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# Global Warming and Storms

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***ABSTRACT:*** ***Climate change discussions also mix scientific with political concerns. Discussion of extreme events is a common locus of such uncertainty owing to their severe and visceral impacts. This background is properly characterized by Linda Means of the National Center for Atmospheric Science (NCAR). In this paper, in the light of global warming, we focus on a specific category of severe occurrence, the tropical cyclone. We follow the distinctions between incident risk and result risk provided by Sarewitz et al in our debate. 'Event risk' refers to the emergence of a specific activity and we rely on averages and forecasts of storm frequencies and intensities in the form of hurricanes. "Vulnerability" refers to "a system's inherent features that create the potential for harm," but are independent of the likelihood of incidents. Vulnerability in the sense of the economic consequences of tropical cyclones has been described in terms of demographic and income patterns that set the stage for damage caused by storms. "Outcome risk" combines hazard factors with event risk in order to describe an occurrence that causes losses. The incidence of a hurricane of $100 billion in the United States is an instance of result possibility. To measure such a chance allows both vulnerability and incident probability to be taken into account. From both of these viewpoints, this post addresses hurricanes and global warming.***

***KEYWORDS:****the Intergovernmental Panel on Climate Change (IPCC), hurricane, global warming, storms.*

## INTRODUCTION

Many experts, reporters, and decision makers were scrambling for clear solutions at the end of the 2004 Atlantic hurricane season to clarify the magnitude of the damage, which, according to the National Hurricane Center, totaled more than $40 billion. Some leading scientists have indicated that the extreme hurricane season of 2004 and its major effects, particularly in Florida, may be related to global warming resulting from greenhouse gas emissions into the atmosphere[1]. The current state of climate science, however, does not accept such a close correlation.Tropical cyclones may be thought of as a natural heat engine or Carnot cycle to a first approximation. From this view, by modifying the surface energy flux and/or the upper-level cold exhaust, global warming will potentially change the overall possible strength of tropical cyclones. But there is also no statistical foundation for predicting improvements in the occurrence of tropical cyclones, while observational studies offer some guidance as to the thermodynamic and dynamic ingredients required for tropical cyclogenesis.

Since 1995, the number of storms and, in particular, the number of major hurricanes (categories 3, 4 and 5) in the Atlantic has been rising. But the shifts in these metrics over the past decade are not so significant as to explicitly suggest that something other than the multidecadal instability that has been well recorded since at least 1900 is going on. Consequently, the influence of greenhouse gases on the occurrence of storms or major hurricanes, in the absence

of significant or unusual patterns, is inherently very difficult to discern in the sense of this recorded instability[2].There is no question that modern experience influences views on hurricanes, with comparatively few major hurricanes recorded in the 1970s, 1980s, and early 1990s, compared to widespread activity during the 1940s, 1950s, and early 1960s. For Florida, the period from 1944 to 1950 was especially productive. 11 hurricanes battered the state over that time, at least one each year, resulting in damage equal to billions of dollars in each of those years. No surge in tropical cyclone activity has been recorded globally for at least the last few decades. The few global simulation observations are conflicting, in addition to a lack of hypothesis for potential shifts in storm frequencies[3].Since historical and observational hurricane and tropical cyclone records are relatively stable, it is clear that recent tropical climate patterns have not been monitored by storm frequency. Research on potential future increases in the occurrence of hurricanes due to global warming is unclear, with most studies predicting that future changes would be regionally based, and reflecting a lack of accuracy in forecasting a rise or decrease in the overall number of storms worldwide. Ses experiments have such conflicting findings that the state of understanding of tropical cyclogenesis offers too weak a basis for any possible predictions to be focused on.Although there is always a degree of uncertainty about the future and model-based outcomes are often fickle, the current state of understanding is such that we should expect hurricane frequencies to have a lot of year-to-year and decade-to-decade variation in the future, as has been observed over the past decades and longer[4].

The question of patterns in tropical cyclone intensity is more complex precisely because there are several possible intensity metrics, such as maximum potential intensity, average storm life, average intensity, maximum sustained wind speed, maximum storm life, average wind speed, maximum wind raft, dissipation of power, total cyclone energy, etc.Statistical study of past tropical cyclone intensity indicates a close association with the intensity of the thermodynamic threat, indicating that increasing potential intensity should contribute to an increase in real storm intensity[5]. As forecast by global climate simulations, the increasing possible severity associated with global warming is consistent with the rise in model storm intensities in a warmer climate, as would be expected. However, while tropical and subtropical sea surface temperature measurements have indicated an average rise of approximately 0.2°C over the past ~50 years, there is only poor evidence of a systemic increase in future severity.

Emanual records a very important upward trend in power dissipation, i.e. the amount of the highest wind velocity cubed in the North Atlantic and Western North Pacific over the lifespan of the storm, with an almost doubling over the past 50 years. It is not yet known the exact reason for this trend. In addition, in the North Atlantic, broad multidecadal variations can be traced to much of the recent upward rise in Atlantic storm frequency and strength[6]. As of this writing, Emanuel has just been released and is likely to motivate a balanced and vigorous community discussion.During the decades of accurate data, other reports that have addressed fluctuations in tropical cyclone severity indicate no clear secular patterns. As the global earth system is highly dynamic, it would be premature to assume with certainty that such a correlation occurs or is relevant (from the point of view of any occurrence or outcome risk) in the light of uncertainty before an association between real storm strength and tropical climate change is explicitly demonstrated and acknowledged by the larger community.Furthermore, any such

association between sea surface temperature patterns and separate tropical cyclone intensity measurements does not actually mean that the 2004 or 2005 storms or their subsequent destruction could be directly or indirectly attributed to an increase in greenhouse gas emissions.

Looking to the future, climate simulation reports show the possibility for relatively minor shifts in global warming-related tropical cyclone intensities. For a 2 °C rise in tropical sea surface temperature, early experimental work indicated an increase of around 10 percent in wind speed. A 2004 analysis by the Princeton, New Jersey, Geophysical Fluid Dynamics Laboratory, using a mesoscale model downscaled from related global climate model runs, shows the likelihood of a 5 percent rise in hurricane wind speeds by 2080[7]. Michaels et al. say that even this 5 percent growth could be overstated, and that about half of that level is on the order of a more rational projection.Even if one agrees that the outcomes of Knutson and Tuleya are in the correct ballpark, this would mean that improvements in hurricane wind speeds which occur today in the order of 0.5-1.0 m s-1. This value is exceptionally poor in the light of, for example, the more than doubling of the number of major hurricanes in the Atlantic between quiet and active decadal cycles. Furthermore, with today's mixture of aircraft reconnaissance and satellite-based strength forecasts, such a shift of intensities will not be detectable, which only resolves wind velocities of actual tropical cyclones to increments of at least 2.5 m s-1.

## SUSCEPTIBILITY AND THREAT

In the sense of rapidly increasing human exposure to hurricane effects, awareness of patterns and forecasts of tropical cyclone frequencies and intensities takes a particular viewpoint. There is overwhelming evidence that human exposure to such impacts is the most critical aspect driving patterns and predictions correlated with hurricane impacts on population, and not the trends or changes in the storms themselves[8]. In the coming years, rising population and resources in exposed coastal areas guarantee increased economic damage, regardless of the specifics of potential severity or frequency trends.In less developed areas, in fact, as seen in Haiti during Hurricane Jeanne, tropical cyclones can also result in death and misery. According to studies focused on the assumptions of the Intergovernmental Panel on Climate Change (IPCC), the scientific body assembled to report on the science of climate change, the long-term consequences of changes in culture outweigh the effects of any predicted changes in tropical cyclones. We should predict an improvement in damage due to population growth and income by 2050 for every additional dollar of damage that the IPCC predicts to result from the impact of global warming on tropical cyclones, between $22 and $60[9].How culture establishes and plans for storms rather than any presently possible potential improvements in the occurrence and severity of storms are the key variables that control the extent and trends of future damage and causalities. Note that if income and population per capita rise at a combined 5% a year, this means a doubling of the actual cost of hurricanes every 15 years or so[10]. In such a context, to be discernible in the record of impacts, any climate trend would have to be quite large.

## CONCLUSIONS

To summarise, for three reasons, reports of linkages between global warming and hurricane impacts are premature. First, no correlation between greenhouse gas emissions and the hurricane activity observed has been identified. Such a relation is indicative of Emanuel, but is by no means definite. Such a relation could be identified in the future, e.g. in the case of Emanuel's observations or Knutson's and Tuleya's predictions, or in the sense of other tropical cyclone strength and period parameters, which remain to be closely examined.Second, the peer-reviewed literature reflects that there is a scientific consensus that in the sense of observed instability, any potential increases in hurricane strength are likely to be minor, although the scientific issue of tropical cyclogenesis is so far from being solved that nothing can be known about possible frequency changes. And thirdly, under the IPCC's estimates, the potential future risk to civilization from its predicted changes in hurricane activity is dwarfed by the effects of its own forecasts of rising income and population.Although these findings can also be reversed by future studies or practise, the state of the peer-reviewed information today is such that there are strong reasons to believe that no definitive correlation can be made between global warming and hurricanes or their impacts in the near term.

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