A multi-pronged effort to enhance measurements of GHG vertical profiles

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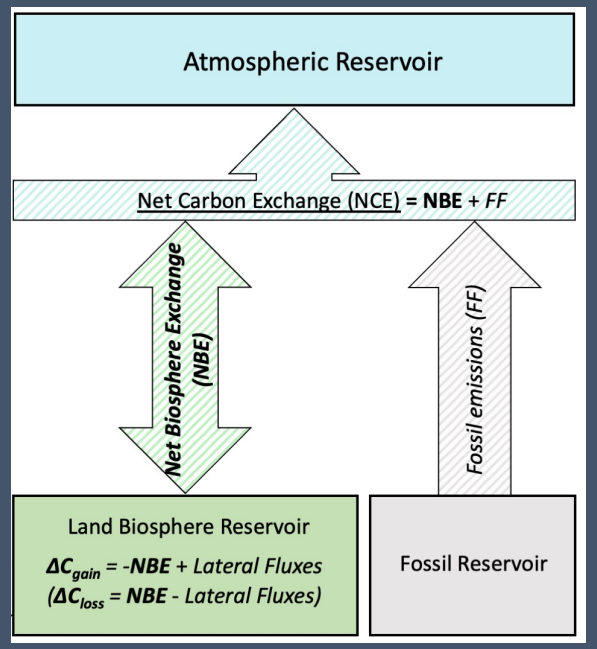
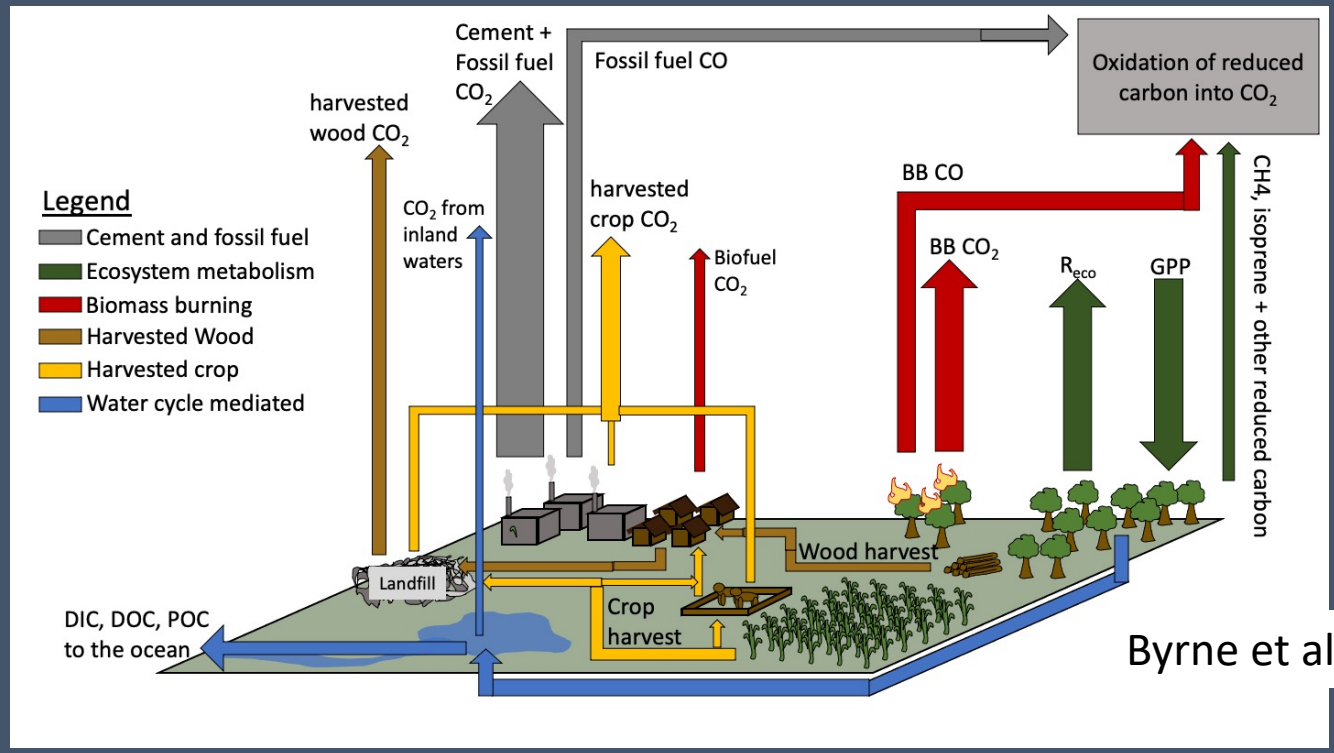
Goals for an integrated GHG Observing System



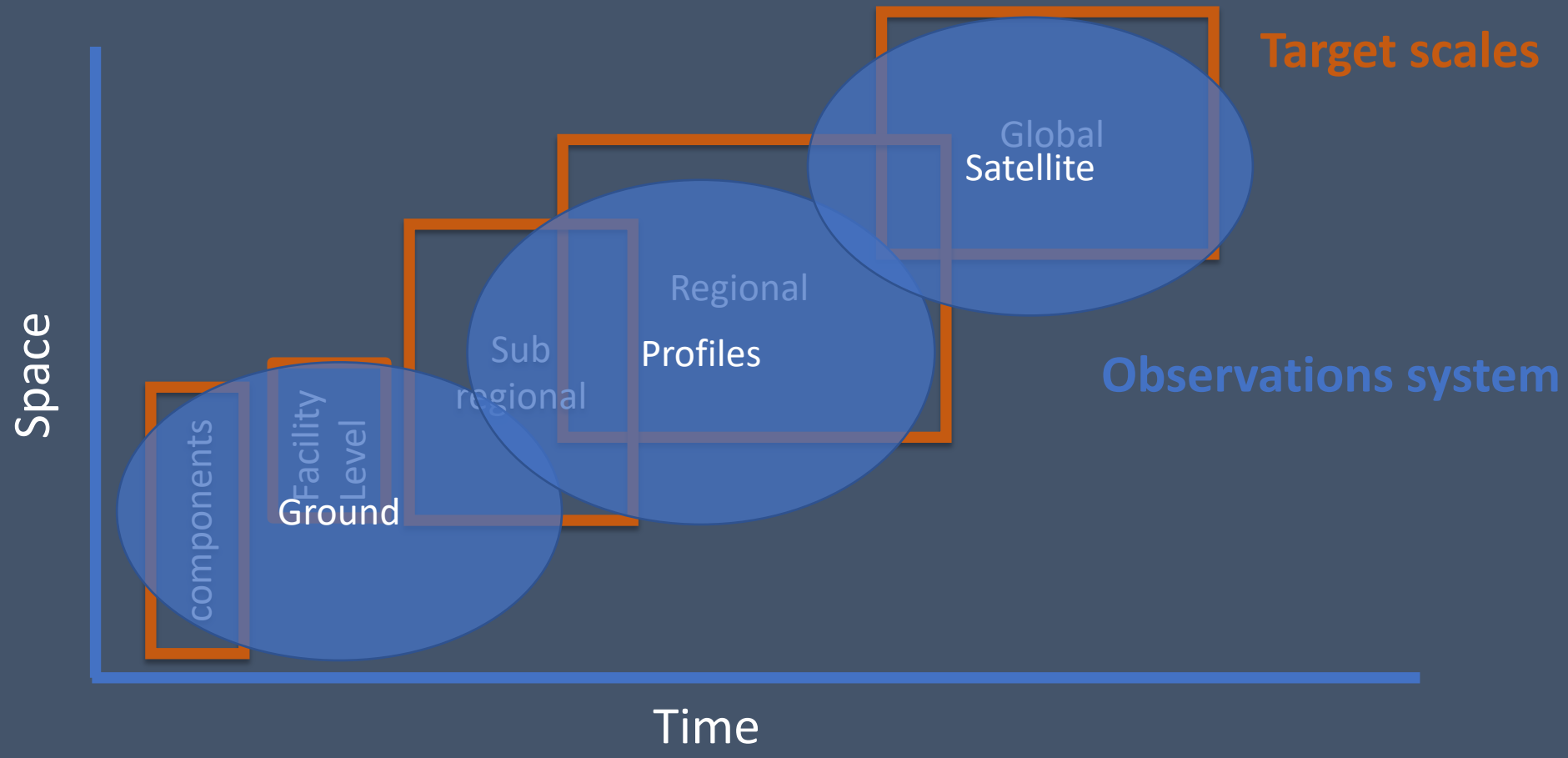


Byrne et al. (in prep)

Global Stocktake ⟷ **Quantification of a specific emitter**

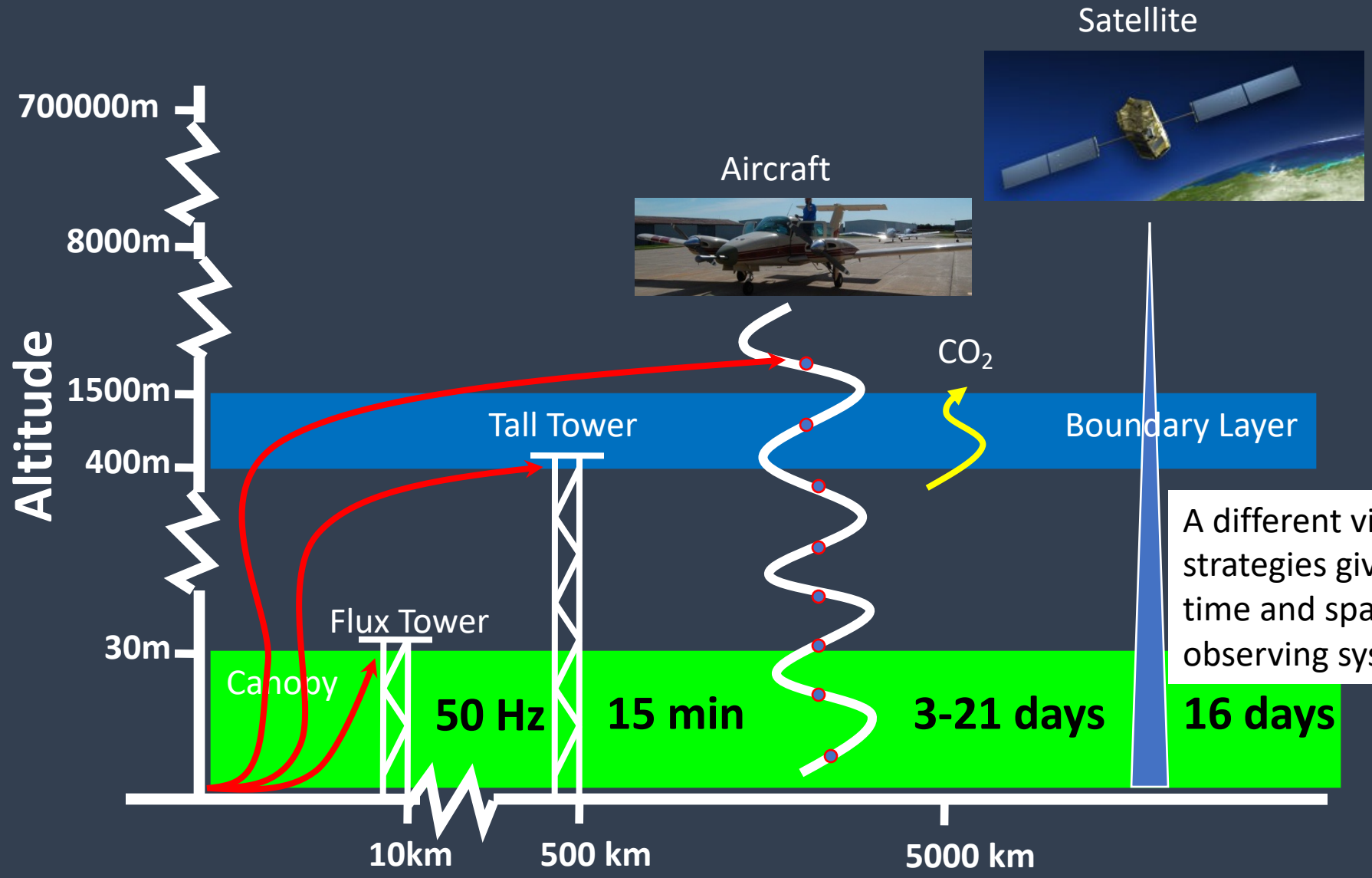
On one end of the spectrum of goals for an integrated observing system is the Global Stocktake on the other is quantifying underlying processes

The Space/Time perspective



To cover the required space and time scales we will be relying on an integration of many different observing system

Observing the terrestrial emissions



A different view of observing strategies gives a picture how time and space scales with observing systems

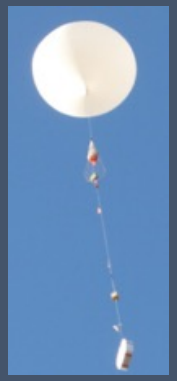
How do we get profiles:

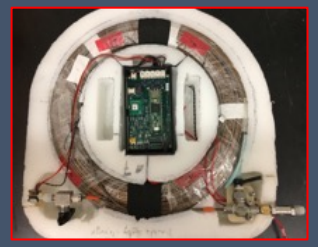
Atmospheric profiles currently come from a variety of platforms but they are limited in frequency and special extent with particular lack of resolution at smaller temporal and spatial scales

Flask Sampling

- Weekly to monthly
- Background sites
- US/Siberia

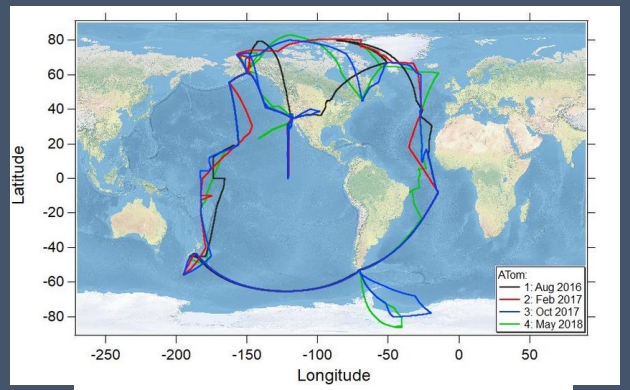
AirCore

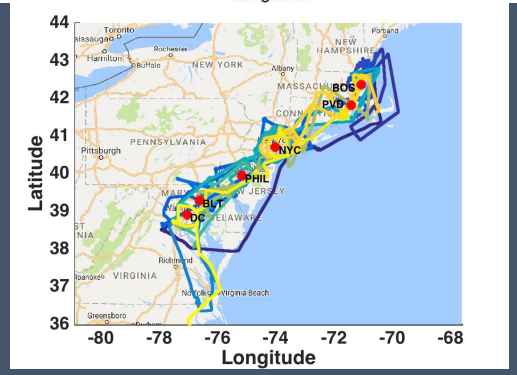




- Monthly
- Background sites
- US, FR, NZ, AU, FI, NL

Campaigns



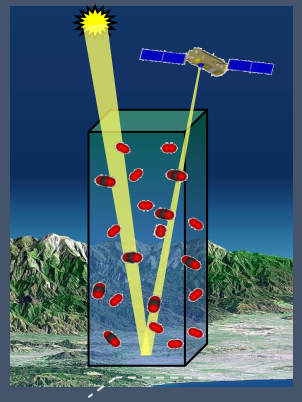


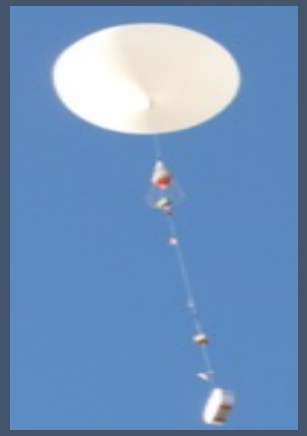
- Multi-day
-Background/process
- Global to local

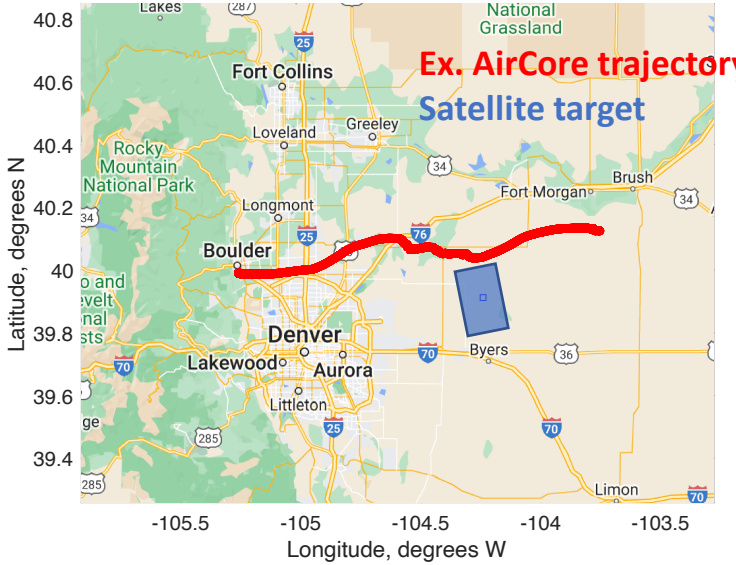
- Daily
- Background/Metro
- Global to local

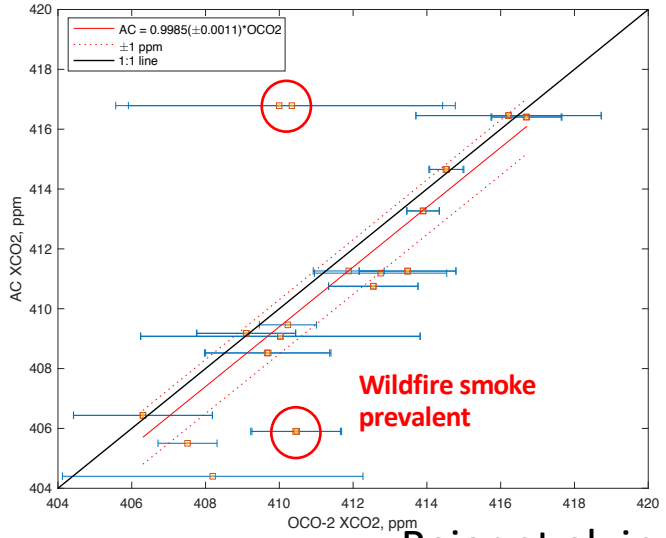
Satellite validation – AirCore example

A critical role for profiles is as a tool to evaluate satellite retrievals. It turns out the AirCore is the most effective but timing overpasses with flights remains are biggest problem







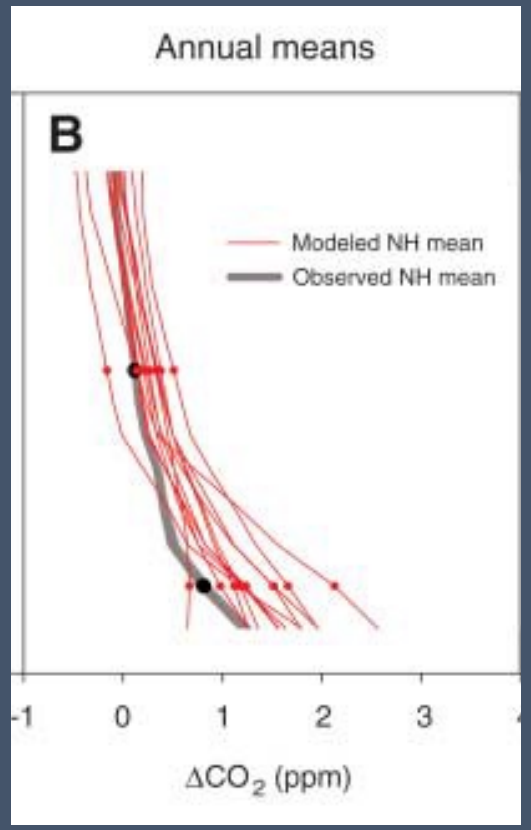


Baier et al. in prep

Platform	Altitude ceiling (km)	Estimated XCO_2 Error (ppm)	Estimated Average Cost per Profile ($)
Light aircraft	~4	1.2	1.5K
Jet	~12	0.3	10K
AirCore	~30	0.1	5K

Model Validation

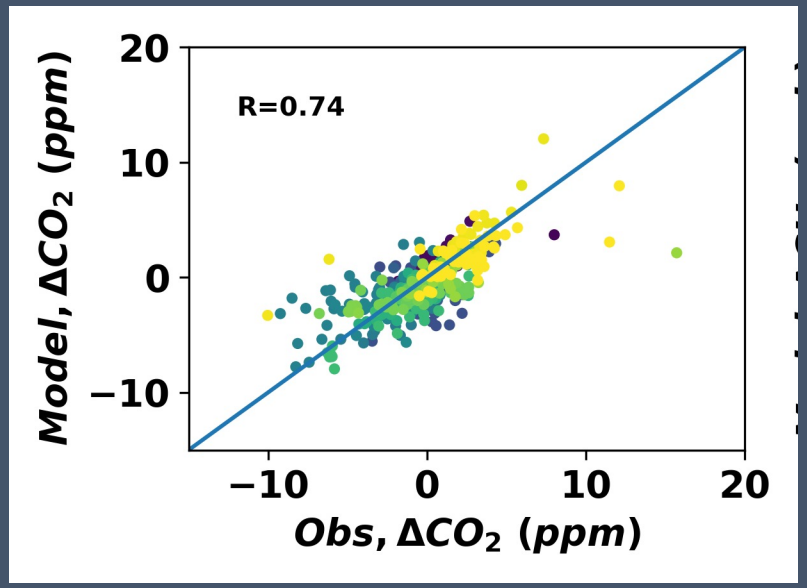
Biases in Vertical Gradients



Multiple studies have suggested a miss-match in vertical gradients leads to local and global flux biases.

Stephens et al. 2007

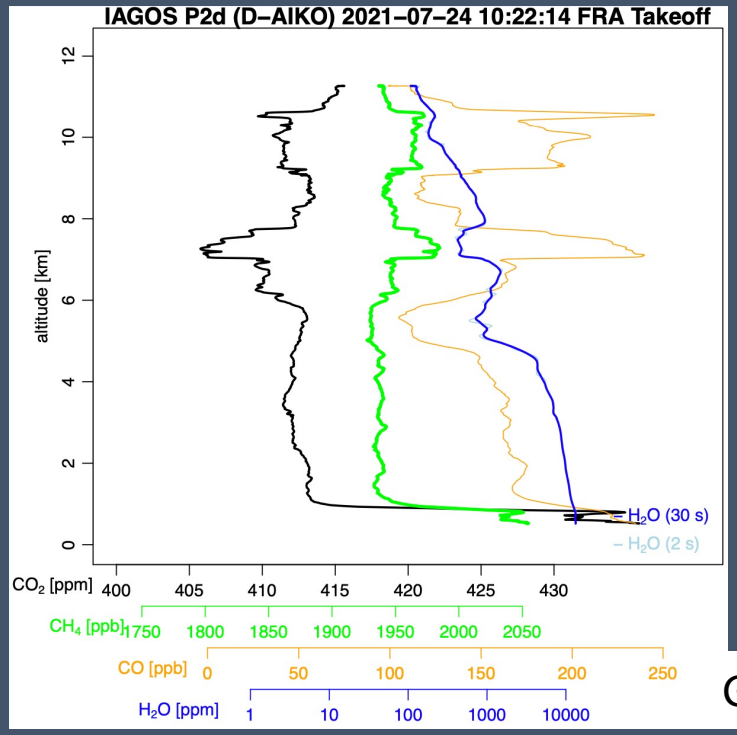
Emissions biases (fluxes in/out of atm.)



Detailed measurements in vertical profiles allows us to not only integrate the full change but to account for FT biases

Why do we care about measurements above boundary layer?

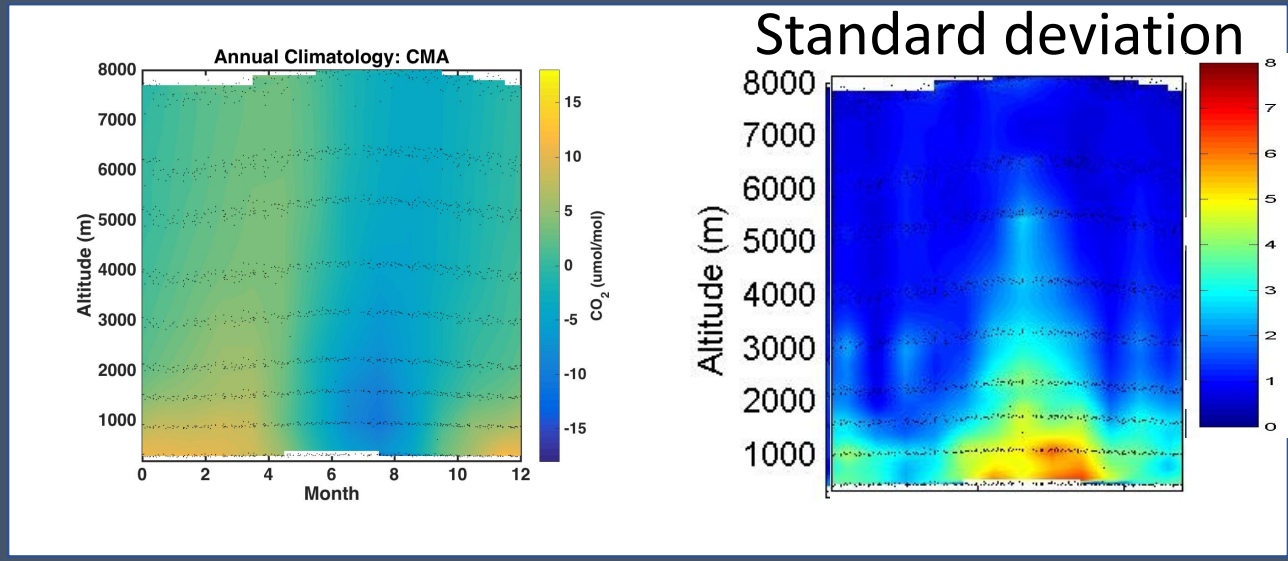
Potential for high variability from IAGOS



Gerbig et al. (in prep)

High variability in free troposphere suggests non local emissions

Independent means for extracting background



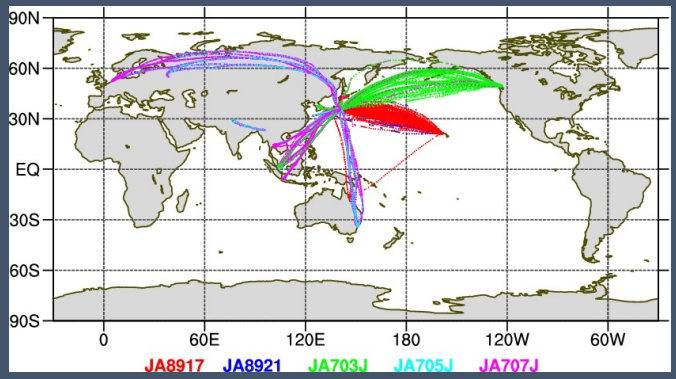
Standard deviation for 15 years of measurements shows that the free troposphere can be a good background.

What resources do we have?

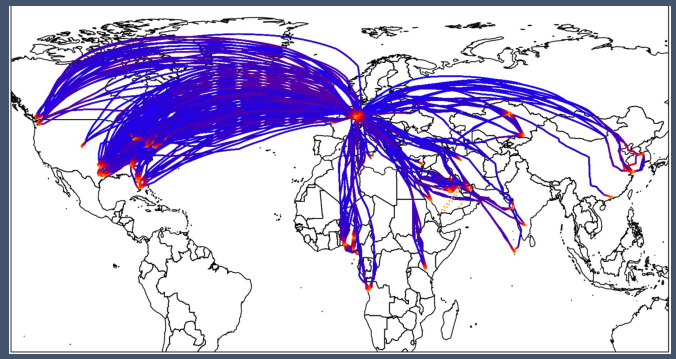
- **Flask profiles**
  - 15 sites (low frequency)
- **AirCore**
  - ~ 5 sites (low frequency)
- **Commercial Aircraft**
  - Contrail (B777 and B787): 8-10 aircraft
  - IAGOS (A330 and A340): 1 current – 3 more on the way
- **Light Aircraft**
  - Brazil
  - Uganda/Africa

Our current profile coverage is not enough

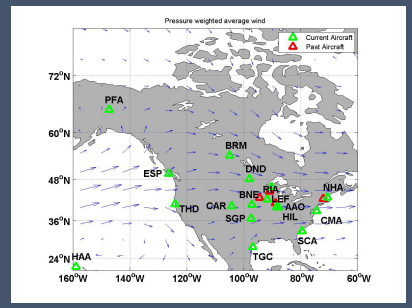
Contrail



IAGOS



Light Aircraft

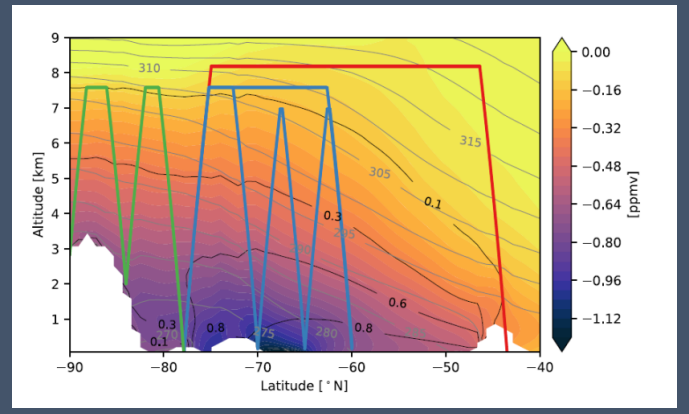


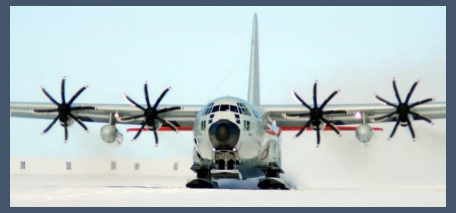
What's new?

Reginal jets like the B737 and A320 are going to give us more flights a day

Regional commercial Aircraft flights

Southern Ocean Carbon Gas Observatory (SCARGO)



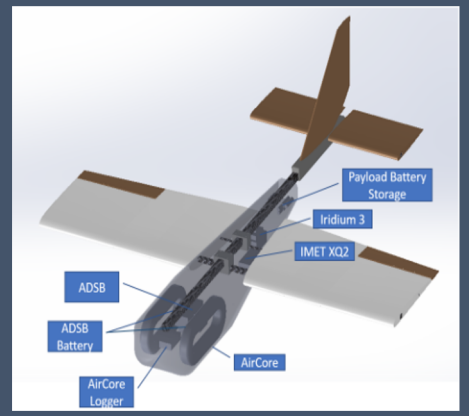


Uganda

Dedicated 3- 4 year campaigns covering multiple seasons in background observatories are needed to cover polar and gaps in global networks.

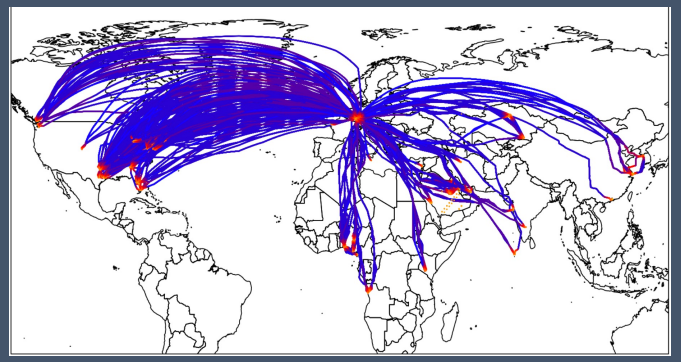
Return vehicle for AirCore

Launch locations for the AirCore are limited because balloon package is at the mercy of the wind



What does the mult-pronged network look like?

Commercial Aircraft



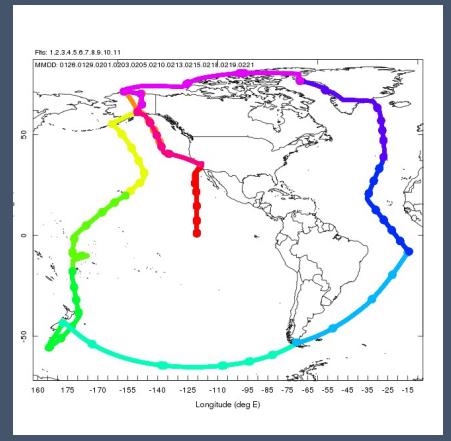
Long-haul

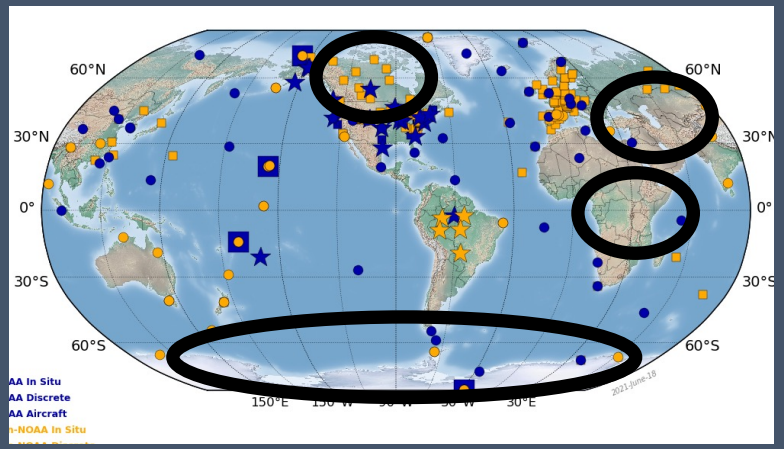
Regional

Balloon-borne

Light Aircraft

Campaigns





We need to enhance our airborne sampling efforts by more than an order of magnitude this will require enhancing regional coverage where commercial aircraft are available and where they are not we will have to rely on light aircraft, balloons and campaigns