What tower “observation” has received the most attention within LBA?

“Towers indicate a high uptake of CO$_2$, ranging between 3 to 7 ton C ha$^{-1}$ y$^{-1}$”
This is unfortunate

• **Weak evidence** – The evidence supporting this claim is weak.

• **A distraction** – These claims have received so much attention that other exciting results have gone unnoticed.
The Carbon Cycle at Santarem km 83 site
CD-04 (Goulden/da Rocha/Miller)
Experimental Plan

Logged Site (km 83, USP/UCI)

Tapajos River

Control Site (km 67, Harvard)

Wind dir

INDEX MAP
Seabrook, PA

60 km

16 km
Tower Measurements

**METEOROLOGY**

PAR (up/down)
Radiation (short and long wave, up and down)
Rain

**PROFILES**

Wind (6 levels cups and 2D Sonics)
Temperature (6 levels)
CO$_2$/H$_2$O (12 levels)

**FLUXES (64 meters)**

Momentum/Heat  sonic anemometer
CO$_2$/H$_2$O  Infrared Gas Analyzer
Sonic anemometer looks **East**, the most common wind direction.
4km

Tower

400 ha selectively logged in 2001

Highway to town

Winds E to W

4km
Effects of selective logging on Forest CO$_2$ exchange

- 2-3 trees ha$^{-1}$ removed
Select site

Infrastructure Installed

Ground-Based Measures begin

Tower measure begins

Soil chambers installed

Undisturbed Baseline

SITE IS LOGGED

Logged Forest

Measurements to characterize logging

Second tower installed
Carbon Balance during undisturbed phase:
Was the primary forest a large Carbon sink?

The **Uncorrected calculation** indicates a large carbon sink, similar to previous reports.
However, the uncorrected observations underestimate CO$_2$ loss on calm nights.
There is no evidence that biotic CO$_2$ production decreases on calm nights.

Most researchers believe CO$_2$ escapes on calm nights undetected by the tower.

The underestimation of CO$_2$ loss results in a large overestimation of annual CO$_2$ gain.

This effect must be corrected, typically using a $u^*$ filter.
The u* filter is widely used for calculating annual sums

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<th>Published reports using u* filter</th>
<th>Published reports not using u* filter</th>
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</table>
u* corrected tower flux agrees with Biometry – There is no evidence that the primary forest was a large Carbon sink.

See poster by Miller et al.
• **Weak evidence for large C uptake** – The decision whether or not to use a $u^*$ filter is the main determinant of whether or not a group reports a large amount of annual CO$_2$ uptake.

• We need to move beyond this distraction and begin focusing on the **Surprising Results**.

• **Three ways CO$_2$ exchange differs from our expectations**
  1. The daily pattern of CO$_2$ exchange
  2. The seasonal pattern of CO$_2$ exchange
  3. The effect of logging on CO$_2$ exchange
What controls the daily pattern of CO$_2$ exchange?
Canopy photosynthesis is lower in the afternoon than the morning.
Canopy leaves in **constant light and temperature** still show a decline in photosynthetic uptake during the afternoon and a partial recovery the next day. The reduction in canopy photosynthesis during the afternoon may be caused by a **circadian rhythm**.

See poster by Doughty et al. for details.
What controls the seasonal pattern of CO$_2$ exchange?

See also posters by Figueira et al. and Sousa et al.
Soil respiration is a key

More soil respiration in the wet season
Less C gain measured by tower

Less soil respiration in the dry season
More C gain measured by tower
The effect of litter moisture on soil respiration is particularly obvious at the start of the rainy season.
Photosynthesis does not decline markedly during the dry season.

The trees are deeply rooted, and may use hydraulic lift to avoid drought stress.

See also poster by da Rocha et al.
Effects of selective logging on Forest CO$_2$ exchange

- 2-3 trees ha$^{-1}$ removed
- 5 T C ha$^{-1}$ wood removed
• 15 T C ha⁻¹ slash introduced
GAP MAP

• 10-15% gaps created

600 m
Post-Logging IKONOS Image

Original tower

Second tower

Wind dir

gaps

600 m
Average Daily Cycles of NEE

BLUE: PRE-LOGGING
GREEN: POST-LOGGING

OCT/NOV/DEC

Local Time

Dry Season

Wet Season
Cumulative NEE

BLUE: PRE-LOGGING
GREEN: POST-LOGGING

$u_*$ filtered at 0.2 m s$^{-1}$

2000/2001
2001/2002

?
Subjects needing more attention, both experimentally and in model development

• What causes the afternoon reduction in canopy photosynthesis? Is it a circadian rhythm?

• What controls the seasonal patterns of LAI and canopy photosynthesis? What determines phenology?

• What determines the forest’s ability to avoid drought stress? Can the forest avoid stress in unusually dry years?

• How does the dry season control decomposition?

• The magnitude and causes of the logging effect