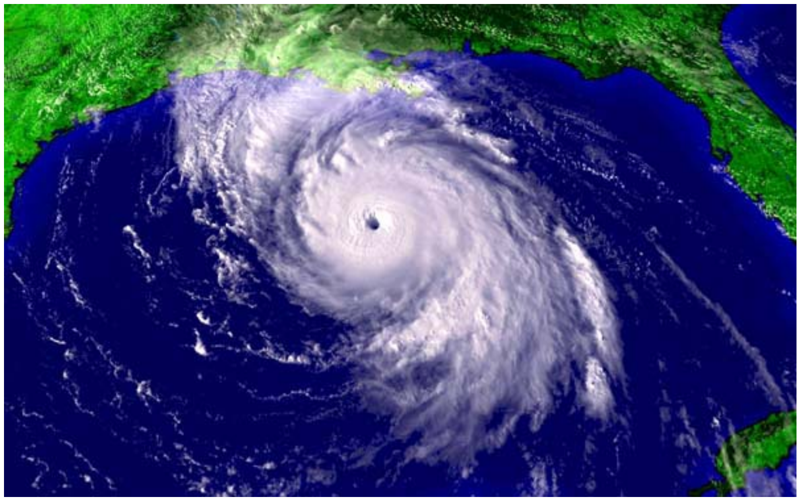
American Meteorological Society's
Environmental Science Seminar Series

New Orleans, Hurricanes and Climate Change: A Question of Resiliency



What is the relation between global warming and hurricane activity? Are the recent active seasons in the Atlantic basin a response to climate warming from increasing greenhouse gases, natural phenomena or something else? What happens when a major U.S. metropolitan community such as New Orleans, is at the epicenter of the convergence of a slow and a fast onset hazard, both of significant proportions? Is New Orleans at the margin of its resiliency with respect to hurricanes and other tropical storms? If so, how can this resiliency be stretched to meet the challenges of a changing climate?

Public Invited

Monday, June 20, 2005, 3:00 – 5:00 PM
Hart Senate Office Bldg., Room 902
Washington, DC
(Please use the North Bank Elevators!)

Reception Following

Introduction
The Honorable Senator Mary Landrieu (LA) – Invited

Moderator
Dr. Anthony Socci, Senior Fellow, AMS

Speakers:
Thomas Knutson, Research Scientist, NOAA Geophysical Fluid Dynamics Laboratory, Princeton, NJ

Dr. Shirley Laska, Director of the Center for Hazards Assessment, Response and Technology (CHART) and Professor of Sociology at the University of New Orleans, New Orleans, LA

Hurricanes in a Warmer World

Relatively homogeneous historical records of tropical storm counts, major hurricane counts, and maximum intensities in the Atlantic basin extend back into the 1940s. Work is underway to extend this record back further in time. Published work on the records from the 1940s forward show little evidence for any long-term trend in hurricane behavior such as that seen for global temperatures. Instead these records show pronounced multi-decadal variability in hurricane counts, with relatively high levels of major hurricane activity during the 1950s and 60s, less activity in the 1970s and 80s, and a return to high levels of activity from the 1990s on. Sea surface temperatures in the tropical Atlantic's "main development region" for hurricanes have fluctuated in a broadly similar manner since the 1940s, with little warming apparent over this period. However, examining data back to the 1870s, sea surface temperatures in this region appear to have a century-scale warming trend, similar to the global temperature trend, but with additional multi-decadal variability superimposed. No strong evidence has been presented to date for a similar century-scale trend in Atlantic major hurricane activity. Similarly, in basins other than the Atlantic, there is little evidence of significant long-term trends in tropical cyclone frequency. Records from other basins are generally of shorter duration and have additional data homogeneity concerns. Hurricane maximum intensity records from the Atlantic dating back to the 1940s similarly show little evidence for long-term trends.

The wide range of global temperature projections for the 21st century by the IPCC (Intergovernmental Panel on Climate Change) typically indicate much larger future warming rates than observed during the past century. Therefore, the absence of detectable trends in hurricane activity since the 1940s does not preclude the possibility of significant 21st century changes. Graphs of hurricane intensity versus sea surface temperature support the notion that warmer sea surface temperatures create the potential for more intense hurricanes, consistent with theories of hurricane potential intensity. Application of these theories to climate conditions obtained from climate models warmed by increased greenhouse gases suggests that the potential intensity of hurricanes increases at the rate of about 10-20% per century (in terms of pressure fall) in response to a strong positive (warming) radiative forcing.

Several high-resolution modeling studies of the relation between greenhouse warming and hurricane intensity were conducted. Under warmer, high CO_2 conditions, simulated hurricanes are more intense and have higher precipitation rates than under present-day conditions. The simulated high CO_2 storms also produce about 18% higher rainfall near the storm (within 100km of the storm center). Our results are broadly robust to the use of different climate models to define the high CO_2 conditions, and detail the treatment of moist convection in the hurricane model. The sea surface temperature (SST) changes due to increased CO_2 in our experiments ranged from about +0.8 to +2.4^{o}C, which is substantially greater than the ~0.5^{o}C warming the tropical Atlantic experienced during the 20th century. A caveat to our results is that they have much greater uncertainty than global temperature projections for the 21st century, since they depend on details of regional climate changes and lapse rates. These factors, and other difficult to project changes such as vertical wind shear patterns, could mitigate or enhance the intensity increases to some degree. With the above caveats in mind, one implication of the results is that if the frequency of tropical cyclones remains the same over the coming century, a greenhouse gas-induced warming may lead to a gradually increasing risk in the occurrence of highly destructive Category 5 storms.

Resiliency in a Climatically-Altered Setting: The Case of New Orleans

Dramatic land loss currently occurring in coastal Louisiana and projections of a period of possibly more powerful hurricanes in the Atlantic basin warrant a closer look at New Orleans as a case study in resiliency, with broad-sweeping implications regarding risk, human lives, and the fate of a major coastal region.

Coastal land loss is brought about by geo-hydrologic processes that occur at the ocean margins of a river delta when the sediment needed to refurbish it no longer is deposited over it during spring floods. This sediment reduction happens when a river is leveed to avoid over-bank flooding into developed communities or when water diverts from the main delta to another pathway as the mature delta "fills" with sediment. Add to these phenomena the cutting of channels into the existing swamps and marshes of the delta for the purpose of oil and gas extraction and then transportation of the resource to and from petrochemical facilities, and one has the makings of the current 24-square mile Mississippi delta land loss occurring currently in coastal Louisiana.

Human activities that fill the coastal zone are placed at risk. Marsh once acting to dampen the storm surge of hurricanes (one estimate is one foot for each mile of marsh) now takes on the appearance of Swiss cheese. Fresh or brackish ecosystems become heavily saline and species on which the coastal fishers are dependent disappear. Oil and gas exploration and production infrastructure, once buried, now exposed, bears the direct brunt of storms, often dispersing oil spills into the fragile marsh.

Beyond the impact that is visible and imaginable along the rural areas of the coast lies the city of New Orleans. While the residents cannot enjoy water views from inside the below-sea-level "bowl" of the city because of the height of the levees, open water is moving increasingly close to the levees and to the limited number of highways, also subsiding, all of which are needed to evacuate the population of the entire region in times of hurricane threat. Due to these limitations to evacuation despite the increasing need to do so, any improvements in hurricane prediction both for direction and intensity will benefit this sole way to protect the population (no sheltering below I-12/I-10 is approved for a category 3 or stronger storm).

Efforts to protect the population through refined evacuation plans and through continued funding of enhanced hurricane protection infrastructure consume the region as each hurricane season approaches. The area contains 1.6 million people below Lake Pontchartrain and I-10 to the west. Some 700,000 people evacuated in Ivan with normal times to destination not uncommonly 12 hours. Contra-flow (all lanes out) modifications now permit eight out-bound lanes. However, with no glitches, this number of lanes will be inadequate unless a large part of the population evacuates before the contra-flow is ordered (when the hurricane could be as far away as the Florida Keys). The roads simply cannot handle the traffic otherwise.

In addition, poverty-induced households without cars (estimated at 57,000 households) are anticipated to bear the brunt of the casualties, with statistics of a possible 60,000+ dead in a category 4 or 5 storm. Use of public and private mass transport means buses, Amtrak, cruise ships, river boats (the latter two both going up river) is being considered and negotiated with each entity. Inland shelters to house such an exodus and the required early departure that would be necessary to reduce the risk of the vehicles/vessels being trapped in the storm put incredible constraints on mass transit options.

The possibility of infrastructure improvements to facilitate evacuation is not promising. Projections of over a decade before major improvements to the levee system and to Lake Pontchartrain portend many hurricane seasons of continued significant risk. Hurricanes that present themselves as "big", such as did Ivan in the fall of 2004, motivate more action reinforced by the increasing recognition within New Orleans that coastal loss is indeed occurring. However, costs to address coastal restoration (estimated at $14 billion) and hurricane protection compete with other major federal needs for funding. The projected timing of the acute phase of the erosion of the Mississippi delta is not good either.

It just may be that New Orleans is already at or near the margins of its resiliency in the context of this discussion. Stretching that resiliency to accommodate a changing climate will be a formidable but seemingly unavoidable challenge.

Biographies

Thomas Knutson has been a Research Meteorologist/Climatologist at the Geophysical Fluid Dynamics Laboratory (GFDL) since 1990. GFDL, which is part of the National Oceanic and Atmospheric Administration, is one of the world's leading climate modeling centers.

Mr. Knutson is the author or co-author of many peer-reviewed articles that have appeared in major scientific journals, including *Science* and the *Journal of Climate*, on the potential impact of climate change on hurricane intensities and precipitation. Much of this work was done in collaboration with Bob Tuleya, a developer of the GFDL Hurricane Model, and others.

In terms of additional scientific accomplishments, Mr. Knutson was recently invited to organize and chair a special session on Tropical Cyclones and Climate Change at the Fourth International Workshop on Tropical Cyclones in Cairns, Australia, and was an invited speaker on this topic at an IPCC (Intergovernmental Panel on Climate Change) Special Workshop on Changes in Extreme Weather and Climate Events in Beijing, China. He has been invited to speak at numerous universities, climate workshops, research institutes, annual professional meetings and, most recently, at a National Academy of Sciences Disasters Roundtable.

Mr. Knutson received a B.S. degree in Computer Science at the University of Virginia, 1982; an M.S. degree in Meteorology at the University of Wisconsin-Madison.

Dr. Shirley Laska is Director of the Center for Hazards Assessment, Response and Technology (CHART) and Professor of Sociology at the University of New Orleans. Prior to serving as the University's Vice Chancellor for Research from 1993-2001 she founded the Environmental Social Science Research Institute, a precursor to CHART. Dr. Laska is an environmental and natural hazards sociologist with a focus on encouraging the application of social science to societal challenges engendered by these phenomena. For this effort in 2000 she received the Outstanding Contribution to Environment and Technology Award given by the American Sociological Association. For over 20 years she has been engaged in policy and applied research funded by the federal agencies such as EPA, MMS, FEMA, NOAA, Sea Grant and HUD as well as state and local agencies. Her work has drawn attention to the need for more sub-regional analysis of hurricane evacuation behavior; more consideration to flood-proofing structures for less than 100-year floods to compliment more stringent protection; more attention to considering local area drainage solutions to repetitive flood loss rather than demolition of individual repeatedly flooded structures; inclusion of the human/social impacts of coastal restoration rather than only the ecological; and also improving hazard mitigation outcomes by including community members and stakeholders as full participants in efforts to reduce the human risk to hazards.

Dr. Laska received a BS degree in Communication at Boston University, MA, 1966; a Ph.D. in Sociology at Tulane University, LA, 1973; and was a post-doctoral fellow at the International Center for Medical Research, Tulane University, School of Medicine, 1972-74. She has been the author, co-author or editor of several books and book chapters, and has published numerous articles in the peer-reviewed literature

The **Next Seminar** is tentatively scheduled for **July, 22, 2005. The topic will be on**:
How Close Are We to Peak Oil Production and What Are the Implications and Prospects?

Please see our web site for seminar summaries and future events:
www.ametsoc.org/atmospolicy

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