

Reply to “Hurricanes and Global Warming—Potential Linkages and Consequences”

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We appreciate the effort taken by Anthes et al. (2006) to respond to our paper “Hurricanes and global warming.” Such open exchanges can help to clarify not only different perspectives on science, but also different perspectives on the structure and function of scientific assessments of peer-reviewed literature.

We are very pleased that there appears to be a strong consensus among Pielke et al. (2005) and Anthes et al. (2006) on what sorts of policy actions make the most sense with respect to hurricane [hereafter, tropical cyclone (TC)] impacts in the context of ever-growing societal vulnerability. It would therefore be a misinterpretation of Anthes et al. (2006) or Pielke et al. (2005) to suggest that they support significantly different approaches to dealing with the impacts of tropical cyclones.

Anthes et al. (2006) present three criticisms of our paper. One criticism is that Pielke et al. (2005) “leaves the impression that there is no significant connection between recent climate change caused by human activities and hurricane characteristics and impacts.” If by “significant” they mean either (a) presence in the peer-reviewed literature or (b) discernible in the observed economic impacts, then this is indeed an accurate reading. Anthes et al. (2006) provide no data, analyses, or references that directly connect observed hurricane characteristics and impacts to anthropogenic climate change.

Anthes et al. (2006) include several important inconsistencies. First, Anthes et al. (2006) cite Emanuel (2005a) and Webster et al. (2005) to support claims of attribution of trends in hurricane intensity to global warming, when neither of those papers focused on attribution. Emanuel (2005a) expressed some uncertainty as to the factors responsible for the trends presented in that paper, stating “Whatever the cause, the near doubling of power dissipation over the period of record should be a matter of some concern” (emphasis added). Webster et al. (2005) even go so far as to observe that “attribution of the 30-year trends to global warming would require a longer global data record and, especially, a deeper understanding of the role of hurricanes in the general circulation of the atmosphere and ocean, even in the present climate state.”¹ Future research may indeed demonstrate attribution, but until that time we should not make the mistake of confusing interesting hypotheses with conclusive research results.

Second, Anthes et al. (2006) neglect two recent papers contradicting the notion that there are changes to hurricane characteristics and impacts outside of that expected due to natural climate variability. In a comment on Emanuel (2005a), Landsea (2005) demonstrated that in employing a correct analysis and not utilizing an out-of-date bias-removal scheme, the last 10 years of activity in the Atlantic basin were virtually indistinguishable from that which occurred

¹ Please note that both K. Emanuel and P. Webster and colleagues have expressed their view that attribution will occur in the literature at some point in the future.

during the middle of the twentieth century. Landsea (2005) also showed a century-long time series of U.S. landfalling tropical cyclones that has distinct multidecadal variations, but no long-term upward trend similar to SSTs. Pielke (2005) presented data indicating that the extreme impacts that occurred in the United States during the 2004 and 2005 hurricane seasons were not to be unexpected given the huge population and coastal infrastructure buildup in recent years.² Emanuel's (2005b) reply to both comments conceded the revised Atlantic hurricane analysis change, and suggested that the lack of detection of hurricane impacts as well as the U.S. tropical cyclone record may suffer from having a too low signal-to-noise ratio.

Third, Anthes et al. (2006) systematically conflate model projections with observations of actual trends. For instance, Anthes et al. (2006) suggest that Knutson and Tuleya's (2004) findings are consistent with the trends in TC intensity presented in Emanuel (2005a) and Webster et al. (2005). In fact, if Emanuel's and Webster et al.'s analyses of recent trends are accurate, they call into question the theoretical basis of Knutson and Tuleya (2004). What Knutson and Tuleya (2004) concluded is at odds with the recent publications on trends:

An important issue is whether and when any CO²-induced increase of tropical cyclone intensity is likely to be detectable in the observations. The magnitude of the simulated increase in our experiments is about +6% for maximum tropical cyclone surface winds . . . The SST changes observed for the past 50 yr in the Tropics imply that the likely SST-inferred intensity change for the past half century is small, relative to both the limited accuracy of historical records of storm intensity and to the apparently large magnitude of interannual variability of storm intensities in some basins. This further implies that CO²-induced tropical cyclone intensity changes are unlikely to be detectable in historical observations and will probably not be detectable for decades to come.

Such conclusions were mirrored in the theoretical work by Emanuel (2004):

Can one detect an actual increase in global tropical cyclone intensity? . . . Since 1950 . . . one would expect to have observed an average increase in in-

tensity of around 0.5 m/s or 1 knot. Because tropical cyclone maximum wind speeds are only reported at 5-knot intervals and are not believed to be accurate to better than 5 to 10 knots, and given the large interannual variability of tropical cyclone activity, such an increase would not be detectable. Thus any increase in hurricane intensity that may have already occurred as a result of global warming is inconsequential compared to natural variability.

Emanuel (2005a) and Webster et al. (2005) provide fundamental surprises in the field because of the theoretical and numerical modeling work to date that global warming would cause an undetectable change in TC intensities in the recent past and in decades to come. To state that recent studies demonstrate a "broad consistency between observations, models, and theory" dramatically misleads readers about our understanding of the science of global warming and hurricanes today. Anthes (2005) presented a much more accurate description of the state of science on TCs and climate observing that

"it will be a number of years—perhaps many—before we know the relationships between climate change and the various characteristics of tropical cyclones (e.g., frequency, intensity, rainfall) . . . Whatever the relationship between hurricanes and global warming turns out to be, it is not likely to be simple. . . ."

In a second criticism, Anthes et al. (2006) point out (quite accurately) that Pielke et al. (2005) failed to discuss the relationship between global warming and rainfall, sea level, and storm surge as related to tropical cyclones. The explanation for this neglect is simple—there is no documented relationship between global warming and the observed behavior of tropical cyclones (or TC impacts) related to rainfall, sea level, or storm surge. The Intergovernmental Panel on Climate Change (IPCC) does expect in the future an intensification of the hydrological cycle, including increased precipitation (IPCC 2001). With respect to rainfall observations to date, a global study has yet to be conducted; however, Groisman et al. (2004) showed no trends in U.S. tropical storm and hurricane precipitation, though substantial multidecadal variations have been analyzed. This is consistent with expectations for a minor increase in tropical cyclone rainfall several decades from now. Like tropical cyclone intensity change, definitive linkages between greenhouse gases and tropical cyclone precipitation may be difficult to conclusively attribute because of the relative size of the expected signal as compared

² Neither comment addressed the other basin studied by Emanuel (2005a) (i.e., the western North Pacific basin).

to documented variability. Indeed, International Ad Hoc Detection and Attribution Group (2005) was unable to attribute historical trends and variations in precipitation to greenhouse gases, so there is no observational basis presently for claiming a linkage between greenhouse gases and TC-related rainfall.

Sea levels, on the other hand, have increased over recent decades, and some part of this rise has been attributed to greenhouse gas emissions (IPCC 2001). We agree that sea level rise will contribute to increased impacts from storm surge even if hurricanes do not substantially increase in intensity due to global warming, especially in areas that are experiencing land subsidence and coastal erosion. It is important to better quantify the impacts that sea level rise is having today and will have in the future upon storm surge damage in light of massive societal alterations that are occurring along our coasts.

A final criticism by Anthes et al. (2006) is that Pielke et al. (2005) “does not take full account of the significance of recently identified trends and variations in tropical storms in causing impacts as compared to increasing societal vulnerability.” Anthes et al. (2006) make no reference to the literature that seeks to distinguish the relative role of climate factors versus societal factors in causing impacts (e.g., Pielke et al. 2000; Pielke 2005), so their point is unclear. There is simply no evidence, data, or references provided by Anthes et al. (2006) to counter the analysis in Pielke et al. (2000) that calculates the relative sensitivity of future global tropical cyclone impacts to the independent effects of projected climate change and various scenarios of growing societal vulnerability under the assumptions of the Intergovernmental Panel on Climate Change. Even inventing hypothetical scenarios where projected changes in tropical cyclones in the IPCC Second Assessment Report (SAR) were off by as much as 100% or more would not fundamentally alter the conclusions of Pielke et al. (2000).

In conclusion, a recent consensus statement from the World Meteorological Organization’s Tropical Meteorology Research Program Panel (McBride et al. 2006) accurately summarizes the current state of science:

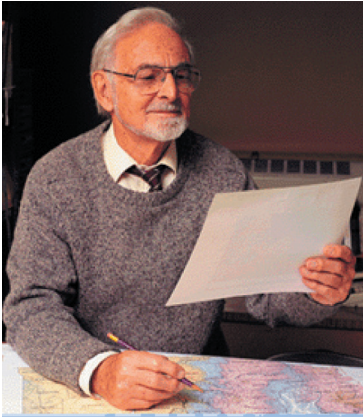
The research issues discussed here are in a fluid state and are the subject of much current investigation. Given time the problem of causes and attribution of the events of 2004–2005 will be discussed and argued in the refereed scientific literature. Prior to this happening it is not possible to make any authoritative comment.

On issues of impacts and policy, it is possible to make an authoritative comment, which is provided in Pielke et al. (2005).

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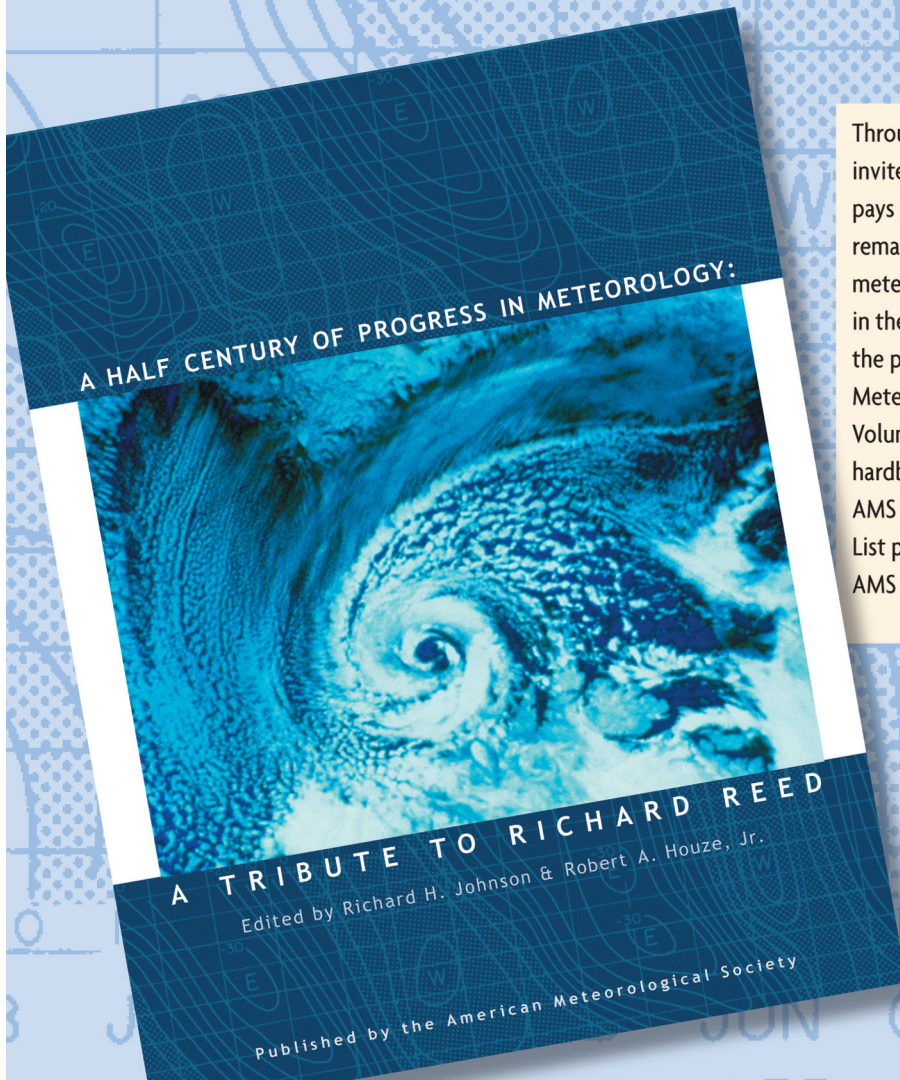
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