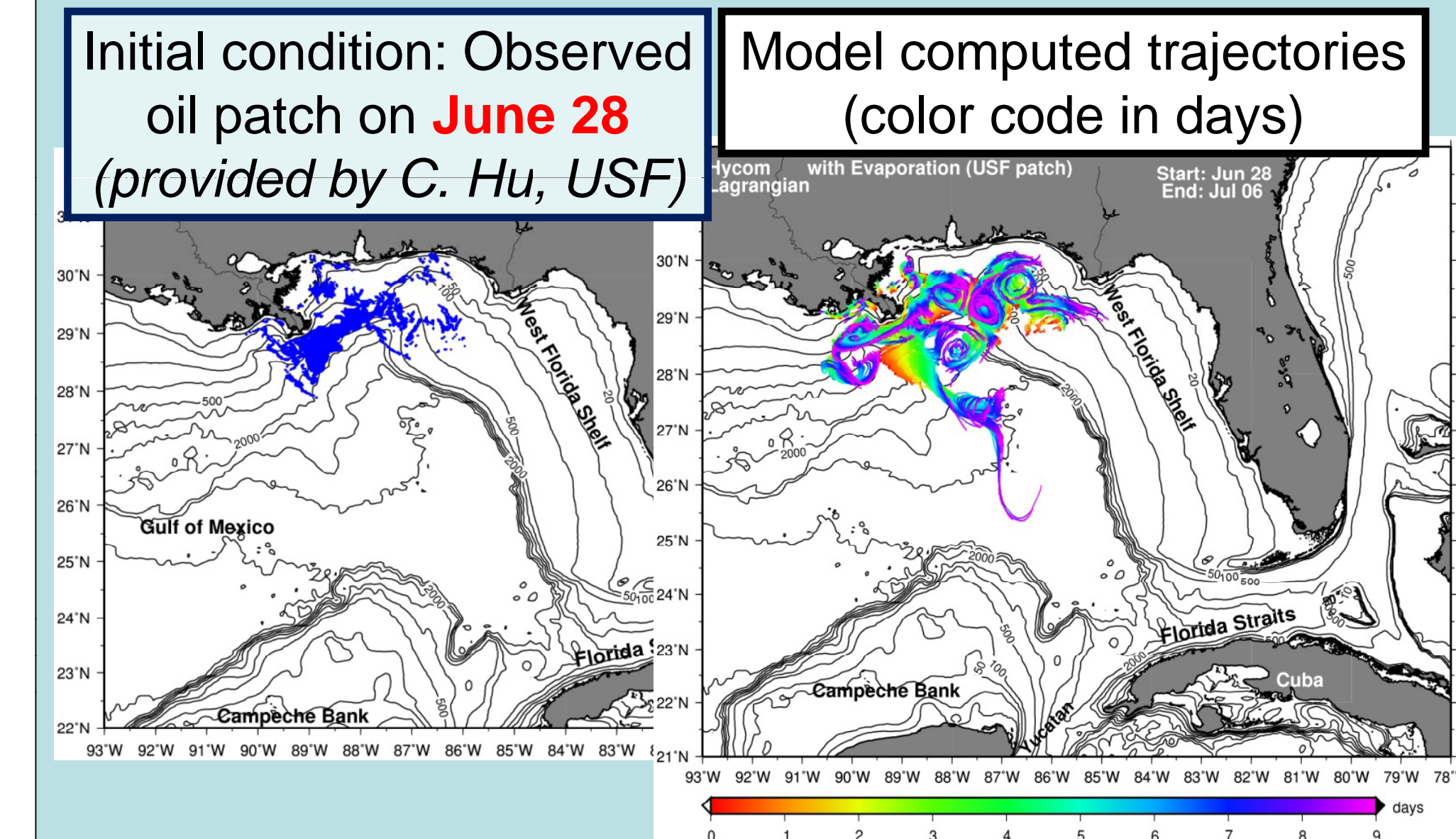
06/06/2010
 (source: the New York Times)

Important processes controlling the transport of waters surrounding the oil spill:

- => wind driven shelf currents
- => Mississippi River plume induced circulation
- => basin-wide circulation (Loop Current and eddies)

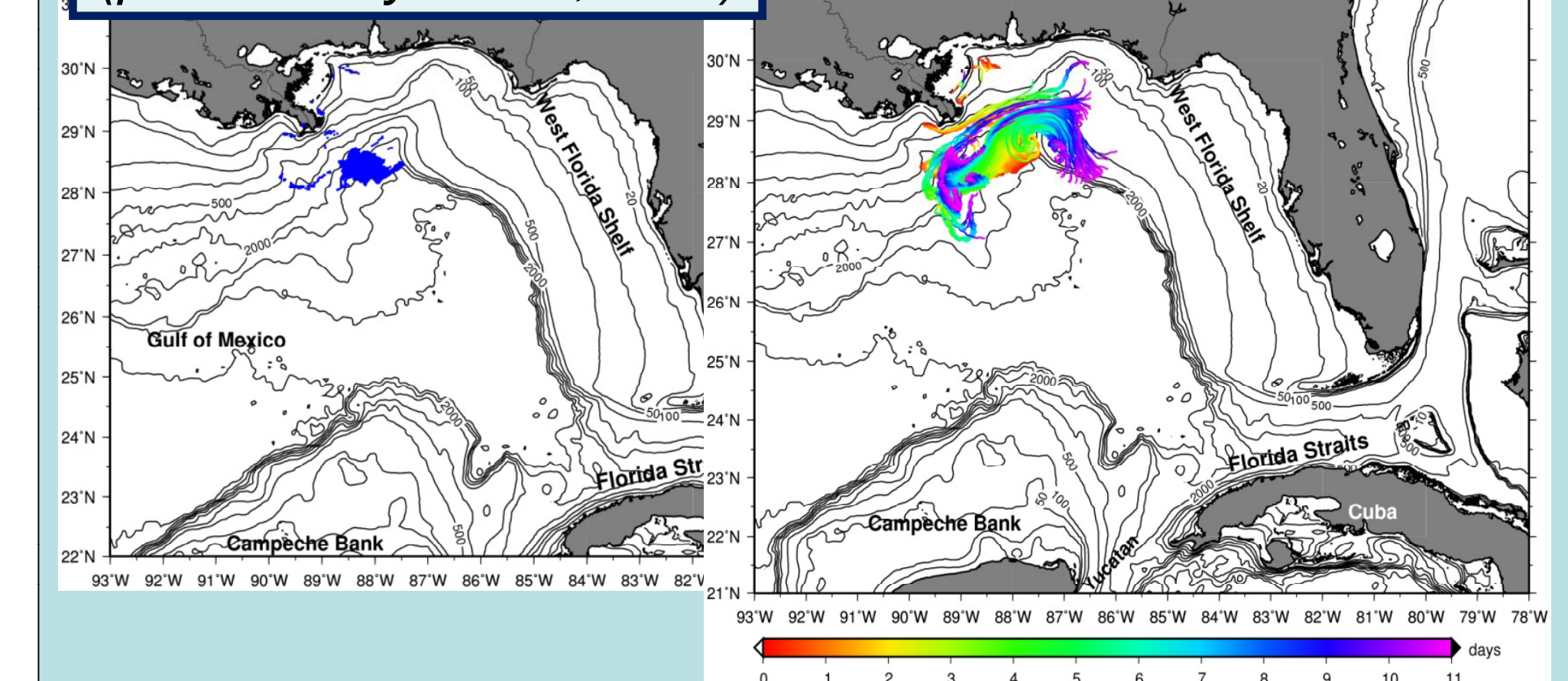
Oil spill related particle trajectory forecasts

Examples: forecast of surface particle displacements

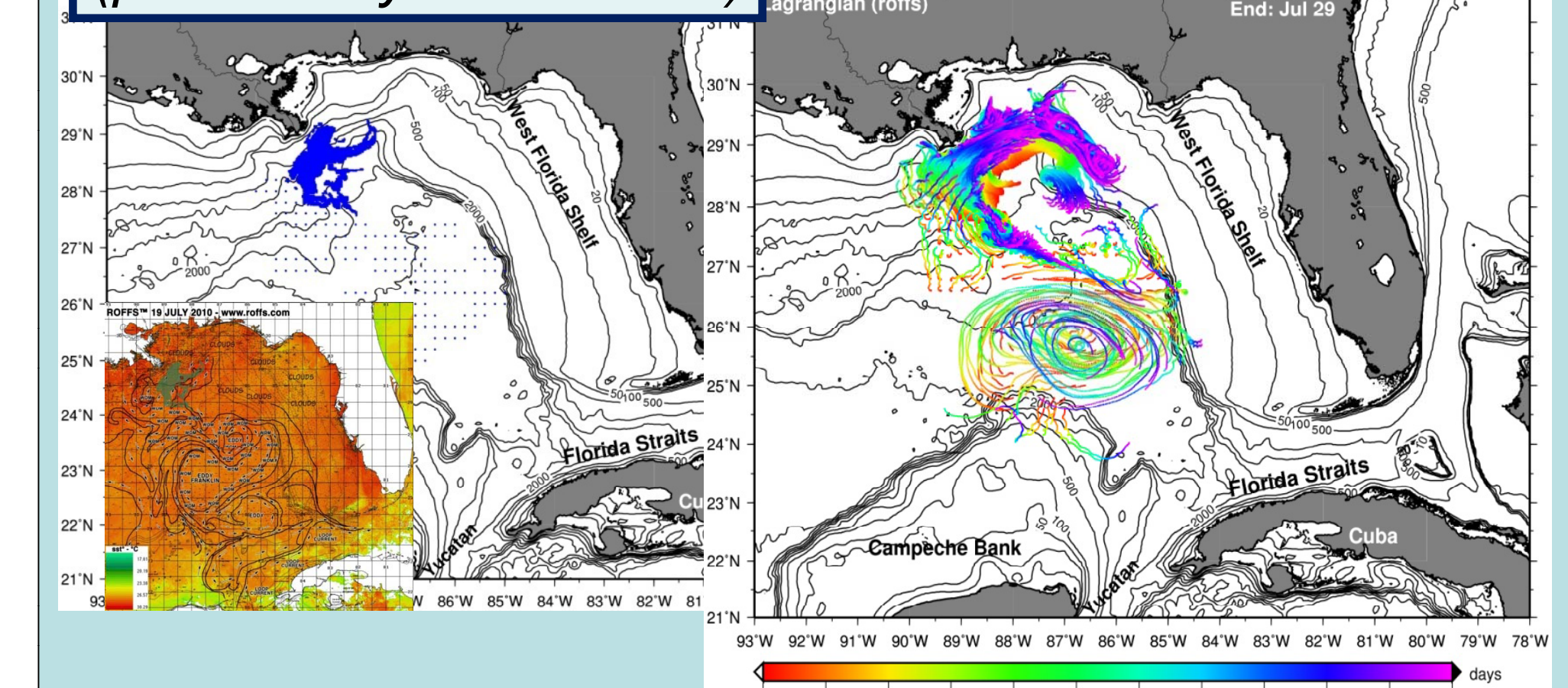


Tendency for certain particles to be entrained in the Loop Current (Colors denote days - up to 8 days- of forecast positions for particle trajectories)

Initial condition: Observed oil patch on July 12 (provided by C. Hu, USF)



Initial condition: Observed oil patch on July 19 (provided by ROFFS Inc.)



Scenarios of oil particles entering the Florida Straits (June 2010)

Main pathway of oil particles potentially entering the Loop Current/Florida Current system is to go through the Straits quickly, but there is also strong evidence of onshore pathways

