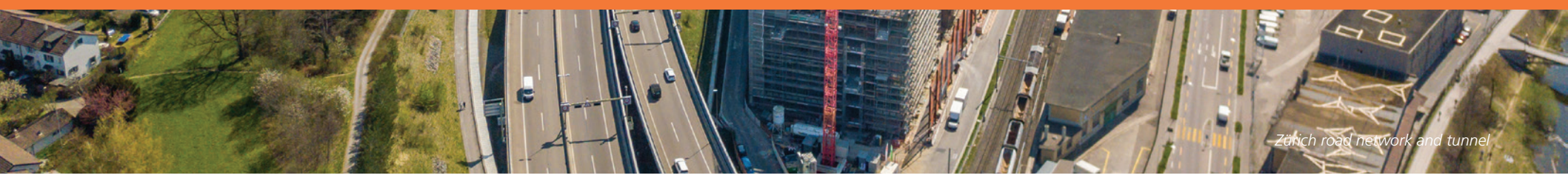
MULTI-COMPONENT QCL –
PROVIDING THE INSIGHT TO COUNTER CLIMATE CHANGE



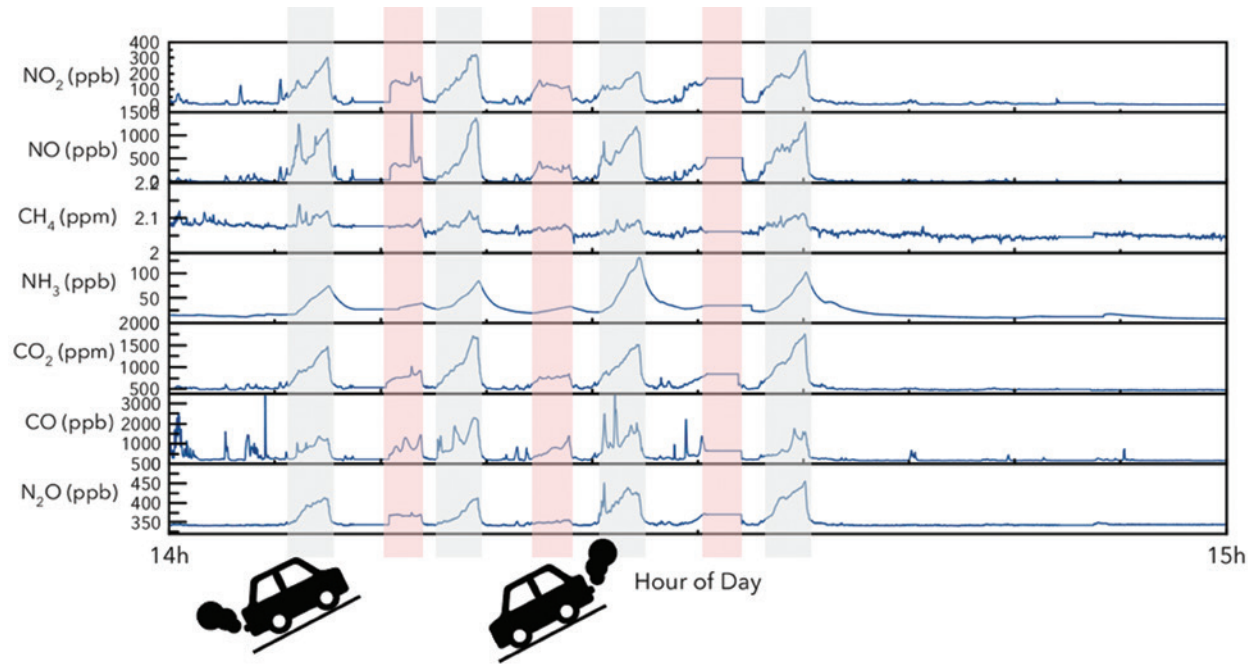
Zürich road network and tunnel

Nitrogen in our Atmosphere – Friend and Foe

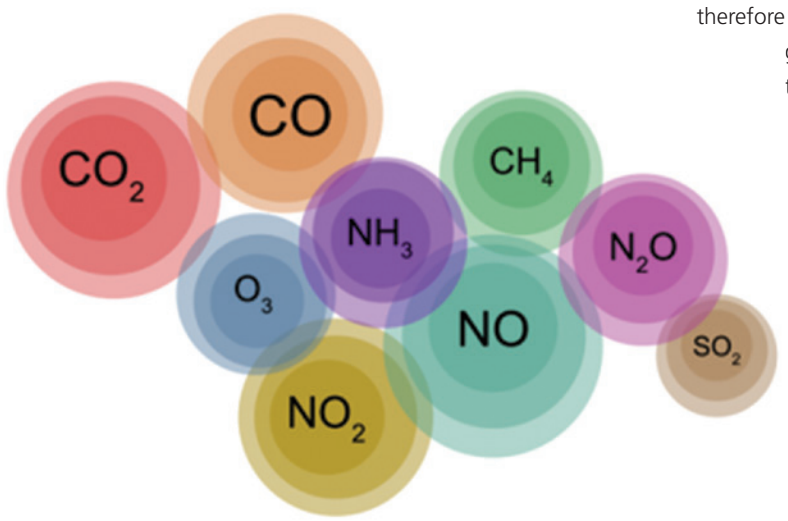
78% of our air is nitrogen. It is inert and in combination with 21% oxygen in the air, nitrogen is harmless. On the other hand, when oxygen and nitrogen combine through combustion or natural events such as lightning strikes oxides of nitrogen are formed. These are by no means harmless. Measurement of the oxides of nitrogen in air is essential to understand atmospheric chemistry and mitigate the impact of human activities on air pollution in a targeted manner.

N_2O – One of the Most Grotesque Greenhouse Gases

Nitrous oxide (N_2O) is used in hospitals to reduce pain – we breathe it in a controlled way for medicinal benefit. In the atmosphere it is an extremely potent greenhouse gas: one Tonne of N_2O emitted to the atmosphere is equivalent to approximately 300 Tonnes of CO_2 emissions. In addition to pollutant gases that are harmful to health, the US EPA 40 CFR suite of automotive emissions regulations apply to three greenhouse gases: CO_2, methane and N_2O – for very good reasons.



Copyright MIRO, Gubrist Tunnel test data showing uphill and downhill results



NO – to be, or not to be a Problem

The role of nitric oxide (NO) in atmospheric science is ambivalent. On one hand, it is a precursor of NO_2 and therefore a problem. On the other hand, it is a sink for ground level ozone and for that we might be thankful. In human health, it also plays positive and negative roles. At low concentrations, it is administered as a therapy to patients with angina and pulmonary hypertension and has been used to save the lives of many prematurely born babies. However, at high concentrations and with prolonged exposure it is toxic.

NO_2 – a Trigger of Respiratory Illnesses

Children with asthma and older people with heart disease are most at risk from NO_2 pollution. Inhalation of nitrogen dioxide increases the likelihood of respiratory problems. NO_2 inflames the lining of the lungs, and it can reduce immunity to lung infections and increase susceptibility to viral infections causing wheezing, coughing and bronchitis. Elevated NO_2 levels are of concern to asthmatics because they may experience an increased frequency and intensity of their asthma attacks.

No More Broad Brush - Speciation is Essential

The 'broad-brush' measurement of the combined oxides of nitrogen (NOx) using a chemiluminescence detector (CLD) has been common practice in regulated industrial or automotive emissions monitoring and ambient air quality monitoring programmes for years. However, as we begin to focus on the various oxides of nitrogen and their individual role in atmospheric science and human health, it becomes clear that measurement of each individual gas molecule (speciation) is required. At this granular level of analysis, the CLD is simply not up to the task.

QCL - the Right Tool for the Job

Laser spectroscopy is a highly precise and responsive analytical technique for gases. Quantum cascade laser (QCL) gas analysers have been in use for more than a decade for automotive emissions monitoring and other environmental gas analysis applications. The QCL is sensitive to the mid-infrared range where many gas molecules can be detected.

A new QCL device, developed by the Swiss tech-start-up MIRO Analytical AG has transformed the multi-component gas analysis landscape. Their gas analyser can simultaneously measure up to 10 chemical species including the individual oxides of nitrogen, other pollutant gases and a range of greenhouse gases such as methane and CO_2.
The equipment is robust and easy to use, making it ideal for mobile applications such as PEMS, maritime or airborne monitoring programmes.

Out of the lab, into the mountains

Having grown out of Empa, the Swiss Federal Laboratories for Materials Science and Technology, the team at MIRO have emerged from one of the leading European climate research institutes. Morten Hundt, CEO and co-founder says that "our connection to Empa is still strong. It is highly valuable to us that leading air quality researchers use our gas analyser and provide feedback for our future innovations".

One of the MIRO devices is installed in the legendary Sphinx observatory located on a rocky peak in the Swiss Alps on the Jungfraujoch, just south of the Eiger, 3,571m above sea level. Its role is to measure minute traces of NO_2 in the atmosphere accurately. These provide boundary conditions for sophisticated air quality simulations which will help scientists model atmospheric chemistry more reliably.

Copyright MIRO, 10 component QCL gas analyzer

Ten Through the Tunnel

In a recent study, conducted by AWEL of the Caton of Zürich, the MIRO QCL gas analyser was used to simultaneously monitor 10 gases inside the Gubrist Tunnel in Zürich. Smaller cars with petrol engines and heavier diesel cars and trucks use the 3.5 km long tunnel continuously. From east to west, there is a 70 m incline in the tunnel. As the test vehicle drove through the tunnel in both directions, data from the test showed conclusively how pollutant and greenhouse gas emissions such as NO, N_2O, NO_2, NH_3, CO_2, CH_4, and CO levels all spiked during the high-load upward haul and were lower on the downhill run.

Sphinx observatory, Jungfraujoch, Switzerland

"Nobody was surprised with the overall results" says Hundt. "It is to be expected that the engine emissions are higher under load. Also, it would be obvious that the air inside the tunnel is more heavily polluted than outside the tunnel. But the high precision and high frequency at which the data has been collected is ground-breaking".

The high level of measurement granularity across multiple gaseous compounds is achievable with a single 19" rack-mounted device that weights only 25kg.

Ready for the Future

As we seek to minimise the environmental impact of transport, emissions-free hydrogen mobility and battery electric vehicles will play an increasing role. However, in Europe petrol and diesel cars still dominate new car purchases and comprise the overwhelming majority of vehicles on the roads today. So, continued investment in engine testing, catalyst performance and real driving emissions monitoring will remain essential for decades to come.

Hundt adds: "our innovation will support scientists and authorities to better understand and mitigate climate change. Through progressive tightening of automotive emissions regulations and the EU IED and MCPD legislation for industrial emissions, I see hope for healthier, cleaner air in the future".

The MIRO QCL is already supporting air quality research and climate science. With its rugged portability 'one-box' ease of use covering ten pollutant and greenhouse gases, it will surely find many applications in transport emissions monitoring and engine development in support of Hundt's vision.

Copyright Michael Götsch, AWEL - test vehicle fitted with the MIRO QCL gas analyser

Copyright Michael Götsch, AWEL - MIRO QCL gas analyser used for the Gubrist Tunnel test

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