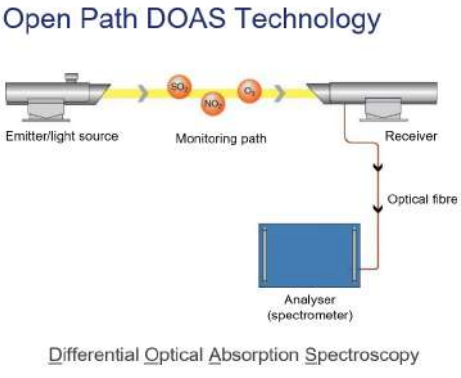
Daring to be different and measuring air quality with open-path DOAS.

There are a great many ways of measuring gaseous air pollution. For instance: diffusion tubes, sensor-based "pods", point-source electro-pneumatic gas analysers and remote-sensing and open-path optical methods. Each of these methods has a part to play in helping us to better understand and quantify levels of air pollution. Whilst diffusion tubes, sensors and traditional point-source gas analysers are extensively used in the UK and well-known techniques, remote-sensing and open-path technologies are less well known and potentially overlooked because they are "different" and less understood. There may also be some misconceptions about them too.

So, what is remote-sensing and open-path monitoring and how does it differ from older, traditional analytical methods such as single gas specific point-source analysers?

Remote-sensing can be explained simply as measuring something from afar, often using optical technology such as LIDAR. Lidar uses ultraviolet, visible, or near infrared light to image objects. It can target a wide range of materials, including non-metallic objects, rocks, rain, chemical compounds, aerosols, clouds and even single molecules. It is often deployed on satellites looking down on the Earth and atmosphere from space and also from ground-based instruments probing the atmosphere, especially the troposphere, looking upwards.

One remote-sensing technology particularly well suited for air quality measurement is DOAS (Differential Optical Absorption Spectroscopy) which can be utilised in what we call "open-path" monitoring systems. Open-path DOAS sounds complicated, but really it isn't.A light source (emitter) is projected horizontally over an open-path through the atmosphere to a



Schematic of DOAS hardware.

receiver. The distance between the emitter and receiver might be 500 metres for instance, with the hardware being mounted on the roof of two buildings, or concrete pillars, anywhere were there is an unbroken line-of-sight. DOAS works on the principle that gaseous molecules, i.e. NO_2, SO_2, O_3, benzene, formaldehyde etc. all have different energy absorption characteristics, or fingerprints if you like.

An Opsis open-path DOAS system in Swansea.

This is what the D and A in DOAS means. A spectrometer (the S in DOAS) measures the differential absorption of the different molecules using classical Beer-Lambert law physics, to calculate the concentration of these gases in micrograms per cubic metre, the units that they are ultimately reported in.

One of the most well-known commercially available open-path DOAS systems is made by the Swedish company Opsis AB. Opsis have been making and continually advancing DOAS technology since the late 1980's so they have not only decades of experience and expertise but also hundreds of open-path DOAS systems installed around the world.

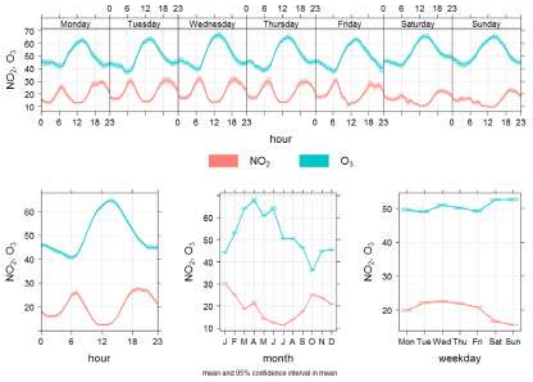
Optical open-path monitoring systems like Opsis DOAS have a great many benefits over the older, more traditional monitoring methods used on networks. However, it is interesting to note that in some countries (i.e. Sweden where Opsis is based) and rapidly developing countries and regions like China and the Far-East and Middle-East, environmental ministries and regulators are choosing to leap-frog some of the older point-source technologies in favour of newer, more innovative and more cost-effective technology like DOAS.

DOAS open-path benefits include:

- Simultaneous multi-gas monitoring from a single instrument (i.e. NO_2, SO_2, O_3, BTEX).
- MCERTS Approval (for the Opsis DOAS system).
- Direct NO_2 measurement (unlike Chemiluminescent NOx analysers).
- Extremely low running costs and much reduced power consumption compared to stand-alone, point-source analysers.
- Minimum maintenance. No pumps, pneumatics, valves, reaction cells etc. to service.
- Path averaged measurements, ideal for street-canyons, urban-background, industrial fence-line and area-wide monitoring (as multiple paths can be measured).
- Other important gases can be added i.e. NH_3, NO, Formaldehyde, HONO etc).

Two popular misconceptions about DOAS open-path systems are that is complicated and expensive. In fact, DOAS is far simpler from an installation, operational and maintenance perspective than a traditional point-source air quality monitoring station. And in terms of cost, a multi-gas DOAS system is comparable in price to a multi-gas traditional air quality station but running costs and maintenance costs are typically far lower.

And what about approvals? Well the Opsis DOAS open-path system is MCERTS approved for NO_2, SO_2, O_3 and Benzene as well as being TÜV approved and US-EPA approved. It is also approved throughout the world for instance in China, where there are hundreds of Opsis DOAS systems in operation.



Example NO_2 and O_3 DOAS data from JAAQS/Joaquin project.

One of the most recent Opsis DOAS installations in the UK was at the University of Brighton where the system is used as part of the international JAAQS/JOAQUIN project operated by UoB's Air Environment Research group (AER).

DOAS is different to some of the older, traditional point-source monitoring technology that was developed in the 1970's and 1980's and that we are still using today, in the 21st Century.

Dr Kevin Wyche, University of Brighton, shown with the Opsis open-path system used on the JAAQS/Joaquin project.

But there is nothing wrong with being different, especially if different might be better, faster, more cost-effective and more user-friendly as well as being tested, verified and approved by institutes and agencies world-wide.

Duncan Mounsor.
Enviro Technology Services Ltd.