The importance of weather monitoring

Sensing the winds and weather has been important to man over the centuries. Athenians built the eight-sided Tower of the Winds in the first century B.C. in honour of the eight gods of the wind. The Tower of the Winds stands to this day in the ancient agora, or market, in Athens. Three significant weather events have affected mankind over the years. We know of these because their effects have become part of history. Since much of history is a recollection of a series of wars and battles, it is interesting to note that a well known early reference to the importance of the weather is from the Chinese philosopher Sun Tsu, who said, “Know yourself and know your enemy, and victory is guaranteed. Know the terrain and know the weather and you will have total victory.”

Much later in history, we know that Napoleon’s invasion of Russia in 1812 was stymied when snow and cold weather came earlier in the season than he and his generals had planned. This, combined with Russian militia attacks, helped defeat the French, who invaded with 50,000 troops, and left with only 20,000 survivors. One hundred thirty years later, this was repeated when Hitler’s invasion of the Soviet Union, and traced back to Chernobyl using sophisticated weather sensors and meteorological models. In a similar fashion, local weather instruments were used to help estimate the impact of smoke and soot from oil well fires set during the 1991 Gulf War.

Modern weather monitoring systems and networks are designed to make the measurements necessary to track these movements in a cost effective manner. This requires that the total life-cycle cost of a monitoring system is minimized, and one way to do this is to minimize or eliminate the maintenance of the weather monitoring system. Using a solid-state sensor to measure the weather, including the wind speed and direction, is paramount to minimize equipment servicing and costs.

Modern technology has allowed the combination of several sensors into one integrated weather station that can be permanently located at one site, or transported to a site where localized weather is needed.

Scientists have worked to develop solid-state meteorological sensors since the 1950s. The first of these were sonic anemometers, which measure the time required for a sound wave to travel from point A to point B. This time is affected by the speed of the wind in a predictable and repeatable way. The earliest sonic anemometers were used to measure the small scale fluctuations of the winds caused by atmospheric turbulence. The earliest sensors were not very stable and needed a great deal of maintenance to keep them operating. Thus, since the turbulence is measured by subtracting a running mean value from the data to determine the fluctuations, and since the means were unreliable, this was a perfect use of this instrument. It is only in the past 10 to 15 years that the electronics have become suitable for use in an instrument that is used for long term measurements of the winds.

There have been other types of instruments developed to measure the winds without moving parts. One of these is a thermal anemometer – an instrument that measures the temperature of a small element in the sensor, and calculates the wind by measuring the amount of energy carried away from the anemometer. These are often called hot wire or hot film anemometers. Significant drawbacks of these sensors are that they are very prone to contamination by dirt, and it is difficult to distinguish energy carried away by the wind from cooling caused by the impact of raindrops and snowflakes.

Another technique used to measure the winds is to measure the vortices caused by a fixed shape that is projected into the wind. These vortex shedding anemometers operate on the principle that when a fluid flows around an obstruction in the flow stream, vortices are shed from alternating sides of the obstruction in a repeating and continuous fashion. The frequency at which the shedding alternates is proportional to the velocity of the flowing fluid. Sensors downstream of the obstruction sense the presence of the
vortices and derive the wind speed from them. These work well in pipes and ducts, but have not been successfully implemented in the ambient environment.

**Solid state anemometers**

There are many manufacturers of solid state anemometers today, but few have integrated the anemometer into a single-piece solid-state weather station. Of the three that appear to be available today, one is a lightweight plastic unit that might not stand up to rough handling, and the other is very expensive. Only the robust TACMET II weather station provides a rugged yet accurate and reliable solid-state solution for fixed or mobile weather monitoring requirements at a modest price.

One current example of this precept is a military user who has the responsibility of responding to emergencies when chemical or biological agents are released into the environment. These brave soldiers bring with them the equipment they need for their response activities, including three weather stations, all of which have solid-state weather systems to measure the winds, temperature, relative humidity and pressure. These sensors also have built-in systems to protect them against the effects of radio frequency and electromagnetic interference, and they automatically orient the wind direction to North using an internal flux-gate compass. These systems communicate with the base station.

The system is easily carried in two cases. One case houses the radio, battery and charger, and the other holds the weather station, tripod, mount to attach the sensor to the tripod, and all of the system’s cables.

In the case of a second user, a time difference of just under a year has allowed an improvement in the ability to package several of the system components inside the weather station. Recently, a state government’s toxic air pollutant monitoring group, in the division of air quality in the department of natural resources, procured a group of three such portable weather stations, all of which report their data to a base station via spread spectrum radio. The ability to switch between the two communication media was one of the principal features requested by the users of these systems. The system is used to determine where the detected material came from, and to predict where it is travelling. This information is used to warn personnel downwind to take protective action, and to take action against the enemy forces who released the biological agents into the environment.

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