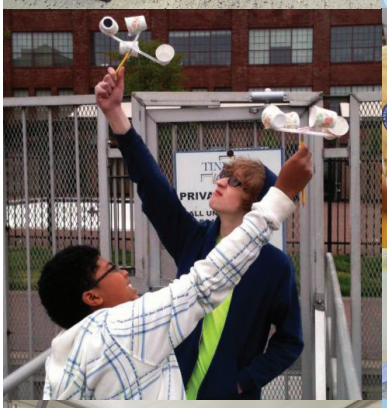








Science
Technology
Engineering
Math

US SAILING

REACH

US SAILING'S STEM EDUCATION INITIATIVE

Dear Level 1 Student,

Congratulations on pursuing a future in sailing education and instruction. Your passion for sailing and teaching others may be a good fit with Reach, US Sailing's STEM Education Initiative. As you begin engaging youth in the great sport of sailing please utilize the attached Reach Module 1: Measuring Wind as a resource. If you enjoy the module and the teaching perspective it shares, please join us in the future for a Reach Educator Course.

In 2012, US Sailing launched Reach, a national education initiative connecting youth to STEM education and innovation through sailing. US Sailing's leadership in embracing STEM education to engage students in hands-on learning opportunities in a natural environment is challenging students higher academically. US Sailing's network of training programs for US Sailing certified instructors along with our network of waterfront sailing organizations provide a natural learning environment for students nationwide.

Why use Reach?
- Adventure programing focusing on the "How"and "Why"of sailing
- Kids stay engaged on no-wind or rainy days

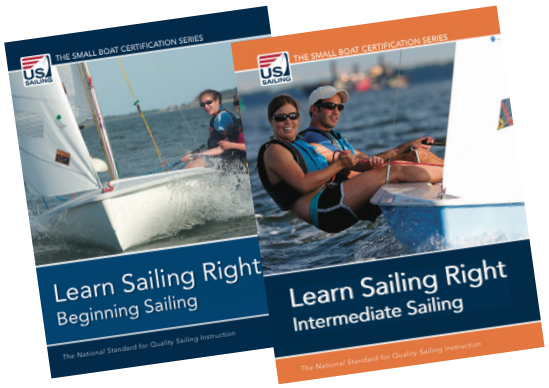
Reach Resources:
Educator Guide - A sailing instructor or teacher' s guide featuring 10 learning modules for middle school aged youth integrated with on and off the water learning opportunities. The curriculum is designed to reinforce sailing skills while exploring the natural world around them. Modules can be easily implemented in a one week camp, seasonal after school program, summer sailing program, field trips and learn to sail programs. See Module 1: Measuring Wind.

Student Logbook and Portfolio - Perfect for youth ages 10-16, the Reach Student Logbook & Portfolio provides a place for youth sailors to track their sailing skills, collect data, reflect on their learning, and engage in Science, Technology, Engineering, Math (STEM) and the environment around them. Students will be inspired through the many "Career Connections" to peruse their love of sailing for a lifetime. The student book directly aligns to Modules 1-10 in the Reach Educator Guide: Middle School. A fit for Adventure Sailing Classes, Learn to Sail programs, and of course, Reach programing. See Student Logbook & Portfolio except attached.

STEM Educator Course: Middle School 1 - Just getting started? Check out the STEM Educator Course for teachers and sailing instructors. A one-day, eight-hour professional course supported by learning materials and instructional methodologies, as well as a walk-through of all 10 Reach modules. Upon completion attendees receive a course certificate and a personal copy of the Reach Educator Guide for Middle School, Modules 1-10.

Fair Winds,
The Reach Team at US Sailing

Learn more: Visit www.reach.usailing.org or email reach@ussailing.org
to find a Reach Educator course in your area. Thank you!



A Perfect Fit, Reach and Learn Sailing Right

Reach Module	Learn Sailing Right (LSR) Correlation	Sailing Skills
Module 1: Measuring Wind	LSR Beginner Chapter 4 LSR Intermediate Chapter 2	Preparation, Wind Awareness, Wind Detection, Wind Direction Clues
Module 2: Buoyancy	LSR beginner Chapters 2, 3, 4 and 7 LSR intermediate Chapters 2, 4 and 5	Know your boat, Directional Terms, When the Boat is in the Water and Proper Position in the Boat
Module 3: Sail Area and Perimeter	LSR Beginner Chapters 3 and 4 LSR Intermediate Chapters 3 and 4	Sail shape and control of the boat, Basic science of how a sail works
Module 4: Simple Machines on Sailboats	LSR Beginner Chapters 3 and 4 LSR Intermediate Chapters 8 and 11	Pulleys, levers and other basic rigging and their effect on sailing
Module 5: Water Quality Testing	LSR Beginner Chapter 4 LSR Intermediate Chapter 2	Sailing a course, water temperature and clarity
Module 6: Marine Debris	LSR Beginner Chapter 10 LSR Intermediate Chapter 15	Navigation, anchoring, mooring, sailing and safety
Module 7: Upwind Sailing Angles	LSR Beginner Chapter 12 LSR Intermediate Chapter 6	Coordination between trim and steering and anticipation of wind change
Module 8: Land and Sea Breezes	LSR Beginner Chapter 10 LSR Intermediate Chapter 2	Movement of air, weather prediction and safety
Module 9: Wind Power	LSR Beginner Chapters 4 and 10 LSR Intermediate Chapters 2 and 4	Maximizing wind, basic science of how a boat works
Module 10: Underwater Exploration	N/A	N/A

MODULE 1: MEASURING WIND

How can we use wind if we can't see it?

Learn Sailing Right! **Beginner Chapter 4 & Intermediate Chapter 2**

Subject Areas
Earth Science, Math (Statistics and Conversion)

Summary
Students construct anemometers to measure wind speed, collect data, and compare wind velocity in different locations.

Duration
Lesson Time:
Part I: 20 minutes
Part II: 20 minutes
Part III: 45 minutes
Part IV: 60 - 120 minutes
Part V: 45 minutes

Skills
Gathering Information, Organizing Data, Analyzing, Interpreting, Applying, Measurements, Conversion, Averaging

Sailing Skills
Preparation, Wind Awareness, Wind Detection, Wind Direction Clues, Reading Wind on the Water, Wind Velocity, True and Apparent Wind

Vocabulary
Standard Units, Beaufort Wind Scale, Anemometer, Wind Puff, Miles Per Hour (mph), Wind, True Wind, Apparent Wind

Standards
See Standards Correlation Charts related to the National Standards. Common Core Standards relate to mathematics and the K-12 Framework for Science Education relate to Science.

Objectives
Students will:
- Define wind scientifically using speed and direction.
- Construct an anemometer and use it to take accurate measurements of wind speed.
- Convert revolutions per minute to miles per hour and collect wind speed data.
- Be introduced to the Beaufort Wind Scale.

- Compare their data to the Beaufort Wind Scale and explain why we have standards in measurement.
- Identify wind using visual clues.

Materials

- US Sailing – *Learn Sailing Right!* Beginner Chapter 1: Preparing Yourself for Sailing
- Pencil with new eraser- One per person
- Paper Dixie cups-Four per person
- Two paper drinking straws per person (non bending)
- Masking Tape
- Straight pin (used for sewing)
- Black permanent marker
- Clipboard
- Stopwatch/timer
- Whiteboard
- Weather report from daily paper
- Electric fan
- Smart phones
- Weather apps
- Radar

Sailing Centers

Sailing Centers should complete Parts I, II, and III followed by 2 hours of sailing time applying boat handling and wind awareness skills. The goal of this lesson is to help students identify wind and understand the complexity of wind, it's direction, and changes in velocity. By improving wind awareness and detection skills students will be able to predict shifts and identify wind patterns becoming more knowledgeable sailors.

Formal Classroom Settings

Classroom Teachers should complete Parts I, and III in a single class period followed by Parts II and IV in period 2, and Part V in period 3. The extension activity can be implemented in period 4. On day 5 invite your local meteorologist to the classroom to present on local weather patterns in your area and the causes of typical wind patterns in your area.

Career Connection

There are many careers in weather; meteorologist, hurricane hunter, weather reporter, weather writer, wind turbine engineers. Contact your local NOAA weather station to connect students with a meteorologist.

PROCEDURE

Part I: What Do We Know About Wind?
Classroom - *10 minutes*

1. Access Prior Knowledge (APK) Place the word "wind" on the board. Ask students, "What do we know about wind?" Brainstorm in pairs. Ask, "Why is wind important to us? What are the different uses of wind in our world today." Have groups share out their answers with the class.

2. Ask students when they have witnessed the effects of wind. List concrete examples on the board; *For example* - wind blowing leaves. Looking at these examples. Does it take the same strength of wind to move leaves in a tree as it does to demolish a house? Ask students, "Is it important for you to be aware of the wind's strength in your everyday life? Why? Where would you locate the strength of the wind for the day?" (newspaper, internet, or TV).

3. Now that you have listed examples of wind and we understand why it is important to know the wind's strength for the day, let's define wind. Ask students to define wind and list answers on the board. Guide students by asking, "Who talks about wind and what do they say?" After a few minutes of questioning lead students to the definition that wind is the horizontal movement of air; it is a current of air that moves along or parallel to the ground, moving from an area of high pressure to an area of low pressure. Surface wind is measured by anemometers or its effect on objects, such as trees. Take this opportunity to discuss careers within wind and weather such as meteorologists, and climatologists.

4. Leaving the word "wind" on the board with the definition, now ask students how you can measure something you cannot see? Collect responses on the board. Ask students, "How do we measure wind?". Lead students to explain how wind is reported on their local news or in the newspaper. Wind is measured by speed and direction.

5. Show students the weather report from the daily paper or the National Weather Service via the internet. Sailors should always check the weather before spending a day on the water. A good rule of thumb for new sailors is to stay on the docks if the wind is 20mph or over.

6. Take the daily weather report of X mph at X direction and write it on the board.

7. Ask students what the unit of measure is in wind speed. They should identify mph as miles per hour. In the United States we use mph as our standard in wind speed.

Part II: Identify Wind Clues
Outdoor Classroom - *10 minutes*

1. Take students to the docks or beach area to look at boats and sailing location. Ask students to identify the source of power on the safety boat. Ask students to identify the source of power on a sailboat (wind). Take a look at boats on a mooring. Are they all facing the same direction? Why?

2. While standing on the dock or the beach ask students to look for clues about wind. We can't see wind, but we can see the results of wind. Have students identify clues about wind. Can they feel it on their faces? Is it strong or weak? Lead students to identify wind on the water, the blowing of leaves, the movement of trees, flags, halyards, or the result of wind on other boats on the water. Show students the body of water they will be sailing on and discuss the typical wind patterns during their sailing time.

3. Tell students, "Since we can't see wind, we need to use clues about wind to help power our boats." Take 5 minutes and ask students to make observations about the wind silently, then share them with the group. If students are struggling lead them by asking students if the wind is always moving at the same speed, or if it changes.

4. Have students make predictions about the current wind speed and direction and how it will or would affect sailing today. (High winds will make the boats go fast.)

5. Return to classroom to review: Wind is the horizontal movement of air; it is measured in speed and direction. The standard unit of measurement is miles per hour. Now, how can we make an instrument to measure wind speed? Have students design their own instrument on paper.

Part III: Making A Wind Anemometer

Classroom - Outdoor - *45 minutes*

Note: Educators have two options. The first option is a quick option, show students a preassembled anemometer. The second option is to provide students with the materials and ask them to build and test their own. If time allows, option 2 has a lasting result and involves engineering, design, and problem solving.

1. Mark one of the cups with a black permanent marker; this will be the marker when counting spins (revolutions per minute).

2. Arrange 4 paper dixie cups and two drinking straws to form a cross.

3. Tape the straws to the top of Dixie cups. The open end of all cups should face the same direction. Let the students test the cups at different angles if time permits.

4. Push a straight pin through the center of the straws into an eraser on the end of a pencil to provide an axel. This instrument is called an

anemometer, it is used to measure wind speed. The more spins per minute, the greater the wind velocity (speed). Once the students have completed construction of the anemometer they should test it with a fan.

5. While holding the anemometer in front of an electric fan on low, count how many times the marker cup (with the black line) goes by. This is the number of spins or revolutions per minute (10 revolutions per minute is approximately 1 mile per hour).

Note: Average = (Trial 1 + Trial 2 + Trial 3 + Trial 4)/4

Trial #	Number of rpm (spins per minute)
1.	
2.	
3.	
4.	
Average:	

Have students compare their data collected on average spins (revolutions) per minute from the fan on low with each other. They can record their data on the student data collection sheet. Students can then find the class average (sum divided by amount of values, median (middle number), and mode (most often used number).

Student Name	Average RPM with fan on low
Student 1	
Student 2	

Part IV: Measuring Wind in Multiple Locations

Outdoor Classroom - *60 - 120 minutes*

Note: This activity can be done on the water while sailing or on land. For seasoned sailors, have them place the boat in safety position before taking a reading. For first time sailors, have the coach place the boat in safety position. For students on land or on the safety boat have students go to various locations. As a challenge, have students take readings during puffs and lulls in different locations on and off the water so they begin to know the winds at their sailing location better.

1. Divide class into groups of three. Each group will have a timer, record keeper, and a holder. The timer will run the stop watch for 1 minute and say "Go" to start the counting and "Stop" to end the counting. The counter will count how many revolutions (spins) by counting the number of times the black marker cup passes by. The holder will hold the anemometer so the wind is unobstructed.

2. Identify four locations to collect wind speed. They can be on or off the water. Students should take three readings at each location. Make sure groups go to different locations, you can show them on a map or chart, suggest protected vs. unprotected areas. Have students identify the locations through a discussion.

3. Before students head out to collect wind speed data, have them make predictions about the locations that will have higher wind speeds compared to those with lower wind speeds. Have them explain why (their reasoning) they made such predictions. Students should average the three readings at each location and record the groups average wind speed at each location on the class data sheet.

4. Once all the groups have compiled and calculated the average wind speed at each location gather the students to draw conclusions about their data. Ask students if their predictions were correct. Have them explore why wind speeds vary between the locations and what may have caused a difference in the readings. Students can analyze the class data on the Class Data Sheet.

Part V: Beaufort Wind Scale

Classroom - *45 minutes*

1. Introduce students to the Beaufort Wind Scale. Have students read Student Sheet 3 on the Beaufort Wind Scale silently, or read it to them aloud. Explain that this is the first standard on wind speed. Explain that it was developed by sailors.

2. Ask students to name a few standards of measurement - inches, miles, feet, meters, pounds. Ask students why we have standards. Discuss how standards are used to create a common understanding in measurement. Lead students to make the connection the Beaufort Wind Scale was the first standard in measuring wind.

3. Review the description of each force and have student visualize the effects of wind.

4. Have each group of students act as meteorologists and create a weather report for a particular location using the terms from the Beaufort Wind Scale. Once they are finished they can give their weather report to the class. This can be completed by accessing buoy data from NOAA's nbdb.org or they can look up weather reports from different cities. They can select a buoy, and record current wind speed data all over the US. Students can collect data using Student Sheet.

Student Example:

"Good afternoon Seattle, this is Michael and Oliva to tell you your afternoon weather forecast. It is 47 °F out with a slight chance of showers. There is a force of 2 on the Beaufort Wind Scale so you should see your weather vanes and smoke moving to the West. There is a slight breeze to your face and leaves wrestling in the trees. It is a great day for boating. There will be miniature wavelets with glassy crests with no breaking waves."
By: 6th grade students from Edison Sailing Center in Fort Myers, FL

RESOURCES

NOAA Tornado Facts – Facts on wind speed
(http://www.spc.noaa.gov/faq/tornado/beaufort.html)

National Earth Science Teachers Association - Two minute video on Beaufort Scale
(http://www.windows2universe.org/earth/Atmosphere/wind_beaufort_scale_lsop_video.html)

The Weather Channel Kids – Daily weather report
(http://www.theweatherchannelkids.com/weather-center/)

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

Careers in Weather
(http://www.youtube.com/watch?v=7ex1wFtX-7Y)

Science Centers - Many cities have hands-on science museums and/or Imaginariums that have a weather/wind exhibits, visit yourself or bring your students.

Weather Stations – Add a permanent weather station for students to note data and keep your sailors safe. They are available at your local Walmart ($100)or online from $100-$500 (Davis model)

Module 1: Student Sheet 1

Wind Speed Data Collection

Student Name: _____ Date:_____

Student Anemometer Reading with Fan on High

Trial #	Number of rpm (spins per minute)
1.	
2.	
3.	
4.	
Average:	

Local Wind Speed Readings

Location	Reading 1	Reading 2	Reading 3	Average Reading (Reading 1 + Reading 2 + Reading 3)/3
Location 1 _____	_____ RPM	_____ RPM	_____ RPM	_____ RPM
Location 2 _____	_____ RPM	_____ RPM	_____ RPM	_____ RPM
Location 3 _____	_____ RPM	_____ RPM	_____ RPM	_____ RPM
Location 4 _____	_____ RPM	_____ RPM	_____ RPM	_____ RPM

Module 1: Student Sheet 2

Group Wind Speed Data Analysis

Student Name: _____ Date:_____

List each group's average wind speed at each location

Local Wind Speed Readings

Group	Location 1	Location 2	Location 3	Location 4
Average Wind Speed at each location				

1. Which location had the highest wind speed?

2. Which location had the lowest wind speed?

3. List three factors that affect wind speed.

a.

b.

c.

4. List three indicators of wind.

a.

b.

c.

Module 1: Student Sheet 3

Student Wind Report

Student Name: _____ Date: _____

Beaufort Wind Scale

Wind speed is measured by using a scale of 0-12 based on visual clues originally developed in 1806 by Sir Francis Beaufort. He developed a rating system to make accurate recordings of wind speed. This system was developed for sailors, but has since been modified by the National Weather Service for use on land.

History of the Beaufort Wind Scale

According to the National Weather Service, The Beaufort Wind Force Scale was developed by Rear Admiral, Sir Francis Beaufort, who was born in Ireland in 1774. Beaufort is said to have had an illustrious career on the seas and by 1800 had risen to the rank of Commander. In the summer of 1805, Commander Beaufort was appointed to the command of the Woolwich, a 44-gun man-of-war. It was at this time that he devised his wind force scale. By 1838, the Beaufort Wind Force Scale was made mandatory for log entries in all ships of the Royal Navy. Although he describes them in terms that may be vague to a modern sailor, his descriptions would certainly convey the full meaning of the force of the wind to men who shared years of sailing in ships with characteristics similar to the Woolwich.

The effect of the wind on an 18th-century fighting ship is at the heart of Beaufort's scale. Note that Beaufort intends that you look at the ship, not at the wind! The scale was devised for a group of men who shared the same experience – years of unremitting blockade of Europe in sailing ships, which were all quite similar in characteristics. His descriptions are in terms of the ship's characteristics under sail. The descriptions for Beaufort numbers 0 through 4 describe the wind in terms of the speed that it may propel the ship; those for 5 through 9 in terms of her mission and her sail carrying ability; and those for 10 through 12 in terms of her survival.

Directions: According to Beaufort's Wind Scale on Student Sheet 4, give a weather report for your location. Use the back of this worksheet. Make sure to mention wind speed, direction and use the term from the National Weather Service.

Module 1: Student Sheet 4

Beaufort Wind Scale

Student Name: _____ Date: _____

Beaufort Force	Wind Speed (MPH)	Sea Indicators	WMO Classification
0	0-1	Sea surface smooth and mirror-like	Calm
1	1-3	Scaly ripples, no foam crests	Light Air
2	4-7	Small wavelets, crests glassy, no breaking	Light Breeze
3	8-12	Large wavelets, crests begin to break, scattered whitecaps	Gentle Breeze
4	13-18	Small waves 1-4 ft. becoming longer, numerous whitecaps	Moderate Breeze
5	19-24	Moderate waves 4-8 ft taking longer form, many whitecaps, some spray	Fresh Breeze
6	25-31	Larger waves 8-13 ft, whitecaps common, more spray	Strong Breeze
7	32-38	Sea heaps up, waves 13-19 ft, white foam streaks off breakers	Near Gale
8	39-46	Moderately high (18-25 ft) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Gale
9	47-54	High waves (23-32 ft), sea begins to roll, dense streaks of foam, spray may reduce visibility	Strong Gale
10	55-63	Very high waves (29-41 ft) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Storm
11	64-72	Exceptionally high (37-52 ft) waves, foam patches cover sea, visibility more reduced	Violent Storm
12	73 or more	Air filled with foam, waves over 45 ft, sea completely white with driving spray, visibility greatly reduced	Hurricane

Module 1: Student Sheet 5

Charting Wind Speed and Direction

Name: _____ Date: _____

Select a buoy using NOAA's National Buoy Data Center at www.ndbc.noaa.gov. Chart the wind speed and air temperature in the table below for the past 5 complete days. Take note time is based on a 24 hour clock. Click on a buoy. Click on history. Click on real time data. Click on real time standard meteorological data.

Buoy Number and Location: _____

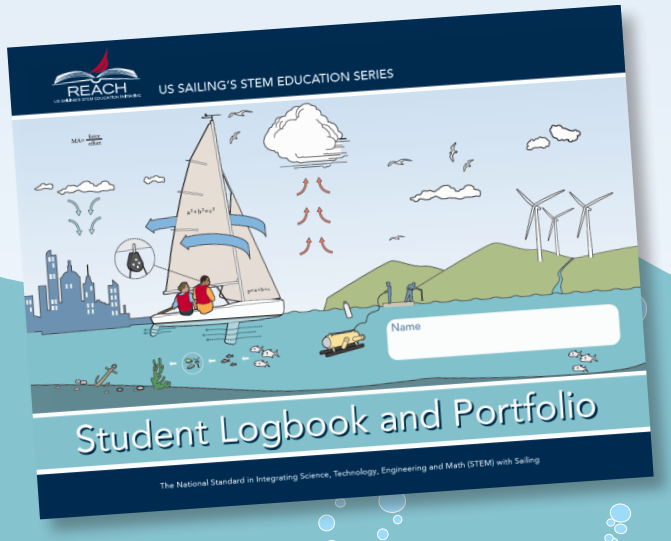
Date	Time	Wind Speed	Air Temperature

Date	Time	Wind Speed	Air Temperature

Date	Time	Wind Speed	Air Temperature

Date	Time	Wind Speed	Air Temperature

Date	Time	Wind Speed	Air Temperature



From the Reach Student Logbook and Portfolio

REACH SAILING SKILLS
SELF ASSESSMENT

Wind Direction

Skills	✔	Instructor Initial
I can identify three wind indicators: a. b. c.		
I can identify the wind direction: (North, South, East, West)		
Wind is measured by _____ and _____		

Parts of the Boat

Skills	✔	Instructor Initial
I can name the parts of the boat.		
I can name the parts of the sail.		
I can identify Port and Starboard.		

Rigging/ Unrigging

Skills	✔	Instructor Initial
I can Rig the sails, attaching them at the head, clew, and tack.		
I can unrig, roll or flake, and stow the sails.		

Knots/Lines

Skills	✔	Instructor Initial
I can tie a Cleat Hitch using a deck cleat.		
I can tie a Figure 8		
I can tie a Bowline		

Points of Sail

Skills	✔	Instructor Initial
I can identify the points of sail.		
I can sail on a Close-Hauled course with proper sail trim.		
I can sail down-wind on a run with proper sail trim.		
I can sail on a Broad or Beam Reach with proper sail trim.		

Boat Handling

Skills	✔	Instructor Initial
I can tack. "Prepare to Tack."		
I can hold the tiller properly.		
I can Jibe. "Prepare to Jibe."		

Safety

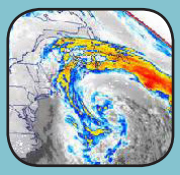
Skills	✔	Instructor Initial
I always wear my life jacket on the dock and on the boat.		
I can float in my life jacket.		
I can demonstrate a Signal of Distress		
I can identify basic navigational aids (buoys, markers.)		

MODULE ONE
Measuring Wind

How can we use wind if we can't see it?

Fun Facts about Measuring Wind

- The highest surface wind speed ever recorded by man was 372 kph (231.15 mph) at Mount Washington Observatory in North Conway, New Hampshire on April 12, 1934."
- The anemometer was originally designed by Leon Batista Alberti in 1450, but the famous Leonardo da Vinci made variations to the original design between 1483 and 1486.
- The first windmills were developed in Persia and China around 2000 B.C.





Calculate your anemometer's average "spin" or rotation per minute.

Trial 1	Trial 2	Trial 3

Average Spin

Hint: Average = (Trial 1 + Trial 2+ Trail 3)/3

Joseph M. Sienkiewicz Chief of the Ocean Applications at NOAA

Joseph M. Sienkiewicz is the Chief of the Ocean Applications Branch at the NOAA/NWS Ocean Prediction Center based in College Park, Maryland. Joseph's responsibilities include forecast technique development and optimization of the use of ocean and satellite observing systems for ocean weather forecasting for the Ocean Prediction Center. Mr. Sienkiewicz graduated from the NY Maritime College and received his Master of Science in Atmospheric Science from the University of Washington. He began his career as a professional mariner and worked as mate and relief captain on tugboats out of the New York harbor in the early 1980's. Joseph's professional interests include: explosively intensifying ocean storms, extreme winds in ocean storms as well as wave development and propagation. His passion for weather began as a youth sailor at Community Boating Inc. in Boston, Massachusetts, which eventually led him to a career in meteorology.

Career Connection

There are many careers in weather and meteorology. Can you imagine yourself as a hurricane hunter, meteorologist, or climatologist?

LOCATIONS	TIME & DATE		
	4/11 @ 5pm		
North Docks	30 RPM or 3mph		

RECORD YOUR WIND SPEED DATA

Use your anemometer or standard anemometer, collect and record wind speed data at various times and locations. Do you notice any trends in the data based on location or time?

Which location had the highest wind speeds?

Which location had the lowest wind speeds?

List 3 factors that affect wind speed:
a.
b.
c.

List 3 indicators of wind:
a.
b.
c.

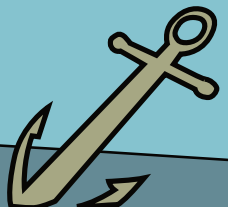
Environmental Connection

After hurricanes, tsunamis, and other major weather related events, large amounts of debris are washed into our oceans and waterways. What determines the path of this debris (docks, boats, houses, etc) through the water? Physics! A combination of characteristics of the object, patterns of wind, and ocean currents all play a role in where marine debris moves in our oceans, lakes, and bays. Following the devastating tsunami that struck Tohoku, Japan in 2011, models have been used to predict the path of the tons of debris that washed out to the Pacific Ocean. Windage is one term scientists are now using to predict an object's path.

List and describe the local weather stations and buoys that collect wind speed data in your area:

Buoys:

Weather Stations:



Notes

Science
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US SAILING

REACH
US SAILING'S STEM EDUCATION INITIATIVE