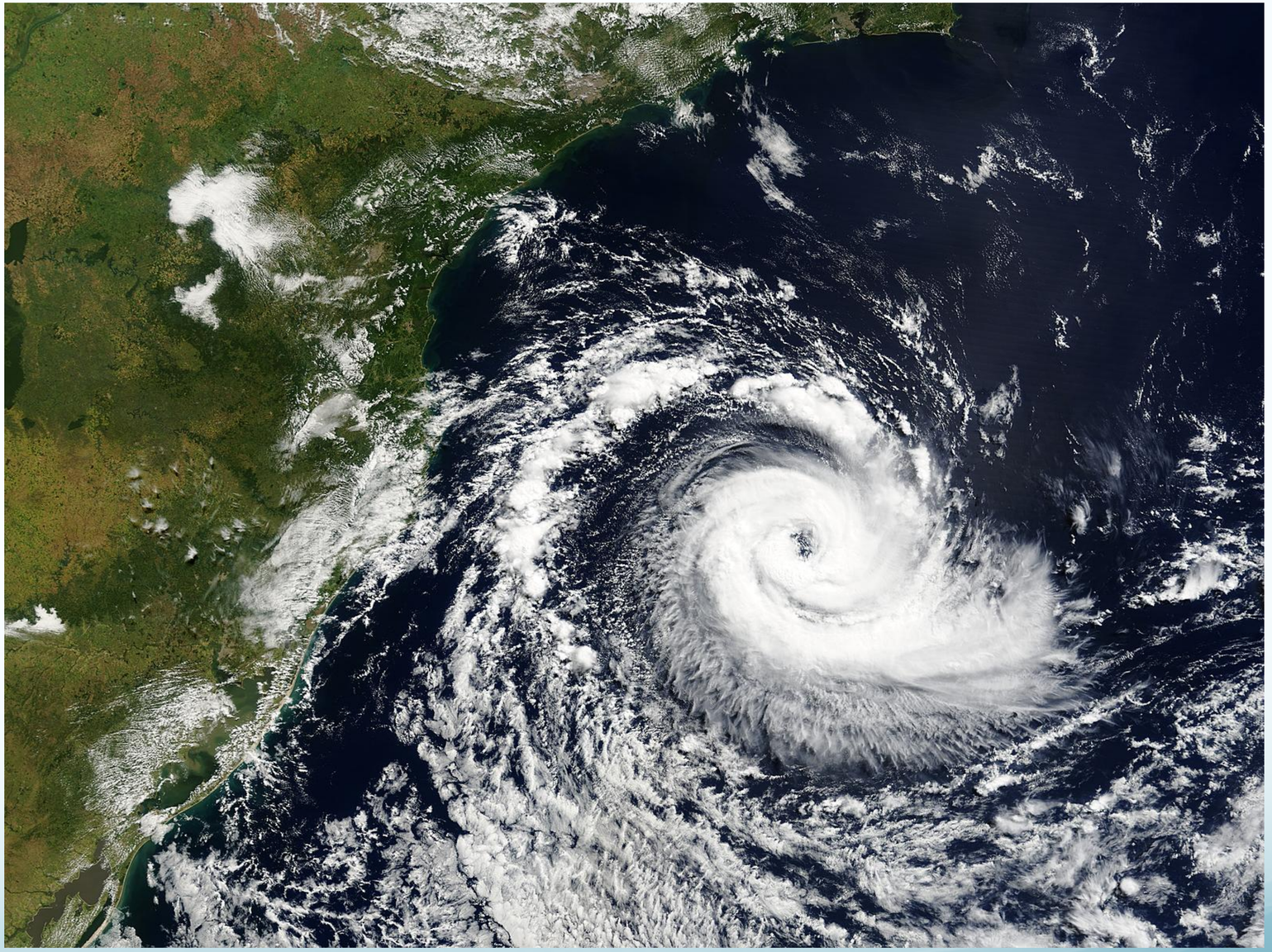
ATM S 103

Hurricanes and Thunderstorms

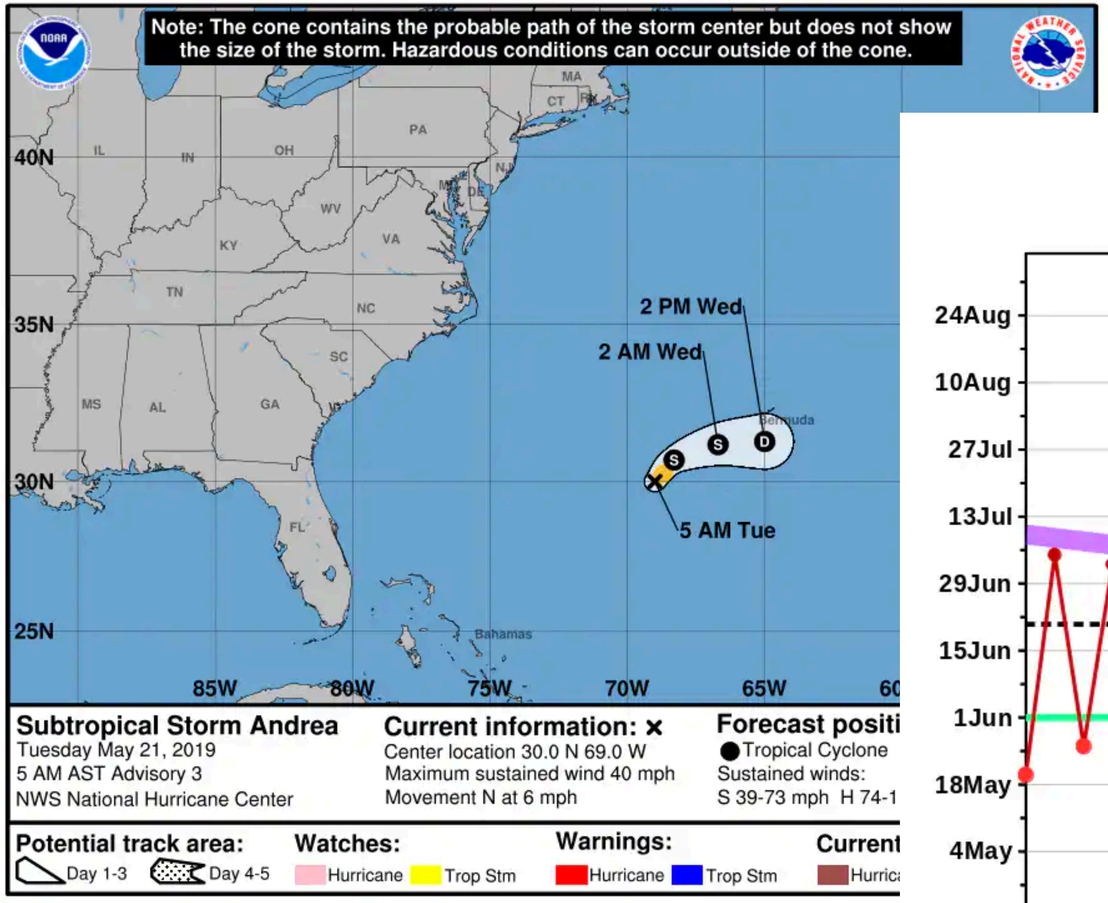
Their Science and Impacts

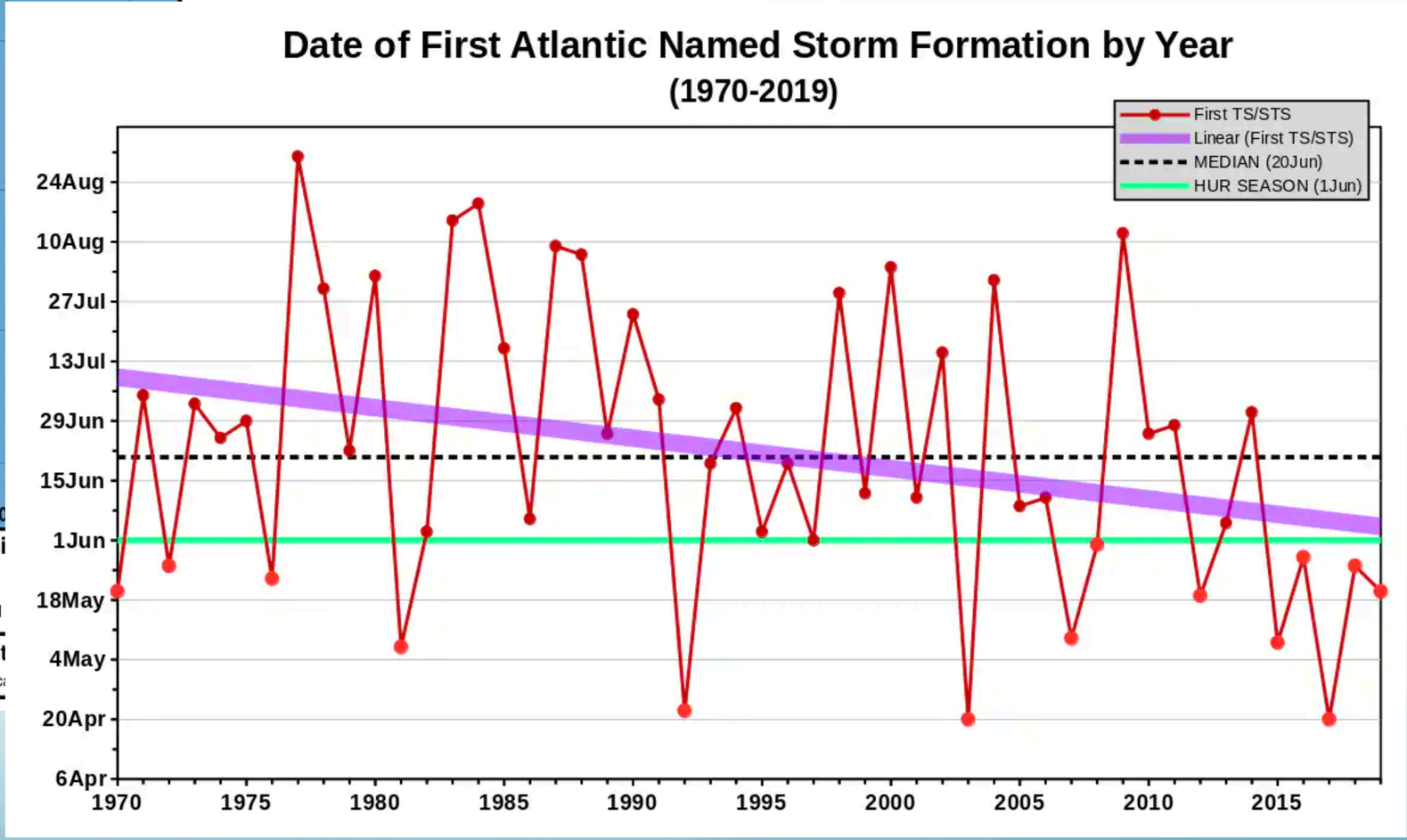


Hurricane Catarina, March 26, 2004 (Cat 2)

Capital Weather Gang

Andrea begins the 2019 Atlantic hurricane season early





https://www.washingtonpost.com/weather/2019/05/21/andrea-kicks-off-atlantic-hurricane-season-early/?noredirect=on&utm_term=.dfe78e0cea2e

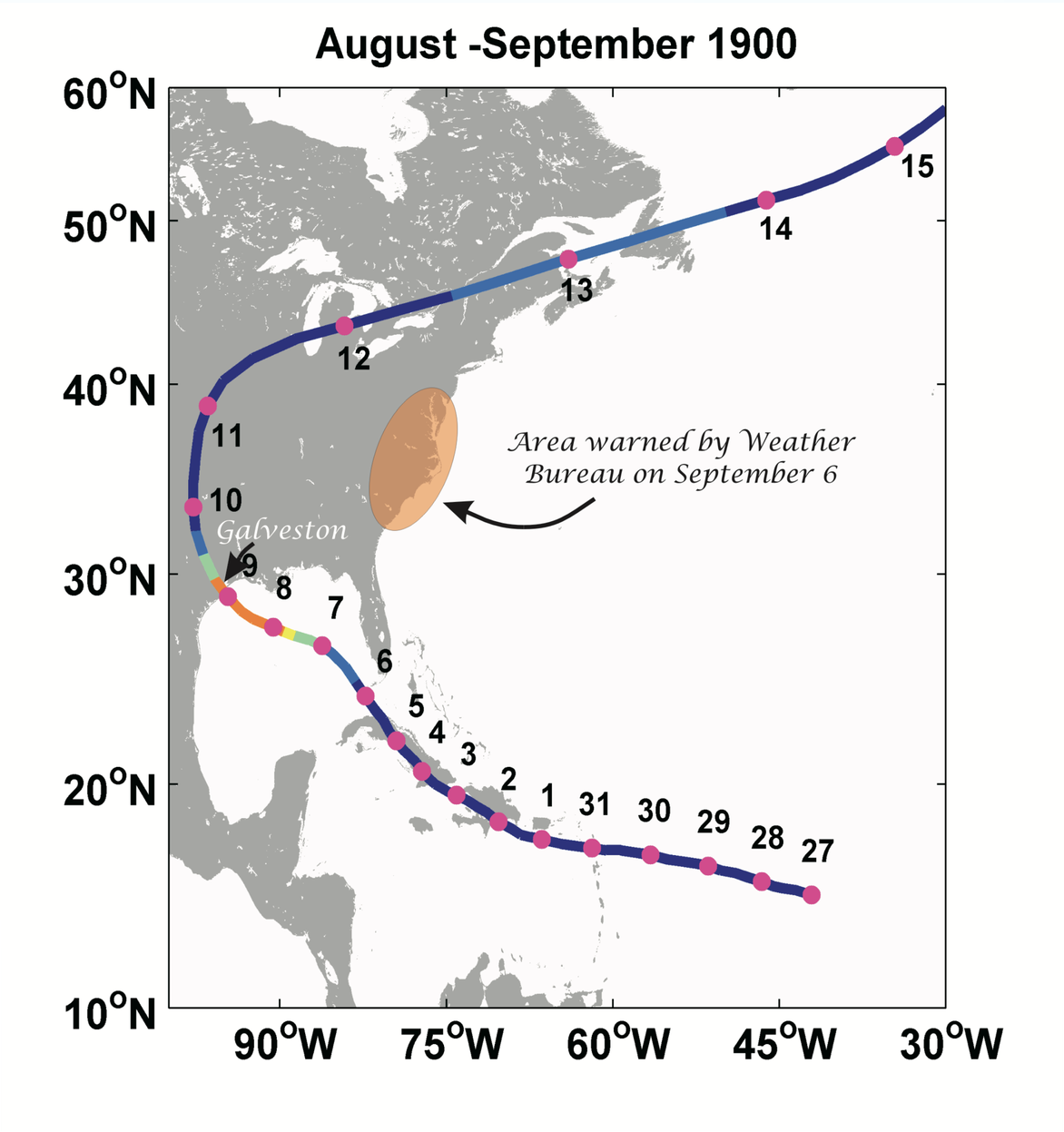
Topics for today

- Galveston
  - 1900 and hurricane IKE
- Satellite images
  - Visible and Infrared (IR)
- Transition of tropical cyclones into extra-tropical cyclones

Taken by surprise

September 8, 1900

- Warnings from Cuban forecasters ignored
- 15’ storm surge
- Galveston Island was only 8’ above sea level



Galveston: 1900

Storm surge simulation

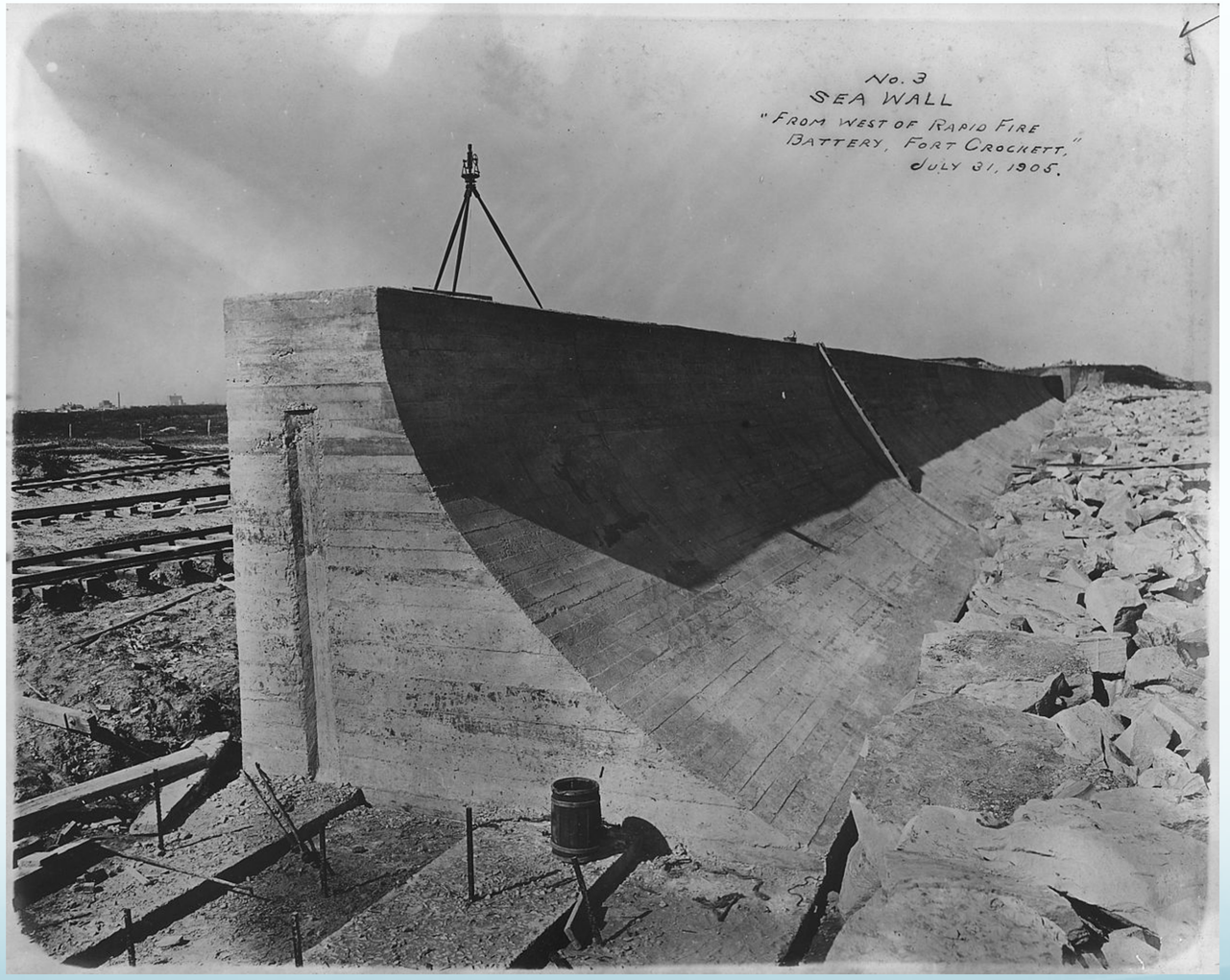
Galveston Damage: 1900

Documentary

Aftermath

- 6,000-12,000 dead (worst US disaster)
- Galveston was finished as “The New York of the Gulf”, but not abandoned.
- 17’ high sea wall was built and the city raised as much as 17’ within the wall
- A similar storm in 1915 caused much less damage and 53 deaths.

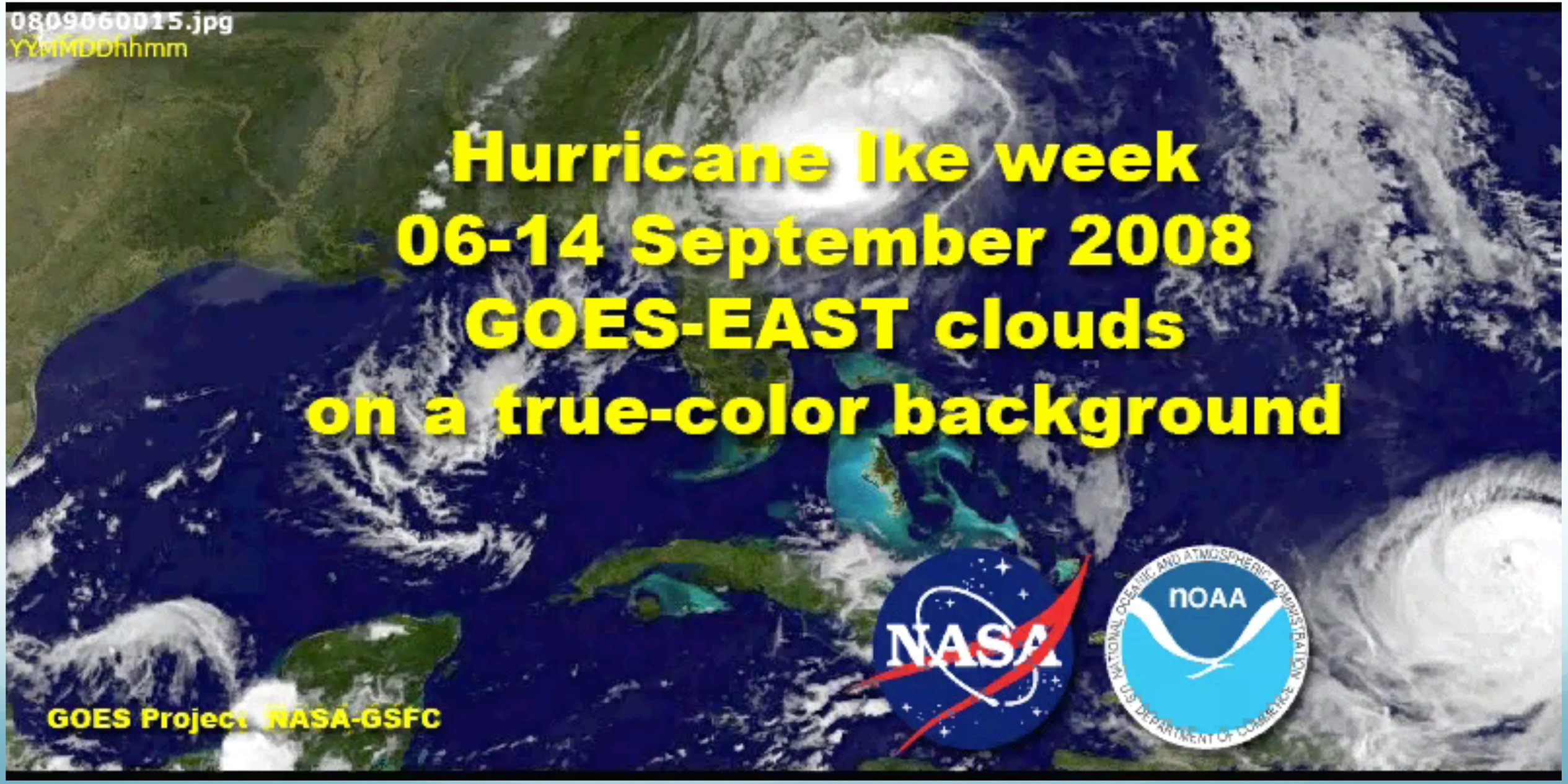
The Seawall


No. 3
SEA WALL
"FROM WEST OF RAPID FIRE
BATTERY, FORT CROCKETT."
JULY 31, 1905.

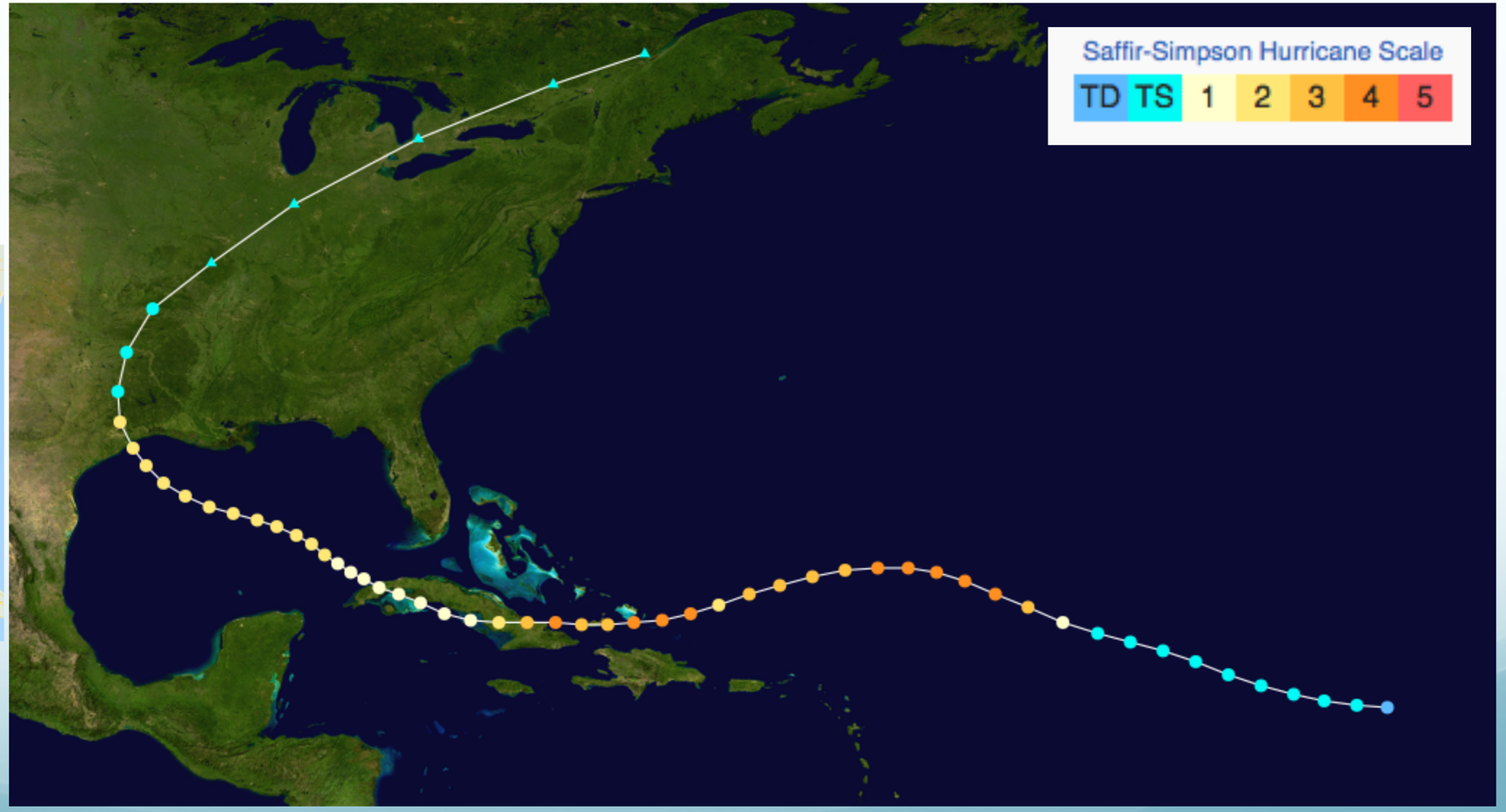
Sea Wall Topped by Monument in 2000

Seawall and Monument

Hurricane Ike


08090600015.jpg
YYMMDDhhmm
Hurricane Ike week
06-14 September 2008
GOES-EAST clouds
on a true-color background
GOES Project NASA-GSFC
NASA
NOAA

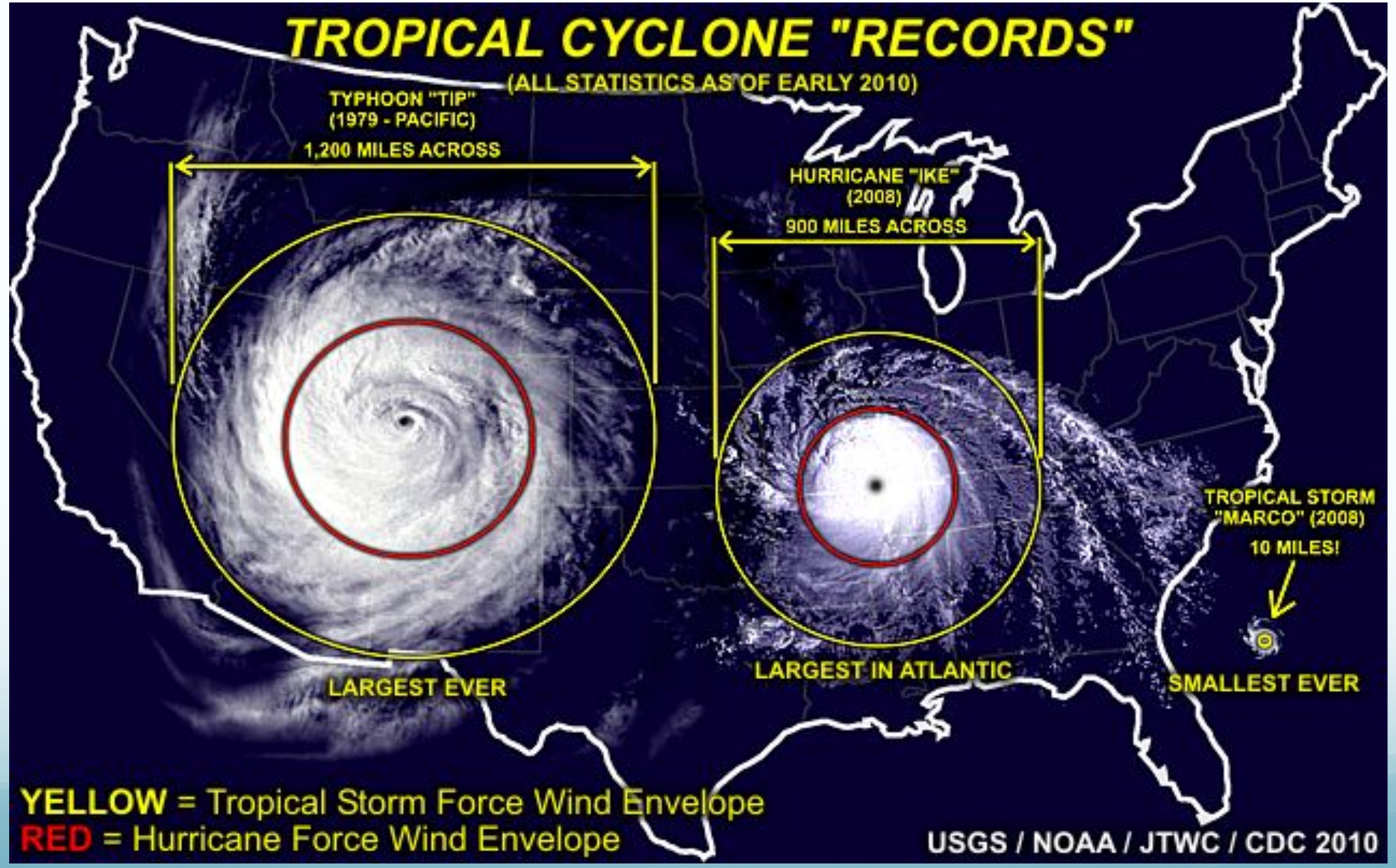
Hurricane Ike Track



Hurricane Ike (2008)

- 195 killed; US share 112 plus 23 missing
- 4th costliest hurricane in US history (inflation adjusted)
  - Katrina, Sandy and Andrew were worse
- Strong category 2 storm!
  - Never stronger than category 2 while in the Gulf of Mexico
- With its immense size, Ike caused catastrophic damages

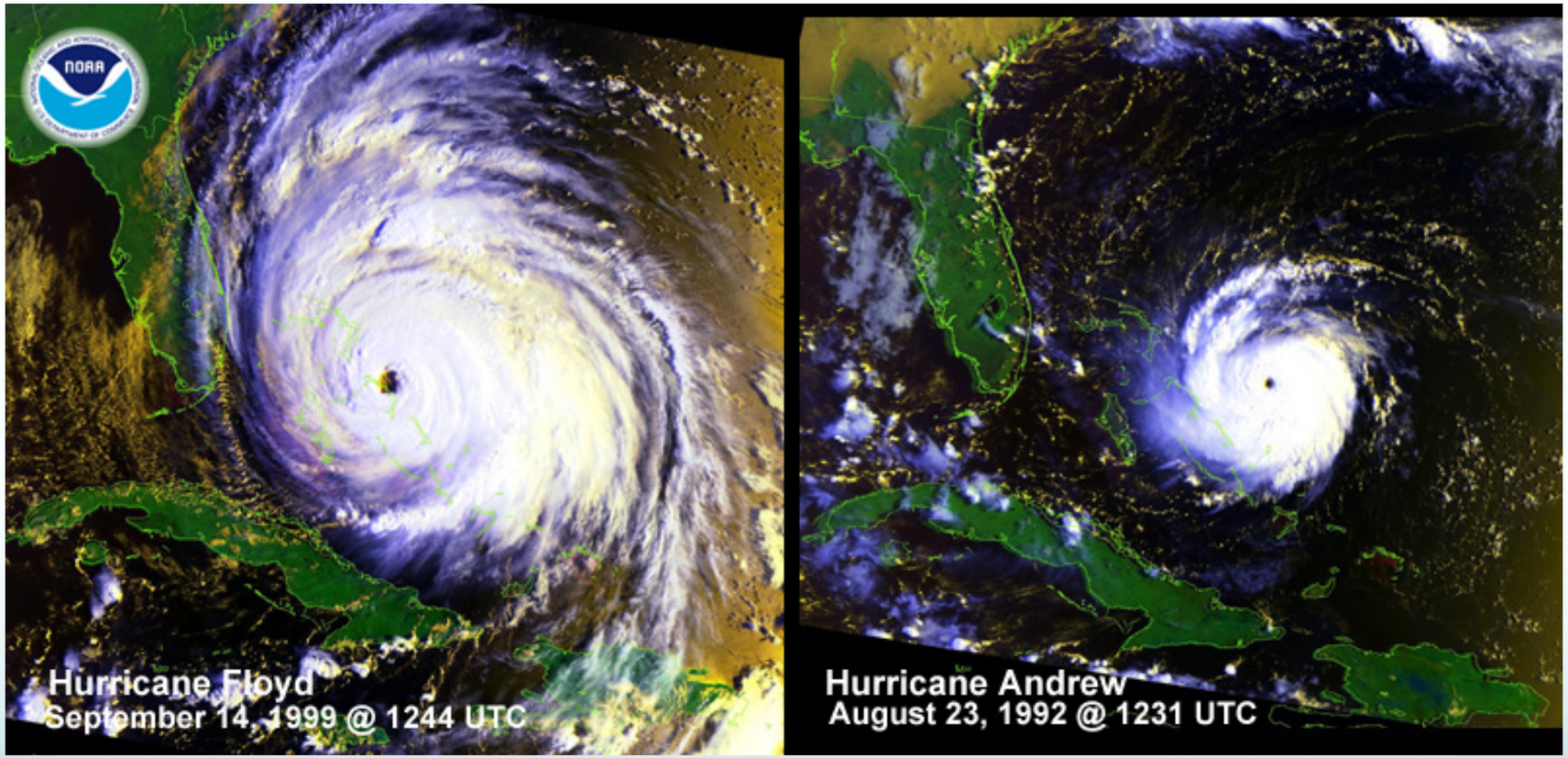
Tip and Ike


TROPICAL CYCLONE "RECORDS"
(ALL STATISTICS AS OF EARLY 2010)
TYPHOON "TIP"
(1979 - PACIFIC)
1,200 MILES ACROSS
LARGEST EVER
HURRICANE "IKE"
(2008)
900 MILES ACROSS
LARGEST IN ATLANTIC
TROPICAL STORM
"MARCO" (2008)
10 MILES!
SMALLEST EVER
YELLOW = Tropical Storm Force Wind Envelope
RED = Hurricane Force Wind Envelope
USGS / NOAA / JTWC / CDC 2010

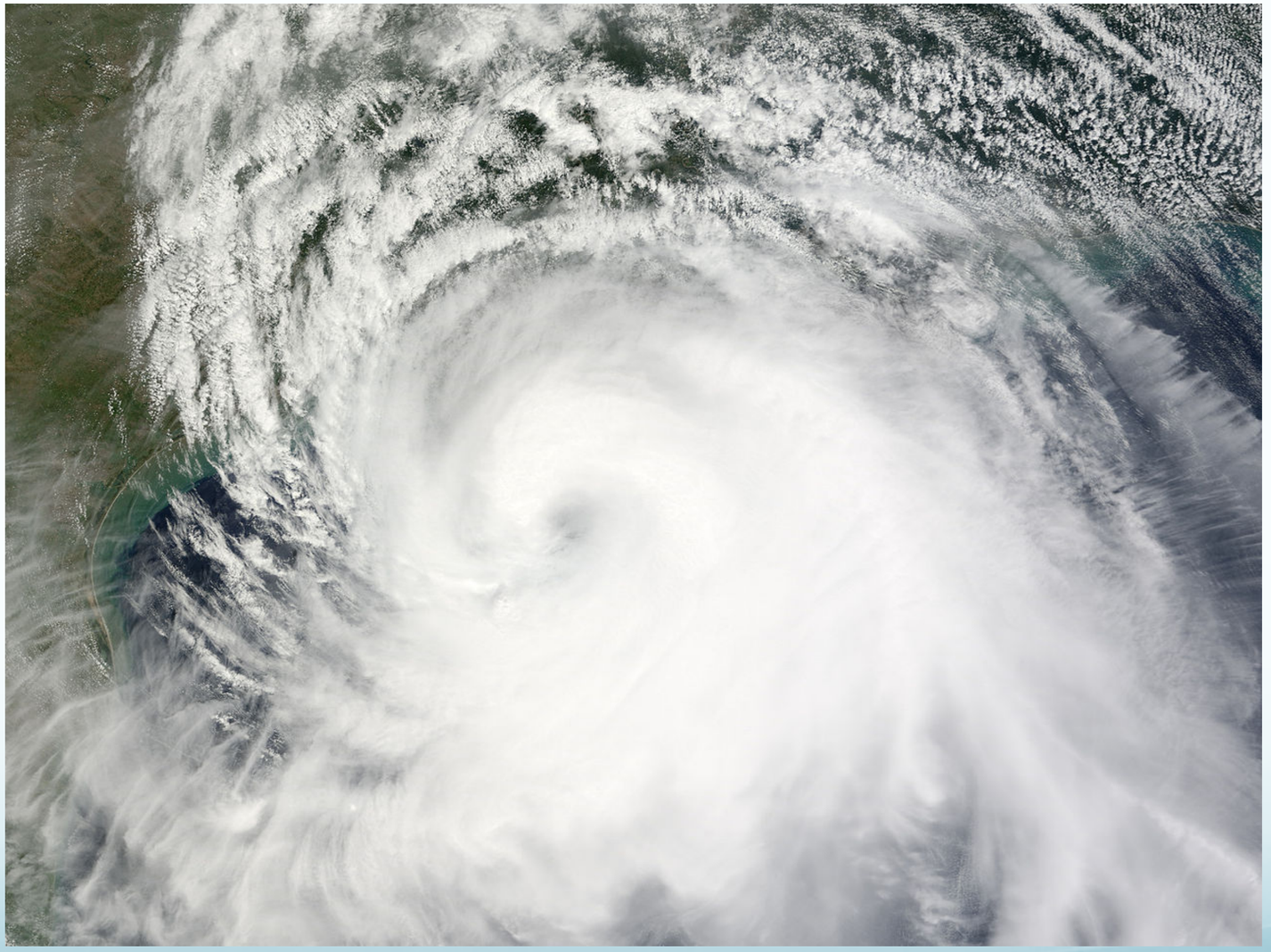
Hurricane Records

- Most “intense”: Typhoon Tip in the Northwest Pacific Ocean on 12 October 1979
  - Measured central pressure of 870 mb
  - Estimated sustained winds of 190 mph
- Smaller Atlantic Hurricanes had similar 190 mph winds
  - Hurricane Camille
  - Hurricane Andrew

Both Central Pressures About 933 mb

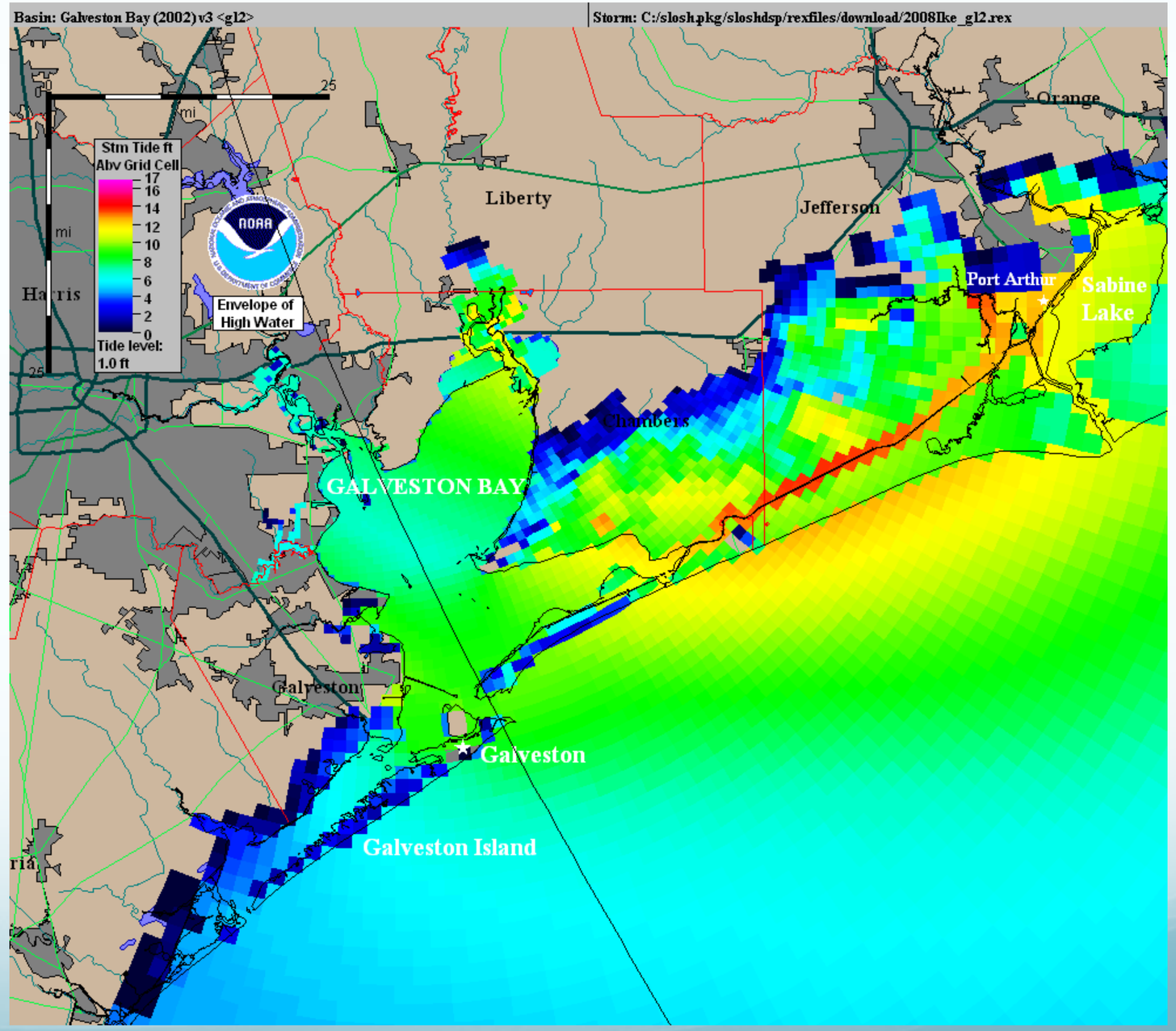


Ike



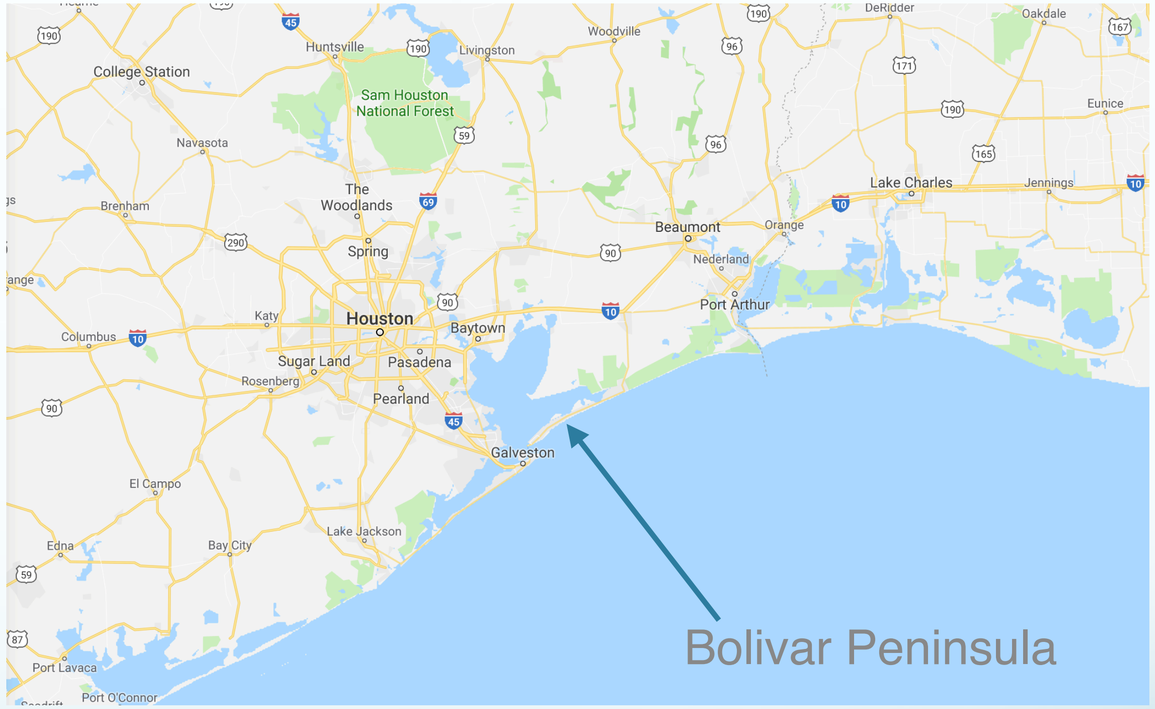
Ike storm surge: envelope of high water

Historical simulation



Storm surge

- 19 feet near Galveston
- 22 feet near Port Arthur (highest ever recorded there)
- Bolivar Peninsula covered by at least 5 ft of water with 15 ft in most areas (not counting wave action).



Bolivar Peninsula Aftermath

Hurricane Ike Galveston Seawall

Storm surge waves the evening before Hurricane Ike made landfall
“ Most of the buildings you see in this video don't exist any longer.”

Poor judgement

Hurricane Ike Debris

Galveston

Ike: Evacuations

- Authorities in Louisiana and Texas ordered major evacuations for Hurricane Ike. Roughly 1 million people left their homes, but more than 100,000 people did not.
- The special needs population was effectively managed during the evacuation of Hurricane Ike.
- “Despite dire warnings of storm surge and certain death from forecasters, <u>an estimated forty percent of Galveston's residents did not evacuate in response to the mandatory order</u>.”
- It was the local indifference to the storm surge hazard that reduced evacuation compliance and ultimately led to a significant loss of life in the Galveston area.

Ike Aftermath

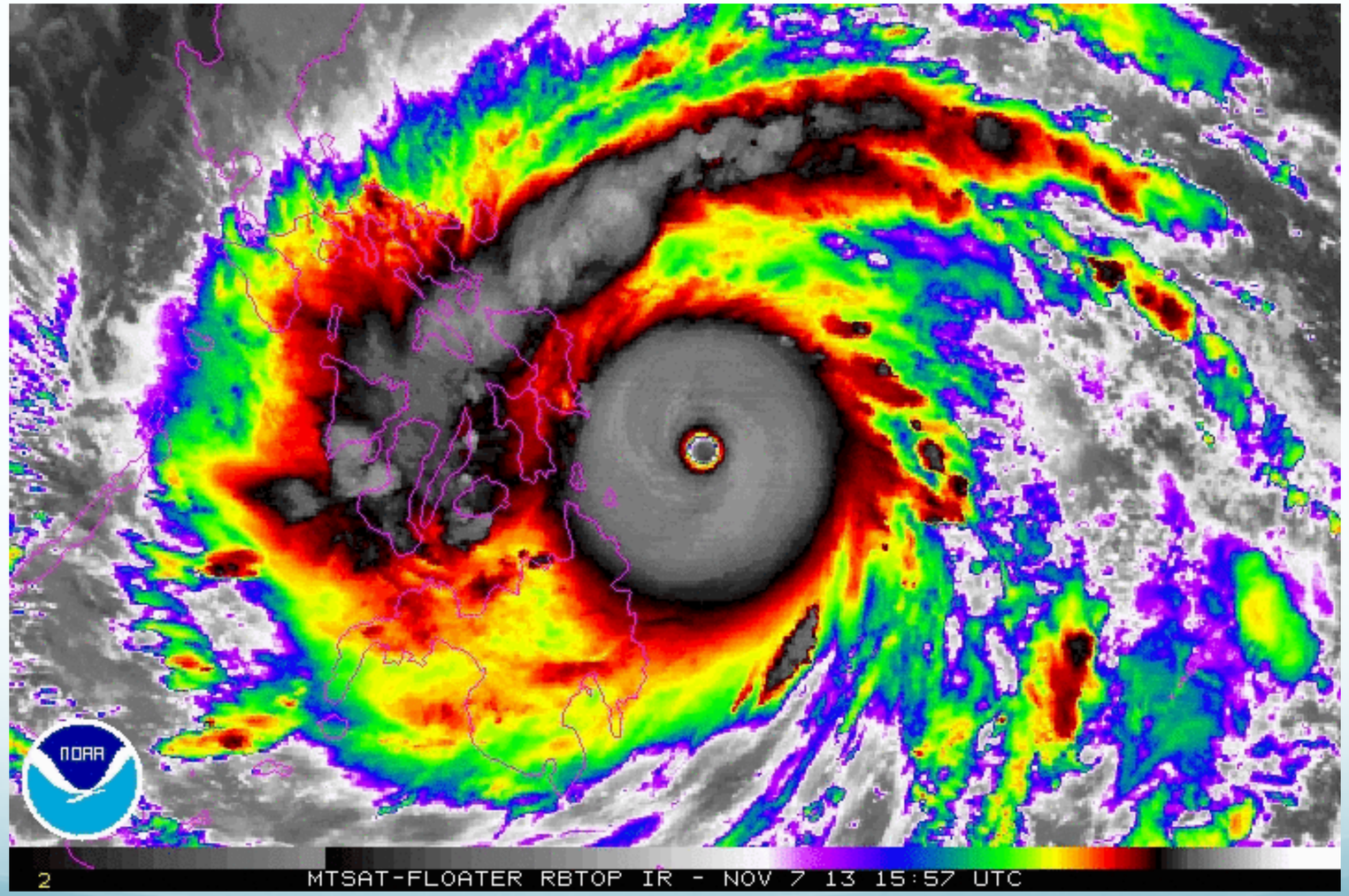
Many Houston residents without power for 2-3 weeks.

Bolivar Pennisula: Before and after

Satellite Observations

Super Typhoon Haiyan

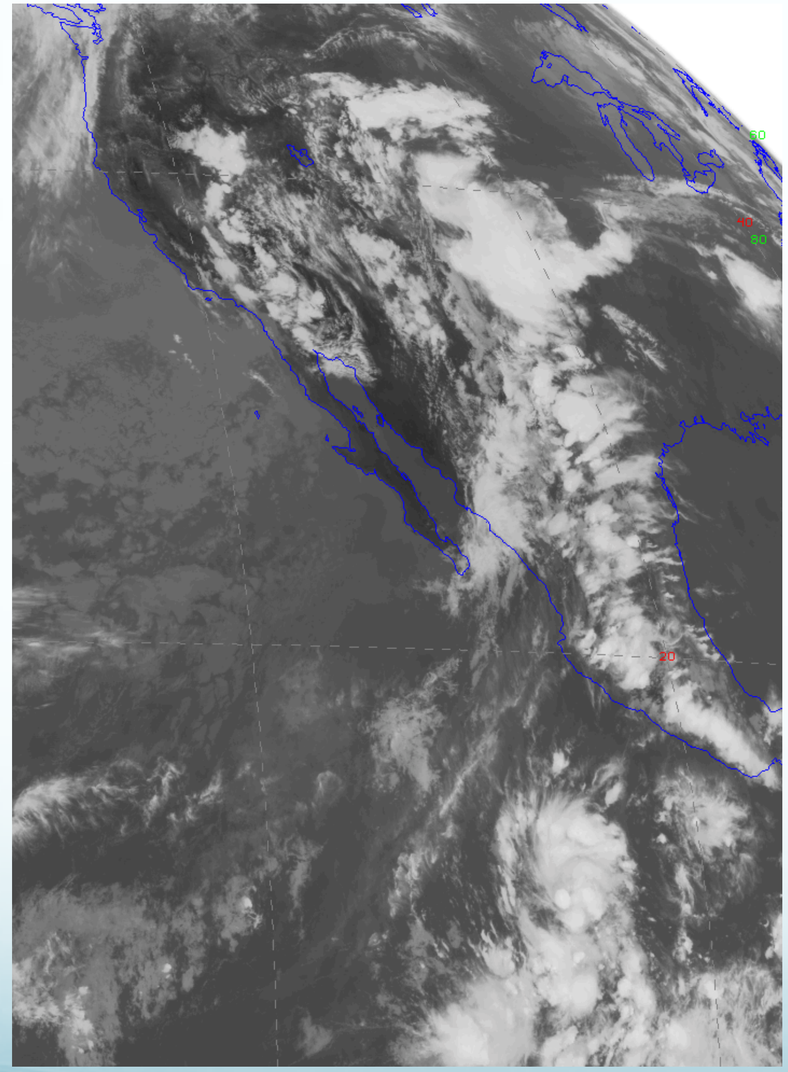
What kind of image is this? How strong is the storm?



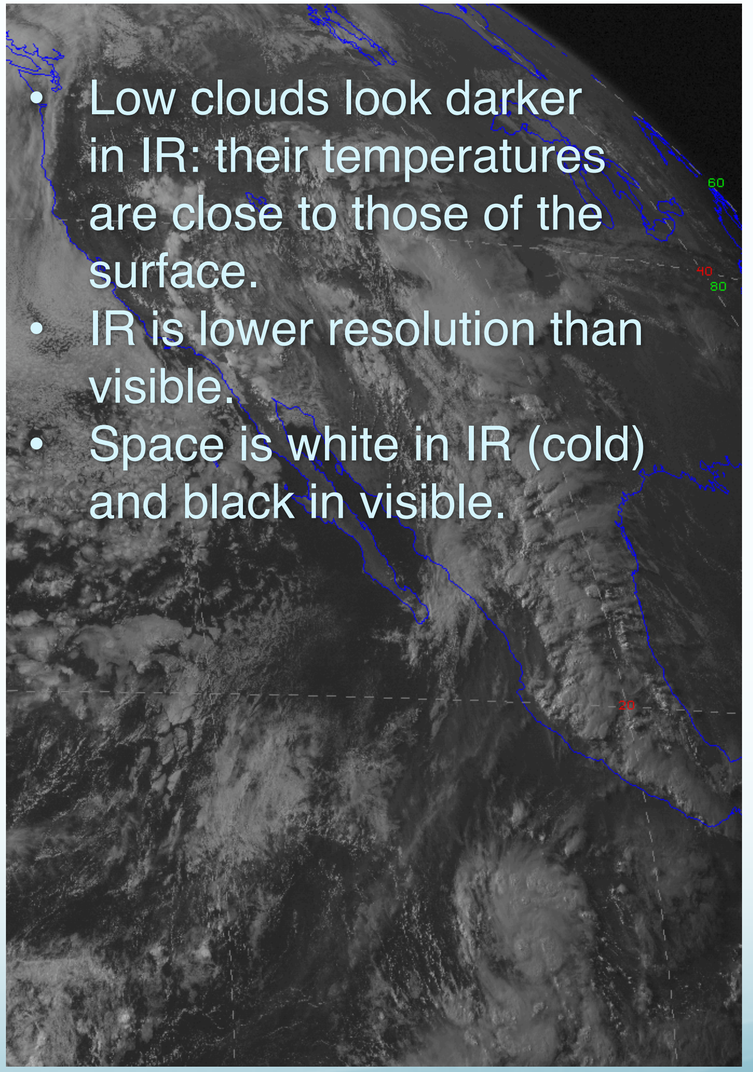
Interpreting Satellite Images

- Visible images
  - Black and white photo of the clouds and surface.
  - Not useful at night – can’t loop images for long periods.
- IR images
  - Satellite senses the temperature of the clouds and surface.
  - Images available night and day.

Visible and IR, which is which?



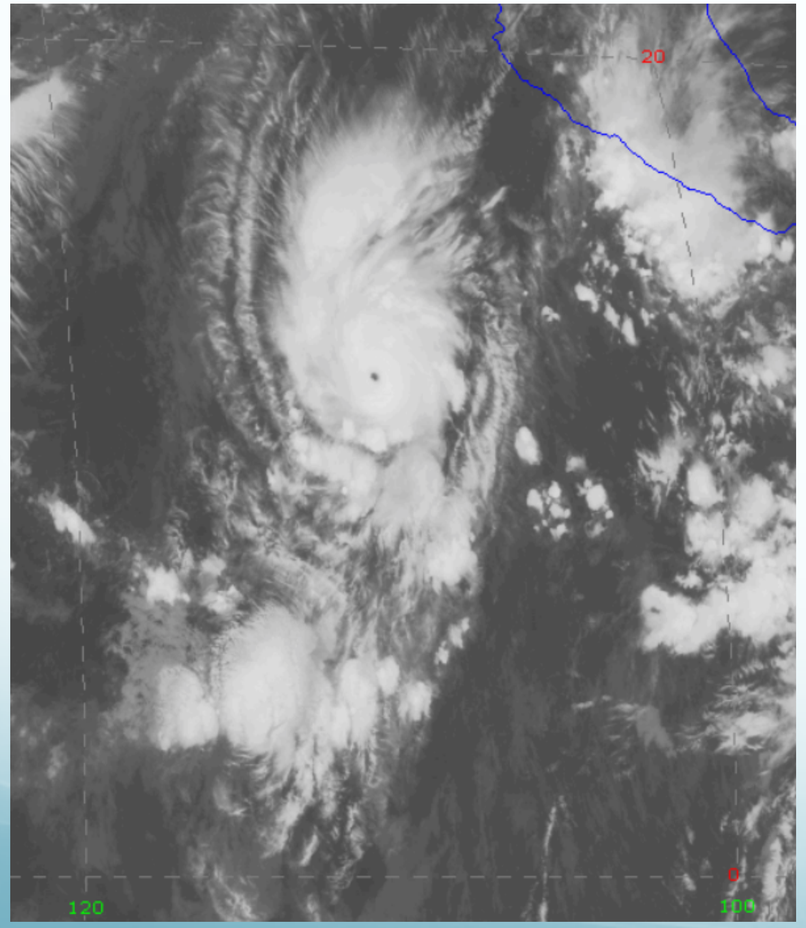
IR



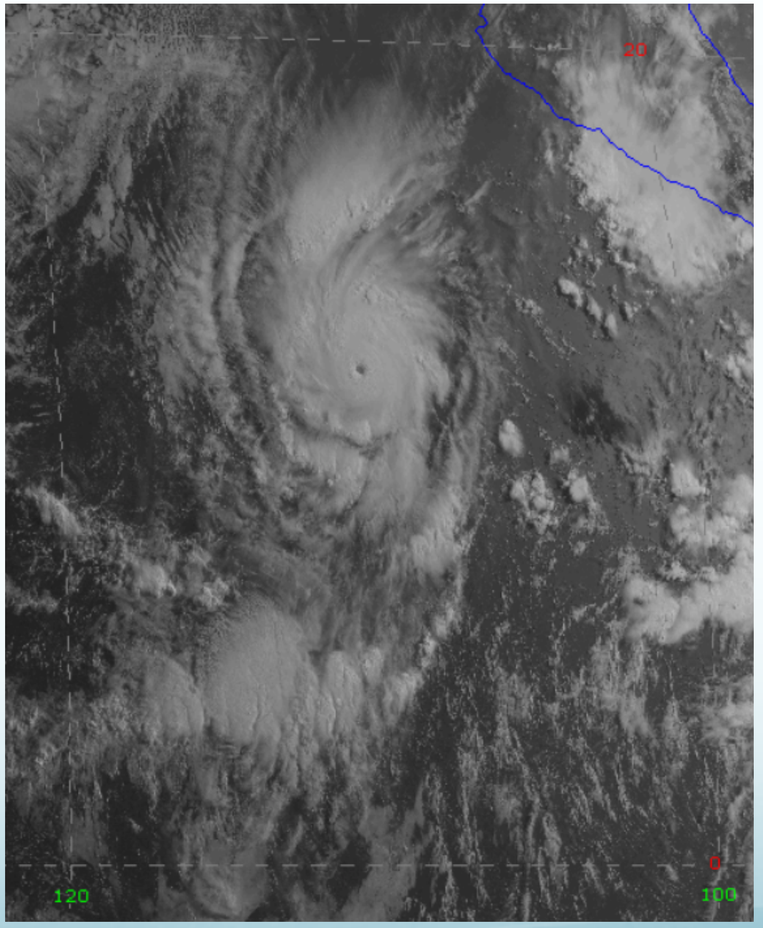
- Low clouds look darker in IR: their temperatures are close to those of the surface.
- IR is lower resolution than visible.
- Space is white in IR (cold) and black in visible.

Visible

Amanda: 8 AM PDT, May 25, 2014

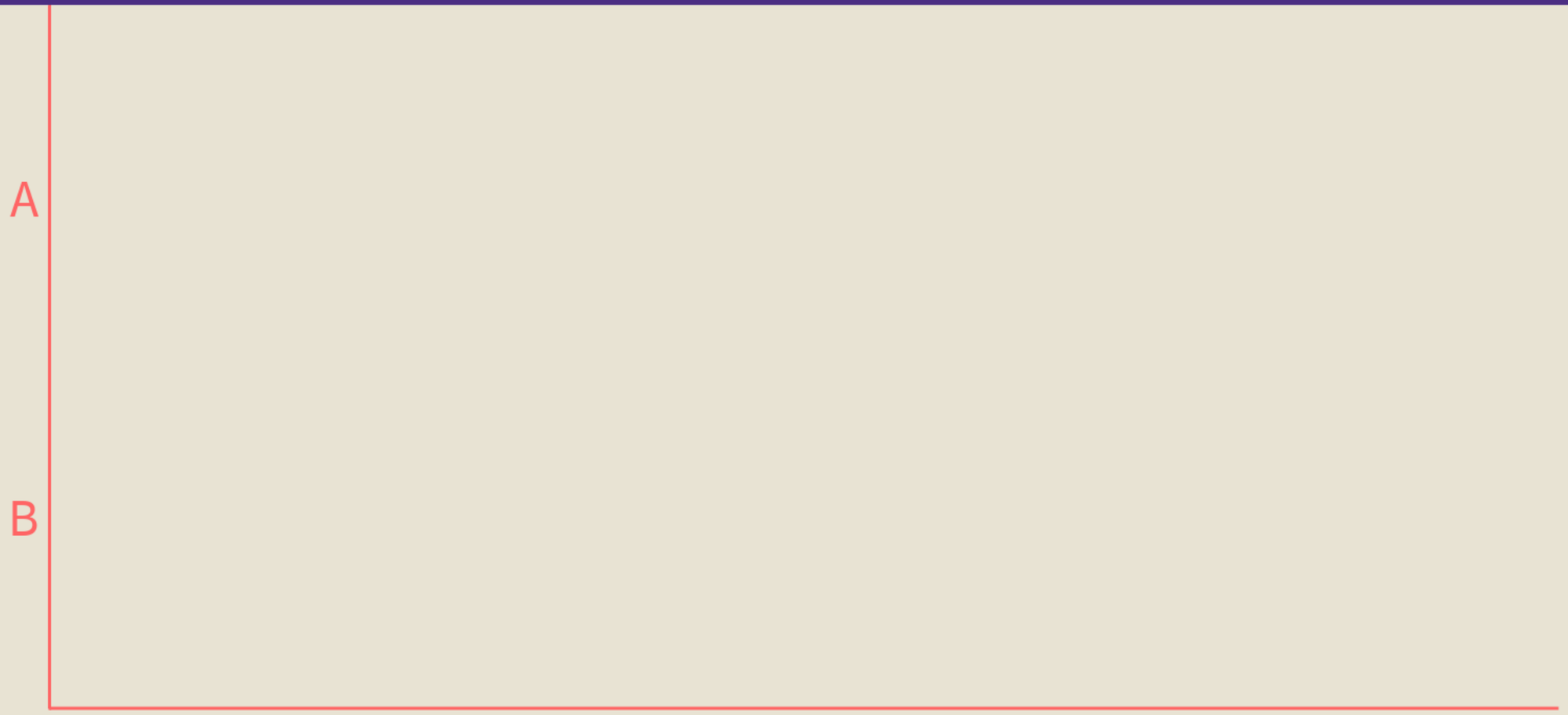


A



B

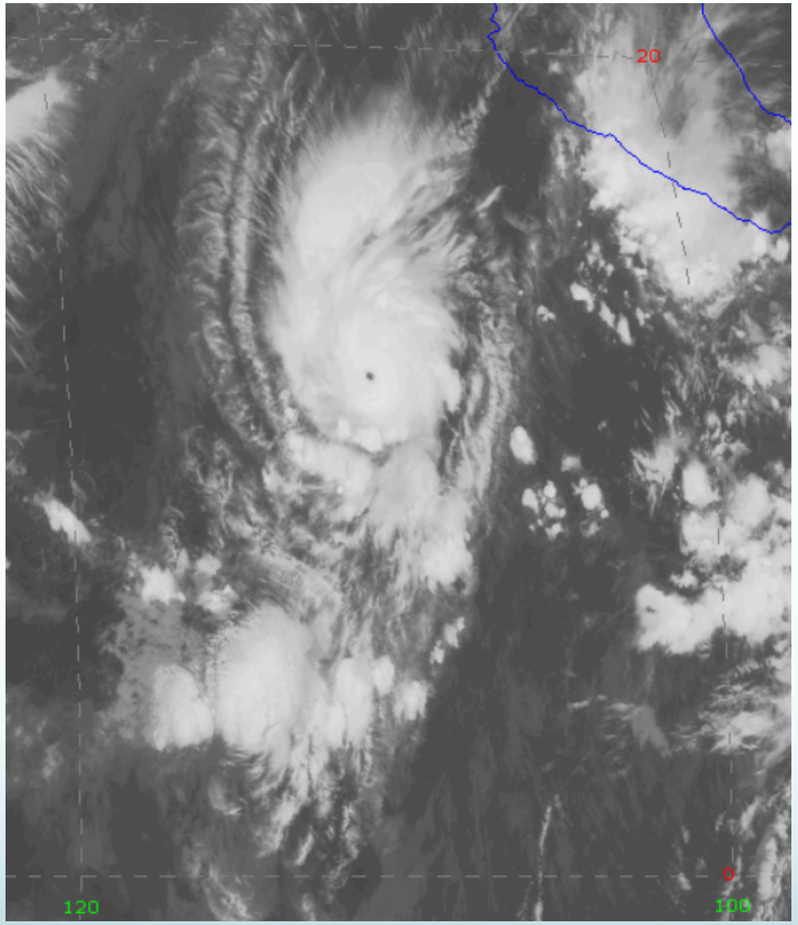
Which one is an IR image?



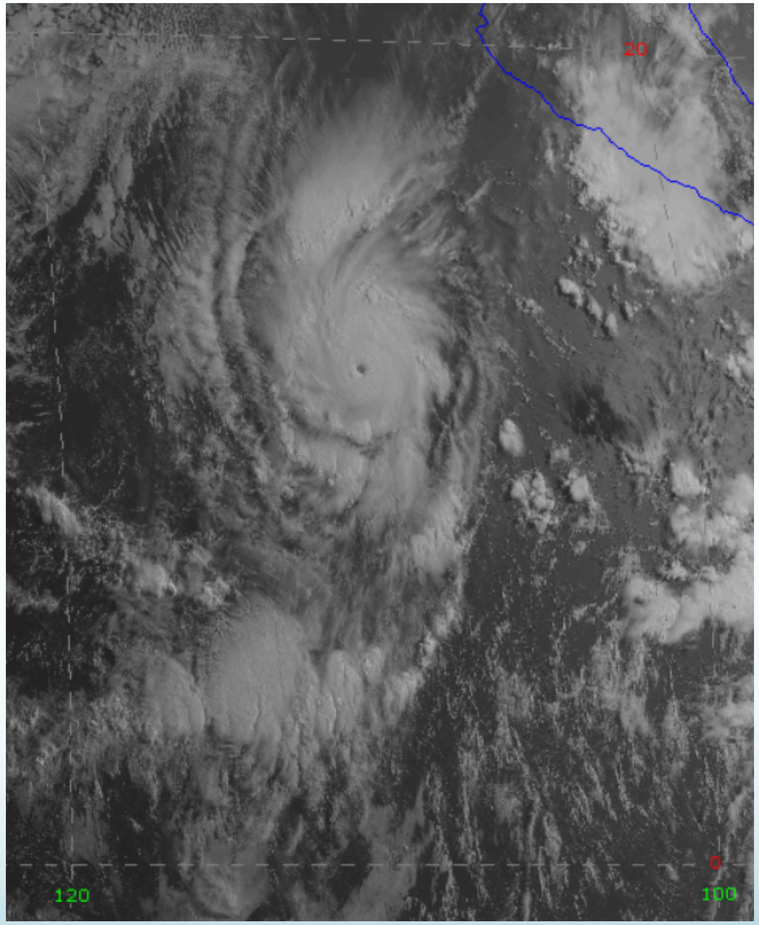
Start the presentation to see live content. Still no live content? Install the app or get help at **PollEv.com/app**

Total Results

Answer: A

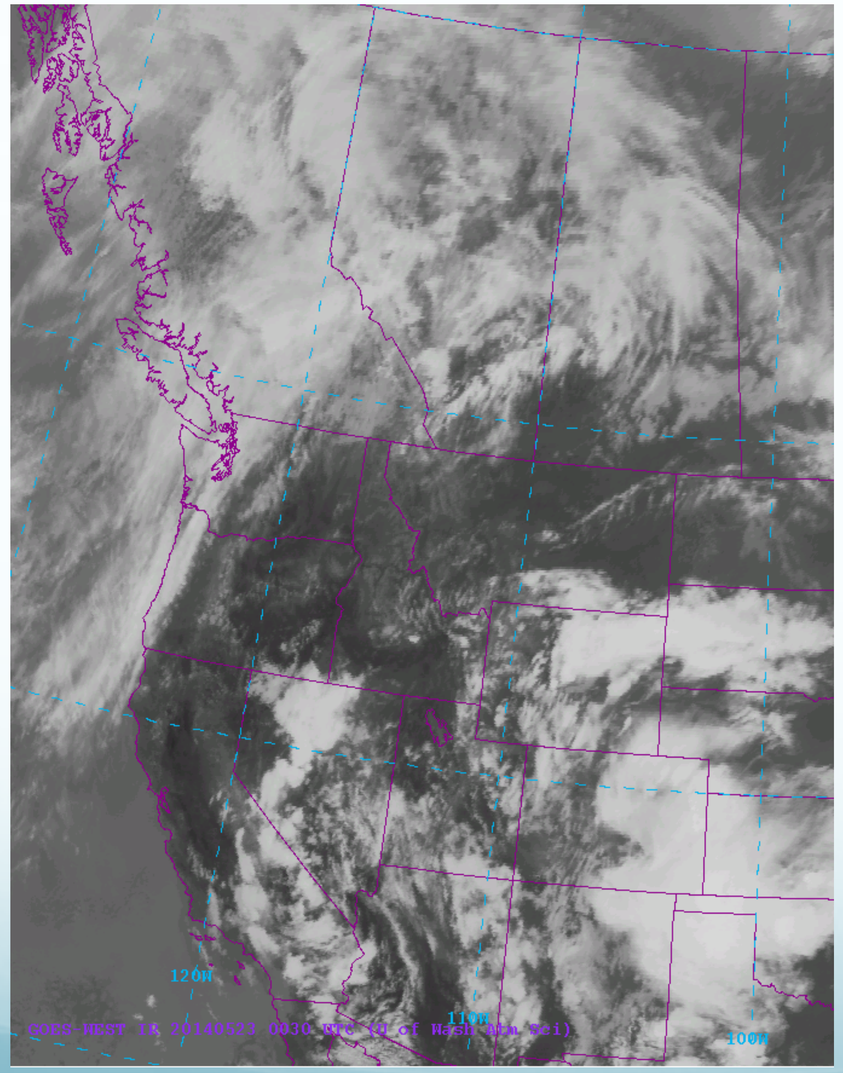


IR

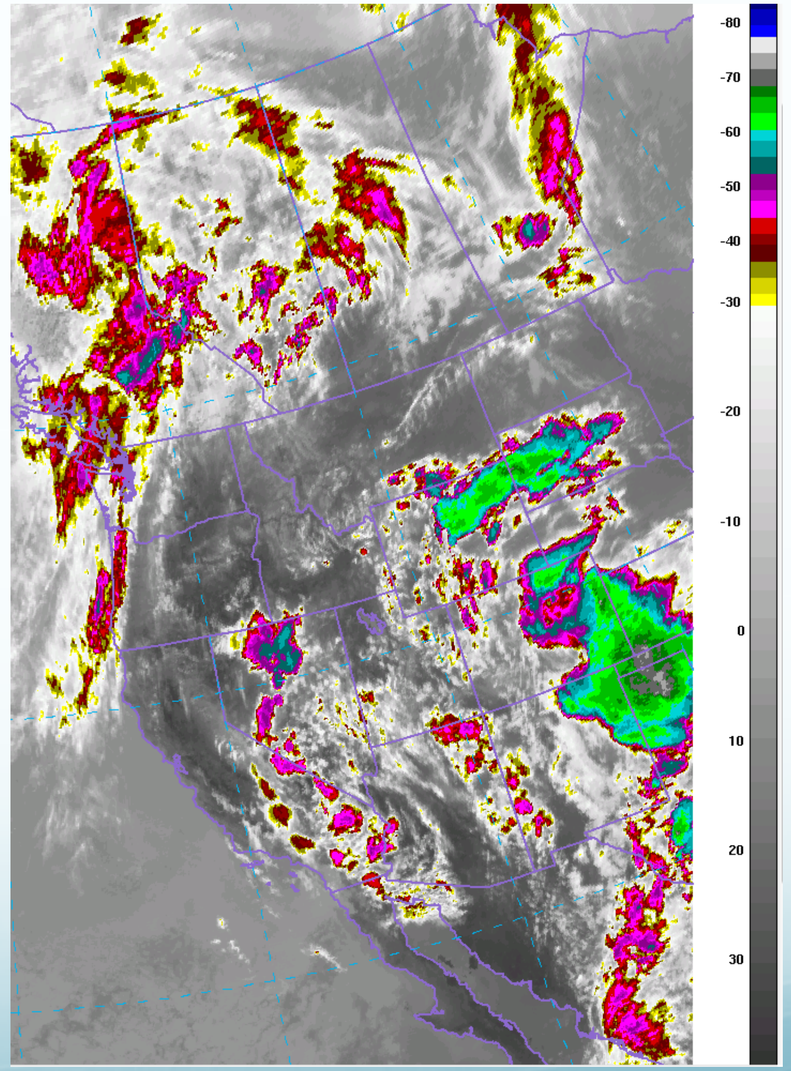


Visible

Color can be added to IR images to highlight the coldest (highest) clouds.



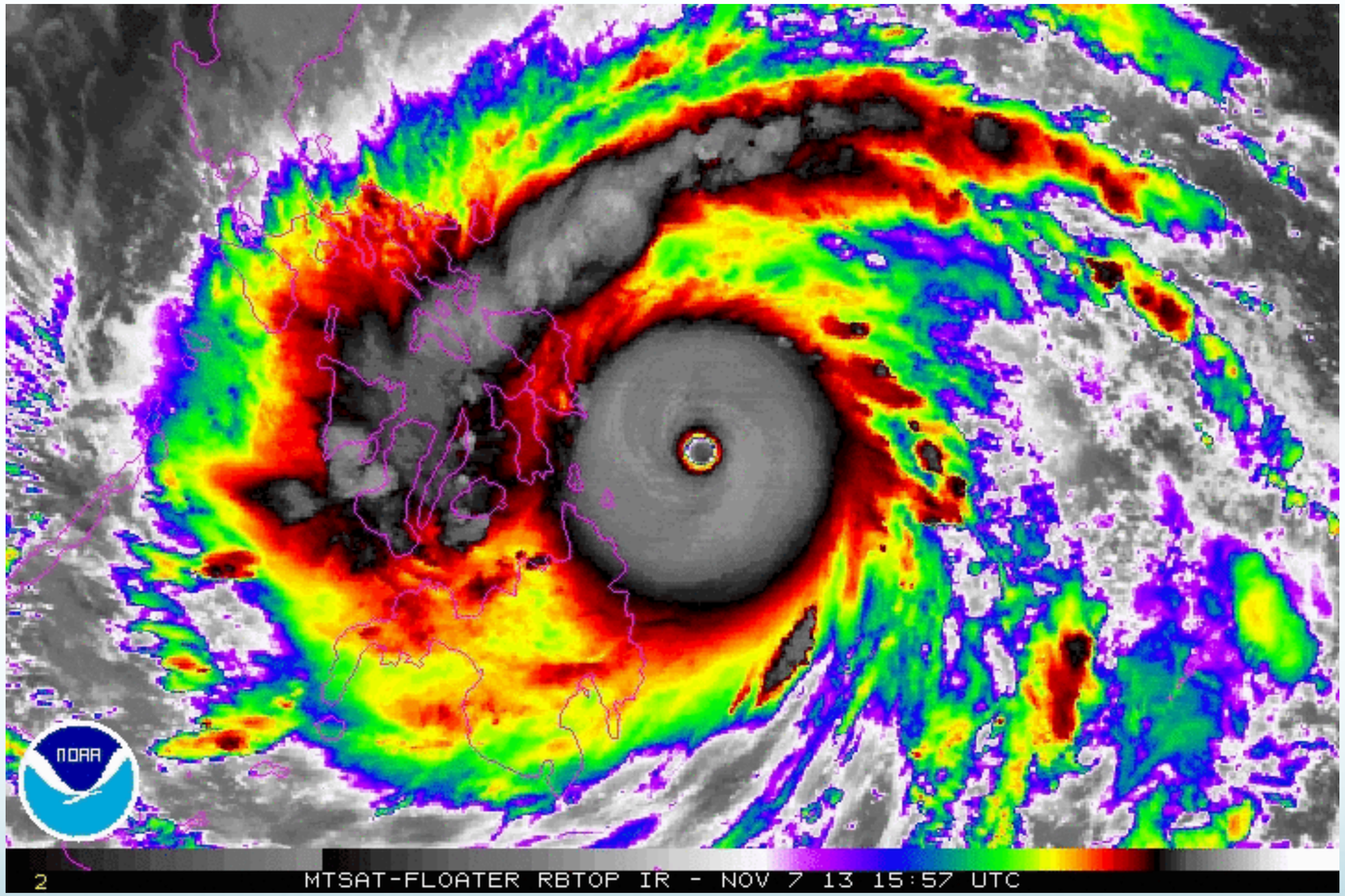
Standard IR



Enhanced IR

Super Typhoon Haiyan

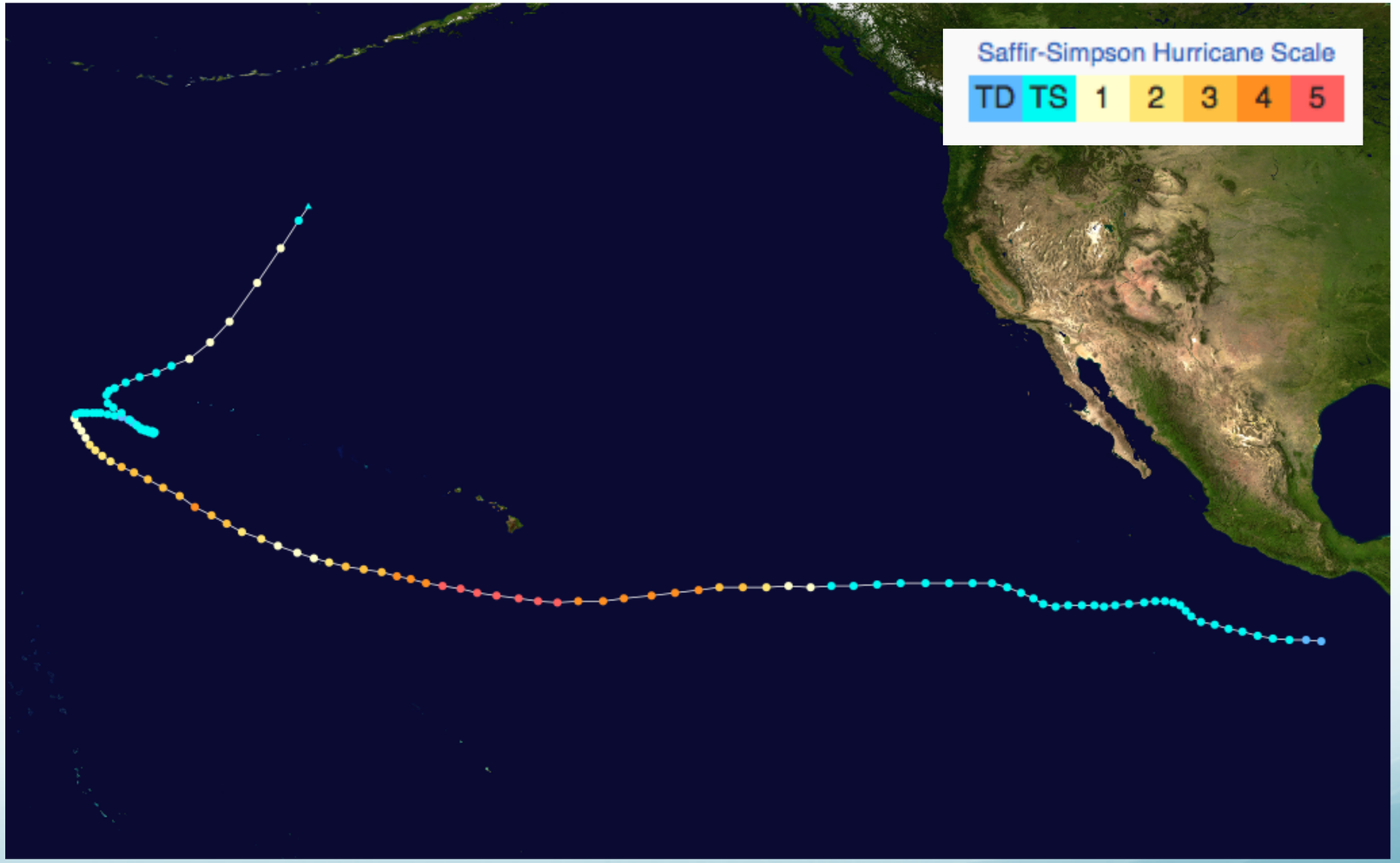
Enhanced IR images



Hurricane Death and (Maybe) Rebirth

Hurricane John 1994

- Record for
  - Longest lived: 31 days
  - Longest track: 7,165 miles
- No deaths, only minor damage
- It avoided land, cold water, and high wind shear regions



Once over land, hurricanes weaken rapidly. The biggest reason for this is

Increases in rainfall intensity over land

The increase in drag encountered by winds blowing over a land surface

The reduction in the water vapor evaporated from the surface beneath the storm

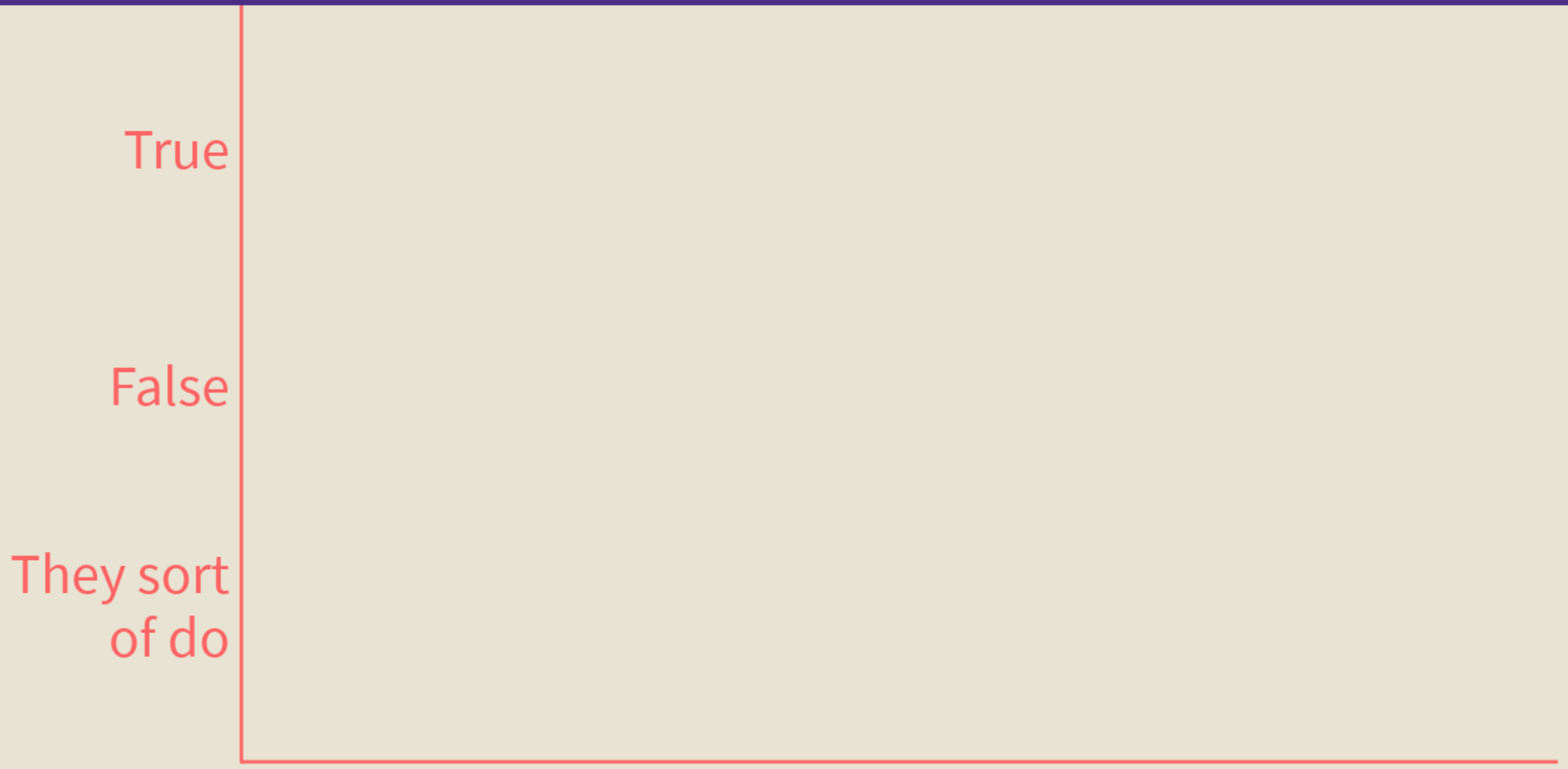
Answer: Hurricanes weaken over land because they can no longer ingest water vapor from the sea surface.

- Increasing rainfall releases more latent heat, which might (other things being equal) strengthen the storm.
- Extra drag on the surface winds over land, does tend to weaken the storm, but not nearly as much as the loss of its fuel supply: water vapor evaporated off a warm sea-surface.

Rebirth as a Mid-latitude Low

- Hurricanes die when they move
  - Over land or cold water
  - Into a region of strong vertical wind shear
- Hurricanes that recurve over the ocean can become intense mid-latitude lows.
  - John became a low that influenced Alaska

Hurricanes never impact Washington State



Start the presentation to see live content. Still no live content? Install the app or get help at **PollEv.com/app**

Total Results

Answer: any of the above can be argued as correct.

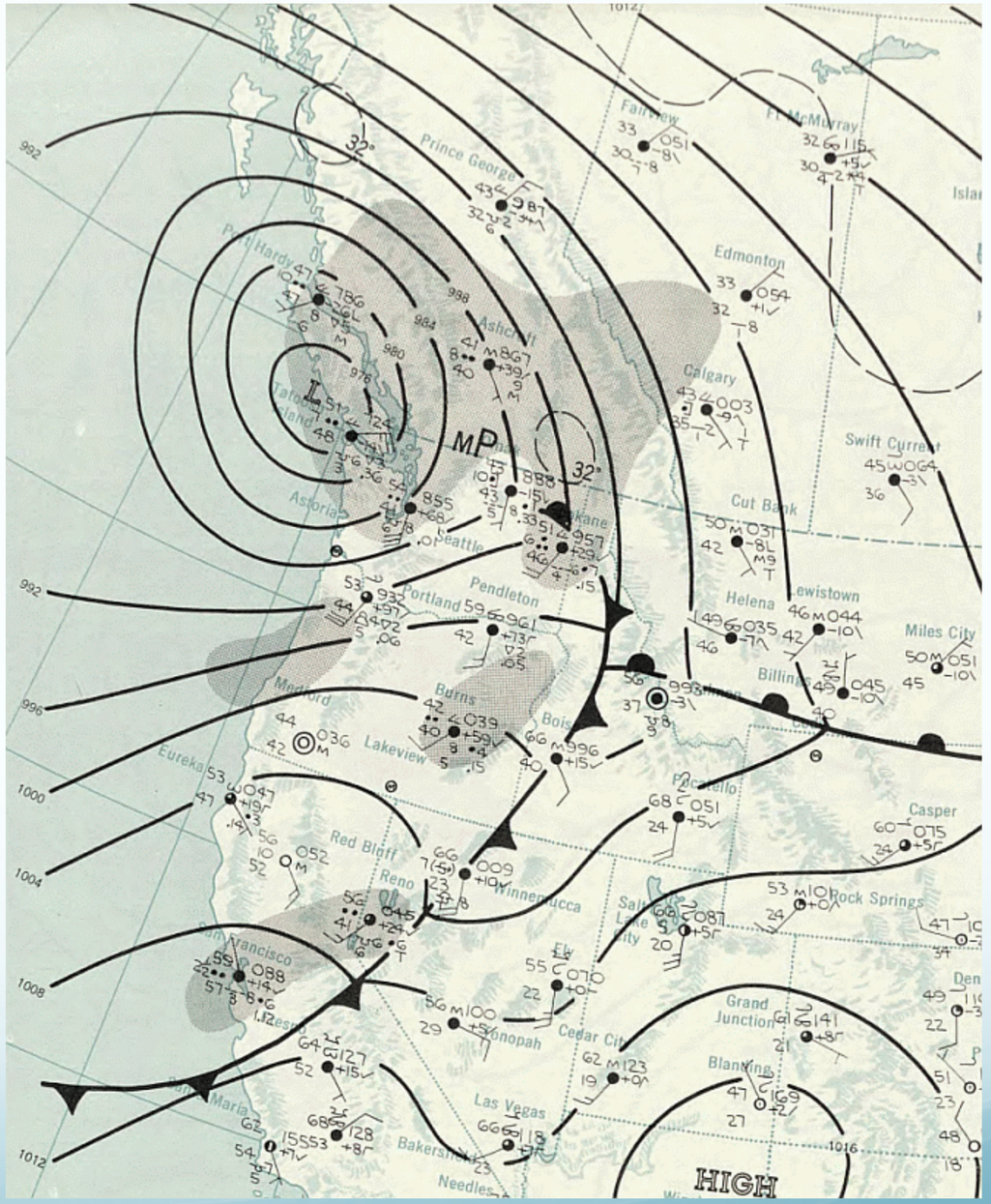
- Hurricanes never come ashore in Washington as a tropical cyclone.
- But hurricanes can be reborn as very intense extra-tropical cyclones (mid-latitude low pressure systems).
- These intense systems occasionally have great impact on the Pacific Northwest.

Columbus Day Storm 1962

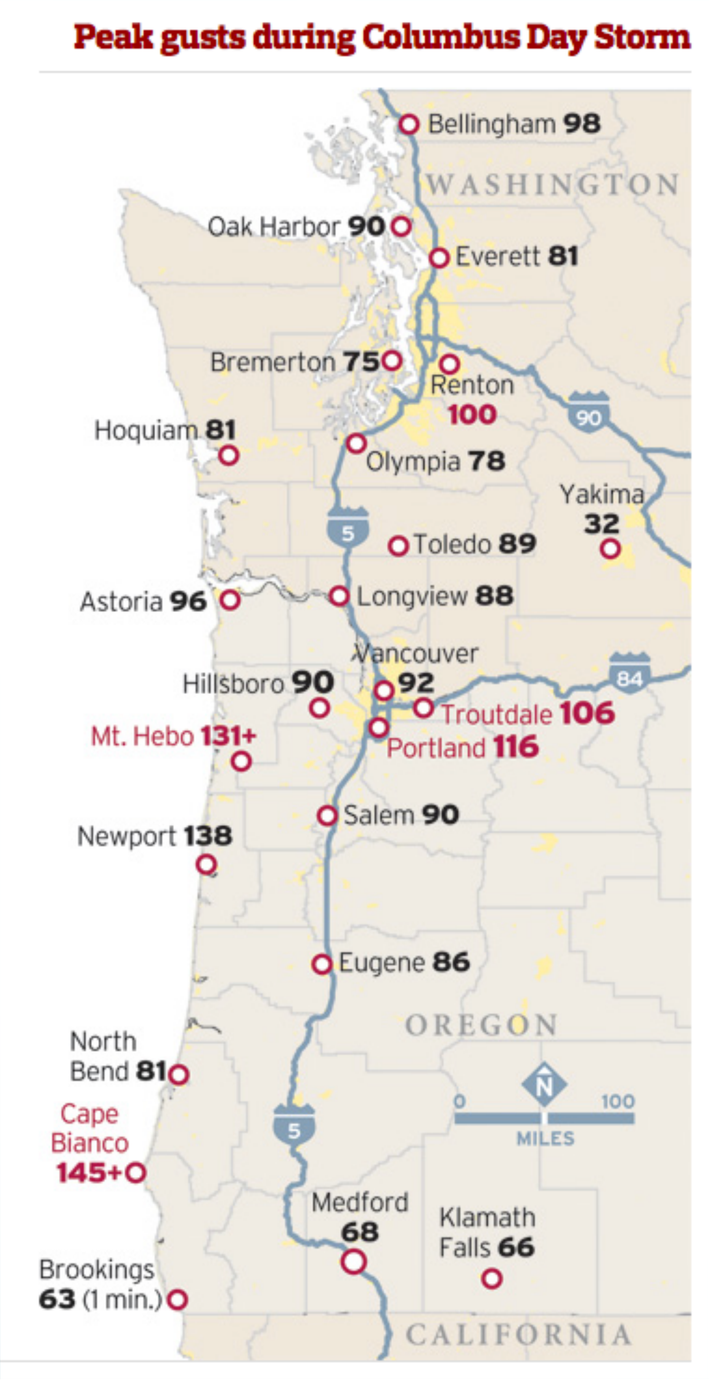
Hurricane Freda Catches the Westerlies

The Low Comes Ashore

Oct 13, 1962



Peak Wind Gusts



Campbell Hall: Oregon College of Education