PERFORMANCE ANALYSIS OF THE LOFLO CONTINUOUS CO_2 ANALYSER: MONITORING OF BASELINE AND URBAN AIR; DESCRIPTION OF ITS DIAGNOSTIC CAPABILITY, AND POTENTIAL FOR ENHANCED CO_2 CALIBRATION

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ABSTRACT

Results are presented from recent evaluations of multiple "LoFlo" CO_2 analysers. These experiments were conducted at both an urban site (Aspendale, a suburb of Melbourne, Australia), and the Cape Grim baseline site. Figure 1 shows the preliminary results from an overlap experiment involving two LoFlo analysers (identified here as LoFlo-2A, and LoFlo-2B, each one operating with its own suite of calibration gases) measuring marine boundary layer air from a shared single air intake at the Cape Grim Baseline Air Pollution Station, in northwest Tasmania, during April/May 2005. The figure shows the differences between hourly CO_2 values from the two analysers, during those periods when baseline conditions were experienced. The seven high pressure, CO_2-in-dry air calibration standards used for the LoFlo-2B system have been calibrated at the Carbon Cycle Gases Group (CCGG), United States National Oceanic and Atmospheric Administration (NOAA), Climate Monitoring and Diagnostics Laboratory (CMDL), designated by the World Meteorological Organization (WMO) as the CO_2 Central Calibration Laboratory. The calibration suite of LoFlo-2A, also consisting of seven CO_2-in-dry air standards in high-pressure aluminium cylinders, was calibrated intensively against the LoFlo-2B calibration suite using the LoFlo-2B analyser. The mean difference between the hourly baseline atmospheric CO_2 concentration measured by the two individually calibrated analysers was 0.009 ± 0.011 μmol mol^{-1} CO_2. The results so far of this overlap experiment show a very small but systematic offset of less than 0.01 μmol mol^{-1} CO_2 between the two analysers, with the CO_2 values from LoFlo-2B being slightly lower. These results clearly demonstrate the very high precision achievable measuring atmospheric CO_2 with the LoFlo technology, which should allow the successful resolution of small atmospheric CO_2 spatial gradients across large expanses of the Southern Ocean, and the inference of CO_2 fluxes in this region. This level of intercomparison between CO_2 analysers is considerably better than the WMO recommended level of consistency required for intercomparison purposes of 0.05 μmol mol^{-1} in the southern hemisphere [*World Meteorological Organization*, 1993].

In addition, a comparison will be presented between continuous atmospheric CO_2 measurements from Cape Grim and other LoFlo instruments operating regionally in Aspendale (Victoria), Bago State Forest (New South Wales, 35.66ºS, 148.15ºE) and a recently installed (March 2005) LoFlo at the remote Macquarie Island (54.48ºS, 158.97ºE) in the Southern Ocean. This regional measurement network is expanding with the recent LoFlo installation at the Danum Valley Global Atmosphere Watch station operated by the Malaysian Meteorological Service (installed September 2004), and soon-to-be deployed LoFlo analysers by Seoul National University (South Korea) and the National Institute for Environmental Studies (Japan).

A series of calibration experiments have also been conducted to investigate the assignment and propagation of values to CO_2–in-air standards. Various LoFlo calibration suites (typically seven CO_2-in-dry air standards in high-pressure aluminium cylinders), some calibrated by the WMO Central CO_2 laboratory, were analysed using several different, and individually calibrated LoFlo CO_2 analysers. The results of these experiments will be described in detail.

The LoFlo analyser systems have demonstrated enhanced precision in the measurement of CO_2 in both ambient air and CO_2-in-air gas standards. In addition to direct biogeochemical applications, these instruments have the diagnostic capability to investigate possible sources of systematic bias affecting both CO_2 calibration methods and conventional techniques for atmospheric CO_2 measurement. The use and evaluation of LoFlo systems in the laboratories of collaborators has the potential to enhance the goal of the seamless merging of CO_2 datasets.

Ongoing improvements to the LoFlo technology are being conducted and will be described in detail. These include issues such as: the automatic flagging of data based on measured instrumental parameters; corrections based on differential cell pressure (the pressure difference between the reference and sample cells of the Li-Cor infrared optical bench), and the improved ease of reprocessing of data sets.

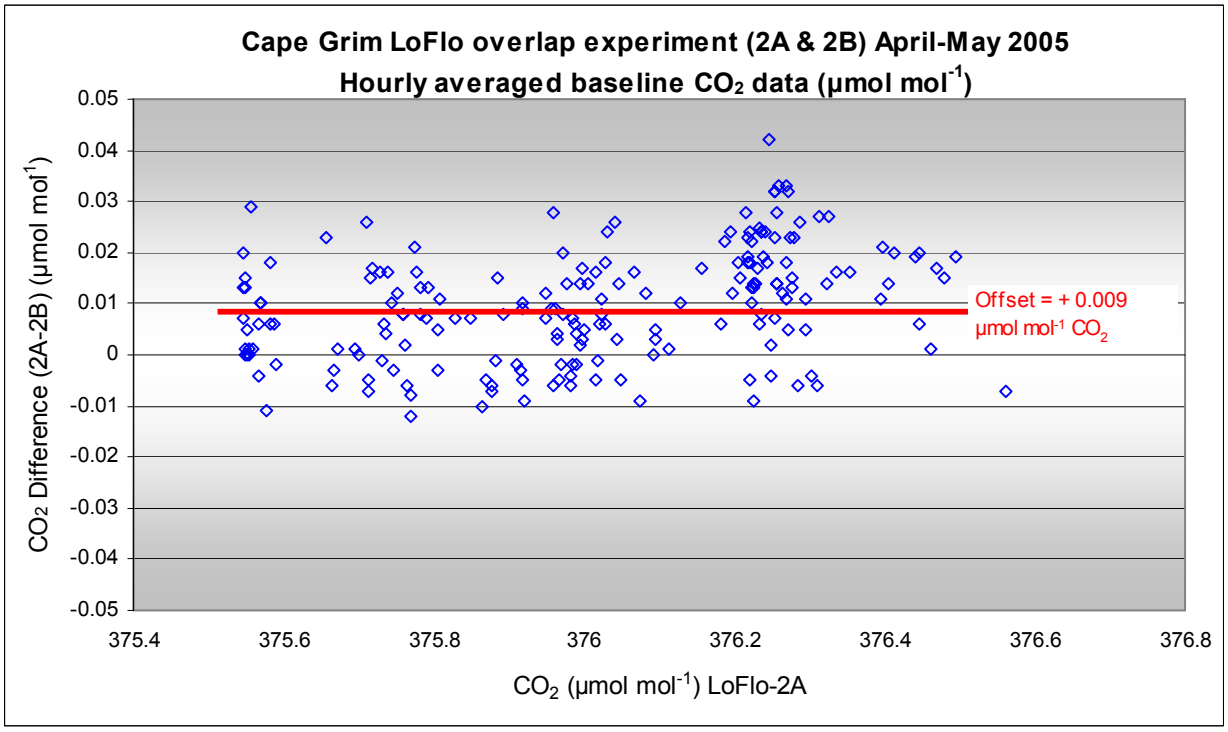

Fig. 1: Results from Cape Grim LoFlo (2A & 2B) overlap experiment during April-May 2005. Differences between the hourly averaged baseline atmospheric CO_2 (µmol mol^{-1}).

REFERENCES

World Meteorological Organization Global Atmosphere Watch (1993), Report of the Seventh WMO Meeting of Experts on Carbon Dioxide Concentration and Isotopic Measurement Techniques, *WMO TD-No. 669, No. 88*, Rome, Italy, 1993.