Real-time HYCOM nowcast/forecast systems

O. M. Smedstad
Planning Systems Inc.

J. A. Cummings, E. J. Metzger, P. J. Hogan, H. E. Hurlburt,
J. F. Shriver, A. J. Wallcraft
Naval Research Laboratory

E. P. Chassignet
Florida State University

http://www.hycom.org

Present nowcast/forecast systems

1/12º Atlantic near real-time system
- Running once a week since July 2002
- Assimilation: gridded surface observations only
- 10 day hindcast, 14 day forecast

1/25º Gulf of Mexico real time system
- Running since 25 October 2006
- Assimilation: NCODA
- 5 day hindcast, 7 day forecast

1/12º Global real time system
- Running since 22 December 2006
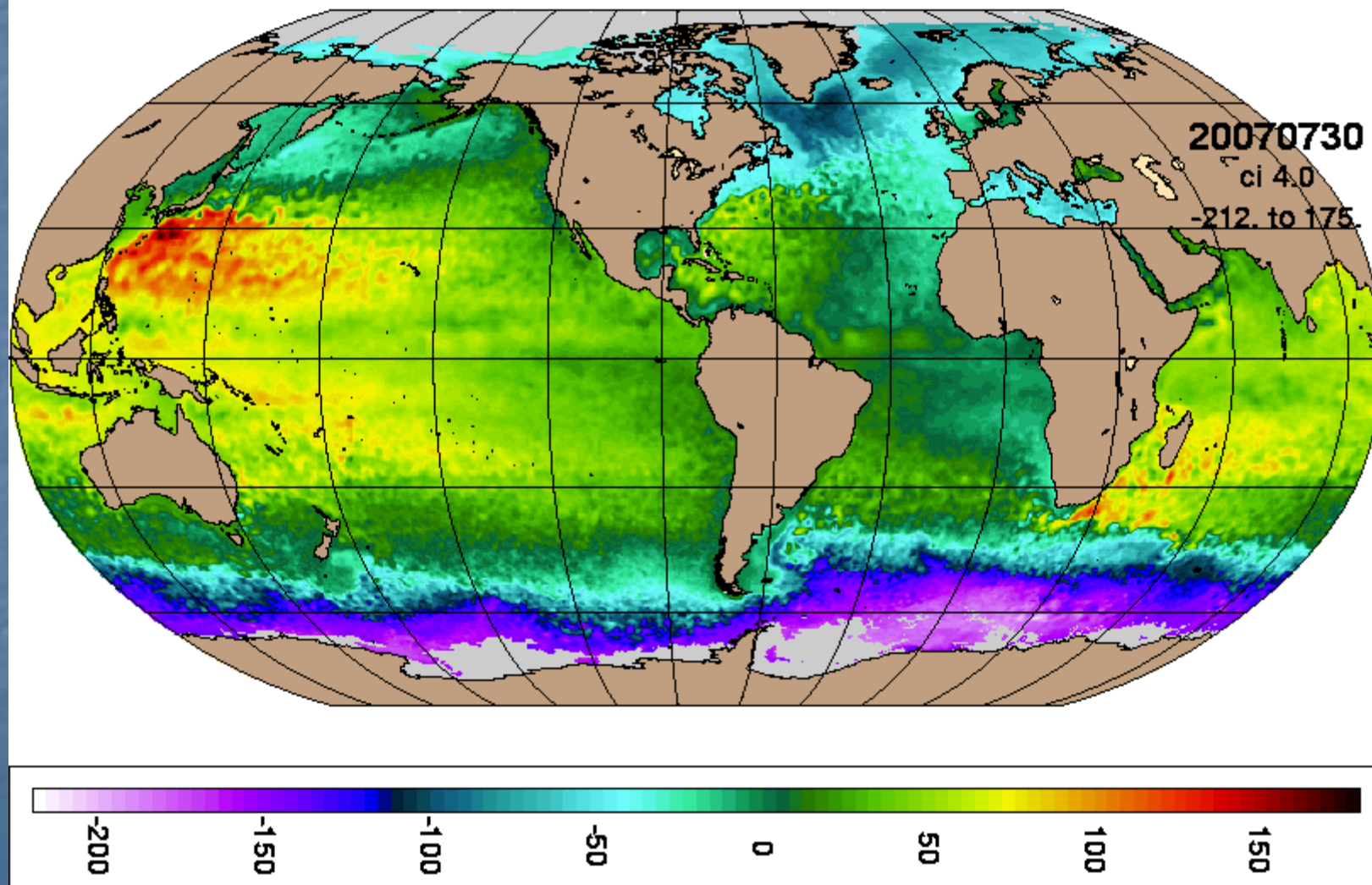- Assimilation: NCODA
- 5 day hindcast, 4(5) day forecast

1/12º Global HYCOM Configuration

- **Horizontal grid: 1/12° equatorial resolution**
  - 4500 x 3298 grid points, ~6.5 km spacing on average, ~3.5 km at pole

- **Mercator 79°S to 47°N, then Arctic dipole patch**

- **Vertical coordinate surfaces: 32 for σ_2***

- **KPP mixed layer model**

- **Thermodynamic (energy loan) sea-ice model**

- **Surface forcing: wind stress, wind speed, thermal forcing, precipitation, relaxation to climatological SSS**

- **Monthly river runoff (986 rivers)**

- **Initialize from January climatology (GDEM3) T and S, then SSS relaxation from PHC 3.0**
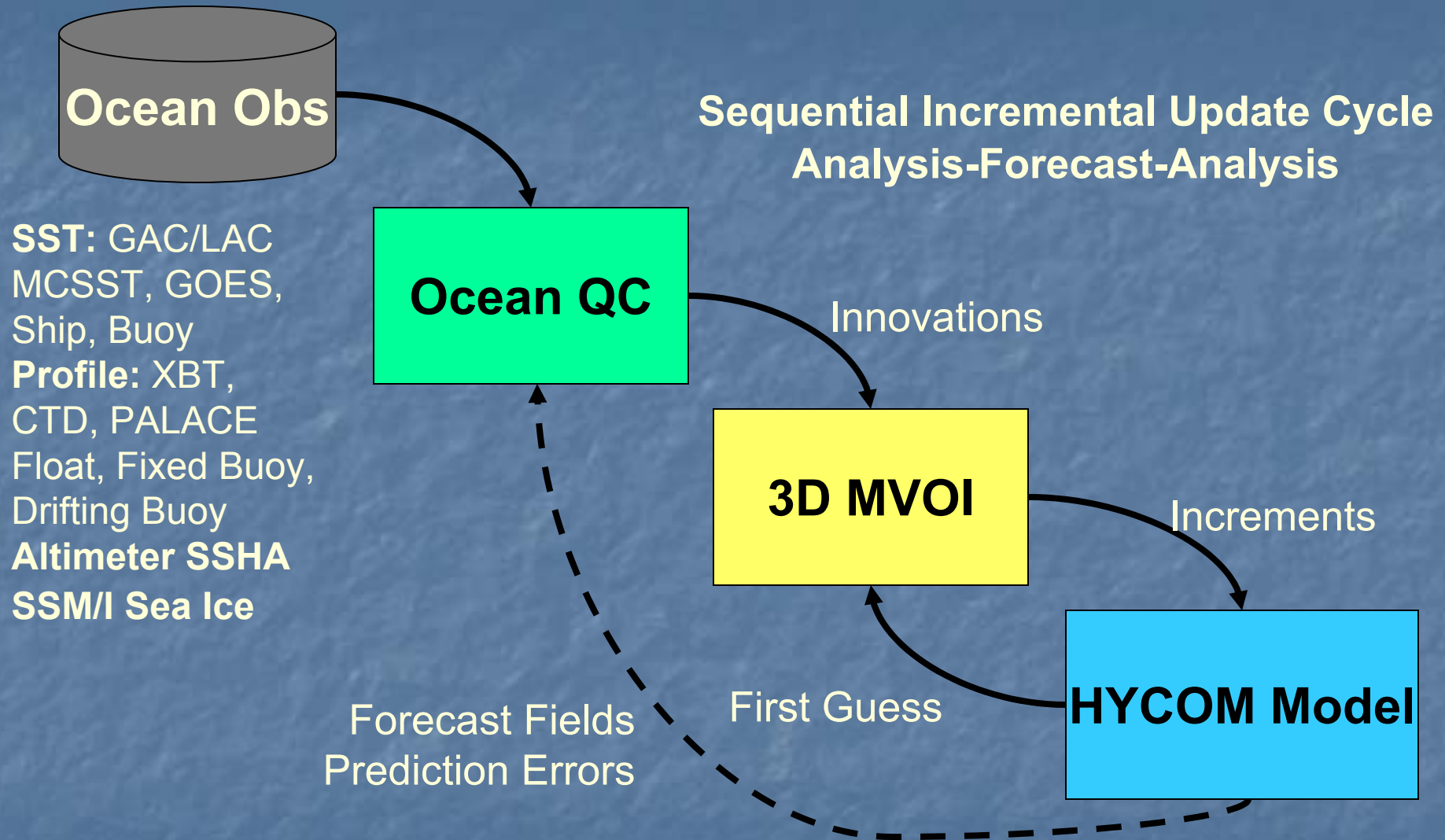 - No subsurface relaxation to climatology

1/12º Global HYCOM
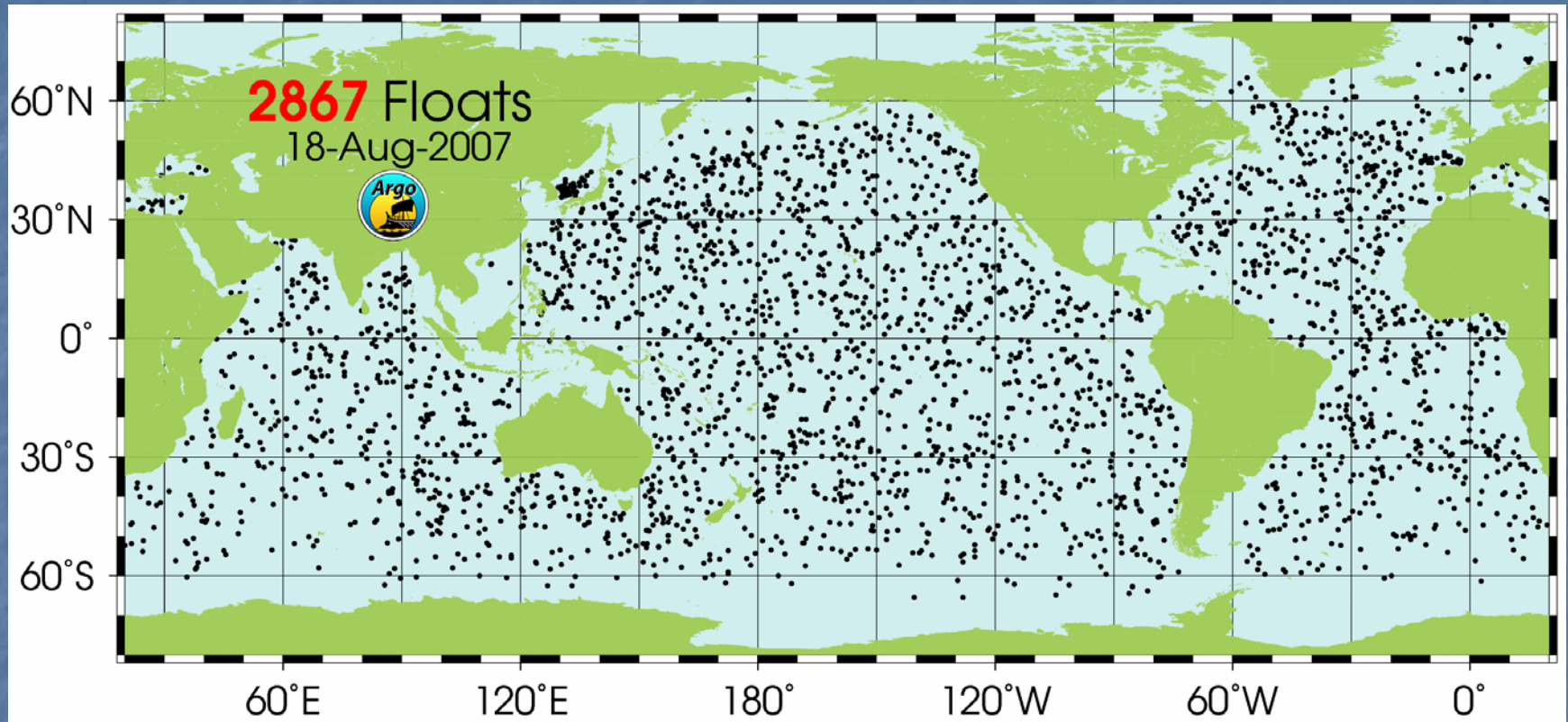
Real time run started 22 December 2006

Navy Coupled Ocean Data Assimilation (NCODA)

Ocean Obs

Sequential Incremental Update Cycle
Analysis-Forecast-Analysis

SST: GAC/LAC MCSST, GOES, Ship, Buoy
Profile: XBT, CTD, PALACE Float, Fixed Buoy, Drifting Buoy
Altimeter SSHA
SSM/I Sea Ice

Ocean QC

Innovations

3D MVOI

Increments

HYCOM Model

Forecast Fields
Prediction Errors

First Guess

MVOI - simultaneous analysis 5 ocean variables temperature, salinity, geopotential, layer pressure, velocity (u,v)

ARGO floats

2867 Floats
18-Aug-2007

http://www.argo.ucsd.edu/

Available altimeter data
9 June 2007

HYCOM/NCODA Runstream

Valid
nowcast time

00Z	00Z	00Z	00Z	00Z	00Z	00Z	00Z	00Z	00Z

tau =   -120   -96   -72   -48   -24   0   +24   +48   +72   +96

NCODA analysis windows centered at these times
±36 hours for altimeter data
±12 hours for all other data
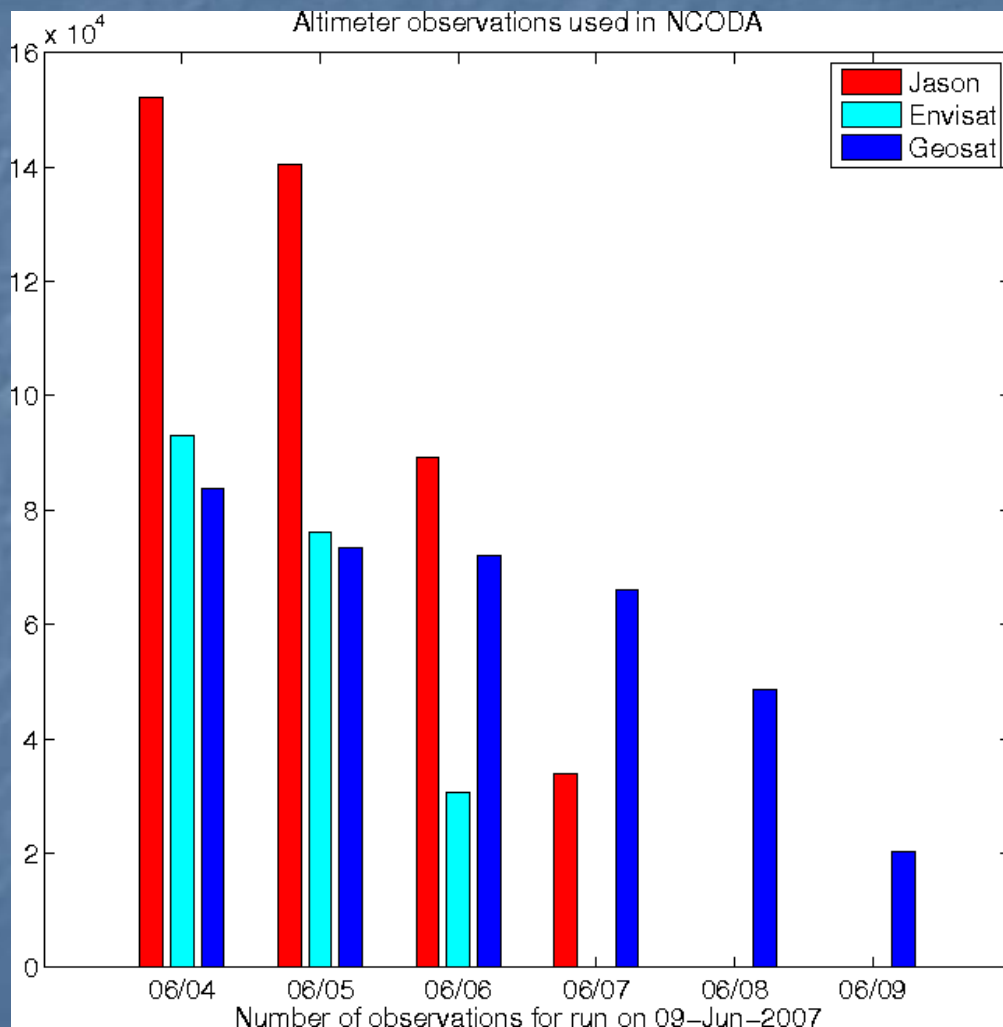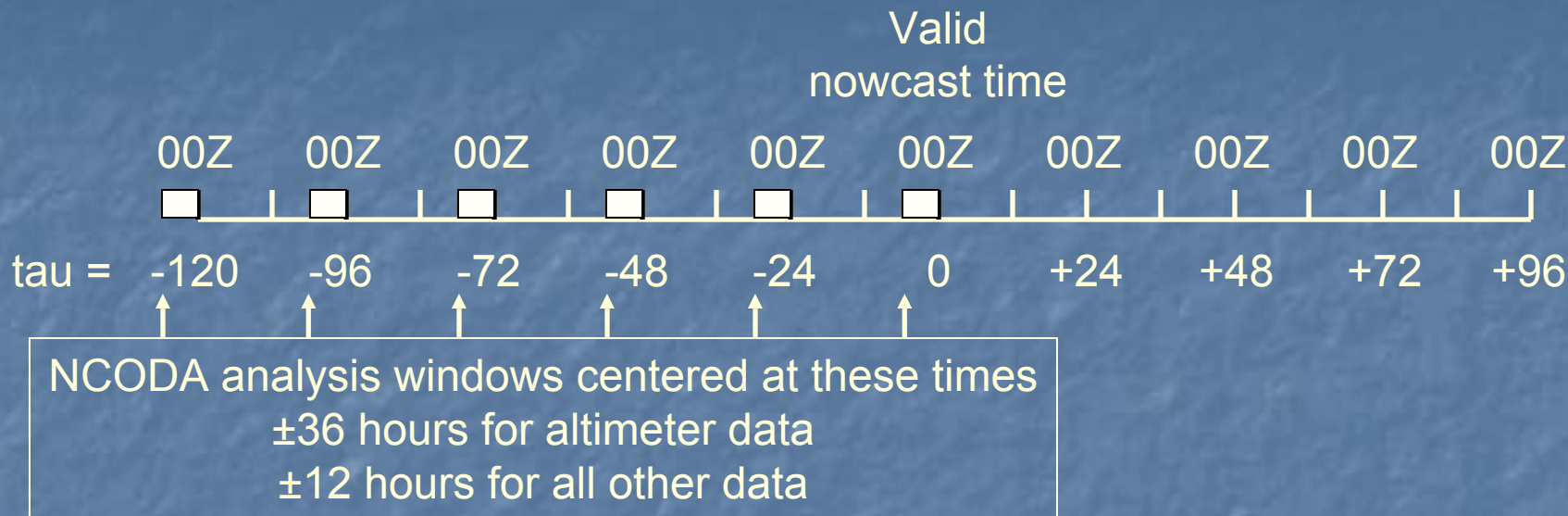
1) Perform first NCODA analysis centered on tau = -126, i.e. 18Z
2) Run HYCOM for 24 hours using incremental updating (▭) over the first 6 hrs starting at 18Z
3) Repeat steps 1) and 2) until the nowcast time
4) Run HYCOM in forecast mode out to tau = 96, eventually to tau = 120

Approximate run times* (using 379 IBM Power 5+ processors):
1) Six NCODA analyses: 0.9 hrs/analysis = 5.4 hrs
2) Five HYCOM hindcast days @ 150 sec Δt: 1.1 hrs/day = 5.5 hrs
3) Four HYCOM forecast days @ 150 sec Δt: 1.1 hrs/day = 4.4 hrs
4) Total: 15.3 hrs
* Timings do not include PIPS coupling; assimilation in the Mercator part of grid only

Data Assimilation Subregions
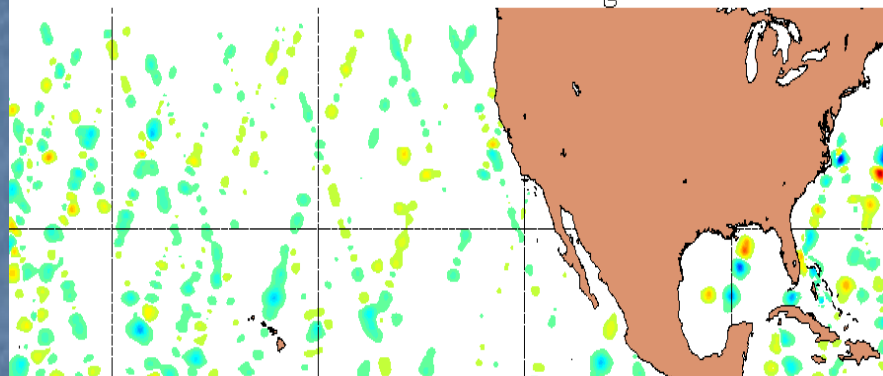## Overlaid on SSH valid on 9 June 2007
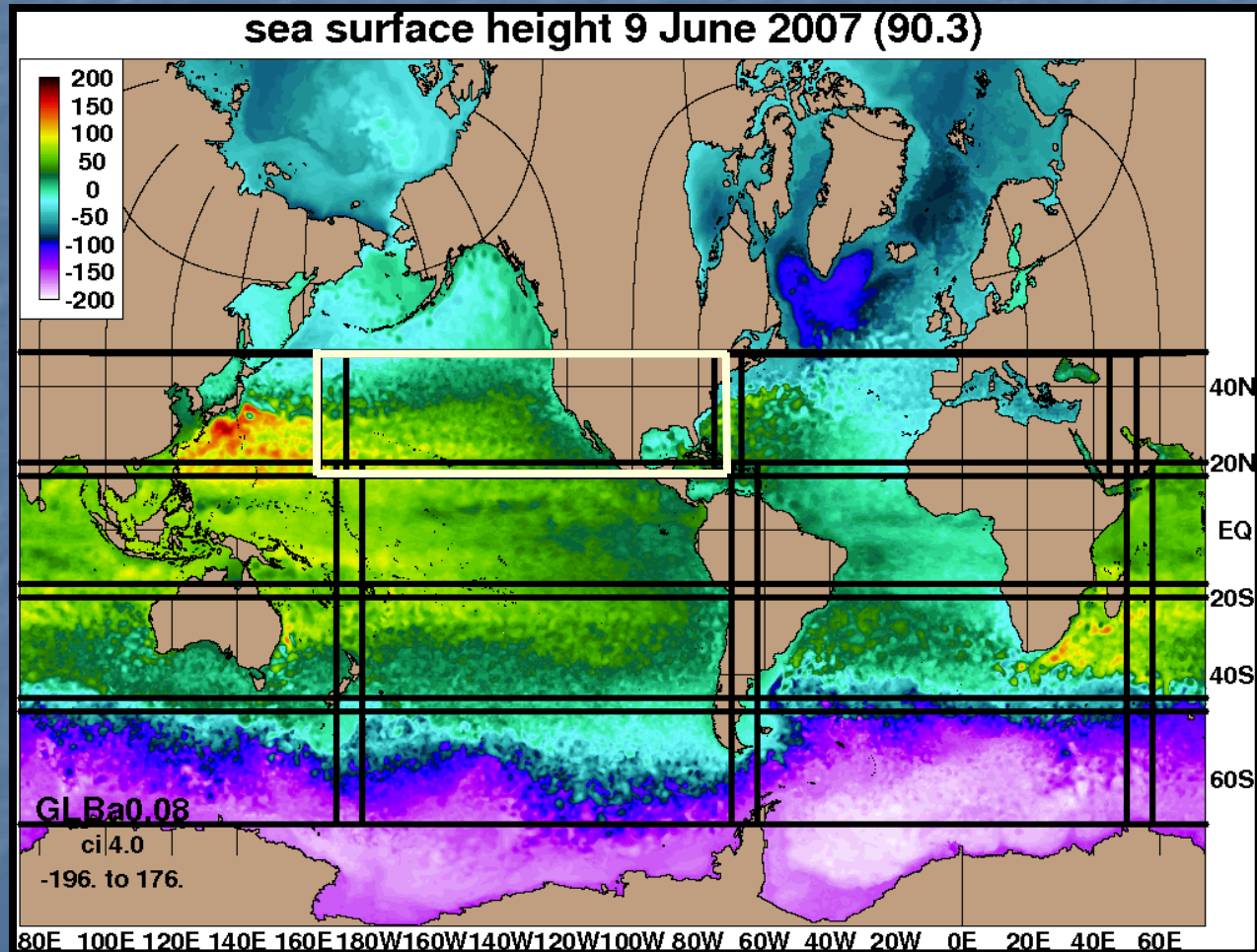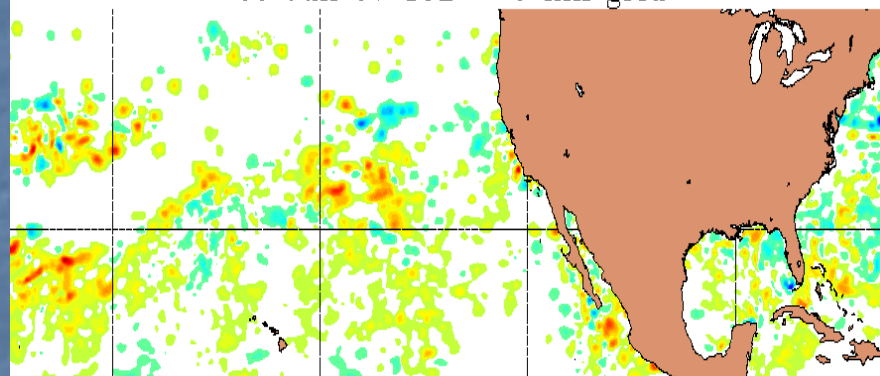
NCODA Observation Locations
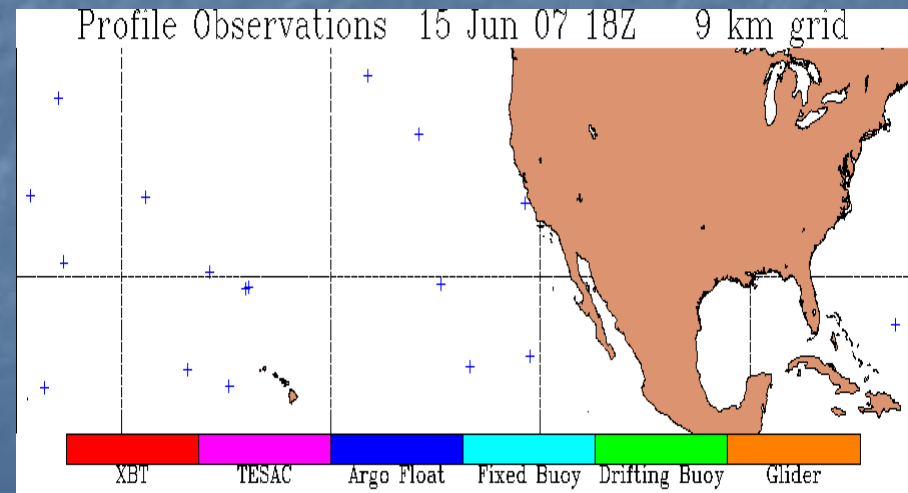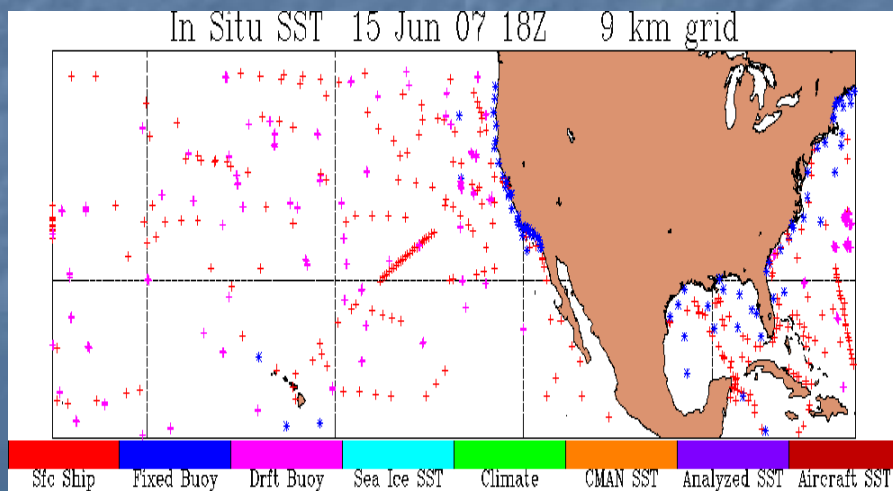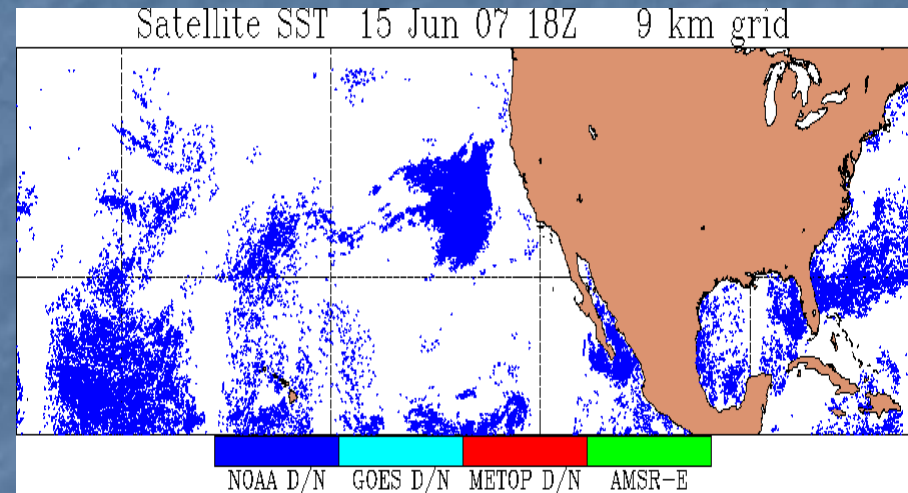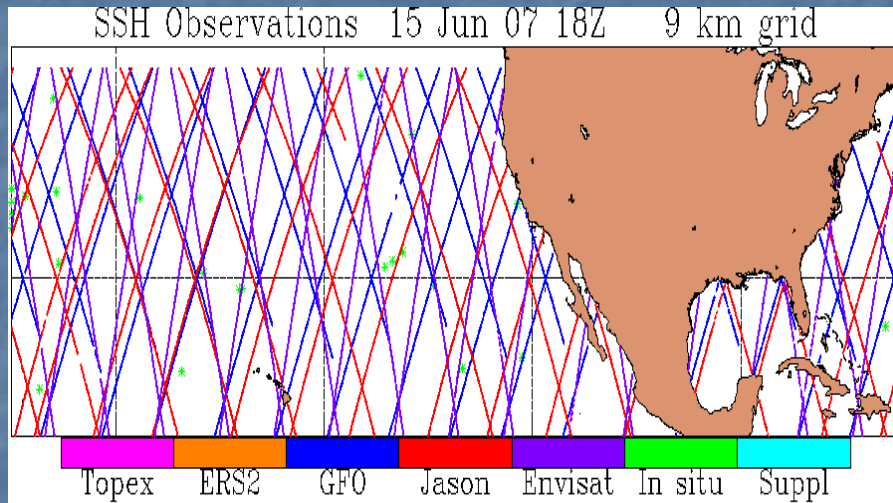
Sea Surface Height and Temperature Increments

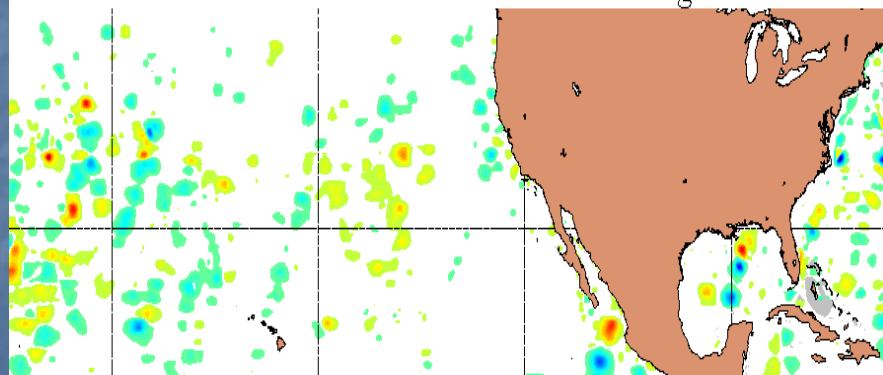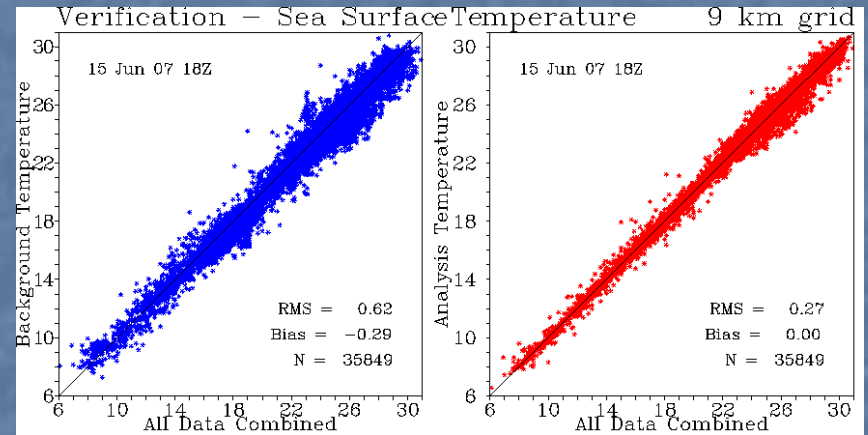## 9 June 2007
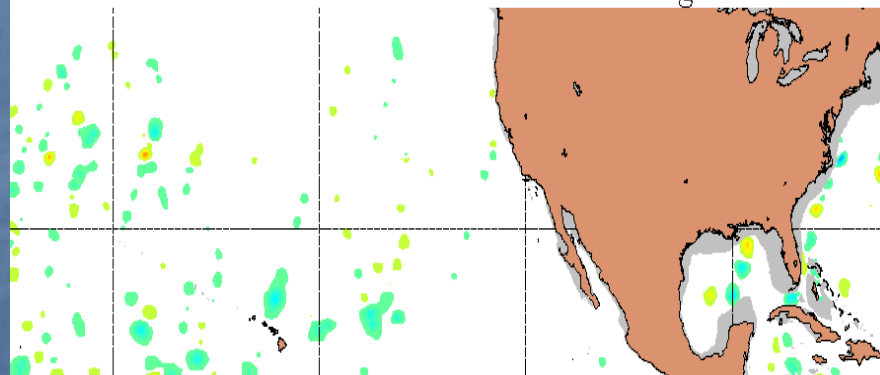
NCODA verification

SSH verification
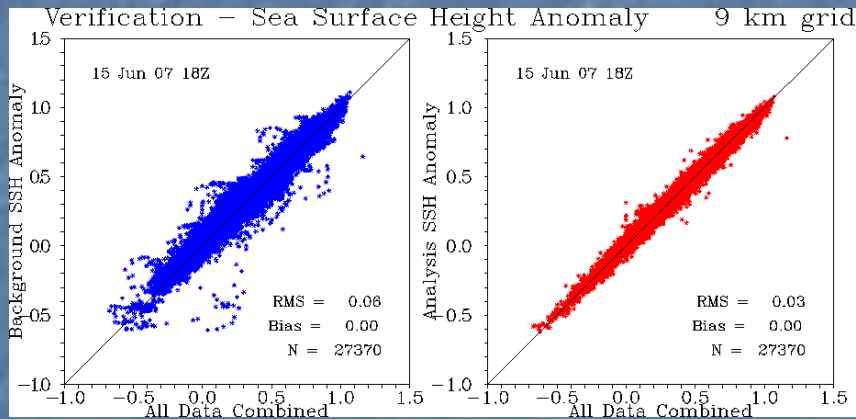
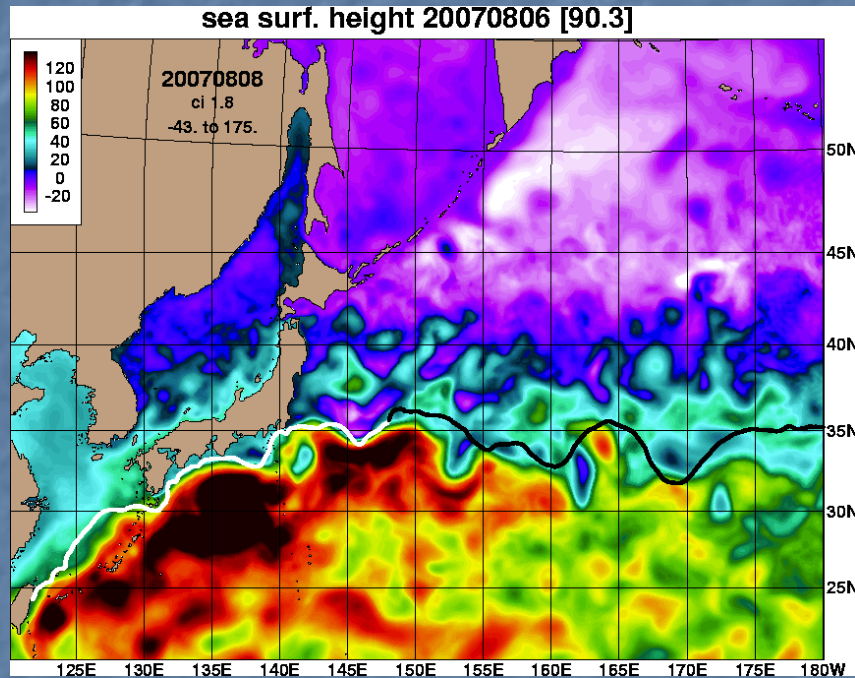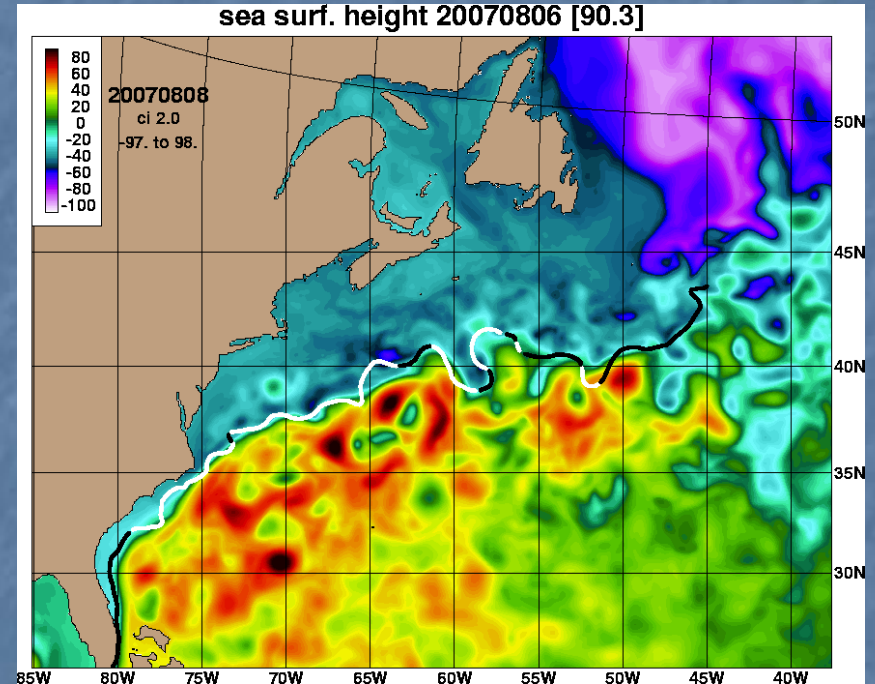## SST verification

Data Assimilation in Global HYCOM
Gulf Stream and Kuroshio SSH with SST-based frontal analysis overlaid
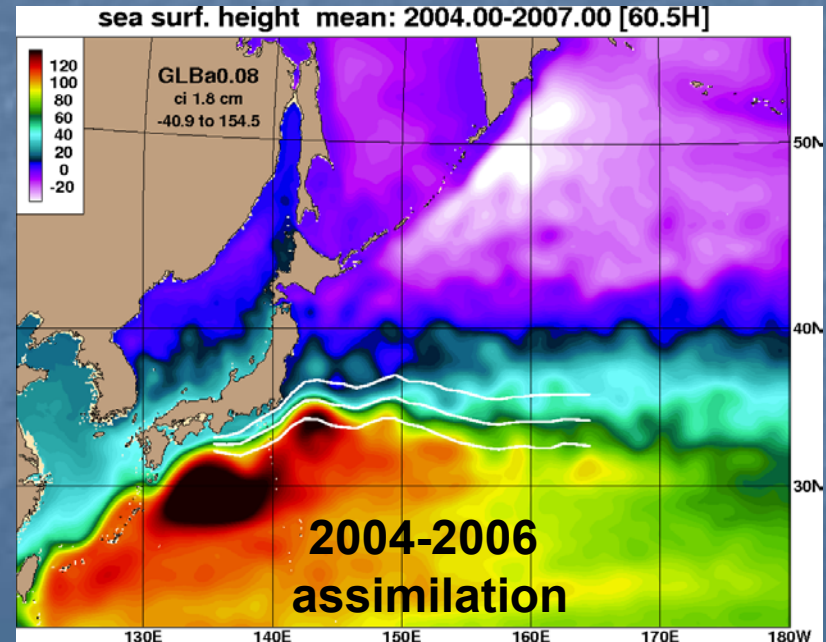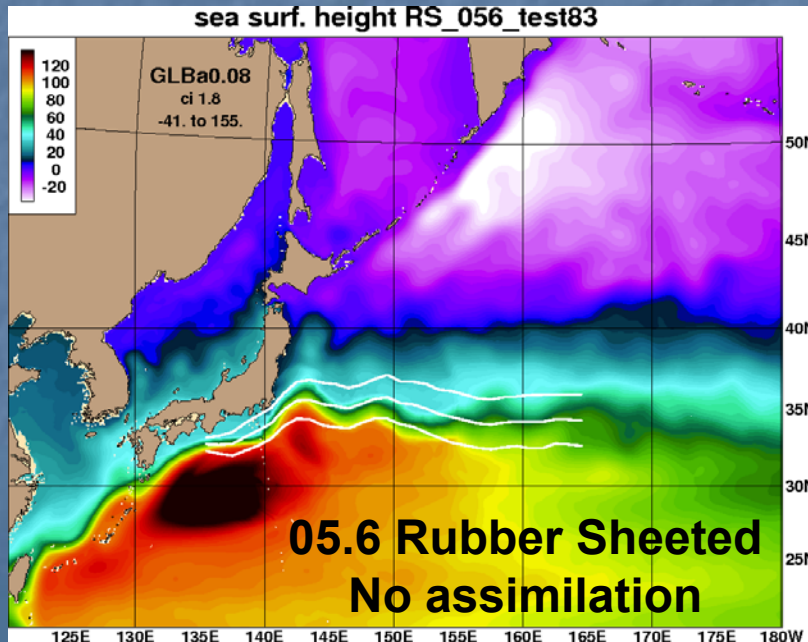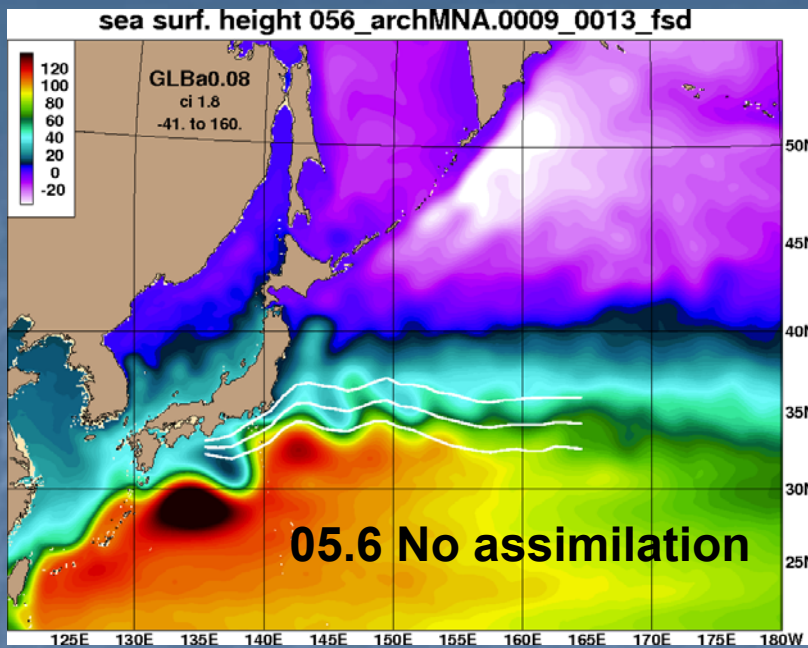
6 August 2007

6 August 2007

**Frontal analysis < 4 days old = white,
analysis ≥ 4 days old = black**

sea surf. height 056_archMNA.0009_0013_fsd

GLBa0.08
ci 1.8
-41. to 160.

05.6 No assimilation

1/12º Global HYCOM Mean SSH Kuroshio region

sea surf. height RS_056_test83

GLBa0.08
ci 1.8
-41. to 155.

05.6 Rubber Sheeted No assimilation

sea surf. height mean: 2004.00-2007.00 [60.5H]

GLBa0.08
ci 1.8 cm
-40.9 to 154.5

2004-2006 assimilation

White lines are the mean position and +- 1 stdv

1/12° Global HYCOM Mean SSH
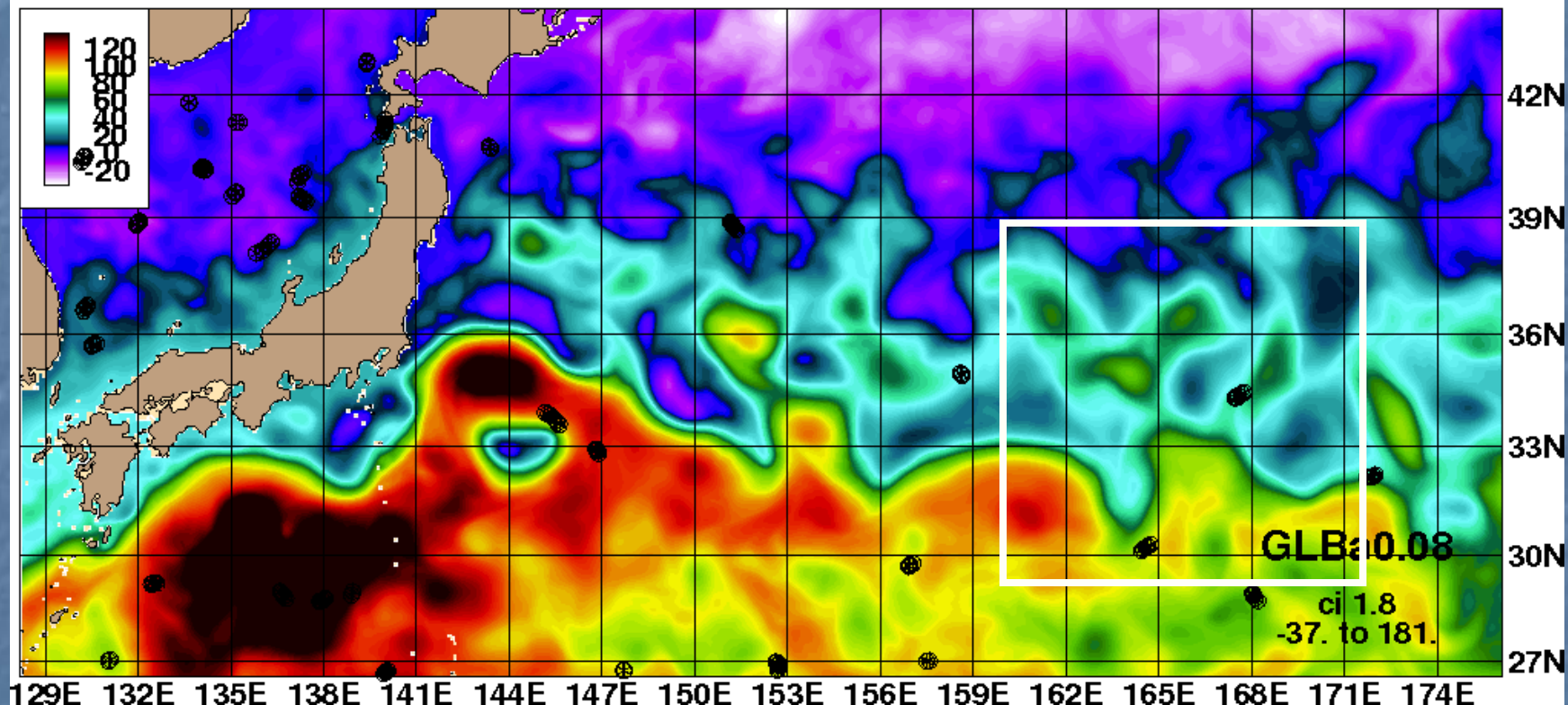
Gulf Stream region

sea surf. height 056_archMNA.0009_0013_fsd

GLBa0.08
ci 2.0
-102. to 64

05.6 No assimilation

sea surf. height RS_056_test83

GLBa0.08
ci 2.0
-102. to 58

**05.6 Rubber Sheeted
No assimilation**

sea surf. height mean: 2004.00-2007.00 [60.5H]

GLBa0.08
ci 2.0 cm
-91.0 to 56.9

**2004-2006
Assimilation**

White lines are the mean position and +- 1 stdv

1/12º Global HYCOM
SSH and surface drifters

1/12º Global HYCOM
SSH and surface drifters

1/12 Global HYCOM 20070601

1/12º Global HYCOM
SSH and surface drifters
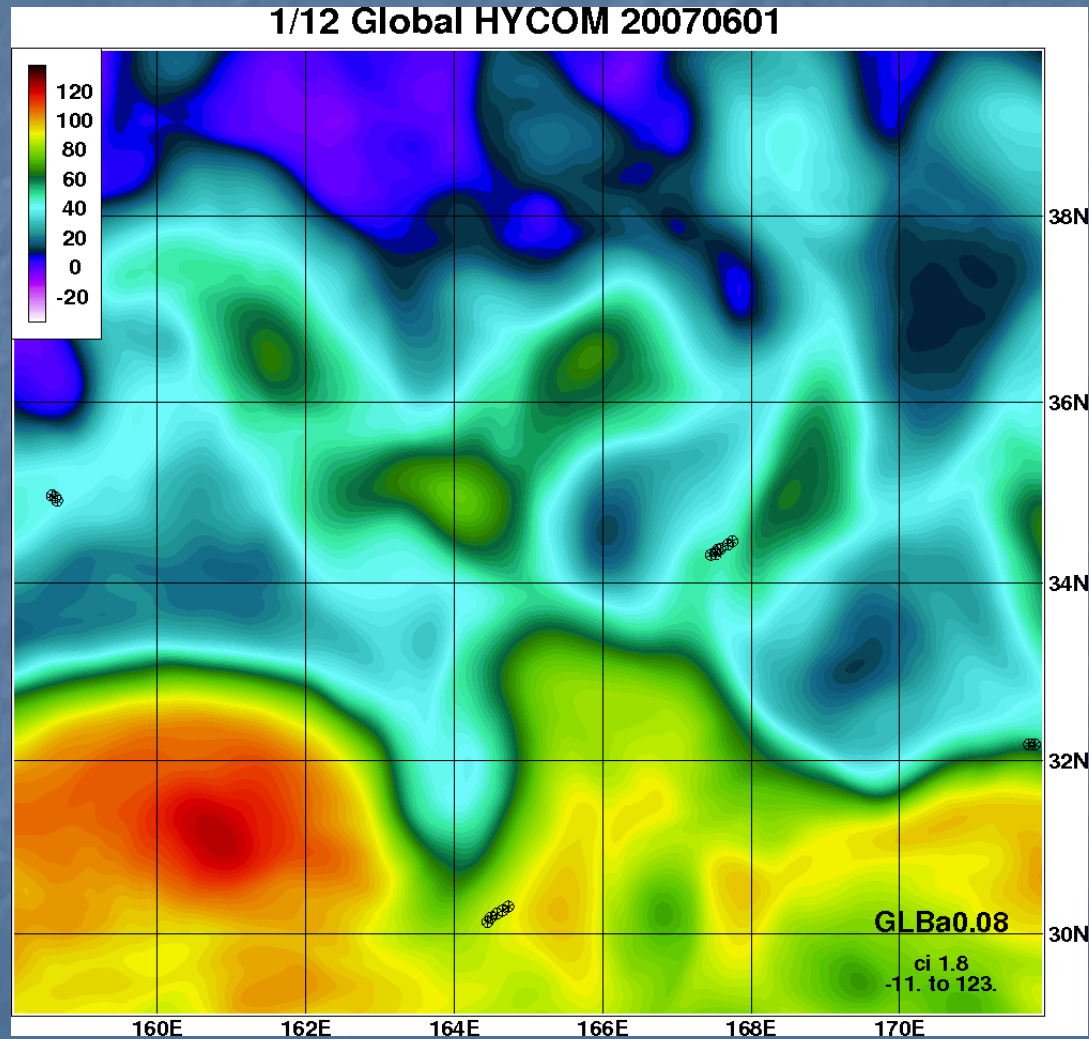
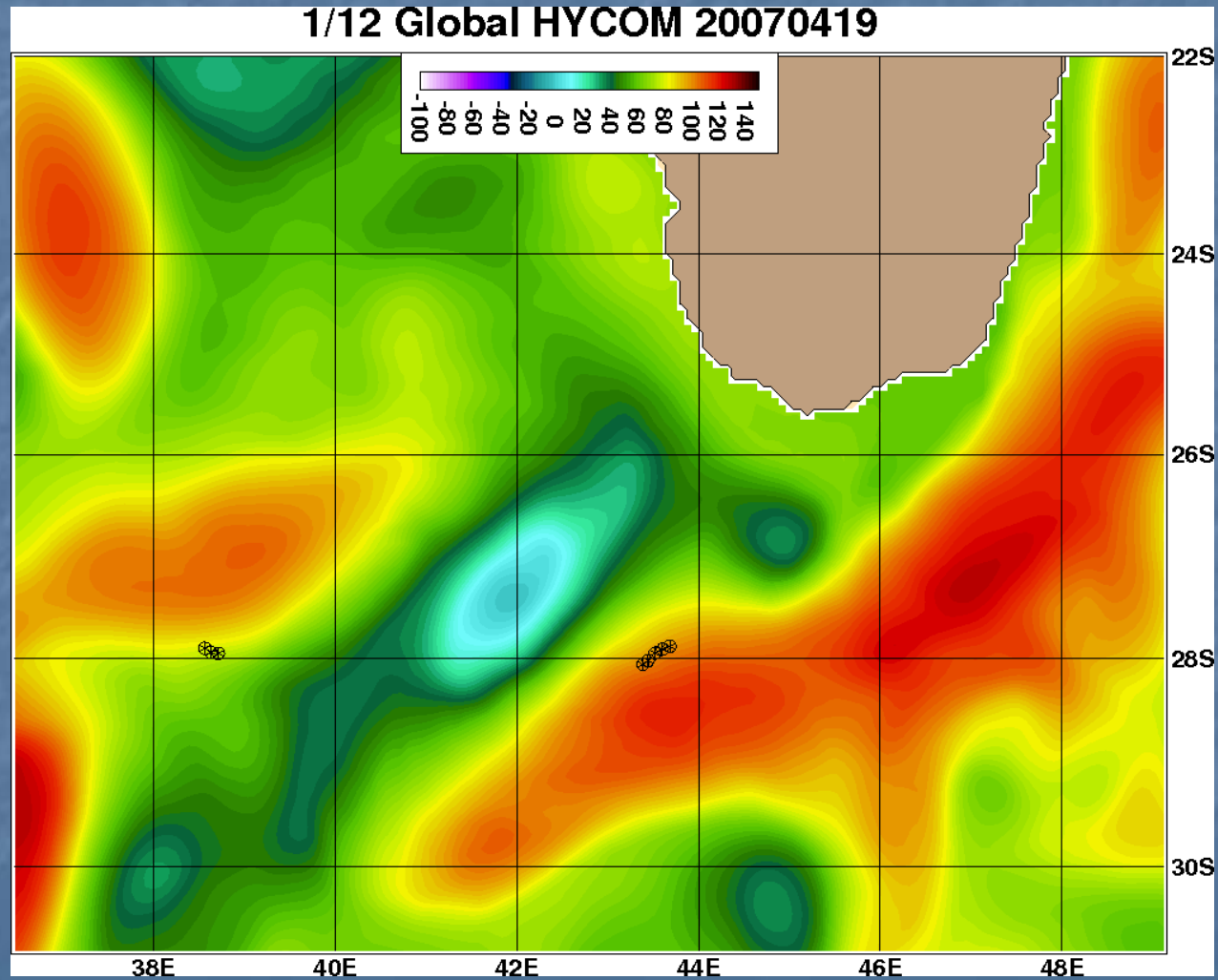
1/12 Global HYCOM 20070419

GLBa0.08
ci 2.5
-77. to 151.

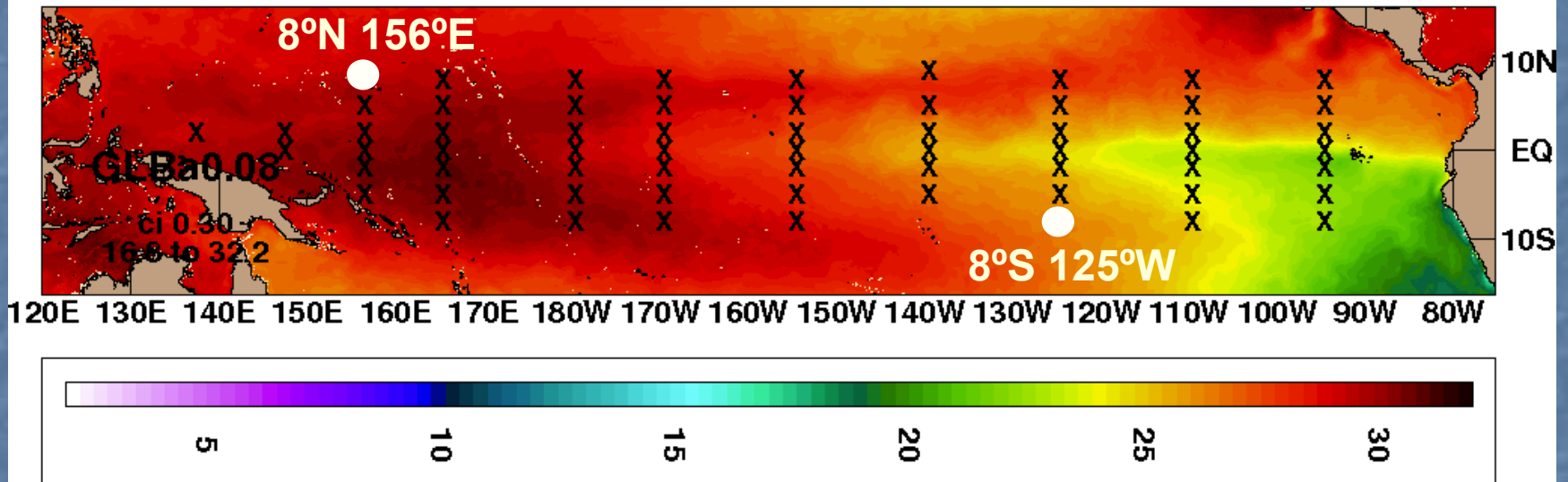# 1/12º Global HYCOM
SSH and surface drifters

1/12 Global HYCOM 20070419
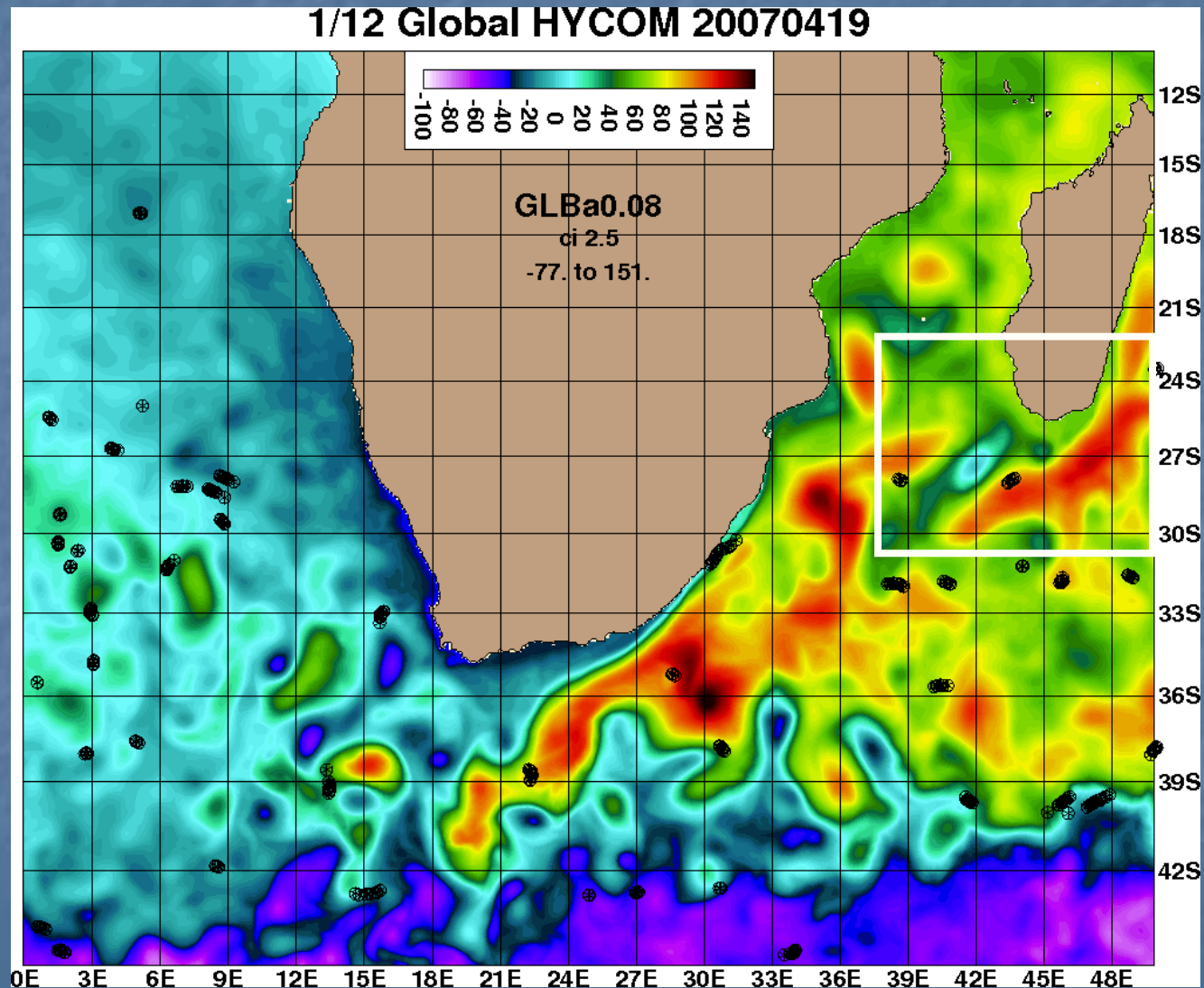
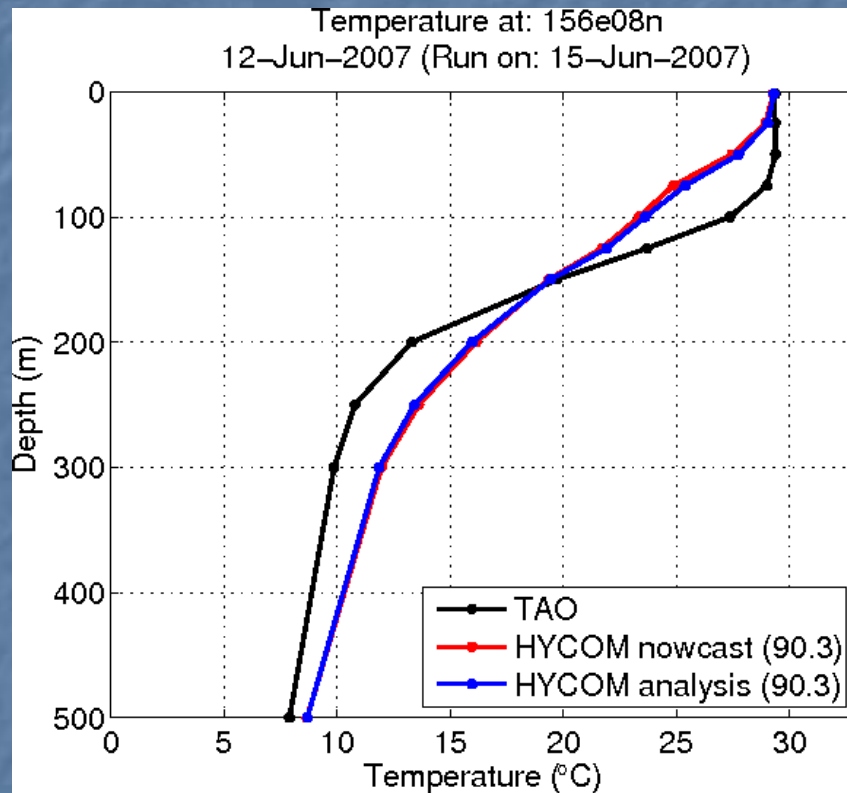# 1/12° Global HYCOM
Position of TAO/TRITON

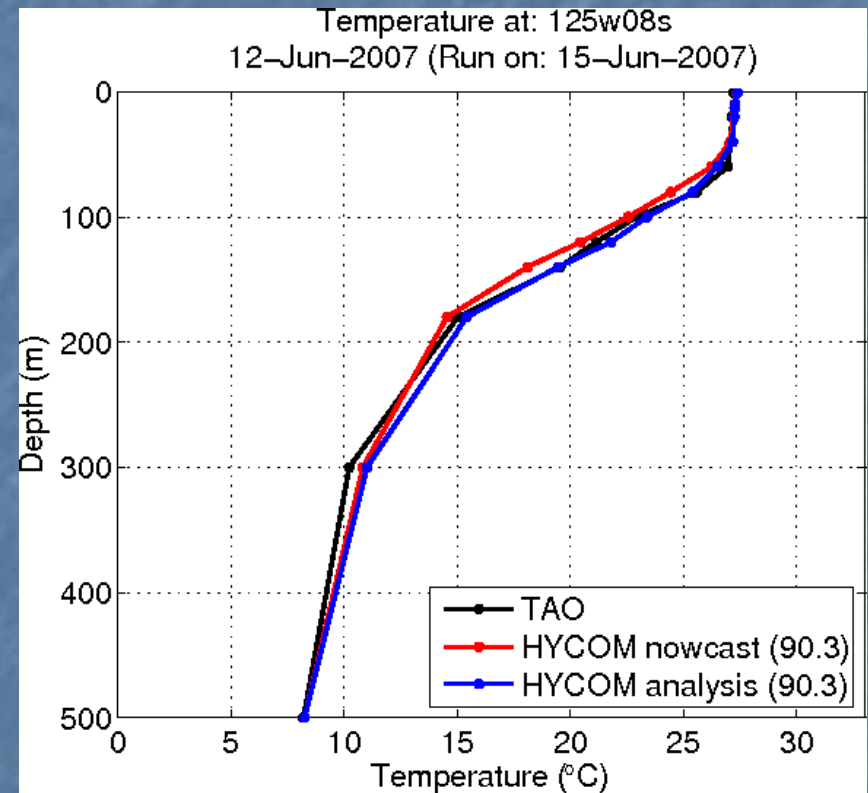Mean sea surface temperature January 2004 (60.5)

Vertical temperature profiles

8ºN 156ºE

8ºS 125ºW

1/25º Gulf of Mexico HYCOM CONFIGURATION

- Horizontal grid: 1/25° (517 x 349 grid points, 4 km spacing on average)
- 18°N to 31°N
- 20 vertical coordinates
- Bathymetry: real coastline (minimum depth 2m)
- Surface forcing from FNMOC/NOGAPS
- Monthly river runoff
- Nested Boundary:

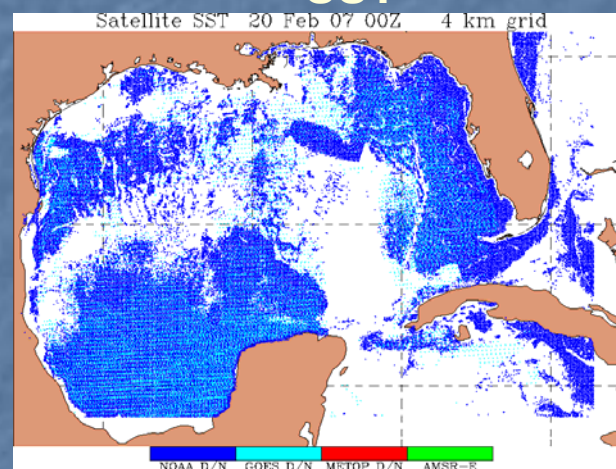 relaxation to the 1/12° Atlantic HYCOM climatological T, S, U and V along open boundary

1/25º Gulf of Mexico HYCOM
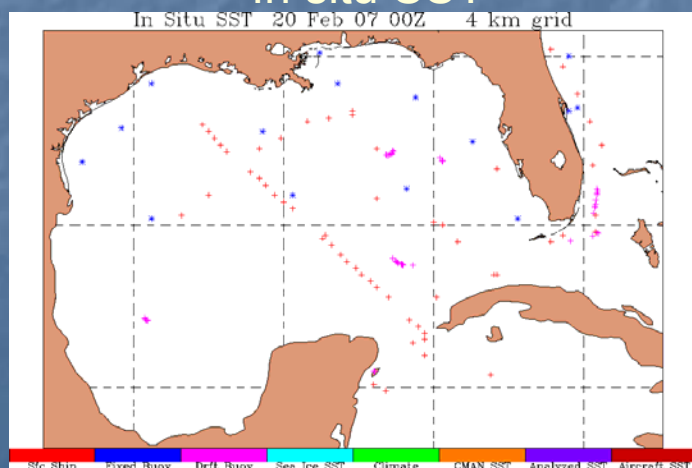
NCODA observations 20 February to 21 March 2007

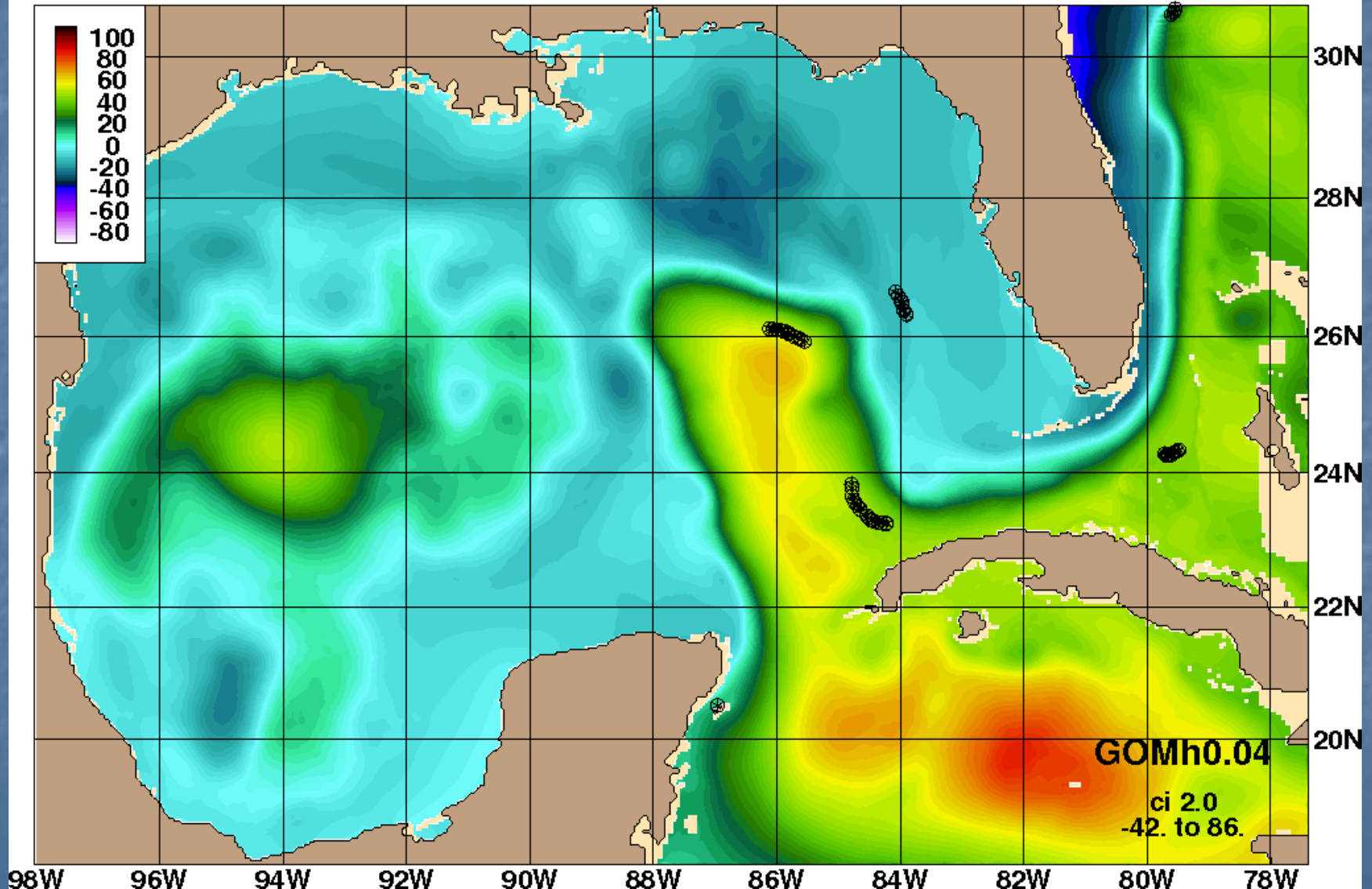**SSH**
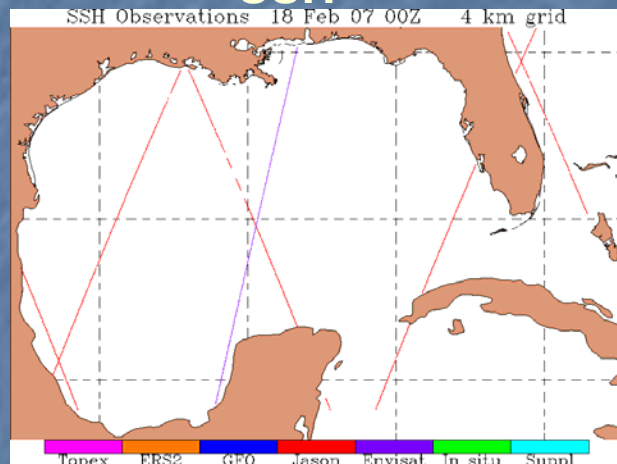
SST

In situ SST

Profiles

Profiles not available

1/25° GULF OF MEXICO HYCOM

1/25 GOM (90.1) 2007022700

New Data Assimilation Subregions
Overlaid on SSH valid on 9 June 2007

sea surface height 9 June 2007 (90.3)