

# TROPICAL CYCLONES AND CLIMATE CHANGE ASSESSMENT

## Part I: Detection and Attribution

THOMAS KNUTSON, SUZANA J. CAMARGO, JOHNNY C. L. CHAN, KERRY EMANUEL,  
CHANG-HOI HO, JAMES KOSSIN, MRUTYUNJAY MOHAPATRA, MASAKI SATOH,  
MASATO SUGI, KEVIN WALSH, AND LIGUANG WU

This document is a supplement to “Tropical Cyclones and Climate Change Assessment. Part I: Detection and Attribution,” by Thomas Knutson, Suzana J. Camargo, Johnny C. L. Chan, Kerry Emanuel, Chang-Hoi Ho, James Kossin, Mrutyunjay Mohapatra, Masaki Satoh, Masato Sugi, Kevin Walsh, and Liguang Wu (*Bull. Amer. Meteor. Soc.*, **100**, 1987–2007) • ©2019 American Meteorological Society • Corresponding author: Thomas R. Knutson, tom.knutson@noaa.gov • DOI:10.1175/BAMS-D-18-0189.2

### PREVIOUS ASSESSMENT SUMMARY.

Previous global assessments of this topic include Knutson et al. (2010), which was a WMO task team report, and the IPCC Fifth Assessment Report (AR5) assessment (Bindoff et al. 2013). Some key aspects of the IPCC AR5 assessment on TC activity are reproduced here for reference and comparison to the current assessment.

Regarding attribution of past TC changes, IPCC AR5 (Bindoff et al. 2013) concluded, “Globally, there is low confidence in any long-term increases in tropical cyclone activity (section 2.6.3) and we assess that there is low confidence in attributing global changes to any particular cause. In the North Atlantic region there is medium confidence that a reduction in aerosol forcing over the North Atlantic has contributed at least in part to the observed increase in tropical cyclone activity since the 1970s. There remains substantial disagreement on the relative importance of internal variability, GHG [greenhouse gas] forcing and aerosols

for this observed trend. It remains uncertain whether past changes in tropical cyclone activity are outside the range of natural internal variability.”

### AUTHOR RESPONSES TO ELICITATION ON CONFIDENCE/LIKELIHOOD LEVELS.

Table ES1 provides a full list of elicitation responses from each individual author for the specific detection and attribution statements listed.

### REFERENCES

- Bindoff, N. L., and Coauthors, 2013: Detection and attribution of climate change: From global to regional. *Climate Change 2013: The Physical Science Basis*, T. F. Stocker et al., Eds., Cambridge University Press, 867–952.
- Knutson, T. R., and Coauthors, 2010: Tropical cyclones and climate change. *Nat. Geosci.*, **3**, 157–163, <https://doi.org/10.1038/ngeo779>.





TABLE ESI. Continued.										
S. Camargo	J. Chan	K. Emanuel	C.-H. Ho	T. Knutson	J. Kossin	Mohapatra	M. Satoh	M. Sugi	K. Walsh	L. Wu
<b>Detectable increase in the intensity of Haiyan-like supertyphoons in the western North Pacific in recent decades; and anthropogenic forcing contributed to the intensity of Supertyphoon Haiyan in 2013.</b>										
no and yes	no and no	yes and no	yes and yes	no and no	no and yes	no and no	no and yes	no and yes	no and no	no and no
<b>Detectable long-term increase in the occurrence of Hurricane Harvey-like extreme precipitation events in the Texas region (U.S.); and anthropogenic forcing has contributed to increased frequency of Hurricane Harvey-like precipitation events in the Texas region.</b>										
yes and yes	yes and yes	yes and yes	yes and yes	yes and yes	yes and yes	yes and yes	yes and yes	yes and yes	yes and yes	yes and yes
<b>Detectable increase in the frequency of moderately large U.S. surge events since 1923 as documented by the index of Grinsted et al. (which strongly filters out sea level rise influences); and anthropogenic forcing has contributed to this increase.</b>										
no and no	yes and yes	yes and yes	no and no	no and no	no and no	no and no	no and no	no and no	no and no	no and no
<b>Detectable decrease in the global-scale propagation speed of TCs since 1949; and anthropogenic forcing has contributed to this decrease.</b>										
yes and no	no and no	yes and yes	yes and no	yes and no	yes and no	no and no	no and no	yes and no	yes and no	yes and no
<b>Detectable decrease in severe landfalling TCs in eastern Australia since the late 1800s; and balance of evidence suggests anthropogenic forcing has contributed to this decrease.</b>										
yes and no	yes and no	yes and no	no and no	yes and no	yes and no	yes and no	no and no	yes and no	yes and no	yes and no
<b>Detectable decrease in U.S. landfalling-hurricane frequency since the late 1800s; and anthropogenic forcing has contributed to this decrease.</b>										
no and no	no and no	no and no	no and no	no and no	no and no	no and no	no and no	no and no	no and no	no and no
<b>Detectable increase in global major-hurricane-landfall frequency in recent decades; and anthropogenic forcing has contributed to this increase.</b>										
no and no	no and no	no and no	no and no	no and no	no and no	no and no	no and no	no and no	no and no	no and no
<b>Detectable decrease in TC frequency in the southeastern part of the western North Pacific (1992–2011); and anthropogenic forcing (changes in aerosol emissions) has contributed to this decrease.</b>										
no and yes	no and no	no and no	no and no	no and yes	no and no	no and no	no and no	no and yes	no and yes	no and yes
<b>Detectable multidecadal increase in TC occurrence near Hawaii and in the eastern and central Pacific Ocean basins; and anthropogenic forcing contributed to the recent unusually active TC seasons near Hawaii in 2014 and 2015 and in the eastern and central Pacific Ocean in 2015.</b>										
no and yes	no and no			no and yes	no and no	no and no	no and yes	no and yes	no and no	no and no