Long-term Measurements of Carbon Dioxide and Carbon Monoxide Concentrations to Help Constrain Regional Carbon Budgets.

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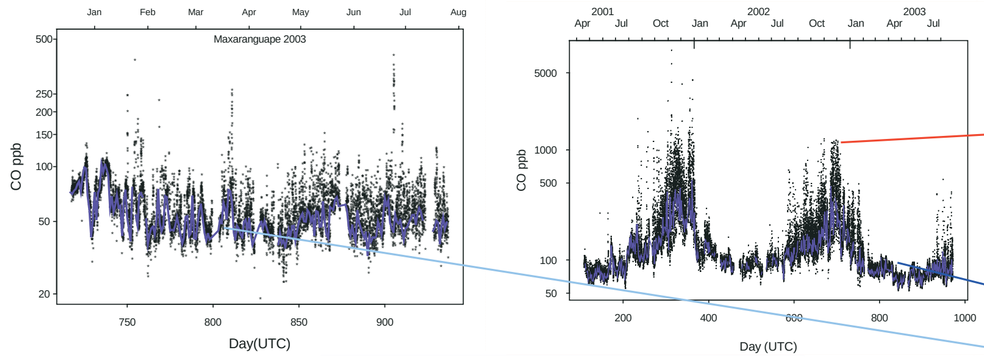
Abstract

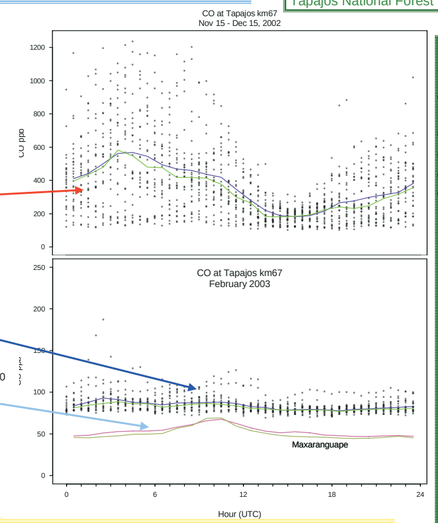
In order to supplement the network of detailed process studies based on direct small-scale to canopy level measurements being made a the LBA tower sites we have established a pair of carbon dioxide and carbon monoxide observatories within the Amazon basin and at the coastline.

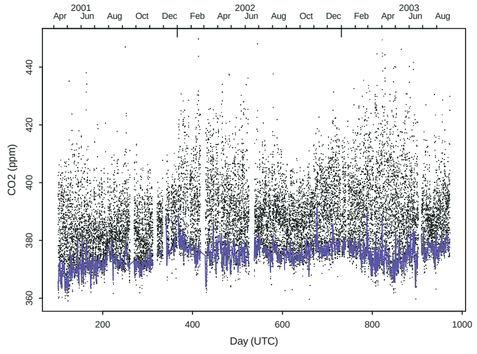
The interior site is located in the Tapajos Forest at the km67 flux tower site. Carbon dioxide and carbon monoxide concentrations have been measured continuously since April 2001. The coastal station is located in Maxaranguape, approximately 50km NW of Natal. Carbon monoxide has been measured there since December 2002 and carbon dioxide measurements began in August 2003. Observations at this site are useful to establish the boundary conditions for tropical marine air that enters the basin.

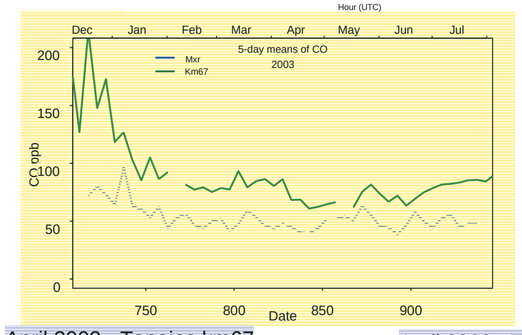
At both sites, carbon dioxide is measured using a modified Licor 6262 infra-red gas analyzer. Carbon monoxide is measured using a Thermo Environmental Instruments 48CTL gas-filter correlation IR absorption analyzer that has been modified by including a cold trap to remove water, pressure control, and frequent zeroing.

Concentrations of CO distinguish combustion sources from biological activity affecting the carbon dioxide concentrations and provide constraints on estimates of regional biomass burning estimates. Concentrations of CO during the well mixed mid-day period at Tapajos are near 70 ppb during the wet season and increase to near 300 ppb during the dry season as burning influence increases. In the onshore flow at Maxaranguape CO is around 50 ppb. At the Tapajos site, diel cycles of carbon dioxide have amplitude of 50 ppm. Seasonal and annual cycles have much smaller amplitudes; mid-day values exceeded 370 ppm at the end of dry season and declined to about 365 ppm during the wet season.









Objectives

The work shown here is intended to quantify atmospheric concentrations of CO and CO_2 at a central Amazonian forested site and in tropical marine inflow at the coast.

Observed concentration patterns depend on the integral of upwind sources and sinks, lateral boundary conditions, and vertical entrainment.

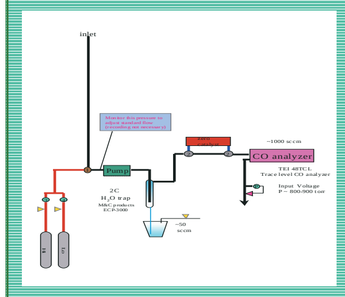
Results so Far

- CO in tropical marine air ranges from 50-100 ppb
- In the wet season, CO is enhanced by ~25 ppb at the forested site relative to the incoming marine air mass.
- Very large enhancements are observed in the late dry season when widespread biomass burning activity adds CO to the regional air mass.
- Slow growth in CO_2 concentrations have been observed at the forested site.
- There is not a marked seasonal pattern to CO_2 concentrations
- The daily cycle of CO_2 concentration (peak-to-peak amplitude) ranges from 23 ppm at wet-dry transition to over 40 ppm in the middle of wet season when biological activity is at a maximum
- CO_2 concentration measurements at the coastal site have just begun and data quality checking is incomplete

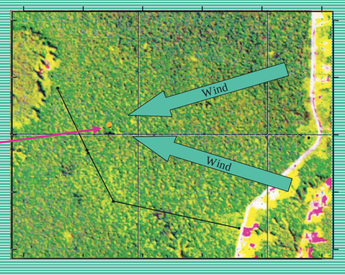
Future plans

- Evaluate the daily CO and CO_2 growth rates along with data for mixed layer depth and entrainment from aloft to infer surface emission.
- Combine continuous surface concentration measurements with vertical profile data as it becomes available.
- Use transport model to estimate regional CO/CO_2 exchanges through inverse analysis.

METHODS

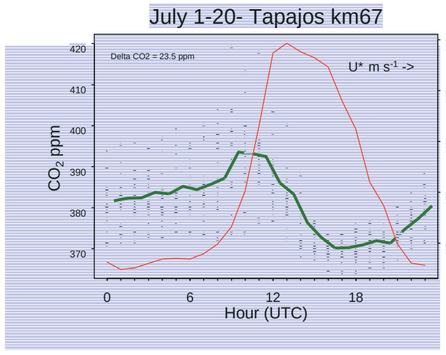


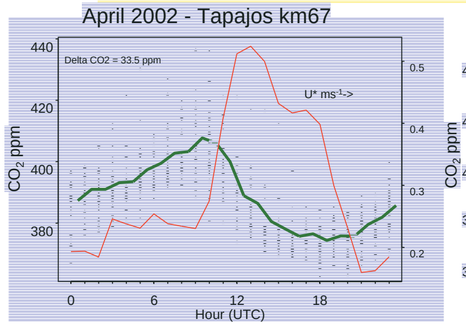
CO is measured using a Thermoenviromental Model 48CTL analyzer.
Sample and standards are brought to constant dewpoint in a chilled water trap. The instrument is frequently zeroed by passing sample through a CO catalyst (Sofnocat). Concentrations are computed by a second order fit to the signal from zero, 100 and 500 ppb

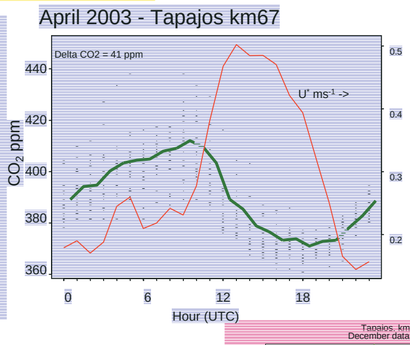


The coastal measurement site is located in Maxaranguape, east of Natal, on a bluff directly over above the beach. Prevailing easterly winds bring tropical marine air to the site

The Tapajos site at km67 is surrounded by the Flona Tapajos. Agricultural development east of the highway generates smoke emissions







Monthly mean diel CO_2 patterns for 3 periods show the nighttime buildup from respired CO_2 beneath the inversion layer. CO_2 drawdown begins in the morning from photsynthesis and vertical mixing (as indicated by u* of lower CO_2 concentrations in air above the inversion.

What about a CO:CO_2 emission ratio?

We see a wide range in $\Delta CO:\Delta CO_2$ during the burning season
High $CO_2$is almost certainly from respiration, but highest CO values imply very inefficient combustion (smoldering fires over night)