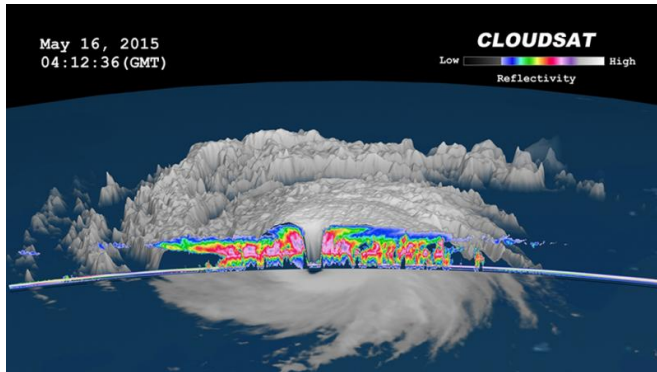


How does NASA study hurricanes?

17 August 2015, by Max Gleber



Skofronick-Jackson, the project scientist for NASA's Global Precipitation Measurement mission at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "You would have no idea if a hurricane was coming until it was too late."

Hurricanes in the Atlantic Ocean can form when sub-Saharan thunderstorms travel westward with areas of lower pressure. These troughs are known as African Easterly Waves. Warm, moist air rises within the storm clouds, drawing air into the thunderstorms. Like an ice skater pulling in her arms to increase her spin, this inward moving air increases the rotation of the air within the storm cloud. Moving across the warm Atlantic, this cycle repeats on a daily basis, and, with a favorable environment, potentially accelerates to create a monstrous vortex powered by oceanic heat.

Hurricanes are the most powerful weather event on Earth. NASA's expertise in space and scientific exploration contributes to essential services provided to the American people by other federal agencies, such as hurricane weather forecasting.

The National Oceanic and Atmospheric Administration and the National Hurricane Center (NHC) use a variety of tools to predict these storms' paths. These scientists need a wealth of data to accurately forecast hurricanes. NASA satellites, computer modeling, instruments, aircraft and field missions contribute to this mix of information to give scientists a better understanding of these storms.

NASA's research role

NASA's role as a research agency is to bring new types of observational capabilities and analytical tools to learn about the fundamental processes that drive hurricanes and work to help incorporate that data into forecasts. NASA collaborates with its interagency partners so that the nation benefits from our respective capabilities.

"Before we had satellites and aircraft, hurricanes would destroy entire cities, like the Labor Day Hurricane in Key West back in 1935," said Gail

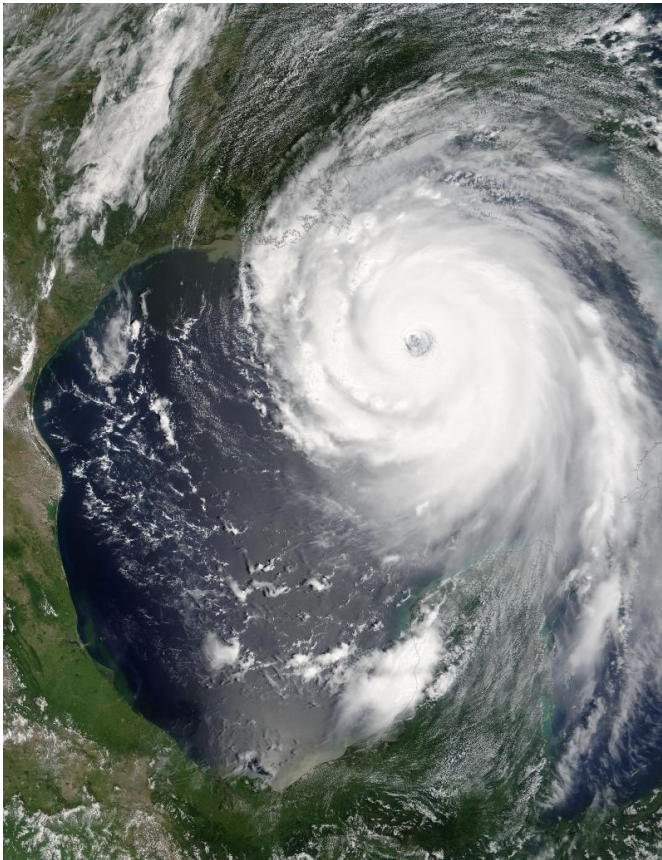
NASA uses an arsenal of instruments to learn more about how these storms progress as they form. These devices orbit Earth on a fleet of spacecraft, including Aqua, Terra, the Global Precipitation Measurement core observatory, NASA-NOAA's Suomi NPP satellite, Calipso, Jason-2 and CloudSat.

"There are typically multiple instruments on every spacecraft with various purposes that often complement each other," said Eric Moyer, the Earth science operations manager at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "We can see the progression of a storm from one day to the next using the Terra and Aqua satellites—a morning and afternoon view of every storm system, every day."

What NASA studies

These instruments analyze different aspects of these storms, such as rainfall rates, surface wind speed, cloud heights, ocean heat and environmental temperature and humidity. Observing these factors helps identify the potential for storm formation or intensification. Similarly, the data allows meteorologists to better predict where,

when and how hard hurricanes will strike land.



This visible image of Hurricane Katrina was taken on August 29 at 05:16 UTC (1:16 a.m. EDT) by the MODIS instrument that flies aboard NASA's Aqua satellite as it approached landfall in Louisiana. Credit: NASA Goddard MODIS Rapid Response Team

NASA's RapidScat instrument that flies aboard the International Space Station measures surface winds over the ocean and is used to gather data on [tropical cyclones](#). This can show where in a hurricane the strongest winds occur. RapidScat continues a long satellite record of these observations that began with NASA's QuikScat satellite.

Scientists must completely understand a hurricane to predict its trajectory and strength. This means meteorologists must peer inside the cloud itself.

"Looking at the cloud structure can help us

understand the storm's structure and location, which improves our forecasts," said Michael Brennan, a senior hurricane specialist at the National Oceanic and Atmospheric Administration's National Hurricane Center. "We heavily rely on the passive microwave imagers from satellites to see what is happening in the core of the storm."

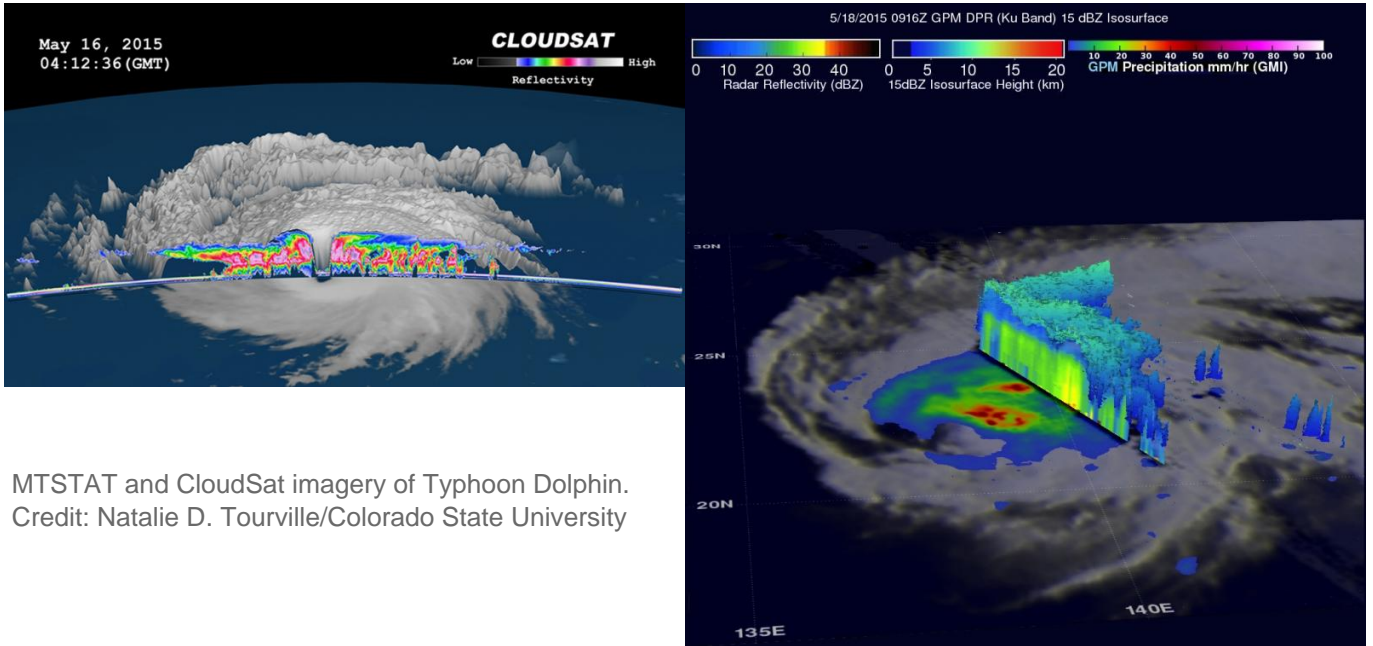
Passive microwave imagers aboard NASA's Global Precipitation Measurement and NASA-NOAA's Suomi National Polar-orbiting Partnership missions can peer through cloud canopies, allowing scientists to observe where the water is churning in the clouds.

"Just like a doctor using x-rays to understand what's happening in the human body, our radiometers can pierce the clouds and understand the cyclone's structure," Skofronick-Jackson said. "We learn about the amount of liquid water and falling snow in the cloud. Then we know how much water may fall out over land and cause floods."

"Having satellites to watch the oceans is critical, and that will never change," Skofronick-Jackson said. "Radars on Earth can only see a certain distance out in the ocean, so without spacecraft, you would need radars on every ship. With satellite data informing computer models, we can predict the storms' paths, to the point where regions only need to evacuate half as much coastline as before. That's important, because it costs a lot of money to pack up, move to a hotel and close down businesses."

Computer modeling

Computer modeling is another powerful NASA research tool.



MTSTAT and CloudSat imagery of Typhoon Dolphin.
Credit: Natalie D. Tourville/Colorado State University

NASA's Global Modeling and Assimilation Office, or GMAO works to improve the understanding of hurricanes and assess models and procedures for quality. GMAO helps to identify information that was missing and determines what services could be added to help future investigation and prediction of hurricane systems.

This 3-D view of the area northeast of Typhoon Dolphin's eye on May 16 created by data from NASA/JAXA's GPM core satellite shows heaviest rain over the open waters of the Pacific Ocean at a rate of over 65 mm (2.6 inches) per hour. Credit: NASA/SSAI/JAXA, Hal Pierce

As NASA launches more sophisticated Earth-observing instruments, teams produce models with higher and higher resolutions, the ability to ingest such data, or the data assimilation procedure, increases. Each new instrument provides scientists and modelers a closer and more varied look at tropical cyclones. The higher the resolution of models and the capability of data assimilation systems, the easier it is to exploit data from satellite-borne instruments and to determine a hurricane's intensity and size in terms of things such as the wind field and cloud extent.

Airborne missions

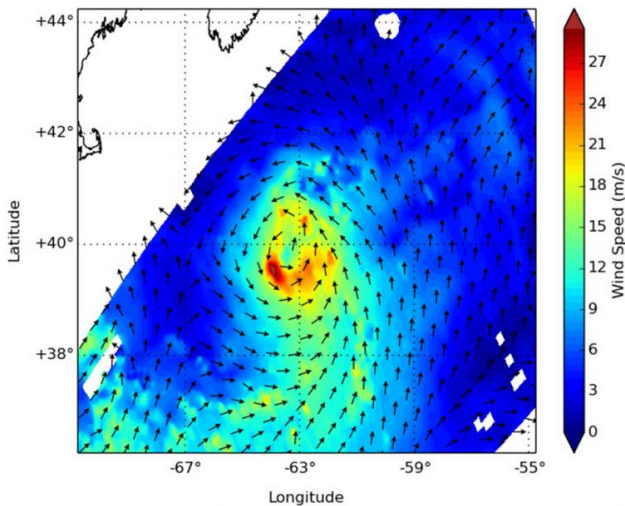
NASA also conducts field missions to study hurricanes. With an arsenal of instruments, ranging from radiometers that read moisture levels; lidars that measure aerosols, moisture, and winds; dropsonde systems to measure high-resolution profiles of temperature, pressure, moisture, and winds; to Doppler radar systems to map the 3-D precipitation and winds within storms. These instruments monitor the structure and environment of hurricanes and tropical storms as they evolve.

The most recent NASA field mission to study hurricanes was the Hurricane and Severe Storm Sentinel or HS3. For three consecutive years, the HS3 mission investigated the processes that underlie hurricane formation and intensity change in the Atlantic Ocean basin. The mission used the Global Hawk, a high-altitude long-endurance aircraft capable of flights of 26 hours at altitudes above 55,000 ft. Flying from the Wallops Flight Facility in Virginia, the uninhabited Global Hawks

could cover the entire Atlantic Ocean, enabling measurements of storms at early stages in the central or eastern Atlantic or spending 12-18 hours over storms in the western Atlantic.

Provided by NASA

RapidScat subset from 2015-07-14 05:39:00Z to 2015-07-14 08:44:00Z



On July 14, RapidScat saw the sustained winds surrounding Claudette's center of circulation were no stronger than 21 meters per second with the exception of stronger winds in the southwestern quadrant. Credit: NASA JPL/Doug Tyler

A future mission

In 2016, NASA is launching the Cyclone Global Navigation Satellite System, a constellation of eight small satellites. CYGNSS will probe the inner core of hurricanes in such detail to better understand their rapid intensification. One advantage of CYGNSS is that it can get frequent measurements within storms. This allows CYGNSS to make accurate measurements of ocean surface winds both in and near the eye of the storm throughout the lifecycle of tropical cyclones. The goal is to improve hurricane intensity forecasts.

NASA data and research allows scientists to observe the fundamental processes that drive hurricanes. Meteorologists incorporate this satellite, aircraft and computer modeling data into forecasts in the United States and around the world.

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