

Differential Optical Absorption Spectroscopy for the Measurement of Air Pollutants

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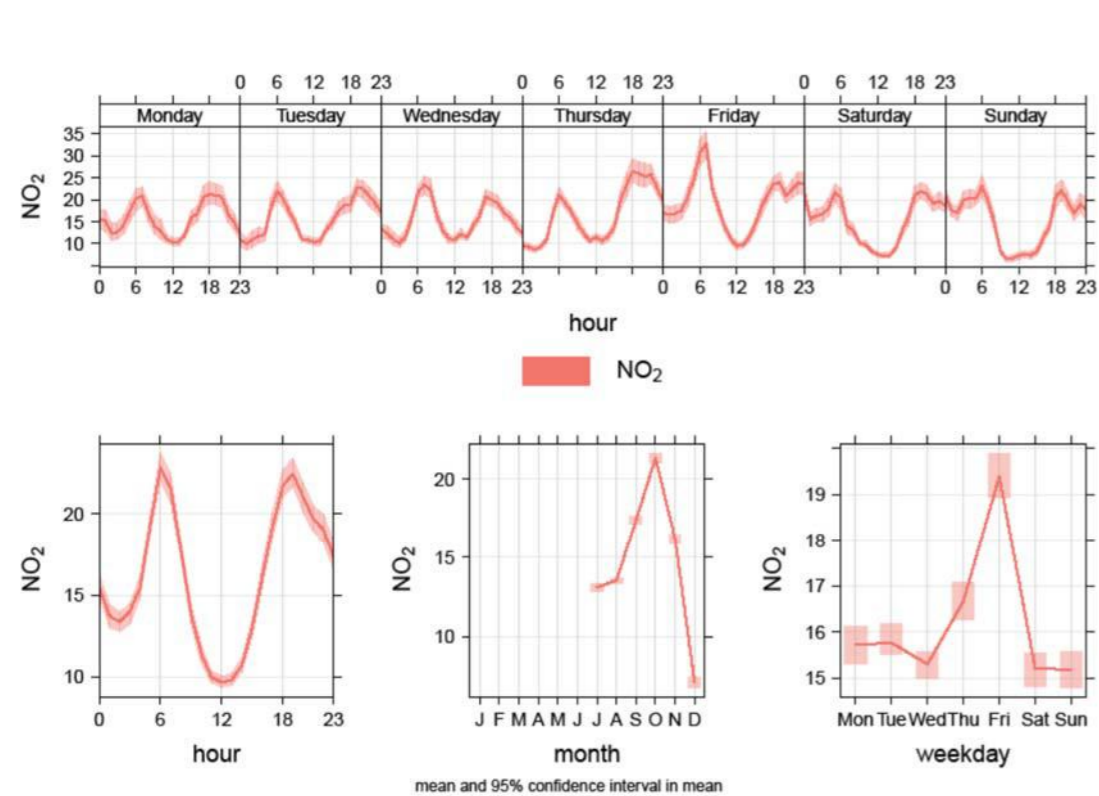
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Introduction

Differential Optical Absorption Spectroscopy (DOAS) is a remote sensing technique employed for the measurement of trace gas species, e.g. air pollutants. It is an absolute spectroscopic technique, i.e. it is based on the interrogation of electromagnetic rays which interact with the target medium. The Brighton JAAQS hosts a long-path Opsis DOAS for the measurement of NO₂, O₃, SO₂, HCHO and HONO.

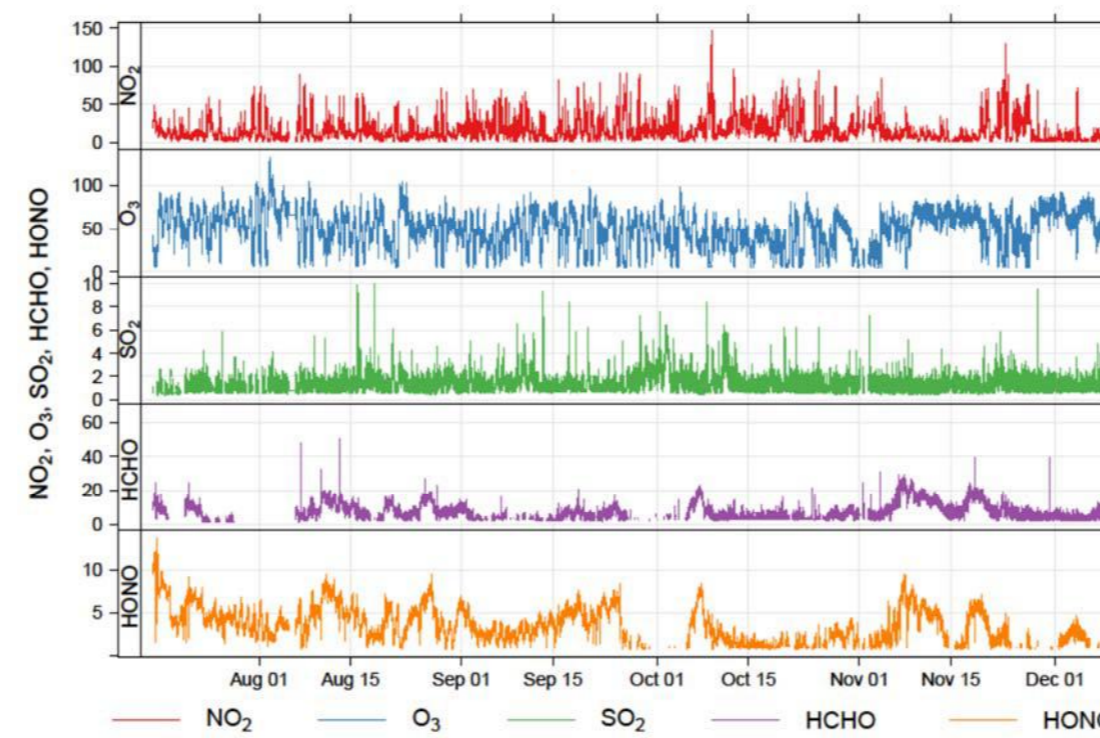
Methodology

A Xenon arc lamp inside the transceiver emits a beam of light, which travels a given distance to a retroreflector, where it is reflected back along the same path and is collected by a telescope inside the transceiver. A fibre optic cable takes the collected light to the analyser, which contains an imaging spectrometer. The spectrometer separates the light into its component wavelengths to produce a spectrum that is analysed by an optical detector.



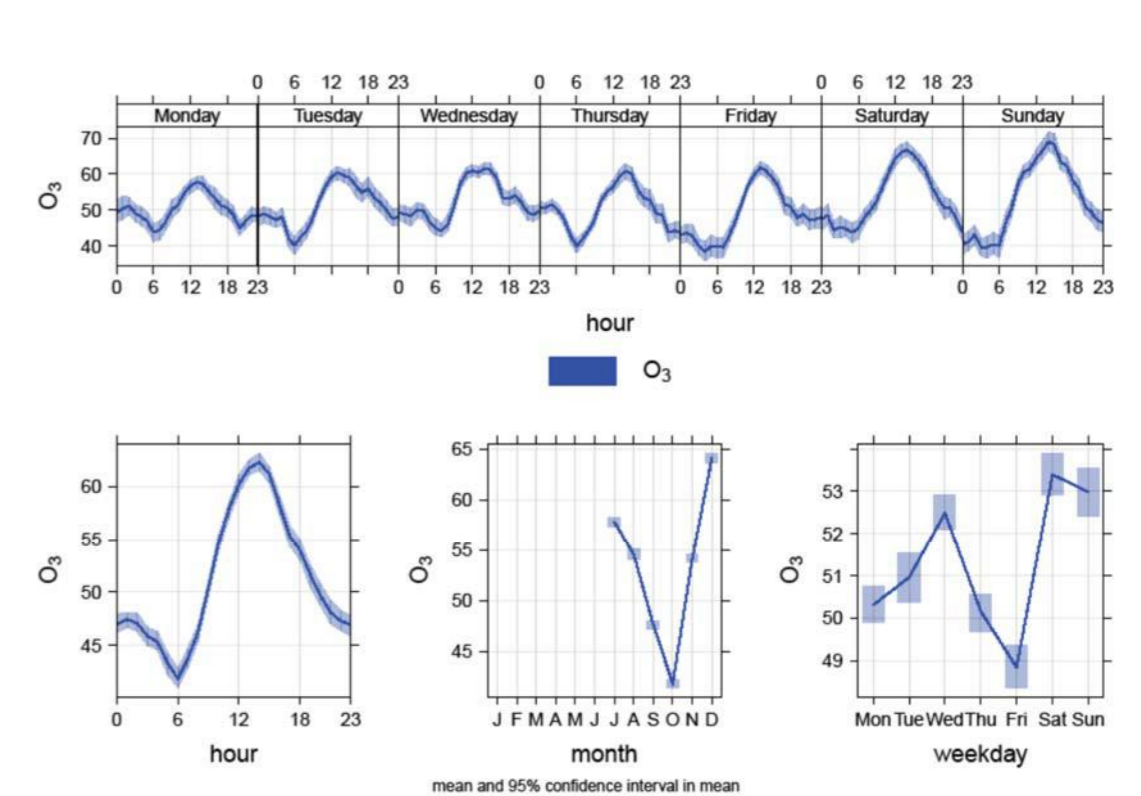
Nitrogen dioxide (NO₂)

NO₂ was observed to exhibit a classic bimodal diurnal profile, with peaks in line with “rush-hour” periods; however, here the PM peak was comparable in magnitude to that observed during AM. Weekdays exhibited high NO₂ concentrations, particularly Thursday and Friday.



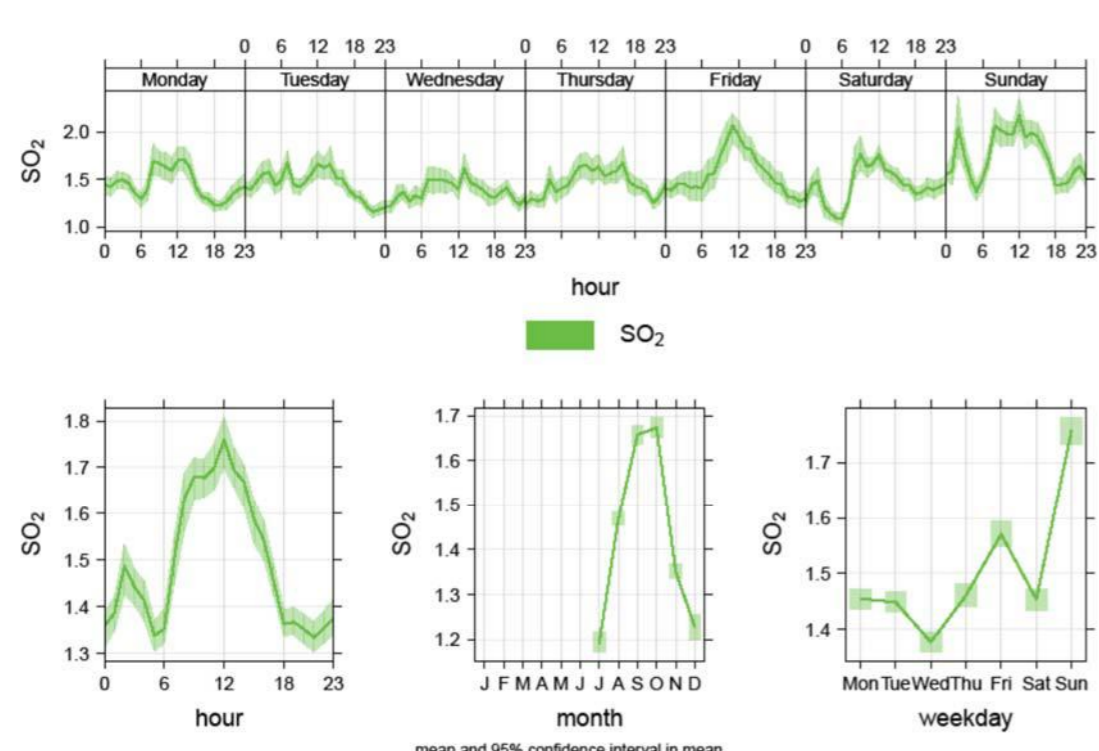
Initial results

Continuous 5-minute data has been acquired for NO₂, O₃, SO₂, HCHO and HONO over the first 6-months of operation at the University of Brighton JAAQS.



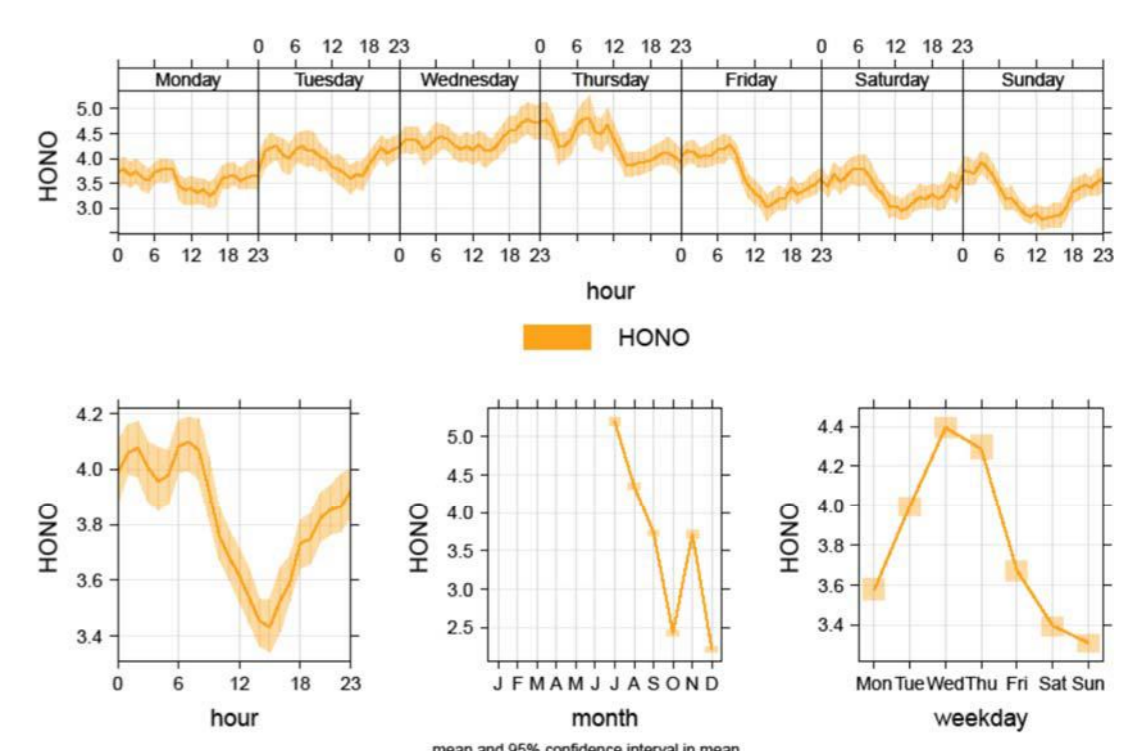
Ozone (O₃)

O₃ is a secondary pollutant, formed *via* reactions involving NO_x and VOCs during daylight hours. The measured O₃ profiles follow classic secondary, photo-product behaviour, with a distinct midday peak correlating with solar radiation. With O₃ being formed from the photolysis of NO₂, their respective profiles exhibited anti-correlation.



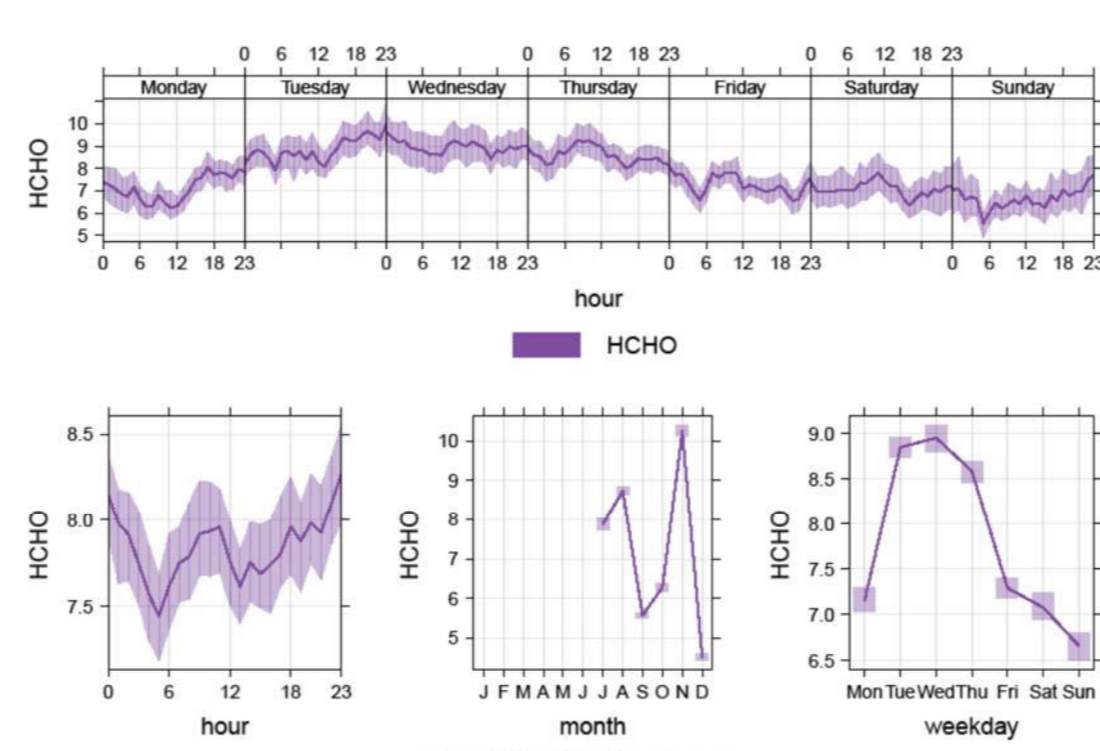
Sulphur dioxide (SO₂)

Following the successful implementation of legislation, SO₂ concentrations in the UK have decreased significantly. However, here we still measure ~ 2 µg m⁻³ of SO₂ in Brighton’s suburban air, with a distinct midday concentration peak. This temporal behaviour could be a result of the proximity of the local rail line and increased commuter traffic throughout the day.



Nitrous acid (HONO)

HONO comprises an important night-time reservoir for NO_x and the OH radical. As the sun begins to rise, HONO undergoes photolysis to yield NO and OH; this can be seen in the average diurnal profile, where HONO concentration is anti-correlated with solar radiation. This release of radicals can be a very important contributor to kick starting typical “pollution chemistry” in the early rush hour period.



Formaldehyde (HCHO)

HCHO is the end point OVOC of tropospheric chemistry, being formed from the degradation of larger VOCs; as such it comprises a marker for hydrocarbon oxidation. Furthermore, HCHO can undergo photolysis to produce the OH radical and hence influence the oxidising capacity of the troposphere. HCHO concentrations are observed to be larger during the working week and have a small peak during the early morning.

Conclusions

DOAS offers an excellent platform to provide high time resolution long term monitoring of air pollutants with high specificity and sensitivity. It can provide concomitant measurements of a wide range of pollutants to the sub µg m⁻³ level. The JAAQS DOAS will monitor “classic” and “emerging” pollutants and the data that it will provide will enable us to better understand tropospheric composition and reaction pathways behind contemporary pollution episodes.

Acknowledgements

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