



Monitoring Abnormal

Bio-optical and Physical Properties in the Gulf of Mexico Flower Garden Banks

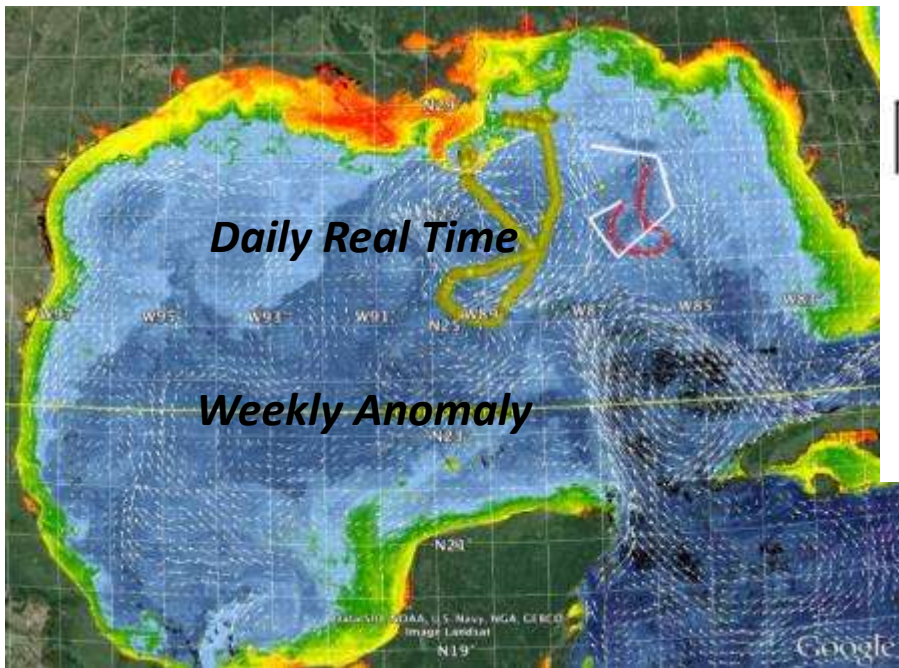
- 1. OWX – Products**
- 2. Anomaly and Masking Levels**
- 3. Anomalies – Salinity, CHL examples**
- 4. Other Events**
 - Spillway**
 - Hurricanes**
- 5. Public Data access – Data management
Demonstration**

Robert Arnone, Brooke Jones

University of Southern Miss

Stennis Space Center, MS

OWX - USM FGB



VIIRS - Color / SST

Satellite Products
750m

- Biology – Chlorophyll
 - Light attenuation
 - Particles – Backscatter
 - Absorption
 - CDOM
 - Detritus
 - Phytoplankton
 - Sea surface Temperature
 - Sea surface Salinity
- Euphotic Depth

HYCOM and, NCOM (4, 1 km)

Model Products

- Sea Surface Temperature
- Sea Surface Salinity
- Mixed Layer Depth
- Intensity of Mixed Layer
- Sea Surface Height
- Current Vectors
- Current Magnitude
- Model Differences
- Regional Cross Sections

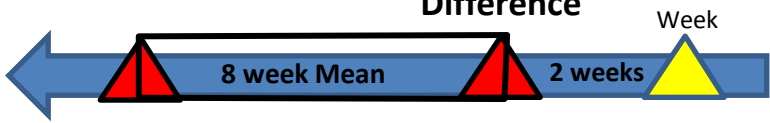
**Weekly Products --- “Hotspots”
Abnormal Environmental Conditions**

Dynamic Anomaly Products **Weekly and - Moving Averages
Anomaly, Standard Deviation Masks (1,2,3)**

Identified events affecting the environmental bio-physical properties in the Gulf of Mexico

NOWCAST and ANOMALY

Weekly
DAP Anomaly
Difference



Satellite Products 6 :

- | | |
|-------------------------------|------------------------|
| 1) Chlorophyll - chl | 2) SST - mcsst |
| 3) Euphotic Depth – ZEU | 4) Absorption 443 a443 |
| 5) Backscattering (particles) | 6) Salinity -sal |

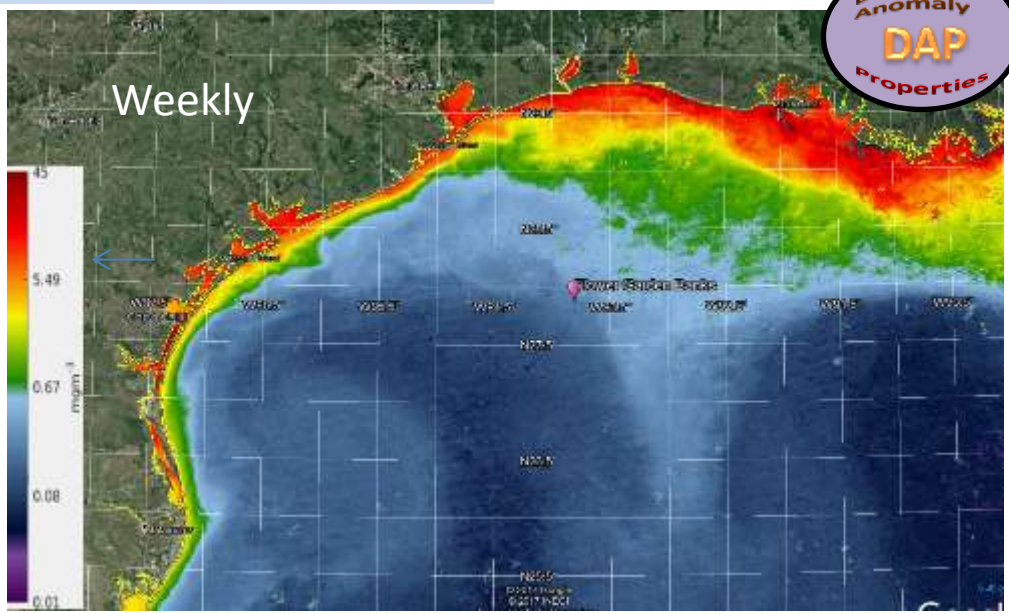
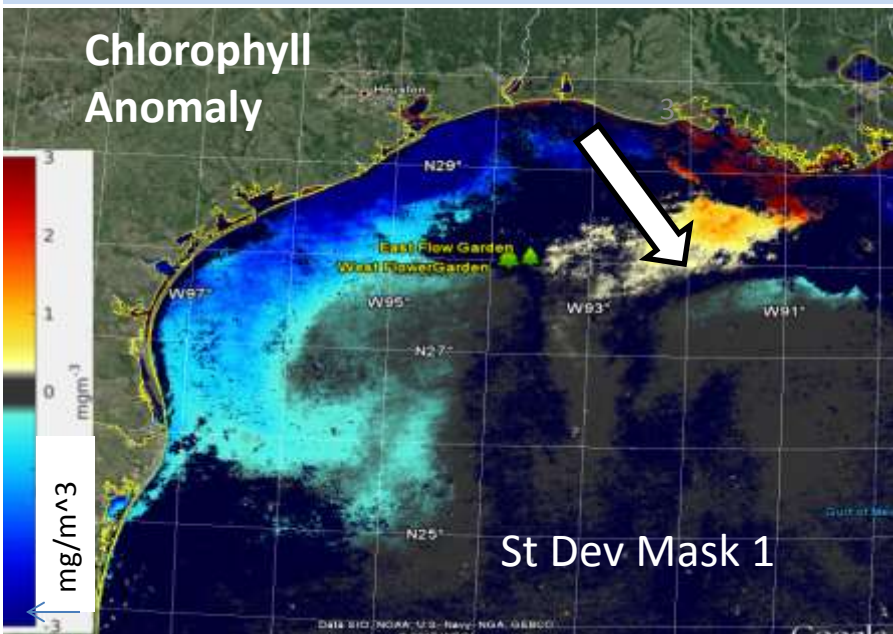
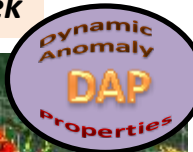
Circulation Model –America Seas Model

- | | |
|------------------------------|-----------------------|
| 1) Sea Surface Temperature - | 2) Surface Salinity – |
| 3) Surface Current magnitude | 4) direction |

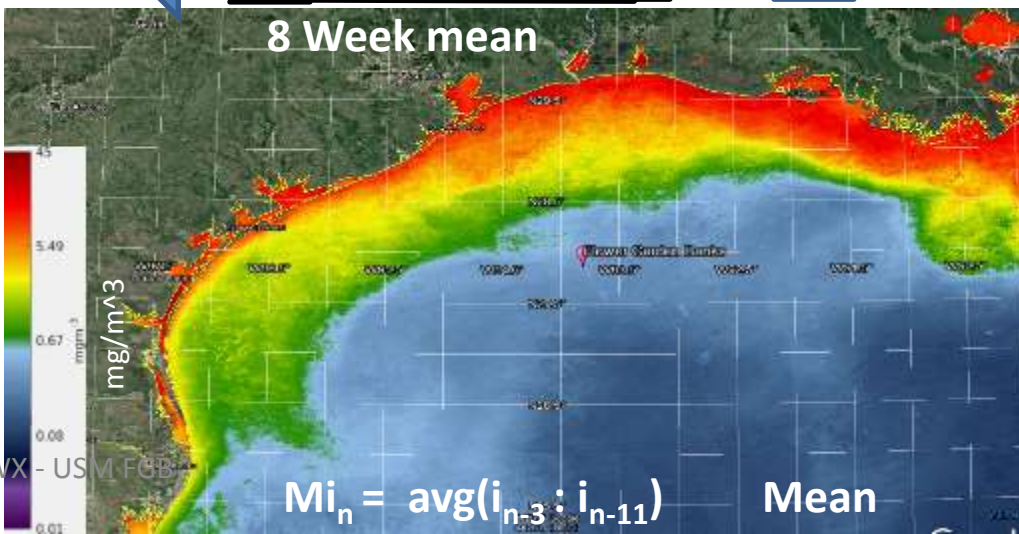
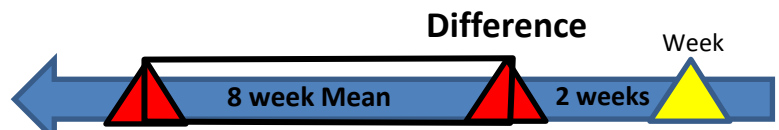
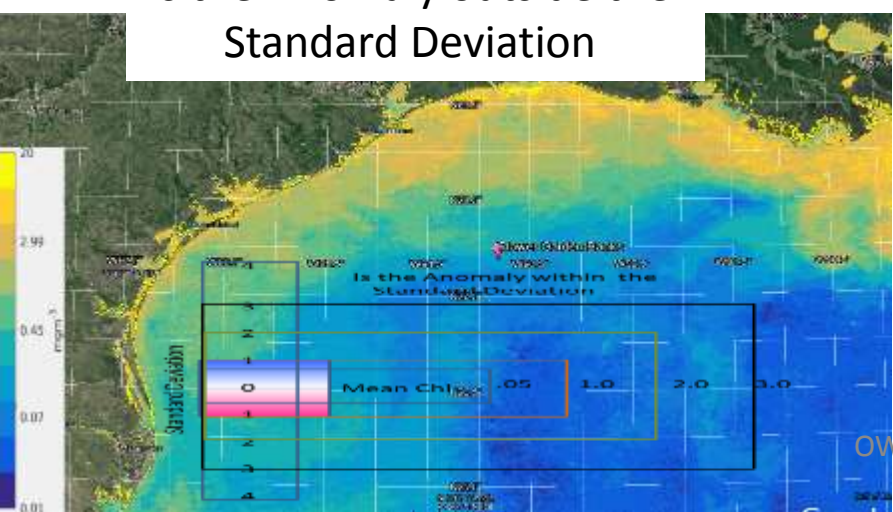
Defining the Level of Abnormality

Is the Anomaly within the Variance of the Region

July 27 2016 Week



Mask Levels 1,2,3,4
Is the Anomaly outside the
Standard Deviation



$Mi_n = \text{avg}(i_{n-3} : i_{n-11})$ Mean

JULY 11, 2016

HOW ABNORMAL IS THE DYNAMIC CHLOROPHYLL HOTSPOT?

Masking the Levels of Standard deviation

Anomaly - mask 0

Anomaly - mask 1

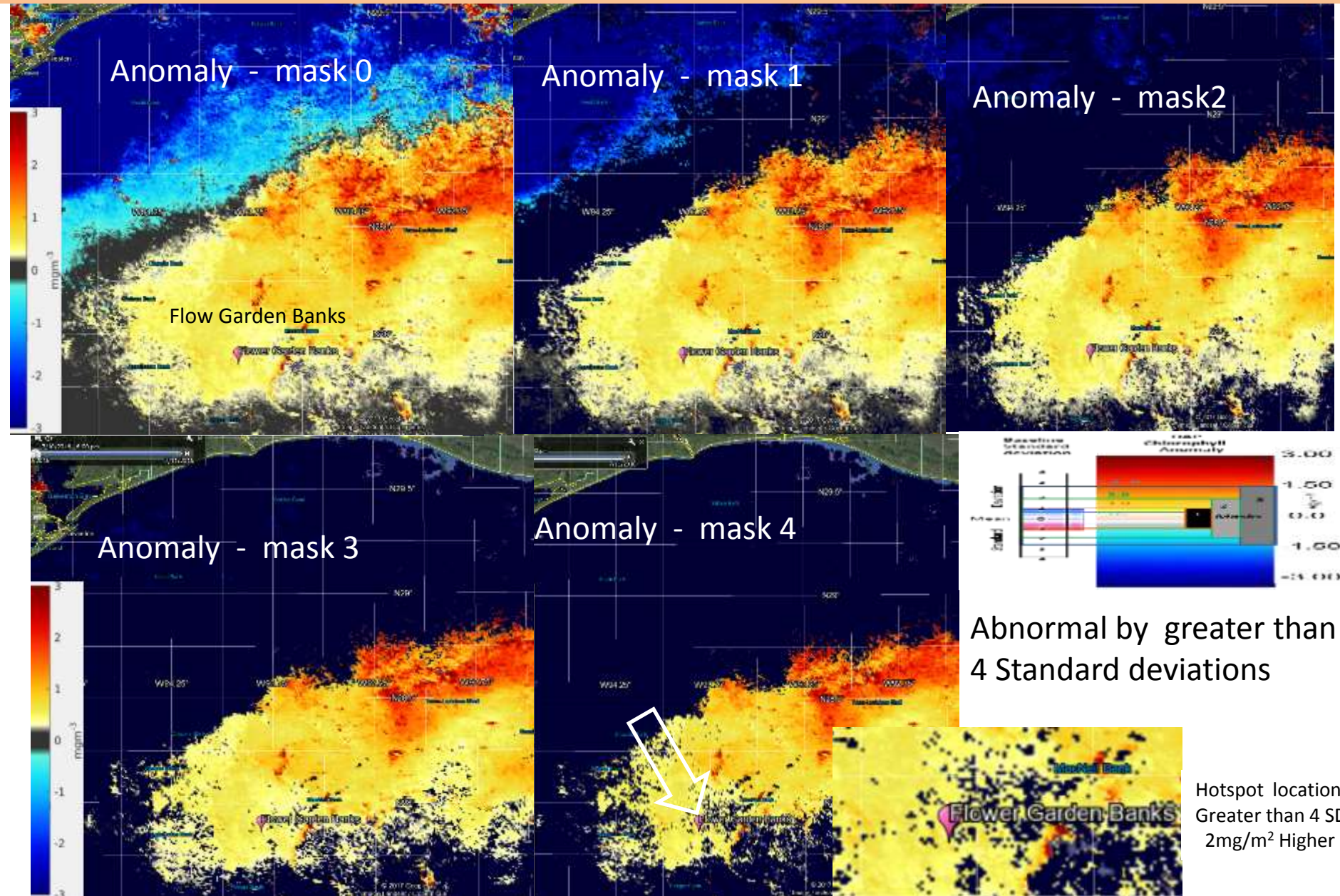
Anomaly - mask 2

Anomaly - mask 3

Anomaly - mask 4

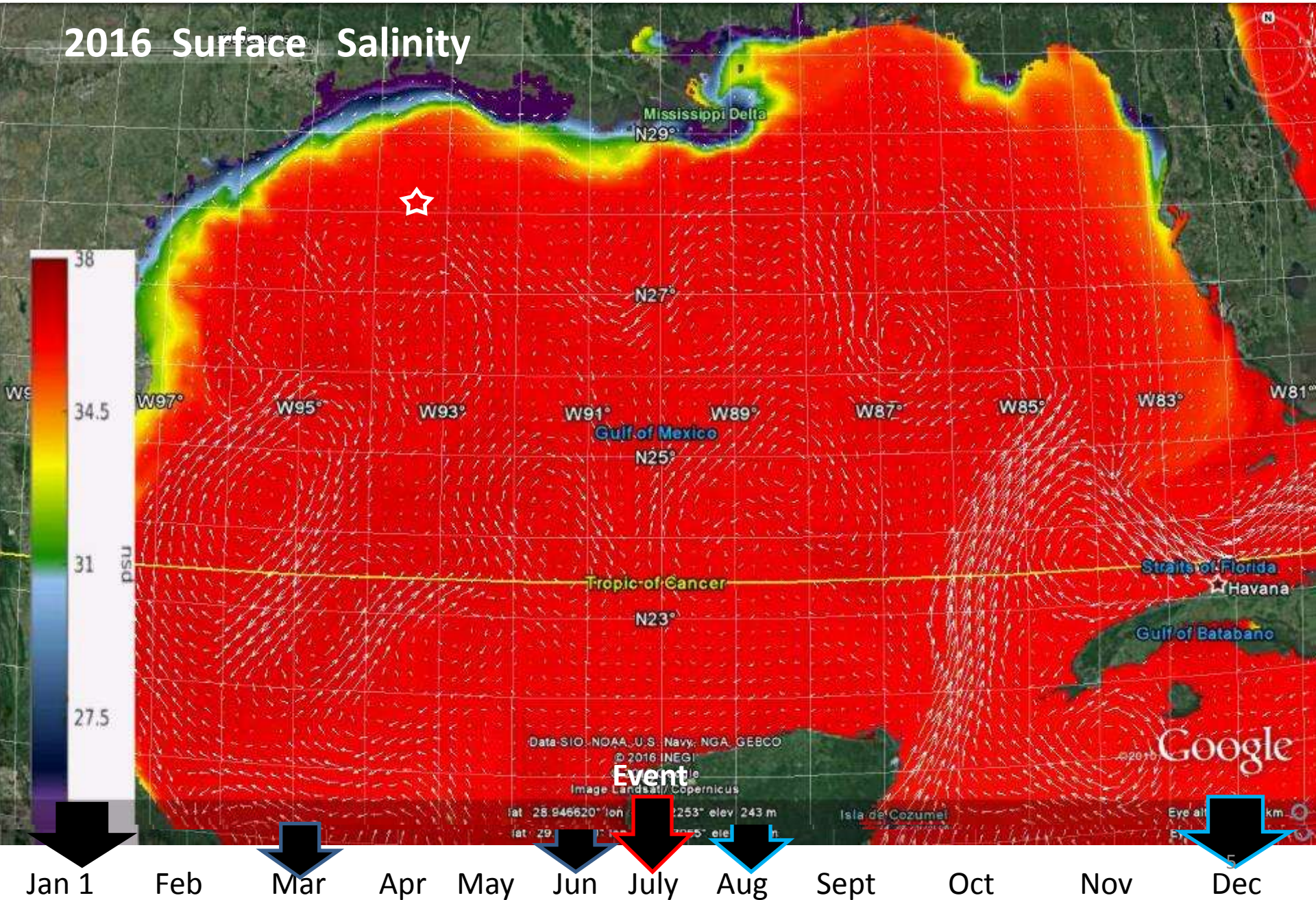
Abnormal by greater than 4 Standard deviations

Hotspot location
Greater than 4 SD
2mg/m² Higher



Weekly Model - Flower Garden Banks in 2016

2016 Surface Salinity



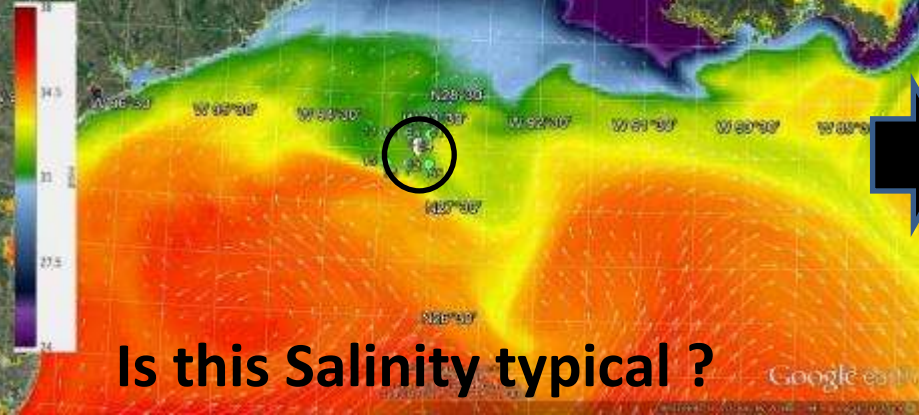
- Flower Garden Banks July 2016



Bleaching event was observed in late July

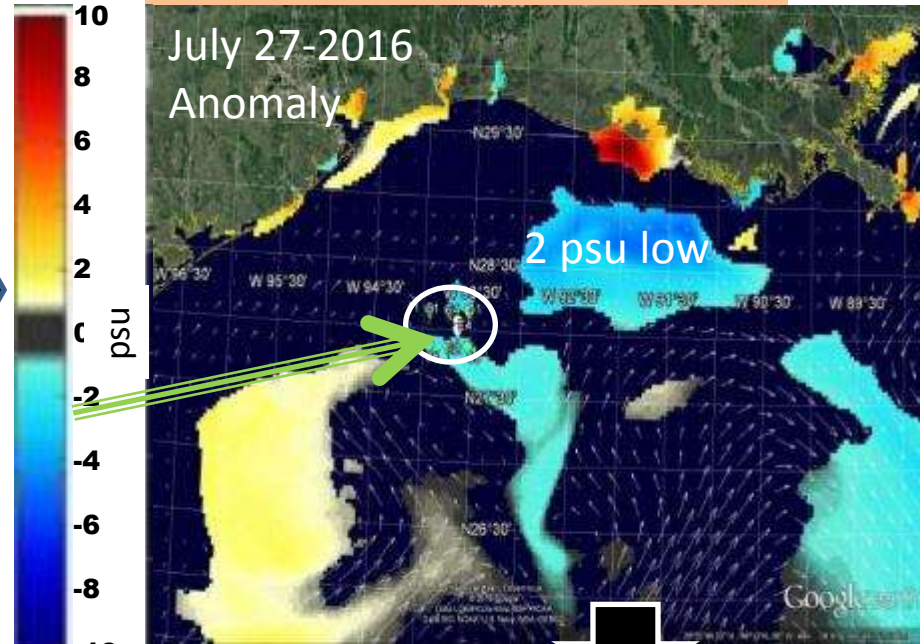
Salinity Anomaly - MASK 2

July 27, 2016
Weekly



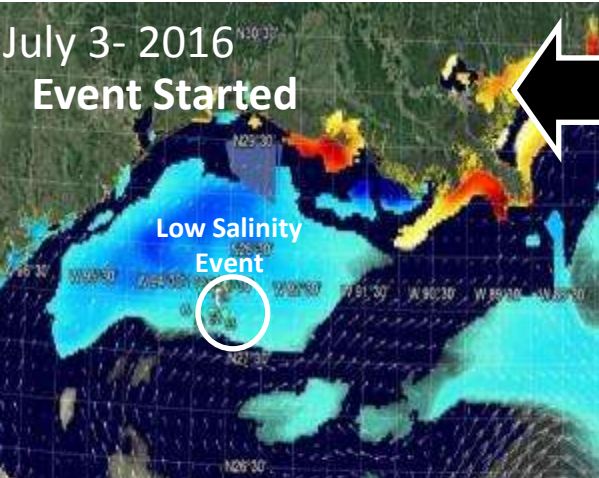
Is this Salinity typical ?

Weekly Changes in Salinity Anomaly



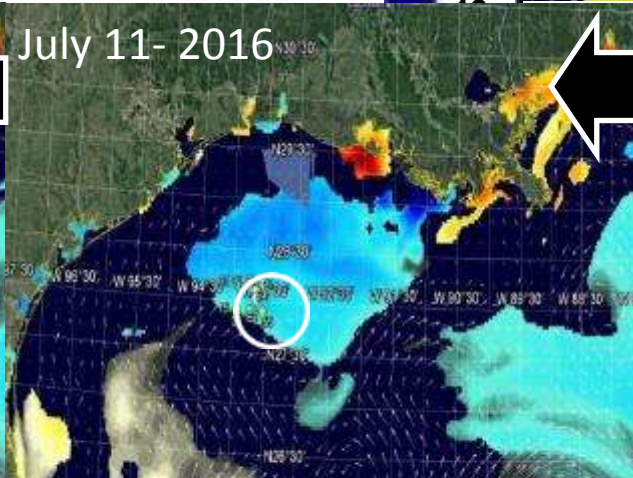
2 psu low

July 3- 2016
Event Started

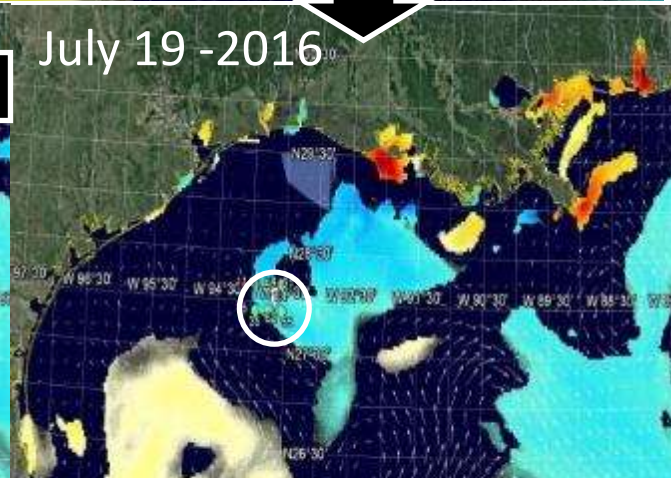


Low Salinity
Event

July 11- 2016



July 19- 2016



Large regional of Abnormal
Low Salinity

Example from Chl

Arnore, R., Jones, B. " Monitoring abnormal bio-optical and physical properties in the Gulf of Mexico ", *Proc. SPIE* 10186, Ocean Sensing and Monitoring IX, 101860O (May 22, 2017); doi:10.1117/12.2266789 <http://dx.doi.org/10.1117/12.2266789>

Chlorophyll Anomaly Sequence Similar timing as salinity anomaly

Flower Garden Banks HOTSPOTS was in Early July 2016

Greater than 3 St Dev

July 3, 2016

Flower Garden Banks

Largest Anomaly Occurs
July 11, 2016

July 19, 2016

Next

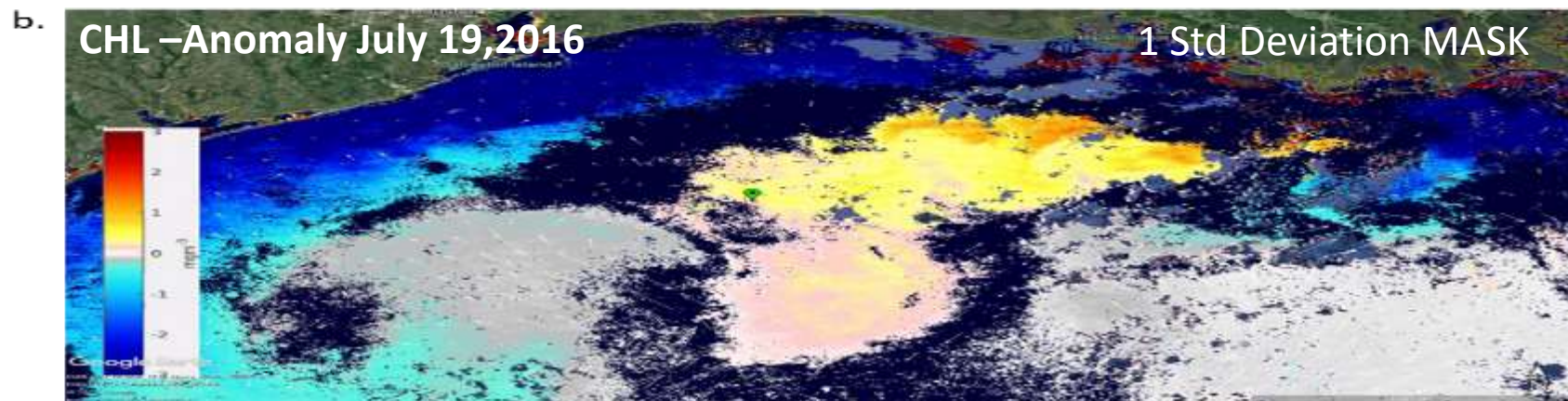
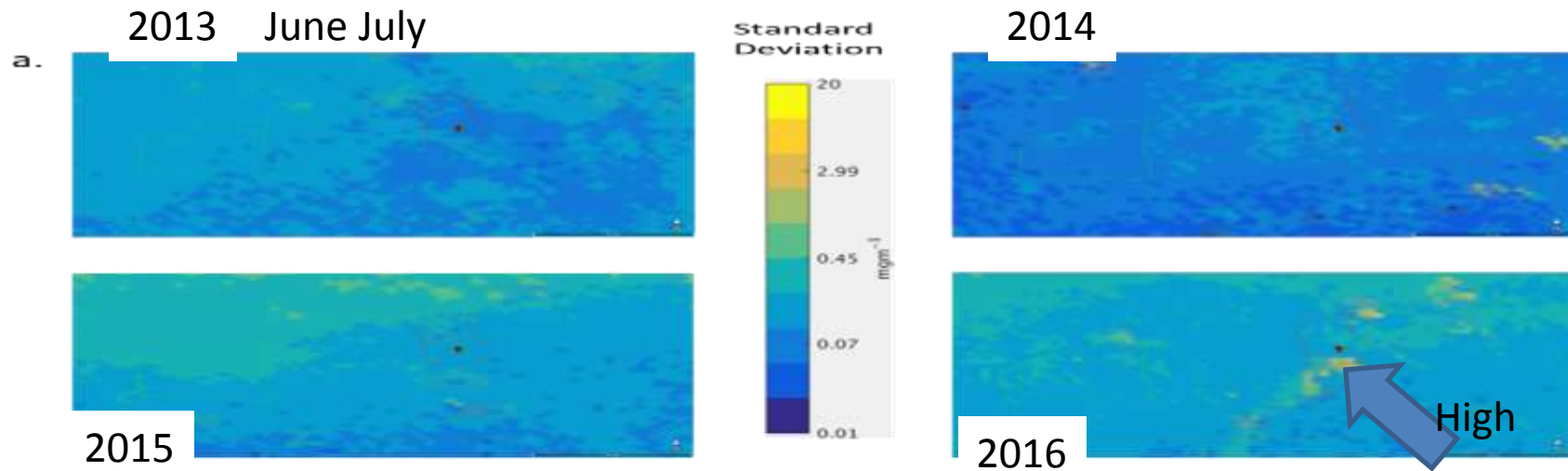
OWX - USM FGB

July 27, 2016

Hotspots event appears
Over

Flower Garden Banks CHLOROPHYLL

a) Standard deviation of Chlorophyll during June-July of years 2013, 2014, 2015, 2016 in Flower Garden Banks region. The location track for Flower Garden Banks West (green) and East (red) banks are delineated. The red marker denotes the site of the buoy where bleaching was discovered. Arrow is high variability.



b) The weekly Chlorophyll anomaly for Flower Garden Banks bleaching event in July 2016. A (black) mask of one standard deviation beyond the previous 8-week mean has been applied. The location of the buoy where the bleaching occurred is denoted with a green marker. The Box represents the std dev region (13a)

Have Other Example Products of the Bleaching Event.

Euphotic Depth (1% light level)

Backscattering

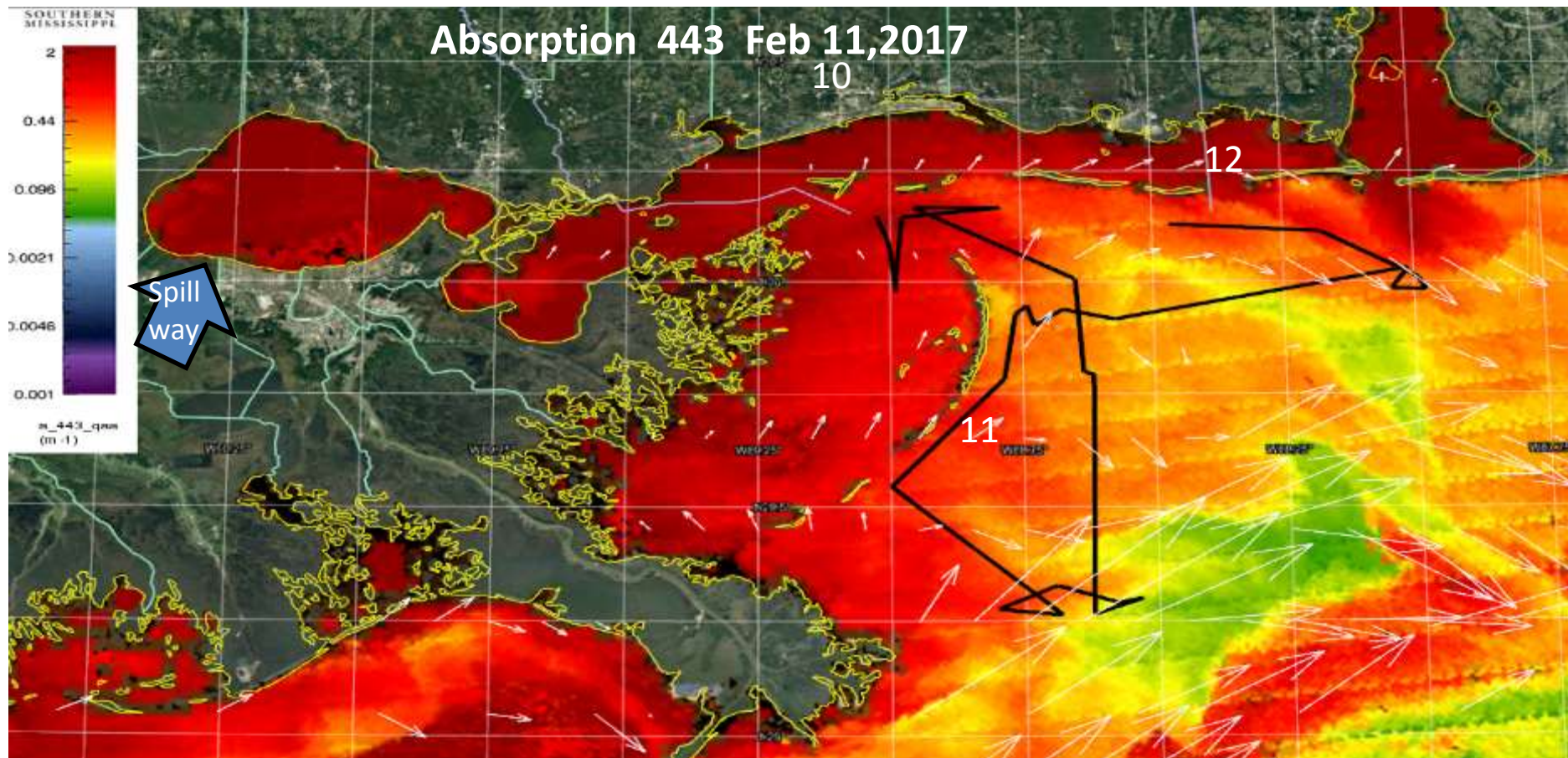
Temperature

Currents

Other Events

Mississippi River --- Bonnet Carré Spillway opening Jan to Feb 2016

How did the Spillway opening affect the Waters
CDOM- Colored Dissolved Organic Matter
Elevated Absorption from the MS River

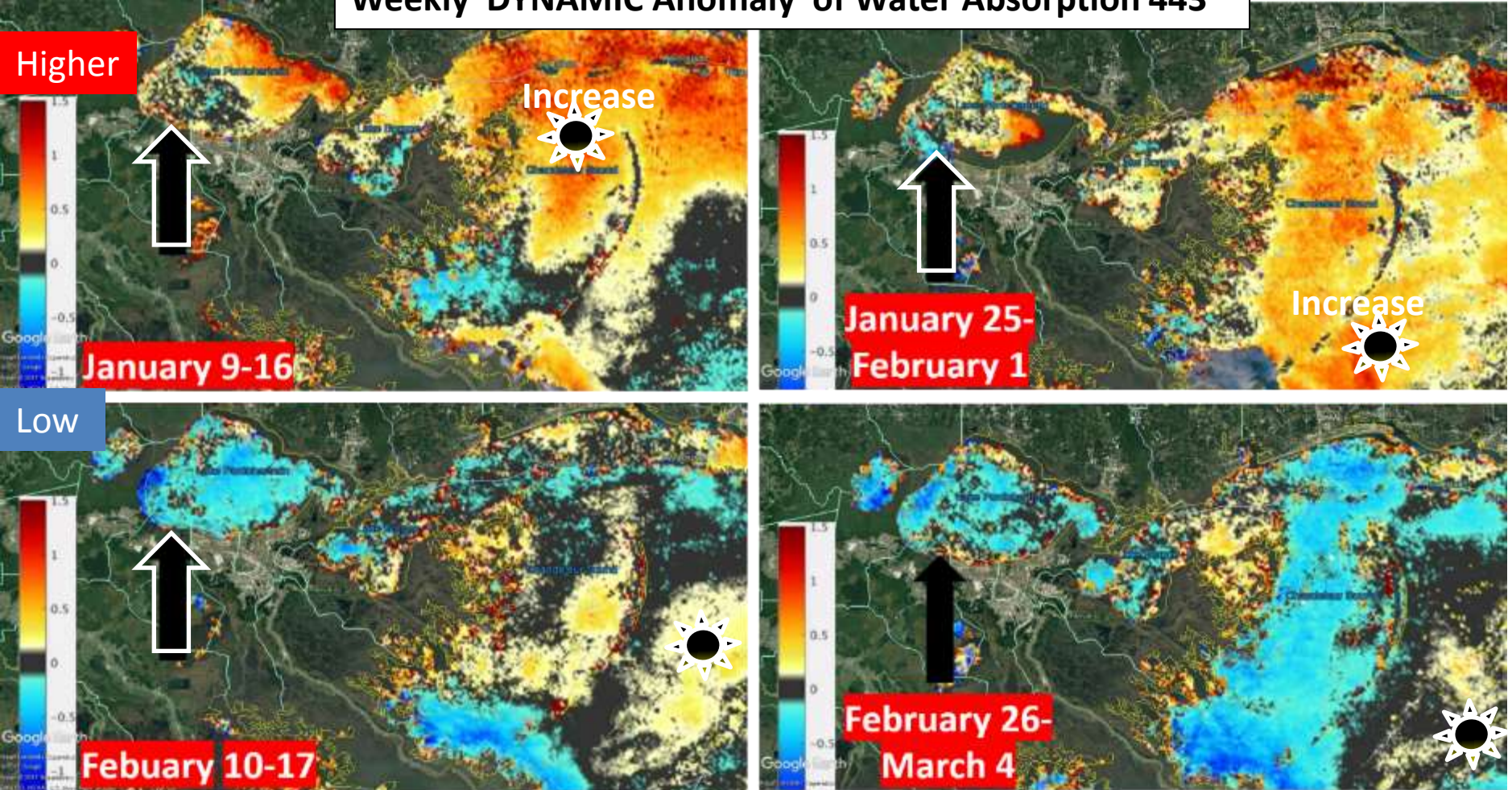


OWX - USM FGB
Cruise track on Feb 10, 11, 12

Bonnet Carré Spillway opening led to elevated absorption.

The dynamic anomaly for absorption shows the time and areal scales of impact to surrounding waters, and the migration of the event offshore.

Weekly DYNAMIC Anomaly of Water Absorption 443



VIIRS Absorption Dynamic Anomaly for the weeks of the spillway opening show the increased absorption values in nearby ecologically important waters. As a proxy for the released water mass, the absorption indicates that the river water moved away from the Mississippi Bight (Feb 26, 2016) approximately 4 weeks following the closing of the spillway (Feb 2, 2016).

What effects did the Hurricanes have on ocean waters?

2017 Hurricanes

1) Harvey

2) Irma

3) NATE

Abnormal Conditions
in the Gulf of Mexico

Have Slides of the other Hurricanes if Interested

Monitoring Biological and Physical Properties

Satellite VIIRS products - Chl, SST, Salinity
Backscattering, Euphotic Depth

Ocean Model -America Seas - SST, Salinity,
Currents

Abnormal Events

Harvey Track -Houston

Location on 8/25/17, at 10:00 PM CDT
Harvey makes landfall 30 miles northeast of Corpus Christi as a Category 4 storm.

Corpus Christi

Friday Aug 25 8:37PM

Sat Aug 26 12:45 PM

Sun Aug 27 12:45 PM

Mon Aug 28 12:30 PM

Tues Aug 29 12:30 PM

Wed Aug 30 12:30 PM

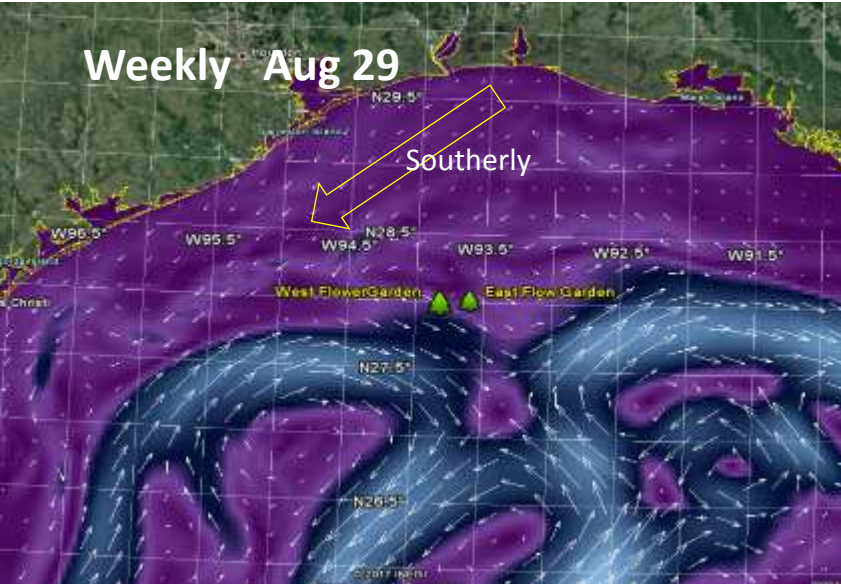
Thurs Aug 31 9:45 AM

AM Seas Model Currents

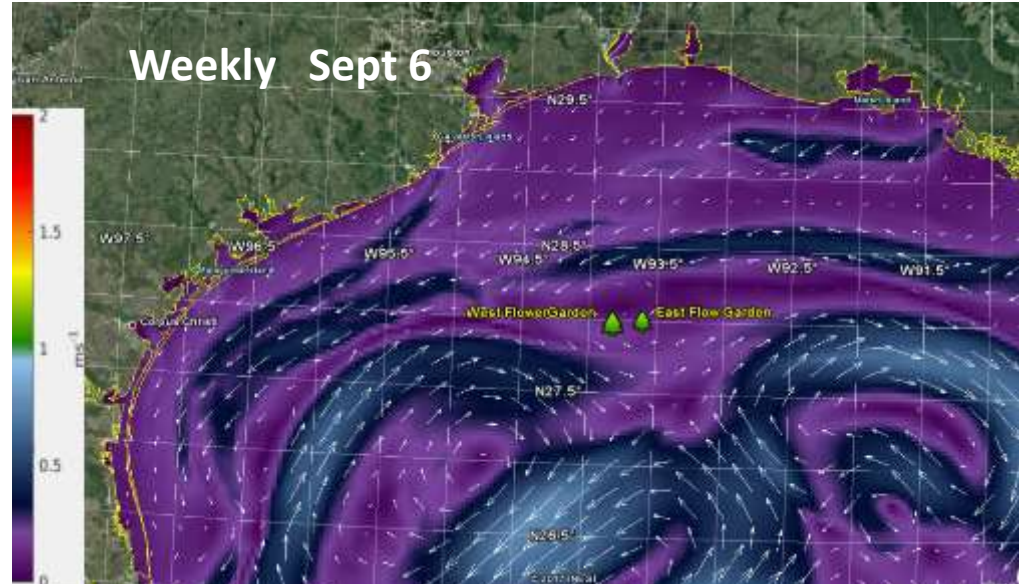
Winds affects on currents

Harvey -Houston

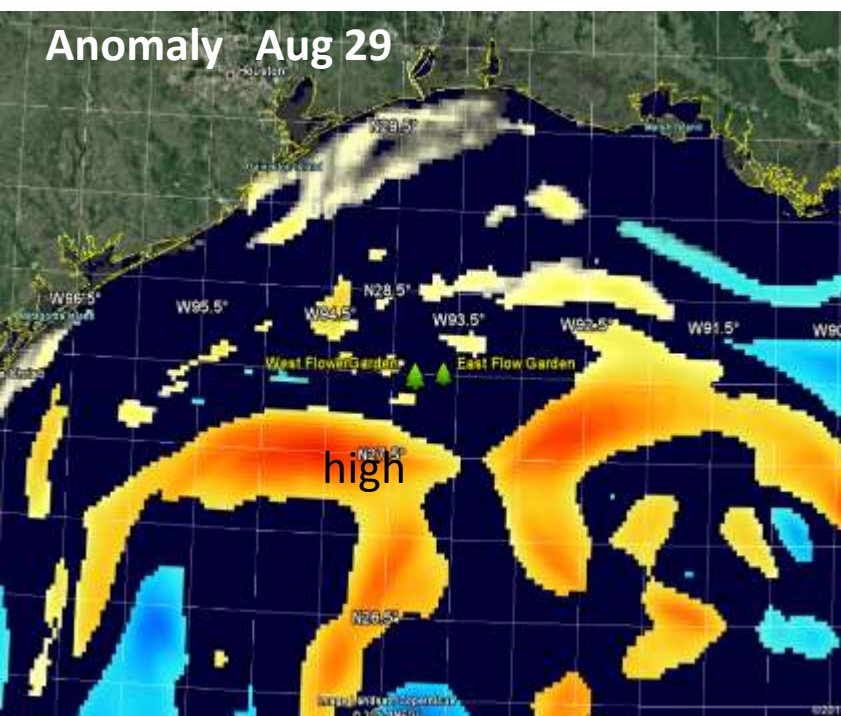
Weekly Aug 29



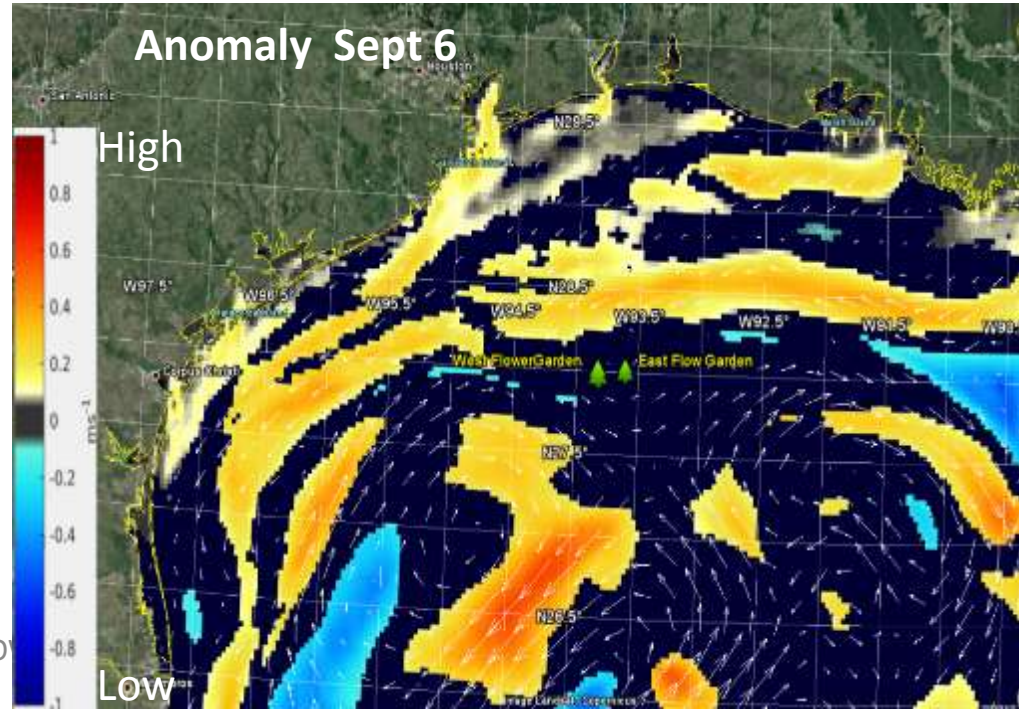
Weekly Sept 6



Anomaly Aug 29

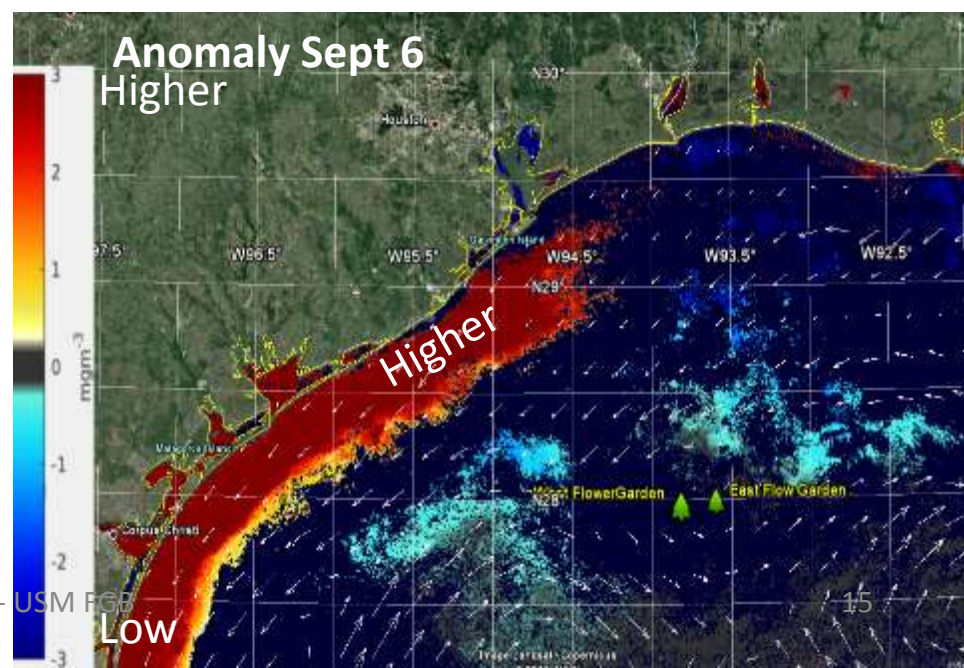
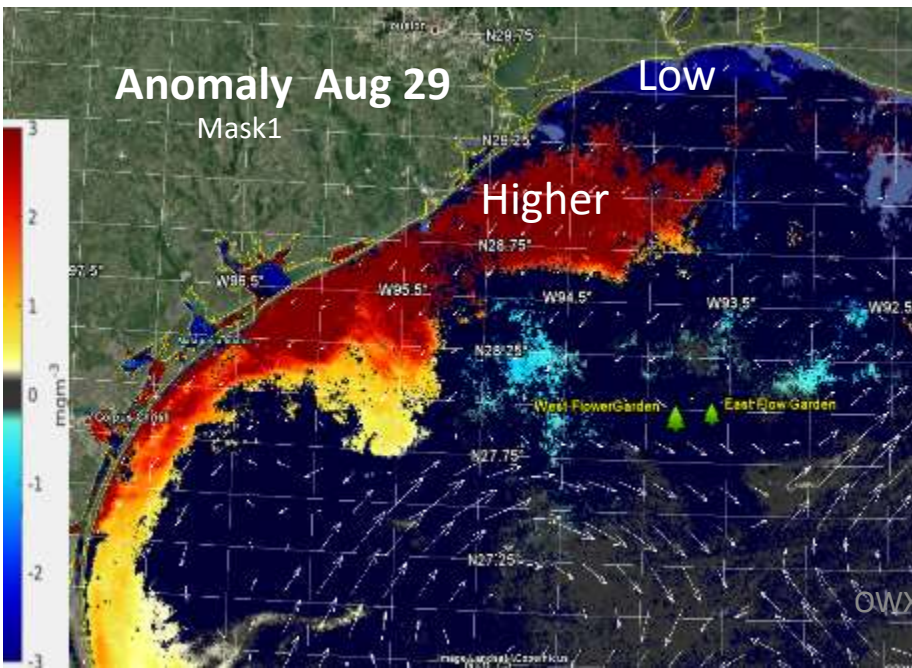
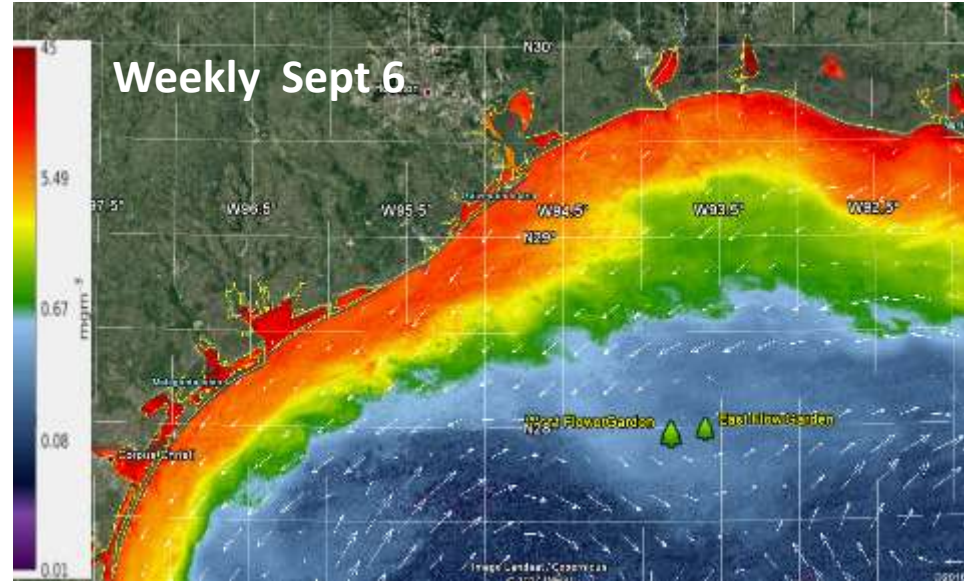
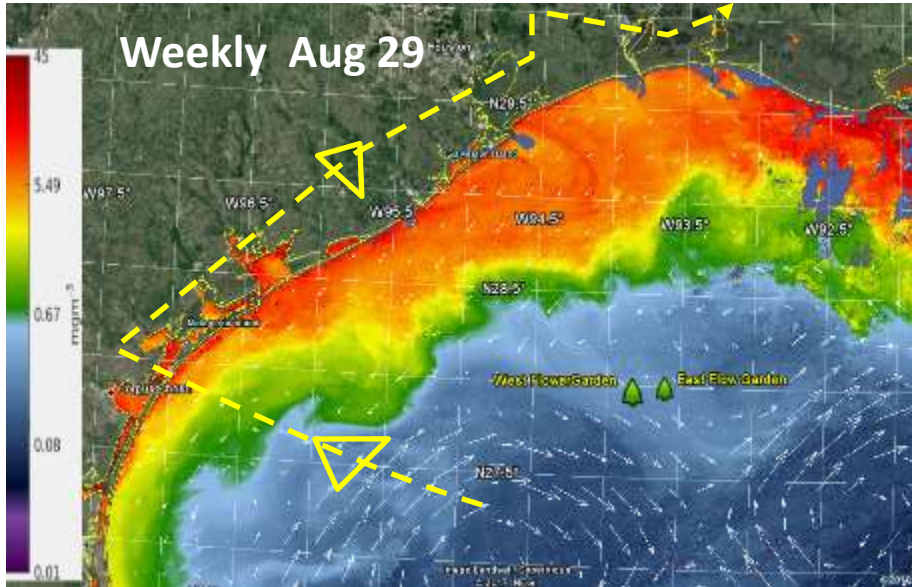


Anomaly Sept 6



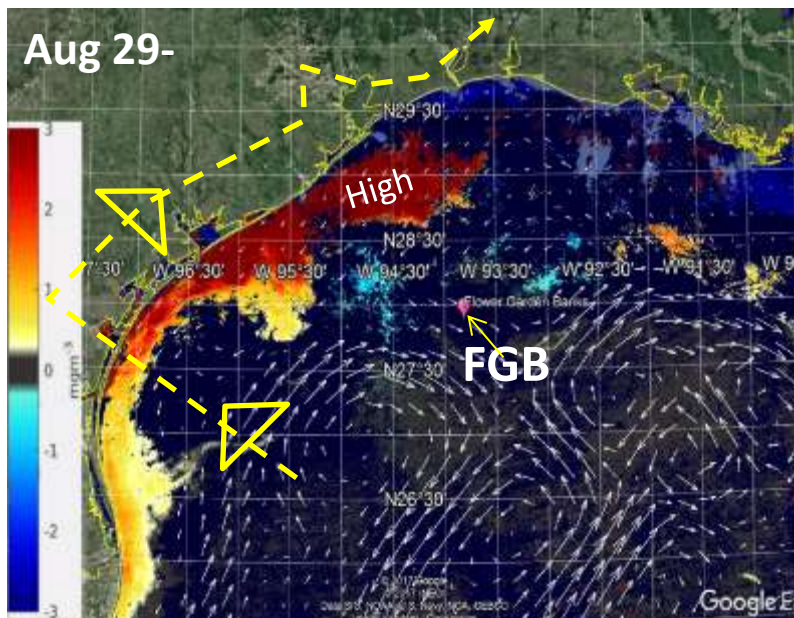
Hurricane Harvey -Houston

Chlorophyll Anomaly



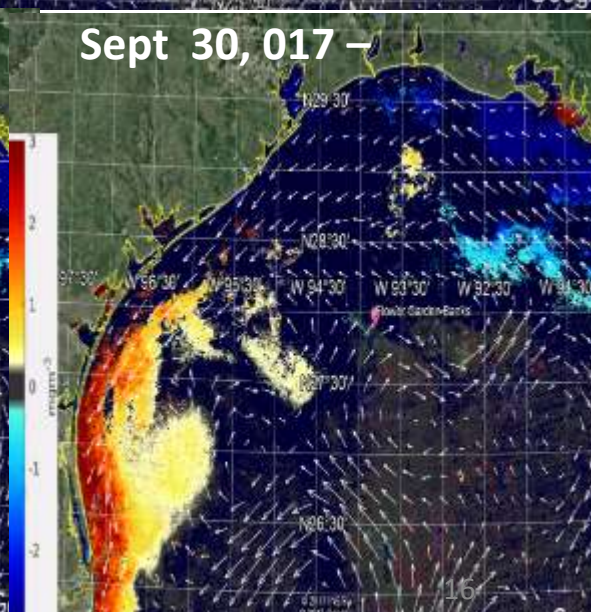
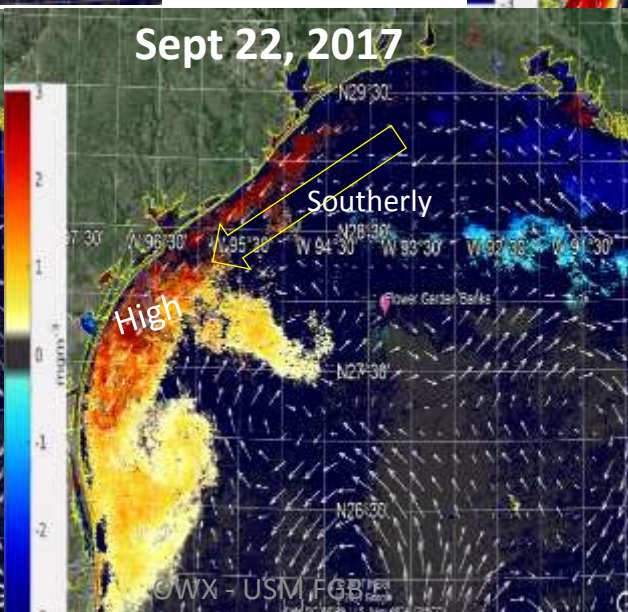
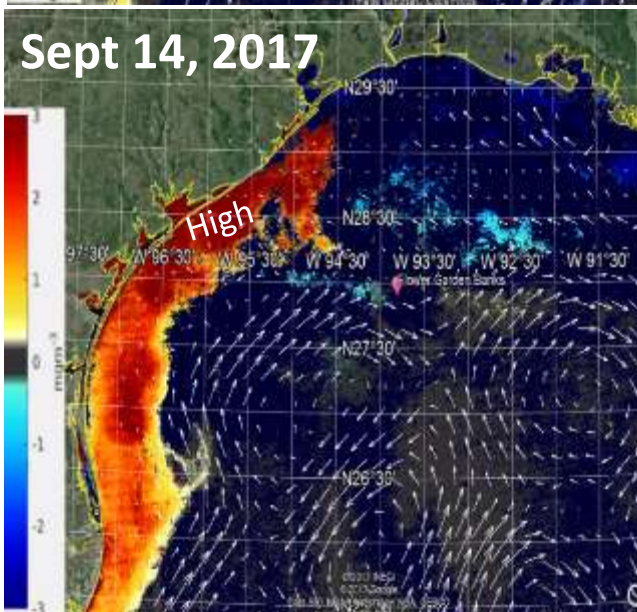
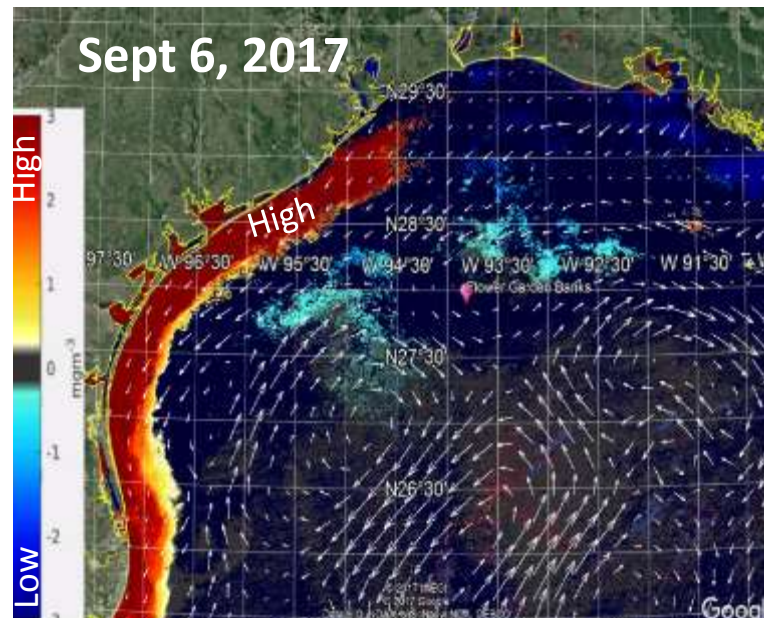
Harvey -Houston

Changes in the Chlorophyll Anomaly Following Harvey FGBV



Harvey
Chlorophyll
Anomaly

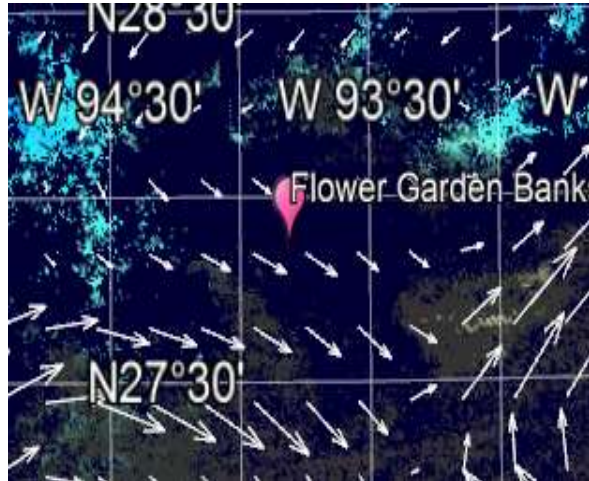
Aug 29
Sept 6
Sept 14
Sept 22
Sept 30



Hurricane Harvey - Houston

Changes in the Chlorophyll Anomaly at Flower Garden Banks

Aug 29- Mask 1

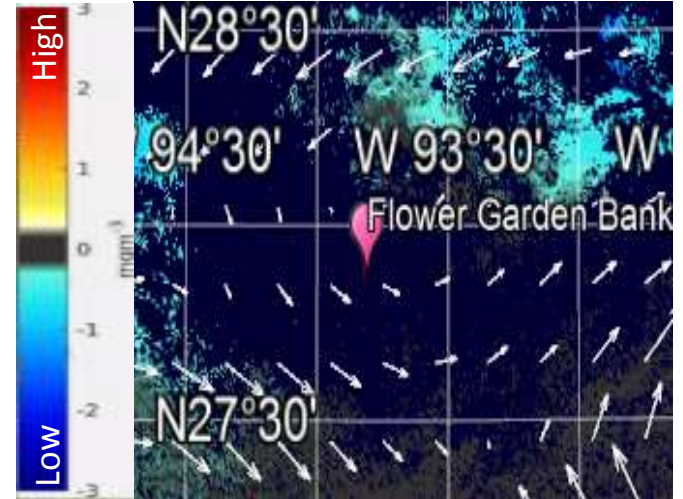


Chl Anomaly

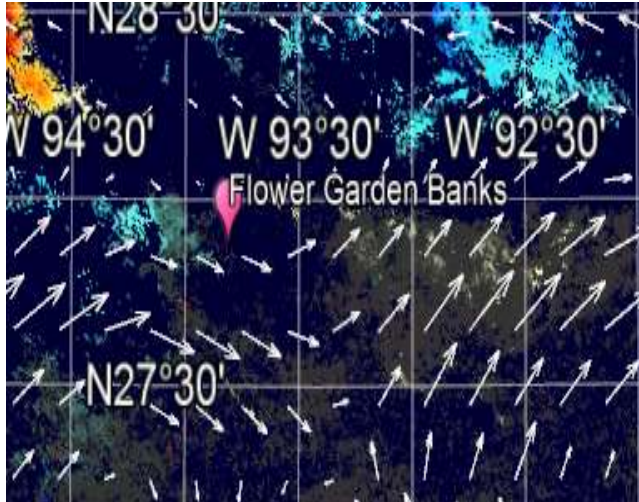
Aug 29
Sept 6
Sept 14
Sept 22
Sept 30

No Major events ?

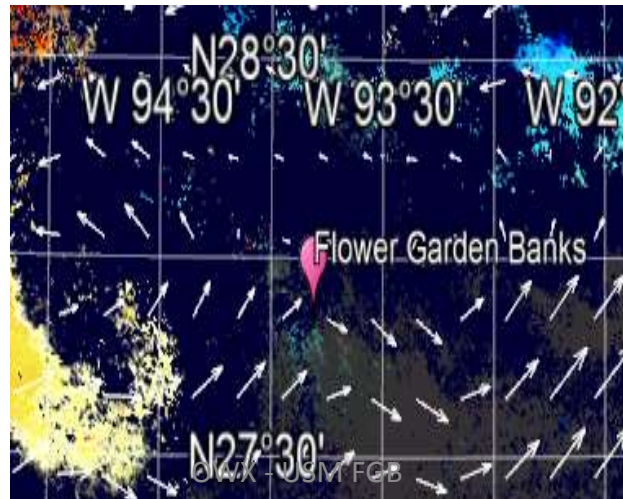
Sept 6, mask 1



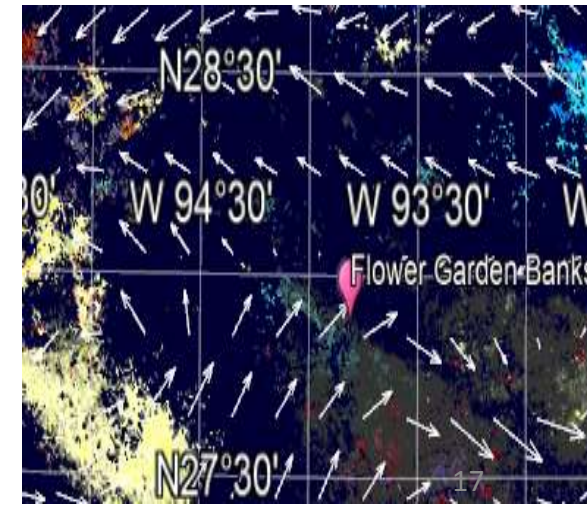
Sept 14, 2017 Mask 1



Sept 22, 2017 mask 1



Sept 30, 2017 - Mask 1



Hurricane Harvey -Houston Fresh Water input

Difference in the salinity from
America Sea Model and VIIRS salinity Algorithms

AmSeas and VIIRS - Salinity

Model does not input the hurricane fresh water directly
Uses climatology of the river inputs .
Limited affects of the Fresh water input .

VIIRS salinity not as accurate for salinity but better at anomaly ..
Salinity algorithm is based on the difference in
spectral difference in water Absorption A486– A550

Sept 6

Sept 14

Sept 22

Sept 30

Oct 8

Oct 16

Weeks following the storm

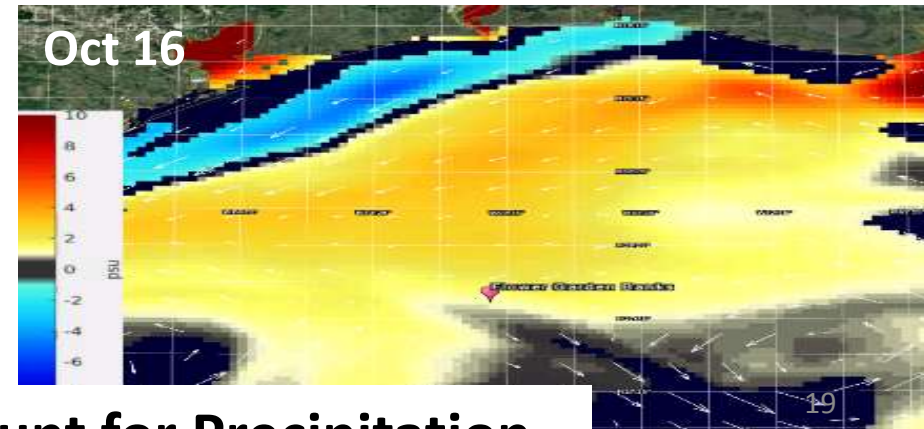
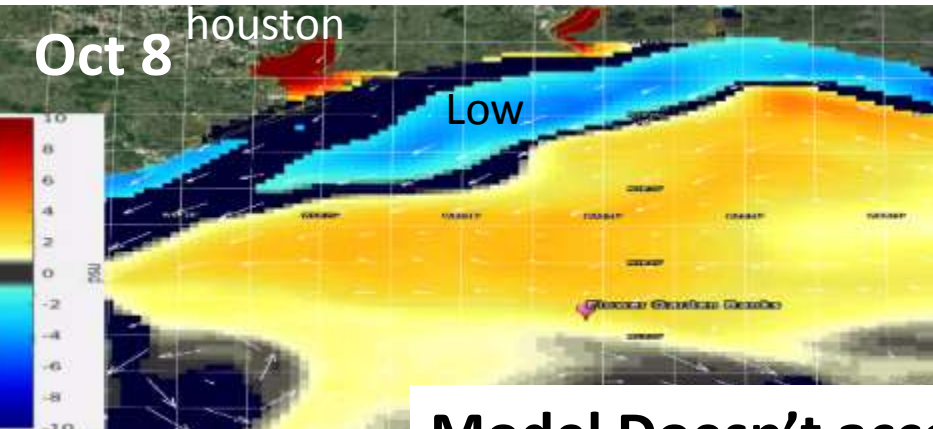
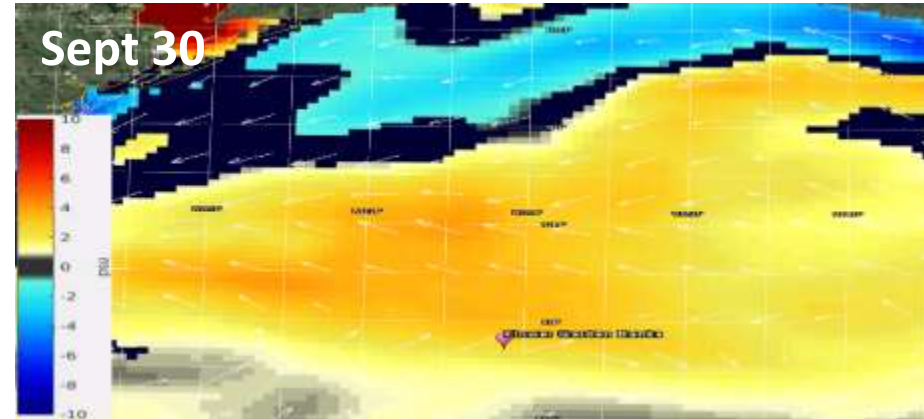
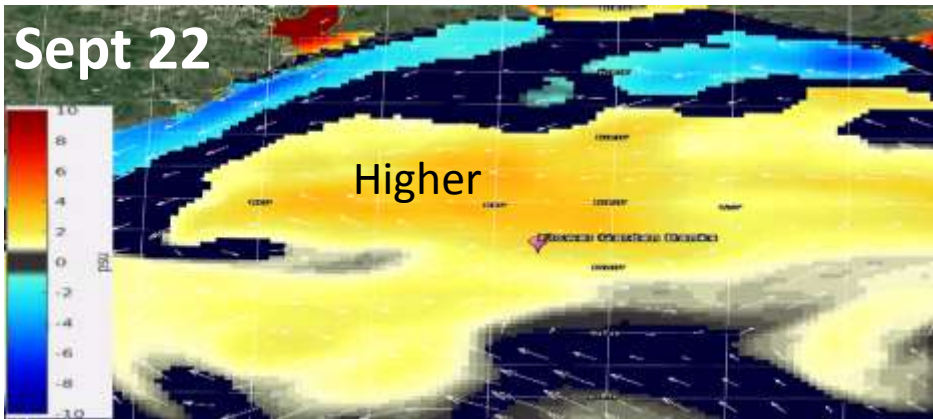
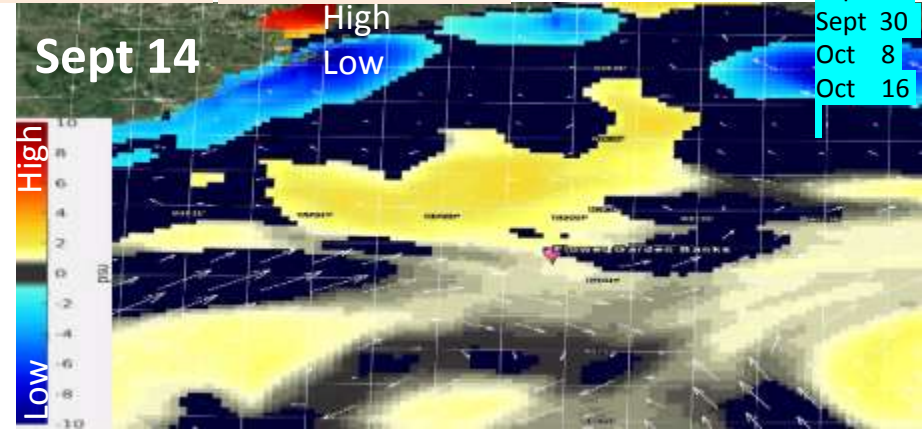
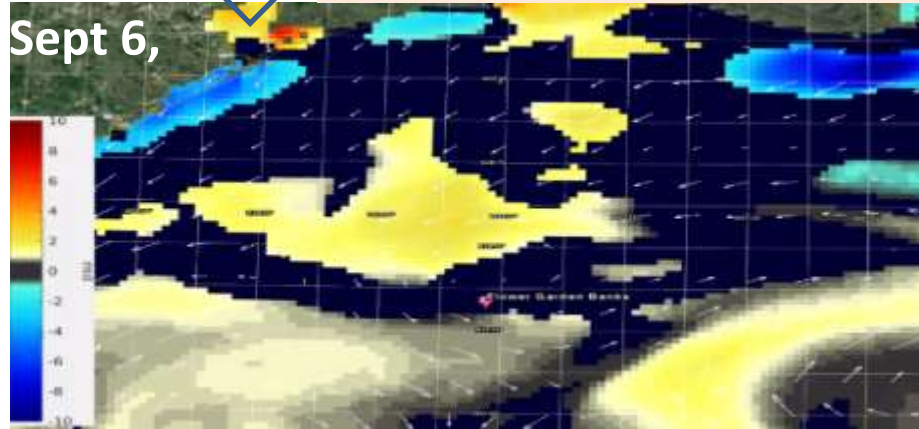
High? ↓

Model Salinity Am Seas

Anomaly

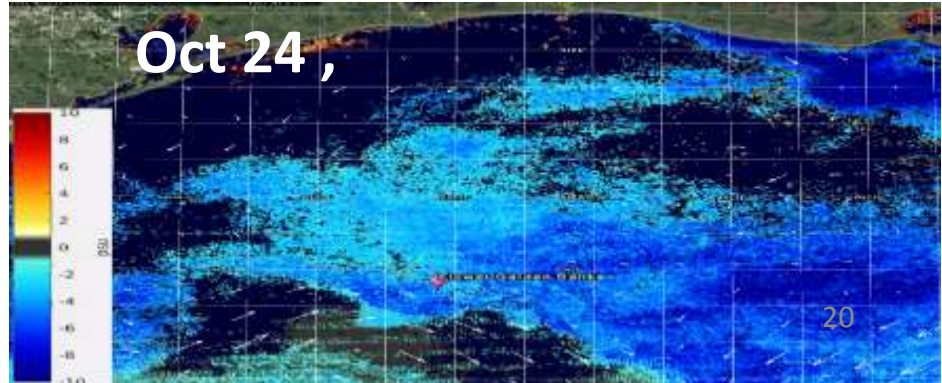
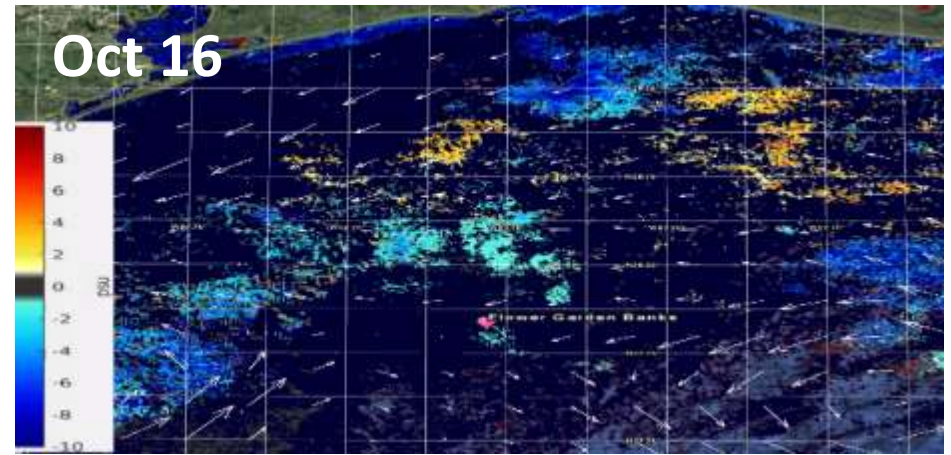
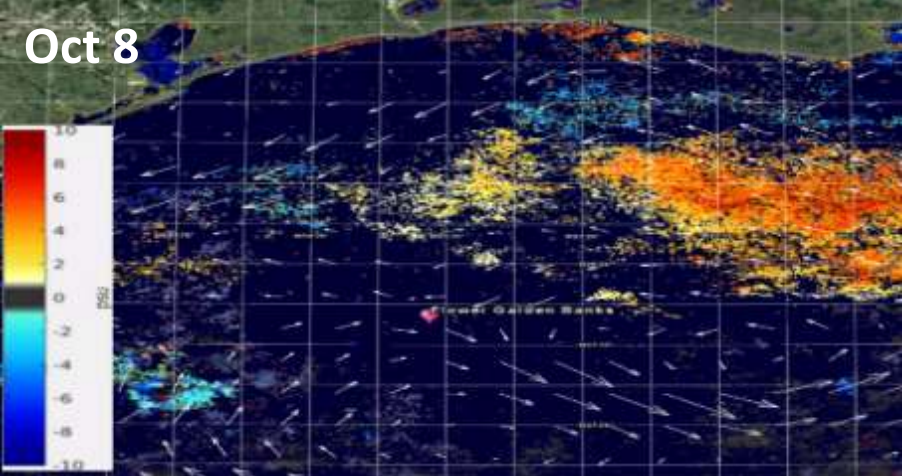
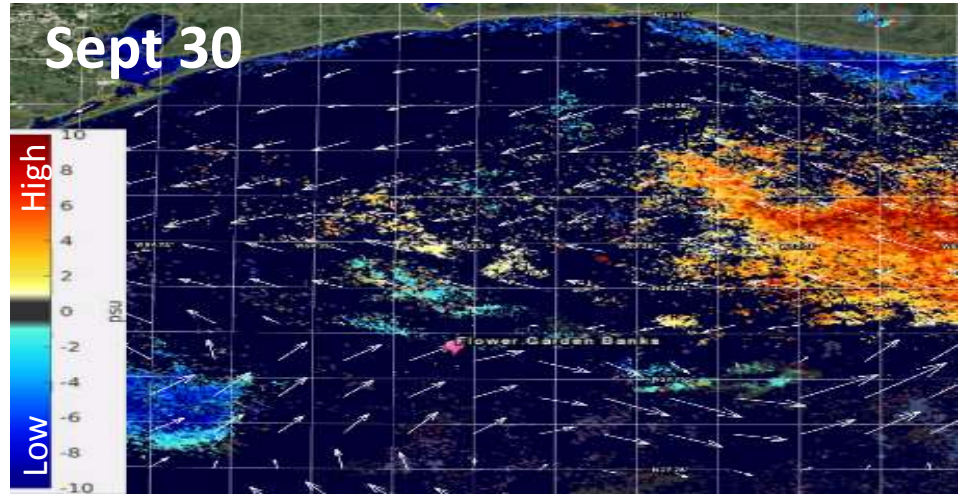
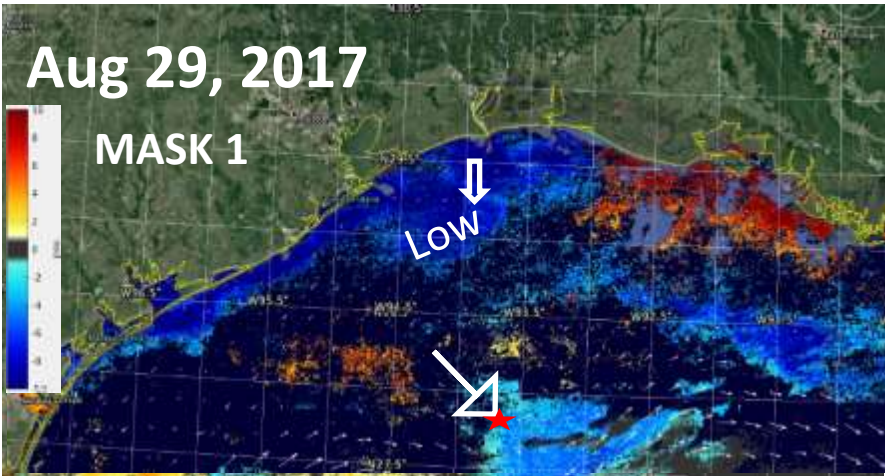
2017

- Sept 6
- Sept 14
- Sept 22
- Sept 30
- Oct 8
- Oct 16



Model Doesn't account for Precipitation

VIIRS Salinity Anomaly – Harvey



Fresh water Anomaly during Harvey –
Month Later is OK.

VIIRS salinity Algorithm –
Based Absorption 486 -555



SUMMARY

1. OWX – Nowcast of ocean conditions in Northern Gulf Integration of models, satellite and *in situ* products

- Spatial – temporal uncertainty in ocean processes.
- Applications for Adaptive Sampling.

2. Weekly Dynamic Anomaly Properties – DAP of Bio-physical Properties. Anomaly of weekly mean and 8-week mean (with 2 week lag)

[Chlorophyll, Euphotic Depth, Backscattering, Currents, Salinity, Temperature
Products are Publicly Available on Line at NOAA NCEI -

3. Events - Flower Garden Banks 2016

event occurs in early July Before was detected

Bonnie Carrie Spillway 2016

Hurricane Harvey 2017

Ability to monitor GULF Conditions Available Weekly

Data Available

Dynamic Anomaly Properties (DAP) - for Gulf of Mexico

1- DAP products – Updated Weekly

2- Real time Weekly Anomaly Imagery

USM Web page on line → <https://www.usm.edu/marine/research-owx>

3 - DAP products 2013- 2017 to Present

Provided to NOAA - [NOMADS](#) - [Online as Sept – 2017](#)

Data Online – NCDF and KML → https://ecowatch.ncddc.noaa.gov/thredds/AMSEAS_VIIRS_DAP/catalog_data.html

4- Data site is being enhanced in ERDAP

How to Access Data?

Demonstration Example: Do you have Google Earth?

GET the Euphotic Depth kmz file for July 11, 2016 - Go to

https://ecowatch.ncddc.noaa.gov/thredds/AMSEAS_VIIRS_DAP/catalog_data.html

Click → KMZ → 2016 → 07 → 07112016 → Zeu_Anomaly , Zeu_StDevMask1