Measurements of Formaldehyde by Difference Frequency Absorption Spectroscopy (DFGAS)

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Formaldehyde in the Atmosphere

1. Indicator of HC activity
2. Test species in HC oxidation
3. Source of HO₂ and CO
4. Important ozone precursor
5. Tests understanding of convective transport, processing, liquid phase chem & uptake
6. Tests understanding of Br & Cl chem. in the Arctic
Formaldehyde Measurements – Box Model Comparisons During MIRAGE

First Phase

Second Phase

- Binned Median TDLAS Measurement
- Binned Median Box Model

Radar Altitude (km)

[CH$_2$O] pptv

0 500 1000 1500 2000 2500

0 100 200 300 400 500

21 50 63 86 174 92 65 120 118 189 188 207 184 74 33 111
Difference Frequency Generation

\[ \omega_i = \omega_p - \omega_s \]

PPLN (2nd-order Nonlinear Optical Crystal)

\[ \omega_S \]
1562 nm

\[ \omega_P \]
1083 nm

3532 nm

L
DFG Spectrometer

Multi-Pass Cell

Reference Detector
Sample Detector
Noise Detector

Beam Splitter 2%
16%
82%

Reference Gas Cell

Spot Pattern

Collimation Lens

Bulk-PPLN

Ball Lens Fiber

P_{ref} = 0.4 mW
(@3.53 µm)

Pump DFB-fiber laser 1083 nm

Signal DFB-diode laser 1562 nm

Polarization CTRL

Ytterbium Amplifier

Erbium Amplifier

WDM
Once system running no optical adjustments (semi-autonomous)
1 Sec LOD (1 σ) 60-85 pptv
1 Min LOD (1 σ) 11–15 pptv
Demonstration of Fast Instrument Response

Airborne DFG CH$_2$O, and DACOM CO, and CH$_4$ measurements in a Pyro-Convective plume during the summer ARCTAS phase
System Upgrades & Timeline

- Pressure Control of Optical System – Early Next Year (Investigating Feasibility)
Plans/Concerns for Integration

- System Location - Left side of aircraft
- Access to Front and Back of Inboard Rack
- Place onboard for Al air cylinder or Allowance for Use of Carbon Fiber Cylinder and small cylinder for MeOH
- Cover Over Inlet Probe at Night
- Temp Cabin Max 35 C

Flight Constraints - None
Data Analysis Plans

- Collaborations with NASA Modelers
  - Continuation of Measurement-Model Comparisons
  - Integrated Column Comparisons
  - Continuation of Assessment of CH$_2$O Sources & Sinks
  - Detailed Comparisons with Ground-Based Measurements
  - Interesting to Carry Out Lagrangian Flight Patterns