CTFS/SIGEO Global Forest Carbon Research Initiative:
Quantifying and explaining variation in carbon pools and fluxes

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Implemented by collaborating scientists at CTFS/SIGEO sites around the world: www.ctfs.si.edu/group/Carbon and http://www.ctfs.si.edu/plots/pi/

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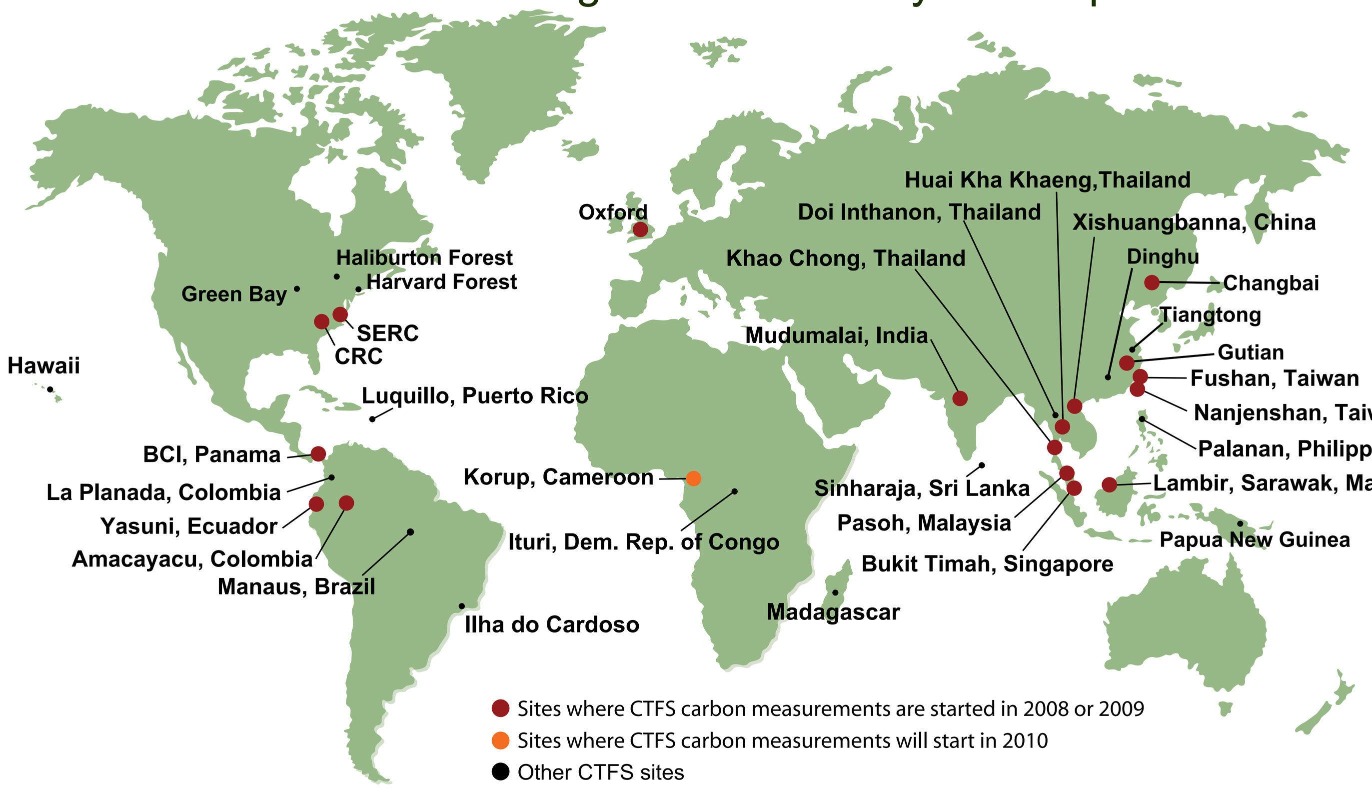
Abstract

Because tropical and temperate forests together encompass an estimated 38% of terrestrial carbon pools and 48% of terrestrial net primary production, knowledge of their carbon budgets and of how these budgets respond to natural and anthropogenic global change is key to understanding the global carbon cycle today and in the future. Regrettably, there are still large gaps in our understanding of forest carbon pools, short- and long-term carbon fluxes, the mechanisms underlying these fluxes, and the likely impacts of global change – especially for tropical forests. The new CTFS Global Forest Carbon Research Initiative aims to fill these gaps through research quantifying the sizes of forest carbon pools and fluxes, their spatial and temporal variation, and the drivers of this variation at multiple tropical and temperate forest sites around the globe.

CTFS has a 27-year history of forest dynamics research monitoring growth and mortality of >3 million trees of >8200 species (10% of the world's tree diversity). Building on this work, we are now censusing carbon pools in soil, fine roots, coarse woody debris, and lianas as well as trees. We are measuring tree growth, tree mortality, litterfall, and soil respiration annually or subannually in order to estimate interannual variation in associated carbon fluxes. We will analyze the relationship of spatial and temporal variation in these carbon pools and fluxes to variation in climate and chemical drivers in order to test hypotheses regarding the effects of global change on forests, and develop a better basis for predicting future forest carbon budgets.

Center for Tropical Forest Science
A network of large-scale forest dynamics plots



Locations of the forest dynamics plots affiliated with the CTFS network. Each site has a large plot (10-52 ha in size) at which all trees greater than 1 cm in diameter are identified to species, mapped, measured, and recensused at 5 year intervals. In total, over 8200 species and 3 million trees are monitored in CTFS.

Objective 1:
Quantify current forest carbon pools

In order to enhance understanding of spatial variation in these pools, enable more accurate valuation of forest carbon pools today and establish a baseline for detecting future changes.

Tree trunks and branches
*~ **40-50%** of tropical forest carbon pools*

We will improve estimates of carbon pools in tree trunks and branches by collecting additional species- and site-specific data on wood specific gravity and tree height.

Total biomass and carbon in tree trunks and branches of each tree is estimated from stem diameter using allometric equations specific to the forest type (Chave et al. 2005).

Soil and fine roots
*~ **30-40%** of tropical forest carbon pools*

Soil samples will be taken in every ha of each plot (1-13 samples per ha, depending on depth), with 1 sample per ha taken to the maximum depth possible. Fine root and soil C will be analyzed for samples pooled by ha and by depth class (10-20, 20-50, 50-100, 100-200, and >200 cm)

Soil profile for a tropical forest in Singapore. Like many tropical soils, this ultisol (Typic Paleudult) contains a high carbon concentration in the surface 0.2 m. The red subsoil, which extends > 5.5 m below the surface, has a low carbon concentration but its large volume means that it adds substantially to the total carbon.

Woody necromass
*~ **5-10%** of tropical forest carbon pools*

We use line transects (21 km per plot) to estimate the volume of fallen woody debris, conduct plot censuses of standing dead trees (16 ha per plot)to estimate their volume, and collect and analyze wood samples to obtain necromass.

Fallen trees and branches and standing dead trees contain considerable carbon

Lianas
*~ **1-3%** of tropical forest carbon pools*

At those sites without previous liana inventories, we will census lianas using a spatially- and size-stratified design.

Though lianas are a small carbon pool in themselves, they have major impacts on overall forest carbon pools and fluxes because any increases in their leaf area are associated with corresponding decreases in tree leaf area – and trees hold much more woody carbon per unit leaf area. Previous studies suggest lianas are increasing in tropical forests (Phillips et al. 2002, Wright et al. 2004).

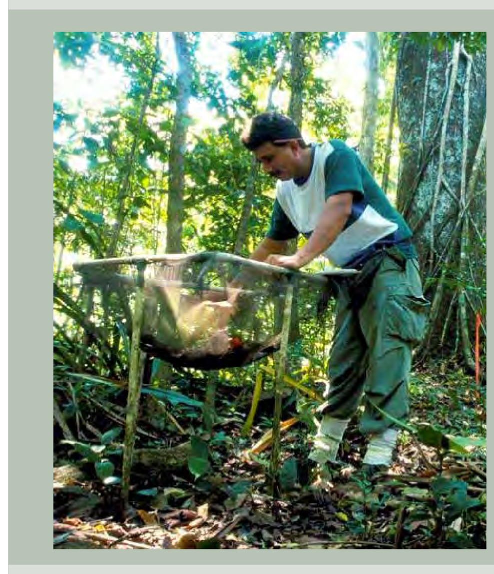
Objective 2:
Quantify major forest carbon fluxes

And their interannual variation in order to improve understanding of spatiotemporal variation, analyze the influences of climate and other factors on these fluxes and establish a baseline for detecting fugure change.

Annual tree diameter measurements
to measure wood production and loss

We are installing dendrometers on 2000 trees per plot, stratified across 5 size classes and 100 subplots, to be remeasured 2 x per year.

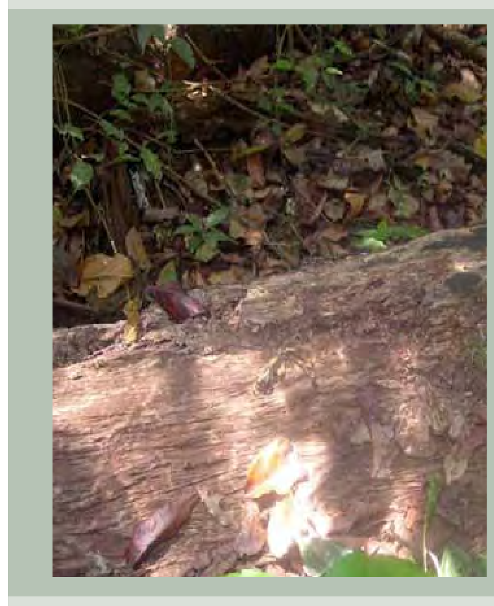
Dendrometer band being installed on a tree at the Khao Chong plot in Thailand; the inset shows a closeup of the window in the band used to measure tree growth. The band design is due to Jeff Chambers.



Litter trapping
to measure leaf, fruit, flower production

We are installing 100 litter traps per plot, with litter collected biweekly, oven-dried, sorted (to leaves, woody, reproductive, and other), and weighed.

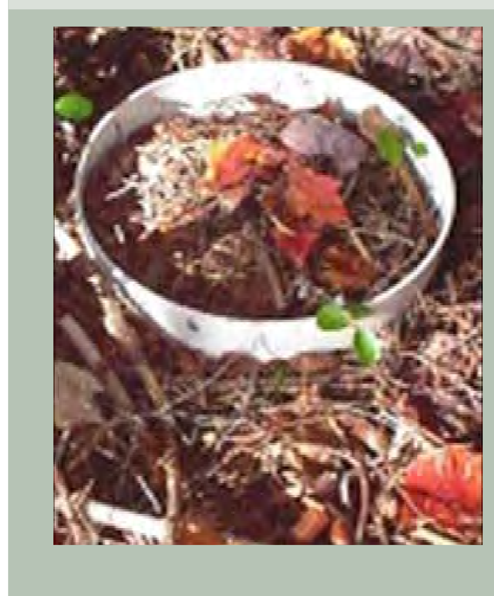
Litter trap being censused on Barro Colorado Island, Panama by Osvaldo Calderon. The trap design is due to Joe Wright.



Repeated censuses of necromass
to assess carbon fluxes in and out of this pool

We will be conducting repeated censuses of standing dead trees and fallen tees and branches to investigate rates of input via mortality and branchfall, and rates of output via decomposition.

Tree mortality rates and corresponding input to the necromass pool varies greatly in space and time, while branchfall rates and their contributions are poorly known. Decomposition rates vary with site conditions and among species.



Soil respiration measurements
to estimate below-ground production and allocation

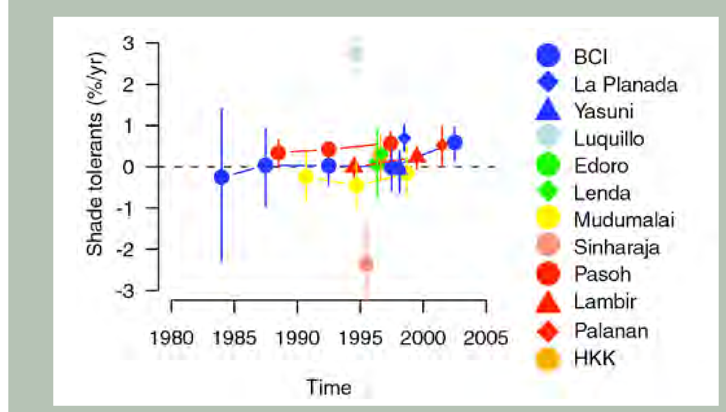
We plan to install 25-100 soil respiration sampling points per plot, with respiration measured at least monthly.

A collar installed in the soil for measurements of soil respiration. We are currently evaluating different techniques and equipment for conducting the measurements – comments and suggestions welcome!

Objective 3:
Investigate the mechanisms

That drive spatial and temporal variation in forest carbon pools and fluxes and test related hypotheses in order to develop a better basis for predicting future forest carbon budgets.

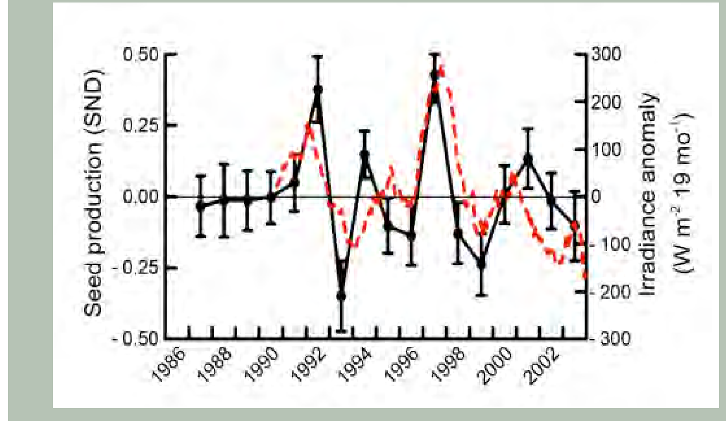
Role of plant functional types



Global change can affect forest carbon budgets not only through direct physiological mechanisms, but also by changing the relative competitive ability of different plant functional types differing in their influences on carbon pools and fluxes.

Shifts in plant functional types defined by demography in different CTFS sites and census intervals. Overall, there is an increase in shade tolerants, defined as slow-growing and low-mortality species (Chave et al. 2008 *PLOS Biology*).

Spatiotemporal variation in carbon budgets



We will analyze the relationship of spatial and temporal variation in carbon pools and fluxes to variation in topography, climate and soils.

Interannual variation in seed production on Barro Colorado Island, Panama, is strongly related to variation in incoming solar radiation. (Wright and Calderon 2006)

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Acknowledgments

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