



Hurricanes and Climate Change

Around the globe, 80-100 tropical storms are observed every year. These storms are unevenly distributed across the Indian, Pacific, and Atlantic oceans. About half go on to reach hurricane strength and a smaller percentage, about one-quarter, become major hurricanes. The generic term “tropical cyclone” can be used to describe tropical storms, hurricanes and typhoons. While most tropical cyclones complete their lifecycle without impacting land, many each year cause catastrophic damage and loss of life to coastal nations including the United States. While this summary focuses on the Atlantic Ocean basin, much of the information also can be applied to the other ocean basins. Here, the most up-to-date information on how climate change is expected to impact hurricanes in the future is presented.

Two complementary lines of evidence are used to diagnose climate change effects upon hurricanes including historical records of observed activity and computer modeling. Many scientists have dedicated their careers to improve the understanding of hurricanes and published countless papers that help inform the scientific consensus. NOAA’s Geophysical Fluid Dynamics Laboratory in Princeton NJ has concluded:

“In summary, it is premature to conclude with high confidence that increasing atmospheric greenhouse gas concentrations from human activities have had a detectable impact on Atlantic basin hurricane activity, although increasing greenhouse gases are strongly linked to global warming...Human activities may have already caused other changes in tropical cyclone activity that are not yet detectable due to the small magnitude of these changes compared to estimated natural variability, or due to observational limitations.”¹

Regardless of the scientific ability to make confident conclusions regarding every impact of climate change on hurricanes, we can be assured that hurricanes will continue to occur and devastate rapidly growing coastal regions. The only proven and practical way to prevent loss of life and property damage is to prepare ahead with improved building codes and to maintain a high level of vigilance and resilience in the face of natural disasters.

Characteristic or Behavior and Impact	Expected Change [sign] over the next several decades	Knowledge Level High Med Low	Confidence Level High Med Low
Frequency	No Change [0]	Medium	Medium
Intensity	Storm Maximum Intensity [+]	Medium	High
Intensification	More Rapid Cases [+]	Medium	Medium
Location	Northward Expansion [+]	Medium	Medium
Speed of Movement	Slowing [+]	Low	Low
Rainfall	More Intense [+]	High	High
Sea Level Rise	Increasing Storm Surge and Flooding [+]	High	High

Note that a lack of evidence does not imply an absence of evidence. It simply indicates that, at present, we have either an incomplete knowledge, inadequate methodology, or a lack of observations. Nevertheless, a medium to high confidence can still exist in the expected outcome based upon our fundamental understanding of physics and fluids.

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For Further Information

Knutson, T., S.J. Camargo, J.C.L. Chan, K. Emanuel, C. Ho, J. Kossin, M. Mohapatra, M. Satoh, M. Sugi, K. Walsh, and L. Wu (2019): Tropical cyclones and climate change assessment: Part I: Detection and attribution. *Bulletin of the American Meteorological Society*, **100**(10), 1987-2007.

Knutson, T., S.J. Camargo, J.C.L. Chan, K. Emanuel, C. Ho, J. Kossin, M. Mohapatra, M. Satoh, M. Sugi, K. Walsh, and L. Wu (2020): Tropical cyclones and climate change assessment: Part II: Projected response to anthropogenic warming. *Bulletin of the American Meteorological Society*, **101**(3), E303-E322.

NOAA Hurricane Research Division Re-Analysis Project (2016). https://www.aoml.noaa.gov/hrd/hurdat/Data_Storm.html

¹ <https://www.gfdl.noaa.gov/global-warming-and-hurricanes/>