Travels with an EM27, measurements of CO2 and CH4 below 45 degrees south.

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Introduction

In 2004 NIWA's Lauder station became one of the first sites in the Total Carbon Column Observing Network (TCCON)(Wunch et al., 2011) and it currently maintains the longest TCCON data series in the Southern Hemisphere (Pollard et al., 2017).

The high precision TCCON retrievals of the column averaged, dry-air mole fraction of several greenhouse gases, including CO2, CH4 and CO (denoted Xgas), have been essential for many satellite and model validation exercises as well as algorithm development. The demand for satellite validation data continues to grow as the number of satellites measuring atmospheric greenhouse gases increases.

The TCCON is, and will continue to be, the gold standard in ground based Near Infrared (NIR) Fourier Transform Spectrometry (FTS) remote sensing of greenhouse gases but does have some limitations. The instruments are large, expensive and require significant infrastructure. This means that the network is somewhat sparse, particularly in the Southern Hemisphere with no sites below 45 degrees South.

The low resolution, portable Brucker EM27/SUN spectrometer can measure XCO and XCH4 with a similar precision to TCCON (Gisi et al., 2012) and XCO at nearly the same precision (Hase et al., 2016). A network like the TCCON is being developed based around the EM27/SUN, known as the Collaborative Carbon Column Observing Network (COCCON).

In this work we describe the deployment of an EM27/SUN to the Lauder TCCON site and to the Arrival Heights atmospheric laboratory on Ross Island, Antarctica. An initial deployment for 2 weeks was carried out in February 2016 with a further deployment from November 2019 to March 2020 capturing an entire Austral summer season.

Data Processing

TCCON data are processed and retrieved using a standardised suite of software known as GGG, currently at the 2014 version (Wunch et al., 2015). Prior data are generated from NCEP reanalysis for meteorological fields with the chemistry generated using a set of empirical functions that are optimised to fit observations from several different in situ sources as a function of latitude, longitude and season, as well as taking account of long-term variability. Measured surface pressure is taken from the NIWA climate station at Lauder.

The 2016 EM27 spectra were processed using the PROFFIT retrieval code (Hase et al., 2004), while for the most recent deployment, a more efficient variant, specifically developed for these low resolution instruments, PROFFAST was used (https://www.imk-asf.kit.edu/english/3225.php). TCCON and NCEP prior data were generated for both Lauder and Arrival Heights and measured surface pressure from the Lauder and Scott Base climate stations were used for the Lauder and Arrival Heights retrievals respectively, with appropriate corrections for the difference in altitude. Time series of daily average data from both EM27 deployments as well as the corresponding Lauder TCCON data are shown to the right.

Data Availability

TCCON data are available from the TCCON archive (https://tccdata.org/).

The EM27/COCCON data are available from the authors and will be made available on the COCON centralised data server which is currently in development.

References