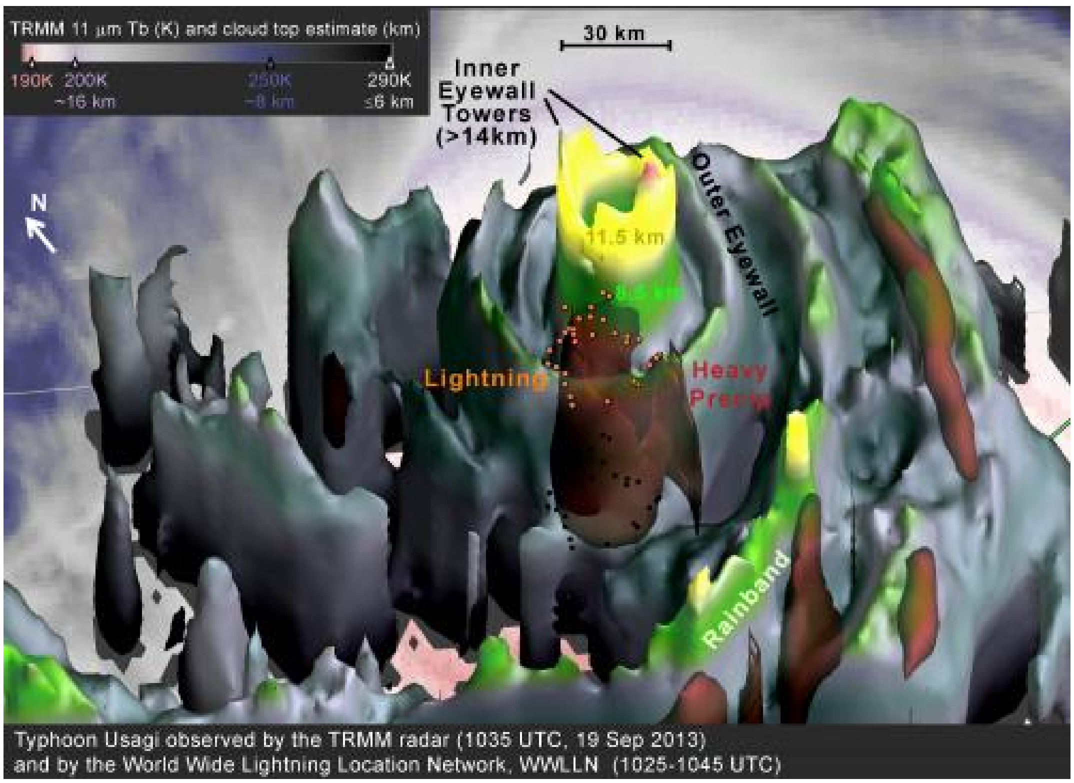
NASA sees super-rapid intensification of Supertyphoon Usagi

September 20 2013, by Owen Kelley



This TRMM 3-D image of Super-Typhoon Usagi on Sept. 19 shows heavy rain (red) at the base of the eyewall. The lightning flashes (ring of small orange dots) are displayed at 5 km altitude. That's near the freezing level in tropical cyclones and near the top of the heavy precipitation. Credit: Image Credit: NASA/Owen Kelley

The radar on the Tropical Rainfall Measuring Mission (TRMM) satellite captured an image of Supertyphoon Usagi near the end of a 24-hour period in which Usagi intensified by 65 knots. This is more than twice the commonly used 30-knot threshold for defining rapid intensification.

The TRMM data was used to create a 3-D image. The data was collected at 1035 UTC/6:35 a.m. EDT on Thursday, September 19, 2013, when Usagi was at category 3 on the Saffir-Simpson hurricane intensity scale. A few hours later, Usagi completed its lightning-fast intensification to category 5, the highest category in the scale. While the center of this tropical cyclone is forecast to past just south of Taiwan in a few days, some forecasts have it striking Hong Kong a few days after that.

A number of the features of the TRMM radar observations are consistent with a well-organized storm with an efficient "heat engine." A tropical cyclone's heat engine extracts heat from the ocean's surface through wind-enhanced evaporation and converts a portion of that energy into kinetic energy of the destructive winds that circle under the eyewall of the storm. The eyewall is an arc or ring of string storms just outside the mostly cloud-free eye at the center of rotation of the tropical cyclone.

Radars almost always see eyewalls in strong tropical cyclones, but few tropical cyclones have such symmetric eyewalls as does Supertyphoon Usagi in the TRMM 3-D image. The 3-D image was multi-colored to show the volume of the light precipitation lifted to high altitudes, and heavy precipitation at the base of the eyewall (using a radar reflectivity threshold of 20 and 40 dBZ, respectively). Even the heavy precipitation at the base of the eyewall is fairly symmetric which is somewhat unusual.

Tropical cyclone eyewalls that are this symmetric are called "annular," and they have a tendency to maintain their intensity for longer periods than do tropical cyclones with more lopsided eyewalls (Knaff et al., 2003). At two locations in the eyewall, updrafts are strong enough to lift ice precipitation up and out of the troposphere, the layer of the atmosphere that usually confines the weather. Such tall storm cells are called "hot towers" and are associated with periods of tropical cyclone intensification.

Lightning flashes were detected by a group of ground-based sensors called the World-Wide Lightning Location Network (WWLLN, http://wwlln.org). The WWLLN does not measure the altitude of the lightning, so the flashes were depicted in TRMM data at a 5 km altitude, which is near the freezing level in tropical cyclones and near the top of the heavy precipitation detected by the TRMM radar.

Lightning requires strong updrafts to form, indicating locations where storm cells are releasing considerable energy into atmosphere. It is an active area of research, however, to pin down the exact relationship between bursts of eyewall lightning and current or future changes in tropical cyclone intensity (Thomas et al., 2010; DeMaria et al., 2012). The lightning plotted in the TRMM image was observed during a 20 minute period centered on the time of the TRMM overflight. The flash rate was about 1.5 flashes per minute during this period, and the flash rate held fairly steady during a full six hours centered on the time of the TRMM overflight.

More information: References:

Knaff et al., 2003: Annual hurricanes, *Weather and Forecasting*.
Thomas et al., 2010: Polarity and energetics of inner core lightning in three intense North Atlantic hurricanes, *J. Geophysical Research.*
DeMaria et al., 2012: Tropical cyclone lightning and rapid intensity change, *Monthly Weather Review*.

Provided by NASA's Goddard Space Flight Center