ACG37-P01 Room:Convention Hall Time:May 21 18:15-19:30

Interannual variation in ecosystem CO_2 exchanges in a semiarid grassland of Mongolia

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In Mongolia, grassland covers approximately 80% of the country and comprises a major part of East Asian grasslands. The plants live in a semiarid climate, and have often suffered from droughts. Exchange of CO_2 between grassland ecosystems and the atmosphere is controlled by environmental parameters such as temperature, soil moisture, and plant biomass. Studies have indicated that the grasslands respond sensitively to changes in climate, suggesting that interannual climate variability can lead to major changes in the CO_2 exchanges between the atomosphere and ecosystem. The objectives of this study are to estimate interannual variability of ecosystem CO_2 exchanges and to examine its controlling factors.

Our study site was located in a grassland area (47^{o}02.6'N, 105^{o}57.1'E) in Bayan-Unjuul (BU) county in central Mongolia, which contain typical steppe vegetation that is grazed by livestock. Rates of gross primary production (GPP) and ecosytem respiration (Reco) were measured using a closed-chamber technique during the growing seasons of 2004, 2005, 2006, 2009, 2010, and 2011. Net ecosystem CO_2 exchange (NEE) has also deteremined by an eddy covariance (EC) method since 2008. We set up automated weather and ground observation systems at site BU in June 2004, and standard meteorological and soil parameters were continuously measured at 30-minute intervals. Live aboveground biomass (AGB) was measured by clipping green parts of the vegetation and oven-drying them at 80^{o}C for 48 hours for each point where the closed-chamber measurements were made. Based on the results of our measurements, we constructed an empirical model in which the rates of GPP and Reco are computed from the air and soil temperatures, vapor pressure deficit, photosynthetically active radiation, soil water content, and AGB. In this study, the half-houly rates of GPP and Reco during the growing season (May-September) from 2007 to 2011 at site BU were calculated from the observed meteorological and soil parameters. Since AGB was not continuously measured at site BU, temporal changes in AGB were estimated from a remotely sensed vegetation index (NDVI). The model was validated by comparing the observed NEE by EC technique and the calculated values. The comparizon demonstrated that our model was able to reproduce the carbon budget in the semiarid grassland with high accuracy. Cumulative rates of NEE during the growing seasons varied from -42 (carbon uptake) to 34 (carbon release) g C m^{-2}. This result suggested that semiarid grassland might be a net carbon source even during the growing season depending on climate conditions.

Keywords: carbon cycle, photosynthesis, ecosystem respiration, semiarid grassland, Mongolia

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Recent Active Peat Fire Situation in Kalimantan, Indonesia

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Fires in peatland in Kalimantan have become more severe in recent years. This may suggest peatland in Kalimantan is now toward destruction. This situation is made due to rapid deforestation and irreparable destruction of nature, such as Mega Rice Project (MRP) in central Kalimantan.

In this study, analysis of the most recent 10-year period (2002 to 2011) of MODIS hotspots data (fires) and precipitation in Palangkaraya and Pontianak was carried out to identify seasonal and spatial fire occurrence in Kalimantan under El Nino conditions. Most data was tallied every 10-days to analyze seasonal and spatial fire occurrence. Seasonal and spatial analysis results for severe fire years, namely 2002, 2004, 2006 and 2009, under El Nino conditions were as follows: the severest fire incidents occurred in mid October in 2006 under the driest conditions in both Palangkaraya and Pontianak. The second severest fires in occurred in 2002, under the second driest conditions. The severest fires for the MRP area and its vicinity occurred in late September in 2009 under the driest conditions only for Palangkaraya. The fourth severest fires occurred in 2004, when heavy rainfall in July delayed the onset of drought conditions. Fire activity in the last four-years in Central Kalimantan was more severe than that in West Kalimantan. This may be explained by different dry conditions of peat in both places, namely the peat in East Kalimantan could become dryer under the relatively long dry season (about 3-month) compared with peat under a shorter dry season (2/3-month) in West Kalimantan. Spatial analysis of the fire distribution of the severest fires that occurred in mid October in 2006 clearly showed a so-called a fire belt shape arising from severe fires that occurred mainly on the southern coastal peatland from West to Central Kalimantan. The typical West Kalimantan fires that occurred in early August 2009 coincided with the dry season period of West Kalimantan. Typical pre-dry season (caution) fires occurred in late June in 2009. Most of these fires occurred on peatland in West and Central Kalimantan. These results lead us to infer that the MRP was carried out in the worst part of Kalimantan from a climate perspective.

Keywords: peat fire, hotspot, dry season, Kalimantan, MRP

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Observation of vegetation by GOSAT

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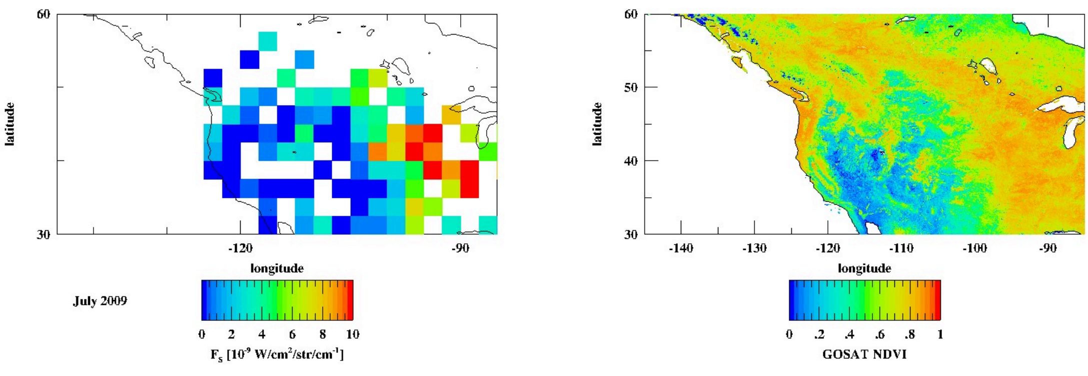
The Japanese Greenhouse gases Observing SATellite IBUKI (GOSAT) is the first satellite that is designed specifically to measure greenhouse gases such as carbon dioxide and methane. After the launch in January 2009, GOSAT is operating succesfully for more than 4 years. The main sensor of GOSAT is the Fourier Transform Spectrometer TANSO-FTS, which has 3 bands in the near-infrared and 1 band in the thermal infrared. Among these bands, TANSO-FTS has an observation window in oxygen A band at 0.76 micron to derive column amount of oxygen (equivalently, column amount of dry air or surface pressure), and to correct effects of clouds and aerosols on the retrievals of column amount of greenhouse gases. Recently, Joiner et al. (2011) and Frenkenberg et al. (2011) have shown that absorption lines in oxygen A band measured by TANSO-FTS can be used to detect chlorophyl fluorescence emitted by plants, and that GOSAT will be useful in wider fields of scientific research.

Chlorophyl fluorescence can be as intense as a few percent of TOA radiance at oxygen A band. Neglecting chlorophyl fluorescence could produce bias errors up to 2 ppm in the retrieved column-averaged mol fraction of carbon dioxide (XCO_2), depending on regions and seasons. Regionally or seasonally dependent bias errors in retrieved XCO_2 degrade the accuracy in inverting the amount of emission and absorption of greenhouse gases, which is the scientific goal of the GOSAT project. We are therefore developing an algorithm which is capable of retrieving XCO_2 and chlorophyl fluorescence simultaneously. Left panel of the figure shows 2.5 degree grid monthly averaged intensity of chlorophyl fluorescence in North America. It can be seen that the distribution of chlorophyl fluorescence is closely related to the normalized vegetation index (NDVI) shown in the right panel of the figure, which was derived from observations of TANSO-CAI (Cloud and Aerosol Imager) onboard GOSAT.

In addition to greenhouse gases, GOSAT is acquiring and processing observation data on vegetation such as chlorophyl fluorescence and NDVI. NDVI data are now provided to public users as a standard product of the GOSAT project. Long term observations of this kind of data are expected to be carried out by the GOSAT successor or similar satellites planed in several countries, and would be useful in studies on vegetation models.

Keywords: chlorophyl fluorescence, vegetation index



ACG37-P04 Room:Convention Hall Time:May 21 18:15-19:30

Allocation based robust methodology for simultaneous reproduction of carbon fluxes, LAI, and forest biomass

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The terrestrial carbon flux and storage are influenced by many environmental and physiological factors, such as drought, windstorms, fire, human activities, vegetation types, forest age, or soil structure. To assess the terrestrial carbon flux and storage, terrestrial ecosystem models have been used for decades. Despite the long history of development and evaluation, however, there are still substantial uncertainties in their predictions. With the current state of performance, it is often the case that models need to be calibrated by adjusting predefined parameters for having agreement with observations.

Although calibration is necessary, seeming success of model based assessment of carbon flux often accompanies with the ill effect, substantial misrepresentation of storage. Because of its strong association with climate change, carbon fluxes have been more rigorously investigated by the terrestrial ecosystem modeling community. In practice, a number of model based analyses have paid attention solely on carbon fluxes and often neglected carbon storages such as forest biomass. As a result of this practice, model parameters are inevitably biased to carbon fluxes.

Against this ill practice, there are studies introduced methods for constraining both carbon flux and storage components. Richardson et al., 2010 is one of studies attempted to constraint both carbon fluxes and storages with the DALEC model using eddy covariance and multiple biometric observations. Although they successfully constrained model parameters, computational cost was significant with their approach: it involves several stage of model runs requiring 50,000 iterations for exploring parameter space for a single site. Their approach is effective for identifying physiological characteristics of a particular site, but is not ideal for analyzing multi-sites or large scale ecosystems. In that case, a more robust and simple methodology is needed.

Establishment of such a methodology may be more feasible by focusing on key physiological parameters. Such parameters have to be (1) strongly correlated to both carbon flux and storage so that simultaneous reproduction of carbon cycle components can potentially be achieved by manipulation of those parameters and (2) the fundamental backbone structure common to ecological modeling so that the same method can be applied to existing models. Ones that satisfy these requirements may be carbon allocation parameters. Carbon allocations can influence the plant growth by controlling the amount of investment acquired from photosynthesis, as well as carbon fluxes by controlling the carbon content of leaves (which turns into Leaf Area Index (LAI)) and litter, both are active media for photosynthesis and decomposition. Thus, LAI, gross primary productivity (GPP), ecosystem respiration (RE), and forest biomass can potentially be reproduced by allocation parameters.

Toward the full reproduction of carbon cycle, the present study explored the existence of such suitable balances of carbon allocations for several carbon flux and storage components: LAI, GPP, forest biomass, and the below- to above-ground biomass ratio. An experiment was performed with a widely used model, Biome-BGC. Through a process of testing the simultaneous reproducibility with the Biome-BGC, we evaluate and discuss consequences of commonly accepted practices in ecosystem modeling: (1) the carbon flux-oriented calibration and (2) application of fixed allocation parameter values for vegetation type. Appropriateness of fixed allocation parameter values was evaluated with a set of allocation parameter values estimated from the optimization.

Acknowledgments
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Reference

Richardson, A. D., et al., 2010. Estimating parameters of a forest ecosystem C model with measurements of stocks and fluxes as joint constraints. Oecologia, 164, 25-40.

Keywords: optimization, allocation, terrestrial ecosystem model, carbon fluxes, biomass

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Change in the carbon emission from wild fire to the periodic variation of precipitation and temperature over Africa

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1 Introduction

In semi-arid regions of Africa, wildfire frequently occurs during dry season. The wildfires strongly constrain the structure, dynamics, and distribution of vegetation, and emit the large amount of carbonaceous aerosol. The atmospheric carbonaceous aerosol has ability to change climatic system, because it absorbs or reflects shortwave radiation. The change pattern of the carbon emission from wild fire to the fluctuation of precipitation was estimated using a dynamic global vegetation model. However, in order to change the cycle of sea surface temperature of the Atlantic and Indian Oceans, annual precipitation varies periodically in Africa. In addition, because the vegetation response to be sensitive to changes in temperature as well as precipitation, it is necessary to pay attention to the temperature as well. Our purpose is to estimate the change in the amount of carbon emissions from the fire to the periodic variation of annual mean temperature and annual precipitation in Africa.

2 Experiments

In this study, we estimate the rate of change of carbon emissions from wild fire for periodically changing precipitation and temperature using SEIB-DGVM (Spacialy Explicit Individual Base Dynamic Global Vegetation Model). The study area is African continent (37N-34S, 17W-59S). The following three experiments were conducted. First, control experiments: the simulation was run for 13 years from 1997 to 2009. Second, there is no period of climate change: the average value of the annual mean temperature and annual precipitation from 1982 to 2009 were used as the input climate data set. Third, climate change 6, 10, 20 year period: the precipitation and temperature data, which changes periodically based on the standard deviation, were used as the input climate data set.

3 Results and Discussion

3-1. Control Experiment: The simulation was in good agreement with the spatial distribution of the annual carbon emissions from wild fire obtained from satellite observations GFEDv3. However, the mean values in each of the northern and southern hemispheres of carbon emissions were overestimated than the observed value. This is caused due to over-estimation of the biomass.

3-2. There is no periodic variation in annual precipitation and mean annual temperature: The Carbon emissions in the northern hemisphere are decreased, while it increased in the southern hemisphere. A tree coverage and biomass were increased because of tree mortality was reduced by extreme drought and high temperatures was eliminated. The reduced carbon emission in the northern hemisphere, because the probability of occurrence of fire was reduced by an increase in tree coverage. On the other hand, in the Southern Hemisphere, the amount of carbon emissions increased by an increase in biomass.

3-3. The annual precipitation and annual mean temperature varies in a cycle of 6, 10, and 20 years: the rate of change of carbon emission for the period change of precipitation is greater than temperature. In the northern hemisphere, there is a tendency to increase carbon emission in the short period. In the long period of climate change, there was very difference in carbon emissions by phase. In the northern hemisphere, the tree coverage showed a relatively low value when there is no variation in the periodic precipitation. As a result, carbon emissions increased due to the relatively high probability of fire.

4 Summary

A carbon emission from the current fire is affected by cyclical fluctuations climate (especially precipitation). In the Northern Hemisphere of Africa, the impact on carbon emissions from the change in tree coverage was strong in the short-period variation in precipitation. In the long-period variation of precipitation, there is a large difference in carbon emissions by phase.

Keywords: DGVM, carbon emission, fire, Africa

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Impact of drought due to climate change on dry matter production and ecosystem function in tropical rain forests

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Since 1980's, climate changes caused by the El Nino-Southern Oscillation have been reported to result in the widespread death of trees due to droughts in many parts of the world.Tropical regions receive strong solar radiation, and tropical vegetation shows a strong feedback effect to carbon sequestration, water circulation, and climate formation.In addition, tropical forests are important ecosystems, and they act as a huge carbon sink because they cover 7-10% of the land area of the Earth and accumulate 40-50% of land vegetation carbon. In a biological community such as a tropical forest that consists of various species, response to changes in the physical environment depends on the operating functional group.A dynamic change in a particular functional group that plays a significant role in the biological community may influence the structure and ecosystem functions of the tropical forests. Although some model studies have been conducted on the response of vegetation to drought due to climate change, most of the models did not consider the ecophysiological mechanisms on the mortality process, and they could not be applied to the different climatic zones and types of forest vegetation. In this study,we predicted the impact of drought on dry matter production and ecosystem functions in tropical rain forests by using a spatially explicit individual-based biogeochemical model developed for predicting vegetation dynamics in response to climate change at the global level, such as global warming (SEIB-DGVM). In the model simulation, the estimated values, such as temperature and precipitation, for the global climate models were used in the vegetation dynamics model, and the dynamics of tropical rain forests for 200 years were described. The predicted result was compared with the meteorological and tree data, including the 1997/98 El Nino, of the tropical rain forests of Sumatra Island in Malaysia that were measured in 1997-2009 and was validated.

Keywords: drought, El Nino, tropical rain forests, ecological function, SEIB-DGVM

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Evaluating future land-use change scenario in the negative fossile fuel emissions

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Bioenergy with Carbon Capture and Storage (BECCS) is a key component of mitigation strategies in the future socio-economic scenarios to keep mean global temperature rise below 2 degree Celsius above pre-industrial, which would require net negative fossil fuel emission in the end of 21st century. Large scale BECCS requires additional production of biofuels, which could potentially cause substantial emissions from the land-use change. Developing sustainable low carbon scenarios require careful consideration of the land-use implications involving large scale BECCS. I use a global terrestrial biogeochemical cycle model and a global crop model to evaluate effects of land-use change in RCP2.6, which is a scenario with net negative fossil emission aiming to keep the 2 degree Celsius temperature target for upcoming Intergovenmental Panel on Climate Change Fifth Assessment Report. Our analysis reveals that first generation bioenergy crop production would not be sufficient to achieve the required BECCS of RCP2.6 scenario even when I consider the higher fertilizer and irrigation use cases. It requires more than doubling the area for bioenergy crops around 2050 assumed in RCP2.6, however, such scenarios implicitly induce large scale land-use changes that emit significant amount of carbon from deforestation. Otherwise land use conflict with food production is inevitable.

Keywords: land-use change