NOAA Chemical Sciences Laboratory

Instrument Fact Sheet

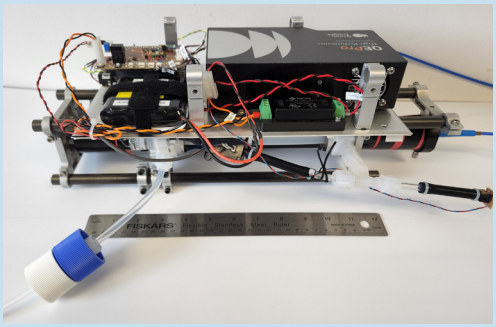
NOAA CHEMICAL SCIENCES LABORATORY

Photo credit: Patrick Cullis, NOAA/CIRES

mACES: Miniature Airborne Cavity Enhanced Spectrometer

Background :

Nitrogen dioxide (NO_2) comes from fossil fuel combustion, and glyoxal is a marker of VOC oxidation chemistry. Measuring these species is key to understanding O_3 and PM2.5 pollution in the troposphere. But often, pollution occurs above populated areas, where traditional aircraft and surface measurement can't easily reach. Uncrewed aerial systems (UAS) combined with high quality sensors have the potential to greatly expand where we can measure pollution. But current NO_2 electrochemical sensors are not nearly accurate enough.



The NOAA CSL mACES instrument.

Description :

mACES is the first research-grade instrument for measuring NO_2 and glyoxal from a UAS platform, attaining excellent precision and fast time response, and weighing only 3 kg. The technique is cavity-enhanced spectroscopy, a selective and sensitive measurement of the optical response of gas-phase species that absorb light in the UV-visible light range.

Instrument Specifications :

- Weight: 3 kg
- Power consumption: 15 – 35W
- Battery operation time: 2.5 hours
- Limit of detection: 43 ppt NO_2 in 1 second
- Accuracy: 4.5%

Test flight of mACES on the CSL hexacopter in Boulder, CO.

Instrument Uses :

- Measure vertical profiles of the lowest part of the boundary layer
- Target high emission areas, such as power plant stacks and highways
- Measure urban area outflow of pollutants
- Validate the next generation of geostationary satellites such as TEMPO and GEO-XO, and upward facing PANDORA NO_2 spectrometers. These provide nationwide monitoring, but rely on algorithms for extracting vertical profiles. We can now measure these directly.

Provisional patent granted June 2022.

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