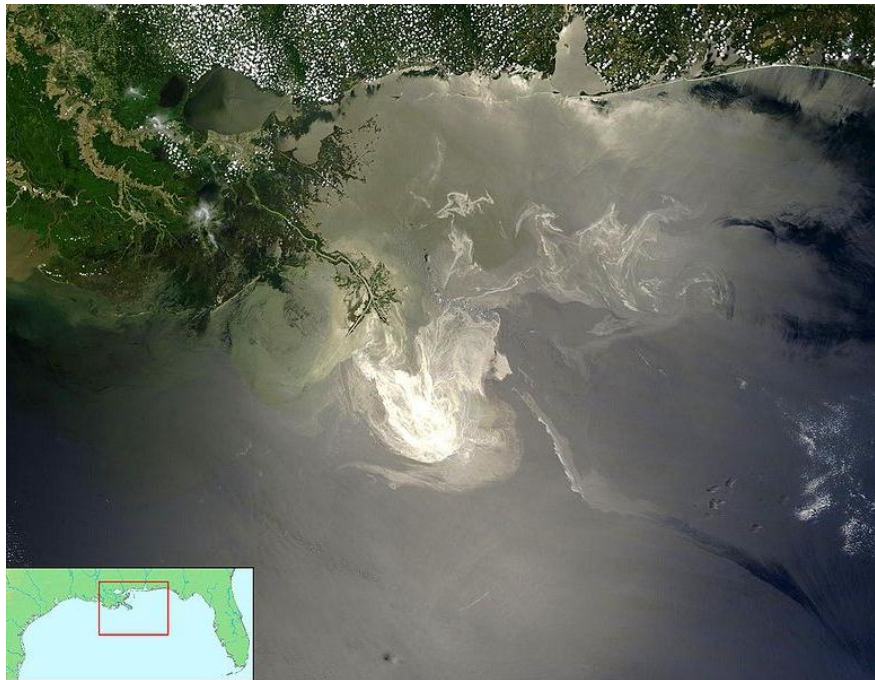


Non-intentional Weather Modification in the Gulf of Mexico:

A brief case study

Humberto L. Varona , Henry Hodelin (University of Oriente, Cuba)

and Arquímedes Ruiz-Columbié (AISM)



The oil slick as seen from space by [NASA's Terra](#) satellite on May 24, 2010.



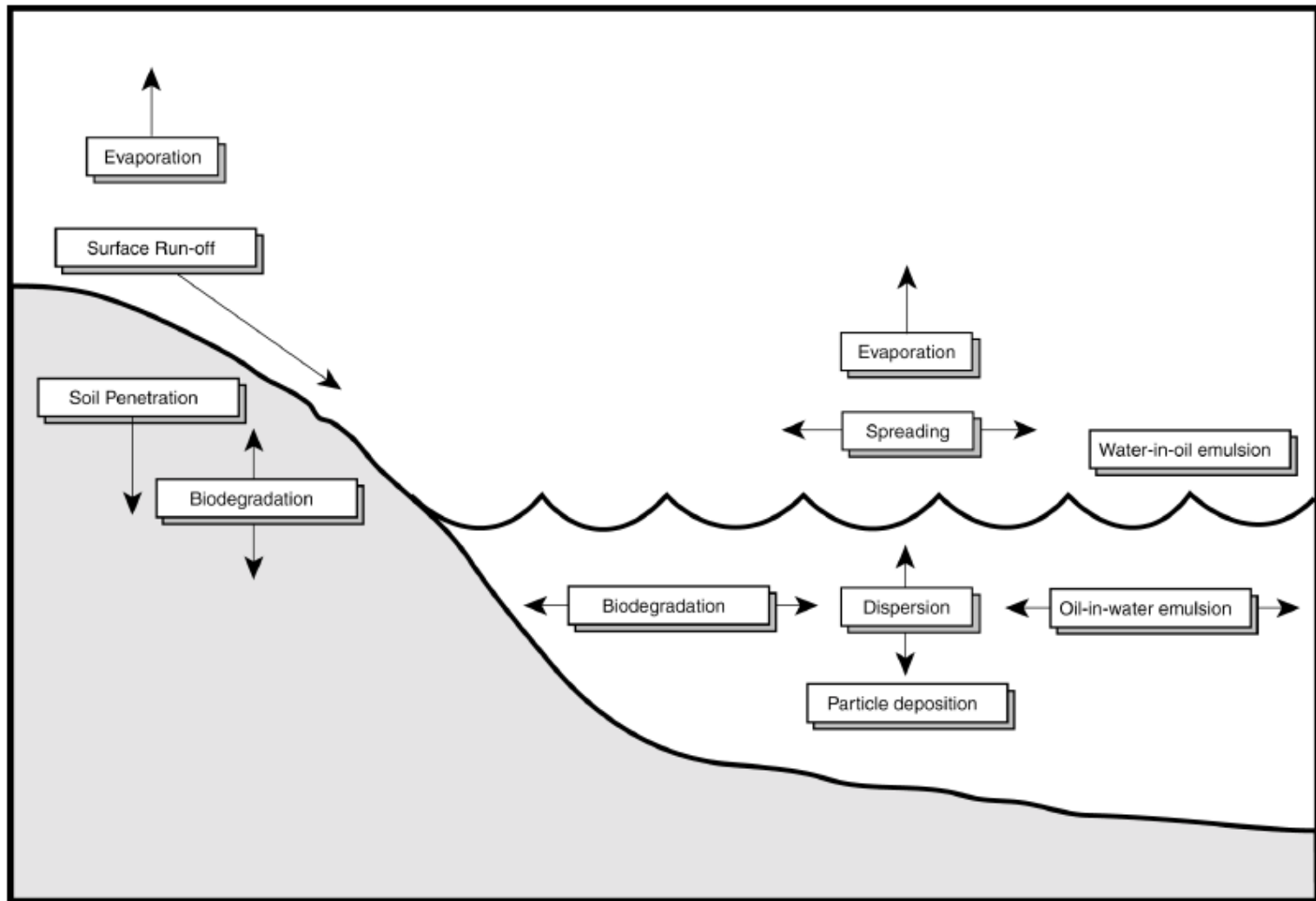
The Deepwater Horizon rig blew out
On April 20th 2010.

Eleven workers died in the explosion.

Two days later the rig sank.

On July 15th 2010 for the first time in
87 days oil did not flow into the Gulf
(2:45 pm CT)

Losses estimated in more than
1.6 billion dollars



Processes on oil immediately after any spill:
(Understanding oil spills and oil spill response, EPA:
<http://www.epa.gov/oem/content/learning/pdfbook.htm>)



Dolphins swimming amongst the oil in the Gulf of Mexico



Brown pelican in disgrace

Looking for data

Buoy Standard Meteorological Data (hourly data: ~ 0.02 Hz):

http://www.ndbc.noaa.gov/download_data.php?filename=42001h2009.txt.gz&dir=data/historical/stdmet/
http://www.ndbc.noaa.gov/download_data.php?filename=42040h2009.txt.gz&dir=data/historical/stdmet/

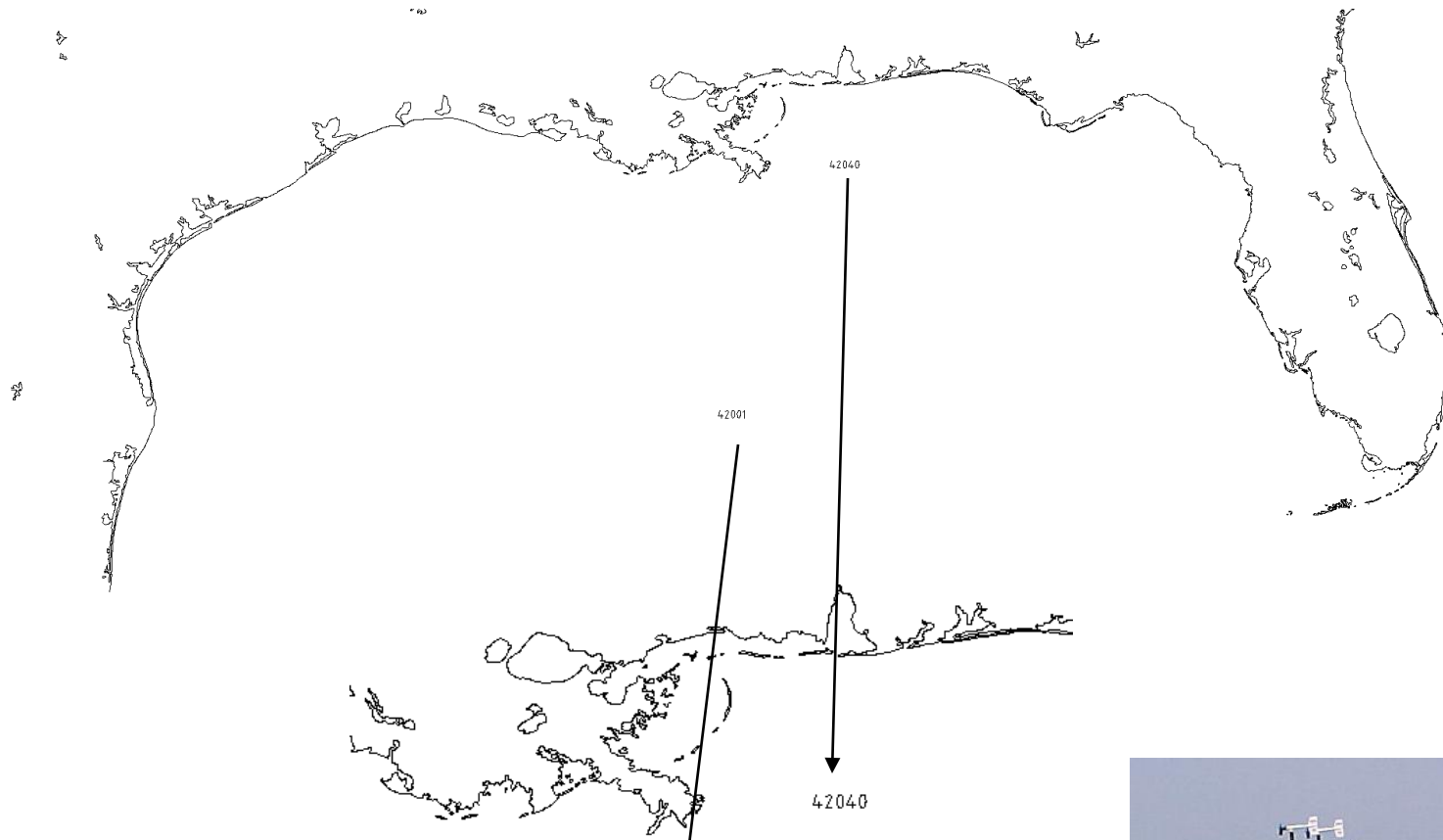
Station 42001 (LLNR 1400) - MID GULF 180 nm South of Southwest Pass, LA
Owned and maintained by National Data Buoy Center
25.888 N 89.658 W (25°53'16" N 89°39'27" W)

Site elevation: sea level
Air temp height: 4 m above site elevation
Anemometer height: 5 m above site elevation
Barometer elevation: sea level
Sea temp depth: 1 m below site elevation
Water depth: 3365 m
Watch circle radius: 3114 yards

Station 42040 (LLNR 293) - LUKE OFFSHORE TEST PLATFORM 64 nm South of Dauphin Island, AL
Owned and maintained by National Data Buoy Center
29.212 N 88.207 W (29°12'45" N 88°12'27" W)

Site elevation: sea level
Air temp height: 10 m above site elevation
Anemometer height: 10 m above site elevation
Barometer elevation: sea level
Sea temp depth: 1 m below site elevation
Water depth: 164.6 m
Watch circle radius: 288 yards

First Problem: incomplete series



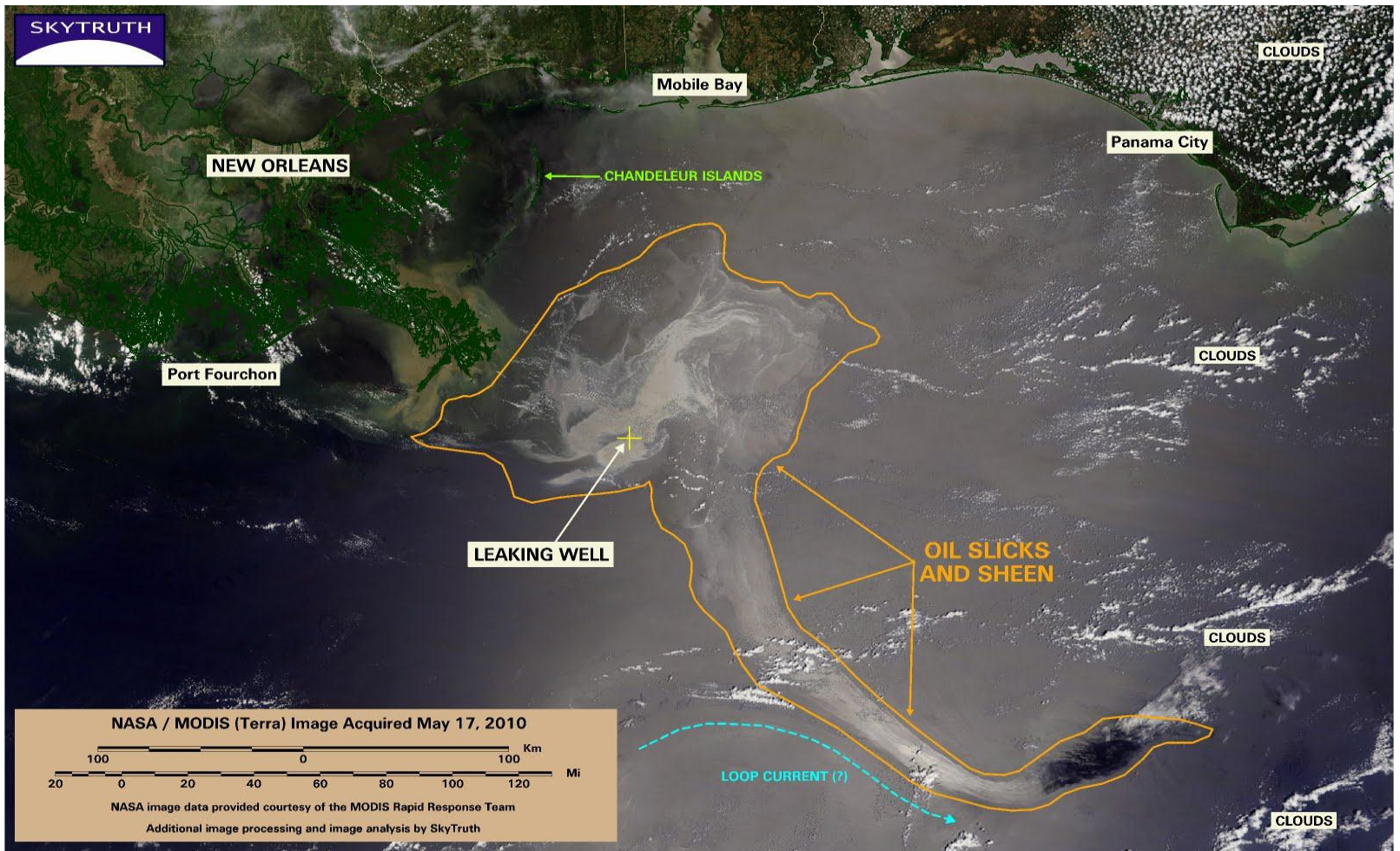
Graphics created using
SATVECT 1.01 (Arbois and Varona, 2011)

Target buoy: 42040
55 km away

Control buoy: 42001
345 km away



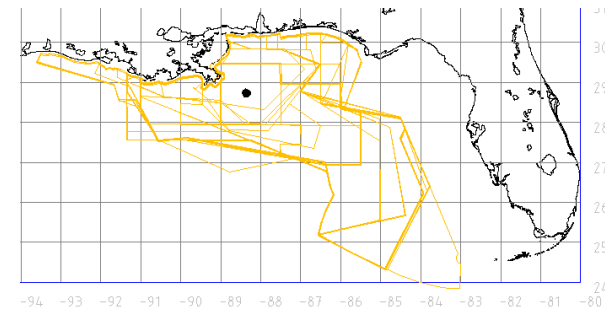
NOAA buoy



May 17th 2010

Software SATVECT 1.01 uses satellites images and was capable to track the oil spill evolution determining the buoys affected. For more information visit:

<http://satvect.blogspot.com>

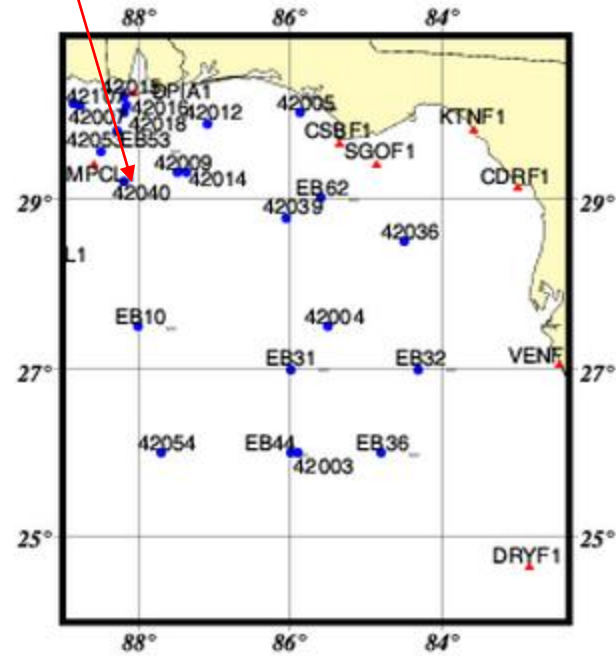


Target: Buoy 42040



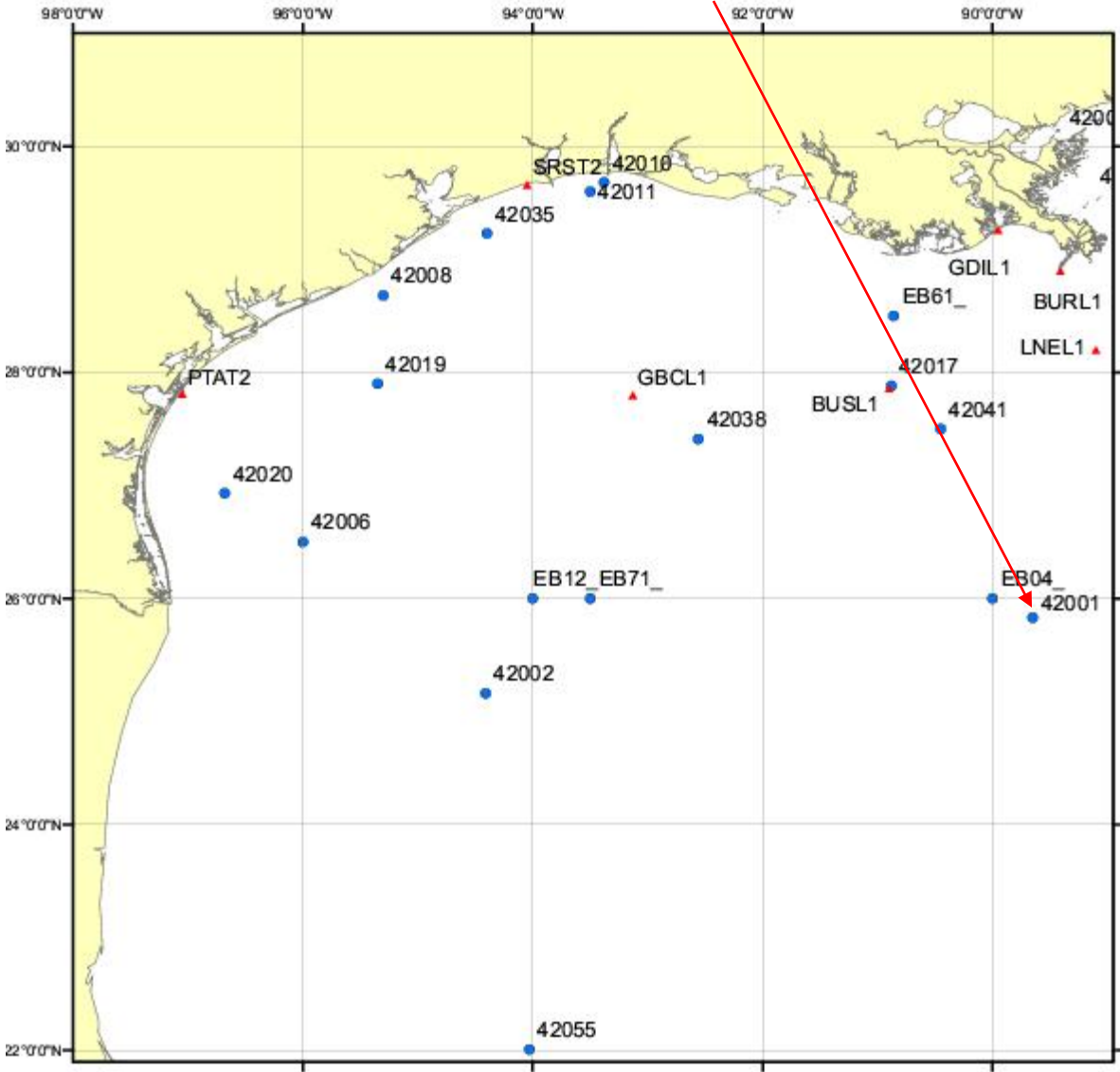
Station 42040
NDBC
Location: 29.212N 88.207W
05/10/2010 0150 UTC
Winds: E (80°) at 5.8 kts gusting to 7.8
Significant Wave Height: 2.3 ft
Dominant Wave period: 6 sec
Mean Wave Direction: ENE (71°)
Atmospheric Pressure: 30.17 in and rising
Air Temperature: 72.5 °F
Dew Point: 54.9 °F
Water Temperature: 76.8 °F

[See more observations from 42040](#)

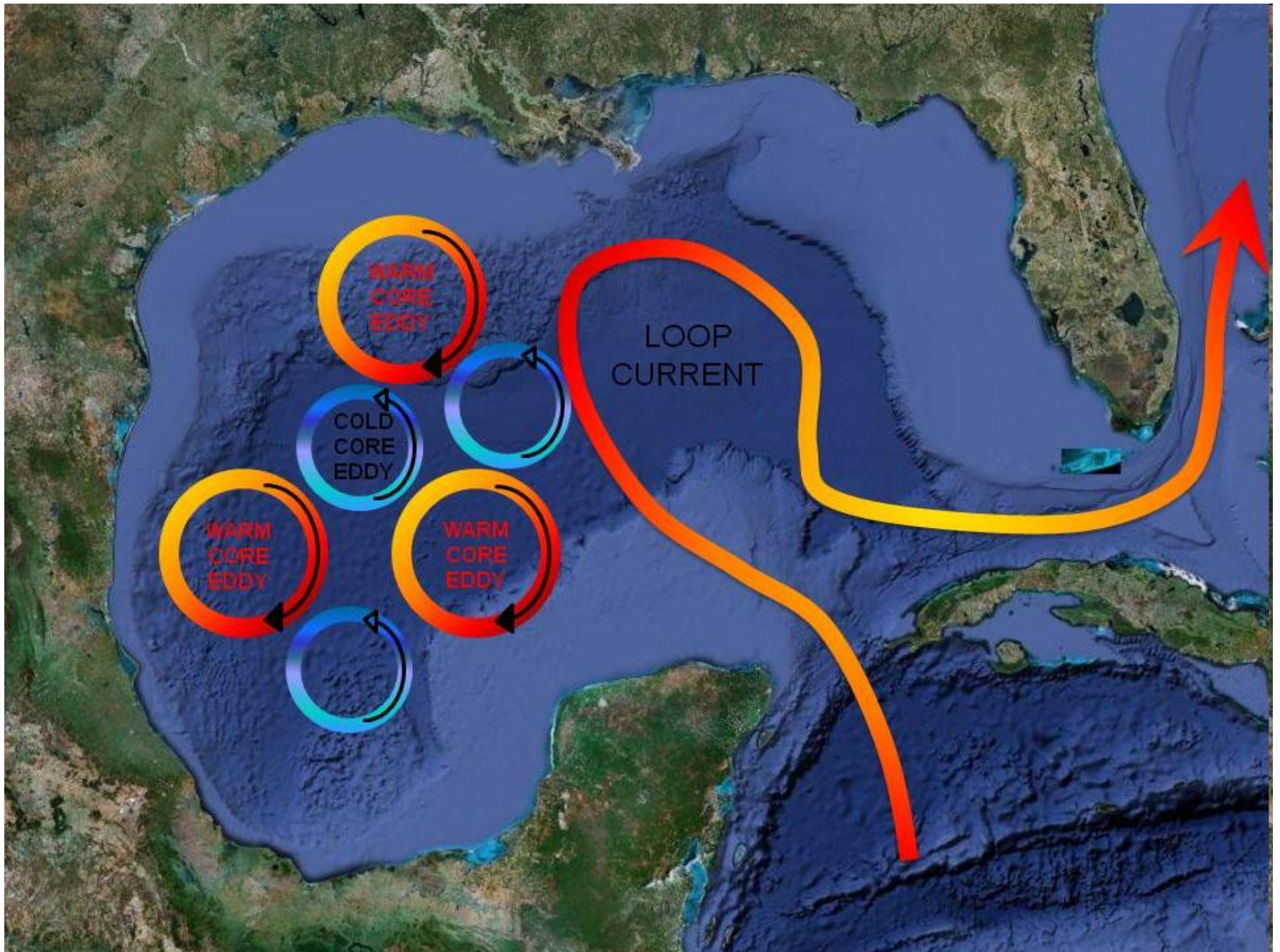


© 2010 Europa Technologies
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image U.S. Geological Survey

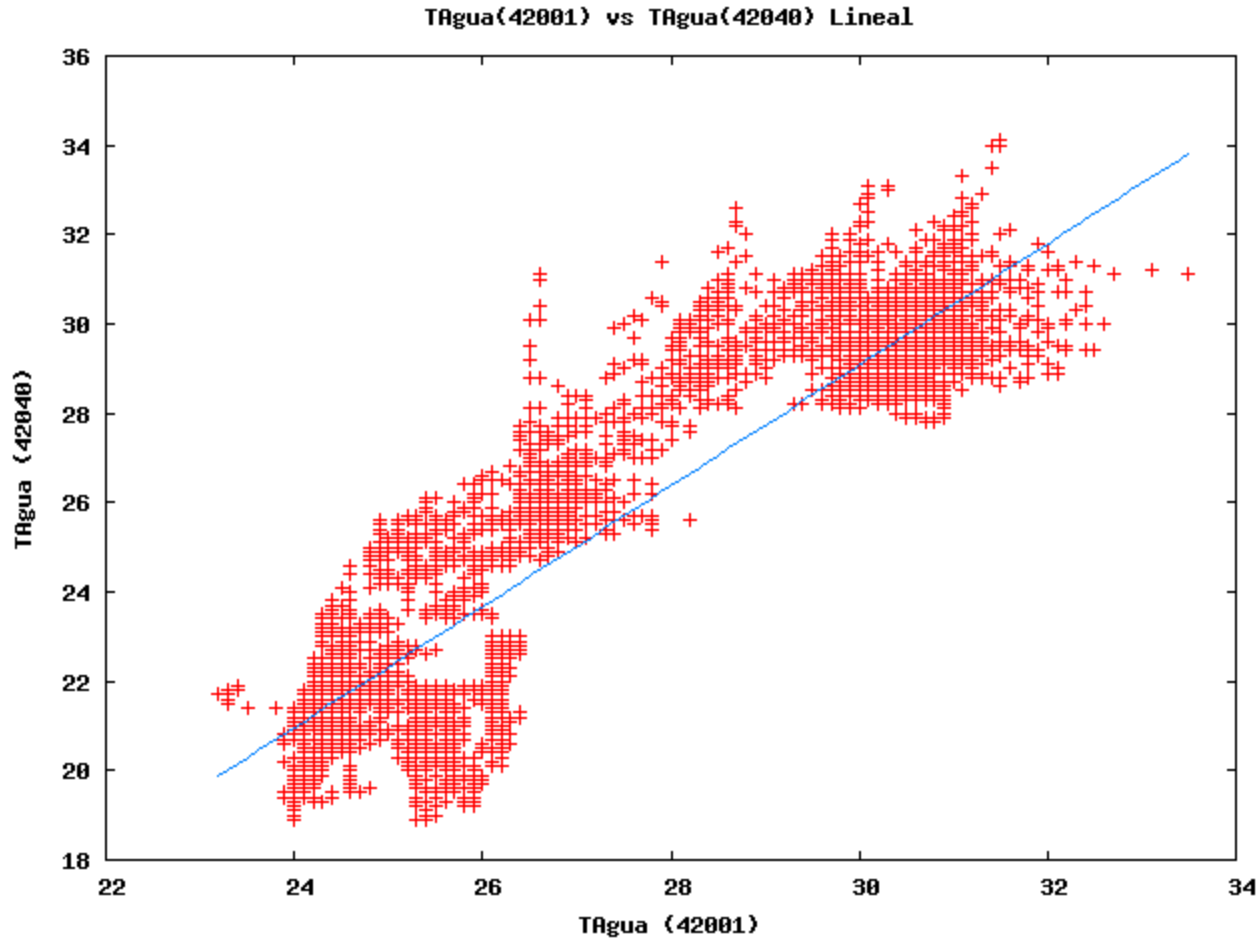
Control: Buoy 42001



Latitude: 25 54 00; Longitude: 89 40 00 W



Before oil spill: hourly data (2008 12 31- 2009 10 05)

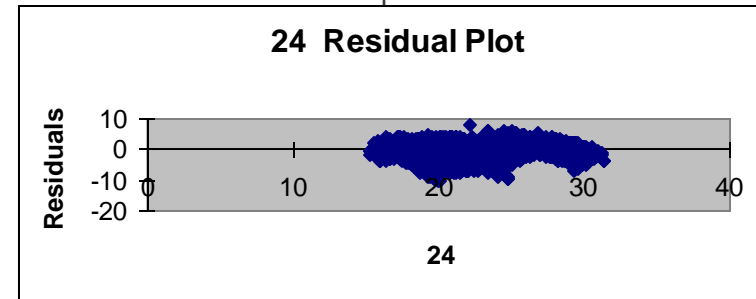
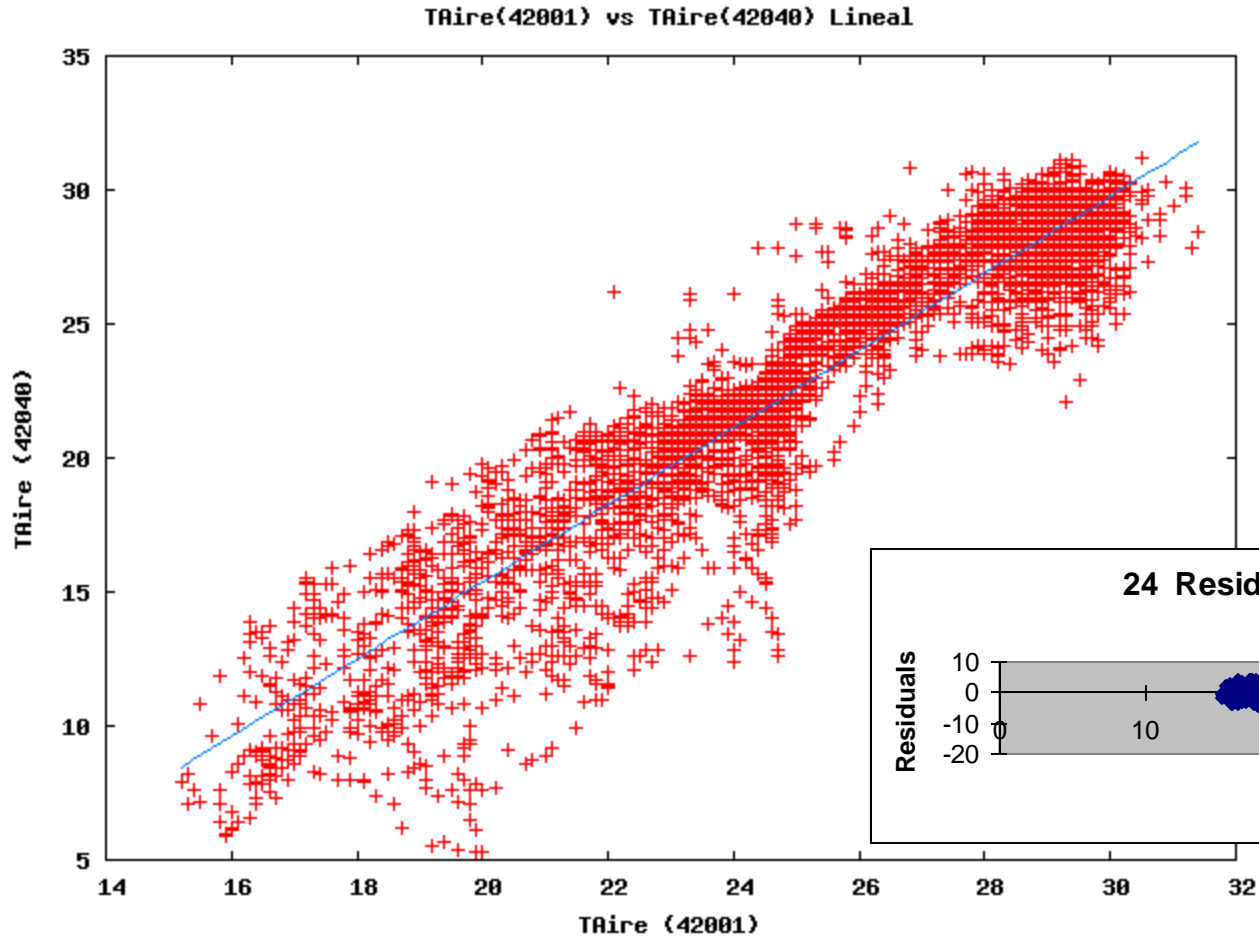


$$T_{\text{target}(42040)} = 1.35 * T_{\text{controll}(42001)} - 11.54$$

$$r = 0.93, \sigma = 1.44, n = 6639$$

(noticeable heteroskedasticity problems)

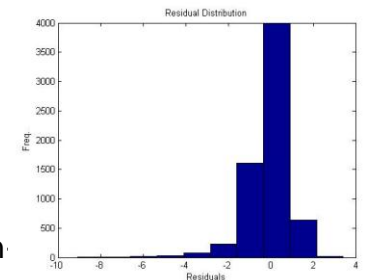
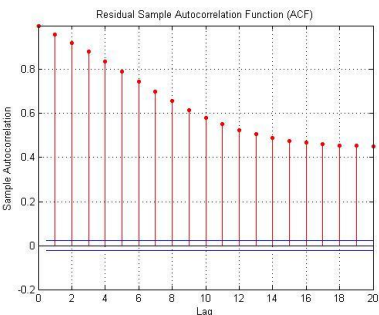
Before oil spill: hourly data (2008 12 31- 2009 10 05)



$$\text{Air: } T_{\text{target}(42040)} = 1.44 * T_{\text{control}(42001)} - 13.41$$

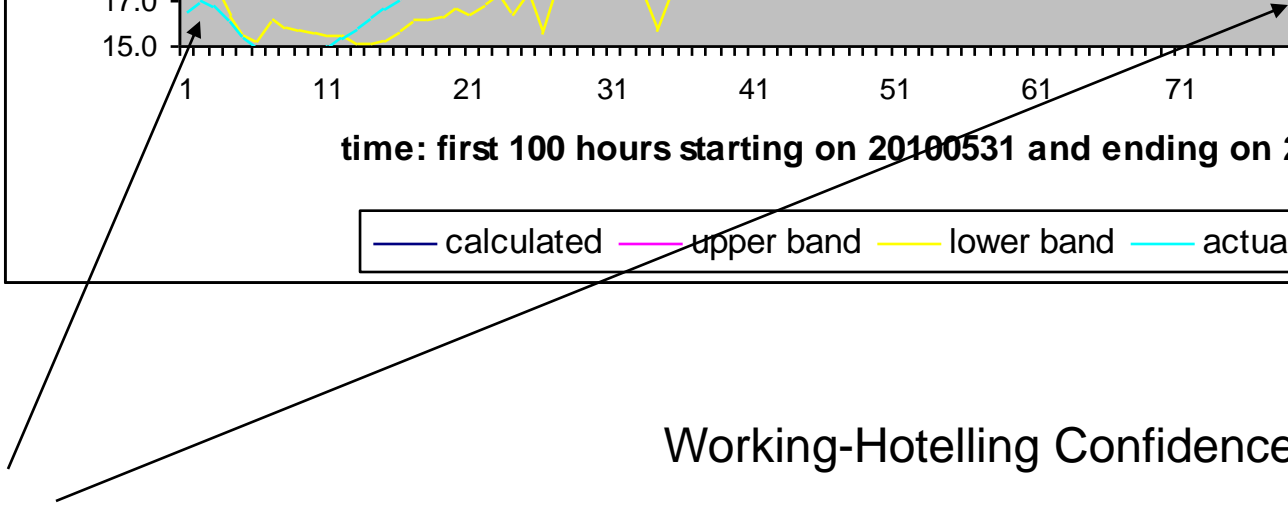
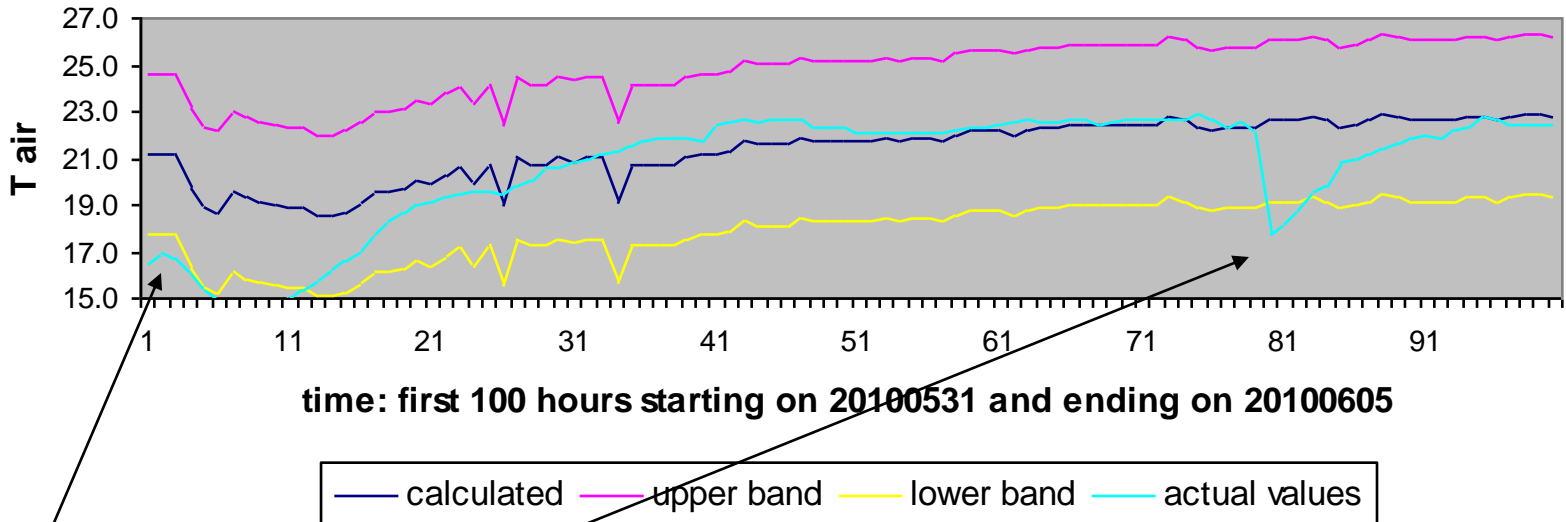
$$r = 0.94, \sigma = 1.76, n = 6639$$

(some heteroskedasticity problems, high residual autocorrelation and non-



Air Temperature Regression Estimations after oil spill (May 31st - June 05 2010)

CI:95%



Possible signals of impact

Working-Hotelling Confidence Bands:

$$\hat{Y} \pm st_{n-2}$$

$$s^2 = s_{Y/X}^2 \left[1 + \frac{1}{n} + \frac{(x - \bar{x})^2}{\sum (x_i - \bar{x})^2} \right]$$

Encountered Problems in Residuals:

- 1) Heteroscedasticity
- 2) Non-normality
- 3) High autocorrelation

These three problems can lead to trouble in the forecasts and confidence intervals, and insights yielded by such a regression model may be incompetent or severely biased or deceptive.



Those aforementioned problems are common when one uses proxy or proxy-like measurements (a typical thing in Weather Modification). Sampling and instrumental errors as well as unrecognized assumptions and extrapolations are the main sources of trouble.

It is not only “data high variability”, the most widespread quoted problem. Remember that “any conclusion is as good as the data supporting it”.



THANKS!

Questions

