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Droning on about the weather: meteorological science on a school-friendly scale

Phil Murphy, Ashley O'Neill and Abby Brown

ABSTRACT Meteorology is an important branch of science that offers exciting career opportunities and yet is not usually included in school curricula. The availability of multi-rotor model aircraft (drones) offers an exciting opportunity to bring meteorology into school science.

Why does meteorology matter in school science?

Meteorology is vital to understanding and predicting our changing climate and yet it is rarely included in school science, at either primary or high school level. Practical experience in schools that deliver science outreach and careers guidance has shown that students are often not familiar with the word meteorology. When asked, few students at key stage 2 (ages 8–11) knew what meteorology was: some suggested 'meteors' or 'meteorites and stars', although a few could define meteorology correctly as 'the study of the weather'. The situation was little different at key stages 3 and 4 (ages 11–16).

The lack of staff trained within the field of meteorology is also an issue, as delivery of any subject by non-specialists often leads to poor student attainment. Yoon and Peate (2015) discuss the lack of qualified secondary earth and space sciences (ESS) teachers in the USA, and state that less qualified teachers may have difficulty covering this area because of its complexities. They concluded that participating students had little conceptual understanding of the area, reflecting the current decline in the number of highly qualified ESS teachers. In the UK, there is no obvious training provision for environment teachers – a search for teacher training courses through UCAS (University and Colleges Admission Service; www.ucas.com/ucas/teacher-training) did not identify any environmental science courses at primary or secondary level. Osborn (2015) has issued a plea for the provision of environmental science in schools and the need for training environmental science teachers.

The demand for skills and understanding in atmospheric science is at a new high as crucial environmental issues such as climate change, air pollution and extreme weather become more apparent. The need for meteorological expertise in both industry and business has resulted in an increased demand for professional meteorologists in fields such as insurance and transportation. Bringing the role of the meteorologist to the attention of students is important, as few will know that meteorology can provide an exciting and rewarding career (www.rmets.org/our-activities/careers/employers); there is a lot more to meteorology than being the television weather presenter!

Recruitment onto the BSc/MEnv Meteorology and Climate Science degree programme within the School of Earth and Environment at the University of Leeds has always been problematic. Dealing with poor recruitment is a priority in order to secure a long-term future for the teaching of meteorology within the University. This failure to recruit is partly a result of the lack of teaching about meteorology in school curricula – a problem for many programmes of study that are not 'main stream' subjects in schools. For geology, for example, this has been overcome by ensuring that high-quality branded lessons are delivered in the science curriculum, achieved through the provision of in-service training (www.earthscienceeducation.com). This has also helped promote the subject in terms of potential career opportunities and thus recruitment to higher education. Part of the appeal for teachers in delivering geology has been the provision of practical activities that can be easily undertaken in the school environment (www.earthlearningidea.com).

Fitting meteorology into the school curriculum

Finding a place where meteorology can fit into the curriculum is a challenge. Many students will only touch upon it in geography lessons. It is, however, a science discipline, with scientific processes underpinning the study; the route to a career as a graduate meteorologist is via a numerate scientific degree. The historical subdivision of scientific endeavour into chemistry, physics and biology still in use in schools does not reflect the modern world where many scientists are working on problems that cross these restrictive disciplinary boundaries. However, the National Curriculum in England and Wales (science programmes of study) does provide opportunities for the incorporation of meteorology and climate science at all the key stages. For example in key stage 3 'the composition of the atmosphere' and 'the production of carbon dioxide by human activity and the impact on climate' are specified under the 'Earth and atmosphere' section of the chemistry subject content (Department for Education, 2013). In key stage 4 the 'Earth and atmosphere' section consists of five points, four of which are directly related to the composition and evolution of the atmosphere (Department for Education, 2014).

Practical teaching of meteorology

Practical work is a prominent and distinctive feature of science education; practical activities are therefore needed to ensure that meteorology is seen as truly a part of science in schools, particularly activities that allow direct measurement of atmospheric parameters. The incorporation of hands-on real-time activities into the teaching of meteorology, rather than the making of long-term weather records, can at first seem rather daunting. Outreach activities such as those described by the University of Reading are often too logistically complex, time-consuming and expensive to be realistically used by schools (Charlton-Perez *et al*., 2010). However, the Royal Meteorological Society (the professional body for meteorology in the UK) has developed a range of high-quality activities on meteorology and climate science specifically for schools (www.metlink.org).

Satellites, balloons and kites

The development of satellites since the 1960s has revolutionised the gathering of data (Reynolds, 2009) in order to produce a weather forecast, although weather balloons are still released daily around the world to measure atmospheric parameters (www.noaa.gov/features/02_monitoring/balloon.html). The release of weather balloons by schools and individuals to record data and images has become increasingly popular (www.metlink.org/observations-data/weather-balloon.html; www.dailymail.co.uk/sciencetech/article-1091896/Out-world-British-teddy-bears-strapped-helium-weather-balloon-reach-edge-space.html) but is a complex technical and logistical undertaking, involving significant cost. We have found that kite aerial photography (KAP) can be used to take atmospheric measurements and allows the testing of hypotheses, even if at only a relatively low altitude, and avoids the technical and logistical issues associated with weather balloons. KAP is a well-established technique used by enthusiasts and archaeologists to obtain low-altitude aerial images with a relatively small financial outlay (Barber, 2011). We have used a 3 m span Cody box kite – the design originally developed by Samuel Franklin Cody in 1901 for the War Office to carry a human observer. We have deployed kites from the school playing fields, so the aerial photographs are of the school and surrounding areas, giving relevance to the students' lives but also illustrating the concepts of remote measurement and scale. The equipment has also carried school-standard measurement and logging equipment to test students' ideas on the nature of the atmosphere, such as whether the temperature increases as you move closer to the Sun. While we have had some success with kites, they are quite complex to deploy and they are dependent on wind speed and direction; they also have a rather 'retro' feel that does not fit well with the cutting-edge science of meteorology.

Introducing the drone

We have used multi-rotor model aircraft, more commonly referred to as drones (e.g. www.dji.com/product/phantom), to bring a contemporary and high-tech feel to our meteorology lessons, while maintaining the practical aspects and ensuring simplicity of use. Drones are now widely available from hobbyist suppliers and are very easy to fly. They are reliable, robust and easily deployed by schools. The equipment

allows the taking of high-resolution photographs, controlled from a tablet or mobile phone. They are quick to use, efficient and suitably high-tech for today's technologically savvy school cohort. The legal and insurance issues around flying such drones are explained on the British Model Flying Association website (bmfa.org), and insurance cover for pilots is available through membership of the organisation. While modern craft are easy to fly and have a failsafe mode to ensure an automatic safe landing should the battery power fail, practice and a risk assessment are needed before deployment. Safety advice and guidance for non-commercial drone flying is available from the Civil Aviation Authority (www.caa.co.uk/drones; www.caa.co.uk/WorkArea/DownloadAsset.aspx?id=4294975468).

We have used drones in a series of lessons, giving the flying activities meteorological context; we have deployed drones from school playing fields and a car park, thus getting students outdoors but remaining on the school premises (Figure 1). Avoiding the need for off-premises trips has proved popular with our school partners, and the use of the schools' outdoor spaces brings home the importance of fieldwork (Boyd, 2013) (Figure 2).

Miniaturised measurement and datalogging equipment is available from education equipment suppliers and can easily be mounted on a drone. Sensors for measuring temperature, humidity, barometric pressure and light intensity are usually available, as a minimum, in a school datalogging package. Data capture can be simplified by programming the loggers before launch, thereby avoiding the need for a data link to the instruments during the flight. While less 'headline-grabbing' than a balloon launch and being limited to the lowest 100 m or so, deployment of drones nevertheless offers an exciting, accessible and inspirational way to bring meteorology into school science lessons.

Figure 1 Deploying a drone on school playing fields – with a typical enthusiastic response from students

Conclusion

Meteorology as a scientific endeavour is not usually included in school syllabuses. This situation needs to be addressed, as the need for meteorological expertise in both industry and research is increasing. Opportunities do exist within the National Curriculum to incorporate meteorology but it is important to include practical activities to reinforce that meteorology is a scientific endeavour. The use of kites and drone technology provides low-cost, exciting and innovative ways to introduce meteorological measurement into school science curricula. The use of drone technology could be expanded upon in future by using the drone to measure variation of parameters in the vertical profile of the atmosphere, such as pressure, temperature and wind speed, in a similar way to weather balloons.

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Figure 2 Aerial photography provides a simple first step in familiarising students with the drone's capabilities before moving on to scientific measurement

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