TOWER- AND BIOMETRY-BASED MEASUREMENTS OF TROPICAL FOREST CARBON BALANCE

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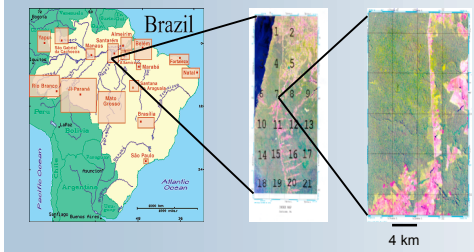
OVERVIEW

- We have been making continuous eddy covariance measurements of energy and trace gas exchange at km 83 in Tapajos National Forest, Para, since June 2000. We used the first year of data to calculate a tower-based carbon balance for this forest.
- An inventory of trees in 96 ha of this forest, including the tower footprint, was done in 1984, and repeated in 2000. We used these inventories to calculate a biometry-based average carbon balance for the forest over this 16 year interval.
- Here, we compare the carbon balance using these 2 methods.



RESULTS OF BIOMETRY

- Comparison between year 2000 inventory and detailed 1984 inventory of trees > 55 cm allows calculation of net wood increment over **16 years***.
  - 1984 tree biomass (96ha) **78 T C ha^{-1}**
  - 2000 tree biomass (96ha) **78 T C ha^{-1}**
  - Net wood increment: **0 +- 1 T C ha^{-1}yr^{-1}**
- Geochemical analyses (Trumbore) in tropical forests indicates soil carbon carbon storage of
  - **0 +- 0.5 T C ha^{-1}yr^{-1}.**
- Independent of eddy-correlation, we therefore estimate the annual C balance to be

0 +- 1.5 T C ha^{-1}yr^{-1}

- See green shaded region in Figure 2.

* we account for possible methodological differences between surveys by using a large uncertainty

TOWER MEASUREMENTS

TOWER TOP (64 m)

Momentum, Heat Flux	Campbell CSAT3
CO_2/H_2O Flux (1)	LI-7500 (Open Path)
CO_2/H_2O Flux (2)	LI-7000 (Closed Path)
PAR (up/down)	LiCor
Solar Radiation	Kipp & Zonen
Net Radiation	REBS Q*7
Rain	Tipping Bucket

PROFILE

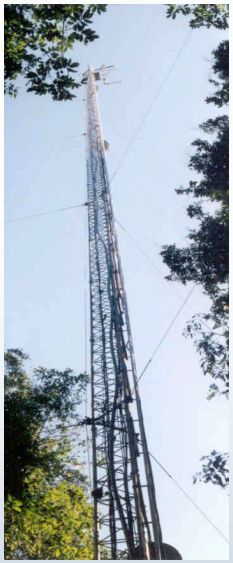
CO_2/H_2O	0.1m-64m	LI-7000 (12 hts)
Wind	1.3m-64m	Cups/2D sonics (6 hts)
Temperature	2m-64m	Thermistors, (6 hts)

TOWER TOP LOOKING EAST

ELEVATOR LOWERS INSTRUMENTS

INSTRUMENT RACK IN A/C SHACK

65 METER TOWER



TOWER DATA SUMMARY

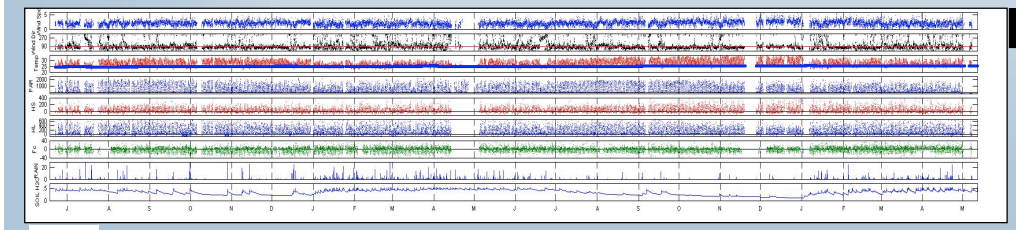
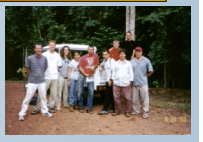


Figure 1

RESULTS



CUMULATIVE SUM OF CO2 EXCHANGE

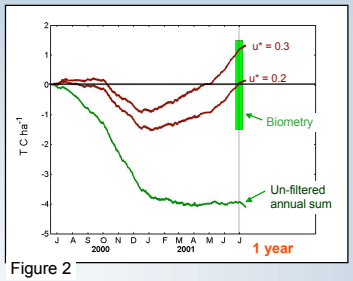


Figure 2

The "**raw**" tower-based carbon balance indicated a very high rate of carbon sequestration (**4 Tons C ha^{-1} yr^{-1}**, green curve, Figure 2). This result is consistent with other tower-based results in Amazonia (e.g., Malhi et al. 1998, Grace et al. 1996).

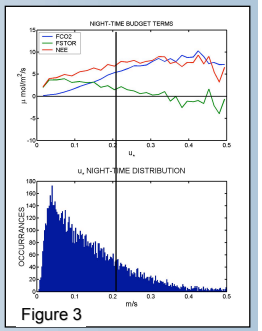


Figure 3

THE NIGHT TIME PROBLEM

- The annualized flux calculated with all the data likely **overestimates C uptake** since transport mechanisms during calm, stable nocturnal periods may remove CO_2 by routes that are not included in the covariance (e.g., drainage).
- To compensate for this, most researchers* reporting tower-based annual sums apply a so-called **u*-filter**, where NEE during night time periods with little turbulent mixing are replaced with observations from more turbulent periods.
- In this data set, NEE approaches independence from above canopy mixing around u* = 0.2 ms^{-1}. (Figure 3a). But, using this criterion, conditions are calm for about 70-80% of night time intervals (Figure 3b) above this forest.
- Using a u* = 0.2 ms^{-1} filter resulted in a Net Ecosystem Production (NEP) of **+0.1 T C ha^{-1} yr^{-1}**, such that tower- and biometry-based approaches were in agreement (Figure 2, red curves).
- The uncertainty of tower-based carbon balance is much greater in tropical forest than temperate or boreal forest due to their high Gross Primary Production (Figure 4) and the high sensitivity of the annual sum to the choice of u* threshold (Figure 5 and Figure 2, red curves).

* a meta-analysis of the literature found over 95% of reported annual sums apply a u* filter

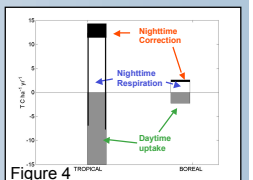


Figure 4

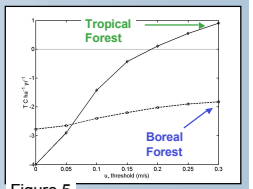


Figure 5

CONCLUSION

Our combined tower- and biometry-based best estimate of NEP from July 2000-July 2001 is

+0.1 T C ha^{-1} y^{-1}

indicating the forest **neither gained nor lost large amounts of carbon** during this interval.

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