Contributions and the future of the vertical profile to constrain continental and regional North American carbon budget

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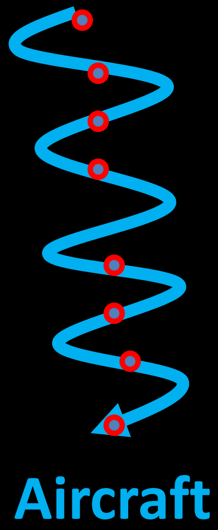
Main Points

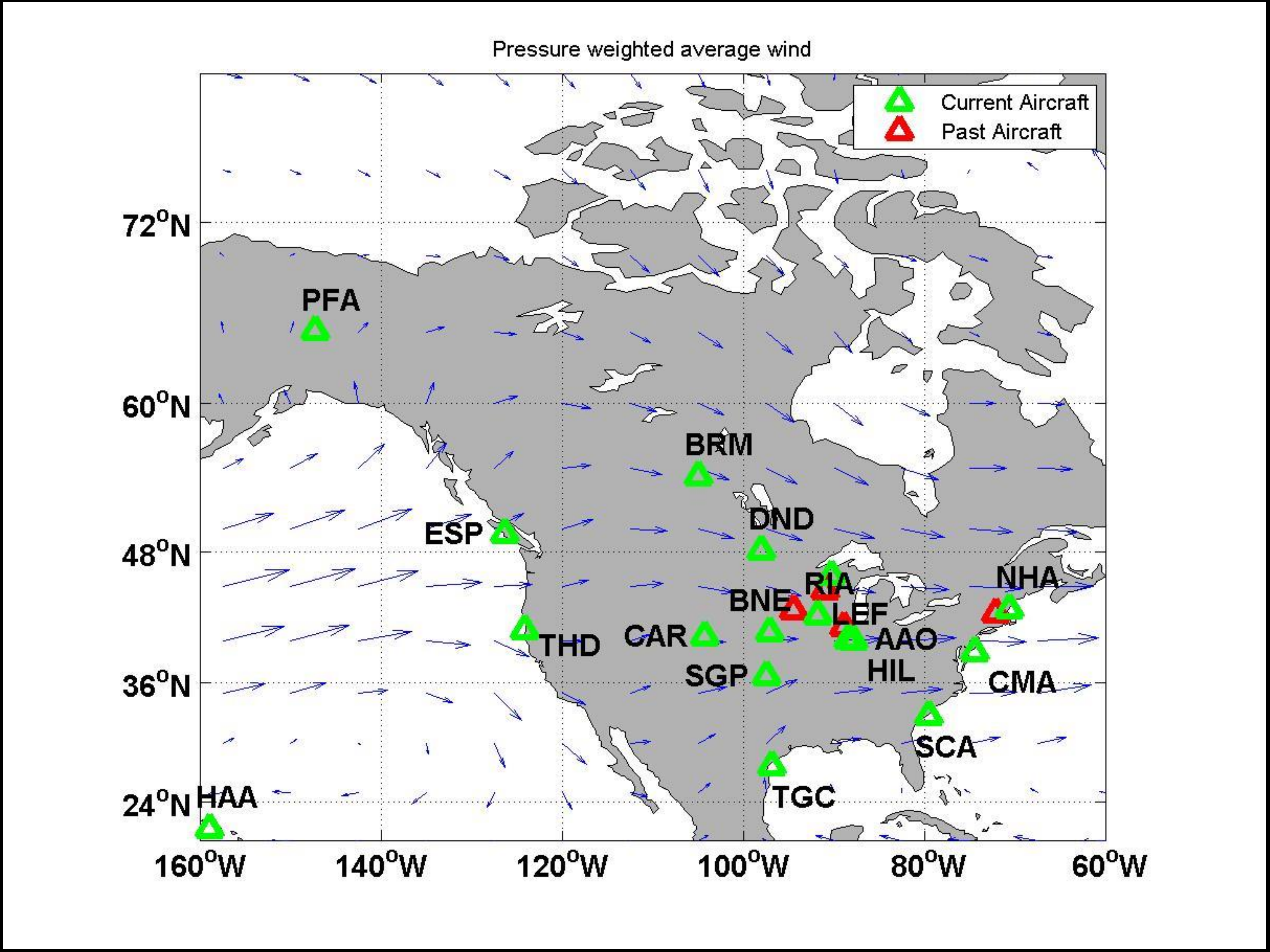
1. **Independent flux estimate: Less dependent on vertical transport**
2. **Background: In situ aircraft profiles are a key source of validation for background conditions.**
3. **Need more measurements:**
   a. **Interannual variability in surface fluxes**
   b. **Regional estimates of surface fluxes**
   c. **Troposphere/stratospheric exchange**

Automated Flask Sampling from Aircraft:

- One twelve-pack per flight
- Typical profile from 500 m AGL to 8000 m ASL
- Species: CO_2, CO, CH_4, N_2O, SF_6,
  stable isotopes, halocarbons, COS,
  hydrocarbons…
  $^{14}CO_2$ on a limited number of samples



Current Aircraft Network



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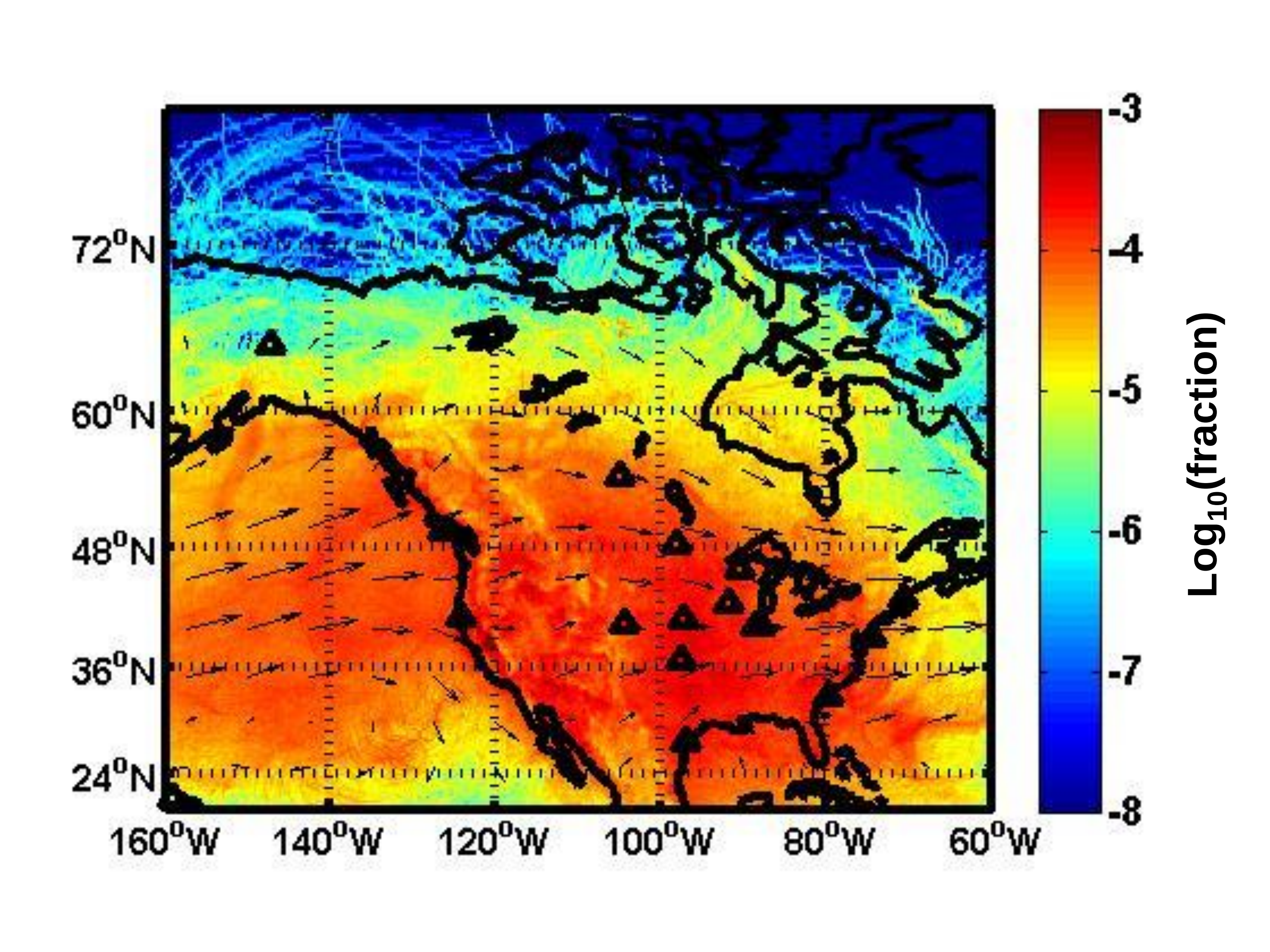
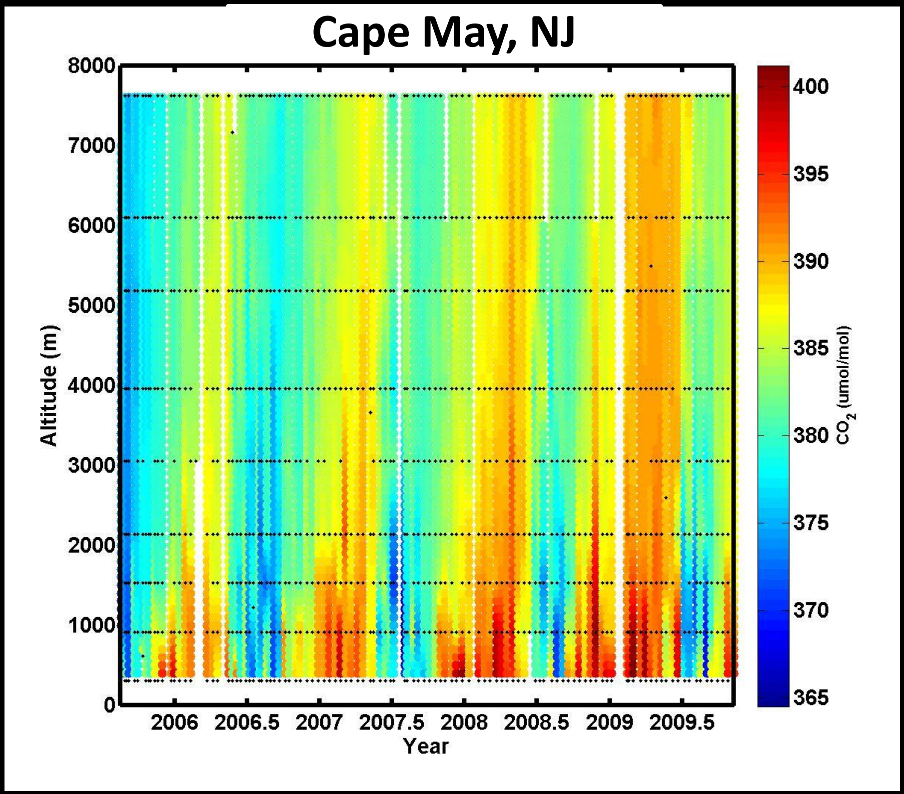
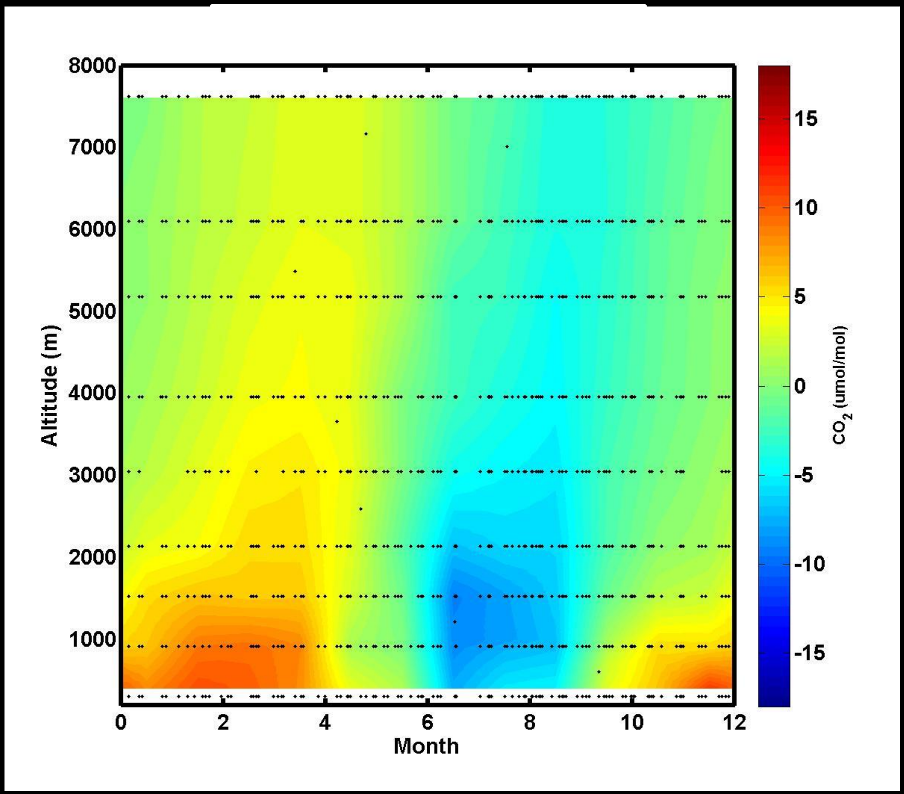
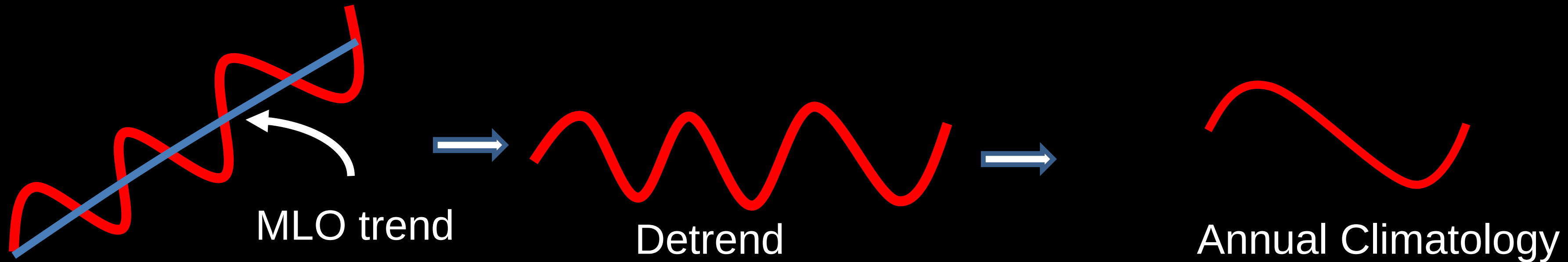
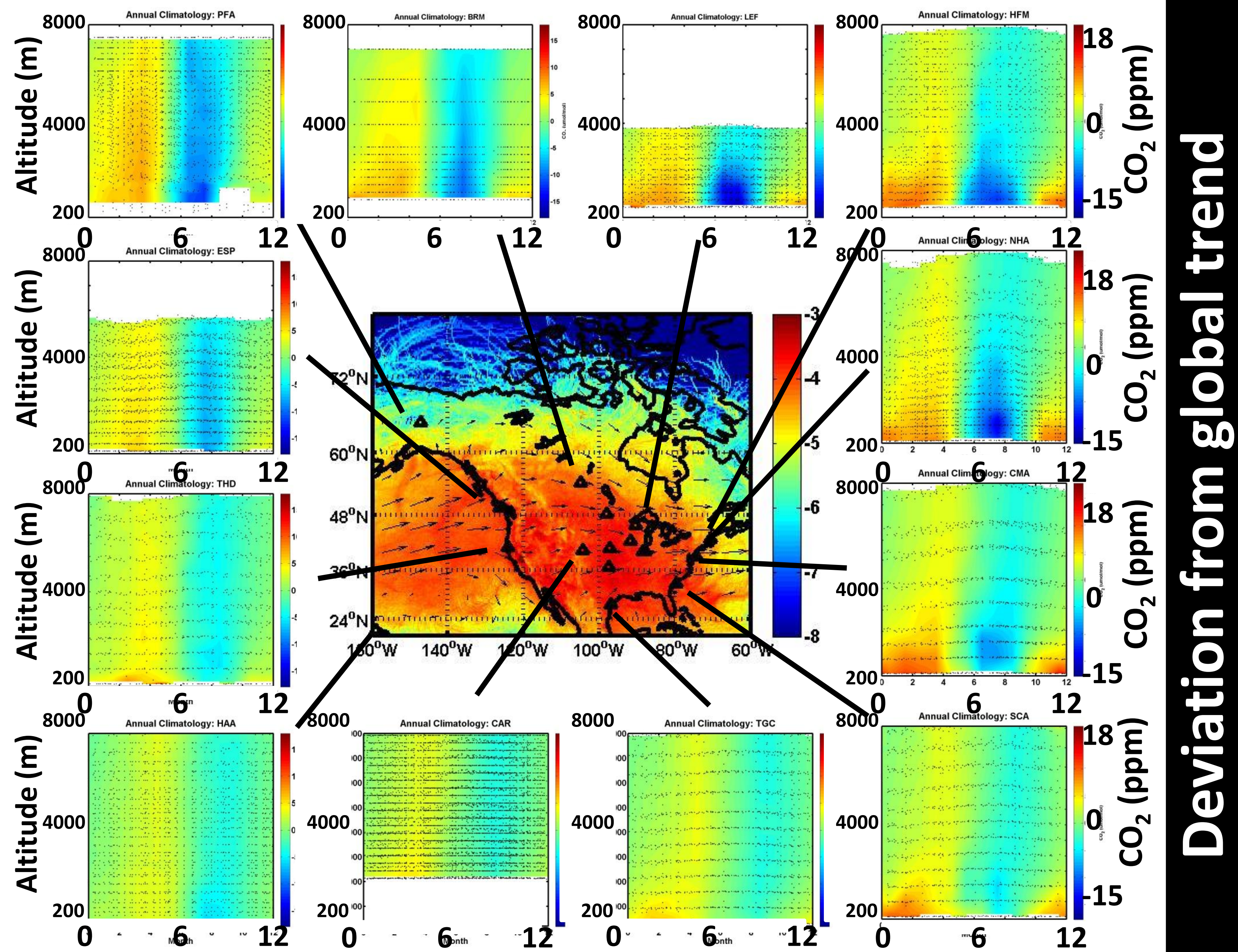


Annual Climatology

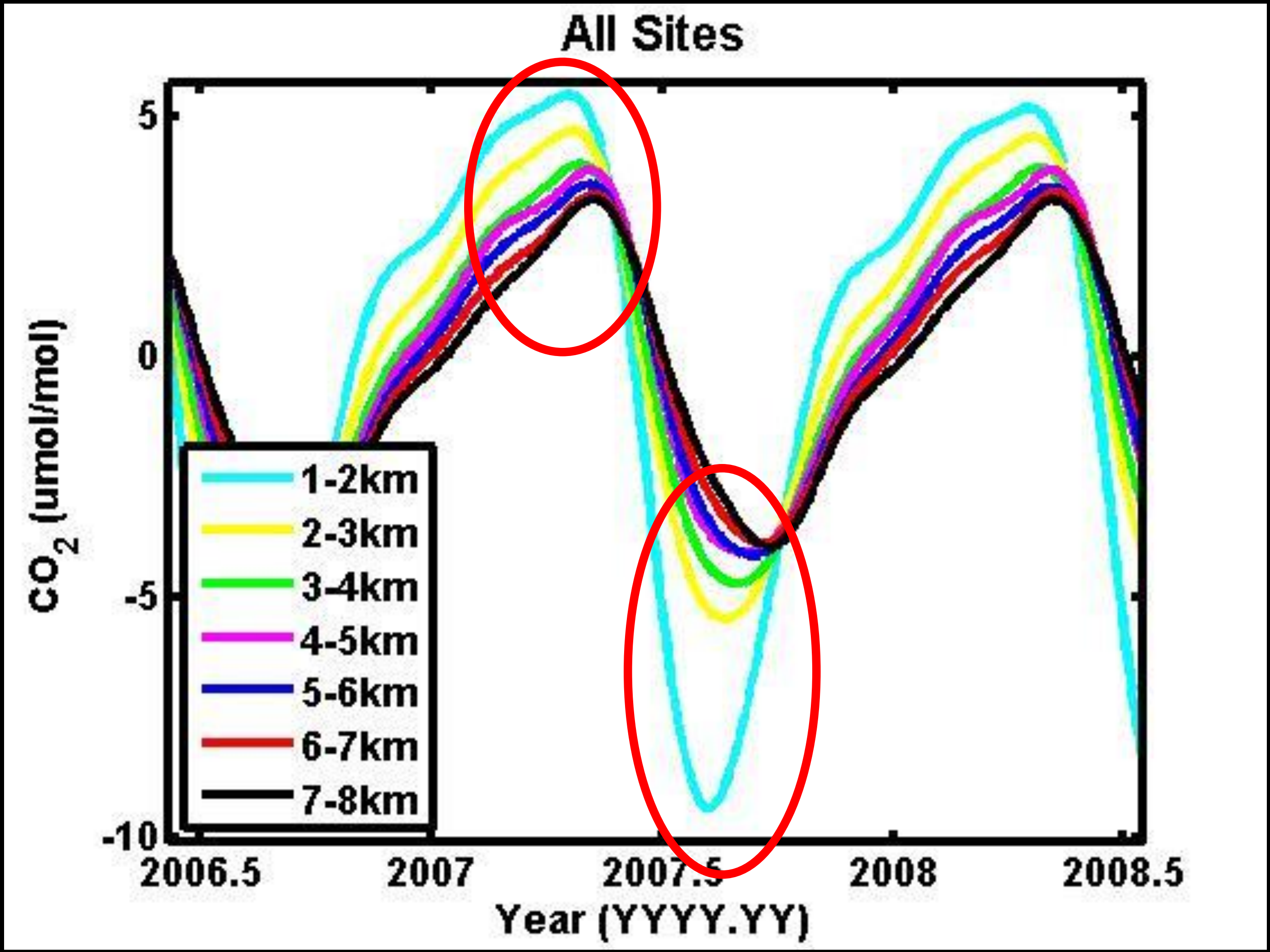




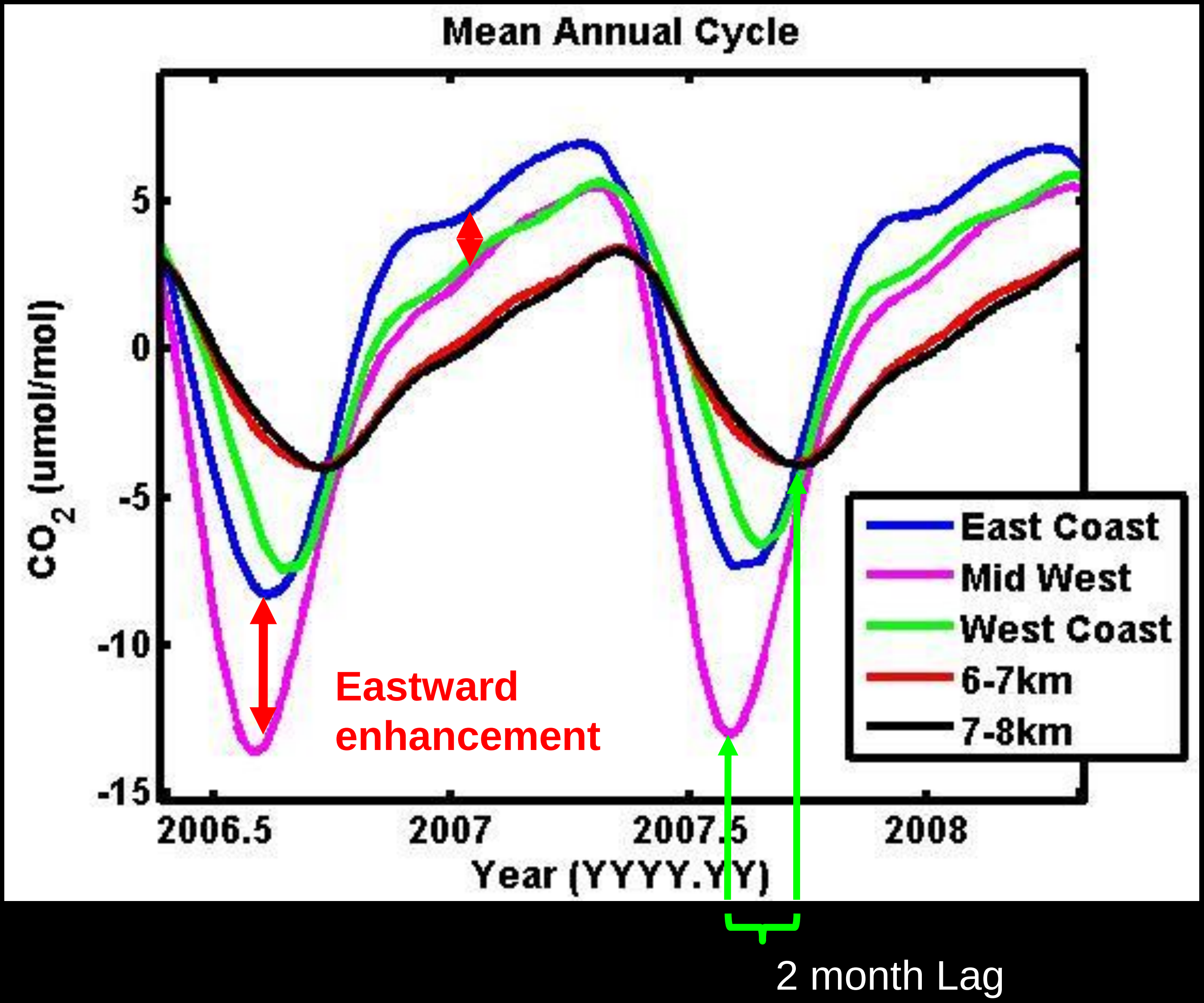




Deviation from global trend
Annual Climatology: PFA
Annual Climatology: BRM
Annual Climatology: LEF
Annual Climatology: HFM
Annual Climatology: ESP
Annual Climatology: NHA
Annual Climatology: THD
Annual Climatology: CMA
Annual Climatology: HAA
Annual Climatology: CAR
Annual Climatology: TGC
Annual Climatology: SCA
Altitude (m)
CO_2 (ppm)
8000
4000
200
0
6
12
18
-15
72°N
60°N
48°N
36°N
24°N
160°W
140°W
120°W
100°W
80°W
60°W
-3
-4
-5
-6
-7
-8

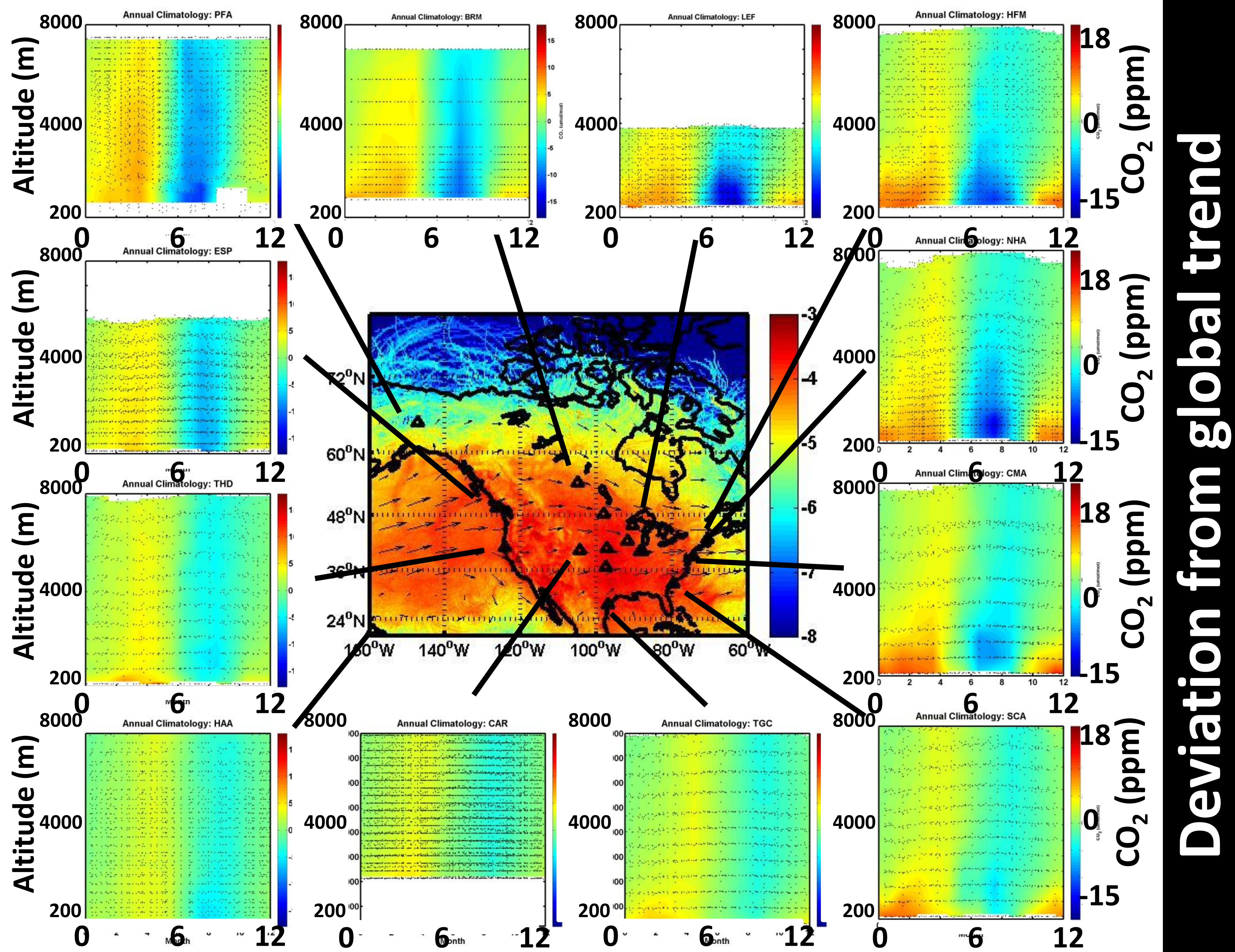


Significant (up to 6 ppm) gradients from boundary layer to 4 km



Mid-West BL is 2 months ahead of FT

Fossil fuel significantly increases east coast signal both in summer and winter



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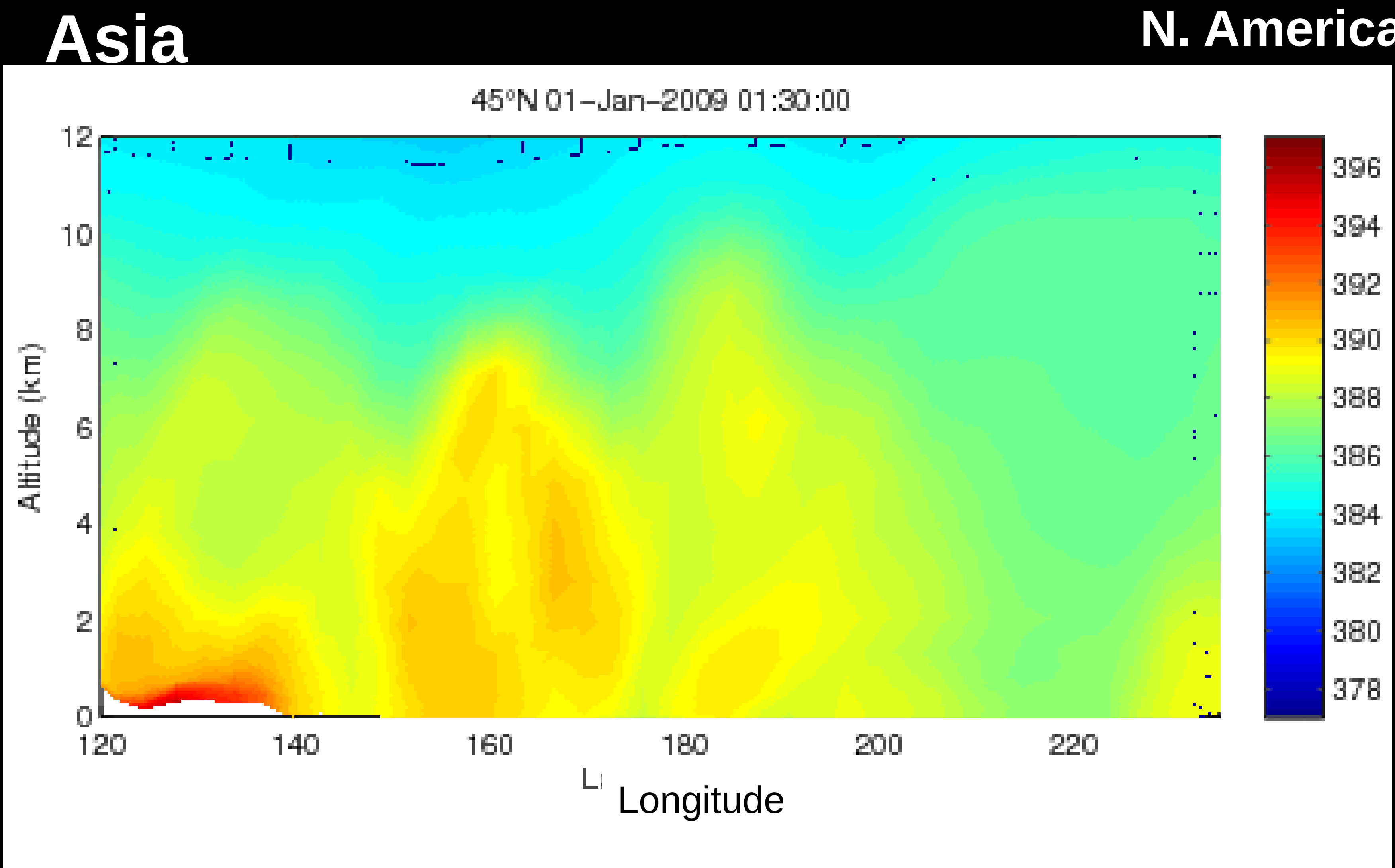
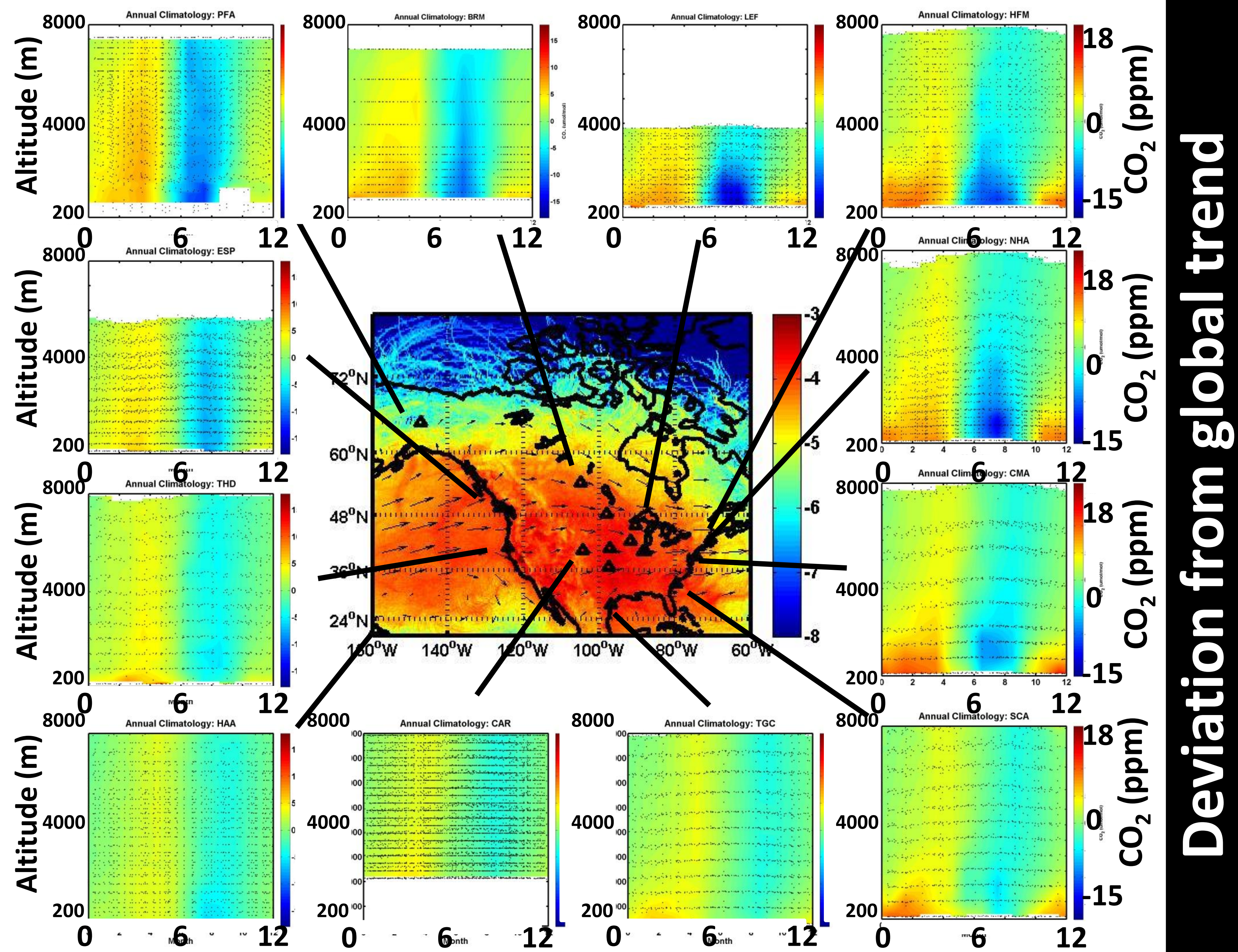
Deviation from global trend

Transport from Asia

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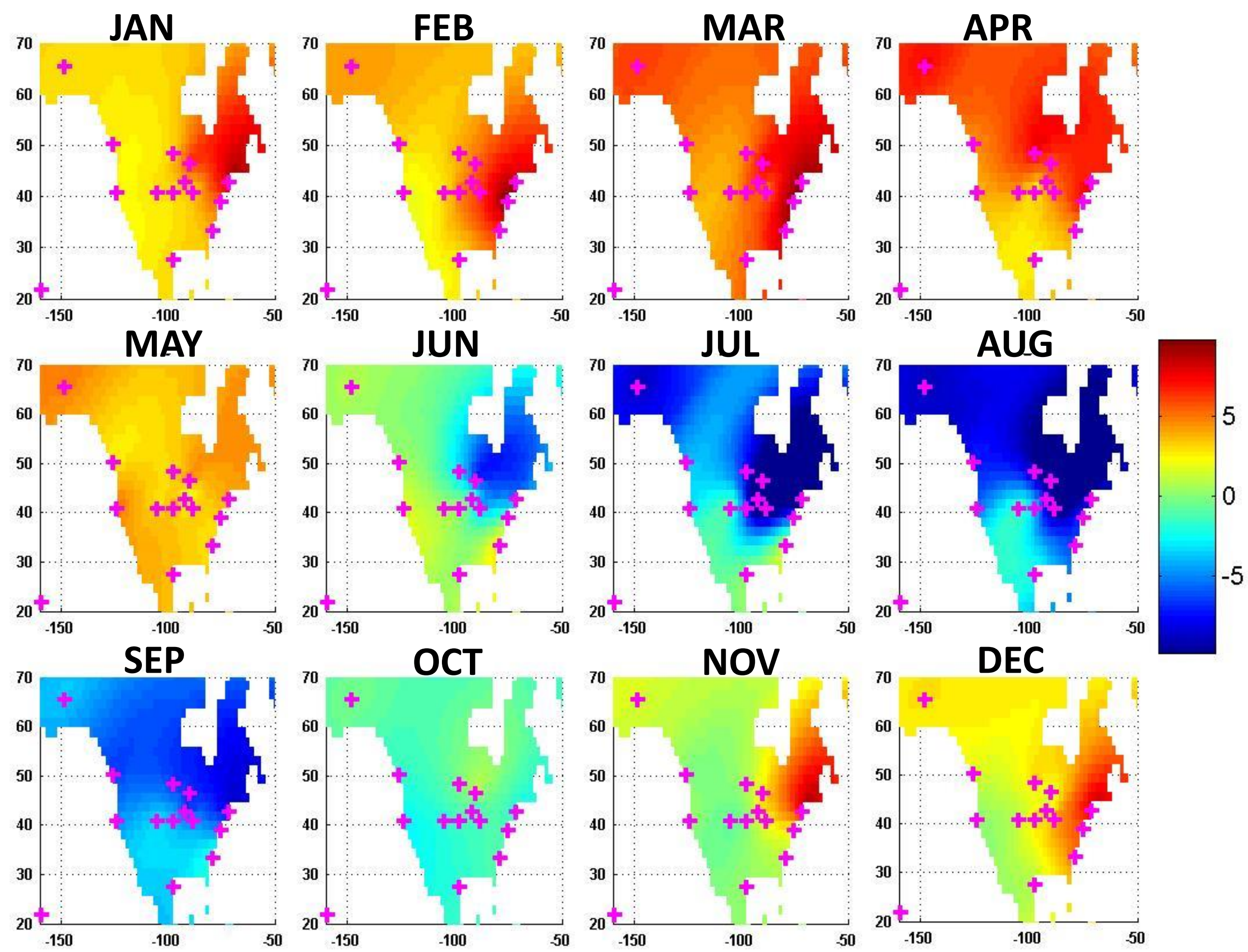
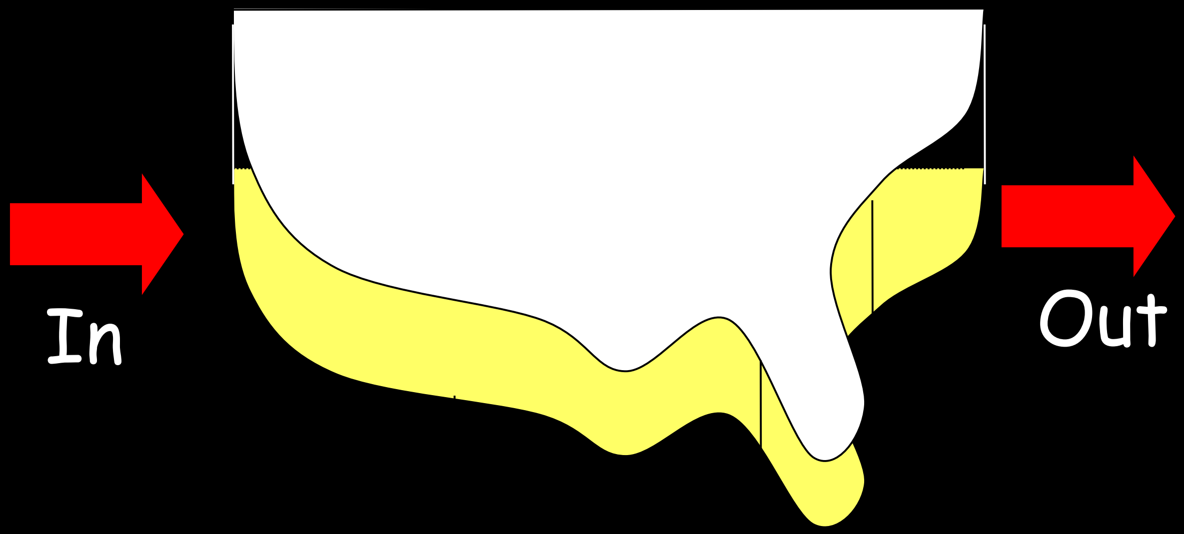
Deviation from global trend

Kriging interpolation – 850 mbar





F_{surf} → 1.22 GtC.yr^{-1}

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

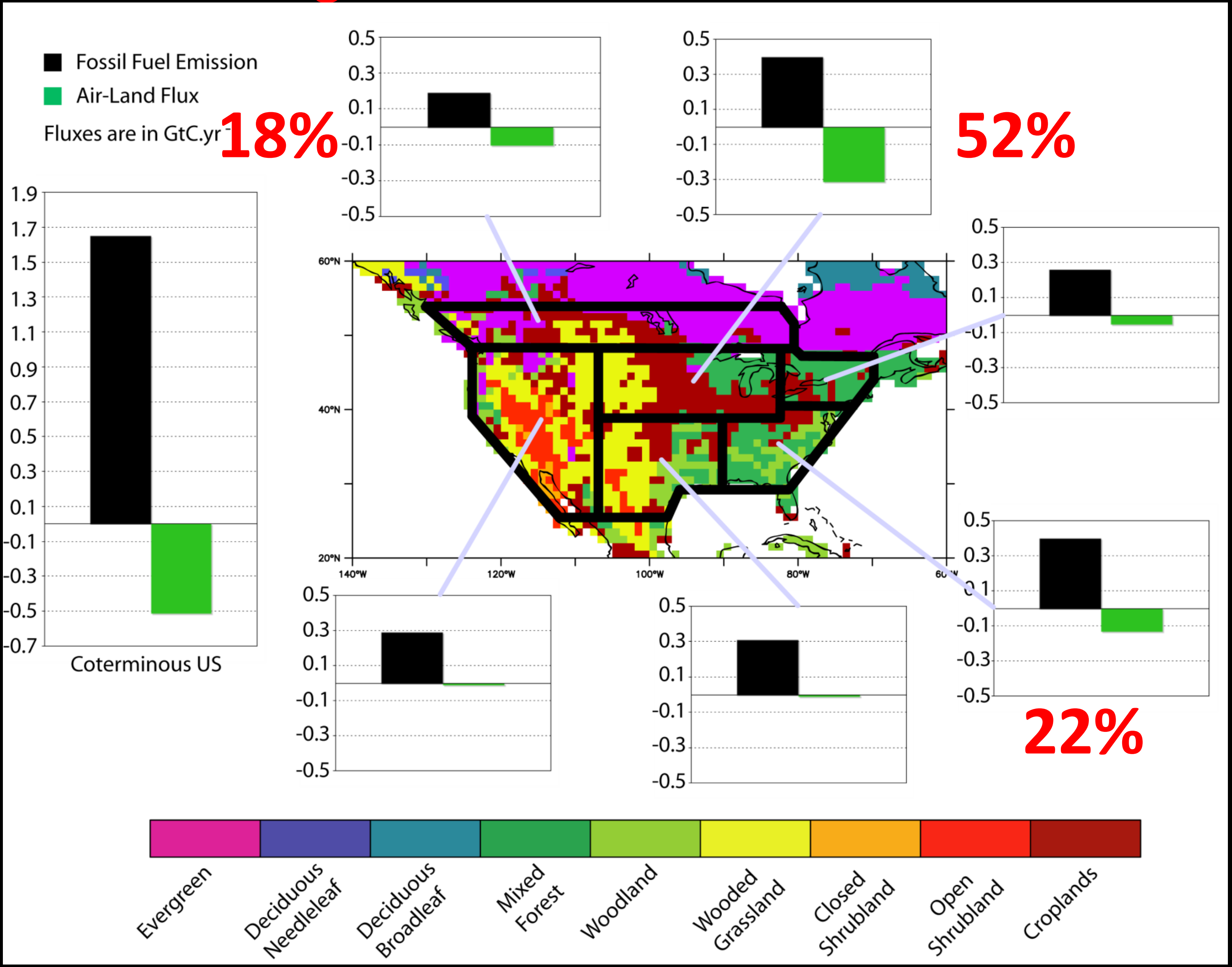
North American sink: → -0.5 ± 0.4 GtC.yr^{-1}

- ✓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).

Crevoisier et al. 2010

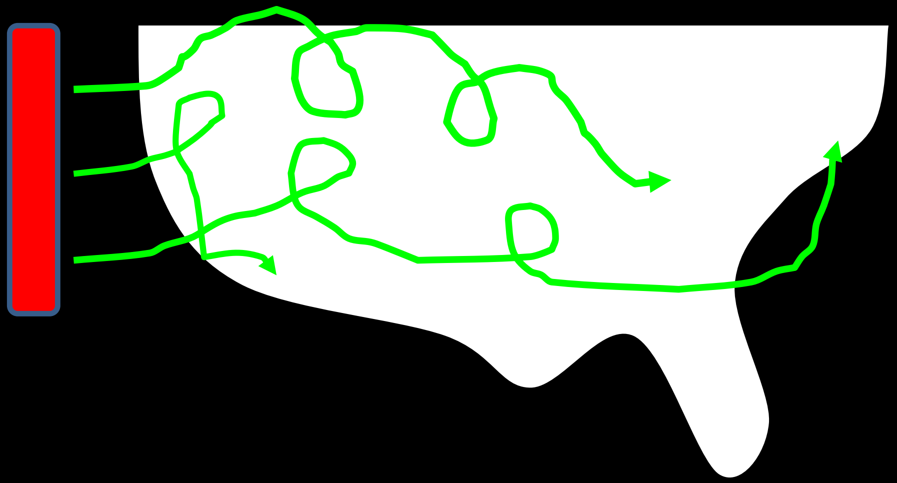
Regional Flux estimates

Regional distribution of sinks



Crevoisier et al. In revision 2009

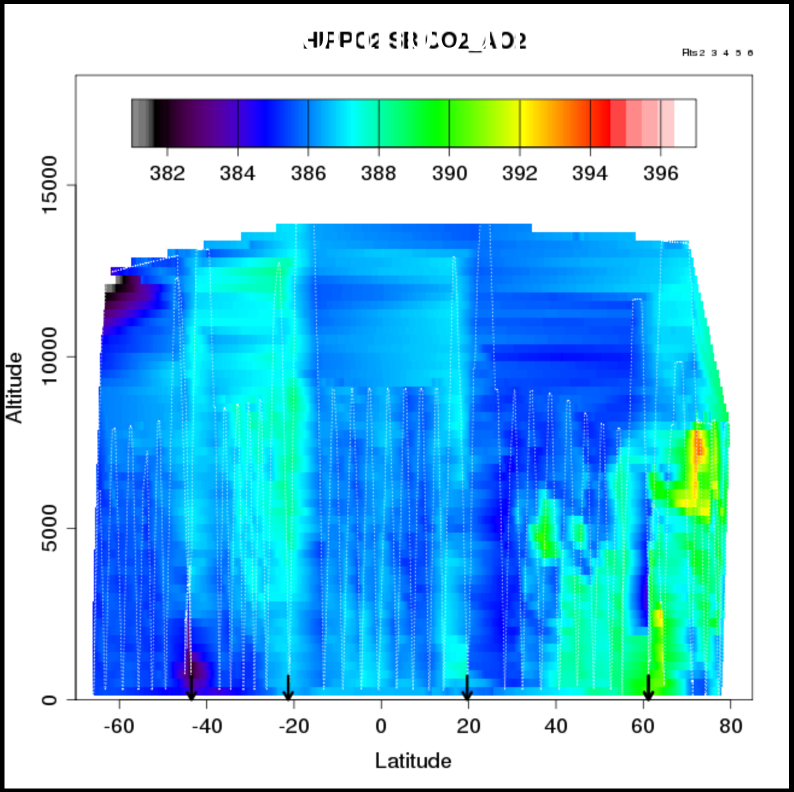
Background CO_2



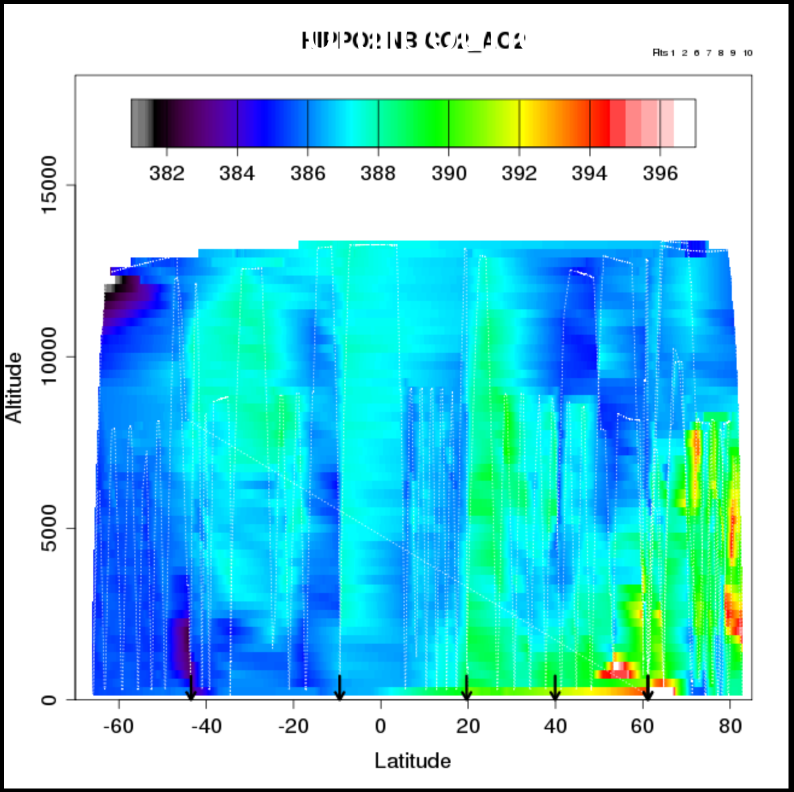
Flux	= (obs – background) * transport
transport	= $(365/5 * 10^{20}g)/29$
Obs – Background	= 0.5 ppm
Flux	= 1.5 Gt C/yr

HIPPO2 CO_2 Slices, 2009

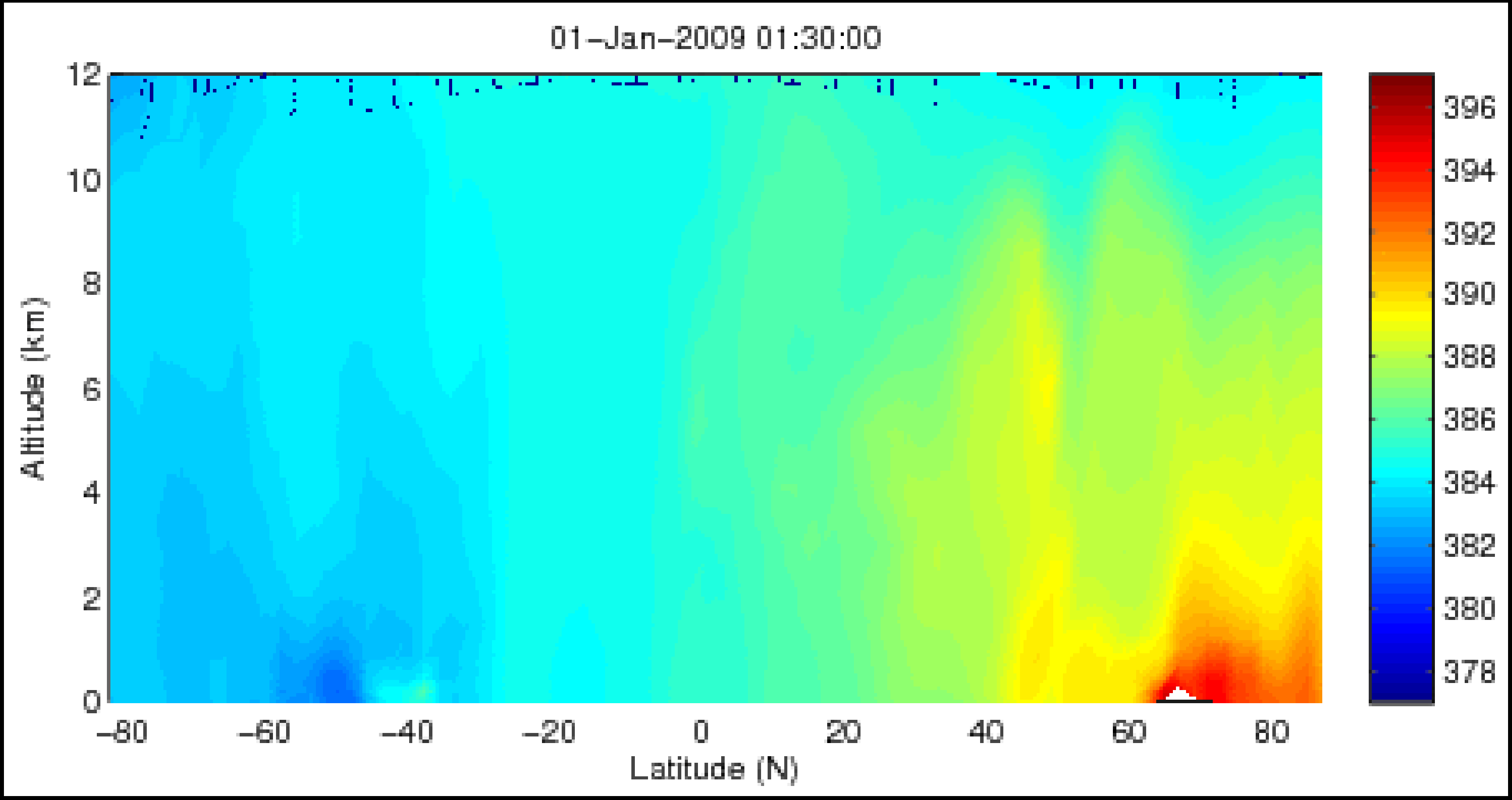
Early November



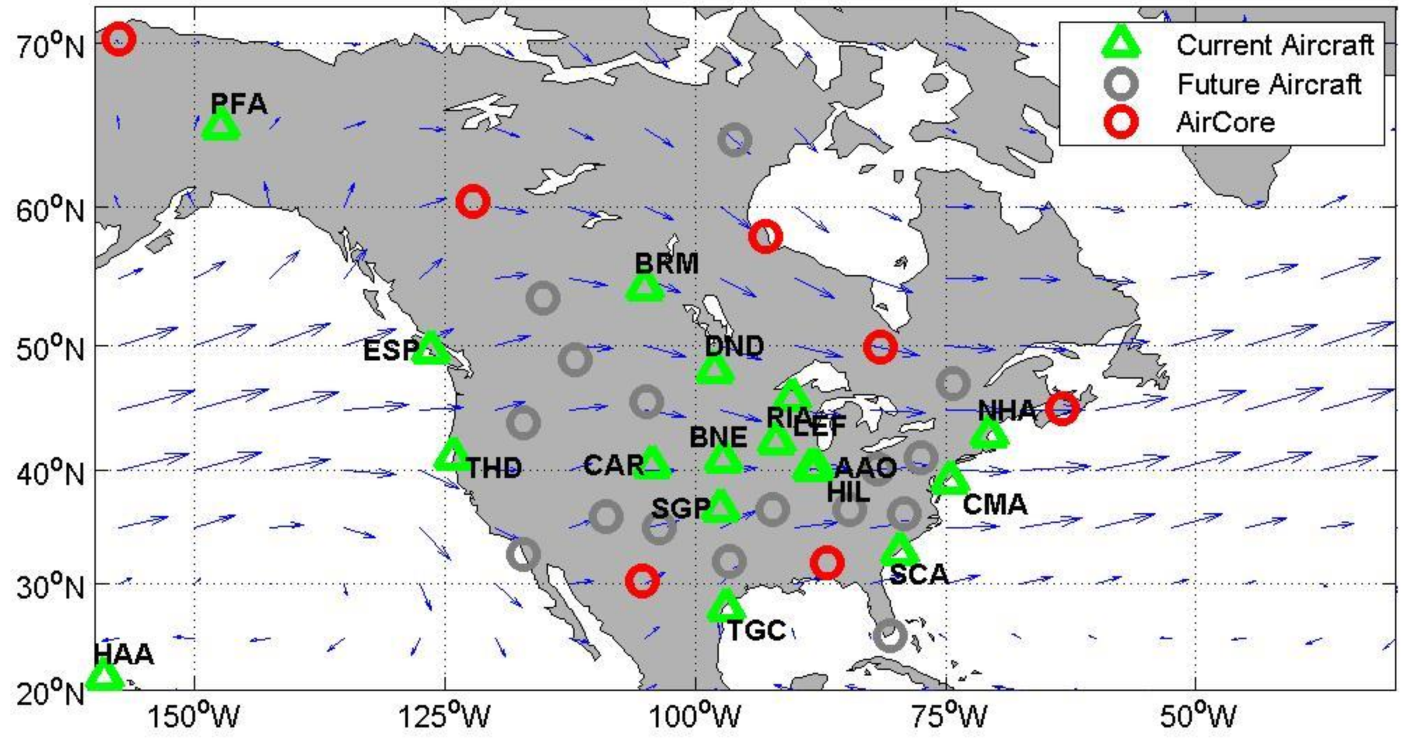
Late November



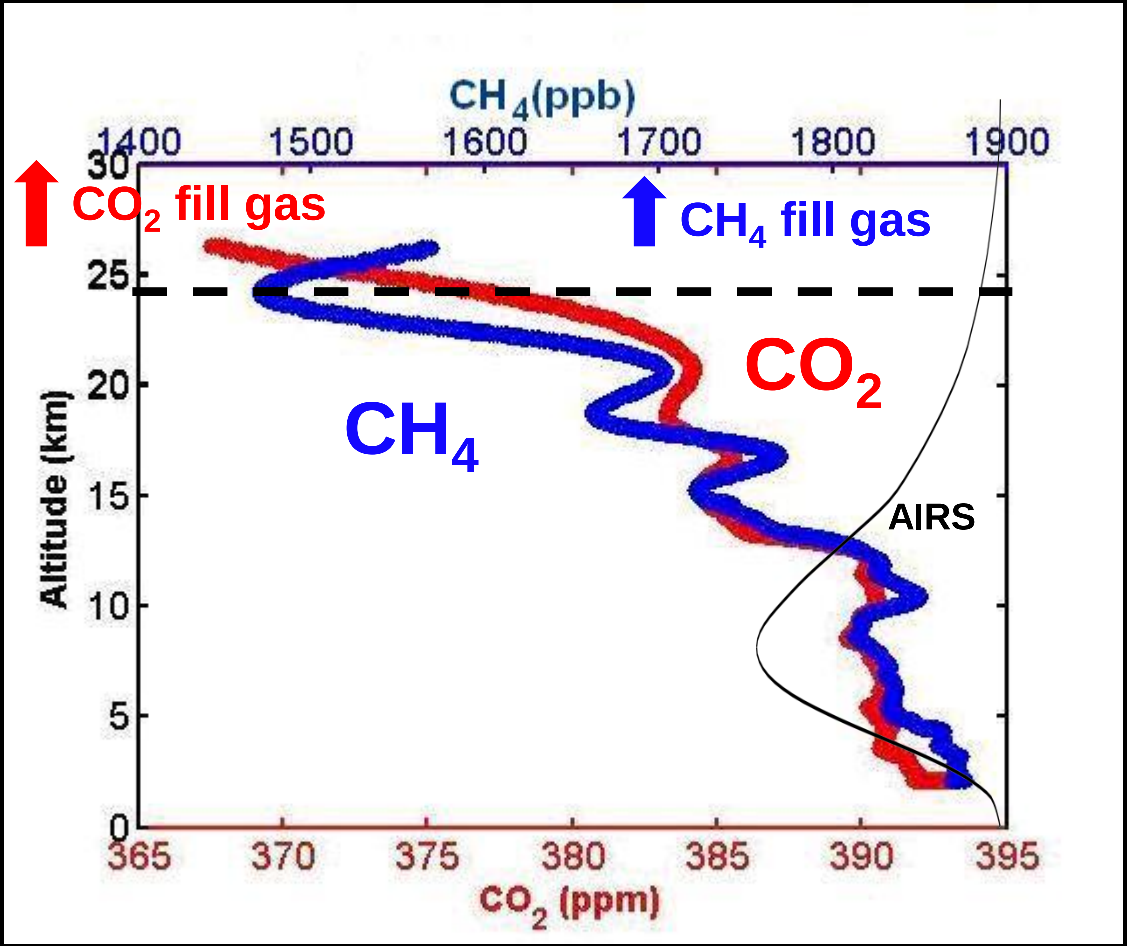
Hippo N/S Transect in Carbontracker



Future Aircraft Network

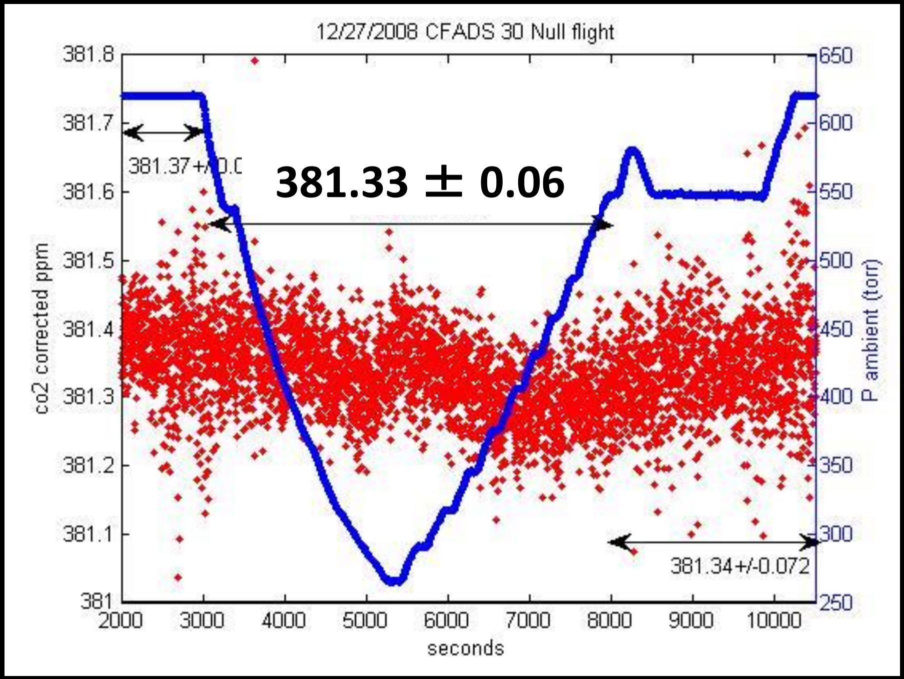


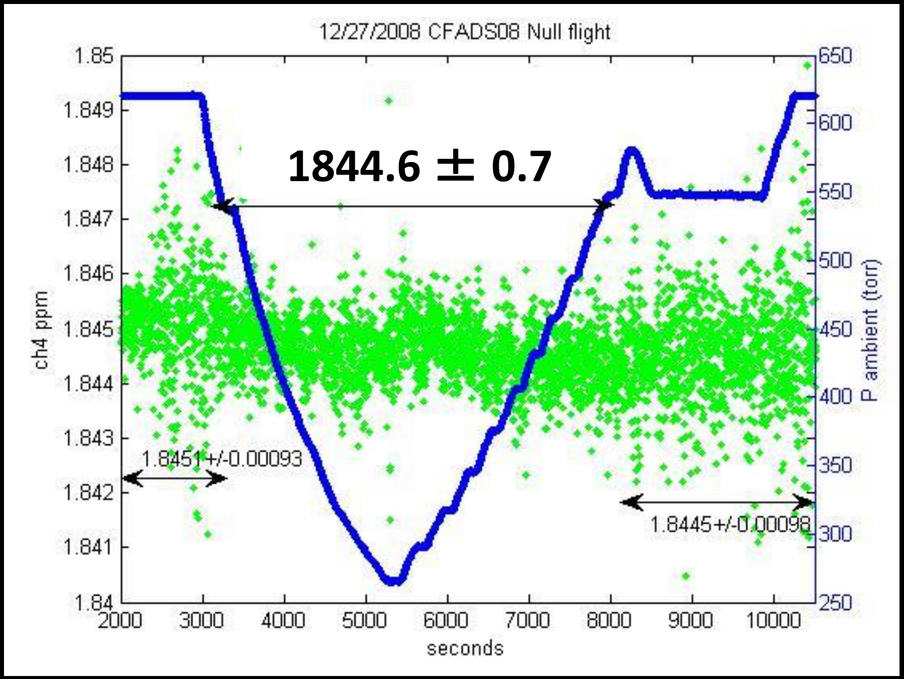
Troposphere/Stratosphere -AirCore-



Karion et al. 2010

In situ measurements

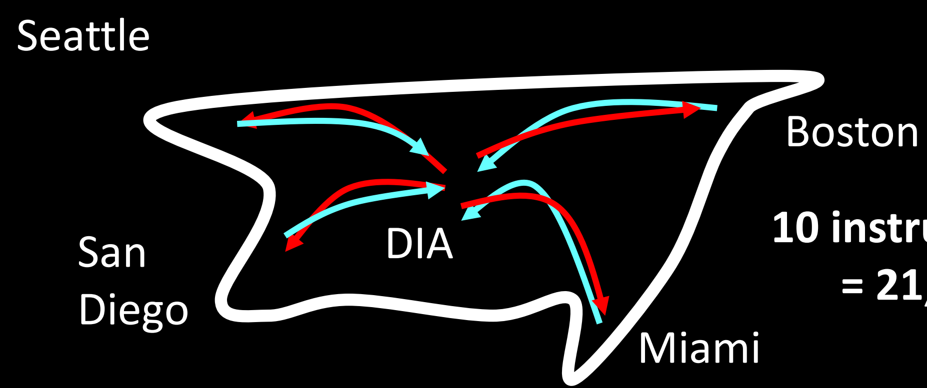




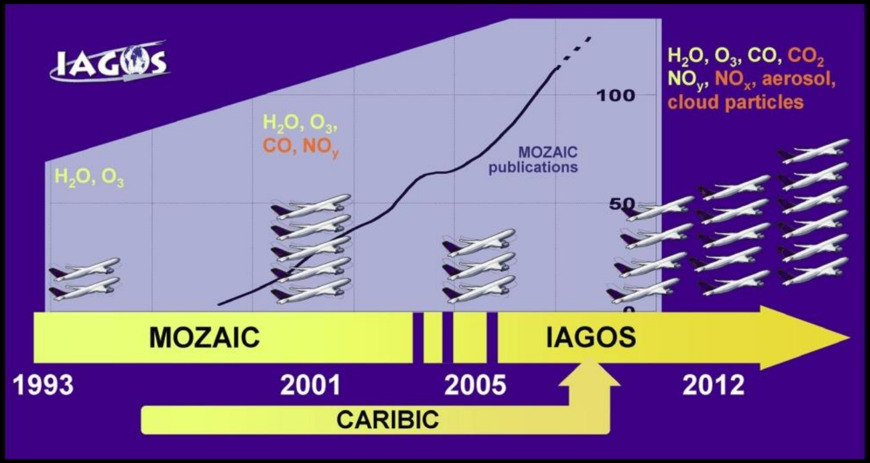
CO_2 **CH_4**

- No need for drying samples
- Linear response and long term stability

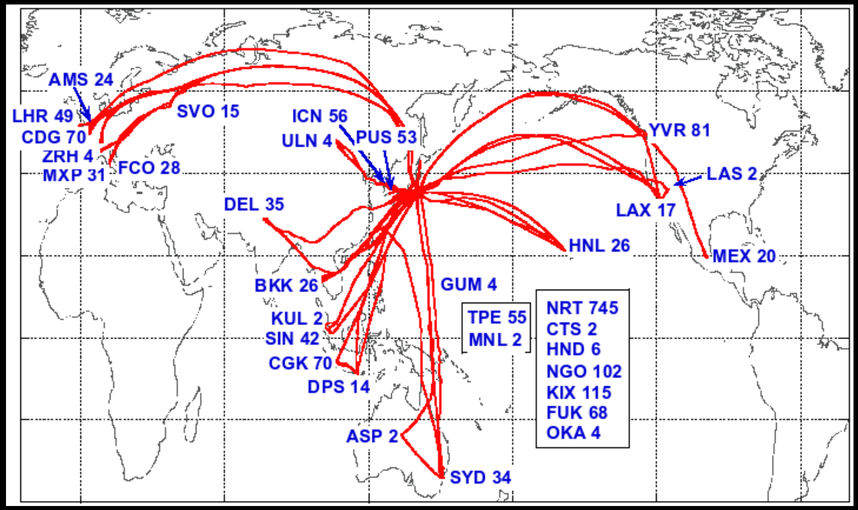
Commercial Aircraft



10 instruments x 6 profiles x 365 = 21,900 profiles per year



IAGOS



CONTRAIL

Conclusion

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