



## Lesson Plan: Conditions at Sea Data Activity

### Summary

Forecasting the conditions at sea is an important tool for sailors, fishers, maritime transportation, anyone on the water. In Conditions at Sea, a three-part series, students first learn about the concepts of wave formation and forecasting, conduct an in-class wave-making activity, and access near real-time and real-time data from ocean observing buoys to investigate the relationship between wind and wave height, and predict the actual conditions out at sea using the Beaufort scale.

### Subject Area

Physical Science/ Earth science

### Grade Level

6-12

### Key Concepts

- Ocean wave formation is primarily caused by wind.
- Wave characteristics can be forecasted from wind data.
- Forecasting is an important tool for mariners

### Objectives


- Access and use near real-time data to make predictions on sea conditions.
- Analyze the relationship between the ocean and the atmosphere.

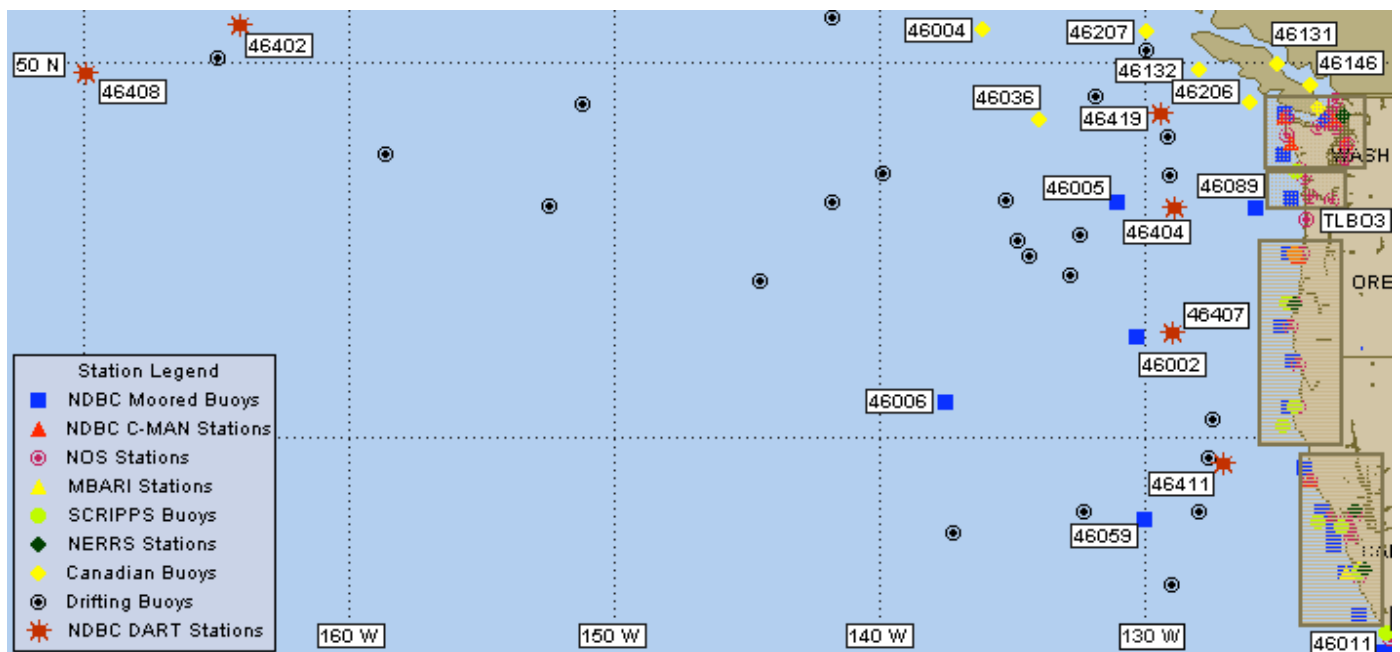


## Materials

- Computer lab with internet access or projection screen
- Science journal or similar for each student

## Procedure:


1. Engage students in a class discussion, considering the following questions:
    - What factors influence wave formation?
    - What information on wind and waves would be useful for forecasting sea conditions?
    - Given wind data, could you predict wave conditions? How?
  2. Have students work in small groups to explore buoy data on the internet. If computers are not available, you can use a digital projector to display the computer screen for entire class, or gather data on buoys before class and disseminate to the students.
    - Go to the NANOOS Home page, [www.nanoos.org](http://www.nanoos.org). Under left menu item, “Data Explorer,” click “Products,” scroll down to “NOAA Buoys,” and click.
    - Have students explore this map, zooming in to their state, and/or an area of interest, and clicking on buoys to bring up the most recent data from that buoy.
- 



Interactive Map of West Coast buoys. Clicking a symbol will pull up data from that buoy.

- NDBC Moored Buoys: wind and wave data
- ▲ NDBC C-MAN Stations: wind data
- ⊙ NOS Stations: wind data
- SCRIPPS Buoys: wave data.
- ◆ NERRS Stations: wind data
- ◇ Canadian Buoys: wind and wave data

- Have students choose a region of the Pacific Coast, Pacific Ocean, or Great Lakes, and gather data from buoys in the region. Include date and time of the latest observation, wind speed, and wave height from buoys. (Alternative: to groups of students assign a geographic area from which to gather data.)
- Post or pass around a Beaufort Scale to all students. Students should use their data to determine the Beaufort Wind Force Scale at each of their buoy



locations, and whether or not they expect it to be safe to travel in the area of the buoy.

- Have each group compile a report to mariners based on this information.

MAREP or MARiner REPort:

MAREPs are messages about weather and sea conditions that you and other mariners have observed at sea. They are used to inform other mariners about actual sea conditions, helping mariners decide where they may or may not travel on the water. They can also be used by weather forecasters to update marine warnings and forecasts.

Information for your reports to mariners includes:

- Radio call sign
- Time of observation
- Location
- Wind direction and speed
- Seas
- Swell direction and height
- Visibility
- Present weather
- Barometer (air pressure) – inches (in) or millibars (mb), if rising or falling
- Air temperature
- Sea water temperature
- Wind gusts – seas higher than average, heavy rain, dense fog, etc.
- Any other conditions you feel are important

Resources from NOAA:

MAREP user guide:

<http://www.nws.noaa.gov/om/marine/marepreport.pdf>

Guide to Mariner Reports (MAREPs)

<http://www.nws.noaa.gov/om/marine/marep.pdf>



- If students would like more information to include in their forecast, they can access the National Weather Service, at : <http://www.nws.noaa.gov/> to find information on temperature, precipitation, and cloud cover.
- As a class, students can come together to determine the best and worst places to be out on the water based on their data. They can use the sample Data Table below.

Sample Data Table:

Buoy #	Location	Obs. Date	Obs. Time	Wind speed	Wave Height	Beaufort #	Expected Conditions	Safe to travel?

- In class or small groups have students graph wind and wave data from their data table. What do students expect the relationship to be between wind and waves, based on their experience in the introductory activity? Does their graph meet their expectations? If not, have a class discussion on reasons this may be.
- For an explanation on this, direct students to these education pages on the National Buoy Data Center:

<http://www.ndbc.noaa.gov/educate/pacwave.shtml> . Make sure students read through the page and click “Answer” at the bottom to get the explanation of why wind and wave data may not correlate as nicely as they might expect.

## Resources

- National Geographic wave simulator. Students can adjust wave height, wave period wave length.  
<http://www.nationalgeographic.com/volvoceanrace/interactives/waves/>
- Background information on waves:  
[http://www.windows.ucar.edu/tour/link=/earth/Water/ocean\\_motion.html](http://www.windows.ucar.edu/tour/link=/earth/Water/ocean_motion.html)
- NDBC Science Education Page:  
<http://www.ndbc.noaa.gov/educate/pacwave.shtml>

## Standards

**OLEP** (Ocean Literacy Essential Principles)

**NSES** (National Science Education Standards)

Washington State **EALRs** (Essential Academic Learning Requirements) and **GLEs** (Grade Level Expectations)

## Oregon Science Standards

### Content Standard or Essential Principle

### LEARNING GOALS

A: Abilities necessary to do science

- Develop descriptions, explanations, predications, and models using evidence. (6-8)
- Think critically and logically to make the relationships between evidence and explanations. (6-8)

*NSES*

7: The ocean is largely unexplored.

- Understanding the ocean is more than a matter of curiosity. Exploration, inquiry, and study are required to better understand ocean systems and processes.

*OLEP*

- New technologies, sensors, and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on

satellites, drifters, buoys, subsea observatories and unmanned submersibles.

Scientific Inquiry

- Summarize and analyze data including possible sources of error. Explain results and offer reasonable and accurate interpretations and implications.

*OR*

EALR 2: Inquiry  
Core Content: Questioning and Investigating

- Collecting, analyzing, and displaying data are essential aspects of all investigations.

*WA*

EALR 3: Application  
Core Content: Science, Technology, and Society


- The ability to solve problems is greatly enhanced by use of mathematics and information technologies.








*WA*

### Acknowledgements





- Introductory lesson modified from lesson by Margaret Olsen, SouthEast COSEE
- Data lesson based on “Sea State” lesson from the Bridge:  
<http://www2.vims.edu/bridge/search/archives.cfm>

### MODERN BEAUFORT SCALE

Beaufort Number	Wind Speed (mph)	Description	Wave height (ft)	Sea Conditions	Land Conditions	Sea State Photo
0	<1	<a href="#">Calm</a>	0	Flat. Sea like a mirror	Calm. Smoke rises vertically.	

1	1-5	<a href="#">Light air</a>	0.33	Ripples, without crests	Smoke drifts in the wind.	
2	6-11	Light <a href="#">breeze</a>	0.66	Small wavelets. Crests have glassy appearance, not breaking	Wind felt on exposed skin. Leaves rustle.	
3	12-19	Gentle <a href="#">breeze</a>	2	Large wavelets. Crests begin to break; scattered whitecaps	Leaves and smaller twigs in constant motion.	
4	20-28	Moderate <a href="#">breeze</a>	3.3	Small waves. Numerous whitecaps	Dust, leaves, and loose paper raised. Small branches move.	
5	29-38	Fresh <a href="#">breeze</a>	6.6	Many whitecaps. Some foam and spray.	Branches of a moderate size move. Small trees sway.	
6	39-49	Strong <a href="#">breeze</a>	9.9	Large waves with foam crests and some spray. Whitecaps everywhere	Large branches move. Whistling in overhead wires. Umbrella use becomes difficult.	
7	50-61	High wind, Moderate <a href="#">Gale</a> , Near Gale	13.1	Sea heaps up and foam begins to be blown in streaks in wind direction.	Whole trees in motion. Effort needed to walk against the wind. Swaying of skyscrapers may be felt.	



<b>8</b>	62-74	Fresh <a href="#">Gale</a>	18	Moderately high waves with breaking crests forming spindrift. Streaks of foam.	Twigs broken from trees. Cars veer on road.	
<b>9</b>	75-88	Strong <a href="#">Gale</a>	23	High waves with dense foam. Sea begins to roll. Considerable spray.	Larger branches break off trees, and small trees uprooted. Temporary signs and barricades blow over.	
<b>10</b>	89-102	Whole <a href="#">Gale/Storm</a>	29.5	Very high waves with overhanging crests. Foam gives the sea a white appearance. Airborne spray reduces visibility.	Trees are broken off or uprooted, saplings bent and deformed, Shingles in poor condition peel off roofs.	
<b>11</b>	103-117	Violent storm	37.7	Exceptionally high waves. Foam covers much of the sea surface. Airborne spray severely reduces visibility.	Widespread damage. Damage to most roof surfaces, older curled/fractured asphalt tiles may break away completely.	

12

≥118

Hurricane-  
force

≥46

Huge waves.  
Sea is  
completely  
white with  
foam and  
spray. Air  
filled with  
spray,  
visibility  
greatly  
reduced

Considerable  
widespread  
damage, windows  
broken, structural  
damage to mobile  
homes, sheds and  
barns. Debris may  
be hurled about.

