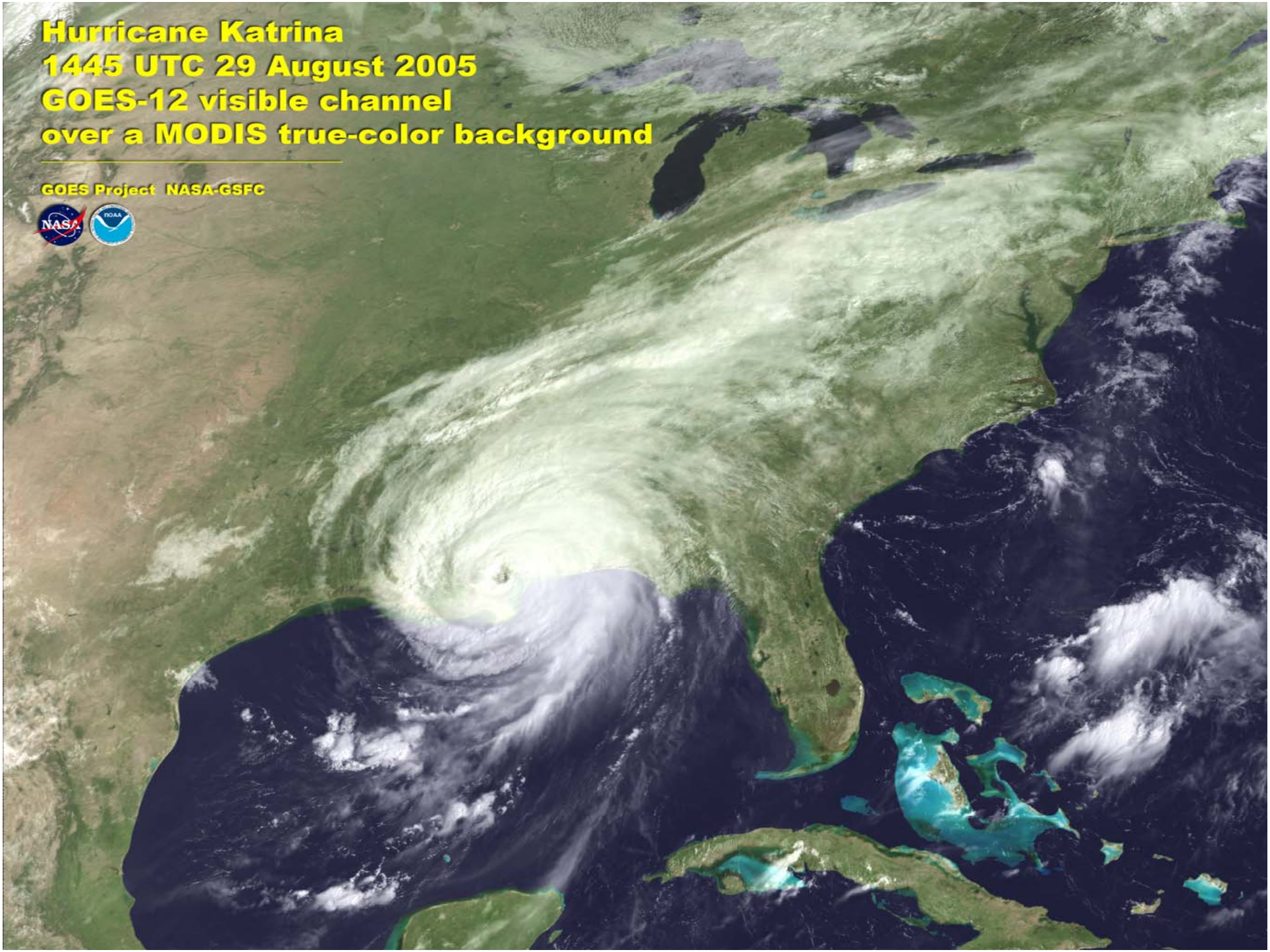
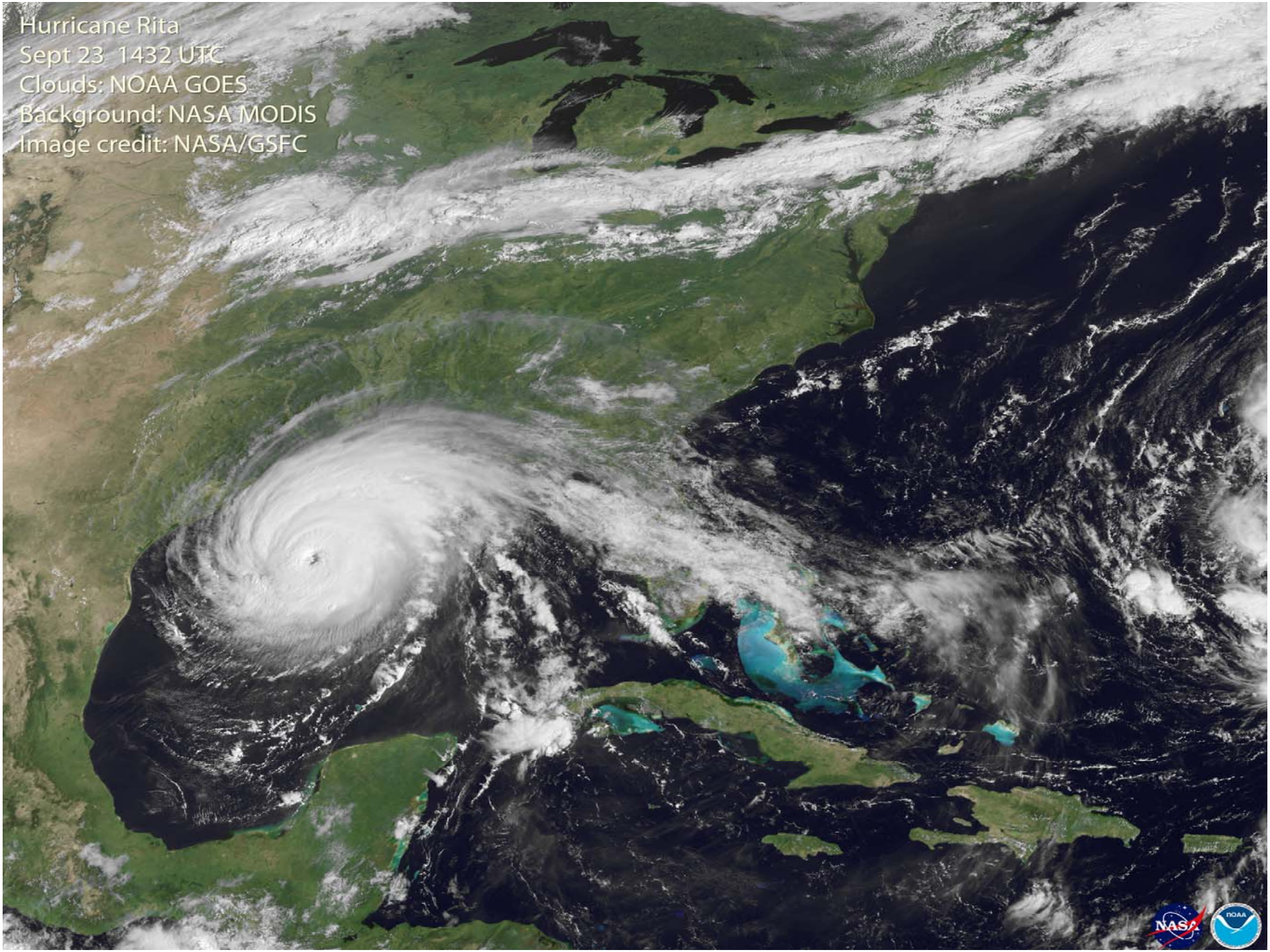
Plan Formulation Workshop for Levee Alignments and Coastal Restoration Features

Lafayette, LA February 13-14, 2006

Brief Summary Of Workshop Held In Vicksburg, MS Dec 20-21, 2005

US Army Corps of Engineers


Hurricane Katrina
1445 UTC 29 August 2005
GOES-12 visible channel
over a MODIS true-color background
GOES Project NASA-GSFC


Hurricane Rita
Sept 23 1432 UTC
Clouds: NOAA GOES
Background: NASA MODIS
Image credit: NASA/GSFC
NASA
NOAA

Public Law 109-103

Energy and Water Development Appropriations Act, 2006

DEPARTMENT OF THE ARMY

Corps of Engineers--Civil

The following appropriations shall be expended under the direction of the Secretary of the Army and the supervision of the Chief of Engineers for authorized civil functions of the Department of the Army pertaining to rivers and harbors, flood control, shore protection and storm damage reduction, aquatic ecosystem restoration, and related purposes.

INVESTIGATIONS

....That using $8,000,000 of the funds provided herein, the Secretary of the Army, acting through the Chief of Engineers, is directed to conduct a comprehensive hurricane protection study at full Federal expense to develop and present a full range of flood, coastal and hurricane protection measures exclusive of normal policy considerations for south Louisiana and the Secretary shall submit a feasibility report for short-term protection within 6 months of enactment of this Act, interim protection within 12 months of enactment of this Act and long-term comprehensive protection within 24 months of enactment of this Act: *Provided further*, That the Secretary shall consider providing protection for a storm surge equivalent to a Category 5 hurricane within the project area and may submit reports on component areas of the larger protection program for authorization as soon as practicable: *Provided further*, That the analysis shall be conducted in close coordination with the State of Louisiana and its appropriate agencies.

.....long-term comprehensive protection within 24 months of enactment of this Act: *Provided further*, That the Secretary shall consider providing protection for a storm surge equivalent to a Category 5 hurricane within the project area and may submit reports on component areas of the larger protection program for authorization as soon as practicable.....

Saffir-Simpson Scale

Category 1	74 – 95 mph winds
Category 2	96 – 110 mph winds
Category 3	111 – 130 mph winds
Category 4	131 – 155 mph winds
Category 5	155+ mph winds

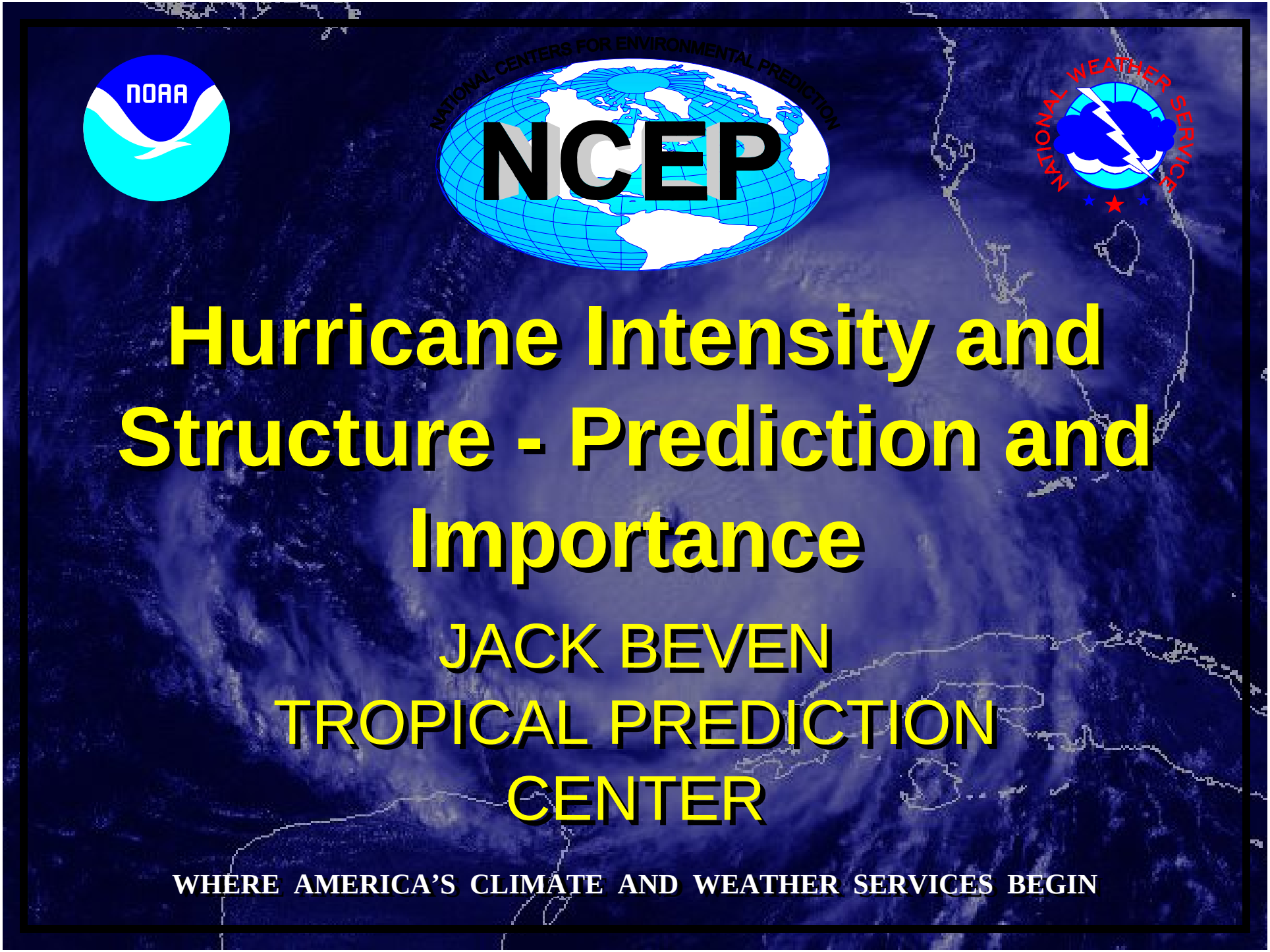
Category 5 Workshop 20-21 Dec 2005
Engineering Development Research Center
ERDC

Winds - Tropical Cyclones

Water Levels – Storm Surge

Waves – Design Wave Heights

Risk– Frequency of Occurrence



Hurricane Intensity and Structure - Prediction and Importance

JACK BEVEN
TROPICAL PREDICTION CENTER

WHERE AMERICA'S CLIMATE AND WEATHER SERVICES BEGIN

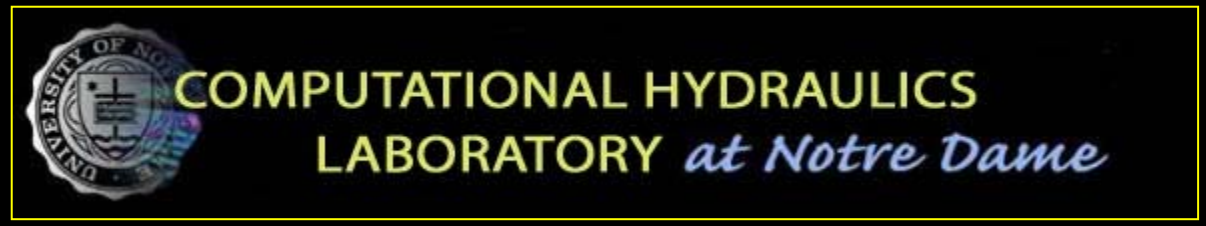
HURRICANE KATRINA WIND FIELDS

Mark Powell
NOAA Hurricane Research Division, Miami FL

The use of computational models in water control of The Netherlands

Guus Stelling,Vicksburg, December 2005

TU Delft



Storm Surge Prediction in Southern Louisiana

Joannes Westerink and Shintaro Bunya
University of Notre Dame

Rick Luettich
University of North Carolina – Chapel Hill

Clint Dawson
University of Texas - Austin

ERDC Category 5 Hurricane Workshop

December 20, 2005

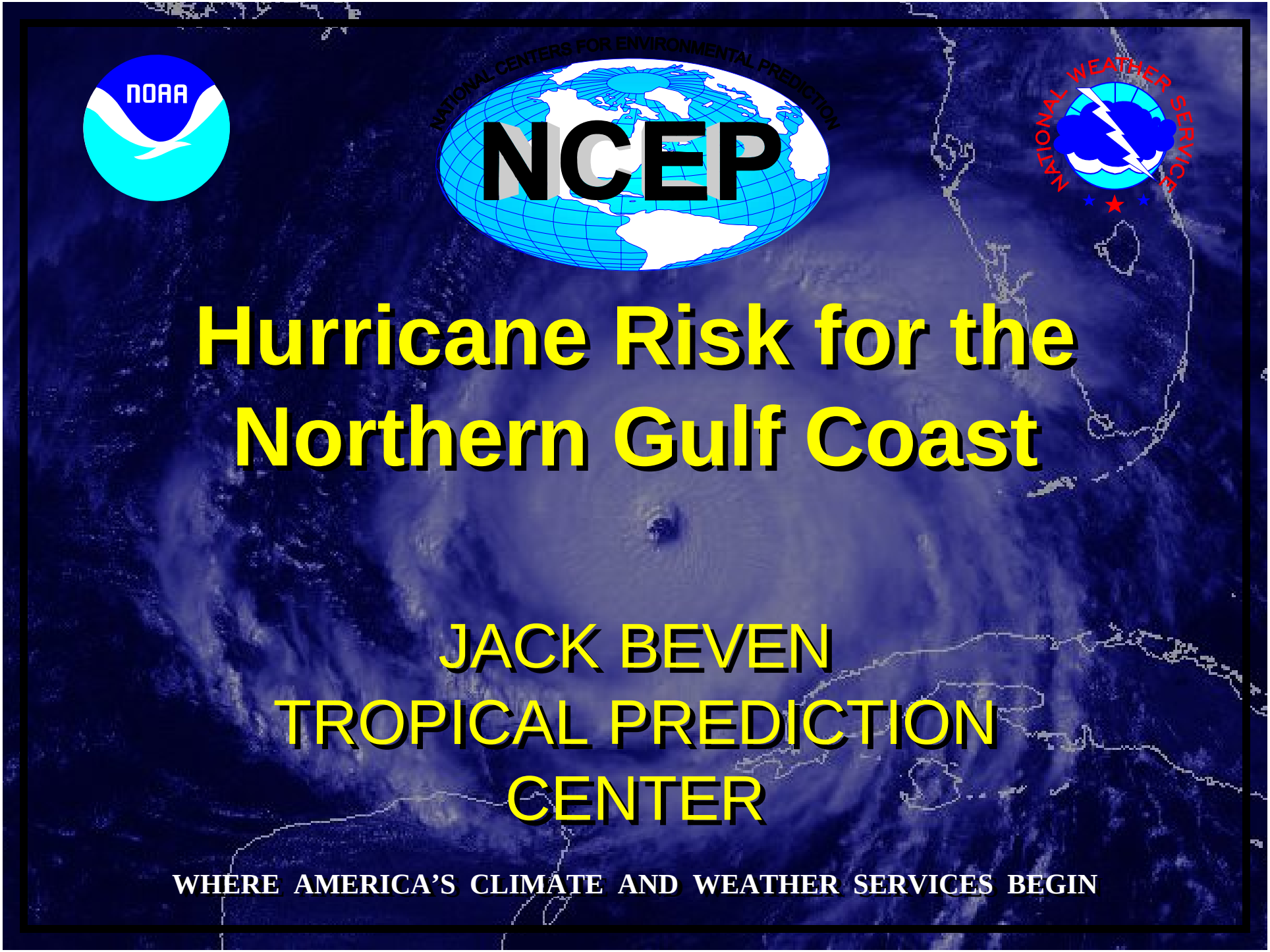
Hurricane Protection Design Workshop

Vicksburg, MS

Dec. 20-21, 2005

Dr. Wilson (Will) Shaffer

NATIONAL WEATHER SERVICE



Hurricane Risk for the Northern Gulf Coast

JACK BEVEN
TROPICAL PREDICTION CENTER

WHERE AMERICA'S CLIMATE AND WEATHER SERVICES BEGIN

Estimating Storm Frequency

Don Resio

Coastal and Hydraulics Lab, ERDC, Vicksburg, MS

Hurricane Protection Design Workshop
December 20-21, 2005

Assessing Hurricane Risk along the US Coastline

Peter J Vickery
Applied Research Associates
8540 Colonnade Center Drive
Raleigh, NC, 27615

APPLIED RESEARCH ASSOCIATES, INC.
An Employee-Owned Company

Effect of waves and morphology on boundary conditions

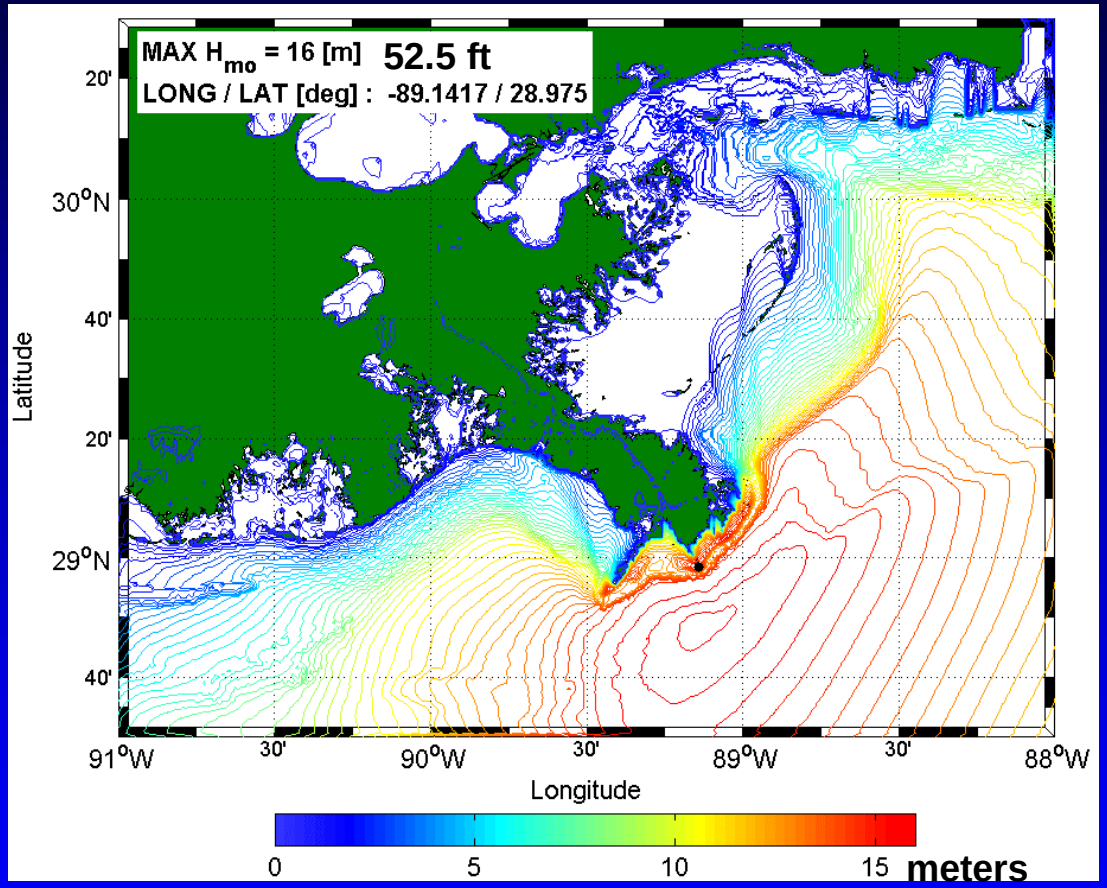
New Orleans Hurricane Protection Design Workshop,
20-21 December, 2005

Prof. Dano Roelvink

UNESCO-IHE, Delft Hydraulics and Delft University of Technology

UNESCO-IHE
Institute for Water Education

Wave Prediction in Southeast Louisiana



J.M. Smith, R.E. Jensen, and A.R. Sherlock

US Army Corps of Engineers

Coastal and Hydraulics Laboratory - ERDC

A selection of Slides taken from the Workshop presentations follows:

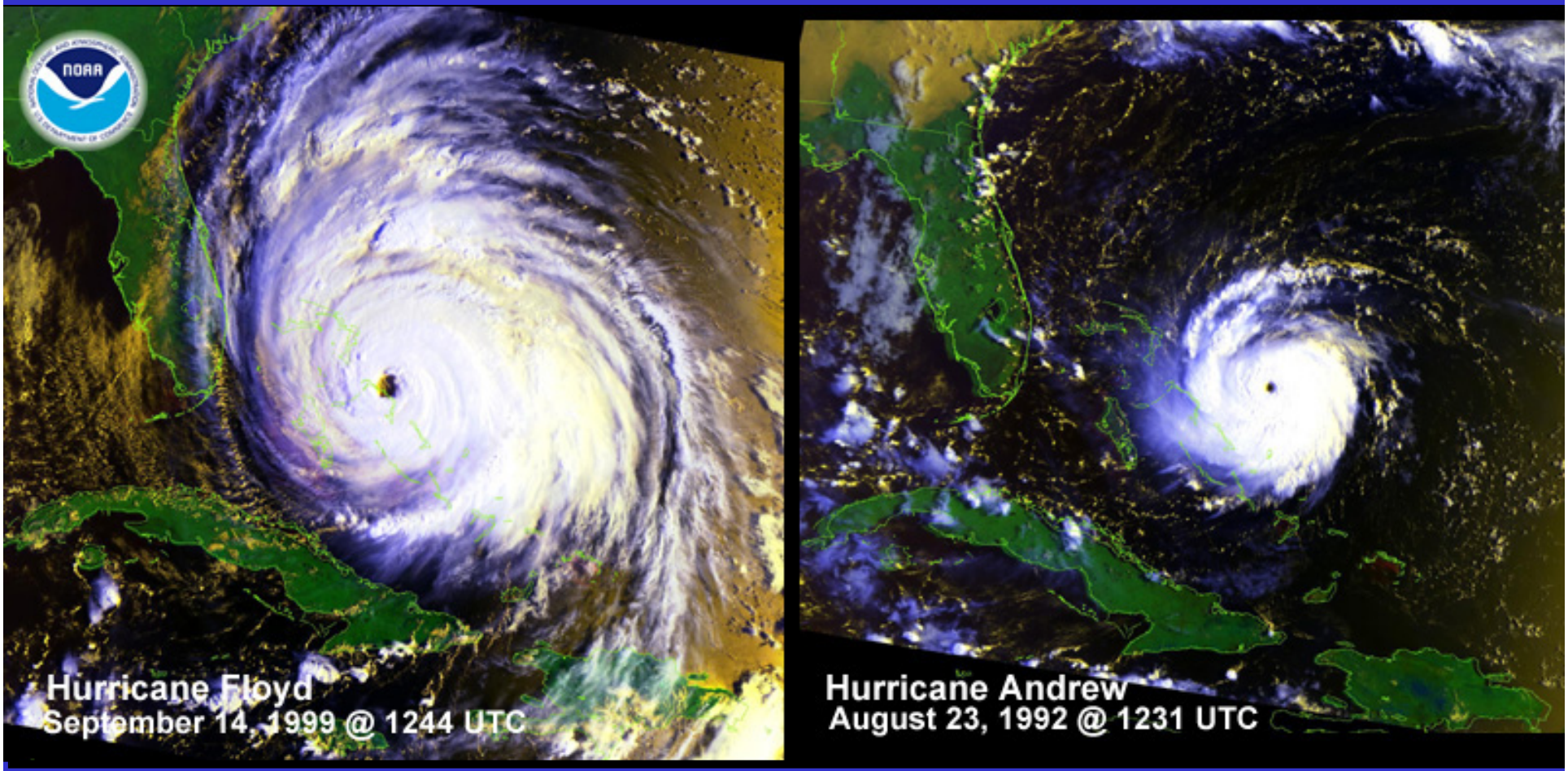
Tropical Cyclone Intensity

- The intensity is the maximum sustained wind anywhere in the cyclone
- These maximum sustained winds normally cover only a limited area near the center of the cyclone
- Generally, the stronger the cyclone, the closer the maximum winds are to the center

Structure and Intensity Variability

930 mb

933 mb



Maximum winds: 105 kt

TS Force winds: 250 n mi

Maximum winds: 145 kt

TS Force winds: 75 n mi

Beven

Tropical Cyclone Structure

- Shows tremendous storm-to-storm variability
- Can also show tremendous variability in any given storm
- As a generality, tropical cyclones get larger with time, increasing intensity, and increasing latitude
- Two important elements are the overall size of the wind field and the radius of maximum winds (RMW)

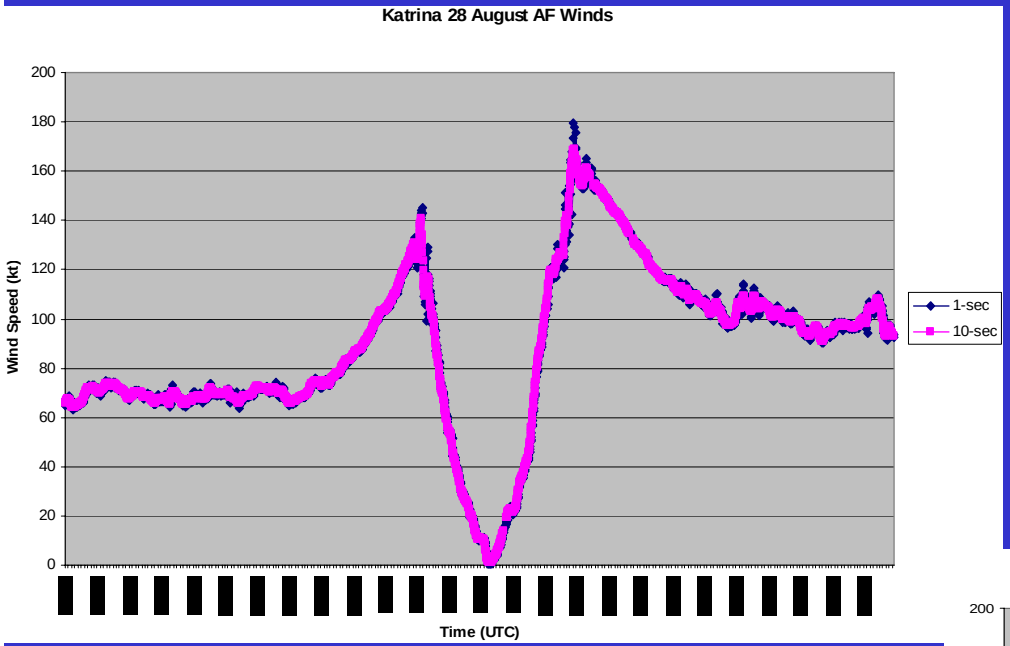
Beven

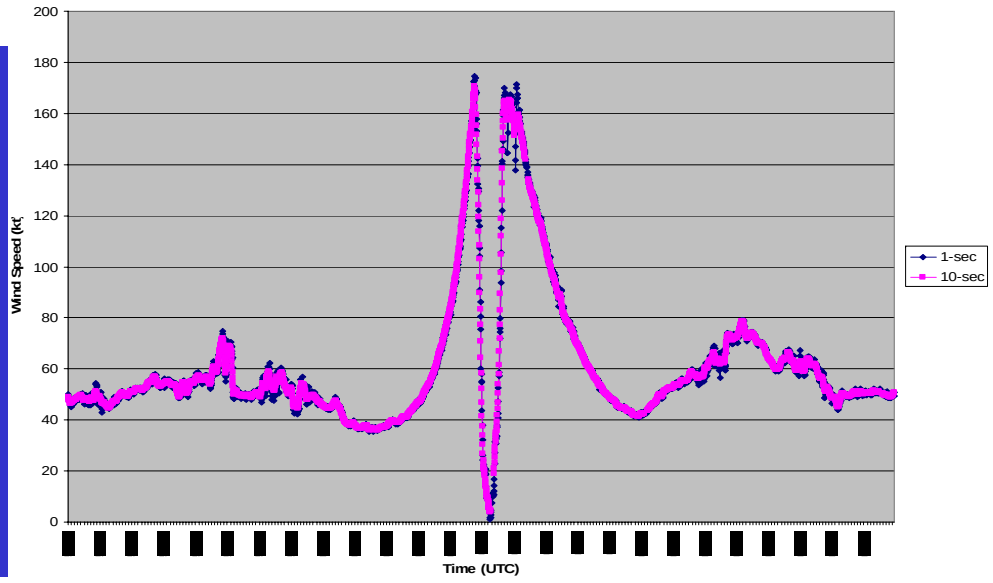
Radius of Maximum Wind

- The distance of the maximum sustained winds from the center of the cyclone - usually just outside the eye of a hurricane
- The TPC does not forecast the RMW quantitatively, and the qualitative forecast skill would be low
- The TPC Sea-Lake and Overland Surge from Hurricanes (SLOSH) model is very sensitive to this parameter
- While small storms will generally have relatively small RMW's, large storms can have a variety of RMW sizes ranging from very small to very large

Beven

Same Strength, Different Sizes





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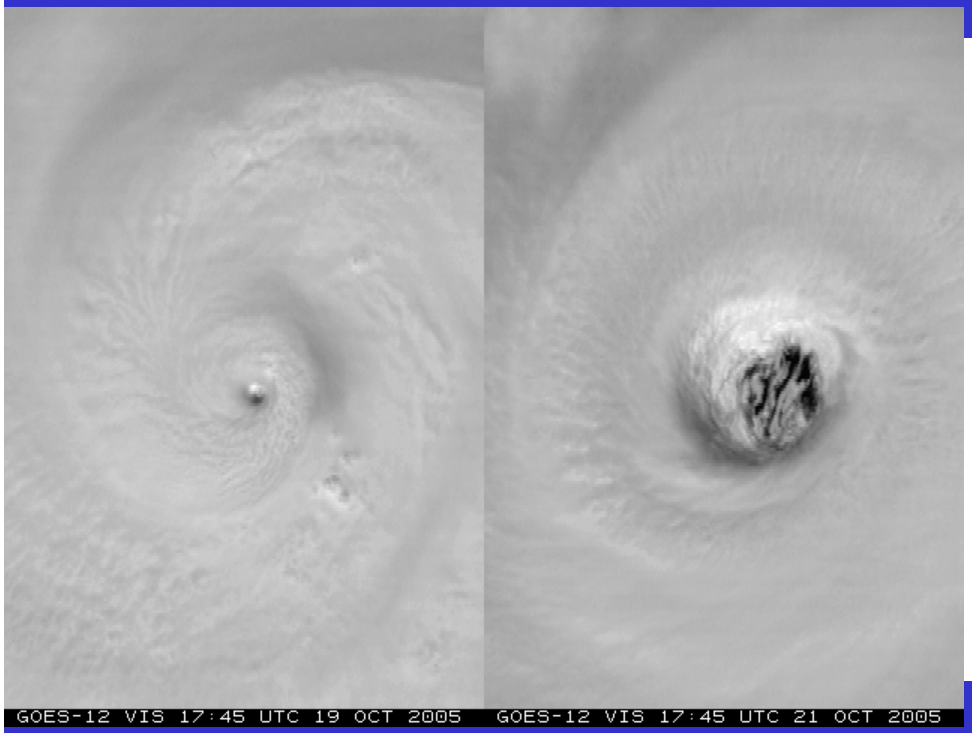
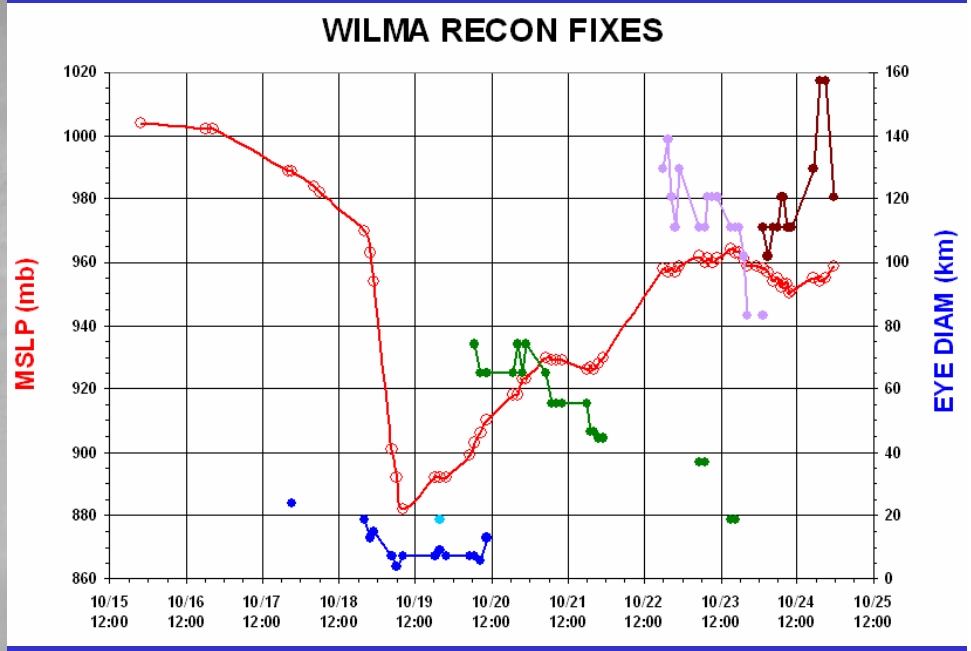
Changes In The Eye of Wilma



Pinhole eye on 19 October

Larger eye after eyewall cycle



Pressure and eye size evolution

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Importance of Structure on Surge and Waves

- Generally, for storms of equal intensity the amount and aerial coverage of storm surge increases as the RMW gets larger
- Generally, for storms of equal intensity the amount and aerial coverage of storm surge increases as the overall size increases
- Larger RMW's and overall sizes generally mean larger fetch areas for wave generation

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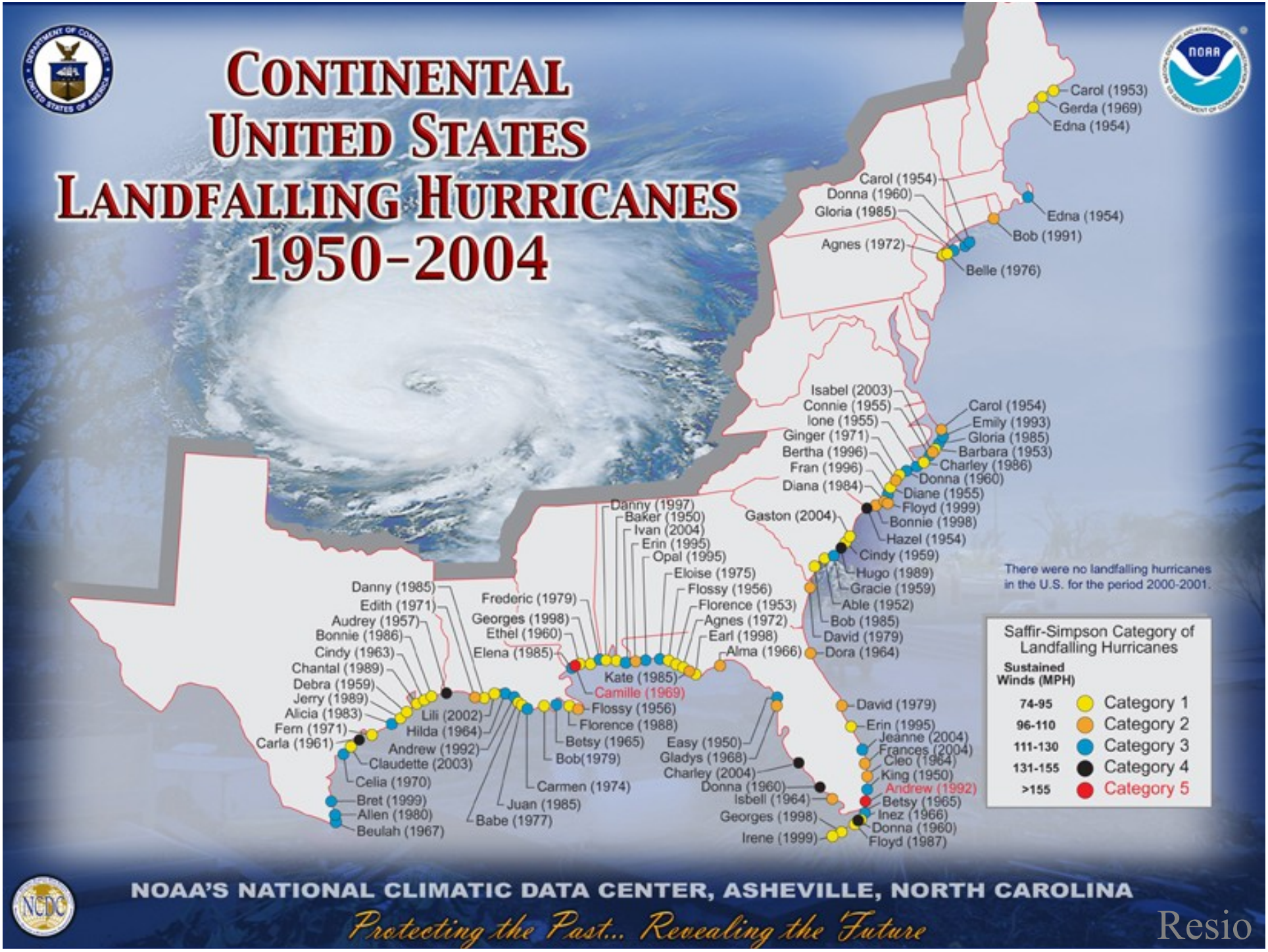
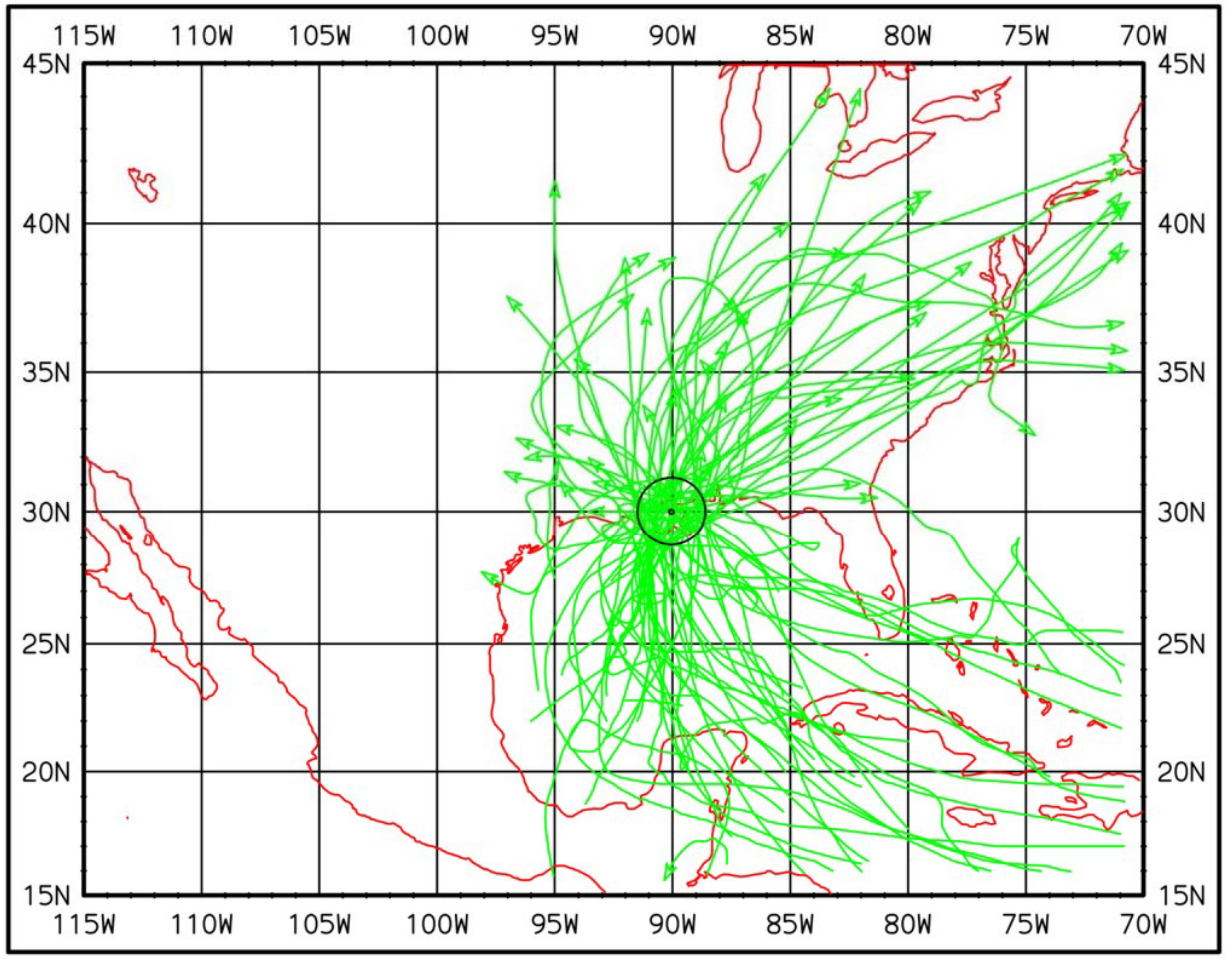

CONTINENTAL UNITED STATES LANDFALLING HURRICANES 1950-2004
Carol (1953)
Gerda (1969)
Edna (1954)
Carol (1954)
Donna (1960)
Gloria (1985)
Agnes (1972)
Edna (1954)
Bob (1991)
Belle (1976)
Isabel (2003)
Connie (1955)
Ione (1955)
Ginger (1971)
Bertha (1996)
Fran (1996)
Diana (1984)
Carol (1954)
Emily (1993)
Gloria (1985)
Barbara (1953)
Charley (1986)
Donna (1960)
Diane (1955)
Floyd (1999)
Bonnie (1998)
Hazel (1954)
Gaston (2004)
Cindy (1959)
Hugo (1989)
Gracie (1959)
Able (1952)
Bob (1985)
David (1979)
Dora (1964)
Danny (1997)
Baker (1950)
Ivan (2004)
Erin (1995)
Opal (1995)
Eloise (1975)
Flossy (1956)
Florence (1953)
Agnes (1972)
Earl (1998)
Alma (1966)
Danny (1985)
Edith (1971)
Audrey (1957)
Bonnie (1986)
Cindy (1963)
Chantal (1989)
Debra (1959)
Jerry (1989)
Alicia (1983)
Fern (1971)
Carla (1961)
Frederic (1979)
Georges (1998)
Ethel (1960)
Elena (1985)
Kate (1985)
Camille (1969)
Flossy (1956)
Florence (1988)
Betsy (1965)
Bob(1979)
Carmen (1974)
Juan (1985)
Babe (1977)
Lili (2002)
Hilda (1964)
Andrew (1992)
Claudette (2003)
Celia (1970)
Bret (1999)
Allen (1980)
Beulah (1967)
Easy (1950)
Gladys (1968)
Charley (2004)
Donna (1960)
Isbell (1964)
Georges (1998)
Irene (1999)
David (1979)
Erin (1995)
Jeanne (2004)
Frances (2004)
Cleo (1964)
King (1950)
Andrew (1992)
Betsy (1965)
Inez (1966)
Donna (1960)
Floyd (1987)
There were no landfalling hurricanes in the U.S. for the period 2000-2001.
Saffir-Simpson Category of Landfalling Hurricanes
Sustained Winds (MPH)
74-95 Category 1
96-110 Category 2
111-130 Category 3
131-155 Category 4
>155 Category 5
NOAA'S NATIONAL CLIMATIC DATA CENTER, ASHEVILLE, NORTH CAROLINA
Protecting the Past... Revealing the Future

Tropical Storms and Hurricanes Near New Orleans 1886-2003



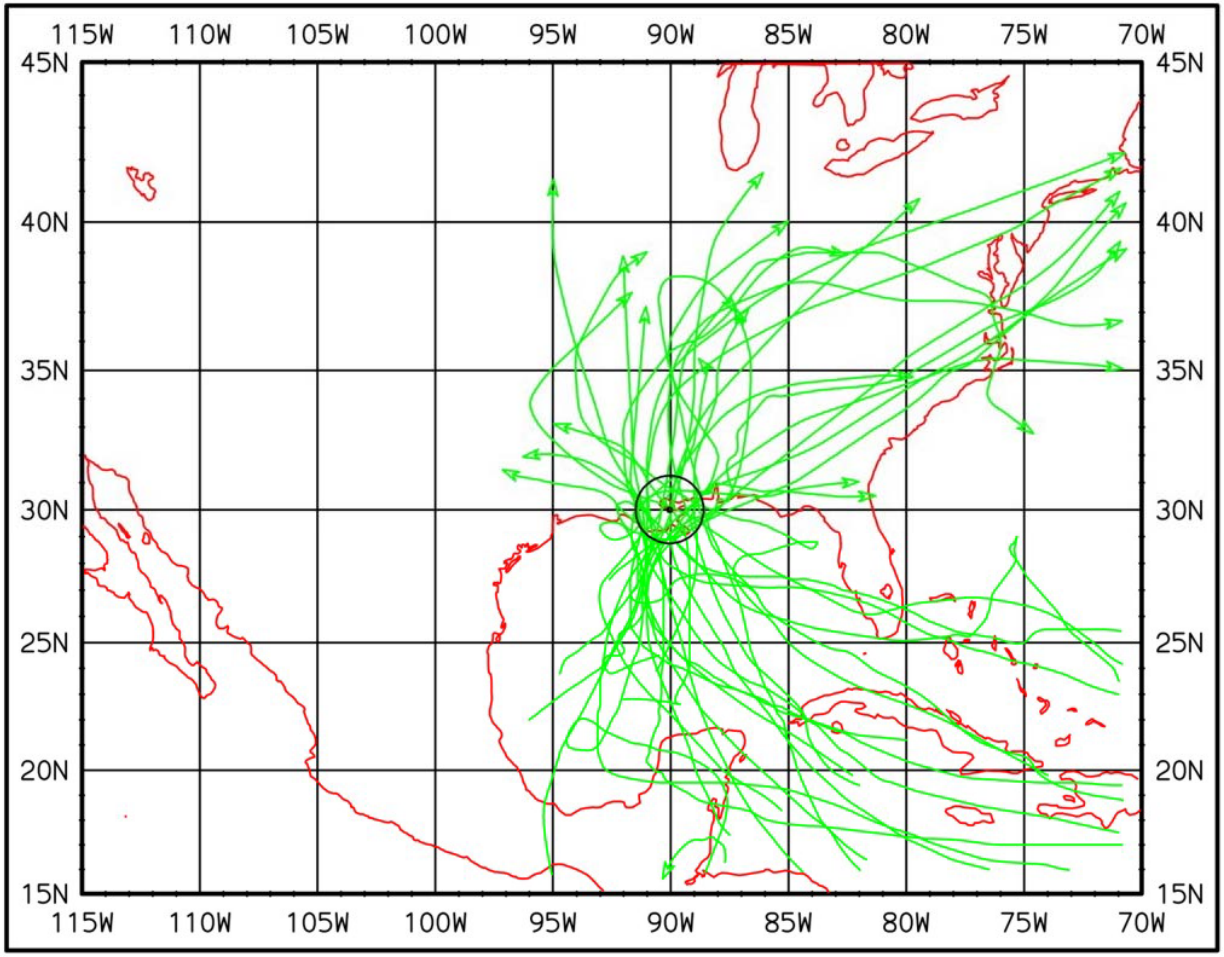
TROPICAL STORMS AND HURRICANES PASSING WITHIN 75 NMi OF NEW ORLEANS, 1886-2003

NUMBER OF STORMS IS 58

CHART 2

Beven

Hurricanes
Near New Orleans 1886-2003

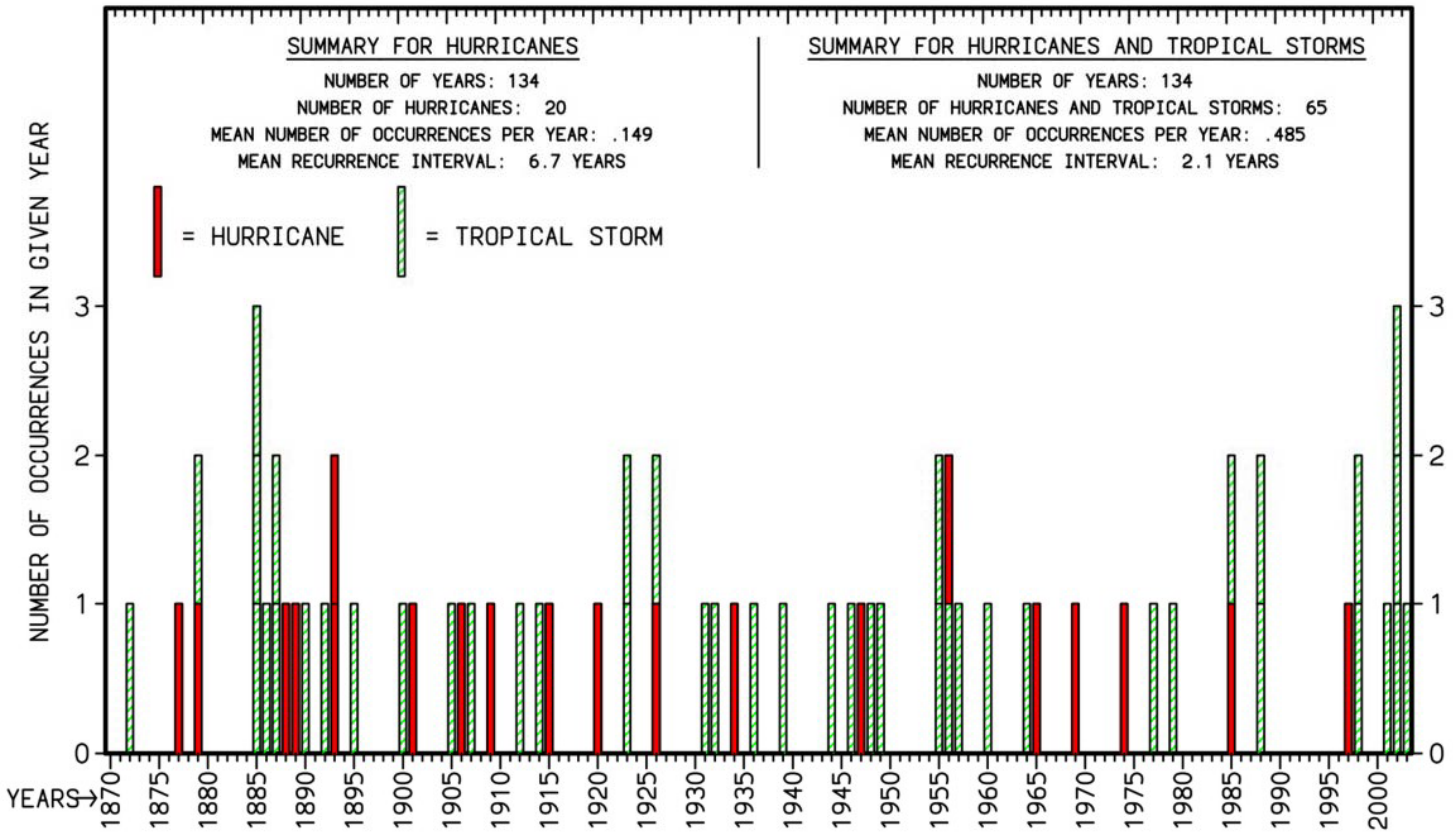


HURRICANES PASSING WITHIN 75 NMi OF NEW ORLEANS, 1886-2003
NUMBER OF STORMS IS 28

CHART 3

Beven

Tropical Storms and Hurricanes Near New Orleans 1886-2003



CHRONOLOGY OF THE 65
TROPICAL STORMS AND HURRICANES PASSING WITHIN 75 NMi OF NEW ORLEANS, 1870-2003

(Note: Designation as tropical storm or hurricane is at time of closest point of approach to site.)

CHART 4

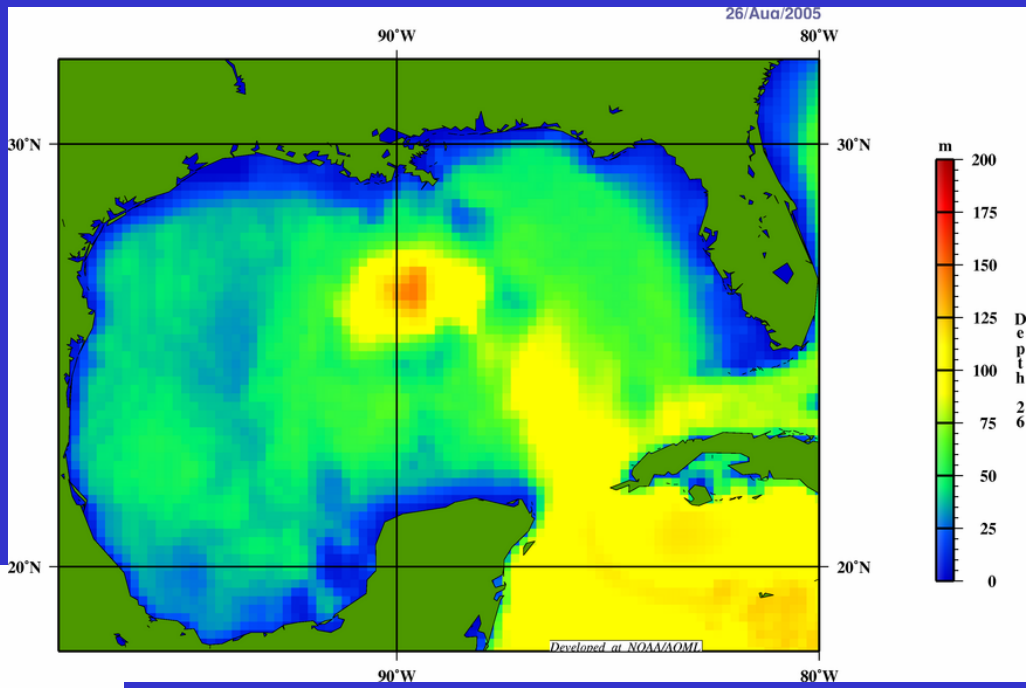
Beven

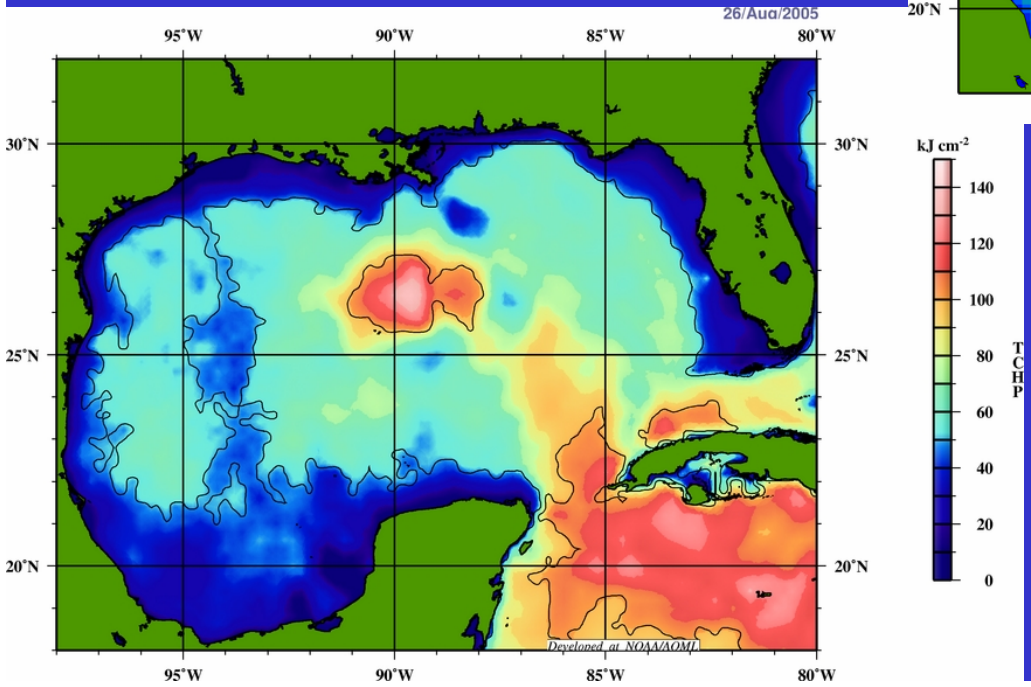
Role of The Loop Current

- The Loop Current is a normally-occurring deep warm water eddy in the central Gulf of Mexico
- This feature has a large resovoir of oceanic energy to supply to hurricanes
- Hurricanes Camille, Katrina, and Rita had significant portions of their tracks over the Loop Current

Role of The Loop Current

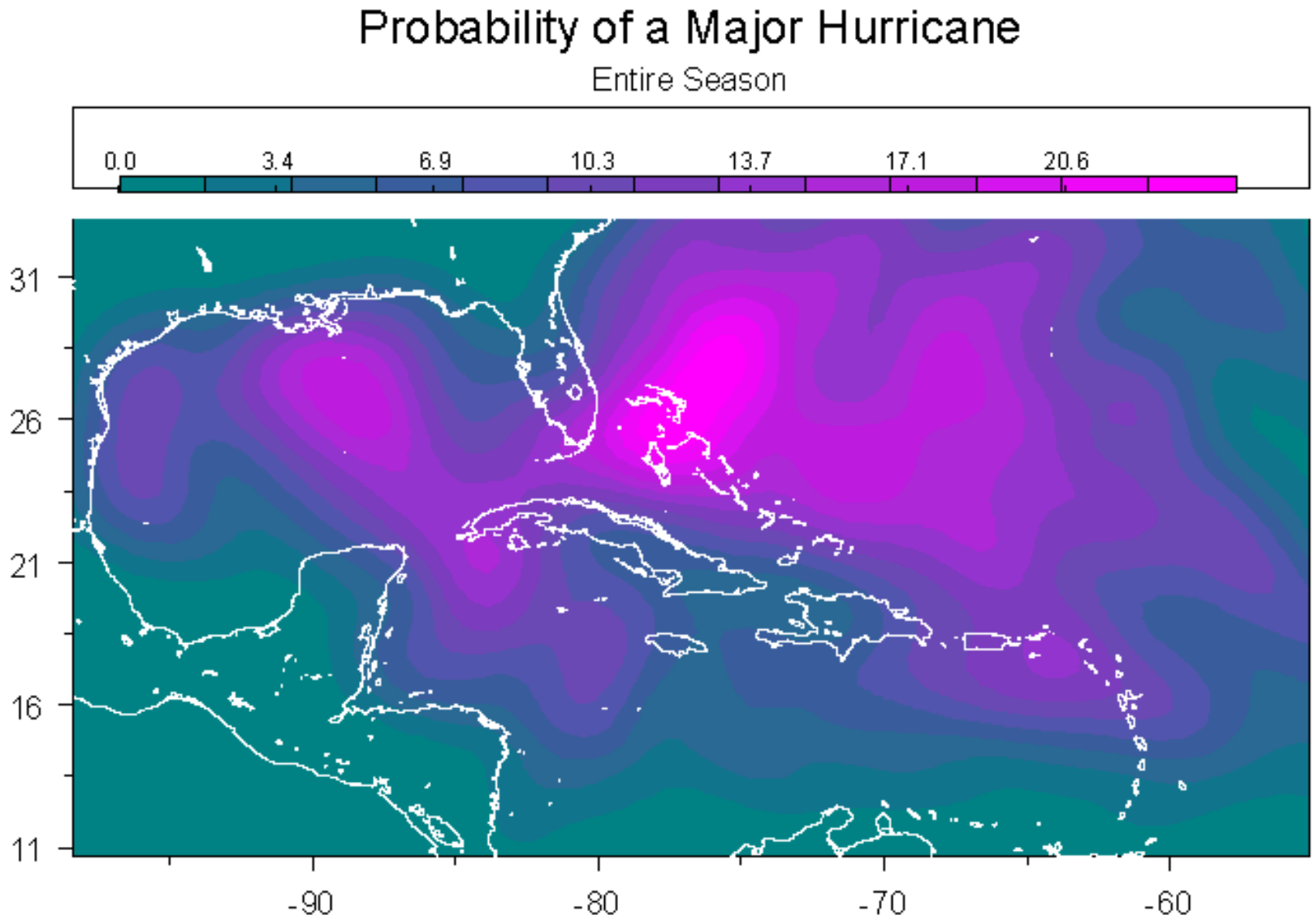
Depth of 26C Isotherm





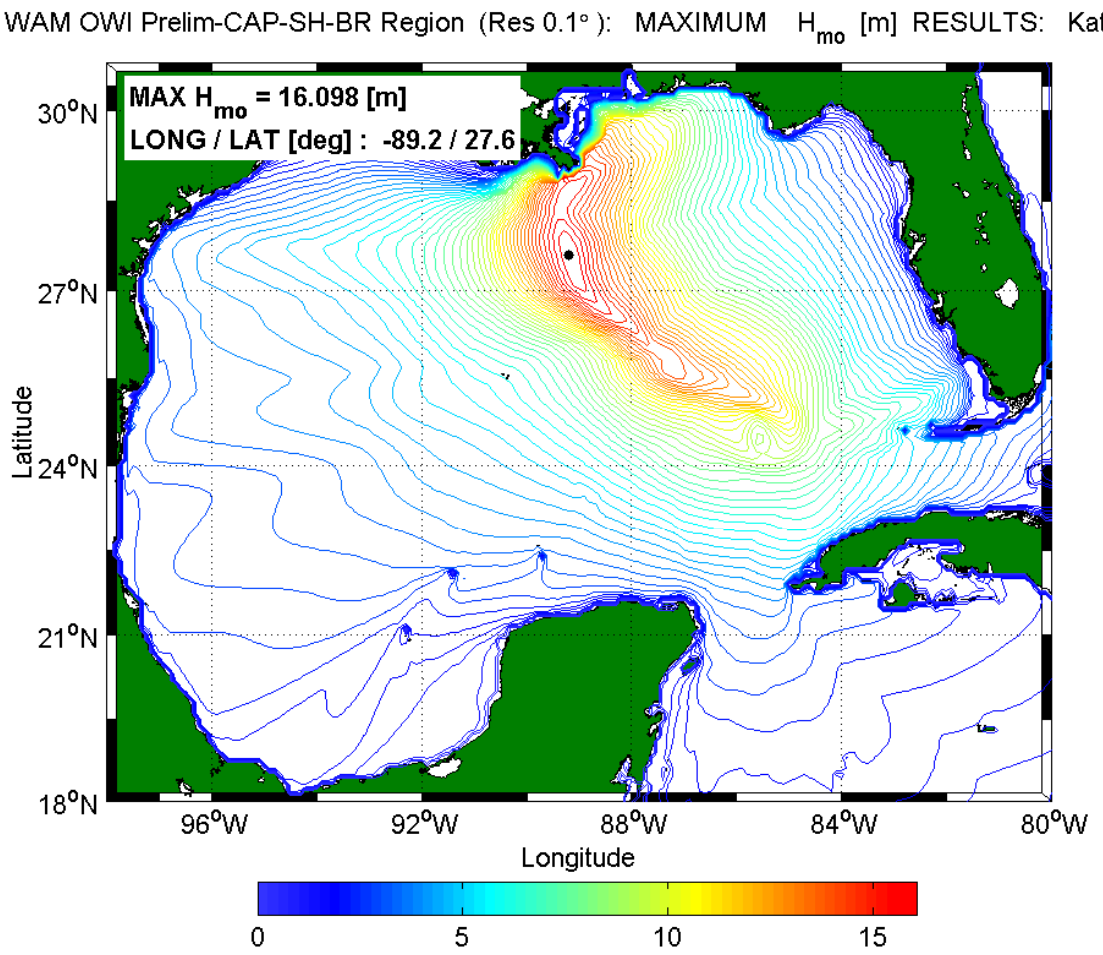
Oceanic Heat Content

Beven

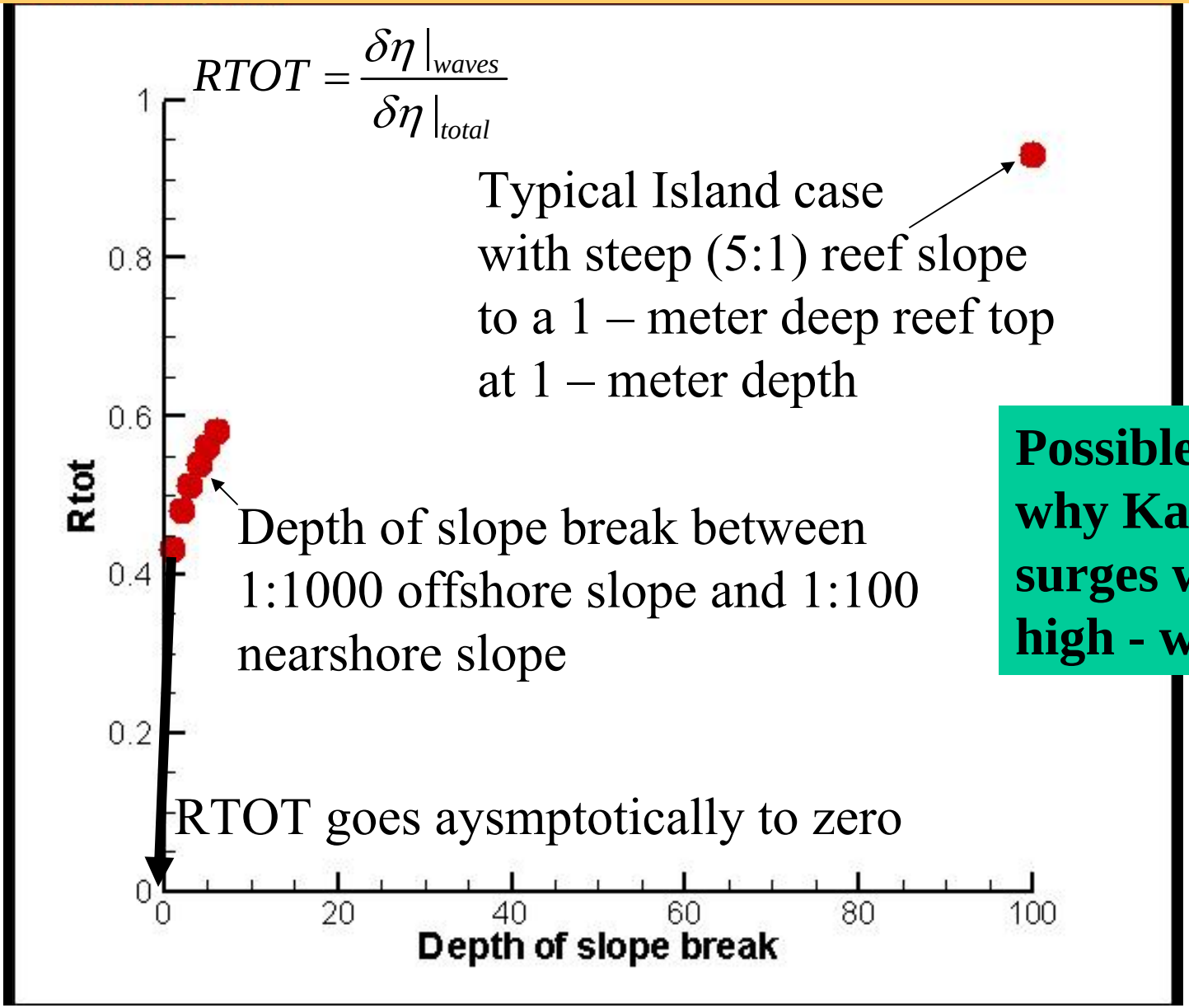


Major hurricane probabilities are not spatially homogeneous.

Resio

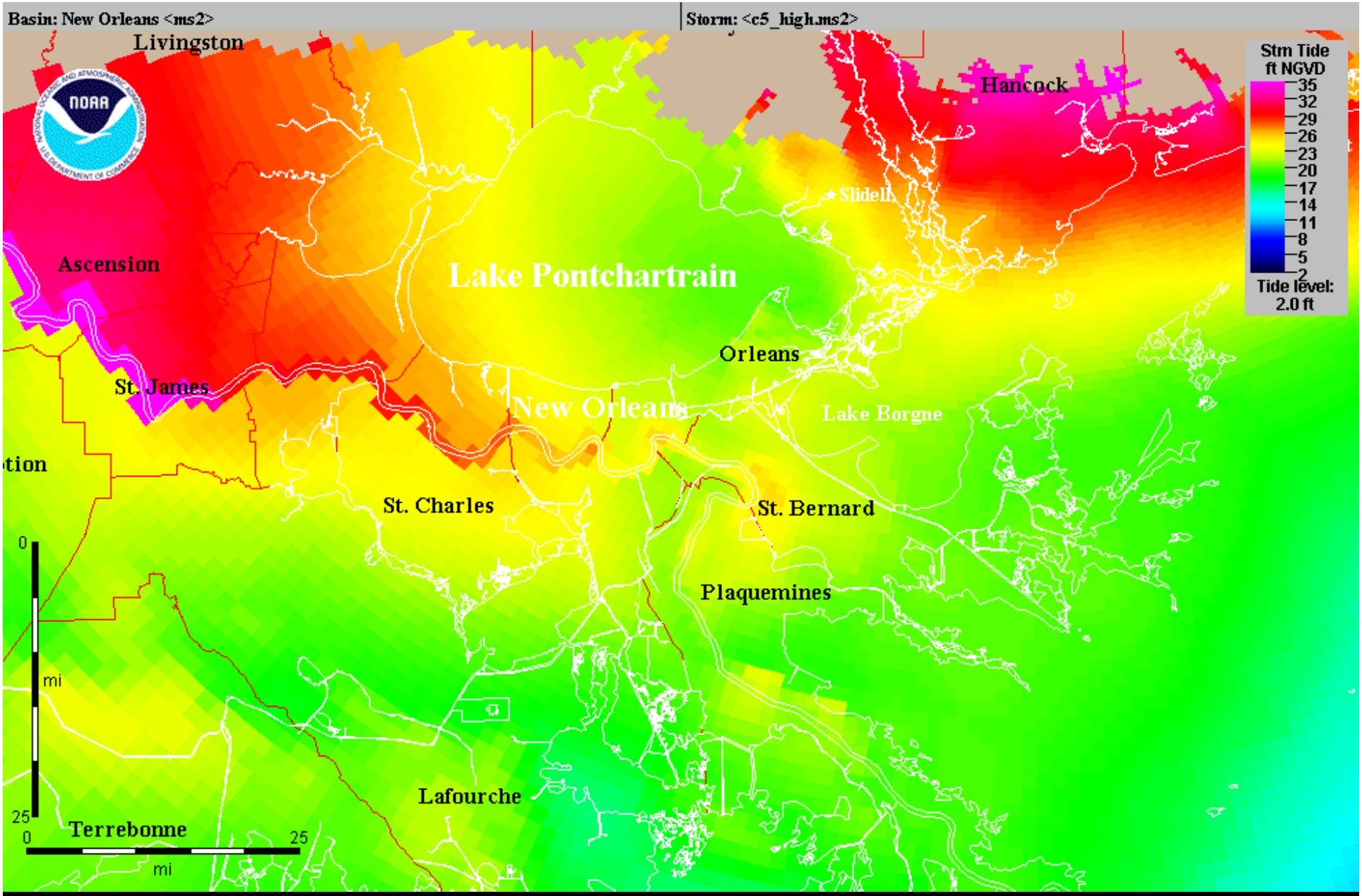

WAM OWI Prelim-CAP-SH-BR Region (Res 0.1°): MAXIMUM H_{mo} [m] RESULTS: Katrina
MAX H_{mo} = 16.098 [m]
LONG / LAT [deg] : -89.2 / 27.6
30°N
27°N
24°N
21°N
18°N
Latitude
96°W
92°W
88°W
84°W
80°W
Longitude
0
5
10
15

Ratio of wave contribution to surge to total surge,
Assuming energy loss is one of two regions ($k^{-5/2}$ or $H \sim \gamma h$)



Possible reason why Katrina surges were so high - waves?

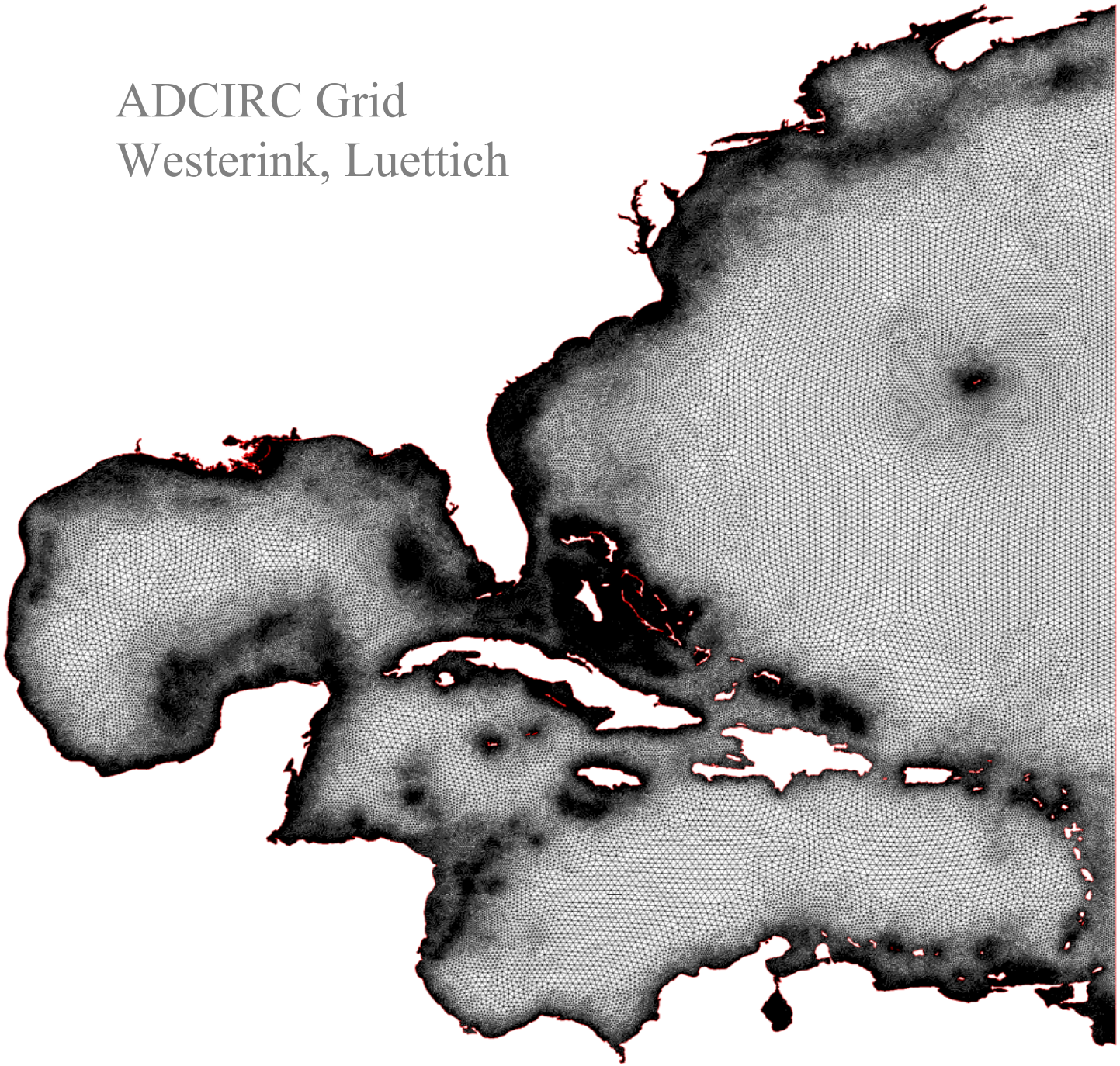
Resio



Cat 5 MOM – High Tide

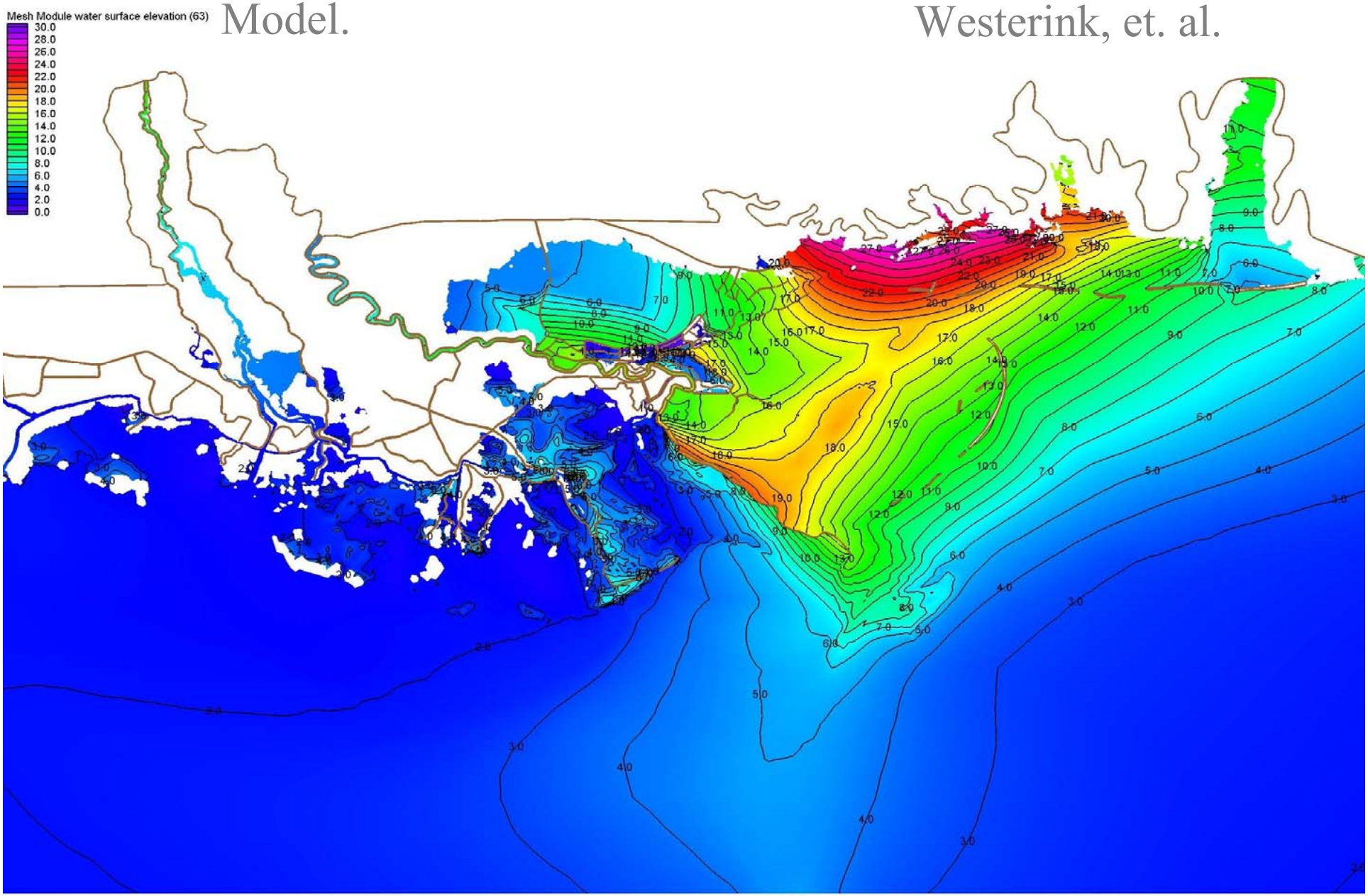
Shaffer

ADCIRC Grid
Westerink, Luettich



Hurricane Katrina Maximum Water levels Using ADCIRC Model.

75% Solution IPET Westerink, et. al.



Teams Identified At Workshop

1. **Design** – layout protection schemes; Harley Winer, Joe Suhayda, Paul Kemp, Robert Twilley, State Reps, DNR, DOT, Joannes Westerink, Carl Anderson, Bruce Ebersole, Vann Stutts, Mary Cialone, Edmund Russo, Buddy Clairain, Roy Dokka, Denise Reed, Rick Luettich, Dano Roelvink

2. **Statistics/Risk** – defining maximum hurricane, Peter Vickery, Nancy Powell, Don Resio, Daniele Veneziano, Joe Suhayda, Mark Powell, Jen Irish, Jeff Melby, Leon Borgman, Jack Beven, Will Shaffer

3. **Modeling** – comparison to data/ setup subgroup fits here, Rick Luettich, Bob Dean, Dano Roelvink, Jane Smith, Peter Vickery, Will Shaffer, Mark Powell, Janis Hote, Joannes Westerink, Dave Mark, Jen Irish, Steve Hughes, Jay Ratcliffe, Ray Chapman, Paul Kemp, Vince Cardone, Bob Jensen, Andy Cox, Nobu Kobayashi, Ty Wamsley

Teams Identified At Workshop

ITR suggested members:

1. Design – Reed Mosher, John Day, Don Boesch, Jim Coleman, Han Vrijling, Dag Nummedal, Ray Seed
2. Statistics - Han Vrijling, David Bowles, Bruce Ellingwood, Marty McCann, David Divoky, Chris Zervas
3. Modeling – Guus Stelling, Bob Reid, Frank Aikman, Jurjen Battjes, Tony Dalrymple

LACPR Team Co-Leads*

- **Engineering Management**
  - Tim Ruppert, CEMVN-ED-SP
  - Pam Deloach, CEMVN-ED-SP
- **Coastal and Hydraulics Design**
  - Van Stutts, CEMVN-ED-H
  - Kevin Knuuti, CEER
- **Hydrodynamic Modeling**
  - Van Stutts, CEMVN-ED-H
  - Ty Wamsley, CEERD
- **Coastal and Hydraulics Risk/Statistics**
  - Van Stutts, CEMVN-ED-H
  - Don Resio, CEERD-H
- **Structures/Mechanical/Electrical Design**
  - Don Jolissant, CEMVN-ED-G
  - Stan Woodson, CEER
- **Cost Engineering**
  - John Petitbon, CEMVN-ED-C

Workshop - Engineering Technical Approaches and Innovations

Where:Vicksburg MS @ ERDC

When: March 2 – 3, 2006