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NOAA HURRICANE FORECASTING

HEARING

BEFORE THE

COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED NINTH CONGRESS

FIRST SESSION

OCTOBER 7, 2005

Serial No. 109–26

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NOAA HURRICANE FORECASTING

FRIDAY, OCTOBER 7, 2005

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
Washington, DC.

The Committee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Sherwood L. Boehlert (Chairman of the Committee) presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

NOAA Hurricane Forecasting

Friday October 7, 2005

10:00 AM – 12:00 PM
2318 Rayburn House Office Building (WEBCAST)

Witness List

Brigadier General David L. Johnson (ret.)
Director
NOAA National Weather Service

Mr. Max Mayfield
Director
NOAA Tropical Prediction Center/National Hurricane Center

Section 210 of the Congressional Accountability Act of 1995 applies the rights and protections covered under the Americans with Disabilities Act of 1990 to the United States Congress. Accordingly, the Committee on Science strives to accommodate/meet the needs of those requiring special assistance. If you need special accommodation, please contact the Committee on Science in advance of the scheduled event (3 days requested) at (202) 225-6371 or FAX (202) 225-0891.

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HEARING CHARTER

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

NOAA Hurricane Forecasting

FRIDAY, OCTOBER 7, 2005
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose:

On October 7, 2005 at 10:00 a.m., the House Science Committee will hold a hearing on hurricane forecasting by the National Oceanic and Atmospheric Administration (NOAA). The Committee is holding the hearing to better understand the prediction of hurricanes and the outlook for the remainder of the 2005 hurricane season.

The Committee plans to explore several overarching questions:

1. What are the different responsibilities of the National Hurricane Center and local weather forecast offices when a tropical storm or hurricane threatens the United States?
2. What were the timelines of Katrina and Rita progressing from tropical depressions to major hurricanes and when were warnings issued to the public and to federal, State, and local officials? Was there any difference in how the National Weather Service forecast and issued warnings for these two major hurricanes?
3. What is the outlook for the remainder of the 2005 hurricane season and for the next five to 10 years? Are we in a period of increased hurricane frequency and/or intensity? If so, what is the likely cause of this increase?
4. What can be done to improve prediction of hurricanes, both in the short-term and in the long-term?

Witnesses:

Brigadier General David L. Johnson (ret.), Director of NOAA's National Weather Service.

Mr. Max Mayfield, Director of the National Weather Service's National Hurricane Center.

Background:

What Are Hurricanes?

The terms "hurricane" and "typhoon" are regionally specific names for a strong "tropical cyclone." A tropical cyclone is the generic term for a low-pressure weather system over tropical or sub-tropical waters with organized thunderstorm activity. Tropical cyclones with maximum sustained surface winds of less than 39 mph are called "tropical depressions." Once the tropical cyclone reaches winds of at least 39 mph, it is called a "tropical storm" and assigned a name. If winds reach 74 mph then the storm is called a "hurricane" in the Atlantic Ocean or a "typhoon" in the Pacific Ocean. Typically, the more intense a tropical cyclone is, the less area it covers. Hurricane Katrina was unusual in that it both was very intense and very large (400 miles across).

The United States utilizes the Saffir-Simpson hurricane intensity scale to give an estimate of the potential flooding and damage to property given a hurricane's estimated intensity. The scale is summarized in Appendix A.

How Hurricanes Are Forecast

In the United States, the Atlantic hurricane season is from June 1 to November 30. The National Weather Service (NWS), which is part of the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce, has responsibility "to provide weather, hydrologic, and climate forecasts and warnings for the United States, its territories, and adjacent waters, for the protection of life and property and the enhancement of the national economy." The National Hurricane

Center in Miami, which is part of NWS, monitors and forecasts tropical storms and hurricanes in the Atlantic and Northeast Pacific oceans.

The National Hurricane Center (NHC) compiles data about ocean temperature, wind speed and direction, barometric pressure, and other factors and enters that data into computer models to forecast hurricanes. This data is obtained from satellites, ocean buoys and radars. Also, a large amount of data comes from sensors dropped by "hurricane hunter" airplanes as they fly into the storms. Hurricane hunters are flown by the Air Force and NOAA out of Keesler Air Force Base in Mississippi and MacDill Air Force Base in Florida. The planes are modified to carry weather instruments to measure wind, pressure, temperature and dew point and to drop instrumented sensors into hurricanes. When a storm is within three days of potential landfall, hurricane hunters fly into the storm once every six hours.

When tracking a tropical storm or hurricane, the NHC issues official forecasts and warnings every six hours. As a storm nears landfall, the forecasts are updated more frequently. The information goes out to the public via the Internet (http://www.nhc.noaa.gov/) and through NOAA Weather Radio. NOAA Weather Radio is a nationwide network of radio stations broadcasting continuous weather information from nearby National Weather Service offices. Every six hours, the NHC also provides (via conference calls and the Internet) "technical discussion products" tailored to federal, State, and local emergency managers and decision-makers. Local weather forecast offices use the information from the NHC to provide advisories tailored to their region. An example of a tailored hurricane advisory from the New Orleans weather forecast office is provided in Appendix B. Whenever a hurricane threatens U.S. territory, the Federal Emergency Management Agency (FEMA) activates the Hurricane Liaison Team (HLT). This team consists of federal, State and local emergency managers, NWS meteorologists and computer specialists who help the NHC rapidly exchange information with federal, State and local emergency managers. The HLT works directly out of the NHC in Miami. For Hurricane Katrina, the HLT was activated on Wednesday, August 24.

Timeline of Hurricane Katrina and Hurricane Rita and NWS Warnings to Federal, State and Local Officials

Hurricane Katrina made landfall on the southeast corner of Louisiana at 6:10 am Central Daylight Time (CDT) on Monday, August 29 as a Category 4 storm (maximum sustained winds of 145 mph) that was unusually large, measuring approximately 400 miles across. At 5:00 pm (CDT) on Friday, August 26, 56 hours before Katrina made landfall, the National Weather Service forecast the storm hitting near New Orleans as a Category 4 or 5 hurricane. NWS was very accurate with its forecast and the final landfall location was only 20 miles off from Friday's forecast. Since meteorological conditions that affect the track and intensity of the storm were relatively stable, NWS was especially accurate in forecasting Katrina.

Between 7:00 and 8:00 pm CDT on Saturday August 27, 35 hours before landfall, the Director of the National Hurricane Center called State officials in Louisiana, Mississippi, and Alabama. At 7:00 am on Sunday, August 28, NWS advisories stated that Katrina was a "potentially catastrophic" storm. A more detailed description of Katrina's development from tropical storm to hurricane and the associated warnings are provided in Appendix C.

Hurricane Rita made landfall near Port Arthur, TX around 2:30 am CDT on Saturday, September 24 as a Category 3 storm (maximum sustained winds of 120 mph) and measuring 170 miles across. At 4:00 pm CDT on Tuesday, September 20, the National Weather Service began warning that northwestern regions of the Gulf of Mexico should prepare for a major hurricane.

Hurricane Katrina and Hurricane Rita Compared to Previous Major Storms

While Hurricane Katrina was over the Gulf of Mexico, NOAA measured winds reaching 175 mph, making it the strongest hurricane ever measured in the Gulf of Mexico. By the time it hit the Gulf Coast, Katrina's winds decreased to 145 mph, down to a Category 4 level but still a very strong storm. There have been three previous Category 5 storms (1935 Labor Day storm, Florida Keys; 1969 Camille, Mississippi; and 1992 Andrew, south Florida) to hit the U.S. and six previous Category 4 storms (2004 Charley, 1989 Hugo, 1961 Carla, 1960 Donna, 1957 Audrey, 1954 Hazel) to hit the U.S. The last major storm affecting New Orleans was Hurricane Betsy in 1965, during which winds hit 125 mph before equipment failed. Hurricane Camille (August 1969) was also a major hit but made landfall east of the city and was a more compact storm than either Betsy or Katrina. Hurricane Katrina was unusual in that it was both very intense and large.

Typically, major hurricanes begin in the eastern Atlantic ocean near Cape Verde in western Africa, providing forecasters many days to track, study, and warn of the

storms before they threaten U.S. coasts. Since records have been kept, 85 percent of major Atlantic hurricanes have originated from the eastern Atlantic. However, this year all nine tropical depressions that developed intro hurricanes did not form until the systems were west of 55 degrees longitude (near Barbados), providing forecasters only a couple of days to study the storms and citizens less time to prepare their homes.

The last time such a large percentage of hurricanes formed in the western Atlantic was in 1969, when 10 of 12 hurricanes formed west of 55 degrees latitude. That was the year Hurricane Camille struck New Orleans. Scientists can determine after the fact that the factors favoring quick formation of hurricanes in the Caribbean are a combination of favorable wind patterns and sea surface temperatures, but scientists cannot predict these patterns ahead of time.

Outlook for Future Hurricanes

Hurricane Rita was the 13th named storm of the 2005 hurricane season. Typically the month of September is the peak month for hurricane activity. Through November 30 (end of hurricane season), NOAA expects seven to 10 additional named storms, of which one to three could be major hurricanes of Category 3 strength or higher. The chance of one of those major hurricanes making landfall somewhere in the U.S. is 21 percent. However, it is difficult to predict exactly where a hurricane would hit because the path of a hurricane is primarily determined by day-to-day weather patterns. Historically, weather patterns in October push tropical storms north from the Caribbean and back out to sea, decreasing the chances that the Gulf Coast will be hit by another hurricane. However, there is still a chance that the Gulf could see another storm this year.

Most scientists agree that the Atlantic Ocean is currently in a period of increased hurricane activity, which is part of a natural 25- to 40-year cycle known as the "Atlantic multi-decadal signal," a shift in the sea surface temperatures in the Atlantic. Warmer sea surface temperatures combined with optimal wind conditions cause more tropical depressions to develop into hurricanes. Scientists are unsure of the cause of the natural temperature and wind shifts in the Atlantic. The last period of high tropical Atlantic activity was 1920–1966. The average number of hurricanes in a warm period is 10 per year, while the average number of hurricanes in a cold period is six storms per year. Today, many more people live in hurricane prone areas than during the last period of high tropical activity, meaning that today's storms will affect more people and cause more damage than historical storms. Appendix D contains more detail on the Atlantic multi-decadal signal and hurricane frequency.

While most scientists agree that the current increase in hurricane frequency is not due to global climate change, over the next 50 years hurricane intensity (not frequency) could increase as ocean temperatures rise. Also, two recent studies have shown some evidence that current hurricane intensity has slightly increased since 1970. The first study, published in *Nature* in July, looked at the North Atlantic Ocean and found that hurricane intensity has increased 50 percent in the past 50 years.[1] The second study, published in *Science* in September, looked globally at all oceans and found that the number of Category 4 and 5 hurricanes has nearly doubled each decade since 1970, while the total number of hurricanes has remained constant.[2]

Improving Hurricane Forecasts

In 1954, the NHC first issued one-day forecasts of hurricanes. Since 1964, the NHC has provided three-day hurricane forecasts. In 2003, the forecasts were extended to include five-day predictions. Appendix E contains examples of the five- and three-day forecasts for Hurricane Katrina. Today, a three-day forecast is as accurate as those issued for a two-day prediction in the late 1980s. While NHC has significantly improved the forecast of where a hurricane is likely to go, the forecasts of hurricane intensity have not improved at the same pace.

NOAA currently supports research in its own labs and provides grants to universities to try to improve hurricane forecasts. Other agencies that support this type of research include the National Science Foundation and the National Aeronautics and Space Administration. The most useful information to researchers comes from taking observations from hurricane hunter airplanes and ocean buoys during a real hurricane, which can be used to develop new forecasting models. As Congress debates supplemental spending and regular agency budgets, some experts think an additional hurricane hunter airplane equipped with research sensors would help re-

[1] K.A. Emmanuel, *Nature,* 436, 686 (2005)
[2] P.J. Webster, G.J. Holland, J.A. Curry, H.R. Chang, *Science* 309, 1844 (2005)

searchers improve computer models of hurricane intensity. (Also, NOAA lost some facilities during Hurricane Katrina and may require additional funding to rebuild those facilities.)

NOAA Hurricane Forecasting and Research Funding History (dollars in millions)

NOAA Office/ Program	FY2004	FY2005	FY2006 request	FY2006 House	FY2006 Senate
National Weather Service	$827	$783	$840	$842	$863
National Hurricane Center (subset of NWS total budget)	$4.9	$5	$5.2	Not specified*	Not specified*
NOAA Hurricane Research	$9.7	$12	$10	Not specified*	Not specified*
NOAA Satellites Service	$814	$907	$964	$968	$1000

*The House and Senate appropriations bills only contain a number for the National Weather Service overall and do not detail specific spending for NHC or for all hurricane research.

Witness Questions:

The witnesses were asked to address the following questions in their testimony.

1. What are the different responsibilities of the National Hurricane Center and local weather forecast offices when a tropical storm or hurricane threatens the United States?
2. What were the timelines of Katrina and Rita progressing from tropical depressions to major hurricanes and when were warnings issued to the public and to federal, State and local officials? Was there any difference in how the National Weather Service forecast and issued warnings for these two major hurricanes?
3. What is the outlook for the remainder of the 2005 hurricane season and for the next five to 10 years? Are we in a period of increased hurricane frequency and/or intensity? If so, what is the likely cause of this increase?
4. What can be done to improve prediction of hurricanes, both in the short-term and in the long-term?

Appendix A: Summary of Saffir-Simpson Hurricane Scale

Saffir-Simpson Hurricane Scale
Category 1 (Minimum Damage): Maximum sustained wind speed, 74-95 mph; storm surge 3-5 feet
"Damage primarily to shrubbery, trees, foliage, and unanchored homes. No real damage to other structures. Some damage to poorly constructed signs. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorage torn from moorings."
Category 2 (Moderate Damage): Maximum sustained wind speed, 96-110 mph; storm surge 6-8 feet
"Considerable damage to shrubbery and tree foliage; some trees blown down. Major damage to exposed mobile homes. Extensive damage to poorly constructed signs. Some damage to roofing materials of buildings; some window and door damage. No major damage to buildings. Coast roads and low-lying escape routes inland cut by rising water 2 to 4 hours before arrival of hurricane center. Considerable damage to piers. Marinas flooded. Small craft in unprotected anchorages torn from moorings. Evacuation of some shoreline residences and low-lying areas required."
Category 3 (Extensive Damage): Maximum sustained wind speed, 110-130 mph; storm surge 9-12 feet
"Foliage torn from trees; large trees blown down. Practically all poorly constructed signs blown down. Some damage to roofing materials of buildings; some wind and door damage. Some structural damage to small buildings. Mobile homes destroyed. Serious flooding at coast and many smaller structures near coast destroyed; larger structures near coast damaged by battering waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Flat terrain 5 feet or less above sea level flooded inland 8 miles or more. Evacuation of low-lying residences within several blocks of shoreline possibly required."
Category 4 (Extreme Damage): Maximum sustained wind speed, 131-155 mph; storm surge 13-18 feet
"Shrubs and trees blown down; all signs down. Extensive damage to roofing materials, windows and doors. Complete failures of roofs on many small residences. Complete destruction of mobile homes. Flat terrain 10 feet or less above sea level flooded inland as far as 6 miles. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single-story residences within 2 miles of shore."
Category 5 (Catastrophic Damage): Maximum sustained wind speed, 156+ mph; storm surge 19+ feet
"Shrubs and trees blown down; considerable damage to roofs of buildings; all signs down. Very severe and extensive damage to windows and doors. Complete failure of roofs on many residences and industrial buildings. Extensive shattering of glass in windows and doors. Some complete building failures. Small buildings overturned or blown away. Complete destruction of mobile homes. Major damage to lower floors of all structures less than 15 feet above sea level within 500 yards of shore. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of residential areas on low ground within 5 to 10 miles of shore possibly required."

Appendix B: New Orleans Weather Forecast Office Hurricane Katrina Advisory

Urgent Weather Message

National Weather Service
New Orleans, LA

1011 AM CDT

Sun Aug 28 2005-09-07

****

Devastating damage expected

****

Hurricane Katrina … A most powerful **hurricane** with unprecedented strength … rivalling the intensity of **Hurricane Camille** of 1969.

Most of the area will be uninhabitable for weeks … perhaps longer. At least one half of well-constructed homes will have roof and wall failure. All **gabled** roofs will fail … leaving those homes severely damaged or destroyed.

The majority of industrial buildings will become non-functional. Partial to complete wall and roof failure is expected. All wood-framed low-rising apartment buildings will be destroyed. Concrete block low-rise apartments buildings will sustain major damage … including some wall and roof failure.

High-rise office and apartment buildings will sway dangerously … a few to the point of total collapse. All windows will blow out.

Airborne debris will be widespread … and may include heavy items such as household appliances and even light vehicles. Sport utility vehicles and light trucks will be moved. The blown debris will create additional destruction. Persons … pets … and livestock exposed to the winds will face certain death if struck.

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.

The vast majority of native trees will be snapped or uprooted. Only the heartiest will remain standing … but be totally defoliated. Few crops will remain. Livestock left exposed to the winds will be killed.

An inland hurricane wind warning is issued when sustained winds near hurricane force … or frequent gusts at or above hurricane force … are certain within the next 12 to 24 hours.

****

Once tropical storm and hurricane force winds onset … do not venture outside!

****

Appendix C: Hurricane Katrina and Hurricane Rita Timelines

Hurricane Katrina

- *4:00 pm CDT Tuesday August 23:* First public advisory of Tropical Depression Twelve.
- *7:00 am CDT Wednesday August 24:* FEMA activated the Hurricane Liaison Team.
- *10:00 am CDT Wednesday August 24:* Tropical Depression Twelve develops into Tropical Storm Katrina over the Bahamas.
- *2:30 pm CDT Thursday August 25:* Tropical Storm Katrina develops into Hurricane Katrina, located 15 miles off the coast of Ft. Lauderdale, FL.
- *5:30 pm CDT Thursday August 25:* Hurricane Katrina makes landfall as a Category 1 hurricane on the southeast coast of Florida. As it passes over Florida it weakens back down to a tropical storm and moves into the Gulf of Mexico.
- *4:00 am CDT Friday August 26:* After passing over Florida, Katrina regains hurricane status over the Gulf of Mexico.
- *5:00 pm CDT Friday August 26:* Every NWS warning beginning Friday evening, 56 hours before landfall, showed Hurricane Katrina making landfall in southeastern Louisiana as a Category 4 or 5 hurricane.
- *10:00 am CDT Saturday August 27:* At 44 hours before landfall, the NWS issued a hurricane watch including New Orleans. A hurricane watch advises of possible hurricane conditions, with the objective of providing 36 hours notice. The watch for Katrina surpassed that objective by eight hours.
- *4:00 pm CDT Saturday August 27:* At 42 hours before landfall, the hurricane watch was extended to Mississippi and Alabama.
- *7:25 pm CDT Saturday August 27:* Max Mayfield (Director of the National Hurricane Center) called Gov. Blanco of Louisiana.
- *7:35 pm CDT Saturday August 27:* Max Mayfield called Bill Filter, Chief of Operations for Alabama Emergency Management Agency.
- *7:45 pm CDT Saturday August 27:* Max Mayfield called Gov. Barbour of Mississippi.
- *8:00 pm CDT Saturday August 27:* Max Mayfield called Mayor Nagin of New Orleans.
- *10:00 pm CDT Saturday August 27:* At 32 hours before landfall, the NWS issued a hurricane warning that included New Orleans. A hurricane warning advises that a hurricane will likely hit, with the objective of providing 24 hours lead time. The watch for Katrina surpassed that objective by eight hours. Every NWS warning beginning Saturday evening, 32 hours before landfall, stated that "Preparations to protect life and property should be rushed to completion" and predicted coastal storm surge of at least 15 to 25 feet.
- *7:00 am CDT Sunday August 28:* Every NWS warning beginning 23 hours before landfall, began with the headline indicating that Hurricane Katrina could be "Potentially Catastrophic." Due to the advanced warning provided by NWS, a mandatory evacuation was put in place for New Orleans on Sunday morning (24 hours before landfall) and the President declared a state of emergency on Sunday, meaning that Louisiana could use federal resources before the hurricane hit. Typically, the President waits until after an event.

Hurricane Rita

- *10:00 pm CDT Saturday September 17:* First public advisory of Tropical Depression 18.
- *6:00 am CDT Sunday September 18:* FEMA activates the Hurricane Liaison Team.
- *4:00 pm CDT Sunday September 18:* Tropical Depression 18 develops into Tropical Storm Rita.
- *10:00 pm CDT Sunday September 18:* Hurricane and tropical storm warnings issued for southern Florida.
- *10:00 pm CDT Monday September 19:* Rita is predicted to strengthen to a Category 2 hurricane before hitting Florida.

- *10:00 am CDT Tuesday September 20:* Rita elevated to a Category 1 hurricane.
- *1:00 pm CDT Tuesday September 20:* Rita elevated to a Category 2 hurricane as it moves over Florida.
- *4:00 pm CDT Tuesday September 20:* At 82 hours before landfall, NWS warns that "all indications are that Rita as an intense hurricane will be approaching the Texas Coast in about three days."
- *10:00 pm CDT Tuesday September 20:* NWS warns that Rita could reach Category 4 status by Wednesday evening.
- *1:00 am CDT Wednesday September 21:* Rita elevated to a Category 3 hurricane.
- *6:00 am CDT Wednesday September 21:* Rita elevated to a Category 4 hurricane.
- *10:00 am CDT Wednesday September 21:* At 64 hours before landfall, NWS states that "interests in the northwestern Gulf of Mexico should monitor the progress of dangerous Hurricane Rita. . .Rita is extremely dangerous category four hurricane. . .some additional strengthening is forecast during the next 24 hours and could reach category five intensity in the central Gulf of Mexico."
- *4:00 pm CDT Wednesday September 21:* At 58 hours before landfall, Rita elevated to a Category 5 hurricane. Hurricane and tropical storms watches are posted for Louisiana and Texas.
- *11:00 am CDT Thursday September 22:* At 39 hours before landfall, Rita downgraded to a Category 4 hurricane. Hurricane and tropical storms warnings issued for Texas and Louisiana.
- *10:00 am CDT Friday September 23:* At 16 hours before landfall, Rita predicted to hit early Saturday morning as either a Category 3 or 4 hurricane. Rita is expected to come ashore as "a dangerous hurricane."
- *2:30 am CDT Saturday September 24:* Rita makes landfall in extreme southwest Louisiana as a Category 3 hurricane (with top winds of 120 mph).
- *7:00 am CDT Saturday September 24:* Rita downgraded to Category 2 hurricane.
- *10:00 am CDT Saturday September 24:* Rita downgraded to Category 1 hurricane.
- *1:00 pm CDT Saturday September 24:* Rita downgraded to a tropical storm.
- *8:00 pm CDT Saturday September 24:* Rita downgraded to a tropical depression. Last NHC advisory.

Appendix D: Contrast of Atlantic Hurricanes

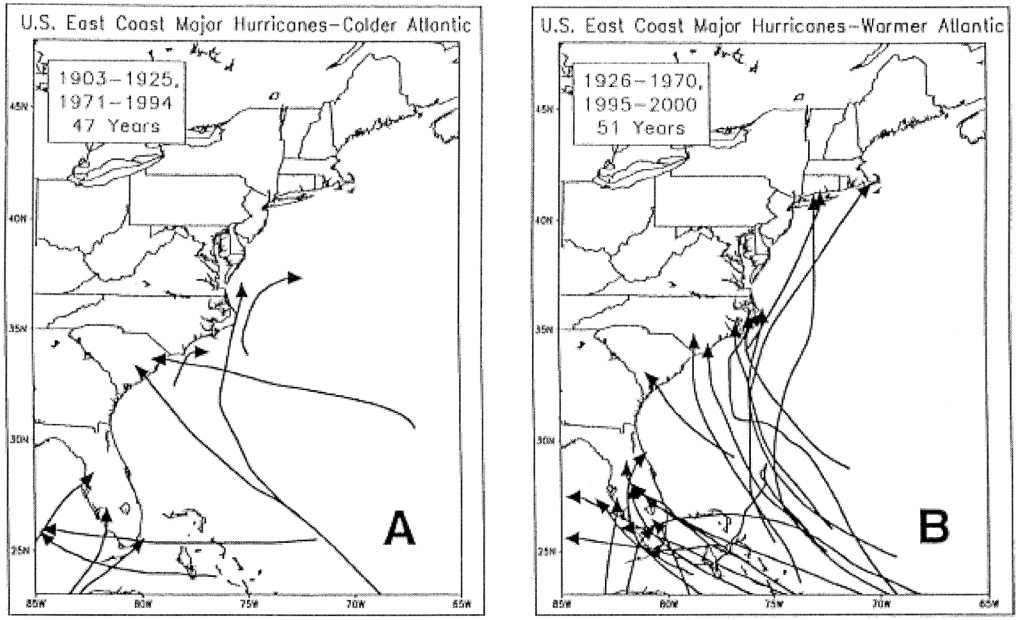
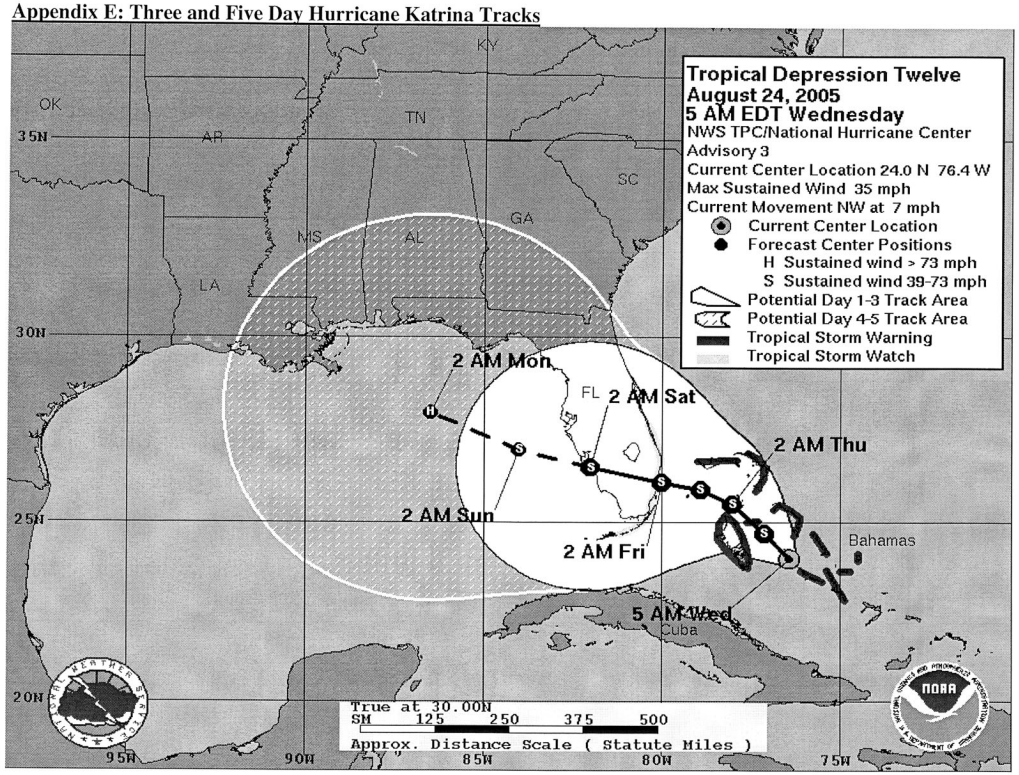
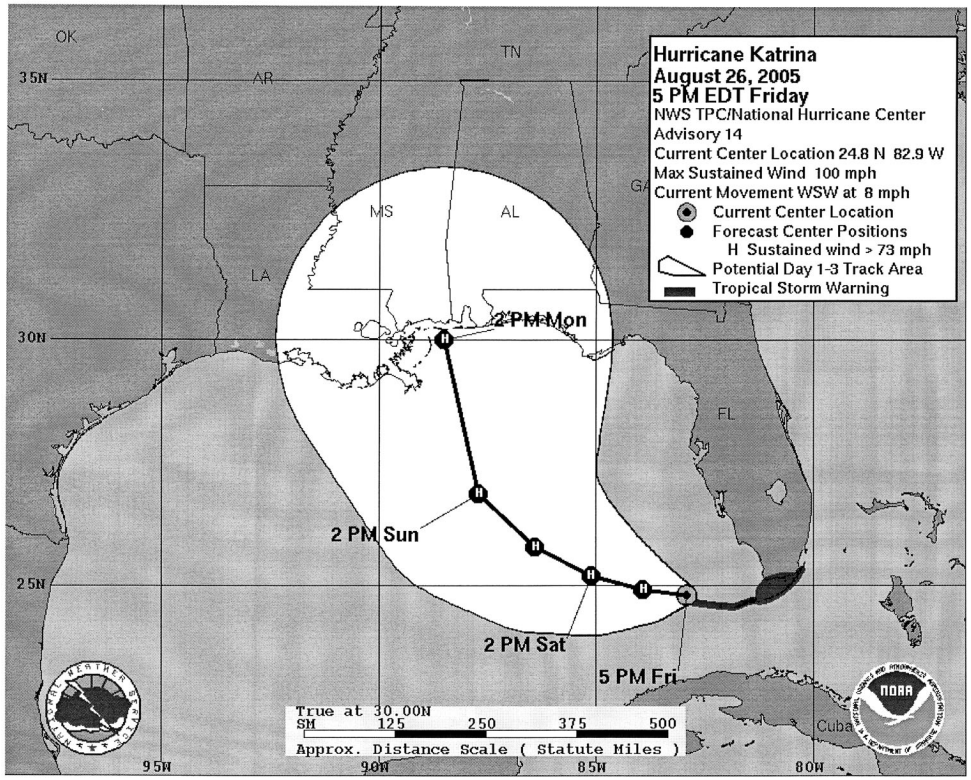


Fig. 5. Contrast of U.S. East Coast major hurricane landfalls for colder (**A**) versus warmer (**B**) values of Atlantic multidecadal mode. The tracks of major hurricanes that affected the U.S. East Coast at that strength are indicated by solid red lines. The years are like those in (*44*) except that the first four warmer years (1899-1902) are not included to make the number of colder and warmer years similar. Colder years (47 years) include 1903-25 and 1971-94. Warmer years (51 years) include 1926-70 and 1995-2000. (From Goldenberg et al., July 20th, 2001, *Science*)

Appendix E: Three and Five Day Hurricane Katrina Tracks




Hurricane Katrina
August 26, 2005
5 PM EDT Friday
NWS TPC/National Hurricane Center
Advisory 14
Current Center Location 24.8 N 82.9 W
Max Sustained Wind 100 mph
Current Movement WSW at 8 mph
Current Center Location
Forecast Center Positions
H Sustained wind > 73 mph
Potential Day 1-3 Track Area
Tropical Storm Warning
OK
AR
TN
MS
AL
GA
LA
FL
Cuba
35N
30N
25N
95W
90W
85W
80W
2 PM Mon
2 PM Sun
2 PM Sat
5 PM Fri
True at 30.00N
SM 125 250 375 500
Approx. Distance Scale (Statute Miles)

Chairman BOEHLERT.Thank you for being here today at this long awaited hearing. We had hoped to have this hearing back in September but we postponed it twice, once because Hurricane Ophelia was developing and once to give the chance for the Select Committee to get started with its investigation.

I participated in the Select Committee's hearing and I made clear then that the Science Committee retained all of its jurisdiction and interest in this subject and that we would be rescheduling our hearing today and that is why we are here today. Unfortunately, because of the Energy Bill on the Floor, my attendance today will be intermittent, but my focus will not. And incidentally, that is calling the attention of so many of our colleagues because of the significance of the bill on the Floor.

The National Weather Service is probably the agency we oversee that has the most impact on the every day lives of our constituents, and we want to make sure we do everything we can to make sure it is in top form. Based on its recent performance trialed by water one might say, I do not think we have too much to worry about when it comes to the Weather Service. Let me repeat what I said at the Select Committee's hearing. The National Weather Service performed magnificently in tracking Hurricanes Katrina and Rita and in providing information before, during, and after the hurricanes made landfall. Max Mayfield was the indispensable man in the lead up to the storms and we owe the entire staff of the National Weather Service a debt of gratitude and that comes with all the sincerity that I can command.

The men and women of the Weather Service and the men and women of the Armed Forces who fly into hurricanes to get data on storms get no special perks if they have had a rough couple of days or a bad season. They have to be ready for the next storm.

I was talking the other day to Deputy Secretary Sampson of the Commerce Department and he had just been down to visit the National Hurricane Center. He said that morale at the center was suffering because the staff felt so saddened that Katrina had produced such suffering. That speaks volumes about the kind of people we have working for us down there.

In all reality, all the Weather Service can do is provide the best information they can, which in the case of Katrina happened to be especially accurate because conditions were ideal for monitoring the storm. In short, the Weather Service can lead officials to information but they cannot make them think or act, I might add. Now that does not mean of course that nothing can be improved, we will want to see and hear today about any steps the Weather Service is taking to ensure that Federal, State, and local officials are receiving the information that the Weather Service is putting out. But it is not the Weather Service's job and it can't be to ensure that others are heeding its warnings.

So I hope we will not be asking our witnesses today questions that fall beyond their purview. I also hope that we can ask questions beyond rehearsing the prelude to the most recent storms. We should be looking for information about the rest of the hurricane season, it is not over yet, about what is behind the increased frequency and intensity of hurricanes. And most important, about what tools the National Weather Service needs to continue to im-

prove its ability to forecast and track storms. If nothing else, the horrifying events of recent weeks have underscored the value of the National Weather Service. We need to work together to make sure that the Weather Service can provide the best information possible.

With that, it is my pleasure to recognize the distinguished Ranking Member, Mr. Gordon of Tennessee.

[The prepared statement of Chairman Boehlert follows:]

PREPARED STATEMENT OF CHAIRMAN SHERWOOD L. BOEHLERT

I want to thank everyone for being here today at this long awaited hearing. We had hoped to have this hearing back in September, but we postponed it twice—once because Hurricane Ophelia was developing and once to give the Select Committee a chance to get started with its investigation.

I participated in the Select Committee's hearing, and I made clear then that the Science Committee retained all its jurisdiction—and interest—in this subject and that we would be rescheduling our hearing. And that is why we are here today.

Unfortunately, because of the Energy Bill on the Floor, my attendance today will be intermittent, but my focus is not. The National Weather Service is probably the agency we oversee that has the most impact on the everyday lives of our constituents, and we want to do everything we can to make sure it is in top form.

Based on its recent performance—trial by water, one might say—I don't think we have too much to worry about when it comes to the Weather Service. Let me repeat what I said at the Select Committee's hearing: the National Weather Service performed magnificently in tracking Hurricanes Katrina and Rita, and in providing information before, during and after the hurricanes made landfall. Max Mayfield was the indispensable man in the lead-up to the storms, and we owe the entire staff of the National Weather Service a debt of gratitude.

The men and women of the Weather Service and the men and women of the armed forces who fly into the hurricanes to get data on storms get no special perks if they've had a rough couple of days or a bad season. They have to be ready for the next storm.

I was talking the other day to Deputy Secretary Sampson of the Commerce Department, and he had just been down to visit the National Hurricane Center. He said that morale at the Center was suffering because the staff felt so saddened that Katrina had produced such suffering. That speaks volumes about the kind of people we have working for us down there.

For in reality, all the Weather Service can do is provide the best information they can—which in the case of Katrina happened to be especially accurate because conditions were ideal for monitoring the storm. In short, the Weather Service can lead officials to information, but they can't make them think. Or act, I might add.

Now that doesn't mean, of course, that nothing can be improved. We'll want to hear today about any steps the Weather Service is taking to ensure that federal, State and local officials are receiving the information that the Weather Service is putting out. But it's not the Weather Service's job, and it can't be, to ensure that others are heeding its warnings. So I hope we won't be asking our witnesses today questions that fall beyond their purview.

I also hope that we can ask questions that go beyond rehearsing the prelude to the most recent storms. We should be looking for information about the rest of the hurricane season, about what is behind the increased frequency and intensity of hurricanes, and most important, about what tools the National Weather Service needs to continue to improve its ability to forecast and track storms.

If nothing else, the horrifying events of recent weeks have underscored the value of the National Weather Service. We need to work together to make sure that the Weather Service can provide the best information possible. Thank you.

Mr. GORDON. Thank you, Mr. Chairman.

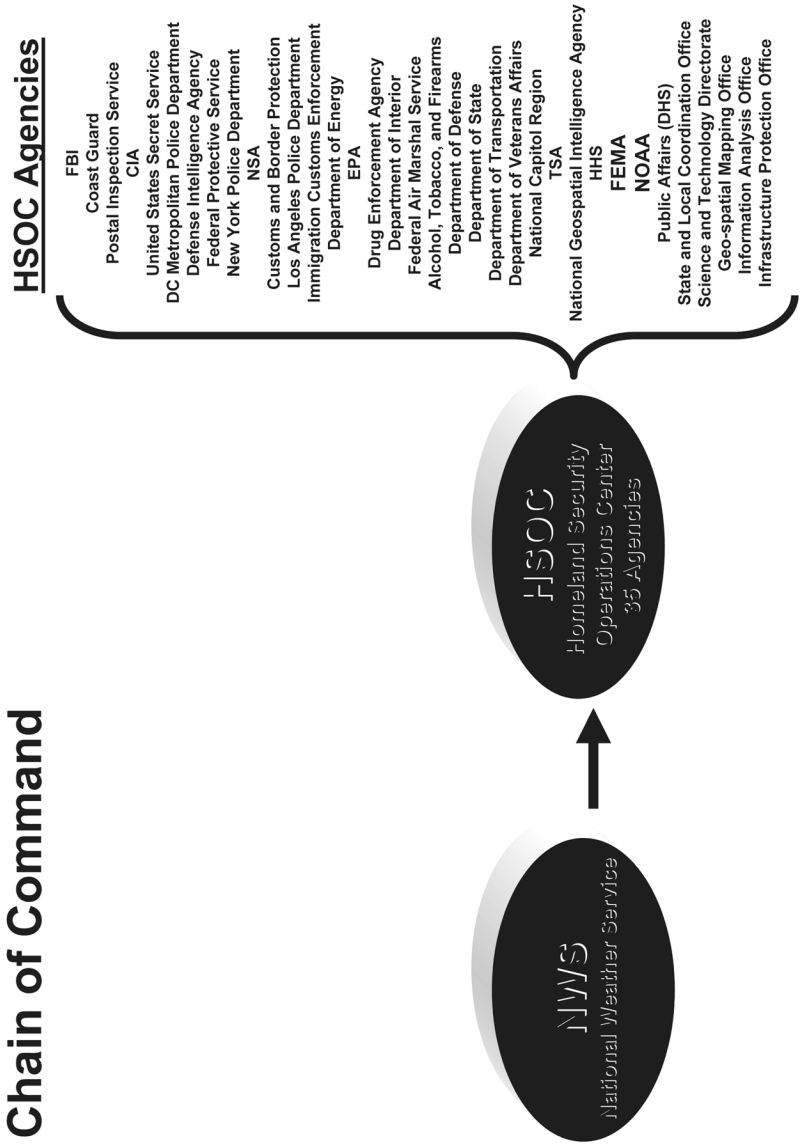
And let me concur with your comments and certainly your compliments to the Weather Service and the team they have put together.

This hearing today is vitally important. We have recently been reminded of both the power of weather and weather prediction and I look forward to exploring these topics. Over the years, we have spent billions of dollars on the Weather Service to improve our capacity to predict the weather. We do it not simply because it is

good science, but because we can save lives if we provide accurate warnings for severe weather events. We have also spent hundreds of billions of dollars on homeland security. We do it to enhance our capacity to stop terrorist attacks and to mobilize our nation's forces in cases of catastrophic incidents, whether by terrorists or by natural disaster.

The goal of both of these sets of expenditures is to keep Americans secure and to come to their aid when they most need it. In the last few weeks, it appears that one of these systems worked and one of these systems failed. And failure has consequences. In this case, some of those who died, and we do not yet know how many, they died because the Federal Government did not get there in time. As Walter Maestri, the Emergency Management Chief of the Louisiana Jefferson Parish put it, "The cavalry did not arrive."

Information regarding the power of Hurricane Katrina went right to the top. One of our witnesses here today conducted briefings that included President Bush, Secretary Chertoff, and Under Secretary Brown. May I have the first chart?



The other witness heads an agency which has placed an employee inside the nerve center for the Federal Government's response to catastrophic events, Homeland Security Operations Center.

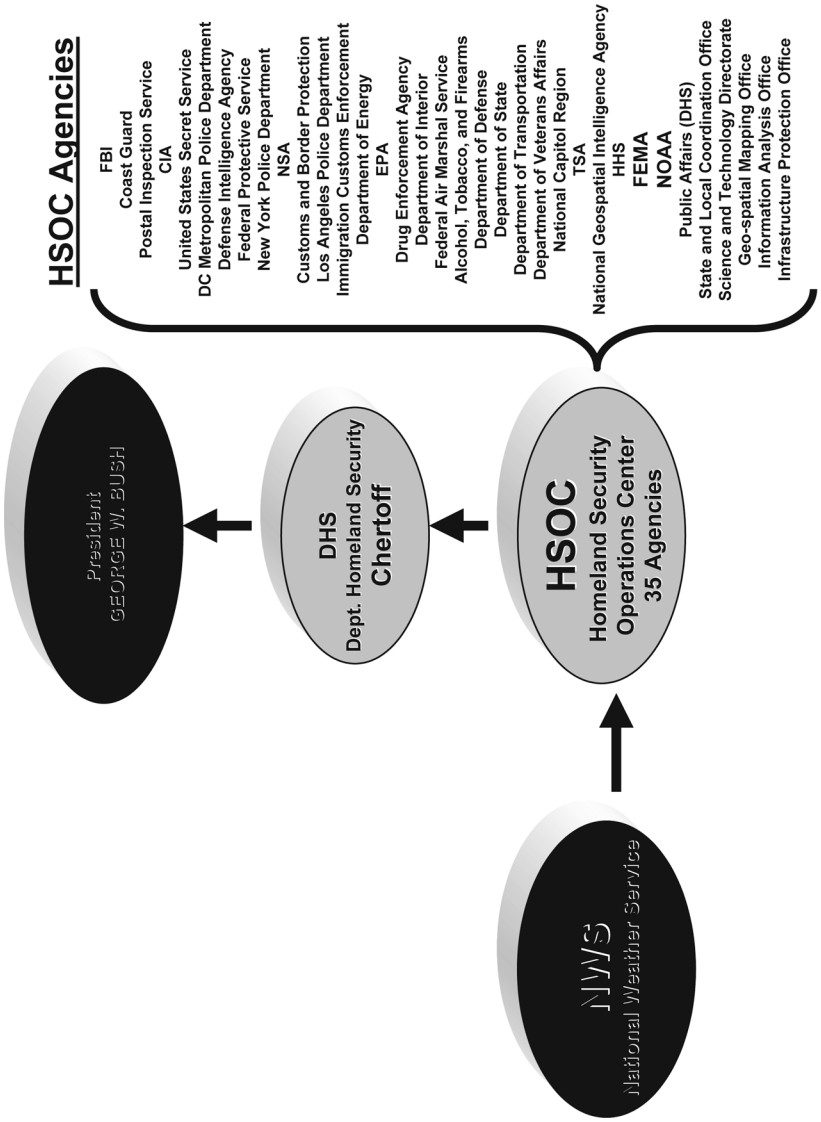


Chart 2. As the graph on the screen demonstrates, Secretary Chertoff is the head of that center and information is supposed to flow up to the secretary from its work and also to President Bush. So the information from the Weather Service was flowing to our emergency response leaders through two paths, and yet our Government seemed taken by surprise. FEMA Head, Michael Brown said on CNN on August 31 and I quote, "I must say, this storm is much bigger than anyone expected."

Is it possible that the Weather Service simply wasn't being articulate about the nature of the threat posed by Katrina? I do not

think that to be true, but we have a chance today to confirm it. Apparently, one of our witnesses didn't think it was true either. Mr. Mayfield, according to the *St. Petersburg Times* story on August 30 based on an interview with Max Mayfield in Chart 3 and I will quote that. "On Sunday night, Mayfield was so worried about Hurricane Katrina that he called the Governors of Louisiana, Mississippi, and the Mayor of New Orleans. On Sunday, he even talked about the forces of Katrina during a video conference call to President Bush at his ranch in Crawford Texas." "I just wanted to be able to go to sleep that night knowing I did all I could do," said Mr. Mayfield.

August 30, 2005

On Saturday night, Mayfield was so worried about Hurricane Katrina that he called the governors of Louisiana and Mississippi and the mayor of New Orleans. On Sunday, he even talked about the force of Katrina during a video conference call to President Bush at his ranch in Crawford, Texas.

"I just wanted to be able to go to sleep that night knowing that I did all I could do," Mayfield said.

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On Sunday, Mr. Mayfield conducted his regular presentation to the Hurricane Liaison Team/FEMA conference call. According to

Mr. Mayfield's press account and the government's records, the President and Secretary Chertoff and Undersecretary Brown were on the calls either Saturday or Sunday and we know from other sources that President Bush and Chertoff were both on the line on the August 28 briefing.

President George W. Bush is handed a map by Deputy Chief of Staff Joe Hagin, center, during a video teleconference with federal and state emergency management organizations on Hurricane Katrina from his Crawford, Texas ranch on **Sunday August 28, 2005**. White House photo by Paul Morse.
CAPTION FROM THE WHITE HOUSE WEB SITE – www.whitehouse.gov.

On the screen is a photograph released by the White House of the President participating in this video conference. On the screen in front of the President is Max Mayfield and over Mr. Mayfield's shoulder is an image of a powerful storm.

New Orleans Times Picayune
Sunday, September 4, 2004, 4:44 p.m.

“We were briefing them way before landfall,” Mayfield said. “It’s not like this was a surprise. We had in the advisories that the levee could be topped."

“I keep looking back to see if there was anything else we could have done, and I just don’t know what it would be,” he said.

In an article printed in the September 4 *Times Picayune* of New Orleans, Mr. Mayfield said reacting to the claims by some that the storms surprised them in its veracity and consequences, Chart 5, and I quote, "We were briefing them way before landfall. It is not that this is a surprise. We had advisories that the levee could be topped. I kept looking back to see if there was anything else we could do, could have done, and I just don't know what it would be."

So I hope today in your testimony, Mr. Mayfield, you can address whether anything else has come to your mind that could have been done to get the attention of our emergency response leaders.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Gordon follows:]

PREPARED STATEMENT OF REPRESENTATIVE BART GORDON

Thank you Mr. Chairman.

This hearing today is vitally important. We've recently been reminded of both the power of weather and weather prediction, and I look forward to exploring these topics.

Over the years, we've spent billions of dollars on the Weather Service to improve our capacity to predict the weather. We do it not simply because it is good science, but because we can save lives if we provide accurate warnings of severe weather events.

We have also spent hundreds of billions of dollars on homeland security. We do it to enhance our capacity to stop terrorist attacks and to mobilize our nation's forces in cases of catastrophic incidents—whether by terrorism or by natural disaster.

The goal in both sets of expenditures is to keep Americans secure and to come to their aid when they most need it.

In the last few weeks, one of these systems worked and one of these systems failed. And failure has consequences—in this case some of those who died, and we do not yet know how many, they died because the Federal Government did not get there in time. As Walter Maestri, the Emergency Management Chief for Louisiana's Jefferson Parish put it: "the cavalry didn't arrive."

The information regarding the power of Hurricane Katrina went right to the top. One of our witnesses here today conducted briefings that included the President, Secretary Chertoff and Under Secretary Brown.

The other witness heads an agency which has placed an employee inside the nerve center for the Federal Government's response to catastrophes: the Homeland Security Operations Center (HSOC).

As the graphic on the screen demonstrates, Secretary Chertoff is the head of that center and information is supposed to flow up to the Secretary from its work and also to the President.

So the information from the Weather Service was flowing to our emergency response leaders through two paths and yet our government seemed taken by surprise.

FEMA head Michael Brown said on CNN on August 31, "I must say, this storm is much bigger than anyone expected."

Is it possible that the Weather Service simply wasn't being articulate about the nature of the threat posed by Katrina? I don't think that to be true, but we will have a chance today to confirm it.

Apparently one of our witnesses didn't think it was true. Mr. Mayfield. According to a *St. Petersburg Times* story on August 30, based on an interview with Max Mayfield:

> "On Saturday night, Mayfield was so worried about Hurricane Katrina that he called the Governors of Louisiana and Mississippi and the Mayor of New Orleans. On Sunday, he even talked about the force of Katrina during a video conference call to President Bush at his ranch in Crawford, Texas."
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On Sunday Mr. Mayfield conducted his regular presentation to the Hurricane Liaison Team/FEMA conference call. According to Mr. Mayfield's press account and government records the President, Secretary Chertoff and Under Secretary Brown

were on calls either Saturday or Sunday and we know from other sources that the President and Chertoff both were on line for the August 28 briefing.

On the screen is a photo released by the White House of the President participating in this video teleconference. On the screen in front of the President is Max Mayfield and over Mr. Mayfield's shoulder is an image of a powerful storm: Hurricane Katrina.

In an article printed in the September 4 *Times Picayune* of New Orleans Mr. Mayfield said, reacting to the claims by some that the storm surprised them in its ferocity and consequences.

"We were briefing them way before landfall.. . . It's not like this is a surprise. We had the advisories that the levee could be topped. I keep looking back to see if there was anything else we could have done, and I just don't know what it would be."

I hope in your testimony Dr. Mayfield you can address whether anything else has come to mind that you could have done to get the attention of our emergency response leaders.

Thank you Mr. Chairman.

Chairman BOEHLERT. Thank you very much.

Dr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman.

In the last six weeks, two of the strongest hurricanes ever recorded in the Gulf of Mexico hit the Gulf Coast region. Hurricanes Katrina and Rita left a wake of devastation and destroyed the homes and disrupted the livelihoods of countless Americans. My prayers continue to go out to the victims of these horrible events.

Experts agree that the Atlantic Ocean is in a natural period of increased tropical storm activity. The last time were in an active period like this was 1920 to 1966. Obviously, these are very long-term cycles. However, today many more people live in hurricane-prone areas. To help prepare and respond better in the future, it is urgent for us to understand the forecasting of Katrina and Rita and what future hurricane seasons may hold. In that vein, I am pleased that Chairman Boehlert organized today's hearing about NOAA's hurricane forecasting.

As the Chairman of the Environment and Technology and Standards Subcommittee, I am proud of the National Oceanic and Atmospheric Administration's Weather Service. The Weather Service, in particular through its National Hurricane Center in Miami, Florida, did an excellent job forecasting Katrina and Rita. Weather Service employees worked countless long hours to ensure that federal, State, and local officials and the public have the most accurate and up to date information about dangerous weather events. I applaud their hard work and look forward to learning more about how they do it. And I also am very anxious to find out how we can possibly alert the public anymore than has already been done to make certain the public responds and doesn't take it for granted.

I yield back.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

In the last six weeks, two of the strongest hurricanes ever recorded in the Gulf of Mexico hit the Gulf Coast region. Hurricanes Katrina and Rita left a wake of devastation and destroyed the homes and disrupted the livelihoods of countless Americans. My prayers continue to go out to the victims of these terrible events.

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Chairman BOEHLERT. Thank you very much, Dr. Ehlers.

Mr. Wu.

Mr. WU. As Ranking Member of the Environment, Technology, and Standards Subcommittee, I would like to begin by yielding time to one of my several good friends who were affected by Hurricanes Katrina and Rita, in this case, Mr. Melancon, the gentleman from Louisiana.

Mr. MELANCON. Thank you, Mr. Wu, I appreciate it.

As you all know, my district suffered catastrophic losses and damage, lots of lives during Hurricane Katrina. It is hard to relate in words the situation that Katrina left behind. The challenges to rebuilding and putting the South Louisiana area back together again are complex and the progress will be slow.

The loss of life, livelihood, homes and communities defy description but the courage and the resilience of the people of South Louisiana is all evident. We have taken a mighty blow from Mother Nature and we are stunned, but we are still standing and we are going to recover from this and restore our communities but we have a long and hard road ahead. The Federal Government must work with the State and local governments to rebuild our communities, our livelihoods, and the natural and manmade structures that protect us from these storms.

We have heard criticism of the Government's response at all levels. In the midst of all this finger pointing, however, I think it is important that we highlight the many local officials who took care of their people when the network to support them collapsed. If not for the efforts of these heroes, many people would not have been evacuated and many of those who did not evacuate would not have survived. My constituents are not interested in partisan bickering or Monday morning quarterbacking. They need their immediate needs addressed and they need to have help to rebuild their lives.

As federal officials, we need to ensure the Federal Government is ready to respond rapidly to future situations where citizens are victimized by natural or manmade disasters. State and local governments cannot be expected to provide sustained response and assistance from within a vast devastated area. The Federal Government is the only organization with the resources to provide the type of emergency assistance our citizens need.

We can learn from some of the federal agencies that did perform well, such as the National Weather Service and the U.S. Coastguard. The National Weather Service worked cooperatively with State and local officials and with the media to get information out to the public. Their forecasts were accurate and their warnings were clear. Without these forecast and warnings and the lead time they provided, we would not have been able to evacuate as many people as we did and the loss of life would have been much greater.

Their performance emphasizes the need for Congress to ensure that this agency stays adequately funded.

To the American people and my fellow Members on this committee, I thank you. You have reached out to me and my district these past days and your generosity has not gone unnoticed. Rest assured with your help, Louisianans will survive. We will rebuild and our state will be strong again.

On behalf of my constituents, I thank you, Mr. Mayfield and the other employees of the Hurricane Center and the National Weather Service for your fine work. I am anxious to work with my colleagues on the Committee to ensure that NOAA has the resources it needs to continue to improve hurricane forecasting. Additionally, I would also want to ensure that NOAA's other branches have the resources they need to help us rebuild our coastal wetlands and our fisheries.

On behalf of the people of Louisiana and I would believe on behalf of the people of the entire Gulf Coast, I thank you.

With that, I yield back my time.

[The prepared statement of Mr. Melancon follows:]

PREPARED STATEMENT OF REPRESENTATIVE CHARLIE MELANCON

As you all know, my district suffered catastrophic damage and tragic loss of life due to Hurricane Katrina. It's hard to relate in words the situation that Katrina left behind. The challenges to rebuilding and putting South Louisiana back together again are complex and the progress is slow. The loss of life, livelihood, homes, and communities defies description.

But, the courage, resilience, and strength of Louisiana's citizens is also evident. We have taken a mighty blow from Mother Nature and we're stunned, but we're still standing. We are going to recover from this and restore our communities, but we have a long hard road ahead. The Federal Government must work with the State and local governments to rebuild our communities, our livelihoods and the natural and the man-made structures that protect us from these storms.

We've heard criticism of the government response at all levels. In the midst of all this finger-pointing, however, I think it is important that we highlight the many local officials who took care of their people when the network to support them collapsed. If not for the efforts of these heroes, many people would not have evacuated and many of those who did not evacuate would not have survived.

My constituents are not interested in partisan bickering or Monday-morning quarterbacking. They need their immediate needs addressed and they need help to rebuild their lives. As federal officials, we need to ensure the Federal Government is ready to respond rapidly to future situations where citizens are victimized by natural or man-made disasters. State and local governments cannot be expected to provide sustained response and assistance from within a vast devastated area. The Federal Government is the only organization with resources to provide the type of emergency assistance our citizens need.

We can learn from some of the federal agencies that did perform well—the National Weather Service and the U.S. Coast Guard are two examples.

The National Weather Service worked cooperatively with State and local officials and with the media to get information out to the public. Their forecasts were accurate, and their warnings were clear. Without these forecasts and warnings, and the lead time they provided, we would not have been able to evacuate as many people as we did and the loss of life would have been much greater. Their performance emphasizes the need for Congress to ensure that this agency stays adequately funded.

To the American people and my fellow Members on this committee—thank you. You have reached out to me and my district these past days and weeks and your generosity has not gone unnoticed. Rest assured, with your help, Louisianians will survive; we will rebuild; and our state will be strong again.

On behalf of my constituents; thank you Dr. Mayfield, and the other employees of the Hurricane Center and the National Weather Service for your fine work. I am anxious to work with my colleagues on the Committee to ensure that NOAA has the resources it needs to continue to improve hurricane forecasting. Additionally, I

would also want to ensure that NOAA's other branches have the resources they need to help us to rebuild our coastal wetlands and our fisheries.

Thank you, and I yield back my time.

Chairman BOEHLERT. Thank you very much for those heartfelt remarks and I think we all identify with them.

And without objection, all other Members will be able to offer opening statements at this juncture in the record.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good morning. I want to thank the witnesses for appearing before our committee to examine hurricane forecasting by the National Oceanic and Atmospheric Administration (NOAA). The devastating affects of hurricanes are familiar to all of us. In the wake of Hurricanes Katrina and Rita, it is important to gain a better understanding of the prediction of hurricanes and determine what can be done to improve prediction of hurricanes, both in the short-term and the long-term.

Within the NOAA, the National Weather Service (NWS) and the National Hurricane Center (NHC) predicted the severity of Hurricane Katrina and issued multiple warnings for the Gulf Coast as early as 5 pm on Thursday, August 25th. By late Sunday night, early Monday morning, August 29th, the National Hurricane Center issued an advisory stating "coastal storm surge flooding of 18 to 22 feet above normal tide levels. . .locally as high as 28 feet.. . .*Some levees in the greater New Orleans could be overtopped.*" This is not an instance where science failed us. The science of hurricane prediction has increased dramatically with observational work and research done by NOAA.

For decades FEMA, the Army Corp of Engineers, academics and other federal, State and local agencies have performed simulations and analyses to determine the affect of a hurricane on the New Orleans area. These analyses overwhelming concluded that should a Category 3, or higher, hurricane strike New Orleans, the result would be catastrophic flooding, loss of property and life *with or without a levee breach*. Simple overtopping of the levees alone was predicted by the Red Cross to result in between 25,000–100,000 lives.

Hurricane Katrina revealed that despite billions of dollars in emergency response preparation and a complete overhaul of the federal domestic security system embodied in the Department of Homeland Security, Americans are not secure today from the ravages of nature. Thus, within this chaos, one thing is clear; this disaster was not the fault of the NOAA or their sub-components the NWS or the NHC. The aftermath was not due to a failure of science to predict. The aftermath was a failure of emergency response to act on sound engineering, oceanographic and atmospheric science that predicted that Katrina could be devastating and the Gulf region in particular, New Orleans, because the city sits below sea level and is dependent on levees and pumps to keep the water out.

I thank the witnesses for their testimony and look forward to hearing what the outlook is for the remainder of the 2005 hurricane season and for improving hurricane predictions in the short- and long-term.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman and Ranking Member.

Hurricanes Katrina and Rita devastated thousands of lives in New Orleans, southern Louisiana, Mississippi, and other parts of the Southeast.

I am anxious to hear about how NOAA and the National Weather Service predict hurricanes and how we as legislators can remove barriers so that you can do your important work to the best of your ability.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Mr. Chairman and Mr. Ranking Member, thank you for hosting this hearing.

I am pleased that the Science Committee is taking this very important step to exercise its oversight role, particularly after such horrific natural disasters have occurred. We owe it to the American public to do everything possible to make sure this type of tragedy never happens again.

After reviewing the written testimony of our witnesses it is clear to me that NOAA, the National Weather Service and the National Hurricane Service did an outstanding job predicting the course of Hurricane Katrina and the ensuing devastation that followed. To prevent another Katrina, we must equip the National Hurricane Center and keep it as strong as it is today. But, we must also look outside this committee and revisit many of the policies promoted by the Bush Administration, reform FEMA and ensure that funds directed toward emergency management are held accountable.

General Johnson and Dr. Mayfield, we are pleased to have you with us and I look forward to hearing your testimony.

[The prepared statement of Ms. Jackson Lee follows:]

PREPARED STATEMENT OF REPRESENTATIVE SHEILA JACKSON LEE

Mr. Chairman, let me first thank you for holding this important hearing on hurricane forecasting.

It was about five weeks ago that we first heard reports of a hurricane building in the Atlantic Ocean and heading towards our coast. We had heard this warning many times before, but the size and the scale of this one was different. There hasn't been a hurricane this big and this powerful in decades, and it was heading toward one of the most vulnerable cities in the country. We have since witnessed the awesome destructive power Mother Nature still commands over mankind. Few could have imagined the immense devastation and human suffering Katrina would bring to our shores.

If there is something positive we can take from this disaster, however, it will be our collective national resolve to never allow this to happen again. While this event is still fresh in our memories, we must learn from what we did wrong, strengthen what we did right and strive to find new ways to ensure the safety of the citizens of this country.

On the forefront of this effort, of course, are the fine people of the National Oceanic and Atmospheric Administration. Their state-of-the-art forecasting, detection and tracking systems saved hundreds, if not thousands of lives this past month. Their accuracy in the forecasting of Katrina was outstanding, and very impressive in Rita as well. Questions remain to be answered regarding what the proper response to NOAA's warnings *should* have been, but it is very apparent that in the case of Rita and Katrina, NOAA performed extremely well, and we commend them for that.

NOAA's impressive performance in this instance, however, serves only to further emphasize the need for more work in the area of hurricane forecasting. We can't ever expect to conquer Mother Nature, or turn back hurricanes with the press of a button. In the wake of this disaster, however, we need to constantly be asking each other "What more could we have done?"

The Committee posed some very difficult questions for our distinguished panel, that I hope we can explore today. I hope those questions are appropriately addressed, with special attention to what can be done to improve forecasting of hurricanes in the future.

Thank you very much for being here today. I am sure this hearing will be very productive, and I look forward to hearing the testimony from the panelists as well as from my fellow colleagues.

Chairman BOEHLERT. Let me welcome our two distinguished visitors, Brigadier General David L. Johnson, who is Director of the NOAA National Weather Service; and Mr. Max Mayfield, who is the Director of NOAA's Tropical Prediction Center and National Hurricane Center. And let me say to both of you gentlemen, I can speak, I think, for my colleagues of all persuasions from all regions of the country, we appreciate the magnificent performance of your people in this tragic incident and we are so proud of what you do and do so well.

The purpose of this hearing, though, is not to give you additional pats on the back, well deserved though they are. It is to go forward and to try to determine what more you might need, what assistance we might be able to provide. But I stress my strong, personal feeling that you have been magnificent in the performance of your

job. I cannot say that about every other official at every level of government but I can say it about you two and all the people that you represent. Thank you.

With that, our first witness, General Johnson, Director of the National Weather Service. General, the Floor is yours.

STATEMENT OF BRIGADIER GENERAL DAVID L. JOHNSON (RET.), ASSISTANT ADMINISTRATOR FOR WEATHER SERVICES; DIRECTOR, THE NATIONAL WEATHER SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Mr. JOHNSON. Mr. Chairman and Members of the Committee, I am David Johnson, the Assistant Administrator for Weather Services at NOAA and Director of the National Weather Service. Thank you very much for inviting me here today to discuss NOAA's role in forecasting and warning the public about hurricanes. And Mr. Chairman, I would like to thank you personally and all of the Members of the Science Committee for your leadership in this area and for your support last year when you provided funding to get us seven additional buoys and provide dollars for the Air Force Reserve to put some urgently needed instrumentation on their airplanes. They are working towards getting me one airplane for the '06 season and then additional airplanes after that.

I am accompanied by Max Mayfield, my Director of the National Hurricane Center. He will be focusing on Hurricane Katrina and Rita, communicating our forecasts, as well as the outlook for the future. I will be focusing on our role in hurricane tracking and forecasting, as well as, ongoing and future research efforts.

NOAA's forecast and warnings for Hurricane Rita and Katrina pushed the limits of state-of-the-art hurricane prediction and our current continuous research efforts including observations, modeling, and expanded computational resources at NOAA and in partnership with other federal agencies lead to our current predictive capabilities and improved ways of describing uncertainty in prediction. But NOAA's work does not stop there. NOAA assesses damage from storms and evaluates waterways to assist dredging operations, reopening our nation's ports and waterways impacted by the storms. NOAA also assesses the impact to area fisheries, supports hazardous materials containment and abatement efforts, and we provide environmental data critical for post storm recovery operations.

The mission of the National Weather Service is to issue weather, water, and climate forecasts for the protection of life and property and the enhancement of the economy. Nowhere is that more evident than in the hurricane program. Various components of the National Weather Service play important roles in the overall hurricane forecasting and warning process and the National Hurricane Center within the NWS has been the centerpiece of our nation's Hurricane Forecast and Warning Program for 50 years.

The National Hurricane Center, ably led by Max Mayfield, is responsible for predicting the path and intensity of the storm, issuing coastal hurricane watches and warnings, and describing broad impacts to the areas impacted, including projected storm surge levels.

After each hurricane season, your Weather Service undertakes an effort to improve how we can communicate our information more clearly. For example, after the 2004 season, we focused on how to improve the communication of uncertainty. Again this year, we have several experimental products on our website for review. We will do a hot wash after this season to see how we can do our job better.

Local National Weather Forecast Offices and River Forecast Centers also play a critical role in this process. They use their local expertise to refine National Hurricane Center advisories and provide specific detailed information about storm impacts from the hurricane to their local forecast area of responsibility.

Weather forecast office staffs have detailed knowledge of the local terrain and impacts and provide this information through direct interaction with local emergency managers via their local forecast products and messages. This detailed information is used by local emergency managers in their evacuation and other preparedness decisions.

Using a combination of atmospheric and ocean observations from satellites, aircraft, and all available surface data over the ocean, NOAA conducts experiments to better understand internal storm dynamics and interactions between a hurricane and the surrounding atmosphere and oceans. Through greater understanding of the physical processes in advanced hurricane modeling, NOAA continually improves models for predicting hurricane intensity and track. These numerical modeling improvements, once demonstrated, are then transitioned into operations. Our track forecasts have shown consistent improvement; however, we have not seen a comparable improvement in our intensity forecasts.

From a scientific point, the gaps in our capabilities fall into two broad categories. First, our ability to measure and assess the current state of hurricane and its environment doing that analysis, and second, our ability to predict the hurricane's future state, that is the forecast. We need to enhance our observation network. Many of the enhancements required to improve hurricane analyses particularly over the data sparse ocean areas will be addressed through such programs as the Global Earth Observation System of Systems or GEOSS, a ten-year international endeavor of which the United States is a member and NOAA a key participant.

Predicting hurricane intensity remains an acute challenge. Even though we knew conditions were favorable for the storms to intensify, we do not know why the storm underwent its rapid intensification once it passed the Florida Peninsula and reentered the gulf. We are now at the point in improving intensity forecasts that we were at a decade ago with the track forecast. Our 2005 version of our high resolution model improved some of the intensity forecasts over the current statistical models when we run them on last year's 2004 hurricanes. So we have potential there.

To advance hurricane prediction, especially hurricane and size forecasts, NOAA is developing the Hurricane Weather and Research Forecasting System. The Weather Service works with the research community to incorporate advanced model physics into a hurricane model which integrates the physical interactions of the atmosphere, land, and oceans into a single model. Our goal here is

to couple an advanced wave model with a dynamic storm surge model to better predict coastal impacts of waves and the storm surge.

Mr. Chairman, while there are no quick fixes, we are very optimistic that we will continue to make advances in our operational forecast of tropical cyclone intensity, wind structure, size and rainfall in the near future.

So in conclusion, the government's ability to observe, predict, and respond quickly to storm events is critical to public safety. At NOAA, we will continue our efforts to improve hurricane track and intensity forecasting including wind, storm surge, and rainfall amounts. We will also continue to provide the technical tools and planning expertise to states and local governments to help mitigate future natural disasters and provide our assistance for response and recovery.

With that, sir, I am happy to answer any questions you may have.

[The prepared statement of Brigadier General Johnson follows:]

PREPARED STATEMENT OF BRIGADIER GENERAL DAVID L. JOHNSON

Mr. Chairman and Members of the Committee, I am General David L. Johnson, Assistant Administrator for Weather Services at the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce. Thank you for inviting me here today to discuss NOAA's role in forecasting, and warning the public about hurricanes, as well as NOAA's essential role and activities following landfall.

The devastation along the Gulf Coast from Hurricane Katrina and Hurricane Rita is like nothing I have witnessed before. It is catastrophic. Words cannot convey the physical destruction and personal suffering in that part of our nation. However, without NOAA's forecasts and warnings, the devastation and loss of life would have been far greater.

NOAA's forecasts and warnings for Hurricane Katrina and Hurricane Rita pushed the limits of state-of-the-art hurricane prediction. In partnership with DOD, NASA, NSF, and other federal agencies, the long-term continuous research efforts, including observations, modeling, and expanded computational resources have led to NOAA's current predictive capabilities and improved ways of describing uncertainty in prediction. But NOAA's work does not end there. NOAA assesses damage from storms and evaluates waterways to assist dredging operations, allowing our nation's ports and waterways impacted by the storm to open. NOAA also assesses the impact to the areas' fisheries, supports hazardous materials containment and abatement efforts, and provides necessary data critical for post storm recovery operations.

The Role of the National Weather Service in Tracking, Forecasting and Communicating the Threats of Hurricanes

The mission of the National Weather Service (NWS) is to issue weather, water and climate forecasts and warnings for the protection of life and property and the enhancement of the national economy. Nowhere is that more evident than in the hurricane program. Various components of the NWS play important roles in the overall hurricane forecasting and warning process. The National Hurricane Center (NHC) within the NWS has been the centerpiece of our nation's hurricane forecast and warning program for 50 years. The mission of the NHC is to save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, and forecasts of hazardous tropical weather and by increasing the public's understanding of these hazards.

NHC tropical cyclone forecasts are issued at least every six hours, more frequently during landfall threats, and include text messages as well as a suite of graphical products depicting our forecasts and the accompanying probabilities and "cone of uncertainty," as it has become known. The NHC is responsible for predicting the path and intensity of the system, issuing coastal hurricane watches and warnings, and describing broad impacts to the areas impacted, including projected storm surge levels.

Local National Weather Service Weather Forecast Offices (WFO) also play a critical role in this process. The WFOs use their local expertise to refine NHC advisories and provide specific, detailed information about the impacts from the hur-

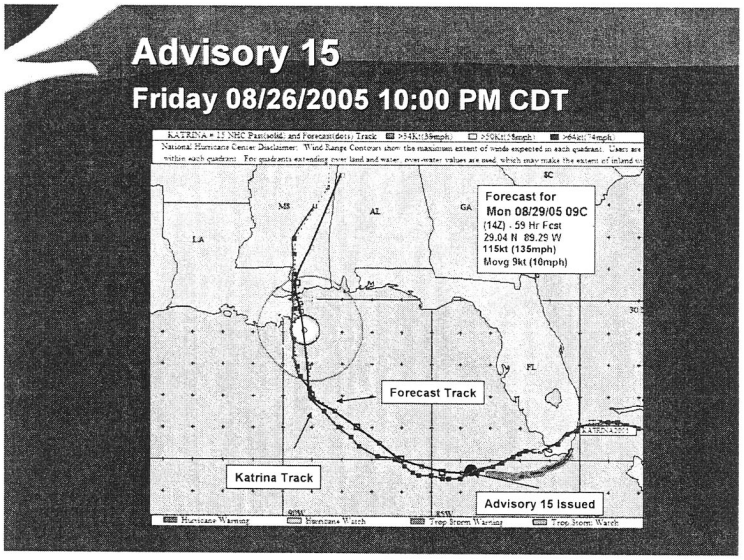
ricane to their local forecast area of responsibility. Weather forecast staff have detailed knowledge of the local terrain and impacts, and provide this information through direct interactions with local emergency managers and via their local forecast products and messages. This detailed information is used by local emergency managers when making their evacuation and other preparedness decisions. The effects of hurricanes can reach far inland and it is the responsibility of the local WFO to issue inland hurricane and tropical storm warnings and describe the local impacts here as well. These inland impacts include flood and flash floods as well as tornadoes.

Tracking and Forecasting Hurricane Katrina

Hurricane Katrina began as a tropical depression near the southeastern Bahamas on Tuesday, August 23, 2005. The National Hurricane Center accurately predicted it would become a Category 1 hurricane before making landfall near Miami. The storm deluged southeast Florida with 16 inches of rain in some places, causing downed trees, flooding, and extended power outages as it passed across the southern portion of the state.

Once Katrina re-emerged into the Gulf of Mexico, NOAA hurricane forecasters correctly predicted re-intensification of the storm. Katrina intensified more quickly and became stronger than initially predicted. Within nine hours, Katrina intensified from a tropical storm, with winds of 70 miles per hour, to a Category 2 storm with 100 mile per hour winds.

As you can see in the graphic below, our forecast track from Friday night (August 26), about 56 hours before landfall, had the storm curving northward and headed directly toward southeastern Louisiana and Mississippi. The projected path of Katrina aimed directly at southeast Louisiana, and the prediction was for Katrina to make landfall as a Category 4 hurricane. The actual track would deviate little from this and subsequent forecasts for the rest of Katrina's approach. On average, NOAA forecasts of where Katrina would go were more accurate than usual, with all of the forecast tracks during the last 48 hours lining up almost directly on top of the actual track. This forecast beats the Government Performance and Results Act goal established for NOAA hurricane forecasts this year.



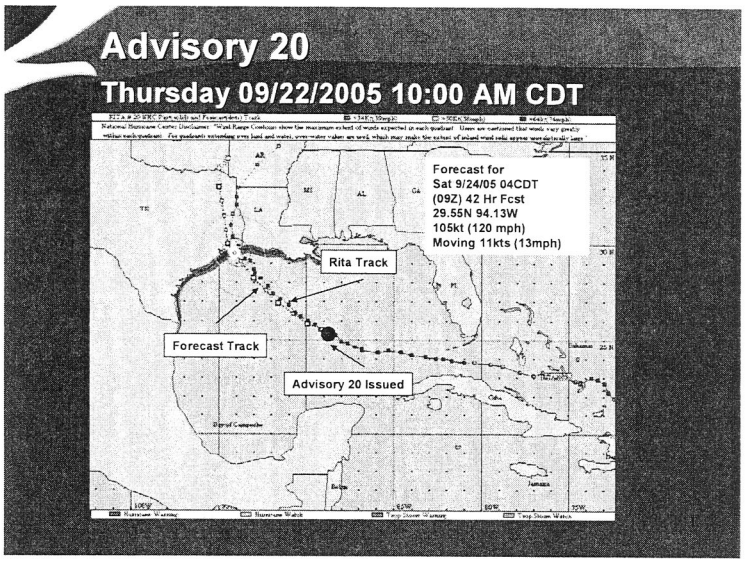
At 10:00 am Central Daylight Time (CDT) Saturday morning, August 27, the National Hurricane Center posted a hurricane watch for southeast Louisiana, including the city of New Orleans. The hurricane watch extended eastward to Mississippi and Alabama that afternoon. A hurricane watch means hurricane conditions are possible in the specified area, usually within 36 hours. Messages from the National Hurri-

cane Center highlighted the potential for this storm to make landfall as a Category 4 or Category 5 storm.

Tracking and Forecasting Rita

Rita began as a tropical depression at 10:00 pm CDT Saturday, September 17, 2005, east of the Turks and Caicos Islands north of the Caribbean. The National Hurricane Center accurately predicted the center of the storm to pass just south of the Florida Keys as a hurricane on Tuesday, September 20, and predicted it to become a major hurricane as it moved over the warm waters of the Gulf of Mexico. Hurricane Rita continued to intensify in the Gulf of Mexico and became a Category 5 hurricane at 4:00 pm CDT Wednesday, September 21 with winds of 165 miles per hour.

On Thursday, September 22, approximately two days before landfall, the forecast track was shifted eastward to just west of the Louisiana/Texas border. Rita's actual track would deviate little from this and subsequent projections. As Hurricane Rita neared landfall, the National Hurricane Center accurately predicted its decrease in intensity. Hurricane Rita made landfall as a Category 3 storm just east of Port Arthur, Texas, near the Texas/Louisiana border.



Storm Surge

Storm surge has caused most of this country's tropical cyclone fatalities, all too vividly evident in the past several weeks, and represents our greatest risk for a large loss of life in this country. Following Hurricane Camille in 1969, NOAA established a group that developed and implemented a storm surge model called SLOSH (Sea, Lake, and Overland Surges from Hurricanes). The SLOSH model calculates storm surge heights resulting either from historical, hypothetical or actual hurricanes. SLOSH incorporates bathymetry and topography, including bay and river configurations, roads, levees, and other physical features that can modify the storm surge flow pattern. Comprehensive evacuation studies, conducted jointly by the Federal Emergency Management Agency (FEMA), the U.S. Army Corps of Engineers, NOAA, and State and local emergency managers, are based on the simulated surges computed by SLOSH.

The National Hurricane Center introduced storm surge forecasts for the Gulf Coast in public advisories at 10:00 pm CDT Saturday—32 hours prior to Katrina's landfall in Louisiana. The initial forecast (10:00 pm CDT, Saturday, August 27) for storm surge was predicted at 15 to 20 feet, locally as high as 25 feet, and that forecast was updated the following morning to a range of 18 to 22 feet, locally as high

as 28 feet, when the forecast intensity for landfall was increased. "Large and battering" waves were forecast on top of the surge. In addition, the 4:00 pm CDT public advisory issued by the National Hurricane Center on Sunday, August 28, stated that some levees in the greater New Orleans area could be overtopped. Actual storm surge values are being determined at this time.

Storm surge values for Rita were also issued well in advance of landfall. At 10:00am CDT on September 22, 40 hours before landfall, the National Hurricane Center predicted a storm surge of ". . .15 to 20 feet above normal tide levels, along with large and dangerous battering waves, can be expected near and to the right of where the center makes landfall." While exact levels of the surge are still being determined, the damage from the surge was similar to damage witnessed in Mississippi and Louisiana with Katrina.

In the case of Hurricane Katrina, there have been news reports that Max Mayfield, the Director of the National Hurricane Center, notified FEMA that the New Orleans' levees would be breached. In fact, he did not say this. He indicated in his briefings to emergency managers and to the media the possibility some levees in the greater New Orleans area could be overtopped, depending on the details of Katrina's track and intensity. This possibility was also indicated in the National Hurricane Center advisory products and local weather office Hurricane Local Statements and has been discussed at conferences and briefings with emergency managers, media, and the public for many years.

Communicating Our Forecasts

The FEMA/NWS Hurricane Liaison Team (HLT), established in 1996, coordinates communications between NOAA and the emergency management community at the federal and State levels. Membership consists of FEMA Hurricane Program Managers and Disaster Assistance employees as well as National Weather Service meteorologists and hydrologists. The Hurricane Liaison Team is activated by FEMA, at the request of the Director of the National Hurricane Center, or his or her designee. The HLT is activated a few days in advance of any potential U.S. hurricane landfall. Once activated, FEMA hosts the daily HLT audio or video conference calls. FEMA invites State and local emergency managers in the potential impact area to participate in these calls. The National Hurricane Center, as an invited participant, opens each call by providing an updated forecast. After consulting with our local weather service offices and the National Hurricane Center, emergency managers make evacuation and other preparedness decisions. The HLT provides an excellent way to communicate with the large number of emergency managers typically impacted by a potential hurricane. This is a critical effort to ensure emergency managers and first responders know what to expect from the hurricane.

The reported evacuation rate during Hurricane Katrina of near 80 percent, however, far exceeds the 25–50 percent rates usually noted. This large evacuation saved many lives and did not happen by accident. Rather, it resulted from a long working relationship and open communication between NOAA, the emergency management community at all levels, and the media. This collaboration is especially close and complementary during a hurricane threat. For example, since the 1970s, NOAA has been delivering and updating thousands of storm surge simulations it generates for the entire vulnerable coast from Texas to Maine long before any specific event. These simulations are the basis for the evacuation plans and storm-specific decisions made by the communities there. In addition, NOAA provides real-time storm surge information.

I believe the high evacuation rate for Katrina was also due to the broad distribution and diverse formats of National Weather Service text and graphical forecast and warning products, the 471 media interviews conducted by NHC staff, the more than 2.3 billion "hits" the National Weather Service forecast products received on our public website, and the interactions of local National Weather Service offices and the National Hurricane Center with emergency managers in the days prior to landfall. For Hurricane Rita, National Hurricane Center staff provided 935 media interviews. In addition, National Weather Service web activity, as supported by NOAA's web-mirroring project, registered over 2.9 billion "hits" during Hurricane Rita.

On Saturday evening, August 27, Max Mayfield personally called the Chief of Operations at the Alabama Emergency Management Agency, as well as the Governors of Louisiana and Mississippi and the Mayor of New Orleans, to communicate the potential meteorological and storm surge impacts from Hurricane Katrina.

NOAA Aircraft Support Efforts

NOAA Aircraft, the W–P3 Orions and the Gulf Stream IV "Hurricane Hunters," provided essential observations critical to the National Hurricane Center forecasters

and supplement U.S. Air Force Reserve Command's 53rd Weather Reconnaissance Squadron flights. A specialized instrument flown on one of the W–P3s, the Stepped Frequency Microwave Radiometer (SFMR), provided essential hurricane structure and surface wind data to hurricane forecasters for both hurricanes. The *Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act,* 2005 (P.L. 108–324) provided $10.5M to the Air Force to outfit the complete fleet of Hurricane Hunters with this instrument, the first of these additional units should be available during the 2006 Hurricane Season.

The *Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act,* 2005 also provided funding to NOAA for seven hurricane buoys, which NOAA deployed this past year in the Caribbean, the Gulf of Mexico, and the Atlantic. These new buoys provided us with critical information during this active hurricane season.

NOAA's Activities After Hurricane Katrina's and Hurricane Rita's Landfall

Immediately following Hurricane Katrina's second landfall, and also following Hurricane Rita's landfall, several NOAA ships and aircraft were tasked with assisting in the hurricane response. Our aircraft flew damage assessment flights using a sophisticated digital camera to collect imagery to assess damage. Over 10,000 high-resolution images were collected by NOAA aircraft for the areas impacted by Hurricanes Katrina and Rita. These images are assisting emergency managers and other agencies in recovery operations and long-term restoration and rebuilding decisions. They are also publicly available on NOAA's website to allow those displaced by the storms to view their homes and neighborhoods via the Internet.

It is also NOAA's responsibility to assess the damage to the commercial fishing industry in those sections of the Gulf of Mexico. We are working closely with each of the impacted State resource agencies and commercial entities to assess the storm's impacts to the longer-term social and economic viability of local fishing communities. NOAA employees also are assisting recovery efforts by working with other federal agencies in planning, organizing, and conducting oil spill and hazardous material response and restoration in the impacted areas of the Gulf.

NOAA vessels are tasked with surveying critical ports and waterways for depths, wrecks and obstructions for navigational safety. NOAA Navigation Response Teams were on the scene before both hurricanes hit to survey for hazards and help the U.S. Coast Guard and the Army Corps of Engineers re-open waterways to commercial and emergency traffic. Our ships use highly specialized hydrographic equipment to survey near shore and mid-water areas to assess potential obstructions to navigation caused by Hurricane Katrina, and Rita. The efforts of these NOAA ships are critical to rebuilding the Gulf's economic infrastructure by enabling vessels of all sizes to pass safely through these waterways thereby allowing emergency materials, oil, and commercial goods to make it to their destinations.

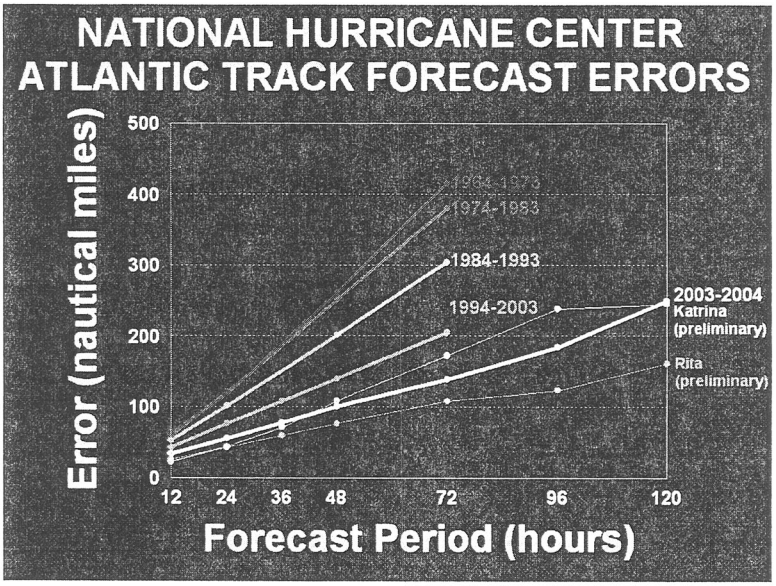
Outlook for the Future

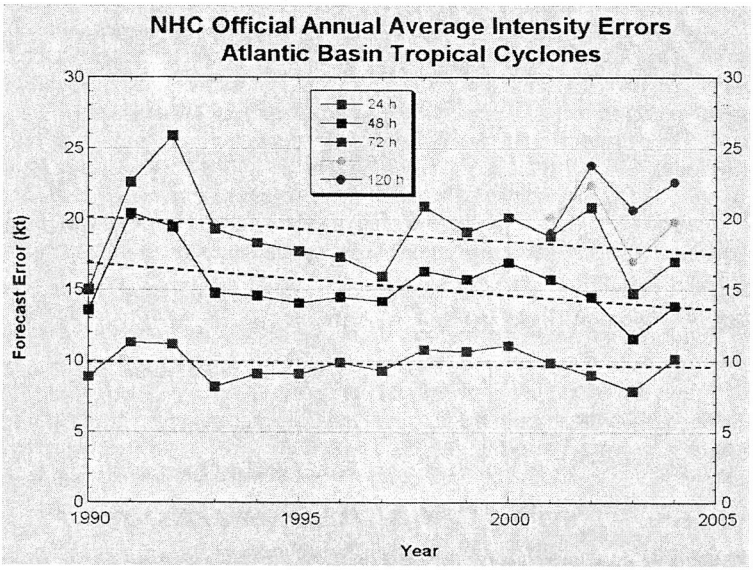
Today is October 7; to date we have had seventeen tropical storms, nine of which have become hurricanes, five of those have been major hurricanes at Category 3 or stronger. We believe we will continue to have an active season, with a total of l8–21 tropical storms. We believe this heightened period of hurricane activity will continue due to multi-decadal variance, as tropical cyclone activity in the Atlantic is cyclical and tied to fluctuations in sea surface temperatures and other characteristics of the coupled ocean-atmosphere system. The 1940's through the 1960's experienced an above average number of major hurricanes, while the 1970's into the mid-1990's averaged fewer hurricanes. The current period of heightened activity could last another 10–20 years. The increased activity since 1995 is due to natural fluctuations/cycles of hurricane activity, driven by the Atlantic Ocean itself along with the atmosphere above it. The natural cycles are quite large with 3–4 major hurricanes a year on average during active periods and only about 1–2 major hurricanes annually during quiet periods, with each period lasting 25–40 years.

Current and Future Research Efforts

Through greater understanding of physical processes and advanced hurricane modeling, NOAA continually improves models for predicting hurricane intensity and track, in collaboration with federal partners, academic researchers, and commercial enterprises. These numerical modeling improvements, once demonstrated, are transitioned into operations.

NOAA is focused on improving the forecasting of hurricane frequency, track, and intensity as well as predicting hurricane impacts on life and property. We depend on numerous critical research activities inside and outside NOAA. Our track forecasts have shown continued improvement. However, we have not seen a comparable improvement in our intensity forecasts.





From a scientific standpoint, the gaps in our capabilities fall into two broad categories: first, our ability to measure and assess the current state of a hurricane and its environment (analysis), and second, our ability to predict a hurricane's future state (the forecast).

Many of the enhancements required to improve hurricane analyses, particularly over the data-sparse ocean areas, will be addressed through such programs as the Global Earth Observation System of Systems (GEOSS), a 10-year international endeavor of which the United States is a member and NOAA, NASA, and USGS are key participants.

Using a combination of atmospheric and ocean observations from satellites, aircraft, and all available surface data over the oceans, NOAA, NASA, NSF and other federal agencies conduct experiments to better understand internal storm dynamics and interactions between a hurricane and the surrounding atmosphere and ocean. Much of NOAA's improvement in tropical cyclone forecasting is attributed to advances in Numerical Weather Prediction (NWP). In collaboration with many scientists and developers in the domestic and international operational NWP centers, the NOAA Environmental Modeling Center develops state-of-the-art numerical modeling systems. Predicting hurricane intensity remains one of our acute challenges. For example, even though we knew conditions were favorable for the storms to intensify, and we forecast strengthening, there was some error for both storms in the intensity forecast for the eastern Gulf due to their rapid intensification. Through our NWP advancements, our 2005 version of our high-resolution model improved some intensity forecasts over the statistical models when run on several 2004 Atlantic storms. To advance hurricane prediction, especially hurricane intensity and size forecasts, NOAA is developing the Hurricane Weather and Research Forecasting (HWRF) system. The HWRF system uses a collaborative approach among the research community and will apply advanced model physics as HWRF couples the atmosphere, land, and ocean into an integrated model. Our goal is to couple an advanced wave model with a dynamic storm surge model to better predict coastal impacts of waves and storm surge.

We have increased our efforts to transfer research into operations. The United States Weather Research Program (USWRP) Joint Hurricane Testbed (JHT) was formed in late 2000. The mission of the JHT is to facilitate the transfer of new technology, research results, and observational advances of the USWRP, its sponsoring agencies, the academic community, and the private sector for improved operational tropical cyclone analysis and prediction.

While there are no quick fixes, we are very optimistic that we will continue to make advances in operational forecasts of tropical cyclone intensity, wind structure, size, and rainfall in the near future.

Conclusion

The government's ability to observe, predict, and respond quickly to storm events is critical to public safety. We must now look ahead to post-storm redevelopment strategies for communities impacted by Katrina, Rita and future storms, to help manage and anticipate these extreme events. NOAA has the expertise in coastal management and hazard mitigation, and is committed to working with our partners to reduce the Nation's vulnerability to hurricanes and other coastal storm events. It is critical that we work to protect and restore natural features along the Gulf Coast, such as dunes, wetlands, and other vegetated areas that offer protection against coastal flooding and erosion.

Hurricanes Katrina and Rita will not be the last major hurricanes to hit a vulnerable area, and New Orleans is not the only location vulnerable to a large disaster from a land-falling hurricane. Houston/Galveston, Tampa Bay, southwestern Florida, the Florida Keys, southeastern Florida, New York City/Long Island, and New England, are all especially vulnerable. And New Orleans remains vulnerable to future hurricanes.

In partnership with NASA, NSF, and other agencies, NOAA we will continue efforts to improve hurricane track, intensity, rainfall and storm surge forecasting. NOAA will also continue to provide technical tools and planning expertise to States and local governments to help mitigate future natural hazards and provide our assistance for response and recovery efforts.

With that, I'll be glad to answer any questions Members may have.

NOAA National Hurricane Center

Hurricane Katrina Forecast Timeline

TUESDAY, AUGUST 23, 2005
1600 CDT: Katrina forms as a Tropical Depression 12, near Nassau in the Bahamas. Tropical Depression 12 Advisory 1 issued: "A TROPICAL STORM OR HURRICANE WATCH MAY BE REQUIRED FOR PORTIONS OF SOUTHERN FLORIDA LATER TONIGHT."

WEDNESDAY, AUGUST 24, 2005
0400 CDT: The National Hurricane Center's five-day forecast puts the projected path of Katrina in the southeast Gulf of Mexico (as the system is still a tropical depression in the central Bahamas).

0700 CDT: Katrina is elevated to a Tropical Storm.

1000 CDT: Tropical Storm Katrina Advisory 4 is issued: ". . .A TROPICAL STORM WARNING AND A HURRICANE WATCH HAVE BEEN ISSUED FOR THE SOUTHEAST FLORIDA COAST. . ."

THURSDAY, AUGUST 25, 2005
1430 CDT: Katrina is elevated to a Category 1 Hurricane.

1730 CDT: Katrina makes landfall in Florida as a Category 1 Hurricane.

WEDNESDAY/THURSDAY, AUGUST 24/25:
Hurricane Liaison Team conference calls were conducted both days, and included Florida emergency managers, FEMA Headquarters (FEMA HQ), and Region IV.

FRIDAY, AUGUST 26, 2005
0200 CDT: Katrina entered the Gulf of Mexico as a Tropical Storm.

0400 CDT: Katrina is elevated to a Category 1 Hurricane.

1000 CDT: Hurricane Katrina Advisory Number 12 is issued: "KATRINA IS A CATEGORY ONE HURRICANE ON THE SAFFIR-SIMPSON SCALE. SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS. . .AND KATRINA COULD BECOME A CATEGORY TWO HURRICANE ON SATURDAY."

1015 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1030 CDT: Katrina is elevated to a Category 2 Hurricane. Hurricane Katrina Advisory Number 13 is issued: ". . .KATRINA RAPIDLY STRENGTHENING AS IT MOVES SLOWLY WESTWARD AWAY FROM SOUTH FLORIDA AND THE FLORIDA KEYS. . .KATRINA IS MOVING TOWARD THE WEST NEAR SEVEN MPH. . .AND THIS MOTION IS EXPECTED TO CONTINUE FOR THE NEXT 24 HOURS. . .RECENT REPORTS FROM AN AIR FORCE RESERVE UNIT HURRICANE HUNTER AIRCRAFT NOW INDICATE MAXIMUM SUSTAINED WINDS ARE NEAR 100 MPH. . .WITH HIGHER GUSTS. KATRINA IS NOW A CATEGORY TWO HURRICANE ON THE SAFFIR-SIMPSON SCALE. SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS. . .AND KATRINA COULD BECOME A CATEGORY THREE OR MAJOR HURRICANE ON SATURDAY."

1100 CDT: Hurricane Liaison Team Coordination Video Conference with FEMA HQ, Region IV, FL, AL, and GA.

1600 CDT: Hurricane Katrina Discussion Number 14 is issued: ". . .THE MODELS HAVE SHIFTED SIGNIFICANTLY WESTWARD AND ARE NOW IN BETTER AGREEMENT. THIS HAS RESULTED IN THE OFFICIAL FORECAST TRACK BEING SHIFTED ABOUT 150 NMI WEST OF THE PREVIOUS TRACK. . .HOWEVER. . .PROJECTED LANDFALL IS STILL ABOUT 72 HOURS AWAY. . .SO FURTHER MODIFICATIONS IN THE FORECAST TRACK ARE POSSIBLE. KATRINA IS EXPECTED TO BE MOVING OVER THE GULF LOOP CURRENT AFTER 36 HOURS. . .WHICH WHEN COMBINED WITH DECREASING VERTICAL SHEAR. . .SHOULD ALLOW THE HURRICANE TO REACH CATEGORY FOUR STATUS BEFORE LANDFALL OCCURS."

1615 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

2200 CDT: Hurricane Katrina Discussion Number 15 is issued: "THE OFFICIAL FORECAST BRINGS THE CORE OF THE INTENSE HURRICANE OVER THE NORTH CENTRAL GULF OF MEXICO IN 48 HOURS OR SO. IT IS WORTH NOTING THAT THE GUIDANCE SPREAD HAS DECREASED AND MOST OF THE RELIABLE NUMERICAL MODEL TRACKS ARE NOW CLUSTERED BE-

TWEEN THE EASTERN COAST OF LOUISIANA AND THE COAST OF MISSISSIPPI. THIS CLUSTERING INCREASES THE CONFIDENCE IN THE FORECAST."

SATURDAY, AUGUST 27, 2005

0400 CDT: Katrina is elevated to a Category 3 Hurricane. Hurricane Katrina Advisory Number 16 is issued: "KATRINA BECOMES A MAJOR HURRICANE WITH 115 MPH WINDS. . .SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS. . .RECONNAISSANCE AIRCRAFT DATA AND SURFACE OBSERVATIONS INDICATE THAT KATRINA HAS BECOME A LARGER HURRICANE. . ." Hurricane Katrina Discussion Number 16 is issued: "DUE TO THE DECREASING SPREAD IN THE MODELS. . .THE CONFIDENCE IN THE FORECAST TRACK IS INCREASING."

1000 CDT: Hurricane Katrina Advisory Number 17 is issued: "A HURRICANE WATCH IS IN EFFECT FOR THE SOUTHEASTERN COAST OF LOUISIANA EAST OF MORGAN CITY TO THE MOUTH OF THE PEARL RIVER. . .INCLUDING METROPOLITAN NEW ORLEANS AND LAKE PONCHARTRAIN. . .A HURRICANE WATCH WILL LIKELY BE REQUIRED FOR OTHER PORTIONS OF THE NORTHERN GULF LATER TODAY OR TONIGHT. INTERESTS IN THIS AREA SHOULD MONITOR THE PROGRESS OF KATRINA. . .SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS. . .AND KATRINA COULD BECOME A CATEGORY FOUR HURRICANE. . ." Hurricane Katrina Discussion Number 17 is issued: ". . .IT IS NOT OUT OF THE QUESTION THAT KATRINA COULD REACH CATEGORY 5 STATUS AT SOME POINT BEFORE LANDFALL. . ."

1015 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1100 CDT: Hurricane Liaison Team Coordination Video Conference with FEMA HQ, Region IV and VI, FL, LA, MS, AL, and GA.

1600 CDT: Hurricane Katrina Advisory Number 18 is issued: "THE HURRICANE WATCH IS EXTENDED WESTWARD TO INTRACOASTAL CITY LOUISIANA AND EASTWARD TO THE FLORIDA-ALABAMA BORDER. A HURRICANE WATCH IS NOW IN EFFECT ALONG THE NORTHERN GULF COAST FROM INTRACOASTAL CITY TO THE ALABAMA-FLORIDA BORDER. A HURRICANE WARNING WILL LIKELY BE REQUIRED FOR PORTIONS OF THE NORTHERN GULF COAST LATER TONIGHT OR SUNDAY. INTERESTS IN THIS AREA SHOULD MONITOR THE PROGRESS OF KATRINA." Hurricane Katrina Discussion Number 18 is issued: "THE INTENSITY FORECAST WILL CALL FOR STRENGTHENING TO 125 KT AT LANDFALL. . .AND THERE REMAINS A CHANCE THAT KATRINA COULD BECOME A CATEGORY FIVE HURRICANE BEFORE LANDFALL."

1615 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1925 CDT: Louisiana Gubernatorial Briefing: Max Mayfield, Director of NOAA's Tropical Predication Center/National Hurricane Center provides a briefing to Kathleen Babineau Blanco.

1935 CDT: Max Mayfield, Director of NOAA's Tropical Predication Center/National Hurricane Center provides a briefing to Bill Filter, Chief of Operations, Alabama Emergency Management Agency.

1945 CDT: Mississippi Gubernatorial Briefing: Max Mayfield, Director of NOAA's Tropical Predication Center/National Hurricane Center provides a briefing to Haley Barbour.

2000 CDT: New Orleans Mayoral Briefing: Max Mayfield, Director of NOAA's Tropical Predication Center/National Hurricane Center provides a briefing to Ray Nagin.

2200 CDT: Hurricane Katrina Advisory Number 19 is issued: ". . .DANGEROUS HURRICANE KATRINA THREATENS THE NORTH CENTRAL GULF COAST. . .A HURRICANE WARNING ISSUED. . .AT 10 PM CDT. . .0300Z. . .A HURRICANE WARNING HAS BEEN ISSUED FOR THE NORTH CENTRAL GULF COAST FROM MORGAN CITY LOUISIANA EASTWARD TO THE ALABAMA/FLORIDA BORDER. . .INCLUDING THE CITY OF NEW ORLEANS AND LAKE PONCHARTRAIN. . .PREPARATIONS TO PROTECT LIFE AND PROPERTY SHOULD BE RUSHED TO COMPLETION. . .COASTAL STORM SURGE FLOODING OF 15 TO 20 FEET ABOVE NORMAL TIDE LEVELS. . .LOCALLY AS HIGH AS 25 FEET ALONG WITH LARGE AND DANGEROUS BATTERING WAVES. . .CAN BE EXPECTED NEAR AND TO THE EAST OF WHERE THE CENTER MAKES LANDFALL. . .HEAVY RAINS FROM KATRINA SHOULD BEGIN TO AFFECT THE CENTRAL GULF COAST SUNDAY EVENING. RAIN-

FALL TOTALS OF FIVE TO 10 INCHES. . .WITH ISOLATED MAXIMUM AMOUNTS OF 15 INCHES. . .ARE POSSIBLE ALONG THE PATH OF KATRINA." Hurricane Katrina Discussion Number 19 is issued: ". . .DESPITE THESE CHANGES IN THE INNER CORE. . .THE BOTTOM LINE IS THAT KATRINA IS EXPECTED TO BE AN INTENSE AND DANGEROUS HURRICANE HEADING TOWARD THE NORTH CENTRAL GULF COAST. . .AND THIS HAS TO BE TAKEN VERY SERIOUSLY."

1500–2230 CDT: Media pool operated; TPC/NHC provided 12 television and two radio interviews. In addition, TPC/NHC participated in 51 telephone briefings or media contacts on August 27th.

SUNDAY, AUGUST 28, 2005

0040 CDT: Katrina is elevated to a Category 4 Hurricane.

0100 CDT: Hurricane Katrina Special Advisory Number 20 is issued: ". . .KATRINA STRENGTHENS TO CATEGORY FOUR WITH 145 MPH WINDS. . ."

0400 CDT: Hurricane Katrina Discussion Number 21 is issued: "THE SPREAD IN THE MODEL TRACKS ALONG THE NORTHERN GULF COAST IS AT MOST 90 MILES. . .SO CONFIDENCE IN THE OFFICIAL FORECAST IS RELATIVELY HIGH."

0615 CDT: Katrina is elevated to a Category 5 Hurricane.

0700 CDT: Hurricane Katrina Advisory Number 22 is issued: ". . .KATRINA. . .NOW A POTENTIALLY CATASTROPHIC CATEGORY FIVE HURRICANE. . .HEADED FOR THE NORTHERN GULF COAST. . .MAXIMUM SUSTAINED WINDS ARE NEAR 160 MPH. . .WITH HIGHER GUSTS. KATRINA IS A POTENTIALLY CATASTROPHIC CATEGORY FIVE HURRICANE ON THE SAFFIR-SIMPSON SCALE. SOME FLUCTUATIONS IN STRENGTH ARE LIKELY IN THE NEXT 24 HOURS."

1000 CDT: Hurricane Katrina Advisory Number 23 is issued: ". . .POTENTIALLY CATASTRPHIC HURRICANE KATRINA. . .EVEN STRONGER. . .HEADED FOR THE NORTHERN GULF COAST. . .REPORTS FROM AN AIR FORCE HURRICANE HUNTER AIRCRAFT INDICATE THAT THE MAXIMUM SUSTAINED WINDS HAVE INCREASED TO NEAR 175 MPH. . .WITH HIGHER WIND GUSTS. . .HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 105 MILES FROM THE CENTER AND TROPICAL STORM FORCE WINDS EXTEND OUTWARDS UP TO 205 MILES. . .COASTAL STORM SURGE FLOODING OF 18 TO 22 FEET ABOVE NORMAL TIDE LEVELS. . .LOCALLY AS HIGH AS 28 FEET ALONG WITH LARGE AND DANGEROUS BATTERING WAVES. . .CAN BE EXPECTED NEAR AND TO THE EAST OF WHERE THE CENTER MAKES LANDFALL. Hurricane Katrina Discussion Number 23 is issued: ". . .HURRICANE FORCE WINDS ARE FORECAST TO SPREAD AT LEAST 150 N MI INLAND ALONG PATH OF KATRINA. CONSULT INLAND WARNINGS ISSUED BY THE NATIONAL WEATHER SERVICE FORCAST OFFICES. . ."

1015 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1100 CDT: Hurricane Liaison Team Coordination Video Conference with FEMA HQ, Region IV and VI, FL, LA, MS, AL, GA, TX.

1300 CDT: Hurricane Katrina Advisory Number 23A is issued: "SIGNIFICANT STORM SURGE FLOODING WILL OCCUR ELSEWHERE ALONG THE CENTRAL AND NORTHEASTERN GULF OF MEXICO COAST."

1600 CDT: Hurricane Katrina Advisory Number 24 is issued: "KATRINA IS MOVING TOWARD THE NORTHWEST NEAR 13 MPH. . .AND A GRADUAL TURN TO THE NORTH IS EXPECTED OVER THE NEXT 24 HOURS. ON THIS TRACK THE CENTER OF THE HURRICANE WILL BE NEAR THE NORTHERN GULF COAST EARLY MONDAY. HOWEVER. . .CONDITIONS ARE ALREADY BEGINNING TO DETERIORATE ALONG PORTIONS OF THE CENTRAL AND NORTHEASTERN GULF COASTS. . .AND WILL CONTINUE TO WORSEN THROUGH THE NIGHT. . .KATRINA IS A POTENTIALLY CATASTROPHIC CATEGORY FIVE HURRICANE ON THE SAFFIR-SIMPSON SCALE. SOME FLUCTUATIONS IN STRENGTH ARE LIKELY UNTIL LANDFALL. KATRINA IS EXPECTED TO MAKE LANDFALL AT CATEGORY FOUR OR FIVE INTENSITY. WINDS AFFECTING THE UPPER FLOORS OF HIGH-RISE BUILDINGS WILL BE SIGNIFICANTLY STRONGER THAN THOSE NEAR GROUND LEVEL. . .SOME LEVEES IN THE GREATER NEW ORLEANS AREA COULD BE OVERTOPPED."

1615 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

2200 CDT: Hurricane Katrina Advisory Number 25 is issued: "A HURRICANE WARNING IS IN EFFECT FOR THE NORTH CENTRAL GULF COAST FROM MORGAN CITY LOUISIANA EASTWARD TO THE ALABAMA/FLORIDA BORDER. . .INCLUDING THE CITY OF NEW ORLEANS AND LAKE PONCHARTRAIN. PREPARATIONS TO PROTECT LIFE AND PROPERTY SHOULD BE RUSHED TO COMPLETION."

MONDAY, AUGUST 29, 2005

0200 CDT: Hurricane Katrina is downgraded to a Category 4.

0400 CDT: Hurricane Katrina Advisory Number 26 is issued: "EXTREMELY DANGEROUS CATEGORY FOUR HURRICANE KATRINA MOVING NORTHWARD TOWARD SOUTHEASTERN LOUISIANA AND THE NORTHERN GULF COAST. . .SOME FLUCTUATIONS IN STRENGTH ARE LIKELY PRIOR TO LANDFALL. . .BUT KATRINA IS EXPECTED TO MAKE LANDFALL AS A CATEGORY FOUR HURRICANE."

0600 CDT: Hurricane Katrina Advisory Number 26A is issued: "KATRINA REMAINS A VERY LARGE HURRICANE. HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 120 MILES FROM THE CENTER. . .AND TROPICAL STORM FORCE WINDS EXTEND OUTWARD UP TO 230 MILES."

0610 CDT: Hurricane Katrina makes landfall in southeastern Louisiana as a Category 4 hurricane.

0800 CDT: Hurricane Katrina Advisory Number 26B is issued: ". . .THE CENTER OF HURRICANE KATRINA WAS LOCATED...ABOUT 40 MILES SOUTHEAST OF NEW ORLEANS LOUISIANA AND ABOUT 65 MILES SOUTHWEST OF BILOXI MISSISSIPPI. . .MAXIMUM SUSTAINED WINDS ARE NEAR 135 MPH. . .WITH HIGHER GUSTS. KATRINA IS AN EXTREMELY DANGEROUS CATEGORY FOUR HURRICANE ON THE SAFFIR-SIMPSON SCALE. WEAKENING IS FORECAST AS THE CIRCULATION INTERACTS WITH LAND TODAY. . .COASTAL STORM SURGE FLOODING OF 18 TO 22 FEET ABOVE NORMAL TIDE LEVELS. . .ALONG WITH LARGE AND DANGEROUS BATTERING WAVES. . .CAN BE EXPECTED NEAR AND TO THE EAST OF THE CENTER. STORM SURGE FLOODING OF 10 TO 15 FEET. . .NEAR THE TOPS OF LEVEES. . .IS POSSIBLE IN THE GREATER NEW ORLEANS AREA. SIGNIFICANT STORM SURGE FLOODING WILL OCCUR ELSEWHERE ALONG THE CENTRAL AND NORTHEASTERN GULF OF MEXICO COAST."

1000 CDT: Hurricane Katrina makes a second landfall at the LA/MS border as a Category 3 hurricane.

1015 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1100 CDT: Hurricane Liaison Team Coordination Video Conference with FEMA HQ, Region IV and VI, LA, MS, AL, FL, TX.

1615 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

TUESDAY, AUGUST 30, 2005

1000 CDT: Katrina is downgraded to a tropical depression with winds of 35 mph, 25 miles south of Clarksville, TN. The final TPC/NHC advisory is issued at this time; the Hydrometeorological Prediction Center assumes inland public advisories.

WEDNESDAY, AUGUST 31, 2005

2200 CDT: Hurricane Katrina has dissipated; remnants absorbed by a front in southeast Canada.

NOTES:

- Timeline highlights the major aspects of NOAA's Tropical Prediction Center/National Hurricane Center (TPC/NHC). All advisories (graphic and text) are available on the Katrina archive page: http://www/nhc.noaa.gov/archive/2005/KATRINA/shtml?
- Storm surge is a consistent concern and associated threat with any land-falling hurricane, especially a major hurricane.
- Hurricane Liaison Team Coordination calls included the State emergency management officials for the states listed; calls with the State of Florida included both local and State emergency management officials.
- For Katrina (including for Florida) NOAA's Tropical Predication Center/National Hurricane Center provided a total of 471 television and radio interviews, through their media pool or via telephone.

BIOGRAPHY FOR DAVID L. JOHNSON

David L. Johnson serves as the Assistant Administrator, National Oceanic and Atmospheric Administration (NOAA) for Weather Services (National Weather Service). Johnson heads the Nation's weather service and is responsible for the day-to-day management of NOAA's domestic weather and hydrology operations.

Prior to joining NOAA, Johnson served as the U.S. Air Force director of weather. He retired from the Air Force as a brigadier general, after a 30-year military career. As Director of Weather, he was one of ten directors at the Headquarters Air Force, Air and Space Operations, and was responsible for developing doctrine, policy, requirements and operational organizations to support Air Force and Army operations worldwide. He also served as one of NOAA's military deputies.

Notably, he organized, trained and equipped forces for the war in Afghanistan and the war in Iraq, and managed a steady flow of accurate and focused environmental information to battlefield commanders. He was a key advisor in the development of the National Polar-orbiting Environmental Operational Satellite System (NPOESS).

Johnson's career is marked by his strong management and fiscal capabilities. During his time as Director of Weather, he led a massive re-engineering effort that revised the organizational structure, training and operations of the 4,000-person career field. Under Johnson's steady hand, retention of weather-career airmen and officers grew to 97 percent, up from 74 percent previously.

Johnson guided the planning, programming and budgeting process implementation at the highest levels in the Air Force and in the Department of Defense. He has a world-wide perspective, having served in leadership positions on the Joint Staff with planning portfolios in Europe/NATO and Asia/Pacific. He secured funding for a new facility for the Air Force Weather Agency to house collection, analysis, modeling and career-field supervision functions.

Prior to his service as the Director of Weather, Johnson flew fighter, transport and special operations aircraft. He has over 3,800 flying hours including 78 combat sorties. Johnson commanded airdrop and air/land operations in Bosnia-Herzegovina and was deputy commander of the Joint Task Force for Operation Support Hope in Rwanda. He was selected for early promotion three times.

Johnson is an honor graduate from the University of Kansas with a degree in geography, and earned his Master's degree in human relations from Webster's University. He is a graduate of the National War College, Maxwell School of Citizenship and Public Affairs at Syracuse University, and from the Paul Nitze School of Advanced International Studies at Johns Hopkins University.

Chairman BOEHLERT. Thank you very much, General.

Mr. Mayfield.

STATEMENT OF MR. MAX MAYFIELD, DIRECTOR, NOAA TROPICAL PREDICTION CENTER/NATIONAL HURRICANE CENTER

Mr. MAYFIELD. Mr. Chairman and Members of the Committee, I am Max Mayfield, the Director of the Tropical Prediction Center and National Hurricane Center which is a part of the National Weather Service at NOAA. Thank you for inviting me here today to discuss NOAA's National Weather Service role in forecasting and warning the public about hurricanes.

The catastrophic devastation along the Gulf Coast from Hurricane Katrina is like nothing I have ever witnessed. Words cannot convey the physical destruction and the personal suffering in that part of our nation. However, without NOAA's National Weather Services forecasts and warnings, the loss of life could have been far greater.

Hurricane Katrina began as a tropical depression near the Southeast Bahamas on Tuesday, August 23rd. The National Hurricane Center's tropical cyclone forecasts were routinely issued every six hours with intermediate updates as necessary and included text and graphical products. The National Hurricane Center accurately predicted Katrina would become a Category 1 hurricane before making landfall near Miami.

Chairman BOEHLERT. Sorry for the interruption.

Mr. MAYFIELD. That is okay.

Chairman BOEHLERT. We are just getting these buzzers now. You conclude your opening statement and then we will have to take a recess and go to the Floor and vote and we will be back shortly thereafter.

Mr. MAYFIELD. Thank you.

Once Katrina emerged into the Gulf of Mexico, the National Hurricane Center forecast correctly predicted a re-intensification of the storm. Within nine hours, Katrina intensified from a tropical storm to a Category 2 hurricane. It later reached Category 5 status. Our forecast track from Saturday morning, August the 27th, about two days before landfall, had the storm curving northward and heading directly towards Southeast Louisiana and Mississippi. And the prediction was for Katrina to make landfall as a Category 4 hurricane. The actual track would deviate little from this and subsequent forecasts for the rest of Katrina's approach.

The intensity forecast would also prove to be very good. At 10:00 a.m. central daylight time, Saturday, August 27th, the National Hurricane Center posted a hurricane watch for Southeast Louisiana, including the City of New Orleans. We issued additional watches and warnings for Louisiana to the Florida panhandle soon thereafter. After reaching Southeast Louisiana, Katrina made final landfall along the Louisiana/Mississippi border on Monday morning as a Category 3 hurricane.

I should also briefly mention the tracking forecasting on Hurricane Rita. Rita began as a tropical depression on Saturday, September 17th over the Atlantic east of the Turks and Caicos Islands. The National Hurricane Center accurately predicted the center of the storm to pass just south of the Florida Keys as a hurricane on September 20 and predicted it to become a major hurricane as it moved over the warm waters of the Gulf of Mexico. Later, Rita, just like Katrina, strengthened to Category 5 status. On Thursday, approximately two days before landfall, the forecast track was shifted eastward to just west of the Louisiana/Texas border. Rita's actual track would deviate little from this and subsequent projections. The National Hurricane Center accurately predicted Rita would weaken before landfall but still come ashore as a Category 3 hurricane.

It is critical that we effectively communicate our forecast information to everyone. The Hurricane Liaison Team is a partnership between the National Weather Service and FEMA. The team is a cadre of federal, State, and local emergency managers and National Weather Service meteorologists and hydrologists. As tropical systems threaten the United States, the HLT deploys at the request of the National Hurricane Center to assist in coordination efforts. The team's mission is to support hurricane response operations through the rapid exchange of critical information between the National Hurricane Center and emergency managers at all levels. Once activated, FEMA hosts and facilitates audio and national video conference calls. On these calls, FEMA advises State and local emergency managers in the potential impact area to participate.

The National Hurricane Center is an invited participant and opens each call providing an updated forecast. The Hurricane Liaison Team provides an excellent way to communicate with the large number of emergency managers potentially impacted by an approaching hurricane. After consulting with our local weather service offices and the National Hurricane Center, emergency managers make evacuation and other preparedness decisions.

The media is also an essential partner and helps us get the information widely distributed to the public. The media provided an invaluable service to the people of the impacted Gulf Coast by communicating National Hurricane Center forecasts and warning information about Hurricanes Katrina and Rita. In addition, National Weather Service web activity as supported by NOAA's premiering project registered over 2.3 billion hits during Katrina and 2.9 billion hits during Rita.

Today is October 7, hopefully on the downside of this year's hurricane season. To date, we have had 19 tropical storms, 10 of which have become hurricanes and five of those have been major hurricanes of a Category 3 or stronger. This season has already been one of the most active on record and we still have another seven weeks to go. We believe the heightened period of hurricane activity that we are in will continue due to multi-decadal variations, because tropical cyclone activity in Atlantic is cyclical and tied to fluctuations in sea surface temperatures. For example, the 1940's through the '60s experienced an above average number of major hurricanes while the '70s into the mid-'90s averaged fewer hurricanes. The current threat of heightened activity could last another 10 to 20 years. These natural cycles are quite large in amplitude with an average of three to four major hurricanes per year in active periods and only one to two major hurricanes annually during the quiet periods with each period lasting 25 to 40 years.

While we must focus our energy on addressing the impacts of Hurricane Katrina, we also need to look at the future. Katrina will not be the last major hurricane to hit a vulnerable area. And New Orleans is not the only location at risk to a large disaster from a hurricane. Galveston/Houston, Tampa Bay, southwestern Florida, the Florida Keys, southeastern Florida, New York City and Long Island, and believe it or not, New England are especially vulnerable. And of course, New Orleans will be hit again by a hurricane some day.

At NOAA, we will continue our efforts to improve our hurricane track, intensity, precipitation and storm surge forecasting and work with our partners to ensure the best possible outcome during future hurricane events.

With that, I will be glad to answer any questions from the Members of the Committee.

[The prepared statement of Mr. Mayfield follows:]

PREPARED STATEMENT OF MAX MAYFIELD

Mr. Chairman and Members of the Committee, I am Max Mayfield, Director of the Tropical Prediction Center/National Hurricane Center. The National Hurricane Center is a part of the National Weather Service (NWS), of the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce. Thank you for inviting me here today to discuss NOAA's role in forecasting, and warning

the public about hurricanes, as well as NOAA's essential role and activities following landfall.

The devastation along the Gulf Coast from Hurricane Katrina is like nothing I have witnessed before. It is catastrophic. Words cannot convey the physical destruction and personal suffering in that part of our nation. However, without NOAA's forecasts and warnings, the devastation and loss of life would have been far greater.

NOAA's forecasts and warnings for Hurricane Katrina pushed the limits of the state-of-the-art of hurricane prediction. Our continuous research efforts at NOAA, and in partnership with other federal agencies, have led to our current predictive capabilities and improved ways of describing uncertainty in prediction. But NOAA's work does not end there. NOAA does extensive work assessing damage from storms and evaluating waterways to assist dredging operations, to open our nation's ports and waterways impacted by the storm. NOAA also assesses the impact to the areas' fisheries, supports hazardous materials containment and abatement efforts, and provides necessary data critical for post storm recovery operations.

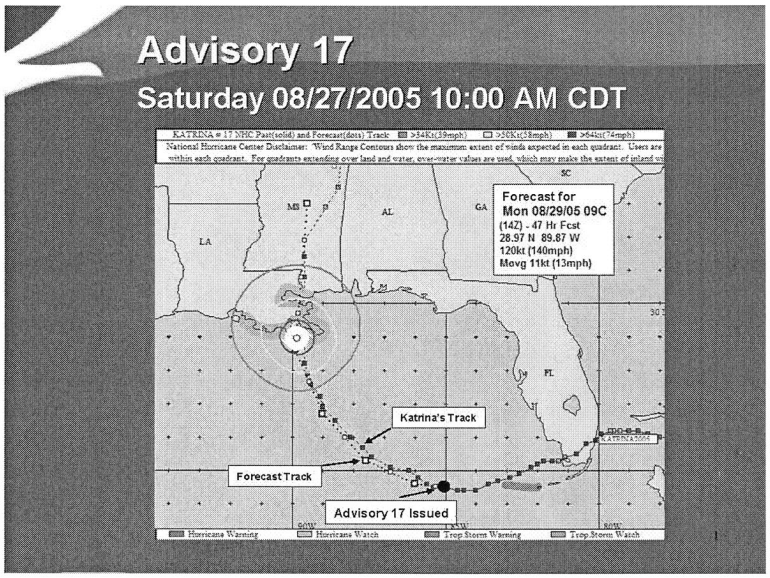
Tracking and Forecasting Hurricane Katrina

The National Hurricane Center (NHC) within the NWS has been the centerpiece of our nation's hurricane forecast and warning program for 50 years. The mission of the NHC is to save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, and forecasts of hazardous tropical weather, and by increasing the public's understanding of these hazards.

NHC tropical cyclone forecasts are issued every six hours and include text messages as well as a suite of graphical products depicting our forecasts and the accompanying probabilities and "cone of uncertainty," as it has become known. Hurricane Katrina began as a tropical depression near the southeastern Bahamas on Tuesday, August 23. The National Hurricane Center accurately predicted it would become a Category 1 hurricane before making landfall near Miami. The storm deluged southeast Florida with 16 inches of rain in some places, causing downed trees, flooding, and extended power outages as it passed across the southern portion of the state.

Once Katrina re-emerged into the Gulf of Mexico, NOAA hurricane forecasters correctly predicted re-intensification of the storm. Katrina intensified more quickly and became stronger than initially predicted. Within nine hours, Katrina intensified from a tropical storm, with winds of 70 miles per hour, to a Category 2 storm with 100 mile per hour winds.

As you can see in the graphic below, our forecast track from Saturday morning, August 27, about two days before landfall, had the storm curving northward and headed directly toward southeastern Louisiana and Mississippi. The projected path of Katrina aimed directly at southeast Louisiana, and the prediction was for Katrina to make landfall as a Category 4 hurricane. The actual track would deviate little from this and subsequent forecasts for the rest of Katrina's approach. On average, NOAA forecasts of where Katrina would go were more accurate than usual, with all of the forecast tracks during the last 48 hours lining up almost directly on top of the actual track. This forecast beats the Government Performance and Results Act goal established for NOAA hurricane forecasts this year.



At 10:00 am Central Daylight Time (CDT) Saturday morning, August 27, the National Hurricane Center posted a hurricane watch for southeast Louisiana, including the city of New Orleans. The watch extended eastward to Mississippi and Alabama that afternoon. A hurricane watch means hurricane conditions are possible in the specified area, usually within 36 hours. Messages from the National Hurricane Center highlighted the potential for this storm to make landfall as a Category 4 or Category 5 storm.

Predicting hurricane intensity remains a challenge. Even though we knew conditions were favorable for the storm to intensify, there was some error in the intensity forecast for the eastern Gulf due to its rapid intensification. While we accurately predicted the intensity at landfall, there is still more work to be done in improving intensity prediction, especially for rapidly intensifying or rapidly weakening storms.

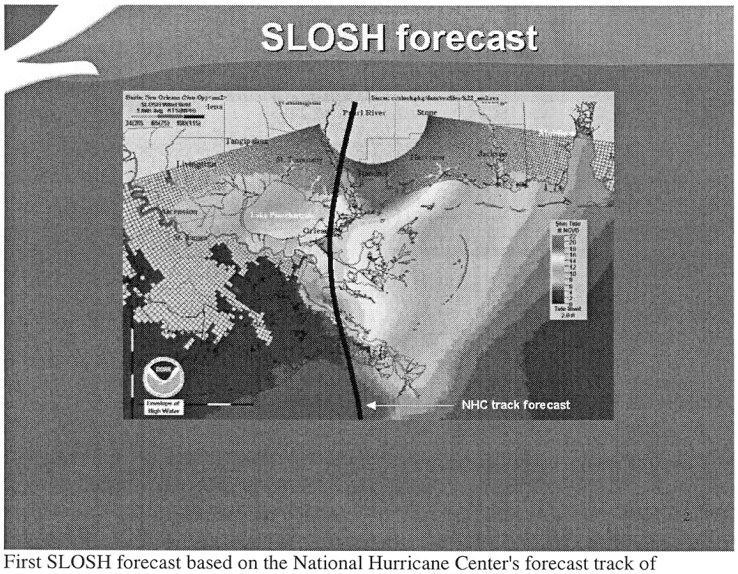
Storm Surge

Storm surge has caused most of this country's tropical cyclone fatalities, all too vividly evident in the past two weeks, and still represents our greatest risk for a large loss of life in this country. Following Hurricane Camille in 1969, NOAA established a group that developed and implemented a storm surge model called SLOSH (Sea, Lake, and Overland Surges from Hurricanes). The SLOSH model calculates storm surge heights resulting either from historical, hypothetical or actual hurricanes. SLOSH incorporates bathymetry and topography, including bay and river configurations, roads, levees, and other physical features that can modify the storm surge flow pattern. Comprehensive evacuation studies, conducted jointly by the Federal Emergency Management Agency (FEMA), the U.S. Army Corps of Engineers, NOAA, and State and local emergency managers, are based on the simulated surges computed by SLOSH.

The National Hurricane Center introduced storm surge forecasts for the Gulf Coast in public advisories at 10:00 am CDT Saturday—32 hours prior to Katrina's landfall in Louisiana. The initial forecast (10:00 am CDT, Saturday, August 28) for storm surge was predicted at 15 to 20 feet, locally as high as 25 feet, and that forecast was updated the following morning to a range of 18 to 22 feet, locally as high as 28 feet, when the forecast intensity for landfall was increased. "Large and battering" waves were forecast on top of the surge. In addition, the 4:00 pm CDT public advisory issued by the National Hurricane Center on Sunday, August 28, stated

that some levees in the greater New Orleans area could be overtopped. Actual storm surge values are being determined at this time.

I know there have been recent news reports that I notified FEMA that the New Orleans' levees would be breached. In fact, I did not say that. What I indicated in my briefings to emergency managers and to the media was the possibility that some levees in the greater New Orleans area could be overtopped, depending on the details of Katrina's track and intensity. This possibility was also indicated in our advisory products.



First SLOSH forecast based on the National Hurricane Center's forecast track of Hurricane Katrina. This information was available on the Internet at 9:20 a.m. CDT Sunday, August 29. The graphic depicts the predicted high water level above mean sea level. Additional SLOSH model forecasts were available following each advisory issued by the National Hurricane Center.

Communicating Our Forecasts

The FEMA/NWS Hurricane Liaison Team (HLT), which is activated at NHC a few days in advance of any potential U.S. hurricane landfall, coordinates communications between NOAA and the emergency management community at the federal and State levels. The HLT was established in 1996. After consulting with our local weather service offices and the National Hurricane Center, *emergency managers* make evacuation and other preparedness decisions. The HLT provides an excellent way to communicate with the large number of emergency managers typically impacted by a potential hurricane. This is a critical effort to ensure emergency managers and first responders know what to expect.

The media is our most essential partner and helps us get the information to the public. Without the media, it would be very difficult to get the information as widely distributed. The media provided an invaluable service to the people of the impacted Gulf Coast by communicating National Hurricane Center forecast and warning information about Hurricane Katrina. From Thursday, August 25, through Katrina's landfall in Mississippi on Monday, August 29, NOAA's Tropical Prediction Center/National Hurricane Center provided a total of 471 television and radio interviews, through their media pool or via telephone.

On Saturday evening, August 27, I personally called the Chief of Operations at the Alabama Emergency Management Agency, as well as the Governors of Louisiana and Mississippi and the Mayor of New Orleans, to communicate the potential meteorological and storm surge impacts from Hurricane Katrina. In addition, the

National Hurricane Center web activity, as supported by NOAA's web-mirroring project, registered 900 million hits during Katrina.

NOAA Support Efforts

NOAA is focused on improving the forecasting of hurricane frequency, track, and intensity as well as predicting hurricane impacts on life and property. Using a combination of atmospheric and ocean observations from satellites, aircraft, and all available surface data over the oceans, NOAA conducts experiments to better understand internal storm dynamics and interactions between a hurricane and the surrounding atmosphere and ocean. Through greater understanding of physical processes and advanced hurricane modeling, NOAA continually improves models for predicting hurricane intensity and track, in collaboration with federal partners, academic researchers, and commercial enterprises. These numerical modeling improvements, once demonstrated, are transitioned into operations at the National Hurricane Center.

NOAA Aircraft, the W–P3 Orions and the Gulf Stream IV, provided essential observations critical to the National Hurricane Center forecasters and supplement U.S. Air Force Reserve Command's 53rd Weather Reconnaissance Squadron flights. A specialized instrument flown on one of the W–P3s, the Stepped Frequency Microwave Radiometer (SFMR), provided essential hurricane structure, surface wind and rain rate data to hurricane forecasters right up to and following landfall in Louisiana and Mississippi. The *Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act,* 2005 (P.L. 108–324) provided $10.5M to the Air Force to outfit the complete fleet of Hurricane Hunters with this instrument, the first of these additional units should be available during the 2006 Hurricane Season.

The *Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act,* 2005 also provided funding to NOAA for seven hurricane buoys, which NOAA deployed this past year in the Caribbean, the Gulf of Mexico, and the Atlantic. Those new buoys provided us with critical information during this active hurricane season.

NOAA's Activities After Hurricane Katrina's Landfall

Immediately following Hurricane Katrina's second landfall, several NOAA ships and aircraft were tasked with assisting in the hurricane response. Our aircraft flew damage assessment flights using a sophisticated digital camera to collect imagery to assess damage. Over 5,000 high-resolution images collected by NOAA aircraft are assisting emergency managers and other agencies in recovery operations and long-term restoration and rebuilding decisions.

It is also NOAA's responsibility to assess the damage to the commercial fishing industry in that section of the Gulf of Mexico. We are working closely with each of the impacted State resource agencies and commercial entities to assess the storm's impacts to the longer-term social and economic viability of local fishing communities. NOAA employees also are assisting recovery efforts by working with other federal agencies in planning, organizing, and conducting oil spill and hazardous material response and restoration in the impacted areas of the Gulf.

NOAA ships are tasked with surveying critical ports and waterways for depths, wrecks and obstructions for navigational safety. NOAA Navigation Response Teams were on scene before the hurricane hit to survey for hazards and help the U.S. Coast Guard and the Army Corps of Engineers re-open waterways to commercial and emergency traffic. The THOMAS JEFFERSON, a highly specialized hydrographic survey ship equipped with multi-beam and side scan sonar and two 28-foot launches for near shore and mid-water surveys will be surveying the entrances to Pascagoula and Gulfport, Mississippi. Another NOAA ship, the NANCY FOSTER, is outfitted with survey technology and is presently conducting wreck and obstruction surveys in Mobile Bay, Alabama. The efforts of these NOAA ships are critical to rebuilding the Gulf's economic infrastructure by enabling vessels of all sizes to pass safely through these waterways thereby allowing emergency materials, oil, and commercial goods to make it to their destinations. Other NOAA ships and aircraft are assisting directly with the recovery effort by providing fuel, communications, and supplies to NOAA facilities as well as temporary office space for local emergency responders.

Outlook for the Future

Today is September 21, near the historical peak of the hurricane season. To date we have had fifteen tropical storms, seven of which have become hurricanes, four of those have been major hurricanes at Category 3 or stronger. We believe we will continue to have an active season, with a total of l8–21 tropical storms. We believe this heightened period of hurricane activity will continue due to multi-decadal vari-

ance, as tropical cyclone activity in the Atlantic is cyclical. The 1940's through the 1960's experienced an above average number of major hurricanes, while the 1970's into the mid-1990's averaged fewer hurricanes. The current period of heightened activity could last another 10–20 years. The increased activity since 1995 is due to natural fluctuations/cycles of hurricane activity, driven by the Atlantic Ocean itself along with the atmosphere above it and not enhanced substantially by global warming. The natural cycles are quite large with on average 3–4 major hurricanes a year in active periods and only about 1–2 major hurricanes annually during quiet periods, with each period lasting 25–40 years.

While we have made significant progress in hurricane forecasting and warnings, we believe we have more work to do. From a scientific standpoint, the gaps in our capabilities fall into two broad categories: first, our ability to assess the current state of a hurricane and its environment (analysis), and second, our ability to predict a hurricane's future state (the forecast). Finally, we would like to improve public preparedness.

Conclusion

The government's ability to observe, predict, and respond quickly to storm events is critical to public safety. We must also now look ahead to post-storm redevelopment strategies for communities impacted by Katrina and future storms to help manage and anticipate these extreme events. NOAA has the expertise in coastal management and hazard mitigation, and is committed to working with out partners in reducing vulnerability to hurricanes and other coastal storm events. It is critical that we work to protect and restore natural features along the Gulf Coast, such as dunes, wetlands, and other vegetated areas that offer protection against coastal flooding and erosion.

While we must focus our energy on addressing the impacts of Hurricane Katrina, we also need to look to the future. Katrina will not be the last major hurricane to hit a vulnerable area, and New Orleans is not the only location vulnerable to a large disaster from a land-falling hurricane. Houston/Galveston, Tampa Bay, southwest Florida, Florida Keys, southeast Florida, New York City/Long Island, and believe it or not, New England, are all especially vulnerable. And New Orleans remains vulnerable to future hurricanes.

At NOAA we will continue our efforts to improve hurricane track, intensity, and storm surge forecasting, as well as provide technical tools and planning expertise to states and local governments.

With that, I'll be glad to answer any questions Members may have.

NOAA National Hurricane Center

Hurricane Katrina Forecast Timeline

TUESDAY, AUGUST 23, 2005
1600 CDT: Katrina forms as a Tropical Depression 12, near Nassau in the Bahamas. Tropical Depression 12 Advisory 1 issued: "A TROPICAL STORM OR HURRICANE WATCH MAY BE REQUIRED FOR PORTIONS OF SOUTHERN FLORIDA LATER TONIGHT."

WEDNESDAY, AUGUST 24, 2005
0400 CDT: The National Hurricane Center's five-day forecast puts the projected path of Katrina in the southeast Gulf of Mexico (as the system is still a tropical depression in the central Bahamas).

0700 CDT: Katrina is elevated to a Tropical Storm.

1000 CDT: Tropical Storm Katrina Advisory 4 is issued: ". . .A TROPICAL STORM WARNING AND A HURRICANE WATCH HAVE BEEN ISSUED FOR THE SOUTHEAST FLORIDA COAST. . ."

THURSDAY, AUGUST 25, 2005
1430 CDT: Katrina is elevated to a Category 1 Hurricane.

1730 CDT: Katrina makes landfall in Florida as a Category 1 Hurricane.

WEDNESDAY/THURSDAY, AUGUST 24/25:
Hurricane Liaison Team conference calls were conducted both days, and included Florida emergency managers, FEMA Headquarters (FEMA HQ), and Region IV.

FRIDAY, AUGUST 26, 2005
0200 CDT: Katrina entered the Gulf of Mexico as a Tropical Storm.

0400 CDT: Katrina is elevated to a Category 1 Hurricane.

1000 CDT: Hurricane Katrina Advisory Number 12 is issued: "KATRINA IS A CATEGORY ONE HURRICANE ON THE SAFFIR-SIMPSON SCALE. SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS. . .AND KATRINA COULD BECOME A CATEGORY TWO HURRICANE ON SATURDAY."

1015 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1030 CDT: Katrina is elevated to a Category 2 Hurricane. Hurricane Katrina Advisory Number 13 is issued: ". . .KATRINA RAPIDLY STRENGTHENING AS IT MOVES SLOWLY WESTWARD AWAY FROM SOUTH FLORIDA AND THE FLORIDA KEYS. . .KATRINA IS MOVING TOWARD THE WEST NEAR 7 MPH. . .AND THIS MOTION IS EXPECTED TO CONTINUE FOR THE NEXT 24 HOURS. . .RECENT REPORTS FROM AN AIR FORCE RESERVE UNIT HURRICANE HUNTER AIRCRAFT NOW INDICATE MAXIMUM SUSTAINED WINDS ARE NEAR 100 MPH. . .WITH HIGHER GUSTS. KATRINA IS NOW A CATEGORY TWO HURRICANE ON THE SAFFIR-SIMPSON SCALE. SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS. . .AND KATRINA COULD BECOME A CATEGORY THREE OR MAJOR HURRICANE ON SATURDAY."

1100 CDT: Hurricane Liaison Team Coordination Video Conference with FEMA HQ, Region IV, FL, AL, and GA.

1600 CDT: Hurricane Katrina Discussion Number 14 is issued: ". . .THE MODELS HAVE SHIFTED SIGNIFICANTLY WESTWARD AND ARE NOW IN BETTER AGREEMENT. THIS HAS RESULTED IN THE OFFICIAL FORECAST TRACK BEING SHIFTED ABOUT 150 NMI WEST OF THE PREVIOUS TRACK. . .HOWEVER. . .PROJECTED LANDFALL IS STILL ABOUT 72 HOURS AWAY. . .SO FURTHER MODIFICATIONS IN THE FORECAST TRACK ARE POSSIBLE. KATRINA IS EXPECTED TO BE MOVING OVER THE GULF LOOP CURRENT AFTER 36 HOURS. . .WHICH WHEN COMBINED WITH DECREASING VERTICAL SHEAR. . .SHOULD ALLOW THE HURRICANE TO REACH CATEGORY FOUR STATUS BEFORE LANDFALL OCCURS."

1615 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

2200 CDT: Hurricane Katrina Discussion Number 15 is issued: "THE OFFICIAL FORECAST BRINGS THE CORE OF THE INTENSE HURRICANE OVER THE NORTH CENTRAL GULF OF MEXICO IN 48 HOURS OR SO. IT IS WORTH NOTING THAT THE GUIDANCE SPREAD HAS DECREASED AND MOST OF THE RELIABLE NUMERICAL MODEL TRACKS ARE NOW CLUSTERED BE-

TWEEN THE EASTERN COAST OF LOUISIANA AND THE COAST OF MISSISSIPPI. THIS CLUSTERING INCREASES THE CONFIDENCE IN THE FORECAST."

SATURDAY, AUGUST 27, 2005

0400 CDT: Katrina is elevated to a Category 3 Hurricane. Hurricane Katrina Advisory Number 16 is issued: "KATRINA BECOMES A MAJOR HURRICANE WITH 115 MPH WINDS. . .SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS. . .RECONNAISSANCE AIRCRAFT DATA AND SURFACE OBSERVATIONS INDICATE THAT KATRINA HAS BECOME A LARGER HURRICANE. . ." Hurricane Katrina Discussion Number 16 is issued: "DUE TO THE DECREASING SPREAD IN THE MODELS. . .THE CONFIDENCE IN THE FORECAST TRACK IS INCREASING."

1000 CDT: Hurricane Katrina Advisory Number 17 is issued: "A HURRICANE WATCH IS IN EFFECT FOR THE SOUTHEASTERN COAST OF LOUISIANA EAST OF MORGAN CITY TO THE MOUTH OF THE PEARL RIVER. . .INCLUDING METROPOLITAN NEW ORLEANS AND LAKE PONCHARTRAIN. . .A HURRICANE WATCH WILL LIKELY BE REQUIRED FOR OTHER PORTIONS OF THE NORTHERN GULF LATER TODAY OR TONIGHT. INTERESTS IN THIS AREA SHOULD MONITOR THE PROGRESS OF KATRINA. . .SOME STRENGTHENING IS FORECAST DURING THE NEXT 24 HOURS. . .AND KATRINA COULD BECOME A CATEGORY FOUR HURRICANE. . ." Hurricane Katrina Discussion Number 17 is issued: ". . .IT IS NOT OUT OF THE QUESTION THAT KATRINA COULD REACH CATEGORY 5 STATUS AT SOME POINT BEFORE LANDFALL. . ."

1015 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1100 CDT: Hurricane Liaison Team Coordination Video Conference with FEMA HQ, Region IV and VI, FL, LA, MS, AL, and GA.

1600 CDT: Hurricane Katrina Advisory Number 18 is issued: "THE HURRICANE WATCH IS EXTENDED WESTWARD TO INTRACOASTAL CITY LOUISIANA AND EASTWARD TO THE FLORIDA-ALABAMA BORDER. A HURRICANE WATCH IS NOW IN EFFECT ALONG THE NORTHERN GULF COAST FROM INTRACOASTAL CITY TO THE ALABAMA-FLORIDA BORDER. A HURRICANE WARNING WILL LIKELY BE REQUIRED FOR PORTIONS OF THE NORTHERN GULF COAST LATER TONIGHT OR SUNDAY. INTERESTS IN THIS AREA SHOULD MONITOR THE PROGRESS OF KATRINA." Hurricane Katrina Discussion Number 18 is issued: "THE INTENSITY FORECAST WILL CALL FOR STRENGTHENING TO 125 KT AT LANDFALL. . .AND THERE REMAINS A CHANCE THAT KATRINA COULD BECOME A CATEGORY FIVE HURRICANE BEFORE LANDFALL."

1615 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1925 CDT: Louisiana Gubernatorial Briefing: Max Mayfield, Director of NOAA's Tropical Predication Center/National Hurricane Center provides a briefing to Kathleen Babineau Blanco.

1935 CDT: Max Mayfield, Director of NOAA's Tropical Predication Center/National Hurricane Center provides a briefing to Bill Filter, Chief of Operations, Alabama Emergency Management Agency.

1945 CDT: Mississippi Gubernatorial Briefing: Max Mayfield, Director of NOAA's Tropical Predication Center/National Hurricane Center provides a briefing to Haley Barbour.

2000 CDT: New Orleans Mayoral Briefing: Max Mayfield, Director of NOAA's Tropical Predication Center/National Hurricane Center provides a briefing to Ray Nagin.

2200 CDT: Hurricane Katrina Advisory Number 19 is issued: ". . .DANGEROUS HURRICANE KATRINA THREATENS THE NORTH CENTRAL GULF COAST. . .A HURRICANE WARNING ISSUED. . .AT 10 PM CDT. . .0300Z. . .A HURRICANE WARNING HAS BEEN ISSUED FOR THE NORTH CENTRAL GULF COAST FROM MORGAN CITY LOUISIANA EASTWARD TO THE ALABAMA/FLORIDA BORDER. . .INCLUDING THE CITY OF NEW ORLEANS AND LAKE PONCHARTRAIN. . .PREPARATIONS TO PROTECT LIFE AND PROPERTY SHOULD BE RUSHED TO COMPLETION. . .COASTAL STORM SURGE FLOODING OF 15 TO 20 FEET ABOVE NORMAL TIDE LEVELS. . .LOCALLY AS HIGH AS 25 FEET ALONG WITH LARGE AND DANGEROUS BATTERING WAVES. . .CAN BE EXPECTED NEAR AND TO THE EAST OF WHERE THE CENTER MAKES LANDFALL. . .HEAVY RAINS FROM KATRINA SHOULD BEGIN TO AFFECT THE CENTRAL GULF COAST SUNDAY EVENING. RAIN-

FALL TOTALS OF FIVE TO 10 INCHES. . .WITH ISOLATED MAXIMUM AMOUNTS OF 15 INCHES. . .ARE POSSIBLE ALONG THE PATH OF KATRINA." Hurricane Katrina Discussion Number 19 is issued: ". . .DESPITE THESE CHANGES IN THE INNER CORE. . .THE BOTTOM LINE IS THAT KATRINA IS EXPECTED TO BE AN INTENSE AND DANGEROUS HURRICANE HEADING TOWARD THE NORTH CENTRAL GULF COAST. . .AND THIS HAS TO BE TAKEN VERY SERIOUSLY."

1500–2230 CDT: Media pool operated; TPC/NHC provided 12 television and two radio interviews. In addition, TPC/NHC participated in 51 telephone briefings or media contacts on August 27th.

SUNDAY, AUGUST 28, 2005

0040 CDT: Katrina is elevated to a Category 4 Hurricane.

0100 CDT: Hurricane Katrina Special Advisory Number 20 is issued: ". . .KATRINA STRENGTHENS TO CATEGORY FOUR WITH 145 MPH WINDS. . ."

0400 CDT: Hurricane Katrina Discussion Number 21 is issued: "THE SPREAD IN THE MODEL TRACKS ALONG THE NORTHERN GULF COAST IS AT MOST 90 MILES. . .SO CONFIDENCE IN THE OFFICIAL FORECAST IS RELATIVELY HIGH."

0615 CDT: Katrina is elevated to a Category 5 Hurricane.

0700 CDT: Hurricane Katrina Advisory Number 22 is issued: ". . .KATRINA. . .NOW A POTENTIALLY CATASTROPHIC CATEGORY FIVE HURRICANE. . .HEADED FOR THE NORTHERN GULF COAST. . .MAXIMUM SUSTAINED WINDS ARE NEAR 160 MPH. . .WITH HIGHER GUSTS. KATRINA IS A POTENTIALLY CATASTROPHIC CATEGORY FIVE HURRICANE ON THE SAFFIR-SIMPSON SCALE. SOME FLUCTUATIONS IN STRENGTH ARE LIKELY IN THE NEXT 24 HOURS."

1000 CDT: Hurricane Katrina Advisory Number 23 is issued: ". . .POTENTIALLY CATASTROPHIC HURRICANE KATRINA. . .EVEN STRONGER. . .HEADED FOR THE NORTHERN GULF COAST. . .REPORTS FROM AN AIR FORCE HURRICANE HUNTER AIRCRAFT INDICATE THAT THE MAXIMUM SUSTAINED WINDS HAVE INCREASED TO NEAR 175 MPH. . .WITH HIGHER WIND GUSTS. . .HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 105 MILES FROM THE CENTER AND TROPICAL STORM FORCE WINDS EXTEND OUTWARDS UP TO 205 MILES. . .COASTAL STORM SURGE FLOODING OF 18 TO 22 FEET ABOVE NORMAL TIDE LEVELS. . .LOCALLY AS HIGH AS 28 FEET ALONG WITH LARGE AND DANGEROUS BATTERING WAVES. . .CAN BE EXPECTED NEAR AND TO THE EAST OF WHERE THE CENTER MAKES LANDFALL. Hurricane Katrina Discussion Number 23 is issued: ". . .HURRICANE FORCE WINDS ARE FORECAST TO SPREAD AT LEAST 150 N MI INLAND ALONG PATH OF KATRINA. CONSULT INLAND WARNINGS ISSUED BY THE NATIONAL WEATHER SERVICE FORECAST OFFICES. . ."

1015 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1100 CDT: Hurricane Liaison Team Coordination Video Conference with FEMA HQ, Region IV and VI, FL, LA, MS, AL, GA, TX.

1300 CDT: Hurricane Katrina Advisory Number 23A is issued: "SIGNIFICANT STORM SURGE FLOODING WILL OCCUR ELSEWHERE ALONG THE CENTRAL AND NORTHEASTERN GULF OF MEXICO COAST."

1600 CDT: Hurricane Katrina Advisory Number 24 is issued: "KATRINA IS MOVING TOWARD THE NORTHWEST NEAR 13 MPH. . .AND A GRADUAL TURN TO THE NORTH IS EXPECTED OVER THE NEXT 24 HOURS. ON THIS TRACK THE CENTER OF THE HURRICANE WILL BE NEAR THE NORTHERN GULF COAST EARLY MONDAY. HOWEVER. . .CONDITIONS ARE ALREADY BEGINNING TO DETERIORATE ALONG PORTIONS OF THE CENTRAL AND NORTHEASTERN GULF COASTS. . .AND WILL CONTINUE TO WORSEN THROUGH THE NIGHT. . .KATRINA IS A POTENTIALLY CATASTROPHIC CATEGORY FIVE HURRICANE ON THE SAFFIR-SIMPSON SCALE. SOME FLUCTUATIONS IN STRENGTH ARE LIKELY UNTIL LANDFALL. KATRINA IS EXPECTED TO MAKE LANDFALL AT CATEGORY FOUR OR FIVE INTENSITY. WINDS AFFECTING THE UPPER FLOORS OF HIGH-RISE BUILDINGS WILL BE SIGNIFICANTLY STRONGER THAN THOSE NEAR GROUND LEVEL. . .SOME LEVEES IN THE GREATER NEW ORLEANS AREA COULD BE OVERTOPPED."

1615 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

2200 CDT: Hurricane Katrina Advisory Number 25 is issued: "A HURRICANE WARNING IS IN EFFECT FOR THE NORTH CENTRAL GULF COAST FROM MORGAN CITY LOUISIANA EASTWARD TO THE ALABAMA/FLORIDA BORDER. . .INCLUDING THE CITY OF NEW ORLEANS AND LAKE PONCHARTRAIN. PREPARATIONS TO PROTECT LIFE AND PROPERTY SHOULD BE RUSHED TO COMPLETION."

MONDAY, AUGUST 29, 2005

0200 CDT: Hurricane Katrina is downgraded to a Category 4.

0400 CDT: Hurricane Katrina Advisory Number 26 is issued: "EXTREMELY DANGEROUS CATEGORY FOUR HURRICANE KATRINA MOVING NORTHWARD TOWARD SOUTHEASTERN LOUISIANA AND THE NORTHERN GULF COAST. . .SOME FLUCTUATIONS IN STRENGTH ARE LIKELY PRIOR TO LANDFALL. . .BUT KATRINA IS EXPECTED TO MAKE LANDFALL AS A CATEGORY FOUR HURRICANE."

0600 CDT: Hurricane Katrina Advisory Number 26A is issued: "KATRINA REMAINS A VERY LARGE HURRICANE. HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 120 MILES FROM THE CENTER. . .AND TROPICAL STORM FORCE WINDS EXTEND OUTWARD UP TO 230 MILES."

0610 CDT: Hurricane Katrina makes landfall in southeastern Louisiana as a Category 4 hurricane.

0800 CDT: Hurricane Katrina Advisory Number 26B is issued: ". . .THE CENTER OF HURRICANE KATRINA WAS LOCATED. . .ABOUT 40 MILES SOUTHEAST OF NEW ORLEANS LOUISIANA AND ABOUT 65 MILES SOUTHWEST OF BILOXI MISSISSIPPI. . .MAXIMUM SUSTAINED WINDS ARE NEAR 135 MPH. . .WITH HIGHER GUSTS. KATRINA IS AN EXTREMELY DANGEROUS CATEGORY FOUR HURRICANE ON THE SAFFIR-SIMPSON SCALE. WEAKENING IS FORECAST AS THE CIRCULATION INTERACTS WITH LAND TODAY. . .COASTAL STORM SURGE FLOODING OF 18 TO 22 FEET ABOVE NORMAL TIDE LEVELS. . .ALONG WITH LARGE AND DANGEROUS BATTERING WAVES. . .CAN BE EXPECTED NEAR AND TO THE EAST OF THE CENTER. STORM SURGE FLOODING OF 10 TO 15 FEET. . .NEAR THE TOPS OF LEVEES. . .IS POSSIBLE IN THE GREATER NEW ORLEANS AREA. SIGNIFICANT STORM SURGE FLOODING WILL OCCUR ELSEWHERE ALONG THE CENTRAL AND NORTHEASTERN GULF OF MEXICO COAST."

1000 CDT: Hurricane Katrina makes a second landfall at the LA/MS border as a Category 3 hurricane.

1015 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

1100 CDT: Hurricane Liaison Team Coordination Video Conference with FEMA HQ, Region IV and VI, LA, MS, AL, FL, TX.

1615 CDT: Hurricane Liaison Team Coordination Audio Conference with FL.

TUESDAY, AUGUST 30, 2005

1000 CDT: Katrina is downgraded to a tropical depression with winds of 35 mph, 25 miles south of Clarksville, TN. The final TPC/NHC advisory is issued at this time; the Hydrometeorological Prediction Center assumes inland public advisories.

WEDNESDAY, AUGUST 31, 2005

2200 CDT: Hurricane Katrina has dissipated; remnants absorbed by a front in southeast Canada.

NOTES:

- Timeline highlights the major aspects of NOAA's Tropical Prediction Center/National Hurricane Center (TPC/NHC). All advisories (graphic and text) are available on the Katrina archive page: http://www/nhc.noaa.gov/archive/2005/KATRINA/shtml?
- Storm surge is a consistent concern and associated threat with any land-falling hurricane, especially a major hurricane.
- Hurricane Liaison Team Coordination calls included the State emergency management officials for the states listed; calls with the State of Florida included both local and State emergency management officials.
- For Katrina (including for Florida) NOAA's Tropical Predication Center/National Hurricane Center provided a total of 471 television and radio interviews, through their media pool or via telephone.

BIOGRAPHY FOR MAX MAYFIELD

Max Mayfield has served as the Director of NOAA's Tropical Prediction Center, National Hurricane Center, which is part of NOAA's National Centers for Environmental Prediction/National Weather Service since 2000 and has been a NOAA employee since 1972.

Mr. Mayfield is a Fellow of the American Meteorological Society (AMS) and has presented invited papers at several scientific meetings and lectured in several World Meteorological Organization (WMO) sponsored training sessions, as well as provided numerous interviews to electronic and print media.

In 1996, he was awarded the Francis W. Reichelderfer Award from the AMS for exemplary performance as coordinator of hurricane preparedness presentations by the National Hurricane Center to emergency preparedness officials and the general public. He received an Outstanding Achievement Award at the 2000 National Hurricane Conference for the development of an innovative approach to expand the educational opportunities to State and local officials in hurricane preparedness, and was awarded the Richard Hagemeyer Award at the 2004 Interdepartmental Hurricane Conference for his contributions to our nation's Hurricane Warning Program. Also in 2004, Mr. Mayfield was presented the Governor's Award by the National Academy of Television Arts and Sciences' Suncoast Chapter. This Emmy Award is given to someone who has made extraordinary contributions to television and who is not otherwise eligible for an Emmy.

Mr. Mayfield has been recognized by the Department of Commerce with Gold Medals for his work during Hurricanes Andrew and Isabel, with a Silver Medal during Hurricane Gilbert, and was awarded a National Oceanic and Atmospheric Administration Bronze Medal for the creation of a public/private partnership in support of disaster preparedness for the Nation.

He is the current Chairman of the WMO's Regional Association—IV Hurricane Committee which consists of 26 members from the international community. He has played a key role in forecast and service improvements at the National Hurricane Center.

Mr. Mayfield is married, has three children, and resides in Miami, Florida.

Chairman. BOEHLERT. Thank you for your testimony.

We will have to recess briefly to allow Members to go to the Floor to vote. We have two votes so we will presumably be gone 15 to 20 minutes. We will reconvene as soon as the vote is over.

[Recess.]

DISCUSSION

Mr. EHLERS. [Presiding] We will call the hearing to order. We thank the gentlemen for their testimony. We will begin the questioning period. Five minutes per Member for questions and answers. And because there are quite a number of Members here and I know they are anxious to have their questions answered, we will attempt to stick to the five minute rule as much as possible and I will try to be ruthless. And the Ranking Member laughs.

LESSONS LEARNED

General Johnson, based on lessons learned from Katrina and Rita is the National Weather Service going to change anything about the way you communicate forecasts and warnings to federal, State, and local officials?

Mr. JOHNSON. Thank you for the question, Mr. Chairman.

At the end of each hurricane season, we do a pretty extensive hot wash. We go through and review all of our procedures and——

Mr. EHLERS. Could you explain for the record what a hot wash is?

Mr. JOHNSON. Yes, sir. We get people who participate in communicating those threats, those warnings, those watches to the American public. We get media, we get emergency managers, we get peo-

ple from the Hurricane Center all together and say how could we better communicate?

I appreciate very much Mr. Melancon's characterization of us as accurate and clear this year but I believe, sir, that there is always room for improvement. And last year, we had a pretty unprecedented significant season, probably a better word, in five land falling hurricanes. And at the end of last year, we decided that we needed special emphasis on the communication of uncertainty. I think you remember, sir, the assertion of the skinny black line. We wanted to address uncertainty so we redoubled our efforts on uncertainty. At the end of this season, sir, we will go through and review all of our procedures and see if there is a better way to——

COMMUNICATION WITH EMERGENCY MANAGEMENT OFFICIALS

Mr. EHLERS. Okay. The question then is, to my understanding there is no mechanism in place for NOAA and the Hurricane Center to confirm that officials at agencies such as FEMA and other State and local agencies have received all the national and local hurricane forecasts issued by the Weather Service. Shouldn't there be some sort of confirmation mechanism that you get affirmation or confirmation from these folks that they got the message, that they are going to act on it? Is there anything you can do along that line?

Mr. JOHNSON. I will defer to Max on the specific operation of the Hurricane Liaison Team. But the weather forecast offices also communicate with local emergency managers and we participate in for example the Louisiana Emergency Operations Center and actually have people positioned in that facility to facilitate the communications of that environmental information. So we routinely provide discussion in trying to further the understanding of the message at different intervals always at the six hour intervals when the hurricane center issues.

Mr. EHLERS. Mr. Mayfield, would you expand on that? And also if it appears useful, do you have intermediate reports between the six hour reports? I would appreciate your comments on this.

Mr. MAYFIELD. Right. The National Hurricane Center takes the big picture and we routinely issue a five-day forecast every six hours. When we have watches and warnings in effect, we will go to a two or three-hour cycle, depending on how close it is and how well defined it is on radar. If there is something unexpected in the track or intensity, we will do what we call a special advisory and we did that, we certainly did that a few times on both Katrina and Rita. So there is a continual flow of information from the hurricane center and as General Johnson said, it is really important, too, to get down to those local decision-makers. And the local weather forecast offices do a tremendous amount of handholding with the commanders in their local area. They are under their area responsibility.

Mr. EHLERS. Now do you get confirmation from everyone that they have received the message and the warning?

Mr. MAYFIELD. They are actually talking to them. I mean these are actually telephone——

Mr. EHLERS. Do you do some sort of a role call to make sure they are actually on the phone and listening?

Mr. MAYFIELD. That is for the local office, I am not sure how they do that but I—we can find out about that. But the National Hurricane Center, we are indeed an invited participant on those Hurricane Liaison Team briefings. And FEMA headquarters, as far as I know, they do not take an individual role call but they do take an office role call. In other words, they will—when I come in, I will hear them say, you know, it is the hurricane center on line, FEMA Region 6, FEMA Region 4, Louisiana Emergency Operating Center are you on line? So they at least do that, yes, sir.

Mr. EHLERS. And when you come back two hours later, do they report at all what they have done to——

Mr. MAYFIELD. I do not listen—I do not participate on that part.

Mr. EHLERS. Okay.

Mr. MAYFIELD. We are there to provide the, you know, the best forecast we can.

Mr. EHLERS. Yeah.

Mr. MAYFIELD. And then often I will do that and then I will go back to work.

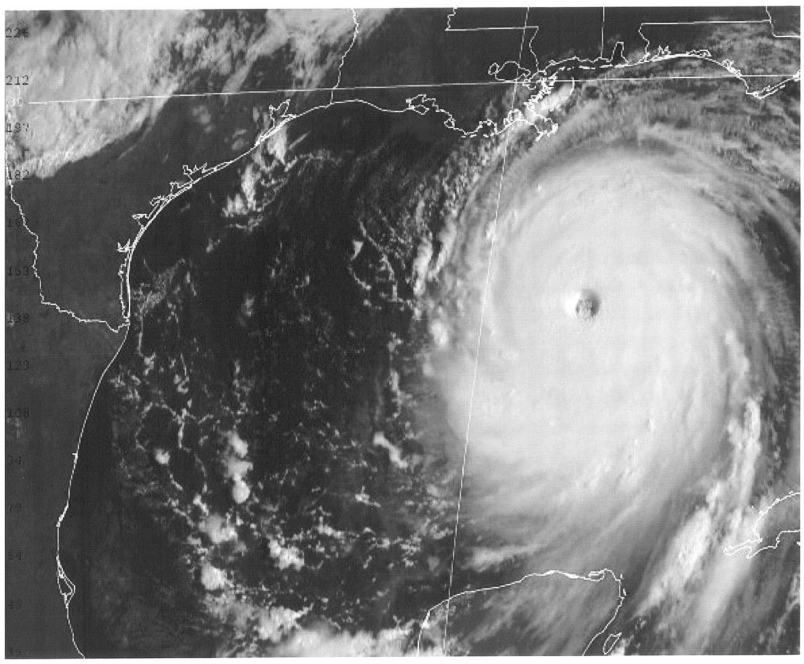
Mr. EHLERS. All right. My time has expired.

I will turn to the Ranking Member, Mr. Gordon.

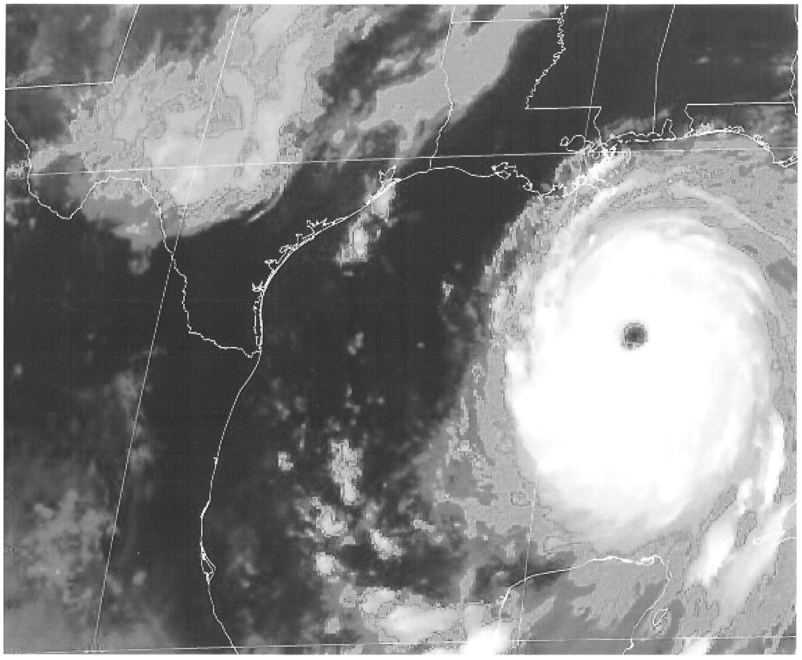
Mr. GORDON. Thank you, Mr. Chairman.

I think with all the information, it is on the public record now, it has become pretty evident of two things. One, that the Weather Service did an excellent job in predicting the hurricane and in the accuracy of doing so. I think we also know that FEMA and the Federal Government did not react well. And I am trying to find where was that disconnect. And so, Mr. Mayfield, I am wondering whether that in addition to the accuracy of the forecast there was also adequate information about the consequences of the hurricane. And as you know, we have asked you to bring your briefing materials from the August 28 briefing with President Bush and Secretary Chertoff. And if you would present that to us at this time, we would appreciate it.

Mr. MAYFIELD. I would be glad to if we can get that—okay. This is exactly what—these are the briefing slides that I used on that Sunday, August the 28th briefing, you know, from the National Hurricane Center. And I do not have a transcript but I am pretty sure I will be very, very close and the briefing I would give today would be very close to the briefing I gave before, although probably a little condensed version here.

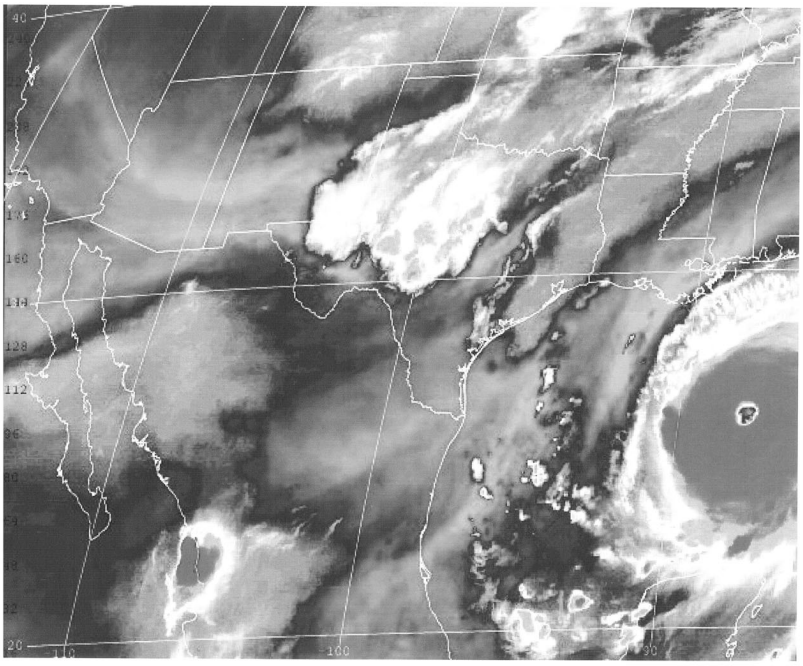


That first slide, I showed just to demonstrate the—or make sure they knew the size of the hurricane and not only is it well defined but it is not a small hurricane, it is a very, very large hurricane. The next slide, please.

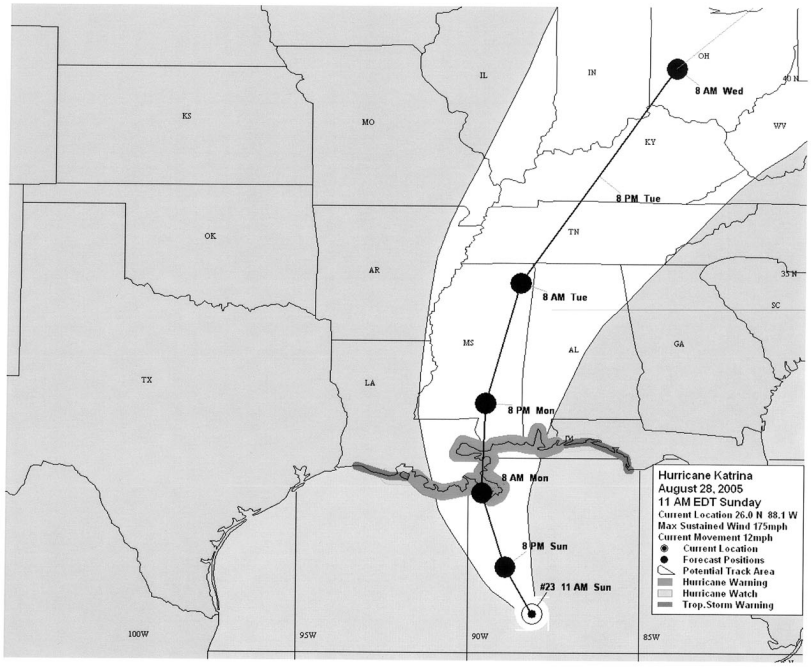


That was a visible picture. This one is an infrared and very, very distinct eye. When you have that, you always have a powerful hurricane and, in fact, this was a Category 5 hurricane. And I said that not only is this a Category 5 hurricane like Andrew, but there is a big, big, difference. And the difference is that it is a much larger hurricane than Andrew was.

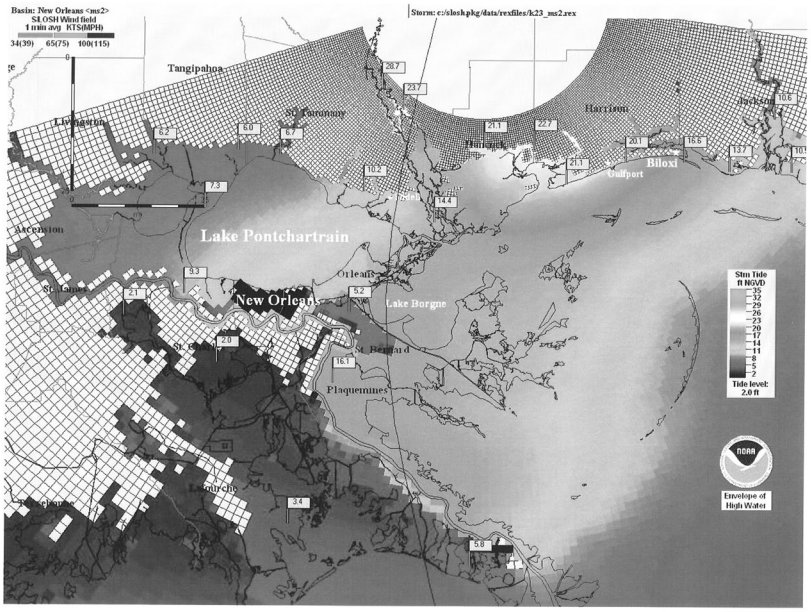
And I also made a comparison to Hurricane Lily back in 2002 that struck Louisiana. Lily had been a Category 4 hurricane in the middle of the Gulf of Mexico. It weakened down to a Category 1 hurricane. There was a big difference. With Lily, we had a very, very small eye. We call it a pinhole eye. And when you have those small eyes like that, typically they just do not persist for very long. And I did say that given this more typical sized eye, we really do not expect significant weakening like Lily did. The wise thing to do here would be to prepare for a Category 5 hurricane.



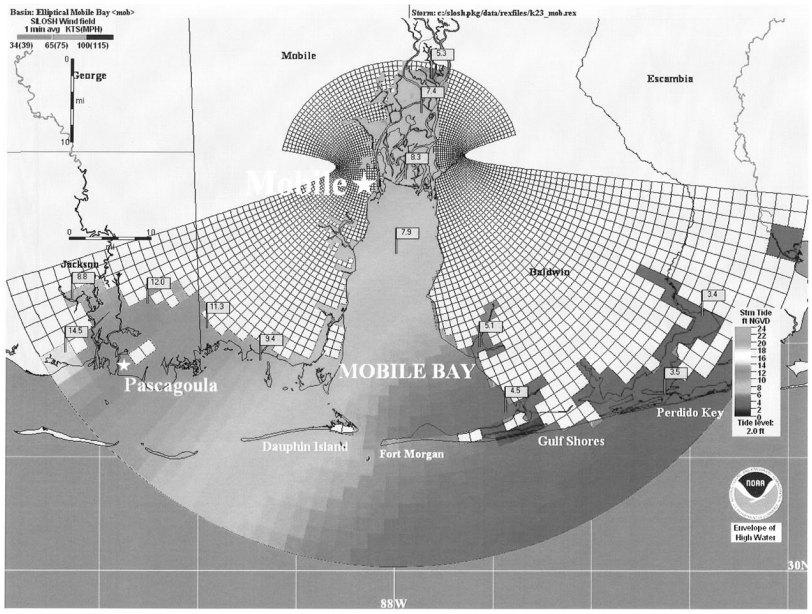
The next slide is a water vapor loop and we were also showing animations of these I might add on the video teleconference. And I show this one just to talk about the future motion. There was a trough coming in from the west that was eventually going to turn this up more to the north and eventually northeast. And the computer models differed somewhat on when that turn will occur and it makes a big, big difference whether it happens, you know, right at landfall, or before landfall, or well inland there. And what I would have said was that no one can tell you exactly, you know, where Katrina's going to make landfall but again I emphasized it was a large hurricane and wherever it made the actual landfall, it was going to impact a very large area.

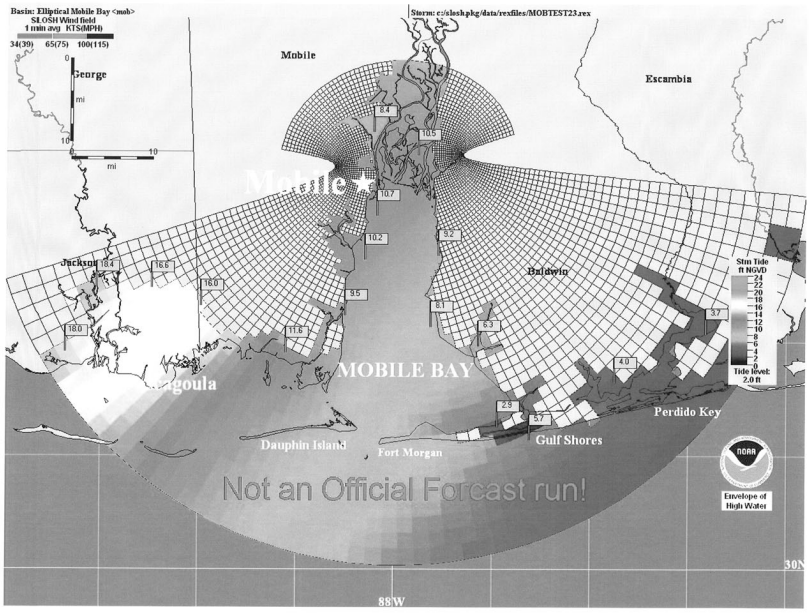


Then the next slide is—this is a Hurrevac slide and that is a software program actually developed by a former Weather Service employee paid for by FEMA after he retired and this is a really nice package here that you can animate this, you can do all types of displays here. And I would not have taken the time to—I mean they use this—we show this at every single briefing we give but for your information, that red area there that you see, the bright red from Morgan City, Louisiana over to the Florida/Alabama border, that was where the coastal hurricane warning was in place. We had tropical storm warnings and hurricane watches on either side of that. And then you can see the forecast track of the center of the hurricane and we always and General Johnson mentioned there, we do not like to poke attention to that skinny black line. We have that cone of uncertainty based on our previous 10-year forecast errors showing where the center of the hurricane can be. And when I showed this, I said that this is not just a coastal event, the strong winds, the heavy rains, the tornadoes will spread well inland. But—and I am also sure that I said this, I want to make absolutely clear that the greatest potential for large loss of life is also from the storm surge. And that transitions over to the next slide.



This is a storm surge simulation from the actual forecast that was available at that time. This went along with the 11:00 a.m. eastern daylight time advisory and this was for that noontime eastern daylight time Hurricane Liaison Team briefing. And I think you can see Lake Pontchartrain there and certainly the Mississippi coastline and much of the Louisiana coastline. The colored areas are areas that are indeed inundated from that specific forecast. Now again, we are doing this every six hours based on the most recent forecast but the point here is that those, the light greens and the yellows, those were all storm surge valves of over 20 feet. And I would have explained the circulation around the eye of the hurricane goes counterclockwise so that means that we would have northerly flow over Lake Pontchartrain. And I did say that no one can tell you with absolute confidence if the levees would be overtopped but it was obviously a very grave concern there. And I also would have said that if the track had shifted a little bit to the west or to the left there, it would have been even worse than on our current forecast track there. I really do not want anyone to think that we could give a perfect forecast.





And then the last two very quickly here, the storm surge in Mobile. This showed seven to eight feet of surge there. I was concerned that we had that much with Hurricane George in 1998 and that was only a Category 2 hurricane. So I did not know for sure

if the storm surge model really did justice to that. Wind speed also, I asked that that be run a little further to the east. And the next to the last slide there, this actually shifted the track, I believe 15 to 30 miles to the east and this gave us 10 to 11 feet of storm surge even up into the northern portion of Mobile Bay, Dolphin Island, portions of the Gulf Shores. Most of the Gulf Shores are under water. So those are the exact slides that I shared on that Sunday briefing.

This was a FEMA conference call and they invited the Hurricane Liaison Team to participate. This was a daily call and it was held during Katrina. Every day it was held at noon eastern time.

Mr. GORDON. At noon. And when did Katrina actually hit the City of New Orleans with its maximum force?

Mr. MAYFIELD. Well the first landfall there on the mouth of the Mississippi and south of Buras, Louisiana was about 7:10 a.m. on Monday morning, the 29th and then by the time it made the final landfall near the Louisiana/Mississippi border, that would have been about 10:00 or 11:00 a.m., so shortly before that.

DIRECTING HURRICANES

Mr. ROHRABACHER. Okay, all right. Thank you very much. Mr. Chairman, first of all let me apologize.

I have a mark up in another committee, International Relations Committee that I will have to attend afterwards. This has been so enlightening already and I hate to miss the rest of the questions but let me just proceed with a few of my own.

Let me note, these photographs and the tracking that NOAA and the National Weather Service forecasts have been utilizing are based on space based assets that this committee has supported over the years and have given the American people a tremendous leverage in terms of preventing the death and destruction from hurricanes like this. And I want to pat us on the back, Congress on the back for actually doing their job in terms of providing this type of technology and also a pat on the back for the National Weather Service and NOAA for the terrific job that they did in this and in other weather based dangers that we faced during my two decades of service here in Congress. You have always done a terrific job and this is yet another example.

Where we seem to have had a breakdown as we have indicated by the Ranking Member's comments that there may have been some sort of breakdown somewhere on the governmental level outside of the knowledge base but in terms of the coordination base. I would not put that all on the Federal Government; however, I do believe that the President by the time of this briefing at noon had already talked to the Major of New Orleans and asked that people be evacuated and that the efforts on the part of the people in charge at that level of government, did not move forward with the type of speed that was consistent with the danger that was being explained. So although let us just say whether it is the local level or the national level, there needs to be better coordination on both sides.

And this is not towards you folks but it just appears that there is not an emergency plan. We have got an emergency warning system but we do not have an emergency plan that is in place that

you go this is Step 1, 2, 3, 4 and this is what has happened. Now much of that has to be done at the local level but the Federal Government could have or our FEMA directors could have had that plan in place to be working with the local officials and said are you now on Stage 2, Stage 3, Stage 4. That obviously did not happen especially considering the 2,000 buses that were parked in New Orleans rather than used for evacuation purposes.

There has been a lot of talk about whether or not these hurricanes while we cannot, you know, everybody says you can talk about the weather, you cannot do anything about it. I have actually seen some reports and some in Scientific American and other magazines suggesting that in the future we might be able to direct the path of hurricanes and what do you guys have to say about that?

Mr. MAYFIELD. You know that question has been around for a long, long time if man can, you know, mitigate the hurricanes and it is very difficult to get some people to understand both the size and the tremendous power of a hurricane. And you know, nature can do a lot of things on its own. The United States Government used to have a program called Project Storm Fury where we would see, we would fly the NOAA hurricane hunter aircraft through the hurricane, seed silver iodide on the outside of the eye wall of the hurricane with the intent being to weaken——

Mr. ROHRABACHER. Well, before my time totally runs out, let me ask you specifically.

Mr. MAYFIELD. Sure.

Mr. ROHRABACHER. We have already, you know, seen what science can do to alert us and give us emergency signs of these hurricanes to understand they are coming. Do you think in 20 years from now we will be able to use space-based assets perhaps to warm the water or cloud seeding to actually help direct the path of a hurricane to prevent the type of landfall that we just had in Katrina?

Mr. MAYFIELD. Well, it is great to have a vision to do something like that but I am a very pragmatic type of guy and I am certainly not going to hold my breath for that.

Mr. EHLERS. The gentleman's time has expired.

Mr. ROHRABACHER. Yeah, could I ask unanimous consent to have the general answer that question for less than a minute?

Mr. JOHNSON. Yes, sir. There is a massive amount of energy in a hurricane and I think the efforts of man will be a very small infinitesimal amount of the——

Mr. ROHRABACHER. Thank you very much, General.

You now have told us that we—to alter the course of that hurricane, we are going to have to all learn how to pray, I think. Thank you very much.

Mr. JOHNSON. A higher power, yes, sir.

Mr. EHLERS. I suspect that is good advice. As a physicist, I can tell you that you could explore 120 megaton bombs in that and the hurricane would not even notice it so, a very depressing thought.

On that cheery note, we will turn to the gentleman from Colorado, Mr. Udall.

COMMUNICATION WITH EMERGENCY MANAGEMENT OFFICIALS (CONT.)

Mr. UDALL. Thank you, Mr. Chairman.

I want to also extend my gratitude to the panel for your presence here today and your compelling and enlightening testimony.

I intend to yield to the Ranking Member, Mr. Gordon, but I did want to just remind all the Committee Members here in the audience that in my district which includes the City of Boulder where we are fortunate to have a NOAA facility which is a tremendous asset. I cannot think of a harder working cohort of people and I want to pay tribute to them and the good work they do and the role they play in weather forecasting, as well as, the climate studies that are undertaken in Boulder.

So thanks again to the panel. With that, I would like to yield the remaining amount of my time to the gentleman from Tennessee, Mr. Gordon.

Mr. GORDON. Thank you, Mr. Udall.

Once again, Mr. Mayfield, you have been mentioned a variety of times, thank you for your service to the country, thank you for that powerful presentation.

Let me ask you, you told them to prepare for a Category 5. Is that correct in that presentation?

Mr. MAYFIELD. That is correct.

Mr. GORDON. Did you explain or did they understand the consequences of a Category 5? Did you explain that to them?

Mr. MAYFIELD. Those briefings, Congressman, are not—you know, it is really not the time to, you know, to teach a course in meteorology 101 but they, the folks on that, the emergency management folks on that conference call certainly should understand what a Category 5 hurricane can do.

Mr. GORDON. And though just a short time before that, through that PAM exercise, they had a chance. It was not a five but a four so you would know what was going on there.

So would you tell us, then, would you describe what are the consequences to that region for a Category 5?

Mr. MAYFIELD. Well you have to deal with all the hazards of the hurricane. The first is the storm surge. It is a dome of water that comes in near to where the center makes landfall. Very unique set of circumstances there in Louisiana that it is just so low lying and of course the city itself being like a bowl and much of the city below sea level. That has always been a concern with a storm surge in that area.

Number two, of course, are the strong winds and the winds were, you know, a Category 4 or 5 hurricane can do tremendous wind damage. And we have also learned over the years that the winds are stronger aloft. We put a statement in our advisories on Sunday saying that being that the windows could be blown out in, you know, high rise structures. Then you have to worry about the rainfall. And this is a team effort. We have the rainfall experts within NOAA, the Hydro Meteorological Prediction Center. And I did not mention this earlier but they actually were on those Hurricane Liaison Team briefings with us every day. I would do the basic meteorology and then they would chime in on the rainfall forecast. And

then, of course, the fourth main hazard would be the tornadoes that can spread well inland and can be well removed from the eye of the hurricane.

Mr. GORDON. Thank you, sir.

As I quoted earlier, Michael Brown said, "I must say, this storm is much bigger than anyone expected." Was it bigger than you expected and bigger than you predicted?

Mr. MAYFIELD. We briefed routinely and then in every advisory we issued, we would give the size. Are we, you know, differentiating between the size of the hurricane and the intensity? There is a difference. You can have a large powerful hurricane or a large weak hurricane or a small powerful hurricane or small, you know, weak hurricane so those are two different things. I am not sure exactly what Mike Brown meant by that if he—I suspect he meant it was, you know, an extreme event. I am not sure he really meant large in terms of size, but that I will think you will have to ask him what he actually meant from that.

Mr. GORDON. Thank you, Mr. Udall.

Mr. BONNER. [Presiding] I believe the Chair controls the time but the gentleman from Minnesota has another appointment so I would now recognize Mr. Gutknecht.

HURRICANE MULTI-DECADAL CYCLE

Mr. GUTKNECHT. I thank the Chair.

Mr. Mayfield, I would like to switch gears for just a minute because we have heard from some other experts and I would like to hear it right from the top guns here. That we may expect more hurricanes this year and we are in a hurricane cycle where we may see more. First, a simple question, how many more hurricanes should we expect this year?

Mr. MAYFIELD. I wish I could tell you for sure about that. I cannot be exact. Our seasonal forecasters were calling even back in early August 18 to 21 named storms, we have already had 19. We were calling for nine to 11 hurricanes and we have had ten. And we were calling for five to seven major hurricanes and we have had five. I think the best way I could answer that, if you go back the last 40 years or so, we typically averaged two or three named storms in October and November. I would like to say we could count Stan and Tammy on that but I really do not think we can. I think a reasonable expectation would be for another two to three named storms. One or two of those might be hurricanes. I think one of the important things is that and I just checked on this. If you go back to 1995 when this active period began, we have had eight major hurricanes in the month of October, two major hurricanes in the month of November so we are averaging, you know, one major hurricane per year in October and November in this active period.

Mr. GUTKNECHT. Now you have just touched on this and I am sorry, I had an agricultural hearing and a markup and some of us are in and out and that does not mean that it is not important, but can you talk a little bit about those cycles? I mean, we hear about that on the news. Where do you think we are in the cycle and how long will it last?

Mr. MAYFIELD. Well we have got some not very good news here. These cycles, you know, will go 10 to 30 or 40 years and you can go well back in the record books here to look at these cycles. And if, for example, the '50s and '60s indeed were very, very active with a lot of major hurricanes. And we need to remember that most of the loss of life and most of the damage occurs from these major hurricanes, Categories 3, 4, and 5 on the Saffir-Simpson Hurricane Scale. Then in 1995, somebody seems to have thrown a switch here and it has really gotten active. We have had a tremendous number of major hurricanes. And the research meteorologists unfortunately are telling us that this active period will very likely last another 10 or 20 years or more.

Mr. GUTKNECHT. Thank you, Mr. Chairman.

Mr. BONNER. Thank you.

The Chair recognizes the gentleman from North Carolina, Mr. Miller.

FUNDING FOR HURRICANE RESEARCH

Mr. MILLER. Thank you, Mr. Chairman.

I agree with Mr. Gordon that certainly NOAA's performance was probably the best one we had in the Federal Government.

General Johnson, when you count your life's blessings, count the fact that there was never a moment on National television that President Bush said to you, Johnny, you are doing a heck of a job. You all certainly did a much better job than other agencies of the Federal Government. But I am very concerned about our continued ability to do a good job and to do a better job. And certainly there seems to be room for improvements in the technology, in the science forecasting even if we do not look to that millennial day when we can actually control hurricanes, we certainly could do better in forecasting their exact path, their intensity, their rainfall, the inland flooding that they cause.

General Johnson, the difference between the House and the Senate budget for NOAA is $1 billion. What would the House budget due to NOAA's ability to improve upon the science or even maintain what you have, to maintain or improve the buoy system, to improve upon science? I understand that the scientists at NC State by the way did a better job of forecasting the path and intensity of the storm because they are using more advanced methodology. General Johnson, what would that budget difference due to NOAA's ability to improve or even keep what you got?

Mr. JOHNSON. I have had the opportunity to look at the House mark and the Senate mark at a very conceptual level.

Mr. MILLER. I sort of thought that would get your attention, yeah.

Mr. JOHNSON. Yes, sir. There is a significant different there and we are anxiously awaiting the conference and what really comes out of that. There is always an opportunity to do better and to improve. And I think in my opening statement, we talked about observations, opportunities in modeling, and my written statement I highlight some of those as well.

I appreciate the support in the Science Committee overall and right now we are anxiously awaiting what comes out of that to see

how we can continue to serve the American public with accurate and timely advise and forecasts like we have been.

Mr. MILLER. What are your feelings, Mr. Mayfield?

Mr. MAYFIELD. If I could just say one thing and I need to say this very carefully for the folks who were impacted. In both Katrina and Rita, to some extent, we were fortunate because they were both major hurricanes, in fact, Category 5 hurricanes well before they made landfall. You know, if you look at all the storms and hurricanes that hit the United States, only about 20 percent of them are major hurricanes, Category 3, 4, and 5, yet that 20 percent causes over 80 percent of the damage. Most major hurricanes become major hurricanes by going through some rapid intensification cycle that we simply do not understand yet. And both Katrina and Rita did this rapid intensification fortunately well, you know, away from that landfall point. If that rapid intensification had happened right at the time of landfall, in other words, people are going to bed preparing for let us say a Category 1 or 2 hurricane and then if they, you know, awaken to a Cat 4, I would not be sitting here today I suspect.

Anyway, we do need help especially with that rapid intensification.

LOCAL FORECASTS

Mr. MILLER. You would be testifying before the Government Reform Committee rather than the Science Committee.

Mr. Mayfield, in my state, you said someone threw a switch in 1995. My district, not just my state, but my district and, in fact, my house has been affected by Fran and Floyd. And the great bulk of the damage has been inland flooding, tornadoes. It has been a local forecast that would be most helpful in preparations and in response. How important or what is the current status of our ability to do local forecast and how will the proposal to cut the number of the local offices from I think 122 to maybe 20 or 30, how will that affect your ability to do the local forecasting?

Mr. JOHNSON. Let me take that one.

Mr. MILLER. Okay.

Mr. JOHNSON. We are constantly looking at opportunities to improve the way we provide products and services. And one of the things that I am looking at is our concept of operations. We have 122 weather forecast offices and 13 river forecast centers that provide services for America. I am looking at economies and efficiencies in how can we best provide those products and services. There is no proposal to cut the number of offices at this time. We are looking at how we can use the resources we have and be good stewards of the taxpayers dollars. So there is no proposal out there to cut numbers of offices.

EVACUATION DECISION

Mr. BONNER. The gentleman's time has expired.

I will reclaim my time and I want to express as others have. I would be remiss if I did not. As someone who lives in Mobile, Alabama and since last September with Hurricane Ivan, has experienced the good fortune of relying on both of you two gentlemen and

the many men and women who work with you, our thanks for the great job you all do and for the service you render our entire country in terms of giving us adequate warning that a storm is imminent.

I would like to go back to a question I think Mr. Gordon raised, but others have as well, and that deals with the issue of shelters. Because we experienced during Hurricane Ivan and we certainly did during Hurricane Dennis where the Governor of our State, Bob Riley ordered a mandatory evacuation of Mobile County, Alabama and the coastal area of Baldwin County and turned both lanes of I–65 northbound, the first time we had done that. It was successful in terms of evacuating a lot of people. Fortunately for us in Alabama, Dennis veered a little bit to the right, unfortunately for our friends in Florida, but as a result, we had a good lesson on evacuation.

But General Johnson, Mr. Mayfield, is there ever a time when a community, a state, or the Federal Government should encourage people to stay in an area when a Category 4 or a Category 5 storm is coming. Using New Orleans as an example, should any official of government have recommended that people stay in a city with a Hurricane 4 or a Hurricane 5 coming into that city?

Mr. JOHNSON. The role of the National Weather Service is to provide that accurate timely and focused information. We refer to our colleagues over in Emergency Management side on evacuation decisions and whether they should shelter in place. We do work with them in the off season to see how much time would be required and available. That is part of the hot wash at the end because evacuations from certain areas take much longer than others depending on the infrastructure but I would defer to them.

Mr. MAYFIELD. And that doesn't mean we do not care about those things. I mean it is a real team effort, the Nation's Hurricane Warning Program, you know, it consists of the forecasters, the emergency management, the community, and the media. The media is a big part of this. And we certainly care about that and our message has been so consistent in urging every individual, every family, every business, and every community to develop that hurricane plan and know what to do. But as General Johnson said, the roles are defined. And our role is to provide the best forecast that we possibly can.

Mr. BONNER. But even with your role, you still have a wealth of knowledge. Mr. Mayfield if you had been in New Orleans watching TV, the reports that your office and that you in fact were the one that was on national TV recommending, would you have stayed in that city?

Mr. MAYFIELD. I think that I would hope that the mayors and the governors were not telling me how to forecast and I am sure they would appreciate me not telling them how to evacuate.

Mr. BONNER. The next question goes to the gentlelady from California, Ms. Woolsey.

HURRICANE LIAISON TEAM

Ms. WOOLSEY. Thank you very much.

First of all, congratulations for both of your agencies for providing—using federal funds. And we have to take credit for that.

We invested in the right thing so that you had weather service. Information that was timely, accurate, and focused. And thank you, thank you. It proves, I believe, that we can achieve our goals. When there is a will, there is a way. And now I think we have the opportunity to know how your good information was used. So I have a couple questions about that.

Mr. Mayfield, I know you do not keep a log of who is on the daily Hurricane Liaison Team, the HLT, on the calls, but would you say there is good participation or there was by the State and local folks on these calls in general? Could you tell? Did you know?

Mr. MAYFIELD. I am not sure if you were in here, Congresswoman, but as far as I know, FEMA does not take, you know, an individual role call but they do and I mean I am talking about these daily video teleconferences now. I mean, there is a lot of additional coordination. But they do have a role call of offices. In other words, they would come and ask, "hurricane center, are you on line? FEMA Region 6, are you on line? Mississippi EOC, are you on line?" They would do that so that information I would think would be available from FEMA. I did not take role though.

Ms. WOOLSEY. Okay. Well, we have used this process for a long time now and you know so much more know than we ever knew, you know, in previous—in years passed. So would you say this process has provided a good forum of information or an exchange between the various levels of government or is there a way that you would suggest changing the process based on the post hurricane season and get local government more involved?

Mr. MAYFIELD. Congresswoman, you know if there is anything that we could have done differently or better on our end, I assure you that I want to know exactly what that is. I can tell you that FEMA sponsored a briefing, the noontime video teleconference involving the Hurricane Liaison Team. That was done the same way in Hurricane Katrina that it was done in all the hurricanes, all four of those hurricanes that hit Florida last year, and done exactly the same way with Hurricane Rita. That process did not change.

Ms. WOOLSEY. But should it go lower to get the local folks more involved?

Mr. MAYFIELD. Oh, you are asking should the local folks be on that video teleconference?

I have absolutely no objection to that. If I could give you my own opinion on that, this is a big picture of sort of the real big picture, the overview. The locals, I think are best served by that handholding going on in their local community by the local National Weather Service offices. Right before every forecast is issued from the National Hurricane Center, we have a hurricane hot line call with all of our potential impacted local Weather Service forecast offices, the river forecast centers, the rainfall forecasters of the Hydro Meteorological Prediction Center, the tornado forecasters and the Storm Prediction Center. The Department of Defense is online. They would be Norfolk, Jacksonville, Pensacola, and others. NASA is on that line. So we do a tremendous amount of coordination. And those local forecasters, you know, in the local communities, they know everything we do right before the advisory goes out. And then they turn around and do that handholding with the local emergency management and other officials. And I know these

folks in Slidell and in Mobile and I have known them for years and I know that they did their job. If there is something else that could have been done, I am sure they will want to know that too.

Ms. WOOLSEY. Okay, thank you very much. Thank you.

FACILITIES AND EQUIPMENT

Mr. EHLERS. [Presiding] The gentlewoman's time has expired.

General Johnson, were any of your vital facilities or equipment damaged or destroyed in Katrina and Rita? If so, what is the status of those facilities today and what are you doing to maintain capabilities in the short-term?

Mr. JOHNSON. Yes, sir. We had some significant damage to facilities. We had a back up plan in place so that when we lost power in the Slidell office for example, the Mobile office picked up those requirements. I was down there yesterday, Mr. Chairman, checking out how operations were going and there is some roof damage and some other things that we need to address. I know we lost services of a couple of buoys, some NOAA weather radios, those kinds of things, sir, and we are in the process of assessing those right now.

Mr. EHLERS. Do you have the resources to do—to make these repairs and get back on line during the rest of the hurricane season?

Mr. JOHNSON. Sir, with the start of the fiscal year and a continuing resolution I am going through an assessment right now and we are looking forward to the '06 ability to get an infusion of funds to address those.

Mr. EHLERS. All right.

LONG-TERM OUTLOOK

Mr. Mayfield, I am interested in a little futurism here. What is the future outlook with respect to both hurricane frequency and intensity during the next 50 to 100 years? Do you have any—and I know that is very long-term but what factors contribute to the frequency and intensity and what do you see developing that could have an impact on both frequency and intensity?

Mr. MAYFIELD. Well, I would like to jump right to the bottom line but I will hold that for a little bit. One of the biggest correlations that we have with hurricane activity in the Atlantic is the sea surface temperatures. And just as the sea surface temperatures have cycles of warm and cold, warm and cold, so does the hurricane activity so I cannot tell you with any certainty what the future will hold other than these cycles will very, very likely continue. Ten to 40 year cycles are active and then, you know, followed by inactive periods there.

But this is important, too. We need to remember that you do not have to be in an active period to have that one powerful hurricane. And 1992 was well below the average number of storms and hurricanes. This was not in a warm period, it was—we only had six storms that year, only four of those were hurricanes, but yet we had that one little hurricane called Andrew. So no matter what period we are in, active or inactive, the bottom line from my perspective is that we need to be prepared. We need to have those hurricane plans in place. And everyone down to that individual taking

that personal responsibility needs to know what to do before the next one comes.

Mr. EHLERS. So in other words, the frequency follows certain cycles but there is no relationship between intensity and frequency?

Mr. MAYFIELD. No, there is, I am sorry, sir. I did not understand that. Yeah, in the active periods, we do tend to have more major hurricanes so that obviously is a concern. I was just trying to say that even in the inactive periods you can still have that——

Mr. EHLERS. Right, okay. But there is some correlation between frequency and intensity. Okay.

And much of it is related then to the cycling of the surface temperatures in the gulf and in the western Atlantic. Is that correct?

Mr. MAYFIELD. Right. We typically look at our main development region, the tropical Atlantic, the Caribbean and part of the Gulf of Mexico.

You know, you can correlate a lot of different things with, you know, the activity and that sea surface temperature is one of the best things that we have.

Mr. EHLERS. Well at least you have not tried to correlate it with full moons which seemed to be the favorite thing people like to correlate things with.

My time has expired. We recognize the gentlewoman from Texas, Ms. Sheila Jackson Lee.

TIMELINE

Ms. JACKSON LEE. Thank you very much, Mr. Chairman.

Let me thank the Chairman and the Ranking Member for what I think is both a vital and timely hearing, and allow me to thank both General Johnson and Mr. Mayfield for, I know a grateful America for the existence of NOAA but also its technology. For that reason, allow me for a line of questioning that again may take you over the timeline that I view is so very crucial to the component of saving lives.

Backtrack for me again if you would, the time that you began to assess Hurricane Katrina. And I may interrupt you and forgive me only because I have a series of questions and I know my time is short. So when I look at sort of the end of August, how far back did you begin tracking Hurricane Katrina?

Mr. MAYFIELD. Well we were tracking the disturbances, the tropical waves come off the coast of Africa every three or four days just like clockwork all through the hurricane season and we were tracking a tropical wave that really did not form. It became a depression on Tuesday, the 23rd of August. I asked for activation of the Hurricane Liaison Team to start on the 24th. It was activated at 7:00 a.m. on Wednesday, the 24th, became a storm on the 24th, and then it became a hurricane just before it made landfall on the 25th near Miami.

Ms. JACKSON LEE. And it was what category at that point?

Mr. MAYFIELD. A Category 1 hurricane when it made landfall there. And it became at Cat 1 just an hour or two before landfall.

Ms. JACKSON LEE. A measure or two.

At that time, were you on any kind of large conference calls with all necessary parties including the President or his representatives starting at that point?

Mr. MAYFIELD. I honestly do not remember when the President was on it except I know for a fact that he was on that Sunday, August the 28th as it was in the Gulf of Mexico. I do not remember and quite honestly some time ago on the video teleconference monitor will have nine or more little pictures there and it may say the White House or it may say, you know, Louisiana Emergency Operations Center and I really cannot see exactly who is there in each of those offices. But the video—well on Wednesday the 24th, we had a telephone conference call with FEMA and by the time it hit Florida there on the 25th, we had the video teleconferences going daily at noontime. And I am sorry but I cannot tell you exactly, you know, which individuals were on there.

Ms. JACKSON LEE. But you know that he was on on the 28th, which was that Sunday?

Mr. MAYFIELD. That is correct.

Ms. JACKSON LEE. And were local officials on as well?

Mr. MAYFIELD. The local officials were not on but the States, Texas, Louisiana, Mississippi, Alabama, Florida, and Georgia emergency operation centers were on that big picture. Again, that the big picture called there on that video teleconference. Of course FEMA headquarters facilitated the call and then FEMA Region 4 out of Atlanta, Georgia and FEMA Region 6 out of Denton, Texas.

Ms. JACKSON LEE. How much guidance do you give as you are providing the science of these Cats 1, 2, 3, and 4, and 5? How much direction can you give to FEMA or how much direction are they seeking from you as partly the agency dealing with natural disasters, the National FEMA as opposed to State emergency agencies?

Mr. MAYFIELD. Well, a fair question but the roles are defined here and our role is to provide the best forecast that we can. So we would be reporting, I would be briefing on, you know, the current location and strength of the hurricane, the future track of the hurricane, the future intensity forecast, the potential storm surge, rainfall, tornado activity. Our role is to provide the best, you know, weather information that we possibly can.

Ms. JACKSON LEE. But at some point, the human factor must play in where somebody takes a deep breath to say guys this is a Cat 5, we have got to move. I am sure sometimes in the course of conversation that happens. Is that correct?

Mr. MAYFIELD. Well, we certainly said that this was a Cat 5, you know, when it became a Cat 5 and I did, I mean, I firmly believe that people understood the potential that this hurricane held.

Ms. JACKSON LEE. General, let me ask you this. With the work that you have done, my understanding is that there is a difference of $1 billion between the Senate's mark and the House mark as it relates to NOAA. This Committee has always been a strong advocate of funding for NOAA but it baffles me as to what you will do with that shortfall.

And then let me raise this with you. Clearly as Mr. Mayfield, said there is a point where there is an exasperation or an exasperated voice saying, you know, this is a Cat 5 and you are speaking to I call it level folk that are at the level of State government but the Federal Government is there. Do we need to legislate, if you will, a stronger role for NOAA as it relates to the interaction between agencies like FEMA because we all know that despite the

local responsibility and the state in natural disasters when NOAA is on the line saying with its refined science there is a Cat 5, somebody at the top level should act. In the case of Hurricane Katrina, it is well known that they did not act. Do we need to provide some greater cohesion so that the Federal Government can be working more effectively together and get people out and save lives. But I ask that question in the cut in your seemingly proposed cut in the dollars that are going to you this time around.

Mr. EHLERS. The gentlewoman's time has expired. Please give a brief answer.

Mr. JOHNSON. Ma'am, we are an important part of the team and weather service characterizes the storm and provides that accurate timely information. We also pay very much attention to the National Hurricane Center that takes that very big picture and takes the larger view. The local weather forecast offices translate that view into specific local topography, bathymetry, and specific events. You know, characterizing, you know, where the effects are going to be held. We also in the messages that we put out through NOAA weather radio and all of our communication techniques and capabilities, emphasize paying attention to your local emergency manager because they are an important part of the team as well.

Right now, I am hopeful that the Conference Committee will find a good accommodation and take care of the requirements for NOAA and the Weather Service and allow us to continue to do the job that we are capable of doing.

FIVE-DAY FORECASTS

Mr. EHLERS. The gentlewoman's time has expired.

Question for either one of you, you can decide who is to answer. But you have introduced a five-day hurricane track prediction, where as I recall last year you were doing three-day. What has your experience been so far and I am curious why do you believe the data has improved sufficiently you can now give accurate five-day reports and do you plan to continue to do that or have you discovered some weaknesses?

Mr. MAYFIELD. Mr. Chairman, we really do listen to our users. You know, most coastal states now have a yearly hurricane conference. We have a national hurricane conference, we have interdepartmental hurricane conference. There are a lot of venues that allow customers to, you know, share with us what they would like. And that five-day went well into effect here in 2003, I believe after a couple of years of testing. And that was actually stated as a requirement by the United States Navy. And, you know, we cannot produce a product with taxpayer money and just give it to a few chosen people. With the public/private partnership we have when we create our product, we make that available to, you know, anyone and everyone.

The feedback that I have gotten on the five-day has been on the most part very positive though the truth is a five-day forecast is as accurate as the three-day forecast was just 15 or so years ago. We put out on our graphical products a cone. That cone at the extended periods of four and five days is very, very large because we have these large areas. But for most people, for the public, the only thing I ask is that if you are within that large cone at those ex-

tended time periods, just start thinking about what you might do if the hurricane continued to head toward your community. Most people do not need that four- and five-day lead time there but there are some users, NASA if the Space Shuttle is on the launch pad or the Navy with all their aircraft carriers in Norfolk for example and they have to get people back from shore leave and get the ships ready and underway and away from the coast before the arrival, you know, of high seas and storm force winds. So there are some customers who indeed make very good use of that four- and five-day forecast.

REBUILDING NEW ORLEANS

Mr. EHLERS. And may I ask both of you, do you have any involvement in the rebuilding of New Orleans? Are you making any recommendations? What is your relationship with the local officials on that?

Mr. JOHNSON. Sir, NOAA is actively involved in restoration, clearing the shipping channels to allow the port to reopen, looking at the ecosystems and what needs to be done to restore those. Your weather service continues to provide information on post-Katrina, the Rita impacts, as well as, the daily forecast to all the people who are down there working. And sir, they are paying attention to the forecast. So, yes, sir, we are actively involved at all levels of NOAA.

Mr. EHLERS. It would be nice also if you could persuade them not to rebuild in areas below sea level but I will leave that to your discretion.

My time has nearly expired. Mr. Davis?

Mr. DAVIS. Mr. Chairman, thank you very much for recognizing me. I will not make a large speech.

But I think as we observed what happened with the hurricane that came through the gulf, perhaps tells all of us in Congress, as well as, those who live in the area and certainly NOAA that we need to make a serious visit to the predictions. Obviously, the ability that you have and a way to protect those who live in an area where the hurricanes often frequent in the gulf or other areas in Florida.

I represent an area that is in Tennessee. Obviously, we get a goodness many times from the hurricanes because we get rainfall that comes in that helps our farmers have the rainfall that is needed. But also coming with those many times are tornadoes that are spawned from the high winds and as a result of that, we have small footprint of damage and destruction that was observed in a large footprint across the gulf—down the road would be the wooly warm would be dark on one or the other or all the way through would mean a rough winter. The thickness on the bark of a tree or where a wasp or a hornet would hang their nest, how low in the trees it would be.

Obviously, we have greatly expanded and improved upon predicting the weather and how forceful, how almighty it can be, how damaging, and how harmful it can be. And it is my hope that those of us who serve in Congress realize that continued funding for the predictability of weather that will save lives is certainly a homeland security issue to us. I do believe that people throughout this nation today have had a taste of the damage of the hurricane for

a reason. The lesser amongst us who lived along the coast in Alabama, Mississippi, and New Orleans have been displaced because their economic conditions would not permit them to rebuild or did they live in an area where they could move to a family. And as a result of that, we have seen evacuees throughout this nation be dislodged from their home. I do not believe there is a state in this nation that has not accepted evacuees. Those who have lost their homes and everything that they have and the ability even to survive and in many cases, the retirees, their small Social Security check that can help them have some means of living in many cases to them what would appear to be almost a foreign country moving from their home in the gulf inland to states all across this nation. I think all of us have felt and have been made aware of and can see the damage that has occurred.

So it is my hope that those of us here in Congress realize that it is our responsibility as a nation to be sure that we adequately fund the weather predictors which is NOAA and that we do not cut dollars in that area. I applaud the efforts, I applaud the accuracy of the agency that has provided us with a safety net in many cases for those to escape. That happened when Rita visited the area of Texas and we saw lesser at least personal harm done to those.

Having said that, I would yield the remainder of my time to a Ranking Member with permission from the Chairman to Representative Bart Gordon from Tennessee.

COMMUNICATING WITH MEDIA

Mr. GORDON. I thank my friend from Tennessee.

There is a variety of things that we do not know but I think a couple of things that we do know is that it is unfortunately inevitable that there will be another catastrophe of this magnitude or worse whether it is by force of nature or force of man. And the other thing that we know is that on the federal, State, and probably local level, our governments did not serve us as well as they should and we would hope for them to do. So it is important that we look at what went right, look at what went wrong, try to make preparations for the future to get the wrongs to the right. I think in doing that, it is important that we have transparency. I think it is also important that we have an independent commission that will review the various information and try to make non-partisan, non-bias suggestions. But again to do that, it has got to be transparent.

And so I want to get a few things on the record because I am confident that in trying to do the right thing we will have this independent commission later. So General, if you would, let us see, would you put up the memo, please?

General, just again, just for the record, I cannot speak to the truth or not of this. This was on a blog supposedly leaked from NOAA staff. It is concerning a memo that went out on Thursday, the 29th of September 2005 from a Jim T-e-e-t, is that how you pronounce that, his name?

Mr. JOHNSON. I believe so, sir.

Mr. GORDON. Okay. And you can tell me whether this is accurate. "Good day all. I have been informed that any request for an interview with a national media outlet reporter must now receive prior approval by DOC, Department of Commerce. Please ensure

therawstory

Commerce Department tells National Weather Service media contacts must be pre-approved

10/04/2005 @ 1:16 pm
Filed by Larisa Alexandrovna

The Department of Commerce has issued a blanket media policy to employees of the National Oceanic and Atmospheric Administration (NOAA), requiring that all requests for contact from national media be first approved by the Department, RAW STORY has learned.

According to a leaked Sept. 29 email memo sent out to NOAA staff, including employees of the National Weather Service (NWS) -- both of which are under the Department of Commerce -- employees must collect information from reporters and forward it to the Department.

From "Jim Teet" Jim.Teet@noaa.gov
Date Thu, 29 Sep 2005 12:04:34 -0600
To _NWS WR WFO MICs wr.wfo.mics@noaa.gov, _NWS WR WCMs wr.wcms@noaa.gov
Subject DOC Interview Policy

Good Day All:
I have been informed that any request for an interview with a national media outlet/reporter must now receive prior approval by DOC. Please ensure everyone on your staff is aware of this requirement.
Any request for an interview requires the following information to be forwarded to me immediately, so this process may begin:
The name of the reporter and their affiliation; Their deadline and contact phone number; Name of individual being requested for the interview and purpose of the interview; Additional background about the interview subject, and expertise of requested interviewee on this subject.
The request will be forwarded through NWS/NOAA to DOC; however, the individual to be interviewed ultimately will be determined by DOC.
If any requests for an update concerning the interview are received from the media, refer the individual to me for a response via my cell phone: (XXX) XXX-3516.
Thanks, Jim Teet

everyone on your staff is aware of this requirement. Any request for an interview requires that the following information to be forwarded to me immediately so this process may begin. The name of the reporter and their affiliation, their deadline, the contact number, the name of the individual being requested for the interview, the purpose of the interview, additional background information about the interview subject, and expertise of the requested interviewee on the subject. The request will be forwarded through NWS, NOAA to DOC. However, the individual to be interviewed ultimately will be determined by DOC."

Is that an accurate memo?

Mr. JOHNSON. Sir, I would say that memo did go out. It is, in fact, a——

Mr. GORDON. That is fine. This was what I wanted to know whether that was accurate so it was not just something very——

Mr. JOHNSON. No, sir. It is a statement of a long standing policy. The term now is an unfortunate choice of——

Mr. GORDON. I think it is also unfortunate that as we try to have transparency and find out what went wrong that apparently members of your organization have to go through some type of a buffer. I think that is unfortunate, too but let me continue to try to get some things on the record here.

I want to note that we asked on this side for several things that we have not been delivered. We have requested for the reports in whatever form they may take that are produced by NOAA employee who works at the NOAA desk in the Homeland Security Operations Center. My understanding is the Department of Homeland Security is raising objections to this request as are counsel at the department. So I want to deliver a formal request for those documents today and they will be given to you. Go ahead, Leigh Ann.

This letter also asks that the department make available to our staff the person who was assigned to the HSOC desk so that we may interview that person. We asked that earlier but again there has been national security objections hinted in the refusals. General Johnson, I hope you will do all you can to shake these things loose. It is silly to think that there is anything referred to in NOAA's work on Hurricane Katrina that could in any way compromise national security.

Further, I ask that two letters be entered into the record. I have written to the White House asking for the transcript of the HLT briefing the President participated in. I also asked for the names of any White House staff who communicated with NOAA regarding Katrina.

In the second letter, you will see that I have asked FEMA to release any reports they maintain of the HLT briefing from August 27 and August 28. I have not received any sort of response to either letter. *[See Appendix 2: Additional Material for the Record.]*

Now General, my interest is not playing a game of got you. It is trying to do legitimate oversight. As we said, this is going to happen again in some way or the other. We need to be prepared. My wife and daughter live here in the District and I suspect that a variety of your employees, maybe your family, Members here today have family here. It is very likely that this region could be one of those hit with a catastrophe, more likely the man kind than the

natural kind. So it is very important that we again learn our lessons, try to prepare. This is a matter of life and death.

Thank you, General.

[The information follows:]

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE

SUITE 2320 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
(202) 225-6371
TTY: (202) 226-4410
http://www.house.gov/science/welcome.htm

October 7, 2005

Navy Vice Admiral (ret.) Conrad C. Lautenbacher
Undersecretary of Commerce for Oceans and Atmosphere
National Oceanic and Atmospheric Administration
Department of Commerce

Dear Under Secretary Lautenbacher,

By this letter I am formally requesting that National Oceanic and Atmospheric Administration (NOAA) provide to me copies of all reports, in whatever form, that were produced by NOAA staff assigned to cover the Homeland Security Operations Center (HSOC) NOAA desk and sent back to NOAA through your Incident Coordination Center. We request these records for the dates from Friday, August 26 through Saturday, September 3.

I am also formally requesting that NOAA make available the person permanently assigned to the HSOC desk for an interview with my Committee staff.

Please comply with this request by October 21, 2005. If you have any questions about this request, please contact my staff at 202-225-4494.

Sincerely,

BART GORDON
Ranking Member

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE
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WASHINGTON, DC 20515–6301
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http://www.house.gov/science/welcome.htm

September 14, 2005

The Honorable George W. Bush
President of the United States of America
The White House
1600 Pennsylvania Avenue, N.W.
Washington, D.C. 20500

Dear Mr. President:

I write because of my committee's jurisdictional responsibilities over the National Oceanic and Atmospheric Administration (NOAA) and more specifically over the National Weather Service (NWS) and its National Hurricane Center (NHC).

According to press reports, Max Mayfield, director of the National Hurricane Center, personally briefed you on Sunday, August 28 about the impending landfall of Hurricane Katrina and its potential effects.

The oversight responsibilities of the Science Committee make it imperative that the committee fully understand the depth and substance of the communications between the NHC and your Administration. That understanding necessarily includes the details of your conversation with the NHC Director and any other conversations between senior White House staff and members of NOAA, including the NWS and its NHC.

We request the following:

1) The full transcript of your Sunday, August 28, 2005 videoconference with NHC director Max Mayfield, including names and affiliations of all the parties who were involved either by physically attending the videoconference with you in Crawford or by other electronic means.

2) A list of all persons in the White House who were contacted by Max Mayfield, Brigadier General David Johnson (ret.), or Vice Admiral Conrad C. Lautenbacher, Jr. between August 23 and August 31, 2005 regarding Hurricane Katrina.

3) Where transcripts exist, transcripts of all conversations that took place between NOAA, NWS or NHC personnel and White House Advisors or staff.

Given the importance and magnitude of this tragedy, we trust that you will provide a prompt and full accounting concerning this chain of communication. As you may be

aware, on Wednesday, September 21, 2005, the full Science Committee will be holding a hearing on NOAA's hurricane forecasting. As such, we ask that you respond by the c.o.b. Tuesday, September 20, 2005.

If you have any questions regarding this letter, please contact my staff at (202) 225-4494.

Sincerely,
Bart Gordon
Ranking Member
House of Representative
Committee on Science

U.S. HOUSE OF REPRESENTATIVES
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September 30, 2005

The Honorable R. David Paulison
Acting Under Secretary/U.S. Fire Administrator
Office of the Director
500 C Street, SW
Washington, DC 20472

Dear Under Secretary Paulison:

I write because of my committee's jurisdictional responsibilities over the National Oceanic and Atmospheric Administration (NOAA) and more specifically over the National Weather Service (NWS) and its National Hurricane Center (NHC).

The oversight responsibilities of the Science Committee make it imperative that the committee fully understand the depth and substance of the communications between the NHC and local, state and federal emergency response, including FEMA. It is impossible to fully assess the Federal preparedness for Hurricane Katrina without understanding specifically what the NHC's representatives were telling the participants in the HLT briefings in the two days prior to Hurricane Katrina making landfall.

Specifically, the Hurricane Liaison Team (HLT), which consists of FEMA, NWS, and state and local emergency management officials, is tasked with coordinating closely with FEMA Headquarters Staff by phone and video conferencing systems. According to NOAA records, the Hurricane Liaison Team was launched by the Director of the National Hurricane Center on August 25 in anticipation of Hurricane Katrina making landfall.

We ask for all records relating to the Hurricane Liaison Team briefings of August 27 and August 28. Our request includes, but is not limited to memos, transcripts, notes, recordings, and meeting minutes, whether in paper or electronic form, related to Hurricane Katrina that were generated during or because of the August 27 and 28 briefings. This request includes a list of the names and affiliations of all parties who were invited to participate in these calls as well as indications that the invitees were actually involved in the call.

September 30, 2005
Page 2

Given the importance and magnitude of the questions associated with the governmental response to Hurricane Katrina, we trust that you will provide a prompt and full response. As you may be aware, on Friday, October 7, 2005, the full Science Committee will be holding a hearing on NOAA's hurricane forecasting. As such, we ask that you respond by the c.o.b. Wednesday, October 5, 2005.

If you have any questions regarding this letter, please contact my staff at (202) 225-4494.

Sincerely,

Bart Gordon

BART GORDON
Ranking Member

CONCLUDING REMARKS

Mr. EHLERS. The gentleman's time has more than expired. I was generous in giving him extra time because as a Ranking Member he is entitled to a closing statement. That may not have been a wise decision but we appreciate your efforts to get at some of these issues.

Just a quick question to wrap it up and then I will have a closing statement. I would like to ask you is there anything that you need from the Congress, anything that the Congress could do that would help you do a better job forecasting and warning about hurricanes. In other words, do you in your experience of the past few years of this, has anything come to mind where we are getting in the way rather than helping the process?

Mr. JOHNSON. Sir, in my opening oral testimony I thanked you and the Committee for your support after last year. The oral remarks also talked about modeling and observing and we can always do a better job. I am anxious for the Air Force to get the sensors modified and airplanes up to speed. And I look forward to the '06 budget, as well as the other activities that can help support us overall. We are very appreciative of what you have already done.

Mr. EHLERS. Thank you.

Mr. Mayfield, do you have anything to add?

Mr. MAYFIELD. No. We certainly appreciate everything that you have done. And those buoys that the Congress helped us get at the end of last year have been very, very, very useful already in several storms and hurricanes already. And we certainly will appreciate the additional support here as we continue to improve.

Mr. EHLERS. Well thank you.

And I would like to just make a few closing comments along the lines of Mr. Rohrabacher and Mr. Davis pointing out how far we have come. We often neglect that, but I must say as I watched this unfold on my own TV screen, I could not help but marvel at the changes from my childhood. I grew up on the plains of Minnesota and we used to have what we called cyclones then not tornadoes. No warning whatsoever. Everyone just watched the sky and when it got bad enough, you headed for the basement. And sometimes you miscalculated. Some real tragedies occurred as a result. Today, we have tremendous warning systems for hurricanes, floods, tornadoes and particularly the satellites. And we often hear complaints from the public about wasting our tax money, et cetera. I think this is a good example of good use of tax money. Obviously it costs much, much more to run the National Weather Service relatively speaking than it did 40 years ago, but I would maintain that investments in science such as we are doing in this case have a very good rate of return. I am certain that the lives saved even property damage averted as a result of the work that you do and that you have done not just in forecasting but making us aware of the dangers of nature, the tax money has more than paid for itself and the extra information provided in particularly in the saving of lives. And I think that is a very important point to note.

I also would comment there was some comment made earlier about the lack of funding for NOAA and what happens in the budget. Unfortunately, NOAA frequently in the past has been the target

of what we politely here call earmarks in which money is diverted from a good cause such as the Weather Service or other areas and assigned to some other cause which in the eyes of the earmarked is more appropriate and more important. I think it is time that the Congress and the Nation wake up and realize NOAA is really important. This is not a little pork barrel that people can dip into and move the pork somewhere else. The work you do is extremely important to the livelihood of our nation, particularly in agriculture and shipping but in other ways as well and we certainly appreciate what you have done.

I hope that the new satellites we are putting up are going to help you even more and do a better job. The new supercomputers which this committee has initiated the funding for will help you do a more accurate reporting and forecasting. I think if you hold a similar hearing ten years from now, I do not expect to be here but I am sure that my successors will find even more astonishing results and even better forecasting in the future.

So I want to thank you for being here today, for testifying before the Committee. It has been a highly educational hearing. And you have given this committee a lot to consider about the role of NOAA in hurricane prediction. If there is no objection, the record will remain open for additional statements from the Members and for answers to any follow up questions the Committee may ask of the panelists. Without objection so ordered. The hearing is now adjourned.

[Whereupon, at 12:30 p.m., the Committee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Brigadier General David L. Johnson (ret.), Assistant Administrator for Weather Services; Director, The National Weather Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Questions submitted by the Majority

Q1. What are the various notification systems the National Weather Service uses to disseminate weather warnings and information? For each notification system, please explain how Federal, State and local government officials receive the information. For each level of government (Federal, State and local), please explain how the National Weather Service (including its local weather forecast offices) confirms that government officials received emergency messages. Do these procedures change in case of an "incident of national significance" declared by the Department of Homeland Security?

A1. National Weather Service (NWS) warnings are distributed through a vast dissemination network. These systems include NOAA Weather Radio All Hazards (NWR), which can reach anyone in the area who has a NWR receiver; NOAA Weather Wire Service; Emergency Managers Weather Information Network (EMWIN); Internet; local paging systems to emergency managers; high-speed direct communications with users of large volumes of weather data (i.e., commercial meteorological firms) connected by landlines (Family of Services), by satellite broadcasts (NOAAPORT), or both. The media uses one or more of these feeds to receive the information and then rebroadcast it. Federal, State, and local officials typically receive weather warnings and information from different combinations of the above systems. Some officials also obtain information from the private sector.

These dissemination systems do not have a mechanism in place to verify the user received the message. However, each state emergency operations center has a direct feed from the NOAA Weather Wire Service, paid for by the NWS, to help ensure NWS warnings and other information are received by emergency managers. The State emergency managers then redistribute the data and information, as appropriate, to local emergency managers. Government officials also typically receive messages from several systems (listed above). During major weather situations, many NWS offices or regional headquarters send a meteorologist to State emergency operations centers, or place phone calls to these centers to ensure emergency managers have the most current information and interpretation possible.

These procedures do not change for an "incident of national significance."

Q2. For each notification system described in the answer to question one, please explain how often the National Weather Service and its local forecast offices test the systems to make sure they are working. Are the notification systems redundant to such a degree that no significant communications capability would be lost if any one of the notification systems fails to function during a severe weather event?

A2. Each local weather forecast office tests the NOAA Weather Radio All Hazards (NWR) Network in its local area once a week to ensure the system is operating. Other dissemination systems are monitored continuously at the National Weather Service Telecommunication Gateway and any communications outages are addressed immediately.

If a NWR transmitter becomes inoperable, messages are not transmitted to the NWR receivers. NOAA is working to further increase the reliability of NOAA Weather Radio All Hazards (NWR) transmitters to allow operation in adverse conditions, when normal communications systems can fail. Nearly $5M in funding provided to NOAA in the FY 2006 hurricane supplemental will be used to provide backup electrical power for NOAA Weather Radios and Automated Surface Observing Sites in coastal areas. Not only is NWR network reliability important, increasing the number of individuals who own NWR receivers is also critical. NOAA works with the private sector to promote the use of NWR receivers and recently worked with FEMA and the Department of Education to distribute 16,000 NOAA Weather Radios to public schools across the country. Also, with $1M in additional funding provided in the supplemental, NOAA will expand the NWS Weather Wire Satellite Communication System to improve communications capability at coastal Weather Forecast Offices for timely transmission of weather warnings to the public and the media.

One benefit of having multiple dissemination systems is redundancy. If one method is non-operational, others still disseminate important information. However, this

strategy is successful only when recipients have access to multiple dissemination systems. Redundancy is one of the items stressed in the National Weather Service StormReady program, to ensure communities and emergency managers can receive warnings and information different ways. Communities can receive NWS and emergency messages through NWS dissemination systems which include NOAA Weather Radio All Hazards (NWR), which can reach anyone in the area who has a NWR receiver; NOAA Weather Wire Service; Emergency Managers Weather Information Network (EMWIN); Internet; local paging systems to emergency managers; and via commercial meteorological or communication (e.g., phone) companies.

Q3. What are NOAA's back-up procedures during severe storms if a radar, buoy, or entire local weather forecast office is destroyed or cannot communicate? Please explain the circumstances that would trigger back-up procedures. Were any back-up procedures triggered during Hurricanes Katrina or Rita? If so, please explain what happened and what NOAA is doing to fix any damage.

A3. The National Weather Service (NWS) has robust backup procedures in place to ensure continuity of operations. The NWS radar network was designed to provide radar coverage for the contiguous United States to ensure radar coverage for severe weather, including hurricanes. Should a radar fail, adjacent radar stations and other observation systems provide sufficient coverage. Other observation systems, such as satellites and surface observation stations, provide a sufficient level of coverage to assist meteorologists in the forecast and warning function. NOAA operated WSR–88D radars have an operational availability of 99.1 percent.

NOAA/NWS recently added connection to four Federal Aviation Administration Terminal Doppler Weather Radars—Orlando, FL; West Palm Beach, FL; New Orleans, LA; and Houston, TX—in hurricane-prone areas as another mechanism to ensure weather radar data are available to forecasters. During both Hurricanes Katrina and Rita all radars remained operational, providing data to the local weather forecast offices.

NOAA/NWS buoys have redundant wind sensors and barometers that provide data if the primary instrument fails. Several of the large buoys, including three in the Gulf of Mexico and the seven new buoys deployed with FY04 Hurricane Supplemental funds have a complete second operational system on board that serves as a back-up. Should a buoy suffer catastrophic damage, which rarely occurs, NOAA maintains a network of large buoys which provide some overlapping coverage. Further, other weather observation systems (for example satellites and hurricane reconnaissance flights) also provide coverage. Repairing buoys is a high priority but depends on ship availability. NOAA fixes damaged buoys within the Atlantic Hurricane Basin as quickly as possible, usually within a few months. NOAA/NWS can also provide manual backup should an automated surface observing system fail at a Weather Forecast Office (WFO) or major airport.

During Hurricane Katrina, the NWS implemented backup coverage for the New Orleans, Louisiana; Lake Charles, Louisiana; and Jackson, Mississippi offices when communications to and from the offices were lost due to an MCI/communications backbone failure. The FY 2006 Hurricane Katrina/Rita Emergency Supplemental provides NOAA $1M to improve (harden) hurricane-prone WFOs communication capabilities via backup satellite communications. The NWS offices in Mobile, Alabama; Houston, Texas; and Huntsville, Alabama assumed forecast and warning responsibility for the area normally covered by the New Orleans, Lake Charles, and Jackson offices, respectively. During Hurricane Rita, the NWS implemented backup operations for the Lake Charles, Louisiana WFO when the office lost its communications just after landfall. The backup service was provided by the WFO in Houston, Texas.

Q4. In your testimony you mentioned that at the end of each hurricane season NOAA leads a "hot wash" to review all of its hurricane procedures with emergency managers and weather forecasters. Please provide the following information about the annual hot wash:

Q4a. Who from Federal, State, and local government agencies participates in the annual hot wash? Who from the private sector participates? Do you solicit input and/or participation from non-governmental organizations and the public?

Q4b. What is the process for selecting participants?

Q4c. What is the process for reviewing and prioritizing recommendations that result from the hot wash?

Q4d. What is the process for providing resources, if needed, for implementing priority recommendations?

Q4e. What "hot wash" recommendations were made in the last three years? Which of these recommendations have been implemented and which have not been implemented? If applicable, please explain why recommendations were not implemented.

A4a,b,c,d,e. Answer: The "hot wash" (a colloquialism for a series of agency-directed reviews) is a review and analysis of the past hurricane season and occurs on many levels. The first is an internal NOAA examination of operations and procedures to see what went well and where improvements could be made. The second is the Interdepartmental Hurricane Conference, an internal Federal Government review, which includes NOAA, the Department of Defense, the Federal Emergency Management Agency, NASA, the National Science Foundation, and others. And finally, a National Hurricane Conference is conducted which includes all levels of government, as well as emergency managers, private sector meteorologists, and media representatives. Participation in the National Hurricane Conference is open to everyone. Local Weather Forecast Offices also conduct more informal analyses of hurricane operations and work with their local emergency management counterparts to identify best practices and where improvements in the overall hurricane program can be made.

Attached are summaries of the recommendations from the NOAA review and the Federal Government review for the past three years (included as Appendix 1 and 2, respectively). It is a high priority for NOAA and the NWS to implement as many of the recommendations as possible for the next hurricane season using existing resources and follow normal funding request procedures if necessary.

Q5. Is the ability to forecast marine wave height and wind speed important for predicting storm surge and inland flooding? If so, please explain why. What are the current capabilities of NOAA to forecast marine wave height and wind speed? Does NOAA require additional observational equipment to improve wave forecasts?

A5. Storm surge predictions are based on the size of the storm, the strength of the winds and the bathymetry of the ocean. Predicting the size and strength of the storm remains most critical to storm surge prediction. Winds push water ahead of the storm, causing the water level to rise along the shoreline. The stronger the wind and the larger the wind field, the larger the storm surge will be. Waves are also driven by surface wind speed. NOAA's operational numerical computer wave model (WAVEWATCH) provides predictions of wave height for NOAA forecasters to use as they prepare storm surge forecasts. Wave predictions from the WAVEWATCH model at 24 hours are accurate to within about 1¼ feet during the summer and about 2½ feet on average during the stormy winter months. The WAVEWATCH model will eventually be coupled to the Hurricane Weather Research and Forecasting Model to provide an advanced storm surge model. Battering coastal waves also push water up along the coastline. In fact, the battering waves that were on top of the storm surge were responsible for the extensive damage along North Carolina during Isabel and the catastrophic damage along the Northern Gulf of Mexico coastline during Katrina. $2.5M was provided in the FY 2006 hurricane supplemental to accelerate storm surge forecasting, which includes improvements to the Sea Lake and Overland Surges from Hurricanes (SLOSH) model.

Additional observations, such as those planned under the Global Environmental Observation System of Systems (GEOSS), will help improve model predictions. NOAA is working with the National Aeronautics and Space Administration to develop new observing technologies, such as a scanning radar altimeter. When flown on the NOAA P–3 aircraft, this new technology can provide valuable information as was demonstrated during Hurricane Rita. Data from the instrument were used to help measure significant wave height and transmit that information directly the National Hurricane Center.

Inland flooding associated with hurricanes is generally due to freshwater flooding from hurricane-related rainfall, not wind driven storm surge or waves. With funding provided in the FY 2006 hurricane supplemental ($2.5M), we are accelerating the development of new localized flood-forecast products and services for hurricane-prone states.

Q6. What is the status of all marine buoys in the Caribbean and Gulf of Mexico? According to an article in the Miami Herald *on October 9, 2005, the National Hurricane Center needs 13 additional marine buoys ($250,000/buoy) to improve its hurricane forecasts. Why has NOAA not requested funding for additional buoys?*

A6. All of the marine buoys in the Caribbean and Gulf of Mexico are operational. NOAA used funding from the *Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act, 2005* (P.L. 108–324) to deploy seven buoys in the Gulf of Mexico, Caribbean Sea and Atlantic Ocean. These buoys provided critical data to help forecasters accurately track and predict the intensity and path of hurricanes during the 2005 hurricane season. With incorporation of the eight buoys provided in the FY 2006 hurricane supplemental, NOAA believes the current configuration is adequate. Additional observations, are also being planned under the Global Earth Observation System of Systems (GEOSS) to further improve predictions.

Q7. According to an article in the Miami Herald *on October 9, 2005, older dropwindsondes fail at least half the time in strong winds but it would only cost $1 million to fully upgrade to newer, more resilient dropwindsondes. What are the failure rates for old and new dropwindsondes in high winds? When will NOAA's old supply of dropwindsondes be depleted such that the agency will only rely on newer dropwindsondes? If NOAA has known that it would only take $1 million to upgrade the dropwindsondes, why didn't NOAA fix this problem sooner?*

A7. Failure of older dropsondes in high winds occurs primarily in the very lowest level winds (about 500 feet altitude), when wind speeds exceeded 100–112 miles per hour. NOAA worked with the National Center for Atmospheric Research and the Air Force Reserve Command to test an updated dropsonde in 2004 that performed more reliably in these high wind situations. These new dropsondes were mass produced by the primary vendor (Vaisala) and used for most of the 2005 hurricane season. Preliminary indications are that the new dropsondes performed in 2005 as well as they did in the tests in 2004, with no failures reported in high winds. However, we are still evaluating their performance to ascertain whether these new dropsondes have any limitations of their own. NOAA has only 220 of the older dropsondes in stock which will be used before the next hurricane season.

Q8. For the past five years, what is the annual number of Doppler radar failures due to lightning strikes? Where did these failures occur geographically? What is the justification for not pursuing the $3.5 million fiber optic solution for protecting Doppler radars from lightning strikes? What lightning protection projects has NOAA completed or is NOAA planning to complete in lieu of the fiber optic solution? What has been or is predicted to be the cost of those projects?

A8. On average, 25 of 158 operational WSR–88D radar systems have been damaged, apparently due to lightning strikes, annually during the last five years (17 in 2005; 33 in 2004; 27 in 2003; 34 in 2002; and 12 in 2001). Radars in all areas of the contiguous United States have received lightning damage; this type of damage is not any more or less prevalent in any one geographical location. Radar towers are usually the tallest structure in the local area, making them a likely target for lightning strikes. NOAA operated WSR–88D radars have an operational availability of 99.1 percent. The average time to repair a radar is about 6.5 hours.

Recognizing early in the program that radars are susceptible to lightning strikes, NOAA/NWS took aggressive action to make the radars more robust. We focused on actions that would have the most immediate and largest payback. NOAA/NWS has completed several lightning mitigating projects as part of sustaining engineering and retrofit actions:

(1) Stocking lightning sensitive spare parts at field sites and in a "lightning kit" maintained at our logistics centers, to reduce radar down time due to awaiting parts delivery.

(2) A retrofit of the grounding grid at radar sites in 1993–1998 ($1.9 million) greatly reduced lightning susceptibility and reduced the number of lightning-damaged radar parts by an estimated 50 percent.

(3) Surge protection devices were added to the radar shelters in three different projects ($732,000).

(4) Replacement of aging copper communication lines with fiber optic communication lines which are less susceptible to lightning damage/interruption in 2004–2005 ($1.6 million).

(5) Preventative maintenance inspections have been refined to mitigate lightning impacts.

(6) Depot-level engineering visits to the occasional sites that appear to have an unusual susceptibility to lightning have corrected a number of small issues and subsequently reduced the occurrences of lightning induced damage. A

visit of this type was conducted at the Miami WSR–88D last year after we noticed an anomalously high number of lightning failures. Since the engineering team visit, there have been no lightning failures.

(7) Transition power maintenance systems were installed in 1998–2003 ($45.3 million). These systems enable the "ride through" of commercial power outages until engine generator power becomes available and they condition the commercial power to eliminate "spikes" due to nearby lightning strikes. These features reduce the likelihood of lightning induced radar damage.

(8) A National Severe Storm Laboratory study in 2000 showed the current radome lightning rod configuration is the most effective design.

These initiatives have been very effective and made the radars more resilient under lightning conditions. It is important to note that it is not possible to make the radars lightning proof against a direct strike. However, we are taking all steps necessary to mitigate the effects of lightning. On those occasions when radars fail due to a direct lightning strike, the adjacent radars are positioned to provide backup coverage.

Q9. Please provide a funding history, including number of full-time employees, for the Hurricane Research Division for the past twenty years.

A9. The first table below summarizes the funding history of the Hurricane Research Division for the past twenty years. Non-base support includes other NOAA support received through funded proposals to Hurricane Research Division scientists through projects such as the Joint Hurricane Testbed. Non-base support also includes extramural support from other federal agencies, including the National Aeronautics and Space Administration and the Federal Emergency Management Agency. The second table summarizes Hurricane Research Division staff history broken into FTEs and cooperative institute (CI)/contract personnel.

Year	Base ($M)	Non-base ($M)	Total ($M)
1985	2.63	0.28	2.91
1986	2.63	0.28	2.91
1987	2.63	0.28	2.91
1988	2.63	0.28	2.91
1989	2.63	0.28	2.91
1990	2.63	0.35	2.98
1991	2.63	0.31	2.94
1992	2.63	0.38	3.01
1993	2.63	0.68	3.31
1994	2.63	0.88	3.51
1995	2.63	1.58	4.21
1996	2.63	0.81	3.44
1997	2.63	0.73	3.36
1998	2.63	0.81	3.44
1999	2.63	0.82	3.45
2000	2.63	1.30	3.93
2001	2.47	1.34	3.81
2002	2.82	1.71	4.53
2003	2.84	1.55	4.39
2004	2.95	1.56	4.51
2005	3.03	2.05	5.08

Year	HRD FTE	CI/contract	total HRD staff
1985	NA	NA	NA
1986	NA	NA	NA
1987	NA	NA	NA
1988	NA	NA	NA
1989	NA	NA	NA
1990	32	11	43
1991	34	10	44
1992	31	11	42
1993	30	12	42
1994	32	12	44
1995	30	12	42
1996	31	12	43
1997	32	11	43
1998	30	11	41
1999	30	11	41
2000	27	10	37
2001	26	10	36
2002	25	10	35
2003	26	10	36
2004	25	10	35
2005	23	12	35

NOAA conducts hurricane research not only at HRD, but also at its Geophysical Fluid Dynamics Laboratory and Environmental Modeling Center. Through its hurricane research program, NOAA develops new technologies for observing hurricanes, further improves its models for predicting hurricane track and intensity, and provides critical assistance to forecasters at the National Hurricane Center. All together, these efforts resulted in the vast track improvements over the past 20 years.

Q10. According to an article in the Miami Herald *on October 10, 2005, Hurricane Research Division scientists use sensors called Airborne Expendable Bathythermographs to measure the temperature of the ocean down to 1,000 feet. But, researchers can't get the data to forecasters because they need to develop software to use the data (estimated software cost is $200,000). Is this characterization accurate, and if so, why has NOAA not provided the funding for the software development?*

A10. The October 10, 2005 *Miami Herald* article is correct per se, in that software needs to be developed to get the data to forecasters; however the article is inaccurate in its implication that NOAA has neglected to fund software development as there is no current operational requirement for the observations/data from the ocean probes. The ocean probes used were acquired from the Navy surplus by the Hurricane Research Division (HRD) for use in research missions. The HRD maintains software to process and quality-control these data for research purposes. After these data are collected and processed for quality control, they are sent to NOAA's operational modeling center to determine utility of the data.

Q11. When does NOAA plan to completely upgrade all 102 stations in the weather balloon observation network? What is the failure rate for weather balloons and what could be done to reduce the failure rate?

A11. NOAA oversees 102 upper air stations in the United States and throughout the Caribbean. Our FY 2006 operating plan supports the upgrade of 78 of those sites, which are scheduled to be upgraded by the end of Fiscal Year 2010.

During the period of October 2004 through October 2005, 98 percent of launches have reached the minimum successful height of 400 hecto Pascals* (standard is 90 percent), and 66 percent of launches have reached 10 hecto Pascals* (standard is 60 percent). The system is meeting the NWS performance requirements. (*Hecto Pascals is a standard of pressure measurement used by the National Weather Service. At 10 hecto Pascals, the balloon is at a height of approximately 100,000 feet.)

Q12. NOAA has acknowledged that some hurricane research software still runs on old computers because the software has not been converted to run on newer machines. Are there plans to update the software to run on newer computers? If so, when will that update be completed? If not, why not?

A12. The Hurricane Research Division manages a 4–5 year information technology (IT) strategy to upgrade and replace all IT equipment in order to meet NOAA's IT security requirements. NOAA completed the third year of this strategy in 2005 and we have replaced or upgraded our complete network infrastructure, most of our servers, and 67 percent of our desktop computers. Our strategy calls for completion of the server and desktop upgrades in 2006, and completing the software update in 2007. All of our processing software runs on our recently upgraded UNIX servers, and we currently are upgrading some of the software that will run on the aircraft to process and quality control observations in real time to run under LINUX (Aircraft Operations Center's preferred operating system). Last year, the Aircraft Operations Center provided a LINUX server for HRD to use and we are purchasing a new LINUX server this year to accommodate this transition. NOAA is working to streamline and upgrade the SATCOM data transfer from the aircraft to the ground as part of our strategy to provide more data from the aircraft to our operational partners. As part of this upgrade we are working to define requirements for data transfer and quality control of the data to ensure the IT infrastructure on the aircraft meet all NOAA's needs.

Questions submitted by the Minority

Q1. For Hurricane Katrina, the weather forecasting offices that were in the main path of the hurricane were the New Orleans forecast office in Slidell, LA; the Mobile forecast office in Mobile, AL; Jackson, MS; and Lake Charles, LA. For Hurricane Rita, Houston, TX and Lake Charles, LA were in the main path of the storm.

According to NOAA's daily Incident Coordination Center reports for Katrina, at least four other local offices were at-the-ready or engaged to provide backup for these offices—Shreveport, LA; Huntsville, AL; Houston, TX; and Tallahassee, FL. For Rita, it appeared to be the Fort Worth, TX WFO acting as the backup office.

The Southern Region Headquarters also provided additional personnel to the local forecast offices, the State emergency operations centers, and coordinated the backup plan and response for the offices in the hurricane path.

It appears NWS met its goal of maintaining continuity of weather forecasting capabilities overall for the affected areas during these hurricanes even as some of the local offices were experiencing communication and other equipment failure problems. It appears NWS had a good internal preparation and response plan.

What is your assessment of the performance of the NWS internal preparation and response plan for these storms? What changes, if any, are you considering to further improve the procedures for maintaining continuous NWS forecasting capabilities during hurricanes? What is the current status of the impacted NOAA offices and equipment damaged by these two storms?

A1. The National Weather Service (NWS) plans for continuity of forecast and warning operations worked well during Hurricane Katrina. Our procedures worked well but we are working to address some technical issues, such as phone line failures, to make these systems even more robust during natural disasters.

The National Data Buoy Center (NWS), the National Coastal Data Development Center (NESDIS), and the National Marine Fisheries Service (NMFS) laboratory located at John C. Stennis Space Center in Bay St. Louis, MS, sustained damage. The NWS Weather Forecast Office (WFO) in Slidell, LA, was constructed to be able to withstand a Category 3 hurricane (with an internal room able to withstand a Category 5), and sustained minimal damage from the storm. Power and communications were quickly restored to the facility. NWS WFOs in Mobile, Lake Charles, and Houston provided backup forecast and warning services while communications were compromised.

Additional NOAA facilities/equipment which sustained damages include the NMFS lab in Pascagoula, MS, and the Office of Marine and Aviation Operations (OMAO) port office and warehouse, personal offices co-located at Halter Marine, and the NOAA ship, OREGON 11, all located in Pascagoula. Also, two NOAA lab facilities in Miami, FL, sustained damage and two National Water Level Observation Network (NWLON) stations are being replaced.

Ten NWS Automated Surface Observing Systems (ASOS) were impacted by Katrina, mainly by loss of communications or power. Two systems were destroyed; two systems sustained damage and continue to have intermittent communications and power problems. The Doppler radar at Slidell remained operational throughout the storm. Once communication was restored, data were available to all users. Five buoys and four Coastal Marine Automated Network (C–MAN) stations were damaged or destroyed by the two storms. The buoys and one of the C–MAN stations have been repaired. The offshore platforms containing the other three C–MAN stations were demolished, and will be repaired. The FY 2006 Hurricane Katrina Supplemental provides funding to repair or replace the ASOS and C–MAN stations that remain down. We are currently awaiting local infrastructure restoration (restoration of commercial power and communications to the area) before we can address these repairs.

Q2. How does the declaration of an Incident of National Significance by the Secretary of the Department of Homeland Security (DHS) change the operations of the National Weather Service with respect to regional forecasting, participation in HLT conference calls, local forecasting or the other standard operations of NWS for a hurricane?

How does the flow of information between NOAA and the Homeland Security Operations Center (HSOC) at DHS change if an Incident of National Significance is declared for a hurricane?

A2. The operations of National Weather Service (NWS) units do not change when an Incident of National Significance is declared. Our operation procedures are designed to "automatically" include incident escalation. NOAA/NWS responds to similar situations whenever a thunderstorm becomes severe or produces a tornado, or when a strong winter storm develops. To keep up with the latest information, the NOAA Watch Desk at the Homeland Security Operations Center (HSOC) coordinates closely with the NOAA Incident Coordination Center (NOAA ICC) or the ap-

propriate NWS Regional Operations Center. Important products such as watches, warnings and advisories especially for significant meteorological events such as tornadoes, flash floods, and blizzards—are automatically routed directly from the main NWS communications center, the NWS Telecommunication Gateway, and transmitted via e-mail to the NOAA Watch Desk. Additionally, for a selected group of these products, such as tornado warnings, flash flood warnings, hurricane forecasts and statements, information is sent directly to the Department of Homeland Security Senior Watch Officer in the HSOC.

Q3. The Slidell office managed to get a flash flood message out about the levee breach in New Orleans at 8:14 am Central Daylight Time the morning Hurricane Katrina made landfall. The office lost its communication capability a short time later.

The top of the Bulletin has a line that reads: EAS Activation Requested. What action does that request set into motion?

What systems would transmit this message and who would receive a flash flood message of this type (e.g., the Emergency Operations Center in Baton Rouge; the Region VI FEMA office; NWS Southern Regional Headquarters)? Please trace the path of this message.

A3. Transmitting the message "EAS Activation Requested" initiates the Emergency Alert System. The Emergency Alert System (EAS) is designed to provide the President with a means to address the American people in the event of a national emergency. Through the EAS, the President would have access to thousands of broadcast stations, cable systems, and participating satellite programmers to transmit a message to the public. The EAS and its predecessors, CONELRAD and the Emergency Broadcast System (EBS), have never been activated for this purpose. But beginning in 1963, the President permitted State and local level emergency information to be transmitted using the EBS (now EAS).

Once activated, the EAS, depending on the message, generates tone alerts on radio stations, crawls or programming interruptions for television broadcasts, and immediate retransmissions by "intermediaries" (e.g., private weather companies, television stations, web-based organizations, etc.) to cell phones, e-mail messages, Internet notifications, etc. The message is also immediately broadcast on NOAA Weather Radio All Hazards (NWR). State Emergency Operations Centers are equipped to receive these warning messages through various methods, including NWR, Internet, Emergency Managers Information Network (EMIN), and NOAA Weather Wire Service (NWWS). NOAA's responsibility is complete once the message is transmitted; we do not verify receipt of transmission.

The flash flood warning message was transmitted by the Slidell Weather Forecast Office and routed immediately onto NOAA Weather Radio. From there, the Emergency Alert System was activated, with the message and EAS activation request reaching media within seconds. The message was also transmitted through all other NWS dissemination systems, including NOAA Weather Wire Service (NWWS), Emergency Managers Weather Information Network (EMIN), NOAAPORT, Internet, Family of Services, and others.

Questions submitted by Representative Eddie Bernice Johnson

Q1. What role does NOAA play in providing information to the Army Corps of Engineers regarding the potential and magnitude of flooding and storm surge that would factor into setting construction standards for the New Orleans levee system? How often is this information updated?

A1. NOAA's National Weather Service (NWS) runs the SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model in simulation studies to estimate potential hurricane storm surge flooding. This work is done as part of comprehensive hurricane evacuation planning. Data from these model simulation studies are used, in addition to other relevant information, to develop evacuation plans. NOAA/NWS also runs the SLOSH model for post-storm analysis, using the exact track of the storm, to help assess storm impacts.

The U.S. Army Corps of Engineers (USACE) and FEMA are the primary Federal agencies providing funding for these SLOSH simulation studies. NOAA is responsible for running the simulations. The Atlantic and Gulf coastlines of the United States, from Texas to Maine, can be divided into 41 geographic regions, or basins. SLOSH updates are generated for each of the 41 basins, including the New Orleans area, according to a list of priorities established by the Interagency Coordinating Committee on Hurricanes (ICCOH), of which the USACE, FEMA, and NOAA are

members. The ICCOH determines when the SLOSH model studies are updated, and makes the request to NOAA. These NOAA simulations are used primarily for evacuation studies and planning. NOAA conducted SLOSH model simulation studies for the New Orleans area in 1989, 1994, and 2002. These studies are not done on a scheduled basis, but when levee data or upgrades to the storm surge model physics warrant, and as resources permit. SLOSH is used primarily by the USACE to support evacuation studies and emergency response activities.

For engineering studies and flood protection structure design the USACE uses NOAA wind fields and other storm meteorological data as well as bathymetric map products to drive high resolution storm surge and wave models.

At the request of the U.S. Army Corps of Engineers, NOAA's Office of Oceanic and Atmospheric Research provides post-storm analysis of wind fields to assist USACE post-storm analysis of storm surge modeling and impact.

Appendix I

Federal Interdepartmental Hurricane Conference (IHC) Recommendations

57th IHC ACTION ITEMS (2002)

Recommendation: Amend NHOP to carry Internet address. **Implemented.**

Recommendation: Amend NHOP to reflect changes in tropical cyclone breakpoints. **Implemented.**

Recommendation: Amend NHOP Appendices H and I when information is received from NOAA/NWS. **Implemented.**

Recommendation: Amend appropriate sections of NHOP to reflect forecasts extended to five days. **Implemented.**

Recommendation: Delete section A.1.7 of the NHOP. **Implemented.**

Recommendation: Add to Appendix L—Glossary section of NHOP. **Implemented.**

Recommendation: NOAA/NWS will provide OFCM further details. Add product to appropriate section of NHOP. **Implemented.**

Recommendation: The name Isidore be retired and suggest replacement names Irving, Icaro, or Ike. Recommend the name Lili be retired and suggest replacement names Lucy, Laura, or Lisette. Recommend the name Kenna be retired and suggest replacement names Karina, Katherin, or Kayla. IHC to forward suggestions to the RA–IV Hurricane Committee. **Implemented.**

Recommendation: Update NHOP to reflect changes by AFWA. **Implemented.**

Recommendation: Amend NHOP to reflect changes from 53 WRS. **Implemented.**

58th IHC ACTION ITEMS (2003)

Recommendation: Amend the NHOP to add the GPS dropwindsonde splash time to the TEMP DROP 62626 section. **Implemented.**

Recommendation: Amend NHOP for deployment of drifting buoys. **Implemented.**

Recommendation: Amend NHOP to reflect replacement names for retired storm names Fabian, Isabel, Juan and Lili. **Implemented.**

Recommendation: Ask the Navy to run the GFDN at 0, 6, 12, and 18Z out to 126 hours. **Implemented—**FNMOC will increase the run frequency and extend the forecast period of the GFDN, resources permitting.

Recommendation: Amend the 2004 NHOP to include approved recommended changes from 53 WRS. **Implemented.**

59th IHC ACTION ITEMS (2004)

Recommendation: Have at least one of the two P–3s operationally configured and available to respond within 24 hours to reconnaissance taskings from 1 June through 30 November. The minimum operational configuration for the P–3 includes the SFMR and the Airborne Vertical Atmosphere Profiling System. Modify the 2005 National Hurricane Operations Plan accordingly. **Implemented.**

Recommendation: Retire storm names Charley, Frances, Ivan, and Jeanne. **Implemented.**

Recommendation: Ask SAB to continue to provide Dvorak satellite classifications for tropical weather systems in the Atlantic, eastern and central north Pacific basins. **Implemented**

Recommendation: Correct NHOP. **Implemented.**

Recommendation: Make the appropriate changes to NHOP section 5.5.4 to allow the NRL P–3 to operate jointly with the other aircraft in the effected airspace. **Implemented.**

Recommendation: Revise the Memorandum of Agreement (MOA) in the NHOP Appendix F, as needed, to reflect changes in agency contacts and approving officials for 2005. **Implemented.**

Recommendation: Update NHOP Table 6–2 and Appendices I and K. **Implemented.**

Recommendation: During the 2005 Atlantic Hurricane Season, UBLOX dropsondes are to be used in the eyewall of intense (Cat. 3–5) hurricanes and in drop locations adjacent to land on any reconnaissance or surveillance flights. GPS121 dropsondes should be used elsewhere to deplete the current inventory of these sondes before becoming obsolete. **Adopted—**Coordination is ongoing between TPC/HRD/AOC/53 WRS.

Recommendation: The OFCM should facilitate the identification of engineering support necessary design, testing and replacement of components of the GPS dropsonde. **Action—**The OFCM will facilitate the development of an implementation strategy to pursue the development and procurement of the next-generation dropwindsonde.

OPEN ACTION ITEM (from 56th IHC)

Recommendation: Amend Section 3.3 of the NHOP to reflect designation of tropical and subtropical cyclones. **Implemented.**

Appendix 2

NOAA 2003 Hurricane Conference Action Items

Recommendation: Add the GPS dropwindsonde splash time to the TEMP DROP 62626 section. **Implemented.**

Recommendation: Identify simplest mechanisms to get P–3 the data to the GTS. **Implemented.**

Recommendation: Attendees to make decisions regarding Tropical Cyclone Wind Team for: what type of 34-, 50-, and 64-kt wind distribution should be represented *for tropical depressions, tropical storms, and hurricanes;* whether a wind team is needed, and whether the team charter should be continued and why. **Implemented.**

Recommendation: Include three- to five-day tropical cyclone information in the Offshore Waters Forecasts. **Implemented.**

Recommendation: NWS grids need to be consistent between coastal WFOs and OPC. **Implemented.**

Recommendation: WFOs need to ensure consistent information when re-issuing NHC products. **Implemented.**

Recommendation: Rerun the SLOSH model "MOMs" using larger storm wind fields, farther west tracks, climatologically curved tracks, and for time periods that extend well beyond the storm center's passage. **Implemented.**

Recommendation: Redo the PC SLOSH version of the Chesapeake Basin used by WFOs with these modifications. **Implemented.**

Recommendation: Make storm specific SLOSH output available to the field offices 24 hours prior to landfall. Output from several runs with tracks both to the left and right of the official forecast track, and perhaps of different categories, would be valuable. **Implemented.**

Recommendation: Allow WFOs to run storm specific surge models locally. **Not Implemented—**Computer resources not available locally, and differing solutions could hamper preparedness actions.

Recommendation: Work in partnership with the academic sector to develop a more sophisticated storm surge model. **Implemented.**

Recommendation: Work in partnership with the academic sector to develop probabilistic methods of displaying storm surge forecasts. **Implemented.**

Recommendation: Work in partnership with the academic sector to develop high resolution storm surge inundation mapping. **Implemented.**

Recommendation: When forecasting positions over land, decay the winds according to model guidance. **Implemented.**

Recommendation: Reword Section 6.1.1 of NWSI 10–601 to clarify requirements of offices designated as "inland" by regions, for issuing and updating NPWs for Inland Tropical Storm/Hurricane Watch/Warnings. **Implemented.**

Recommendation: An automated solution needs to be found so all approved break points are handled by the NHC software and so in the future, it correctly plots watches and warnings affecting the Chesapeake Bay area on the NHC Web site. **Implemented.**

Recommendation: Develop a method for allowing local offices to correct erroneous tropical issuances, bearing in mind this includes web based products. **Will be Implemented—**Awaiting AWIPS software build to establish a national standard map and removal process by product cancellation.

Recommendation: NWS internet software should use FFA to paint flood watch maps and NPW to correctly plot wind warnings/advisories during tropical weather. A product should be developed to correctly plot tropical weather flags. This would also solve the problem of automated NOAA Weather Radio dissemination. **Implemented, with modifications to use other products at this time.**

Recommendation: Could TPC issue a product that would include the coastal county codes within the TC Watch and/or Warning areas, as well as a simple line of text detailing the breakpoints of the watch/warning area? This product could then be

sent over AWIPS and used by the appropriate WFOs to send to their CRS broadcast. **Will be Implemented in a future AWIPS software load.**

Recommendation: Make surface data received at NHC from mobile platforms available to the coastal WFOs through AWIPS. **Implemented to the degree possible—**Supplemental/experimental wind information data from non-NOAA sources will be accessible via the Internet, when possible.

Recommendation: Using input from TAFB, OPC and local WFOs, NHC advisories should include a statement advising not just "marine" interests, but the public, to be alert for dangerous surf conditions including rip currents. **Implemented.**

Recommendation: Once TPC commits to beginning an advisory package for a new system, a DSA should always be issued to inform all users. **Implemented.**

Recommendation: TPC should be more diligent to place additive information below the $$. NWR automation software could also be modified to search for key words and remove such from being broadcast. NHC will make all efforts to place product ID information regarding on-going storms at the bottom of the TWO. **Implemented.**

Recommendation: Determine if a national model/standardized gHLS format/software should be developed for use by all WFOs. If yes, work towards developing the national model/standard. A team approach might be most effective to move this initiative along. **Not Implemented—**A national implementation of a gHLS or some form of graphical hurricane hazard representation will not take place for the 2004 season. OS21 talking with regions about forming a team to look at implementation of some form of graphical hurricane hazard product in 2005. Update of this team will be made at the 2004 Hurricane Conference.

Recommendation: Initiating and receiving agencies should coordinate in the formulation of best-track positions to avoid discontinuities or discrepancies near the point of transfer. **Implemented.**

Recommendation: Expand TCU and TCE product header information to associate these products with the particular tropical cyclone they describe. Introduce MIATCUATx, MIATCEATx, MIATCUEPx, MIATCEEPx, where x varies from 1–5 along with the associated tropical cyclone. **Implemented.**

Recommendation: TPC and WFOs will complete their coordination on the list of secondary breakpoints. When complete for a given year, TPC will post the list on its web page in a manner similar to the standard breakpoints. TPC will coordinate with OCWWS, NCO, and FSL to develop a scheme for communicating via the WWA product breakpoint information (e.g., county and lat/lon) for any site not on the standard and secondary list. **Implemented.**

Recommendation: Change wording in last sentence of NWSI 10–601, 7.5 to "The appropriate regions will ensure Tropical Cyclone Center(s) obtain significant information (e.g., deaths and damages) from WFOs not preparing formal post-storm reports." WFOs should clearly label those reports which are unofficial in the PSH, Internet and other information source outlets. **Implemented.**

Recommendation: Delete the definitions of "advisory" and "hurricane local statement" from NWSI 10–604. **Implemented.**

Recommendation: For a well forecasted storm, such as Isabel, it would appear the New York City OEM would usually be best served if the storm that is handled in a non-tropical fashion during the watch phase continued to be handled in a non-tropical fashion during its warning stage. Similarly, tropical issuances should generally follow in the warning phase, if initially introduced during the watch stage. However, all things considered, the New York City OEM would generally opt for tropical versus non-tropical issuances if the situation is a "toss-up." **Implemented.**

Recommendation: There needs to be a standard operating procedure to address medium range tropical cyclone forecasting. **Implemented.**

Recommendation: Clarify the standard for handing off a tropical cyclone from the TPC to the HPC. **Implemented.**

Recommendation: Change the National Hurricane Operations Plan (NHOP) regarding deployment of drifting buoys. **Implemented.**

Recommendation: Initiate an annual Hurricane Liaison Team (HLT) review of the past season's "lessons learned" and implement suggested "best practices" prior to the beginning of the tropical season. **Implemented.**

Recommendation: Develop a comprehensive package of geographical locations, pronunciations and tropical related impacts pertinent to each coastal WFO. Provide the package to the detailed HLT prior to arrival at NHC. **Not Implemented—**Eastern and Southern Regions will provide WFOs and RFCs with templates for developing standardized information guides, to include tropical-related impacts and geographical pronunciations. Regions will complete guides prior to beginning of 2006 season with the final guides available to TPC/NHC for HLT activations.

Recommendation: Fabian, Isabel and Juan will be retired. Replacement names to be decided at WMO RA–IV meeting. **Implemented.**

Recommendation: The Navy run the GFDN at 0, 6, 12, and 18Z out to 126 hours. Forward to IHC. **Implemented.**

NOAA 2004 Hurricane Conference Action Items

Recommendation: Change NWSI 10–601 to establish a "Hurricane Eye-wall Warning" product with unique PIL and EAS code to be issued by WFOs for landfalling tropical cyclones with distinct eye-wall and inner rainband features with destructive winds. **Implemented.**

Recommendation: To increase the visibility of the inland hurricane (wind) hazard, create a new PIL (IHW?) for Inland Hurricane (Wind) Watches/Warnings to elevate/distinguish the watch/warning from the more universal non-precipitation weather (NPW) PIL. **Not Implemented—**Existing products must be more effectively used to communicate the potential threats.

Recommendation: To better align terminology between the coastal and inland watches/warnings, change the name for the (WFO issued) interior watch/warning to "Inland Tropical Storm/Hurricane Watch/Wanting." **Implemented.**

Recommendation: Regions will identify WFOs exempt from the requirement of section 7.3.3.3 of NWSI 10–601. **Implemented.**

Recommendation: To better align NHC and WFO product issuance times, change watch/warning criteria in NWSI section 7.3.2.2. to read: A watch is valid up to 48 hours after the issuance time. The valid time (event start and end times) is described in the watch headline. A warning is valid up to 36 hours after issuance time. The valid time (event start and end times) is described in the warning headline. **Implemented.**

Recommendation: To help direct customers to NWS WFO products that emphasize tropical storm hurricane impacts over non-coastal areas, NHC should include a general reference within the TCP product of wind impacts occurring, or projected to occur, along coastal and inland areas. **Implemented.**

Recommendation: Inland offices may issue HLS-type products using the HLS when tropical cyclone conditions are expected within part or all of the CWA. **Implemented.**

Recommendation: Reinstate language in 10–601 Section 7.1.2.2 to allow WFOs to issue HLSs as needed to dispel rumors or to clarify tropical cyclone related information for their CWA. **Implemented.**

Recommendation: Restructure NWSI 10–601 to encourage WFOs to write single purpose HLSs, to emphasize a specific hazard which is imminent and/or will have a potentially life-threatening impact, or to describe a significant and critical change of short-term hazard impacts. **Implemented.**

Recommendation: All HLSs should include at least one headline. **Implemented.**

Recommendation: Allow WFOs the flexibility to issue Special Marine Warnings on an as needed basis during tropical storm/hurricane watches. **Implemented.**

Recommendation: Use the standard tropical storm symbol for subtropical storms on the NWS unified surface analysis. This will be consistent with warning headlines, which use the phrase ". . .Tropical Storm Warning. . ." for subtropical storms in OPC/TPC high seas forecasts. **Implemented.**

Recommendation: Decide method to provide required information in header. **Implemented.**

Recommendation: OS21 will investigate requirements needed to expand the product bins for NHC numbered products from 5 to 10. We will keep JTWC in mind. **Not implemented—**Will be discussed at the 2005 NOAA Hurricane Conference.

Recommendation: At least one of the two P–3s will be operationally configured and available to respond within 24 hours to reconnaissance taskings from 1 June through 30 November. The minimum operational configuration for the P–3 includes the SFMR and the Airborne Vertical Atmosphere Profiling System. **Implemented.**

Recommendation: Decide on a consistent and appropriate way of indicating wind speeds for tropical cyclones in WFO text forecast products. **Implemented.**

Recommendation: TPC should stop producing the gridded TCM. If the current primary FSL hurricane wind tool does not work, the new generic cyclonic wind tool could be used as backup. **Implemented.**

Recommendation: Allow TPC/NHC to declare Critical Weather Events. **Implemented.**

Recommendation: TPC coordinate with DOD contacts to develop document. Forward to Interdepartmental Hurricane Conference. **Not implemented—**Recommendation withdrawn.

Recommendation: Meet with Executive members of the NHC Electronic Media Pool to assess the scope of costs and impact on local operations; explore means for resolving the problem in the public interest (convenience and necessity). Realign or redefine resources and rules of engagement, as necessary. **Implemented.**

Recommendation: Initiate a low-cost pilot project to demonstrate the feasibility of a local (WFO) level II data archive. The Melbourne, Miami, and San Juan offices will participate in the pilot project. TPC will coordinate among the participating offices and ROC. **Implemented.**

Recommendation: Retire 2004 storm names at the annual WMO RA–IV meeting. It is likely that Charley, Frances, Ivan, and Jeanne will be retired. **Implemented.**

Recommendation: SAB continue to provide Dvorak satellite classifications for tropical weather systems in the Atlantic, eastern and central north Pacific basins. **Implemented.**

Recommendation: Determine best method to use NHC radius of maximum winds in SPC tornado watches' "Mean Vector" line. **Implemented.**

Recommendation: Ensure revised NWS Hurricane Directives are annually available to the field by June 1st. **Implemented.**

Recommendation: Include a landfall point in the TCM product. Both Hurrevac and the TCM tool could be modified to incorporate this additional point and improve the transition between water based points/radii and land based points which have already taken land effects into account in their radii. **Not Implemented—**TPC/NHC agrees to provide guidance on landfall intensity during the Hurricane Hotline Coordination calls.

Recommendation: Reiterate the need to NWS headquarters for ASOS backup power to ensure no loss of data. **Implemented.**

Recommendation: Make a request to the observation branch of OCWWS to upgrade the structural integrity of ASOS system in hurricane-prone areas, making them more resistant to high winds. **Implemented.**

Recommendation: The need for a PSH in these circumstances should be based on a stated need by TPC for the data, and not an all inclusive directive which takes no notice of whether the data is actually needed or useful. **Implemented.**

Recommendation: Due to possible urgency implied in a Tropical Cyclone Update (TCU), it is requested that TPC, using the Hurricane Coordination Hotline, alert WFOs and other users that a TCU is about to be issued. **Implemented.**

Recommendation: Push SLOSH Rex files to WFOs via the AWIPS SBN. **Not Implemented—**Action forwarded to TPC communications specialists in the Technical Support Branch for comment and feasibility due to band width limitations of SBN.

Recommendation: Port the SLOSH software to the LINUX environment and implement it for operational runs on AWIPS. **Not Implemented—**A LINUX version of this program already exists, but it runs rather slowly. TPC will ask MDL (Will Shaffer's group) to work, as time and resources permit, to improve the efficiency of the LINUX SLOSH display software, with the intent to migrate eventually to

AWIPS. WFO Miami and TPC will investigate using an alternative data transmission mode via the AWIPS FTP server.

Recommendation: WFOs need clarification on the convention that NHC will use in the SLOSH runs to ensure appropriate interpretation of the product. **Implemented.**

Recommendation: Make operational a probabilistic storm surge model available to forecasters that can be relayed as information to customers farther in advance than the current approximate 12-hour practice. **Implemented.**

Recommendation: Make corrections to NHOP. **Implemented.**

2005 NOAA Hurricane Conference Action Items

Note: The 2005 NOAA Hurricane Conference occurred in December, 2005. The following recommendations came from that meeting and are being addressed.

Recommendation: Discuss pros and cons of issuing tropical storm/hurricane/typhoon warnings when conditions are expected over land, or along the coast. **Action—**Change wording of first paragraph to "along the coast." Make parallel changes in NHOP if necessary.

Recommendation: Update the directives to formally extend lead time of tropical cyclone watches to 48 or 60 hours. This will better support evacuation orders provided by local emergency management. **Action—**No action required.

Recommendation: Format the Repeat section of the Tropical Cyclone Public Advisory in the current paragraph form or a list. Whatever method is used, consistent formatting, words, dots, spaces is required. Add wind gusts. **Status—**open.

1. TPC will not add gusts in the public advisory.
2. OS will provide documentation/examples on "Repeat" section inconsistencies to TPC.
3. TPC will take steps to ensure the "Repeat" section is formatted consistently in the current narrative fashion.

Recommendation: Add storm identification numbers to the TCP. **Action—**Accept Recommendation for TCP. TPC will also add storm identification number to all TPC text products. A Public Information Statement will be disseminated.

Recommendation: In 10–601, stipulate the use of English and metric system measurements in the TCP. Recommend this include the storm direction in km/hr, maximum sustained winds in km/hr and extent of hurricane and tropical storm winds in km. **Action—**Section 1.1.3.3.a already specifies when TPC should use metric units in the public advisories. This section will be modified to delete the part about "except when the United States is the only country threatened."

Recommendation: Delete the breakpoint at Fort Walton Beach. **Action—**Accepted. Fort Walton Beach will be deleted as a primary breakpoint, but will be retained as a secondary breakpoint. Update NHOP.

Recommendation: Eliminate the Currituck Beach Light breakpoint, and replace it with Duck, NC. **Action—**Accepted. ERH will provide latitude and longitude of Duck breakpoint to OS21 and TPC. Update NHOP. Currituck Beach Light will be retained as a secondary breakpoint.

Recommendation: Suggest substituting Card Sound Road Bridge as a replacement break point. Card Sound Road Bridge is on the Miami-Dade/Monroe county line and is a very tall bridge, well known by anyone in our area. By having Card Sound Road Bridge, tropical cyclone watches and warnings can then specify the entire south coast (Florida Bay coast) of mainland South Florida in an appropriate manner (for example—East Cape Sable to Card Sound Road Bridge). **Action—**Florida City will be deleted as a primary breakpoint and will be retained as a secondary breakpoint. Card Sound Bridge will become a primary breakpoint. SRH will provide latitude and longitude of Card Sound Bridge to OS21 and TPC. Update NHOP.

Recommendation: Provide SLOSH output (MEOWs) for east moving storms in the Morehead City Basin. And include forward movements of 10 mph, 20 mph, and 30 mph as options available to choose from when selecting storm variables. **Action—**This action will be prioritized with ICCOH with respect to other basin restudies. When resources are available, NHC will work with MDL, WFO Morehead City, and

emergency managers to test the Recommendations and incorporate those that are critical in the next restudy of the Pamlico Basin.

Recommendation: Use zero (0) as the baseline water level during real-time SLOSH runs, which would then provide output that is "pure" surge, and can be more easily inserted into WFO products, and conveyed to the public. **Action—**TPC previously agreed to make the real-time SLOSH runs at a 0 ft base tide level for the U.S. East Coast. TPC accepts the Recommendation. Exceptions will be arranged by TPC and the affected WFOs based on coordination during the, event.

Recommendation: Provide training material for real-time SLOSH runs. Update SLOSH display manual to include clear explanation of tide datum used for real-time runs, MEOWs and MOMs. **Action—**A Call for forecaster attendance at the Train the Trainer course was provided to ERH and SRH in November 2005. Additionally, written training material and distance learning formats will be explored by the Warning Decision Training Branch for the Tropical Cyclone Operations Course. ERH will work with NHC and MDL concerning updates to the SLOSH display manual, to be approved by NHC and MDL.

Recommendation: Based upon the work and Recommendations by the Tropical Cyclone Extreme Wind Team, the conference needs to decide future actions. **Action—**For the 2006 season implement Phase II as follows:

- Add new VTEC Phenomenon Code EW,
- Develop template for WARNGEN ready by 2006 season,
- Change MND Product Type Line to Extreme Wind Warning,
- Ensure Standard Format of 1St Bullet by all WFOs,
- Use of the "Go to the lowest floor" Call to Action at WFO discretion,
- WFOs will follow guidance in Directive 10–601 section 7.2,
- Issue a Public Information Statement in early 2006,
- Make decision for experimental vice official product addressed by Headquarters, and
- Team to begin actions for Phase III.

Recommendation: Conference to decide the future direction the wind team should pursue or disband the team. **Action—**The Wind Team should continue into 2006 to address issues related to the usage of TPC's wind speed probabilities product in WFO products.

Recommendation: Modify the TCV to allow local input so the counties in question can be removed as conditions warrant. **Action—**The action was subsequently overtaken by the next item. All WFOs to review the existing "county translation table" and respond to Michelle Mainelli (TPC) by 1 February 2006 if any changes are needed for 2006.

Recommendation: Consideration should be given to use "Zone" codes versus "County" FIP codes in the TCV before it is even considered to make the TCV official. **Action—**For 2006 the TCV will use Zone codes instead of county codes, if the necessary software changes can be made. Regions will coordinate with their WFOs and provide TPC with a list of zone codes to include in the TCV by 1 February 2006.

Recommendation: Just as SPC issues watches for Severe Weather for adjacent coastal waters, NHC needs to, at minimum, issue guidance as to the appropriate Watches and/or Warnings that need to be taken concerning coastal waters. In this era of heightened awareness and coverage of Tropical events by the news media, a more structured approach is required. **STATUS:** Closed (see next item).

Recommendation: There needs to be clarification in either 10–601, granting specific area responsibility for warnings (by zone definition, not just breakpoint), or in 10–310, which would grant the WFO authority over tropical cyclone watches and warnings for coastal marine zones. Note that granting WFO authority over coastal marine zones within 20 nm may result in increased consultation with NHC, since there can be a serious perception issue when warnings from coastal marine zones and adjacent coastal land zones disagree. It is the opinion of this WFO that the warnings and watches between a coastal land zone and an adjacent coastal marine zone (within 20 nm) must agree. **Implemented—**WFOs have full responsibility for watches and warnings in their coastal waters, and will coordinate their issuance with TPC and adjacent WFOs. NWS 10–310 2.3.5 will be clarified to reflect this policy.

Recommendation: To preserve the existing policy in 10–310, there needs to be a choice to use the phrase Small Craft Should Remain in Port that holds the active Small Craft Advisory VTEC in a continuation until the tropical cyclone watch is upgraded to a warning. As a second less-preferred item, we can require that Small Craft Advisories be maintained if necessary (and headlines as such) until the tropical cyclone watch is upgraded (if necessary) to a warning. **Action—**Issue will be resolved through ongoing OS21 update of NWSI 10–310. Modify appropriate directives.

Recommendation: Seek agreement from OPC leading to OPC and TAFB products stating "Maximum significant wave height XX ft. Some individual waves much higher." Change marine directive as necessary. **Action—**For year-round High Seas Forecasts from OPC, TAFB, and WFO Honolulu, the following statement will be included in the synopsis portion: "Seas Given In Significant Wave Heights."

Recommendation: Allow WFO forecast grids to more closely match TCM grid output, even if it is in conflict with existing watches/warnings. **Implemented—**WFO grids should match TCM gridded output.

Recommendation: NHC should be more judicious about and less apt to issue watch/warning combinations. **Action—**None required. There will be occasions when a Tropical Cyclone Warning/Hurricane Watch combination is needed.

Recommendation:

1. Enlist the assistance of NHC/TPC and their associations with the engineering/academic communities to aid NYC OEM towards incorporating up-to-date information for residents of high rise buildings. This then needs to be incorporated into the official "hurricane plan" for NYC.
2. Address the "canyon effect" one would see down New York City main Avenues, which we haven't yet seen with a landfalling hurricane. Could this make a large difference in actual wind speed and ultimate destruction potential?
3. As a result of this, ascertain if each residential building in NYC should have its own "hurricane plan" detailing the safe zones in that building, (e.g., . . .from the 3rd to the 8th floor hallways) and have this information delivered to all tenants annually?

Action—WFO Upton will contact several organizations, such as the NOAA Air Resources Laboratory, who have technical expertise in this area.

Recommendation: HPC generated forecast maps through Day 6 should include remnants for tropical systems. **Implemented.**

Recommendation: Eliminate issuing separate products NPW/FFA except for short fused warnings for inland areas. **Action—**Members of this conference, led by David Manning, WFO Sterling, are tasked to write a short white paper that recommends consolidation of the current suite of WFO tropical cyclone products, including segmentation of the HLS, and submit to OS21 by 1 February 2006.

Recommendation: Delete forecasting wind gust from cyclones after they transition into an extra-tropical low. **Action—**OPC will check for user feedback before any changes are made.

Recommendation: Improve hurricane local statements for clear headers, place most important sections first, do not repeat the TCP advisory, omit sections not needed, do not use headline "updated Storm Information," and the HLS does not need to have all sections. **Will be Implemented** for 2006 Hurricane Season.

Recommendation: Make the HLS a segmented product in time for the 2006 season. **Action—**It is desired for HLSs to become segmented in 2006. WFOs have the option to produce single-segmented or multi-segmented HLS products. Eastern, Southern and Pacific Regions will work with selected WFOs to provide examples of both formats. Regions and WSH will seek customer input regarding segmented HLSs. Mark Tew, OS22, will work with software developers to ascertain the level of effort required for HLS segmentation, and provide a feasible implementation date as soon as possible.

Recommendation: Require that "New Information" be the initial header in all but the first HLS. **Action—**If used, "New Information" must be the initial section header in the HLS.

Recommendation: Allow the flexibility to shorten the HLS to include only the New Information header for life-threatening events within six hours of occurrence. **Action—Will be Implemented** for 2006 Hurricane Season.

Recommendation: Eliminate the requirement to include the entire CWA, for Florida counties, in an HLS that affects a small portion of the CWA. Recommendation from OS21: Rewrite in directive 10–601, section 7.1.2.2 to read (changes in italics):

7.1.2.2 *Issuance Criteria.* The following WFOs will issue HLSs when their area of responsibility is affected by a tropical cyclone watch/warning or evacuation orders. HLSs may also be issued as needed to dispel rumors or to clarify tropical cyclone related information for their CWA. Coastal WFOs have the option to include inland counties in the HLS. *WFOs also have the option to include or not include coastal and inland counties not affected by a tropical cyclone watch or warning.* **Action—** Change 7.1.2.2 to read: The following WFOs will issue HLSs when their zone areas of responsibility are affected by a tropical cyclone watch/warning or evacuation orders. HLSs may also be issued as needed to dispel rumors or to clarify tropical cyclone-related information for their CWA. Coastal WFOs have the option to include inland counties in the HLS. WFOs may exclude zones not affected by a tropical cyclone watch or warning.

Recommendation: Require impact statements for both NPW *and* HLS, based on life-threatening impacts of wind, surge, or inland flood. Emphasize *judicious* use for each case. For wind, the lower limit should be *sustained* Category 2 (96 mph or greater). Impacts for surge and inland flood may be locally defined. **Action—**WFOs will have the option to include strongly-worded impact statements in NPW and HLS products. Judicious use is recommended, commensurate with the threat, to ensure the continued effectiveness of such statements.

Recommendation: Make improving tropical related GHG formatters by next hurricane season a top priority. **Action—**Recommendation accepted. OS21 will forward to FSL. FSL to ensure function to capture text from previous HLS works correctly.

Recommendation: Tropical Storm/Hurricane Wind Impacts should be base lined as a Cal 1To Actions_Tropical_Overrides file in future IFPS builds. **Action—**Recommendation accepted. WFO Slidell will forward files to OS21. OS21 will forward to FSL.

Recommendation: Pursue an agency effort which builds upon the work undertaken at WFOs Miami and Melbourne to include enhanced wording within the ZFP and CWT text products as generated by the GFE formatter. **Action—**Accepted. Wind Team will coordinate the experimental use of probabilistic wind information in the 2006 season. Team will make final Recommendations for the ZFP, CWT, and PFM products.

Recommendation: Provide 'Hurricane Hotlines' for inland office commonly impacted by tropical systems. **Action—**SRH will submit a formal letter for these inland WFOs to OS21.

Recommendation: NWS directives need to better define areas which are included in NHC watches/warnings, and areas which are considered inland, thereby falling under the realm of inland tropical cyclone watches/warnings. **Action—**OS21 will form a team with representatives from Southern, Eastern and Pacific Regions, and TPC, to address this recommendation and the next, as well as associated issues.

Recommendation: To improve the delivery and clear communication of local WFO tropical cyclone watch/warning information to customers in their area of warning responsibility, change the headline in segmented, VTEC ready, NPW products for coastal zones. This improvement would extend to all local WFO issued NPWs for tropical storm/hurricane watches and warnings that affect coastal zones. **Action—** See previous item.

Recommendation: The NHC should provide appropriate error cone radius numbers for each forecast time on TCM and possibly TCD products. Also, NWS tropical web sections (WFOs, NHC, Regional and National HQ, etc.) need to include a good, concise definition and explanation of the error cone and how it should be used. This explanation should be non-technical and geared more toward the public and EMC. **Action—**TPC/NHC will modify their web page text description to include average error values and a better definition of the cone of uncertainty.

Recommendation: TPC should produce an internal pre-TCM flat file just before conference call time. This file would only be available to WFOs and would give them an hour lead time on producing wind grids. If necessary, WFOs can run the

TCMwind tool if there are changes between the preliminary pre-TCM flat file and the final version of the TPC Tropical Cyclone Marine Forecast. **Action—**At conference call time, this forecast information is typically available only in hard copy form on an advisory composition worksheet. TPC/NHC will investigate the possibility of using an electronic tablet to produce this worksheet, so that a file containing the information can be transmitted to the WFOs and the DOD, when available.

Recommendation: A simple solution to "retiring" Greek Alphabet names, if necessary, is to have a floating alternate or secondary name list available that could be placed into service if the primary Atlantic Cyclone name list is exhausted. Named storms from the secondary or alternate list that require retirement could easily be replenished based on Recommendations from the WMO. **Action—**Recommendation accepted. Will be proposed at the upcoming WMO RA–IV hurricane Committee meeting.

Recommendation: Add Pacific Region ASOS sites to be considered for backup power. **Action—**Pacific Region will forward a list of ASOS sites for consideration in this initiative.

Recommendation: Forward to IHC to request action completed by CARCAH, USAF 53rd WRS and NOAA AOC prior to start of 2006 hurricane season. **Action—**Recommendations accepted. Will be forwarded to IHC.

Recommendation: Forward to IHC to request action by Air Force prior to start of 2006 hurricane season. For TP..10 KGWC WMO Fix Message. **Action—**Recommendation Accepted.

Recommendation: Obtain input from the coastal forecast offices, and deliver revised plan prior to start of 2006 hurricane season. **Action—**Recommendation accepted.

Recommendation: Change Subtropical Cyclone Definition in Operational Manuals. **Action—**Recommendation Accepted. Forward to IHC and WMO RA–IV Hurricane Committee.

Recommendation: Standardize Post-Tropical Cyclone Reports:

1) In all issuances of the PSH, follow the existing format in Instruction 10–601 unless and until the format is revised, in particular providing only wind observations with at least gusts of 34 kts or greater, wind speeds in kts, times in UTC, anemometer heights, and sustained wind speed averaging durations.
2) Create a team of TPC, WFO, and NWS Headquarters personnel to agree upon the format of a more standardized PSH and to recommend procedures and/or any software enhancements needed to compose the product in the new format. This could be similar to how WFOs input Local Storm Reports into AWIPS. Recommended standardizations for the team to consider would include but are not necessarily limited to the following:
    a. Standardize the placement of key data values, more specifically than just the order of major sections, to facilitate automated parsing and conversion of the PSH product for multiple uses.
    b. If an instrument failed during the event, or if data is otherwise incomplete, specify the time of the last available observation and the reason for the data outage (e.g., power failure, storm surge, capsized).
    c. For unofficial and/or mobile observation sources, provide the latitude and longitude of the listed observation, if available.
3) Determine if it is possible for the National Data Buoy Center (NDBC) to issue a PSH product or otherwise produce a text product in the same format as the PSH. The product would include similar information in the same format as WFO-issued PSHs for each NDBC site with observed data satisfying the same wind and/or pressure threshold criteria during the tropical cyclone event.

Action—Recommendation (1) is already covered by existing policy. Recommendations (2) and (3) accepted. Dan Brown, TPC, will draft a proposed PSH template format and will forward to the Regions and NWS Headquarters. OS21 will contact NDBC and make a request for them to generate a product in a format consistent with the PSH when conditions warrant.

Recommendation: Correct Offshore Forecast Tropical Cyclone Warning information displayed on the NWS Watch/Warning/Advisory Web map.

Action—

1. Recommended that Warnings for offshore waters not be displayed and a disclaimer/appropriate links be added to the web page. OS21 will forward the Recommendation to the WWA Map Team.
2. Michelle Mainelli will work with Bob Bunge and Leon Minton to determine how existing warning information can be properly displayed on the WWA Map.

Recommendation: (1) Request AXBT deployments (minimum of 12), using present second-hand inventory, on each WP–3D tasked reconnaissance mission. (2) Seek funding support to establish inventory of new, reliable AXBTs. **Action—**Recommendation (1) accepted, and will be forwarded to the IHC. The conference supports Recommendation (2). Additional funds will be requested through the normal program funding process and according to program priorities. Use of the AXBTs is currently for research.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Max Mayfield, Director, NOAA Tropical Prediction Center/National Hurricane Center

Questions submitted by the Majority

Q1. In your testimony you explained that while progress has been made forecasting hurricane tracks, there is much room for improvement in forecasting hurricane intensity. Non-governmental experts have suggested that the Federal Government could improve its ability to forecast hurricane intensity by conducting additional observations and research. Some of the additional activities suggested by these experts include:

Q1a. Hurricane observation flights in the upper troposphere (current flights do not go to that altitude);

Q1b. Improved numerical prediction models that include both ocean and atmospheric observations; and

Q1c. More or improved observations of hurricane cores.

Do you agree that conducting the additional observations/research listed above would likely lead to an improved ability to forecast hurricane intensity in the short-term and/or in the long-term? If not, why not?

A1a,b,c. Currently NOAA is pursuing all three of these activities to improve forecasts of hurricane intensity and structure.

- The NOAA Gulfstream-IV aircraft operates a high altitude sampling of the upper troposphere surrounding hurricanes as part of operational surveillance missions. We are also conducting special research flights into the inner portion of hurricanes including the upper regions in the eye of the hurricane. NOAA has partnered with the National Aeronautics and Space Administration (NASA) on three experiments over the past seven years, the latest conducted this past summer, to obtain high altitude aircraft observations of the inner core of a number of hurricanes and tropical storms from the NASA DC–8 and ER–2 aircraft. These observations, combined with those from the NOAA P–3 aircraft, have provided numerous insights into storm intensity and structure.
- NOAA currently is developing a next generation hurricane prediction system, the Hurricane Weather and Research Forecasting system. The Hurricane Weather and Research Forecasting system consists of (1) advanced high-quality observations for both atmosphere and ocean; (2) advanced data assimilation techniques; and (3) the next generation, coupled air-sea-land prediction system with advanced representation of physical processes. This model is in the testing stage with implementation planned for 2007.
- The NOAA P–3 aircraft operate in the core of the hurricane at altitudes between 1,000–20,000 feet. These aircraft have been used since 1976 to collect research and operational data sets to improve our forecasts and understanding of tropical cyclone track, intensity, and structure. As a result of this research, a number of new technologies, sampling strategies, and concepts have been transitioned to operational use. The most recent of these is the Stepped Frequency Microwave Radiometer (SFMR), which provides surface wind estimates that are a direct measure of the storm structure and intensity. We are in the midst of transferring a new technology into operations, the airborne Doppler radar, for use in initializing and evaluating the new operational modeling system.

Q2. In your opinion, what other areas of additional research or observations are needed to help understand and forecast hurricane intensity in the short-term and in the long-term?

A2. Investing wisely in science and technology is the prudent approach toward improving hurricane understanding and prediction. Observations and research are essential for developing advanced operational numerical systems. Research and operations are linked to achieve improved understanding and prediction of hurricanes. Requirements to better understand and forecast hurricane intensity include numerical weather prediction model guidance of high resolution derived from cutting edge science and advanced data assimilation, as well as a real-time observing network of greater resolution and reliability, especially over ocean areas for forecaster anal-

ysis and short-term forecasts. The FY 2006 hurricane supplemental request included over $31M in new investments to improve hurricane warnings and forecasts. Ocean observations will be expanded by deploying 8 new buoys and re-engineering dropwindsones. The completion of the new Hurricane Weather and Research Forecasting System (HWRF) will be accelerated. The Global Forecast System (GFS) will be enhanced to improve forecasts of hurricane intensity (strength) and structure (size).

Q3. In your opinion, what are the five highest priority areas of additional research or observations needed to improve hurricane intensity forecasts and models in the short-term? Similarly, what are the five highest priority areas to improve this capability in the long-term? What are the estimated costs of implementing theses priority areas? Why has NOAA not implemented research or observations in these areas? Are there plans to move ahead with these activities?

A3. NOAA is working to address its five highest priority areas for both short- and long-term research and observations needed to improve hurricane intensity forecasts and models. These areas include:

1. Increase computational capacity to run sophisticated high resolution numerical weather prediction models.
2. Research for more detailed representation of small scale features in hurricanes and coupling of the wave and hurricane prediction models.
3. Expand the current network of coastal and deep-ocean buoys.
4. Develop and deploy satellite sensors on NOAA geostationary and polar-orbiting satellites that would significantly improve wind force and vector measurements of hurricanes and severe storms.
5. Add additional flight hours for the high altitude NOAA Gulfstream-IV aircraft.

Hurricane modeling is necessary for studying storm dynamics and for forecasting hurricane track, strength, and intensification. One of the limiting factors in hurricane modeling in both the short- and long-term is computational power. The development of higher resolution models that provide more detailed representations of hurricanes is dependent on having the computational power to run these higher resolution models.

While the above list of priorities includes both short- and long-term research goals, additional efforts in the long-term need to focus research on: the effect of upper ocean processes on hurricane intensity and structure; the role the atmospheric environment plays in hurricane intensity and structure change (e.g., how very low humidity in the lower troposphere or very strong vertical shear of the horizontal wind affect hurricane intensity and structure); improving observations of the inner core (eyewall) processes; the role of rain bands in hurricane intensity and structure change; and developing and testing of new advanced models that (1) provide a more detailed representation of the inner-core dynamics of the storm and the interactions between the storm with its environment and (2) provide an optimal forecast framework to help quantify the uncertainty in the forecasts.

Through the Joint Hurricane Testbed, funded primarily through the U.S. Weather Research Program, the National Hurricane Center has devoted considerable time identifying the most pressing needs and priorities. A complete list of program priorities can be found at *http://www.aoml.noaa.gov/hrd/Landsea/jht/JHT_FFO_30June2004.pdf.*

Sufficient resources for operations, research and observations have been provided. We strive to continue to improve our products and services, particularly hurricane intensity forecasting. NOAA continues to implement research to operations and programming, planning and budgeting activities have identified and include the necessary resources to keep up with this demand. We appreciate your continued support of the President's annual budget requests.

Q4. In developing a hurricane forecast, you use weather data collected from a variety of sources, including NOAA satellites, radar, buoys, hurricane hunters, etc. For each of these sources of weather data, please briefly describe the nature of the data you receive and what role it plays in developing a hurricane forecast. In addition, please identify any weather data that is currently available to you from only one source.

A4. There is a tremendous amount of Federal Government (and non-Federal) data available on hurricanes. The sources and use of the data are described below.

AIRCRAFT:

NOAA Gulfstream-IV

Deploys dropwindsondes, which measure pressure, wind speed, wind direction, temperature and dew point, providing a vertical atmospheric profile from wherever it is dropped by aircraft to sea surface. Data are used to increase accuracy in numerical model predictions.

NOAA P–3

Deploys dropwindosondes; provides radar images, visual report of sea surface and estimated surface winds, center position and pressure, wind radii and maximum winds/intensity; Stepped Frequency Microwave Radiometer (SFMR) provides surface wind data; Expendable Bathythermograph (XBT) provides ocean temperature profiles. Some data is used by the forecasters, in numerical model predictions, and used extensively for research activities to increase accuracy and improve physical understanding of ocean and marine interface. NOAA operates two P–3 aircraft, and will purchase a third with funding from the FY06 hurricane supplemental.

U.S. Air Force Reserve C130–J

Deploys dropwindsondes; provides visual report of sea surface and estimated surface winds, center position and pressure, wind radii and maximum winds/intensity. Data is used by numerical models as well as forecasters. The *Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act, 2005* (P.L. 108–324) provided the U.S. Air Force $10.5M to install SFMRs on its fleet of 10 C130–J aircraft.

SATELLITES:

GOES—Geostationary Operational Environmental Satellites

Primary data is provided by GOES–10, GOES–12, and METEOSAT–7 (VIS, IR, WV every 15–30 min). Interpretation of the satellite data provides a classification and analysis of the tropical system and helps determine the center of the storm and its intensity. Images, or "pictures," from GOES allow everyone to see what the hurricane looks like. It is these images that track the storms and are what is so prominently shown by the media.

POES—Polar Orbiting Environmental Satellite

NOAA Polar Orbiting Environmental Satellites (POES) with the advanced microwave sounding unit (AMSU) and the advanced very high radiometer (AVHRR) provide: precipitation estimates, qualitative estimates of storm intensity trends, sea surface temperatures, storm center position, convective structure and atmospheric temperature/humidity profiles.

Note: POES are not always over the storm since these satellites orbit the globe; this is in contrast to the GOES which are stationary relative to Earth surface.

Other Low-Earth Orbiting Satellites

- The *Defense Meteorological Satellite Program,* using the special sensor microwave/imagery (SSMI) suite of instruments, provides information on ocean surface wind speed, precipitation, sea surface temperatures, center position and convective structure.
- The National Aeronautics and Space Administration's (NASA's) *Tropical Rainfall Mapping Mission* (TRMM) satellites, using the TRMM microwave imager (TMI), provide precipitation/rain rate, center position, convective structure, ocean surface wind speed and sea surface temperatures.
- NASA's *OuikSCAT,* using the SeaWinds scatterometer, provides wind speed, wind direction, center location and wind radii.
- The NASA *AQUA* satellite mission uses the moderate resolution imaging spectroradiometer, the advanced microwave scanning radiometer and the atmospheric infrared sounder to provide precipitable water, water vapor, sea surface temperatures, center position, convective structure and atmospheric temperature/humidity profiles.
- *European Research Satellite* (ERS–2), using a wind scatterometer and a radar altimeter, provides the National Weather Service with wind speed and direction, storm center location, wind radii and wave heights.

RADAR:

U.S. WSR–88D—Doppler NEXRAD network provides extensive data as the storm approaches land. Wind speed data is available within 125 miles of the coast and conventional reflectivity data is available out to 250 miles away from the radar.

UPPER AIR OBSERVATIONS:

Observations from soundings of the atmosphere are available from 10 U.S. stations along the Gulf Coast and Puerto Rico. These observations (taken twice per day or every six hours when a hurricane is approaching land) provide temperature, moisture, wind speed and direction from the Earth's surface to as high as 10 miles. Data is also available from other countries in the region covering Central and South America and the Caribbean nations, although this data is not available as consistently as data collected from U.S. sites.

BUOYS:

Drifting

Drifting buoys provide sea surface temperature and some wind speed and direction data.

Moored

Moored buoys provide wind speed and direction, air and sea temperature, barometric pressure, and wave height; and the newer buoys provide wave direction. These buoys provide coverage for the Gulf of Mexico, the Caribbean, and the Atlantic Coast. Specifically, NOAA operates and maintains 12 moored weather buoys in the Gulf of Mexico, three in the Caribbean, and 14 along the Atlantic Coast from Florida to New York, all critical to the Atlantic hurricane program. Forecasters use data from moored buoys operated and maintained by other federal, State, local and private entities as well.

LAND-BASED SURFACE OBSERVING EQUIPMENT:

Automated Surface Observing System (ASOS)

This system measures temperature, wind speed/direction, precipitation, present weather, cloud height, visibility, and barometric pressure.

Private sector wind portable wind towers

These are portable towers, mostly deployed by universities involved in hurricane research efforts. These data are used in post-storm analysis. Data are usually temperature, wind speed/direction, precipitation, present weather, and barometric pressure.

OIL PLATFORM OBSERVATION STATIONS:

Oil platform observation stations can provide data on temperature, wind speed/direction, precipitation, and surface pressure.

SHIPS:

Data collected on ships can include temperature, wind speed/direction, wave height, precipitation, present weather, cloud height, visibility, and pressure.

TIDE GAUGES:

Tide gauges provide information on the level/height of the water. This information is most useful for observing, not forecasting, storm surge.

C–MAN:

C–MAN stations provide data on barometric pressure, wind direction, speed and gust, and air temperature. Some C–MAN stations are designed to also measure sea water temperature, water level, waves, relative humidity, precipitation, and visibility.

COMPUTER MODELS:

The National Hurricane Center relies extensively on computer model output from various numerical weather prediction centers. These data provide guidance on the future track and intensity of tropical cyclones. Other computer models used by the National Hurricane Center help predict potential storm surge the storms could produce.

While some sources of data are unique, NOAA has backup or contingency plans in place to continue the stream of essential data. For example, there is overlapping WSR–88D (NEXRAD) radar coverage—if one goes down, data is provided by an adjacent site; newer models of data buoys have redundant sensors; and NOAA uses

FAA Terminal Doppler Radar data at coastal sites where data are available to provide another layer of backup information.

Q5. If data from polar-orbiting weather satellites was not available to you, how would that affect your ability to forecast hurricanes?

A5. Data from polar-orbiting weather satellites provides information essential to computer model forecasts. This data is the only source that provides information from over the oceans. Internal studies show that lack of polar-orbiting satellite data would have a negative impact on our forecasts, potentially reducing forecast accuracy by 15–20 percent.

Q6. If NOAA had a second Gulfstream jet for studying hurricanes, what improvements could be made to NOAA's hurricane forecasting capability? How long would it be before those improvements could be incorporated into operational prediction models? How much would it cost to procure a second jet and what funding would be required for annual operating costs for a second jet?

A6. NOAA routinely operates the Gulfstream-IV (G–IV) aircraft twice a day on successive 8.5 hour missions during hurricane season. Internal studies show data provided by the current Gulfstream-IV jet have improved track prediction by about 20 percent, primarily during the hurricane watch/warning phase (when the storm is within a day or two of landfall). A second jet would allow more missions to be flown. This could be valuable during an active hurricane season when numerous hurricanes threaten the United States and data from nearly continuous flights would improve predictions.

A new Gulfstream jet, complete with essential equipment, would cost approximately $80 million, assuming the aircraft is purchased under an existing Air Force contract. We estimate that it would cost $5 million per year in operating costs for crew, maintenance, dropwindsondes and fuel.

Any single observational platform needs to be put into the proper context with all other investments in observations. Currently the most important observations needed to improve hurricane intensity and structure forecasts come from the radars flown on NOAA's P–3s. The U.S. Air Force will use funds from the FY 2005 hurricane supplemental to install these Stepped Frequency Microwave Radiometer sensors on its fleet of 10 aircraft, the first of which will be available late in FY 2006. The FY 2006 hurricane funding supplemental provided $9M for an additional, equipped P–3 aircraft to improve observations of hurricanes.

Q7. You have stated that today's average hurricane track forecast errors are only 94 nautical miles, compared with average forecast errors of 230 nautical miles in 1987. Have we reached the theoretical limit of track forecasting with the 94 nautical miles error, or could that error become smaller? If the error could be made smaller, what resources (i.e., observing equipment, computers, research funding, etc.) does NOAA need to improve track forecasting and what is the estimated cost of those resources?

A7. While we may be nearing the theoretical limit of track prediction, we continue to work to improve our track forecasts. Track predictability depends on being able to predict larger scale atmospheric conditions and, on average, we have been successful at predicting the features that "steer" the hurricane. However, storms like Wilma (when it was in the southern Caribbean) and Ophelia (when stationary off the coast of Florida) highlight that we have room for improvement when it comes to predicting tracks for the "outlier" storms that stall or take very erratic paths.

To improve track forecasts we must continue our research efforts and computer modeling development. NOAA is currently developing a next generation hurricane prediction system, the Hurricane Weather and Research Forecasting (HWRF) system. We expect the improvements embodied in the HWRF system will lead to reduced track forecast error. Funding provided in the FY 2006 hurricane supplemental will accelerate the completion of the HWRF system. Additional observations, such as those planned under the Global Earth Observation System of Systems (GEOSS), would also help in defining the conditions for hurricane predictions.

Q8. A recent article in the Miami Herald *asserts that key countries in the Caribbean are not launching weather balloons regularly, despite an agreement with the United States to launch balloons, because the countries did not have all the equipment the U.S. had promised. Would additional funding or other actions help ensure that weather balloon equipment is provided to Caribbean countries in a timely manner and that the countries launch the balloons as needed?*

A8. We face many different challenges when collecting meteorological data. All required equipment and supplies have been provided to the appropriate countries, in

accordance with our agreements. During Hurricane Wilma, four of the sites experienced system malfunctions (hydrogen generator and/or tracking system), which have now been corrected. Releasing weather balloons, using the tracking equipment, and transmitting data back to the international data collection hubs is the responsibility of each country. Issues such as local power, communications, and maintenance are challenges that vary from country to country, which has at times made it difficult to collect meteorological data from balloon launches. While these data are important and NOAA will do all it can to ensure the data are available, dropwindsonde data from hurricane reconnaissance flights provide similar types of data used by our hurricane forecasters and hurricane models.

Q9. In your opinion, if additional funding were available for hurricane forecasting, what are the five highest priority areas of where additional resources would improve operational hurricane forecasts and models?

A9. The highest priority for hurricane forecasting is to improve our prediction of storm intensity. There are many components accompanying that element, including continued improvements in track forecasts and the prediction of the size of the windfield, as well as being able to predict when and how quickly storms will intensify and how strong they will become. Additionally, we need to develop a better understanding of the uncertainty associated with our forecasts of storm intensity (in particular rapid intensification of storms), as well as storm structure/size. These priorities can be addressed through continued research, increased development of our next generation operational hurricane models, and additional observations, such as those planned under the Global Environmental Observing System of Systems (GEOSS). With funding provided in the FY 2006 appropriation, we will add four new hurricane forecasters, who will also enhance operational hurricane forecasts.

Additional priorities are provided in Joint Hurricane Testbed Announcement of Opportunity at the following Internet site: *http://www.aoml.noaa.gov/hrd/Landsea/jht/JHT_FFO_30June2004.pdf.*

Q10. What is the difference between data received from hurricane reconnaissance flights in NOAA's Gulfstream jet, NOAA's P–3 Orions, and the Air Force's WC–130 cargo planes? What factors determine which aircraft is flown to observe a storm? What factors determine how frequently flights are made with each type of aircraft?

A10. The Gulfstream-IV jet is used to obtain data from the environment surrounding the hurricane. These data are then assimilated into NOAA's operational forecast system to better define the atmospheric conditions and steering currents that influence the future track of the hurricane. The data collected by the Gulfstream are also used to help forecasters identify general conditions for storm intensification.

In contrast, the P–3s and the WC–130s provide data from inside the hurricane, including windspeed, and hurricane eye positions, among other vital information. The P–3s are equipped with research instruments to help NOAA and other research scientists develop a better understanding of the inner workings of hurricanes and help to develop improved forecast capabilities, including hurricane intensity forecasts predictions. The P–3s also serve as platforms for testing new observing technologies, such as the Stepped Frequency Microwave Radiometer (SFMR), which measures over-ocean wind speed and rain rate, and Global Positioning System (GPS) dropsondes.

As outlined in the National Hurricane Operations Plan (NHOP), the National Hurricane Center (NHC) requests aircraft reconnaissance data through the Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH). The CARCAH then allocates reconnaissance missions among the U.S. Air Force Reserve Command and NOAA as appropriate. Typically, most missions are carried out by the U.S. Air Force Reserve Command.

Q11. Do other missions for NOAA's P–3 Orions, such as air quality research, interfere with the National Hurricane Center's hurricane forecasting capabilities? If not, why not?

A11. Flight hours for the P–3 Orions are assigned in accordance with NOAA's Marine and Aviation Operations Allocation Plan and coordinated by NOAA's Aircraft Operations Center. In situations when there are competing requests for P–3 usage, the National Hurricane Center has priority access to the P–3 flights for hurricane reconnaissance. In many cases we are able to conduct hurricane research on these reconnaissance flights. Additionally, non-hurricane research missions typically occur in areas that would allow the P–3s to be recalled to MacDill AFB within the range of one flight, so they could be redirected to conduct hurricane reconnaissance if

needed. Further, the non-hurricane research missions are usually flown in the early part of hurricane season, to reduce the number of competing requests for P–3 flight time during the more active portion of the hurricane season. The FY 2006 hurricane supplemental provides NOAA with an additional P–3 aircraft; this should help ensure adequate coverage.

United States Air Force Reserves' 53rd Weather Reconnaissance Squadron maintains and operates a fleet of 10 C130–J aircraft to conduct most hurricane reconnaissance missions and provide storm location and data, including hurricane intensity. The Air Force will use funding from the *Military Construction Appropriations and Emergency Hurricane Supplemental Appropriations Act, 2005* (P.L. 108–324) to outfit its "Hurricane Hunter" aircraft with Stepped Frequency Microwave Radiometer sensors beginning in late FY 2006. SFMR provides meteorologists with critical data on the hurricane surface wind field, and in particular the estimation of wind maxima, which has long been a requirement of the Tropical Prediction Center/National Hurricane Center (TPC/NHC).

Q12. Recent articles in the Miami Herald *assert that "in 2004 before Hurricane Charley. . .weather balloon readings were missing from countries all along its path, leaving hundreds of miles of the atmosphere unmonitored.. . .Three coastal weather-observing stations between the Florida Keys and northwest Florida were malfunctioning, denying forecasters clues about ocean temperature and wind speed." Is this assertion true and if so, why was this observation data unavailable? Also, if the assertion is true, what was the impact on forecasting Hurricane Charley?*

A12. We have encountered some difficulties in obtaining weather balloon releases within the Caribbean region from the countries with which the United States has agreements due to issues such as local power, communications, and maintenance. These problems are being addressed. However, because there was nearly continuous aircraft reconnaissance during Hurricane Charley, we do not believe the lack of data from these sites impacted our forecasts. Our records indicate only one NOAA buoys or Coastal-Marine Automated Network (C–MAN) sites was out of service prior to the passage of Hurricane Charley. We believe lack of data from this one site did not impact our forecasts.

Questions submitted by the Minority

Q1. What role do the local offices play in distributing and refining the forecast for the hurricane prior to the storm and during the storm versus the role of the Hurricane Center?

A1. Local Weather Forecast Offices (WFOs) play an important role by providing more detailed forecasts for their area of responsibility. For example, the National Hurricane Center provides a broad range of values in its storm surge predictions; the WFOs refine those storm surge predictions by identifying vulnerable areas and associating particular values for the surge in those areas. Local WFOs also refine the timing of the onset of hurricane conditions in their area, including information on wind speed, storm surge, rainfall amounts and the potential for tornadoes. The WFOs also coordinate with and brief local emergency managers to ensure the managers have the latest information available to make their preparedness and evacuation decisions.

Q2. The Hurricane Center participates in workshops and conferences after the hurricane season with FEMA and State and local emergency managers and other organizations. Does staff of the local forecast offices also participate in these offseason activities? Why are multiple annual workshops useful in maintaining skills in preparation and response for hurricanes?

A2. Time and resources permitting, local weather forecast offices participate in workshops and conferences. Multiple workshops provide the opportunity to train more individuals than a single training session. Our workshops are coordinated, to the greatest extent possible, to allow emergency managers and National Weather Service (NWS) forecasters from the same local area to attend the same session. This creates a favorable learning environment, and builds/enhances relationships in those local areas. Beginning in 2006, in partnership with the Federal Emergency Management Agency, local weather forecast offices will participate in training sessions for emergency managers on how to use NWS products and how to interpret and understand NWS predictions of storm surge. The emergency managers receiving this training will then return to their offices, where they will train their co-

workers and other local officials. This method of training allows for efficient use of funding and allows us to reach more local officials than possible otherwise.

Questions submitted by Representative Eddie Bernice Johnson

Q1. How would you characterize the participation by State and local emergency managers in the Hurricane Liaison Team conference calls?

The HLT process has been used for a long time now. Would you say this process has provided a good forum for information exchange between the various levels of government?

I understand the Hurricane Center participates in a series of workshops and conferences after the end of the hurricane season. How would you characterize the feedback regarding the HLT process in the post-hurricane season from State and local government people?

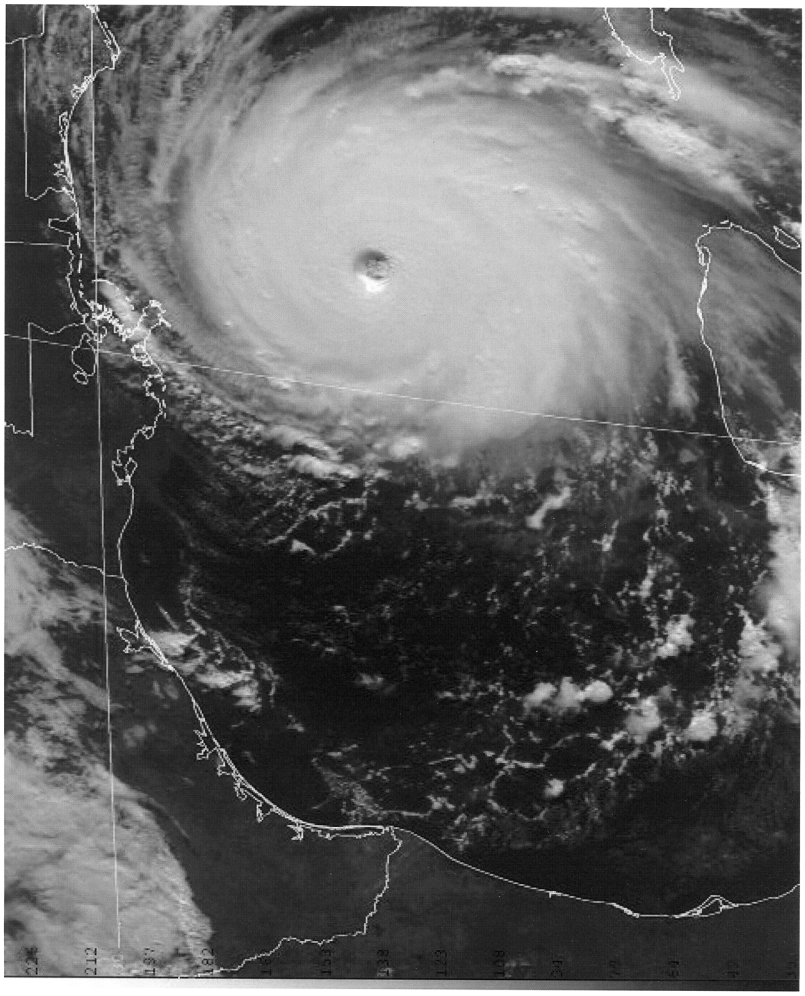
A1. The Hurricane Liaison Team (HLT) conference calls serve as an excellent coordination tool and an efficient use of time. State emergency managers from potentially impacted locations participate on the call listening to the weather briefing and then coordinating emergency management activities. The HLT briefings provide an excellent forum for the National Hurricane Center (NHC) to share meteorological information with the Federal Emergency Management Agency (FEMA) and State Emergency Operations Centers, and also for the NHC to understand the concerns of emergency managers. The National Hurricane Center has received positive feedback in its participation in the Hurricane Liaison Team, from workshops, the National Hurricane Conference, and State hurricane conferences.

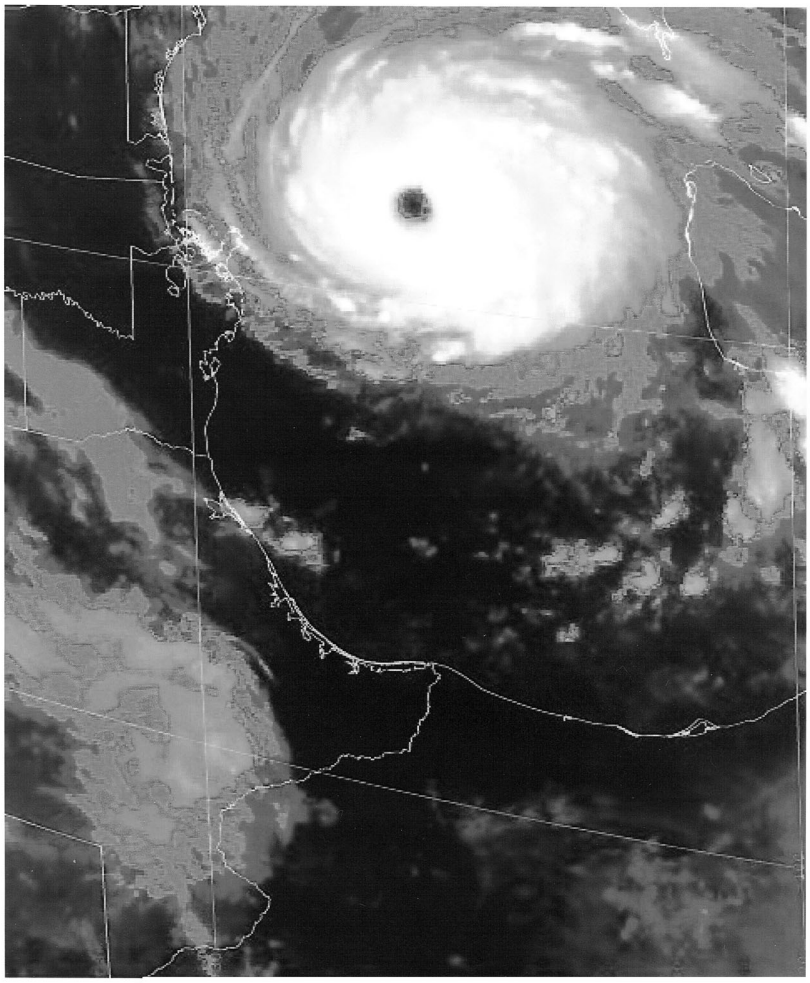
The NHC is an invited participant in the HLT video teleconference briefings facilitated by FEMA. In addition to the NHC, FEMA typically includes State emergency operations centers from the potential impact areas and regional FEMA offices on the HLT briefings. The HLT briefings do not usually include local emergency managers. Local emergency managers have access to National Weather Service (NWS) warnings distributed through a vast dissemination network including NOAA Weather Radio All Hazards (NWR); NOAA Weather Wire Service; Emergency Managers Weather Information Network (EMWIN); Internet; local paging systems to emergency managers; high-speed direct communications with users of large volumes of weather data (i.e., commercial meteorological firms) connected by landlines (Family of Services), by satellite broadcasts (NOAAPORT), or both. In addition there is close coordination that occurs between the National Weather Service Weather Forecast Offices and local emergency managers.

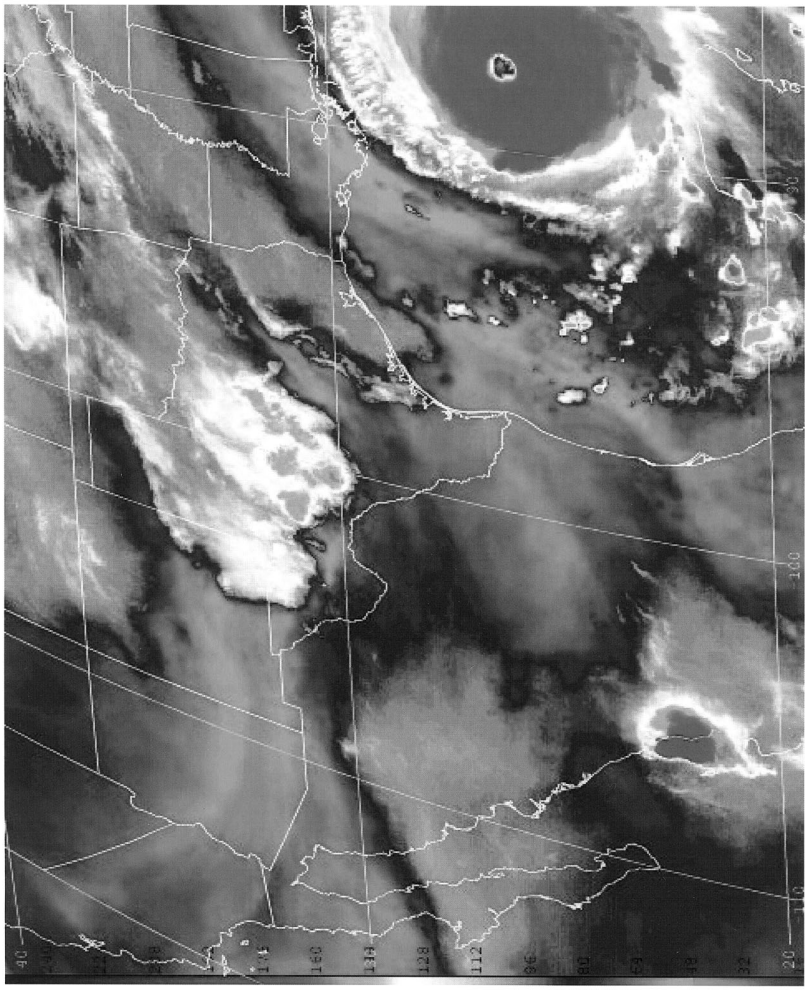
Appendix 2:

Additional Material for the Record

HLT Briefing
August 28, 2005



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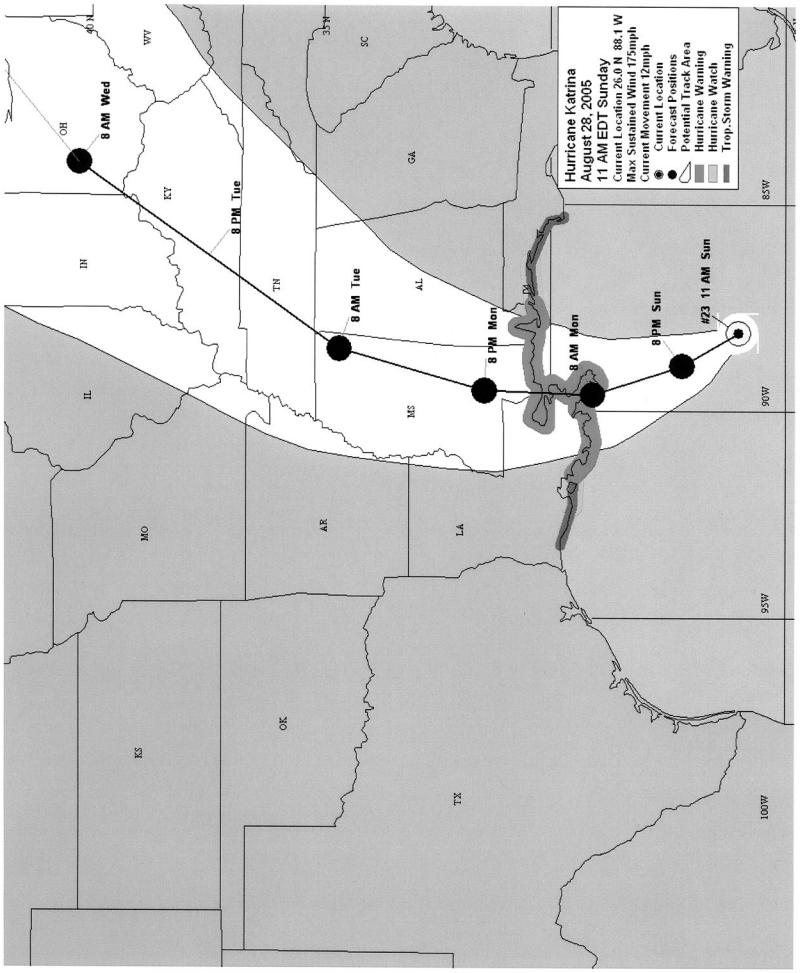
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August 28, 2005
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Current Movement 12mph
Current Location
Forecast Positions
Potential Track Area
Hurricane Warning
Hurricane Watch
Trop.Storm Warning
8 AM Wed
8 PM Tue
8 AM Tue
8 PM Mon
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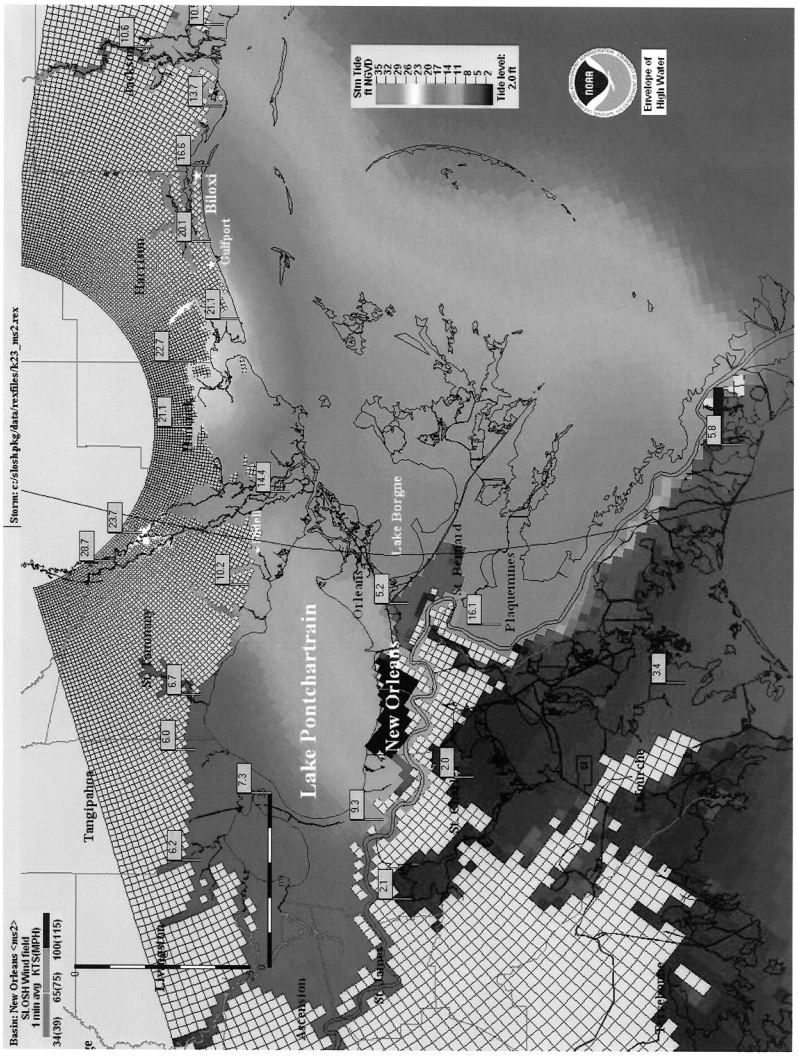
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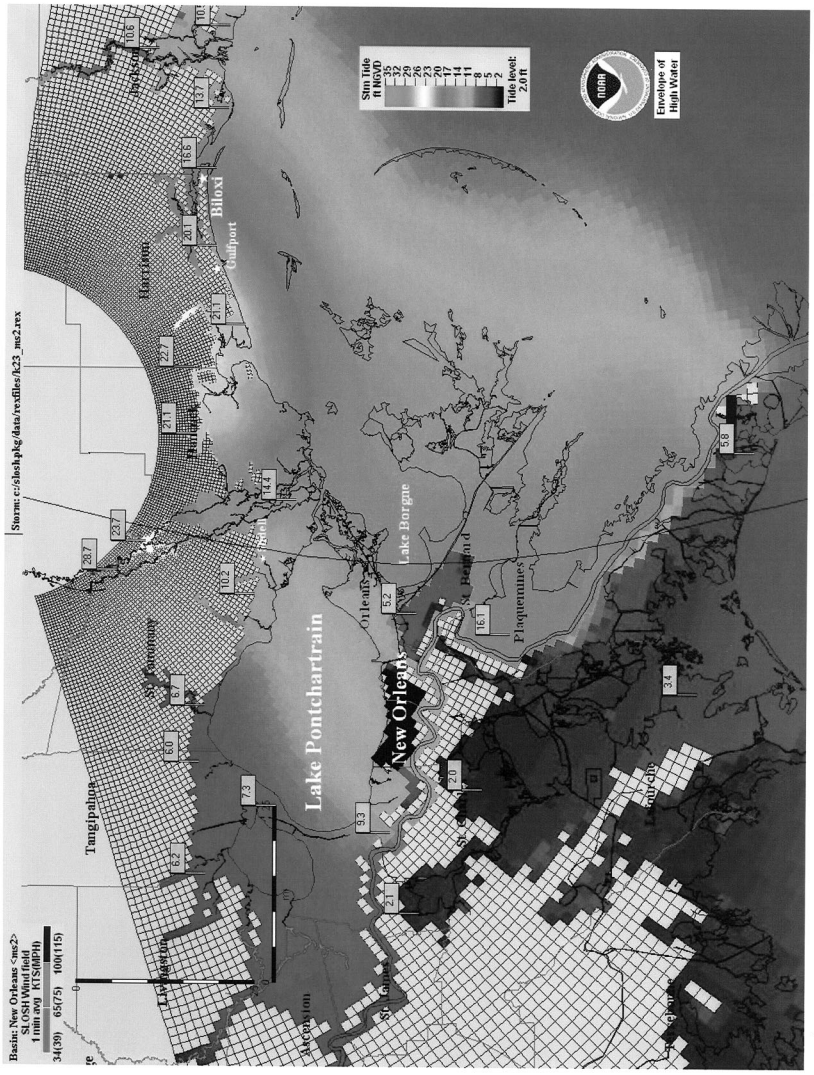
Envelope of
High Water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Gulfport
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Orleans
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Terrebonne
St. Bernard
Jefferson
St. Charles
Ascension
Iberville
Pearl River
Hancock
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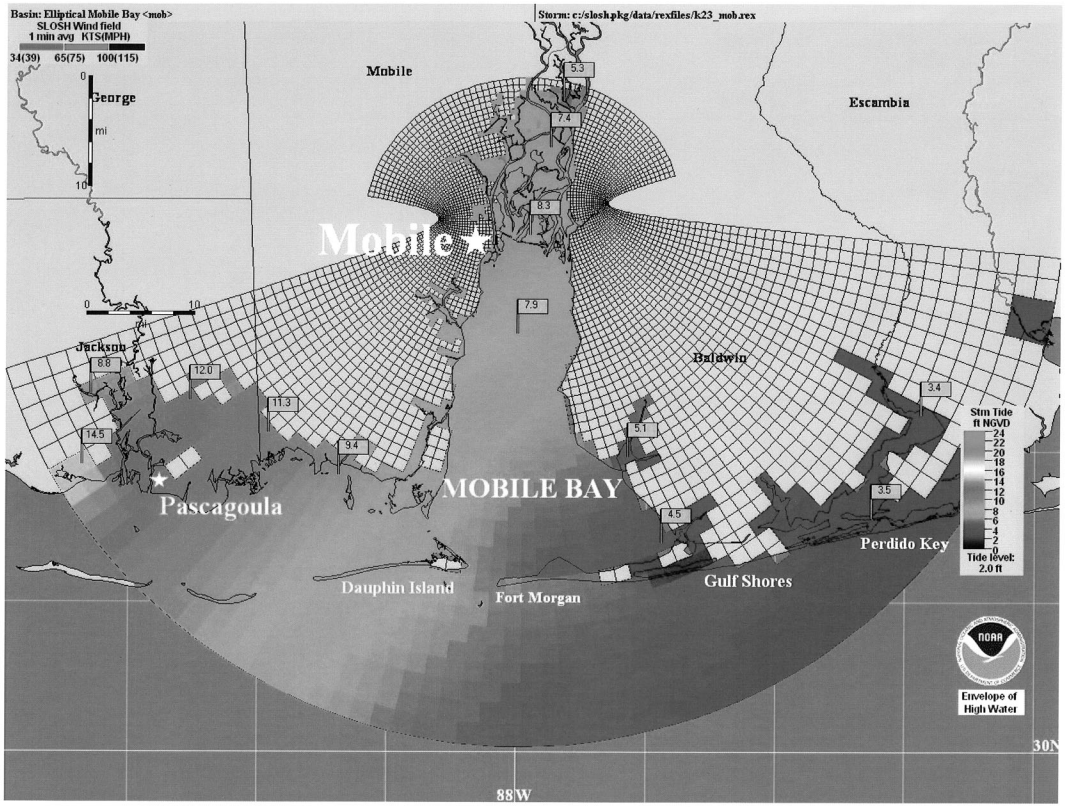
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Stm Tide
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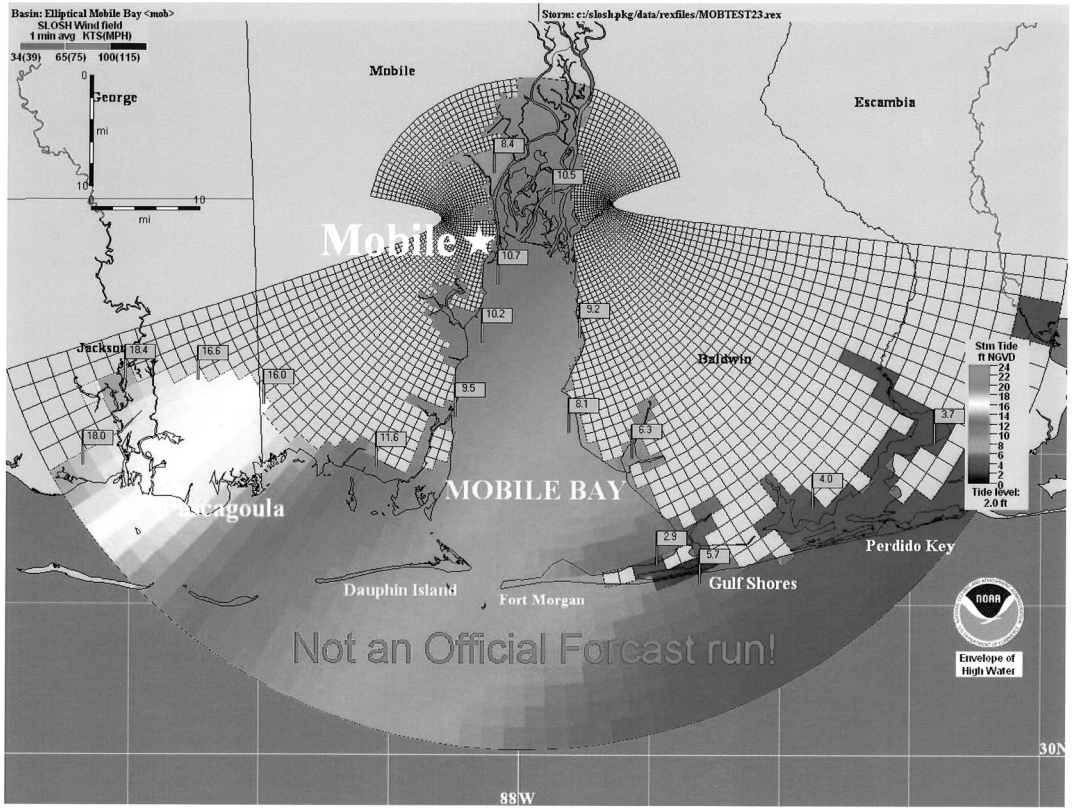
24
22
20
18
16
14
12
10
8
6
4
2
0
Tide level:
2.0 ft
NOAA
Envelope of
High Water
30N
88W


Basin: Elliptical Mobile Bay <mob>
SLOSH Wind field
1 min avg KTS(MPH)
34(39) 65(75) 100(115)
George
mi
Mobile
Escambia
Mobile
Jackson
Baldwin
MOBILE BAY
Pascagoula
Dauphin Island
Fort Morgan
Gulf Shores
Perdido Key
Stm Tide
ft NGVD
Tide level:
2.0 ft
Envelope of
High Water
Not an Official Forcast run!
30N
88W