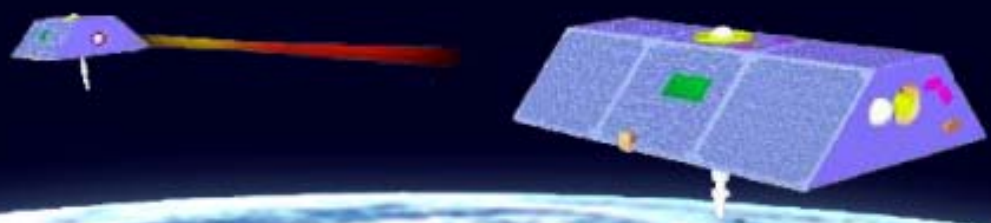
Acquiring Data and Developing Applications for Coastal Zone Studies and Emergency Response

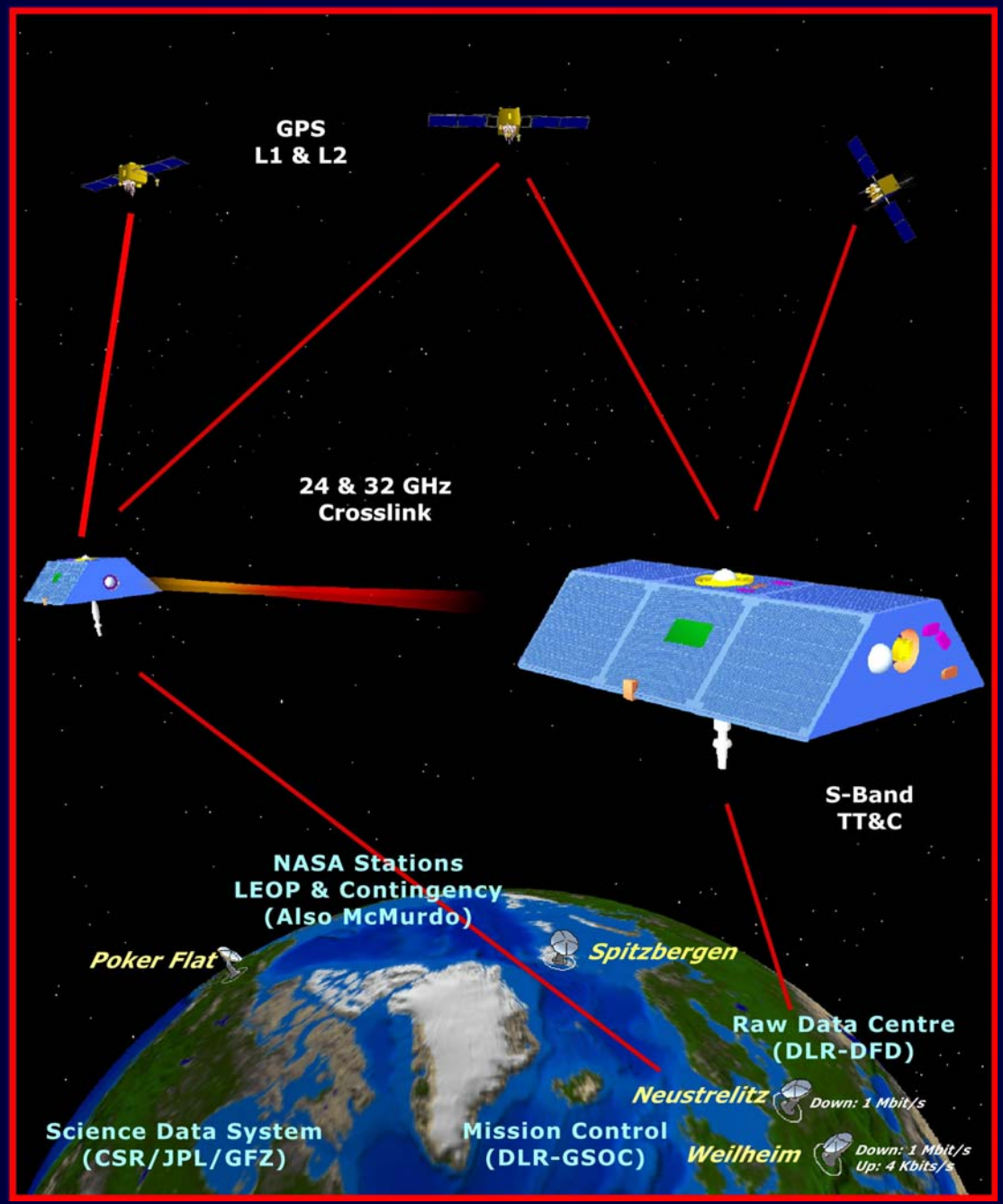
THE UNVERSITY OF TEXAS AT AUSTIN
C S R
Center for Space Research

Gordon Wells

XIII Brazilian Remote Sensing Symposium
Florianopolis, Santa Catarina, Brazil

April 25, 2007





GRACE Mission

Science Goals

High resolution, mean & time variable gravity field mapping for Earth System Science applications.

Mission Systems

Instruments

- HAIRS (JPL/SSL/APL)
- SuperSTAR (ONERA)
- Star Cameras (DTU)
- GPS Receiver (JPL)

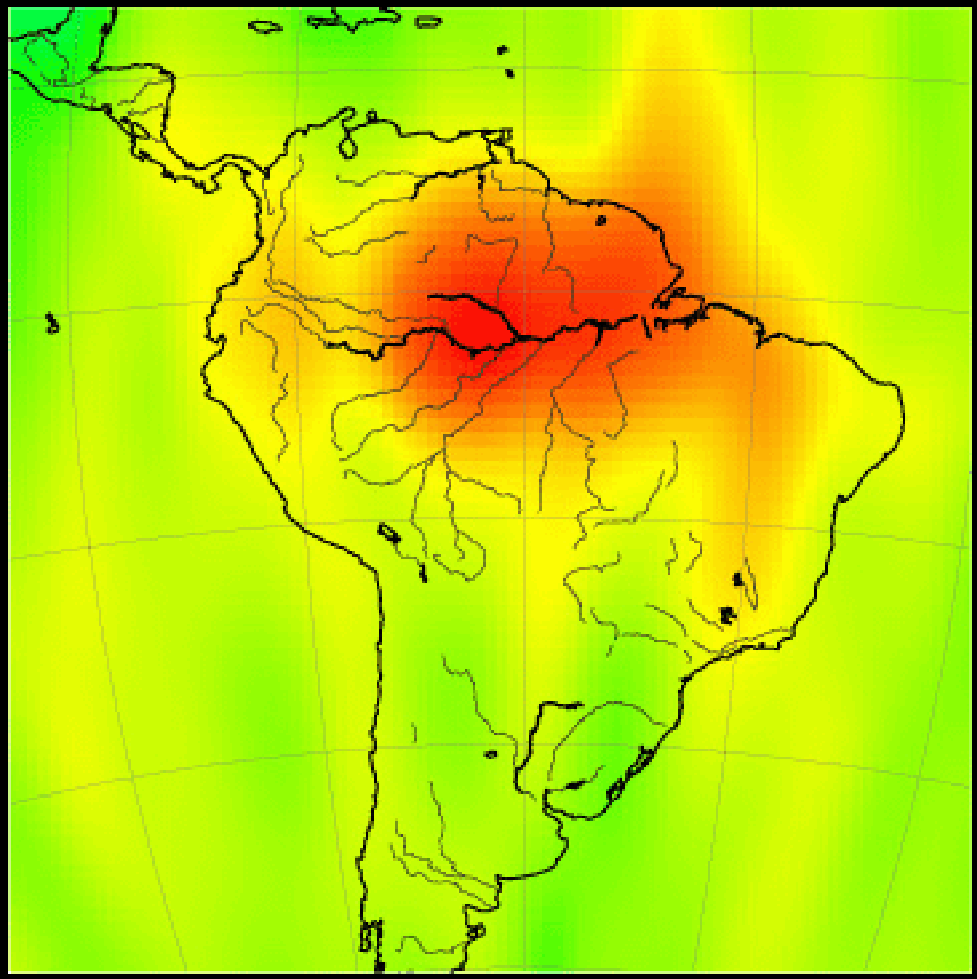
Satellite (JPL/Astrium)
Launcher (DLR/Eurockot)
Operations (DLR/GSOC)
Science (CSR/JPL/GFZ)

Orbit

Launched: March 17, 2002
Initial Altitude: 500 km
Inclination: 89 deg
Eccentricity: ~0.001
Separation Distance: ~220 km
Lifetime: 5 years
Non-Repeat Ground Track, Earth Pointed, 3-Axis Stable

Seasonal Variation in Geoid Height Measured by GRACE

March 2003

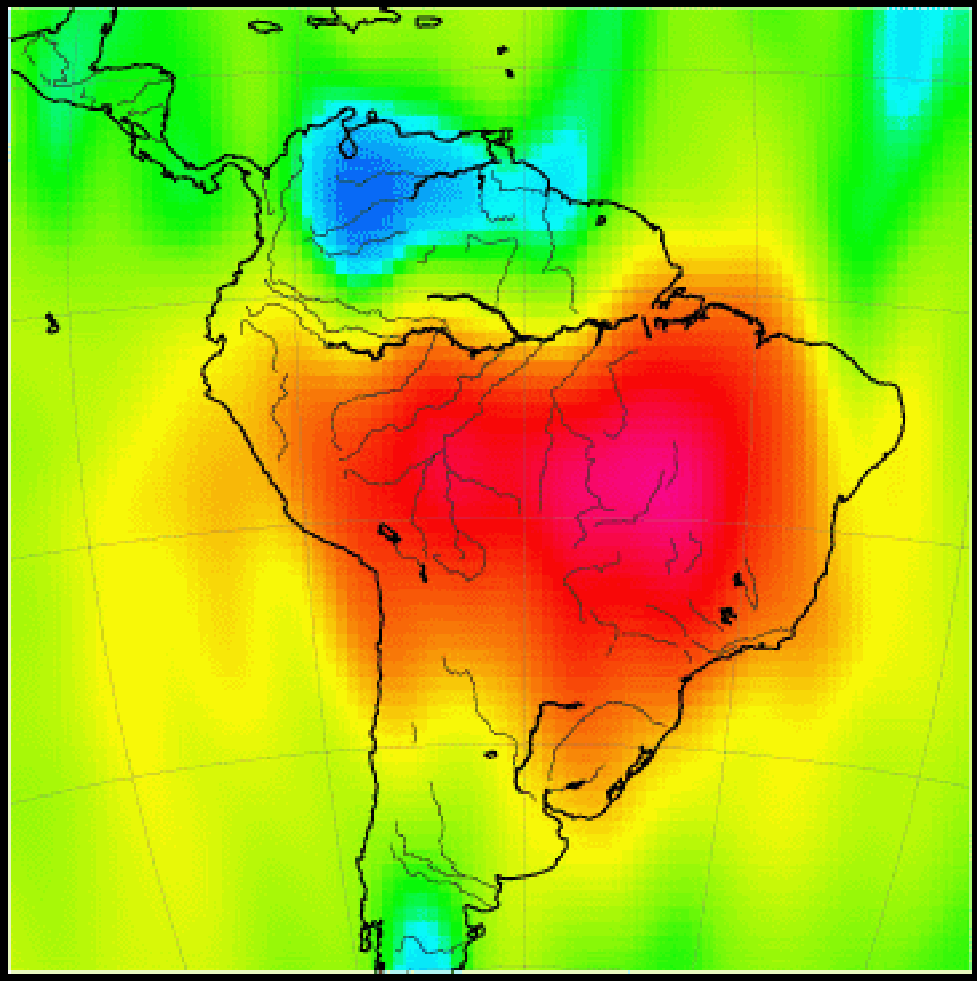


Geoid Height Anomaly (mm)

-12 -6 0 +6 +12

Seasonal Variation in Geoid Height Measured by GRACE

May 2003

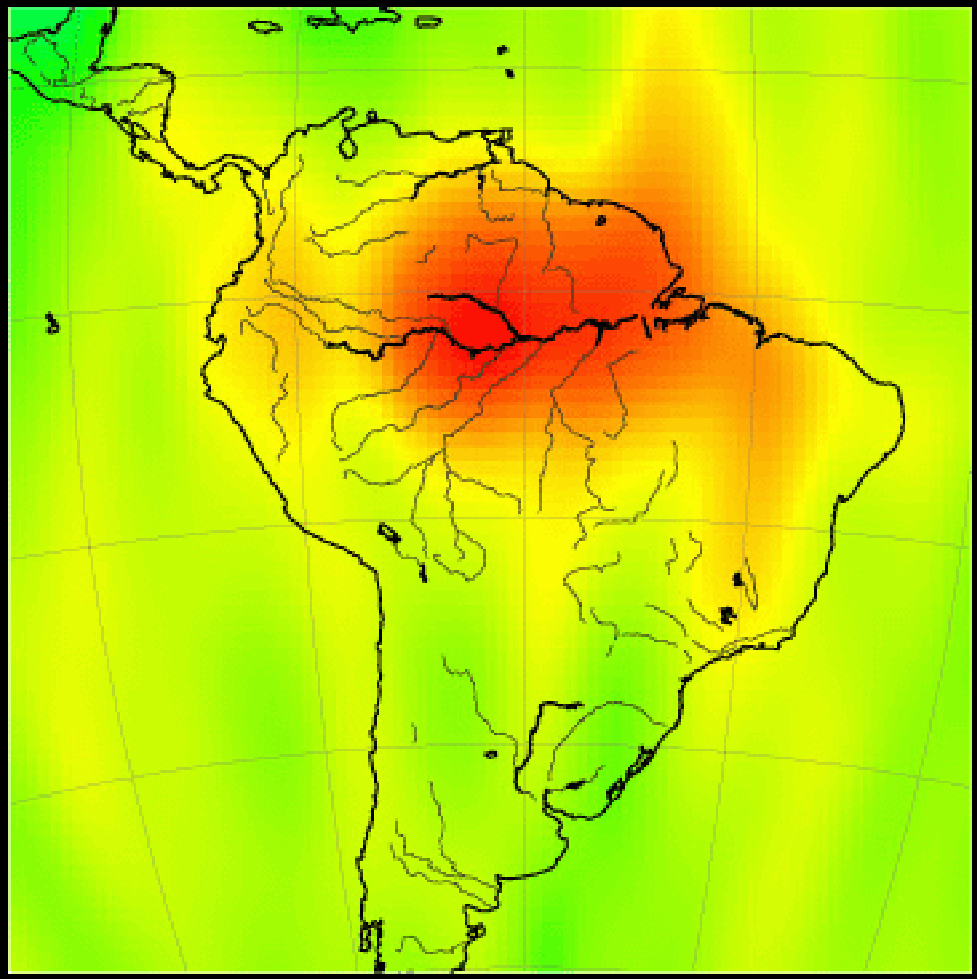


Geoid Height Anomaly (mm)

-12 -6 0 +6 +12

Seasonal Variation in Geoid Height Measured by GRACE

July 2003

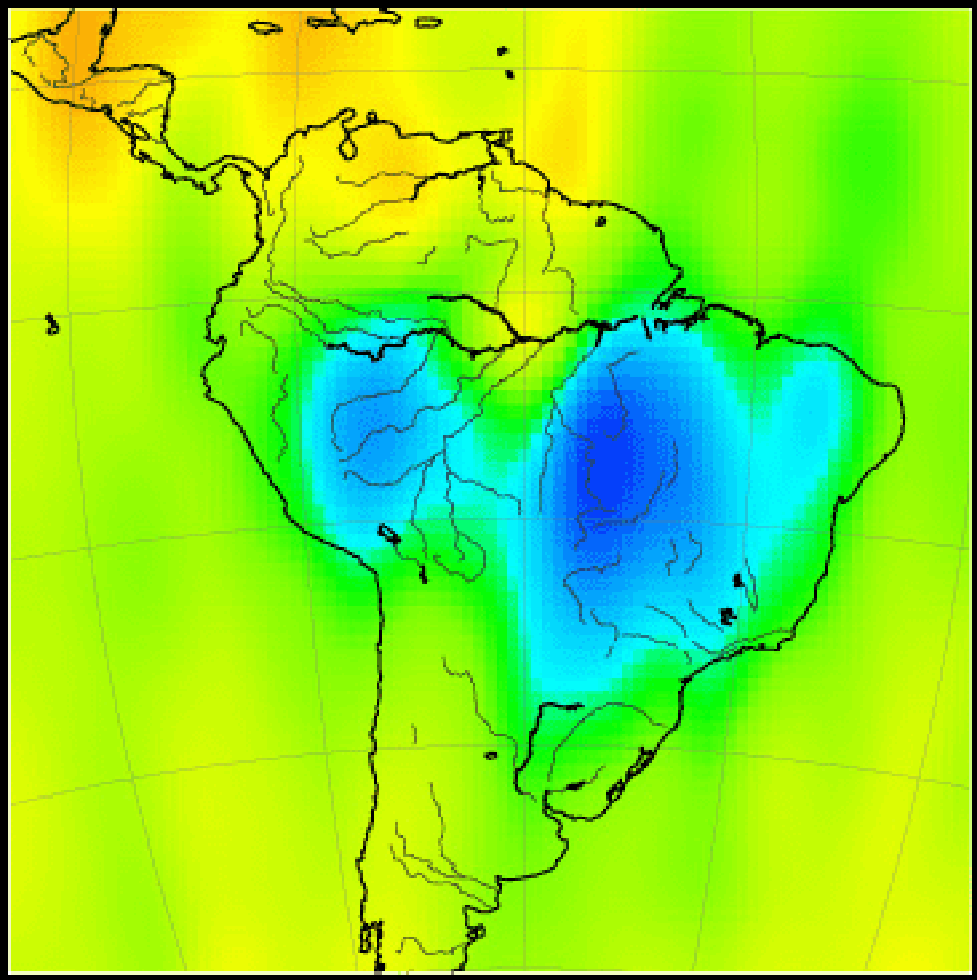


Geoid Height Anomaly (mm)

-12 -6 0 +6 +12

Seasonal Variation in Geoid Height Measured by GRACE

September 2003

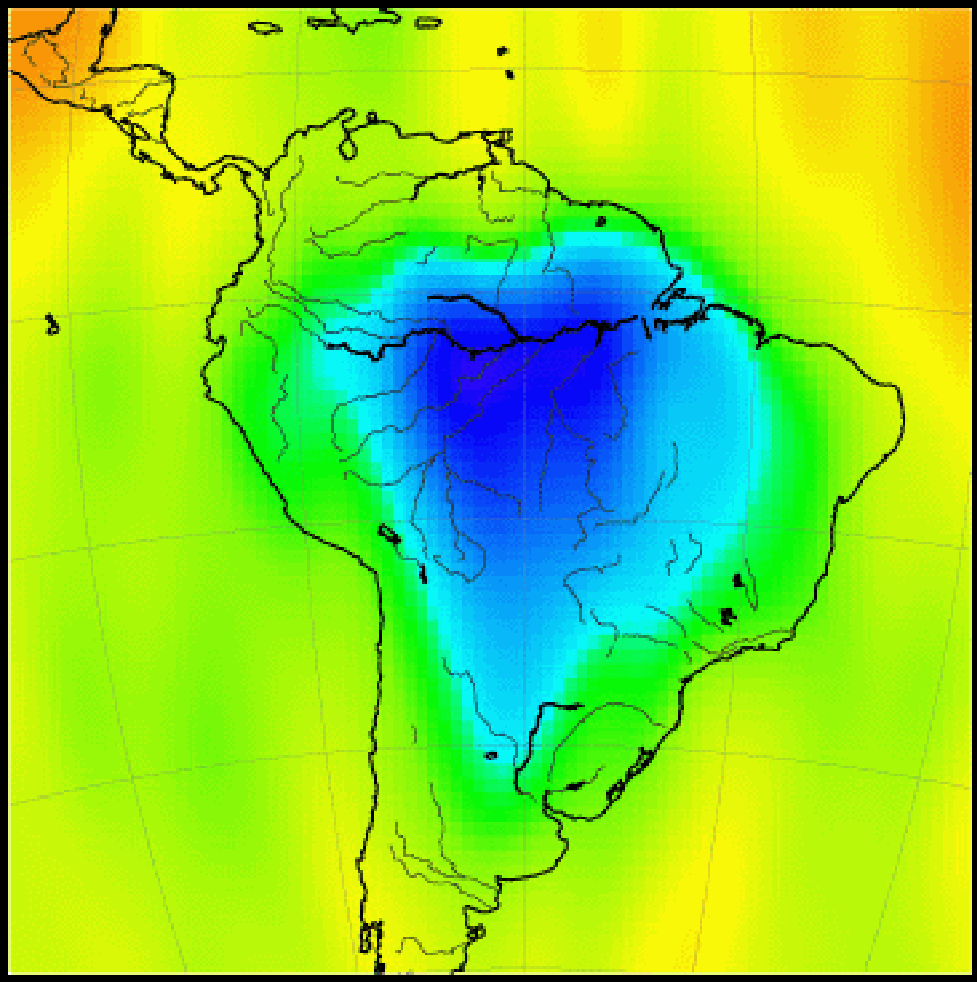


Geoid Height Anomaly (mm)

-12 -6 0 +6 +12

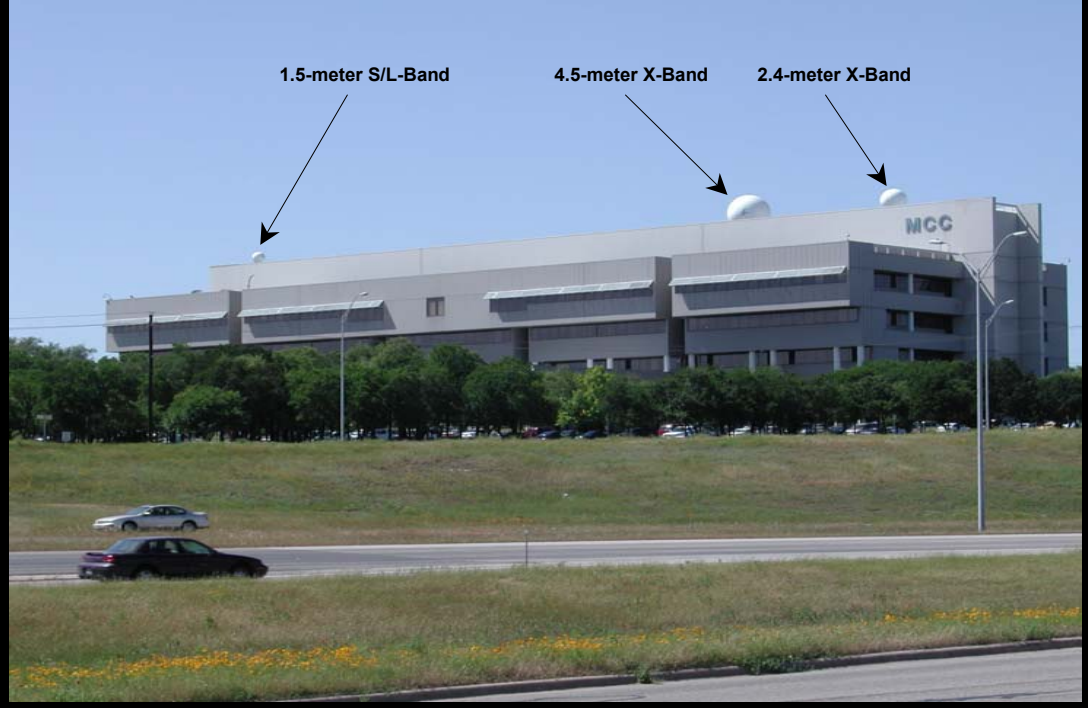
Seasonal Variation in Geoid Height Measured by GRACE

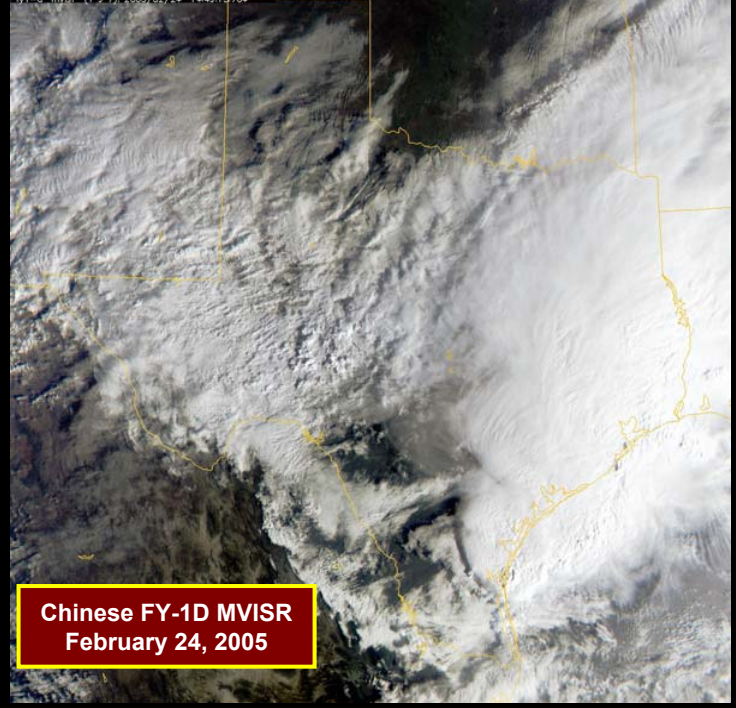
November 2003



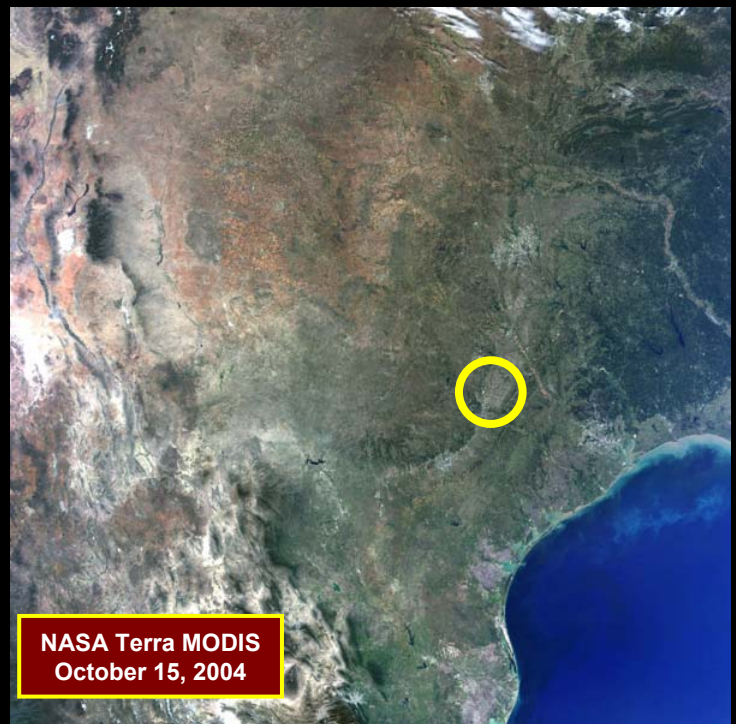
Geoid Height Anomaly (mm)

-12 -6 0 +6 +12


1.5-meter S/L-Band
4.5-meter X-Band
2.4-meter X-Band
MCC


Chinese FY-1D MVISR
February 24, 2005


SeaSpace
CORPORATION


NASA Terra MODIS
October 15, 2004


TERRA
Austin: UT-CSR

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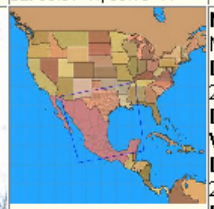
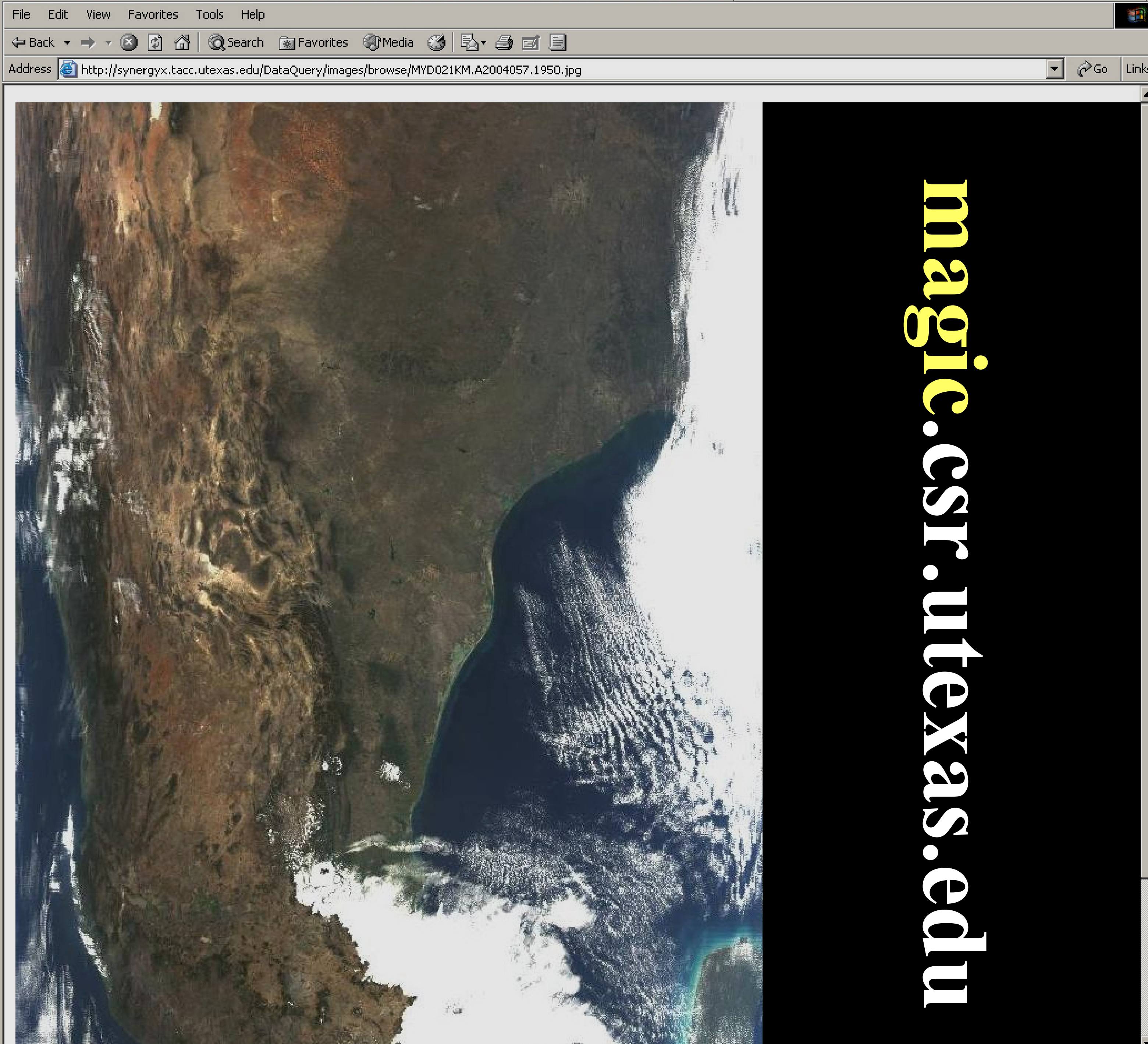
Address http://synergyx.tacc.utexas.edu/DataQuery/servlet/ControllerServlet Go Links

NW: 39.52° N, 114.14° W
NE: 43.78° N, 86.39° W
SW: 22.26° N, 106.70° W
SE: 25.53° N, 83.88° W

17 ☐		 **Corner Coordinates:** **NW:** 33.67° N, 100.38° W **NE:** 37.56° N, 74.90° W **SW:** 16.20° N, 94.01° W **SE:** 19.34° N, 72.16° W	**Name:** MYD02QKM.A2004058.1855.004.2004060022856.hdf **Date/time Acquired:** 2004-02-27 18:55:00.0 GMT **Day of Year:** 58 **Version:** 004 **Date/time Processed:** 2004-02-29 02:28:00.0 GMT **Datum:** Swath
18 ☐		 **Corner Coordinates:** **NW:** 48.24° N, 123.03° W **NE:** 53.30° N, 90.23° W **SW:** 31.45° N, 113.20° W **SE:** 35.01° N, 88.16° W	**Name:** MYD02QKM.A2004057.1955.004.2004059000200.hdf **Date/time Acquired:** 2004-02-26 19:55:00.0 GMT **Day of Year:** 57 **Version:** 004 **Date/time Processed:** 2004-02-28 00:02:00.0 GMT **Datum:** Swath
19 ☐		 **Corner Coordinates:** **NW:** 31.50° N, 113.33° W **NE:** 35.27° N, 88.54° W **SW:** 13.97° N, 107.30° W **SE:** 17.07° N, 85.72° W	**Name:** MYD02QKM.A2004057.1950.004.2004058234953.hdf **Date/time Acquired:** 2004-02-26 19:50:00.0 GMT **Day of Year:** 57 **Version:** 004 **Date/time Processed:** 2004-02-27 23:49:00.0 GMT **Datum:** Swath
20 ☐		 **Corner Coordinates:** **NW:** 46.27° N, 135.42° W **NE:** 51.11° N, 104.01° W **SW:** 29.35° N, 126.25° W	**Name:** MYD02QKM.A2004056.2050.004.2004058000410.hdf **Date/time Acquired:** 2004-02-25 20:50:00.0 GMT **Day of Year:** 56 **Version:** 004 **Date/time Processed:** 2004-02-27 00:04:00.0 GMT **Datum:** Swath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Search
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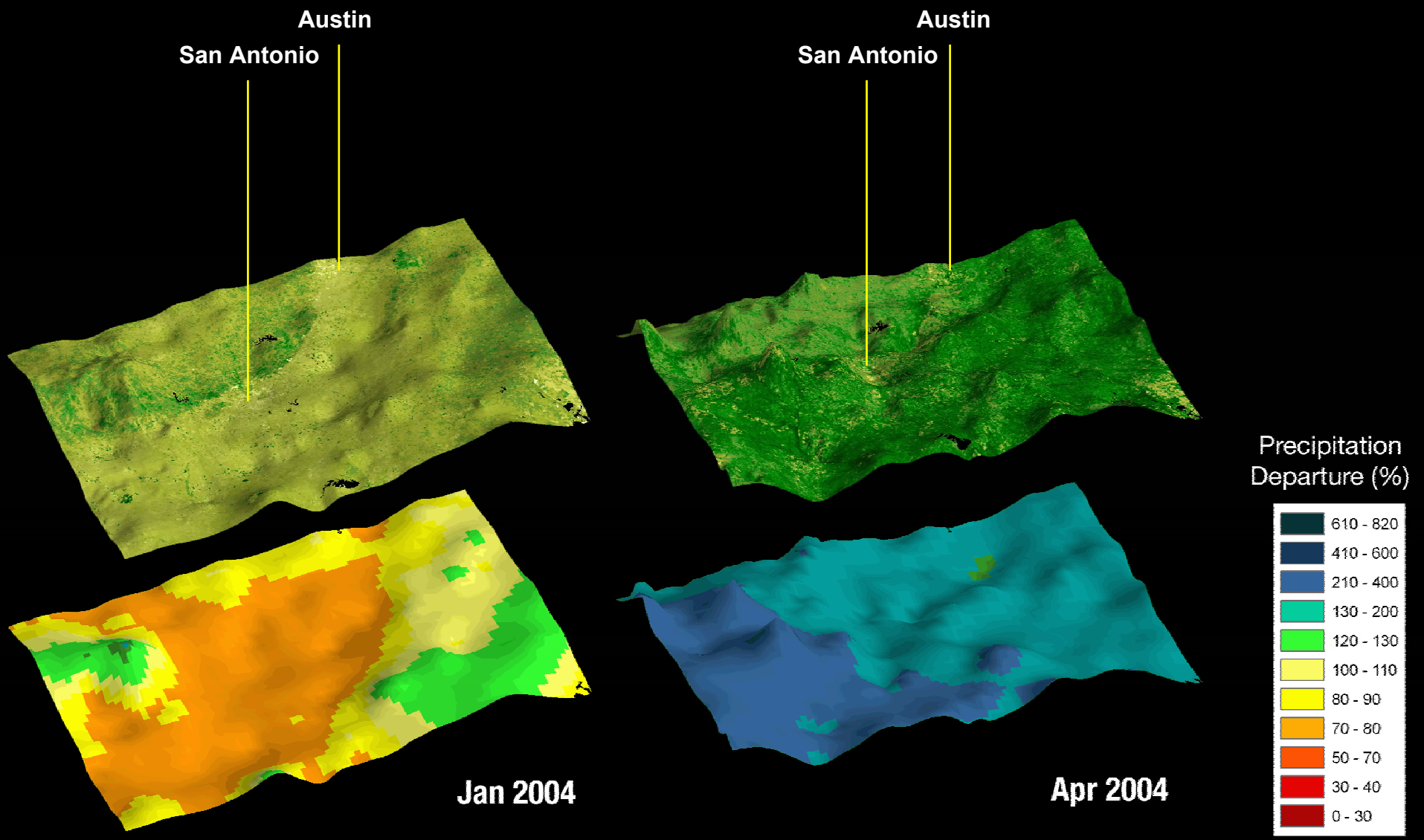
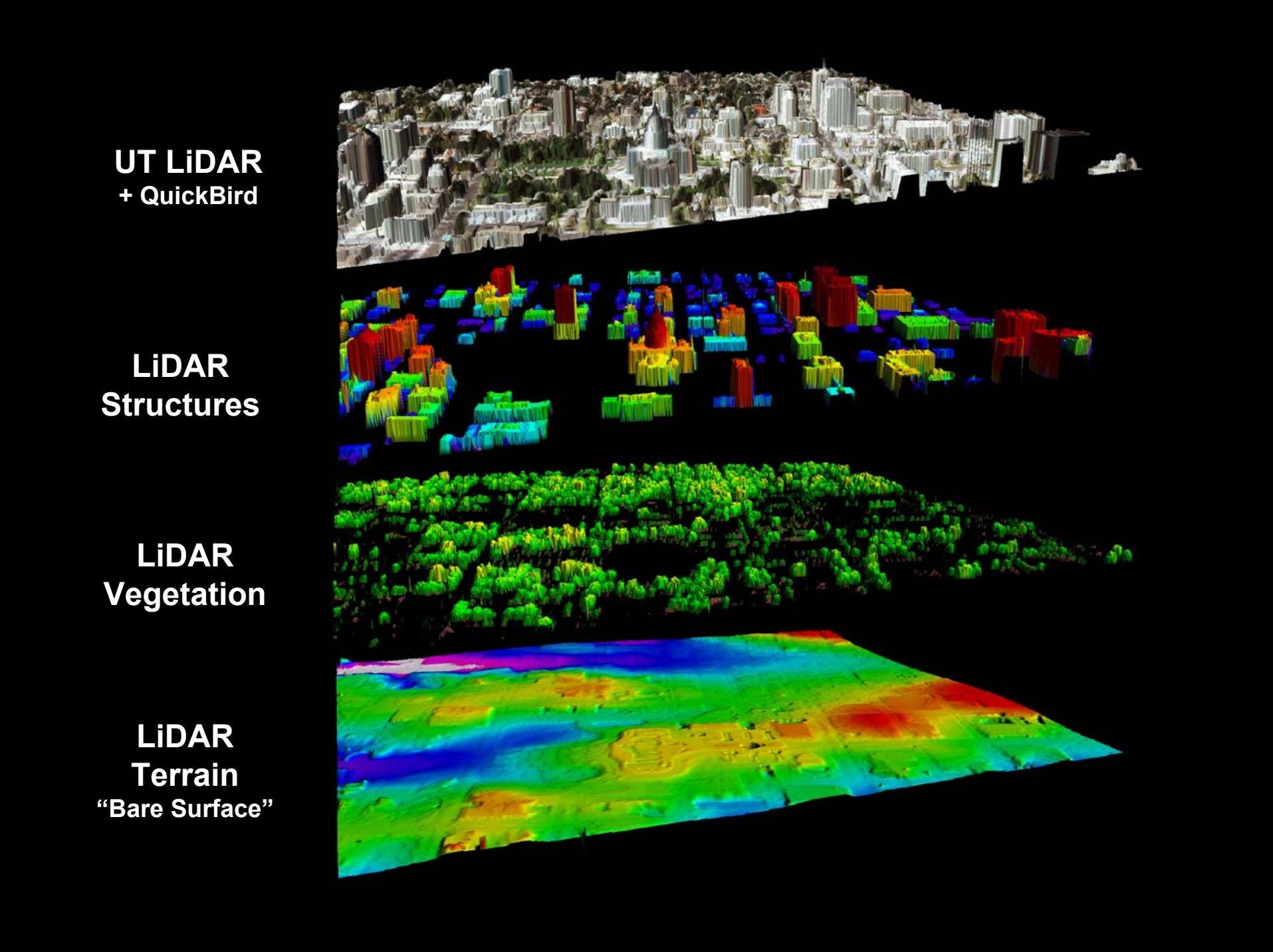
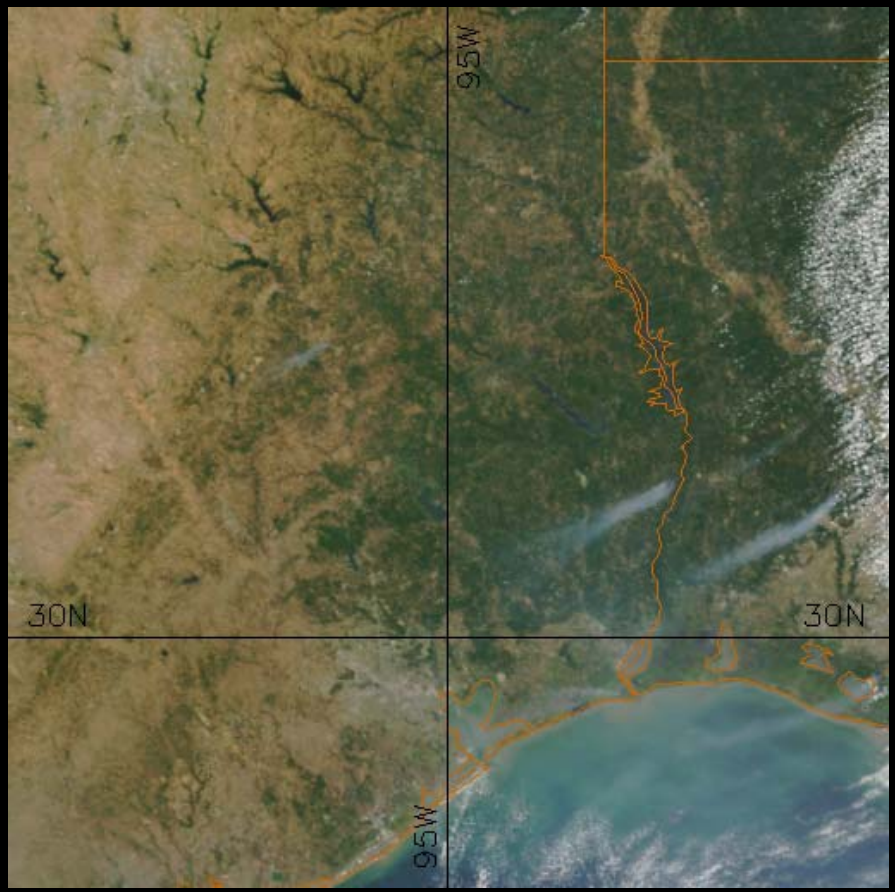
Links
magic.csr.utexas.edu

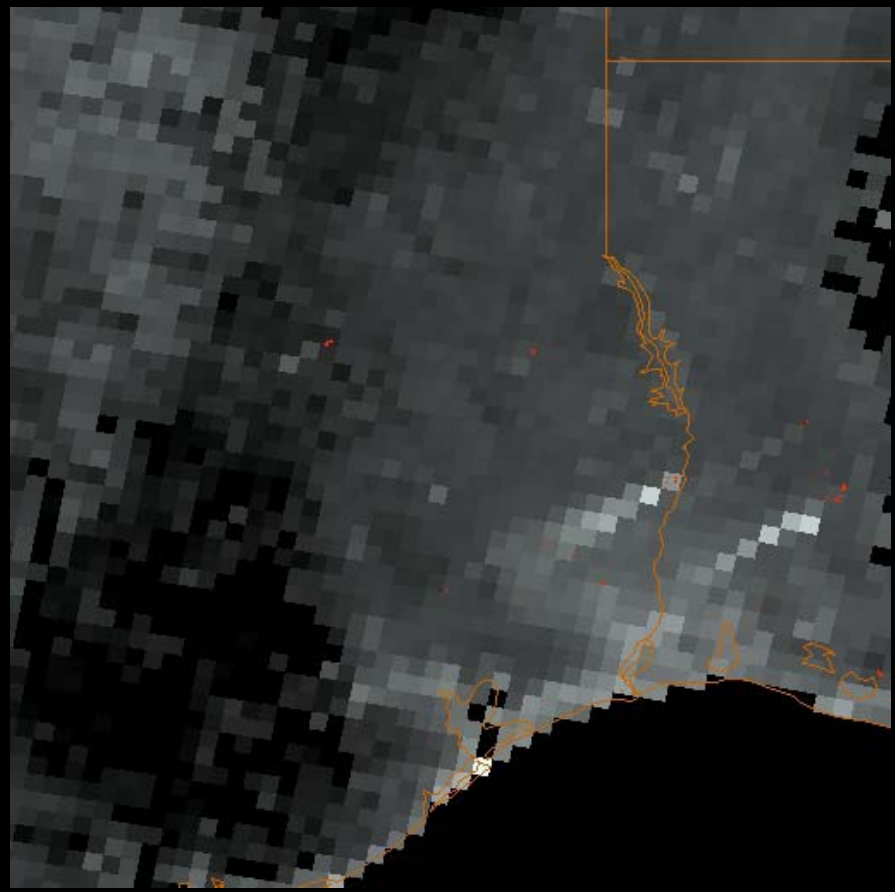


A comparison of Terra MODIS-derived NDVI images (top) from Central Texas and related normalized precipitation departure grids (bottom) illustrates the greening of vegetation as the result of changing hydrological conditions. The monthly precipitation departure topologies serve as the surfaces for both the precipitation and NDVI overlays.


UT LiDAR
+ QuickBird
LiDAR
Structures
LiDAR
Vegetation
LiDAR
Terrain
“Bare Surface”

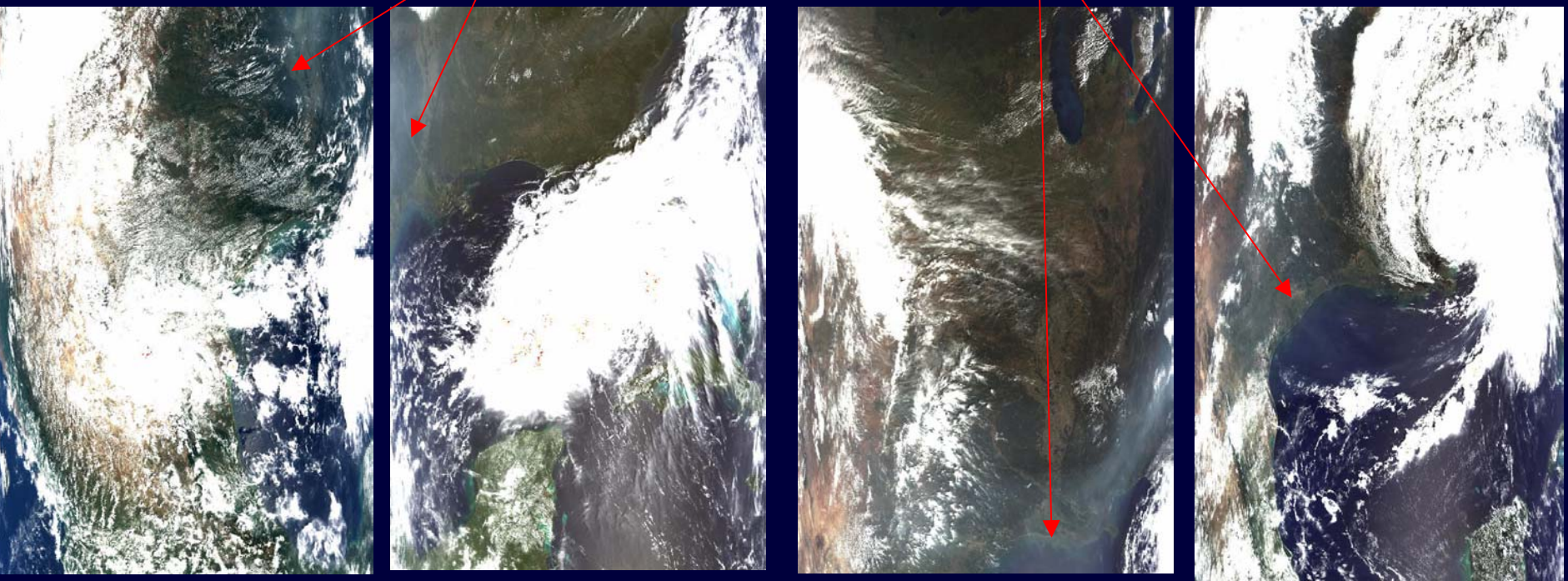
MOODIS Aerosol Optical Depth Products





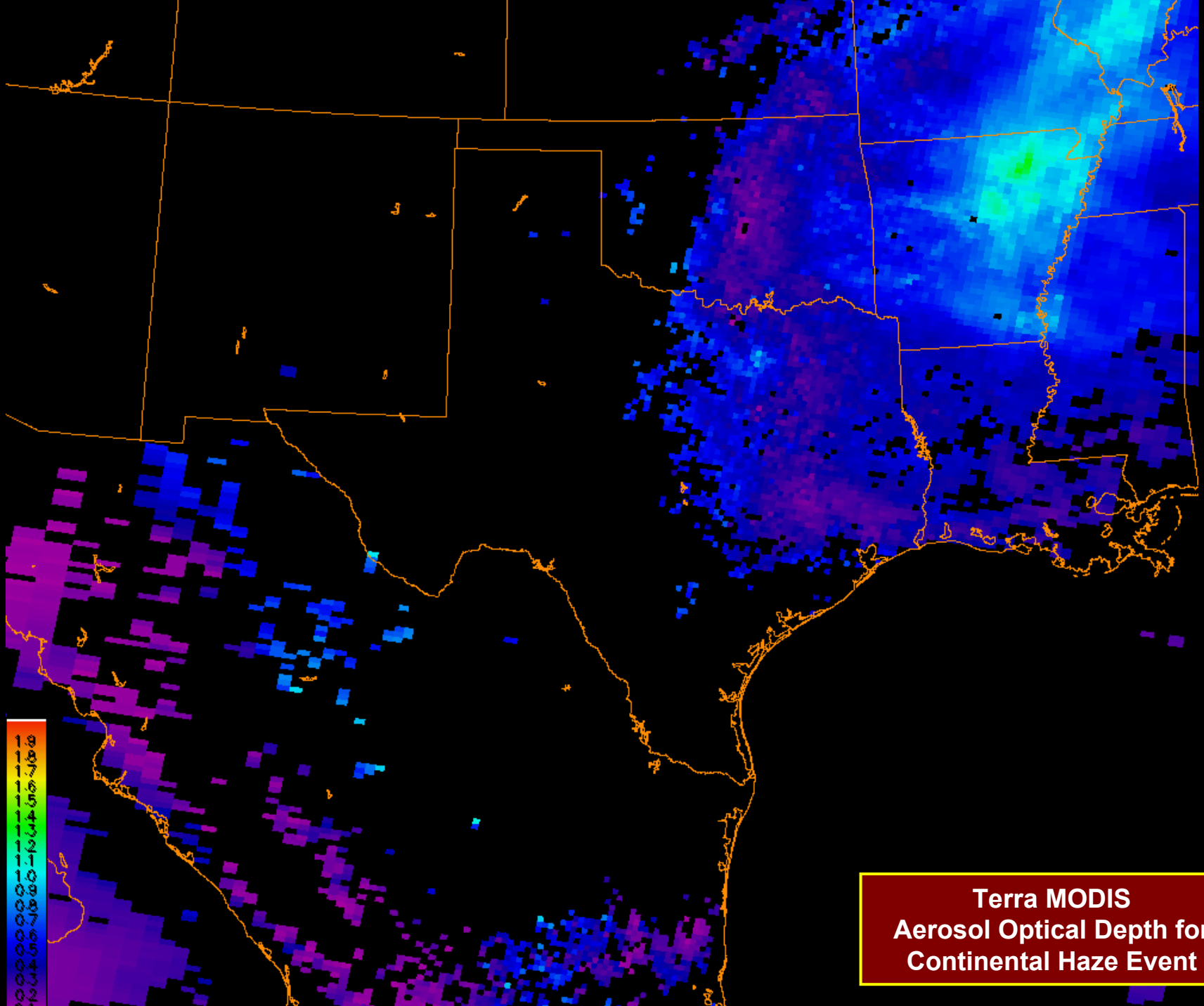
MODIS Imagery Proves Valuable for Monitoring Continental Haze Event*

Continental haze (ozone pollution) uniquely monitored in MODIS Imagery



September 10, 2002 | September 11, 2002 | September 12, 2002 | September 14, 2002

* Hutchison, K. D., 2003: "*Application of MODIS Data and Products for Air Quality Management across the State of Texas*," **Atmospheric Environment 37**: 2403-2412.

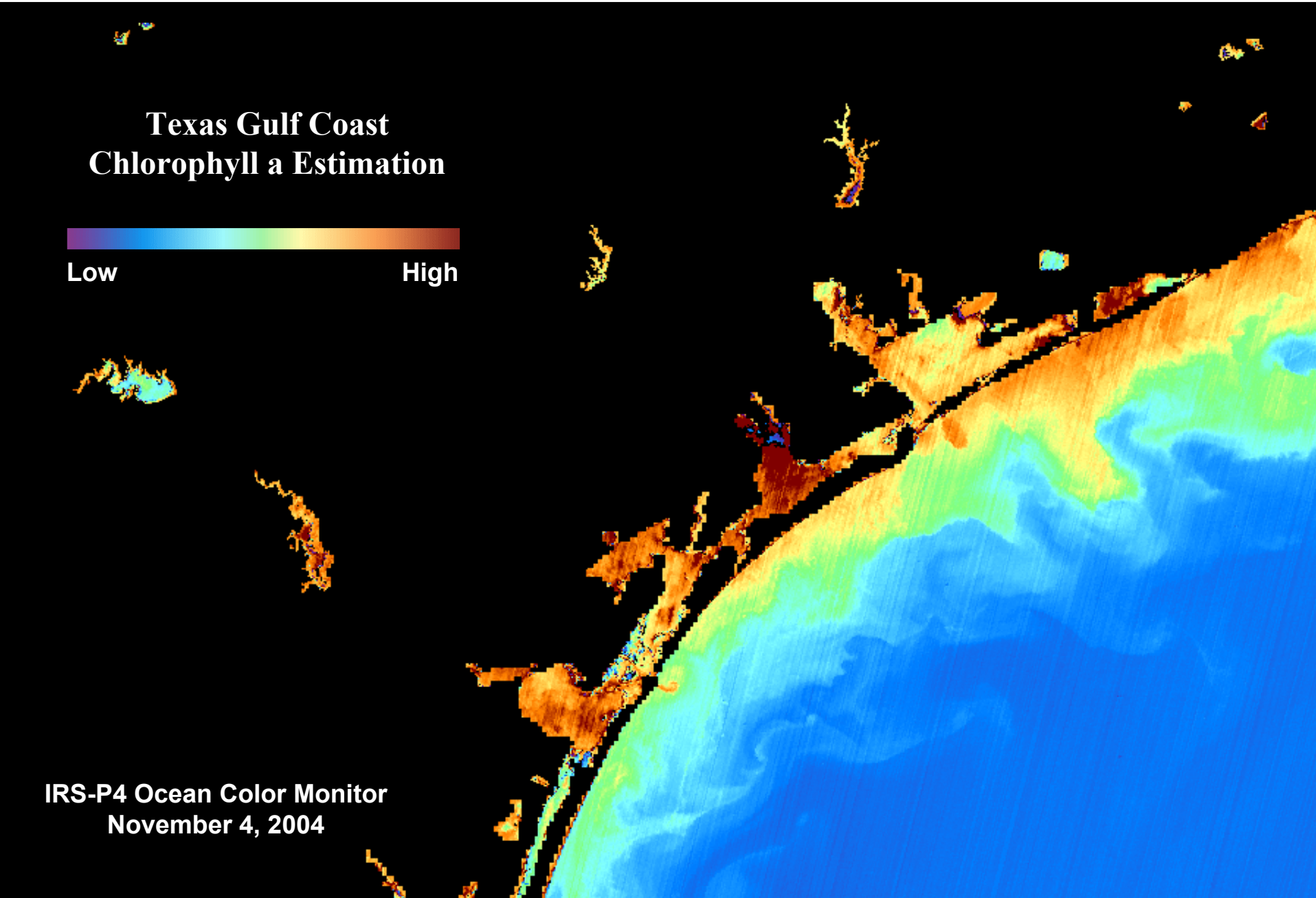

Terra MODIS
Aerosol Optical Depth for
Continental Haze Event

Air Pollution Confirmed by TCEQ Continuous Air Monitoring System Observations

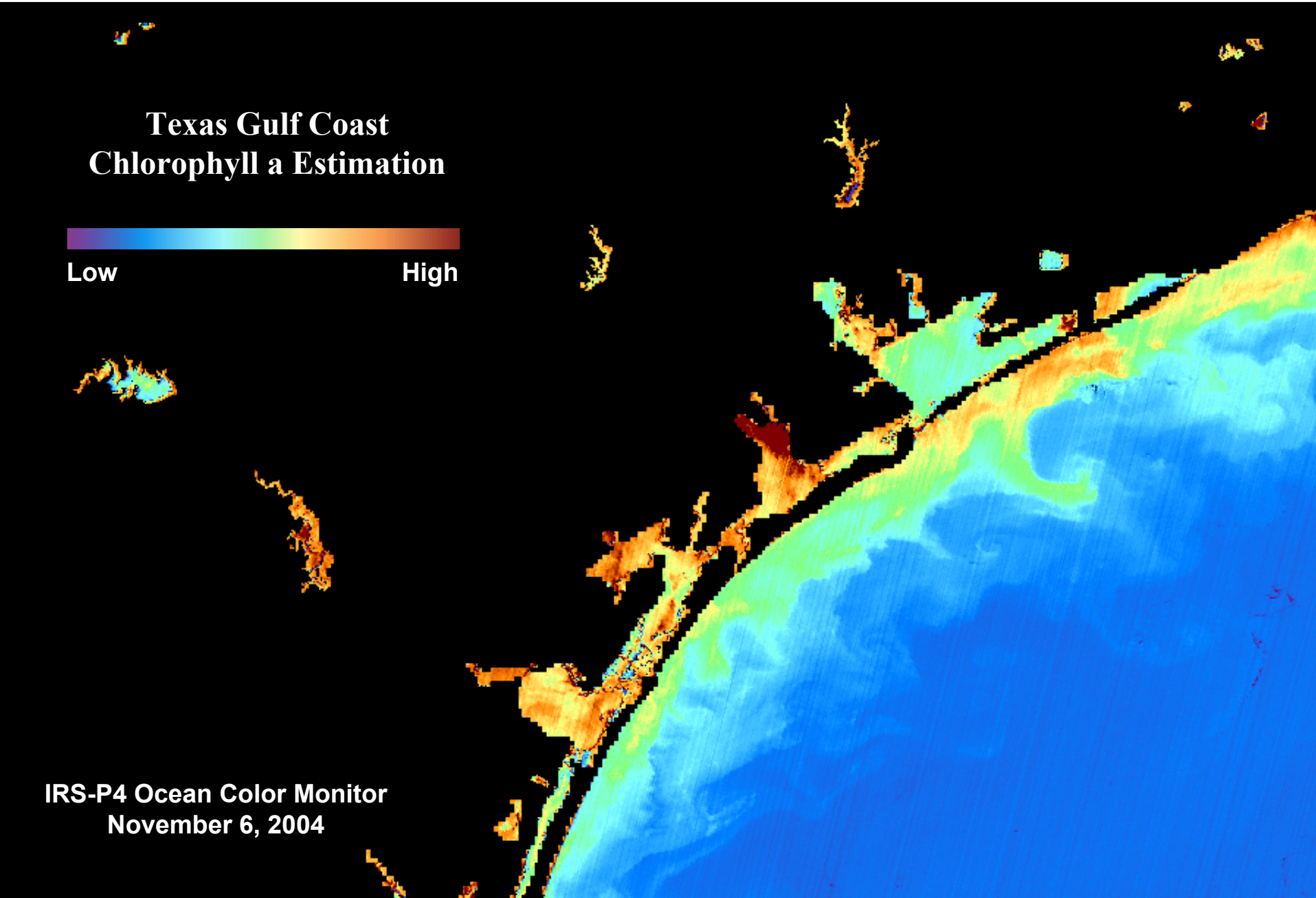
Maximum ozone levels report by TCEQ ground-based instrument during continental haze event.

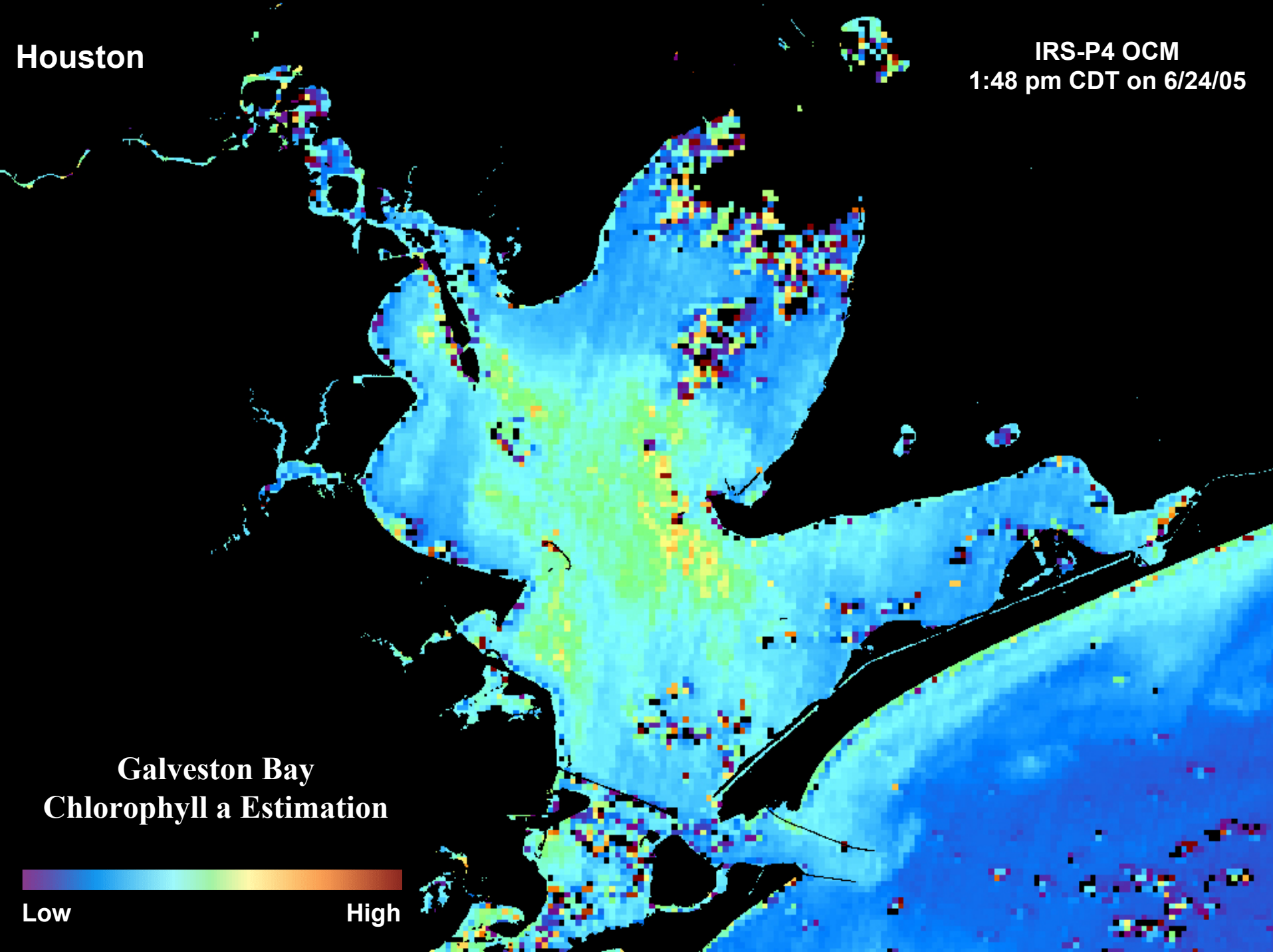
Location		Maximum	Ozone Levels	Reported in	Parts Per Billion	(ppb)		
(CAMS Sites)	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
	9-Sep-02	10-Sep-02	11-Sep-02	12-Sep-02	13-Sep-02	14-Sep-02	15-Sep-02	16-Sep-02
Dallas Hinton St. C401/C60/ C161	56	78	**109**	**102**	**95**	**101**	69	62
Longview C19/C127	49	62	**89**	**81**	**87**	**92**	**107**	47
Beaumont C2/C112	36	67	79	**95**	**81**	**98**	69	24
Austin Northwest C3	39	56	**80**	**100**	**103**	**103**	53	33
Houston Deer Park 2 C35/139/1 001	36	75	**93**	**145**	**161**	**102**	74	22
San Antonio Northwest C23	38	63	79	**130**	**99**	**101**	52	40
Corpus Christi West C4	46	39	76	**107**	**104**	**82**	42	48
Brownsville C80/C180	47	33	29	48	**88**	55	25	32

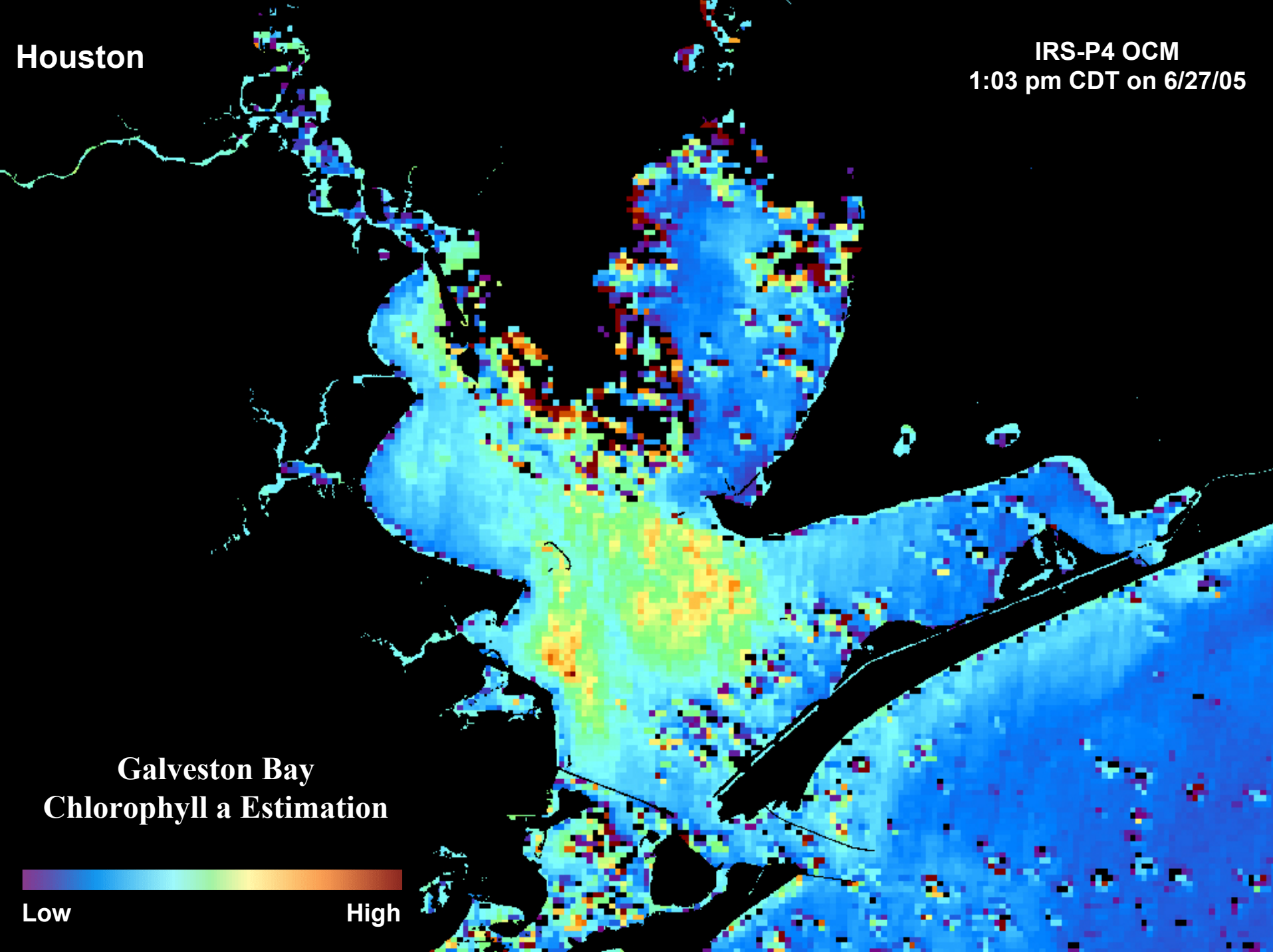
Monitoring Bay and Estuarine Processes

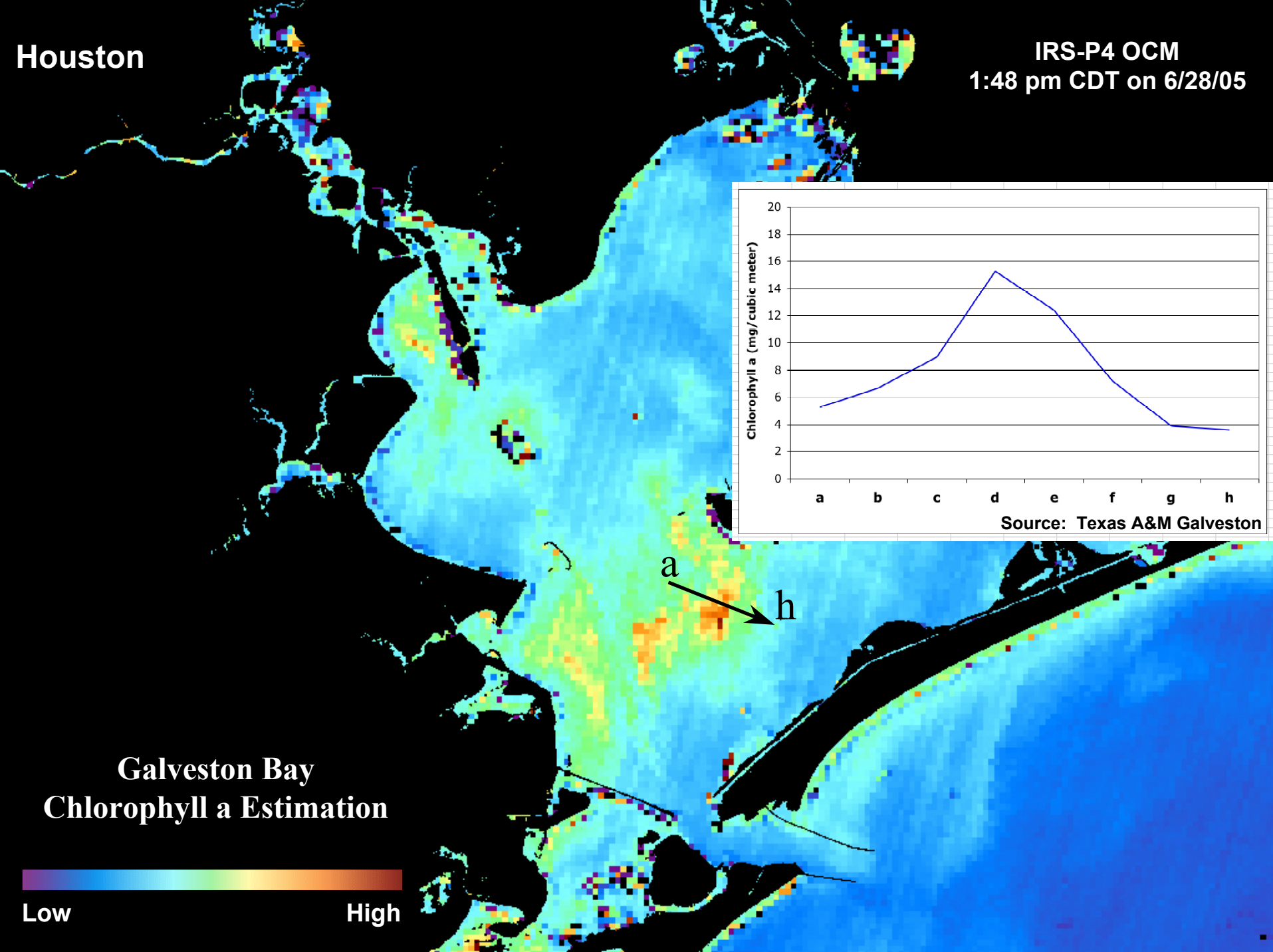


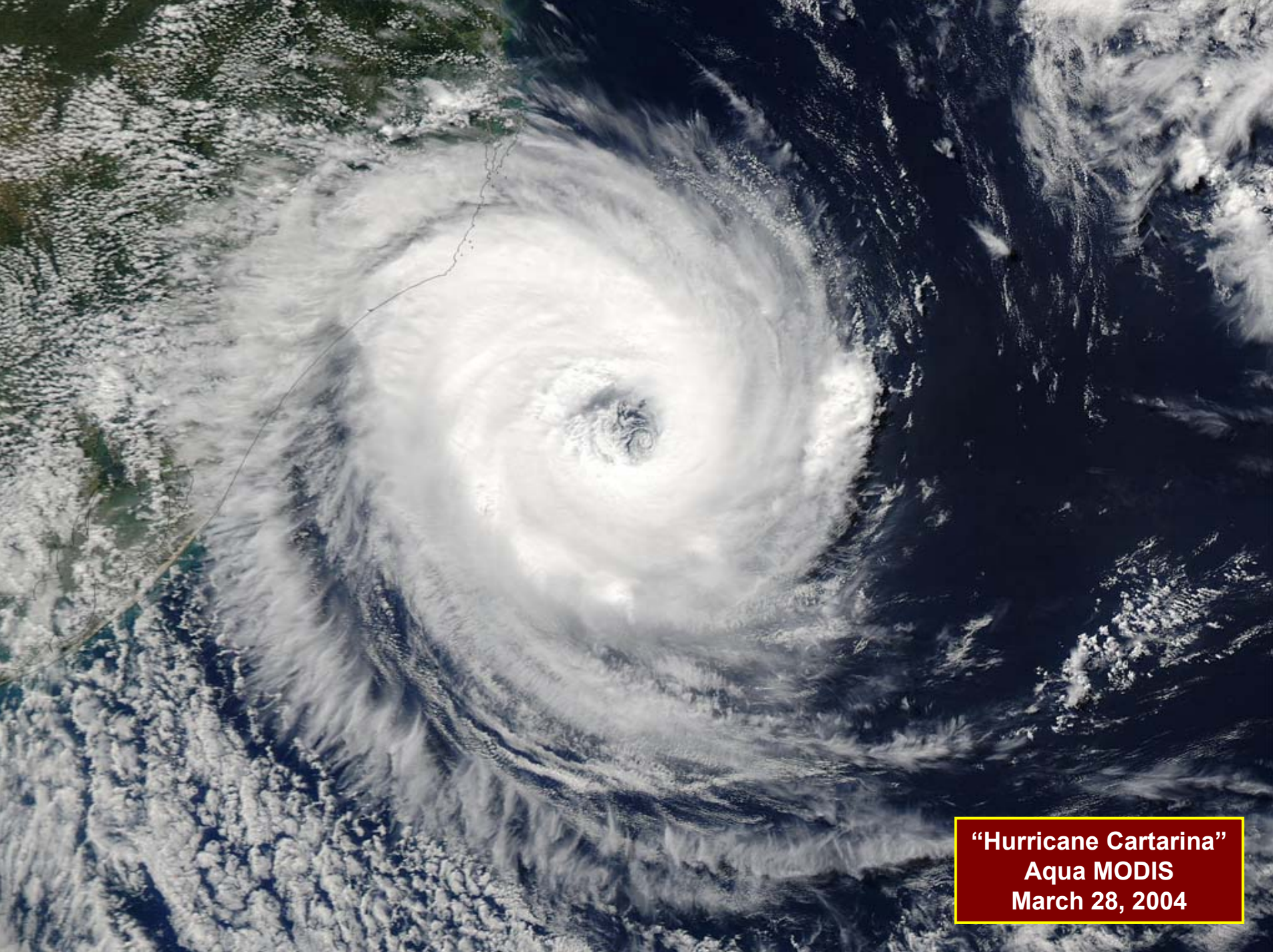
Monitoring Bay and Estuarine Processes

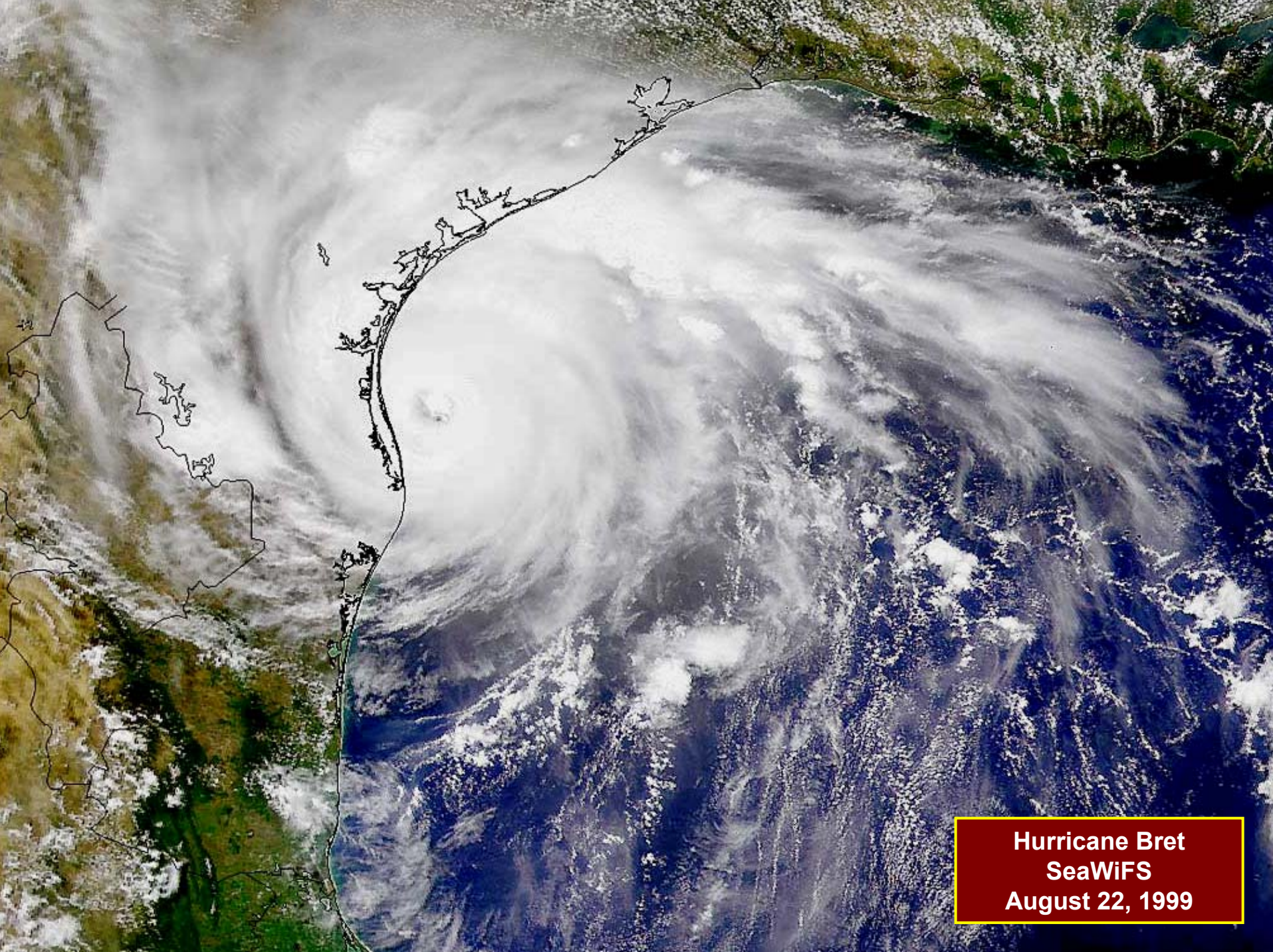


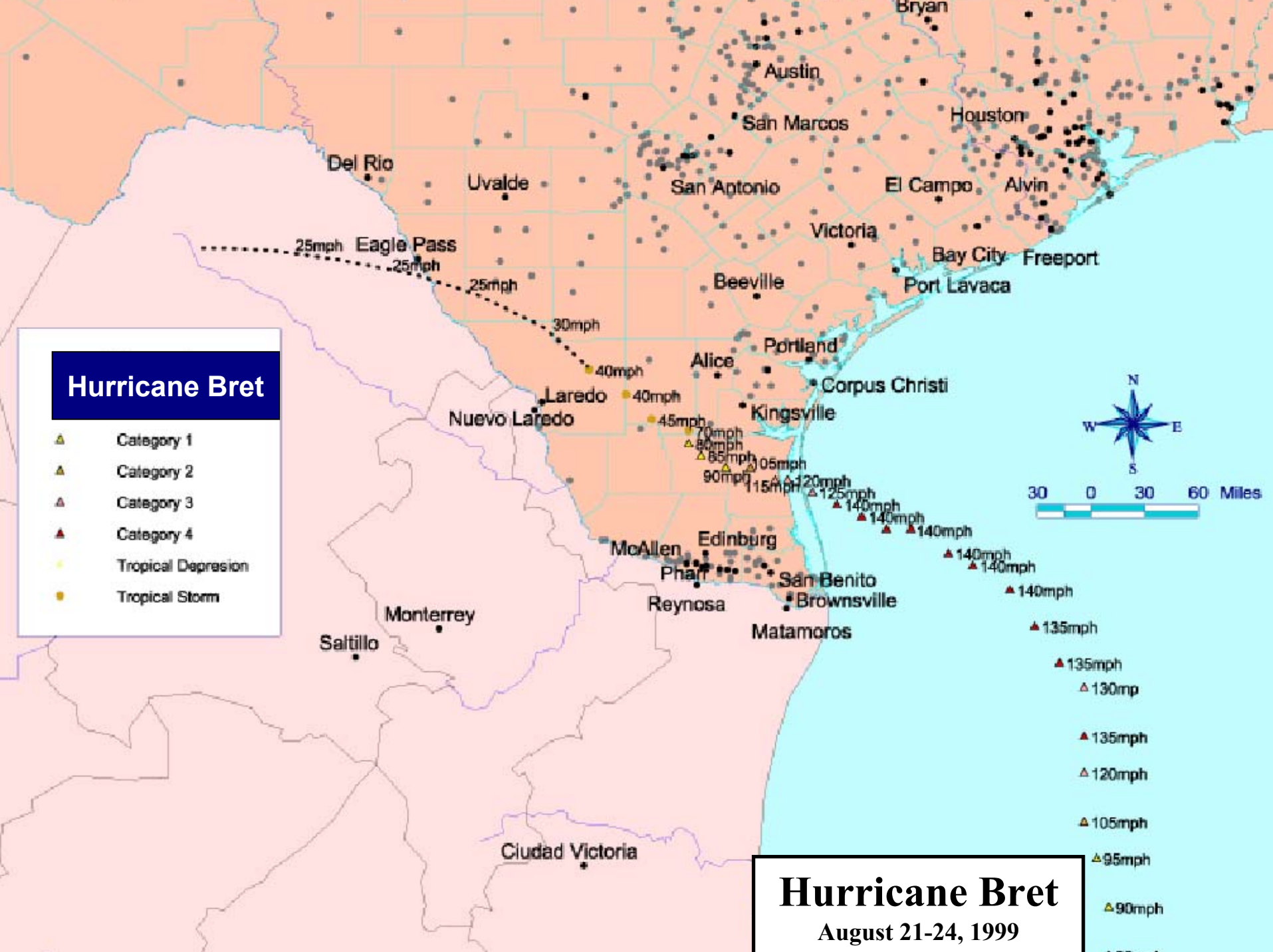

Houston
IRS-P4 OCM
1:48 pm CDT on 6/24/05
Galveston Bay
Chlorophyll a Estimation
Low
High


Houston
IRS-P4 OCM
1:03 pm CDT on 6/27/05
Galveston Bay
Chlorophyll a Estimation
Low
High

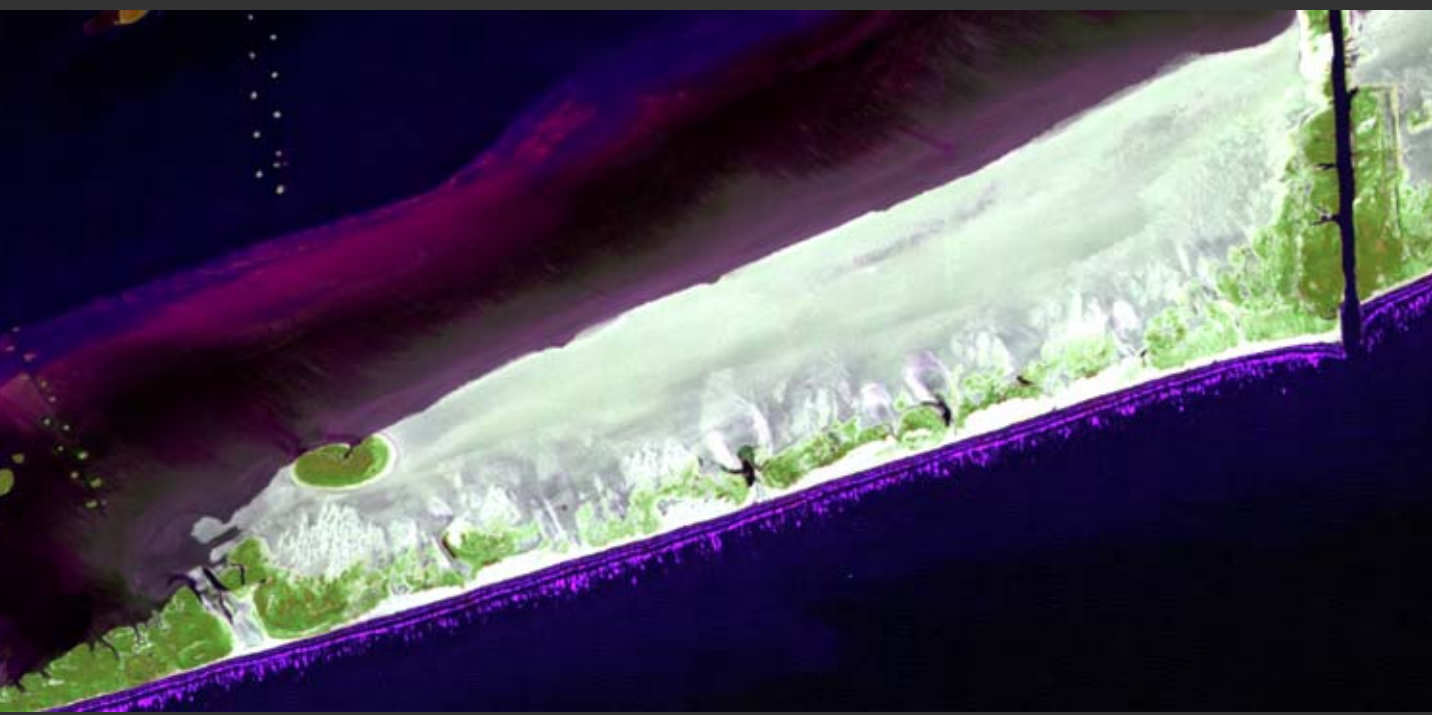

Houston
IRS-P4 OCM
1:48 pm CDT on 6/28/05
Chlorophyll a (mg/cubic meter)
20
18
16
14
12
10
8
6
4
2
0
a
b
c
d
e
f
g
h
Source: Texas A&M Galveston
a
h
Galveston Bay
Chlorophyll a Estimation
Low
High

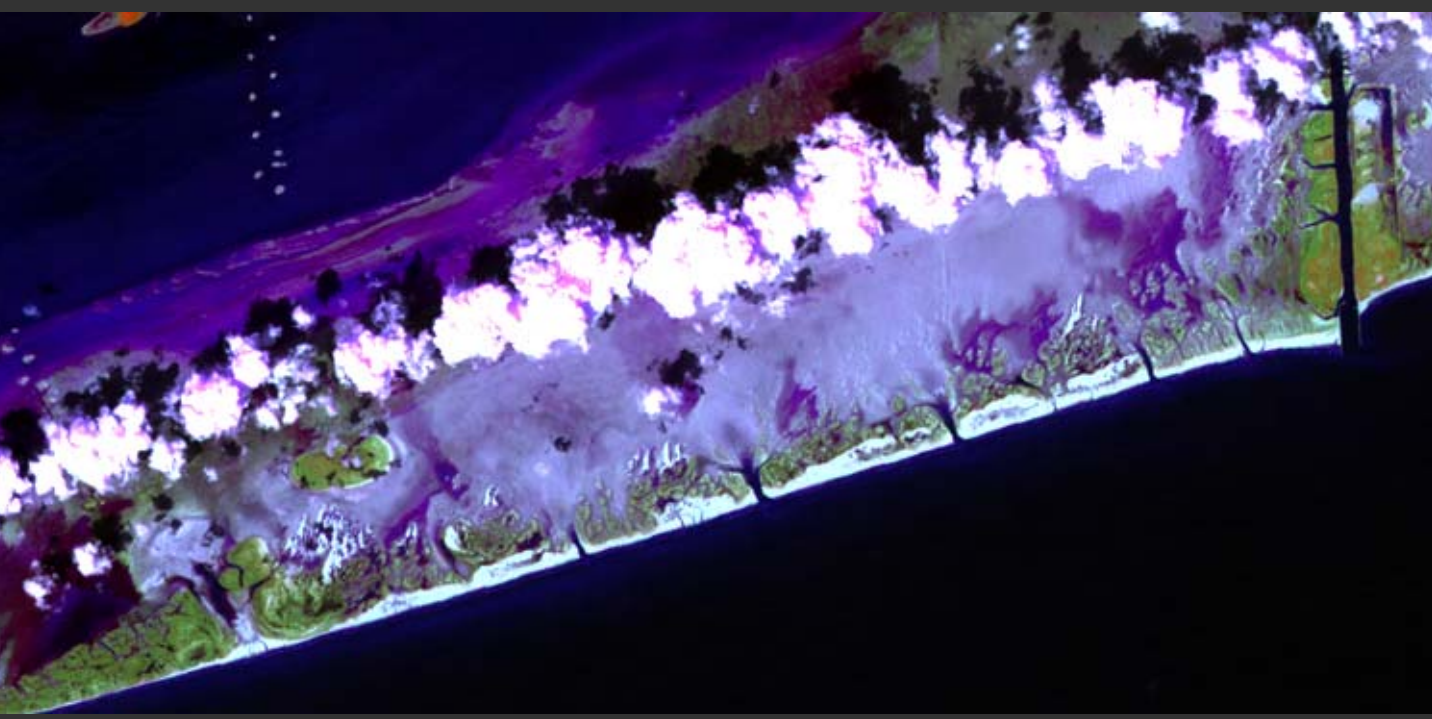

“Hurricane Cartarina”
Aqua MODIS
March 28, 2004


Hurricane Bret
SeaWiFS
August 22, 1999


Hurricane Bret
Category 1
Category 2
Category 3
Category 4
Tropical Depression
Tropical Storm
Bryan
Austin
San Marcos
Houston
Del Rio
Uvalde
San Antonio
El Campo
Alvin
Victoria
Eagle Pass
25mph
25mph
25mph
30mph
40mph
Bay City
Freeport
Beeville
Port Lavaca
Portland
Alice
Corpus Christi
Laredo
40mph
Nuevo Laredo
45mph
Kingsville
70mph
65mph
105mph
90mph
115mph
120mph
125mph
140mph
140mph
140mph
140mph
140mph
140mph
McAllen
Edinburg
Pharr
San Benito
Brownsville
Reynosa
Matamoros
Monterrey
Saltillo
135mph
135mph
130mp
135mph
120mph
105mph
95mph
90mph
Ciudad Victoria
N
W
E
S
30 0 30 60 Miles
Hurricane Bret
August 21-24, 1999

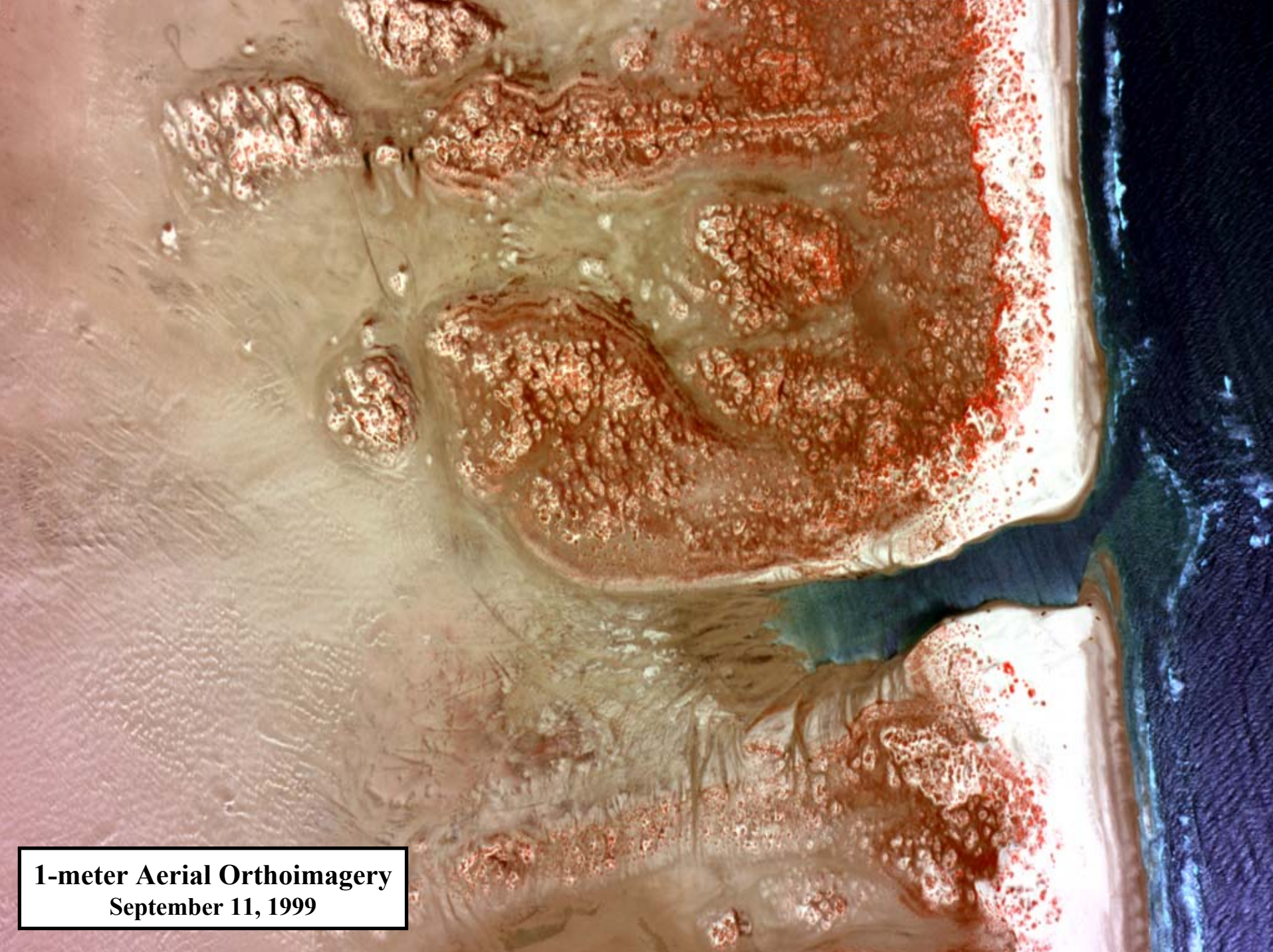
(May 19, 1995) (Landsat 5 TM)

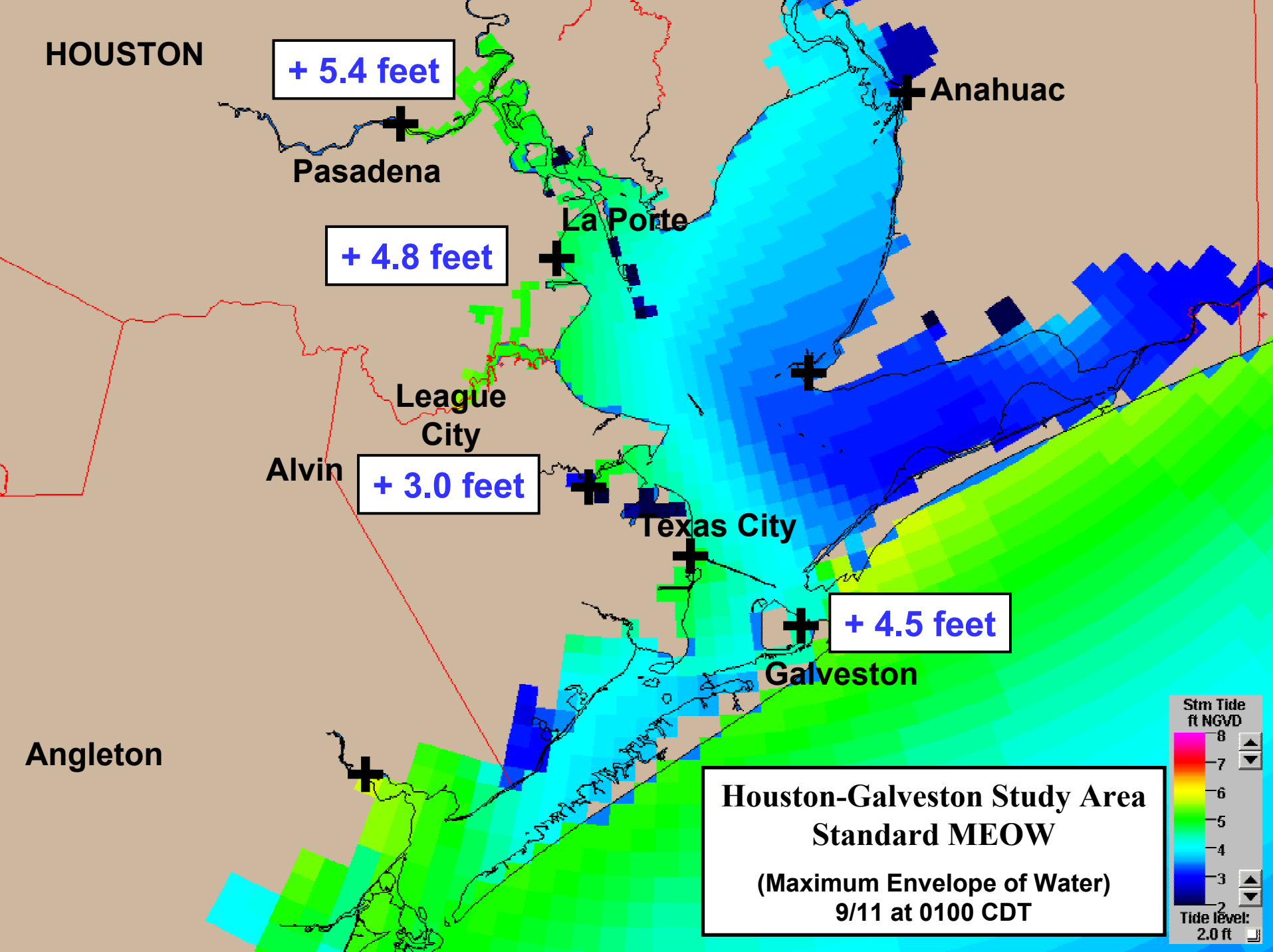


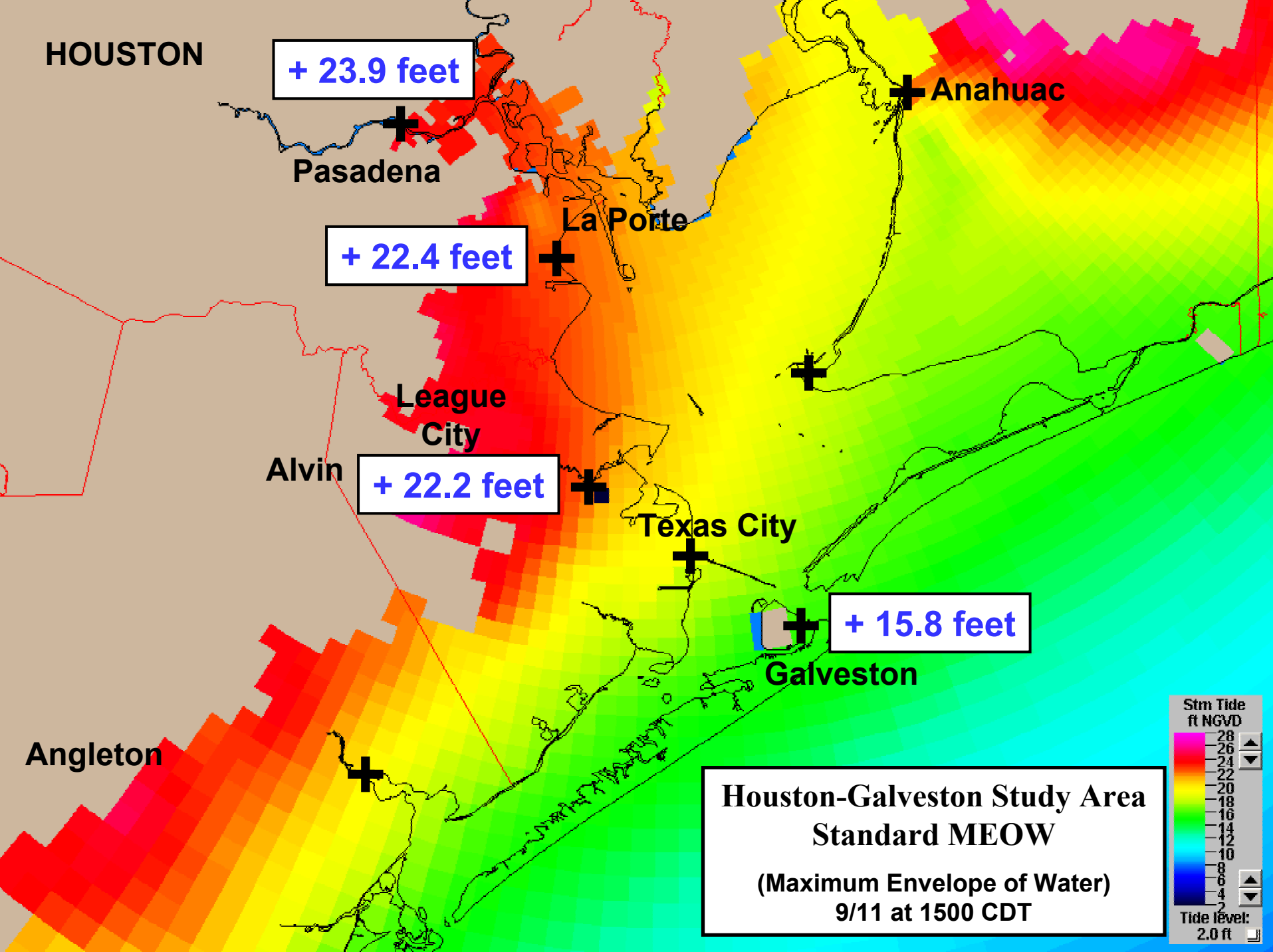


(September 11, 1999) (Landsat 7 ETM+)

1-meter Aerial Orthoimagery
February 2, 1995


1-meter Aerial Orthoimagery
September 11, 1999


HOUSTON
+ 5.4 feet
Pasadena
Anahuac
La Porte
+ 4.8 feet
League City
Alvin
+ 3.0 feet
Texas City
+ 4.5 feet
Galveston
Angleton
Houston-Galveston Study Area
Standard MEOW
(Maximum Envelope of Water)
9/11 at 0100 CDT
Stm Tide
ft NGVD
8
7
6
5
4
3
2
Tide level:
2.0 ft


HOUSTON
+ 23.9 feet
Pasadena
Anahuac
La Porte
+ 22.4 feet
League City
Alvin
+ 22.2 feet
Texas City
+ 15.8 feet
Galveston
Angleton
Houston-Galveston Study Area
Standard MEOW
(Maximum Envelope of Water)
9/11 at 1500 CDT
Stm Tide
ft NGVD
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Tide level:
2.0 ft


Dickinson
Texas City
Galveston
Houston-Galveston
Study Area
Mean Sea Level

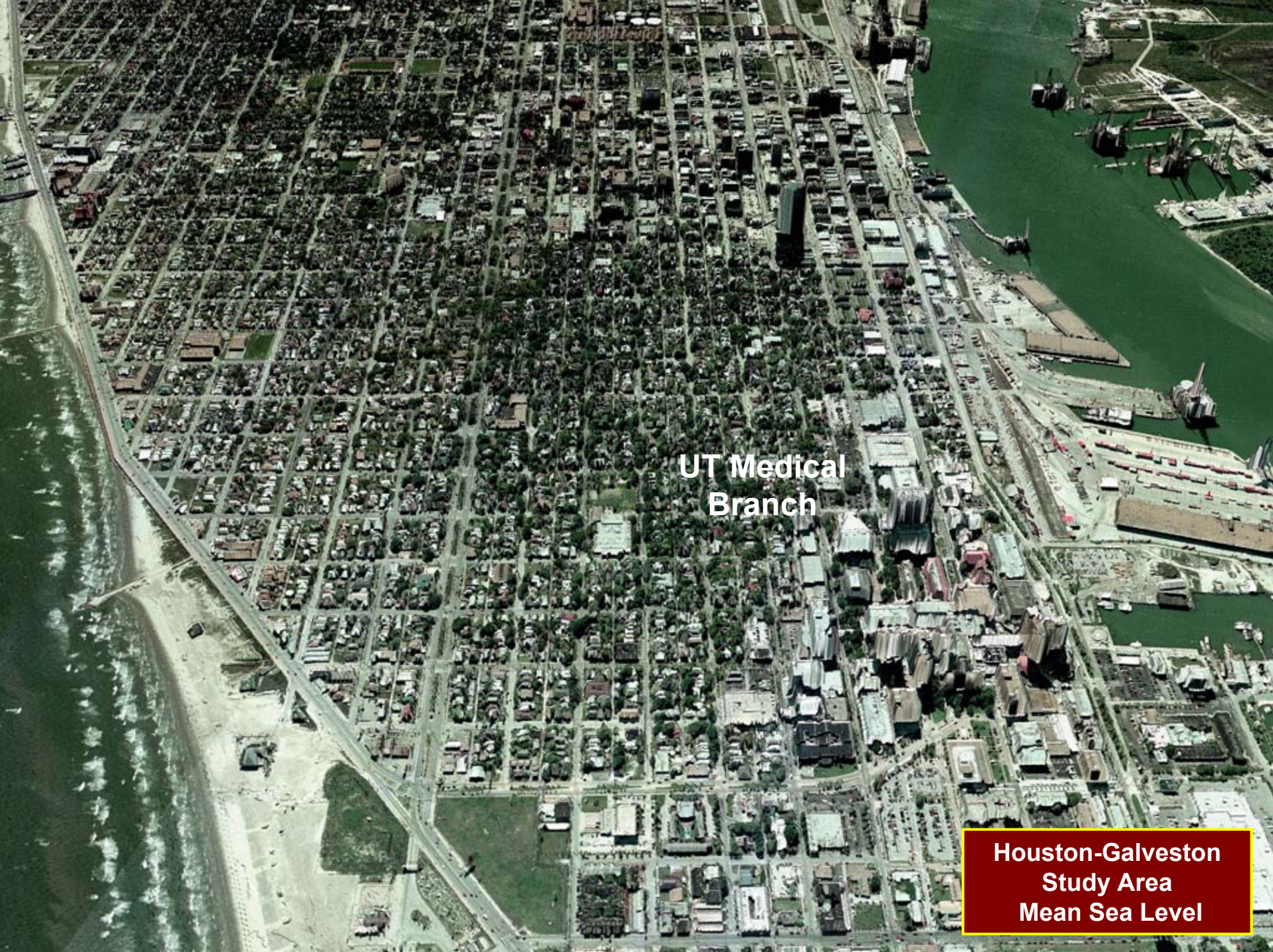

Dickinson
Texas City
Galveston
Hurricane Carly
9/11 at 0100 CDT
MEOW NW at 8 MPH
Surge: 4.5 Feet

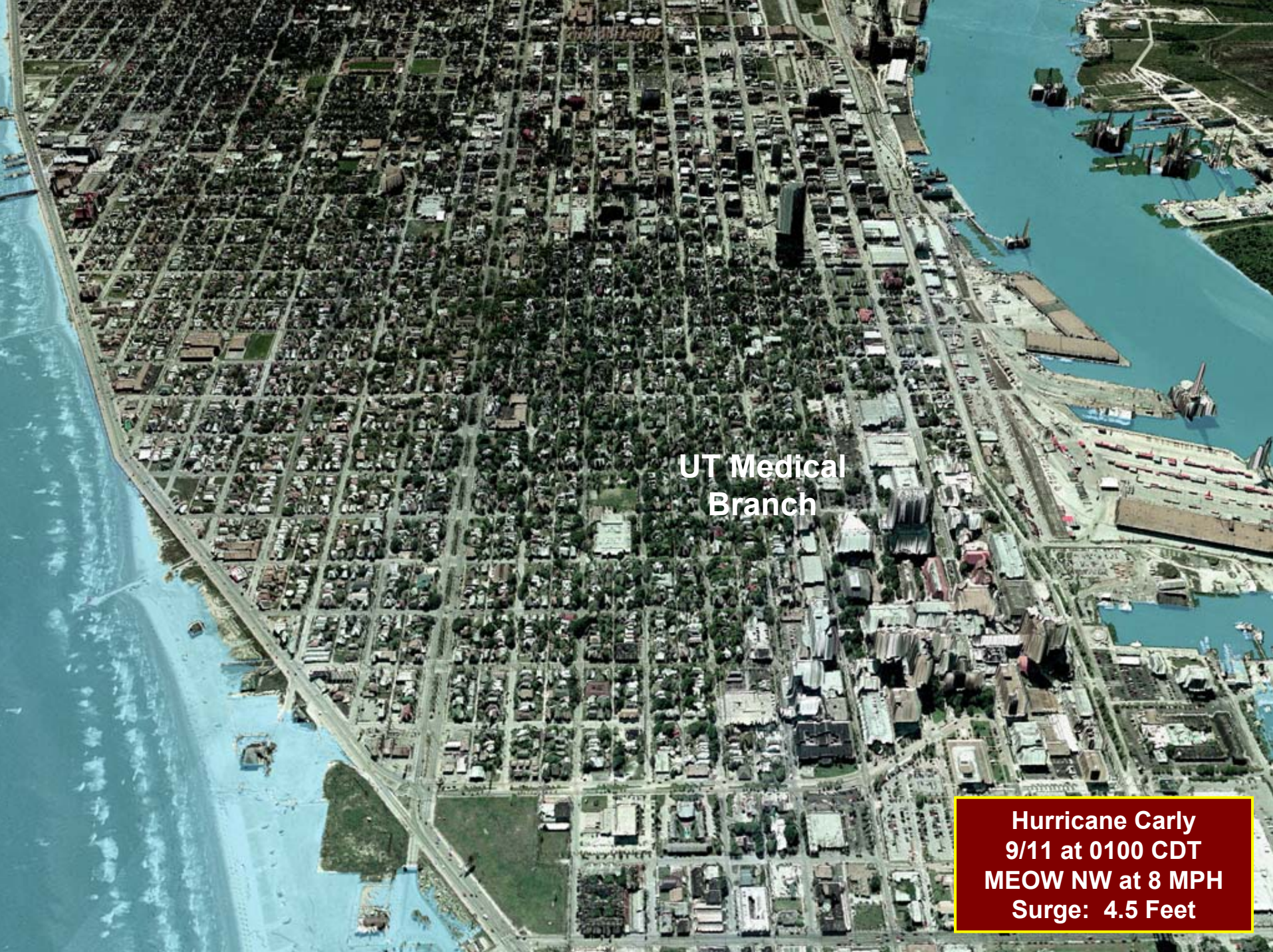

Dickinson
Texas City
Galveston
Hurricane Carly
9/11 at 0500 CDT
MEOW NW at 8 MPH
Surge: 8.5 Feet

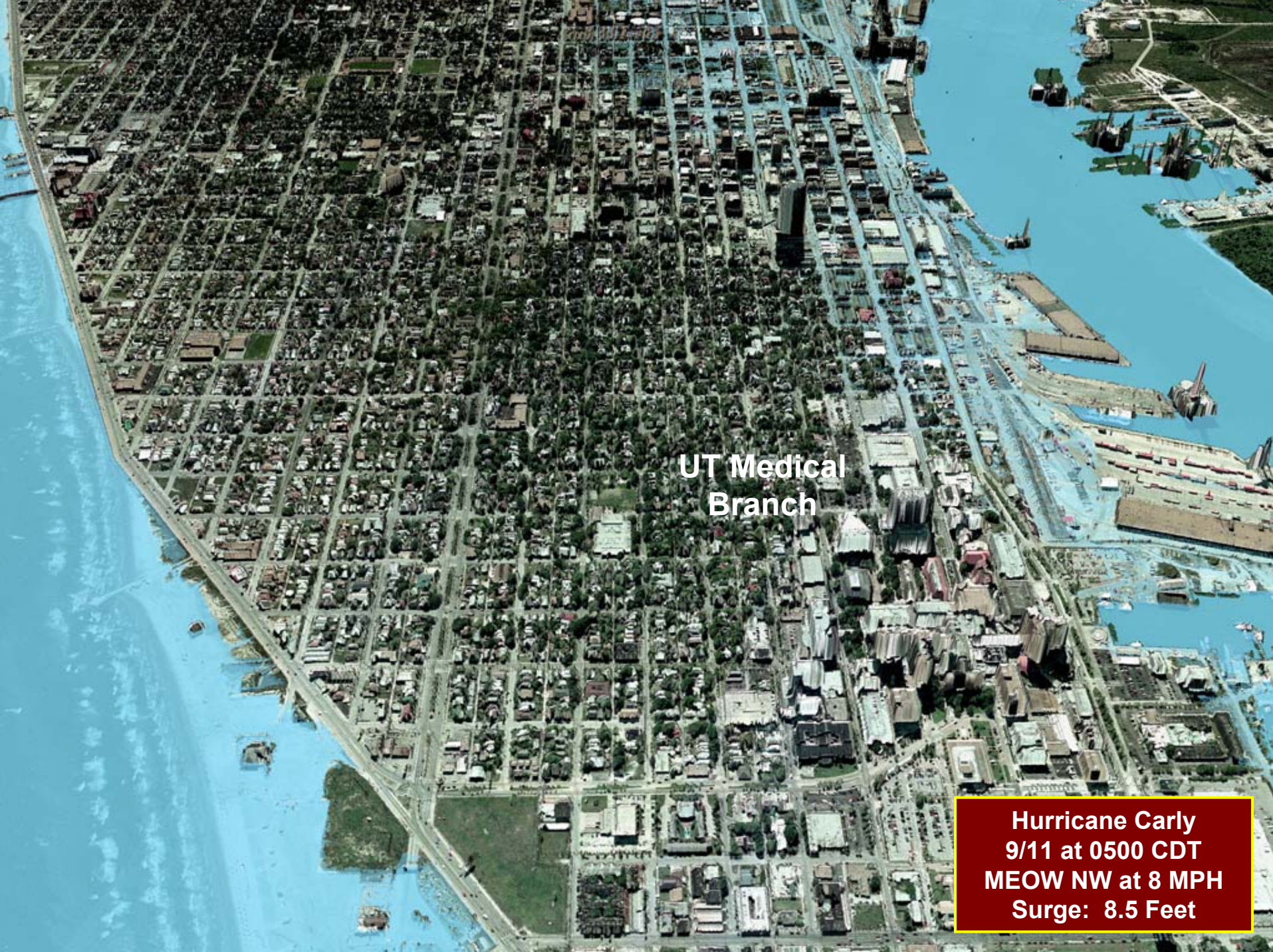

Dickinson
Texas City
Galveston
Hurricane Carly
9/11 at 1000 CDT
MEOW NW at 8 MPH
Surge: 12.8 Feet

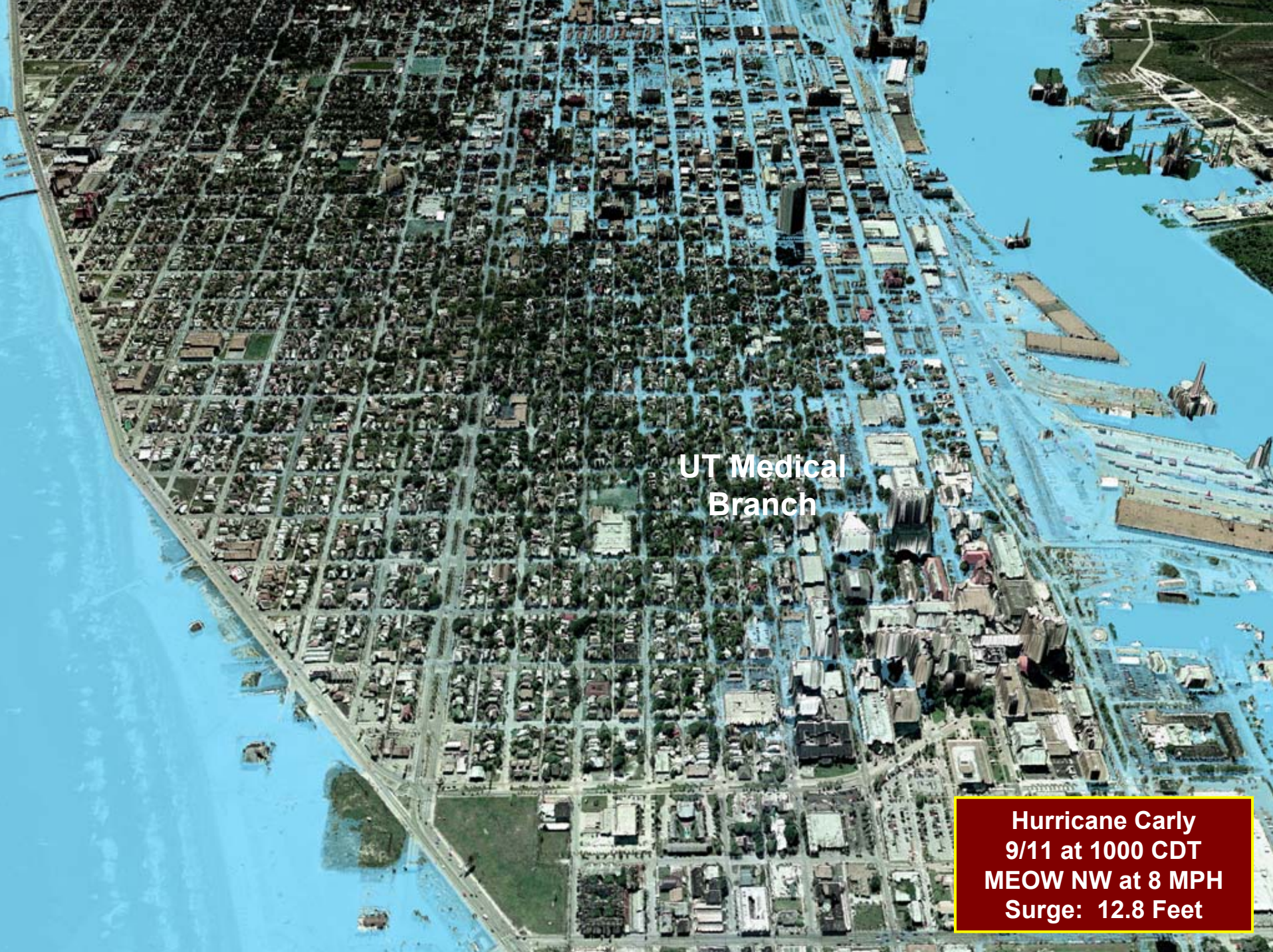

Dickinson
Texas City
Galveston
Hurricane Carly
9/11 at 1500 CDT
MEOW NW at 8 MPH
Surge: 15.8 Feet


Dickinson
Texas City
Galveston
Hurricane Carly
Category 5
MEOW NW at 8 MPH
Surge: 19.0 Feet


UT Medical
Branch
Houston-Galveston
Study Area
Mean Sea Level


UT Medical
Branch
Hurricane Carly
9/11 at 0100 CDT
MEOW NW at 8 MPH
Surge: 4.5 Feet


UT Medical
Branch
Hurricane Carly
9/11 at 0500 CDT
MEOW NW at 8 MPH
Surge: 8.5 Feet


UT Medical
Branch
Hurricane Carly
9/11 at 1000 CDT
MEOW NW at 8 MPH
Surge: 12.8 Feet


UT Medical
Branch
Hurricane Carly
9/11 at 1500 CDT
MEOW NW at 8 MPH
Surge: 15.8 Feet


UT Medical
Branch
Hurricane Carly
Category 5
MEOW NW at 8 MPH
Surge: 19.0 Feet


Houston-Galveston
Study Area
Mean Sea Level

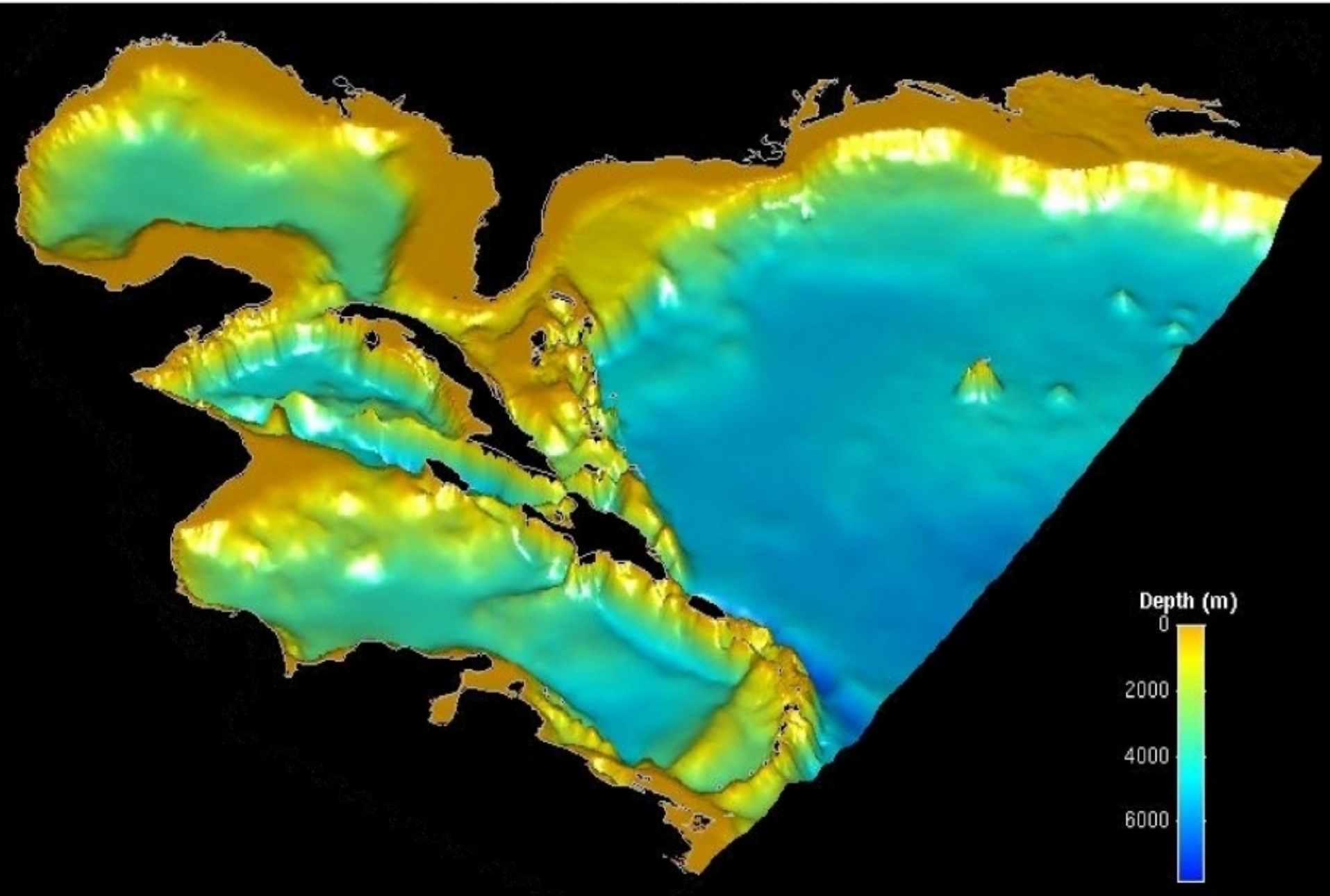

Hurricane Carly
Category 5
MEOW NW at 8 MPH
Surge: 19.0 Feet

Long Term ADCIRC Partners and Sponsors

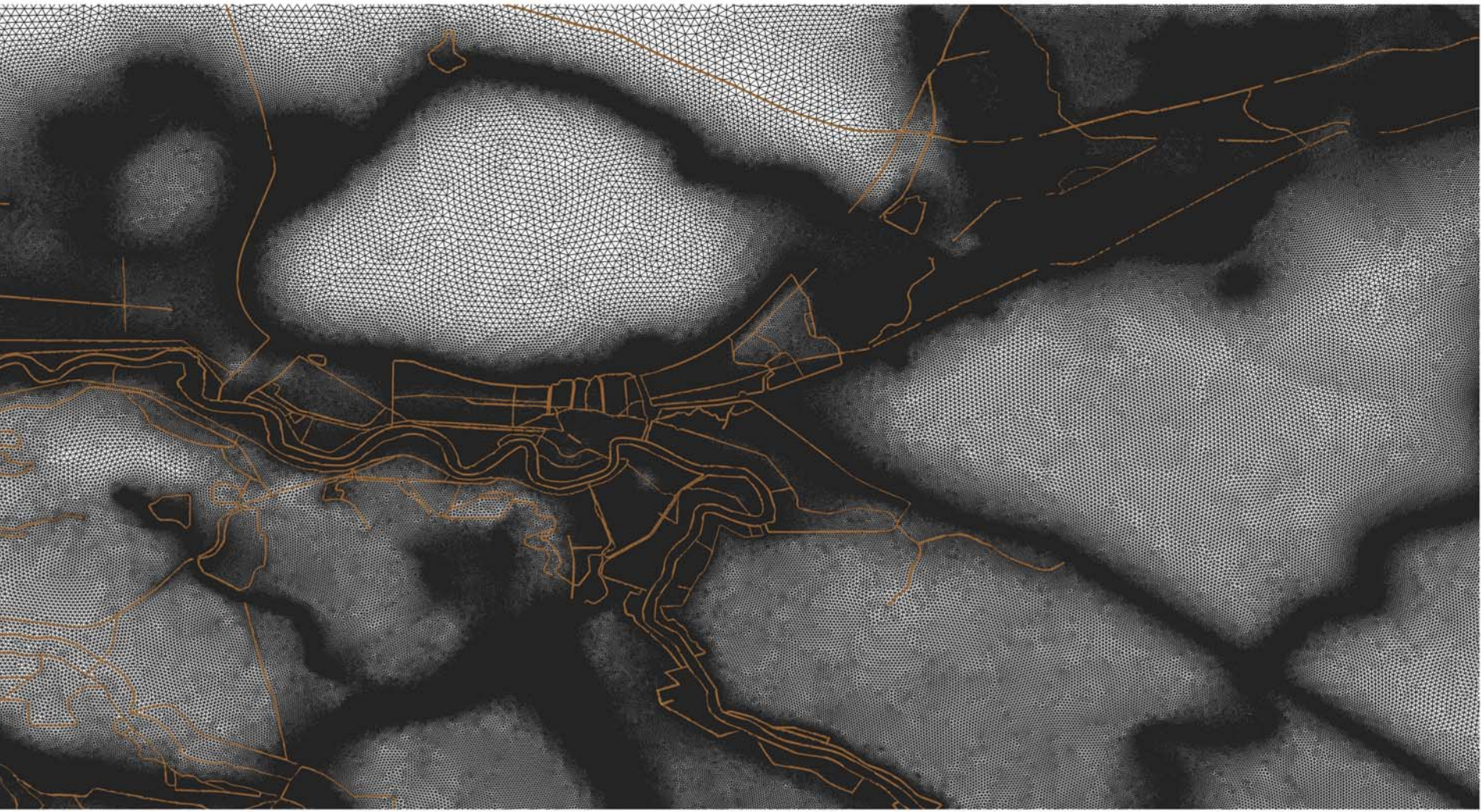
ADCIRC Development

Significant Funding

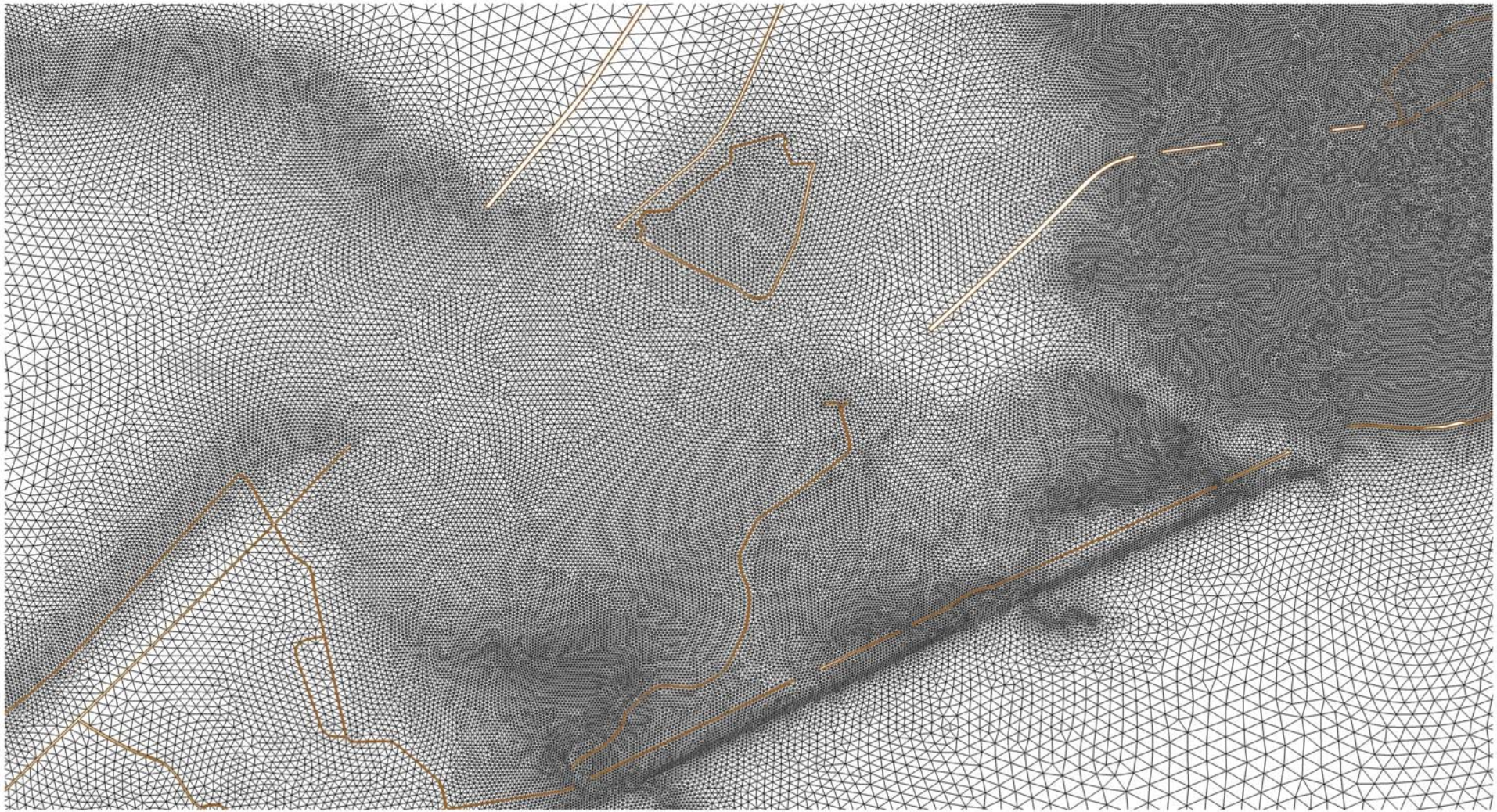
West Atlantic / Gulf Coast ADCIRC Model Domain



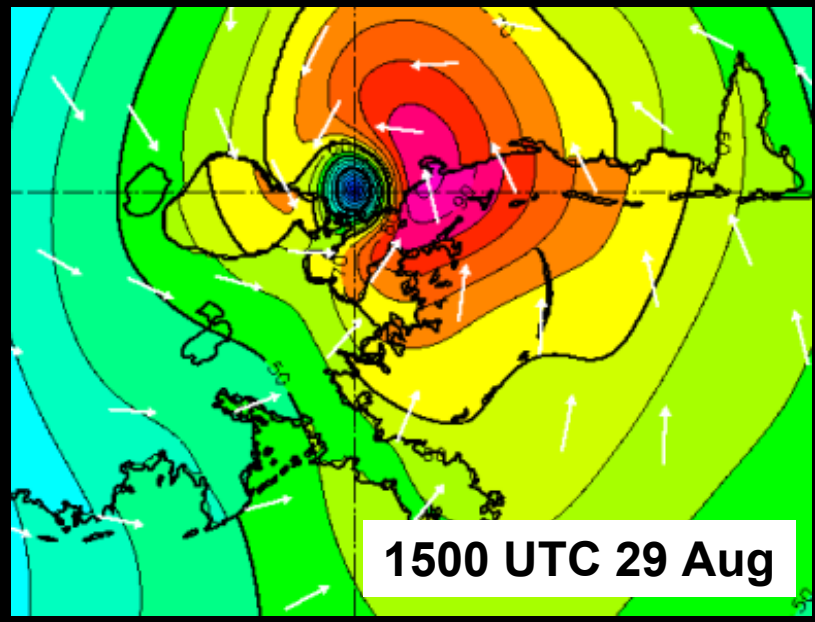
ADCIRC Model Grid for New Orleans, Louisiana

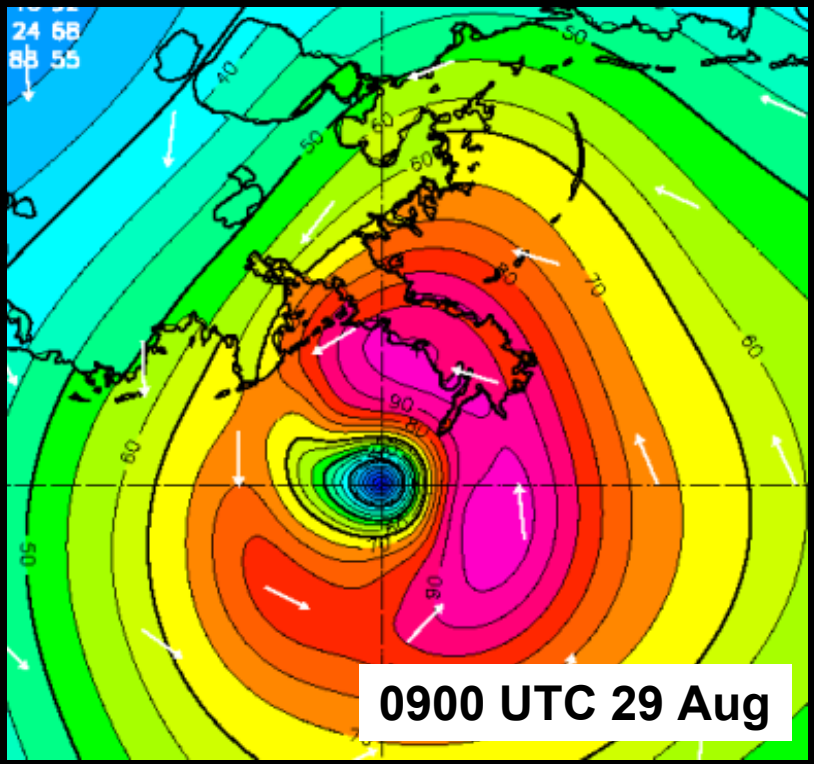


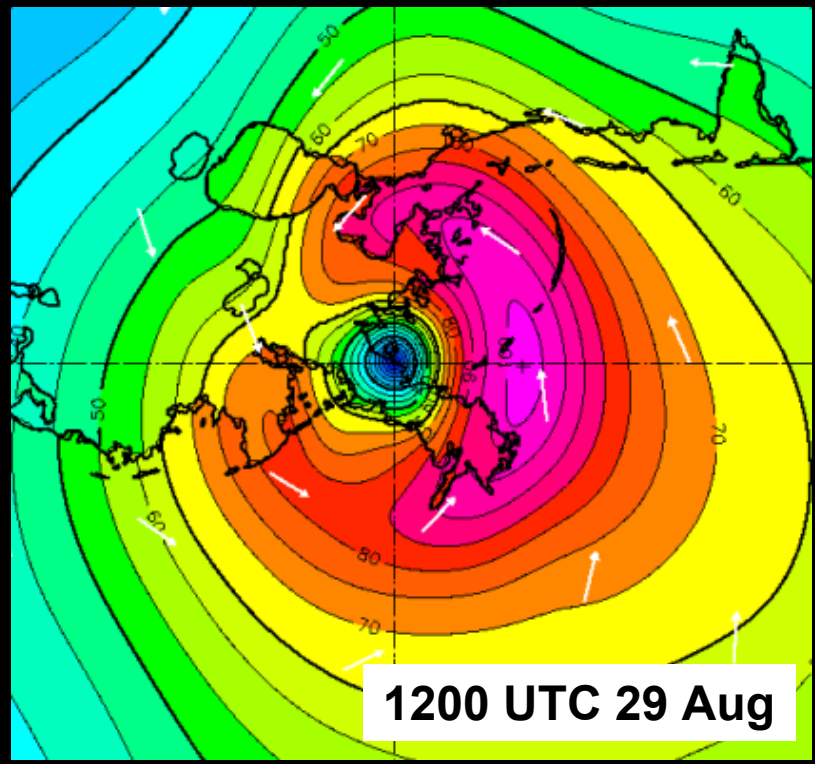
ADCIRC Model Grid for Lake Ponchartrain Outlet



H*Wind Snapshots Near Landfall

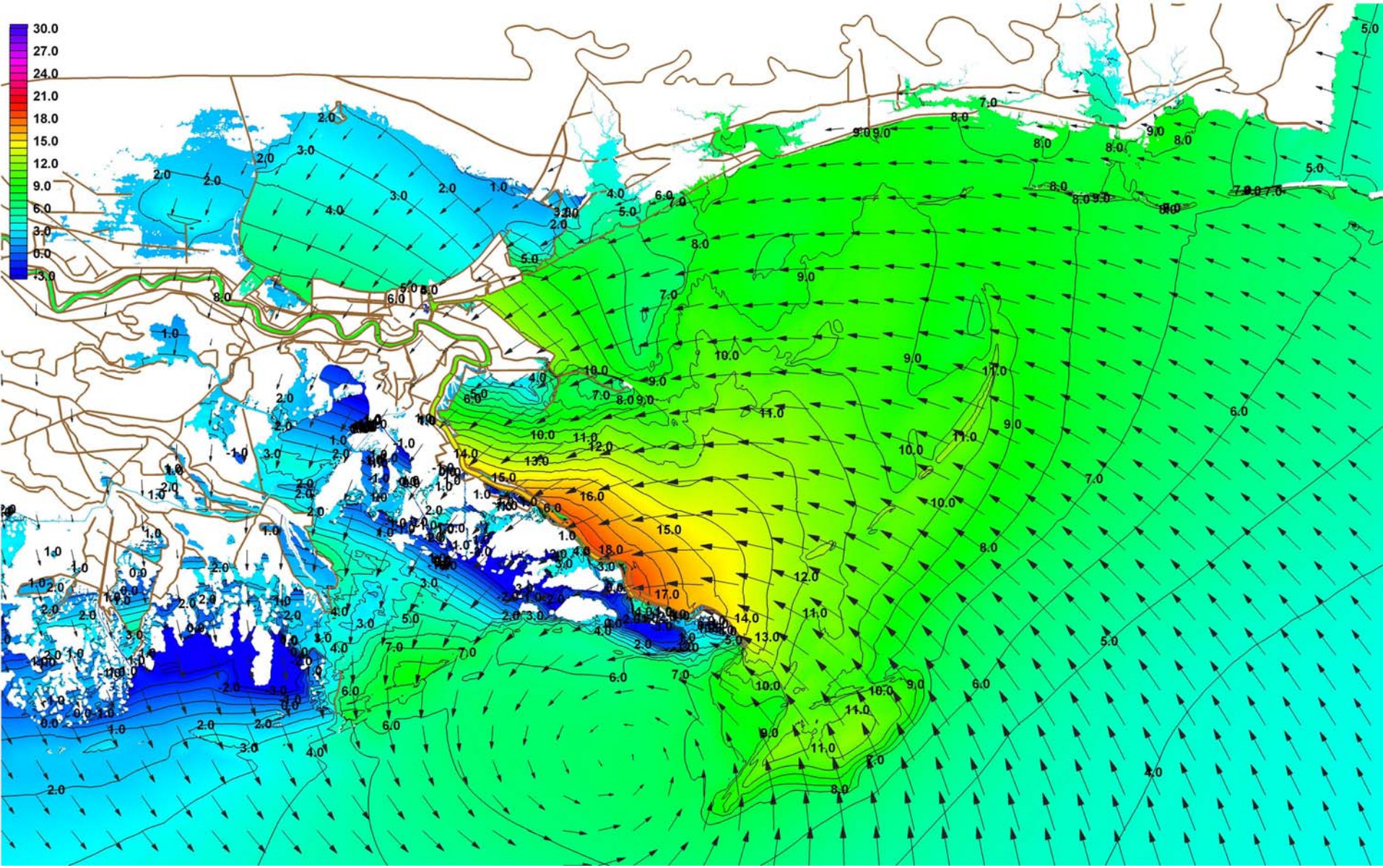






8/29/10Z

Hurricane Katrina Storm Surge

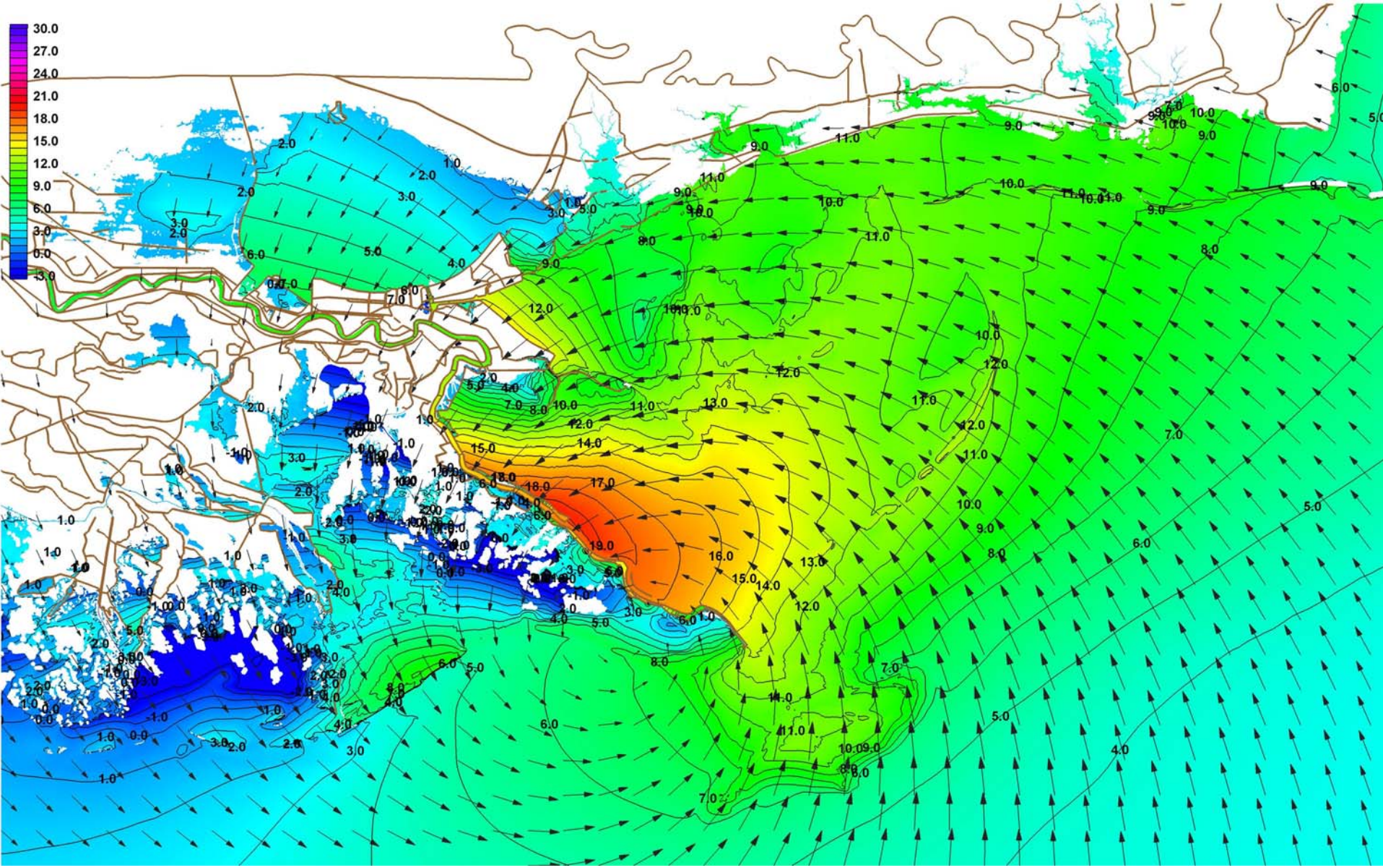


Joannes Westerink and Clint Dawson

ADCIRC Development Team, 2007

8/29/11Z

Hurricane Katrina Storm Surge

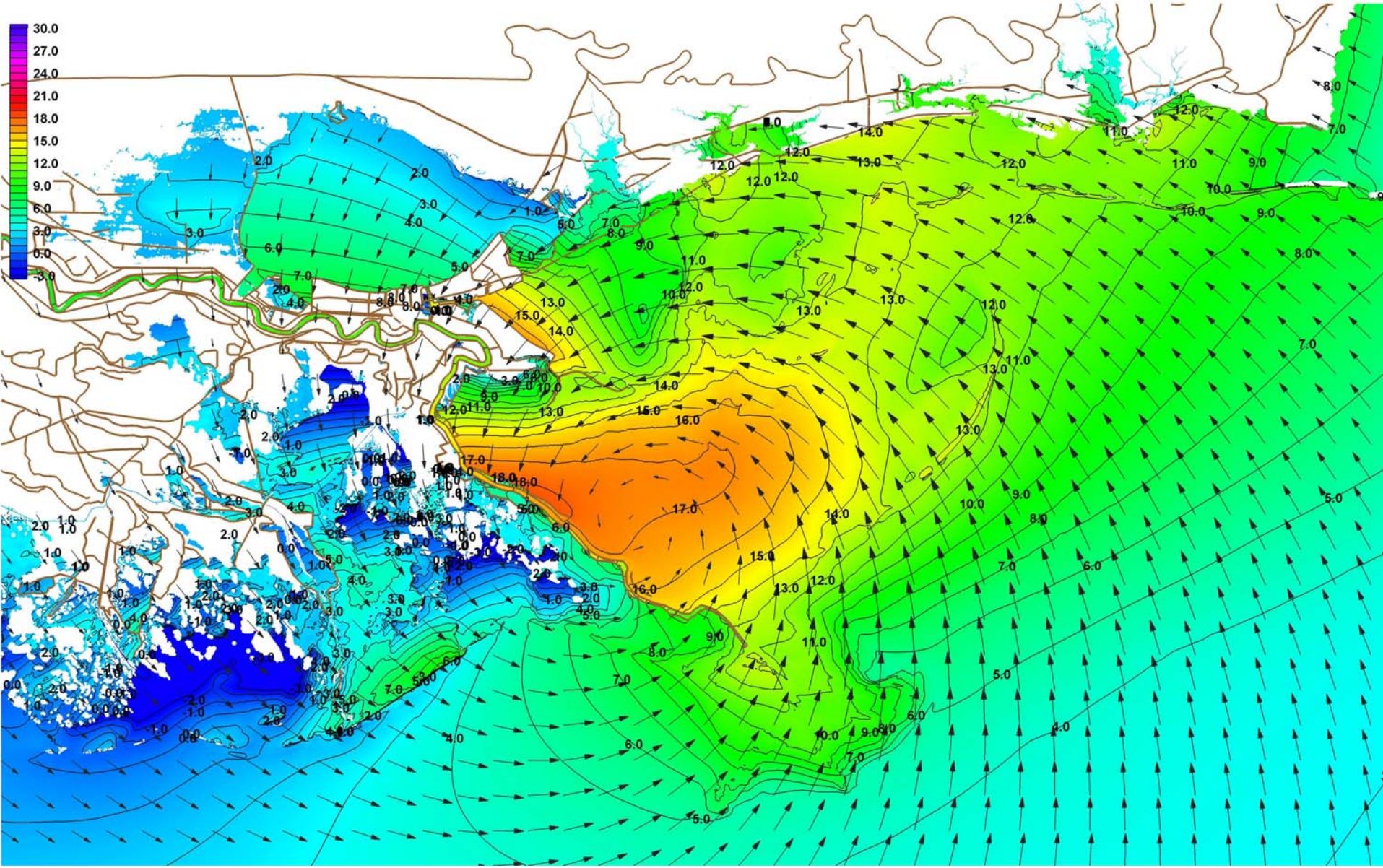


Joannes Westerink and Clint Dawson

ADCIRC Development Team, 2007

8/29/12Z

Hurricane Katrina Storm Surge

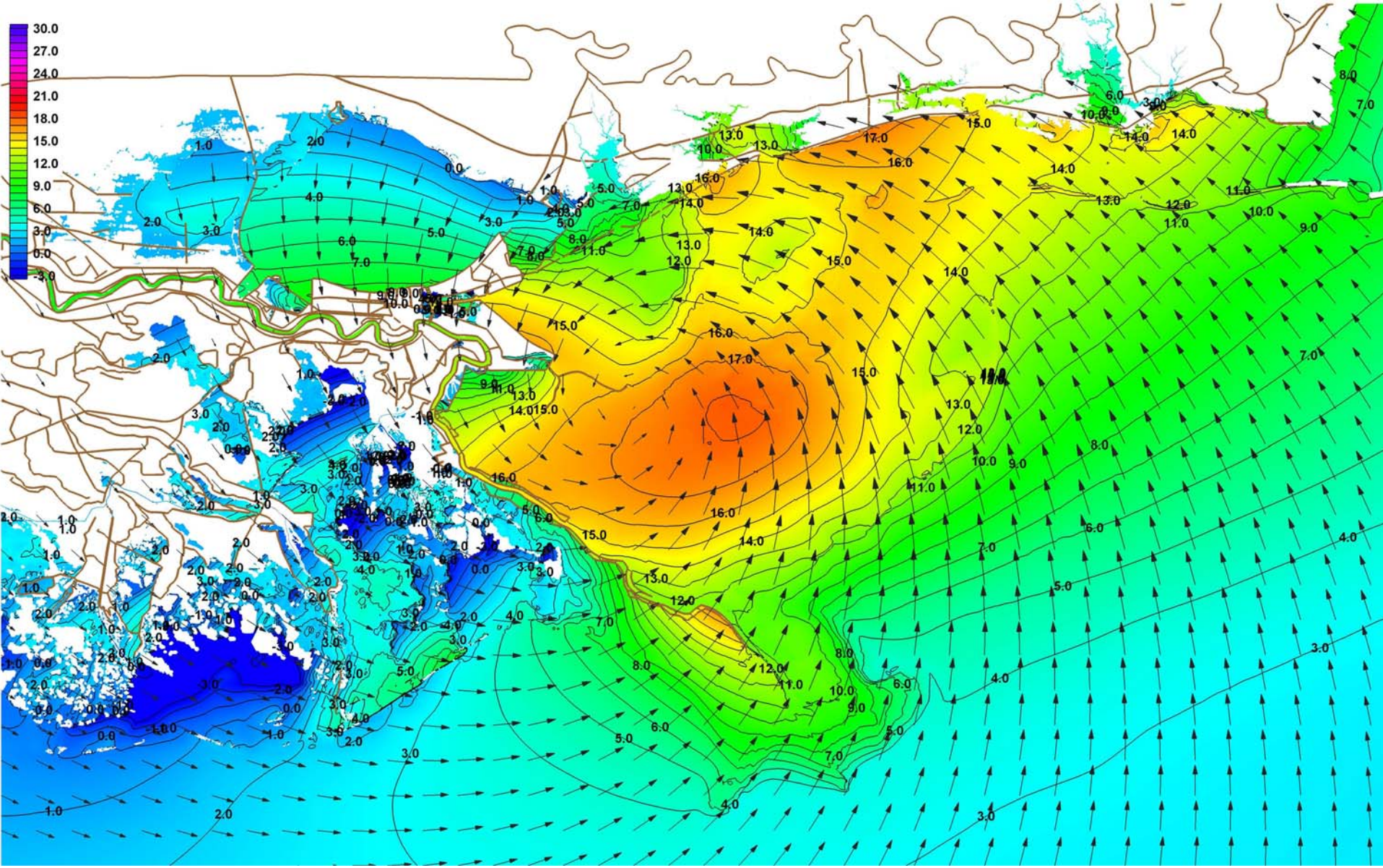


Joannes Westerink and Clint Dawson

ADCIRC Development Team, 2007

8/29/13Z

Hurricane Katrina Storm Surge

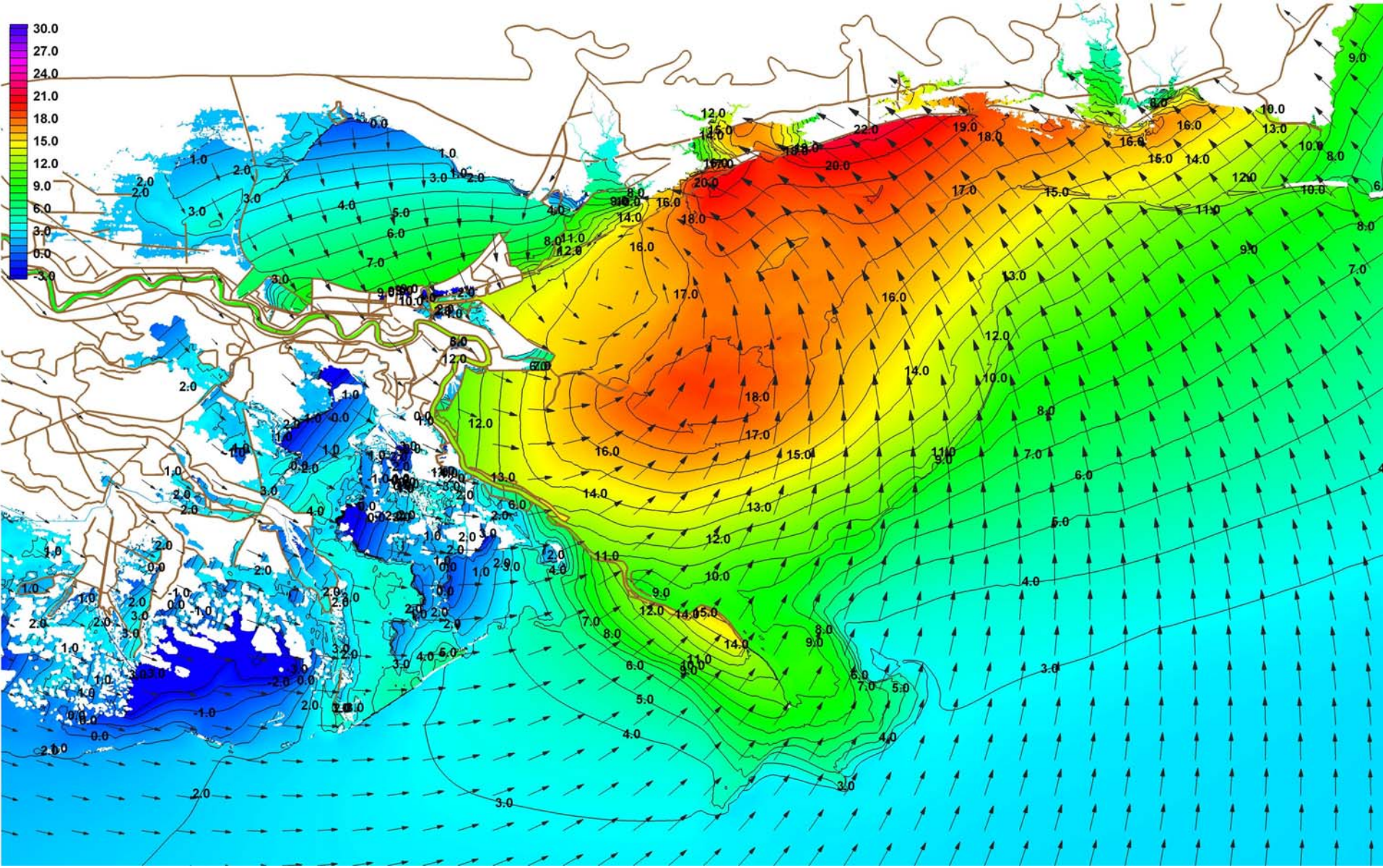


Joannes Westerink and Clint Dawson

ADCIRC Development Team, 2007

8/29/14Z

Hurricane Katrina Storm Surge

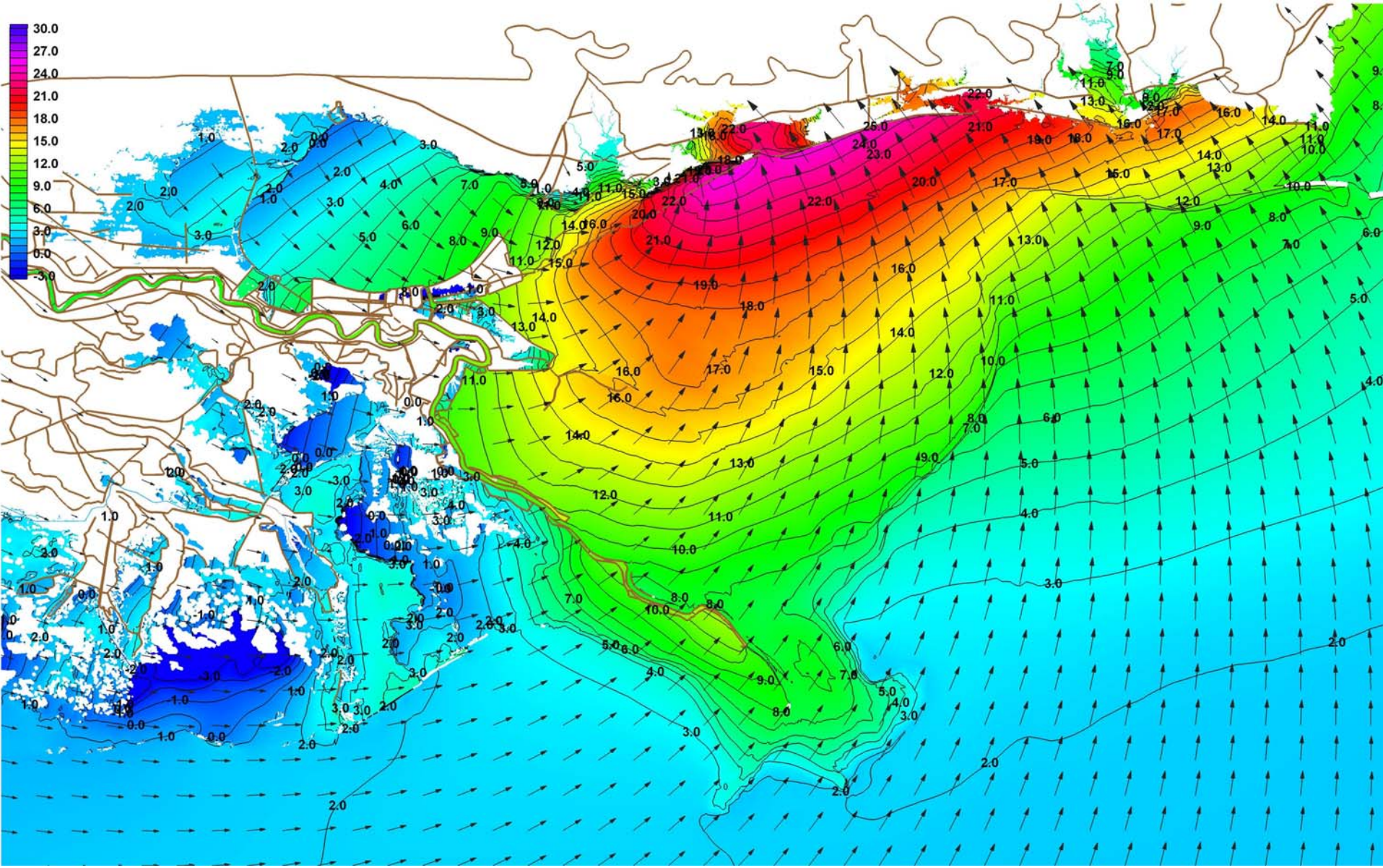


Joannes Westerink and Clint Dawson

ADCIRC Development Team, 2007

8/29/15Z

Hurricane Katrina Storm Surge

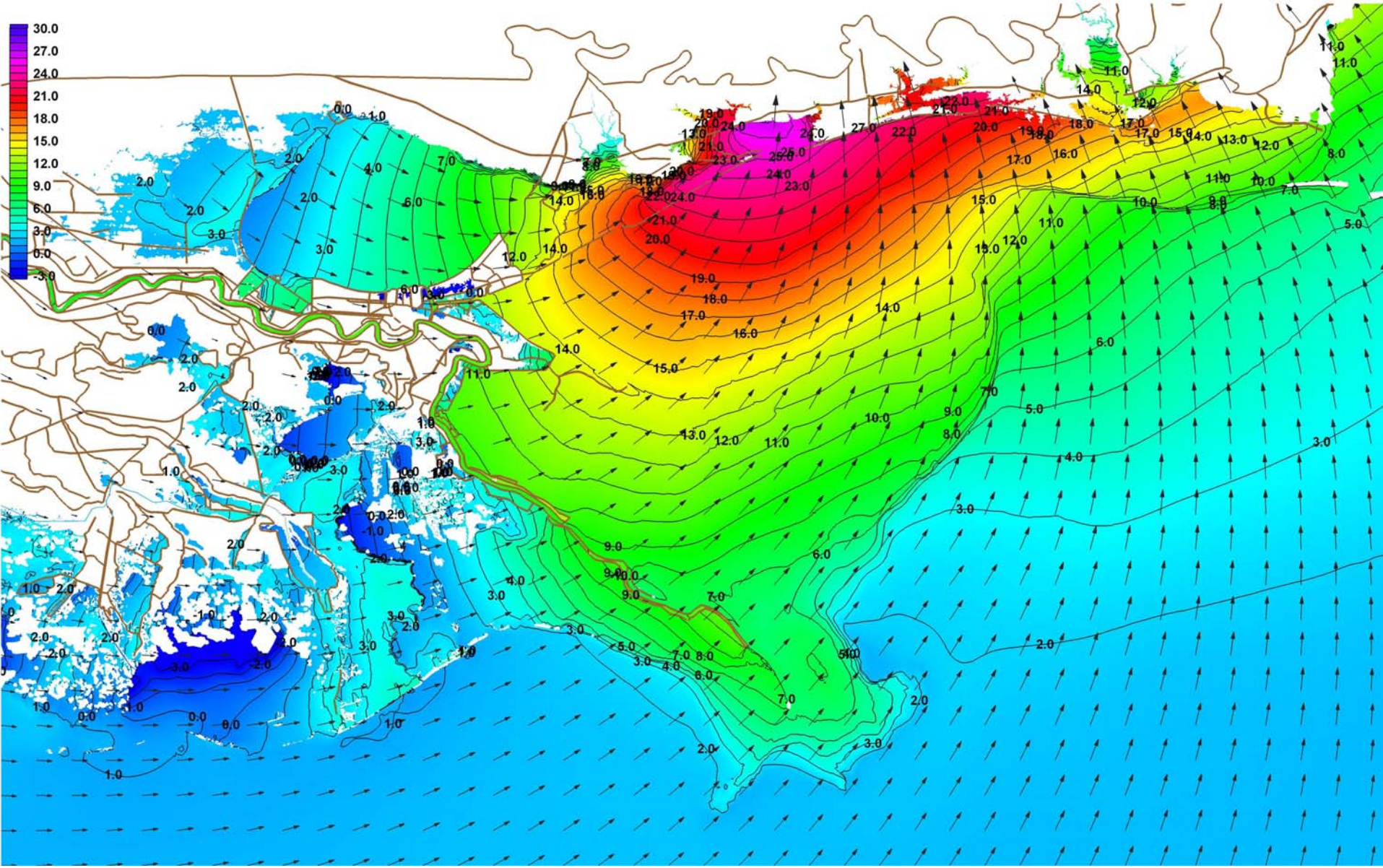


Joannes Westerink and Clint Dawson

ADCIRC Development Team, 2007

8/29/16Z

Hurricane Katrina Storm Surge

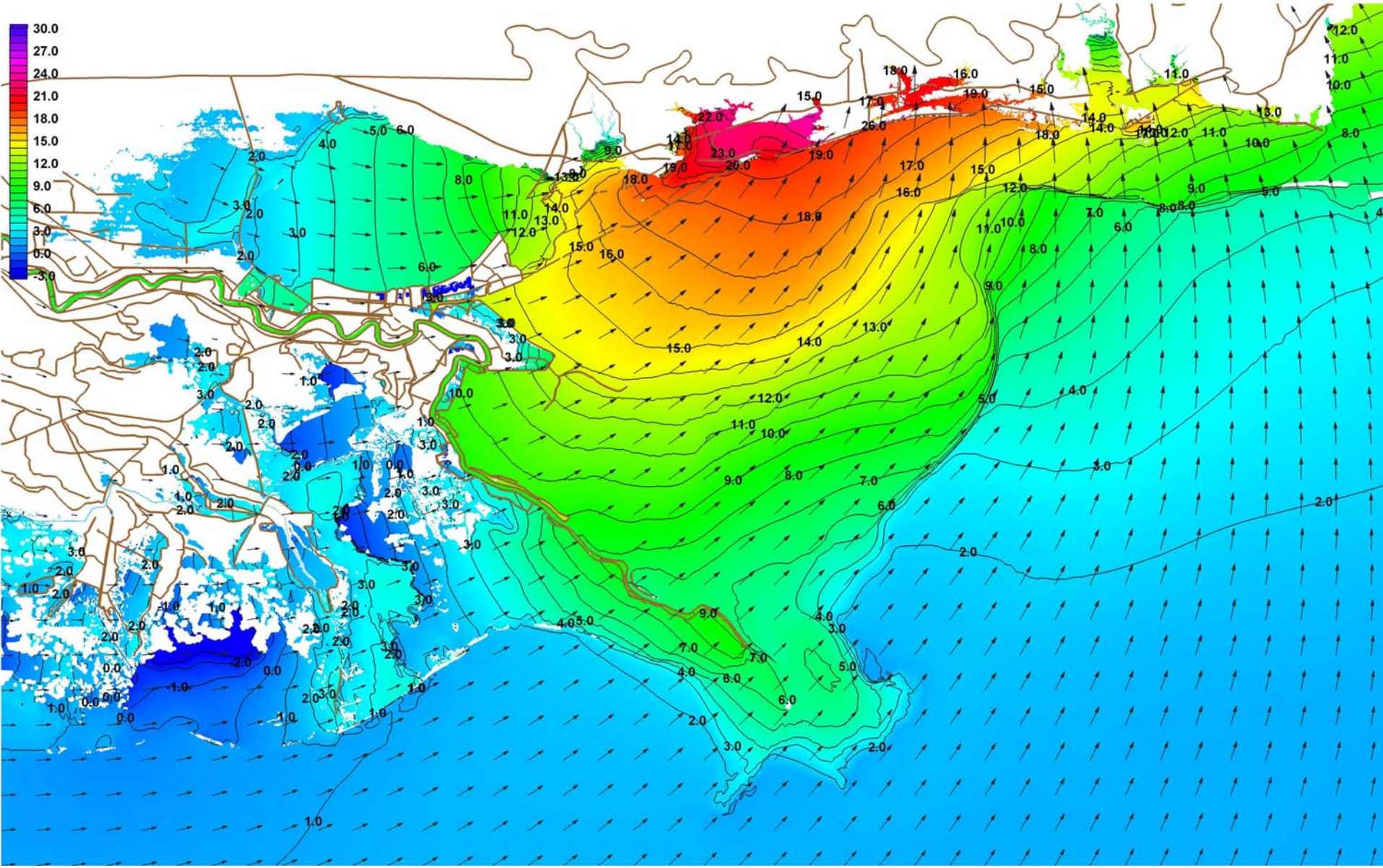


Joannes Westerink and Clint Dawson

ADCIRC Development Team, 2007

8/29/17Z

Hurricane Katrina Storm Surge

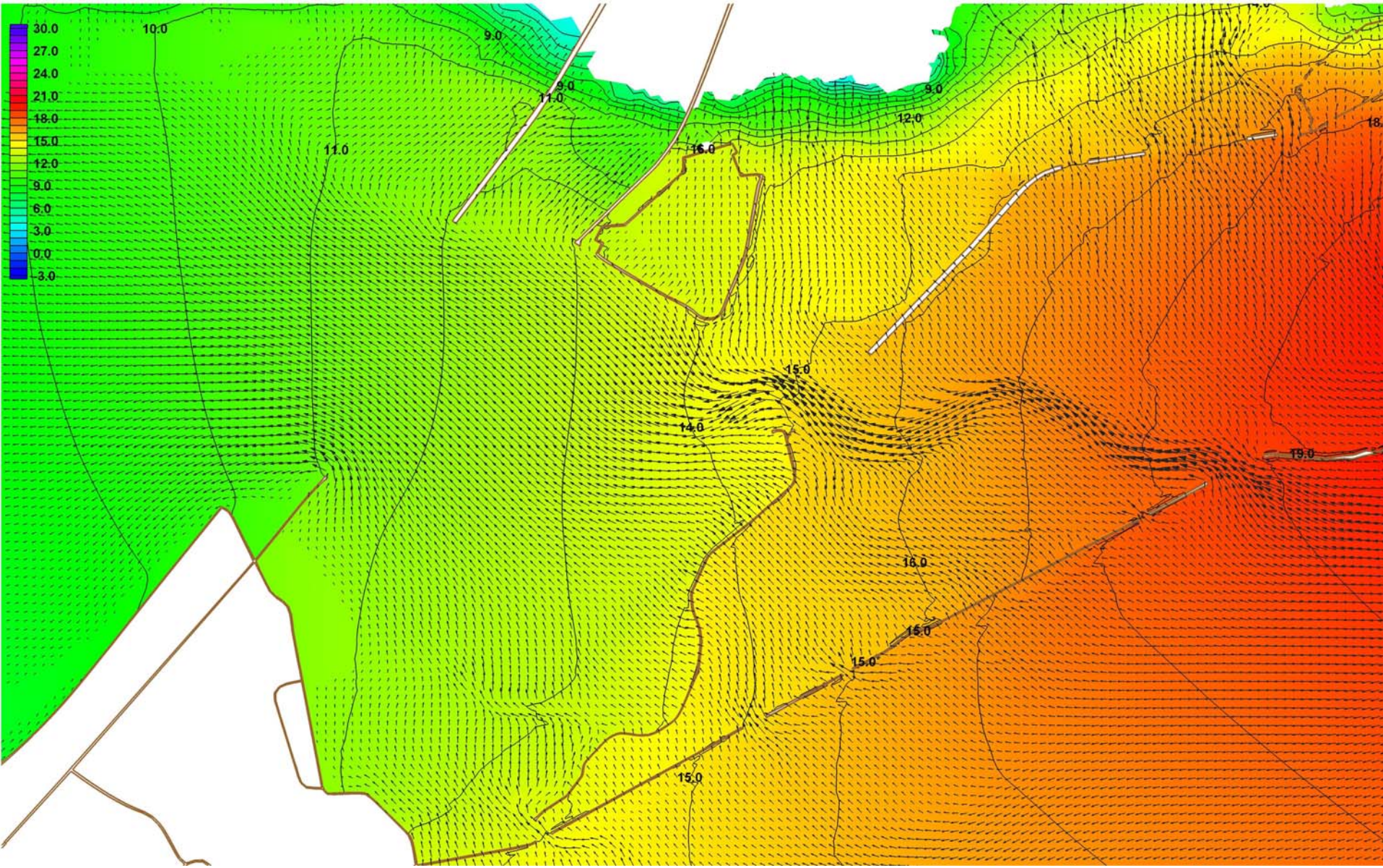


Joannes Westerink and Clint Dawson

ADCIRC Development Team, 2007

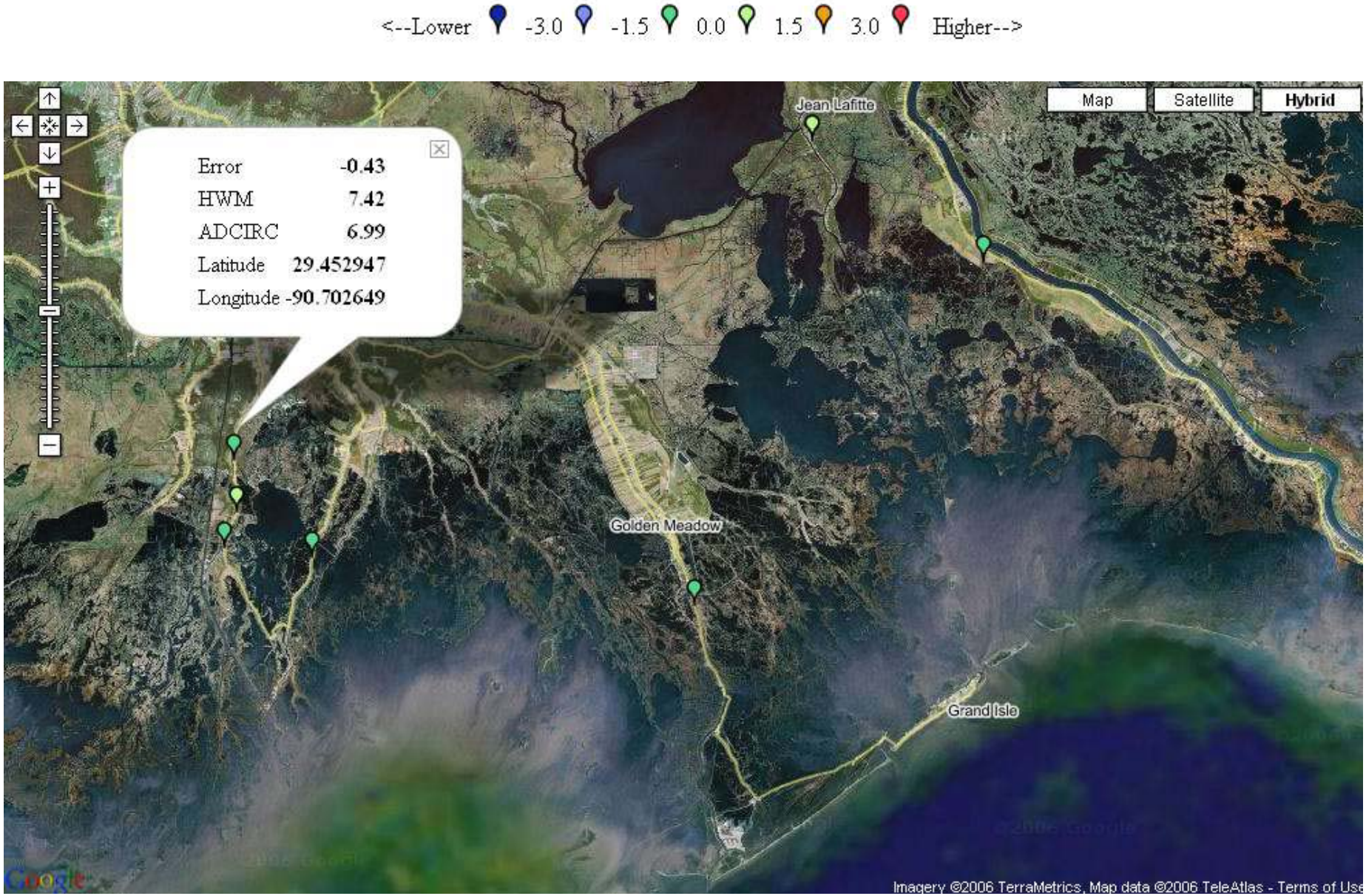
8/29/16Z

Hurricane Katrina Storm Surge (Detail)



Joannes Westerink and Clint Dawson

ADCIRC Development Team, 2007

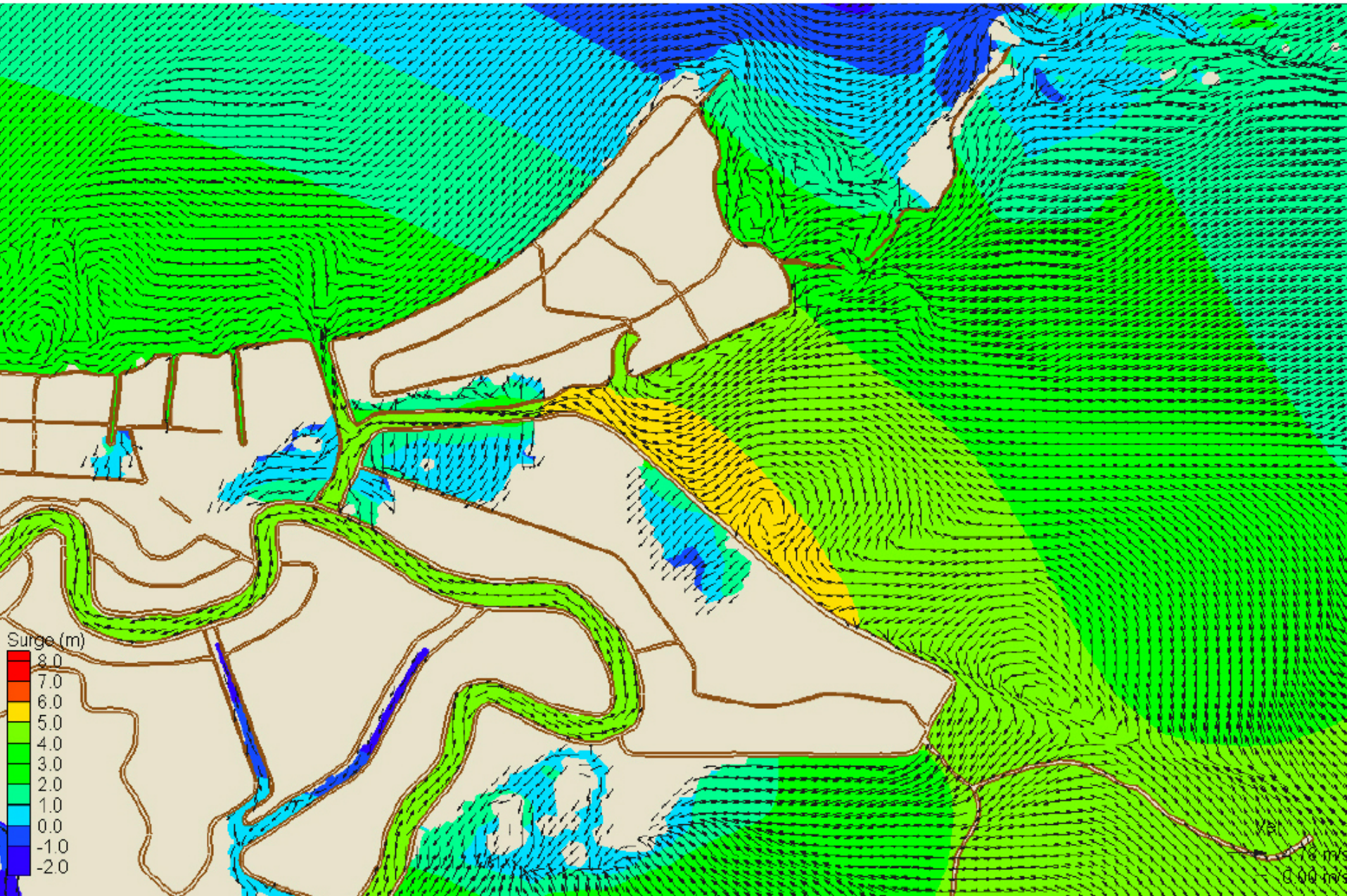


ADCIRC MODEL
Validation

Joannes Westerink and Clint Dawson
ADCIRC Development Team, 2007

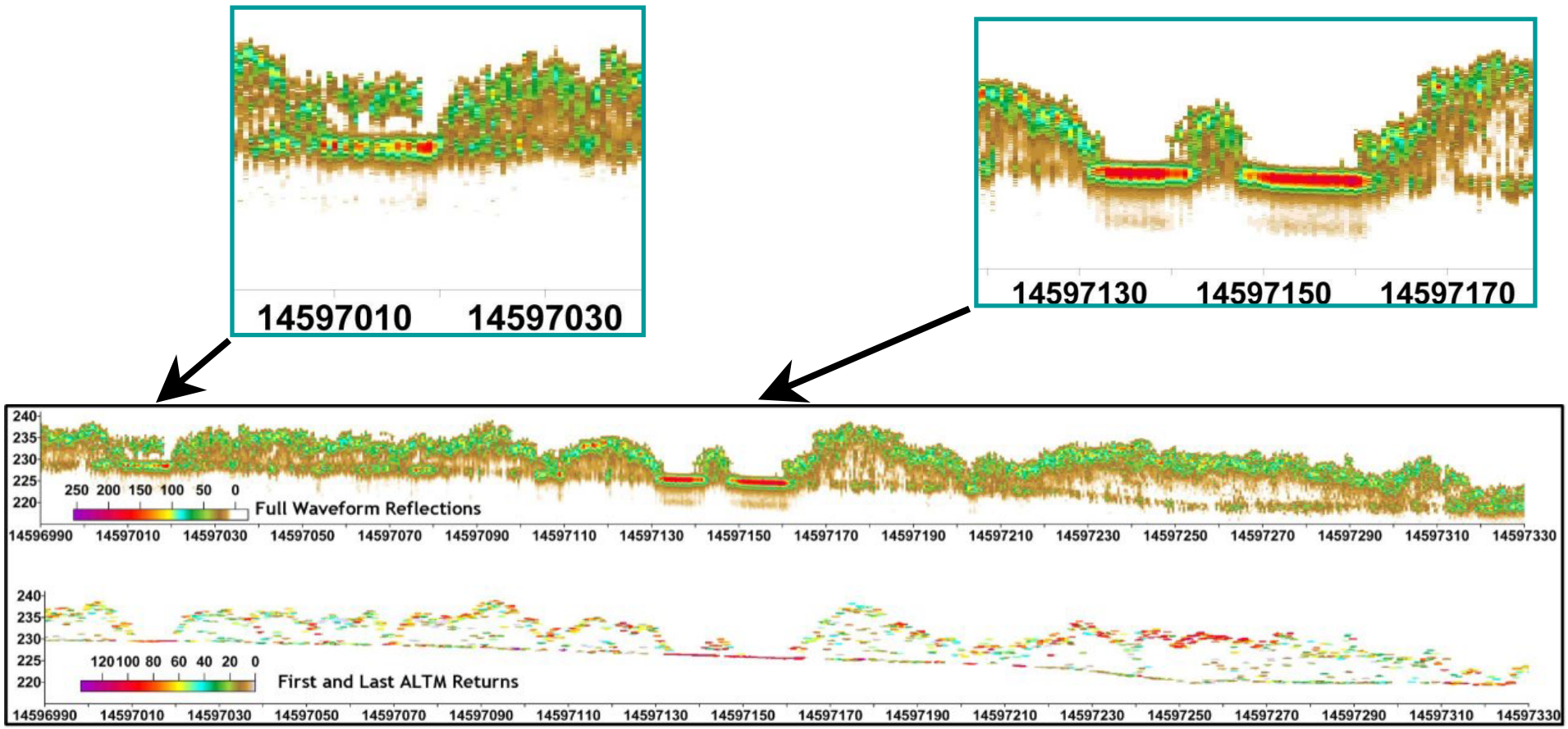
Hurricane Katrina Storm Surge Flow Vectors

Hassan Mashriqui, LSU Hurricane Center



BP Amaco, Texas City
Storm Surge Vulnerability
at 9.5 feet AMSL

UT LiDAR Waveform Digitization



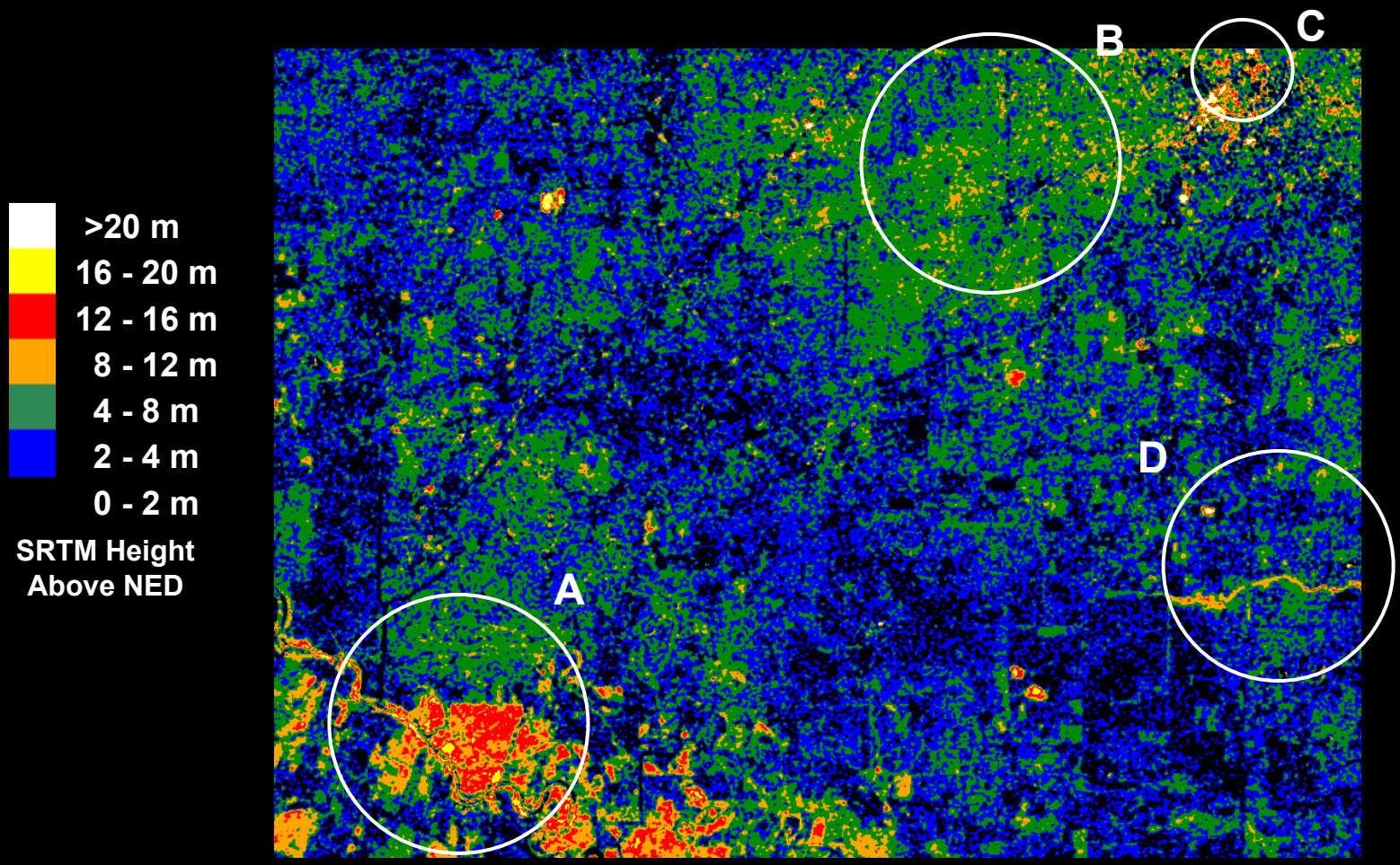
Freeman Ranch:
San Marcos, Texas

Bureau of Economic Geology

Center for Space Research
CSR
The University of Texas at Austin

Shuttle Radar Topography Mission / National Elevation Dataset

30-meter resolution



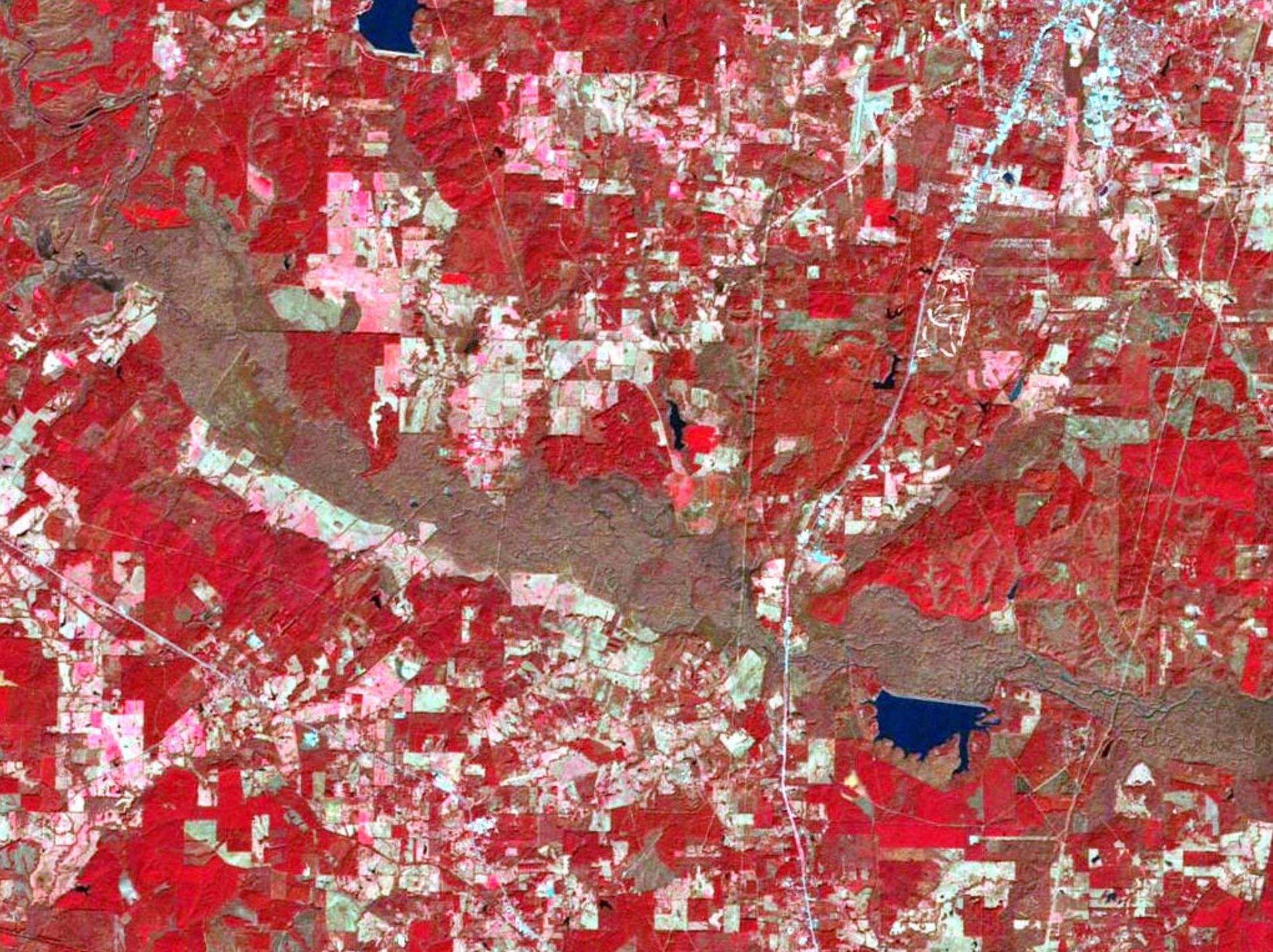
Houston Area:

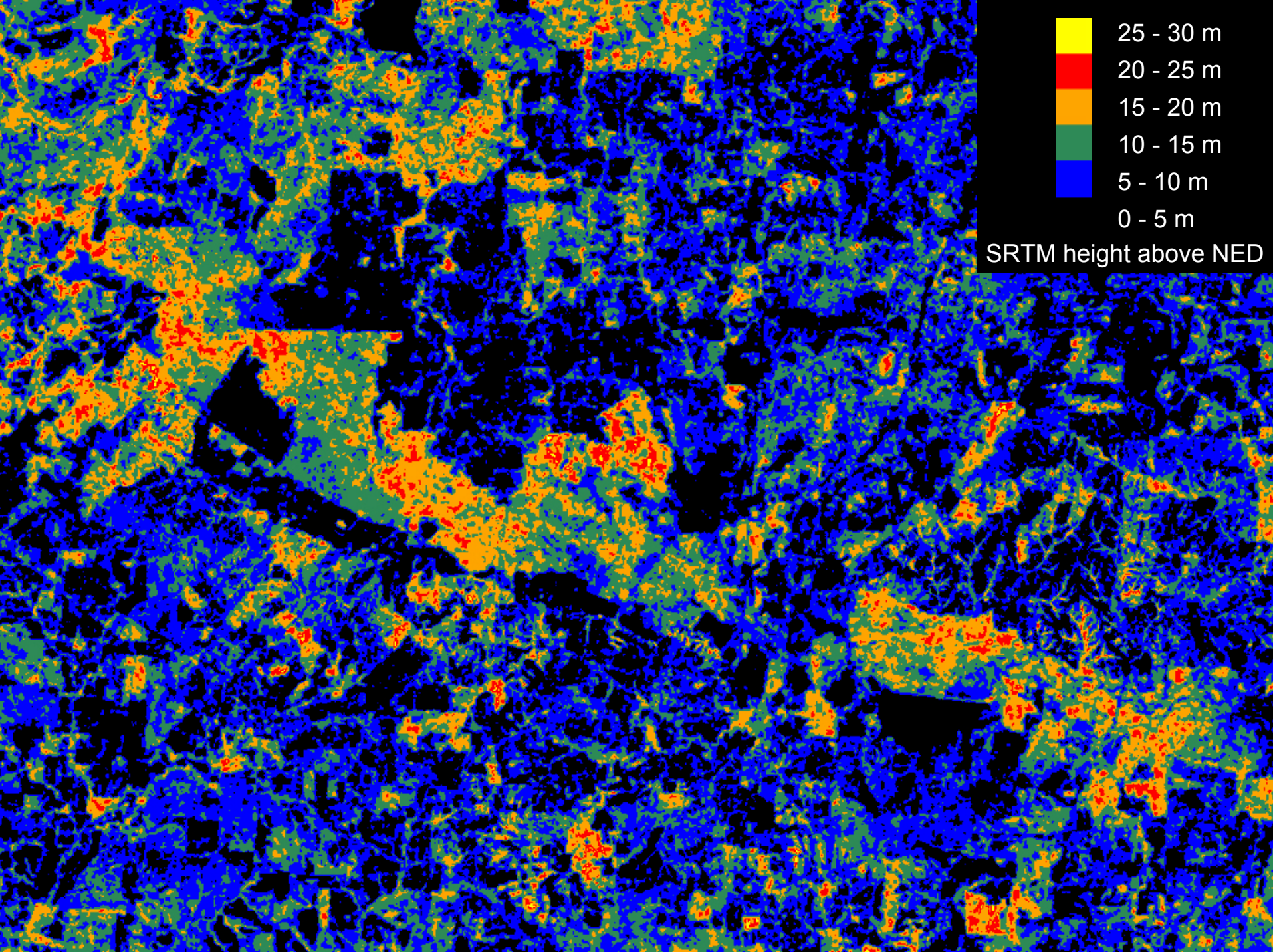
(A) Hardwoods along the Brazos River

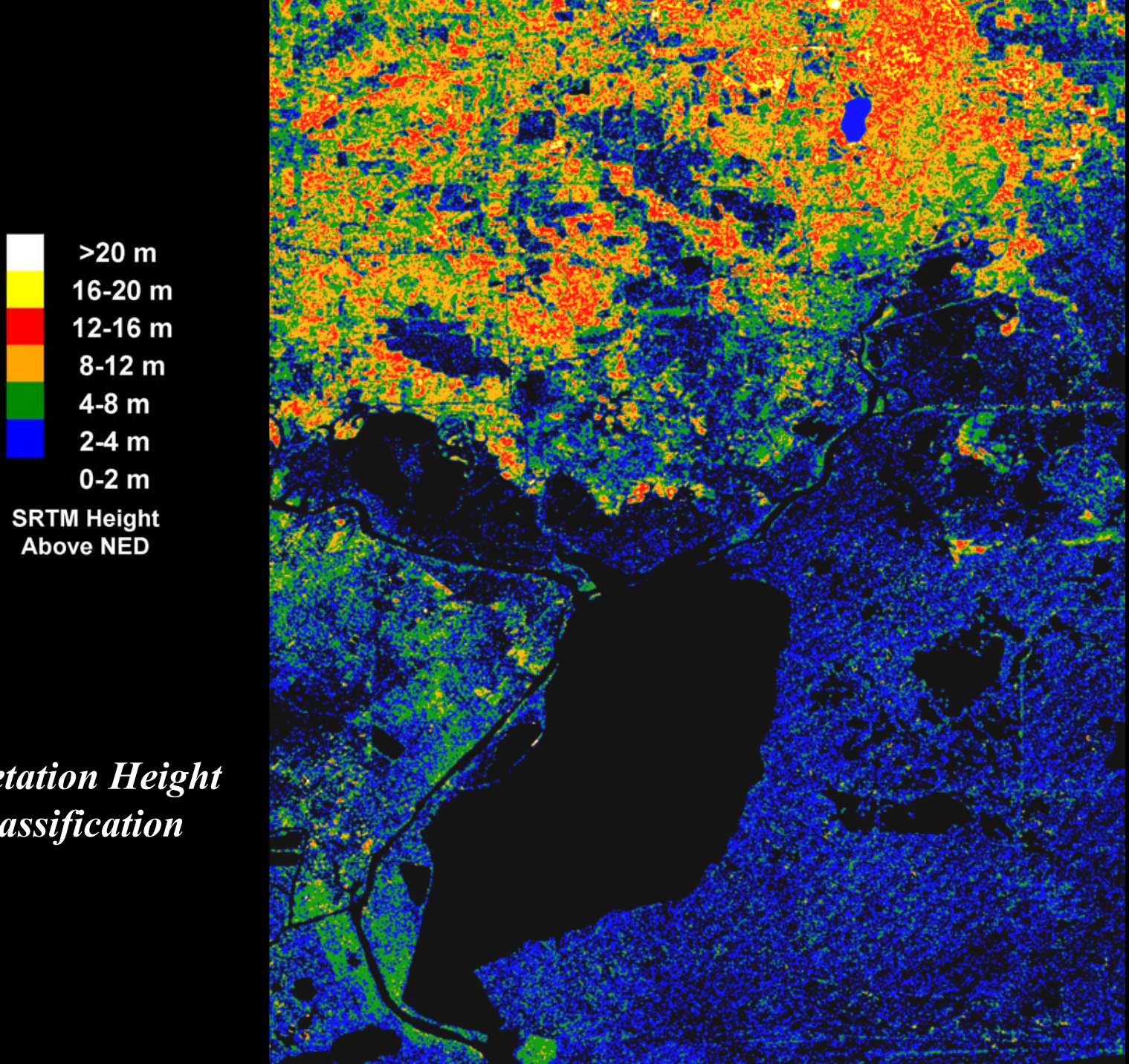
(B) Older neighborhood with taller trees than adjacent residential areas

(C) Texas Medical Center

(D) Riparian corridor




25 - 30 m
20 - 25 m
15 - 20 m
10 - 15 m
5 - 10 m
0 - 5 m
SRTM height above NED

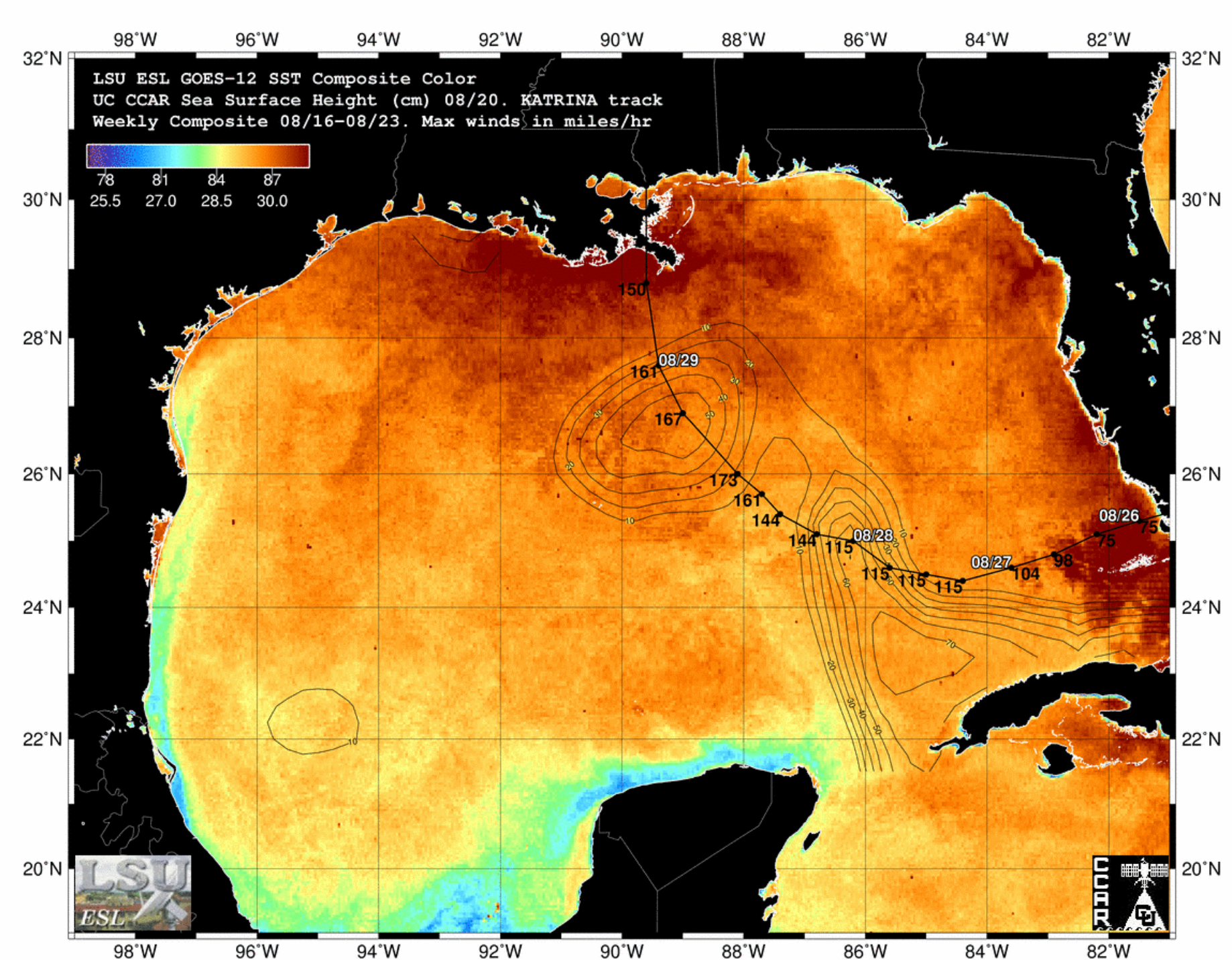


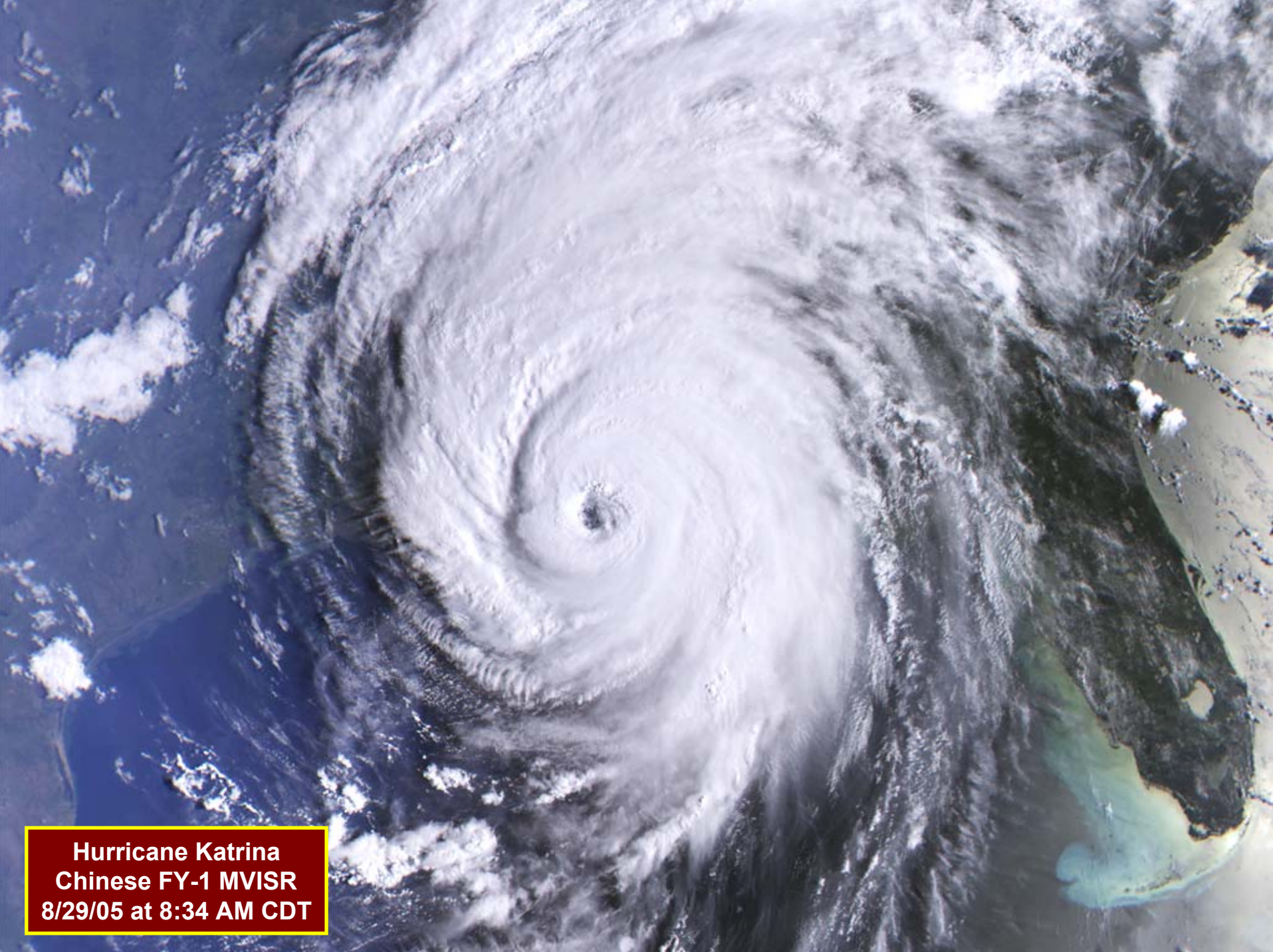
Vegetation Height Classification

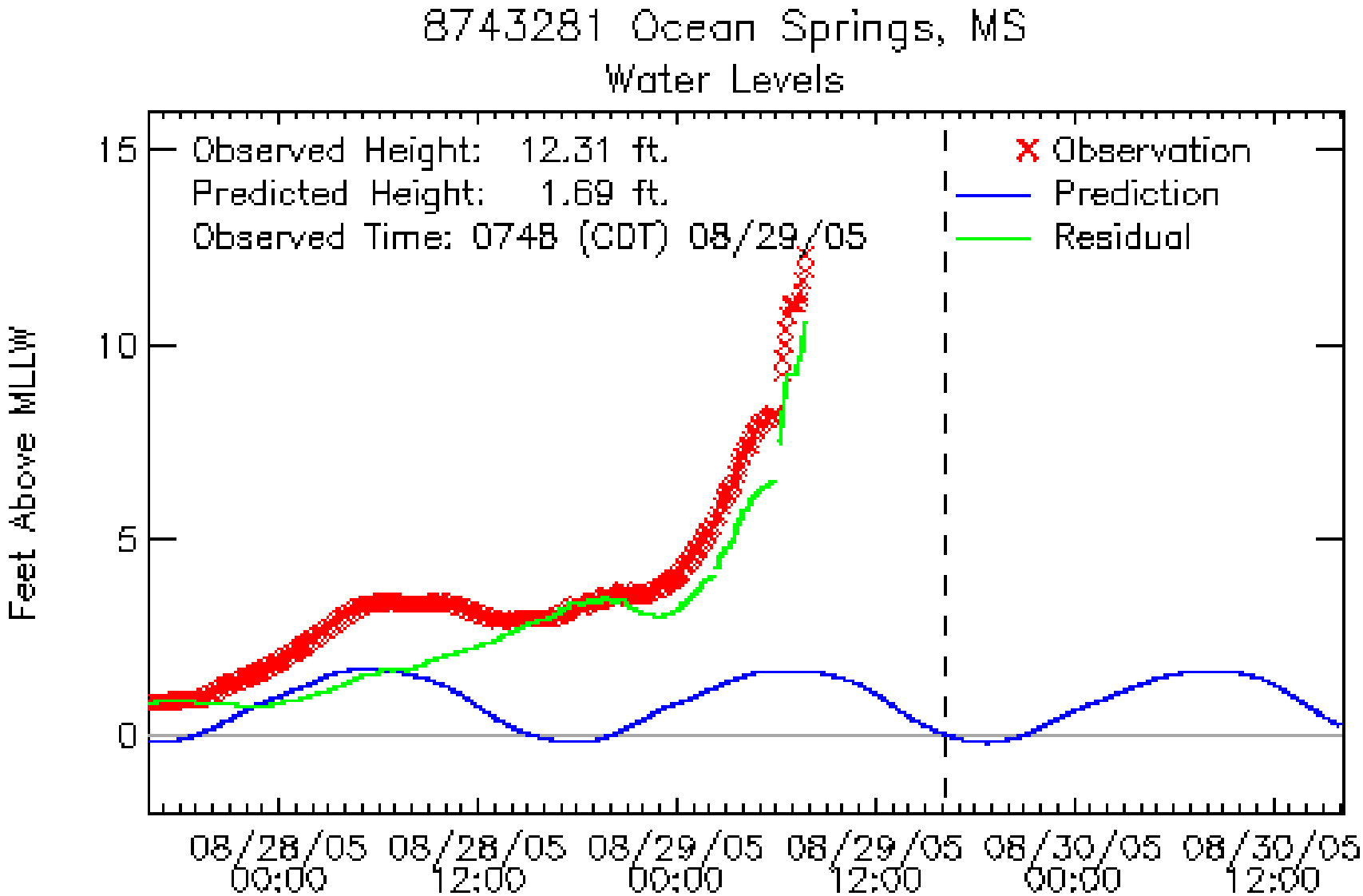
DLR TerraSAR-X

State Operations Center

Austin, Texas


LSU ESL GOES-12 SST Composite Color
UC CCAR Sea Surface Height (cm) 08/20. KATRINA track
Weekly Composite 08/16-08/23. Max winds in miles/hr
78 81 84 87
25.5 27.0 28.5 30.0
98°W 96°W 94°W 92°W 90°W 88°W 86°W 84°W 82°W
32°N 30°N 28°N 26°N 24°N 22°N 20°N
150
08/29
161
167
173
161
144
144
115
08/28
115
115
115
08/27
104
98
08/26
75
75
LSU ESL
CCAR


Hurricane Katrina
Chinese FY-1 MVISR
8/29/05 at 8:34 AM CDT



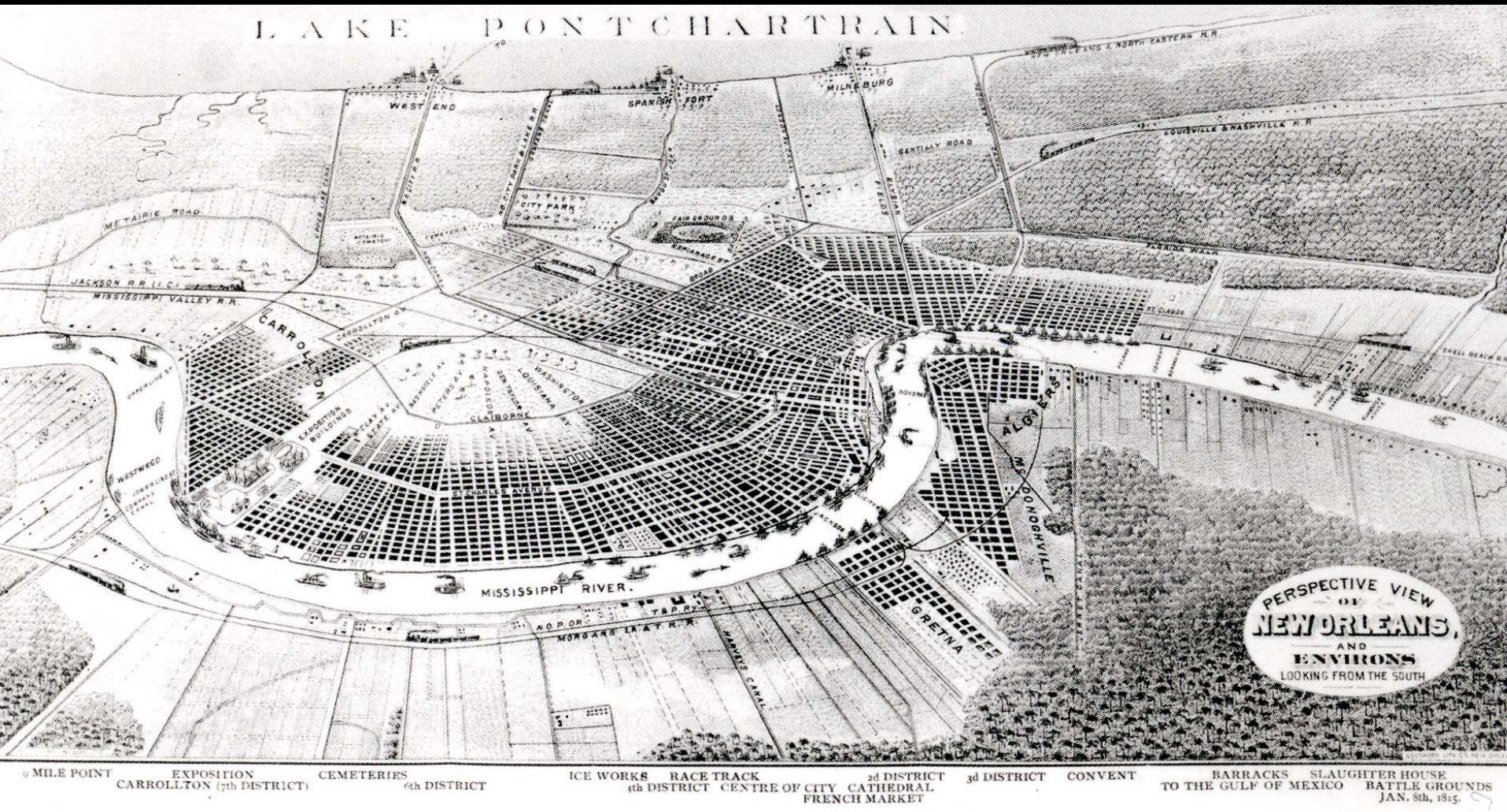
On the morning of August 29, the tidal gauge at Oceans Springs indicated a very large storm surge measured almost four hours before the landfall of Hurricane Katrina. The gauge was destroyed at 7:48 AM CDT.

New Orleans Post-Levee Breach Inundation (SPOT 4 XS 8/30/05)

Industrial Canal Breach
NOAA DSS 8/31/05


-6 Feet Below Water Level (9/02/05)
75 North Park Place
Texas Task Force One
New Orleans Search and Rescue
September 4, 2005

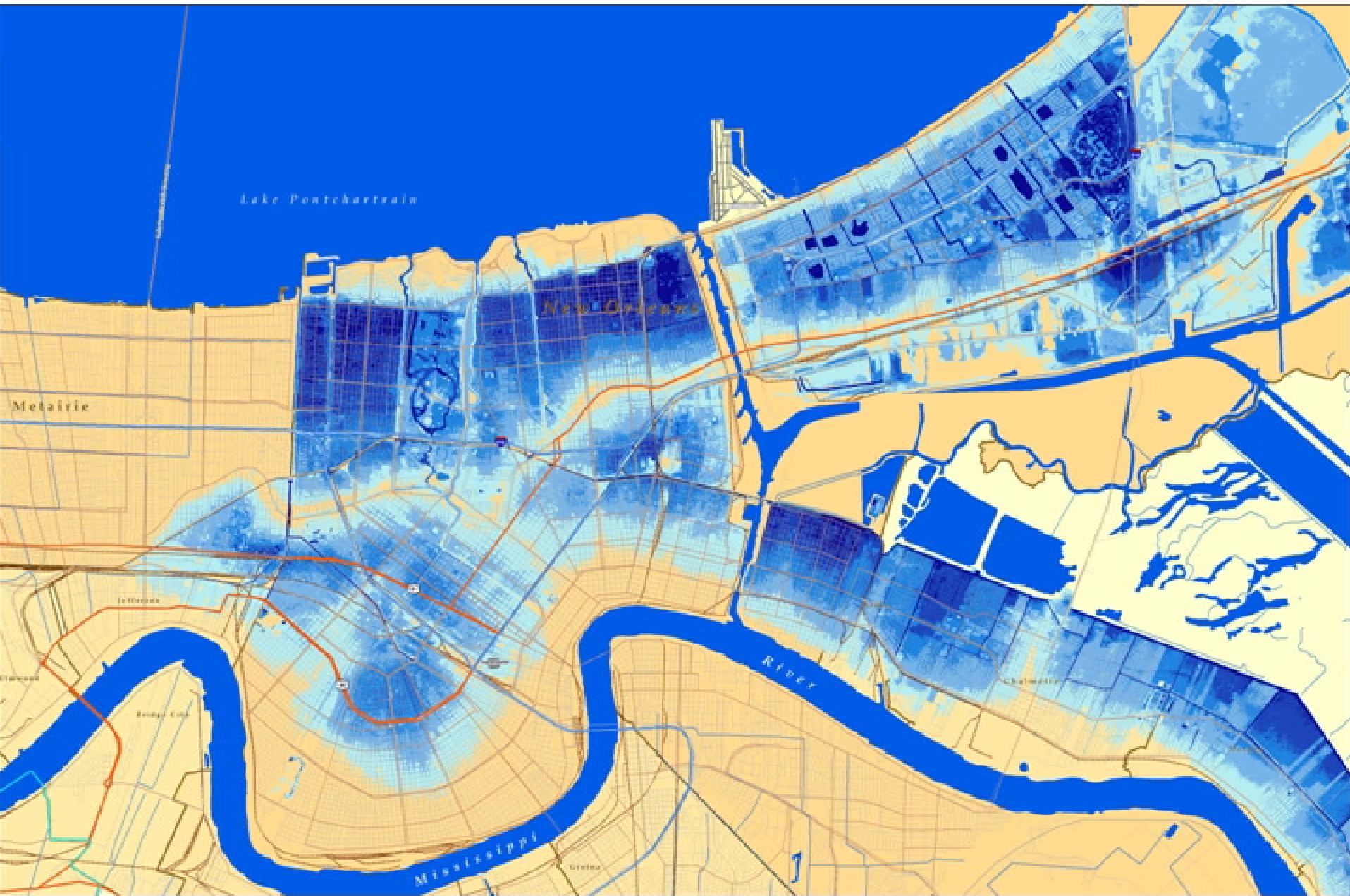

TEXAS PARKS & WILDLIFE DEPT.
1 5:37 PM

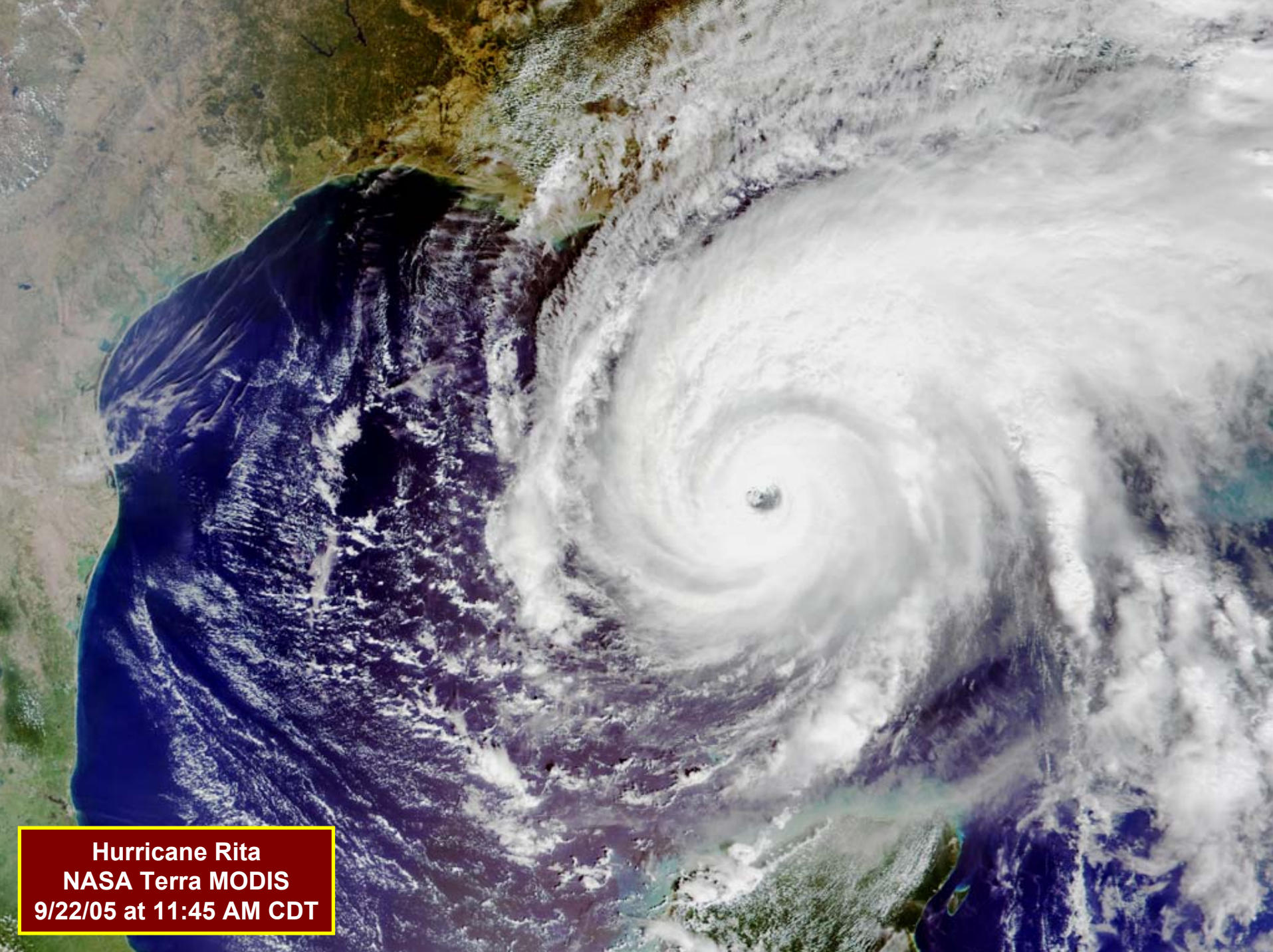


Bird's Eye View of New Orleans

1885

August 31, 2005




Hurricane Rita
NASA Terra MODIS
9/22/05 at 11:45 AM CDT


Radarsat Image collected on
September 25, 2005, at 7:22 AM CDT
[2] Source
Source [3]
Port Arthur
Source [4]
Sabine Lake
[1] 29°46´00.93˝ N, 93°53´42.62˝ W
[2] 29°56´42.29˝ N, 93°53´42.62˝ W
[3] 29°57´01.06˝ N, 93°46´23.24˝ W
[4] 29°52´32.91˝ N, 93°48´12.85˝ W
Source [1]
Possible Pollution Slicks
Detected in Sabine Lake

Slick No. 2 confirmed by Civil Air Patrol photography on September 26, 2005


29/09/2005

Lake Livingston Dam, Liberty County (Texas CAP)
8-foot standing waves removed protective rip-rap and eroded the clay core of the earthen structure.

MAGIC Emergency Response

Rita Data: Imagery | Maps |

Geospatial Support for Hurricane Rita

Persons involved in the Hurricane Rita recovery will find data to support damage assessment, environmental monitoring and general mapping in the following categories:

Imagery

- Post-landfall USACE ADS40 aerial sensor imagery
- Post-landfall NOAA Applanix-Emerge aerial sensor imagery
- Post-landfall oblique aerial imagery by the Texas Civil Air Patrol

rita.csr.utexas.edu

- Texas Civil Air Patrol (CAP) Photo Collection Points
- TEA Impacted ISDs

GIS data

- GIS data and maps can be obtained from the Texas Natural Resources Information System's Hurricane Rita website.

Situation Reports

- Situation Reports from the Governor's Division of Emergency Management.

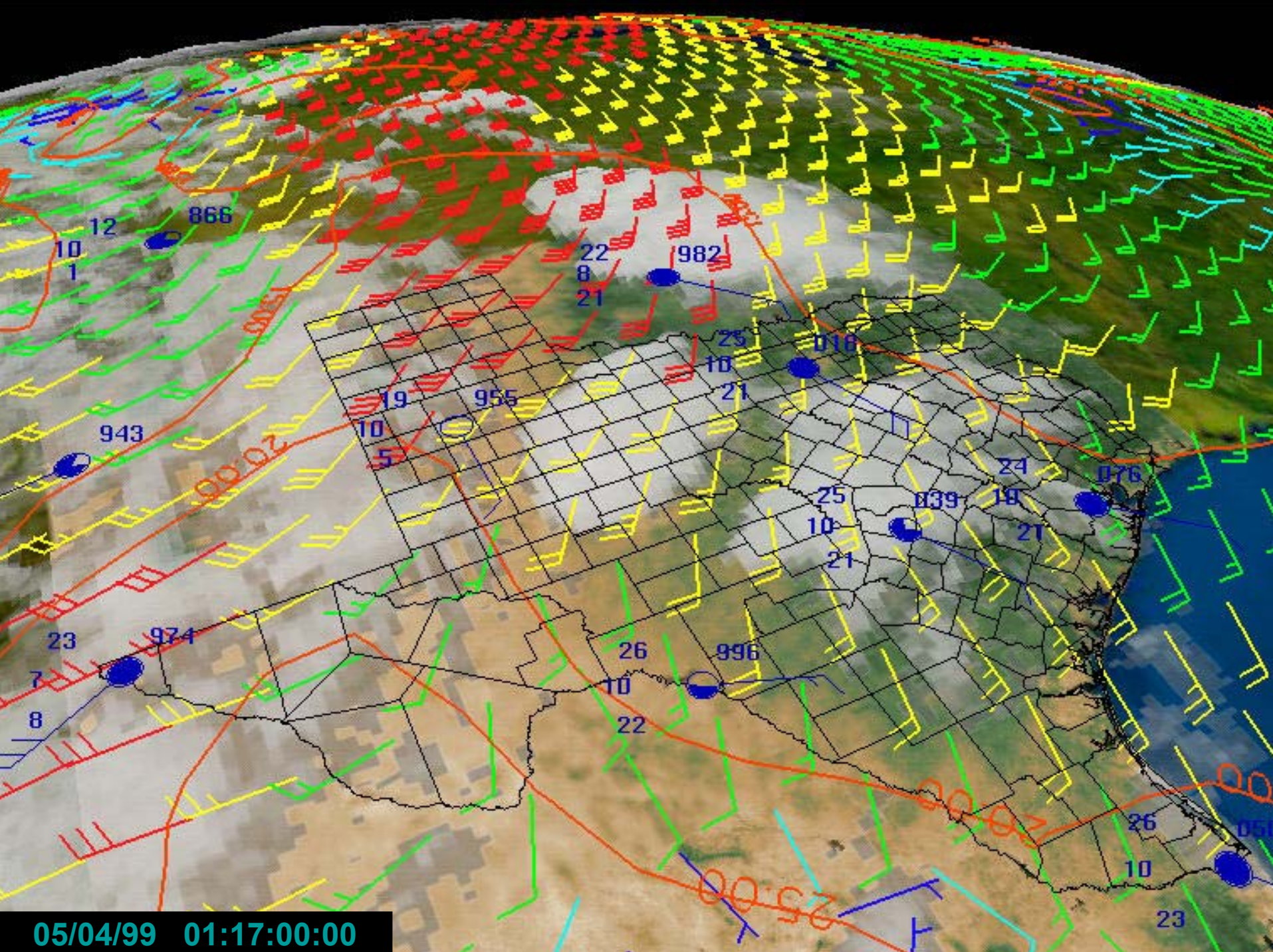
As new data are created and made available, they will be posted to this site.

Summary

- Real-time satellite observations offer tremendous benefits to monitoring the coastal environment.
- Satellite remote sensing can be used to document the impacts of high-magnitude, low-frequency storm events.
- LiDAR and SAR data collection and processing techniques can extract features of importance to the modeling of storm surges.
- Real-time satellite observations aid pollution detection following a natural disaster.
- Better remote sensing technology coupled with improved modeling and simulation can save lives and protect property.

Gordon Wells
gwells@csr.utexas.edu

Center for Space Research
The University of Texas at Austin
3925 W. Braker Lane
Austin, TX 78759
USA


12
866
10
1
22
982
8
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25
018
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19
955
10
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943
24
076
25
039
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05/04/99 01:17:00:00