Hurricanes and Tropical Weather Systems:

An influence on weather in parts of the USA

Meteorology 411 – Iowa State University – Week 2

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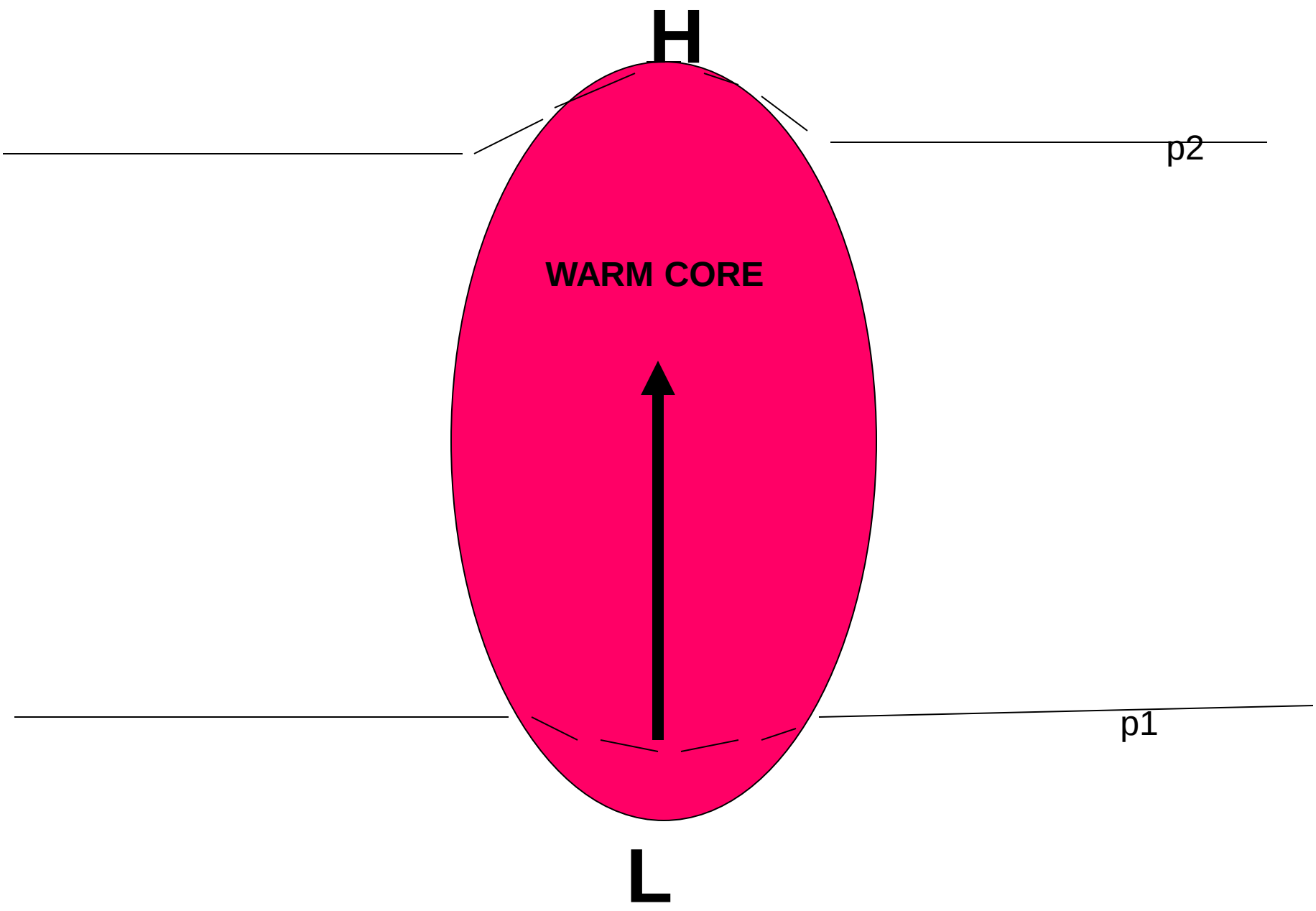
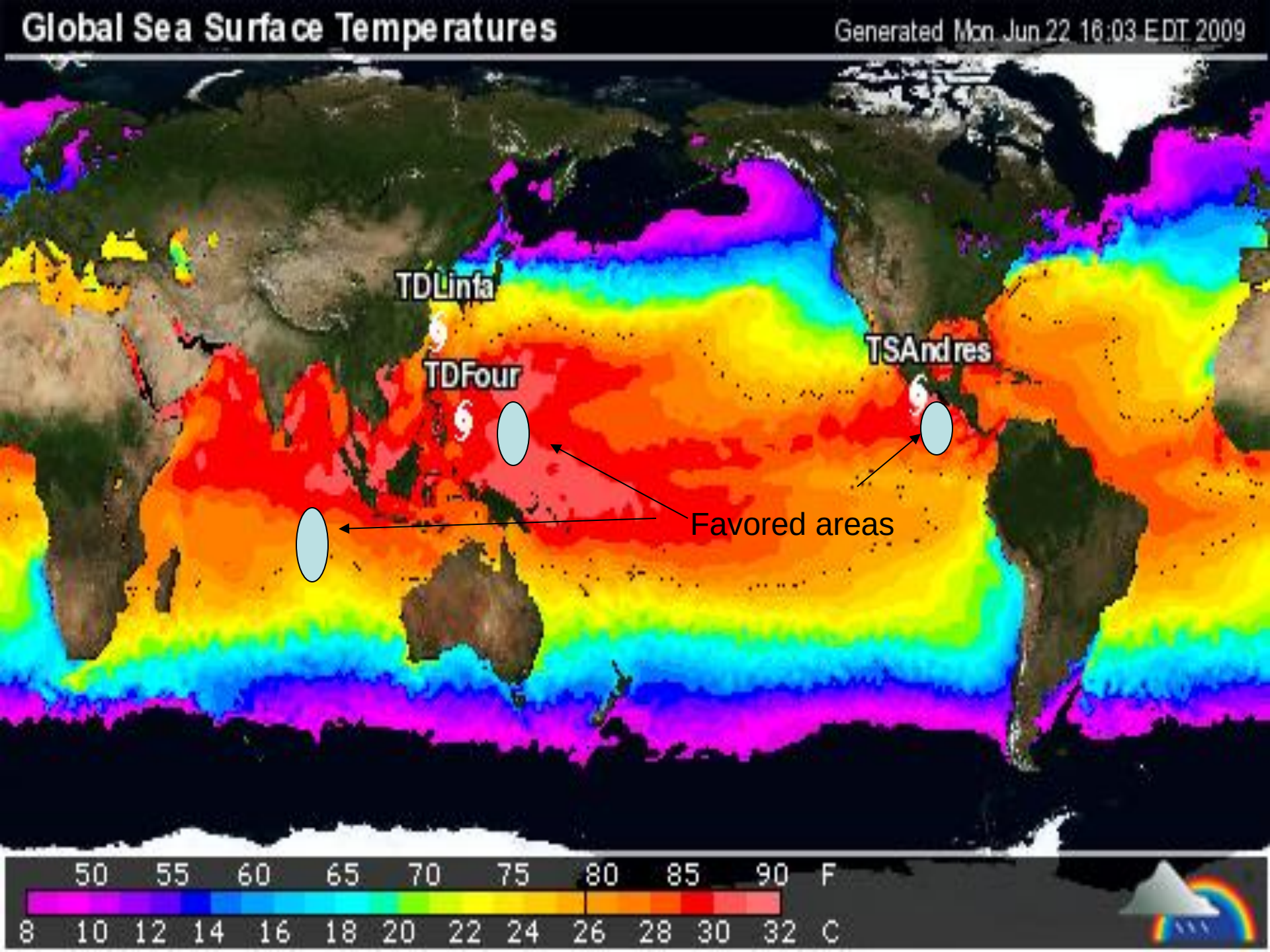
Classification/Terminology

- Tropical Disturbance – enhanced convection without a closed surface circulation
- Tropical Depression – **warm core** LOW with closed circulation and winds ≤ 35 knts
- Tropical Cyclone – general term for low with winds ≥ 35 knts
- Tropical Storm – winds from 35-64 knots
- Hurricane – winds > 64 knots


H
p2
WARM CORE
p1
L

Notes on Genesis

- Cyclones do not form within 4-5 degrees of Equator. Especially favored in 5-15 degree belts. No genesis poleward of 22S but can form up to 36N
- Favored longitudes: 90E, 140E, 105W (Indian Ocean, W Pac, off W. coast of Mexico)
- Most form in summer, but can form all year in W. Pac
- North Indian ocean has 2 seasons – minor in spring with onset of monsoon and major in fall as it retreats
- Favored areas are near ITCZ


Global Sea Surface Temperatures
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TDLinfa
TDFour
TSAndres
Favored areas
50 55 60 65 70 75 80 85 90 F
8 10 12 14 16 18 20 22 24 26 28 30 32 C

Atlantic Season (Jun 1- Nov 30)

- June-July: Southern Gulf of Mexico, Carribean
- Aug-Sept: Cape Verde Region
- Oct-Nov: similar to June/July

Criteria for Development

- > 26 C (79F) ocean temps – acts as energy source with threshold related to instability
- Small wind shear (|V200| - |V850| ≤ 15 knots) – helps keep heating concentrated so pressure will drop
- Pre-existing region of low-level convergence (TRIGGER) such as an MCV, stalled front, easterly wave

Criteria (cont)

- Convectively unstable atmosphere (usually present in tropics)
- Latitude > 4-5 degrees
- Moist mid-levels – diminishes entrainment [watch out for Saharan dry air bursts (SAL) and dust]

Structure

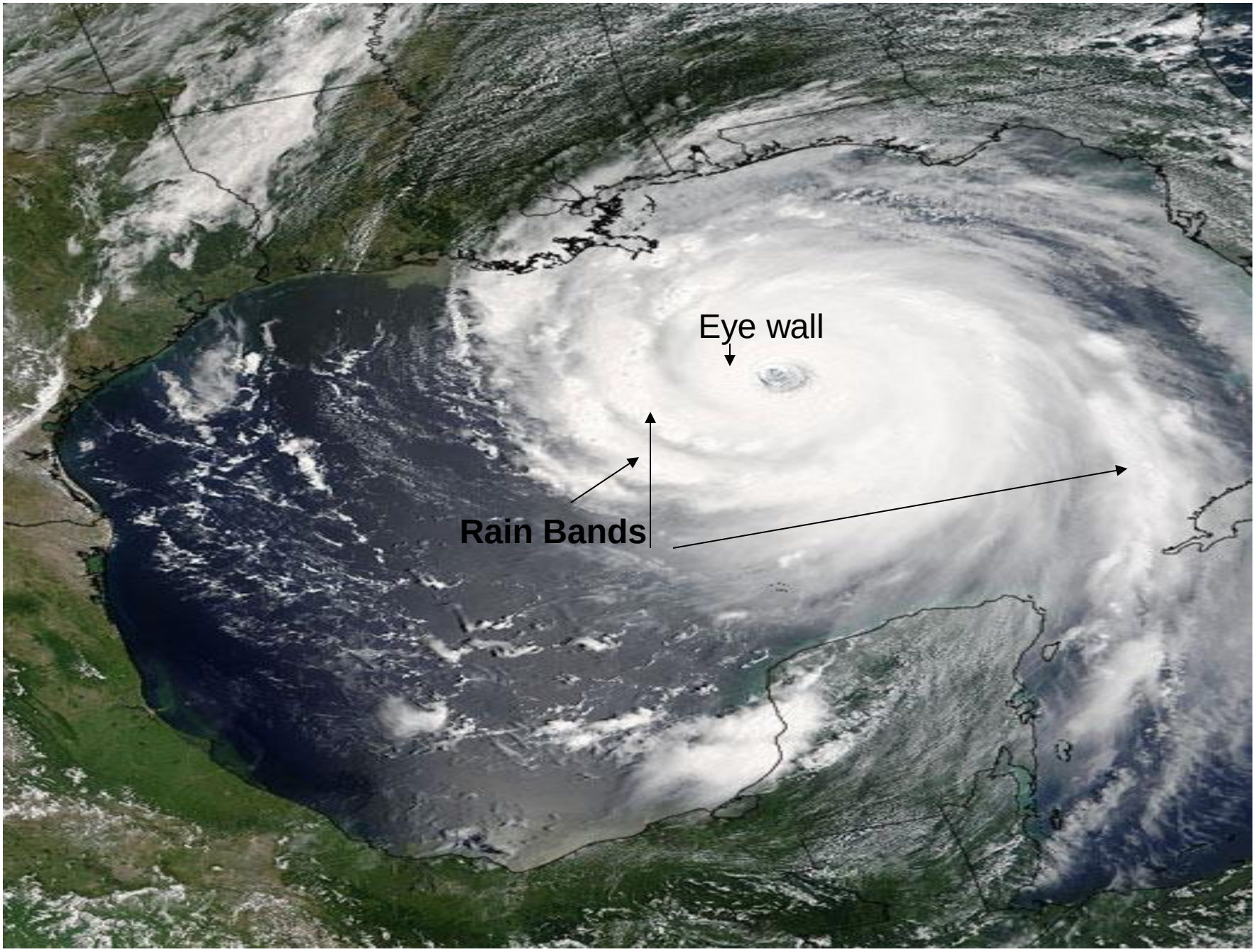
1) Eye – circular 20-50 km diameter region often cloud free and nearly calm. Formed by massive convergence of outflow from ring-shaped eye wall region.

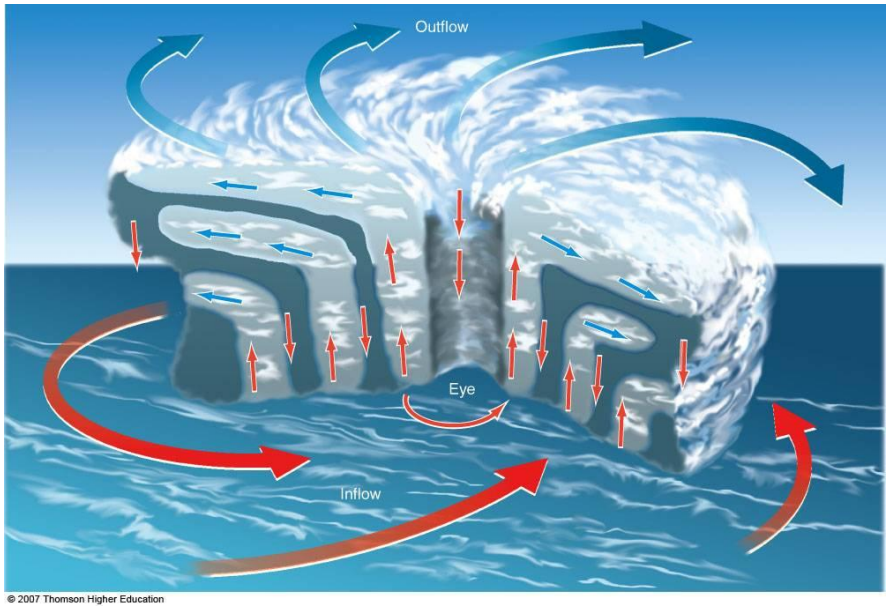
"smaller the eye, stronger the storm"

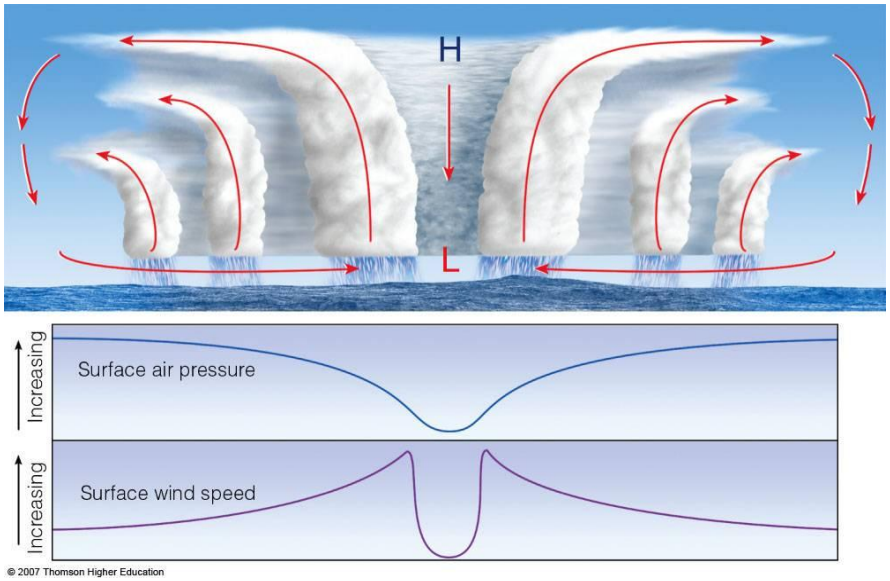
2) Eye Wall – most intense part of hurricane with strongest winds (can reach 100 m/s) and heaviest rain rates (10 cm/h)

Structure (cont)

- Rain Bands – usually quasi-stationary with respect to the moving storm. Most intense one is usually 45 degrees to the right of the storm


Eye wall
Rain Bands





Note: Conditions very gradually go downhill as a hurricane moves in, and then the very bad weather hits fairly quickly as the eye approaches – pressure falls much more rapidly and winds accelerate much more quickly.

Dissipation

- 1) Remove heat source (move over land)
- 2) Shear off the anticyclone aloft (ventilation increases due to wind shear)
- 3) Move into low theta-E air at surface (cold, dry airmass)

Movement of tropical cyclones

- This is difficult but not as hard as forecasting intensity

1) External flow – steering wind some distance away from storm (200-400 km, maybe 500-700 km)

a) use mean 100-1000 mb flow

b) 500-700mb wind

*Layer that works best may depend on strength of the system – weak systems might use 850-700mb, deep ones 100-1000 mb

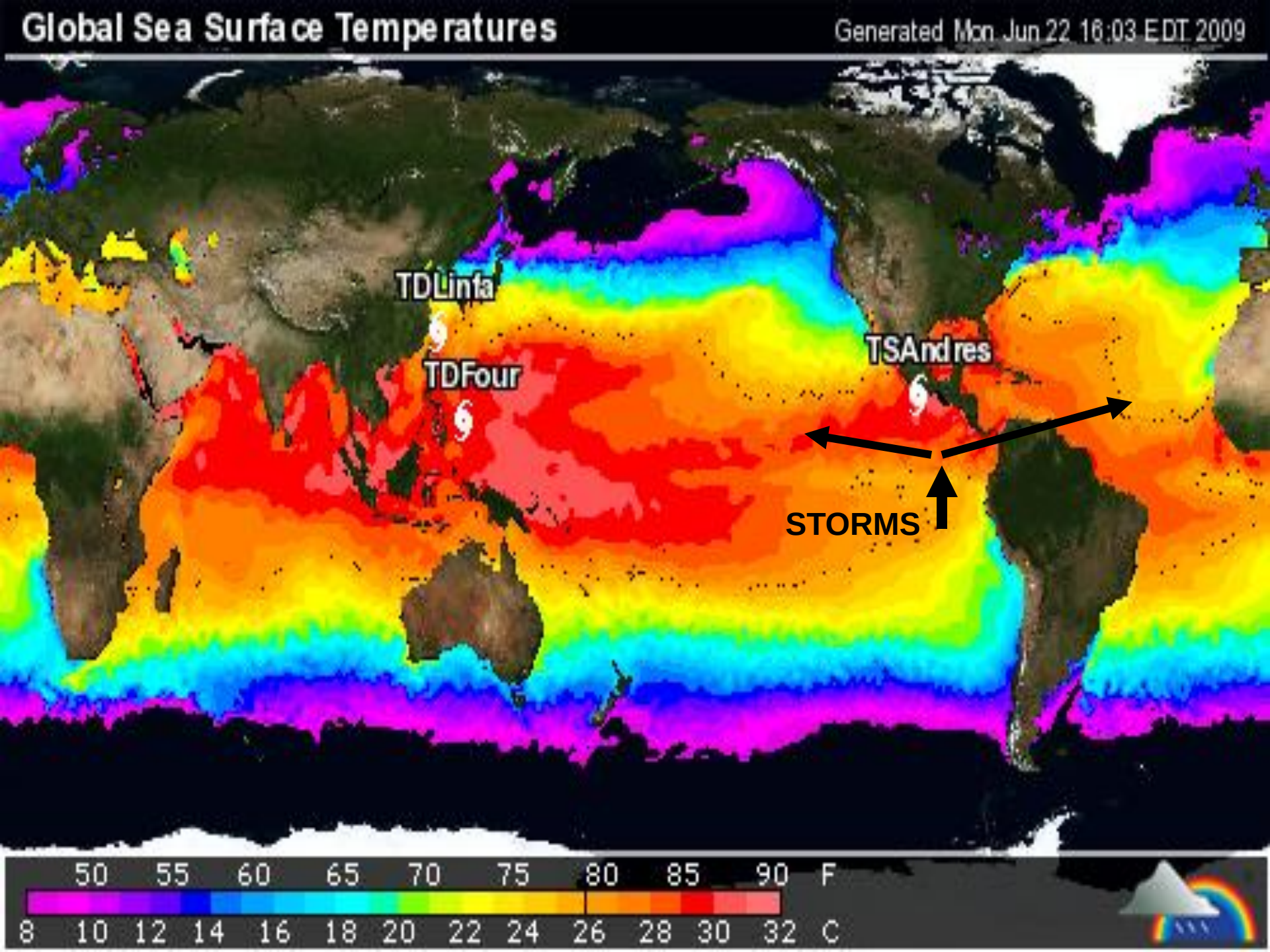
2) Internal flow – tricky since large hurricanes might build a ridge to their north, altering the “external” flow

Seasonal Prediction

- Dr. William Gray at CSU started to do this with some success for Atlantic/Gulf area in 1980s and now NOAA does it too
- Based on some large-scale factors (it seems people are always discovering new things that are important in these forecasts)

Seasonal Prediction (cont)

- 1) El Nino/La Nina: El Ninos have a major negative impact on storm numbers. It is possible the warm water in the east Pacific results in more convection there, and that upper-level divergence/outflow results in more westerly flow aloft over the Atlantic genesis area


Global Sea Surface Temperatures
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STORMS
50 55 60 65 70 75 80 85 90 F
8 10 12 14 16 18 20 22 24 26 28 30 32 C

Seasonal Prediction (cont)

- 2) QBO Phase: this is the status of winds 65,000-100,000 feet above the Equator. Westerly phase is good for hurricanes, along with increasing westerly phase. This might seem odd, but remember the winds here are easterly, so westerly phase means they are slower easterlies with less shear.

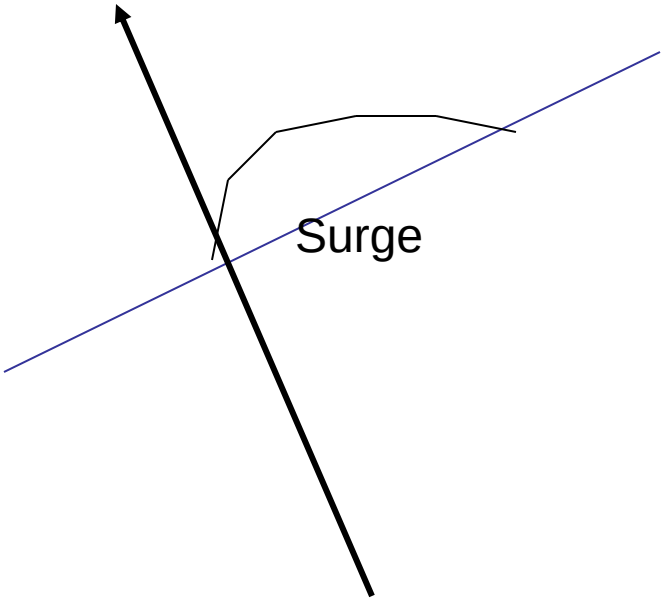
Seasonal Prediction (cont)

- 3) Sea level pressures in Gulf/Carribean (deviation from Apr-Jun mean): low pressure means convergence and spin-up more likely
- 4) West African rainfall: might help get hurricanes since if it is wet there, more MCSs may move off coast into ocean, plus it keeps the dust down, which tends to block sunlight over the ocean and lead to lots of very dry air in midlevels
- 5) SST: warmer than usual waters can help

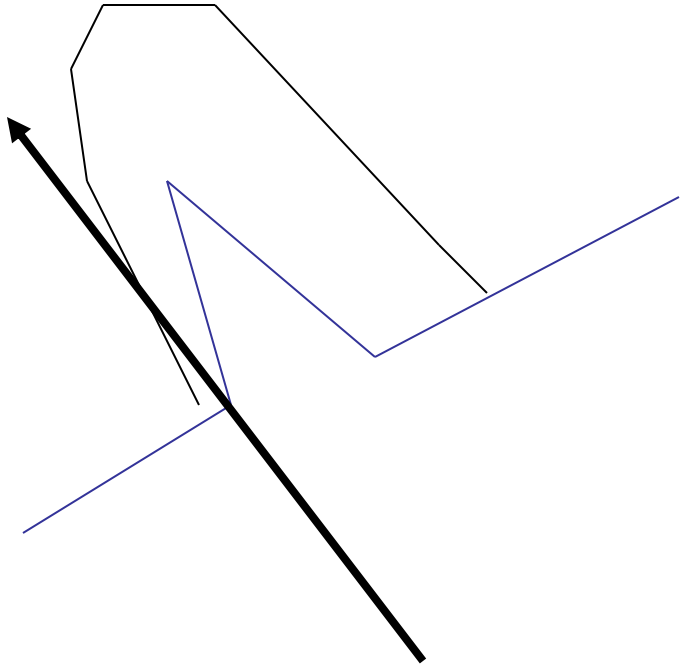
Land Impacts

- 1) Storm Surge: rise in sea level, only slightly due to lower sea level pressure (100 mb drop = 1 m rise) but MAINLY due to wind stress piling up water. Major factor in many Katrina deaths. Can stay high even if winds die down if storm is large. SPLASH model can predict storm surge which is a function of ocean bottom geography

BAD

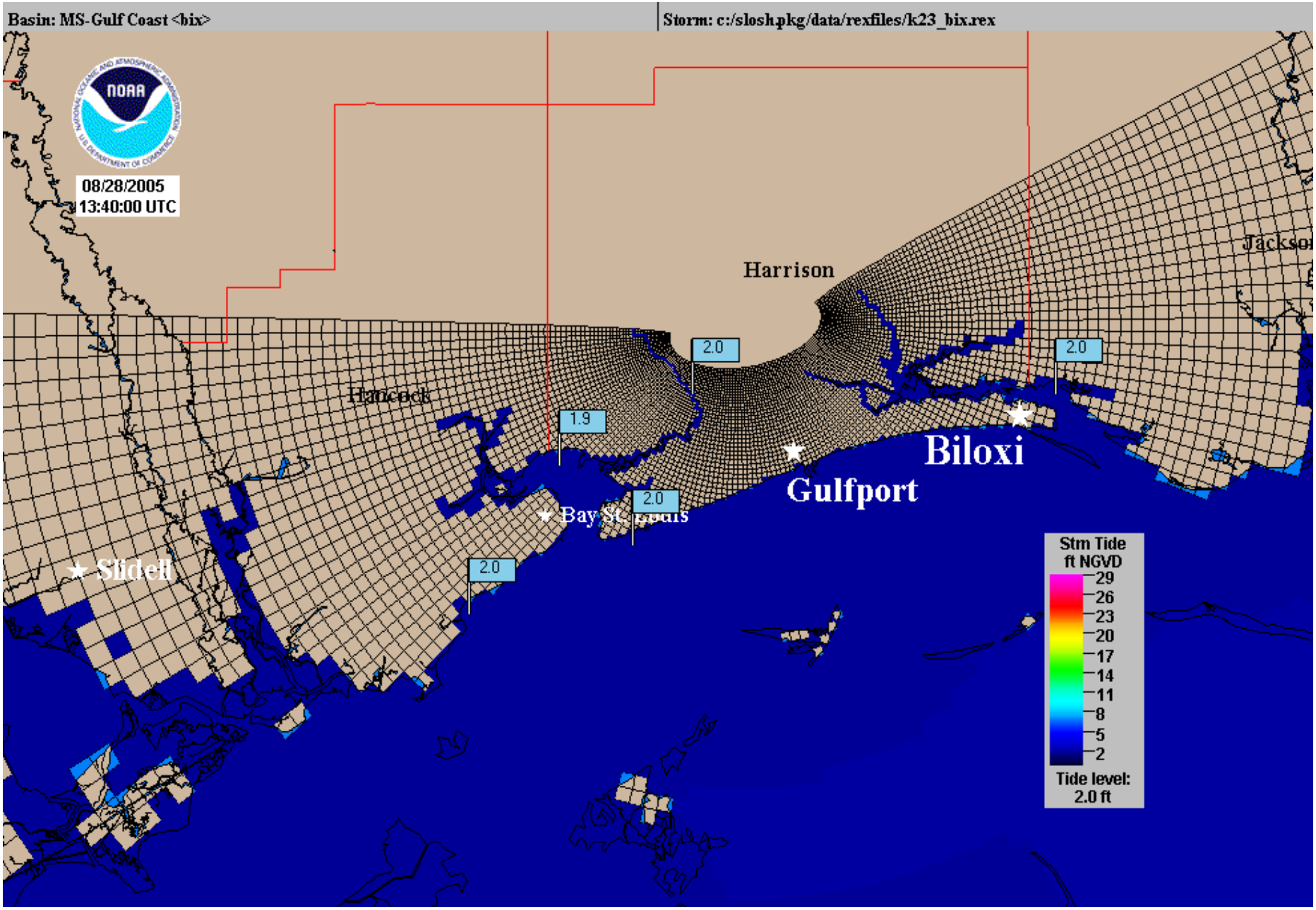


WORSE



Land Impacts

- 2) Wind: resulted in most damage in Hurricane Andrew in 1992, possibly due to small embedded tornadoes
- 3) Rain: due to deep moist layer, 10-20 inch rains are common. For most of period 1970-2000, inland flooding was believed to be most deadly part of hurricane
- 4) Tornadoes: tilting of vorticity under strong updrafts, worse on right-flank of storm as it dissipates over land, especially if dry air gets incorporated into circulation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