High-Resolution Measurements of Atmospheric CO_2 from the DC-8 in Support of the ARCTAS Expedition

Principal Investigator: Stephanie Vay
NASA Langley Research Center
Stephanie.A.Vay@nasa.gov

Co-Investigators: Yonghoon Choi (NIA), Krishna Vadrevu (OSU), and Jung-Hun Woo (Konkuk University)

The **AVOCET** instrument will provide in-situ measurements of atmospheric carbon dioxide (CO_2) aboard the NASA DC-8 during the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (**ARCTAS**) mission. Recently flown during the INTEX-B (2006) and TC^4 (2007) missions, this instrument offers many high performance capabilities including high accuracy and precision; fast-response; continuous; and real-time measurements.

Carbon dioxide measurements are made with a modified LI-COR model 6252 differential, non-dispersive infrared (NDIR) gas analyzer. This dual-celled instrument is composed of a feedback stabilized infrared source, a thermoelectrically cooled solid state PbSe detector, and a narrowband (150 nm) interference filter for selectively passing radiation from the CO_2 4.26 micron absorption band. It achieves high precision by sensing the difference in light absorption between the sample and a reference gas of nearly the same CO_2 concentration, both flowing continuously through identical optical absorption cells. The CO_2 instrument is operated at constant mass flow (1000 cm^3 min^{-1}), pressure (250 torr), and temperature (35˚C). Ambient air samples are acquired via a window-mounted Rosemount inlet, then flow through a permeable membrane dryer to remove $H_2O_{(v)}$ prior to reaching the LI-COR. Frequent but short calibrations are accomplished by periodically flowing reference gas through the instrument's sample cell. By interpolating between these calibrations, slow drifts in instrument response are effectively suppressed, yielding high precision values. Reference gas CO_2 concentrations are established relative to the WMO primary calibration standards maintained at the NOAA GMD laboratory in Boulder, CO.

Table 1. Instrument performance characteristics

Dynamic Range	0 to 3000 ppm
Accuracy	± 0.25 ppm
Precision	≤ 0.1 ppm (1σ)
Data reporting interval	1 second

Figure 1. AVOCET configuration for ARCTAS

The high temporal response measurements that we offer will be quite useful for examining large-scale distributions of a radiative tracer inextricably connected to climate change, and for investigating the influence of long-range transport and boreal wildfires on the Arctic atmosphere. As a passive tracer having a well-defined seasonal cycle, these measurements also afford a distinct label for air entering the upper atmosphere for investigative studies of trop-strat exchange, convection resulting from synoptic weather systems, and pyro-convection fueled by boreal fires. High resolution observations of atmospheric CO_2 will be invaluable for validation of AIRS CO_2 column retrievals, OCO retrieval algorithm development, and benefit temperature retrievals from space-borne sensors (e.g. TES, MLS on Aura and AIRS on Aqua) and meteorological forecasts. They additionally have intrinsic merit for carbon cycle studies, enabling exploration of the connection between the distribution of CO_2 concentrations and the terrestrial biosphere via MODIS, LANDSAT, MISR, and ASTER remote sensing data products.

References

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