Experience of global small sensor co-location comparison studies and applications with AQMesh

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AQMesh has been in use around the world since 2012, measuring pollution gases and particulate matter at single figure ppb / µg/m^3 levels. This small, low power air quality monitoring system can be located flexibly to increase the number and targeting of air quality monitoring points. It uses electrochemical sensors to measure atmospheric gases at low ppb, with proprietary data processing, including cross-gas correction and environmental compensation. Particulate matter is measured using an optical particle counter.

Experience from AQMesh offers insights into sensor development, data processing and management and optimisation of the hardware platform. A review of performance across a wide range of environmental conditions and applications highlights the opportunities presented by small sensor air quality monitoring systems and also the remaining limitations. The scope for use of such systems by air quality professionals and citizens is discussed, as well as the potential for data quality control and validation.

A 'limit of confidence' of 5 ppb is now possible for NO, 10ppb for NO_2 and O_3, allowing for low target gas levels with high environmental noise, although readings closely track reference readings below this level. We summarise the results of co-location studies which compare AQMesh data with reference data, describing challenges overcome, such as O_3 / NO_2 co-responsiveness and temperature sensitivity. Through a series of sensor and processing developments, typical R2 of AQMesh NO_2 readings compared to co-located reference stations has been increased from <0.3 to >0.8. Pre-scaled accuracy for O_3 and NO_2 is now typically ±10ppb and can be improved through scaling against co-located reference, according to recommended QA/QC. Typical $PM_{2.5}$ precision against reference/equivalent measurements at hourly intervals is now R2>0.85 and typical pre-scaled accuracy ±20µg/m^3.

Case studies show the opportunities and limitations of using small sensor systems in a range of applications, as well as remaining challenges, such as environmental destabilisation by users, which limits use beyond the hands of professionals. We discuss some ways in which the data validity of small sensor systems output can be managed, local node data from small systems integrated effectively with air quality models, and the distinction between citizen science tools and small sensor nodes for validated networks.