

# DEVELOPMENT AND APPLICATION OF A BASINWIDE BIOPHYSICAL MODEL

Ehab Meselhe & Melissa Baustian

The Water Institute of the Gulf

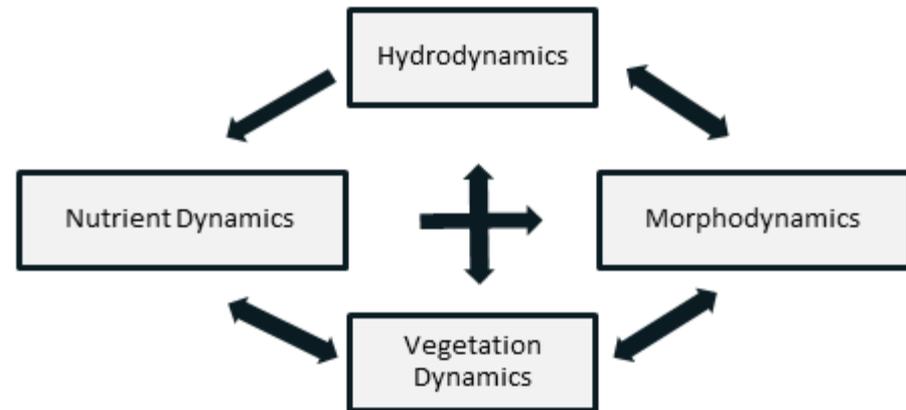


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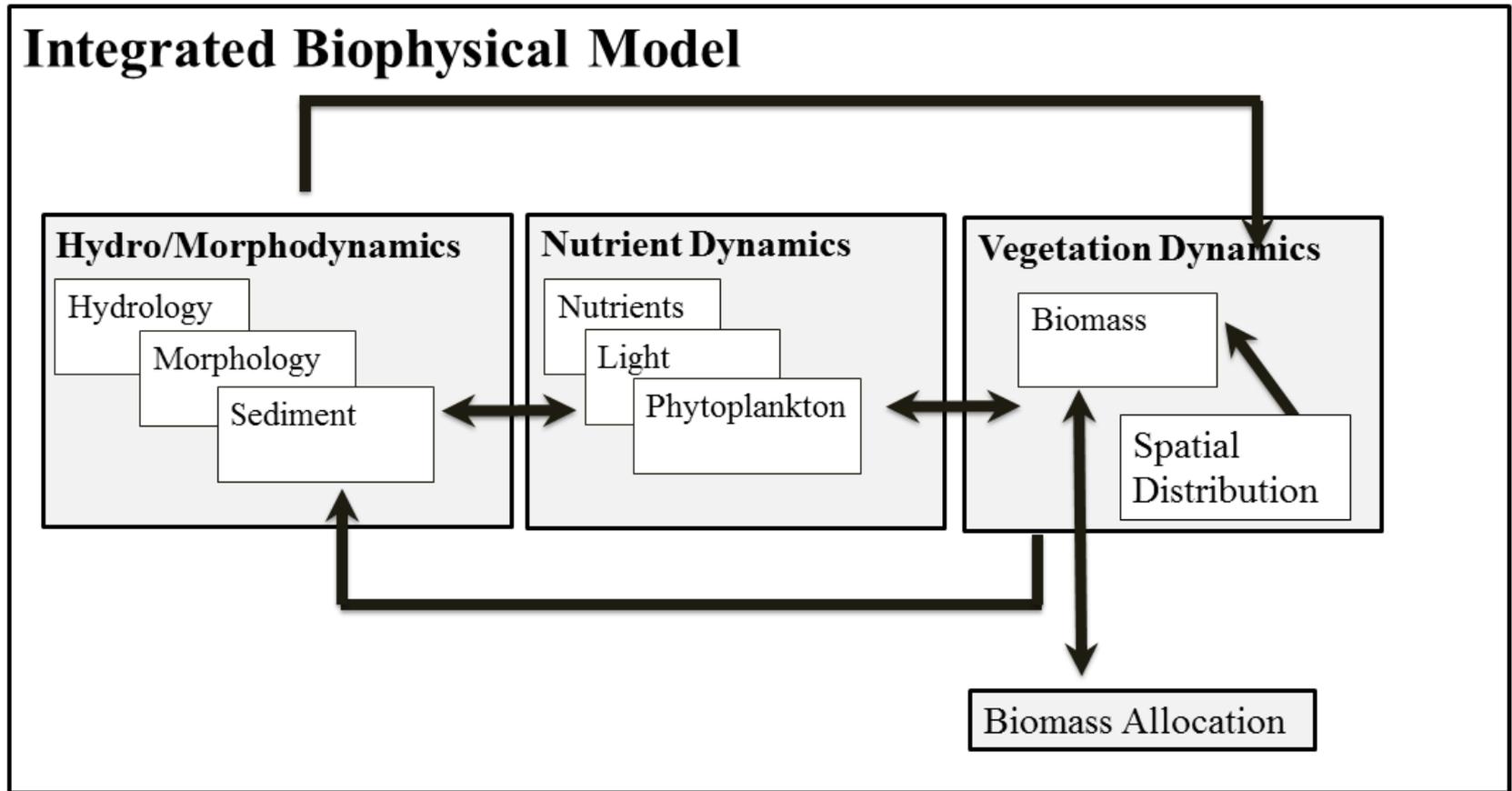


# WHY DEVELOP AN INTEGRATED ECOSYSTEM MODEL?

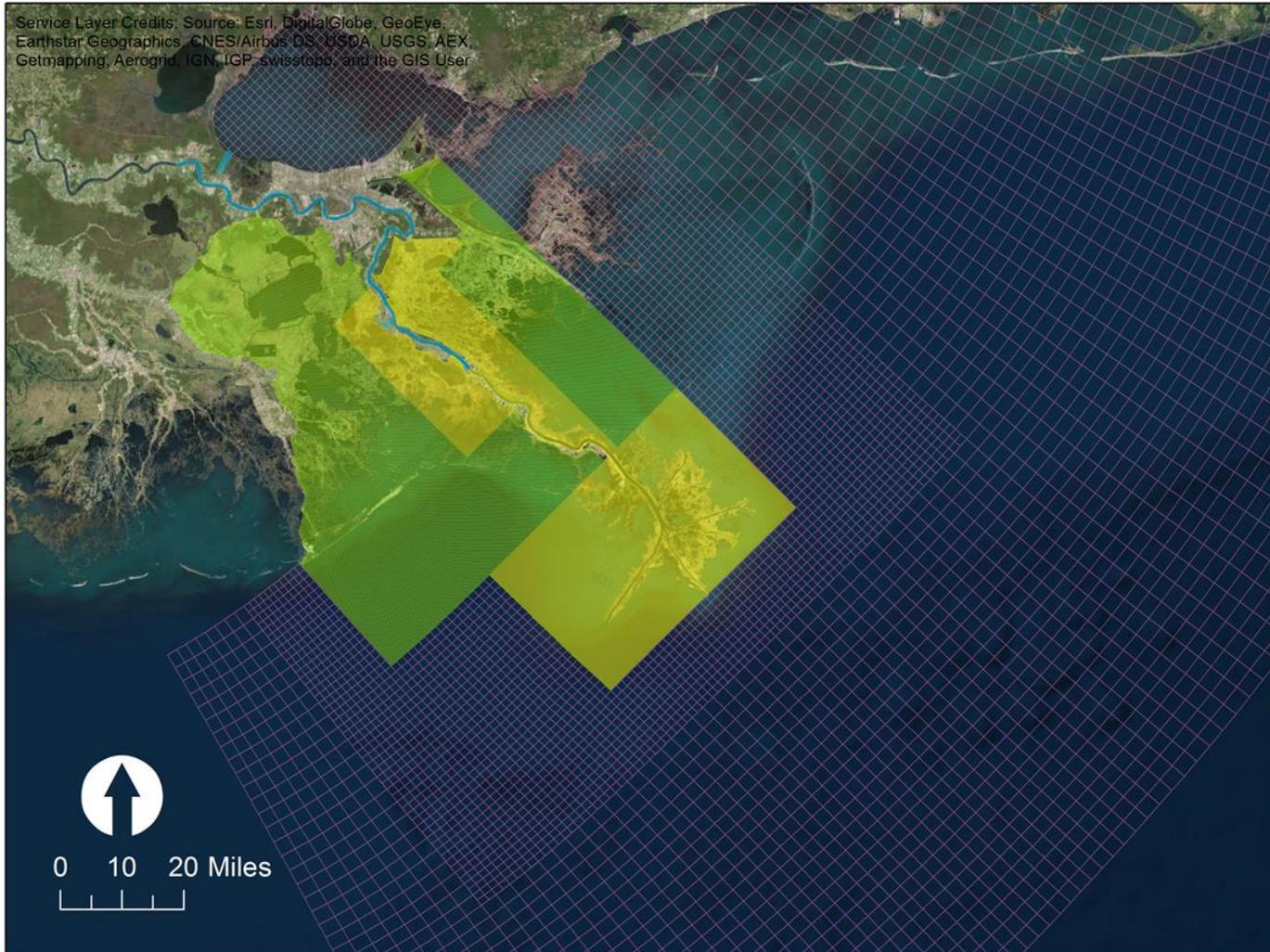
- Link ecosystem components to represent the essential processes and feedbacks in ecosystems
- Research ecosystem level responses to climate change or restoration
- Support managers and planners to inform decisions on an array of restoration projects



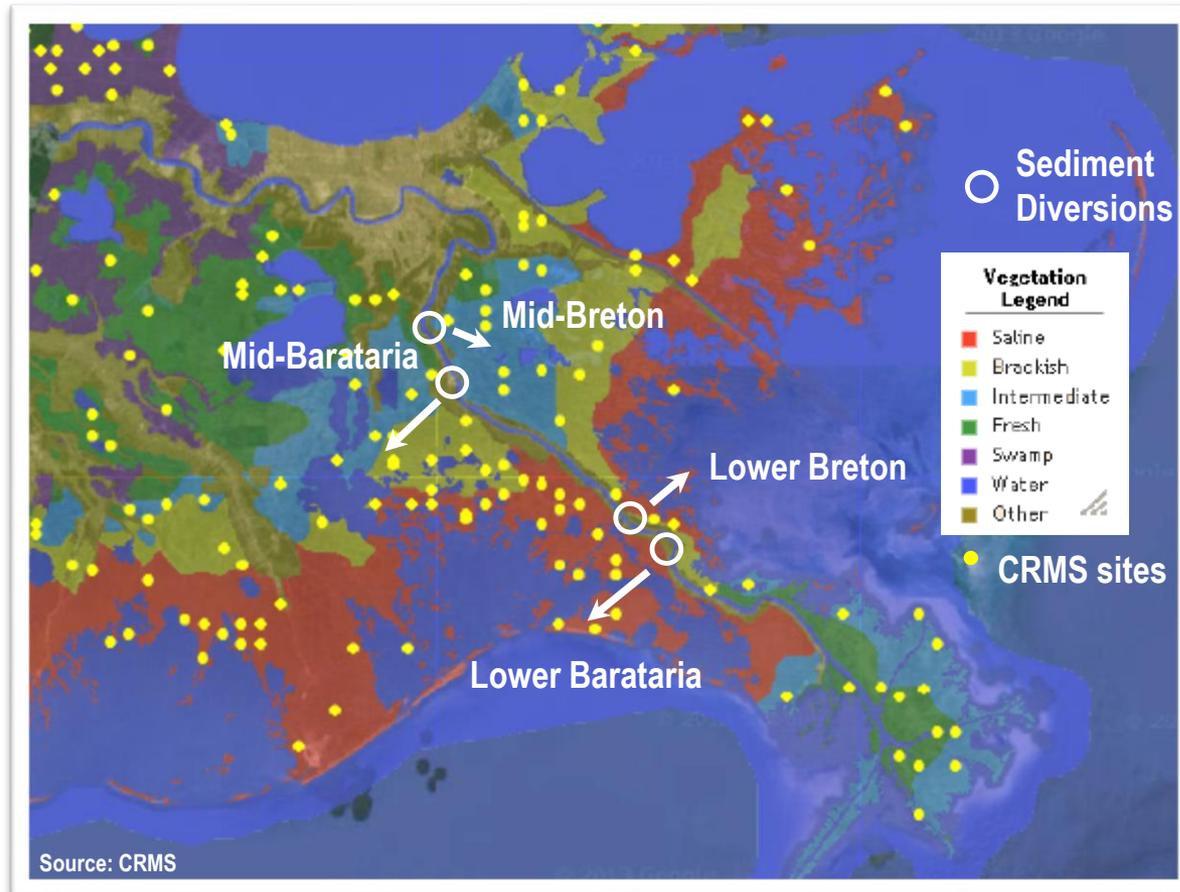
# MODEL DEVELOPMENT



# DELFT-3D MODEL: DOMAIN AND GRID DESIGN



# POTENTIAL SEDIMENT DIVERSION LOCATIONS



Likely flow conditions of four sediment diversions:

- ~35-75,000 CFS (~ 1,000-2,100 CMS)



# CERF: MAP OVERVIEW

Coastal Eco-morphological Real-time Forecasting (CERF) System (Stand alone)

File Tools Options Help

1: Forecasts  
2: Data Viewer  
3: Plot Overview  
4: Plots  
5: Data Viewer  
6: Logs  
7: Forecaster notes

8: Forecaster Help

Measured  
 Import data from OFSDE  
 Import data from SHEF  
 RRS processed data  
 Import data USGS Coastal Sites  
 Import data from GCOOS  
 Import data from CRMS  
 Forecast  
 Westbay  
 Super Regional  
 TO27  
 Boundaries  
 Structures  
 Output

4: Plots Overview  
 ACME  
 ALMO  
 ALTO  
 ANGUILLA  
 ANNAPOLIS  
 ANTOINE RVR @ ANTOINE  
 ARKABUTLA DAM  
 ARKADELPHIA  
 ARKANSAS CITY  
 ARKANSAS/PENDELTON FERRY  
 ARLINGTON  
 ASHEVILLE  
 AUGUSTA  
 Alexandria  
 B.Bartholomew/Bozels

River Discharge Adjusted Instantaneous  
 Observed Tide Instantaneous  
 Precipitation Areal Mean  
 Precipitation Areal Mean (Forecast)  
 Air Temperature Areal Mean  
 Air Temperature Areal Mean (Forecast)

Map Plots Topology Modifiers

\*\*\*\*\* ERROR, PLEASE READ BELOW !!! \*\*\*\*\*  
 07-28-2016 16:45:17 INFO - Application.Startup.Finished: The application finished starting up. (5.8s)  
 07-28-2016 16:45:17 INFO - Gui.Initialized: Graphical user interface initialized.  
 07-28-2016 16:45:15 INFO - Started FewPiSvcImp on localhost: 8100  
 07-28-2016 16:45:15 WARN - User permissions not initialized! Permission EXP will be allowed  
 07-28-2016 16:45:15 WARN - User permissions not initialized! Permission EXP will be allowed  
 07-28-2016 16:45:14 INFO - Session.Created: Stand-alone system  
 07-28-2016 16:45:14 INFO - Config.Check.Finished: Check of configuration finished.  
 07-28-2016 16:45:14 INFO - Configuration.Available: Configuration available in local filesystem.  
 07-28-2016 16:45:14 INFO - Config.Check.Finished: Check of configuration started.

6: Logs 9: Run Info 7: Forecaster notes

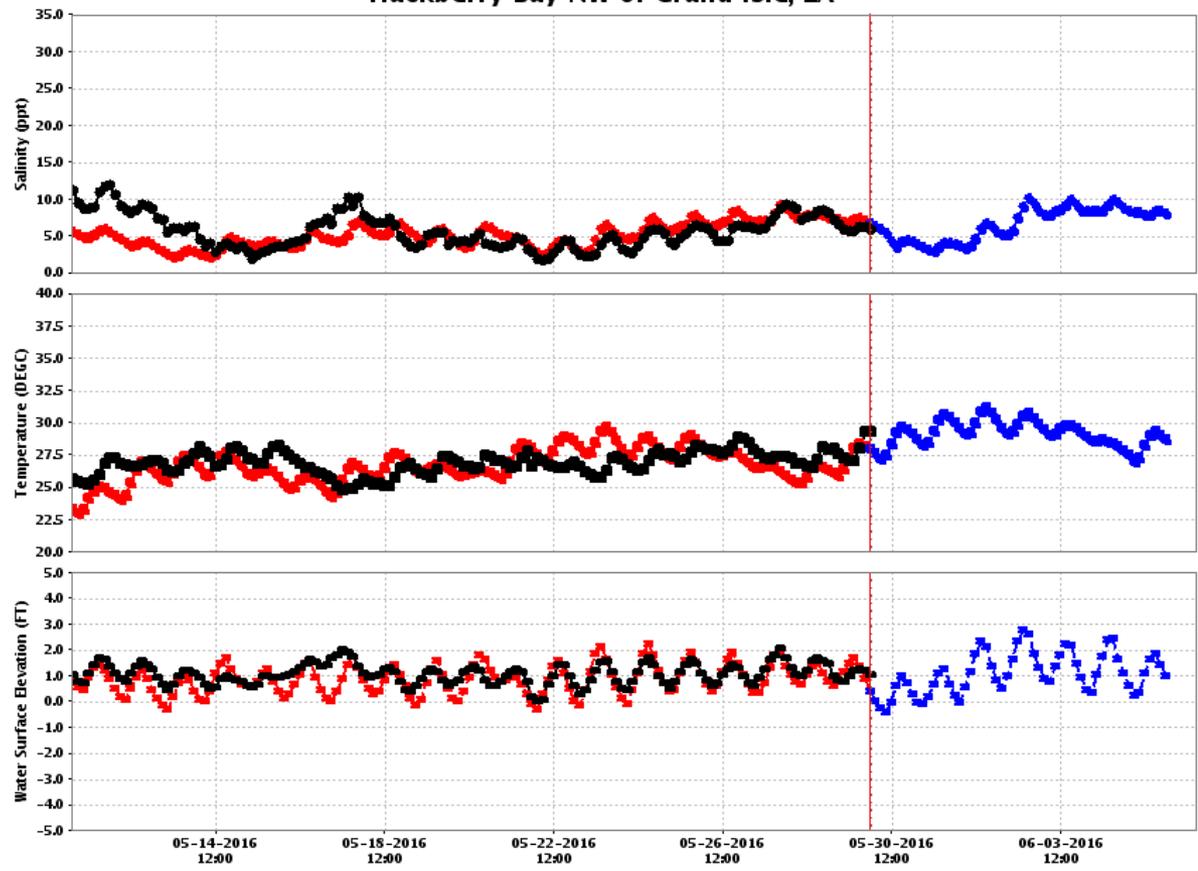
Francesca Messina Current system time:07-26-2016 00:00 GMT 16:48:06 GMT 11:48:06 CDT Stand alone -91.986 , 29.858 0.0 MB/s 150 MB

# CERF: MODEL OUTPUT

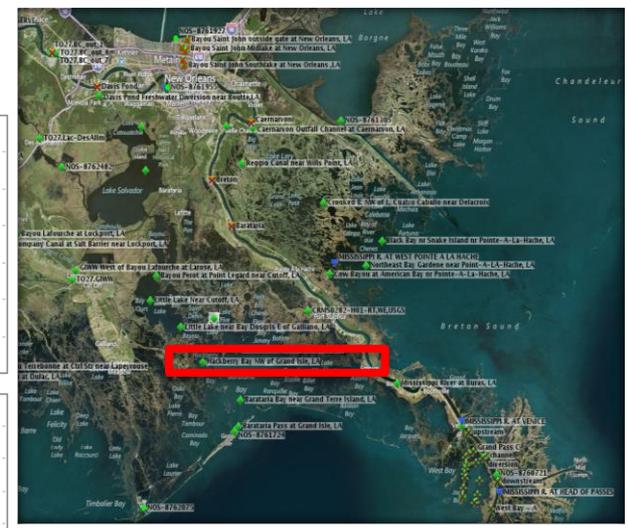
The screenshot displays the CERF software interface. At the top, there is a menu bar (File, Tools, Options, Help) and a toolbar with various icons. On the left side, a 'Data Viewer' panel shows a tree structure of data sources, including 'CEGAPS', 'Measured', and 'Forecast'. Below this is a 'Plot Overview' section with a list of data series and a legend. The main area is a map of the Gulf of Mexico region, showing a color-coded salinity forecast. The map includes labels for cities like Baton Rouge, New Orleans, and Mobile, as well as major water bodies and rivers. A scale bar is visible at the bottom of the map. At the bottom of the interface, there is a status bar with a timeline, navigation buttons (Plots, Topology, Modified, Spatial Data, Database Viewer, Manual Forecast), and a 'Logs' section displaying system information and workflow completion messages.

# MODEL OUTPUT TIMESERIES

### Hackberry Bay NW of Grand Isle, LA



Delft3D\_TO27\_V2\_Hindcast: [1] 05-30-2016 00:00:00 GMT Current Delft3D\_TO27\_V2\_Forecast: [2] 05-30-2016 00:00:00 GMT Current



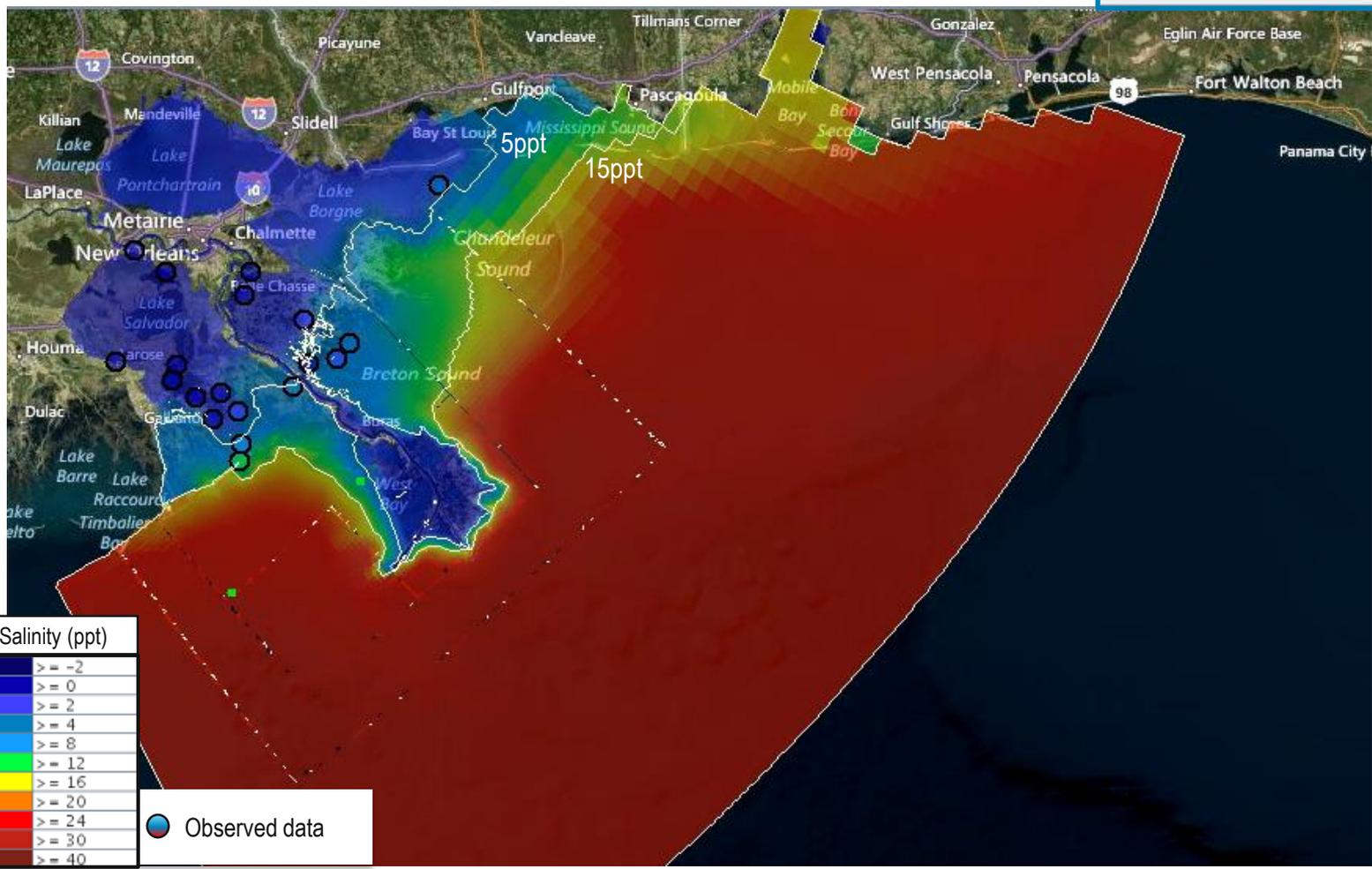
- hindcast
- forecast
- measured



# SALINITY ANIMATION: CURRENT FORECAST

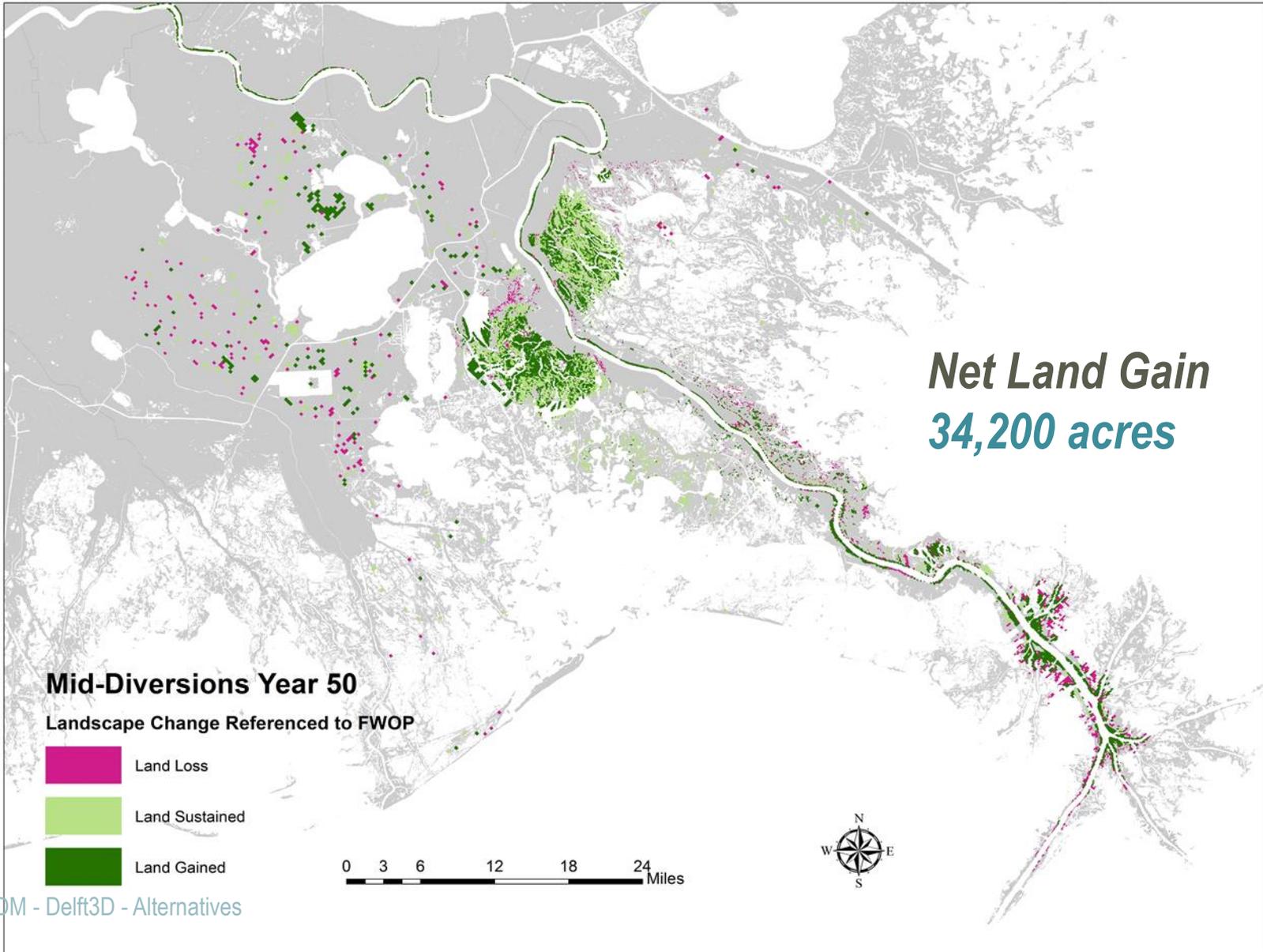
08-21-2016 03:00:00 GMT

Forecast



# LAND CHANGE BY YEAR 2070

## MID DIVERSIONS

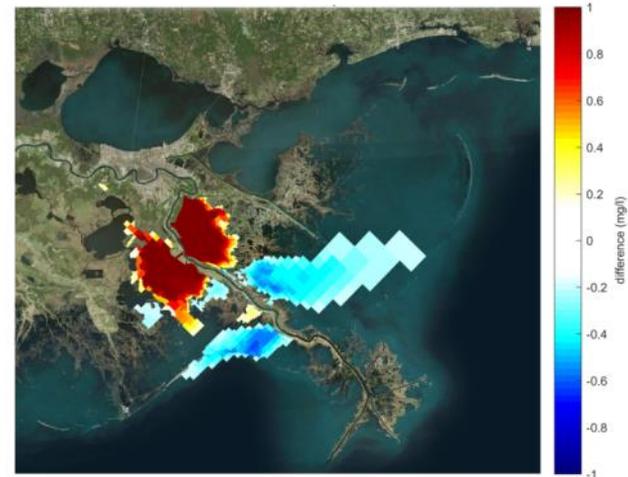
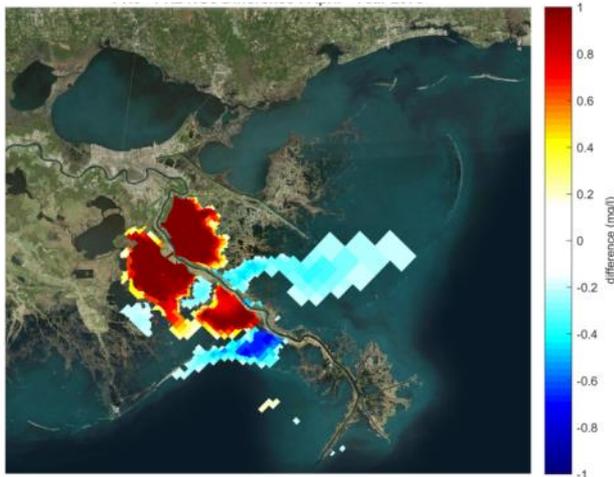


# NITRATE: YEAR 2070

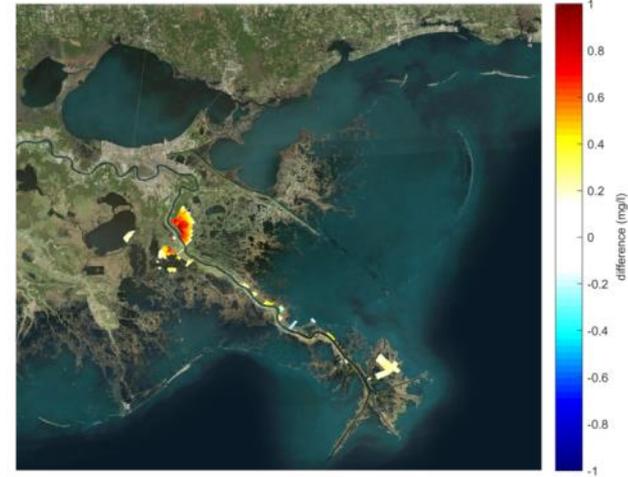
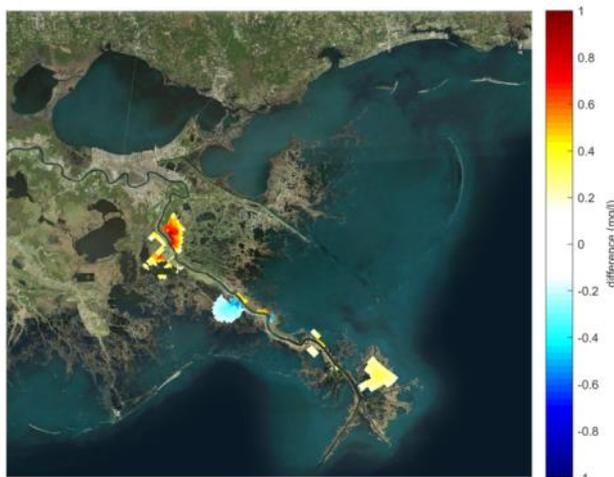
All Diversions – FWOP

Mid Diversions – FWOP

April



October

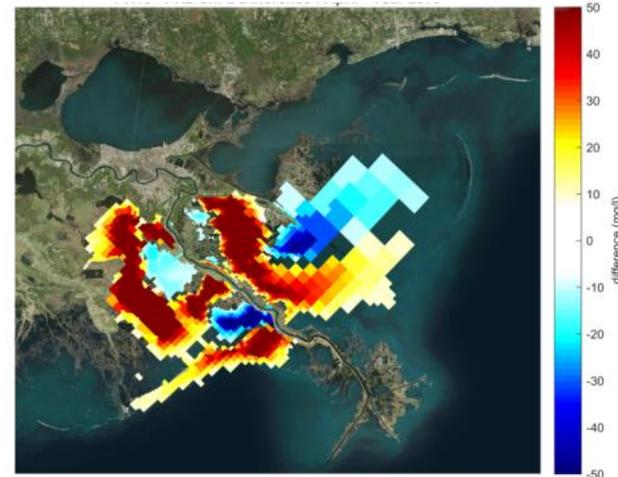
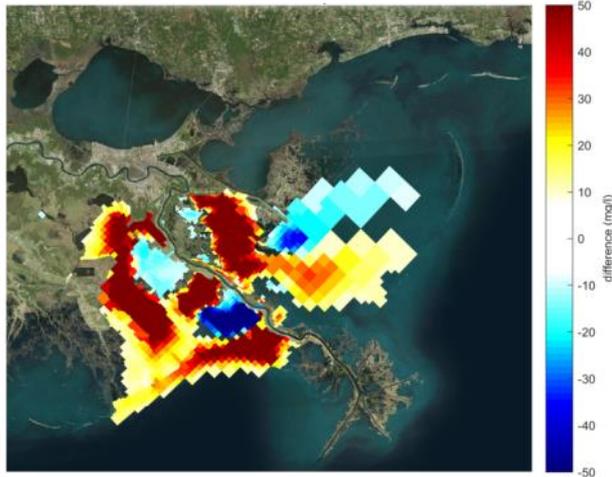


# CHLOROPHYLL A : YEAR 2070

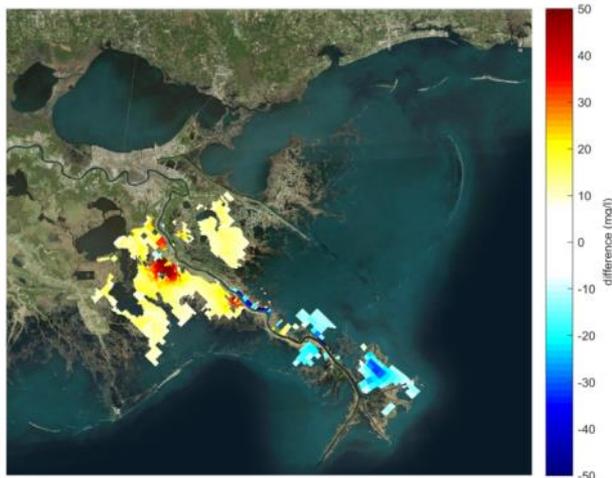
All Diversions –FWOP

Mid Diversions – FWOP

April



October



# YEAR 2070 ANIMATIONS

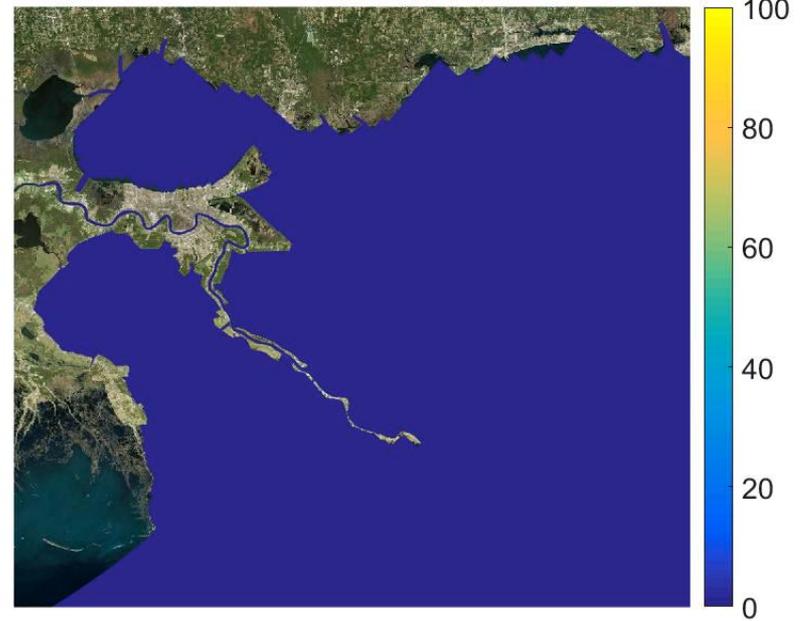
## TSS

TSS 01-Jan-2070 00:00:00



## CHL A

Chl-a 01-Jan-2070 00:00:00



# SEDIMENT DIVERSIONS AND COASTAL HYPOXIA

- Key questions:
  - What is the expected role of proposed sediment diversions in reducing nutrient loading to the Gulf?
    - Uncertainty on how significant sediment diversions will be in reducing nutrient loading.
    - Scientific community needs to help via:
      - Modeling, monitoring and laboratory experiments.



# SEDIMENT DIVERSIONS AND COASTAL HYPOXIA

- Key questions:
  - What is the importance of hypoxia monitoring to assessing the expected benefit of proposed sediment diversions?
    - Very important for assessing the nutrient reduction goal of the MS River watershed and for calibrating and validating models.
    - Example: Need data (flow, salinity, nutrients, etc) of the 8 Barataria passes
    - Need consistent and continual monitoring of coastal hypoxia on continental shelf



# MODELING OF SEDIMENT DIVERSIONS AND HYPOXIA

- Limitations:
  - Data availability for parameterization, baselines, calibration, and validation;
    - Need better estimates of the estuarine and coastal margin processes (e.g., denitrification) during sediment diversion conditions (nutrient and sediment rich freshwater)
    - More collaborations among researchers to help with the models



# MODELING OF SEDIMENT DIVERSIONS AND HYPOXIA

- Limitations:
  - Availability of (and linkage to) spatial hydrodynamic and landscape evolution models.
    - We currently developed an integrated biophysical model that already links hydrodynamics, morphology, vegetation and nutrient dynamics
    - We are about to start a new project with researchers, K. Rose and D. Justic to link models from the MS River watershed to the coastal basins (with proposed sediment diversions) to the continental shelf



# MODELING OF SEDIMENT DIVERSIONS AND HYPOXIA

- Limitations:
  - Predictive understanding of the magnitude of nutrient loading to be reduced by proposed sediment diversions
    - We need to work on this! Scientific community needs to join forces and work on field, laboratory and modeling tasks to help better understand!



# MODELING OF SEDIMENT DIVERSIONS AND HYPOXIA

- Uncertainties on the near-field and far-field effects:
  - Need to investigate the combined effects of nutrients, turbidity, temperature and salinity that proposed sediment diversions will produce on the ecosystem
    - Especially, prior, during, and after operation of diversions
  - Near field: estuarine open water and wetland habitats
  - Far field: coastal waters of continental shelf where hypoxia is observed



# CONCLUSIONS

- Extensive land loss and need for restoration
- One restoration strategy: large-scale sediment diversions to build land
- Estuarine dynamics will be significantly altered, including hydrology, morphology, nutrients, and vegetation
- Restoration at this scale requires research to decrease the uncertainties and understand the potential consequences





# PROJECT SUPPORT

Model development was funded by the Coastal Protection and Restoration Authority under Task Order 27.1.





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**THANK YOU**

 @TheH2OInstitute

301 NORTH MAIN STREET, SUITE 2000  
BATON ROUGE, LA 70825

(225) 448-2813  
**WWW.THEWATERINSTITUTE.ORG**

