Numerical Modeling Analysis of the Katrina Cut Rubble Mound Structure

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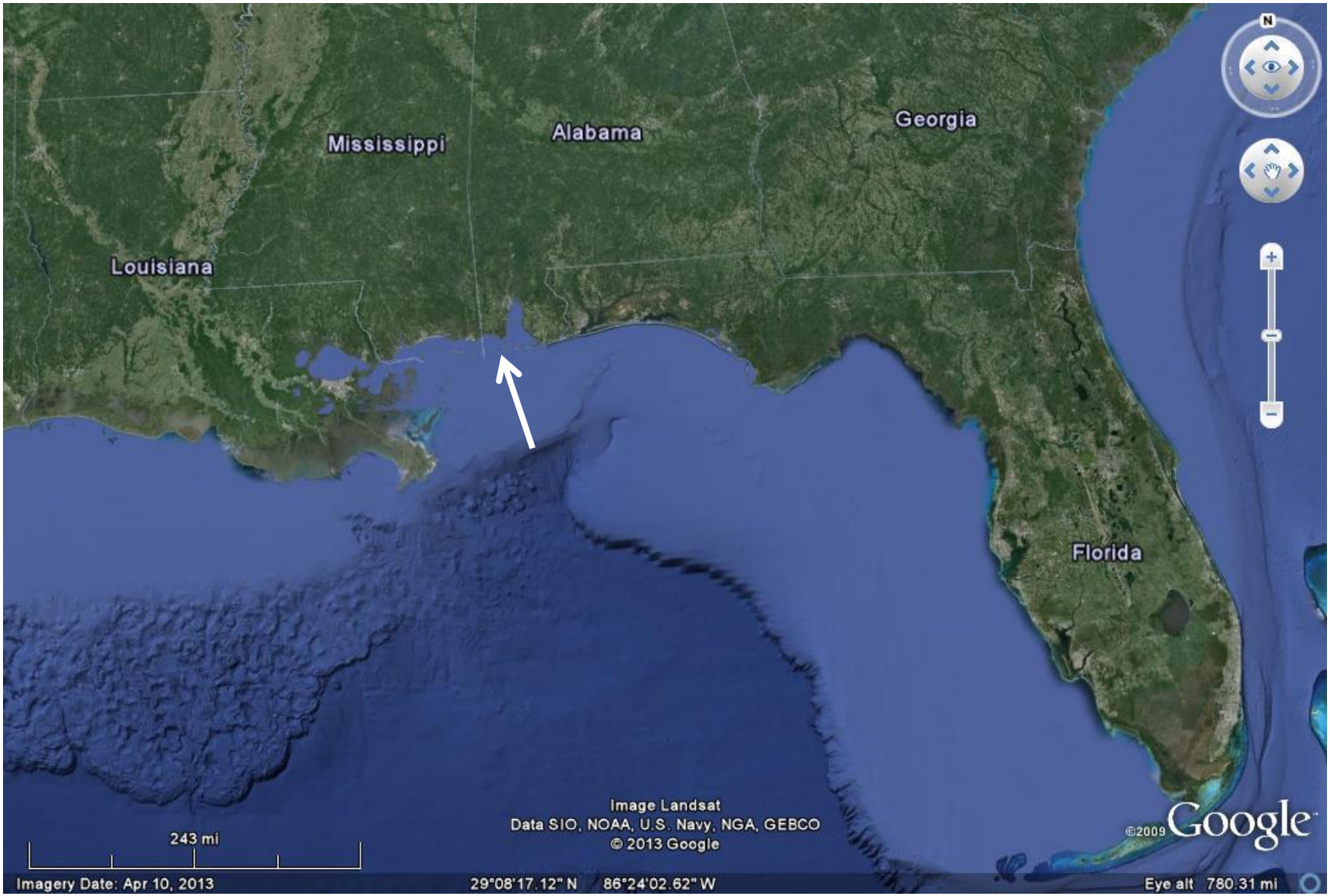
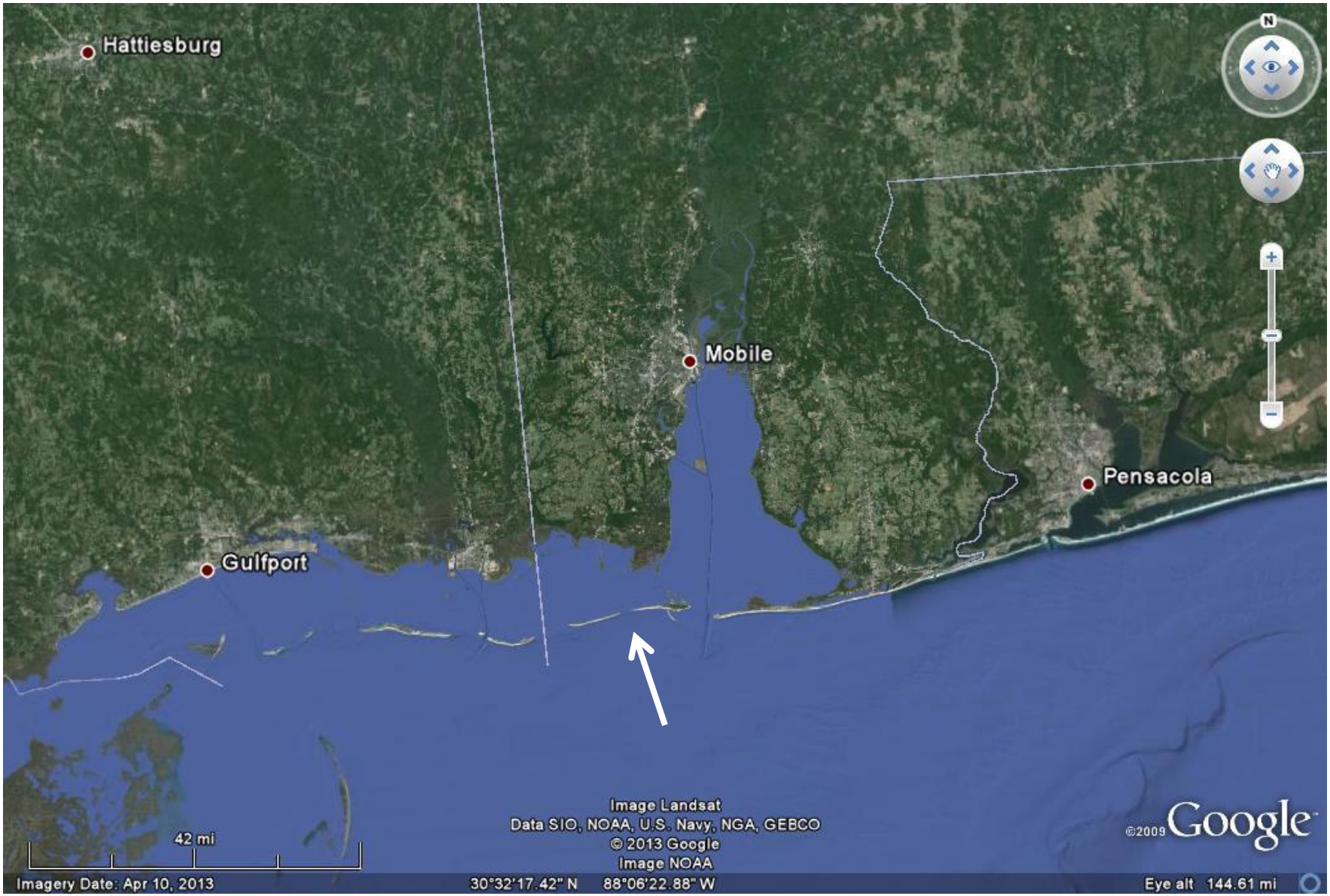
Outline

- Project Location
- History of Breaching
- Katrina Cut
- Emergency Structure
- Risk Assessment and Modeling
  - Calibration
  - Inputs
  - Results
- Summary

Project Location

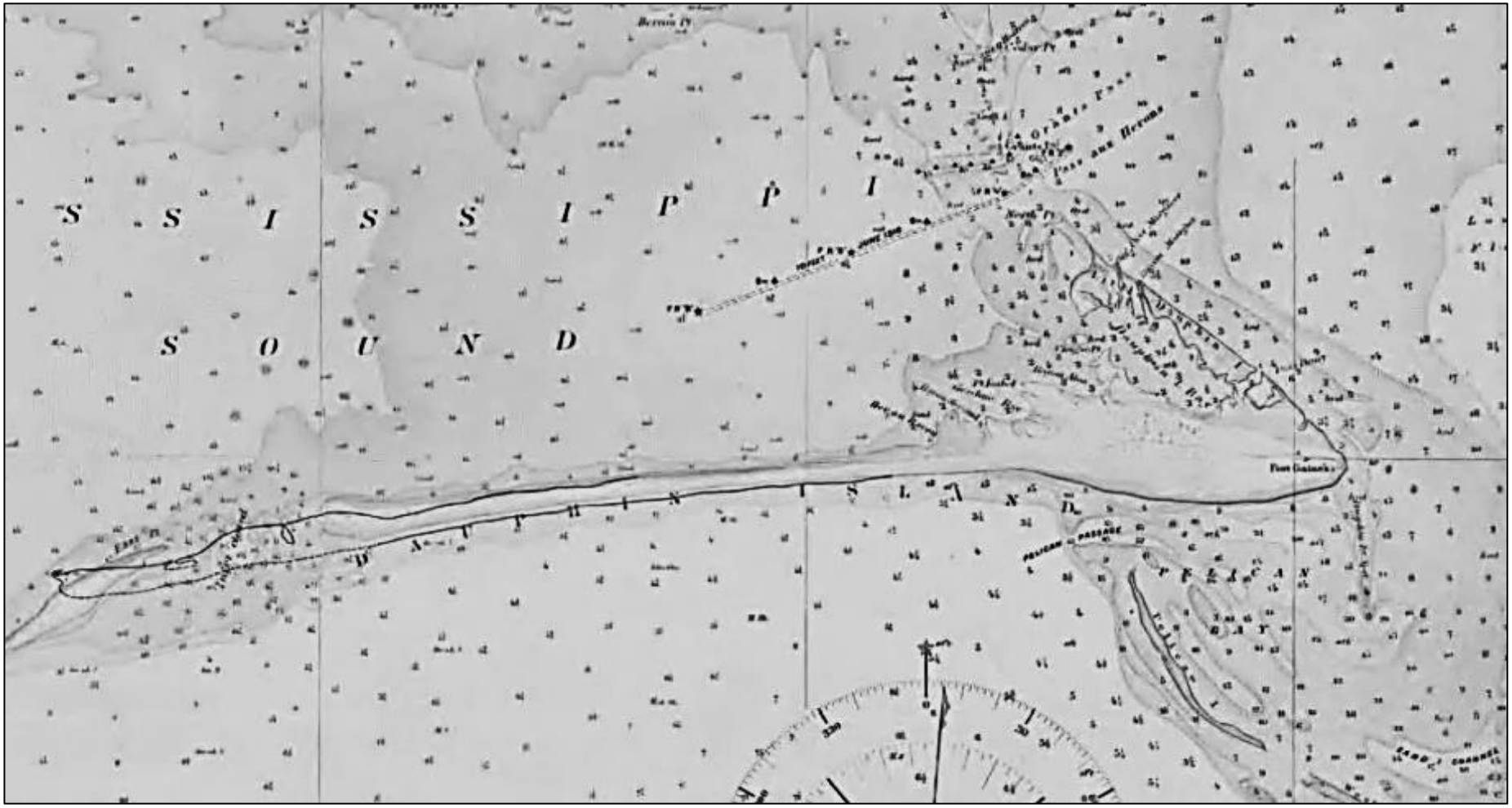


Project Location




Mississippi Sound
193
Mobile Bay
Dauphin Island
Katrina Cut
Pelican Island
Petit Bois Island

History of Dauphin Island Breaching

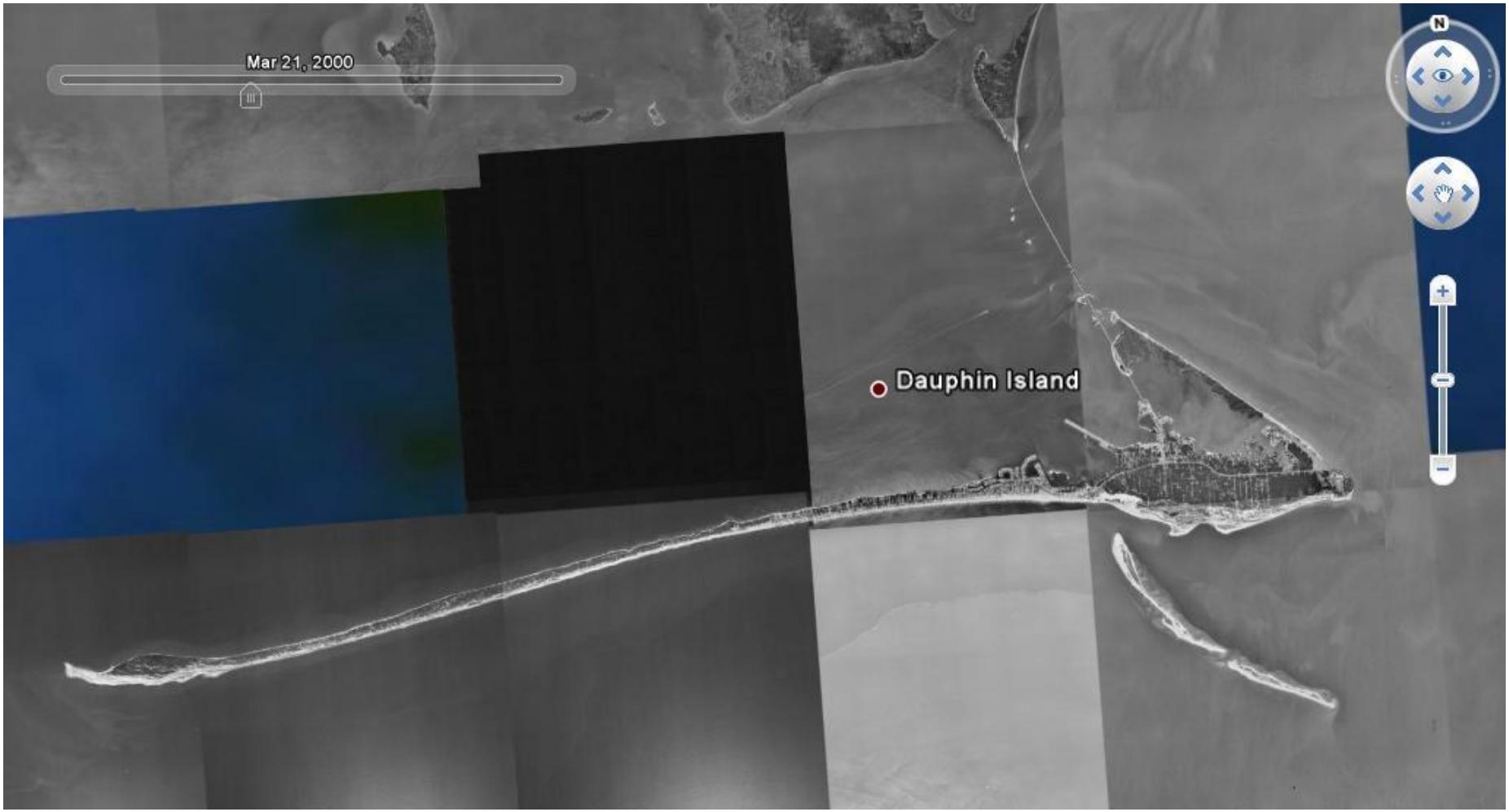


1917

1925

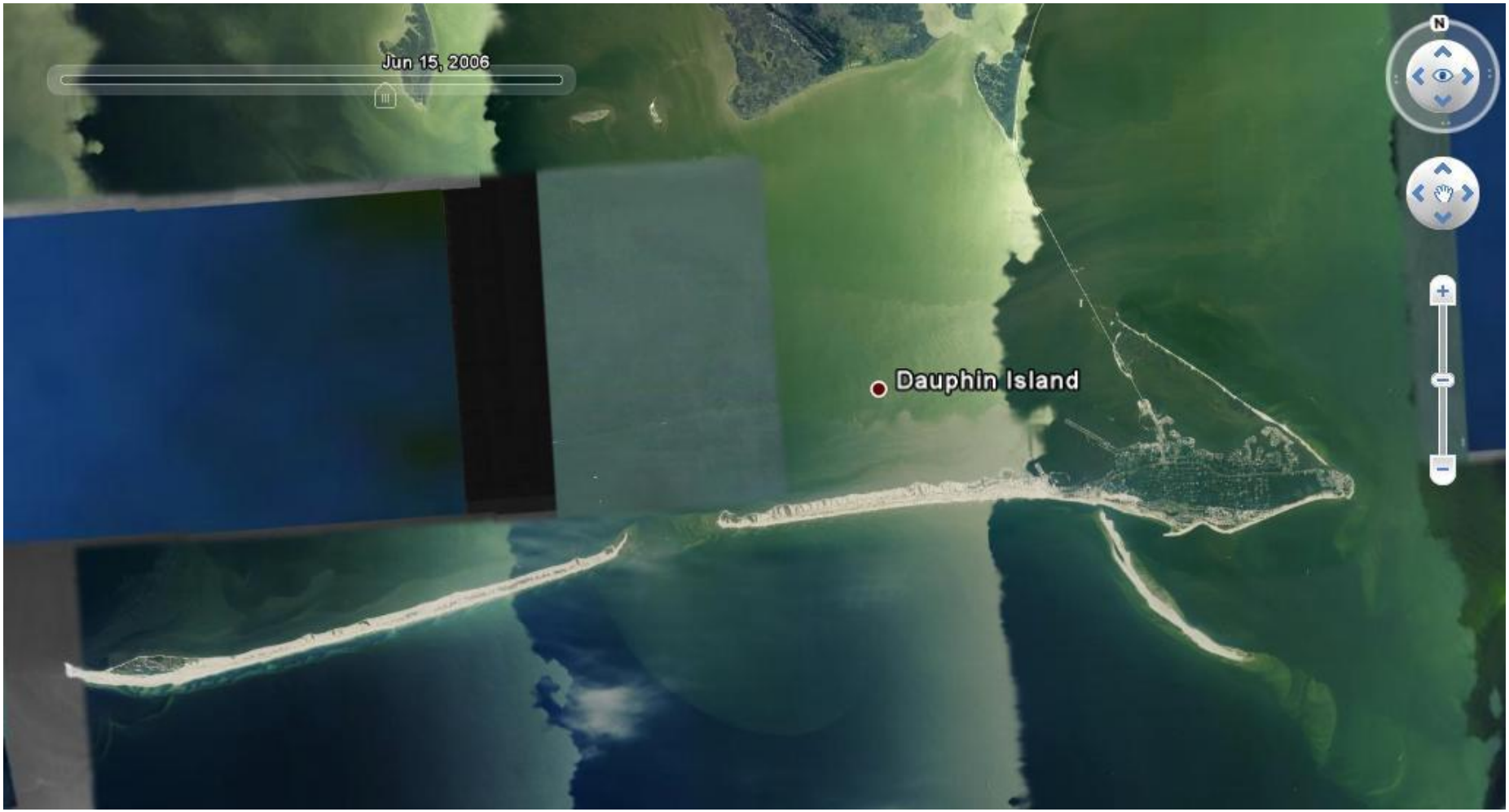
1940

February 1992



March 2000

May 2005



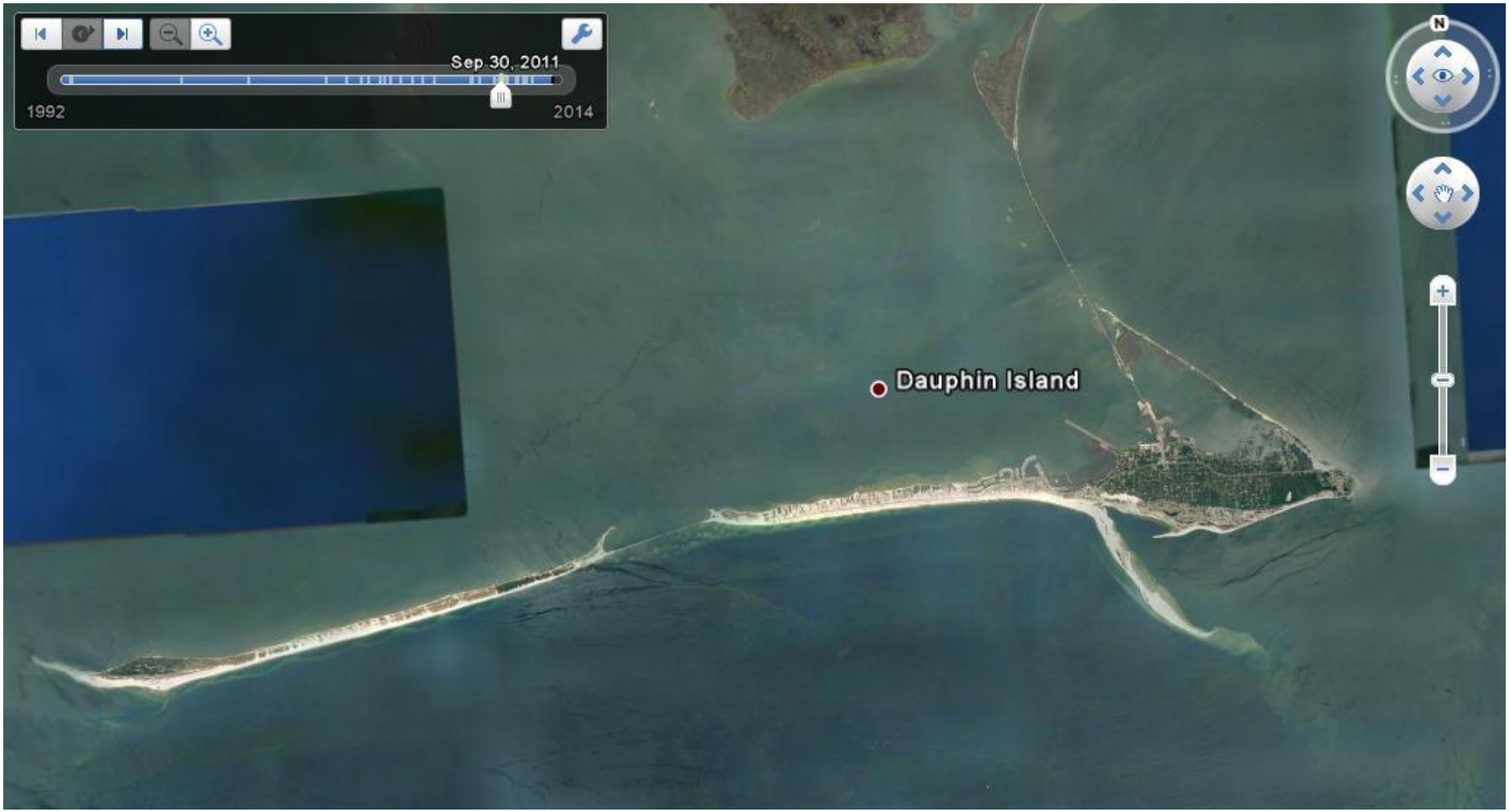
June 2006

February 2008

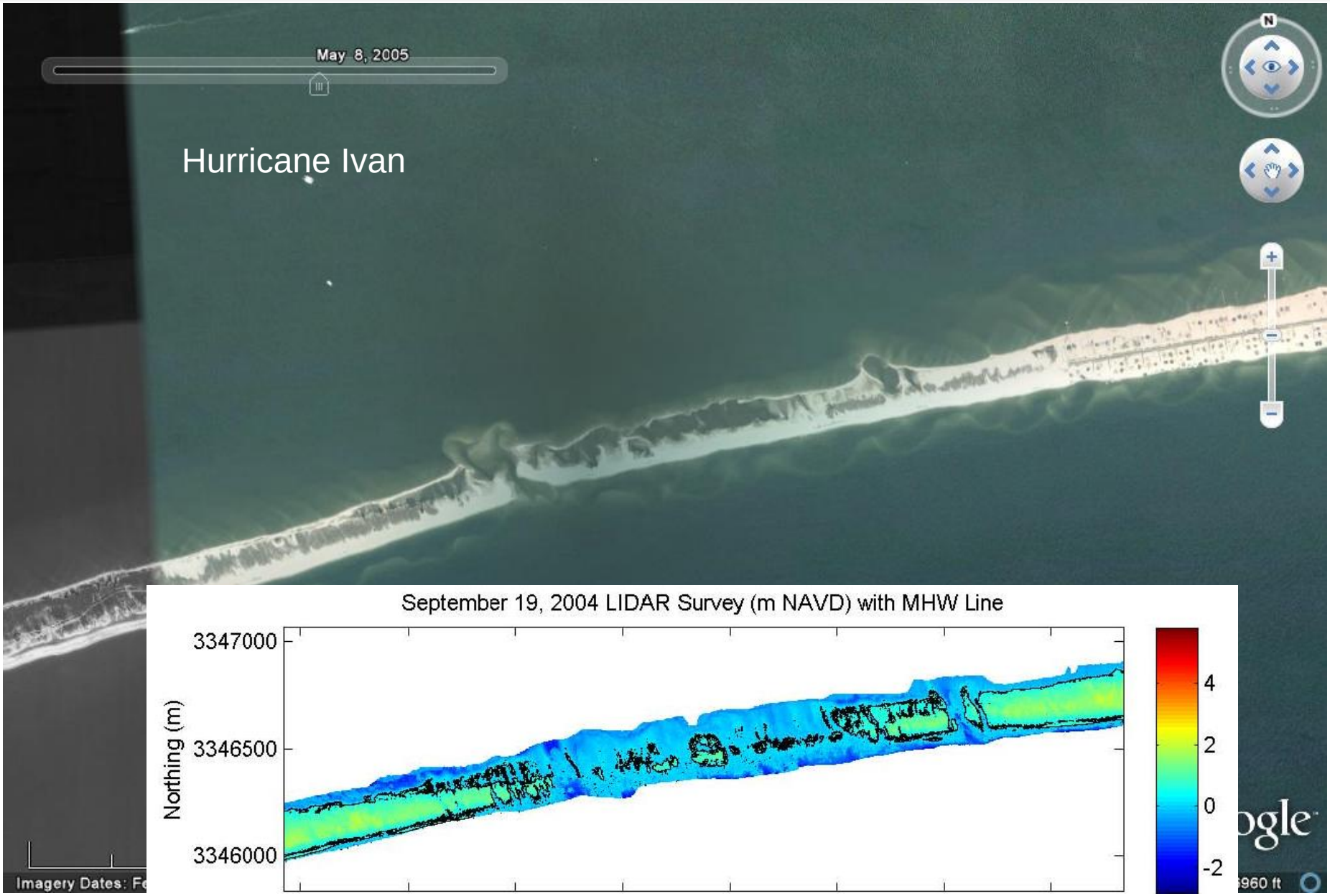
History of Dauphin Island Breaching

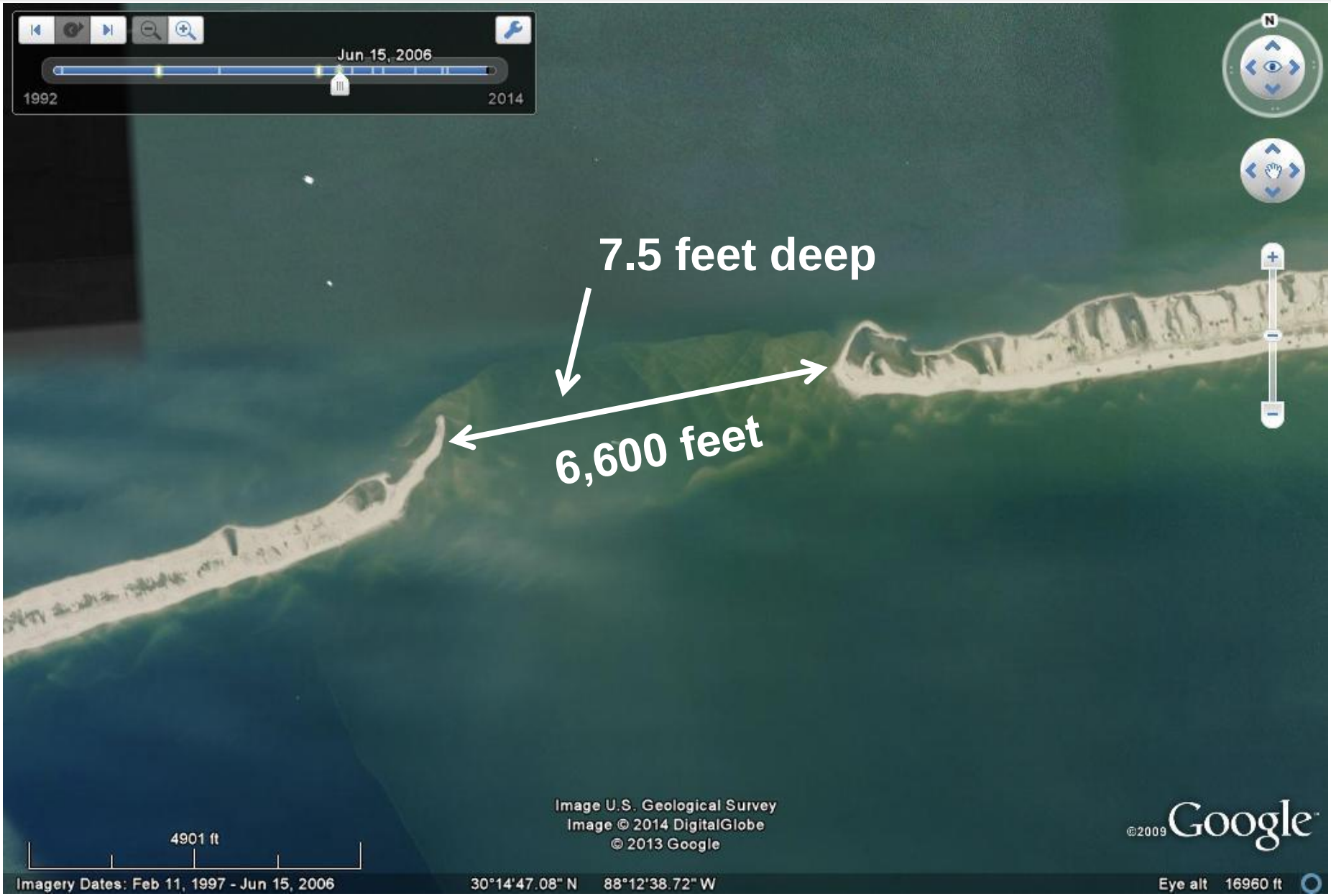
May 2010

History of Dauphin Island Breaching

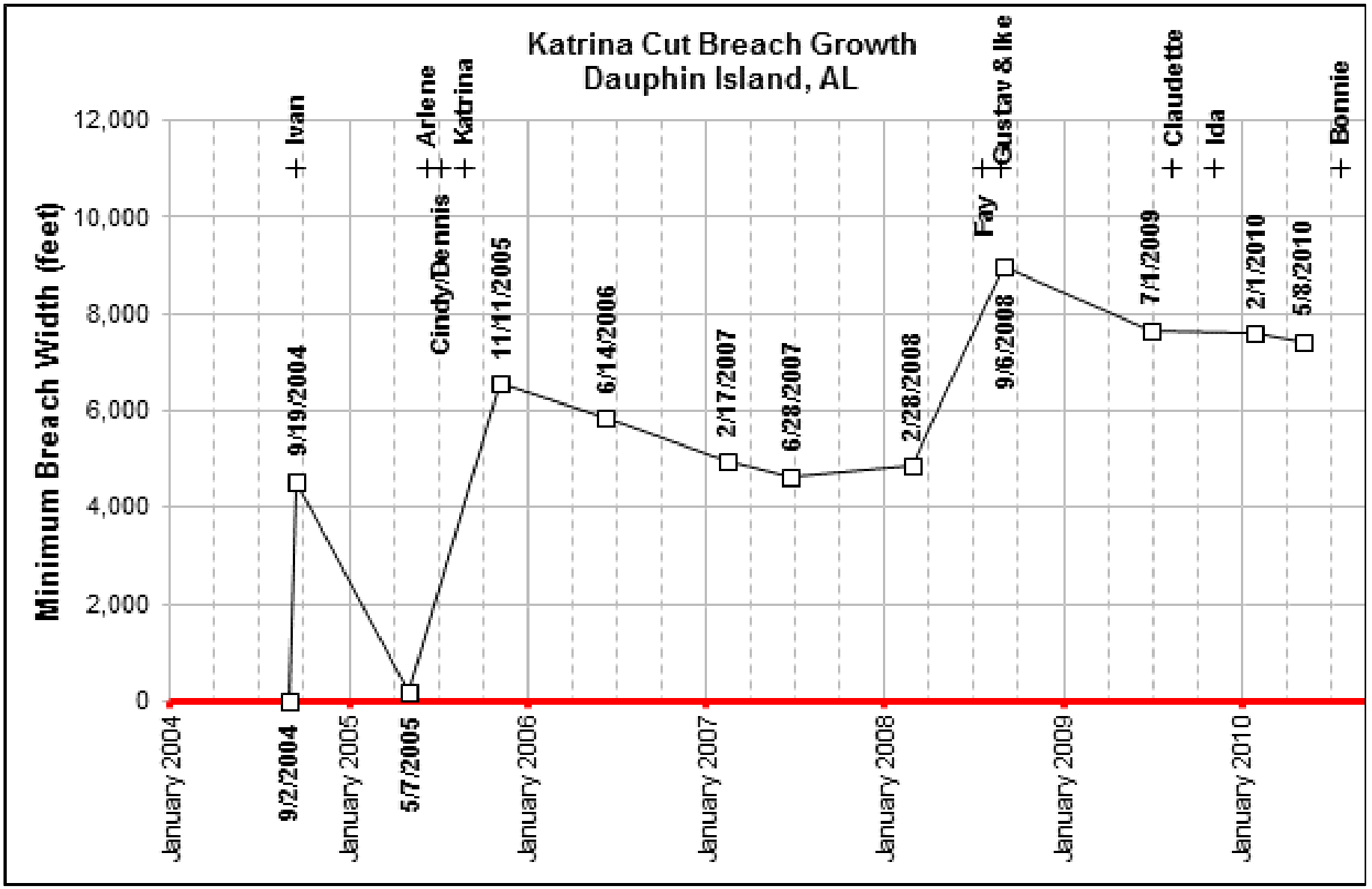


September 2011

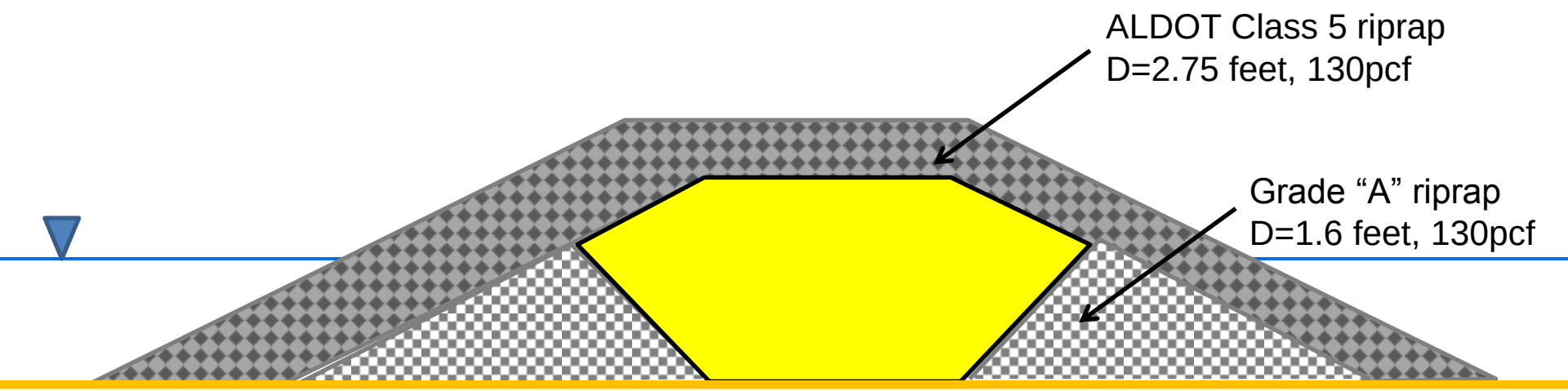

May 8, 2005
Hurricane Ivan
September 19, 2004 LIDAR Survey (m NAVD) with MHW Line
Northing (m)
3347000
3346500
3346000
4
2
0
-2
Imagery Dates: Fe
960 ft


Jun 15, 2006
1992
2014
7.5 feet deep
6,600 feet
Image U.S. Geological Survey
Image © 2014 DigitalGlobe
© 2013 Google
©2009 Google
4901 ft
Imagery Dates: Feb 11, 1997 - Jun 15, 2006
30°14'47.08" N
88°12'38.72" W
Eye alt 16960 ft


Katrina Cut


Katrina Cut Breach Growth
Dauphin Island, AL
Minimum Breach Width (feet)
12,000
10,000
8,000
6,000
4,000
2,000
0
January 2004
January 2005
January 2006
January 2007
January 2008
January 2009
January 2010
Ivan
Arlene
Katrina
Cindy/Dennis
Gustav & Ike
Fay
Claudette
Ida
Bonnie
9/2/2004
9/19/2004
5/7/2005
11/11/2005
6/14/2006
2/17/2007
6/28/2007
2/28/2008
9/6/2008
7/1/2009
2/1/2010
5/8/2010

- Emergency barrier constructed during Deepwater Horizon Spill to limit oil flowing into Mississippi Sound
- Designed and constructed by Thompson Engineering under an emergency permit
- Rubblemound with sand core

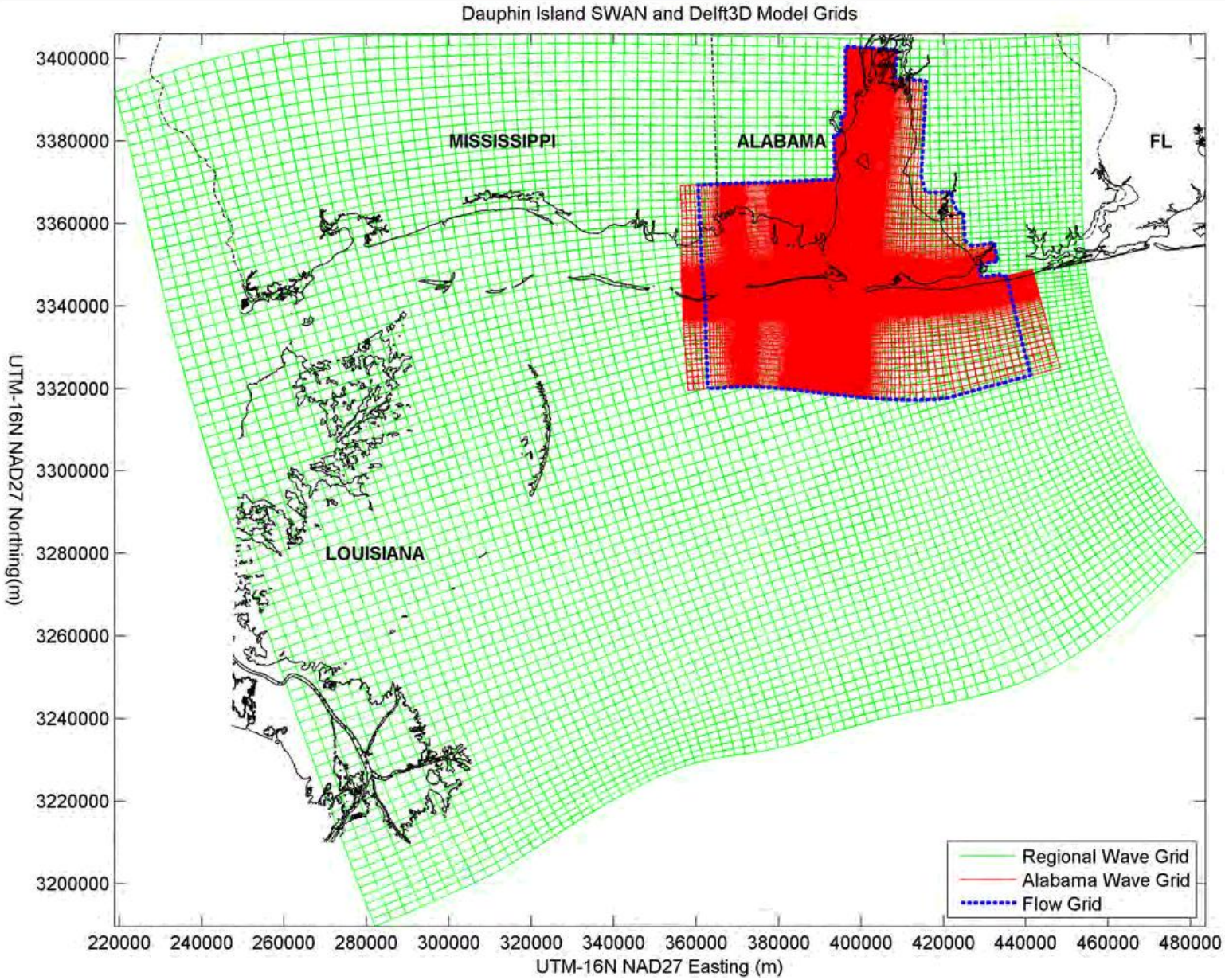


Emergency Barrier

Emergency Barrier

- State has requested to leave the structure in place
- Goal of risk assessment is to provide information to permitting agencies

- Life Cycle Based Analysis
  - Quantify risks associated with structure
    - Breaching
    - Sediment transport
    - Impact to private property, navigation, SAV, pipelines
  - Compare with and without structure condition over a 50 year period


Dauphin Island SWAN and Delft3D Model Grids
MISSISSIPPI
ALABAMA
FL
LOUISIANA
Regional Wave Grid
Alabama Wave Grid
Flow Grid
UTM-16N NAD27 Northing(m)
UTM-16N NAD27 Easting (m)
3400000
3380000
3360000
3340000
3320000
3300000
3280000
3260000
3240000
3220000
3200000
220000
240000
260000
280000
300000
320000
340000
360000
380000
400000
420000
440000
460000
480000

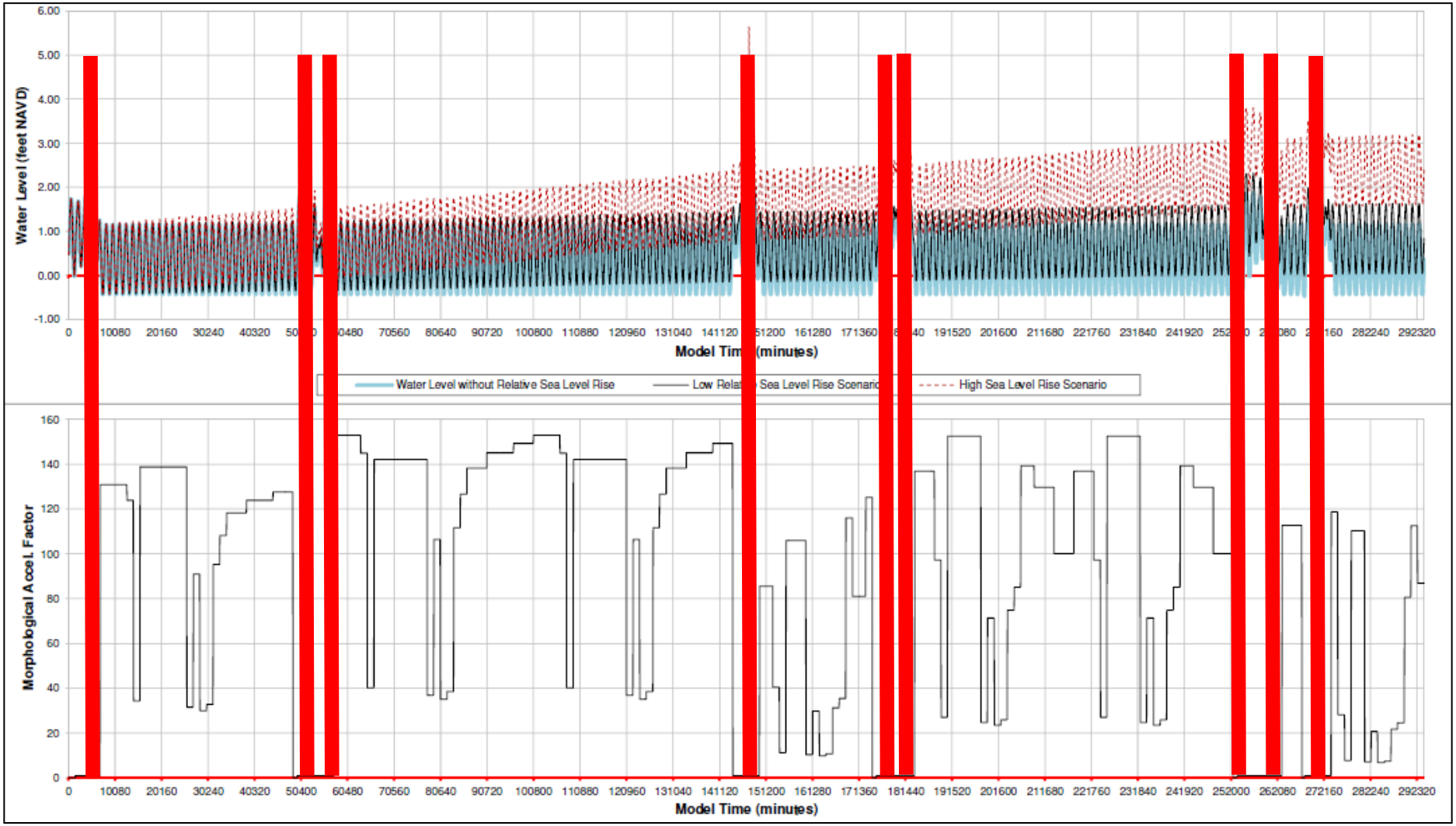
Model Input

- 50 year simulations
- Repeated historic storm record in sequence
  - 1917 to 1967
  - 1960 to 2010

- Average conditions based on 20 year WIS record
  - Non-storm waves were broken into 12 bins

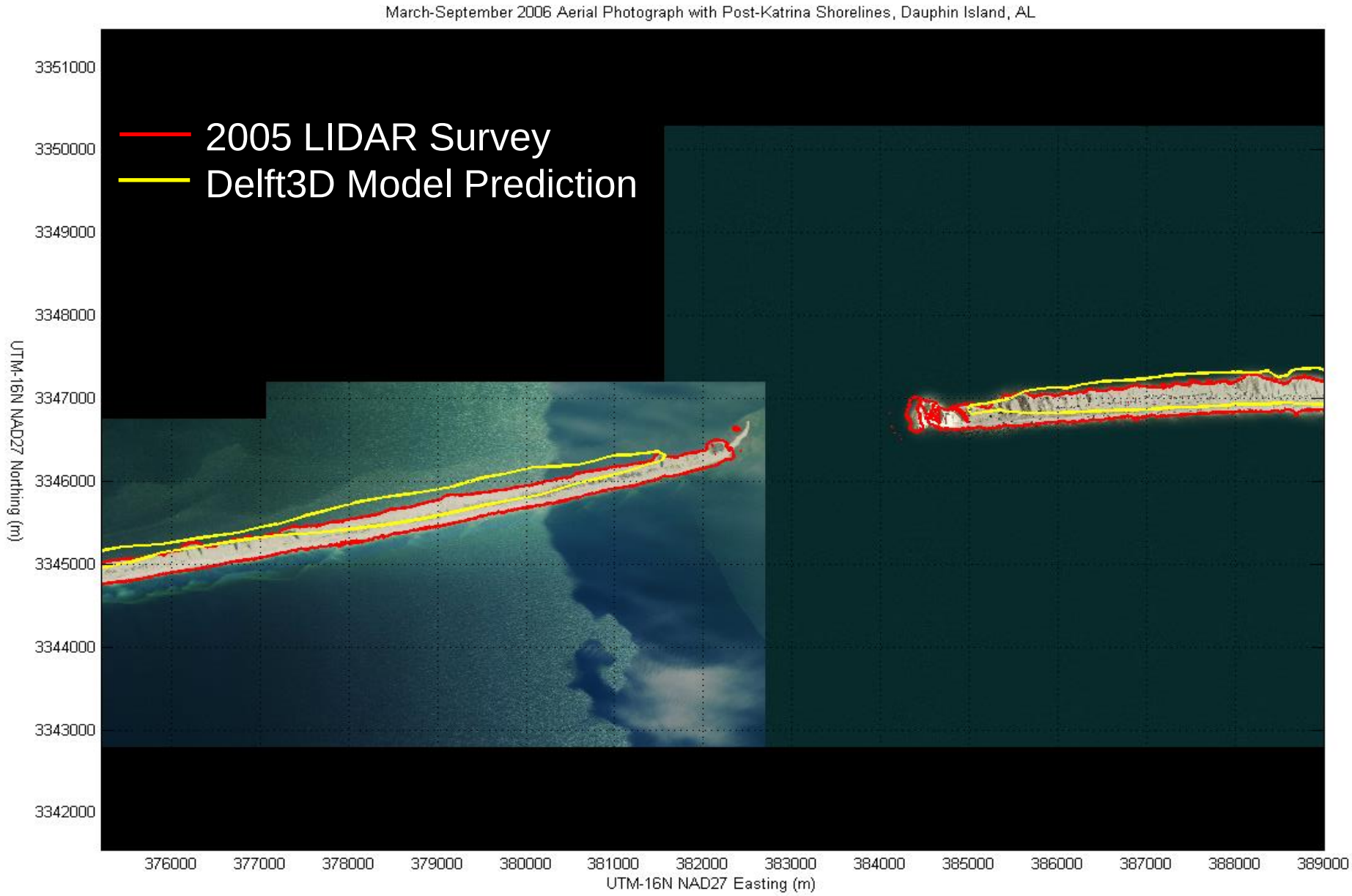
- Performed using two sea level rise scenarios
  - USACE guidance for low and high SLR

- Morfac and storm history for 1917 to 1967

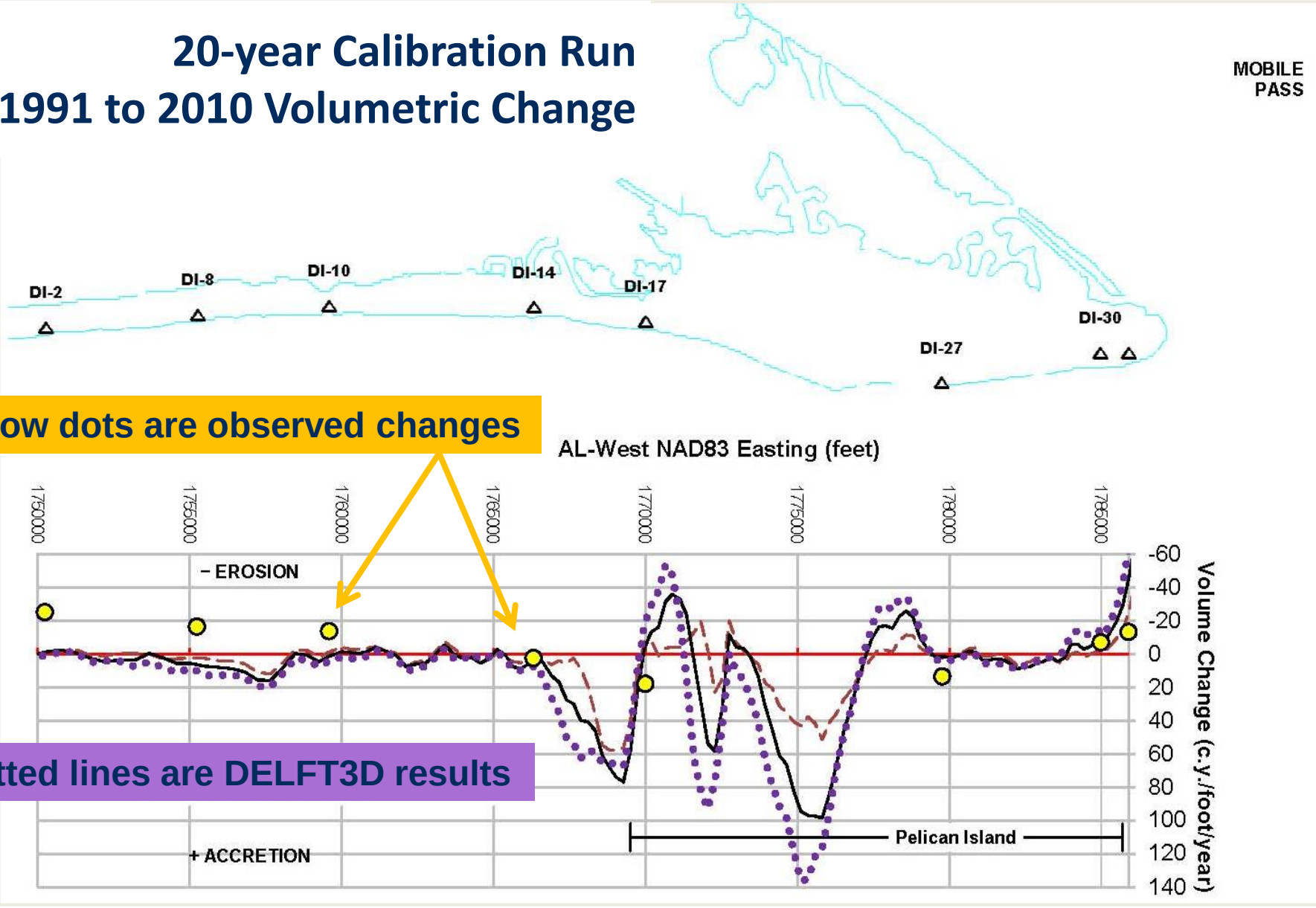


Model Calibration

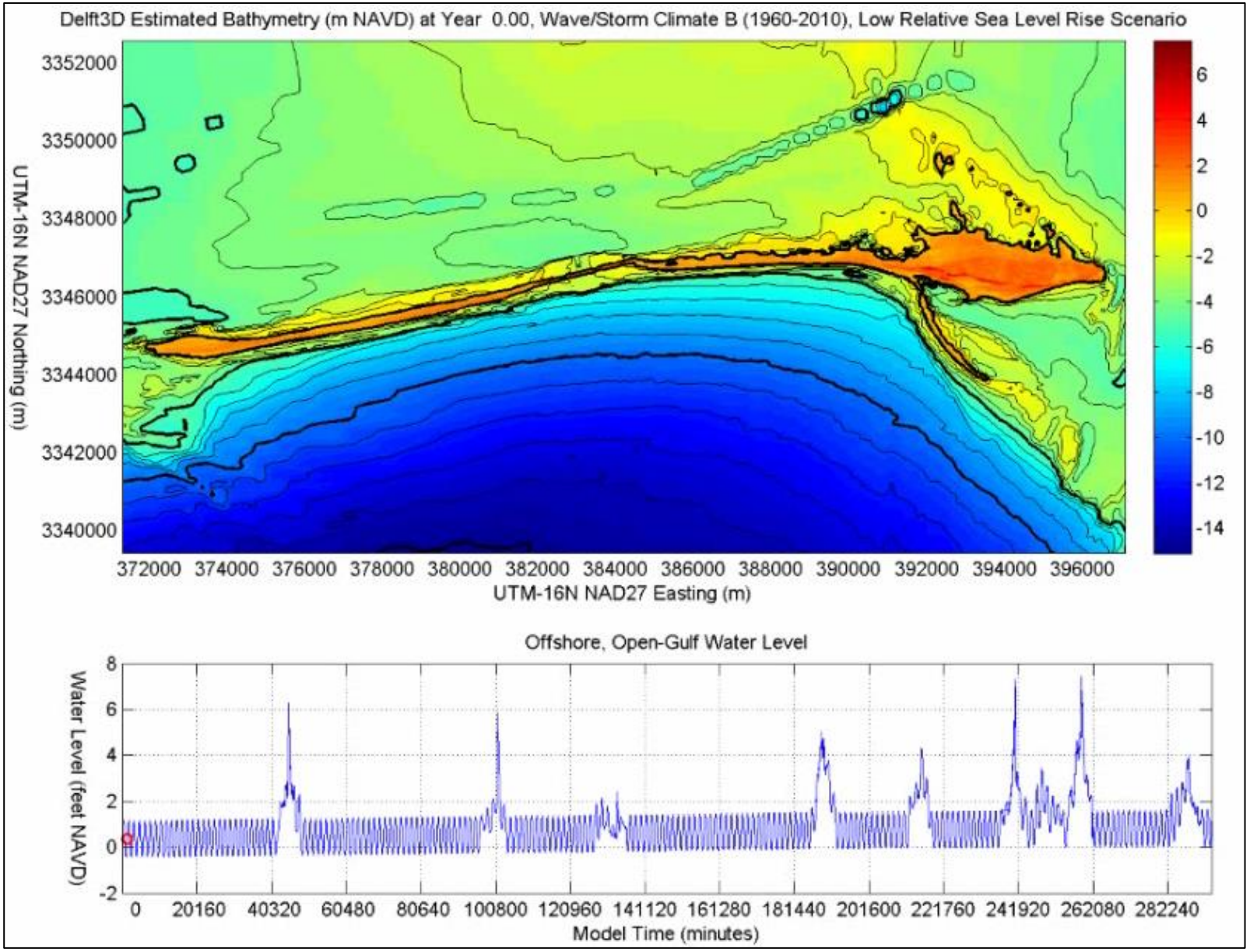
- Calibrated for storm response and long-term volumetric change
  - Repeated Katrina breach
  - 20 year calibration run
- Model verification using Hurricane Ivan and Hurricane Isaac
  - Shoreline and volume changes
  - Breach width


March-September 2006 Aerial Photograph with Post-Katrina Shorelines, Dauphin Island, AL
2005 LIDAR Survey
Delft3D Model Prediction
3351000
3350000
3349000
3348000
3347000
3346000
3345000
3344000
3343000
3342000
UTM-16N NAD27 Northing (m)
376000
377000
378000
379000
380000
381000
382000
383000
384000
385000
386000
387000
388000
389000
UTM-16N NAD27 Easting (m)

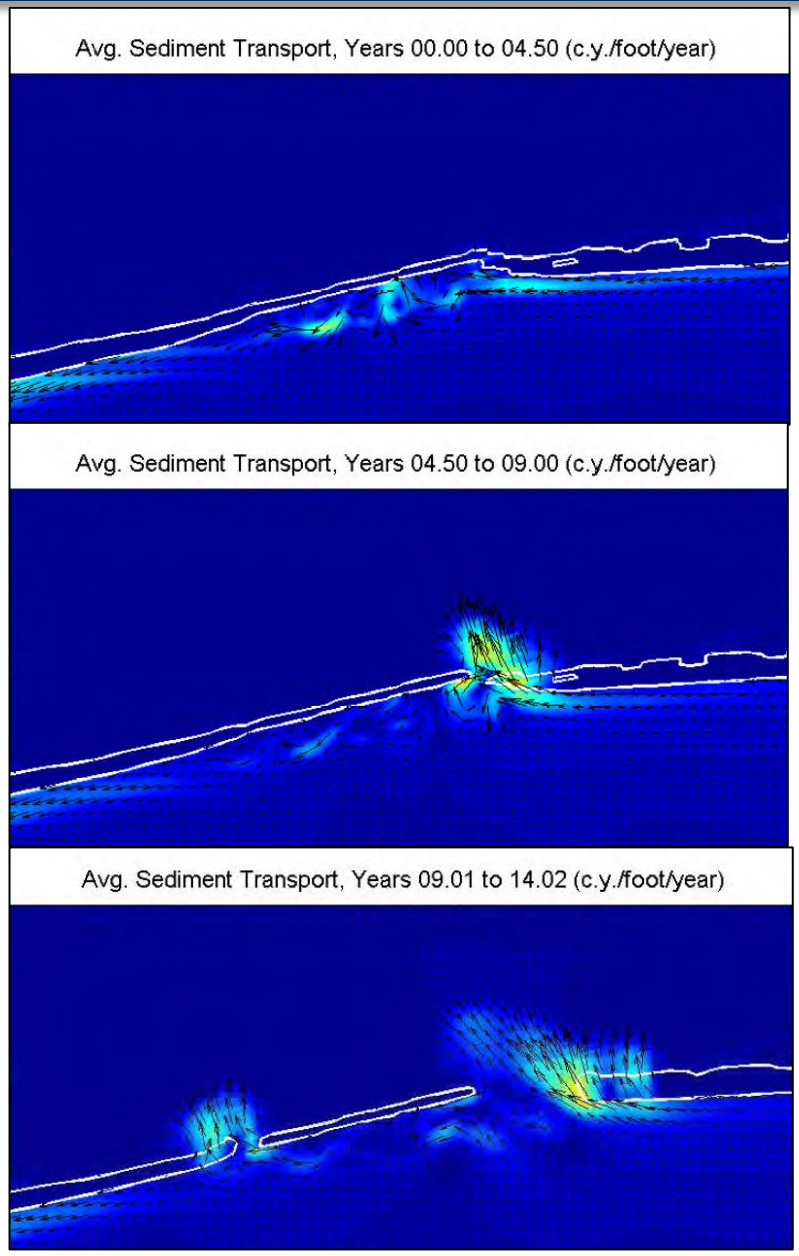
20-year Calibration Run
1991 to 2010 Volumetric Change



Model Results: With Structure



Model Results: With Structure

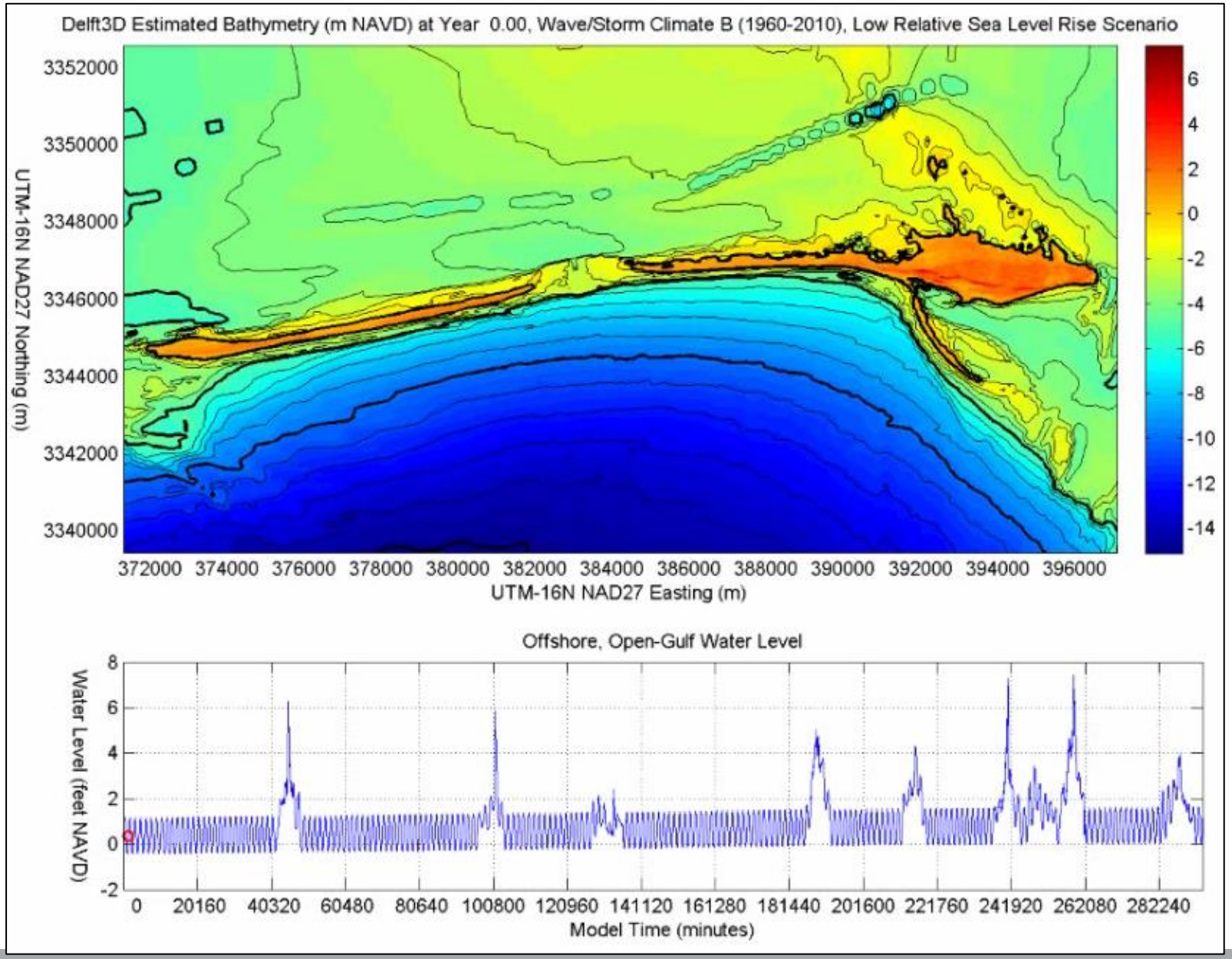


- Structure promotes longshore transport initially
- Breach forms in low lying area adjacent to structure
- Structure is flanked, cross shore transport dominates

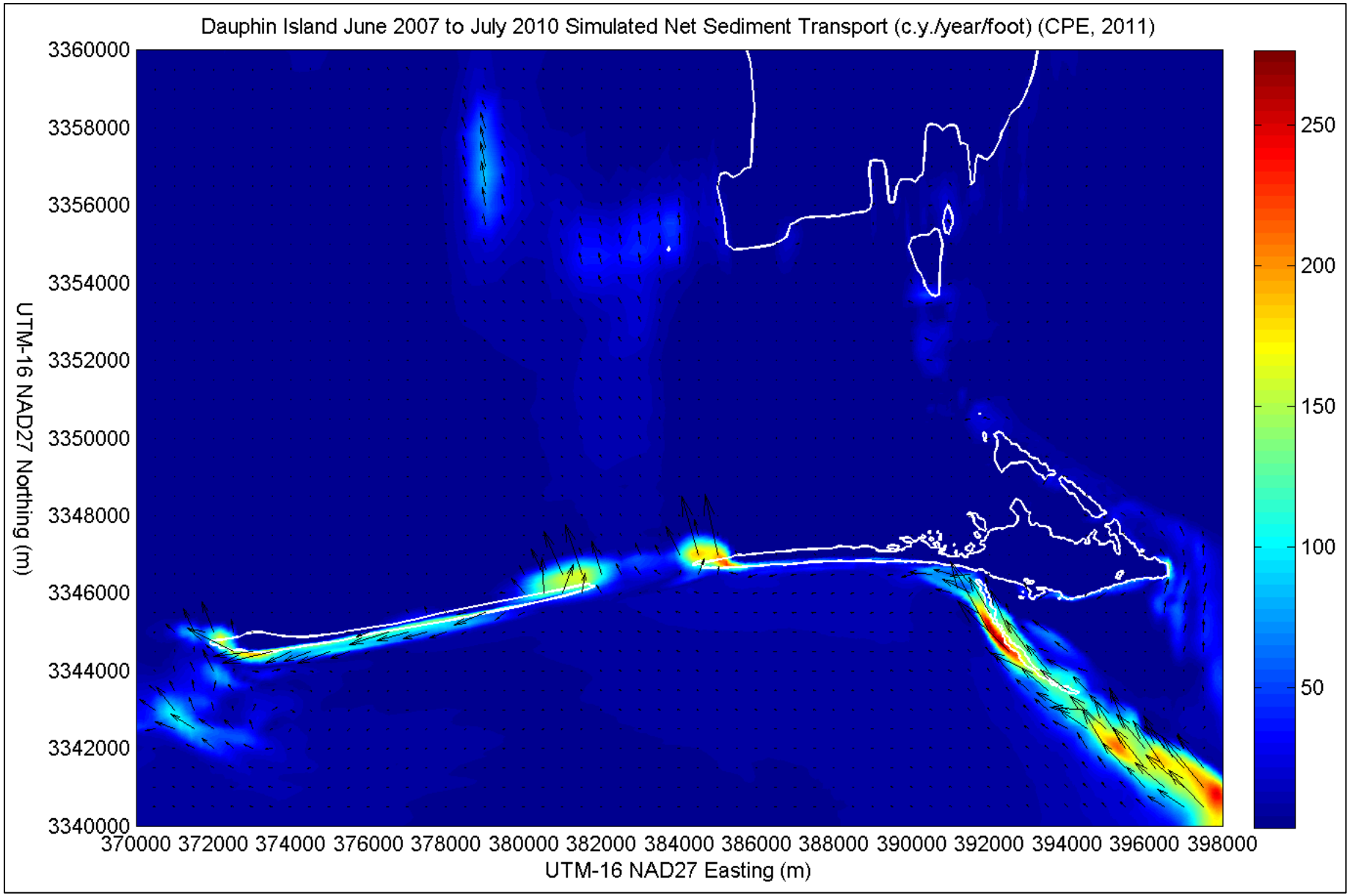
Model Results: With Structure

Model Results : With Structure

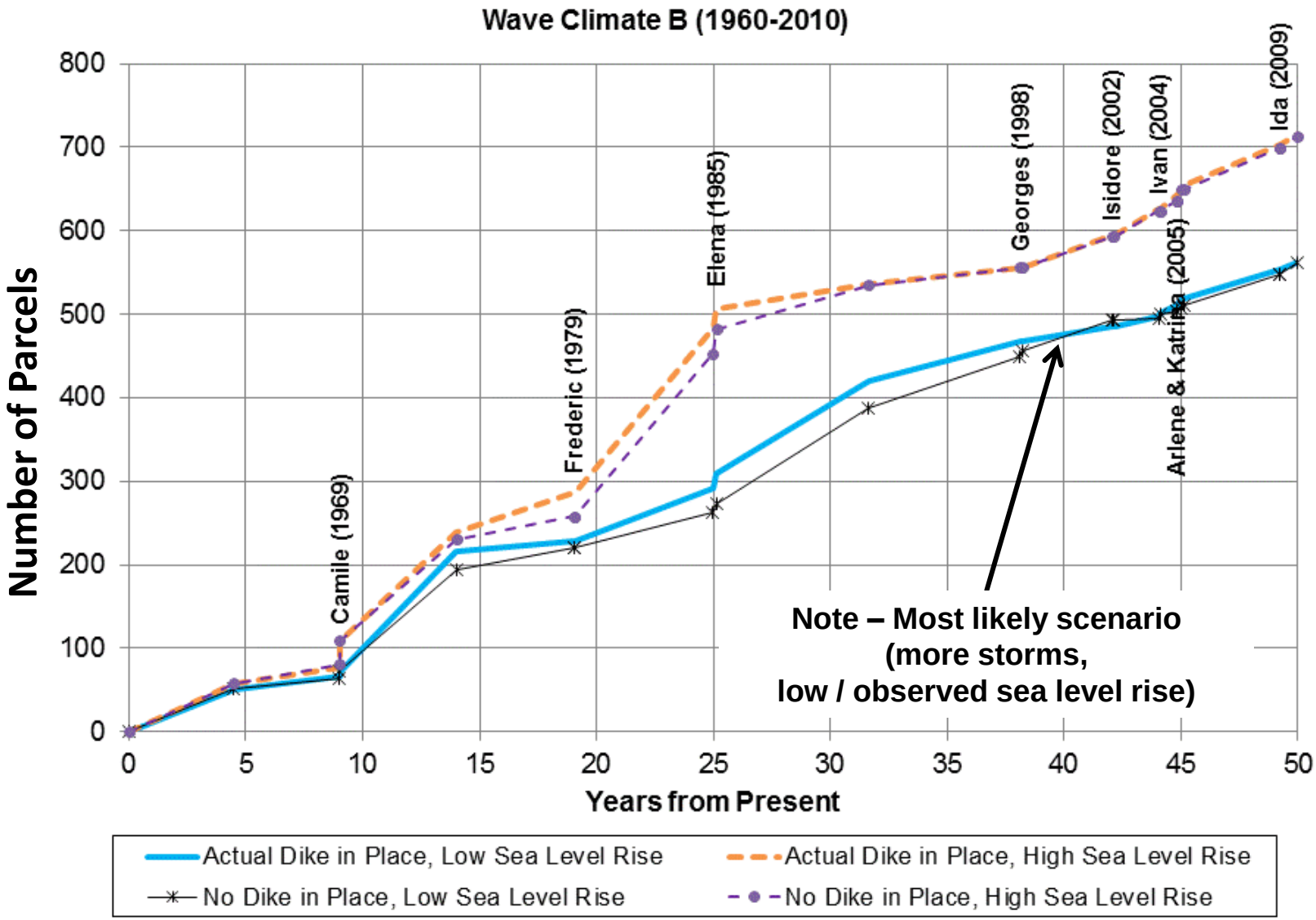
Model Results: Without Structure



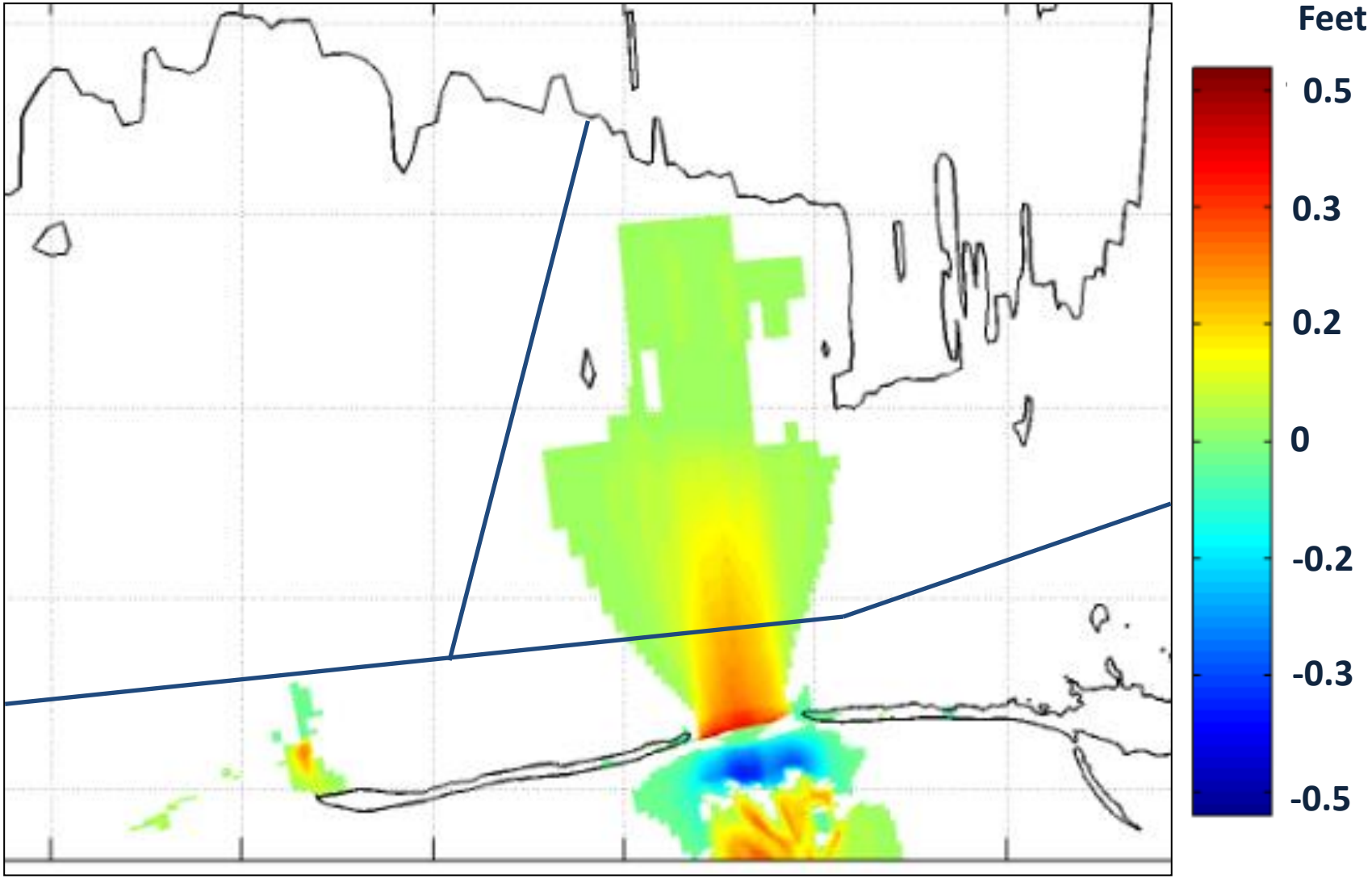
Model Results: Without Structure

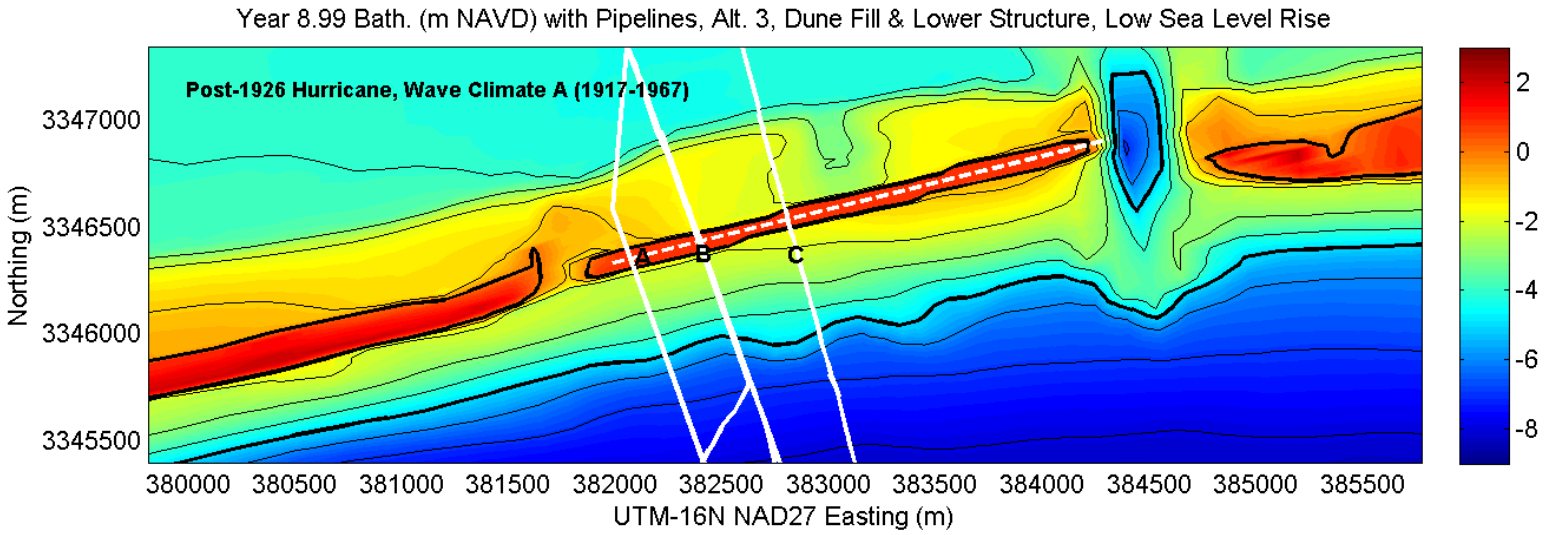


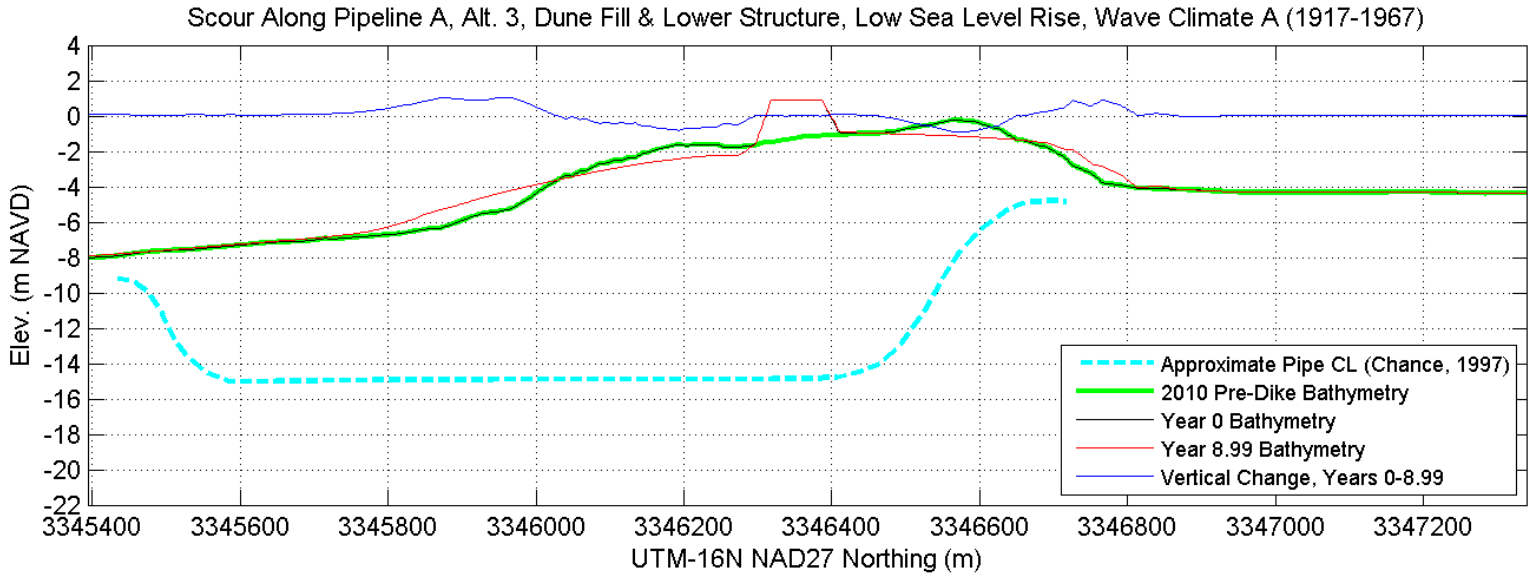
Private Property (Land) Loss

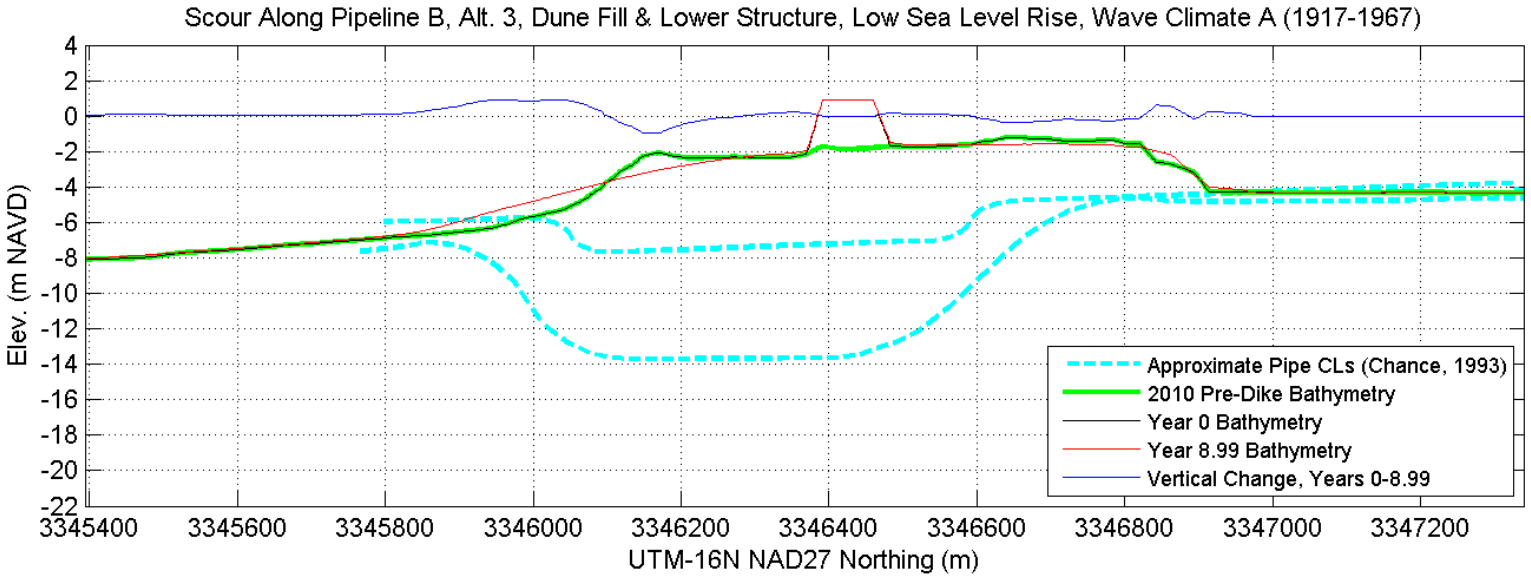


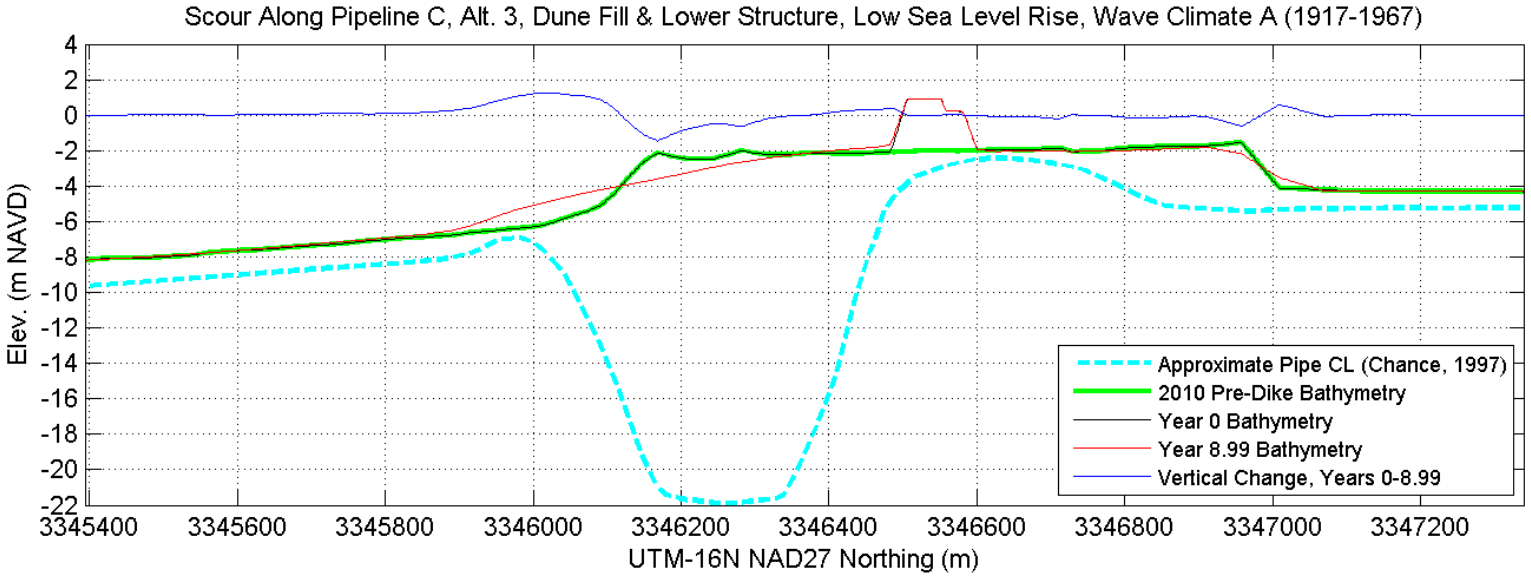
Hurricane Isaac




Year 8.99 Bath. (m NAVD) with Pipelines, Alt. 3, Dune Fill & Lower Structure, Low Sea Level Rise
Post-1926 Hurricane, Wave Climate A (1917-1967)
A
B
C
Northing (m)
3347000
3346500
3346000
3345500
380000 380500 381000 381500 382000 382500 383000 383500 384000 384500 385000 385500
UTM-16N NAD27 Easting (m)
2
0
-2
-4
-6
-8

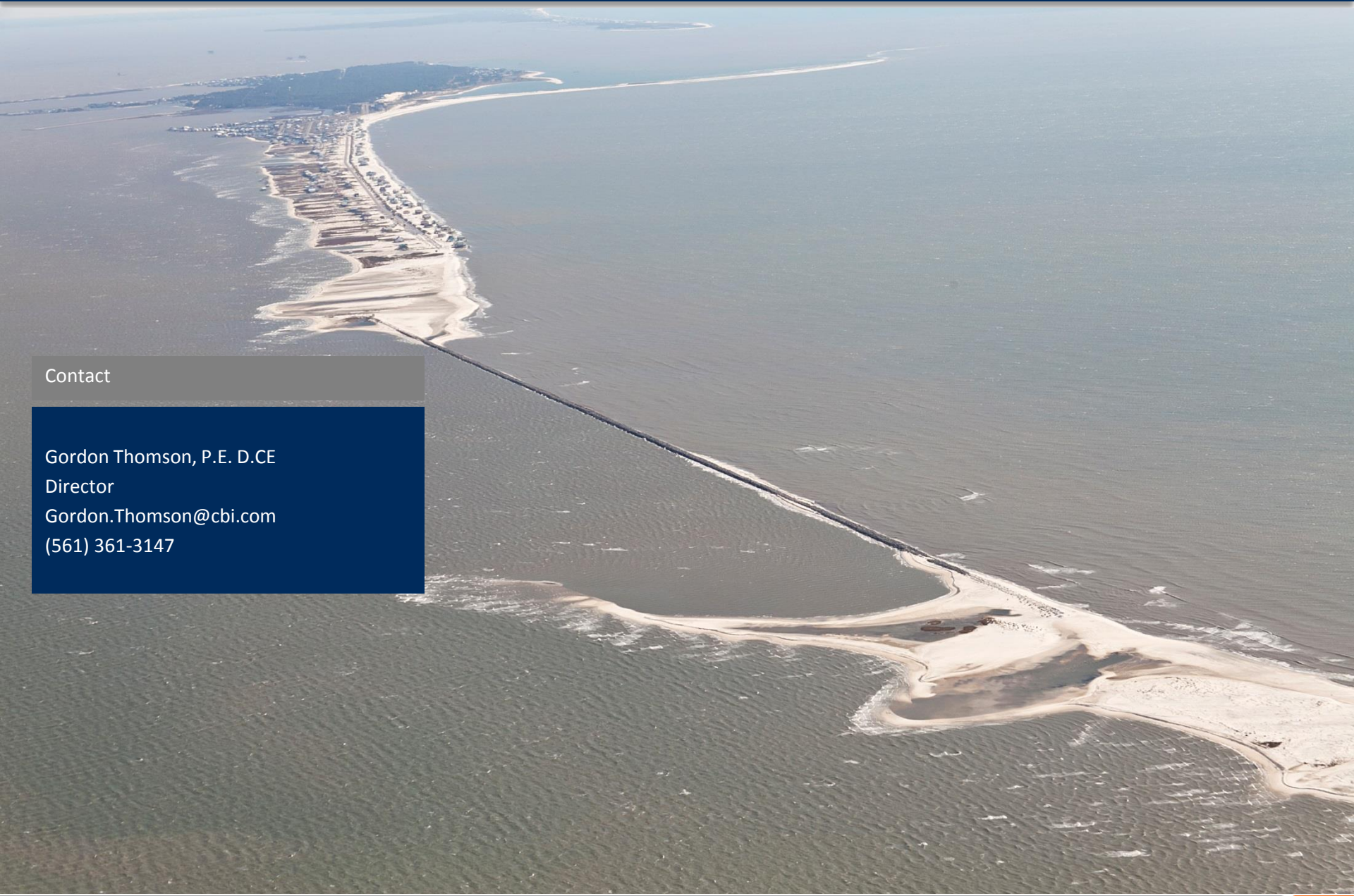

Scour Along Pipeline A, Alt. 3, Dune Fill & Lower Structure, Low Sea Level Rise, Wave Climate A (1917-1967)
Elev. (m NAVD)
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
3345400 3345600 3345800 3346000 3346200 3346400 3346600 3346800 3347000 3347200
UTM-16N NAD27 Northing (m)
Approximate Pipe CL (Chance, 1997)
2010 Pre-Dike Bathymetry
Year 0 Bathymetry
Year 8.99 Bathymetry
Vertical Change, Years 0-8.99


Scour Along Pipeline B, Alt. 3, Dune Fill & Lower Structure, Low Sea Level Rise, Wave Climate A (1917-1967)
Elev. (m NAVD)
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
3345400
3345600
3345800
3346000
3346200
3346400
3346600
3346800
3347000
3347200
UTM-16N NAD27 Northing (m)
Approximate Pipe CLs (Chance, 1993)
2010 Pre-Dike Bathymetry
Year 0 Bathymetry
Year 8.99 Bathymetry
Vertical Change, Years 0-8.99


Scour Along Pipeline C, Alt. 3, Dune Fill & Lower Structure, Low Sea Level Rise, Wave Climate A (1917-1967)
Elev. (m NAVD)
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
3345400
3345600
3345800
3346000
3346200
3346400
3346600
3346800
3347000
3347200
UTM-16N NAD27 Northing (m)
Approximate Pipe CL (Chance, 1997)
2010 Pre-Dike Bathymetry
Year 0 Bathymetry
Year 8.99 Bathymetry
Vertical Change, Years 0-8.99

Summary

- Method for 50 year life cycle analysis
  - Historic storm record
  - Longer calibration period
- Specific findings
  - No breaching along developed section until a major storm event in year 20
  - No difference in breaching potential along inhabited area between the with and without structure scenario
  - Breaching expected adjacent to structure during next major storm
  - Loss of property indistinguishable between with and without structure (within expected model accuracy)
  - Future land loss expected regardless of presence of structure



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