

# FAQ / State of the Science: Atlantic Hurricanes & Climate



*This document represents the state of the science as developed by numerous NOAA researchers. NOAA's tropical cyclone activities include targeted research on hurricane development, intensity, and track; surface, ocean, and in situ observations; reconnaissance aircraft missions; numerical modeling; climate and hurricanes, operational forecasts; outreach and timely dissemination of information; and impact assessments. As new scientific information becomes available, this document will be updated.*

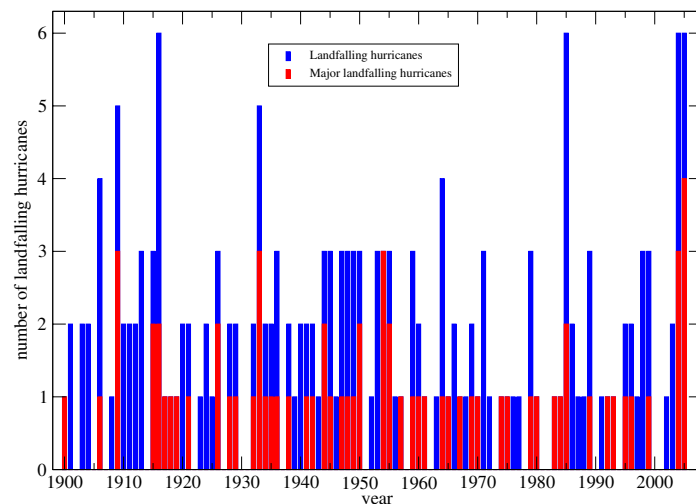
## What Are the Basic Factors that Influence Hurricanes?

- A pre-existing weather disturbance
- Warm ocean water temperatures in the tropical Atlantic Ocean and Caribbean
- Moisture in the atmosphere
- Favorable wind conditions, such as light winds aloft or weak wind shear

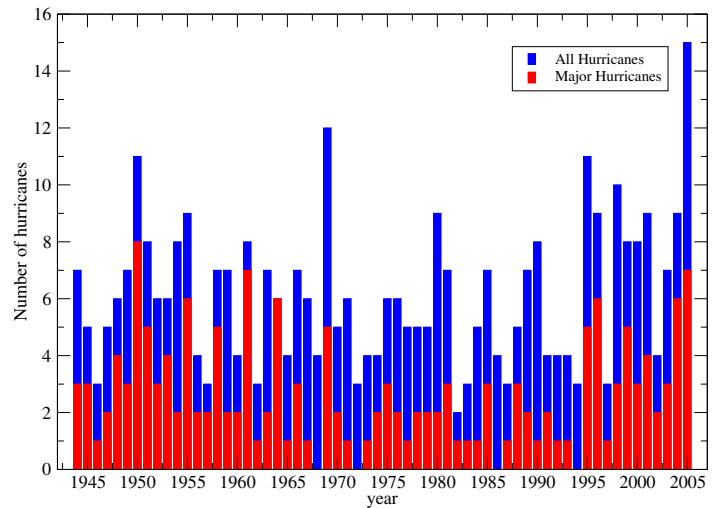
## What Are Examples of Natural Climate Variability and Hurricane Activity?

- El Niño/Southern Oscillation (ENSO) can impact hurricane formation in the Atlantic Basin. All other factors being equal, we have learned that El Niño conditions tend to suppress hurricane development while La Niña conditions tend to favor development.
- The Atlantic Multi-decadal Oscillation (AMO) is an ongoing series of long-duration changes in the sea surface temperature (SST) of the North Atlantic Ocean with cool and warm phases that may last for 20 to 40 years at a time. As our understanding of the AMO continues to improve, we have learned during the warm phases the AMO, the numbers of tropical storms that mature into severe hurricanes is much greater than during cool phases. As a result, we have observed increased Atlantic hurricane

**Figure 2: Landfalling Hurricanes and Major Hurricanes (cat. 3-5) in United States**



**Figure 1: Number of Hurricanes and Major Hurricanes (cat. 3-5); Atlantic Basin (1945-2005)**

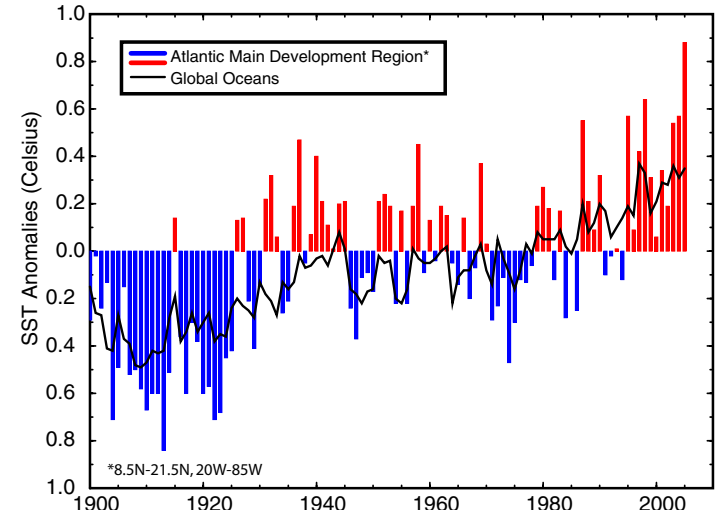


activity from the 1940s to the late 1960s, fewer than average major hurricanes for about the next 25 years, and now an increased number since 1995.

## What Are the Human-Induced Factors in Climate Change and Hurricane Activity?

- The potential impact of anthropogenic warming on hurricanes is a relatively new research area for NOAA scientists.
- There are recent studies that suggest the warming of the oceans in the Atlantic main development region in the 20<sup>th</sup> century is due to the increase in greenhouse gases, and in turn these warmer waters provide more fuel to the development and intensification of hurricanes.
- Another study found that models simulate approximately a  
*(over, please)*

**Figure 3: June - November Average Sea Surface Temperature Anomalies**



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one-half category increase on the Saffir Simpson scale of strong hurricanes in the late 21<sup>st</sup> century, if SSTs are about 1.75 degrees Celsius warmer than the present. The models also show an approximately 20 percent increase in near-storm rainfall rate under those conditions.

### What Was the Atlantic Hurricane Activity During the 20<sup>th</sup> Century?

- Atlantic hurricane seasons since 1995 have been significantly more active, e.g. more hurricanes and more intense hurricanes, than the previous two decades. (figure 1)
- Earlier periods, such as from 1945 to 1970 (and perhaps earlier), were apparently as active as the most recent decade.
- The past decade has seen increased U.S. landfalls, however periods of even higher landfalls occurred early in the century. (figure 2)
- Our science is not mature enough to determine what percentage of anthropogenic climate change and what percentage of natural climate variability is driving our current hurricanes.

### How Long Will the Current Active Period Last?

- Scientists disagree as to whether currently a sound basis exists for making projections on how long the current active period will last. The viewpoints in the scientific community include:
  - Limited understanding of natural decadal variability, combined with its irregular temporal behavior, preclude definitive statements about how long the active period will last.
  - Natural decadal variability suggests high levels of hurricane activity and U.S. landfalls for the next decade and beyond since the previous active period (1945-1970) lasted at least 25 years.
  - Warming suggests more intense hurricanes (e.g., as increasing surface temperatures provide energy for storm intensification), and some non-NOAA scientists suggest global warming will cause the current active period to persist.

### What Are Key Research Areas?

- Understanding the dynamics of the AMO, its links to the larger-scale tropical climate variability, and developing an ocean monitoring and decadal prediction capability
- Improving the quality and scope of hurricane relevant data sets
- Numerically simulating and ultimately understanding seasonal to decadal hurricane variability
- Understanding whether or not and to what degree anthropogenic forcing is having an influence on hurricanes
- Making improvements to short range hurricane track and intensity forecasts through improved models and development of additional capabilities for hurricanes

### Resources for Additional Information

#### • NOAA National Weather Service

##### ❖ National Centers for Environmental Prediction

*Climate Prediction Center:* intraseasonal to multi-season climate forecasts; seasonal hurricane forecasts; diagnostic studies of major climate anomalies; real time monitoring of climate.

<http://www.cpc.noaa.gov>

*Tropical Prediction Center / National Hurricane Center:* issues operational hurricane forecasts; maintain and update the official Atlantic and northeast Pacific hurricane databases from which observational climate studies are conducted.

<http://www.nhc.noaa.gov>

#### • NOAA Satellite and Information Service

*National Climatic Data Center:* official archive for climate data sets; development of global tropical cyclone databases, analysis of historical frequency and strength of Atlantic Basin hurricanes, analyses of climate trends, monitoring and historical perspective on current seasons.

<http://www.ncdc.noaa.gov>

*National Coastal Data Development Center:* distributes data and information associated with natural and man-made events that impact coastal areas.

<http://www.ncddc.noaa.gov>

#### • NOAA Office of Oceanic and Atmospheric Research

*Atlantic Oceanographic and Meteorological Laboratory / Hurricane Research Division / Physical Oceanography Division:* physical understanding of hurricane dynamics through use of research aircraft and field studies; improvements to hurricane track and intensity forecasts; monitoring of Atlantic ocean circulations; studies of Atlantic climate.

<http://www.aoml.noaa.gov>

*Geophysical Fluid Dynamics Laboratory:* studies of climate variability and change; development and use of the required climate models; development of models used for operational hurricane forecasts by NOAA and the Navy; numerical studies of climate impacts on hurricanes and their decadal variability.

<http://www.gfdl.noaa.gov>

*Earth System Research Laboratory:* diagnostic studies of climate variability and changes; impacts of climate on extreme events.

<http://www.esrl.noaa.gov>

*Climate Program Office:* intramural and extramural support for development of a predictive understanding of the climate system, the required observational capabilities, delivery of climate services.

<http://www.climate.noaa.gov>

#### • World Meteorological Organization (WMO)

A summary statement on the possible relationship between global tropical cyclones and climate change was developed by the global community of tropical cyclone researchers and forecasters who participated in the World Meteorological Organization's Sixth International Workshop on Tropical Cyclones in November 2006. Several of the participants were NOAA scientists. The summary statement, as well as a more detailed version, are available on the WMO Web site.

<http://www.wmo.ch/web/arep/arep-home.html>

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