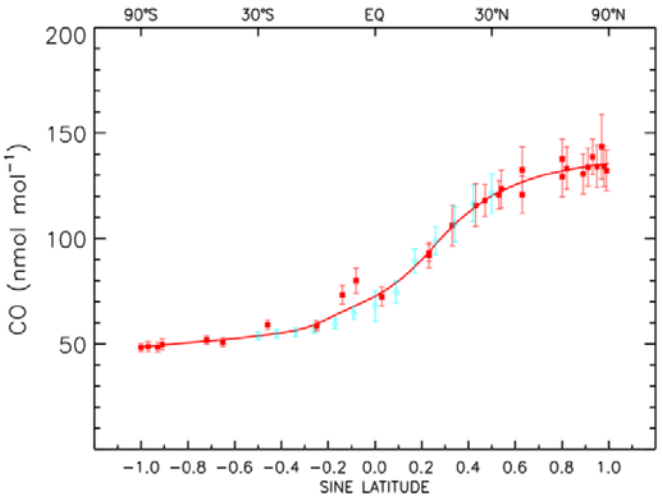

Average Annual CO vs. Latitude

(coastal, island, and ship-borne data)

http://www.esrl.noaa.gov/gmd/ccgg/flask.html

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Measuring CO, CH_4, CO_2 & H_2O in A Single Instrument; Using New CRDS Technology to Characterize Urban Plumes & the Well-Mixed Atmosphere

Gloria Jacobson, Eric Crosson, Chris Rella,

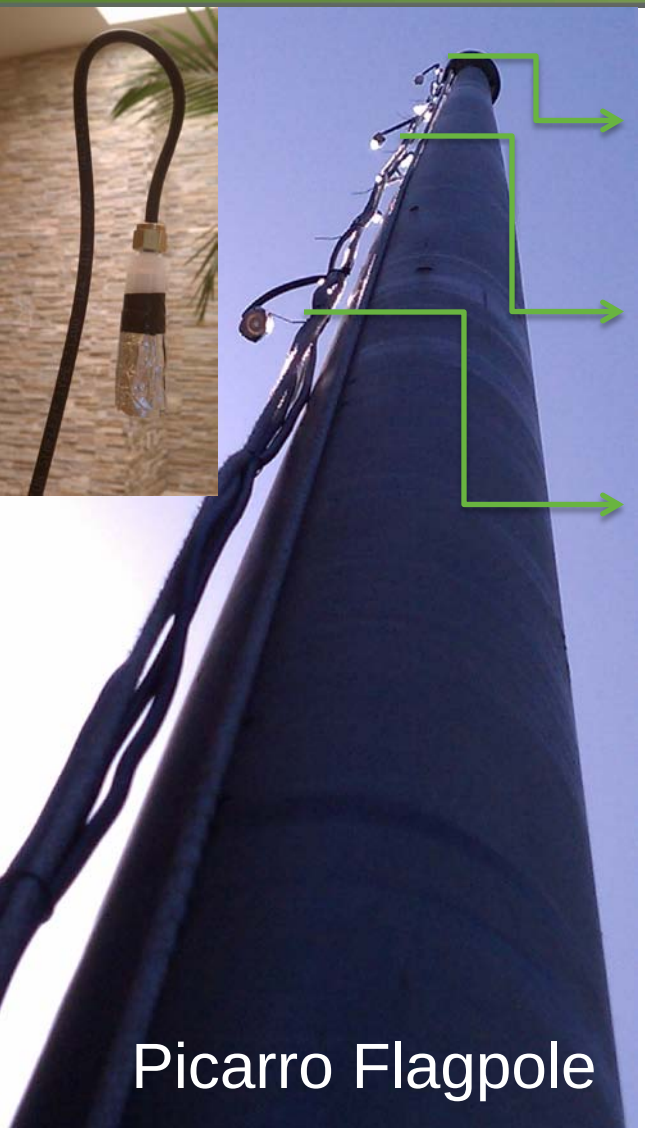
Picarro Inc., 3105 Patrick Henry Drive, Santa Clara California 95054 USA

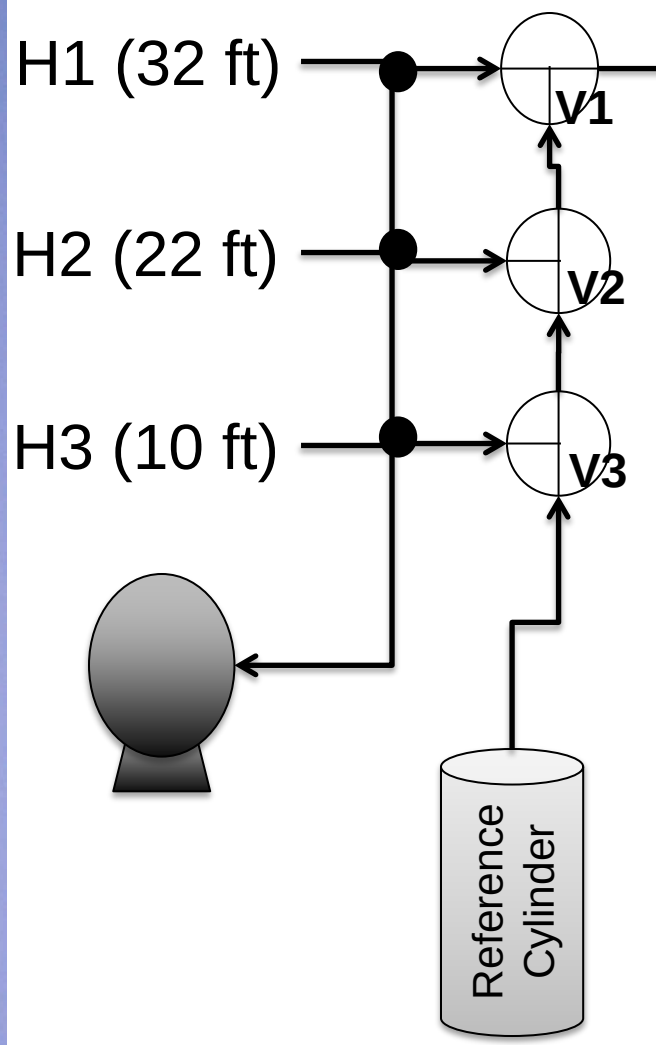
Experiment Motivation

- What information can be gained from “rooftop” (10m or lower) measurements made in dense urban settings?

- In particular,
  a) Do nearby sources (e.g, vehicles) dominate the measurements?
  b) Can you partition anthropogenic and biogenic emissions of CO_2 using measurements of CO?
  c) Can you quantify source locations and/or temporal behavior?

Experimental Set Up





4 Species Analyzer
CO, CO_2, CH_4, H_2O

4- Species Analyzer

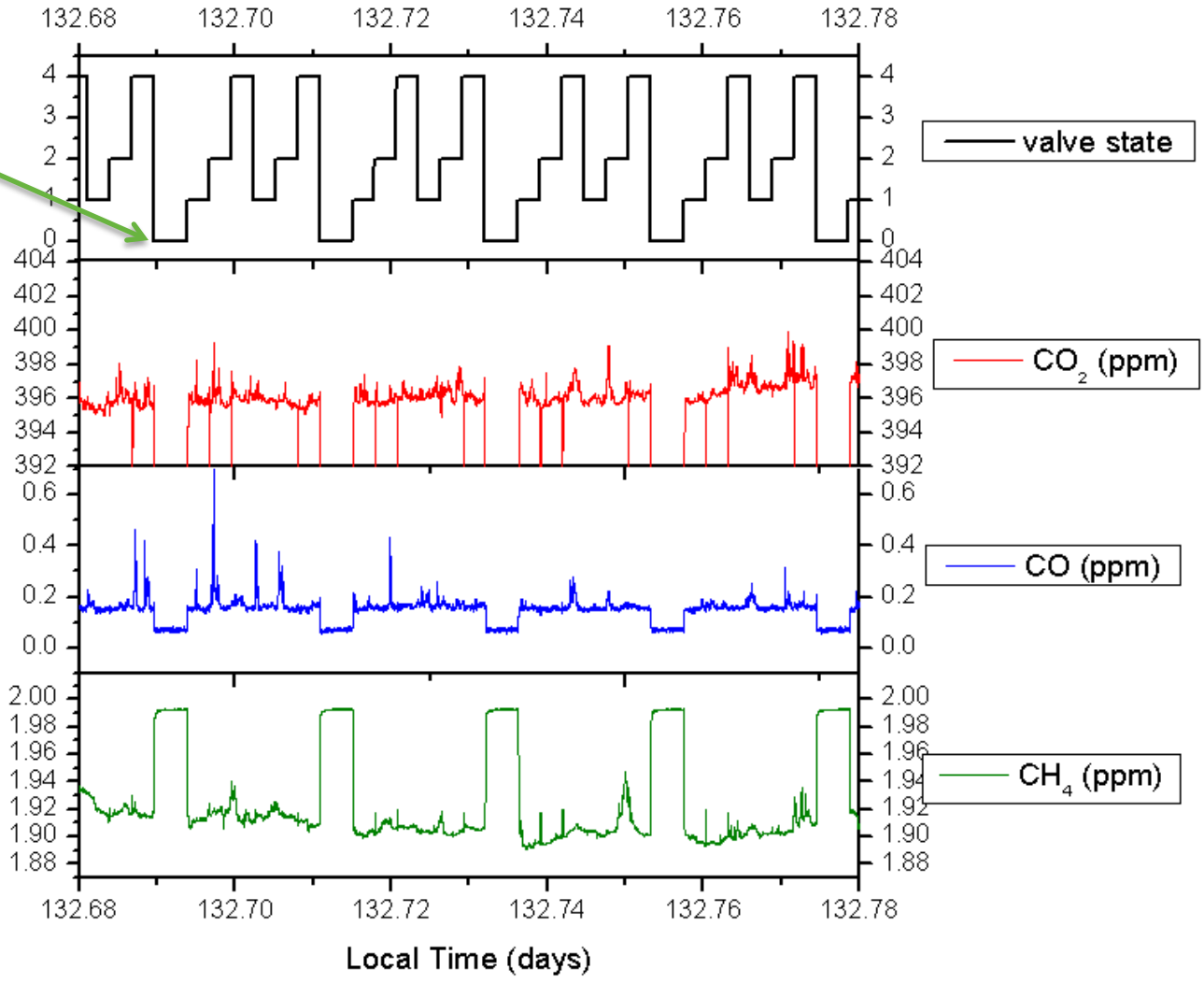
- Measures concentrations of CO, CO_2, CH_4, & H_2O
- Measures all 4 species w/in 5 seconds
- Meets precision spec (1-sigma of 5 min avg)
  - CO < 2 ppb
  - CO_2 < 50 ppb
  - CH_4 < 0.7 ppb
  - H_2O < 50 ppm
- Automatically corrects & reports dry mol fraction
- Instrument was calibrated once prior to experiment

Zoom In on Time Series

Sampling Scheme

1. Bottle (6 min)
2. H1 (4 min)
3. H2 (4 min)
4. H3 (4 min)
5. H1 (4 min)
6. H2 (4 min)
7. H3 (4 min)
8. Repeat

Total Cycle = 30 min



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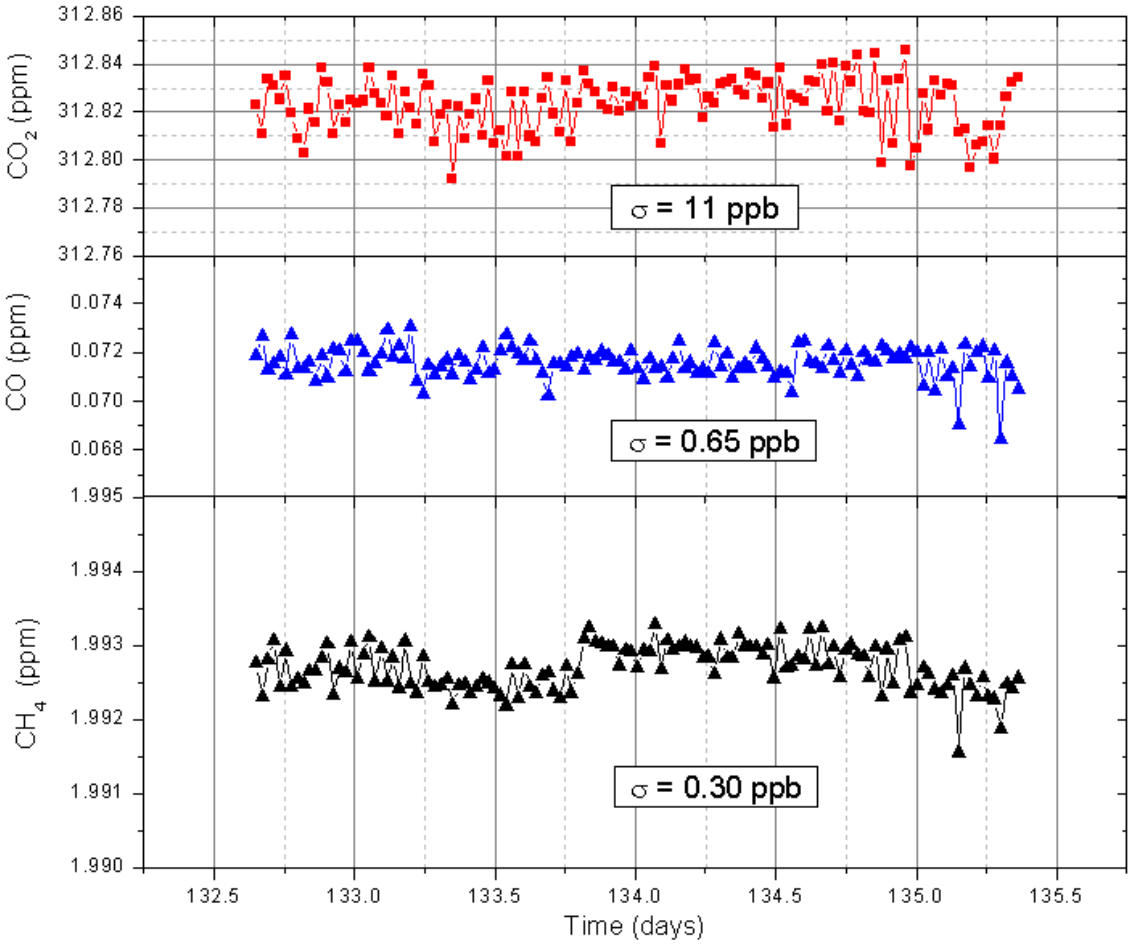
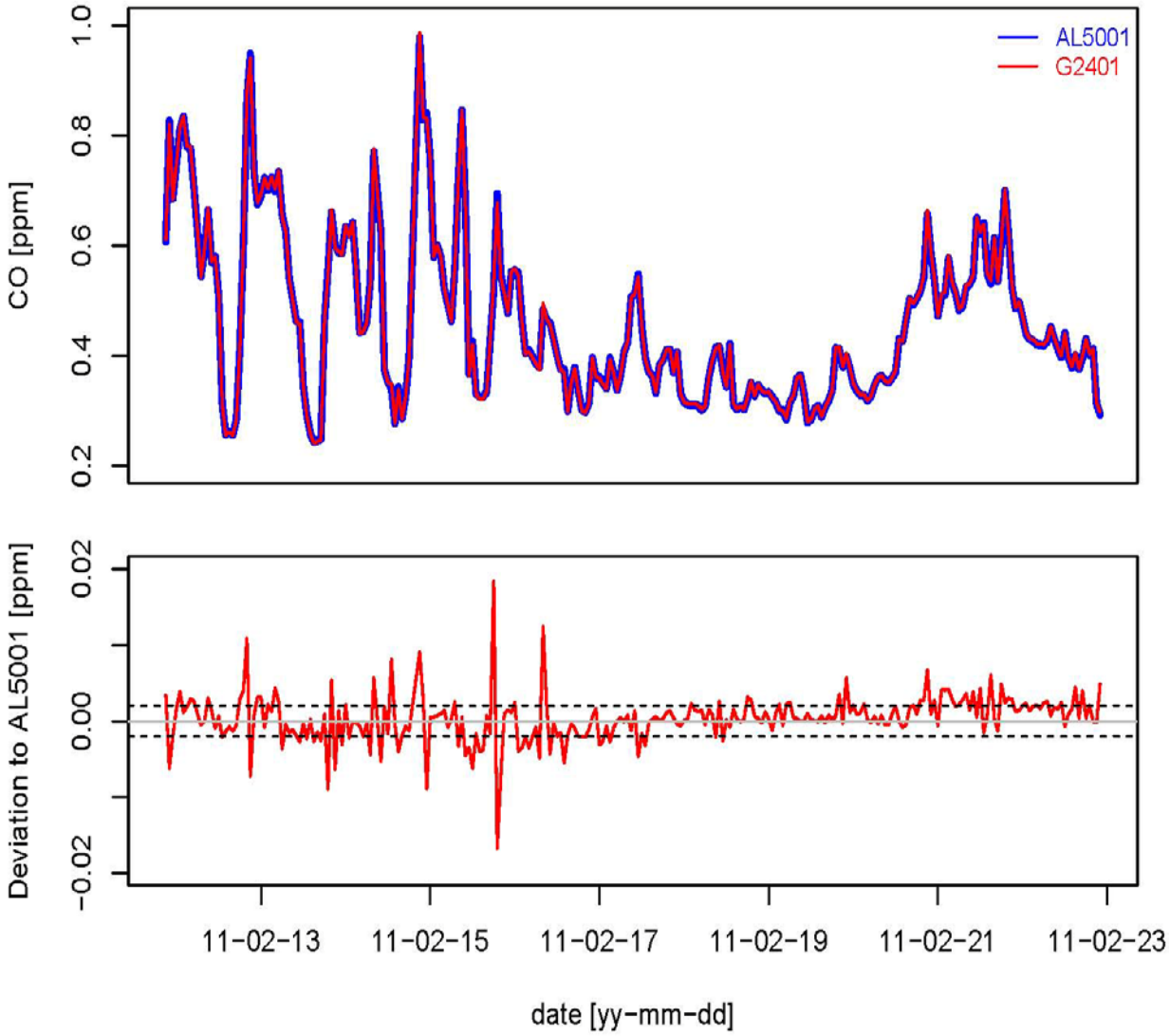
Bottle Data – Instrument Stability

- Single bottle measured 6 minutes every ½ hour
- Used only for quality control – no calibration changes



Instrument Validation Testing



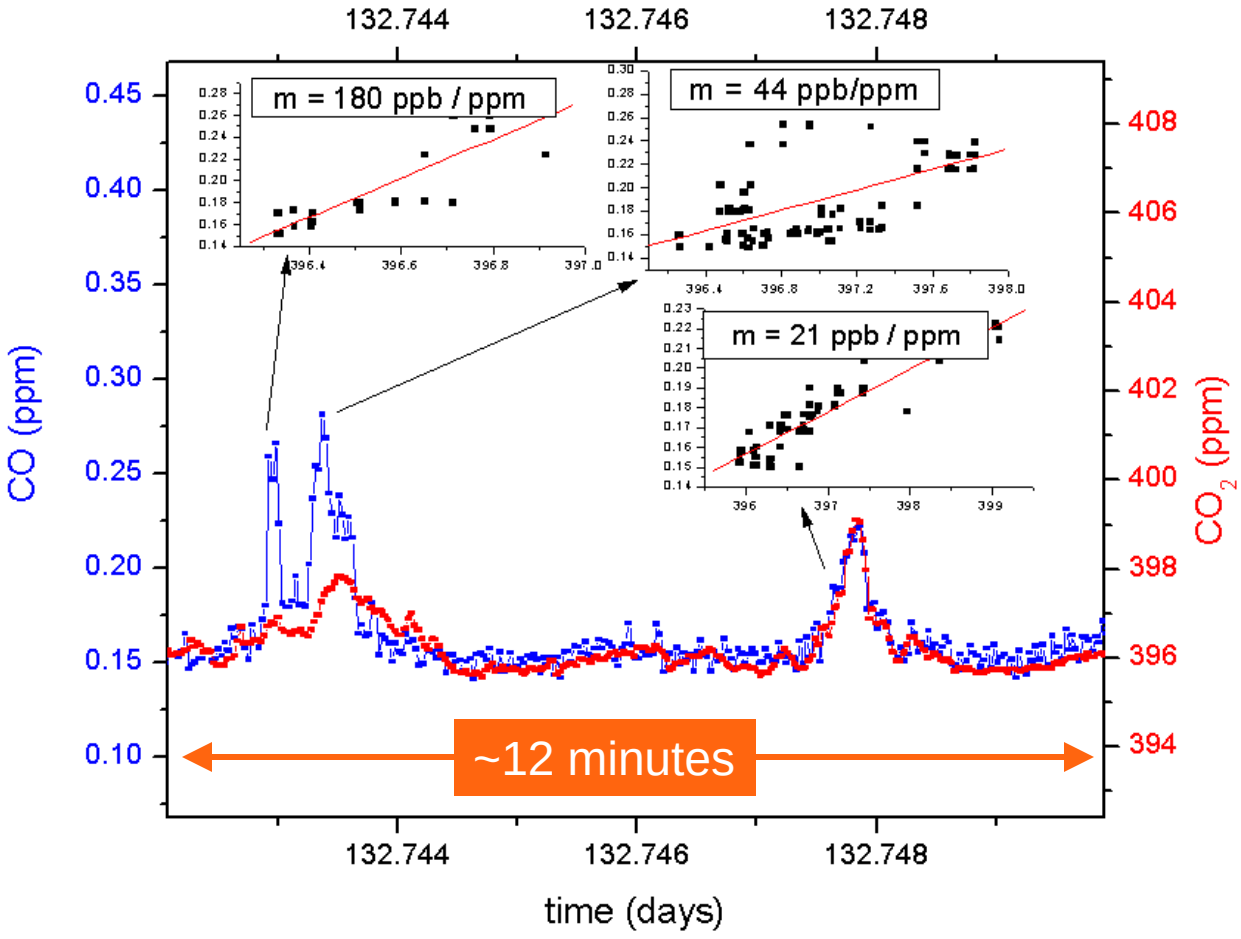
Instrument Calibration

- AL5001: 1 every 2 hrs
- G2401: Once / 10 days

*Data courtesy of Christoph Zellweger, EMPA

Drive-by Events

- Raw data from all heights is shown
- CO/CO_2 plots of individual CO peaks have distinct signatures
- Looks like single and multi-car drive-bys are captured



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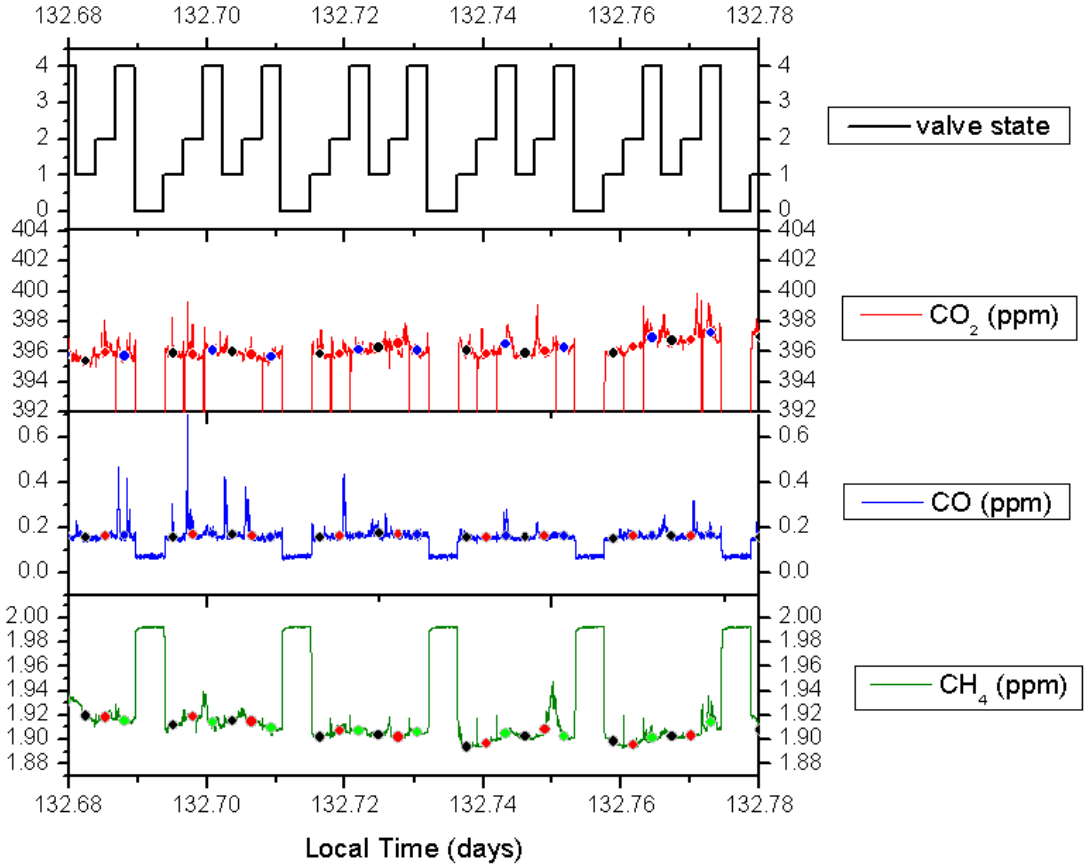
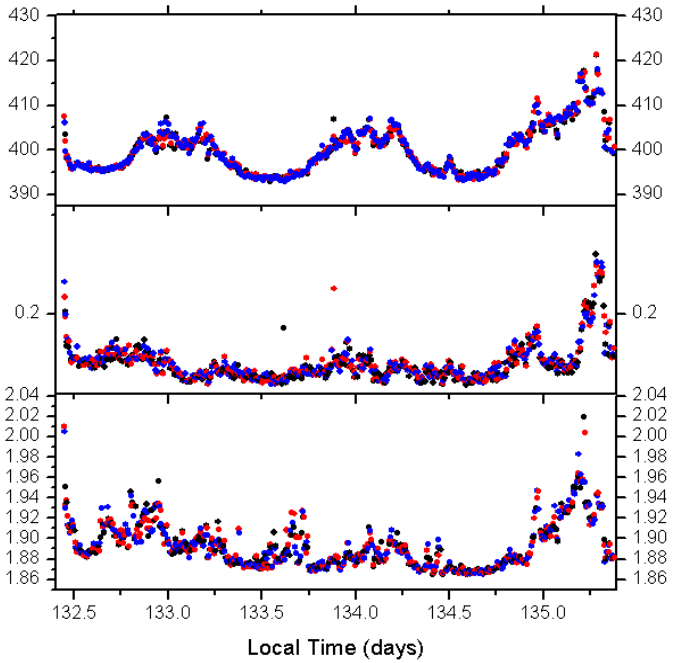
Vertical Profile of Median Data



High
Medium
Low



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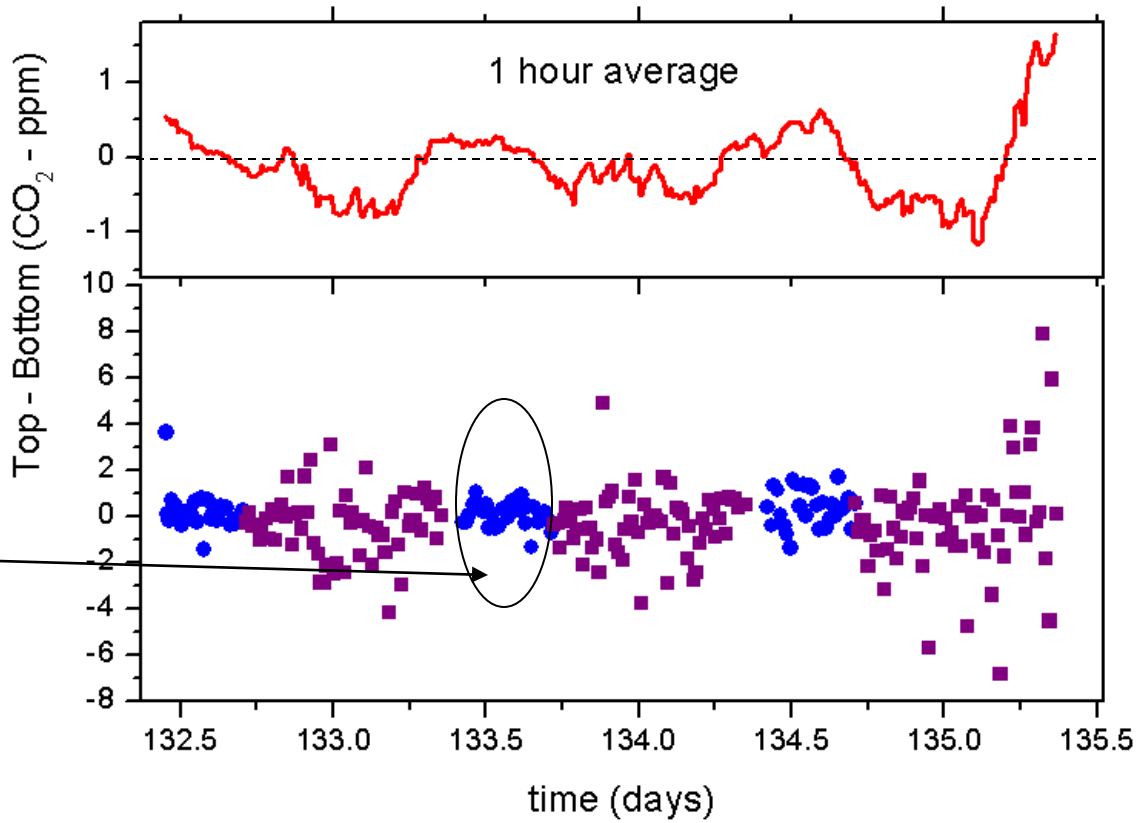
Well-Mixed During Daytime

- Small vertical gradient of about 0.1 ppm / meter in CO_2 observed at nighttime
- Overall difference between top and bottom std. dev = 1.6 ppm
- Daytime CO_2 std. dev = 0.7 ppm
- Daytime CO std. dev = 7 ppb



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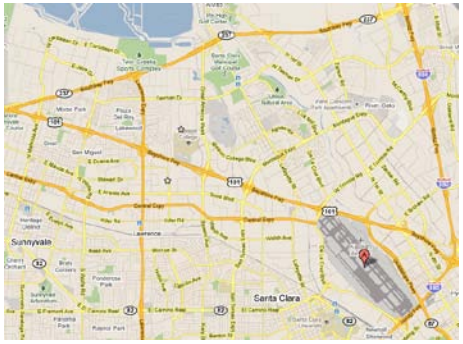
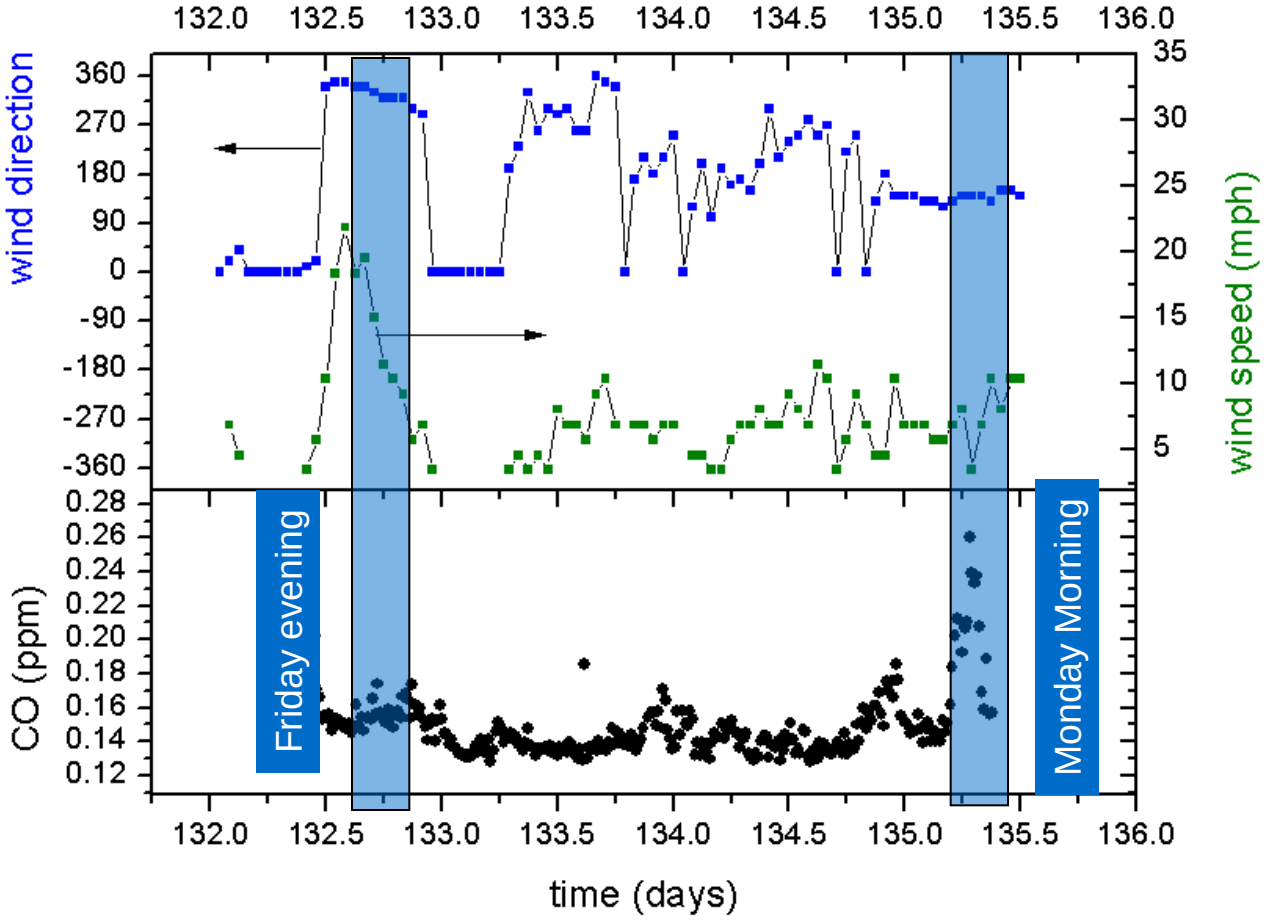
Do The Time Signatures Make Sense?

- CO signatures from transit convolved with atmospheric transport
- Wind speed accounts for some of the difference
- PBL and direction may account for the rest…





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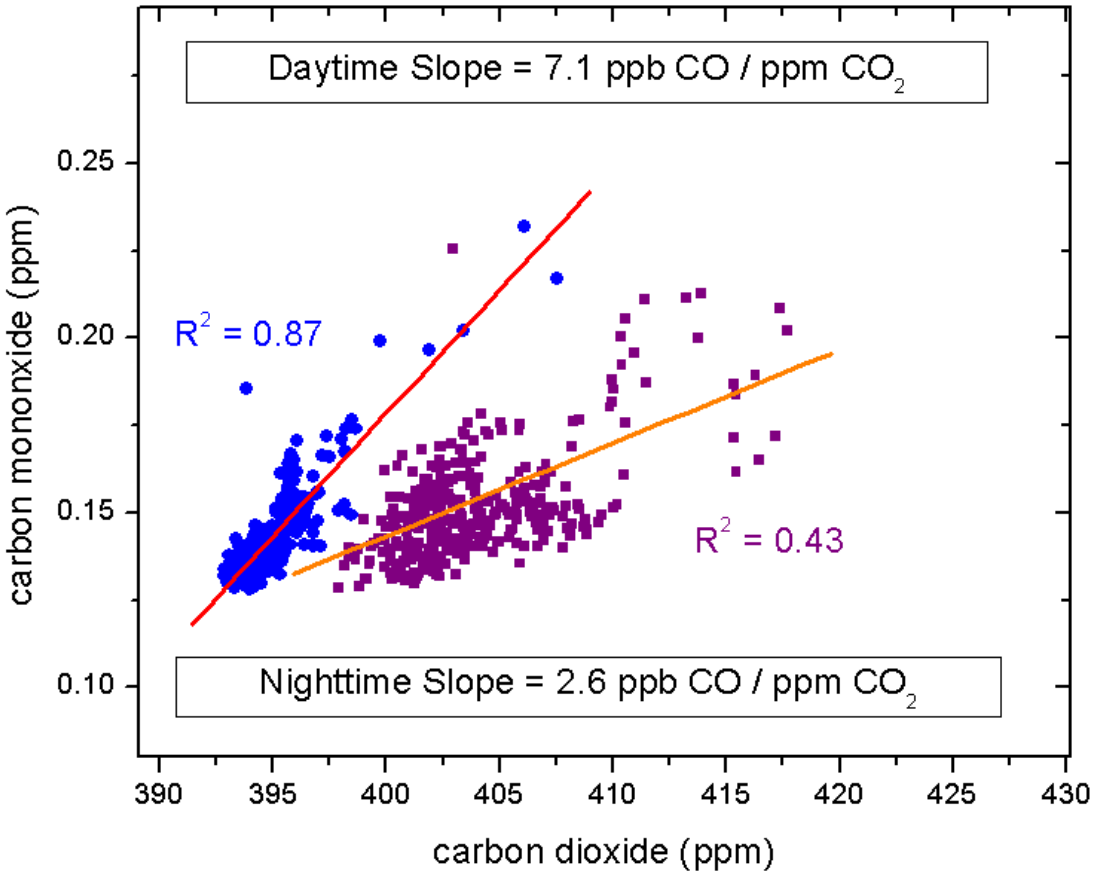
Wind data: www.wunderground.com @ SJC Airport

Emissions Sources

- Daytime should have clearest transit signal - high traffic and relatively low biogenic activity due to cold, 50 F temps and overcast
- Nighttime has mixed transit and biogenic signature



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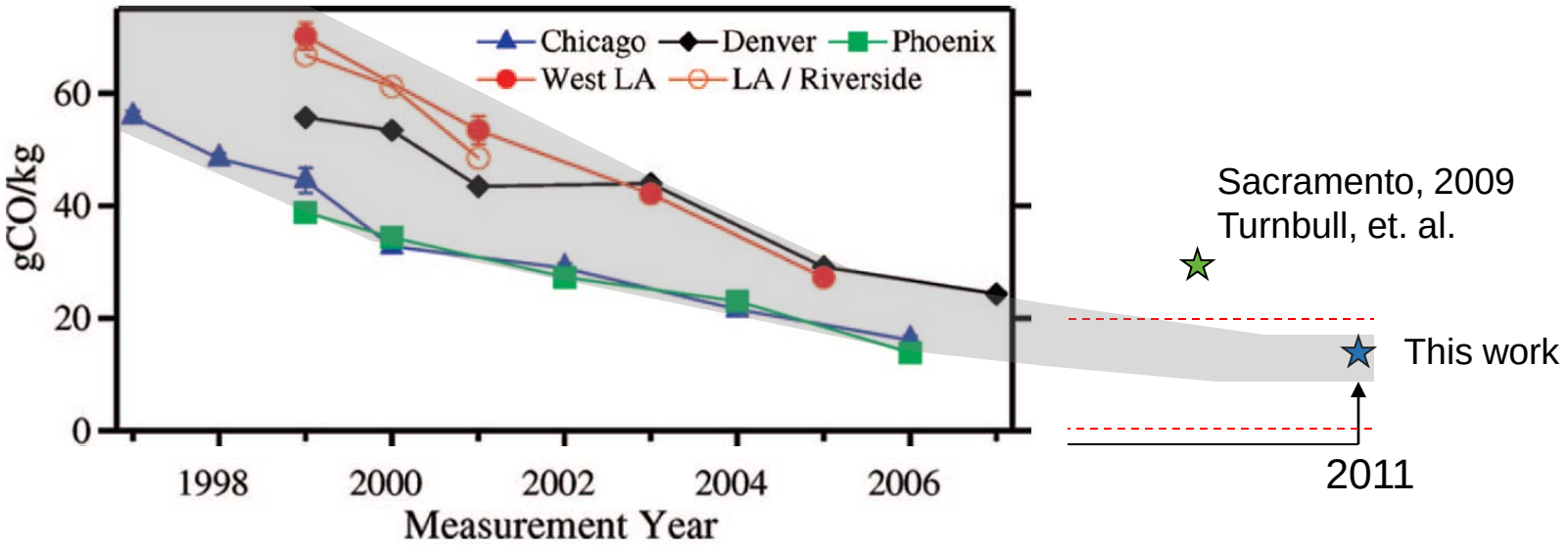
Does This Make Sense?

- Bishop and Steadman (Dec 2007)

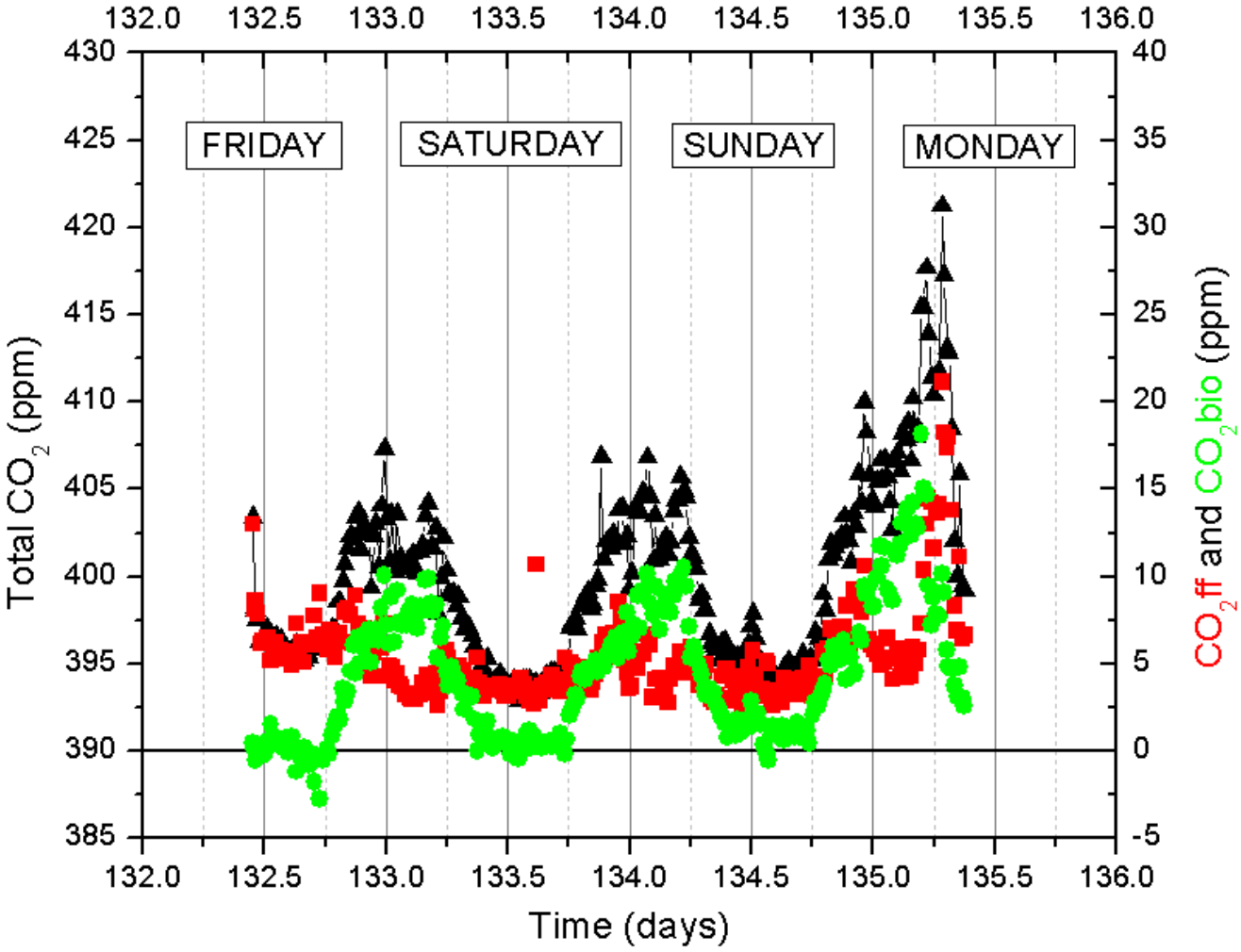


1 gCO/kg fuel = 0.5 ppb CO / ppm CO_2

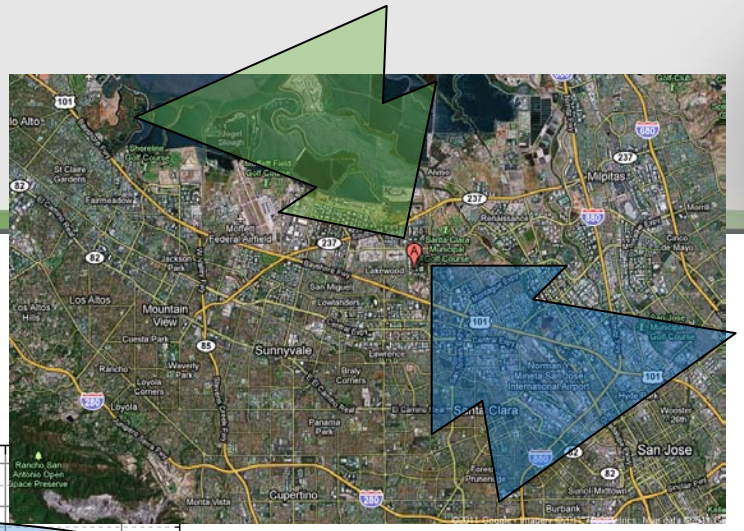
Partitioning Signals

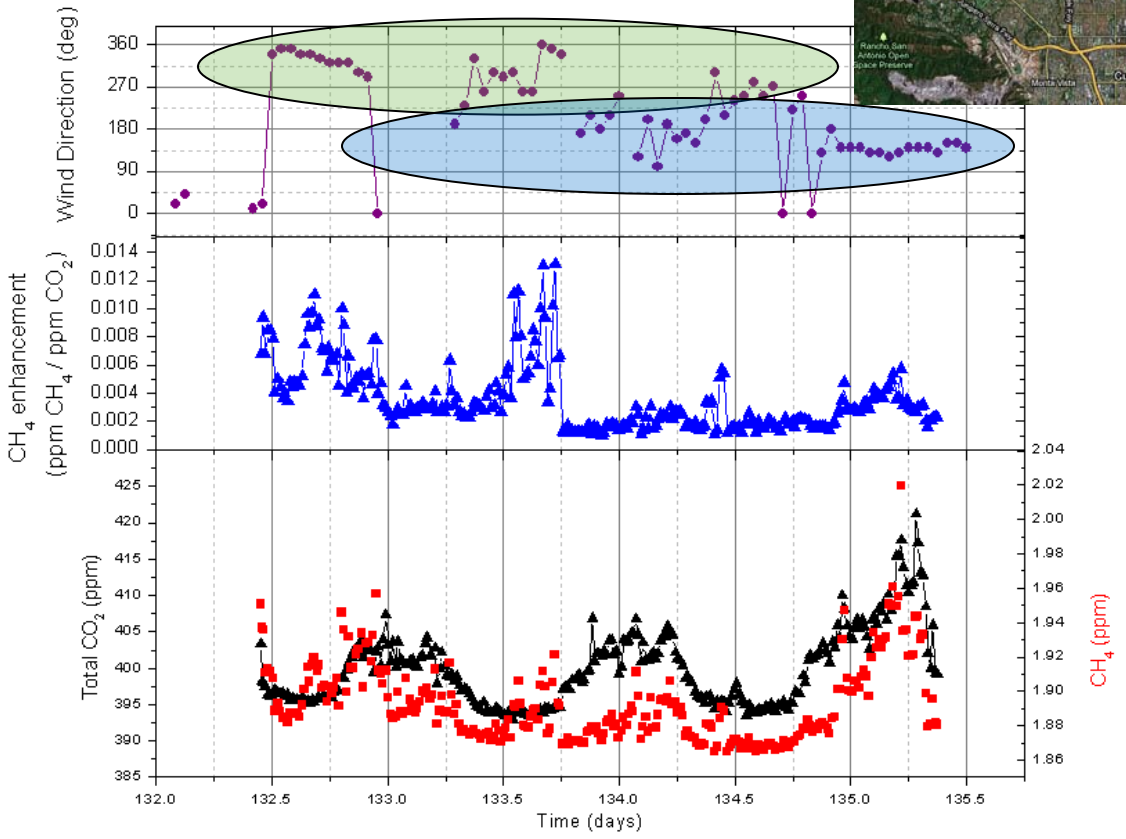
1. Calc CO_2 ff using CO / ppm CO_2 = 7.1 ppb and background values of CO=110 ppb & CO_2 = 390 ppm

2. Subtract CO_2 ff from total to get CO_2 bio



Methane





- CH4 'enhancement' strongly dependent on wind direction
- Strong source to the NW (known sources: active and inactive landfills, wetlands)
- Uses background of 1.86 ppm for CH_4 and 390 ppm for CO_2

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Next Steps

- Longer term data to confirm traffic signatures
  - Add traffic volume data
- Use simple inverse modeling to locate emission sources
  - Add PBL
- Add a web cam for verification of traffic events

– Thank You! –


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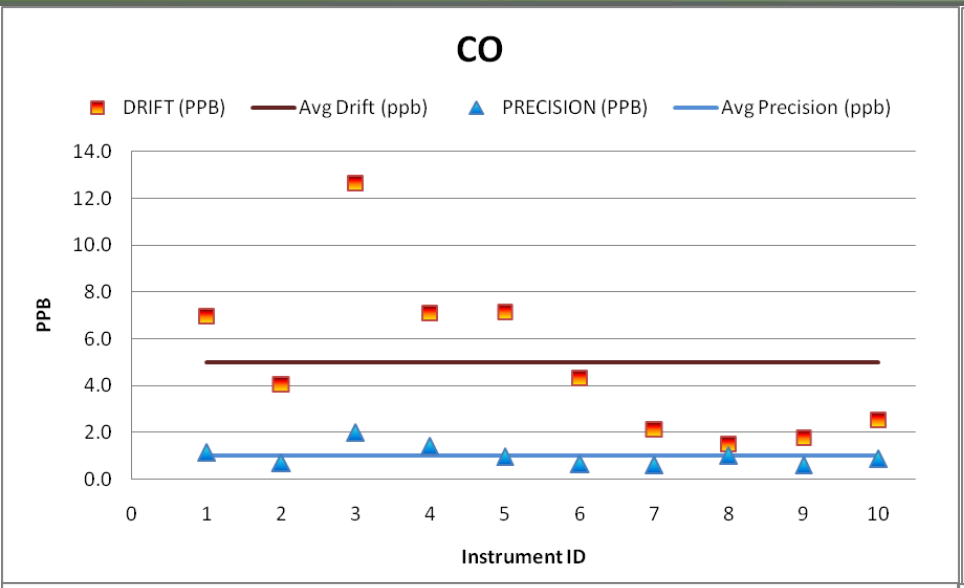
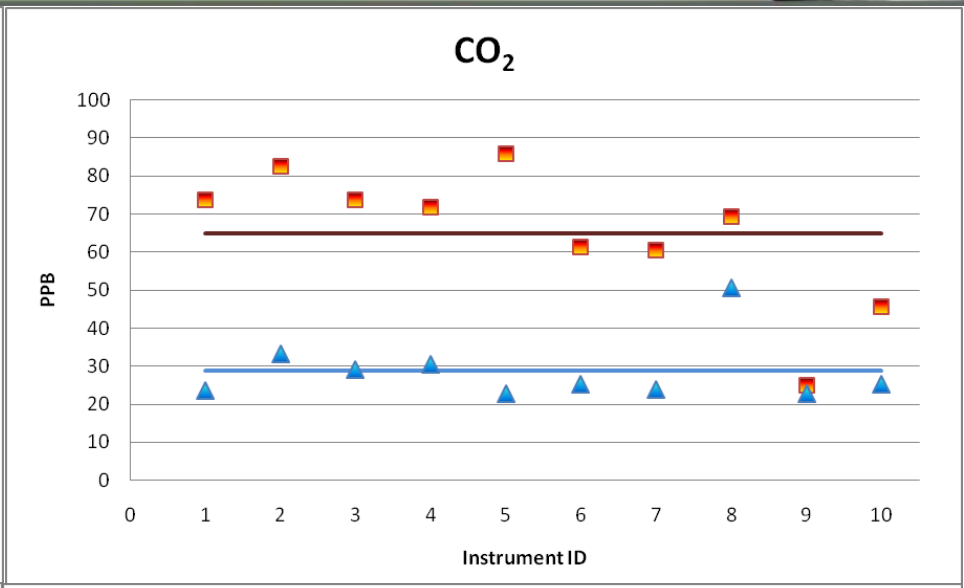
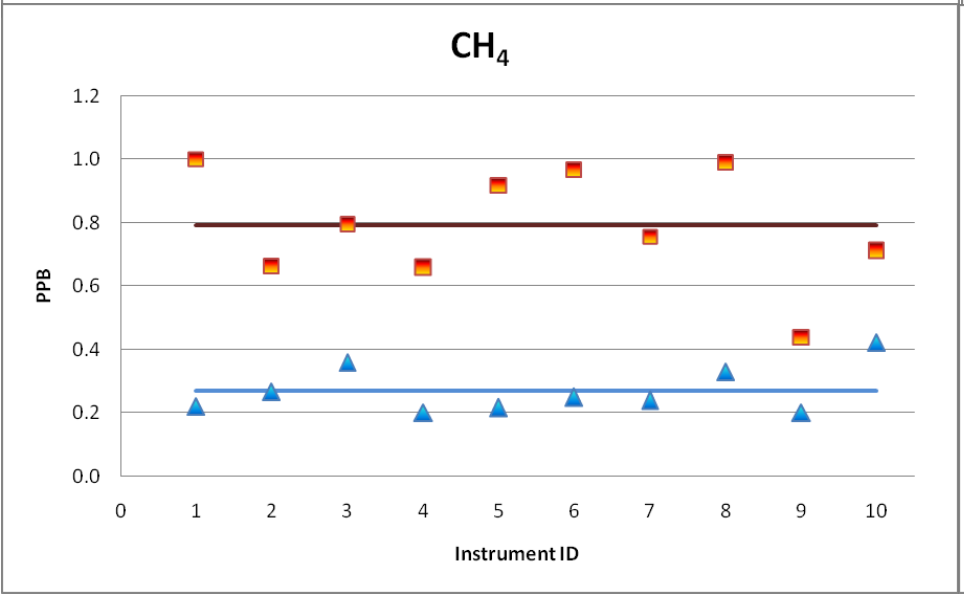
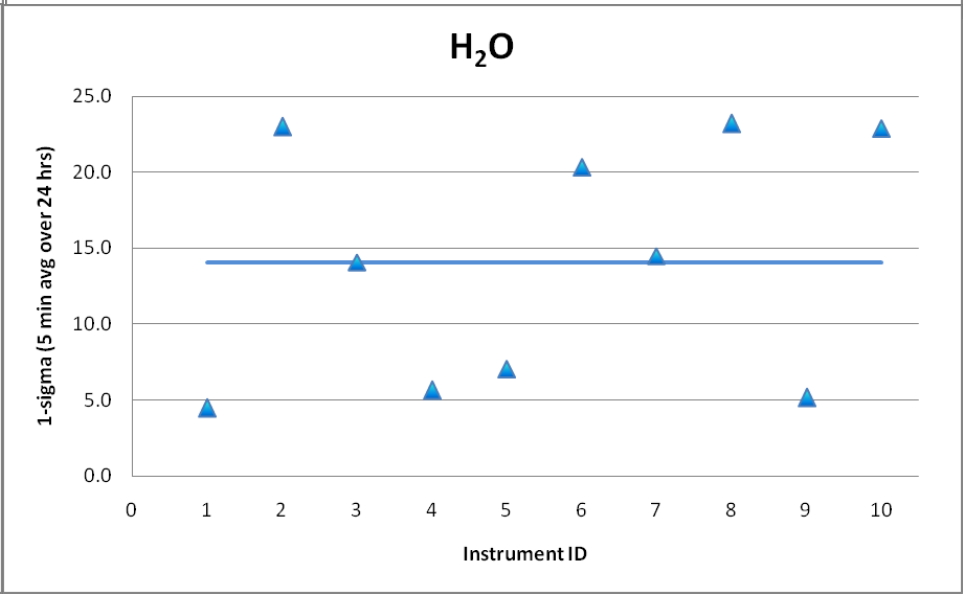
CO_2
CO
CH_4
H_2O

Precision & Drift Testing

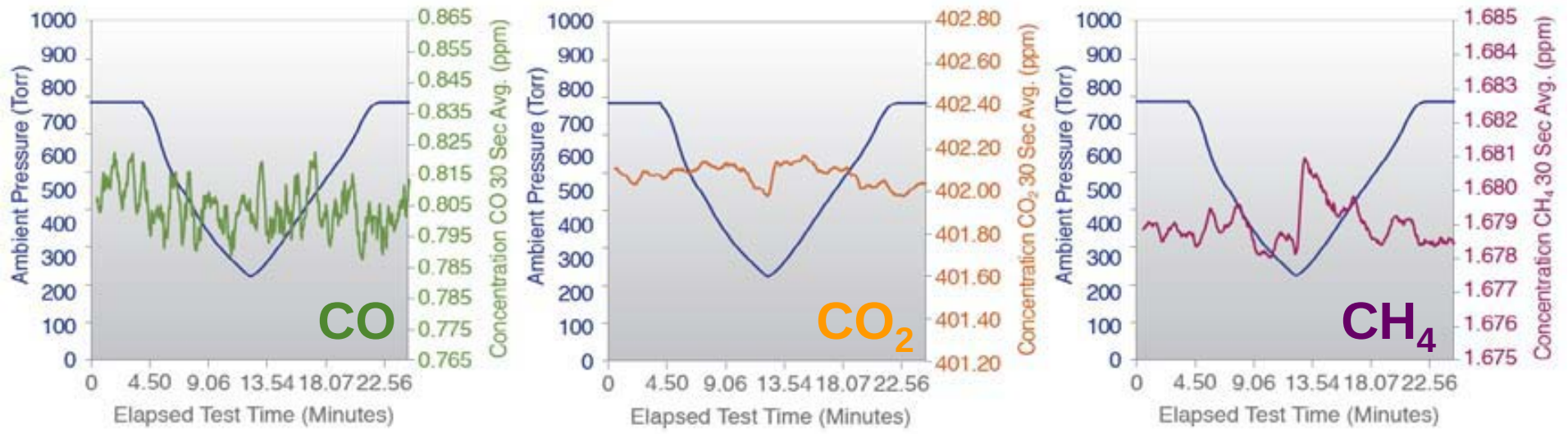








Flight Simulation Test



Drift specs with changing pressure up to 1.4 Torr/second, peak to peak of 30 sec avg

< 50 ppb **< 700 ppb** **< 7.5 ppb**

- Analyzer in hyperbaric chamber with pressure ramps (blue)
- Measure constant concentration gas at chamber pressure 30 second avg shown

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Using CO to measure CO_2^{ff}

- **CO** is a better proxy for **fossil fuel CO_2** than excess CO_2