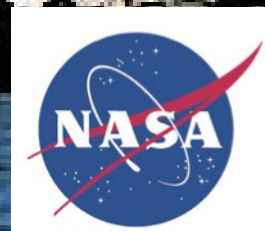


Trace Gas Observations from Small Research Aircraft over the Mid Atlantic States and Hebei, China

Russell R. Dickerson et al.

The University of Maryland

NOAA ESRL Global Monitoring 22 May 2019



Outline

Methods evaluation.

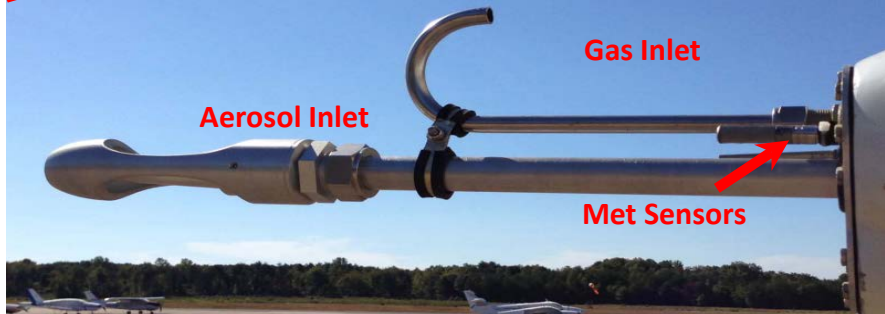
Greenhouse gases in Baltimore/Washington area & Marcellus upwind.

Preliminary results from New York City.

Results for CFCs over Hebei, China.

UMD Cessna 402B Research Aircraft

Heavy lifting: Xinrong Ren



GPS Position (Lat, Long, Altitude)

Met (T, RH, P, wind speed/direction)

Trace gases:

O₃: UV Absorption, modified TECO

SO₂: Pulsed Fluorescence, modified TECO

CH₄/CO₂/CO/H₂O: Cavity Ringdown, Picarro

NO₂: Cavity Ring Down, Los Gatos

NO: Chemiluminescence, modified TECO

HCHO: Fluorescence, NASA

VOCs: whole air samples

Aerosol Optical Properties:

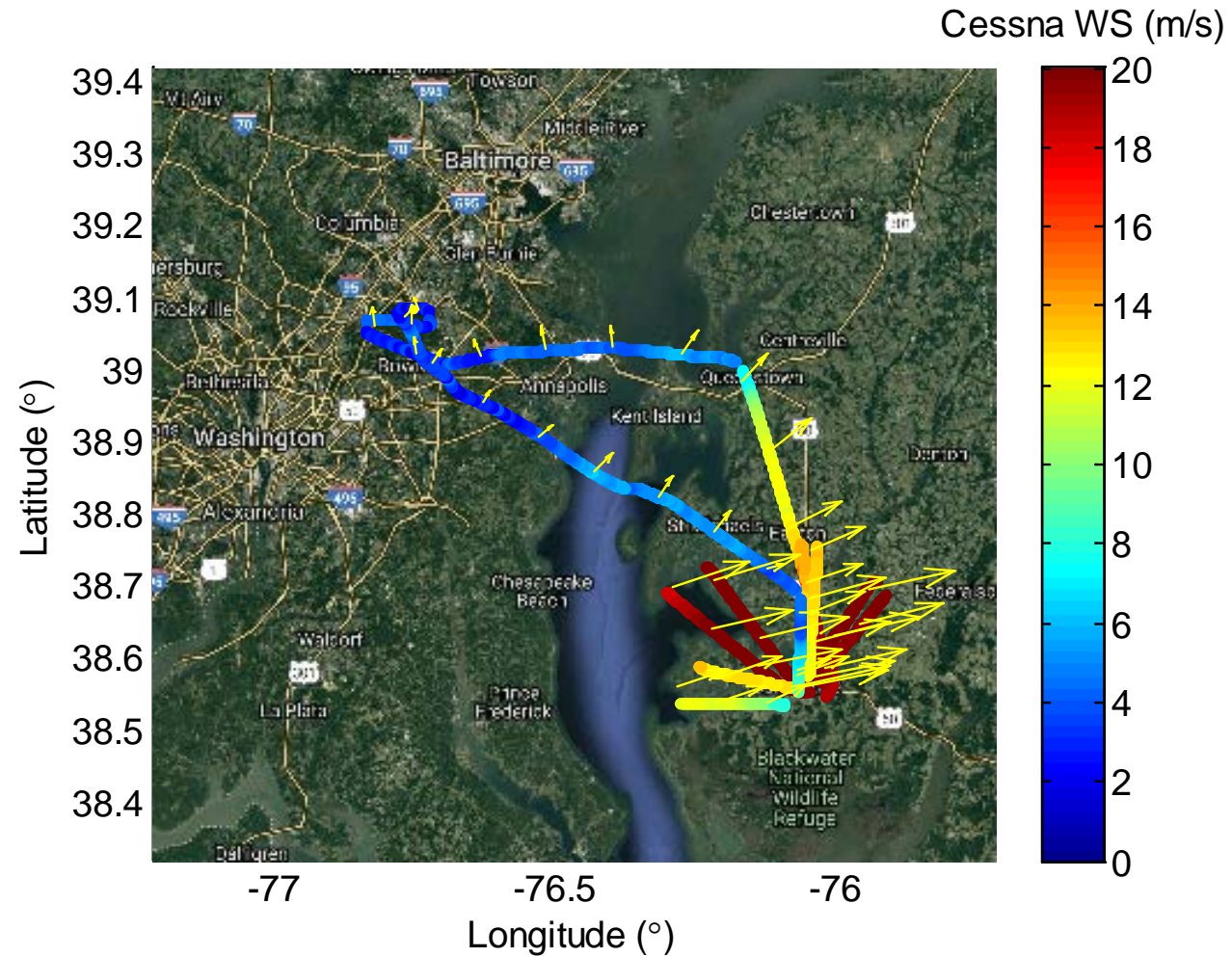
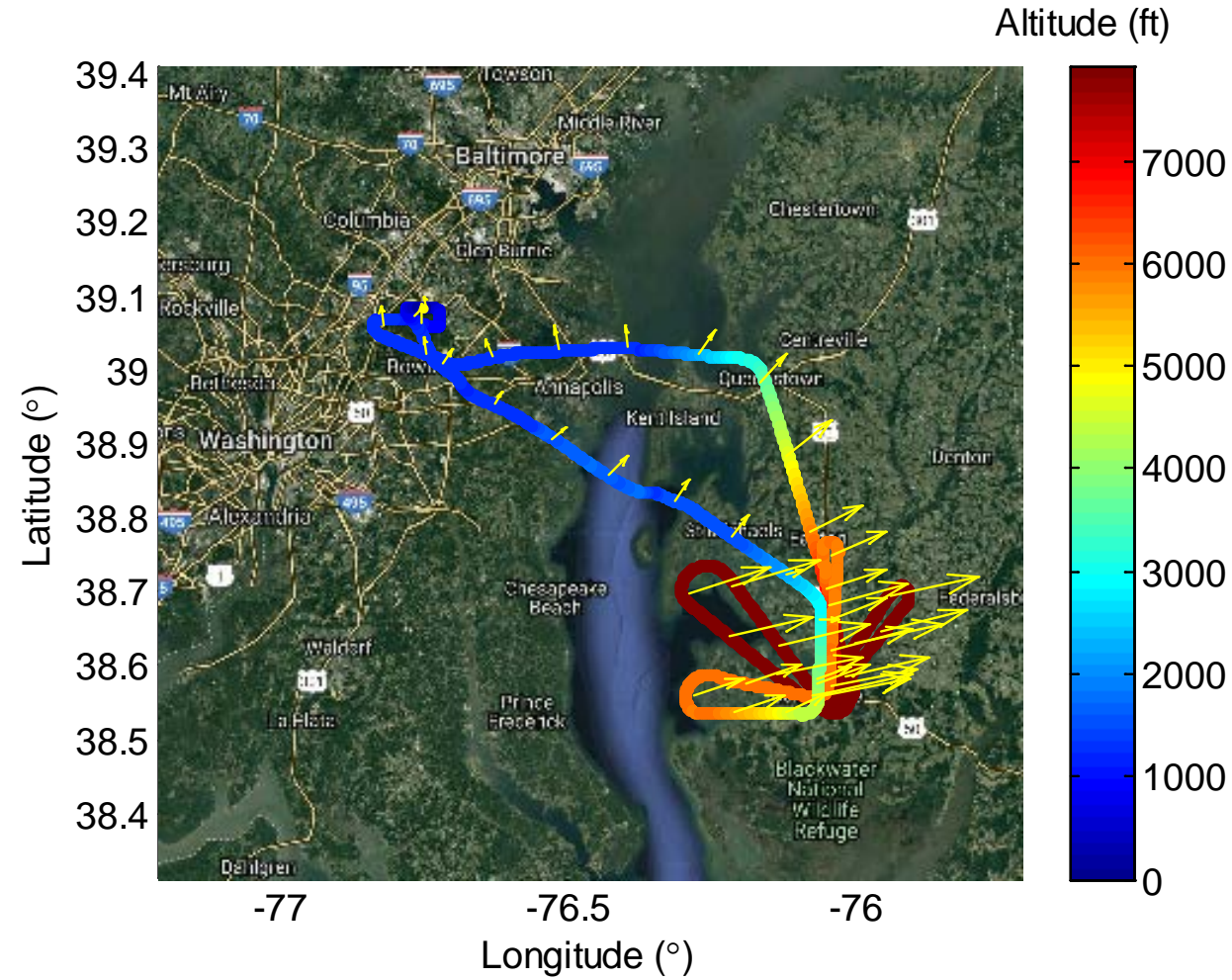
Scattering: b_{scat} (@450, 550, 700 nm),
Nephelometer

Absorption: b_{ap} (565 nm), PSAP

Black Carbon: Aethalometer (370-950 nm)

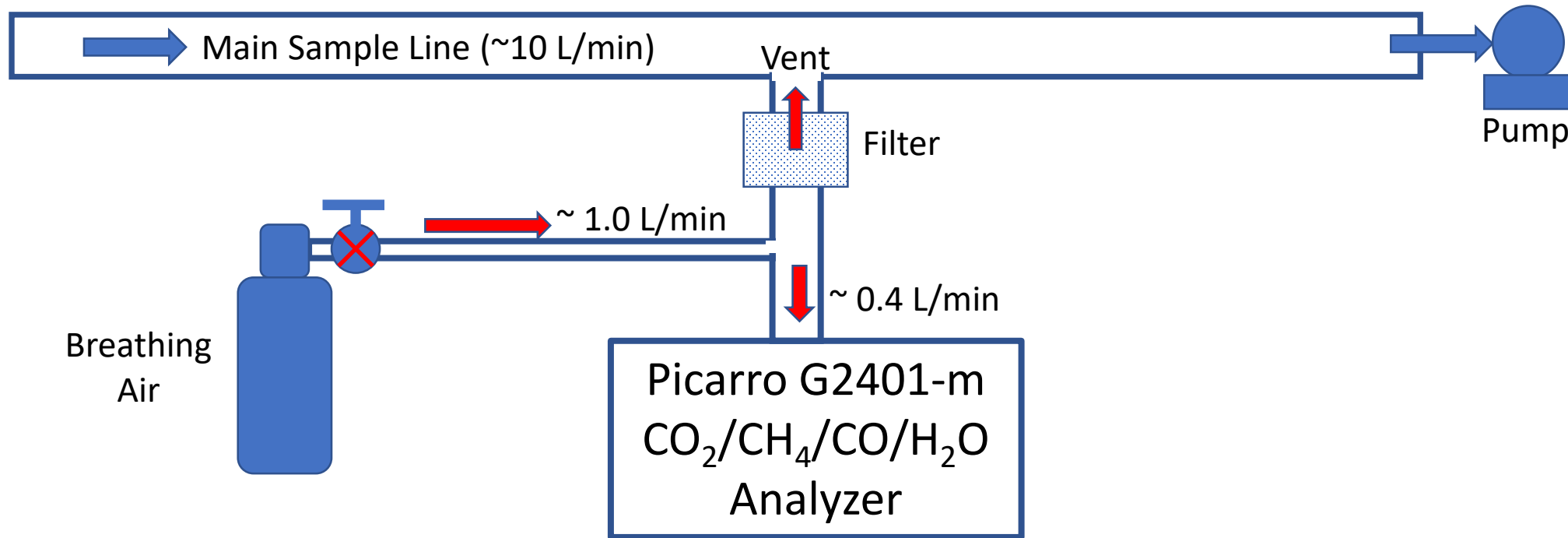
What's our precision? Cessna Test Flight on 2/14/2019

Objectives: Picarro & wind calibration.



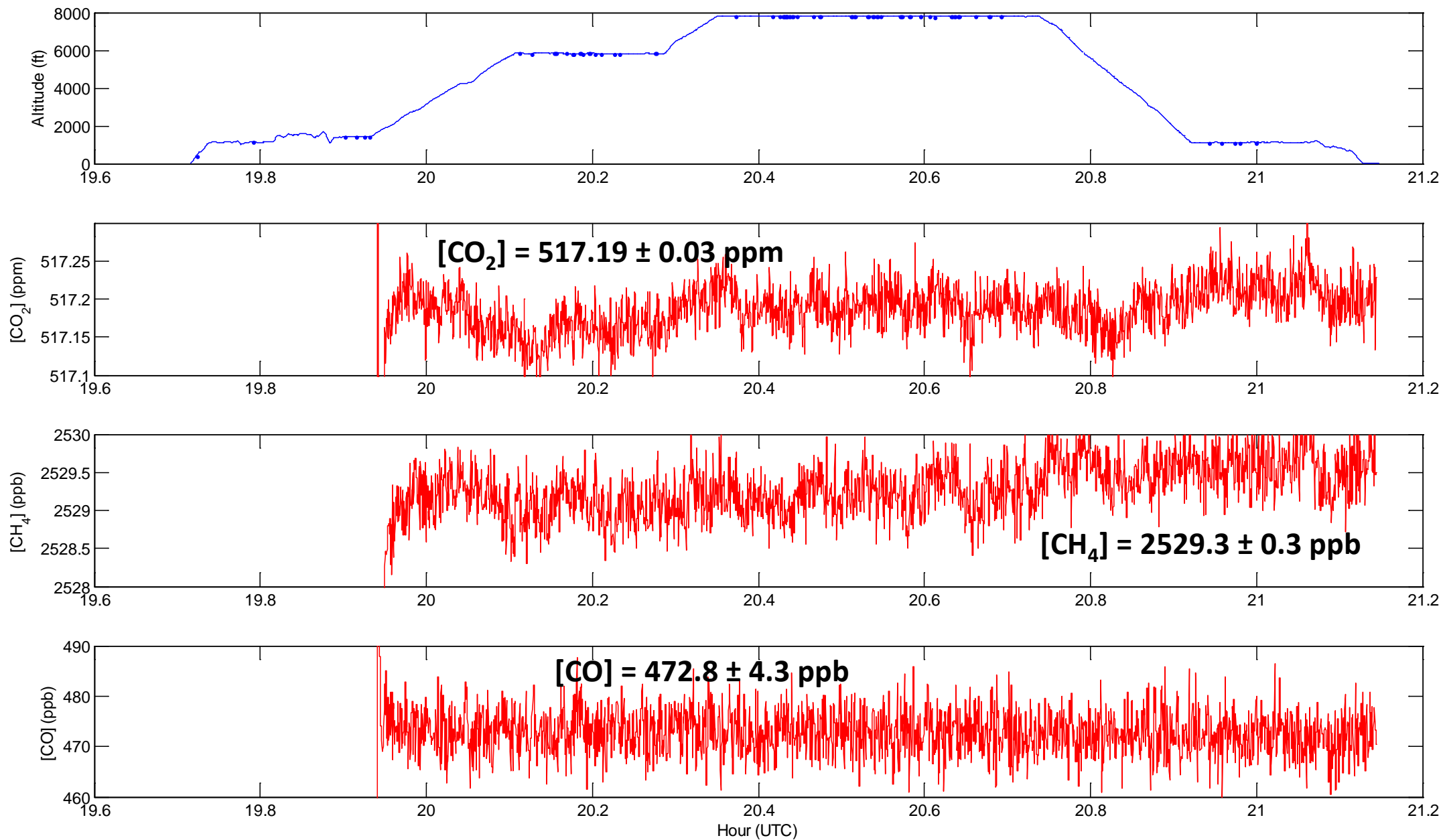
Picarro GHGs Measurement Precision at Altitude

Feed the Picarro analyzer compressed air with constant $[\text{CO}_2]$, $[\text{CH}_4]$, and $[\text{CO}]$.



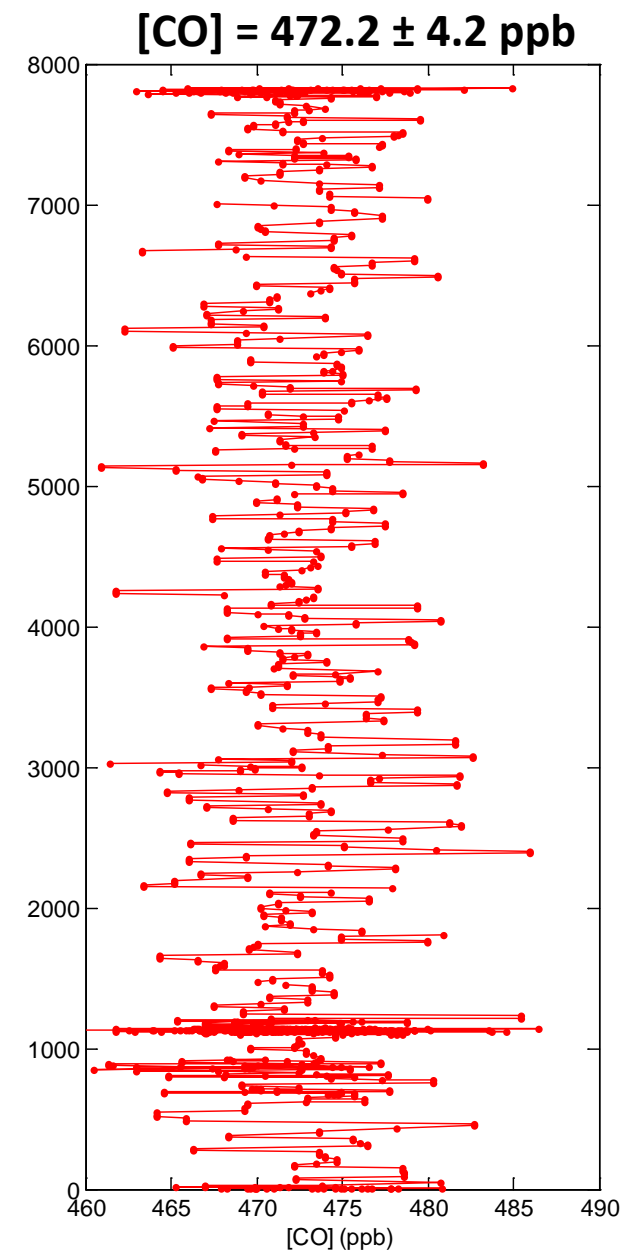
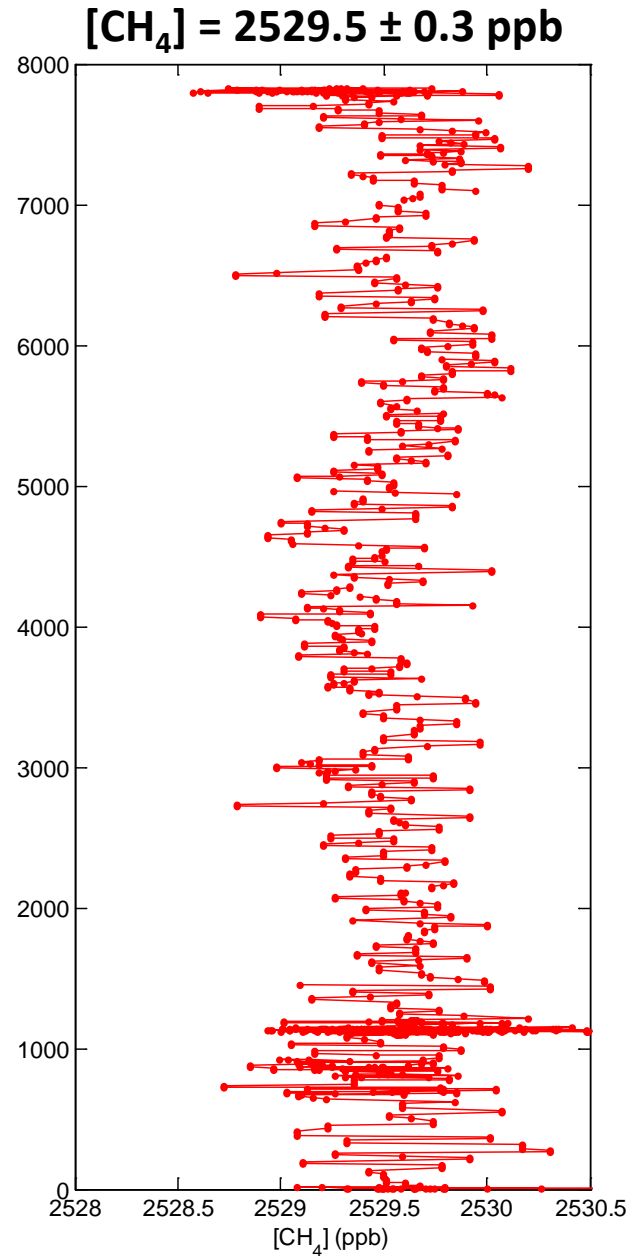
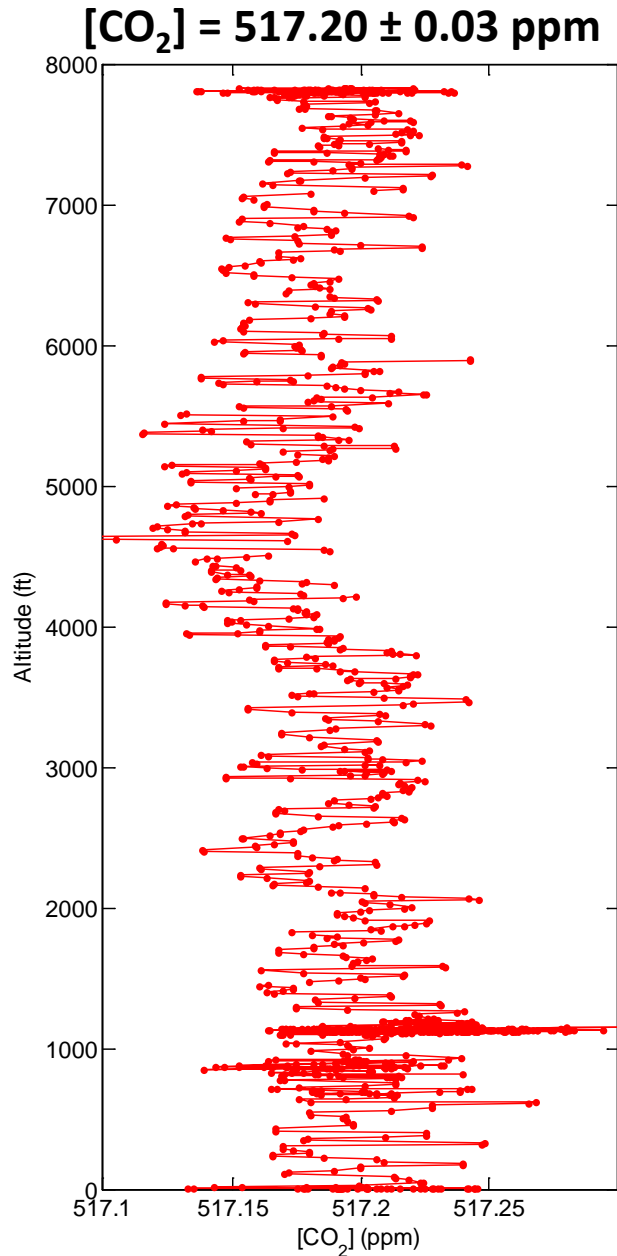
NIST support

Picarro GHG Measurement Altitude Test (1-sec data $\pm \sigma$)

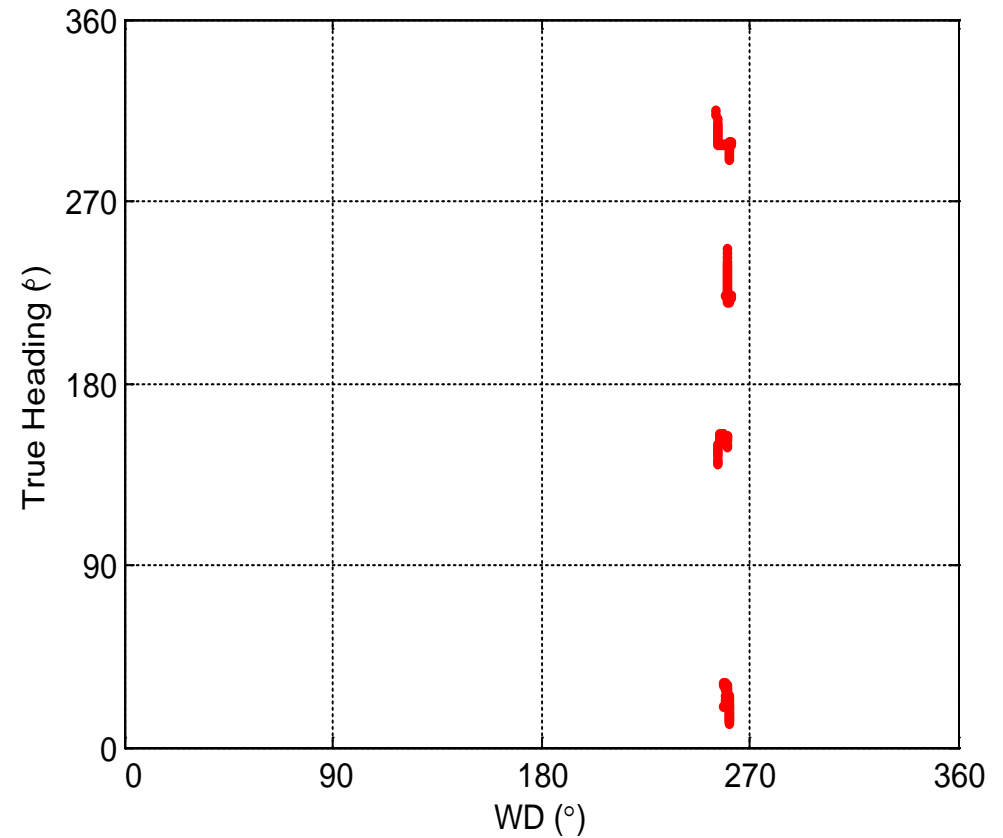
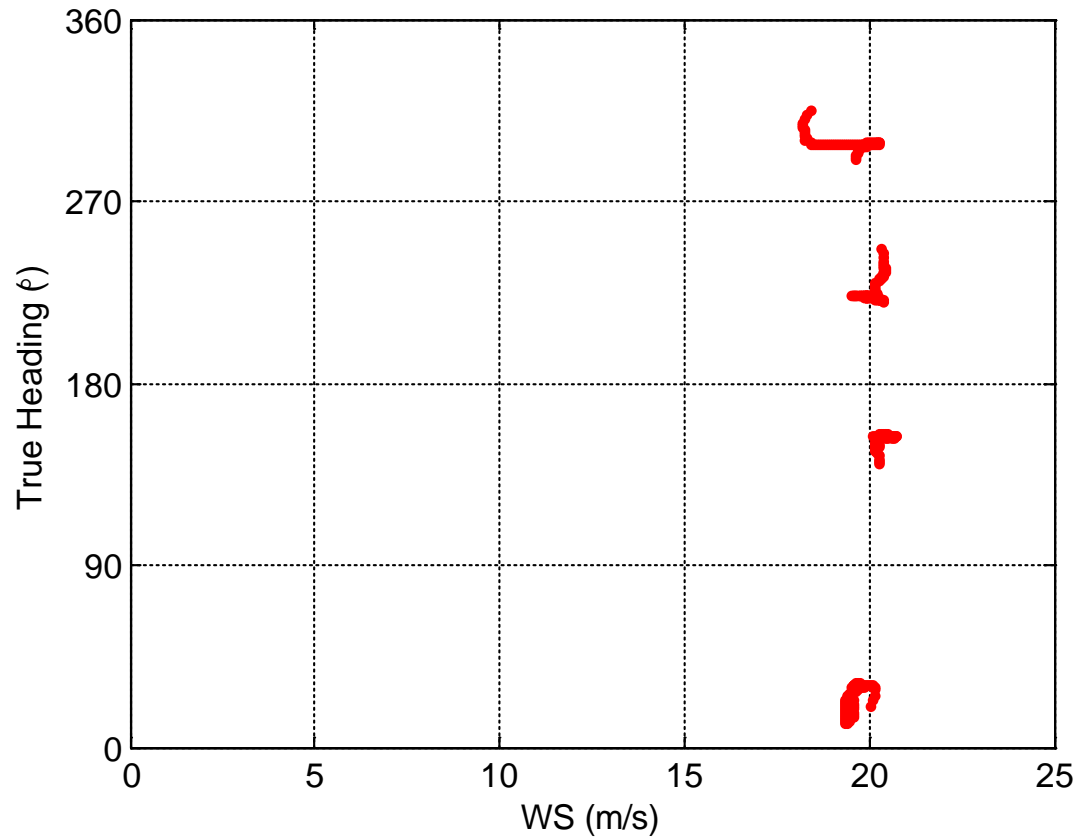


Picarro GHG Measurement Altitude Test

From 8000 ft. (2.4km) to ground before landing



We replaced a bad wind system. Measurements from UMD Cessna over a Profiler



Published results so far, methane.

- CH₄ emissions from Baltimore-Washington area 8.66 ± 4.17 kg/s (2015) and 9.14 ± 4.49 kg/s (2016) or about **0.28 Tg/yr** (Ren et al. JGR 2018). Compare to **0.84 Tg/yr** for 5 cities (Plant et al. later today).
- CH₄ emissions from SW Marcellus **21.2 kg/s** (0.66Tg/yr); 28% from O&NG (Ren et al. JGR 2019).
- CH₄ emissions from SW Marcellus **~0.5%** of production; ratioing to C₂H₆ (Barkley et al. GRL 2019).
- Methane leak rates <1% of NG production, but total emissions much higher than inventories.

Published & submitted results so far, CO₂

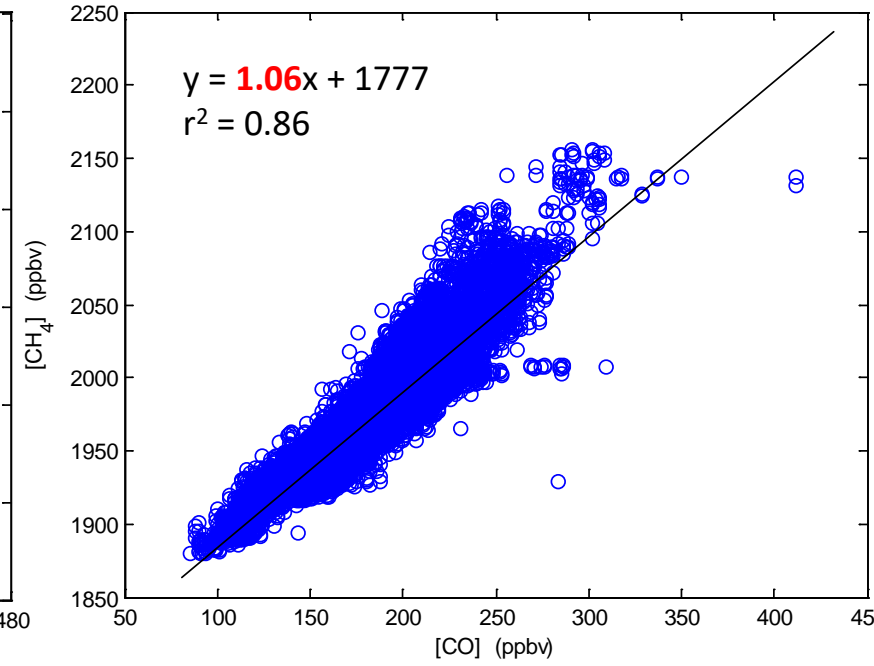
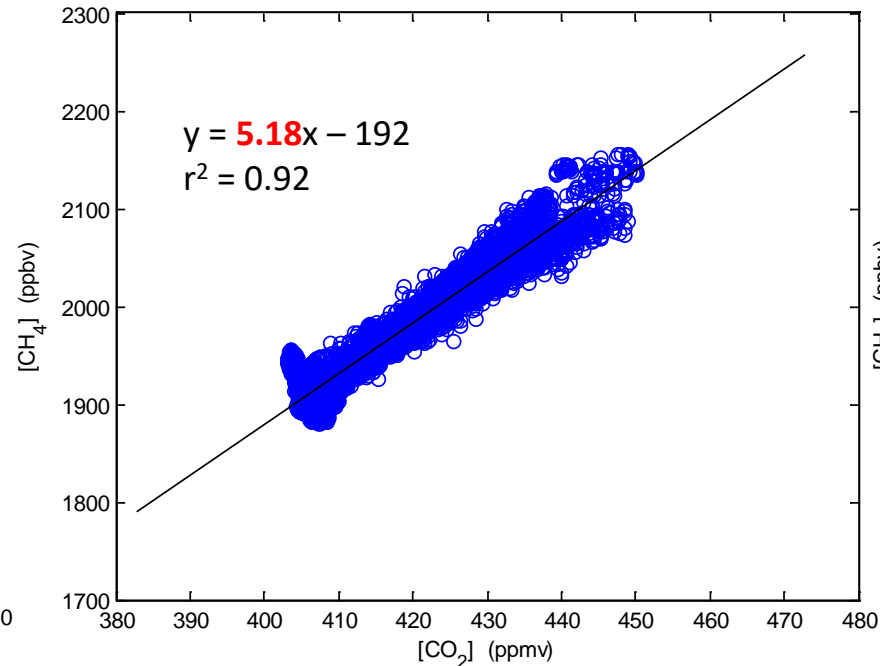
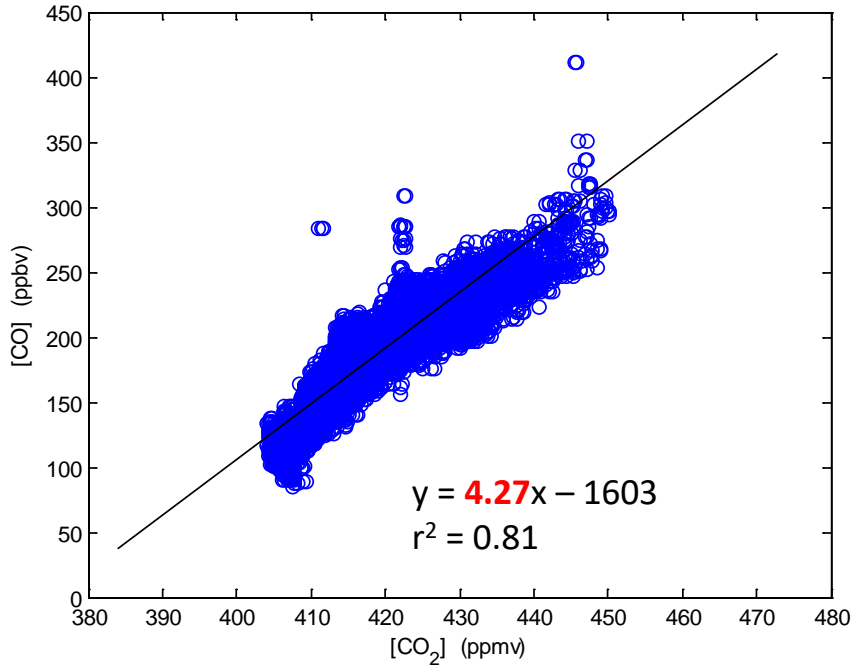
- Aircraft mass balance emissions fossil CO₂ = **2.3±0.5** TgC/mo in Baltimore-Washington in **February** 2015 based on 7 aircraft flights.
- 4 bottom-up inventories suggest fossil **2.2±0.3** TgC/mo. (Ahn et al., in prep 2019).
- Model inversion total CO₂ = **2.5±0.7** TgC (Lopez-Coto et al. submitted 2019).

Long Island Sound Ozone Study – LISTOS NYSERDA and NESCAUM



Correlation among CO, CO₂ and CH₄ over NYC

Afternoon Flight on May 18, 2017

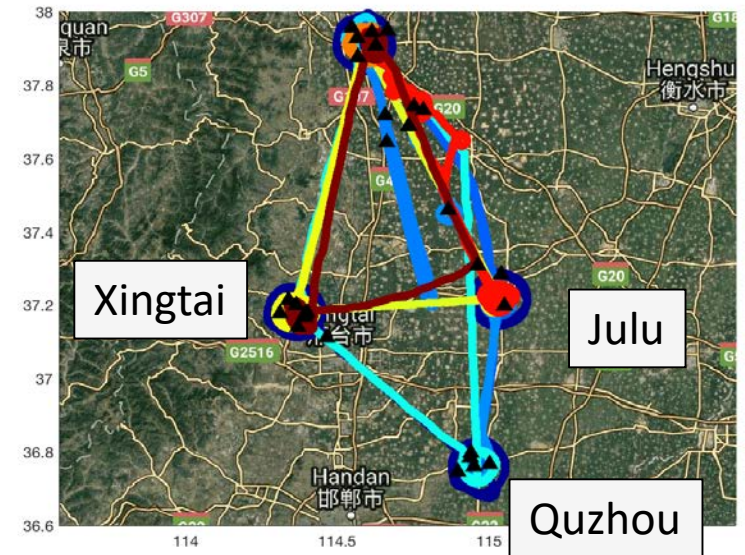
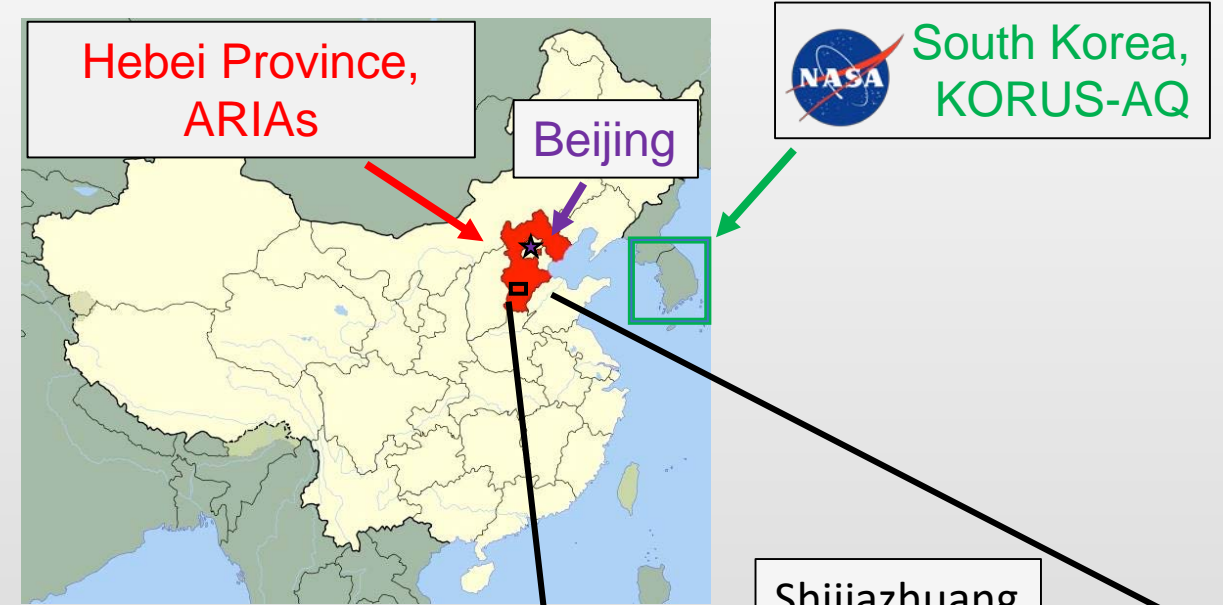


Observed CO and CO₂, CH₄ and CO₂ as well as CH₄ and CO are well correlated.

CO and CO₂ emissions look good,
but CH₄ emissions may be underestimated by a factor of 2-3.

Air Chemistry Research in Asia (ARIAs)

- Peking University, Beijing Normal University, Hebei Provincial weather service, and University of Maryland
- NSF funded
- May-June 2016 in Hebei Province
- 11 research flights, ~3 hours each
- Purpose: Lagrangian study of trace gases and aerosols; complement to NASA KORUS-AQ



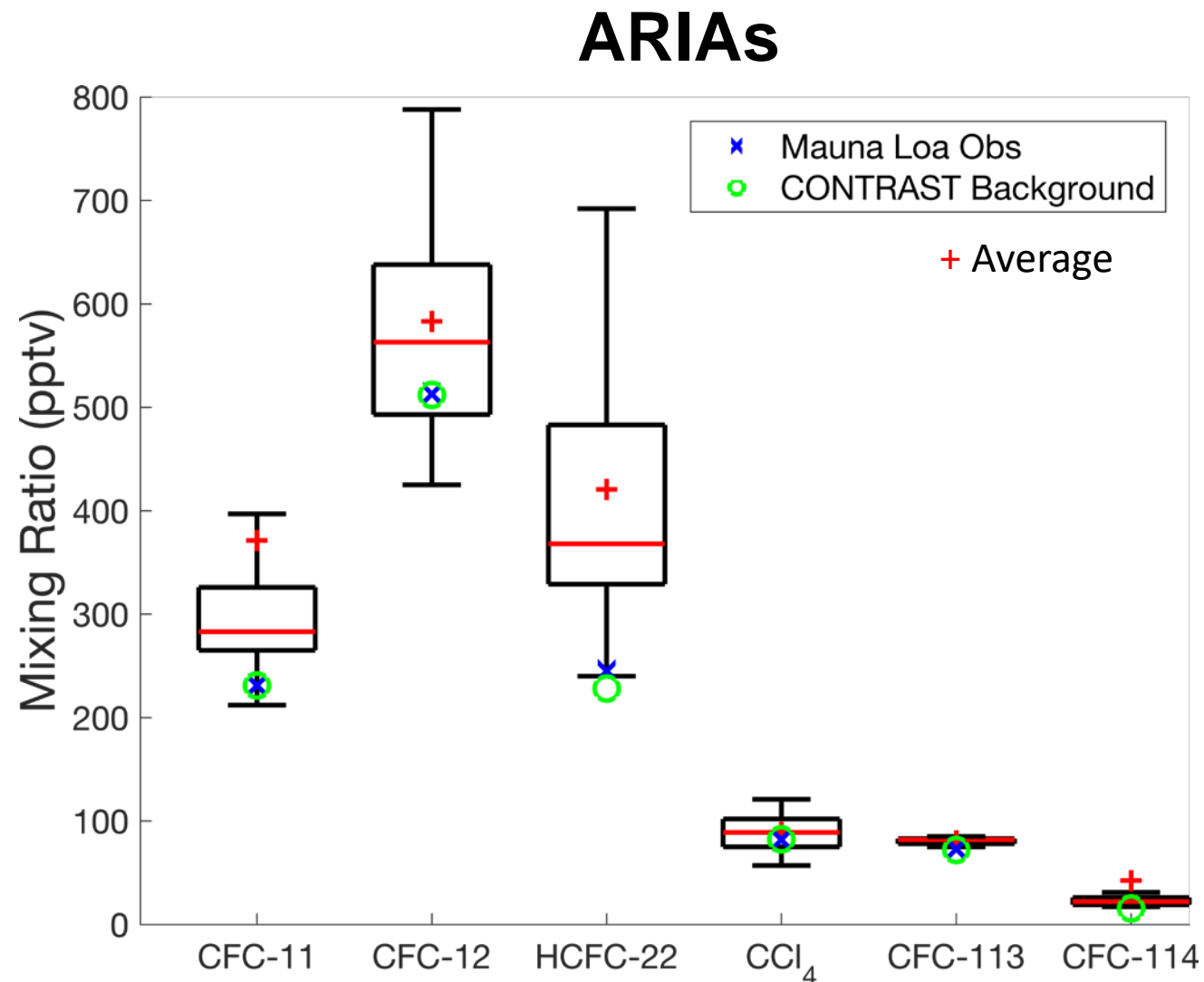
Flight tracks (colors) and location of WAS samples (▲)

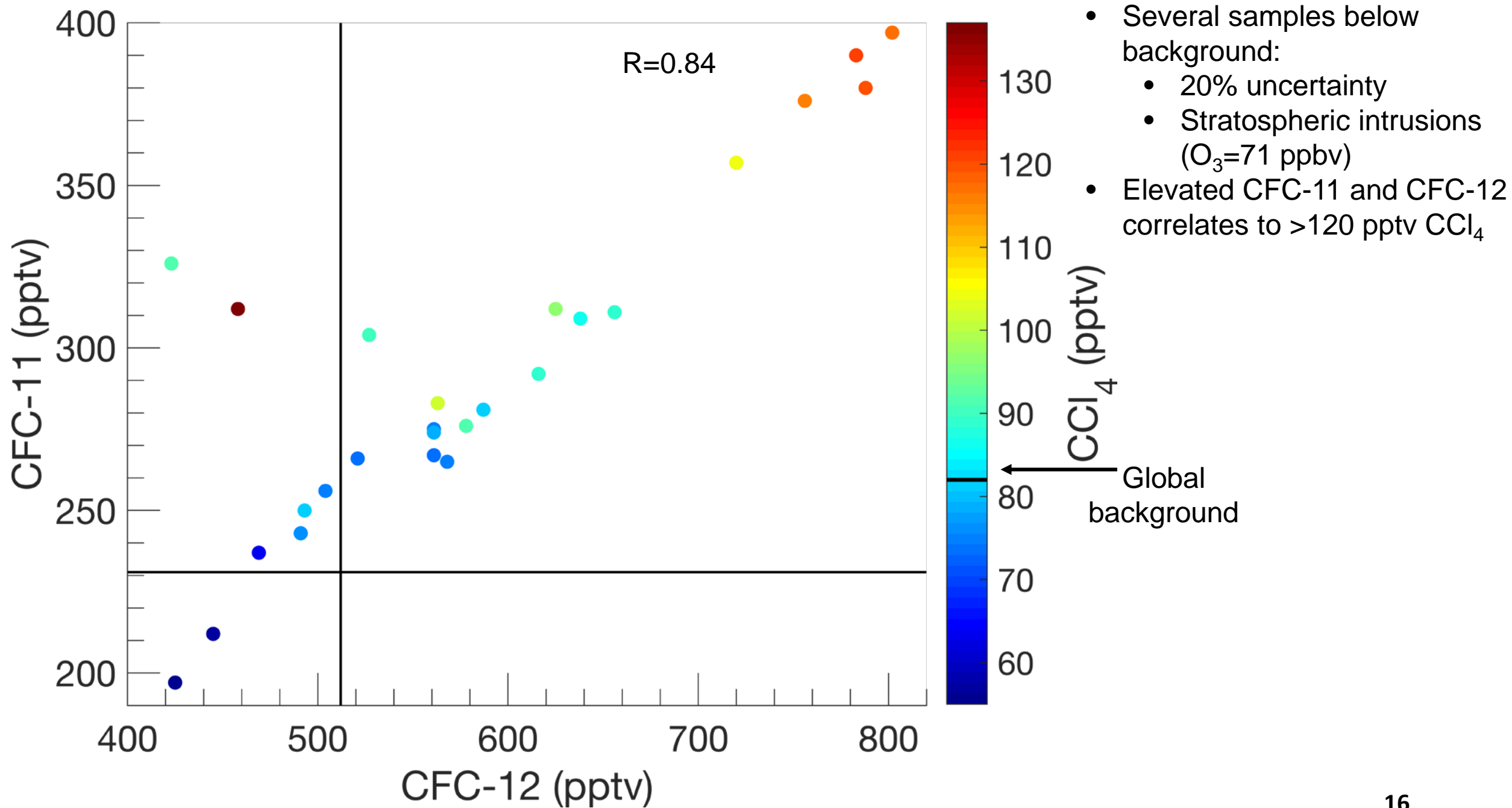


	Background ^{a,b}	ARIAs	
	pptv	Mean (Median), pptv	σ/\bar{x} %
CFC-11	231	370 (280)	109
CFC-12	512	580 (560)	19
HCFC-22	245	420 (370)	18
CCl ₄	82	89 (89)	23
CFC-113	73	80 (80)	4
CFC-114	16	40 (20)	239

^a Mauna Loa May 2016 Mean

^b CONTRAST, 25th percentile below 1500 m (Jan-Feb. 2014)







Sarah Benish

Summary

- Elevated and highly variable CFC-11 values during ARIAs.
- Origins in Shandong and Inner Mongolia
- Strong correlations CFC-11, CFC-12, and CCl_4 .
- Suggestive of new CFC production and foam blowing applications.
- Chinese emissions had an influence on downwind regions such as Korea.

