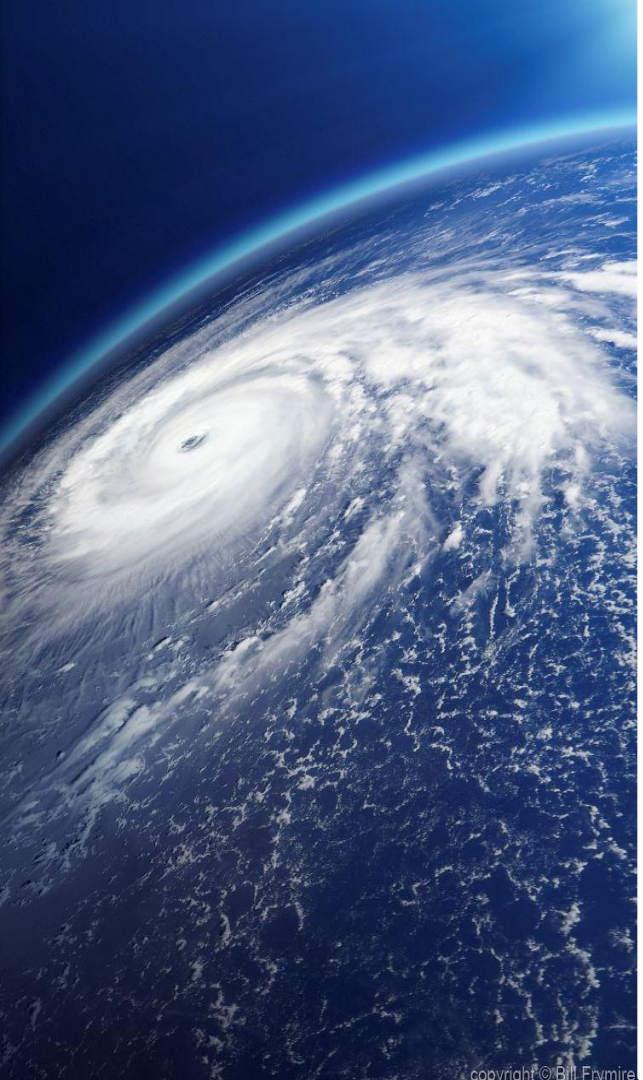
# 2017 AIR U.S. Hurricane Season Preview

*Dr. Eric Uhlhorn, Principal Scientist*

AIR WORLDWIDE®

Season's
Greetings




# AGENDA

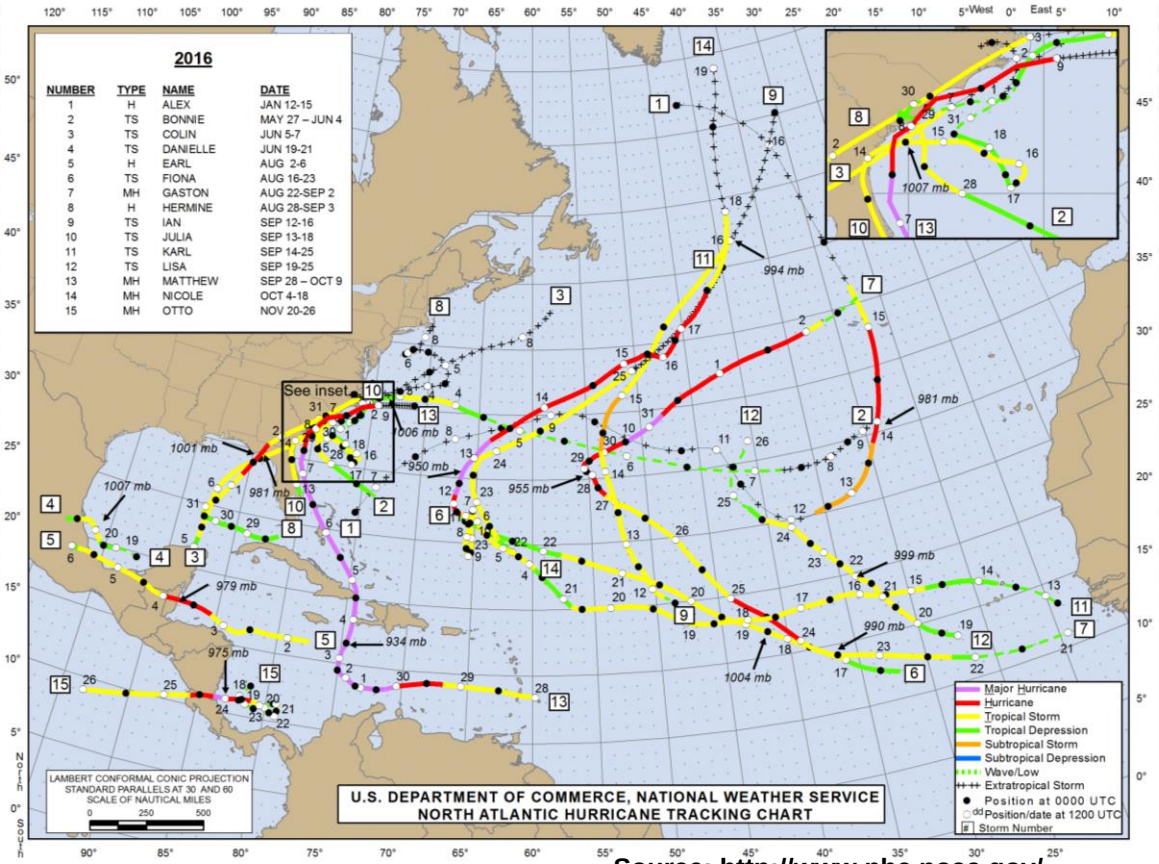
- 2016 Atlantic Hurricane Season Recap
- 2016 Eastern Pacific Hurricane Season Recap
- Factors Influencing Hurricane Activity
- Seasonal Forecasts
- AIR's Hurricane Forecasting Contest

# 2016 Atlantic Hurricane Season Recap

AIR

# A Look Back at the 2016 Atlantic Hurricane Season

- 15 named storms (12 on average)
- 7 hurricanes (6)
- 4 major hurricanes (3)
- 3 of 4 major hurricanes made landfall
- 1st above-average season since 2012




Source: http://www.nhc.noaa.gov/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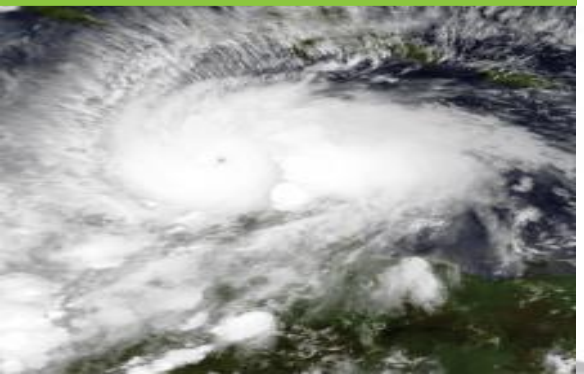
# Two U.S. Land-Falling Hurricanes: Hurricane Hermine and Hurricane Matthew

## *Hurricane Hermine*

- 1st hurricane to make landfall in Florida since Wilma in 2005
- Formed in the Gulf of Mexico
- Storm surge and heavy rainfall along the Florida gulf coast caused significant damage

## *Hurricane Matthew*



- First Category 5 since Hurricane Felix in 2007
- Affected the Caribbean and the southeastern coastline of the United States
- More than1,600 deaths, mostly in Haiti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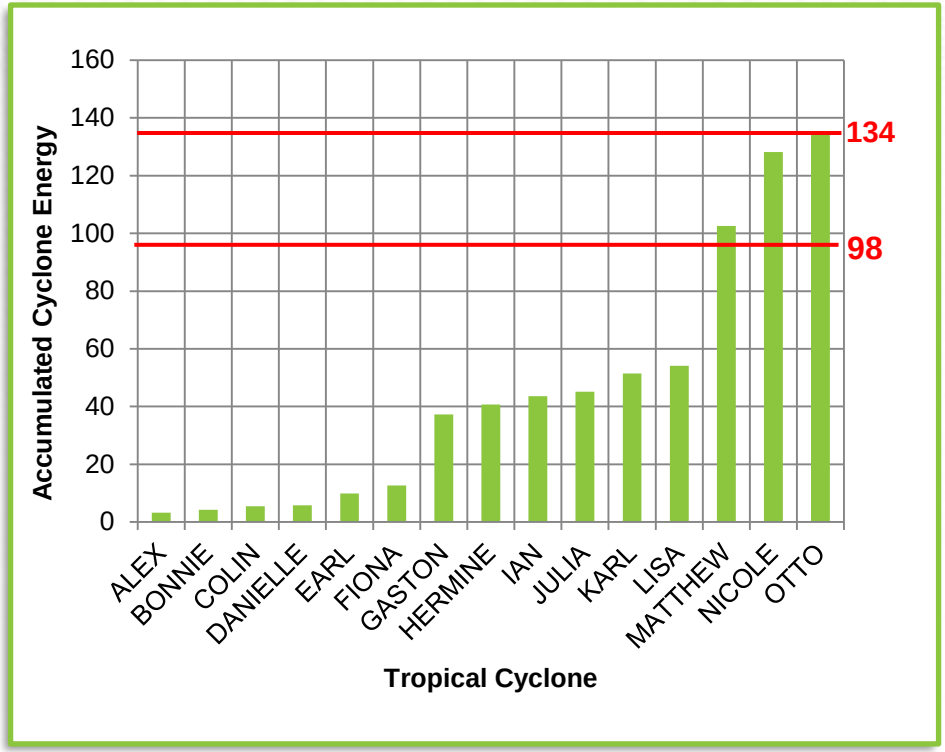
# 2016 Accumulated Cyclone Energy (ACE)

- Another measure of total destructive potential over a season is ACE
  - Defined as sum of squared maximum wind speed at each six-hourly advisory period ($x10^{-4}$)
- Typically ACE = 98
- Ended season at 134





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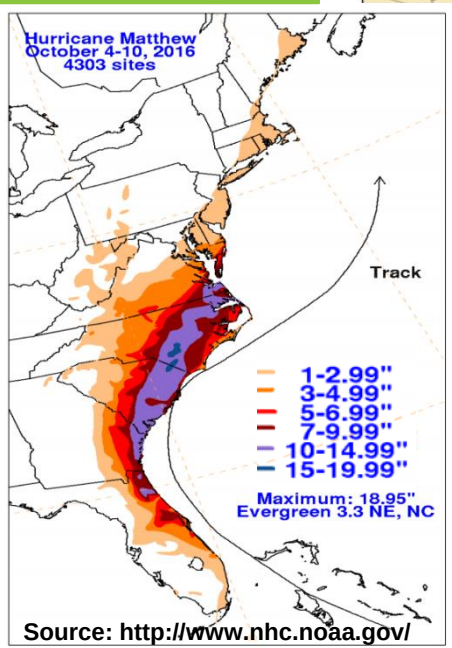
# A Closer Look at Hurricane Matthew

## *Hurricane Matthew*

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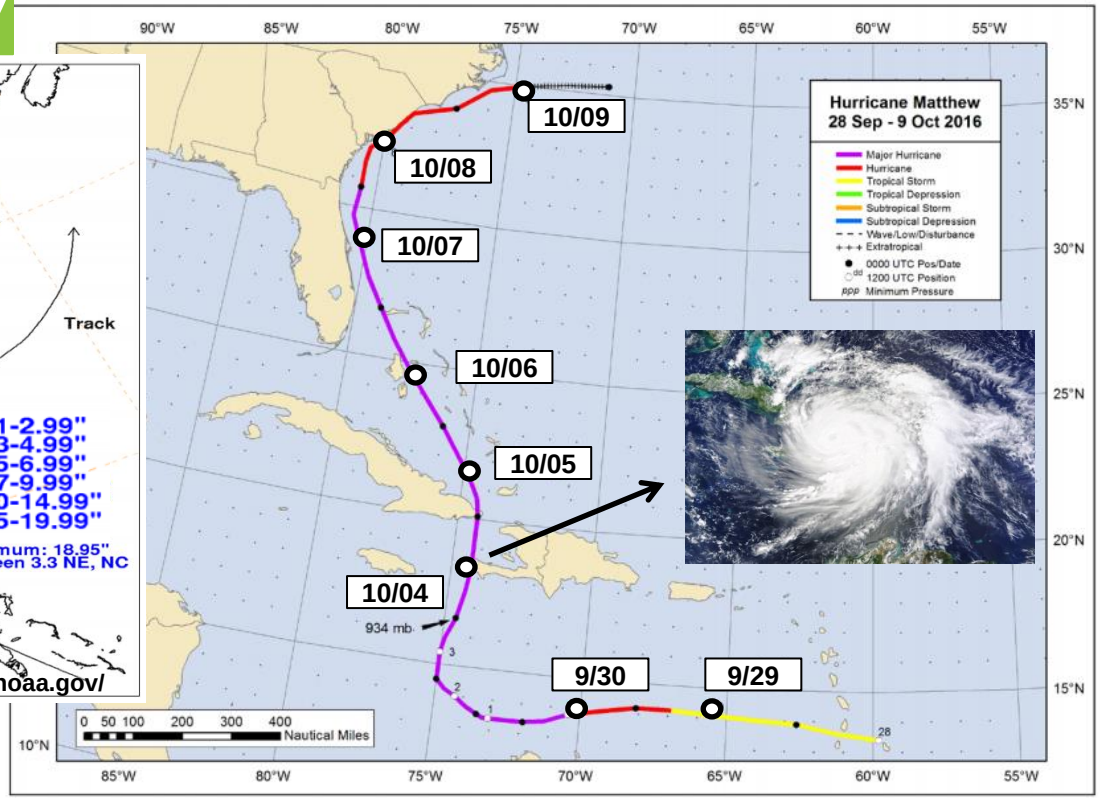


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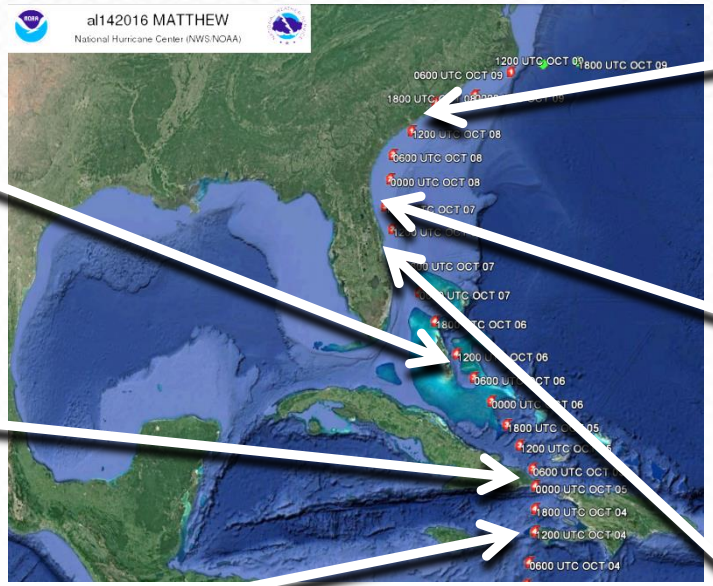
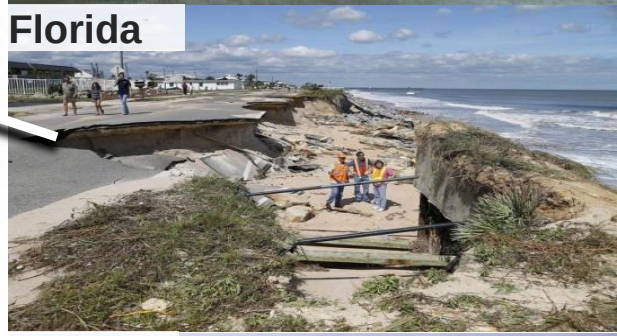
# Impacts from Hurricane Matthew





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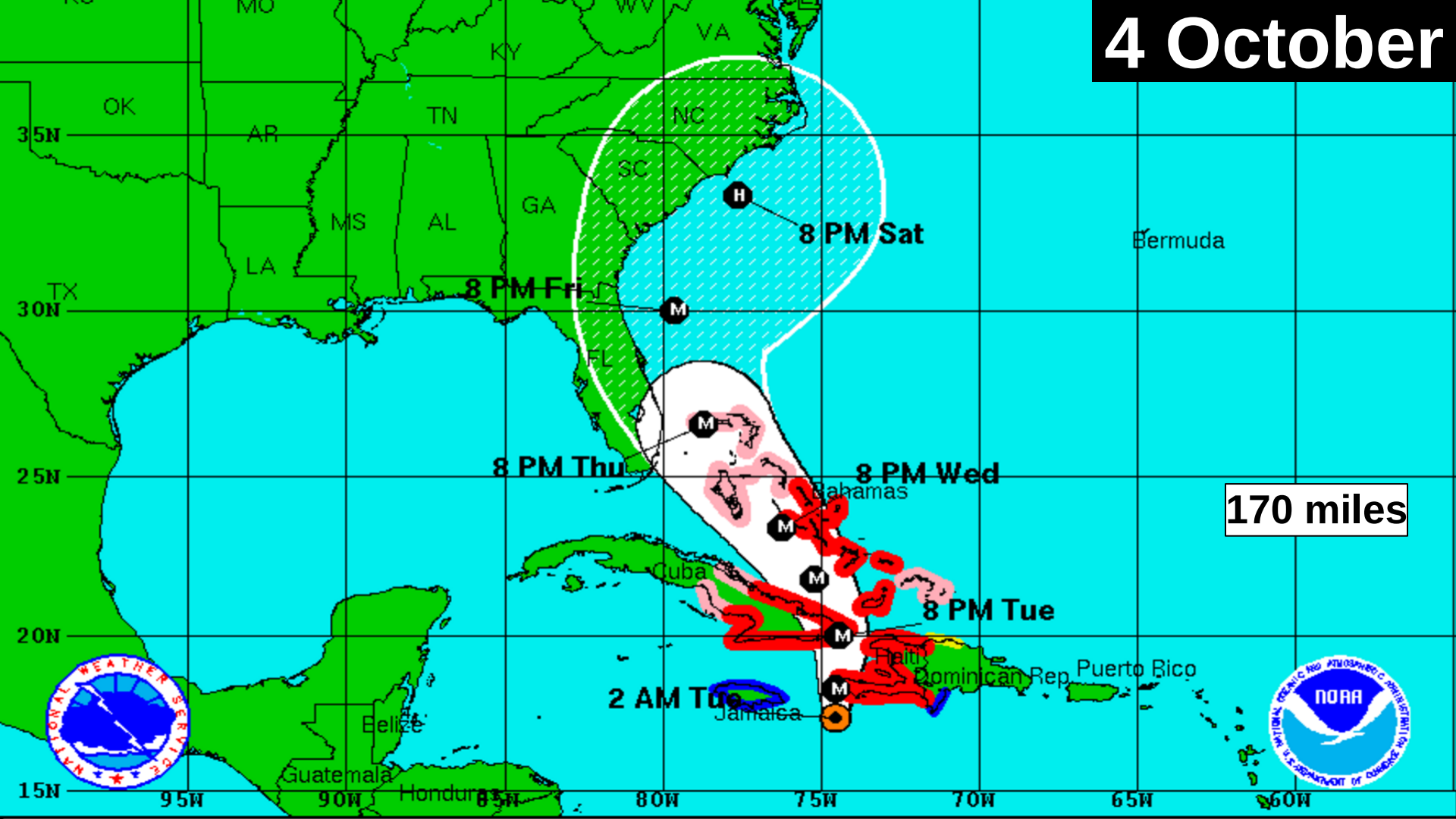
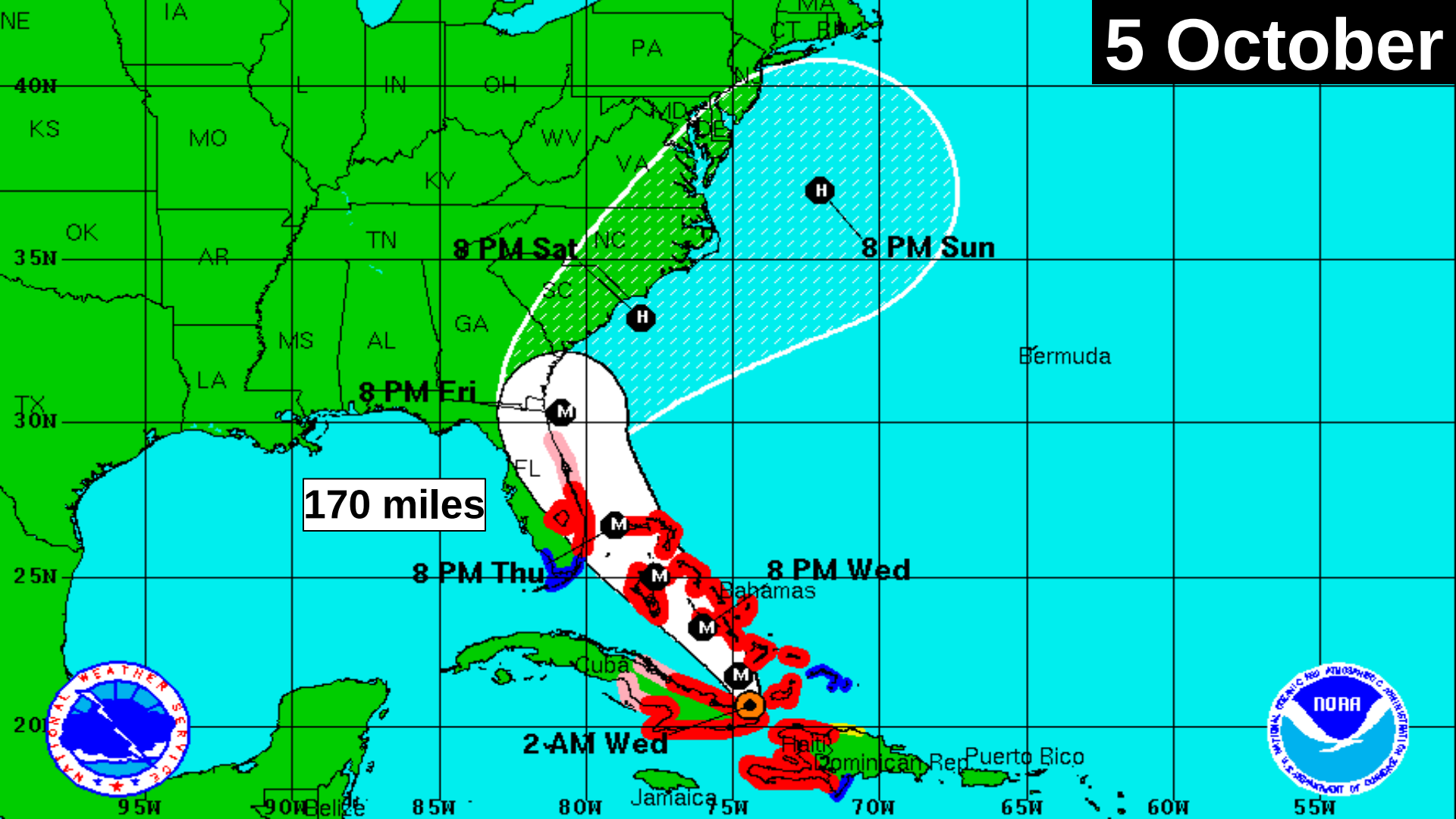

4 October
8 PM Sat
8 PM Fri
8 PM Thu
8 PM Wed
8 PM Tue
2 AM Tue
170 miles
Bermuda
Bahamas
Cuba
Haiti
Dominican Rep
Puerto Rico
Jamaica
Belize
Guatemala
Honduras
MO
KY
WV
VA
OK
AR
TN
NC
SC
GA
MS
AL
LA
TX
FL
35N
30N
25N
20N
15N
95W
90W
85W
80W
75W
70W
65W
60W
NOAA


5 October
8 PM Sat
8 PM Sun
8 PM Fri
8 PM Thu
8 PM Wed
2 AM Wed
170 miles
Bermuda
Bahamas
Cuba
Haiti
Dominican Rep
Puerto Bico
Jamaica
Belize
NE
IA
IL
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OH
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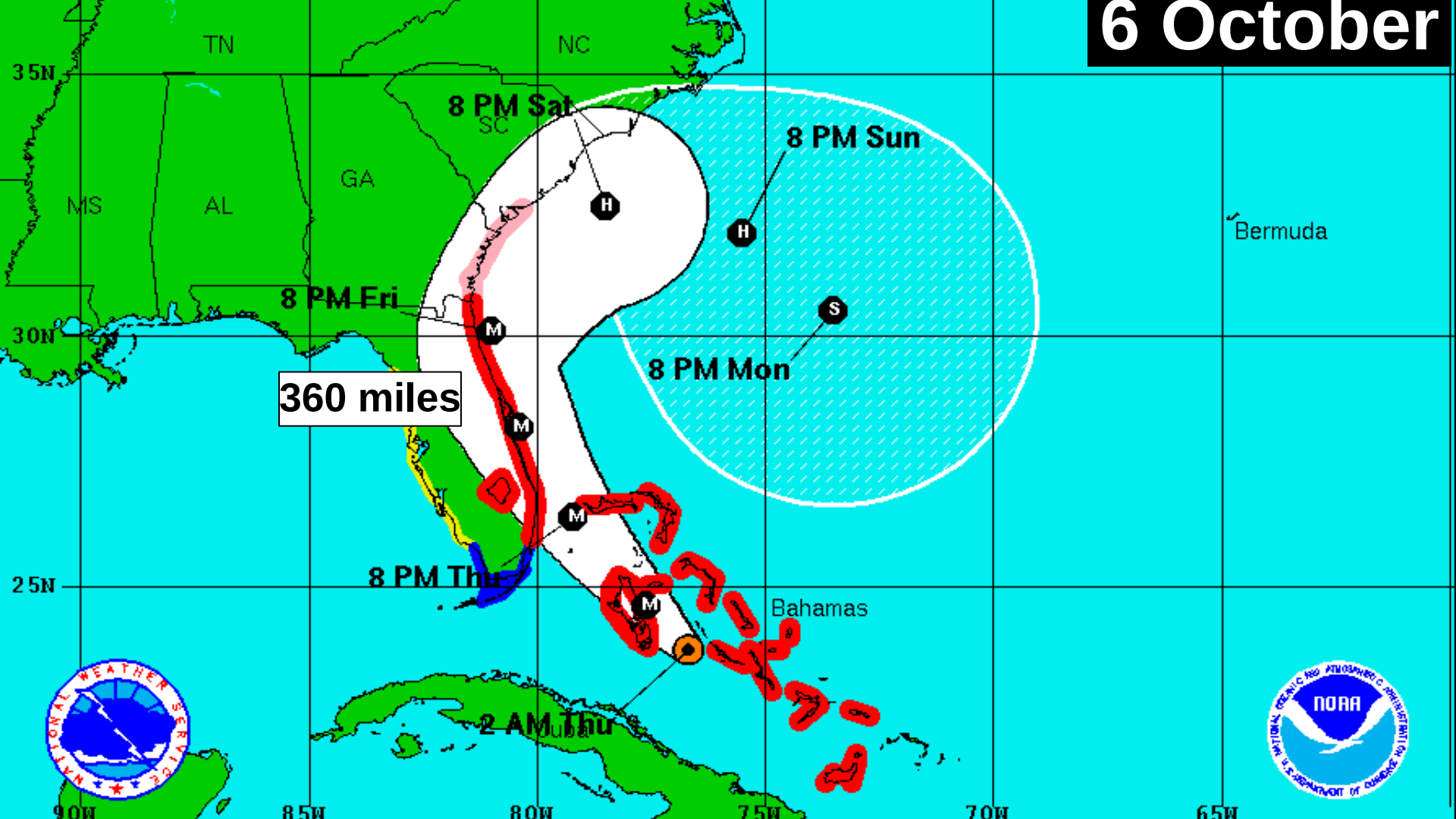
NOAA


6 October
TN
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8 PM Sat
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8 PM Mon
8 PM Fri
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2 AM Thu
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Bermuda
Bahamas
Cuba
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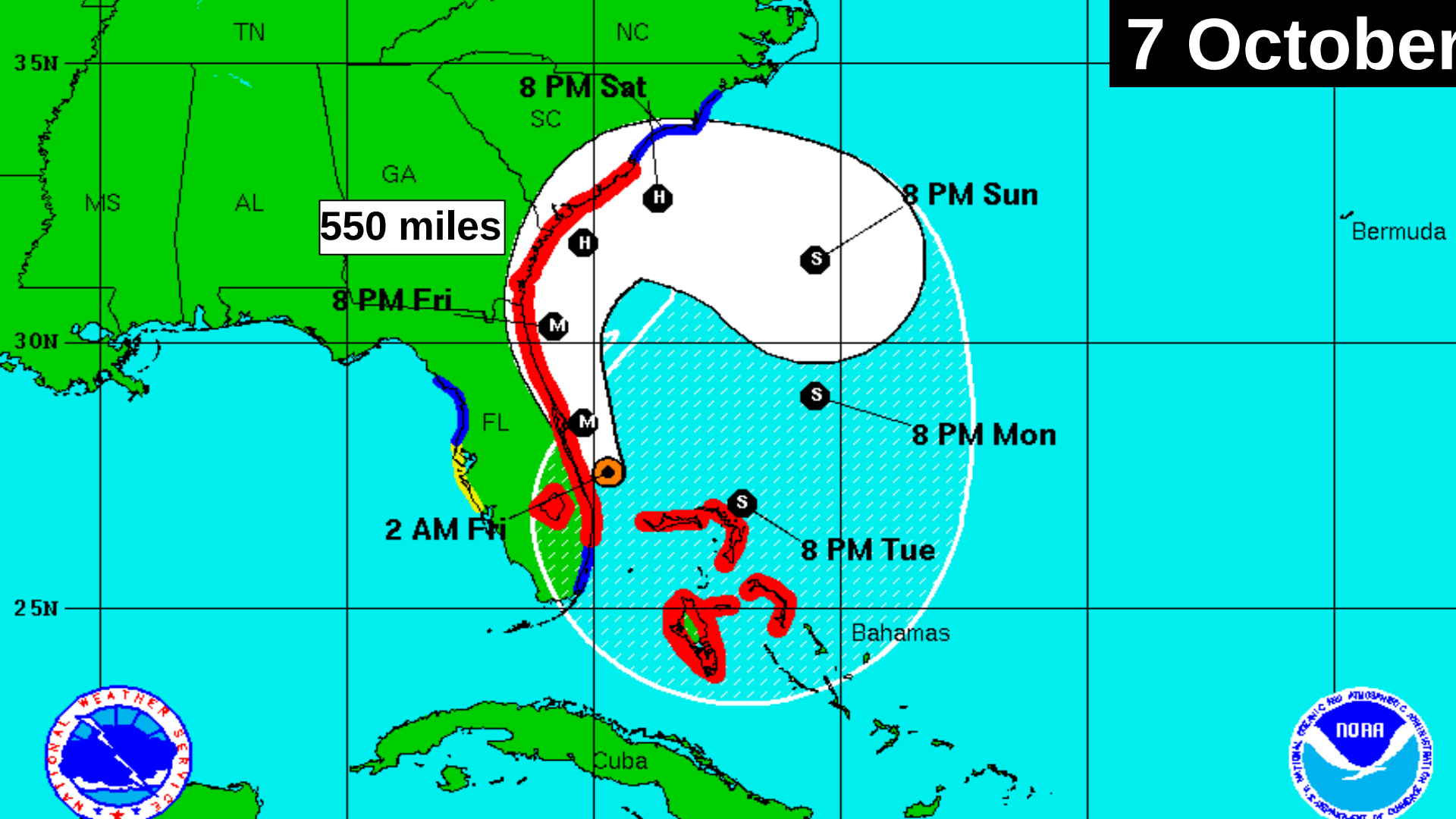
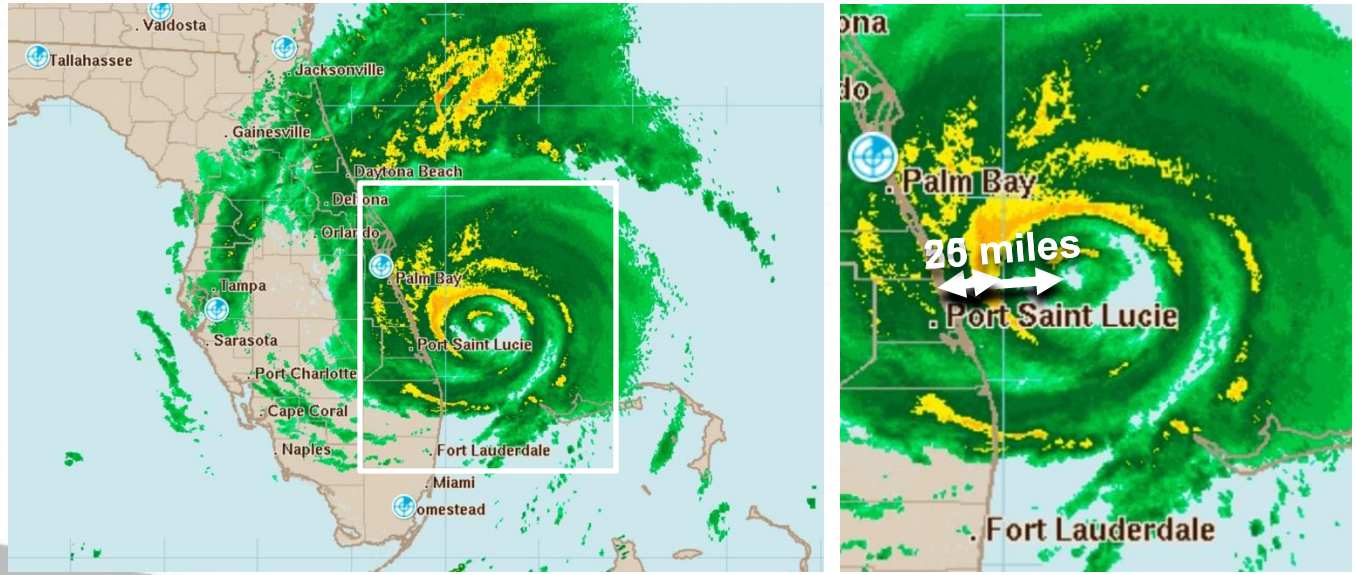
75W
70W
65W
NATIONAL WEATHER SERVICE
NOAA


7 October
TN
NC
35N
8 PM Sat
SC
GA
MS
AL
550 miles
8 PM Sun
Bermuda
8 PM Fri
30N
FL
8 PM Mon
2 AM Fri
8 PM Tue
25N
Bahamas
Cuba
NOAA

# Longest Period Without a U.S. Major Hurricane Landfall

- Last major hurricane to strike the U.S. was Wilma in 2005
- The next-longest streak is 5 years
- As of this season, this streak continues, ***but just barely!***





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# Pop Quiz!

- The 2016 Atlantic *hurricane* season was the longest on record, with Hurricane Alex forming in mid January and Hurricane Otto making landfall around Thanksgiving. TRUE or FALSE?

**TRUE!* 320 days**

*** 1951 was actually the longest season in the Atlantic (341 days) since an unnamed tropical storm formed on January 4th of that year.**


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# 2016 Eastern Pacific Hurricane Season Recap

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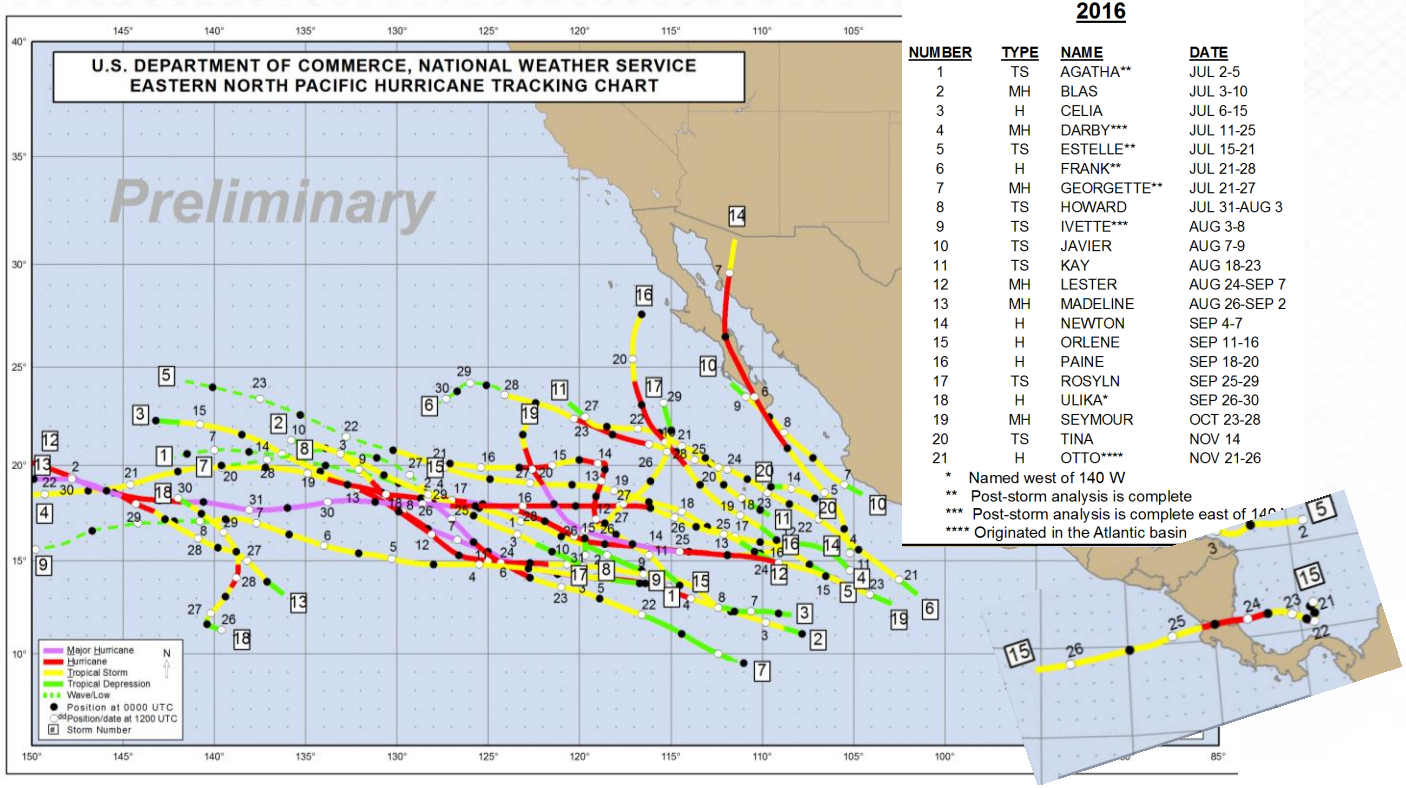
# Overview of the 2016 Eastern Pacific Hurricane Season

In 2016, the Eastern Pacific had an above-average active season:

- 21 named storms
- 11 hurricanes
- 1 hurricane made landfall
- Otto crossed Central America




**2016**

| NUMBER | TYPE | NAME | DATE |
|---|---|---|---|
| 1 | TS | AGATHA** | JUL 2-5 |
| 2 | MH | BLAS | JUL 3-10 |
| 3 | H | CELIA | JUL 6-15 |
| 4 | MH | DARBY*** | JUL 11-25 |
| 5 | TS | ESTELLE** | JUL 15-21 |
| 6 | H | FRANK** | JUL 21-28 |
| 7 | MH | GEORGETTE** | JUL 21-27 |
| 8 | TS | HOWARD | JUL 31-AUG 3 |
| 9 | TS | IVETTE*** | AUG 3-8 |
| 10 | TS | JAVIER | AUG 7-9 |
| 11 | TS | KAY | AUG 18-23 |
| 12 | MH | LESTER | AUG 24-SEP 7 |
| 13 | MH | MADELINE | AUG 26-SEP 2 |
| 14 | H | NEWTON | SEP 4-7 |
| 15 | H | ORLENE | SEP 11-16 |
| 16 | H | PAINE | SEP 18-20 |
| 17 | TS | ROSYLN | SEP 25-29 |
| 18 | H | ULIKA* | SEP 26-30 |
| 19 | MH | SEYMOUR | OCT 23-28 |
| 20 | TS | TINA | NOV 14 |
| 21 | H | OTTO**** | NOV 21-26 |

* Named west of 140 W
** Post-storm analysis is complete
*** Post-storm analysis is complete east of 140
**** Originated in the Atlantic basin

**Source: http://www.nhc.noaa.gov/**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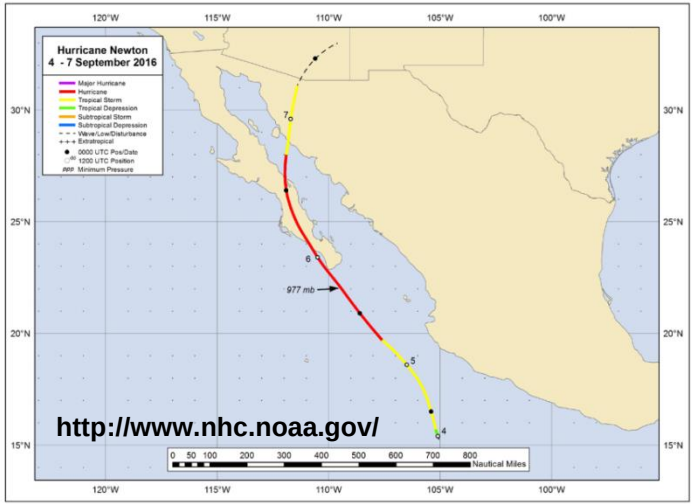
# Hurricane Newton Brought Heavy Rain to Mexico and Southwestern United States

**Hurricane Newton**




**Cabo San Lucas**

**Tucson, AZ**

- Made landfall in Baja California peninsula
- Caused  flooding along the coast of Mexico
- Storm remnants brought heavy rainfall to the southwestern United States, peaking at 5.67 in (144 mm) at Miller Carr Canyon in southeastern Arizona.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# Pop Quiz!

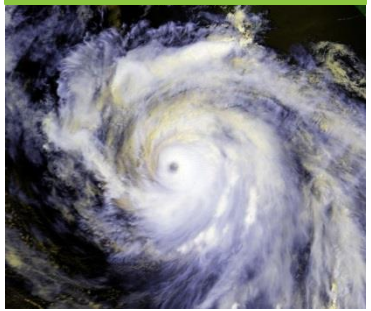
- Hurricane Otto crossed Central America from the Caribbean to the Eastern Pacific last year. What was the last tropical cyclone to do that?

## Hurricane Cesar/Douglas (1996)

**Storms were re-named when crossing basins back then!**

***Hurricane Cesar***

***Hurricane Douglas***

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# Factors Influencing Hurricane Activity

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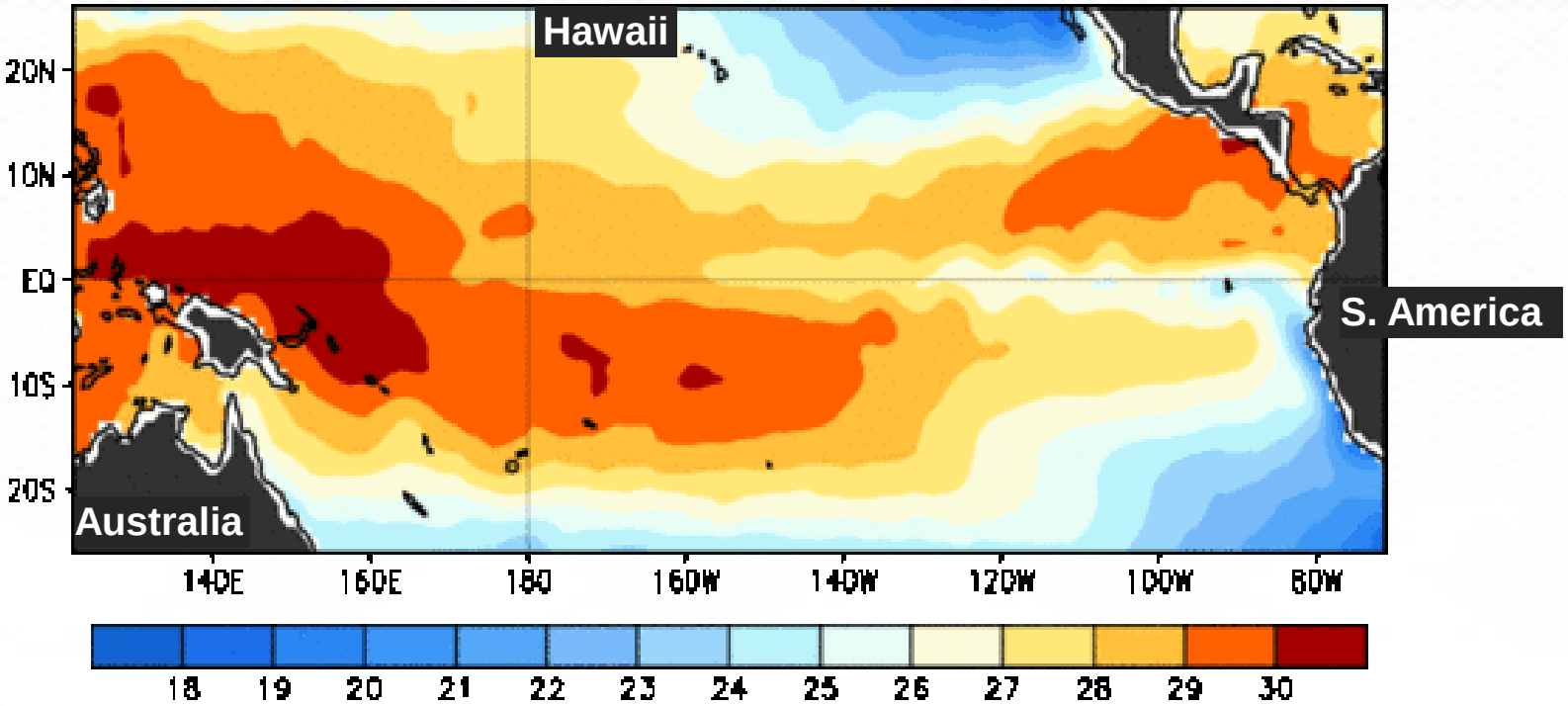
# Current State of ENSO

**Tropical Pacific Observed Sea Surface Temperature (˚C)**




Source: http://www.cpc.ncep.noaa.gov/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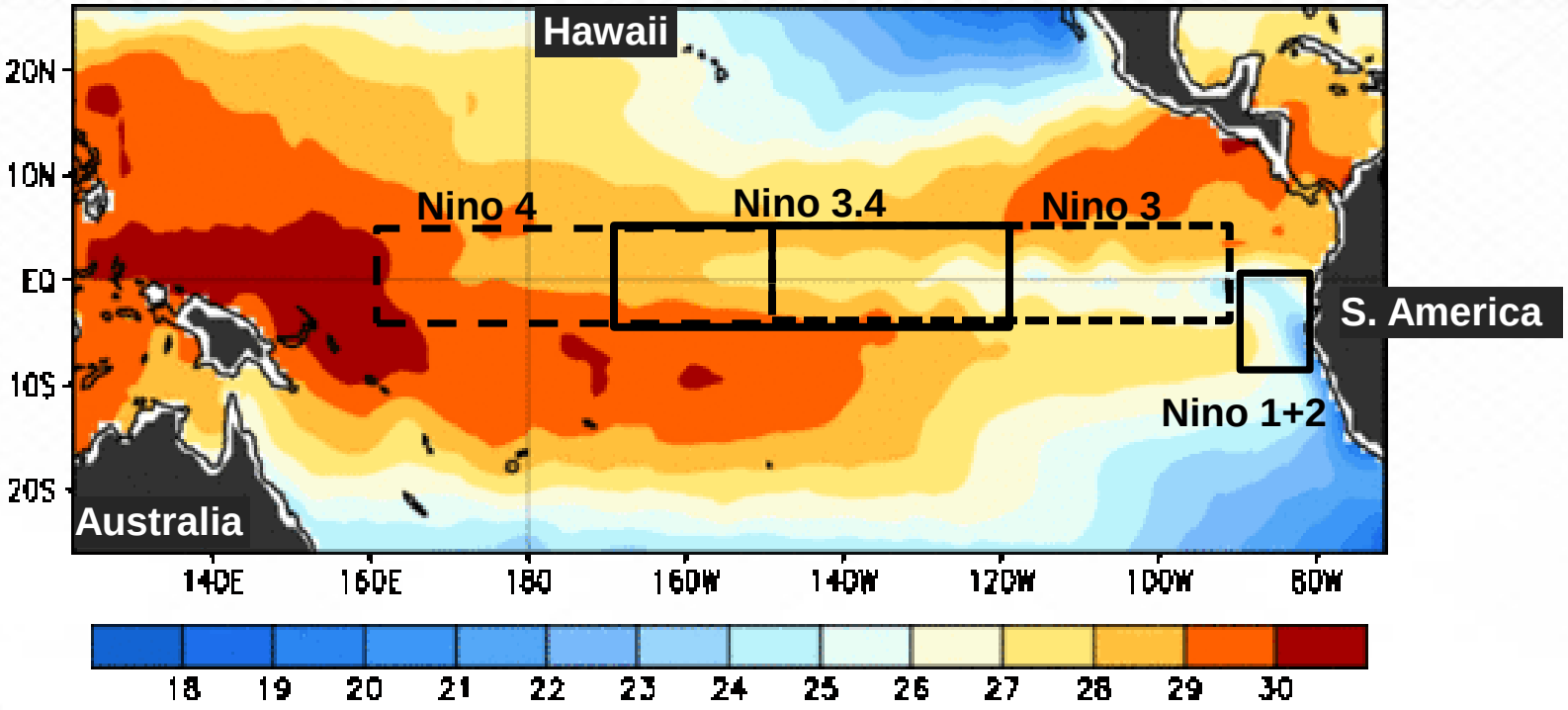
**Tropical Pacific Observed Sea Surface Temperature (˚C)**




Source: http://www.cpc.ncep.noaa.gov/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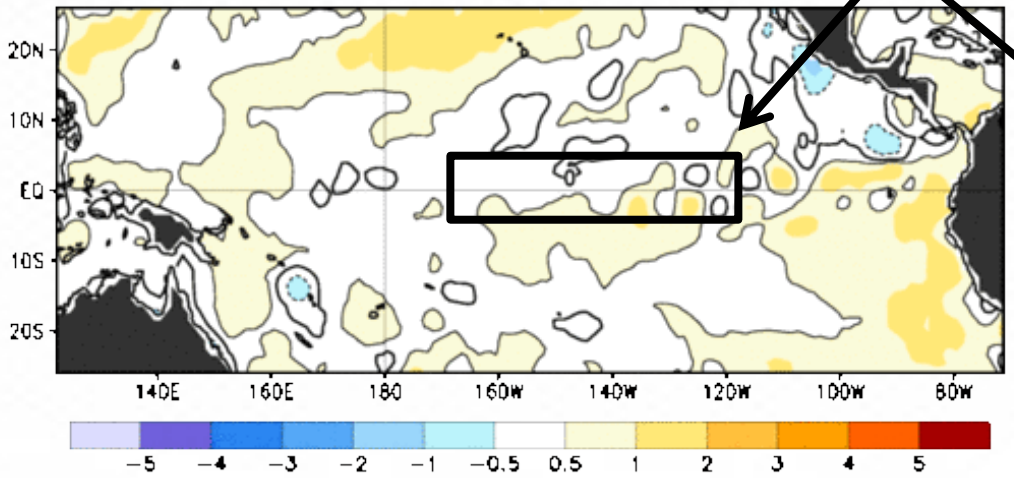
# Current State of ENSO

**Niño 3.4**

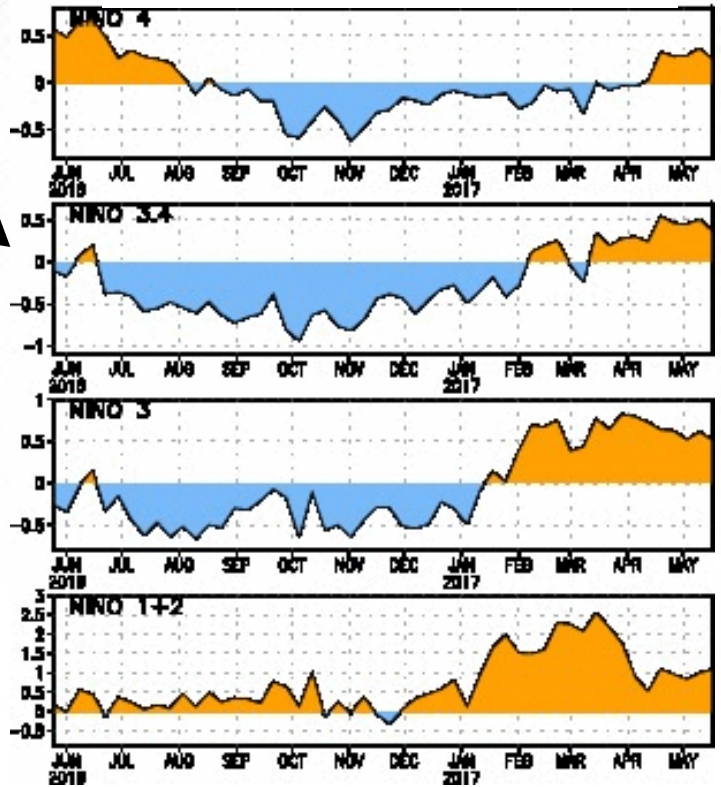
**Observed Sea Surface Temperature Anomalies (°C)**




**7-Day Average Centered on May 17, 2017**

**Source: http://www.cpc.ncep.noaa.gov/**

**SST Anomalies**





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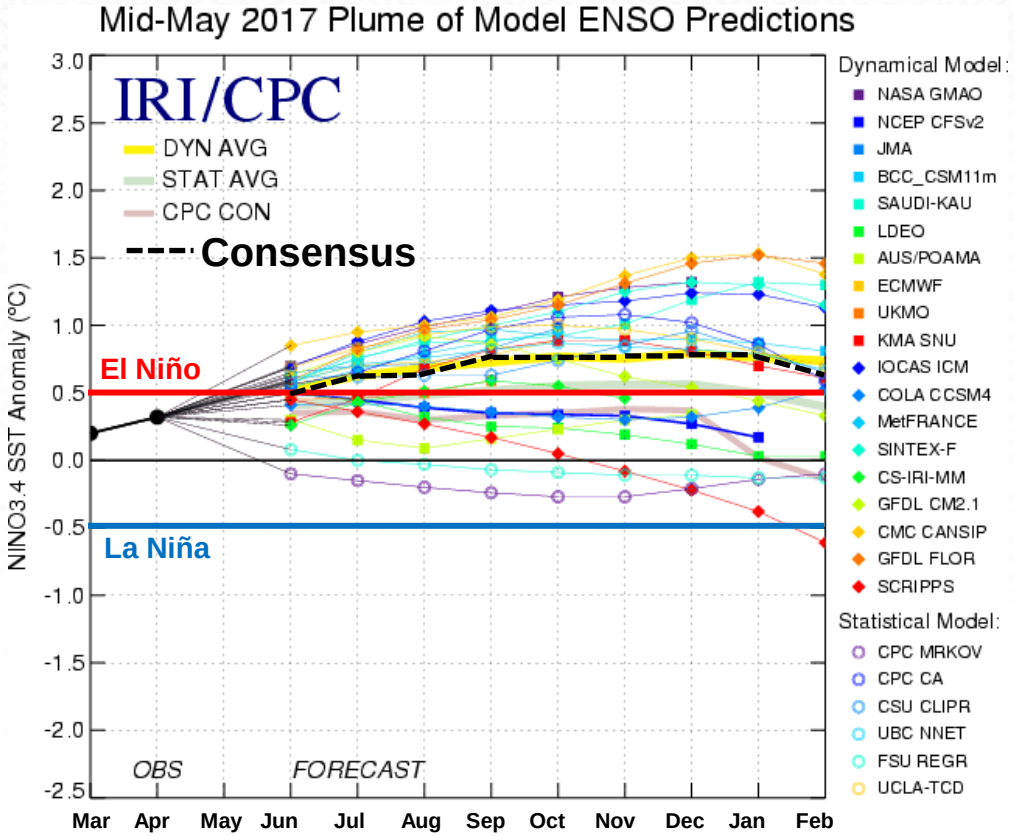
# ENSO Forecasts




*Source: International Research Institute (IRI) for Climate and Society (May 2016)*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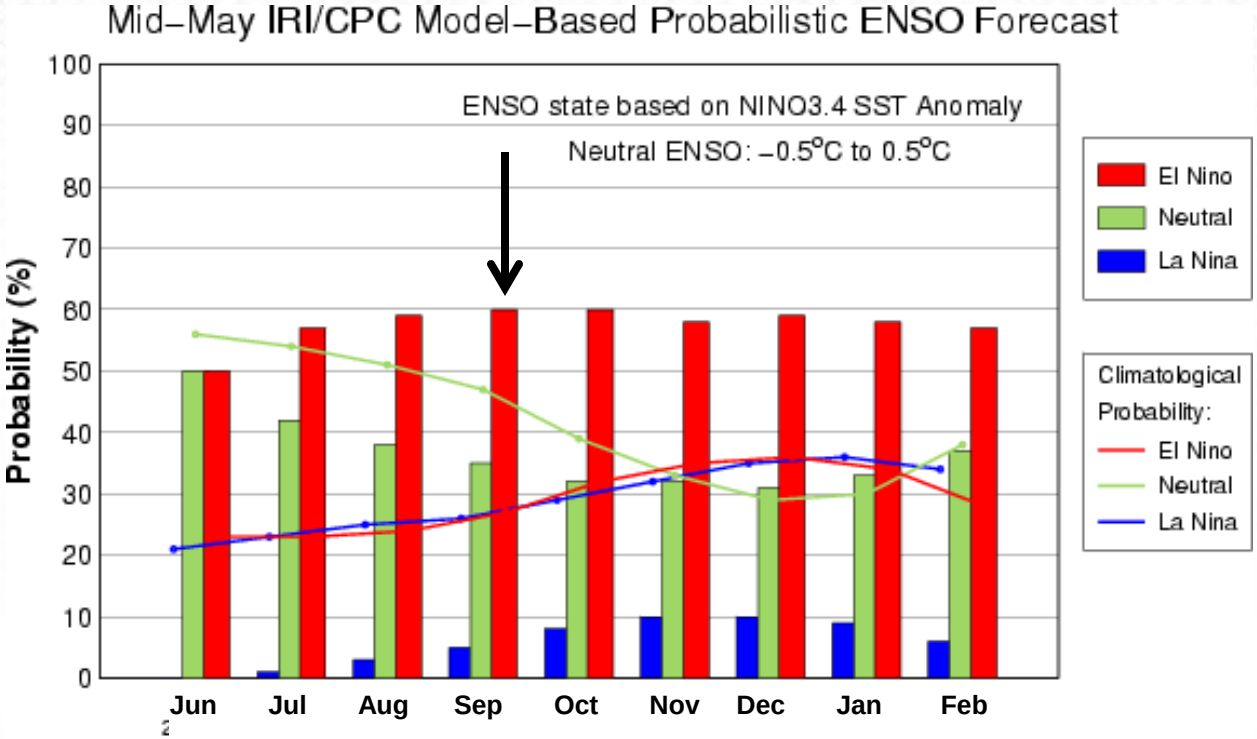
# CPC/IRI Probabilistic ENSO Outlook




*Source: International Research Institute (IRI) for Climate and Society (April 2017)*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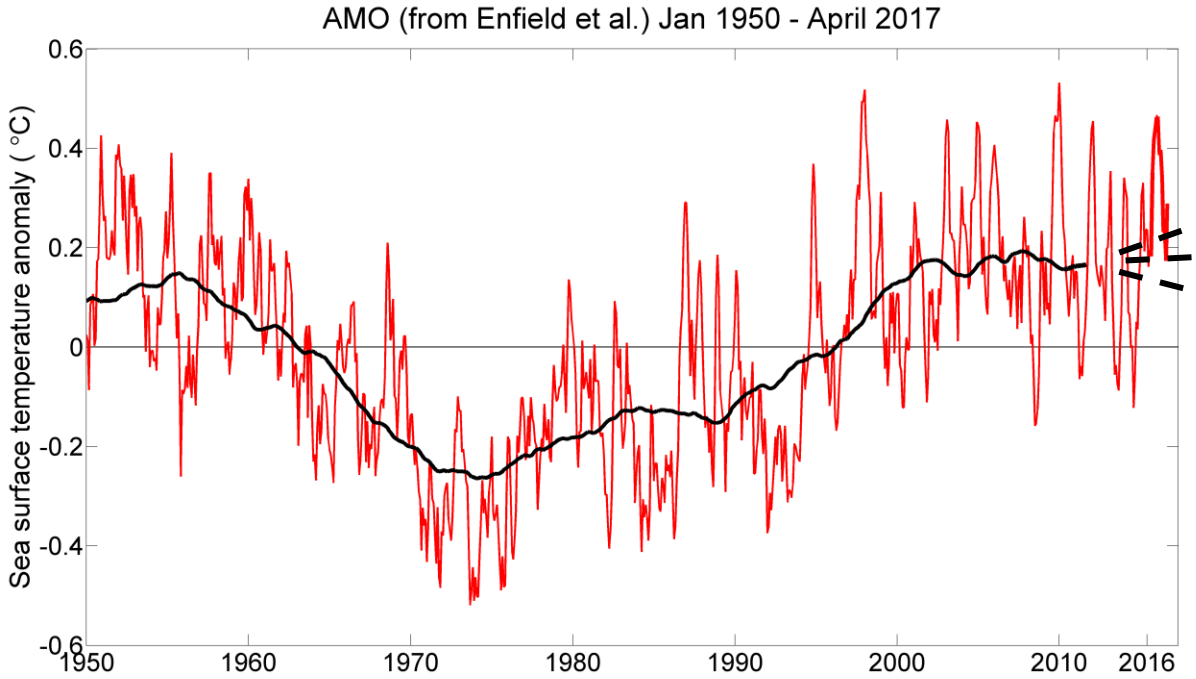
# The Atlantic Multi-Decadal Oscillation (AMO)

**Averaged over the Atlantic from the equator to 70˚N latitude**




**AMO Index for April 2017:**
**+0.289**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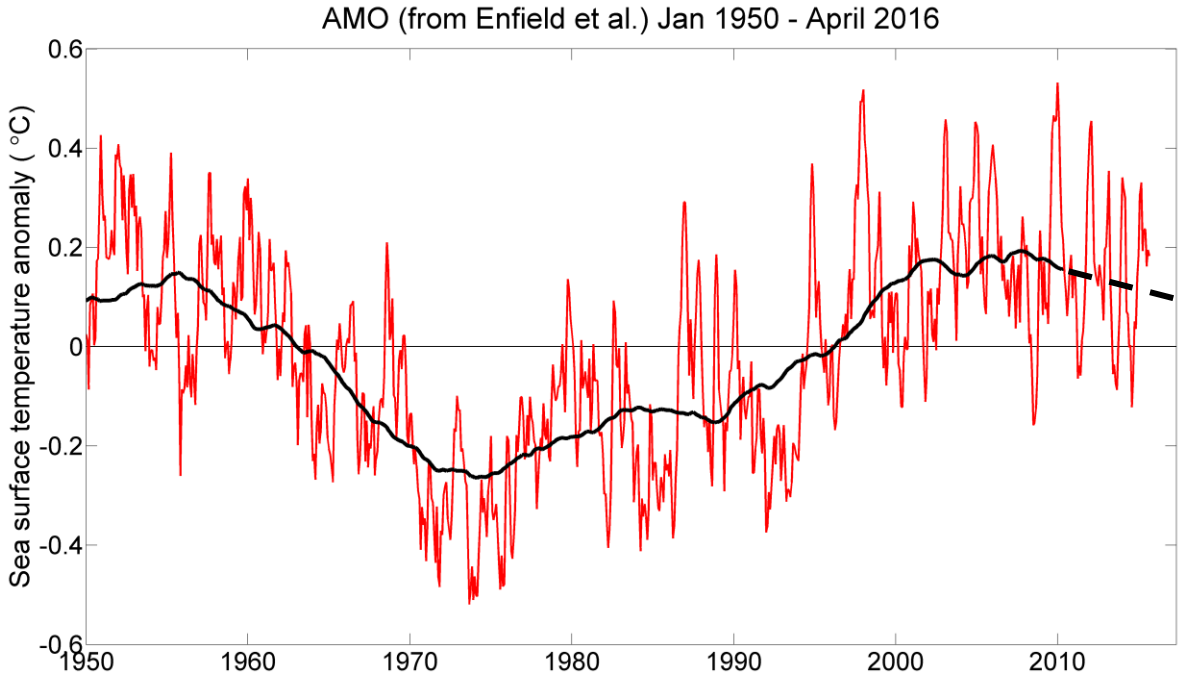


**AMO Index for April 2016:**
**+0.184**


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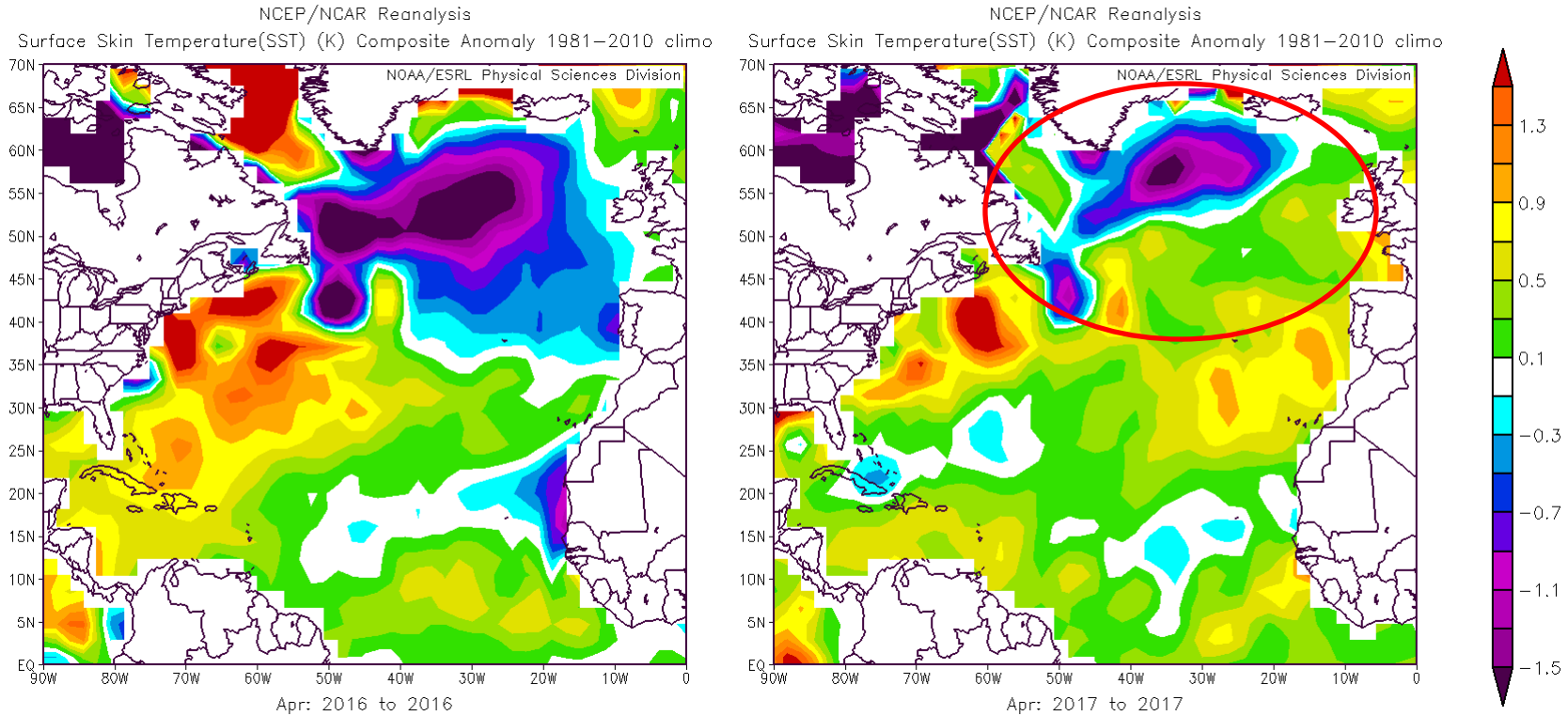
# Atlantic Sea Surface Temperatures and the AMO



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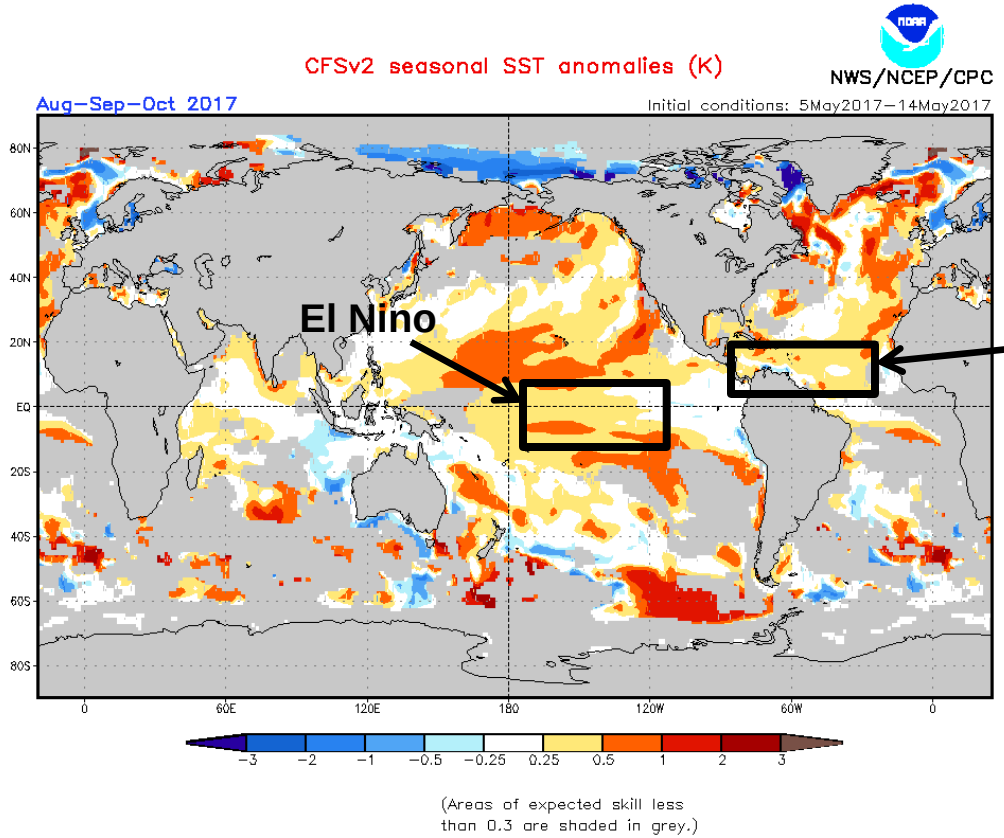
# Sea Surface Temperature Forecast



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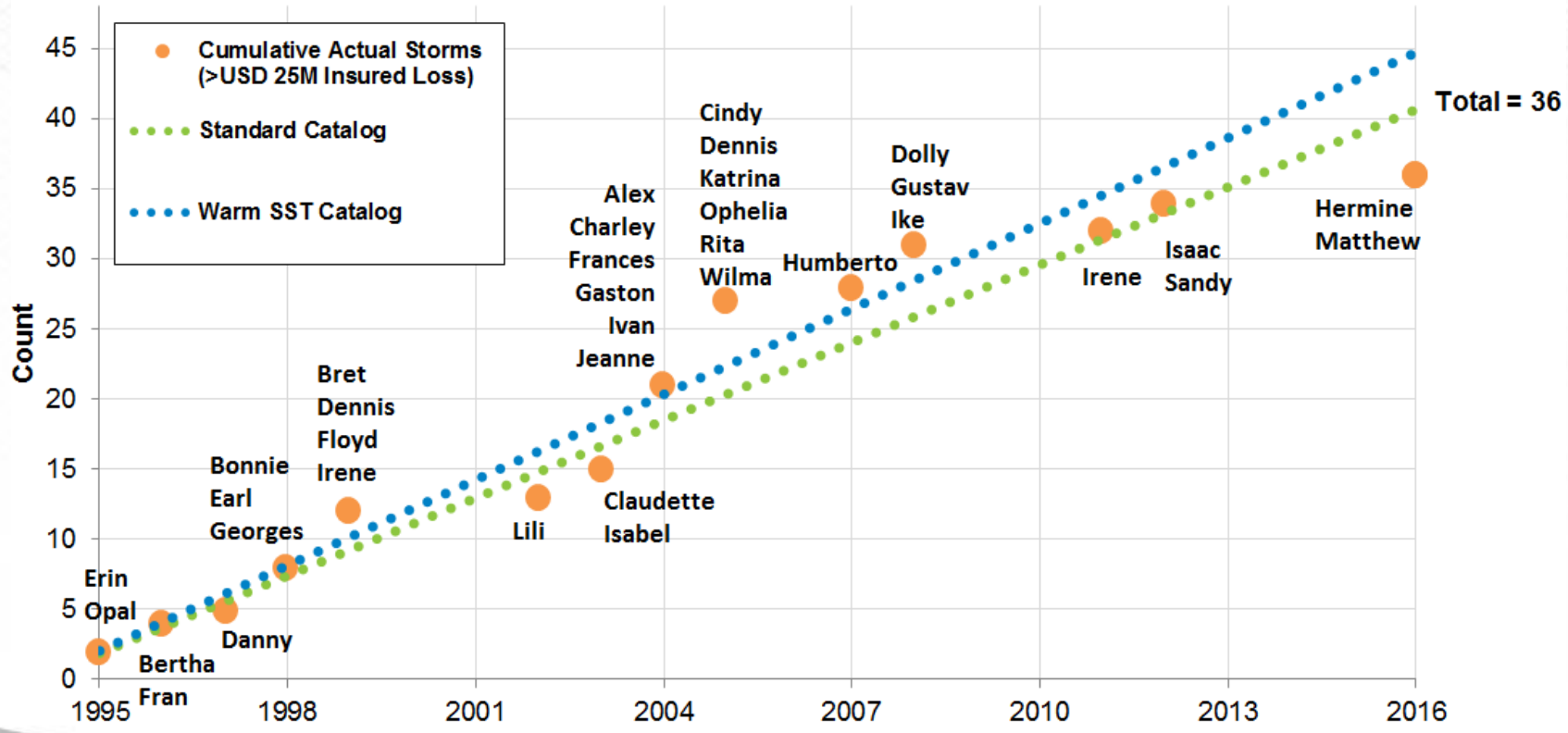
# Long Term View of Risk



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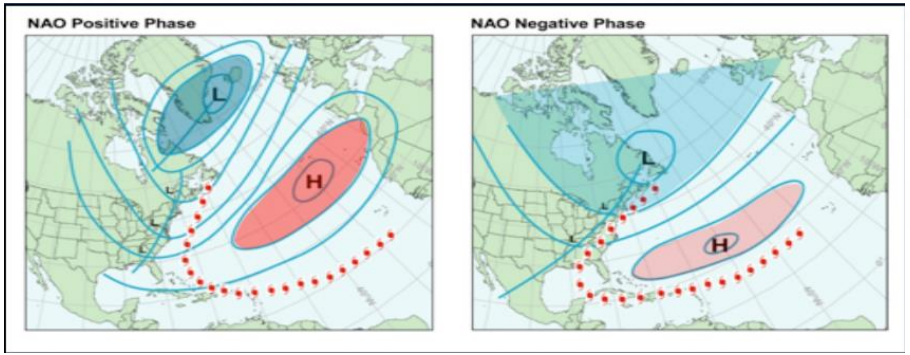
# Why is Near-Term Forecasting Not Suitable for Assessing Hurricane Risk?

- Secondary factors
  - El Nino Southern Oscillation (ENSO)
  - Saharan Air Layer (SAL)
  - Madden Julian Oscillation (MJO)

- Landfall risk poorly correlated with activity
  - North Atlantic Oscillation (NAO)





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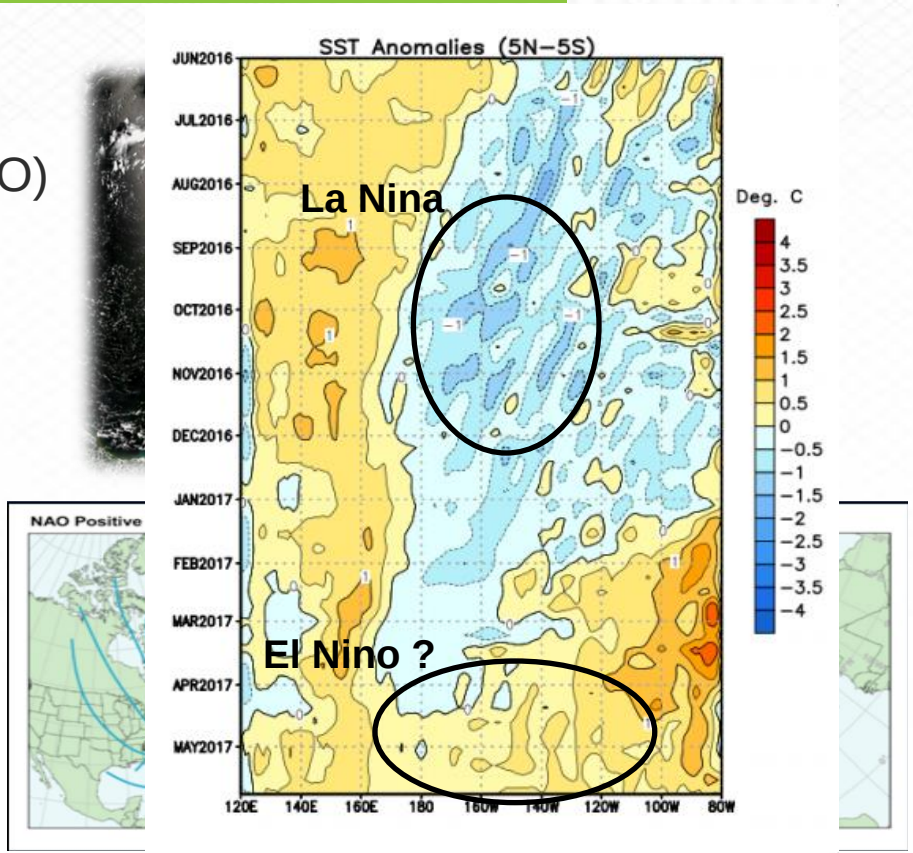



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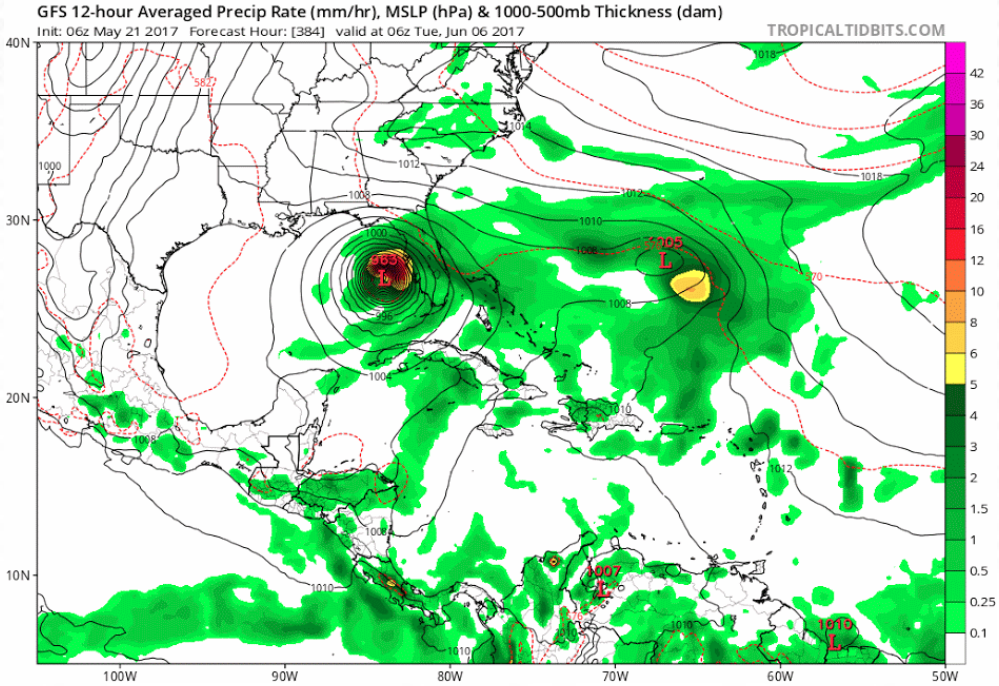
# Accuracy of Numerical Weather Prediction Models Degrades In Time





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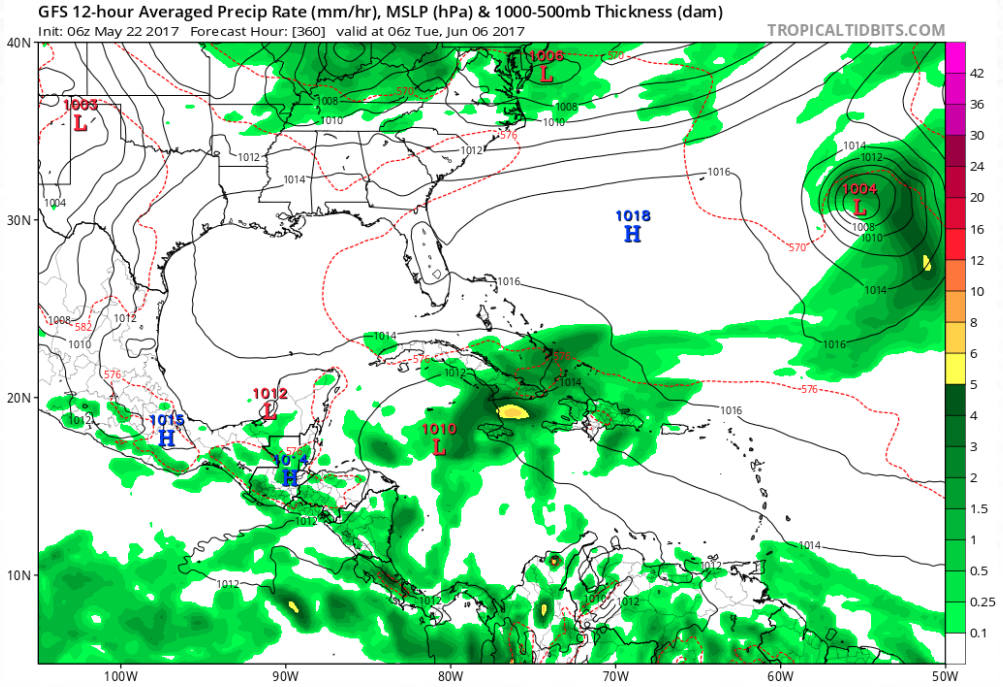

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# Seasonal Forecasts

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# Seasonal Forecasts

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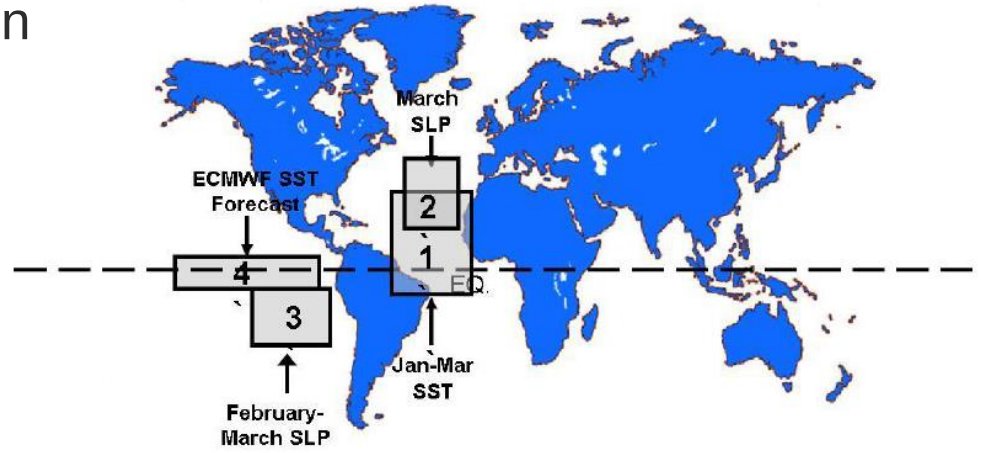
# Summary of June Predictors of Seasonal Activity

1. Observed SSTs in E. Atlantic (+)
2. Observed sea-level pressures (SLP) in Atlantic (-)
3. Observed sea-level pressure in SE tropical Pacific (+)
4. European Centre for Medium Range Weather Forecasts (ECMWF) SST forecast in E. Pacific (-)

Colorado State University

**New April Forecast Predictors**





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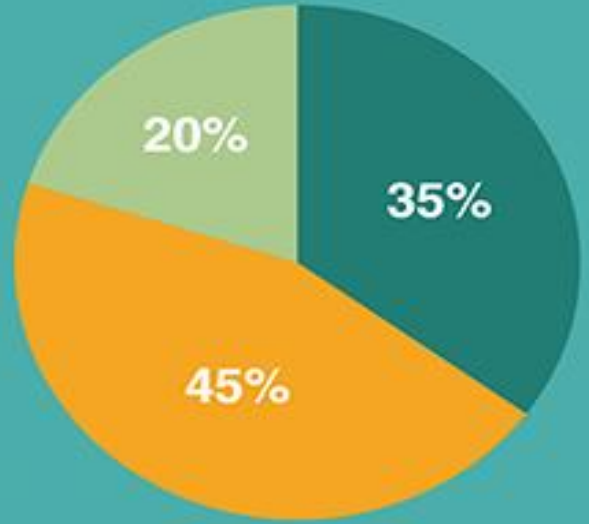
# 2017 Atlantic Hurricane Season Outlook




Above-normal | Near-normal | Below-normal season

Season probability

## Named storms
11-17

## Hurricanes
5-9

## Major Hurricanes
2-4

Be prepared: Visit hurricanes.gov and follow @NWS and @NHC_Atlantic on Twitter.

May 25, 2017

# 2017 Hurricane Season Forecast Summary

**Climatological Average:**

| Named Storms | Hurricanes | Major Hurricanes |
|---|---|---|
| 12.1 | 6.4 | 2.7 |

**May Forecasts:**

| Source | Named Storms | Hurricanes | Major Hurricanes |
|---|---|---|---|
| Tropical Storm Risk | ~~11~~ **14(±4)** | ~~4~~ **6(±3)** | ~~2~~ **3(±2)** |
| Colorado State University | 11 | 4 | 2 |
| Weather.com | ~~12~~ **14** | ~~6~~ **7** | ~~2~~ **3** |
| North Carolina State University | 11-15 | 4-6 | 1-3 |
| AccuWeather | 10 | 5 | 3 |
| NOAA | 11-17 | 5-9 | 2-4 |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# What are Analog Years?

Colorado State University

Hurricane seasons since 1950 which had similar atmospheric-oceanic conditions to those currently being experienced and those that we expect to see this summer and fall

| Year | Storms | Hurricanes | Major Hurricanes |
|---|---|---|---|
| 1957 | 8 | 3 | 2 |
| 1965 | 6 | 4 | 1 |
| 1972 | 7 | 3 | 0 |
| 1976 | 10 | 6 | 2 |
| 2002 | 12 | 4 | 2 |


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# Analog Years

Colorado State University

Hurricane seasons since 1950 which had similar atmospheric-oceanic conditions to those currently being experienced and those that we expect to see this summer and fall.

| Year | Storms | Hurricanes | Major Hurricanes | Notable Hurricanes |
|---|---|---|---|---|
| 1957 | 8 | 3 | 2 | Audrey |
| 1965 | 6 | 4 | 1 | Betsy |
| 1972 | 7 | 3 | 0 | Agnes |
| 1976 | 10 | 6 | 2 | Belle |
| 2002 | 12 | 4 | 2 | Lili |

Retired Names


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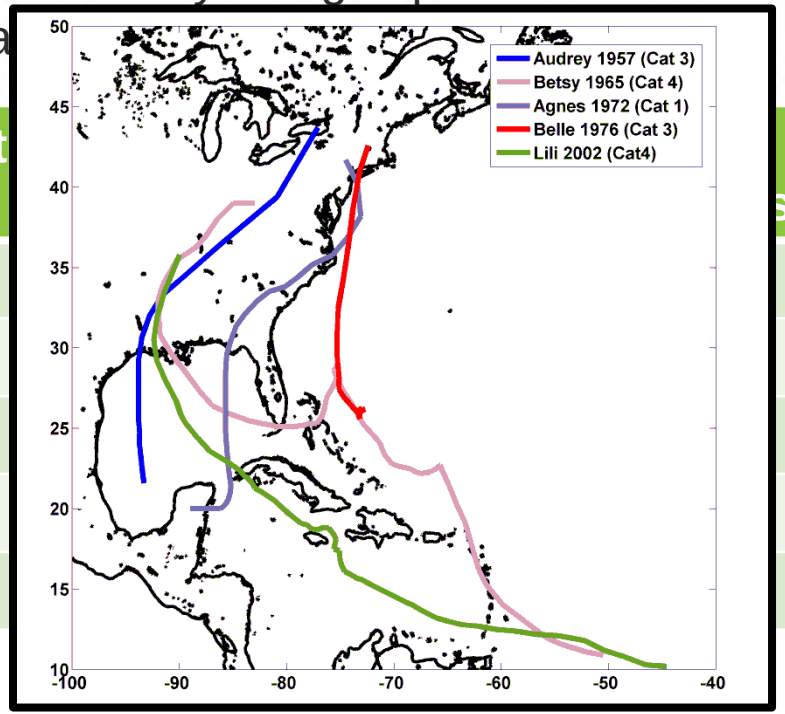
# Analog Years

Colorado State University

Hurricane seasons since 1950 which had similar atmospheric-oceanic conditions to those currently being experienced and those that we expect to see this summer a

| Year | St | s | Notable Hurricanes |
|---|---|---|---|
| 1957 | | | Audrey |
| 1965 | | | Betsy |
| 1972 | | | Agnes |
| 1976 | | | Belle |
| 2002 | | | Lili |




Retired Names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# Pop Quiz!

- As far as we know, there has never been a season without at least one hurricane. TRUE or FALSE?

**FALSE! (sort-of)**

**1907 and 1914 both officially had zero hurricanes form**

**HOWEVER, during the satellite era (since 1966), every season has had at least one hurricane**


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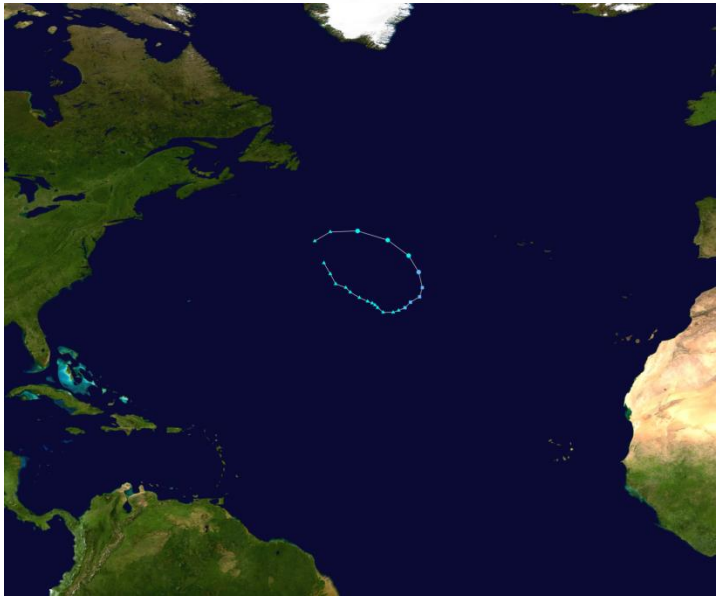
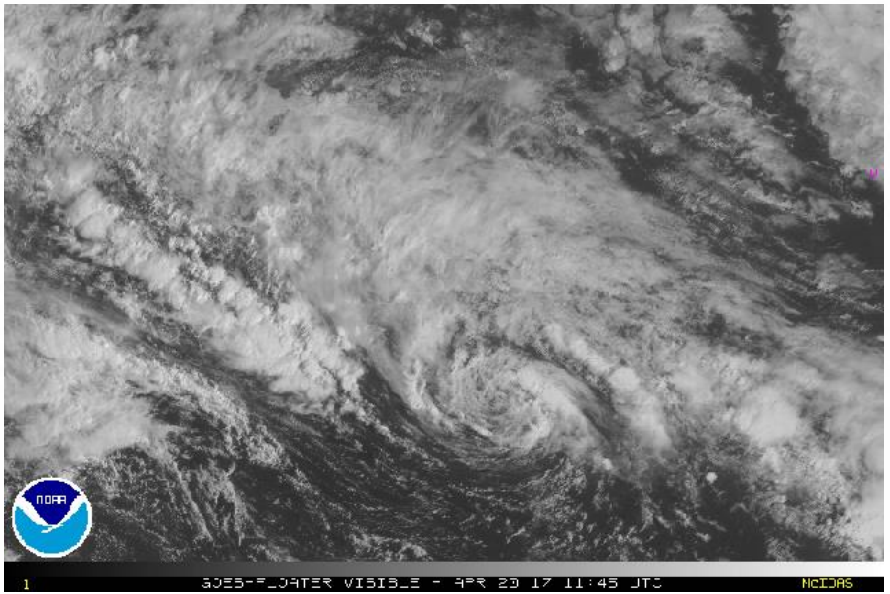
# An Early Start This Year: Tropical Storm Arlene

Second April tropical cyclone on record (Ana 2003)







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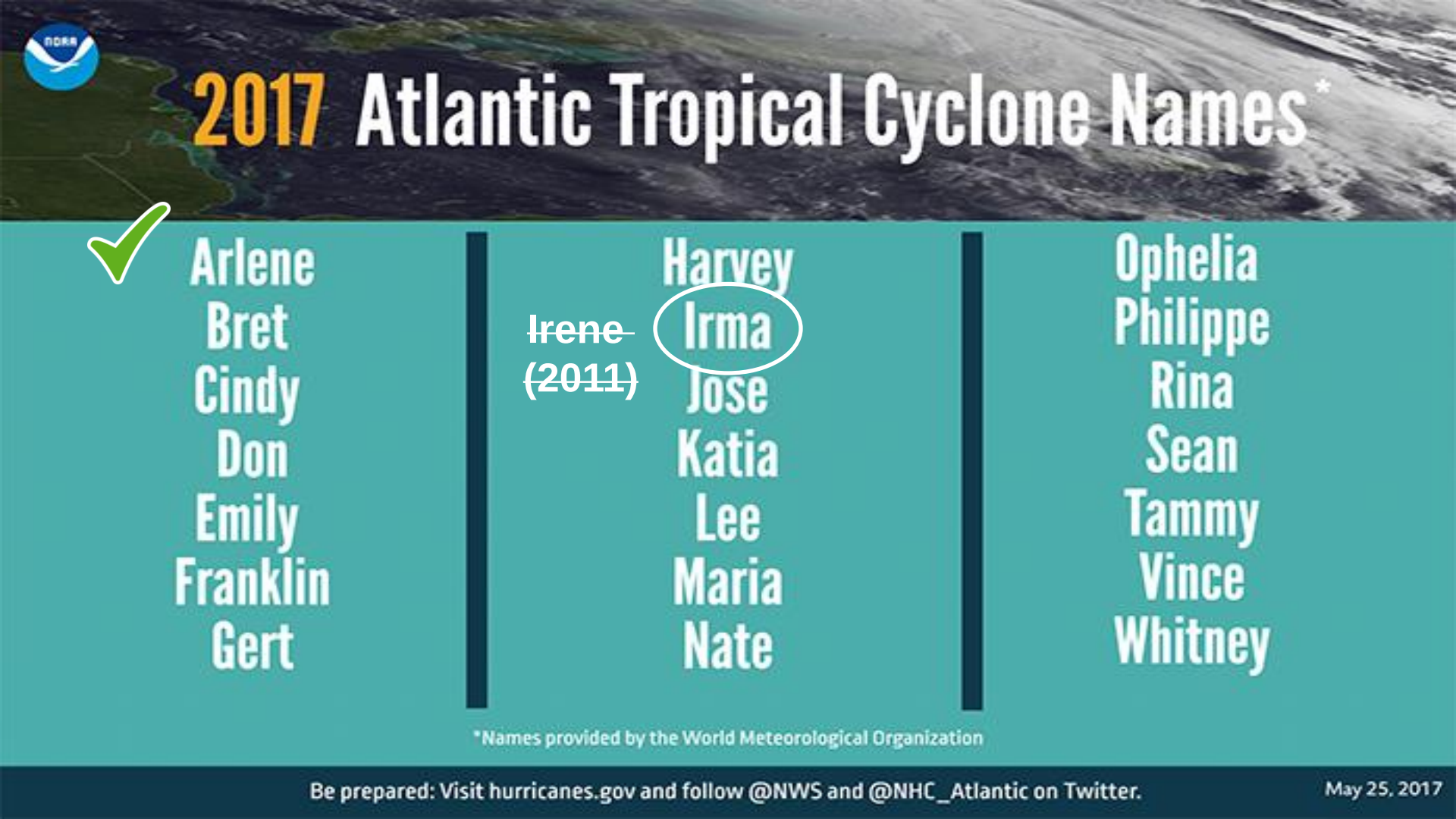
2017 Atlantic Tropical Cyclone Names*
Arlene
Bret
Cindy
Don
Emily
Franklin
Gert
Harvey
~~Irene (2011)~~
Irma
Jose
Katia
Lee
Maria
Nate
Ophelia
Philippe
Rina
Sean
Tammy
Vince
Whitney
*Names provided by the World Meteorological Organization
Be prepared: Visit hurricanes.gov and follow @NWS and @NHC_Atlantic on Twitter.
May 25, 2017

# AIR's Hurricane Forecasting Contest

AIR

# AIR's Hurricane Forecasting Contest

- Predictions

| | Named storms | Hurricanes | Major hurricanes | US Landfalls |
|---|---|---|---|---|
| Average | 14 | 7 | 3 | 2 |
| Max | 100 | 99 | 98 | 7 |
| Min | 1 | 1 | 0 | 0 |


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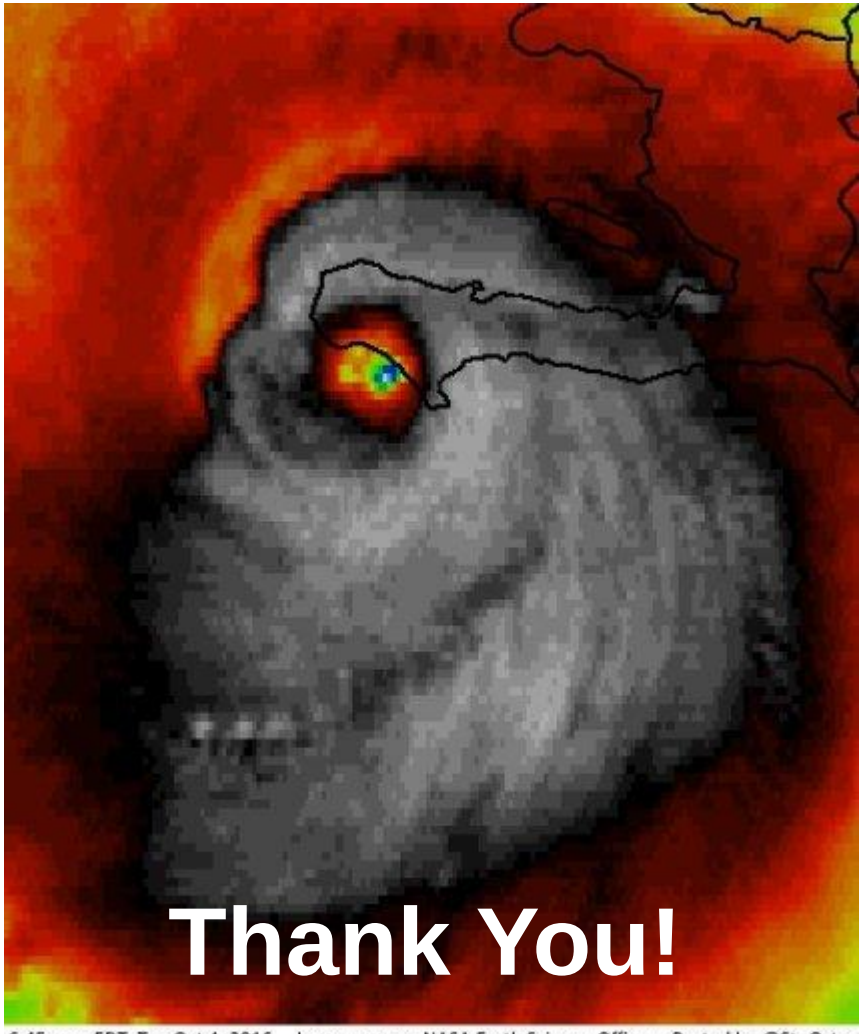
Thank You!
6:45 a.m. EDT Tue Oct 4, 2016 Image source: NASA Earth Science Office Posted by @StuOstro