



CNHR

Center for Natural Hazards Research

Spring/Summer 2009

To the Extreme: NASA Study Funds Research on Precipitation Intensity and Climate Change

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2008-2009 CNHR Publications:

- 28 Refereed Journal Articles
- 8 Conference Proceedings and Book Chapters
- 19 Abstracts
- 36 presentations at conferences and departmental seminars

For more information, please visit www.ecu.edu/hazards

Article by Scott Curtis

Everyone knows that precipitation is highly variable. For example, it could be raining at one location and dry a short distance away. Also, rain could fall one hour and not the next. Finally, precipitation rates can range from a light drizzle to a downpour. This third example of precipitation variability is the backdrop of three years of research performed by Dr. Scott Curtis, atmospheric scientist in the Department of Geography and Assistant Director of the Center for Natural Hazards Research.

Understanding how climate change might impact the probability of extreme rainfall comprises ECU's part of a multi-institutional multi-year NASA project, currently entitled "Global Precipitation Variations and Extremes". One might not think NASA would be interested in rainfall, but the agency has been instrumental in developing global precipitation data sets from a combination of its research satellites, other operational satellites, and rain gauge data to essentially



Dr. Curtis's Coastal Storms class experiences some extreme precipitation firsthand during field observations of Hurricane Ophelia (September 2005).

cover the globe. In fact, one of NASA's longest lived satellites is the highly successful Tropical Rainfall Measuring Mission (TRMM), launched in November 1997.

Extreme rainfall is an important natural hazard as it can lead to flash flooding and landslides. While scientists cannot prevent extreme rainfall from happening, one practical goal is the development of probability forecasts based on patterns of climate change.

One driver of global weather patterns is the El Nino/La Nina cycle. El Nino refers to a warmer than normal equatorial Pacific Ocean. La Nina is the opposite case, when the Pacific is cooler than normal.

In both climate states the changing oceanic heat content affects the large scale atmospheric circulations – regions that are normally dry become wet and vice versa. Also, during El Nino the atmosphere is warmer and less stable than usual, leading to convectively generated precipitation. Since the 1980s, scientists have known that El Nino/La Nina change seasonal rainfall totals over many regions of the globe. What remains a mystery is whether El Nino/La Nina can impact the likelihood of an extreme rain event. Some would argue that extreme events happen when the environmental conditions are just right locally, and aren't much

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Cover Story, cont'd

affected by often distant climate processes. However, others report an increase in the frequency of extreme rainfall during El Niño and use that relationship as a model for what will happen as the Earth warms.

Dr. Curtis sees somewhat of a mixed signal using global satellite data sets. During both El Niño and La Niña many regions have and will continue to experience a greater probability of dry and wet months as compared to their local climatologies. Further the chance of a significant rainfall day goes up. Adding this up over the globe suggests that extremes are more common during El Niño and La Niña than during “normal” periods. Another way to approach ex-

treme rainfall is using a threshold value – “setting the bar” – that must be exceeded. Using daily precipitation data compiled every 1° latitude and longitude in the tropics, Dr. Curtis found that the top 0.1% rainfall value is approximately 72 millimeters or 2.8 inches! The number of observations in excess of this value was slightly higher over the oceans during El Niño and slightly higher over land during La Niña. Lower rainfall thresholds showed a stronger relationship. Thus, the highest rainfall rates appear to lose some connection to climate and have a more random component. This would make long-term probability forecasts more challenging. Dr. Curtis recently submitted a paper with the NASA

project PI (Dr. Adler, University of Maryland) on these findings to the *International Journal of Climatology*.

Finally, Dr. Curtis worked with Geography Masters student Sol Wuensch (MA, 2008) on a study specific to the Carolinas. The purpose was to determine why TRMM and rain gauge data viewed extremes differently. Satellites and gauges are measuring different quantities at different space scales. Thus, one can imagine a single same storm could generate extreme rainfall according to TRMM, but not the gauge, or vice versa. Results indicate that TRMM attributes more extreme precipitation to wintertime cold fronts and mid-latitude cyclones,

whereas the gauge data attributes extreme rainfall to summer and autumn storms. It was also found that the differences were greater over the mountainous west than over the coastal plain. Gauges are point measurements, and are likely better at capturing extreme rainfall over complex terrain than satellites, which have a wide footprint. Dr. Curtis is continuing this work with another Geography Masters student, Robbie Munroe, but with a focus on the entire distribution of rainfall, from light drizzle to downpour, rather than just extreme rainfall.

Faculty Spotlight, Scott Curtis

Scott Curtis has been Assistant Director of the Center for Natural Hazards Research since 2006. He joined the ECU faculty in 2003 as an Assistant Professor in the Department of Geography, and will be promoted to Associate Professor in August. He is one of five atmospheric scientists in Geography. Curtis received his BA in Environmental Sciences at the University of Virginia and Master's and Ph.D. in Atmospheric and Oceanic Sciences from the University of Wisconsin – Madison. After graduating with his Ph.D. he spent five years as a research scientist at NASA Goddard Space Flight Center. In his final year at NASA he was also an Affiliate Assistant Professor in the Department of Geography and Environmental Systems at the University of Maryland – Baltimore County.

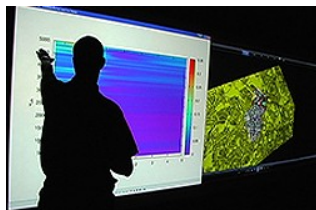
Curtis's research interests include tropical climate variability with an emphasis on precipitation. Curtis is also interested in coastal storms and applications of GIS in atmospheric science. Among the courses Curtis has designed and taught is “Coastal Storms”. The class explores the hazards of coastal storms, including atmospheric dynamics, forecast and risk, socioeconomic and biophysical vulnerabilities, and mitigation strategies. Curtis helped develop a BS in Applied Atmospheric Science, which is expected to begin in the Fall of 2009. The degree is designed to have a strong emphasis on weather hazards. Curtis has authored over 30 publications, many dealing with natural hazard issues, including a satellite perspective on the freshwater input from Hurricane Floyd, published in *Natural Hazards*. In addition to Curtis's NASA funding, Curtis is also currently funded by NSF to uncover the physical mechanisms behind the Caribbean mid-summer drought.

Curtis has experience organizing special conference sessions devoted to hazards: “Storms in the South: Human and Physical Aspects”, “Extreme Hydrometeorological Events”, and “Spatial and Temporal Trends in Hydrometeorological Records as Indicators of Climate Variability and Change”. One of his current tasks as Assistant Director of the Center is coordinating scientific presentations for ECU's Hurricane Floyd Symposium commemorating the 10th anniversary of Hurricane Floyd. Curtis expects the symposium to draw preeminent researchers from around the country to discuss the current state of hurricane hazard research.





RENCI at ECU Shares a Vision with the Center for Natural Hazards Research



Article by Donna Kain.

North Carolina's Renaissance Computing Institute East Carolina University Engagement Center (Renci at ECU) conducts research and outreach that helps North Carolina visualize coastal hazards. By applying technology to problems such as hazard risk perception and regional vulnerability, Renci at ECU assists in the development of decision support tools for improved management and planning. Jamie Kruse, Renci at ECU's first director, set the bar for the center's success, developing the facilities and a cohesive core team.

Besides its first director, Renci at ECU shares with CNHR a mission to improve the ways that people in eastern North Carolina understand and manage the region's relationship to its unique environment and the threats it faces from natural hazards. In its first three years, Renci at ECU supported projects that investigate the impacts of a variety of hazards—both natural and human-created—on the people and places of coastal North Carolina:

- Enrique Reyes, J.P. Walsh and Reide Corbett began developing an ecological model of coastal North Carolina that will help forecast the environmental consequences of coastal storms and aid decision making in natural resource management.
- Lloyd Novick, Wayne Cascio, Walter Pories, and Ruth Little focused on the disaster response requirements of at-risk and medically fragile

populations in the coastal region to help ensure orderly and effective assistance to people before, during, and after emergencies.

- Lee Bartolotti, Paul Fletcher, Yumin Li, Robert Morrison, and Andy Sargent used high level computational chemistry methods investigate mercury in the atmosphere, land, water, and, subsequently, the food chain with the goal of preventing mercury from poisoning the coastal plains and expediting the removal of existing contaminants.
- Jeff Johnson, Craig Landry, Jamie Kruse, Okmyung Bin, Thomas Crawford, and Mohammad Jahan-Parvar began a long-term investigation of human perceptions and knowledge of natural hazards that play a role in vulnerability to and recovery from hazard events.

With the addition of Tom Allen (Geography) as Associate Director in the second year of operations, Renci at ECU began leveraging its significant technological infrastructure to convey visually the results of these and other research efforts. From mapping the locations of medical facilities in areas at risk from hurricanes to modeling coastal storm surge with Google Earth, ADCIRC, and SketchUp, a team led by Allen demonstrates the power of visualization. Products from research are displayed on Renci's VisWall, a 21-foot x 6-foot rear-projection S-video display system capable of visualizing 5 million pixels in 3D. High-resolution data displays in an immersive environment produced with GIS software have the potential for generating new insights in cross-disciplinary studies.



As Allen steps into the role of Director and J.P. Walsh (Geology) becomes Associate Director for the renewed 2009–2012 phase, Renci at ECU will continue its emphasis on visualizing storms, coastal erosion, and sea-level rise. Investigating these complex, intertwined hazards will be an integrated, multidisciplinary effort of eight core faculty, as well as graduate students and staff at ECU. Several projects

- "Project StormViz," focuses on visualization of storm surges for emergency communication. In cooperation with Dare County and New Hanover County Departments of Emergency Management, Renci at ECU will develop, refine, and implement a tool for emergency managers and public information officers to use both in times of imminent hurricane landfall and also in preparedness education for residents and tourists.
- "Bringing Storms to Life" (S2L) aims to capture and convey a sample of North Carolina's most severe coastal disasters, to raise public awareness of catastrophic storms that have affected North Carolina, and to show what events of the same magnitude would do to our more developed and populated coastline today.



- Continuing the capacity-building activities surrounding geospatial and estuarine observing, the ecological modeling group will put scientific data and state-of-the-art technology in the hands of professionals and the public.

Renci at ECU researchers will also begin examining the ways geospatial media communicate information to users by applying measures along multiple dimensions to visualizations. Visual cognition, modes of delivery, and communicative performance will be assessed by the risk communication team. A crosscutting economic component of this project will use the measures developed to assess information tools such as the National Flood Insurance Program's (NFIP) voluntary Community Rating System.

Renci at ECU Outreach and Communication, under the direction of Donna Kain (English), will continue to disseminate information about center efforts through its website and newsletter, *Coastal Systems Update*, as well as sponsor programs on and off campus. Efforts include the annual Visualization Challenge, presentations, workshops and webinars, and programs about the environment and coastal hazards that have so far traveled to over three thousand K-12 students in the region on the Renci ROVER, the center's specially outfitted research and outreach vehicle.

For more information on Renci at ECU, please visit them on the web at www.ecu.edu/renci.



Third International Symposium for the Prevention of Disasters



Left: III Seminario Internacional de Prevención de Desastres (Third International Symposium for the Prevention of Disasters) Panel of speakers (pictured from left to right) Dr. Jamie Brown Kruse, Director of the Center for Natural Hazards Research and Professor of Economics, East Carolina University; Dr. Omar Dario Cardona, Professor of Engineering, National University of Columbia; Lic. Miguel Cancino, Coordinator of the Undersecretariat for the Management of Environmental Protection, Ministry of Environment and Natural Resources of Mexico (SEMARNAT); Valentin Samaniego Araujo, Architect and Deputy Director General of Land and Urban Development, Ministry of Social Development of Mexico (SEDESOL)

Professor Jamie Brown Kruse was invited to speak at the Third International Symposium for the Prevention of Disasters, May 29-30, 2008. Dr. Kruse presented the "Financial Impact of Disasters," to more than 400 registered attendees at the historic Chapultepec Castle in Mexico City. Mexico, with an area of nearly two million square

kilometers must deal with a variety of natural hazards including volcanic activity, earthquakes, hurricanes and tsunamis. In 2007, Hurricane Dean damaged 90,000 homes in Central Mexico and claimed 28 lives. The symposium was sponsored by the Ministry for Social Development of Mexico and the National University of Mexico.

The Ministry for Social Development serves the same purpose for Mexico as the Federal Emergency Management Agency (FEMA) does for the United States. The National University of Mexico was founded in 1551 and has a total enrollment of more than 275,000 students in undergraduate and graduate programs.



Message from the Director

We at the CNHR hope you enjoy reading about a few of our activities and some of the people involved in hazards research. Our group of researchers range across many traditional academic disciplines to address natural hazards. If you would like a more in depth look at our activities, we invite you to download our 2008-2009 Annual Report from the CNHR website. We con-

tinue to be a great investment for the citizens of North Carolina. For every \$1 of internal support our researchers generate \$20 in external funding. This has a two-pronged benefit to eastern North Carolina. First the money supports research that will improve the lives and livelihood of we who live in ENC. Second it brings money into the area that has an economic

multiplier effect that supports jobs and economic development. Although eastern North Carolina is vulnerable to many hazards, the big one is HURRICANE. We must understand the physical processes that are operating to produce rain, wind and flood damage associated with a hurricane. Understanding human processes is equally important so that

we can inform policy that supports economic and cultural development and protect the most vulnerable among us. Since we are coming up on the 10th Anniversary of Hurricane Floyd, we hope you will join us at the Hurricane Floyd Symposium on September 17 and 18 this fall.



East Carolina University
Tomorrow starts here.

Mark your calendar!
September 17-18, 2009

Hurricane Floyd Symposium

Commemorating the
10th Anniversary of Hurricane Floyd

September 17, 2009 Hurricane Floyd Public Forum
Day one focuses on the response to and recovery from Hurricane Floyd. CNHR will host speakers from across the country to discuss a wide array of topics including:

- Lessons learned from Hurricane Floyd
- The state of the region since the flood
- The ways in which state and local officials are addressing issues related to natural disasters
- The ways citizens can better protect themselves and their properties from future disasters.

September 18, 2009 Research Conference
The second day conference brings researchers from various fields of hazards research to ECU to discuss broader issues related to mitigation, response and recovery. Please join us to hear about the latest in cutting edge natural hazards research.

CNHR

Center for Natural Hazards Research



The Center for Natural Hazards Research focuses on hurricane, tornado, flooding and erosion hazards as they affect eastern North Carolina and the United States. The Center offers educational opportunities to the local community and facilitates research on natural hazards in the region. Areas of active research include the financial impacts of hurricanes and floods, the effectiveness of warning systems, evacuation policies and behaviors, and how families and individuals can protect themselves from natural hazards.

Our Vision:

To promote research and analysis that ultimately reduces the harm caused by natural forces to life, communities, and the environment.

Our Mission:

The Center for Natural Hazards Research will foster a multidisciplinary research community that seeks to understand and thereby improve our ability to predict, respond to and recover from adverse events caused by the natural processes.

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