ARM

CLIMATE RESEARCH FACILITY

Education and Outreach Lesson Plan

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Grade levels 7-9

Introduction to wind
Wind, moving water, and waves
Observing wind speed and cloudiness

Introduction to Wind

Objective

Investigate how pressure differences create wind.

Background information

Wind is caused by air flowing from high pressure to low pressure. Since the Earth is rotating, however, the air does not flow directly from high to low pressure, but it is deflected to the right (in the Northern Hemisphere; to the left in the Southern Hemisphere), so that the wind flows *around* the high and low pressure areas. This effect of the wind "feeling the Earth turn underneath it" is important for very large and long-lived pressure systems. For small, short-lived systems (such as in the cold outflow of a thunderstorm) the wind will flow directly from high pressure to low pressure.

Students often have misconceptions about wind and where it comes from. Before the lesson begins, review the concepts provided in the background information. Visit the ARM Education web page at http://education.arm.gov/ for additional lessons on atmospheric pressure.

Activity

Each group of students will need the following:
1 – large balloon
1 – medium balloon
1 – small balloon
1 – bicycle pump (or blow it up yourself for safety)

1. Blow up the balloons by pump or mouth
2. Do not tie it.
3. Hold up the blown-up balloon in one hand and release the air very slowly.
4. As the air is released, the students can observe that air is moving out of the balloon by holding their other hand next to the balloon's opening. The force of the air on their hand is evidence that the air is escaping. In addition, the air escaping the balloon feels like wind.
5. Repeat the process a few more times with different sized balloons. Ask the students to record their observations.

Discussion questions

Describe what happened to the air in the balloon when it was released. Why did this happen? Did you find any difference if the balloon was bigger? Why?

How is the air in the balloon like the air in the atmosphere? What causes the air in the atmosphere to move and cause wind? Why does this happen?

Wind, Moving Water and Waves

Objective

Demonstrate how wind causes water to move and generate waves and how water pressure causes water to move from higher to lower pressure.

Background information

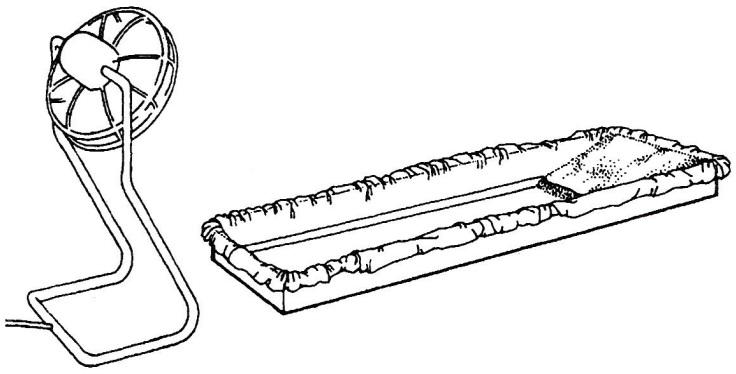
The wind-driven circulation of the ocean results from differences in water pressure. These differences result mainly from changes in the slope of the sea surface due to winds. Winds blowing over the water cause the water to move and build up in the direction that the wind is blowing. This creates a pressure difference between the high and low areas (pressure is higher where the water is piled up). The pressure differences generates a force to push the surface back towards the region of lower pressure. In other words, the water wants to go downhill or down the slope. Because of the Coriolis force (effect of the rotating Earth), however, the moving water or current is deflected to the left in the Southern Hemisphere and to the right in the Northern Hemisphere.

Everyday we see masses of water always on the move. Although there may be very little observable movements on the ocean surface on a very fine day, in fact, the ocean water is always moving. There are many ways that you can make waves in water. Most waves are created by winds.

Activity

Each group of students will need the following:
1 – rectangular metal or glass container
1 – gallon of water
1 – approximately 2 kg of sand
1- an electrical fan or hair drier
1 – stopwatch or watch with second hand

1. With sand, construct a beach at one end of the tank.
2. Fill the tank with water to a depth of about 5 cm
3. Place the fan or hair drier on one side of the container so that the fan can blow onto the surface of the water. It should be aimed down the tank along the surface of the water at about a 45 degree angle.
4. Switch the fan or hair drier on at a lower speed and then at a higher speed. Allow 2 minutes for each trial. Let the students observe the different results.
5. Try step 4 again for 10 seconds only.



Discussion questions

1. What happened when the fan / drier was switched on?
2. What happened to the waves when the fan/ drier switched to a higher speed?
3. What happened to the size of waves as the time progressed?
4. Did you notice any differences in the waves from one end of the tank to the other? If so, what were they?
5. While the fan was running which side of the water tank had the highest pressure of water?
6. What happened when the fan was switched off?
7. From all your observations, what characteristics of wind are important in determining the height of a wave?

Follow-up activity

Ask students to write a short paper on why they think climate studies are so important when it comes to understanding how wind and sea interact. Students should consider the recent climatological events (such as hurricanes and tsunamis) that have occurred around the world. How could a better understanding of climate and weather possibly help people in everyday life? What research is currently being done to better understand weather and climate?

Observing Wind Speed and Cloudiness

Objective

Students will demonstrate their skills in observing the atmosphere, specifically in terms of wind speed and cloudiness.

Background information

Cloud cover affects temperature. Thick clouds reflect incoming solar radiation by day and also prevent much of the long-wave ground radiation (by night) from leaving the lower layers of the troposphere. So cloudy conditions cause lower temperatures by day and higher temperatures by night.

Wind can be generally defined as moving air usually in response to a pressure gradient. Variations in temperature and pressure provide the means to drive the winds of the world. If all points on our planet were exactly the same temperature and pressure then we would have no wind. Air always moves from an area of high atmospheric pressure to an area of low atmospheric pressure.

Cloud cover is usually given in a unit known as okta. One okta means one eighth of the sky. If the sky is completely covered in cloud, the cloud cover is given as 8 okatas, or 8/8. If the sky is half covered, the cloud cover is given as 4 oktas, or 4/8. Clouds can be low [0-3 km high], media [3-6 km high], or high [over 6 km high]. Very high clouds, which are made of ice crystals, are known as *cirrus* clouds. Flat clouds are known as *stratus*. Clouds that have a rounded, fluffy shape are called *cumulus*. Low black or grey clouds that bring rain are known as *nimbus*.

Preparation

Each student should have a cloud chart from the local meteorological service, or one can be found on the Internet. Students should also be familiar with the Beaufort Wind Scale (included in the packet). Each student should have a copy of the wind scale, or a large scale should be posted in the classroom.

Activity

After the teacher's brief introduction, the students should leave the classroom and go out into the open air. Where possible, observations should be made at a site where the view is relatively uninterrupted, so that students can see as much of the sky as possible. For recording wind speed, the students should be encouraged to look at objects that are high up, rather than those that are at ground level. Each student can record wind speed and cloud cover, and results can be compared with other class members. Each student can write down the observations made by him/her and 5 other students. Before the class session concludes, the students should be asked to take further observations by themselves during the day, at specific times, and record the results.

Student Recording Sheet
(for comparing with 5 other students)

Name	Date	Time	Wind speed (Beaufort No)	Cloud cover (okta)	Cloud Height (low, med, high)	Cloud Shape (cirrus, stratus, etc.)

Individual Student Record
(for other observations outside the classroom)

Name	Date	Time	Wind speed (Beaufort No)	Cloud cover (okta)	Cloud Height (low, med, high)	Cloud Shape (cirrus, stratus, etc.)

The Beaufort Wind Scale

Beaufort Number	Wind Speed [km h^{-1}]	Description of Wind	General Condition	Condition of Sea	Wave Height [m]
0	<1	Calm	Smoke rises vertically	Smooth as mirror	0
1	1-5	Light air	Direction of wind shown by smoke drift	Ripple with appearance of scales	0.15
2	6-11	Light breeze	Wind felt on face, leaves rustle	Small wavlelets, glassy crests	0.3
3	12-20	Gentle breeze	Leaves in motion, wind extends light flag	Large wavelets, glassy foam [not yet white]	0.6
4	21-29	Moderate breeze	Raises dust, small branches move	Waves longer, many white areas	1.6
5	30-39	Fresh breeze	Small trees begin to sway	Waves pronounced, white foam crests	3.1
6	40-50	Strong breeze	Large branches in motion, difficult to use umbrellas	Larger waves, white foam crests all over	4.7
7	51-61	Moderate gale	Whole trees in motion, inconvenient to walk	Sea heaps up and white foam from breaking waves	6.2
8	62-74	Fresh gale	Breaks twigs off trees	Moderately high waves	7.8
9	75-87	Strong gale	Slight structural damage occurs	High waves, sea begins to roll	9.3
10	88-101	Storm	Trees uprooted, considerable damage	Very high waves, rolling of sea is heavy	10.8
11	102-120	Violent storm	Widespread damage	Extremely high waves, ships hidden in troughs	*
12	>120	Hurricane	Serious damage	Sea covered with white streaky foam	*