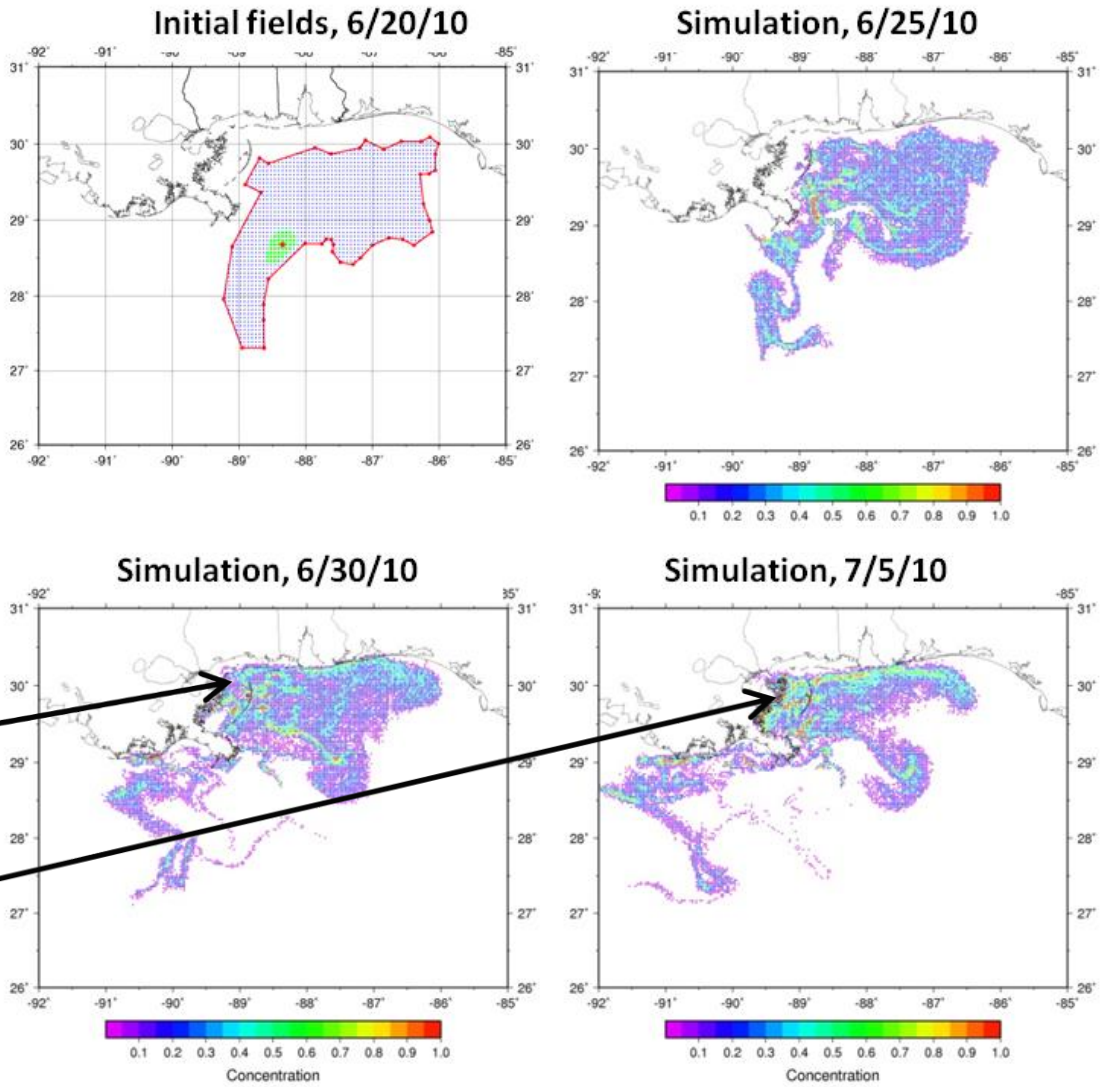
Assessing fate and transport issues of the DWH oil spill using simulations and merged datasets

Pat Fitzpatrick
Geosystems Research Institute
Mississippi State University

- *The influence of cyclones on the DWH oil spill*
- *Update on datasets to validate oil spill simulation*

The influence of cyclones on the Deepwater Horizon Oil Spill

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



Note inshore movement of oil starting late June

Model description

- Lagrangian particle tracker with random walk diffusion

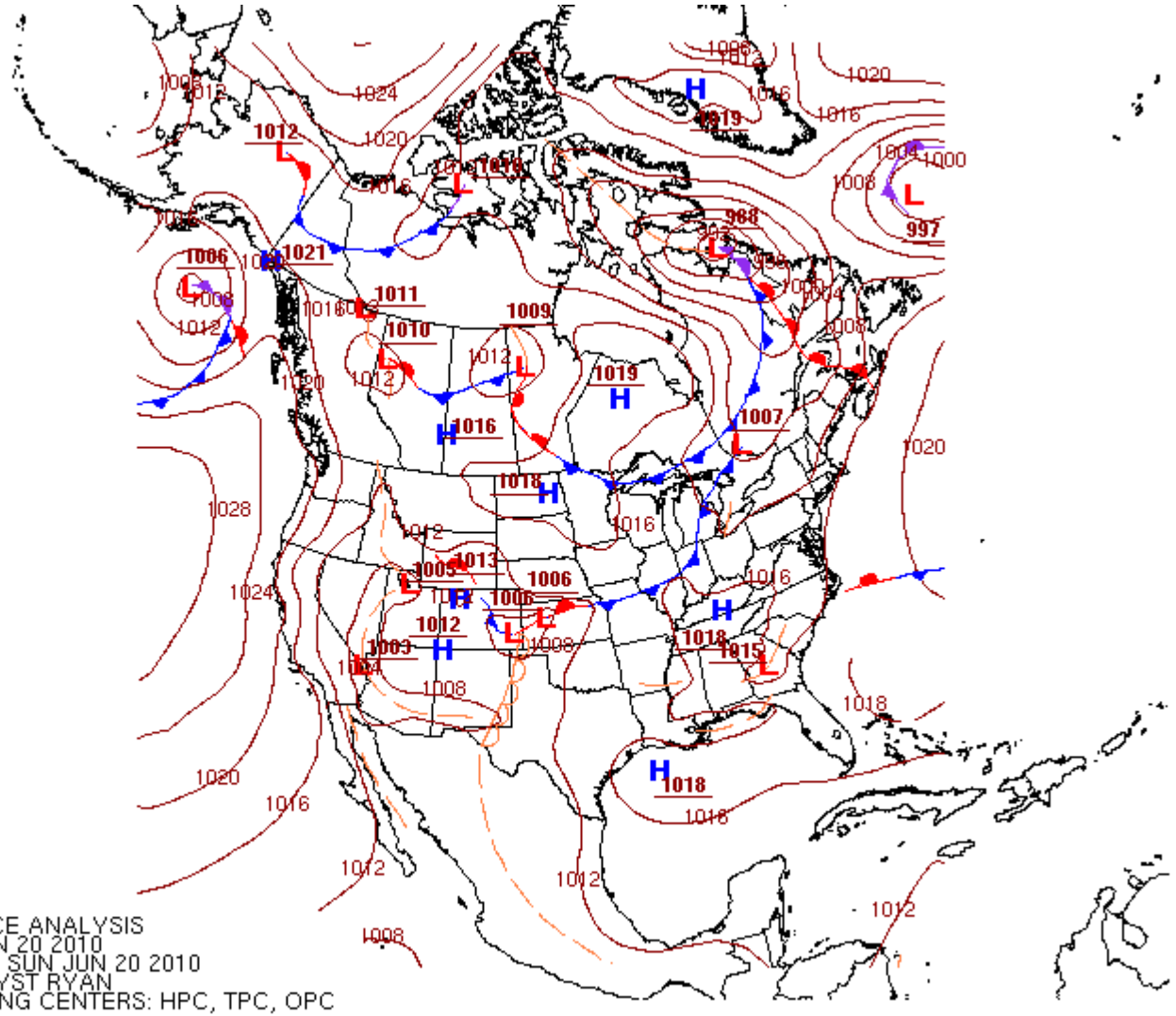
- Input consisted
    i. latitude and longitude parcel positions in the oil-contaminated area
    ii. wind (validation show reasonably accurate with absolute errors of 1.4 ms^{-1} and 33 deg).
    iii. Current (validation to be shown in this talk)
    iv. array of pseudo-random numbers (from Mersenne 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 interpretation 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.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BY HPC ANALYST RYAN
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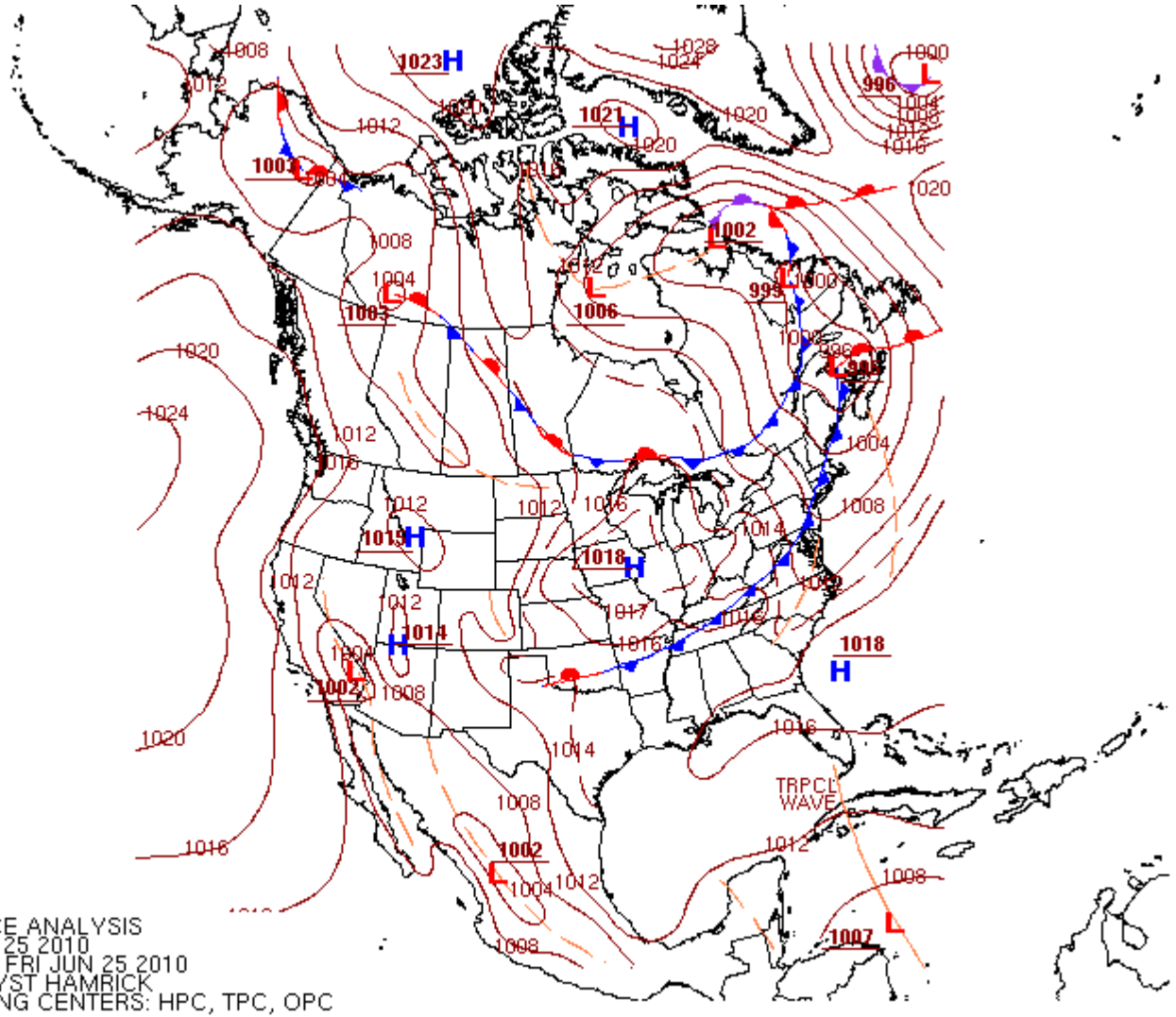

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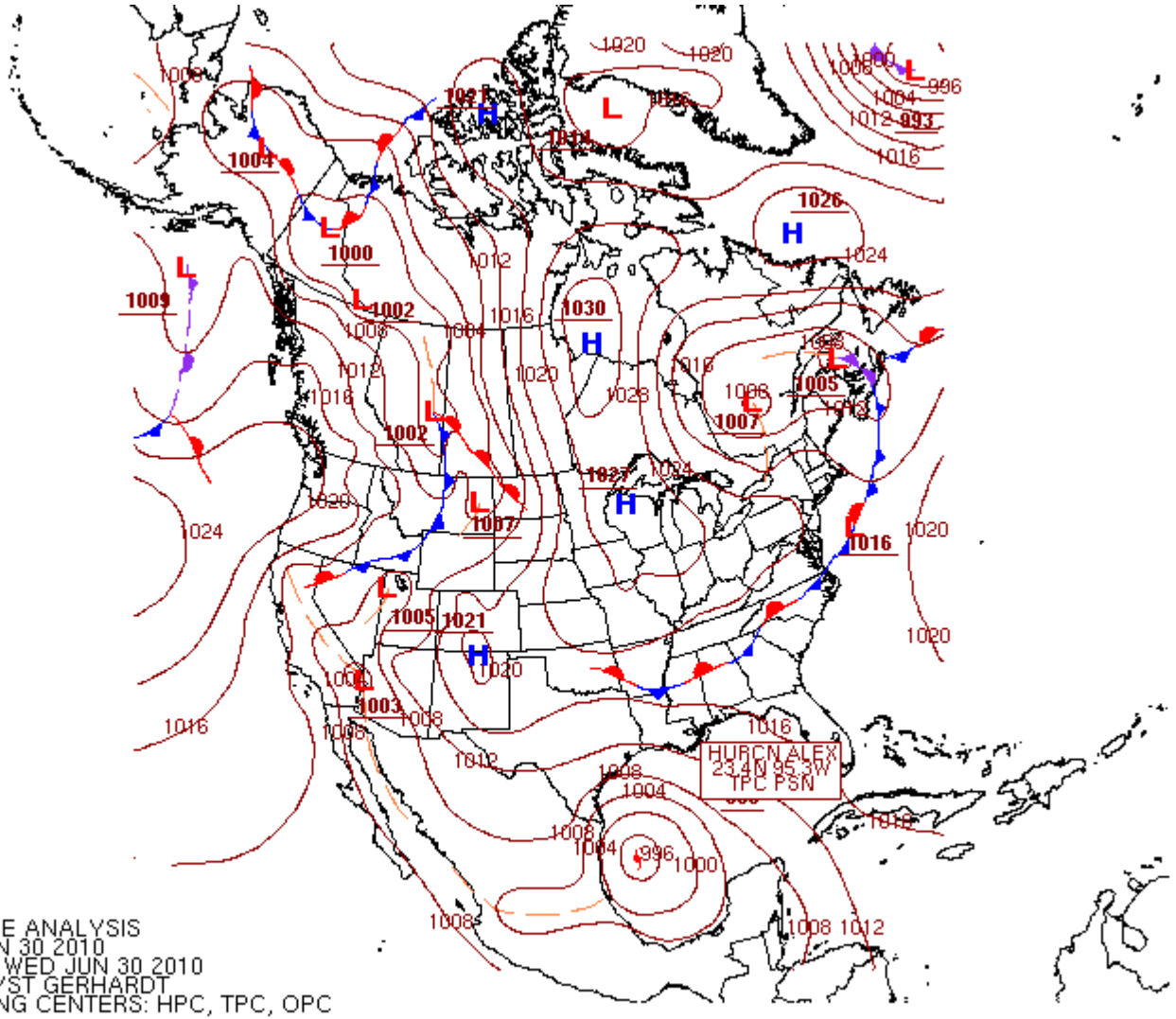

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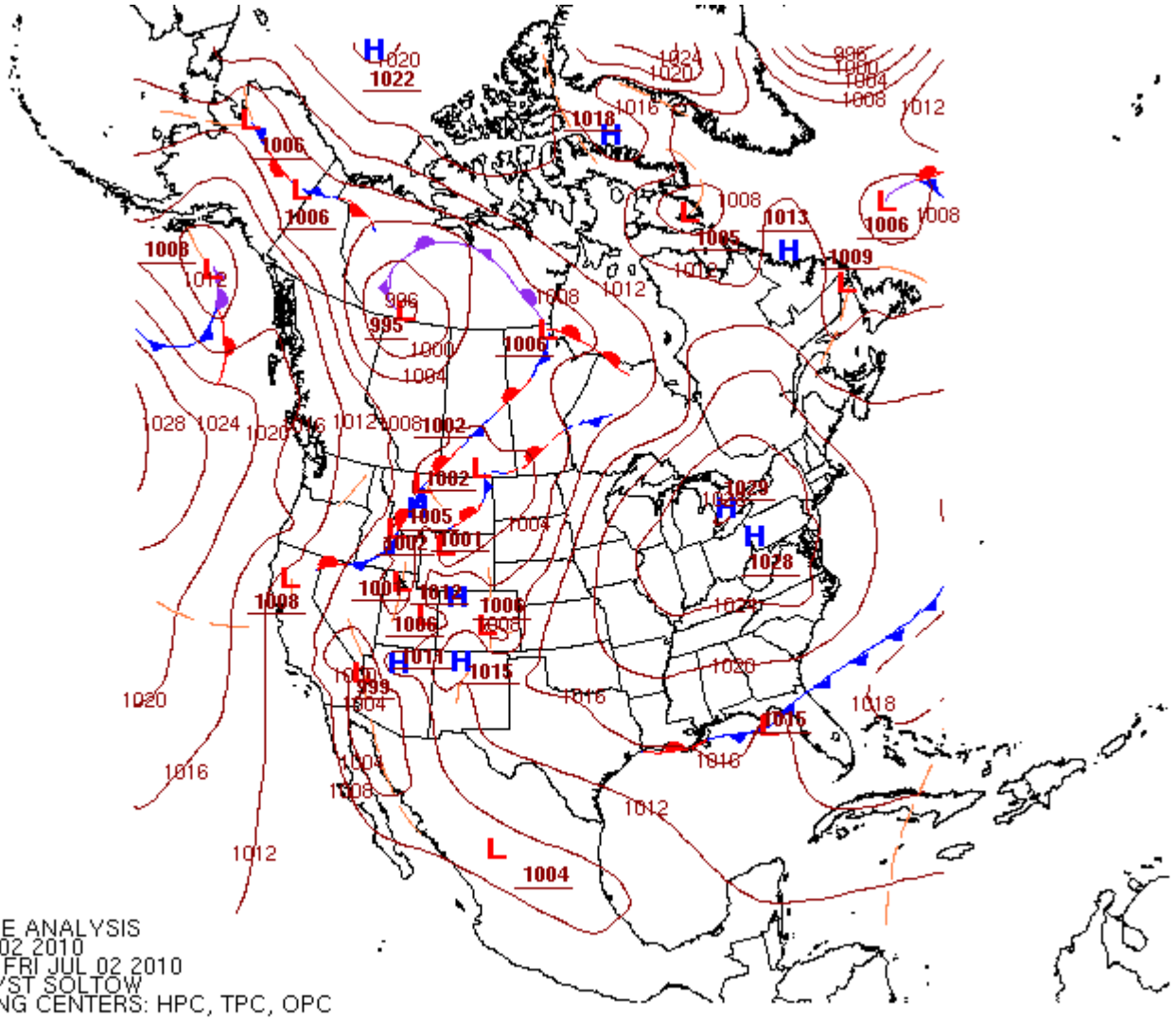
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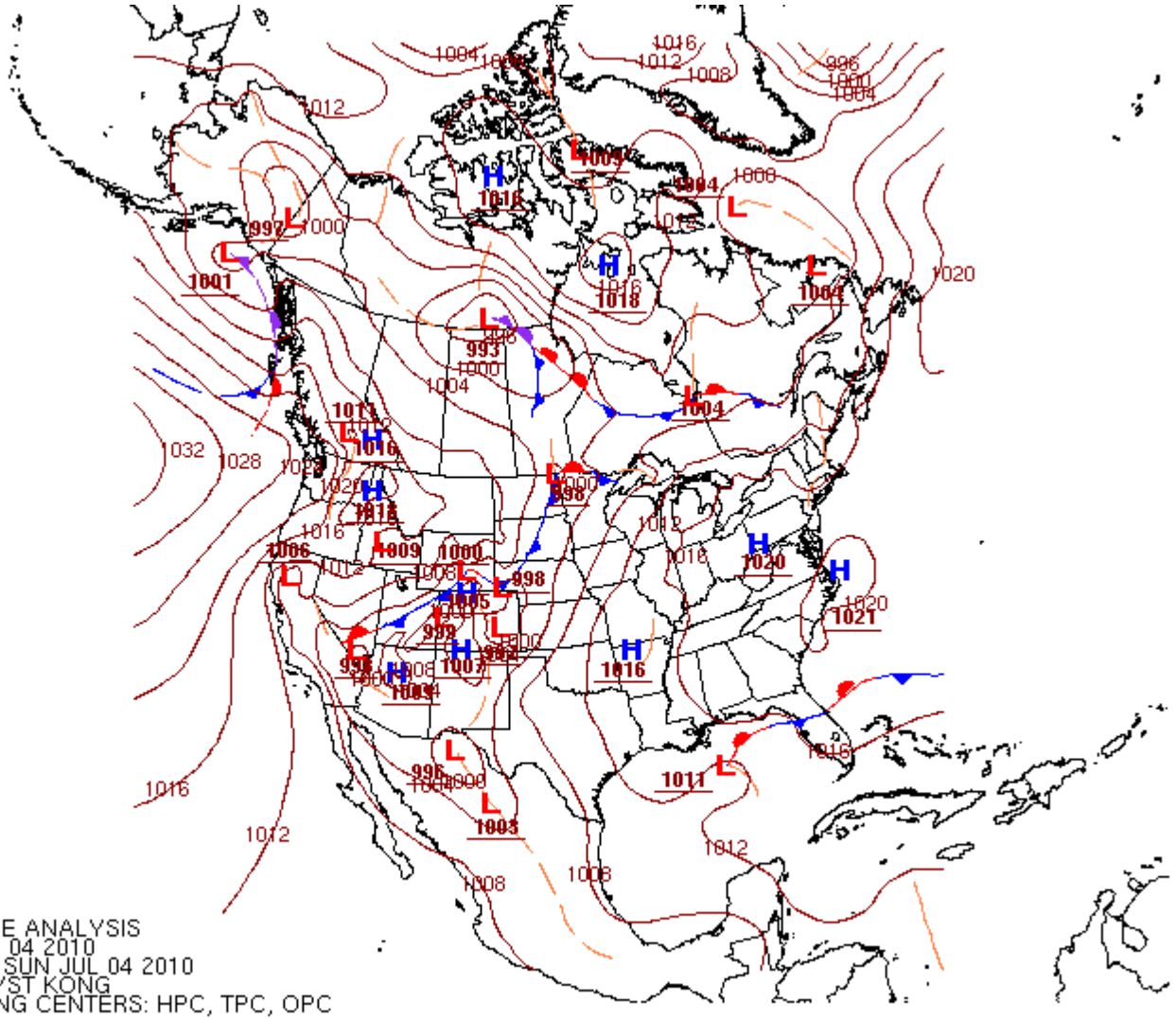
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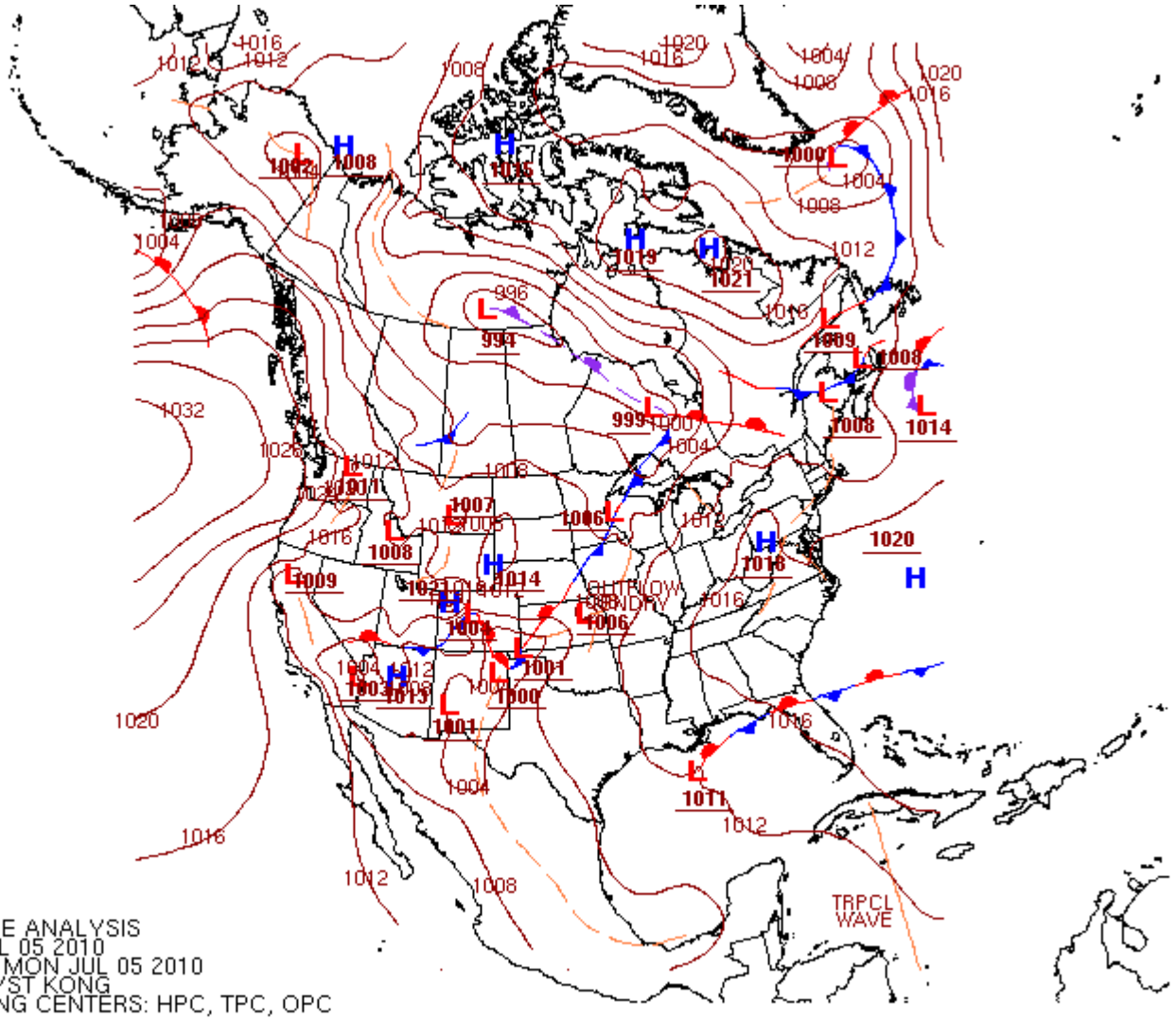

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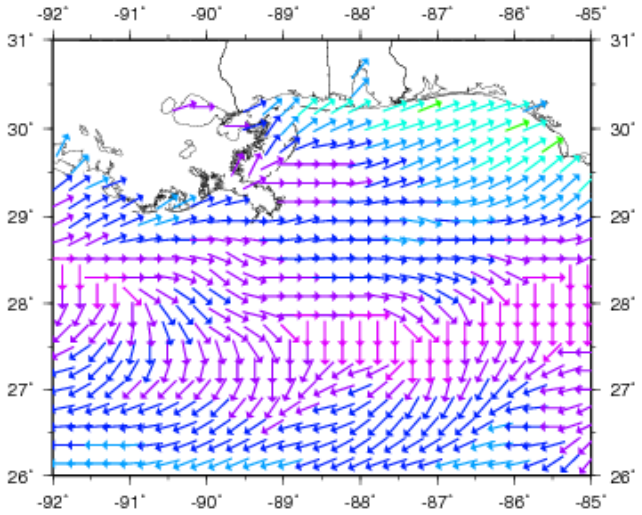
6/20/10



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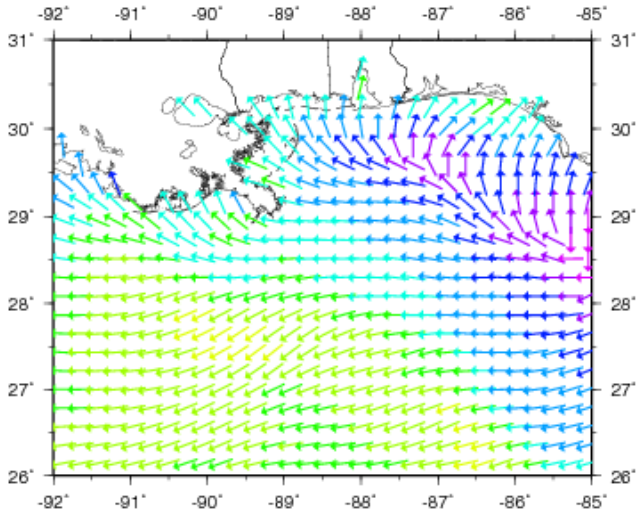

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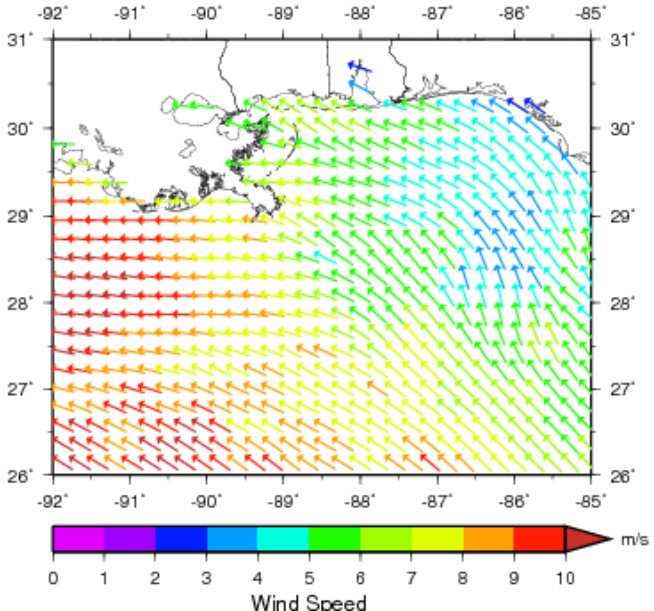
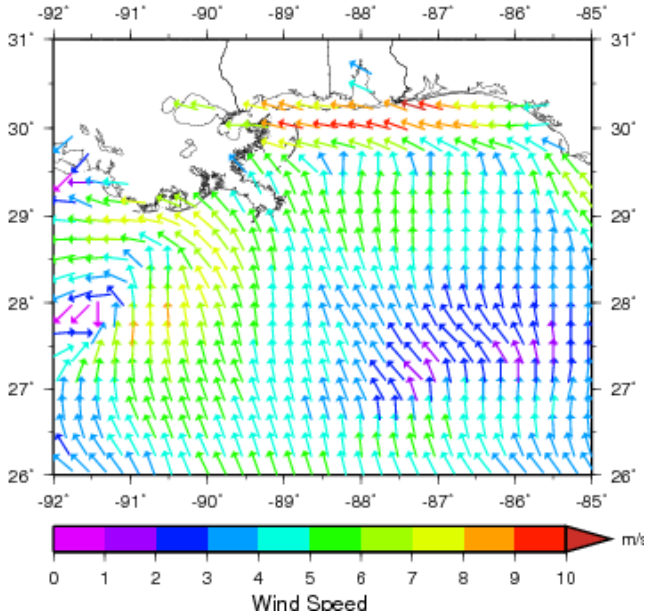
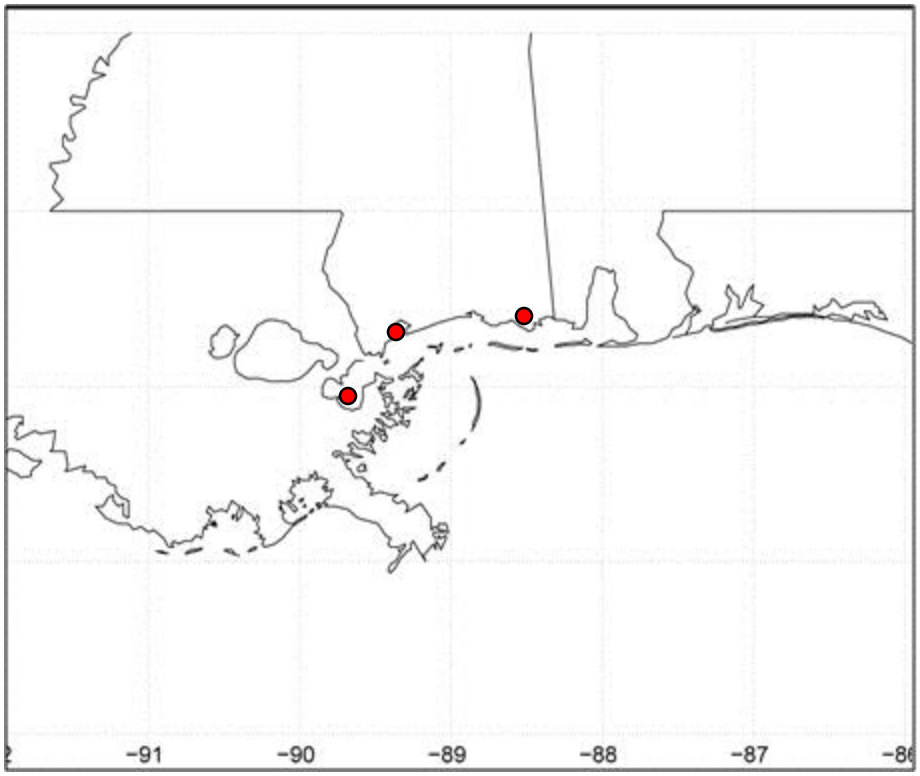


7/5/10

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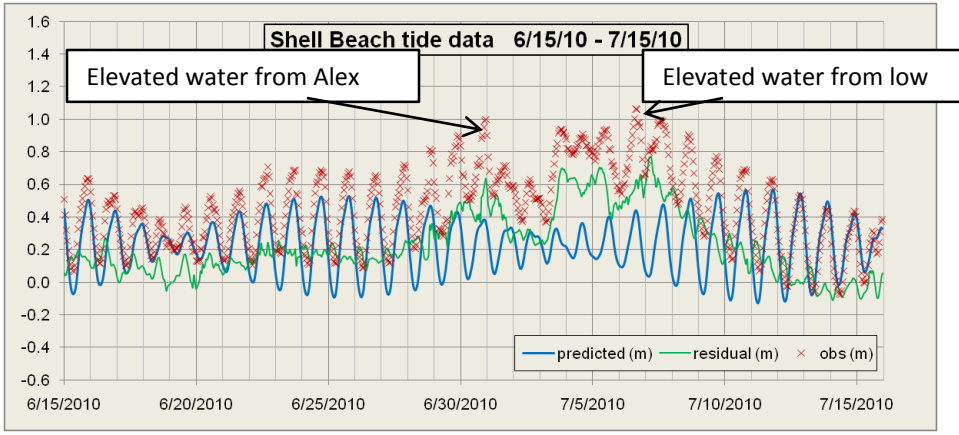
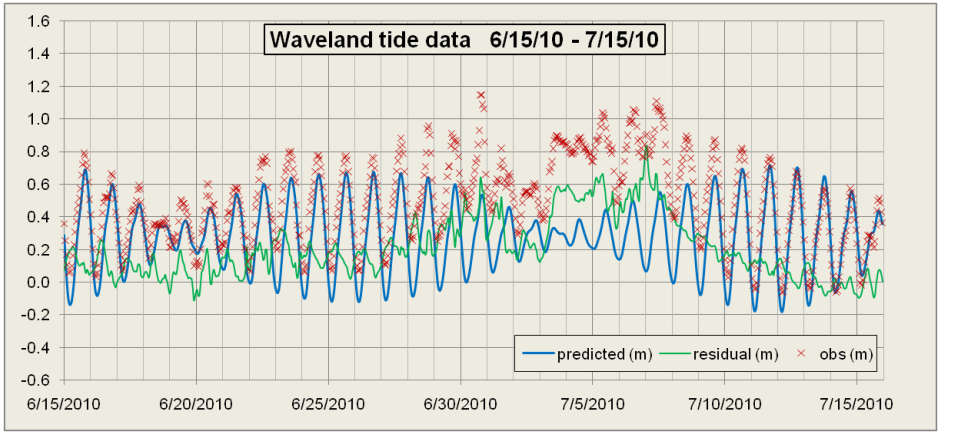
-89
-88
-87


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
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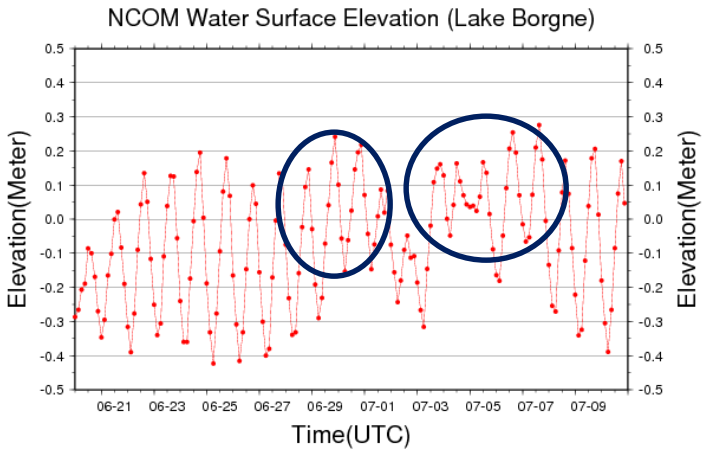
7/10/2010
7/15/2010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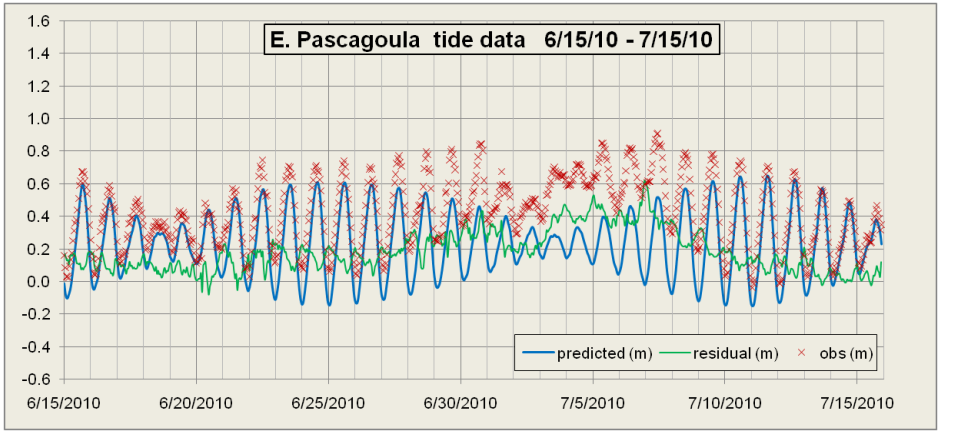
Elevation(Meter)
Time(UTC)
06-21
06-23
06-25
06-27
06-29
07-01
07-03
07-05
07-07
07-09


E. Pascagoula tide data 6/15/10 - 7/15/10
predicted (m)
residual (m)
obs (m)
6/15/2010
6/20/2010
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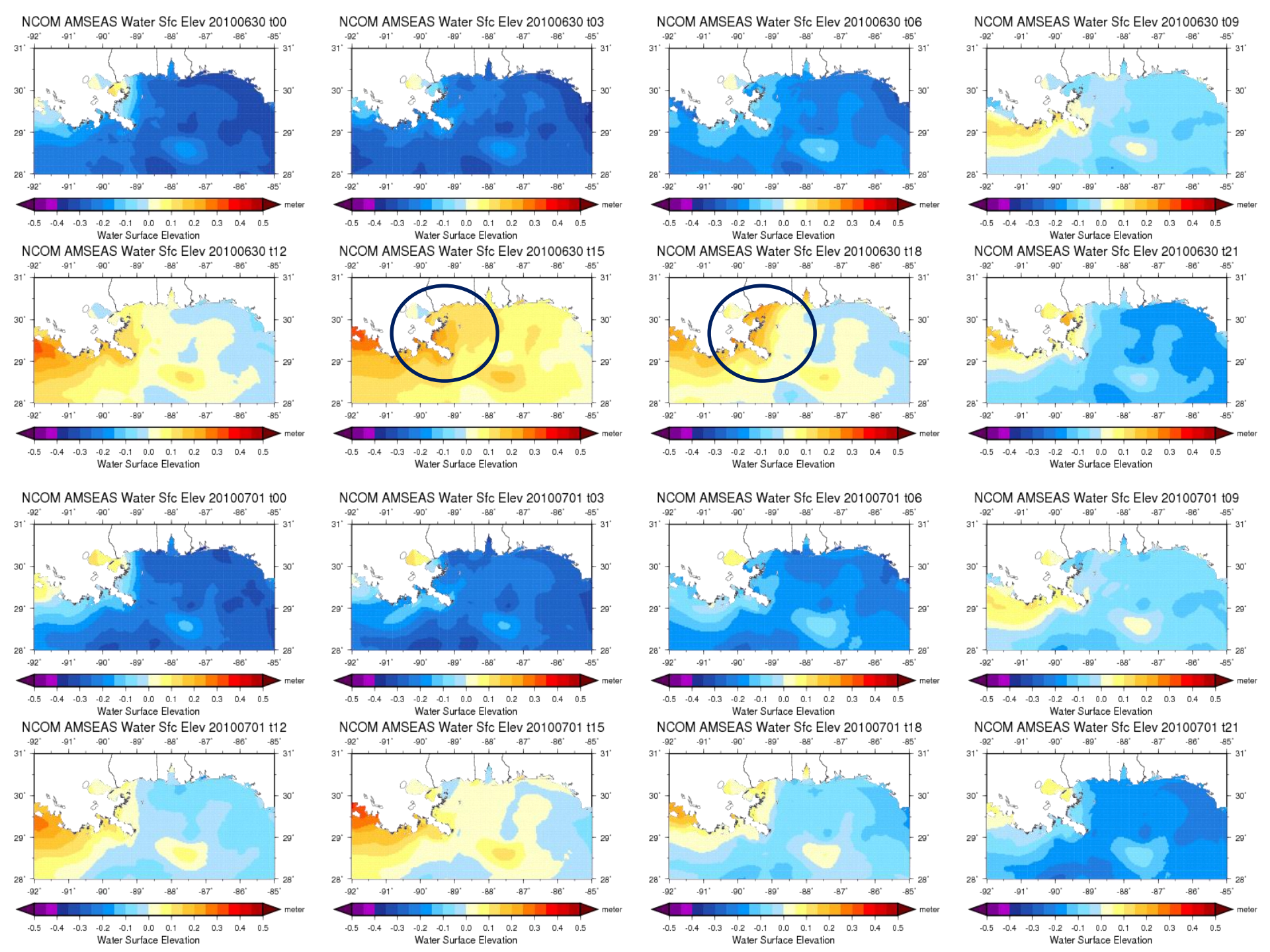
7/10/2010
7/15/2010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NCOM AMSEAS Water Sfc Elev 20100630 t12
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NCOM AMSEAS Water Sfc Elev 20100630 t21
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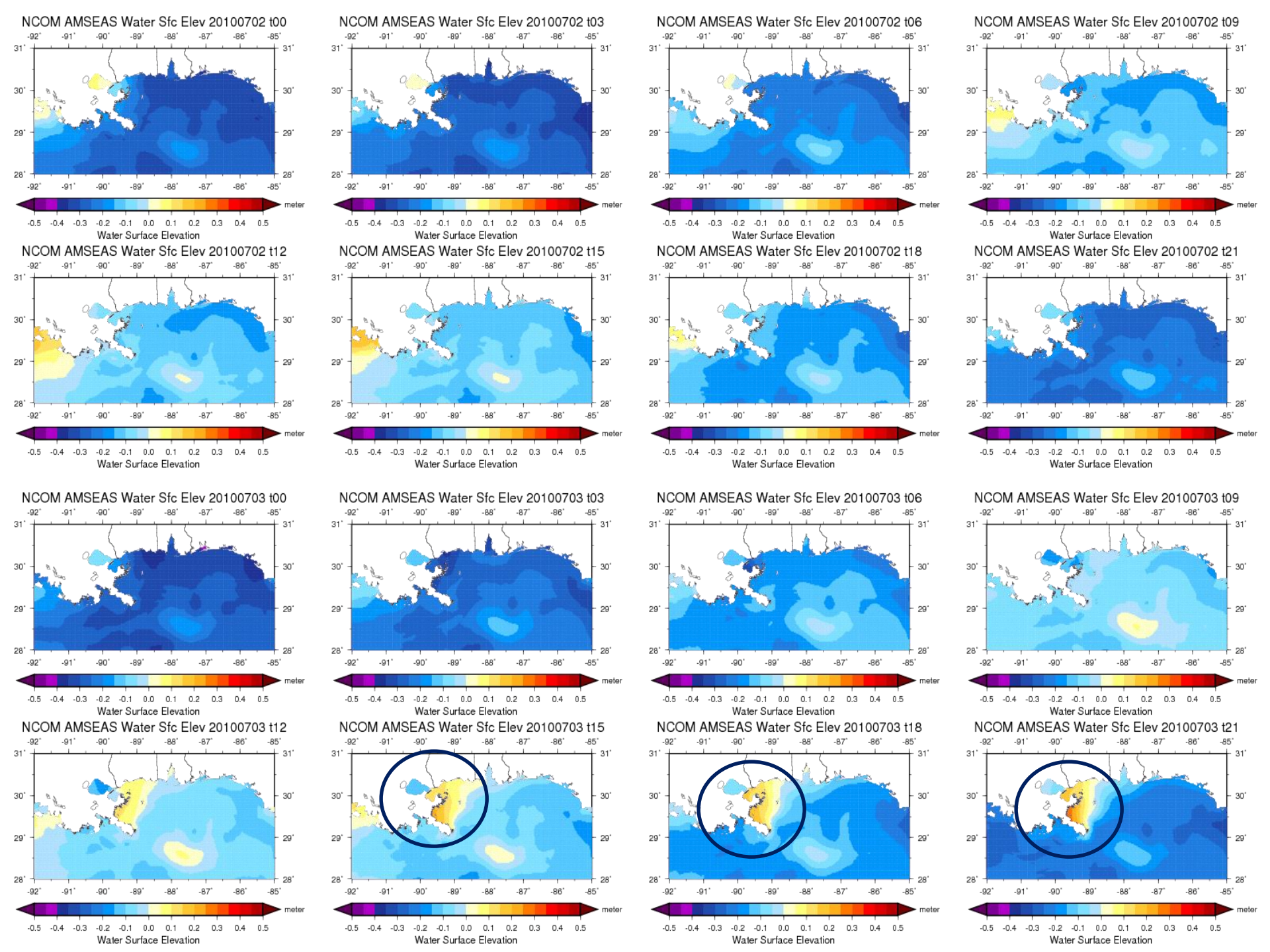
NCOM AMSEAS Water Sfc Elev 20100701 t03
NCOM AMSEAS Water Sfc Elev 20100701 t06
NCOM AMSEAS Water Sfc Elev 20100701 t09
NCOM AMSEAS Water Sfc Elev 20100701 t12
NCOM AMSEAS Water Sfc Elev 20100701 t15
NCOM AMSEAS Water Sfc Elev 20100701 t18
NCOM AMSEAS Water Sfc Elev 20100701 t21
-92° -91° -90° -89° -88° -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 20100702 t21
NCOM AMSEAS Water Sfc Elev 20100703 t00
NCOM AMSEAS Water Sfc Elev 20100703 t03
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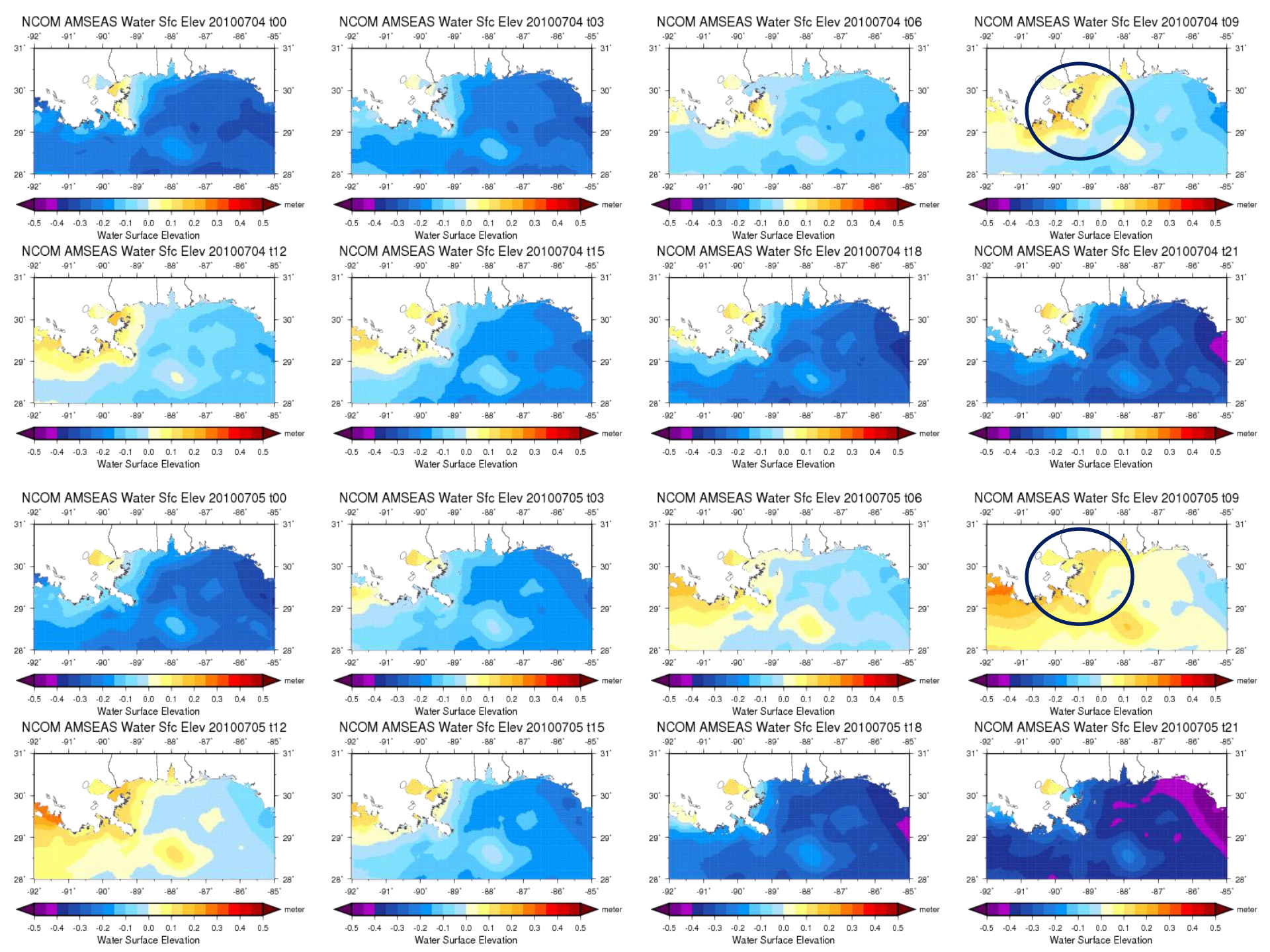
NCOM AMSEAS Water Sfc Elev 20100703 t12
NCOM AMSEAS Water Sfc Elev 20100703 t15
NCOM AMSEAS Water Sfc Elev 20100703 t18
NCOM AMSEAS Water Sfc Elev 20100703 t21
-92° -91° -90° -89° -88° -87° -86° -85°
31° 30° 29° 28°
meter
-0.5 -0.4 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5
Water Surface Elevation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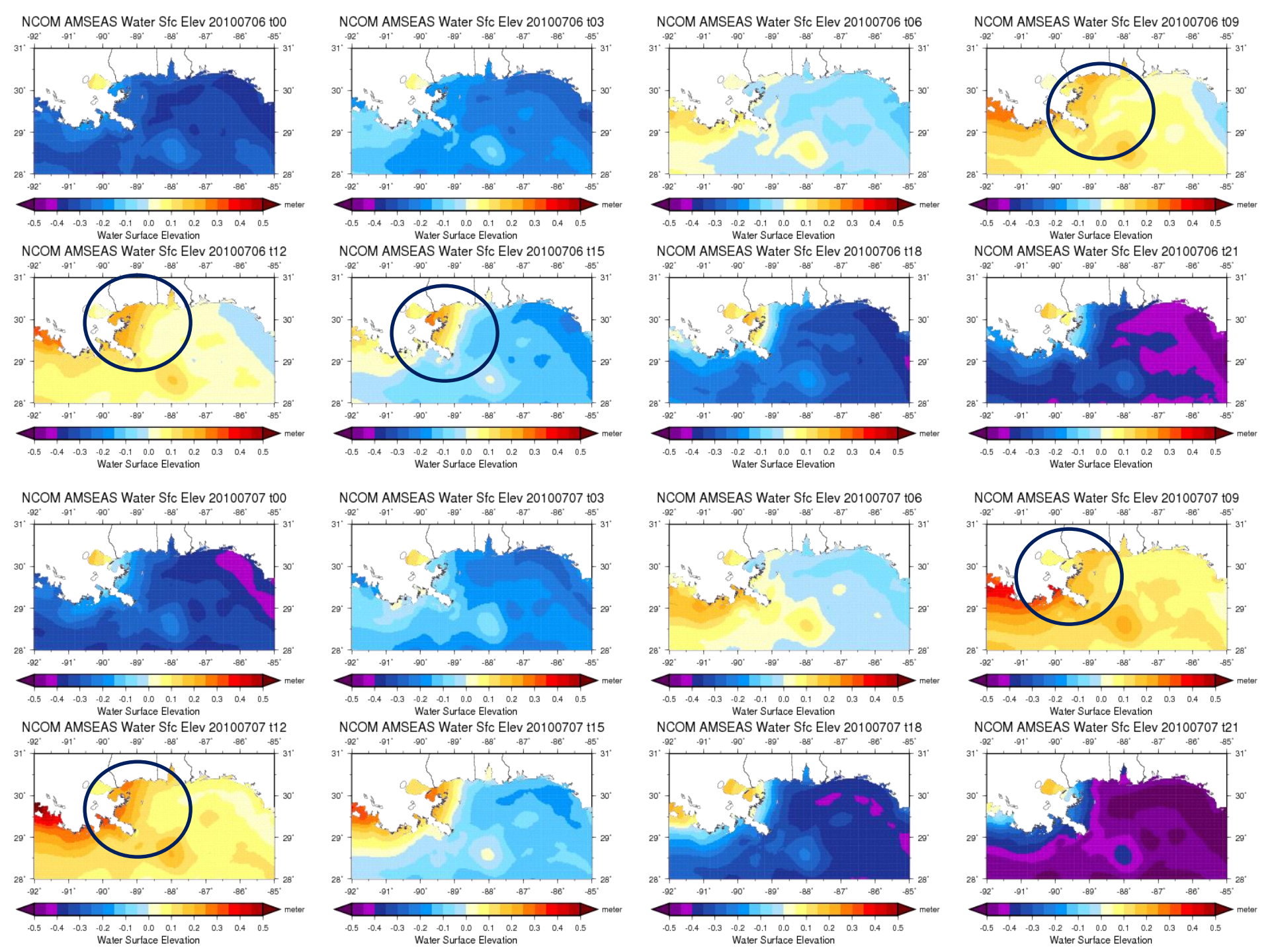
NCOM AMSEAS Water Sfc Elev 20100705 t21
-92° -91° -90° -89° -88° -87° -86° -85°
31° 30° 29° 28°
meter
-0.5 -0.4 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5
Water Surface Elevation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meter
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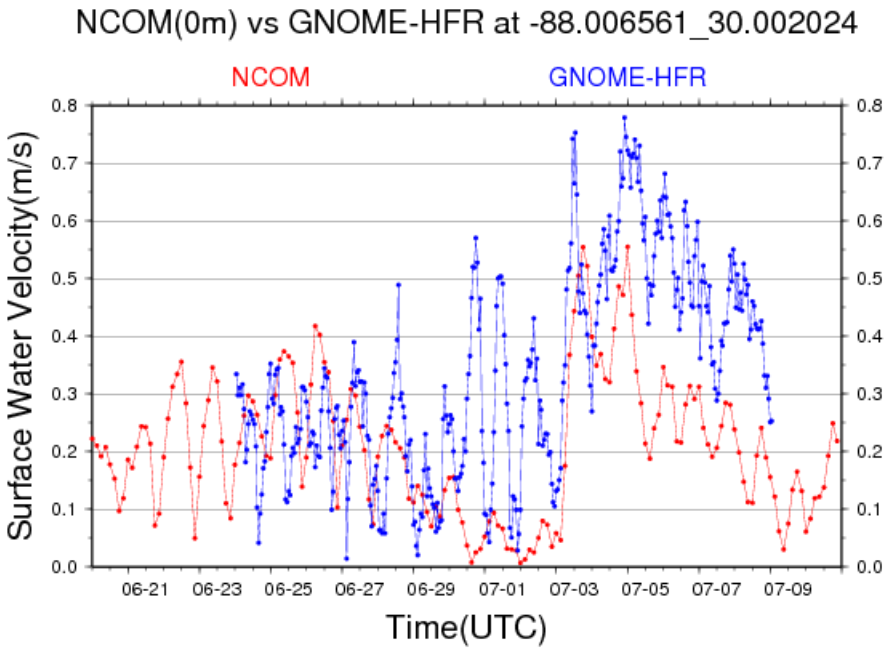
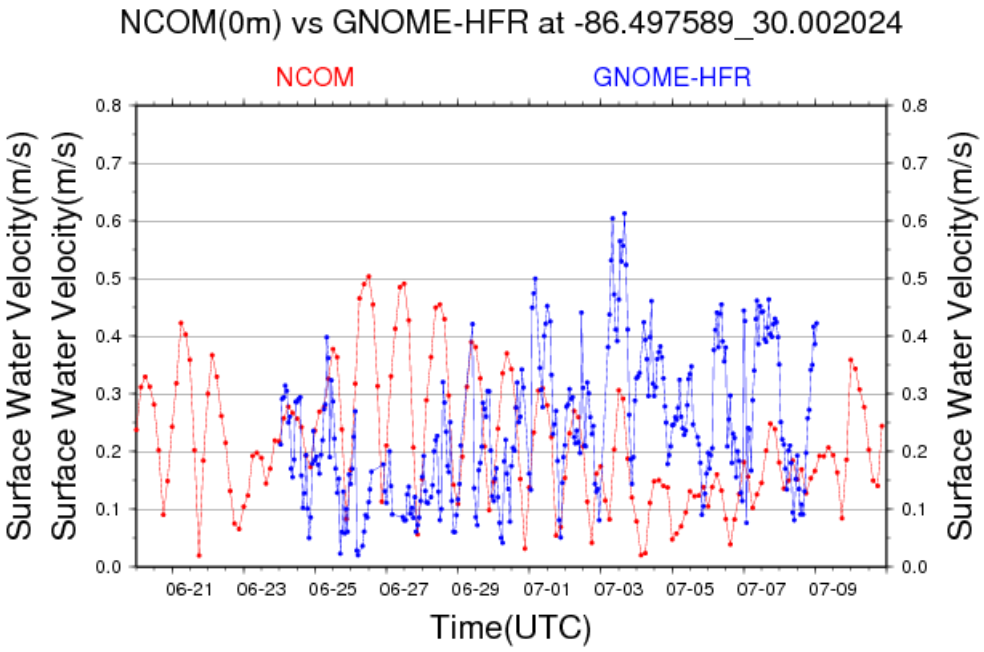
Water Surface Elevation


NCOM(0m) vs GNOME-HFR at -88.006561_30.002024
NCOM
GNOME-HFR
Surface Water Velocity(m/s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
06-21
06-23
06-25
06-27
06-29
07-01
07-03
07-05
07-07
07-09
Time(UTC)


NCOM(0m) vs GNOME-HFR at -86.497589_30.002024
NCOM
GNOME-HFR
Surface Water Velocity(m/s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
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06-21
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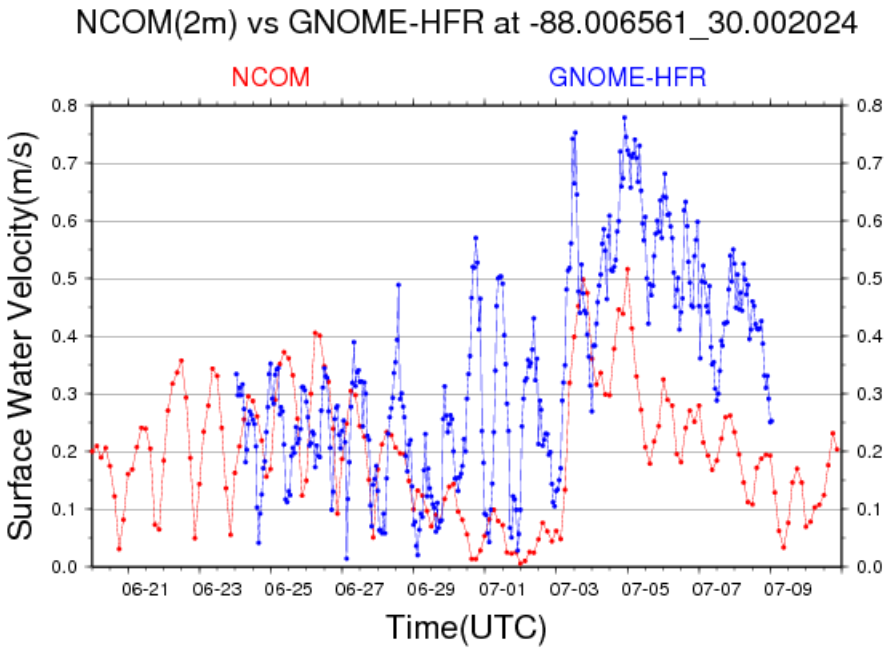
Time(UTC)


NCOM(2m) vs GNOME-HFR at -88.006561_30.002024
NCOM
GNOME-HFR
Surface Water Velocity(m/s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
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06-21
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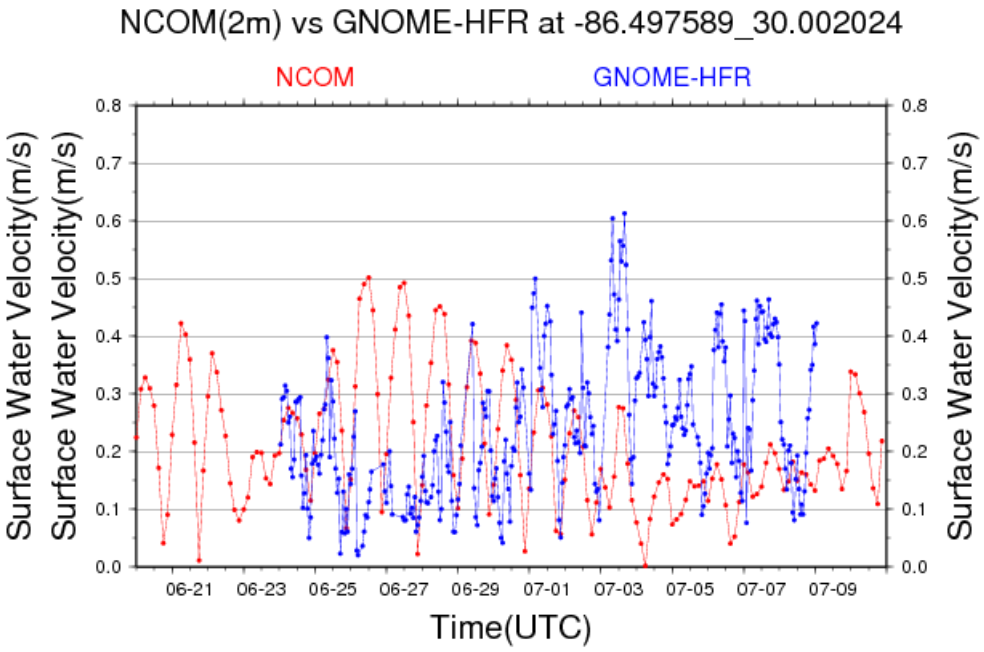
Time(UTC)


NCOM(2m) vs GNOME-HFR at -86.497589_30.002024
NCOM
GNOME-HFR
Surface Water Velocity(m/s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
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06-21
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07-07
07-09
Time(UTC)

Summary

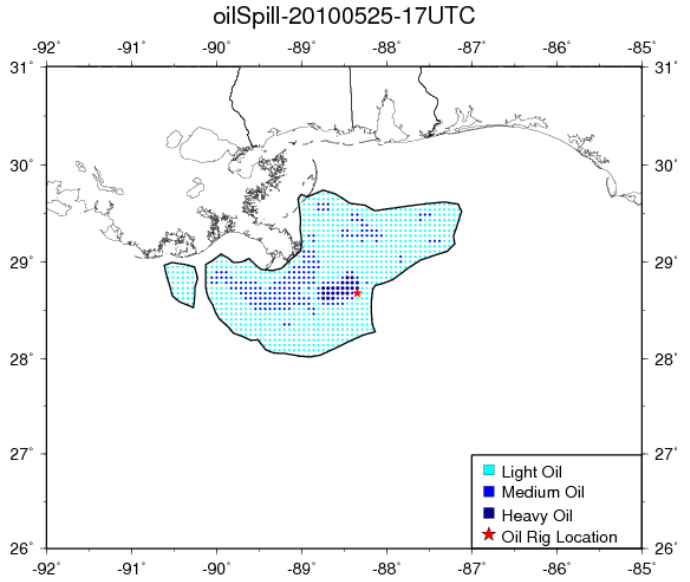
- Oil transport mostly governed by ocean currents
- However, surge events associated with tropical cyclones and non-tropical lows can push oil far into the marsh system
- Difficult to know if a hurricane landfall would have been catastrophic
  - Hurricane tend to flush the ecosystem of pollutants
  - But the potential of inland pollution existed. Our ADCIRC simulations (not shown) suggested deep movement of oil into the marsh system
  - Fortunately, no hurricane landfall occurred.

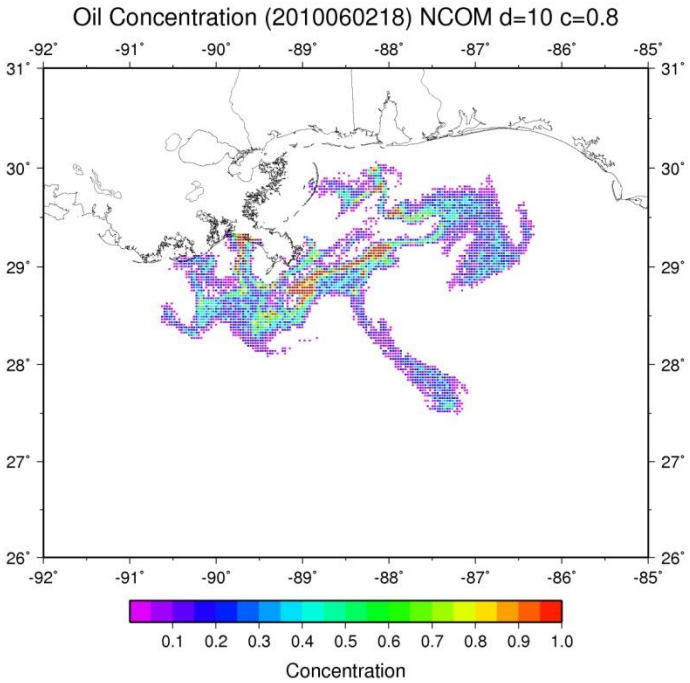
Merging of Oil Datasets

- Shoreline Cleanup and Assessment Technique (SCAT) datasets
- State DEQs
- Louisiana Bucket Brigade
- Lake Pontchartrain Basin Foundation
- Investigating other potential datasets

Original purpose is to provide validation against the oil spill model after dispersion, emulsification, and evaporation/dissolution terms are added.

However, it should be beneficial for other DWH research endeavors.


oilSpill-20100525-17UTC
Light Oil
Medium Oil
Heavy Oil
Oil Rig Location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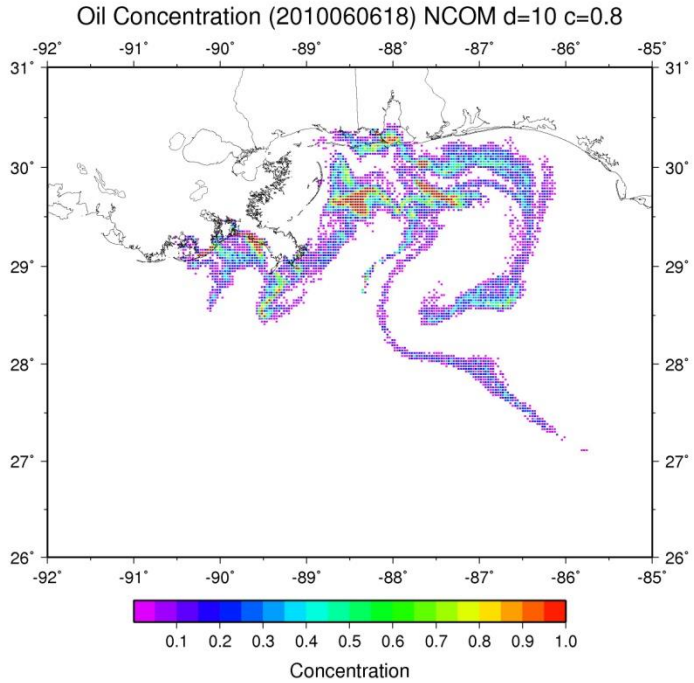
Concentration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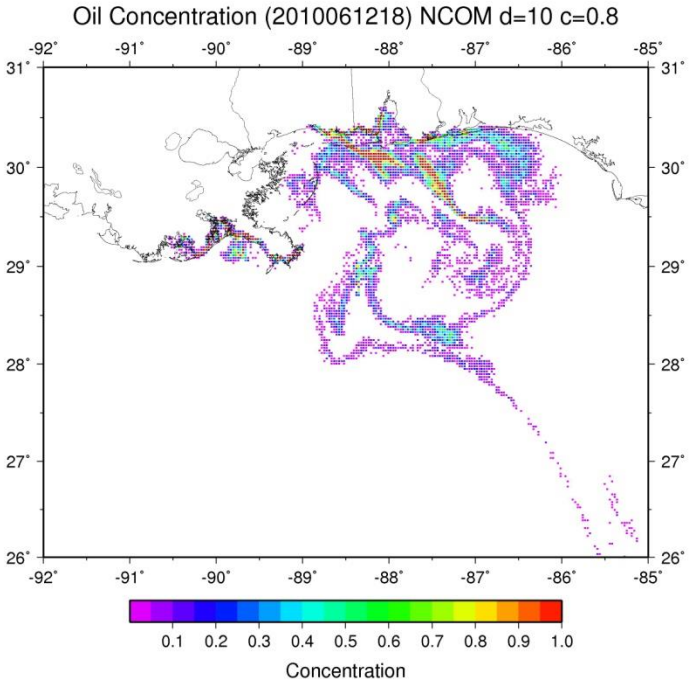
Concentration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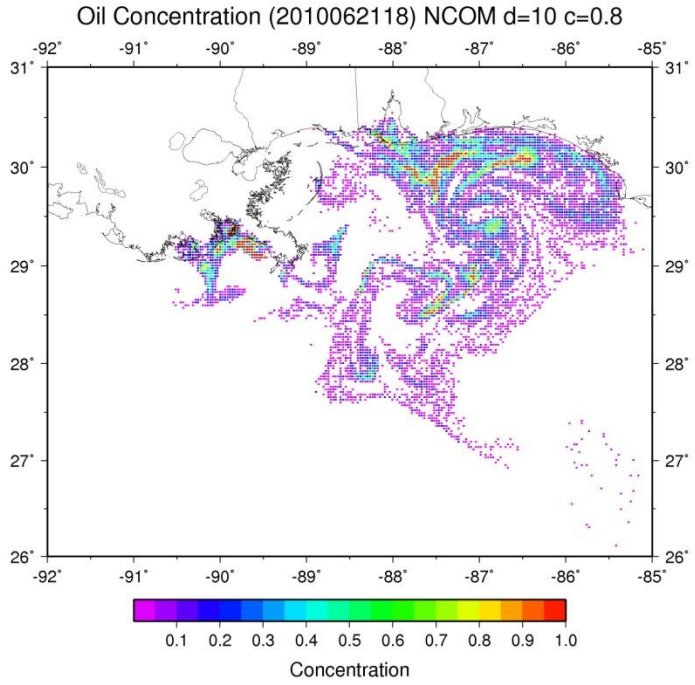
Concentration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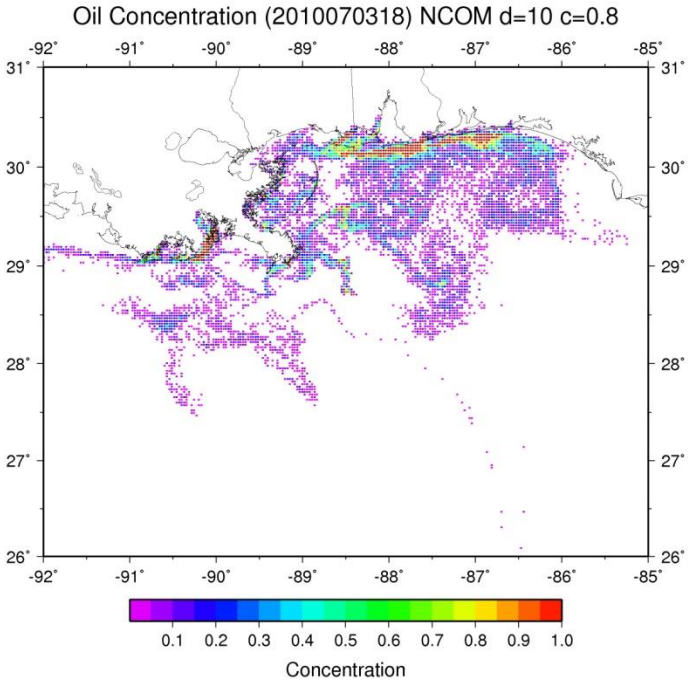
Concentration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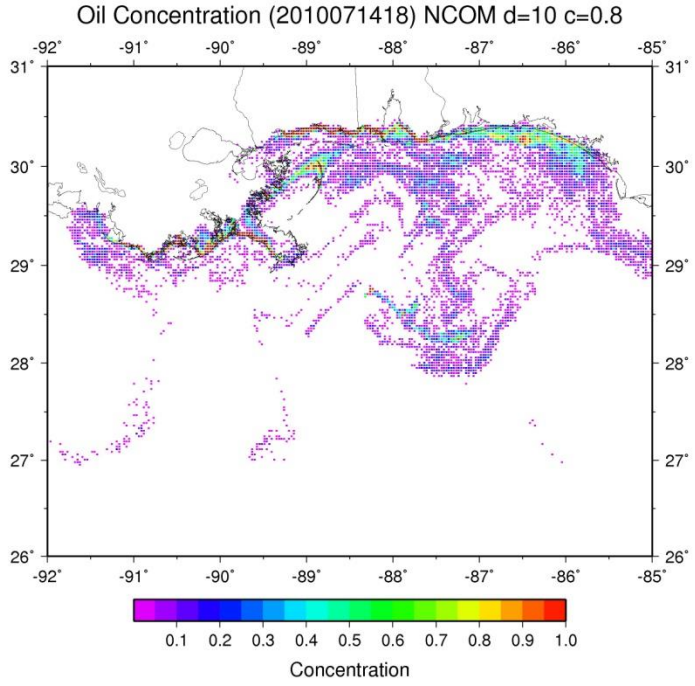
Concentration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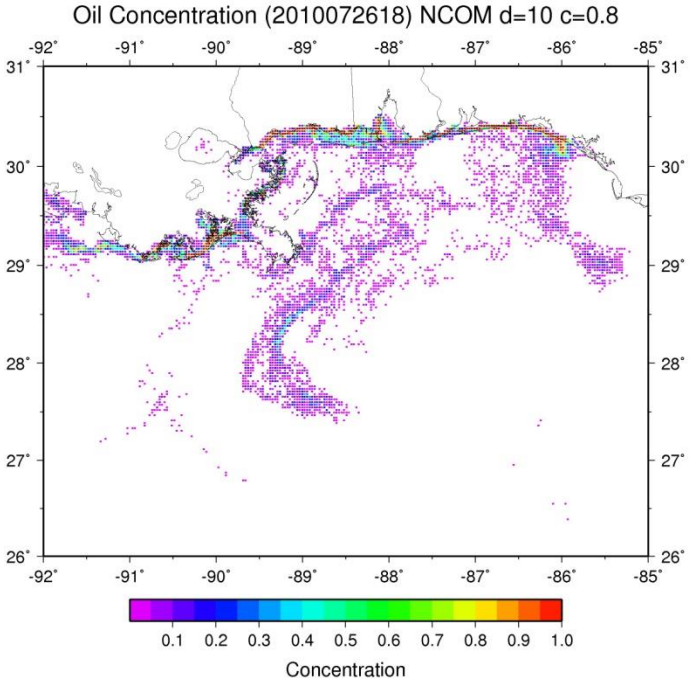
Concentration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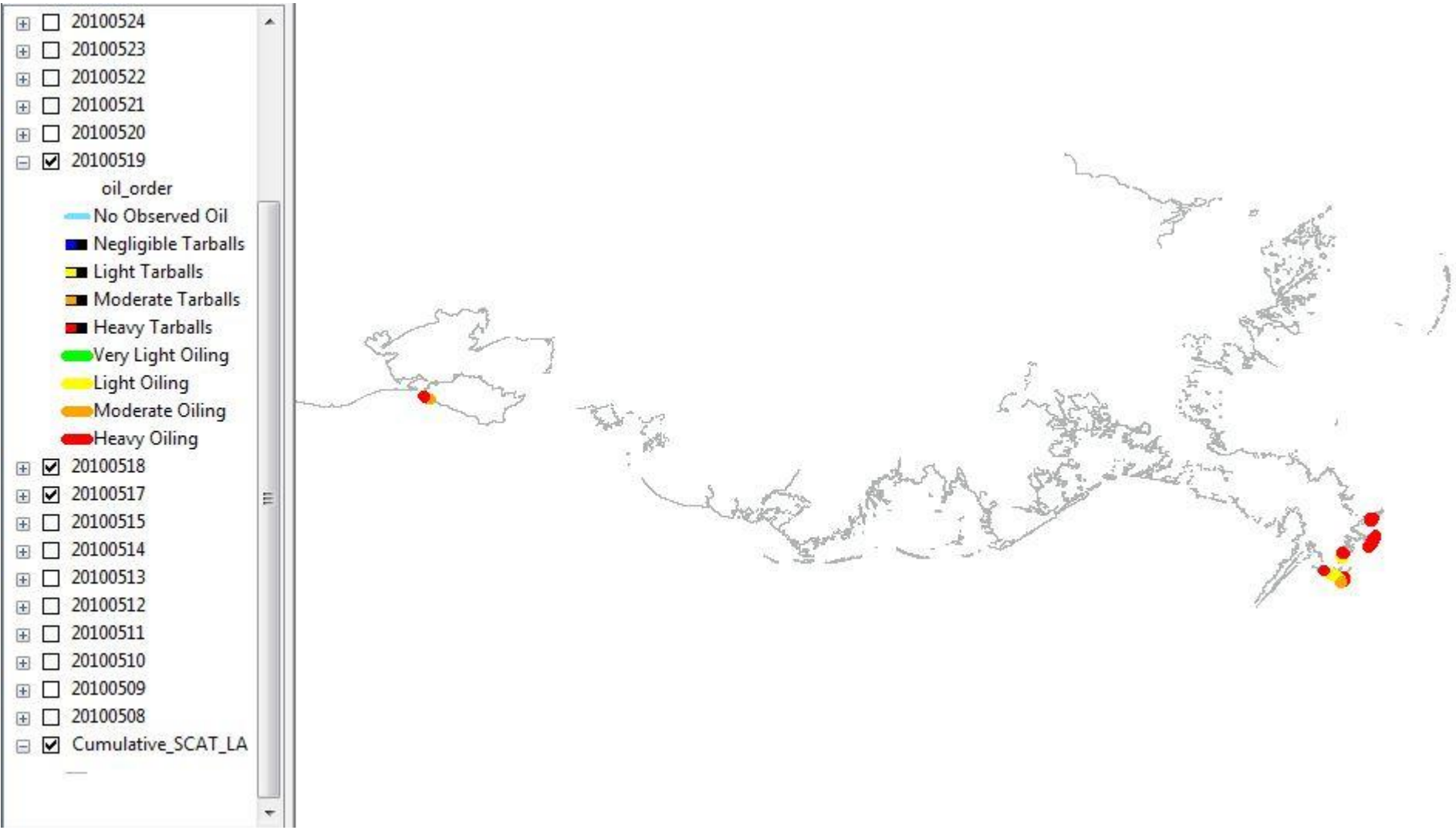
31° 30° 29° 28° 27° 26°
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Concentration

SCAT data

- The SCAT teams performed survey of affected shorelines and collected data on shoreline oiling conditions
- MS-AL SCAT data very coarse and only a few days. Not useful
- LA SCAT data covers most of the oil spill and ample datapoints
  - Spreadsheet available and contains metadata
  - However, many temporal data “holes” exist in different regions. This problem is common for all the datasets, and is the motivation for compositing all the datasets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Light Tarballs
Moderate Tarballs
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Moderate Oiling
Heavy Oiling
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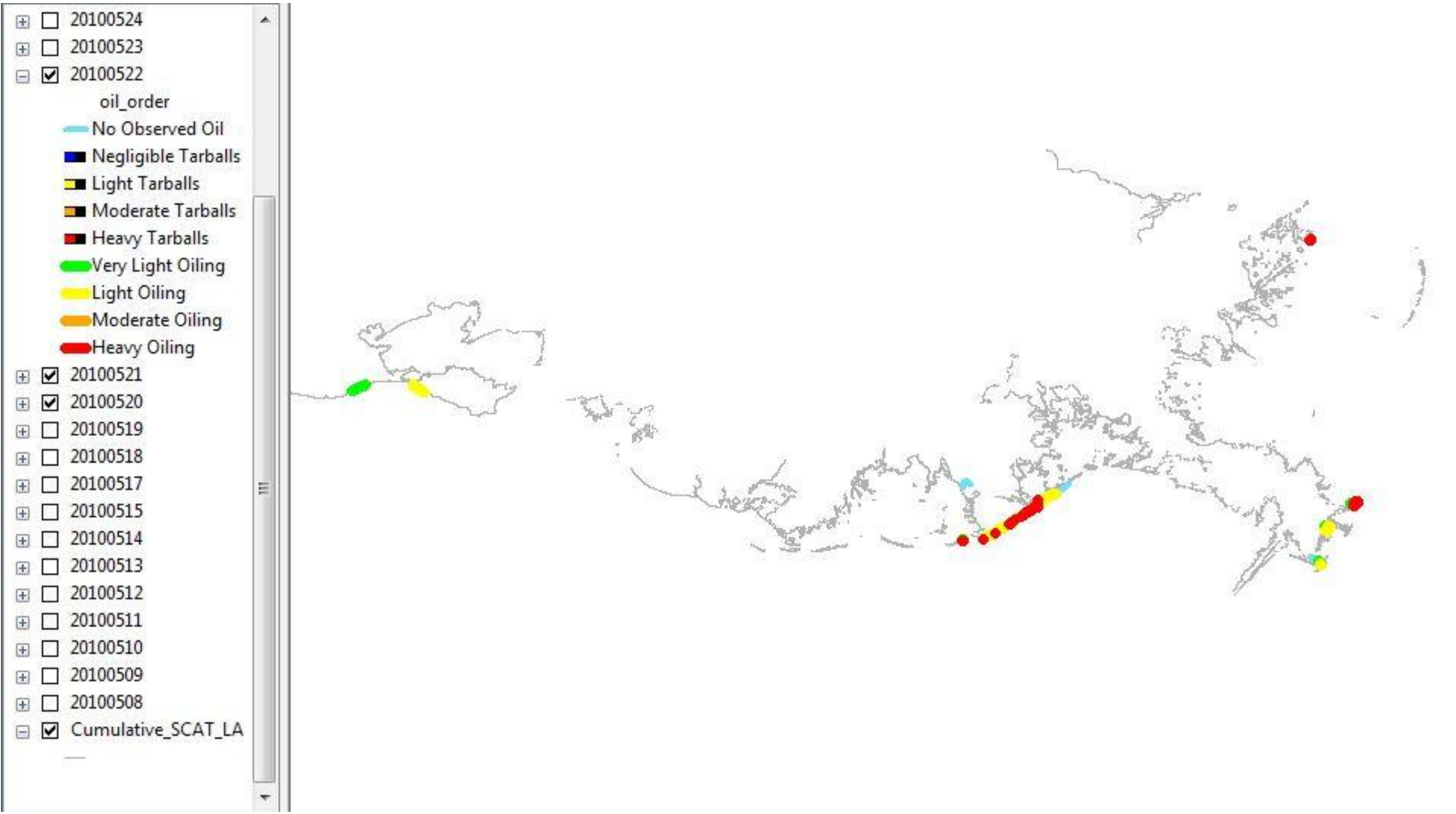
Cumulative_SCAT_LA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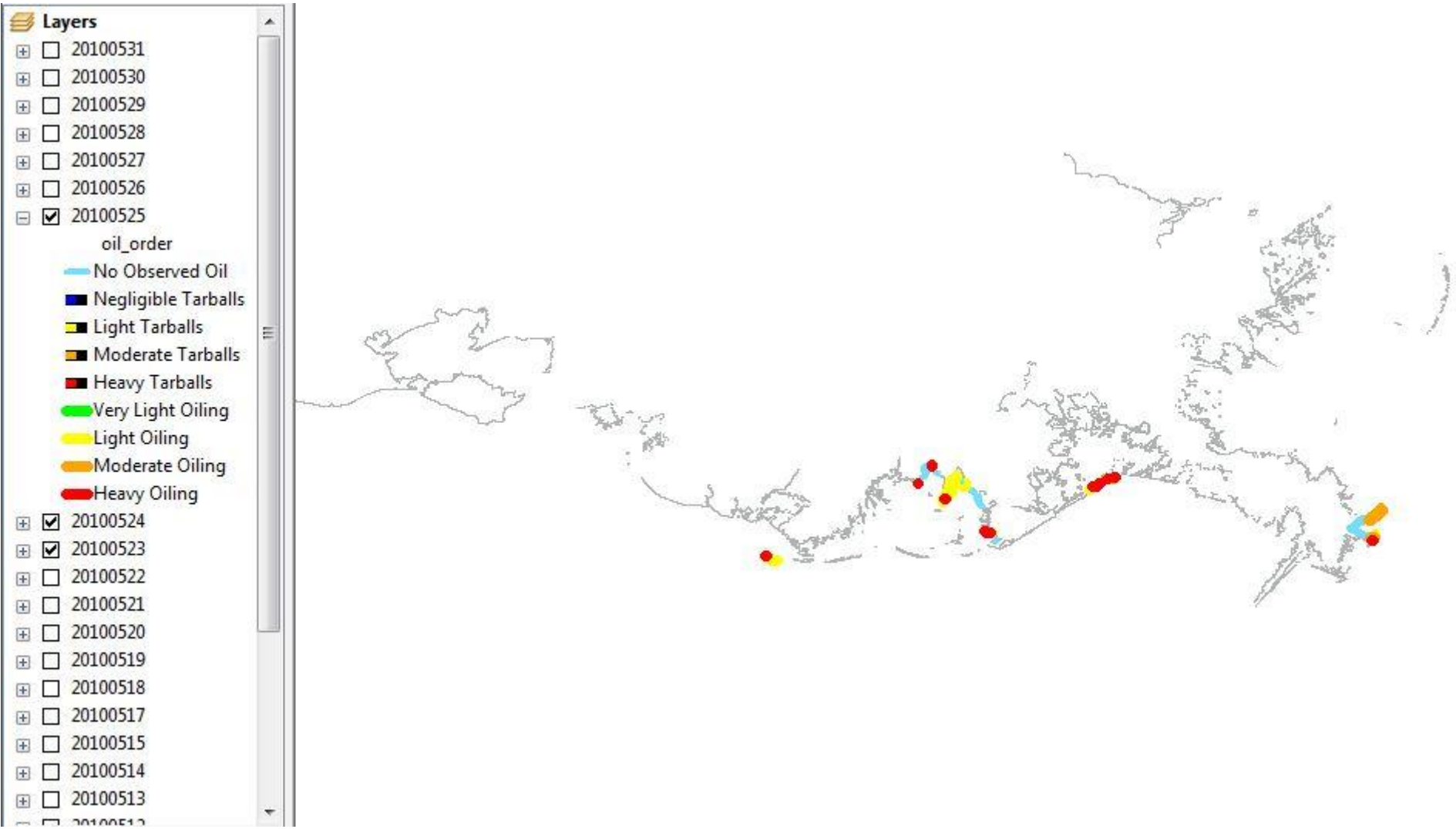
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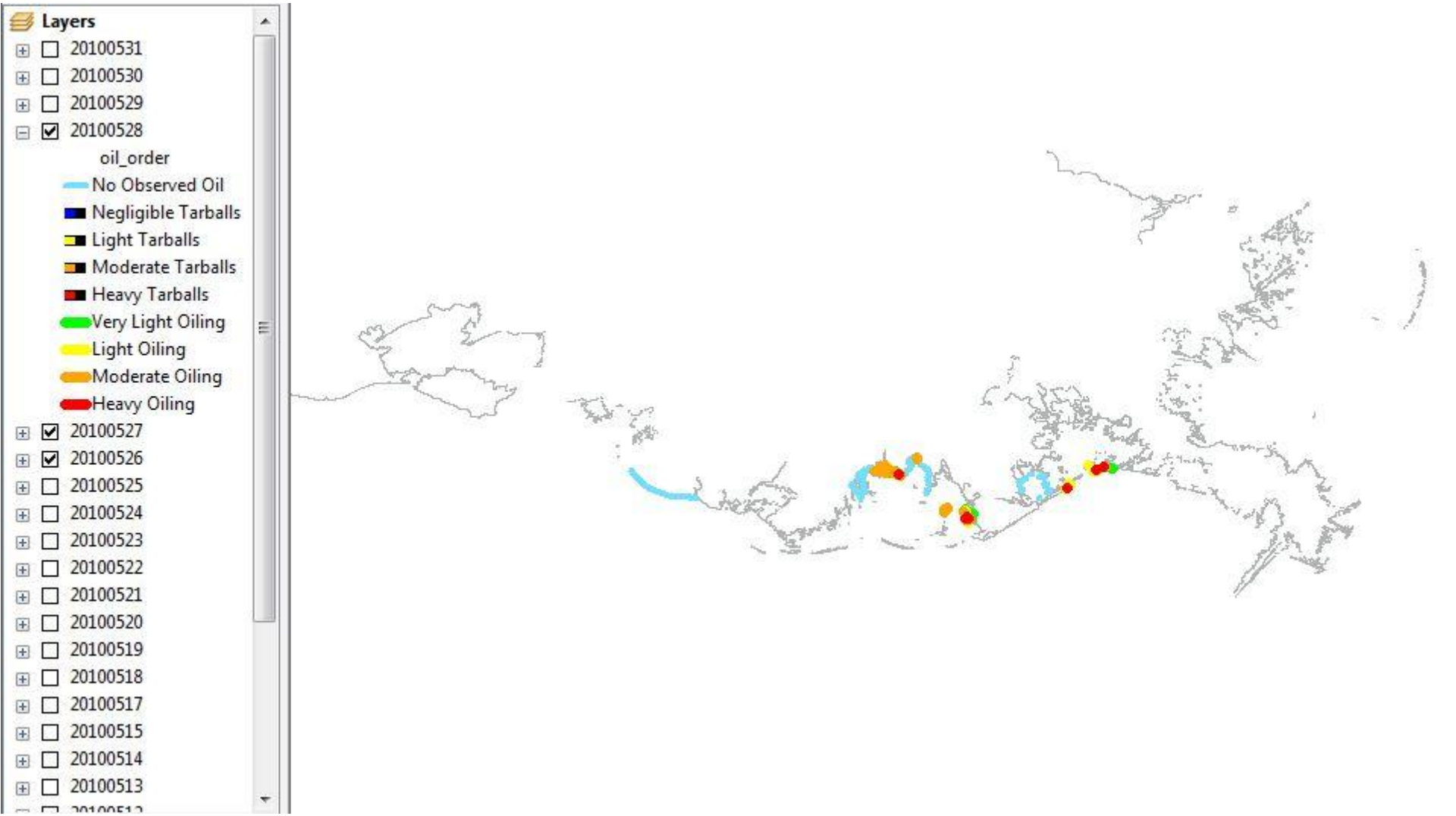
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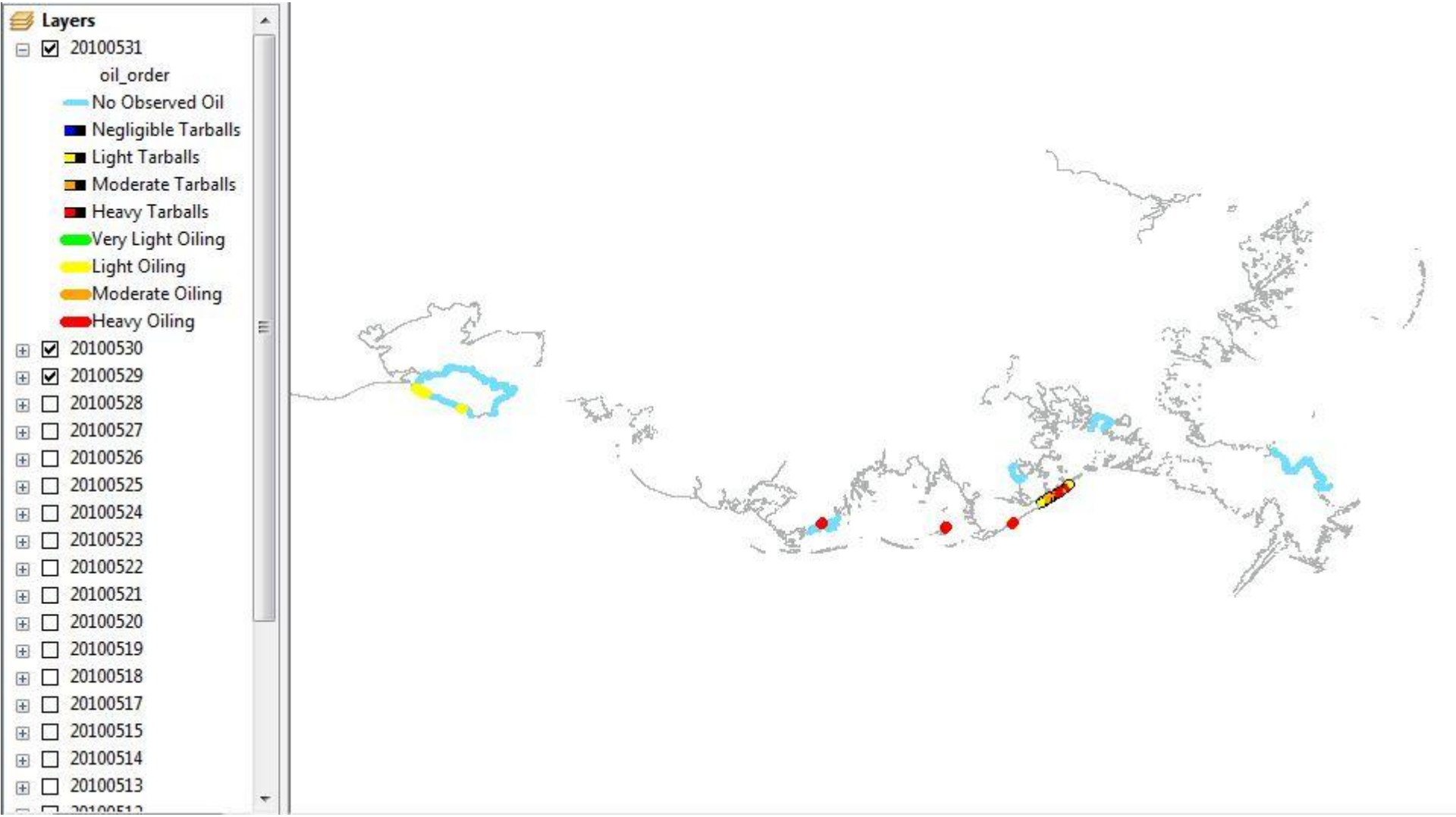
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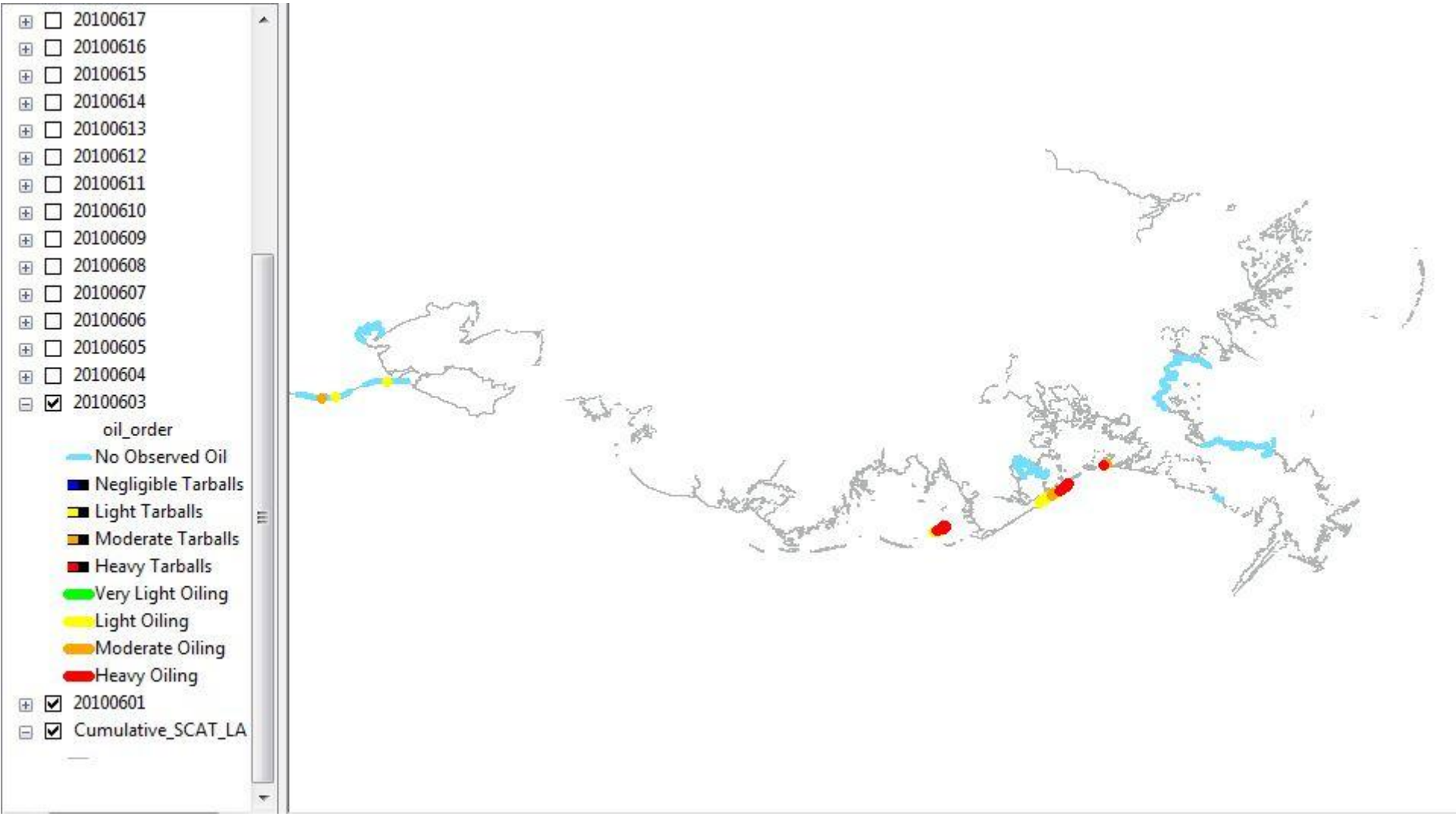
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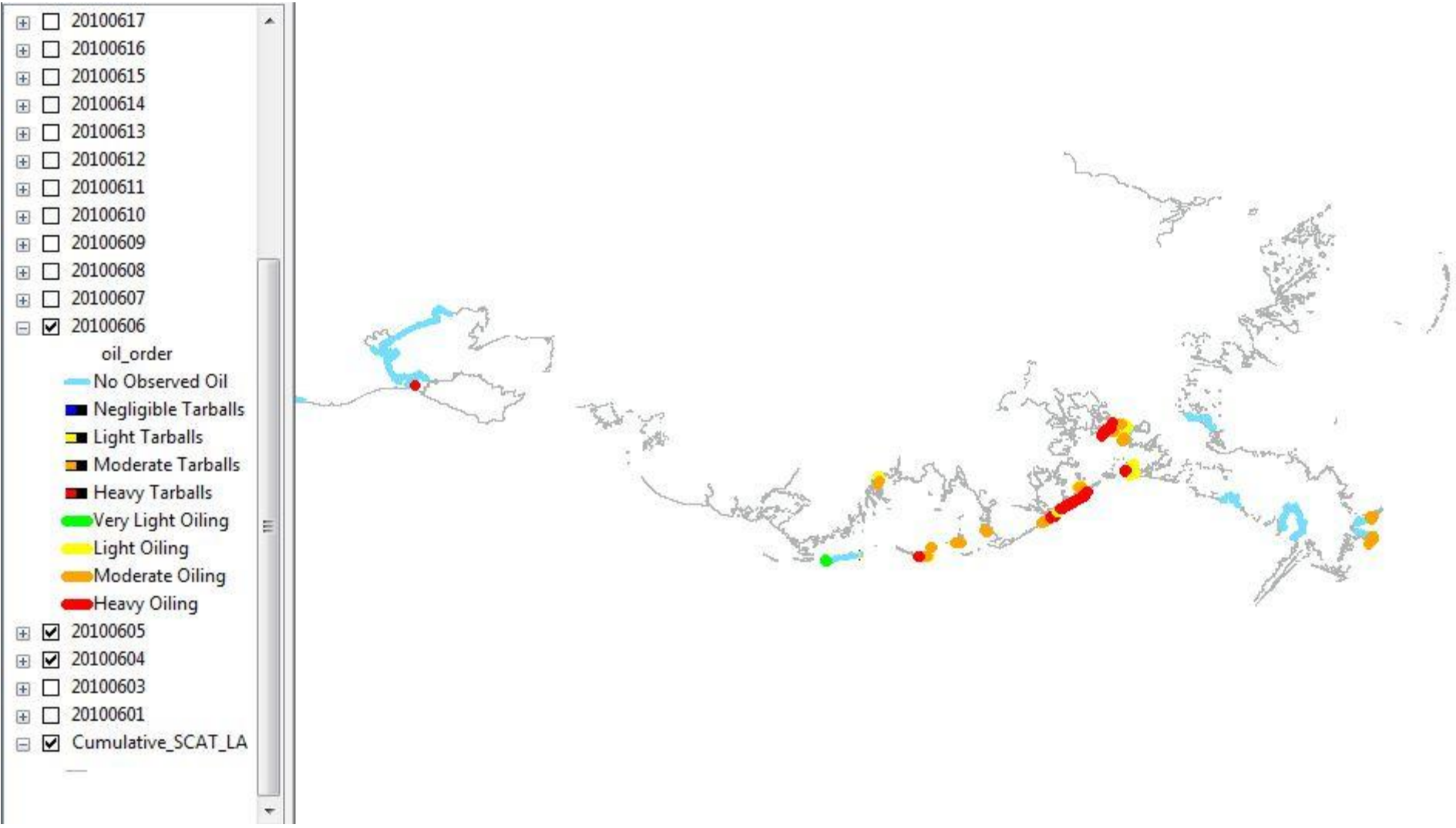
Cumulative_SCAT_LA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Light Tarballs
Moderate Tarballs
Heavy Tarballs
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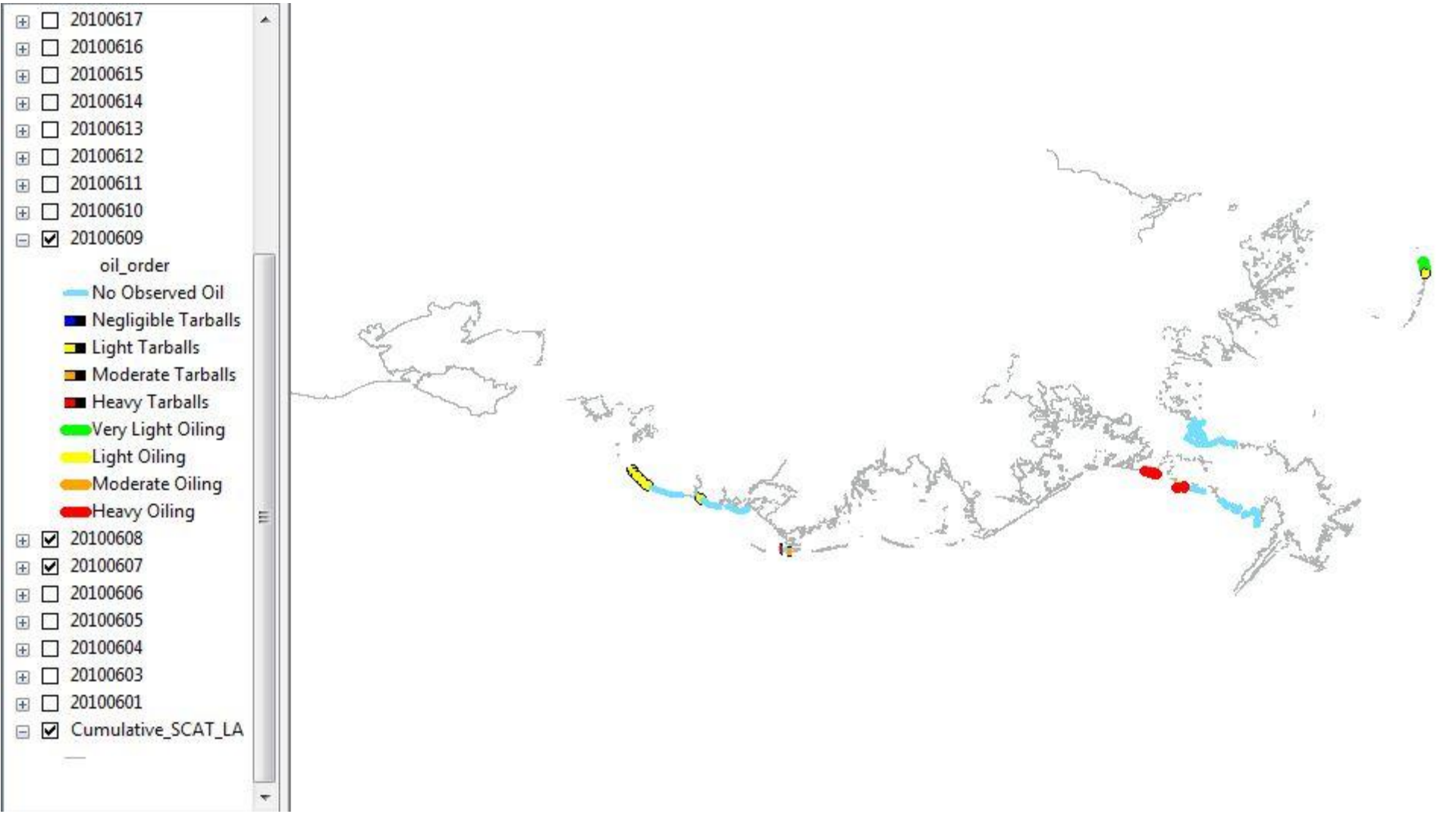
Cumulative_SCAT_LA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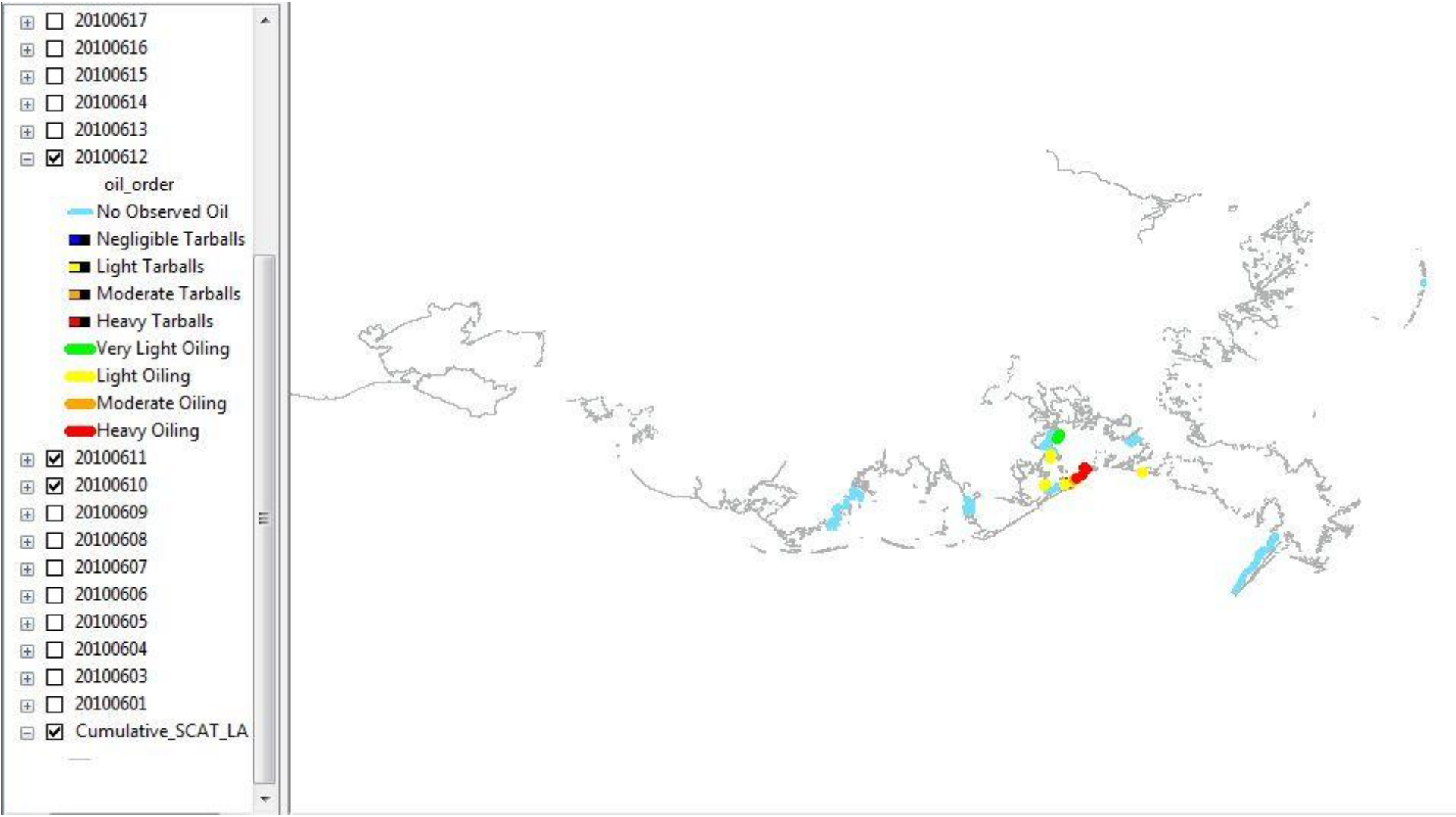
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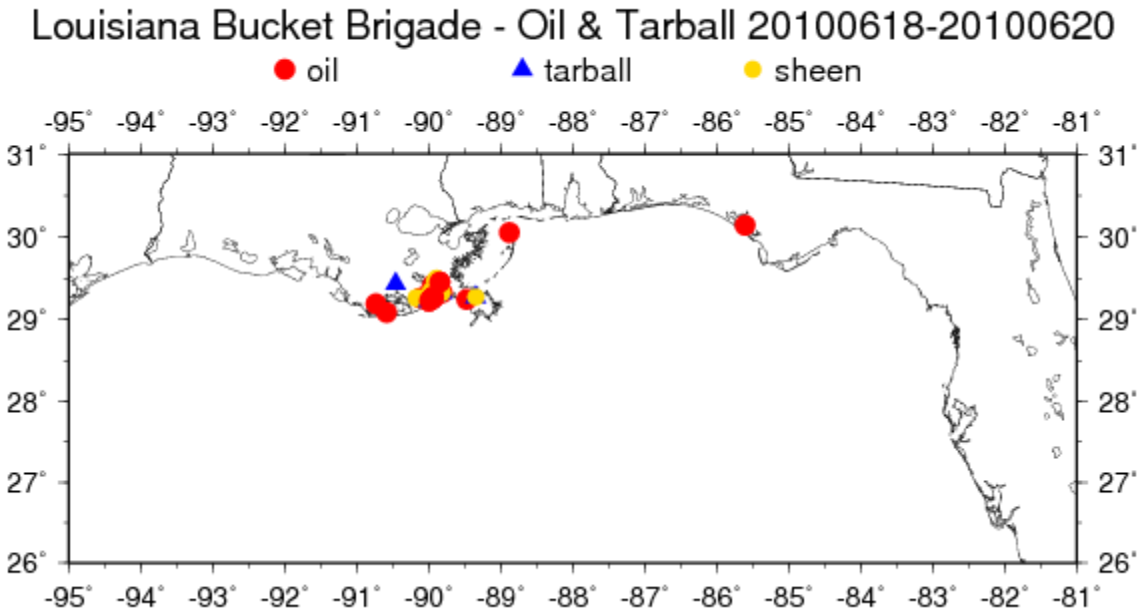
20100601
Cumulative_SCAT_LA

Louisiana Bucket Brigade data

- Volunteer organization which tabulated all oil spill news and information from the media, phone calls, emails, etc.
- Available in a spreadsheet
- Covers the entire oil spill and plentiful datapoints
  - Temporal data holes
  - Dataset also contained news accounts, community meetings, tidbits such as “smells from oil burning.” These have been removed
  - Latitude and longitude not always included, just a specific location. We have added an estimated latitude and longitude if possible


Louisiana Bucket Brigade - Oil & Tarball 20100618-20100620
oil
tarball
sheen
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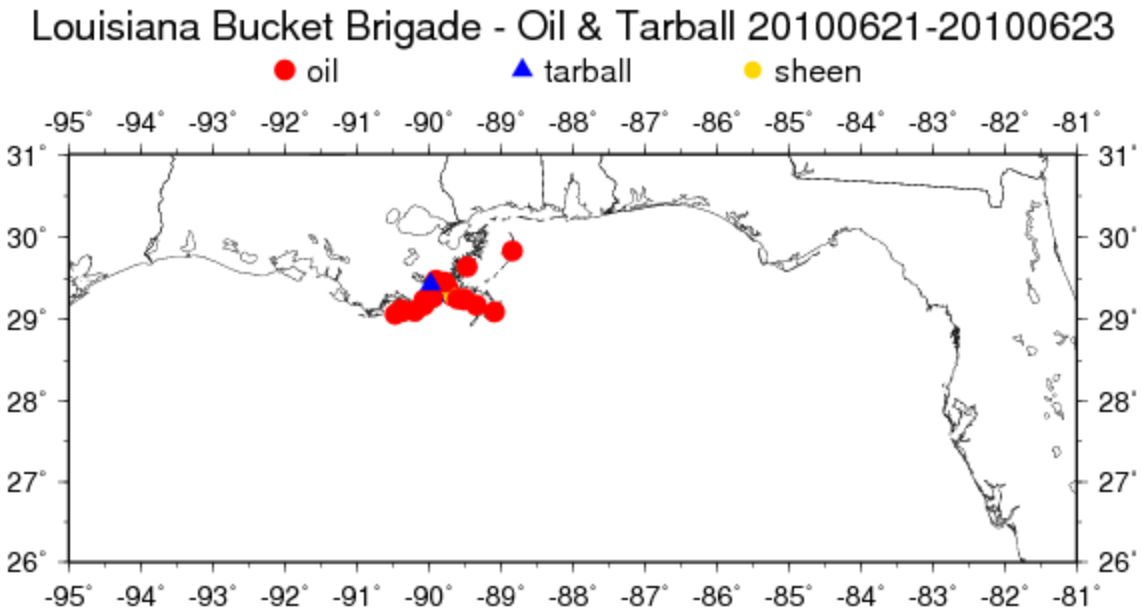
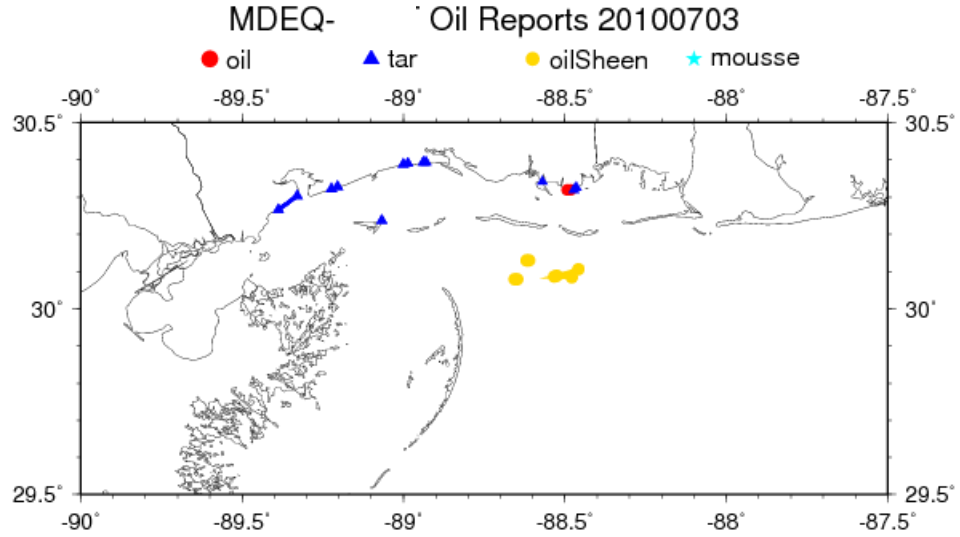
31° 30° 29° 28° 27° 26°

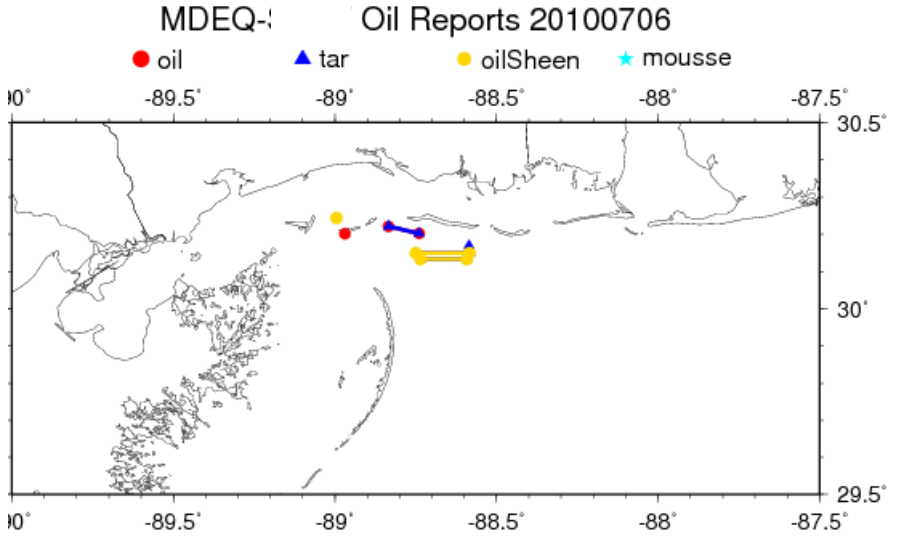

Louisiana Bucket Brigade - Oil & Tarball 20100621-20100623
oil
tarball
sheen
-95° -94° -93° -92° -91° -90° -89° -88° -87° -86° -85° -84° -83° -82° -81°
31° 30° 29° 28° 27° 26°

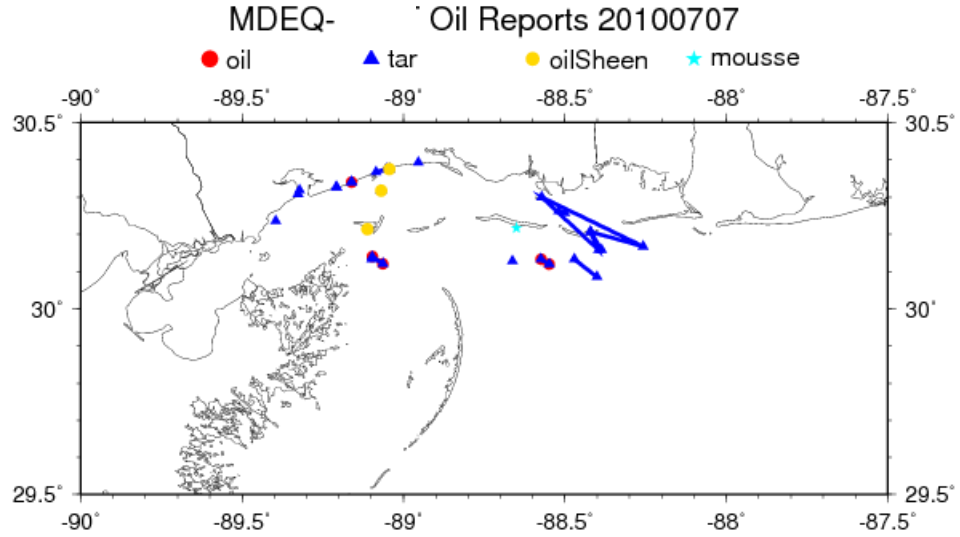
State DEQ

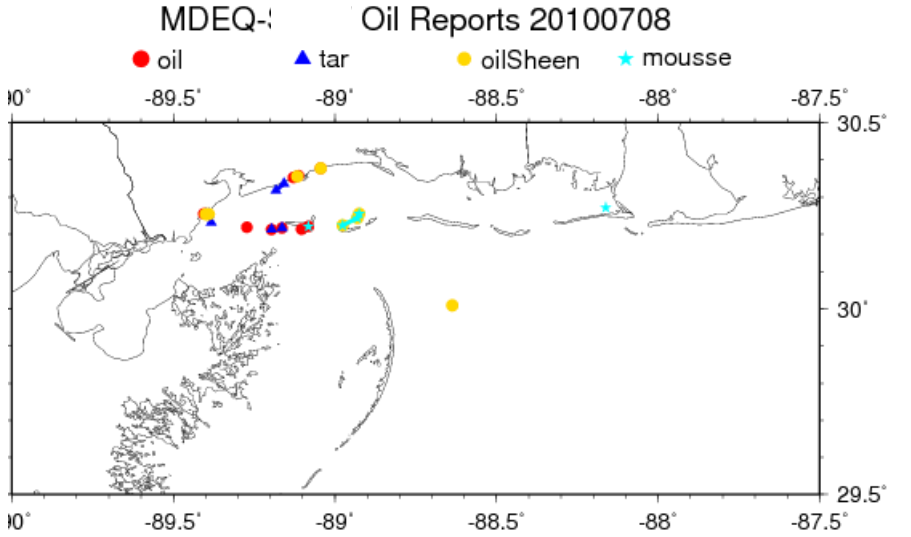
- The DEQs released almost daily statements of oil spill information in pdf reports
- This data is not digitized.
- Covers different timeframes of the oil spill with modest datapoints
  - MS DEQ contained latitude and longitude for most incidents. It also sometimes described geographic coverage, not just points. MSU has developed a spreadsheet of these reports.
  - LA DEQ is similar, but covers the entire period and contains more data. However, it does not provide latitude and longitude. Geographic regions in the marsh or sounds are referenced instead. We are working on a spreadsheet, but it is tedious.

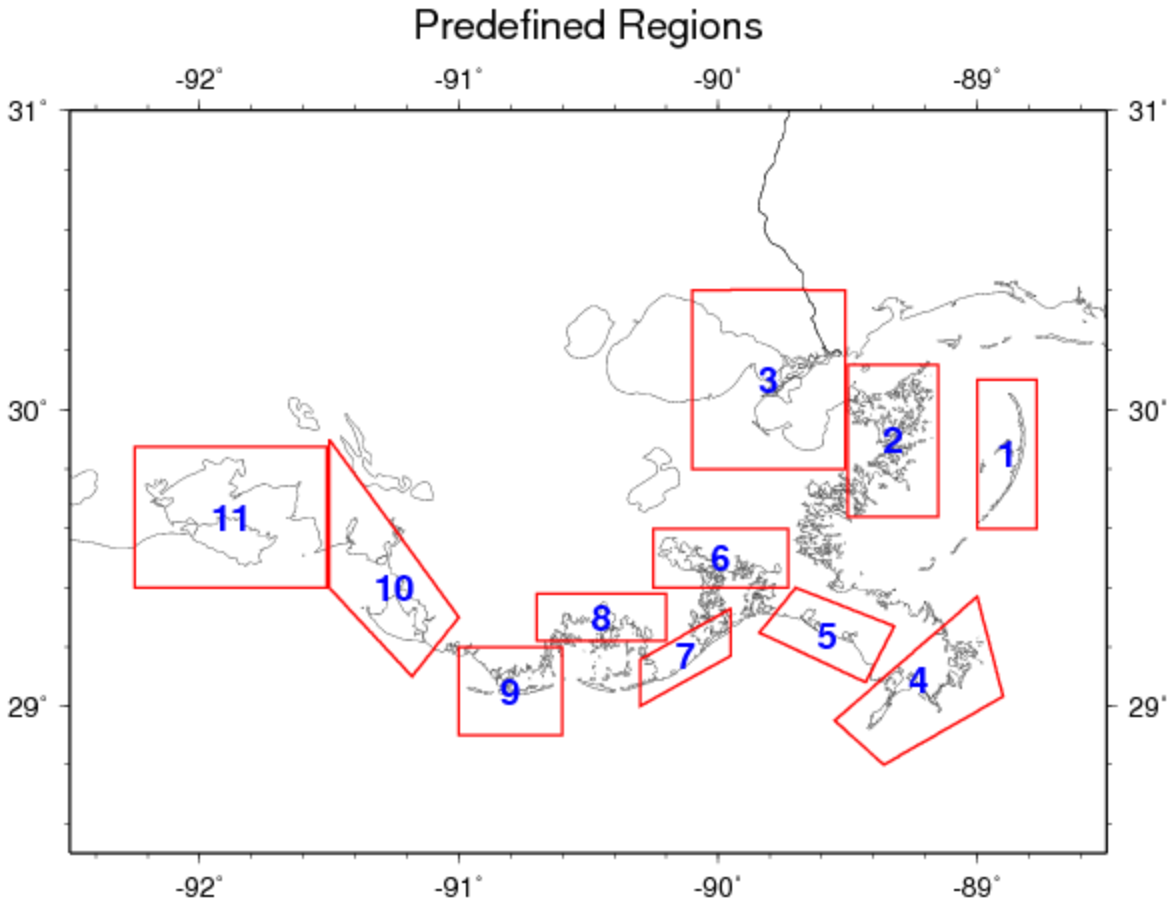
MDEQ dataset example





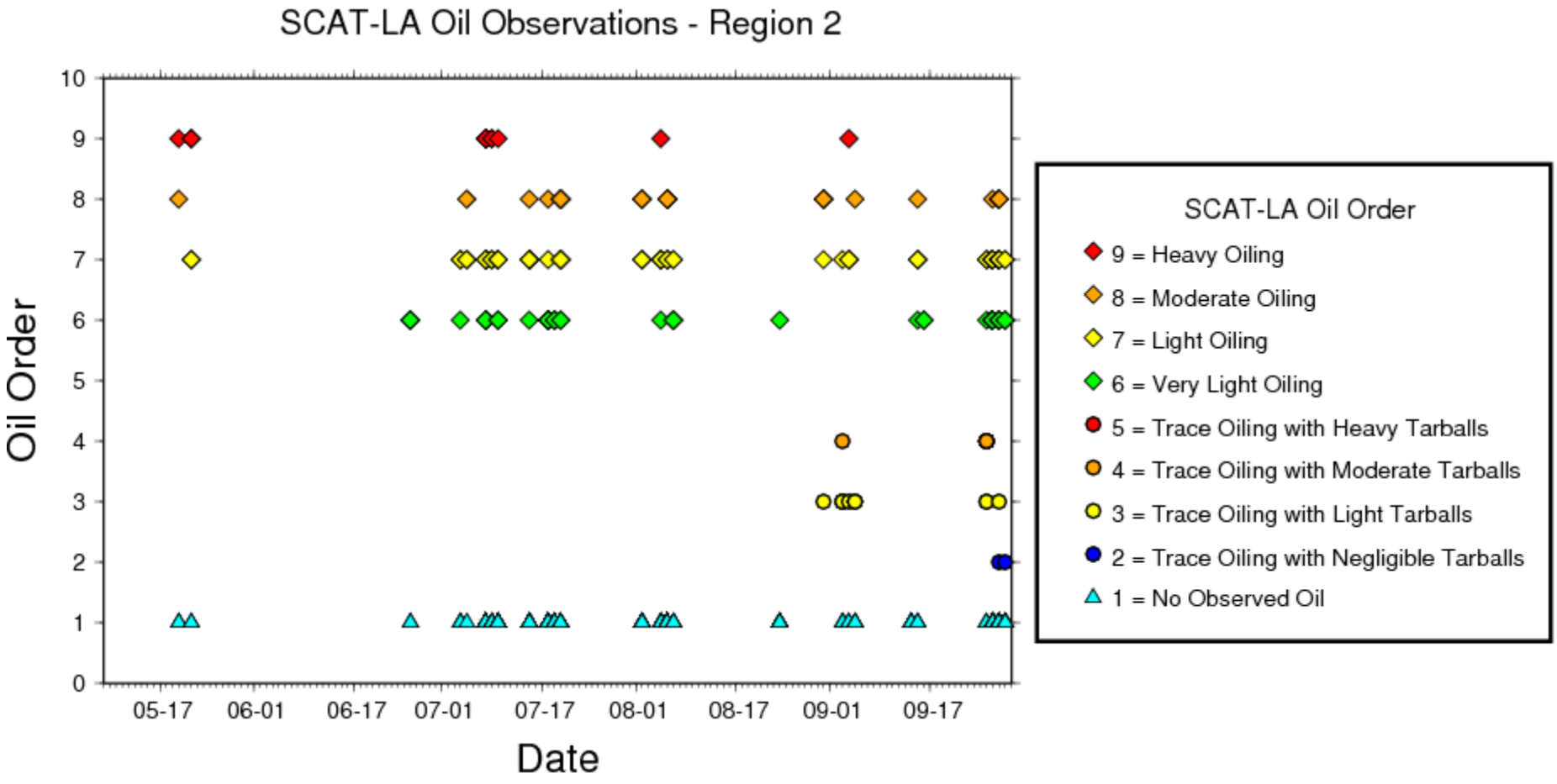




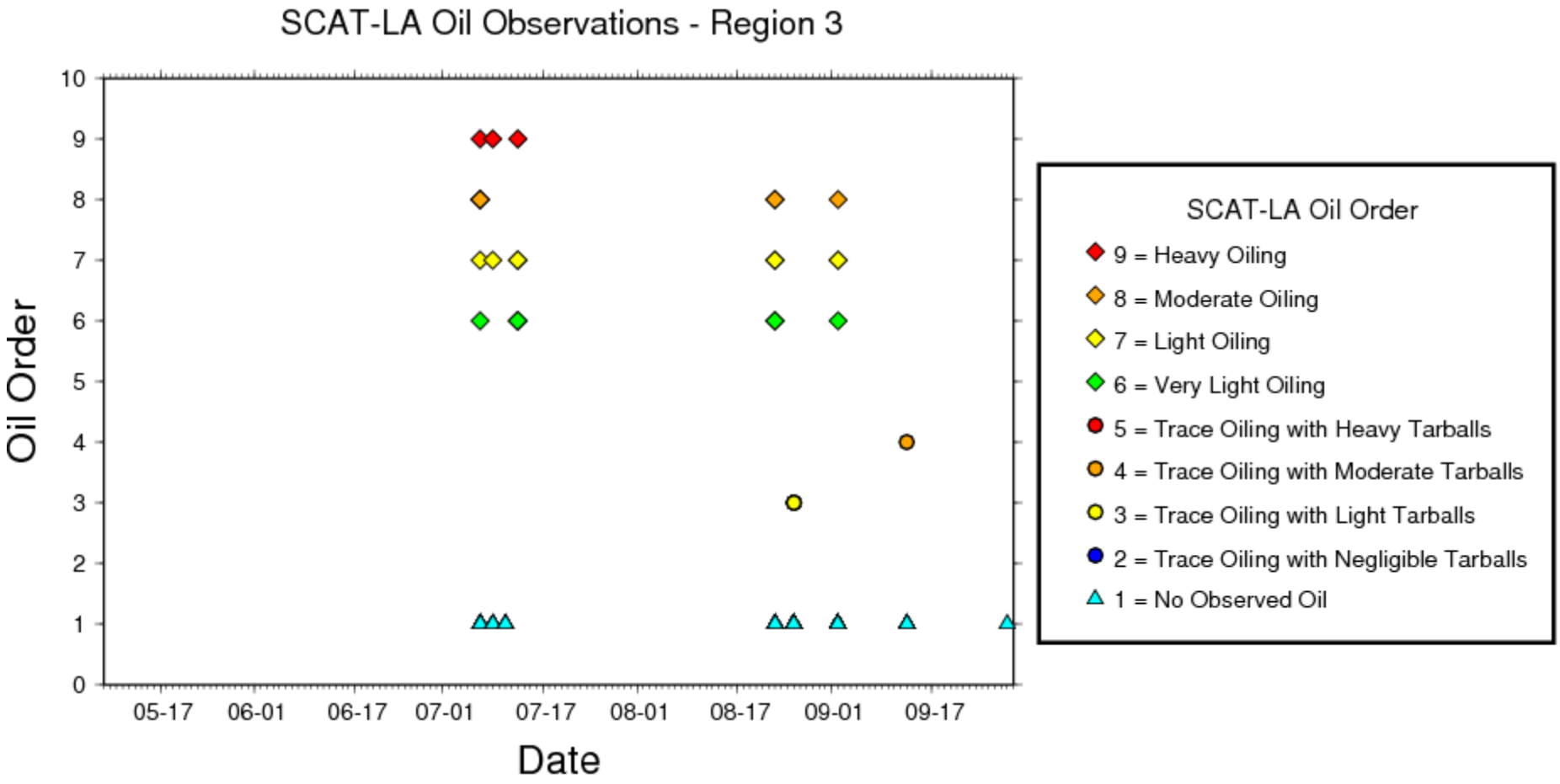


1. Chandeleur Islands
2. Eastern Biloxi Marsh
3. LakeBorge / LakePontchartrain
4. Mississippi River Mouth
5. Sandy Point
6. Barataria Bay North End
7. Grand Isle / Fourchon
8. Terrebonne Bay / Timbalier Bay North End
9. Last Islands
10. Atchafalaya Delta
11. Russell Sage Mash / Vermillion Bay / West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

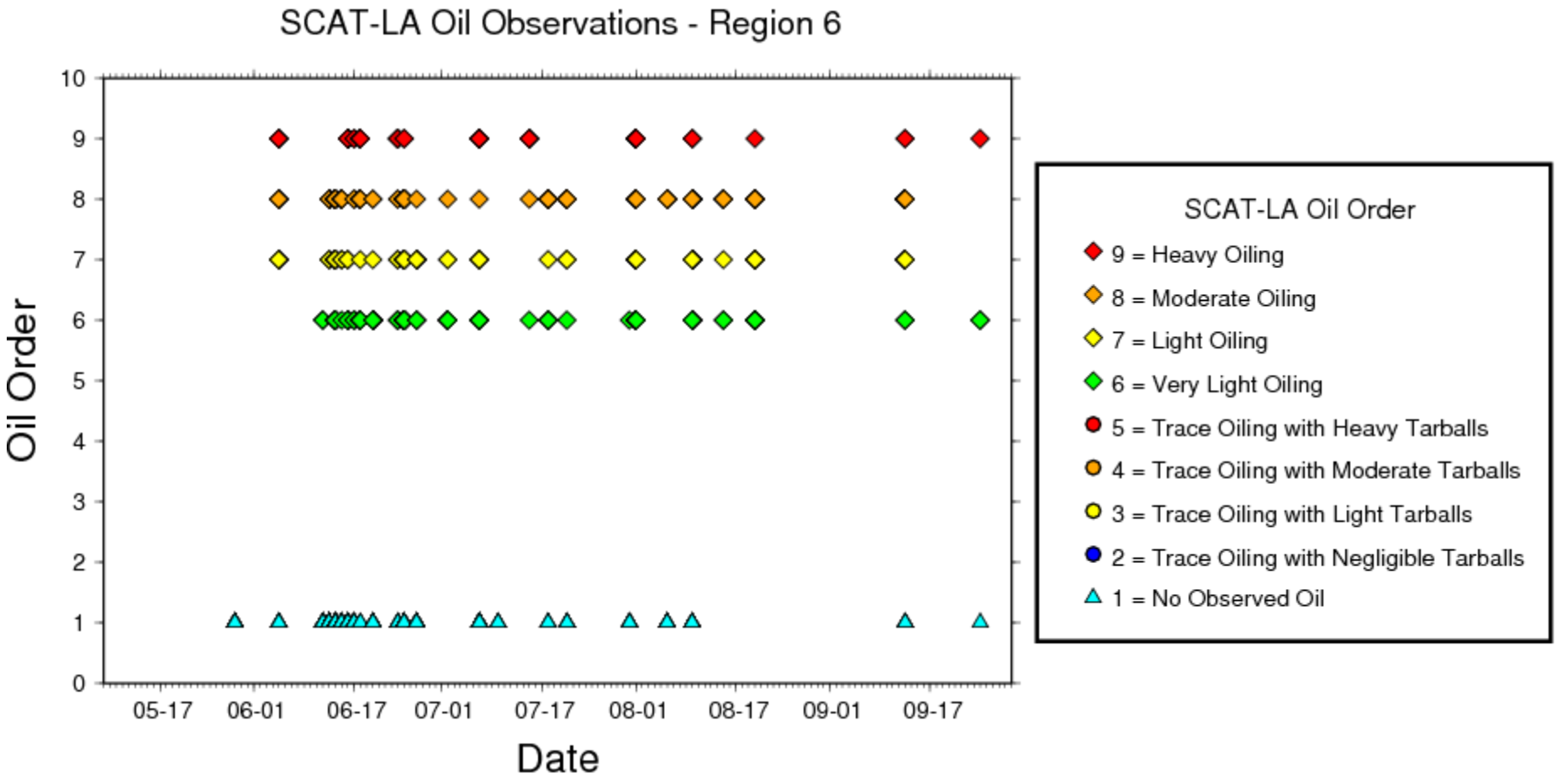
Eastern Biloxi Marsh



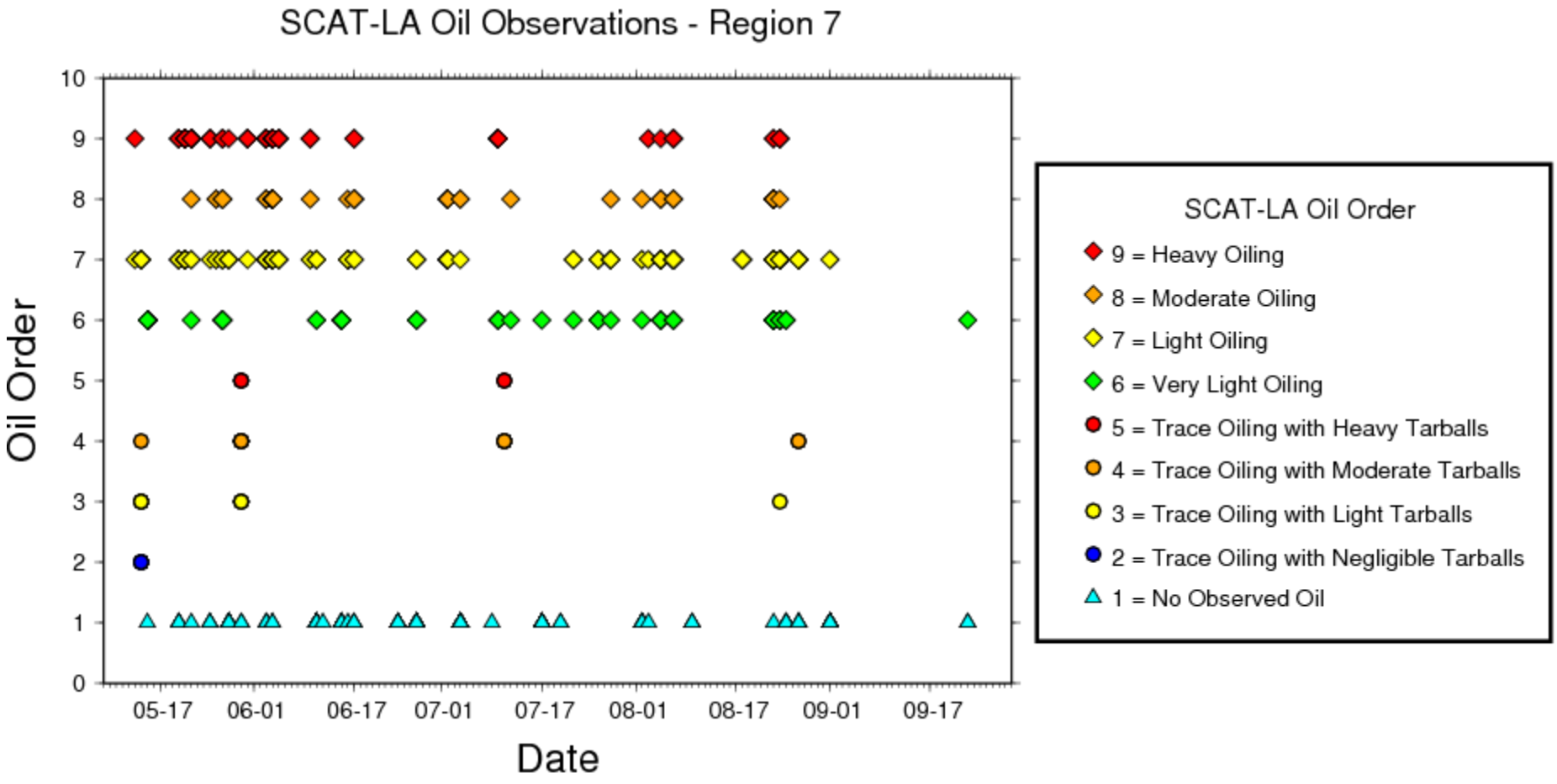
Lake Borgne and Lake Pontchartrain



Northern Barataria Bay



Grand Isle and Fourchon

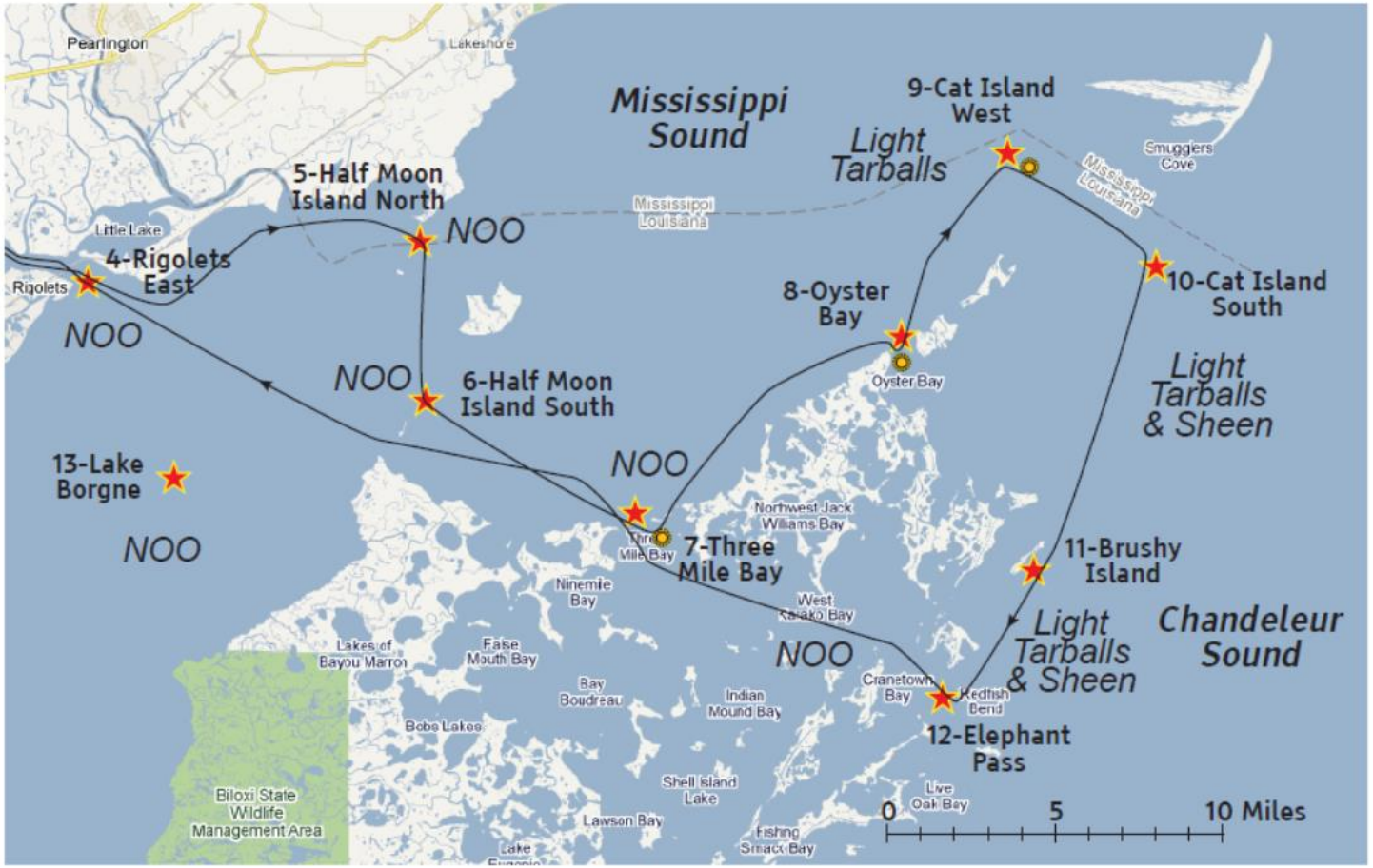


Future work

- Development of oil spill databases for Louisiana DEQ and Lake Pontchartrain Basin Foundation
- Synthesize datasets for comprehensive analysis
- Analysis of all databases, with a summary of all oil incursion along coastline region, wetlands, and in the open waters
- Incorporate dispersion and evaporation components into oil spill model
- Validate oil spill model against database
- Overall goal: fate and transport analysis

Lake Pontchartrain Basin Foundation
Oil Monitoring Report 7/2/2010 Detail

LAKE PONTCHARTRAIN BASIN FOUNDATION
SAVE OUR COAST SAVE OUR LAKE



★ Monitoring Point ⊙ Oil Monitoring Sentinel → Vessel Path

NOO = No Observed Oil Light = <5% Coverage Medium= 5% to 50% Coverage Heavy= >50% Coverage