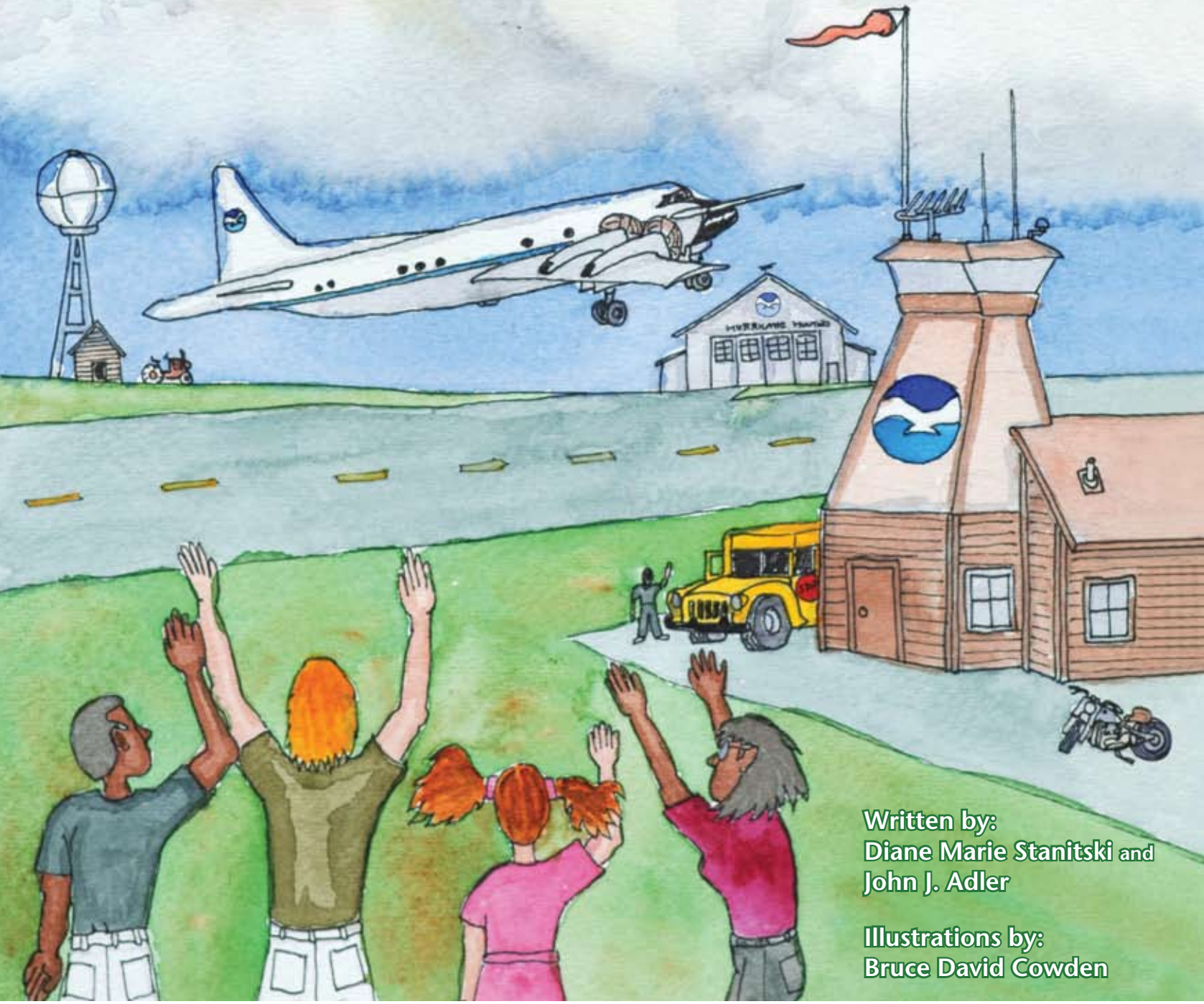
Teacher in the Air

Dr. Diane's Flight with the NOAA Hurricane Hunters



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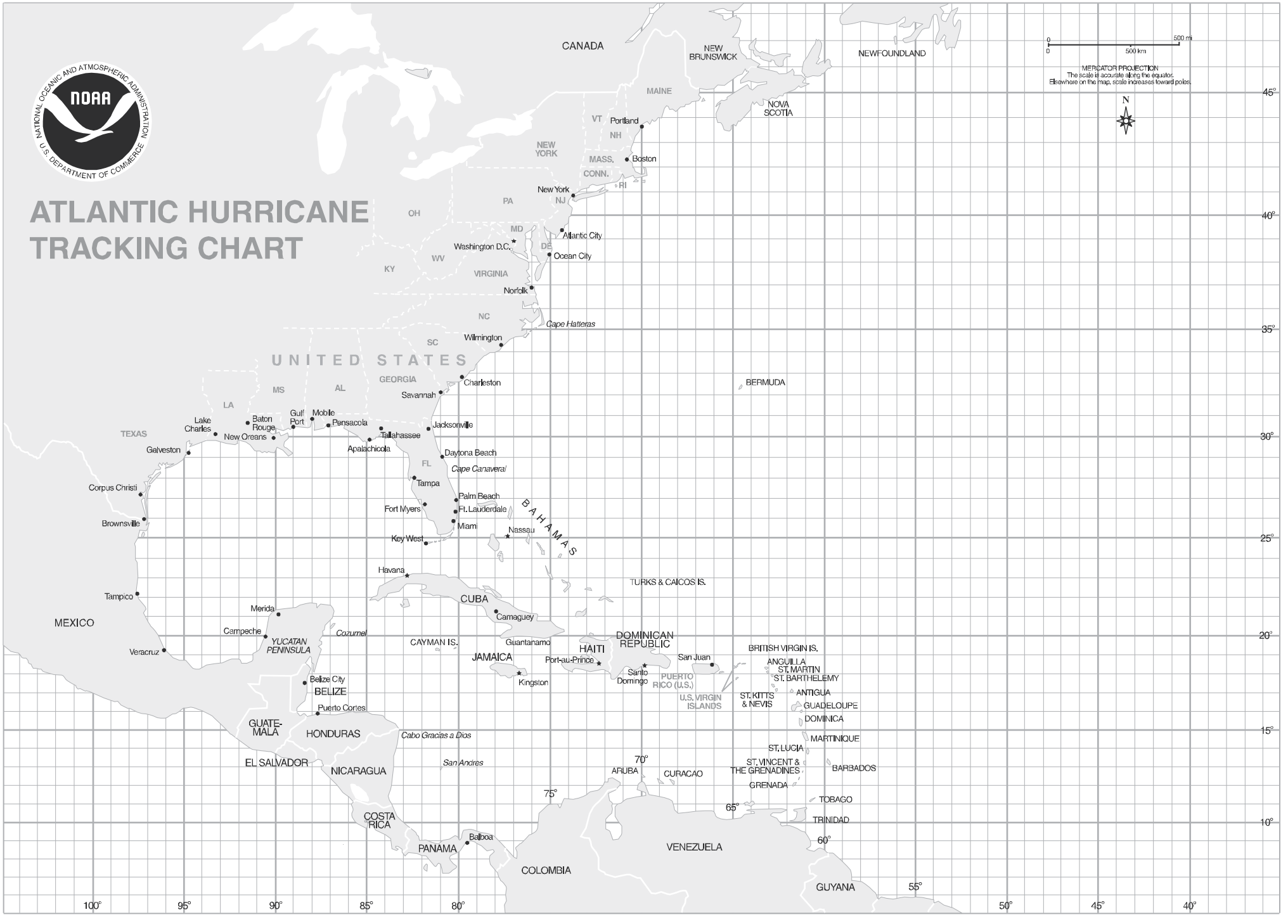
A National Oceanic and Atmospheric Administration (NOAA) Publication


NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
ATLANTIC HURRICANE TRACKING CHART
0 500 mi
0 500 km
MERCATOR PROJECTION
The scale is accurate along the equator.
Elsewhere on the map, scale increases toward poles.
N
CANADA
NEW BRUNSWICK
NEWFOUNDLAND
NOVA SCOTIA
MAINE
VT
NH
MASS.
CONN.
RI
NEW YORK
PA
NJ
OH
MD
DE
WV
KY
VIRGINIA
NC
SC
GEORGIA
MS
AL
LA
TEXAS
FL
UNITED STATES
Portland
Boston
New York
Atlantic City
Washington D.C.
Ocean City
Norfolk
Cape Hatteras
Wilmington
Charleston
Savannah
Jacksonville
Gulf Port
Mobile
Pensacola
Tallahassee
Apalachicola
Lake Charles
Baton Rouge
New Orleans
Galveston
Daytona Beach
Cape Canaveral
Tampa
Palm Beach
Fort Myers
Ft. Lauderdale
Miami
Key West
Corpus Christi
Brownsville
BERMUDA
BAHAMAS
Nassau
Havana
TURKS & CAICOS IS.
CUBA
Camaguey
Tampico
Merida
MEXICO
Campeche
Cozumel
YUCATAN PENINSULA
Veracruz
CAYMAN IS.
Guantanamo
JAMAICA
Kingston
HAITI
Port-au-Prince
DOMINICAN REPUBLIC
Santo Domingo
PUERTO RICO (U.S.)
San Juan
U.S. VIRGIN ISLANDS
BRITISH VIRGIN IS.
ANGUILLA
ST. MARTIN
ST. BARTHELEMY
ANTIGUA
ST. KITTS & NEVIS
GUADELOUPE
DOMINICA
MARTINIQUE
ST. LUCIA
ST. VINCENT & THE GRENADINES
BARBADOS
GRENADA
TOBAGO
TRINIDAD
Belize City
BELIZE
Puerto Cortes
GUATE-MALA
HONDURAS
Cabo Gracias a Dios
EL SALVADOR
NICARAGUA
San Andres
ARUBA
CURACAO
COSTA RICA
PANAMA
Balboa
COLOMBIA
VENEZUELA
GUYANA
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Teacher in the Air

Dr. Diane's Flight With The NOAA Hurricane Hunters

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This book is dedicated to the future scientists and researchers of America and to the employees of the National Oceanic and Atmospheric Administration, especially those committed to improving the public's understanding and awareness of hurricanes.

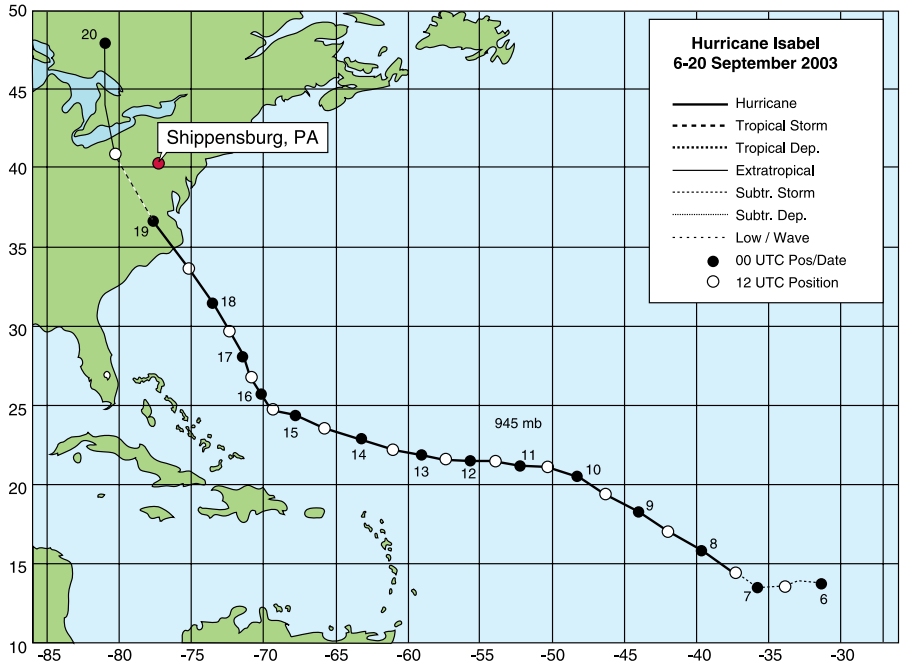
Teacher in the Air

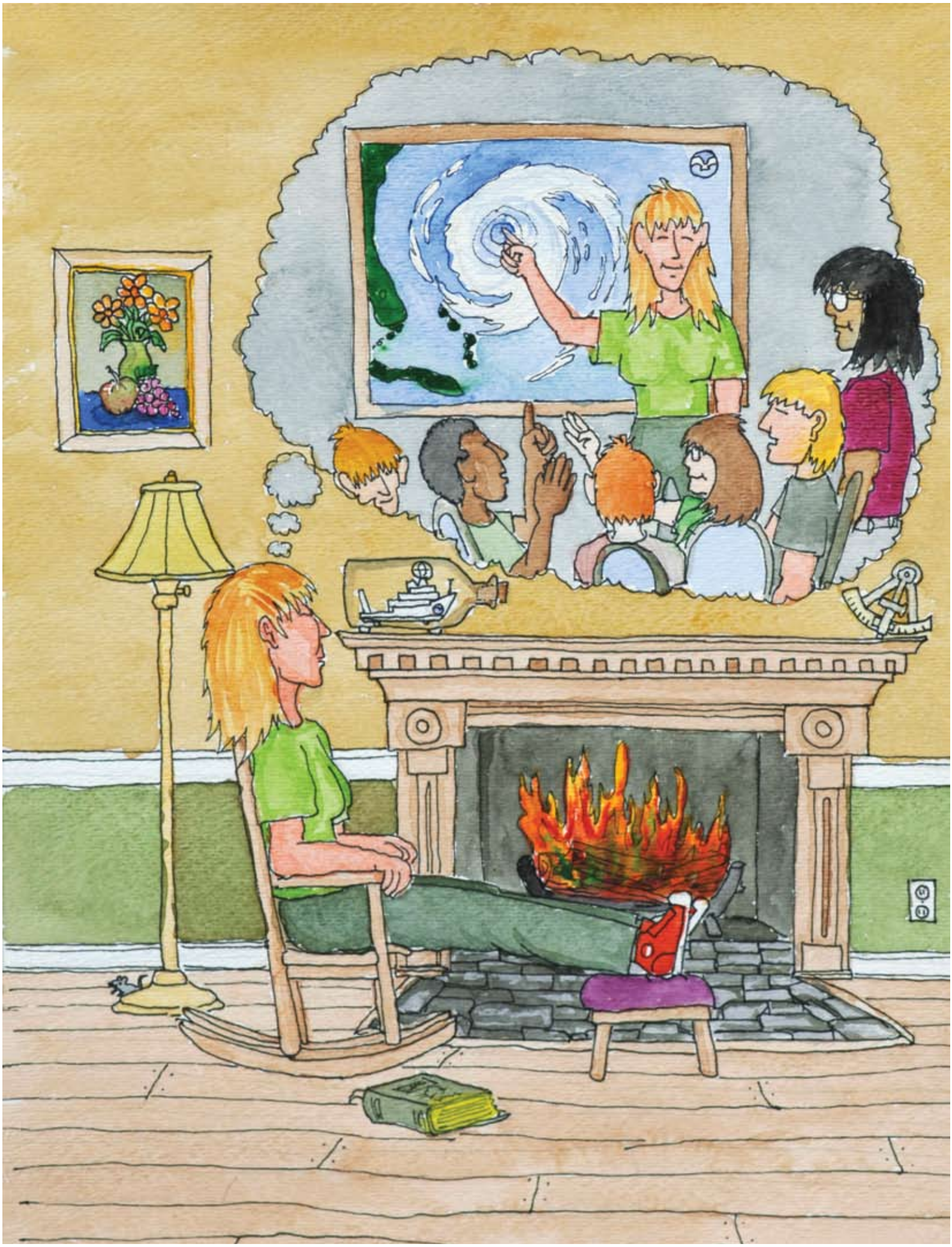
Dr. Diane's Flight with the NOAA Hurricane Hunters

It was a brisk winter day in Shippensburg, Pennsylvania, and Dr. Diane Stanitski sat in front of her fireplace thinking about the wood that fueled the flickering flames and warmed her smile. The logs and branches had come from one of three trees that had fallen, domino fashion, in her backyard during **Hurricane Isabel** the year before. This hurricane was so severe that it brought 50 mph winds to southern Pennsylvania. Damage due to the high winds and heavy rain had been widespread throughout their area…just imagine how extensive it had been where Isabel made **landfall** along coastal North Carolina.

As she stared at the flames, she developed the story in her mind that she would share with her Shippensburg University students later that day. She would describe hurricanes, her favorite topic of the semester! A discussion of hurricane development, storm characteristics, the incredibly destructive **storm surge**, and the unique naming system for hurricanes always enthralled her **meteorology** students.

Dr. Diane was also excited that one of her most enthusiastic students had offered to travel with her to Maryland the following day to volunteer at a student science fair at **NOAA.** They would help judge science projects completed by students at a nearby elementary school. They were told that the 4th, 5th, and 6th grade students consistently created outstanding research projects. She imagined how wonderful it would be if these students grew up to become scientists, perhaps even **meteorologists**!





The next day, as Dr. Diane observed the creative student science projects at NOAA, she encountered another judge who was an officer in the **NOAA Corps**. He was the **navigator** of a NOAA aircraft that flies through hurricanes to collect the information that helps us understand the nature of these powerful storms. She couldn't believe that she had met an actual **hurricane hunter**!! He told her about the NOAA Teacher in the Air Program, and encouraged her to look into participating in research on a NOAA plane. As part of this program other teachers had flown in Alaska and Hawaii to learn about wind flow patterns. Wow! Could she also participate, and learn more about hurricanes? One of Dr. Diane's previous professors who she highly respected had always advised, "Never say no to opportunity!" This could be her big chance to participate in hurricane awareness activities.

By spring, as part of the NOAA Teacher in the Air Program, Dr. Diane left for Maine to travel on the NOAA **WP-3D Orion** plane during the **Hurricane Awareness Tour**. She would learn about the fascinating science and technology on board, and help describe the world of meteorology to students of all ages who visited the plane during the tour. Students could walk through the plane to see the tools used to solve the mysteries of a hurricane. These tools enable meteorologists to precisely predict a hurricane's path as it approaches a coastal area.

The goal of the tour is to inform the public about hurricane safety and preparedness, and for the public to interact with emergency officials from their community. This year, the plane would fly from Bangor, Maine to Baltimore, Maryland, and on to Richmond, Virginia before stopping in Charleston, South Carolina, and Jacksonville, Florida. During each stop the pilots, scientists, and crew on board would share their stories about flying through hurricanes, and the science conducted during each **eye** penetration.

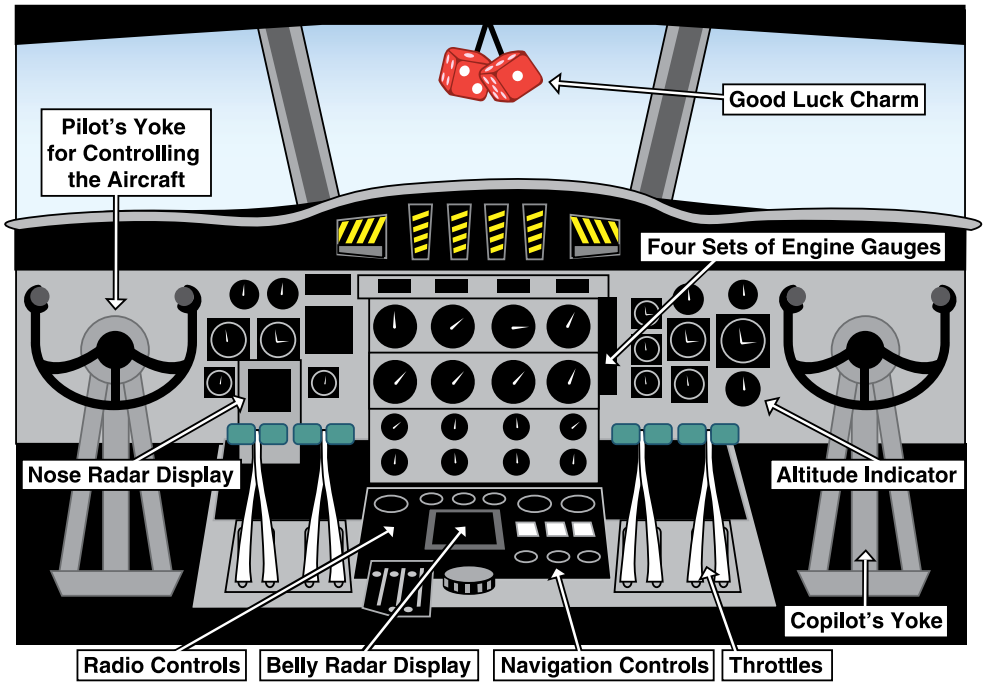
The **Hurricane Awareness Tour** is a week-long event that alternates yearly between selected cities on the Eastern Seaboard and the Gulf Coast states. The WP-3D aircraft spends one day at each city for the public to view. See page 42 for a detailed map of the Hurricane Awareness Tour.


DEPT. OF COMMERCE

The moment that Dr. Diane had been waiting for finally arrived – she was flying with the hurricane hunters! Since this was not an actual flight through a hurricane, she was given a place of honor in the plane's **flight station** (often referred to as the cockpit). She observed the procedures that the **pilots** and **flight engineer** completed as they prepared for takeoff. They pushed a huge array of buttons and levers while communicating with the airport control tower. The quick ascent into the air with views on all sides of the plane was exhilarating! She discovered that during hurricane flights, one pilot focuses on keeping the plane level while the flight engineer throttles the engines to control the altitude changes during intense **updrafts** and **downdrafts**. The co-pilot monitors all instruments to detect problems or emergency situations. Flying through the **eyewall** is the scariest and most dangerous part of the flight for the crew, but their training and experience ensures they are well prepared.

Dr. Diane tried to imagine the worst turbulence she had ever experienced. She noticed that everything on the plane was either tied down or had velcro on it – even the pencils! This is necessary to keep things from shifting during flight. Once the plane leveled at cruising altitude, Dr. Diane unstrapped and left the flight station to walk back and visit the crew. The crewmembers were making final preparations at their stations for the week-long tour, and were happy to explain their duties.

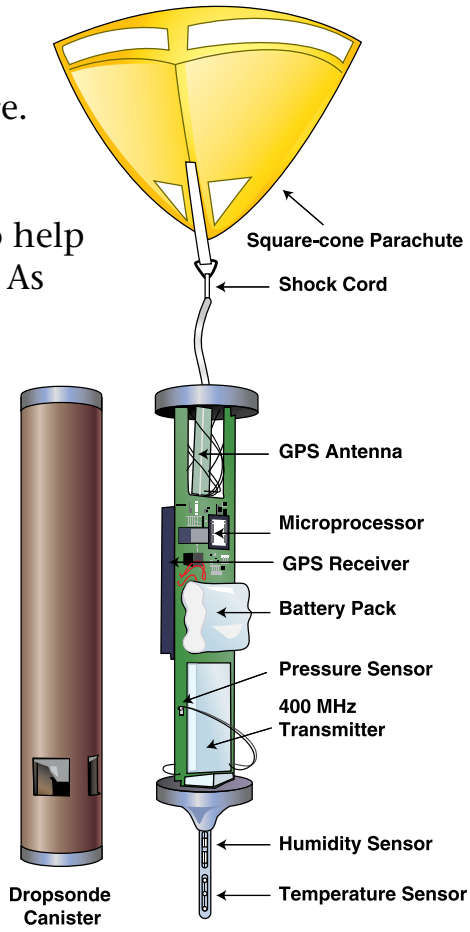
NOAA WP-3D Flight Station



Dr. Diane asked the scientists when they first became interested in weather. Many started observing weather patterns in middle school and sharpening their math and science skills in high school. They never realized that a degree studying science would lead to a career involving the excitement of flying into the eye of a hurricane!

Dr. Diane took pictures of the instruments released through the bottom of the hurricane plane. Information from these instruments assists the meteorologists at the **National Hurricane Center** (NHC) in deciding when and where to post **hurricane watches** and **warnings**.

One of the most important instruments is a **dropsonde**, a weather sensor that measures air temperature, humidity, and atmospheric pressure. These readings are similar to those measured by weather instruments that many people hang on their wall at home. The dropsonde uses a **GPS** to help determine the winds in and around a hurricane. As each probe descends at a velocity of nearly 35 miles per hour (15 m/s), it transmits data back to the aircraft. The hurricane hunters often release over 50 dropsondes into a hurricane during each flight.



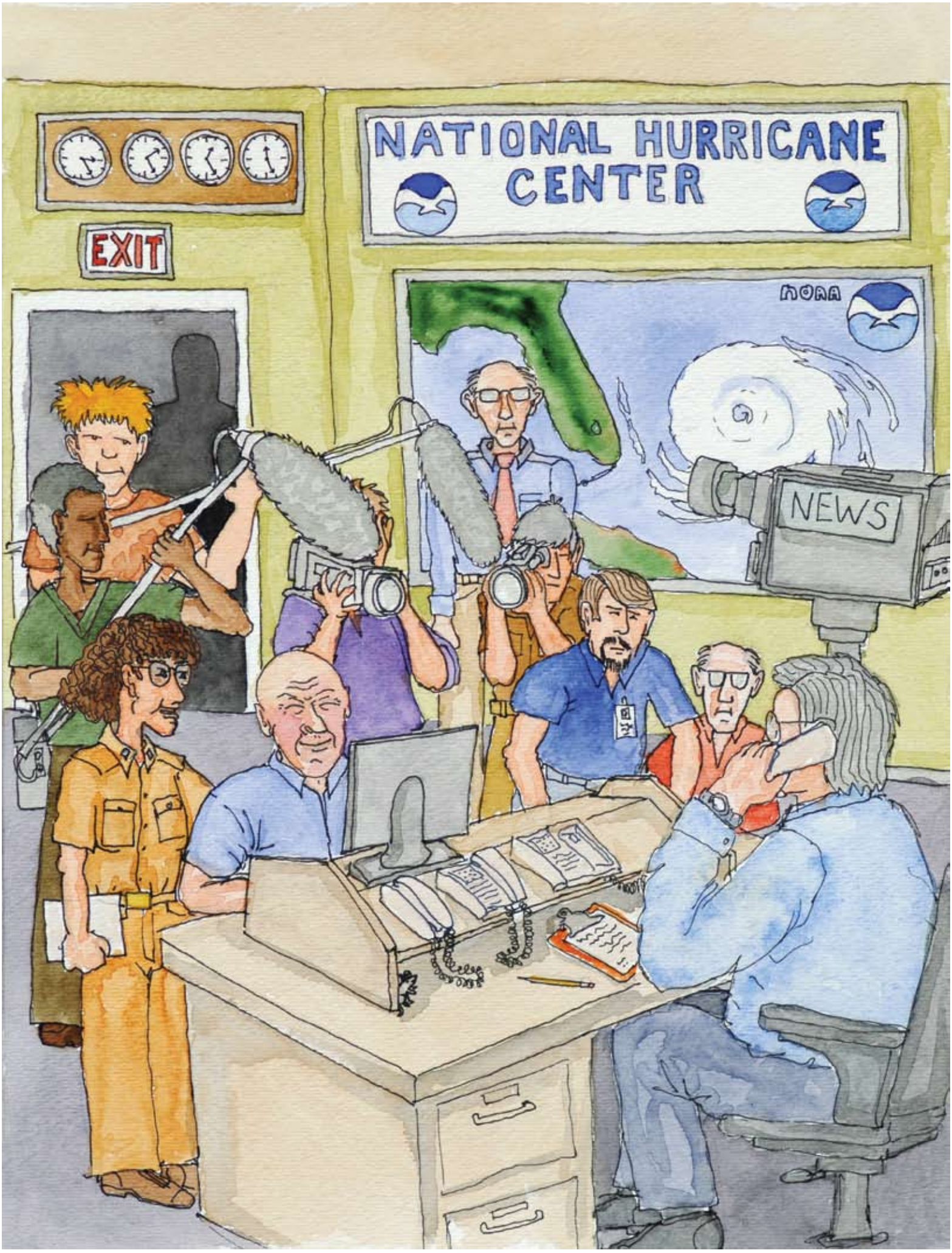
Dr. Diane asked how the dropsondes are deployed from the plane. She learned that a dropsonde operator places them in a tube inside the plane and sends them down a chute where they are released through the bottom of the aircraft. A parachute opens which allows them to float downward while collecting and transmitting their data.

Another important instrument is an aircraft expendable bathythermograph, or **AXBT**. It is a larger probe that is dropped from the bottom of the airplane and falls into the sea. Once this instrument hits the ocean and begins to sink in the water, a float with a radio transmitter rises to the surface for communication with the aircraft above. An AXBT measures water temperature as it descends to a depth of approximately 1,500 feet (457 m).

Dr. Diane then spoke with the Director of the National Hurricane Center who was also on board. She asked how the measurements from the plane's instruments are used. He explained that forecasters need to understand the current oceanic and atmospheric conditions to better predict the movement and intensity of **tropical cyclones**. The aircraft data are very important because the readings are taken in the vicinity of the storm. Forecasters use the data in various computer **models**, developed by NOAA's Environmental Modeling Center and other modeling centers around the globe, to help produce weather watches and warnings. Dr. Diane was amazed by how quickly measurements taken from the plane are used to help predict future conditions in order to save lives. The Director then explained that he often informs the public directly from the NHC, where the media are able to conduct live interviews.

Before she knew it, Dr. Diane was told that the plane would be landing in Baltimore in 20 minutes. She took her seat and fastened the extremely strong 4-point seatbelt by connecting the two shoulder straps to the hip straps at her waist. These seatbelts hold the aircrew firmly in their seats as the plane penetrates through the eyewall of a hurricane. She closed her eyes and imagined such an adventure. She was glad that she would have more time to return to the plane with her students, once on the ground in Baltimore.

The Hurricane Research Division (HRD), part of the **NOAA Office of Oceanic and Atmospheric Research** (OAR), develops models to improve the understanding of hurricanes and other tropical weather. Their research is based mainly on data obtained using aircraft like the WP-3D Orion.


NATIONAL HURRICANE CENTER
EXIT
NOAA
NEWS

Dr. Diane's meteorology students had excitedly watched the television coverage of the hurricane hunters' visit in Bangor the day before. Now, the students traveled by bus from Shippensburg to meet the WP-3D plane as it touched down in Baltimore. Upon arrival, they would visit the scientists and learn about the meteorological and oceanic instruments that are dropped from the plane as it ventures through each hurricane.

After witnessing the thrill of the descent onto the runway from her seat inside the flight station, Dr. Diane stepped out of the plane and was pleased to be greeted by the familiar faces of her students. She also noticed with delight one of the elementary students who completed a project on hurricanes during the NOAA science fair earlier that year. The smiles on the students' faces were a mile wide as one of the pilots of the plane shook their hands. Of course, one of the first questions posed related to the thrill of flying through a hurricane. "What is it *REALLY* like?" they asked.

The pilot told them that flying within the eye is like walking into a massive stadium, where the surrounding eyewall clouds look like white bleachers beneath the blue sky above. The elementary student proudly stated, "I hope to become a hurricane hunter someday, too!"

Everyone was fascinated by the plane. NOAA has two WP-3D Orion aircraft, each with a unique Muppet character's name: ***Kermit*** and ***Miss Piggy***. The planes, based in Tampa, Florida, can travel over 2000 **nautical miles** during each flight. *Kermit* and *Miss Piggy* have been through more than 90 hurricanes since they were built in the mid-1970's. The highest **wind speed** ever experienced on the planes was 206 **knots** (185 mph) during Hurricane Gilbert in 1988.

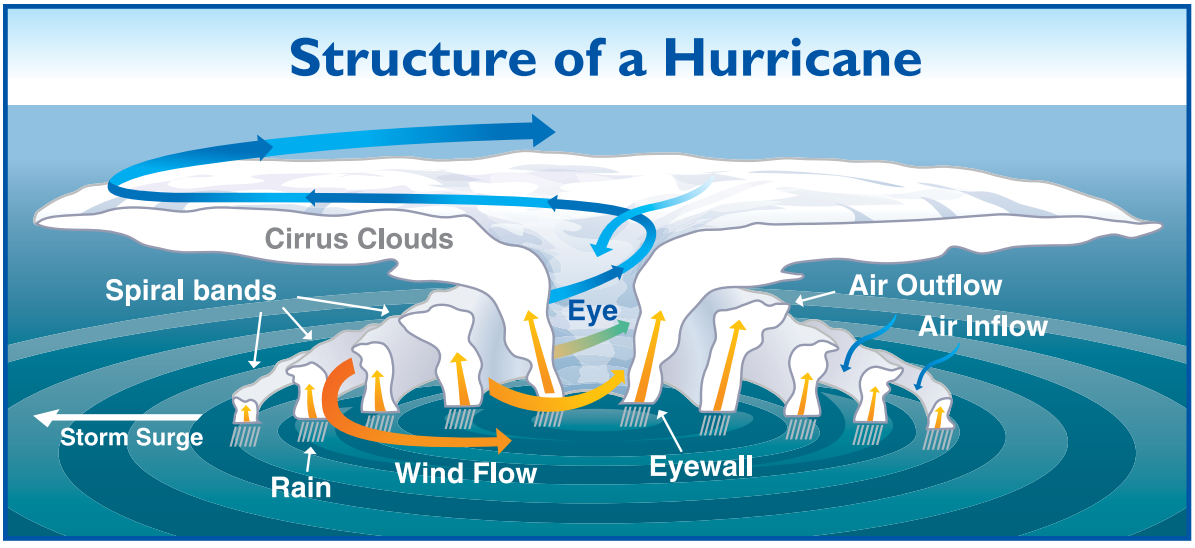
Eighteen people typically fly on hurricane missions, which may last up to eight hours. Amazingly, the plane weighs 135,000 lbs (61,235 kg) when fully loaded. If each plane was fueled with gasoline instead of jet fuel, one flight would use enough gas to fill your car's tank 375 times!

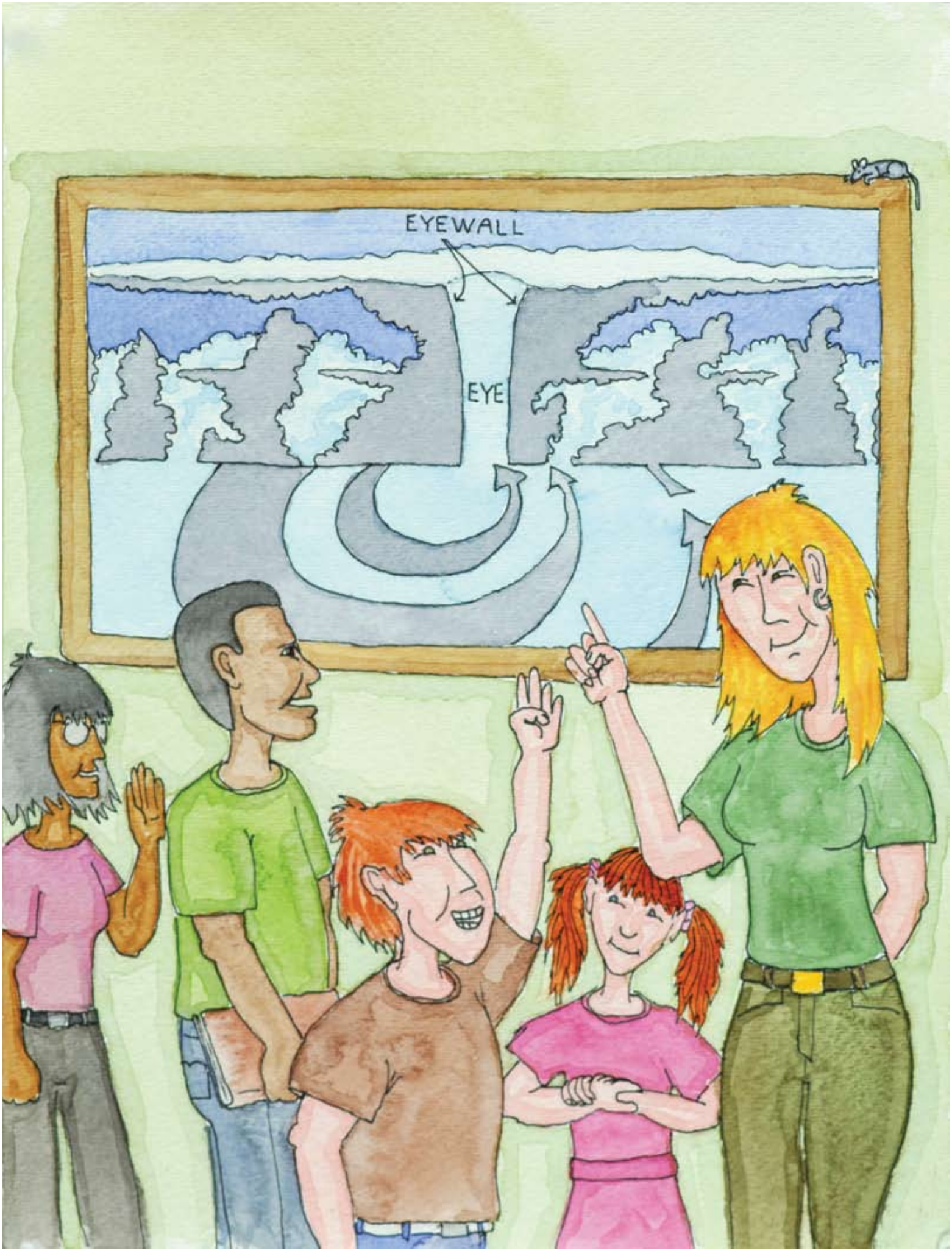
? Since there are 1,852 meters in one nautical mile, how many kilometers can *Miss Piggy* fly in one flight? ?


UNITED STATES DEPT OF COMMERCE
UNITED STATES DEPT. OF COMMERCE

Dr. Diane was excited to be part of the hurricane team during this Hurricane Awareness Tour. Her job was to explain how hurricanes form to people waiting to board the plane. The students were fascinated to know that hurricanes are the largest storms in the world, sometimes extending to 375 miles (600 km) in diameter. They form over large bodies of water in the low **latitude** tropics, close to, but not directly at the equator. There, warm water (26°C or 79°F) provides the fuel to allow hurricanes to grow to over 9 miles (14 km) in height. This is above the altitude of many commercial airplanes as they make a cross-country flight! The chief scientist on the plane added, "Surprisingly, even in the warm tropics, ice often forms on the wings of the plane if *Miss Piggy* flies above the freezing level within the clouds!"

Hurricanes always rotate counter-clockwise in the Northern Hemisphere (and clockwise in the Southern Hemisphere) due to the **coriolis effect**. They are centered around an area of very low air pressure called the eye, which is typically 15-35 miles (24-56 km) in diameter. In the center of the eye, the wind speed is almost zero, while in the surrounding eyewall, winds can reach over 215 mph (350 kph). The **spiral bands** that surround the eyewall extend out to the edge of the storm bringing steady and widespread rainfall. When the eyewall passes over land it brings torrential rain, destructive winds, and sometimes bolts of lightning and tornadoes. A huge storm surge pushes water onshore, often causing incredible destruction of vehicles, boats, and homes.




EYEWALL
EYE

The students speaking with Dr. Diane waited as people entered and exited *Miss Piggy* during their tour. One of the students from a local high school remarked that he has a difficult time remembering the wind speed that upgrades a **tropical storm** to hurricane status. Another student asked how many storm categories there are before an area of low pressure actually becomes strong enough to be called a hurricane.

"Excellent questions," replied Dr. Diane. She described how disturbances in the tropics are called **tropical depressions** if the sustained wind speed remains at or below 38 mph (62 kph). At this point, the National Hurricane Center in Miami gives the tropical depression a number. As the wind speed increases and holds consistently between 39 and 73 mph (63 and 118 kph), the depression becomes a tropical storm. The NHC then gives the storm a **name**. When winds are sustained at 74 mph (119 kph) or greater, the NHC then designates it a hurricane. The **Saffir-Simpson scale** (page 39) is used to place the hurricane into one of five categories depending on its wind speed. The scale also relates to barometric pressure, and indicates storm surge potential and destructive capability, with the least intense hurricanes given a category 1 rating. The most powerful hurricanes are designated as a category 5. Tropical depressions, tropical storms, and hurricanes are collectively referred to as **tropical cyclones**.

After waiting in a long line with curious school children, it was finally time for Dr. Diane's students to board *Miss Piggy*. As they went up the plane's ladder, everyone noticed the hurricane stickers on the side of the plane with the names of each hurricane *Miss Piggy* had flown through. Two students smiled when they saw their names, Danielle and Earl, two hurricanes that had formed in 1998.

Naming tropical storms: Tropical disturbances receive a name when they have sustained winds of at least 39 mph, indicating tropical storm status. Starting in 1953 each tropical storm of the season was named alphabetically with a woman's name, beginning with the letter 'A'. Since 1979, both men's and women's names have been used. Only 21 letters of the alphabet are utilized (Q, U, X, Y, and Z are omitted) and if enough tropical storms form in one season, the names of the Greek alphabet (Alpha, Beta…) are used. A complete list of Atlantic tropical cyclone names for 2005-2010 is shown on page 42.

Category 1 Hurricane — winds 74-95 mph

Category 2 Hurricane — winds 96-110 mph

Category 3 Hurricane — winds 111-130 mph

Category 4 Hurricane — winds 131-155 mph

Category 5 Hurricane — winds greater than 155 mph

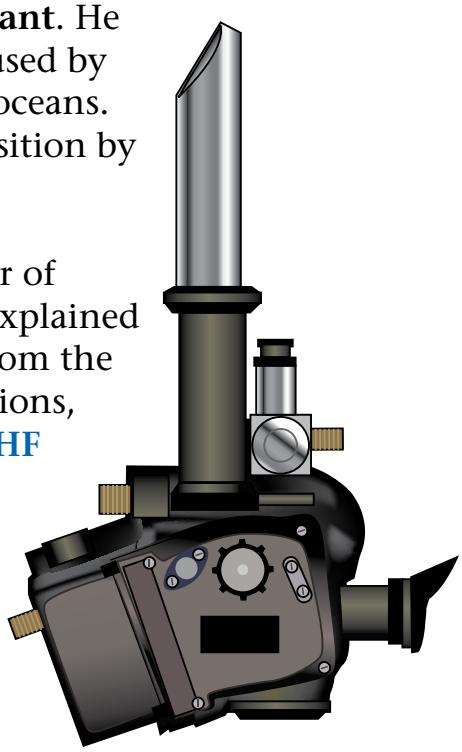
Throughout the tour, the students listened intently to a description of each crewmember's duties. At the flight station, students had the opportunity to sit and talk with a pilot, discussing what it would feel like to fly the plane through a storm. They were also curious about how the pilots know exactly where to fly. The navigator, who determines the tracks for each mission, addressed this question. Using the GPS, the navigator gets the plane in position for an eyewall pass, plots the actual position of the hurricane, and then determines the hurricane's speed and direction of travel.

While flying over the Gulf of Mexico and the Caribbean Sea, the navigator must ensure the plane is flying high enough to clear the numerous mountains on the islands and in coastal areas. The hurricane hunters typically make six passes through the eyewall, so the navigator also keeps track of the total fuel used, guaranteeing the plane can make it back home safely.

The navigator also happened to be a geographer who loved to cross-check his modern electronic systems with a **sextant**. He explained that this is the same instrument first used by explorers almost 300 years ago to cross the vast oceans. The sextant enables him to verify the plane's position by using the sun, moon, stars or planets as a guide.

Dr. Diane noticed that there were a large number of radios at the navigator's station. The navigator explained that there are many ways to send information from the plane. Similar to AM, FM, and satellite radio stations, the plane can transmit information using **HF, VHF** and **satellite communication** radios.

HF (High Frequency) can be used for long distance transmission of voice or data directly to the National Hurricane Center. VHF (Very High Frequency) and UHF (Ultra High Frequency) are used for line-of-sight voice communications between planes or to air traffic control towers. Satellite communication channels are dedicated to either high-speed data or voice transmissions to send crucial data to the NHC, and are typically used when the plane is far offshore.



The sextant is a device used to aid in determining one's position and heading. It measures the angle of a celestial body, such as the sun or stars, from the horizon.

Once the plane is in the correct position to begin a hurricane pass, the **flight director** uses the plane's **radar** equipment to determine where it is safest to fly through the eyewall, and then directs the pilots to enter the eye of the hurricane. There are three radar displays: one showing the horizontal storm image, another the vertical profile, and the third displaying close-up images from the nose of the plane. Looking at the radar images, the flight director determines the best course for the pilots to steer through the gigantic **cumulonimbus** eyewall clouds. What a job! The goal is to enter the eyewall perpendicular to the wind direction without going into the most extreme parts of the storm. Dr. Diane asked the flight director to point out the nose and belly radar on the outside of the plane to her students later that afternoon.

Another job of the flight director is to decide when to launch the scientific probes. Some of the students thought it would be hard to make so many decisions while traveling at 240 knots (275 mph). The flight director winked and said, "That's why they pay me the big bucks."

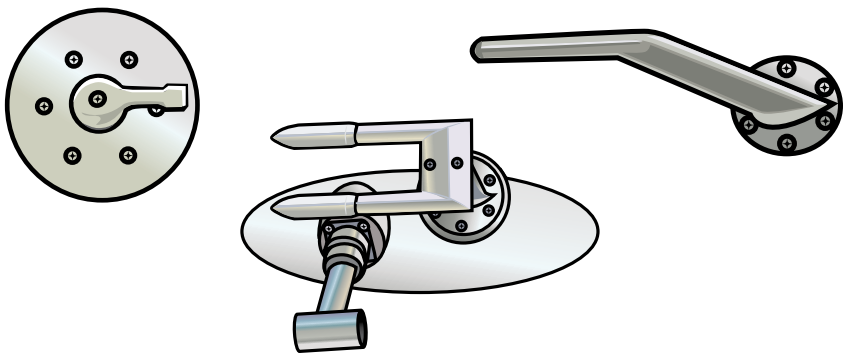
The tour continued and Dr. Diane was eager for her students to learn more about her favorite part of the plane, the science section. The students asked the scientists how they collect data to help answer research questions about hurricanes. The scientists use the same radar images as the flight director, and also collect data from dropsondes and the AXBT's that Dr. Diane had learned about earlier in the morning. She explained to the students, "Data from these sensors are recorded on each flight, and then incorporated into weather forecast models to help predict when and where landfall will occur." Over the past 30 years, the Hurricane Research Division models have greatly improved predictions of where storms will hit the coastline.

The aircraft's nose and belly radar signals reflect off raindrops in the eyewall, allowing the scientists to visualize the hurricane structure. The tail Doppler radar tells scientists the wind speeds and maximum height of the hurricane. *Miss Piggy* enters the eyewall at a relatively low altitude, typically 5,000 feet (1524 m), which is only $^{1}/_{10}$ of the height of the hurricane!


AOC

After touring the inside of the plane, Dr. Diane and her class descended down the steps of *Miss Piggy* onto the **tarmac** to observe the outside of the plane. Many additional sensors are attached along the exterior to monitor atmospheric conditions within a hurricane. A **hygrometer** is used to measure the moisture held within the massive cumulonimbus clouds. The wind speed is calculated from many sources, including a **pitot tube**, which is a pressure **anemometer**. A **thermocouple** is a device used to measure the outside air temperature very accurately. These sensors provide necessary information about the conditions in which *Miss Piggy* flies.

After a final glance at these instruments, Dr. Diane exclaimed, "Time to eat!" She and her students walked over to the edge of the airstrip where volunteers from the local community were serving lunch to the entire hurricane hunter team. The students were thrilled when the flight coordinator, a scientist who had flown through more hurricanes than any other hurricane hunter, asked if he could join them for lunch. The students asked him to share some stories about flights into and out of hurricanes. They asked an array of questions, including, "Which hurricane was the most scary to fly through?" The flight coordinator answered that flying through Hurricane Hugo in 1989, when one of the engines failed, was his most harrowing experience. Fortunately, the plane managed to make it back home safely on three engines.

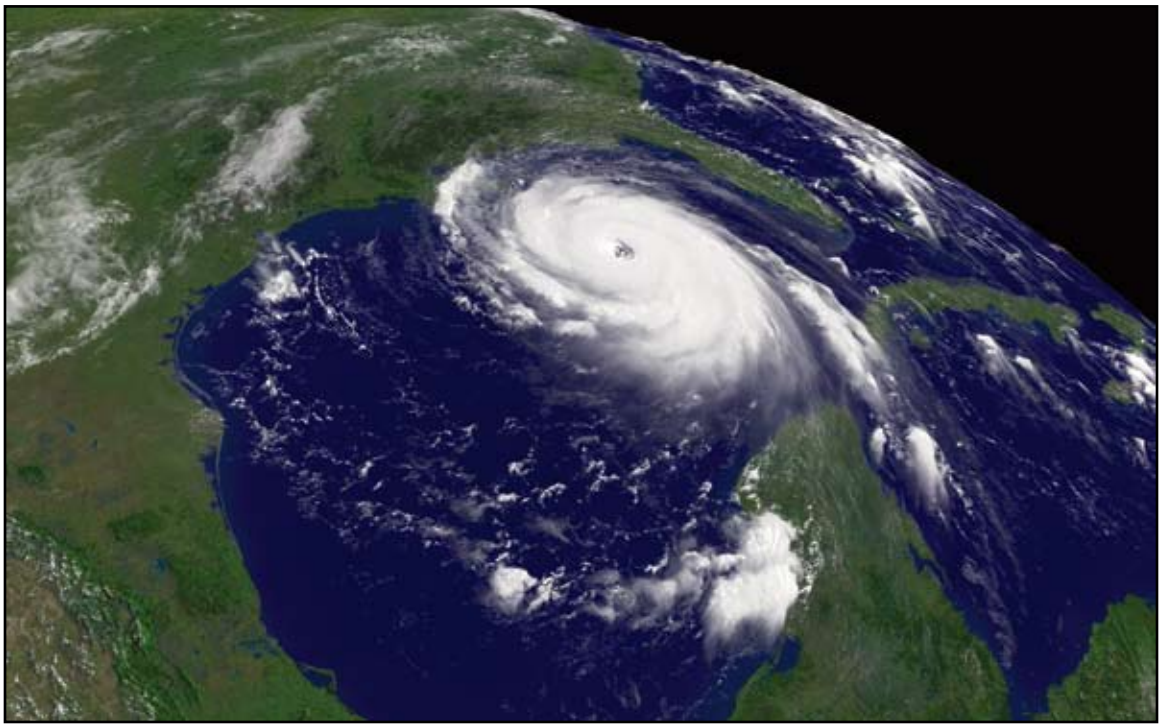


Three examples of the external sensors on *Miss Piggy* that measure the atmosphere's temperature, pressure and humidity.

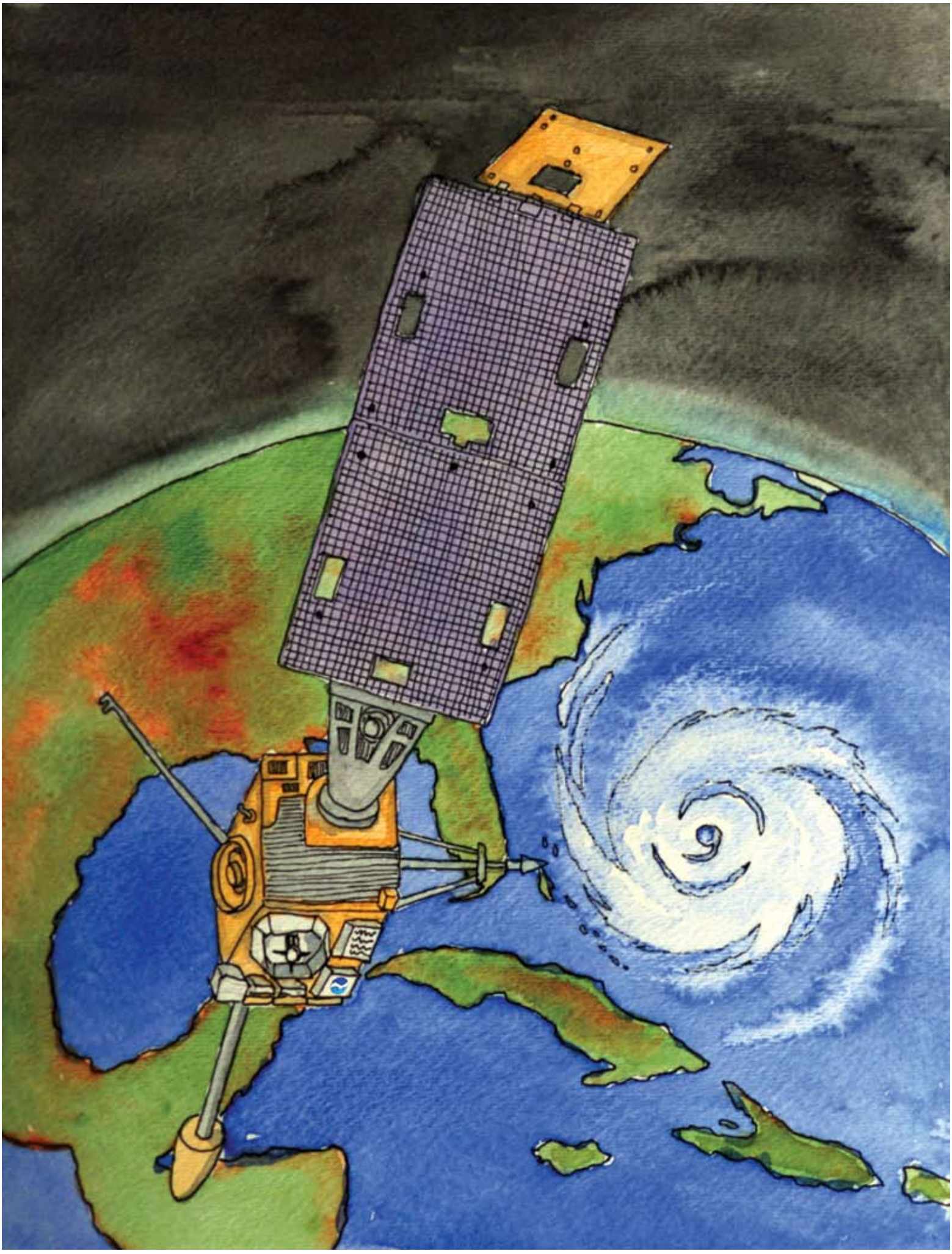

HURRICANE HUNTERS

One student had noticed all of the computer systems on the plane and asked about the data the systems were processing. They were amazed to learn that every tenth of a second, 250 different parameters, such as wind speed, wind direction, and velocity of the plane, are processed by the main database system! Critical portions of the data are transmitted over a satellite link to forecasters at the National Hurricane Center. They then run computer hurricane models, which are a key element in forecasting a hurricane's strength and where it will move. It is therefore essential that *Miss Piggy's* information be analyzed quickly and efficiently.

The students remembered Dr. Diane showing them hurricane data along with NOAA **satellite imagery** from the World Wide Web at the National Hurricane Center website. They could not believe that during a major hurricane the NOAA home page and the NHC website can receive over 295 million hits in one day! Recently, the NHC website received up to 5,200 hits per second as Hurricane Katrina pummeled the Gulf Coast states!



The **NOAA National Environmental Satellite, Data, and Information Service** (NESDIS) produces satellite imagery of hurricanes, which can be found at the NHC website: www.nhc.noaa.gov. This image of Hurricane Katrina was taken from the NOAA **GOES-12** satellite in 2005.



After lunch, the students met with the Director of the National Hurricane Center to learn what happens onshore during a hurricane. Can you imagine 100-year old trees uprooted from the ground, boats carried half a mile inland on a storm surge, or a 20-car pileup from floodwaters that washed them into a heap? The Director explained how extensive damage from a hurricane can also be caused by tree branches as they break, and materials from roofs or signs as they blow downwind due to the immense force of the hurricane. One of Dr. Diane's students asked the Director if wind or water is the most destructive part of the hurricane. He stated that the most extensive damage is related to the storm surge, which causes huge amounts of flooding, especially along the coast when the hurricane hits land. Heavy downpours also add to the flooding caused by the storm surge. Surprisingly, many places rely on the hurricane season to enhance annual rainfall, which can replenish groundwater levels and help prevent drought.

The **NOAA National Ocean Service**, through its **Tides Online website**, shows water levels based on the tides along coastal areas. During a hurricane, the storm surge can raise water levels to dangerous heights, as the Saffir-Simpson scale indicates. The storm surge height depends on the wind speed, the tidal state, the slope of the offshore continental shelf, and the inland **topography**. Dr. Diane told the students that one of the highest storm surges ever recorded in the United States was 24 feet (7.3 m) during Hurricane Opal in 1995!

After Hurricane Katrina, **NOAA National Marine Fisheries Service** veterinarians rescued eight trained dolphins that were swept out to sea from their damaged aquarium. Fisheries scientists also collected and tested samples of water, sediment, and fish tissue from areas in the Gulf of Mexico affected by the storm. This will help ensure that our seafood supply remains free of harmful toxins and bacteria. Other Fisheries scientists evaluated wetlands losses and conducted surveys to determine how populations of native oysters, shrimp and fish changed as a result of Hurricanes Katrina and Rita.

Before Storm Surge

After Storm Surge

Dr. Diane was excited to hear the hurricane experts on the plane discuss the importance of the **NOAA Weather Radio** for hurricane awareness. She uses this radio daily to access current weather information and to receive special severe weather alerts for southern Pennsylvania. She had even given weather radios to friends and family members as birthday gifts. The NOAA weather radio stations provide real-time weather information nationwide on seven different VHF channels. There are over 900 broadcast towers across the United States, which also send out warning signals for other impending public safety issues, both natural and human-induced. Examples include flash floods, volcanic activity, and earthquakes.

Earlier that day, the names of each student and teacher who came to tour *Miss Piggy* were entered into a drawing. The winner would receive a **NOAA weather radio**, which was developed by the **NOAA National Weather Service**. Now they gathered around to see who would be the proud owner of the AM/FM/NOAA radio, which would come in handy during upcoming hurricane seasons. A 7th grade student beamed when his name was called. He accepted the radio graciously, knowing that he would place it in his family's living room for everyone to use.

NOAA Weather Radio

You can receive wave height information during the marine forecast on NOAA weather radio.

? Did you know? … During Hurricane Ivan in 2004, waves over 27 meters high were recorded by buoys in the middle of the Gulf of Mexico. How high were these waves in feet? ?


ROC
NOAA
WEATHER
RADIO

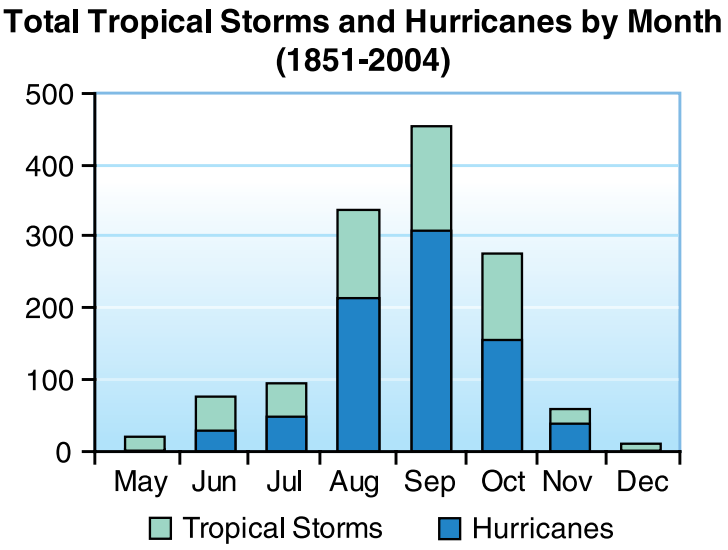
During their visit to see *Miss Piggy*, the students met with members of local emergency management groups. They spoke with firefighters, sheriffs, **ham radio** operators, and members of the police force and National Guard. While best known for assisting after a disaster, these people and organizations also support communities in advance by providing training and guidance.

The students were then asked to be interviewed by the local TV station reporter, who promised that they would be on TV later that night. They couldn't wait to tell their parents the news!

As Dr. Diane and her students departed from the airport in Baltimore, they each received a hurricane tracking chart (inside front cover), similar to charts that can be printed from the National Hurricane Center website. They planned to track each hurricane on their own during the upcoming **hurricane season**.

When the students returned to Shippensburg University they gave a presentation to the campus and local community informing everyone about the importance of hurricane awareness and preparedness. They described what should be done before and during a hurricane, including listening to authorities, leaving if told to evacuate, and preparing to be gone for up to a week or longer. They emphasized that each family should prepare a **hurricane emergency kit** and keep it accessible. Dr. Diane listened with pride as her students conveyed their knowledge of hurricane awareness and safety to those attending the presentation.

The hurricane season is the portion of the year having a relatively high occurrence of hurricanes. The hurricane season in the Atlantic, Caribbean, and Gulf of Mexico runs from June 1 to November 30. Using the bar graph to the right, estimate the total number of tropical storms and hurricanes during each month of the hurricane season. For example, in June, there were 76 tropical storms and 28 hurricanes.

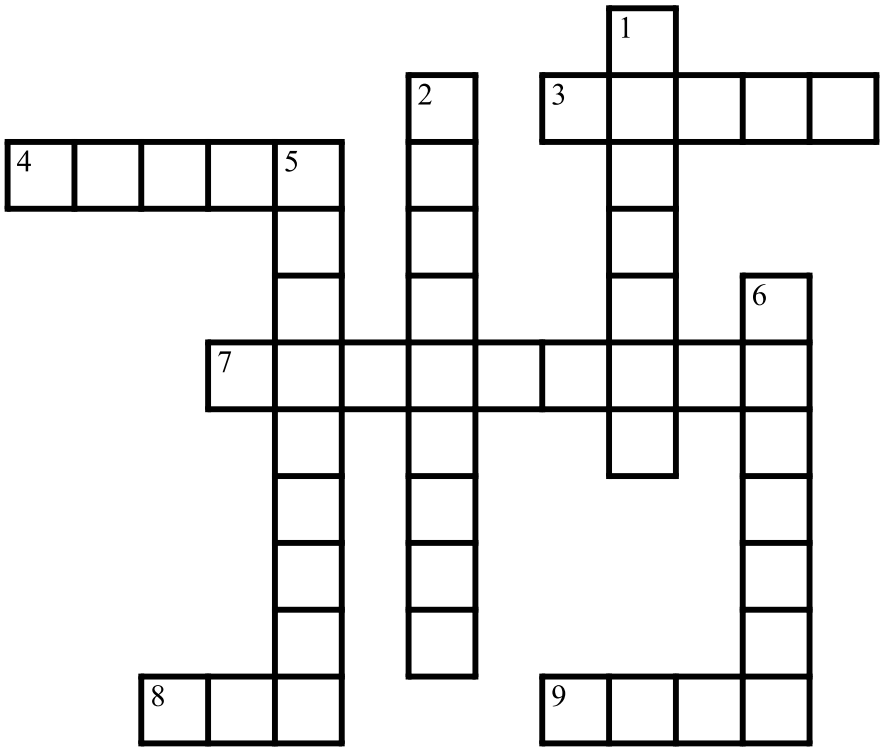



US
COAST GUARD
US NAVY
E & G
ARES
EMT
ARMY
PD
FD
FIRST AID

What a wonderful experience to have been a NOAA Teacher in the Air and a member of the Hurricane Awareness Team! Dr. Diane was thankful to have met the scientists, crew, and forecasters who improve the safety of people living in both coastal and inland regions. The crew of *Miss Piggy* was grateful that Dr. Diane had helped explain to the public how hurricanes form, as well as their destructive potential. Luckily, with today's satellite and computer technology, along with an extensive warning system, people are well informed of a hurricane's arrival far in advance. Dr. Diane's students had also benefited from their experience touring *Miss Piggy*, and many were considering scientific research as an exciting and challenging career, perhaps even working for NOAA someday!

Upon returning to Shippensburg, Dr. Diane smiled as she walked to class, remembering the appreciative looks of her students as they waved goodbye to the pilots on *Miss Piggy*. As she reflected upon the heroic efforts of the men and women who dedicate their lives to gathering hurricane information, she realized that someday her students might also contribute to these important scientific efforts.

Teacher in the Air Hurricane Crossword Puzzle



ACROSS

3 The system that enables the flight director to “see” the hurricanes.

4 What is issued to the public when hurricane conditions are possible within 36 hours.

7 Devices dropped from altitude to measure the winds of the storm.

8 Calmest part of a hurricane.

9 A device dropped from the plane that measures the ocean temperature.

DOWN

1 What is issued to the public when hurricane force winds are expected within 24 hours.

2 The name of the NOAA plane that flies into hurricanes.

5 Name of tropical cyclones with winds greater than 74 mph.

6 The device used by the navigator to determine position from the sun or stars.

*Answers on page 39

NOAA WP-3D and G-IV Hurricane Aircraft


WP-3D Orion

The renowned NOAA WP-3D Orions (*Kermit* and *Miss Piggy*) participate in a wide variety of national and international meteorological, oceanographic and environmental research programs, in addition to their widely known use in hurricane research and reconnaissance. These versatile turboprop aircraft are equipped with a variety of scientific instrumentation, radars and recording systems for measurements of the atmosphere, the earth, and its environment. These robust and well-maintained aircraft have led NOAA's continuing effort to monitor and study hurricanes and other severe storms, the quality of the atmosphere, the state of the ocean, and climate trends.


Gulfstream IV-SP

The Gulfstream IV-SP or G-IV (*Gonzo*) is a high-altitude, high-speed, twin-turbofan jet aircraft configured for operational support flying surveillance missions for the National Hurricane Center. It was designed to collect, process, and transmit vertical atmospheric soundings in the environment of the hurricane. The data are transmitted to the National Centers for Environmental Prediction and the National Hurricane Center for inclusion in global and hurricane models. In addition, hurricane forecasters use the real-time observations to depict the synoptic patterns surrounding hurricanes.

NOAA's Office of Marine and Aviation Operations (OMAO) operates a wide variety of specialized aircraft and ships to complete NOAA's environmental and scientific missions, including *Kermit*, *Miss Piggy*, and *Gonzo*.

Teacher in the Air Glossary

Scientific words in bold print in the text are defined below.

Anemometer – An instrument used to measure wind speed.

AXBT – An expendable bathythermograph measures water temperature. It is launched from an aircraft and equipped with a small parachute to slow its descent from high altitudes.

Coriolis Effect – An apparent movement of the air mass particles to the right of their intended path (in the Northern Hemisphere). It is the result of observations in a rotating reference system, such as the earth.

Cumulonimbus – A vertically developed cumulus cloud, often capped by an anvil-shaped cloud. Also called a thunderstorm cloud, it is frequently accompanied by heavy showers, lightning, thunder, and sometimes hail, gusty winds, or a tornado.

Downdraft – A small-scale column of air that rapidly sinks toward the ground, usually accompanied by precipitation as in a shower or thunderstorm.

Dropsonde (known as a **GPS** dropwindsonde) **–** A weather reporting instrument, about the size of an empty paper towel roll, which is dropped by aircraft into the storm or hurricane. The temperature, pressure and humidity are radioed back to the plane as it falls to the surface. Wind speed and wind direction are also derived.

Eye – The roughly circular area of comparatively light winds that encompasses the center of a severe tropical cyclone. The eye is either completely or partially surrounded by the eyewall cloud, and is the lowest atmospheric pressure point of the hurricane.

Eyewall – An organized band or ring of cumulonimbus clouds surrounding the eye with maximum wind speeds in the hurricane.

Flight Director – A meteorologist flying on the Hurricane Hunter aircraft who determines the scientific profile of each mission. Using the radar, the flight director directs the plane through the eye of the hurricane and then determines the center position of the storm.

Flight Engineer – A flight engineer is a member of the aircrew who is responsible for monitoring aircraft systems during flight. These systems include pressurization, fuel, environmental, hydraulic, and electrical systems.

Flight Station – Also referred to as the cockpit, this area contains all the controls to fly the plane. On *Miss Piggy*, two pilots and one flight engineer operate the aircraft from this location.

GOES-12 – One satellite in the series of Geostationary Operational Environmental Satellites operated by NOAA NESDIS to provide weather information.

GPS – The Global Positioning System is a set of 24 satellites that broadcasts signals worldwide enabling people and machines to know their location (in 3 dimensions) to within 30 meters.

Ham Radio – Amateur radio, a hobby enjoyed by many people throughout the world (as of 2004 about 3 million worldwide). A holder of an Amateur Radio license can transmit information such as voice, data, and even TV signals to others worldwide.

Hurricane – A tropical cyclone in which the maximum sustained surface wind (using the U.S. 1-minute average) is 64 knots (74 mph or 119 kph) or more. The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian. The term typhoon is used for Pacific tropical cyclones north of the Equator west of the International Dateline.

Hurricane Awareness Tour – An education and outreach tour using NOAA's WP-3D Orion research aircraft and crew which provides tours for the public and local school children. Hurricane experts from the National Hurricane Center are available during the day to brief Emergency Management Officials on hurricane forecasting and provide media interviews.

Hurricane Emergency Kit – This portable kit is a necessity for anyone living in a region threatened by hurricanes. Contents of a suggested kit are found on page 40.

Hurricane Hunters – The name used in the U.S. to describe two organizations that fly into the eye of hurricanes supporting the National Hurricane Center. The NOAA team flies the WP-3D Orion research aircraft; the US Air Force Reserve team flies the C-130 cargo aircraft.

Hurricane Season – The hurricane season in the Atlantic, Caribbean, and Gulf of Mexico runs from June 1 to November 30. In the Eastern Pacific the hurricane season runs from May 15 to November 30, and in the Central Pacific the season runs from June 1 to November 30.

Hurricane Warning – A warning that sustained winds 64 knots (74 mph or 119 kph) or higher associated with a hurricane are expected in a specified coastal area in 24 hours or less. A hurricane warning can remain in effect when dangerously high water or a combination of dangerously high water and exceptionally high waves continue, even though winds may be less than hurricane force.

Hurricane Watch – An announcement for specific coastal areas that hurricane conditions are possible within 36 hours.

Hygrometer – An instrument used to measure humidity, which is the amount of moisture in the air.

***Kermit* and *Miss Piggy* –** See page 35 for a complete description.

Knots – A speed measurement used by the maritime and aviation community in place of miles or kilometers per hour. One nautical mile equals one minute of latitude on the surface of the earth. One knot would then be one nautical mile per hour.

Landfall – The intersection of the surface center of a tropical cyclone with a coastline. Because the strongest winds in a tropical cyclone are not located precisely at the center, it is possible for a cyclone's strongest winds to be experienced over land even if landfall does not occur. Similarly, it is possible for a tropical cyclone to make landfall and have its strongest winds remain over the water.

Latitude – An angular measurement of the earth from the equator to either the North or South Pole. There are 90 degrees of latitude from the equator to each pole, each degree designated as a North or South latitude.

Meteorologist – A person who specializes in meteorology in careers such as a research scientist, teacher, forecaster, or weather personality on TV.

Meteorology – The science of the atmosphere and atmospheric processes, including the weather and climate.

Models – Computer programs used by scientists to predict the future position and state of the atmosphere; for hurricanes this includes predicting where the storm will make landfall. Weather models use grid techniques to process massive data sets.

National Hurricane Center – The Center is located in Miami, Florida, and produces the tropical forecasts for the nation. They use data from weather satellites, aircraft, land and shipboard observations to produce advisories, warnings, and watches.

Nautical Mile – A distance related directly to the circumference of the earth, and used for navigation in the air and at sea. The angular distance from the equator to the North Pole is 90 degrees. Each degree of latitude is broken into 60 segments called minutes. Each minute of latitude is further broken down into 60 seconds of latitude. One nautical mile is defined as one second of latitude; this is the same as 1.15 miles along any American highway.

Navigator – Crew member on the NOAA Hurricane Hunters who ensures the safe passage of the aircraft to and from the storm. When flying in the hurricane, the navigator determines the direction and speed of the storm.

NOAA – The National Oceanic and Atmospheric Administration, under the Department of Commerce, is responsible for prediction and research of weather and climate-related events, charting the sea and skies, and providing environmental stewardship of the nation's coast and marine resources.

NOAA Corps – The smallest of the seven Uniformed Services of the United States, with approximately 290 commissioned officers. It is the uniformed service of the National Oceanic and Atmospheric Administration (NOAA).

NOAA National Environmental Satellite, Data, and Information Service (NESDIS) - An office of NOAA that provides timely access to global environmental data from satellites and other sources to promote, protect, and enhance the Nation's, security, environment, and quality of life.

NOAA National Marine Fisheries Service (NMFS) – An office of NOAA dedicated to the stewardship of living marine resources through science-based conservation and management, and the promotion of healthy ecosystems.

NOAA National Ocean Service (NOS) – An office of NOAA that measures and predicts coastal and ocean phenomena, protects large areas of the oceans, and works to ensure safe maritime navigation.

NOAA National Weather Service (NWS) – An office of NOAA that provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property.

NOAA Office of Marine and Aviation Operations (OMAO) – An office of NOAA that operates a wide variety of specialized aircraft and ships to complete NOAA's missions.

NOAA Office of Oceanic and Atmospheric Research (OAR) – An office of NOAA that is responsible for all of NOAA's research, the driving force behind NOAA environmental products and services that protect life and property.

NOAA Weather Radio – A system that broadcasts All Hazards messages to the nation, providing immediate warnings of tornadoes, floods, chemical spills and other perils. These radios are inexpensive and available throughout the US from many different vendors.

Pilot – The person responsible for the safe operation of the NOAA Hurricane Hunter aircraft. The pilot steers the plane into the eye of the storm, and lands the plane after the long mission is over.

Pitot Tube – an instrument used to measure flow rates, and more specifically, used to determine airspeed on aircraft.

Radar – Stands for "Radio Detection And Ranging" and returns echoes from transmitted pulses on any target it hits. In the atmosphere, raindrops reflect the energy, and therefore it is an excellent tool to visualize the hurricane structure.

Saffir-Simpson Scale – A rating, developed by Herbert Saffir and Robert Simpson, consisting of five categories that indicate expected damage to structures based upon wind speed and the effects of storm surge and flooding.

Sextant – A navigational instrument used to determine the vertical position of an object such as the sun, moon or stars. It is used with celestial navigation.

Spiral Bands – Part of the hurricane structure, they radiate outward from the eye of the storm. The spiral bands can extend for up to 300 miles from the eye.

Storm Surge – An onshore rush of water associated with a low pressure weather system, typically a tropical cyclone. Storm surge is caused primarily by high winds pushing on the ocean's surface causing the water to pile up higher than the normal sea level. Low pressure at the center of a weather system also has a small secondary effect, as can the bathymetry of the body of water.

Tarmac – A tar-based pavement at an airport where planes are parked, away from the runway and taxiways.

Thermocouple – A temperature sensor created by joining two dissimilar metals. The junction produces a small voltage as a function of the temperature.

Tides Online Website – NOAA's Tides Online (http://tidesonline.nos.noaa.gov) is a Web-based product, which provides users with the latest graphical and tabular water level observations, predictions and meteorological data in near real-time.

Topography – The relative elevations of the different features of a landscape.

Tropical Cyclone – A warm, low pressure storm originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center.

Tropical Depression – A tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) is 33 knots (38 mph or 62 kph) or less.

Tropical Disturbance – A discrete tropical weather system of apparently organized convection, generally 100 to 300 nautical miles in diameter, that originates in the tropics or subtropics, and moves and maintains its identity for 24 hours or more.

Tropical Storm – A tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 34 knots (39 mph or 63 kph) to 63 knots (73 mph or 118 kph).

Tropical Storm Warning – A warning that sustained winds within the range of 34 to 63 knots (39 to 73 mph or 63 to 118 kph) associated with a tropical cyclone are expected in a specified coastal area within 24 hours or less.

Tropical Storm Watch – An announcement for specific coastal areas that tropical storm conditions are possible within 36 hours.

Updrafts – Rapid movement of air straight upward, usually in the vicinity of the eyewall.

Wind Speed – The velocity of the wind measured in knots or miles per hour.

WP-3D Orion – The National Oceanic and Atmospheric Administration has two planes manufactured by Lockheed based on the Electra airliner. They are the primary research aircraft to peer inside the fast-moving wall clouds of hurricanes since the late 1970s.

Answers:

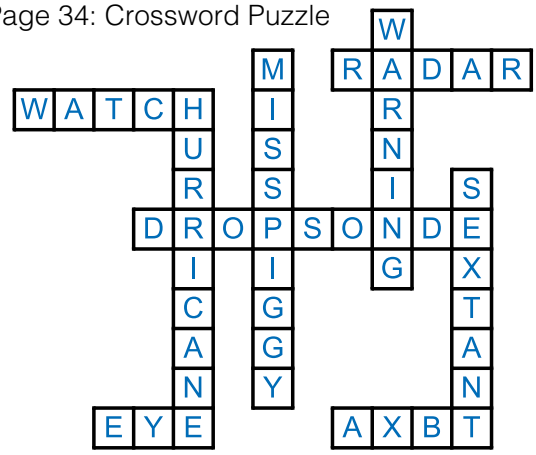
Page 12: *Miss Piggy* can travel 3,704 kilometers in one flight.

Page 28: The wave height was 89 feet.

Page 30: Answers may vary from the actual numbers due to estimation.

Month	Hurricanes	Tropical Storms
Jun	28	76
Jul	47	94
Aug	214	336
Sep	309	448
Oct	154	273
Nov	38	58

Page 34: Crossword Puzzle



Conversions

1 kilometer (km) = 1,000 meters (m) = .6214 miles (mi)

1 foot (ft) = .3048 meters (m)

1 mile (mi) = 5,280 feet (ft) = .8690 nautical mile

1 knot (kt) = 1 nautical mile per hour = 1.15 miles per hour (mph)

1 knot (kt) = 1.85 kilometers per hour (kph)

1 knot (kt) = 1.7 feet per second (ft/s) =.51 meters per second (m/s)

1 meter (m) = 39.37 inches (in)

1 centimeter (cm) = .3937 inches (in)

1 kilogram (kg) = 2.205 pounds (lb)

1 atmosphere (atm) = 14.7 pounds per square inch (psi)

1 yard (yd) = .9144 meters (m)

Saffir-Simpson Hurricane Scale

Tropical Storm
Winds 39-73 mph

Category 1 Hurricane
Winds 74-95 mph (64-82 knots)

Storm surge generally 4-5 ft above normal. No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs. Also, some coastal road flooding and minor pier damage.

Category 2 Hurricane
Winds 96-110 mph (83-95 knots)

Storm surge generally 6-8 feet above normal. Some roofing material, door, and window damage of buildings. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs, and piers.

Category 3 Hurricane
Winds 111-130 mph (96-113 knots)

Storm surge generally 9-12 ft above normal. Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed.

Category 4 Hurricane
Winds 131-155 mph (114-135 knots)

Storm surge generally 13-18 ft above normal. More extensive curtainwall failures with some complete roof structure failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows.

Category 5 Hurricane
Winds 156 mph and up (135+ knots)

Storm surge generally greater than 18 ft above normal. Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage.

Hurricane Emergency Family Disaster Plan and Disaster Supply Kit

(http://www.nhc.noaa.gov/HAW2/english/disaster_prevention.shtml)

Family Disaster Plan

- ☐ Discuss the type of hazards that could affect your family. Know your home's vulnerability to storm surge, flooding and wind.
- ☐ Locate a safe room or the safest areas in your home for each hurricane hazard. In certain circumstances the safest areas may not be your home but within your community.
- ☐ Determine escape routes from your home and places to meet. These should be measured in tens of miles rather than hundreds of miles.
- ☐ Have an out-of-state friend as a family contact, so all your family members have a single point of contact.
- ☐ Make a plan now for what to do with your pets if you need to evacuate.
- ☐ Post emergency telephone numbers by your phones and make sure your children know how and when to call 911.
- ☐ Check your insurance coverage - flood damage is not usually covered by homeowners insurance.
- ☐ Stock non-perishable emergency supplies and a Disaster Supply Kit.
- ☐ Use a NOAA weather radio. Remember to replace its battery every 6 months, as you do with your smoke detectors.
- ☐ Take First Aid, CPR and disaster preparedness classes.

Disaster Supply Kit

- ☐ Water - at least 1 gallon daily per person for 3 to 7 days
- ☐ Food - at least enough for 3 to 7 days
  - non-perishable packaged or canned food / juices
  - foods for infants or the elderly
  - snack foods
  - non-electric can opener
  - cooking tools / fuel
  - paper plates / plastic utensils
- ☐ Blankets / Pillows, etc.
- ☐ Clothing - seasonal / rain gear/ sturdy shoes
- ☐ First Aid Kit / Medicines / Prescription Drugs
- ☐ Special Items - for babies and the elderly
- ☐ Toiletries / Hygiene items / Moisture wipes
- ☐ Flashlight / Batteries
- ☐ Radio - Battery operated and NOAA weather radio
- ☐ Cash - Banks and ATMs may not be open or available for extended periods
- ☐ Keys - to important items such as the house, a car or a safe deposit box
- ☐ Toys, Books and Games
- ☐ Important documents - in a waterproof container or watertight resealable plastic bag — insurance, medical records, bank account numbers, Social Security card, etc.
- ☐ Tools - keep a set with you during the storm
- ☐ Vehicle fuel tanks filled
- ☐ Pet care items
  - proper identification / immunization records / medications
  - ample supply of food and water
  - a carrier or cage
  - muzzle and leash

Teacher in the Air and Teacher at Sea Programs

The NOAA Teacher in the Air Program is an offshoot of NOAA's Teacher at Sea Program and was first piloted in 2004. It has enabled teacher participants to observe research activities and interact with scientists while on board NOAA aircraft. Science projects have focused on wind flow patterns, hurricane awareness, and monsoons. Future TIA opportunities may be available for K-12 and university teachers and will be posted at http://www.teacheratsea.noaa.gov.

Since its inception in 1990, the NOAA Teacher at Sea (TAS) program has offered educators around the country the opportunity to see NOAA's exciting scientific research first hand. As of 2005, 430 teachers have participated in the program, representing 45 states, American Samoa, Chile, and Argentina. The program provides kindergarten through college-level teachers the chance to live and work side-by-side, day and night, with those who contribute to the world's body of scientific knowledge, and then take that experience back to the classroom.

Internet Resources for Teachers, Parents, and Students

Geophysical Fluid Dynamics Laboratory (GFDL): http://www.gfdl.noaa.gov

NOAA Coastal Services Center (NCSC): http://www.csc.noaa.gov

NOAA Hurricane Hunters (Aircraft Operations Center): http://www.aoc.noaa.gov

NOAA Hurricane Research Division (HRD): http://www.aoml.noaa.gov/hrd

NOAA National Environmental Satellite, Data, and Information Service (NESDIS): http://www.nesdis.noaa.gov

NOAA National Hurricane Center (NHC): http://www.nhc.noaa.gov

NOAA National Marine Fisheries Service (NMFS): http://www.nmfs.noaa.gov

NOAA National Ocean Service (NOS): http://www.oceanservice.noaa.gov

NOAA National Weather Service (NWS): http://www.nws.noaa.gov

NOAA Office of Education (OEd): http://www.oesd.noaa.gov

NOAA Office of Marine and Aviation Operations (OMAO): http://www.omao.noaa.gov

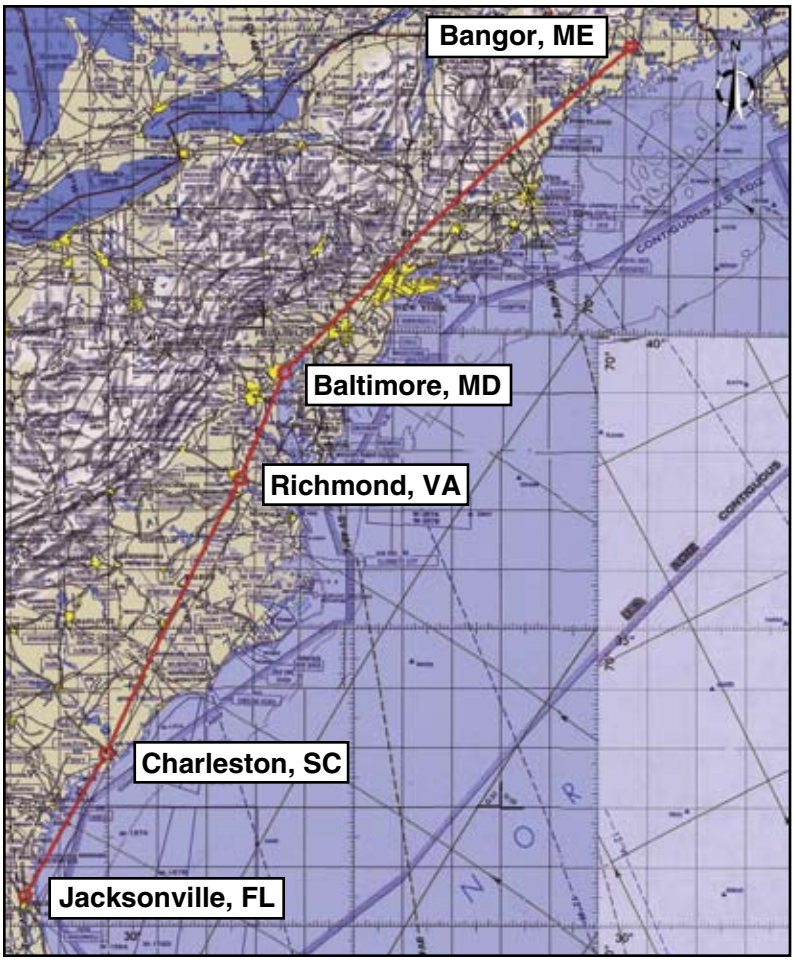
NOAA Office of Oceanic and Atmospheric Research (OAR): http://www.research.noaa.gov

NOAA Teacher in the Air Program: http://www.teacheratsea.noaa.gov

NOAA Weather Radio: http://weather.gov/nwr

Tides Online: http://tidesonline.nos.noaa.gov

Hurricane Awareness Tour Map



Atlantic Tropical Cyclone Names

2005	2006	2007	2008	2009	2010
Arlene	Alberto	Andrea	Arthur	Ana	Alex
Bret	Beryl	Barry	Bertha	Bill	Bonnie
Cindy	Chris	Chantal	Cristobal	Claudette	Colin
Dennis	Debby	Dean	Dolly	Danny	Danielle
Emily	Ernesto	Erin	Edouard	Erika	Earl
Franklin	Florence	Felix	Fay	Fred	Fiona
Gert	Gordon	Gabrielle	Gustav	Grace	Gaston
Harvey	Helene	Humberto	Hanna	Henri	Hermine
Irene	Isaac	Ingrid	Ike	Ida	Igor
Jose	Joyce	Jerry	Josephine	Joaquin	Julia
Katrina	Kirk	Karen	Kyle	Kate	Karl
Lee	Leslie	Lorenzo	Laura	Larry	Lisa
Maria	Michael	Melissa	Marco	Mindy	Matthew
Nate	Nadine	Noel	Nana	Nicholas	Nicole
Ophelia	Oscar	Olga	Omar	Odette	Otto
Philippe	Patty	Pablo	Paloma	Peter	Paula
Rita	Rafael	Rebekah	Rene	Rose	Richard
Stan	Sandy	Sebastien	Sally	Sam	Shary
Tammy	Tony	Tanya	Teddy	Teresa	Tomas
Vince	Valerie	Van	Vicky	Victor	Virginie
Wilma	William	Wendy	Wilfred	Wanda	Walter

Biographies

Diane Stanitski is a climatologist and associate professor at Shippensburg University in Pennsylvania where she teaches meteorology and atmospheric science courses. She served as both a NOAA Teacher in the Air in 2005 and a NOAA Teacher at Sea in 2002. She worked as a program manager in the NOAA Office of Climate Observation from 2003-2005 to help build the global ocean observing system. Diane was co-author of the book, *Teacher at Sea: Miss Cook's Voyage on the RONALD H. BROWN*. She is passionate about science and loves spending time with her family, traveling, playing soccer, and running.

John Adler is a Lieutenant Commander in the NOAA Corps and served for five years as a navigator onboard *Miss Piggy*, the NOAA Hurricane Hunter plane. Previously, he served for 11 years as an aerial navigator specializing in Polar Regions in the US Navy. John is currently an Instrument Manager for the next generation polar orbiting operational environmental satellite system (NPOESS) at NOAA. He lives in Shepherdstown, West Virginia, with his three sons, Austen, Ian, and Collin. Together, they enjoy sailing, reading, bicycling, and Macintosh computers.

Bruce Cowden is Chief Boatswain on the RONALD H. BROWN (RHB) and was illustrator for the book, *Teacher at Sea: Miss Cook's Voyage on the RONALD H. BROWN*. He lives in Charleston, South Carolina, the homeport of the RHB. He started going to sea at the age of 18 where he cruised around the Caribbean on sailing vessels. He then joined the US Navy and sailed with them for six years. In 1988, he began his career with NOAA on the research vessel *MALCOLM BALDRIGE*. He worked his way up to Boatswain group leader and then took the Chief Boatswain position on the NOAA Ship FERREL. After a few years on the FERREL, he started working in Gray's Reef National Marine Sanctuary in Savannah, Georgia, where he served as captain of the Sanctuary's support vessel and was a diver, ROV operator, and submersible pilot for sustainable seas operations. He then started working on the RHB where he currently serves as Chief Boatswain and Dive Master. His hobbies include cartooning, watercolor painting, and carving jewelry and figurines.

TEACHER in the AIR, Dr. Diane's Flight with the NOAA Hurricane Hunters

Diane Marie Stanitski and John J. Adler

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