

Investigating weather through fieldwork

Sylvia outlines some weather investigations that can be carried out in the school grounds and local area.

The weather is a fieldwork resource available to every school, making a range of investigations possible without even leaving the school grounds. These will give students an appreciation of their local environment as well as an understanding of how urban structures influence the weather. This article gives three ideas.

School microclimate investigation

When planning weather fieldwork, the greatest challenge lies in selecting an investigation that will produce interesting results with the weather on that day. For example, on a windy day it is good to measure wind speeds, but measuring temperature might not give very interesting results (Figure 1). A still, wet day will probably not give much variation in temperature around the school grounds. The equipment available for measuring the weather must also be considered. If a camera is used in conjunction with the weather recording instruments then a photo story can be produced telling a story of how the weather changes around the school grounds.

Anemometers for measuring wind speed work well, but are expensive and delicate. If you are considering buying anemometers for your school, be aware that 'cup' style anemometers are much easier to use than propeller anemometers, as you do not have to point them into the wind.

Thermometers also need to be used with care. Most digital thermometers have a long adjustment time – they need to be left *in situ* for a few minutes to give an accurate reading – and no thermometer should be left in direct sunlight. Also, while they might seem to give a very precise reading (often to a tenth of a degree) they might well have a $\pm 3^{\circ}\text{C}$ bias. This means that you cannot compare results from different thermometers unless the thermometers are first compared at the same location. Alternatively, you could use the same thermometer at each location.

Infrared thermometers, which measure temperature from a distance, are now available for under £30. They detect the infrared radiation (heat) emitted by an object, and from that calculate its temperature. They are an effective way of investigating the albedo (the proportion of radiation reflected) of different surfaces; darker surfaces absorb more of the Sun's light, heating them up, than lighter surfaces. In winter, students can use the thermometers to identify places where heat is being lost from school buildings. They are also great for measuring the temperature of clouds, from which you can calculate how high the clouds are.

Most microclimate investigations examine only wind speed and temperature; however if you have a barometer available you can take it to high

Figure 1: Measuring wind speed and temperature in the school grounds.
Photo: Shaun Flannery.





Figure 2: The University of Manchester in the centre of the city, temperatures can be a few degrees higher than in open, rural areas.
Photo: Bryan Ledgard.

points in the school buildings to show how air pressure falls with height.

Hand-held or complete weather stations can be left in place to record data over a period of time, and then linked to a computer for data analysis.

Questions for students

- Where is the warmest/coldest place in the school grounds? Where is the windiest place? Why?
- Where would you position a wind turbine on the school grounds? (Turbines like fast wind speeds, but not turbulence.)
- Where is the best place for a solar panel? (Solar panels need wind to cool them as well as good exposure to the sun.)
- Which buildings are least well insulated?
- How do the school buildings affect the wind and temperature at different places in the school grounds?
- How does the wind speed vary with height? Why?

This means anticyclonic weather conditions are ideal, particularly as they tend to last for a few days.

There are two good approaches – either weatherproof thermometers can be left outside overnight and read first thing in the morning, or measurements can be made during the journey to school. These can be supplemented with car temperature measurements, which are surprisingly good. However, as with all temperature readings, care needs to be taken to make sure that the thermometer has been allowed enough time to adjust to the local conditions. If using a digital thermometer, the sensor hole must not be obstructed. When using a set of thermometers, they should be compared with one another first under the same conditions (for example in the classroom) so that the measurements can be compared. If thermometers are left outside, they should be about 1m above the ground and at least 3m from any building.

Urban heat island investigation

It should be possible for most schools whose catchment covers a built-up area to carry out an urban heat island investigation. Urban heat islands, where surface air temperatures can be a few degrees higher than in open, rural areas, occur as a result of urban development: the storage of solar heat in the fabric of roads and buildings; the heating of buildings; heat generated by industry and transport; and the relative lack of water and vegetation (Figure 2). Heat can also be trapped by turbulent air flow around buildings.

For good results, care needs to be taken to select the right conditions. Ideally, the investigation should be carried out:

- during the night, or shortly after dawn
- when there is no wind
- in relatively constant weather conditions – no changes for a few hours
- when the skies are clear.



Figure 3: Manchester's urban heat island. This data was collected by schools, with additional data from the general public and sources of weather data online. Analysis of the data showed that those areas with higher vegetative coverage and low building density (e.g. farmland, low-density residential, recreational zones) experienced lower temperatures than more 'urbanised' land use types (e.g. manufacturing, retail, high-density residential).



Figure 4: Built in 1902, the Flat Iron building was one of the tallest buildings in New York at the time. With Broadway on one side, Fifth Avenue on the other, and the open expanse of Madison Square and the park in front of it, the wind currents around the building could be treacherous. Wind from the north would split around the building, downdrafts from above and updrafts combine to make the wind unpredictable. View the impacts in a film from 1903 on Youtube at www.youtube.com/watch?v=porZ2jOaYew. **Photo:** Nick Totterdell.

All records should also include the time (after sunrise, the temperature will change rapidly), the location (post codes can be converted to grid references online, or Google Earth can be used to find latitudes and longitudes) as well as information about the surrounding landscape – is it low-density housing, a park, near a body of water, an industrial or retail area? Even if the school catchment area does not extend into the countryside, you should see good variations between areas with more vegetation, water or concrete. The results can be recorded on a map or on Google Earth.

If students are given the task of planning the fieldwork, they could consider how they might collect additional data – what local weather data is available online? School staff who live outside the school's catchment area could be asked to collect data as well.

Air flow around buildings

In urban areas, as well as affecting the pattern of temperatures, tall buildings and a generally

Useful weblinks

The Royal Meteorological Society website (www.metlink.org) has more information on planning weather fieldwork, how to make simple weather instruments, and weather instruments and investigation kits for loan to schools. The software to create a photo story can be downloaded from www.microsoft.com/download/en/details.aspx?id=11132

irregular land surface disturb the flow of air, altering the course of the wind and producing turbulence. Turbulence is rotational, three-dimensional air flow. Even a single building can create complex air flow; this can be easily investigated in the school grounds. You require a windy day, a stand alone school building that students can access all the way round, several pots of bubbles or bubble blowers, a compass and a map of the school grounds. It might be a good idea to warn other users of the building that distracting bubbles will be blowing around!

Find an upwind side of a school building. Standing in front of and close to the building, blow some bubbles upwards and watch which way they blow. Students should walk around the building, blowing bubbles and recording on a map which way they travel and how fast. This can be done at points close to the building and further away. Students should draw longer arrows for faster winds than for slower ones, and mark a 'T' where there is turbulence, i.e. where the bubbles seem to go in circles (Figure 5). | **TG**

Questions for students

- Is it what you would expect? Was it noticeably windier at some places around the building than at others?
- If the school building is losing heat to the environment, where would you expect it to end up?
- Was the air flow reflected in where leaves and litter were collecting? Where might pollution be highest, if there were a source in or near the school grounds?
- If you repeated the exercise with the wind blowing in a different direction, how would you expect the air flow to be different?
- Are there other buildings nearby? How might they be affecting the wind?

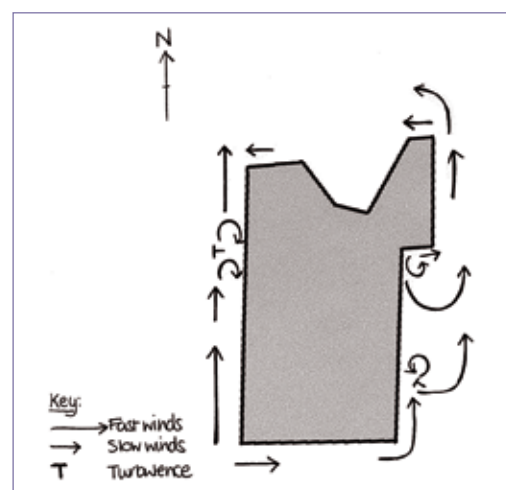


Figure 5: Investigating airflow around a building. Wind direction data collected when the clouds were blowing from the south-west.

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