NOAA Nitrogen Oxides and Ozone (NO_yO_3)

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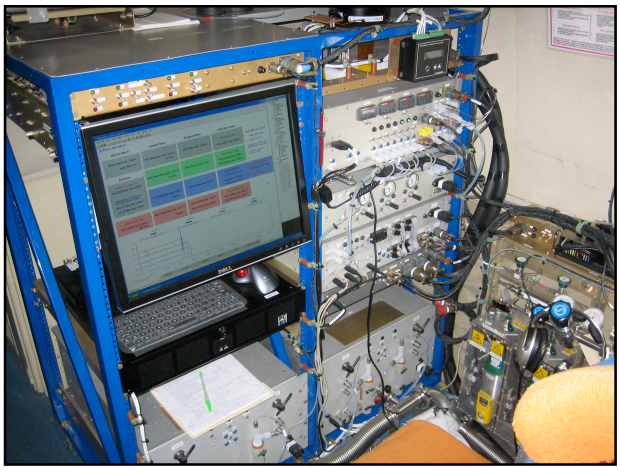

The **NOAA NO_yO_3** 4-channel chemiluminescence (CL) instrument will provide in-situ measurements of nitric oxide (NO), nitrogen dioxide (NO_2), total reactive nitrogen oxides (NO_y), and ozone (O_3) on the NOAA P-3 during the Southeast Nexus (SENEX) project. This instrument has flown on the NOAA P-3, the NCAR Electra, and the NASA DC-8 research aircraft on multiple field projects since 1995. It provides fast-response, chemically specific, high precision, and calibrated measurements of nitrogen oxides and ozone at a spatial resolution of better than 50m at typical P-3 research flight speeds.

Detection is based on the gas-phase CL reaction of NO with O_3 at low pressure, resulting in photoemission from electronically excited NO_2. Photons are detected and quantified using pulse counting techniques, providing ~5 to 10 part-per-trillion by volume (pptv) precision at 1 Hz data rates.

One CL channel of the integrated 4-channel instrument is used to measure ambient NO directly, a second channel is equipped with a high-power UV-LED converter to photodissociate ambient NO_2 to NO, and a third channel is equipped with a heated gold catalyst to reduce ambient NO_y species to NO. Reagent ozone is added to these sample streams to drive the CL reactions with NO. Ambient O_3 is detected in the fourth channel by adding reagent NO.

Instrument performance is routinely evaluated in flight by standard addition calibrations delivered within a few centimeters of the inlet tips. The separate NO and NO_2 sample paths, detectors, and inlet residence times are identical, permitting artifact-free calculation of ambient NO_2 by difference at high time resolution, with no lagging or smoothing relative to NO or to other fast-response measurements aboard the aircraft. A high-power UV-LED converter developed in our laboratory provides NO_2 conversion fractions exceeding 0.6 at a converter sample residence time of 0.11 seconds. This offers a significant advantage in terms of NO and NO_2 spatial resolution compared to other airborne NO_2 instruments. The NO_y channel is calibrated to NO, NO_2, and HNO_3 in

flight and the O_3 channel is calibrated over an atmospherically-relevant range of ozone mixing ratios in flight.

Measurements of nitrogen oxides and ozone will be used to address several objectives of SENEX including:

- Understanding tropospheric ozone chemistry in the presence of biogenic and anthropogenic precursor emissions
- Understanding air quality – climate interactions
- Comparison with regional air quality models; evaluation of satellite observations

References

Pollack, I.B., Lerner, B.T., and Ryerson, T.B. (2011), Evaluation of ultraviolet light-emitting diodes for detection of atmospheric NO_2 by photolysis-chemiluminescence. *Journal of Atmospheric Chemistry* 65:111–125, 10.1007/s10874-011-9184-3.

Ryerson, T.B., Williams, E.J., and Fehsenfeld, F.C. (2000), An efficient photolysis system for fast-response NO_2 measurements. *Journal of Geophysical Research*, *105*(D21), 26,447-426,461.

Ryerson, T.B., Huey, L.G., Knapp, K., Neuman, J.A., Parrish, D.D., Sueper, D.T., and Fehsenfeld, F.C. (1999), Design and initial characterization of an inlet for gas-phase NO_y measurements from aircraft. *Journal of Geophysical Research*, *104*(D5), 5483-5492.