COBRA-BRAZIL (CD-14)

CO_2 Boundary-layer Regional Airborne Experiment—Brazil

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ABSTRACT

The Amazon Basin is a key component of the global carbon cycle, containing one-half of the world's undisturbed tropical forest and accounting for ~10% of global terrestrial net primary productivity. Current estimates of carbon fluxes in Amazônia at the regional and Basin scales are subject to large uncertainties that propagate into the global carbon budget. Regional and Basin scale carbon exchanges fall into the "missing scale" in carbon cycle science due to *a*) dearth of CO2 observations over the continent to constrain inverse models and *b*) lack of independently validated methodologies to scale up local measurements.

The proposed study will conduct in-situ airborne measurements of CO_2 and CO in the lower- and mid-troposphere over the Amazon Basin. The proposed strategy for observations and analysis will provide direct estimates of carbon fluxes at the missing regional and Basin scales. We plan to conduct this study during both wet and dry seasons to capture the seasonal variability and to complement LBA airborne remote-sensing missions.

OBJECTIVES

- directly quantify regional and Basin-scale fluxes in Amazônia using airborne measurements of CO2 and other tracers in and above the planetary boundary layer (PBL);
- establish the relationships between vertical concentration gradients and exchange fluxes observed at the eddy flux towers in LBA and over adjacent regions;
- test hypotheses central to LBA that Amazônia is a major net source or sink for CO2;
- characterize horizontal and vertical distributions of atmospheric CO2 over Amazônia for the purposes of planning remote sensing instrumentation

Aircraft: University of North Dakota Citation II

Instrumentation and measurements:

- Licor Infrared Gas Analyzer: in situ CO_2 concentration
- Aero-Laser VUV Resonance Fluorescence Analyzer: in situ CO concentration
- Laser absorption hygrometer: Atmospheric concentrations of H_2O
- Flask Samples (glass flasks collected on board and shipped to Boulder, CO for analysis): Atmospheric measurements of O_2/N_2, Ar/N_2, ^{13}C and ^{18}O in CO_2, CH_4, N_2O, H2, SF_6, CO_2, and CO
- Standard Aircraft Instrumentation: latitude, longitude, altitude, Radar height, pressure, temperature, horizontal & vertical wind speed, Aircraft orientation (Heading, Pitch, Roll, Yaw, Ground Speed, Vertical Acceleration).

Deliverables

Data product	Ancillary data	Intermediate product	Analysis product
Regional scale profiles of CO_2	Regional scale profiles of CO, winds	Regional scale CO_2 cross-sections	Regional fluxes of CO_2
Regional scale profiles of CO	Regional scale profiles of winds	Regional scale CO cross-sections	Regional fluxes of CO or constraint on transport budget
Regional scale profiles of H_2O	Regional scale profiles of CO	Regional scale H_2O cross-sections	Constraint on scaling-up methods for H_2O and CO_2 fluxes
Numerous profiles of CO_2 at different times of the day	Profiles of CO, Lagrangian experiment	Diurnal variations in CO_2 profiles at different locations	Assessment of Eulerian methods for regional fluxes
CO_2 profiles in the inflow, middle, and western regions of Amazon Basin	CO profiles plus diurnal CO_2 changes from Eulerian approach	Large-scale cross-sections upstream and downstream of the Basin	Basin-wide fluxes of CO_2
Profiles spanning the tropical and mid-latitudes		Meridional cross-section	Hemispheric distribution for CO_2 and CO

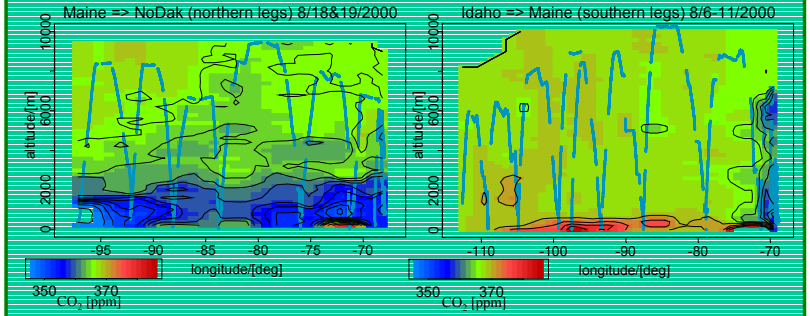
Location of intensive flight areas

Santarém intensive flight area: Lagrangian experiments and multiple diurnal profiling, covering the area around Santarem, including Tapajos National forest, Tapajos River, and Amazon River. We plan to do these experiments around the first 1.5 weeks after we arrive in Brazil, i.e. beginning of November 2002.

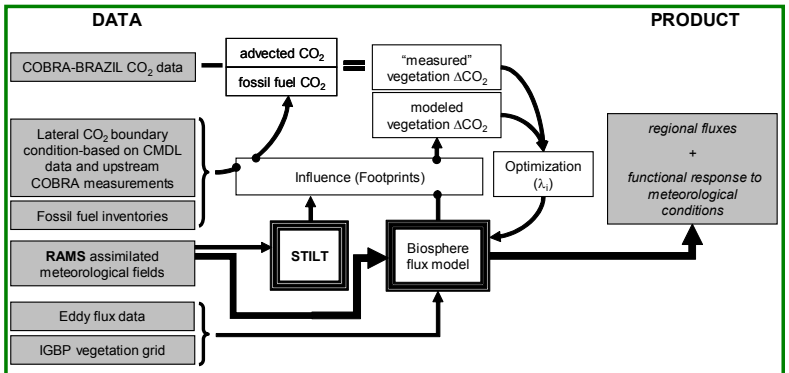
Rondônia intensive flight area: Lagrangian experiments and multiple diurnal profiling, covering the area east of Porto Velho. Since the long-term eddy flux tower observations are currently interrupted at Rondônia, the intensive area might instead be relocated to Manaus.

APPROACH

- ***Lagrangian regional experiments***: diurnal airborne measurements of CO2, CO, and H2O within and above the Planetary Boundary Layer (PBL) in an airmass-following framework which provide tight constraints on regional fluxes and their variations across different disturbance regimes. Included is the characterization of incoming air at the Atlantic coast and basin scale cross-sectionst; these flights will take place in the middle of the campaign period.
- ***Eulerian experiments***: vertical profiles at different times of the day over selected locations yield first-order estimates of carbon fluxes and define the diurnal variations for each region
- ***Large-scale surveys***: sampling of large-scale CO2 distribution along the synoptic flow pattern, combined with knowledge of diurnal variations from the Eulerian experiments, gives Basin-scale flux constraints
- ***Hemispheric-scale cross-sections***: observations during transit flights between North Dakota and Brazil will enable construction of CO2 cross-sections that span from the mid- to tropical latitudes.



An example showing the cross section of CO2 concentrations over the US in COBRA-2000. The flight tracks are shown as grey lines. These flights traversed 2/3 of the US, the left one near the Canadian border, the right through from Idaho, south to Oklahoma. In the northern transect, the effect of vegetation uptake (growth) on CO2 can be seen; due to drought, there was no uptake in the southern transect.



Data analysis framework

Footprints (sensitivity of tracer concentration at measurement location to upstream surface fluxes) will be derived with STILT (Stochastic Time-Inverted Lagrangian Transport) [Gerbig et al., 2002; Lin et al., 2002], which is driven by RAMS winds and turbulence.

Flux constraints from COBRA-Brazil data will be translated into optimized biospheric parameters describing the biospheres response to environmental forcing (light, temperature, water).

This framework can easily be augmented to trace gases other than CO_2.

REFERENCES

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