**Comparison of in situ $N_2O$ and CO measurements using gas chromatography, reduction gas analysis and off-axis integrated cavity output spectroscopy.**

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Atmospheric $N_2O$ and CO mole fraction measurements have been made within the UK Deriving Emissions linked to Climate Change (DECC) network since it first started in 2012. These measurements have been used to better understand regional pollution events, calculate UK emissions of trace gases in conjunction with inverse models and verify UK emission inventories for the Kyoto basket gases (Ganesan et al., 2015; Manning et al., 2011). Historically $N_2O$ and CO measurements have been made using gas chromatography coupled with electron capture detectors (GC-ECD) and reduction gas analysers (RGA) within the network. These older measurement techniques have provided high frequency, good quality data; however they no longer meet the World Meteorological Organization Global Atmosphere Watch (WMO/GAW) recommended $N_2O$ inter-laboratory comparability goal of ±0.1 ppb (Lebegue et al., 2016). In addition, $N_2O$ pollution events are often sporadic and may not be captured by the temporally limited (10-minute) sampling frequency of the GC-ECD and RGA.

A number of new optical instruments have become commercially available over the past few years, which are more precise and collect data at a higher frequency than previous systems. Lebegue et al. (2016) has previously compared $N_2O$ measurements made with optical instruments within a laboratory setting. However, sampling and environmental conditions (e.g. temperature stability and pressure fluctuations) at field locations are often different to those within a laboratory; therefore, comparisons of in situ measurements are needed.

In September 2016, an off axis-integrated cavity output spectrometer (OA-ICOS; Los Gatos Research EP30 $N_2O$/CO analyser with Scripps Institute of Oceanography modifications) was installed at one of the UK DECC network stations (Tacolneston tall tower, Norfolk, UK; GAW ID: TAC), where it has been running alongside a GC-ECD and RGA system. A comparison of in situ $N_2O$ and CO mole fractions made using GC-ECD, RGA, and OA-ICOS will be presented. OA-ICOS precision up until 1st May 2017 was enhanced compared to the older system for $N_2O$ (c.f. 0.08 and 0.2 ppb for the OA-ICOS and GC-ECD, respectively) and CO (c.f. 0.19 and 0.53 ppb for the OA-ICOS and RGA) based on repeat injections of a calibrated standard gas. A mean bias of -0.42 ppb $N_2O$ and -2.84 ppb CO (GC-ECD/RGA – OA-ICOS) was observed in air samples (minute means and discrete samples used for OA-ICOS and GC-ECD/RGA) between 1st September 2016 and 30th April 2017. The exact mechanism driving the bias between instruments is not yet clear.

References

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