Commentary
Continuous air monitoring results laid bare: do we know what we know?

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As an analytical chemist based in academia, I am cautious about air monitoring results. Every analysis has some degree of uncertainty, both with respect to identification of the compounds present, as well as their concentrations. The reality is that even certified reference materials (such as those supplied by the US National Institute of Standards and Technology, NIST) which have been analysed rigorously by many laboratories using state-of-the-art equipment, require updating of their certificates of analysis ("accurate" concentrations) over time as technology progresses, resulting in lowered detection limits or improved precision. Many professionals working in the environmental sciences, however, take analytical results generated for them or by them, as absolute. Treating chemical analyses as a "black box" can lead to incorrect conclusions, unsuitable mitigation measures or management options…and ultimately, the environment which we are trying to protect may suffer.

A recent article which I read in a Royal Society of Chemistry publication (Steinmark, 2017) prompted me to write this commentary. It describes an incident that occurred on a Sunday afternoon at Birling Gap on the south coast of England in August last year. An acrid smelling haze suddenly appeared, people began vomiting and their eyes were streaming. Panic ensued; the beach was evacuated, people were hospitalised, some began driving to get away from the area and others were warned to stay inside. The thing is that the source and composition of this air pollution has still not been established, even though there were two operational continuous air monitoring stations in the area. The wind direction and back trajectory calculations ruled out some initial theories of emissions from potential sources such as adjacent countries and a sunken World War I ship. The monitoring data showed an apparent four times increase in ozone concentration during the incident, but the level that the ozone increased to was still only moderate, and importantly the health effects experienced were not consistent with the respiratory impacts associated with ozone.

The problem is that many volatile organic compounds can also be detected by ozone sensors. This cross-sensitivity arises from the fact that typical ozone monitors are based on a spectroscopic measurement and hundreds of organic compounds, in addition to ozone, absorb UV light. The ozone sensor compares absorbance at 254 nm in the air sample to that of the air sample after it has passed through a scrubber to remove ozone. The difference in absorption between the two samples is proportional to the ozone concentration. Organic compounds present in the air may be scrubbed along with ozone, and also absorb light from the source. This gives an overestimation of the concentration of ozone present in the air and a possible misidentification of the air pollutant(s) present in the sample.

In the end, the UK authorities stated that the most plausible theory for what happened at Birling Gap was that the source of the emission was a passing ship transporting organic compounds. This incident prompted UK scientists to highlight the complexity of determining specific compounds present in the air at any point in time: a complexity which cannot be fully addressed by standard routine continuous monitoring technologies. Monitoring results from a continuous time-of-flight mass spectrometer would have been needed at the time of the incident to assist with compound elucidation.

In South Africa, we are fortunate to have a network of continuous air monitoring stations, which has allowed us to better determine our air quality and to establish trends in this regard over time. The incident in the UK last year, however, highlights the importance of fully understanding the scientific principles on which our monitoring technologies are based, as well as their inherent limitations, when drawing conclusions from the data which they generate.

Reference

Steinmark, I.E. 2017, *Education in Chemistry*, 54 (6), 5.