

# RESULTS FROM THE NOAA COLLABORATIVE TALL TOWER NETWORK FOR MONITORING CARBON DIOXIDE AND RELATED GASES

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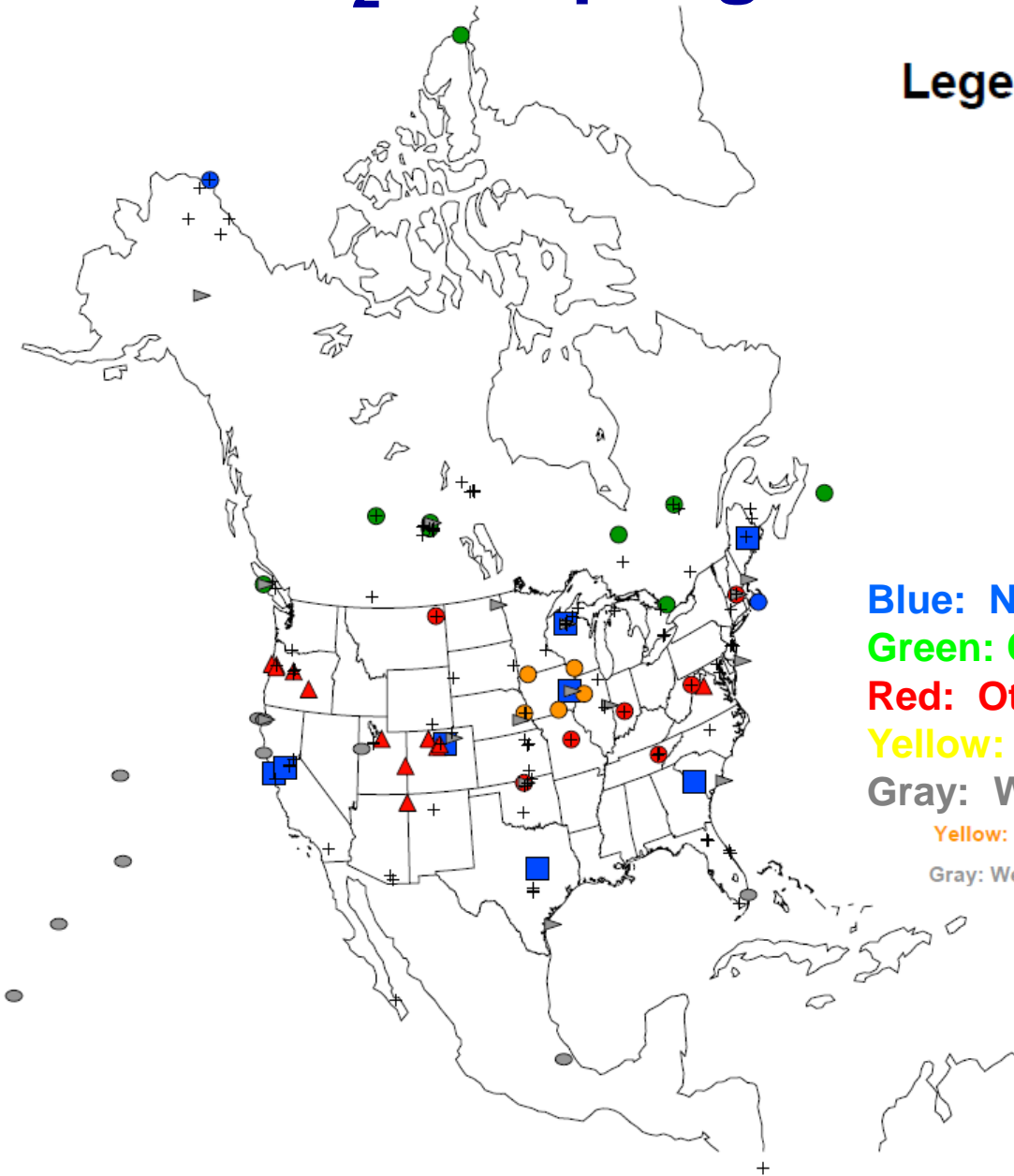
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# CO<sub>2</sub> Sampling in North America

## Legend: Sampling Platform

- Surface-layer tower
- Mixed-layer (tall) tower
- ▲ Complex terrain
- ▶ Aircraft Profile
- Weekly Surface Flask
- + Ameriflux tower

- Blue: NOAA ESRL & Collaborators
- Green: Canadian Carbon Program
- Red: Other (PSU, ORST, Harvard, NCAR)
- Yellow: MCI Ring of Towers 2 (PSU)
- Gray: Weekly or Infrequent Sampling
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Slide courtesy of Scott Denning

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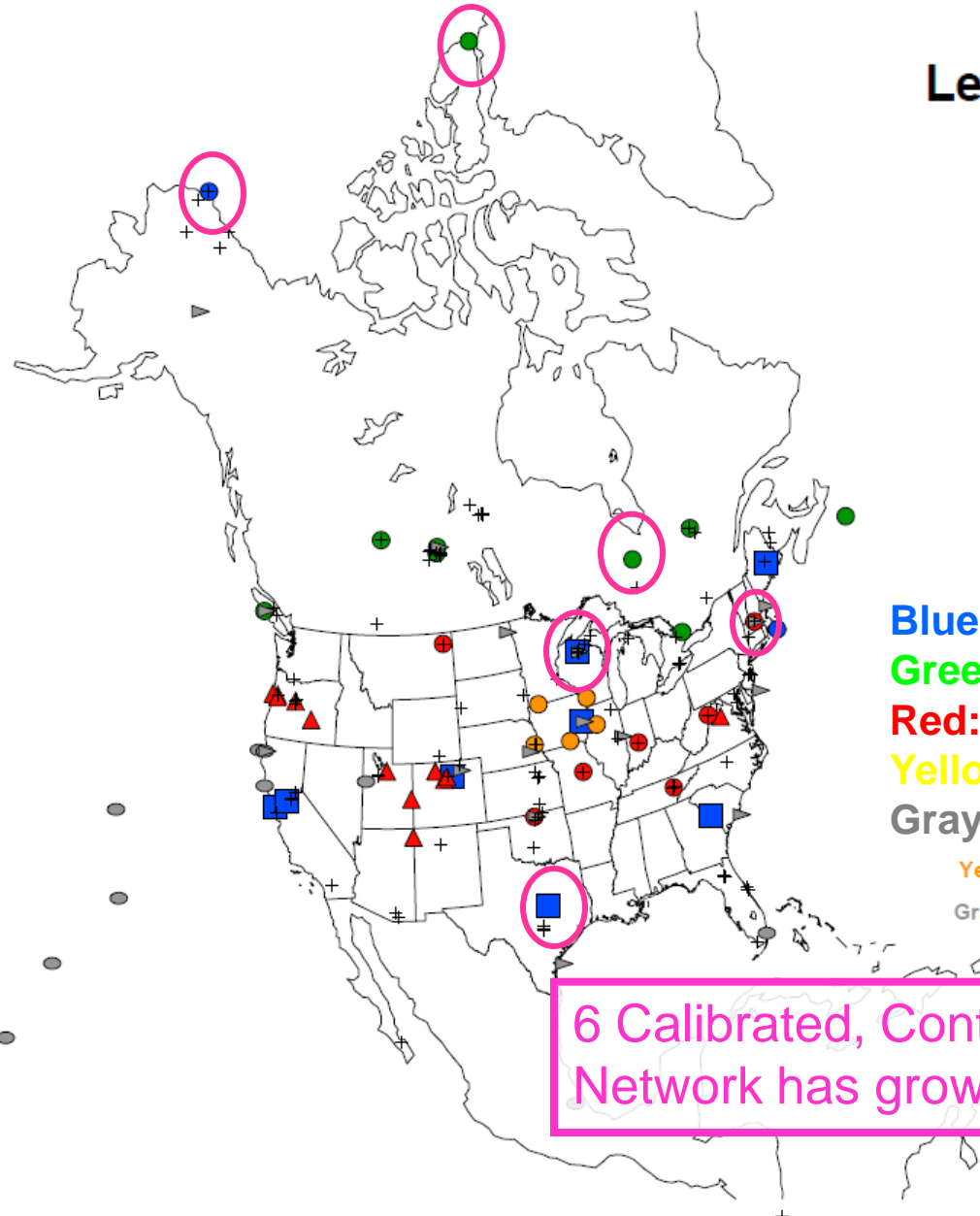
Yellow: MCI Ring of Towers 2 (PSU)

Gray: Weekly or Infrequent Sampling

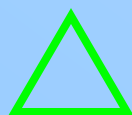
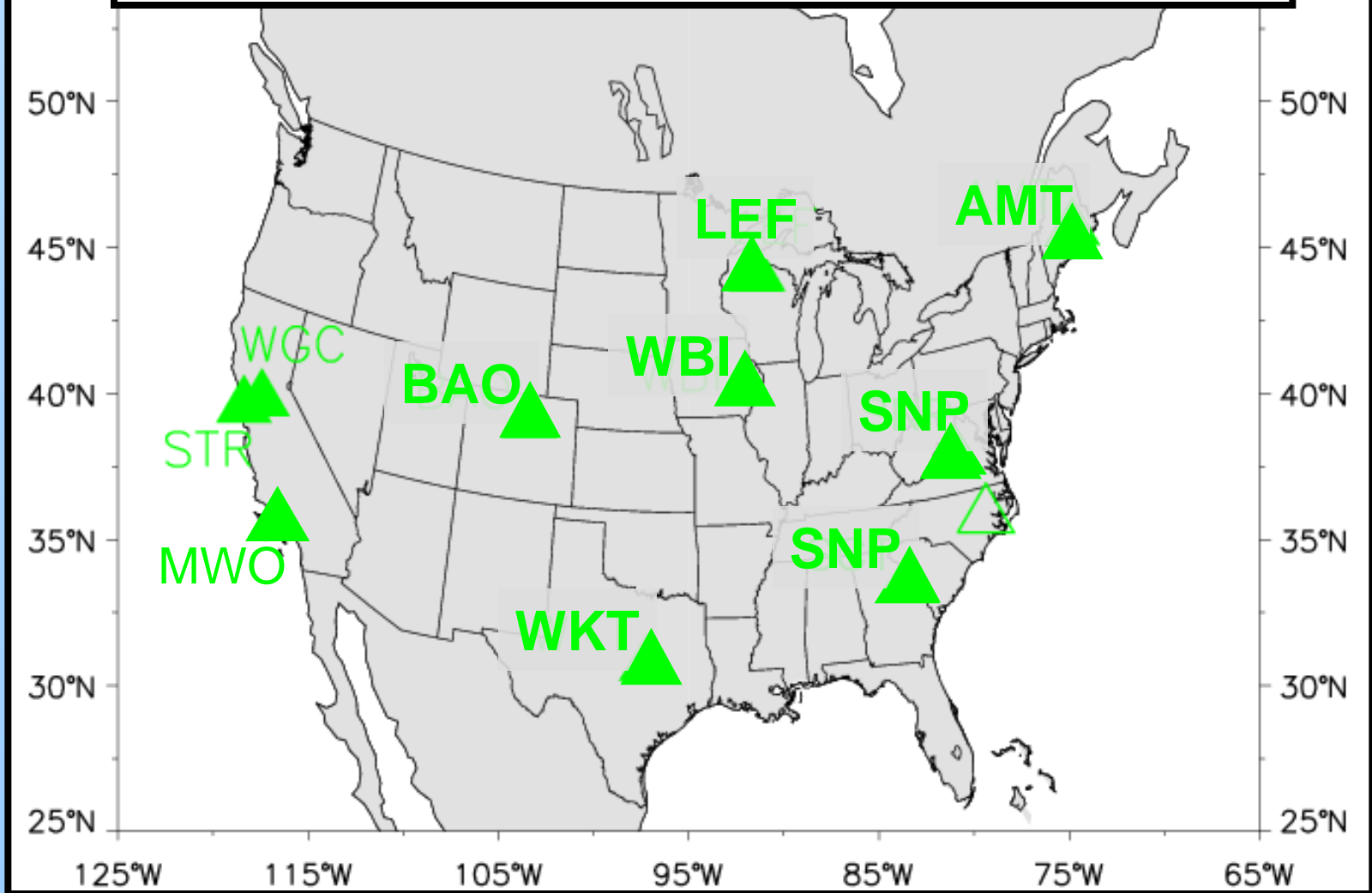
Yellow: MCI Ring of Towers 2 (PSU)

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6 Calibrated, Continuous Sites Operating in 2001  
Network has grown to ~40 by 2008!



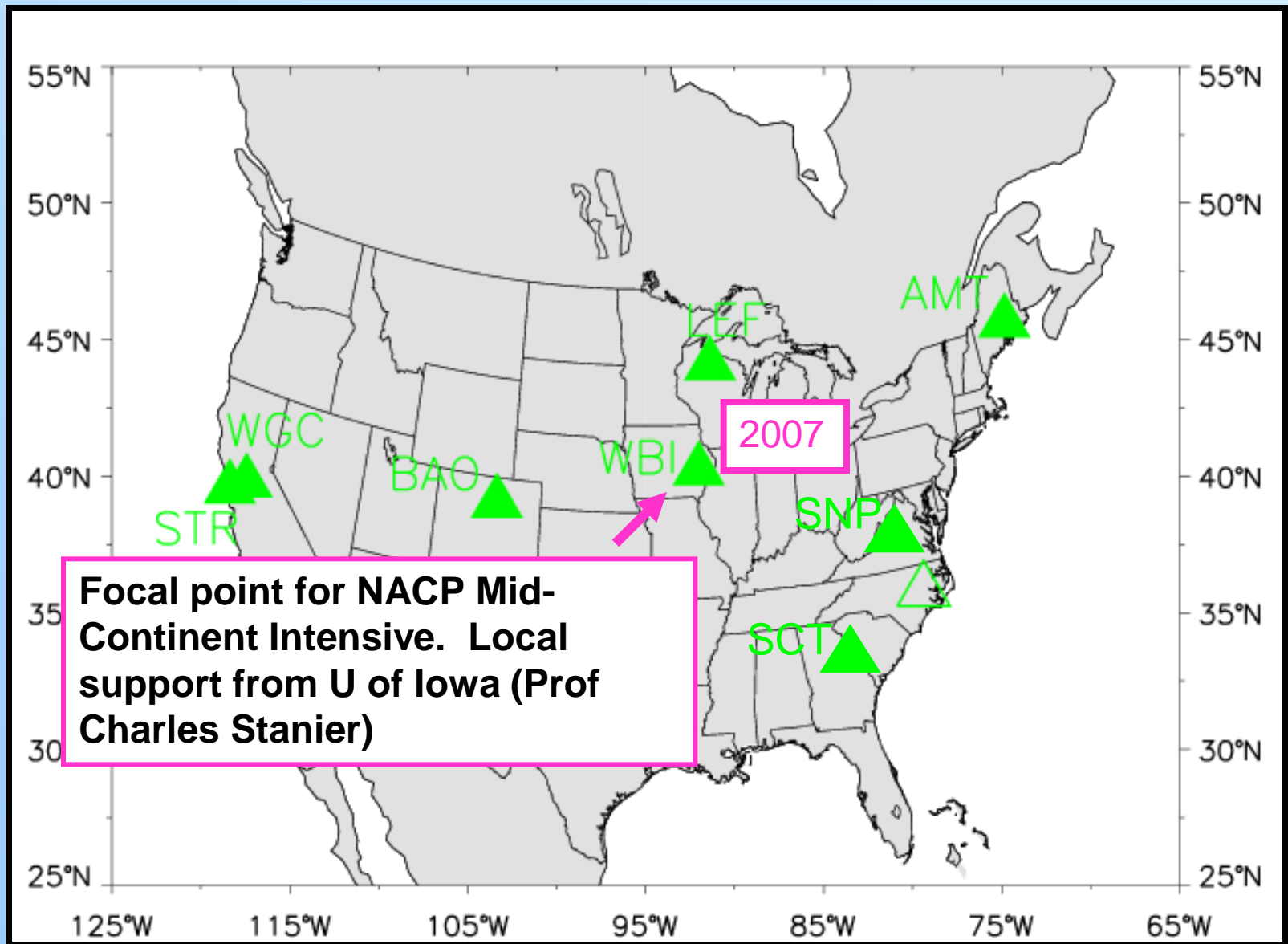
# NOAA ESRL Collaborative Tall Tower Network



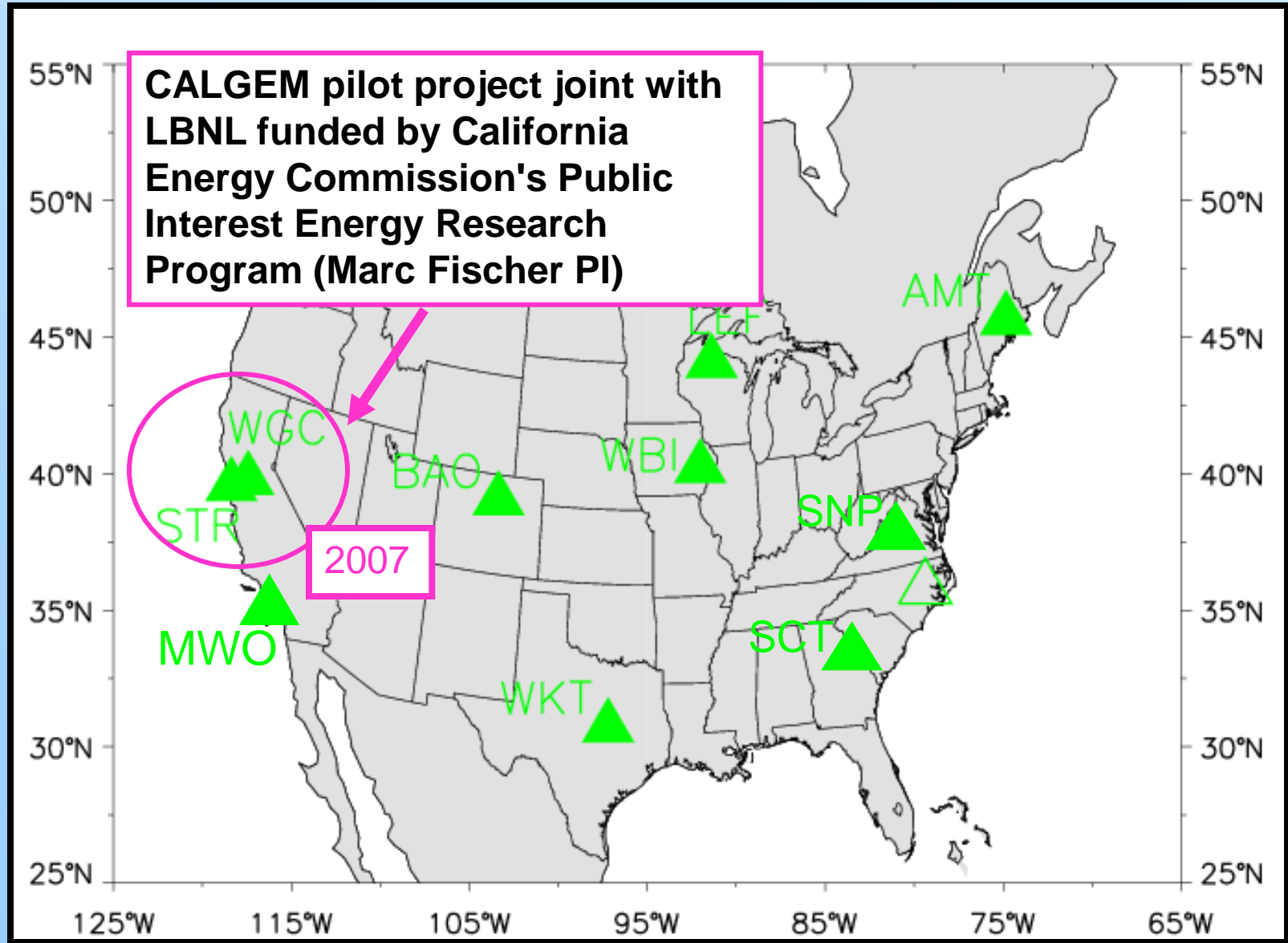
ITN (1992-1999)



Active Sites

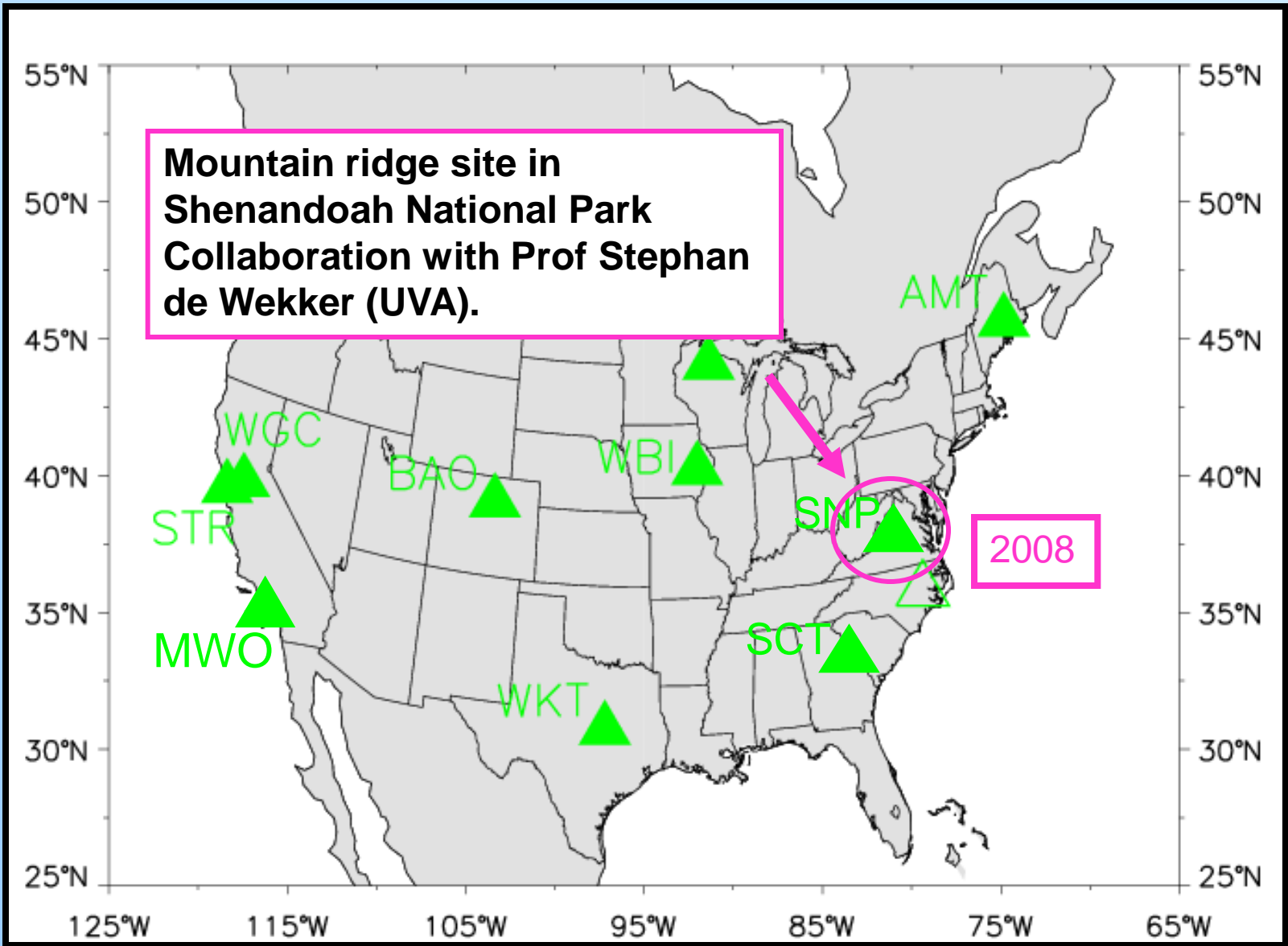


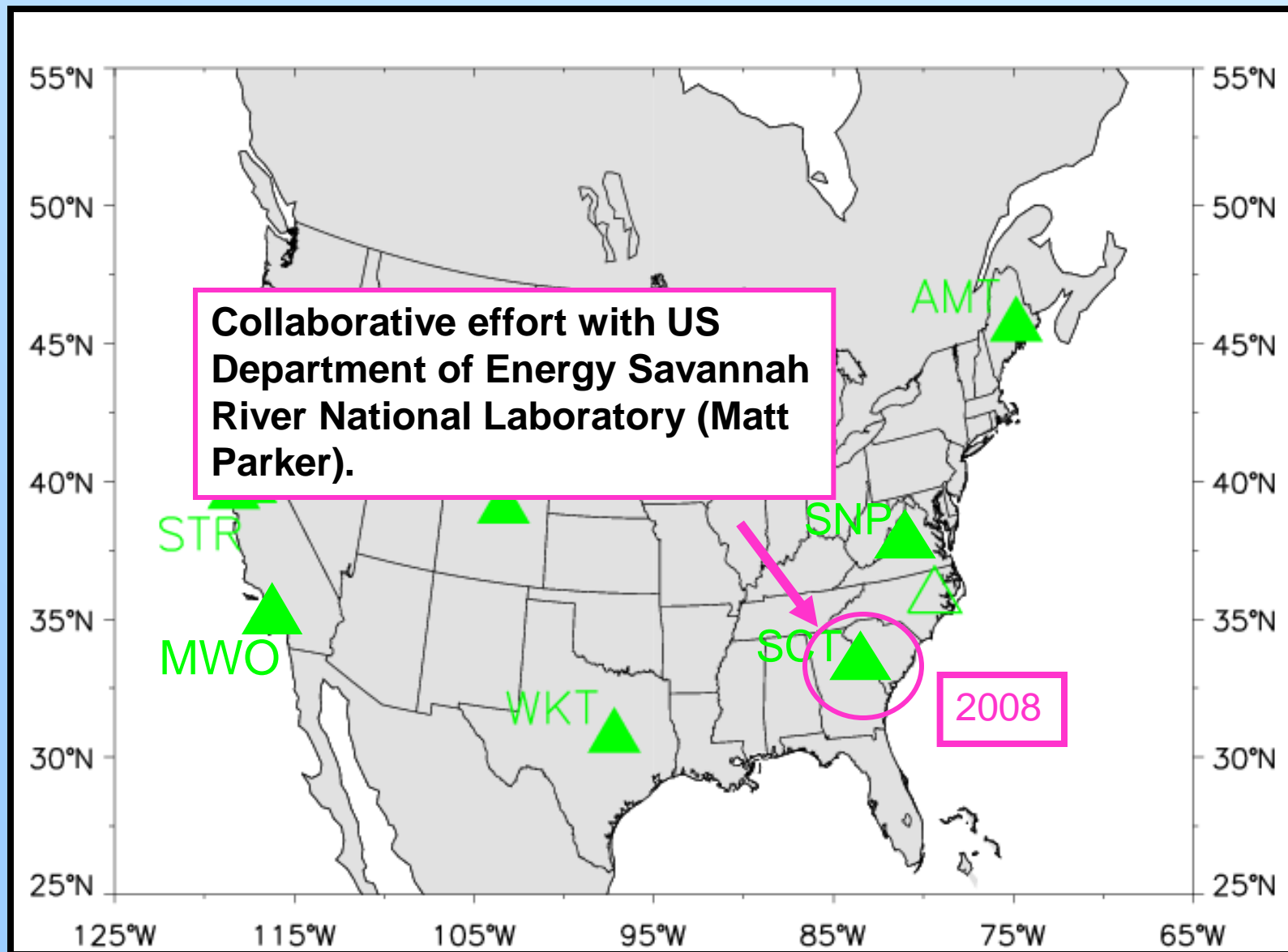
**CALGEM pilot project joint with  
LBNL funded by California  
Energy Commission's Public  
Interest Energy Research  
Program (Marc Fischer PI)**



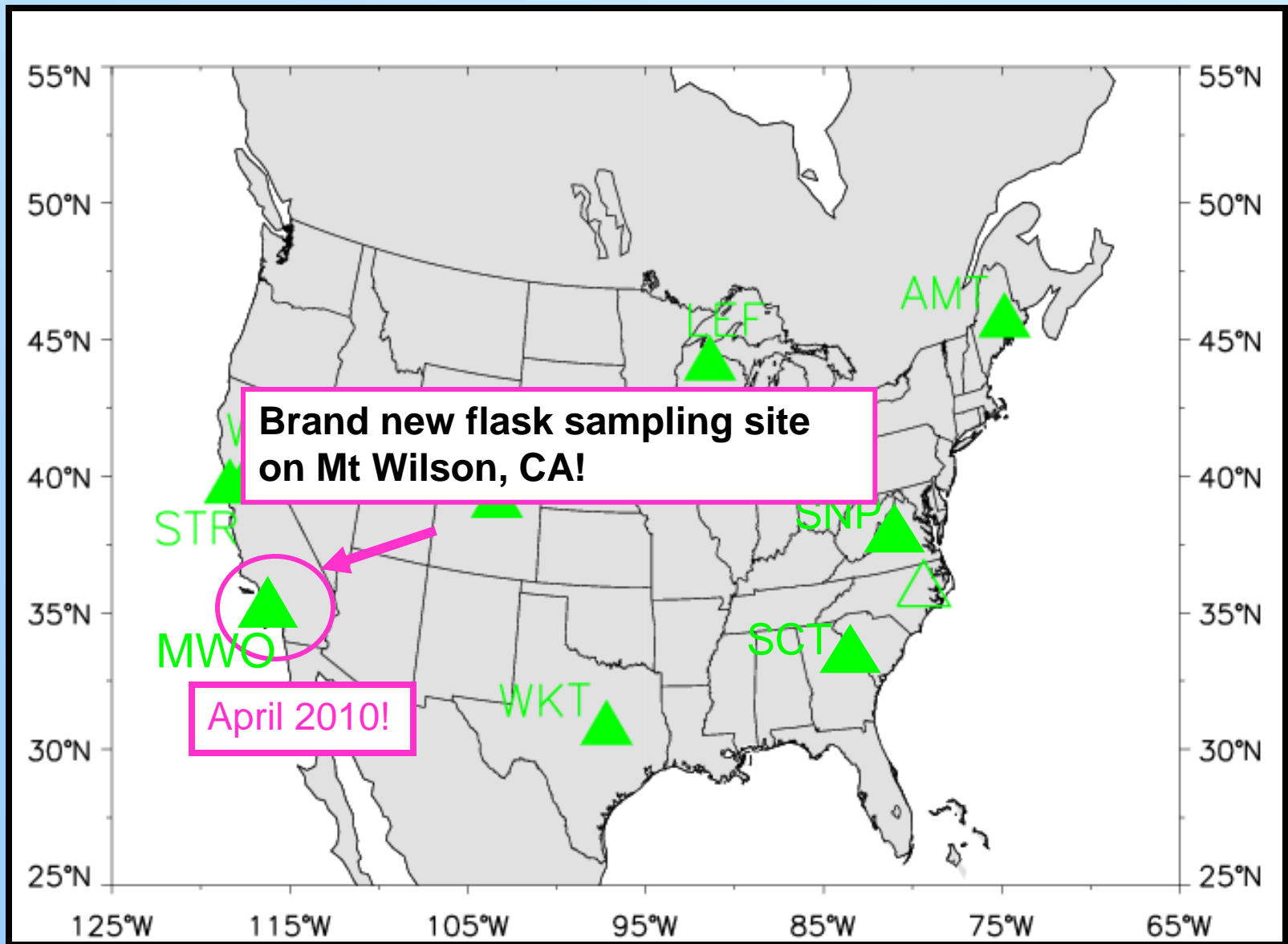
**Mountain ridge site in  
Shenandoah National Park  
Collaboration with Prof Stephan  
de Wekker (UVA).**

2008









# New Tower Image Viewer Software for daily QA/QC:

Image Viewer - Towers

https://om.cmdl.noaa.gov/viewer/towers.php

NOAA ESRL  
Global Monitoring Division

Image Viewer  
Tall Towers

Code: lef

Date(s): 2010-05-10 2010-05-10

Search

Plot Types

- co-smp-flow
- co-temperature
- co-unc
- co-voltage
- co-voltage-cals
- co-voltage-diurnal
- co-water-vapor
- co2-cal-gain
- co2-correlations
- co2-mr

Select All Unselect All

Preferences

Save Load

lef\_20100510\_co2-mr.png PDF PS

LEF: 20100510 - CO<sub>2</sub> Mixing Ratio

CO<sub>2</sub> ( $\mu\text{mol mol}^{-1}$ )

Hour

30 m  
122 m  
396 m

NOAA ESRL Carbon Cycle, 2010-05-12

Image list

By Dan Chao

Mike Trudeau and Dan Chao

# New Tower Image Viewer Software for daily QA/QC:

## NOAA ESRL

Global Monitoring Division

## Image Viewer

Tall Towers

<<
>>
lef\_20100510\_co2-residuals.png
[PDF](#) [PS](#)

### LEF: 20100510 - CO<sub>2</sub> Target/Cal Gas Residuals

Tower	SN(s)	Assigned MR(s)	Avg ± Std
C1	CA06374	351.93000	0.04 ± 0.02
C2	CA07919	381.86000	-0.04 ± 0.01
C3	CA07152	408.95000	-0.03 ± 0.03
C4	CA07006	462.54000	0.03 ± 0.02
T1	CA07188	395.40000	0.01 ± 0.05

**General**

Code:

Date(s):

**Plot Types**

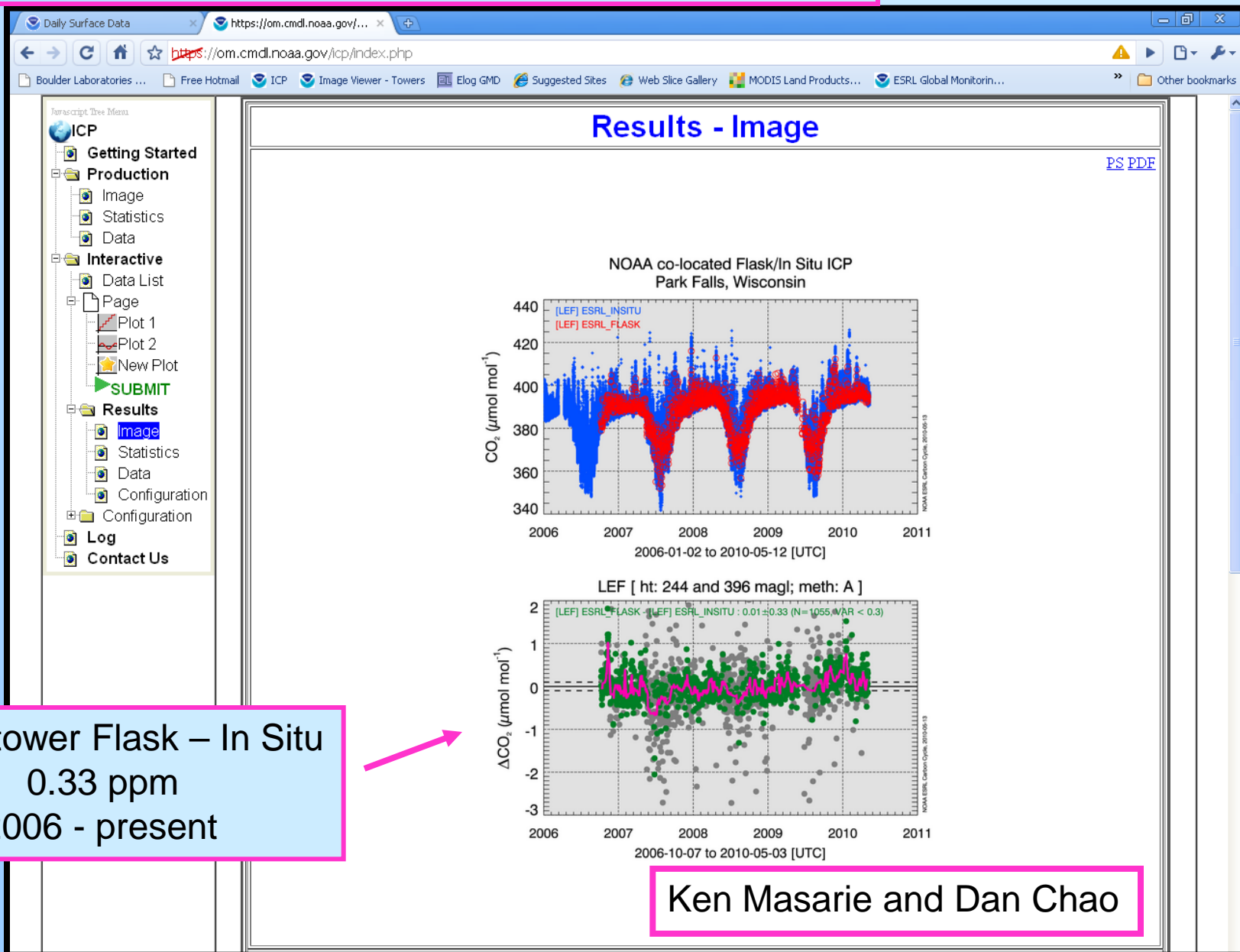
- co-unc
- co-voltage
- co-voltage-cals
- co-voltage-diurnal
- co-water-vapor
- co2-cal-gain
- co2-correlations
- co2-mr
- co2-pressure
- co2-residuals

**Preferences**

[Image list](#)

By Dan Chao

# New “intercomparison” website provides quick look plots of flask/in situ data agreement:



2006      2007      2008      2009      2010      2011  
 2006-10-07 to 2010-05-03 [UTC]

## Results - Statistics

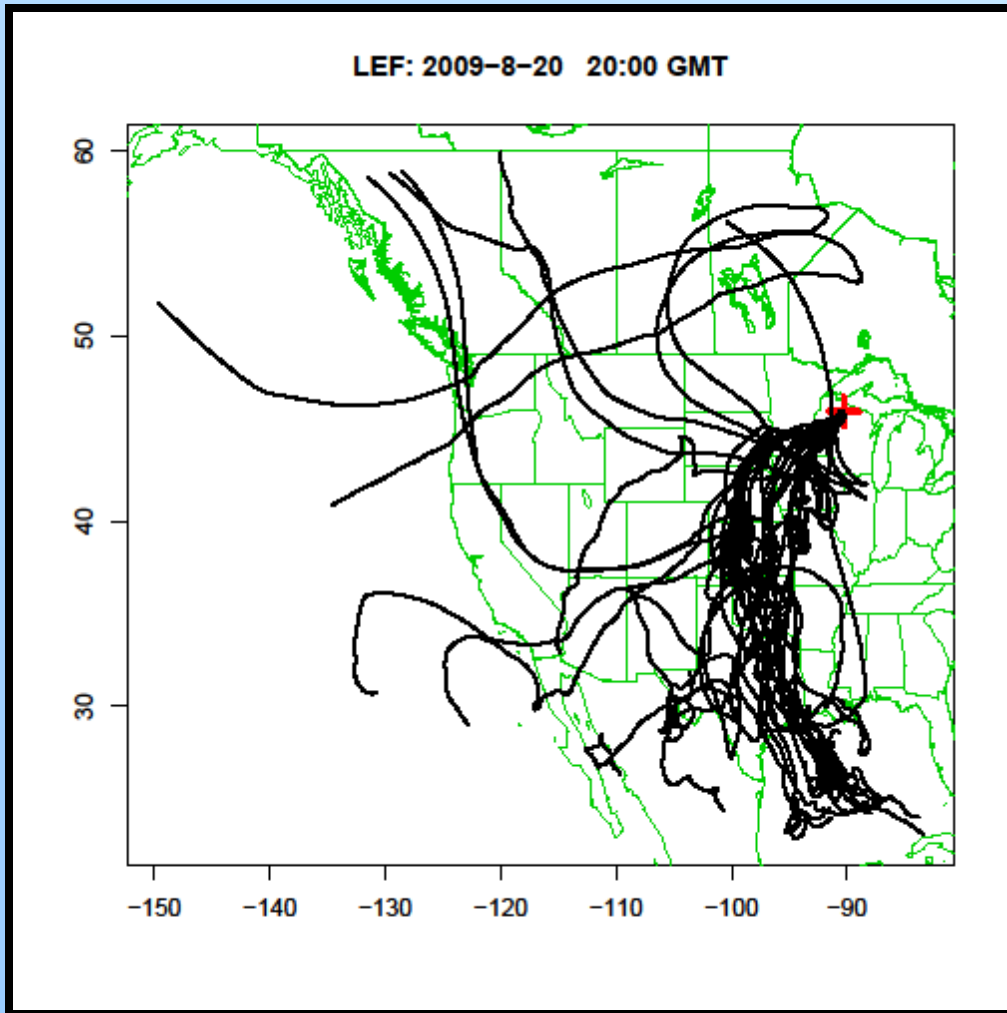
Text file p2d1\_lef\_co2\_esrl\_flask\_lef\_co2\_esrl\_insitu\_comp\_matchsummary

2007 03	-0.0179	0.0000	45
2007 04	-0.0632	0.0000	36
2007 05	-0.1055	0.0000	21
2007 06	-0.0571	0.0000	7
2007 07	0.0118	0.0000	12
2007 08	-0.1814	0.0000	10
2007 09	0.0562	0.0000	13
2007 10	-0.0210	0.0000	19
2007 11	0.0656	0.0000	30
2007 12	-0.0459	0.0000	24
2008	-0.0207	0.0648	318
2008 01	-0.0400	0.0599	36
2008 02	-0.0787	0.0000	32
2008 03	0.0550	0.0000	38
2008 04	-0.0259	0.0000	39
2008 05	0.1014	0.0000	34
2008 06	-0.0612	0.0000	13
2008 07	-0.0110	0.0000	5
2008 08	-0.1663	0.0000	11
2008 09	-0.0300	0.0000	7
2008 10	-0.0369	0.0000	32
2008 11	-0.0133	0.0000	34
2008 12	-0.0364	0.0000	37
2009	0.0252	0.0663	270
2009 01	-0.0157	0.0415	29
2009 02	-0.0609	0.0000	21
2009 03	0.0298	0.0000	37
2009 04	0.0478	0.0000	45
2009 05	-0.0546	0.0000	23
2009 06	0.0186	-999.9990	2
2009 07	0.0553	0.0000	3

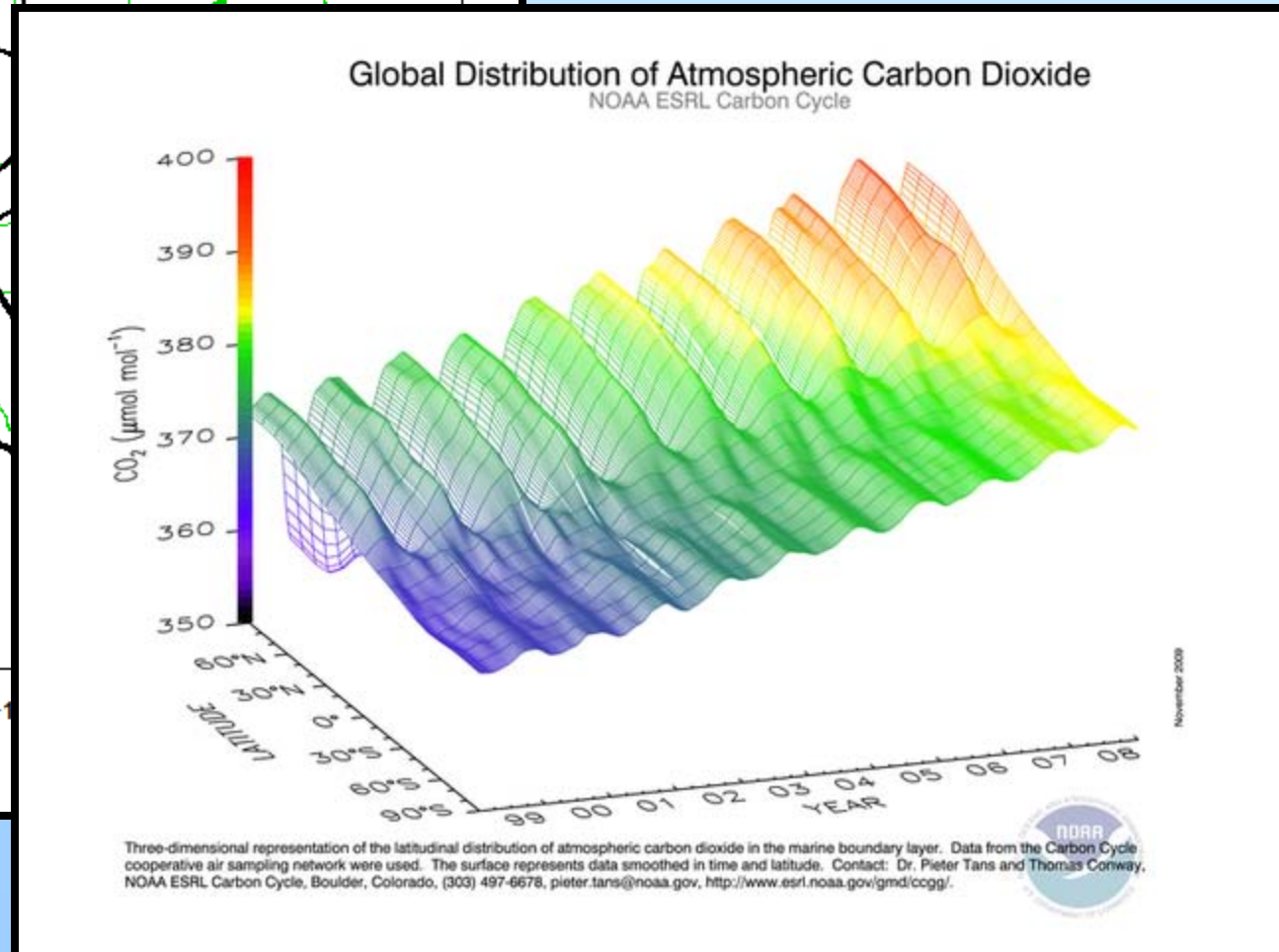
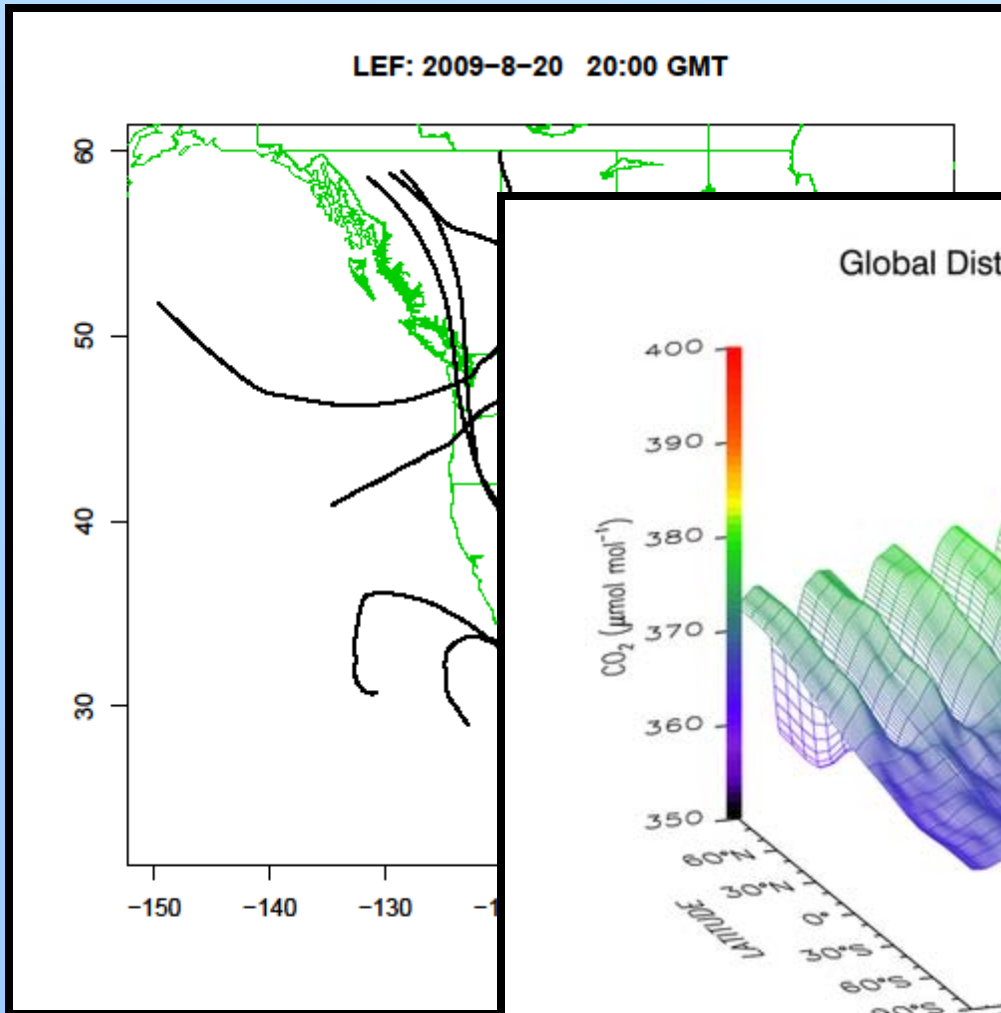
## Results - Data

- [p1d1\\_lef\\_co2\\_esrl\\_insitu\\_mr-ts\\_data.txt](#)
- [p1d2\\_lef\\_co2\\_esrl\\_flask\\_mr-ts\\_data.txt](#)
- [p2d1\\_lef\\_co2\\_esrl\\_flask\\_lef\\_co2\\_esrl\\_insitu\\_comp\\_matchdata.txt](#)
- [p2d1\\_lef\\_co2\\_esrl\\_flask\\_lef\\_co2\\_esrl\\_insitu\\_comp\\_matchdiff.txt](#)

# Estimating CO<sub>2</sub>, CO and CH<sub>4</sub> background concentrations using ensemble trajectory analysis combined with Globalview-like background reference surfaces:

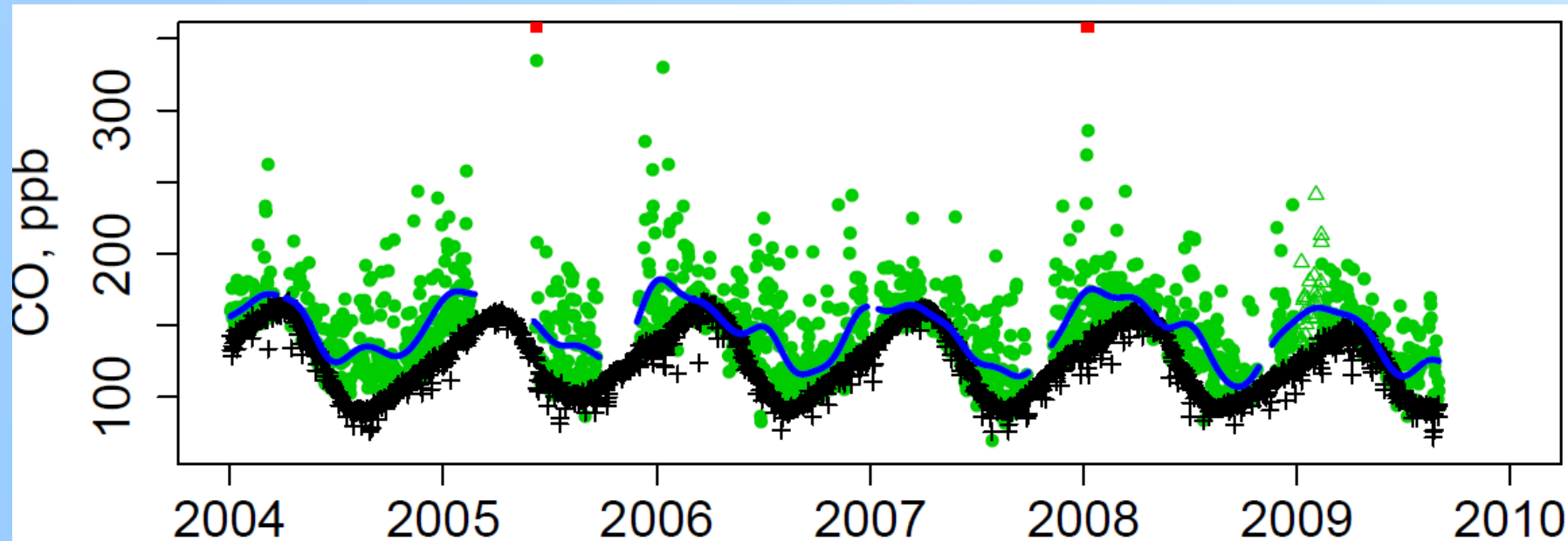
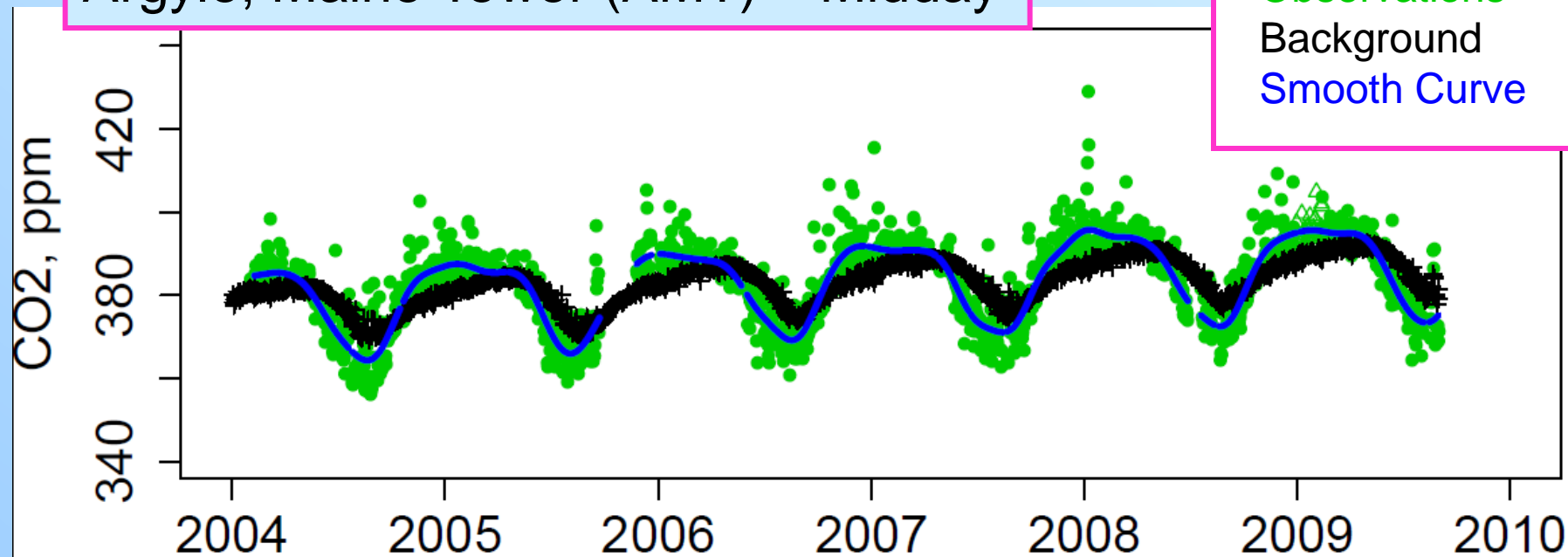


Multiple trajectory analysis combined with Globalview-like background reference surfaces for CO<sub>2</sub>, CO and CH<sub>4</sub> provides estimate of background concentration:



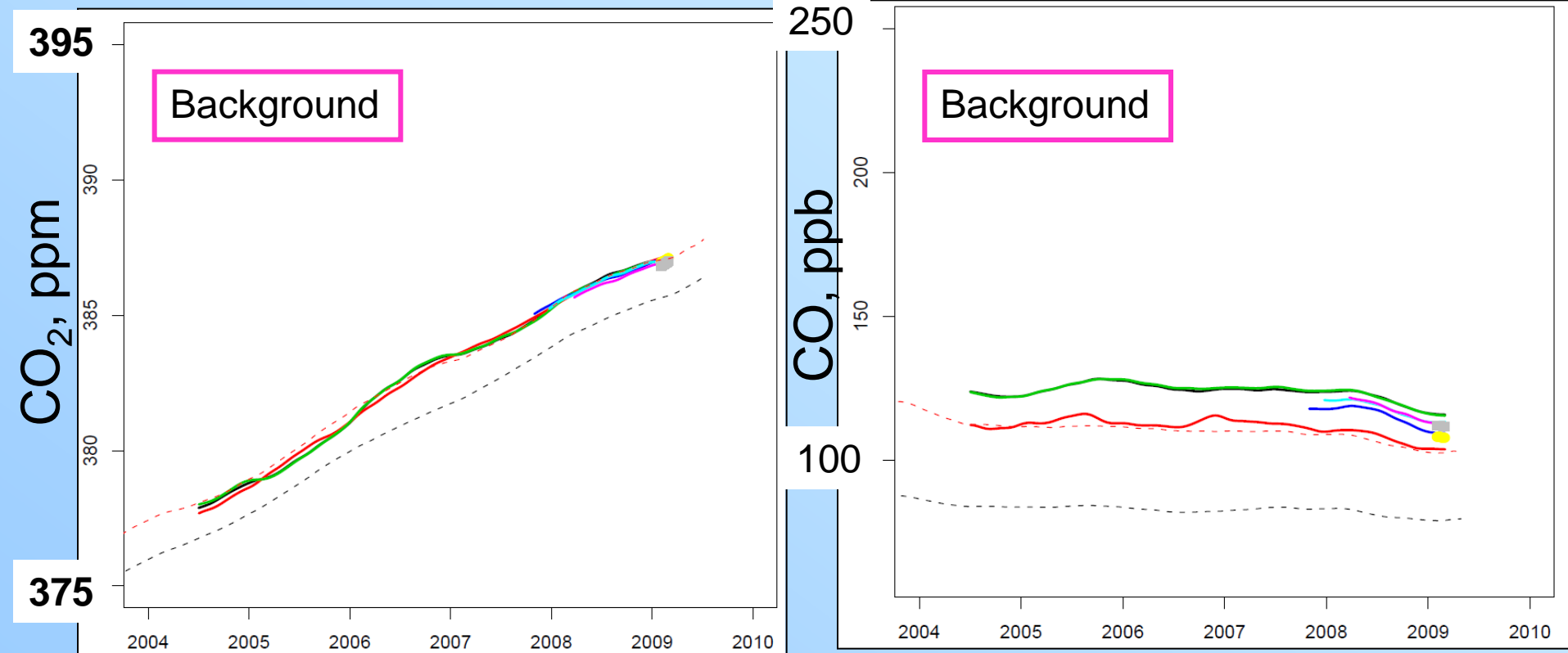
# Argyle, Maine Tower (AMT) – Midday

Observations  
Background  
Smooth Curve

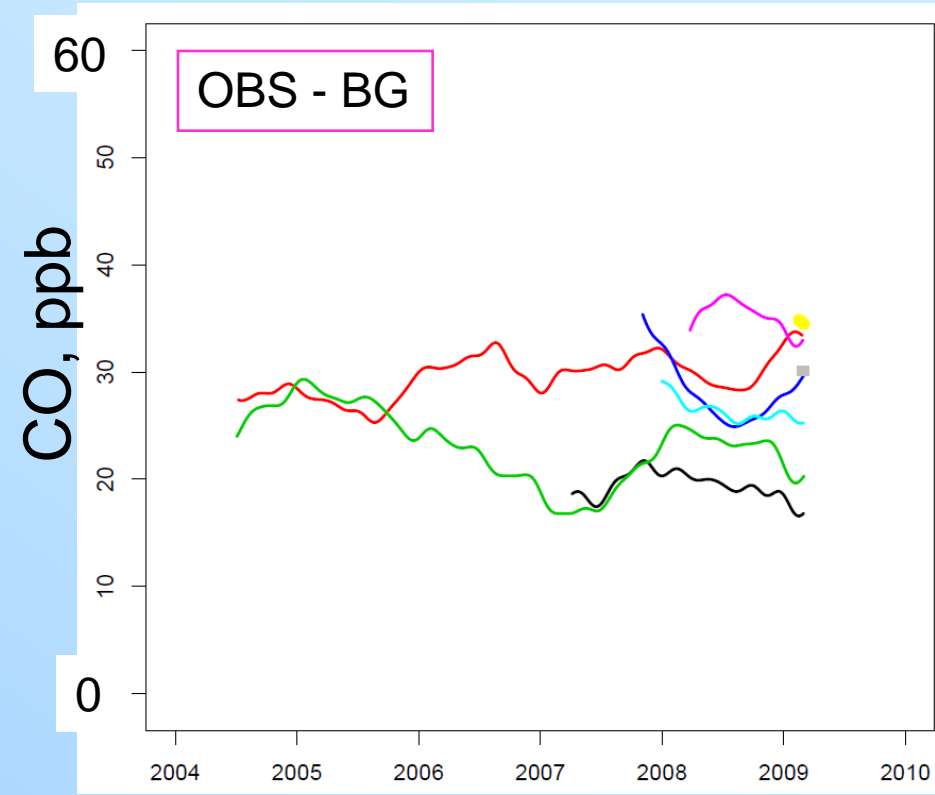
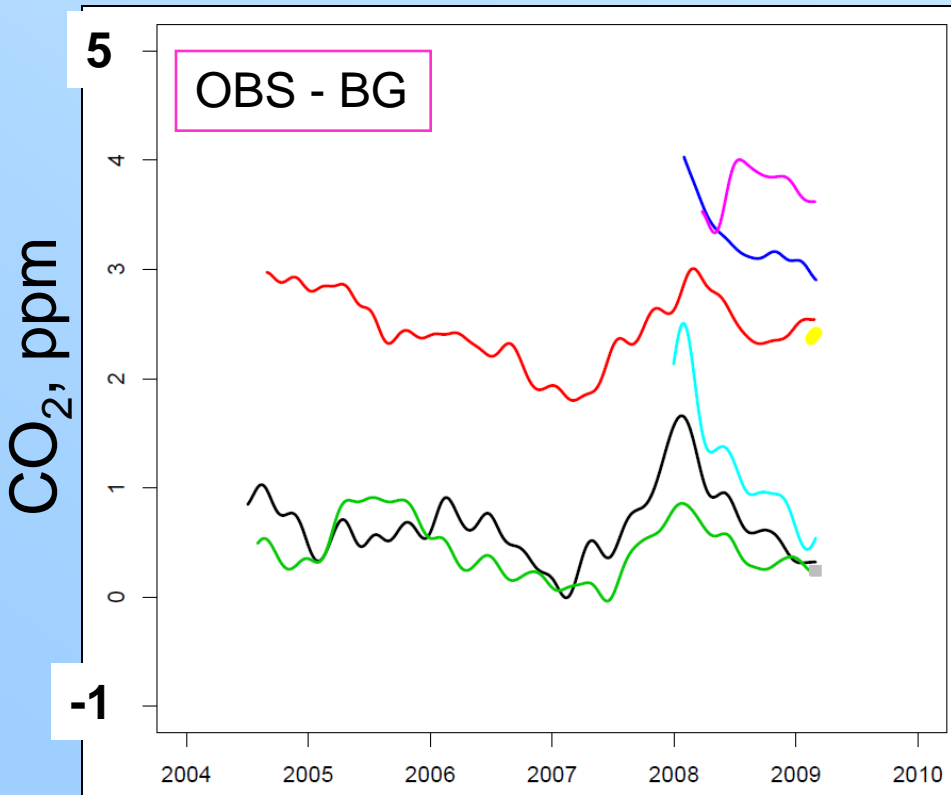




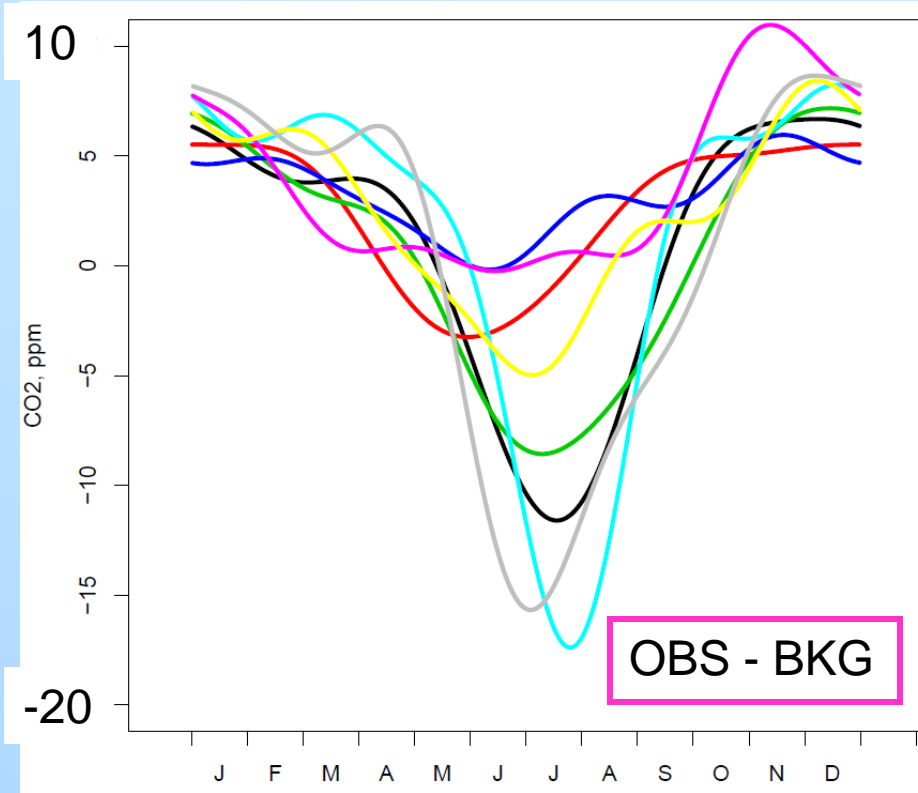
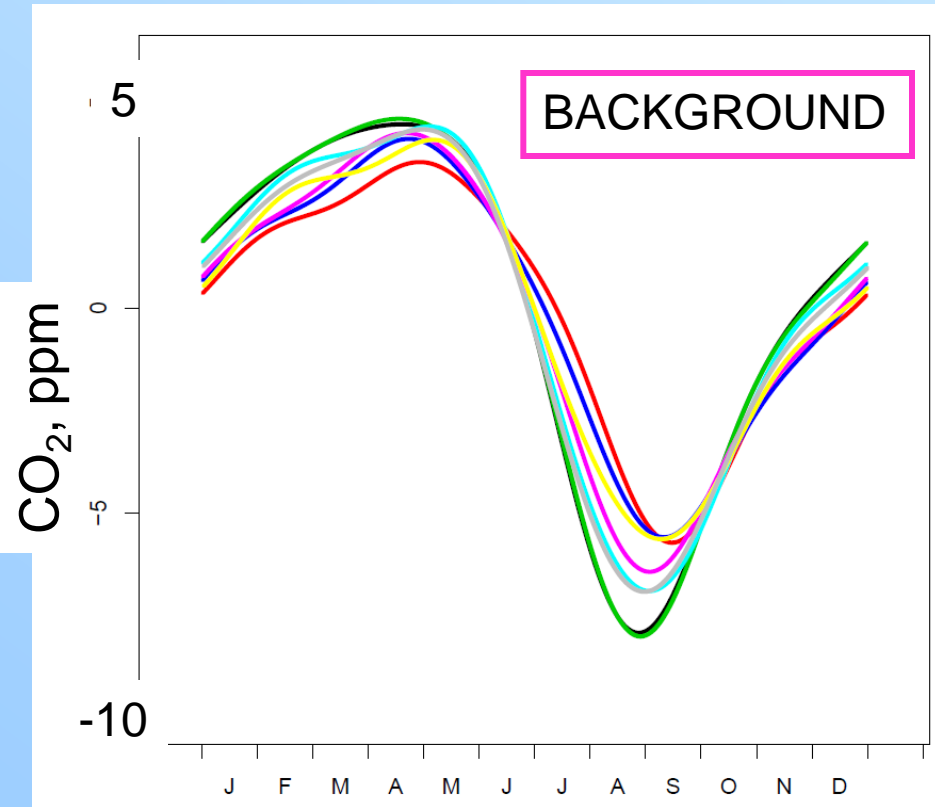
# Long-term Trend: 12-month running average of mid-afternoon data



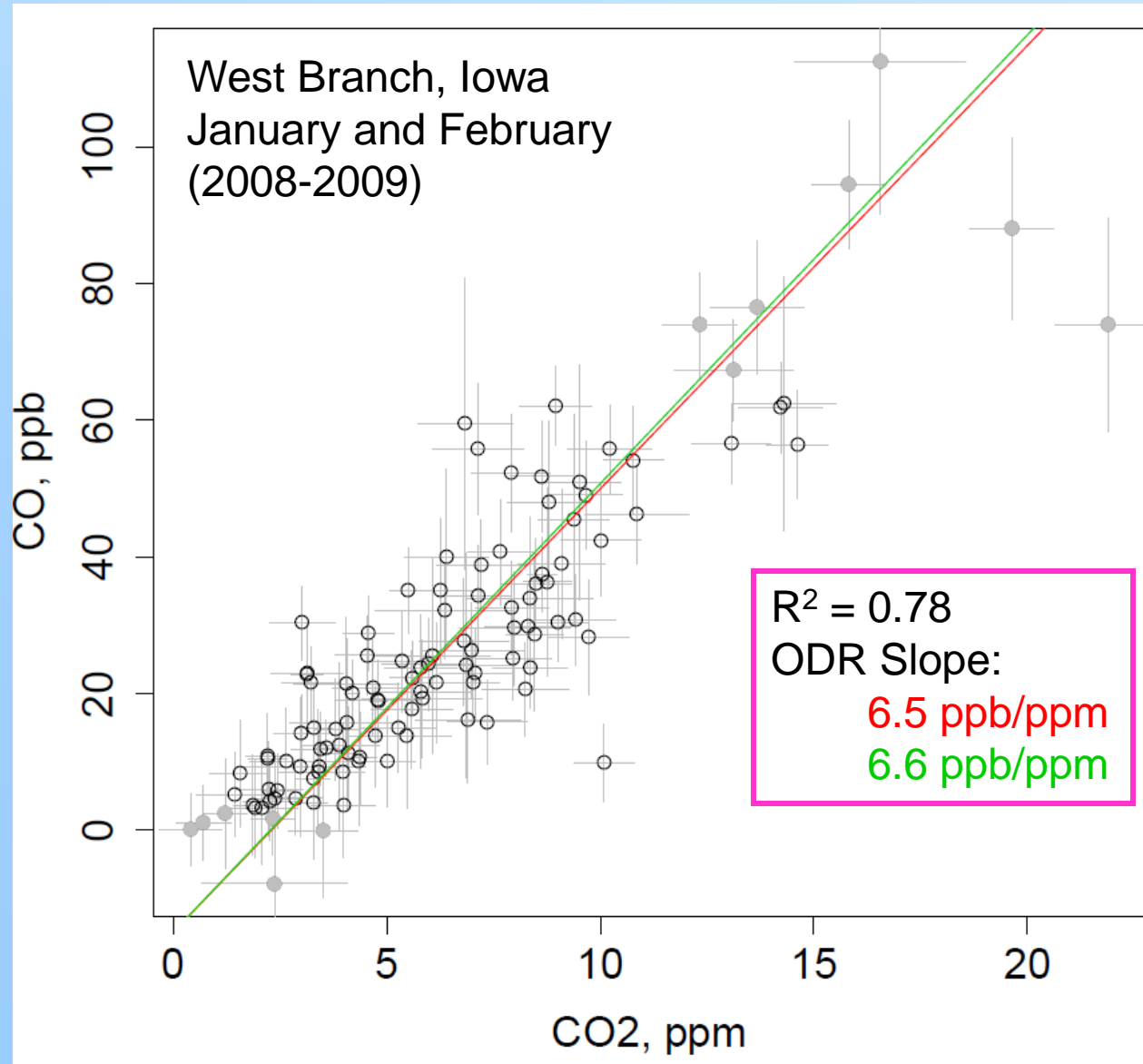
# Long-term Trend: 12-month running average of mid-afternoon data



# CO<sub>2</sub> Seasonal Cycle



# Wintertime CO: CO<sub>2</sub> Correlations



# CO<sub>2</sub> vs CO Correlations (Enhancement over Background):

	<b>R<sup>2</sup></b>	<b>SLOPE</b>	<b>N</b>
<b>WI</b>	0.76	6.3±0.3	136
<b>TX</b>	0.66	7.4±0.4	210
<b>ME</b>	0.93	6.5±0.1	235
<b>CO</b>	0.90	7.0±0.2	89
<b>IA</b>	0.78	6.5±0.3	114
<b>CA</b>	0.73	7.0±0.5	85
<b>SC</b>	0.54	7.4±1.1	39
<b>VA</b>	0.78	7.4±0.6	49

# Highlights

- **CarbonTracker 2010 will be the first release with strong surface data constraints in the Southeastern US (SC and VA sites online Aug 2008).**
- **New Web-based tools facilitate quality control and flask/in situ comparison.**
- **Automated flask samples are now collected at all tall tower sites and analyzed for >40 species. Routine graphite extraction for radiocarbon analysis began in 2009 for several sites.**
- **Trajectory analysis allows separation of continental influence from background – new look at seasonal cycle and trends.**
- **CO<sub>2</sub> and CO co-vary strongly in winter with nearly constant slope across the US, reflecting a broad-area mixture of combustion and biological sources.**

Cumulative  $\Delta$ ppm CO<sub>2</sub> for each site versus distance from tower  
22-31 July 2008  
CarbonTracker 2008 Fossil Fluxes

