23rd New Phytologist Symposium

Carbon cycling in tropical ecosystems

Yanling Hotel, Guangzhou, China
17–20 November, 2009

Programme, abstracts and participants

Organized by:

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Organizing committee

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Programme, abstracts and participant list compiled by Jill Brooke.
'Carbon cycling in tropical ecosystems' illustration by A.P.P.S., Lancaster, U.K.

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Speaker Abstracts

Session 1: **Introduction**
Chair: *Richard Norby*

1.1 Biogeography of tropical China

HUA ZHU
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The tropical zone in China was suggested to be generally in south of the Tropic of Cancer except parts of southwest China from the mainstream viewpoint although there were some other suggestions of the tropical zone beyond the Tropic of Cancer in east China in broad sense, and of limited to only southern Hainan and southern margin of Taiwan in narrow sense. Distributions of strictly tropical families and genera in China indicate that the extreme southeastern part of Xizang (Tibet), southern Yunnan, southwestern Guangxi, Hainan and the southern-most Taiwan are biogeographically the tropical areas in China. Biogeographical patterns of genera of Chinese seed plants revealed that the line of c. 22º 30' N latitude, with the tropical genera accounting for more than 80% of the total genera, more or less corresponds to the line of the northern border of the tropical monsoon forest and rain forest in eastern China. The line of c. 22º30' N latitude is therefore suggested to be the northern boundary of the tropical zone in south and southeastern China. The tropical rain forests, disjunctly occurring at lowlands across tropical areas in China, are conspicuously similar on physiognomic characteristics and floristic composition to tropical lowland rain forests of SE Asia, and represents SE Asian tropical rain forest at its latitudinal and altitudinal limits. The tropical floras in southern Yunnan, southwestern Guangxi and Hainan are basically the same floristically, and belong to the same floristic unit and compose the flora of tropical China. Tropical floristic elements at the generic level form a major contribution (more than 70%) to the total flora of tropical China, of which the dominant geographical elements are those of tropical Asian distribution (more than 25%). This reveals that the flora of tropical China is tropical in nature and has a close affinity to the tropical Asian flora. The floristic similarities between the flora of tropical China and the floras of mainland SE Asia and west Malaysia are more than 80% at the family level and more than 60% at the generic level. This suggests that the tropical flora of China together with the mainland SE Asian flora belongs to Indo- Malaysia flora biogeographically.

1.2 Tropical forests, ice ages and the global carbon cycle

COLIN PRENTICE
QUEST, Earth Sciences, University of Bristol, BS8 1RJ, UK

Pollen records show that the global land surface during the last glacial maximum (LGM, ca 21 000 years before present) was less forested than during the present (Holocene) interglacial. Tropical forests were partially replaced by savannas, and savannas by grasslands. Various lines of isotopic evidence also indicate greater predominance of C_4 plants in tropical regions, reduced global terrestrial primary production, and reduced carbon storage on land.
A unified approach to understanding glacial-interglacial transitions in the Earth system is possible through the use of global models. Climate models with ice-age boundary conditions (continental ice sheets, low sea level, low atmospheric CO_2) provide simulated climate regimes, which can be used to drive global vegetation models. But the climate changes alone are not sufficient to explain the observed vegetation changes, especially the reduction of tropical forests. The additional factor needed is the direct effect of low CO_2 in suppressing primary production, especially by C_3 plants. With this effect included, models produce a credible reconstruction of the ice-age world.
Two phenomena observed in recent decades have been attributed to direct CO_2 effects on plants: the continuing uptake of CO_2 by the terrestrial biosphere (with a substantial part of this uptake occurring in the tropics), and the worldwide trend towards increased tree dominance in savannas. Both attributions are highly contentious, and experimental work to date has not been able to definitely confirm or reject them. The data from the past confirm that the direct CO_2 effect is large, persistent (over millennia), and consistent with model predictions.

Session 2:	**Global and Regional Analyses** **Chair: *Daniel Metcalfe***

2.1 Changes in biomass carbon stocks of global tropical forests

JINGYUN FANG
Peking University, China

2.2 Comprehensive assessment of carbon productivity, allocation and cycling in lowland and montane forests in Amazonia and the Andes

YADVINDER MALHI[1], CECILE A. J. GIRARDIN[1], LUIZ E. O. C. ARAGÃO[2], DANIEL B. METCALFE[1], JAVIER E. SILVA ESPEJO[3], ANTONIO C. L. DA COSTA[4], SAMUEL ALMEIDA[5], NORMA SALINAS[3], MARLENE MAMANI[3], WALTER HUARACA HUASCO[3], LILIANE DURAND[3], AMANDA ROBERTSON[6], PATRICK MEIR[7]

[1]Environmental Change Institute, School of Geography and the Environment, University of Oxford, UK; [2]University of Exeter, UK; [3]Universidad San Antonio Abad, Cusco, Peru; [4]Universidade Federal do Para, Belem, Para, Brazil; [5]Museu Parense Emilio Goeldi, Belem, Para, Brazil; [6]University of Alaska, Fairbanks, Alaska, USA; [7]School of GeoSciences, University of Edinburgh, UK

There have been few studies that present a comprehensive description of the magnitude and allocation of net primary production, autotrophic respiration and gross primary production in tropical forests. Here we present results from a network of studies ranging across the Amazon and Andes region. In three lowland rainforest sites in Brazilian Amazonia, estimates of gross primary production and soil respiration from 'bottom-up' studies compare favourably with this from 'top-down' studies of gas exchange from flux towers and soil CO2 efflux studies. The carbon use efficiency of old-growth Amazonian forests is around 30%; this seems to increase after disturbance to about 50%. Studies of the allocation of NPP across Amazonia suggest some consistent patterns: NPP increases with soil fertility but the relative allocation above vs. below-ground remains relatively constant. Recovery from disturbance seems to favour disproportionate allocation above-ground, probably because of the enhanced competition for light. New data from an elevation transect in the Peruvian Andes yield further insights into carbon cycling. Both above-and below-ground NPP decline with elevation along our transect in approximately constant proportion. Most heterotrophic respiration processes decline with elevation, probably because of the influence of lower temperatures, but autotrophic processes tend to show much less decline with elevation, suggesting plant acclimation to ambient temperatures. The overall partitioning of NPP between stems, canopy and fine roots is relatively invariant across Amazonian and Andean forests. Leaf litter fall is found to be a good predictor of total NPP in low-disturbance tropical forests, and may provide useful estimates of NPP where comprehensive NPP data are not available.

2.3 Global impact of regional-scale interactions between the carbon and water cycles

PIERRE FRIEDLINGSTEIN, P. BAINES, P. CIAIS, P. FOSTER, S. LEWIS, S. PIAO, C. PRENTICE, S. SITCH
Laboratoire des Sciences du Climat et de l'Environnement, CEA-Saclay, France

Water exerts a strong control on ecosystem functioning and hence on carbon exchange between land and the atmosphere. Here we combine a wide variety of observation datasets with state of the art dynamic global vegetation models (DGVMs) to investigate the water-carbon interactions in the Tropics and their impact on the global scale. The analysis spans across multiple time scales from seasonal, El Nino related interannual to multi-decadal. Site level ground-based flux measurements are used to constrain the water control on plant growth during the dry season, plot scale biomass inventories are used to analyze ecosystem response to drought, the 2005 drought in the Amazon basin being an ideal test case for models. We use remote sensing products (SEAWIFS) to derive climate-vegetation activity spatio-temporal connections, as well as atmospheric CO2 inversions to infer trends and variability in carbon uptake in the tropics. DGVMs forced by historical evolution of atmospheric CO2, climate and land use are then challenged to simulate these observed multi-temporal patterns. From this original benchmarking we infer models limitations in process representation that are used to guide us when analysing these DGVMs responses to future climate change.

2.4 Excessive nitrogen supply accelerate the fluctuation and decline trends of old-growth forest by actuating phosphorus limitation

GUOYI ZHOU, **WEJUN HUANG, XULI TANG**
South China Botanical Garden, Chinese Academy of Sciences, Guangzhou, 510650, China

Fluctuation and slow decline of forest productivity occurs in old-growth forests. Several hypotheses have been proposed to explain the universal phenomenon but none is satisfactory. Furthermore, what would be under worldwide enhancement of N deposition? Here we used data collected from long-term research plots in monsoon evergreen broadleaved forest where productivity has rapidly fluctuated and been in decline trends over the last 20 years without any damage symptom to understand how the fluctuation and decline trends in old-growth forest occurred. Our conclusion is that excess N deposition strengthens the fluctuation and decline trends by actuating P limitation. As comparison, long-term research plots were also established in a successional series including pine forest (pioneer community), mixed pine and broadleaved forest (transition community) to monitor growth patterns and biogeochemical processes since 1979. The results clearly showed that increases of nitrogen stock in soil pools through atmospheric deposition and self-accumulation in old-growth forest would, in turn, require more available phosphorus to match to complete biological processes. However, as much more organic matter was accumulated and thus, much more phosphorus is tied up in old-growth forest, there is much less available phosphorus in soils. The two processes result in significantly higher N/P ratios in living leaves and litter fall of the old-growth forests, which cause the old-growth forest to fluctuate greatly and to decline.

2.5 Vulnerability of carbon pools in tropical peatlands

JOSEP CANADELL
Global Carbon Project/CSIRO, Canberra, Australia

There are well over 300,000 Km^2 of peatlands in tropical regions including Southeast Asia, Africa and Central and South America. They are a significant global reservoir of carbon of the order of 60 Pg C (billion tonnes of carbon) of which its majority is located in Southeast Asia. The islands of Borneo, including the Indonesian and Malaysian parts, and Sumatra hold the largest reservoirs of peat carbon. Their stability and growth depends on organic inputs from vegetation and the maintenance of high water tables which prevents organic matter from decomposing and burning.

During the last decade and a half, tropical peatlands in Southeast Asia have been subject to rapid transformation through drainage and logging to open new lowland for oil palm and pulp plantations. A continue increase in commodity prices and a new interest in bio-diesel from palm oil has further contributed to this rapid transformation.

Drainage and logging has led to the lost of carbon sinks and the creation of significant new carbon sources from decomposition of organic matter and fires. The latter is the result of a dramatic increase in fire presence in an ecosystem which is not well adapted to fire. Current estimates show that drained peatlands in Southeast Asia account for 355 Mt y^{-1} to 855 Mt y^{-1} of emissions of CO_2, and about double this amount of emissions from fires. Emissions from decomposition are continuous with smaller inter-annual variability than emissions from fires which are closely link to dry conditions, particularly to El Niño-ENSO events. Reduced emissions from fires in the region over the last two wet years confirm this tight relationship between human activity and drought events.

Future dynamics of emissions from tropical peatlands depend to large extent on the speed of deforestation in the region and rehabilitation opportunities provided by the Reduced Emissions from Deforestation and Degradation mechanism of the UNFCC.

Session 3:	Human Interactions and Mitigation Chair: *Julian Fox and Stefan Arndt*

3.1 The role of species and functional diversity in determining carbon stocks in tropical landscapes: a comparison of plantations, selective logging, and natural forests

MARÍA DEL CARMEN RUIZ-JAEN, CATHERINE POTVIN
McGill University, Canada

Tropical forests harbor most of the world's biological diversity and store large amounts of carbon, yet very little is known about the relative role species and functional diversity in determining levels of carbon storage in these tropical forests. We studied pools and fluxes of C in an experimental tree plantation and in natural forests in central Panama. In the plantation, we estimated carbon cycling by measuring aboveground biomass change through time (growth and mortality), litter production, coarse woody debris, and soil respiration across plots of different levels of species diversity (1 to 18 species). Our results indicate that plots with higher species diversity also have greater levels of growth and carbon storage coupled with lower levels of soil respiration, suggesting that plots establishment with a high species number will be more efficient at storing carbon. To link results of the high diversity plantation (i.e. 6, 9 and 18 species) with a nearby natural forest (300 tree species), we adopt a functional trait approach. Since, this approach reduced diversity to its functional components that might enhance the possibility of uncovering patterns in highly diverse ecosystems. In the natural forest, we examined the relationship between standing biomass and the variability of three key functional traits: wood density, maximum height at maturity, and leaf mass per area. We found that functional diversity plays a larger role in determining spatial variation in tree carbon storage than does the abiotic environment, forest structure, or species diversity. We also identified an interaction between functional diversity and forest structure, which is mostly driven by the species identity of large trees. Given the relationship between functional diversity and carbon storage in natural forests, we are designing methodologies that will allow us to maximize species diversity, functional diversity, and carbon storage in plantation systems.

3.2 Mitigation potential of reducing GHG emissions from deforestation and degradation: challenges and opportunities

SANDRA BROWN
Winrock International, 1621 N Kent St., Suite 1200, Arlington, VA 22209, USA

Deforestation and forest degradation in developing countries significantly impacts the accumulation of greenhouse gases in the atmosphere. Although tropical deforestation and forest degradation are significant contributors to total greenhouse gas emissions, estimated to account for up to 15-20% of the total anthropogenic emissions, activities to reduce such emissions were not accepted under the Kyoto Protocol. However, since 2005, developing countries have united and proposed that with incentives such as carbon-offset markets there are large opportunities to reduce these emissions. Under a reduction in emissions from deforestation and degradation (REDD) mechanism, countries will need to show credible reductions in emissions measured against a baseline at specific intervals in time –that is REDD is likely to be a performance-based mechanism.. Developing a baseline will likely be based on historic emissions of GHGs as a starting point, and monitoring will be crucial as it will show the success of REDD policies and interventions measured as reduced emissions against such a baseline. Many technical issues and challenges are cited as to why including REDD for mitigating GHG emissions is fraught with problems. In my presentation, I will present what these purported issues and challenges are and describe the status of current scientific understanding. This will include the existing methods used for accounting for changes in forest carbon stocks, and thus emissions, from activities related to forest clearing and degradation, what new technologies are emerging to improve monitoring and what challenges and gaps still exist. The science exists for the REDD mechanism to become a reality, but the biggest need is for the developed world to make a commitment to assist developing countries increase their capacity to acquire and analyze the required data and tools.

Session 4: **Physiological Studies**
Chair: *Shiqiang Wan*

4.1 Resolution of biome-specific CO_2 fertilization effects in terrestrial ecosystems

SONJA G. KEEL, STEFAN GERBER, ELENA SHEVLIAKOVA, LARS O. HEDIN
Department of Ecology & Evolutionary Biology, Princeton University, Guyot Hall, Princeton, NJ 08540, USA

Nutrient availability has the potential to limit growth responses of plants to rising atmospheric CO_2. Yet, carbon-nutrient interactions are still poorly resolved in global dynamic land models, if at all. As a consequence these models tend to over-estimate effects of so called CO_2-fertilization. Here we address the potential of nitrogen restriction in the Princeton-GFDL LM3V-N, a global carbon-nutrient model, which includes advanced treatment of biological nitrogen fixation and belowground carbon-nitrogen (C-N) interactions. A particular feature of our model is the functional difference in biological N fixation between tropical and extratropical forests. In the tropics, the model's N-fixation adapts fast to N-demand based on recent observations made in Panamanian forests, whereas temperate and boreal ecosystems lack such a capability. The biome-specific regulation of N fixation leads to differences in growth responses of forests to elevated atmospheric CO_2. Our model predicts persistent increases in above ground biomass in N-rich tropical forests if subjected to rising CO_2 concentrations, in line with observations from tropical forest inventories. The model results are also consistent with observations from free CO_2 enrichment experiments in temperate forests, which only show weak or transient growth responses. However, where anthropogenic N depositions are high, atmospheric N inputs can compensate for the lower N fixation rates in the extratropics and sustain growth enhancements. On global scales, our model predicts lower C sequestration if allowing for C-N feedbacks compared to a C-only version, mainly because of N constraints in temperate and boreal forests. This has potential implications for climate carbon-cycle feedbacks.

4.2 Elevated CO_2 effects on photosynthesis of tropical plants

ANDREW D. B. LEAKEY
University of Illinois at Urbana-Champaign, USA

The photosynthesis and productivity of all terrestrial, higher plant functional types can be stimulated by elevated CO_2. This includes all three photosynthetic types (C_3, C_4, CAM), species of all growth forms (herbaceous, shrub, vine, epiphyte, tree) and functional groupings including annuals, perennials and legumes. However, there is substantial variation in the impact of elevated [CO_2] on productivity among plant functional types and across the growing conditions which they experience. For example, the productivity of C_4 species is only stimulated by growth at elevated [CO_2] in times and places of drought. Generalizations about the mechanism and magnitude of responses to elevated [CO_2] by different functional groups are key inputs to models of ecosystem carbon fluxes. Tropical forest and savanna ecosystems contribute more than 50 % of global net primary productivity, yet very little experimental data on their response to elevated [CO_2] is available. Consequently, knowledge of functional group responses from temperate zones, which dominate the literature, is often extrapolated to tropical species and growth conditions. This talk will review the available evidence of tropical species photosynthetic and growth responses to elevated [CO_2] and evaluate the way in which knowledge of functional type responses to elevated [CO_2] is used to try and fill key knowledge gaps regarding the impact of elevated [CO_2] on carbon fluxes in tropical ecosystems.

4.3 Interannual variability of carbon flux in an old growth tropical rain forest

MOLLY CAVALERI
School of Forest Resources and Environmental Science, Michigan Technological University, 1400 Townsend Dr., Houghton, MI 49931, USA

We explored the drivers of interannual variability in both tree growth and eddy covariance-based net ecosystem exchange (NEE) of carbon in an old growth tropical rain forest in Costa Rica. We set out to determine whether this temporal variability over three years, including an El Niño Southern Oscillation year (ENSO, 1998), was caused primarily by changes in ecosystem respiration or photosynthesis. Ecosystem respiration (R_{eco}) was estimated by summing chamber-measured foliar, woody, soil, and coarse woody debris respiration fluxes, then modeling rates with temperature data over three years. We measured foliar and woody respiration rates from 52 tower transects throughout the old growth forest. Ecosystem photosynthesis (gross primary production, GPP), was estimated with MAESTRA, a 3-dimensional canopy processes model. We parameterized the model with detailed canopy structure and leaf physiology data gathered from the tower transects, and validated results with eddy covariance measurements of the same forest. Estimates of total daily GPP and response surfaces of GPP vs. temperature, vapor pressure deficit, and radiation were similar whether modeled with MAESTRA or eddy covariance. Neither interannual differences in modeled GPP nor R_{eco} could explain the previously measured differences in NEE or wood growth. Several possibilities could explain why modeled GPP did not capture this interannual variability. First, the model may not be sensitive enough to temperature or vapor pressure deficit changes. Another possibility is that changes in wood growth may not be due to changes in GPP. Higher temperatures at night may be affecting cell expansion, even if there is sufficient carbon being assimilated during the day. This phenomenon could decrease sink strength and effectively decouple patterns in wood growth from patterns in GPP. Understanding the drivers of interannual changes in GPP, NEE and tree growth can help predict how old growth tropical forest carbon fluxes may change with climate change.

4.4 Estimating the canopy carbon assimilation by combining the sap flow and ^{13}C isotope measurements

PING ZHAO
South China Institute of Botany, Chinese Academy of Sciences, Guangzhou 510650, China

In order to find a proper method measuring forest C assimilation, a approach combining sap flow and ^{13}C techniques was proposed in this study. This approach, obtained through a strict mathematic derivation, combines sap flow measurement-based canopy stomatal conductance (G_S) and ^{13}C discrimination to estimate instantaneous carbon assimilation rate of forest. Namely the canopy stomatal conductance that is acquired from accurate measurement of sap flux density is integrated with the relationship between ^{13}C discrimination (Δ) and C_i/C_a (intercellular / ambient CO_2 concentrations) and with that between leaf net photosynthetic rate (A_{net}) and g_{CO2} (stomatal conductance for CO_2), so that a new relation between forest C uptake (stand photosynthesis $\overline{A}$) and Δ as well as G_S (calculated from sap flow-based stand transpiration E_t) is established: $\overline{A}=\frac{E_l\times G_v\times(T+273)\times C_a\times(b-\Delta)}{1.6\times V_m\times D\times(b-a)}$. It would become a new method for studying the C exchange between forest and atmosphere based on experimental ecology. We applied this method to estimate $\overline{A}$ of an *Acacia mangium* plantation in hilly land of South China, and to compare with those obtained by gas exchange method. It showed that the mean canopy stomatal conductance (G_S) highly correlated with the leaf stomatal conductance (g_s) based on gas exchange measurement (r^2=0.4394, n=111, P=0.001). The $\overline{A}$ also showed linear agreement with A_{net}, however, the determination coefficient was low and the A_{net} was in average lower than $\overline{A}$ (r^2=0.1826, n=111, P=0.001). A much more effective way is needed to be designed to verify the method combining the sap flow and ^{13}C isotope measurements.

4.5 Seasonal and annual controls on forest carbon exchange processes

LUCY HUTYRA
Department of Geography & Environment, Boston University, Boston, MA, USA

Tropical rain forests store vast quantities of carbon within their biomass and annual rates of plant photosynthesis and respiration exceed total anthropogenic fossil fuel carbon emissions to the atmosphere. Seemingly small changes in the stocks of forest biomass or the balance between carbon uptake and release have the potential to dramatically affect our atmospheric CO_2 concentrations and climate. The long-term resilience of Amazonian forests to climate changes and the fate of their large stores of organic carbon depend on the ecosystem response to climate and weather. This work will present 4 years of eddy covariance data for CO_2 and H_2O fluxes in an evergreen, old-growth tropical rain forest examining the forest's response to seasonal variations and to short-term weather anomalies. We observed that photosynthetic efficiency declined late in the wet season, before appreciable leaf litter fall, and increased after new leaf production midway through the dry season. Rates of evapotranspiration were inelastic to dry season precipitation. However, ecosystem respiration was inhibited by moisture limitations on heterotrophic respiration during the dry season. The annual carbon balance for this ecosystem was very close to neutral, with mean net loss of 890 ± 220 kg C ha-1 yr-1. The annual carbon balance was sensitive to weather anomalies, particularly the timing of the dry-to-wet season transition, reflecting modulation of light inputs and respiration processes. Canopy carbon uptake rates were largely controlled by phenology and light with virtually no indication of seasonal water limitation during the 5-month dry season. Eddy-covariance measurements are a powerful tool to provide detailed data on CO_2/H_2O exchange and responses to the environment in these forests, but accurate estimates of the net ecosystem exchange of CO_2 and ecosystem respiration also requires careful analysis of data representativity, treatment of data gaps, correction for systematic errors, and independent validations of the results.

4.6 Nitrogen deposition to tropical ecosystems

JIANGMING MO
South China Botanical Garden, Guangzhou, *China*

A field experiment was conducted to examine the effects of simulated N deposition on tropical forests in southern China. The experiment was designed with four N treatment levels (three replicates) (0, 50, 100, 150 kg N ha^{-1} a^{-1} for Control, Low-N, Medium-N, and High-N treatment, respectively) in a mature forest, but only three levels (Control, Low-N, and Medium-N) in a disturbed (pine) and a rehabilitated (pine and broadleaf mixed) forests. Here we reported the effects of N addition on the green gas fluxes from soil in those forests and on plant diversity of the understory layer in the mature forest. There was a significant increase in soil N_2O emission following N additions in the mature forest. In the disturbed forest a significant increase was observed in the Medium-N plots, but not in the Low-N plots. The rehabilitated forest showed no significant response to N additions. Annual mean soil respiration rate in the Control, Low-N and Medium-N plots did not differ significantly in the mature forest, whereas it was 14% lower in the High-N plots compared with the Control plots. Annual mean soil respiration rate in the rehabilitated forest was 20% lower in the Low-N plots and 10% lower in the Medium-N plots than in the Control plots, but no significant difference among treatments in the disturbed forest. Average CH_4 uptake rates decreased when compared to the Control plots for the N treated plots in the mature forest. However, N additions had no significant effect on CH_4 uptake in the rehabilitated and disturbed forests. No understory species exhibited positive growth response to any level of N additions during the study period. Although Low-to-Medium levels of N addition generally did not alter plant diversity through time, high levels of N addition significantly reduced species diversity and functional diversity.

Session 5:	**Plant–Soil Interactions** **Chair: *Andrew Smith***

5.1 Biogeochemical cycling in tropical forests: feedbacks to climate change

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Carbon cycling in humid tropical forests is generally assumed to be relatively insensitive to climate, due to near constant warm temperatures and abundant rainfall throughout the year. We explored intra- and inter-annual variability in litterfall and soil respiration, two of the largest annual carbon fluxes in humid tropical forests, to determine the sensitivity of these fluxes to climate. We also examined how the relationship between climate and carbon fluxes changes following canopy disturbance. Over a six year period we measured large intra-annual variability in both litterfall (0.5 to 1.5 g C m^{-2} d^{-1})and soil respiration (2.4 to 4.8 g C m^{-2} d^{-1}), which appeared to be coupled to small changes in temperature and light availability. We conducted a full factorial canopy trimming experiment that separated the effects of canopy opening from the effects of litter deposition. Litter additions increased soil respiration under a closed canopy by approximately 2.5 g C m^{-2} d^{-1}, while canopy disturbance significantly decreased soil respiration by approximately the same amount. As expected, soil respiration declined most strongly in the treatment that combined canopy disturbance and litter removal. Treatments did not appear to significantly affect the seasonal pattern of soil respiration, but altered the amplitude of peaks and troughs. Our results suggest that carbon fluxes in humid tropical forests are sensitive to relatively small changes in climate. Our results also suggest that increased disturbance frequency and severity expected with climate change has the potential to alter carbon cycling and increase carbon emissions over the short term.

5.2 Litter decomposition in an Amazonian rainforest

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Contributing to roughly 50% of total soil respiration, soil heterotrophs play a key role in the global C cycle with an often greater sensitivity to global change than autotrophs. Only slight changes in the flow rate of energy and matter in the decomposer system can have a large impact on the global C cycle. It is thus critical to understand the control factors on decomposition and how they are influenced by the ongoing global change and biodiversity loss. Litter decomposition in forests of the humid tropics is generally perceived as a rapid process, because of favorable climatic conditions for microbial activity. Another common assumption is that litter C:N or lignin:N ratio, shown to correlate well with decomposition in numerous studies from the temperate zone, are robust predictors of decomposition for large-scale C cycle models including the tropics. Data from recent field experiments in a lowland Amazonian tropical forest challenge both of these assumptions. The slow decomposition of tropical leaf litter does not correlate with any N related quality parameters. Litter P status also does not explain any variation in litter decomposition which is even more surprising given the extremely low soil P concentrations. Instead, carbon quality that varies considerably among tree species predicts litter decomposition well. Tree diversity associated litter mixture effects and the structure of the decomposer community, with a dominant role of soil macrofauna, are additional drivers of tropical litter decomposition. Collectively, our data suggest that decomposition in the studied Amazonian rainforest is primarily energy limited, and thus, best predicted by C quality of plant residues. As a consequence, for some tropical rainforests, future changes in decomposition and C cycling due to global change and biodiversity change might be best evaluated by the associated changes in the soil energy budget.

5.3 Physiological responses of tropical trees to drought

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Drought strongly affects rain forest functioning at seasonal, interannual and longer time-scales and is predicted for some rain forest regions this century. The mechanisms underlying the effects of drought on the cycling of water and carbon by rain forest are under increasing scrutiny because they have the potential to guide or misguide climate-sensitivity predictions for rain forest-atmosphere interactions.
We present data from an artificial through-fall exclusion experiment in eastern Amazonia where water was excluded from the soil over 1 ha of forest. We also compare these results with a similar experiment conducted a few hundred kilometres west, also in Amazonia. Our aim is to examine the mechanisms underlying the response by rain forest to drought. We report an analysis of data from the first three years of measurements, examining the effect of soil moisture reductions on photosynthesis, respiration and other components of productivity. The rainfall exclusion experiment has been extended over 5 additional years, with a less intensive measurement program considering longer-term ecological processes and we also use these data to interpret the detailed shorter-term physiological analysis, and to provide context in relation to biogeographically more extensive studies of drought. The results of our analysis provide the first detailed measurement-driven quantification of the impacts of large scale experimental drought on net ecosystem production (NEP). They not only demonstrate some expected reductions in both respiration and photosynthesis, but also differences in the response in respiration by different components of the ecosystem.
These differences in response (e.g. between soil and leaves) have a significant impact on the change in NEP under drought and may need to be incorporated into the next generation of land surface models.

5.4 Water uptake from tropical soils

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Tropical savannas cover about one-eighth of the global land surface and are characterized by high plant species diversity. Both, herbaceous and woody plants are adapted to frequent fires, extremely poor soils and a long dry season of about 5 months duration. Tree species tend to have deep root systems that allow them to use deep soil water sources and exhibit a large diversity also in terms of life history traits. Deciduous and brevideciduous Cerrado trees, for example, that have a dimorphic root system with both shallow and tap roots, are involved in lifting water from deeper soil layers. Despite its geographical extent, biotic richness, and vulnerability to impacts by human activities, this biome has received relatively little attention from researchers in comparison to tropical rain forests. We will examine seasonal patterns of soil water utilization in Neotropical savannas of Central Brazil (Cerrado). The effects of relative abundance of woody plants, leaf phenology and root architecture on the soil water partitioning will be shown. We will also discuss about the effects of conversion of Neotropical savannas to plantations and pastures as well as the consequences of soil fertilization on soil water use.

Poster Abstracts

Listed alphabetically by first author, presenting author is underlined

1. Hydrological apparatus of forest and savanna trees

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In this study we used a newly established earth impedance method to determine the root absorbing area of tropical forest and savanna trees. Roots function to supply water from the soil which is needed to sustain transpiration through the same
stomata that acquire carbon dioxide needed for photosynthesis. Achieving a sustainable water balance in arid climates becomes increasingly difficult as the supply of water from the soil diminishes and atmospheric demand increases. One particularly important adaptation for maintaining an efficient water balance is the root to leaf area ratio. Despite its importance, we have a very limited understanding of the role roots play in the supply of water to the leaves. Here we compare the water absorbing root area index (RAI) with the effective transpiring leaf area index (LAI). We took measurements within different vegetation types characterising the transition zone between the Amazonian forest and the Brazilian Cerrado. The resulting root:leaf area ratio will improve our understanding of the adaptive nature of this highly fragile and dynamic frontier.

2. Effect of long-term fertilization on soil plough layer carbon storage in a reddish paddy soil of China

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With a reddish paddy soil of China as test materials，soil profile carbon storage in long-term different fertilization system(1990-2006) have been investigated and compared the effects of soil bulk density and topsoil statistic depth on C storage. The result showed that there is a significant relationship between the soil bulk density and the depth change of profile soil．The C storage would be greatly underestimated by 20.6％ or 11.3％if we only take 20 cm or 23 cm as the standard depth in the estimating method for C storage，it also would be underestimated the difference of treatments．when comparing or estimating the effect of farming methods on C storage, it was necessary to estimate the change of profile depth, especially under the soil bulky density changing greatly. The result indicated that recycling of organic matter significantly increased C storage(ranged from 57.7 to 66.2 t/hm^2), and it increase by 18.7-27.2 t/hm^2 compared with C storage of 1990，but it increased by 5.4 t/hm^2 with only application of chemical fertilizers．Saturated carbon storage of paddy soils was 84.0 t/hm^2，and the C sequestration potential ranged from 17.8-43.7 t／hm^2 compared with the current C storage．

3. A Preliminary Study on the Change of Soil Organic Carbon and Carbon Cycling of Loess Hilly Region Slope Land

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DNDC (denitrification - decomposition) model is feasible in hilly and gully areas of Loess Plateau, which was validated by the soil organic carbon (SOC) data derived from Long-term experiment. So it was used to study continuous SOC change and carbon cycle feature in hilly and gully areas of Loess Plateau. The simulation results indicated that fertilizer application significantly increased the amount of input exogenous carbon and consuming endogenous carbon; the effect of organic manure was most significant. On the whole, the SOC content of 0~30cm in the single-organic manure treatment and in the organic manure + nitrogen fertilizer treatment were 48.09% and 47.01% higher respectively than the starting values 40 years ago. However, the SOC content in the control and the nitrogen treatments were 0.34%、3.72% respectively lower than the starting values 40 years ago. According to the simulation results, on the sloping land in hilly areas of Loess Plateau, applying organic manure mainly with a certain amount of nitrogen fertilizer will be an effective measure for maintaining improving soil fertility, increasing the amount of storage of the organic carbon pools in soil.

4. Unravelling the role of leaf nitrogen and phosphorus over photosynthetic capacity

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The relationships between foliar nutrient content, specific leaf area and photosynthetic capacity (Vcmax and Jmax) were examined in the present study, enabling us to test our understanding of nutrient constraints on leaf physiology improving regional and global photosynthesis models. Earlier studies indicate distinct relationships between foliar nutrient and photosynthetic capacity parameters among temperate and tropical vegetation. A robust test of this hypothesis is needed and here we reveal the largest data set hitherto available from tropical vegetation (forests and savannas). 680 A-ci response curves where obtained from trees and shrubs (121 species) from 30 different plots assessed in Africa and South America. This large and complex dataset showed that, leaf [N-mass] explained only 25% of the variation in Vcmax, while [P-mass] alone explained 17% of the variation of that parameter. The single best predictor of Vcmax was specific leaf area (SLA), which explained 36% of the variation. Multiple correlation analyses showed that the interaction between SLA and [N-mass] improved Vcmax prediction (42%), while a linear model involving SLA, [N-mass] and [P-mass] did not improve the upon the former model. We also examine similar relationships with Jmax and consider local and regional scale patterns in both parameters.

5. Modelling aboveground forest carbon dynamics in Papua New Guinea; isolating the influence of selective-logging and El Niño

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Selective-logging is the dominant tree harvesting method in tropical countries, but its impact on the aboveground forest carbon balance remains poorly understood. Quantifying the carbon (C) emissions due to this activity is an important technical challenge for the Reduced Emissions from Deforestation and Degradation (REDD) initiative. However, other disturbances also impact the forest C balance. In 1997/1998, the 20th century's most intense El Niño Southern Oscillation (ENSO) event provoked severe droughts and fires across equatorial tropical forests which severely impacted aboveground C dynamics.

We apply a Hierarchical Bayesian Model (HBM) to 18 years of census for a Permanent Sample Plot (PSP) network in Papua New Guinea. The PSP network consists of 114 one hectare plots in selectively-logged lowland tropical forest, and 11 plots in primary (undisturbed) forest. The HBM allows us to isolate the influence on aboveground C dynamics of selective-logging and the ENSO event of 1997/1998. The HBM also provides a statistically valid estimate of average C sequestration for selectively-logged and primary forest. The HBM methodology has statistical advantages compared to simply averaging C sequestration across forest plots as done in many previous studies, and can be used to isolate the influence of external drivers on the forest C balance.

6. Carbon dynamics from Andes to Amazon

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The net primary productivity, carbon stocks and turnover rates (i.e. carbon dynamics) of tropical forests are crucial to the global carbon cycle. Whereas these variables have been investigated in lowland tropical forests, they have rarely been studied in tropical montane forests. This study examines spatial patterns of above- and below-ground carbon dynamics along a transect ranging from lowland Amazonia to the high Andes in S.E. Peru. Above ground net primary productivity and biomass were measured using litertraps and dendrometer bands; below-ground productivity and biomass was measured with rhyzotrons and ingrowth cores; weather stations and rain gauges were installed at each elevation.Below-ground biomass values increased from 1.5±0.01 Mg C ha^{-1} at 194m to 4.95±0.62 Mg C ha^{-1} at 3020 m, reaching a maximum of 6.83±1.13 Mg C ha^{-1} at 2020 m. Above-ground biomass values decreased from 123 Mg C ha^{-1} at 194 m to 47.03±12.5 Mg C ha^{-1} at 3020 m. Average annual below-ground productivity was highest in the most fertile lowland plots (7.39±1 Mg C ha^{-1} yr^{-1}) and typically ranged between 3.43±0.73 Mg C ha^{-1} yr^{-1} and 1.48±0.40 Mg C ha^{-1} yr^{-1} in the pre-montane and montane plots. Mean annual above-ground productivity was estimated between 8.40±0.48 Mg C ha^{-1} yr^{-1} (210 m) and 2.50±0.02 Mg C ha^{-1} yr^{-1} (2020 m), with lower values observed in the cloud immersion zone of the montane forest. Fine root carbon residence time increased from 0.31±0.04 years in lowland Amazonia to 3.78±0.81 years at 3020 m and stem carbon residence time remained constant along the elevational transect (53±7 years). The ratio of fine root biomass to stem biomass increased significantly with increasing elevation, whereas the allocation of net primary productivity above- and below-ground remained constant at all elevations. Although net primary productivity declined in the tropical montane forest, the partitioning of productivity between the ecosystem sub-components remained the same in lowland, pre-montane and montane forests.

7. Seasonal changes in *Cyclobalanopsis glauca* transpiration and canopy stomatal conductance and their dependence on subterranean water and climatic factors in rocky karst terrain

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The forest is very important in regulating ground water in karst environments through uptake of underground moisture through transpiration, contributing greatly to the regional hydrological cycle. The transpiration and canopy conductance from a *Cyclobalanopsis glauca* (syn. *Quercus glauca*) stand on a rocky hilly slope in South China was measured during 2006-2007 by using the Granier's sap-flow method. Annual stand transpiration (836mm y^{-1}) accounted for 48.7% of the rainfall during the experimental year. Per month, daily stand transpiration (E_c) maximums between 2.1mm d^{-1} in January to 5.1mm d^{-1} in July were recorded, with transpiration higher in the hot season than in the cool season. In the driest months, September and October, E_c of *C.glauca* was still high. Solar radiation, vapor pressure deficiency, and air temperature were simple influences on transpiration of *C. glauca,* which attributed to a quadratic power model, while soil moisture influence on transpiration was complicated. High stomatal openness in *C.glauca* occurred earlier in the morning and declined throughout the day. Relation coefficient between canopy stomatal conductance (G_c) and E_c in our study ranged high when *VPD*>1.0kPa, moderate when 0.5kPa<*VPD*<1.0kPa, and low when *VPD*<0.5kPa. Under high vapor pressure deficiency, stomatal control of transpiration is high. The pattern of seasonal change of transpiration and canopy stomatal conductance of the plant in karst regions is different from that in non-karst regions, with the stand transpiration and canopy stomatal conductance being high even during the dry season in the karst region. This is due to karst plants partially uptaking water from the epikarst, which is normally rich in water. With high stand transpiration and canopy stomatal conductance, karst vegetation is presumed to be the most important 'pathway' for epikarst-soil- plant- atmosphere continuum (*ESPAC*), and water from the epikarst plays an important role for net primary production (*NPP*).

Key words: Transpiration, canopy stomatal conductance, karst, *Cyclobalanopsis glauca*, epikarst, climatic factors

8. Responses of *Arabidopsis thaliana* leaves to elevated temperature: a neglected contributor to the future global warming?

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As an important organ of plant, how leaf will respond to future global warming? We tested this using *Arabidopsis thaliana* plants respectively grown at three day/night temperatures of 23/18°C, 25.5/20.5°C and 28/23°C to simulate the middle and the upper projected warming expected within the 21st century. Chemical composition and activities of antioxidant enzymes in leaves, gas exchange and leaf structure were investigated. Concentrations of starch, chlorophyll and proline were the lowest at 28/23°C among three temperatures, whereas concentrations of chlorophyll and proline, stomatal density and conductance, and photosynthetic and transpiration rates were the highest at 25.5/20.5°C. Additionally, number of chloroplasts and mitochondrion size were highest at 25.5/20.5°C and lowest at 28/23°C. These results indicate that warming of 2.5°C was advantageous for *Arabidopsis* leaf growth, but a rise of 5°C produced significant negative effects. It is suggested that many plants might adapt well to and even benefit from a moderate rise in climatic temperature in the near future, but severe warming of 5°C may have a great negative impact on plants and even restrict their ability to absorb carbon dioxide from the atmosphere. This consequence could be an important contributing factor to positive feedback of complex processes associated with global warming.

9. Partitioning soil CO_2 flux on DIRT (Detritus Input Removal Transfer) experiment in tropical forest

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Soil respiration is a critical component in the carbon cycle processes as well as the biogeochemical cycles. Inputs and removal of aboveground (leaves, twigs, seeds, other fine litters) and belowground (mostly fine roots) sources on soil organic matter dynamics influence decomposition and soil respiration rates. Measuring soil CO_2 flux for each component is complex and thus still poorly understood. We established the long-term DIRT (Detritus Input Removal and Transfer) Experiment to control and manipulate soil organic matter. Our goal is to measure and assess CO_2 flux from soil partitions under different treatments of chronically altered above- and belowground inputs. The treatments are: control (C), exclusion of aboveground litter (NL), exclusion of root inputs (NR), exclusion of aboveground litter and root inputs (NI), O/A-less horizon soil treatment (O/A), doubling of aboveground litter (DL), and mycorrhizal treatment (MY), established on two DIRT plots of sandy loam and clay soils replicated 2m x 2m plots (n=3 treatments). Soil respiration was measured by combining monthly and continuous measurements to capture seasonal variations. Initial results demonstrate that soil CO_2 flux corroborates with the influence of above- and belowground plant inputs.

10. Comparisons of tropical savanna systems across Africa, Australia and South America

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Tropical savannas cover 15% of the earth's land surface and large parts of Australia (30%), Africa (50%) and South America (45%). These highly dynamic systems burn frequently and are changing the world over via such processes as woody thickening and conversion to agricultural land. Despite their broad extent, productivity and their substantial role in the global carbon cycle, our understanding of the climatic bounds, spatial and temporal heterogeneity of biomass production and functional differences across continents is limited. A working group funded by the ARC-NZ Vegetation Function Network, have synthesised data examining spatial variability in biomass and the climatic bounds of these systems across the three savanna continents, Africa, Australia and South America. Where savannas occur in Africa and Australia, patterns of biomass appear closely related to key climate and fire parameters. In contrast, South America is anomalous, suggesting annual water limitation does not strongly determine the extent and heterogeneity of savannas on this continent. A network of relationships between precipitation, climate seasonality and fire frequency predicts patterns of biomass well. However, the relative importance of these drivers varies markedly across continents. It is apparent the substantial local-scale variability in biomass is highly likely to be a product of fine scale heterogeneity of soils, historical contingencies and spatio-temporal variability in disturbance mechanisms, particularly fire and grazing. Future development from the working group will link these empirical analyses to simulation modelling which will examine the complex climate–fire–soil–vegetation interrelationships to predict how the extent and heterogeneity of this biome may shift as a result of global change.

11. Comparing stomatal conductance models in a tropical rain forest of Xishuangbanna, southwest China

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Humidity of air plays a key role in controlling the stomatal conductance (*g*) of plant leaves. The stomatal conductance-humidity relationships have been argued substantially in the last several decades, and the focus of these debates is whether stomatal conductance correlates well with relative humidity or water vapour pressure deficit. This study evaluate various models of stomatal conductance response to humidity using the diagnostic parameter *f(H)* and the eddy covariance fluxes data measured at the canopy level in Xishuangbanna tropical seasonal rainforest, Southwest (SW) China. The results show the weak correlations between the canopy stomatal conductance and humidity when fitting this relationship according to the form of Ball-Woodrow-Berry (BWB) model and Leuning model, in which g is underestimated at high humidity and overestimated at mid-to-low range of humidity. In contrast, the Wang model-h_a and -D_a that employ the power function of (1-h_a) and D_a perfectly fit the sensitivity of stomatal response to humidity at any range of humidity. The model comparisons also show that the Wang model-D_a presents the best performance (highest *r* and smallest σ) when fitting *g*-humidity relationships. This best-fit model can reduce the errors of estimation of canopy stomatal conductance, and improve the accuracies of simulation in evapotranspiration and CO_2 exchanges between the tropical canopy and atmosphere.

12. Responses of Japanese forest soil emission to global warming

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Since 2005, we installed six soil warming experiment sites each represents the major forest ecosystem in Japan. We installed fifteen automated chambers (0.9m×0.9m×0.5m, L×W×H) at each site for continuous measurement of soil CO_2 efflux. We made ten 1m×1m (40 cm in depth) root exclusion plots. To prevent in growth of new roots, after the trenching treatment, we inserted a plastic sheet down to 25 cm around the edge of the plot. Half of the trenched plots (five plots) at each site were used for soil warming experiment, and the other half of the plots were used as control plots by keeping them in the ambient environment. For the soil warming plots, an 800W infrared heater was vertically hanged over the center of the plot at 1.6m above the soil surface. Compared to the control plots, the infrared heater could warm the soil for 3.0, 2.5, 2.0, 1.7, and 1.5°C at depth of 0, 5, 10, 20, and 30cm, respectively. The primary results showed that heterotrophic respiration increased at a rate between 3.5% and 19% per °C, in corresponding with soil organic carbon (SOC) density, vegetation type, as well as the regional climate.

13. Ecophysiological traits of *Dipterocarpus sublamellatus* Foxw. (Dipterocarpaceae) as correlates of natural regeneration in a lowland tropical rainforest at Pasoh, Peninsular Malaysia

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A field study of a late-successional species, *Dipterocarpus sublamellatus* Foxw. in a lowland primary dipterocarp forest at Pasoh, in Peninsular Malaysia, focused on the responses of leaf ecophysiological characteristics to the vertical microenvironment. We studied samples of different regeneration phases, including young seedlings (0.10 to 0.20 m tall, 2 years old), saplings (1.5 to 2.0 m tall, 12 years old), adult trees in the canopy layer (24 to 28 m, various ages), and emergent layer (32 to 38 m tall, various ages). Maximum photosynthetic rates generally increased with tree maturity. These patterns corresponded with trends in leaf chlorophyll and nitrogen contents, and specific leaf mass. With higher CO_2 concentrations near the forest floor, seedlings and saplings adapted to the shade in the understory by adjusting photosynthetic efficiencies via reductions in dark respiration rate, photosynthetic light-compensation point, and light-saturation point. Leaves from emergent trees had significantly lower leaf water potential and showed photosynthetic depression in early afternoon, indicating that leaves at emergent layer are unable to fully utilize high levels of light efficiently due to hydraulic limitations. As a result of acclimation to vertical gradients in light availability and CO_2 concentration, photosynthetic light saturation points increased with increasing maturity.

14. The Soil CO_2 Release Rule of Vegetable Land System in Solar Greenhouse

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The Soil CO_2 release of vegetable land system in solar greenhouse is one of important composition part of carbon cycling in earth ecological system. It is a main format of soil organic carbon output. There are many research results of soil carbon release in crop land eco-system, but in vegetable land system in solar greenhouse, the information is more lack. In order to study the soil CO_2 release rule of vegetable land in greenhouse, the experiments were conducted in Yan'an, Shaanxi province on the Loess Plateau, using the static closed chamber alkali absorption method. The results indicated that Comparing with fallow, the treatments of 6 kind preceding crops could increase soil CO_2 release intensity in fruit stage of cucumber, the order of soil CO_2 release intensity was greengrocery >maize for green manure >cowpea >tomato> kidney bean>black bean for green manure> fallow. Soil CO_2 release intensity was decreased as continuous cropping years increasing, after 4 years continuous cropping, soil CO_2 release intensity decreased fearfully. It was conclusions that soil CO_2 release intensity in fruit stage of cucumber could be adjustment through change preceding crops and continuous cropping years.

15. Impact of drought on carbon cycling at an Amazon rainforest

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The Amazon rainforest plays a key role in the global climate system, because each year it absorbs a quantity of the greenhouse gas carbon dioxide (CO_2) equivalent to the emissions of the entire European Union. However, some computer climate models predict that an increased frequency and severity of drought events in the Amazon region may cause large areas of the forest to become a net source of CO_2 over the next hundred years. We know little about how the Amazon ecosystem will respond to drought, and what the implications could be for the release of CO_2 into the atmosphere.
My research aimed to address this gap in our knowledge by quantifying the amount of carbon stored in different components of an Amazonian rain forest, and the pattern of carbon transfer between components. The effects of drought were inferred by comparing a one hectare plot where rainfall had been excluded with a similar, but unmodified, control plot.
The results indicate that the forest, at least in this region of the Amazon, is remarkably resilient to drought. While there was a decrease in CO_2 uptake by the trees on the droughted plot relative to the control, this was outweighed by a simultaneous decline in CO_2 emerging from the forest soil, with the result that the droughted forest was actually estimated to be a net carbon sink during the year of measurement. These results advance our understanding of the interactions between climate and forests, and should improve current estimates of future atmospheric CO_2 levels.

16. Isotopic evidences of CH_4 emission in dry land tropical forests of the Amazon

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Here we present results of the stable carbon isotopic composition ($\delta^{13}CH_4$) and concentration of methane in atmospheric air samples from in upland tropical forests in the Amazon. This is the first dataset ever collected in the region for stable carbon isotopes analyses using flux towers installed in the tropical forest. The campaigns were carried out at the Tapajós National Forest (TNF) and Caxiuanã National Forest (CNF). Atmospheric air samples were collected in a vertical profile (0.2, 7.0, 15.0, 22.0, 35.0, and 45.0 m) in different times of the day (4:00, 16:00, 22:00, and 24:00h) during the wet, intermediary, and dry season. The air samples were pulled through tubes by a battery-operated pump and then stored into glass flasks. The $\delta^{13}CH_4$ was determined by mass spectrometry (Finnigan Mat 252 equipped with HP 5890GC, interfaced to a CF/GCC/MS) and the concentration was determined by gas chromatography (Shimadzu 14A – Greenhouse). The $\delta^{13}CH_4$ varied from -49.46‰ to -46.00‰. The overall mean value found was equal to -47.51‰. The concentration varied from 1.82ppmv to 2.75ppmv, with overall mean equal to 2.09ppmv. $\delta^{13}CH_4$ and concentration were both in the range for values found for atmospheric methane. Both sites showed seasonal variation in $\delta^{13}CH_4$ and concentration, being more depleted in ^{13}C and more concentrated during the dry season than during the wet season. A spatial variation was observed only for $\delta^{13}CH_4$. The CNF showed a mean value of $\delta^{13}CH_4$ more depleted than the mean values measured at the TNF. The lightly depleted values observed at the lowest height (0.2m) suggests that microbial production might be an important

source of the gas, however other sources with different origins could co-exist along the profile and could contribute differently to the isotopic composition of the CH_4 released.

17. Quantifying and explaining variation in carbon pools and fluxes

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There are still large gaps in our understanding of forest carbon pools, short- and longterm carbon fluxes, the mechanisms underlying these fluxes, and the likely impacts of global change – especially for tropical forests. The 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 25-year history of forest dynamics research monitoring growth and mortality of 3.5 million trees of approximately 7500 species. 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 and litterfall. 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.

18. Grassland landscape structure change and its driving factors during past twenty years in Xiwuzhumuqin, Inner Mongolia

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Based on FRAGSTATS, RS and GIS, this paper studied the grassland landscape structure change during the past twenty years in Xiwuzhumuqin grassland, Inner Mongolia, from the aspects of general landscape features, landscape type characteristics. The results showed that the landscape spatial patterns have changed and the trend of land desertification was obviously, the proportions of artificial landscape were increasing, but general landscape patterns were stable, and the area of grassland landscape accounted for its total area above 86%. The general landscape showed that high fragmentation and low cohesion. With increasing of population and livestock quantity, the human activities become more and more intense and the ecology system trend to degeneration due to Overgrazing and abandoned cultivation in the past 20 years. It was an important reason of landscape structure changes that the hydrological indicators and air temperature were raising.

19. The effect of fire intensity and frequency on miombo woodland tree populations and biomass

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Miombo woodlands are the largest savanna in the world and dominate southern Africa. They are strongly influenced by anthropogenic fires and support the livelihoods of over 55 million people.
Managing the fire regime of such a flammable system is difficult, but crucial for sustaining current biodiversity, ecosystem services and carbon stocks. Fire intensity is more easily manipulated than fire frequency as suppression is expensive and ineffective. However, there are important issues relating fire intensity to top-kill, reprouting and regrowth, which need to be understood to inform management approaches.
Here we present results from a fire experiment in Mozambican miombo; the results of a 50-year fire experiment in Zimbabwean miombo; and observations of forest structure at a dry forest site in Mozambique. We synthesise these data with a process-based gap model of stem growth, regeneration and mortality, which explicitly considers the effect of different frequencies and intensities of fire. We use the model, tested against the field data, to explore the sensitivity of woodland tree population and biomass to fire intensity and frequency.
Our results show that large (>5 cm DBH) stems are vulnerable to fire with top-kill rates of up to 12% in intense fires. In contrast to idealised physical representations of tree mortality, stems > 10 cm DBH did not gain further protection from fire with increasing DBH. Resprouting was very common and not obviously linked to fire intensity.
Overall, miombo woody biomass is shown to be very sensitive to fire intensity, offering opportunities for effective management. At any achievable fire return interval (<5 years), low intensity fires are required to maintain observed biomass. Model predictions and field experiments show that no tree biomass can be sustained under annual fires.

20. Plant effects on soil carbon processes

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In the Ailaoshan Natural Reserve in southwestern China we are conducting a long-term forest study of chemical and biological effects of aboveground litter denial, root trenching and tree-stem girdling, with treatments applied singly and together. Removing aboveground litterfall and the humus layer reduced soil respiration by more than the litter-C input, a respiration priming effect, but this effect was absent from the trenching and girdling treatments. Aboveground litter input increased the temperature sensitivity of soil respiration (Q10), but root processes did not alter it. The litter layer had highest Q10, and mineral soil alone the lowest. Soil concentrations of sugars were also regulated by aboveground litter input, while amino acids were affected by temperature-mediated microbial activity and belowground carbon input. Litter removal caused greater reductions of soil microbial biomass carbon (MBC) in the ungirdled than girdled plots. Trenching, girdling and their interactions influenced MBC in the humus layer, but neither treatment affected MBC in the mineral soil. Labile organic carbon (LOC) and MBC were higher in humus than in mineral soil. The turnover rates of LOC, and MBC by depth suggest that LOC derived directly from plants decomposes more slowly than LOC from microbial debris.

21. Integrative analysis of hydraulic lift in tropical savannas

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The objective was to assess the magnitude of hydraulic lift (HL) in Brazilian savannas and to test the hypothesis that herbaceous plants contribute substantially to maintain relatively high water potentials (Ψ_{soil}) in the upper soil layers during the dry season. To that effect, field observations of soil water content and water potentials, manipulative experiments, and model simulations, were used. Results of the manipulative experiment indicated that removal of above-ground herbaceous during the dry season substantially enhance diurnal recovery of Ψ_{soil}, suggesting that reverse flow from shallow roots of the herbaceous, as a consequence of HL, is of importance to the water balance of shallow rooted plants. Woody plants HL contribute only 1% of the total daily water use by trees and contributed about 2% to the partial daily recovery of soil water storage. The herbaceous contributes the rest (98%). During a 70 days drought period the Ψ_{soil} dropped to -2.0 MPa near the soil surface while the mathematical model predicted that without HL, Ψ_{soil} in the upper soil layers would have dropped to -3.8 MPa. The maximum HL contribution of upward water movement to the upper 100 soil layer was 0.7 mm day^{-1} near the middle of the dry season. Hydraulic lift can replace, during the peak of the dry season, the 35% of the ecosystem level water losses by evapotranspiration and consequently influences greatly the water economy, and other ecosystem level processes, of savanna vegetation.

22. Contribution of palms to aboveground biomass estimates in a tropical rainforest of Southwest Amazonia

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Allometric equations to estimate aboveground biomass (AGB) take into account diameter at breast height (DBH), wood specific gravity and tree height, being DBH the main factor that reflects changes in AGB. However, palm biomass variations cannot be tracked by changes in DBH, but by their crown dynamics. Here we report crown dynamics of a set of palm species present in a permanent sample plot. For this purpose, two permanent sample plots of 1ha each were selected due to the contrast in palm abundance. For palm species at each plot, ten individuals as minimum were randomly chosen in order to record leaf fall rates and phenology. When a specie had less than ten individuals, all of the individuals of each specie were evaluated. Leaf fall was the main contributor to total AGB, while flowering and fruiting showed a lower contribution. Iriartea deltoidea was the specie that showed the highest contribution to AGB. Therefore, attention should be given to palm crown as they are better indicators of its changes in biomass.

23. Origins of the determinants of the variations in trunk CO_2 efflux of trees in a tropical rainforest

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In tropical rainforests, the origin of the interspecific variability in trunk CO_2 efflux (Et) and of seasonal variations in Et have not yet been explained. We conducted a study to test which biotic and abiotic determinants would contribute to these variations. Et and a set of wood anatomical and functional characteristics were measured on trees in two habitats (*Terra Firme* forest *vs.* seasonal flooded forest) in a Neotropical rainforest over a 18-months' period including a range of climatic and soil water conditions. The large variability in Et (0.33 to 3.15 µmol CO_2 m^{-2} s^{-1} in *Terra Firme* forest) was associated with tree diameter and growth respiration (Eg), although maintenance respiration (Em) was the main component of Et. Neither wood properties nor sapflow density were correlated with trunk CO_2 efflux. The large seasonal variations in Et were correlated with diameter growth and surface soil water content (SWC). These data underlined the absence of clearly identified biotic determinants, beside growth, to explain the interspecific variability in Et. We emphasized the fast response of growth and maintenance respiration processes to seasonal variations in SWC that potentially has consequences on the carbon cycle in the ecosystem under upcoming climatic changes.

24. Erosion and vegetation restoration impacts on ecosystem carbon dynamics in South China

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To quantify the consequences of erosion and vegetation restoration on ecosystem carbon (C) dynamics (a key element in understanding the terrestrial C cycle), field measurements were collected since 1959 at two experimental sites set up on highly disturbed barren land in South China. One site had received vegetation restoration (the restored site) while the other received no planting and remained as barren land all the time (the barren site). The Erosion-Deposition-Carbon-Model (EDCM) was used to simulate the ecosystem C dynamics at both sites. The on-site observations in 2007 showed soil organic C (SOC) storage in the top 80-cm soil layer at the barren site was 50.3±3.5 Mg C ha^{-1}, half of that at the restored site. Surface soil loss and SOC erosion at the restored site from 1959 to 2007 was 2.2 cm and 3.7 Mg C ha^{-1} respectively, 1/8 and 1/3 of that at the barren site. The on-site C sequestration in SOC and vegetation at the restored site was 0.67 and 2.5 Mg C ha^{-1} yr^{-1} respectively from 1959 to 2007, driven largely by tree growth and high atmospheric nitrogen (N) deposition in the study area. Simulated findings suggested that higher N deposition resulted in higher on-site ecosystem C sequestration as long as N saturation is not reached. Lacking human-induced vegetation recovery, the barren site remained as barren land from 1959 to 2007 and the on-site C decrease was 0.28 Mg C ha^{-1} yr^{-1}. Our study clearly indicated that vegetation restoration and soil erosion provide a large potential C sink in terrestrial ecosystems.

25. No detectable maternal effects of elevated CO_2 on *Arabidopsis thaliana* over 15 generations

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Maternal environment has been demonstrated to produce considerable impact on her offspring growth. However, few studies have been carried out to investigate multi-generational maternal effects of elevated CO_2 on plant growth and development. Here we present the first report on the responses of plant reproductive, photosynthetic, and cellular characteristics to elevated CO_2 over 15 generations using *Arabidopsis thaliana* as a model system. We found that within an individual generation, elevated CO_2 significantly advanced plant flowering, increased photosynthetic rate, increased the size and number of starch grains per chloroplast, reduced stomatal density, stomatal conductance, and transpiration rate, and resulted in a higher reproductive mass. Elevated CO_2 did not significantly influence silique length and number of seeds per silique. Across 15 generations grown at elevated CO_2 concentrations, however, there were no significant differences in these traits. In addition, a reciprocal sowing experiment demonstrated that elevated CO_2 did not produce detectable maternal effects on the offspring after fifteen generations. Taken together, these results suggested that the maternal effects of elevated CO_2 failed to extent to the offspring due to the potential lack of genetic variation for CO_2 responsiveness, and future plants may not evolve specific adaptations to elevated CO_2 concentrations.

26. Soil nitrogen and carbon status of three successional forest stages in subtropical China

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Within a recently initiated biodiversity ecosystem functioning experiment (BEF China) we investigate the influence of successional stage and woody plant diversity on nitrogen (N) and carbon (C) cycling in subtropical broad-leaved forest stands. We aim to identify impacts of tree diversity on biogeochemical transformation processes and pool sizes of N and C. Study area is the Gutianshan National Nature Reserve located in Zhejiang Province, East China. In 2008, 27 permanent vegetation plots (30 x 30 m) were established in three successional forest stages. Total N and C as well as seasonal changes of plant available ammonium (NH_4^+) and nitrate (NO_3^-) were measured in the mineral soil for five depth increments. In parallel, we determined net N-mineralization rates in the upper 10 cm of the mineral soil by in situ incubation of soil cores. We observed considerable seasonal variations of net N-mineralization rates and plant available NH_4^+ and NO_3^-. Soil C and N concentrations were significantly influenced by successional forest stage. C concentrations increased during succession whereas total N was highest in young forests and lowest in middle-aged forest stands. Our first results indicate

pronounced changes in N and C dynamics during secondary succession and strong seasonal fluctuations of mineral soil N concentrations.

27. Variation of photosynthetic capacity, leaf dark respiration and leaf traits in the canopy of a tropical montane cloud forest in Peru

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There are many uncertainties regarding the productivity of tropical montane cloud forests (TMCFs), and in particular about photosynthetic capacity, which has been presumed to be low. We measured the photosynthetic parameters (V_{max}, J_{max}), leaf dark respiration (R_d), foliar nutrients (N and P), leaf mass per area (L_a) and leaf density (L_d) at different canopy heights of 33 trees in a TMCF in Peru at 3000 m asl. A multilevel random intercept model showed that variance in V_{max}, J_{max}, R_d, P and $L_a$was mostly explained by canopy position, while for N and L_d, the variance was mostly explained by differences between species. The vertical gradients in photosynthetic parameters (V_{max} and J_{max}) were larger than for R_d, showing that respiration changes much less within the TMCF canopy than photosynthesis. Surprisingly, V_{max} and J_{max} values were of a similar value and range as found in lowland tropical rainforests (LTRFs) (44.3 ±SE 2.8 μmol m^{-2} s^{-1} and 85.2 ±SE 05.6 μmol m^{-2} s^{-1} respectively) and the slope and intercept of the V_{max}-N relationship resembled the V_{max}-N relationship of temperate forest types, rather than that of LTRFs. We therefore conclude that the CO_2 uptake capacity by TMCF is much higher than previously assumed.

28. Seasonal variations in photosynthetic performance of the two tree fern species (*Dicksonia antarctica*, Dicksoniaceae and *Cyathea australis*, Cyatheaceae)

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Steady state and dynamic responses of two tree fern species of contrasting origins, *D. antarctica* (Gondwanan) and *C. australis (*Indo-Malayan*)*, were studied over two years under field conditions in Victoria's Central Highlands, Australia. Irrespective of their different origins and micro-site preferences, there were no significant differences in photosynthetic performance between the species and both had greatest photosynthetic capacity in winter. Temperature was the most influential environmental factor on plant performance under field conditions. Plant water status had no effect on any of the measured parameters. Both species displayed seasonal acclimation in a number of measured photosynthetic parameters and frond traits. Acclimation potential of stomatal density to spatial variation in growth light environment seemed limited in both species, although stomatal pattern differed between species. Because there were no significant differences between the two species in photosynthetic parameters, both species could be described by the same carbon gain and water use models at the leaf-scale.

29. Biological controls on soil organic carbon turnover in contrasting land uses in Xishuangbanna, SW China

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Climate, litter quality, and soil texture are generally viewed as the main determinants of soil organic carbon (SOC) turnover, and are the only factors included in dynamic ecosystem C models. However, climate and litter quality have indirect effects on decomposition through their influence on the activity of soil flora and fauna. Our research on proximate biological controls of SOC turnover considers three main topics: 1) Effects of land-use change on soil CO_2 efflux; 2) Effects of soil arthropod community structure on above- and belowground decomposition and 3) Role of soil microbial community structure and oxidative enzyme activity on lignin degradation in contrasting land uses. We are exploring these topics within a single experimental framework in a tropical secondary forest and rubber plantation in Xishuangbanna, SW China. Litter manipulations and chemical fertilizer treatments are being used in conjunction with a litterbag-decomposition experiment to study the effects of land use, soil fauna, and the soil microbial community on SOC turnover. Early results indicate soil CO_2 efflux, temperature, and moisture relationships differ between natural forest and rubber stands. Also, soil microbial community profiles (assessed by DGGE) and oxidative enzyme activities differ between forest and rubber soils.

30. Biomass carbon accounting factors of *Pinus massoniana* in China based on literature data

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Pinus massoniana forest, distributing widely in southern China, play an important role in biomass carbon accounting. Our objective was to understand its biomass carbon accounting factors: biomass conversion and expansion factor(*BCEF*), biomass expansion factor (*BEF*), below-ground biomass to aboveground biomass ratio (*R*), community biomass expansion factor(*CBEF*) and carbon fraction (*CF*). We collected data on biomass and related parameters for *Pinus massoniana* forest from published literature, calculated carbon accounting factors, and analyzed their relationships to stand age(*A*), diameter at breast height(*DBH*), stand height (*H*), stand volume(*V*) and stand density(*D*). The results show that mean *BCEF*, *BEF*, *R*, *CBEF* and *CF* were 0.790 $t \cdot m^{-3}$(n=108，SD=0.586), 1.360 (n=389，SD=0.320), 0.179 (n=332，SD=0.072), 1.045 （n=32，SD=0.039）and 0.52（n=12, 1SD=0.038）respectively. There were no significant differences of *BCEF*, *BEF* and *R* between natural forests and plantations, as for *CBEF*, further study should be done. Compared with IPCC default values, domestic values derived from our study will reduces significantly the uncertainty in estimation of biomass carbon.

31. The effects of management on tree plantation carbon cycle: a case study in subtropical red soil of South China

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Tree plantation plays an important role in mitigating the global warming. China has the largest tree plantation areas in the world, so it is very important for the government to understand the effects of forest management activities on carbon sequestration potential in tree plantation. The sound forest management activity will be a good means for policy-makers to quantify past forest carbon stocks and stock changes and to explore future forest and land-use policy options.
In this study, the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) model was first validated by the field observations of tree plantation in subtropical red soil of South China, and then the model was used to assess the effects of forest management activities (such as fertilization, logging etc.) on the tree plantation carbon cycle.

32. The 'Carbon lake' phenomenon and its effects on the Xishuangbanna tropical mountainous region, SW China

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Continuous measurements of CO_2 concentration profiles, with varying heights, were created using a CO_2 profile instrument in the mountain valley of the Xishuangbanna tropical seasonal rainforest. After analyzing data over the course of one year, the study aims to validate the existence of the 'Carbon lake' phenomenon. Using the cluster analysis approach to classify the 'Carbon lake' phenomenon according to surface layer characteristics (0.5m) of CO_2 concentration diurnal variation, the results indicated that the 'Carbon lake' phenomenon could be found in mountainous areas. We divided the 'Carbon lake' phenomenon into two groups. Group 'A' (containing five types), represents the 'Carbon lake' phenomenon emergence, with a frequency of 51.8%, while group 'B' (containing three types), represents the absence of 'Carbon lake' appearance. When the 'Carbon lake' was removed, the peak value of CO_2 concentration appeared even. The intensity of the 'Carbon lake' was higher in the daytime than nighttime, and was higher during the rainy season than the dry season. The 'Carbon lake' phenomenon can be observed every month. The highest frequency record of 'Carbon lake' appeared in June, while the lowest frequency was in February. Variations of CO_2 concentration occurred primarily in the forest. Spatio-temporal variations of average CO_2 concentration in different distribution types have varying distribution characteristics and rules. These can have obvious impact on the carbon flux and carbon storage capacity of tropical rain forest. In summary, the effects produced by the 'Carbon lake' phenomenon have obvious impact on NEE. Likewise, the effect of the phenomenon on the tropical rain forest carbon source/sink cannot be ignored.

33. Soil organic carbon content and density in typical Peak-Karst landscape, southwest China

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To make an insight into soil organic carbon in typical Peak-Karst landscape, three typical landscapes were selected in southwest China: Peak-Cluster depression (PCD, ecological restoration site and nature reserve) and peak-forest valley (PFV). With a high-density sampling strategy (1308 surface samples and 92/760 soil profiles/samples), soil organic carbon content (SOCc) was analyzed among different land uses or coverage. Carbon density (SOCd) was calculated as a weighted average according to topography (slope or depression) or land uses (farmland, ecological recovered woodland/shrub/grassland or undisturbed woodland/shrub). Gravel content and bare-rock ratio was measured or estimated according to the sampling plots. An empirical model was built to estimate SOCd in 0-100 cm from 0-20 cm. Results showed that: 1, SOCc in soil profiles in natural reserve was the highest (P<0.01), followed by that in shrub in PFV, and in PCD secondary forest > shrub > plantation = grassland, upland was the lowest. 2, SOCd in PFV (8.11 kg m^{-2}) was higher than that in PCD (7.81 and 5.02 kg m^{-2} in natural reserve and restoration site respectively). In Peak-Karst landscape ecological restoration increased SOC content and density which indicated certain C sequestration potential. Method for SOC density was imprecise but acceptable for larger scale.

34. The influence of soil temperatures and soil moisture to soil respiration in different tropical forests of Xishuangbanna Southwest China

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The seasonal relationships between soil respiration and soil temperature and moisture in different land use types of tropical regions are not well studied. Information about the soil CO_2 efflux from these ecosystems is particularly scarce from southwest China, although it has been shown that soil respiration, temperature, soil moisture and their inter-relationships have strong seasonal dynamics there. We conducted a one-year *in-situ* study to investigate the seasonal dynamics of soil respiration rate (SR) and the seasonal relationships of SR with temperature and soil moisture in tropical seasonal rain forest (SRF), artificial economic species forest (*Hevea brasiliensis, Rauvolfia verticillata*, *Cinchona succirubra*, *Baccaurea ramiflora*, *Homalomena occulta*, *Amomum dealbatum*, ARF) and rubber plantation (RP) in Xishuangbanna, southwest China. The SR was measured by IRGA from Aug. 2005 to Aug. 2006, along with soil temperature at 10 cm depth (T10), 5 cm depth (T5), surface temperature (T0), soil respiration chamber temperature (Tcell), and soil volumetric water content (SWC). Results showed that: 1. SR in the three forests was relatively high during the rainy season, low in the fog-cool season and intermediate in the dry season, with significant seasonal different among forests ($p < 0.001$). 2. The seasonal dynamics of soil temperatures varied with depth (T10>T5>T0) under the three forests, and coincided with SR differences. However, within seasons, there were no obvious differences among forests in soil temperatures at the same depth. 3. The seasonal dynamics of SWC in all three forests were ranked rainy season > fog-cool season > dry season. In each season, SWC of SRF was the highest, RP was intermediate and ARF was the lowest. 4. Pearson correlations showed significant relationships between SR and soil temperature and moisture by season and forest type, and that the SR differences among forests were primarily related to variations in soil moisture content.We also modeled SR based on T5 and SWC in these three forests by season respectively which can explain the difference among forests and seasons. This study illustrates the seasonal patterns and how environmental factors influenced SR seasonal dynamics in these three forest types. In conclusion, soil CO_2 flux variations among forests and seasons were driven by environmental factors, and land-use change will alter soil carbon fluxes due to soil environment differences.

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Late Poster Abstracts

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35. The study of soil organic carbon stability in different soil types in Karst landscape, southwest China

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To get to the bottom of whether Karst landscape is carbon source or not,we select three soil types (typical red soil, terra fusca and rendzina) in southwest China for a test.The experiment soil is from topsoil in 0-15 cm.we found that pH in descending order is rendzina(8.2)> terra fusca (6.8)> typical red soil(4.1),and the same sequence as the content of calcium: rendzina(1.760%)> terra fusca (0.711%)> typical red soil(0.018%). Organic carbon in different soil types show that rendzina is the highest while typical red soil is the lowest one. Across to the correlation analysis between organic carbon and three different element(Ca,Fe,Mn) we can see R_{Ca}^2 =0.9788, R_{Fe}^2=0.8799, R_{Mn}^2=0.7825. Compared with Fe and Mn, Ca has the most correlation with organic carbon .It seems that calcium is helpful to Carbon fixation. And calcium is most likely to be the important role to reduce soil carbon release in Karst landscape.

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** S=speaker abstract; P=poster abstract*

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