PANTHER Gas Chromatograph: A Progress Report

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Abstract

- PAN (Peroxy Acetyl Nitrate) and other Trace Hydrohalocarbon ExpeRiment (PANTHER) is a next generation gas chromatograph (GC) capable of measuring trace gases involved in air quality, climate forcing, and stratospheric ozone depletion. It has four gas chromatograph-electron capture detector (GC-ECD) and one gas chromatograph-mass selective detector (GC-MSD) channels.
- This instrument has been integrated on the NASA ER-2, WB-57F, and DC-8 aircraft. It has flown on test flights on the WB-57F and DC-8 aircraft. It would require some modification (thermal issues) to fly on NASA balloon platforms.
- This instrument flew on its first test during the CRYSTAL-FACE mission. The flight was a successful engineering flight, but didn’t lead to any science quality data.
- PANTHER flew on all SOLVE-2 test and science flights. It got science quality data on all science flights except one.
- For SOLVE-2, three electron capture detector and mass spectrometer channels were operating.
Applications: Justification of new airborne gas chromatograph for the short-lived trace gases

- Future airborne missions will focus on more atmospheric chemistry, mainly in the troposphere and lowermost stratosphere.
- Ground-truth measurements for satellite- and space-borne instruments.
- Shorter lived trace gases, like hydrocarbons, organic nitrates, hydrogen substituted halocarbons (Cl and Br solvents: CH₂Cl₂, C₂Cl₄, and HFCs, HCFCs) play a major role in air pollution and climate change.
- Recent amendments to the U.S. Clean Air Act (control of Cl solvents).
- Cryogenically trap large air samples and scan for unknown trace gases.
PANTHER Schematic (4 ECD and 1 MSD channels)
CRYSTAL-FACE Real air signal
July 31, 2002

[Graph showing relative signal over time with peaks labeled CFC-12, CFC-11, and halon-1211]
Test Flight Successful (July 31, 2002)
PANTHER team participates in SOLVE-2 at NASA Dryden & Kiruna, Sweden on DC-8

Jim Elkins & Fred Moore in front of DC-8.

Fred Moore running PANTHER on DC-8.

PANTHER’s inlet on DC-8.

PSCs outside hangar on January 11, 2003.

Instrument Details: Station 5 on NASA DC-8 aircraft, 200 lbs., 24” w x 28” l x 15” h, 1 kw (2 kw peak)
PANTHER ECD Chromatograms during SOLVE-2

- **ECD Channel 1**
  - Relative Signal
  - Time (seconds)
  - Peaks: Air, SF₆, N₂O

- **ECD Channel 2**
  - Relative Signal
  - Time (seconds)
  - Peaks: Air, CFC-11, CFC-113, CHCl₃, CH₃CCl₃, CCl₄

- **ECD Channel 3**
  - Relative Signal
  - Time (seconds)
  - Peaks: H₂, Air, CH₄
January 19, 2003

- ECD channels- CFC-11, CFC-113, CHCl₃, CH₃CCl₃, CCl₄, CH₄, H₂, N₂O, SF₆
- Mass Spectrometer channel: CH₃Cl, CH₃Br, HCFC-22, COS, HCFC-142b, CFC-12, HFC-134a

Inverse relationship of CFC-11 Versus ozone (O₃).

Tight correlation of source gases.
PANTHER MSD Chromatograms

- **HCFC-22 ion 51**
- **CH₃Br ion 96**
- **HCFC-22 + Others**
- **CH₃Cl ion 50**
- **CH₃Br ion 94**
- **CFC-12 ion 85**
- **COS ion 60**
- **HFC-134a ion 83**
- **HCFC-142b ion 65**
First *in situ* Measurements of methyl chloride (CH$_3$Cl)
January 24, 2003

Data are preliminary.