
EL NINO & LA NINA...

Scoundrels or Scapegoats?

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5/21/2008

What Is Our Goal?

- **Directly Or Indirectly... Most Current Hurricane Seasonal Forecast Schemes In Some Way Relate Back To The Phase Of ENSO... The Southern Oscillation (El Nino Vs. Neutral Vs. La Nina)**
- **This Infers That ENSO Phase Is A Key Component In The Determination Of How “Busy” Or “Quiet” A Season Will Be.**
- **Our Goal Is To Examine How Valid That Assumption Really Is...**

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First, Some Basic Assumptions...

- **In General... El Nino Tends To Produce Conditions In The Atlantic Development Region Which Are Hostile To Tropical Cyclone Development.**
- **By Contrast... La Nina Tends To Create Favorable Conditions For Development.**
- **Here's How It Works...**

TROPICAL CYCLONE FORMATION

THREE NECESSARY INGREDIENTS...

- Pre-Existing Disturbance with Thunderstorms
- Warm Sea Surface Temperatures (At least 80 deg. F to a depth of 150 meters)
- And The Big One For The Purposes Of Our Discussion:
Light Vertical Wind Shear – No Drastic Changes In Wind Speed Or Direction With Height. This Allows Energy To Concentrate In A Vertical Column. This Is Where El Nino And La Nina Can Play An Important Role!

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IT STARTS WITH WHICH WAY THE WIND BLOWS...

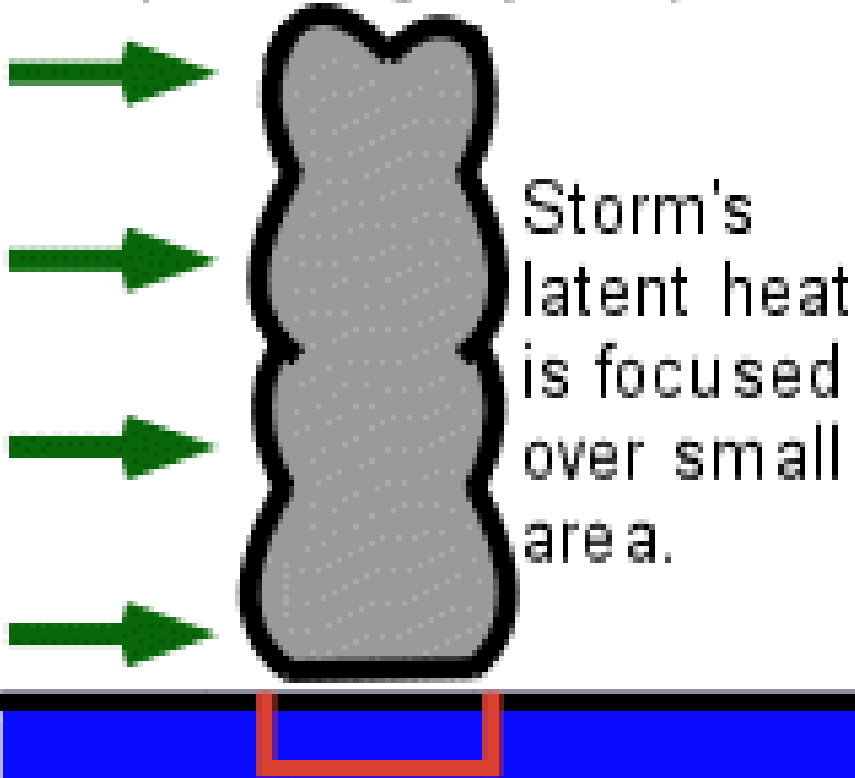
THE IMPORTANCE OF EL NINO & LA NINA

- **El Nino Produces Westerly Winds In The Middle Atmosphere Across The Tropics... Creating Wind Shear Which Inhibits Development.**
- **During La Nina... These Westerly Winds And The Corresponding Wind Shear Decrease... Creating More Favorable Conditions.**

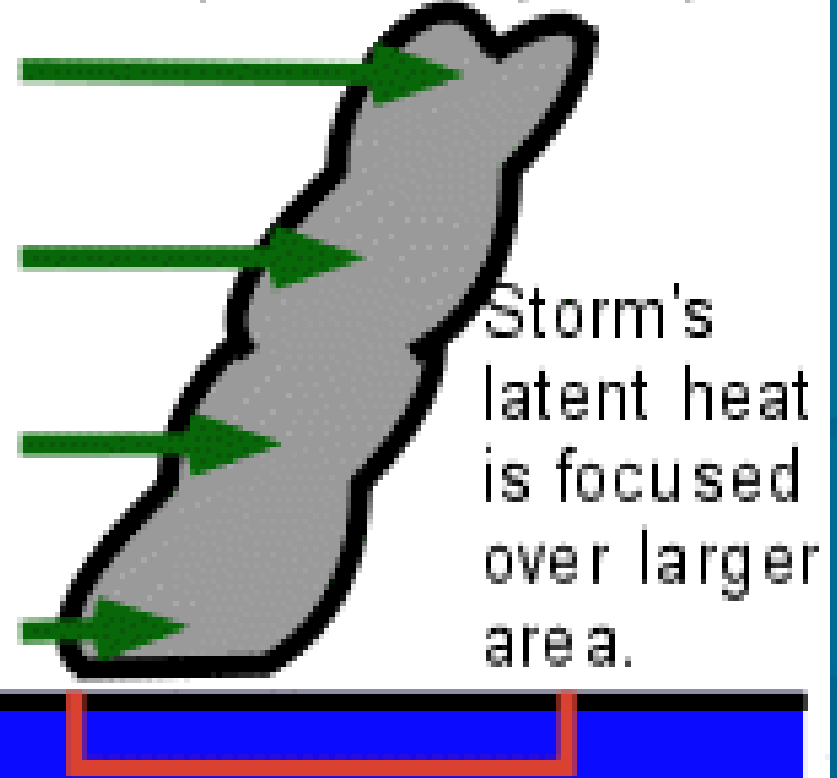
HERE'S HOW IT WORKS...

Atlantic Ocean

Low wind shear
(Average year)



High wind shear
(El Niño year)



SO...

JUST HOW DOES EL NINO

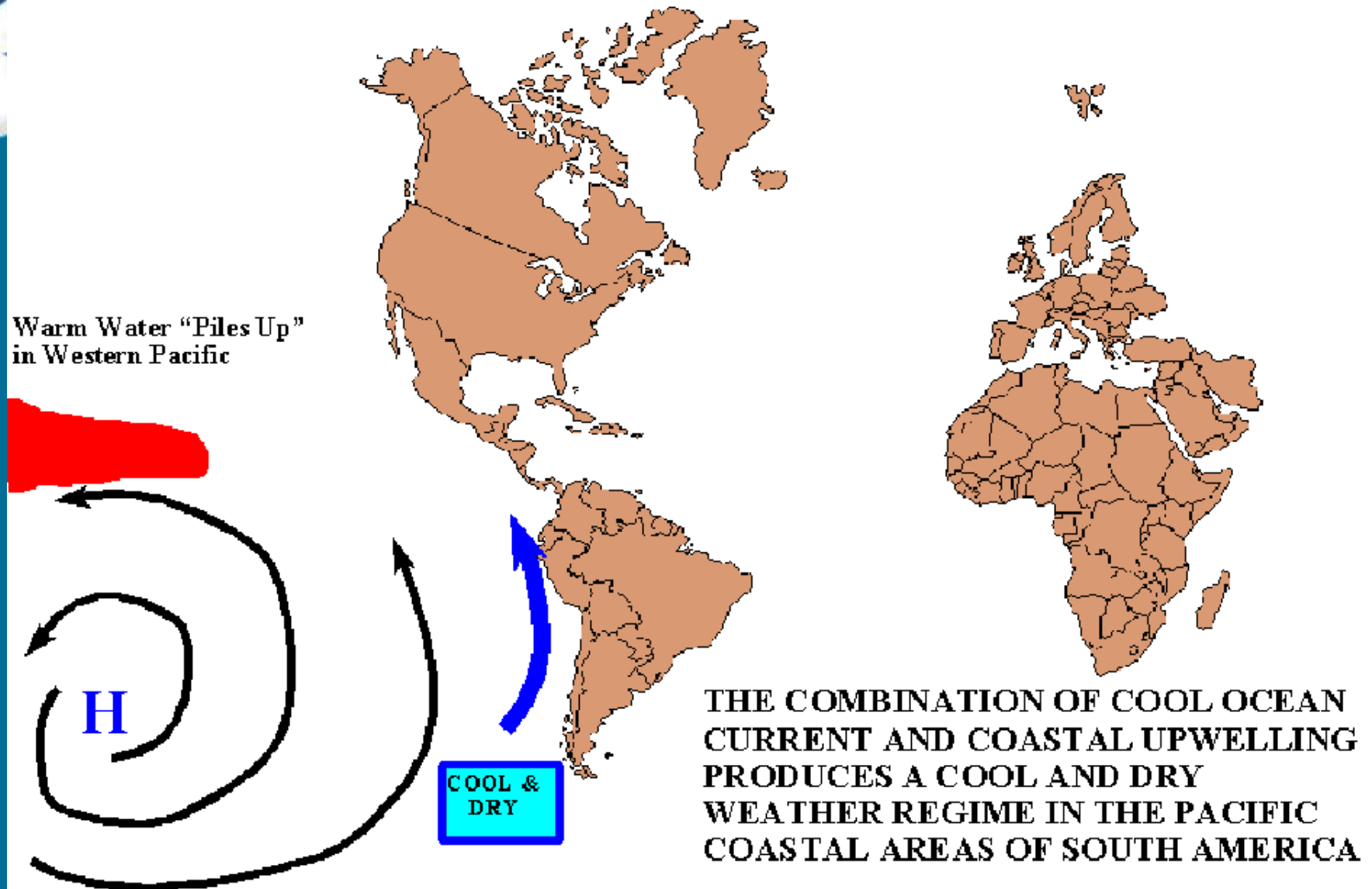
PRODUCE THOSE

WESTERLY WINDS ACROSS

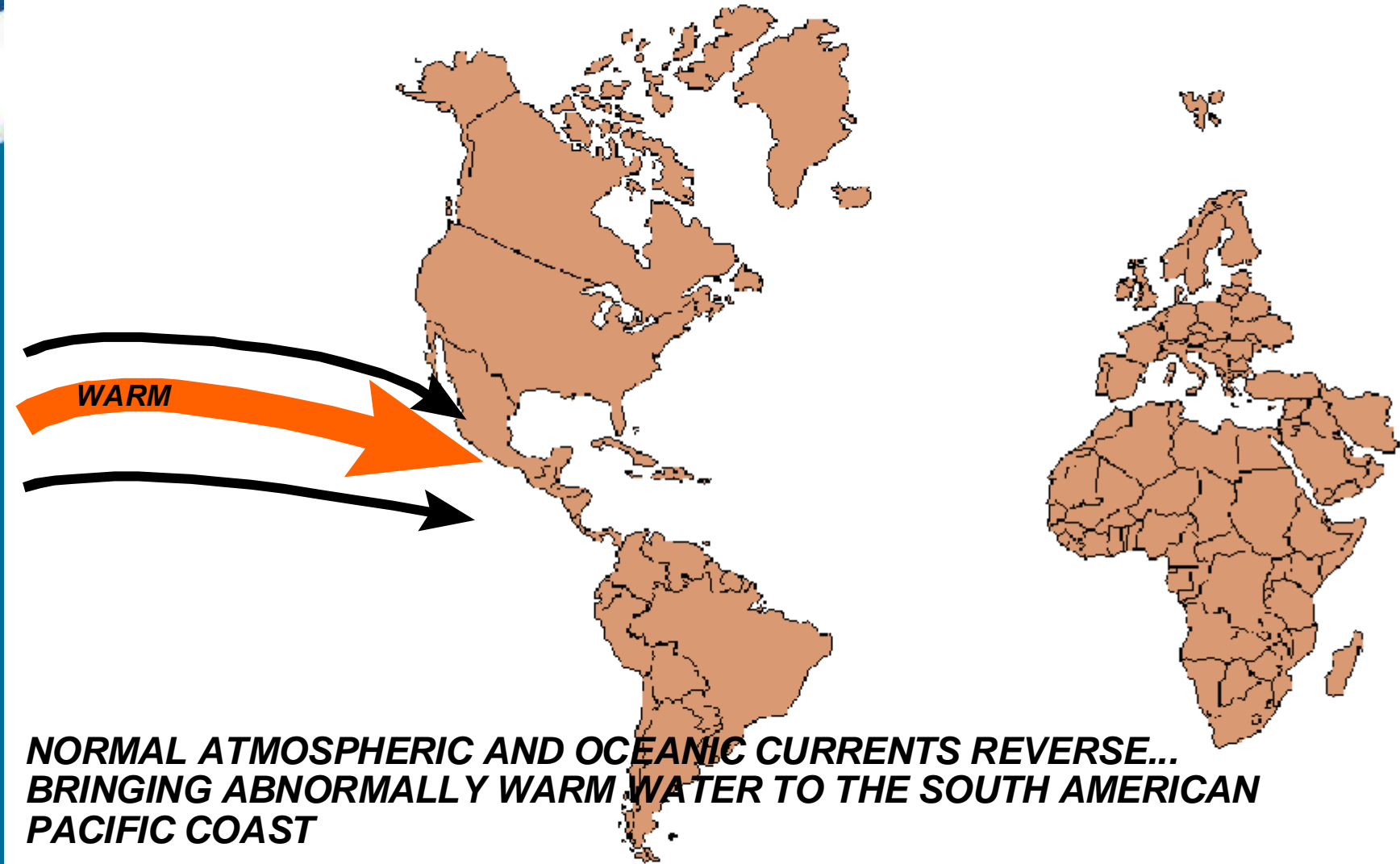
THE TROPICS???

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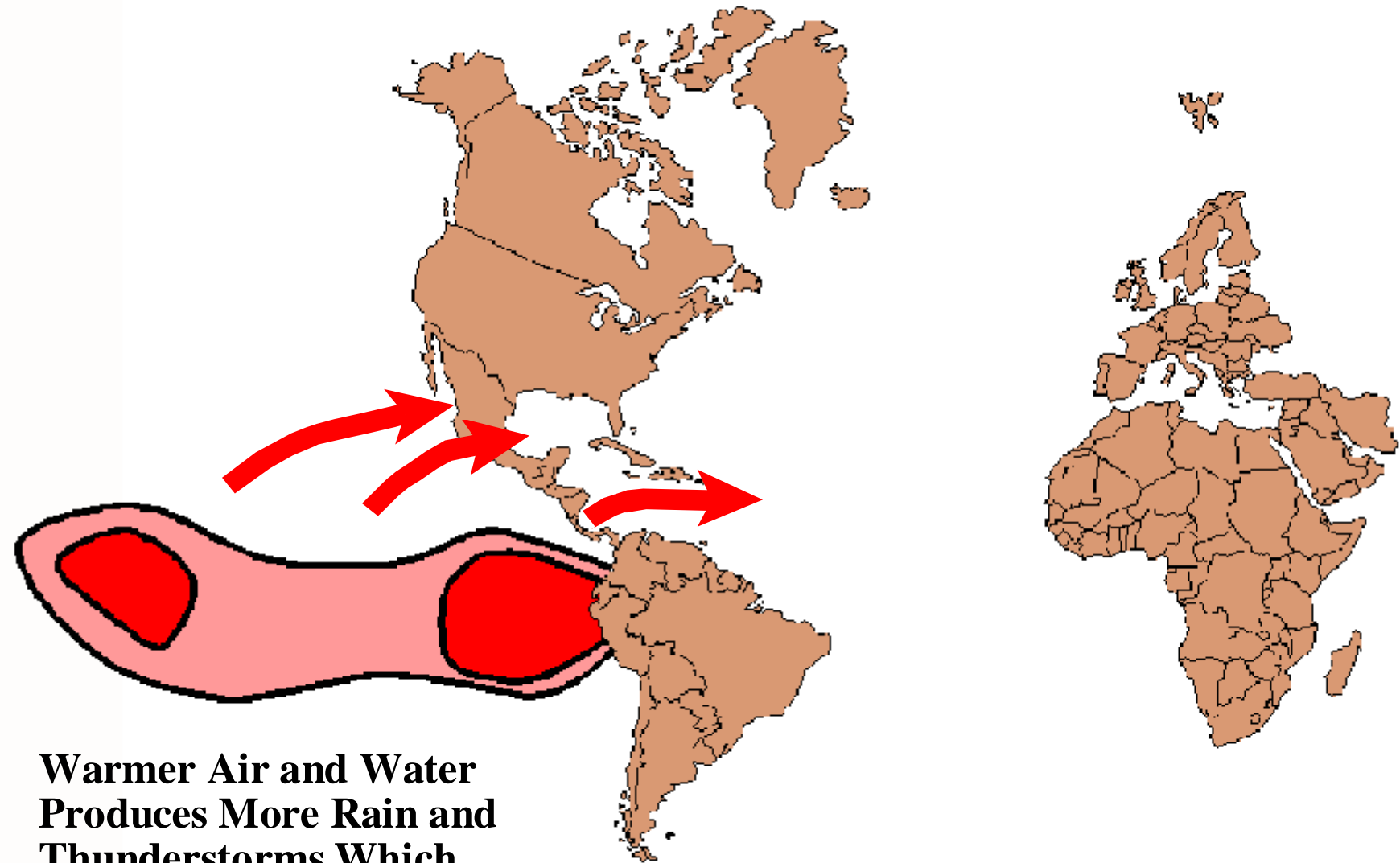
“NORMAL” (NON-EL NINO) CONDITIONS



EL - NINO CONDITIONS

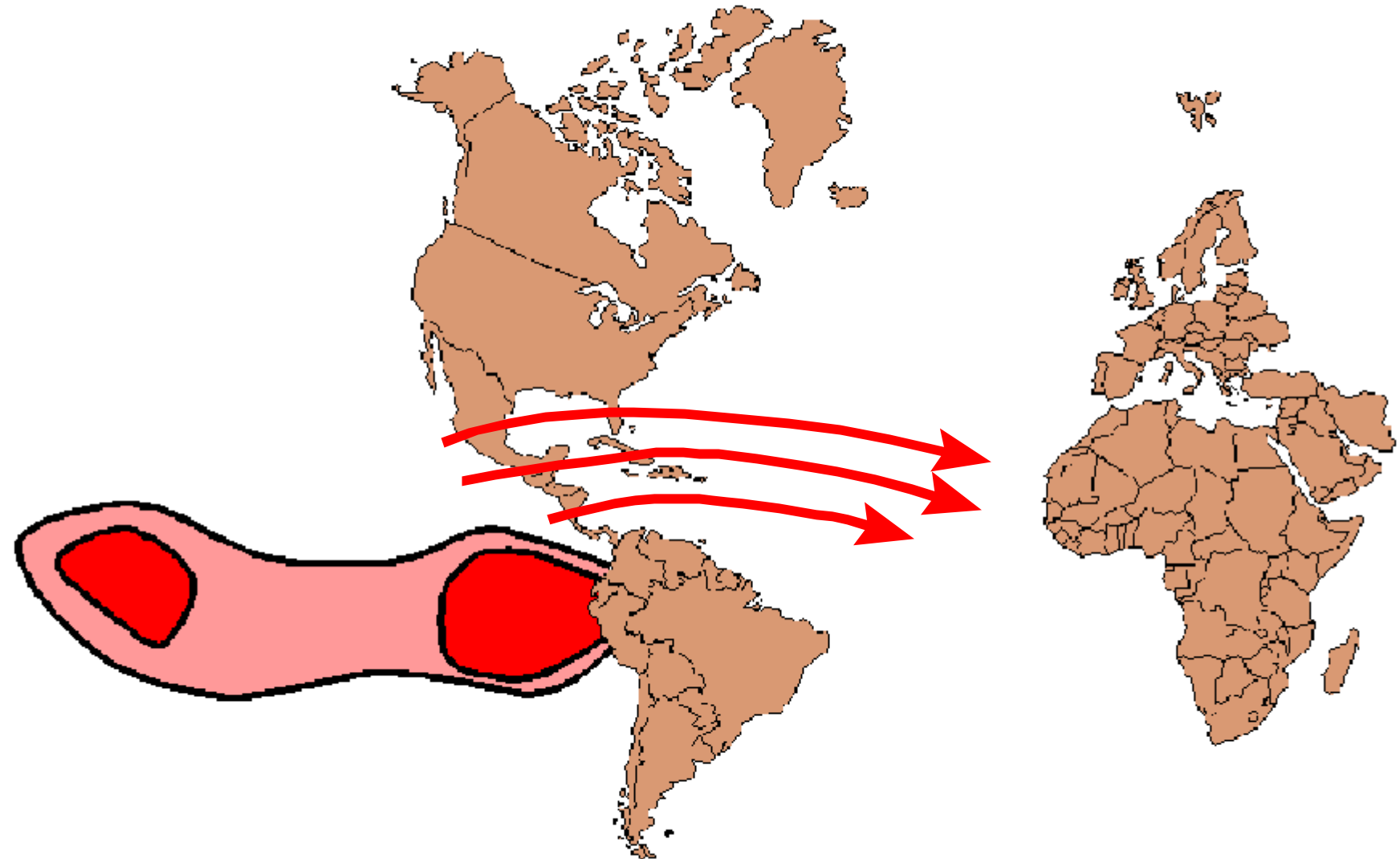


EL - NINO (ENSO) CONDITIONS



**Warmer Air and Water
Produces More Rain and
Thunderstorms Which
Release Added Heat into the
Mid and Upper Atmosphere**

EL - NINO CONDITIONS



***THIS EXTRA HEAT LOWERS PRESSURES IN THE UPPER AIR...
PULLING THE JET STREAM SOUTH... CREATING STRONG
WESTERLY WINDS ACROSS THE TROPICAL ATLANTIC***

**STRONGER UPPER WINDS
DESTROY SEEDLING STORMS
BEFORE THEY HAVE A
CHANCE TO DEVELOP**

UPPER WIND FLOW

UPPER WIND FLOW



UPPER WIND FLOW

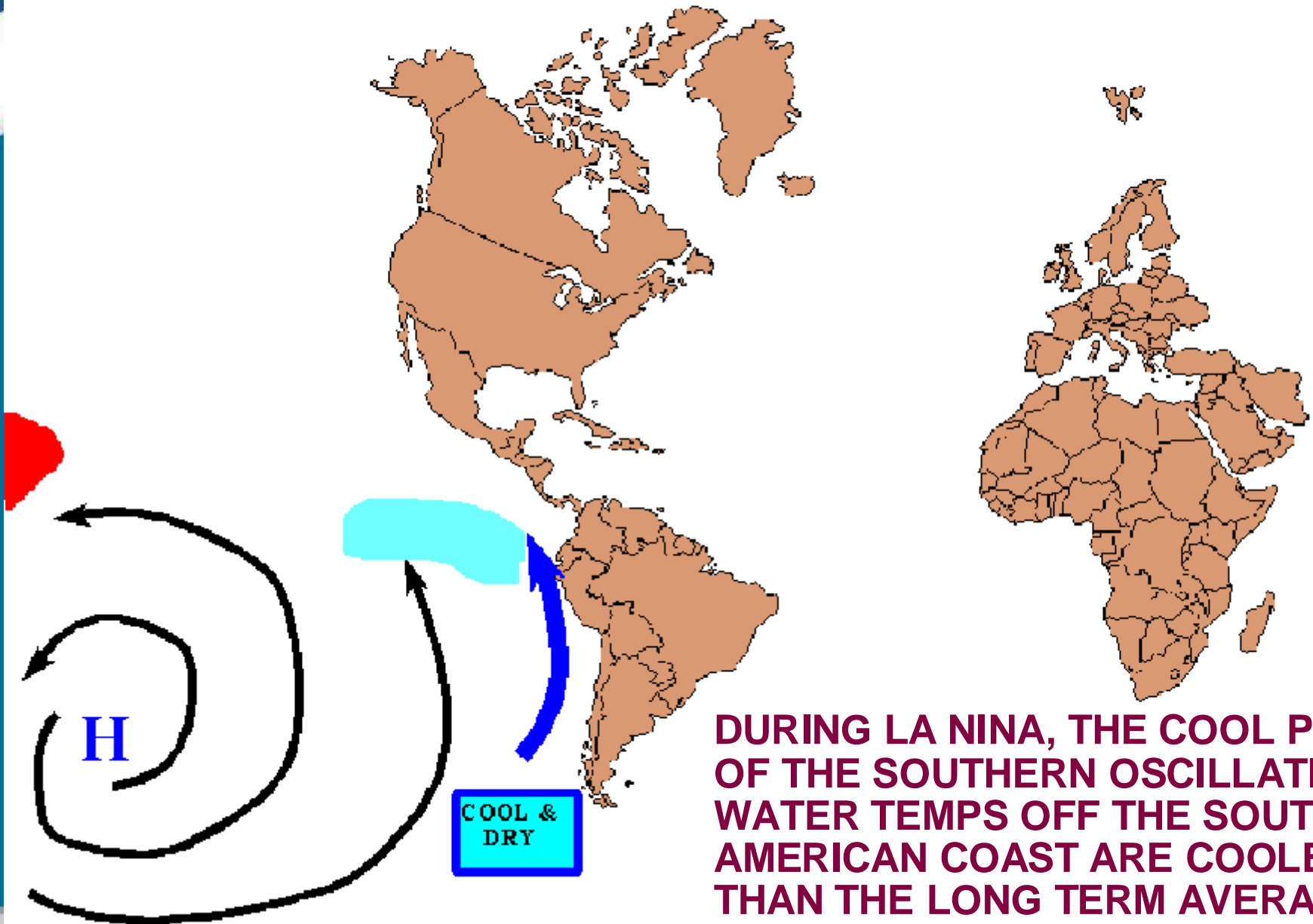


THIS HOSTILE ENVIRONMENT CAN HAVE SIGNIFICANT EFFECTS ON SEVERAL PARAMETERS:

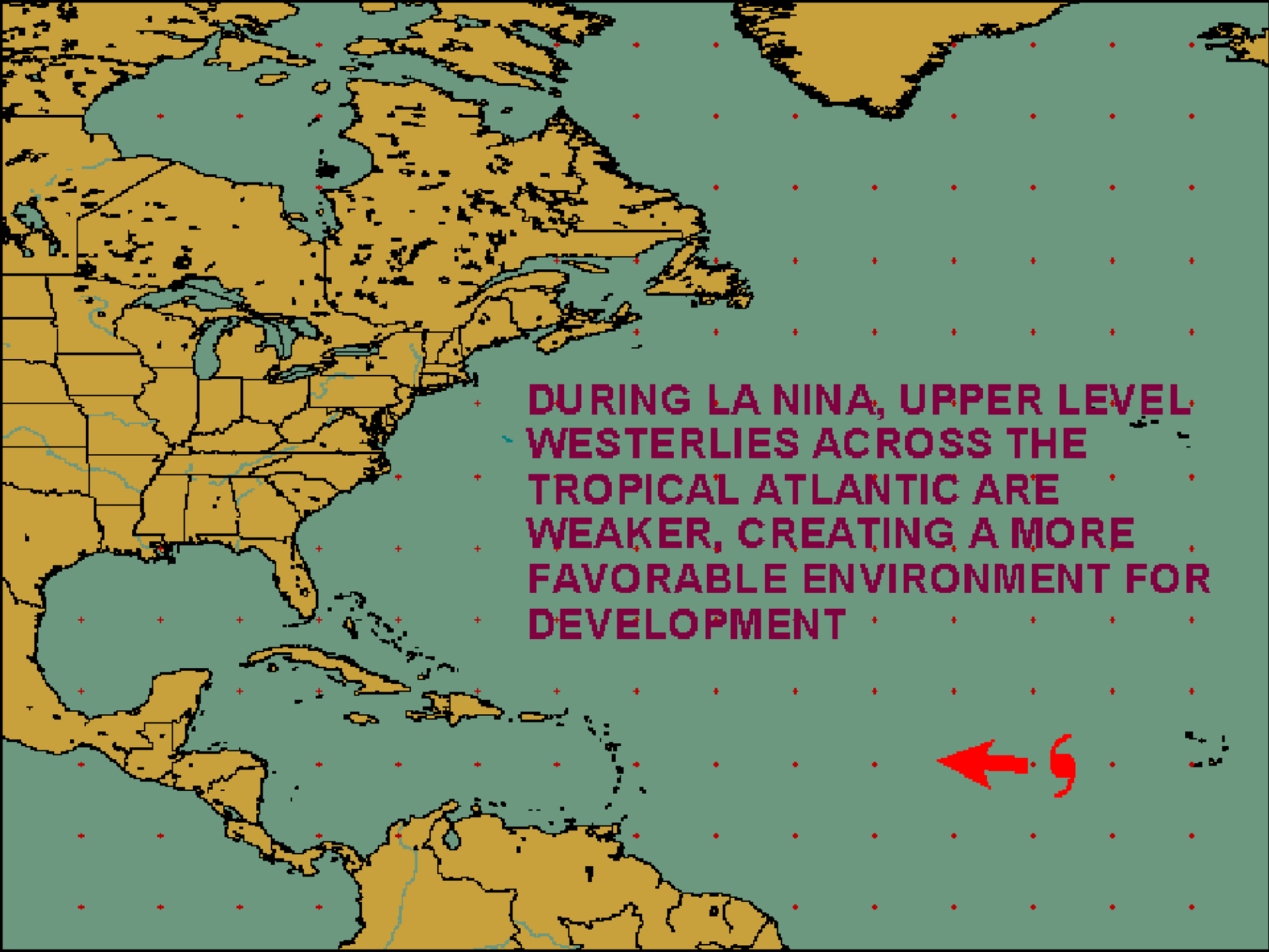
- **NUMBER OF HURRICANES**
- **NUMBER OF MAJOR HURRICANES**
- **AREA OF ORIGIN**
- **AREAS AFFECTED**

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LA NINA (COOL PHASE) CONDITIONS

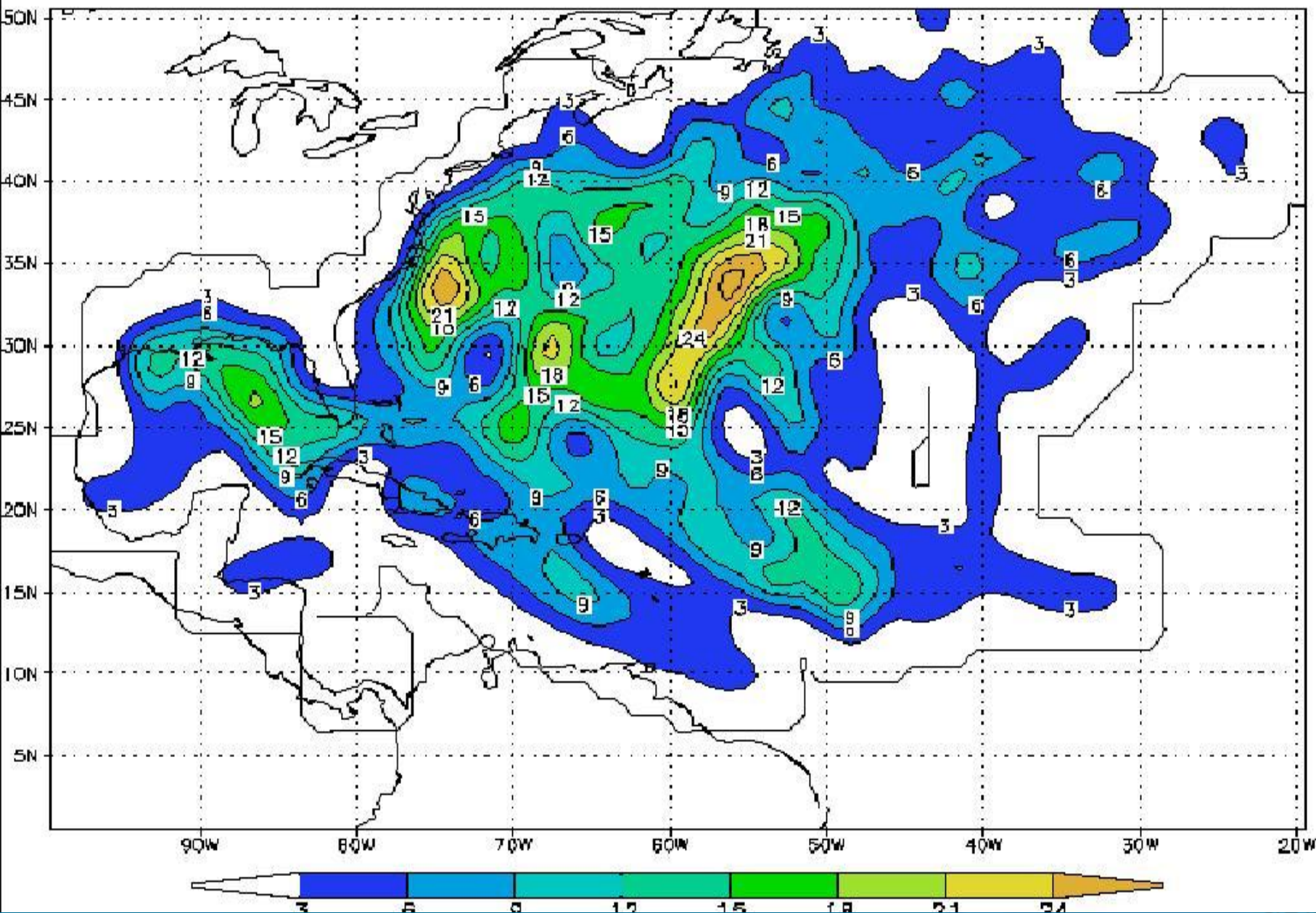


DURING LA NINA, THE COOL PHASE OF THE SOUTHERN OSCILLATION, WATER TEMPS OFF THE SOUTH AMERICAN COAST ARE COOLER THAN THE LONG TERM AVERAGE.



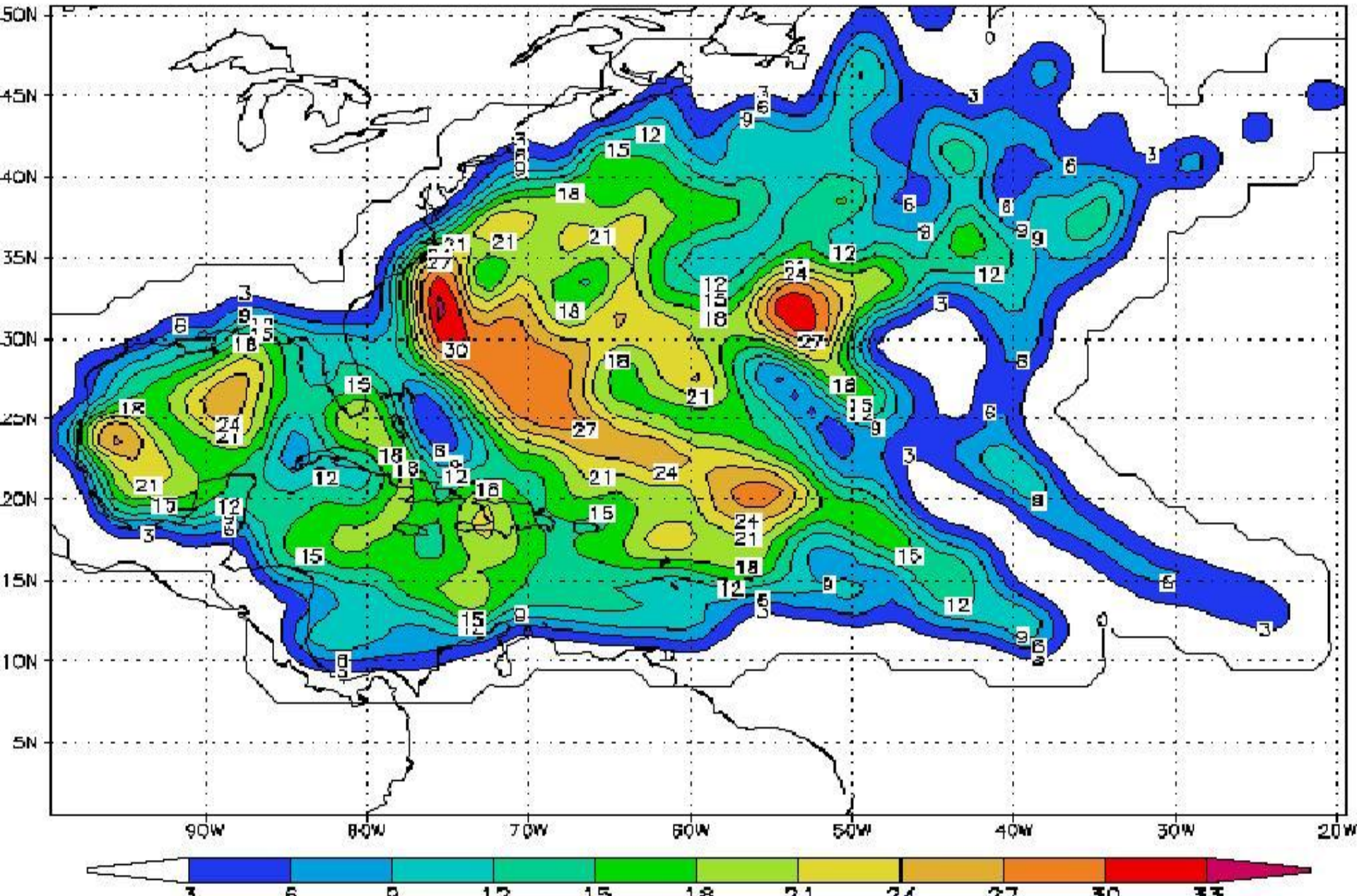
DURING LA NINA, UPPER LEVEL WESTERLIES ACROSS THE TROPICAL ATLANTIC ARE WEAKER, CREATING A MORE FAVORABLE ENVIRONMENT FOR DEVELOPMENT

Probability of an Hurricane in an El Nino Year



2008

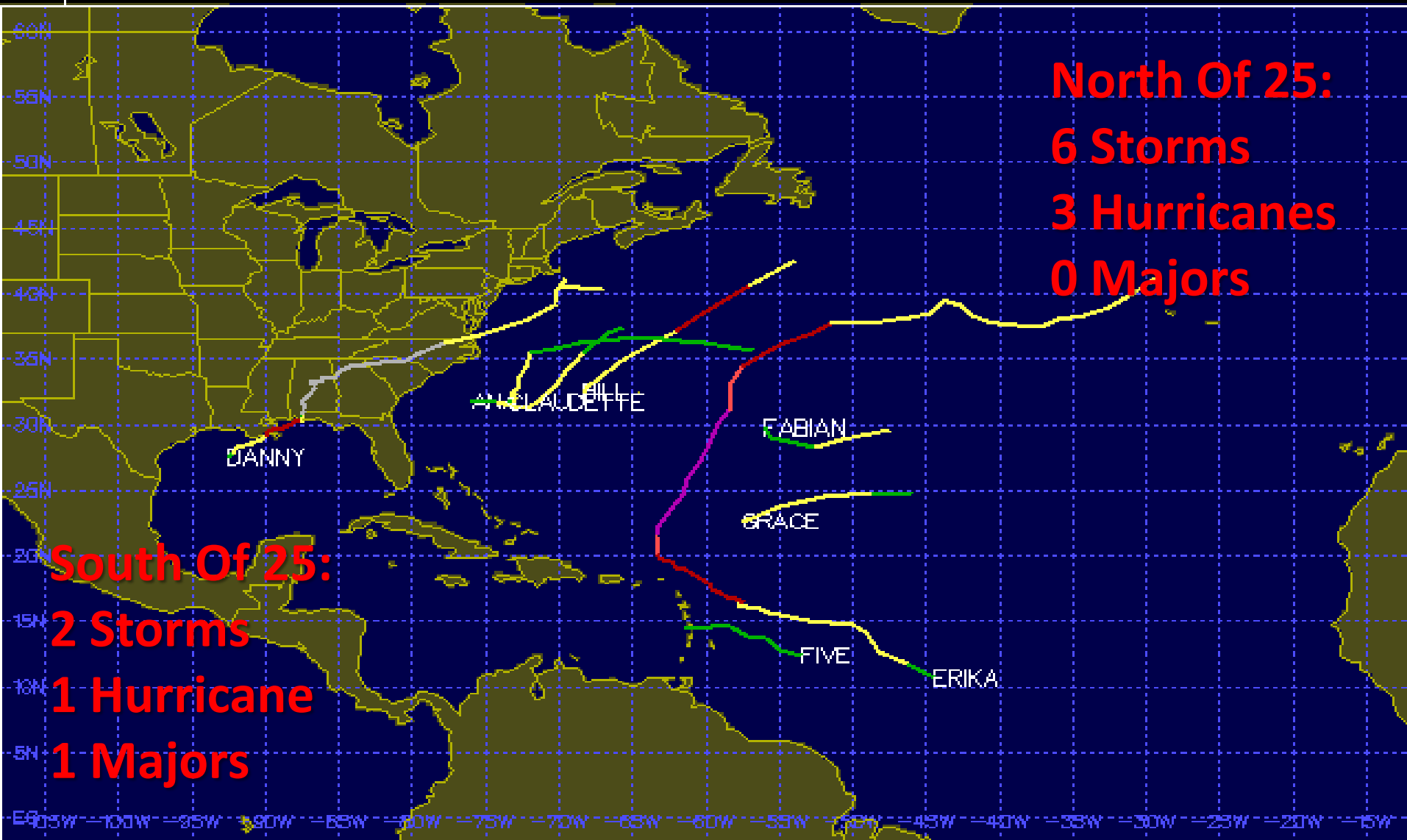
Probability of an Hurricane in a La Niña Year

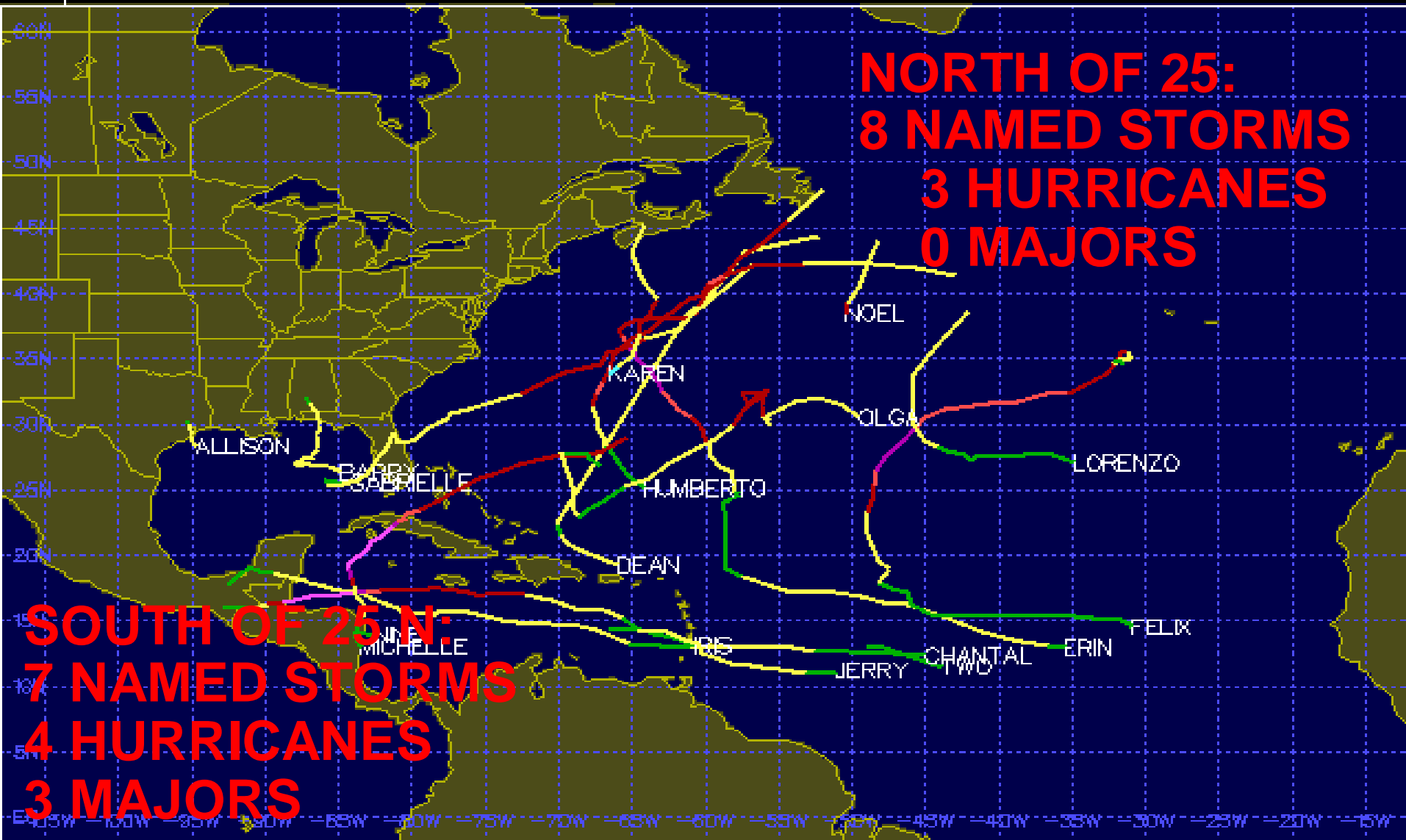


1997: El Nino

Tropical Storm Tracks

Year 1997H

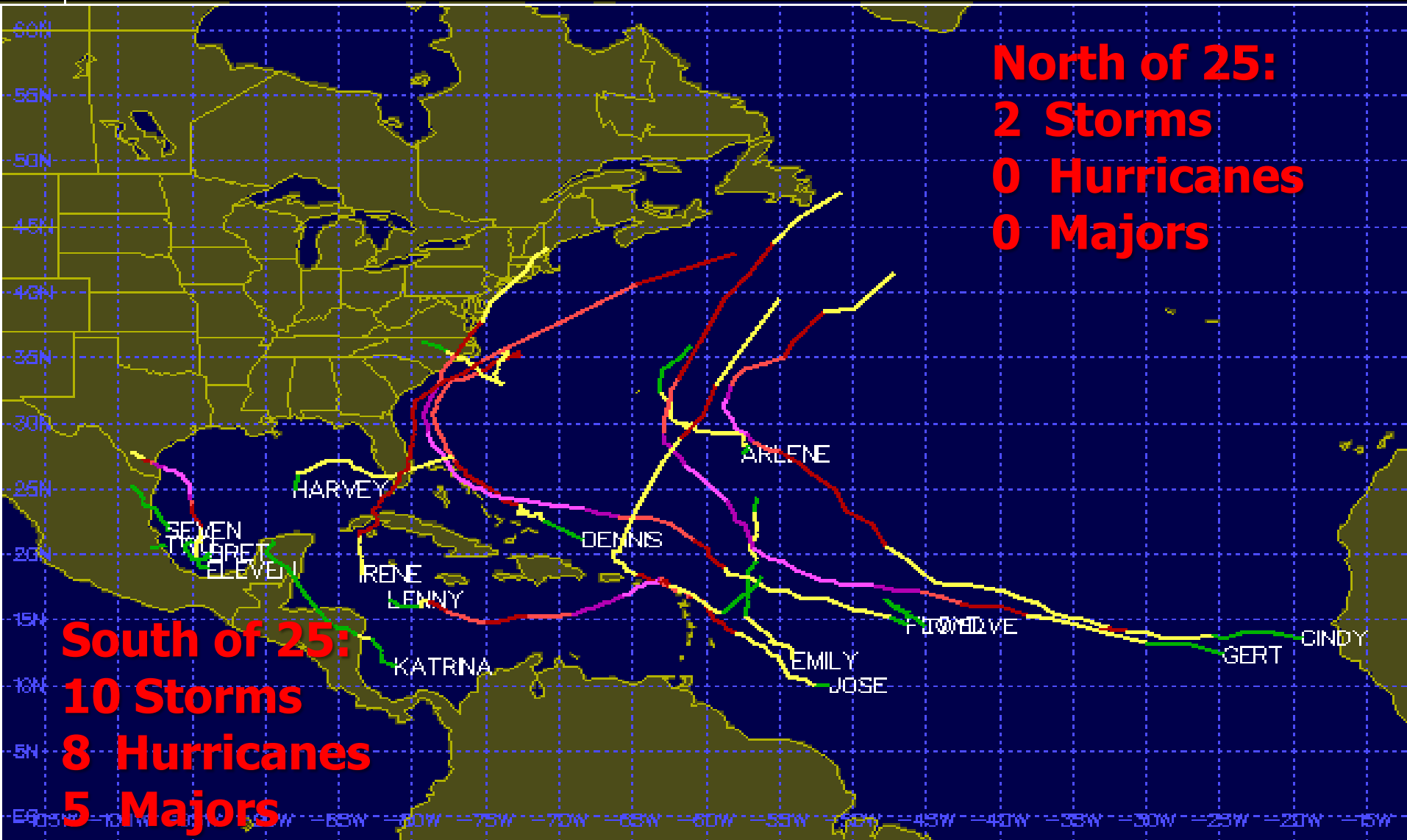




1999: La Nina

Tropical Storm Tracks

Year 1999H



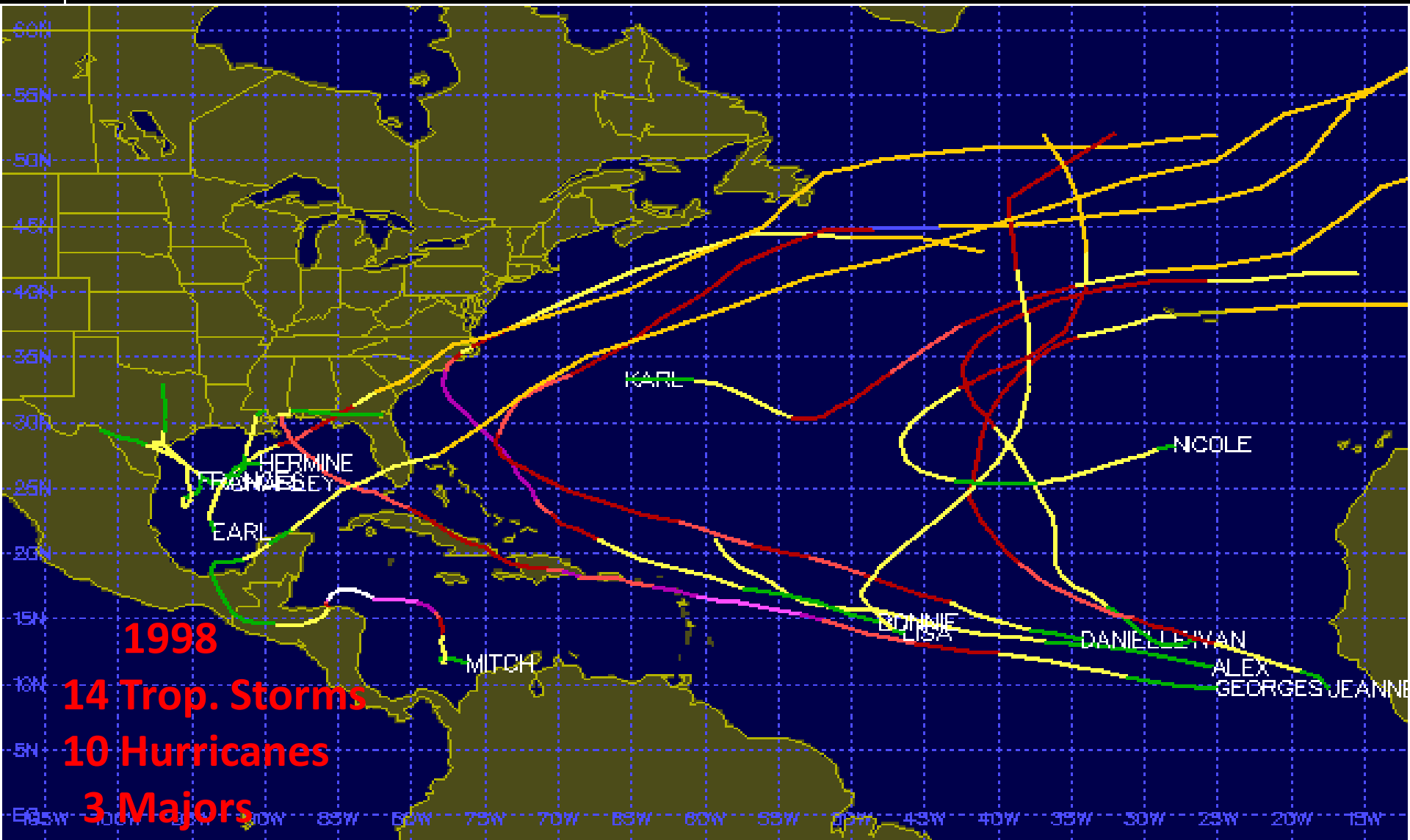
**Now, Let's Use Our New
Knowledge To Infer ENSO
Phase For A Couple Of
Past Examples:**

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El Nino or La Nina???

Year 1998

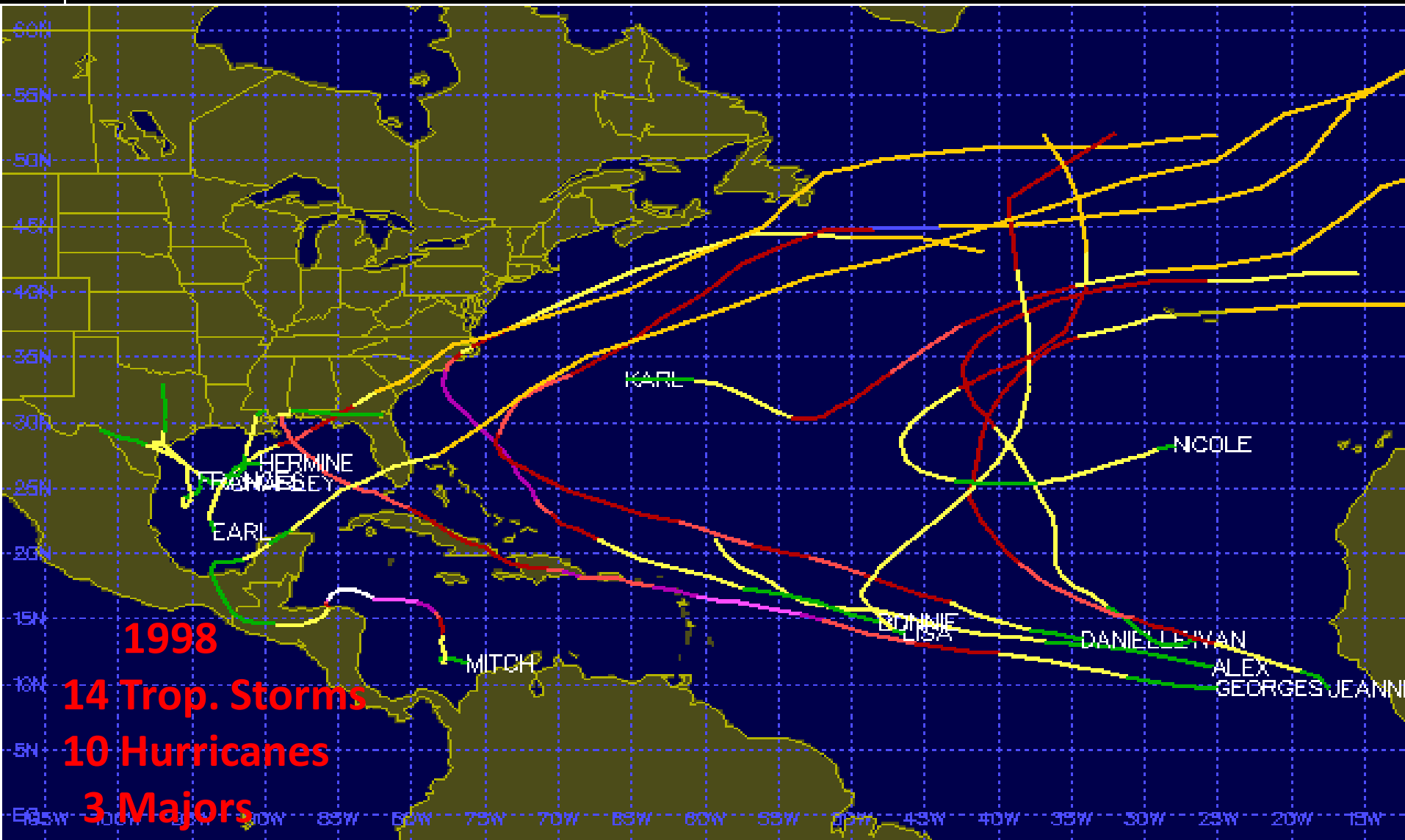
Tropical Storm Tracks



La Nina!!!

Tropical Storm Tracks

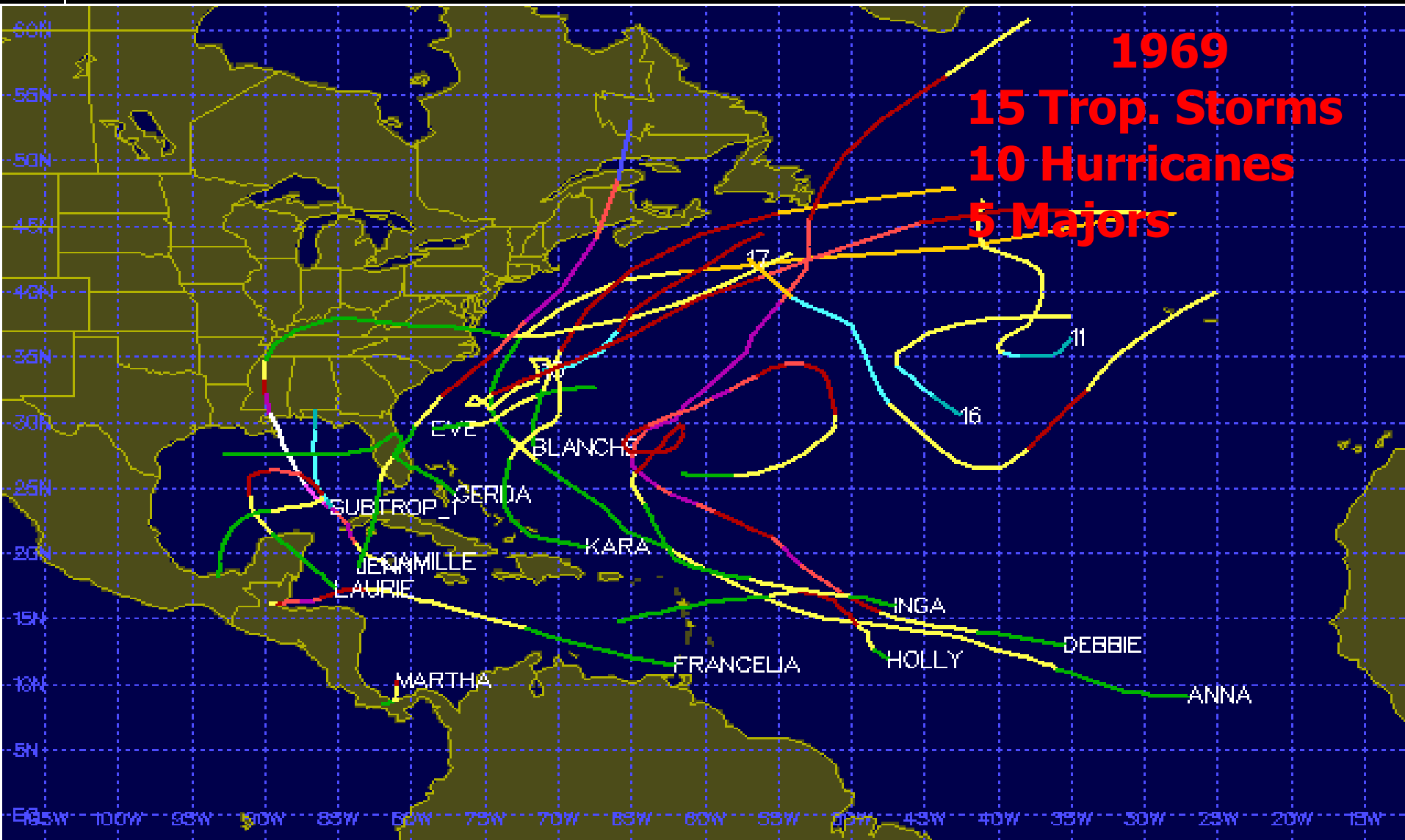
Year 1998



El Nino Or La Nina???

Year 1969

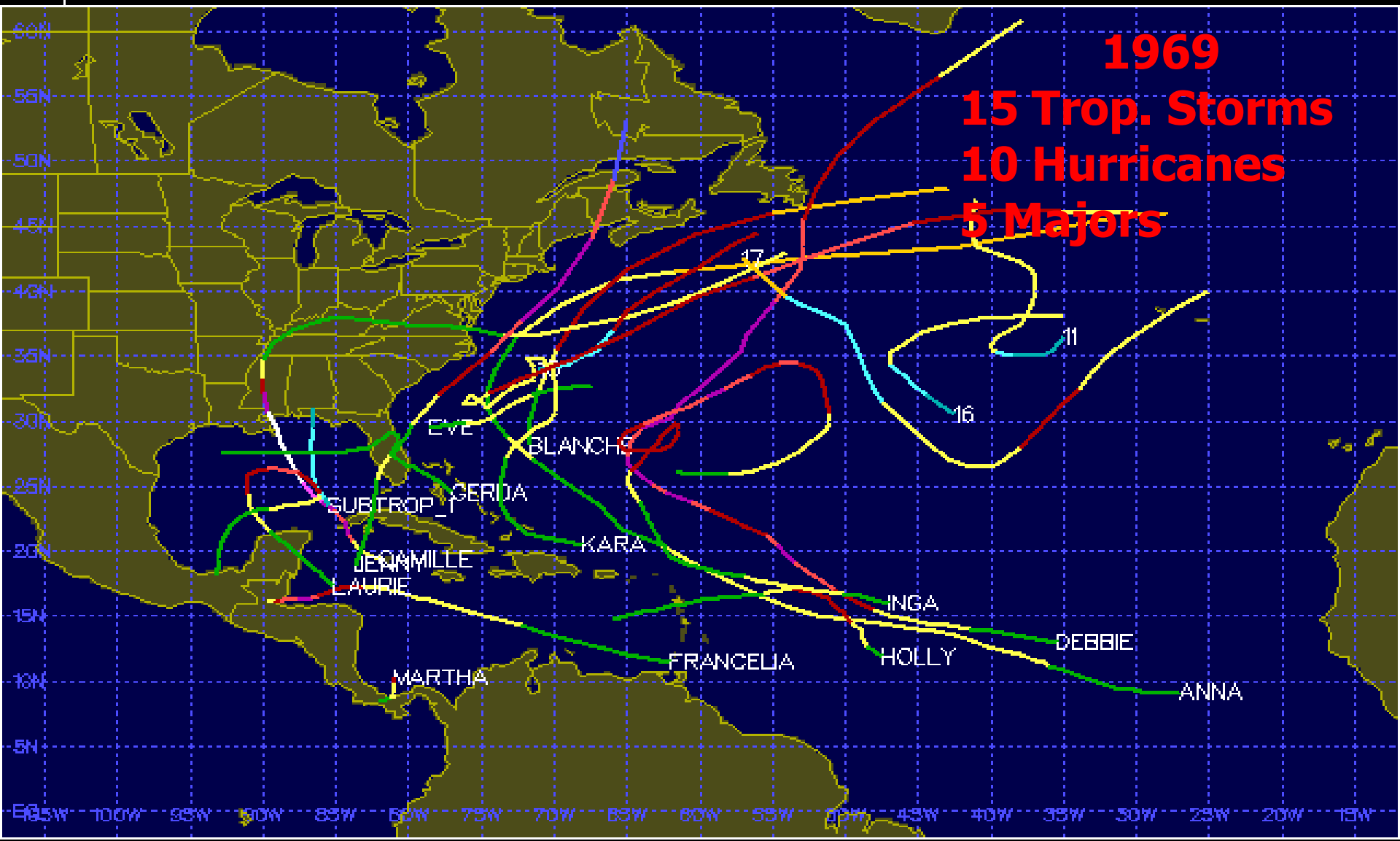
Tropical Storm Tracks



Slide Courtesy UNISYS

El Nino!!! (And A Fairly Good One, At That!) Year 1969

Tropical Storm Tracks

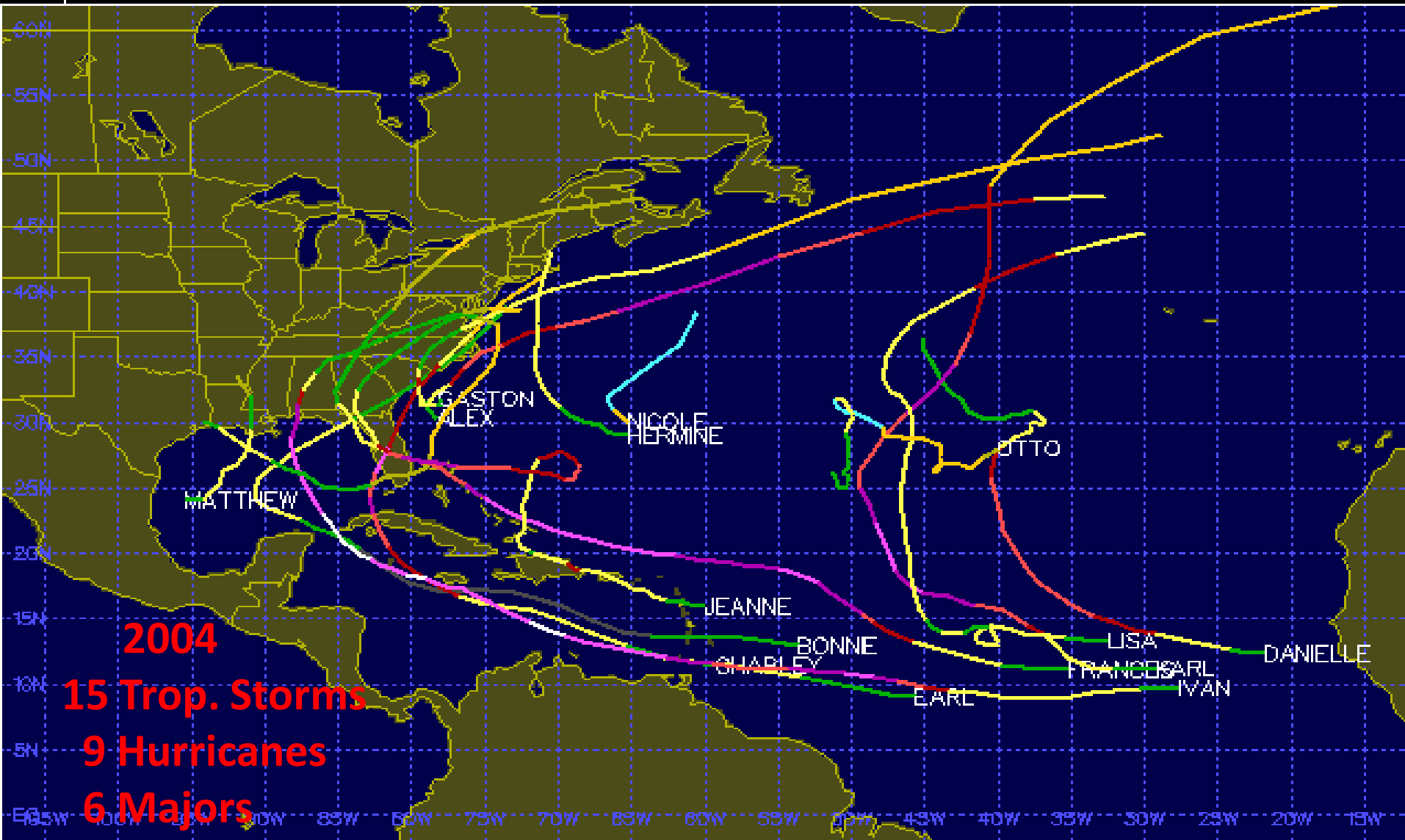


Slide Courtesy UNISYS

El Nino Or La Nina???

Tropical Storm Tracks

Year 2004



2004

15 Trop. Storms

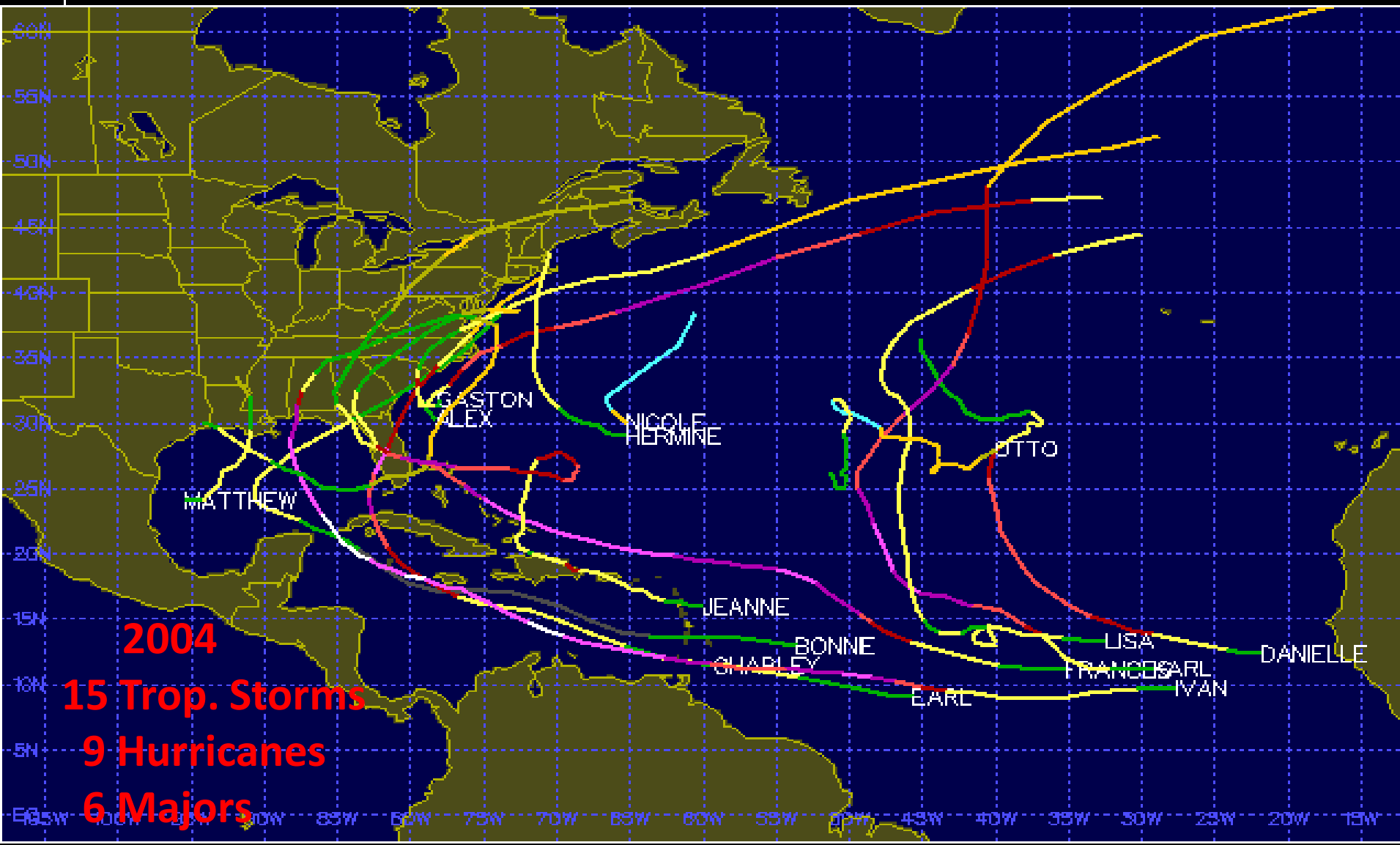
9 Hurricanes

6 Majors

El Nino Again !?!?!?

Tropical Storm Tracks

Year 2004



2004

15 Trop. Storms

9 Hurricanes

6 Majors

So What's Going On?

- **El Nino's & La Nina's Are NOT All Created Equal! They Can Come In Many Different Intensities.**
- **ENSO Can Actually Be A Good Indicator Of Overall Seasonal Activity... *Provided It Is A Strong Event... And That Doesn't Happen Often!***
- **For Weaker Events, Though, *There Is Obviously Something Else Going On Besides Just ENSO!***

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The Statistics

Tropical Cyclone Frequency in El Nino vs La Nina Years

Phase	# Cases	Total Storms	Hurricanes
Strong La Nina	2	10.5	7.5
Mod. La Nina	7	11.1	6.9
Weak La Nina	5	11.4	6.6
Weak El Nino	7	9.6	5.0
Mod. El Nino	10	8.8	4.4
Strong El Nino	4	6.8	3.0

Not So Much!

Large Difference

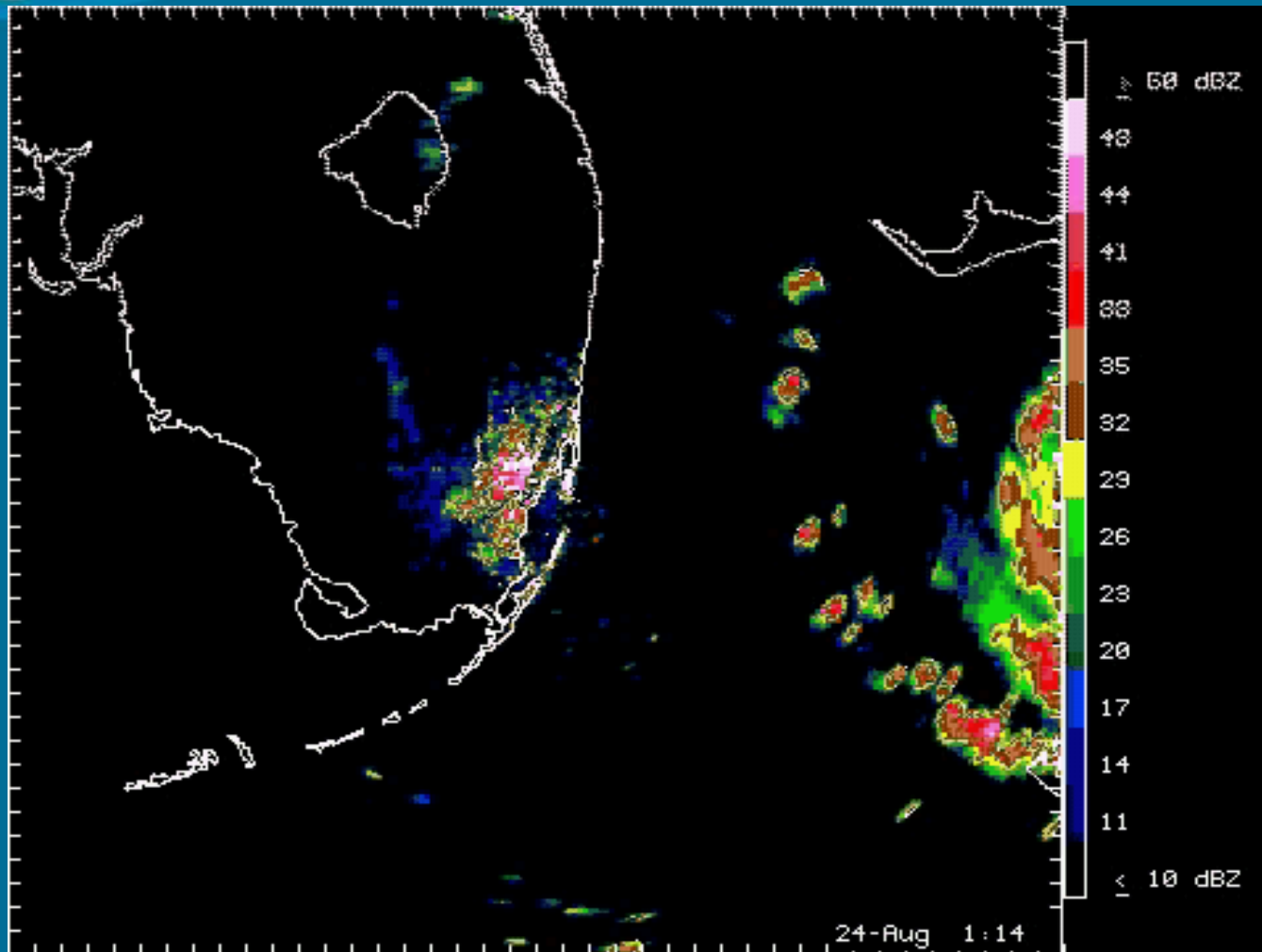
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***OVERALL THEN... STRONGER EL NINOS
TEND TO PRODUCE:***

- **FEWER OVERALL STORMS**
- **FEWER INTENSE STORMS**
- **FEWER MAJOR STORMS
AFFECTING THE UNITED STATES**

BUT...

Remember This Guy???

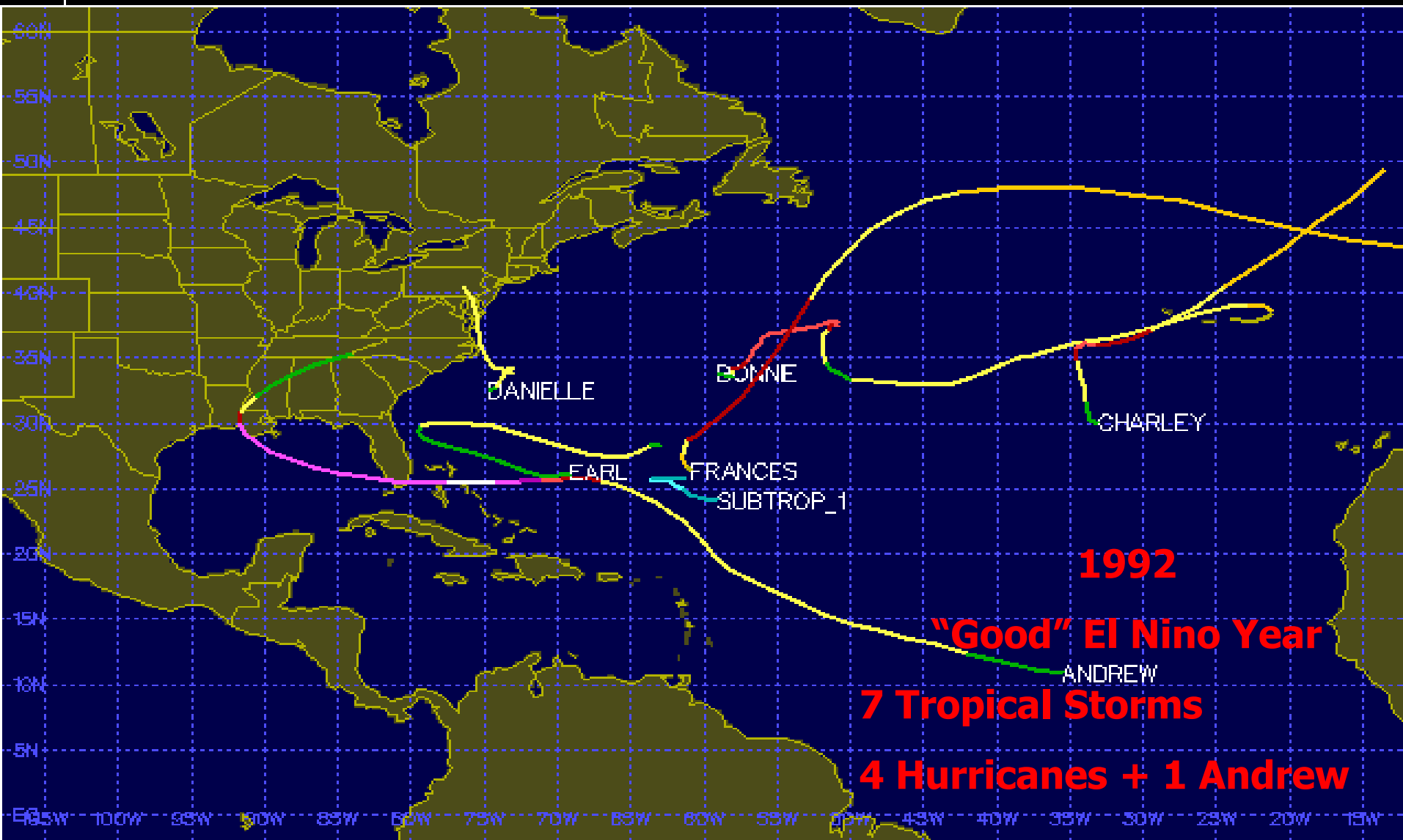


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Yes, This WAS An El Nino Year, & Numbers Were Down...

Tropical Storm Tracks

Year 1992



1992

"Good" El Nino Year

7 Tropical Storms

4 Hurricanes + 1 Andrew

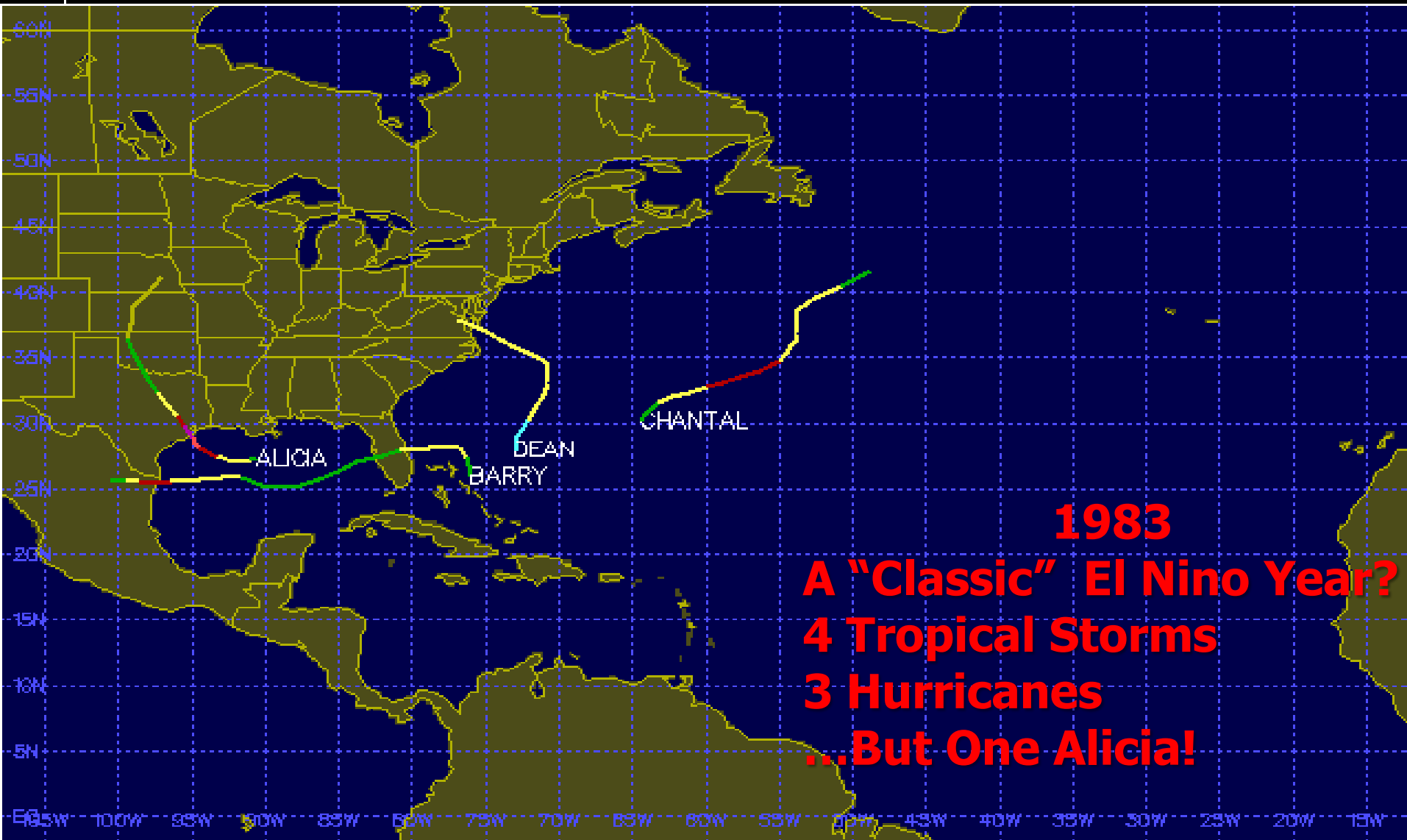
But Could It Really Be Considered Quiet???

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Yet Another Perplexing Example...

Tropical Storm Tracks

Year 1983



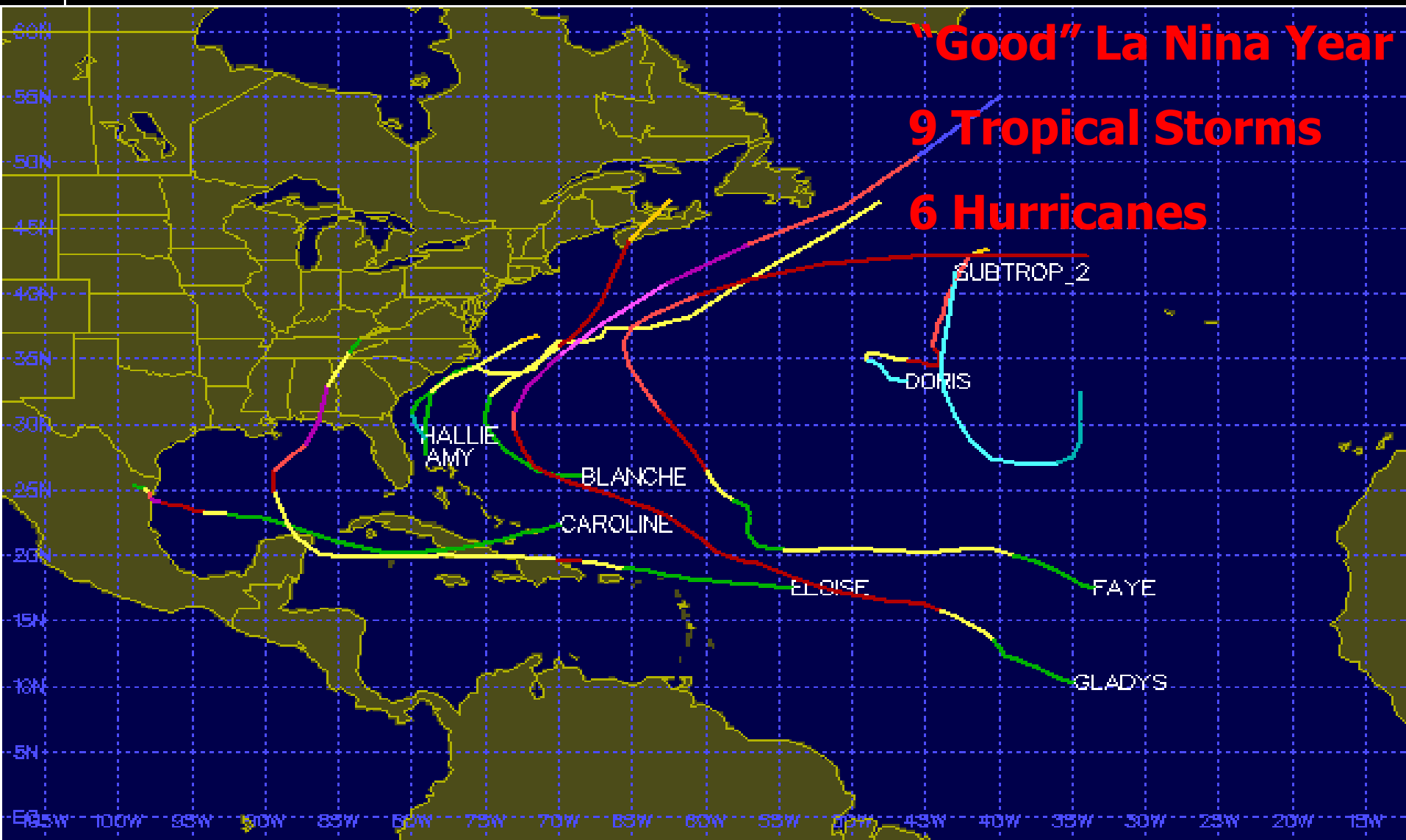
1983
A "Classic" El Nino Year?
4 Tropical Storms
3 Hurricanes
...But One Alicia!

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1975

Year 1975

Tropical Storm Tracks



“Good” La Nina Year
9 Tropical Storms
6 Hurricanes

Slide Courtesy UNISYS

What...If Any... Conclusions CAN We Make Regarding El Nino & La Nina?

- **While Weak To Moderate El Nino's & La Nina's Are Subject To Many Other Atmospheric & Oceanic Factors, A Strong El Nino Does Tend To Overshadow Other Factors.**
- ***IN A STRONG EL NINO YEAR:***
 - **THE TROPICAL LOWER ATMOSPHERE IS HIGHLY SHEARED, INHIBITING DEVELOPMENT**
 - **PURELY TROPICAL SYSTEMS ARE AT A MINIMUM**
 - **STORMS THAT DO FORM ARE OFTEN EITHER INITIATED OR ENHANCED BY NON-TROPICAL PROCESSES**

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A Strong El Nino Will Also...

- **...Tend To Shift The Preferred Genesis Area Farther North (A Reflection Of More Non, or Semi Tropical Formation Processes**
- **It Will Not...However... Prevent The “Rogue” Storm Which Finds A Brief Window Of Opportunity... See Andrew And Alicia!!**

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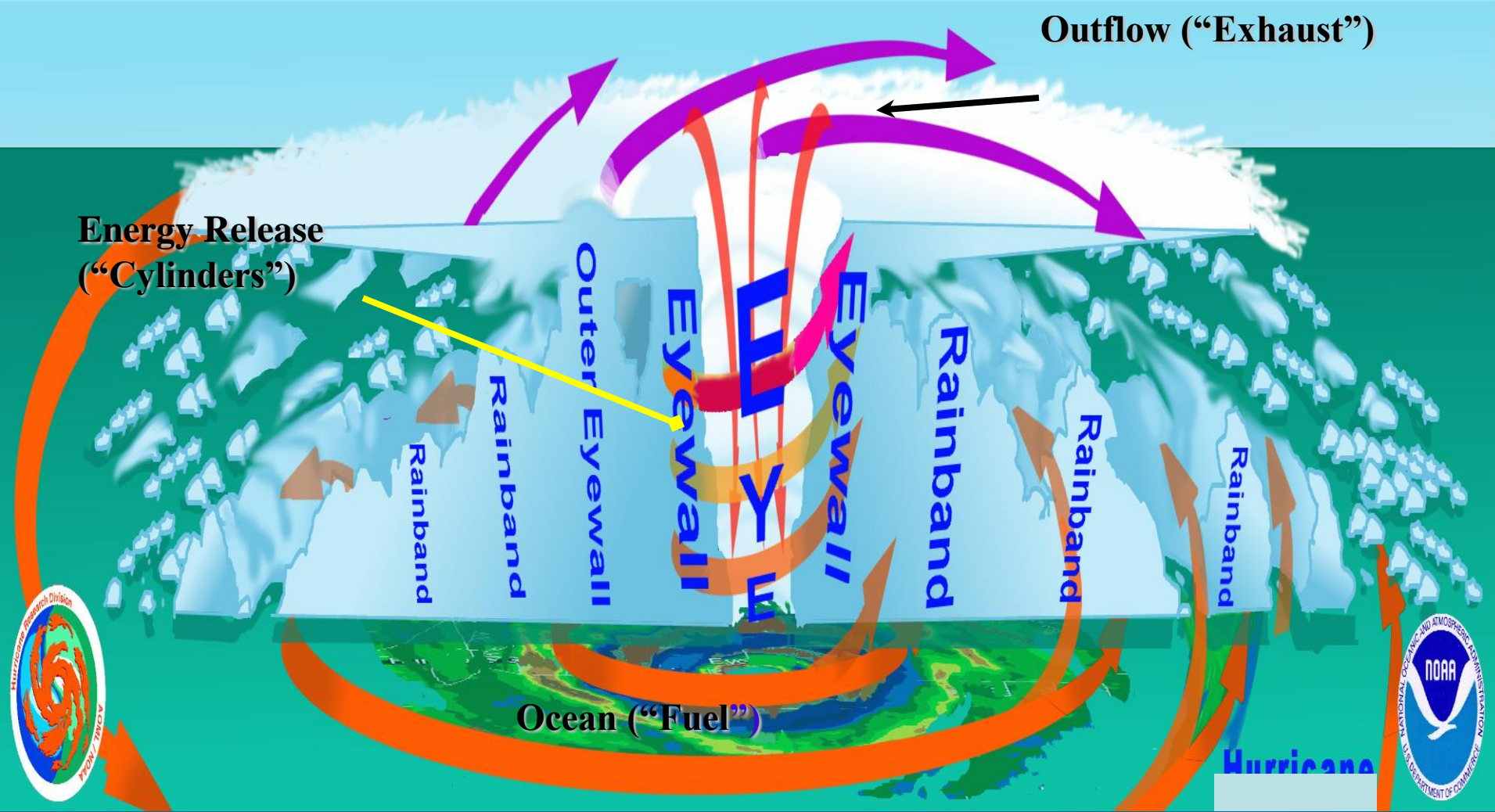
But... The Question Remains... If Weak To Moderate ENSO Events Do NOT By Themselves Dictate Seasonal Activity...

What Does???

The Clues May Lie In A Fundamental Understanding Of What A Tropical Cyclone Really Is...

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Nature's Great Heat Engine... The Hurricane



**"Fuel" (heat) Is Processed Into Energy In The "Cylinders" (Eyewall & Rainbands)
And The Spent Fuel Is Expelled As "Exhaust"**

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If Any Of The Three Main Parts Of The Engine...

- 1. Availability of Fuel***
- 2. Ability To Process The Fuel Into Energy***
- 3. Ability to Exhaust The Waste***

... Are Interfered With... The Engine Cannot Function Efficiently

What Affects These Parameters?

1. Availability of Fuel

Oceanic Heat Content: The Atlantic Thermohaline Circulation Provides a Background of Warmer Than Normal Values

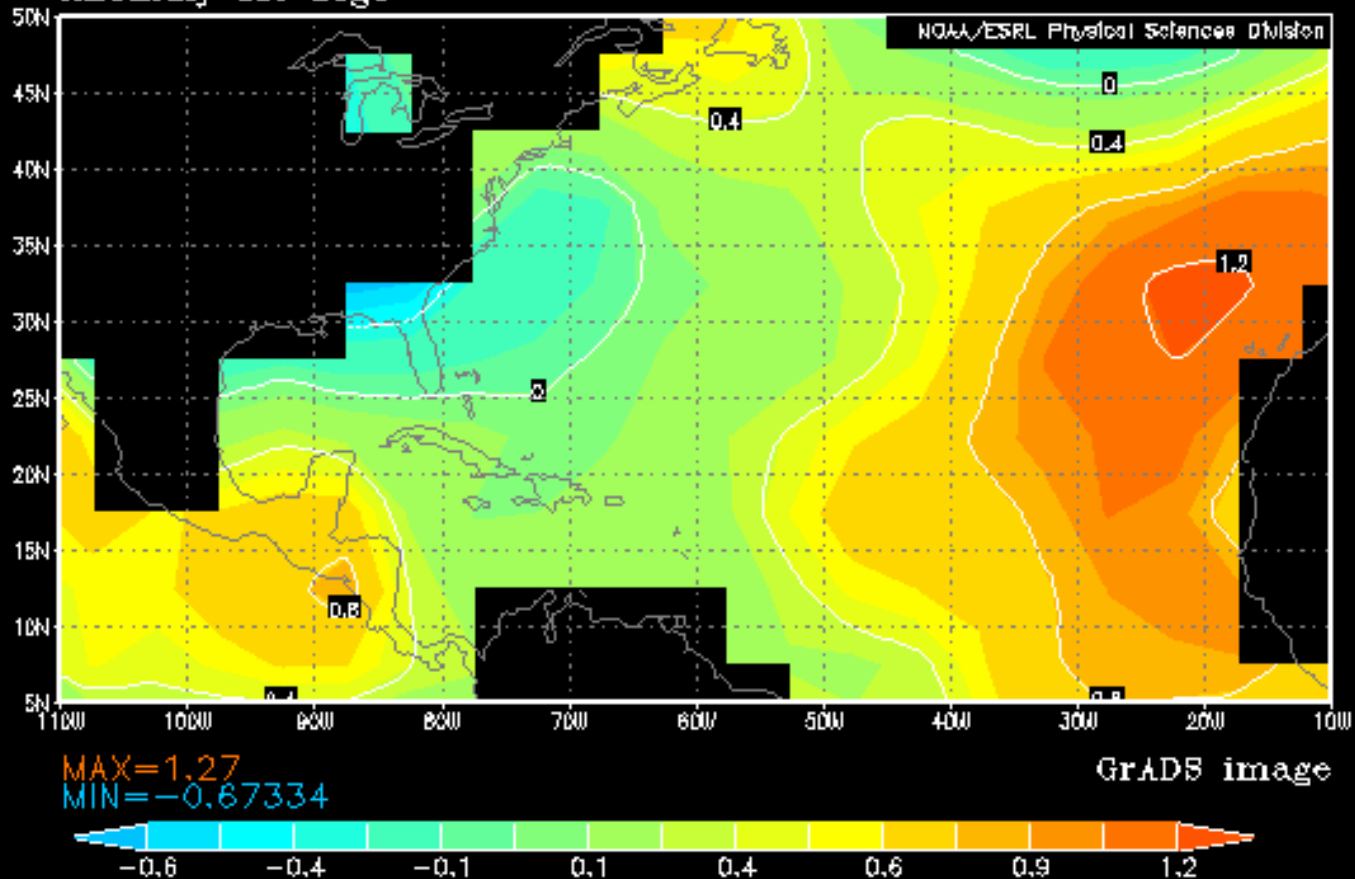
But Intraseasonal Variables Such as Upwelling and Reduced Insolation (Strong Saharan Air Layer) Can Reduce These Values In Different Parts Of The Basin In Any Given Season.

Let's Look At SST's Over The Last Few Years...

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lon: plotted from -110 to -10
lat: plotted from 5.0 to 50.0
t: averaged over Aug 2004 to Oct 2004
lev: 0

Anomaly sst degC



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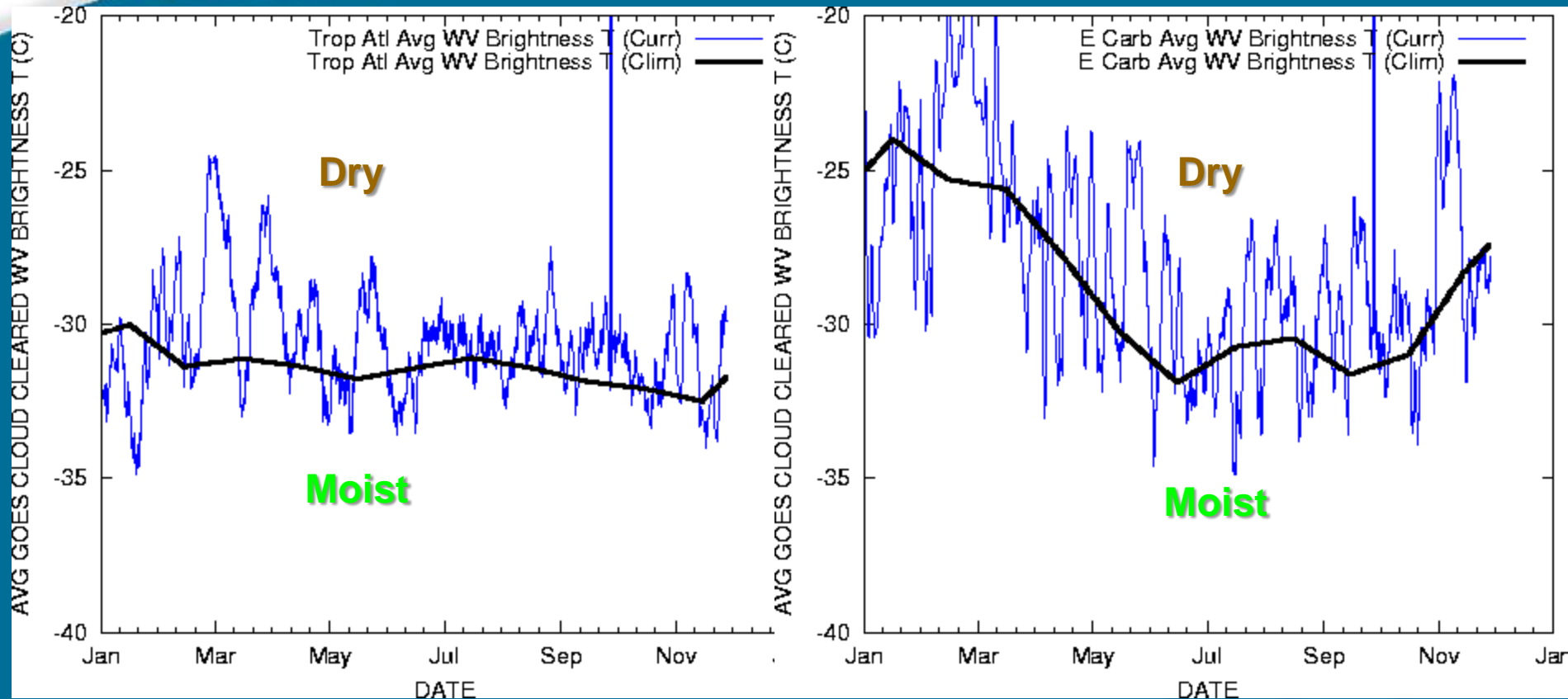
A satellite image of the Atlantic Ocean showing a large, dark, dusty plume extending from the African continent. The plume is a thick, brownish-grey layer that covers a significant portion of the ocean's surface. The African continent is visible on the right side of the image, with its coastline and some internal features. The ocean surface is dark blue, and the plume is a stark contrast to it. The text is overlaid on the image in orange and yellow colors.

**African Dust Blankets Much of the Atlantic
“Main Development Region”, or MDR. This
continued through much of 2006 & 2007**

**This Saharan Air Layer (SAL) Can Reduce The
Amount Of Surface Heating Of The Ocean By
Interfering With Receipt of Solar Energy**

21/2008

In 2007, Dry Air In The Middle To Upper Levels Over The Tropical Atlantic Ocean And Caribbean Sea Was More Pronounced Than Average During The Hurricane Season (Figures Courtesy CIRA)

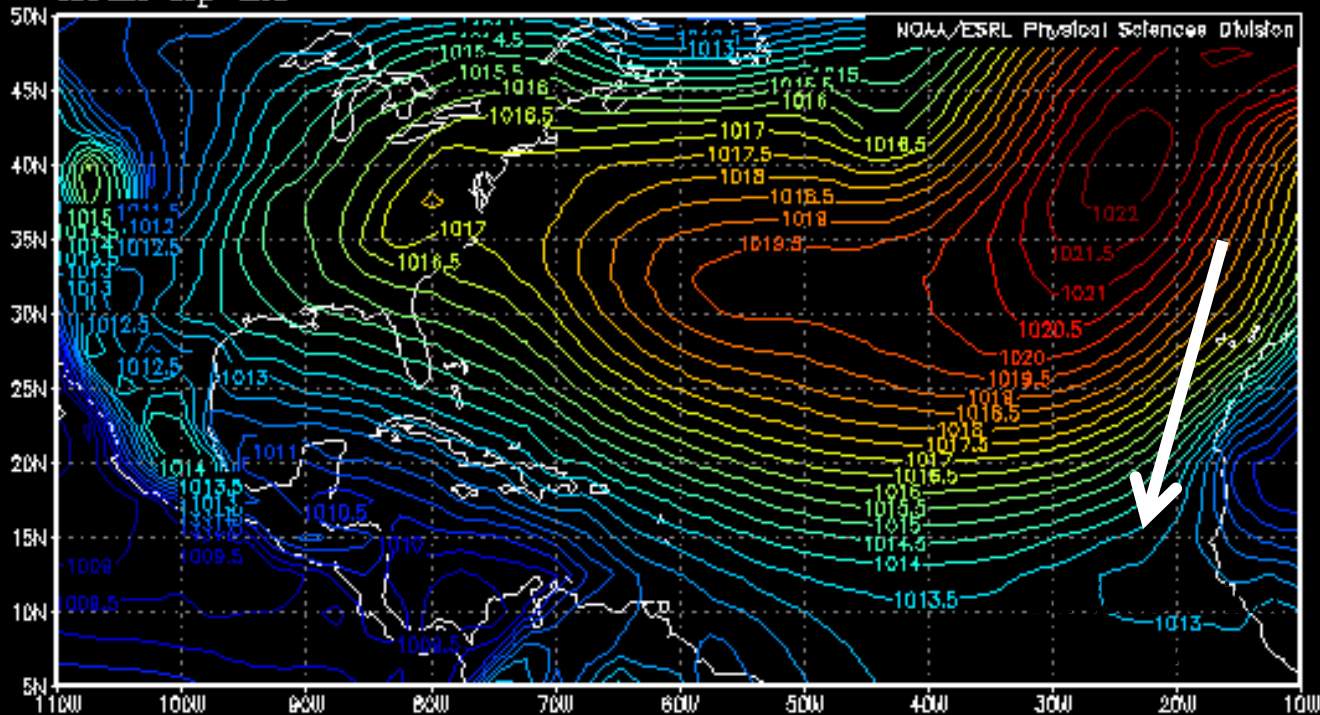


5/21/2008

In 2007... The Strong High Pressure Over The East Atlantic Produced Cool Upwelling In Much Of The Main Hurricane Development Region (MDR)

lon: plotted from -110 to -10
lat: plotted from 5.0 to 50.0
t: averaged over Aug 1 2007 to Oct 25 2007
lev: 0

Mean slp mb

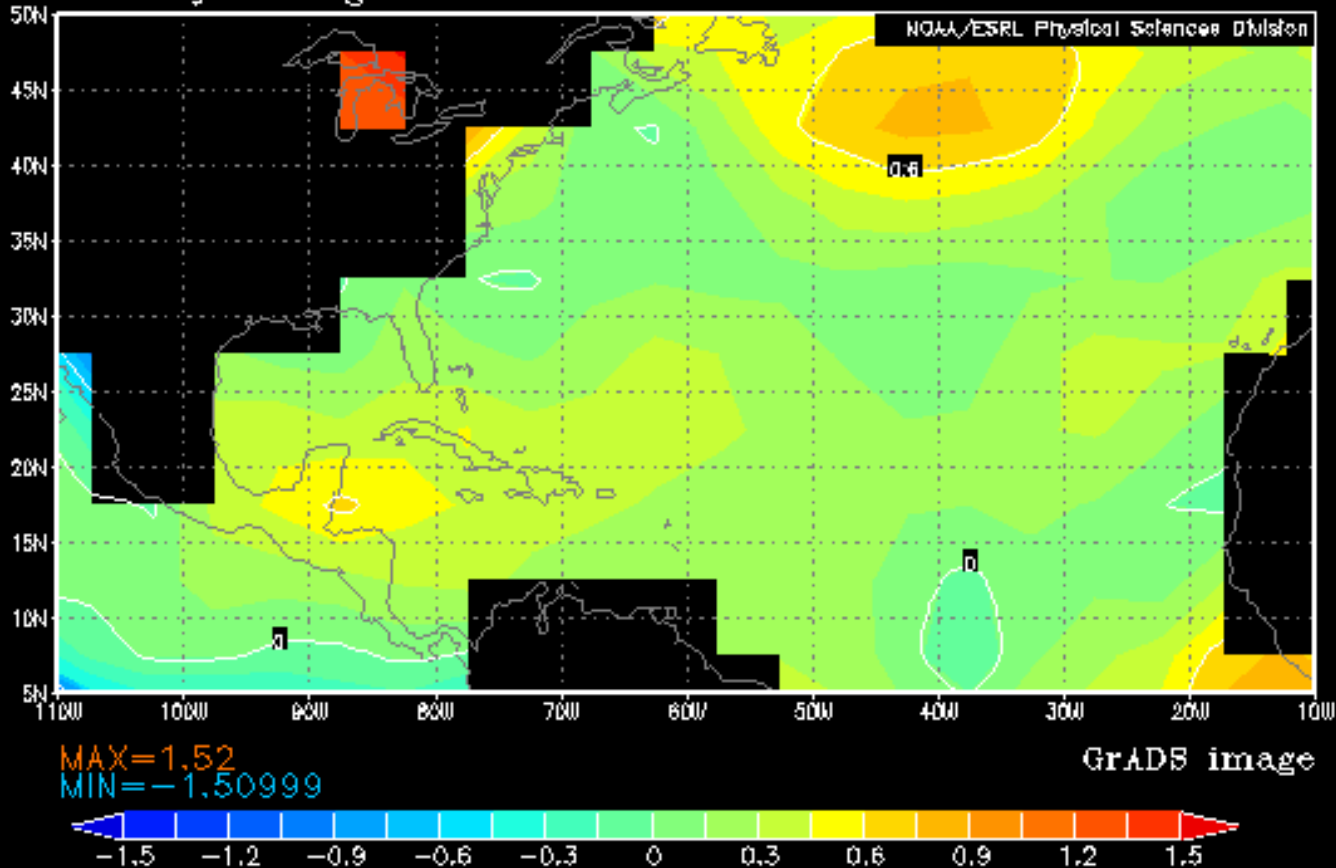


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The Net Result... Cooler SST's Over The East Atlantic

lon: plotted from -110 to -10
lat: plotted from 5.0 to 50.0
t: averaged over Aug 2007 to Sep 2007
lev: 0

Anomaly sst degC

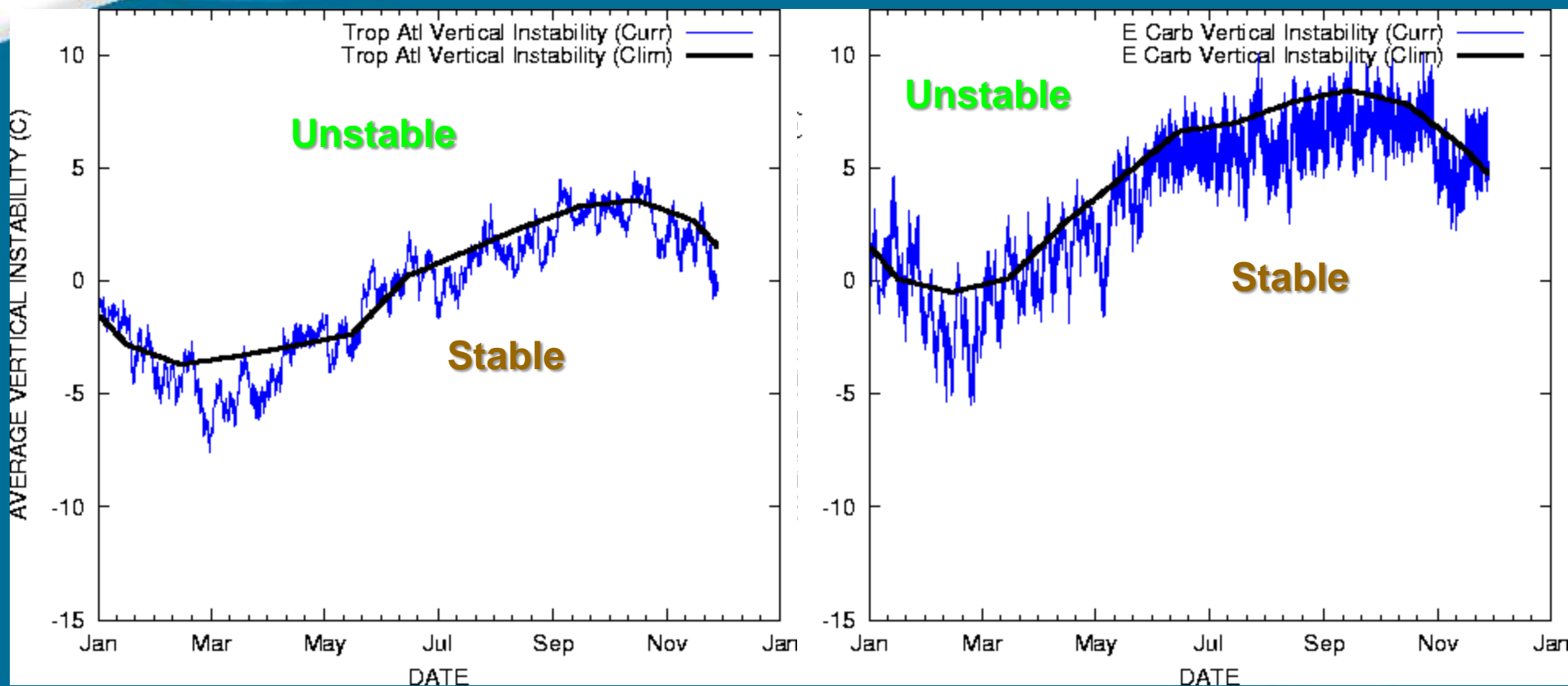


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2. Ability To Process Fuel Into Energy

Atmospheric Stability: The Ability of the Lower Atmosphere To Develop & Sustain Convection In Seedling Disturbances. This is Determined To A Large Extent By The Positioning Of Synoptic Scale Features In The Tropics... Also Subject To Significant Intraseasonal Variation!

Instability over the tropical Atlantic Ocean and Caribbean Sea was less than average during the hurricane season (figures courtesy CIRA)



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What Affects These Parameters?

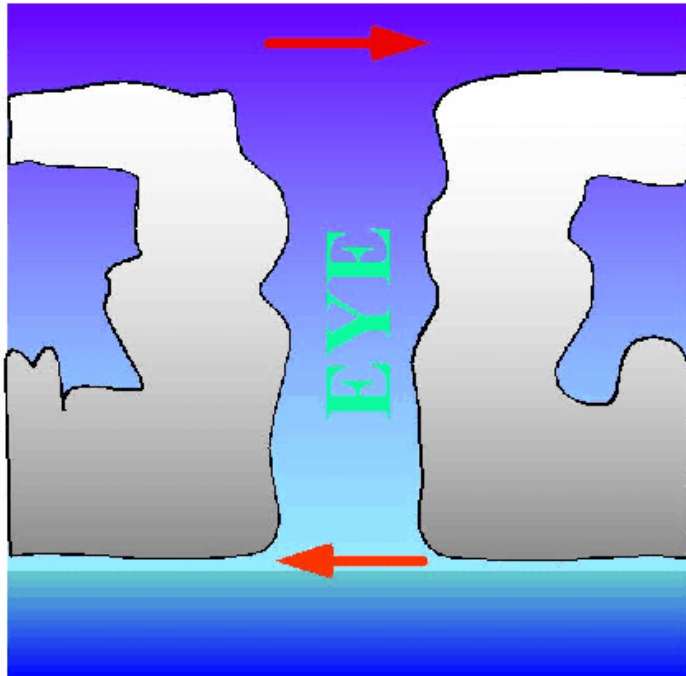
2. Ability To Process Fuel Into Energy

Vertical Shear: High Shear Values Adversely Affect The Ability of Convection To Efficiently Organize Around The Center

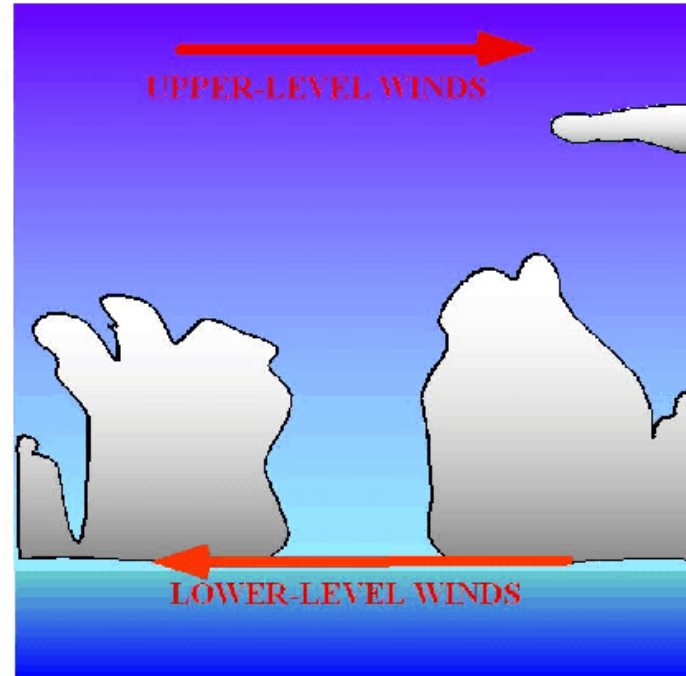
Strong Wind Shear Inhibits The “Cylinders”... By Disrupting Their Efficiency

(This Is Also Why We Tend To See Fewer Storms In El Nino Years)

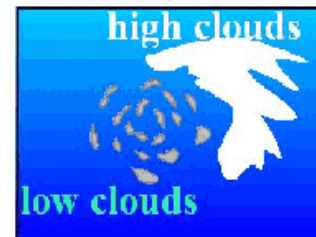
Effects of Vertical Wind Shear (V_z) on Tropical Cyclones



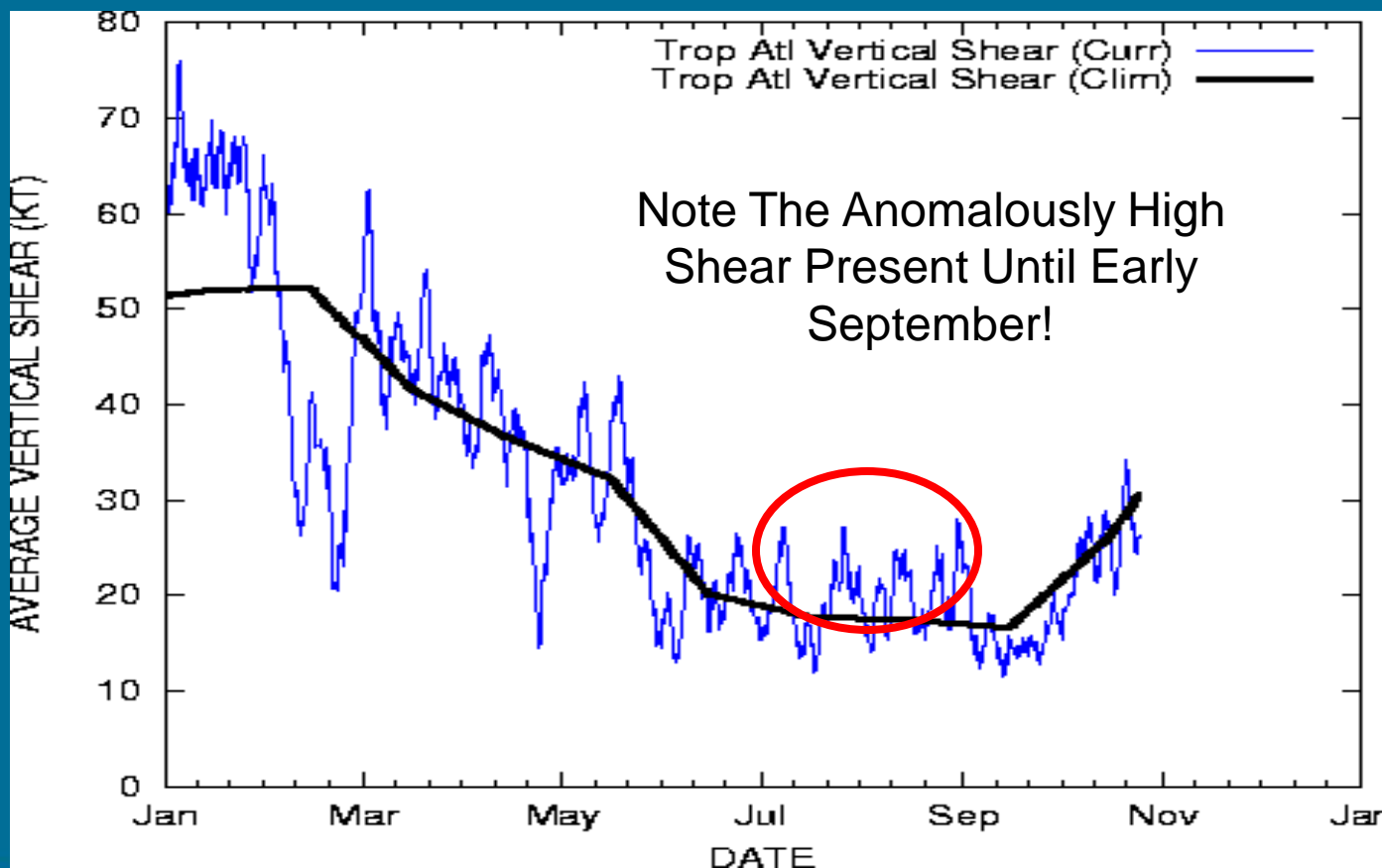
WEAK SHEAR = FAVORABLE



STRONG SHEAR = UNFAVORABLE



While A Warm ENSO Event (El Nino) Certainly Correlates With Above Normal Shear... A Quick Look At The 2007 Shear... With La Nina Conditions in Place... Shows That Shear Over The Tropical Atlantic Is Clearly Dependent On More Than Just ENSO Phase!

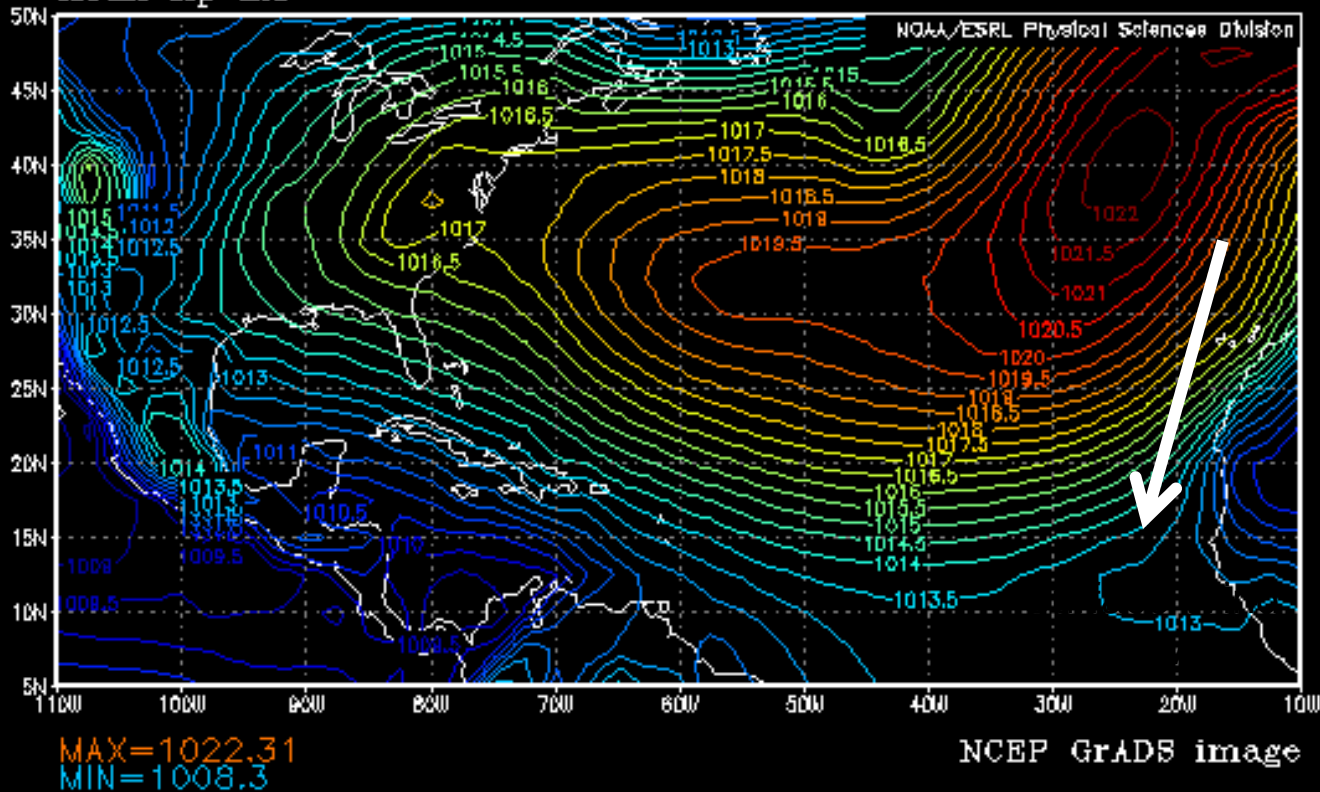


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In 2007... The Strong High Pressure Over The East Atlantic Produced Stronger Than Normal Shear Across Much Of The Tropics

lon: plotted from -110 to -10
lat: plotted from 5.0 to 50.0
t: averaged over Aug 1 2007 to Oct 25 2007
lev: 0

Mean slp mb



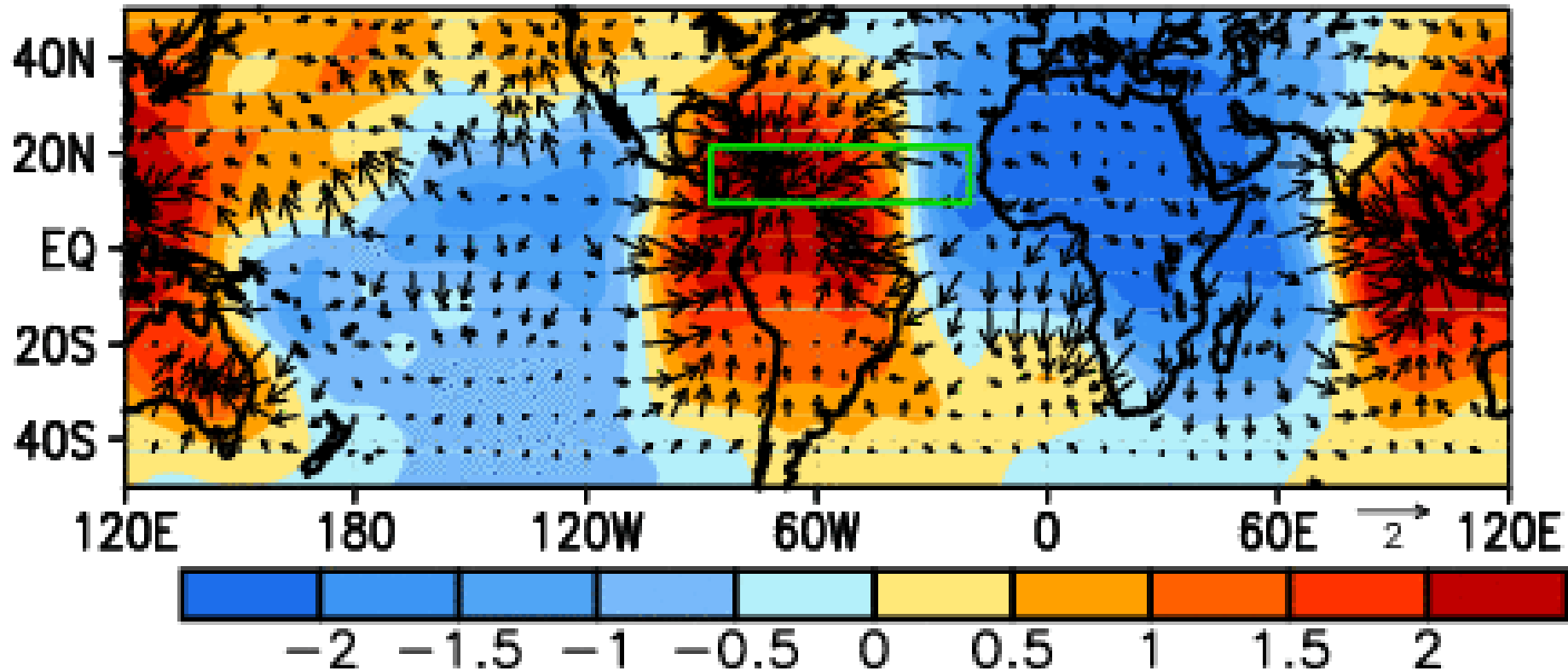
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What Affects The “Exhaust”?

- 3. Divergent Pattern Aloft To Enhance Outflow**
Anomalously Strong Convergence Across The MDR Inhibits Storms From Sustaining Strong Convection By Limiting The Efficiency Of The “Exhaust” In The Upper Levels. This Pattern Was Evident Throughout Both 2006 & 2007.

2006

UPPER LEVEL "EXHAUST" POTENTIAL

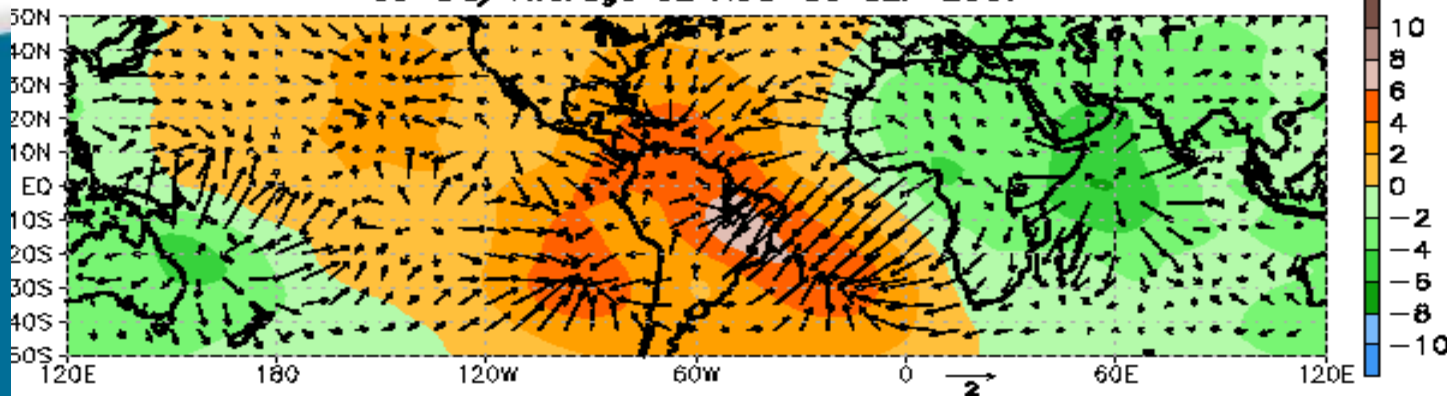


Very High Values = Exhaust Is Choked Off = Less Potential for Development

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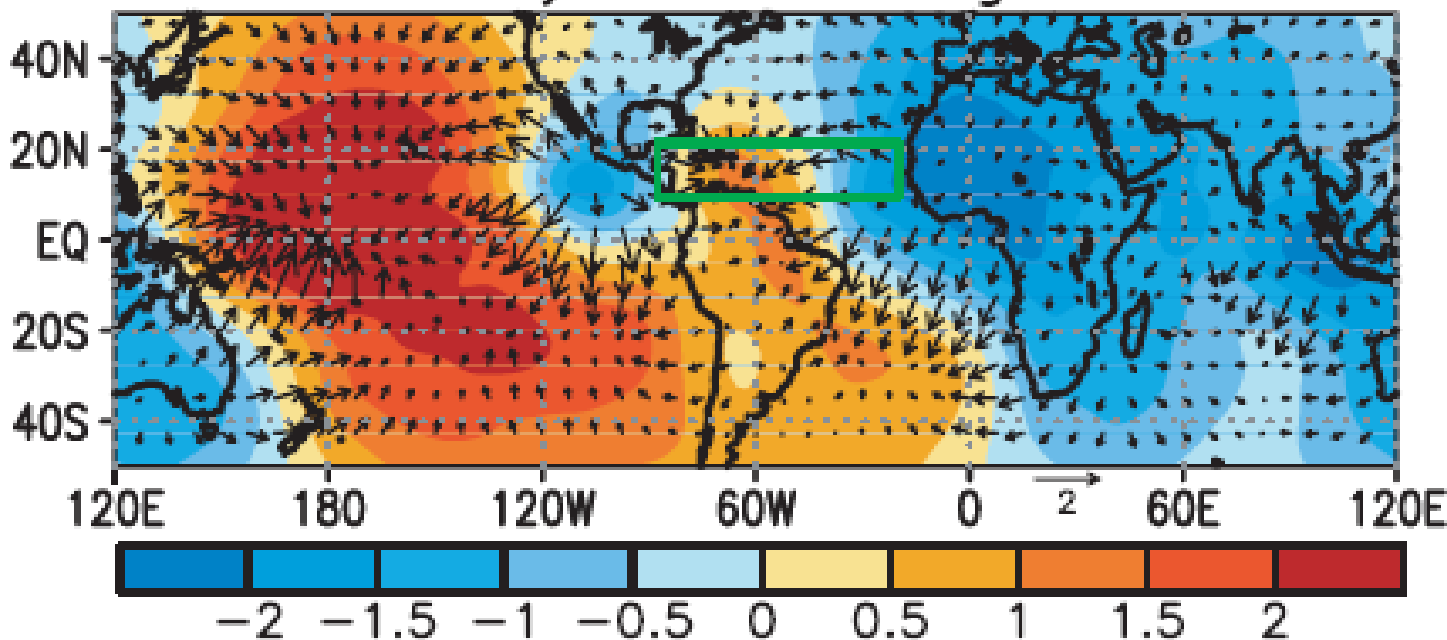
While The 2007 Anomalies Were Not As Great... They Still Indicate A Generally Unfavorable Environment... With No El Nino To Blame

200-hPa Anomalous Velocity Potential ($\times 10^6$), Divergent Winds
60-Day Average 02 AUG-30 SEP 2007



2007

200-hPa Velocity Potential and Divergent Wind Vector



1995-2005

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How Much Of This Is ENSO Related? And Can We Really Predict It?

- **Since Ocean Temps Do Not Change Rapidly, There Is Some Degree Of Predictability On A Seasonal Basis.**

...But, As We've Just Seen, Intra-Seasonal Adjustments In Large Scale Weather Patterns Can Produce Upwelling Or Other Factors That Can Produce Unforeseen Changes

At Any Rate, There Is Little Correlation Between ENSO and *Atlantic* Ocean Heat Content!

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How Much Of This Is Enso Related? And Can We Really Predict It?

- How About The “Cylinders... Where The Fuel Is Processed Into Energy?
- While A Decently Strong El Nino Can Play A Role In Disrupting The “Cylinders”... Other Factors Such As Atmospheric Stability and Moisture Content Are Also Factors... And Are More Dependent On Larger Scale Atmospheric Patterns

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How Much Of This Is Enso Related? And Can We Really Predict It?

- Well, What About The “Exhaust”?
 - A Moderate to Strong El Nino Actually Does Correlate To A Disrupted “Exhaust” Pattern... But The Correlation Is Not Nearly As Strong With La Nina... Which Would Contribute To More Activity. This Indicates...Again... That Other Atmospheric Factors Are At Work.

What Are These “Large Scale Weather Patterns”?

• **There’s A Lot More Going On In The Atmosphere & Ocean Than Just ENSO And It’s Effects: Some Other Important Large Scale Features Include:**

- Madden-Julian Oscillation
- North Atlantic Oscillation
- Tropical Upper Tropospheric Troughs (TUTTs)
- Pacific-North American Oscillation
- Arctic Oscillation
- ... And For Every One We Know About, There Are Probably 5 More We Haven’t Even Identified Yet!

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To Make Matters Worse...

While We've Recently Witnessed First Hand How Unpredictable El Nino/La Nina Can Be...

Most Of These Other Factors Are Even *LESS* Predictable than El Nino/La Nina!

And... Even If We KNEW What They All Were, And Each Had A Decent Degree Of Predictability, We Would Still Be Faced With The Problem Of How They All Interact With Each Other!

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Conclusions:

- **While ENSO Phase...Especially Strong Events... Definitely Can Impact Tropical Cyclone Activity, Other Factors That Vary Within The Season Also Set The Stage For Genesis, Development, And Motion.**
- **These Factors Are The Sum Of Many Large Scale Patterns That Are Constantly Evolving And Interacting.**

The Bottom Line:

- In Seasonal Forecasts...And Most Other Forecasts... El Nino & La Nina Are Definitely Not “Magic Bullets” or The “Holy Grail” (choose your metaphor) Of Weather & Hurricane Forecasting!
- So Far, No Such Magic Bullets Have Been Discovered!.

So... To Answer Our Original Question:

*Are El Nino & La Nina Scoundrels or
Scapegoats?*

**Sometimes They Truly Are
Scoundrels... But More Often Than
Not, They Are Probably the
Scapegoats**

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The End!

THIS PRESENTATION IS AVAILABLE AT:

www.weather.gov/jax

