

2016 AIR Hurricane Season in Review

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AIR WORLDWIDE®

Agenda

2016 AIR Hurricane Season in Review

Atlantic Hurricane Season

Noteworthy Events of 2016

Seasonal Forecasts

Factors That Influenced Activity

Activity in Other Basins

ALERT™

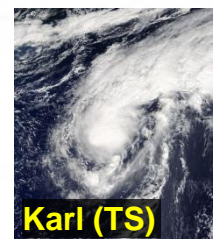
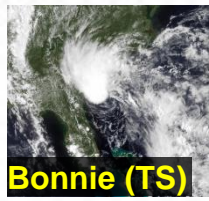
AIR's Hurricane Contest

Atlantic Hurricane Season

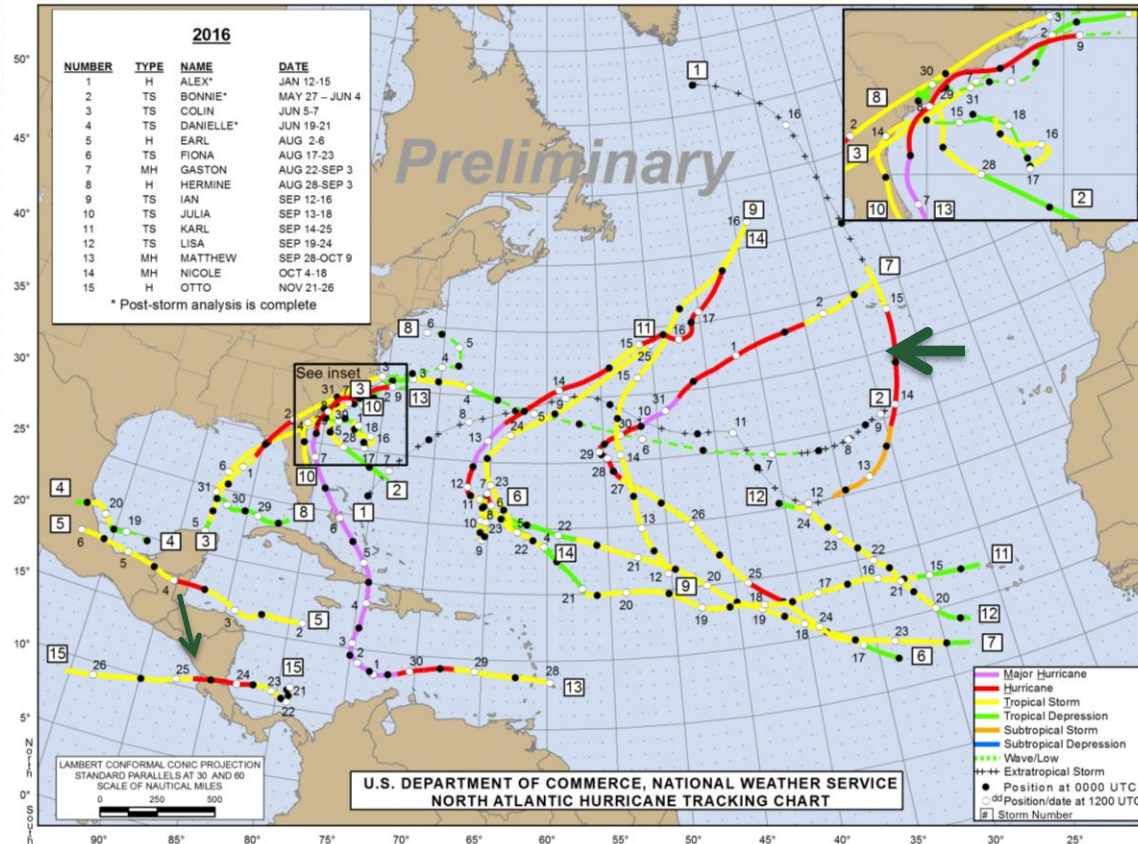


Actual 2016 Atlantic Basin Activity through Today

- Named storms: **15 (avg. 12)**
- Hurricanes: **7 (avg. 6)**
- Major hurricanes (Category 3+): **3 (avg. 2)**
- U.S. landfalling hurricanes: **2**
- Total landfalling hurricanes: **5**



Tropical Cyclone Tracks in 2016



Noteworthy Events of 2016

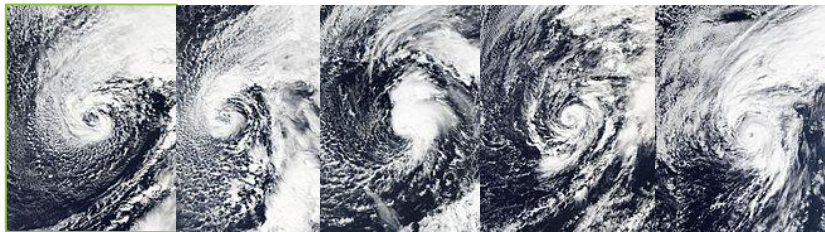


Hurricane Alex: A January Hurricane

Hurricane Alex

- First Atlantic hurricane to form in January since 1938
- Transitioned from an extratropical cyclone to become a Category 1
- Impacted the Azores Islands in the eastern Atlantic as a tropical storm

Jan. 10 Jan. 11 Jan. 12 Jan. 13 Jan. 14

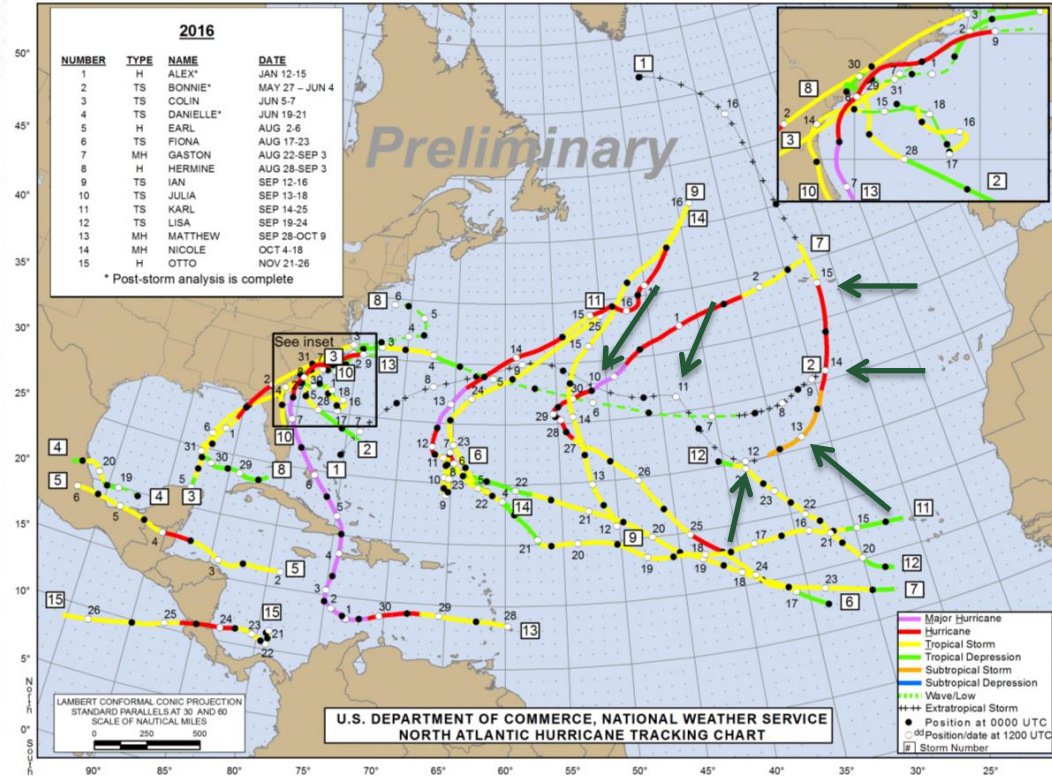


Extratropical

Transitioning

Tropical Storm

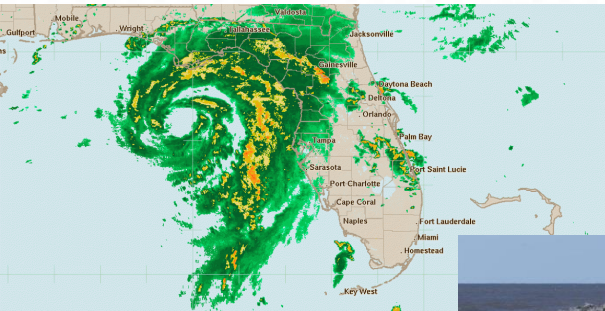
Hurricane



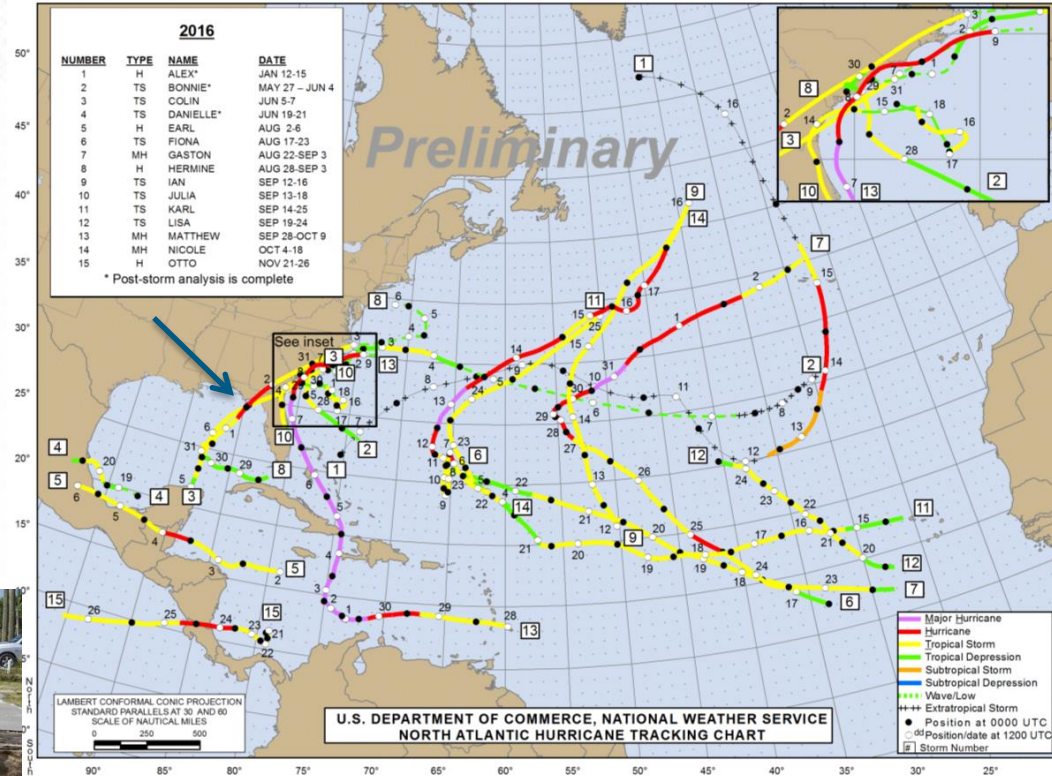
Hurricane Hermine: First Landfalling Hurricane

Hurricane Hermine

- Category 1
- First hurricane to make landfall in Florida since Hurricane Wilma in 2005



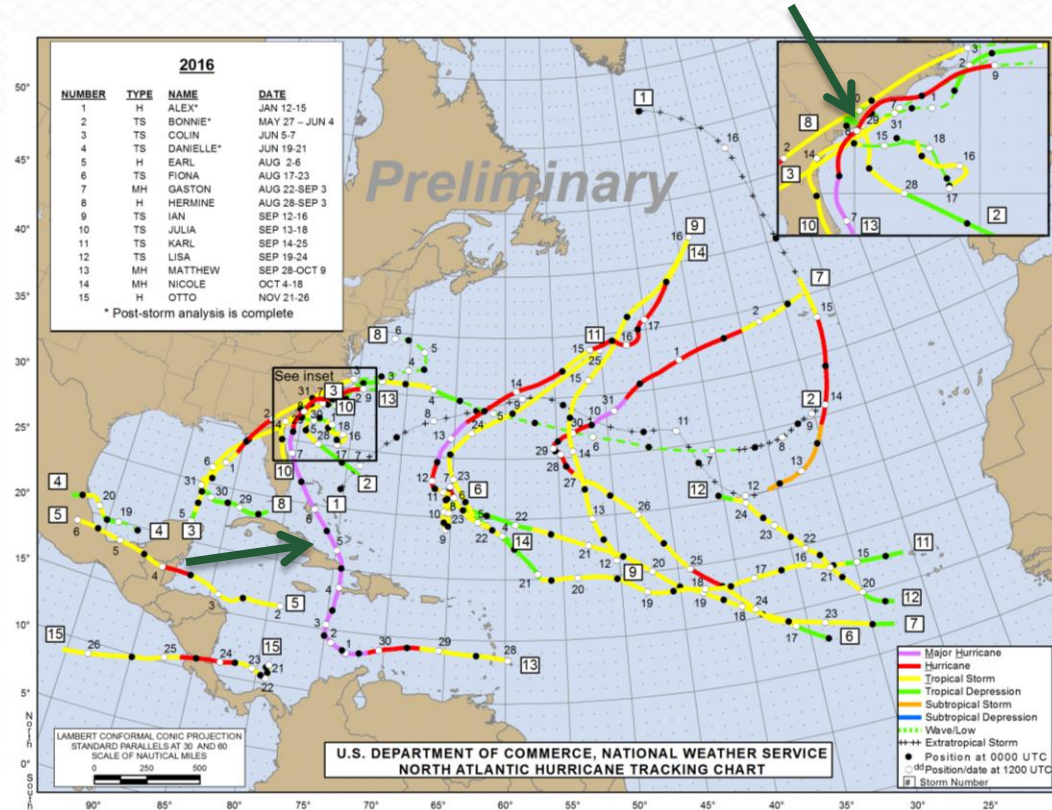
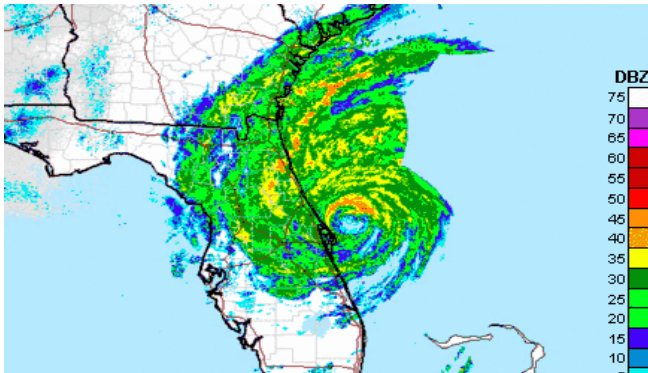
St. Marks, FL



Hurricane Matthew: First Category 5 Since 2007

Hurricane Matthew

- First Category 5 since Hurricane Felix in 2007
- Affected the Caribbean and the southeastern coastline of the U.S.
- More than 1,600 deaths, mostly in Haiti
- Matthew made landfall in the U.S., striking South Carolina at Category 1 intensity



Impacts from Hurricane Matthew

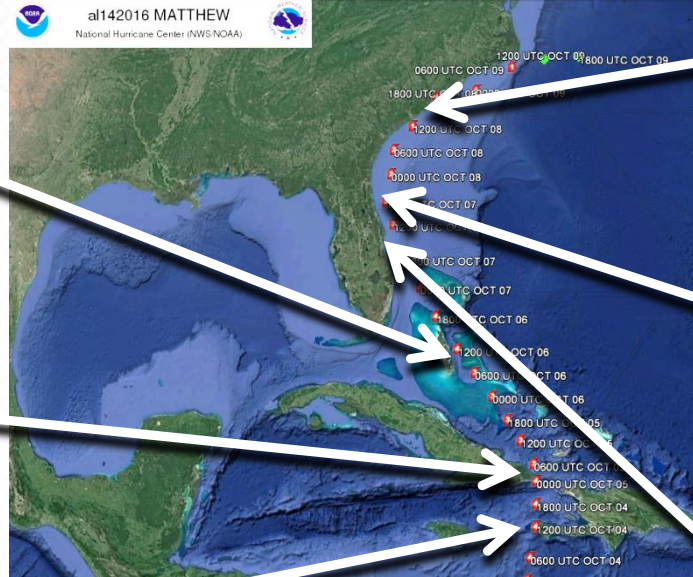
Bahamas



Cuba



Haiti



Charleston, SC



Florida

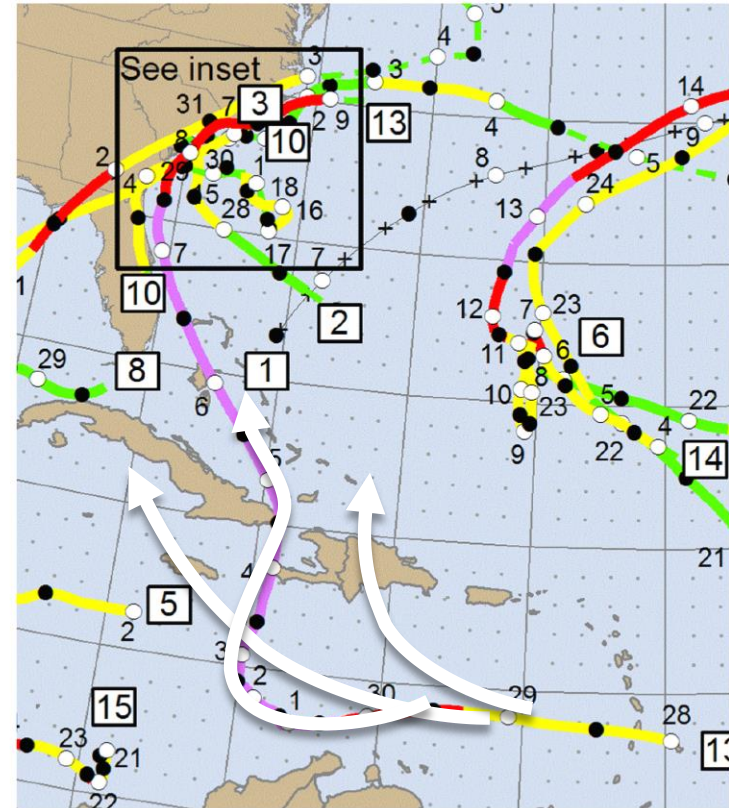


Florida



Matthew's Unusual Track

- Storms traveling north from the Caribbean typically cross Hispaniola or Cuba
 - High terrain
 - Weakens intensity
- Matthew largely avoided these islands
- Maintained intensity through the Bahamas and toward the U.S.

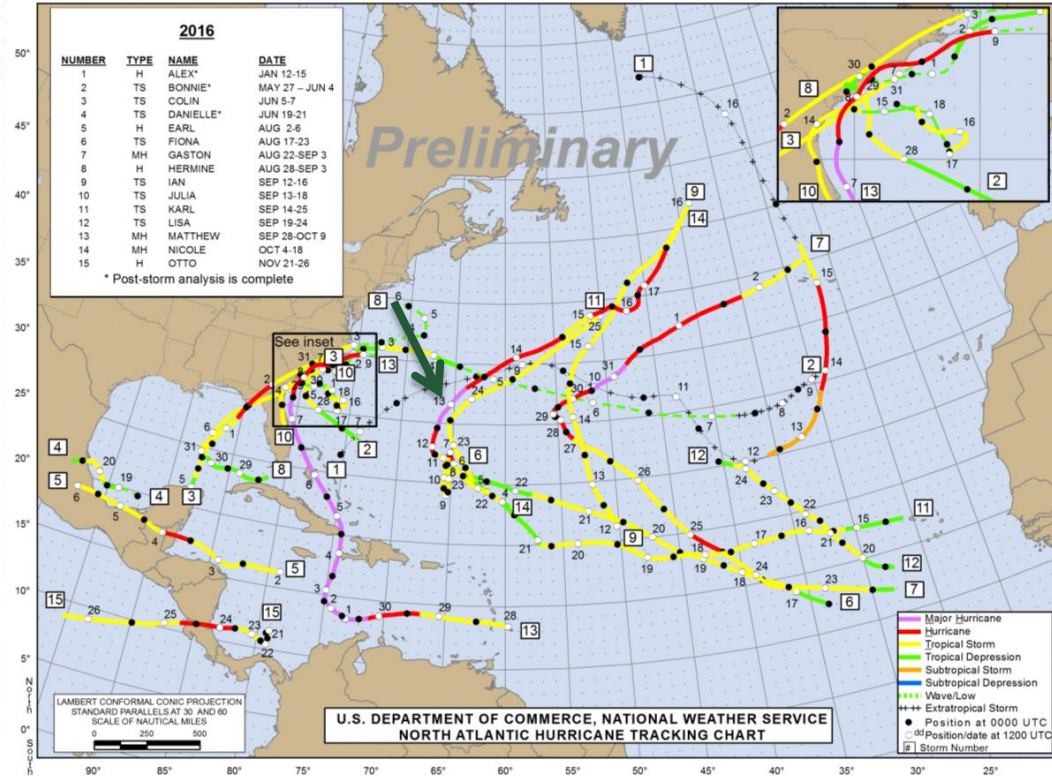
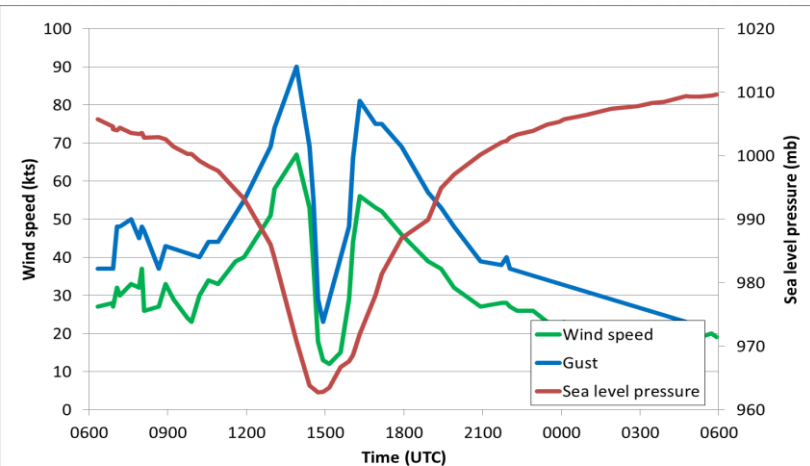


U.S. DEPARTMENT OF COMMERCE, NATIONAL WEATHER SERVICE
NORTH ATLANTIC HURRICANE TRACKING CHART

Hurricane Nicole's Strike on Bermuda

Hurricane Nicole

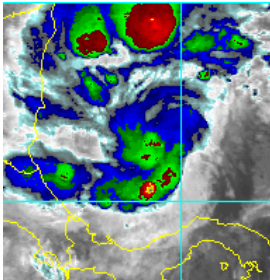
- Reached Category 4
- First major hurricane to strike Bermuda since Fabian in 2003



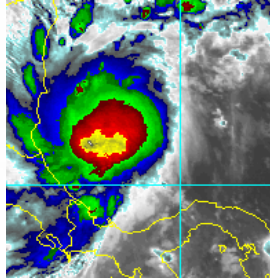
The Atlantic's Latest Landfall

Hurricane Otto

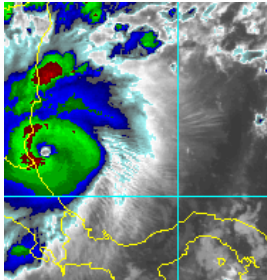
- Latest hurricane in Caribbean since 1969
- Latest Atlantic basin landfall on record
- Most southern landfall in Central America



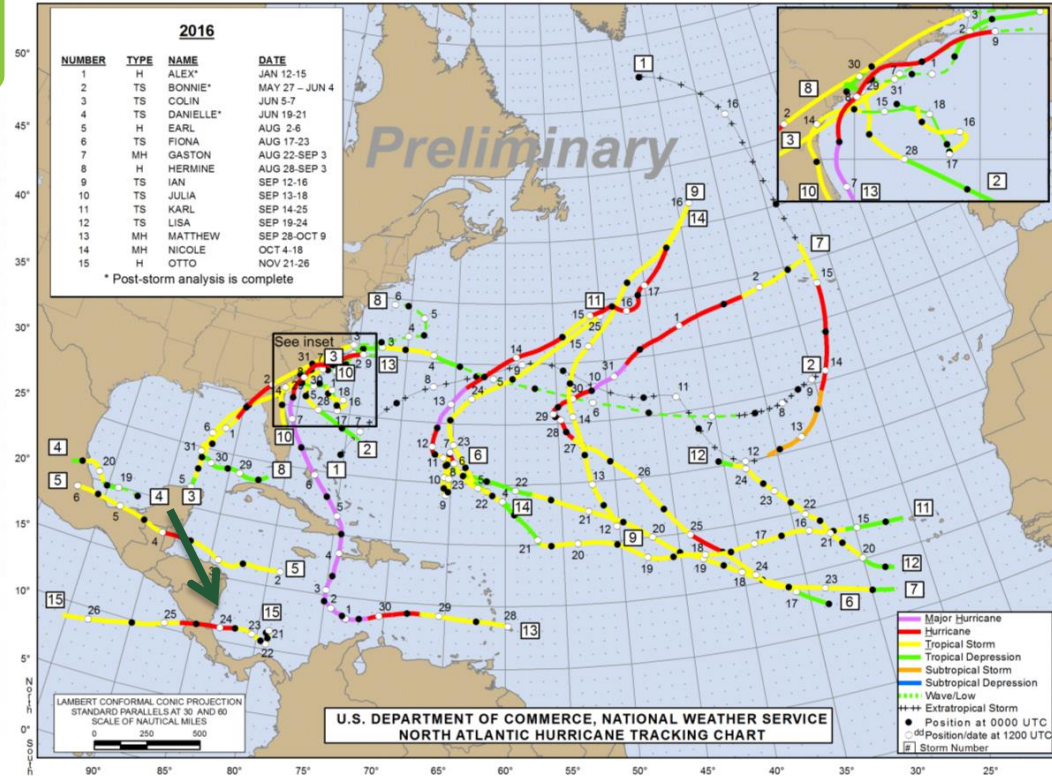
Nov. 23
15:00 UTC
70 mph



Nov. 24
03:00 UTC
85 mph

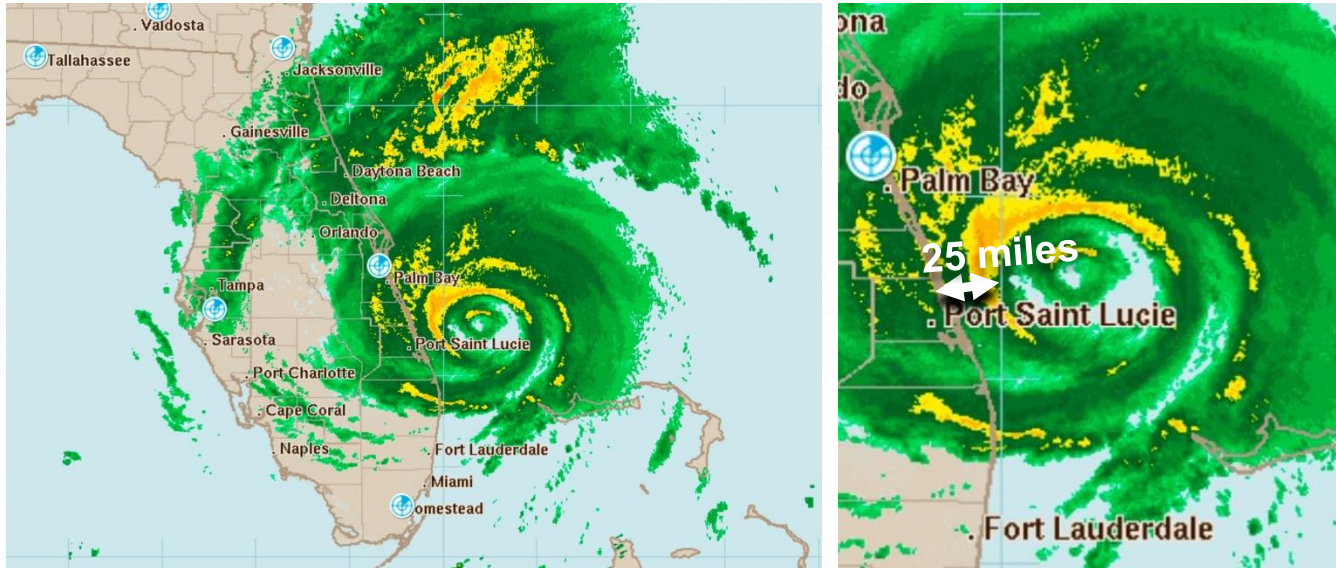


Nov. 24
15:00 UTC
110 mph



Longest Period without a Major Hurricane Landfall in the U.S.

- The 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!***



A satellite image of a hurricane, identified as Hurricane Joaquin, approaching the United States. The hurricane is shown as a large, swirling cloud system with a bright white eye and a dark, dense center. The surrounding clouds are white and billowing. The ocean is visible as a dark blue area. The landmasses of Central and South America are partially visible on the left side of the image. The text is overlaid on the image in various colored boxes.

ARTICLES

THE ARBITRARY DEFINITION OF THE CURRENT ATLANTIC MAJOR HURRICANE LANDFALL DROUGHT

BY ROBERT E. HART, DANIEL R. CHAVAS, AND MARK P. GUSHARD

Although nine years have passed since the last U.S. major hurricane landfall, the existence and relative significance of the current drought are largely artifacts of the chosen metric.

1337 UTC 1 Oct 2015: Major Hurricane Joaquin approaching the United States and threatening to end the almost 10-yr absence of major hurricane landfalls in that country.

Hart et al., 2016
*Bulletin of the American
Meteorological Society*

Seasonal Forecasts



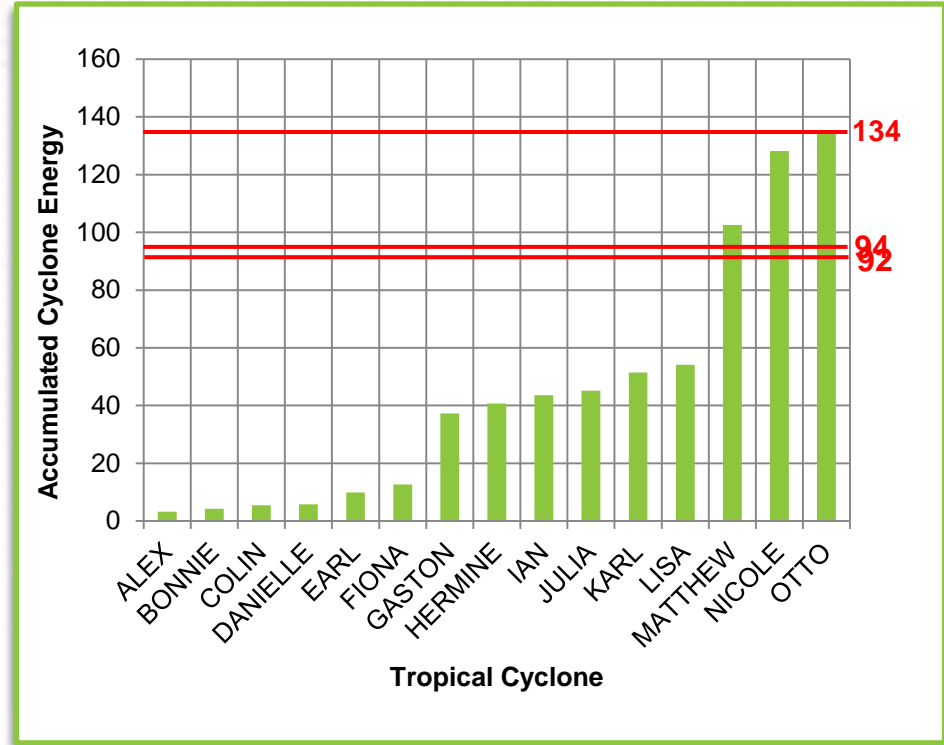
Forecasts for 2016 Atlantic Basin Activity

Agency	Forecast Date	Named Storms	Hurricanes	Major Hurricanes
CSU	June 1	14	6	2
WeatherTiger	June 1	14	9	3
NOAA	May 27	10–16	4–8	1–4
Tropical Storm Risk	May 27	17 (± 4)	9 (± 3)	4 (± 2)
UK Met Office*	May 12	14	8	--
CCU	April 28	13	7	3
Weather Channel	April 22	14	8	3
NCSU	April 15	15–18	8–11	3–5
AccuWeather	April 9	14	8	4
Consensus		14	8	3
Final		15	7	3

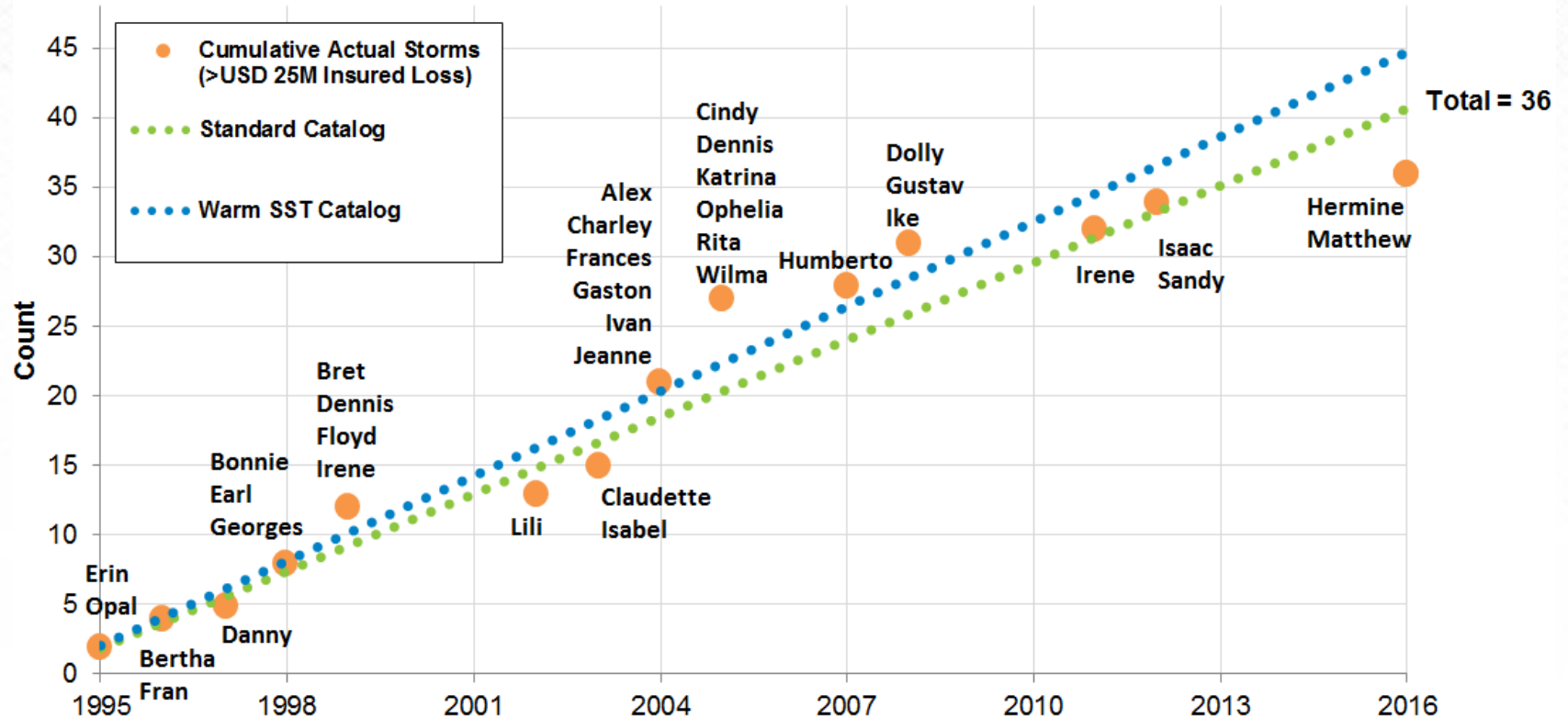


Accumulated Cyclone Energy (ACE)

- Another measure of total destructive potential over a season is ACE
 - Defined as sum of squared maximum wind speed at each six-hour advisory period
- Typically ACE = 92
- Colorado State forecast 94
- Ended season at 134 (146% of mean)



The Long-Term View of Landfall Risk



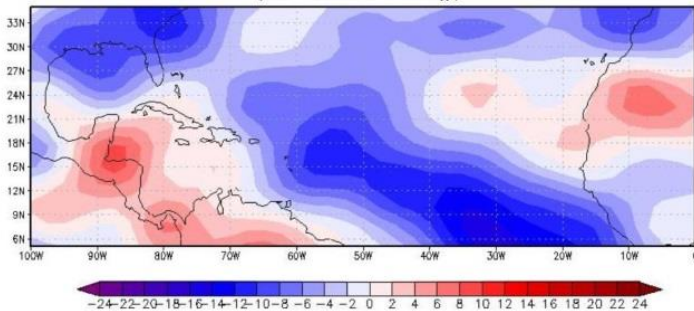
Factors That Influenced Activity



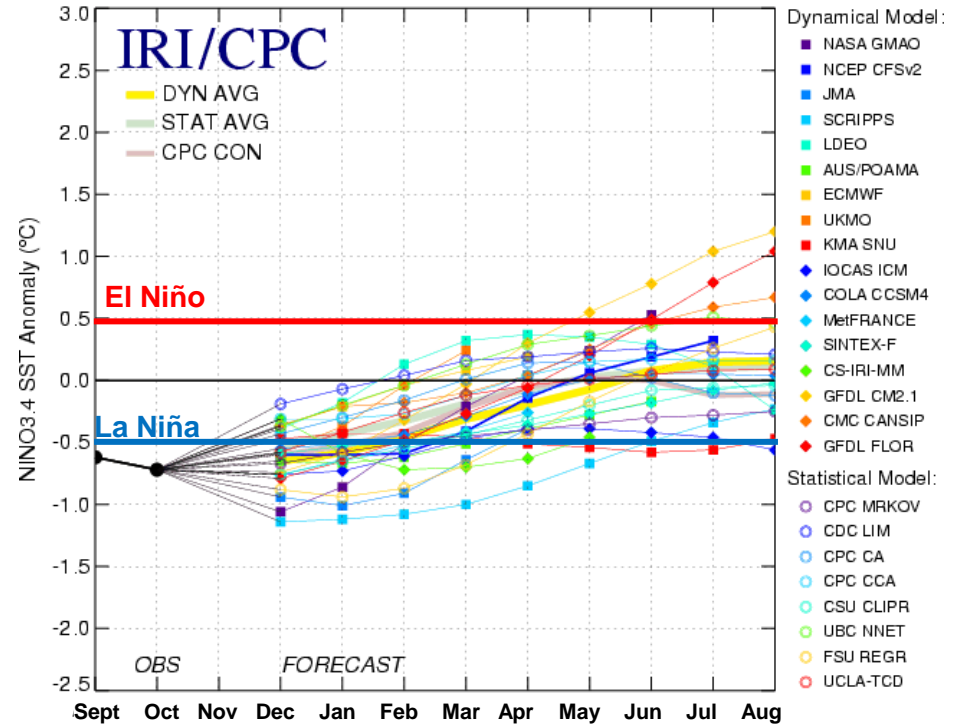
El Niño-Southern Oscillation (ENSO) in 2016

- El Niño had a large impact on activity in 2015
- Forecasts were for cool-neutral to weak La Niña conditions to develop in 2016
 - Forecast was accurate
- Vertical shear was generally weaker in 2016

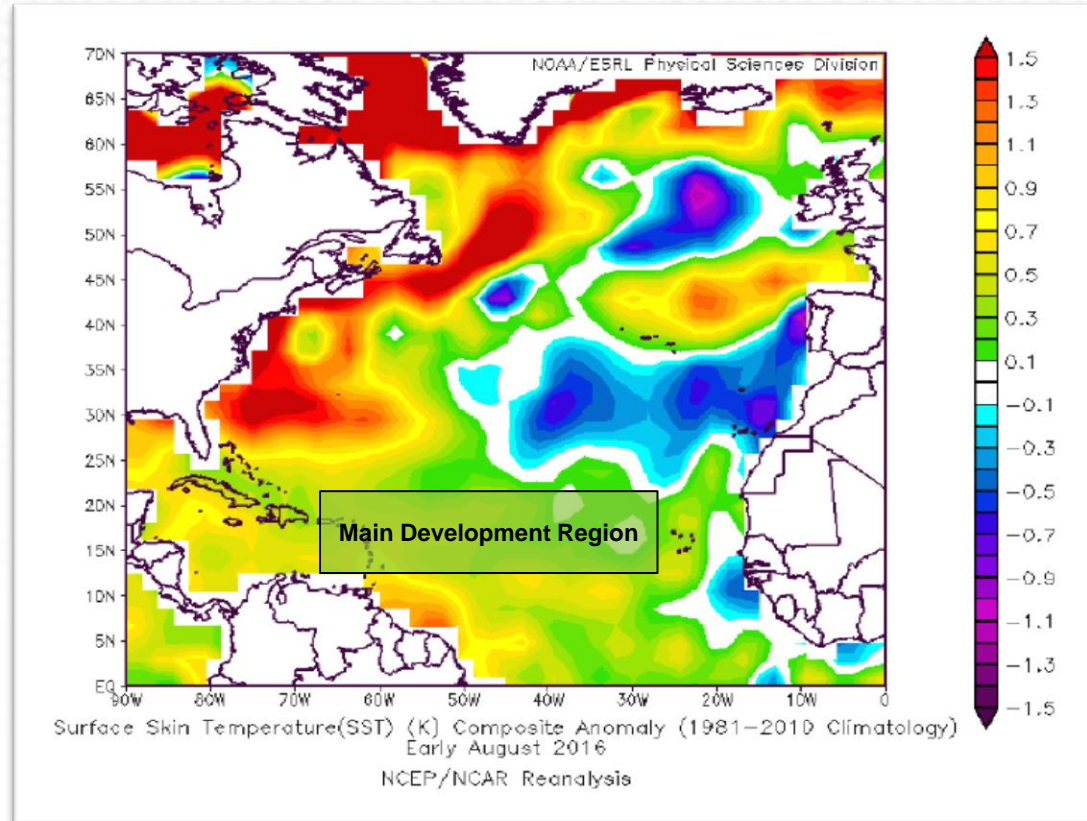
August Through October 2016 Average
Zonal (200–850 mb) Vertical Wind Shear Anomaly (kts)
(1981–2010 Climatology)



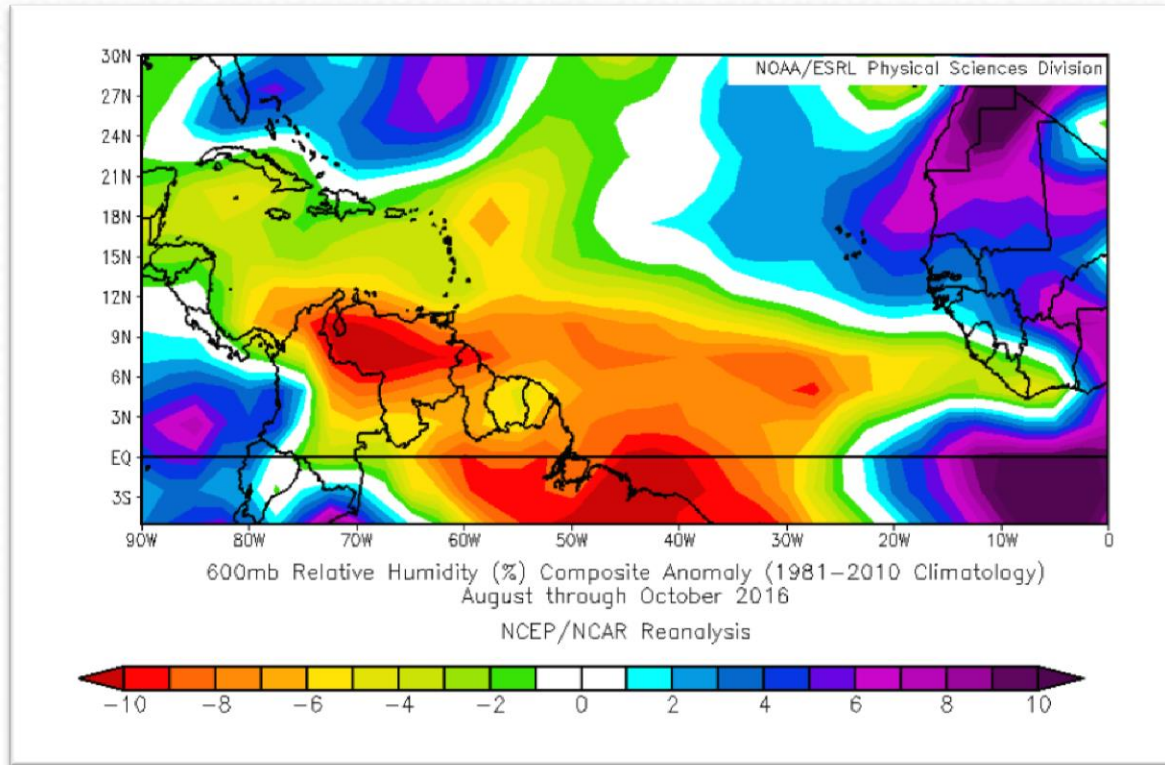
Mid-Nov 2016 Plume of Model ENSO Predictions



The Atlantic Multi-decadal Oscillation (AMO)

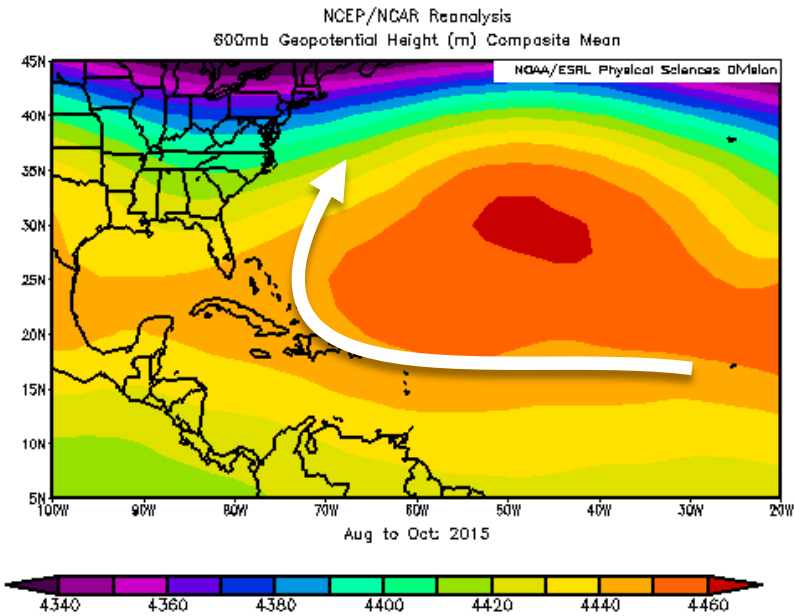


Tropical Atmospheric Moisture

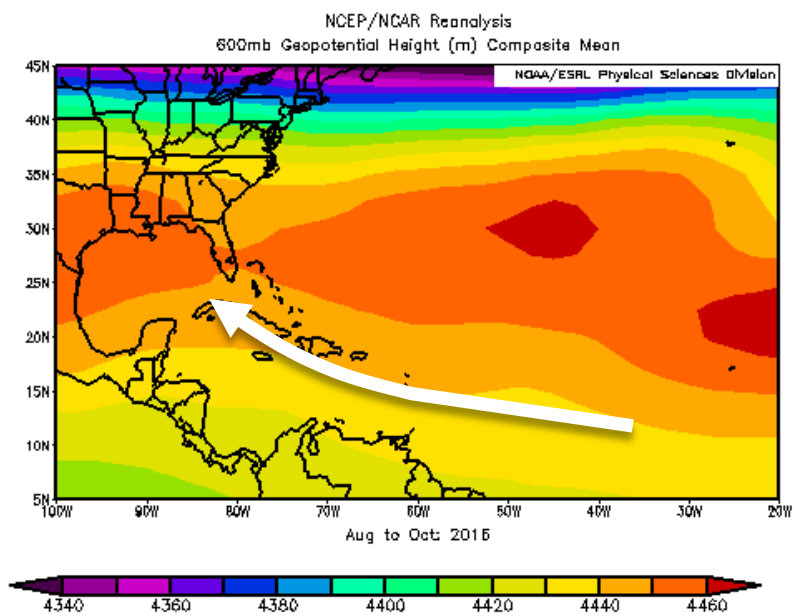


Steering Currents and the North Atlantic Oscillation (NAO)

2015 – Negative NAO



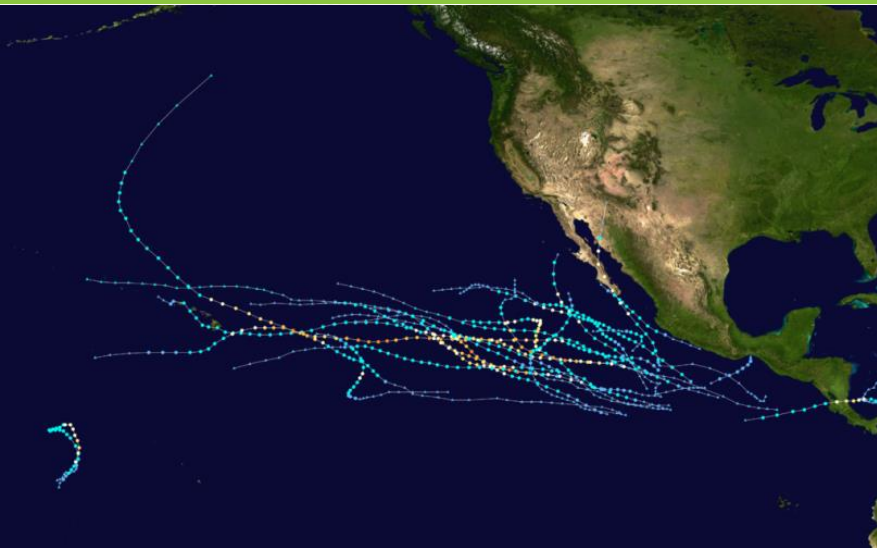
2016 – Positive NAO



Activity in Other Basins



Eastern and Central Pacific Basin Activity



22

**Named
storms**

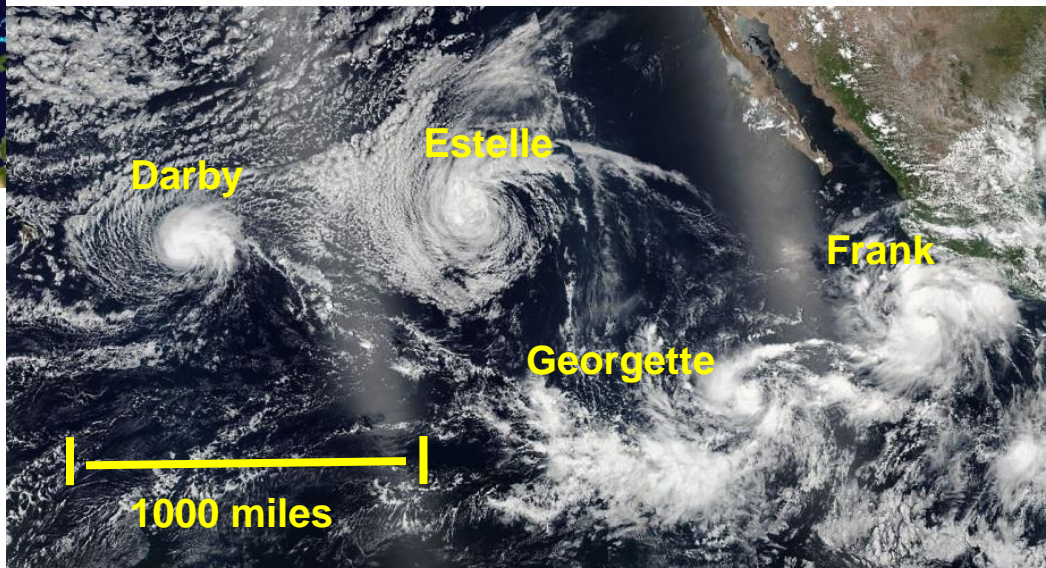
13

Hurricanes

6

**Major
hurricanes**

- Newton, the only landfalling hurricane (Baja California and mainland Mexico)
- Tropical storm Otto crossed Central America into Eastern Pacific (2 “O” storms; Hurricane Orlene)



Western Pacific Typhoon Activity

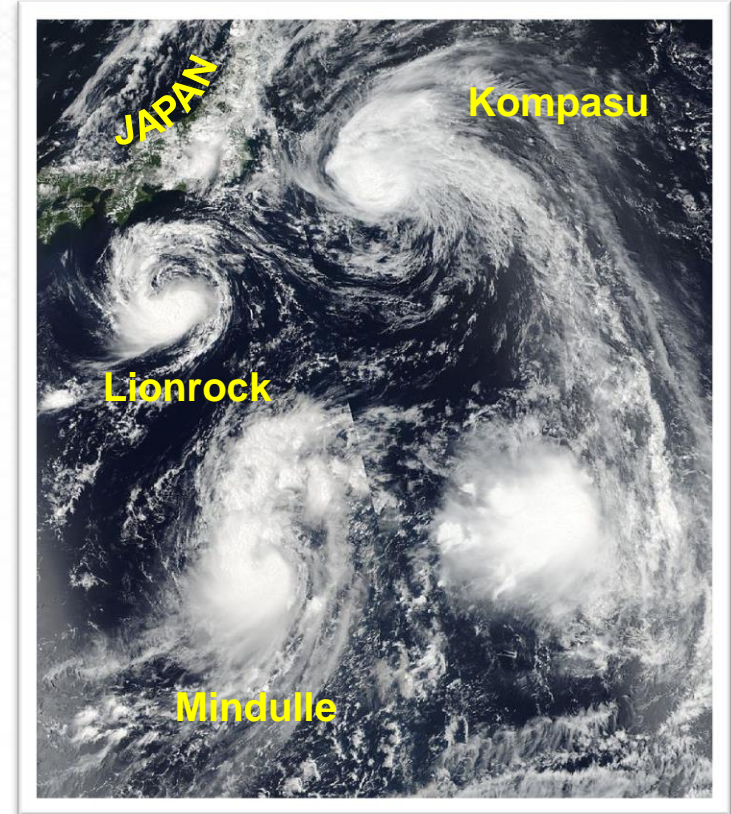
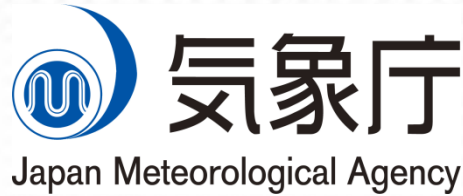
25 Named storms

12 Typhoons

5 Super Typhoons

Season started late but activity was close to average

- First named storm didn't form until July 3 (second-latest on record)
- Burst of activity from Sept. 1 to Oct. 15 when 11 named storms formed

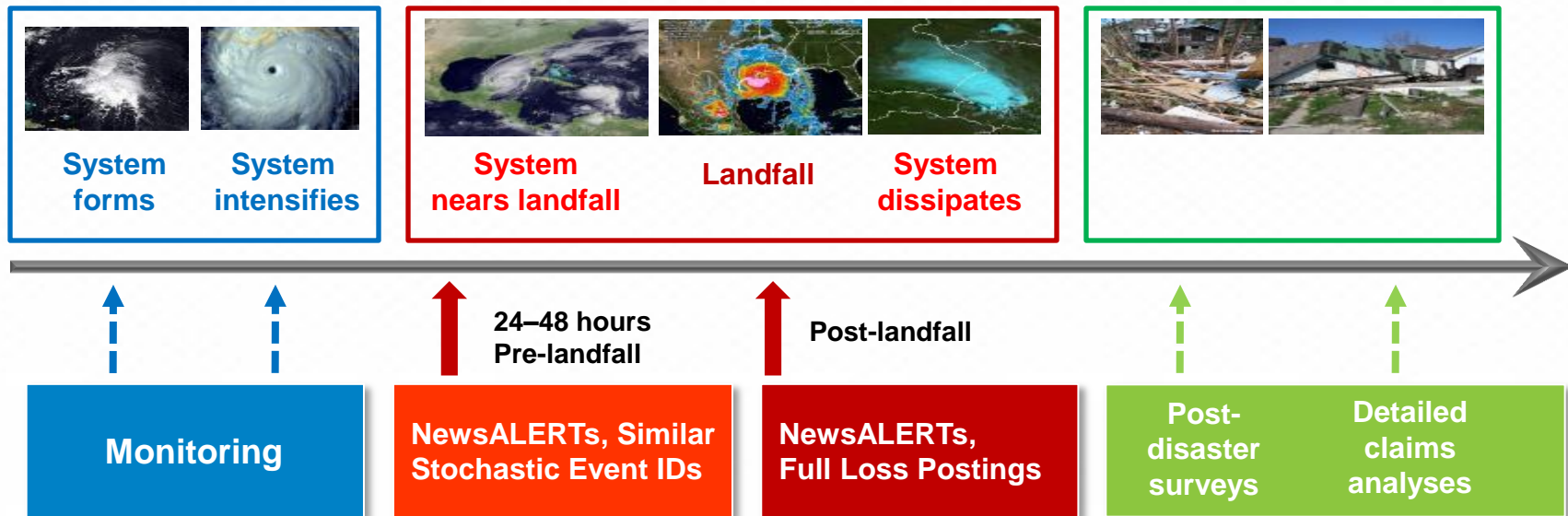


ALERT



Overview of the ALERT™ Process for U.S. Hurricanes

AIR Loss Estimation in Real Time



AIR's Hurricane Contest



Contestant Picks

	Storms	Hurricanes	Major hurricanes	Landfalling hurricanes
Actual	15	7	3	2
Contestants (Median)	12	6	3	2

Total Participants = 309

Forecast Error Consensus (Mean Absolute Error)

Error = | Forecast named storms – Actual named storms | +
| Forecast hurricanes – Actual hurricanes | +
| Forecast major hurricanes – Actual major hurricanes | +
| Forecast U.S. landfalling hurricanes – Actual U.S. landfalling hurricanes |

$$MAE = \frac{1}{n} \sum \text{Error}$$

	Named storms	Hurricanes	Major hurricanes	U.S. landfalling hurricanes	Total
<i>MAE</i>	3.4	1.8	0.9	1.0	7.0

Thank You!

