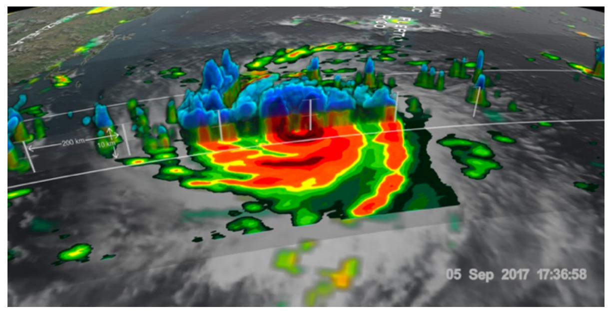
Looking at Storms in 3D: Outreach Activity Description

The Dual-Frequency Precipitation Radar aboard the Global Precipitation Measurement Mission Core Observatory allows us to see into clouds, detecting the size, shape, and distribution of liquid and solid water particles within clouds in three dimensions, and therefore illuminating the structure of storms. For outreach purposes, the data is usually rendered into animations showing both the structure and precipitation intensity. In this case the 3D-printed storms were made directly from GPM data, creating a tangible view of different types of storms, although the unicolor printing of most 3D printers doesn't allow for the intensity information to be shown. The width of the printed models corresponds to the width of the DPR Ku-band instrument swath, which is 245km. The height of the data has been exaggerated to enhance the level of detail - while each storm varies in height, the cloud tops of powerful tropical cyclones can reach as high as 16km or more. These storms are well suited to a table demonstration, but could also be used in small groups in a classroom setting. (See the website below for larger stand-alone versions of the images for use at outreach events.)

3D printable files and more information: gpm.nasa.gov/3dprinting

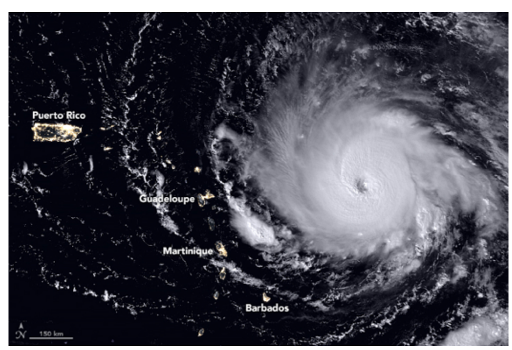
Hurricane Irma



The GPM core observatory satellite had an exceptional view of hurricane Irma's eye when it flew above it on September 5, 2017 at 12:52 PM AST (1652 UTC). Irma was approaching the Leeward Islands with maximum sustained winds of about 178 mph (155 kts). This made Irma a dangerous category five hurricane on the Saffir-Simpson hurricane wind scale. Intense rainfall is shown within Irma's nearly circular eye. GPM's radar revealed that the heavy precipitation rotating around the eye was reaching altitudes greater than 7.75 miles (12.5 km). The tallest thunderstorms were found by GPM's radar in a feeder band that was located to the southwest of Irma's eye. These extreme storms were reaching heights of over 10.0 miles (16.2 km). Intense downpours in the eye wall were found to be returning radar reflectivity values of over 80dBZ to the GPM satellite.

Irma rapidly intensified on September 4-5 as it moved over very warm waters and into an environment will weak vertical wind shear (the change of winds with height). Irma maintained maximum winds of 185 mph for a day and a half, making it one of the longest-lived storms at this intensity. That intensity made it the strongest observed storm over the Atlantic Ocean (excluding the Gulf of Mexico and Caribbean). Irma's rapid intensification was very similar to Hurricane Harvey's in the Gulf about 10 days earlier.

Text and image source: https://svs.gsfc.nasa.gov/4584

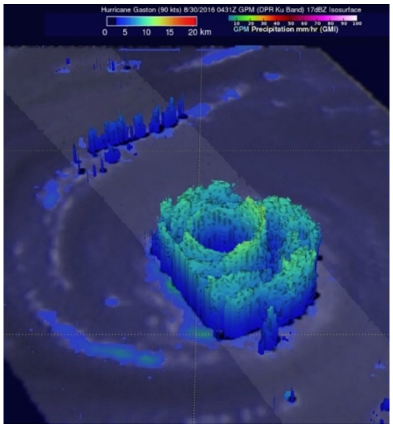


The Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite captured this nighttime view of the storm in the early hours of September 5. The image was acquired by the VIIRS "day-night band," which detects light in a range of wavelengths from green to near-infrared and uses filtering techniques to observe signals such as city lights, auroras, wildfires, and reflected moonlight. In this case, the clouds were lit by the nearly full Moon. The image is a composite, showing storm imagery combined with VIIRS imagery of city lights.

The VIIRS image is a flat image of the storm, showing only the cloud tops, and can be used to show the difference between what various satellites can see of hurricanes, and especially point out how useful it is to have the GPM radar to look inside the storms and view the 3D structure.

NASA's Earth Observatory: https://go.nasa.gov/2wKn9hG

Hurricane Gaston



Hurricane Gaston was located in the central Atlantic Ocean west of Bermuda when the GPM core observatory satellite passed over on August 30, 2016 at 00:31 AM EDT (0431 UTC). Gaston was a category two on the Saffir-Simpson hurricane wind scale with maximum sustained winds of about 103.5 mph (90 kts). GPM happened to fly over as Gaston was undergoing an eye wall replacement. Intense rainfall was clearly shown by GPM in rain bands of both the inner and the outer replacement eye walls. Another striking feature as seen by GPM was Gaston's large relatively rain free inner eye area. Many storm tops were measured by GPM's radar stretching to altitudes higher than 8 miles (13 km).

https://pmm.nasa.gov/extreme-weather/gpm-views-hurricane-gaston-eye-wall-replacement

Big squall line/Mesoscale Convective System over the central United States

A squall line is a line of thunderstorms forming along or ahead of a cold front. This storm can be compared to the hurricanes, showing the very different structure – moving in one direction rather than the distinctive spiral of the hurricane. It can also be pointed out that the height of the precipitation droplets in the clouds is similar to the hurricanes, although the shape is very different. Note: The picture included is not the exact same storm as the 3D print, but a storm with a similar structure.

Image source: SturmjaegerTobi on Pixabay, pixabay.com/en/sky-landscape-agriculture-3171382
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Thunderstorm anvil

This is most interesting in terms of pointing out that we are looking inside a cloud at where the water droplets are. You can imagine the outside appearance of the thunderstorm anvil cloud, and we are looking inside it to see the actual locations of the droplets. Note: As with the previous image, this is not the exact storm that has been 3D printed, but is a storm with a similar structure to help visualize the shape.

Image source: Jeff Kubina on Flckr, www.flickr.com/photos/Kubina
(CreativeCommons Share with Attribution license)

Late season snowstorm over New England

The winter storm shows very little in terms of distinctive structure, but the height of the droplets in the cloud can be compared to both the hurricanes and squall line – the winter storm shows precipitation (probably snow) much lower in the atmosphere.

Thunderstorms near the Himalayan Mountains

In this case, the surface elevation is the base level of the model, so one side of the model (labelled) is at the level of the Himalayan Mountains. This shows how high in the atmosphere clouds can be compared to the tallest mountains.