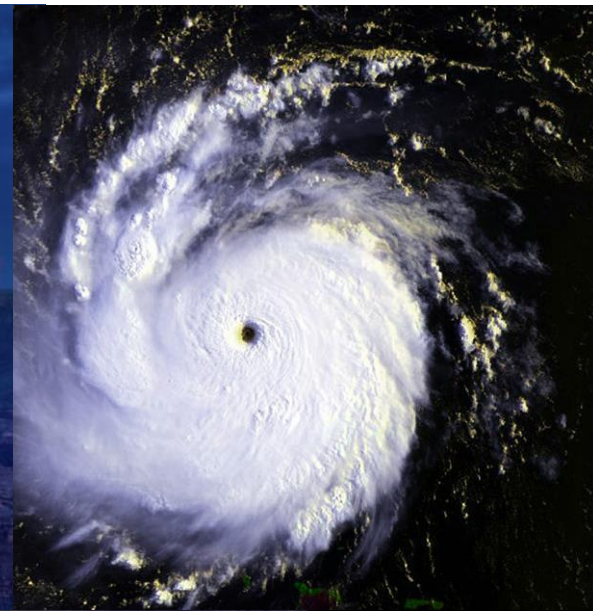


# Severe Weather



**Part 2**



# Tornado Facts

- Tornadoes can occur almost **anywhere in the world**.
- Most form during the months of **April and May**.
- 99% of all tornadoes in **Northern Hemisphere** rotate **counterclockwise**.
- Duration: most tornadoes last **a few minutes**.
- Average diameter 250 feet (80 m), average travel length 4 miles (6 km).
- Funnel can travel with speeds ranging from zero up to ~70 mph, ~30 mph on average.
- Wind speeds within vortex are *usually* less than 110 mph (180 km/h).
- The **most extreme tornadoes**: wind speeds of more than **300 mph (480 km/h)**, stretch more than **2 miles (3 km) across**, and stay on the ground for dozens of miles (more than 100 km).
- Which state has highest frequency of tornadoes?









**TEXAS!**



# Tornado Classification

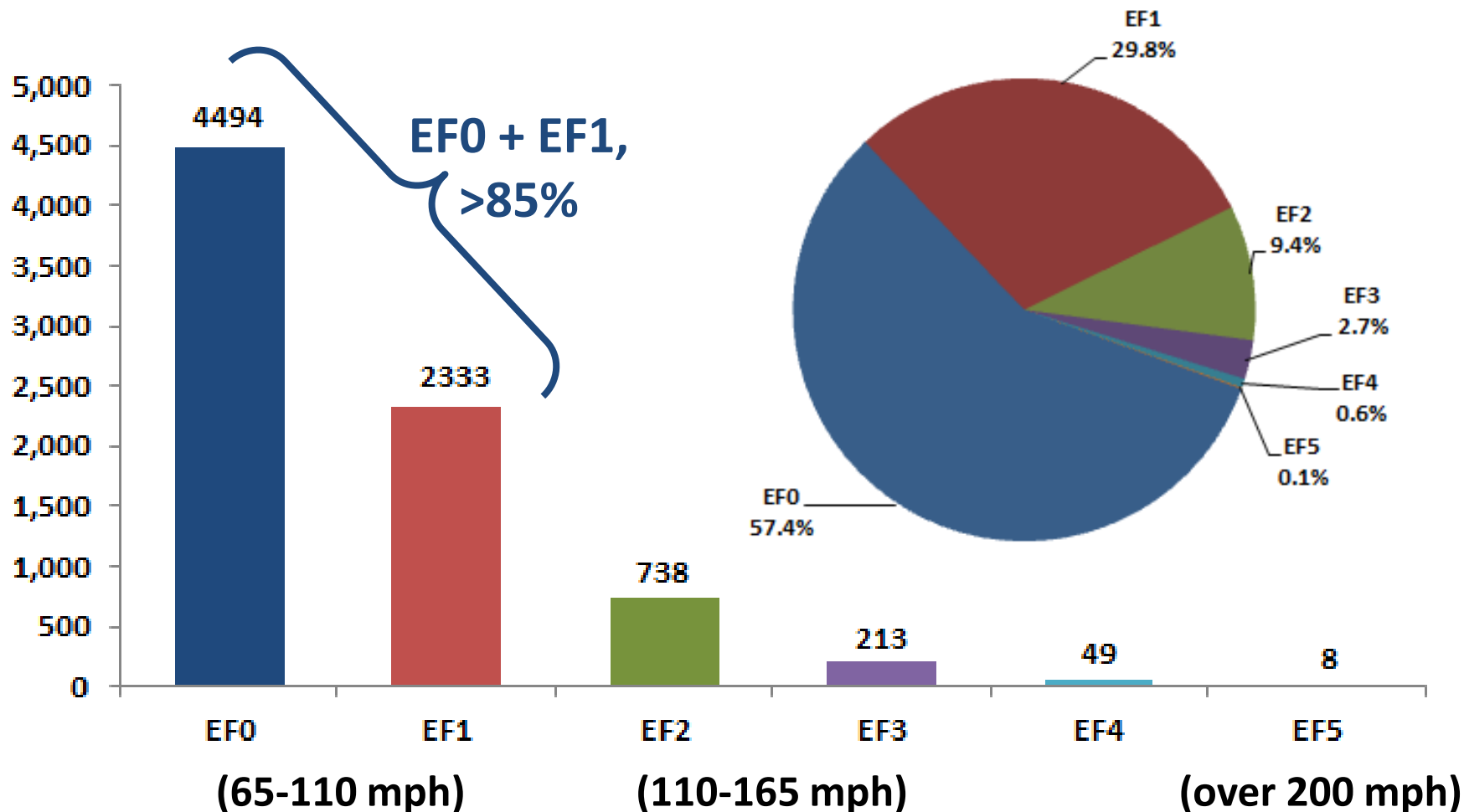
Tornadoes are classified into 6 categories **F0** – **F5** using the (Enhanced) Fujita scale.

- In rating tornadoes, only surface wind speeds, or the wind speeds indicated by the damage resulting from the tornado, are considered.
- Rating is based on the **amount of damage**, ranging from “**weak**” **F0** to “**violent**” **F5**.
- Outside Tornado Alley, and North America in general, **violent tornadoes are extremely rare**.

	Damage: <b>Incredible</b>	<b>EF5</b>	Windspeeds: Greater than 322km/h (200mph)
	Damage: <b>Devastating</b>	<b>EF4</b>	Windspeeds: 267-322km/h (166-200mph)
	Damage: <b>Severe</b>	<b>EF3</b>	Windspeeds: 218-266km/h (136-165mph)
	Damage: <b>Considerable</b>	<b>EF2</b>	Windspeeds: 178-217km/h (111-135mph)
	Damage: <b>Moderate</b>	<b>EF1</b>	Windspeeds: 138-177km/h (86-110 mph)
	Damage: <b>Light</b>	<b>EF0</b>	Windspeeds: 105-137km/h (65-85mph)

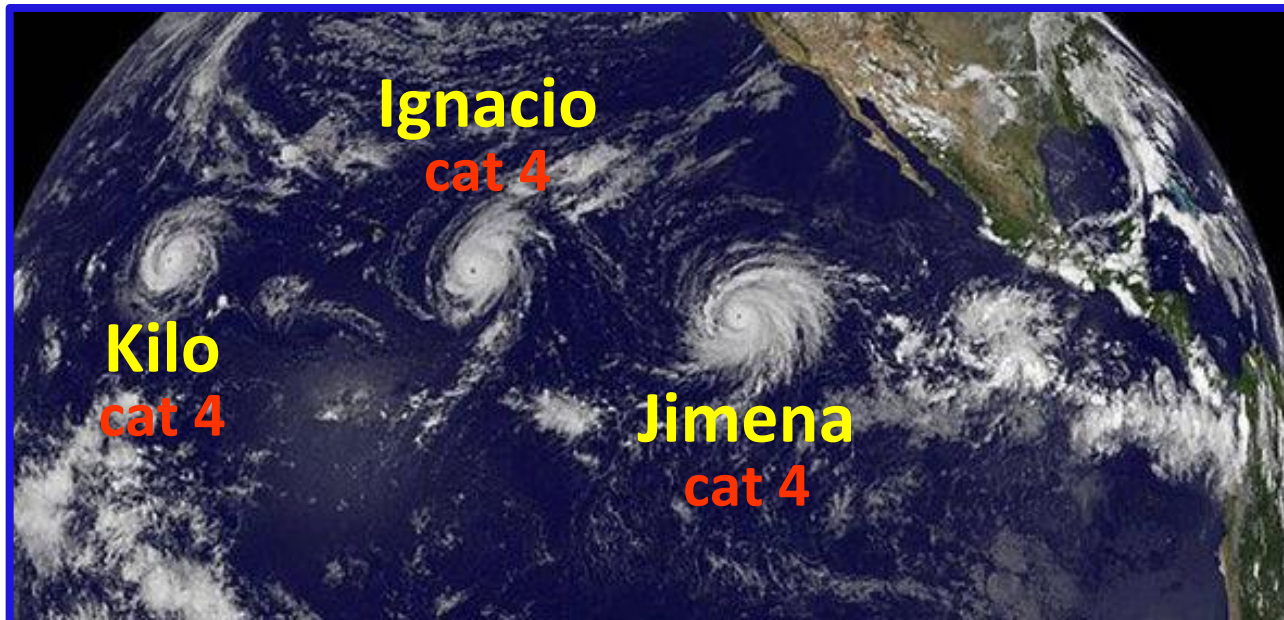
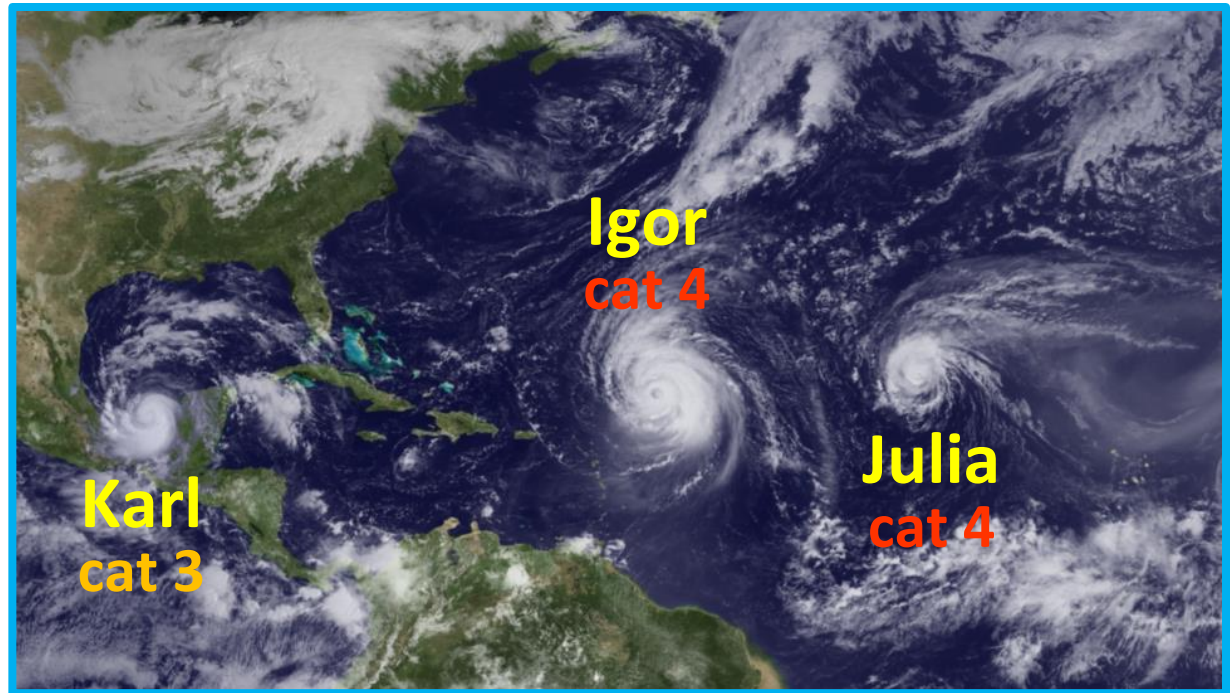
# US Tornado Frequency

Number of Reported U.S. Tornadoes by EF Rating  
for the time period between 2/2007 and 12/2012



# Hurricane

North  
Atlantic  
Basin,  
09/19/10



Pacific  
Basin,  
08/31/15

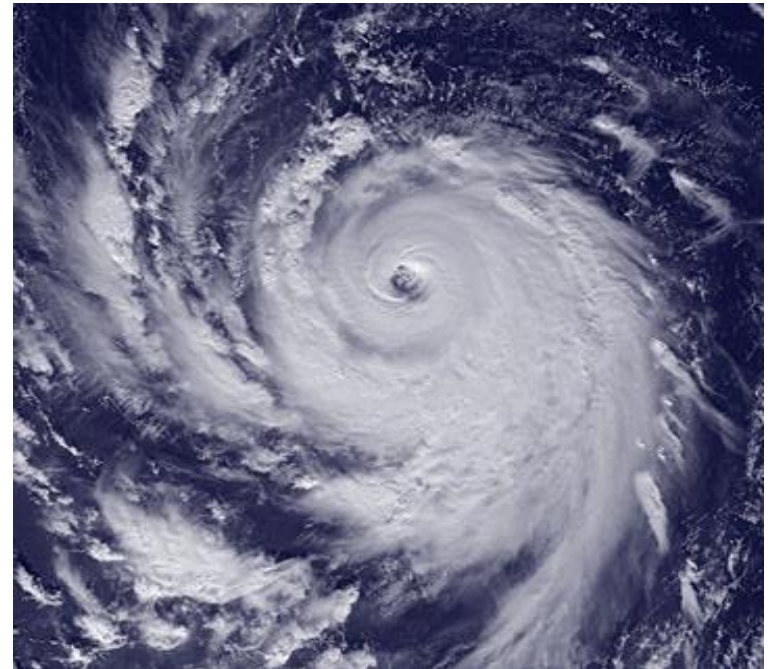


# Cyclonic Storm

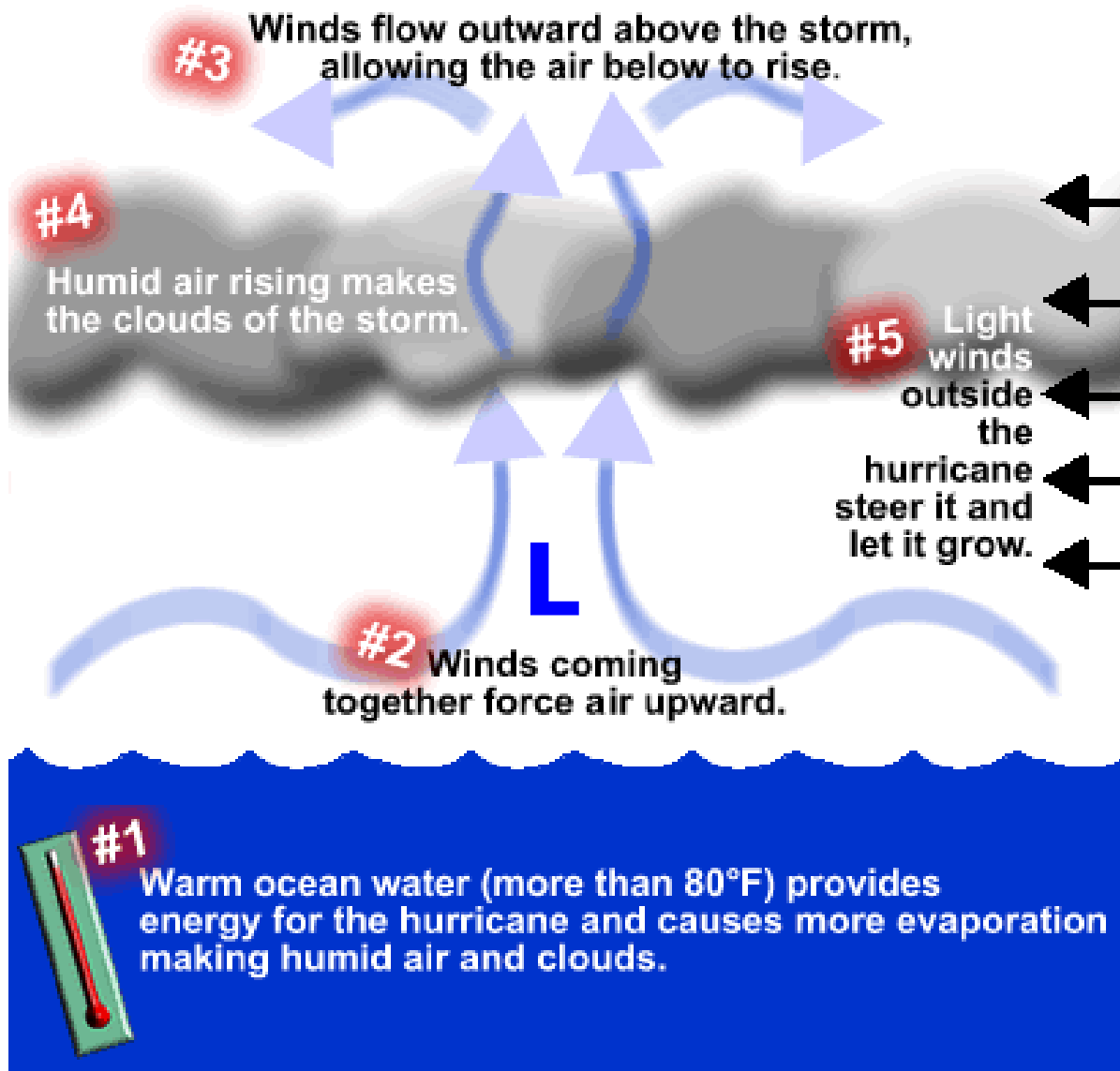
A cyclonic storm is a large-scale **rapidly rotating storm system** characterized by a **low-pressure center, strong winds**, and a spiral arrangement of thunderstorms that produce **heavy rain**.

- Formed from *organized groups of thunderstorms*.
- Classified depending on its strength and location:

- Tropical Depression
  - Tropical Storm
- } **< 74 mph winds**
- Tropical cyclone (Southern Hemisphere and Indian Ocean)
  - Typhoon (Northwestern Pacific)
  - Hurricane (Northeast Pacific or North Atlantic)

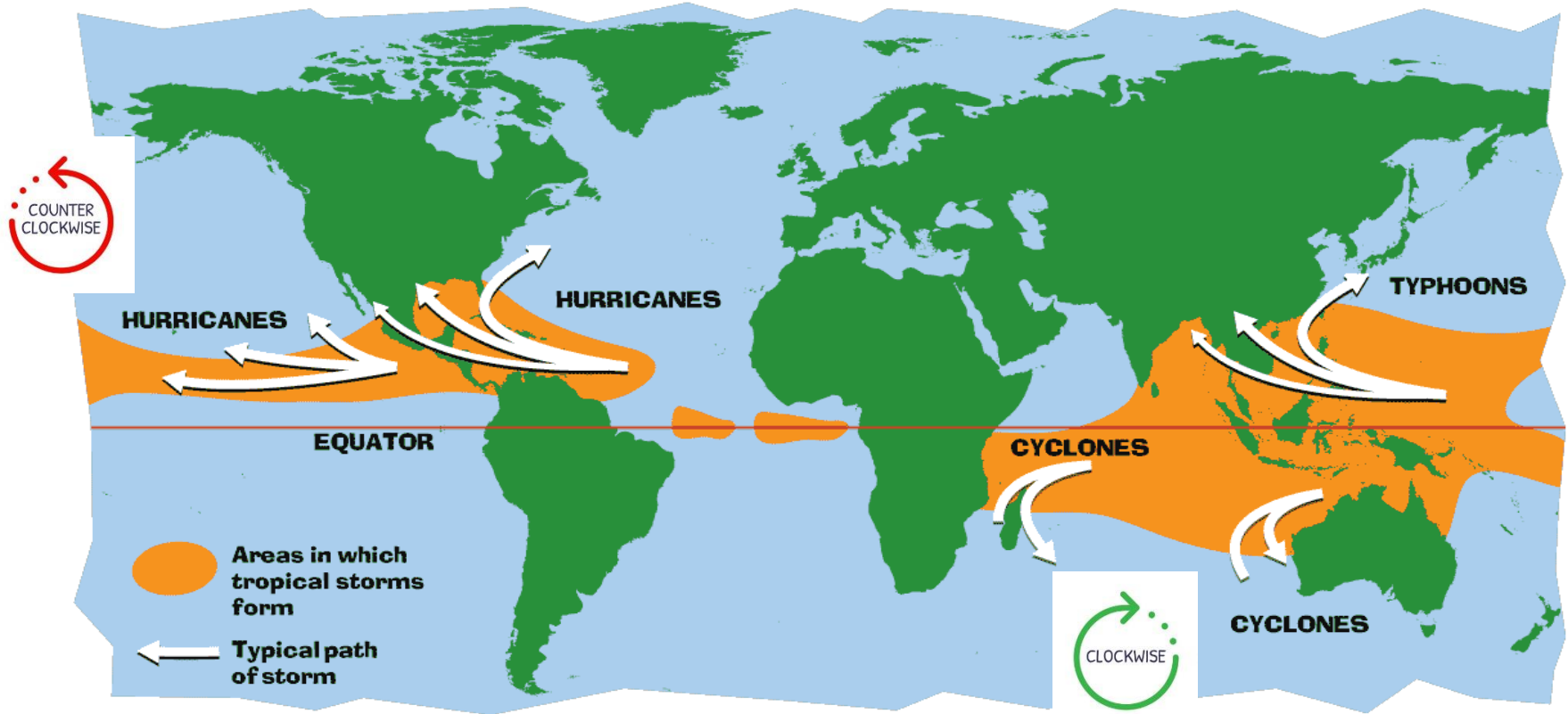


# Ingredients of a Cyclonic Storm



- **Warm water**  
(at least 26.5°C/  
79.7°F are needed  
down to a depth of  
at least 50 m/ 160 ft)
- **Time to grow**
- **Conditions  
to develop  
circulation**  
(location off equator)
- **Light upper  
level winds**  
(wind shear destroys  
thunderstorm  
organization)

# Formation and Typical Paths



The majority of cyclonic storms **form between 10 and 30 degrees** of latitude away of the equator:

- **87%** between **10-20 degrees north or south**,
- **rarely** form or move **within 5 degrees of the equator** where Coriolis effect (responsible for storm rotation) is low.



# Hurricane Structure

EYE WALL

Outflow

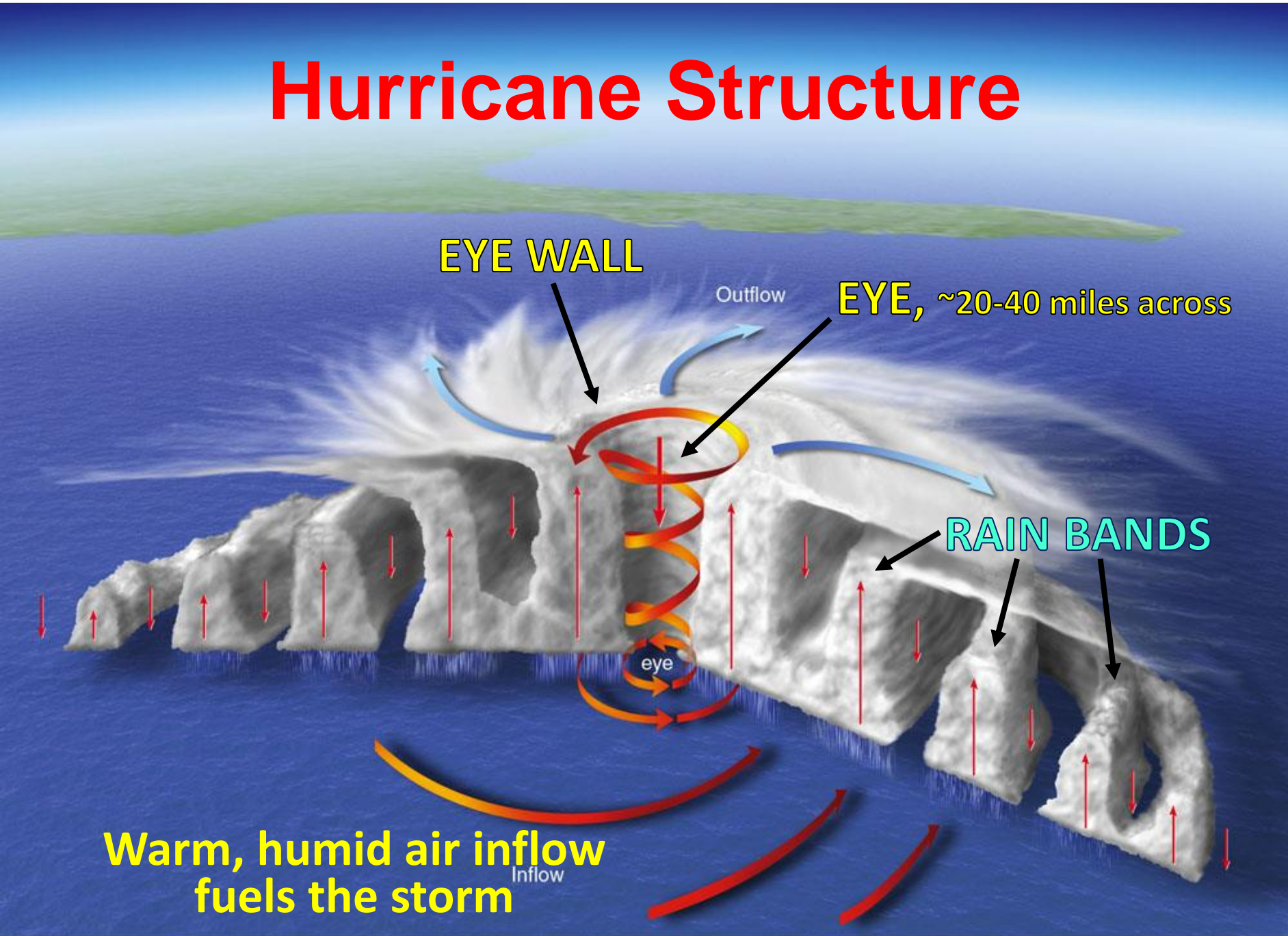
EYE, ~20-40 miles across

RAIN BANDS

Warm, humid air inflow  
fuels the storm

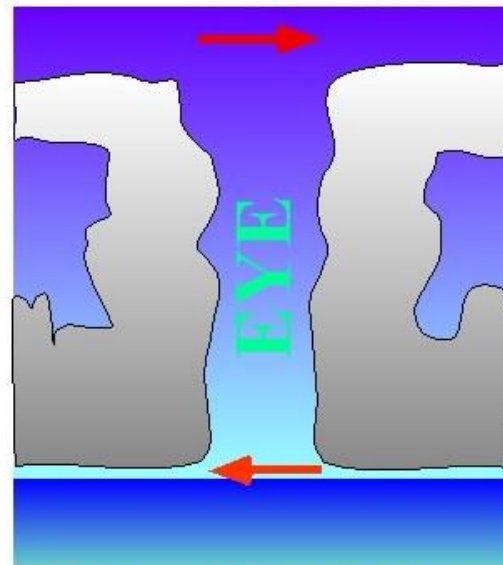
Inflow

eye

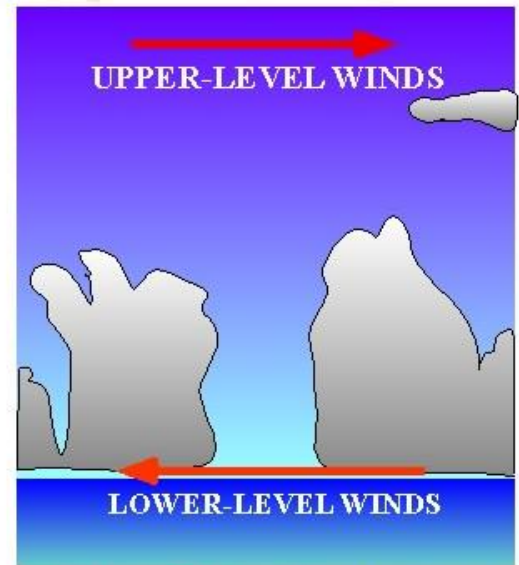


# What destroys a hurricane?

- Strong vertical wind shear causes convection and loss of vertical storm organization.
- Cold water (moving over waters significantly below 26.5 °C/79.7 °F).



WEAK SHEAR = FAVORABLE

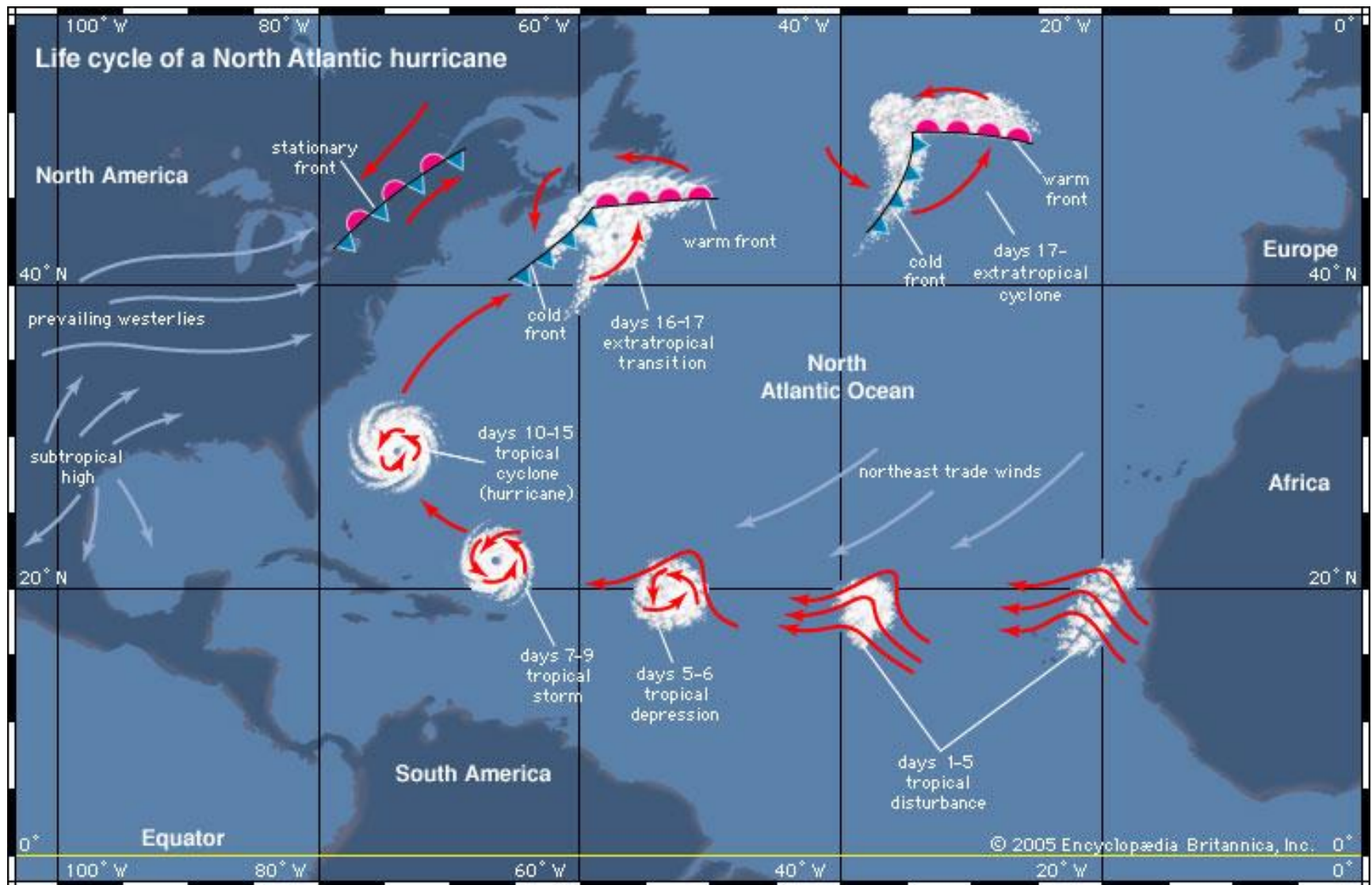


STRONG SHEAR = UNFAVORABLE



- Movement over land - most strong storms lose their strength very rapidly after **landfall** and become disorganized areas of low pressure within a day or two as a result of **friction** and **lack of moisture**.

# North Atlantic Hurricane Lifecycle

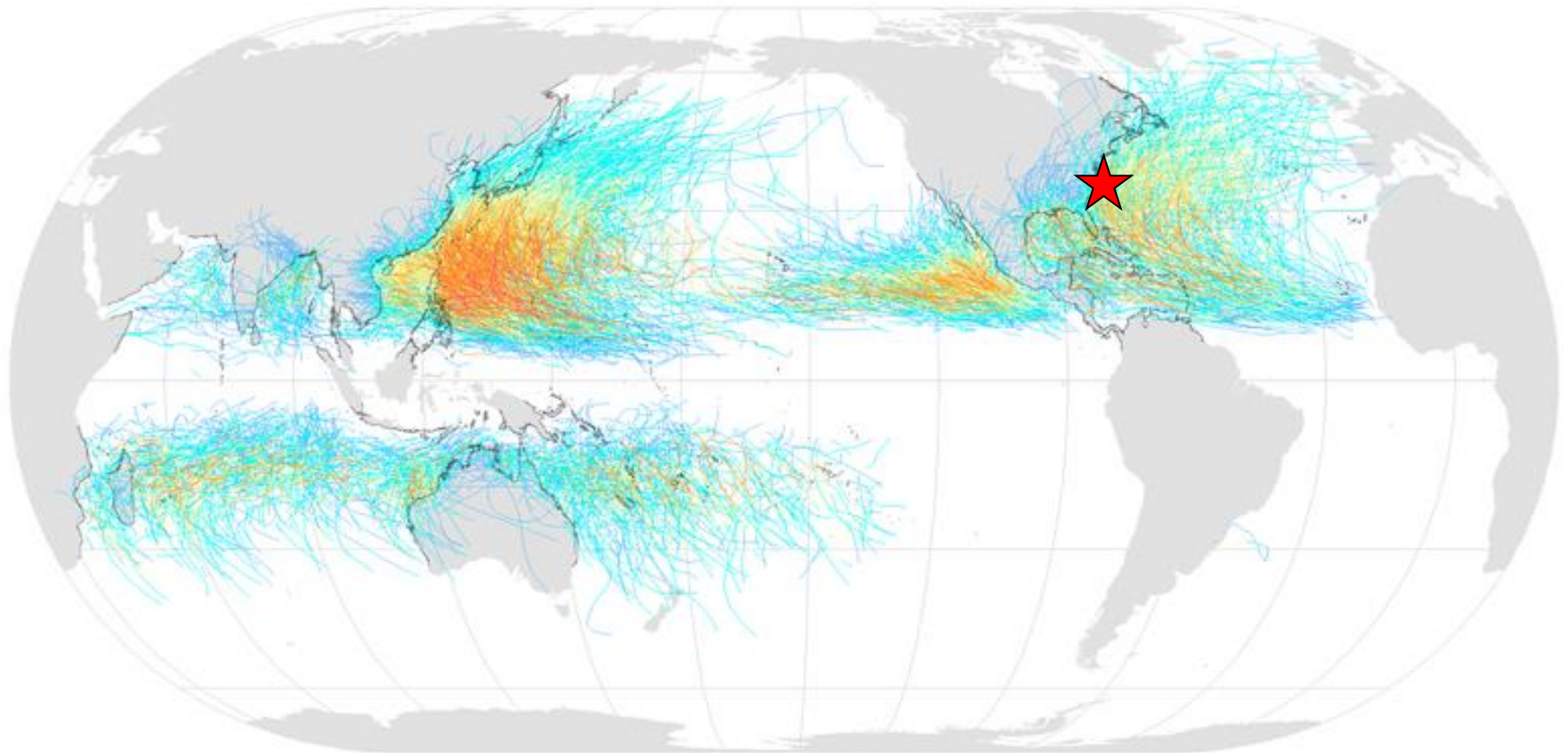


**North Atlantic hurricane season: June 1 to November 30.**



# Historical Data

## Tropical Cyclones, 1945–2006



Saffir-Simpson Hurricane Scale:

tropical  
depression

tropical  
storm

hurricane  
category 1

hurricane  
category 2

hurricane  
category 3

hurricane  
category 4

hurricane  
category 5

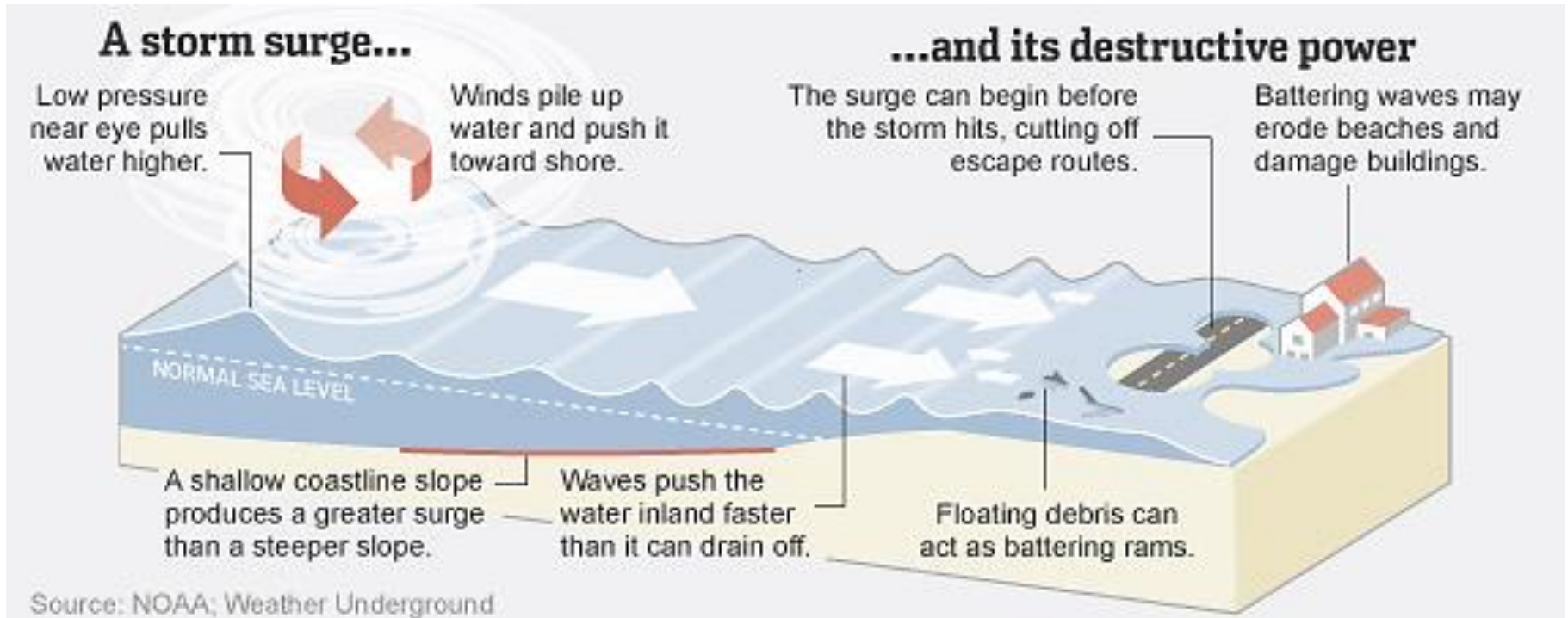
# Measuring Hurricane Strength

## Saffir-Simpson Hurricane Scale

Category	Wind speed (mph)	Storm surge (feet)
5	156+	More than 18
4	131–155	13–18
3	111–130	9–12
2	96–110	6–8
1	74–95	4–5
Additional classifications		
Tropical storm	39–73	0–3
Tropical depression	0–38	0

# What is Storm Surge?

Storm surge is an abnormal rise of water generated by a storm, **over and above** the predicted **astronomical tides**.

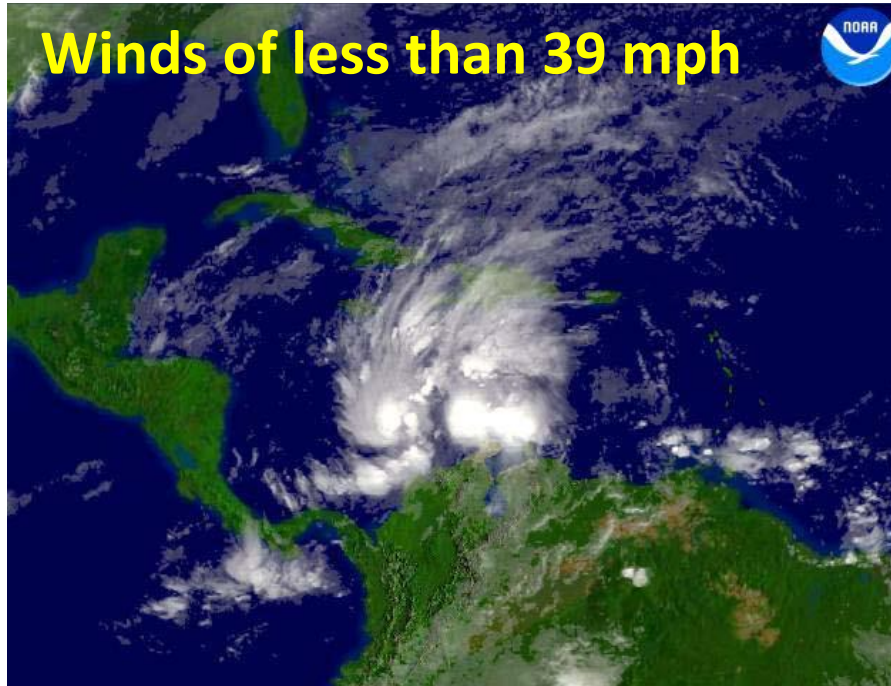


Important factors: storm **intensity** (wind speed) and size, **forward speed**, **angle of approach** to the coast, central pressure (minimal contribution in comparison to the wind), the **coastline shape and bathymetry**.



# Stages of Hurricane Development

## 1. Tropical Depression (Wave)



**Lacks structure** – no well developed feeder bands or eye.

**Not given a name yet.**

## 2. Tropical Storm



**Feeder bands** are beginning to develop. Eye and eye wall still not well formed.

In the Atlantic, storms are **given a name** at that stage.

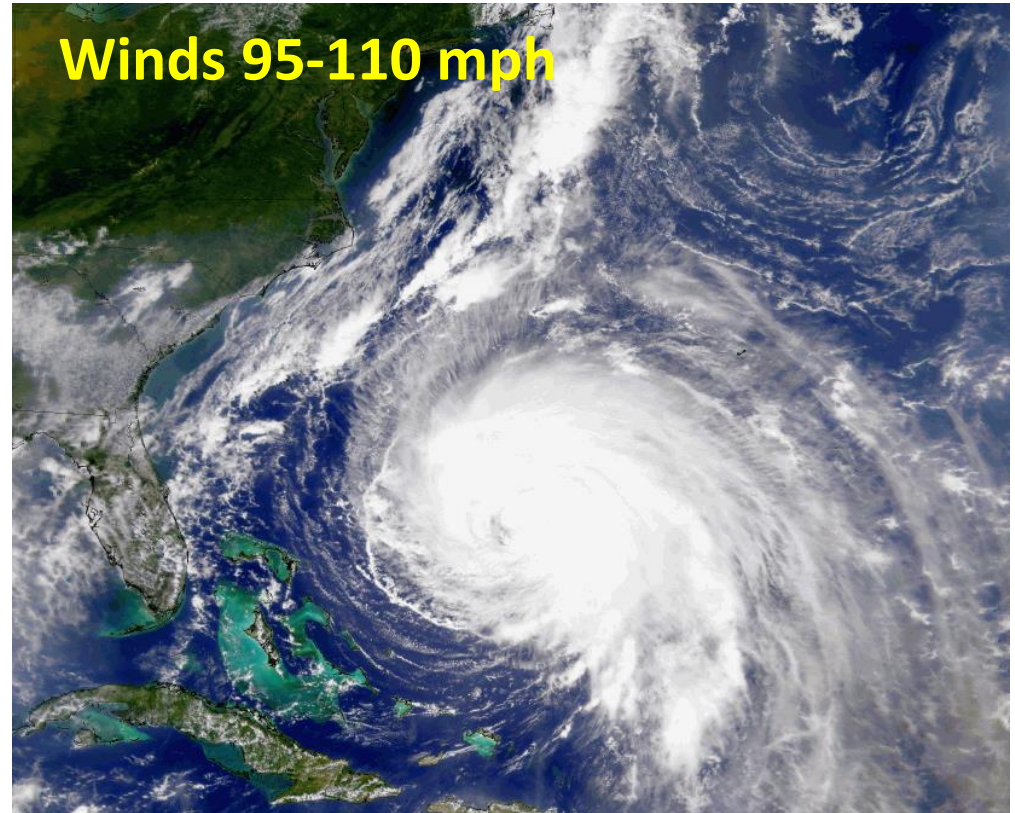
# Stages of Hurricane Development

## 3. Category 1 Hurricane



Well developed feeder bands. An **eye** begins to form.

## 4. Category 2 Hurricane

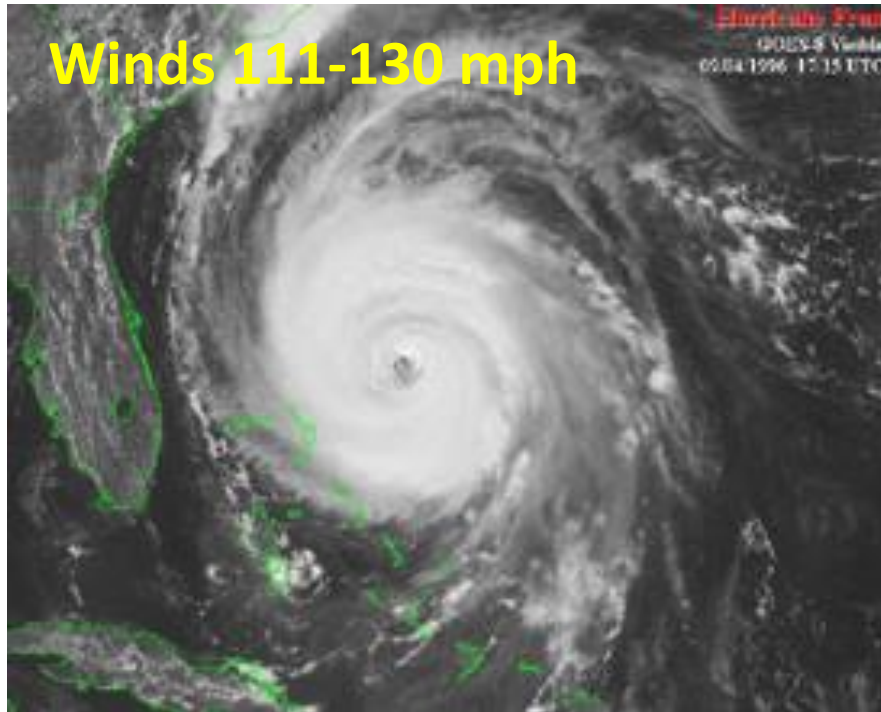


An **eye and eye wall** are usually very well formed.  
Storm is tightening around center.



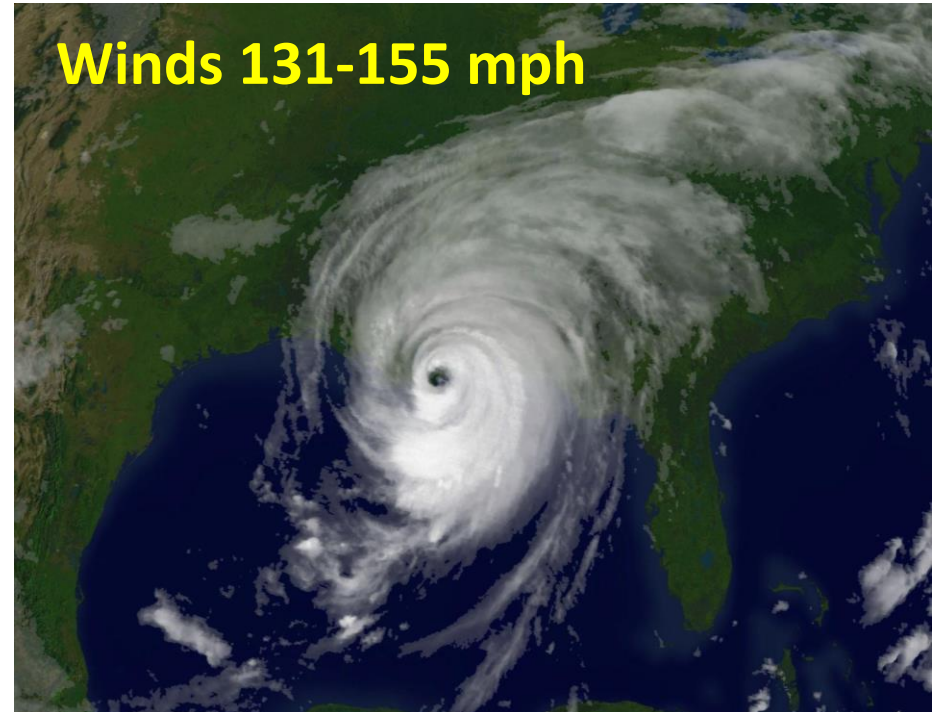
# Stages of Hurricane Development

## 5. Category 3 Hurricane



Now a **“Major Storm”**.  
**Intense flooding and building damage** will occur to most areas on the coast. Further inland, the damage will still be substantial.

## 6. Category 4 Hurricane

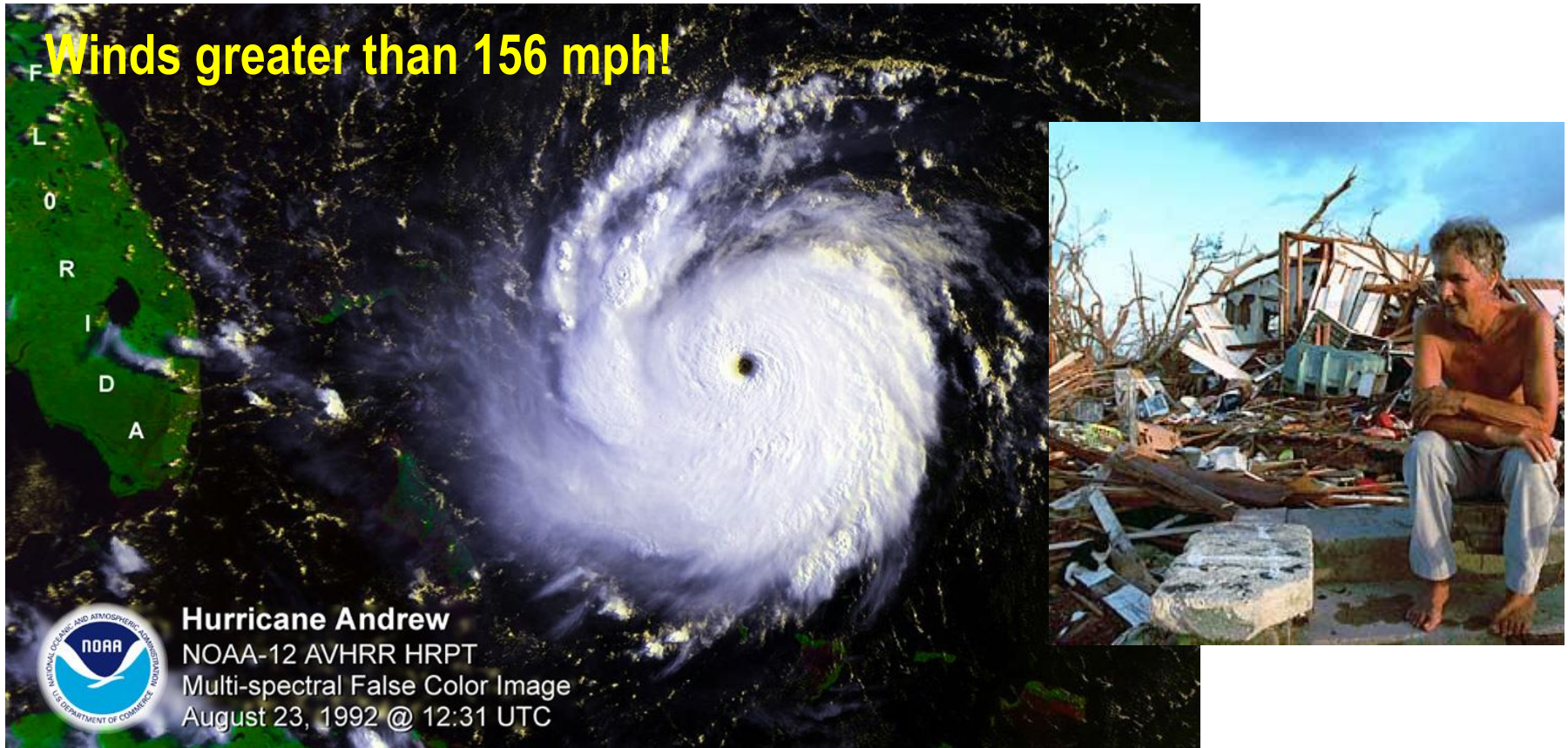


All shrubs, signs and trees blown down. **Extensive damage** to doors and windows.  
**Major damage** to lower floors of structures near the coast **due to storm surge**.



# Stages of Hurricane Development

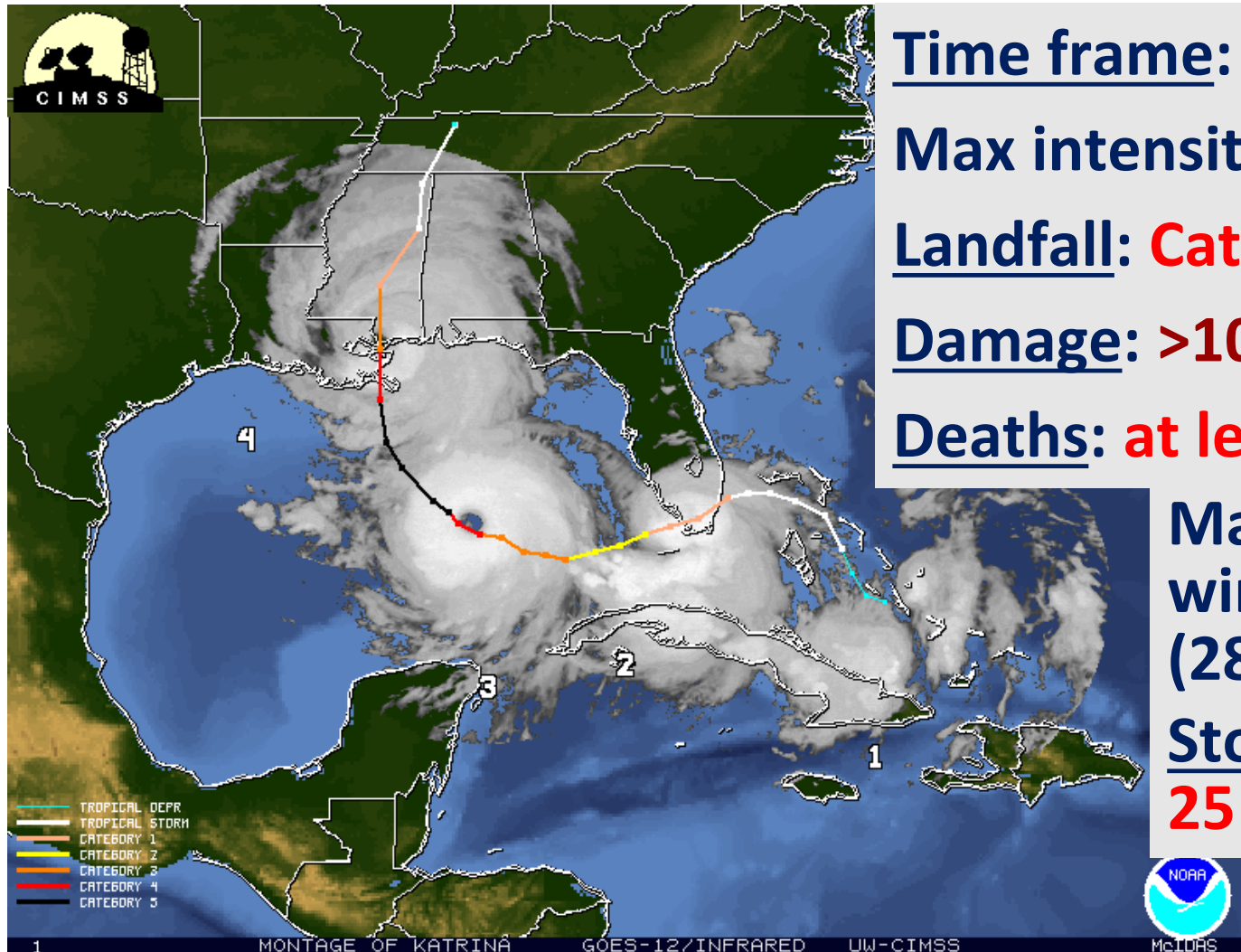
## Stage 7 – Category 5 Hurricane



**Complete roof failure** on many residential and industrial buildings. Some **complete building failures**. Massive evacuation of residential areas on low ground (5-10 miles).

# Hurricane Katrina, 2005

the **costliest** hurricane ever recorded in the Atlantic



Time frame: **August 23-31**

Max intensity: **Category 5**

Landfall: **Category 3**

Damage: **>100 billion USD**

Deaths: **at least 1,833**

Max sustained winds: **175 mph**  
(280 km/h)

Storm surge:  
**25 to 28 feet**