

Catch The SEACOOS Wave!

Lundie Spence, Terri Hathaway, Margaret Olsen,
Maia McGuire, Carrie Thomas, Jennifer Jolly Clair



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South Atlantic Coastal Ocean Observing System

“We've made the investment needed to venture into the skies, and it has paid off mightily. We've neglected the oceans, and it has cost us dearly. This is the time to do for [the oceans in] the 21st century what our predecessors did for space”

- Sylvia Earle

Why are we interested in observing ocean waves?

- Safe and efficient shipping requires an understanding of waves
 - 95% of U.S. foreign trade passes through ports and harbors
 - 50% of all materials shipped through U.S. waters are hazardous
- Coastal states earn 85% of all U.S. tourism revenues.
 - Surfing, fishing, boating, swimming safety and pleasure requires knowledge of waves
- Safe extraction: 25% of U.S. natural gas production and about 17% of U.S. oil production come from the Outer Continental Shelf





How Does This Information Help?

Commercial Transportations
Search and Rescue Operations
National Security



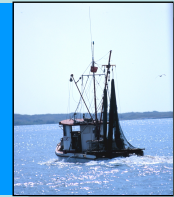
Coastal Storm Preparedness
Coastal Erosion Prevention
Flooding



Safe Marine Operations

Mitigating Natural Hazards

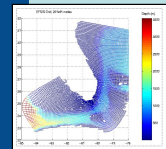
Commercial Fishing
Endangered Species
Aquaculture



Living Marine Resources

Scientific Contributions

Baselines
New Discoveries
Detect Changes





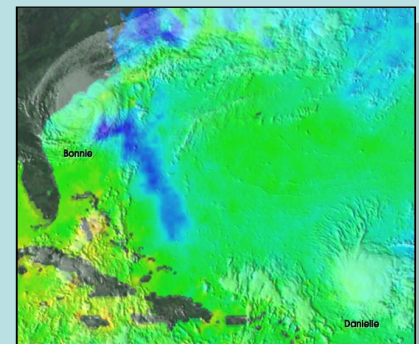
What Other Parameters Does Ocean Observing Monitor?

Physical Ocean Conditions

Atmospheric Conditions

Biological and
Ecological Conditions

- Temperature
- Wind
- Currents
- Water Levels
- Salinity Fields
- Pressure
- Fog
- Nutrients
- Contaminants
- Benthic Habitat
- Chlorophyll



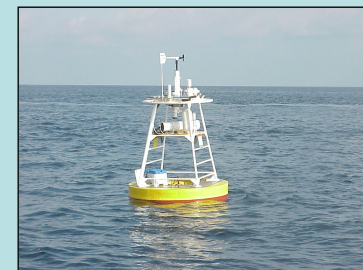
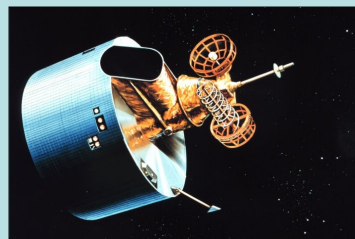


SECOORA wave observations use many instruments

“What’s In the Field ?”



Every ocean observing system depends upon the actual equipment in the field.



- in situ moored and drifting sensing systems offshore and in currents
- coastal and offshore instrumented installations, such as platforms and towers
- remote sensing from satellites and aircraft
- shore-based remote sensing with radar CODAR



Why use waves in the Classroom?

Ocean Observing wave data and images provide real time information, graphing, predictions and analysis. These apply to science standards in earth sciences, physical sciences, physics, marine sciences



Water Waves are fun to surf, but they can be dangerous in nor'easters, hurricanes and tsunamis.

COSEE and SEACOOS--Wave Lessons and Poster!

MAKING WAVES

What is a Wave?

Waves are energy transmitted through matter. The matter can be in any state; solid, liquid or gas.

Surface ocean waves transmit energy along the surfaces between air and water. As ocean waves travel particles of water in the surface of the ocean travel in circular orbits. That is why these waves are also called **progressive orbital waves**.

What Causes Ocean Waves?

Waves on the surface of the ocean are created when the wind blows over the surface of the water. As waves grow larger they capture more of the wind's energy and as a result the wave's wavelength and height increases. The waves also change from smooth, curved waves into pointy, crest shaped waves.

However, for any given wind speed, there is a maximum duration (how long the wind blows) and fetch (distance over which the wind blows in one direction) beyond which the waves will not get any bigger.

Anatomy of a Wave



Parts of a Wave

Parts of a wave include the **Crest**, or the high parts of the wave, and the **Trough**, the low parts of a wave. Waves are characterized by scientists according to several properties.

Wave height: The vertical distance between the highest point of the Crest and the lowest point on the Trough.


Wavelength: The horizontal distance between two corresponding points on a wave form, for example from Crest to Crest.


Wave Steepness: The ratio of height to wavelength. When wave steepness exceeds 1/7, breakers form.

Wave period: The time that elapses during the passing of one full wavelength. Oceanographers use this unit most frequently to relate wavelength and speed.

Wave speed: The velocity of which a wave is travelling. Speed is best calculated by dividing wavelength by period.

Wave frequency: The number of wavelengths that pass a fixed point in one minute. Frequency is rarely used by oceanographers because ocean waves are long and slow.



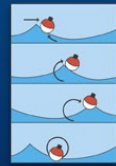


South Atlantic Bight WAVE FACTS

- Off SC and GA, the wide shelf extends 60-70 miles (100-115 km). Long period, ocean swells "feel" the bottom well offshore, and lose energy before hitting the beach. Result: smaller waves at the beach. During winter storms with northeast winds reaching 25-35 miles per hour (40-60 km/h), with a duration over 24 hours and fetch over 300 miles (500 km), waves in deep water (80-110 ft or 25-30 m) can reach over 5 m (15 feet) in height. Storm waves with a short period (8-12 seconds) can get very steep and thus hazardous to boaters.
- Off Cape Hatteras, NC, the shelf is narrower. Ocean waves have more energy at the beach. Result: some of the best and largest East Coast surfing waves.
- Off east coast of Florida --the Florida Current (Gulf Stream) streaming northward causes higher, steeper, offshore waves than are found near the beaches.
- The size of waves generated by hurricane winds in the SAB depends on the size of the storm, which influences fetch and how fast the hurricane is moving (duration).

Fetch and Duration required to create a fully developed sea for several different wind speeds.

Wind Speed km/hr (mi/h)	Fetch km (mi)	Duration hr
20 (12)	24 (15)	2.75
40 (25)	176 (25)	11.5
60 (37)	660 (37)	27.5
80 (50)	1662 (50)	50



A bobber floating on water as a wave passes demonstrates the orbit that molecules of water take as surface ocean waves move along the air sea interface.

The diameter of the orbit is equal to the wave height at the ocean's surface.

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Fpo Legal lines, copyright info, version, date, etc?

Get the Poster and lessons: secoora.org
Find out about your COSEE: COSEE.NET

Use archived wave information in your classroom

- **Predict** maximum wave size resulting from sustained winds (duration) over large distances (fetch).
- **Investigate** hurricane waves, generated by hurricane winds in the SE, which depend on the size of the storm (fetch for the winds) and how fast the hurricane is moving (duration over a given fetch).
- **Compare and analyze** wave heights at South East Atlantic shorelines. Investigate the differences.

How and where are Waves measured?

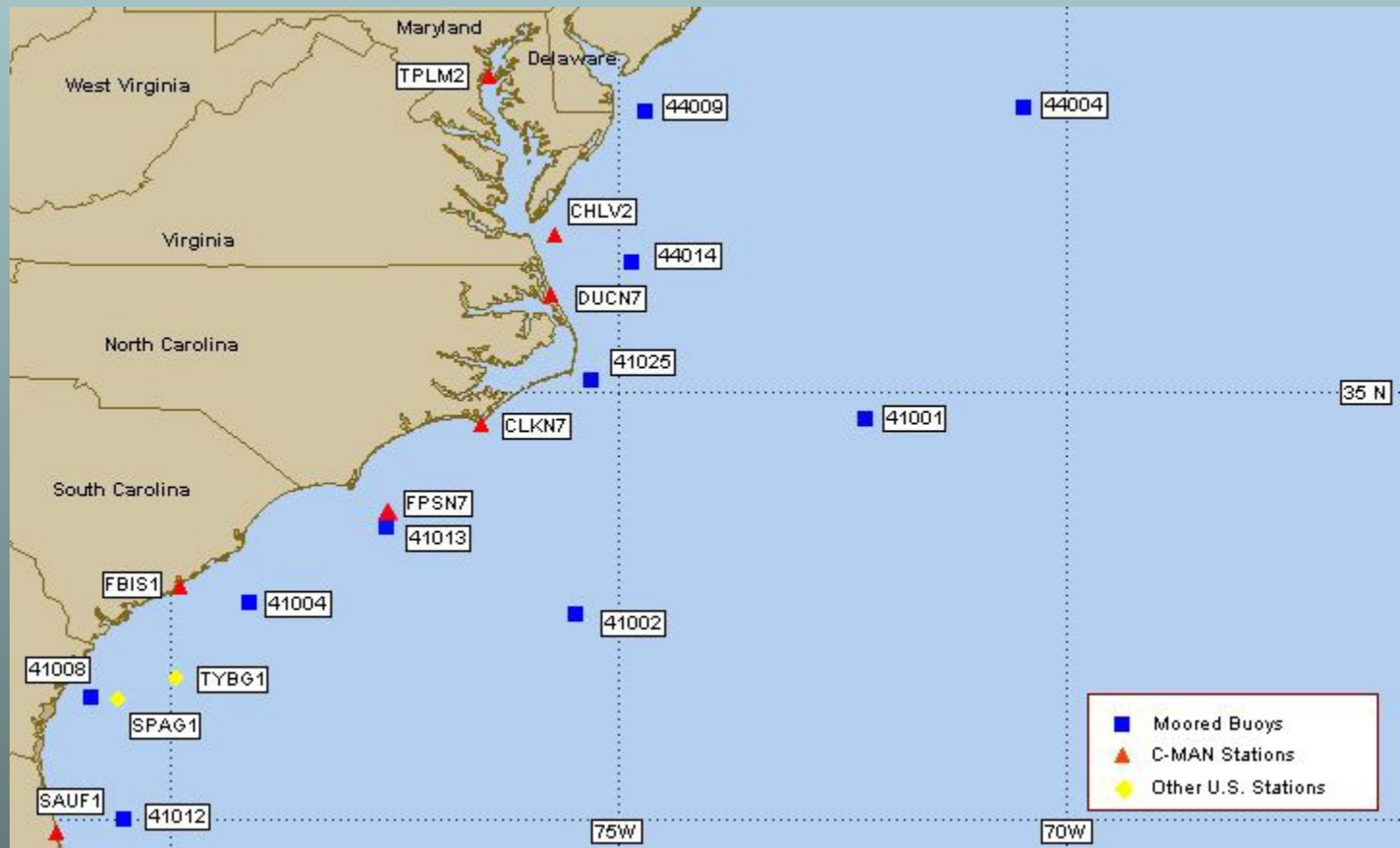
National Data Buoy Center (<http://www.ndbc.noaa.gov/>)



Towers



Buoys



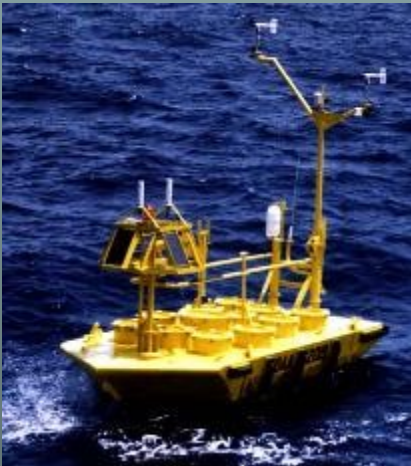
Buoys have instruments to measure vertical motion--rise and fall.
Towers have a high resolution, submerged, pressure sensors.

Instrumented Buoys

Diamond Shoals Buoy
8 nautical miles
off Cape Hatteras, NC

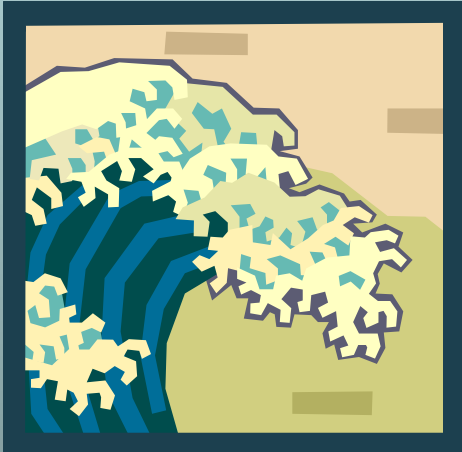


Gray's Reef Buoy
40 nautical miles off Savannah, GA



Cape Canaveral Buoy
120 Nautical miles off Florida

Fact to Know: Wave Data on most graphs is “Significant Wave Height”



Wave height is the distance between the crest and the trough.

Instruments are programmed to provide significant wave height.

- Definition: Significant wave height is the average height of $\frac{1}{3}$ of the highest waves.
- Significant wave height does not identify the largest waves in a storm.

Using Data in a Lesson

Idea: Follow a Hurricane Event to compare wind speed and wave height.

Sample 1: Hurricane Isabel, September 2003, off South Atlantic Bight

Sample 2: Hurricanes Isadore, Lili and Hannah, Lili, September 2002, off west coast of Florida

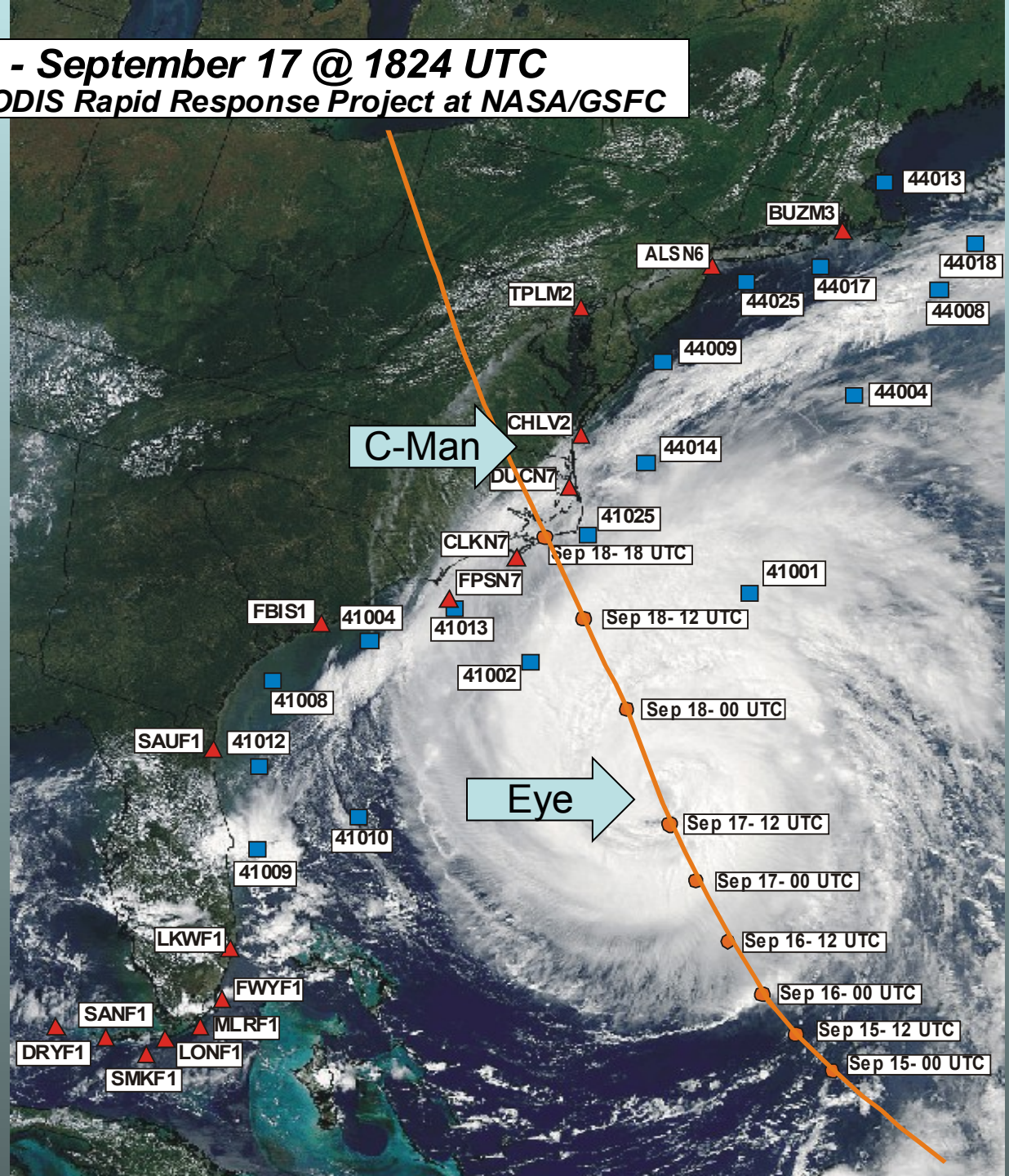
Image courtesy of MODIS Rapid Response Project at NASA/GSFC

Symbols

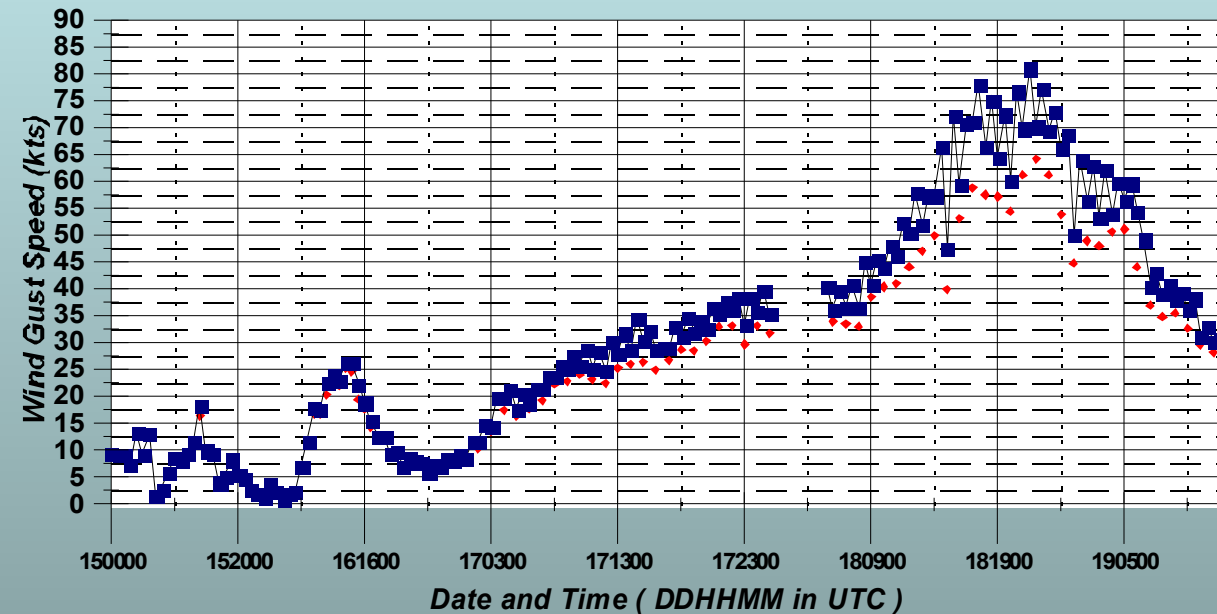
C-Man Platforms

Moored Buoys

Eye of Storm



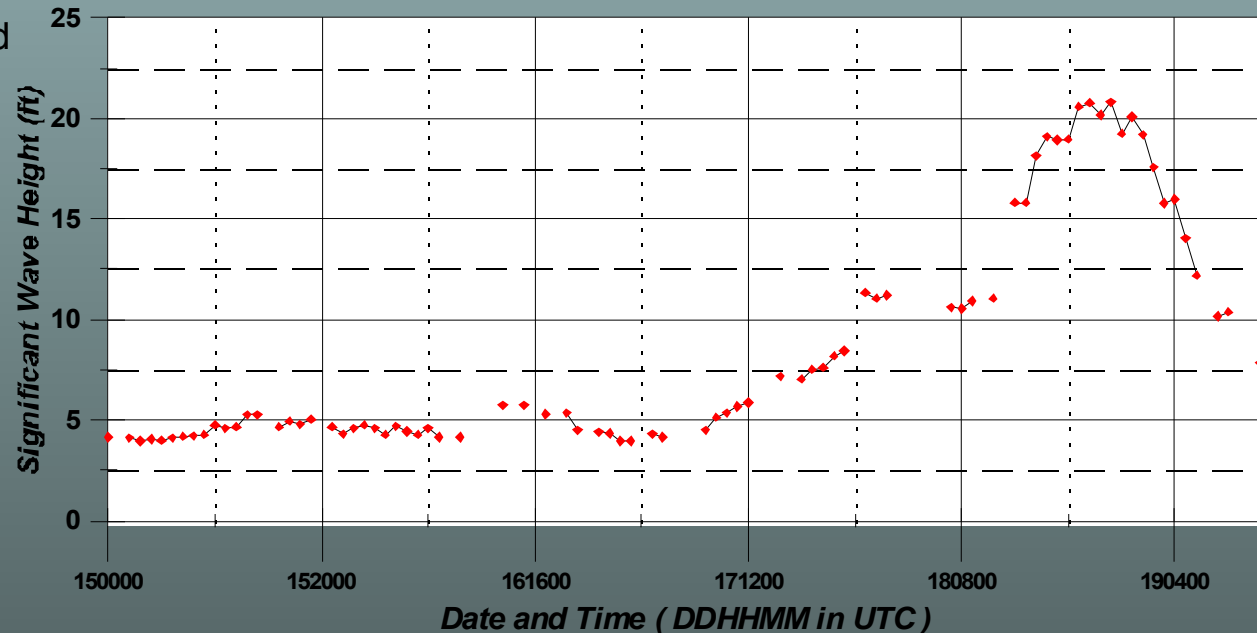
Hurricane Isabel-CHLV2 C-Man Station
September 15-19, 2003



Hurricane Isabel- CHLV2 C-Man Station
September 15 - 19, 2003

Blue line = 5 second peak wind gust speed
 Red line = 2 minute average wind speed.

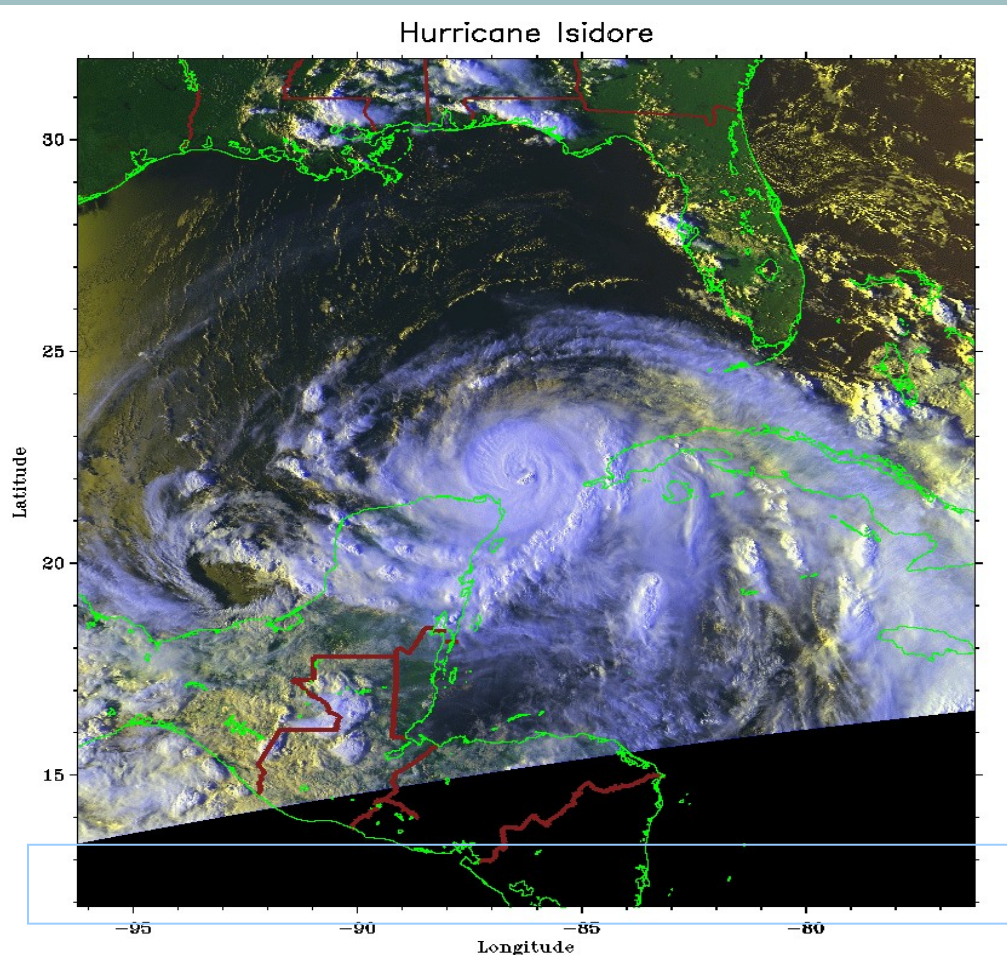
Student Inquiry:
What is the relationship
between wave
height and wind
speed?



Two of eight hurricanes near Florida in 2002

September 18, 2002

Hurricane Isidore



AVHRR 3 Channel Color Composite
NOAA-12 AVHRR 2002 Sep 21 22:17 UT
Daytime: R=C1 G=C2 B=-C4

Copyright © 2002 by the Ocean Remote Sensing Group, Johns Hopkins University Applied Physics Laboratory, 22:32:38

September 30, 2002

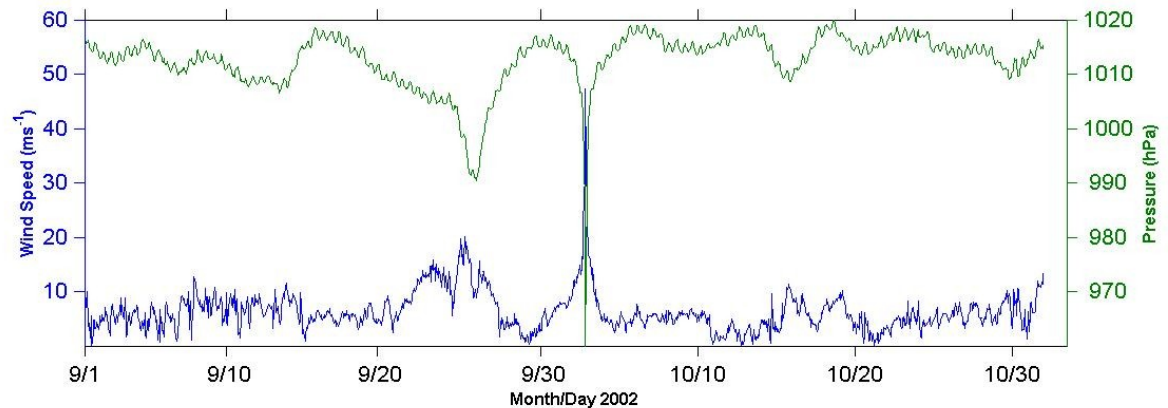
Hurricane Lili



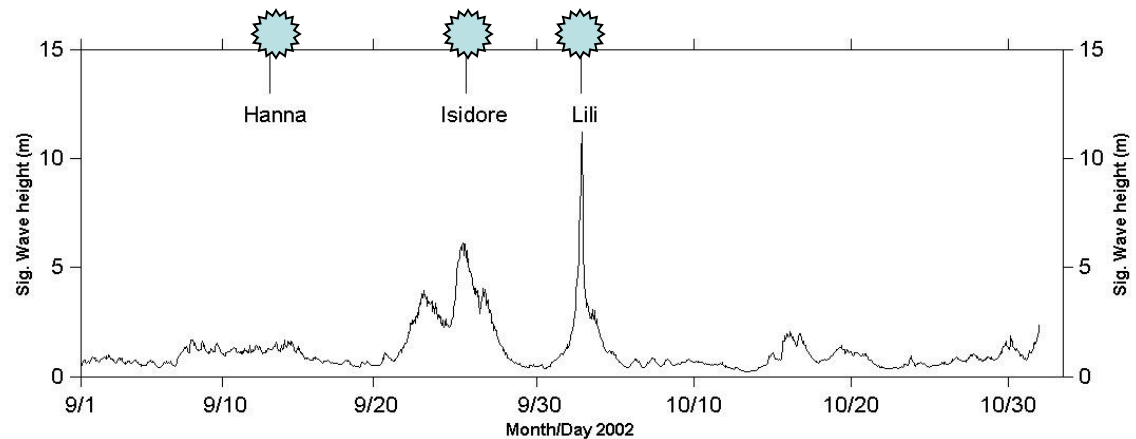
Hurricanes: Hanna (9-14-02)
Isidore (9-18-02)
Lili (9-30-02)

Compare the wind
speed vs wave
heights

SPEED

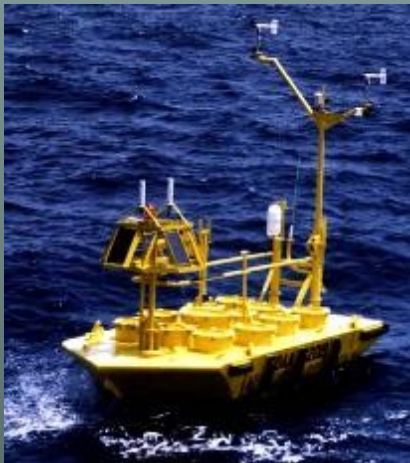


WAVE HEIGHT

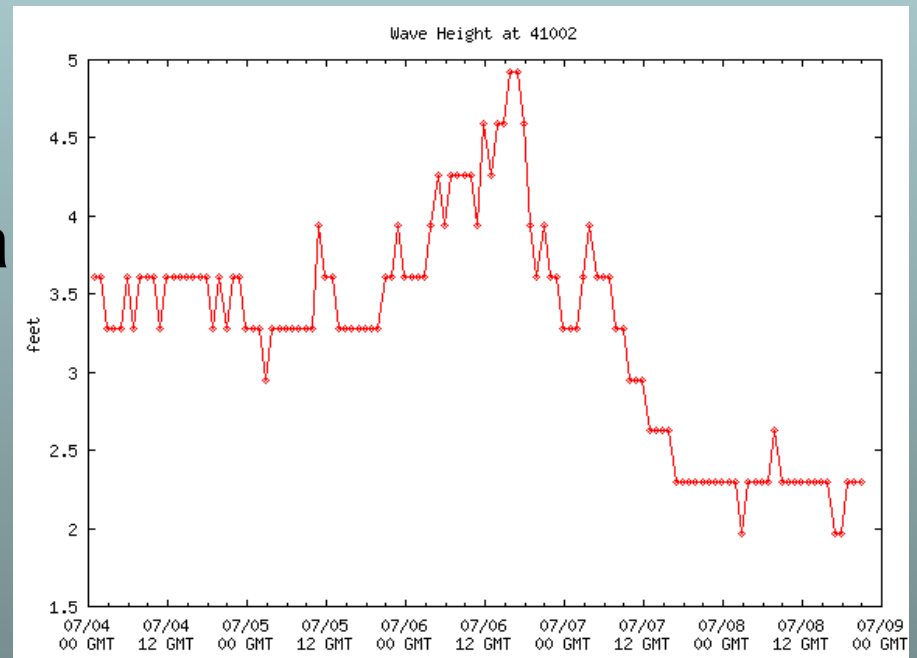


Idea: Find current wave data

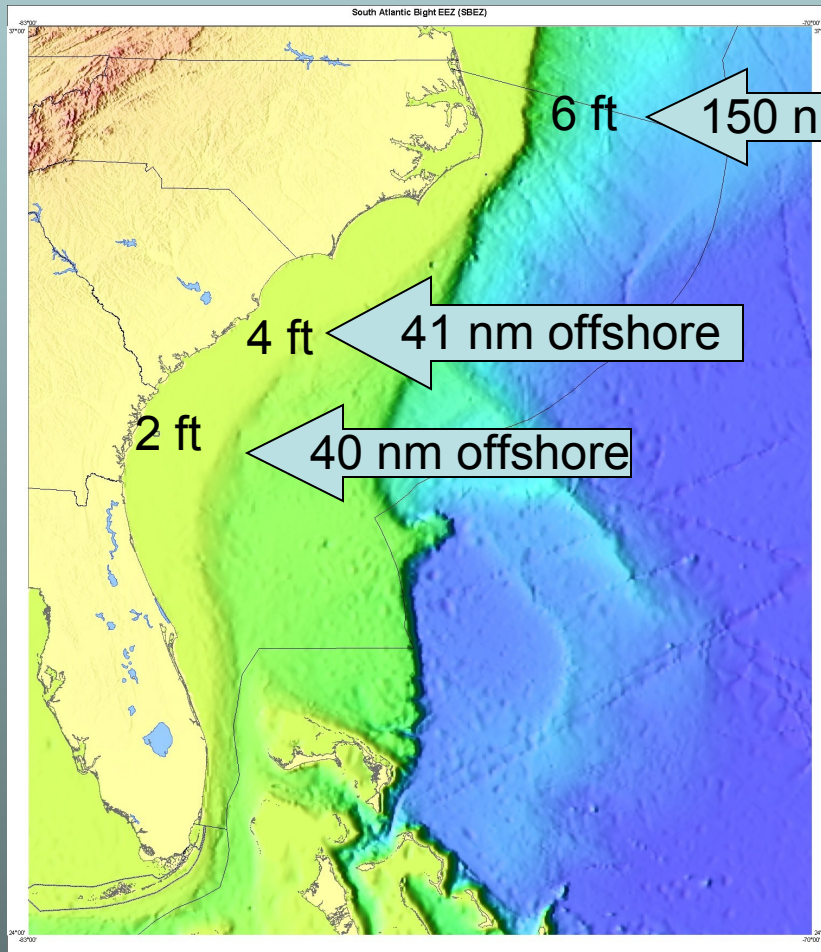
1. Use a 5 day graph from the National Data Buoy Center
2. Select your buoy and dates
2. Sample of wave data July 4-9, 2004
3. Compare to winds



Buoy 4102
250 nautical
miles off
Charleston,
SC



Idea: Compare Average Wave Heights in the South Atlantic Bight



Increasing width of the Continental shelf
Increases bottom friction of Waves—so what happens?

Check NBDC under historical wave data to compare heights.

Web References:

Wave Conditions and Classroom Lessons

USING REAL TIME WAVE DATA

- The National Data Buoy Center. You can select location and buoys to find real time wave height: <http://www.ndbc.noaa.gov/>
- US graphic of daily waves and weather for sailors: <http://www.intellicast.com/Sail/World/UnitedStates/WaveHeights/>
- To learn about wave measurements from the National Data Buoy Center: <http://www.ndbc.noaa.gov/wavecalc.shtml>
- East Coast Surf Waves: <http://www.surfinfo.com/html/fnmoc.html>
- NOAA's Wave Watch III: <http://polar.wwb.noaa.gov/waves/>

LESSONS

- National Geographic Activity on Interactive Waves: <http://www.nationalgeographic.com/xpeditions/lessons/07/g35/wavesheight.html>
- http://www.thecoolroom.org/swimmers/swim_help_waves.htm