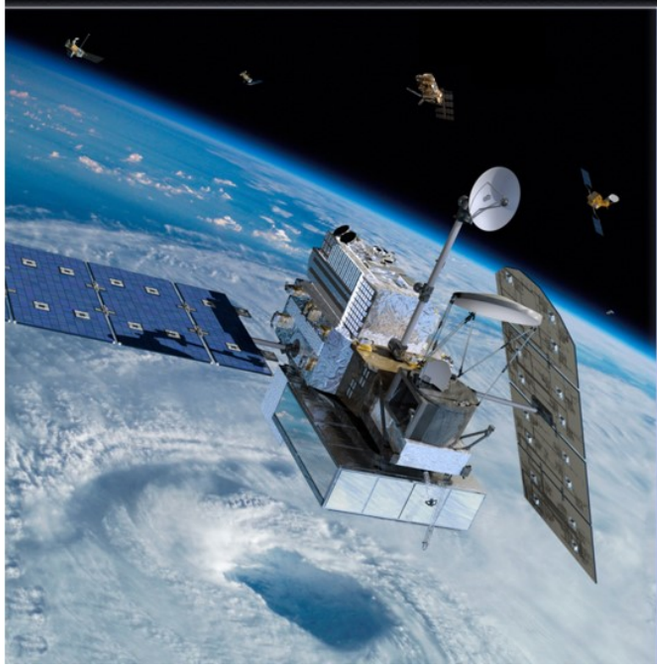
Building for Hurricanes: Engineering Design Challenge



Global Precipitation Measurement Mission

Developed by the GPM Education Team

NASA Goddard Space Flight Center

Overview

Whether you live in an area prone to hurricanes or not, you've seen images of the destruction caused by such storms.

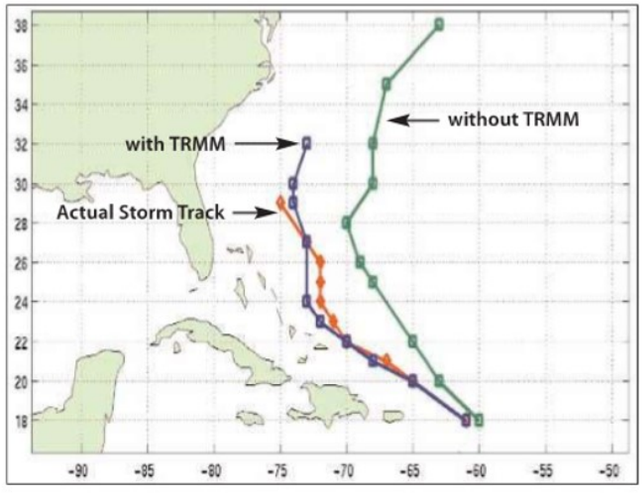
In the top image, taken in 1998, notice the pier, pier house, and the antebellum house. The bottom image shows the same location on August 31, 2005, two days after Hurricane Katrina made landfall. This photo shows the complete destruction of these landmarks.

(Image and text from http://coastal.er.usgs.gov/hurricanes/katrina/photo-comparisons/mainmississippi.html)

GLOBAL PRECIPITATION MEASUREMENT

Satellite Data

Data from satellites like the Tropical Rainfall Measuring Mission and soon the Global Precipitation Measurement mission have vastly improved our ability to forecast the track of storms and has led to insights that allow us to know when a storm will intensify.



Hurricane Bonnie, August 1998: 5-Day Forecasts vs. Actual Storm Track.

Improved forecasts can save money ($600K to $1M per mile of coast evacuated) and lives by more precisely predicting where the hurricane eye will be located at landfall. Source. Dr. A. Hou, NASA DAO

Hurricane Damage

Builders in areas at risk for hurricanes need to plan for that in their designs. That is the role you will take on today—designing a building that can withstand a (simulated) hurricane. Damage to buildings can come because of wind, storm surge, or heavy rainfall leading to flooding. For today's activity, we will focus primarily on wind damage, although you may choose to think about the others as well.

Damage caused by Hurricane Katrina
Images from: http://sos.noaa.gov/Education/forecast.html

Instructions and Materials

Your challenge is to build a freestanding tower that can support a tennis ball as high as possible off the ground (measured from the bottom of the tennis ball) while withstanding the wind from a fan. (Optional extra tough challenge: add a spray bottle to represent rain!)

Materials available to build your tower:

- Index cards
- Straws
- Craft sticks
- Pipe cleaners
- Tape
- String

Materials to help you plan and build, but not part of the final tower:

- Paper and pencil for brainstorming
- Scissors
- Ruler

Remember, the tower needs to be freestanding – that means you can't tape the tower to the table!

Generate Ideas

Before you begin designing, think about answers to the following questions. Use the paper given for brainstorming to record your ideas.

- Which combination of materials will make the tower as tall as possible (measured to the bottom of the tennis ball)?
- What tower shapes could you use? Should your base be round? Square? Triangular?
- Can you be creative about using the materials in an unexpected way?
- How can you get the tower to be freestanding, not taped to the table, and yet not fall over?
- Think about the forces on the tower, wind from the side and gravity pulling down. How you will build your tower to resist them?

Develop and Test Solutions

Look at the towers on the following slides to give you ideas about structures and shapes you might use when designing your tower.

Once you've decided on your design, work as a team to build your tower! When everyone is finished, we'll share your designs and put them to the test with the fan. If you have time, try to redesign your tower with what you've learned from testing. For example, if the tower tips over, the tennis ball won't stay in place, or the weight of the tennis ball collapses the tower.

The Eiffel Tower, France and the CN Tower, Canada

Azadi Tower, Iran

Water Towers: Carmel, Indiana and Chrisman, Illinois

El Faro Towers, Buenos Aires, Argentina

Tower of the Great Mosque of Kairouan, Tunisia

Guy's Tower, Warwick Castle, Warwick, UK

30 St Mary Axe ("The Gherkin"), London, UK

Teepee

Notre Dame Cathedral, Paris France

For an aerial view, click here.