Hurricanes and Global Warming; Debates 2004 – 2006

This document is in 2 parts (RJ0406 and RJ0407)

How fast has the earth been warming?

Abstract and 9-page summary of conclusions.


The Kossin paper used satellite data in a consistent way & changed results (Fall 2006).

Atlantic hurricanes for 1850 – 2005 from J. Sanchez.

Media blitz during Sep – Oct 2005 (Katrina hit New Orleans).

Six short published papers; hurricanes and warming

Debates and fights at hurricane meetings, 2006

Paleo information on old hurricanes.

Junk science

Bunch of stories from NCAR bulletin board.

And much more.

All ready to scan April 9, 2007, total of 248 pages.

Doc RJ0406 (Part 1) has 128 pages.

Doc RJ0407 (Part 2) has 120 pages.

Doc RJ0407

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Roy Jenne
Apr 12, 2007
# Hurricanes and Global Warming: A Debate

**Roy Jenne**  
Jan 9, 2005  
Rev Dec 15, 2006  
Rev Apr 9, 2007

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2. What is said about the intensity of hurricanes and global warming (1 p)  
3. How fast has the Earth been warming? (2 p)  
   - And one more page on the hurricane/global warming debate.  
4. The effect of warming on hurricanes; brief summary (5 p)  
5. Intensity of tropical storms and warming; debates 2004 – 2006 (10 p)  
   - A one page abstract  
   - The nine page summary paper here  
6. The Kerr report in *Science*, and more (6 p)  
   - Does global warming have big effect on hurricanes (1 p)  
   - The Kerr report (2 p)  
   - Hurricanes vs global warming (2 p)  
   - Science board recommends major hurricane research program (1 p)  
7. Kossin study; analyze world 3-hr satellite data for 1983 – 2005 (4 p)  
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Global Warming & Hurricanes

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Big Hurricanes Found to Occur More Frequently
By Gautam Naik

The number of powerful hurricanes occurring world-wide has nearly doubled during the past 35 years, according to a study appearing this week in the journal Science.

BIGGER, BADDER TROPICAL BLOWS
Long-term cyclical storm patterns are to blame, but data also point to effects of global warming

Global Warming
Severe Hurricanes Increasing, Study Finds
By Juliet Eilperin
Washington Post Staff Writer

Hurricane Katrina came ashore near New Orleans on Aug 29, 2005
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Global Warming

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Study Links Warmer Seas, Worst Hurricanes

Global warming is fueling nastier storms, expert says

Cyclones and hurricanes do follow decades-long cycles of strengthening and weakening, Emanuel says, but the study effects are above and beyond

- Hurricane and cyclone reported durations have increased by roughly 60% since 1945.
- Average peak storm wind speeds have increased about 50% since the 1970s.
- Sea surface temperatures have swung upwards since 1975 at rates that exceed normal swings from regular El Niño or Atlantic cycles.

The report serves as a warning about future global warming effects, says atmospheric scientist Kevin Trenberth of the National Center for Atmospheric Research in Boulder, Colo. Major losses from storms rise with hurricane wind speeds, the study notes. And island damage from flooding and heavy rains also results from more intense storms, Trenberth says.
Global warming is fueling nastier storms, expert says

Find disagrees with old view

By Dan Vergano
USA TODAY

Hurricanes have grown fiercer in recent decades, spurred by global warming, and even tougher storms are likely on the way, a researcher predicts.

In his new study, ocean climatologist Kerry Emanuel of the Massachusetts Institute of Technology, suggests that the power of big ocean storms has increased and will continue to do so, even if their numbers stay the same.

The analysis, released online today by the journal Nature, confounds some past studies that had indicated that increasing average temperatures worldwide over this century — a United Nations climate panel has projected that temperatures will rise from 2 to 10 degrees worldwide by 2100 — would have little effect on hurricanes.

"The best way to put it is that storms are lasting longer at high intensity than they were 30 years ago," says Emanuel.

In an analysis of sea surface temperatures and storms since 1930, he found that a combined measure of duration and wind speeds among North Atlantic hurricanes and North Pacific cyclones has nearly doubled since the 1970s. "I was quite surprised by the magnitude of the increase," he says by e-mail.

Scientists had not correlated the frequency, intensity and duration of the storms until now, he says, but past reports have raised questions:

- Hurricane and cyclone reported durations have increased by roughly 60% since 1949.
- Average peak storm wind speeds have increased about 50% since the 1970s.
- Sea surface temperatures have swung upwards since 1975 at rates that exceed normal swings from regular El Niño or Atlantic cycles.

Cyclones and hurricanes do follow decades-long cycles of strengthening and weakening, Emanuel says. But the study effects are above and beyond the current cycle, which has seen stronger hurricanes in recent years.

The report serves as a warning about future global warming effects, says atmospheric scientist Kevin Trenberth of the National Center for Atmospheric Research in Boulder, Colo. Dollar losses from storms rise with hurricane wind speeds, the study notes. And inland damage from flooding and heavy rains also results from more intense storms, Trenberth says.

"I think that this is very good science and a very important paper, but I don't think it settles every question," says National Oceanic and Atmospheric Administration hurricane expert Chris Landsea. He wants researchers to delve further back into past hurricane records to verify the trend.

"It's a bit of a surprise," he says, given that earlier studies had suggested a warming climate would lead to only small changes in storm wind speeds.

With more people living on coasts in more expensive housing, Landsea says, the study underlines the importance of five-day hurricane forecasts, better building codes and homeowners buying shutters and storm doors.

"Although it is difficult to separate the cyclical effects from global warming effects in the Atlantic only, which experiences large cyclical swings, it is not difficult to see it in the global data which is less influenced by the natural oscillations."

— Kerry Emanuel, ocean climatologist

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WASHINGTON, DC
MONDAY 2.220.663
AUG 1 2005

Aug 1, 2005
USA Today
Global Warming

Severe Hurricanes Increasing, Study Finds

By Juliet Eilperin
Washington Post Staff Writer

A new study concludes that warming sea temperatures have been accompanied by a significant global increase in the most destructive hurricanes, adding fuel to an international debate over whether global warming contributed to the devastation wrought by Hurricane Katrina.

The study, published today in the journal Science, is the second in six weeks to draw this conclusion, but other climatologists dispute the findings and argue that a recent spate of severe storms reflects nothing more than normal weather variability.

Katrina's destructiveness has given a sharp new edge to the ongoing debate over whether the United States should do more to curb greenhouse gas emissions linked to global warming. Domestic and European critics have pointed to Katrina as a reason to take action, while skeptics say climate activists are capitalizing on a national disaster to further their own agenda.

According to data gathered by researchers at the School of Earth and Atmospheric Sciences at Georgia Tech and the National Center for Atmospheric Research, the number of major Category 4 and 5 hurricanes worldwide has nearly doubled over the past 35 years, even though the total number of hurricanes, including weaker ones, has dropped since the 1990s. Katrina was a Category 4 storm when it made landfall.

Using satellite data, the four research-
The number of Category 4 and 5 hurricanes has risen in recent years, according to a new study.

Number of Category 4 and 5 hurricanes, by ocean basin

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<td>NORTH INDIAN</td>
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<td>12</td>
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<td>NORTH ATLANTIC</td>
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<td>185</td>
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<tr>
<td>WEST PACIFIC</td>
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SOURCE: Science Magazine

Study Links Warmer Seas, Worst Hurricanes

Study, From A13

Scientists found that the average number of Category 4 and 5 hurricanes — those with winds of 131 mph or higher — rose from 10 a year in the 1970s to 18 a year since 1990. Average tropical sea surface temperatures have increased as much as 1 degree Fahrenheit during the same period, after remaining stable between 1900 and the mid-1960s.

Georgia Tech atmospheric scientist Judith A. Curry — co-author of the study with colleagues Peter J. Webster and Hai-Ru Chang, and NCAR's Greg J. Holland — said in an interview that their survey, coupled with computer models and scientists' understanding of how hurricanes work, has given the researchers a better sense of how rising sea temperatures are linked to more intense storms.

"There is increasing confidence, as the result of our study, that there's some level of greenhouse warming in what we're seeing," Curry said. "Is it the whole story? We don't know."

Higher ocean temperatures result in more water vapor in the air, which, combined with certain wind patterns, helps power strong of an increase in intensity."

But both Emanuel and Gavin Schmidt, a climatologist at NASA's Goddard Institute for Space Studies, said today's Science paper is important because it examines worldwide hurricane patterns.

"If you look at it on the global basis, it makes that signal of global warming easier to see," Schmidt said. "You have to be extremely conservative — with a small 'c' — to think [rising sea temperatures and stronger hurricanes] are not related."

And some hurricane experts who previously have questioned the influence of global warming now say the evidence is mounting that it has contributed to recent intense tropical storms.

Florida International University researcher Hugh Willoughby, who headed NOAA's hurricane research division between 1995 and 2003, said the recent two hurricane studies are "very persuasive" and helped move him "toward the climate corner" of the debate.

"It's really hard to find any holes in this, and I'm the kind of person who's inclined to look for holes," he said of the new study in Science. The arguments against
Global warming linked to increase of hurricanes

By Mark Henderson
Science Correspondent

HURRICANES of the intensity of Katrina have become almost twice as common over the past 35 years, according to research suggesting that global warming could be worsening severe storms.

The overall frequency of tropical storms worldwide has remained broadly static since 1970, but the number of extreme category 4 and 5 events has risen sharply, satellite measurements have shown.

Since 1990, an average of 18 category 4 and 5 storms, of similar strength to Hurricane Katrina, have occurred every year, compared with an average of 10 in the 1970s, US scientists have found.

Ocean surface temperatures — one of the key drivers of hurricane intensity — have increased by an average of 0.5°C (0.9°F) over the same period, indicating a potential connection to global warming.

Researchers said it was too early to be certain that climate change is fuelling stronger hurricanes, but such a link would be consistent with the best predictions of the likely effects of warmer seas.

Tropical storms, which always form over water, are known as hurricanes when they occur over the Atlantic, and as typhoons or cyclones in the Pacific and Indian oceans. The storms are heat engines that build intensity by sucking up more and more water vapour, generating winds of more than 100mph.

Category 4 hurricanes sustain winds of between 130mph and 155mph, and the biggest category 5 storms blow at 156mph or more. Hurricane Katrina reached category 5 at its peak over the Gulf of Mexico and stood at category 4 when it devastated New Orleans and Mississippi.

In the latest study, published today in the journal Science, a team led by Peter Webster of the Georgia Institute of Technology analysed all the satellite records of hurricanes and typhoons since 1970.

“What we found was rather astonishing,” he said. “In the 1970s, there was an average of about 10 category 4 and 5 hurricanes per year. Since 1990, the number of category 4 and 5 hurricanes has almost doubled, averaging 18 per year.”

Judith Curry, his colleague, said: “Category 4 and 5 storms are also making up a larger share of the total number of hurricanes. Category 4 and 5 hurricanes made up about 20 per cent of all hurricanes in the 1970s, but over the past decade they have accounted for about 35 per cent of these storms.”

The findings, Dr Webster said, could be a result of global warming, though he said much more research was needed.

“Our work is consistent with the concept that there is a relationship between increasing sea surface temperature and hurricane intensity,” he said. “However, it’s not a simple relationship.”

Several recent studies indicate that intense storms can be expected to become more common with climate change. In August, research by Kerry Emmanuel of the Massachusetts Institute of Technology, published in Nature, found that the destructive energy of hurricanes had increased in line with rising ocean temperatures. “We are clearly seeing the same signal in the data,” Dr Emmanuel said yesterday.

Another Science paper, by Kevin Trenberth of the US National Centre for Atmospheric Research, found in July that there is 2 per cent more water vapour above the oceans today than there was in 1988. This suggests that more water will be drawn into swirling tropical storms, generating higher wind speeds and greater rainfall.
Banner year for monster hurricanes stirs up debate

Researchers spar over the causes

By Beth Daley
GLOBE STAFF

As Wilma hurtles toward Florida, 2005 has already hit the history books as the year of the monster hurricane.

But another storm is gathering in the scientific world over exactly why. Most scientists agree that the United States is in the midst of a cycle of fierce hurricanes, but unknowns remain about the storms' intensity, forecasting, frequency, and duration. The lack of long-term hurricane data and the politics surrounding global warming has complicated the problem.

"This is a new field, it's relatively new research," said Isaac Ginis, a professor of oceanography at the University of Rhode Island. "But as people become more creative on how to analyze the data, we will see significant improvements in our modeling and forecasting."

Hurricanes are fed by warm ocean waters that allow heat and moisture to rise into the atmosphere. Winds near the ocean surface spiral inward, gathering more moisture and energy. If conditions remain ideal, the telltale hurricane whorl forms and grows stronger as it picks up even more energy from the ocean surface.

Tropical sea surface temperatures have risen by 0.5 degrees Celsius in the past 35 years, and two papers in the journals Nature and Science in the past three months have linked that rise to an increase in hurricane intensity.

Kerry Emanuel at the Massachusetts Institute of Technology concluded that today's North Atlantic and North Pacific human-induced global warming probably helped warm the seas.

The other paper, by Georgia Institute of Technology researchers, concluded that there was almost a doubling of the frequency of the most intense hurricanes -- categories 4 and 5 in oceans the world over.

"The key point is that global warming is not the whole story, but it's a big player," said Kevin Trenberth, head of the Climate Analysis Section at the National Center for Atmospheric Research.

"Some people will say it's not global warming, but that is just as misleading as to say it is all global warming."

Confusion abounds because hurricanes are influenced by many other factors.

"After several quiet decades of hurricane activity, the number of the storms during the past decade has risen -- as anyone looking at this year's record-breaking 12 hurricanes knows."

But to confuse the subject further, the overall number of hurricanes -- called typhoons and cyclones elsewhere in the world -- has remained at about 80 a year for decades.

Many scientists assert that the hurricane cycle is part of the natural variability of hurricanes.

Meanwhile, Katrina and Rita may also have been influenced by the weather system El Nino last winter, which tends to bring warmer waters to the Caribbean in subsequent years.

Ginis, however, thinks Katrina and Rita grew into such monsters because of a tongue of very deep warm water that escapes from Caribbean waters into the Gulf of Mexico.

Normally, Caribbean waters are warm as far down as 300 feet, while the Gulf's heat ends about 100 feet down. This year, the paths of Katrina and Rita passed over this area.

"That's why the hurricanes had much more heat energy to intensify," Ginis said. "It was perfect storm conditions."
BIGGER, BADDER TROPICAL BLOWS

Long-term cyclical storm patterns are to blame, but data also point to effects of global warming

By Thomas Hayden and Megan Barnett

Katrina’s fury had not yet subsided last week when Germany’s environment minister sparked a tempest of his own. Writing in the Frankfurter Rundschau newspaper, Jürgen Trittin suggested that the hurricane’s severity was at least partly a result of global warming and charged that “the American president is closing his eyes to the economic and human costs” of refusing to sign the Kyoto Protocol, which seeks to limit production of climate-warming greenhouse gases.

Trittin’s message of “you asked for it” certainly won’t be winning him any awards for tact. But with this year threatening to overtake last as the most expensive American hurricane season ever, it’s hard not to wonder if maybe he has a point. Are hurricanes getting worse? And if so, is global warming to blame?

Simple enough questions, but the answers are less so. There certainly have been more Atlantic hurricanes recently. According to the National Oceanic and Atmospheric Administration, the Atlantic has kicked up an average of 7.8 hurricanes and 3.8 major hurricanes per year since 1995, compared with an annual average of just five hurricanes and 1.5 major hurricanes over the preceding 25 years. But most scientists agree that the increased frequency is caused by a natural cycle, not global warming. And over the past 50 years at least, increased numbers of hurricanes in the Atlantic are generally offset by fewer tropical cyclones in the Pacific and Indian oceans; the global average is holding steady at about 90 per year.

Still, there is growing evidence that global warming is making the storms stronger and wetter. For all the unstoppable power of a fully formed hurricane, a nascent tropical cyclone is a fairly fuzzy thing, says climate researcher Tom Murphy of the Naval Postgraduate School in Monterey, Calif., requiring just the right conditions in the sea and the air to develop into a destructive powerhouse like Katrina. In a June article in Science, head climate analyst Kevin Trenberth of the National Center for Atmospheric Research in Boulder, Colo., warned that global warming may already be nudging some of those conditions—like warm surface waters and increased moisture in the air—in directions that intensify storms.

Kerry Emanuel, a professor of atmospheric science at the Massachusetts Institute of Technology, thinks he has found evidence of that trend. In a study published last month in Nature, Emanuel calculated the intensity and duration of tropical cyclones for the past 75 years, estimating each storm’s destructive power. “When you look at the numbers globally,” he says, “you see a 70 to 80 percent increase in the potential destructiveness of tropical cyclones over the last 30 years. That’s much more than anyone expected.” And that surprising jump, he says “is strongly in concert with increases in the tropical sea surface temperature over the same time period.” Many oceanographers are convinced that those warmer seas are the direct result of human-caused global warming.

Building boom. Even though hurricane activity along the Gulf Coast and up the Atlantic is expected to stay high for years, and maybe even intensify, official warnings and expert opinion apparently do nothing to dampen people’s desire for living on or near the water. “People think a hurricane might not hit, or it might not flood, for 20 years,” says Chip Law, an insurance industry analyst with SNL Financial, a research firm. Coastal development in the hurricane zone has been booming for years, he says, and even after Katrina, “it’s not going to slow down.”

Understanding hurricanes better may help scientists predict their severity. But thanks to the building boom—aided, in some cases, by taxpayer-backed federal flood insurance—limiting storm damage in the future won’t depend on brilliant atmospheric science nearly so much as it will on common-sense planning and regulation.

See The cyclical pattern of storms

U.S. NEWS & WORLD REPORT • SEPTEMBER 12, 2005
Storm warning

The hurricane forecast is becoming clearer, and the news is not good

OUT of a fog of meteorological data, an alarming picture of intensifying tropical cyclones and hurricanes is emerging. It can be summed up in two words: more Katrinas.

The likely effects of climate change on the number and intensity of tropical storms has been debated for years. Some argued that warmer sea surface temperatures would mean more and stronger storms; after all, the moisture from evaporating ocean water is the feedstock of cyclones, including hurricanes. Others predicted that climate change would alter heat distribution in the oceans to damp down storms.

Until recently, no one could say for sure which of these predictions would be correct. The haphazard business of spotting and measuring cyclones left trend analysis bedevilled by uncertainty over the quality of data. As late as last year, the consensus among meteorologists remained that no discernible trend could be distinguished from natural variations.

Now that has changed. Three reports have found a clear signal amid the statistical noise. In June, Kevin Trenberth at the US National Center for Atmospheric Research in Boulder, Colorado, uncovered a rising intensity of hurricanes in the North Atlantic (Science, vol 308, p 1753). Last month, Kerry Emanuel at the Massachusetts Institute of Technology found a 50 per cent increase in the destructive power of cyclones in the past half-century (Nature, vol 436, p 686).

And now comes the most detailed study yet: an analysis of the cyclones in all tropical oceans since 1970 (see page 10). The 35-year time span was chosen because this is the era of global satellite coverage, so we can be fairly sure there is no hidden bias caused by any improved ability to spot and measure cyclones. The good news is that there is no rising trend in the overall number of hurricanes, nor any sign that the worst storms are growing fiercer. But there is bad news too: there has been a near doubling in the number of the strongest categories of hurricanes – the category 4 and 5 storms exemplified by Katrina. Equally dramatic is the discovery that the trend towards stronger cyclones occurs in every ocean, has been continuous for more than three decades, and closely tracks the rise in sea surface temperatures right across the tropics.

It is this near-uniform global picture that warns us the trend is genuine, rather than the result of natural variability. Local and regional conditions fluctuate all the time, but rarely does the whole of nature move swiftly in one direction unless there is some external cause. As the report's co-author, Judy Curry of the Georgia Institute of Technology in Atlanta, puts it: "We can say with confidence that the trends in sea surface temperatures and hurricane intensity are connected to climate change."

What next? We all saw the economic, social and political havoc wrought by Katrina, and the new analysis suggests there is more to come. The consequences of other storms of similar force striking this year or next would be profound. Perhaps climate change, and the need to stop it, would at last be promoted from political nuisance to political necessity. ●
Big Hurricanes Found to Occur More Frequently

By Gautam Naik

The number of powerful hurricanes occurring worldwide has nearly doubled during the past 35 years, according to a study appearing this week in the journal Science.

The finding adds to a growing body of research that links rising sea temperatures to the increasingly frequent appearance of powerful hurricanes such as Katrina, which devastated the Gulf Coast. A study published in July similarly found a marked increase in the duration and power of hurricanes in the North Atlantic and North Pacific oceans. Such storms are also known as typhoons or cyclones, depending on where they occur.

"In all water basins, the intensity of hurricanes is increasing substantially," said Peter Webster, professor at Georgia Institute of Technology in Atlanta. Prof. Webster co-wrote the latest study with colleagues from Georgia Tech and a scientist from the National Center for Atmospheric Research in Boulder, Colo.

Climate researchers believe that human-induced global warming is the main cause of higher sea temperatures, which have risen between half a degree and one degree Fahrenheit in the past three decades. Scientists also believe that when sea temperatures rise, more water vapor is released through evaporation, and that, in turn, fuels more-powerful storms.

Prof. Webster and his colleagues assessed a hurricane's intensity by its wind speed. They found that since 1990, there has been a yearly average of 18 Category 4 and 5 hurricanes, up from 10 such storms annually in the 1970s. A Category 4 hurricane packs sustained winds from 131 to 155 miles per hour, while a Category 5 hurricane, such as Katrina at its peak, has winds of 156 miles or more.

According to the study, the largest increases in the number of intense hurricanes occurred in the North Pacific, Southwest Pacific and the North and South Indian oceans, with slightly smaller increases in the North Atlantic.

One puzzling finding was that, in the past decade, though hurricanes have be-
Global warming? You better believe it

While there has been no increase in the actual number of storms worldwide, the Georgia Tech/NCAR study found the number of hurricanes that reached categories 4 and 5, with winds of at least 131 miles per hour, have gone from comprising 20 percent of hurricanes in the 1970s to 35 percent today. This is with only a half-degree centigrade rise in tropical surface water temperatures.

The percentage of big storms in the North Atlantic has increased from 20 percent to 25 percent. The rise is much worse in the rest of the world, where millions of less fortunate people cannot flee the coast in SUVs on interstate roads.

In the 1970s, no ocean basin saw more than 25 percent of hurricanes become a 4 or 5. Today, that percentage is 34, 35, and 41 percent, respectively, in the South Indian, East Pacific, and West Pacific oceans. The biggest jump was in the Southwestern Pacific, from 8 percent to 25 percent.

Emanuel, who formerly doubted that hurricane intensity was tied to global warming, said that he was stunned when his research showed that just that half-degree rise in tropical ocean temperatures has also seen a 50 percent rise in average storm peak winds in the North Atlantic and East and West Pacific in the last half century.

The accumulated annual duration of storms in the North Atlantic and the western North Pacific has shot up by 60 percent.

“'I wasn’t looking for global warming,” Emanuel said by cell phone in Spain where he is conducting research on Mediterranean storms. “But it stuck out like a sore thumb.”

Emanuel originally thought that a half-degree rise in ocean temperatures should have resulted in wind speeds much lower than that. Emanuel said he hoped the more recent findings would be taken as a signal for action. The average hurricane, he said, releases the equivalent of worldwide electrical capacity. Hurricanes Katrina and Rita are 10 times stronger.

Not surprisingly, these new findings have drawn skepticism from scientists who cling to past climate models and flat denials from a Bush administration that has all but censored serious talk about global warming.

The National Oceanic and Atmospheric Administration’s website says, “The strongest hurricanes in the present climate may be upset by even more intense hurricanes over the next century as the earth’s climate is warmed by increasing levels of greenhouse gases.”

But Max Mayfield, director of NOAA’s National Hurricane Center, testified this week before a Senate committee that increased hurricane activity “is due to natural fluctuations” and is “not enhanced substantially by global warming.”

The one-two punch of Katrina and Rita does not yet have us reaching for the smelling salts. We are still waiting for global warming to hit us below the belt.
California ponders how to handle major earthquake

In wake of Katrina, state weighs its own preparedness

By Jia-Rui Chong and Hector Becerra

Los Angeles Times

LOS ANGELES — U.S. Geological Survey seismologist Lucy Jones remembers attending an emergency training session in August 2001 with the Federal Emergency Management Agency that discussed the three most likely catastrophes to strike the United States.

First on the list was a terrorist attack in New York. Second was a super-strength hurricane hitting New Orleans. Third was a major earthquake on the San Andreas fault.

Now that the first two have come to pass, she and other earthquake experts are using the devastating aftermath of Hurricane Katrina as an opportunity to reassess how California would handle a major temblor.

Jones, scientist-in-charge for the geological survey’s Southern California Earthquake Hazards Team, and other experts generally agree that California has come a long way in the last two decades in seismic safety.

In Los Angeles, all but one of the 8,700 unreinforced masonry buildings — considered the most likely to collapse in a major quake — have been retrofitted or demolished. The state spent billions after the 1994 Northridge quake to retrofit more than 2,100 freeway overpasses, reporting last week that only a handful remain unreinforced.

Despite these improvements, however, officials believe that a major temblor could cause the level of destruction and disruption seen over the last weeks on the Gulf Coast.

More than 900 hospital buildings that state officials have identified as needing either retrofitting or total replacement have yet to receive them, and the state recently agreed to five-year extensions to hospitals that can’t meet the 2008 deadline to make the fixes. More than 7,000 school buildings across the state would also be vulnerable during a huge temblor, a state study found, though there is no firm timetable for upgrading the structures.

And four Los Angeles Police Department facilities — including the Parker Center headquarters downtown — worry officials, because they were built to weaker earthquake standards and might not survive a major temblor. Only two of the LAPD’s 19 stations meet the most rigorous quake-safe rules.

A catastrophic temblor at the right spot along the San Andreas could significantly reduce energy and water supplies — at least temporarily, she and others said. Researchers at the Southern California Earthquake Center said there is an 80 percent to 90 percent chance that a temblor of 7.0 or greater magnitude will strike Southern California before 2024.

Recently, the Legislature sent to the governor’s desk a bill that encourages local governments to develop retrofitting programs for “soft story” wood-frame apartment buildings.

There are an estimated 70,000 such structures in the state, and experts worry that they could sustain major quake damage, because they often have tuck-under parking and lack solid walls at their bases.

Although Los Angeles, Long Beach, Pasadena and several other cities have reinforced almost all their masonry buildings, about a third of such structures across the state remain unprotected, said Frank Turner, an engineer with the Seismic Safety Commission.

A state study published last year on hazard reduction paints a sobering picture of California’s earthquake danger. About 62 percent of the population lives in a zone of high earthquake danger, including 100 percent of the population of Ventura County, 99 percent of Los Angeles County and 92 percent of Riverside County.

Since 1971, there have been at least 13 earthquakes of magnitude 6.0 or greater in the state, and research conducted after the 1989 Loma Prieta quake in the Bay Area found a 62 percent probability that at least one earthquake of magnitude 6.7 or more would strike the Bay Area before 2032.

Because the Los Angeles region is so much larger than the Louisiana city, it is difficult to conceive of a disaster — “short of an A-bomb” — that would blanket the whole city, let alone the whole county, in ruin, said Lee Sapidan, a spokesman for Los Angeles County’s Office of Emergency Management.
Several Scientists ---

publish a good hurricane paper
( Nov 2005)

- R. Pielke Jr. (Univ of Colorado)
- Chris Landsea, (Hurricane Research Division)
  of NOAA - AOML
- Max Mayfield (Chief, National Hurricane Center, Miami)
- Jim Larson (Head Climate Prediction Center)
  - A branch at NOAA - NCEP.
  - NCEP makes global weather prediction
    and does climate work.
- R. Pasch (Scientist, National Hurricane Center)

[see the paper]
[on next 2 pages]

Roy Herne
Oct 28 - 2005
 Debate over climate change frequently conflates issues of science and politics. Because of their significant and visceral impacts, discussion of extreme events is a frequent focus of such conflations. Linda Mearns, of the National Center for Atmospheric Research (NCAR), aptly characterizes this context: "There's a push on climatologists to say something about extremes, because they are so important. But that can be very dangerous if we really don't know the answer" (Henson 2005). In this article we focus on a particular type of extreme event—the tropical cyclone—in the context of global warming (tropical cyclones are better known in the United States as hurricanes, i.e., tropical cyclones that form in the waters of the Atlantic and eastern Pacific oceans with maximum 1-min-averaged surface winds that exceed 32 m s\(^{-1}\)).

In our discussion we follow distinctions between event risk and outcome risk presented by Sarewitz et al. (2003). "Event risk" refers to the occurrence of a particular phenomenon, and in the context of hurricanes we focus on trends and projections of storm frequencies and intensities. "Vulnerability" refers to "the inherent characteristics of a system that create the potential for harm," but are independent from event risk. In the context of the economic impacts of tropical cyclones vulnerability has been characterized in terms of trends in population and wealth that set the stage for storms to cause damage. "Outcome risk" integrates considerations of vulnerability with event risk to characterize an event that causes losses. An example of outcome risk is the occurrence of a $100 billion hurricane in the United States. To calculate such a probability requires consideration of both vulnerability and event risk. This article discusses hurricanes and global warming from both of these perspectives.

**EVENT RISK.** At the end of the 2004 Atlantic hurricane season, many scientists, reporters, and
Since 1995 there has been an increase in the number of storms, and in particular the number of major hurricanes (categories 3, 4, and 5) in the Atlantic. But the changes of the past decade in these metrics are not so large as to clearly indicate that anything is going on other than the multidecadal variability that has been well documented since at least 1900 (Gray et al. 1997; Landsea et al. 1999; Goldenberg et al. 2001). Consequently, in the absence of large or unprecedented trends, any effect of greenhouse gases on the frequency of storms or major hurricanes is necessarily very difficult to detect in the context of this documented variability. Perspectives on hurricanes are no doubt shaped by recent history, with relatively few major hurricanes observed in the 1970s, 1980s, and early 1990s, compared with considerable activity during the 1940s, 1950s, and early 1960s. The period from 1944 to 1950 was particularly active for Florida. During that period 11 hurricanes hit the state, at least one per year, resulting in the equivalent of billions of dollars in damage in each of those years (Pielke and Landsea 1998).

Globally there has been no increase in tropical cyclone frequency over at least the past several decades (Webster et al. 2005; Lander and Guard 1998; Elsner et al. 2006).

CONCLUSIONS. To summarize, claims of linkages between global warming and hurricane impacts are premature for three reasons. First, no connection has been established between greenhouse gas emissions and the observed behavior of hurricanes (Houghton et al. 2001; Walsh 2004). Emanuel (2005) is suggestive of such a connection, but is by no means definitive. In the future, such a connection may be

Yet, claims of such connections persist (cf. Epstein and McCarthy 2004; Eilperin 2005), particularly in support of a political agenda focused on greenhouse gas emissions reduction (e.g., Harvard Medical School 2004). But a great irony here is that invoking the modulation of future hurricanes to justify energy policies to mitigate climate change may prove counterproductive. Not only does this provide a great opening for criticism of the underlying scientific reasoning, it leads to advocacy of policies that simply will not be effective with respect to addressing future hurricane impacts. There are much, much better ways to deal with the threat of hurricanes than with energy policies (e.g., Pielke and Pielke 1997). There are also much, much better ways to justify climate mitigation policies than with hurricanes (e.g., Rayner 2004).

REFERENCES

Harvard Medical School, cited 2004: Experts to warn global warming likely to continue spurring more outbreaks of intense hurricane activity. [Available online at www.med.harvard.edu/chge/hurricanespress.html; full transcript of the press conference can be found online at www.ucar.edu/news/record/transcripts/hurricanes102104.shtml.]

Please get the paper. See the whole list.
Can We Detect Trends in Extreme Tropical Cyclones?

Christopher W. Landsea, Bruce A. Harper, Karl Hoarau, John A. Knaff

Recent studies have found a large, sudden increase in observed tropical cyclone intensities, linked to warming sea surface temperatures that may be associated with global warming (1–3). Yet modeling and theoretical studies suggest only small anthropogenic changes to tropical cyclone intensity several decades into the future [an increase on the order of ∼5% near the end of the 21st century (4, 5)]. Several comments and replies (6–10) have been published regarding the new results, but one key question remains: Are the global tropical cyclone databases sufficiently reliable to ascertain long-term trends in tropical cyclone intensity, particularly in the frequency of extreme tropical cyclones (categories 4 and 5 on the Saffir-Simpson Hurricane Scale)?

Tropical cyclone intensity is defined by the maximum sustained surface wind, which occurs in the eyewall of a tropical cyclone over an area of just a few dozen square kilometers. The main method globally for estimating tropical cyclone intensity derives from a satellite-based pattern recognition scheme known as the Dvorak Technique (11–13). The Atlantic basin has had routine aircraft reconnaissance since the 1940s, but even here, satellite images are heavily relied upon for intensity estimates, because aircraft can monitor only about half of the basin and are not available continuously. However, the Dvorak Technique does not directly measure maximum sustained surface wind. Even today, application of this technique is subjective, and it is common for different forecasters and agencies to estimate significantly different intensities on the basis of identical information.

The Dvorak Technique was invented in 1972 and was soon used by U.S. forecast offices, but the rest of the world did not use it routinely until the early 1980s (11, 13). Until then, there was no systematic way to estimate the maximum sustained surface wind for most tropical cyclones. The Dvorak Technique was first developed for visible imagery (11), which precluded obtaining tropical cyclone intensity estimates at night and limited the sampling of maximum sustained surface wind. In 1984, a quantitative infrared method (12) was published, based on the observation that the temperature contrast between the warm eye of the cyclone and the cold cloud tops of the eyewall was a reasonable proxy for the maximum sustained surface wind.

In 1975, two geostationary satellites were available for global monitoring, both with 9-km resolution for infrared imagery. Today, eight
satellites are available with typically 4-km resolution in the infrared spectrum. The resulting higher resolution images and more direct overhead views of tropical cyclones result in greater and more accurate intensity estimates in recent years when using the infrared Dvorak Technique. For example (13), Atlantic Hurricane Hugo was estimated to have a maximum sustained surface wind of 59 m s⁻¹ on 15 September 1989, based on use of the Dvorak Technique from an oblique observational angle. But in situ aircraft reconnaissance data obtained at the same time revealed that the hurricane was much stronger (72 m s⁻¹) than estimated by satellite. This type of underestimate was probably quite common in the 1970s and 1980s in all tropical cyclone basins because of application of the Dvorak Technique in an era of few satellites with low spatial resolution.

Operational changes at the various tropical cyclone warning centers probably also contributed to discontinuities in tropical cyclone intensity estimates and to more frequent identification of extreme tropical cyclones (along with a shift to stronger maximum sustained surface wind in general) by 1990. These operational changes include (13-17) the advent of advanced analysis and display systems for visualizing satellite images, changes in pressure-wind relationships used for wind estimation from observed pressures, relocation of some tropical cyclone warning centers, termination of aircraft reconnaissance in the Northwest Pacific in August 1987, and the establishment of specialized tropical cyclone warning centers.

Therefore, tropical cyclone databases in regions primarily dependent on satellite imagery for monitoring are inhomogeneous and likely to have artificial upward trends in intensity. Data from the only two basins that have had regular aircraft reconnaissance—the Atlantic and Northwest Pacific—show that no significant trends exist in tropical cyclone activity when records back to at least 1960 are examined (7, 9). However, differing results are obtained if large bias corrections are used on the best track databases (7), although such strong adjustments to the tropical cyclone intensities may not be warranted (7). In both basins, monitoring and operational changes complicate the identification of true climate trends. Tropical cyclone “best track” data sets are finalized annually by operational meteorologists, not by climate researchers, and none of the data sets have been quality controlled to account for changes in physical understanding, new or modified methods for analyzing intensity, and aircraft/satellite data changes (18-21).

To illustrate our point, the figure presents satellite images of five tropical cyclones listed in the North Indian basin database for the period 1977 to 1989 as category 3 or weaker. Today, these storms would likely be considered extreme tropical cyclones based on retrospective application of the infrared Dvorak Technique. Another major tropical cyclone, the 1970 Bangladesh cyclone—the world’s worst tropical-cyclone disaster, with 300,000 to 500,000 people killed—does not even have an official intensity estimate, despite indications that it was extremely intense (22). Inclusion of these storms as extreme tropical cyclones would boost the frequency of such events in the 1970s and 1980s to numbers indistinguishable from the past 15 years, suggesting no systematic increase in extreme tropical cyclones for the North Indian basin.

These examples are not likely to be isolated exceptions. Ongoing Dvorak reanalyses of satellite images in the Eastern Hemisphere basins by the third author suggest that there are at least 70 additional, previously unrecognized category 4 and 5 cyclones during the period 1978-1990. The pre-1990 tropical cyclone data for all basins are replete with large uncertainties, gaps, and biases. Trend analyses for extreme tropical cyclones are unreliable because of operational changes that have artificially resulted in more intense tropical cyclones being recorded, casting severe doubts on any such trend linkages to global warming.

There may indeed be real trends in tropical cyclone intensity. Theoretical considerations based on sea surface temperature increases suggest an increase of ~4% in maximum sustained surface wind per degree Celsius (4, 5). But such trends are very likely to be much smaller (or even negligible) than those found in the recent studies (1-3). Indeed, Klotzbach has shown (23) that extreme tropical cyclones and overall tropical cyclone activity have globally been flat from 1986 until 2005, despite a sea surface temperature warming of 0.25°C. The large, step-like increases in the 1970s and 1980s reported in (1-3) occurred while operational improvements were ongoing. An actual increase in global extreme tropical cyclones due to warming sea surface temperatures should have continued during the past two decades.

Efforts under way by climate researchers—including reanalyses of existing tropical cyclone databases (20, 21)—may mitigate the problems in applying the present observational tropical cyclone databases to trend analyses to answer the important question of how human-kind may (or may not) be changing the frequency of extreme tropical cyclones.

References and Notes
3. C. D. Hoyos, P. A. Agudelo, P. J. Webster, J. A. Curry.
Summary of News Stories, Sep 2005

(compiled by NCAR press clips, abstracts)

- Only a selection of the abstracts are here --- Roy Renne

Note: The news about hurricane Katrina (in New Orleans) was very intense in Sep 2005.

10 pages here
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Top Stories

Global Warming: The Culprit?—Evidence mounts that human activity is helping fuel these monster hurricanes
Time (September 26, 2005) circ. 4,034,061 (by subscription only)
Nature doesn't always know when to quit—and nothing says that quite like a hurricane. The

In the eye of the storms
USA Today (September 25, 2005) circ. 2,220,863
... In the Science report, researchers at Georgia Tech and the National Center for Atmospheric Research found that the number of category 4 and 5 hurricanes, with sustained winds of 131 mph and above, almost doubled worldwide in the past 35 years.

Global warming? You better believe it
Boston Globe (September 24, 2005) circ. 434,329
... [R]esearch continues to increasingly tie global warming to an increase in the intensity of tropical storms. ... Another was published last week in the journal Science by atmospheric researchers at Georgia Tech and the National Center for Atmospheric Research. While there has been no increase in the actual number of storms worldwide, the Georgia Tech/NCAR study found the number of

hurricanes that reached categories 4 and 5, with winds of at least 131 miles per hour, have gone from comprising 20 percent of hurricanes in the 1970s to 35 percent today.

Strong hurricanes becoming more common,
Scientists, Insurers Face the Deluge
Forbes (September 23, 2005) circ. 925,959

... Scientists expect that changing climate trends in the Atlantic Ocean will make hurricanes stronger. ... Kevin Trenberth, a climatologist at the National Center for Atmospheric Research, says we might already be seeing the effects. He says that it's reasonable to assume because of increasing temperatures that the rainfall from storms like Katrina has increased 8% since 1970.

Managing the next disaster
Los Angeles Times (September 23, 2005) circ. 907,997
Newsday (New York) (September 26, 2005) circ. 459,305

... But understanding what this hurricane season is really telling us about why we're so vulnerable to climate-related catastrophes means facing up to an unavoidable fact: Efforts to slow global warming will have no discernible effect on hurricanes for the foreseeable future. ... As James Hurrell, a scientist at the U.S. National Center for Atmospheric Research, testified before the U.S. Senate in July, "It should be recognized that [emissions reductions actions] taken now mainly have benefits 50 years and beyond now."

End of 'normal' hurricanes means preparing for global warming
San Francisco Chronicle (September 23, 2005) circ. 485,668

... Scientists from the National Center for Atmospheric Research and the Georgia Institute of Technology presented research recently that showed a steady increase in Category 4 and 5 hurricanes between 1970 and 2005. While environmentalists and their conservative opponents argue about whether global warming is the result of human activities or natural cycles, scientists have documented that temperatures have risen steadily and that the average temperature of the world's oceans increased by 1 degree Fahrenheit.
On the horizon

*Christian Science Monitor* (September 22, 2005) circ.
Hurricanes are growing stronger worldwide, feeding
off of ever-warmer water in the tropical oceans,
according to a new study by a team of scientists at
Georgia Tech in Atlanta and the National Center for

**Atmospheric Research** in Boulder, Colo.

**Hurricane link to climate change is hazy**

*Nature* (September 22, 2005) circ. 61,618 (by
subscription only)

... "The potential for more events like Katrina is on
the rise," says **Greg Holland**, a hurricane expert at
the National Center for Atmospheric Research in
Boulder, Colorado, and an author of the *Science*
paper. "You can never be sure, but it seems to be
consistent with global change."

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**KPFA Evening News** (radio)
KPFA-FM 94.1 (FM) San Francisco (September 22,
2005) DMA: 6
06:00 PM - 07:00 PM
00:15:41 Global Warming I; **Kevin Trenberth**, 
Climate Analysis Section, Center For Atmospheric
Research, discusses the issues pertaining to the
storms and global warming. PPhone I; Kurt Davies,
Spokesman, Greenpeace, says we should spend
money to cut global warming pollution and we should
also spend money to adapt to it. He says that the
Kyoto Protocol is mandatory. Megan Kaiser reporting
00:20:30

**MSNBC News Live** (TV)
MSNBC -- National (September 20, 2005)
02:00 PM - 03:00 PM
00:47:11 TZ; Hurricane Expert: Hurricane Rita is the
9th hurricane this year. According to the National

**Center For Atmospheric Research**, the number of
category 4 and 5 hurricanes world wide has nearly
doubled over the last 35 years. I; Stanley
Goldenberg, Meteorologist with the National
Oceanographic and Atmospheric Administration,
speaks about Hurricane Rita being part of a long-term
cycle over several decades of below normal and
above normal activity that traces back hundreds of
years. GR; Why So Many Hurricanes. 00:51:02
The Daily Drum (radio)
WHUR-FM 96.3 (CBS) Washington, DC (September 20, 2005) DMA: 8
06:30 PM - 07:00 PM
00:00:12 Storms. >00.12 Hurricane Rita gains strength as it passes Key West. I; Mary Cruz (?), National Hurricane Center, says it is expected to move into the Gulf of Mexico as it passes the Florida Keys. 02.57 >02.58 A study looks at the increase in storms and global warming. I; Greg Holland, National Center for Atmospheric Research, study coauthor, says warmer ocean waters make more intense systems more likely. Gene Colletta (?) reporting. 00:03:35

Up To The Minute (TV)
CBS -- National (September 19, 2005)
03:30 AM - 04:30 AM
00:01:37 Natural Disasters: Katrina was the biggest natural disaster in US history. V; Katrina winds and rain. I; Tom Herrington, Professor of Ocean Engineering, Katrina could be a sign of much more active period of strong hurricanes. According to the National Center for Atmospheric Research the number of category number of 4-5 hurricanes worldwide has almost doubled over the last 35 years. I; Bruce Molina, research geologist, human activities are in some way influencing how climate is changing. 00:03:42

Not more storms, but deadlier
Australian (September 19, 2005) circ. 416,000
... The biggest jump in intense storms occurred in the north Pacific, southwest Pacific and the north and south Indian Oceans, Prof Webster and his colleagues at Georgia Tech and the National Centre for Atmos. Res.

9/27/2005
Experts say global warming is causing stronger hurricanes
USA Today (September 15, 2005) circ. 2,220,863
Washington Post (September 15, 2005) circ. 1,007,487
Los Angeles Times (September 16, 2005) circ. 907,997
San Francisco Chronicle (September 16, 2005) circ. 485,668
Newsday (September 16, 2005) circ. 459,305
Boston Globe (September 16, 2005) circ. 451,471
Minneapolis Star Tribune (September 15, 2005) circ. 378,316
CBS News.com (September 15, 2005)
CNN.com (September 16, 2005)
MSNBC.com (September 15, 2005)
and these other publications
The number of hurricanes in the most powerful categories — like Katrina and Andrew — has increased sharply over the past few decades, according to a new analysis. . . . Co-author Greg Holland of the National Center for Atmospheric Research said the researchers can't say rising sea-surface temperatures caused Hurricane Katrina. But their study shows the potential for more Katrina-like events to occur, he said.

Hurricanes will happen faster and stronger
Financial Times (London) (September 15, 2005) (by subscription only)
Devastation similar to that caused by Hurricane Katrina is likely to be repeated in the next few decades, perhaps with greater ferocity, if a spate of recent studies into the science of hurricanes is correct. [full citation not available]

Global warming linked to increase of hurricanes
Times (London) (September 15, 2005) circ. 632,274
Hurricanes of the intensity of Katrina have become almost twice as common over the past 35 years, according to research suggesting that global warming could be worsening severe storms. . . . Another Science paper, by Kevin Trenberth, of the US National Centre for Atmospheric Research, found in July that there is 2 per cent more water vapour above the oceans today than there was in 1988.

'Warming link' to big hurricanes
BBC News (September 15, 2005)
Warming world blamed for more strong hurricanes
New Scientist (September 15, 2005) circ. 138,000
A massive global increase in the number of strong
hurricanes over the past 35 years is being blamed on
global warming, by the most detailed study yet. . . .
"This trend has lasted for more than 30 years now.
So the chances of it being natural are fairly remote," says Greg Holland of the National Center for
Atmospheric Research (NCAR) at Boulder, Colorado.

Study Links Hurricanes to Global Warming
Forbes.com (September 15, 2005)
ABC News.com (September 15, 2005)
and these other publications

Did Global Warming Boost Katrina's Fury?
ABCNEWS.com (September 14, 2005)
. . . Global warming didn't create Katrina. But
research indicates it enhanced it. "Our estimate is
that rainfall from Katrina was about 7 percent
enhanced by global warming," says Kevin
Trenberth, head of the climate analysis section of
the National Center for Atmospheric Research in
Boulder, Colo.

Bigger, Badder Tropical Blows
2,014,422
. . . Are hurricanes getting worse? And if so, is global
warming to blame? . . . In a June article in Science,
head climate analyst Kevin Trenberth of the
National Center for Atmospheric Research in
Boulder, Colo., warned that global warming may
already be nudging some of those conditions--like
How did modest Katrina morph into monster?
_Houston Chronicle_ (September 12, 2005) circ. 554,783
Well before Hurricane Katrina slammed into the Gulf Coast shores . . . it was clear to storm experts . . . that powerful forces of nature, and possibly human influences on the Earth's environment, would create a weather milestone of devastating fury. . . . **Kevin Trenberth** . . . at the **National Center for Atmospheric Research** . . . sees a convincing trend under way. . . . Sea temperatures have risen nearly 1 degree in the tropics over the last century . . . and most of that increase can be attributed to the release of carbon dioxide . . . he said.

_**Washington all but ignoring debate on climate change**_
_Scripps Howard News Service_ (September 23, 2005)
Researchers at the School of Earth Atmospheric Sciences at Georgia Tech and the **National Center for Atmospheric Research** claim the number of Category 4 and 5 hurricanes has almost doubled since 1970, going from 10 a year in the 1970s to 18 a year in the 1990s, even though the number of hurricanes actually has declined. Sea-surface temperatures have increased by about a half a degree Centigrade over the same time.

_Hurricanes, energy crisis prompt local thought, action_
_Los Alamos Monitor_ (September 19, 2005)
. . . A study by the Georgia Institute of Technology and the **National Center for Atmospheric Research**, published in the Sept. 16 issue of _Science_ magazine, reported the doubling of Category 4 and 5 hurricanes worldwide over the last 35 years.

_Potential For More Katrinas Has Increased Says Study_
_All Headline News_ (September 16, 2005)
. . . Co-author **Greg Holland** of the **National Center for Atmospheric Research** says they can't say rising sea-surface temperatures caused a specific storm, such as Katrina. But, their study shows the potential for more Katrina-like events to occur.
Study links global warming to stronger storms
Houston Chronicle (September 16, 2005) circ. 527,744
Katrina's blunt assault of the upper Gulf Coast has reigned one of the most controversial debates in science today. . . . Gregory Holland, [sic] a scientist at the National Center for Atmospheric Research and another author of the new study, defended his group's research. The data is reliable, he said.

Major storms become more frequent
Atlanta Journal-Constitution (September 16, 2005) circ. 381,730
and these other publications

Deadly storms around the globe on the rise?
Philly.com (September 16, 2005)
Whatever the study's weaknesses, the team's overarching finding was unmistakable, said study coauthor Greg Holland, a researcher at the National Center for Atmospheric Research, who, like Landsea, is a former student of Gray's. "There is no doubt that there's a substantial increase in Category 4 and 5 hurricanes," he said. "The increase is consistent with what we would expect in global change."

study finds
Scripps Howard News Service (September 15, 2005)
and these other publications

If You Don't Like the Climate, Wait a Minute
Grist Magazine (September 15, 2005)
. . . [Heidi] Cullen, a climatologist, was hired two years ago by The Weather Channel, plucked from her post-graduate work at the National Center for Atmospheric Research in Boulder, Colo.
Weather Seer: ‘We’re Lucky’

Eight of the last 10 years have been very active—we’ve never had as much activity. Yet we went from 1992 until last year with no hurricanes coming through Florida.

How did you get involved in predicting hurricanes?
G: It was an outgrowth of my teaching. We always wanted to know when we went to Florida whether the Atlantic basin would have an active season or not, because it has the most variable season of the global basins. There are some years with very few storms and other years with a large number of them. Twenty-five years ago, there was no way to tell. We tried studying local variation in the sea surface temperatures in the western Atlantic, the surface pressures, the wind shears, and various other things, but we could not develop a scheme that worked very well. Then I discovered that the secret was to look globally. I found that if there is an El Niño in the Pacific, the Atlantic seasons tend to be rather weak; if there is not an El Niño, they tend to be stronger. Then we found that if the global stratospheric winds blow from the west, we tend to have more storms. We looked at West African rain—we hadn’t been doing that—and found that had a precursor signal to it too. The more we learned, the better the predictions got.

How can you predict hurricanes six or nine months in advance but not the weather next week?
G: We don’t say where or when the storms are going to occur. We give a number for the season. It is a different prediction.

What is the point in predicting the severity of the season if you can’t say where a storm will hit, or when?
G: People want to know what the odds look like, and we can say something about that by looking at the conditions that existed before the active season in prior years and comparing those to what we see now.

A few years ago when there were quite a few light seasons in a row, you said Florida had just been lucky—and that it was going to end.
G: They’ve been extremely lucky. The last major storm to come through Florida, before hurricane Andrew hit in 1992, was hurricane Betsy in 1965, which went through the Keys. Eight of the last 10 years have been very active—in fact, we’ve never had as much activity on the records, going back to about 1870 or so, as in the past 10 years—and yet we went from 1992
‘Our feeling is that the United States is going to be seeing hurricane damage over the next decade or so on a scale way beyond what we have seen in the past.’

1930s and ’40s, and then there was a slight global cooling from the middle ’40s to the early ’70s. And there has been warming since the middle ’70s, especially in the last 10 years. But this is natural, due to ocean circulation changes and other factors. It is not human induced.

That must be a controversial position among hurricane researchers.

G: Nearly all of my colleagues who have been around 40 or 50 years are skeptical as hell about this whole global-warming thing. But no one asks us. If you don’t know anything about how the atmosphere functions, you will of course say, “Look, greenhouse gases are going up, the globe is warming, they must be related.” Well, just because there are two associations, changing with the same sign, doesn’t mean that one is causing the other.

With last year’s hurricane season so active, and this year’s looking like it will be, won’t people say it’s evidence of global warming?

G: The Atlantic has had more of these storms in the last 10 years or so, but in other ocean basins, activity is slightly down. Why would that be so if this is climate change? The Atlantic is a special basin? The number of major storms in the Atlantic also went way down from the middle 1960s to the middle ’90s, when greenhouse gases were going up.

Why is there scientific support for the idea?

G: So many people have a vested interest in this global-warming thing—all these big labs and research and stuff. The idea is to frighten the public, to get money to study it more. Now that the cold war is over, we have to generate a common enemy to support science, and what better common enemy for the globe than greenhouse gases?

Are your funding problems due in part to your views?

G: I can’t be sure, but I think that’s a lot of the reason. I have been around 50 years, so my views on this are well known. I had NOAA money for 30 some years, and then when the Clinton administration came in and Gore started directing some of the environmental stuff, I was cut off. I couldn’t get any NOAA money. They turned down 13 straight proposals from me.
Scientists unite in bid to drive policy

SAN DIEGO
Tired of having their work ignored by politicians, scientists in the United States are taking matters into their own hands by using political organizations to advance scientific causes.

Political action committees, or PACs, have been around for years in US politics. They are typically used by powerful special-interest groups to collect donations while circumventing the controls on political contributions to specific candidates. But the handful of science-oriented PACs that have emerged in the past year or so represent a new trend to educate voters and politicians. They are formed by scientists and aimed to influence voting or elected officials on specific topics, such as marine environmental policy, stem-cell research or conservation.

Ocean Champions, a California-based organization founded by marine biologist David Wilmot and environmental attorney Jack Sterne, is one example. "In the past, we would watch great science get ignored, manipulated or worse in the political process," says Wilmot, who has worked for several environmental groups. "We would have all our ducks lined up, but in the end we couldn't influence the political decisions. I was tired of losing. We are now using science to create clout to drive good policy."

The PACs are typically targeting US congressional races — although some are already eyeing the 2008 presidential and state elections. And they say they will promote their causes, not any political party. For instance, of the 11 winners among the 14 Senate and House candidates backed by Ocean Champions last year, 6 were Democrats and 5 were Republicans.

Another science-related PAC, StemPAC of Washington DC, was created in July to push stem-cell research. StemPAC came out of 'kitchen table talk' by Democratic political consultants concerned about Tay-Sachs disease, for which stem-cell research might lead to therapies. The group jumped immediately into presidential politics by creating advertisements targeting Senator Bill Frist of Tennessee — the Republican majority leader of the Senate, and a physician, who had seemed reluctant to back stem-cell research.

The day the advertisements highlighting Frist's opinions were to begin running in New Hampshire, the site of the first presidential primary for the 2008 election, Frist publicly came out in favour of stem-cell research. Political consultant Bud Jackson, a StemPAC founder, doesn't think the advertisements, which he says never ran, were the main reason Frist changed his mind, but says, "I think we contributed to hastening his decision." Politicians from all parties will be fair game, he adds. "If they are opposed to stem-cell research, we will hit them where it hurts."

StemPAC officials declined to discuss the organization's monetary goals. But at Ocean Champions, Wilmot says the organization aims to raise $1 million during the forthcoming two-year federal-election cycle. Last week in Washington, the group held a 'coming-out' fund-raiser to boost its profile. Since forming in 2003, the group has raised about $630,000, Wilmot adds.

Participation in such organizations may be a problem for scientists, many of whom are cautious about leaving the lab for the rough-and-tumble world of politics, and worried that their credibility or funding may be affected. "Scientists are afraid of advocacy," says ecologist David Blockstein, senior scientist for the National Council for Science and the Environment in Washington DC. "But this is changing."

Rex Dalton
The Peter Webster Paper

In Science, 16 Sep 2005

Four pages follow
- Introduction by Richard Kost (1 page)
- The Webster paper (3 pages)

5 pages here

Page 164
Is Katrina a Harbinger of Still More Powerful Hurricanes?

Mounting evidence suggests that tropical cyclones around the world are intensifying, perhaps driven by greenhouse warming, but humans still have themselves to blame for rising damage.

Were New Orleans and coastal Mississippi victims of global warming? Greenhouse alarmists and the tabloids say yes, but until recently, most scientists would have answered no way. There was no evidence that global warming has had any effect on the planet’s most powerful storms—dubbed hurricanes, typhoons, or cyclones depending on the ocean that spawns them.

Now, however, a connection is emerging between warming oceans and severe tropical cyclones. On page 1844, meteorologists report a striking 80% increase worldwide in the abundance of the most powerful tropical cyclones during the past 35 years. The study lends support to another, independent study published last month that found a similar intensification in the Atlantic and western North Pacific. At the same time, the tropical oceans have been warming, driven, most researchers agree, by rising greenhouse gases. “There’s a strong suggestion of a link” between the growing greenhouse and intensifying tropical cyclones, says meteorologist Kerry Emanuel of the Massachusetts Institute of Technology, sole author of the earlier paper.

But you still can’t blame Katrina’s damage on global warming, says Emanuel. There have been too few powerful storms striking densely populated coasts to declare with any confidence that intensifying storms are increasing the damage. And vulnerable coastal populations have swollen so much in recent decades that the increase in damage due to demographics is swamping any sign of increased damage due to storm intensification. But just wait until the second half of the century, he says.

Global warming and tropical cyclones are naturally linked by the storms’ appetite for heat. Tropical storms are heat engines that draw their energy upward from warm ocean water to drive their winds before expelling waste heat to the upper atmosphere. So warming the tropical oceans—in effect throwing more wood on the fire—might be expected to spawn more frequent and more intense tropical cyclones. To find out whether warming has done that, meteorologist Peter Webster of the Georgia Institute of Technology in Atlanta and his colleagues examined satellite records of storms around the tropics, a history now 35 years long. The temperature contrast between a storm’s eye and the adjacent cloud tops provides a gauge of maximum wind speed, as calibrated in the Atlantic and western North Pacific against direct measurements of wind speeds by storm-penetrating aircraft.

Webster and colleagues seem to have been one for two in their search for warming effects. They found no long-term trend in the number of storms per year, only natural ups and downs, even as summer tropical sea surface temperatures rose 0.5°C. In the North Atlantic, where hurricane numbers have surged since 1995, such variability arises from changes in the strength of warm ocean currents (Science, 1 July, p. 41). But the researchers did find a sharp increase during the past 35 years in the number of category 4 and 5 tropical cyclones, the most intense storms that cause most of the damage on landfall. Globally, category 4 and 5 storms climbed 57% from the first half of the period to the second.

That growing proportion of tropical cyclones in categories 4 and 5 “is very consistent with my results,” says Emanuel. As he reported in the 4 August issue of Nature, he calculated the total power released during the life of Atlantic and western North Pacific storms (the Pacific spawns about five times as many storms as the Atlantic does) based on reported maximum sustained winds. Because of stronger winds and longer storms, this power dissipation index rose between 40% and 50% from the first half of the 45-year record to the second, in step with rising ocean temperatures. With two studies finding that the same trends correlate with sea surface temperatures in a half-dozen ocean basins, “it’s fairly well established that the measure of hurricane intensity has been increasing,” says Emanuel.

Perhaps predictably, that hasn’t stopped other researchers from giving the two papers a guarded initial reception. Meteorologist Kevin Trenberth of the National Center for Atmospheric Research in Boulder, Colorado, notes inevitable reservations about such indirectly measured records. And modeler Thomas Knutson of the Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey, says, “We would not have expected the signal [of storm intensification] to be detectable at the present time,” based on theory and his modeling of storms under a growing greenhouse. That, he says, prompts the question, “Are these trends real?”

In any case, no one, including Webster and Emanuel, is claiming that these two positive results suffice to link global warming firmly to tropical cyclone intensification. Webster, for one, would first want to understand exactly how warming waters could trigger such a large response.

Even if global warming is driving a real intensification of tropical cyclones, notes climatologist Roger Pielke Jr. of the University of Colorado, Boulder, it shouldn’t change anyone’s plans. It’s easy to see a rising trend in U.S. hurricane damage as people flock to the coasts, he says, and even the effects of the natural North Atlantic oscillation and of El Niño on hurricanes are recognizable in storm damage. But there’s no sign of an effect of storm intensification. That’s down in the noise and will be for many decades, he says.

A beach house owner on the southeast U.S. coast has plenty to worry about from current storm hazards, Emanuel agrees. But anyone operating globally on a half-century time scale or longer, such as some insurance companies, should expect to see big changes later this century, he says. Then global warming can start taking the blame.

—Richard A. Kerr
Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment

P. J. Webster, G. J. Holland, J. A. Curry, H.-R. Chang

We examined the number of tropical cyclones and cyclone days as well as tropical cyclone intensity over the past 35 years, in an environment of increasing sea surface temperature. A large increase was seen in the number and proportion of hurricanes reaching categories 4 and 5. The largest increase occurred in the North Pacific, Indian, and Southwest Pacific Oceans, and the smallest percentage increase occurred in the North Atlantic Ocean. These increases have taken place while the number of cyclones and cyclone days has decreased in all basins except the North Atlantic during the past decade.

During the hurricane season of 2004, there were 14 named storms in the North Atlantic, of which 9 achieved hurricane intensity. Four of these hurricanes struck the southeast United States in rapid succession, causing considerable damage and disruption. Analysis of hurricane characteristics in the North Atlantic (1, 2) has shown an increase in hurricane frequency and intensity since 1995. Recently, a causal relationship between increasing hurricane frequency and intensity and increasing sea surface temperature (SST) has been posited (3), assuming an acceleration of the hydrological cycle arising from the nonlinear relation between saturation vapor pressure and temperature (4). The issue of attribution of increased hurricane frequency to increasing SST has resulted in a vigorous debate in the press and in academic circles (5).

Numerous studies have addressed the issue of changes in the global frequency and intensity of hurricanes in the warming world. Our basic conceptual understanding of hurricanes suggests that there could be a relationship between hurricane activity and SST. It is well established that SST > 26°C is a requirement for tropical cyclone formation in the current climate (6, 7). There is also a hypothesized relationship between SST and the maximum potential hurricane intensity (8, 9). However, strong interannual variability in hurricane statistics (10–14) and the possible influence of interannual variability associated with El Niño and the North Atlantic Oscillation (11, 12) make it difficult to discern any trend relative to background SST increases with statistical veracity (8). Factors other than SST have been cited for their role in regulating hurricane characteristics, including vertical shear and mid-tropospheric moisture (15). Global modeling results for doubled CO2 scenarios are contradictory (15–20), with simulations showing a lack of consistency in projecting an increase or decrease in the total number of hurricanes, although most simulations project an increase in hurricane intensity.

Tropical ocean SSTs increased by approximately 0.5°C between 1970 and 2004 (21). Figure 1 shows the SST trends for the tropical cyclone season in each ocean basin. If the Kendall trend analysis is used, trends in each of the ocean basins are significantly different from zero at the 95% confidence level or higher, except for the southwest Pacific Ocean. Here we examine the variations in hurricane characteristics for each ocean basin in the context of the basin SST variations. To this end, we conducted a comprehensive analysis of global tropical cyclone statistics for the satellite era (1970–2004). In each tropical ocean basin, we examined the numbers of tropical storms and hurricanes, the number of storm days, and the hurricane intensity distribution. The tropical cyclone data are derived from the best track archives.
of the Joint Typhoon Warning Center and of international warning centers, including special compilations and quality control (22).

Tropical cyclonic systems attaining surface wind speeds between 18 and 33 m s⁻¹ are referred to as tropical storms. Although storms of intensity $\geq33$ m s⁻¹ have different regional names, we will refer to these storms as hurricanes for simplicity. Hurricanes in categories 1 to 5, according to the Saffir-Simpson scale (23), are defined as storms with wind speeds of 33 to 43 m s⁻¹, 43 to 50 m s⁻¹, 50 to 56 m s⁻¹, 56 to 67 m s⁻¹, and $\geq67$ m s⁻¹, respectively. We define the ocean basins that support tropical cyclone development as follows: North Atlantic (90° to 20°W, 5° to 25°N), western North Pacific (120° to 180°E, 5° to 20°N), eastern North Pacific (90° to 120°W, 5° to 20°N), South Indian (50° to 115°E, 5°-20°S), North Indian (55° to 90°E, 5°-20°N), and Southwest Pacific (155° to 180°E, 5° to 20°S). Within these basins, total tropical storm days are defined as the total number of days of systems that only reached tropical storm intensity. Total hurricane days refer to systems that attained hurricane status, including the period when a system was at tropical storm intensity. Total tropical cyclone number or days refers to the sum of the statistics for both tropical storms and hurricanes.

Figure 2 shows the time series for the global number of tropical cyclones and the number of hurricane days for the period 1970–2004, for hurricanes, tropical storms, and all cyclonic storms. None of these time series shows a trend that is statistically different from zero over the period (24). However, there is a substantial decadal-scale oscillation that is especially evident in the number of tropical cyclone days. For example, globally, the annual number of tropical cyclone days reached a peak of 870 days around 1995, decreasing by 25% to 600 days by 2003. Figure 3 shows that in each ocean basin time series, the annual frequency and duration of hurricanes exhibit the same temporal characteristics as the global time series (Fig. 2), with overall trends for the 35-year period that are not statistically different from zero. The exception is the North Atlantic Ocean, which possesses an increasing trend in frequency and duration that is significant at the 99% confidence level. The observation that increases in North Atlantic hurricane characteristics have occurred simultaneously with a statistically significant positive trend in SST has led to the speculation that changes in both fields are the result of global warming (3).

It is instructive to analyze the relationship between the covariability of SST and hurricane characteristics in two other ocean basins, specifically the eastern and western North Pacific. Decadal variability is particularly evident in the eastern Pacific, where a maximum in the number of storms and the number of storm days in the mid-1980s (19 storms and 150 storm days) has been followed by a general decrease up to the present (15 storms and 100 storm days). This decrease accompanied a rising SST until the 1990–1994 pentad, followed by an SST decrease until the present. In the western North Pacific, where SSTs have risen steadily throughout the observation period, the number of storms and the number of storm days reach maxima in the mid-1990s before decreasing dramatically over the subsequent 15 years. The greatest change occurs in the number of cyclone days, decreasing by 40% from 1995 to 2003. In summary, careful analysis of global hurricane data shows that, against a background of increasing SST, no global trend has yet emerged in the number of tropical storms and hurricanes. Only one region, the North Atlantic, shows a statistically significant increase, which commenced in 1995. However, a simple attribution of the increase in numbers of storms to a warming SST environment is not supported, because of the lack of a comparable correlation in other ocean basins where SST is also increasing. The observation that increases in North Atlantic hurricane characteristics have occurred simultaneously with a statistically significant positive trend in SST has led to the speculation that the changes in both fields are the result of global warming (3).

Examination of hurricane intensity (Fig. 4) shows a substantial change in the intensity distribution of hurricanes globally. The number of category 1 hurricanes has remained approxi-

Fig. 2. Global time series for 1970–2004 of (A) number of storms and (B) number of storm days for tropical cyclones (hurricanes plus tropical storms; black curves), hurricanes (red curves), and tropical storms (blue curves). Contours indicate the year-by-year variability, and the bold curves show the 5-year running average.

Fig. 3. Regional time series for 1970–2004 for the NATL, WPAC, EPAC, NIO, and Southern Hemisphere (SIO plus SPAC) for (A) total number of hurricanes and (B) total number of hurricane days. Thin lines indicate the year-by-year statistics. Heavy lines show the 5-year running averages.
mately constant (Fig. 4A) but has decreased monotonically as a percentage of the total number of hurricanes throughout the 35-year period (Fig. 4B). The trend of the sum of hurricane categories 2 and 3 is small also both in number and percentage. In contrast, hurricanes in the strongest categories (4 + 5) have almost doubled in number (50 per pentad in the 1970s to near 90 per pentad during the past decade) and in proportion (from around 20% to around 35% during the same period). These changes occur in all of the ocean basins. A summary of the number and percent of storms by category is given in Table 1, binned for the years 1975–1989 and 1990–2000. This increase in category 4 and 5 hurricanes has not been accompanied by an increase in the actual intensity of the most intense hurricanes: The maximum intensity has remained remarkably static over the past 35 years (solid black curve, Fig. 4A).

Cyclone intensities around the world are estimated by pattern recognition of satellite features based on the Dvorak scheme (25). The exceptions are the North Atlantic, where there has been continuous aircraft reconnaissance; the eastern North Pacific, which has occasional aircraft reconnaissance; and the western North Pacific, which had aircraft reconnaissance up to the mid-1980s. There have been substantial changes in the manner in which the Dvorak technique has been applied (26). These changes may lead to a trend toward more intense cyclones, but in terms of central pressure (27) and not in terms of maximum winds that are used here. Furthermore, the consistent trends in the North Atlantic and eastern North Pacific, where the Dvorak scheme has been calibrated against aircraft penetrations, give credence to the trends noted here as being independent of the observational and analysis techniques used. In addition, in the Southern Hemisphere and the North Indian Ocean basins, where only satellite data have been used to determine intensity throughout the data period, the same trends are apparent as in the Northern Hemisphere regions.

We deliberately limited this study to the satellite era because of the known biases before this period (28), which means that a comprehensive analysis of longer-period oscillations and trends has not been attempted. There is evidence of a minimum of intense cyclones occurring in the 1970s (11), which could indicate that our observed trend toward more intense cyclones is a reflection of a long-period oscillation. However, the sustained increase over a period of 30 years in the proportion of category 4 and 5 hurricanes indicates that the related oscillation would have to be on a period substantially longer than that observed in previous studies.

We conclude that global data indicate a 30-year trend toward more frequent and intense hurricanes, corroborated by the results of the recent regional assessment (29). This trend is not inconsistent with recent climate model simulations that a doubling of CO₂ may increase the frequency of the most intense cyclones (18, 30), although 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.

References and Notes
31. This research was supported by the Climate Dynamics Division of NSF under award NSF-ATM 0328842 and by the National Center for Atmospheric Research, which is funded by NSF.

Table 1. Change in the number and percentage of hurricanes in categories 4 and 5 for the 15-year periods 1975–1989 and 1990–2004 for the different ocean basins.

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The most damaging types of hurricane are getting more frequent

A M ID the handwringing that has followed the devastation of New Orleans by Hurricane Katrina, a persistent question whispered in the background has been whether hurricanes are getting worse. A paper in this week's Science, by Peter Webster of the Georgia Institute of Technology, in Atlanta, and his colleagues suggests that they are, but only in one, specific way.

Hurricanes can form only over oceans that have a surface temperature above 26°C. That is well known. What is debatable is what effect, if any, raising the temperature beyond that has. It might increase the number of storms, the length they last, their maximum strength or the proportion that are strong. Or it might have no effect. Since average ocean-surface temperatures have risen by about half a degree since 1970, this is not an idle question, and it has, indeed, been asked in the past. But it has been asked largely of the North Atlantic and North Pacific, because they are fringed by countries that can afford to do the asking. Dr Webster, by contrast, has looked at the whole planet—or, rather, the six ocean basins on its surface that act as hurricane nurseries.

He and his team used satellite data to obtain consistent observations from around the world. (This was the reason they were able to go back only as far as 1970; before that, there were not enough observations.) Analysing the sea-surface temperatures in the six basins (the North Atlantic, the West Pacific, the East Pacific, the Southwest Pacific, the North Indian Ocean and the South Indian Ocean), they found statistically significant temperature rises in all but the Southwest Pacific.

Looking at the hurricanes themselves, though, they found no long-term trends in the number of storms per ocean basin or the length a storm lasts, except in the North Atlantic, where both increased. That is unfortunate news for Caribbean countries and the United States, which bear the brunt of those storms. But it suggests that whatever is increasing hurricane inci-
NCAR Expert: Hurricanes to Intensify as Earth Warms

Warmer oceans, more moisture in the atmosphere and other factors suggest that human-induced climate change will increase hurricane intensity and rainfall, according to climate expert Kevin Trenberth of the National Center for Atmospheric Research (NCAR).

Trenberth’s paper “Uncertainty in Hurricanes and Global Warming,” follows last year’s extensive tropical activity, including a record number of hurricane landfalls affecting Florida and typhoons striking Japan. These landfalls were related to persistent large-scale circulation features that steered these systems toward land, Trenberth says. It is unclear how global warming will affect these circulation patterns, he adds.

The strongest links between hurricane intensity and climate change, according to Trenberth, are a long-term rise in ocean temperatures and an increase in atmospheric water vapor. Both processes are already underway and expected to continue, he says. The additional water vapor will tend to produce heavier rains within hurricanes and an increased risk of flooding at landfall, Trenberth notes.

Most hurricanes that strike the U.S. coastline are born in the tropical North Atlantic, where sea-surface temperatures over the last decade have been the warmest on record. Water vapor over oceans worldwide has increased by about two percent since 1988. The warmer sea surface and moister atmosphere furnish potential energy for the showers and thunderstorms that fuel hurricanes.

Much more uncertain is the effect of human-induced climate change on hurricane numbers and landfalls. Models disagree on how global warming might affect the wind shear that can either support or discourage hurricane formation.

Globally, the number of hurricanes and typhoons tends to hold relatively steady from year to year. When activity increases in the Atlantic, it often decreases in the Pacific, and vice versa, based in part on El Niño and La Niña.

Trenberth points out that, because hurricane numbers vary so greatly on a regional level from year to year and decade to decade, it is often difficult to use statistical techniques to extract longer-term trends in the number of hurricanes that form and where they move. 

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Trenberth again pushes for stronger hurricanes from global warming

R. Jenne
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A Hurricane of Issues:
Global Warming, Oil and Race

A community gathering on the fourth anniversary of 9/11

This event will include:
• Opportunities for involvement and action
• Information and education from experts speaking to the issues exposed by Hurricane Katrina
• Information and tables by numerous organizations working on these issues locally
• The collection of donations for hurricane survivors taking refuge at the former Lowry Air Force Base. Items needed include luggage, tote bags, backpacks, personal hygiene items, towels and wash cloths, non-perishable snacks and non-perishable food

Event moderated by Joel Edelstein of KGnu. Panelists include:
• Tom Plant (Colorado State Representative, Executive Director: Center for ReSource Conservation) on issues surrounding the government's response to natural disasters and global warming
• Malaika McKee-Culpepper (Doctoral Candidate, University of Minnesota) on the role of race in responding to Hurricane Katrina
• Ronald Forthofer (Ph.D., Former Green Party Candidate for Congress) on oil imperialism and profiteering
• Adam Stenftenagel (ReSource, Boulder Green Building Guild) on local efforts for renewable energy, energy and resource conservation, green building, and reducing dependence on foreign oil

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-Ray Jaimes

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Finger-Pointing Storm Erupts in Congress
Both Parties Know Stakes Are High in the Sparring Over Post-Katrina Relief Efforts

Katrina's Price Tag Surges Higher
Bush Asks Congress to Allot Additional $51.8 Billion To Fund Recovery Efforts

Ten days after Katrina, the private economy is holding up nicely. Oil platforms and pipelines are being repaired, traffic is returning on the Mississippi, gasoline prices are stabilizing, and the stock market has rallied two days in a row.

The biggest threat now to a rapid and complete recovery is the storm-after-the-storm in Washington, where the politicians are making Governor Blanco look composed.

Our panic, or shall we say opportunistic, solons are already using Katrina to bust through whatever spending limits they had previously set for themselves. Following last week's $10.5 billion, Congress is set to appropriate $52 billion more this week, and not just for the Gulf Coast. Senate Minority Leader Harry Reid has already tossed out $150 billion as a spending goal, and Republicans are saying they won't be outbid. No one wants to be stingy.

Oil-Rig Insurers Expect Price Jumps
Premiums Could Rise 50% Following Damages in Gulf To at Least 58 Installations

A Massive Repair Job Begins To Fix Gulf's Broken Oil Network
Some Refineries Come Back, And a Big One Was Spared; Crude Is Flowing to It
Paying for Flood Damage Looms as Big Challenge

Many in Gulf Coast Region Had Little or No Insurance; A New Compensation Fund?

As the cleanup from Hurricane Katrina begins, a big fight could be brewing among insurers, policyholders, lawyers and regulators over who will shoulder the enormous cost of damage to thousands of homes.

Most homeowners in the hardest-hit Gulf Coast states lacked any flood insurance at all, even in flood-prone neighborhoods. Standard homeowners' policies exclude flood coverage, which generally must be bought from the federal government and is capped at $250,000. Katrina also sent flood waters deep into areas that hadn't flooded before, in which many homeowners thought they didn't need coverage.

Consequently, many who lost their homes in devastated areas—including much of New Orleans and large chunks of Biloxi, Pascagoula and Gulfport, Miss.—could find themselves without any insurance proceeds to help rebuild demolished homes and businesses.

Yesterday, insurance commissioners from the Gulf Coast states met in Atlanta to assess the challenges, while some civil-rights groups and others suggested creating a victim-compensation fund, similar to one established after the Sept. 11, 2001, terrorist attacks.

Intensifying the emerging debate will be the sheer logistical challenge of assessing hundreds of thousands of ruined structures. That process is certain to stir up a series of thorny questions, such as whether flood or wind—which is covered under many homeowners' policies—caused damage to homes. Determining whether wind-driven rain or rising floodwaters caused damage can be tricky, especially in areas that suffered both.

Though home-insurance providers face little or no exposure to flood damage, some are calling for them to step in, given the widespread, costly scale of damage. Among them is Richard Scruggs, a well-known class-action attorney who made his name suing the tobacco and asbestos industries—and whose own beachfront house in Mississippi, which had flood insurance, was partly destroyed by Katrina.

Mr. Scruggs said he plans to urge Mississippi Attorney General Jim Hood to try to override flood-exclusion clauses in homeowners' policies in that state in the interest of public policy, a move that could force insurers to pay many billions more toward rebuilding costs. Through a spokesman, Mr. Hood said: "I'm reviewing these contracts to determine if there are unconscionable provisions."

Insurers are likely to resist any such effort, though a fight could be a costly public-relations nightmare. Industry officials argue that they can't afford to take on flood risks because they haven't been paid to do so.

"Where does that money come from?" said Allstate Corp. spokesman Mike Trevino. "We didn't collect any premiums that contemplated flood as an exposure that we would have to cover."

Said Stephen Cozen, a Philadelphia attorney:
Bush Asks Congress to Allot Additional $51.8 Billion To Fund Recovery Efforts

By DAVID ROGERS

WASHINGTON—President Bush asked Congress for an additional $51.8 billion for Hurricane Katrina recovery efforts, with nearly half the money going toward providing temporary housing and financial assistance for 1.1 million households displaced by the storm.

Together with a $10.5 billion emergency spending bill approved last week, the new request means the federal commitment for Katrina has climbed above $62 billion—roughly equal to the annual cost of U.S. military operations in Iraq.

Prompted by its leaders estimate the total cost of the multiyear recovery could reach $150 billion to $200 billion. The White House declined to comment on those estimates, but said the new money will carry the relief effort into early October, when Mr. Bush is expected to submit a third, still-larger Katrina request.

Meanwhile in the region, Alabama, structure is sure to be huge. While freight activity along the Mississippi River is rebounding, large stretches of shipping terminals remain closed because they lack power, workers and trucks. And from the damaged Louisiana Superdome to highways and schools, the region faces a major rebuilding that will greatly add to the final cost of recovery and recovery efforts.

The administration's request promises the Army Corps of Engineers $400 million—targeted toward dredging navigational channels and repairing locks in the region—plus $3 billion from the FEMA funds to cover costs of emergency missions such as repairing damaged levees in New Orleans. An estimated $7.6 billion is also allocated to help state and local governments begin infrastructure repairs, but the absence of any new money to repair major federal highways is a concern for Mississippi, where the interstate system was badly damaged.

In addition, the administration may face objections to its proposal to greatly expand the ability of agencies to expedite procurement contracts that are free of some small-business and competitive requirements.

Current law allows such flexibility for purchases of as much as $25,000. The administration wants to raise this threshold to $250,000 for purchases related to the disaster-recovery effort.

In other developments:

■ Administration officials told Congress they were optimistic that energy and communications facilities in the storm-damaged area will recover fairly quickly. David K. Garman, an undersecretary in the Energy Department, told the House Energy and Commerce Committee yesterday that half the oil-refining capacity knocked out by Katrina will be back in operation within a week. Federal Communications Commission official Kenneth P. Moran said telephone service has been restored to two million of three million homes that lost the service.

■ Despite Republican objections, Democrats in Congress want to give Katrina victims a one-year reprieve from the new bankruptcy law that goes into effect Oct. 17. Consumer groups and bankruptcy attorneys say the new law's increased paperwork requirements and additional costs will further hurt hurricane victims who may be forced to seek bankruptcy protection.

■ Transportation Secretary Norman Mineta said the full extent of the damage to the transportation infrastructure has yet to be assessed. Asked about tax rollbacks to help airlines cover fuel costs, Mr. Mineta and Assistant Policy Secretary Tyler Duvall said the department wouldn't be opposed to considering those moves but that the administration "hasn't taken a position" on the issue.
United States

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Hurricane

Sat Sep 3 - 05

Hurricane Katrina

After the flood

NEW ORLEANS, NEW YORK AND WASHINGTON, DC

Hurricane Katrina has devastated New Orleans. Picking up the pieces will not be cheap or easy

WHAT I saw today is equivalent to what I saw flying over the tsunami in Indonesia. There are places that are no longer there." That is how Mary Landrieu, one of Louisiana's senators, described the scenes she saw below her on August 30th. She was flying by helicopter over the aftermath of Hurricane Katrina, a devastating hurricane that had swept in from the Gulf of Mexico. The storm hit land near New Orleans on August 29th at a speed of some 145mph, and then went on to pummel parts of Mississippi before ultimately fading further north.

Though not on the vast scale of the tsunami, the human and economic costs of Katrina are serious and still mounting. The mayor of New Orleans, Ray Nagin, thinks the death toll will be "minimum hundreds, most likely thousands". Tens of thousands have been displaced. "This recovery will take a long time", George Bush warned the nation after he flew over the carnage. "This recovery will take years."

Unlike most hurricanes, which are over in a relatively brief burst of fury, this one continued to get worse. For two days after the storm had passed, floodwaters continued to rise around the Big Easy. Those waters swept away the joy of many who thought they had narrowly escaped. The floods brought with them poisonous snakes, water-borne diseases and the grotesque carcasses of dead neighbours and abandoned pets.

It was unclear when the waters would recede, never mind when life would return to normal. Power may not be restored for weeks, said utility officials, because the electricity infrastructure has been so badly damaged. Looting, too, has taken its toll. Mr Nagin said the city might be uninhabitable for three months.

Already a series of questions appear behind the tragedy. What is the cost to the area and the national economy? What can be done with the displaced people? But begin with the one that matters most: was part of this unfolding tragedy preventable?

Of course, hurricanes themselves are not preventable. Though global warming may increase the intensity of storms like hurricanes, abandoning fossil fuels in favour of windmills and bicycles would not make the world safe from cyclones. Historical records show that hurricanes were devastating the coast of the Gulf of Mexico long before sport-utility vehicles ever hit America's roads.

Experts have stressed for quite some time that New Orleans is exceptionally vulnerable to a killer storm such as Hurricane Katrina. Fred Caver, of the Army Corps of Engineers, recently urged officials to shore up their defences: "You're living on borrowed time today. You have until the next big storm zeroes in on coastal Louisiana directly." There is irony, however, in this warning coming from the Corps of Engineers. Just as with the Everglades in Florida, New Orleans's vulnerability has been exacerbated by the corps' excellence in reshaping nature's waterways to suit mankind's whims. In the middle of the last century, engineers succeeded in re-plumbing the great Mississippi river to make shipping easier and to control floods.

Alas, those same measures also hastened erosion of the coastal marshes that used to buffer New Orleans, leaving the city needlessly exposed. Most of the metropolitan area lies below sea level on drained swamp land. Levees normally hold back the Mississippi and Lake Pontchartrain, but those were not designed to handle the waters that would come with such a powerful hurricane.

America's Geological Survey has estimated that if nothing is done by 2050, Louisiana will lose another 700 square miles of coastal wetlands. Various local groups have long called for reconstruction of the marshes along the lines of the troubled $10 billion Everglades rejuvenation project. The New Orleans version, which would cost $4 billion more, would divert some 200,000 cubic feet of water each second from the Mississippi 60 miles through a channel to feed the existing marsh and to build two new deltas. The plan, which would also shut canals and locks to keep out salt water and would build artificial barrier islands, may find more adherents.

Even if New Orleans had not been protected by such a grand scheme, it seems that much more could have been done to make the city a little less vulnerable to water and wind. When Hurricane Katrina...
President Bush addresses the nation on Hurricane Katrina tonight, and after keeping too quiet for too long there’s a lot for him to say. We hope he tells Americans that such a demonstrable failure at all levels of government is a rare opportunity to change that government, not another excuse to expand it willy-nilly.

Two weeks after the hurricane, we have a clearer picture of both the storm damage and the bureaucratic mistakes. The former is happily lower in human terms than the 10,000 deaths predicted by New Orleans Mayor Ray Nagin, as of Tuesday much lower at 423 (659 throughout the region). The Gulf Coast has begun to rebuild, and even many residents of the Big Easy are returning to clean up the mess.

The political trauma that has followed Katrina is almost entirely a result of the slow, hap hazard government response in the first days after the storm hit. Mayor Nagin had an evacuation plan sitting in a drawer but never got the buses in place to implement it. He then blamed everyone else. Louisiana Governor Kathleen Blanco froze amid the crisis and failed to deploy the National Guard properly to protect those stranded at the Convention Center and Superdome. She is still blaming everyone else.

FEMA was overwhelmed by the magnitude of the storm, and former director Michael Brown showed he was clueless about events that he could see merely by turning on his TV set. Notably, he is the only public official so far to lose his job, just as Mr. Bush is the only elected official who has so far accepted any public “responsibility.” Alas, tonight the President isn’t likely to assail the Department of Homeland Security that he helped to create, but he at least ought to admit that federal and state disaster duties and communication need to be better sorted out. He could also praise the Pentagon’s relief success.

Only in Washington, however, could so much government failure be used to justify expanding the size and scope of government. Some emergency money is essential. But Congress has already appropriated some $62 billion, with essentially zero accountability, to be spent by such models of compassion as the Department of Housing and Urban Development. Another $100 billion may soon follow. Ted Kennedy has proposed that Congress create another Tennessee Valley Authority for the Gulf region. Give them one more week to panic, and Republicans on Capitol Hill will be demanding another Great Society.

Mr. Bush has a chance tonight to turn all of this around. Instead of channeling more cash through the same failed bureaucracies, he should declare the entire Gulf Coast region an enterprise zone, with low tax rates for new investments and waivers for any regulatory obstacles to rebuilding. He can also learn from California’s 1994 earthquake experience—which former Governor Pete Wilson described on this page on Tuesday—and demand emergency powers to waive rules and allow bonus payments for contractors that finish projects ahead of time.

Above all, he can reframe the entire debate on how to help the poor of New Orleans. The people who couldn’t flee the storm were not ignored by “small government conservatism,” as if that actually still exists outside of Hong Kong. The city’s poor have been smothered by decades of corrupt, paternal government—local, state and federal.

While Chicago and other cities leveled their public housing projects, the Big Easy has continued to run nasty places like the Lafitte homes. The city’s crime rate is 10 times the national average, even as New York and other big cities have seen their rates fall. Its public schools are as bad as any, and its city government more corrupt than most. The last thing the poor need is to be returned to such tender, loving care.

This would include killing the idea, floated by the White House, of buying 300,000 mobile homes for the displaced. Governor Blanco wants to build communities of thousands of trailers for a year or more near Baton Rouge and Shreveport. Such shelter makes sense in some parts of the Gulf Coast where there literally is no housing stock left. But it is an act of insanity—defined as repeating the same mistake over and over—to recreate trailer-park versions of Lafitte on military bases, isolating the poor once again and returning them to dependence on the government. Far better to give them vouchers to find housing of their own, especially where there is unused rental space.

The same goes for the city’s 77,000 displaced public school students. Their parents should be given vouchers for the equivalent of their tuition, with the option of using it at any school where they can find an opening, public or private. Charter schools should be allowed to expand immediately, and the Bush Administration could seek an emergency federal waiver of state charter laws to let them accept New Orleans kids now swamping other public schools.

There are other good ideas, but the key point is for Mr. Bush and Republicans to get back on the political and intellectual offensive. With media help, Democrats and the left have used Katrina to portray a systemic collapse of “conservative” government. It was certainly a collapse of government, but more accurately of bureaucracy and the welfare state. If Mr. Bush uses his bully pulpit to explain this, Americans will understand and follow.
Finger-Pointing Storm Erupts in Congress
Both Parties Know Stakes Are High in the Sparring Over Post-Katrina Relief Efforts

By Brody Mullins

CONGRESSIONAL LEADERS plan to form a bipartisan House-Senate committee to investigate the government's response to Hurricane Katrina. But there's nothing bipartisan about the political finger-pointing under way as Republicans and Democrats begin jockeying for electoral advantage.

Both sides know the stakes in public perceptions after a crisis are high. President Bush's performance following the Sept. 11, 2001, attacks sent his approval ratings soaring, helped his party gain ground in the 2002 elections, and aided his own hard-fought victory for a second term.

But unlike the aftermath of 9/11, when America's enemies temporarily bound the two parties together, Katrina has generated near-immediate partisan combat. Democrats frustrated by Mr. Bush's successes sense the possibility of erosion in the president's public support, while Republicans hoping to retain their majorities in 2006 midterm contests seek to head off by assigning blame for the slow recovery effort to Democratic state and local officials in Louisiana.

The result: Combative rhetoric and an absence of cooperation that was evident across Capitol Hill yesterday. Republican leaders met several times to plan ways to help Katrina victims get back on their feet—without Democratic counterparts, who were busy denouncing Mr. Bush. When House Speaker Dennis Hastert and Senate Majority Leader Bill Frist announced the bipartisan investigation, no Democrat was on hand to take part.

The major party committees were especially pointed. The Democratic National Committee circulated critical newspaper editorials under the headline, "The Country Reacts to Bush Administration's Failed Response to Katrina." Republican National Chairman Ken Mehlman, meanwhile, said Democratic leaders were "pointing fingers in a shameless effort to tear us apart."

"Politicians see this as a potentially defining event and they are worried how

The fact that high gas prices and struggles in Iraq saddled Mr. Bush with record-low approval ratings before Katrina has only intensified such attacks. Democrats have pressed for an investigation by an independent commission, like the outside panel that examined circumstances surrounding the 9/11 attacks.

"Nearly four years after the terrorist attacks of 9/11 sent a clear signal that we needed to be better prepared for major catastrophes on U.S. soil, the American people have a right to expect their government to perform better," Senate Democratic Leader Harry Reid of Nevada wrote in a letter to the Senate Committee on Homeland Security and Governmental Affairs. Mr. Reid said Congress's investigation should focus on such topics as "administration inaction in warning of catastrophic flooding" and "absence from Washington of the president and key officials."

That demand was the backdrop for the Republican call yesterday for a congressional investigation—after relief efforts have been largely concluded. "What we don't want to do is pull every agency out of New Orleans to prepare for dozens of hearings," Mr. Hastert said.

As a result, Republicans say they won't immediately ask top officials at FEMA or the Homeland Security Department to testify about their response. "An investigation of the Republican administration by a Republican-controlled Congress is like having a pitcher call his own balls and strikes," Mr. Reid said.

At the same time, Republicans have begun pointing more directly toward Democratic officials in Louisiana for failing to prepare for and respond to Hurri-
WASHINGTON — In less enlightened times, there was no catastrophe independent of human agency. When the plague or some other natural disaster struck, witches were burned, Jews were massacred and all felt better (except the witches and Jews).

A few centuries later, our progressive thinkers have progressed not an inch. No fall of a sparrow on this planet is not attributed to sin and human perfidy. The three current favorites are: (1) global warming, (2) the war in Iraq and (3) tax cuts. Katrina hits and the unholy trinity is immediately invoked to damn sinner-in-chief George W. Bush.

This kind of stupidity merits no attention whatsoever, but I'll give it a paragraph. There is no relationship between global warming and the frequency and intensity of Atlantic hurricanes. Period. The problem with the evacuation of New Orleans is not that National Guardsmen in Iraq could not get to New Orleans, but that National Guardsmen in Louisiana did not get to New Orleans. As for the Bush tax cuts, administration budget requests for New Orleans flood control during the five Bush years exceeds that of the five preceding Clinton years. The notion that the allegedly missing revenues would have been spent wisely by Congress, targeted precisely to the levees of New Orleans, and reconstruction would have been completed in time, is a threefold fallacy. The argument ends when you realize that, as The Washington Post notes, "the levees that failed were already completed projects."

Let's be clear. The author of this calamity was, first and foremost, Nature (or if you prefer, Nature's God). The suffering was augmented, aided and abetted in descending order of culpability by the following:

1. The mayor of New Orleans. He knows the city. He knows the danger. He knows that during Hurricane Georges in 1998, the use of the Superdome was a disaster and fully two-thirds of the residents never got out of the city. Nothing was done. He declared a mandatory evacuation only 24 hours before Hurricane Katrina hit. He did not even declare a voluntary evacuation until the day before that, at 5 p.m. At that time, he explained that he needed to study his legal authority to call a mandatory evacuation and was hesitating to do so lest the city be sued by hotels and other businesses.

2. The Louisiana governor. It's her job to call up the National Guard and get it to where it has to go. Where the Guard was in the first few days is a mystery. Indeed, she issued an authorization for the National Guard to commandeer school buses to evacuate people on Wednesday afternoon — more than two days after the hurricane hit and after much of the fleet had already drowned in its parking lots.

3. The head of FEMA. Late, slow and in way over his head. On Thursday he says on national television that he didn't even know there were people in the Convention Center, when anybody watching television could see them there destitute and desperate. Maybe in his vast bureaucracy he can assign three 20-year-olds to watch cable news and give him updates every hour on what in hell is going on.

4. The president. Late, slow and simply out of tune with the urgency and magnitude of the disaster. The second he heard that the levees had been breached in New Orleans, he should have canceled his schedule and addressed the country on national television to mobilize it both emotionally and physically to assist in the disaster. His flyover on the way to Washington was the worst possible symbolism. And his Friday visit was so tone-deaf and politically disastrous that he had to fly back three days later.

5. Congress. Now as always playing holier-than-thou. Perhaps it might ask itself who created the Department of Homeland Security in the first place. The congressional response to all crises is the same — rearrange the bureaucratic boxes, but be sure to add one extra layer. The last four years of DHS have been spent principally on bureaucratic reorganization (and real estate) instead of, say, a workable plan for as predictable a disaster as a Gulf Coast hurricane.

6. The American people. They have made it impossible for any politician to make any responsible energy policy over the last 30 years — but that is a column for another day. Now is not the time for constructive suggestions. Now is the time for blame, recriminations and sheer astonishment. Mayor Nagin has announced that, as bodies are still being found and as a public health catastrophe descends upon the city, he is sending 60 percent of his cops on city funds for a little R&R, mostly to Vegas hotels. Asked if it was appropriate to party in these circumstances, he responded: "New Orleans is a party town. Get over it."
REVIEW & OUTLOOK

Beltway Hurricane

Ten days after Katrina, the private economy is holding up nicely. Oil platforms and pipelines are being repaired, traffic is returning on the Mississippi, gasoline prices are stabilizing, and the stock market has rallied two days in a row.

The biggest threat now to a rapid and complete recovery is the storm-after-the-storm in Washington, where the politicians are making Governor Blanco look composed.

Our panic, or shall we say opportunistic, solons are already using Katrina to bust through whatever spending limits they had previously set for themselves. Following last week’s $10.5 billion, Congress is set to appropriate $52 billion more this week, and not just for the Gulf Coast. Senate Minority Leader Harry Reid has already tossed out $150 billion as a spending goal, and Republicans are saying they won’t be outdone. No one wants to be stingy, but it’s time to worry when the same people who passed a $286 billion highway bill without enough money for Louisiana levees now want to throw money at everything in sight.

If you think we’re being cynical, consider that it took all of two days from recession for Democratic leaders yesterday to propose killing this year’s budget resolution. That document is hardly a fiscal straitjacket. But it is the only mechanism Congress has for putting any restraint on Medicaid and other entitlements growing by 7% to 8% a year, or the inflation rate. It’s a terrible sign for fiscal sanity that GOP leaders gave in yesterday and agreed to suspend “budget reconciliation” for at least two weeks.

The real agenda here is to use Katrina to kill the Bush tax cuts and restore Congressional spending at-will. The rules of “reconciliation” allow tax cuts to pass the Senate with 50 votes, rather than with the 60 needed to break a filibuster. So Republicans had hoped to use those rules to extend the Bush tax cuts on dividends and capital gains for another two years, through 2010. Without reconciliation, tax cuts are dead.

The irony is that Congress is doing all of this just as the U.S. economy spurred by tax cuts is throwing off record increases in revenues. Federal coffers are rising this year to the tune of $262 billion more than in fiscal 2004, and most state budgets are also brimming. If America is going to have any hope of financing both a war on terror and hurricane relief, it needs to keep this expansion growing. Telling investors that their tax rates on dividends will soon rise back to 35% from 15%, and on capital gains to 20% from 15%, would both shock the stock market and hurt growth.

Financial markets have been resilient so far in part because they realize the economy had enormous underlying strength before Katrina hit. Only last Friday, the August jobs report showed strong job growth and the lowest unemployment rate in five years. Oil prices have fallen to $68 a barrel from a high of about $72. A disaster such as Katrina is an immediate blow to GDP because it destroys productive capital stock. But over time it can lead to an increase in the rate of GDP growth by creating new investment needs and opportunities.

The largest danger now is that Members of Congress will get in the way of this natural economic recovery by exploiting Katrina to spend like they’re back on Bourbon Street. That will tell Americans that tax increases are inevitable down the road, and that they’d better start dampering the animal spirits the nation will need to rebuild New Orleans and the rest of the Gulf Coast.

Which leads us to ask: Where is President Bush? Helicopter tours of the disaster zone are important to reassure the suffering, and the federal disaster-bureaucracy needs to be shaken up. But in our system only a President can stop a runaway Congress. Mr. Bush needs to start explaining to the country that while Washington will spend what it takes to assist the victims, he won’t allow Congress to exploit this disaster to build more Alaskan bridges to nowhere.

Pearl in Pakistan

Pakistan President Pervez Musharraf has survived at least four al Qaeda assassination attempts. But such attacks have so far seemed to solidify his post-9/11 resolve to side with civilization against terror. He has taken considerable political risk by deflating atti-
Parts Shortages, Logistics Hamper Power Restoration

By REBECCA SMITH

Utilities working to restore power to hundreds of thousands of customers in Louisiana and Mississippi remain without power, according to the Department of Energy. Because these statistics track metered accounts, not people, the number likely understates the impact to individuals.

Utilities have well-honed plans to switch electricity back on quickly after natural disasters, and those plans were strengthened after a hurricane flogged Florida and the Gulf Coast last year. As Katrina approached land, for example, Florida Power & Light, a unit of FPL Group Inc., had more than 2,000 workers and their bucket trucks at staging areas outside the storm's expected arc of destruction, ready to roll into action once it passed.

But a host of unexpected factors, ranging from projected parts shortages to unanticipated logistical problems and dicey work conditions, are likely to slow the restoration of power significantly in some places. The difficulty in securing such basic items as wooden utility poles is likely to further impede efforts.

Mississippi Power, a unit of Atlanta-based Southern Co., said yesterday it had restored power to 65% of its customers “who can receive power,” tacitly acknowledging that many buildings are too badly damaged to take service, even when local utility wires are re-energized.

In many cases, utility crews are actually reconnecting people rather than reconnecting them at this point. As Cleco Corp. utility crews move through neighborhoods in central Louisiana, for example, they are disconnecting wires from buildings that have been hit by trees or show signs of water damage. Once the bulk power system is again able to function, individual homes and businesses will have to be inspected one by one before they can be reconnected to the grid, a potential choke point that could frustrate the restoration effort.

and hoping they will have customers able to take the power before too long. And they are working under the direst conditions, sometimes in snake-infested swamps and forests, thick with mud, debris and, often, dead animals.

Also setting Katrina apart isn’t only the degree of damage, but also the necessary support services—telephones, roads, potable water supplies, hotels, gasoline stations and the like—that also got knocked out. Utility workers are in the awkward position of competing with relief workers and displaced residents for basic amenities like a place to eat, shower and sleep.

Entergy Corp., the hardest hit company with four of its five subsidiaries affected, is feeding and housing 3,000 of its own workers and volunteers from other utilities, putting them up in tent cities scattered across its territory. When crews for Alabama Power, a unit of Southern Co., rolled into half a dozen tent cities in Mobile, Ala., each night, tanker trucks were standing by to refuel them so they could be back on the road at daybreak. “It’s nothing to put up poles and wire,” says Robin Hurst, head of disaster logistics at Alabama Power. “We’re good at that. The hard part is housing and feeding 3,000 people where there’s none of the infrastructure left to support them.” Alabama Power said yesterday nearly all of its customers now have service.

Utilities agree that certain items have been in short supply, like helicopter parts needed to assess damage, flat-bottom boats able to get into flooded areas, hip waders and sleeping cots.

Communications also has been a big problem. Cleco, the utility that serves central Louisiana, lost its entire communications system when the storm hit. It installed a 100-foot radio tower way to communicate with the command center in Pineville, La., until late the next day when a communications system was patched back together. Cleco storm boss Mike Clark wants a second radio tower, at a cost of about $50,000, so that he can guarantee uninterrupted radio links.

Utilities are providing more job-related assistance. Several days after utility workers have lost their homes, too. Southern Co. brought in grief counselors and nurses to help distressed employees at its Alabama Power, Mississippi Power and Gulf Power units. It also bought more than two dozen 31-foot trailer homes for employee families left homeless. It has paid employees in cash when they couldn’t find open banks or working ATMs.

Apart from the human toll, some managers fear that parts shortages could impede the restoration effort. Ready supplies of wooden poles, now needed by the thousands, may be exhausted before the rebuilding is complete. Some electronic equipment, like special relays and switches, aren’t stockpiled in the huge quantities now needed. Getting enough of them, in a timely fashion, could strain the supply chain.

Although New Orleans’s underground electric network appears to have held up well against the flooding, that isn’t the case for above-ground transmission substations not designed to sit in brackish water. Substations ringing New Orleans have suffered serious damage. Big transmission lines also have been knocked down, and that could delay restoration of electricity to some oil refineries by two to three weeks.

Utilities are also looking over their shoulders, fearing the next storm. The National Weather Service predicts five to seven major Atlantic hurricanes this year, meaning some communities could be repeatedly hammered. In response, utilities are striking deals. They will send crews north to help with ice storms and blizzards, if the cold-state utilities will commit more “boots to the Gulf during hurricane season. Utilities always have helped one another when disasters strike, but there is growing awareness that the decades-old, ad hoc system may be inadequate. “There’s a new model about to be formed,” says Geisha Williams, head of power restoration for FPL Group.

New storm tools are coming along. Southern Co. is creating a storm-damage predictive tool based on a giant database that compares predictions of storm velocity and equipment durability with what actually happened in five recent hurricanes. The goal is to have a tool that would give estimates of probable damage even before a hurricane makes landfall, says Alabama Power’s Mr. Hurst. That would help utilities set up better

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Old-Line Families
Escape Worst of Flood
And Plot the Future

* * *

Mr. O'Dwyer, at His Mansion,
Enjoys Highball With Ice;
Meeting With the Mayor

By CHRISTOPHER COOPER

NEW ORLEANS—On a sultry morning earlier this week, Ashton O'Dwyer stepped out of his home on this city's grandest street and made a beeline for his neighbor's pool. Wearing nothing but a pair of blue swim trunks and carrying two milk jugs, he drew enough pool water to flush the toilet in his home.

The mostly African-American neighborhoods of New Orleans are largely underwater, and the people who lived there have scattered across the country. But in many of the predominantly white and more affluent areas, streets are dry and passable. Gracious homes are mostly intact and powered by generators. Yesterday, officials reiterated that all residents must leave New Orleans, but it's still unclear how far they will go to enforce the order.

The green expanse of Audubon Park, in the city's Uptown area, has doubled in recent days as a heliport for the city's rich—and a terminus for the small armies of private security guards who have been dispatched to keep the homes there safe and habitable. Mr. O'Dwyer has cellphone service and ice cubes to cool off his highball in the evening. By yesterday, the city water service even sprang to life, making the daily trips to his neighbor's pool unnecessary. A pair of oil-company engineers, dispatched by his son-in-law, delivered four cases of water, a box of delicacies including herring with mustard sauce and 15 gallons of generator gasoline.

Despite the disaster that has overwhelmed New Orleans, the city's moneyed, mostly white elite is hanging on and maneuvering to play a role in the recovery when the floodwaters of Katrina are gone. "New Orleans is ready to be rebuilt. Let's start right here," says Mr. O'Dwyer, standing in his expansive kitchen, next to a counter covered with a

Field Work
A Massive Repair Job Begins
To Fix Gulf's Broken Oil Network

Some Refineries Come Back,
And a Big One Was Spared;
Crude Is Flowing to It

A Watery Escape at Exxon

By SUSAN WARREN
And RUSSELL GOLD

In the days after Hurricane Katrina tore through the Gulf Coast last week, the oil industry put in motion a massive effort to assess the damage left behind and restart its most important assets.

El Paso Corp. converted a barge into a floating heliport-refueling station. Enbridge Inc. installed satellite links for its network of natural-gas pipelines to keep them running from afar. Exxon Mobil Corp. sent workers across Louisiana to operate pipelines manually. And Colonial Pipeline Co.—needing to bring in giant generators to repower its gasoline pipeline—pulled strings to make sure trucks carrying them wouldn't be stopped by highway weight limits.

The push to restart the energy patch appears to be yielding results this week, especially in refining. While power outages, flooding and battered pipelines will keep many refineries in the area from returning to full operations for days or weeks, and in some cases for months, it now appears that half of the last refinery output in the region will be restored soon. That should mean averting a worst-case shock to the economy.

Looking to the Future

- Ripple effects hit farming, amid spending and hiring cutbacks
- The rebuilding of New Orleans poses complex issues, but its key tourist areas are mostly unscathed
- The New Orleans Saints football team, a beloved local symbol, are now a vagabond franchise
- Americans around the country are volunteering their time and services to help with the relief effort

Production of oil and gas in the Gulf of Mexico is a tougher case, with many facilities, especially underwater pipelines, still not fully assessed. The Gulf accounts for about 29% of domestic oil production and 21% of domestic gas production. In all, the global fossil-fuel system of one city-sized refinery in Baton Rouge to keep churning out gasoline amid the unfolding chaos stood in the way of that crisis. The Exxon complex, the second-largest in the U.S. after Exxon’s refinery in Baytown, Texas, can handle 500,000 barrels of crude a day. It proved far enough away from the brunt of the storm to avoid direct damage.

Even as it escaped, its ability to keep operating was imperiled by the severe crimp in the supply of crude oil. Some ingenious moves, including getting a legal waiver that permitted a foreign-owned tanker to ferry in crude, helped keep it going.

The hurricane has underlined one of America's energy vulnerabilities: concentration. A quarter-century ago, dozens of small refineries dotted the nation. Today, a handful of giant facilities dominate oil refining. The day before Katrina hit, eight nearby refineries had completely shut down, and more than 10% of the nation's refining capacity was idled, sending gasoline prices above $3 a gallon.

In the Gulf, the storm destroyed at least 29 drilling platforms and hobbled four deep-water ones that pump about 10% of the Gulf's output. It is likely that a maze of underwater pipelines was scrambled as well, since last year's lesser hurricane, Ivan, tied some of them in knots. While the Gulf's oil and gas production is back to about 52% of normal, according to the federal Minerals Management Service, some of the rest will be time-consuming to restore because it will require repairing the complex facilities.
A Massive Repair Job Begins
To Fix Gulf’s Broken Oil Network

Continued From First Page

move oil ashore, such as one special tanker that’s now positioned near Newfoundland, Canada.

Exxon came through better than some other oil companies. Company moves both before and after the huge storm show how the industry is trying to get things back to normal as quickly as possible.

As the hurricane slammed ashore on Aug. 29, Exxon safety-group leader Peter Daggett was holed up in a command center for local emergency officials near the company’s jointly owned refinery in Chalmette, on the east side of New Orleans. His mission: watch over a complex that turns 190,000 barrels of oil a day into gasoline.

As water surged to the second floor, Mr. Daggett and local emergency workers climbed into boats from a second-floor window and made their way to the refinery, on higher ground. Mr. Daggett glanced at a wind gauge: 162 miles per hour.

At the company’s refining headquarters in Fairfax, Va., Exxon executive Dennis Houston dispatched workers across Louisiana—as soon as the winds let up—to check pipelines that feed crude to inland refineries and take gasoline north to Atlanta, Washington and Newark.

The news wasn’t good. The Louisiana Offshore Oil Port, or Loop, which collects oil from oceangoing tankers and offshore platforms and sends it ashore in giant pipes, was without power and out of operation. Word came that two pipelines that carry gasoline to the Midwest and Northeast were down, as well. “I’ve been in the business more than 30 years,” says Mr. Houston, executive vice president for Exxon’s Refining & Supply Co. “This redefined the word ‘problem’.”

A company has begun bracing for Katrina as early as Aug. 24, when its weather service warned of a tropical depression east of Florida. As the storm zeroed in on the Gulf Coast two days later, the company installed dozens of computers and phone lines in an emergency command center in Houston, where 100 employees would monitor and coordinate a disaster response.

At 4:30 a.m. Saturday, scores of workers, including some of the oil companies, were holding a meeting at Houston’s Galveston cleanup vessel docked in Galveston, Texas. Then they settled down to wait. Soon, reports from scattered workers pinpointed widespread electrical outages and flooding that paralyzed refineries and pipelines.

By Monday night, with the storm over but flooding making New Orleans’ situation dire, Exxon determined that the Baton Rouge refinery could come through in good shape, ready to crank up operations—if only Exxon could find a way to supply it with crude oil. Some would be available from the Strategic Petroleum Reserve, U.S. Energy Department officials privately assured Exxon. But with pipelines down, Exxon had to figure out how to get it to Baton Rouge from a storage facility in far southern Louisiana.

Tuesday morning, operations experts studied the logistical jigsaw of pipelines and shipping routes that connected Exxon refineries with oil-storage sites, looking for options. They found that they could get crude to the St. James pipeline terminal south of Baton Rouge, with pipes out of service, had no way of getting oil from there to the refinery.

One solution: get permission to use a foreign-owned tanker to move oil from the terminal up river to Baton Rouge. To do that, Exxon had to request a government waiver to the Jones Act, which restricts movement of foreign ships between U.S. ports. Exxon got the waiver and moved the oil.

Meanwhile, to assess damage to offshore facilities, helicopters took off at first light Tuesday to begin flying over about 100 platforms in Katrina’s path.

The helicopters flew just 300 feet above the water for a close view of the damage. Early signs were discouraging: The team sighted competitors’ platforms that were tilted, adrift or sinking. Exxon’s flyover team was one of the first in the air, and as the crew radioed back latitude and longitude of damaged platforms, Exxon began calling competitors with the bad news.

By the end of the survey, officials were relieved to find all of Exxon’s own platforms intact, though there was lots of superficial damage, such as twisted handrails and stairs. On a few, it was worse; a rig on one platform fell over, needing repair before production could resume. But most major structures were intact, and storage tanks secure.

...
Oil prices ravage poor areas

Fuel costs strain economies in Central America

By Will Weisert
Associated Press

TILAPA, Guatemala — After 12 hours of bone-jarring waves and skin scorching sun and salt, Rolando Linares might pull enough fish from the Pacific to buy two gallons of gas.

“It keeps getting more expensive and the price of fish stays the same,” says the 17-year veteran fisherman of the waters off western Guatemala.

The same soaring fuel prices squeezing family pocketbooks and slicing into cooperative profits in the United States and Europe are especially catastrophic in the poorest corners of the globe. Here, more money spent on gasoline can push small businesses into bankruptcy and families into poverty, while straining fragile economies to the point of near collapse.

High prices at the pump across Africa are crippling public transportation and few in Asia have been harder hit than Indonesia — where the national currency, the rupiah, has fallen to four-year lows against the U.S. dollar as skyrocketing fuel subsidies drain government coffers.

Oil prices are a national security issue for the Philippines. For every $10 increase in world crude prices per barrel, the government must spend an extra $1.26 billion of its foreign exchange reserves, President Gloria Macapagal Arroyo estimates.

Terrorists “tend to take advantage of situations like this,” Arroyo said.

And even though the poor don’t have cars, they feel the higher oil prices as food, energy and transportation costs rise.

With inflation in Sri Lanka increasing to 15 percent thanks to high oil prices, M. Maheswari now skips breakfast so her 11-year-old son, Kugan, can have his.

“I am finding it difficult to have three meals for all of us,” said the house maid, who makes a monthly salary of $65.

 Presidents in Central America have for months pleaded with oil-rich Venezuela and Mexico to help bring down gas prices.

In Guatemala, a gallon of gas in the capital of Guatemala City costs an average of $3.26, and prices in the countryside and at other points throughout the country are even higher.

Please see OIL on 2B
Oil-Rig Insurers Expect Price Jumps

Premiums Could Rise 50% Following Damages in Gulf To at Least 58 Installations

By ULRIKE DAUER

Dow Jones Newservices

Insurers of offshore oil rigs and platforms are expected to push for steep increases in premium prices in contract talks after Gulf Coast oil and natural-gas production sites were battered by Hurricane Katrina last week.

Katrina damaged or displaced at least 58 oil platforms and drilling rigs—including about 30 irretrievably lost—in the Gulf of Mexico, the American Petroleum Institute said. While the industry assumes much of its own risk, rising premiums to insurers could still add costs to their projects.

Insurers plan to seek price increases of more than 50% for oil rigs in the Gulf of Mexico when contract-renewal talks start next month, said Charles Franks, an energy-insurance underwriter with Kiln PLC, one of the syndicates in the United Kingdom Lloyd’s market.

Overall claims for damaged or lost offshore oil rigs and platforms in the Gulf could rise to $5 billion, Mr. Franks said. Those claims are on top of the $3 billion in claims insurers received after Hurricane Ivan last year, he added.

“Large disasters—and notably natural disasters—are on the rise, and the need to insure such risks will be higher than in the past,” said Jürgen Thiede, a managing director of German insurer Gerling Allgemeine Versicherungen AG. “Prices for such insurance cover have to be in line with the large individual risks involved.”

One industry participant said oil companies spend about 0.4% of revenue on insurance products. To cover the additional premiums, companies will likely pass the costs on to customers.

Companies could also increase their reliance on the industry’s own insurance plan, the Bermuda-based Oil Insurance Ltd., which was established in 1972 and had $448 million in net premiums in 2004. That represents about 16% of the $2.7 billion in overall premiums for energy-related insurance, according to Willis Group Holdings Ltd., a London-based insurance broker.

About 4,000 offshore oil rig and natural-gas rigs are scattered along the Gulf of Mexico, with a total value of more than $100 billion, according to Risk Management Solutions Inc., a Newark, Calif., risk-assessment firm that runs an insurance coverage database. An oil-production platform typically costs about 30% of the value of the platform, which can range from $10 million to more than $1 billion, Mr. Franks said.

Policies generally cover the property, including the steel construction, drills and other machinery, the wells on the ground of the ocean, the pipeline and the oil gas or in the pipeline if lost. Many policies also insure the potential business interruption. Such policies usually cost at least 1% of the value of the platform, Mr. Thiede said.

He said prices for insurance policies covering offshore oil rigs last year fell by 20% on average from the previous year, mainly because of strong competition among insurers and a history of few damage claims. But that scenario could be changing, experts said. “We expect prices to go up, due to large offshore losses,” said Mr. Franks, who said he wants future premiums to better reflect the increased frequency of hurricanes.

Shell Oil Co., the U.S. unit of Royal Dutch Shell PLC, which saw damage to two oil- and gas-producing platforms in the Gulf of Mexico, declined to comment on what price increases it would accept for insurance policies. The company, which is one of 86 shareholders of the industry’s own plan, said when asked about its platforms that it doesn’t maintain business-interruption insurance.

Hurricane Katrina hit the U.S. just ahead of the annual contract-renewal talks. Insurers and reinsurers generally negotiate with clients starting in October as rates are set for the next calendar year.

In next month’s negotiations, insurers are expected to point out that Katrina, which could turn out to be the costliest natural disaster in history, could be just the start. The U.S. National Oceanic and Atmospheric Administration said it expects 11 to 14 tropical storms from August through November, with three to five major hurricanes.

“This will make any discussions over lower prices for [these types of policies] a nonissue,” said Eike Koenig, chief financial officer of Hannover Re AG, the world’s third-largest reinsurer by premiums.

The Lloyd’s market, the oldest and largest commercial-insurance marketplace in the world, tends to dominate insurance for big-ticket items such as oil rigs, since the risk on any one policy is shared among a number of companies, so no one company is overexposed. Lloyd’s said last week that it expects to receive significant insurance claims as a result of Hurricane Katrina, predominantly in relation to offshore energy installations in the Gulf, property damage and business interruption.

Reinsurance companies, which insurers use to spread out the risk for large claims, will be hit hard by the storm. Last week, Hannover Re issued a profit warning: Munich Re AG said its exposure to Katrina may top €400 million ($499 million) gross, meaning some of that will be shared with other reinsurers, and Swiss Reinsurance Co. said its exposure to the hurricane will be about $500 million. Some analysts said that, in the future, it might become more difficult to obtain insurance for offshore oil rigs, forcing more companies to accept higher deductibles or even to self-insure their rigs.

“The question is whether insurance companies, which are obliged to make money with every policy, will insure such risks in the future,” said M.M. Warburg analyst Ralf Dibbern. “Many insurers might ask themselves whether they can afford such risks in the future.”

Hospitals Battle a Fresh Round of Injuries, Illnesses

By BETSY MCKAY

Earlier this week, Mike O’Brien breathed a sigh of relief. The wave of victims airlifted to NorthShore Regional Medical Hospital in Slidell, La., where Dr. left the city, you must do so.” Children are particularly at risk from lead poisoning, since it can cause learning and behavioral problems.

At Northshore, located across Lake Pontchartrain from New Orleans, one

Fears that the hospital could attract looters or gangs prompted Tenet to hire a team of armed security guards and 11 volunteer Houston police officers. “This was a field combat,” says Dr. O’Brien.

Staff members, many of whom lost
Does global warming cause hurricanes? Don’t ask a scientist. Get your actuary to tell you — By Tomas Kellner

Global warming may or may not have fueled Katrina’s fury. No scientific consensus has formed on that point. But this hasn’t stopped the property-casualty industry from weighing in.

The biggest firm that models catastrophes for insurers says it’s convinced that warming of the Earth will increase the number and intensity of hurricanes over the next five years. One more excuse for insurance premiums to go up.

Risk Management Solutions of Newark, Calif., says that expected annual insurance losses from Atlantic hurricanes, calculated at $7 billion using average 20th-century storminess, should now be adjusted upward to $10 billion. (The estimated $80 billion payout for 2005 has to be viewed as a fluke.) RMS goes on to estimate that global warming is to blame for somewhere between 10% and 60% of the $3 billion boost, with cyclical weather patterns explaining the balance. At 60%, climate change would be costing insurers $1.8 billion in additional annual losses.

Says Robert Muir-Wood, chief research officer: “If you ask us, ‘Is there climate change in this?’ the answer is yes.” Whatever the dollar figure, Muir-Wood says, the significance is that his firm is now including climate change in its forecasting model, which is assembled by its 15 meteorologists, climatologists and outside experts.

RMS’ 450 clients, such as Swiss Re, Allianz and Allstate, use the model to help price policies that will cover future storms. Typically insurers can apply for rate hikes with state regulators only if they are justified by past losses, not forecasts. This may be changing, however. In 2004 Massachusetts passed the nation’s first bill that allows certain insurers to base rates on predicted hurricane losses. And in December a group of 20 state treasurers and pension funds like Calpers, with combined assets of $800 billion, called on 30 public insurers to disclose their financial exposure to climate change.

Still, to get an idea of how squishy this area remains, consider the conclusion of RMS competitor AIR Worldwide, from Jayanta Guin, vice president of research and modeling: “We don’t see any scientific evidence to support the idea conclusively that global warming has a component [in hurricane activity].”

- Exaggeration about global warming on hurricanes will increase the insurance costs

- Insurance Rates
Louisiana Toughens Building Codes

New Rules Aim to Limit Storm Property Damage And to Reassure Insurers

By JEFF D. ODYKIE

Louisiana’s new statewide building codes likely will limit property damage from future hurricanes and encourage insurers to do business in the state. But they could increase the costs of rebuilding devastated houses by tens of thousands of dollars apiece, and low-lying properties in New Orleans will remain vulnerable to floods.

The state legislature approved the toughened building requirements Tuesday, the last day of a special session called to deal with the financial crisis created by Hurricanes Katrina and Rita. Gov. Kathleen Blanco, a Democrat, is expected to sign the bill into law.

The bill divides the state into several wind zones, each with a mandated construction style and building materials requirements. Homes built in southeastern parishes that put into the Gulf of Mexico will face the most-stringent requirements, including larger wall studs and metal strapping to secure the roof to the underlying structure. The new building rules are less strict in cities farther north like Shreveport and Monroe.

The changes take effect in 30 days in the most-devastated areas.

The changes take effect in 30 days in the most-devastated areas, and in coastal areas will add as much as 14% to overall construction costs, according to the Louisiana Home Builders Association, a trade group in Baton Rouge. In New Orleans, where the average home price was $179,000 before Katrina, costs will rise an estimated 4% to 8%.

The statewide changes are in addition to federal requirements that houses be built as much as six feet off the ground. Elevation-related rules already were in place when the two hurricanes hit, but the regulations didn’t apply to thousands of buildings that were constructed before the rules were adopted in 1970. Homes built since then generally have been built to minimum-elevation requirements, but the standards have varied over time.

Now, complying with the higher-elevation rules will be mandatory for many homeowners rebuilding in much of New Orleans, particularly the heavily damaged Lakeview and Lower Ninth Ward neighborhoods. The requirements apply to any “substantially damaged” home, meaning damage of at least 50% of a home’s pre-Katrina value, said Mike Robinson, a senior program specialist in the federal National Flood Insurance Program’s floodplain-management section.

Among the ways to increase the elevation of a house are building it on piers or atop a garage, or raising the height of the ground with dirt. Such changes will boost building costs by 20% to 30%, said Ronnie Kyle, president of the homebuilders’ group.

There likely will be even more financial hardship for Louisiana residents still reeling from one or both hurricanes. Homeowners largely will have to bear the costs of the tougher building codes, since insurance policies typically replace only what existed before the damage occurred—not an improved version. So-called replacement policies provide as much as 25% more than face value, but replacement costs exclude changes mandated by strengthened building codes. “We will look at the line-by-line items of what is going into a house,” said Mike Trevino, a spokesman for Allstate Corp., an insurer based in Northbrook, Ill.

And residents who can afford to rebuild still will be at risk during future hurricane seasons. The elevation rules are based upon a 100-year rain event, not the type of storm surges or breached levees inundated New Orleans during Katrina. Parts of the city were flooded again when Rita slammed into Louisiana.

Still, the added costs of the state-wide building codes and friction between lawmakers from the hardest hit areas and those from other parts of the state didn’t derail the bill, which was approved by a wide margin. Supporters of the changes convinced other lawmakers that statewide rules would accelerate rebuilding by making it easier for homeowners to get permits. Insurers are seen as more likely to return or remain in Louisiana, since new or rebuilt homes will better withstand hurricane-force winds. That could lead to lower premiums for policyholders.

CORRECTIONS & AMPLIFICATIONS

Readers can alert THE WALL STREET JOURNAL to any errors in news articles by e-mailing wsjcontact@wsj.com or by calling 888-410-2867.

FORD MOTOR CO.’s provision for loan-loss reserves has fallen from $2.75 billion in 2002 to $87 million at the end of the third quarter of 2006. An article Tuesday incorrectly gave the figure at the end of this year’s third quarter as $78 million.

Jacques Aigrain, who is to take over as Swiss Reinsurance Co.’s chief executive officer in January, is currently the company’s deputy CEO and was formerly head of Swiss Re’s financial-services business group. An article in Wednesday’s Money & Investing section incorrectly identified him as chief financial officer.

Tronox Inc.’s initial public offering of stock was priced at $14. The low
Buyers Needed for Harvested Crops

Ripple Effects of Hurricane Hit Farm Town as Grain Piles Up, Prices Decline

By SCOTT KILMAN

OSCEOLA, Ark.—After a long summer battling drought and soaring costs of fuel and fertilizer, farmer Ben Sexton fears that—thanks to Hurricane Katrina—he is now harvesting crops that nobody will want.

"I can't absorb the loss," said Mr. Sexton, 42 years old, standing at the top of a hill where farmers gathered around him on a dirt road. They nodded. "We're going to lose the money we've made over the last couple years," said neighbor Joe Tacker.

The soybeans, corn and wheat reaped from fields in northeastern Arkansas usually command some of the highest prices because they are harvested several weeks before Midwest farmers go into their fields. Katrina affected all of the crops, and the ripple effects are already being felt in these flat-farm towns along the Mississippi River some 50 miles north of Memphis, Tenn.

Because the crumbled river is largely unavailable to haul grains out of Osceola, prices have fallen for these crops, which were the most expensive ever to grow. Some growers are considering whether to abandon the harvest or even quit farming altogether. They are falling behind on their bills and are cutting back on hiring and spending.

"This situation could get critical here by the end of the month," said Rickey L. Stewart, executive director of the Mississippi County office of the Farm Service Agency, the Agriculture Department branch that issues subsidies checks to growers. "We have several who are right on the edge."

As military convoys pour south on Interstate 55 and evacuees settle into local shelters and motels, officials here fear the grain problems could spread to community and school coffers. The town of Osceola, population 5,575, collects a fee for every ton of grain shipped from the city-owned dock. The fee adds $100,000 to the annual budget, said Mayor Dickie Kennemore. "But my bigger worry is that the river is vital to the farmers, and they are our biggest industry."

Even though shipping for all types of goods is beginning to show signs of recovery along the Mississippi River, with as much as 50% of prestorm traffic moving through its breadbasket, the Mississippi River and its tributaries—the Missouri, Illinois and Ohio rivers—form an arterial system for floating grain thousands of miles to the Gulf Coast on barges, by far the cheapest way to move goods. One of the few U.S. industries to still generate a trade surplus, the USDA forecast just before the hurricane that the farm sector would export $2 billion of commodities during the year ending Sept. 30. The USDA hasn't adjusted that forecast yet.

The barge system is so efficient that many river towns long ago turned their backs on railroads and trucking, both much more expensive. "Usually the river is our friend," said Robert Holthouse, a 47-year-old Osceola farmer. "But we are captive to it."

Sandra Spears, the USDA's farm-ordination officer in Osceola, figures that probably a quarter of her borrowers will have a hard time making their payments and will try to have their loans restructured. "They were already hurt by high fuel and fertilizer prices," said Ms. Spears. "But if the river stays closed for too long, some will just quit."

Worried about whether he will be able to sell his soybeans, Mr. Sexton, who farms 400 acres, has already put off plans to dig a well and buy land. His neighbor, Mr. Tacker, has dropped plans to hire a crew to level one of his fields so that it is better suited for growing rice.

Many farms in the county are owned by landlords, who expect to see their income drop this year. Mr. Holthouse, who farms 7,000 acres, pays rent to 21 landlords by giving them 25% of the crops grown on their property. His landlords include former farmers, widows and the East Poinsett County School District, which owns 160 acres.

"The farm economy affects the budgets of everything in town around here," said Micky Pierce, school superintendent.

Ernest Portis, 60, said that much of his family's income depends on the crops it collects as rent from thousands of acres, some of it farmed by Mr. Holthouse. "It's falling to me to tell the family that we aren't going to Montana for vacation," said Mr. Portis.

Some Delta grain elevators aren't hiring as many workers as they usually do during the harvest because they can't move crops down the Mississippi River as quickly as normal. The Osceola grain terminal owned by Bunge Ltd. of White Plains, N.Y., hasn't loaded a barge with grain since Katrina hit New Orleans and has stopped storing grain for farmers.

"I'm afraid this is going to be a long, drawn-out affair," said Jim Brady, director of the regional grain association at Commodity Credit Co., which cross-subsidizes grains produced in the Delta to make them competitive.

Normally, the 10 big grain-loading facilities around New Orleans would be clamoring for Osceola grain. The terminals mostly weathered the storm intact: the USDA estimated yesterday that 63% of the area's grain-handling capacity is in workable condition. But some of their owners are still struggling to find workers. So many busses and other navigation aids were destroyed that the Coast Guard isn't allowing ships to move through the channels at night. The New Orleans ports, which normally export about two billion bushels of grain annually—or half all U.S. exports—probably will operate far below capacity for the foreseeable future.

The price of Osceola corn is 23% lower than a year earlier. The price of soybeans has fallen 8%. The falling prices don't bode well for farmers farther up the river if efforts to open the New Orleans ports falter.

At the moment, the grain market is telling farmers to wait until January to bring their grain. Grain elevators in central Iowa yesterday were offering farmers $1.95 a bushel for corn and $1.35 for soybeans, down from $2.50 in January. "We're working on it, but the market's not our best friend," said Tom Welsch, president of Grain Marketing, a grain broker in Des Moines.

Farmers in and around Osceola are scrambling to store crops, in hopes of waiting out Katrina's price disruptions. But there aren't enough bins to hold it all. Some Delta grain elevators are already full, with weeks of harvesting yet to come.

"Nobody is buying grain," said Wilma Lark, manager of the Consolidated Grain and Barge Co. terminal that hugs the Mississippi River here.

A big reason the U.S. is the world's leading grain exporter is that it has the world's best grain elevators and storage facilities, according to Michael Petras, director of the U.S. Department of Agriculture's National Agricultural Statistics Service, which monitors the nation's grain trade.

The agency estimates that 40% of the grain sold in the world moves through ports in the United States, according to Michael Petras, director of the U.S. Department of Agriculture's National Agricultural Statistics Service, which monitors the nation's grain trade. The U.S. currently accounts for 55% of the world's exports of grain.
Number of dead could be lower than initially feared

By Erin McClain
Associated Press

NEW ORLEANS — Alarming predictions of as many as 10,000 dead in New Orleans may have been greatly exaggerated, with authorities saying Friday that the first street-by-street sweep of the swamped city revealed far fewer corpses than feared.

"Some of the catastrophic deaths that some people predicted may not have occurred," said retired Marine Col. Terry Ebbert, the city's homeland security chief.

He declined to give a revised estimate. But he added: "Numbers so far are relatively minor as compared to the dire projections of 10,000."

The encouraging news came as workers repairing New Orleans' system of levees and water pumps projected Friday that it will take a month to dry out the city ravaged by Hurricane Katrina.

Authorities officially shifted most of their attention to counting and removing the dead after spending days cajoling, persuading and all but strong-arming the living into leaving the city because of the danger of fires and disease from the fetid floodwaters.

Please see TOLL on 6A

Toll may be lower than first feared

Continued from 1A

Ever since the hurricane struck Aug. 29, residents, rescuers and cadaver-sniffing dogs have found bodies floating in the waters, trapped in attics or left lying on broken highways. Some were dropped off at hospital doorsteps or left slumped in wheelchairs out in the open.

Mayor Ray Nagin suggested last weekend that "it wouldn't be unreasonable to have 10,000" dead, and authorities ordered 25,000 body bags. But soldiers who had been brought in over the past few days to help in the search were not seeing that kind of toll.

"There's nothing at all in the magnitude we anticipated," said Maj. Gen. Bill Caldwell, commander of the Army's 82nd Airborne Division.

Ebbert said the search for the dead will be done systematically, block-by-block, with dignity and with no news media allowed to follow along.

The U.S. Army Corps of Engineers said most of the city could be drained by Oct. 2, but some of the eastern areas of New Orleans and the hard-hit community of Chalmette, across the Mississippi River, could be under water until Oct. 8. Plaquemines Parish, which suffered a storm surge from the coast, could take another 10 days to drain.

The Corps previously had said it could take up to 80 days to drain the city. Friday marked the first time engineers offered detailed time tables.

The effort to get water out of the city, which had been 80 percent covered following the storm and levee breaches, was helped by dry weather and gaps blown in the levees to allow floodwaters to drain out.

Over the past few days, police and soldiers trying to rescue the living marked houses where corpses were found, or noted their location with global positioning devices, so that the bodies could be collected later.

A dozen boats awaiting calls to retrieve bodies were lined up early Friday on an interstate ramp that was being used as a makeshift boat launch.

Soldiers also hauled the last of the bodies out of the convention center, which became an increasingly violent and chaotic place before the evacuees finally were removed a week ago.

State officials could not provide an exact count of the dead recovered so far. Corpses from New Orleans were taken to a morgue in nearby St. Gabriel, where medical examiners worked to identify the remains.

Hurricane Katrina
New Orleans

Sat Sep 10 - 2005

First they said about 10,000 dead
About 1200 did perish

P17
What Are the Lessons of Katrina?

In answer to the question above, there are many lessons, but because of bureaucratic realities, most will not be applied to the disasters of the future. Yet here are a few for what they might be worth:

First, the blame game is missing the mark. George W. Bush is being accused by his natural enemies of everything from being asleep on the job to racism. But his real error came long before Katrina, when he and Congress created a Department of Homeland Security (DHS) in response to 9/11.

After a disaster, politicians want to “do something.” Striking back at U.S. enemies was essential and Mr. Bush did that against al Qaeda with the enthusiastic approval of Congress, launching the war that continues today with considerably less support. The DHS also had overwhelming congressional approval, but was based on a flawed concept.

Creating a bigger bureaucracy to deal with the failures of two existing bureaucracies—the FBI and the CIA—was simply giving free rein to Beltway gluttony. The DHS has spent many billions, but when a hurricane equivalent of a weapon of mass destruction struck, the DHS was too cumbersome to respond quickly.

That leads to lesson No. 2: If an agency is meant to cope with emergencies, don’t put lawyers in charge. DHS Secretary Michael Chertoff is an admirable man but former federal judges aren’t trained for quick executive action. To his credit, he recovered from early fumbles by pulling fellow lawyer Michael Brown out of the front line in Louisiana and replacing him with a military man, Vice Adm. Thad Allen.

Sen. Trent Lott of hurricane-ravaged Mississippi was referring to Mr. Brown’s missteps as head of the Federal Emergency Management Agency when he said: “Pencil pushers make lousy crisis managers. Michael Brown has been acting like a private instead of a general.” In Mr. Brown’s defense, lawyers are conditioned by training and experience to read all the rules first before taking decisive action, so the administration that hired him is at fault.

Which brings us to lesson three: There are a lot of rules. Laws and regulations are mass-produced by regulatory agencies and all the various branches of government. In an emergency, the first response by government bureaucrats is to look at the rule book to find out what they are allowed to do. Time was wasted after Katrina struck.

Some of those limitations were built into the Constitution’s limits on federal powers. President Bush could not nationalize the Louisiana National Guard without the consent of Gov. Kathleen Babineaux Blanco, which was not immediately forthcoming.

The Northern Command of the U.S. Army, set up specifically for homeland defense three years ago, was also prevented from acting immediately because the Posse Comitatus Act (circa 1878) bars the army from conducting police activities on U.S. soil without a waiver. The best army in the world was ready, with equipment and men in place, but was left waiting for orders.

On to lesson four: In the U.S. federal system, state and local governments are the first line of defense, simply because the first responders—police, firemen, emergency medical services—report to mayors and governors. When Katrina hit, New Orleans first responders were not up to the challenge. One-third of the police force deserted, leaving the streets to looters and felons, one reason householders and business owners were reluctant to flee the rising waters.

Mayor C. Ray Nagin panicked, leaving the city’s fleet of buses sitting in the flood’s path instead of using them for evacuation. He neglected to provide the thousands who fled to the Superdome and convention center with adequate police protection and supplies. Acting more like the private than the general in Trent Lott’s terms, Mayor Nagin instead raged to the TV cameras about the lack of federal help—as if the feds were supposed to do his job.

You’re only as good as your first responders: New York rose to the occasion after 9/11; after Katrina, New Orleans didn’t.

Lesson five is that the media play a central role. They and the national weather services did a great job of warning Gulf Coast residents that a big one was coming, enabling a million to flee. They were at their best, as usual, covering the suffering and destruction. But then they became involved in the political debate, as Republicans and Democrats tried to outdo each other in assigning blame, with often spurious charges.

Mayor Nagin’s wild estimate of 10,000 deaths was broadcast world-wide. The death toll for all the Gulf Coast, when fully tallied, may be well below 1,000, judging from the numbers counted so far.

The media have a natural tendency to make a big story sound even bigger than it is. Politicians and bureaucrats know that the bigger the disaster, the more money is likely to be showered on them. They are being proved right by the $60 billion in federal aid envisioned so far.

But there is a good side. Katrina was indeed a huge tragedy for the many thousands of people who were displaced and whose homes in many cases are no longer there or uninhabitable. Global media coverage arouses global compassion. Governments around the world are offering help, reciprocating for the massive U.S. effort during the Asian tsunami. NATO commanders agreed in an emergency meeting to provide ships and planes to help deliver aid to the victims.

The private sector came up with the quickest responses. Drug companies sent medicine. Wal-Mart is pitching into the reconstruction effort. Families in cities near and far are taking refugees into their homes. Money and gifts are pouring in from non-governmental organizations in the U.S. and abroad. Individual acts of heroism by helicopter crews and other volunteers who helped pull people off the roofs of flooded homes are too numerous to count.

So that brings lesson number six: While America’s critics cry shame about the less-than-admirable governmental response to the needs of a poor and predominantly black community, Americans acting on their own are picking up the slack. That kind of individual initiative is what has made the U.S. a great country.
KATRINA
State of Emergency

Introduction by Ivor van Heerden
Labor Day, 2005 ... a national holiday and day of rest for Americans to escape the daily grind of the workplace, greatly anticipated for its three-or four-day weekend status. But for thousands on the Gulf Coast, this September 5th is a day when many wish they still had a job. Or a house to go when the work day ends. Or a city to work in. For most, as far as the eye can see, it’s either miles of water or miles of debris. It’s been exactly one week since Hurricane Katrina turned back the clock on the Gulf Coast.

“When this thing happened, you got people shooting each other, stealing from each other. The only thing I trusted was my dog. I’m not going to leave her. You guys are going to have to shoot me to get me to leave.”

—Unidentified man, New Orleans

The most significant change in New Orleans is that levees have been repaired and the pumps are now working. The city is not expected to be drained, though, for months, and the water grows increasingly filthy. Mosquitoes breed and bacteria multiplies in the heat and humidity. The threat of forced evacuation looms for those who still won’t leave—it’s estimated there are about 10,000 remaining. The elderly, injured, homeless, mentally challenged—thousands are still out there in wheelchairs, or walking down the streets, their worldly possessions stacked into a shopping cart. Some are too afraid to come out, convinced that if they do, they’ll never find their way back. Other determined citizens who have clung to their property in hopes of waking up to a drier tomorrow begin to emerge from their hiding places. Exhausted, hungry and numb. Ready to get out.

Christianne Amanpour: “Streets that are now rivers, houses that are still flooded, bloated bodies that still bob in the putrid water. And into this festering filth wades a man desperate to be rescued. Forty-two-year-old Tommy Thomas has survived on M&Ms and chocolate bars for days now. Stunned, exhausted, he’s hauled to safety and given food and fresh water.”

Tommy Thomas, hurricane survivor: “Water was so deep, you know, I had to come out, you know. Running out of food. That’s why I came out. I was running out of food.”

At last count, a quarter of a million Katrina victims were sprawled over 20 states, living in close to 800 shelters. Dozens of evacuees arrive in Los Angeles this morning; four planesloads of survivors have landed in Phoenix, Ariz. Some will take up a new life in those places. They have lost everything that means anything to them.

“When all is said and done, this will be the largest displacement of Americans since the Civil War.”

—Aaron Brown

This morning, some that did make it out are already trying to return. A line of cars formed Sunday night in New Orleans, after an announcement that residents of
Praise for CNN’s Coverage

“Mr. Cooper’s well-shaded outrage—he stopped just this short of editorializing—elicited the kind of anger that has been mostly missing from a toothless press. After a couple of years on the run from the government, public skepticism, and self-inflicted wounds, the press corps felt its toes touch bottom in the Gulf Coast and came up big.”
—David Carr, New York Times, Sept. 6, 2005

“In cable, Cooper burnished a reputation built during the Asian tsunami, Iraq, and other foreign stories as CNN’s go-to anchor-correspondent for breaking news. His confrontation with Sen. Mary Landrieu (D-La.) was one of the more poignant and memorable moments to come out of Katrina.”
—Michael Learmonth, Variety, Sept. 12, 2005

“CNN also had Jeanne Meserve, who from the beginning was warning that the situation was worse than many knew. Her trembling account of the first night of flooding was full of passion, honesty, and fear.”
—Broadcasting and Cable, Sept. 6, 2005

“The gold-star heroes were the men and women who operate the cameras, because they vaulted logistical hurdles that stymied hapless federal, state, and local officials and found a way to do what only television can: Show us what’s happening as it happens. . . . While officials were still issuing reports of minor flooding in New Orleans and putting themselves on the back for dodging a bullet, CNN’s Jeanne Meserve made her way to a neighborhood near one of the breached floodwalls and told a completely different story. ‘This is Armageddon,’ she reported, struggling to find words for what she was seeing. That was the moment when I realized that this was a major disaster. It wasn’t what she said, it was the quaver in her voice as she said it.”
—Eugene Robinson, Washington Post, Sept. 20, 2005

“The network morning shows were awash with storm reports yesterday, but because of its fleet-footedness and technical expertise, CNN was the place during the day actually to see what was going on.”
—Jonathan Storm, Philadelphia Inquirer, Aug. 30, 2005

“Journalism may be the only profession where someone who helped save more than a dozen lives felt compelled to reassure his bosses that his time was well spent. The night after Hurricane Katrina struck, veteran CNN photographer Mark Biello brought back vivid images of New Orleans residents rescued from floodwaters that chased them to roofs or attics. Some he pulled into a boat himself.”
—David Bauder, Associated Press, Oct. 3, 2005

“It was also CNN that exposed the gruesome nature of conditions at the Superdome, the Convention Center, and the hospital corridors.”
—Nikki Finke, LA Weekly, Sept. 9, 2005

“Ernie Allen, president and CEO of the National Center for Missing & Exploited Children, expects most families will eventually be reunited. He says the media’s vast coverage has helped. He credits CNN’s 64 consecutive hours of posting photos of lost kids with resolving at least 15 cases and prompting many parents to call the center’s hotline.”
—Wendy Koch, USA Today, Sept. 20, 2005

“Anger and frustration over the handling of the Katrina relief effort have been so overwhelming in the weeks since the hurricane struck the Gulf Coast that one of the government’s many blunders almost slipped under the radar. But when officials tried to restrict journalists’ coverage of recovery efforts, a single news organization, CNN, stood up to the bullies and reminded them that the First Amendment still guarantees the public a right to know what’s going on.”
—TV Week, Sept. 19, 2005

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**ABSTRACT**

Recent US major landfalling hurricanes Katrina and Rita and last year’s four U.S. landfalling major hurricanes have spawned an abundance of questions concerning the role that global warming might be playing in these events. This idea has been given added credence by the September 2005 *Science* paper of Webster, Holland, Currie and Chang (Vol. 304, pp. 1844-1846) showing that the global number of Category 4-5 hurricanes have increased in the last 15 years (1990-2004) in comparison with the prior 15-year period of 1975-1989. They report 171 Category 4-5 hurricanes in the earlier 15-year period vs. 269 (56% increase) in the later 15 year period. Global mean surface temperature in the later period has been about 0.3°C higher than in the earlier period. The authors’ imply that their measured rise in global Category 4-5 hurricanes is likely related to these higher global temperatures.

Having been involved with hurricane research and forecasting for nearly 50 years, I feel I have an obligation to offer comments on this paper’s primary finding on the recent rise of global Category 4-5 hurricanes. I do not agree that global Category 4-5 tropical cyclone activity has been rising, except in the Atlantic over the last 11 years. The recent Atlantic upsurge has explanations other than global temperature rise.

*Note: About Nov 18, 2005, *Science* refused to print this because Gray had put it on his Web site too. But this has a lot of history of hurricane measurements that people need to know.*
DISCUSSION

The near universal reference to this paper over the last few weeks by most major media outlets is helping to establish a false belief among the general public that global hurricane intensity has been rising and that global warming may be a contributing factor. I cannot accept the accuracy of the authors' measurements of global Category 4-5 hurricanes during 1975-1989 as indicated in their Table 1. This earlier 15 year global data set would not have been able to accurately delineate Category 4-5 hurricanes from Category 3 hurricanes or even at times from Category 1-2 hurricanes. It was just not possible to confidently distinguish the dividing line between maximum sustained surface winds above or below 130 mph (110 knots) in most global storm basins during the 1975-1989 period.

In the late 1970s I visited all the global tropical cyclone centers and observed their satellite capabilities and the training of their forecasters as part of a World Meteorological Organization (WMO) tropical cyclone survey trip that I was commissioned to make. The satellite tools and forecaster training in the tropical cyclone regions of the Indian Ocean and Southern Hemisphere during the 1975-1989 period was not adequate for the task of objectively distinguishing Category 4-5 hurricanes from Category 3 hurricanes or to always be able to confidentially distinguish Category 4-5 hurricanes from Category 1-2 hurricanes. Table 1 of the Webster et al. paper indicates that there were 32 Indian Ocean and South Pacific Category 4-5 tropical cyclones in 1975-89 and 79 (247 percent more) during the 15-year period of 1990-2004. Such large increases are not reasonable given our lack of confidence in the Category 4-5 measurement techniques and the fact that the frequencies of the weaker cyclones in these basins did not show much difference.

This paper also presents data which shows that there has been no general increase in the number of global hurricanes and tropical storms over the last 35 years during which global sea-surface temperatures have been rising. I concur
with this measurement. It agrees with the recent research by my colleague, Phil Klotzbach, who has made similar tabulations.

**DETERMINATION OF TROPICAL CYCLONE MAXIMUM WIND SPEEDS**

There always has been, and there probably always will be, problems in assigning a representative maximum sustained surface wind to a hurricane. As technology advances and the methods of determining a tropical cyclone's maximum sustained surface winds change, different values of maximum winds will often be assigned to hurricanes than the values that would have been assigned in previous years.

With the availability of new aircraft deployed inertial dropwindsondes and the new step-frequency surface wind measurement instruments in the Atlantic, it is being found that Atlantic hurricanes and some Northeast Pacific hurricanes that were flown have sustained surface winds that are often stronger than would have been estimated from wind values extrapolated from aircraft altitude. Due to these recent and continuing changes in measurement techniques (Franklin et al. 2003), Saffir-Simpson category numbers in the Atlantic have and likely will continue to creep upward. These changes will likely be translated to other global tropical basins.

**CHANGE IN INTENSITY MEASUREMENT TECHNIQUES IN THE NORTHWEST (NW) PACIFIC**

The Northwest Pacific basin is the most active of all tropical cyclone basins. It had aircraft reconnaissance center fixes during the period 1945-1986 but has not had aircraft reconnaissance since. The satellite has been the only tool to track NW Pacific typhoons since 1987.
There was an anomaly in the measurement of typhoon intensity in the 14-year period of 1973-1986 when the Atkinson-Holliday (1977) technique for typhoon maximum wind ($V_{\text{max}}$) and minimum sea-level pressure (MSLP) was used. The Atkinson-Holliday (AH) technique is known to have significantly underestimated the maximum winds of typhoons in comparison with their central pressures. This interpretation has been supported by a combination of comparative satellite-aircraft data from the Atlantic; by pre-1973 NW Pacific aircraft-measured wind-pressure, and by the pure satellite measurement since 1987. This topic has been extensively reviewed by Knaff and Zehr (2005). Table 1 shows the official average of the annual number of super typhoons in the West Pacific (equivalent to the number of category 3-4-5 or major hurricanes of the Atlantic). Note that between 1950-1972 and over the last 18 years (1987-2004), the number of super-typhoons has averaged about five per year while during the Atkinson-Holliday period of 1973-1986 it was less than half this number. Yet weaker storm frequency during the 1973-1986 period was about the same as in the earlier and later periods. If we disregard this anomalous 1973-1986 period and compare annual frequency of super-typhoon activity between 1950-1972 versus 1987-2004, we see little difference despite the recent global warming trend.

Table 1. Comparison of the annual average of super-typhoon activity in three multi-decadal periods in the western North Pacific. The middle period (1973-1986) used the Atkinson-Holliday (1977) intensity scheme. Reported maximum wind values were too low.

<table>
<thead>
<tr>
<th>Years</th>
<th>Annual Average Number of Super-Typhoons</th>
<th>Basin July-Sept SST (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-1972</td>
<td>5.3</td>
<td>28.93</td>
</tr>
<tr>
<td>1973-1986 (AH)</td>
<td>2.3</td>
<td>28.92</td>
</tr>
<tr>
<td>1987-2004</td>
<td>4.9</td>
<td>29.22</td>
</tr>
</tbody>
</table>
Who would believe that the annual super typhoon activity of the 14 year period 1973-86 (years AH technique was applied) would be only 44 percent of the annual super typhoon activity of the prior 23-year period or the current 18-year period? This period of suppressed super-typhoon frequency during 1973-86 closely corresponded with the first 15-year period of Webster et al.'s 1975-89 Category 4-5 data.

**VARIATION IN MAJOR HURRICANE NUMBERS DURING THE LAST TWO DECADES OF GLOBAL WARMING**

As tropical cyclone maximum wind ($V_{max}$) observational techniques are frequently not adequate to distinguish between Category 4-5 and Category 3 hurricanes, it might be more representative to observe the increase of major hurricanes (Category 3-4-5). There has been US-Japanese satellite coverage of the north Pacific during the last 20 years, and both satellite and aircraft reconnaissance data have been available in the Atlantic. The biggest rise in global surface air temperature occurred during the last 10 years. The NOAA-NCEP reanalysis of global mean temperature differences between the last two 10-year periods show that the last 10 years (1995-2004) of global surface temperature have been about 0.4°C warmer than the earlier 10-year period of 1985-1994. If there was an influence of global warming on major hurricane activity, one would expect to see this increase represented by greater numbers of global major hurricanes during the last 10 years in comparison with the earlier 10-year period.

Table 2 shows the number of measured major hurricanes (Cat. 3-4-5) around the globe (excluding the Atlantic). Note that there has been no apparent difference in reported major (Cat. 3-4-5) hurricanes between these two 10-year periods despite the globe being about 0.4°C warmer in the recent period.
Compare two recent 10-year periods when observing methods were similar and no big problems as for 1973-1986.

Table 2. Comparison of observed major (Cat. 3-4-5) tropical cyclones in all global basins (except the Atlantic) in the two most recent 10-year periods of 1985-94 and 1995-2004.

<table>
<thead>
<tr>
<th>Region</th>
<th>1985-1994 (10 Years)</th>
<th>1995-2004 (10 Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North &amp; South Indian Ocean</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>South Pacific &amp; Australia</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>NW Pacific</td>
<td>88</td>
<td>87</td>
</tr>
<tr>
<td>Northeast Pacific</td>
<td>41</td>
<td>40</td>
</tr>
<tr>
<td>GLOBE TOTAL (excluding Atlantic)</td>
<td>218</td>
<td>218</td>
</tr>
</tbody>
</table>

By contrast, the Atlantic has seen a very large increase in major hurricanes during the last 10-year period in comparison to the previous 10-year period (38 between 1995-2004 vs. 14 during 1985-1994). The large increase in Atlantic major hurricanes during the last 10 years is primarily a result of the multi-decadal increase in the Atlantic Ocean thermohaline circulation (THC) and not due to global temperature increase. Changes in salinity are believed to be the driving mechanism. These multi-decadal changes have also been termed the Atlantic Multi-Decadal Oscillation (AMO). Even when the large increase in Atlantic major hurricane activity is added to the non-Atlantic global total of major hurricanes, there is no significant global difference (232 vs. 256) in the numbers of major hurricanes between these two most recent 10-year periods.
COMPARISON OF PACIFIC CATEGORY 4-5 TROPICAL CYCLONE ACTIVITY DURING THE LAST TWO 10-YEAR PERIODS

The most reliable comparison of Category 4-5 hurricanes that can likely be made is to compare the last ten years (1995-2004) with the prior ten years (1985-1994) for the storm areas monitored by the US and Japan. The two North Pacific basins do not indicate that the number of hurricanes of Category 4-5 intensity have increased in the last 10 years when global surface temperature have risen (Table 3).

Table 3. Comparison of the number of Category 4-5 hurricanes in the North Pacific during the last two 10-year periods.

<table>
<thead>
<tr>
<th></th>
<th>1985-1994 (10 Years)</th>
<th>1995-2004 (10 Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE PACIFIC</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td>NW PACIFIC</td>
<td>70</td>
<td>65</td>
</tr>
<tr>
<td>TOTAL</td>
<td>101</td>
<td>95</td>
</tr>
</tbody>
</table>


There have been past hurricane periods in the Atlantic which have had just as many major hurricanes and Category 4-5 hurricanes as in recent years. A comparison of the last 15 years of hurricane activity with an earlier 15-year period from 1950-64 shows no significant difference in major hurricanes or Category 4-5 hurricanes (Table 4) even though the global surface temperatures were colder and there was a general global cooling during 1950-64 as compared with global warming during 1990-2004. The maximum sustained winds from
1950-1964 have been adjusted downward using the Landsea (1993) adjustment factor.

\((T_S)\)

The number of weak tropical storms rose by over 50 percent during this later 15 year period, however. This is a reflection of the availability of the satellite in the later period. It would not have been possible that a hurricane, particularly a major hurricane, escaped detection in the earlier period. But many weaker systems far out in the Atlantic undoubtedly went undetected before satellite observations.

**Table 4. Comparison of Atlantic tropical cyclones of various intensities between 1950-1964 and the recent 15 year period of 1990-2004.**

<table>
<thead>
<tr>
<th></th>
<th>Cat. 4-5</th>
<th>Cat. 3</th>
<th>Net IH</th>
<th>Net H</th>
<th>Cat. 1-2</th>
<th>Trop. Storm</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-64 (15 yrs)</td>
<td>24</td>
<td>23</td>
<td>47</td>
<td>98</td>
<td>51</td>
<td>50</td>
<td>148</td>
</tr>
<tr>
<td>1990-04 (15 yrs)</td>
<td>25</td>
<td>18</td>
<td>43</td>
<td>100</td>
<td>57</td>
<td>78</td>
<td>178</td>
</tr>
<tr>
<td>1990-04 minus 1950-64</td>
<td>+1</td>
<td>-5</td>
<td>-4</td>
<td>+2</td>
<td>+6</td>
<td>+28</td>
<td>+30</td>
</tr>
<tr>
<td>Percent Increase</td>
<td>+4%</td>
<td>-22%</td>
<td>-9%</td>
<td>+2%</td>
<td>+12%</td>
<td>+56%</td>
<td>+18%</td>
</tr>
</tbody>
</table>

**SUMMARY**

Despite what many in the atmospheric modeling and forecast communities may believe, there is no physical basis for assuming that global tropical cyclone intensity or frequency is necessarily related to global mean surface temperature changes of less than ±0.5°C. As the ocean surface warms, so does the global upper air temperature to maintain conditionally unstable lapse-rates and global rainfall rates at their required values. Seasonal and monthly variations of SST
within individual storm basins show only very low correlations with monthly, seasonal, and yearly variations of hurricane activity. These correlations are typically of the order of about 0.3, explaining only about 10 percent of the variance. Other factors such as tropospheric vertical wind shear, surface pressure, low level vorticity, mid-level moisture, etc. play more dominant roles in explaining hurricane variability on shorter time scales. Although there has been a general global warming over the last 30 years and particularly over the last 10 years, the SST increases in the individual tropical cyclone basins have been smaller (about half) and, according to the observations, have not brought about any significant increases in global major tropical cyclones except for the Atlantic which as discussed, has multidecadal oscillations driven primarily by changes in salinity. No credible observational evidence is available or likely will be available in the next few decades which will be able to directly associate global temperature change to changes in global Category 4-5 hurricane frequency and intensity.

**Acknowledgement:** I would like to acknowledge beneficial discussions on this topic with John Knaff and Philip Klotzbach.
REFERENCES


Does Global Warming Make Hurricanes Worse?

Four stories follow:

- 2 pages from *Science News* (Sep 17, 2005, weekly)
- 6 pages from *Discover* (Jan 2006, monthly)
- 6 pages from *New Scientist* (Dec 3, 2005, weekly)
- 8 pages from *Time* (Oct 3, 2005, weekly)

Roy Jenne
Dec 2005

( 23 pages here )
THE WIND AND THE FURY

Has climate change made hurricanes fiercer, or are such claims hot air?

BY NAILA MOREIRA

As Hurricane Katrina steamed forward on Thursday, Aug. 25, residents of the southeastern U.S. shore breathed sighs of relief. The storm passed Miami as a weak hurricane, rating as only a category 1 storm on a scale from 1 to 5. But within days, relief turned to alarm, amid warnings from forecasters that the worst might be yet to come. The storm sucked energy from warm Gulf of Mexico waters as it moved west, swelling into a category 5 monster and then weakening only slightly before it slammed into the Mississippi shore as a category 4 hurricane. Abundant rain and a surge of ocean water overwhelmed flood-control measures and broke levees at nearby Lake Pontchartrain, deluging New Orleans with up to 20 feet of water and plunging the city into mayhem.

Katrina's ferocity left many people asking whether the monster storm came from mere chance or from something more long-lasting—global warming. Although hurricane numbers and intensities are known to vary naturally, with some years producing many violent hurricanes and others hardly any, Hurricane Katrina isn't the only exceptionally destructive event in recent memory. In 1992, Hurricane Andrew topped the charts as the most costly U.S. hurricane then on record, wreaking $25 million in damage in Florida—a record that Katrina will certainly break.

In the tropical Atlantic, moreover, hurricane numbers have been on the uptick since 1995, according to the National Oceanic and Atmospheric Administration (NOAA). In 2004, Florida suffered its worst hurricane season in 118 years, with nine hurricanes, five of which were classified as major. For 2005, NOAA's forecast predicted yet another above-average hurricane season for the region.

Scientists are divided on whether climate change, induced by industrial and automotive release of carbon dioxide and other greenhouse gases, is driving these statistics. Most climate scientists say that natural, cyclic phenomena that affect ocean currents and atmospheric temperature—such as El Niño in the Pacific Ocean and the North Atlantic Oscillation—yield decade-to-decade swings in total hurricane numbers that have nothing to do with global warming. Some researchers say that these phenomena are also responsible for all the observed changes in storm intensity.

But many other climate scientists are now pointing to global warming as the culprit for increasingly ferocious hurricanes worldwide. Both scientific theory and computer modeling predict that as human activities heat the world, warmer sea-surface temperatures will fuel hurricanes, increasing wind speeds and rainfall. Now, several new studies suggest that climate change has already made hurricanes grow stronger.

Many scientists predict that such an increase in storm violence will have consequences for coastal communities.

COOKING UP A STORM Hurricanes gain their destructive power from ocean moisture and heat. As the sea and atmosphere warm, more water evaporates from the ocean surface. When that moisture reaches the cool upper atmosphere, it condenses, releasing the energy that originally went into evaporating it. This "latent heat" powers the growing storm, says meteorologist Tom Knutson of NOAA's Geophysical Fluid Dynamics Laboratory in Princeton, N.J.

How warm the sea surface gets and how high into the atmosphere the evaporated water climbs set a speed limit on hurricane winds, says Kerry Emanuel of the Massachusetts Institute of Technology in Cambridge. In 1997, Emanuel predicted that with global warming, this speed limit would rise and that hurricanes would rev up their engines.

"If the climate warms, hurricanes have the potential to become substantially more intense," agrees Knutson. He and Robert E. Tuleya of Old Dominion University in Norfolk, Va., have used computer models to simulate how hurricanes would change in a warming world. If the atmospheric concentration of carbon dioxide, the greenhouse gas most responsible for global warming, doubles in the next 80 years, hurricanes' wind speeds will rise by about 5 percent, the researchers predicted in the Sept. 15, 2004, Journal of Climate.

Moreover, with the increase in atmospheric moisture that accompanies global warming, hurricane rainfall will increase by about 18 percent, Knutson and Tuleya calculate.

But in practice, changes in rainfall within a hurricane are hard to pick out. Hurricanes pour out rain in localized outbursts, but rain gauges tend to be widely dispersed and often miss the main downpour, Emanuel notes. Also, most hurricanes don't strike land, where rainfall can be tallied. "It's a hopeless measurement problem," he says.
Pavel Grosisman of the National Climatic Data Center in Asheville, N.C., says that his work and that of others show no measurable change in the total rain dumped by hurricanes. "When we have very strong hurricanes, we do not see changes in intensity of precipitation," he reports.

The increase of just 5 percent in hurricane intensity predicted by Knutson and Tuleya led many researchers to suggest that the variability attributable to El Niño or the North Atlantic Oscillation would dwarf any change resulting from global warming, at least for the next few decades.

"What folks in the field thought was, we weren't going to see any global warming and hurricane association for decades to come," says Christopher Landsea of NOAA's Atlantic Oceanographic and Meteorological Laboratory in Miami.

ALL A WHIRL. Researchers have recently discerned, however, storm-intensity trends that correlate with global warming. In the Aug. 4 *Nature*, Emanuel reports the first evidence that today's hurricanes are more powerful than those of 30 years ago.

To gauge storm intensity, Emanuel developed a measure he calls the power-dissipation index. For each Northern Hemisphere hurricane in the tropical Atlantic and western Pacific over the past century, he used the maximum wind speed and the life span of the storm to calculate a number that estimates the energy expended by a hurricane. The measurement also relates to the total damage a hurricane can wreak on buildings and construction, Emanuel says.

Overall, he found that the power-dissipation index had doubled over the past 30 years in all the regions that he has studied—an increase that he says probably reflects the effect of global warming over that same period. "I was startled to see this sort of upward trend globally," he says. "It's a big trend."

Landsea contends that problems with the historical record of hurricane data render Emanuel's conclusions uncertain. Scientists have measured wind speeds in different ways over the past century, including by aircraft and satellites. To make these different measurements compatible over time, Emanuel had to apply correction factors that could introduce bias, Landsea says.

"He may think it's the smoking gun linking hurricanes and global warming, but I'm reluctant to say so at this point," says Landsea.

Emanuel concedes that wind-speed numbers are uncertain. However, he says, several factors mitigate that problem. For example, Emanuel says that his wind-speed data correlate perfectly with sea-surface temperatures over time that, in contrast to wind speeds, have been carefully measured.

"Every piece of evidence has a problem, but when you take them all together, they all point in the same direction," he says.

Oceanographer Isaac Ginis of the University of Rhode Island in Narragansett says that the measure provides a strong suggestion that hurricane intensity may already be on the upswing. "The signal is so robust, based on what I've seen in [Emanuel's] paper, that it looks fairly convincing to me," he says.

Moreover, Emanuel's finding no longer stands alone. The number of large hurricanes appears to have increased since 1970, while smaller hurricanes have become less common, report Greg Holland of the National Center for Atmospheric Research and his colleagues in the Sept. 17 *Science*. "What we've done is show that there's actually an increase in the number of intense storms," he says.

To count the hurricanes worldwide in each category of storm intensity, Holland and his colleagues used satellite data collected by scientists since about 1970. They found that the number of storms in categories 4 and 5 doubled during the past 35 years, while storms in categories 1 to 3 dropped off. Overall, he says, the larger storms now occur 20 to 35 percent more often than smaller storms do.

Peter Webster, a coauthor of the report, says, "The intensity of Katrina is consistent with the type of storms we've been finding, [which are] increasing in intensity globally."

Hurricane Katrina strengthened over anomalously deep warm waters in the Gulf of Mexico, Webster notes. If the warm patch had been shallower, the hurricane might have churned up cooler waters that would have reduced the storm's intensity. He cautions, however, that neither the warm area nor Katrina's intensity can necessarily be attributed to global warming rather than chance.

TYphoon TALLY. Hurricane intensity may be going up, but Webster and Holland find no change in the total number of hurricanes worldwide. These findings join others indicating that total hurricane numbers stay the same or even decrease as the world warms.

So far, yearly hurricane numbers have oscillated around a mean value of 90. "Since 1970, the global annual frequency of storms has been, I would say, rock steady," says Emanuel. "There's no systematic trend that you can see."

Computer simulations of the future give conflicting results for expected hurricane frequency. "Different models give different things," says Ruth McDonald of the Hadley Centre for Climate Prediction and Research in Exeter, England. "There's a large uncertainty as to whether they find fewer or more storms."

McDonald and her colleagues used a global-climate model to predict how the annual hurricane number will change as the globe warms during the next 17 years. Their model suggests that global hurricane numbers will decrease by 6 percent by 2022, a result published in an upcoming *Climate Dynamics*.

Inconsistencies among studies result from different spatial scales used by different models, says Seita Emori of the National Institute for Environmental Studies in Tsukuba, Japan. Climate simulations on a large scale, such as McDonald's, can't easily see hurricanes, which occur on a scale of only a few kilometers. Smaller-scale models don't necessarily take into account all the climate variables that come into play. Researchers also lack a clear understanding of the physical processes that control hurricane genesis, Emori says.

To better understand how climate might affect hurricane numbers, Claudia Mora of the University of Tennessee in Knoxville is looking into the past. She's examining tree rings to improve the currently spotty historical record of hurricanes.

"Tree rings are a natural archive," she says. "They occur in pretty much all the coastal areas that are affected by hurricanes, and they are exactly datable."

Trees record hurricanes because the storms change the composition of rainwater. Water contains two forms of oxygen. These oxygen isotopes always have the same number of protons, but they have different numbers of neutrons. A water molecule containing an oxygen isotope with more neutrons is heavier than a molecule having an oxygen isotope with fewer neutrons.

Early on, hurricanes tend to rain out water molecules containing heavy isotopes, so later rainfall is isotopically light. When this lightweight rainfall enters the soil, it's taken up by a tree and incor...
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**2005**

The Year of Global Warming

In the year we’re leaving behind, there were so many tropical storms and hurricanes that meteorologists were forced to dip into the Greek alphabet after exhausting their A to Z list of names. There were so many category 5 hurricanes that the United States sustained the worst storm damage in its history. There was so much hype and misinformation about whether global warming caused our bad weather and whether humans were at fault that only good science could sort out the facts. For the truth, simply turn to page 20 and read Discover's number one story of 2005, surely the most remarkable year in science ever.
Hurricanes Intensify Global-Warming Debate

Katrina. Rita. Wilma. Tropical storms seem to be getting bigger and more destructive every year. Are humans to blame? By Robert Kunzig

If there is one thing everyone involved in the great global-warming debate should be able to agree on, it is that global warming didn’t “cause” hurricane Katrina—and neither did George W. Bush.

Naturally, not everyone agrees. “The hurricane that struck Louisiana yesterday was nicknamed Katrina by the National Weather Service. Its real name is global warming,” the journalist and environmental advocate Ross Gelbspan announced in the Boston Globe on August 30, as floodwaters were still rising in New Orleans. The German minister of the environment, Jürgen Trittin, made the point more stridently: He blamed Katrina on the Bush administration and its climate policies.

The simple and obvious truth is that hurricanes happen regardless of humans. Researchers last year found themselves having to emphasize that message once again, as they had in 2004 when four hurricanes hit Florida. Pretending that we could have prevented Katrina serves no purpose. If Bill Clinton had submitted the Kyoto treaty to the U.S. Senate, which had then ratified it, and if Ralph Nader had been elected president in 2000 and, with a large green majority in both houses, had forced the United States to meet its targets for emission reductions in a way that even the European Union is falling far short of doing today, it still would not have made the slightest difference to New Orleans on August 29, 2005.

But does that mean there is no possible connection between global warming and hurricanes, especially future ones? It does not. After all, smoking doesn’t “cause” lung cancer either, in the sense that many factors contribute to a cancer, and you could never prove that cigarettes caused an individual case; many blameless nonsmokers die of lung cancer every year. We know, however, that smoking increases the frequency of cancer and thus makes a given case more likely to occur. A similar statistical association might in theory hold between global warming and hurricanes—but in fact all experts agree that there has been no long-term increase in the frequency of hurricanes. Their numbers in a given ocean basin seem to rise and fall every few decades in a natural cycle, and since 1995 or so the Atlantic seems to be in a phase of frequent storms. There is no evidence of a trend in storm frequency that could be attributed to global warming, nor is there any particular reason to think there should be.

There is very good reason to think, however, that global warming might make the hurricanes that do occur more powerful. Tropical cyclones—whether they’re called hurricanes or typhoons—draw their energy from warm tropical seas. Those seas are getting warmer,
Hurricane Dennis July 4–13

Hurricane Katrina August 23–31

Hurricane Rita September 17–26

Hurricane Wilma October 15–25

The first hurricane of the year, Dennis, came earlier than usual—in July. It caused at least 71 deaths and $5 billion in damage. The three most powerful hurricanes this year—all reached category 5 at one point—were Katrina, Rita, and Wilma. Katrina, the third strongest storm of the season, was the most expensive in history, causing more than $70 billion in damages and killing more than 1,300 people. The most intense hurricane was Wilma, which pounded the Yucatán for two days before hitting Florida.
and the pattern fits what might be expected from man-made pollution of the atmosphere. This past year two new studies were published that suggest the intensity of tropical cyclones worldwide is already increasing—and far more than anyone would have expected.

THE FIRST STUDY CAME FROM KERRY EMMANUEL OF MIT. He is well known in the hurricane business. It was Emanuel who, in 1987, showed theoretically how global warming might intensify hurricanes—and by how much. He predicted then that if tropical sea surface temperature were to rise by 1 degree Celsius, the maximum wind speed in hurricanes would rise by 7 percent. Studies done with computer climate models have since more or less confirmed that result. Until this year, the general consensus among researchers was that the intensification of hurricanes by global warming was likely to be real but not likely to be observed at landfall for 50 years or more. In the past few decades, tropical sea surface temperatures have warmed by around half a degree Celsius, which means that hurricane winds should have increased at most by 2 to 3 percent. “We all knew that wasn’t detectable,” says Emanuel.

Emanuel wasn’t trying to detect it. He was looking for evidence for a pet theory of his, which holds that by stirring up the ocean, hurricanes help drive a global system of currents called thermohaline circulation. To quantify how much energy the storms transmit to the ocean, he invented the “power dissipation index,” or PDI, which is proportional to the cube of the wind speed added up over the whole life of the hurricane. Then he collected data on tropical cyclones that took place over the past 50 years in the north Atlantic and the northwest Pacific, the two places where research aircraft fly right into storms and get the best measurements of barometric pressures and wind speeds. Because he wasn’t interested in the damage caused per se, he calculated the PDI for thousands of storms, not just the tiny fraction that made landfall. “It was a piece of work that by all rights should have remained obscure,” he says.

But the results made that impossible in this eventful year. Emanuel found that the energy released by the average hurricane had increased by 50 to 80 percent over the past 30 years. Wind speeds had increased by 15 percent, and storms were lasting longer, as intense ones tend to do. To be sure, there were wiggles in the PDI curve that looked like natural cycles. “But this overall upward trend was inescapable,” says Emanuel. No known natural cycle could explain it, but it closely matched the upward trajectory of tropical sea surface temperatures—that is, cause and effect seemed to be moving together in a sensible way.

Meanwhile, another group of researchers was taking an even broader view of the problem: They were looking at data from tropical cyclones all over the world, including the Southern Hemisphere. To do that, Peter Webster and his colleagues at the Georgia Institute of Technology and Greg Holland of the National Center for Atmospheric Research had to limit their study to the period since 1970, when reliable satellite weather data first became available. Forecasters who don’t have an airplane flying into a storm estimate intensity either by eyeballing satellite images or by using a computer program.

Collecting such estimates from forecast offices around the world, Webster and his colleagues confirmed that the total number of tropical cyclones has not changed much since 1970. But, as they reported in the journal Science just two weeks after Katrina hit, the frequency of intense category 4 or 5 storms has nearly doubled. “The end result is basically the same,” as Emanuel’s, Holland says—which tends to make both results more believable.

“Our analysis indicates global warming has already increased the likelihood of storms like Katrina happening,” says Holland, “although we can’t say it caused Katrina itself.”

Some researchers question both the data and the analysis. Chris Landsea of the National Hurricane Center knows the Atlantic data as intimately as anybody; he has flown into 15 hurricanes himself. The problem with trying to identify a trend in intensities, Landsea says, is that the data are full of errors, and the methods used to collect and analyze them have changed over the years. The best data are from the Atlantic, he says, and they show the smallest increase in storm intensity since 1970—one that to him looks more like the upward slope of some long natural cycle rather than a trend caused by global warming. “The one basin that we have reliable records for it’s not part of a trend,” he says. “And the concern about the data in the other basins is so severe that I don’t trust them.”

Another reason to be skeptical, says Landsea, is that the supposed upward trend in hurricane intensity is so much larger than hurricane theory would have predicted. Emanuel and Holland, who were both leaders in developing that theory, see the same contradiction differently; they worry not that the data are wrong but that there might be something missing from the theory that could explain why global warming seems to be intensifying storms much more than even they had predicted. “There are errors in the data—that’s absolutely certain,” says Holland. “But we’re not talking about small changes. We’re talking about nearly a 100 percent increase in the proportion of major hurricanes. It’s a large number. So the odds are it’s not just errors in the database,” says Emanuel. “The signal is so big—too big to ignore. For the first time in my professional career, I got alarmed.”

ENVIRONMENT: Are hurricane increasing in number? Although 2005 broke a record for the number of hurricanes, scientists do not know if it points to a pattern connected to global warming. But at least they have a new tool—tree rings—to help them determine just how fast a trend is.

Tree rings can tell tales because hurricanes produce rain with low amounts of a specific isotope—oxygen-18. When the rainfall is absorbed by the shallow roots of pine trees the low oxygen-18 signal is locked in the cellulose that forms rings. To test the data, University of Tennessee geochemist Claudia Moro and dendrochronologist Heinrich Gleick and Mayer studied rings from longleaf and slash pines in Valdosta, Georgia.

Whenever they found large dips in the oxygen-18 isotope, they found a corresponding historical record of a hurricane. The two now have continuous tree-ring records for parts of the southeast dating back 227 years, from 1770 to 1997. Their goal: “A 500-year archive with exact dates on everything.”

That record could help paleoclimatologists understand decade-and-century-long variations in hurricane patterns and begin to unravel the impact of global warming on storm cycles. Nonetheless, Moro says tree rings can’t show the intensity of a hurricane. “That’s the one thing we can’t do. Hurricanes are dynamic systems. They strengthen, they weaken, and they’re moving. We’re capturing a record in a stationary tree.” —Anne Sasson

**Tree Rings Tell Hurricane Tales**

**32**
LANDSEA WAS IN THE EYE OF KATRINA WHEN THE storm made landfall in Louisiana on August 29. By then the eye had filled with clouds, and the scientists could not see the ground. "It had started getting weaker," he says. "It was no longer a category 5. We were hopeful that the worst would be avoided."

Thanks to people like Landsea and his colleagues, the worst has been avoided many times. There are now far more people living on the coasts in the path of hurricanes, and yet hurricanes in the United States, at least, kill many fewer people than they used to—if only because the ability to observe them and forecast their path has improved so much that people now get out of the way. Hurricanes are causing ever more damage in dollar terms, but the reason, according to Landsea and Roger Pielke Jr., of the University of Colorado, is that there is more in their path to damage. If you correct for inflation and for the increase in wealth and population in coastal areas, they say—that is, if you compare historical hurricanes to how much damage they would do if they followed the same path today—you find that there has actually been no trend toward increasing damage by hurricanes. Until Katrina, the worst hurricane in history in terms of financial loss was the 1926 category 4 storm that passed directly over Miami. People didn't know it was coming, and they didn't know what an eye was back then; when the lull settled briefly over the town, they walked outside, only to be swept away by 130-mile-per-hour winds.

Pielke argues that by far the best way to prevent future hurricane damage is not to combat global warming but to protect vulnerable coastal zones with better dikes, building codes, and evacuation plans. "Hurricane Katrina tells us that New Orleans was suboptimally prepared for a hurricane," he says. If this year's studies are borne out by further research, though, and it is established that global warming is indeed sending more intense hurricanes our way, then a rational plan of preparedness will have to include combating global warming as well—something we have many other reasons for doing. But for now, one certain lesson from Katrina is this: Unlikely catastrophes happen if you wait long enough. We knew the hurricane was coming, for decades we knew it was coming and wished it wouldn't, and when it came we weren't ready and wished we had been. Will we have to say the same thing about global warming one day?

**BIOLOGY—2005 proved a banner year for microbes, the world's oldest and most abundant inhabitants. Intrepid researchers turned up new organisms that offer proof of life's ability to take root in four extreme environments.**

**Deepest**: Using a remotely operated vehicle, a team from the Japan Agency for Marine-Earth Science and Technology, Shizuoka University, and the Southampton Oceanography Center in England identified single-celled organisms living seven miles below the surface at the ocean's deepest point, named Challenger Deep. The creatures represent a branch of foraminifera dating back at least 9 million years. The deep trenches supply refuge from predators for ancient-rooted organisms," says Hiroshi Kizawa, the team's leader.

**Saltiest**: Near the island of Crete, Paul van der Wielen and colleagues from Kiwa Water Research in the Netherlands detected the DNA of bacteria and even more ancestral microbes called archaea in briny basins of concentrated magnesium chloride 100 times saltier than seawater. These salt pockets date from a time when water in the eastern Mediterranean Sea evaporated, leaving a salt residue that became trapped in the earth. If life can exist here, the researchers suggest, perhaps it can get by in salt chambers on other planets.

**Hottest**: A team from the University of Colorado at Boulder found that microbes in Yellowstone National Park's 160-degree hot springs gain sustenance not from sulfur, as expected, but from molecular hydrogen, or H₂. At those temperatures, microbes rely on chemical energy for fuel instead of light. The scientists say that astrobiologists should keep this type of metabolism—possibly one of the oldest on Earth—in mind when searching for life on other planets.

**Loneliest**: Until the Larsen B ice shelf, which once capped part of Antarctica's coastal waters, broke up in 2002, researchers believed that nothing lived below it. Bacteria have proved them wrong. In July Hamilton College geologist Eugene Domack and his colleagues announced they had discovered a lumpy white bacterial mat growing on one patch of the pitch-dark seafloor and observed foot-long clams nearby. "This system is much more isolated than anything we've ever found before," Domack says. "Its way of making a living may be very different from anything we know about."

—Megan Mansell Williams
Is global warming making hurricanes stronger?

FEATURES

THE GATHERING STORM
There's a wild controversy raging over whether global warming is making hurricanes stronger

The news stories about Katrina and New Orleans were extremely strong during Sept 2005. R James 213
A bitter controversy is raging over whether global warming is making hurricanes stronger. **Fred Pearce** reports

CORKY PERRET lost everything when Hurricane Katrina hit. His house on the beachfront out on Highway 90 between Gulfport and Biloxi, Mississippi, was reduced to firewood by the winds and washed away by a 10-metre storm surge. “Nothing is left, it was totally destroyed,” he says.

Some of his neighbours are going for good. Perret, a fisheries official, would like to stay and rebuild. But he is still unsure what to do. His house was built during a period when there were few hurricanes. For the next few years at least, that era is over. And it could be that the quiet days will never return. Whatever happens, the effects of future hurricanes will probably be worse, he says, because the offshore islands that provided some protection have been partly washed away.

Perret is one of the many people around the Gulf of Mexico trying to cope with an uncertain future after an extraordinary year in the Atlantic. There were so many tropical storms that for the first time ever forecasters ran out of names. Wilma became the most powerful Atlantic hurricane ever recorded. Katrina brought New Orleans to its knees, while consumers across the world reeled as oil prices shot up.

So what’s going on? Are hurricanes becoming more destructive as global warming kicks in? Not long ago, the world’s leading hurricane experts all agreed on the answer: the upsurge in Atlantic hurricanes is just part of a normal long-term cycle. There is no sign that global warming is making hurricanes anywhere in the world stronger or more frequent. As for the future, we haven’t got a clue, because our models are not good enough to predict how climate change will alter tropical storms.

That was the official consensus in 1996. Two years later the top researchers, including William Gray of Colorado State University and Kerry Emanuel of the Massachusetts Institute of Technology, felt confident enough to go a little further. In a paper in the *Bulletin of the American Meteorological Society* in 1998, they concluded that a doubling of carbon dioxide levels in the atmosphere (CO₂ levels are now up about a third) would not affect the frequency of tropical cyclones or alter the areas they affect, and would increase their intensity only slightly, by around 10 per cent or so.

Now this consensus has been shattered. Alarm has grown with a flurry of papers claiming that, contrary to expectations, the surge in temperatures over the past 30 years has already made hurricanes more severe. Not more frequent, but more intense, with stronger winds, longer durations, more rainfall and even less predictable paths.

And if the odds on powerful hurricanes are already shortening, there might be worse to come. “Future warming may lead to an upward trend in tropical cyclone destructive potential,” Emanuel wrote in one paper, “and – taking into account an increasing coastal population – a substantial increase in hurricane-related losses in the 21st century.”

Such claims have created a schism among the high priests of hurricane forecasting.
Many, like Gray, see no upward trend and no human fingerprint. They accuse the authors of the latest papers of bias. So who is right?

Worldwide there are about 85 tropical cyclones each year, of which about two-thirds reach hurricane force. The number does not vary much year by year, but their distribution does. Global conditions that encourage hurricanes in the Atlantic tend to discourage them in the Pacific, and vice versa. This year the Atlantic has been battering, but the Pacific has been relatively peaceful (see Map, page 41). But the world’s hurricane cockpit, with more than a third of the world total, is the western North Pacific. Last year Japan alone was hit by 10 typhoons (the local name for hurricanes), three times the usual number.

Tropical cyclones start off as clusters of thunderstorms, which often form as warm, humid air rises from the surface of a tropical ocean. As the air rises, the water vapour condenses, releasing latent energy that heats the air and sends it even higher. This latent energy is what drives hurricane formation.

If enough storm clouds form in close proximity, they can create what Emanuel calls a “piller” of humid air, extending from the ocean surface right up to the boundary with the stratosphere. The low pressure at the base of the pillar sucks in more air, which picks up energy in the form of water vapour as it flows over the sea surface and releases it as it rises, lowering the pressure still further. If this happens more than four degrees north or south of the equator, the Coriolis forces acting on the inward-flowing air start the cyclone spinning.

When conditions are favourable, a tropical cyclone can rapidly gain strength, turning from a depression into a storm and finally a hurricane as wind speeds pick up (see Diagram, opposite). Its power is staggering: Chris Landsea of the US National Oceanic and Atmospheric Administration (NOAA) in Miami has calculated that a typical hurricane can release over 10 million trillion joules a day – the equivalent of about a million Hiroshima bombs. Luckily for us, most of this energy goes into driving air upwards rather than sideways.

On the face of it, global warming can only make things worse. The initial pillar of humid air generally forms only when the temperature of the sea surface exceeds 26°C. As the oceans warm, larger areas will exceed the threshold. And every degree above the threshold seems to encourage stronger hurricanes. When Katrina hit category 5 back in August, the surface of the Gulf of Mexico was around 30°C. This has encouraged the view that a warmer world will have more hurricanes, stronger hurricanes and hurricanes in places till now outside their range.

There are other complications, too. Even when conditions are just right, no hurricane will form unless an atmospheric disturbance provides a trigger. And even then, most tropical storms fizzle out instead of growing into hurricanes. So, while it is important to know if global warming will more frequently create the conditions needed for hurricanes to form, it is equally important to know whether it will be more likely to trigger them and, once formed, to kill them.

There are two ways to kill a hurricane. The first is to shut off its fuel – the supply of warm, humid air that comes from warm ocean waters. This happens most obviously when a hurricane passes over land. But it can also happen at sea. As the storm grows, its waves stir up the ocean, mixing the warm surface water with the generally cooler water beneath. The surface cools and, particularly for slow-moving hurricanes, that can be the end.

This means that a hurricane can grow very intense only when the warmest extends for tens of metres below the surface. Katrina strengthened as it moved towards New Orleans because the water was warm to a depth of more than 100 metres. Leaving Katrina aside, here, for once, the effect of global warming looks clear-cut: warmth is penetrating ever deeper into the world’s oceans and setting up ideal conditions for hurricane growth.

But the second way by which hurricanes are defused could have the opposite effect. Winds can disrupt the pillar of humid air. Even quite small invasions of wind can mess up a potential hurricane by introducing dry air, preventing thunderclouds forming or lopping off their tops. Climate models are not good at replicating small-scale features like hurricanes, but most suggest that global warming will increase wind speeds in the upper atmosphere to levels that would disrupt hurricanes.

Bill Gray

How to kill a hurricane

But the world is not that simple. As Gray, one of the founders of hurricane science, pointed out decades ago, a hurricane can form only when a whole set of atmospheric conditions are just right. One of these is the difference between the sea temperature and the air high above it. This is what drives the convection currents that are necessary for the initial storm clouds to form. If, as climate models suggest, global warming raises average temperatures high in the atmosphere as well as at the ocean surface, then the sea surface may have to get even warmer before it triggers hurricanes – and the hurricane-generating potential of the tropics would remain largely unchanged.

Nor are hurricane formation zones certain to expand. Hurricanes usually develop in or near the band of rising air called the intertropical convergence zone, which moves across the equator with the seasons. And for every spot where warm air rises, other air has to fall. Beyond 20 degrees north or south, descending air generally blocks storm formation. It is possible, though, that warmer seas will allow hurricanes to travel further out of the tropics after they have formed.

Can we rely on past measurements made by planes flying through the eye of a hurricane?

"If we can understand why the world sees 85 storms a year, and not 25 or 200, then we could say what global warming will do"
THE BIRTH OF A HURRICANE

A tropical cyclone has different names depending on its size and strength.

Tropical disturbance
A cluster of thunderstorms forms in an area with sea surface temperatures above 26°C, pushing warm, humid air up into the atmosphere.

Tropical depression
The pressure falls as the thunderstorms grow bigger and start to merge. As air flows towards the low pressure zone, it picks up more energy from the warm sea surface and also starts to rotate due to Coriolis forces. Wind speeds up to 63 km/h.

Tropical storm
The system takes on a circular shape as it becomes more organised, with a clear centre. Wind speeds up to 117 km/h, with heavy rain.

Tropical hurricane
The storm turns into a highly organised hurricane as wind speeds exceed 117 km/h. A relatively calm "eye" cloud-free zone forms at the eye, surrounded by spiral rain bands.

With all these uncertainties and contradictions, it is not surprising that different computer models have predicted everything from fewer hurricanes to more hurricanes as global warming kicks in. It doesn’t help that even the best models are not that good at predicting hurricanes in today’s world. “If we can understand why the world sees about 85 named storms a year and not, for example, 200 or 25, then we might be able to say more about what we’d expect in a global warming scenario,” says Peter Webster of the Georgia Institute of Technology in Atlanta. “Without this understanding, forecasts are merely statistical extrapolation.”

It gets worse. Another complication is whether climate change will encourage or discourage the natural climatic cycles that are known to influence the virulence of hurricane seasons. El Niño, the periodic reversal of wind and ocean currents in the equatorial Pacific, is a key player here. During an El Niño event, the warm waters of the tropical western Pacific spread east and the zone where thunderstorms can form spreads with them. Result: more hurricanes for the year or so that the event lasts. El Niños have the opposite effect in the tropical Atlantic, where they disrupt hurricane formation by increasing westerly winds high in the atmosphere.

But Atlantic hurricanes also have longer-term cycles. The last upsurge ran from the 1940s to the 1960s. The current one has been running for a decade and could last another 20 years. The driver for this cycle appears to be changes in the Atlantic circulation system known as the ocean conveyor, which powers the Gulf Stream.

There are other factors at work, too. Atlantic storms mostly form in the waters off west Africa and are more likely when this region is wet. This may be because during dry years in West Africa, dry, dusty winds blow over the Atlantic, disrupting hurricane growth. But none of this helps much with predicting hurricanes in a warmer world. No one is clear what global warming will do to El Niño. Climate change may or may not shut down the ocean conveyor. The Sahara could get wetter, but then again it might get drier.

Faced with such overwhelming uncertainty, until recently researchers all agreed that predicting exactly how global warming will change hurricane patterns in specific regions is impossible. As for the global picture, theory and the latest models suggested only a small increase in intensity in the future.
Kevin Trenberth of the National Center for Atmospheric Research in Boulder, Colorado, was the first to break ranks. In October 2004, after a record Atlantic hurricane season, he sparked controversy when he claimed that global warming was already making a difference: "High sea surface temperatures... make for more intense storms and this is consistent with the evidence that we're seeing."

Trenberth's claim infuriated Landsea, who was then working with Trenberth on a chapter for the next Intergovernmental Panel on Climate Change report on, among other things, hurricanes. Landsea promptly resigned from the IPCC. "I cannot... continue to contribute to a process that I view as both being motivated by preconceived agendas and being scientifically unsound," he wrote. Ouch.

But this August, Emanuel published a study suggesting that not only is Trenberth right, but the trend is already far greater than expected. After trawling records of hurricane intensity worldwide for the past half-century, Emanuel concluded that on average storms are lasting 60 per cent longer, with wind speeds up to 15 per cent higher (Nature, vol 436, p 686). This may sound small, but the damage done by a hurricane is proportional not to the wind speed, but to the wind speed cubed. The results suggest the destructive power of a typical hurricane has increased by 70 per cent. "This work implies that global tropical cyclone activity is responding in a rather large way to global warming," Emanuel says. "I was one of the sceptics myself a year ago," he adds.

A month later, Webster and Greg Holland of NOAA also published evidence supporting Trenberth (Science, vol 308, p 1853). "We went about this business because we did not believe his allegation that what has happened with Atlantic hurricanes is due to global warming," says Webster. "We finished up thinking his conclusions were partly right."

While there has been no overall increase in the number of hurricanes, Webster and Holland conclude that the frequency of the strongest storms has almost doubled since the early 1970s. The trend, they say, is global and clearly connected to the worldwide rise in sea surface temperatures. That makes it extremely unlikely to be caused by natural cycles, which are relatively short-term and confined to single ocean basins. "We can say with confidence that the trends in sea surface temperatures and hurricane intensity are connected to climate change," Curry declared.

The controversy has grown bitter. In a

"We went about this because we did not believe what has happened in the Atlantic is due to global warming. We finished up thinking it is in part"
Tropical storms and hurricanes form only in narrow zones north or south of the equator during summer or autumn, when the sea surface temperature exceeds 26.5°C and humidity is high and winds are light.

Tropical storm paths up to October →

Detailed response posted on his website in mid-October (http://tropical.atmos.colostate.edu), Gray claims that Emanuel’s calculations “are not realistic”, while Webster’s findings are “not physically plausible.” Webster points out that Gray has contributed to only one paper on global warming and hurricanes. “We are responding to a person who has not done the research.”

So what is the controversy about? Put simply, Gray believes that both papers are based on bad data. In particular, he says, measurements from flights through typhoons between 1973 and 1986 in the western Pacific, the largest area of hurricane activity, cannot be relied upon. During this period, a new method for converting raw measurements into estimates of wind speeds was adopted that, all researchers now accept, produced systematic underestimate. This polluted Emanuel’s calculations, Gray says, and provided most of the baseline for Webster’s claims of an increase in category 4 and 5 hurricanes.

“If we disregard this anomalous period...we see little difference,” Gray says. Exclude the bad data, he concludes, and there are no trends to speak of outside the North Atlantic — and there the recent upsurge is due to a well-established natural cycle.

Neither Emanuel nor Webster deny that there are problems with data consistency, but they both say they have made appropriate corrections. And Emanuel did tweak his corrections to Atlantic data in September after discussions with Landsea (http://wind.mit.edu/~emanuel), “Gray has not brought to my attention any difficulties with the data of which I was not already aware and had corrected for,” Emanuel says. The more reliable records of air pressure in the eye of hurricanes provide a means of checking the validity of the wind speed measurements, he points out.

Webster says his figures all come from the period after 1970, when satellite measurements can corroborate those from aircraft. He accuses Gray of “grasping at thin air”.

Super Typhoon Tip

Part of the reason for the dispute may be the different perspectives of the protagonists. Gray’s forecasts are largely based on what happened when conditions were similar in the past. The business of climate researchers is to disentangle long-term trends — to look for differences, not similarities. Likewise, Gray’s main interest is the 10 per cent of hurricanes that occur in the Atlantic, where everyone acknowledges that, whatever part climate change is playing, the natural cycle is still the dominant factor driving storm frequency and intensity. Webster and Emanuel are equally concerned with the other 90 per cent of hurricanes around the world.

So where does that leave us? There is as yet nothing extraordinary about recent hurricanes. The storm that hit Galveston, Texas, in 1900 killed more people than Katrina in 2005. Both pale compared with the East Pakistan hurricane of 1970, which probably killed half a million people in what is now Bangladesh. And the largest and most powerful hurricane ever recorded occurred in 1979. Typhoon Tip had a central pressure of just 870 millibars, wind speeds of 300 kilometres per hour and a diameter of 214 kilometres. Luckily, it had weakened greatly before it swept over Japan.

It is also pointless to argue about whether any recent individual hurricanes have been made worse by global warming — it is simply impossible to know. In fact, Emanuel estimates that it will take 50 years to detect a clear trend in the intensity of hurricanes hitting the US, because the numbers are so low. But in the North Atlantic as a whole, the large upswing in hurricanes in the last decade is “unprecedented, and probably reflects the effect of global warming”, he declared in his Nature paper.

Evidence, then, is starting to emerge of a human fingerprint in hurricane trends. It is not yet proof, but neither can it be ignored. And perhaps the most striking finding of both Emanuel and Webster is the strong link between sea surface temperature and storm strength (see Graphic, page 40). At least for now, the simplistic view that warmer seas mean stronger hurricanes is holding true.

What worries a growing number of researchers is the possibility that this trend will continue, that hurricanes will respond to the increasing amounts of energy swirling around in a warmer world by becoming substantially stronger. We might be, to put it simply, throwing more fuel on the fire.

Even small increases in wind speed, rainfall or the level of storm surges can have huge implications for the damage a hurricane causes, and for the likely death toll. On the other hand, the impact could be greatly reduced if we prepare for the worst: stopping development in the most vulnerable areas and making buildings and infrastructure more wind and flood-proof. Perhaps the question planning authorities should be asking is not, "Are Emanuel and Webster right?", but "Can we afford to bet on them being wrong?". It’s a question occupying Corky Perret, too.
ARE WE MAKING HURRICANES WORSE?

THE IMPACT OF GLOBAL WARMING
THE COST OF COASTAL DEVELOPMENT
PLUS: CHARTING THE GULF COAST DESTRUCTION

Oct 3, 2005
GLOBAL WARMING: THE CULPRIT?

TIME says YES.

COVER

Rita's Ride She blew ashore weaker than Hurricane Katrina but still spawned floods and fires—and left millions in evacuee hell. From Louisiana to Texas, a TIME special report.......................... 30

COOKING UP STORMS: Category 5 hurricanes are more common than ever. Even skeptics now wonder: Is global warming to blame? ....... 40

40 A increasingly warm ocean waters may be fueling more killer storms

RISING STORM:
Galveston, Texas, emptied out as Rita closed in, leaving a solitary cyclist to brave a lonely pier

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Evidence mounts that human activity is helping fuel these monster hurricanes

By JEFFREY KLUGER

Nature doesn't always know when to quit—and nothing says that quite like a hurricane.

Says climatologist Judy Curry, chair of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology: "The so-called once-in-a-lifetime storm isn't even once in a season anymore."

"There is no doubt that climate is changing and humans are partly responsible," says Kevin Trenberth, head of the climate-analysis section at the National Center for Atmospheric Research (NCAR) in Boulder, Colo. "The odds have changed in favor of more intense storms and heavier rainfalls." Says NCAR meteorologist Greg Holland: "These are not small changes. We're talking about a very large change."

But do scientists really know for sure?

The warmest year ever recorded was 1998, with 2002, 2003 and 2004 close behind it. So that ought to mean a lot more hurricanes, right? Actually, no—which is one of the reasons it's so hard to pin these trends down. The past 10 stormy years in the North Atlantic were preceded by many very quiet ones—all occurring at the same time that global temperatures were marching upward. Worldwide, there's a sort of equilibrium. When the number of storms in the North Atlantic increases, there are fewer elsewhere.

How much is global warming to blame?

Since ocean heat gives hurricanes their power, it's reasonable to conclude that global warming is at least indirectly responsible for the increase in powerful storms—but skeptics do remain.

Intense storms: the number of Categories 4 and 5 storms—the most powerful ones—has climbed dramatically. In the 1970s, there were an average of 10 Category 4 and 5 hurricanes a year worldwide. Since 1990, the annual number has nearly doubled, to 18. Overall, the big storms have grown from just 20% of the global total to 35%. "We have a sustained increase in hurricane intensity over 30 years all over the globe," says Holland.

The main message:

The power of strong hurricanes has jumped by 50% in 30 years. There are now many more intense storms.

Be careful—next page
The TIME story (Oct 3-05) did include some doubts. Political Passions

Thus scientific uncertainty enters the debate—a debate already intensified by the political passions that surround any discussion of global warming. The fact is, there is plenty of room for doubt on both sides of the argument. Chris Landsea, a science and operations officer at the National Hurricane Center in Miami, is one of many experts who believe that global warming may be boosting the power of hurricanes—but only a bit, perhaps 1% to 5%. "A 100-mile-per-hour wind today would be a 105-mile-per-hour wind in a century," he says. "That is pretty tiny in comparison with the swings between hurricane cycles."

Maybe a small boost: 0% to 5% by yr 2100.

Expected hurricane changes rather small, not big.

Time again says that the global warming change is huge.

Even correcting for our tendency to pay more attention to what is happening in our backyard, however, the global census of storms and the general measurement of their increasing power don't lie. And what those measurements tell scientists is that this already serious problem could grow a great deal worse—and do so very fast.

- The problem is now serious.
- It could get a lot worse.
- It could get worse very fast.

Changes in hurricane data

Skeptics are also troubled by what they see as a not inconsiderable bias in how hurricane researchers collect their data. Since most hurricanes spend the majority of their lives at sea—some never making land at all—it's impossible to measure rainfall precisely and therefore difficult to measure the true intensity of a storm.

What's more, historical studies of hurricanes like Emanuel's rely on measurements taken both before and during the era of satellites. Size up your storms in radically divergent ways, and you're likely to get radically divergent results. Even after satellites came into wide use—adding a significant measure of reliability to the data collected—the quality of the machines and the meteorologists who relied on them was often uneven. "The satellite technology available from 1970 to 1989 was not up to the job," says William Gray of Colorado State University. "And many people in non-U.S. areas were not trained well enough to determine the very fine differences between, say, the 130-m.p.h. wind speed of a Category 4 and, below that, a Category 3."

Be careful

This issue has been getting more and more hyped, especially since Jan 2005.
Evidence mounts that human activity is helping fuel these monster hurricanes

By JEFFREY KLUGER

Nature doesn't always know when to quit—and nothing says that quite like a hurricane. The atmospheric convulsion that was Hurricane Katrina had barely left the Gulf Coast before its sister Rita was spinning to life out in the Atlantic. In the three weeks between them, five other named storms had lived and died in the warm Atlantic waters without making the same headlines their ferocious sisters did. With more than two months left in the official hurricane season, only Stan, Tammy, Vince, and Wilma are still available on the National Hurricane Center's annual list of 21 storm names. If the next few weeks go like the past few, those names will be used up too, and the storms that follow will be identified simply by Greek letters. Never in the 52 years we have been naming storms has there been a Hurricane Alpha.

If 2005 goes down as the worst hurricane season on record in the North Atlantic, it will join 2004 as one of the most violent ever. And these two seasons are part of a trend of increasingly powerful and deadly hurricanes that has been playing out for more than 10 years. Says climatologist Judy Curry, chair of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology: "The so-called once-in-a-lifetime storm isn't even once in a season anymore."

Head-snapping changes in the weather like this inevitably raise the question, is global warming to blame? For years, environmentalists have warned that one of the first and most reliable signs of a climatological crash would be an upsurge in the most violent hurricanes, the kind that thrive in a suddenly warmer world. Scientists are quick to point out that changes in the weather and climate change are two different things. But now, after watching two Gulf Coast hurricanes reach Category 5 in the space of four weeks, even skeptical scientists are starting to wonder whether something serious might be going on.

"There is no doubt that climate is changing and humans are partly responsible," says Kevin Trenberth, head of the climate-analysis section at the National Center for Atmospheric Research (NCAR) in Boulder, Colo. "The odds have changed in favor of more intense storms and heavier rainfalls." Says NCAR meteorologist Greg Holland: "These are not small changes. We're talking about a very large change."

But do scientists really know for sure? Can man-made greenhouse gases really be blamed for the intensity of storms like Rita and Katrina? Or are there, as other experts insist, too many additional variables to say one way or the other?

That global warming ought to, in theory, exacerbate the problem of hurricanes is an easy conclusion to reach. Few scientists doubt that carbon dioxide and other greenhouse gases raise the temperature of Earth's atmosphere. Warmer air can easily translate into warmer oceans—and warm oceans are the jet fuel that drives the hurricane's turbine. When Katrina hit at the end of August, the Gulf of Mexico was a veritable hurricane refueling station, with water up to 5°F higher than normal. Rita too drew its killer strength from the Gulf, making its way past southern Florida as a Category 1 storm, then exploding into a Category 5 as it moved westward. "The Gulf is really warm this year, and it's just cooking those tropical storms," says Curry.

Local hot spots like this are not the same as global climate change, but they do appear to be part of a larger trend. Since 1970, mean ocean surface temperatures worldwide have risen about 1°F. Those numbers have moved in lockstep with global air temperatures, which have also inched up a degree. The warmest year ever recorded was 1998, with 2002, 2003 and 2004 close behind it.

So that ought to mean a lot more hurricanes, right? Actually, no—which is one of the reasons it's so hard to pin these trends down. The past 10 stormy years in the North Atlantic were preceded by many very quiet ones—all occurring at the same time that global temperatures were marching upward. Worldwide, there's a sort of equilibrium. When the number of storms in the North Atlantic increases, there is
HURRICANE RITA

A VICIOUS CYCLE

Over the past 35 years, the number of hurricanes each season has remained constant, but their average intensity has increased, with the number of Category 4 and 5 storms—the most powerful—nearly doubling. Given the swelling populations along the coasts, the danger from monster hurricanes like Rita and Katrina has risen dramatically.

1. AREAS OF LOW PRESSURE over the ocean draw in air from surrounding, higher-pressure areas. The earth’s rotation makes those winds spiral counterclockwise in the northern hemisphere.

2. MOIST AIR WARMED by the heat of the ocean rises through the storm, intensifying the suction effect. Eventually, the storm dumps some of its water as rain, which falls away and can then be pulled in again.

3. IF STRONG ATMOSPHERIC WINDS don’t break this cycle, the storm becomes a hurricane when spiraling air speeds reach 74 m.p.h. (119 km/h), forming a vortex of rain-laden clouds that circle a calm eye.

Usually, a corresponding fall in the number of storms in, say, the North Pacific. Over the course of a year, the variations tend to cancel one another out. "Globally," says atmospheric scientist Kerry Emanuel of the Massachusetts Institute of Technology, "we do not see any increase at all in the frequency of hurricanes."

But frequency is not the same as intensity, and two recent studies demonstrate that difference. Two weeks ago, a team of scientists that included Curry and Holland published a study in the journal Science that surveyed global hurricane frequency and intensity over the past 35 years. On the whole, they found, the number of Category 1, 2, and 3 storms has fallen slightly, while the number of Categories 4 and 5 storms—the most powerful ones—has climbed dramatically. In the 1970s, there were an average of 10 Category 4 and 5 hurricanes a year worldwide. Since 1990, the annual number has nearly doubled, to 18. Overall, the big storms have grown from just 20% of the global total to 35%. "We have a sustained increase [in hurricane intensity] over 30 years all over the globe," says Holland.

Emanuel came at the same question differently but got the same results. In a study published in the journal Nature last month, he surveyed roughly 4,800 hurricanes in the North Atlantic and North Pacific over the past 56 years. While he too found no increase in the total number of hurricanes, he found that their power—measured by wind speed and duration—had jumped 50% since the mid-1970s. "The storms are getting stronger," Emanuel says, "and they’re lasting longer."

Several factors help feed the trend. For example, when ocean temperatures rise, so does the amount of water vapor in the air. A moister atmosphere helps fuel storms by giving them more to spit out in the form of rain and by helping drive the convection that gives them their lethal spin. Warm oceans produce higher levels of vapor than cool oceans—at a rate of about 1.3% more.
Hurricanes...are getting more powerful...causing a lot more damage

**How much is global warming to blame?**

Since ocean temperatures are rising, hurricanes tend to be longer and stronger. Scientists estimate that global warming could lead to a 30% increase in the intensity of hurricanes. However, other factors like El Niño and La Niña also play a role in the formation of hurricanes. The increase in ocean temperature due to global warming is a significant contributor to the increase in hurricane strength and duration.
HURRICANE RITA  GLOBAL WARMING

There’s a subtler, less scientific bias going on, one driven not by the raw power of the storms but by where they do their damage. Hurricanes that claw up empty coasts don’t generate the same headlines as those that strike the places we like to live—and increasingly we like to live near the shore. The coastal population in the U.S. jumped 28% between 1980 and 2003. In Florida alone, the increase was a staggering 75%. Even the most objective scientists can be swayed when whole cities are being demolished by a hurricane.

“The storm activity this year is not necessarily higher than in previous high-activity years. It’s just where they are going,” says meteorologist Stan Goldenberg of the National Oceanic and Atmospheric Administration in Key Biscayne, Fla. “If you’ve suddenly it turns into steam.) Ice cores taken from Greenland in the 1990s by geoscientist Richard Alley of Pennsylvania State University show that the last ice age came to an end not in the slow creep of geological time but in the quick pop of real-time, with the entire planet abruptly warming in just three years.

“There are thresholds one crosses, and change runs a lot faster,” Alley says. “Most of the time, climate responds as if it’s being controlled by a dial, but occasionally it acts as if it’s controlled by a switch.” Adds Laurence Smith, an associate professor of geography at UCLA who has been studying fast climate change in the Arctic: “We face the possibility of abrupt changes that are economically and socially frightening.”

Do we have the time to avert even a relatively slow climate change, or at least the nimbleness to survive it? That’s what a lot of scientists are trying to determine, Japanese climatologists, for example, are using the Earth Simulator in Yokohama—one of the most powerful supercomputers in the world—to develop climate models that are more and more sophisticated. Scientists like geologist Claudia Mora of the University of Tennessee at Knoxville are going in another direction, studying isotopes locked in old tree rings to look for clues to past eras of heavy and light rainfall. Pair that information with global-temperature estimates for the same periods, and you can get a pretty good idea of how heat and hurricanes drive each other. “We’ve taken it back 100 years and didn’t miss a storm,” said Mora.

It’s impossible to say whether any of that will convince the lingering global-warming skeptics. What does seem certain is that the ranks of those skeptics are growing thinner. In Washington successive administrations have ignored greenhouse warnings, piling up environmental debt the way we have been piling up fiscal debt. The problem is, when it comes to the atmosphere, there’s no such thing as creative accounting. If we don’t bring our climate ledgers back into balance, the climate will surely do it for us. —Reported by Mike Billips/Atlanta, Rita Healy/Denver, Kristin Kleberdanz/Chicago, Terry McCarthy/Los Angeles and Siobhan Morrissey/Miami

FIRE AND RAIN  As Rita approached, fire fighters fought to contain a blaze in three downtown Galveston buildings in near hurricane-force winds

got a guy shooting a machine gun but he’s not shooting toward your neighborhood, it doesn’t bother you.”

Even correcting for our tendency to pay more attention to what is happening in our backyard, however, the global census of storms and the general measurement of their increasing power don’t lie. And what those measurements tell scientists is that this already serious problem could grow a great deal worse—and do so very fast.

Some scientists are studying not just climate change but the even more alarming phenomenon of abrupt climate change. Complex systems like the atmosphere are known to move from one steady state to another with only very brief transitions in between. (Think of water, which when put over a flame becomes hotter and hotter until it suddenly turns into steam.)
CLIMATE CHANGE: Ga. Tech researcher links hurricanes to global warming, attacks climate skeptics

An increasing number of scientists say there is a connection between rising ocean temperatures and stronger hurricanes, with major studies on the subject published recently in journals such as Science and Nature. In today's OnPoint, Judith Curry, a professor at Georgia Tech's School of Earth and Atmospheric Sciences and the co-author of a recent study, explains some of her findings. Curry also addresses criticism of her research and the heavily politicized world of climate science. Plus, she claims that a recent hearing on global warming chaired by Sen. James Inhofe (R-Okla.) excluded key members of the scientific community.

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Transcript

CLIMATE CHANGE: Ga. Tech researcher links hurricanes to global warming, attacks climate skeptics

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Brian Stempeck: Hello and welcome to OnPoint. I'm Brian Stempeck. Joining us today to talk about climate change and hurricanes is Dr. Judith Curry, a professor at Georgia Tech. Dr. Curry thanks a lot for being here today.

Judith Curry: My pleasure Brian.

Brian Stempeck: Now you're the author of a study that was published in the Journal of Science in September. You were one of the
authors talking about how warmer oceans may have been behind some of the stronger hurricanes that we're seeing. Give us a sense of the findings of this report.

Judith Curry: OK. What we did was we look at the period from 1970 to 2004 and we chose this period because this is a period where we have satellite coverage and we can actually look at the global population of hurricanes. What we found was over this period that there was no increase in the number of storms, however the strongest storms, Category 4 and 5 storms, the number of those had almost doubled over this period. And we found this in every ocean basin where they have hurricanes, Pacific, Indian Ocean, as well as the Atlantic. And at the same time this increase of number of Category 4 and 5 storms seems to map with the increase in sea surface temperature over this period. And we put forth a hypothesis that the increase in sea surface temperature was resulting in a global increase in the intensity of the strongest, of hurricanes.

Brian Stempeck: Now a lot of people would say, some of the criticism of this report is saying that you only went back to 1970. So is this enough of a set of data to take a look at this and say this enough for a trend?

Judith Curry: OK, well, you never have all the data you want. As far as the climate data record goes the quality of this data is pretty high. Now if you go back in time during the period 1945 to 1970 we have information about Atlantic and North Pacific hurricanes, but this is only about 15 percent of the global hurricanes. If you go back further in time, say to 1900, we have information about U.S. land falling hurricanes, but that's only 2 percent of the population of global hurricanes. And you can't draw any inferences about what's going on globally from what's going on with U.S. land falling hurricanes. So we simply don't have the information to go back earlier than 1970 to talk about global hurricanes characteristics.

Brian Stempeck: Some people say that this is opportunistic though. We see a major hurricane hit New Orleans and then immediately afterwards we see a lot of environmental groups, Democrats, leaders in Europe come in and say, look, climate change is causing these hurricanes and that's the reason why this is happening. Do you think ...

Judith Curry: OK. There were two papers, Kerry Emanuel's paper which was submitted in spring. Our paper was submitted around the first of July. These were submitted before the 2005 hurricane season. The timing of the publication of these papers obviously coincided with some major hurricanes. We did not plan this in advance, so we had no, it just was a luck of timing that our papers came out right at the time of these very intense hurricanes. So as scientists we're not personally being opportunistic, but certainly the coincidence of these two papers and the two very strong hurricanes that hit the U.S. has certainly focused attention on the subject.

Brian Stempeck: Let's go back to your study a little bit. You mentioned that this is basically a hypothesis saying that the warmer seas could be causing the stronger hurricanes. But at same time I saw interviews with some of the report authors, including yourself, where people say that we're not making a direct correlation here. We're not saying that this is definitely the case.

Judith Curry: Well, OK, they're correlated. The sea surface temperature and the hurricane intensity are definitely correlated. In terms of causality, a correlation does not prove causality. However, we have strong theoretical underpinnings. We have observational, additional observational evidence and also climate modeling simulations that help us understand how this works in terms of increase of sea surface temperatures causing increase in hurricane intensity. There was a beautiful example of how this works and we saw Rita, a little tropical storm before it hit the gulf. Then it went into the gulf. The gulf with several degrees warmer than usual. It intensified and when it went over this very warm loop current it went from a 2 to a 5 in one afternoon. It moved off the very warm loop current and then went down to a 5. You could see how this increase in sea surface temperature was fueling Rita very vivdly. I mean sea surface temperature isn't the only factor, but it's certainly is a major factor in determining hurricane intensity.

Brian Stempeck: Do you think there's a scientific consensus on this issue, when you're talking about warmer water leading to stronger hurricanes and climate change being behind that?
Judith Curry: OK. From a statistical point of view, yes, but you can't make the statement about every single storm. Some storms will go over warm water and they won't intensify and this may be for a variety of reasons. It may be because of wind shear, and maybe some dry air moving in at higher levels, that's sort of shutting down the convection. So there's a number of reasons where you can go over warm water and not have a hurricane intensify. So it doesn't hold for every individual storm, but it holds statistically.

Brian Stenpeck: But as far as the consensus though that, I mean we hear a lot that climate change might lead to stronger storms in the future. Do you think there is consensus on that issue?

Judith Curry: Probably, but the issue that people, the key part of the debate is whether the increase in sea surface temperature, that we see, is caused by greenhouse warming or whether it's natural variability. That's where most of the debate is centered around, although people who don't like that conclusion are looking to find other aspects of our argument to pick on, but it's really not holding up. The key issue debate is really whether or not this increase in sea surface temperature is associated with the burning of fossil fuels.

Brian Stenpeck: Now one of the major critics of these kinds of studies is William Gray who's a professor at Colorado State and one of the, I guess you could say one of the first major hurricane forecasters. What he says, one of the criticisms that he brought up about the MIT study and your own, was saying that at the same time that in the Atlantic Ocean you have these hurricanes increasing in strength and a greater number of them. He said you don't see that in the other hurricane basins. I know you just said the opposite of that.

Judith Curry: OK. You do, Bill Gray, to my knowledge, has never published any research on global hurricane statistics, OK? He hasn't looked carefully at the hurricanes in other basins. If he has he hasn't published this. So he's making a statement that is not supported in the scientific literature. So I don't really have an answer for that. The data that we use is publicly available data. You can pull it off the Web site, OK? If he has some secret data set that I don't know about, it's just not out there in the published literature for scientists to look at. So it's not a real useful statement.

Brian Stenpeck: Now at the same time though even these other people have criticized this as well, you have Max Mayfield, who's the head of the National Hurricane Center and who recently testified before Congress. And he said that warmer water is probably only caused hurricanes to get about 5 percent stronger. He is, again, disagreeing with your study.

Judith Curry: OK. He's basing that on climate model projections, simulations. Now climate, these are the same people who say there is no greenhouse warming, but then they're believing one particular prediction of a climate model. The climate models do a good job at predicting sea surface temperature. They don't do a great job at predicting precipitation or hurricane intensity. So that conclusion is less robust. I mean look at even the weather forecast of hurricanes. They can do a good job on the track. They do not do the job on intensity. There are some very complex things going on in intensity that we don't do very well with the models. So using a climate model projection to disprove our data set doesn't quite make sense. We should be using our data to test the models, not the models to discredit our data.

Brian Stenpeck: Clearly this is a very touchy subject when you're talking about politicians dealing with climate science. And this is an issue we've been hearing about as White House officials resign or the White House comes under fire for certain things it did to an EPA report on climate change. We've also talked a little bit about Senator [James] Inhofe holding hearings on climate change. Do you think that science and politics is getting too muddled and what's the solution to that?

Judith Curry: It is extremely muddled. In a rational society you look at the scientific evidence. There's a lot of political motivation going on and discrediting research related to greenhouse warming. And I'm having a hard time trying to understand where that's coming from because a lot of the energy companies seem to get it, the financial sector seems to get it. It's not a simple, a lot of Christians seem to understand this problem.
Brian Stempeck: There's a wide diversity of people.

Judith Curry: There's a wide diversity of people, so I don't understand why a certain group of politicians and the media are so vehement against us. I don't understand.

Brian Stempeck: Well, what does it say to you that we saw Senator Inhofe have a hearing in the Environment and Public Works Committee last week and Michael Crichton, the author of a global warming was invited to testify?

Judith Curry: OK, they invited two people to testify. Michael Crichton, the author, and Bill Gray, who's an anti-greenhouse warming person. The American Association for the Advancement of Science, who publishes the Journal of Science, tried to get Peter Webster to ...

Brian Stempeck: He's the co-author of this report.

Judith Curry: ... give testimony. He was the lead author of the report. They tried to get him to be invited. They would not invite him, instead the AAAS was able to setup a briefing that Peter Webster did, off the record so to speak, to the congressional aides of the people on the committee, but they would not allow him to make testimony for the Congressional Record.

Brian Stempeck: Do you think that's an isolated incident? I mean is it just Senator Inhofe or do you think it's the rest of Congress who's missing this message?

Judith Curry: Not the rest of Congress, about half of Congress. Again, it's become very politicized and when you're in an environment where people choose not to believe in evolution because it goes against their religious beliefs that opens the door to choosing not to believe other scientific evidence because it's inconvenient. I mean it's anti-capitalist or it's inconvenient or whatever. We're starting to see a lack of rationality, where people are discounting science.

Brian Stempeck: Do you think politicians are missing a real wake-up call here? I mean you have the study from Dr. Emanuel, you have the study from yourself.

Judith Curry: They're missing a real wake up call. With the hurricane problem, I mean we have to do some serious adaptation to face this problem in terms of the engineering and disaster management and stuff that we need to do for our coastal regions. In terms of the burning of fossil fuel issue, I mean it's already too late for us to do anything that's going to help the hurricane problem in the short term. Not that we shouldn't do something about greenhouse gas emissions for longer term issues, but it's already too late to save us from problems that we're facing over the next few decades.

Brian Stempeck: Because the carbon dioxide is really ...

Judith Curry: It's high and it's not going to go low. There's nothing that's going to bring those temperatures back down to the levels they were in the 1970s over the next few decades.

Brian Stempeck: One last question for you. The American public also doesn't seem to be totally getting the message here. There was a survey done by the Washington Post and they found that about 56 percent of the people think global warming is happening. That was about the same as six months ago, even after the hurricane. Do you think that message is also getting lost with American citizens?
Judith Curry: It is. We're making progress. Ten years ago we were having the debate as to whether the earth was warming or not. Most people think that the earth is now warming, but they attribute it to natural causes rather than to burning of fossil fuel. So the terminology global warming is getting convoluted in terms of whether it means the temperatures are increasing or whether it means that burning of fossil fuels is actually the cause. So people interpret global warming in different ways.

Brian Stetmpeck: Do you think the American public though understands how much of a problem this is?

Judith Curry: The most visible issues have been the warming in the Arctic and also like the melting of the Peruvian glaciers and while there are certainly socioeconomic impacts associated with this and very visible, you can see the glaciers shrinking, it hasn't been a crisis. But if global warming, greenhouse warming, is causing an increase in intensity of hurricanes, like Katrina, then we have a catastrophe and crisis on our hands. And it's this sort of crisis potential that has gotten people's attention in a way that the melting of the ice caps in the Arctic and the Peruvian glaciers hasn't really captured the public's attention. I mean everybody felt the effects of Katrina. Again, when we went to the gas pumps and had to pay a very high prices for gas right after Katrina and seeing refugees from Katrina in our own communities. So everybody in the U.S. is feeling that in a way that we haven't, weren't impacted by stories about the Arctic and the Peruvian glaciers.

Brian Stetmpeck: All right. Dr. Curry we're out of time. We're going to stop there. I'd like to thank our guest today that was Dr. Judith Curry of Georgia Tech. I'm Brian Stetmpeck. This is OnPoint. Thanks for watching.

[End of Audio]

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CLIMATE CHANGE: Ga. Tech researcher links hurricanes to global warming, attacks climate skeptics

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Author Chris Mooney points to political meddling on climate science (OnPoint, 09/29/2005)
President's Corner

Hurricane Katrina: An act of God?

"Act of God: an extraordinary interruption by a natural cause (as a flood or earthquake) of the usual course of events that experience, prescience, or care cannot reasonably foresee or prevent."

—Merriam-Webster Online Dictionary

More than two months after Hurricane Katrina tore into Louisiana and Mississippi, causing one of the worst “natural” disasters in U.S. history, it is a challenging task to say something that hasn’t been said already about this storm. There are so many fascinating and horrifying strands to the story: short-term forecasting success, planning and response failure, population growth in a vulnerable area, development in sensitive protective wetlands, economic inequality, land subsidence and sea-level rise, and climate change.

There can be little doubt that the failure of society and government on all levels contributed so much to this disaster that it can hardly be called an act of God. Years of warning about the vulnerability of New Orleans and the Gulf Coast produced no focused, coordinated government response to guard against the well-known risks. Indeed, human activities over the years actually worsened the problem; for example, the development of fragile wetlands that had helped protect inland areas exacerbated the risk and vulnerability. Plans for responding to the inevitable emergency were not executed promptly when it occurred, and while a horrified nation watched the disaster unfold on television, government at all levels remained paralyzed for more than three days before acting. Thus, in spite of a nearly perfect 60-hour forecast of the hurricane track and landfall position (see figure below left) and a good forecast of hurricane intensity, hundreds of people unnecessarily lost their lives, and property damage ran into the billions of dollars. Some estimates put the total costs at well over $100 billion.

This is not to say at all, however, that the slowness of government response and the societal issues associated with a huge underclass living in a bowl below sea level made the forecasts irrelevant. To the contrary, roughly 80% of the population of about a million people were given more than two days of warning and were able to evacuate to safety, many of them carrying irreplaceable personal property and records. Without this warning, many more lives would have been lost, and police, fire departments, and emergency response teams—stretched extremely thin as it was—would have had five times the number of people to evacuate from the wind, floods, and chaos. Thus the excellent forecasts proved their worth, and the wisdom of government investments in the weather forecast and warning enterprise over the years was well justified.

The Tropical Prediction Center (TPC) of the National Weather Service deserves enormous credit for its life-saving forecasts and warnings, and I join many colleagues in the community in congratulating them. It is worth noting, however, that the TPC stands at the most visible end of a complex scientific and technological system that has taken years to develop, and much of this system is largely invisible to the public and to most policy makers. It is worthwhile summarizing the reasons that the Katrina forecasts were as accurate as they were, where they could have been improved, and how to ensure that forecasts of future hurricanes are as good as possible.

"New Orleans is a disaster waiting to happen."
—Scientific American, October 2001

"Hundreds of thousands would be left homeless, and it would take months to dry out the area and begin to make it livable . . . but officials say that right now, nothing can stop ‘the big one.’"

—New Orleans Times-Picayune, October 2001 (see “On the Web”)

"Power outages will last for weeks . . . as most power poles will be down and transformers destroyed. Water shortages will make human suffering incredible by modern standards."

—Special weather statement, National Weather Service, Slidell, Louisiana, 10:11 a.m. CDT, Sunday, 28 August
The accuracy of forecasts of hurricane tracks has been increasing steadily over the years (right), and especially over the last decade. The reasons for this steady increase include five important and essential factors:

- the increasing diversity, accuracy, and coverage of atmospheric and ocean observations, especially satellite observations;
- better use of the billions of observations through the assimilation of the observations in numerical weather prediction (NWP) models;
- better NWP models, including higher resolutions and more accurate treatment of physical processes such as clouds, precipitation, radiation, and boundary layer effects; and
- more powerful computers that make it possible to assimilate the observations into the models and run the models fast enough in real time to be useful to forecasters.

Overarching all four of these factors is the fifth: scientific advances that allowed researchers and engineers to build the satellites and their instruments, to process the data, to

(continued on p. 4)

Hurricanes and global warming

The possible relationship of Hurricane Katrina and other recent powerful hurricanes to global climate warming has been a topic of much speculation in the media and scientific community. This is a complicated, important scientific topic that is currently under study, and 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). However, a few well-accepted facts appear relevant.

1. Climate is changing. The atmosphere and tropical oceans are warming, and the water vapor in the atmosphere is increasing.

2. Tropical cyclones owe their existence to warm, moist tropical air and high sea-surface temperature.

3. The formation, intensity, size, and movement of tropical cyclones depend upon the large-scale atmospheric circulation and associated properties such as wind shear and static stability. Some aspects of large-scale circulation appear to be changing as the mean global climate warms.

Given these facts, there are several plausible ways that tropical cyclone characteristics could change in a warmer climate. It is tempting to hypothesize from (1) and (2) that both the frequency and the intensity of tropical cyclones will increase as Earth warms. However, hurricanes do not form everywhere in the tropics at once; at any given time, large-scale areas of ascent and descent tend to favor cyclone formation in some areas and disfavor it in others. Changes in these circulation patterns could have major implications, probably differing in different ocean basins. Two major studies this summer (see page 6) indicate a steady or even decreasing number of total tropical cyclones over the last several decades, coupled with greater intensities among the cyclones that do form. One possible explanation is that the climatological circulations and static stability distributions will become less favorable for tropical cyclogenesis, but the systems that do form will be more intense on average because of the higher ocean temperatures.

Whatever the relationship between hurricanes and global warming turns out to be, it is not likely to be simple, and we will never be able to attribute a single event like Katrina to a changed climate. We can only hope to understand changes in the statistics of many storms and their relationship to climate change.
assimilate them effectively in the models, and to improve the models. The excellent forecast shown on p.2 and the improvements over the years did not just happen by chance; they happened as the result of public investment in science and technology in government laboratories and universities by NASA, NSF, and NOAA. This includes basic research in mathematics, Earth science, and computer science, as well as the education and training needed to bring the research findings to fruition and benefit society. These reasons for the excellent forecast must be understood and remembered, and they form the foundation for a strategy to move forward to improve forecasts of hurricanes and other natural disasters in the future.

The recent NRC report Earth Science and Applications from Space: Urgent Needs and Opportunities to Serve the Nation (see “On the Web”) emphasizes the importance of the Earth sciences and their applications to meeting societal needs. Hurricane Katrina reiterates this point, yet there are ominous signs that the nation’s research and operational satellite programs are in danger. The NRC report sounded the alarm: “Today, this system of environmental satellites is at risk of collapse.” Additional threats to the nation’s satellite system have emerged since the report was released. Space News reports that NPOESS, the nation’s future polar orbiting satellite system, is having significant developmental and budget problems, and the originally projected launch in 2010 may be delayed as much as four years. We can only hope that the government response to the NRC warning is more effective than the response to the warnings about the vulnerability of New Orleans to a major hurricane.

But you might ask, Aren’t forecasts good enough already? How could we have improved on the forecast shown on p.2, and what good would it have done, given the overwhelming societal issues in this case? There are several ways of answering this. First, although the forecasts 60 hours in advance of landfall were excellent, forecasts at longer lead times (three days and beyond) were not nearly as good. Second, the forecasts for Katrina within 60 hours of landfall were better than most; the average 60-hour error in forecast hurricane position is approximately 260 kilometers (160 miles). Hurricane Rita, a second Category 5 system in the Gulf of Mexico just two weeks after Katrina, proved more challenging to predict. Although Rita made landfall well within the 48-hour forecast zone, the landfall location (near the Texas-Louisiana border) was well east of the three-day projections. If three- to four-day forecasts had more skill and greater certainty, the massive evacuation of Houston might have been avoided. So there is significant room for continued improvements, and there is every reason to believe these improvements are possible following the formula above.

Looking to the future, it is essential to do more than address the Katrina disaster and then carry on with business as usual. Katrina was not an isolated event, and similar disasters (winter storms, floods, droughts, earthquakes) will happen again and again. It is essential to learn from this disaster and act in fundamentally different ways to prepare for the future, as outlined in the 2001 AMS and UCAR document A National Priority: Building Resilience to Natural Hazards (see “On the Web”). The university community, including UCAR and NCAR, stands ready to help in making the necessary changes through research, technology development and transfer, and education and training.

The unprecedented, but not unforeseen, disastrous impacts associated with Hurricane Katrina could have been largely mitigated, likely at a cost much less than what is now being spent on recovery. This lesson must be learned and remembered, and appropriate actions must be taken so that future hurricanes and other natural disasters do not result in a similar catastrophic loss of life and property. As Katrina showed, there are huge costs and consequences for not acting. Understanding, predicting, and preparing for disasters are all major issues for our nation’s health, prosperity, and defense, and they must be treated as a long-term priority along with other issues such as the economy and traditional forms of national defense.

Rick Anthes

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NCAR hurricane work reaches new intensity

Shortly before Hurricane Rita strengthened into the second Category 5 hurricane in a month, *Science* published an intriguing study of tropical cyclones. By analyzing satellite data, the authors, including MMM director Greg Holland, found that the proportion of tropical cyclones that reach Category 4 or 5 status has nearly doubled in the last 35 years.

The September 16 article, whose lead author was Peter Webster of the Georgia Institute of Technology, added fuel to an already contentious debate over whether climate change is playing a role in this year’s unusually active Atlantic hurricane season, or whether the series of powerful hurricanes is part of a natural cycle. Researchers don’t know enough about hurricanes, typhoons, and other kinds of tropical cyclones to be certain of the answer—yet.

But over the next few years, Greg and other tropical cyclone experts may learn much more. NCAR, in collaboration with Georgia Tech and other partners, is launching a series of projects involving climate change and hurricane research.

(continued on page 2)

Views of a hurricane. The two top images show Hurricane Katrina, slightly weakened but still at Category 5 intensity, as it moved over warm water in the Gulf of Mexico on August 28. Twelve hours later, the eyewall was disrupted by interaction with the land surface. (Images courtesy Jeff Weber, Unidata, based on satellite data.)

Silver lining

This image of a cloud’s silver lining, captured by UCAR photographer Carlye Calvis, is one of a series of photos on display at the Mesa Lab that demonstrate meteorological optics. Silver lining typically occurs when large cloud droplets diffract sunlight along the edge of a thick cloud. For more on the photos and a new exhibit on future climate, see page 10.

Remembering Vin Lally see page 6

First-class conference facilities see page 7

Blue Vista arrives see page 9
Hurricane research
(continued from page 1)

computer modeling, data assimilation, and additional techniques to look at
the formation of cyclones and their structural changes of landfall, as well as to improve
cyclone forecasting. The work on tropical
cyclogenesis in particular may shed light
on the question of whether warming
global temperatures are partly to blame
for the proliferation of powerful storms.

"These projects are fascinating scientificaly and can yield great benefits for
society," explains UCAR president Rick
Anthes, who has devoted much of his
research career to studying hurricanes
and other tropical cyclones. "As coastal
communities become more populated,
it is more important than ever to under-
stand hurricanes, their relationship with
climate change, and how to improve forecasts of these storms."

Computing muscle

In one of the major hurricane initiatives, NCAR will tap its newest
supercomputer, blue visa, to study the
genesis of cyclones in the world’s tropical
oceans. The problem is so demand-
ing, computationally, that it will occupy
much of blue visa’s available time from
October through December. (For more
on blue visa, see page 9).

A central issue that Greg and his col-
leagues hope to explore is why certain
tropical waves, or areas of unsettled
weather, grow into cyclones while oth-
ers simply dissipate. This will involve
answering such questions as whether
a tropical wave is far more likely to
become a cyclone if the winds to its east
are easterly rather than westerly.

"The balance of
probability is that this
[increased hurricane
intensity] is associated with
the changing climate."

—Greg Holland

Among the many researchers work-
ing on the project are CGD’s Julie
Caron, Bill Collins, Peter Gent, Jim
Hack, Jim Hurrell, Bill Large, Phil
Rasch, Joe Tribbia, Mariana Vertenstein,
and Steve Zander, and MMM’s James
Done, Jimy Duchia, Tom Henderson,
Joe Klemp, Bill Kuo, and John
Michalakes. Additional staffers in those
divisions and in SCD, as well as at sever-
al universities, are contributing time and
expertise to the project. In addition, the
Pacific Northwest National Laboratory
piece is led by the laboratory’s Ruby
Leung.

To study the problem, the team
is nesting the Weather Research and
Forecasting model (WRF) within
the atmospheric component of the
Community Climate System Model
(CCSM). The models complement each
other: WRF has a fine-scale resolution
that can capture individual storms, while
the coarser-scale CCSM is designed to

A visitor from New Orleans

One positive side effect of Hurricane
Katrina is that NCAR gained a new visiting
scientist from the pool of refugees. Sandy
Johnson, a professor of epidemiology at
Louisiana State University Health Sciences
Center, is currently stationed in ISSE. Her
recent work has focused on health dispari-
ties and underserved populations in the
greater New Orleans area. On September
29, she gave an informal presentation,
"Rebuilding a Sinking City—A New Orleans
Perspective on Hurricane Katrina," as part
of ISSE’s “coffee talk” series.

Sandy said that while the system of
warning people before the storm was
successful, the response afterward failed.
"Getting more than 1 million people out
of harm’s way is a success," she said. "On a
micro scale, however, the evacuation failed
in that the most vulnerable were left to
their own devices and abandoned by the
government. We’re learning that there
are some hard truths about money affording protection. The storm exposed a
breakdown along development and class lines."

Some of the most important questions that society needs to answer before
rebuilding New Orleans have an ethical dimension. "Who will be on the recon-
struction committee?" Sandy asked. "How will they make room for the poor to
return?" She pointed out that many refugees are so impoverished that although
they owned their own homes, they have no insurance and can’t afford recon-
struction loans from the Federal Emergency Management Agency.

"Hopefully we can understand that people must be incorporated into the
science we do,” she concluded. *Nicole Gordon

Sandy Johnson.
simulate global climate over long periods of time. The models will produce a series of five-year simulations, which will be compared to actual observations.

In addition to shedding light on cyclones, the project may pave the way for improving CCSM’s handling of certain tropical processes. The climate model currently fails to capture aspects of the structure of the intertropical convergence zone, for example, and it creates El Niño events every two years instead of every four to five years.

“This is a challenge for all coupled climate models, and it’s something we want to address,” explains CGD’s Joe Tribbia. “It’s hoped that by improving the representation of convection in CCSM, we will improve our ability to simulate tropical climate variability and more accurately reproduce events like large-scale tropical waves, Madden-Julian oscillations, and ENSO (El Niño-Southern Oscillation).”

The cyclogenesis project is part of a far-reaching NCAR initiative known as Predicting the Earth System Across Scales. The initiative will be a major step forward in developing a model that can seamlessly move between studies of local weather and global climate, using the correct scale for each type of problem.

**Prediction and landfall**

When Hurricane Katrina bore down on New Orleans, WRF was one of several models that predicted the storm’s track with great accuracy. Hurricane Rita, however, tracked slightly farther to the east than the model predicted.

To improve hurricane and other weather forecasts by WRF—which is still being run on an experimental basis—MMM and RAL are collaborating on a project to assimilate radar data from storms into the model. Such data would enable models to begin a simulation already armed with considerable detail about the hurricane’s structure, rainbands, and wind fields. Currently WRF and other models rely on coarser-scale information from satellite observations and dropsondes when initiating a simulation.

“What we hope will come out of this is a substantial improvement in forecasting storms as they come within 24 to 48 hours of landfall,” Greg explains.

Jenny Sun of RAL and MMM, a member of the assimilation team, believes the project eventually will lead to improvements in WRF as well as in other forecasting models. But she warns that the work may take several years. One of the biggest challenges in developing algorithms for the assimilation is to extract useful information from imperfect data.

“The observations have errors, the model has errors, the forecast has errors. The proper treatment of all those errors is very important,” Jenny explains. “It’s really a long-term project.”

The team also includes Dale Barker, Chris Snyder, and Qingnong Xiao (all in MMM); Andrew Crook (RAL/MMM), So-Young Ha and Bill Kuo (both MMM/COSMIC), and Soichiro Sugimoto (a visitor in MMM).

Along with fine-tuning the forecasts, Greg hopes to develop a better understanding of the physics of a hurricane’s landfall. A storm’s vortex can break down into smaller vortices when it comes ashore, creating severe shifts in winds and rains. Predicting these changes at landfall would help society better protect people in exposed areas from a storm’s most damaging effects.

Greg is working with Chris Davis and Kristen Corbosiero in MMM to investigate these landfalling cyclone characteristics and expects that the project eventually will expand to include ISSE and RAL staff.

In time, such information may prove invaluable to the insurance industry. Already, Swiss Re, one of the world’s leading reinsurance companies, is collaborating with NCAR on an experimental simulation of Hurricane Katrina’s impact on the Gulf Coast. By coupling Swiss Re’s computer models of properties in a given city with WRF’s simulations of hurricane winds and rainbands, insurers hope to eventually better anticipate property losses.
SACNAS visitors

Science students from colleges around the country took a break from a national conference on September 29 to tour the Mesa Lab with EO’s Teri Eastburn and Tim Barnes. They also heard words of welcome from NCAR director Tim Killeen and SCD’s Wes Wildcat.

The students were in Denver for the annual meeting of the Society for Advancement of Chicanos and Native Americans in Science (SACNAS). UNAVCO and UCAR co-hosted the tour of ML, as well as tours of other Denver area geoscience facilities, to help inform the students about careers in the field.

Are storms getting stronger?

But no matter how well societies can forecast storms, coastal communities are going to be in trouble if, in fact, tropical cyclones keep getting stronger.

Scientists are vigorously debating the question of whether there is a link between climate change and the increasing number of Category 4 and 5 storms, the most intense on the Saffir-Simpson scale. The paper in Science suggests that rising sea surface temperatures (which have warmed by 0.6 degrees Celsius, or 1 degree Fahrenheit, since 1970) are fueling more powerful cyclones.

Georgia Tech’s Judith Curry and Hai-Ru Chang co-authored the paper with Peter Webster and Greg.

The team utilized the best available data on tropical cyclones from around the globe for the Science article. They focused on the satellite era to minimize errors. In contrast to the sustained rise in cyclone intensity, they found that the frequency of cyclones around the world did not appear to follow a steady pattern. The number of storms increased substantially during the first part of the study period, then dropped in the last decade.

The study lends support to climate models that show tropical cyclones will become more powerful as the world warms during the next century. Scientists are cautious, however, because other factors can affect the intensity of a hurricane, such as atmospheric moisture and variations in winds. In addition, long-term cycles, such as the El Niño-Southern Oscillation, can influence fluctuations in hurricane intensity.

“Our still don’t have enough knowledge at this stage to say unequivocally. There could be problems with the data, and we cannot rule out natural variability,” Greg says. But he adds that in his view, “The balance of probability is that this is associated with the changing climate.”

CGD’s Kevin Trenberth is pretty certain that greenhouse gases are at least partly to blame for the recent increase in hurricane intensity. After Katrina devastated New Orleans and other parts of the Gulf Coast, he began working on a paper that looked at the extent to which warming temperatures are affecting moisture in the atmosphere. His conclusion: since water vapor amounts over the ocean have increased by an estimated 4% since 1970, which has enhanced both storm winds and moisture inflow to the storms, a preliminary estimate of the net global enhancement of hurricane intensity and rainfall is about 4 to 11% since 1970.

Greg has not attributed a percentage of a cyclone’s strength to climate change. But he is struck by the extent to which cyclones have increased in intensity across the tropics.

According to Greg, “There used to be a one-in-five chance that a hurricane would reach Category 4 or 5 status. Now, there’s a one-in-three chance. If you live in the tropics, that’s a pretty big difference.”

Hurricane research (continued from page 3)

As Greg explains, “We are moving into an era where it is becoming possible to directly predict the impacts of hurricanes, and this can only help with planning adequate responses.”

David Hosansky
COMMENTS ON HURRICANES AND GLOBAL WARMING

By

William M. Gray

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There is another side to this dispute that most of you are likely not aware of. The media naturally came to me for comments on how I interpreted the very active and damaging hurricane seasons of 2004-2005. This is because I have been issuing Atlantic seasonal hurricane forecasts for 23 years and studying hurricanes for nearly 50 years. I have been given wide media coverage for my seasonal hurricane forecasts and I feel an obligation to try to set the record straight on how to interpret these two recent year very active hurricane seasons.

The statements by Emanuel, Trenberth, Holland, Webster and Curry – henceforth referred to as the ‘Gang-of-Five’ have caused needless alarm and worry among hundreds of thousands of coastal residents in the US and abroad. They have not recognized that they do not have a license to yell ‘Fire’ along a crowded US coastline.

Unprecedented increases in US hurricane damage were anticipated by me and other hurricane specialists for a number of years prior to 2004-05 when we entered a new phase of the Atlantic multi-decadal oscillation (AMO) in 1995. This expectation was due to the large coastal population increases since the last active Atlantic hurricane period of the 1940s and 1950s. Most of us who have studied and forecasted hurricanes for a long time believe that the US hurricane damage of 2004-2005 was well within the range of natural variability.
But suddenly in 2005 out steps the Gang-of-Five to confidently proclaim, (with no valid evidence) that human-induced global warming played a significant role in the 2004-2005 US hurricane destruction. How did they know what the rest of us who have more background in hurricane climate and forecasting not know? How could they be so confident of their results that they felt at ease alarming the public in the way they did? Of the Gang-of-Five, only Emanuel has any prior research experience in climate-hurricane association.

\[ TC = \text{Tropical Cyclone} \]

The Gang-of-Five appears to have not comprehended the implications of their papers upon a much larger and a more serious arena than the typical TC papers we publish within our peer group. Most TC papers don't go much beyond our own group and can do little harm. As well established senior scientists they (Emanuel, Trenberth, Webster, Holland and Curry) had a professional responsibility (beyond their own interests) not to falsely alarm the public at such an unusually period of massive U.S. hurricane destruction. I would not have made comments on the *Nature* and *Science* papers if they had not become so public and so believable by a public already brainwashed about global warming. In the usual case there would have been little problem. Our own peer group would have gradually sorted out the faulty data and results would not have been so extensively discussed in the media.

Senior meteorologists (such as Emanuel, Trenberth, Webster, Holland and Curry) should have developed, over the years, a better intuitive feeling about how the atmosphere-ocean functions. They should have been more surprised and far more critical of their data which, if correct, had profound meaning for global climate change and future hurricane destruction. As well known and respected scientists they should have been more cautious and should not have so easily surrendered their objectivity and their responsibility as they have done.
The Gang-of-Five encouraged the media to trumpet their findings with no concern or sense of responsibility for the effect their comments might have on many millions of coastal residents of the US and abroad who are not able to judge the validity of their comments. Their continuing comments have affected many of the decisions of the insurance industry, investment groups, business owners, etc., besides causing unneeded alarm and worry among millions of hurricane vulnerable homeowners.

When data to the contrary has been presented to the Gang-of-Five they do not back away, but criticize the person presenting the alternate view. The alleged personal attacks that the Gang-of-Five say I have made on them by trying to tell the truth about their data errors are (from my view) much less egregious than the media blog reports of what outlandish things they have been saying about me in these venues. Given their responses to me, I can understand why younger more vulnerable colleagues would have been reluctant to confront them on this topic.

It appears that no reasonable amount of data or valid counter arguments will disway them. For example, Holland's talk to a congressional committee of two weeks ago (27 Oct.) saying, from NCAR,

"The strong relationship between increases in storm and hurricane numbers and increases in SSTs leads to the inescapable conclusion that the majority of current hurricane activity is a direct result of greenhouse warming."

Emanuel continues to muddy the waters with outrageous claims that the Multi-decadal oscillation (MDO) does not exist. Trenberth gives information on the percent of Atlantic

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1 Here is an excerpt from a letter I recently received from a large Florida hotel operator. “As the owner operator of seven hotels in Central Florida with approximately 6,500 rooms, I must confess that in recent months I have become quite concerned and somewhat curious as to why we have witnessed such a severe decline in occupancies for the months of August-October. Indeed, when compared to the past 30 years that we have been in business here in Central Florida, the three months in question have declined to the lowest levels of occupancy we have every experienced. Concerned about this rather strange phenomena we decided to conduct an extensive survey of former guests in an attempt to discover the reason for the decline. We surveyed hundreds of guests who had previously stayed with us during these very same months in past years, and we asked them why they chose not to return this year. The results of our survey were stunning. Approximately 75% of those surveyed indicated that they chose not to return because of their concern about hurricanes. No doubt, hundreds of thousands would-be visitors to Florida decided not to come presumably because of your rather dire forecast. In Central Florida alone we have lost tens of millions of dollars in revenue, as well as hundreds, perhaps thousands of jobs. If one were to extrapolate from our experience in Central Florida to the state as a whole, possibly billions of dollars have been lost and tens of thousands of hospitality workers have either lost their jobs or had their hours dramatically reduced.”
hurricane activity in 2005 that is due to global warming and implies that humans are a significant part of the observed hurricane activity of last year. He does not tell how he knows this. None of the Gang-of-Five appears to know what they are talking about. ‘All’ of their statements can and will in time be refuted.

It is important to realize that the Gang-of-Five’s statements do not fit into the normal esoteric kind of data crunching or modeling that typically remains within our peer group. They are having an undeserved impact on the public’s perception of hurricanes and future hurricane destruction.

When the media repeatedly asks me why the Gang-of-Five would so exaggerate human influences on hurricane destruction when the evidence does not support this assessment what am I to say? Their resort to my criticism is not to present more and better evidence to better back their claims, but to attack me with the argument that I am engaging in character assassination.

Rather than complaining about me to my Department Head, Rick Anthes should be taking some responsibility for not reigning in Trenberth and Holland’s wild and wrong assertions about humans causing more intense hurricanes. As a public institution, NCAR-UCAR ought to feel some obligation not to falsely alarm the public. Rick has a strong background in tropical cyclones and he is well qualified to speak out. Rick and I sat next to each other at dinner in Miami in May 2006. I told him of UCAR’s problems with Trenberth and Holland but he did not wish to talk about it. I judge Rick, unfortunately, to be a silent supporter of the Gang-of-Five’s claims.

The Gang-of-Five’s assertions have become the laughing stock of most of the experienced hurricane researchers I know and respect. Their ideas would totally collapse before a group of us who really know something about hurricanes. It is ludicrous to hear Judy Curry and Peter Webster, who have no previous hurricane experience, discussing the coming CO₂ induced hurricane increases on national TV and radio.

As highly talented and credentialed researchers the Gang-of-Five has apparently believed that their reputations will be able to convince the uninformed of their assertions.
and they will be able to sell Washington funding sources of their views – they apparently believe they can just run over their critics.

Here are a few of the Gang-of-Five’s misrepresentations:

Trenberth – “At the same time, there’s been a surge over the past 35 years in the number and proportion of intense hurricanes (not true). It’s highly likely that greenhouse gases are partly to blame and that the trend will continue (likely not true).

“The prospects are for more intense storms, heavier rainfall and flooding, and more coastal damage. Global warming also boosted the amount of rainfall in several of the most powerful 2005 hurricanes – including Katrina and Rita – by 7 percent.” (How can he possibly estimate 7 percent?)

Holland – Compares increases in named storms from 1900-present before aircraft/satellites were used. Many of the earlier period cyclone numbers and those in the central Atlantic were consequently missed. His upward trend in named storms means nothing. Holland knows better than this but persists in this charade.

Emanuel – uses the cube of the TC’s maximum winds over data deficient oceans. Cubing poor data leads to wild errors. He has misrepresented past data sets to get desired TC upward curve results. He doesn’t understand the Atlantic multi-decadal data set and says it does not exist.

Webster and Curry – They show Cat. 4-5 cyclones increasing from the 1970s. I visited all global tropical cyclone centers in 1978-79 as part of a WMO survey trip and I have stated many times that there is no way these centers could have distinguished Category 4-5 cyclones from Cat. 1-2-3 cyclones. The satellites at these centers often did not work and forecasters were not trained to use them as they presently are. These centers naturally underestimated the number of Cat. 4-5 cyclones in these earlier years. An upward trend in Cat. 4-5 cyclones from the 1970s means nothing.
My motivation in all this is only to try to help maintain the integrity of American science which, in my view, has been badly compromised by the global warming issue and now recently by the issue of global warming causing more frequent and more intense hurricanes. Having received federal support for my hurricane research and forecasting endeavors for nearly 50 years, I feel I have an obligation to speak out on issues involving my expertise, particularly when statements are made which are contrary to everything I have learned over my long career. I would feel guilty if I said nothing.

Attached is an Appendix of an alternate view of reality.
APPENDIX

ANOTHER VIEW OF REALITY

Although global surface temperatures have increased over the last century and over the last 30 years, there is no reliable data available to indicate increased hurricane frequency or intensity in any of the globe’s seven tropical cyclone basins. Meteorologists who study tropical cyclones have no valid physical theory as to why hurricane frequency or intensity would necessarily be altered by small amounts (< ±0.5°C) of global mean temperature change.

In a global warming or global cooling world, the atmosphere’s upper air temperatures will warm or cool in unison with the sea surface temperatures. Vertical lapse-rates will not be significantly altered. We have no plausible physical reasons for believing that Atlantic hurricane frequency or intensity will change significantly if global ocean temperatures continue to rise. For instance, in the quarter-century period from 1945-1969 when the globe was undergoing a weak cooling trend, the Atlantic basin experienced 80 major (Cat 3-4-5) hurricanes and 201 major hurricane days. By contrast, in a similar 25-year period of 1970-1994 when the globe was undergoing a general warming trend, there were only 38 major hurricanes (48% as many) and 63 major hurricane days (31% as many). Atlantic sea-surface temperatures and hurricane activity do not necessarily follow global mean temperature trends.

The most reliable long-period hurricane records we have are the measurements of US landfalling tropical cyclones since 1900 (Table 3). Although global mean ocean and Atlantic surface temperatures have increased by about 0.4°C between these two 50-year periods (1900-1949 compared with 1956-2005), the frequency of US landfall numbers actually shows a slight downward trend for the later period. If we chose to make a similar comparison between US landfall from the earlier 30-year period of 1900-1929 when global mean surface temperatures were estimated to be about 0.5°C colder than they have been the last 30 years (1976-2005), we find exactly the same US hurricane landfall numbers (54 to 54) and major hurricane landfall numbers (21 to 21).
We should not read too much into the last two hurricane seasons of 2004-2005. The activity of these two years was unusual but well within natural bounds of hurricane variation. Between 1966 and 2003, US major hurricane landfall numbers were below the long-term average. Of the 79 major hurricanes which formed in the Atlantic basin from 1966-2003 only 19 (24 percent) of them made US landfall. During the two seasons of 2004-2005, seven of 13 (54 percent) came ashore. This is how nature sometimes works. What made the 2004-2005 seasons so unusually destructive was not the high frequency of major hurricanes but the high percentage of major hurricanes which were steered over the US coastline. The unanticipated breaching of the New Orleans levees likely doubled or tripled the damage caused by Katrina. The major US hurricane landfall events of 2004-2005 were primarily a result of the favorable, upper-air steering currents which were present during the past two hurricane seasons.

Table 3. US Landfalling tropical cyclones by intensity during two 50-year periods.

<table>
<thead>
<tr>
<th>YEARS</th>
<th>Named Storms</th>
<th>Hurricanes</th>
<th>Intense Hurricanes (Cat 3-4-5)</th>
<th>Global Temperature Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-1949</td>
<td>189</td>
<td>101</td>
<td>39</td>
<td>+0.4°C</td>
</tr>
<tr>
<td>(50 years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1956-2005</td>
<td>165</td>
<td>83</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>(50 years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Although 2005 had a record number of tropical cyclones (27 named storms, 15 hurricanes and 7 major hurricanes), this should not be taken as an indication of something beyond natural processes. There have been several other years with comparable hurricane activity to 2005. For instance, 1933 had 21 named storms in a year where there was no satellite or aircraft data. Records of 1933 show all 21 named storm had tracks west of 60°W where surface observations were more plentiful. If we eliminate all the named storms of 2005 whose tracks were entirely east of 60°W and therefore may have been missed given the technology available in 1933, we reduce the 2005 named storms by seven (to 20) – about the same number which occurred in 1933.
Utilizing the National Hurricanes Center's best track database of hurricane records back to 1875, six previous seasons had more hurricane days than the 2005 season. These years were 1878, 1893, 1926, 1933, 1950 and 1995. Also five prior seasons (1893, 1926, 1950, 1961 and 2004) had more major hurricane days. Finally, five previous seasons (1893, 1926, 1950, 1961 and 2004) had greater Hurricane Destruction Potential (HDP) values than 2005. HDP is the sum of the squares of all hurricane-force maximum winds and provides a cumulative measure of the net wind force generated by a season's hurricanes. Although the 2005 hurricane season was certainly one of the most active on record, it is not as much of an outlier as many have indicated.

The cycle of Atlantic hurricanes

Most of my tropical cyclone colleagues who have spent years forecasting and studying hurricanes do not subscribe to the alarmist views of those saying we should expect hurricanes to get worse due to human-induced global warming. We believe that the Atlantic basin is currently in an active hurricane cycle. This active cycle is expected to continue for another decade or two at which time we should enter a quieter Atlantic major hurricane period like we experienced during the quarter century periods of 1970-1994 and 1901-1925. Atlantic hurricanes go through multi-decadal cycles. These cycles have been observationally traced back to the mid-19th century and inferred from Greenland paleo ice-core temperature measurements that go back thousand of years.