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Center for Meteorology and Physical Oceanography, Masschusetts Institute of Technology, Cambridge, MA, U.S.A.

Comments on "Carbon Dioxide and Hurricanes: Implications of Northern Hemispheric Warming for Atlantic/Caribbean Storms"

K. A. Emanuel

With 1 Figure

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Concern about possible global warming due to anthropogenic increases in radiatively active trace gases had led naturally to a proliferation of scientific research on this and related issues. It is also quite natural, though unfortunate, that the heightened sense of importance of such research leads to overly speculative investigations on the part of scientists, on the one hand, and widespread misinterpretations of legitimate research results by the media and even by scientists themselves. A case in point is an article by the author (Emanuel, 1987) on the dependence of hurricane intensity on climate, which has been widely misquoted by news organizations and also in some scientific literature, most recently in the work of Idso et al. (1990). I should like to use some statements made in that paper as an opportunity to set the record straight on my own work.

Idso et al. (1990) claim that "Emanuel (1987) ... found that a doubling of the air's CO_2 content produced a 40 to 50% increase in the strength of simulated storms". There are three important inaccuracies in this statement. The first is that no storms were actually simulated; rather, their intensity was estimated from a theoretical Carnot cycle. The second misconception is that the statement implies that the author concluded that a doubling of CO_2 would lead to a 40–50% increase in hurricane intensity; whereas, in fact, I pointed out that this would be true if the general circulation model whose climate was the basis of the calculation were correct. Finally, and most importantly, my result pertained only to the maximum intensity of hurricanes, with no implication for either their average intensity or their frequency. (To quote from Emanuel, 1987, "This analysis pertains only to the maximum sustainable pressure drop in tropical cyclones and has no direct implications for either the average intensity of cyclones or their frequency of occurrence.") Particularly disturbing is Idso et al.'s reference to hypercanes in the context of their article. Emanuel's (1988) theoretical work on the subject made no attempt to link the occurrence of these postulated storms to climate change; indeed the author stated that "it is very unlikely that (hypercanes) happened in the recent geologic past or will happen in the near future".

The analysis of Idso et al. (1990) is interesting, but somewhat irrelevant to the points made by Emanuel (1987), which strictly concerned the *upper bound* of hurricane intensity as a function of sea surface temperature. The distinction between this and average intensity is important and is nicely illustrated by Fig. 1, taken from the work of Merrill (1985). This shows the measured wind speeds in cyclones as a function of sea surface temperature. Clearly, a regression line through data with

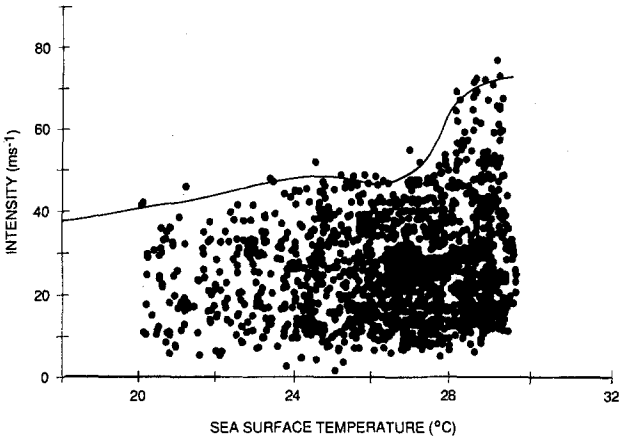

Fig. 1. Scatter diagram of monthly mean sea surface temperature and best-track maximum wind speeds (after removing storm motion) for a sample of North Atlantic tropical cyclones (Merrill, 1985). The line indicates the 99th percentile and provides an empirical upper bound on intensity as a function of sea surface temperature

such large scatter would be meaningless, consistent with the results of Idso et al. (In fact, it might have a negative slope for the simple reason that there are many weak storms over warm water, where they form, whereas only relatively strong storms survive transit over water with temperatures less than about 26 °C.) At the same time, there is a fairly well-defined *upper bound* on cyclone intensity, which increases with sea surface temperature, consistent with the theoretical results alluded to by Emanuel (1987). Thus there is no inconsistency between Emanuel's and Idso et al.'s results.

The by now well-known decrease of hurricanes striking the U.S. mainland (e.g., Gray, 1990) is also supported by Idso et al.'s analysis. This appears to be part of a general cycle of Atlantic hurricanes whose cause is uncertain, but may be linked to African drought cycles (Gray, 1990). As it happens, the last, declining phase of this probably natural variability has coincided with an alleged global warming, leading Idso et al. to the non sequitur that global warming will lead to a "significant decrease" in the intensity of hurricanes.

The recent tragedy in Bangladesh reminds us of how important it is to understand the enigmatic behaviour of hurricanes. We do not understand very well the factors that control either their intensity or their frequency, though the ocean temperature places a firm upper bound on intensity. There is no evidence that tropical sea surface temperature is increasing and thus no reason to suspect that the upper bound on intensity is changing; let us hope that this remains true. We can all agree with Idso et al.'s emphasis on the importance of further empirical and theoretical research on this subject.

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Author's address: Prof. Kerry A. Emanuel, Center for Meteorology and Physical Oceanography, Room 54-1620, Massachusetts Institute of Technology, Cambridge, MA 02139, U.S.A.