NASA Watches Rain in 3D

Hurricane Hot Towers Seen from Space

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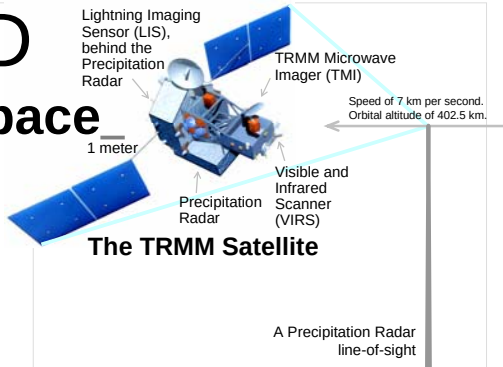
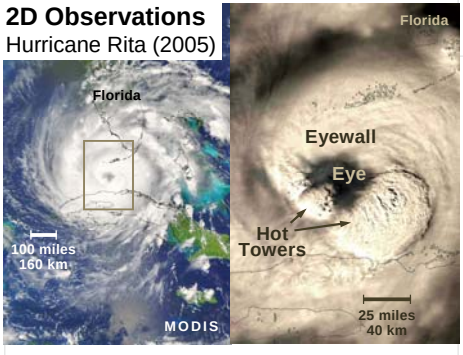
Introduction

By studying the rainfall inside of storms we can improve our understanding of storms which may eventually lead to better storm predictions. The satellite that can provide the best 3D observations of rainfall is the Tropical Rainfall Measuring Mission (TRMM) in space since 1997. Large portions of the satellite were built here at NASA Goddard and by the Japanese space agency. NASA Goddard also operates the satellite. Scientists from around the world study TRMM data. Several agencies use TRMM data to monitor or predict weather [*NRC*, 2004]. The TRMM satellite has turned out to be able to study hurricanes, although that task was not one of the original mission goals. This poster describes one way that the TRMM satellite can be used to study hurricanes. At NASA, in Japan, and elsewhere, work has begun on the next generation 3D rainfall satellite, which is call the Global Precipitation Measurement (GPM) mission.



2D Observations

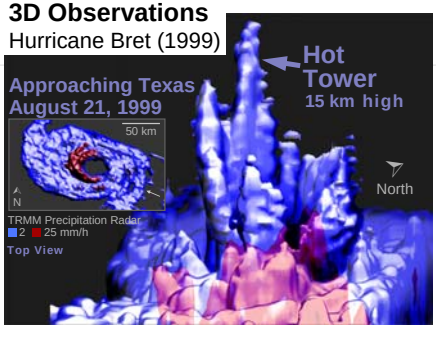
Hurricane Rita (2005)



Data such as this from the MODIS instrument on NASA's Aqua and Tera satellites has a variety of uses. One limitation, however, is that MODIS can only give us limited information about what is going on inside the storm.

3D Observations

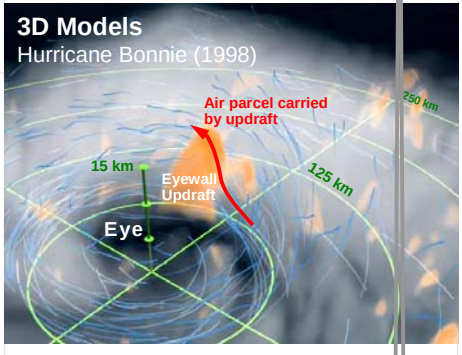
Hurricane Bret (1999)



Data such as this from the Precipitation Radar on the TRMM satellite shows us the detailed three dimensional structure of rainfall regions inside of storm clouds. Studies have shown that there is a correlation between tall rain cells in hurricane eyewalls and hurricane intensification [*Kelley et al.*, 2005].

3D Models

Hurricane Bonnie (1998)



Scientists at NASA Goddard are using high resolution models to try to understand the rainfall structure observed by the TRMM satellite [*Braun et al.*, 2006]. These models can challenge our physical understanding of hurricanes just as new kinds of observations can challenge us.

Related News

- 2006 / 09: NASA field campaign studies hurricane precursors as they float off Africa
- 2006 / 08: TRMM data used to locate the most intense thunderstorms on Earth [*Zipser et. al*, 2006]
- 2006 / 05: TRMM data used to estimate the potential for flash floods [*Hong et al.*, 2006; *Hossian et al.*, 2004]
- 2006 / 04: NASA launches a cloud radar, which will compliment the TRMM rainfall radar
- 2005 / 03: NASA awards the contract for the construction of the GPM Microwave Imager (GMI)

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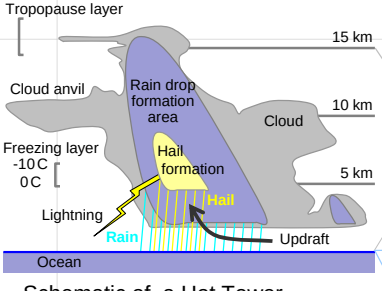


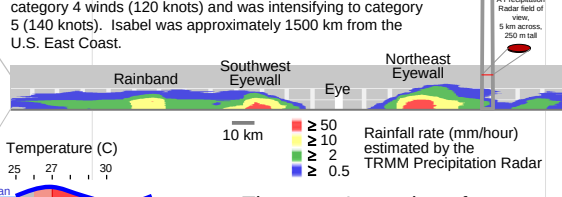
Schematic of a Hot Tower Outside of a Hurricane

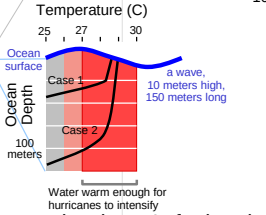
The TRMM satellite has instruments that can see the clouds tops, rain, hail, and lightning inside of a tall storm cell. Tall storm clouds are sometimes called "hot towers."

Vertical Cross Section

Hurricane Isabel (2003/09/10 2141UT)

At the time of the TRMM overflight, Hurricane Isabel had category 4 winds (120 knots) and was intensifying to category 5 (140 knots). Isabel was approximately 1500 km from the U.S. East Coast.





The ocean—a hurricane's fuel tank

The warmer the ocean's surface temperature, the higher the "octane" of the hurricane "fuel". The deeper the warm water reaches, the more fuel there is in the fuel tank [*Shay*, 2000; *Halliwell*, 2005].

The ocean's rough surface under a hurricane

The ocean's surface acts as a drag against a hurricane's surface winds. It is difficult to measuring ocean drag at hurricane wind speeds, but drag is important for calculating the maximum possible hurricane intensity [*Emanuel*, 2003]. The photo shows Hurricane Hugo (1989) with 20-27 m high waves driven by 100 knot winds, as seen from an aircraft. [NOAA Photo Library, image #fly229].