NCAR NO-NO_2 Instrument

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Instrument Description and Background:

This is a 2-channel instrument based on the chemiluminescence detection of NO via reaction with O_3 to form excited NO_2, which is detected via photon counting. One sample channel is used to measure nitric oxide, NO, and the second measures nitrogen dioxide, NO_2, by flowing ambient air through a glass cell illuminated by light-emitting diodes at 395 nm, for the conversion of NO_2 to NO via photolysis. The instrument is similar to instruments previously built at NCAR [Ridley and Grahek, 1990; Ridley et al., 2004].

In the UTLS region, NO_x (=NO + NO_2) is mostly in the form of NO and is formed in situ by lightning, is emitted by aircraft, and may be transported to the UTLS from the boundary layer by convection.

Hardware:

The instrument (Figure 1) is centered around a 2-channel detector box which includes the reaction vessels (2), zero volumes (2), and photomultiplier tubes (2) for simultaneous detection of two sample flows, together with a number of flow controllers (for calibration flows, O_3 reagent flows, zero-air flows) and pressure transducers. A second box houses the computer for data acquisition and instrument control, together with power supplies, and a third box houses two ozonizers which produce O_3 for reaction with NO to enable detection via production of excited NO_2. Additionally, there is a vacuum pump, three gas bottles (zero air, O_2 for O_3 generation, and NO-in-N_2 calibration gas), and inlet components (photolytic converter for NO_2, identical dummy cell for NO, two sample flow controllers, valves for calibration gas addition). Dry ice is required for PMT cooling.

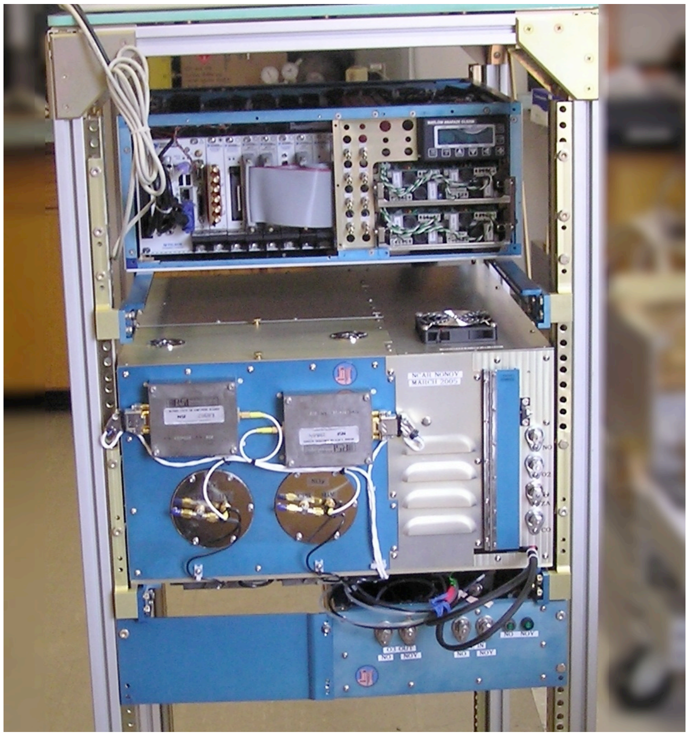

Figure 1. The upper box is the data acquisition and control system, including power supplies. The middle box is the main instrument module with 2 channels of detection, and the lowest box houses two ozonizers.

Configuration on GV for DC3/SEAC^{4}RS:

The instrument can fly as a stand-along instrument, but for DC3/SEAC^{4}RS there will be a significant sharing of components with the O_3 chemiluminescence instrument. This will result in considerable weight, space, and power savings for the overall payload. The items to be shared include these: data acquisition and control system, power distribution and power supplies, vacuum pump, pressure-control valve, zero air bottle, and inlet. The entire installation will occupy approximately three-fourths of a pair of racks plus some floor space. One rack is devoted to NO-NO_2, and the companion rack is devoted to O_3 along with the VUV instrument for CO and the Picarro instrument for CO_2 and CH_4. Thus the O_3 instrument is fully integrated with NO-NO_2, electrically and in the plumbing and in the data acquisition, and the rack pair houses NO-NO_2, O_3, CO, and CO_2-CH_4 instruments.

Data:

Data will be recorded at 10 Hz, though the true frequency response is not that fast, and data will be archived at 1 Hz. The precision of 1-s values is estimated to be in the range of 5-10 pptv, dependent on performance characteristics to be determined in flight. Overall uncertainty of 1-sec values is estimated to be 10% or better for large mixing ratios (> 50 pptv). Further characterization of measurement error will be determined during data reduction.

References:

Ridley, B.A.; Grahek, F.E. (1990), A small, low flow, high-sensitivity reaction vessel for NO chemiluminescence detectors, J. Atmos. Oceanic Technol, 7, 307-311.

Ridley, B., L. Ott, K. Pickering, L. Emmons, D. Montzka, A. Weinheimer, D. Knapp, F. Grahek, L. Li, G. Heymsfield, M. McGill, P. Kucera, M. J. Mahoney, D. Baumgardner, M. Schultz, G. Brasseur, Florida thunderstorms: A faucet of reactive nitrogen to the upper troposphere, *J. Geophys. Res., 109*, D17305, doi: 10.1029/2004JD004769, 2004.