

Anderson-Teixeira *et al.* (2014), *Global Change Biology*

SUPPLEMENTARY INFORMATION

CTFS-ForestGEO: A worldwide network monitoring forests in an era of global change

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Appendix S1. Data sources and analysis methods

1. Climate and atmospheric deposition data

CGIAR-CSI Climate Data

In order to obtain standardized climate data for all sites, global climate data with 0.5 degree spatial resolution were downloaded from the CGIAR-CSI database (<http://www.cgiar-csi.org/data>) in January 2014. Specifically, we retrieved monthly data for 1951 – 2012 for ten variables: daily mean temperature (°C), monthly average daily minimum temperature (°C), monthly average daily maximum temperature (°C), diurnal temperature range (°C), frost day frequency (days), precipitation (mm), wet day frequency (days), cloud cover (%), and vapour pressure (hecta-Pascals) from the CRU-TS v3.10.01 Historic Climate Database for GIS (<http://www.cgiar-csi.org/data/uea-cru-ts-v3-10-01-historic-climate-database>). In addition, potential evapotranspiration (PET; mm day⁻¹) estimates were obtained from the Global Potential Evapo-Transpiration (Global-PET) dataset (<http://www.cgiar-csi.org/data/global-aridity-and-pet-database>; Zomer, 2007; Zomer *et al.*, 2008). Data for each CTFS-ForestGEO site was extracted and is available online (www.ctfs.si.edu/Data).

Monthly data were used to calculate the annual values. Annual values were averaged over 1980-2012 to obtain climatic averages (Table S2). Recent change (Fig. 4, Table S3) was calculated as the difference between 2008-2012 and 1951-1980 average.

Note: Comparison of available local weather station data (Table 2) to CRU data revealed close correlation for MAT ($R^2 > 94\%$). However, CRU data tended to systematically underestimate MAP at sites with high MAP, particularly those receiving >3000

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mm yr⁻¹ (e.g., Korup, Kuala Belalong, Sinharaja, Fushan, La Planada). *Thus, CRU precipitation values for high precipitation sites should be considered probable underestimates.*

WorldClim current and projected climate data

Current and projected future climate data (Fig. 2; Table S4) were downloaded from WorldClim (<http://www.worldclim.org>; Hijmans *et al.*, 2005) in November 2013 at the highest available spatial resolution (30 arc-seconds for current climate; 30 seconds for future climate). Current climate is based on an interpolation of observed data, representative of 1950-2000 (v. 1.4). Future projections are based on predictions of the *HadGEM2-ES* model as part of the CMIP₅ (IPPC Fifth Assessment) for the year 2050 (2041-2060 climatic average) under the lowest and highest emissions scenarios (RCP 2.6 and RCP 8.5, respectively). These data have been downscaled and calibrated using WorldClim's current climate (v. 1.4) as a baseline, which makes it appropriate to compare current and future climate data from these sources (e.g., Fig. 2).

Note: Comparison of available local weather station data (Table 2) to WorldClim data revealed close correlation for MAT ($R^2 > 97\%$). However, WorldClim data tended to systematically underestimate MAP at sites with high MAP, particularly those receiving $> 3000 \text{ mm yr}^{-1}$ (e.g., Korup, Kuala Belalong, Sinharaja, Fushan, La Planada). Thus, WorldClim precipitation values for high precipitation sites should be considered probable underestimates.

Atmospheric deposition

Data on deposition of nitrogen (NO_y and NH_x) and sulfur (SO_x) were obtained from the data set of N Dentener *et al.* (2006) (F. Dentener, personal communication). These data are estimates for the year 2000 and have one-degree resolution.

2. Multivariate spatial clustering analysis

Multivariate Spatio-Temporal Clustering (MSTC) (Hoffman & Hargrove, 1999; Hargrove & Hoffman, 2004; Hoffman *et al.*, 2008; Kumar *et al.*, 2011) and network representativeness analysis (Hargrove *et al.*, 2003; Hoffman *et al.*, 2013) were used to calculate representativeness for the CTFS-ForestGEO network in forested and non-forested areas. These analyses require continuous grids of each variable for the extent of the study area. The data used for both the MSTC and for the subsequent representativeness analysis of the CTFS-ForestGEO network were 17 variables on a 4 km grid comprised of 13,719,022 map cells of global land area (Baker *et al.*, 2010). The 17 variables in the dataset were: (1) precipitation during the hottest quarter (mm); (2) precipitation during the coldest quarter (mm); (3) precipitation during the driest quarter (mm); (4) precipitation during the wettest quarter (mm); (5) ratio of precipitation to potential evapotranspiration (unitless); (6) temperature during the coldest quarter (°C); (7) temperature during the hottest quarter (°C); (8) day/night diurnal temperature difference (°C); (9) sum of monthly T_{avg} where $T_{avg} \geq 5^{\circ}\text{C}$ (°C); (10) integer number of consecutive months where $T_{avg} \geq 5^{\circ}\text{C}$ (unitless); (11) available water holding capacity of soil (unitless); (12) bulk density of soil (g/cm³); (13) carbon content of soil (g/cm²); (14) nitrogen content of soil (g/cm²); (15) compound topographic index (relative wetness; unitless); (16) solar interception (kW/m²); (17) elevation (m).

Fifty ecoregions were delineated using MSTC (Kumar *et al.*, 2011). The regions produced by this unsupervised classification method were then labeled with ecoregion or land cover type names derived from a suite of expert maps compared with the spatial clusters using the Mapcurves algorithm developed by Hargrove *et al.* (2006). Forested areas were then extracted and combined to derive the global forested area delineated in Figure 1. Representativeness analysis provided a quantitative “dissimilarity score” for each of the CTFS-ForestGEO 59 sites using the Euclidean distance in 17-dimensional data space between each site and every other

cell in the map. The 59 individual site maps were then combined to create a single map by selecting the minimum value for each grid cell from the collection of 59 individual dissimilarity scores. The final map is the minimum representativeness surface for the entire network.

For a high resolution version of Figure 1 and additional figures and information from the MSTC analysis, Mapcurves analysis, and representativeness analysis see Maddalena *et al.* (2014).

3. Analysis of forest degradation, loss, and fragmentation

To evaluate forest degradation, loss, and fragmentation surrounding CTFS-ForestGEO plots, we performed a spatial and temporal analysis using global data on deforestation and forest cover and change with 30m resolution (Hansen *et al.* 2013, data downloaded February 2014 from <http://earthenginepartners.appspot.com/science-2013-global-forest>). Raw raster data was downloaded for: (a) Tree canopy cover, defined as ‘canopy closure for all vegetation taller than 5 m in height’, in the year 2000 (%); (b) pixels converted from forest to other land uses between 2000 and 2012; and (c) areas of no data, mapped land surface, and permanent water bodies. A separate raster of forest area was calculated from the tree canopy cover raster using a threshold function that defined terrestrial land surface pixels having greater than 10% canopy cover as forest, following the definition used by FAO (2000). To define areas of original forest cover surrounding each site, a global raster map of original pre-human modification forest cover produced by UNEP-WCMC was downloaded April 2014 from http://www.unep-wcmc.org/generalised-original-and-current-forests-1998_718.html. Only four sites had less than 100% original forest coverage within 50km. All spatial statistics were limited to terrestrial land areas of original forest cover.

Spatial analyses were performed in R (R Core Team, 2013) using the raster, geosphere, and rgdal packages using parallel processing via the foreach and dosnow packages. The land surrounding each CTFS-ForestGEO plot was buffered into five distinct spatial zones: (i) within the plot (but not including the entire plot; calculated as a circle originating at the plot center with a radius of half the smaller plot dimension); (ii) from the plot to 1 km distance; (iii) from 1-5 km; (iv) from 5-25 km; and (v) from 25-50 km. Three core metrics were calculated: (a) percentage tree cover in 2012; (b) percentage of tree cover present in 2000 that was lost by 2012, and (c) forest fragmentation, defined as the length of forest edge adjacent to a deforested area (i.e., an area of original forest no longer forest) per unit forest area (units: km km⁻²).

An index of forest degradation was calculated for the purpose of comparing the severity of forest degradation and loss across sites (e.g., Fig. 3). Specifically, the index is the average of eight numbers: % reduction in tree cover relative to plot (calculated from ‘a’ above) and % forest loss from 2000-2012 (‘b’ above), each at the four distance zones outside of the plot (ii-v above). Thus, the index integrates forest loss across a range of distances from the plot, giving more weight (on a per-area basis) to the area immediately surrounding the plot. It combines historical (pre-2000) and recent (2000-2012) forest loss, giving more weight to recent forest loss.

It is important to note that the Hansen *et al.* (2013) dataset does not distinguish between natural forest and agroforestry areas; agroforestry areas with greater than 10% canopy cover and vegetation taller than 5 m in height are included in this definition of “forest”. Thus, “forest cover” in the surrounding landscapes is not necessarily primary or natural forest, and “forest loss” may include cutting of agroforestry plantations (i.e., as part of a rotation cycle). For example, at Pasoh (Malaysia), oil palm and rubber plantations are a feature of the landscape around the reserve, and “forest loss” from 2000-2012 adjacent to the reserve is attributable to the oil palm rotation, not to original forest loss. Moreover, the dataset does not distinguish between natural disturbance and deforestation; rather, “forest loss” implies either a stand-clearing disturbance or deforestation.

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Selected results are provided in Table S5; full data are available for download at www.ctfs.si.edu/Data. Copies of R scripts used in the above analyses are available for download from the Harvard Dataverse Network at <http://thedata.harvard.edu/dvn/dv/eben>.

Appendix S2. CTFS-ForestGEO measurement protocols

This section describes the CTFS-ForestGEO core census and other protocols applied at five or more sites across the network (Table 3).

1. Plants

1.1. Core census

Protocols for the tree core census are described in detail by Condit (1998). In brief, every free-standing woody stem >1cm DBH consist is identified to species, mapped, and tagged when it first enters the census within a plot. On each stem, diameter is measured at breast height (1.3 m) or above stem irregularities (Manokaran *et al.*, 1990; Condit, 1998). The census is typically repeated every five years. Database standards and management practices are described in Condit *et al.* (2014). Analysis of CTFS-ForestGEO census data is commonly conducted using the CTFS R package, which includes functions to analyze tree abundance, growth, mortality and recruitment rates, biomass, and demographic changes (downloadable at <http://ctfs.arnarb.harvard.edu/Public/CTFSRPackage/>).

1.2. Lianas

Lianas (woody vines) are inventoried as part of the core census at some sites. Lianas are mapped, identified to species, and measured at breast height (1.3m) according to the protocols detailed in Gerwing *et al.* (2006) and Schnitzer *et al* (2008).

1.3. Functional Traits

Detailed methods for functional trait measurements are publicly available at www.ctfs.si.edu/group/Plant+Functional+Traits/Protocols. Below is a summary:

1.3.1. Wood density (WD)

Wood density is measured for trees and lianas. Methods for collection may differ across sites, but processing methods are identical, following Cornelissen *et al.* (2003). At sites where wood collection is prohibited due to the destructive nature of the method (e.g., BCI), samples are collected opportunistically from outside the permanent plot. Wood samples are collected with an increment borer for trees larger than 10 cm DBH, and a 10-cm long, 1-cm diameter stem segment is taken from lianas and shrubs. In some cases, 1-cm diameter branch samples are used in place of cores. Wood specific gravity is measured using the water displacement method to determine fresh volume. Samples are then dried in a convection oven (at 60°C) to finally calculate oven dried wood specific gravity (i.e., density).

1.3.2. Height (H)

Tree height is measured either (1) on a size-stratified sample of trees (e.g., Bohlman & O'Brien, 2006) or (2) on the largest-diameter individuals in the plot for the purpose of estimating maximum tree height (Wright *et al.*, 2010). Methods for measuring tree height are described online (http://www.ctfs.si.edu/data//documents/Crown_traits_draft.pdf) and in Larjavaara & Muller-Landau (2013); the CTFS-ForestGEO standard is to use what Larjavaara & Muller-Landau refer to as the sine method.

1.3.3. Crown traits (C)

Crown traits measured across the network include crown diameter and crown exposure index. To estimate crown diameter (m), the crown radius is measured from the center to the edge of the crown in eight cardinal directions, then averaged. A qualitative crown exposure index serves as a proxy for light availability is recorded following a procedure adapted from Clark & Clark (1992). Full details are available online at http://www.ctfs.si.edu/data//documents/Crown_traits_draft.pdf.

1.3.4. Leaf traits (L)

Six leaf traits are measured following the procedures of Cornelissen *et al* (2003): lamina size (mm^2); specific leaf area ($\text{m}^2 \text{kg}^{-1}$); leaf thickness (μm); N concentration (mg g^{-1}); P concentration (mg g^{-1}); and dry matter content (mg g^{-1}). The most recent tree census is used to randomly select 5-6 of the largest and smallest individuals of each tree species for sampling. Two to five leaves are measured for each individual. Fresh mass is recorded upon leaf removal and dry mass after drying at 60°C for 72 hrs.

1.3.5. Reproductive traits (R)

Four reproductive traits are measured: dispersal mode (categorical), diaspore shape (unitless), diaspore mass (mg), and seed mass (mg). Diaspores are the unit that is dispersed by explosive force, by wind or by animals. Diaspores are dissected to isolate the embryo plus endosperms (i.e., seed). Collection of plant reproductive parts happens opportunistically and varies across sites subject to plant phenology. We attempt to collect five mature fruits from five individuals of each species, although for rare species or for those from which fruits rarely fall we collect single fruits or diaspores. Dispersal mode and shape classification follows Cornelissen *et al* (2003).

1.4. High-precision diameter growth

1.4.1. Infrequent (<1 measurement/month) dendrometer band measurements (P1)

Metal or plastic dendrometer bands are installed on trees to obtain precise estimates of diameter growth. Bands are fixed to a stratified random subset of trees ($n= 225 - 3,000$; varies by site) and are measured one to four times per year using precision digital calipers. In temperate regions, measurements are made at the beginning and end of the growing season. Crown exposure index, crown condition (completeness), and sometimes liana coverage of the crown are also judged on a 5-point scale at every recensus. Protocols for construction, materials and installation of metal and plastic bands are available at <http://www.ctfs.si.edu/group/Carbon/Protocol+Documents>.

1.4.2. Frequent dendrometer (≥ 1 measurement /month) band measurements (P2)

To resolve seasonal growth patterns, dendrometer bands installed on a subset of trees are measured at least once a month (commonly every two weeks) during the growing season. A workflow for optimizing the fit and interpretation of intra-annual growth measurements in a seasonal forest (SERC) is detailed in McMahon & Parker (2014). This paper outlines methods for fitting growth models to intra-annual measurements using R (R Core Team, 2013).

1.5. Flower and seed production

Flower and seed production of trees and lianas is monitored using flower/seed traps (n=60-336; varies by site). Each flower trap has a surface area of 0.5 m² and is elevated off the ground to reduce risk of seed predation. Traps are located randomly within plots (to represent different habitat types), or in a stratified random design at 4-13 m intervals on alternating sides of pre-existing trails. Specimens are collected weekly to bimonthly. All plant reproductive parts are identified to species, seed and fruits are counted and flowers recorded on a qualitative logarithmic scale. Details for trap construction and methods are available online (<http://www.ctfs.si.edu/floss/page/methods/>).

1.6. Seedling performance

To monitor the establishment, growth, and survival of seedlings, three 1-m² seedling plots are installed in association with each flower/seed trap (n \leq 1,008 seedling plots associated with \leq 336 seed traps; n varies by site). Woody seedlings are identified, measured (height and number of leaves), and permanently tagged. They are monitored annually (quarterly at some sites) from germination until plants reach 1 cm DBH and enter the core census. Canopy photographs are taken over each seedling plot annually to assess light availability. The proximity of seed traps and seedling plots enables an evaluation of the seed-to-seedling transition through comparisons of seed inputs and seedling recruitment.

1.7. DNA barcoding of plants

DNA sequences are being captured at multiple genetic loci for all tree species in the CTFS-ForestGEO network, with nearly 3,000 plant species sequenced to date (<http://www.ctfs.si.edu/group/Science+Initiatives/DNA+Barcoding>). Collection of plant samples for DNA barcode data begins with proper taxonomic identification of individual species from which a reference voucher and tissue sample are collected (see Kress *et al.*, 2012 for workflow). Ideally, 4-5 individuals are sampled per species. Field collected samples consist of 0.1-0.5 grams of green leaf tissue that are placed in silica gel desiccant. Only 0.01 gram of tissue is used in DNA extraction for plants where PCR and sequencing follows Fazekas *et al.* (2012; see also <http://ccdb.ca/resources.php>). Sequence data are cleaned and aligned into a multi-gene sequence matrix using Geneious (version 7.0, Biomatters), and then used in maximum-likelihood based phylogenetic reconstruction following Kress *et al.* (2009) to generate phylogenetic trees. Quantitative assessment of phylogenetic diversity metrics are conducted in R using the Picante package (see Swenson, 2012; picante.r-forge.r-project.org/). DNA barcode data are included in the BOLD database (e.g., Wabikon, USA: dx.doi.org/10.5883/DS-WABLK).

2. Animals

2.1. Arthropods

Multi-taxon censuses are being conducted at five tropical sites (Table S6-S7), focusing on a target set of assemblages chosen for their ecological relevance, taxonomic tractability and ease of sampling (Table S7; <http://www.ctfs.si.edu/group/arthropod%20monitoring/>).

2.1.1. Light traps

We use 10 W black light traps (automatic bucket-type model) fitted with intercept panes and a roof protecting catches from rain (Kitching *et al.*, 2001). Traps are filled with crumpled paper to provide surface to hold moths and other insects so that they do not

lose most of their scales. Plastic, open egg trays separate larger insects from more fragile specimens. Insects are collected dry and killed by five strips of DDVP insecticide dispensed in the trap. The attraction range of one trap is < 50m (Baker & Sadovy, 1978).

2.1.2. Winkler

To concentrate and extract litter ants, mini-Winkler collectors (Besuchet *et al.*, 1987; Agosti, 2000) are used from a 0.25 m² sample of leaf litter. The litter is picked up from within a 0.25m² frame, concentrated with a litter sifter and stored into a cloth bag. Each replicate (sample) is calibrated with a 400ml cylinder randomly scooped up and hung in a mini-Winkler. The extraction of material lasts for 72 hours. Ants are collected in ethanol and then processed as required.

2.1.3. McPhail traps

McPhail traps (International Atomic Energy Agency, 2003; model from Biobest, www.biobest.be), baited with methyleugenol and cue lure are used to attract tephritid flies. The traps are running for a week and are set up in the vegetation, not in direct sunlight, at 3-4 m height. Attraction range of baits is < 100-200m (Cunningham & Couey, 1986).

2.1.4. Butterfly transects

Walking transects of 500 m, timed to about 30 minutes (similar to Caldas & Robbins, 2003) are established to observe and catch butterflies. The observer restricts his/her attention to a 2 m wide strip across the transect and up to 5m height. For each transect, air temperature, relative humidity (%), and wind speed are also recorded. Cloudiness (%) is estimated visually. A full description of the protocol and how to implement it practically (establishment of local reference collection, etc.) is detailed in (Basset *et al.*, 2013).

2.1.5. Termite transects

Termite sampling transects are destructive (wood fragmentation, soil disturbance, etc.) and therefore are performed outside the permanent plots. Each year, we sample one transect of 400m, including 1 quadrat of 5m² searched for 30 minutes by one person, every 10m (total 40 samples; Roisin *et al.*, 2006). This include 4 different operations: (a) inspection of all trunks and branches for termite galleries up to 2m in height; (b) breaking any dead logs and branches; (c) scooping 6 smaller soil samples of ca. 15x15x10 cm; and (d) stirring and inspecting most of litter within the quadrat.

2.1.6. Bee baits

Cineole baits are used to attract euglossine bees traps (Ackerman *et al.*, 1982; Roubik, 2001), dispensed in McPhail traps (see item 3). The traps are baited with 7ml cineole and 100ml of commercial ethyleneglycol (car coolant) and run for a week.

2.1.7. Interaction studies: seed predation

Non-rotting fruit and seeds from focal plant families are collected from inside and outside the plots. Fruits/seeds are processed as soon as possible after collection and placed in suitable rearing containers covered with black mesh and lined with tissue paper. Fruits of different species, tree individuals, collection sites, stage of maturity, size, and collection date are stored in separate rearing containers. Containers are checked a minimum of two times per week for emerging seed predators and parasitoids. Fruit/seeds are kept in a rearing shed for a period of three months. After this period, fruits/seeds are dissected before being discarded. In cases where developing larvae are encountered during dissection, fruits/seeds are returned to the rearing shed to allow for continued development of immature individuals. The protocol was adapted from (Janzen, 1980).

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2.1.8. DNA barcoding of arthropods

Field arthropod samples are collected by placing a leg of each individual into wells of a microplate filled with 95% ethanol. The voucher specimen is dry mounted, pictured and preserved in a local reference collection. Vouchers are later transferred into collections of national importance in the host country. Sample preparation and DNA sequencing for arthropods are detailed in Wilson (2012; see also <http://ccdb.ca/resources.php>). Sequences and voucher pictures are gradually becoming all public at <http://www.boldsystems.org/>.

2.2. Vertebrates

The vertebrate program (<http://www.ctfs.si.edu/group/vertebrates>) is collecting data on vertebrates in selected sites across the ForestGEO network. To date, the focus is on ground-dwelling mammals, which are monitored using standardized camera trapping procedures.

2.2.1. Camera trapping: TEAM Protocol (P1)

Terrestrial mammals are monitored following the terrestrial vertebrate monitoring protocol implemented by the Tropical Ecology Assessment and Monitoring Network (TEAM Network, 2011; see also <http://www.teamnetwork.org>). This protocol uses digital camera traps (60-90 camera traps points) at a density of 1 camera every 2 km² to monitor the status of species and changes in the community. Photographs are processed with an application called DeskTEAM (Fegraus *et al.*, 2011). The data product is used to build annual occupancy and spatial occurrence models through sites. Protocols are available at <http://www.teamnetwork.org/protocols/bio/terrestrial-vertebrate>.

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2.2.2. Camera trapping: CTFS-ForestGEO Protocol (P2)

Terrestrial mammals are monitored using camera traps deployed at points in a 1-km² grid centered on each plot at a density of 1 camera trap / 2 ha (one hundred times more dense than TEAM protocol). The rates at which species pass in front of the cameras and are photographed are used as proxy for their abundance and can be compared between survey years and across plots. Photographs are securely stored and processed with custom-made database and processing tools (Kays *et al.*, 2009). Protocols are at <http://www.ctfs.si.edu/group/vertebrates>.

3. Ecosystem and Environmental Variables

3.1. Aboveground biomass

3.1.1. Ground based estimates

Biomass is estimated from tree diameter, height, and wood density data (when available) using the best available allometric equations. In the tropics, calculations rely on standard allometric equations (e.g., Chave *et al.*, 2005). In the temperate and boreal regions, species- and even site-specific allometric equations are sometimes available (e.g., Yosemite; Lutz *et al.*, 2012), and generic allometries (e.g., Jenkins *et al.*, 2003) are used when these are not available.

Aboveground biomass (AGB) based on general allometric equations (currently Chave *et al.*, 2005) can be calculated using the CTFS R package available at <http://ctfs.arnarb.harvard.edu/Public/CTFSRPackage/index.php/web/tutorials/biomass/index>. This code will soon be updated to take advantage of the newest tropical forest allometries (Chave *et al.* 2014).

3.1.2. Airborne LiDAR estimates

Airborne LiDAR measurements have been made following a variety of protocols (e.g., Lefsky *et al.*, 1999; Parker *et al.*, 2004; Weishampel *et al.*, 2007; Mascaro *et al.*, 2011). There is not a specific CTFS-ForestGEO protocol.

3.2. Dead Wood/ Coarse Woody Debris (CWD)

Two alternative sets of protocols for measuring necromass have each been implemented at multiple CTFS-ForestGEO sites. The CTFS Forest Carbon Research Initiative methods include CWD long transect, and fallen and standing CWD dynamics (P1-P3 below). An alternative method that has been employed at several temperate sites involves comprehensive inventories of all woody debris within the plot perimeter (P4 below). These methods are described below.

3.2.1. CWD long transect (P1)

Dry mass of fallen woody debris per area is quantified using line-intersect surveys following Warren & Olsen (1964). An inventory of fallen coarse pieces (or CWD, >200 mm in diameter) is performed on the entire transect, and fine woody debris (or FWD, 20-200mm in diameter) on 10% of the transect (2 m of every 20 m). The diameter of each piece intersecting a transect is measured to enable estimation of the average volume of woody debris on the plot as a whole and its confidence limits. Where permitted, a sample is also taken from each piece to enable estimation of the dry mass of woody debris per unit area on the plot as a whole, with its confidence limits (Larjavaara & Muller-Landau, 2011). Where sampling on the plot is not allowed, other data on the wood density of woody debris are used instead. Hardness of coarse pieces is in all cases recorded using a penetrometer, and these values can be used as a basis for assigning wood densities (Larjavaara & Muller-Landau, 2010). The protocol is described in detail at <http://www.ctfs.si.edu/group/Carbon/Protocol+Document>.

3.2.2. *Fallen CWD dynamics (P2)*

Fallen coarse woody debris (CWD; >200 mm diameter) is quantified using a repeated inventory of line transects. Transects are 20-m long within typically one hundred 40 m x 40 m subplots (same subplots used for the standing CWD and the stratified sample of dendrometers). More details can be found in the online protocol document (<http://www.ctfs.si.edu/group/Carbon/Protocol+Documents>).

3.2.3. *Standing CWD dynamics (P3)*

Standing dead trees are inventoried within 40 m x 40 m sub-plots. Standing CWD (>200 mm) are censused throughout the whole subplot, while standing FWD (20-199 mm) are censused only in the central area with a radius of 5 m. For each standing dead tree greater than 200 mm in diameter, dbh (or diameter above buttress), height, and hardness (using a penetrometer) are measured. In addition, the proportion of branches remaining is categorized. More details can be found in the online protocol document (<http://www.ctfs.si.edu/group/Carbon/Protocol+Documents>).

3.2.4. *CWD comprehensive (P4)*

This alternative method of inventorying woody debris includes all deadwood objects within a plot perimeter (at some sites, only trees >100 mm dbh are measured). All pieces are outlined as vectors on a site local map, which allows posterior calculation of length and orientation plus local coordinates. Objects are sorted by two binary classifications into a “standing/lying” and “whole/broken” class. According to their combination and height attributes six deadwood types are defined: whole dead standing tree, broken dead standing stem (snag), whole dead lying tree, base part of dead lying stem, further parts of dead lying stem, and stump. Volume is calculated using DBH allometric equations (truncated cones for stem parts). A decomposition class (hardwood, touchwood, and disintegrated) is assigned to each piece to track tree individuals until their final decomposition (Král *et al.*, 2014).

3.3. Soil Carbon and Fine Root Biomass

Soil samples are systematically taken from around the center 20 x 20 m quadrat in every hectare at each plot. Soil is sampled to 3 m in the center of the quadrat, with additional samples taken to 1 m (x4) and 10 cm (x9) around the quadrat. Roots are separated by hand into fine roots < 2 mm and coarse roots > 2 mm diameter, dried at 60°C, and weighed. The soils are air-dried, sieved (<2 mm) and a subsample ground for analysis. Soil carbon concentration is determined by combustion and gas chromatography using a Thermo Flash EA 1112 Elemental Analyzer (for details, <http://www.ctfs.si.edu/group/Carbon/Protocol+Documents>)

3.4. Soil Nutrients

3.4.1. Soil nutrient mapping (P1)

Soils are sampled using a regular grid of points every 50 m within sites. Each alternate grid point is paired with an additional sample point to capture variation in soil properties. 50 g of topsoil (0- to 10-cm depth) is collected at each sample point, and available cations and P are extracted using the Mehlich-3 extractant solution. N mineralization rates are measured on site using 3-inch diameter pipes 15 cm into the ground and incubated for 28 days (in-field incubation). Maps of estimated soil resource availability at the 10 x 10 m scale for each plot are then generated following John *et al.* (2007).

3.4.2. Soil nutrient mapping-Turner protocol (P2)

More recent nutrient mapping has used Bray-1 solution to determine available phosphorus and 0.1 M BaCl₂ to determine exchangeable base cations and extractable Al and Mn. The latter is preferred to the Mehlich extraction because it yields measures of effective cation exchange capacity, base saturation, and the potential toxins Al and Mn. It does not, however, provide extractable micronutrient data. Soil pH is determined in deionized water, 0.01 M CaCl₂ and 0.1 M BaCl₂.

3.4.3. Soil nutrient mapping-Turner protocol (P3)

This method follows same steps as P2 above for cations but includes measurements of N mineralization (NH_4 and NO_3) using in-field resin bags. Briefly, mixed ion exchange resins are sealed in mesh bags and placed in the upper 10 cm of soil at the same sample locations as in P1 above. After three weeks, resin bags are removed, cleaned, and extracted in 0.5 M HCl. In addition to nitrogen, the extracts are also analyzed for P and base cations.

3.5. Litterfall

Litter production of the stand, including trees and lianas of all species combined, is monitored using a set of aboveground and ground litter traps (n=100 pairs). Traps are located systematically or randomly within plots. Each aboveground litter trap has a surface area of 0.5 m² and is elevated off the ground to reduce risk of seed predation. Ground traps are next to the aboveground trap and are used to monitor palm fronds and branchfalls of material that is too large to be captured in the aboveground traps. The traps are censused on a weekly to monthly basis. Trap contents are oven-dried at 65 C, then sorted into leaves, reproductive parts (flowers, seeds, fruits), fine woody material, and other. These fractions are weighed for each trap. Details of trap construction and methods are available online at <http://www.ctfs.si.edu/group/Carbon/Protocol+Documents>.

3.6. Bio-micrometeorology

At or adjacent to 15 sites, ecosystem-atmosphere gas exchange has been measured using the eddy-covariance technique (e.g., Barford *et al.*, 2001; Kume *et al.*, 2011; Thomas *et al.*, 2011; Kosugi *et al.*, 2012; Soderberg *et al.*, 2012; Wharton *et al.*, 2012; Zhang *et al.*, 2012). There is not a specific CTFS-ForestGEO protocol. While integration between flux measurements and core tree census data remains limited, these co-located measurements represent an important opportunity to link the growth and water use of individual trees to whole-ecosystem carbon cycling and evapotranspiration.

3.7. Micrometeorology

Meteorological stations vary by site. At sites with meteorological stations installed as part of the CTFS Carbon Program (BCI, SCBI, Huai Kha Khaeng, Khao Chong, and Pasoh), a standardized meteorological station installed within or adjacent to the plot. The stations include several sensors recorded automatically by a CR1000 datalogger (Campbell Scientific) at a 5-minute interval. These sensors include: 1) an aspirated and shield temperature and a relative humidity sensor plus an additional secondary temperature sensor (MetOne Instruments); 2) a 2-D sonic anemometer WS425 (Vaisala); 3) a tipping rain bucket TB4-L (Campbell Scientific); and 4) a solar radiometer CMSP2 (Kipp & Zonen), plus a secondary radiometer LI-290 (LiCOR biogeoscience).

In addition to meteorological data, some sites monitor soil temperature, moisture, and/or snow presence (e.g., Raleigh *et al.*, 2013).

Table S1. Geographic coordinates, elevation data, and references to site descriptions for all CTFS-ForestGEO sites.

#	Site	Latitude	Longitude	Elevation-min (m)	Elevation-max (m)	Topographic relief (m)	Site Description
1	Korup	5.07389	8.85472	150	240	90	Thomas <i>et al.</i> , 2003, 2015; Chuyong <i>et al.</i> , 2004
2	Ituri (Edoro and Lenda)*	1.4368	28.5826	700	850	150	Makana <i>et al.</i> , 2004
3	Rabi	-1.9246	9.88004	28	54	26	
4	Mpala	0.2918	36.8809	1660	1800	140	Georgiadis, 2011
5	Wanang	-5.25	145.267	90	190	100	
6	Kuala Belalong	4.5384	115.154	160	320	160	
7	Dinghushan	23.1695	112.511	230	470	240	Pei <i>et al.</i> , 2011
8	Heishiding	23.27	111.53	435	698	263	Yin & He, 2014
9	Hong Kong	22.4263	114.181	145	257	112	
10	Jianfengling	18.7308	108.905	866	1017	151	
11	Nonggang	22.4333	106.95	370	180	190	Wang <i>et al.</i> , 2014
12	Xishuangbanna	21.6117	101.574	709	869	160	Cao <i>et al.</i> , 2008
13	Mudumalai	11.5989	76.5338	980	1120	140	Sukumar <i>et al.</i> , 2004
14	Danum Valley	5.10189	117.688				
15	Lambir	4.1865	114.017	104	244	140	Lee <i>et al.</i> , 2003, 2004
16	Pasoh	2.982	102.313	70	90	20	Manokaran <i>et al.</i> , 2004
17	Palanan	17.0402	122.388	72	122	50	Co <i>et al.</i> , 2004
18	Bukit Timah	1.35	103.78	74	124	50	Lum <i>et al.</i> , 2004; LaFrankie <i>et al.</i> , 2005
19	Sinharaja	6.4023	80.4023	424	575	151	Gunatilleke <i>et al.</i> , 2004
20	Fushan	24.7614	121.555	600	733	133	Su <i>et al.</i> , 2007
21	Kenting	21.98	120.7969	250	300	50	Lin <i>et al.</i> , 2011; Wu <i>et al.</i> , 2011

#	Site	Latitude	Longitude	Elevation-min (m)	Elevation-max (m)	Topographic relief (m)	Site Description
22	Lienhuachih	23.9136	120.879	667	841	174	Lin <i>et al.</i> , 2011; Chang <i>et al.</i> , 2012
23	Nanjenshan	22.059	120.854	300	340	40	Sun & Hsieh, 2004
24	Zenlun	23.4247	120.5509				
25	Doi Inthanon	18.5833	98.4333	1630	1710	80	Kanzaki <i>et al.</i> , 2004
26	Huai Kha Khaeng	15.6324	99.217	549	638	89	Bunyavejchewin <i>et al.</i> , 2004, 2009
27	Khao Chong	7.54347	99.798	110	360	250	
28	Mo Singto	14.4333	101.35	725	815	90	Brockelman <i>et al.</i> , 2011; Chanthorn <i>et al.</i> , 2013
29	Haliburton	45.2901	-78.6377	412.5	454.4	41.9	
30	Scotty Creek	61.3	-121.3	258	274	16	Chasmer <i>et al.</i> , 2014
31	Harvard Forest	42.5388	-72.1755	340	368	28	Motzkin <i>et al.</i> , 1999
32	Lilly Dickey Woods	39.2359	-86.2181	230	303	73	
33	Santa Cruz	37.0124	-122.075	314	332	18	Gilbert <i>et al.</i> , 2010
34	SCBI	38.8935	-78.1454	273	338	65	Bourg <i>et al.</i> , 2013
35	SERC	38.8891	-76.5594	6	10	4	McMahon & Parker, 2014
36	Tyson Research Center	38.5178	-90.5575	172	233	61	
37	Wabikon	45.5546	-88.7945				
38	Wind River	45.8197	-121.9558	352.4	384.7	32.3	Lutz <i>et al.</i> , 2013
39	Yosemite National Park	37.7662	-119.819	1774.1	1911.3	137.2	Lutz <i>et al.</i> , 2012
40	Ilha do Cardoso	-25.0955	-47.9573	3	8	5	de Oliveira <i>et al.</i> , 2014
41	Manaus	-2.4417	-59.7858	40	80	40	Gomes <i>et al.</i> , 2013
42	Amacayacu	-3.8091	-70.2678				Arias Garcia <i>et al.</i> , 2009
43	La Planada	1.1558	-77.9935	1796	1840	44	Vallejo <i>et al.</i> , 2004

#	Site	Latitude	Longitude	Elevation-min (m)	Elevation-max (m)	Topographic relief (m)	Site Description
44	Yasuni	-0.6859	-76.397	215	245	30	Valencia <i>et al.</i> , 2004
45	Barro Colorado Island	9.1543	-79.8461	120	160	40	Hubbell, 1979; Condit, 1998; Leigh <i>et al.</i> , 2004
46	Cocoli	8.9877	-79.6166				Condit <i>et al.</i> , 2004
47	San Lorenzo/ Sherman	9.2815	-79.974				Condit <i>et al.</i> , 2004
48	Luquillo	18.3262	-65.816	333	428	95	Thompson <i>et al.</i> , 2002; Thompson <i>et al.</i> , 2004
49	Laupahoehoe	19.9301	-155.287	1150	1170	20	Ostertag <i>et al.</i> , 2014
50	Palamanui	19.7394	-155.994	255	275	20	Ostertag <i>et al.</i> , 2014
51	Badagongshan	29.46	110.52	1470	1369	101	Wang <i>et al.</i> , 2014
52	Baotianman	33.4956	111.9397			241	
53	Changbaishan	42.3833	128.083	792	810	18	Wang <i>et al.</i> , 2009
54	Donglingshan	39.9566	115.425	1290	1509	219	Liu <i>et al.</i> , 2011
55	Gutianshan	29.25	118.117	446	715	269	Lai <i>et al.</i> , 2009; Ma <i>et al.</i> , 2009; Lin <i>et al.</i> , 2012
56	Tiantongshan	29.8116	121.783	304	602	298	Yang <i>et al.</i> , 2011
57	Zofin	48.6638	14.7073	735	825	90	Král <i>et al.</i> , 2010; Šamonil <i>et al.</i> , 2011
58	Speulderbos	52.253	5.702	49	63	14	Wijdeven, 2003
59	Wytham Woods	51.7743	-1.3379	104	163	59	Butt <i>et al.</i> , 2009; Thomas <i>et al.</i> , 2011b

* Ituri has four plots at two locations (Edoro and Lenda). Geographic coordinates are the midpoint value.

Table S2. Climate data for all CTFS-ForestGEO sites: average for 1980-2012 from CGIAR-CSI climate data.

Additional climate data are available online (www.ctfs.si.edu/Data). *Note:* These values do not correspond exactly to values in Table 2 (most of which come from local weather stations measured over a range of time frames) or Figure 2 (which come from the WorldClim database). For high precipitation-sites within the CTFS-ForestGEO network, values from the CRU-TS v3.10.01 Historic Climate Database tend to underestimate MAP, dramatically so at some sites (e.g., Korup, Kuala Belalong, Sinharaja, Fushan, La Planada; see Appendix S1).

#	Site	Annual temperature (°C)	January temperature (°C)	July temperature (°C)	Frost days (days/yr)	Annual PET (mm/yr)	MAP (mm/yr)	Months with PPT<PET	Precipitation Seasonality (CV; %)	Precipitation days (days/yr)	Cloud Cover (%)
1	Korup	26.4	26.2	25.0	0.0	1050	2440	4.0	77	172	84
2	Ituri (Edoro and Lenda)	24.2	24.1	23.2	0.0	1168	1430	4.2	43	137	69
3	Rabi	26.1	27.3	23.6	0.0	956	1943	4.3	85	139	90
4	Mpala	17.7	16.4	16.9	2.3	1280	773	10.0	71	116	69
5	Wanang	26.5	26.8	25.8	0.0	1183	3366	0.6	44	278	75
6	Kuala Belalong	26.6	26.2	26.6	0.0	1164	3757	0.8	47	276	69
7	Dinghushan	22.0	13.4	28.8	0.5	1065	1870	4.2	86	148	70
8	Heishiding	21.5	12.6	28.4	1.5	1022	1719	4.4	83	155	72
9	Hong Kong	23.0	15.7	28.6	0.0	-	2334	-	99	158	66
10	Jianfengling	24.9	19.7	28.5	0.0	1197	2102	4.9	89	110	69
11	Nonggang	22.5	14.2	28.5	0.2	1066	1345	6.0	86	156	73
12	Xishuangbanna	21.1	16.2	24.0	0.2	1054	1423	5.9	91	203	63
13	Mudumalai	24.3	22.6	23.6	0.0	1498	1079	7.6	89	60	51
14	Danum Valley	25.6	25.3	25.4	0.0	1104	2724	1.2	49	253	70
15	Lambir	26.3	25.7	26.5	0.0	1114	3249	1.0	50	284	71
16	Pasoh	26.3	25.7	26.4	0.0	1120	1896	2.5	47	240	74
17	Palanan	25.1	22.5	26.6	0.0	1238	2724	3.2	73	172	65
18	Bukit Timah	27.5	26.6	27.7	0.0	1172	2301	2.5	52	264	74
19	Sinharaja	26.9	26.2	27.0	0.0	1384	2533	3.3	64	130	65

#	Site	Annual temperature (°C)	January temperature (°C)	July temperature (°C)	Frost days (days/yr)	Annual PET (mm/yr)	MAP (mm/yr)	Months with PPT<PET	Precipitation Seasonality (CV; %)	Precipitation days (days/yr)	Cloud Cover (%)
20	Fushan	21.4	15.3	27.3	0.0	1085	2121	2.8	66	205	73
21	Kenting	23.5	18.4	27.7	0.0	-	2207	-	85	175	68
22	Lienhuachih	16.7	11.8	21.2	3.1	908	1958	3.6	84	187	71
23	Nanjenshan	23.3	18.7	26.8	0.0	1255	2157	5.4	99	144	67
24	Zenlun	17.4	12.8	21.5	1.6	943	2031	3.8	88	179	71
25	Doi Inthanon	23.1	19.4	23.8	0.0	1135	1201	6.3	97	159	55
26	Huai Kha Khaeng	25.1	22.6	25.6	0.0	1202	1448	5.9	92	154	58
27	Khao Chong	27.1	26.3	27.2	0.0	1208	2331	3.4	67	174	72
28	Mo Singto	27.4	25.6	27.8	0.0	1300	1672	5.9	94	141	62
29	Haliburton	4.8	-11.2	18.8	186.2	653	1176	2.7	34	172	63
30	Scotty Creek	-2.7	-23.5	16.8	231.0	511	380	6.0	72	100	61
31	Harvard Forest	8.8	-5.0	21.6	157.0	910	1150	4.4	47	135	66
32	Lilly Dickey Woods	11.9	-1.8	24.4	115.3	981	1130	4.9	52	126	66
33	Santa Cruz	14.6	10.3	18.1	9.6	1084	664	8.2	134	42	48
34	SCBI	12.8	1.0	24.3	110.1	1003	1029	5.9	52	133	66
35	SERC	14.1	1.8	26.1	82.3	1111	1128	5.8	52	119	61
36	Tyson Research Center	13.6	-0.5	26.6	99.6	1138	992	7.3	59	117	61
37	Wabikon	4.2	-11.4	18.4	199.2	684	748	5.4	64	130	68
38	Wind River	8.3	0.6	17.9	141.9	770	1893	4.3	86	129	71
39	Yosemite National Park	10.8	2.6	21.3	154.3	1293	960	7.5	120	44	49
40	Ilha do Cardoso	21.2	24.8	17.3	0.0	-	2265	-	60	227	65
41	Manaus	27.3	26.8	27.0	0.0	1166	2177	3.3	58	249	82
42	Amacayacu	25.8	25.8	25.3	0.0	1010	2623	0.8	41	337	82
43	La Planada	16.1	15.8	16.1	0.0	920	1612	3.5	59	197	81
44	Yasuni	25.9	26.3	24.8	0.0	1380	3270	1.0	42	300	83
45	Barro Colorado Island	26.3	25.7	26.9	0.0	1311	3025	4.0	76	218	58

#	Site	Annual temperature (°C)	January temperature (°C)	July temperature (°C)	Frost days (days/yr)	Annual PET (mm/yr)	MAP (mm/yr)	Months with PPT<PET	Precipitation Seasonality (CV; %)	Precipitation days (days/yr)	Cloud Cover (%)
46	Cocoli	26.6	26.2	27.2	0.0	1385	1709	4.6	75	217	56
47	San Lorenzo/ Sherman	26.3	25.7	26.9	0.0	1311	3025	4.0	76	218	58
48	Luquillo	25.6	23.4	27.0	0.0	1219	2363	2.8	61	201	61
49	Laupahoehoe	18.8	17.1	20.3	0.0	1091	2041	3.3	64	246	69
50	Palamanui	17.6	15.9	19.1	0.0	1052	1587	4.3	56	246	68
51	Badagongshan	14.0	2.8	24.3	55.0	821	1250	3.9	67	177	75
52	Baotianman	14.3	1.6	25.8	82.0	959	781	8.6	88	93	63
53	Changbaishan	1.3	-18.6	17.8	215.9	762	877	7.8	112	109	53
54	Donglingshan	8.1	-8.7	22.7	160.3	1057	461	10.8	117	69	44
55	Gutianshan	15.9	4.0	26.8	48.3	934	1637	3.3	66	153	66
56	Tiantongshan	16.8	5.9	27.9	28.3	906	1430	3.1	63	163	68
57	Zofin	8.5	-1.5	18.3	123.1	704	726	5.3	57	166	66
58	Speulderbos	10.0	2.8	17.6	78.4	619	802	4.7	50	192	77
59	Wytham Woods	10.3	4.5	17.2	64.7	637	681	5.3	52	156	77

Table S3. Recent climate change at CTFS-ForestGEO sites (difference between 2008-2012 and 1951-1980 average) calculated from CGIAR-CSI climate data.

Additional climate data are available online (www.ctfs.si.edu/Data). *Note:* For high precipitation-sites, values from the CRU-TS v3.10.01 Historic Climate Database tend to underestimate MAP, dramatically so at some sites (e.g., Korup, Kuala Belalong, Sinharaja, Fushan, La Planada; see Appendix S1).

#	Site	Δ MAT (°C)	Δ January T (°C)	Δ July T (°C)	Δ Frost days (days/yr)	Δ Annual PET (%)	Δ MAP (%)	Δ Months pPT<PET (months/yr)	Δ Precipitation Seasonality (%)	Δ Precipitation days (days/yr)	Δ Cloud Cover (%)
1	Korup	0.74	0.50	0.66	0.0	1.56	-6.7	0.7	7.2	-2.1	0.4
2	Ituri (Edoro and Lenda)	1.28	1.26	1.29	0.0	3.20	3.5	-0.9	-22.1	4.7	-1.2
3	Rabi	0.31	0.08	0.31	0.0	0.55	3.3	-0.2	-11.5	4.0	0.1
4	Mpala	1.01	1.08	1.03	-2.1	3.75	-5.3	0.9	-27.9	-31.5	-1.3
5	Wanang	0.19	0.20	0.20	0.0	0.63	4.4	-0.8	-15.6	10.9	1.2
6	Kuala Belalong	0.28	0.27	-0.04	0.0	-1.80	21.8	-0.3	5.9	23.2	1.5
7	Dinghushan	0.27	-1.19	0.58	-0.1	8.15	7.6	-0.5	-3.4	3.1	-2.3
8	Heishiding	0.05	-1.39	0.36	0.5	6.93	3.1	-0.7	-9.5	3.0	-2.4
9	Hong Kong	-0.10	-0.73	-0.42	0.0		-5.2		-8.3	-3.0	-1.0
10	Jianfengling	0.27	-0.38	0.22	0.0	4.05	24.5	-1.4	-17.9	0.2	1.7
11	Nonggang	0.13	-1.31	0.25	0.1	5.89	-1.1	-0.2	-12.7	-11.5	-2.7
12	Xishuangbanna	1.23	1.43	1.00	-1.6	7.73	6.5	-0.3	-6.2	-4.9	-6.2
13	Mudumalai	0.90	1.24	0.80	0.0	0.80	-1.0	-0.6	-14.9	6.3	3.8
14	Danum Valley	0.60	0.77	0.36	0.0	-0.87	22.2	-0.5	-1.4	16.3	0.9
15	Lambir	0.08	-0.05	-0.24	0.0	-3.08	18.9	-0.2	18.7	20.4	1.9
16	Pasoh	1.18	0.92	1.30	0.0	2.02	5.3	-1.7	-33.5	13.2	0.5
17	Palanan	0.52	0.34	0.18	0.0	2.06	16.9	-0.6	7.5	-10.9	-0.9
18	Bukit Timah	0.95	0.63	1.20	0.0	2.04	12.0	-0.2	-0.9	8.9	-0.2
19	Sinharaja	0.66	0.58	0.72	0.0	0.22	-10.5	-0.6	-9.0	14.2	1.9

#	Site	Δ MAT (°C)	Δ January T (°C)	Δ July T (°C)	Δ Frost days (days/yr)	Δ Annual PET (%)	Δ MAP (%)	Δ Months pPT<PET (months/yr)	Δ Precipitation Seasonality (%)	Δ Precipitation days (days/yr)	Δ Cloud Cover (%)
20	Fushan	0.58	0.41	0.40	0.0	10.73	12.4	-0.3	-20.0	7.4	3.6
21	Kenting	0.46	0.26	0.25	0.0		-2.7		-25.4	-0.7	3.5
22	Lienhuachih	0.65	0.46	0.53	-2.7	12.17	7.2	-1.3	-19.0	5.7	5.6
23	Nanjenshan	0.53	0.35	0.34	0.0	6.14	-0.3	-1.0	-8.0	0.8	4.2
24	Zenlun	0.63	0.41	0.50	-1.6	11.26	5.7	-1.1	-11.8	4.4	5.1
25	Doi Inthanon	0.85	1.99	0.37	-0.3	2.74	-6.3	0.2	-1.2	-0.5	-2.6
26	Huai Kha Khaeng	0.22	0.56	-0.14	0.0	-2.48	17.7	-0.3	-1.1	5.7	3.2
27	Khao Chong	0.69	0.90	0.60	0.0	-0.79	13.0	-0.5	-12.5	0.7	4.8
28	Mo Singto	0.52	0.87	0.19	0.0	-2.05	22.2	-1.3	-4.2	1.6	5.4
29	Haliburton	1.22	1.31	0.90	-11.3	1.02	7.4	-0.7	-22.7	7.9	3.3
30	Scotty Creek	0.99	2.83	1.04	-7.3	6.12	9.2	0.3	-25.2	-25.5	0.4
31	Harvard Forest	1.23	0.76	1.05	-14.5	7.33	19.9	-0.2	8.4	6.8	4.4
32	Lilly Dickey Woods	1.25	0.27	1.55	-21.1	9.29	15.4	-0.7	14.3	5.7	6.6
33	Santa Cruz	0.58	1.15	0.20	-8.7	-2.16	-0.7	-0.1	5.0	1.0	8.7
34	SCBI	0.28	-0.06	0.52	-8.0	1.67	2.7	-0.9	-22.4	8.5	5.5
35	SERC	0.90	0.35	1.29	-11.4	10.14	6.8	-0.1	-3.5	8.0	4.8
36	Tyson Research Center	1.29	1.42	1.39	-14.5	8.07	26.3	-0.8	4.4	18.0	5.4
37	Wabikon	0.55	0.17	0.70	-6.4	-5.30	-0.9	0.4	5.4	-5.8	6.6
38	Wind River	-0.06	1.20	0.17	-5.5	-3.69	1.8	-1.1	-15.0	8.2	3.5
39	Yosemite National Park	1.58	1.97	2.05	-39.0	0.75	-18.7	0.1	10.6	-0.5	18.7
40	Ilha do Cardoso	1.09	0.65	1.16	0.0		29.5		-4.7	15.5	-0.5
41	Manaus	0.77	0.32	0.84	0.0	2.46	9.5	-0.2	5.2	-10.7	-0.4
42	Amacayacu	0.25	-0.05	0.44	0.0	-1.57	-7.8	0.4	14.2	-8.1	0.3
43	La Planada	-0.01	-0.27	0.22	0.0	-12.70	2.4	-0.3	10.2	3.0	5.8
44	Yasuni	-0.02	-0.30	0.35	0.0	-7.30	8.4	0.2	25.8	5.2	4.8

#	Site	Δ MAT (°C)	Δ January T (°C)	Δ July T (°C)	Δ Frost days (days/yr)	Δ Annual PET (%)	Δ MAP (%)	Δ Months PPT<PET (months/yr)	Δ Precipitation Seasonality (%)	Δ Precipitation days (days/yr)	Δ Cloud Cover (%)
45	Barro Colorado Island	0.36	0.46	0.44	0.0	-3.31	17.9	0.1	9.2	13.3	2.7
46	Cocoli	0.33	0.41	0.41	0.0	-3.01	11.2	-0.5	3.9	11.2	1.8
47	San Lorenzo/ Sherman	0.36	0.46	0.44	0.0	-3.31	17.9	0.1	9.2	13.3	2.7
48	Luquillo	0.34	0.08	0.60	0.0	-0.16	29.0	-0.6	2.9	11.4	1.2
49	Laupahoehoe	-0.04	0.03	0.01	0.0	-7.27	-20.7	1.3	18.2	4.7	2.6
50	Palamanui	0.07	0.13	0.11	0.0	-7.21	-28.4	2.8	-4.2	-3.4	3.0
51	Badagongshan	0.29	-0.79	0.13	-5.6	0.67	-5.6	1.2	-6.8	-3.1	6.8
52	Baotianman	0.90	0.10	0.55	-15.0	4.55	-1.7	0.4	-3.9	-1.6	5.8
53	Changbaishan	0.71	0.87	0.02	-9.7	4.67	0.2	-0.3	2.7	-9.9	-6.0
54	Donglingshan	1.51	0.80	1.73	-16.8	11.70	2.8	0.3	-10.7	0.5	-2.1
55	Gutianshan	0.25	-0.87	0.17	0.1	10.96	3.0	0.2	-15.7	2.0	-0.8
56	Tiantongshan	0.29	-0.58	0.35	-2.5	3.91	10.6	-0.4	-2.7	6.0	1.7
57	Zofin	1.32	1.82	1.26	-17.4	9.01	4.8	0.0	-4.1	1.2	-5.6
58	Speulderbos	0.99	0.95	1.30	-14.7	16.24	6.7	0.3	6.1	3.3	-4.0
59	Wytham Woods	0.75	0.65	0.61	-15.1	6.51	3.3	1.1	-12.1	-17.2	2.8

Table S4. Climate Change Projections for CTFS-ForestGEO sites.

Recent climate ('R'; 1950-2000 average; source: WorldClim) and future- HADGEM2-ES model Climate Change Projections for 2050 (2041-2060 average) under two emissions scenarios: RCP 2.6 (IPCC's most optimistic scenario, with emissions going to zero by 2070) and RCP 8.5 (IPCC's most pessimistic emissions scenario). Full data on climate change projections are available online (www.ctfs.si.edu/Data). *Note:* These values do not correspond exactly to values in Table 2 (most of which come from local weather stations measured over a range of time frames). For high precipitation-sites within the CTFS-ForestGEO network, values from the WorldClim Database tend to underestimate MAP, dramatically so at some sites (e.g., Korup, Kuala Belalong, Sinharaja, Fushan, La Planada; see Appendix S1).

#	Site	Mean Annual Temperature (°C)			Max T of warmest month (°C)			Min T of coldest month (°C)			Mean Annual Precipitation (mm yr ⁻¹)			Precipitation of wettest month (mm mo ⁻¹)			Precipitation of driest month (mm mo ⁻¹)		
		R	RCP 2.6	RCP 8.5	R	RCP 2.6	RCP 8.5	R	RCP 2.6	RCP 8.5	R	RCP 2.6	RCP 8.5	R	RCP 2.6	RCP 8.5	R	RCP 2.6	RCP 8.5
1	Korup	26.6	28.3	29.3	32.5	34.1	35	22	23.9	24.9	2680	2763	2762	411	426	408	29	32	31
2	Ituri (Edoro and Lenda)	24.3	26.3	27.5	31.3	33.1	34.6	17.9	20	21.2	1750	1775	1818	198	198	200	67	84	77
3	Rabi	25.6	27.3	28.2	32.3	33.9	34.9	18.5	20.6	22	1970	2026	2002	371	398	423	2	2	3
4	Mpala	17.9	20	21.1	28	29.7	30.8	8.1	10.7	12.1	709	648	662	133	125	142	21	17	17
5	Wanang	26.2	27.8	28.6	30.9	32.5	33.4	21.4	23	24	3764	4006	4074	430	516	539	180	143	134
6	Kuala Belalong	26.5	27.9	28.8	30.4	31.9	33	23	24.5	25.3	3767	3890	4061	370	391	441	247	252	248
7	Dinghushan	19.7	21.8	22.7	30.1	31.8	32.8	7.1	9.8	10.8	1735	1829	1847	283	318	339	33	31	30
8	Heishiding	22	24.2	25.1	33.5	35.3	36.2	8.9	11.5	12.4	1440	1507	1506	245	254	263	33	34	33
9	Hong Kong	21.9	24	24.8	30.5	32.1	33	11.3	13.9	14.6	2286	2312	2280	415	451	452	28	26	25
10	Jianfengling	20.4	22.1	22.8	27.4	28.9	30	10.9	13	13.6	1657	1569	1355	318	310	349	17	18	17
11	Nonggang	22.5	24.8	25.8	32.6	34.8	36.3	10.2	12.6	13.5	1376	1356	1343	240	228	246	24	29	24
12	Xishuangbanna	21.3	23.1	24.4	30.4	32.9	34.5	9	10.6	12.2	1611	1641	1579	290	289	288	21	25	22
13	Mudumalai	22.3	24	25	30.1	31.9	32.8	14.9	16.4	17.6	1480	1658	1582	409	410	392	2	1	1
14	Danum Valley	25.9	27.3	28.2	30.5	32.1	33.1	21.8	23.3	24.2	2466	2412	2525	275	261	294	147	130	111
15	Lambir	26.5	27.8	28.6	30.8	32.1	33	22.5	24	24.7	2929	3076	3234	347	350	395	170	170	173
16	Pasoh	26.4	28	28.9	32.1	33.9	34.9	21	22.6	23.5	1975	1861	1975	254	209	239	103	112	101
17	Palanan	26.5	27.9	28.6	33.4	35.1	36	19.5	20.7	21.3	2644	2724	2707	558	573	594	79	70	65
18	Bukit Timah	26.9	28.1	28.9	31.5	32.9	33.6	22.1	23.4	24	2371	2374	2367	301	284	287	153	162	158

19	Sinharaja	23.6	25	25.8	29.1	30.8	31.7	18.7	19.8	20.6	3442	3716	3556	434	607	529	162	115	119
20	Fushan	19.3	21.1	21.7	28.1	29.8	30.3	10.1	12	12.8	3189	3018	3139	461	482	513	125	107	106
21	Kenting	24.4	25.8	26.3	30.6	32	32.6	16.6	18.2	18.6	2470	2401	2468	565	568	551	30	25	25
22	Lienhuachih	19.3	21.1	21.7	27	28.7	29.2	10.3	12.1	12.9	2345	2313	2437	488	602	551	25	19	18
23	Nanjenshan	22.9	24.3	24.8	29.1	30.5	31.1	15.1	16.6	17.1	3034	2901	2986	703	662	696	54	45	45
24	Zenlun	22.7	24.3	24.9	30.9	32.5	33	12.9	14.7	15.4	2620	2591	2780	613	600	655	16	12	12
25	Doi Inthanon	19.7	21.7	22.9	30.6	32.5	33.4	7.1	9.5	11	1057	1080	992	195	220	202	10	11	12
26	Huai Kha Khaeng	24.8	26.7	27.8	34.3	35.9	36.9	14.3	16.6	17.9	1347	1327	1224	257	254	257	3	4	4
27	Khao Chong	26.9	28.2	29.1	34	35.8	36.8	21	22.4	23.2	2114	2243	2211	324	342	372	38	43	33
28	Mo Singto	23.5	25.6	26.8	31.6	33.8	35.1	13.2	15.9	17.2	1098	1083	975	236	226	229	6	6	8
29	Haliburton	4.2	7.3	8.6	24.5	27.3	29.6	-16.9	-13.1	-12.3	962	1064	1048	94	110	115	62	69	67
30	Scotty Creek	-3.5	0.1	2.2	23	25.4	26.8	-30.5	-26.3	-22.7	372	411	418	59	64	60	18	20	20
31	Harvard Forest	6.7	9.6	10.7	26	28.7	30.4	-12.8	-8.8	-8.4	1151	1267	1288	106	122	126	82	90	82
32	Lilly Dickey Woods	11.4	14.1	15.5	29.7	33.4	36.9	-7.1	-4.7	-3.3	1088	1158	1087	120	133	120	69	61	61
33	Santa Cruz	13.2	15.1	16	24.7	26.6	27.7	3.4	5.3	5.9	899	1006	1007	193	230	239	2	2	2
34	SCBI	11.2	13.8	15	29.2	32	34.9	-7.1	-4.6	-3.7	1011	1055	1033	102	108	101	64	64	60
35	SERC	13.2	15.8	16.9	30.4	33	35.5	-3.8	-1.2	-0.4	1068	1135	1093	112	117	114	71	71	74
36	Tyson Research Center	12.4	15.1	16.4	31.5	35.3	37.7	-7.7	-5.3	-3.8	999	1048	1014	107	122	120	51	61	64
37	Wabikon	4.2	7.3	8.6	25.4	28.5	29.9	-17.9	-13.9	-12	803	799	826	106	99	101	24	28	27
38	Wind River	9.4	11.9	13	25.3	28.6	30.5	-1.6	0.3	1.2	2565	2602	2447	458	487	490	22	22	22
39	Yosemite National Park	7.4	9.7	10.8	25.1	27.6	28.9	-5.1	-3.4	-2.5	1034	1081	1076	184	210	214	7	7	7
40	Ilha do Cardoso	22.5	23.7	24.4	30.9	32.3	33	13.8	14.8	15.6	2479	2549	2605	377	332	359	85	90	96
41	Manaus	26.7	28.8	30.2	32.3	34.4	36.1	22	23.7	24.9	2404	2213	2122	314	320	313	110	100	102
42	Amacayacu	25.9	27.7	28.9	31.2	33.2	34.5	20.2	22.2	23.3	2790	2635	2758	317	321	332	150	140	148
43	La Planada	17.8	19.4	20.4	23.7	25.4	26.5	12.3	13.9	14.9	1716	1872	1765	214	270	252	40	42	42
44	Yasuni	25.1	26.8	27.9	30.9	32.6	33.6	19.7	21.4	22.4	3115	3208	3236	329	351	364	197	210	208
45	Barro Colorado Island	25.9	27.5	28.3	30.8	32.2	33.1	21.6	23.4	24.2	2635	2999	3006	386	446	463	26	35	32
46	Cocoli	26.6	28.2	29.1	32.2	33.5	34.5	21.9	23.7	24.5	2018	2211	2242	317	306	328	11	15	14
47	San Lorenzo/ Sherman	26.2	27.8	28.6	30.4	31.9	32.7	22.3	23.8	24.6	3188	3723	3702	501	575	591	48	61	49
48	Luquillo	22.6	24.1	24.7	28.6	30	30.7	16	17.6	18.3	3015	3019	2686	336	434	384	129	145	132

49	Laupahoehoe	16.2	18	18.7	22.7	24.8	25.5	10.1	11.8	12.5	1937	1890	1921	255	334	334	43	42	48
50	Palamanui	22.2	24.1	24.8	28	30.2	31	16.3	18	18.7	1177	1246	1303	124	176	172	71	57	40
51	Badagongshan	15.9	18.1	19.1	31.2	33.4	34.9	0.8	3.3	4.3	1410	1678	1566	229	291	252	33	36	36
52	Baotianman	8.1	10.3	11.4	23.9	25.9	27.2	-9.4	-7.1	-6.3	950	1067	1013	192	219	224	15	18	18
53	Changbaishan	2.3	4.7	5.8	24.5	26.5	27.3	-24.3	-20.7	-19.4	693	769	788	163	194	193	7	9	11
54	Donglingshan	4.7	6.9	8.1	24.6	26.3	27.3	-18.3	-15.2	-13.7	519	616	614	148	191	182	4	4	4
55	Gutianshan	15.4	17.9	18.8	30.6	33.6	34.6	-0.3	2.3	3.3	1860	1917	1934	317	343	332	51	51	53
56	Tiantongshan	14.4	16.8	17.6	28.5	31.2	31.8	0.1	2.6	3.5	1480	1476	1514	204	222	223	52	48	49
57	Zofin	5.7	8.7	9.9	20.7	25.4	28.2	-7.2	-3.9	-2.6	949	931	912	122	118	104	55	55	63
58	Speulderbos	9	11.3	12.2	21	24.5	26	-1	0.7	2	803	794	764	78	84	88	49	51	42
59	Wytham Woods	9.3	11.5	12.4	20.7	24.7	26.6	0	1.3	2.3	657	656	626	65	68	73	39	43	30

Table S5. Atmospheric deposition; forest degradation, loss, and fragmentation; and local anthropogenic disturbances at CTFS-ForestGEO sites.

Atmospheric deposition data in year 2000 estimated from Dentener *et al.* (2006). Statistics on tree cover, recent forest loss, forest fragmentation, and forest degradation calculated from the data of Hansen *et al.* (2013) as described in Appendix S1. Note that in this analysis, “forest” can include agroforestry areas. Local anthropogenic disturbances refer to perturbations within the plots. Complete data are available online (www.ctfs.si.edu/Data).

#	Site	NO _y deposition (g N m ⁻² yr ⁻¹)	NH _x deposition (g N m ⁻² yr ⁻¹)	SO _x deposition (g S m ⁻² yr ⁻¹)	Tree cover in originally forested land area relative to tree cover in plot (%)				Percent of 2000 forest area lost by 2012				Forest fragmentation index (edge km / area km ²) in 2012				Degradation Index	Anthropogenic Disturbance- Past [†]	Anthropogenic Disturbance- Ongoing [*]
					<1 km	1-5 km	5-25 km	25- 50 km	<1 km	1-5 km	5-25 km	25- 50 km	<1 km	1-5 km	5-25 km	25- 50 km			
1	Korup	0.45	0.54	0.17	99	101	99	90	0.1	0.1	0.7	1.1	0.2	0.2	0.5	0.8	2	f, e, h	-
2	Ituri (Edoro and Lenda) [‡]	0.46	0.48	0.14	100	100	99	99	0.0	0.0	1.1	0.9	0.0	0.0	0.4	0.4	1	-	h
3	Rabi	0.31	0.20	0.11	99	95	99	98	0.2	0.9	0.7	0.7	0.3	1.2	0.5	0.5	1	W	w
4	Mpala [§]	0.16	0.39	0.08	>100	>100	>100	>100	0.0	0.0	0.0	0.4	-	-	-	-	0	P, A, W,E,H	P, A, I
5	Wanang	0.06	0.11	0.79	129	136	142	141	6.5	3.2	2.9	2.8	5.8	3.5	2.5	2.6	2	H	H
6	Kuala Belalong	0.18	0.19	0.18	100	99	91	83	0.0	0.9	3.6	6.0	0.0	0.6	3.2	4.2	5	h	-
7	Dinghushan	0.67	2.16	1.85	92	76	46	39	0.0	8.3	8.8	13.0	3.0	6.6	13.5	20.3	22		
8	Heishiding	0.63	2.25	1.60	35	17	63	73	14.2	30.0	16.9	14.8	33.4	47.1	19.9	16.2	36		
9	Hong Kong	0.65	1.18	1.79	93	51	40	22	0.3	0.4	1.1	8.1	1.0	8.1	11.9	17.6	25	F, W, B, H, E	e
10	Jianfengling	0.35	0.79	0.71	102	93	51	39	0.1	0.5	6.0	8.8	0.1	2.2	7.7	12.8	16		
11	Nonggang	0.45	2.00	0.81	99	110	62	59	0.3	1.2	1.9	5.2	4.6	3.8	12.5	13.1	11	-	-
12	Xishuangbanna	0.39	1.26	0.43	79	74	76	75	1.1	5.4	4.2	6.1	5.3	6.5	5.5	5.9	14	H	
13	Mudumalai	0.38	0.95	0.79	106	95	66	54	0.0	0.0	0.7	0.8	0.2	2.0	7.1	9.0	11	W, H	h
14	Danum Valley	0.14	0.13	0.17	102	103	90	79	0.2	0.5	6.8	13.9	0.3	0.6	4.4	6.8	7		
15	Lambir	0.18	0.16	0.18	97	82	45	57	1.2	7.1	44.0	31.7	0.7	5.2	14.1	9.6	25	H, e	H
16	Pasoh	0.32	0.41	0.41	99	53	52	61	0.1	44.0	32.9	24.1	0.1	5.2	12.8	10.0	30		h, e
17	Palanan	0.15	0.30	0.35	99	67	94	71	0.8	2.6	1.2	3.8	0.8	6.9	2.0	6.2	10	H, w, e	-

18	Bukit Timah	0.32	0.25	0.49	70	37	22	50	0.3	2.3	17.2	28.0	7.3	17.4	24.3	13.9	34	F, CC	
19	Sinharaja	0.20	0.47	0.36	98	93	82	68	0.1	0.5	1.2	1.9	0.1	1.1	4.1	8.4	8		e
20	Fushan	0.52	0.54	1.47	102	101	81	69	0.0	0.0	0.3	0.7	0.0	0.1	3.0	5.0	6		h
21	Kenting	0.35	0.34	0.81	84	68	79	90	1.7	1.7	2.0	3.1	4.2	8.0	5.4	4.2	11	F, e	e
22	Lienhuachih	0.49	0.92	1.21	94	84	71	61	0.8	1.4	1.1	0.6	2.5	4.7	5.9	4.9	12	H, F	h
23	Nanjenshan	0.44	0.63	1.07	97	80	70	75	1.3	1.6	2.3	3.4	1.1	5.0	4.9	5.0	11	-	-
24	Zenlun	0.49	0.92	1.21	114	95	82	88	8.0	4.5	1.3	1.6	11.4	10.0	5.5	5.8	6	W	W
25	Doi Inthanon	0.46	0.92	0.36	97	85	61	51	0.0	0.6	3.9	3.3	0.4	6.0	5.8	7.8	14	-	-
26	Huai Kha Khaeng	0.45	0.65	0.43	96	98	83	64	0.1	0.0	0.3	0.5	0.1	0.0	1.0	2.5	7	-	h
27	Khao Chong	0.23	0.28	0.27	98	92	57	47	0.0	2.1	12.0	14.2	0.3	2.4	12.8	15.5	17		
28	Mo Singto	0.49	0.63	0.54	102	97	68	24	0.1	0.1	0.8	1.5	0.1	1.0	5.5	16.7	14		
29	Haliburton Forest	0.51	0.31	0.87	100	98	97	95	0.1	0.6	0.4	0.6	0.4	1.1	1.4	1.9	1		
30	Scotty Creek Forest Dynamics Plot**	0.03	0.02	0.74	138	139	184	177	0.0	0.0	0.1	0.3	-	-	-	-	0		
31	Harvard Forest	0.94	0.27	1.16	98	92	88	78	3.7	1.7	2.0	2.2	1.1	3.3	4.2	6.3	7	P, W, I	I
32	Lilly Dickey Woods	0.99	0.59	1.73	99	82	67	29	0.1	0.2	0.4	0.5	0.4	4.4	6.1	13.3	15	W, b, h	b, h, i
33	Santa Cruz	0.27	0.13	0.15	84	71	77	31	0.9	1.1	3.0	1.6	5.0	6.5	4.0	13.6	18	w	I
34	SCBI	0.99	0.38	1.60	87	69	57	51	0.0	1.9	1.3	2.0	2.1	7.3	8.3	9.9	18	P, I	I
35	SERC	1.07	0.32	1.51	78	53	49	37	4.3	1.3	2.3	3.7	7.0	13.9	13.5	16.4	24		
36	Tyson Research Center	0.84	0.65	1.36	87	69	43	33	0.0	2.1	1.8	1.6	2.4	6.8	13.5	14.8	22	H, W, p, i	i, h
37	Wabikon Lake Forest	0.40	0.34	0.59	95	93	83	81	1.5	0.8	2.8	3.4	0.6	1.8	4.3	3.9	7	W, h	h
38	Wind River	0.18	0.19	0.21	81	93	89	71	0.0	1.3	2.1	8.8	2.9	1.6	1.9	5.7	10	I	I
39	Yosemite National Park	0.26	0.10	0.14	92	85	56	32	4.0	7.6	6.0	5.8	2.7	5.0	6.9	12.0	20	I	I
40	Ilha do Cardoso	0.29	0.44	0.26	100	95	92	88	0.4	0.0	0.3	1.4	0.4	1.6	2.2	3.2	3		
41	Manaus	0.24	0.22	0.11	100	100	98	96	0.0	0.1	0.9	2.1	0.0	0.0	0.6	1.4	1		
42	Amacayacu	0.20	0.10	0.09	100	95	95	96	0.0	1.4	1.7	2.1	0.0	1.8	1.3	1.0	2		
43	La Planada	0.20	0.35	0.49	99	93	88	74	0.0	1.1	1.3	2.3	0.0	1.6	2.2	5.3	7	P	E
44	Yasuni	0.19	0.28	0.30	99	98	99	97	0.0	0.2	0.1	1.8	0.1	0.7	0.2	0.8	1	cc	e, h
45	Barro Colorado Island	0.20	0.20	0.23	101	100	69	63	0.1	0.1	4.3	6.7	0.1	0.4	8.4	11.4	10	w, f	-
46	Cocoli	0.21	0.22	0.25	87	72	55	60	4.9	4.4	3.9	4.4	3.8	7.1	10.2	9.8	18		

47	San Lorenzo/ Sherman	0.20	0.20	0.23	101	99	79	65	0.3	0.7	4.8	7.5	0.4	1.2	7.2	11.3	9		
48	Luquillo	0.09	0.07	0.13	99	83	49	54	0.3	1.4	2.8	2.3	0.5	5.7	15.3	12.6	15	CC, F	
49	Laupahoehoe	0.04	0.04	0.12	100	95	42	33	0.0	0.1	0.5	0.9	0.0	0.7	6.7	8.4	16	I, A	I, H
50	Palamanui	0.04	0.04	0.12	105	68	68	64	6.9	2.2	0.9	0.5	20.0	16.2	15.6	13.3	14	I, A	I
51	Badagongshan	0.73	3.05	2.34	104	103	103	95	0.3	0.1	0.4	0.8	9.4	9.8	9.2	11.3	1	e	
52	Baotianman	0.83	1.84	2.83	94	91	74	46	0.6	0.3	0.6	0.9	1.1	1.4	5.5	8.9	12		
53	Changbaishan	0.38	0.74	0.84	101	95	95	87	0.0	0.6	0.9	1.0	0.2	2.2	3.0	4.7	3	w	-
54	Donglingshan	0.64	0.81	2.18	78	35	28	18	0.0	0.2	0.2	0.5	6.3	19.9	22.5	26.5	30	CC	
55	Gutianshan	0.94	2.02	2.93	95	87	74	71	0.1	0.2	4.1	3.2	0.3	2.4	6.3	5.8	10	w, b, H	-
56	Tiantongshan	0.81	1.13	3.14	104	86	30	37	0.0	0.4	0.7	0.9	1.7	4.9	12.0	13.0	19		
57	Zofin	0.76	1.09	1.08	90	80	50	45	8.8	11.3	4.6	5.0	7.1	9.5	13.2	13.7	21	w, h	-
58	Speulderbos	0.82	1.48	1.00	80	61	38	20	1.2	3.0	5.1	2.8	4.9	9.3	17.1	29.0	27		
59	Wytham Woods	0.73	0.97	0.96	60	7	5	8	0.0	0.7	2.0	1.7	7.2	48.3	47.1	40.2	40	P, W, h, I	I

[†] Codes are as follows: F-farming; P-pasture; W-wood harvesting; CC-clear cut/ complete clearing; B-burn; H-hunting; E-extraction of NTFP (non-timber forest products); I-invasive species; ‘-’ no significant disturbances. Capital letters denote strong pressure; lowercase denote mild pressure.

[‡] Forest cover/ loss/ fragmentation/ degradation are average values for four plots.

[§] Tree cover at this savanna site falls below the 10% tree cover threshold used to classify forest. Therefore, calculations were not limited to areas originally classified as forest. Forest fragmentation index was unreliable due to low-density tree cover and therefore is not reported.

^{**} Forest fragmentation index was unreliable due to low-density tree cover and therefore is not reported.

Table S6. Record of supplementary measurements made at CTFS-ForestGEO sites.

Coded as follows: P(#): measured using standardized CTFS-ForestGEO protocol outlined in Appendix S2 (numbers differentiate multiple protocols in the same category); 'N'- Will be measured by NEON (see NEON, 2011); '+' measured (any protocol); '-' not measured or no information; * in progress; (f)-planned for near future, with funding. Other codes explained in footnotes.

#	Site	N tree censuses ⁺⁺	Lianas	Functional Traits ^{%%}	Dendrometer Bands	Flower & Seed Production	Seedling Performance	DNA barcoding ^{***}	Arthropods ^{†††}	Vertebrates	Airborne LiDAR	Dead Wood/ CWD	Fine Roots	Soil C	Soil Nutrients	Litterfall	Eddy Covariance ^{†††}	Weather station ^{\$\$\$}
1	Korup	3	P	L; SM; H; WD	-	-	-	P(p)*	-	P1	-	-	-	P	P1	-	-	A
2	Ituri (Edoro and Lenda)	3	P	+	-	-	-	-	-	+	-	-	-	-	+	-	-	
3	Rabi	1	-	-	-	-	-	P(p)*	-	-	-	-	-	-	-	-	-	A
4	Mpala	1*	-	+	-	-	-	P(p)*	-	+	-	-	-	-	+, P2(f)	-	+	A
5	Wanang	1	-	+	-	-	-	P(a)	P	-	-	-	-	-	P3	-	-	
6	Kuala Belalong	1*	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	
7	Dinghushan	2	-	L; SM; H; WD	P1	P	P	P(p)	-	P2	-	-	-	-	+	P	-	+
8	Heishiding	1	P	L; SM; H; WD	-	+	+	-	-	-	-	-	-	-	-	-	-	
9	Hong Kong	1*	-	-	-	-	-	P(p)*	P*	-	-	-	-	-	-	-	-	A, C
10	Jianfengling	1	-	L; SM; H; WD	*	P	P	P(p)	-	-	-	-	-	+	+	P	+	A
11	Nonggang	1*	-	L; SM; H; WD	-	-	-	-	-	P2	-	-	-	-	-	-	-	B
12	Xishuangbanna	1	+	L; SM; H; WD	P1	P	P	P(p)	-	P2	-	-	-	-	+	-	-	-
13	Mudumalai	4	-	L; SM; H; WD	P1	-	-	-	-	+	-	P1	-	-	-	P	-	A
14	Danum Valley	1*	-	SM	-	-	-	P(p)*	-	+	-	-	-	+	P1	-	-	A
15	Lambir	4	-	L; SM; H; WD	P1	-	-	-	-	+	-	P1	P*	P*	+	P	+	A
16	Pasoh	6	+	L; SM; H; WD	P1	P	P	-	-	P1	-	P1; P2; P3	P	P	+, P1	P	+	A

#	Site	N tree censuses ^{**}	Lianas	Functional Traits ^{§§}	Dendrometer Bands	Flower & Seed Production	Seedling Performance	DNA barcoding ^{***}	Arthropods ^{†††}	Vertebrates	Airborne LIDAR	Dead Wood/ CWD	Fine Roots	Soil C	Soil Nutrients	Litterfall	Eddy Covariance ^{††††}	Weather station ^{§§§}
17	Palanan	3.5	-	L; H(f)	-	*	*	P(p)	+	+	-	-	-	-	-	*	-	(f)
18	Bukit Timah	6	-	-	P1	-	-	P(p)	-	-	-	P1; P3; P4	P	P	P2	P	-	A
19	Sinharaja	3	-	-	-	+	-	-	-	+	-	-	-	-	+, P1	-	-	
20	Fushan	3	-	H; L; WD	P1	P	P	P(p)	+	+	+	P1; P2; P3	-	-	+	P	-	A
21	Kenting	3	-	H; C; L; SM	P1	P	P	P(p)	-	+	-	-	-	-	-	-	-	C
22	Lienhuachih	1	-	L; SM; H; WD	P1	P	P	P(p)	-	-	-	P1; P2; P3	-	-	+	P	-	A
23	Nanjenshan	3	-	L	-	-	+	P(p)	-	-	-	P1; P2; P3	-	-	-	-	-	A
24	Zenlun	2	-	-	-	P	P	-	+	+	-	-	-	-	-	-	-	A
25	Doi Inthanon	4	-	WD; H	-	-	-	+	-	-	-	-	-	-	-	-	-	C
26	HKK	4	-	-	P1	+	-	-	-	+	-	P1; P2	P(f)	P(f)	+, P	P	-	A
27	Khao Chong	3	-	-	P1	+	+	P(a)	P	-	-	P1	P(f)	P(f)	+, P1; P3	P	-	A
28	Mo Singto	2.5	P	-	P1	-	-	-	-	+	-	P1; P2	-	-	-	P	-	
29	Haliburton Forest	1*(3)	-	L; SM; H; C; WD; O	-	P	-	P(p)	-	+	+	+	-	P	P2	P	+	A, B
30	Scotty Creek	1	n/a	C; WD	P1	-	-	P(a)	-	-	+	-	P(f)	P(f)	-	P(f)	+	A
31	Harvard Forest	1	-	N	P1; P2	-	-	-	N	N	+, N	N	N	N	N	+, N	+, N	A; N
32	Lilly Dickey	1	-	-	P1	-	-	-	-	-	-	-	-	P*	+, P2*	-	-	A
33	Santa Cruz	2	+	H; C; L; WD(f)	-	P	-	P(p)	-	+	+	-	-	-	+	-	-	A
34	SCBI	2	+	L; H; C; O	P1; P2	P	P	P(p)	+, N	+, P2; N	+, N	P1; P3; P4; N	P; N	P; N	+, P2; N	P; N	N	A, N
35	SERC	1	P	N	P1; P2	+	+	P(p)	N	+, P2*; N	+, N	P4; N	P; N	P; N	+, P3; N	N	+, N	A, N
36	Tyson	1(4)	-	L; WD; O	*	+	*	-	-	*	-	P4	-	-	+, P2	+	-	A

#	Site	N tree censuses ⁺⁺	Lianas	Functional Traits ^{\$\$}	Dendrometer Bands	Flower & Seed Production	Seedling Performance	DNA barcoding ^{***}	Arthropods ⁺⁺⁺	Vertebrates	Airborne LIDAR	Dead Wood/ CWD	Fine Roots	Soil C	Soil Nutrients	Litterfall	Eddy Covariance ⁺⁺⁺	Weather station ^{\$\$\$}
37	Wabikon Lake Forest	2	-	-	P1	+	+	P(p)	-	+	-	-	-	-	-	-	-	
38	Wind River	1(2)	n/a	N	P1	+	-	-	N	N	+, N	+, N	N	N	P2(f); N	N	+, N	A; N
39	Yosemite	2*	n/a	-	P1	-	-	-	-	-	+	+	-	-	-	-	-	A
40	Ilha do Cardoso	1	-	+	-	P	-	-	-	-	-	-	-	-	P1/ P2/ +	-	-	
41	Manaus	1	P	-	-	-	-	P(p)	-	P1	-	-	-	-	-	-	-	+
42	Amacayacu	1	-	L; SM; H; WD	P1	-	-	-	-	-	-	P1; P2; P3	P	P	P2	P	+(f)	
43	La Planada	2	-	-	-	-	-	-	-	-	-	-	-	-	P1	-	-	
44	Yasuni	3	+	L; SM; H; WD	P1	P	P	-	P	P1	+	P1; P2; P3	P	P	P1; P2	P	-	A
45	BCI	7	P; +	L; SM; H; C; WD; O	P1	P	P	P(p); P(a)	P	+, P1; P2	+	P1; P2; P3	P	P	P1	P	+	A
46	Cocoli	3	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
47	San Lorenzo	1	+	L; SM; H; WD	P1	P	P	-	-	-	+	-	-	P	P2	-	-	C
48	Luquillo	5	+	L; SM; H; WD, C	P1	P	P	P(p)	+	+	-	+, P	P	P	P2	P	-	A
49	Laupahoehoe	1	-	-	-	P	P	P(p)*	-	-	+	-	-	-	-	+	-	A
50	Palamanui	2*	-	-	-	P	P	P(p)*	-	-	-	-	-	-	-	+	-	A
51	Badagongshan	1*	-	-	P1	P	P	-	-	P2	-	-	-	-	-	P	-	
52	Baotianman	1	-	-	-	P	P	-	-	P2	-	-	-	-	-	-	-	
53	Changbaishan	2	-	L; SM; H; WD	P1	P	P	P(p)	-	P1; P2	-	-	-	-	+	P	-	+
54	Donglingshan	1*	-	L; SM; H; WD	-	P	P	-	-	-	-	P1; P2; P3; P4	-	-	-	-	-	
55	Gutianshan	2	-	L; SM; H; WD	P1	P	P	P(p)	-	+	-	P1; P2; P3	-	-	+	P	-	B
56	Tiantongshan	1	-	L; SM; H; WD	-	P	P	-	-	-	-	-	-	-	-	-	-	

#	Site	N tree censuses ^{††}	Lianas	Functional Traits ^{§§}	Dendrometer Bands	Flower & Seed Production	Seedling Performance	DNA barcoding ^{***}	Arthropods ^{†††}	Vertebrates	Airborne LIDAR	Dead Wood/ CWD	Fine Roots	Soil C	Soil Nutrients	Litterfall	Eddy Covariance ^{††††}	Weather station ^{§§§}
57	Zofin	1(4)	-	+	-	-	+	P(p)*	-	-	+	P4	-	+	+	-	-	A
58	Speulderbos	1	n/a	-	+	-	-	-	-	P2*	-	-	-	-	-	-	-	B
59	Wytham Woods	2	-	+	+	-	+	-	-	+	+	P1; P2; P3	+	+	+	+	+	A

^{††} Number of censuses as of May 2014. Numbers in parentheses indicate total number of censuses including those prior to the sites adoption of the CTFS-ForestGEO core tree census protocol (i.e., censuses with any DBH cutoff and/or smaller plots). These include any in-progress survey.

^{§§} H: tree height; C: crown dimensions; L: leaf traits; SM: seed mass; WD: wood density; O: other

^{***} p- plants; a- arthropods

^{†††} Arthropod measurements made using standardized CTFS-ForestGEO protocol are detailed in Table S7.

^{††††} Measured onsite or at a similar site within 10 km.

^{§§§} A- onsite or a similar site within 10 km that is believed to have similar climate; B- nearby (within 50km), believed to have similar climate (e.g., similar elevation, distance from coast); C- nearby (within 50km), believed to have dissimilar climate (e.g., dissimilar elevation, distance from coast); '-' no known weather station within 50km; N-NEON (future). P denotes CTFS-ForestGEO protocols described in Appendix S2.

Table S7. Record of arthropod sampling at CTFS-ForestGEO sites.

Entries below are no. of individuals/no. of species / no. of DNA sequences / taxonomic knowledge (coded as follows: 1 = work needed; 2 = reasonable; 3 = checklist complete or nearly so) as of November 2013.

Protocol	Target taxa (order)	Guild	BCI	Khao Chong	Wanang	Yasuni	Hong Kong
Light traps	Passalidae (Coleoptera)	Wood eaters	510 / 13 / 51 / 3	-	-	-	-
	Platypodinae (Coleoptera)	Wood eaters	662 / 19 / 56 / 2	959 / 24 / 0 / 1	-	-	-
	Dynastinae (Coleoptera)	Scavengers	1,556 / 24 / 52 / 2	-	-	-	-
	Isoptera	Scavengers	14,289 / 30 / 62** / 2	4,896 / 4 / 0 / 1	-	-	-
	Flatidae (Hemiptera)	Sap-suckers	1,855 / 28 / 97 / 3	311 / 20 / 0 / 1	-	-	-
	Reduviidae (Hemiptera)	Predators	971 / 51 / 65 / 1	100 / 6 / 0 / 1	-	-	-
	Saturniidae (Lepidoptera)	Chewers (leaves)	34 / 714 / 168 / 3	-	-	-	-
	Geometridae (Lepidoptera)	Chewers (leaves)	6,673 / 229 / 961 / 2	6,220 / 396 / 409 / 2	-	-	Planned starting 2014
	Arctiinae (Lepidoptera)	Chewers (leaves)	8,875 / 160 / 812 / 2	4,394 / 174 / 34 / 1	-	-	Planned starting 2014
	Pyraloidea (Lepidoptera)	Chewers (leaves)	11,253 / 339 / 832 / 1	7,412 / 445 / 103 / 1	-	-	Planned starting 2014
	Ecitoninae - alates (Hymenoptera)	Predators	4,416 / 16 / 67 / 1	-	-	-	-
	Apidae + Halictidae - nocturnal (Hymenoptera)	Pollinators	2,904 / 23 / x / 2	140 / 5 / 0 / 2	-	-	-
Winkler	Formicidae - litter (Hymenoptera)	Varia	11,945 / 133 / 957 / 3	10,929 / 134 / 0 / 1	Planned starting 2014	2,500/100/0/ 1	-
McPhail traps	Tephritidae (Diptera)	Chewers (fruits)	-	17,945 / 83 / 93 / 2	Planned starting 2014	-	-
Butterfly transects	Papilionoidea+Hesper	Chewers	8,772 / 350 /	3,567 / 280 /	3,371 / 134 /	-	73 / 28 / 0 / 1

	iidae (Lepidoptera)	(leaves)	1,282 / 3	404 / 2	651 / 2		
Termite transects	Isoptera	Scavengers	2,598 / 13 / 62** / 2	2,268 / 35 / 0 / 2	Planned starting 2014	Planned starting 2015?	Planned starting 2015?
Bee baits	Apidae Euglossini (Hymenoptera)	Pollinators	19,020 / 26 / 96 / 3	-	-	-	-
Seed predation	Various in Lepidoptera, Coleoptera and Hymenoptera	Seed predators	24,000 / ? / 1,148 / 1	1,373 / 90 / 0 / 1	4,626 / 23 / 0 / 1	-	-

** Total number of sequences for all Isoptera

Table S8. Site-specific acknowledgments for selected CTFS-ForestGEO sites.

Site	Acknowledgements
Amacayacu	We thank the Staff of the National Natural Park of Amacayacu and the National System of Protected Areas of Colombia.
Badagongshan	Work at Badagongshan was supported by the National Natural Science Foundation of China (31270562) and the Chinese Forest Biodiversity Monitoring Network (29200931131101919).
Baotianman	The 25 ha Baotianman forest dynamics plot was funded by National Science and Technology Support Plan (2008BAC39B02), State Key Laboratory of Vegetation and Environmental Change (LVEC2011zyts01), the National Science Foundation of China (31070554, 31270642, 31370586), and Biodiversity Committee, Chinese Academy of Sciences. Thanks to hundreds of college students, graduate students, local workers, and researchers for their hard works. Thanks to State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, the Chinese Academy of Sciences, Chinese Forest Biodiversity Monitoring Network, Henan Agricultural University, Nanyang Normal University, China University of Mining & Technology (Beijing), Pingdingshan University, and Baotianman National Nature Reserve for their cooperation and kind support.
Barro Colorado Island	The BCI forest dynamics research project was founded by S.P. Hubbell and R.B. Foster and is now managed by R. Condit, S. Lao, and R. Perez under the Center for Tropical Forest Science and the Smithsonian Tropical Research Institute in Panama. Numerous organizations have provided funding, principally the U.S. National Science Foundation, and hundreds of field workers have contributed.
Danum	The Danum plot is a core project of the Southeast Asia Rain Forest Research Programme (SEARRP). We thank SEARRP partners especially Yayasan Sabah for their support, and HSBC Malaysia and the University of Zurich for funding. We are grateful to the research assistants who are conducting the census, in particular the team leader Alex Karolus, and to Mike Bernados and Bill McDonald for species identifications. We thank Stuart Davies and Shameema Esufali for advice and training.
Harvard Forest	Funding for the Harvard ForestGEO Forest Dynamics plot was provided by the Center for Tropical Forest Science and Smithsonian Institute's Forest Global Earth Observatory (CTFS-ForestGEO), the National Science Foundation's LTER program (DEB 06-20443 and DEB 12-37491) and Harvard University. Thanks to many field technicians who helped census the plot. Jason Aylward was instrumental as a field supervisor and with data screening and database management. Thanks to John Wisniewski and the woods crew at HF for providing materials, supplies, and invaluable field assistance with plot logistics. Joel Botti and Frank Schiappa provided survey expertise to establish the 35-ha plot. Special thanks to Stuart Davies and Rick Condit for field training, database assistance, and plot advice. Sean McMahon and Suzanne Lao were extremely helpful with field planning, data questions, and many plot logistics. Thanks to Jeannette Bowlen for administrative assistance and

Site	Acknowledgements
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Hong Kong	We thank the Hongkong Bank Foundation.
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