



# **NOAA Hurricane Season Forecasting Atlantic and East Pacific**

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**Joint Effort with**

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# Outline

- 1. Basis for NOAA's Atlantic seasonal hurricane outlooks**
- 2. Major regions where hurricanes form and tracks**
- 3. Total Atlantic seasonal activity**
- 4. Conditions associated with above-normal hurricane activity**
- 5. Climate links to the tropics – ENSO and Tropical Multi-Decadal Mode (TMM)**
- 6. Atlantic/Pacific Hurricane Outlooks: procedures, verification, preliminary for May 2004**
- 7. 2003 east Pacific hurricane statistics**
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# Basis for NOAA's Atlantic Seasonal Hurricane Outlooks

**Hurricane extremes are linked to known combinations of wind, air pressure, SST, and vertical wind shear over tropical Atlantic during August-October.**

**1984: Links established between Atlantic hurricane activity and ENSO: Indicates predictability at extended ranges (Dr. William Gray).**

**1992, 1996: Links established between Atlantic hurricane activity and decadal fluctuations in Atlantic Ocean temperatures, and West African monsoon.**



# Basis for NOAA's Atlantic Seasonal Hurricane Outlooks (cont'd)

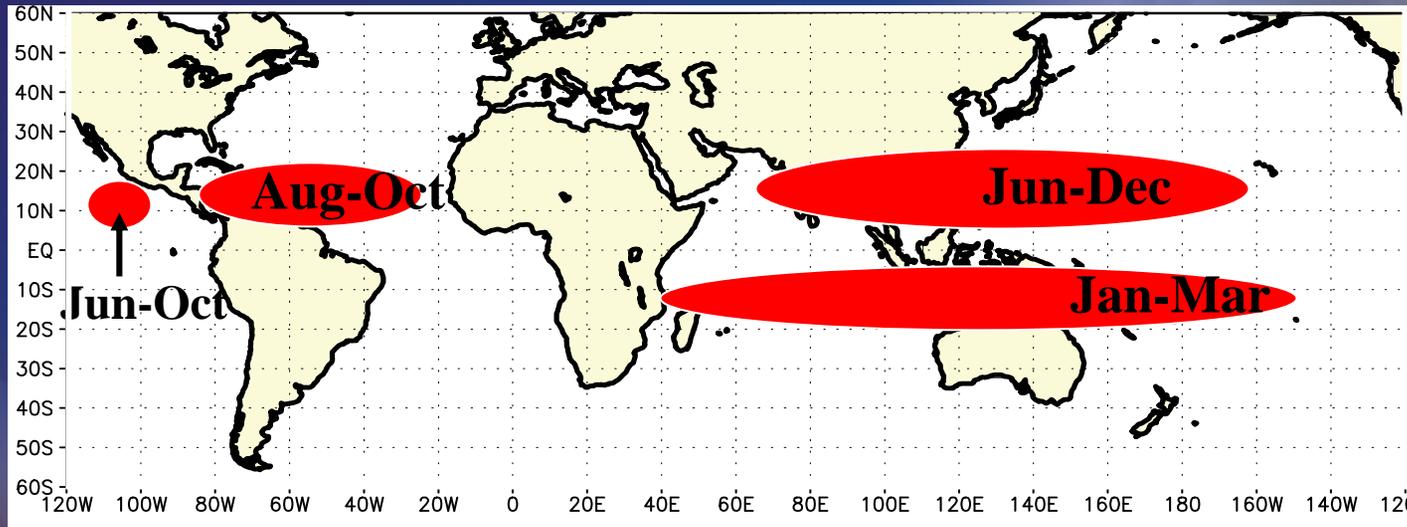
**1998: NOAA releases first Atlantic hurricane outlook in August 1998**

- Links established between Atlantic hurricane activity and tropics-wide multi-decadal mode (Chelliah and Bell 2004)
- Tropical convection forces circulation associated with seasonal and decadal extremes in hurricane activity.
- Combined ENSO + decadal impacts quantified, NOAA outlooks begin.

**2003: NOAA releases first experimental eastern Pacific hurricane outlook.**



# Major Regions Where Hurricanes Form

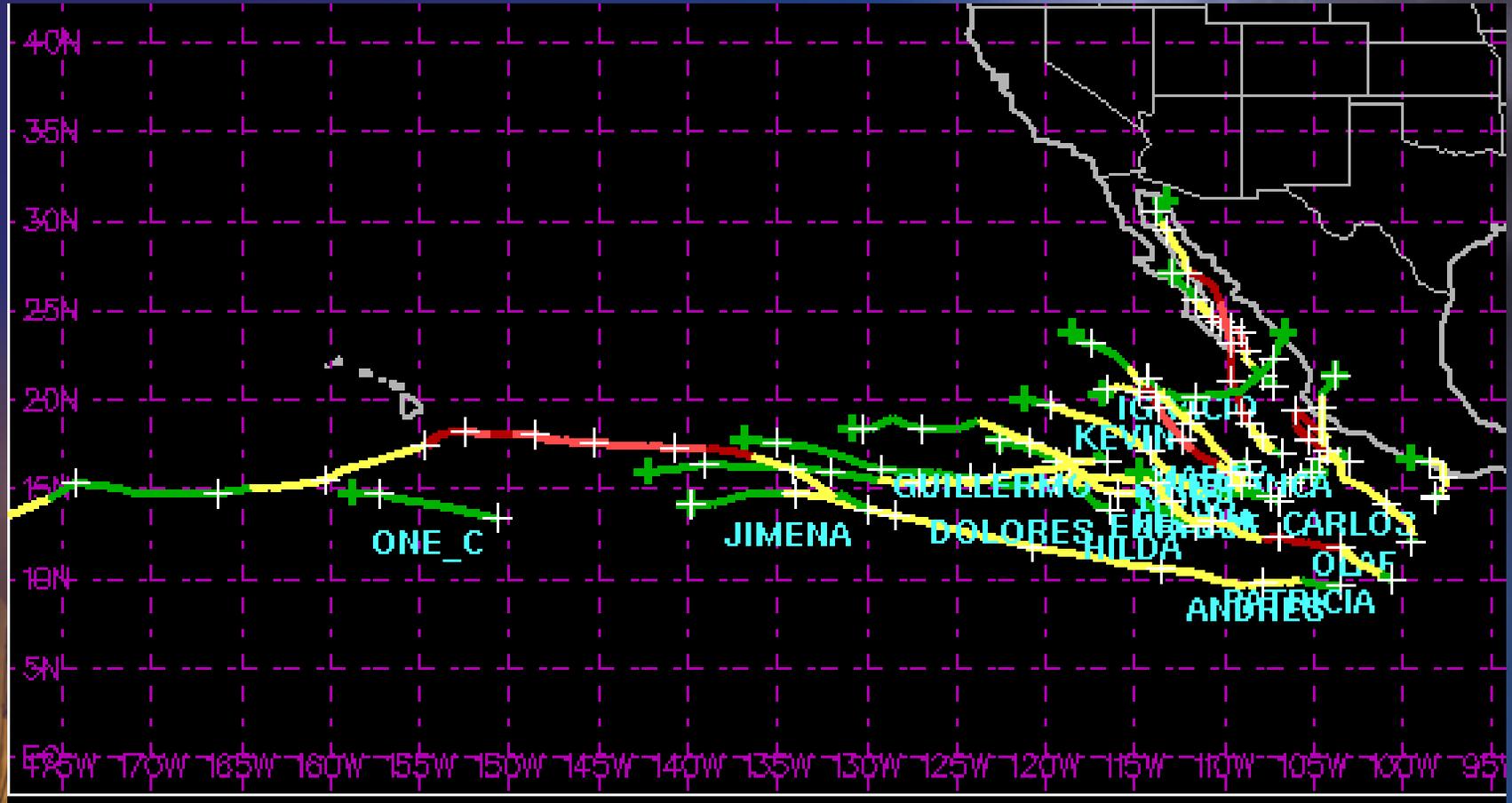


Most Atlantic hurricanes develop from tropical storms that first form in the deep tropics. Conditions in this area determine whether the season will be active or inactive.

The eastern Pacific has the highest concentration of hurricanes in the world.



# East Pacific Region - 2003 Storm Tracks

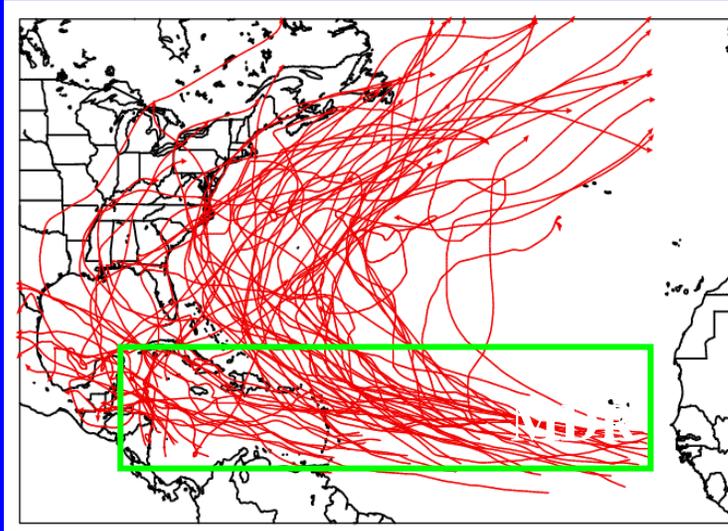


High concentration of activity in eastern Pacific



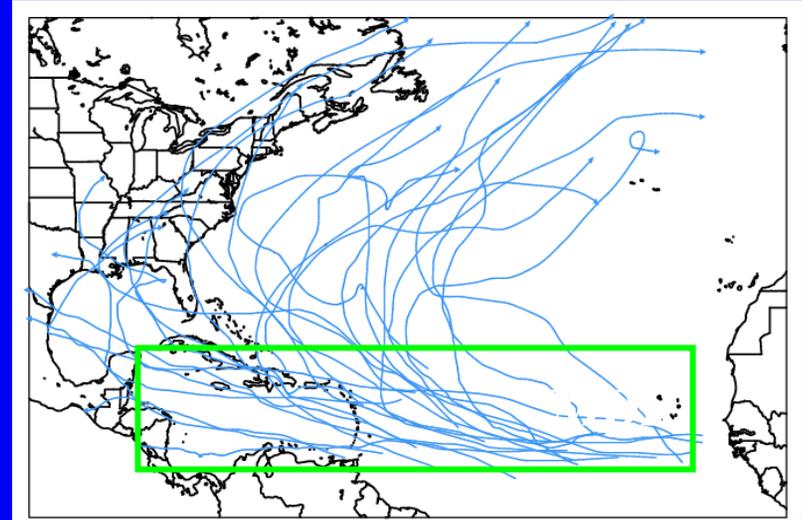
# Atlantic Region Tracks - Major Hurricanes (winds >110 mph) Forming in Deep Tropics

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



**67 Major Hurricanes  
42 Make Landfall as Hurricanes  
31 Hit as Major Hurricanes**

**Inactive 24-Year Period  
1971-1994**



**27 Major Hurricanes  
15 Make Landfall as Hurricanes  
All hit as Major Hurricanes**

Above normal Atlantic hurricane seasons have high concentration of systems forming in deep tropics. They develop from African easterly disturbances during August-October.



# Total Atlantic Seasonal Activity

Collective strength and duration of tropical storms and hurricanes in a given region

- Measured by NOAA's Accumulated Cyclone Energy (ACE) Index:

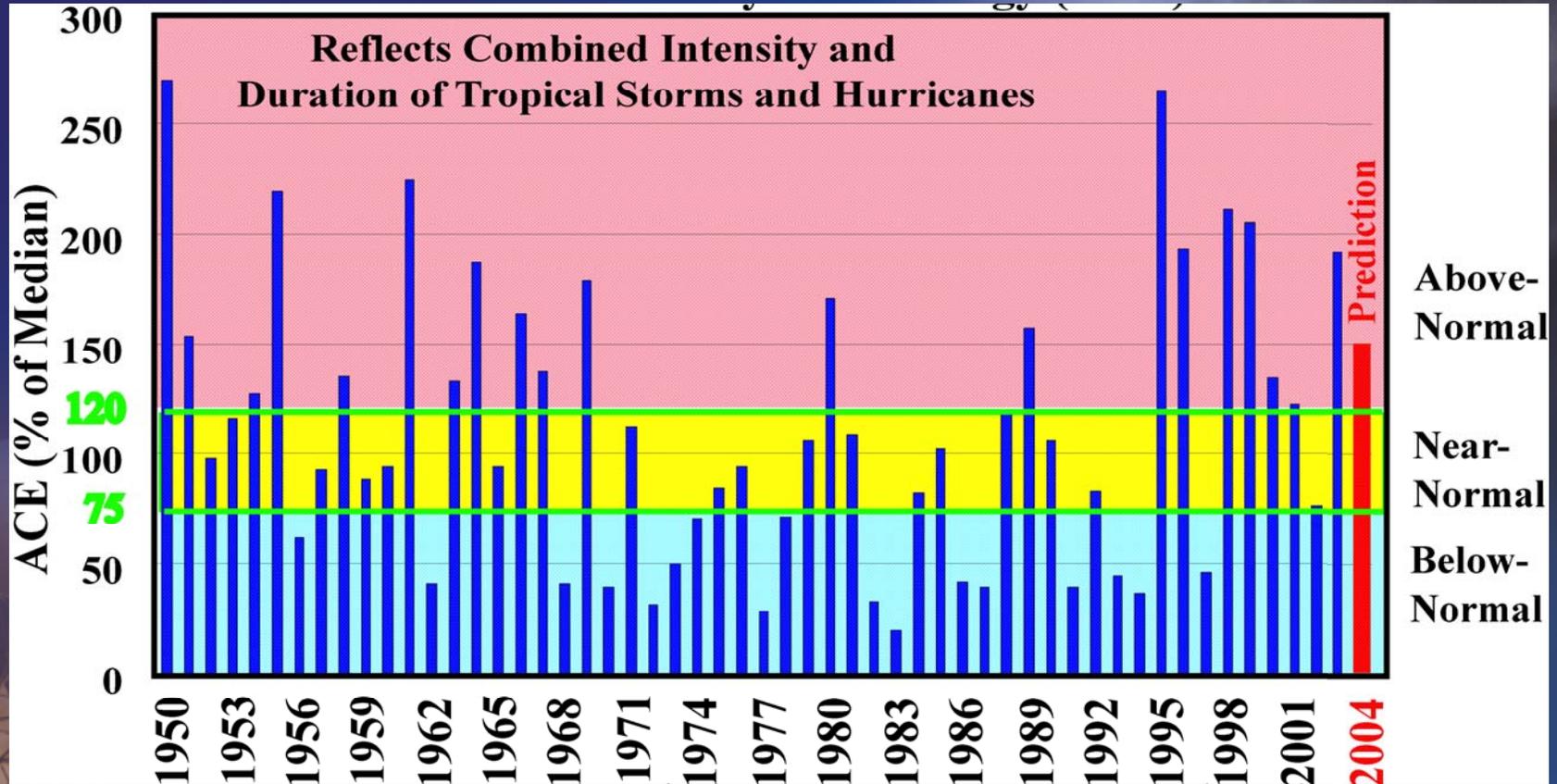
*Energy index defined as sum of squares of 6-hourly maximum sustained wind speed for all systems while at least tropical storm strength.*

- The ACE index is:
  - Highly predictable
  - The Key forecast parameter for NOAA hurricane outlooks
  - Used in defining hurricane season types



# Total Atlantic Seasonal Activity (cont'd)

## NOAA's Accumulated Cyclone Energy (ACE) Index



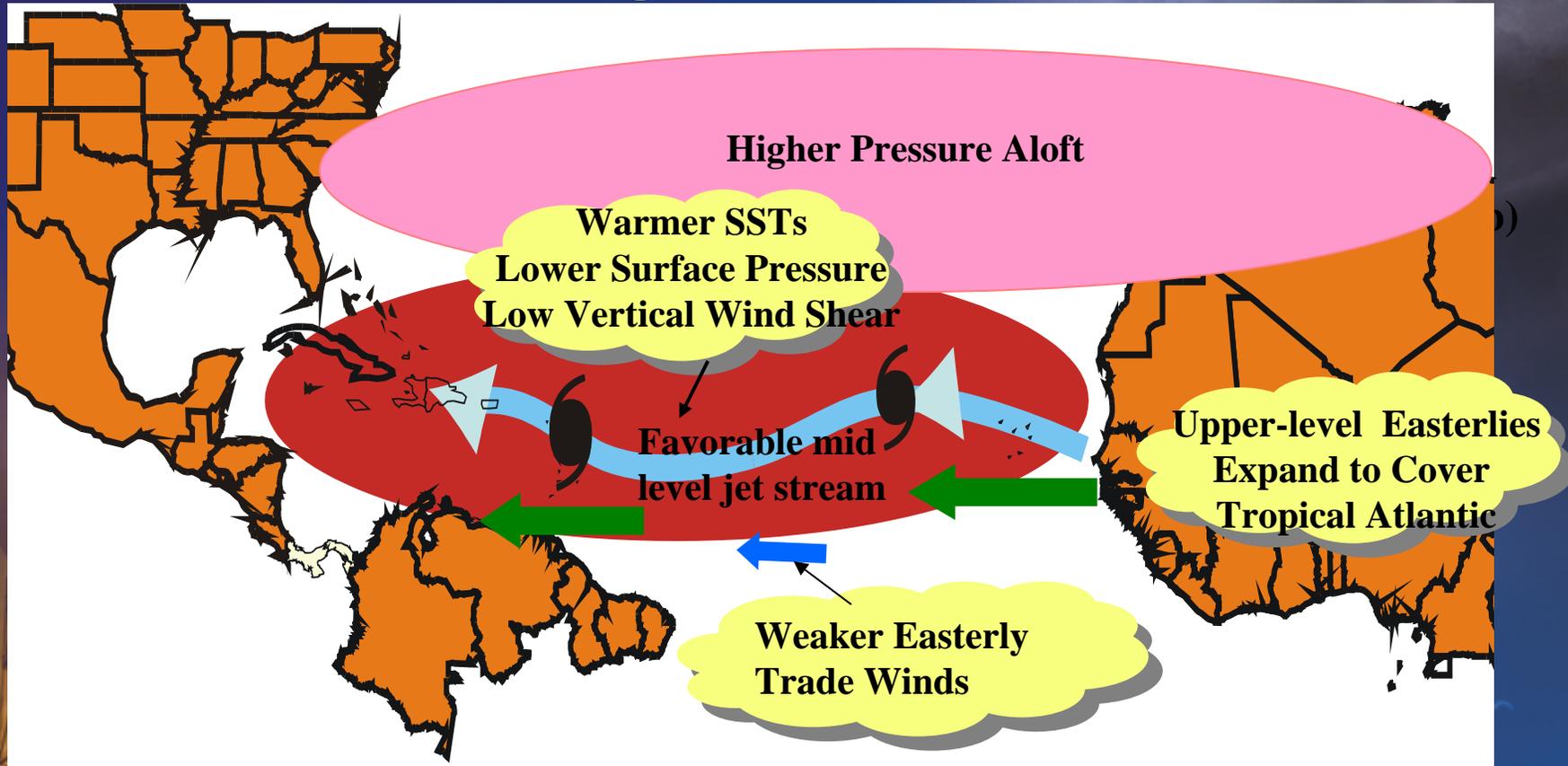
Active: 1950-1969  
ACE = 114  
10 TS, 6.5 H, 3 MH

Inactive: 1970-1994  
ACE = 65  
9 TS, 5 H, 1.5 MH

Active: 1995-pres  
ACE = 134  
13 TS, 8 h, 3.6 MH



# Conditions Associated with Above Normal Hurricane Activity August-October



These conditions are conducive to tropical storm and hurricane formation as disturbances move westward from Africa into the low-shear environment (red area) of the tropical Atlantic.



# Climate Links to the Tropics

Ocean surface temperature patterns and associated tropical convection are dominant forces for Atlantic hurricane extremes. These are strongly controlled by two climate factors:

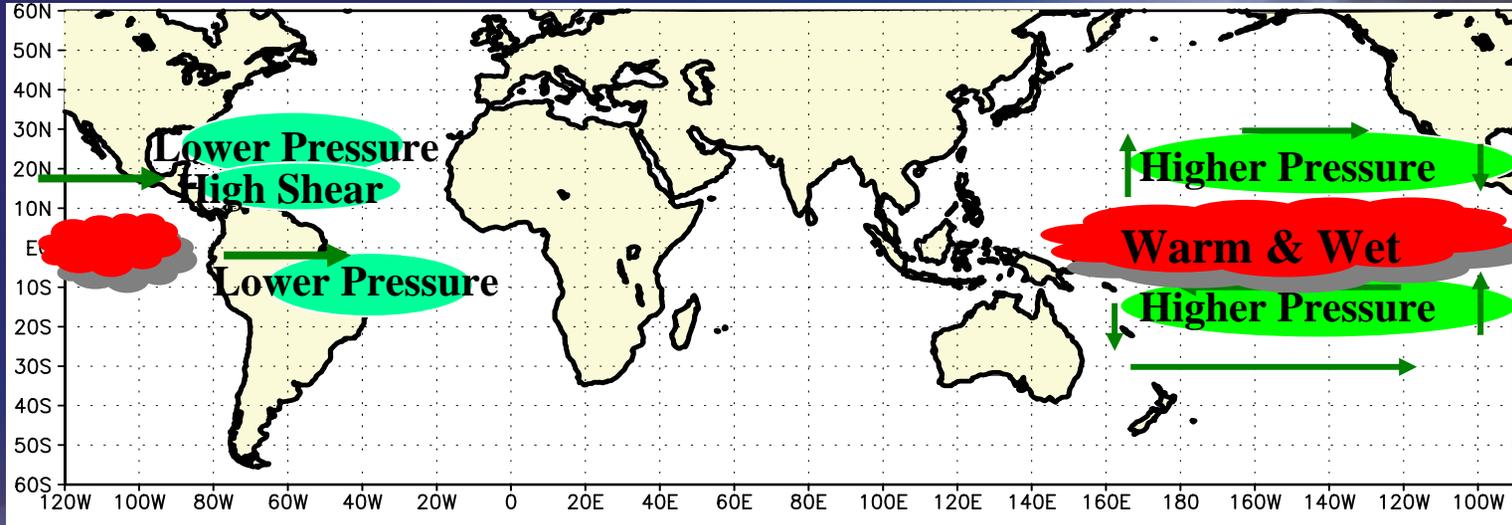
- **El Niño/ Southern Oscillation (ENSO): Gray (1984)**
- **Tropical Multi-decadal Mode (TMM): Chelliah and Bell (2004)**



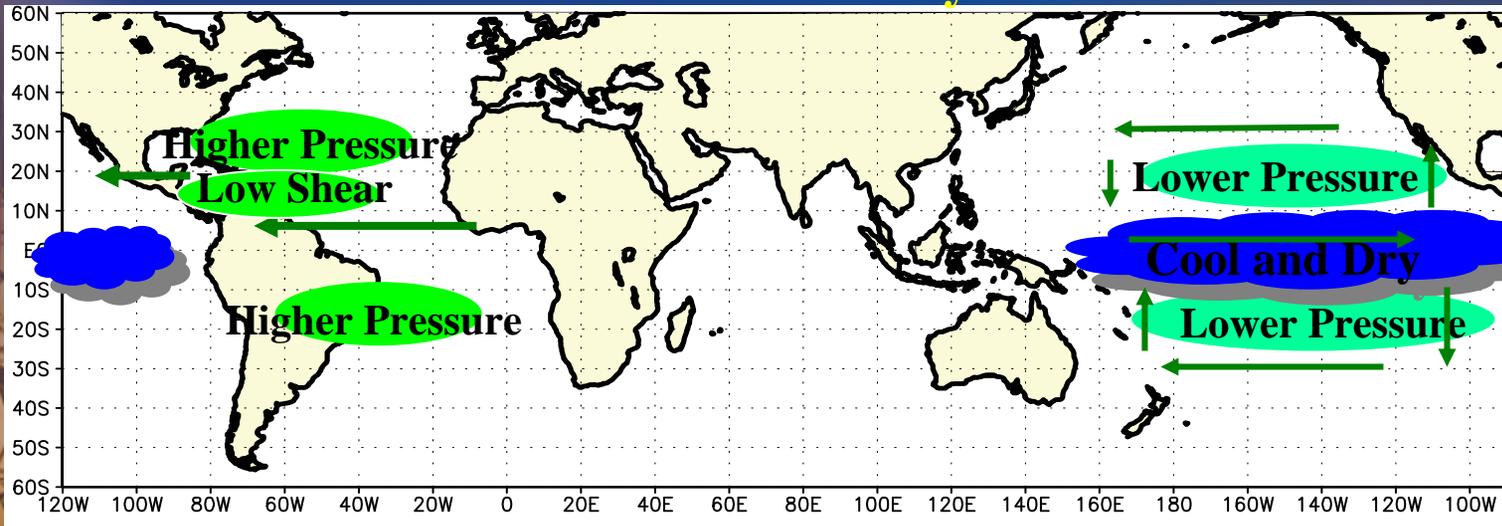


# ENSO: Jet-Stream Level Circulation

## El Niño: Suppressed Activity in MDR



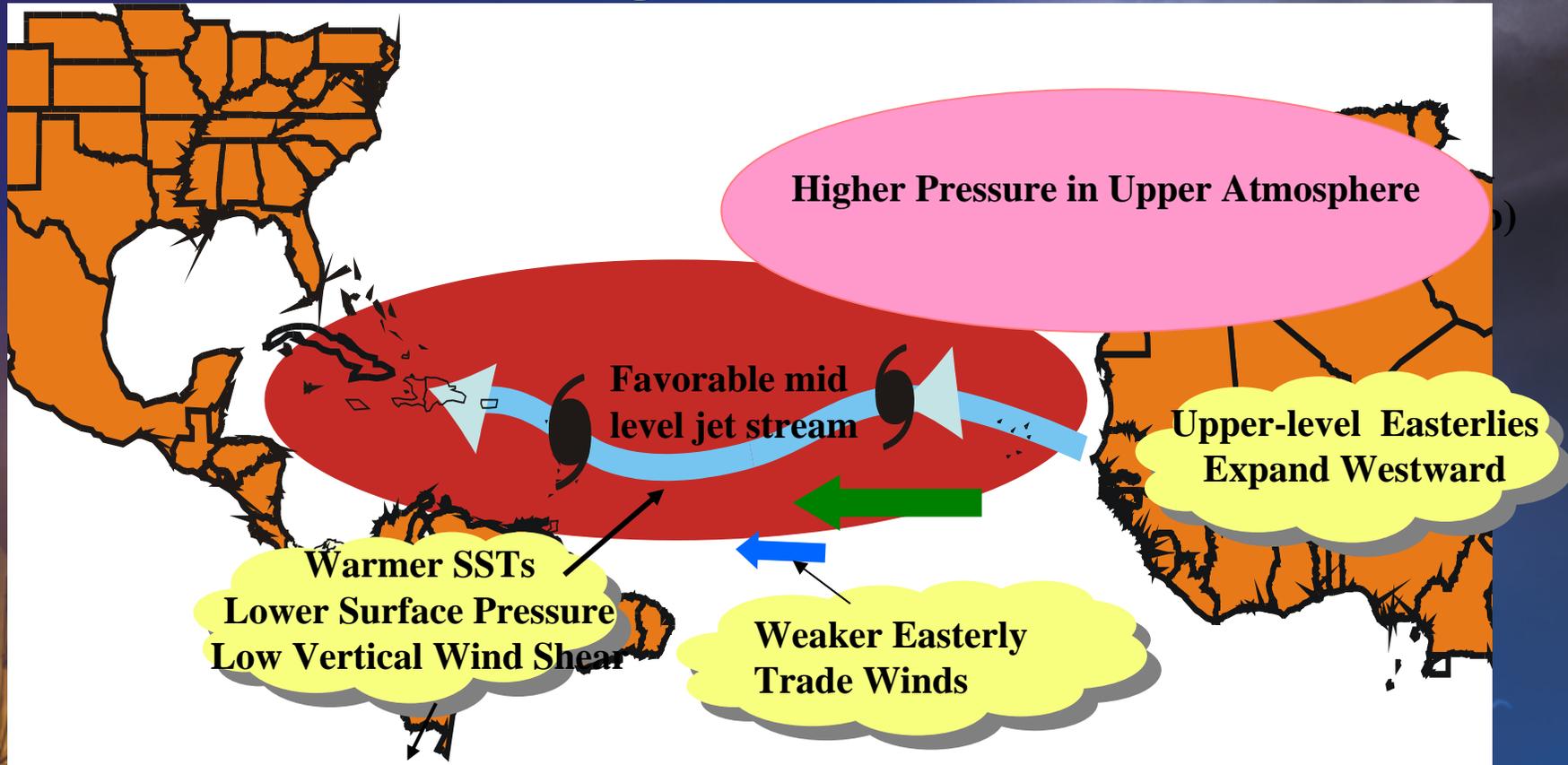
## La Niña: Enhanced activity in MDR



ENSO captures western part of predictive signal



# Tropical Multi-Decadal Mode (TMM): Active Atlantic Phase August-October

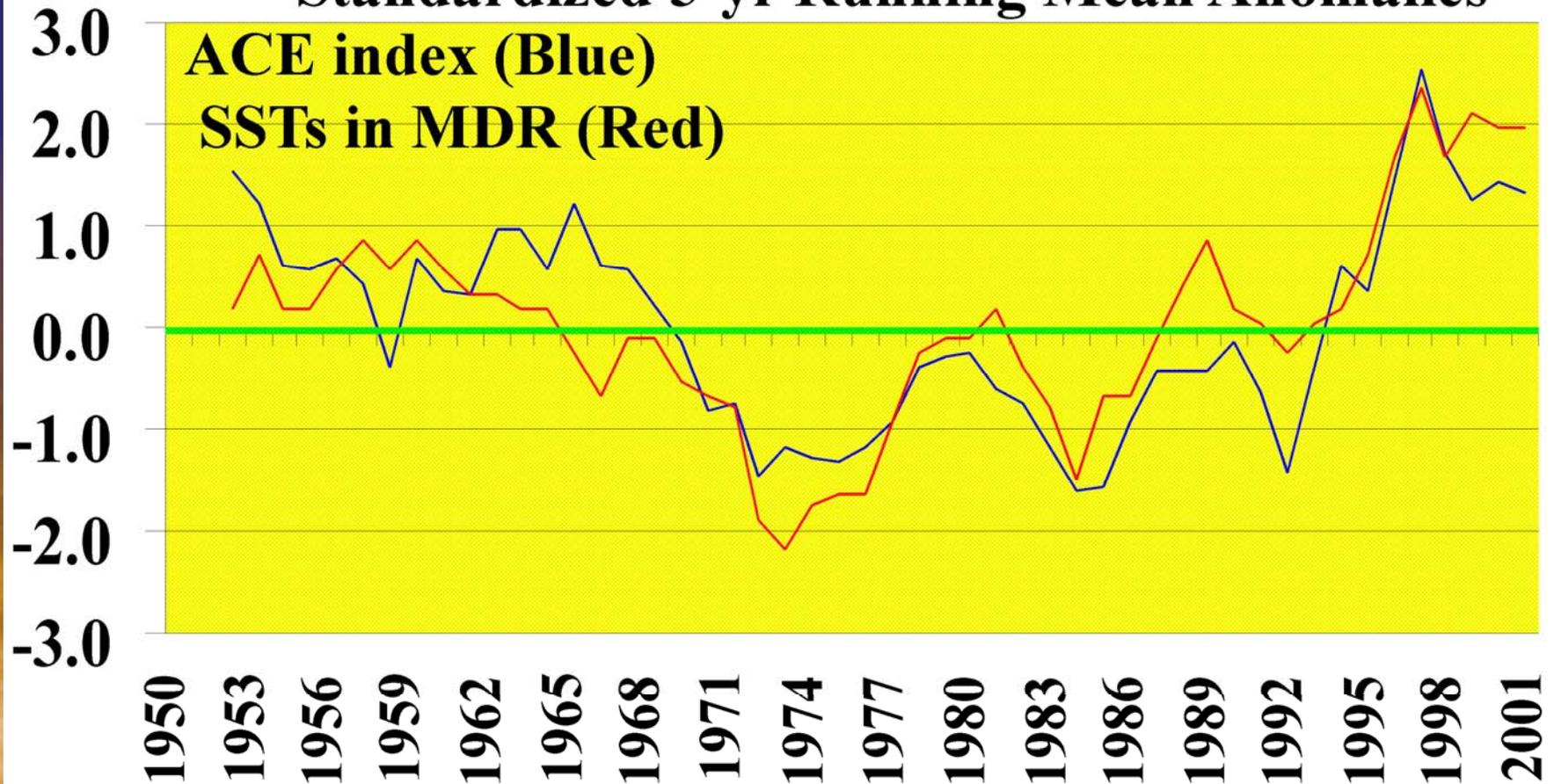


TMM captures eastern part of predictive signal

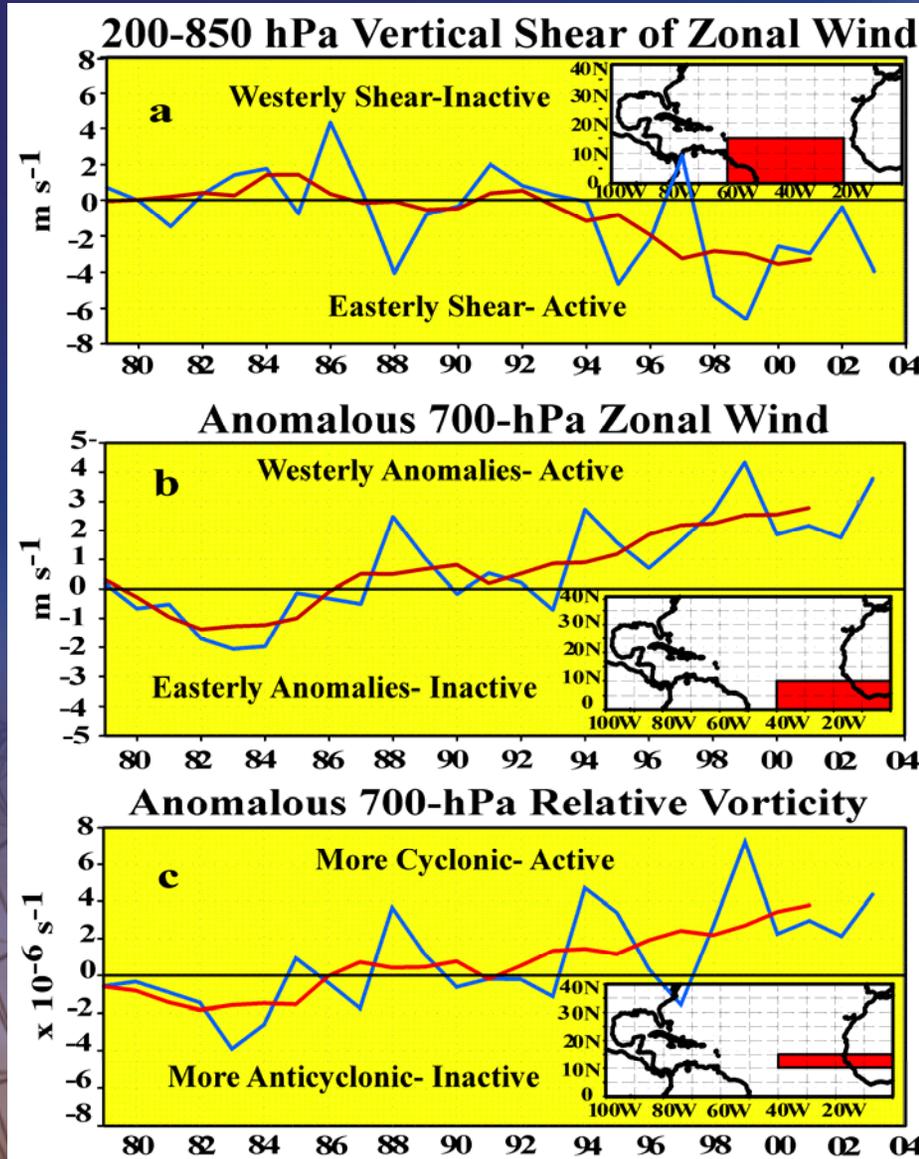


# Multi-Decadal Mode Signal in the Atlantic ACE index and Tropical SSTs

## Standardized 5-yr Running Mean Anomalies



# Multi-Decadal Atmospheric Signal over Tropical Atlantic



Above-Normal Seasons

Lower vertical wind shear critical for hurricane formation

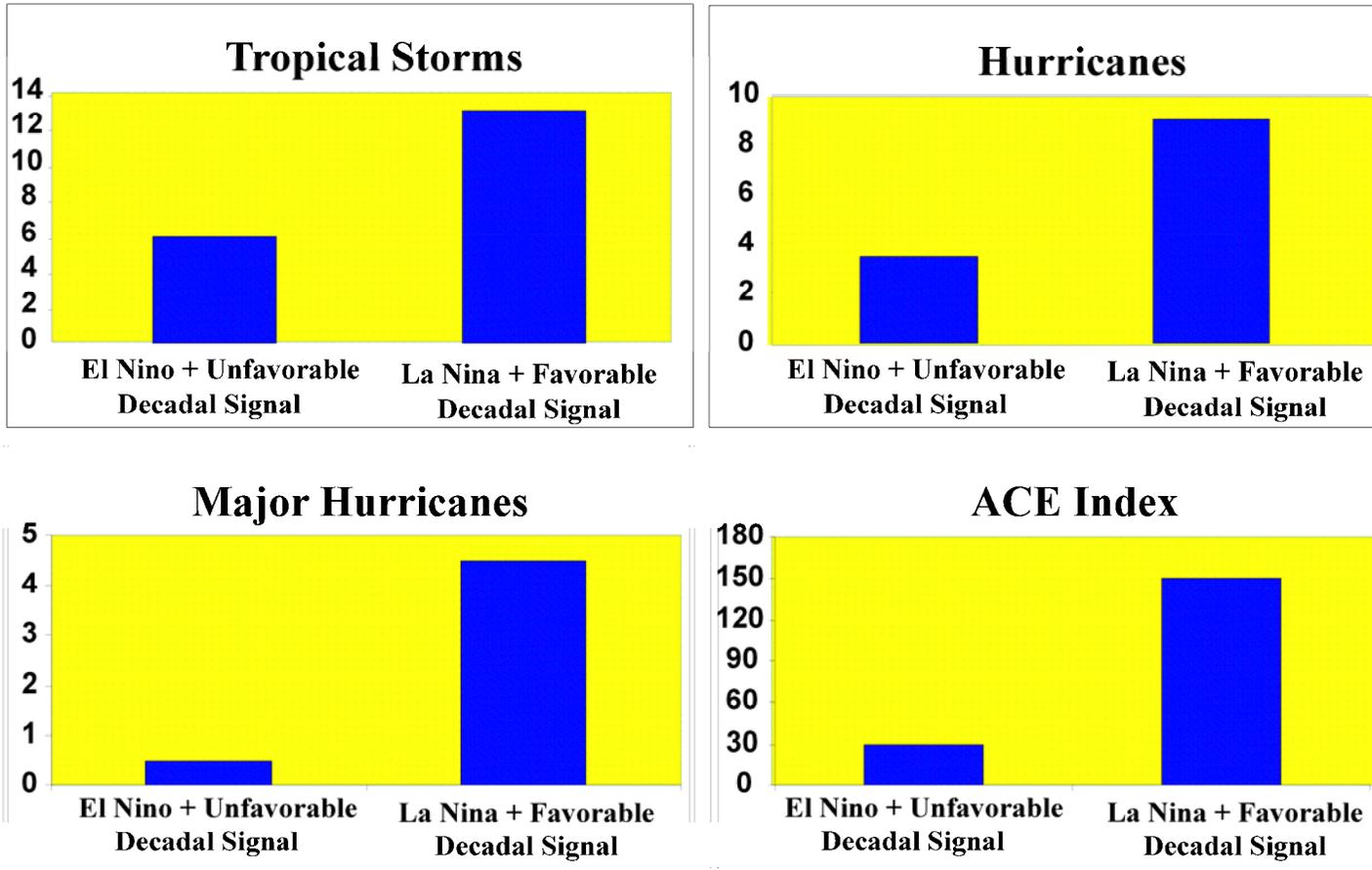
Weaker low-level easterlies associated with northward shift of ITCZ and favorable mid-level flow

Mid-level cyclonic circulation provides energy to developing tropical disturbances.



# Combined ENSO+TMM Activity

## Average North Atlantic Seasonal Activity For Combined ENSO and Multi-Decadal Signal



Combination of El Niño and inactive phase of TMM is least conducive.  
Combination of La Niña and active phase of TMM is most conducive.



# Atlantic Hurricane Outlooks: Procedures

1. Analyze and predict the combined tropical modes and their impacts.
2. Find analogue years having comparable phase and strength of the tropical modes.
3. Identify any additional conditions not linked to leading tropical modes.
4. Subjective blend items 1-3 into a Final Outlook.



# Atlantic and East Pacific Hurricane Outlook Procedures – May 2004

21-23 April	26 April- 2 May	2-7 May	7 May	10-14 May	17 May
<b>Preliminary Outlooks Issued</b>	<b>Revised Outlooks Issued 30 April</b>		<b>Final Hurricane Outlooks Issued</b>	12 May: CPC review of PA Products	<b>Outlook Presentation and Press Conference</b>
<b>PA decision on action. Plans to brief NWS, NOAA</b>	<b>Brief NWS and NOAA on Press Release</b>		<b>PA: Revise doc's. Begins draft of Press Release</b>	13-14 May: PA products through DOC approval	
	<b>Talking Pts -Q's + A's Backgrnd info</b>	<b>Talking Pts -Q's + A's Backgrnd info</b>			

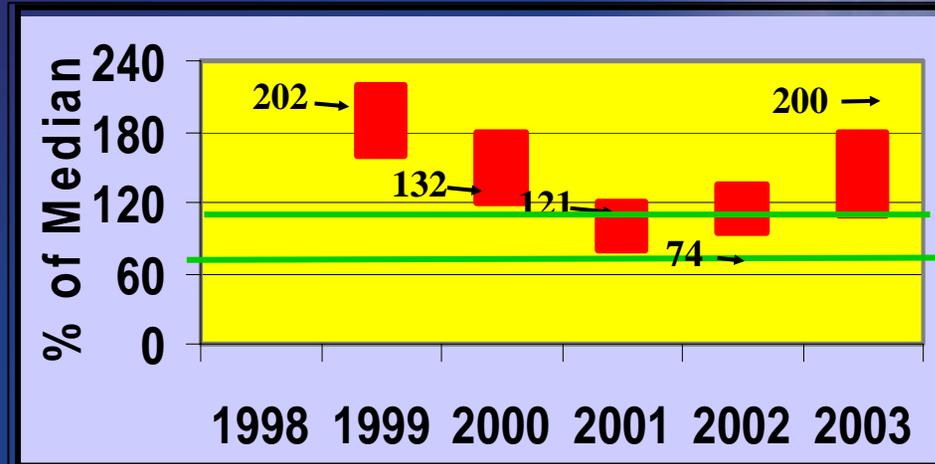


# Atlantic Hurricane Outlooks - Verification

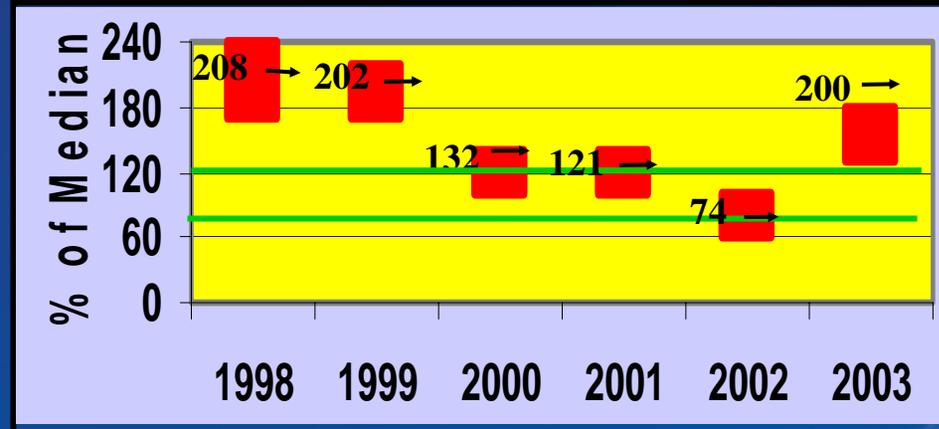
## ACE Index Forecast vs. Observed

### 1998-2003

Issued in May



Issued in August



 Forecast Range     Observed

Outlooks consistently predict accurate ACE range



# Atlantic Hurricane Outlook

## Preliminary for May 2004

<u>Season and Activity Type</u>	<u>2004 Outlook</u>	<u>2003 Observed</u>	<u>Climatological Mean</u>
Chance Above Normal	60%	<b>Above Normal</b>	
Chance Near Normal	35%		
Chance Below Normal	5 %		
Tropical Storms	11-15	16	11
Hurricanes	7-9	6	7
Major Hurricanes	3-4	0	2
ACE Index:	95-140	172	94
ACE % of Median	110%-160%	200%	86%



# 2003 East Pacific Hurricane Statistics

<u>Season and Activity Type</u>	<u>Outlook June 11</u>	<u>Observed</u>	<u>Climatological Mean</u>
Chance Above Normal	10%		
Chance Near Normal	40%		
Chance Below Normal	50 %	<b>Below Normal</b>	
Tropical Storms	11-15	16	15
Hurricanes	6-9	7	9
Major Hurricanes	2-5	0	4.5
ACE Index:	53-124	48.7	130
ACE % of Median	60%-110%	43.1%	113%



# Summary

- 1. The amount of activity forming in the deep tropics determines the character of Atlantic hurricane season.**
- 2. This activity is controlled by two dominant climate features: ENSO and the Tropical Multi-decadal Mode (TMM).**
- 3. Both signals are related to anomalous surface temperatures and associated tropical convection.**
- 4. ENSO and TMM, combined with current conditions, form the basis for NOAA's hurricane outlooks.**
- 5. The climate system provides for predictions of activity ranges, and likelihood of an above-, near-, and below-normal season. It does not indicate an exact numbers of systems.**
- 6. Research is ongoing regarding the physical basis for eastern Pacific outlooks.**