

Nested Gulf of Mexico Modeling with HYCOM

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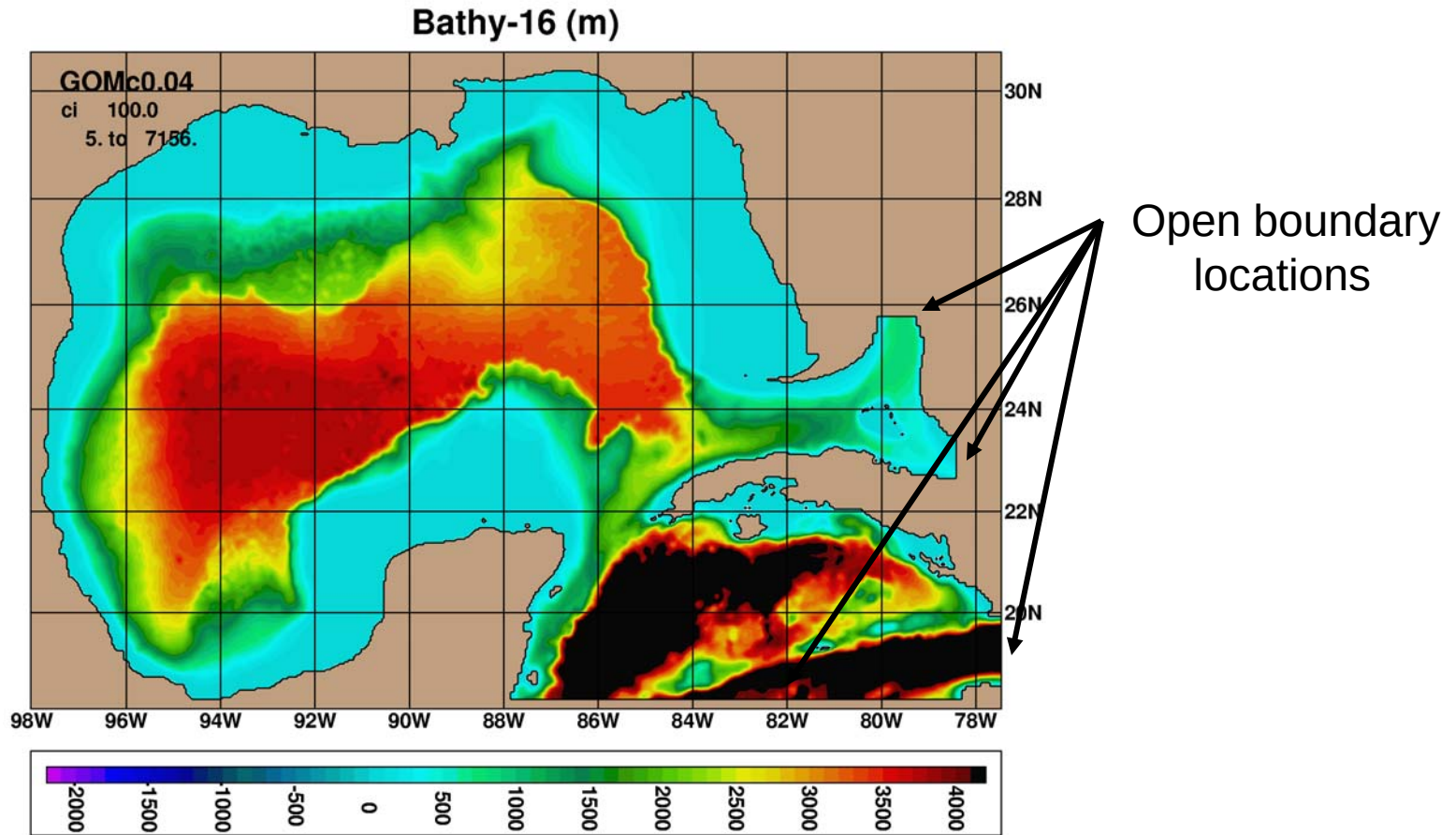
Brief Outline

- 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)



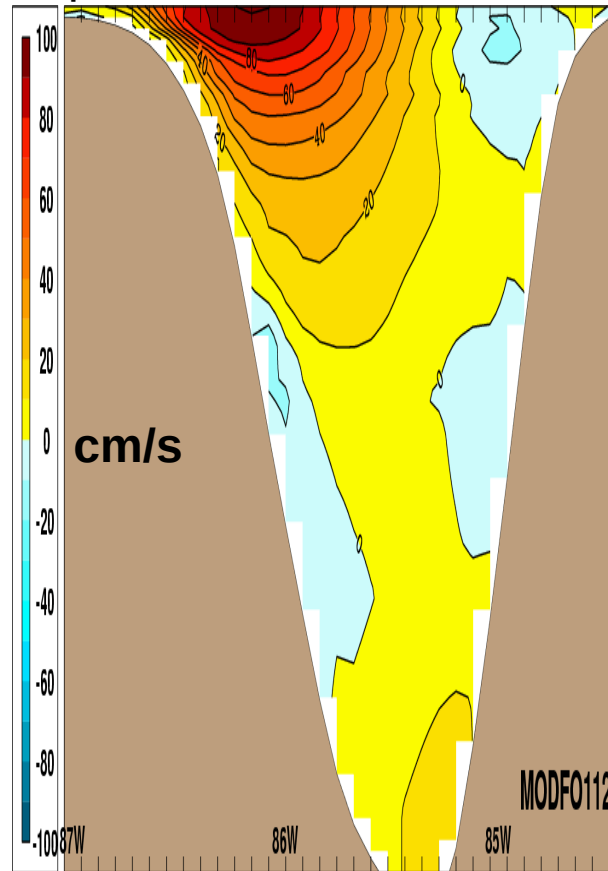
Method of Characteristics used
To update the barotropic mode

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

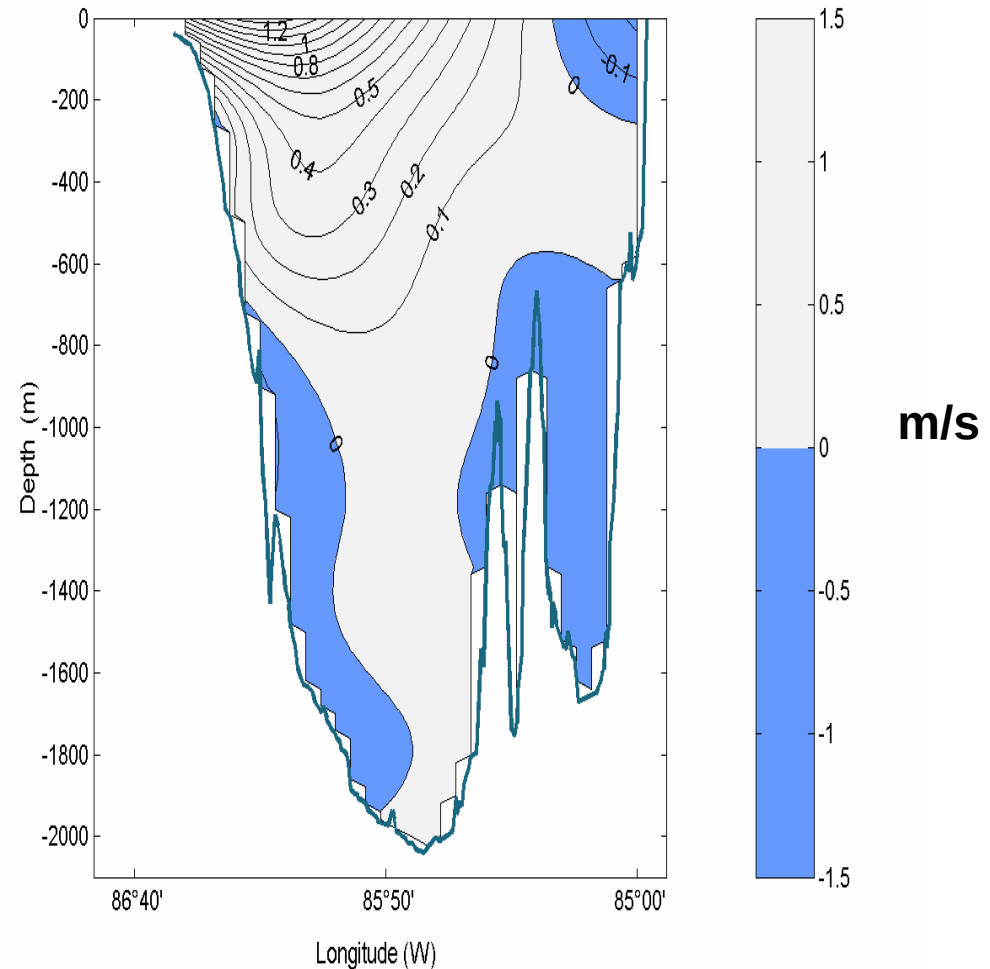
Atlantic boundary data provided daily

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 σ_θ MPDATA Atlantic simulation

1/25° Free-Running Gulf of Mexico HYCOM

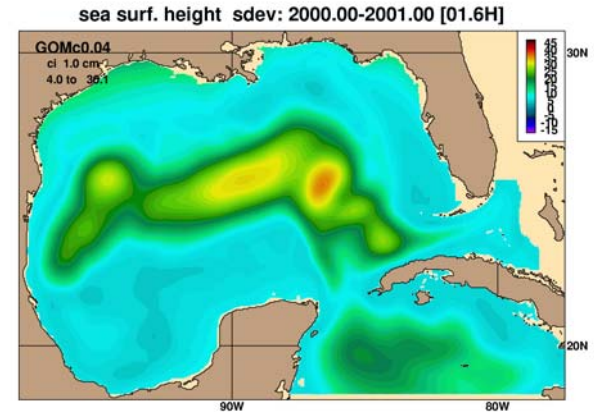
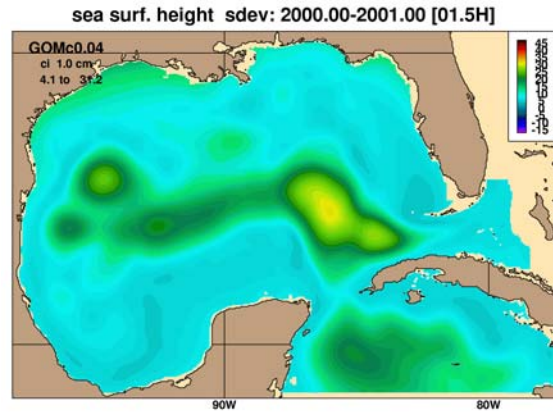
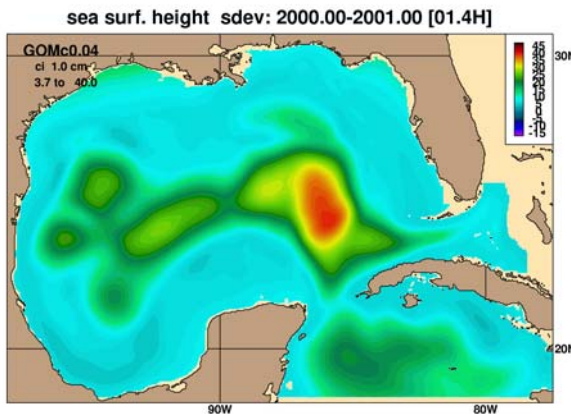
RMS SSH Variability

KPP

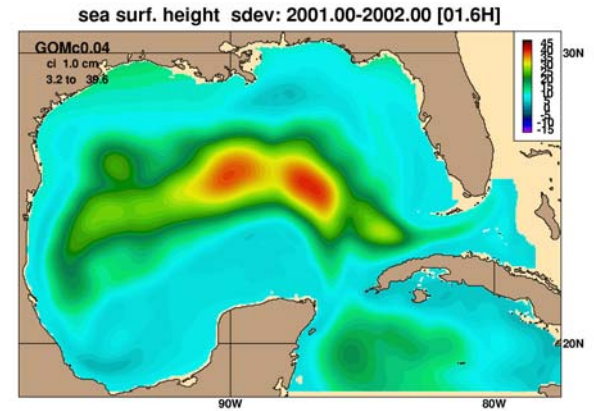
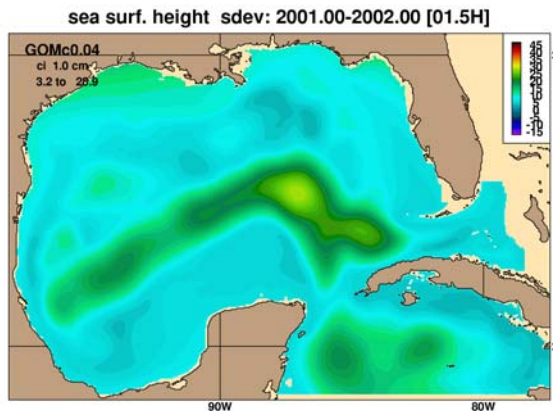
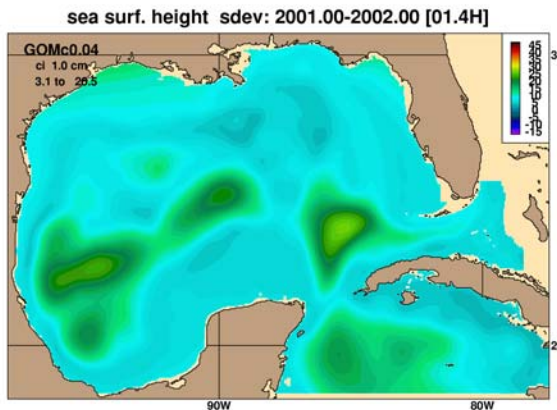
MY-2.5

GISS

2000



2001



KPP variability low in 2001

MY-2.5 variability low in 2000 and 2001

Need longer time series for meaningful statistics

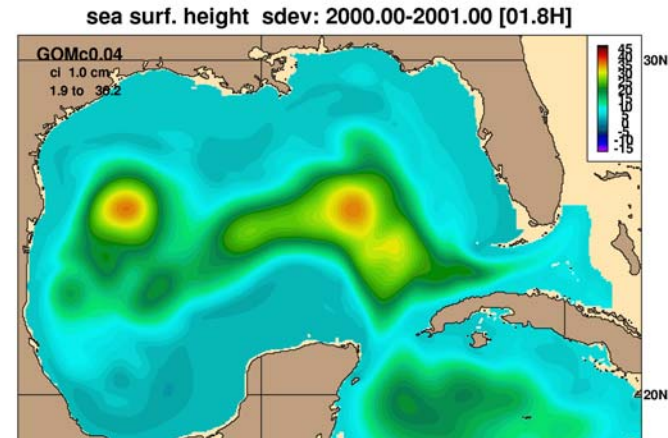
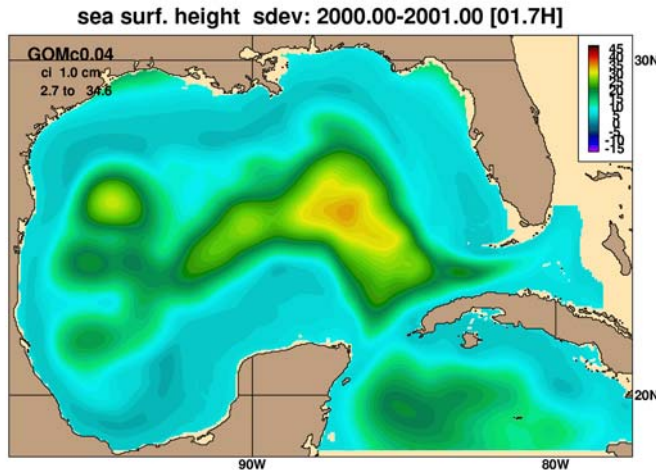
1/25° Nexted Gulf of Mexico HYCOM

RMS Sea Surface Height Variability

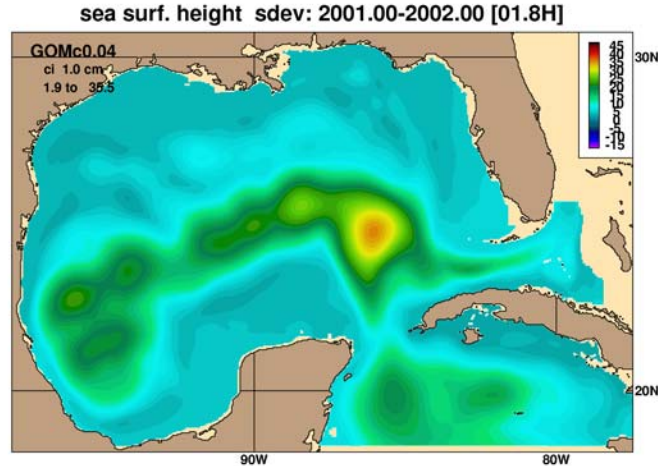
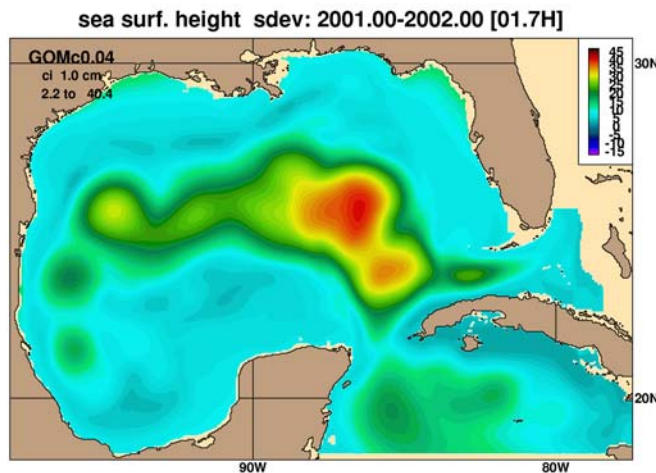
No Mixed Layer*

No Mixed Layer, No Winds

2001



2000

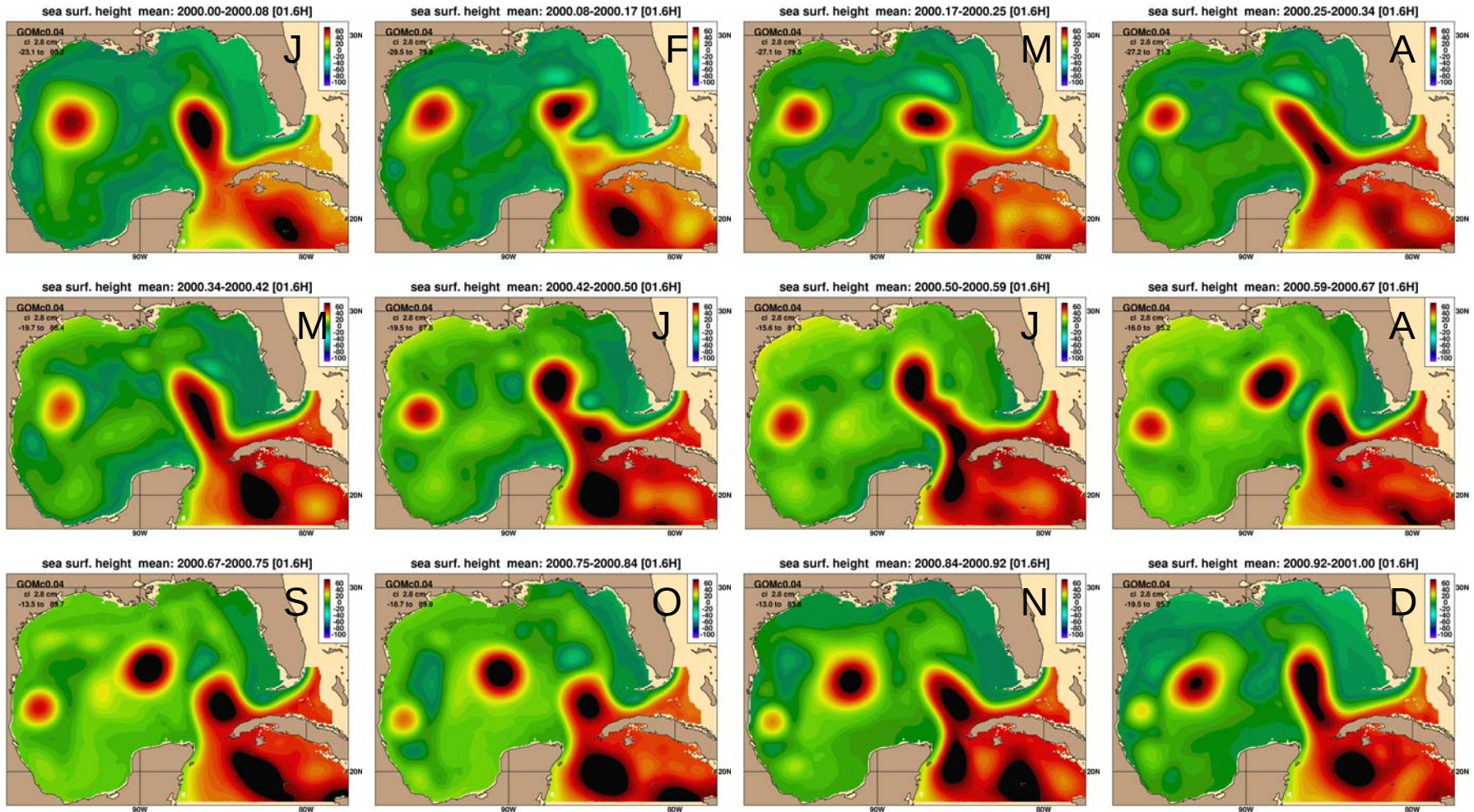


Demonstrates that mixed layer, winds don't impact LCE shedding dynamics

*includes background diapycnal diffusion

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

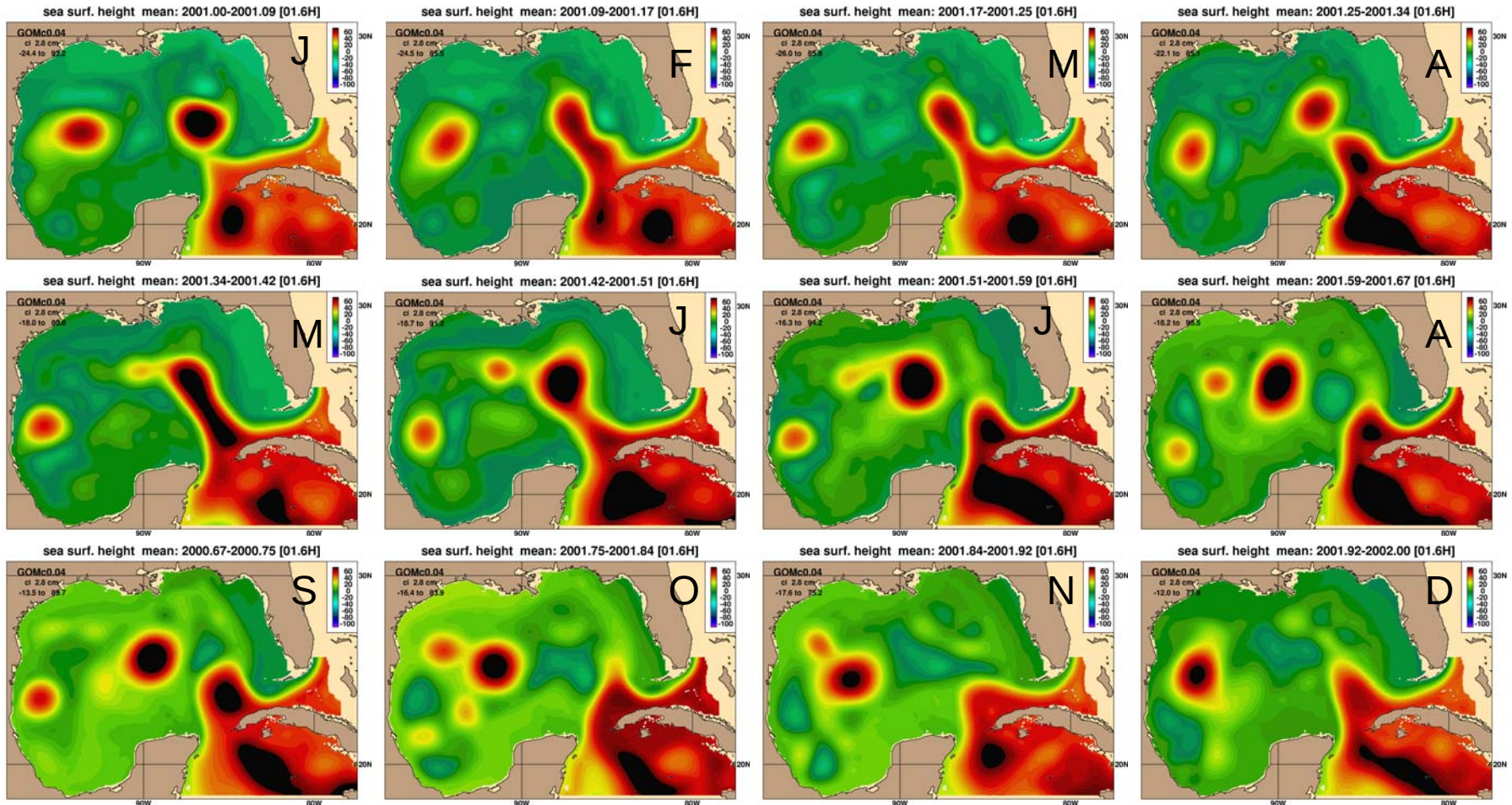
Monthly Mean Sea Surface Height Year 2000



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

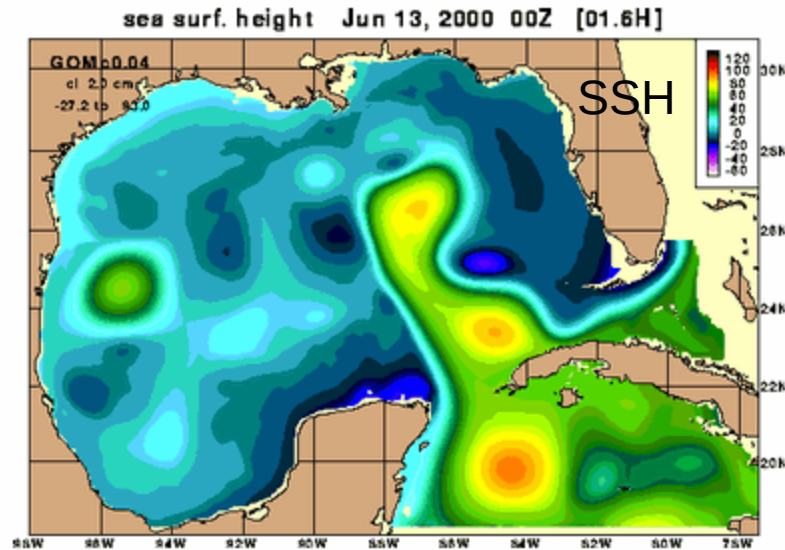
1/25° Nested Gulf of Mexico HYCOM (GISS)

Monthly Mean Sea Surface Height Year 2001

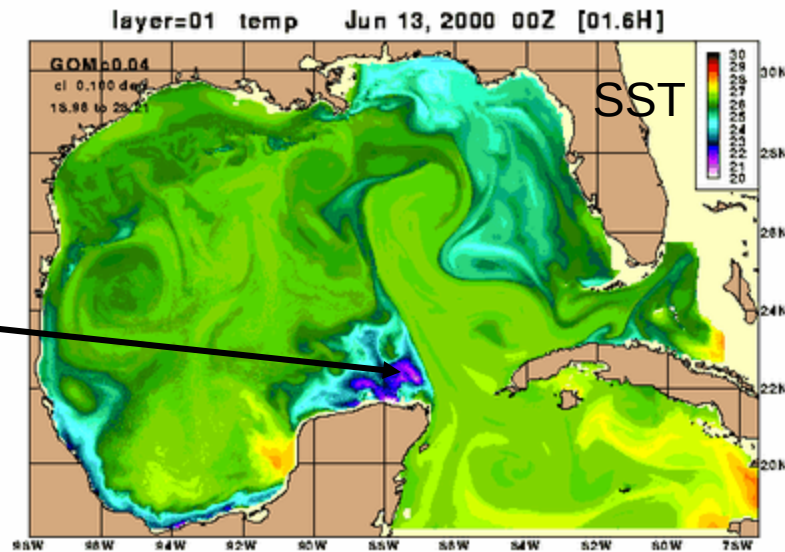


Loop Current Eddy sheds 10 months later (July 2001)
Detached eddy reabsorbed in several cases

1/25° Nested Gulf of Mexico (GISS)



Lots of cyclonic
cold core eddies

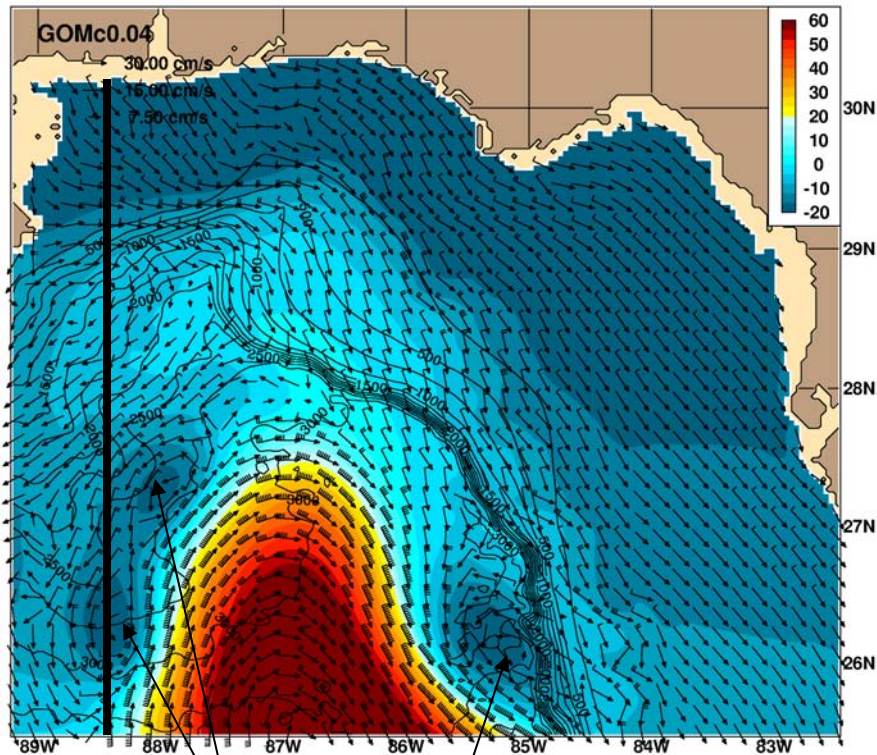


upwelling



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

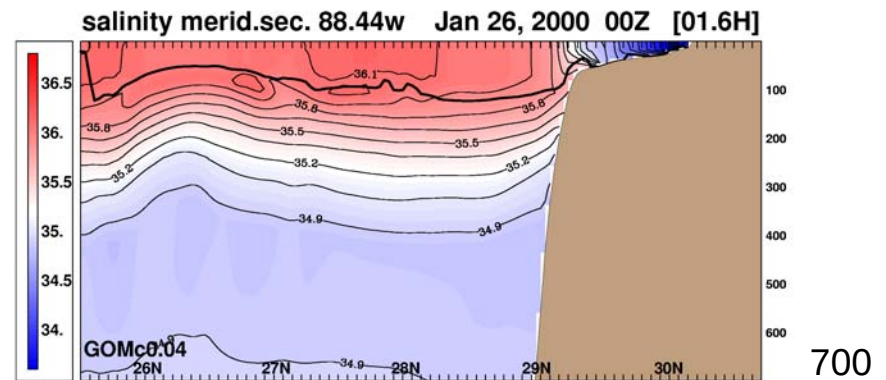
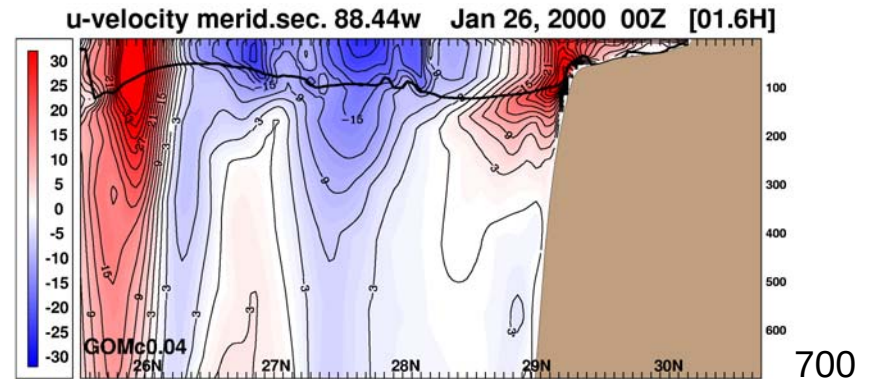
Jan 026 2000 SSH and Surface Currents



cyclones

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

Cross-section along 88.4°W



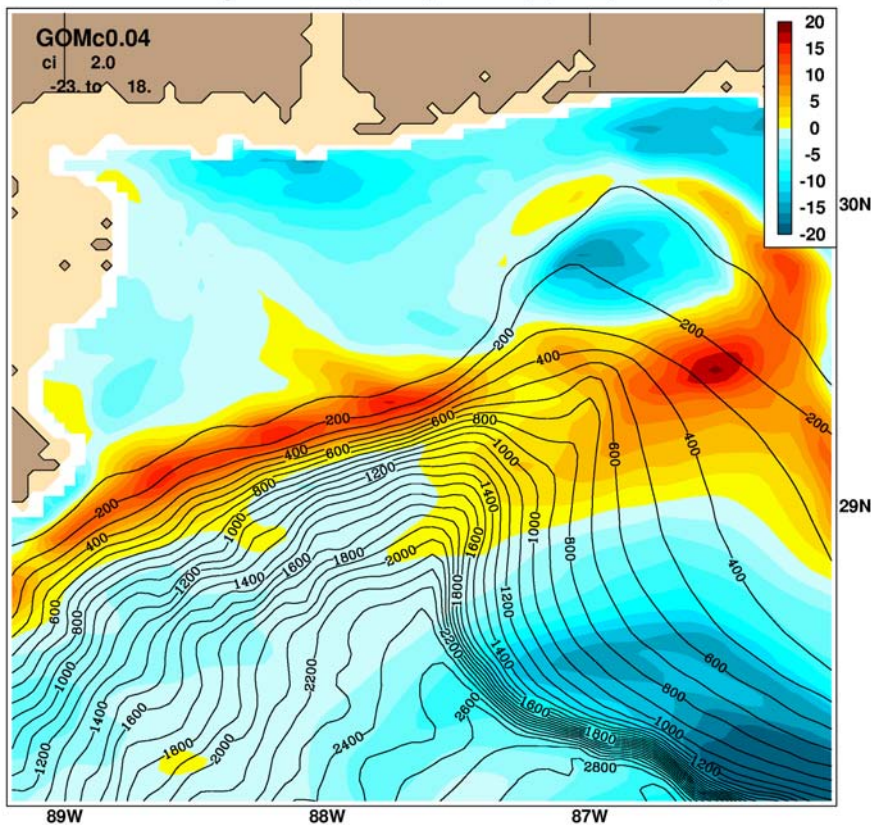
Red=east
Blue=west

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

Barotropic u-velocity

red=east blue=west

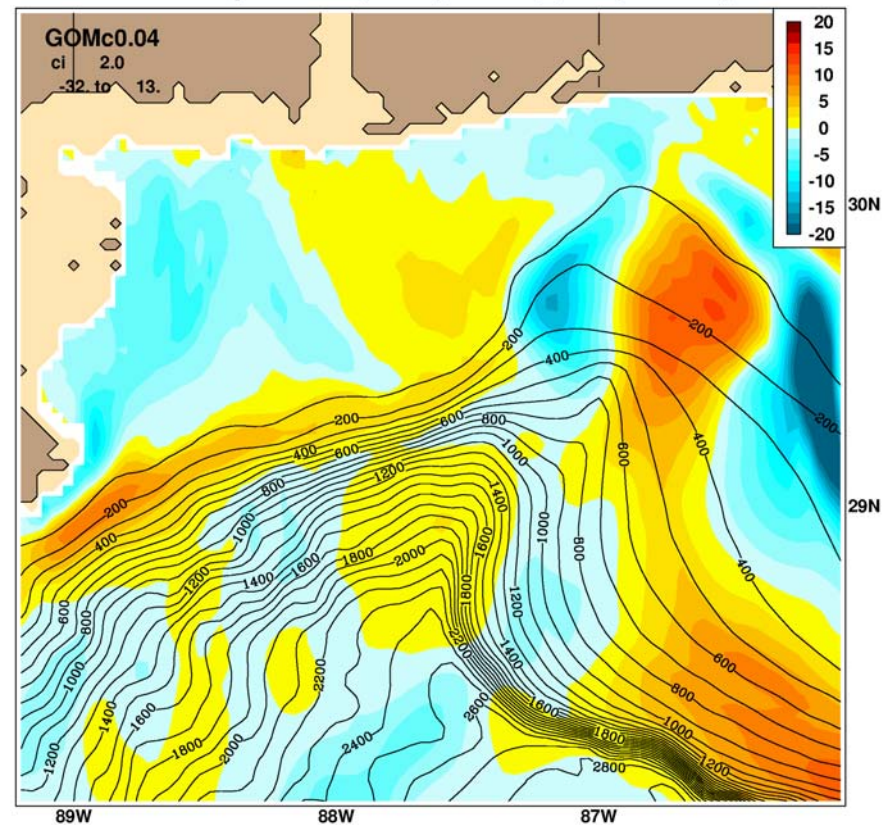
Barotropic u-vel (cm/s) - 2000_049 (archive)



Barotropic v-velocity

red=north blue=south

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

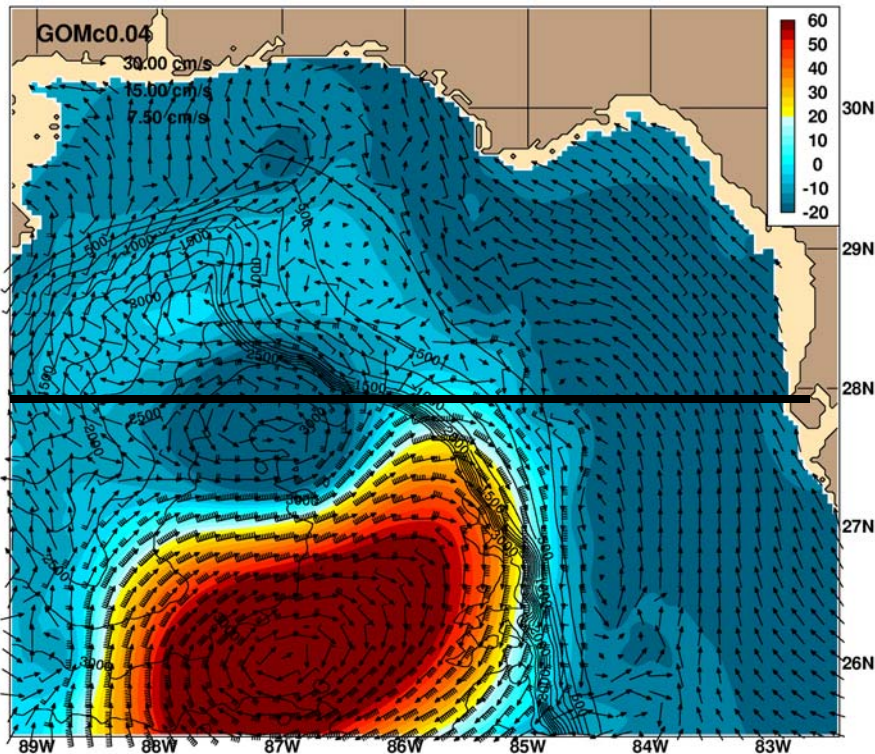


Note topo-trapped cyclone at head of DeSoto Canyon

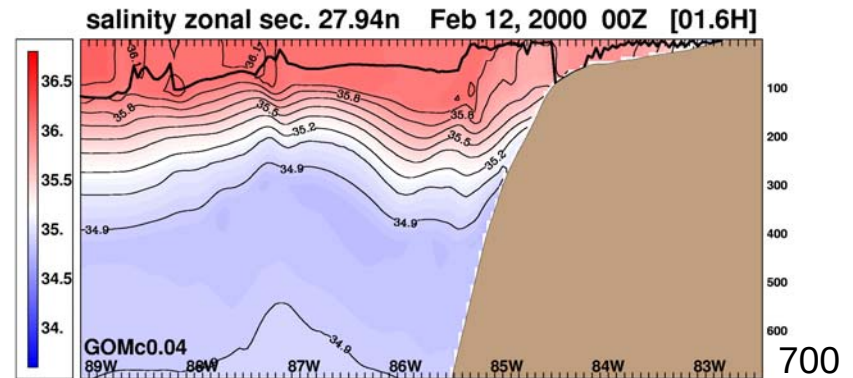
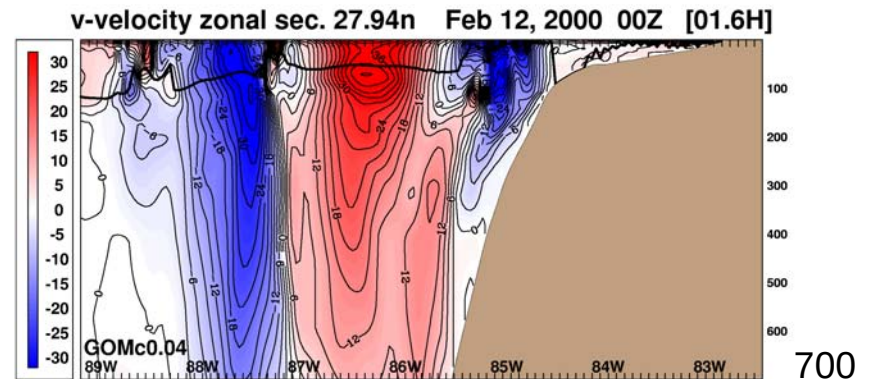
1/25° Nested Gulf of Mexico HYCOM (GISS)

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

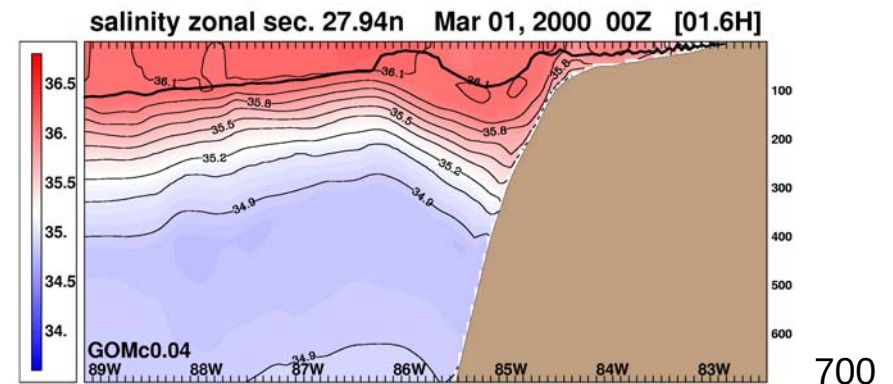
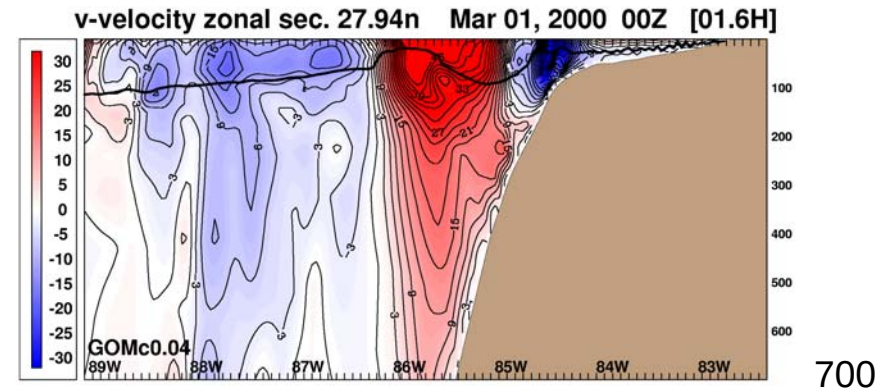
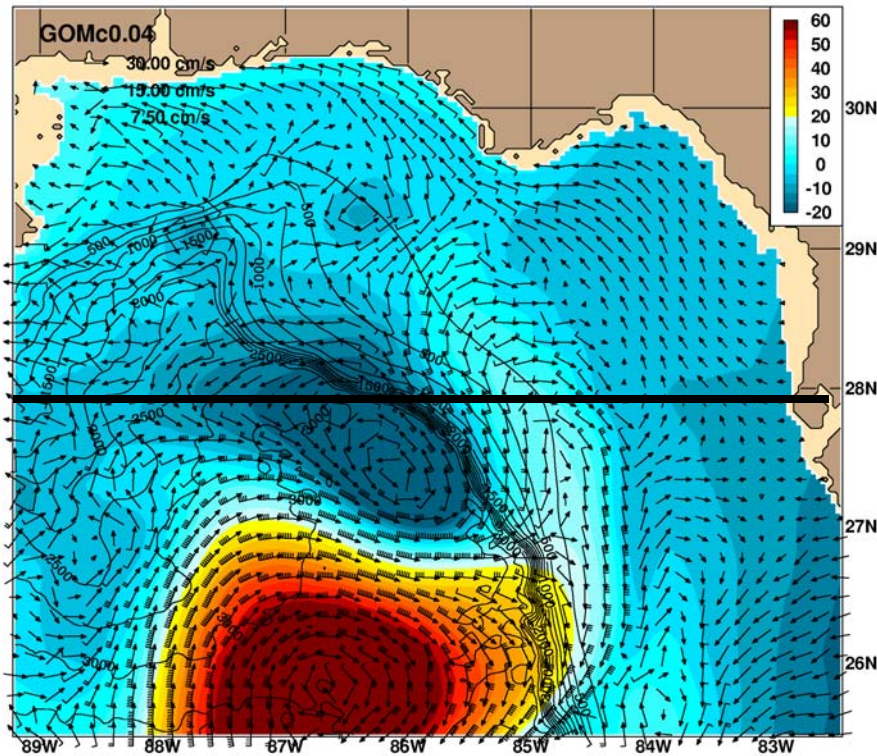
Cyclone also impinging on shelfbreak

- 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



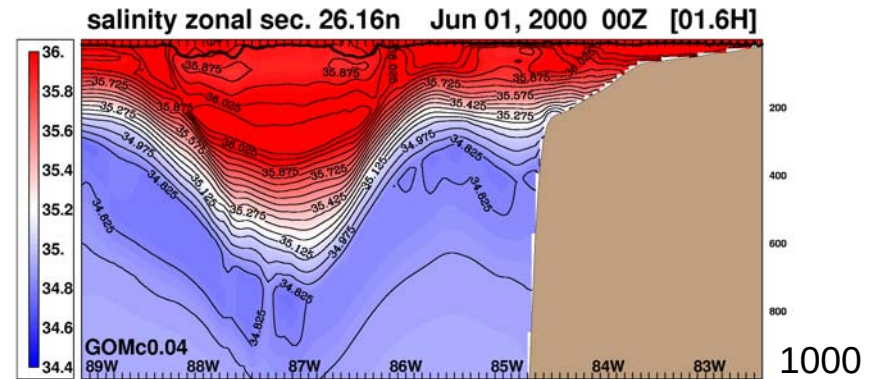
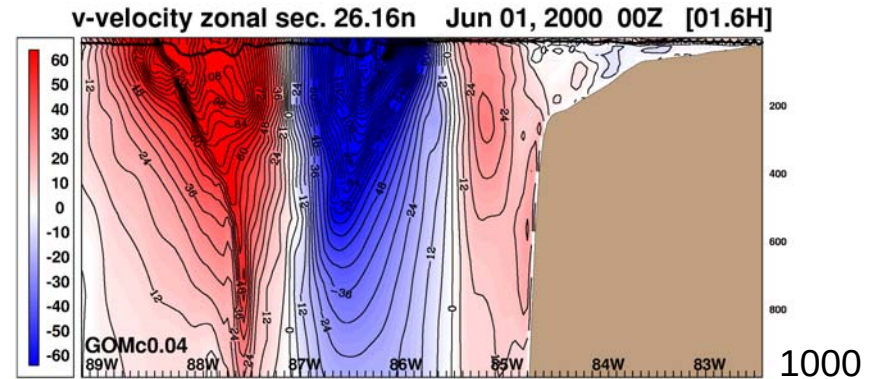
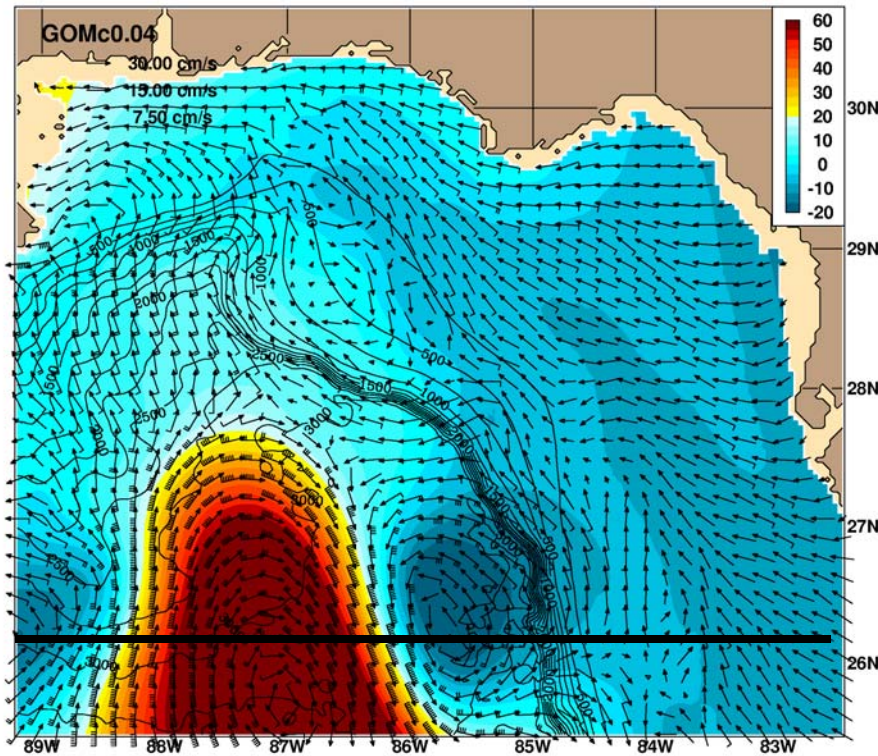
- Cyclone orbiting Loop Current Eddy,
- Loop Current Eddy breaching shelf break
- Southward flow enhanced by vortex compression?

Southward subsurface velocity maximum

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

Red=north
Blue=south

June 02, 2000 SSH and Surface Currents



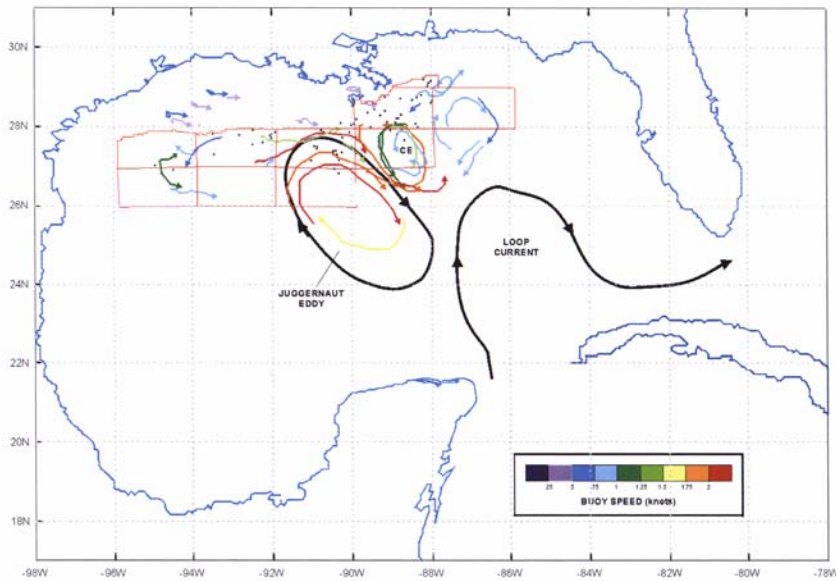
3 months later cyclone hasn't migrated very far but is being steered by the shelf break

- 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



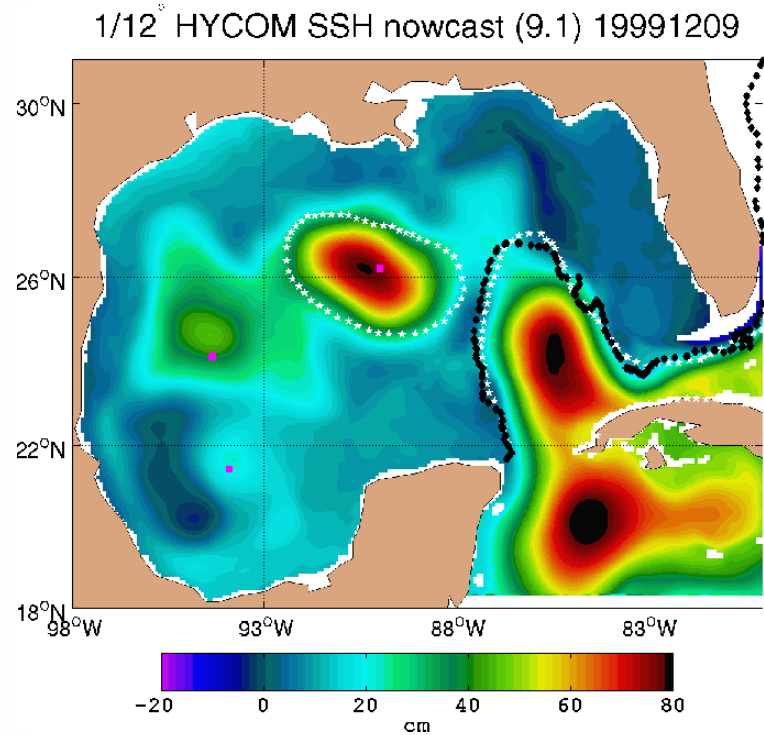
Horizon Marine, Inc.

EDDY WATCH – CONFIDENTIAL

12/09 (343) – 12/16 (350), 1999

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Eddy Watch Analysis 12/09 – 12/16/99

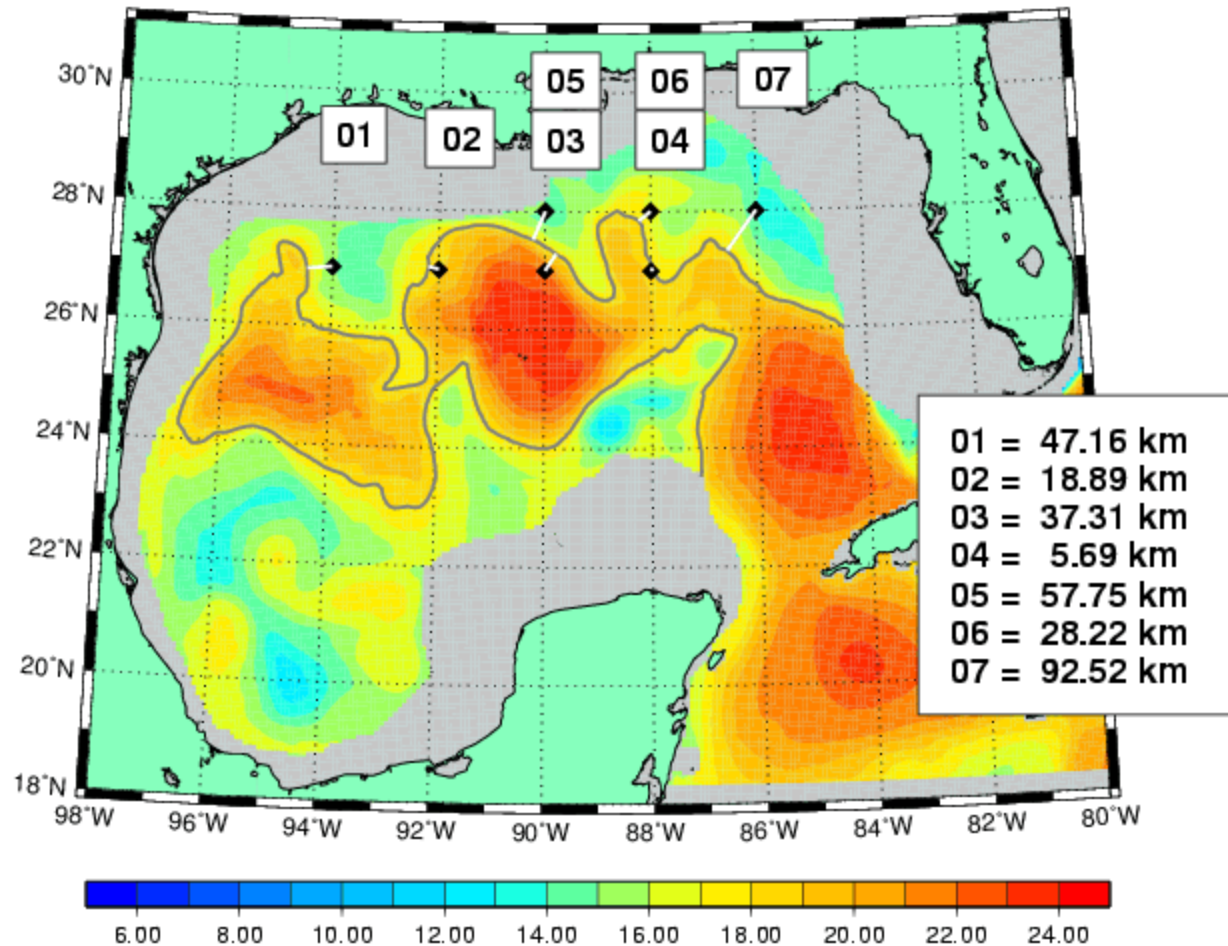


1/12° HYCOM Nowcast 12/09/99

White=Eddy Watch frontal analysis
Black=NAVO MCSST analysis

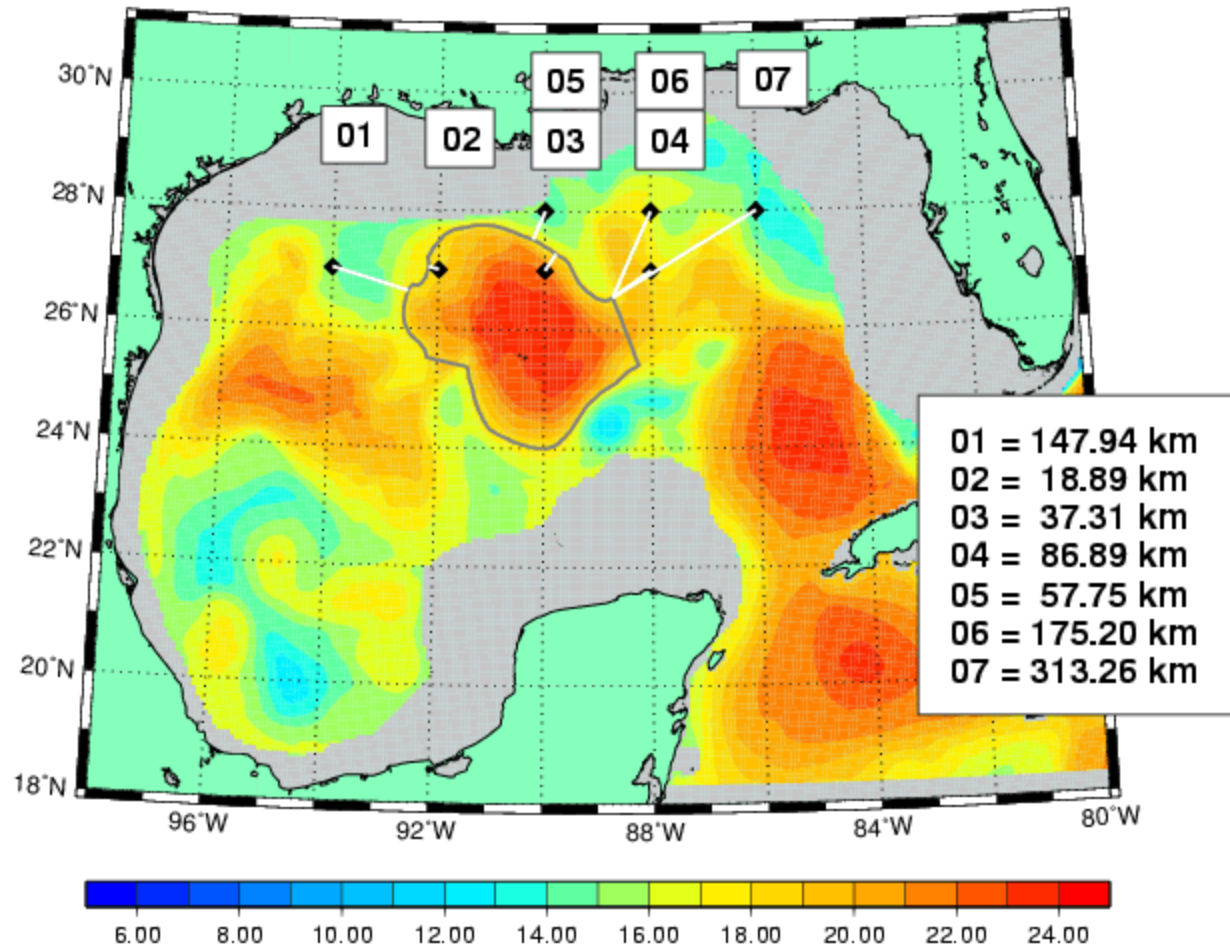
2-week forecast on 12-22-1999

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



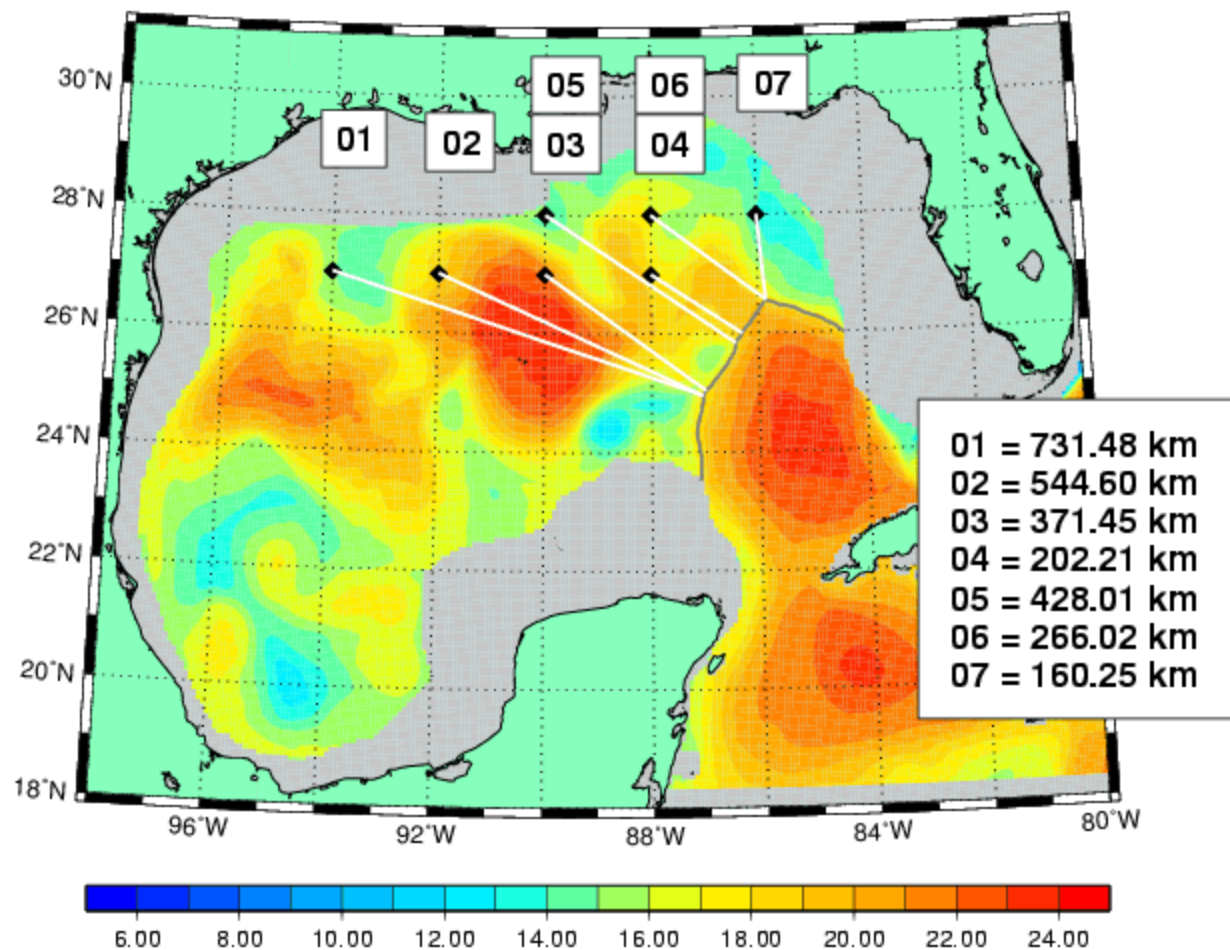
Grey = 18°C isotherm at 200m (automated algorithm)

2-week forecast on 12-22-1999



Manually edited to highlight Eddy Juggernaut

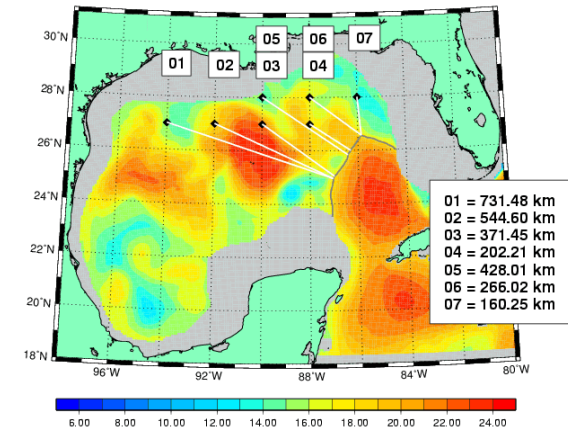
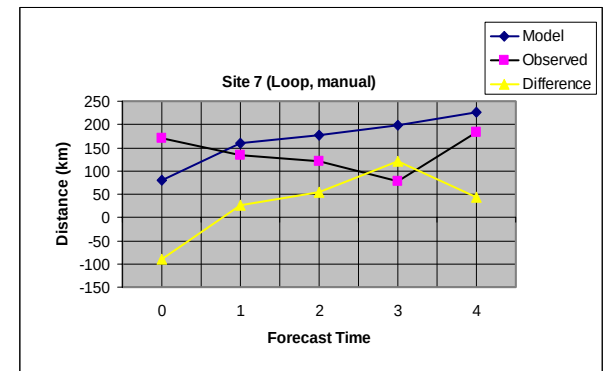
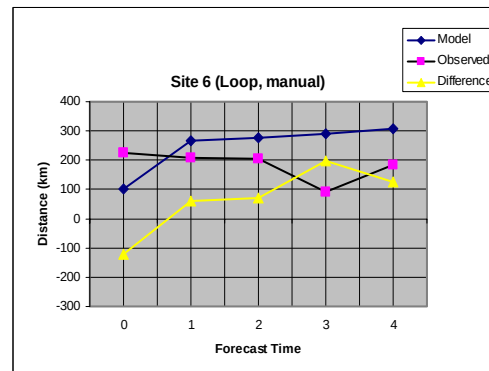
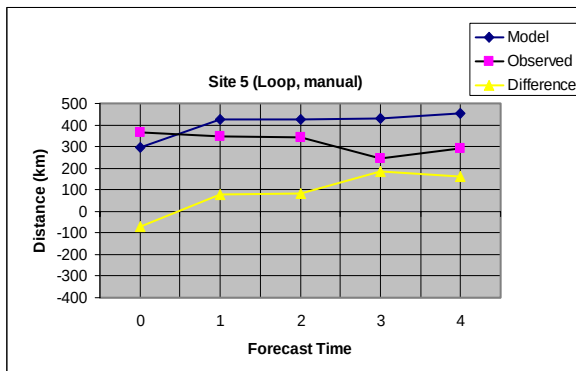
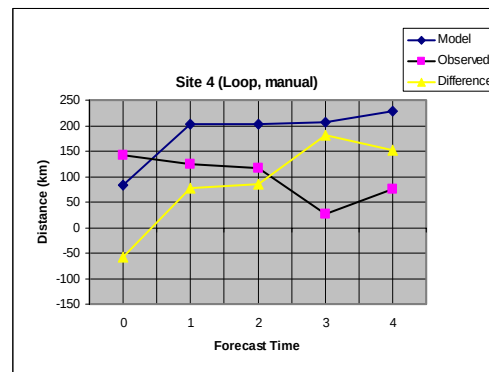
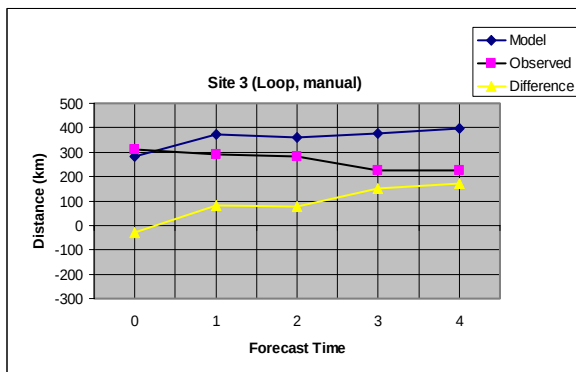
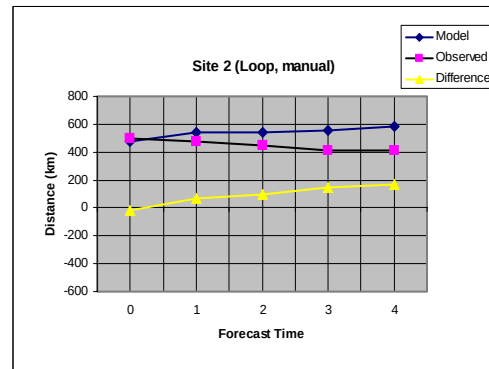
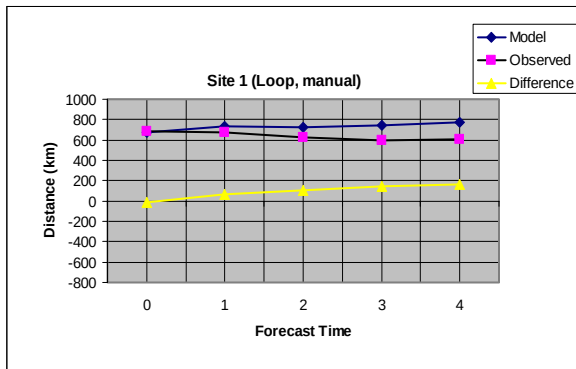
2-week forecast on 12-22-1999
based on 18°C at 200m



Manually edited to highlight Loop Current

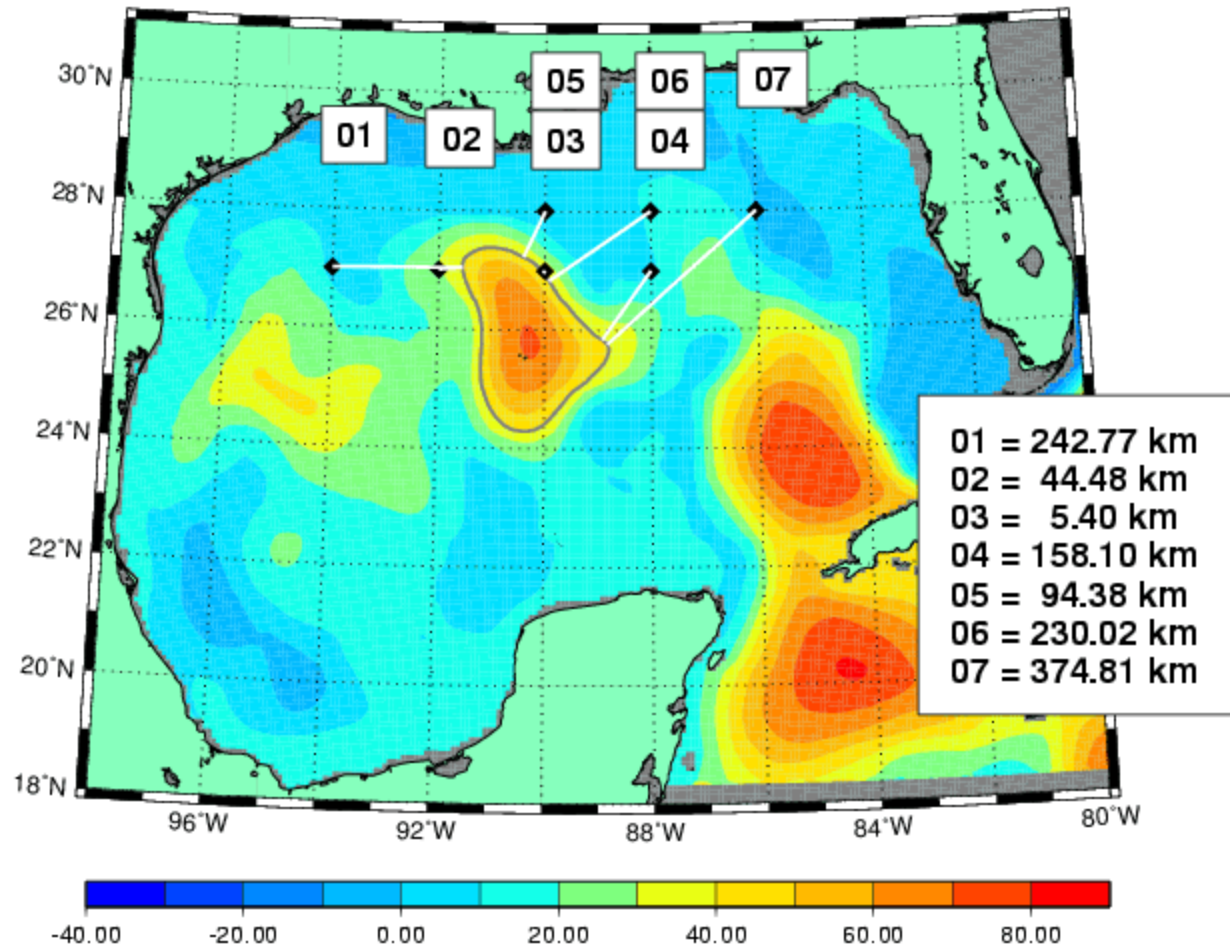
Distance to the Loop Current* vs. Forecast Length: Model vs. Observations

*With manual intervention



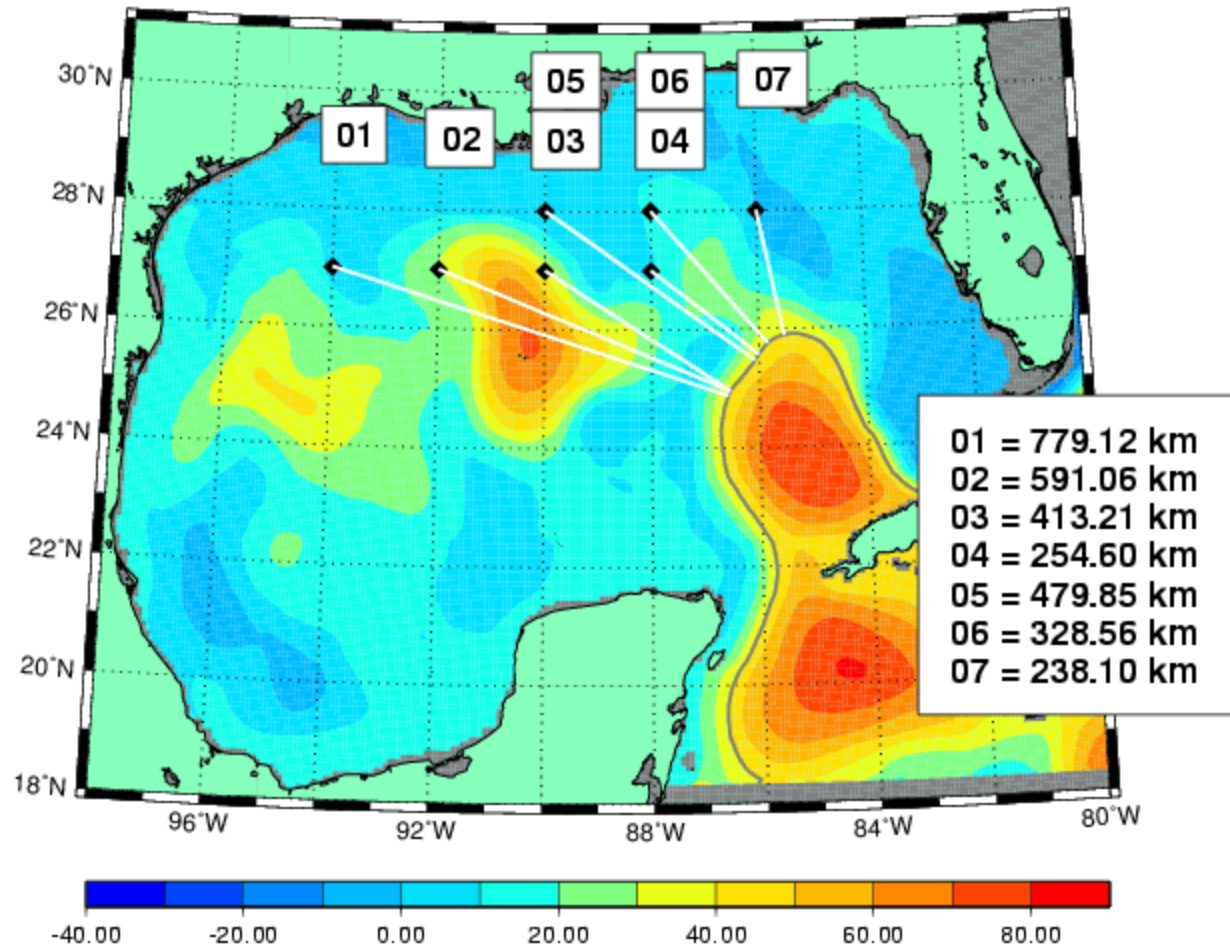
Nowcast is 12/15/99

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

