Getting the Measure OF WEATHER

Author Details

Hilary Kington (Sales and Marketing Administrator)
Richard McKay (Product Manager)
Biral- PO Box 2, Portishead, Bristol, BS20 7JB, UK
Tel: +44 (0) 1275 847 787 Fax: +44 (0) 1275 847 303
Email: met@biral.com Web: www.biral.com

Weather
Monitoring

The weather affects all of us in one way or another every single day of our lives so it is understandable why, world-wide, a considerable amount of energy and resources are spent on gathering and understanding meteorological information. Along with the National Weather Services like the UK Met Office there are many industries, government bodies, agricultural, medical and research groups who share a keen interest in the climate.

For many, the weather is a matter of life and death. Where food and water are scarce as a result of drought conditions there is the ever present risk of starvation and for those encountering extreme weather such as hurricanes and floods, the loss of life, home and livelihood is more than a possibility, as has been particularly demonstrated this year in Boscastle. The more knowledge we have about the processes that produce the weather the better equipped we are to make informed and often critical decisions using modern computer simulations or models, especially in today's changing climate and growing concern for atmospheric warming.

Wind is perhaps the most important factor in weather and there is certainly truth in the saying "where there is wind there is weather". Wind is caused by the differences in temperature that occur both horizontally and vertically. This wind then moves air masses around and they become modified which produces much of the weather we experience. For example, effects caused by land features forcing the air to rise, becomes saturated and possibly produce clouds and precipitation, which in turn can have other impacts such as on the visibility or incoming solar radiation. There are many situations where a knowledge of the wind conditions helps in decision making such as pollution control, safety of tall structures, control of wind turbines, studies on the effects of wind on arable crops and verification of the speed of athletes on athletics tracks to name but a few.

An instrument used to measure the force of the wind is an anemometer. The word comes from the Greek anemos meaning wind, plus meter. Often wind speed and direction are the two elements that are considered most important and for many years mechanical style cup and vane anemometers have been the mainstay. They are usually simple but effective tools with the cup measuring the speed and the vane the direction. Mechanical style systems can record wind speeds up to about 75 m/s (167 miles/hr) and are generally inexpensive.

More recently, ultrasonic anemometers have come onto the market. These have the advantage of having no moving parts and therefore do not suffer from icing damage like the above mechanical style systems, they do not require maintenance and have no initial friction to overcome before providing data, again all traits of the mechanical designs. Ultrasonics are available as 2 axis models for measuring the horizontal speed and direction and 3 axis for full three dimensional real time turbulence profiles. Like their cup and vane cousins the results can be sent to a wide range of recording mediums such as data loggers, digital displays, chart recorders or directly to a PC for viewing and archiving. With a starting price equal to medium quality cup and vane varieties they can provide excellent value for money and as the quality of the instrument increases so does the price. Research models providing 100 data samples per second still offer better value for money than other more sophisticated laser based systems and less hassle.

SODAR

There are many different models on the market today so it is important to match the right instrument to the application. For instance a wind system for use in an Arctic environment would need to be able to operate in harsh conditions, at very low temperatures and as with all instruments sited at remote locations, would need to be reliable and maintenance free. Furthermore, as the instruments are exposed to the environment they are measuring, it is not just the weather conditions they have to withstand as was the case with a high specification datalogger which was found intact and useable even after it had been attacked by polar bears!

Of course, not all anemometers are used for purely meteorological purposes but can be utilised for airflow applications such as ventilation control in road and rail tunnels. In fact any duct over 6 inches in diameter can accommodate an ultrasonic anemometer to monitor the flow of air. Perhaps one of the more bizarre uses was for a study to find the best location for sutures when repairing a horse's larynx. The larynx of a recently deceased animal was attached to a 'wind tunnel', powered by a vacuum cleaner, for a controlled and known 'sucking' force and an ultrasonic anemometer inserted into the larynx to 'see' the movement variations and small changes in volume flow.

However, as useful as they are, anemometers can only measure the wind at the exact point at which they are sited, so what does one do if you need to know what the wind is doing higher up in the atmosphere or if you require a three dimensional wind profile. This is where remote sensing systems known as SODARs (SOnic Detection and Ranging) come into play. SODARs provide three-dimensional profiling of the atmosphere in real-time directly above the unit to heights of several hundred meters for boundary layer studies, local climate and pollution studies, agrometeorology and on airfields. In Spain the renewable energy market is now completely moving over to SODARs for site evaluation for met masts and turbine locations.

Last but not least on the wind front is an optical instrument known as a scintillometer, which is used for measuring atmospheric turbulence, heat flux and crosswinds. It is ideal for measurements over variable terrain, bodies of water and valleys and has a range of up to 13 km. As you might expect both the SODARs and the scintillometer are expensive (but fairly priced for performance) instruments at about three times the price of the most expensive ultrasonic anemometer.

3-Axis Ultrasonic Anemometer

HSS Visibility Sensor

With the wind comes the rain and in the UK we are certainly accustomed to a bit of wet weather and with the seemingly increasing threat of local flooding it is important to know how much rain is falling and where. Currently nearly every National Weather Service in the western world uses the classic tipping bucket rain gauge. The rain is collected into a small bucket that acts like a playground see-saw. When it becomes heavy with water the bucket tips, depositing the water on ground, and closes an electrical circuit sending a signal pulse to a paper graph, digital display or PC. This type of gauge is not new to the market, indeed, it has been in use for nearly 100 years. However, as you might imagine in this age, there is now a newer high tech alternative that has no moving parts, no mechanical wear or friction and therefore no maintenance. It is a more sophisticated instrument which measures the breaks in a laser beam as the water droplets pass through it and can record particle size and velocity as well as quantity. This instrument is rapidly becoming the new standard in precipitation measurement with some National Weather Services already replacing their older mechanical units, the UK Met Office is undertaking long-term trials of this type of measurement.

These are not the only precipitation sensors on the market by any means. They come in all shapes and forms from automatic precipitation collectors to present weather sensors which not only record the amount, type and rate of precipitation but also blowing dust, sand and smoke and some have the added advantage of reporting the current state of visibility.

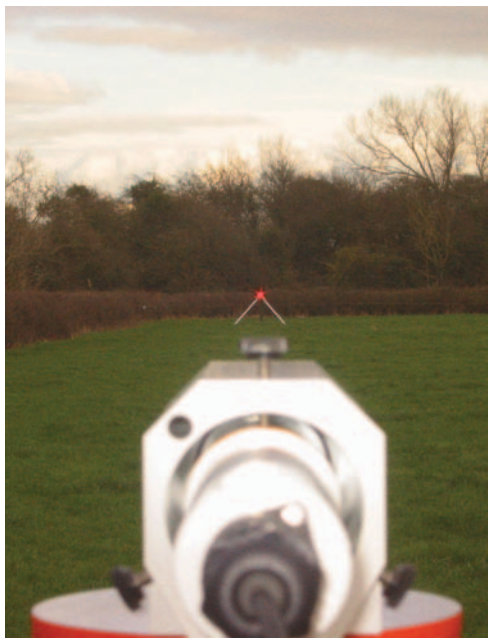
A reduction in visibility, as well as being inconvenient, also poses a safety hazard both at sea and on land. In marine

environments, even with high-tech navigation instruments used today, fog can be deadly. On unmanned lighthouses, for instance, it is crucial to have systems in place that automatically switch on foghorns in poor visibility and it is the visibility sensor which is integral to such a system. This technology can also be used anywhere where a navigational or operational warning alarm or light is needed to aid shipping and aircraft.

However, it is on the roads where most of us experience problems with fog and although not employed in the UK, apart from on the M25, visibility sensors are deployed extensively in many parts of Europe and the USA to warn of fog and automatically switch safety warning signs. They are, however, used more extensively on road bridges and in tunnels in the UK. It might seem strange to site visibility sensors in tunnels but they can control the operation of ventilation fans and act as a backup to smoke detection systems. For instance if a fire breaks out in a long tunnel with visibility sensors placed at intervals, the position and ferocity of the fire can be established without entering the tunnel.

All of the instruments referred to above can be used as standalone instruments or incorporated into weather stations. Weather stations can be sited almost anywhere from airports and highways to wind farms and even your back garden and can be mounted on masts at any height from 1 m to 70 m depending on the purpose for which the data is being collected. Most weather stations are customised to include instruments to measure specific parameters, such as temperature, humidity and pressure but almost always include anemometers. The Met Office can forecast the weather patterns across the UK but rely heavily on the extensive network of weather stations for more in-depth localised reports. So when you next hear a weather presenter say "Aberdeen had the longest amount of sunshine today" or "three inches of rain was recorded in Brighton" this is how the information is being collected and evaluated. Later these records will provide valuable climatological data for global warming and other studies.

Scintillometers



For those interested in finding out more about the weather please see the UK Met Office (**http://www.met-office.gov.uk/**), or The Royal Meteorological Society (**www.royal-met-soc.org.uk/**).