

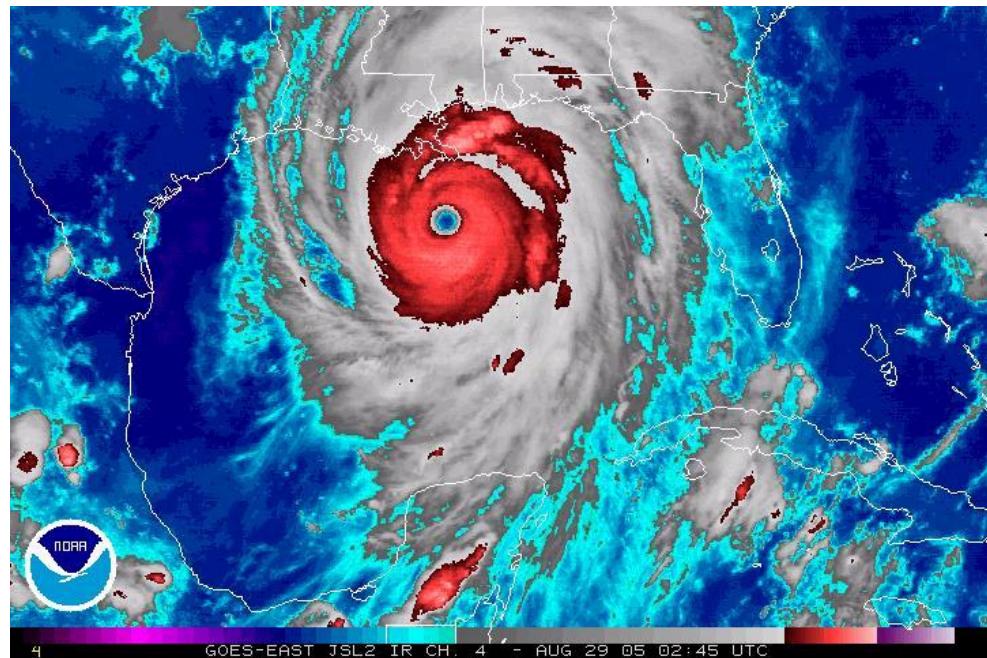
# EARTH 270 – DISASTERS AND NATURAL HAZARDS (v. 2018)



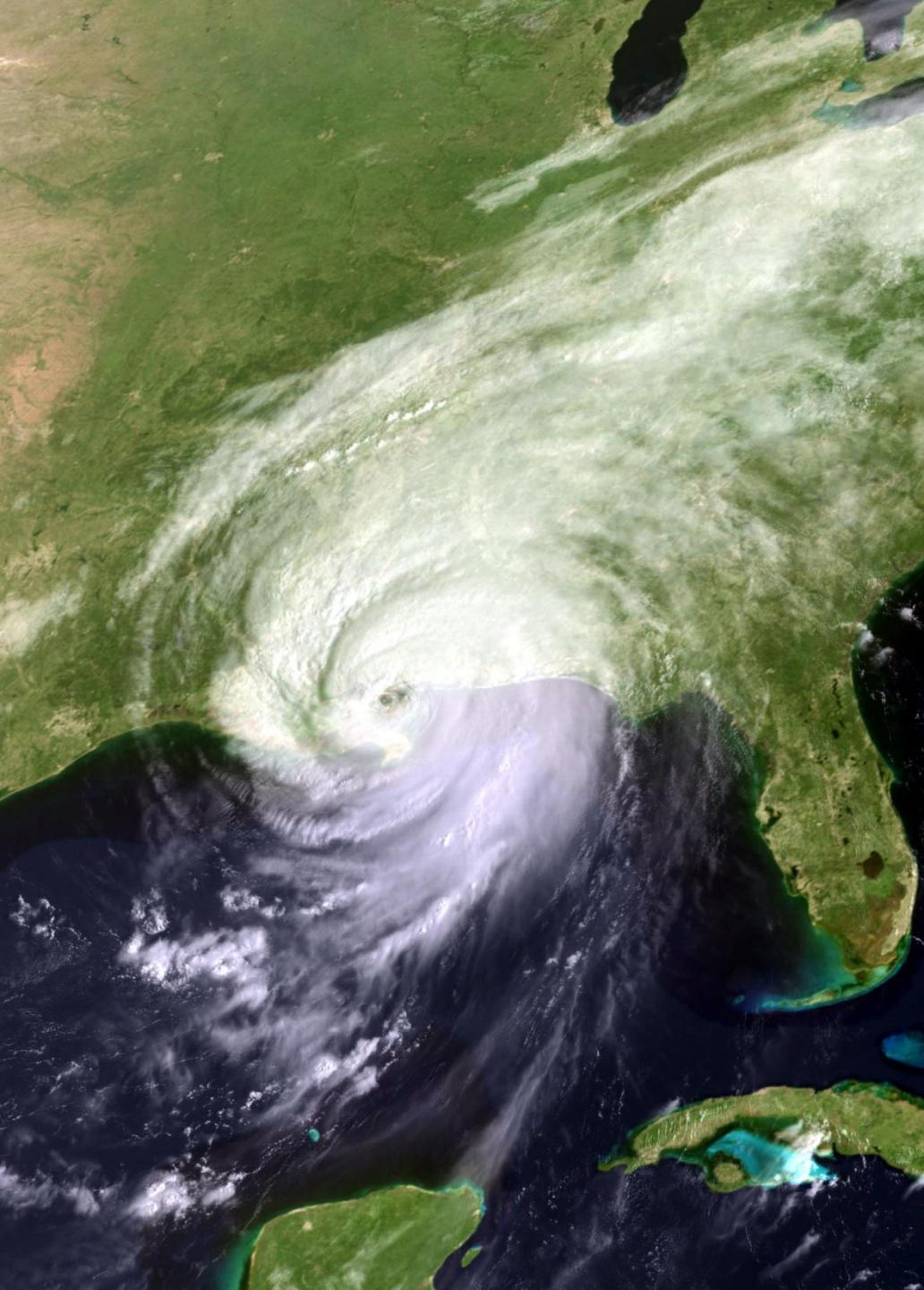
*Kesennuma City, Miyagi Prefecture , Japan, March 2011*

PROFESSOR S.G. EVANS, PhD, PEng (Room 303, Earth Science  
and Chemistry (ESC) Building)

# HURRICANE KATRINA, USA



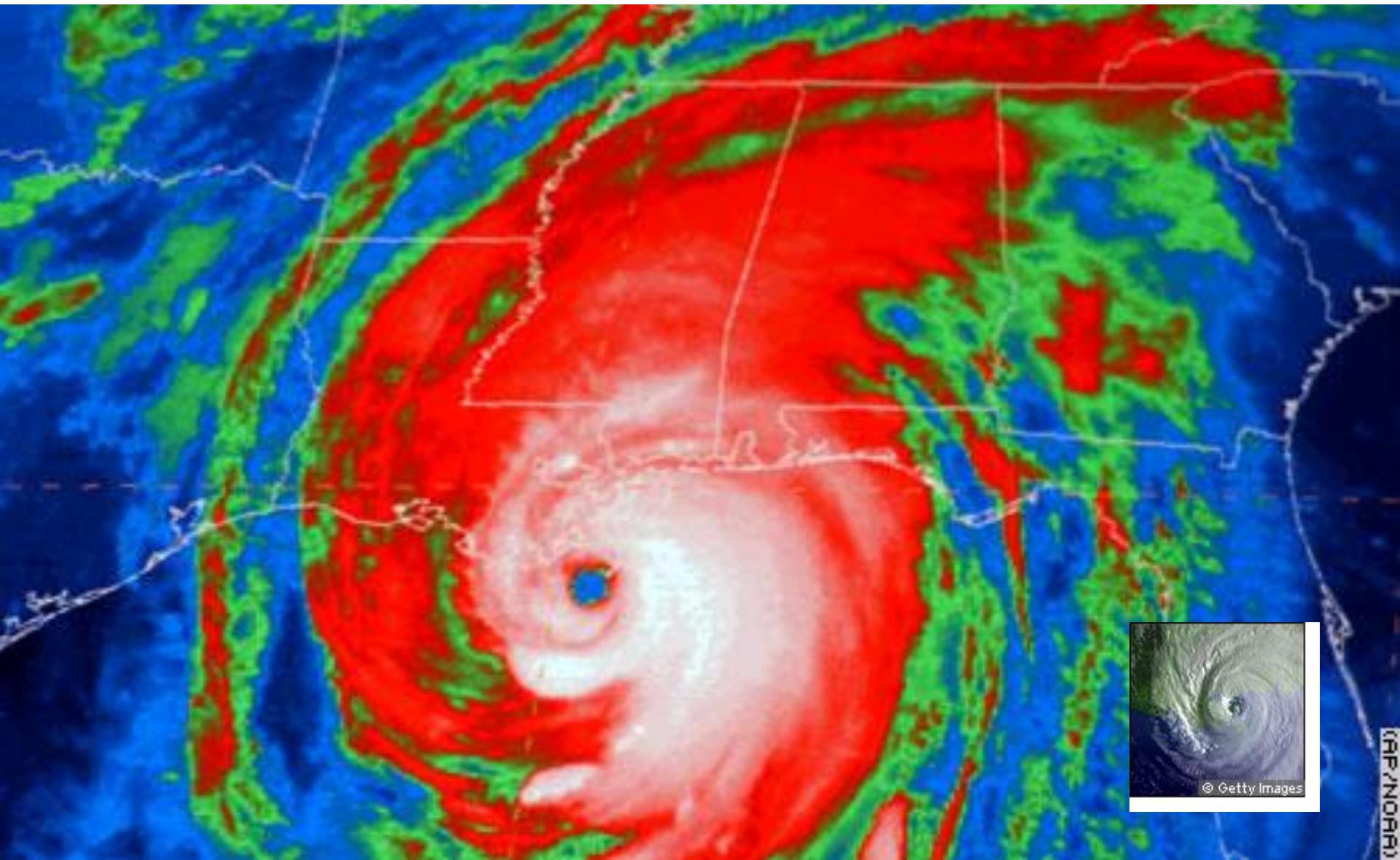
CLIMATE MEETS GEOLOGY





HURRICANE KATRINA – GULF OF MEXICO, USA : AUGUST 2005





© Getty Images

(AP/NASA)

# **DAMAGE AND DESTRUCTION DUE TO;**

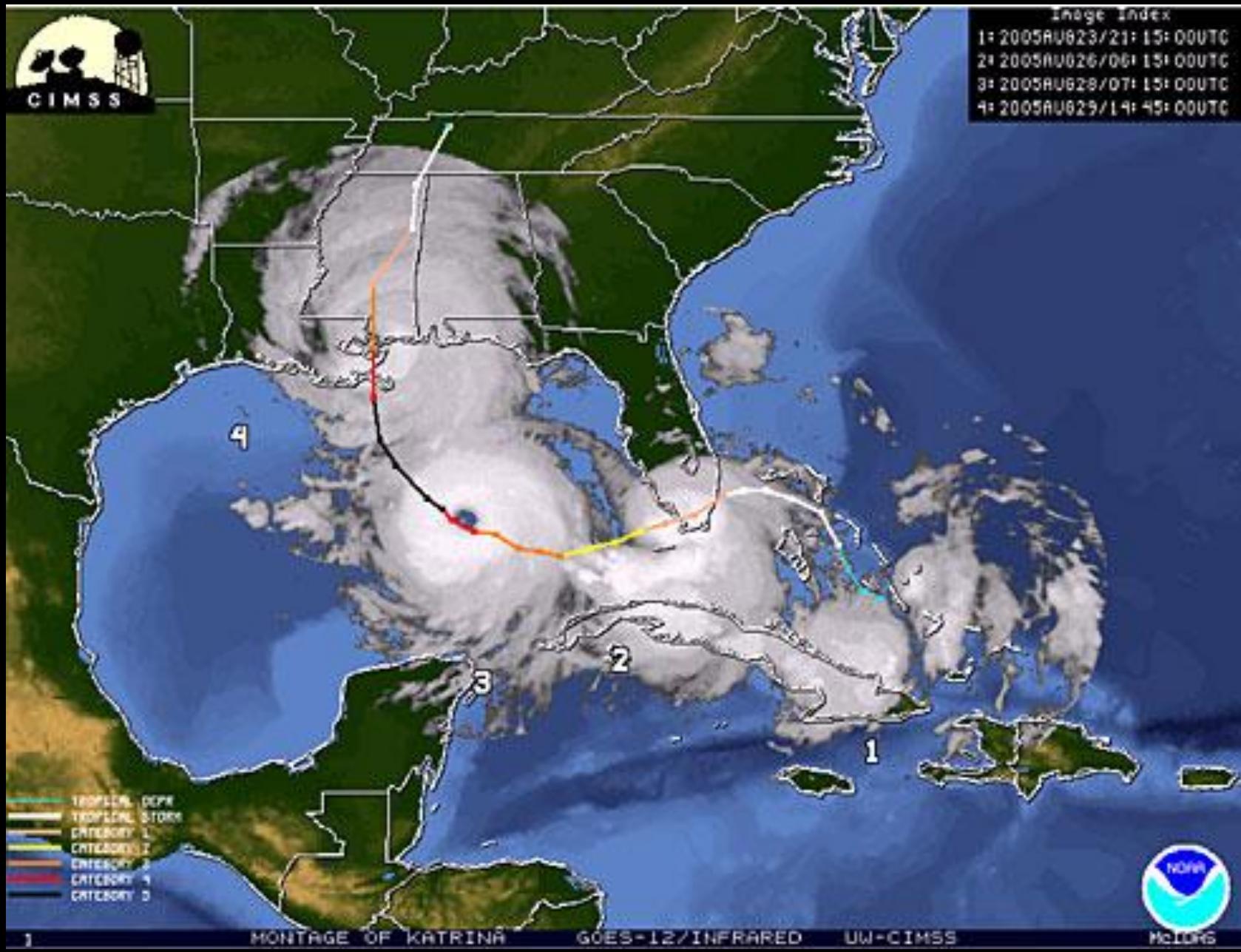
- 1. STORM SURGE**
- 2. HIGH WINDS**
- 3. FLOODING DUE TO LEVEE  
FAILURE**

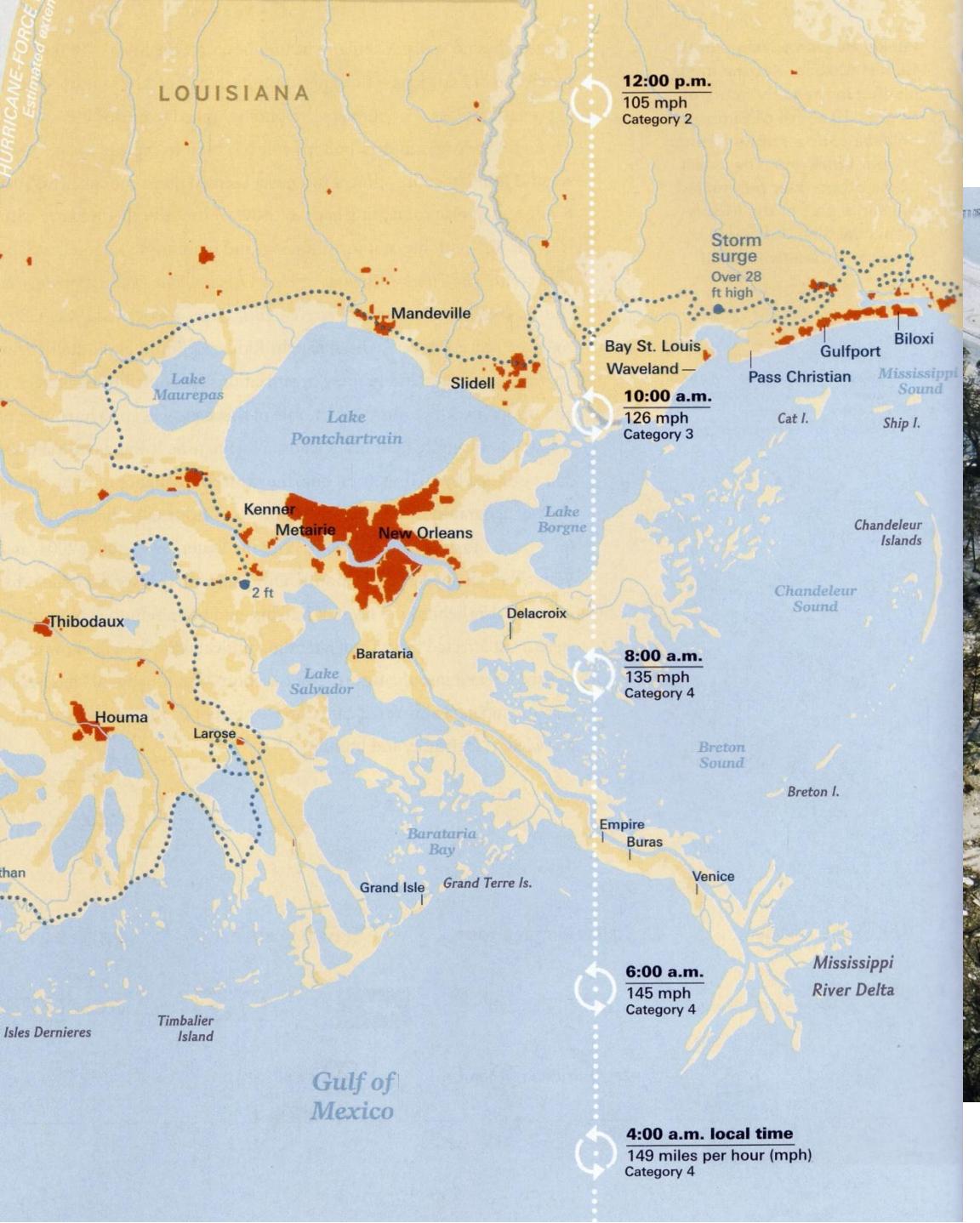


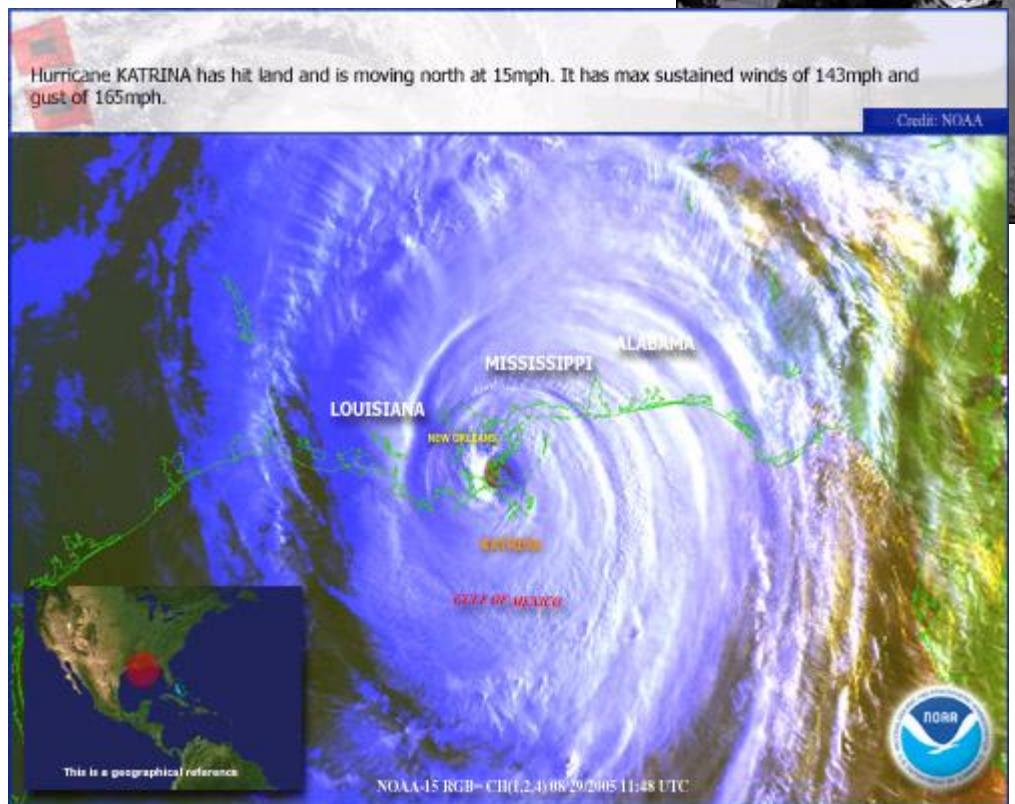


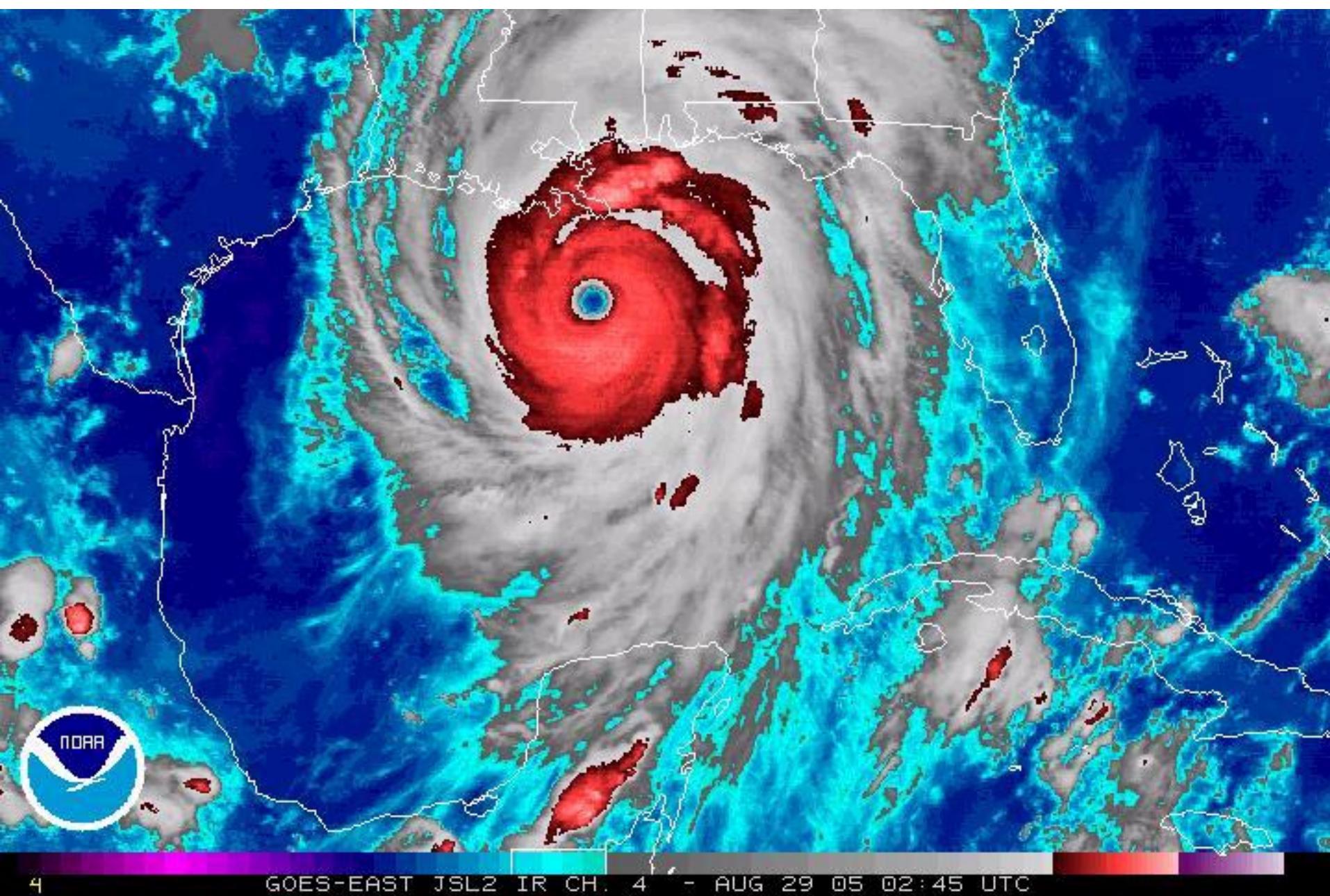
## Image Index

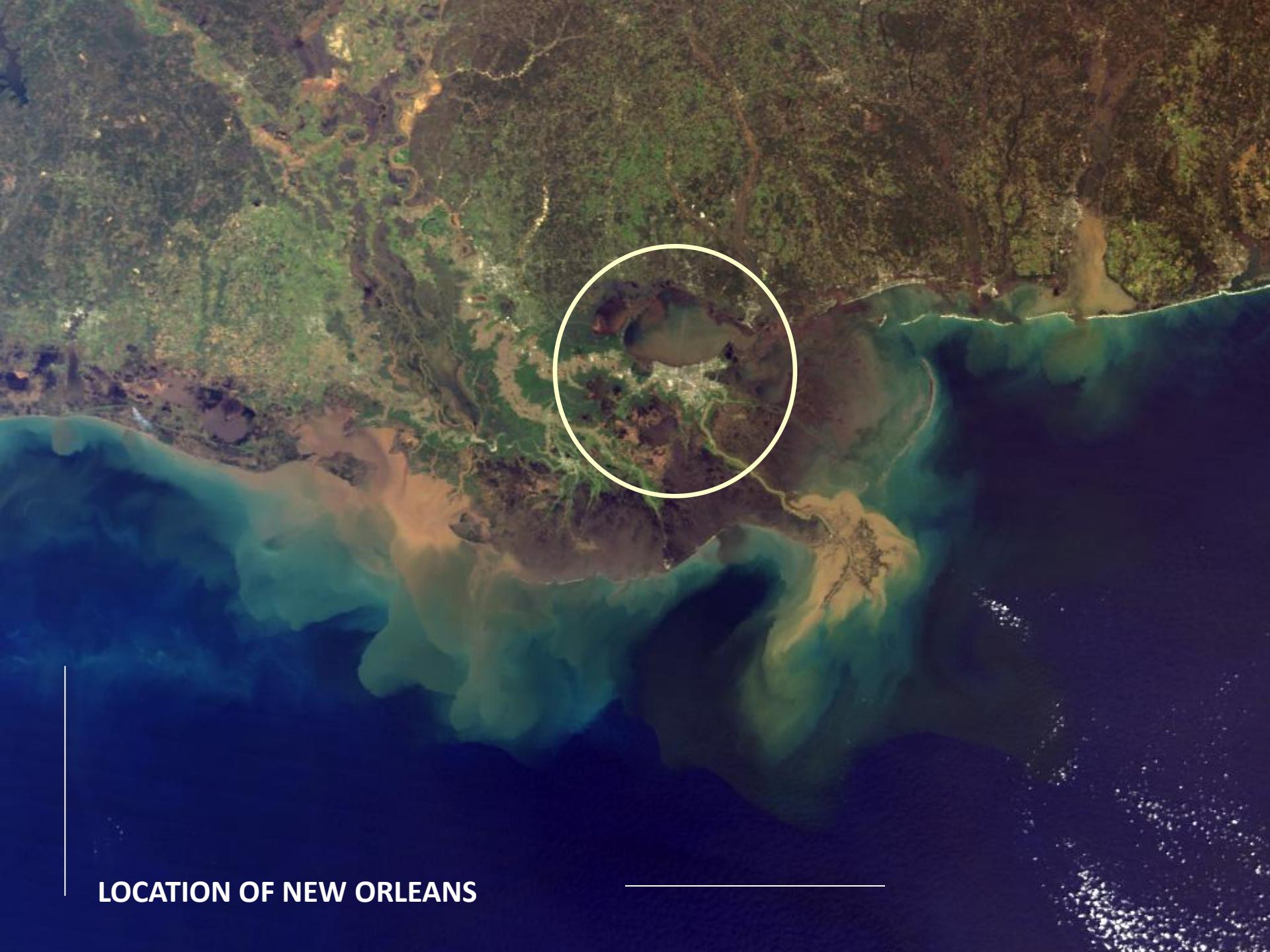
- 1: 2005AUG23/21:15:00UTC
- 2: 2005AUG26/06:15:00UTC
- 3: 2005AUG28/07:15:00UTC
- 4: 2005AUG29/14:45:00UTC









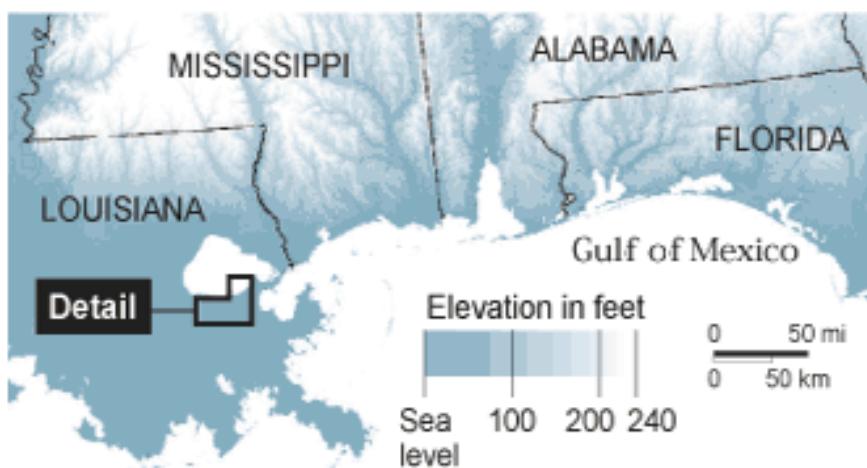


LOCATION OF NEW ORLEANS

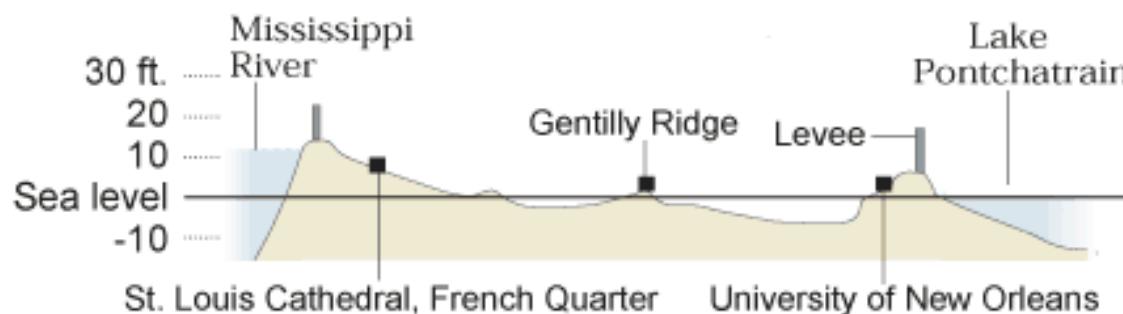
# Gulf Coast areas brace for flooding

Forecasters warn that Hurricane Katrina could produce a storm surge of 18 to 28 feet, topped by even higher waves. Storm surges push water toward the shore by the force of storm winds. SOURCES: Army Corps of Engineers; USGS; NOAA

## Elevation of Gulf coast states



New Orleans is particularly vulnerable to flooding because of its low elevation and close proximity to Lake Pontchartrain and the Mississippi River.

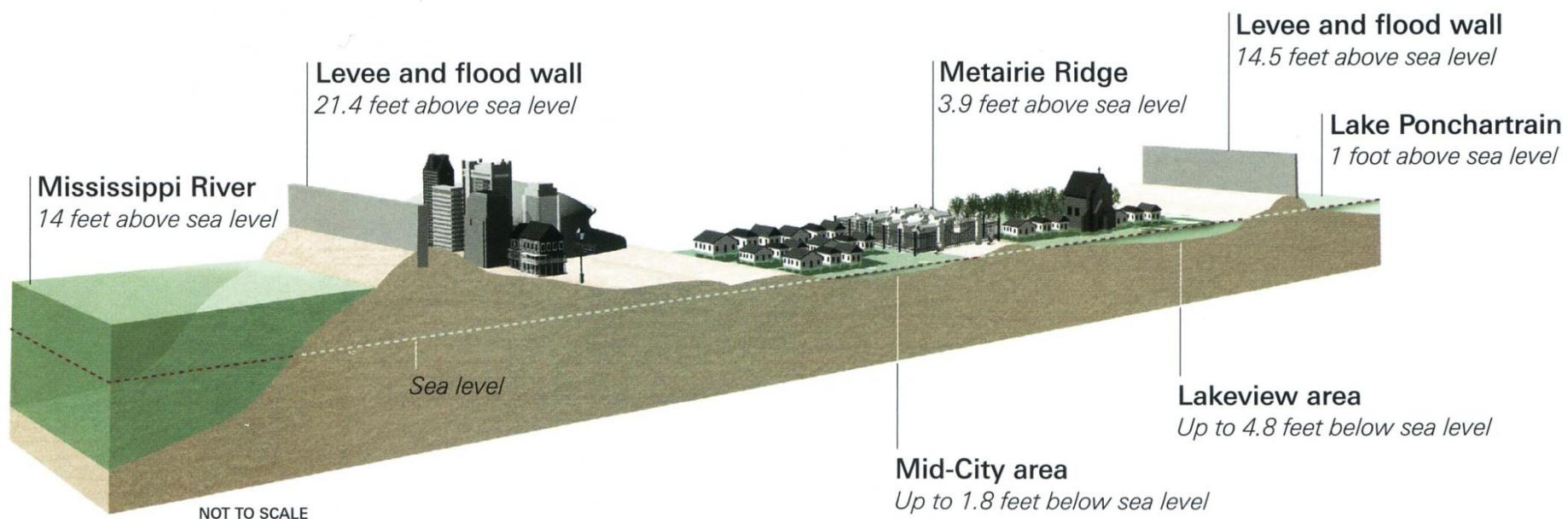


# The nightmare comes true

Long before there was a Katrina, there were grim predictions that a catastrophe was looming. In 2001 *Scientific American* said that a major hurricane hit in New Orleans was “inevitable” and that the city “is a disaster waiting to happen.” In 2002 the *Times-Picayune* newspaper issued similar warnings in a five-part series titled “Washing Away.” And in October 2004 *National Geographic* magazine published “Gone With the Water,” which opened with an eerily prophetic description of the damage, chaos, and

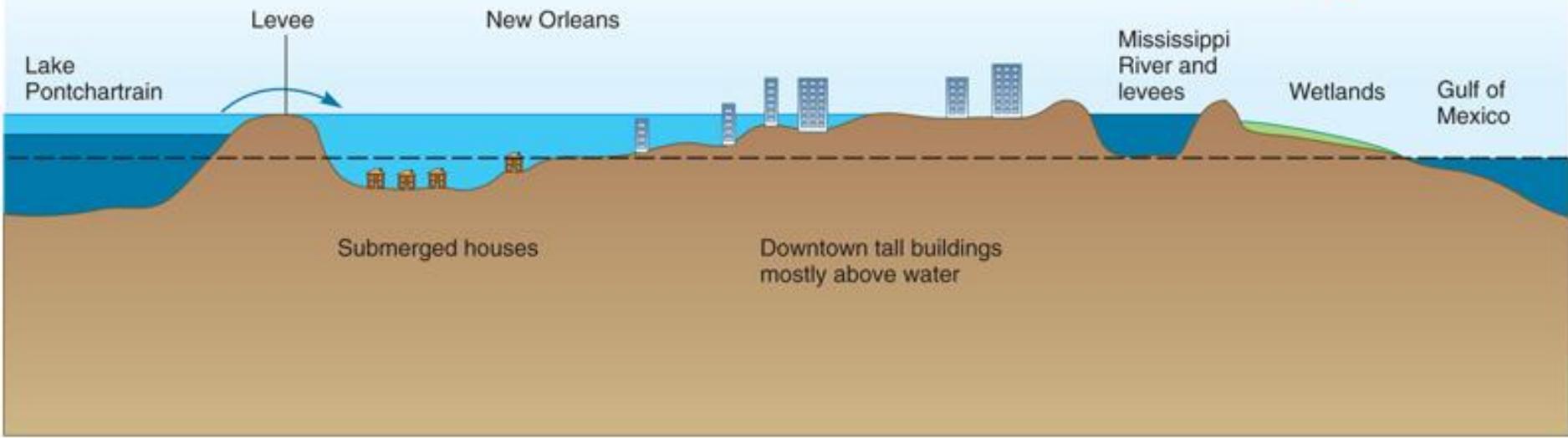
death that would descend with a major hurricane. All three reports noted the challenges presented by New Orleans’ odd topography: The city, surrounded by water on three sides, is built in a shallow bowl that dips below sea level—more than eight feet in some spots—with levees and floodwalls serving as the main defensive barriers against flooding (see cross section, below). To compound the problem, New Orleans and its levees are subsiding, sinking slowly into the marshy muck beneath.

## A CITY BELOW SEA LEVEL



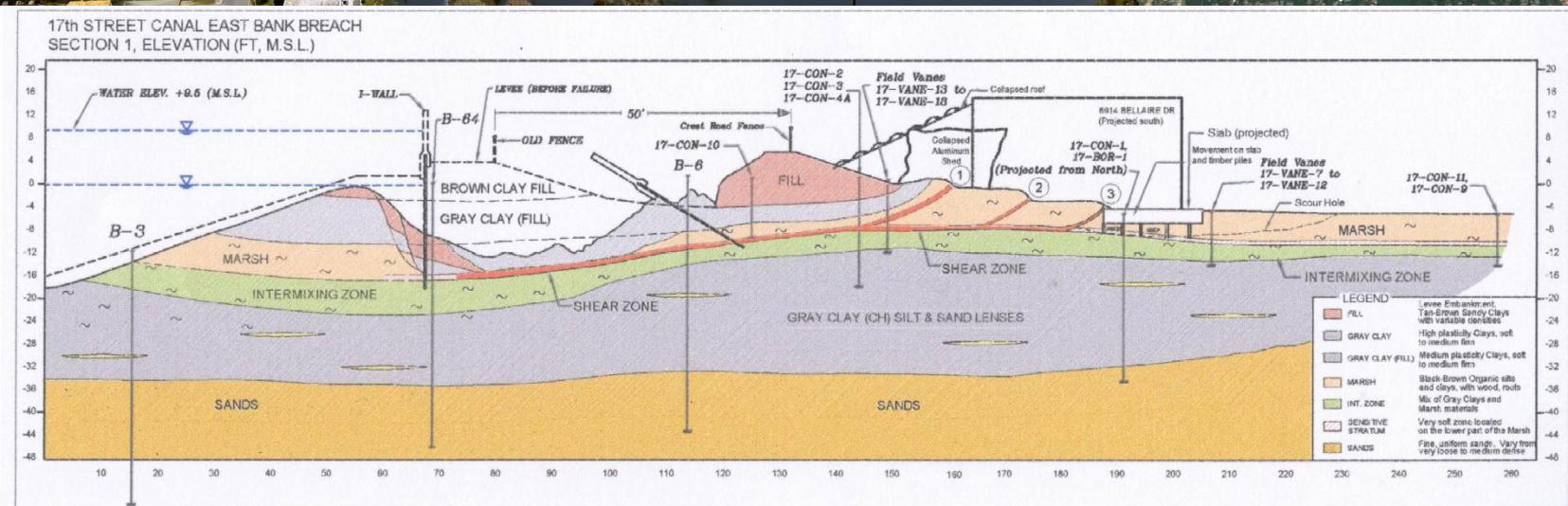
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- Sea level
- Normal water levels  
gulf, lake, river
- Katrina water levels

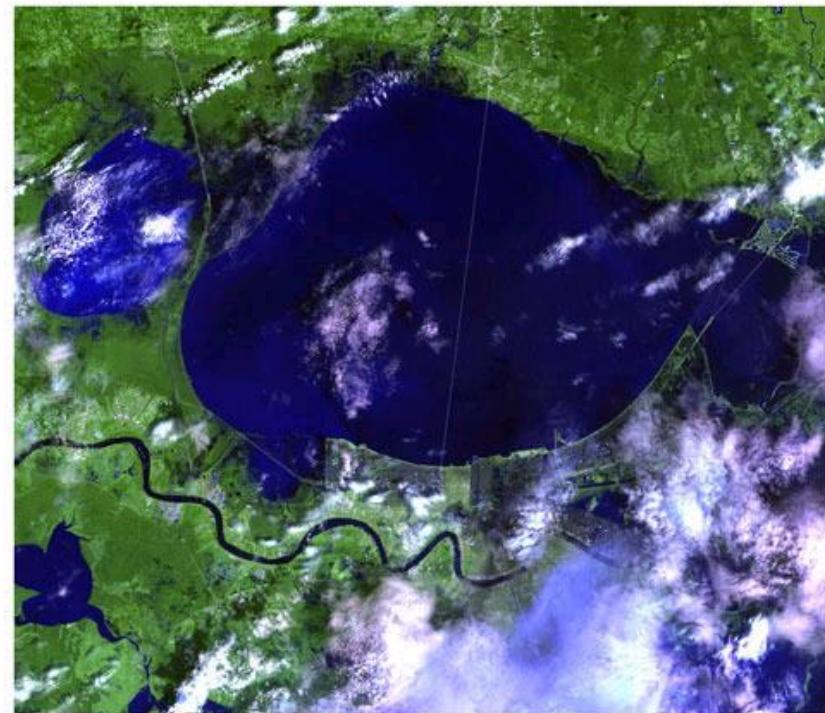




# 2005 HURRICANE KATRINA – FLOODING OF PARTS OF NEW ORLEANS RESULTED FROM FAILURE OF LEVEES FOUNDED ON DELTAIC SOILS



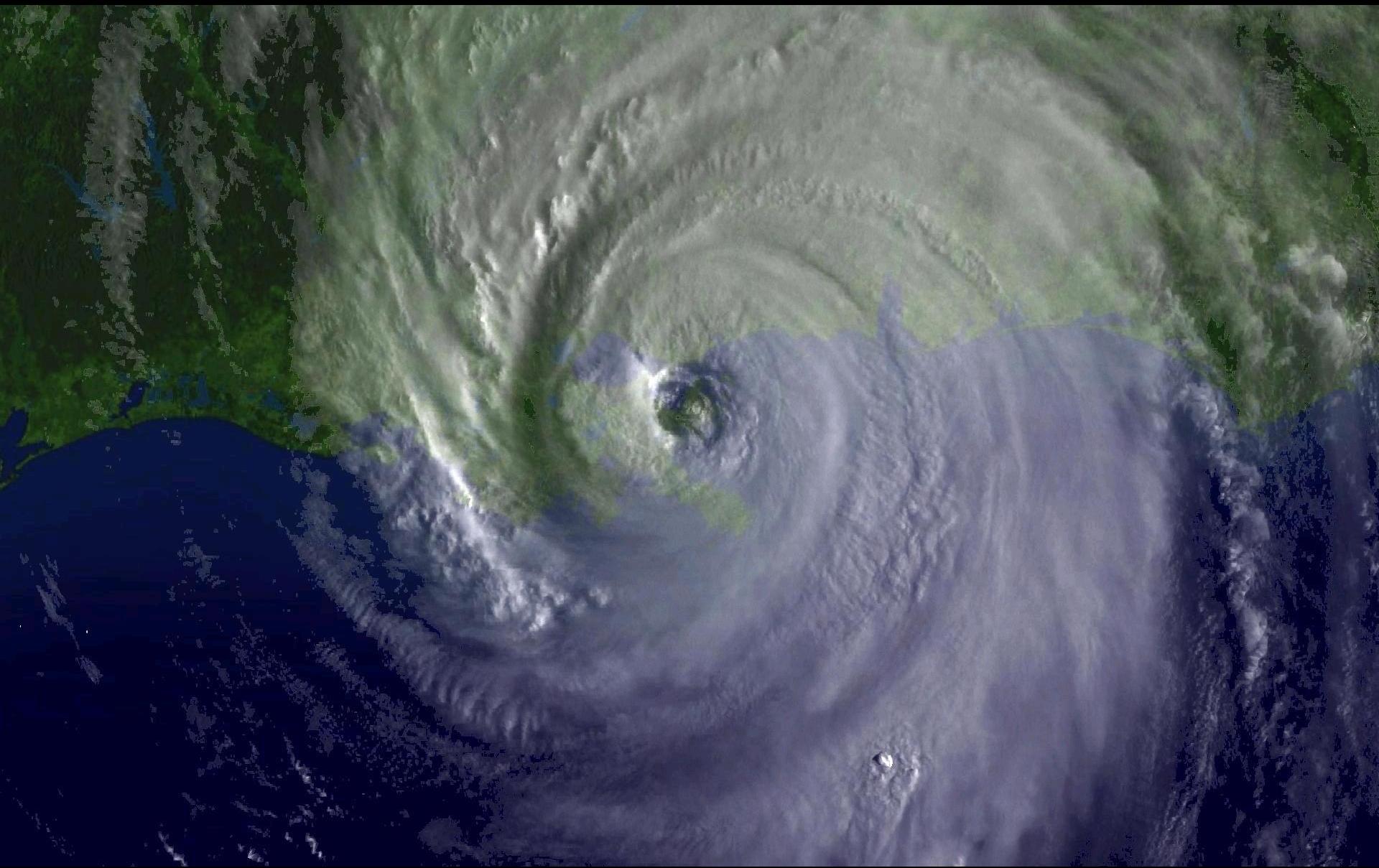
# New Orleans, Louisiana Hurricane Katrina Aftermath



Landsat 7 data acquired 4/24/2005  
Bands 7,5,3

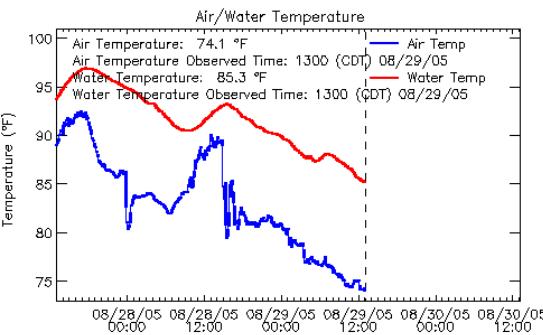
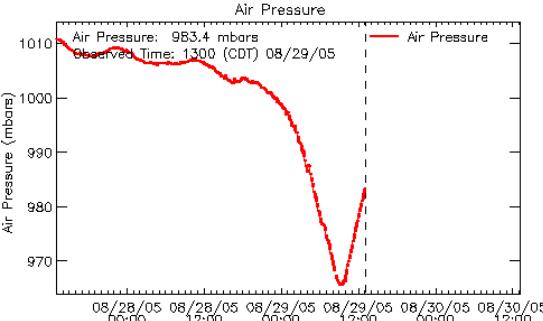
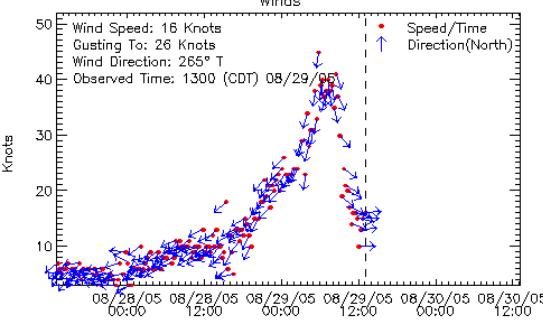
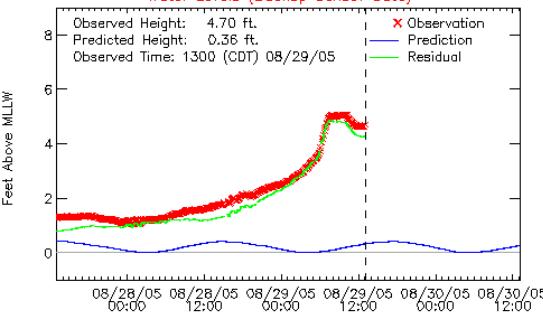


Landsat 7 data acquired 8/30/2005  
Bands 7,5,3



KATRINA HITTING THE COAST OF LOUISIANA, 2005

8762372 East Bank 1, Norco, B. LaBranche, LA  
Water Levels (Backup Sensor Data)





**WIND SPEED FORECAST FOR KATRINA**  
**EXPRESSED AS PROBABILITY**  
**FROM NHC ADVISORY 31**  
**10:00 AM CDT AUG 30 2005**



TIME HOURS	WIND SPEED INTERVAL IN MPH							
	DISSIPATED	TROPICAL DEPRESSION < 39	TROPICAL STORM 39 - 73	HURRICANE >= 74	HURRICANE			
					CAT. 1 74 - 95	CAT. 2 96 - 110	CAT. 3 111 - 130	CAT. 4-5 >= 131
12	5%	45%	50%	<2%	<2%	<2%	<2%	<2%
24	10%	40%	45%	2%	2%	<2%	<2%	<2%
36	15%	35%	40%	5%	5%	<2%	<2%	<2%
48	20%	35%	35%	10%	10%	<2%	<2%	<2%
72	30%	30%	30%	10%	10%	<2%	<2%	<2%

Tyrone Turner, *National Geographic*





# ISSUES

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- 1. STABILITY AND INTEGRITY OF LEVEES**
- 2. RESISTANCE OF BUILDINGS**
- 3. WARNING**
- 4. MAGNITUDE OF STORM SURGE**

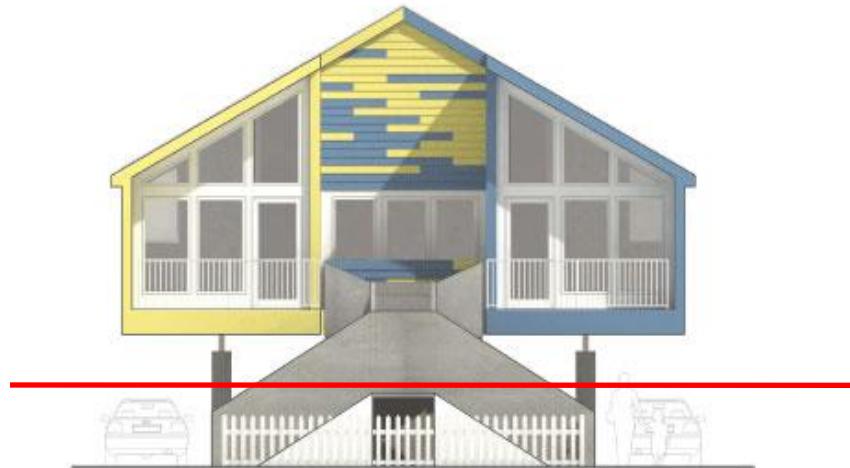


## **HURRICANE KATRINA - LOSSES**

- 1. ABOUT 1,836 DEATHS**
- 2. INSURED LOSSES IN 3 STATES ~ \$40-60 B (NUMBER OF CLAIMS WILL EXCEED 2 MILLION) ; NOW ESTIMATED TO BE \$80 B**
- 3. \$15-\$25 B RELATED TO THE GREAT NEW ORLEANS FLOOD - 60% OF THE CITY WAS INUNDATED**
- 4. TOTAL ECONOMIC LOSSES ~ \$125 B**
- 5. LONG TERM COSTS ARE GREATER DUE TO LOSS OF TOURISM, REPAIRS TO ROADS, CANALS, BUILDINGS, LEVEES, etc.**
- 6. MUCH OF DAMAGE CAME FROM FLOODING RATHER THAN STRONG WINDS**
- 7. FLOODING EXCLUDED FROM MOST INSURANCE POLICIES; FLOOD CLAIMS REMAIN TO BE SETTLED**

# ARCHITECTURAL SOLUTIONS TO FLOOD HAZARD IN THE NEW NEW ORLEANS – DESIGNS BY BRAD PITT`S *MAKE IT RIGHT* FOUNDATION

Designs based on idea of raising house above expected maximum flood level and supporting the structure on columns







HURRICANE KATRINA – GULF OF MEXICO, USA : AUGUST 2005

AP

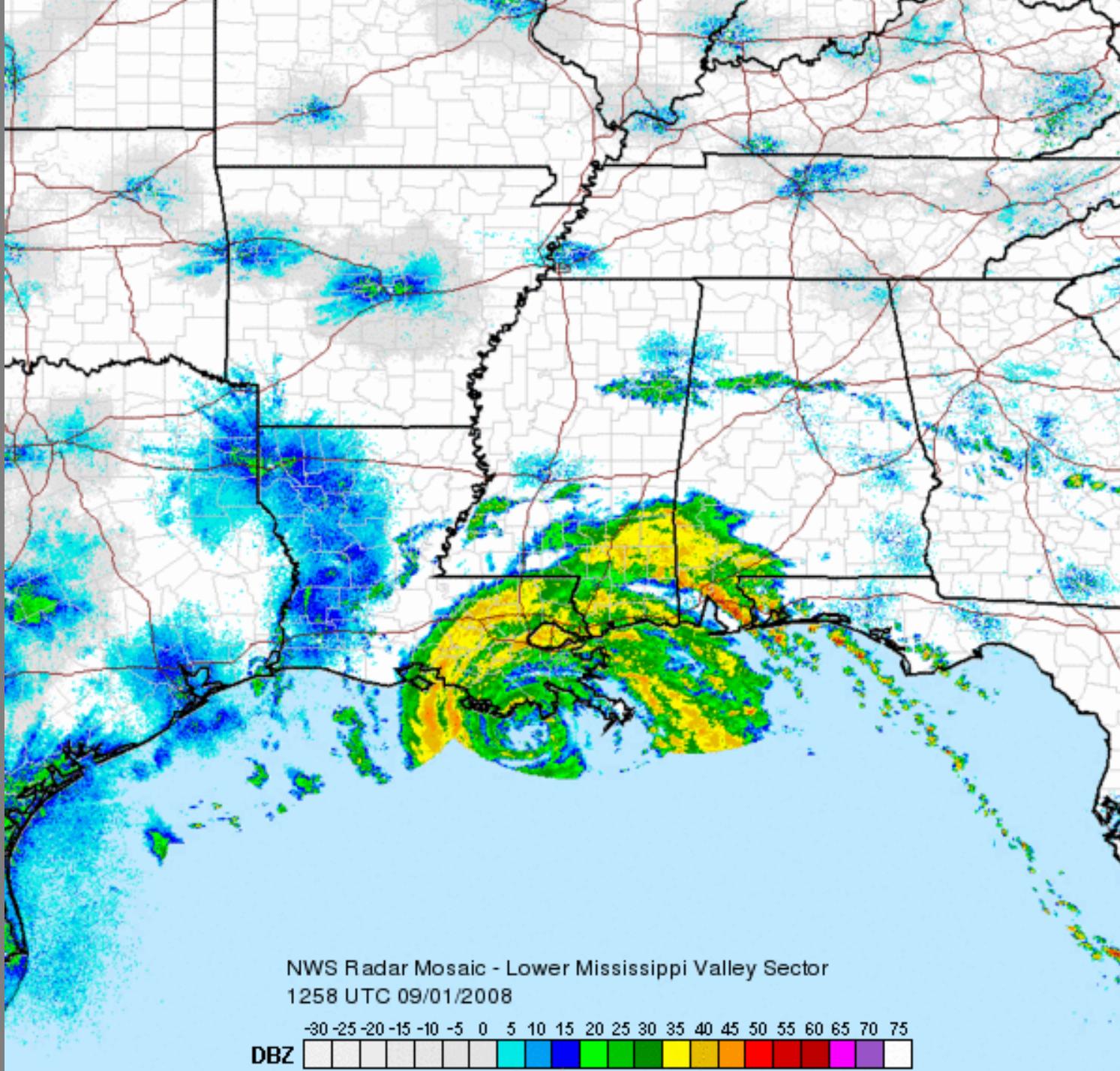
# HURRICANE GUSTAV (CARIBBEAN AND GULF OF MEXICO) – AUGUST 2008



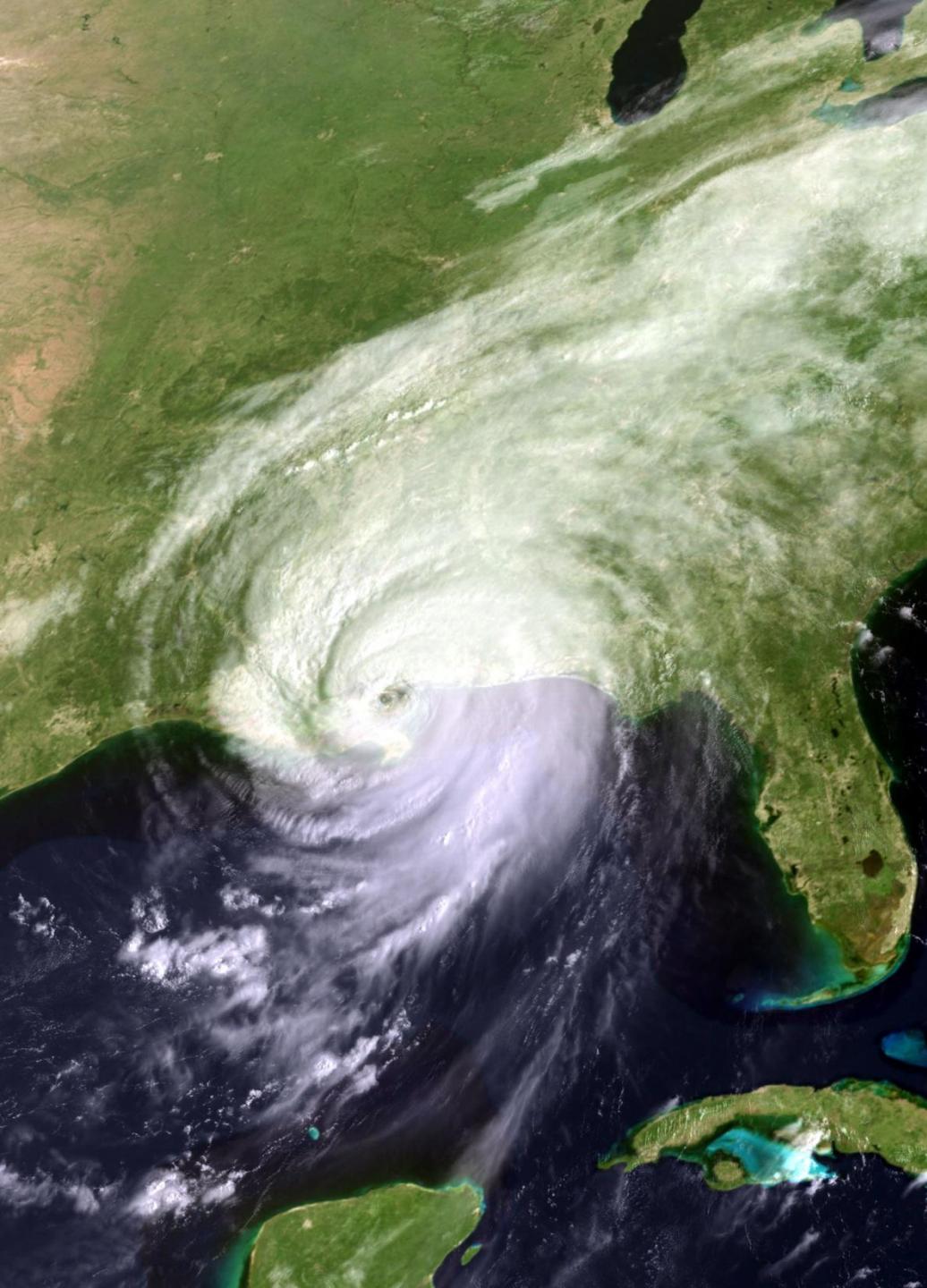
Damage to infrastructure in Jamaica



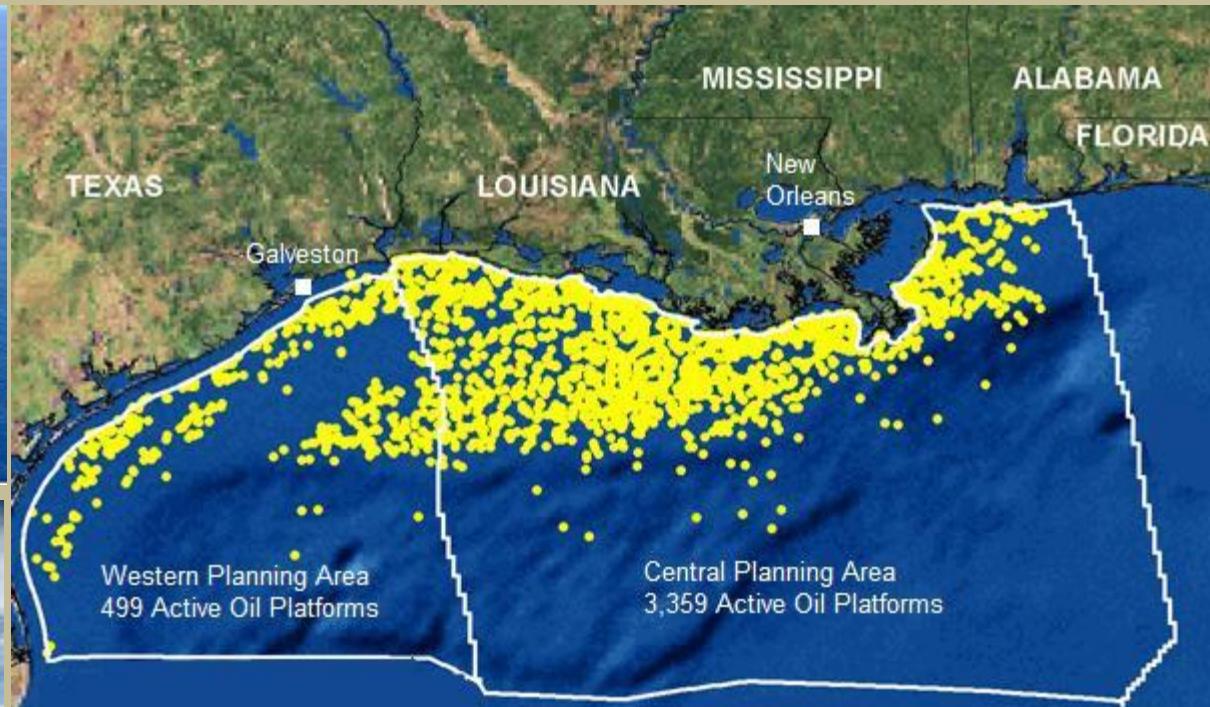
Storm waves, Cayman Islands



# HURRICANES AND RISK TO OFFSHORE DRILLING PLATFORMS

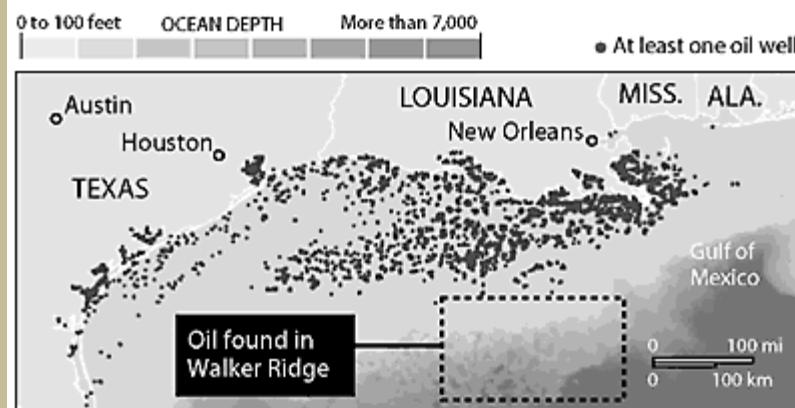


# HURRICANE AND THE PRICE OF OIL - Oil Manipulator Named: Gustav



## Domestic drilling's new frontier

Chevron said it drilled to a total depth of 28,175 feet in waters that are 7,000 feet deep, making it the deepest well tested in the Gulf of Mexico. The find could boost US oil reserves by 50 percent.



GULF OF MEXICO – home to 25% of US Oil production and 40% of refining capacity



*The U.S. Department of the Interior estimates that 76% of the Gulf of Mexico's platforms and 67% of Gulf pipelines were in the direct path of Hurricanes Katrina and Rita in 2005. The cyclones, both of which reached Category 5 strength, destroyed 113 offshore oil and natural gas platforms and damaged 457 pipelines.*



## Looming hurricane may deal a blow to Gulf oil

Friday August 29, 4:05 pm ET

By David Goldman, CNNMoney.com staff writer

**The Gulf of Mexico is home to 4,000 drilling platforms and 33,000 miles of pipeline, which send 1.3 million barrels a day to the Gulf Coast's 56 refineries. But a hurricane threatens to deal a powerful blow to the oil-rich region.**

### Aimed for Where It Hurts

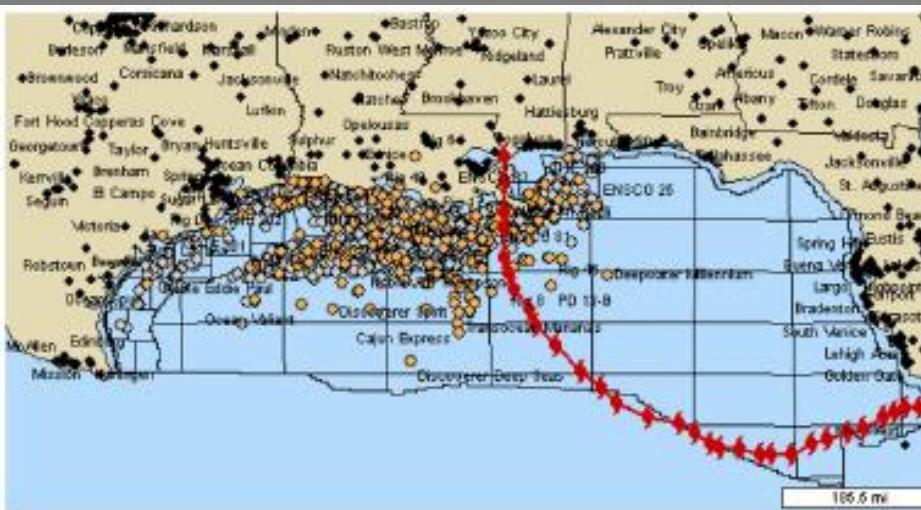
Hurricane Rita is bearing down on offshore oil and natural-gas production facilities in the Gulf of Mexico, including many bypassed by last month's Hurricane Katrina, and is headed toward one of the largest clusters of oil refineries and chemical plants in the U.S. The storm could further disrupt the Gulf's energy operations, which were severely damaged by Katrina.



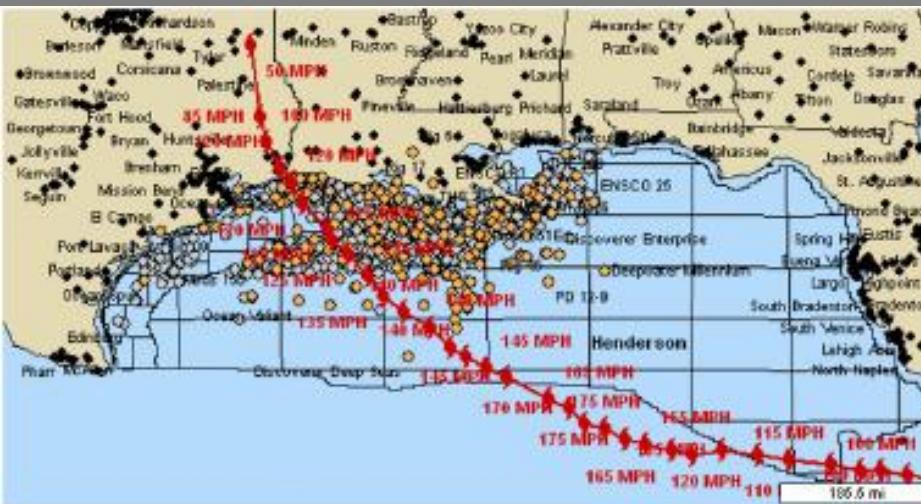
# Damage to offshore oil and gas facilities following hurricanes Katrina and Rita: An overview

A.M. Cruz \*, E. Krausmann

Joint Research Centre, European Commission, TP 361, Via E. Fermi, 2749, I-21027 Ispra (VA), Italy



## KATRINA



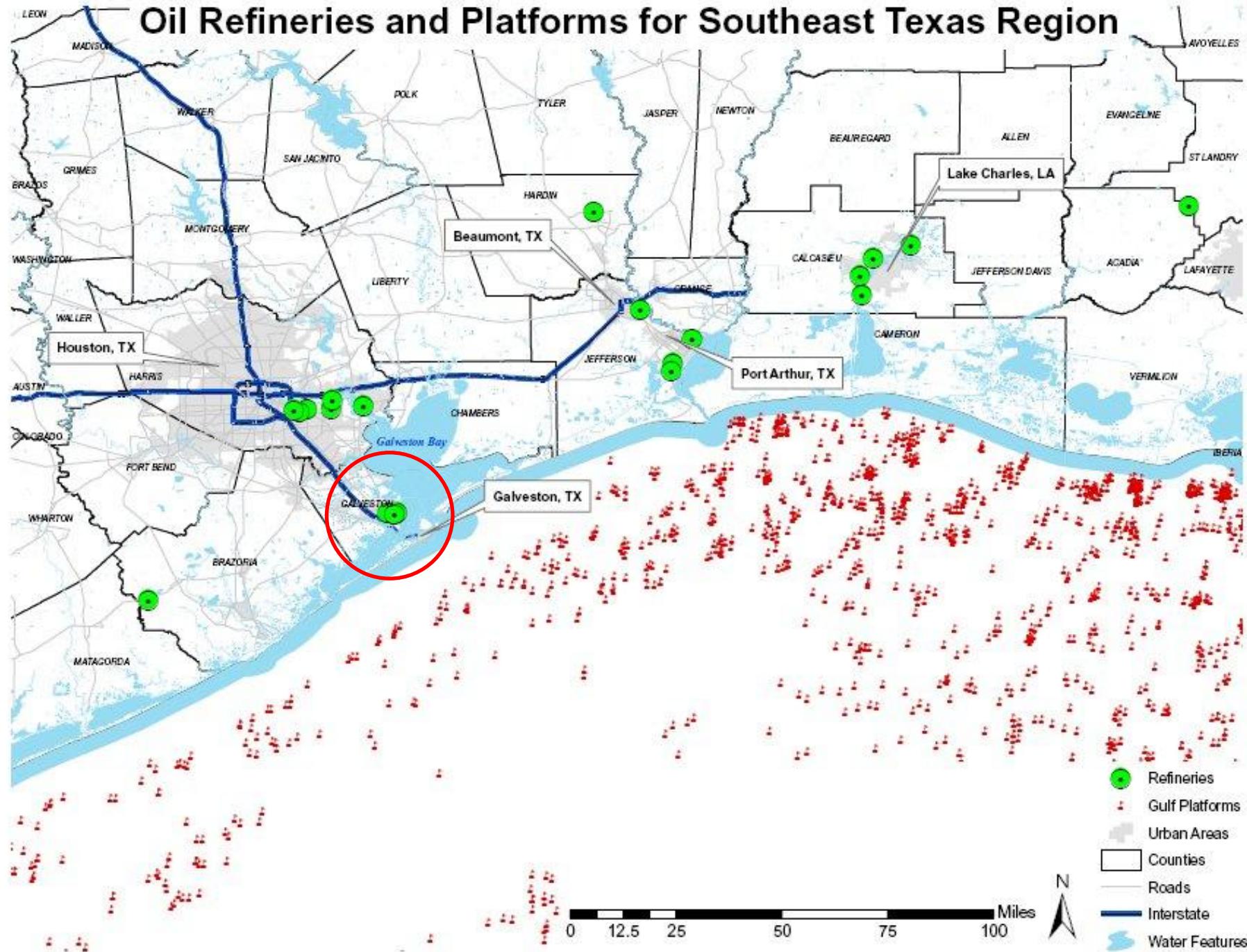
## rita



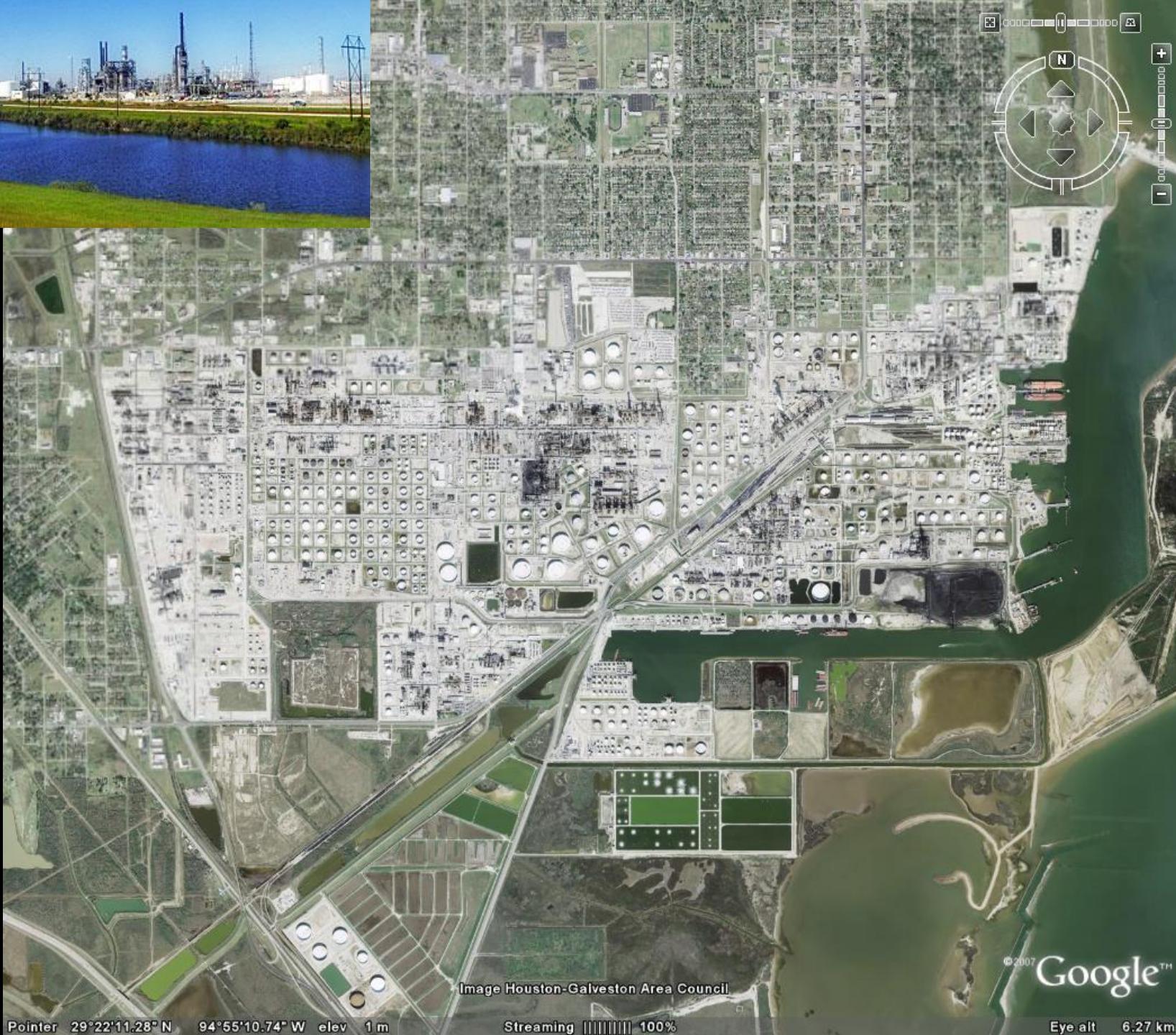


Hurricane Dennis damage to BP drill rig "Thunder Horse", Gulf of Mexico, 2005

# **Oil Refineries and Platforms for Southeast Texas Region**



# BP AMERICA OIL REFINERY COMPLEX, TEXAS CITY, TX



Date: August 30, 2008

## Tropical Storm Gustav Activity Statistics Update – August 30, 2008

*Minerals Management Service monitors activities through its Continuity of Operations Plan.*

**NEW ORLEANS** — Offshore oil and gas operators in the Gulf of Mexico are evacuating platforms and rigs in the path of Hurricane Gustav. The Minerals Management Service has activated its Continuity of Operations Plan team to monitor the operators' activities. This team will be activated until operations return to normal and the storm is no longer a threat to the Gulf of Mexico oil and gas activities.

Based on data from offshore operator reports submitted as of 11:30 a.m. CST today, personnel have been evacuated from a total of 223 production platforms, equivalent to 31.1 % of the 717 manned platforms in the Gulf of Mexico. Production platforms are the structures located offshore from which oil and natural gas are produced. These structures remain in the same location throughout a project's duration unlike drilling rigs which typically move from location to location.

Personnel from 45 rigs have also been evacuated; this is equivalent to 37.2 % of the 121 rigs currently operating in the Gulf. Rigs can include several types of self-contained offshore drilling facilities including jackups, submersibles and semisubmersibles.

From the operators' reports, it is estimated that approximately 76.77 % of the oil production in the Gulf has been shut-in. Estimated current oil production from the Gulf of Mexico is 1.3 million barrels of oil per day. It is also estimated that approximately 37.16 % of the natural gas production in the Gulf has been shut-in. As of June 2008, estimated current natural gas production from the Gulf of Mexico was 7.0 billion cubic feet of gas per day. Since that time, gas production from the Independence Hub facility has increased and current gas production from the Gulf is estimated at 7.4 billion cubic feet of gas per day.

As part of the evacuation process, personnel activate the shut-in procedure, which can also be accomplished from a remote location. This involves closing the safety valves located below the surface of the ocean to prevent the release of oil or gas. During Hurricanes Katrina and Rita, the shut-in valves functioned 100 percent of the time, efficiently closing in production from wells and resulting in no major spills from the Outer Continental Shelf. Shutting-in oil and gas production is a standard procedure conducted by industry for safety and environmental reasons.

The production percentages are calculated using information submitted by offshore operators in daily reports. Shut-in production information included in these reports is based on what the operator expected to produce that day. The shut-in production figures therefore are estimates, which the MMS compares to historical production reports to ensure the estimates follow a logical pattern.

After the hurricane has passed, facilities will be inspected. Once all standard checks have been completed, production from undamaged facilities will be brought back on line immediately. Facilities sustaining damage may take longer to bring back on line. The MMS will continue to update the evacuation and shut-in statistics at 1:00 p.m. CST each day until these statistics are no longer significant.