

# Nested Gulf of Mexico Modeling with HYCOM

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# Report Documentation Page

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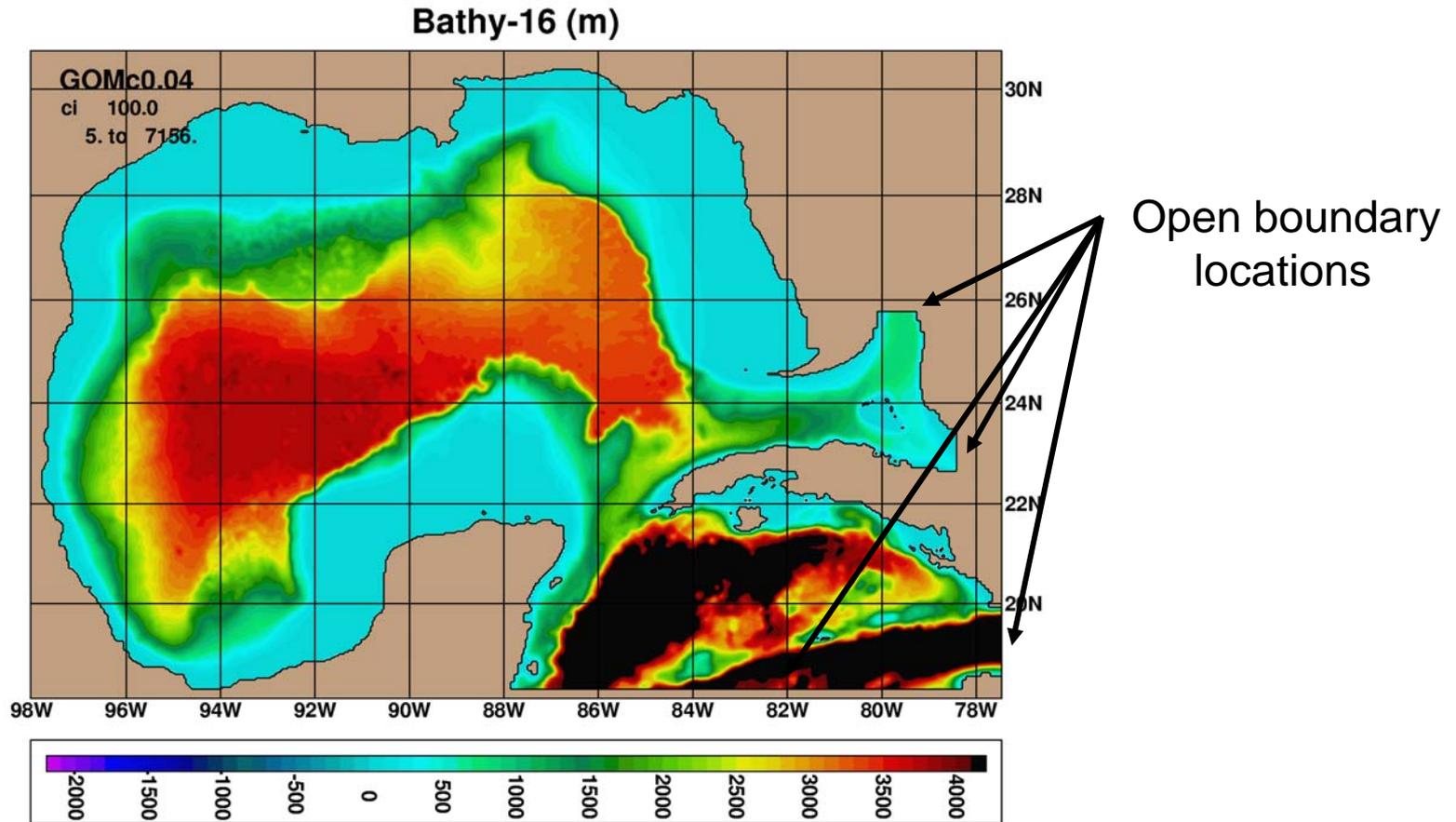
## *Brief Outline*

- 1/25° Free-Running Nested Gulf of Mexico
- 1/12° Assimilative Nested Gulf of Mexico

### *1/25° Free-Running Nested Gulf of Mexico*

- Bathymetry is from NRL DBDB2
- Surface forcing is from 6-hourly/3-hourly NOGAPS (2000/2001)
- 20 layers in the vertical (bottom 5 from Atlantic discarded)
- 16 Rivers included as salinity flux
- Relaxation to SSS
- FCT2 for scalar advection
- Initialized from January 1, 2000 interannually forced Atlantic
- Lateral boundary conditions from 1/12° Atlantic HYCOM
- Integrated over 2000-2001

# 1/25° Gulf of Mexico Model (~4 km)



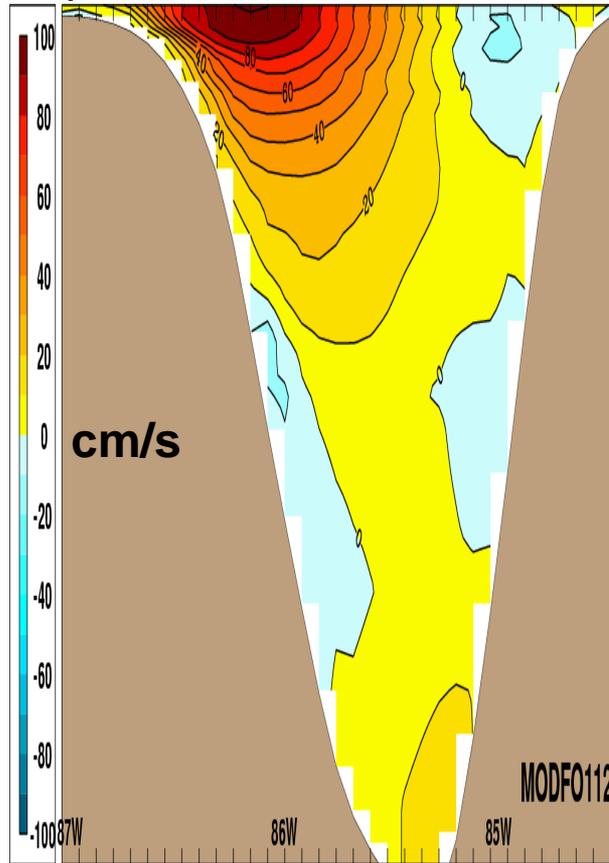
Method of Characteristics used  
To update the barotropic mode

20 gridpoint buffer zone for baroclinic  
mode with e-folding time .1 to 10 days

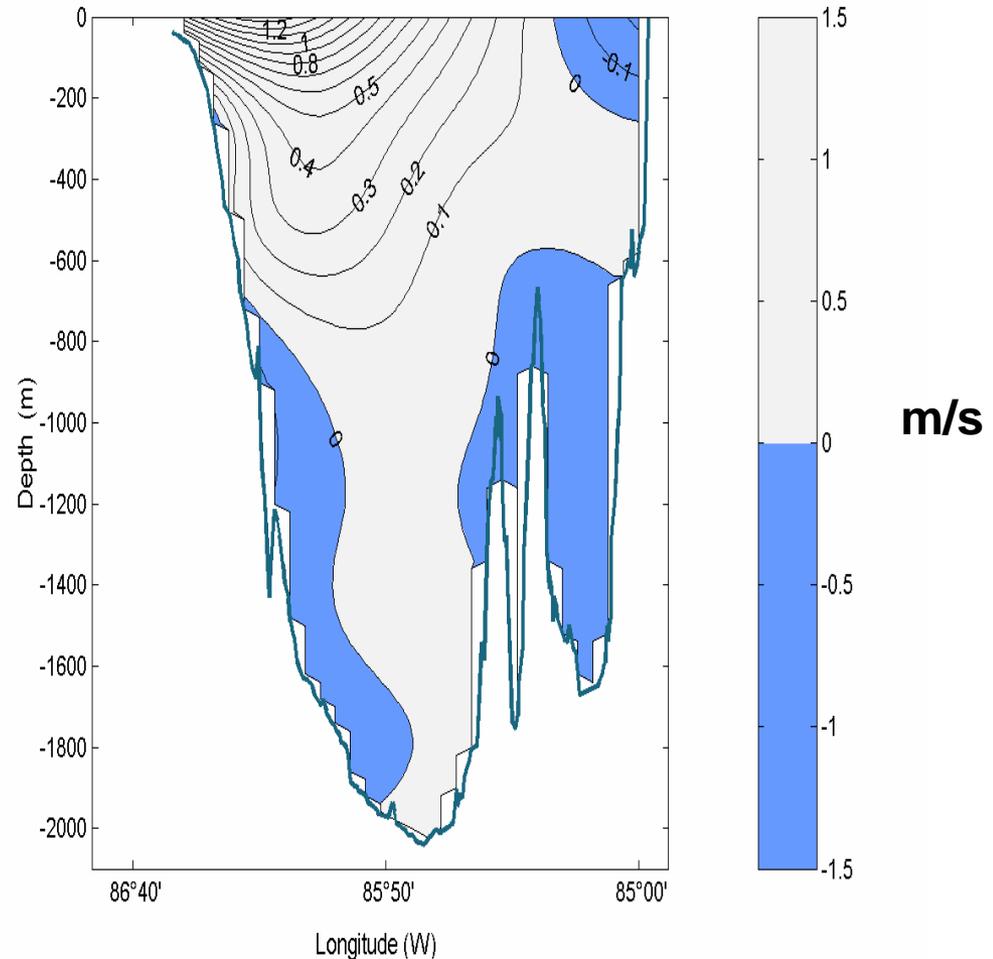
Atlantic boundary data provided daily

# Yucatan Channel Normal Velocity

1/12° Nested GOM HYCOM  
September 1999 – June 2000



Observed Mean 8/1999-6/2000  
(Abascal et al., JGR 2003)



Note: boundary conditions from  $\sigma_\theta$  MPDATA Atlantic simulation

# 1/25° Free-Running Gulf of Mexico HYCOM

## RMS SSH Variability

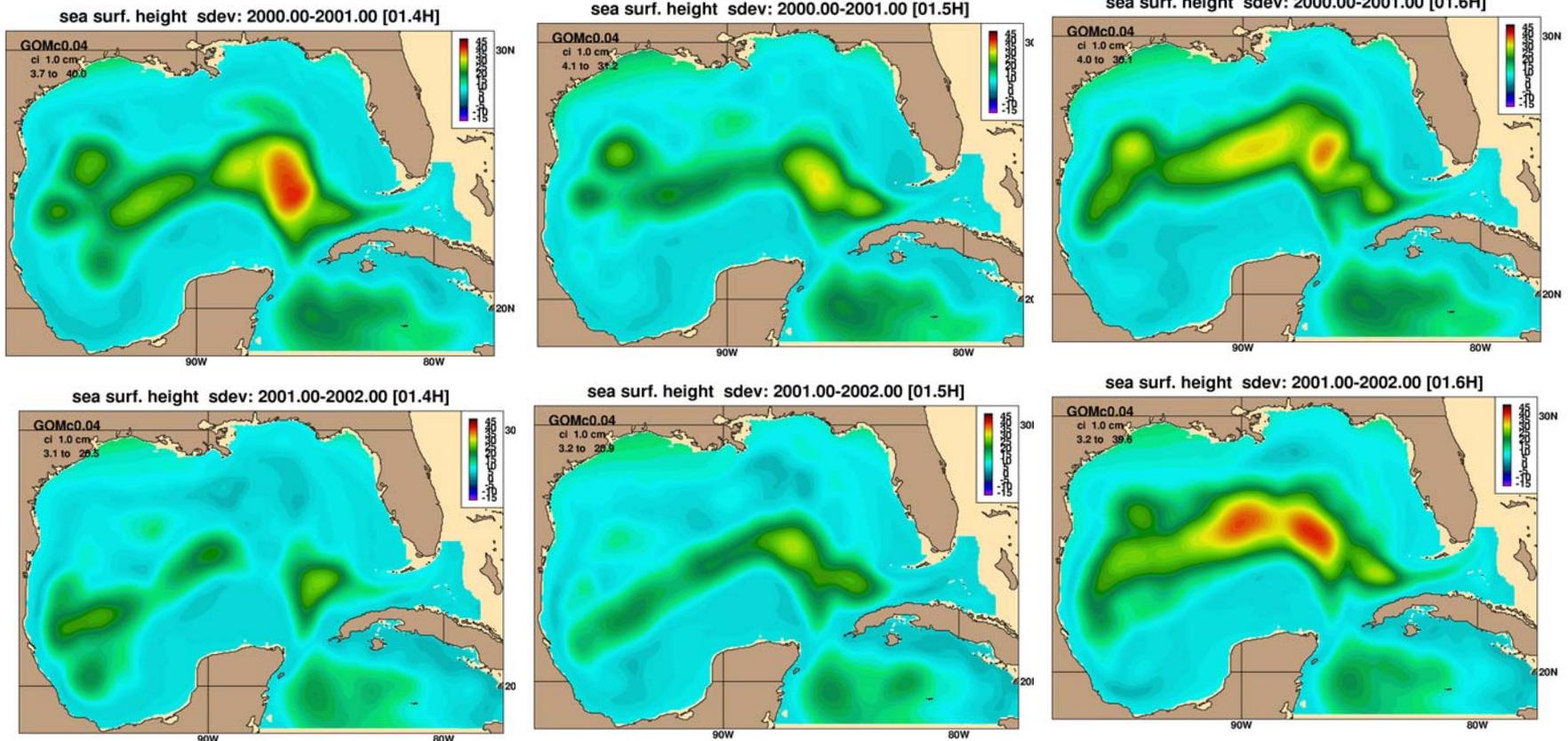
KPP

MY-2.5

GISS

2000

2001



KPP variability low in 2001

MY-2.5 variability low in 2000 and 2001

Need longer time series for meaningful statistics

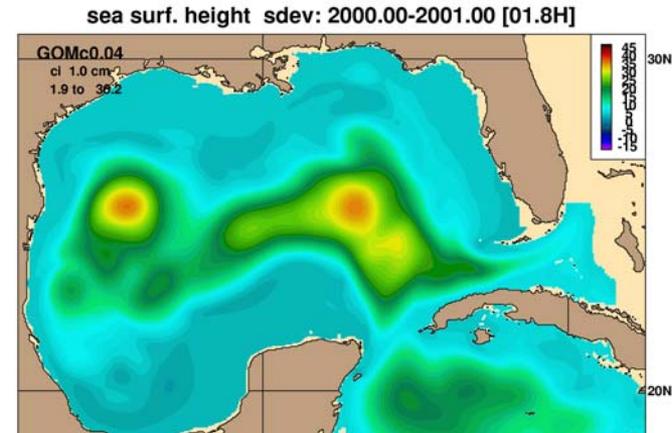
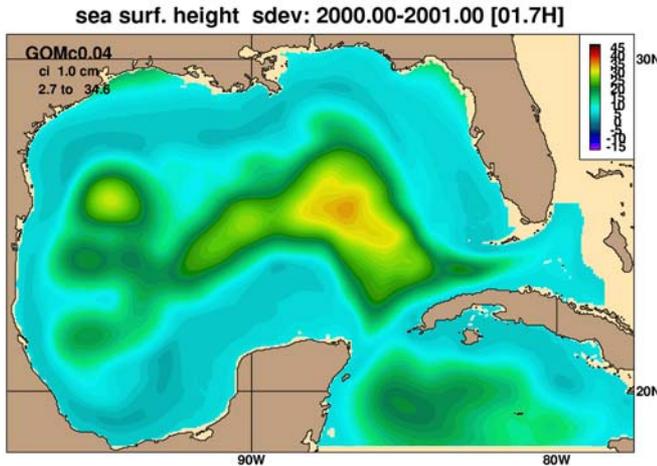
# 1/25° Nexted Gulf of Mexico HYCOM

## RMS Sea Surface Height Variability

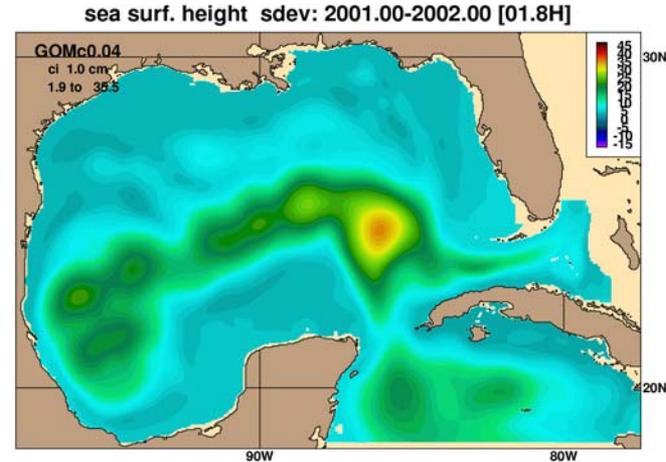
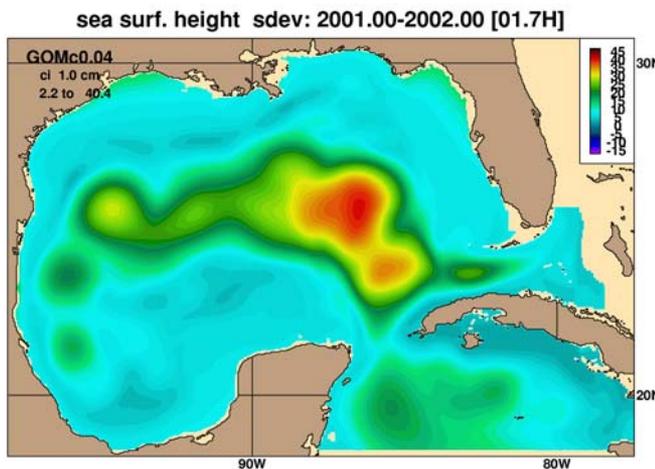
No Mixed Layer\*

No Mixed Layer, No Winds

2001



2000

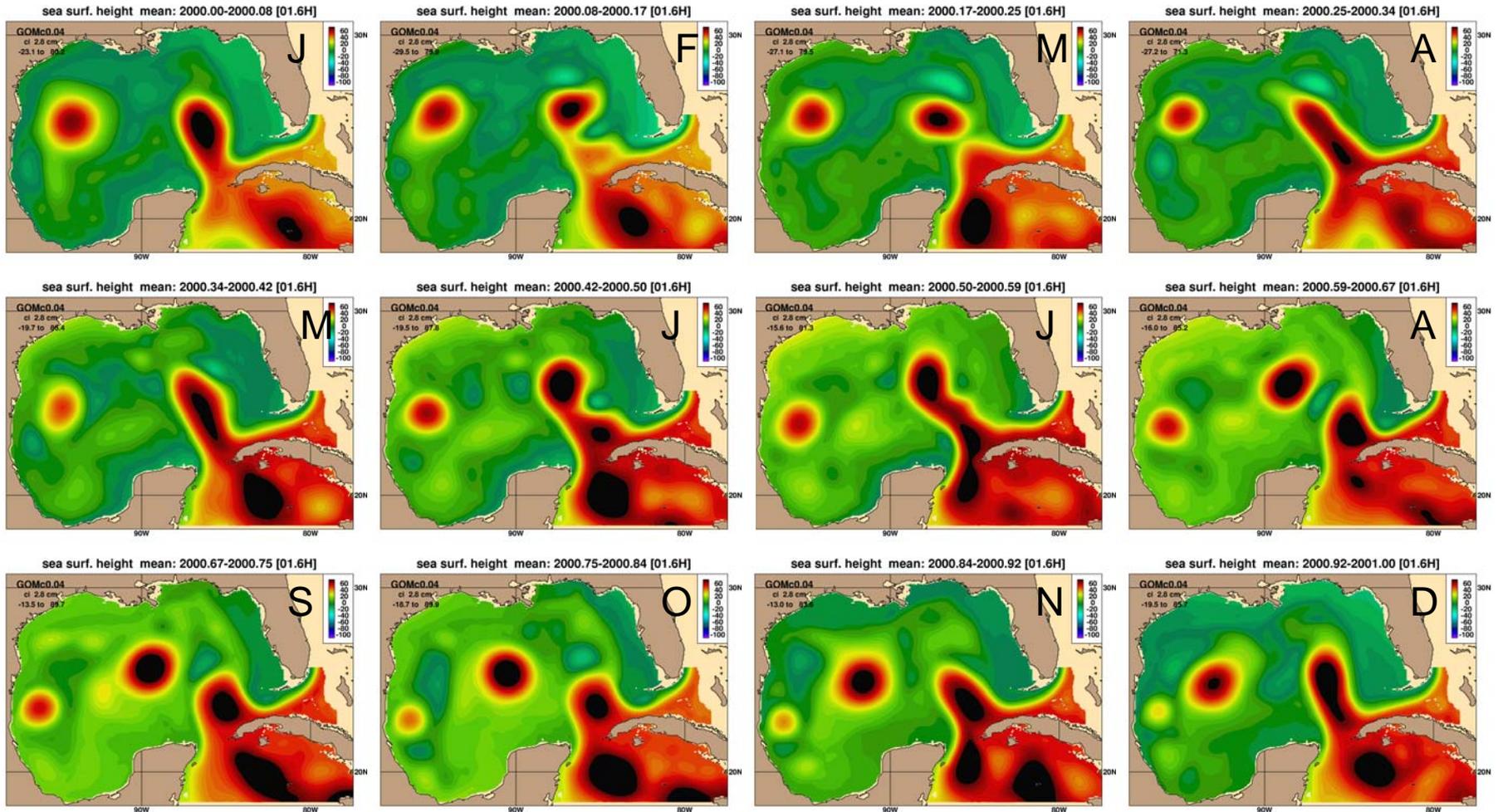


Demonstrates that mixed layer, winds don't impact LCE shedding dynamics

\*includes background diapycnal diffusion

# 1/25° Nested Gulf of Mexico HYCOM (GISS)

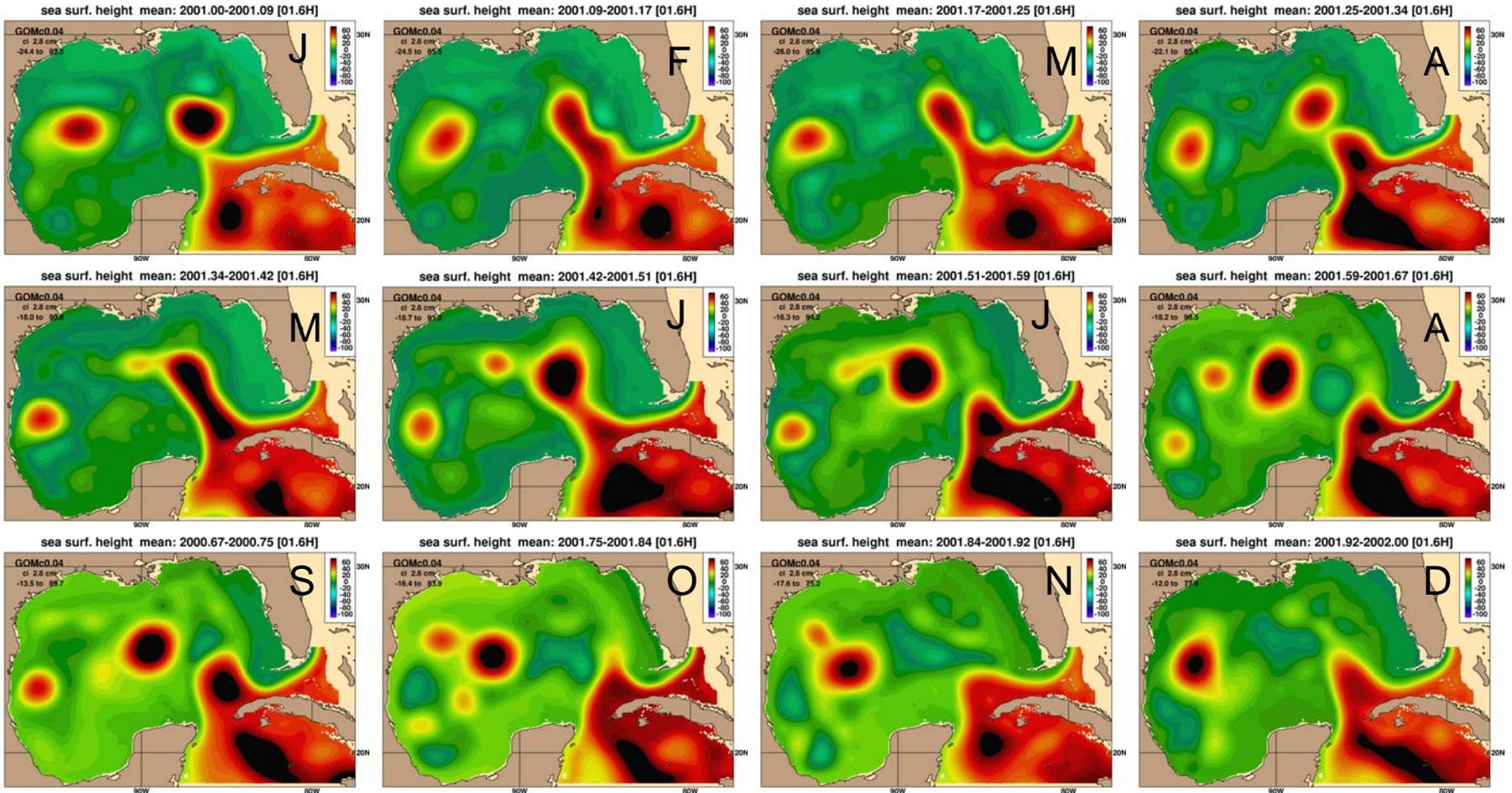
## Monthly Mean Sea Surface Height Year 2000



- Loop Current Eddy sheds in April 2000
- Role of cyclones in Loop Current Eddy shedding evident

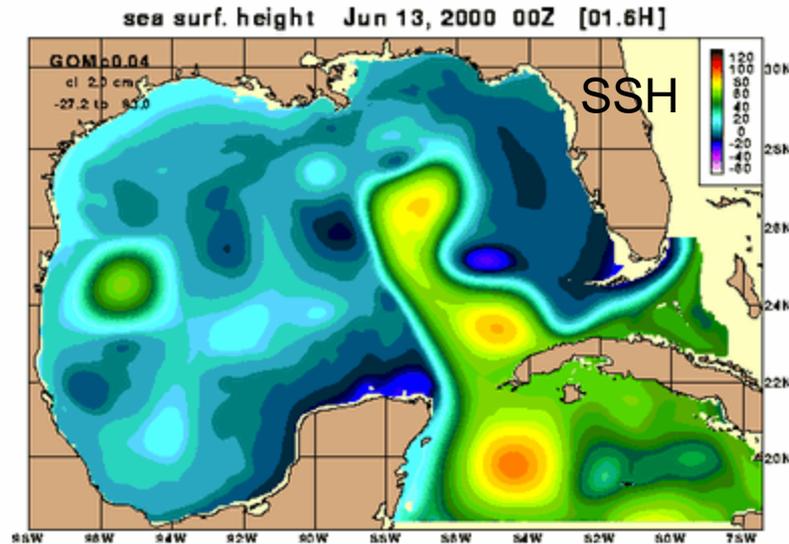
# 1/25° Nested Gulf of Mexico HYCOM (GISS)

## Monthly Mean Sea Surface Height Year 2001

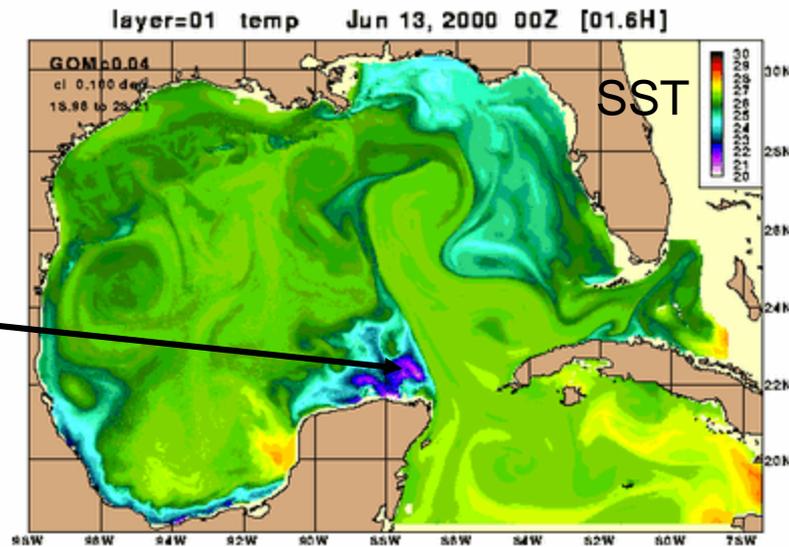


Loop Current Eddy sheds 10 months later (July 2001)  
Detached eddy reabsorbed in several cases

# 1/25° Nested Gulf of Mexico (GISS)



Lots of cyclonic cold core eddies

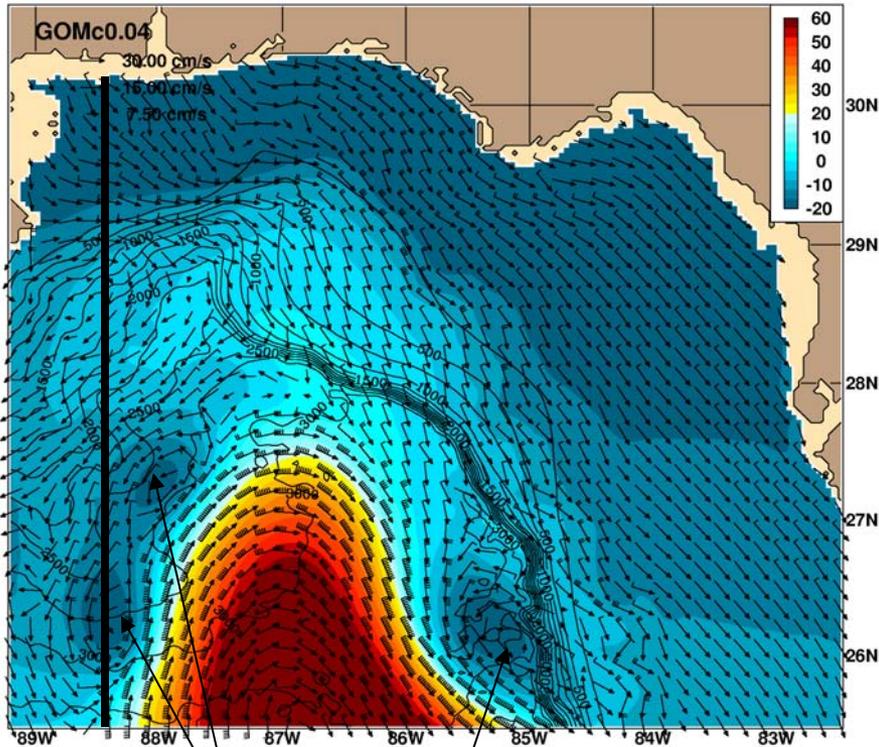


upwelling

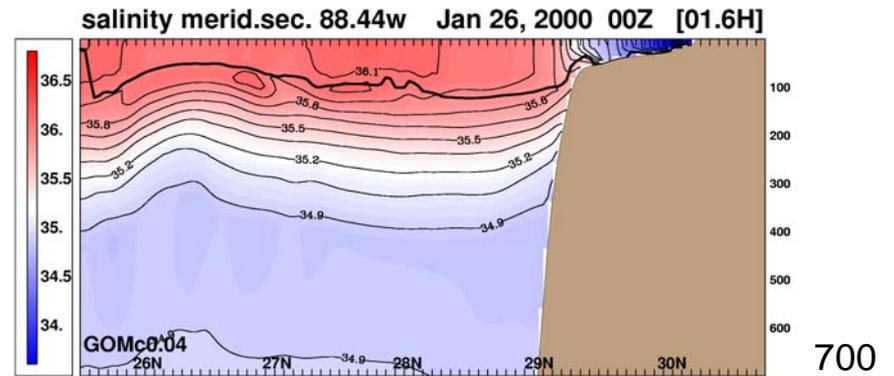
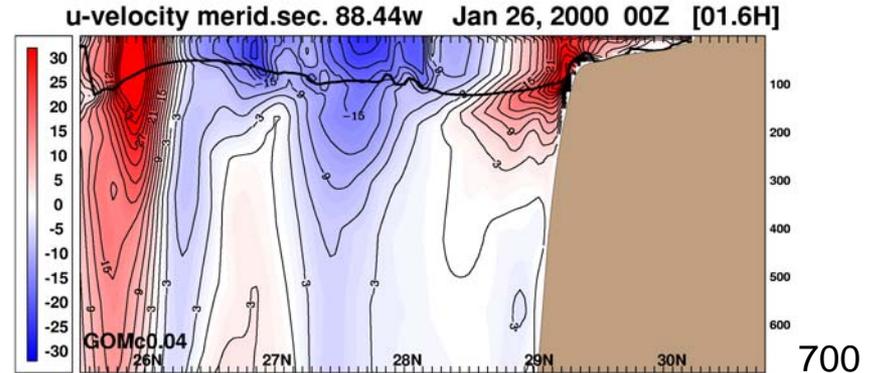


# 1/25° Nested Gulf of Mexico HYCOM (GISS)

Jan 026 2000 SSH and Surface Currents



Cross-section along 88.4°W



cyclones

- Cyclones are fairly shallow
- Robust shelf-break current associated with strong salinity gradient
- Loop Current penetration to ~28°N

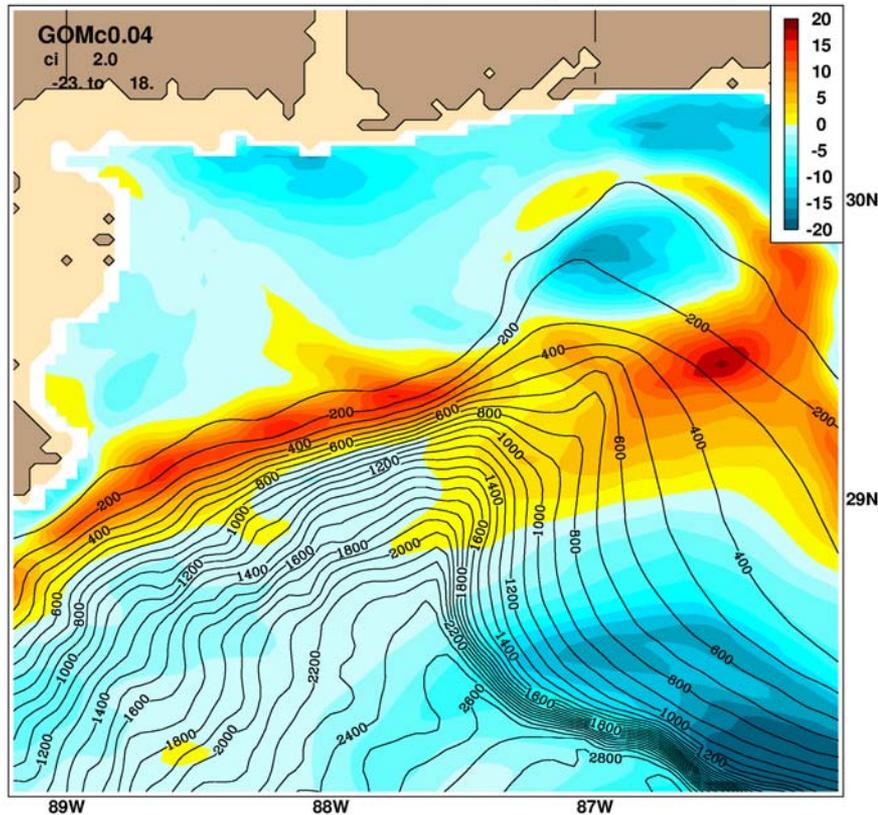
Red=east  
Blue=west

# 1/25° Nested Gulf of Mexico HYCOM (GISS)

Barotropic u-velocity

red=east blue=west

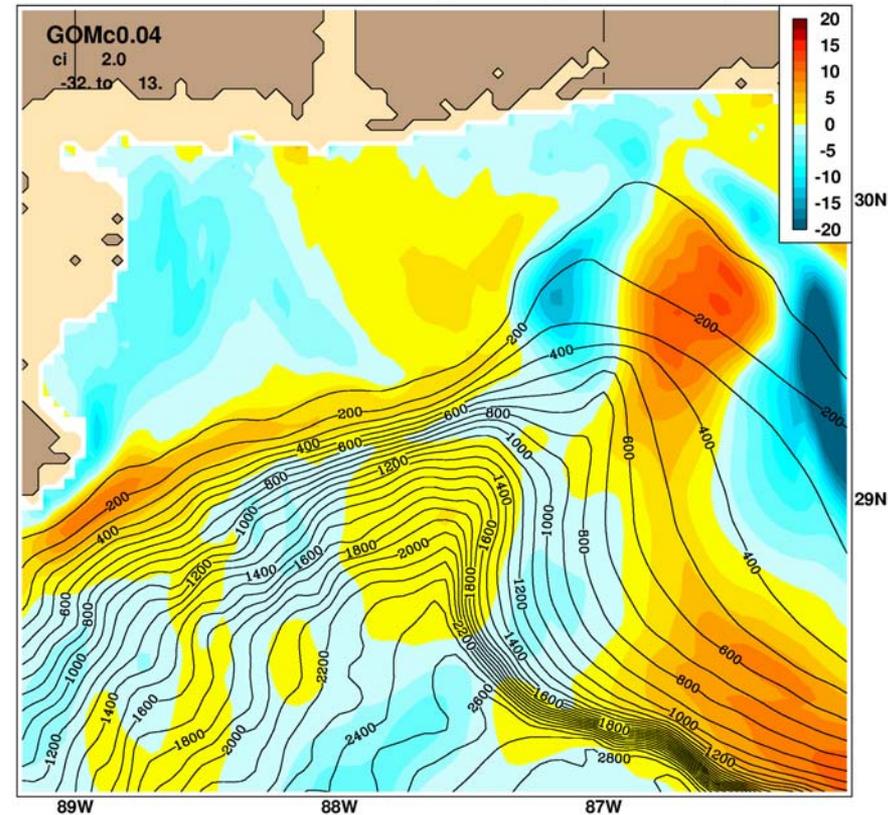
Barotropic u-vel (cm/s) - 2000\_049 (archive)



Barotropic v-velocity

red=north blue=south

Barotropic v-vel (cm/s) - 2000\_049 (archive)

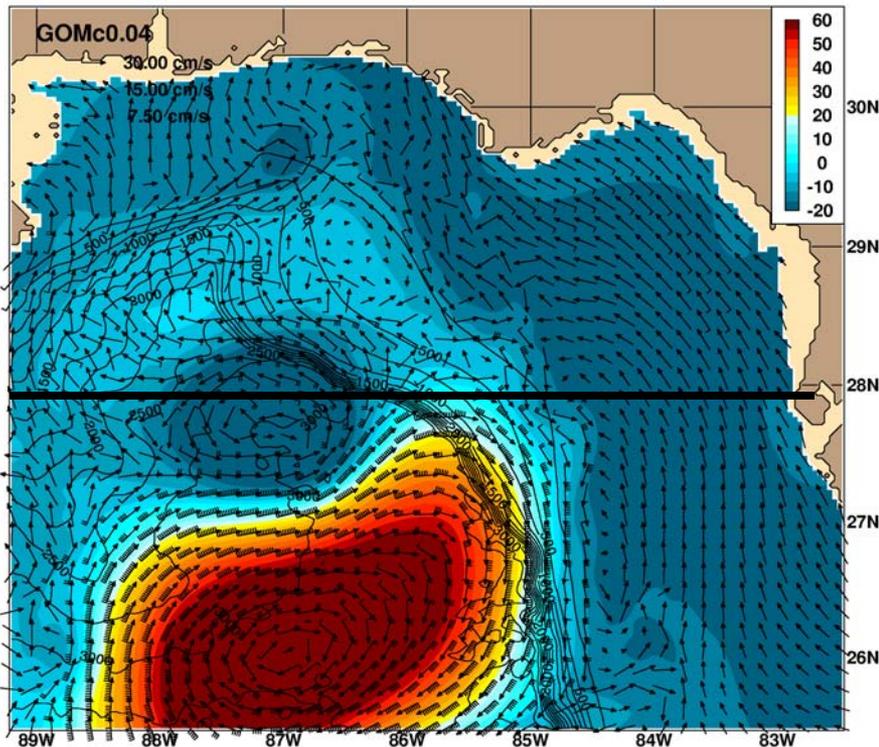


Note topo-trapped cyclone at head of DeSoto Canyon

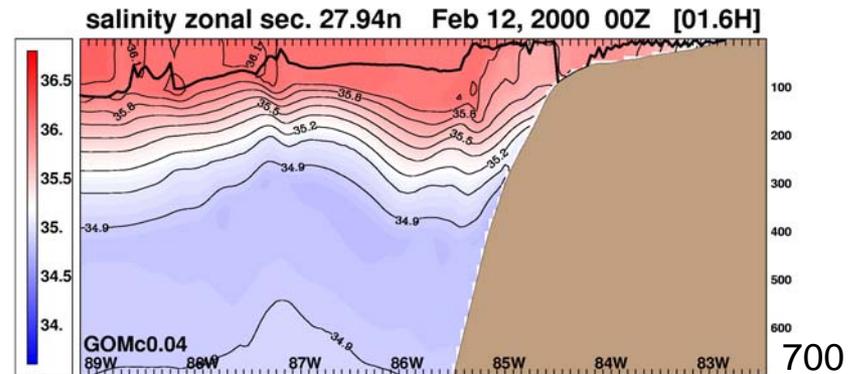
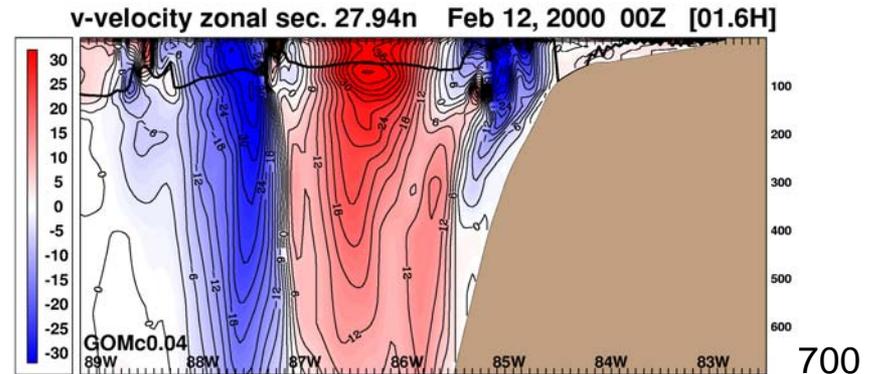
# 1/25° Nested Gulf of Mexico HYCOM (GISS)

Red=north  
Blue=south

## Feb 12, 2000 SSH and Surface Currents



## Cross-section along 27.9°N



Loop Current has migrated to NE  
and is impinging on shelfbreak

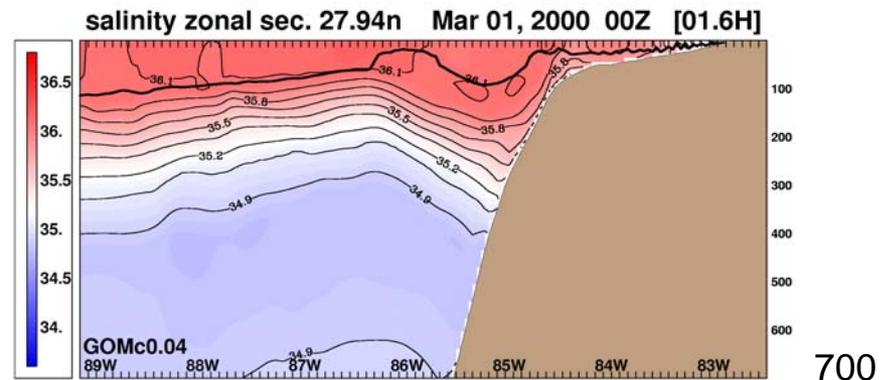
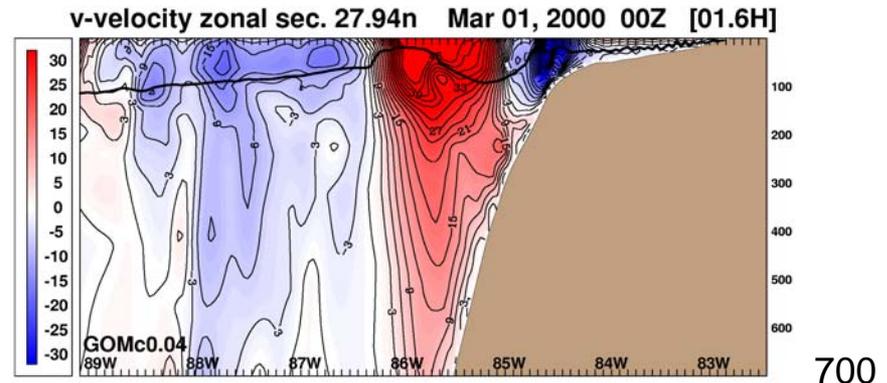
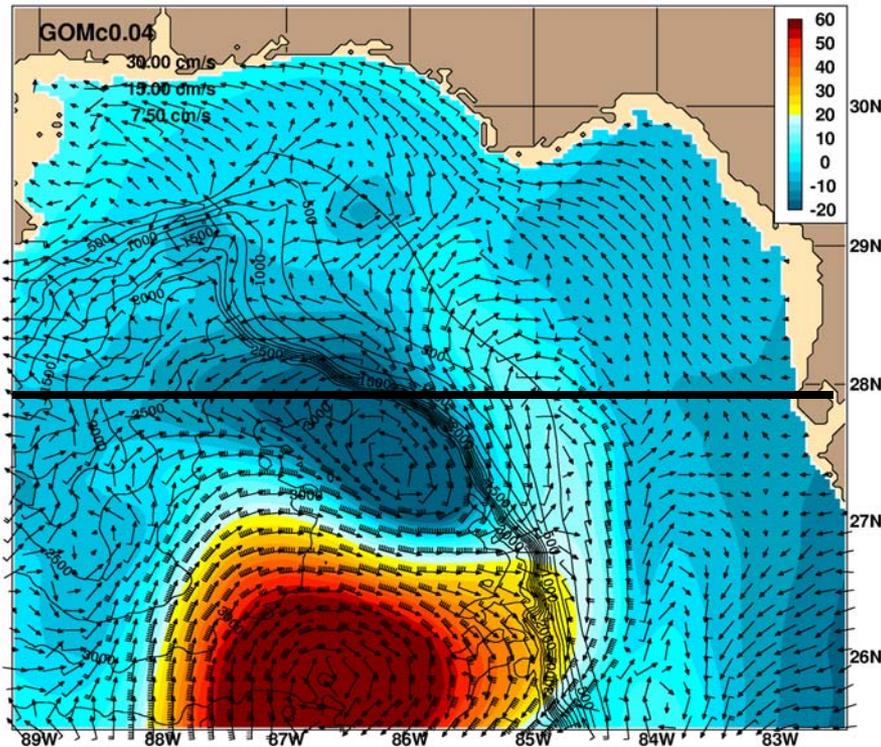
Cyclone also impinging on shelfbreak

- Doming of isopycnals associated with cyclone
- Sharp shelfbreak front
- Intense northward subsurface jet

# 1/25° Nested Gulf of Mexico HYCOM (GISS)

Red=north  
Blue=south

## March 01, 2000 SSH and Surface Currents



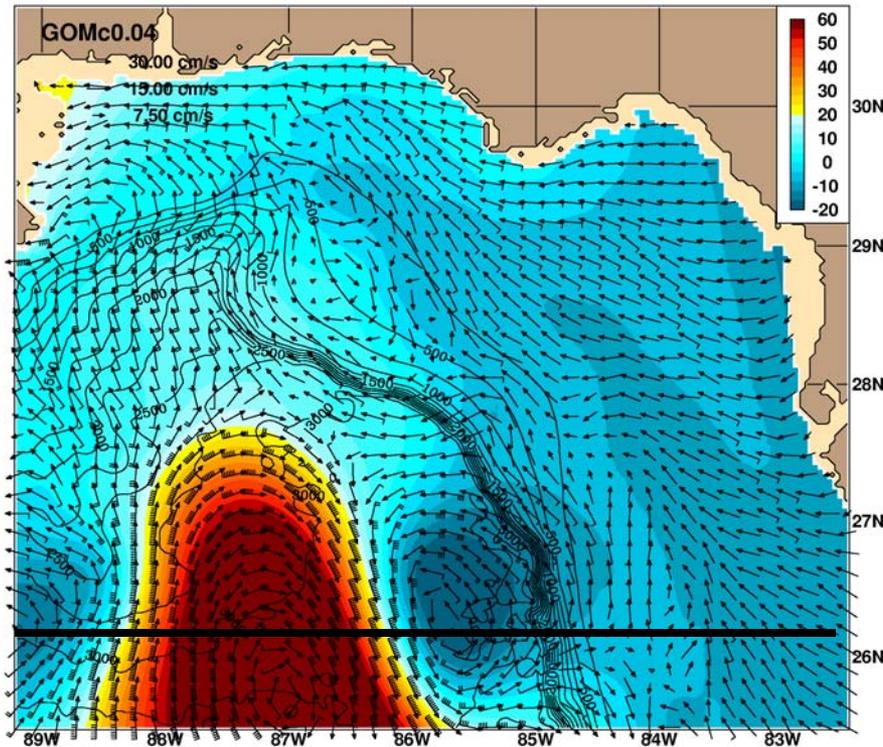
- Cyclone orbiting Loop Current Eddy,
- Loop Current Eddy breaching shelf break
- Southward flow enhanced by vortex compression?

Southward subsurface velocity maximum

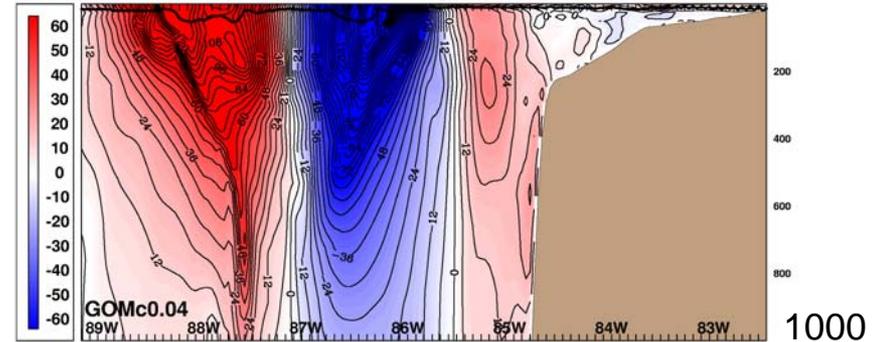
# 1/25° Nested Gulf of Mexico HYCOM (GISS)

Red=north  
Blue=south

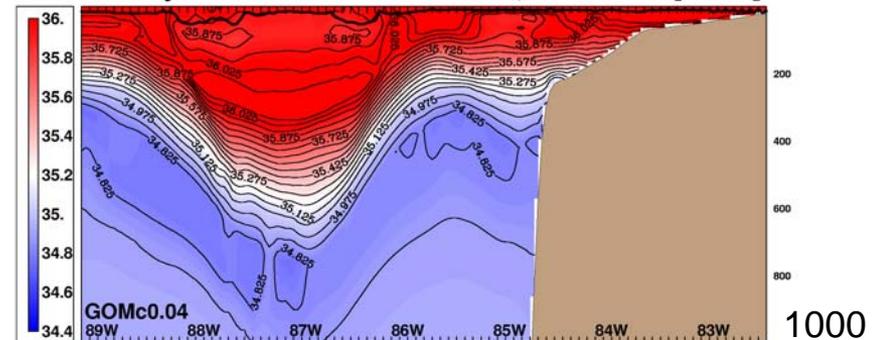
## June 02, 2000 SSH and Surface Currents



v-velocity zonal sec. 26.16n Jun 01, 2000 00Z [01.6H]



salinity zonal sec. 26.16n Jun 01, 2000 00Z [01.6H]



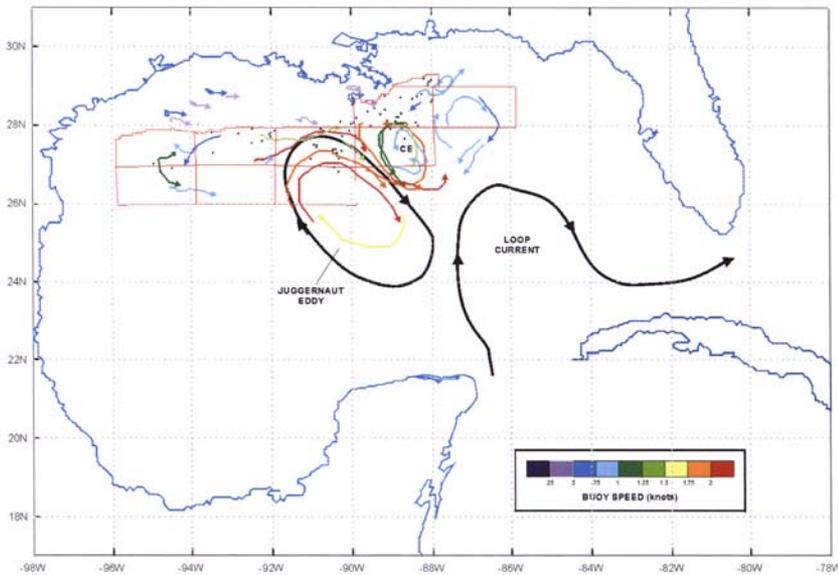
3 months later cyclone hasn't migrated very far but is being steered by the shelf break

- Strange symmetry of LCE especially on western side
- Subsurface salinity max beneath LCE

# 1/12° Assimilative Gulf of Mexico Model

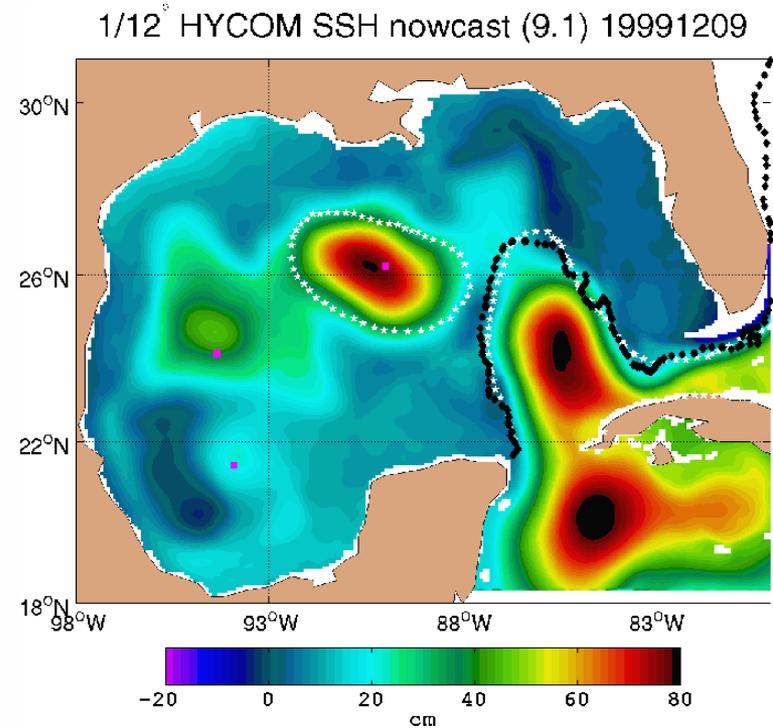
- Participation in DeepStar (Oil Co. Consortium) forecast study
- Hindcast run 1999-2000 (Eddy Juggernaut period)
- Assimilates MODAS analysis of SSH
- SST is relaxed toward MCSST
- 6 hourly NOGAPS winds used for entire forecast period
- 14 4-week forecast periods
- Validation via distance to 18°C isotherm at 200m for both Eddy Juggernaut and the Loop Current

# Comparison of Nowcast to Observations



Horizon Marine, Inc. EDDY WATCH – CONFIDENTIAL 12/09 (343) – 12/16 (350), 1999  
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Eddy Watch Analysis 12/09 – 12/16/99

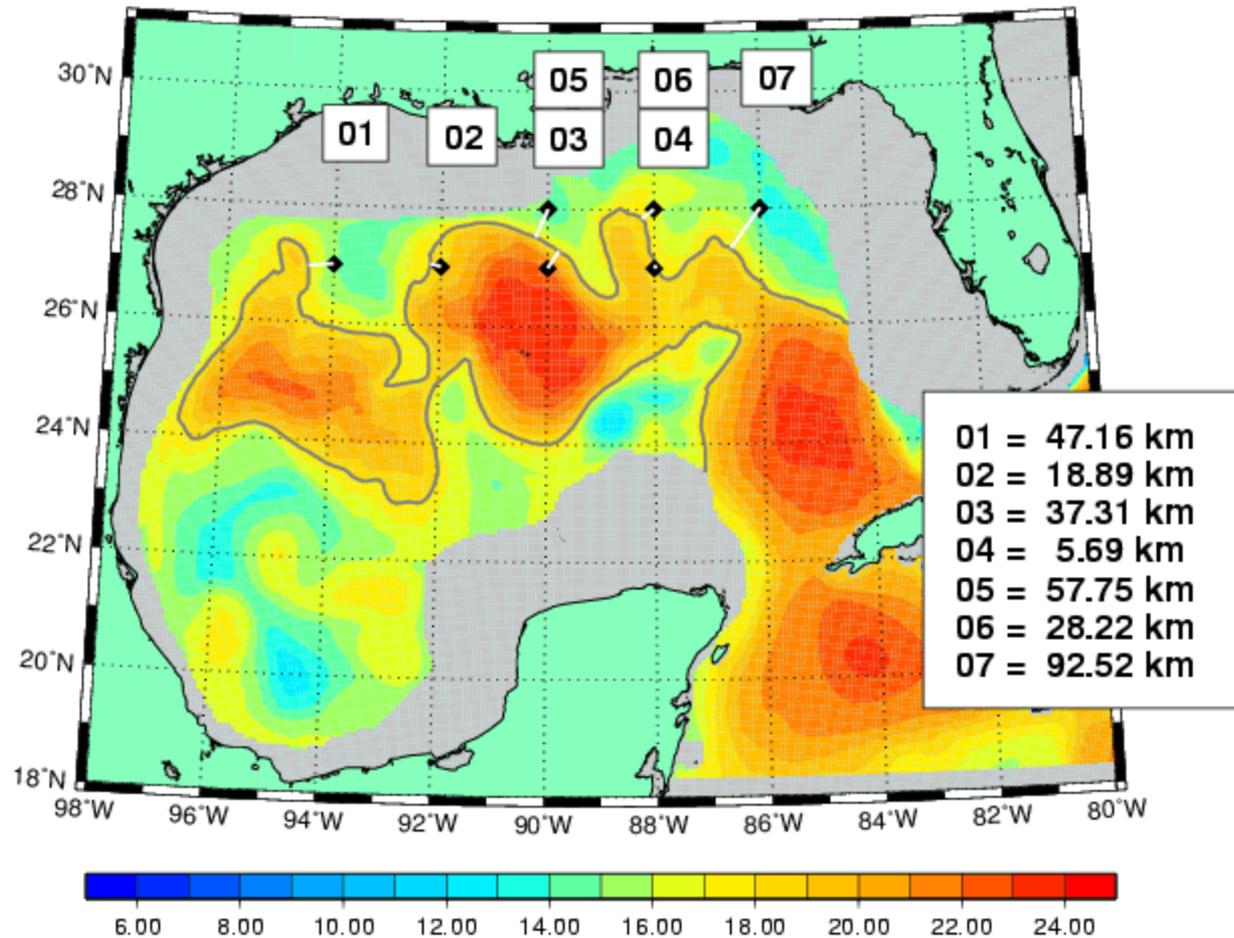


1/12° HYCOM Nowcast 12/09/99

White=Eddy Watch frontal analysis  
Black=NAVO MCSST analysis

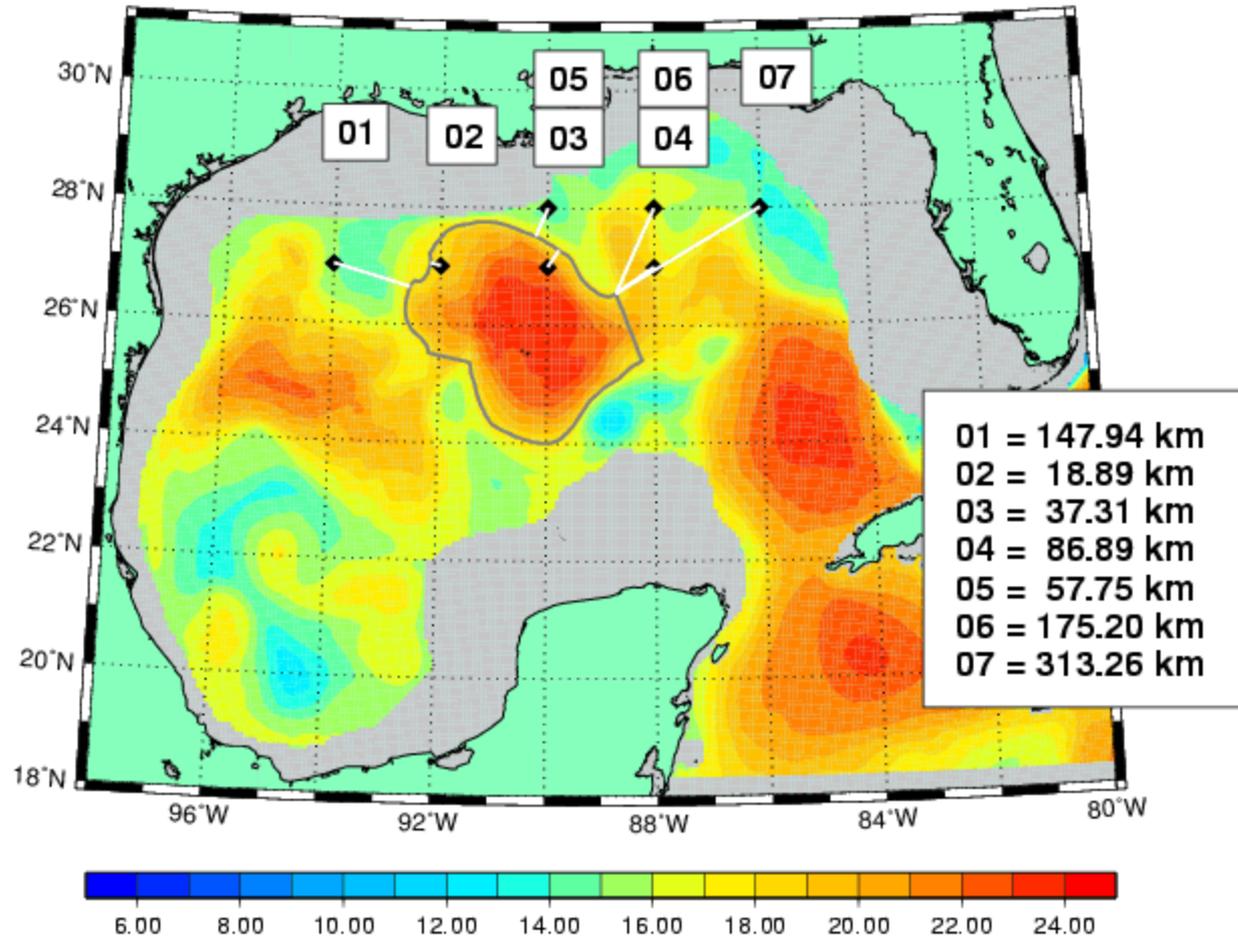
## 2-week forecast on 12-22-1999

(14 forecast periods)(4 1-week forecasts)(7 distances) = 392 distance measurements



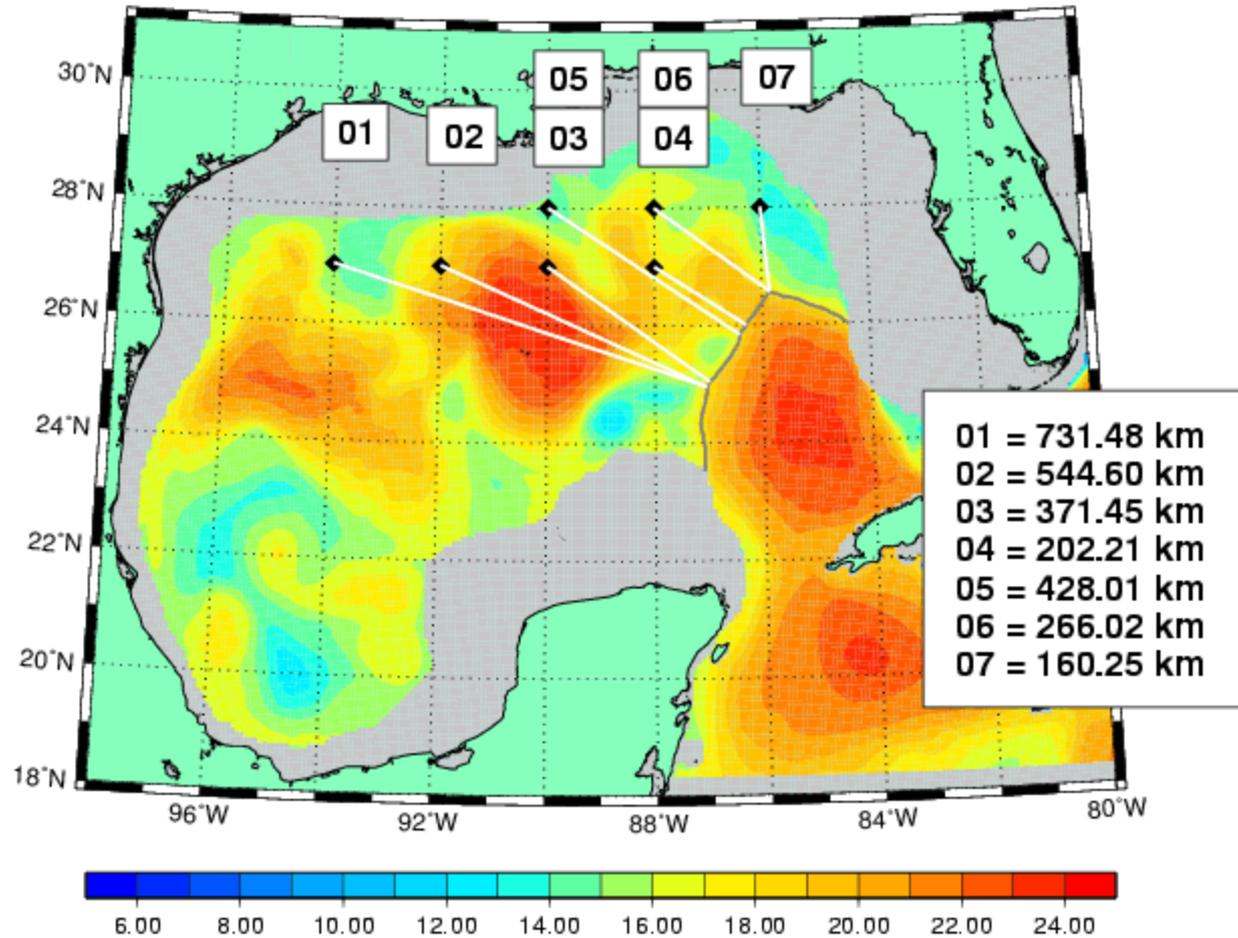
Grey = 18°C isotherm at 200m (automated algorithm)

# 2-week forecast on 12-22-1999



Manually edited to highlight Eddy Juggernaut

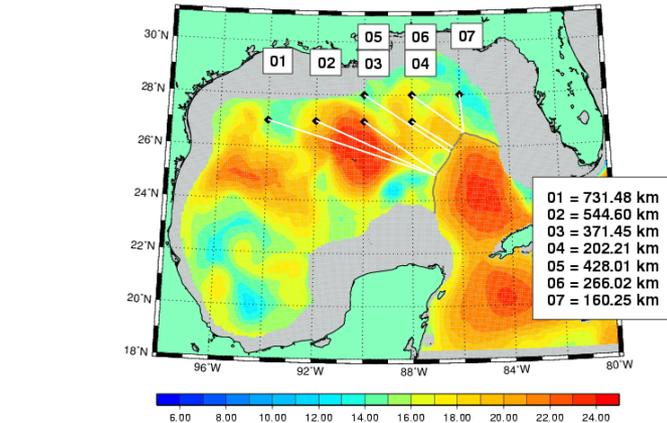
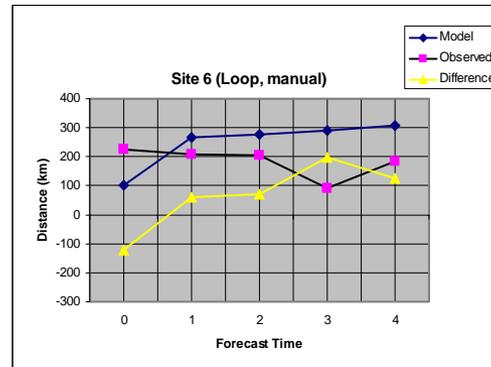
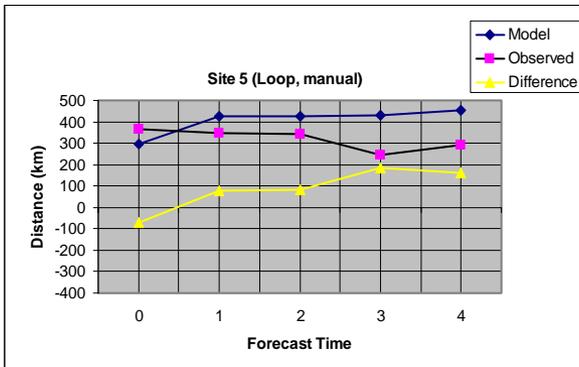
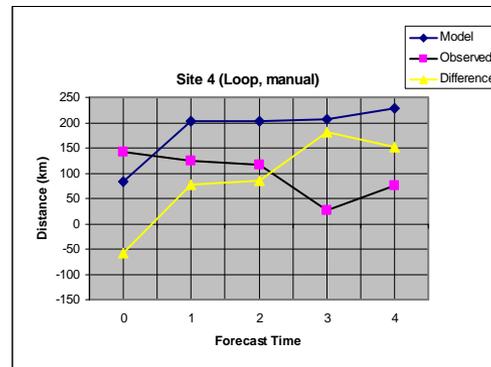
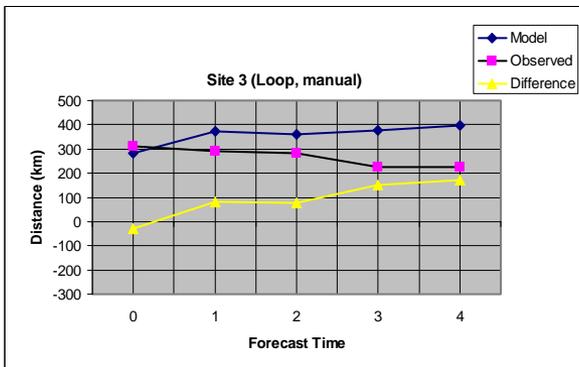
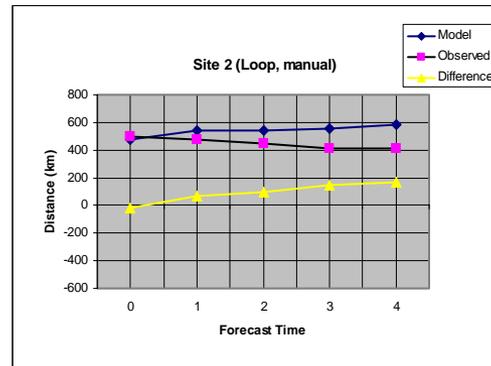
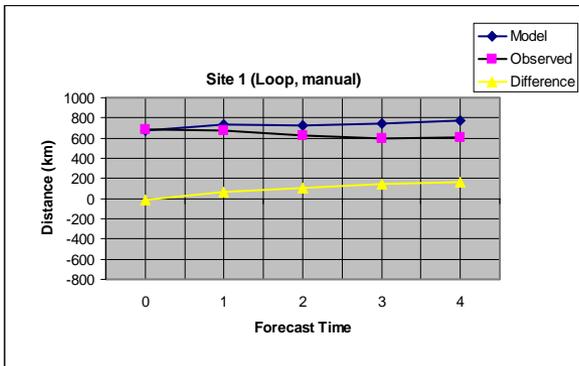
2-week forecast on 12-22-1999  
based on 18°C at 200m



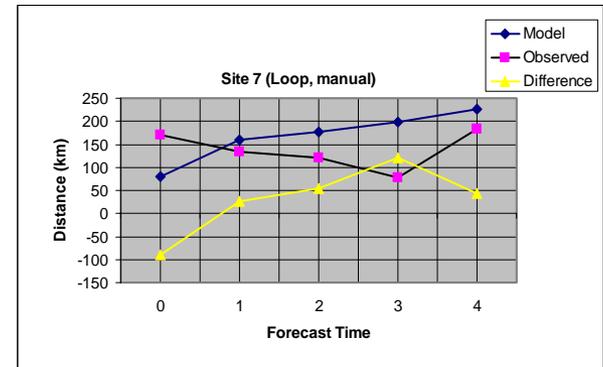
Manually edited to highlight Loop Current

# Distance to the Loop Current\* vs. Forecast Length: Model vs. Observations

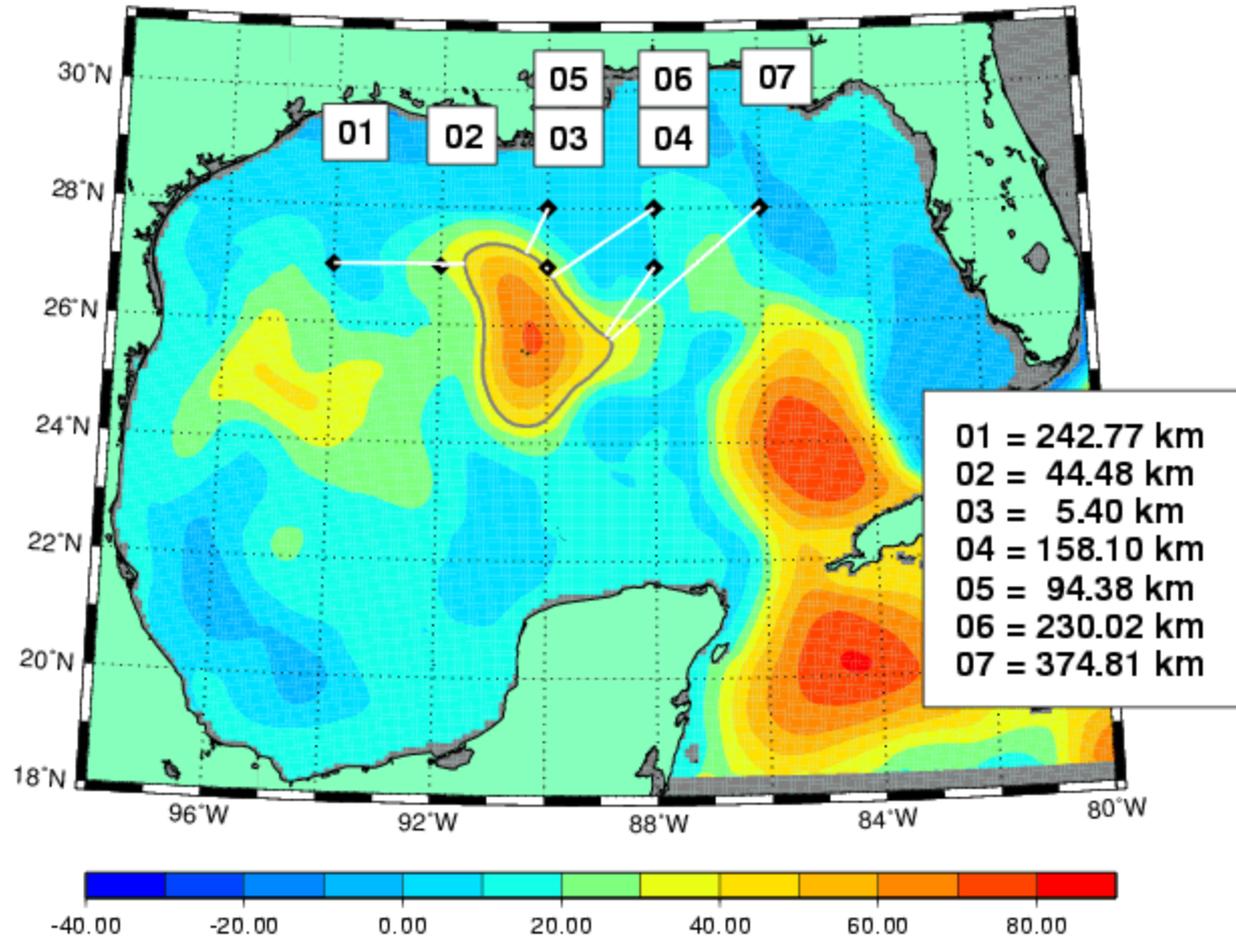
\*With manual intervention



Nowcast is 12/15/99

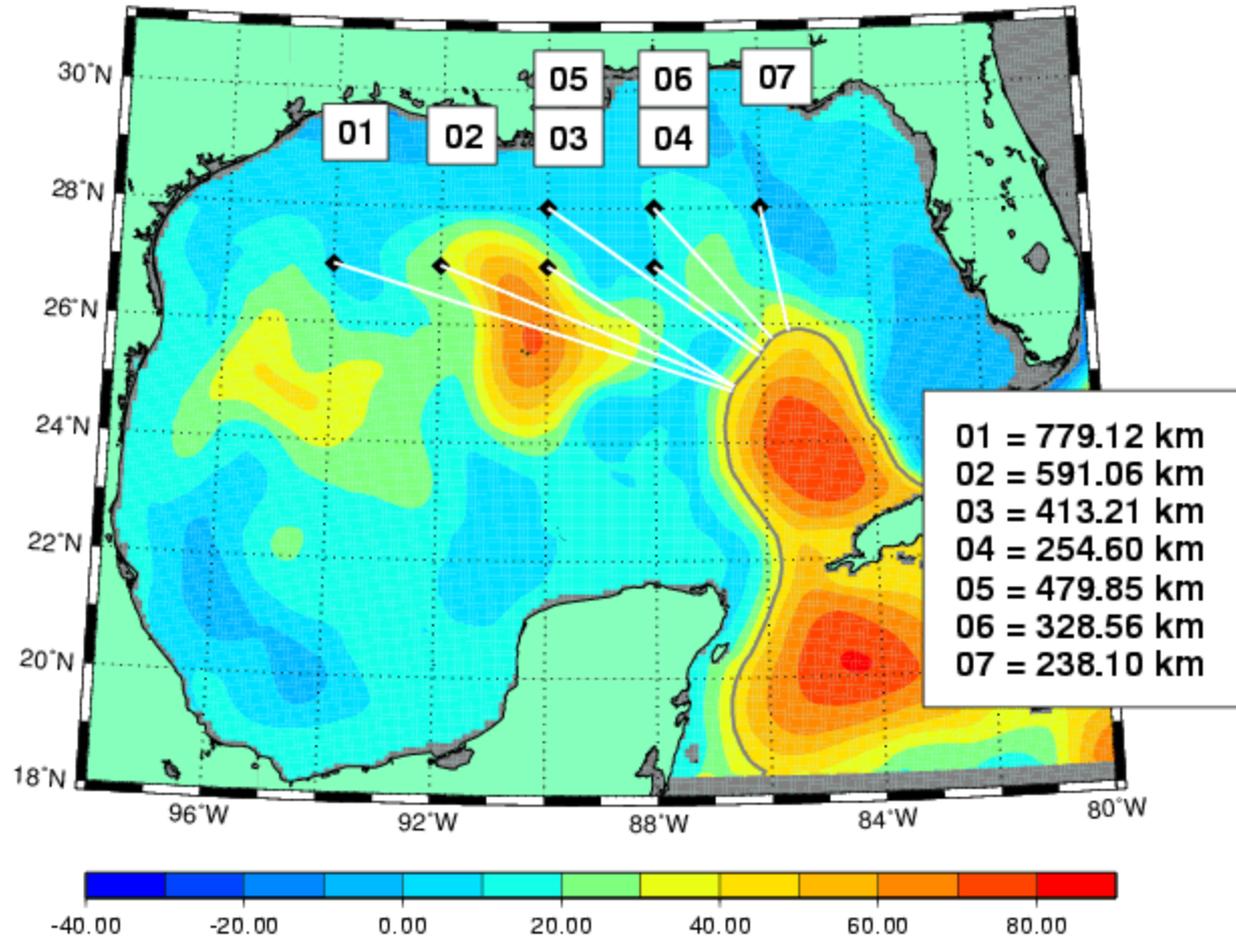


2-week forecast on 12-22-1999  
based on 40cm SSH anomaly



Distance from each station to Eddy Juggernaut

2-week forecast on 12-22-1999  
based on 40cm SSH anomaly



Distance from each station to the Loop Current

# Future Plans

- Nested NE GoM inside nested GoM (3x, ~1.3 km)
- Improved boundary conditions from Atlantic (sigma-2\*)
- 9 km COAMPS surface forcing
- MVOI based assimilation

