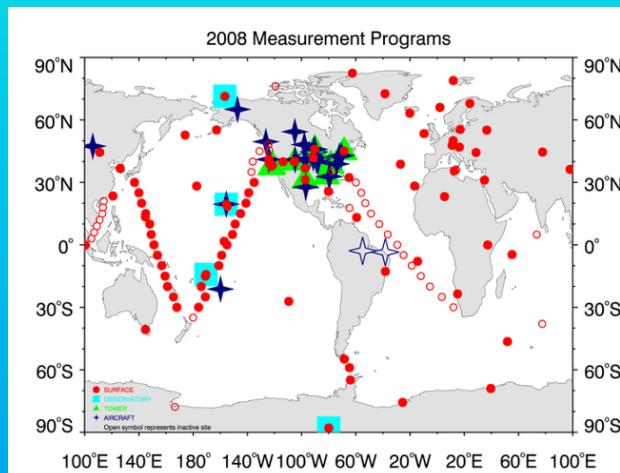


Connecting NOAA and IAGOS

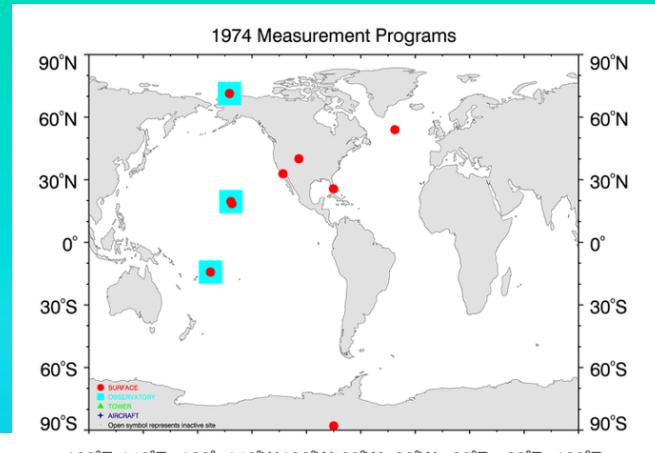
Colm Sweeney

CIRES University of Colorado / NOAA
ESRL, Boulder

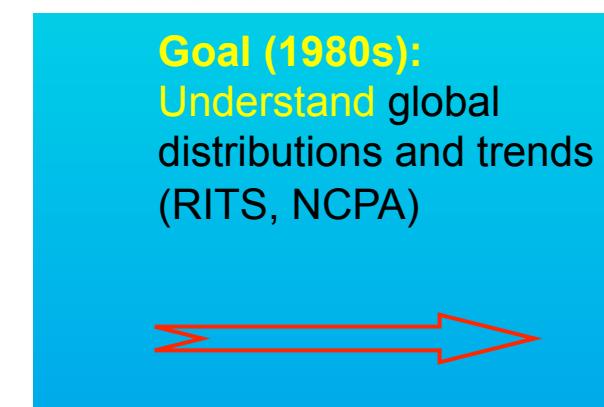
Evolution of NOAA's Global Carbon Cycle Monitoring Network



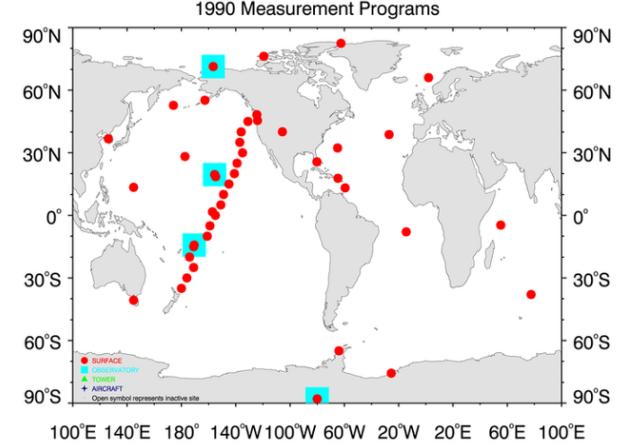
**Goal (2000s): Estimate
and track North American
sources and sinks
(USGCRP, NACP; Clean
Air Act; Fan et al 1998)**



**Goal (1970s): Determine
global trends (NCPA)**



**Goal (1980s):
Understand global
distributions and trends
(RITS, NCPA)**



**Goal (1990s):
Understand regional
sources and sinks (US-
GCRP; UNFCCC; Tans
et al 1990)**



Vaporum Inquisitor

Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE)

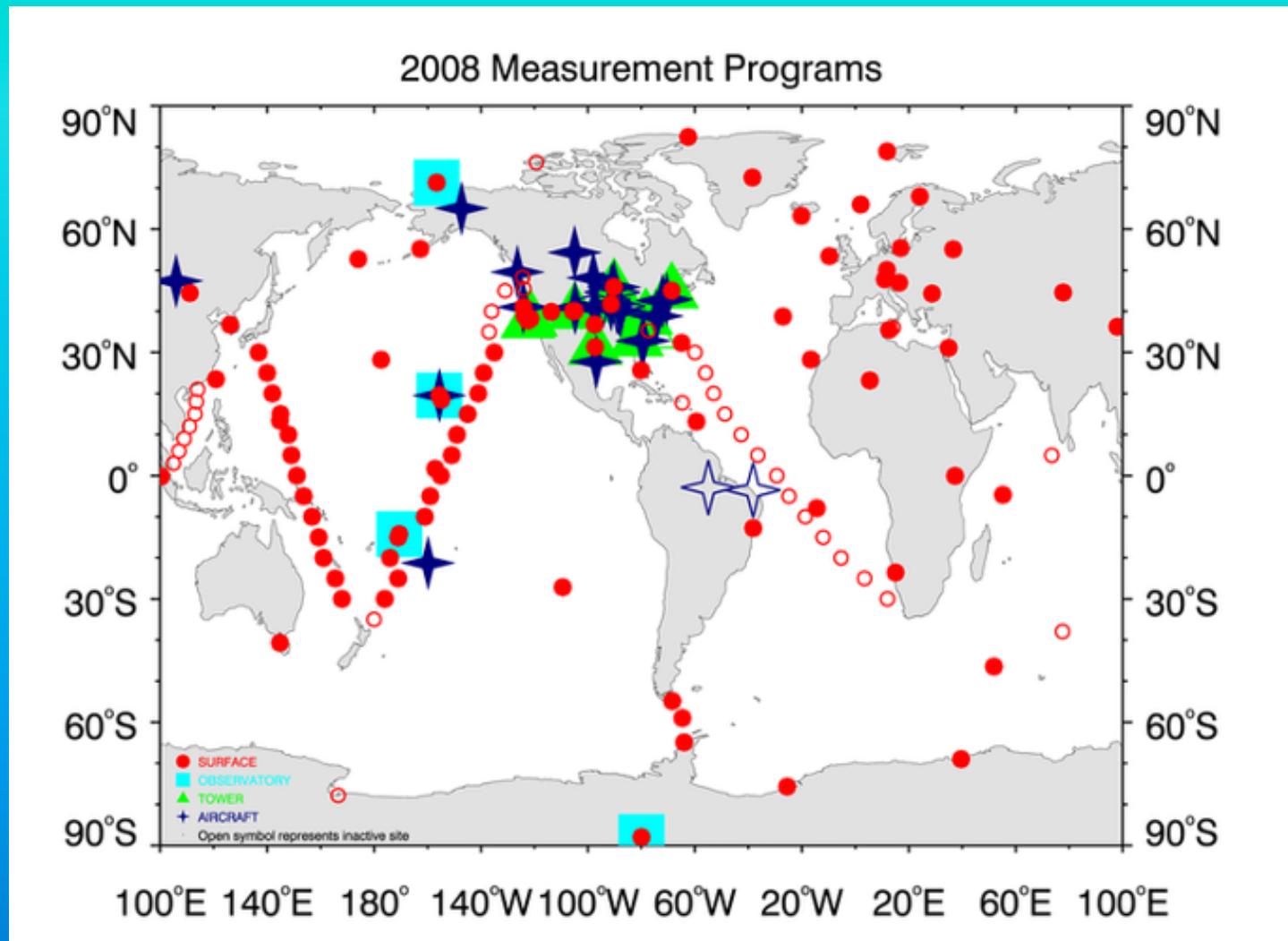
2012 Science Flights
24 July 2012:
Yukon Flats

Charles Miller, PI
Steve Dinardo, PM
Jet Propulsion Laboratory, California
Institute of Technology
and the CARVE Science Team

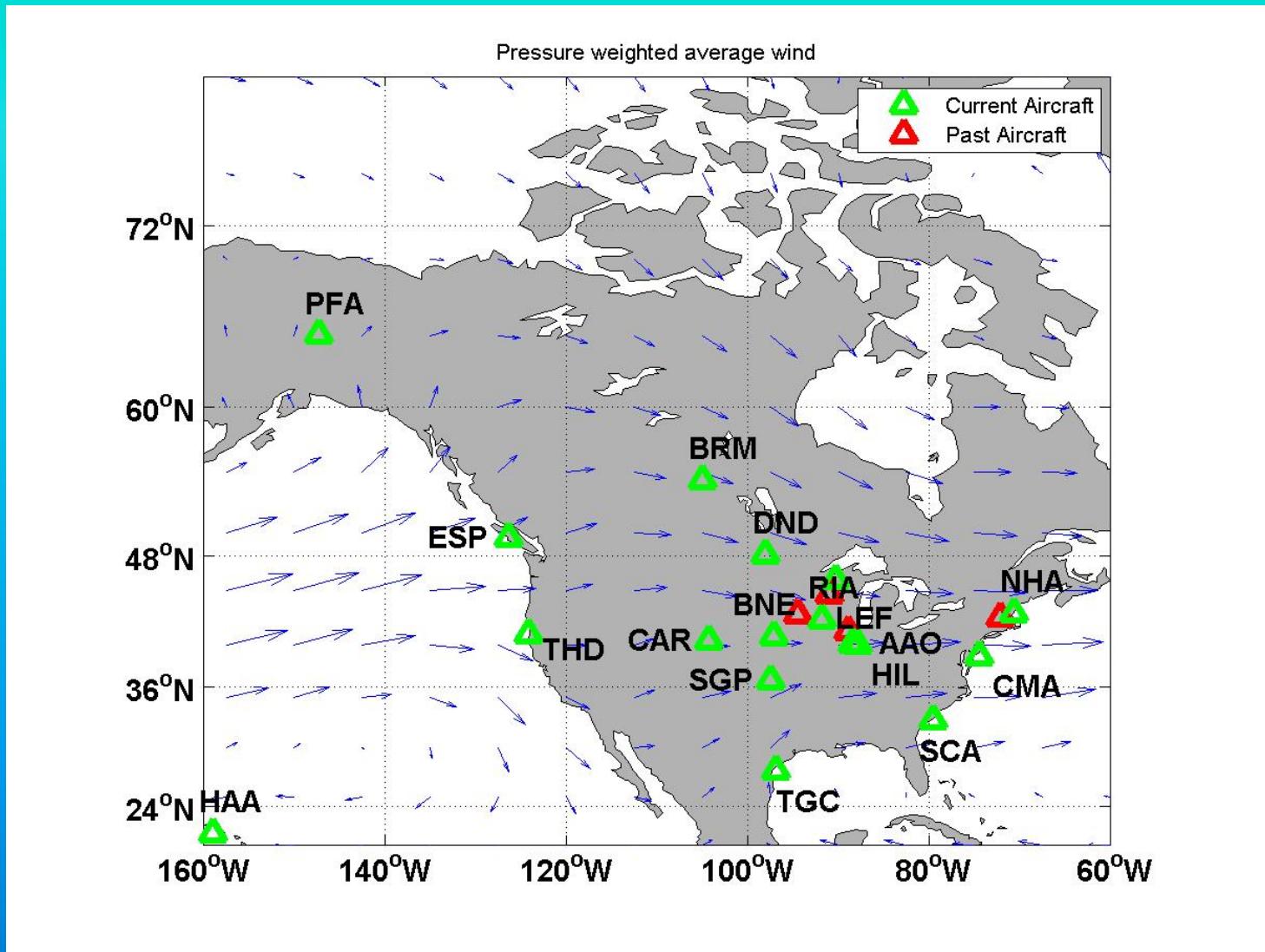
For Diane Wickland, NASA HQ
July 2012

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NOAA Flask and in-situ network



Current Aircraft Network

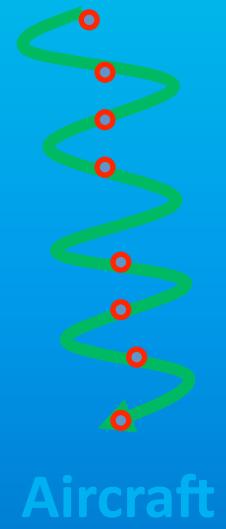




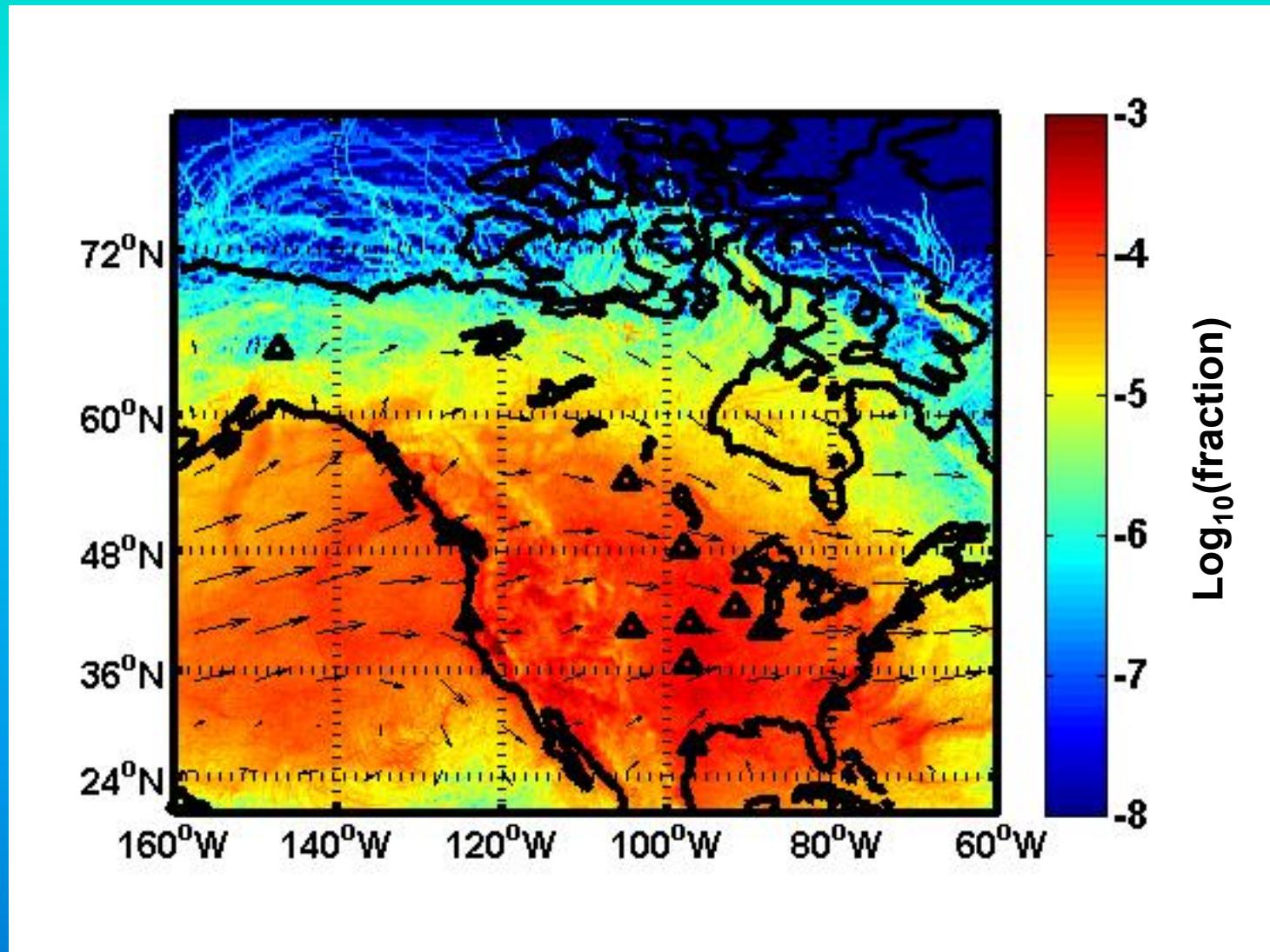
Automated Flask Sampling from Aircraft:

- One twelve-pack per flight
- Typical profile from 500 m AGL to 8000 m ASL
- Species: CO₂, CO, CH₄, N₂O, SF₆,
stable isotopes, halocarbons, COS,
hydrocarbons...

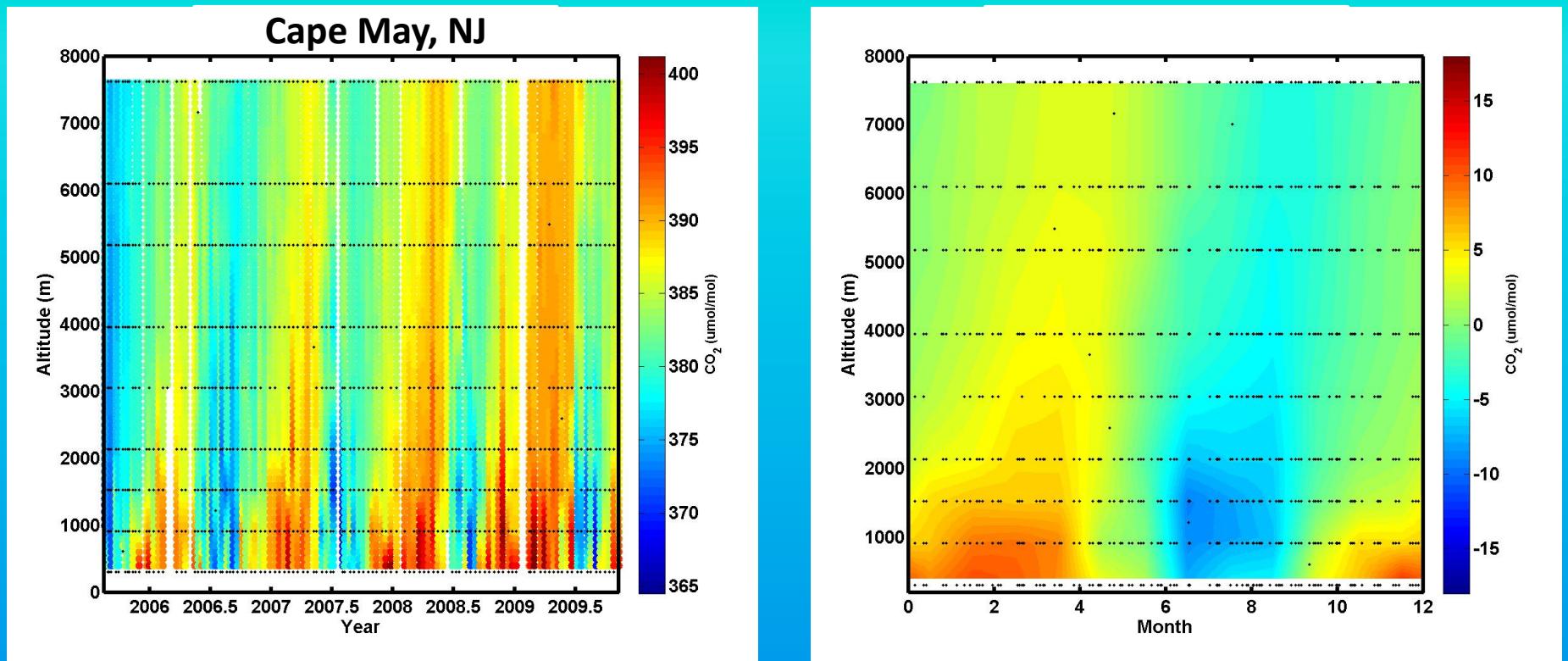
14CO₂ on a limited number of samples



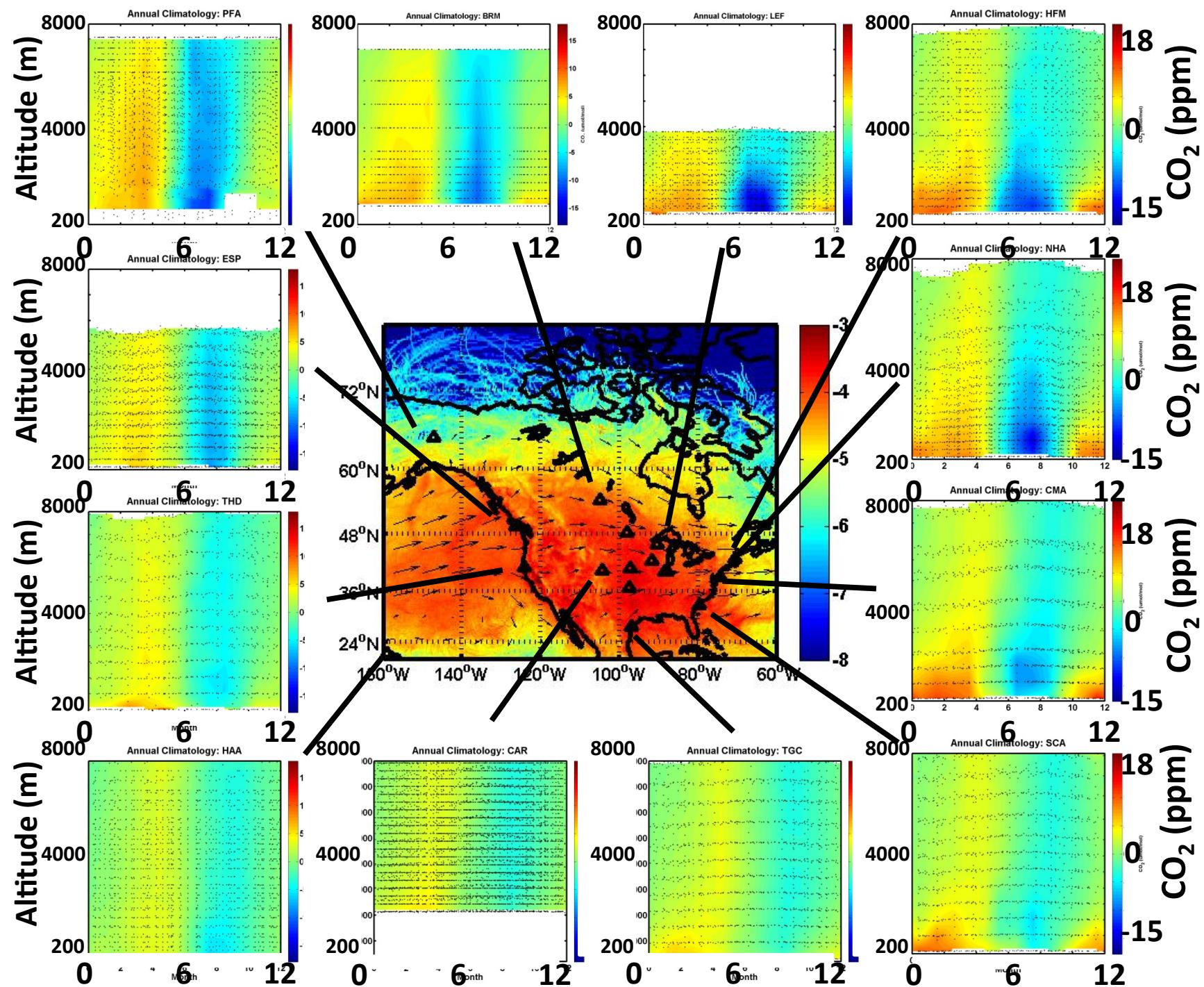
Current Aircraft Network



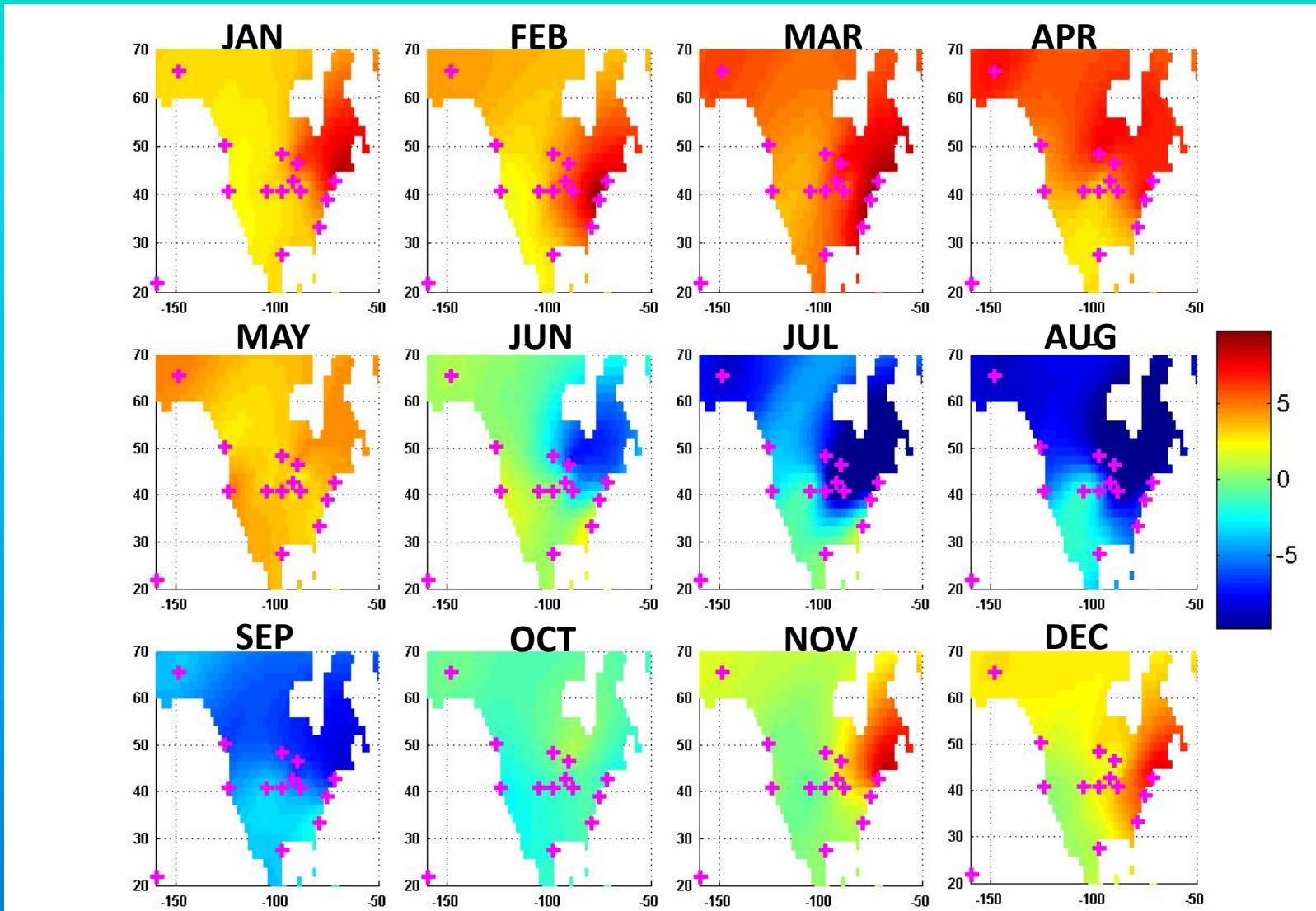
Annual Climatology

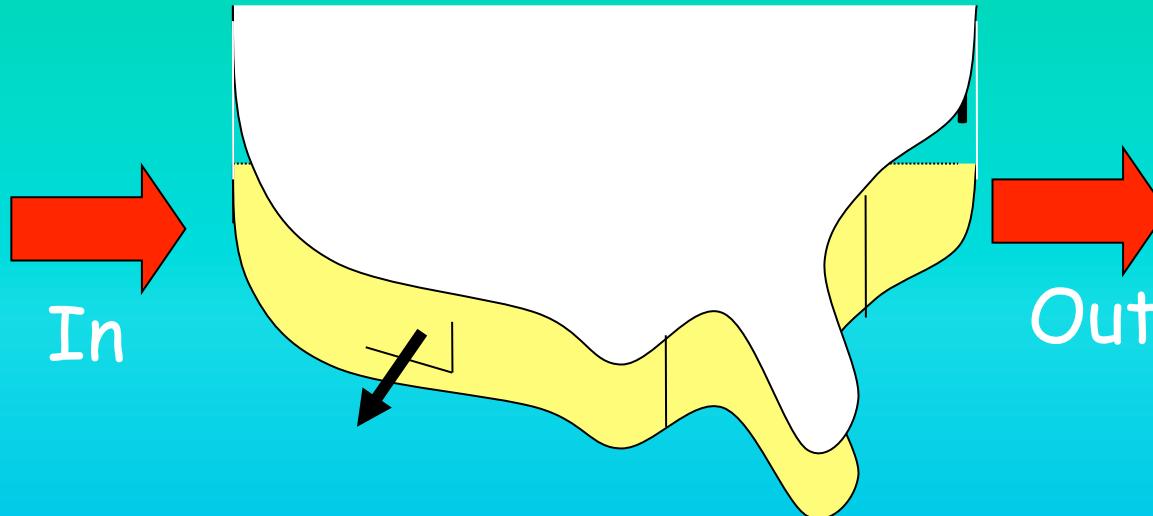


Deviation from global trend



Kriging interpolation – 850 mbar





F_{surf} → 1.22 GtC.yr^{-1}

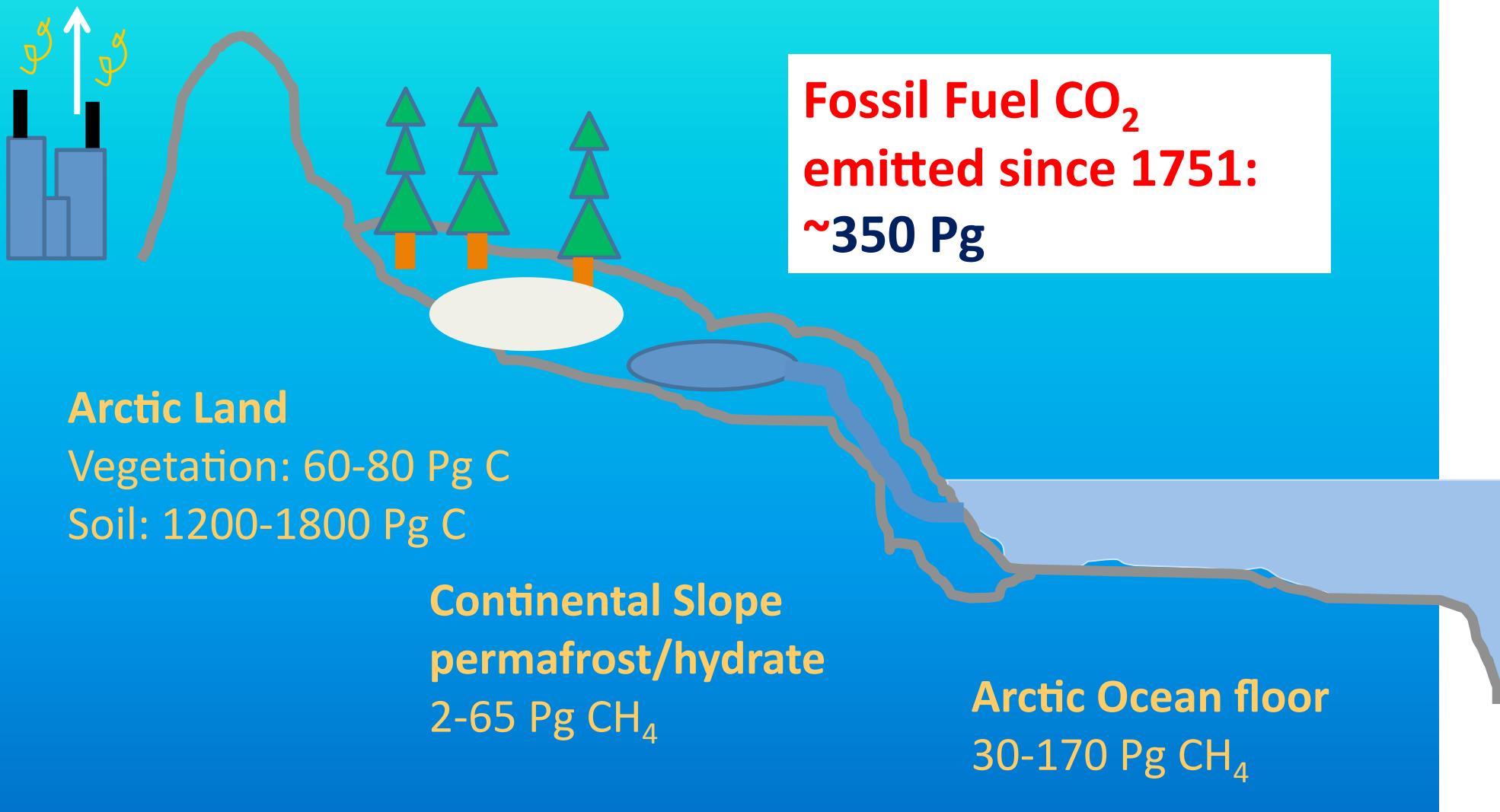
Fossil fuel emission → 1.73 GtC.yr^{-1}

North American sink: → $-0.5 \pm 0.4 \text{ GtC.yr}^{-1}$

- ✓ The **uncertainty** is derived from the kriging estimate of interpolation error and temporal and spatial biases.
- ✓ A potential **bias** comes from the convective flux, even if small, at 8 km.
- ✓ Simulations with atmospheric transport models give an **estimated bias of -0.1 GtC.yr^{-1}** , mainly in the South East during summer (June-August).

>2000 PgC could be released as CH₄ or CO₂

Fossil Fuel CO₂ emitted since 1751:
~350 Pg



Anthropogenic

Energy: 10 - 17 Tg CH₄/yr

Biomass burning: 0.5 - 2.5 Tg CH₄/yr

Waste: 5.3 - 7.5 Tg CH₄/yr

Terrestrial Ecosystem/

Permafrost

31 - 65 Tg CH₄/yr



Arctic Land

Vegetation: 60-80 Pg C

Soil: 1200-1800 Pg C

Continental Slope
permafrost/hydrate
2-65 Pg CH₄

Ocean

1 – 12 Tg CH₄/yr

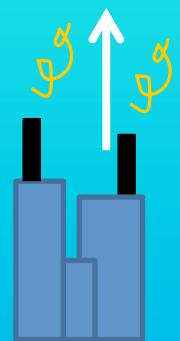
Arctic Ocean floor
30-170 Pg CH₄

Anthropogenic

Energy: 10 - 17 Tg CH₄/yr

Biomass burning: 0.5 - 2.5 Tg CH₄/yr

Waste: 5.3 - 7.5 Tg CH₄/yr



Terrestrial Ecosystem/

Permafrost

31 - 65 Tg CH₄/yr

Lakes (Walter et al. 2007)
16 – 35 Tg CH₄/yr

Arctic Land

Vegetation: 60-80 Pg C

Soil: 1200-1800 Pg C

Continental Slope
permafrost/hydrate
2-65 Pg CH₄

Ocean

1 – 12 Tg CH₄/yr

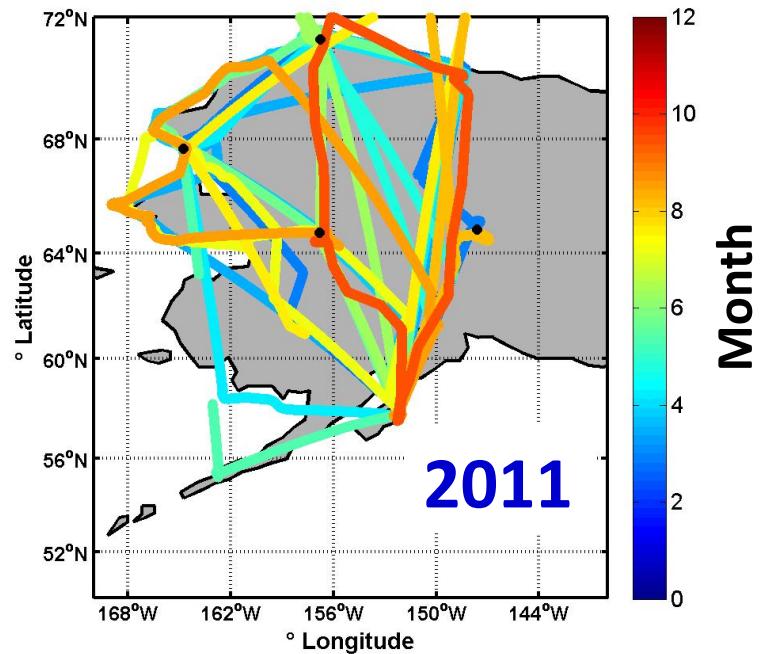
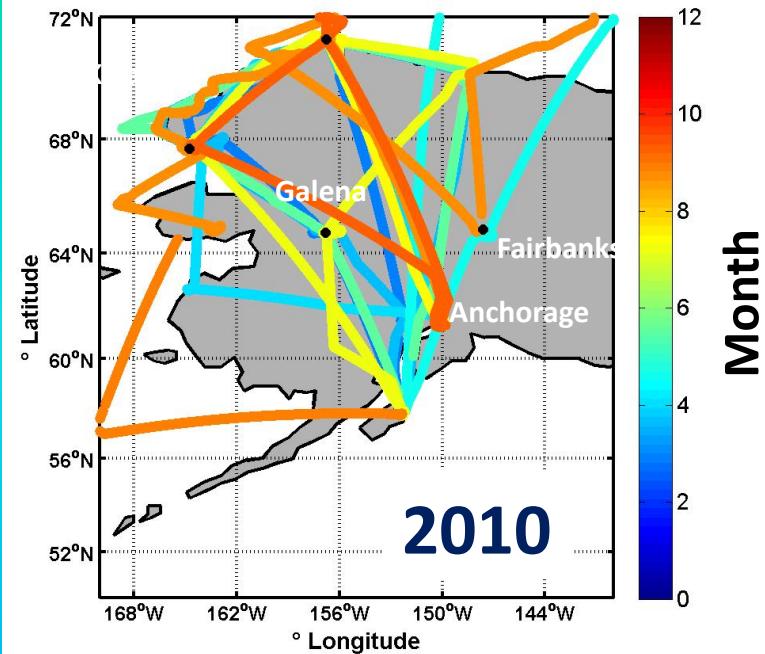
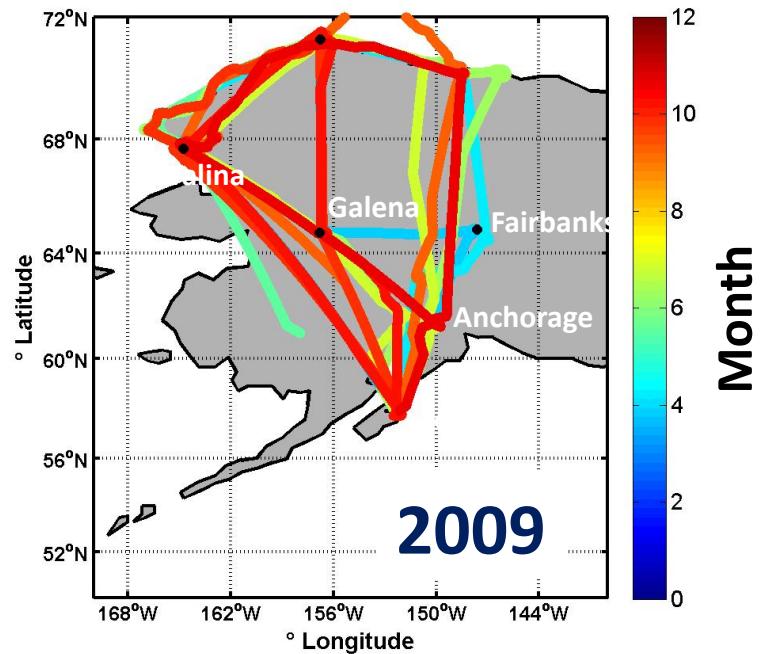
East Siberian Arctic Shelf
(Shakhova et al. 2010)
8 Tg CH₄/yr

Arctic Ocean floor
30-170 Pg CH₄

Alaska Coast Guard (ACG) Aircraft Site

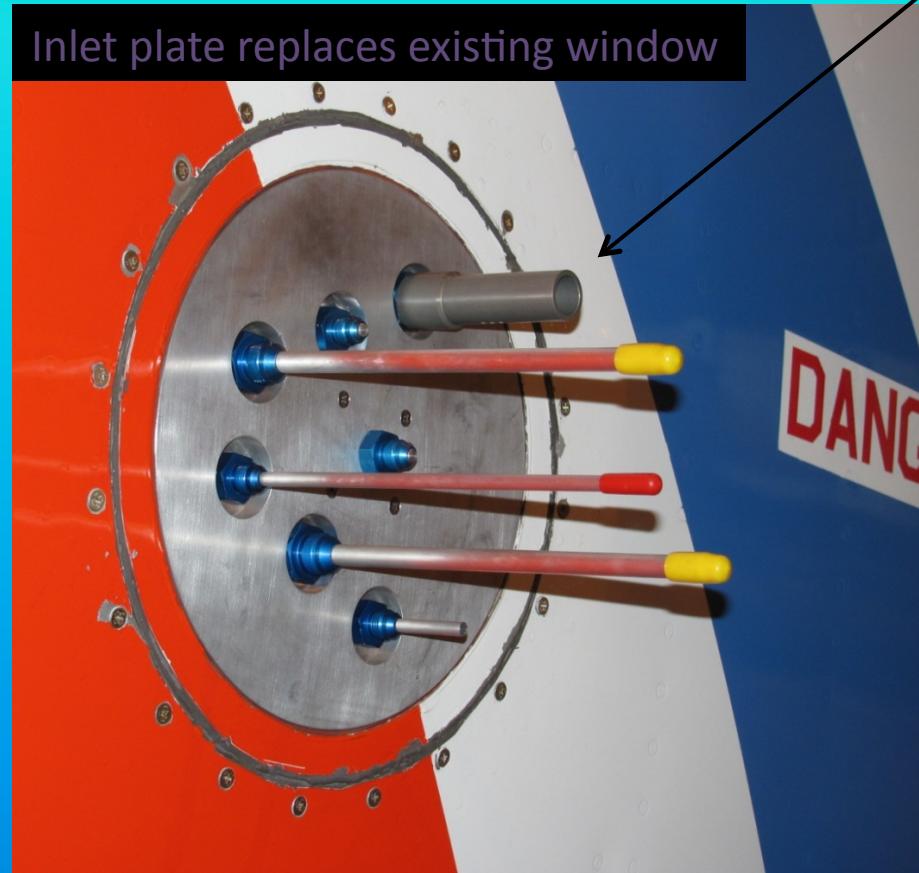


- U.S. Coast Guard conducts regular flights across Alaska for **Arctic Domain Awareness (ADA)**; for search and rescue operations as sea ice melts.
- NOAA/USCG collaboration – flights of opportunity
- Test bed for instrumentation for commercial aircraft
- Unprecedented scientific opportunity
 - monitoring Arctic response to warming and sea ice melting
 - establish baseline and monitor inter-annual variability
 - stratospheric/tropospheric exchange

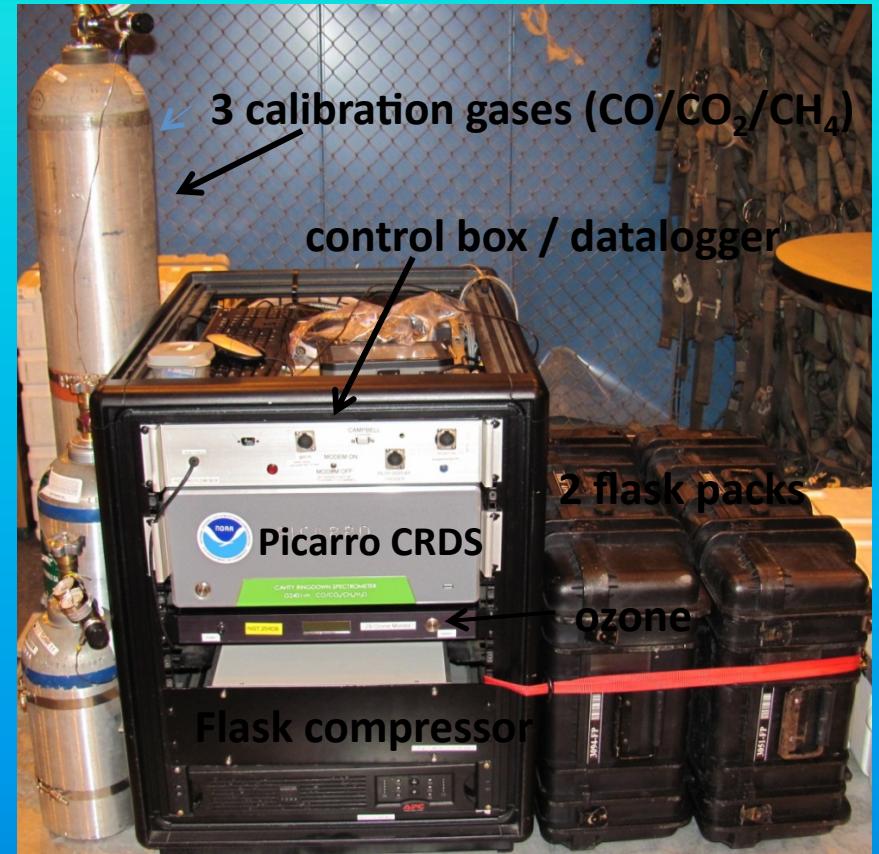


- Bi-weekly 8-hour flights on C-130
- March – November
- **16** flights per season
- large spatial extent (> 3000 km & 3 profiles per flight)
- much of the sampling occurs at high altitude (~8000 m)

Alaska Coast Guard (ACG) Aircraft Site

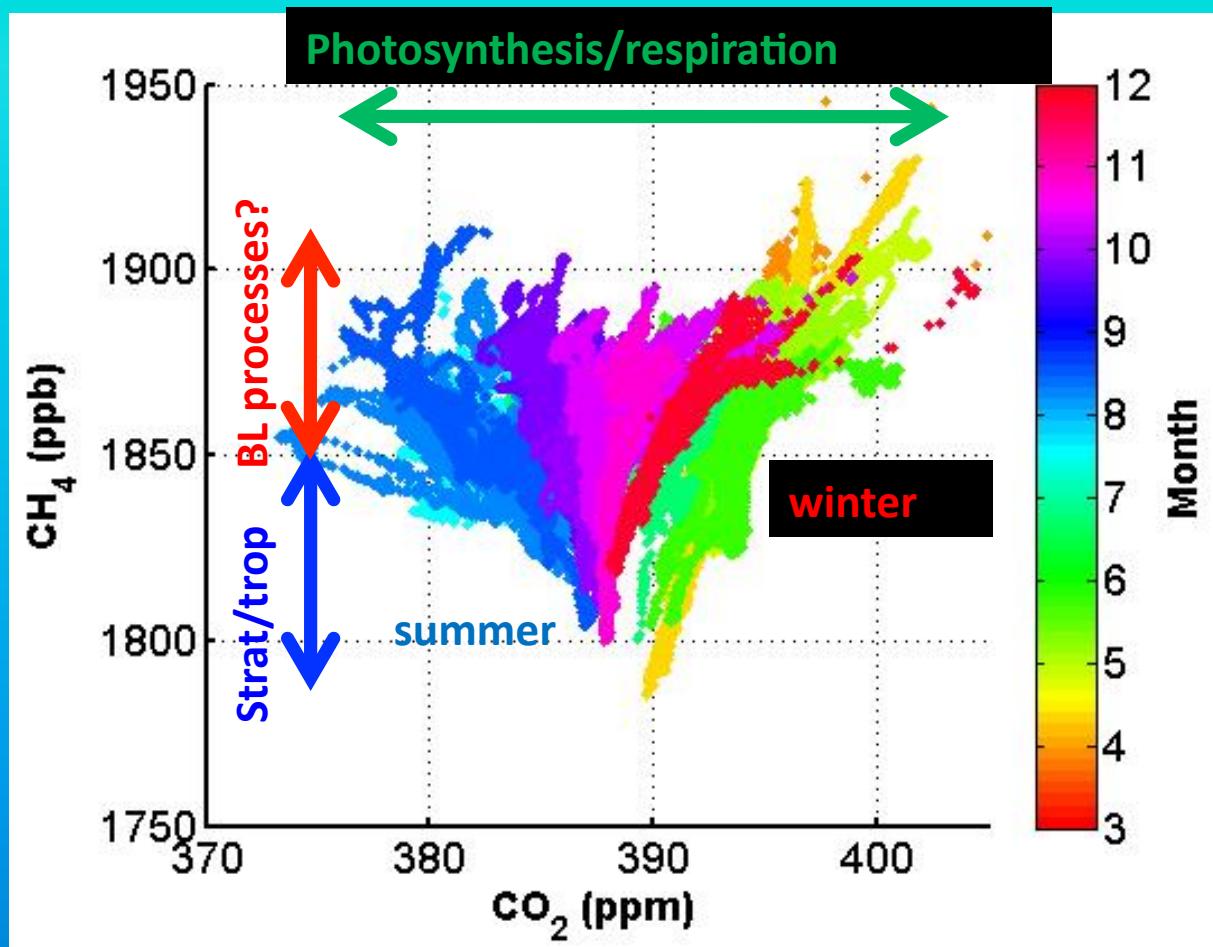


Temperature, RH, and Pressure also measured



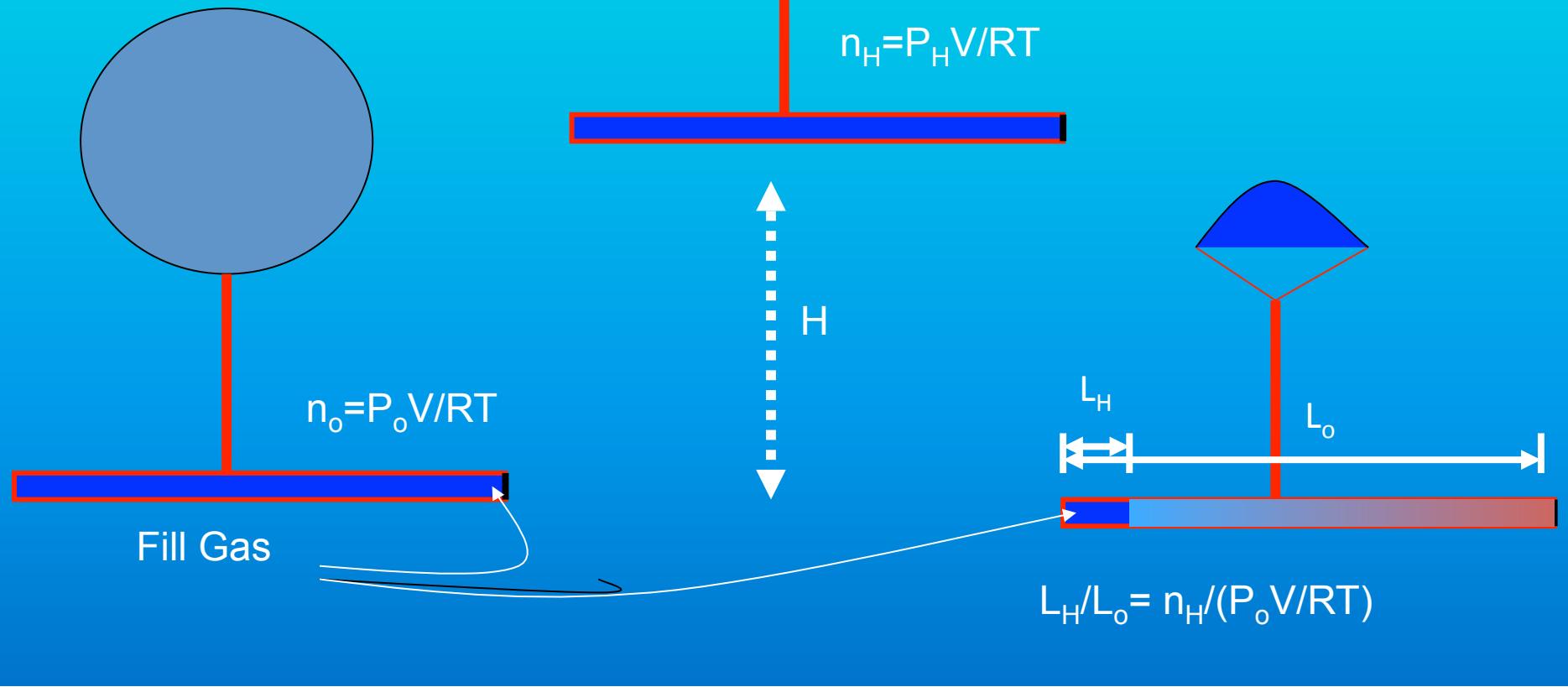
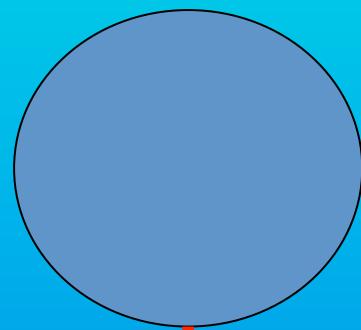
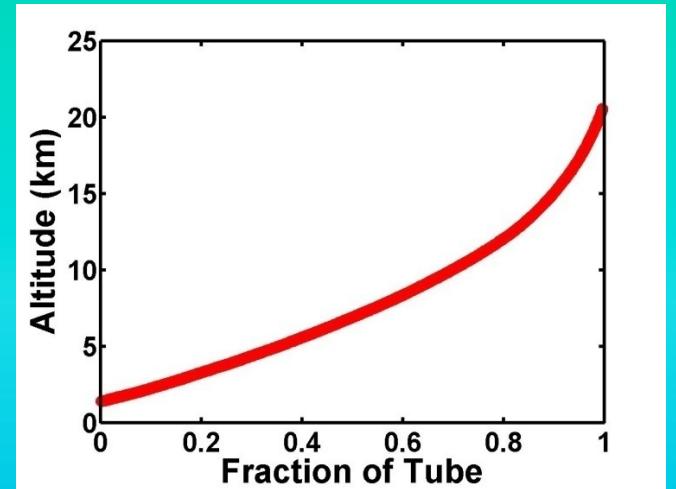
*Thanks to Duane Kitzis, Pat Lang, Paul Novelli for tanks and flask analysis.

Seasonal change in CH₄ and CO₂

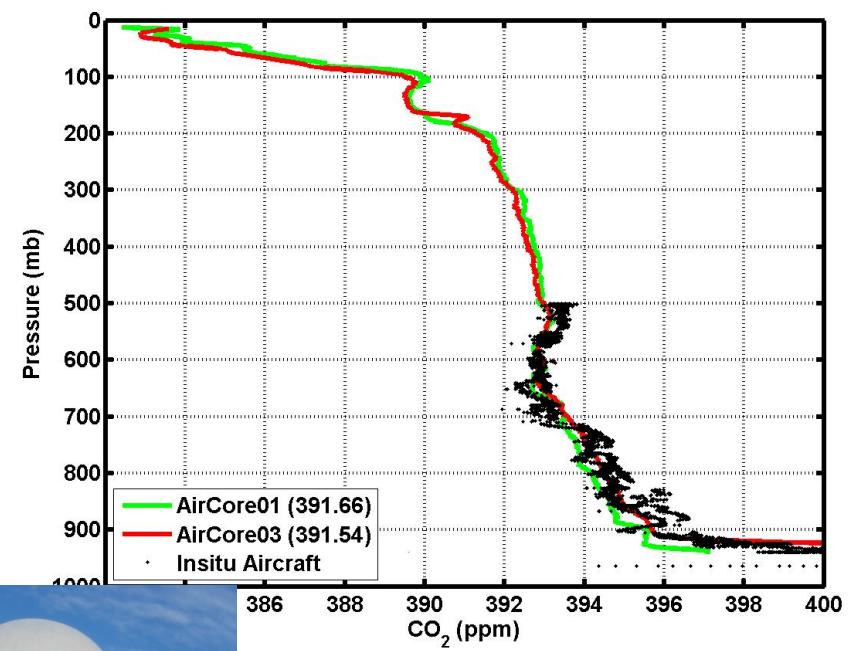
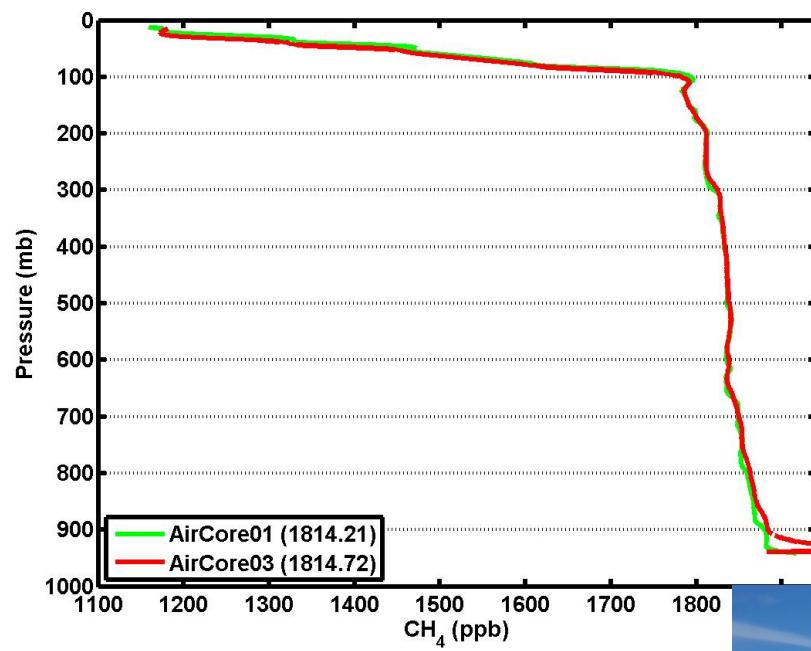




Passive AirCore Sampling System



AirCore



CH₄

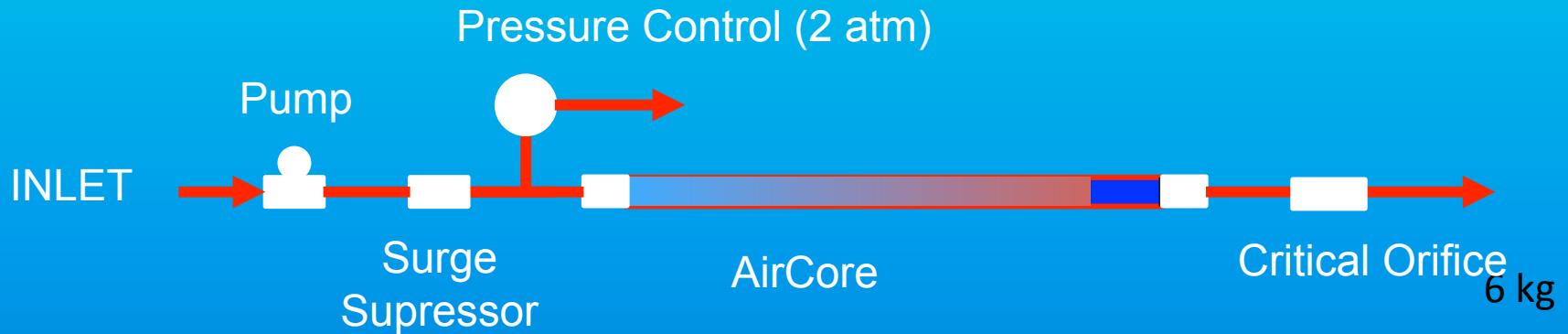


CO₂

Active AirCore Sampling System (Atmospheric Tape Recorder)

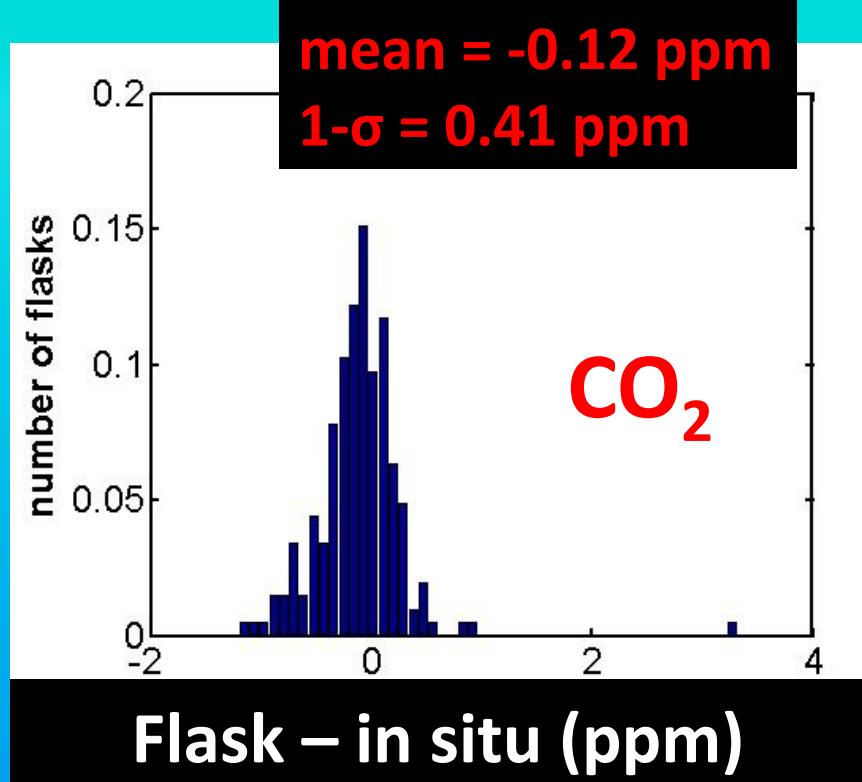


ScanEagle
6kg payload

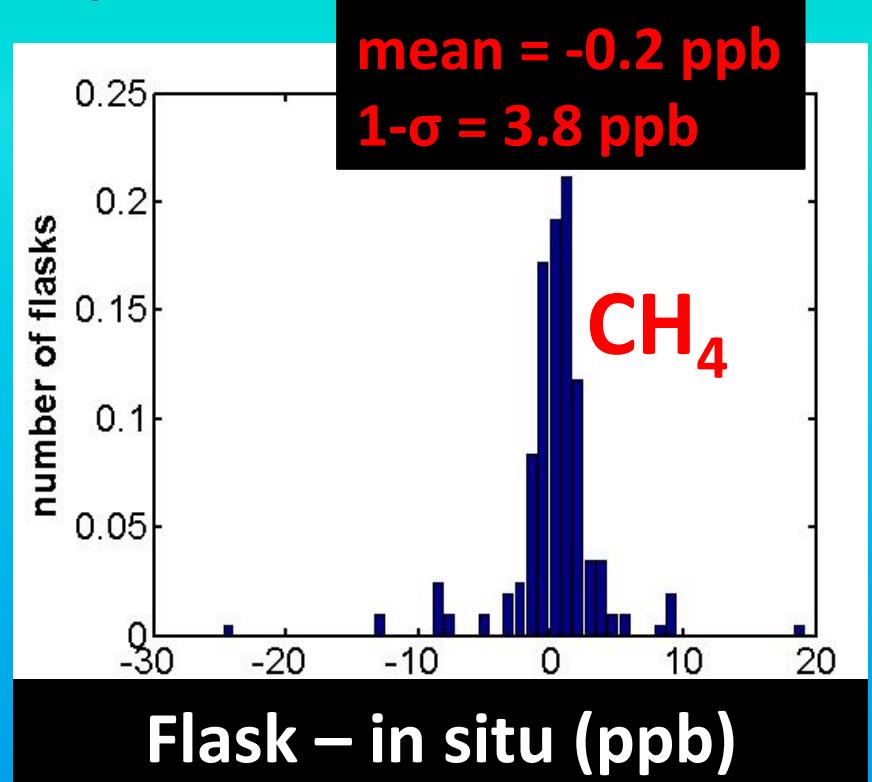


- 210 m stainless steel tube
- 240 discrete atmospheric samples
- 1.7 km during a 4-hour flight assuming an average speed of 60 knots

Flask Comparisons (2010 season)



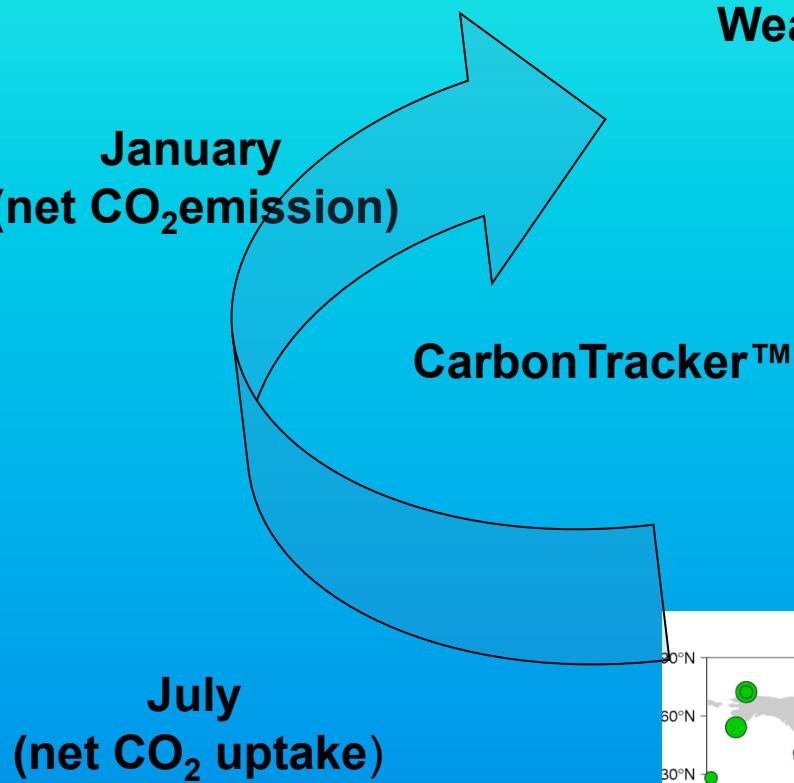
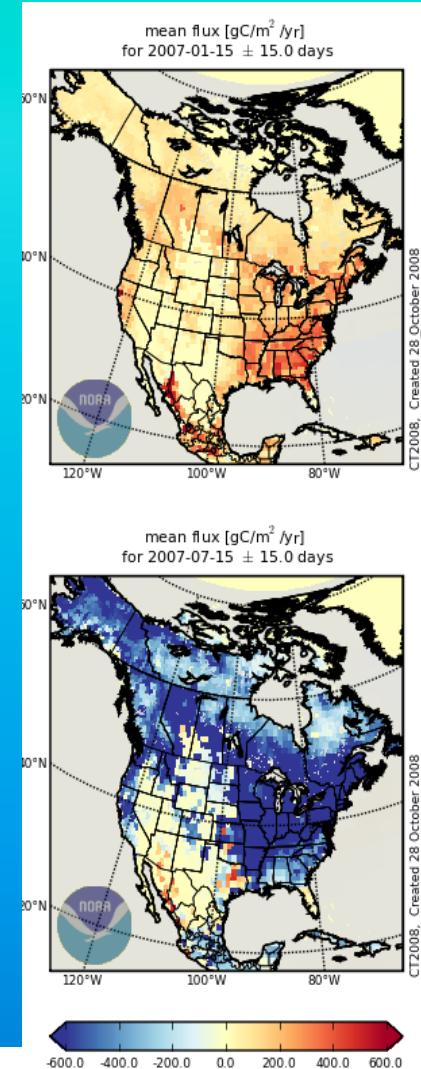
N=205



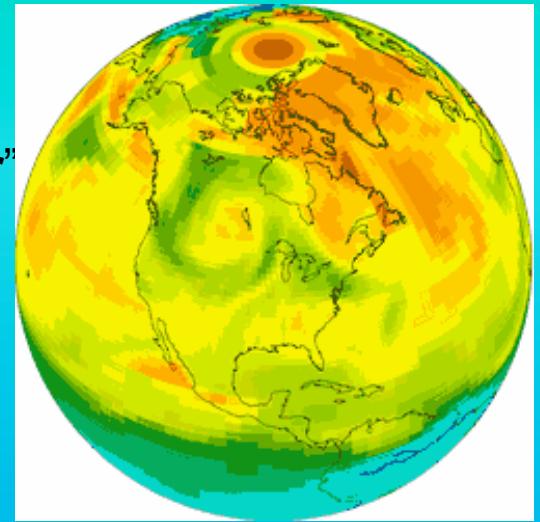
N=203

*only 2 flights with CO
so far: -3 ppb ± 4 ppb

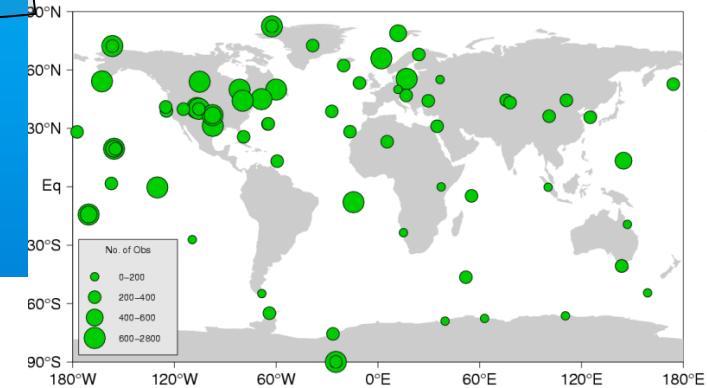
What NOAA does now



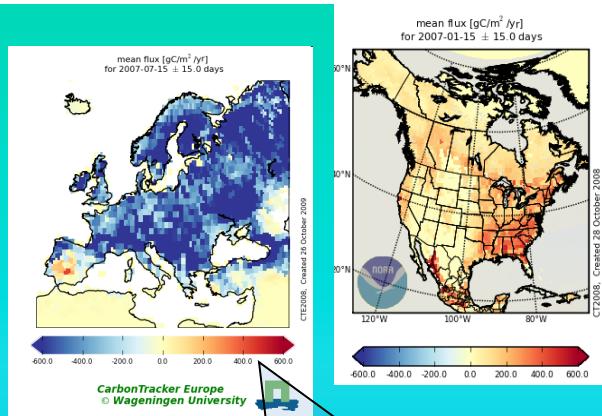
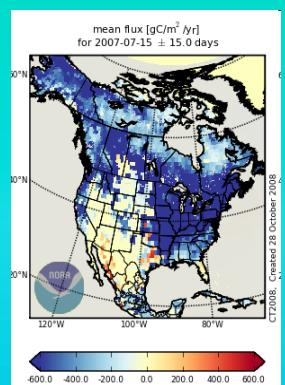
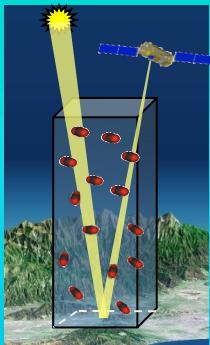
“Carbon Weather”



Long-term
Observations



Satellites



“Carbon Weather”

CarbonTracker™

TCCON



Earth Networks



Current Network

