Experiment E-4
Wind Speed Measurements

Environmental Science

Objectives

- To explore different levels of wind speed.
- To assess the speed of natural or simulated wind by using the Beaufort scale.
- To compare the assessment with the Anemometer logger sensor data.

Modules and Sensors

- PC + NeuLog application
- USB-200 module
- BAT-200 Battery module (optional)
- NUL-242 Anemometer logger sensor

Equipment and Accessories

▪ Utility stand
▪ Right angle clamp
▪ Extension clamp
▪ Fan

- The items above (except for the fan) are included in the NeuLog Utility accessories, UTL-KIT and in the NeuLog Mechanics kit, MEC-KIT.

Introduction

Wind is the movement of air at any velocity, especially a natural movement along the ground. It is caused by differences in air pressure within our atmosphere. Air under high pressure moves toward areas of low pressure. The greater the difference in pressure, the faster the air flows.

The direction of the wind is expressed as the direction from which it is blowing. For example, easterly winds blow from east to west. Sea breezes occur when inland areas heat up on sunny afternoons. That warms the air, causing it to rise. Cooler air rushes in from the ocean to take its place creating wind. Land breezes come at night, when the inland temperature value is low and the ocean is warmer than the land. In this situation, cooler air from the land moves towards the sea. Similar forces produce global wind patterns such as trade winds.

Wind speed relates to observed conditions at sea or on land. The Beaufort scale includes descriptions of these conditions and divides wind speeds into twelve different categories from less than 1 mph or 1.6 Km/hour (no apparent wind) to more than 74 mph or 119 Km/hour (hurricane).

The following Beaufort Scale for wind speed was taken from the University of North Carolina's website:

http://www.unc.edu/~rowlett/units/scales/beaufort.html

Force	Speed			Name	Conditions at Sea	Conditions on Land
	knots	km/hr	mph			
0	< 1	< 2	< 1	Calm	Sea like a mirror.	Smoke rises vertically.
1	1-3	1-5	1-4	Light air	Ripples only.	Smoke drifts and leaves rustle.
2	4-6	6-11	5-7	Light breeze	Small wavelets (0.2 m). Crests have a glassy appearance.	Wind felt on face.
3	7-10	12-19	8-11	Gentle breeze	Large wavelets (0.6 m), crests begin to break.	Flags extended, leaves move.
4	11-16	20-29	12-18	Moderate breeze	Small waves (1 m), some whitecaps.	Dust and small branches move.
5	17-21	30-39	19-24	Fresh breeze	Moderate waves (1.8 m), many whitecaps.	Small trees begin to sway.
6	22-27	40-50	25-31	Strong breeze	Large waves (3 m), probably some spray.	Large branches move, wires whistle, umbrellas are difficult to control.
7	28-33	51-61	32-38	Near gale	Mounting sea (4 m) with foam blown in streaks downwind.	Whole trees in motion, inconvenience in walking.

8	34-40	62-74	39-46	Gale	Moderately high waves (5.5 m), crests break into spindrift.	Difficult to walk against wind. Twigs and small branches blown off trees.
9	41-47	76-87	47-54	Strong gale	High waves (7 m), dense foam, visibility affected.	Minor structural damage may occur (shingles blown off roofs).
10	48-55	88-102	55-63	Storm	Very high waves (9 m), heavy sea roll, visibility impaired. Surface generally white.	Trees uprooted, structural damage likely.
11	56-63	103-118	64-73	Violent storm	Exceptionally high waves (11 m), visibility poor.	Widespread damage to structures.
12	64+	119+	74+	Hurricane	14 m waves, air filled with foam and spray, visibility bad.	Severe structural damage to buildings, wide spread devastation.

How can we measure wind speed? An anemometer is an instrument with three or four small hemispheres set so they can catch the wind and revolve about a vertical rod. The revolutions are recorded and wind speed is calculated (in kilometers/hour or miles/hour).

In this experiment, you will use a fan as a source of wind and simulate different situations, from light breeze to moderate breeze. You will assess the wind speed category by using the Beaufort scale and then compare this assessment with data obtained through an Anemometer logger sensor.

During a windy day, you could do an off-line measurement for a couple of minutes or hours and see the wind velocity changes during this period of time.

Procedure

Experiment setup

1. Set up the experiment as shown in the picture below.

2. Place the fan on the table and the anemometer in front of it at a distance of approximately 30 cm.

Sensor setup

3. Connect the USB-200 module  to the PC.

4. Check that the anemometer sensor  is connected to the USB-200 module.

Note:

The following software functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

5. Run the NeuLog application and check that the anemometer sensor is identified.

Settings

6. Click on the **On-line Experiment** icon  in the NeuLog main icon bar.

7. Click on the **Sensor's Module** box.

8. Click on the **Range** button.

9. Select the km/h button or the mph button to change the sensor's mode (depends on your country). The sample experiments will be conducted in mph mode.

10. Click on the **Experiment Setup** icon  and set the:

Experiment duration to 2 minutes
Sampling rate to 10 per second

Testing and measurements

11. Turn on the fan in its lowest intensity; leave it on for a while and feel the wind with your hands.

12. Look at the Beaufort scale and try to assess the wind speed category.

13. Increase the fan's intensity to the next level and try to assess the wind speed category.

14. Continue this way for all the fan's intensities.

15. Turn off the fan.

16. Click on the **Run Experiment** icon  to start the measurement. Wait 30 seconds with the fan off.

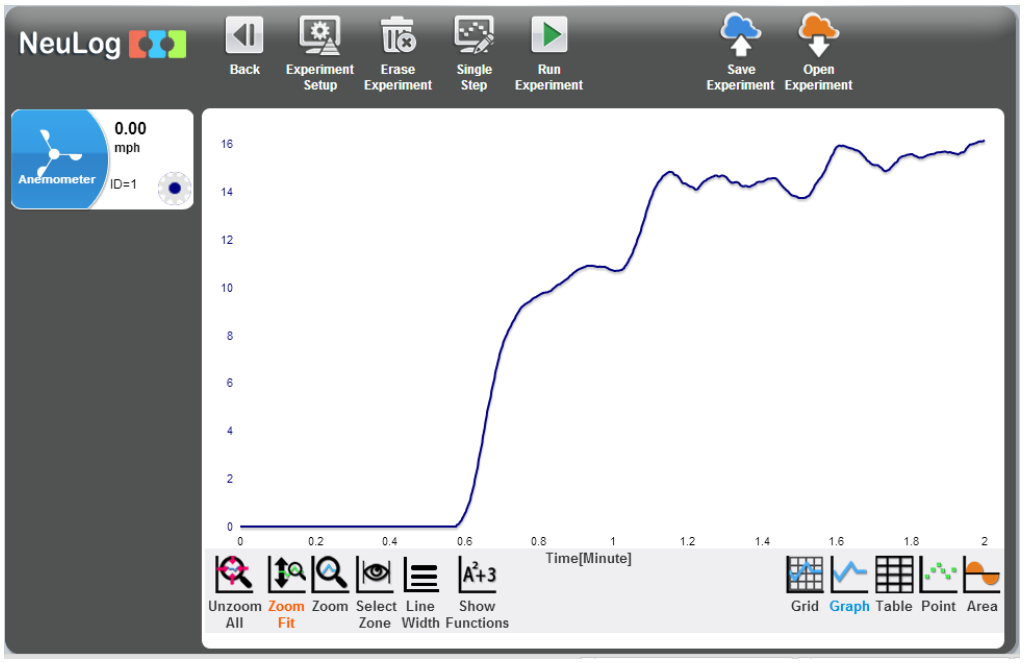
17. Turn on the fan in its lowest intensity; leave it on for 30 seconds.

18. Increase the fan's intensity to the next level and leave it this way for another 30 seconds.

19. Continue this way for all the fan's intensities.

20. Click on the Zoom fit icon  .

21. Your graph should be similar to the following:



22. Save your graph.

23. If it is a windy day, program an off line measurement of 2 hours (for example) and take your sensor outside.

24. Click on the **Off-line Experiment** icon in the NeuLog main icon bar.

25. Click on the **Experiment Setup** icon and set the time and duration.

26. Put the sensor in a stable place.

27. Press the sensor's start/stop button to start the measurement.

28. When the measurement is over, connect the sensor to the computer using the USB-200 module.

29. Click on the **Search Sensors** icon and then click on the **Offline Experiment** icon.

30. Click on the **Load Experiment** icon.

The menu shows a list of stored experiments in the sensor's memory (up to 5).

31. Choose the required experiment and click on the **Load Experiments** button.

32. Click on the **Zoom fit** icon  if needed. This is an example of a short experiment conducted during a storm:

33. Save your graph.

Challenge research

34. Repeat the experiment with different distances between the anemometer sensor and the fan.

Summary questions

1. What wind speeds did you get when using the fan? What wind speed did you get when measuring outdoors?

2. Which Beaufort Scale categories are compatible with your results?

3. Were you able to assess the wind speed using this scale?