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Agricultural Outlook Forum Presented: February 17, 2006

THE SCIENCE BEHIND THE ATLANTIC HURRICANES AND SEASONAL PREDICTIONS

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The Science Behind Atlantic Hurricanes and Seasonal Predictions

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Outline

1. Background
2. NOAA's seasonal hurricane outlooks
3. Measuring seasonal activity
4. Recipe for hurricane formation
5. Climate patterns controlling hurricane extremes
6. Landfalling U.S. hurricanes
7. Summary

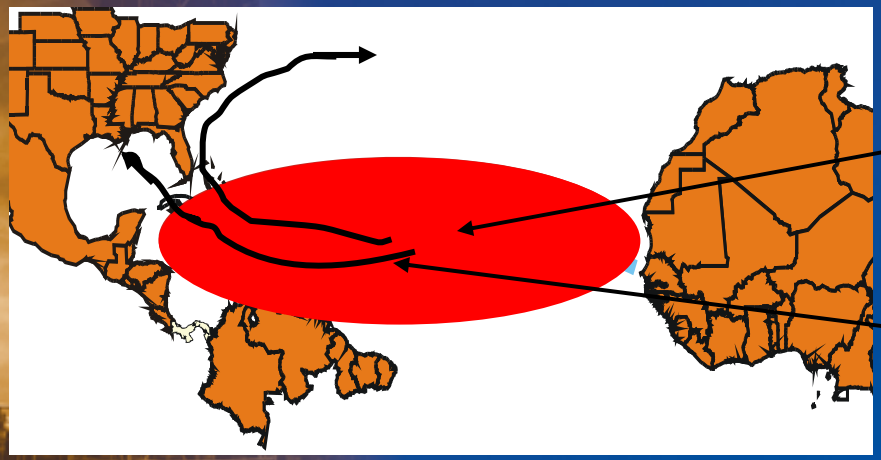
Background

The Atlantic hurricane season runs from June through November.

Most activity occurs during the August-October.

Strong climate control during this period makes seasonal activity very predictable.

Seasonal hurricane forecasts primarily reflect expected activity during August-October.

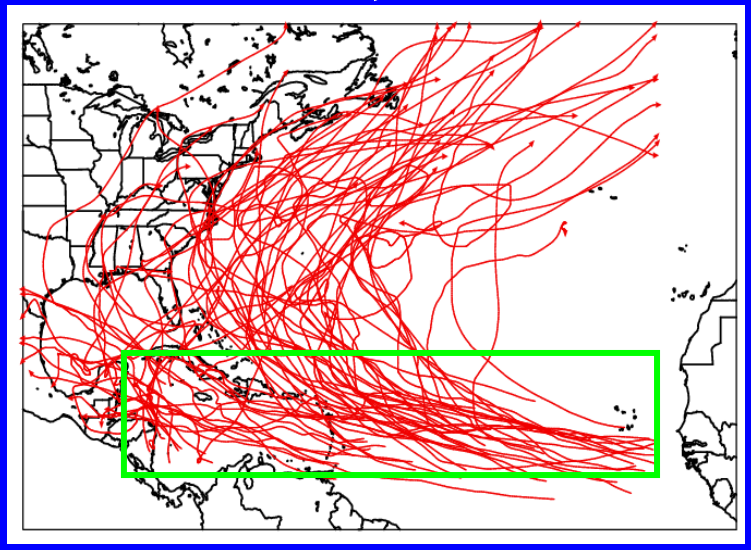


Main tropical storm and hurricane formation region during active seasons.

Common hurricane tracks

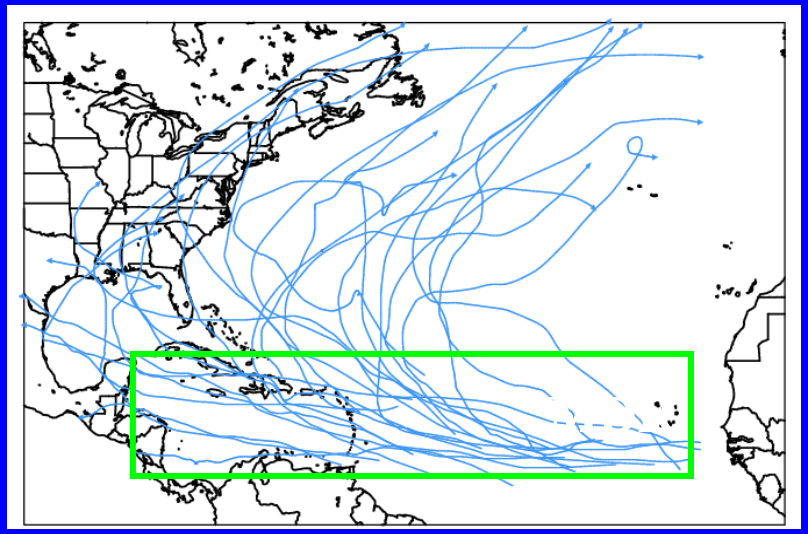
Major Hurricane Tracks

Active 24-Year Period
1955-1970, 1995-2002



67 Major Hurricanes

Inactive 24-Year Period
1971-1994



27 Major Hurricanes

The U.S. averages 2-3 hurricane strikes in an above-normal season, compared to just one in a below-normal season.

NOAA's Seasonal Hurricane Outlooks

- Began in August 1998
- Issued in mid-to-late May and early August
- Seasonal Forecasts are highly confident, but limited to what the predictable climate patterns tell us.

- August 2005 outlook called for near-record activity.

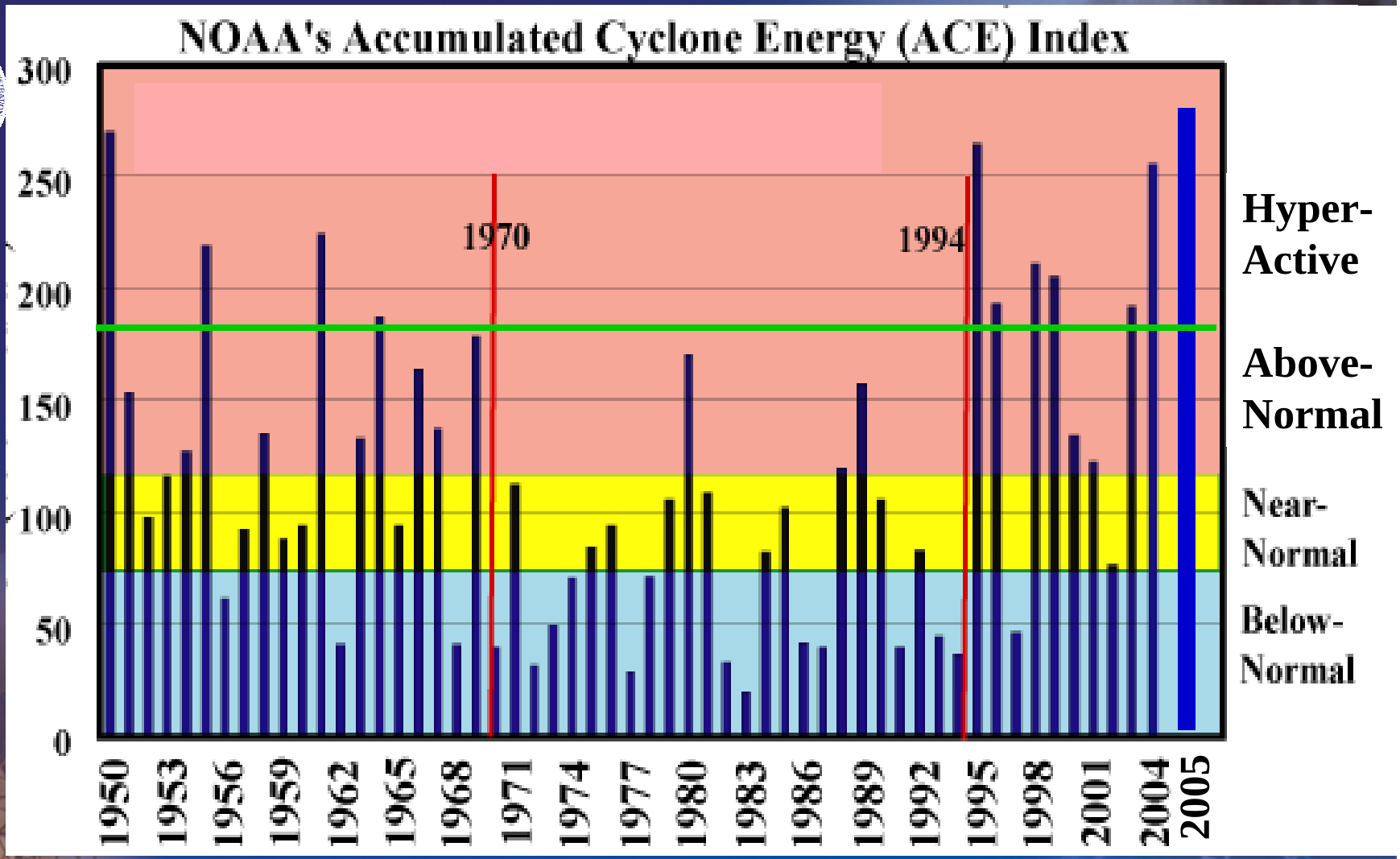
	2 August 2005 Outlook	Observed	Normal
Chance Above Normal	95%-100%		
Tropical Storms	18-21	27 (Record)	10-11
Hurricanes	9-11	15 (Record)	6
Major Hurricanes	5-7	7	2

ACE Index

- **Classifying hurricane seasons is challenging**
  # TS, #H, # MH, # landfalling storms, etc.

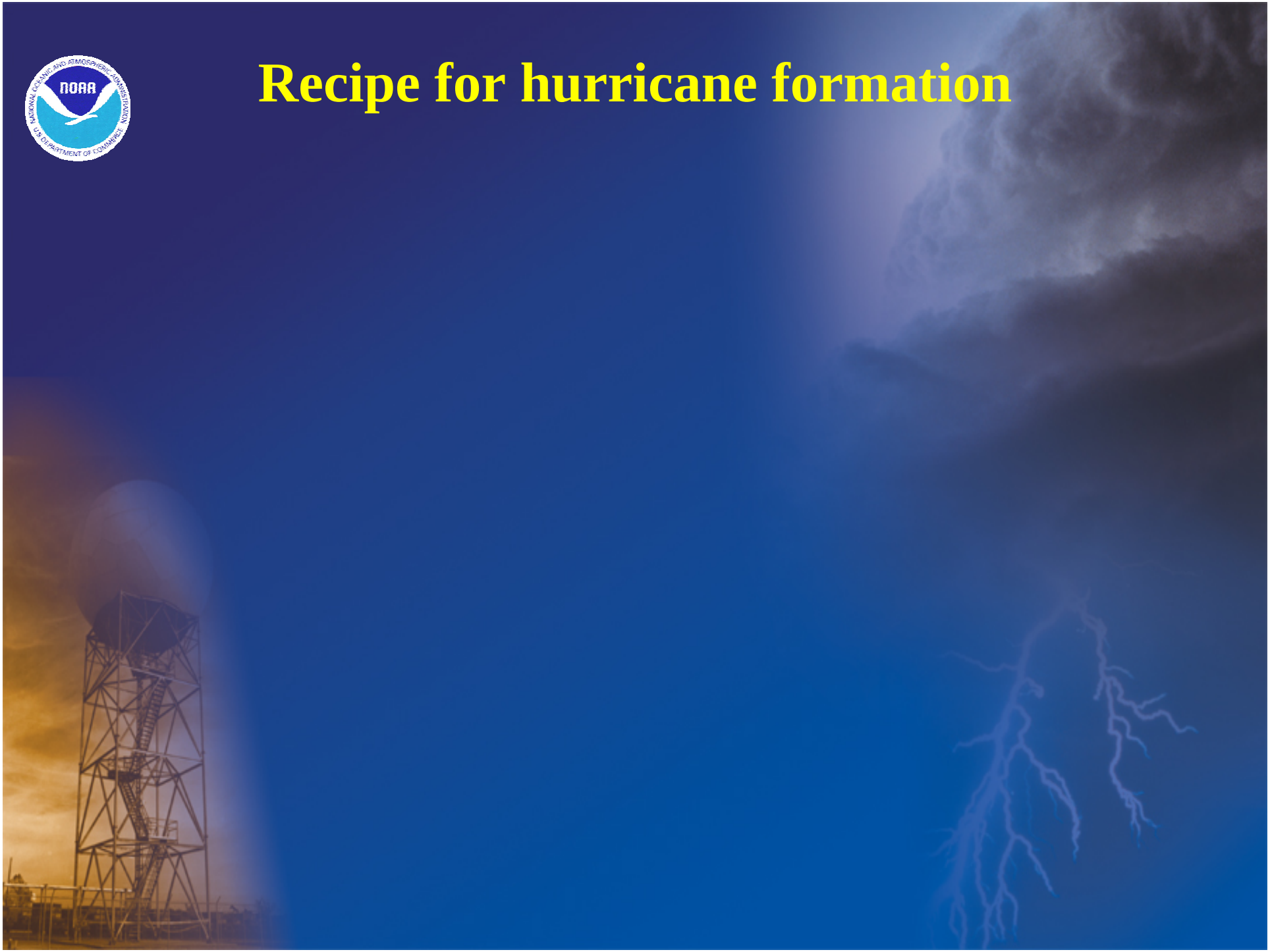
- **NOAA's seasonal Accumulated Cyclone Energy (ACE) index accounts for the combined intensity, numbers, and duration of named storms.**

- **ACE index is widely accepted measure of seasonal activity, allows easy identification of active and inactive hurricane eras**

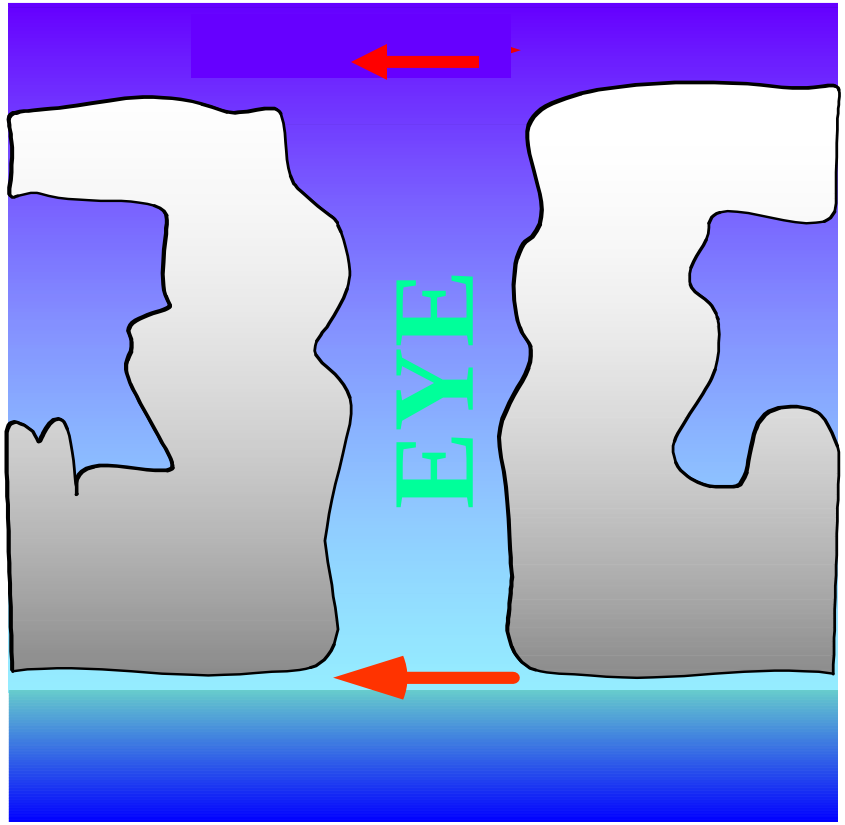


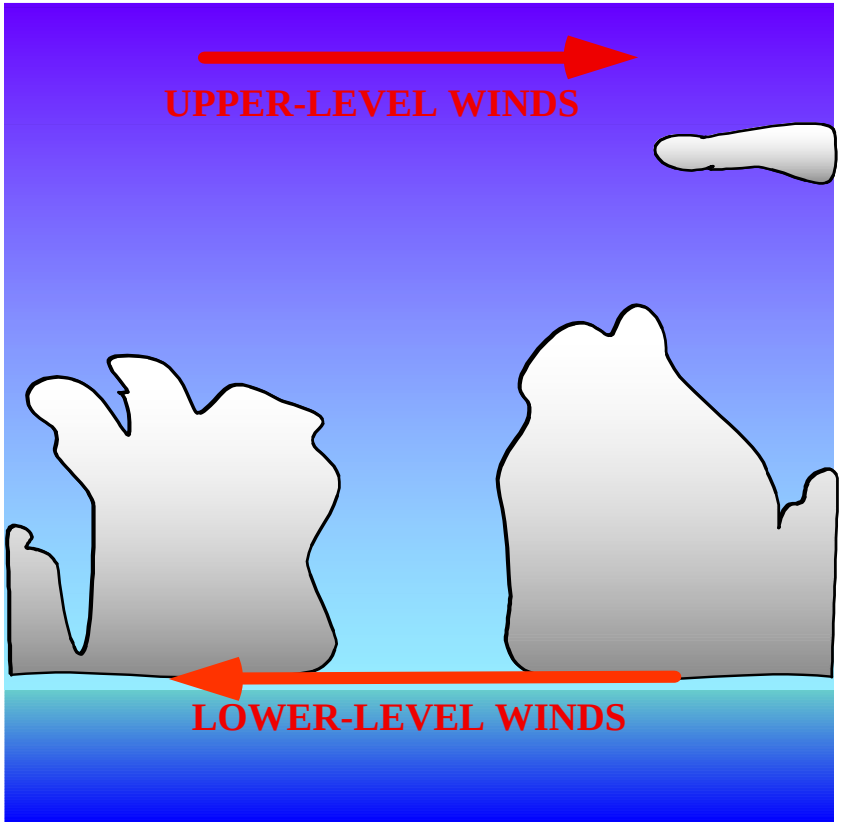
- Alternating 20-40 year periods of active / inactive seasons
- Nine of last 11 years have been active compared to only three active years during 1970-1994 (25 years).
- 1950s-1960 were also an active era (~1930s-1960s).

Recipe for hurricane formation

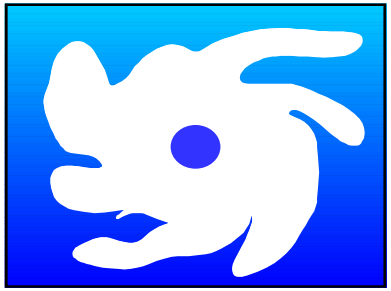


Not too much "Wind Shear"

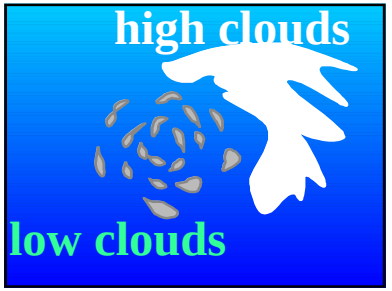




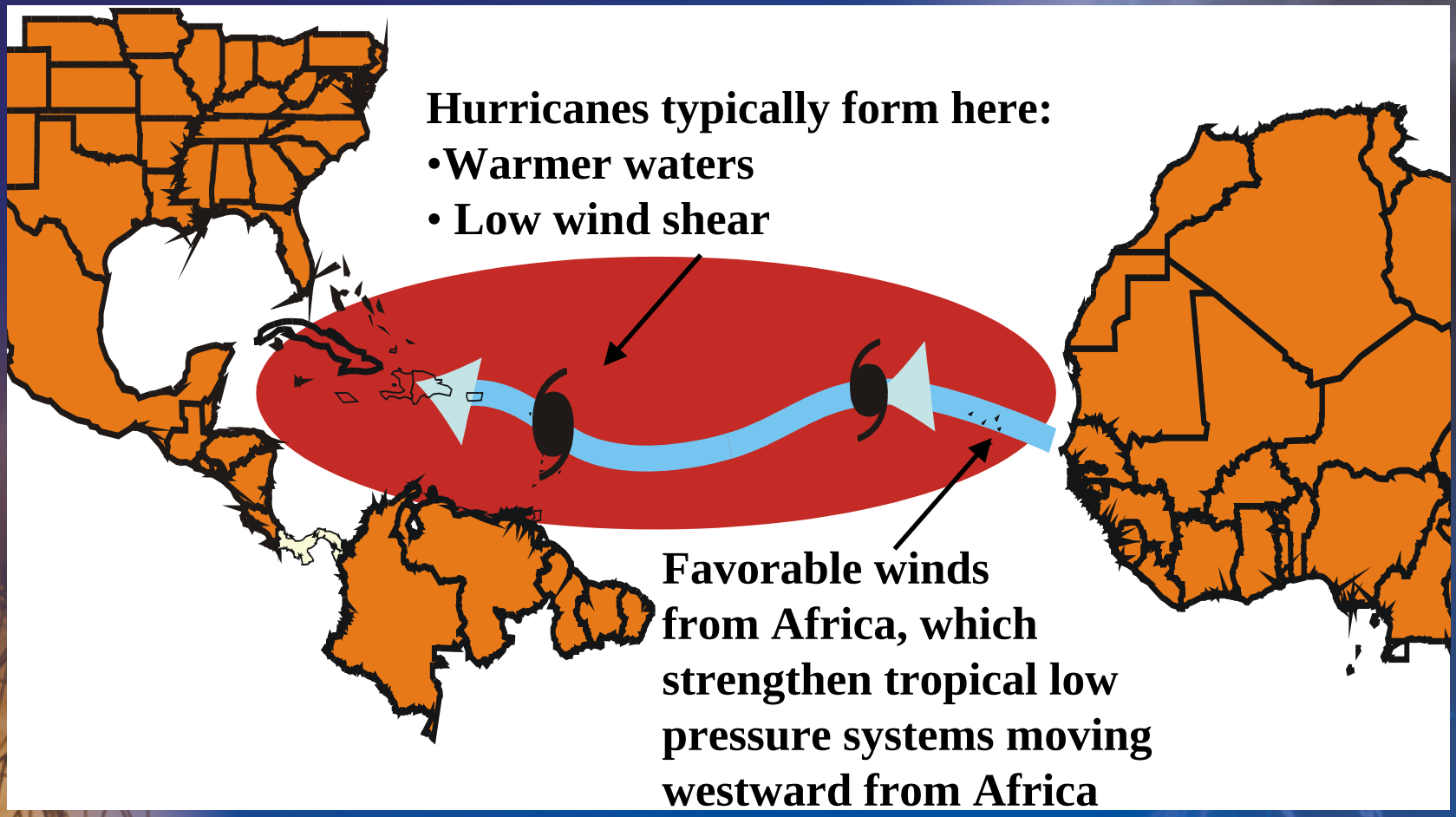
WEAK **SHEAR = FAVORABLE**



STRONG **SHEAR =** ***UN*** **FAVORABLE**



Underlying Conditions
Active Hurricane Era 1995 - 2005



Low wind shear, favorable winds from Africa, and warm ocean waters are essential ingredients of an active season.

Understanding Seasonal Hurricane Activity

Active/ Inactive seasons and decades result from a coherent set of atmospheric and oceanic conditions.

They are NOT random events, nor are they determined by a single factor such as warmer ocean waters.

These conditions mainly occur in response to recurring rainfall patterns along the equator, which are strongly controlled by two dominant climate phenomena.

Climate Phenomena Controlling Seasonal Hurricane Activity

1. The El Niño/ Southern Oscillation (El Niño and La Niña): Influence individual seasons. El Niño suppresses activity, La Niña enhances it.

2. Multi-decadal (approximately 20-40 year) cycles in monsoon rains over western Africa and the Amazon Basin, and in North Atlantic ocean temperatures. These cycles are by far the dominant cause of the alternating 20-40 year periods of active/ inactive hurricane seasons.

- NOAA's seasonal hurricane outlooks are based on analysis and prediction of these two climate phenomena.

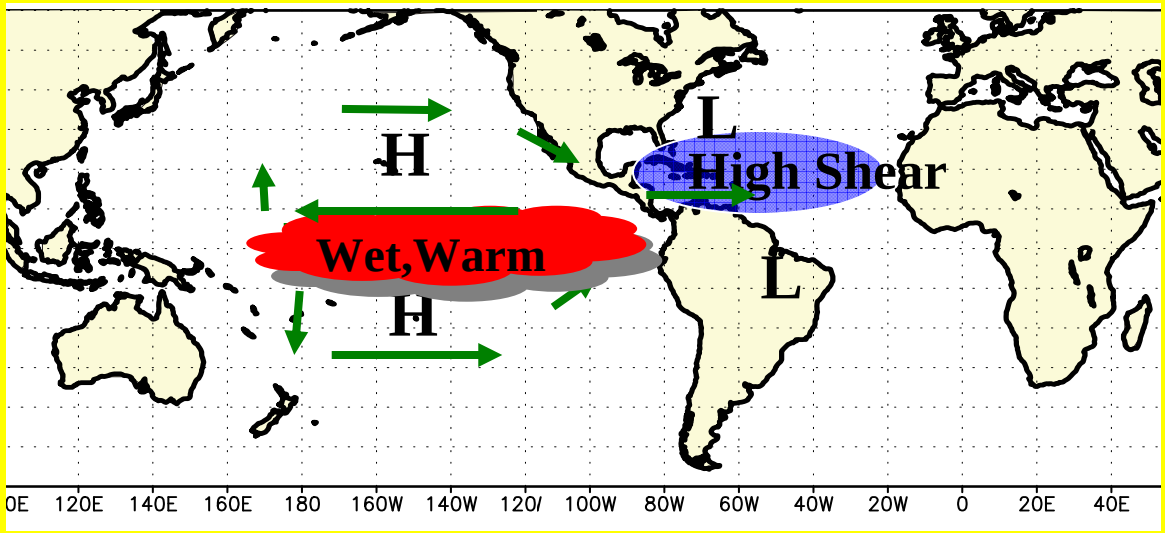
Greenhouse (GH) Warming

- There is incomplete and inconsistent science regarding influence of GH warming on hurricanes.
- Some recent studies suggest GH gases might be increasing hurricane strength by warming the ocean temperatures. Others, indicate the impact on Atlantic hurricanes is likely very small or undetectable at this time because the multi-decadal signal is so overwhelmingly large.
- Regardless, policy makers should not interpret this as an excuse to do nothing. GH warming is a very important global climate issue whether or not it is affecting hurricanes now.

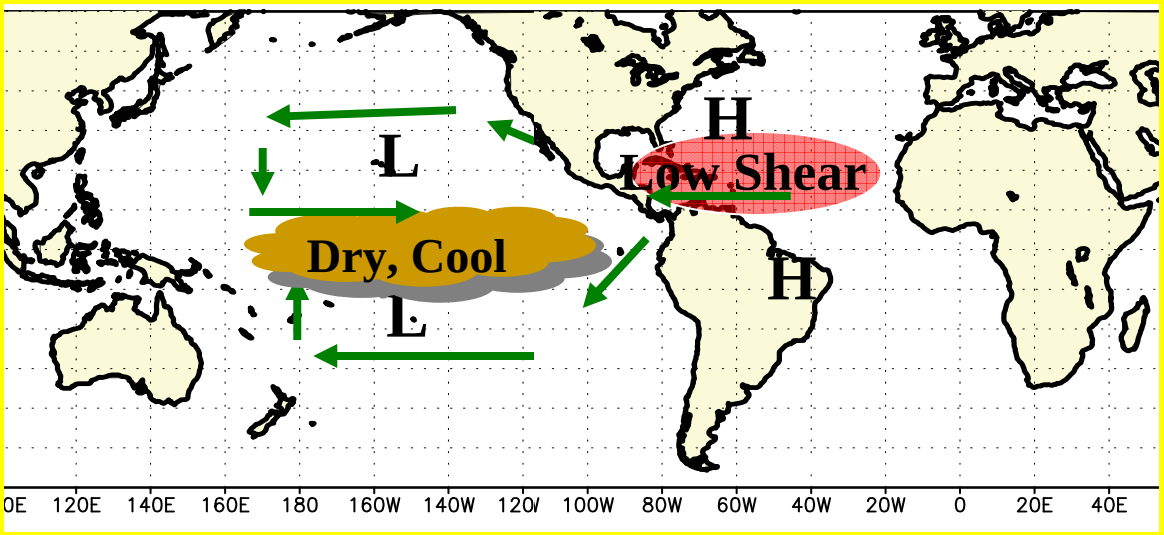
The El Niño/ La Niña Cycle

Pacific Ocean Temperatures, Rainfall, Winds at 40,000 feet

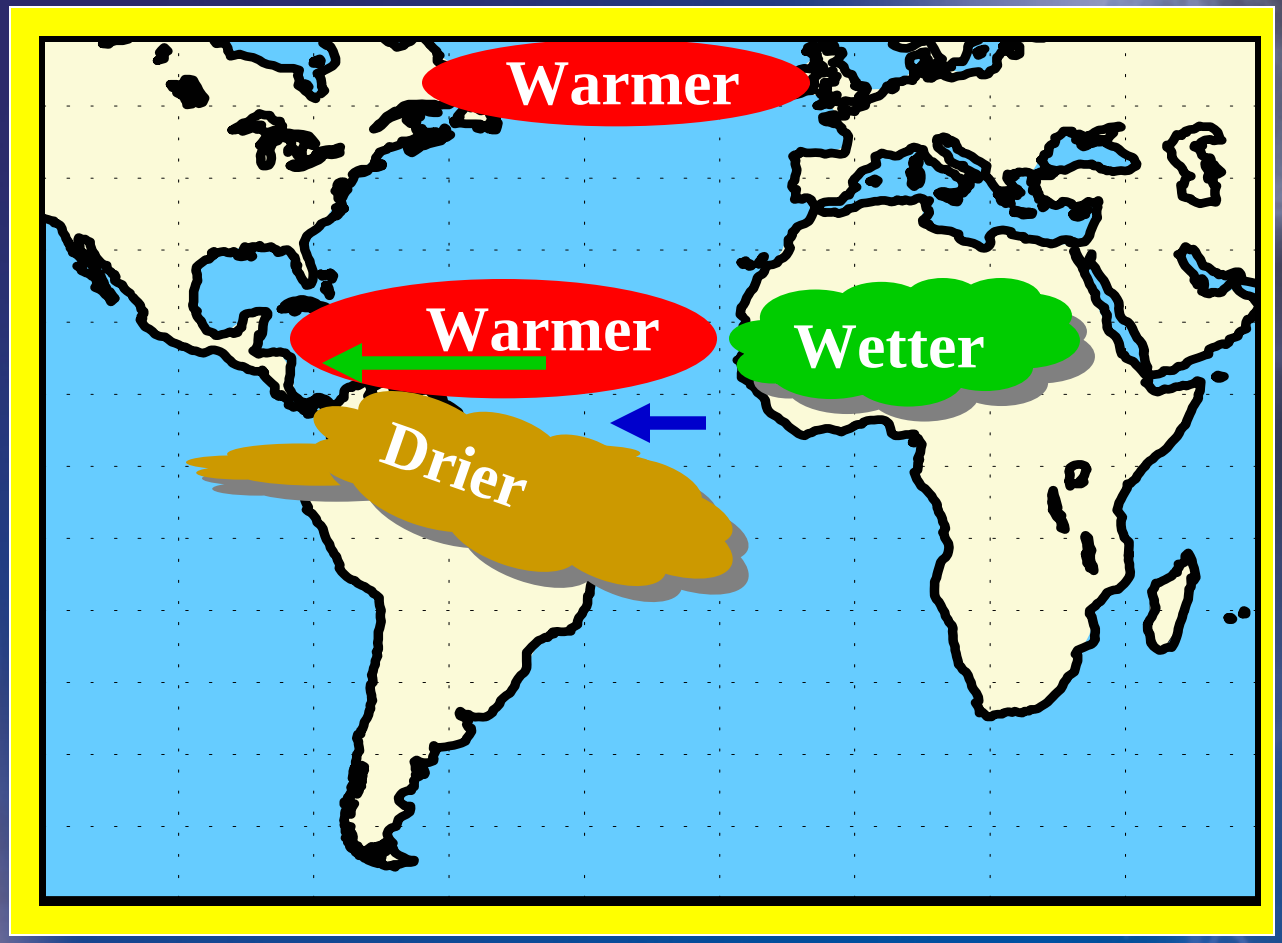
El Niño: Less Atlantic Hurricanes



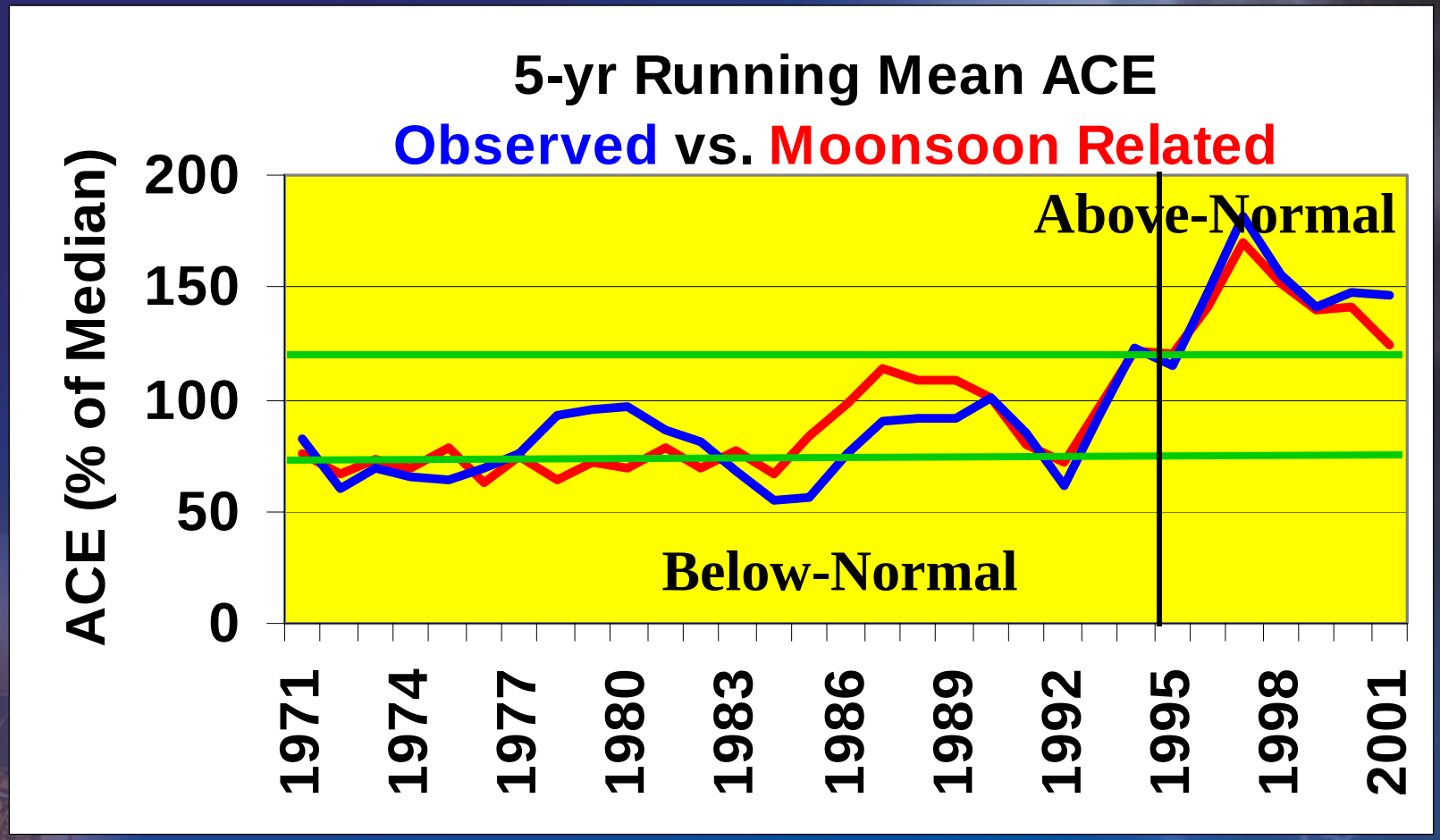
La Niña: More Atlantic Hurricanes



Underlying Climate Pattern for Active Atlantic Hurricane Era

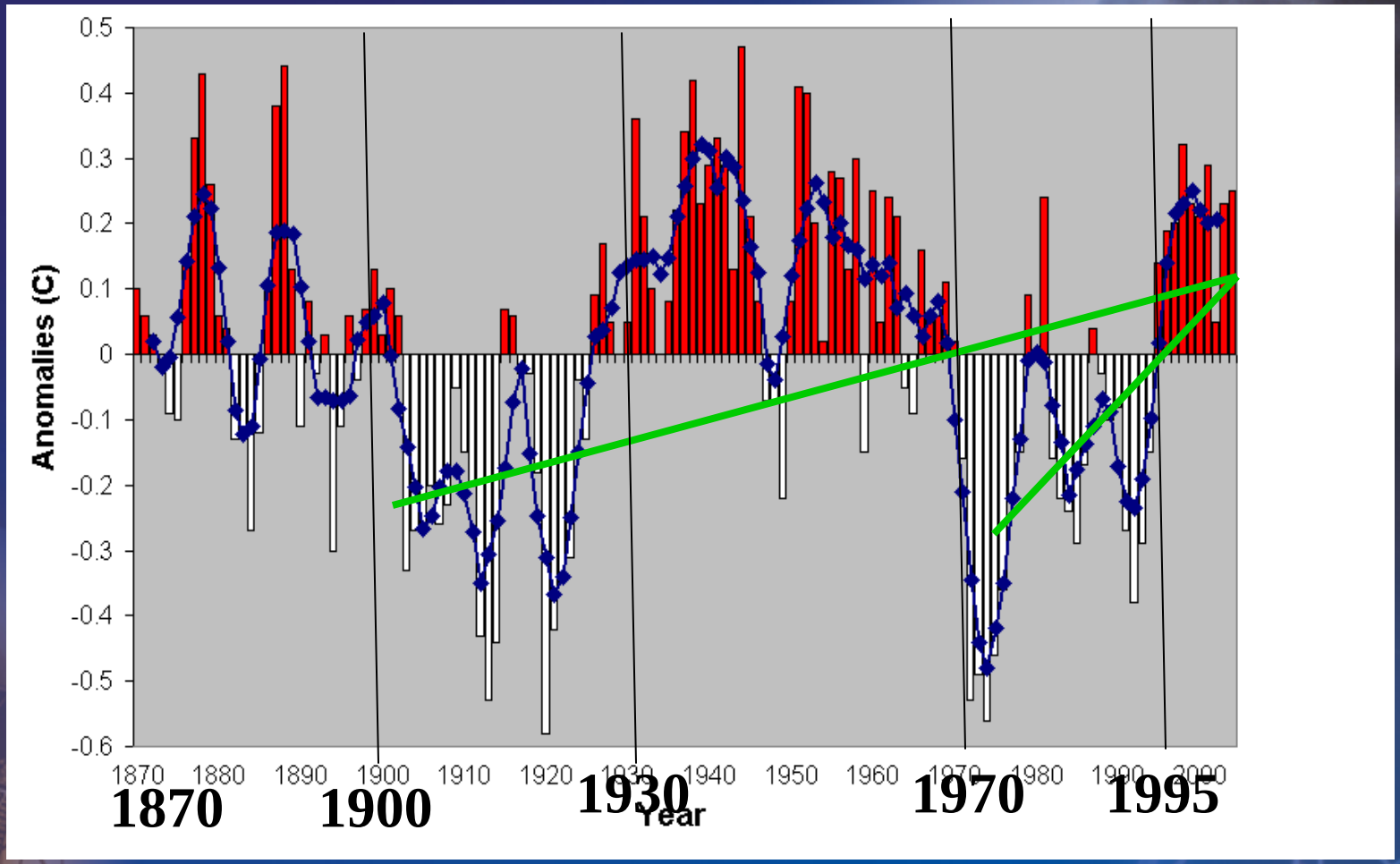


Tropical rainfall (monsoon) patterns strongly control winds, wind shear, and ocean temperatures across the tropical Atlantic. Expanded upper-level easterlies (green arrow) and weaker trade winds (blue arrow) produce low wind shear.



Changes in the West African and Amazon Basin monsoons produced the recent transition to an active hurricane era.

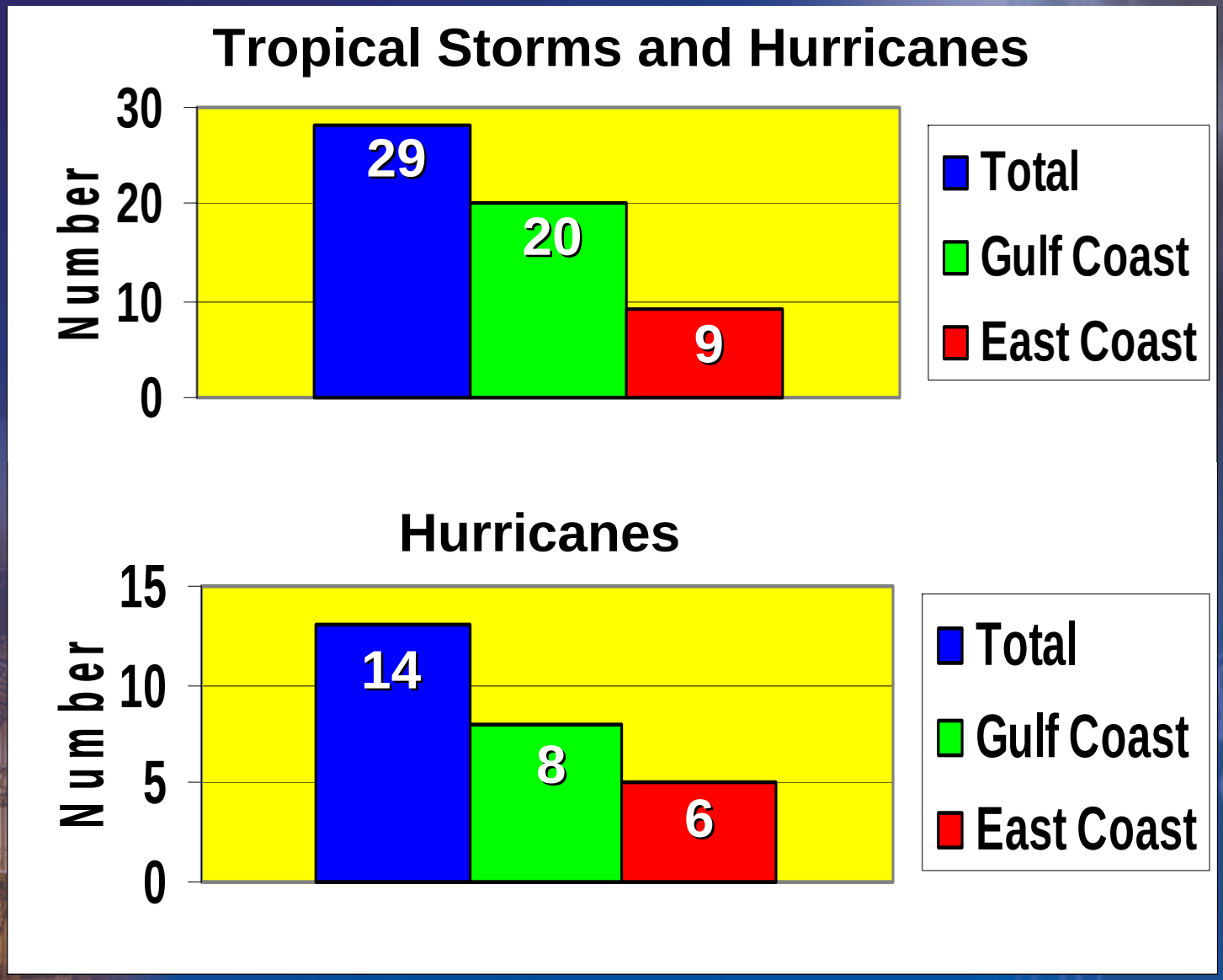
Atlantic Sea Surface Temperature Departures (°C)



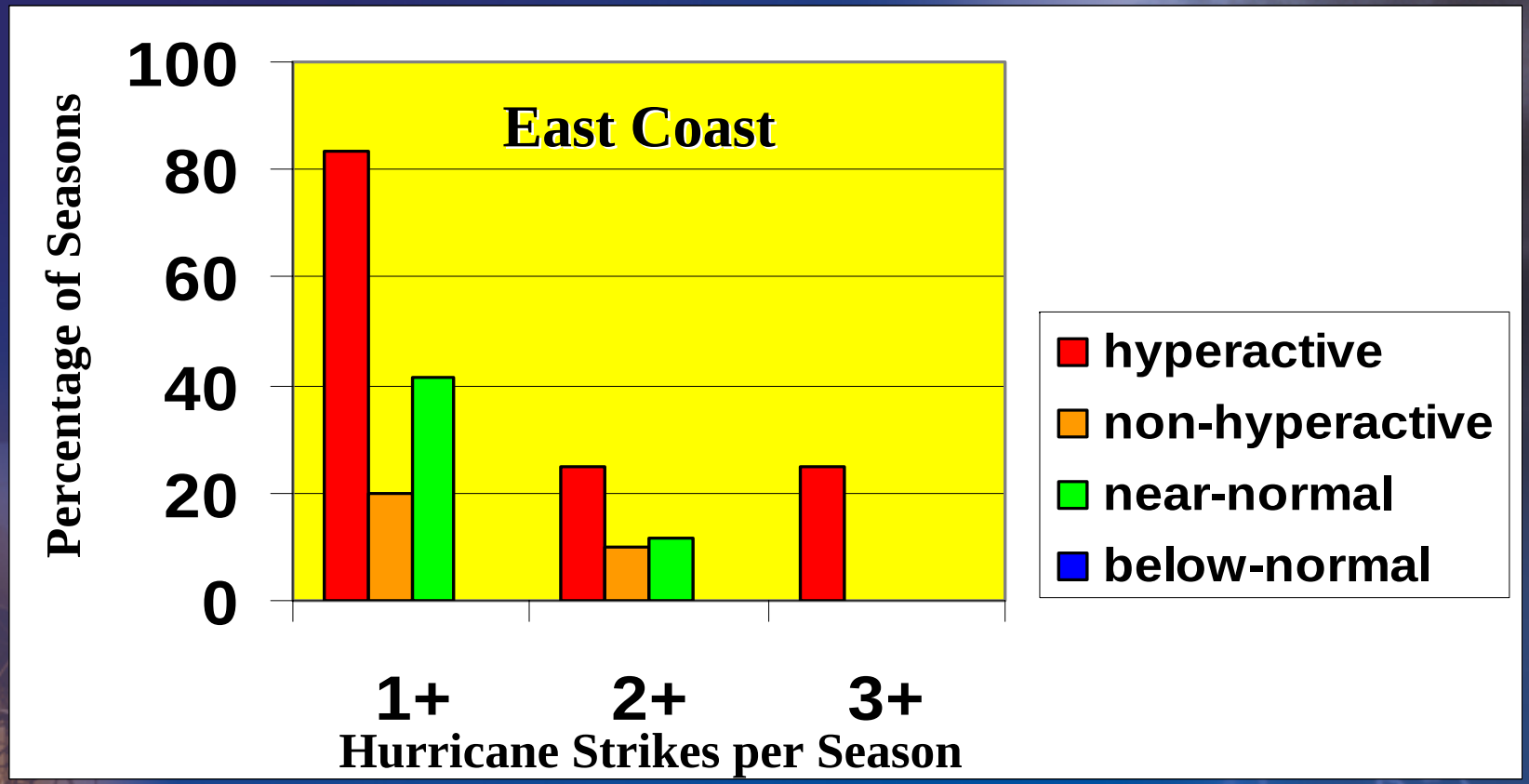
Strong multi-decadal fluctuations in Atlantic temperatures dating back to the 1870's.

Trend lines (green) can be extremely deceptive.

U.S. Landfalls: 2002-2005



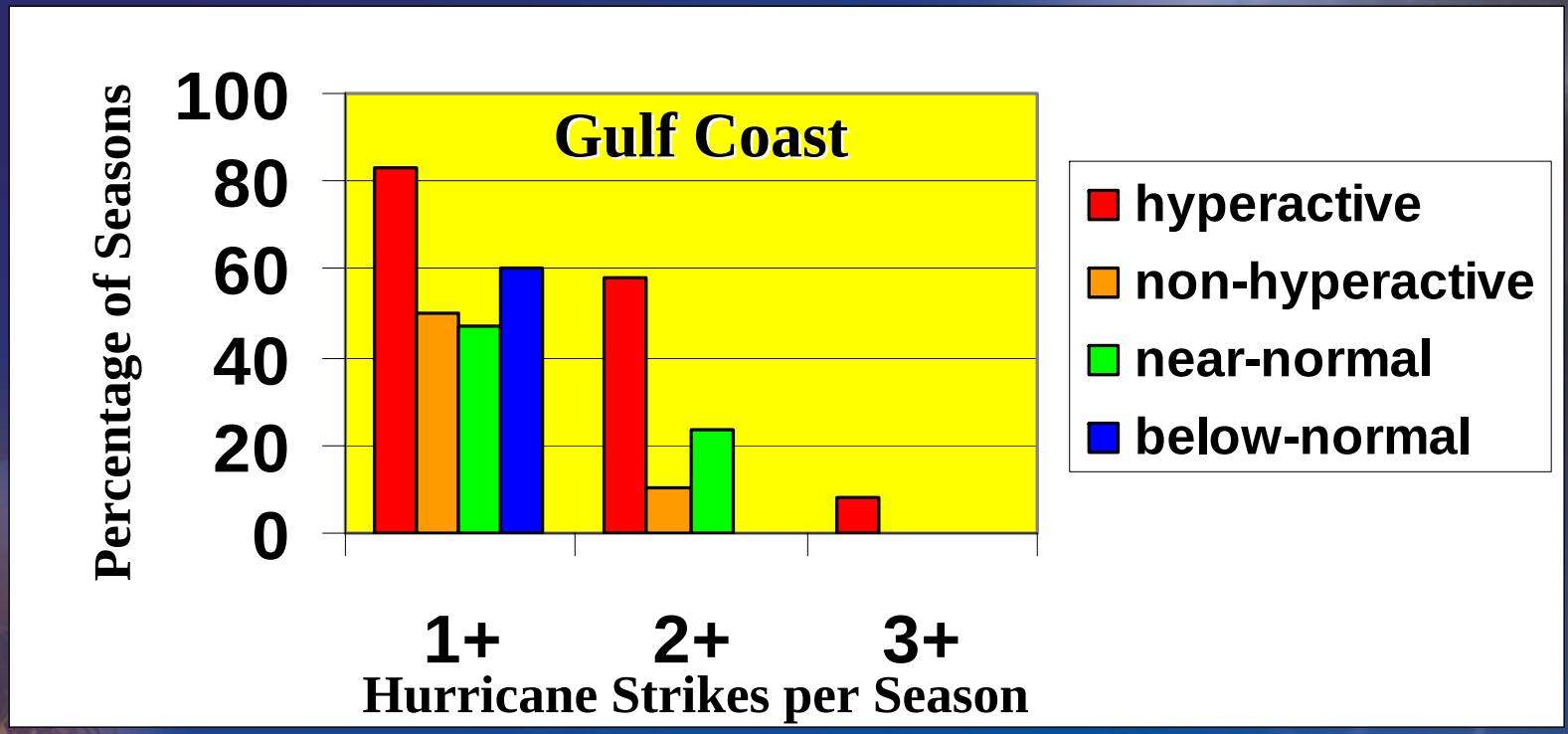
Percentage of Seasons with East Coast Landfalling Hurricanes



East-Coast hurricanes and multiple-strike seasons are skewed toward the hyperactive seasons.

No East Coast landfalls during below-normal seasons

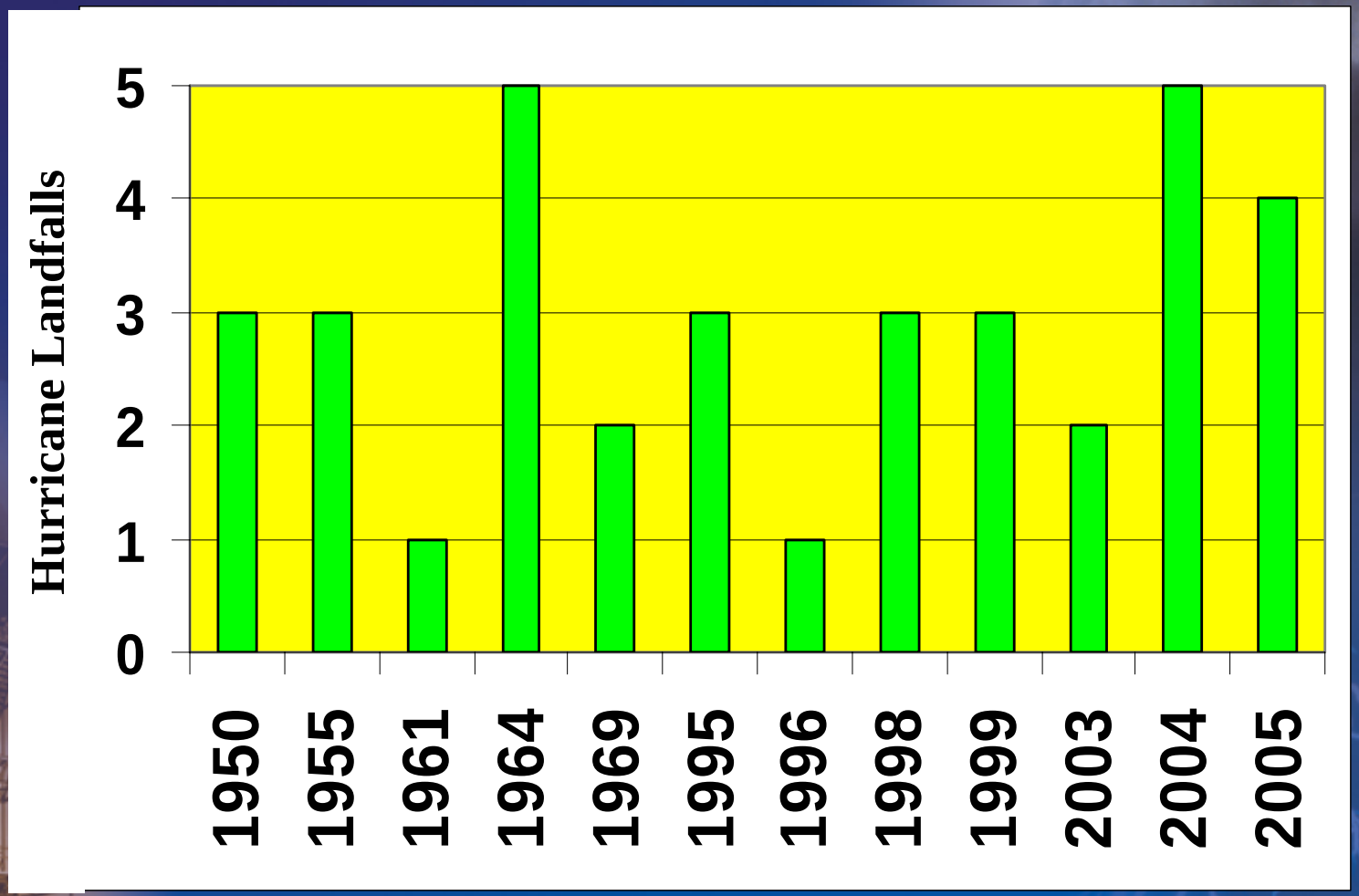
Percentage of Seasons With Gulf Coast Landfalling Hurricanes



Gulf-Coast: hurricane strikes and multiple-hit seasons also skewed toward the hyperactive seasons.

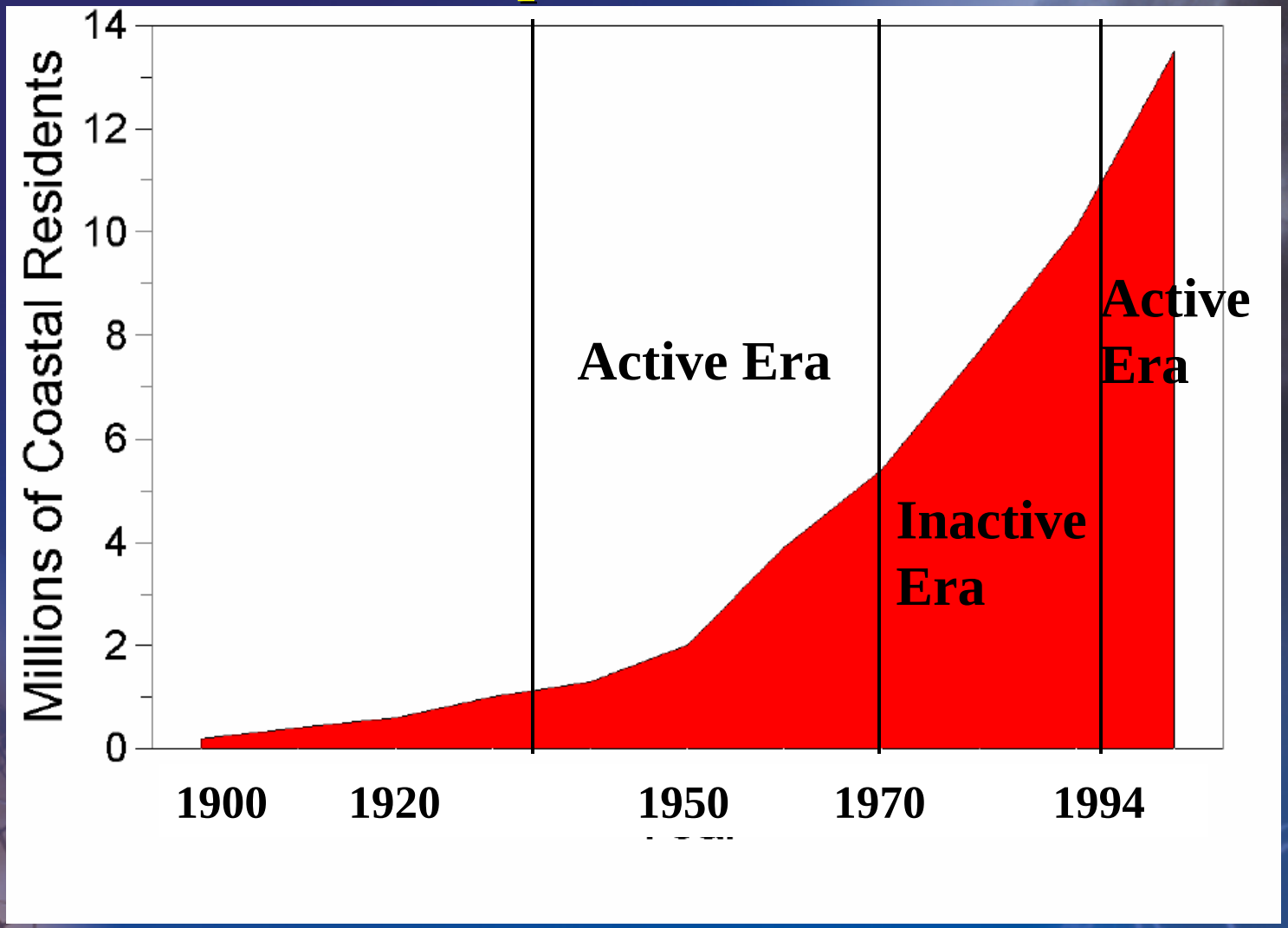
60% of below-normal seasons have a Gulf Coast strike.

U.S. Seasonal Hurricane Landfalls During Hyper-Active Years



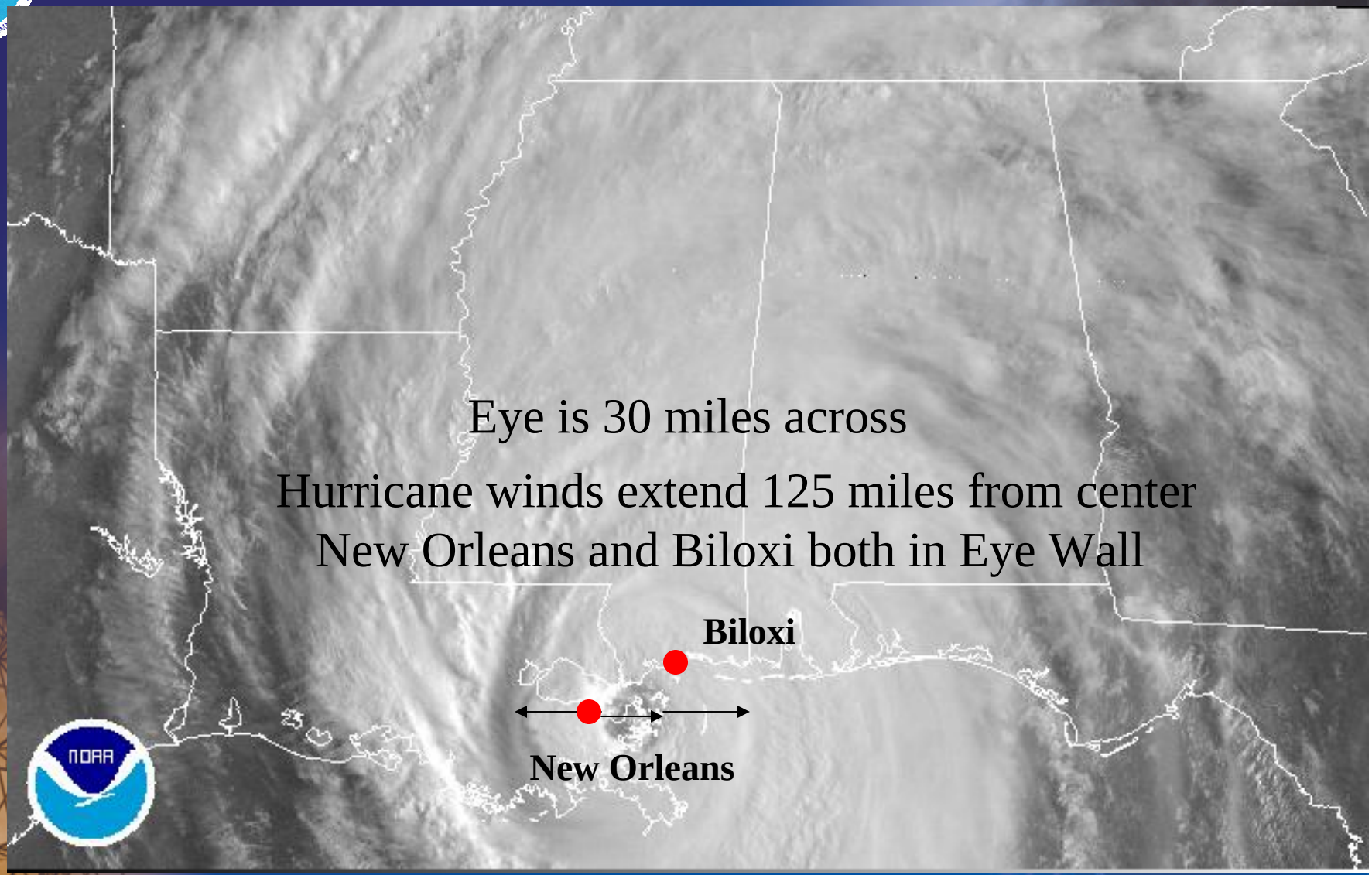
Hyperactive seasons only occur during active hurricane eras.

Florida Coastal Population Growth Since 1900



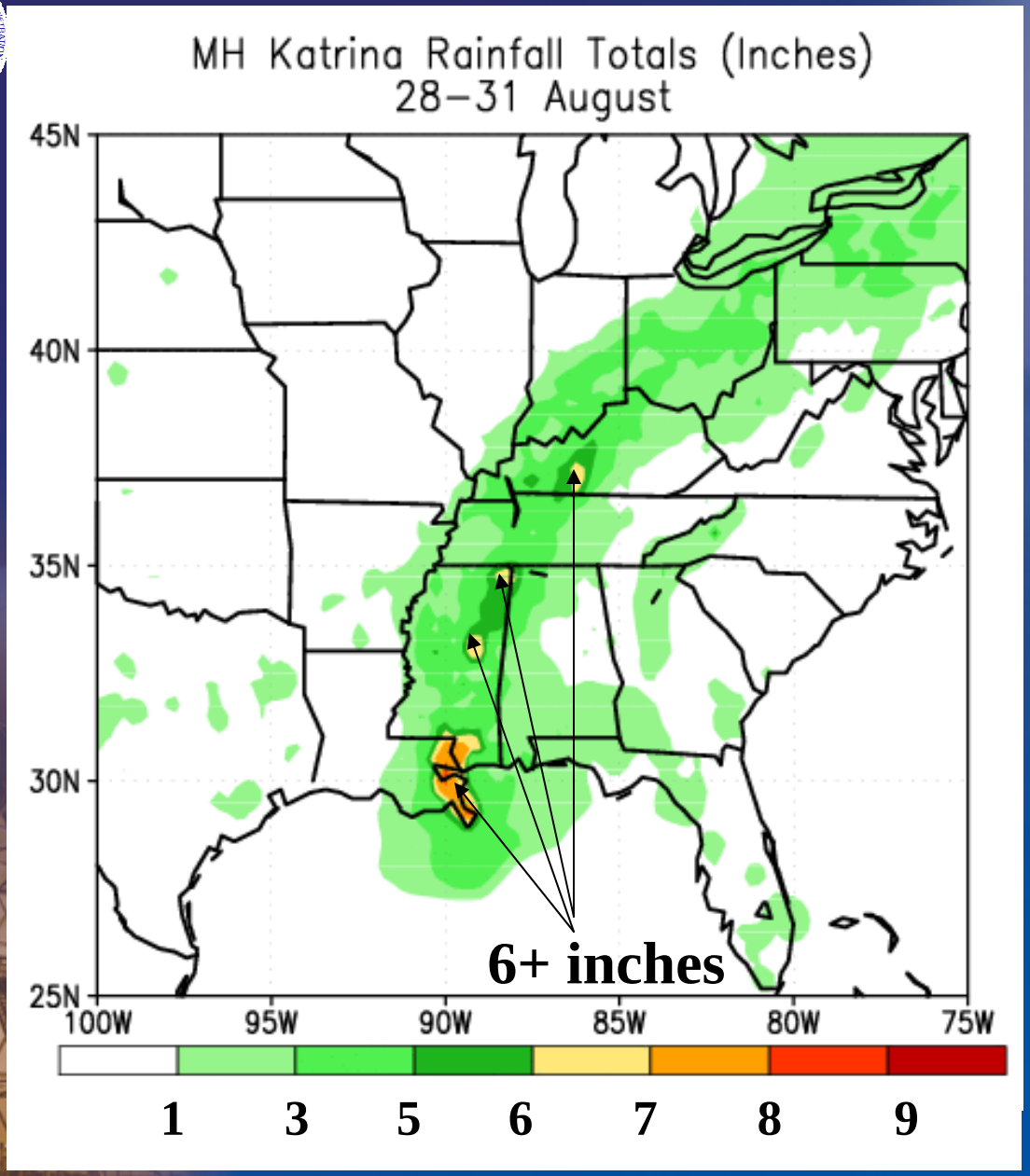
The Census Bureau says 87 million people are Atlantic and Gulf coast residents. That's nearly 30 percent of the U.S. population threatened by Atlantic hurricane season.

MH Katrina- Hit as Cat. 3 (125 mph winds)
August 29th 2005



Cat.-3 hurricanes can produce massive damage

Hurricanes are Not Just a Coastal Event



Leading cause of death is now from inland flooding.

Few people now die from storm surge because they evacuate.

Summary

1. We are 11 years into an active hurricane era that began in 1995. Dominant cause is natural climate variability related to multi-decadal fluctuations in tropical monsoon rainfall and Atlantic Ocean temperatures.

2. Expect high levels of hurricanes and landfalling hurricanes for many years to come (10 to 20+ years).

3. For 2006 season, possible La Niña, combined with active multi-decadal signal, suggests another potentially very active season. NOAA's 2006 seasonal outlook will be issued in late May.

4. Tropical climate patterns since 1995 are similar to active 1950s-1960s. They differ from the inactive 1970-1994 period, when only 3 in 25 seasons were above normal and far fewer hurricanes struck U.S.

5. Preparedness must be for an active era, not just a single season. Meaningful and well thought out preparations must occur at the individual level, AND at all levels of government.

- Multiple U.S. hurricane landfalls in a season,
- Multiple landfalls in a given region in a single season,
- Landfalls in an area that has not recovered from previous season. New Orleans/Mississippi, portions of Florida.
- Inland flooding