AERODYNE RESEARCH, Inc.

CAPS NO_x Monitor

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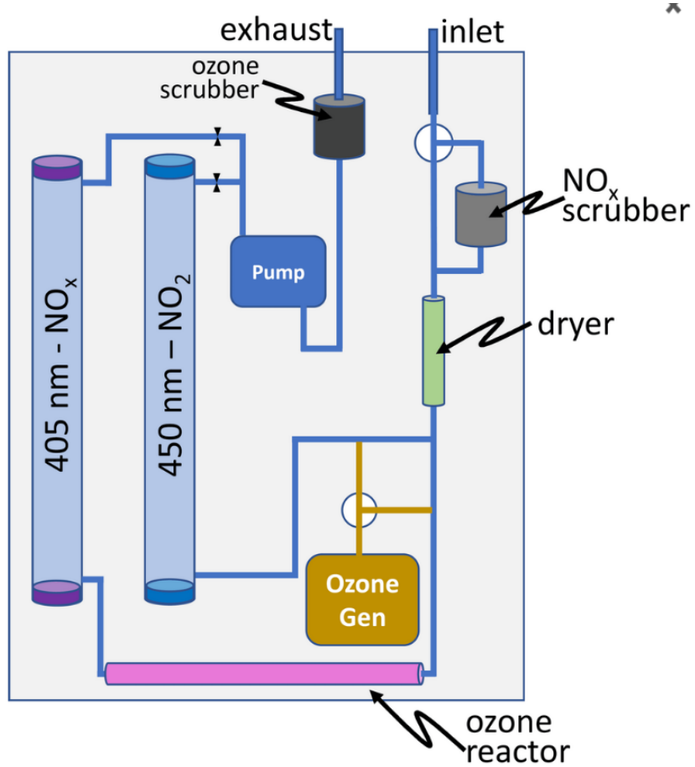
U.S. DEPARTMENT OF ENERGY

Introduction, Background, and Motivation

- Nitrogen cycle is a biogeochemical process that encompasses key roles in the atmosphere (e.g., NO_x = NO+NO_2) and in bio/soil/water (e.g., reactive nitrogen, Nr).
- Robust, inexpensive measurements of emissions, fluxes, and chemical composition are required to understand the nitrogen cycle and its impacts.

- **CAPS NO_x monitor** is being developed as a rapid, robust, inexpensive measure of NO_x and Nr
- **Measures NO_x as NO_2** by converting NO using photolytic production of O_3
- Sample response times up to **10 Hz**
- Combined with Total Reactive Atmospheric Nitrogen Converter (TRANC) to **measure Nr**
- **Technology Readiness Level: 5-6**



Comparison with Other Techniques

- CAPS monitors are **field deployable** for mobile sampling (e.g., mobile labs, aircraft)
- CAPS monitors are **easy to use** with automated and autonomous operation – deployed successfully many times by non-Aerodyne technicians
- CAPS monitors are **inexpensive** to purchase and operate

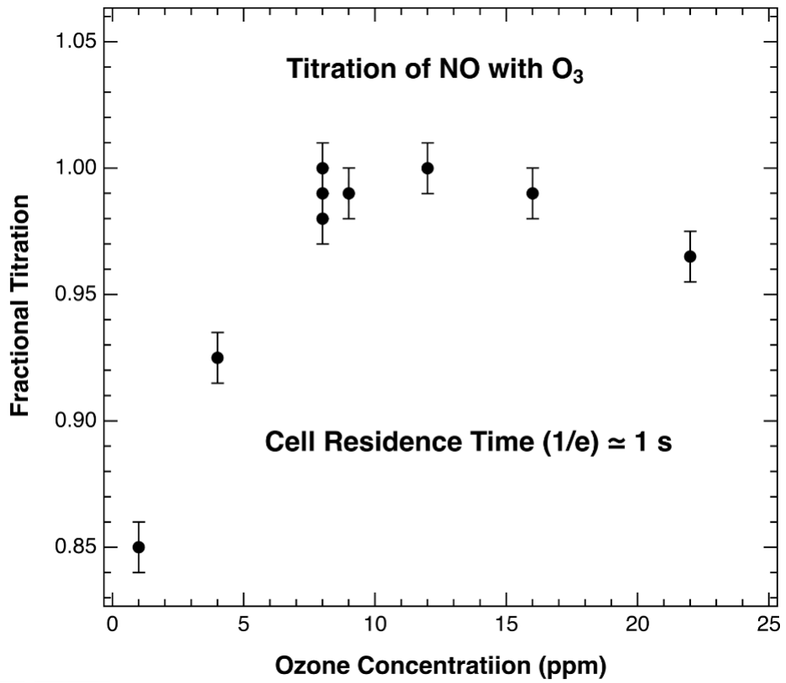
Advantages

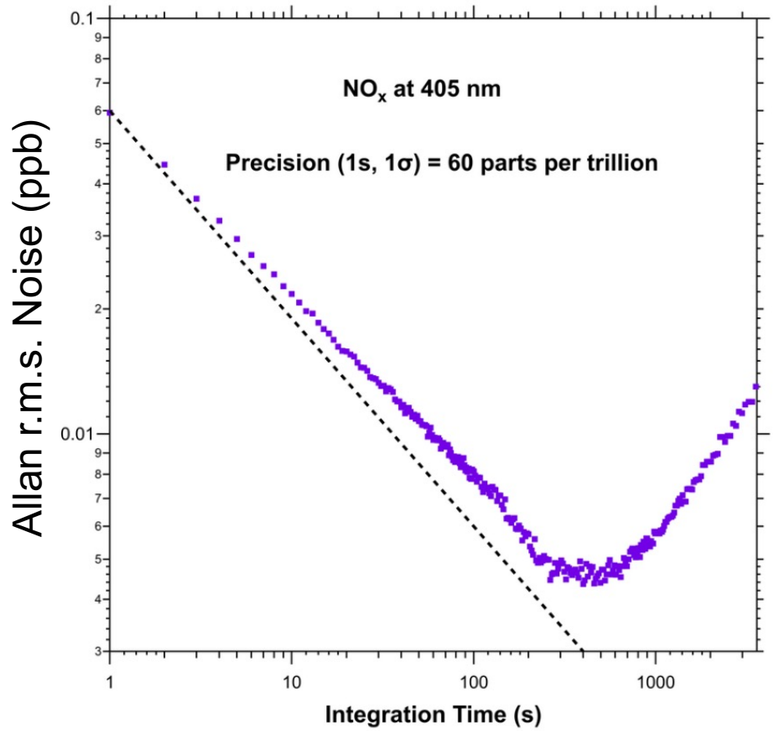
- Direct measurement of analyte (NO_2)
- Specific, well-characterized chemical conversion of NO to NO_2
  - Compared with non-specific NO_2 to NO conversion
- Automated and autonomous operation
- Low weight and power requirements
- Minimal maintenance
- Calibrated with NO gas tank
- Customization Available

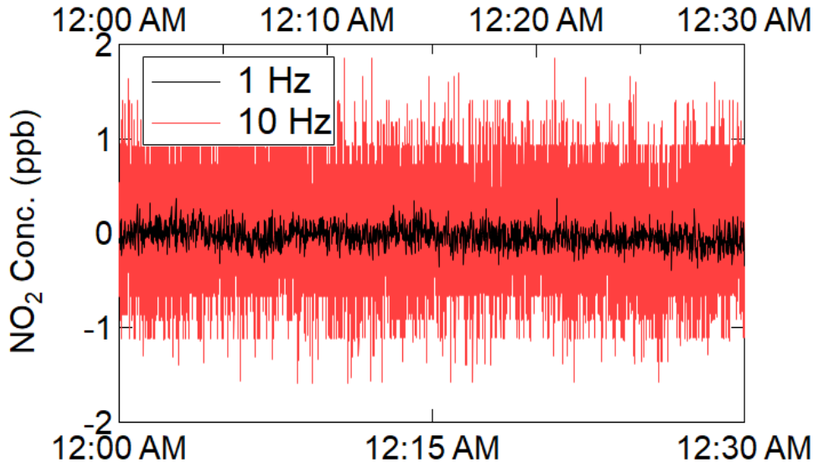
Disadvantages

- Higher detection limits than CLD/LIF methods
  - Limit free tropospheric capabilities
- Spectral interference from glyoxal and methylglyoxal
- Number density detection
  - Pressure-dependent sensitivity
- NO_y not measured
  - Third channel could potentially be added to CAPS with catalyst

Titration, Calibration, Noise, Sample Rate

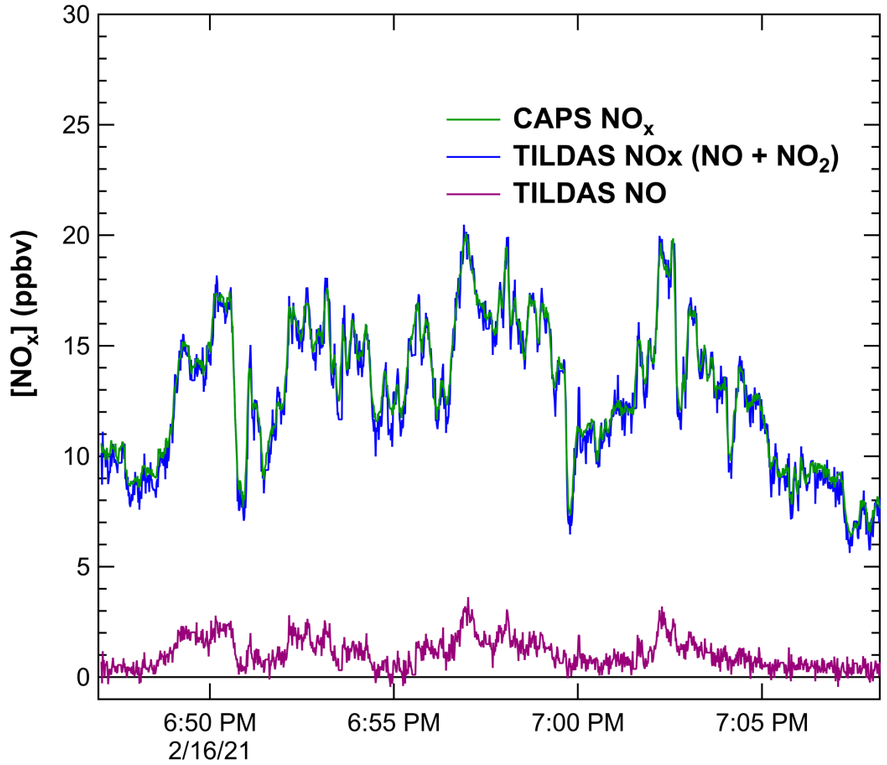


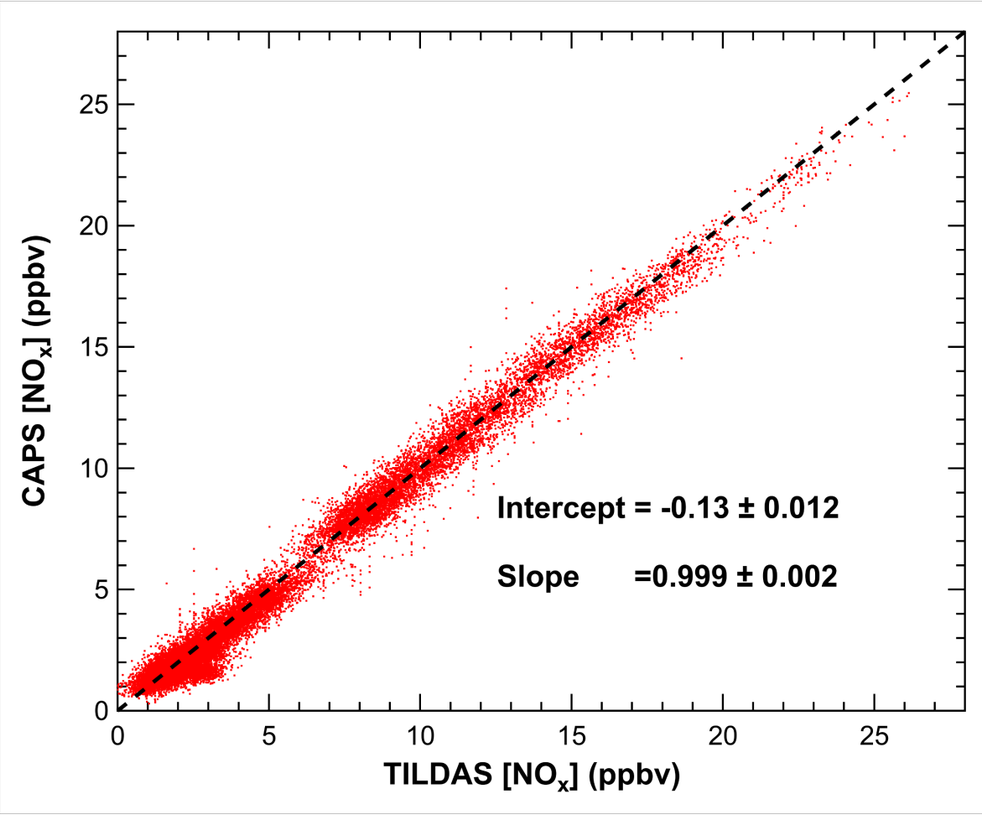




- Titration of NO with O_3 ~100% conversion 7-15 ppm O_3
- NO calibration at 405 nm
- Noise / Detection Limits: 1 σ ~60 ppt @ 1 Hz
- Sample rates up to 10 Hz

Comparison of Field Deployed CAPS NO_x Monitor and TILDAS Trace Gas Analyzer





Comparison of 1 second measurements on Aerodyne Mobile Laboratory from CAPS NO_x and TILDAS NO_x ($NO+NO_2$) monitors.

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Summary

Aerodyne CAPS NO_x is currently being developed under DOE and NASA SBIR projects

- CAPS Total Reactive Nitrogen
  - TRANC front-end to convert reactive nitrogen to NO_2
  - Eddy flux with up to 10 Hz response time (involves both software and hardware changes)
  - **DOE Phase I Project (Contract #: 80NSSC20C0467)**
- CAPS NO_x = NO_x + NO_2 – two cell design
  - Direct replacement of Chemiluminescence NO_x-Box technology/instruments
  - True NO_2 measurement
  - White paper submitted to DOE AAF meeting March 2020
  - **NASA Phase II Project (Contract #: 80NSSC20C0467)**

ASR Atmospheric System Research

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