The influence of cyclones on the Deepwater Horizon oil spill

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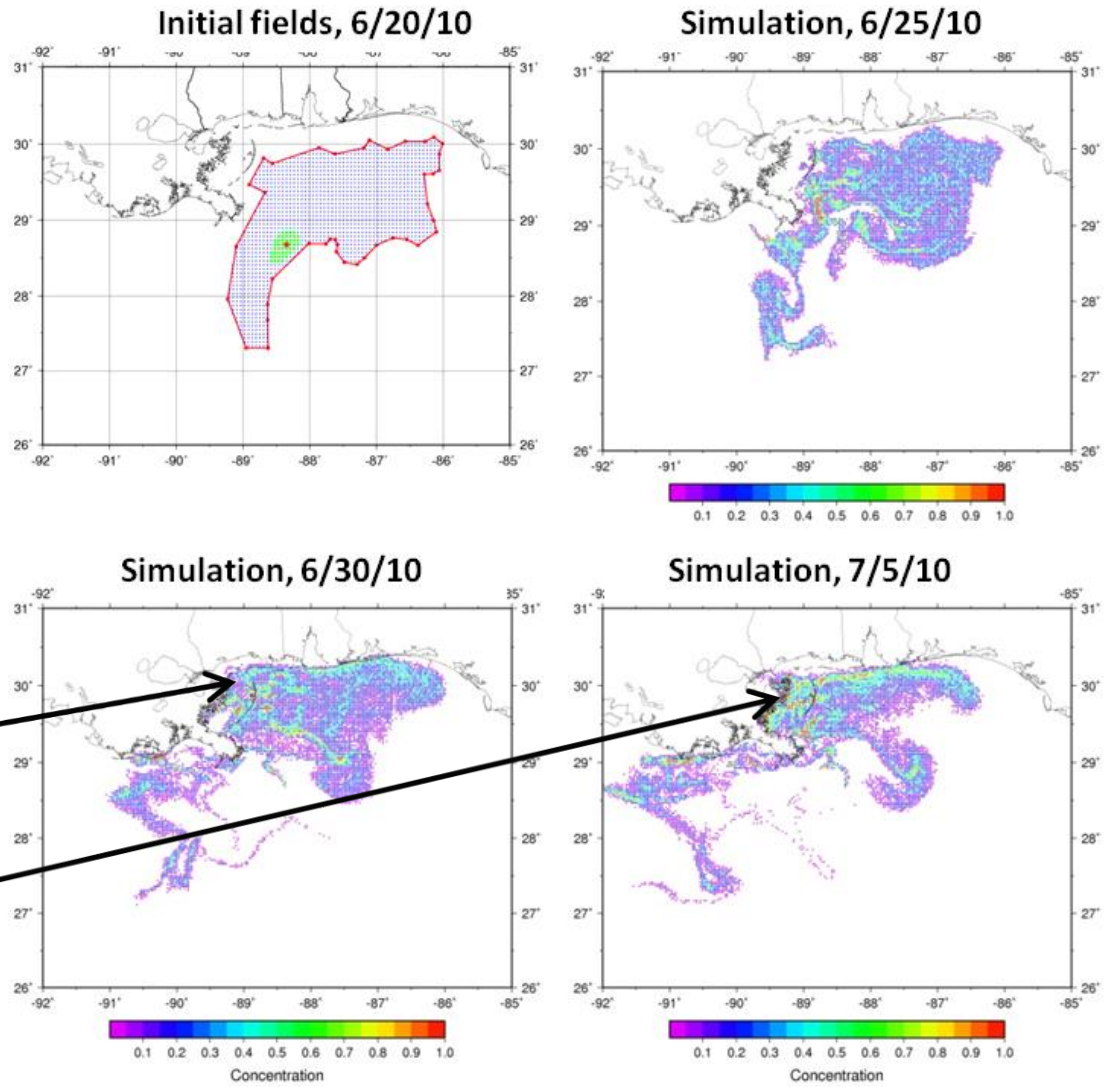
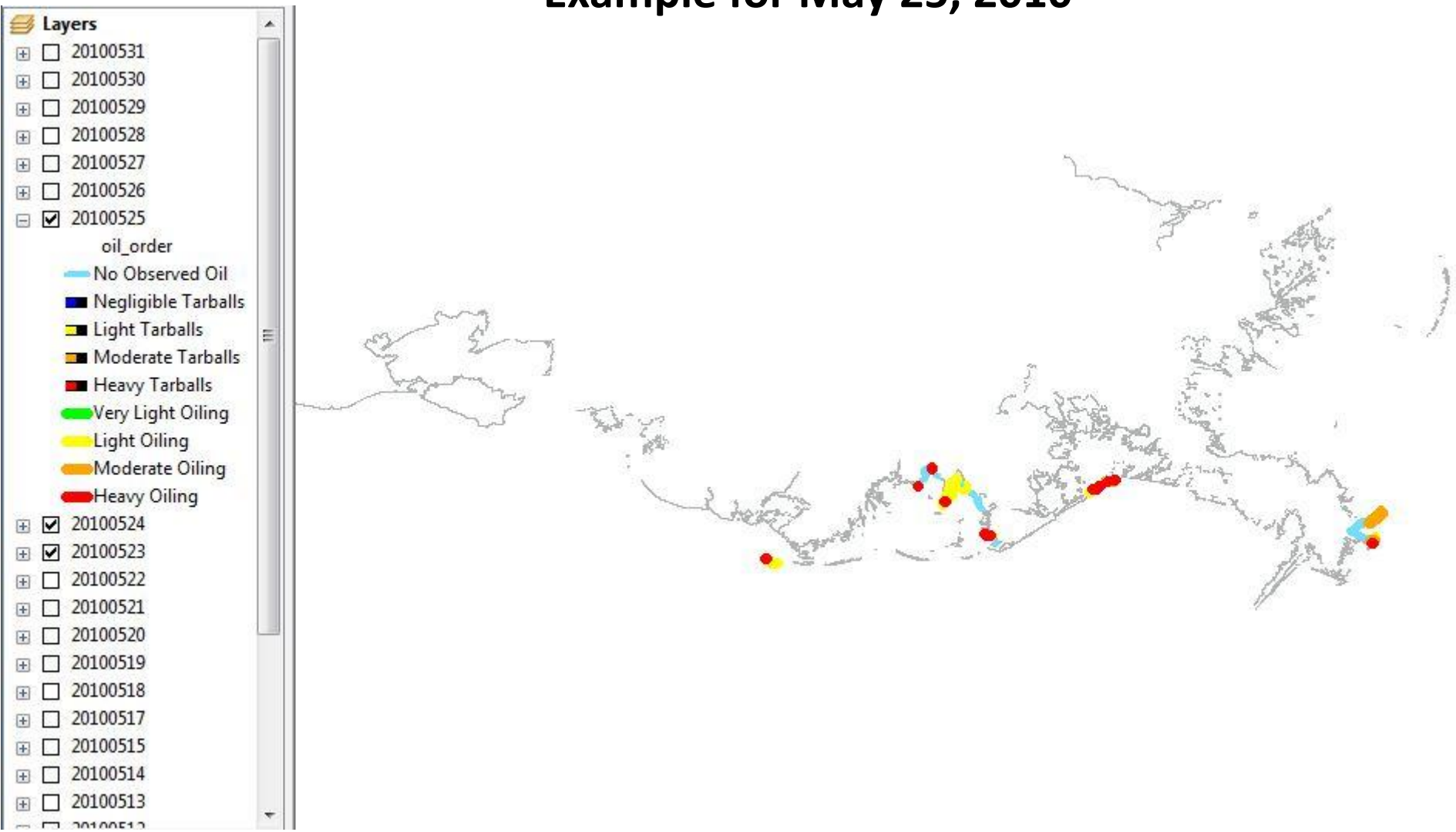
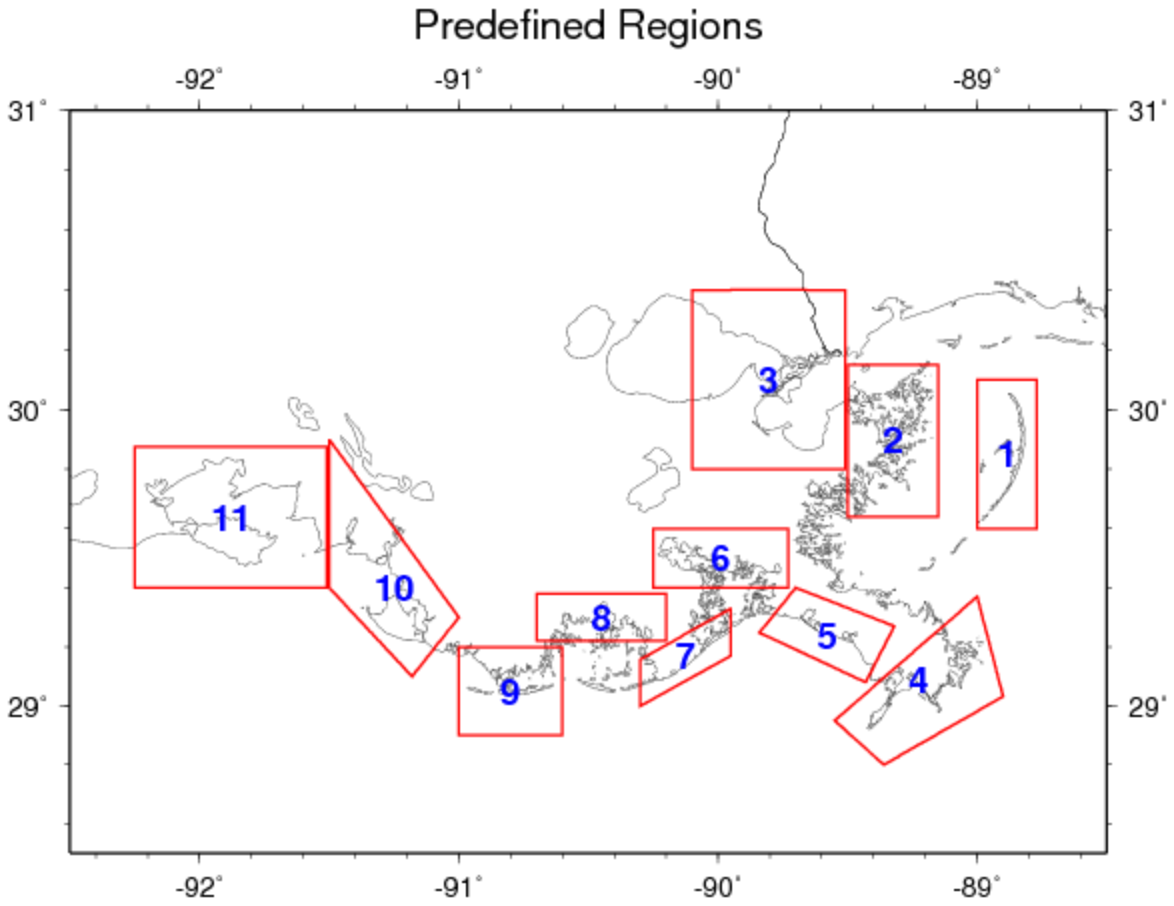
Oil spill simulation from
6/20/10-7/10/10
using AMSEAS NCOM data

Note inshore movement of oil starting late June



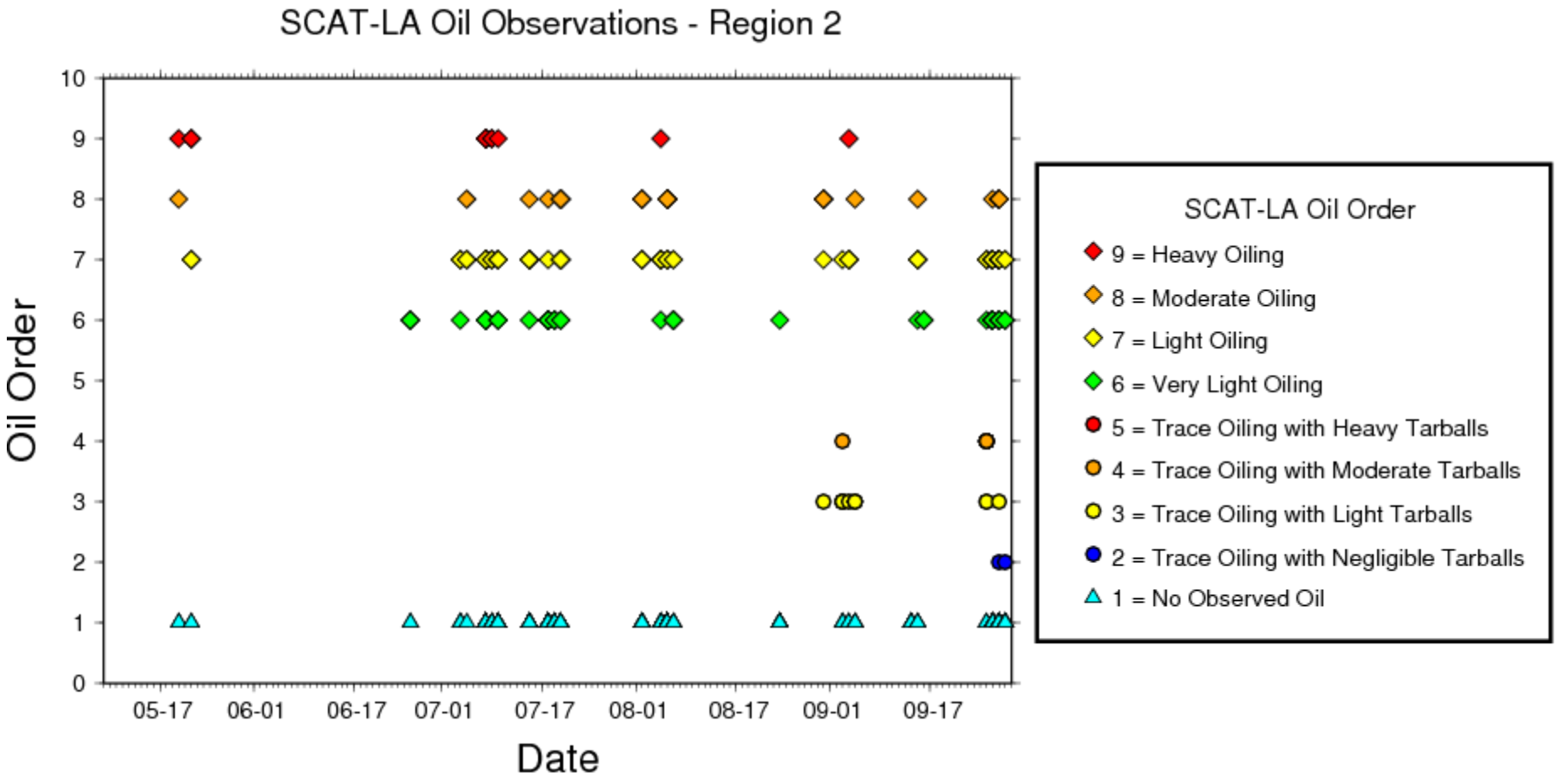
Shoreline Cleanup and Assessment Technique (SCAT) dataset
Example for May 25, 2010



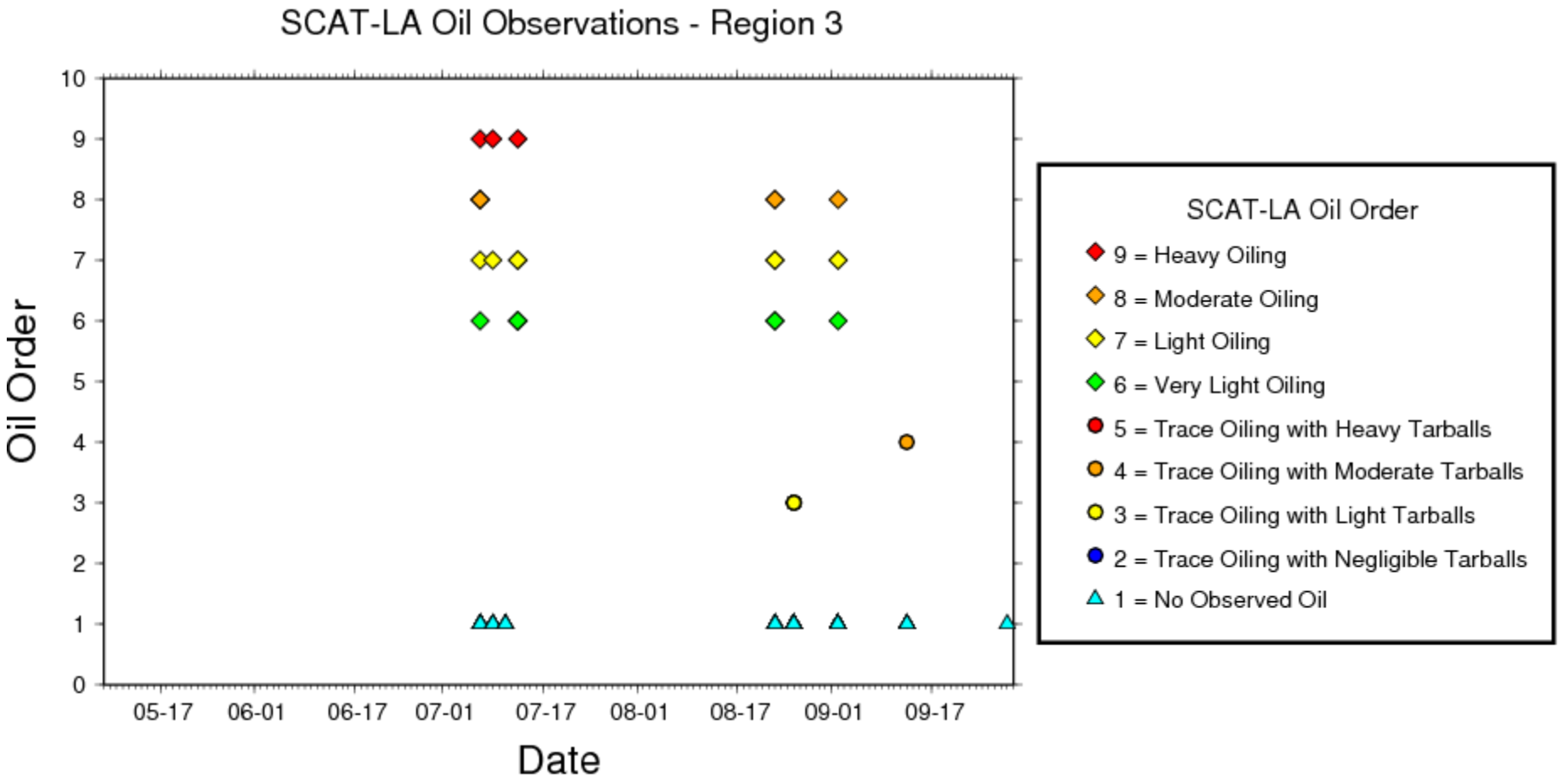


1. Chandeleur Islands
2. Eastern Biloxi Marsh
3. LakeBorge / LakePontchartrain
4. Mississippi River Mouth
5. Sandy Point
6. Barataria Bay North End
7. Grand Isle / Fourchon
8. Terrebonne Bay / Timbalier Bay North End
9. Last Islands
10. Atchafalaya Delta
11. Russell Sage Mash / Vermillion Bay / West Cote Blanche Bay

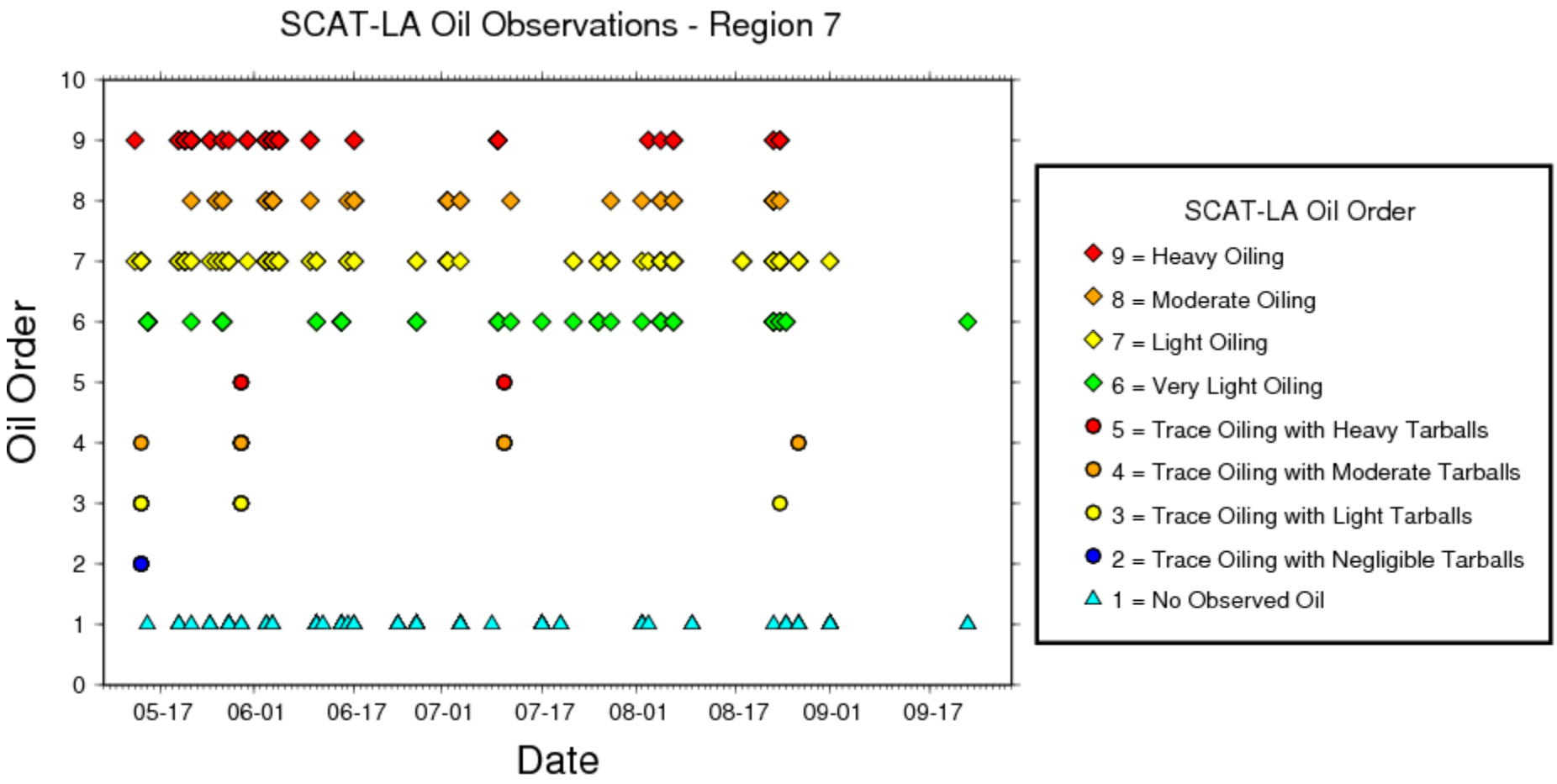
Eastern Biloxi Marsh



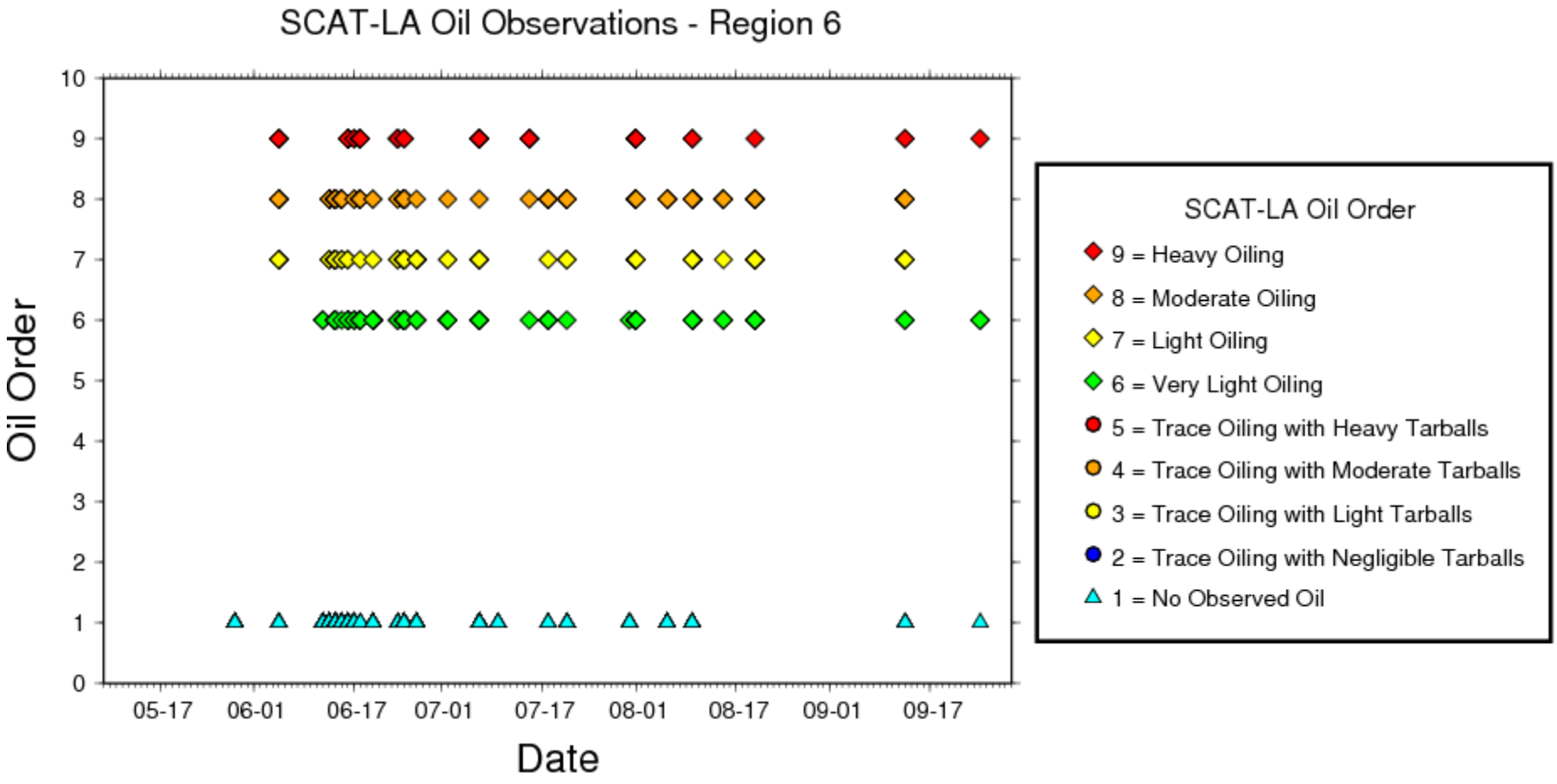
Lake Borgne and Lake Pontchartrain



Grand Isle and Fourchon



Northern Barataria Bay



Oil spill simulation to understand fate and transport issues

Model description

- Lagrangian particle tracker with random walk diffusion

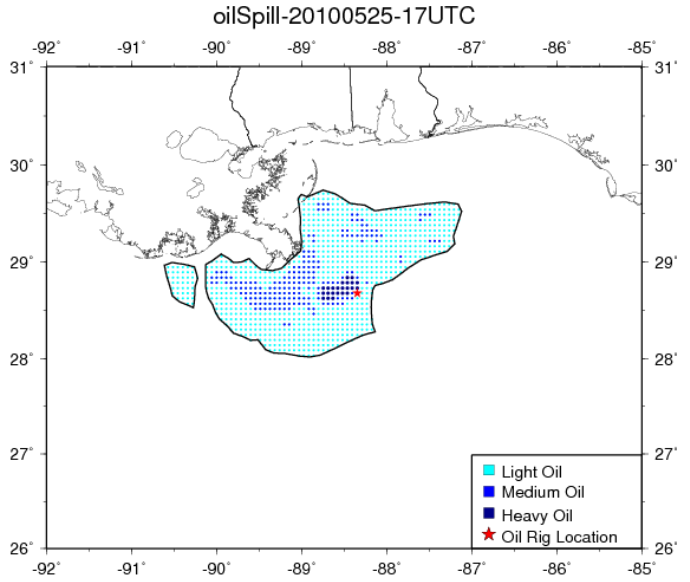
- Input consisted
    i. latitude and longitude parcel positions in the oil-contaminated area
    ii. wind (validation shows reasonably accurate with absolute errors of 1.4 ms^{-1} and 33 deg)
    iii. current (validation to be shown in this talk)
    iv. array of pseudo-random numbers (from Mersenne Twister algorithm, initial seed from machine noise)

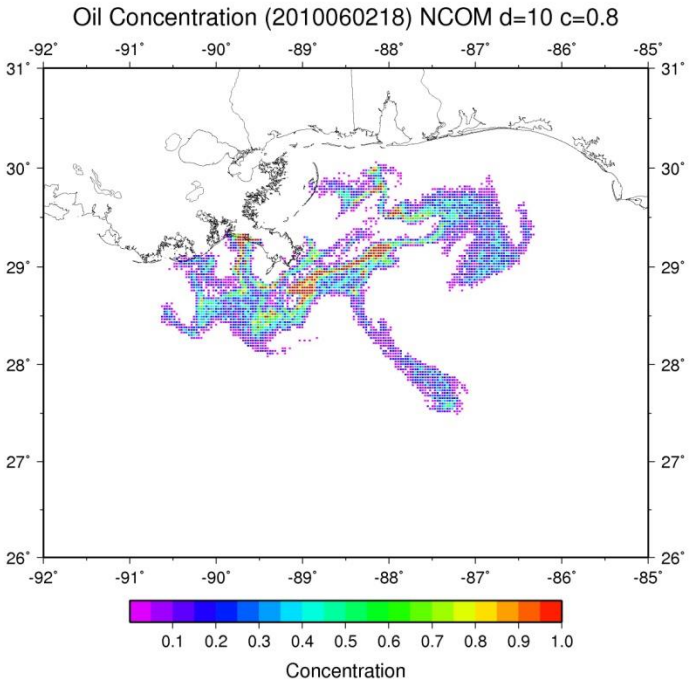
- New parcels were released damaged Macondo rig location at each timestep

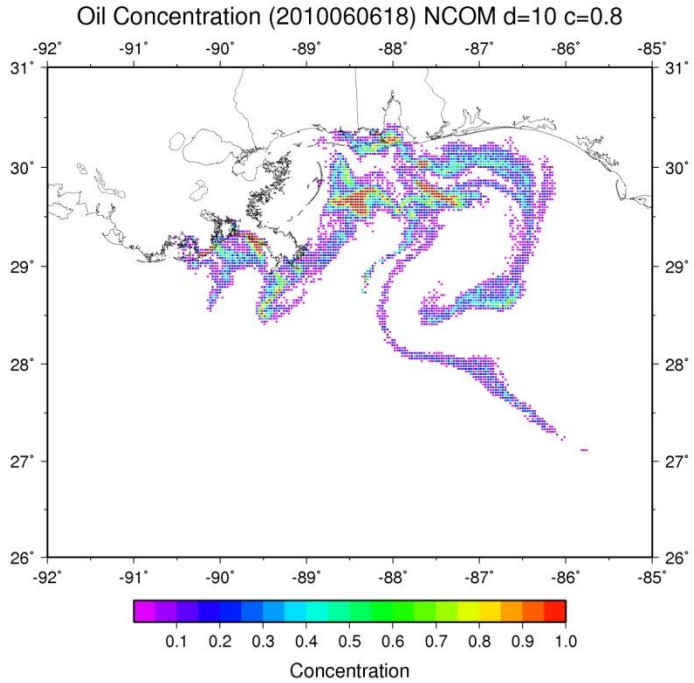
- Twenty-five parcels were released at each position, and when combined with a 10 m^2s^{-1} diffusion coefficient, resulted in a natural trajectory spread with time

- Initial positions based on
    i. NASA MODIS
    ii. SAR imagery from http://www.cstars.miami.edu
    iii. NOAA/NESDIS Satellite Analysis Branch (SAB) experimental surface oil analysis products at http://www.ssd.noaa.gov/PS/MPS/deepwater.html
    iv. NOAA's Office of Response and Restoration oil trajectory maps at http://response.restoration.noaa.gov

- Parcels advected at 80% of the ocean current speed and at 3% of the wind speed. Bilinear interpolation of wind and current applied from model grid to parcel location.


oilSpill-20100525-17UTC
Light Oil
Medium Oil
Heavy Oil
Oil Rig Location


Oil Concentration (2010060218) NCOM d=10 c=0.8
Concentration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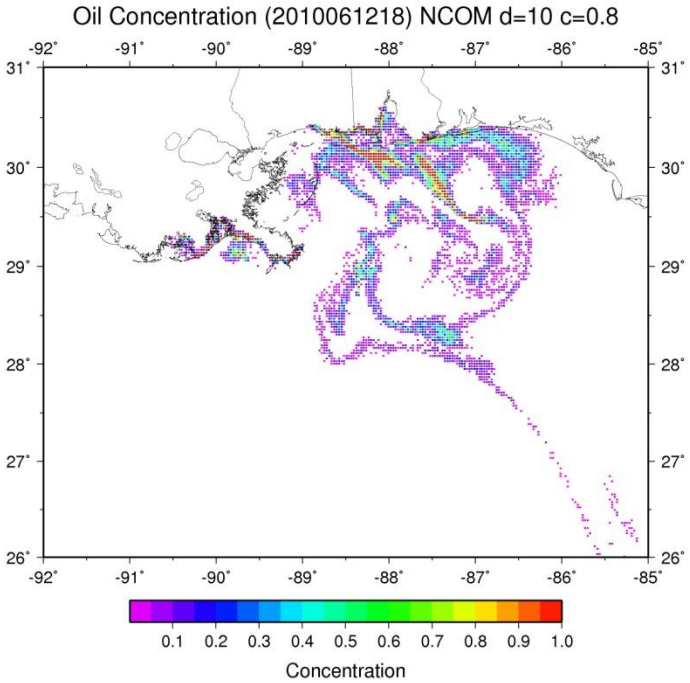
Concentration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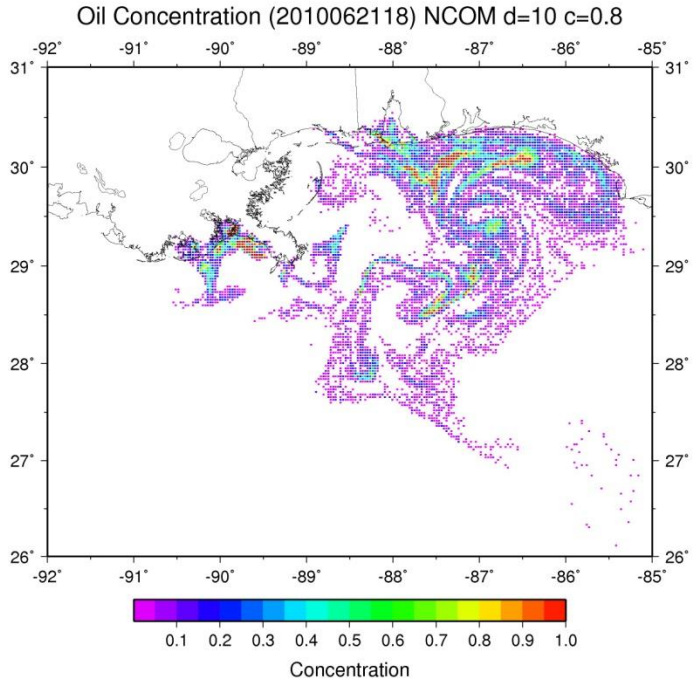
Concentration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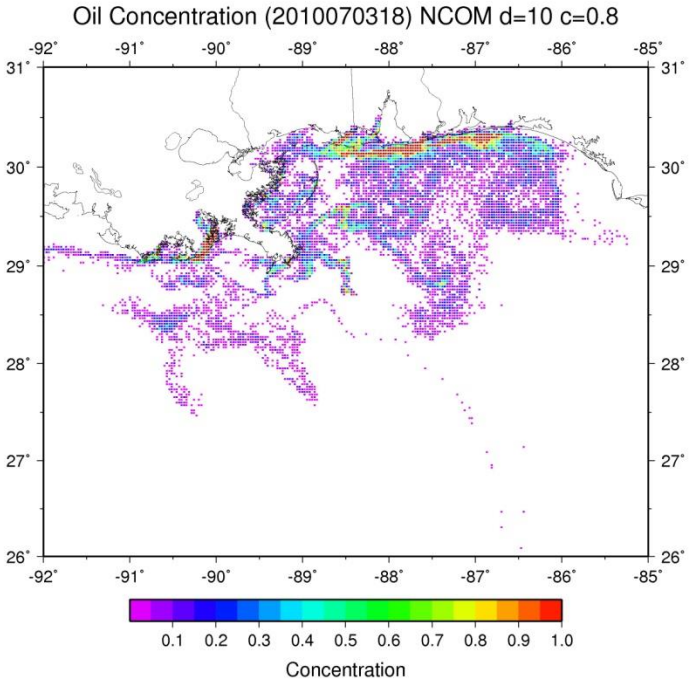
31° 30° 29° 28° 27° 26°
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Concentration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31° 30° 29° 28° 27° 26°
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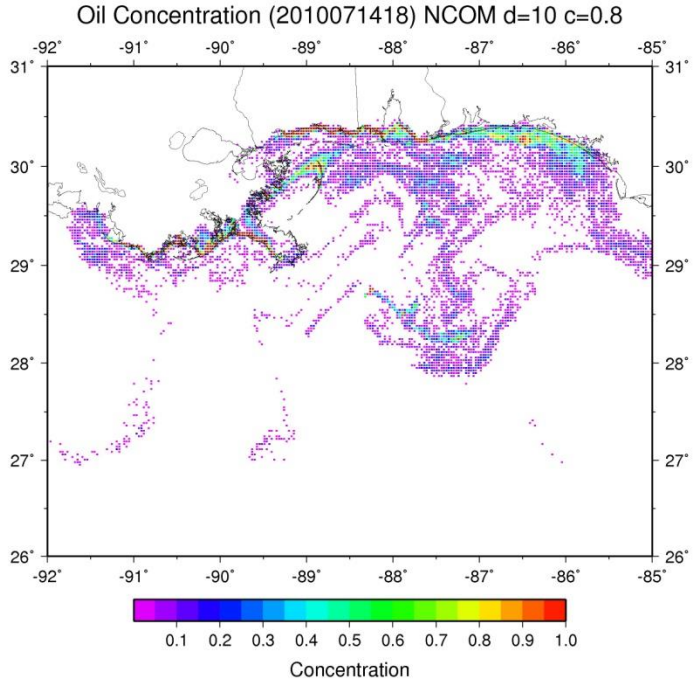
Concentration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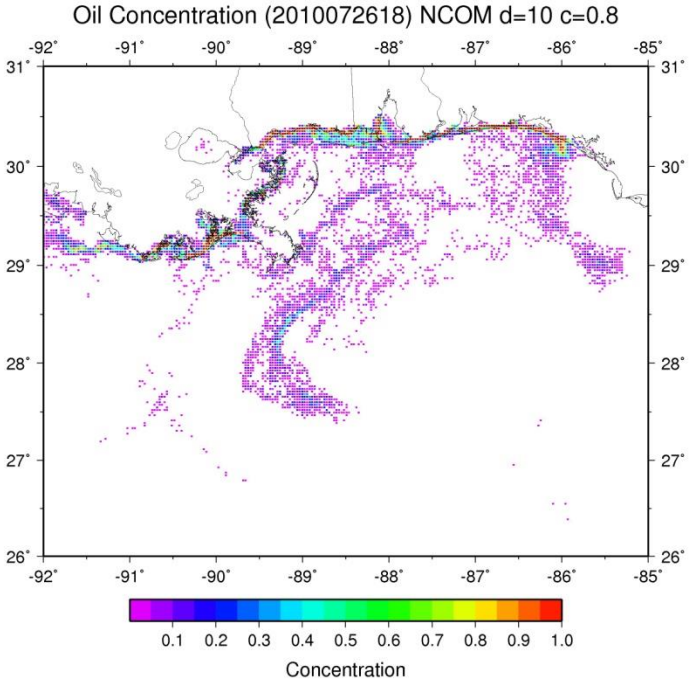
31° 30° 29° 28° 27° 26°
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Concentration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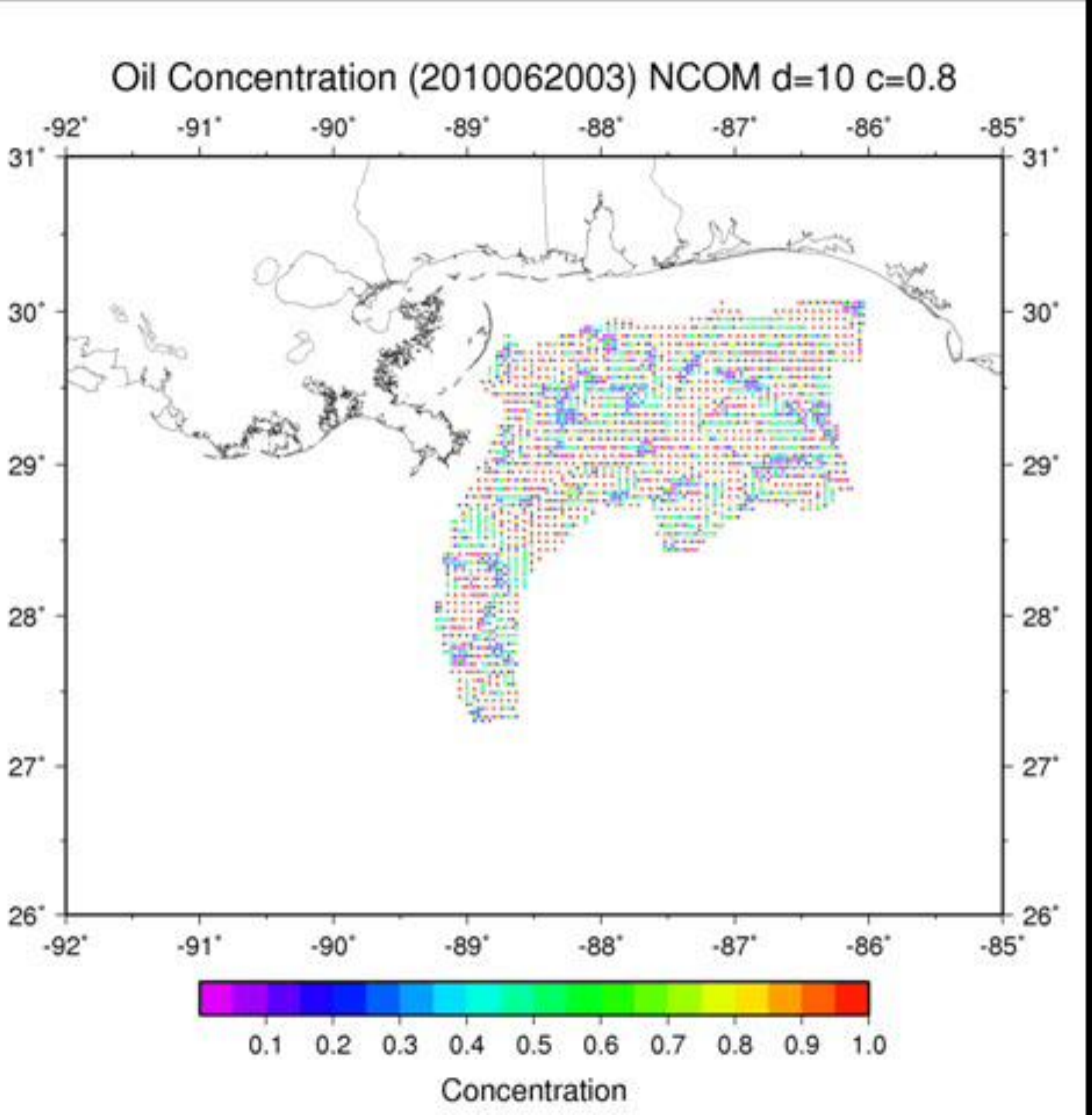
Concentration


Oil Concentration (2010062003) NCOM d=10 c=0.8
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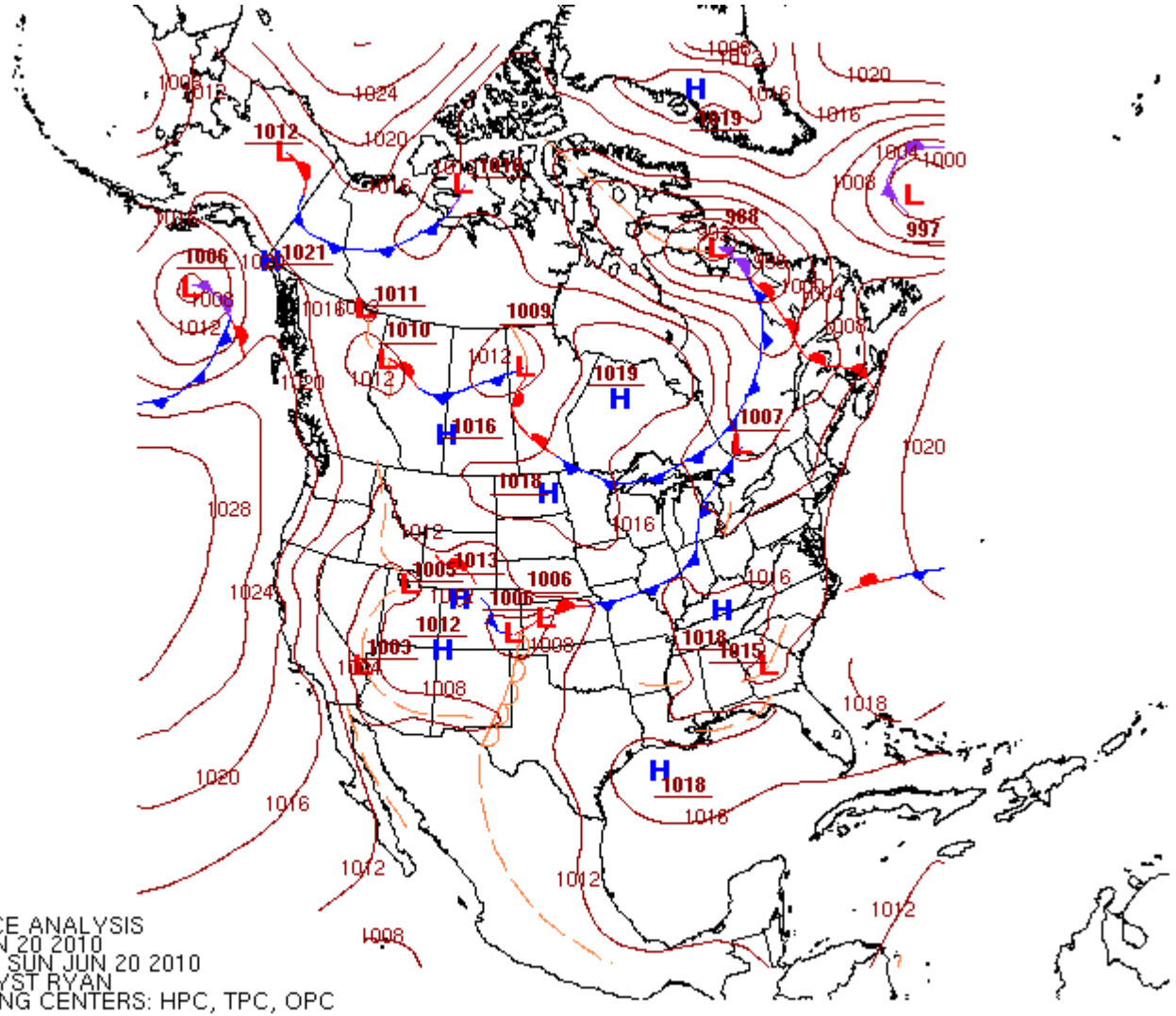
-90°
-89°
-88°
-87°
-86°
-85°
31°
30°
29°
28°
27°
26°
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Concentration

What caused oil incursion into Mississippi Sound, Lake Borgne, and Lake Pontchartrain?

- Two cyclones (one is a tropical cyclone)
- Mini-storm surge events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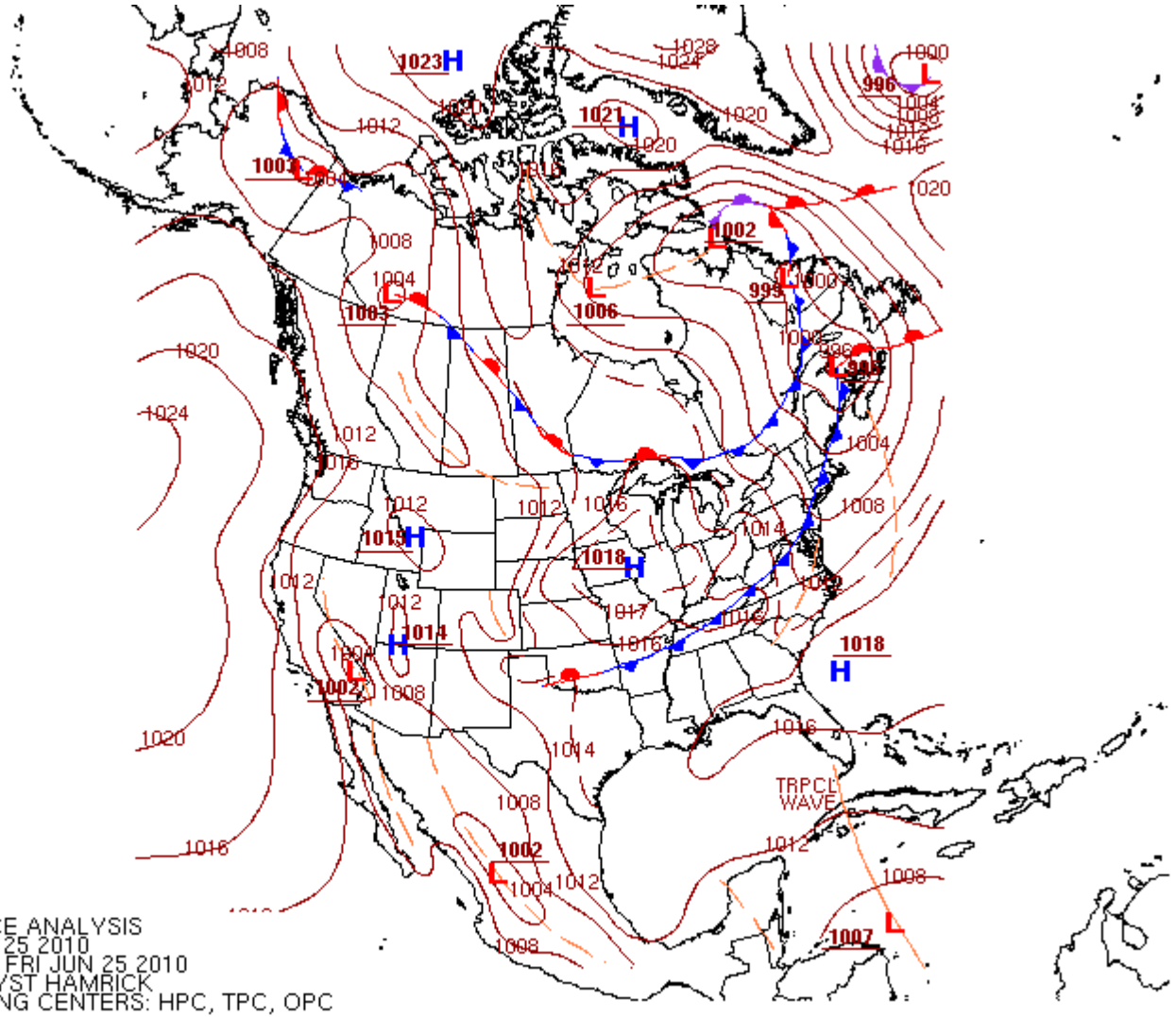
ISSUED: 0128Z SUN JUN 20 2010
BY HPC ANALYST RYAN
COLLABORATING CENTERS: HPC, TPC, OPC



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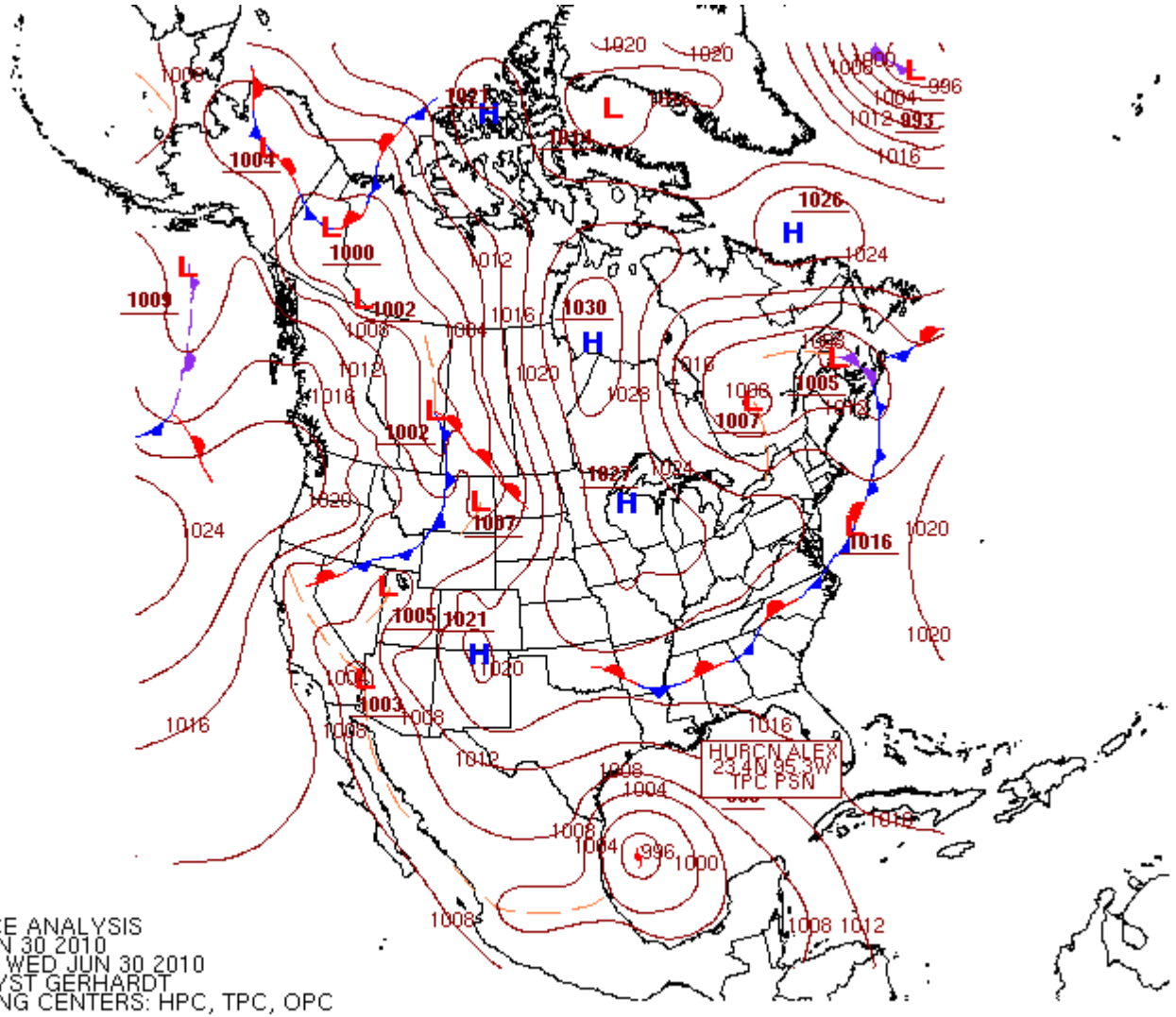
COLLABORATING CENTERS: HPC, TPC, OPC



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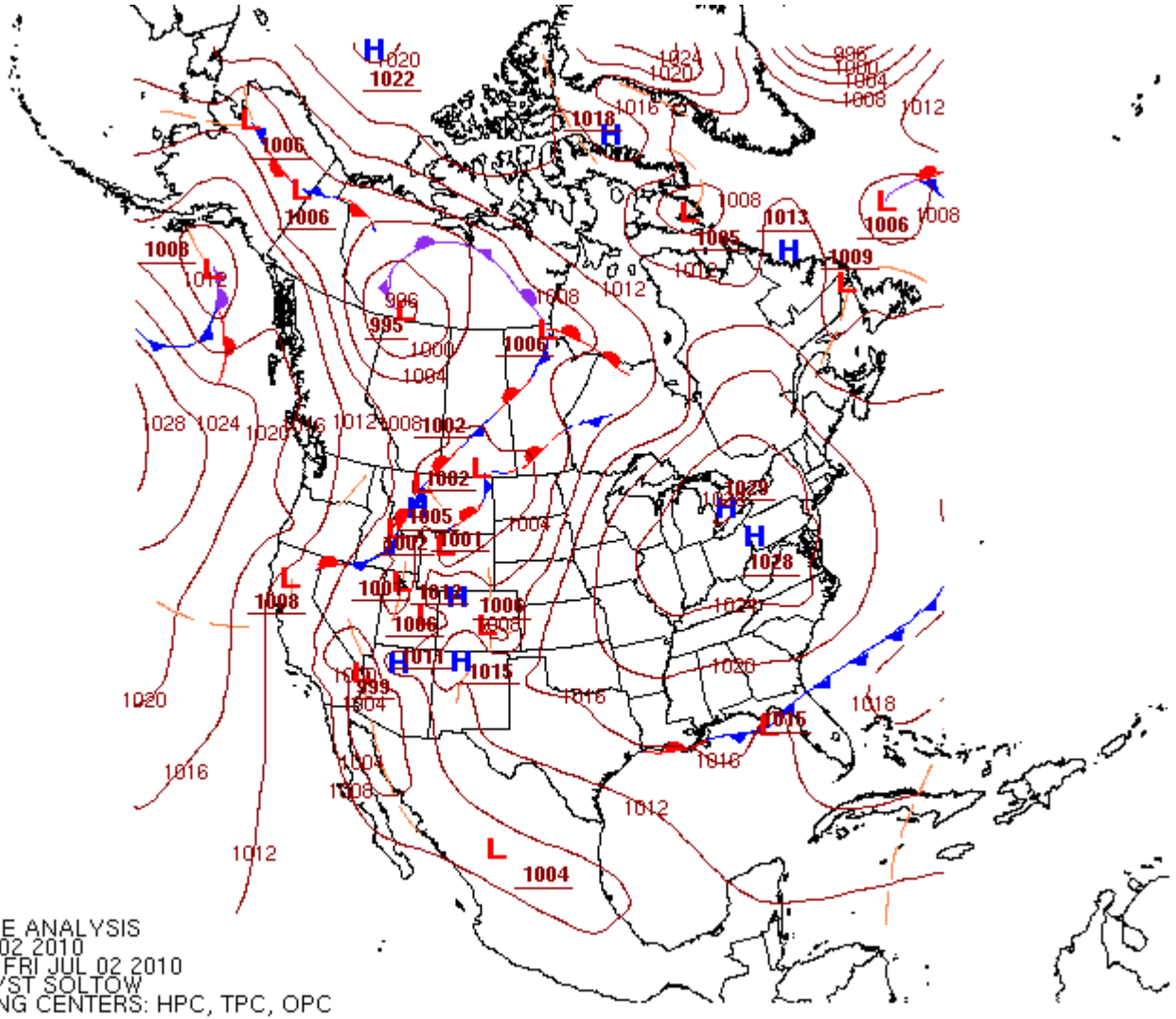
BY HPC ANALYST GERHARDT
COLLABORATING CENTERS: HPC, TPC, OPC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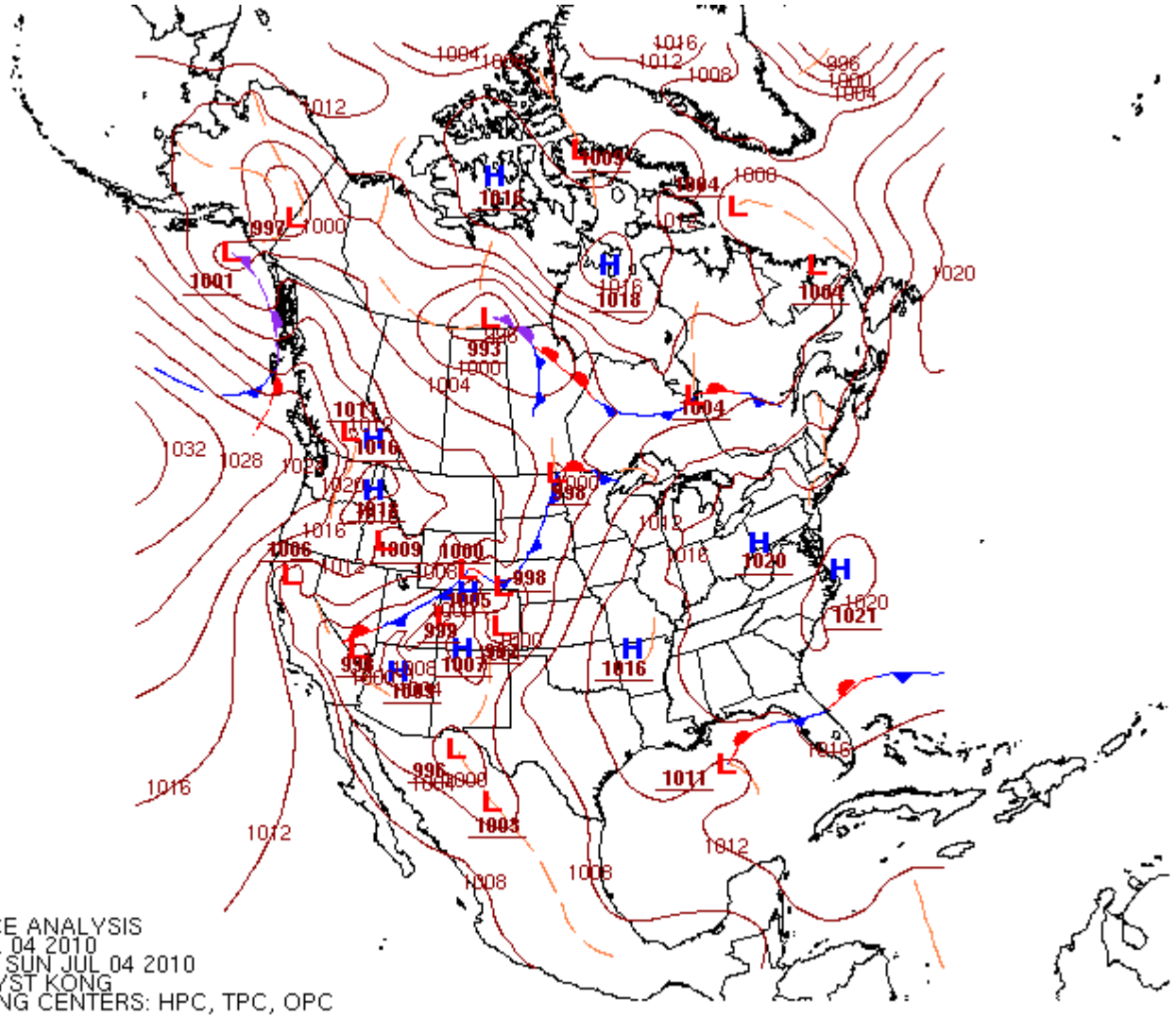

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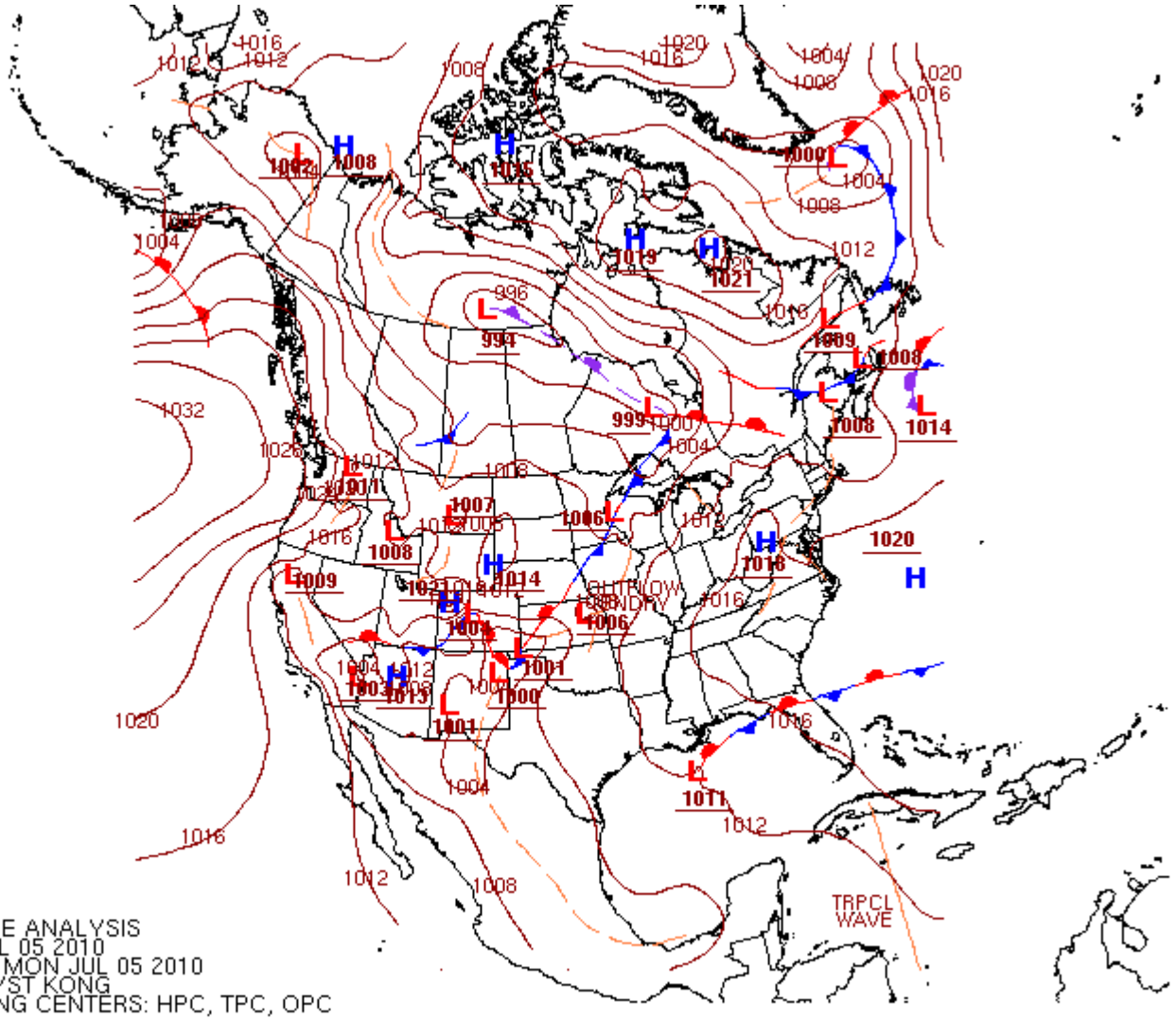

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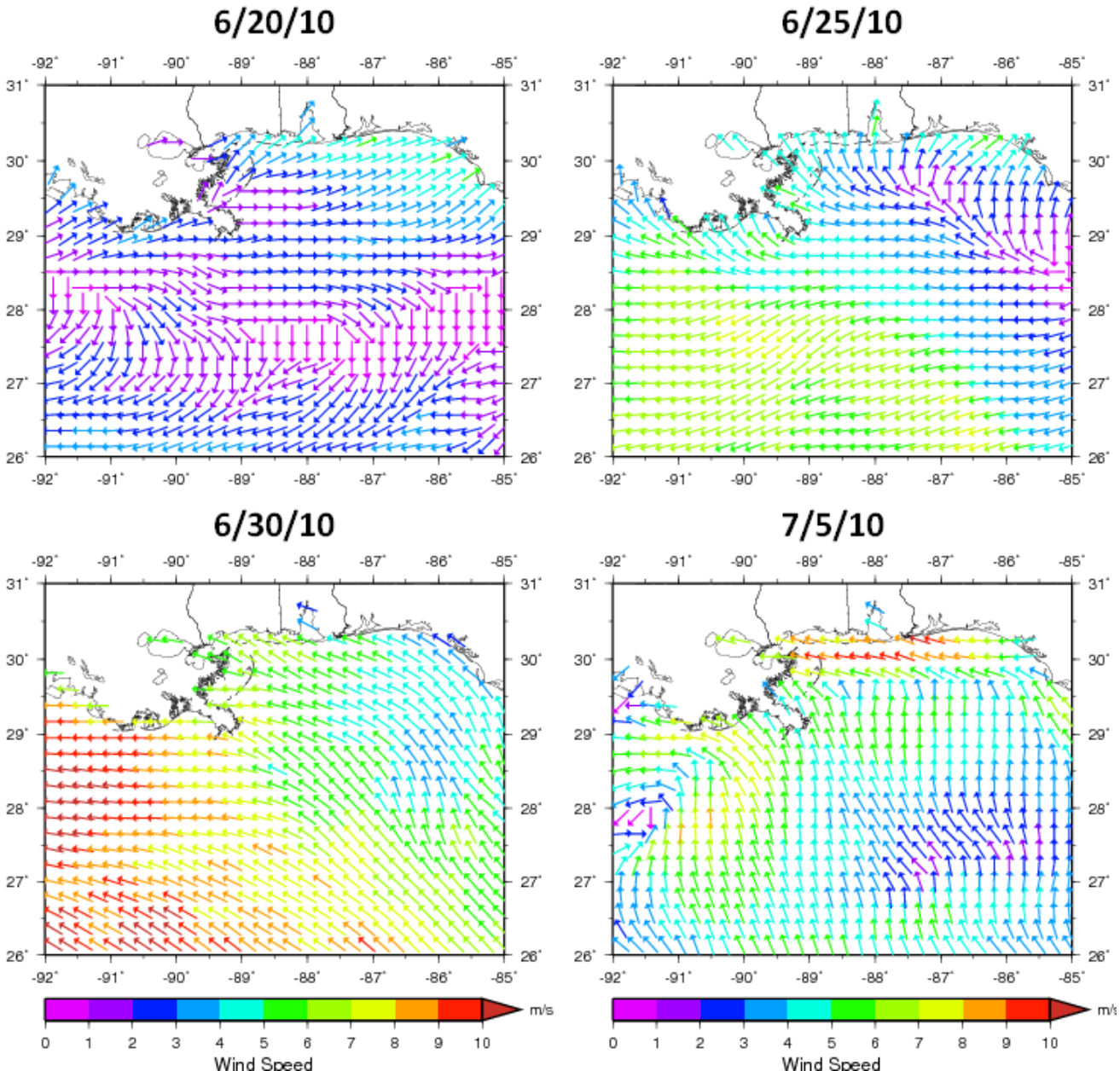
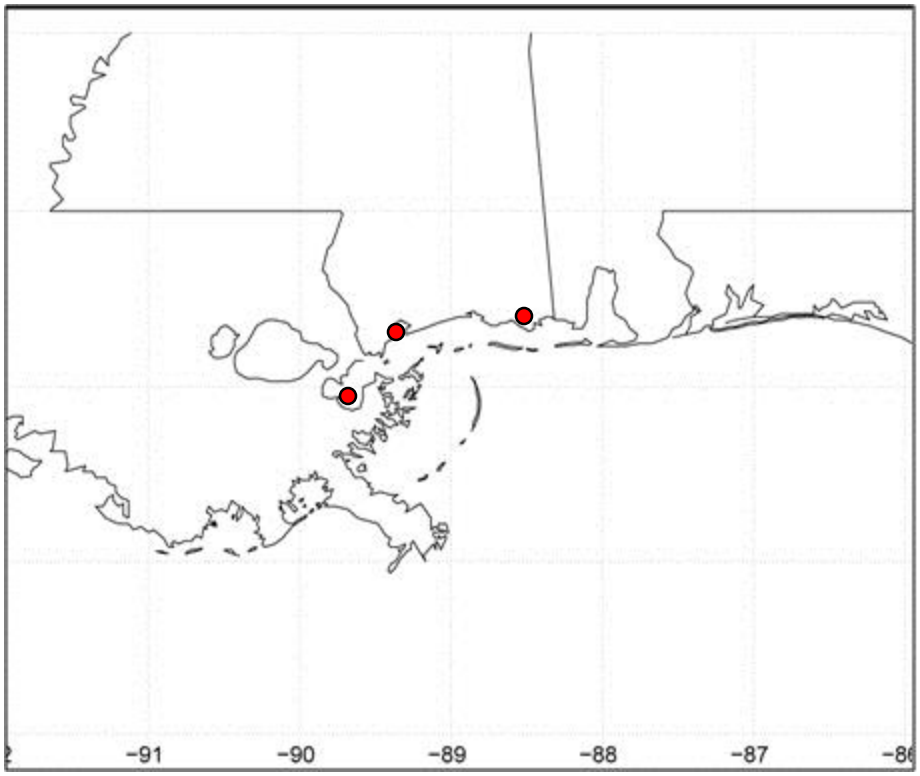
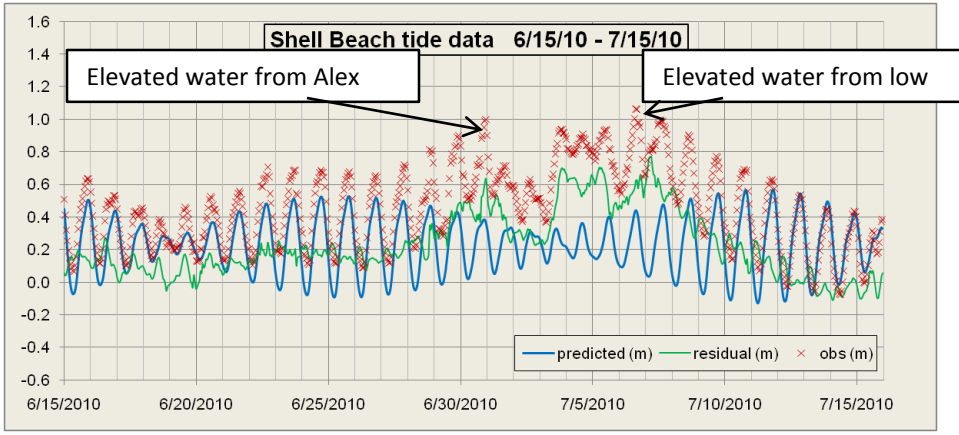
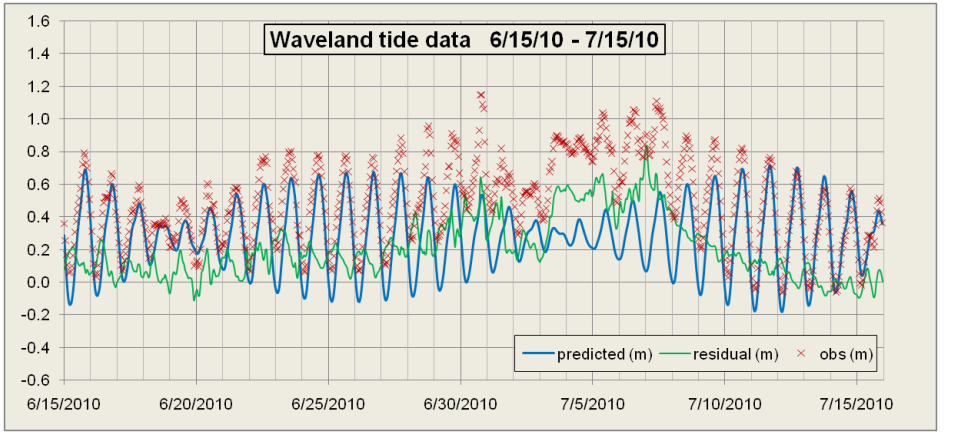
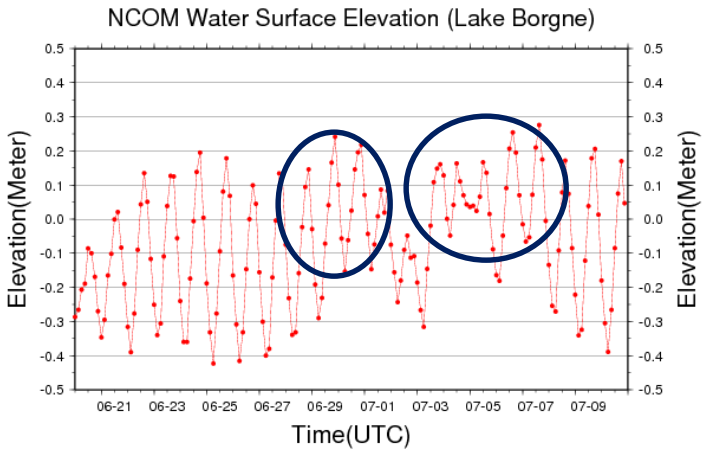

6/20/10
6/25/10
6/30/10
7/5/10
-92° -91° -90° -89° -88° -87° -86° -85°
31° 30° 29° 28° 27° 26°
0 1 2 3 4 5 6 7 8 9 10
m/s
Wind Speed

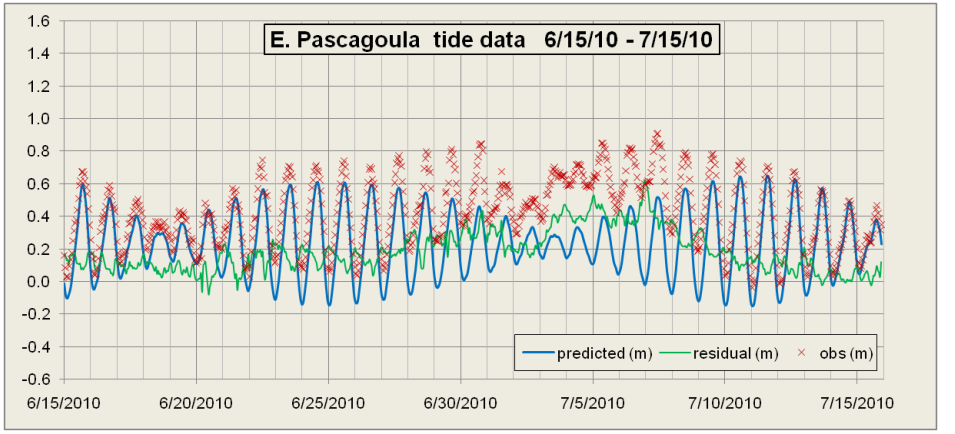
CMAN observations and NCOM show the oil incursion was associated with two mini-storm surge events

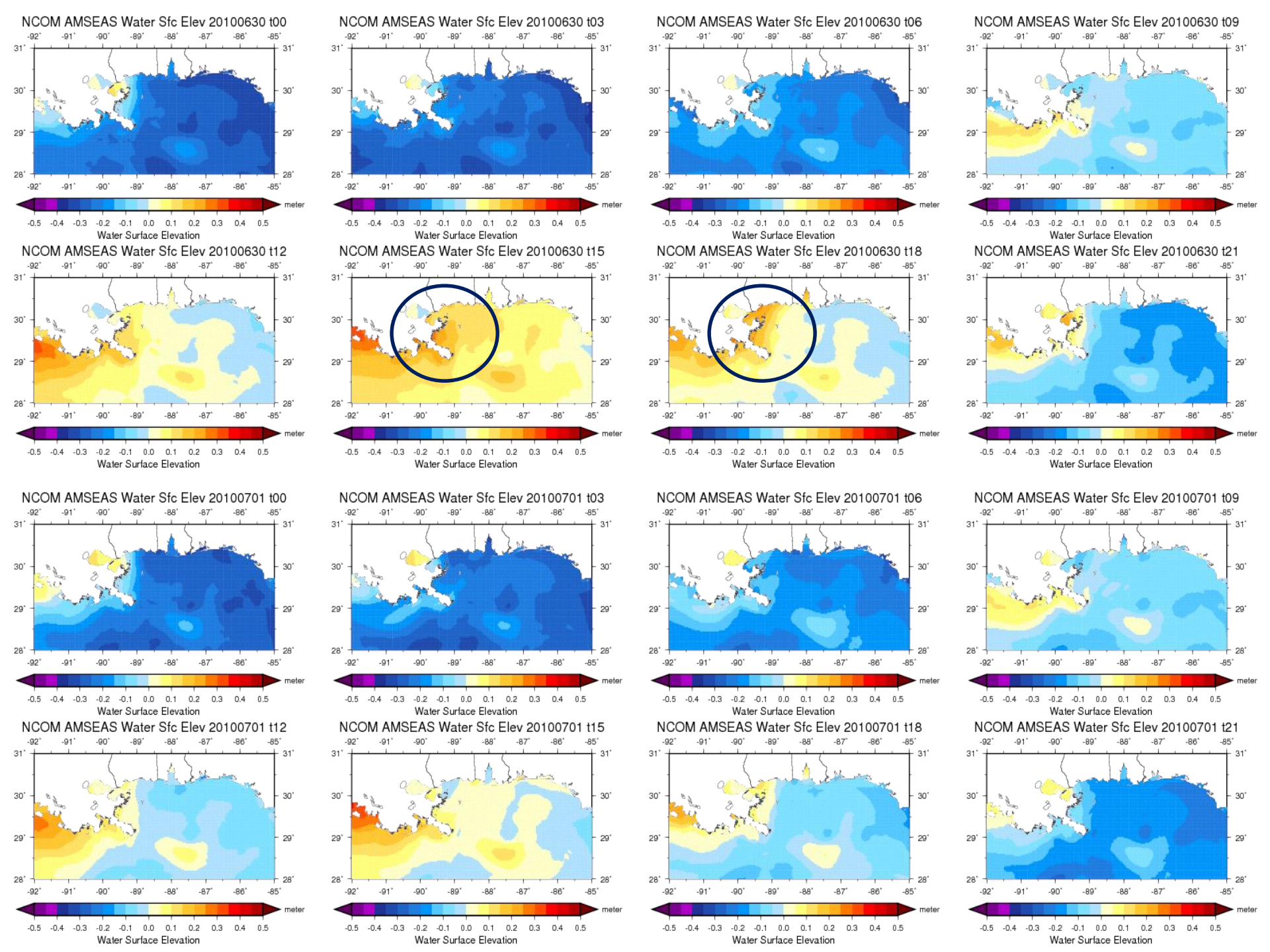

-91
-90
-89
-88
-87


Shell Beach tide data 6/15/10 - 7/15/10
Elevated water from Alex
Elevated water from low
predicted (m)
residual (m)
obs (m)
6/15/2010
6/20/2010
6/25/2010
6/30/2010
7/5/2010
7/10/2010
7/15/2010


Waveland tide data 6/15/10 - 7/15/10
predicted (m)
residual (m)
obs (m)
6/15/2010
6/20/2010
6/25/2010
6/30/2010
7/5/2010
7/10/2010
7/15/2010


NCOM Water Surface Elevation (Lake Borgne)
Elevation(Meter)
Time(UTC)
06-21
06-23
06-25
06-27
06-29
07-01
07-03
07-05
07-07
07-09


E. Pascagoula tide data 6/15/10 - 7/15/10
predicted (m)
residual (m)
obs (m)
6/15/2010
6/20/2010
6/25/2010
6/30/2010
7/5/2010
7/10/2010
7/15/2010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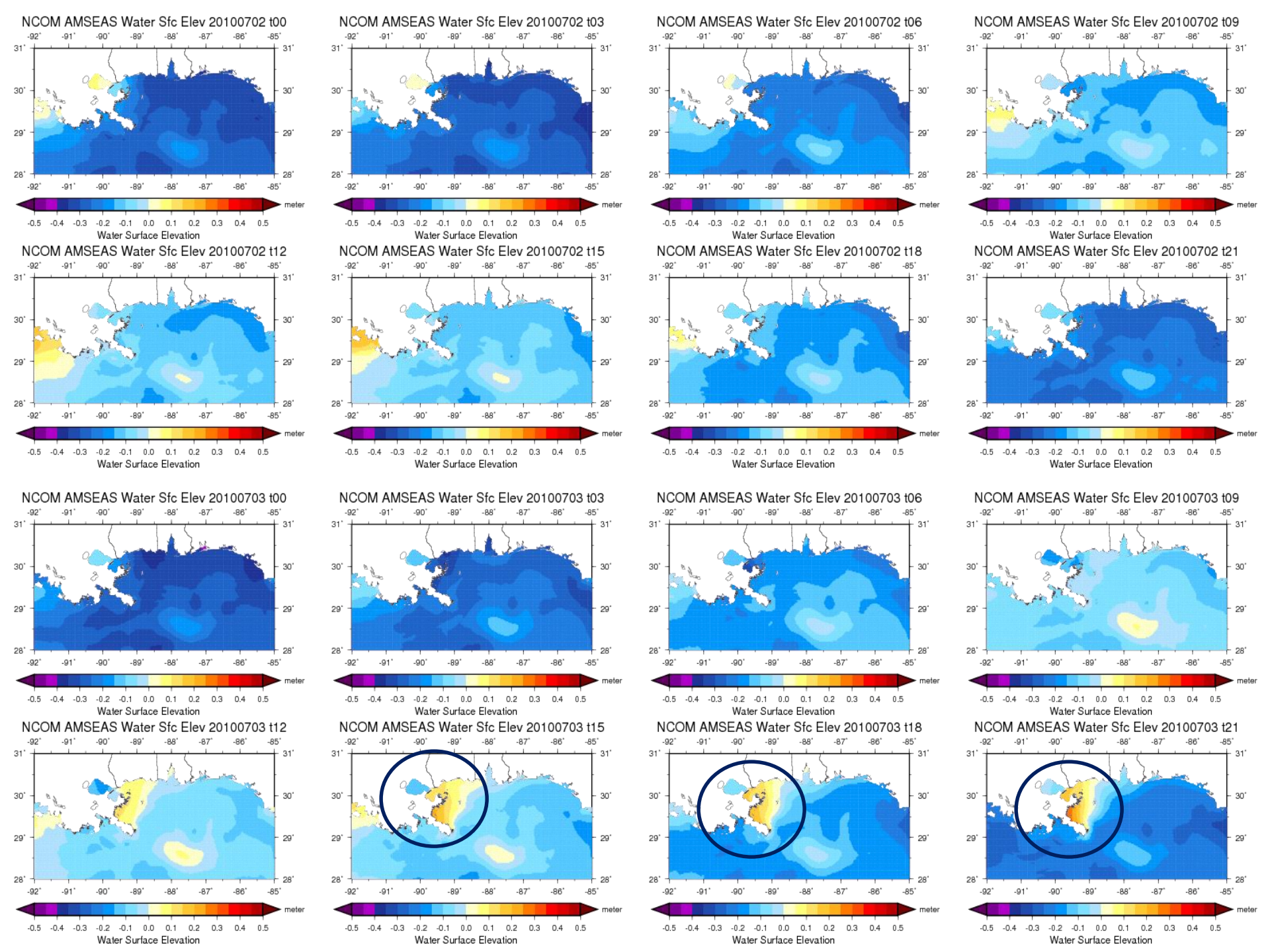
NCOM AMSEAS Water Sfc Elev 20100630 t03
NCOM AMSEAS Water Sfc Elev 20100630 t06
NCOM AMSEAS Water Sfc Elev 20100630 t09
NCOM AMSEAS Water Sfc Elev 20100630 t12
NCOM AMSEAS Water Sfc Elev 20100630 t15
NCOM AMSEAS Water Sfc Elev 20100630 t18
NCOM AMSEAS Water Sfc Elev 20100630 t21
NCOM AMSEAS Water Sfc Elev 20100701 t00
NCOM AMSEAS Water Sfc Elev 20100701 t03
NCOM AMSEAS Water Sfc Elev 20100701 t06
NCOM AMSEAS Water Sfc Elev 20100701 t09
NCOM AMSEAS Water Sfc Elev 20100701 t12
NCOM AMSEAS Water Sfc Elev 20100701 t15
NCOM AMSEAS Water Sfc Elev 20100701 t18
NCOM AMSEAS Water Sfc Elev 20100701 t21
-92° -91° -90° -89° -88° -87° -86° -85°
31° 30° 29° 28°
meter
-0.5 -0.4 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5
Water Surface Elevation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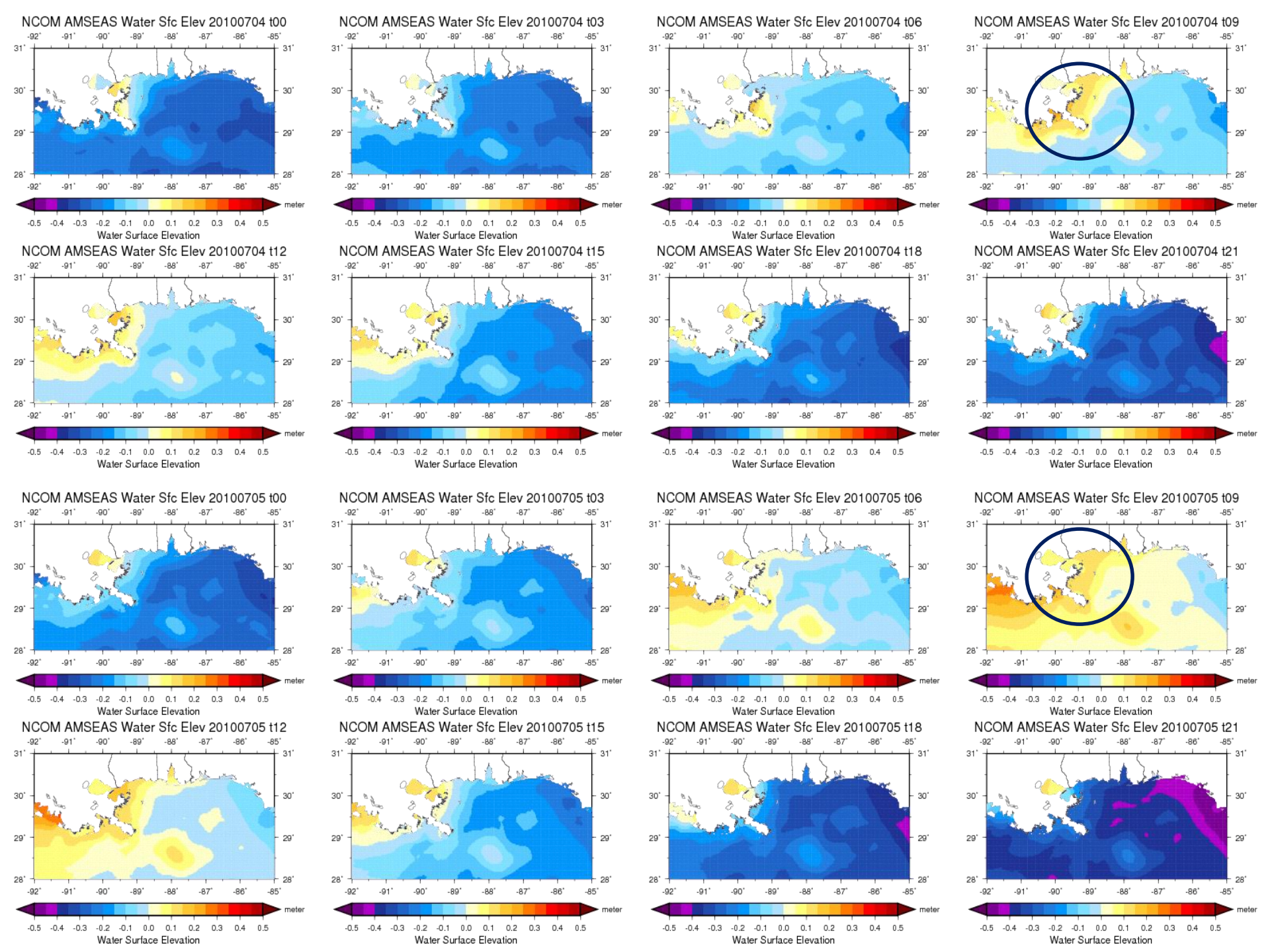
NCOM AMSEAS Water Sfc Elev 20100703 t15
NCOM AMSEAS Water Sfc Elev 20100703 t18
NCOM AMSEAS Water Sfc Elev 20100703 t21
-92° -91° -90° -89° -88° -87° -86° -85°
31° 30° 29° 28°
meter
-0.5 -0.4 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5
Water Surface Elevation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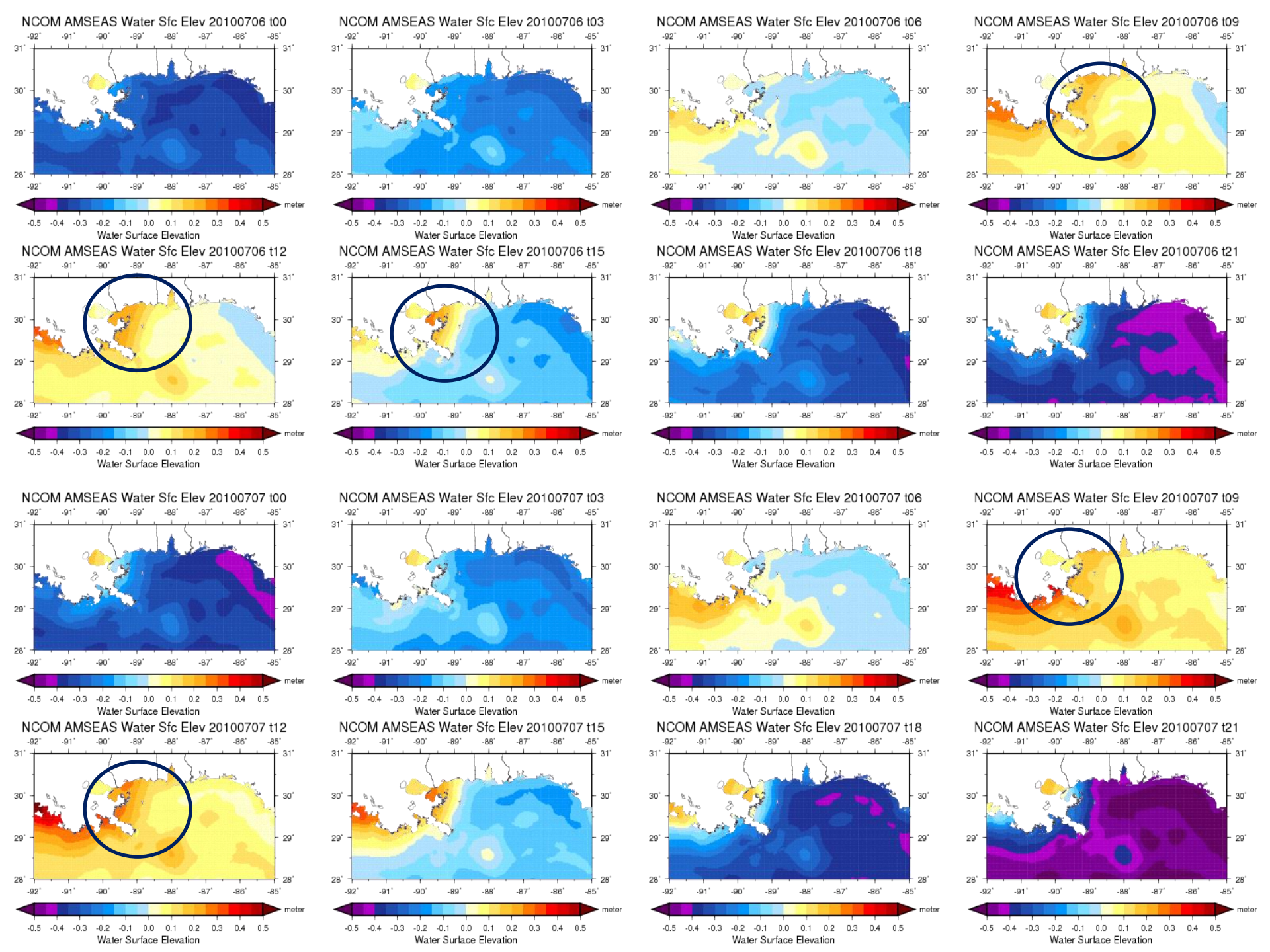
NCOM AMSEAS Water Sfc Elev 20100705 t15
NCOM AMSEAS Water Sfc Elev 20100705 t18
NCOM AMSEAS Water Sfc Elev 20100705 t21
-92° -91° -90° -89° -88° -87° -86° -85°
31° 30° 29° 28°
meter
-0.5 -0.4 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5
Water Surface Elevation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NCOM AMSEAS Water Sfc Elev 20100706 t15
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NCOM AMSEAS Water Sfc Elev 20100706 t21
NCOM AMSEAS Water Sfc Elev 20100707 t00
NCOM AMSEAS Water Sfc Elev 20100707 t03
NCOM AMSEAS Water Sfc Elev 20100707 t06
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NCOM AMSEAS Water Sfc Elev 20100707 t12
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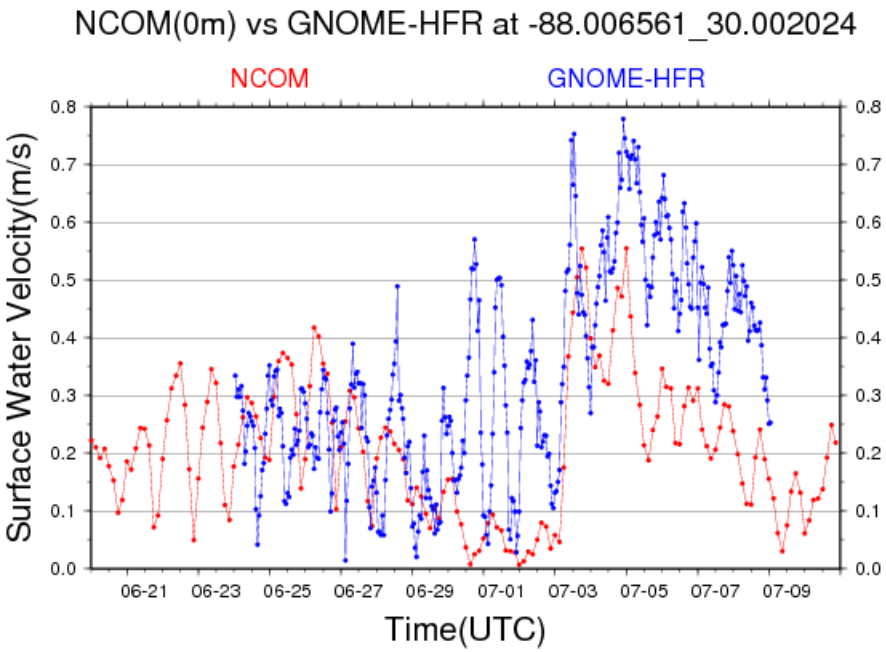
NCOM AMSEAS Water Sfc Elev 20100707 t18
NCOM AMSEAS Water Sfc Elev 20100707 t21
-92° -91° -90° -89° -88° -87° -86° -85°
31° 30° 29° 28°
meter
-0.5 -0.4 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5
Water Surface Elevation

How accurate are NCOM's currents?

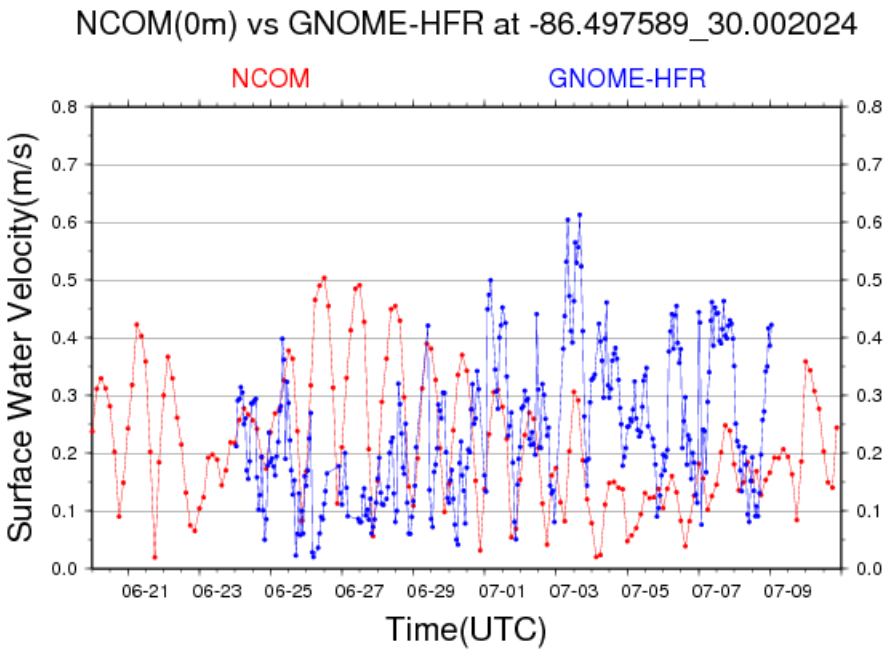
- Mississippi and Breton Sound reasonably accurate
- Alabama/Florida stateline region has issues

Breton Sound (near LA and MS coast)



Reasonably accurate except around 7/1

AL and FL stateline



Currents not accurate simulated

Summary

- Oil transport mostly governed by ocean currents
- However, surge events associated with tropical cyclones and non-tropical lows can push oil far into the marsh system
- Difficult to know if a hurricane landfall would have been catastrophic (because they also flush the system), but the potential of inland pollution existed. Fortunately, no hurricane landfall occurred.