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From leaf, soil & canopy to remote sensing & modelling
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Poster Abstracts

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P2018-1

Patterns and Controls of Soil CO_2/CH_4 Fluxes of the Representative Asian Terrestrial Ecosystems based on an Automated Chamber Network

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Asian terrestrial ecosystems occupy vast areas from tropical forests and wetlands in Southeast Asia to boreal ecosystems in northeast Asia, and from the humid coastal ecosystems to inland arid ecosystems, and as well as alpine ecosystems on the Mongolian and Tibet Plateau. These ecosystems make a significant contribution to the regional and global budgets of carbon dioxide (CO_2) and methane (CH_4). In particularly, monsoon Asia, influenced by the Tibeto-Himalayan Plateau, has sufficient rainfall and lack a subtropical dry belt. Thus, monsoon Asian forests have higher net primary production than other ecosystems at the same latitudes. Consequently, their high productivity leads to abundant SOC accumulation. However, the regional budgets of CO_2 and CH_4 in Asia and how these budgets will vary in the future remain highly uncertain with increasing population pressure, regional climate change, natural and human disturbances. Accurately quantifying CO_2/CH_4 balances is critical for setting targets for their emission reductions and to identify and promote effective mitigation strategies. Since the mid-1990s, we have been installing multichannel automated chamber systems at tundra in the West Siberian lowland, boreal forests in central Alaska, cool-temperate and temperate forests in Japan, Korea and China, subtropical forests in Japan, Mainland China and Taiwan, tropical seasonal forests in China and Thailand, tropical rainforests in China and Malaysia, and even arid grassland in Inner-Mongolia and wetland and permafrost ecosystem on the Tibetan Plateau (image), for continuous measurements of forest floor CO_2 budget as well as net ecosystem production (grassland and wetland). Among the sites, eight of the systems are using for conducting soil warming experiments. Currently, the chamber network is expanding rapidly in the Asian region. Our ultimate objective is to estimate the carbon budget of Asian terrestrial ecosystems as well as its response and feedback to regional climate change.

In recent years, with the rapid technical development of new sensors (e.g. CH_4 and N_2O analyzers), the chamber network is potentially applied for simultaneously measurement of major target GHGs (e.g. CO_2, CH_4, N_2O) budget together. For example, in a subtropical forest in Mt. Ailao in west China, the chamber system is also coupled with a CH_4 analyzer (UGGA, LGR) and ^{13}C/^{18}O analyzer (CCIA, LGR) for measuring soil CO_2/CH_4 fluxes and its isotopes. This talk will present soil CO_2/CH_4 fluxes and their controls of representative Asian terrestrial ecosystems.

P2018-2 Poster download (PDF)

New System for Fully Automated Low-Power Flux Measurements and Calculations

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Growing number of flux stations and networks, larger data streams from each station, and smaller operating budgets require modern tools to efficiently handle the process of flux measurements. These tools should produce standardized verifiable datasets, provide a way to cross-share the standardized data to leverage available funding, and promote data analyses and publications.

In late 2017, the new open-path automated system [1] was developed, based on established models [1,2,3], to simplify hardware configuration, to deploy most careful synchronization available to date [4], to significantly reduce power consumption and cost, and to prevent or considerably minimize flow distortion [5] in the anemometer.

Additionally, the new system incorporates complete automated on-site flux calculations using EddyPro® run by a weatherized remotely-accessible microcomputer providing standardized traceable datasets.

This presentation will describe details and results from the latest field tests of the new flux systems, in comparison to older models and control reference instruments.

References:

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5. Frank et al, 2016. All sonic anemometers need to correct for transducer and structural shadowing in their velocity measurements. JAOT(33)

P2018-3 Poster download (PDF)

Time- and Space-Synchronized Flux, Weather, Soil and Optical Sensor Networks

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Hundreds of flux stations are presently operating as standalone projects and as parts of regional networks. Many have weather and soil data to help clean, analyze and interpret the flux data. However, most do not have optical proximal sensor measurements, do not allow straightforward coupling with remote sensing (drone, aircraft, satellite, etc.) data, and cannot be easily used for validation of remotely sensed products, ecosystem modeling, or upscaling from the field to regional levels.

In 2016-2018, new tools to collect, process, analyze and share time-synchronized flux data from multiple flux stations were developed and deployed globally. Originally designed to automate site and data management and streamline flux data analysis, these tools allow relatively easy matching of tower data with remote sensing data.

Additionally, current flux stations can be augmented with advanced ground-based optical sensors and can use standard routines to deliver continuous products (e.g. SIF, PRI, NDVI, etc.) based on automated field spectrometers (e.g., FloX and RoX, etc.) and other optical systems.

Over 100 of new flux stations already operational globally can be readily used for the proposed workflow. Over 500 active traditional flux stations can be updated to synchronize their data with remote sensing measurements.

This presentation will show how the new tools are used by major networks, and describe how this approach can be utilized for matching remote sensing and tower data to aid in ground truthing, improve scientific interactions, and promote joint grant writing and other forms of collaboration between the flux and remote sensing communities.

P2018-4 Poster download (PDF)

New High-Precision Low-Power Low-Maintenance Closed-Path Analyzers for CO_2 and CH_4

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By 2017, a new lightweight high-precision closed-path technology was developed with the goal of allowing the WMO-quality measurements of CH_4, CO_2 and other gases with a time response of about 1 Hz or faster, the power consumption of about 15 W, with very minimal maintenance and calibration requirements, and with a relatively low cost.

In 2018, this technology resulted in the development of the first two new models of high-precision gas analyzers, for CH_4 and CO_2 respectively. Both models can enable the multitude of methods and approaches including the following:

Approaches relying on very high precision CH_4 concentrations, encompassing those often employed by WMO-GAW and EPA communities, such as a family of the Inverse Flux Methods, Lagrangian Modeling, Mass Balance Method, Fence-Line Monitoring, etc.

Micrometeorological tower methods relying on relatively slow but well-resolved CH_4 concentrations, such as Disjunct Eddy Covariance, Relaxed/Eddy Accumulation, Aerodynamic, Resistance, Integrated Horizontal Flux, Control Volume, Bowen Ratio, etc.

Eddy Covariance method from towers taller than about 10 m when long intake tubes are deployed.

Chamber Flux measurements, including both CH_4 and CO_2 from the same CH_4-CO_2-H_2O gas analyzer.

Distributed Sensors techniques being currently developed for Megacities and Green Cities projects.

Mobile monitoring, including measurements from various moving platforms.

This presentation will describe key instrument principles and elements of the design, and show first laboratory and field results on CH_4 and on CO_2 from a new high-precision low-power CH_4-CO_2-H_2O gas analyzer (e.g., LI-7810), and CO_2 results from a new high-precision low-power CO_2-H_2O analyzer (e.g., LI-7815).

P2018-5 Poster download (PDF)

ICOS Data Model to FAIR Information

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The **I**ntegrated **C**arbon **O**bservation **S**ystem (ICOS), is a pan-European research infrastructure for quantifying and understanding the greenhouse gas balance of Europe and its neighbouring regions. ICOS is collecting an immense amount of data covering a large variety of environmental parameters. At the Carbon Portal we aim to provide all data to the community, following the FAIR principles: **F**indable, **A**ccessible, **I**nteroperable, **R**eusable.

We present a holistic view how to model the data flow to address four main pillars to provide meaning, context and traceability. First a bespoke ICOS vocabulary / ontology is created to represent measurements and meta data for the research infrastructure but taking into account the specific aspects of three domains (ocean, ecosystems, and atmosphere). This will include people, institutions, location, funding bodies etc. Secondly special attention is paid to describe the hardware (instruments and sensors) and the applied conversion, configuration and translation to measure the physical phenomena to provide a long term provenance for raw data up to advanced data products. Thirdly we link the data in a generic way to other semantic standards for information exchange. This makes the collected data set future proof and long term usable. And finally the fourth pillar addresses the problem how different snap shots of data including configuration files, methods, calibration, hardware information etc., which may change over time, can be reproduced.

An implementation of a **U**niversally **U**nique **ID**entifier (UUID) with a **P**ersistent **ID**entifier (PID), like a digital object identifier, is used to ensure a long-term perspective of data reproduction for scientific publications. The combination of well defined ontologies and UUID system provides a tool for humans and machines to find and exchange data.

The model based on these four topics ensures that ICOS data complies to the FAIR Data Principles and provides a flexible and easy to use interface to share data and meta-data which is already collected and stored by the ICOS community.

P2018-6

Global retrieval and assessment of terrestrial solar-induced chlorophyll fluorescence from TanSat satellite measurements

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The advent of the first Chinese carbon satellite, Chinese Carbon Dioxide Observation Satellite Mission (TanSat, also termed CarbonSat) launched on December 21, 2016, is the first Chinese satellite as an Earth Observation project intended to the monitoring and detection of atmospheric carbon dioxide (CO_2). TanSat flies in a sun-synchronous, 700 km altitude orbit with a 13:30 ascending local time and a revisit period of 16 days. The Atmospheric Carbon dioxide Grating Spectraradiometer (ACGS), which uses the grating technique, is able to detect atmospheric O_2 and CO_2 absorption spectra in three narrow bands: near the O_2-A band, weak CO_2 band and strong CO_2 band. Although the primary purpose of the TanSat mission is to retrieve the atmosphere column-averaged CO_2 dry air mole fraction (XCO2), recent studies have also demonstrated that SIF can offer a new way for directly estimating the terrestrial gross primary production (GPP). The retrieval of solar-induced chlorophyll fluorescence on a global scale will been made possible due to the high spectral resolution measurements centered at 0.76 μm by the TanSat–ACGS spectrometer with a spectral resolution of 0.044 nm.

Here, a micro spectral window (~ 2 nm) covered Fe Fraunhofer line is used to explore the potential of TanSat for solar-induced chlorophyll fluorescence retrievals. The basic idea for this retrieval in this work is distinguishing the in-filling effect of Fraunhofer line by fluorescence.

The retrieval approach is based on the singular vector decomposition (SVD) statistical method to derive the fluorescence-free component in the solar radiance reflected by surface-atmosphere.

SVD is a method used to factor real or complex matrices. Similar to Principal Component Analysis (PCA), it invelves the eigendecomposition of a large set of observations of correlated variables into a smaller set of uncorrelated signals called singular vectors. Normally, the singular value decomposition of an m×n real or complex matrix.

One year available measurements are tested to produce the monthly gridded averages on the global scale. Some other remote sensing datasets are also used to validate the reliable of the fluorescence product derived in this work. An overall consistency of fluorescence intensity and spatial patterns of TanSat with OCO-2 fluorescence product on the global scale has been found in this work. And the high agreement between TanSat fluorescence retrievals and OCO-2 and other vegetation indices has consolidated the confidence of the potential and feasibility of TanSat fluorescence retrievals and opens the applications of TanSat measurements in the future scientific studies.

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P2018-7 Poster download (PDF)

Field evidences for the positive effects of aerosols on tree growth

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Theoretical and eddy-covariance studies demonstrate that aerosol-loading stimulates canopy photosynthesis, but field evidence for the aerosol effect on tree growth is limited. Here we measured in-situ daily stem growth rates of aspen trees under a wide range of aerosol-loading in China. The results showed that daily stem growth rates were positively correlated with aerosol-loading, even at exceptionally high aerosol levels. Using structural equation modelling analysis, we showed that variations in stem growth rates can be largely attributed to two environmental variables co-varying with aerosol loading: diffuse fraction of radiation and vapor pressure deficit (VPD). Furthermore, we found that these two factors influence stem growth by influencing photosynthesis from different parts of canopy. By using field observations and a mechanistic photosynthesis model, we demonstrate that photosynthetic rates of both sun and shade leaves increased under high aerosol-loading conditions but for different reasons. For sun leaves, the photosynthetic increase was primarily attributed to the concurrent lower VPD; for shade leaves, the positive aerosol effect was tightly connected with increased diffuse light. Overall, our study provides the first field-evidence of increased tree growth under high aerosol loading. We highlight the importance of understanding biophysical mechanisms of aerosol-meteorology interactions, and incorporating the different pathways of aerosol effects into earth system models to improve the prediction of large-scale aerosol impacts, and the associated vegetation-mediated climate feedbacks.

P2018-8 Poster download (PDF)

Upscaling solar-induced chlorophyll fluorescence from instantaneous to daily scale causes an improved correlation with gross primary productivity

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Solar-induced chlorophyll fluorescence (SIF) is closely linked to the plant's photosynthesis, and has the potential to estimate Gross Primary Production (GPP) at different temporal and spatial scales [1-4]. However, remotely sensed SIF at ground or space level is usually instantaneous, which cannot represent the daily total SIF. The temporal mismatch between instantaneous SIF and daily GPP will impact their correlations across space and time.

Previous studies upscaled the instantaneous SIF to daily scale based on the diurnal cycle of the cosine of solar zenith angle (cos(SZA)) to correct the effects of latitudes and length of days on the variations of SIF-GPP correlation [5,6]. However, the important effects of diurnal weather changes due to cloud and atmospheric scattering were not considered.

In this study, we presented a SIF upscaling method using photosynthetically active radiation (PAR) as a driving variable to correct the all these effects. A conversion factor, i.e. the ratio of the instantaneous PAR to daily PAR, was used to upscale instantaneous SIF to daily scale. With the continuous tower-based spectral and flux measurements at two sites, the performance of the SIF upscaling method was evaluated for changed weather conditions and different latitudes.

The results show that our PAR-based SIF upscaling method outperforms the cos(SZA)-based one for prediction of diurnal and daily SIF, with the decrease of relative root mean square error (RRMSE) from 26.8% to 13.3% at daily interval. Moreover, the PAR-based daily SIF had a stronger liner correlation with daily absorbed PAR (APAR) than either the instantaneous SIF or cos(SZA)-based daily SIF, especially for cloudy days. And for different latitudes, the variations of SIF-APAR correlation were largely reduced by SIF upscaling. At seasonal scale, the SIF-GPP correlations were obviously improved when using the PAR-based daily SIF instead of the instantaneous SIF or cos(SZA)-based daily SIF, with the increase of determination coefficient (R^2) from approximately 0.65 to 0.75.

Our study confirms the importance of upscaling SIF from instantaneous to daily scale when linking SIF with GPP and the necessary to take diurnal weather changes into account for SIF temporal upscaling.

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P2018-9

Using 6-year SMOS soil moisture data combining CO_2 flask samples to constrain carbon fluxes at 2o×2o global scale within CCDAS

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Biosphere carbon cycle is a very important part of global carbon budget due to its large sink and sensitivity to climate change. Terrestrial biosphere models have large uncertainty in estimating carbon fluxes, which impacts global carbon budget assessment. Land surface carbon cycle is tightly controlled by surface moisture through biological processes in plants. In this context, accurate and sufficient soil moisture data will improve modeling of carbon fluxes in a model-data fusion framework. In this respective, we employ the Carbon Cycle Data Assimilation System (CCDAS) to assimilate a 6-year SMOS L3 surface soil moisture product combining flask sites CO2 concentrations at global scale with fine resolution. We find that assimilation of SMOS soil moisture improves soil moisture performance a lot in regions where prior model simulation shows poor correlations with SMOS dataset, and at global scale shows better performance than the assimilation of CO2 concentrations. CO2 concentrations at flask sites from GlobalViewplus are simulated quite well by assimilation of SMOS soil moisture. Uncertainty is detected in modeling NEP and GPP in tropical and subtropical regions. Model shows quite good agreement of inter-annual variability in simulating NEP and GPP with independent datasets from atmospheric inversion and eddy covariance observations. In general, CCDAS obtains smaller annual mean NEP values (2.16 PgC/yr) than the atmospheric inversion and multiple Dynamic Global Vegetation Models (DGVMs), but larger GPP values (167.72 PgC/yr) than the upscaled eddy covariance dataset and the MODIS observations for the years 2010 to 2015. This study demonstrates the high potential of long-term soil moisture in constraining terrestrial biosphere carbon cycle with more reliable inter-annual variability. Appropriate development in model structure and utilization of more datasets in assimilation will be highly demanded for achieving a more reliable SMOS L4 carbon flux.

P2018-10

The effects of sun-viewer geometry on sun-induced fluorescence and its relationship with gross primary production

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Gross primary production (GPP) from photosynthesis by terrestrial vegetation is the largest sink of atmospheric CO2. It dominates inter-annual net biome productivity and contributes most to uncertainties in current global vegetation models and thus carbon cycle projections. Sun-induced chlorophyll fluorescence (SIF) has been shown a powerful proxy for photosynthetic activity and used to estimate GPP. However, both non-physiological and functional factors controlling the emission of canopy SIF. The non-physiological factors, especially the sun-viewer geometry, impact the relationships between SIF and GPP.

In this study, we did near-surface observations of both carbon flux and multi-view-angle spectra above a wheat canopy. The carbon flux was used to calculate GPP and the canopy spectra were used to retrieve red and far-red SIF. SIF observed at three view azimuth angles (i.e. 90º, 180º, 270º, defined from geodetic south), with view zenith angle same as solar zenith angle or 40º when solar zenith angle is bigger than that, are selected to analyze the effects of view angle on SIF observation.

Based on data obtained on a sunny day, the diurnal cycle of red SIF with different view azimuth angles shows larger variance than that of far-red SIF. In addition, red SIF is more correlated with the angle between sun and viewer than far-red SIF (R2=0.71, R2=0.63, respectively). These results indicate that red SIF is more sensitive to sun-viewer geometry. The relationships of red and far-red SIF with GPP are also changing with different view angles. Generally, SIF observed at 180º are more correlated to GPP than that at the other two angles. Furthermore, the closer to hotspot SIF observed, the closer correlation founded between SIF and GPP. These results suggest that effects of sun-viewer geometry on SIF observation need to be corrected for estimation of GPP.

P2018-11 Poster download (PDF)

Effects of sky conditions on net ecosystem productivity of a subtropical coniferous plantation vary from half-hourly to daily timescales

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The dynamic changes of solar radiation have received wide attention in global change studies, but there are controversies about the influence of diffuse radiation on ecosystem carbon sequestration. Using eddy covariance measurements from 2010 to 2012, effects of sky conditions extracted from adjacent sunny, cloudy, and overcast days on net ecosystem productivity (NEP) of a subtropical coniferous plantation were examined from half-hourly to daily scales. Half-hourly NEP responded to the changing radiation more efficiently on overcast days compared to sunny days, but such response did not differ obviously between cloudy and sunny days. Compared with sunny conditions, apparent quantum yield (α) under overcast (cloudy) conditions changed 282.4% (41.7%) in spring, 140.3% (–4.2%) in summer, 218.5% (38.9%) in autumn, and 146.2% (0.5%) in winter, respectively; annually, α under overcast (cloudy) conditions increased by 225.9% (19.8%) in 2010, 189.8% (6.0%) in 2011, and 159.5% (21.4%) in 2012, respectively. Moreover, the potential NEP at the light intensity of 150 and 750 W m-2 was improved due to increased diffuse fraction. However, both daytime and daily NEP were significantly lower under overcast skies than under sunny and cloudy skies. Compared with sunny days, daily NEP on overcast days decreased by 127.7% in spring, 126.4% in summer, 121.8% in autumn, and 100.6% in winter, respectively; annually, daily NEP decreased by 122.5% in 2010, 141.7% in 2011, and 109.9% in 2012, respectively. Diurnal patterns of daily NEP were quite similar between sunny and cloudy days. Both path analysis and multiple regression showed that solar radiation, especially diffuse radiation, was responsible for the variations of NEP under different skies across seasons, but this effect may be weakened by seasonal droughts. This study implies that the effects of sky conditions on NEP are timescale dependent and should be paid more attention in ecosystem carbon cycle study.

P2018-12

A New Way to Include Soil Water Stress in Terrestrial Ecosystem Models

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Abstract. To account for soil water stress, a scalar, fw is usually introduced into the BWB equation to reduce its slope. However, there is no experimental evidence that the use of this scalar in this way is justified. This study firstly quantifies the monthly and diurnal variations in canopy conductance from eddy covariance (EC) flux data at two flux tower sites (US-Var and CA-Oas) representing two plant functional types (grass and forest) by inverting the Penman-Monteith equation. Then, BWB slopes were derived and compared under contrasting water stress conditions by linear regression of canopy conductance and the GPP derived from EC measurements. Finally, the response of Vcmax to accumulated soil water deficit (ASWD) was explored to develop a better scheme of soil water stress in a coupled photosynthesis-conductance model. Our results show: (1) the thresholds of relatively available soil water content (RAW) under which soil water stress occurs were 0.61 and 0.65 for US-Var and CA-Oas sites, respectively, derived from a logistic function that is fitted to the observational data; (2) the difference between the BWB slope during wet periods and that during dry periods was not statistically significant, and this difference was much smaller than the inter-annual variations of BWB slopes, indicating that BWB slopes may be conservative under pronged drought; and (3) under prolonged drought, EC-derived GPP gradually decreased with the increase of ASWD, which can be well captured by a Vmr-ASWD scheme developed in this study. In sum, the Vmr-ASWD scheme would increase the accuracy of GPP simulations of ecosystem models. This study suggests that the use of the fw scalar is not justified according to the experimental data examined and adjusting Vcmax to account for the change in leaf physiology due to prolonged water stress is biologically meaningful and computationally feasible and efficient.

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P2018-13

Satellite chlorophyll fluorescence and soil moisture observations lead to advances in the predictive understanding of global terrestrial coupled carbon–water cycles

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The terrestrial carbon and water cycles are coupled through a multitude of connected processes among soil, roots, leaves, and the atmosphere. The strength and sensitivity of these couplings are not yet well known at the global scale, which contributes to uncertainty in predicting the terrestrial water and carbon budgets. We now have synchronous, global-scale satellite observations of critical terrestrial carbon and water cycle components: sun-induced chlorophyll fluorescence (SIF) and soil moisture. We used these observations within the framework of a global terrestrial biosphere model (Simplified Simple Biosphere Model version 2.0, SSiB2) to investigate carbon-water coupling processes. We updated SSiB2 to include a mechanistic representation of SIF and tested the sensitivity of model parameters to improve the simulation of both SIF and soil moisture with the ultimate objective of improving the first-order terrestrial carbon component, gross primary production (GPP). Although several vegetation parameters, such as leaf area index (LAI) and the green leaf fraction, improved the simulated SIF, and several soil parameters, such as hydraulic conductivity, improved simulated soil moisture, their effects were mainly limited to their respective cycles. One parameter emerged as the key coupler between the carbon and water cycles: the wilting point. Updates to the wilting point significantly improved the simulations for SIF and GPP. This study demonstrates the value of synchronous global measurements of the terrestrial carbon and water cycles in improving the understanding of coupled carbon-water cycles.

P2018-14

Asynchrony sensitivity of canopy and leaf chlorophyll fluorescence on water stress at wheat ecosystem

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Understanding of terrestrial carbon and water cycles is currently hampered by an uncertainty in how to capture the large variety of plant responses to drought. As a novel indicator of photosynthetic activity, chlorophyll fluorescence is intrinsically linked to photosynthetic machinery and could be used to research response of drought. In this study, we presented continuous ground measurements of SIF at 760 nm over nine plots of wheat under different soil moisture. To better understand vegetation response to seasonal drought dynamics, we further investigated the dynamics of SIF in different growth stages, Results showed that SIF responded to drought varied with the development of vegetation. In serious drought, daily SIF advanced to decrease compared to the other two drought level. Trends of SIF at canopy and leaf in the whole growing season showed inconsistency sensitivities. We expect the results of this work to provide new insights into the potential for remote sensing-based, real-time monitoring of the plant physiological response to water stress.

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P2018-15

A meta-analysis of open-path eddy covariance observations of apparent CO_2 flux in cold conditions in the FLUXNET network

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Open-path eddy covariance systems are widely used for measuring the CO2 flux between the land and the atmosphere. A common problem is that they often yield negative fluxes or physiologically unreasonable CO2 uptake fluxes in the non-growing season under cold conditions. In this study, we performed a meta-analysis of the eddy flux data from 64 FLUXNET sites and analyzed the relationship between the observed CO2 flux and the sensible heat flux, which has been found highly correlated in some sites. In theory, these two fluxes should be independent of each other in the cold conditions (air temperature lower than 0 °C) when photosynthesis is suppressed. However, our results show that a significant and negative linear relationship existed between these two fluxes at 37 of the sites. The mean linear slope value is −0.008 ± 0.001 μmol m−2 s−1 per W m−2 among the 64 sites analyzed. The slope value was not significantly different among the three gas analyzer models (LI-7500, LI-7500A, IRGASON/EC150) used at these sites, which means surface heating may not be the main reason (at least not the only reason) for the often-observed wintertime net CO2 uptake. These results suggest a systematic bias towards larger carbon uptakes in the FLUXNET sites that deploy open-path EC systems.

Keywords: Eddy flux; Self-heating; Spectroscopic effects; Air temperature; Absolute humidity; CO2 density

P2018-16 Poster download (PDF)

Revisiting North American Gross Primary Production Estimates: Bridging Gaps between Traditional Biosphere Models and Novel Observation-Oriented Approaches

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Recently, novel Earth observations, e.g. solar-induced chlorophyll fluorescence (SIF) and atmospheric carbonyl sulfide (COS), have been explored to constrain regional to global gross primary production (GPP) estimates. Here, we studied the convergence among novel observation-oriented approaches and traditional biosphere models for North American GPP estimates. We firstly investigated the spatiotemporal consistency between two SIF-based data sets (i.e. WECANN and GOPT), and then compared to light-use efficiency (LUE; including the Carnegie-Ames-Stanford Approach, the Vegetation Photosynthesis Model and the MOD17 algorithm), processes-based (PB; including 7 models from the TRENDY v5 project and BEPS model) and eddy flux upscaling models (i.e. FLUXCOM). As an independent reference, we also included our recent GPP estimate from atmospheric inversion of COS for comparison.

Produced using different approaches, the two SIF-based GPP data sets are quite consistent with each other in seasonal cycles, inter-annual variability, spatial distribution, and response to recent typical climate extremes. The magnitudes of continental GPP estimate from observation-oriented approaches, i.e. SIF-based, eddy flux upscaling and COS-based estimates, were reasonably consistent, while estimates by LUE models and PB models largely divergent. In terms of spatial pattern of GPP in peak growing seasons and response to extreme climate events, large disagreements existed in these traditional biosphere models, especially PB models. We further discussed the possible impacts of structural (e.g. leaf area index) and physiological (e.g. maximum carboxylation velocity, Vcmax) parameters on GPP simulations by PB models. In the future, improving the representativeness of those critical parameterizations is seriously needed to advance regional-to-continental GPP estimates and carbon-climate projections with PB models. To this end, assimilating more useful satellite observations into biosphere models, could be an effective way.

P2018-17

Atmospheric correction for tower-based solar-induced chlorophyll fluorescence observation

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The solar-induced chlorophyll fluorescence (SIF) has been proved to be an efficient indicator of vegetation photosynthesis. In recent years, a series of algorithms have been developed for SIF retrieval from ground-based, airborne and space-borne observations. The tower-based eddy covariance (EC) technique is widely used for the measurement of carbon flux at the ecosystem scale. To investigate the relationship between SIF and GPP, tower-based continuous spectral observations in coordination with the EC measurements are needed. For ground-based SIF retrieval, the mainly used bands are the telluric oxygen absorption bands, which are very sensitive to the atmospheric radiation transfer. Therefore, the atmospheric correction for tower-based SIF observation is important.

In this study, we analyzed the effects of atmospheric radiative transfer for both downwelling irradiance and upwelling radiance for tower-based SIF observation. The aerosol optical depth (AOD) and radiative transfer path length are found to be the main factors influencing the downwelling and upwelling transmittance at the oxygen absorption band. Therefore, a look-up table (LUT) was established to estimate the downwelling and upwelling transmittance using AOD and radiative transfer path length based on MODTRAN simulations with full-width at half maximum (FWHM) of 0.3 nm (same as the spectrometer we used). When the solar zenith angle (SZA) was fixed, the AOD was found to be related to the ratio between the irradiance at 790 nm and 660 nm (Eratio). Therefore, another LUT was built to estimate the AOD using SZA and Eratio.

A series of field measurements were carried out to evaluate the results of the atmospheric correction for tower-based SIF observation. Senescent maize canopy, which was expected with no SIF emission, was observed. For the raw observations without atmospheric correction, the retrieved SIF values were most negative and decreased apparently from dawn to noon, and increased from noon to dusk. After the atmospheric correction, the retrieved SIF values were much closer to zero. The results indicate that the atmospheric correction for tower-based SIF observation is efficient and necessary.

P2018-18 Poster download (PDF)

Responses of water use efficiency and ecosystem carbon exchange to nitrogen addition in Songnen meadow steppe

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Anthropogenic nitrogen inputs to terrestrial ecosystems has substantially increased over the past decades. The influences of N deposition on ecosystem carbon-water relationship are still unclear, especially in grassland characterized by saline-alkaline soil. In 2015, we established a N and P addition experiment including 6 N levels (0, 2.5, 5, 10, 20, 40g N m^{-2} yr^{-1}) and 3 P levels (0, 5, 10g P m^{-2} yr^{-1}) and their combinations in Songnen meadow steppe. Ecosystem carbon exchanges were measured for the 5 N addition treatments (0, 5, 10, 20, 40g N m^{-2} yr^{-1}) with P level at 10g P m^{-2} yr^{-1} from 2016 to 2018. Ecosystem carbon fluxes, ecosystem water use efficiency (WUE) and LAI, all displayed a nonlinear response to the increase in N addition rate. The seasonal dynamics of NEE, ER and GEP all followed a bell-like pattern, but timing of peak values differed among the three experimental years due to variation in seasonal precipitation distribution. The maximum values were observed at N input level of 10 g N m^{-2} yr^{-1}. The detected nonlinear responses may be attributed to shift in limiting resource from nitrogen to others, such as precipitation. Our results provide an experimental evidence that the responses of carbon fluxes and water use efficiency to nitrogen were in a nonlinear pattern, which is critical for better utilization of grassland resources. Future studies are needed to explore the response of carbon exchange and water use efficiency to long-term nitrogen addition and unravel the underlying mechanisms of improved rainfall and water use efficiency.

Key words: nitrogen addition, water use efficiency, ecosystem carbon exchange, meadow steppe

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P2018-19

Diurnal and seasonal patterns of methane fluxes and their controlling factors in an alpine meadow

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To quantify diurnal and seasonal patterns of the methane flux and investigate its controlling mechanisms, we observed net methane (CH4) flux in an alpine meadow by eddy covariance measurements, on the eastern Qinghai-Tibetan Plateau, China, during June 2015–November 2016.

There was an obvious diurnal dynamic characterized by “strong uptake during the nighttime and weak emission during the daytime” in the net CH4 flux in the growing season, whereas the diurnal variation of the CH4 flux in the non-growing season was relatively weaker. The diurnal variation of net CH4 flux was positively regulated by air temperature and gross primary productivity and also showed a significant quadratic polynomial relationship with net radiation, whereas the diurnal dynamics of CH4 flux in non-growing season was mainly positively controlled by air temperature. The net flux of CH4 also showed a clear seasonal dynamic, which was significantly higher in growing season than in non-growing season. The seasonal variation of CH4 flux was mostly due to the changes in temperature and solar radiation, indicating that higher temperature and radiation induced stronger uptake in the growing season.

Empirical equations using controlling factors at different time scale were modified to estimate net CH4 flux in the alpine meadow ecosystems.

Our results may contribute to the improvement of model parameterization for simulating biosphere-atmosphere CH4 exchange processes and for estimating the methane budget.

P2018-20 Poster download (PDF) 2nd Student Poster Award Winner

Applicability of an eddy covariance system based on close-path quantum cascade laser spectrometer for measuring nitrous oxide fluxes from subtropical vegetable fields

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Nitrous oxide (N_2O) is a very important greenhouse gas. Agricultural soils have been identified are the dominating source of anthropogenic N_2O emissions. However, there are significant uncertainties in the estimated N_2O emissions at both regional and global scales.

During the last two decades, with the rapid development in the application of fast response N_2O analyzers based on spectroscopic techniques, e.g. the quantum cascade laser (QCL) spectrometer, N_2O fluxes can now be measured by eddy covariance (EC) methods. As compared to the static chamber techniques, the EC technique has advantages of providing spatial averaged fluxes on field scale without disturbing the environment of the measured objects and also has continuous data coverage in time.

Soil of subtropical vegetable fields is an important source of the atmospheric greenhouse gas nitrous oxide (N_2O). However, few studies for the subtropical vegetable lands were carried out using the EC technique. Therefore, the aims of this study were to evaluate the applicability of the QCL-EC technique for measuring N_2O fluxes from the vegetable fields in the subtropical region of China, and investigate the characteristic of the N_2O emissions during the non-fertilization period and to assess flux uncertainties.

In this study we assembled an EC system linked to a close-path N_2O analyzer based on QCL spectrometer to measure N_2O fluxes from a vegetable field in the subtropical region of China. During the experimental period from October 9, 2014 to February 18, 2015, the detection limit of the EC system for half-hourly fluxes was estimated at 18.5 μg N m^{-2} h^{-1}, i.e. smaller than 97.5% of all measured fluxes. The random uncertainties in the half-hourly fluxes were estimated at 60% on average, of which 62% was due to stochastic variations caused by turbulence and 38% by instrumental noise. The flux systematic uncertainties were estimated at –18% on average, mainly due to the spectral attenuation.

In conclusion, the close-path QCL-based EC technique is capable of measuring the N_2O fluxes from the subtropical vegetable fields of China with high reliability and accuracy.

P2018-21

Quantify the influences of various meteorological factors on vapor isotope parameters in a maize field

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As global water cycle has been augmented by greenhouse effect, water vapor has been increasing among various ecosystems [1]. On the other hand, water vapor is a dominant greenhouse gas which consist of around 50% of the long-wave radiative forcing [2]. It is a meaningful to quantifying and elucidating the processes underlying the variability in atmospheric water vapor. Isotopic composition of atmospheric water vapor, consist with deuterium (D) and oxygen 18 (18O), represents a great opportunity to explore surface–atmosphere interactions, whose database have been extensively expand since the promotion of optical in suit vapor isotope observation [3]. A major challenge is thus to propose associated methodology for data acquisition and interpretation.

The aim of this work is to provide a relationship between near surface ambient water isotope parameters (18O, D and d-excess) and meteorological factors (temperature and humidity). To achieve our goal, 2 steps are taken: a. Research for the correlation between meteorological variables and the isotopic parameters of water vapor, and b. Set up a relationship between near surface ambient water isotope parameters and meteorological factors which is confirmed in step a, by means of isotopic partial least squares regression.

Isotopic compositions of 8 heights (canopy, 2m, 3m, 4m, 8m, 12m, 16m and 20m) background H2O (vapor) were observed at a 24-meter-high flux tower which was the central site of measurements and was located in the middle of maize field. D-excess had a more obvious diurnal variation than D and 18O, and all three isotope parameters were responded to meteorological factors. Temperature, relative humidity, wind speed, ET fluxes and vapor content had linear relationship significantly with isotope data, and a high VIP score (1.503) of relative humidity in isotope partial least squares regression. The rank of VIP scores was relative humidity > temperature > ET fluxes > wind speed > water vapor content.

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P2018-22 Poster download (PDF)

Impacts of natural restoration on carbon flux through atmosphere-plant-soil-cave at the Puding Karst Critical Zone Observatory

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Ecosystem based on carbonate bedrock named as “Karst” is fragile and sensitive to climate change for its unique hydrological and biogeochemical processes. The area of such ecosystem occupy about 15% of world’s waterless land and its’ influence on global carbon cycle is not completely clear. South China Karst centered at Guizhou is one of the largest karst distribution area which undergo strong biological activity and human activity. Since 1990 more than one third slope farmland has been returned to ecological restoration in Guizhou, but the process is little investigated for its’ carbon flux dynamic.

Here we report the results of an ongoing study focused on ecosystem carbon balance contain both aboveground and underground process at Puding Karst Research station. A slope corn farmland was abandoned to natural recovery at 2010 and the monitoring work was began at 2015. The carbon flux through each part of ecosystem were monitored simultaneously with an eddy covariance flux tower to observe ecosystem turbulent exchange, a LI-8150 Automated Soil Gas Flux System to observe soil respiration at 8 plots in the field, a LGR’s Carbon Dioxide Isotope Analyzer with 8 gas inlets to observe cave CO_2 dynamic.

Preliminary results show: First, the ecosystem presented as an obvious C sink during the April 2015 to March 2017 period, with an annual average Net Ecosystem CO_2 Exchange about 290 gCm^{-2}; Second, Although the precipitation varied greatly during the study period, Net Ecosystem CO_2 Exchange is almost stable as a result of comparably increased Gross Primary Productivity and Ecosystem Respiration, which may indicate the enhancement of ecosystem’s resilience due to ecological restoration; Third, cave CO_2 is mainly came from soil respiration and its concentration ranges from about 18000 ppm at autumn to about 2000 ppm at summer, therefore its role as a temporary carbon pool and passage cannot be ignored in karst area, and it’s contribution should be further quantified for local carbon balance.

P2018-23

Modeling water-heat transfer in Soil-Plant-Atmosphere Continuum with Plastic-Mulching

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Based on our previous work of modeling water-heat transfer in soil-plant-atmosphere continuum and crop growth (CropSPAC), the model was improved by coupling photosynthesis and stomatal in the growth of crop and considering the field film mulching effect and was applied on the field of maize in Northwest China. In CropSPAC, the single layer mode and multi-layer model are applied to simulate the energy participation in the canopy and water-heat movement in the soil respectively. Maize growth part includes photosynthesis, growth stage calculation, biomass accumulation and participation etc. CropSPAC model coupled maize growth module and SPAC water-heat transfer module by leaf area index, plant height and soil water stress coefficient. Among them, the leaf area index and plant height data were used as input data for the SPAC water-heat transfer module and SPAC module output soil water stress condition as the input data for maize growth. The objective of this study was to formulate and test the coupled model for crop growth under water deficit treatments with field plastic-mulching. The model was calibrated and validated by a field experiment conducted in Shiyanghe Experimental Station. Results show good agreement between the simulations and measurements of leaf area index, above-ground biomass, soil water content and soil temperature. In future, the model will provide a tool for interpreting the plant physiological processes to the soil water deficit and climate change.

P2018-24 Poster download (PDF)

Empirically Parameter Optimized MOD17A2H Gross Primary Production Over East Asia

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MODIS GPP is a representative global gross primary production product. The most recent version of collection 6 provides 8-day GPP at high spatial resolution of 500 m. Satellite-based MOD17 GPP algorithm is simple to use and useful to estimate terrestrial carbon absorption regularly using both input variables of vegetation-related indices, and meteorological data such as fAPAR, and air temperature and vapor pressure deficit. The algorithm is light use efficiency (LUE)-based model and the LUE is summarized in Biome Property Look-Up-Table (BPLUT) assigning each LUE to 11 kinds of vegetation type. However, the accuracy of MOD17 GPP is controversial especially in East Asia region (Kim et al., 2007) since the vegetation map of the algorithm is coarse to calculate GPP precisely due to the complex terrain of East Asia resulting in high heterogeneity of forests. Furthermore, the spatial resolutions of meteorological reanalysis data (~55 km) are larger than that of the vegetation map (500 m). For that, this study altered both MODIS vegetation map (MCD12Q1) and MERRA reanalysis data to the Finer Resolution Observation and Monitoring-Global Land Cover (FROM-GLC) which is Landsat-based 30 m land cover map (Yu et al., 2013) and JRA-55 (JMA), respectively. Objectives of this study are: i) to combine high- and mid-resolution vegetation map for editing LUEmax parameter in MOD17 GPP algorithm, ii) to optimize TMINmax and VPDmin parameters using 9 flux towers for improving MOD17A2H GPP product, and iii) to evaluate spatiotemporal patterns of improved GPP with other datasets. As the result, RMSEs between flux towers and MOD17A2H GPP, Optimized FROM-MCD (this study), BESS, and FLUXNET-MTE were 21.83, 16.73, 16.71, and 17.51 (gC/m2/8days), respectively. Process-based model, BESS, showed the highest accuracy and the second was shown in this study.

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P2018-25

Monitoring sun-induced chlorophyll fluorescence using a filter-based near-surface remote sensing system

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The emerging technique of remotely sensed sun-induced chlorophyll fluorescence (SIF) has advanced our ability to estimate plant photosynthetic activity at regional and global scales. Substantial efforts have been made to monitor SIF through satellite remote sensing, but continuous and long-term field observation data are still sparse. This is at least partly due to 1) lack of commercially available complete and proven ready-to-use systems and 2) challenges of sensor calibration and maintenance in the field in order to meet the strict requirements necessary for high-quality SIF retrieval. Here, we present the filter-based smart surface sensing system (4S-SIF) to overcome technical challenges of monitoring SiF in the field as well as to decrease sensor cost for more comprehensive spatial sampling. To monitor SIF, we combined ultra-narrow band pass filters and photodiode detectors to observe electromagnetic radiation at specific wavelengths (760nm, 756nm and 770nm). We verified the satisfactory spectral performance of the bandpass filters and confirmed that Digital Numbers (DN) from 4S-SIF exhibited linear relationships with the DN from the QEpro hyperspectral spectrometer in each filter band ($R2 > 0.90$). To verify that the 4S-SIF can actually detect the SIF signal, we installed the 4S-SIF in a rice paddy site also equipped with a QEpro spectrometer. To retrieve SIF from the 4S-SIF sensor, we are using the Fraunhofer Line Depth method with three bands (3FLD) combined with MODTRAN-based atmospheric correction. The current system will be operated throughout the year and we will investigate how SIF differs from NDVI and EVI during the senescence period. We believe that 4S-SIF will be a useful tool for collecting in-situ data across multiple spatial and temporal scales.

P2018-26

BESS-SIF: advances in global-scale process-based modelling of sun-induced chlorophyll fluorescence

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Sun-induced chlorophyll fluorescence (SIF) has been increasingly studied as potential proxy for terrestrial gross primary productivity (GPP). However, more research is needed to better understand the information contained in the SIF signal at large scales and the long term. Recently, several studies presented machine learning-based simulation of global multi-year SIF datasets at moderate spatial resolution. However, so far large scale process-based SIF simulation has been limited in several respects such as spatio-temporal resolution, temporal coverage and implementation of suitable simplified routines for important processes that still show satisfactory performance.

In order to overcome these limitations, we incorporated a SIF leaf module into the Breathing Earth System Simulator (BESS) and produced process-based, global-scale SIF maps for a decadal period at moderate spatial and daily temporal resolution. An important part of the calculation is the canopy scattering of far-red SIF based on a novel approach. We compared our product to available satellite SIF retrievals as well as machine learning-based datasets.

P2018-27

Quantifying CO_2, H_2O, and CH_4 fluxes over an intermittently- irrigated rice

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Rice is a dominant grain for over half of the world's populations. However, growing rice consumes a significant amount of water and emits CH4 fluxes. We present three years (May 2015 through April 2018) eddy covariance measurements of CO2, H2O and CH4 from an intermittently-irrigated paddy rice in South Korea. During the research years, without considering the amount of carbon harvested the rice paddy site acted as CO2 sink (- 38 (± 43) gC m-2yr-1) with 972 (± 120) gC m-2yr-1, 934 (± 108) gC m-2yr-1 for gross primary production (GPP) and ecosystem respiration, respectively. In the third year, however, the rice paddy site marginally acted as CO2 source (7 gC m-2yr-1). The rice paddy emitted 19 (± 1.5) gC m-2yr-1 of CH4, which is comparable to the other rice paddy sites in California, Italy, and India. Rice yield was 7.5(± 1.2) ton ha-1 which is two-fold of mean global rice yield. Evaporation was 655 (± 54) mm yr-1, with rapid increase after irrigation. Although maximum 20 days were different during the three irrigation/transplantation, the timings of increase in GPP were almost identical. This indicates earlier activities lead to unnecessary water loss via evaporation. The results highlight that an integrated management strategy is required to reduce CH4 emission, increase yield, and reduce evaporation loss.

P2018-28

Multi-angular observations of solar-induced chlorophyll fluorescence and its relation to gross primary productivity

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Solar-induced fluorescence (SIF) emitted from vegetation chloroplasts has been used as a novel proxy for the estimation of photosynthesis activity status and functioning, and significant relationships exit between SIF and terrestrial gross primary production (GPP) across diverse scales. The Orbiting Carbon Observatory-2 (OCO-2) provides the newest satellite-based SIF retrievals with high quality in recent years, which have been directly compared with the eddy covariance flux measurements with three observation modes (nadir, glint and target). Compared with nadir mode, the glint and target modes provide SIF with varying viewing zenith angle (VZA), which results in different ranges of SIF. This effect should be taken into account when we use and interpret SIF data. Therefore, it is important to assess the bi-directionality of SIF when using OCO-2 SIF data to evaluate the SIF-GPP relationship. Here, we present a multi-angular SIF effect with OCO-2 SIF data from three modes, we investigate the effects of angular response of SIF on the SIF-GPP relationship. Compared with nadir mode, the glint and target modes provide SIF with varying viewing zenith angle (VZA) for different observation date and location, which results in different ranges of SIF. This effect should be taken into account when we use and interpret SIF data.

P2018-29

Quantifying photosynthetic canopy structure and air pollution removal in the urban forested area by using seasonal bi-temporal terrestrial-LiDAR dataset

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Traditional ways to measure three dimensional canopy structures are usually time-consuming and labor-intensive. However, terrestrial LiDAR has emerged as a powerful technology to collect 3-D data. This research aims at distinguishing only leaves and quantifying the vertical distribution of leaves by using seasonal bi-temporal LiDAR data taken in the leaf-off season and leaf-on season.

We collected the LiDAR point cloud data of 29 Zelkova Serrata trees planted at two plots in the Experimental Forest of Seoul National University, Suwon, Korea (37°15'58.7"N 126°56'22.7"E), on March 22nd (leaf-off season) and August 30th (leaf-on season) using terrestrial LiDAR. The point cloud data of the trees' canopy was normalized by the 5 cm _voxel. Woody voxels were subtracted from the leaf-on data. DBH, crown width, tree height and crown height were also calculated from LiDAR data and were used together with climate data as input parameters to I-Tree model to simulate the air pollution removal by urban trees.

The vertically averaged volume occupied by the woody parts was 0.1±0.07m³ in plot A and 0.25±0.10 m³ in plot B. The vertically averaged volume occupied by the leafy parts was 0.22 ±0.16m³ at plot A and 0.33±0.14 m³ at plot B. The averaged removal of CO, O3, NO2 and SO2 at single tree level were 3.74±1.39g/yr, 42.67±15.92g/yr,38.67±14.43g/yr and 11.31±4.23g/yr at Plot A and 7.56±3.37g/yr, 88.99±39.45g/yr,81.34±36.10g/yr and 23.49±10.40g/yr at

P2018-30 1st Student Poster Award Winner

The influences of growth stages on the relationship of solar-induced chlorophyll fluorescence and canopy photosynthesis for maize from continuous ground measurements

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Remote sensing of solar-induced chlorophyll fluorescence (SIF) provides great potential to estimate Gross Primary Production (GPP) of terrestrial ecosystem. A significant relationship between SIF and GPP has been observed at seasonal scales with ground-based, airborne, and satellite observations. However, a mechanistic upstanding of relationship between SIF and GPP is still limited across multiple scales. It also remains unclear how this relationship varies with different plant growth stages, especially for C4 plants. In this study, seasonal variations of canopy SIF and its yield were investigated in relation to plant growth stages to infer its impact on the link to GPP. Ground continuous measurements were collected for canopy far-red SIF with an eddy-covariance flux tower during the 2017 growing season in a maize field. We found that SIF positively correlates with GPP but highly non-linear at half-hourly resolution for both sunny and cloudy days and linear at seasonal scales. Over the whole growing season, the relationship between SIF and GPP varies with different crop growth stages for maize. This result indicates that crop growth stage has strong impacts on the seasonal variations of canopy SIF and its relation to GPP. The results also showed that SIF better correlates with absorbed photosynthetically active radiation (APAR) (R2=0.78) by chlorophyll than APAR by canopy (R2=0.67). SIFyield (SIF/APAR) is significantly positively correlated with LUE (GPP/APAR) at both diurnal and seasonal time scales under sunny days but weaker in cloudy days. Our observation-based findings help strengthen our understanding on the mechanistic link between canopy SIF and photosynthesis.

P2018-31

A comparison of single-tree AGB estimation derived from traditional methods and terrestrial LIDAR-based methods

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Trees play important roles in cycling carbon. Accurate tree biomass measurements are necessary to quantify carbon stocks, which usually means to quantify the volume of trees. Conventionally, tree volume was usually estimated from allometric relationships. Traditional methods are labor intensive and time consuming and sometimes destructive. Now, terrestrial LiDAR has emerged as a powerful tool to quantify three dimensional canopy structures accurately and efficiently. And tree biomass was successfully calculated from LiDAR data using voxel-based method.

Therefore, the objective of this research is to compare the biomass derived from the allometric functions and LiDAR-based methods.

We mainly studied Zelkova Serrata trees and Prunus serrulata var.spontanea trees planted in the campus of Seoul National University, Republic of Korea since these two species are popular landscape trees of Republic of Korea. The LiDAR data of 30 Zelkova Serrata trees and 20 Prunus serrulata var. spontanea trees was collected in March and June respectively to calculate the biomass of trees in leaf-off season and leaf-on season. Finally, the volume of each tree was calculated from LiDAR data using voxel-based method and from traditional ways and the comparison of the two methods were conducted. Finally, results calculated from all these methods were compared and analyzed comprehensively according to tree species, age, time of data collection and data analysis methods.

P2018-32

Continuous measurement of soil CO_2, CH_4 and N_2O fluxes in a temperate mixed forest in Changbai Mountain

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By the method of continuous measurement with rapid gas analyzers (907-0010 and 907-0014, Los Gatos Research), the flux of soil CO2, CH4 and N2O were measured in situ and continuously from September 2014 in a temperate mixed forest in Changbai Mountain (CBM). Soil temperature (Ts) and soil moisture (Sw) (CS655, Campbell Scientific) were also measured from September 2015, aimed to study the characteristics of the fluxes of soil CO2, CH4 and N2O in response to environmental factors. The thawing period has drawn attention to the huge soil N2O emission at CBM. Soil N2O fluxes was positive with Ts during the non-thawing period, and a rush-out of soil N2O flux was observed during the beginning of spring. While soil flux was generally related exponentially with Ts and soil CH4 flux was negative with Ts. Soil CO2, CH4 and N2O fluxes showed apparent seasonal variations. Comparison experiments of some common methods in soil respiration measurements were also carried out, such as static chamber-gas chromatography method and Li 8100. Continuous measurement will provide more support to understand the responses of soil processes to the rapid changing environment.

P2018-33

Greenhouse gas fluxes in a created wetland in Southern Finland

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Many wetlands have experienced drainage due to urbanization, agriculture, forestry or other purposes, which has resulted in losing their ecosystem services. To protect receiving waters and to achieve services such as flood control and water quality mitigation, new wetlands are created in urbanized areas. However, our knowledge of greenhouse gas (GHG) exchange in newly created wetlands in urban areas is currently limited. Wetting a landscape may enhance the carbon dioxide (CO2) sequestration in the ecosystem, whereas substantial amount of methane (CH4), a more potent GHG, can be emitted due to the anaerobic condition in the soil after wetting.

We conducted measurements of CO2 flux (NEE) and CH4 flux (FCH4) in a created stormwater wetland in Nummela, Vihti, Southern Finland using eddy covariance (EC) technique during one full year and two subsequent growing seasons. The created wetland comprises both open water and vegetated area, the footprint-weighted surface areas of which are 37.4% and 57.5%, respectively. Artificial Neural Network (ANN) was applied to fill the gaps of EC dataset, showing the networks including CO2 and CH4 concentration in the open water had the best correlations with the observations. Results showed the created wetland was carbon neutral, with NEE being 0.89 g C-CO2 m-2 yr-1 and FCH4 equals to 3.23 g C-CH4 m-2 yr-1. The ecosystem sequestered CO2 during summer months (June-August), while the rest of year it was CO2 source. For both years, the highest ecosystem carbon sequestration appeared in June (from -84.1 to -97.7 C-CO2 m-2 month-1). CH4 displayed strong seasonal dynamics, with the highest peak in the end of May and a smaller peak in August. Annual open-water CO2 and CH4 diffusion fluxes was 385 g C-CO2 m-2 yr-1 and 1.73 g C-CH4 m-2 yr-1. Seasonality was minor for open-water CO2 flux, whereas open-water CH4 flux had the same peak as ecosystem CH4 flux observed by EC tower. Consequently, CO2 flux from vegetated area was -248.9 C-CO2 m-2 yr-1. These results demonstrate a minor CH4 emission in the created wetland and a clear effect of CO2 emission from open water which offsets CO2 sequestration by the established vegetation after wetland creation.

P2018-34

A Spatial Hierarchical Integration That Assimilates UAV/Satellite Remote Sensing, Physiology And Growth To Capture And Interpret Spatiotemporal Variations Of Agroecosystem Photosynthetic Productivity

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Over the past five years from 2013 to now, my research primarily focuses on better understanding of ecophysiological mechanisms underlying observed spatiotemporal variations of agroecosystem photosynthetic productivity (gross primarily productivity, GPP) in typical catchments of East-Asia countries. To elucidate the ecological phenomena, measurements at multiple spatial scales (leaf, canopy, field, and landscape) and at multiple temporal scales (hourly, daily, seasonal) were carried out to record data using advanced technologies including GFS3000, customized chamber system, UAV and satellite remote sensing systems. Several important findings and conclusions were arrived as following,

We analyzed effects of biological factors. At leaf level data documented that consider growth environment-induced differences in temperature responses of photosynthetic parameters among cereal crops is indispensable. C3 photosynthesis model lack of considersing gm can not always well track diurnal gas exchange rates. At canopy level, data highlighted multidimensional coordinated structural and physiological adjustments governing GPP over the course of rice crop development. Occurrence of drought spells strengthened spatial variations (SVs) of ecosystem GPP due to compression of photosynthetic physiology. Nevertheless, under none-stressed conditions SVs of the GPP were likely related to leaf area index development. From perspective of land use type and water/fertilizer management, staggered phenology of different crops wherein maximum GPP appeared resulted in extended period of high CO2 uptake. Water management does not necessarily exert greater impacts in strengthening SVs of the GPP as compared to fertilizer management. From viewpoint of climate change, ecosystem photosynthetic productivity is vulnerable to temperature increasing, but its fluctuations across growing seasons are profoundly mediated by radiation intensity. The important regulating implication of radiation intensity changes is attributed to the structure dependent light sensitivity of canopy photosynthesis at the reproductive stage.

See more information here: http://lifesc.lzu.edu.cn/fh/201807/2221.html (xuewei@lzu.edu.cn)

P2018-35

Mesophyll Conductance Limitation of Photosynthesis in Poplar Under Elevated Ozone

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Finite mesophyll conductance (gm) reduces the rate of CO2 diffusion from the leaf intercellular space to the chloroplast and constitutes a major limitation of photosynthesis in trees. While it is well established that gm is decreased by stressors such as drought and high temperature, few studies have investigated if the phytotoxic air pollutant ozone (O3) affects gm. We quantified the relative importance of three different types of limitations of photosynthesis in poplar trees exposed to elevated O3: decreases in stomatal conductance, gm and biochemical photosynthetic capacity. The O3-induced reductions in light-saturated net photosynthesis were linked to significant declines in gm and biochemical photosynthetic capacity (in particular carboxylation). There was no significant effect of O3 on stomatal conductance. Of the O3-induced limitations on photosynthesis, gm limitation was by far the most important (–16%) while biochemical limitation (–8%) was rather small. Both limitations grew in magnitude over the study period and varied in response to leaf-specific O3 exposure. Our findings suggest that declines in gm may play a key role in limiting photosynthesis of plants exposed to elevated O3, an effect hitherto overlooked.

P2018-36

Temporal variation of ecosystem scale methane emission from a boreal fen in relation to common model drivers

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Models for calculating methane emission from wetland ecosystems typically relate the methane emission to carbon dioxide assimilation. Other parameters that control emission in these models are e.g. peat temperature and water table position. Many of these relations are derived from spatial variation between chamber measurements by space-for-time approach.

Continuous longer term ecosystem scale methane emission measurements by eddy covariance method provide us independent data to assess the validity of the relations derived by space-for-time approach. We have analyzed eleven-year methane flux data-set, measured at a boreal fen, together with data on environmental parameters and carbon dioxide exchange to assess the relations to typical model drivers. The data was obtained by the eddy covariance method at Siikaneva mire complex, Southern Finland, during 2005-2015.

The methane flux showed seasonal cycles in methane emission, with strongest correlation with peat temperature at 35 cm depth. The temperature relation was exponential throughout the whole peat temperature range of 0-16°C. The methane emission normalized to remove temperature dependence showed a non-monotonous relation on water table and positive correlation with gross primary production (GPP). However, inclusion of these as explaining variables improved algorithm-measurement correlation only slightly, with r2=0.74 for exponential temperature dependent algorithm, r2=0.76 for temperature – water table algorithm, and r2=0.79 for temperature – GPP algorithm. The methane emission lagged behind net ecosystem exchange (NEE) and GPP by two to three weeks.

Annual methane emission ranged from 8.3 to 14 gC m-2, and was 20 % of NEE and 2.8 % of GPP. The inter-annual variation of methane emission was of similar magnitude as that of GPP and ecosystem respiration (Reco), but much smaller than that of NEE. The interannual variability of June-September average methane emission correlated significantly with that of GPP indicating a close link between these two processes in boreal fen ecosystems.

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Analysis on inter-annual variability of CO2 exchange in Arctic tundra: a model-data approach

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The climate sensitivity of carbon (C) cycling in Arctic terrestrial ecosystems is a major unknown in the Earth system. There is a lack of knowledge about the mechanisms that drive the interactions between photosynthesis, respiration and changes in C stocks across full annual cycles in Arctic tundra. Here we report the independent predictions of net ecosystem exchange (NEE), gross primary production (GPP) and ecosystem respiration (Reco) calculated from the soil-plant-atmosphere (SPA) model across eight full annual cycles. SPA's carbon flux estimates are validated with observational data obtained from the Greenland Ecosystem Monitoring programme in West Greenland tundra (64° N). Overall, the model explained 73%, 73% and 50% of the variance in NEE, GPP and Reco respectively and 85% of the plant greenness variation. Flux data highlighted the insensitivity of growing season NEE to inter-annual meteorological variability, due to compensatory responses of photosynthesis and ecosystem respiration (López-Blanco et al., 2017). In this modelling study, we show that this NEE buffering is the case also for full annual cycles. We show through a sensitivity analysis that plant traits related to nitrogen are likely key determinants in the compensatory response, through simulated links to photosynthesis and plant respiration. Interestingly, we found a similar temperature sensitivity of the trait-flux couplings for GPP and Reco, suggesting that plant traits drive the stabilization of NEE. Further, model analysis indicated that wintertime periods decreased the C sink by 60%, mostly driven by litter heterotrophic respiration. This result emphasizes the importance of wintertime periods and allows a more comprehensive understanding of full annual C dynamics.

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P2018-38 Poster download (PDF)

Evaluation of terrestrial pan-Arctic carbon cycling using a data-assimilation system

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There is a significant knowledge gap in the current state of the terrestrial carbon (C) budget. The Arctic accounts for approximately 50% of the global soil organic C stock, emphasizing the important role of Arctic regions in the global C cycle. Recent studies have pointed to the poor understanding of C pools turnover, although remain unclear as to whether productivity or biomass dominate the biases. Here, we use an improved version of the CARDAMOM data-assimilation system, to produce pan-Arctic terrestrial C-related variables without using traditional plant functional type or steady-state assumptions. Our approach integrates a range of data (soil organic C, leaf area index, biomass, and climate) to determine the most likely state of the high latitude C cycle at a 1° x 1° resolution for the first 15 years of the 21st century, but also to provide general guidance about the controlling biases in the turnover dynamics. As average, CARDAMOM estimates 513 (456, 579), 245 (208, 290) and 204 (109, 427) g C m-2 yr-1 (90% confidence interval) from photosynthesis, autotrophic and heterotrophic respiration respectively, suggesting that the pan-Arctic region acted as a likely sink -55 (-152, 157) g C m-2 yr-1, weaker in tundra and stronger in taiga, but our confidence intervals remain large (and so the region could be a source of C). In general, we find a good agreement between CARDAMOM and different sources of assimilated and independent data at both pan-Arctic and local scale. Using CARDAMOM as a benchmarking tool for global vegetation models (GVM), we also conclude that turnover time of vegetation C is weakly simulated in vegetation models and is a major component of error in their forecasts. Our findings highlight that GVM modellers need to focus on the vegetation C stocks dynamics, but also their respiratory losses, to improve our process-based understanding of internal C cycle dynamics in the Arctic.

P2018-39

Joint structural and physiological control on the interannual variation in productivity in a temperate grassland: A data-model comparison

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Given the important contributions of semiarid region to global land carbon cycle, accurate modeling of the interannual variability (IAV) of terrestrial gross primary productivity (GPP) is important but remains challenging. By decomposing GPP into leaf area index (LAI) and photosynthesis per leaf area (i.e., GPP_leaf), we investigated the IAV of GPP and the mechanisms responsible in a temperate grassland of northwestern China. We further assessed six ecosystem models for their capabilities in reproducing the observed IAV of GPP in a temperate grassland from 2004 to 2011 in China. We observed that the responses to LAI and GPP_leaf to soil water significantly contributed to IAV of GPP at the grassland ecosystem. Two of six models with prescribed LAI simulated of the observed IAV of GPP quite well, but still underestimated the variance of GPP_leaf, therefore the variance of GPP. In comparison, simulated pattern by the other four models with prognostic LAI differed significantly from the observed IAV of GPP. Only some models with prognostic LAI can capture the observed sharp decline of GPP in drought years. Further analysis indicated that accurately representing the responses of GPP_leaf and leaf stomatal conductance to soil moisture are critical for the models to reproduce the observed IAV of GPP_leaf. Our framework also identified that the contributions of LAI and GPP_leaf to the observed IAV of GPP were relatively independent. We conclude that our framework of decomposing GPP into LAI and GPP_leaf has a significant potential for facilitating future model intercomparison, benchmarking and optimization should be adopted for future data-model comparisons.

P2018-40

Modeling soil GHG emission from Changbai Mountain forest ecosystem by Forest-DNDC

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CO2, CH4 and N2O, the three greenhouse gases (GHGs) have increased in the atmosphere since pre-industrial times, and this increase is the main driving cause of climate change. Soil respiration is an important path for the three GHGs exchange between soil and atmosphere, but the process and the sensitivity of soil respiration are poorly known.

This study adopted a biogeochemical model (Forest-DNDC) combined with automatic flux observation system, which aimed to estimate the soil GHGs emissions in Changbai mountian forest ecosystem and to validate this model against observation data, and then to analyze the response of the CO2 emissions by the environment factors (e.g. soil temperature and moisture).

The results show that the Forest-DNDC performed satisfactorily in modeling soil temperature and moisture. The simulated CO2 flux presents a seasonal change and fits well with the observed CO2 flux at daily scale. The simulated CH4 annual cumulative emissions is close to the observed result, but the simulated N2O flux fits poor, mainly affected by the poorly model result of snowpack.

This study trys to quantify the effects of environmental and biological factors on soil GHGs emissions and to estimate the application of soil GHGs emissions in regional situations.

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P2018-41

Ecosystem Succession Alters the Climate Feedback of Greenhouse Gas Emissions under Climate Change

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Projecting biosphere carbon cycle-climate feedback is crucial for setting greenhouse gas (GHG) emission goals that limit climate warming. Ecosystem succession may contribute to large uncertainty in the feedback projection; however, few studies have evaluated its impact. Here, using space-for-time substitution approach, we conducted an in situ GHG flux observation combined with a process-based model to explore how the characteristics, controls and climate impacts of GHG emissions respond to ecosystem succession. Our five-year monitoring showed that annual CO2 and CH4 budgets were 3.3 and 28.0 g C m-2 at wetland, 91.8 and 3.5 g C m-2 at wet meadow, and -114.7 and -0.3 g C m-2 at mesic meadow, respectivity. The changes in CO2 flux were explained by that of soil aeration, soil temperature, and species composition; while CH4 flux varied in a manner corresponding to shifts in abundance of sedge plants and methanogenic archaeal groups. Modeling results showed GHG emissions would produce smaller (decreased by 3.7~49.9%) and larger warming effects (increased by 36.7~4848%) on climate system under “drying and wetting succession” scenarios on a 100-year time horizon, respectively, than expected from current Earth system model assumption that no ecosystem succession occurs. Our study suggests that ecosystem succession can lead to divergent carbon-cycle-climate feedbacks under climate change.

P2018-42

Global Methane(CH4) Emissions Assessment by Simulation

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The three greenhouse gases, CO2, CH4 and N2O, are the atmospheric components that have the greatest impact on global warming. CH4 contributes 20% of the greenhouse effect, while CH4 emissions and air content are small, but its warming potential is much larger than CO2, and its 100-year warming potential is 23 times that of CO2.

CH4 is widely distributed in nature. According to experiments conducted by scientists at the German Institute of Nuclear Physics, both plants and leaves produce methane, and the amount of production increases with temperature and sunshine. In addition, plants produce 10 to 100 times more methane than decaying plants. They have estimated that the annual methane produced by plants accounts for 10% to 30% of the world's methane production.

Studies have shown that at the beginning of the 21st century, the concentration of methane in the atmosphere stagnated, and the greenhouse effect followed the same pattern; however, since 2007, when the concentration of methane began to rise, the greenhouse effect caused by it also rose.

Numerical models are widely used as an important means of assessing CH4 production and emissions. The Community Land Model is one of many land surface models that not only used to simulate and estimate global CH4 flux, but also calculate the natural emissions of various ecosystem organisms. The data used in this paper are methane flux grid data simulated by CLM4.5, including methane fluxes into the atmosphere, CH4 emissions from submerged areas and non-submerged areas. In order to assess global emissions, each grid is considered as a small rectangle. Global total is calculated by grid integration.

P2018-43

Carbon flux patterns of a tea plantation on the Southeast China

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Tea plantation is widely distributed and continuous expanded in subtropical China in recent years. However, Carbon exchange from tea plantation ecosystems is poorly understood at the ecosystem level. In this study, we use the eddy covariance technique to quantify the magnitude and temporal variations of the net ecosystem exchange (NEE) of tea plantation from 2014 to 2017, Southeast China. the mean annual NEE was -222.76 g C m-2, which is much lower than that of other ecosystems in subtropical China. Intense pruning interference during April decreased the daytime photosynthesis and providing large substrate for respiration, which caused the ER/GPP ratio greater than 1 fromApril to June. The results provide quantitative information for the carbon balance in tea plantation under subtropical conditions. And the impact of tea plantation expandation on regional carbon dynamic should not be ignored.

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P2018-44

Analysis of the effects of aerosols on radiation and precipitation in the Yangtze river delta region from 2004 to 2014

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The Yangtze River Delta is an important intersection zone between “the Belt and Road Initiatives”and the Yangtze River Economic Belt. It is an important grain-producing area and also one of the areas with high atmospheric aerosol concentration in China. The analysis of aerosols' impacts on radiation and precipitation in the Yangtze river delta region is of great significance for guiding agricultural production, controlling regional haze and adjusting industrial distribution. In this work, using MODIS08 products from National Aeronautics and Space Administration (NASA), the aerosol chemical composition reanalysis data from The Modern-Era Retrospective analysis for Research and Applications (MERRA-2), and the radiation and precipitation reanalysis data from European Centre for Medium-Range Weather Forecasts (ECMWF), the temporal and spatial variation characteristics of AOD, radiation and precipitation in Yangtze river delta region from 2004 to 2014 are analyzed, and the seasons in which radiation and precipitation are significantly influenced by aerosols and aerosol components which have the greatest influence on radiation and precipitation are determined. It is found that AOD showed an obvious increasing trend in spring and summer during 2004-2008. At the same time, surface net solar radiation (SSR) increased significantly in spring and decreased significantly in summer and total precipitation (tp) increased significantly in summer and decreased significantly in winter. AOD decreased significantly in the autumn of 2009-2014. In spring radiation is most influenced by dust_pm25 and the precipitation is most influenced by dust_coarse ; In summer radiation is most influenced by seasalt_pm25 , and precipitation is most influenced by dust_pm25; In winter precipitation is most influenced by dust_coarse. In addition, the influence of human-made aerosols such as sulfate and black carbon can not be ignored.

Key words: AOD (aerosol optical depth) radiation precipitation

P2018-45

Evaluating High Time-resolved Changes in δ13C and Efflux Rate of Branch, Stem and Soil Respiration Based on Isotope Ratio Infrared Spectroscopy

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Fractionation during dark respiration and rapid dynamics in isotope signatures of leaf- and ecosystem-respired CO2 indicate the need for new methods for high time-resolved measurements of the isotopic signature of respired CO2. We present a non-steady-state chamber system method for online measurements of δ13C and efflux rate of branch, stem and soil respiration based on isotope ratio infrared spectroscopy (OA-ICOS). To assess the reliability of the system, a simulative generator was designed to mimic a emitting CO2 from its surface for the purpose of testing the branch, stem and soil chambers response to known CO2 efflux rates. The calibration system includes mixed gas (CO2/CH4/N2O) cylinder, compression release valve, three-way solenoid valve, high precision injection pump and CO2 simulate flux equipment. The measured values were similar with true values, which were 13.04, 33.57, 55.18 and 14.27, 35.71, 57.17 μmol m-2 s-1 for the flow rate of mixed gas (99% CO2) of 0.2, 0.5 and 0.8 ml min-1 respectively. In the field, we selected three similar trees (masson pine) to install branch, stem and soil chambers. Three different calibration gases with known CO2 concentration and δ13C value were used to calibrate the respired CO2. The isotope ratio infrared spectroscopy (OA-ICOS) can measure theδ13C value with 1 Hz. The switching time among different calibration gases and chambers was less than 100s with the whole observation time of 300s. The non-steady-state chamber system method enables both high time-resolved analysis and in-situ measurement across branch, stem and soil respiration.

P2018-46 Poster download (PDF) 2nd Student Poster Award Winner

Evaluating spatial and temporal patterns of multi-scale satellite NDVI products against in-situ spectral datasets

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Medium/high-resolution satellite image derived NDVI has been used to understand how vegetation responds to environmental variables and climate. However, a few studies tested spatial and temporal patterns of NDVI from different satellite remote sensing products against field measurements. Here we collected spectral data across a 250 by 250 m rice paddy landscape during the whole growing season in 2017. Total 60 elementary sampling units (ESU) were established where each ESU covers 10m x 10m, 4 ESUs cover 30m x 30m, and 60 ESUs cover 250m x 250m. With these datasets, we evaluated Sentinel-2A/B, Landsat-8, and MODIS Terra/Aqua NDVI products at multiple spatial and temporal scales. We found that all satellite NDVI products could capture the seasonal pattern and spatial variations, and showed tight linear relationship to in-situ NDVI dataset. However, all satellite NDVIs appear negatively biased up to 16% (Sentinel-2A/B). We expect this high spatial-temporal resolution ground NDVI datasets will serve as reference dataset to evaluate the medium/high-resolution satellite products.

P2018-47

Estimating crop primary productivity with Sentinel-2 and Landsat 8 using machine learning methods trained with radiative transfer simulations

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Monitoring spatio-temporal changes in terrestrial gross primary productivity (GPP) of crops is key for understanding, estimating and predicting global carbon fluxes. Satellite remote sensing has been widely applied in the last decades to monitor agricultural resources, and the amount and quality of remote sensing data continuously increase. Since recently, and partly due the European Copernicus Programme, an unprecedented amount of open access data suitable for agriculture observations is now available. Benefiting from recent developments in satellite remote sensing technology, great advances in machine learning and advancements in our understanding of photosynthetic processes leading to increasingly complex and detailed photosynthesis models, we developed a hybrid approach to model GPP using satellite reflectance data by combining radiative transfer modeling and machine learning (ML).

We have combined process-based model SCOPE with ML algorithms to estimate GPP of C3 crops using satellite data (Sentinel-2 and Landsat 8) and ancillary meteorological information. We link reflectance and meteorological data directly with crop GPP, bypassing the need of retrieving the set of input vegetation parameters needed to represent photosynthesis in an intermediate step, while still accounting for the complex processes of the original model.

Several ML models, trained with the simulated data, were tested and validated using flux tower data. First, we tested our approach using Sentinel-2 data, which provide high frequency of observation, high spatial resolution of 20 m and multiple bands including red edge. Our final neural network model was able to estimate GPP at the tested flux towers with r2 of 0.92 and RMSE=1.38 gC m-2d-1. Our model successfully estimated GPP across a variety of C3 crop types and environmental conditions, including periods of no vegetation, even tough it did not use any additional local information from the site. Since our learning approach is fast and efficient in the test phase and, at the same time, is based on a process-based model (and not on local empirical relationships), it can be applied globally. Furthermore, the simulated training dataset can be easily adapted to band settings of different instruments, assuring thus consistency among many sensors. However, such a global application requires high computational power and therefore we used Google Earth Engine (GEE) platform, which provides cloud computing resources for processing large geospatial datasets, to apply our approach to Landsat 8 data.

P2018-48

Towards a ground network of FloX systems

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In recent years the large interest arose for the study of sun induced Chlorophyll Fluorescence (SIF), due to its potential of investigating passively and remotely plant physiology. Nevertheless, SIF measurements are not trivial and require sophisticated technology and analysis techniques. The Fluorescence Box (FloX), manufactured by JB-Hyperspectral Devices is an automated field spectroscopy device capable of collecting unattended hyperspectral measurements and specifically designed to passively measure SIF. It has proven as a standard for continuous and long terms measurements of SIF. Currently, FloX systems are monitoring a variety of ecosystems (ranging from croplands to boreal and broadleaf forests) in more than 10 countries. To enable comparison of these various studies an R based open source postprocessing framework was established. Based on this increasing amount of diurnal datasets of hyperspectral radiance, reflectance and SIF we present upscaling efforts that merge the measurements into a database, to serve as a calibration and validation base for earth observing satellite missions. However on the way to a reasonable data product, multiple challenges remain which include atmospheric modelling, diffuse to direct irradiation as well as the canopy architecture of the different observed landscapes. The authors present the first SIF datasets covering complete vegetation cycles and discuss potential outcomes of deeper insights into the response of SIF to varying environmental conditions.

P2018-49 Poster download (PDF)

Effects of grazing and nitrogen fertilization on nitrous oxide fluxes in Songnen meadow grassland

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Globally, nitrous oxide (N2O) is the third most important greenhouse gas. It is of great concern the contribution of N2O emissions to climate warming on both the regional- and global-scale. Annual N2O emission from Songnen grassland have not been well characterized because of the scarcity of whole-year measurements. Moreover, the effects of global change factors, such as N deposition, and grassland management (grazing) on N2O emission remain largely unknown. In this study, the effects of grazing and nitrogen deposition on soil N2O fluxes were examined in the Songnen meadow steppe of north-eastern China. N2O fluxes were measured using the static chamber method for the control, N addition, grazing, and combination of N additon (10 g N m-2 yr-1) and grazing (moderate grazing) treatments (each treatment has 4 replications) from April 2017 to March 2018. The instantaneous N2O flux values ranged from -1.84 to 143.46 ug N2O-N m-2 h-1 and the annual sum ranged from 0.27 ± 0.023 to 0.55 ± 0.013 kg N2O-N ha-1 y-1. No pulse emissions of N2O were found at the nitrogen addition plots and moderate grazing plots during the spring thaw. The contribution of the spring thaw to the total annual N2O budget was small and accounted for only 1% of the annual fluxes. Winter emissions and growing season emissions accounting for 16.2% and 83.7% of annual fluxes, respectively. The soil N2O emission rate waspositively correlated with soil temperature, above-ground biomass, and was negatively correlated with nitrogen mineralization rate. Our findings provide an important reference for better understanding of the mechanisms of nitrogen deposition, grazing and their interactions effects on soil N2O emission and identifying the key drivers of N2O emission in Songnen meadow steppe.

Key words: nitrogen fertilization, grassland, nitrous oxide fluxes, Songnen meadow steppe

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