NOAA Nitrogen Oxides and Ozone (NO_yO_3)

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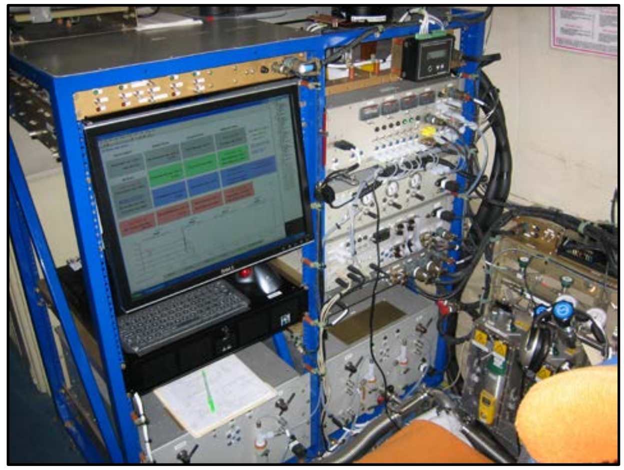

The **NOAA NO_yO_3** 4-channel chemiluminescence (CL) instrument will provide in-situ measurements of nitric oxide (NO), nitrogen dioxide (NO_2), total reactive nitrogen oxides (NO_y), and ozone (O_3) on the NASA DC-8 during the Southeast Asia Composition, Cloud, Climate Coupling Regional Study ($SEAC^4RS$) project. This instrument has previously flown on the NOAA WP-3D research aircraft on multiple field projects since 1995. It offers fast-response, specific, high precision, and calibrated measurements of nitrogen oxides and ozone at a spatial resolution of better than 100m at typical DC-8 research flight speeds.

Detection is based on the classic 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 additions 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 exceptional sensitivity to NO_2, such that conversion fractions exceeding 0.6 are achieved at a photolytic converter sample residence time of 0.11 seconds, a 10-fold improvement over earlier designs. 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.

The nitrogen oxides and ozone data taken during SEAC4RS will be used to determine the nitrogen oxide emissions of biomass burning and lightning; the NO_y budget as a function of transport time downwind of convective systems; the O_3 and NO_2 column loadings between the surface and the lower stratosphere, for evaluation of column retrievals from OMI, SCIAMACHY, and other spaceborn instruments; and the NO_x and O_3 perturbations on the UT/LS resulting from deep convection of clean, and of polluted, boundary layer air.

References

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