Summary Statement on Tropical Cyclones and Climate Change

Prepared by: Tom Knutson, Chair, WMO Task Team on Tropical Cyclones and Climate Change

Date: September 20, 2018

Two frequently asked questions on global warming and hurricanes are the following:

- What changes in hurricane activity are expected for the late 21st century, given the pronounced global warming scenarios from IPCC models?
- Have humans already caused a detectable increase in Atlantic hurricane activity or global tropical cyclone activity?

The IPCC AR5 presents a strong body of scientific evidence that most of the global warming observed over the past half century is very likely due to human-caused greenhouse gas emissions. But what does this change mean for hurricane activity? Here, we address these questions, starting with those conclusions where we have relatively more confidence. The main text then gives more background discussion. "*Detectable*" change here will refer to a change that is large enough to be clearly distinguishable from the variability due to natural causes. Our main conclusions are:

- Sea level rise–which very likely has a substantial human contribution to the global mean observed rise according to IPCC AR5--could be causing higher storm surge levels for tropical cyclones that do occur, all else assumed equal.

- Tropical cyclone rainfall rates will likely increase in the future due to anthropogenic warming and accompanying increase in atmospheric moisture content. Models project an increase on the order of 10-15% for rainfall rates averaged within about 100 km of the storm for a 2 degree Celsius global warming scenario.

- Tropical cyclone intensities globally will likely increase on average (by 1 to 10% according to model projections for a 2 degree Celsius global warming). This change would imply an even larger percentage increase in the destructive potential per storm, assuming no reduction in storm size. Storm size responses to anthropogenic warming are uncertain.

- The global proportion of tropical cyclones that reach very intense (Category 4 and 5) levels will likely increase due to anthropogenic warming over the next century. There is less confidence in future projections of the global number of Category 4 and 5 storms, since most modeling studies project a decrease (or little change) in the global frequency of all tropical cyclones combined.

- In terms of *detection and attribution*, much less is known about hurricane/tropical cyclone activity changes, compared to global temperature. In the northwest Pacific basin, there is emerging evidence for a detectable poleward shift in the latitude of maximum

intensity of tropical cyclones, with a tentative link to anthropogenic warming. In the Atlantic, it is premature to conclude that human activities–and particularly greenhouse gas emissions that cause global warming–have already had a detectable impact on hurricane activity. Reduced aerosol forcing since the 1970s probably contributed to the increased Atlantic hurricane activity since then, but the amount of contribution, relative to natural variability, remains uncertain. There is some evidence for a slowing of tropical cyclone propagation speeds over the past half century, but these observed changes have not yet been confidently linked to anthropogenic climate change. 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.

Likelihood Statements

The terminology here for likelihood statements generally follows the conventions used in the IPCC assessments, i.e., for the assessed likelihood of an outcome or result:

- Very Likely: > 90%,
- Likely: > 66%
- More Likely Than Not (or Better Than Even Odds) > 50%

Disclaimer: This statement is the opinion of the Task Team Chair and does not represent the position of WMO, the Task Team, NOAA, or the U.S. government.