तेजपुर विश्वविद्यालय
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TEZPUR UNIVERSITY
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Napam, Tezpur - 784 028, Assam, India

DEPARTMENT OF ENVIRONMENTAL SCIENCE

A REPORT ON

Soil plant atmosphere study in relation to net CO_2 flux from terrestrial ecosystem of Assam

1. Name of the Collaborative Acyivity: Soil plant atmosphere study in relation to net CO_2 flux from terrestrial ecosystem of Assam

2. Nature of Activity: Major Research work

3. Name of the Collaborative Agency/ Individual with affiliation and contact details: Indian Institute of Tropical meteoriology, Dr. Homi Bhabha Road, Pashan, Pune-411008, Dr. Suprio Chakraborty, Scientist-F

4. Summary of collaboration:

- Finalizing research metnod
- Co-authorship
- Dara analysis and reporting techniques

5. List of year-wise activities under the collaboration:

2021- Publication :.Metya, A., Datye, A., Chakraborty, S. , Tiwari, Y.K.,Sarma, D., Bora A., & Gogoi N. Diurnal and seasonal variability of CO2 and CH4 concentration in a semi-urban environment of western India. Sci Rep 11, 2931 (2021). https://doi.org/10.1038/s41598-021-82321-1.

2021- Publication :Manash Jyoti Bora, Sanandam Bordoloi, Himanshu Kumar, Nirmali Gogoi, Hong-Hu Zhu, Ajit K Sarmah, P Sreeja, S Sreedeep, Guoxiong Mei, Influence of biochar from animal and plant origin on the compressive strength characteristics of degraded landfill surface soils. International Journal of Damage Mechanics, 30(4):484-501, 2021, https://doi.org/10.1177/1056789520925524.

2021- Publication :Abirlal Metya, Supriyo Chakraborty, SK Bhattacharya, Amey Datye, Pramit K Deb Burman, Panini Dasgupta, Dipankar Sarma, Nirmali Gogoi, Abhijit Bora, Isotopic and Concentration Analyses of CO2 and CH4 in Association With the Eddy-Covariance Based Measurements in a Tropical Forest of Northeast India. Earth and Space Science, 8:6, (2021),e2020EA001504.

Signature of Faculty

(Nirmali Gogoi)
Assistant Professor
Dept.of Environmental Science
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Signature and seal of HoD

(R.R. Hoque)
Head
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भारतीय उष्णदेशीय मौसम विज्ञान संस्थान
(पृथ्वी विज्ञान मंत्रालय, भारत सरकार का एक स्वायत्त संस्थान)
डॉ. होमी भाभा मार्ग पाषाण, पुणे- ४११ ००८
IITM
INDIAN INSTITUTE OF TROPICAL METEOROLOGY
(An Autonomous Institute of the Ministry of Earth Sciences, Govt. of India)
Dr. Homi Bhabha Road, Pashan, Pune - 411 008. India
ESSO

प्रो. रवि एस. नन्जुनडैया
निदेशक
Prof. Ravi S. Nanjundiah
Director

150 YEARS OF CELEBRATING THE MAHATMA

Ref: IITM/Metflux/NG/2019-20

Date: 16 September 2019

The Registrar
Tezpur University
Tezpur-784082, Assam

Sub: Sanction of project on "Soil-Plant-Atmosphere Study in Relation to Net CO_2 Flux from Terrestrial Ecosystem of Assam"

Sir,

The Advisory Committee for the MetFlux India Project made an assessment of the project in a meeting held at the Mausam Bhavan, IMD, New Delhi on 9th July 2019. The recommendations are given below.

The data presented by the PI showed relatively high values of positive NEE during the night time, which may have been triggered by high soil respiration. Hence the PI should arrange to install a Soil CO_2 sensor to quantify the heterotrophic respiration. An EC sensor within the canopy should be used to characterise the under story carbon fluxes. Other biophysical parameters such as, plant biomass, leaf are index, fresh litter fall etc. should also be measured on a regular basis. The Committee advised to carry out rigorous estimation of the NEE and its portioning into the GPP and ecosystem respiration. The relation between NEE and various biophysical parameters should be examined. Since a large area of the forest turns to wetland on a seasonal basis, the Methane fluxes may also be measured. The Committee, in principle, recommends allocating funds to meet the operational costs for the next three years, viz, 2019-2020, 2020-2021, and 2021-2022.

Based on the recommendation of the Committee, the Director, IITM, Pune hereby approves the continuation of the above mentioned project for a period of three years (2019-2022). An amount of Rs. 17,75,400/- is being sanctioned for the current financial year (Apr 2019 to Mar 2020).

....2/-

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The year wise break up details of funds under the above mentioned project is furnished below.

S/N	Description	1st Year	2nd Year	3rd Year
01	Manpower: Project Assistant – 01 (salary may be revised as per the MoES notification)	2,64,000	2,64,000	2,64,000
02	Contingency/consumable including a portable cabin to house the sensors, battery etc.	8,00,000	4,00,000	4,00,000
03	Travel	2,00,000	2,00,000	2,00,000
04	Other Cost (Battery replacement/ Additional panels for new systems/ Fencing maintenance/Repainting of tower)	3,50,000	2,50,000	2,50,000
05	Sub-Total	16,14,000	11,14,000	11,14,000
06	Overhead (10 % of (01+02+03+04)	1,61,400	1,11,400	1,11,400
09	TOTAL (05+06)	17,75,400	12,25,400	12,25,400

The basic terms and conditions are appended in the annexure.

Kindly acknowledge the receipt of this letter.

Sincerely yours,

(Prof. Ravi Nanjundiah)

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Earth and Space Science

RESEARCH ARTICLE
10.1029/2020EA001504

Isotopic and Concentration Analyses of CO_2 and CH_4 in Association With the Eddy-Covariance Based Measurements in a Tropical Forest of Northeast India

Abirlal Metya[1,2], Supriyo Chakraborty[1,2], S. K. Bhattacharya[3,4], Amey Datye[1], Pramit K. Deb Burman[1,2], Panini Dasgupta[1,5], Dipankar Sarma[6], Nirmali Gogoi[6], and Abhijit Bora[6]

[1]Centre for Climate Change Research, Indian Institute of Tropical Meteorology, Ministry of Earth Sciences, Pune, India, [2]Department of Atmospheric and Space Sciences, Savitribai Phule Pune University, Pune, India, [3]Institute of Earth Science, Academia Sinica, Taipei, Taiwan, [4]Department of Geology and Geophysics, Indian Institute of Technology Kharagpur, India, [5]Department of Meteorology and Oceanography, College of Science and Technology, Andhra University, Visakhapatnam, Andhra Pradesh, India, [6]Department of Environmental Science, Tezpur Central University, Tezpur, India

Key Points:

- The net ecosystem exchange was measured using an eddy-covariance technique in a forest in India
- Separately the greenhouse gases isotopic data were collected and used to determine the "isofluxes"
- Partitioning of the respiratory and the photosynthetic fluxes was carried out

Supporting Information

Supporting Information may be found in the online version of this article

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Citation:

Metya, A., Chakraborty, S., Bhattacharya, S. K., Datye, A., Deb Burman, P. K., Dasgupta, P., et al. (2021). Isotopic and concentration analyses of CO_2 and CH_4 in association with the eddy covariance based measurements in a tropical forest of northeast India. *Earth and Space Science*, 8, e2020EA001504. https://doi.org/10.1029/2020EA001504

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Abstract Among the natural ecosystems, forests and wetlands emit a sizable amount of carbon dioxide (CO_2) and methane (CH_4) through autotrophic and heterotrophic respiration and bacterial activities. Interestingly, some evidence suggests that a significant amount of CH_4 is generated by the trees in forested ecosystems. The net ecosystem exchange (NEE), measured by the eddy covariance (EC) method, typically represents the net CO_2 flux arising from the photosynthetic and respiration processes in the biosphere. This flux is subsequently partitioned into two components, the respired carbon and the assimilated carbon. However, the usual method of partitioning introduces significant errors in each of these fluxes. The present study was undertaken to address this issue where the NEE partitioning was constrained by using the carbon isotopic ratios of CO_2. We used a real-time in situ analyzer in a tropical forest in northeast India, the Kaziranga National Park. The greenhouse gas analyzer provided CO_2 and CH_4 concentrations, as well as their carbon isotopic ratios. The isotopic data were used to partition the EC-derived NEE values and derive the isoflux values. Additionally, the isotopic data provided evidence of plant-generated CH_4 in conformity with some recent studies, which requires further investigation.

Plain Language Summary The terrestrial vegetation absorbs a vast amount of carbon in the photosynthetic process. They also emit a sizeable amount of carbon through respiration. Eddy-covariance-based technique is often employed to quantify these two opposing fluxes. An eddy-covariance-based system measures carbon dioxide (CO_2) concentrations along with wind speed, and covariance of their fluctuations is used to calculate the net ecosystem exchange (NEE). The NEE is then partitioned into the photosynthetic and respiration components through a series of numerical operations and environmental constraints. Flux measurements in association with carbon isotopic ratios can provide a unique way to partition NEE. We have measured the concentration and isotopic ratio of CO_2 and the eddy covariance-based measurements to obtain the respiratory and photosynthetic fluxes of CO_2 in a tropical forest in India. In addition, methane (CH_4) concentration and its isotopic ratio have been measured to identify if trees can be considered a CH_4 source in this ecosystem.

1. Introduction

Carbon dioxide (CO_2) and methane (CH_4), the two most important greenhouse gases (GHGs) are increasing since the dawn of the industrial era. After years of growth, atmospheric CH_4 achieved a steady state in the late 1990s and early 2000s but then grew rapidly in the 2010s at a rate of 7.18 ppb/yr (E. G. Nisbet et al., 2019). It was also observed that, along with the increase, the CH_4 carbon isotope ratio (denoted as $\delta^{13}CH_4$) shifted toward more negative values. This change in $\delta^{13}CH_4$, in association with the increased concentration, is a matter of intense study because it can elucidate the causative factors like, increase in biogenic emissions (wetlands, ruminants, waste) or a reduction in the atmospheric sink of CH_4 through OH oxidation. If such growth rate continues in the coming decades, it could negate or even reverse the effect of climate mitigation by reduced CO_2 emission (E. G. Nisbet et al., 2019). In this context, some investigators

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Diurnal and seasonal variability of CO_2 and CH_4 concentration in a semi-urban environment of western India

Abirlal Metya[1,2], Amey Datye[1], Supriyo Chakraborty[1,2✉], Yogesh K. Tiwari[1], Dipankar Sarma[1], Abhijit Bora[3] & Nirmali Gogoi[3]

Amongst all the anthropogenically produced greenhouse gases (GHGs), carbon dioxide (CO_2) and methane (CH_4) are the most important, owing to their maximum contribution to the net radiative forcing of the Earth. India is undergoing rapid economic development, where fossil fuel emissions have increased drastically in the last three decades. Apart from the anthropogenic activities, the GHGs dynamics in India are governed by the biospheric process and monsoon circulation; however, these aspects are not well addressed yet. Towards this, we have measured CO_2 and CH_4 concentration at Sinhagad, located on the Western Ghats in peninsular India. The average concentrations of CO_2 and CH_4 observed during the study period are 406.05 ± 6.36 and 1.97 ± 0.07 ppm (μ ± 1σ), respectively. They also exhibit significant seasonal variabilities at this site. CH_4 (CO_2) attains its minimum concentration during monsoon (post-monsoon), whereas CO_2 (CH_4) reaches its maximum concentration during pre-monsoon (post-monsoon). CO_2 poses significant diurnal variations in monsoon and post-monsoon. However, CH_4 exhibits a dual-peak like pattern in pre-monsoon. The study suggests that the GHG dynamics in the western region of India are significantly influenced by monsoon circulation, especially during the summer season.

Carbon dioxide (CO_2) is one of the minor (~ 0.4% of all gaseous species) constituents of the atmosphere[1]. Still, it plays the most significant role in the radiation balance of the planet among the species produced anthropogenically. CO_2 contributes 73% of all positive radiative forcing of the Earth's environment since the pre-industrial era, circa 1750s[1,2]. CO_2 is continuously being exchanged between the terrestrial biosphere, ocean, and the atmosphere[3] and maintained a more or less steady-state, until about 1750. The balance in CO_2 is being perturbed due to the anthropogenic emission of CO_2 and its feedback with the global climate change since the industrialisation[4]. The atmospheric concentration of CO_2 has progressively increased since the beginning of the industrialisation, from 280 ppm (in 1700) to a current level of more than 410 ppm. About one-fourth of the CO_2 emissions from the anthropogenic activities (fossil-fuel consumption, cement production, and land cover land use changes) have been absorbed by the ocean and another one fourth by the terrestrial biosphere during the 2000s[5–7]. The exchange of carbon among the various reservoirs is controlled by complex biogeochemical processes and takes place on various timescales[8]. A better understanding of the carbon exchange process, especially on a short temporal and spatial timescale, is necessary to have a better estimate of the carbon budget[7,8]. This requires a robust network of continuous monitoring of CO_2 concentration and determining its fluxes from different reservoirs[1,9–11].

Methane (CH_4) is the second-largest contributor, among the anthropogenically produced species, to global warming with a positive radiative forcing of about 0.48 ± 0.05 W m^{-2}[12]. The pre-industrial CH_4 concentration was estimated to be 700 ppb, but increased anthropogenic activities have resulted in a steady increase of atmospheric CH_4, up to 1803 ppb in 2011[13,14]. Apart from being a potent greenhouse gas, CH_4 plays an active role in tropospheric chemistry. CH_4 is the main contributor to the increase in stratospheric water vapour, following the loss by reaction with OH radical[14]. The water vapour variation in the upper troposphere and lower stratosphere is highly significant due to its impact on global warming. CH_4 emissions from anthropogenic sources in India have increased from 18.85 to 20.56 Tg $year^{-1}$ from 1985 to 2008[15]. Unlike CO_2, methane has a relatively short lifetime of approximately 10 years[16]. Thus, in comparison with CO_2, CH_4 can attain a steady-state condition and start to

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