# ACCLIP UT/LS Chemical Tracers:

## Enhancing Methane Data Coverage

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*NCAR EOL/RAF and ACOM/ESS, NOAA CSL, and U Miami*

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## Advanced Whole Air Sampler (AWAS)

- Preparation included surface passivation with ~15 Torr water vapor
- Similar collection systems were installed on both GV and WB-57 platforms
- Max samples per flight: 56 (GV) and 50 (WB-57)

*WAS teams: Elliot Atlas, Sue Schauffler, Victoria Treadaway, Kate Smith, Roger Hendershot, Rich Lueb, and Stephen Donnelly*

| PLATFORM | CANISTER VOLUME (L) | ALTITUDE (KM) | FILL TIME (S) | CANISTER MAX P (PSIA) |
|---|---|---|---|---|
| WB-57 | 1.3 | 10 | 14 | 40 |
| | | 20 | 120 | 50 |
| G-V | 1.0 | <5 | 4 | 40-45 |
| | | 12-15 | 26 | 40-45 |
| | 1.3 | 12-15 | 40 | 40-45 |

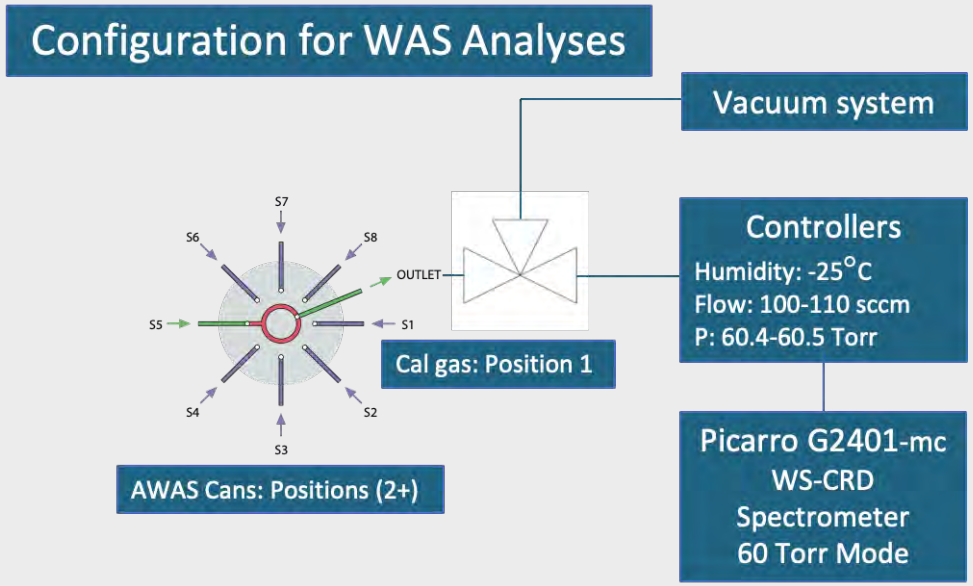
## NCAR Carbon Dioxide, Carbon Monoxide, Methane and Water Vapor Sensor

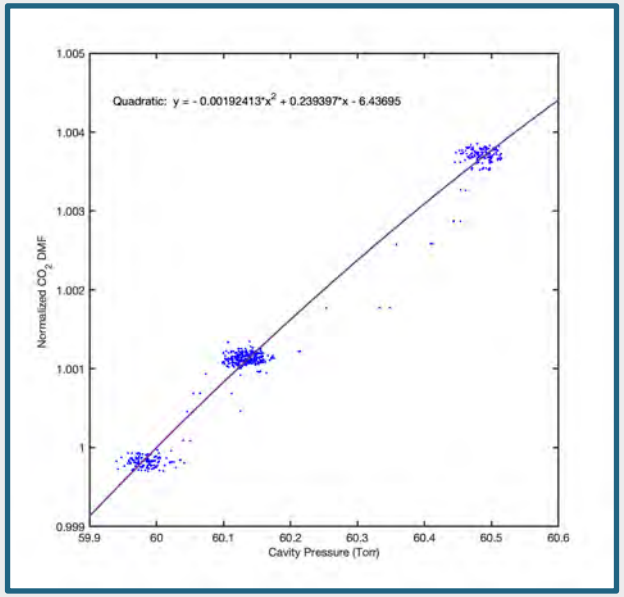
- NCAR GV Picarro G2401-mc: custom low pressure mode for high altitude operation
- NCAR staff modified spectral scan protocols to achieve 2-s temporal resolution with resultant uncertainty specifications:

*NCAR Carbon Picarro Team: Teresa Campos, Ed Kosciuch and Kirk Ullmann*

| Measurand | LLOD | Precision (1-min,1σ) | Uncertainty (± 2σ) |
|---|---|---|---|
| $CO_2$ (µmol/mol) | 0.1 | 0.03 (typical) | ± 0.1 |
| $CH_4$ (nmol/mol ) | 3.0 | 0.5 | ± 3 |
| CO (nmol/mol ) | 5 | 5 | 5 ± 0.1% |
| $H_2O$ (µmol/mol) | 8 | 8 | ± 5% |

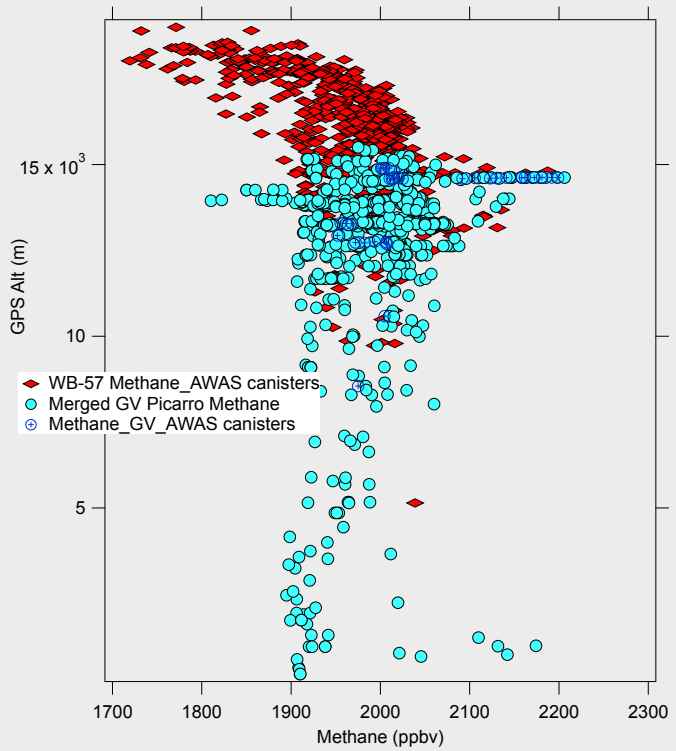
# WAS – Picarro Interface and Experimental Conditions

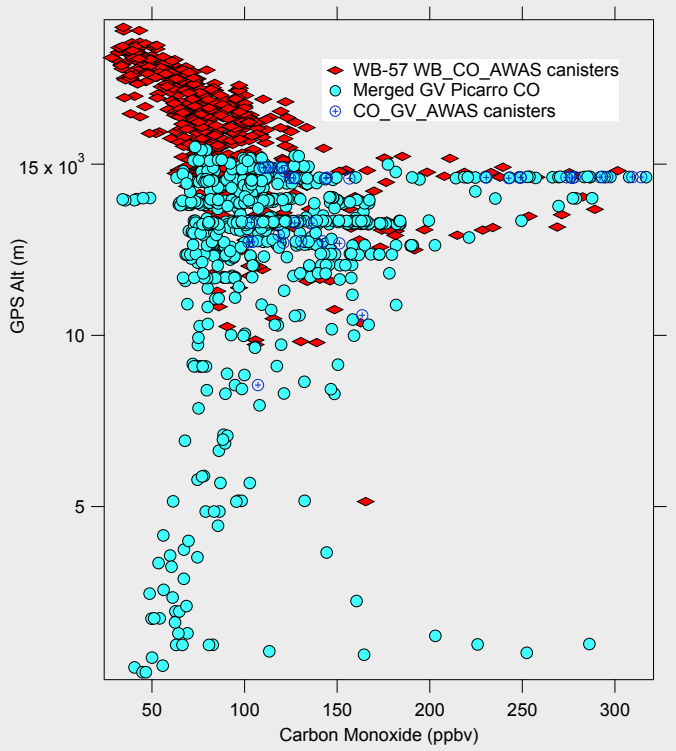


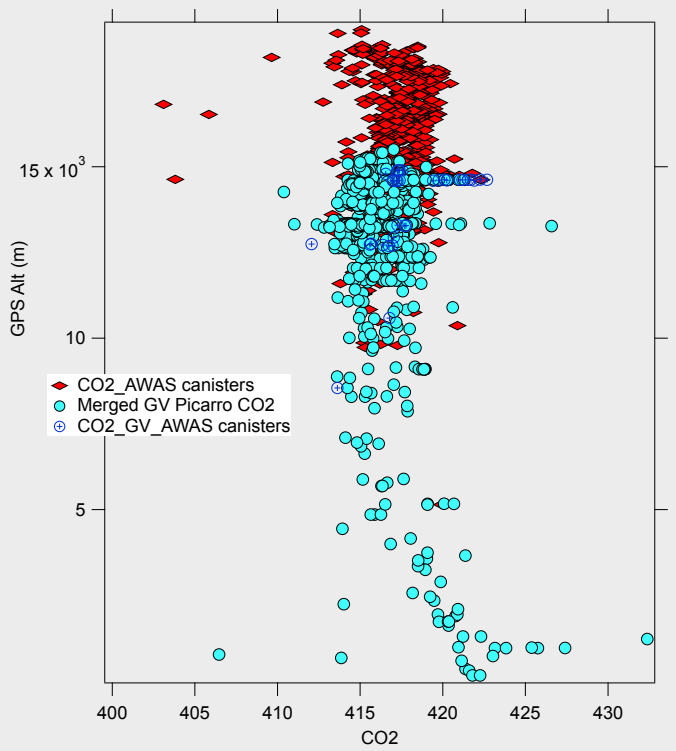




- Sample duration: 2 minutes -> ~ 250 mL gas used and a ~ 3 psig drop in can pressure
- Calibration details:
  - Working standard quantification: 3 replicates of multipoint (4) lab cals traceable to WMO network
  - Single standard run through WAS manifold with each measurement set of ~29 canisters
  - Pre- and post-run standard checks bypassing WAS manifold
- Cavity P dependence characterized to improve measurement accuracy; transfer curve shown above

# Quality Assessment



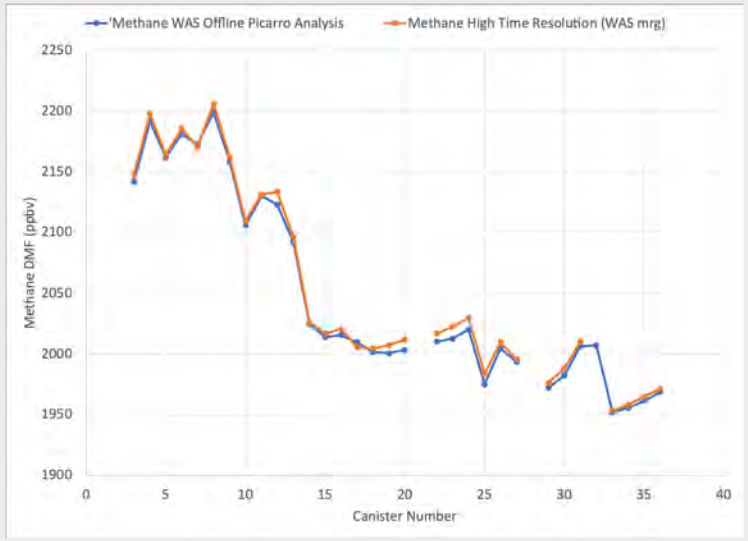



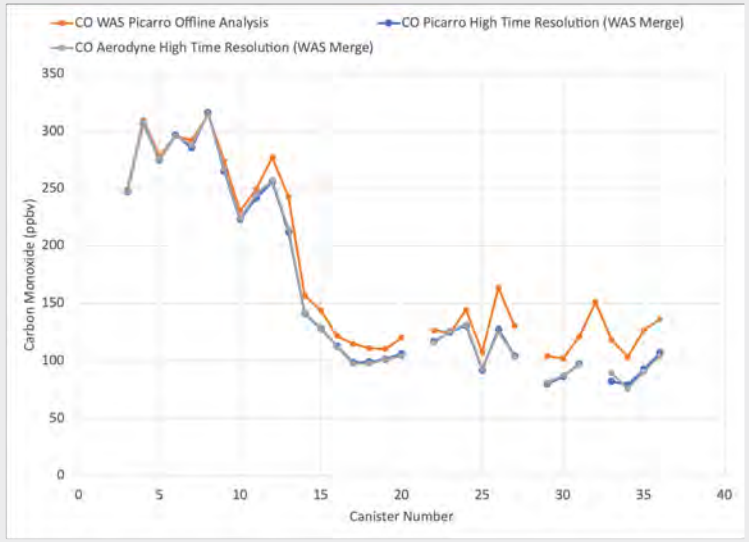

Vertical profiles of methane, carbon dioxide and carbon monoxide:

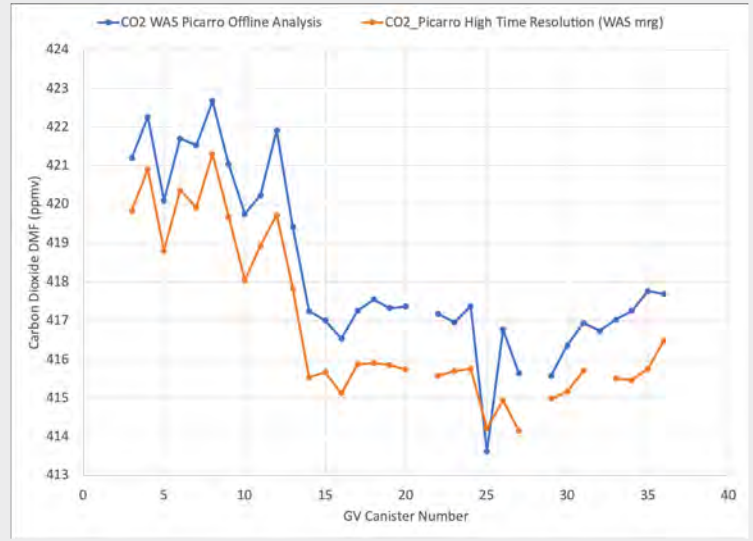
- Red diamonds: WB-57 canister observations
- Aqua circles: WAS merge of G-V high time resolution observations
- Royal blue circled plus markers: G-V canister measurements

G-V canister analyses provided a means of method evaluation

# Quality Assessment




Signals are highly correlated

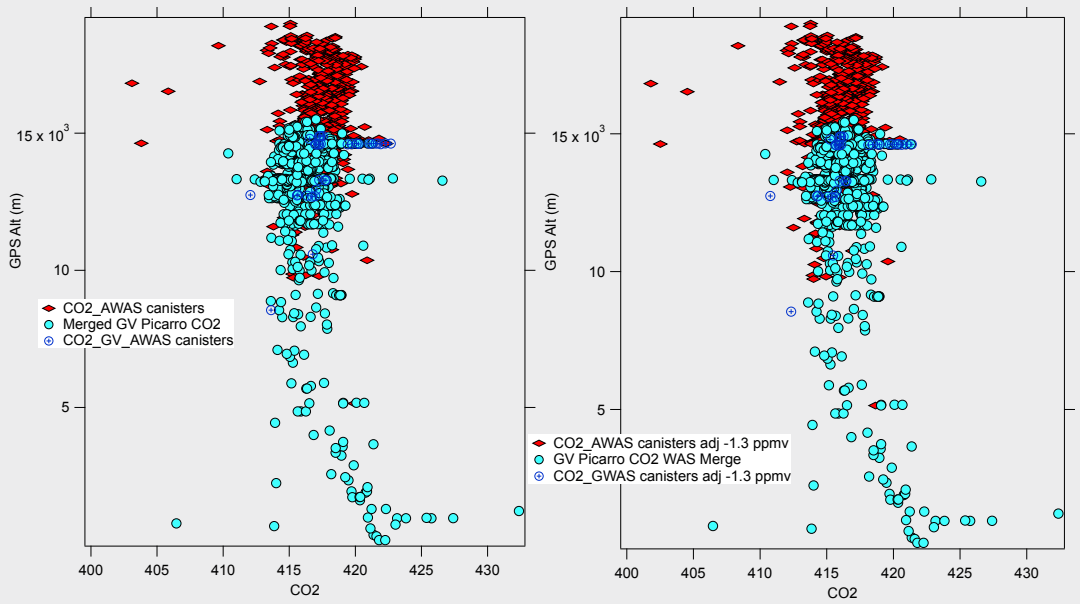
Systematic differences were observed for each species measured

Differences are independent of RH, Picarro cavity P, and Concentration measured

Each has a constant offset of varying magnitude

| | $CO_2$ (µmol/mol) | CO (nmol/mol) | Methane (nmol/mol) |
|---|---|---|---|
| Mean Diff | -1.4 | -2.1 | -4.4 |
| Std | 0.5 | 18.8 | 3.3 |
| Min | -2.2 | -38.4 | -10.4 |
| Max | 0.6 | 27.9 | 4.0 |

# Quality Assessment

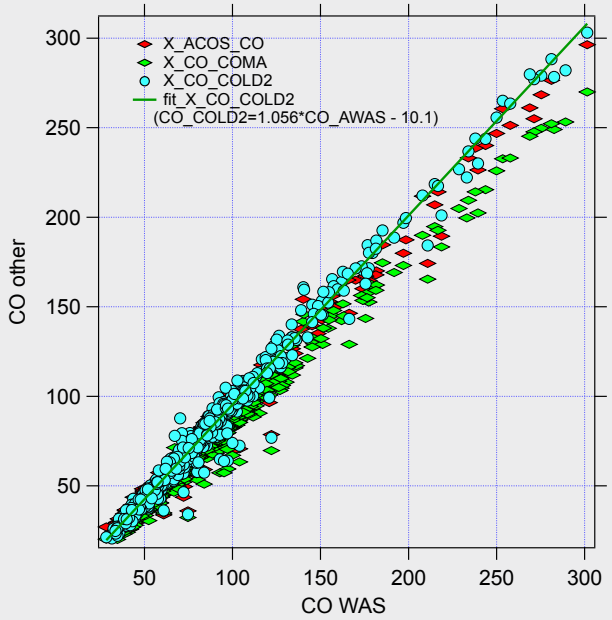



A closer look at CO2 data quality:

Plots above show the impact of applying a -1.3 ppmv shift on $CO_2$ agreement

GV and WB offsets cannot be assumed or expected to be the same

WB-57 measured CO2 < 410 ppmv: likely a problem with these measurements




Reasonably favorable intercomparison between WB-57 canister CO and three WB-57 high temporal resolution CO instruments.

***COLD2 team: Silvia Viciani, Giovanni Bianchini, and Francesco D'Amato***
***ACOS team: Colin Gurganus***
***COMA team: Laura Iraci, Jim Podolski, Emma Yates***

# Summary

- The NCAR Picarro G2401-mc instrument was configured to quantify methane, carbon monoxide and carbon dioxide dry mole fractions within the ACCLIP WB-57 Whole Air Sampler canisters.
- Select GV canisters were also analyzed to provide method evaluation.
- GV canister and high temporal resolution $CH_4$ and CO measurements agree within a few ppbv on average with modest precision reduction.
- WB-57 canister and continuous measurements of CO show reasonably good agreement.
- Carbon dioxide WAS measurements track well, but exhibit a significant offset from GV high resolution observations. The offset is independent of humidity, pressure and $CO_2$ concentration. Estimated overall uncertainty of $CO_2$ observations by this method is therefore estimated at ±1.5 ppmv.
- Validated offline WB-57 WAS canister $CH_4$ have been added to the ACCLIP data archive.