iLEAPS-Japan / GCP Workshop 2025

Program & Abstract

Date	26(Wed)~27(Thu) November 2025
Venue	Hiroshima University, Higashi-Hiroshima Campus, East Library 3F Workshop Area (広島大学 東広島キャンパス 東図書館３Ｆ ワークショップエリア)
Hosted by	iLEAPS-Japan committee, GCP Tsukuba International Office

Purpose of the Workshop (開催趣旨)

持続可能な地球社会の実現をめざす国際協働研究のプラットフォームであるフューチャー・アースには、大気－陸域境界におけるエネルギー・物質の交換と関連諸過程の解明を目指す iLEAPS（Integrated Land Ecosystem-Atmosphere Processes Study）、および炭素循環の定量的理解と将来予測、さらには人間活動と気候変動の相互作用に関する統合的研究を推進する GCP（Global Carbon Project）などが組織されています。

iLEAPS と GCP が取り扱う研究課題には、CO_2やメタンなどの温室効果気体に関する大気－陸域間の収支や、気候と生態系の相互作用における植生機能の役割など、両分野にまたがる重要なテーマが存在します。これらの課題には、今後、両分野の研究者が連携して取り組むことが不可欠です。

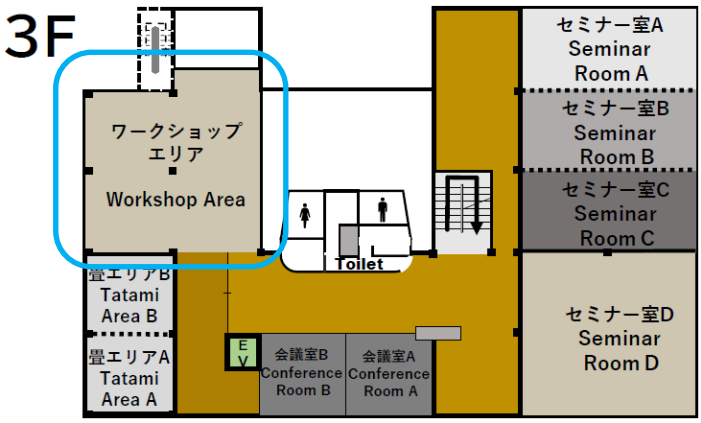
本研究集会では、iLEAPS 日本小委員会の委員および GCP の共同研究者を含む両コミュニティの研究者が一堂に会し、大気－陸域間の相互作用に関する最新の研究成果についての話題提供と討論を行います。その中で、両分野に共通する重要課題を明確化し、それらの解明に向けた将来的な研究の方向性を探ることを目的とします。また、iLEAPS と GCP との連携による研究推進のために、今後重視すべき取り組みを見出すことも、本集会の重要な目標の一つです。

文責：佐藤永（海洋研究開発機構・日本学術会議 iLEAPS 小委員会委員長）

Venue Map

East Library 3F（東図書館 3F）

1-4-5 Kagamiyama, Higashi-Hiroshima City (東広島市鏡山 1-4-5)



Day 1 (26 November) Program

09:30〜09:40 佐藤永 (Hisashi SATO) JAMSTEC
Opening Address, Objectives, and Logistics

09:40〜09:50 近藤雅征 (Masayuki KONDO) Hiroshima Univ.
Activities and Future Perspectives of iLEAPS

Part 1. Crop Production and Agricultural Climate Impacts.

Chair: 佐藤永 (Hisashi SATO) JAMSTEC

09:50〜10:10 李信莉 (Xinli LI) Hokkaido Univ.
Assessing Long-term Yield Trends and Crop Responses to Climate Variability in India

10:10〜10:30 中尾里菜 (Rina NAKAO) Hokkaido Univ.
MATCRO-Potato: Development of a Process-Based Crop Growth Model and its Validation

10:30〜10:50 Praeploy Kongsurakan, Hokkaido Univ.
Over 100 Years of Crop Yields in Thailand: Provincial Trends, Stagnation, and Climate Sensitivity

10:50〜11:00 Break

11:00〜11:20 大津直也 (Nagoya OHTSU) Hokkaido Univ.
Carbon Budget and Evapotranspiration of a Rainfed Maize Field in Hokkaido

Part 2. Terrestrial Ecosystems, Vegetation, and Land-Use Change.

Chair: 伊勢武史 (Takeshi ISE) Kyoto Univ.

11:20〜11:40 Nguyen Duc Long, Hokkaido Univ.
Improving Tree Height Estimation from Spaceborne Full-Waveform Altimetry in the 2000s over Hokkaido, Japan

11:40〜12:00 若松愛子 (Aiko WAKAMATSU) YPU
Developing an AI Model for Bamboo Forest Type Identification

12:00〜12:20 藤中麻帆 (Maho FUJINAKA) YPU
AI-Based Vegetation Classification in Forests

12:20〜13:40 Break for lunch (We plan to arrange a lunch box delivery)

13:40〜14:00 川東夏子 (KAWAHIGASHI Natsuko) Kyoto Univ.
AI-Based Analysis of Changes in Homestead Woodlands in the Tonami Plain, Toyama, Japan

14:00〜14:20 佐藤永 (Hisashi SATO) JAMSTEC
Development of an Interactive Visualization Tool for Process-Based Vegetation Modeling

Part 3. Climate-Land Interactions and Water Cycle.

Chair: 檜山哲哉 (Tetsuya HIYAMA) Nagoya Univ.

14:20〜14:40 南久美子 (Kumiko NAM) Hokkaido Univ.
Evaluating Photosynthetic Acclimation Effects on Global Carbon-Climate Interactions using MIROC-ES2L

14:40〜15:00 沢田芙祐子 (Fuyuko SAWADA) Nagoya Univ.
Interannual Variation of Summer Precipitation in Mongolia: Case Studies from 2016 and 2020

15:00〜15:10 Break

15:10〜15:30 奥村直旦 (Tadaaki Okumura) OMU
Evaluation of Atmosphere-Land Surface Interactions in Interior Alaska Using a Regional Climate Model

15:30〜15:50 岡田創吾 (Sogo OKADA) OMU
Heat and Water Balance in Managed Urban Green Spaces

15:50〜16:10 桑原隼大 (Hayata KUWAHARA) OMU
Two-Decade Variability of Evapotranspiration in a Black Spruce Forest in Interior Alaska

16:10〜16:30 辰己昂大郎 (Kotaro Tatsumi) OMU
「Effects of Weed Management on Partitioning Evapotranspiration」

16:30〜16:40 Break

Part 4. GHG, Carbon Cycle, and Environmental Issues.

Chair: 白井知子 (Tomoko SHIRAI) NIES

16:40〜17:00 和田茂樹 (Shigeki WADA) Hiroshima Univ.
Unraveling Blue Carbon: Toward the Assessment of an Uncertain Carbon Sink

17:00〜17:20 青木翔太 (Shota AOKI) Nagoya Univ.
Carbon Dynamics and their Environmental Drivers in a Spring-Fed Wetland: A Case Study at the Ananomiya site

17:20〜17:35 佐藤響乃 (Hibikino SATO) Hiroshima Univ.
Atmospheric CO_2 Growth Response to the Three-year Consecutive La Niña Events during 2020-2023

17:35〜17:50 Day 1, General Discussion and Summary

19:00〜21:00 Social Gathering (Optional Participation)

Day 2 (27 November) Program

09:00〜09:10 白井知子 (Tomoko SHIRAISHI) NIES
Activities and Future Perspectives of GCP

09:10〜09:30 町田敏暢 (Toshinobu MACHIDA) Hiroshima Univ.
Current activities of Seto Inland Sea Carbon-neutral Research Center, Hiroshima University

09:30〜09:50 田口琢斗 (Takuto TAGUCHI) NIES
Declining Methane Emissions from Oil & Gas: Uncovered by Atmospheric Observation in Western Siberia

09:50〜10:05 佐藤響乃 (Hibikino SATO) Hiroshima Univ.
Greenhouse Gas Budget Assessment of Papua New Guinea for 2000-2019

10:05〜10:15 Break

10:15〜10:35 平林きらり (Kirari HIRABAYASHI) Hiroshima Univ.
Greenhouse Gas Budget Assessment of Myanmar (2000-2019)

10:35〜10:55 PJ Rohan George, Hiroshima Univ.
Trends for Glacial Lake Outburst Floods in High Mountain Asia, 1961-2023

10:55〜11:15 近藤雅征 (Masayuki KONDO) Hiroshima Univ.
Net balance of Volcanic GHG Uptake and Release

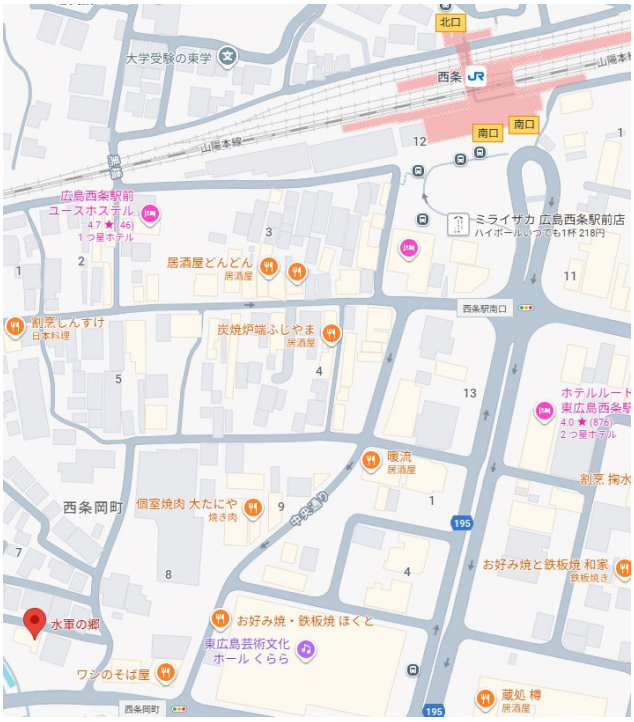
11:15〜11:30
Day 2, General Discussion and Summary

Note: Presentation 15 minutes + Q&A 5 minutes
※発表は、プレゼンテーション 15 分+質疑応答 5 分

Reception Venue (懇親会会場)

Suigun-no-Sato
7-27 Saijō -Okamachi, Higashi-Hiroshima, Hiroshima
(7 minutes on foot from Saijō Station,)

水軍の郷
広島県東広島市西条岡町 7-27
（西条駅 徒歩 7 分）



Abstract

Assessing long-term yield trends and crop responses to climate variability in India

Xinli Li[1], Tomomichi Kato[1], Praeploy Kongsurakan, [1] Tatsuki Nakagawa[2], Azusa Suzuki[1]

[1] Research Faculty of Agriculture, Hokkaido University
[2] Graduate School of Global Food Resources, Hokkaido University

India plays a pivotal role in global food security because of its large population and agriculture-based economy. Understanding spatiotemporal yield trends is crucial for evaluating its food security status. Climate variability, which accounts for nearly one-third of global yield fluctuations, is strongly shaped by large-scale oscillations such as El Niño–Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), and the North Atlantic Oscillation (NAO). These oscillations alter precipitation and temperature patterns, thereby influencing crop performance. In this study, we aim to (1) quantify the long-term yield trends of major crops across India and (2) evaluate their responses to large-scale climate oscillations.

Crop data consisting of production, planting surface and yield were compiled from book sources such as *Statistical Abstract of India* and *Directorate of Economics and Statistics* and ICRISAT sources. Dynamic Linear Models (DLMs) were applied to capture long-term yield trends and reduce extraneous influences, and yield anomalies were defined as deviations from DLM. Finally, we examined the yield anomalies response to ENSO, IOD and NAO events.

Results show that yields of all four crops improved substantially since 1961, while yield stagnation declined but persisted in some states. High-yield regions such as Punjab and Andhra Pradesh consistently outperformed others. Crop yield anomalies exhibited distinct responses to different oscillations: ENSO primarily impacted maize and rice, IOD had stronger effects on barley and wheat, whereas NAO exerted weaker but still negative influences on barley and rice. These findings highlight the coupled dynamics of agriculture and climate in India and provide key insights for developing region-specific adaptation strategies under climate variability.

References:

Chakraborti, R., Davis, K.F., DeFries, R., Rao, N.D., Joseph, J., Ghosh, S., 2023. Crop switching for water sustainability in India's food bowl yields co-benefits for food security and farmers' profits. Nat. Water 1, 864–878.

Heino, M., Puma, M.J., Ward, P.J., Gerten, D., Heck, V., Siebert, S., Kummu, M., 2018. Two-Thirds of Global Cropland Area Impacted by Climate Oscillations. Nat. Commun. 9, 1257.

Day 1, 10:10~10:30

MATCRO-Potato: Development of a Process-Based Crop Growth Model and its Validation

Rina Nakao [1*], Tomomichi Kato [2], Seiji Shimoda [3], Yuji Masutomi [4]

1 Graduate School of Global Food Resources, Hokkaido University, 2 Research Faculty of Agriculture, Hokkaido University, 3 Center for Climate Change Adaptation, National Institute for Environmental Science, 4 National Agriculture and Food Research Organization, Hokkaido Agricultural Research Center, Memuro Research Station
* Corresponding author (e-mail: nakao.rina.r6@elms.hokudai.ac.jp)

Climate change strongly affects crop productivity worldwide (IPCC, 2022). Rising temperatures can reduce yields through earlier phenology. Process-based crop models are valuable tools to assess the impacts of climate change on crop production by simulating plant physiological processes. Potato ranks as the fourth most important food crop globally(FAOSTAT, 2022), cultivated in over 100 countries. However, fewer modelling studies have incorporated its physiological characteristics. A Process-based crop model, MATCRO-Rice (Masutomi et al., 2016) was developed and extended to wheat, maize, and soybean, but not potato yet. Therefore, the objective of this study is to develop process-based potato model as "MATCRO-Potato" for global yield estimation by introducing potato's unique traits.

MATCRO consists of two main modules for plant-carbon dynamics: photosynthesis and crop growth. It requires daily weather, crop calendar for phenology, water management, nitrogen fertilizer application [kg N ha-1], and soil classification as inputs. Crop growth is simulated by partitioning net carbon assimilation among organs during the growing period. The model outputs leaf area index (LAI), biomass [kg ha-1], based on developmental stage (DVS) and yield [kg ha-1]. Parameters of carbon allocation and growth were calibrated with datasets of Raymundo et al. (2018) and Shimoda et al. (2023). Validation was conducted at two scales: point-scale at six sites in Bolivia, China, Colombia, Japan, Scotland and the United States, Global-scale at the spatial resolution of 0.5º x 0.5º under rainfed and irrigated conditions (1981-2010). Simulated yields were compared with FAOSTAT data for the top 30 producing countries.

At the point scale (Figure 1), simulated LAI correlated moderately with observation (COR = 0.657) but was consistently overestimated. Total aboveground biomass showed a weaker correlation (COR = 0.431**) with over-estimation in some sites. Tuber biomass also showed a weaker correlation (COR = 0.457). In contrast, simulated yield correlated negatively with observed values (COR = -0.326), indicating poor model performance, with over-estimation in Bolivia and under-estimation in the United States. Based on current results, several parameters require adjustment. Leaf nitrogen treated as a key factor in reproducing photosynthetic ability. In future work, we will incorporate the relationship between specific leaf nitrogen and the maximum carboxylation rate (Vcmax; µmol m-2 s-1), which reflects RuBisCO activity. This improvement will help capture physiological responses, reduce yield over-estimation and enhance model performance on global scale.

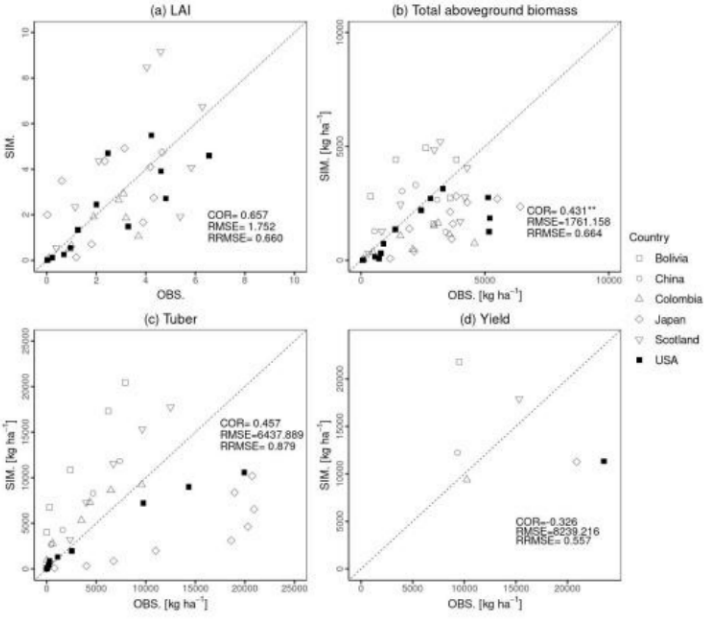


Figure 1. Comparison of (a) LAI, (b) total above-ground biomass, (c) tuber biomass, and (d) final yield between observed and simulated value.

Over 100 Years of Crop Yields in Thailand: Provincial Trends, Stagnation, and Climate Sensitivity

Praeploy Kongsurakan[1], Tomomichi Kato[1*], Li Xinli[1], Tatsuki Nakagawa[2], Azusa Suzuki[1]

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[2] Graduate School of Global Food Resources, Hokkaido University, Hokkaido, 060-8589, Sapporo, Japan

Abstract

Long-term crop yield records are vital for shaping agricultural policy and climate adaptation strategies, yet subnational-scale analyses remain rare in Southeast Asia. Thailand, a major regional producer, still lacks comprehensive assessments that integrate historical trends, stagnation patterns, and climate impacts. We compiled annual rice, maize, and soybean yields for all 77 provinces of Thailand from 1918 to 2023 using national statistics. Yield trends and breakpoints were examined using polynomial detrending and dynamic linear models. Correlations between yield anomalies and key climate indices, including the El Niño–Southern Oscillation (ENSO), Dipole Mode Index (DMI), and Southern Oscillation Index (SOI), were analyzed to assess temporal and spatial variations in climate sensitivity. Rice yields declined in the early 1900s but increased steadily after the 1960s. Maize yields rose sharply during the 1980s, while soybean showed modest and irregular gains. Stagnation was identified in 68% of rice- and 49% of maize-growing provinces, often associated with limited irrigation or economic support, while soybean stagnation was more scattered. ENSO showed positive correlations with rice yields in about 70% of provinces, whereas maize and soybean responses were weaker or negative. Climate–yield relationships were strongest from 1970 to 1999 but weakened in recent decades, likely due to adaptation measures or shifts in climate teleconnections. This study provides the first province-level analysis of crop yield dynamics spanning more than 100 years in Thailand. The results highlight both productivity gains and persistent stagnation, with climate variability playing a significant role, particularly before 2000. These findings emphasize the need for climate-informed agricultural planning, targeted support for vulnerable provinces, and greater integration of socioeconomic data into adaptation strategies.

Keywords: crop yield, yield stagnation, dynamic linear models, climate teleconnections, long-term trends

Day 1, 11:00~11:20

CO_2 budget and evapotranspiration of a rainfed maize field in Hokkaido

Naoya Ohtsu[1,*], Hiroki Ikawa[2], Takashi Hirano[3], Mizuki Horikoshi[1,4], Taiken Nakashima[3], Masaharu Kitano[4]

[1]Graduate School of Agriculture, Hokkaido University
[2]Hokkaido Agricultural Research Center, National Agricultural and Food Research Organization
[3]Research Faculty of Agriculture, Hokkaido University
[4]IoP Collaborative Creation Center, Kochi University
[*]Corresponding author**.** Naoya Ohtsu (otsu.naoya.g7@elms.hokudai.ac.jp)

[objectives] Quantifying carbon and water balances of farmland is important to understand the role of agriculture in the carbon and water cycles in terrestrial ecosystems. In addition, from the perspective of crop production, evaluating CO_2 and water balance of maize at a field scale is essential to achieve sustainable agricultural practice, especially in response to the growing demand for domestic maize production in Japan. Therefore, this study aims to quantify CO_2 balance (net ecosystem exchange: NEE, gross primary production: GPP, and ecosystem respiration: RE) and evapotranspiration (ET) in a rainfed maize field in Hokkaido using the eddy covariance technique.

[Methodology] Eddy fluxes of CO_2 and H_2O were measured using the IRGASON (Campbell Scientific) in a rainfed maize field at Hokkaido University from early July to mid-September in 2024 and 2025. Half hourly NEE and ET were calculated following UEYAMA et al. (2012). GPP was separated from NEE using daytime RE estimated using a random forest-based model developed from daytime NEE.

[Results] In terms of meteorological conditions, 2025 was drier than 2024, with low precipitation, higher air temperature and vapor pressure deficit. Cumulative GPP was almost the same between 2024 (1110 g C m^{-2}) and 2025 (1118 g C m^{-2}), but cumulative PPFD in 2024 and 2025 were 2238 and 2449 mol m^{-2}, therefore light use efficiency (LUE: cumulative GPP / cumulative PPFD) in 2025 slightly declined compared to 2024. Cumulative RE was higher in 2025 (738 g C m^{-2}) than in 2024 (626 g C m^{-2}), resulting in a less negative cumulative NEE in 2025 (-380 g C m^{-2}) than in 2024 (-484 g C m^{-2}). Higher ET was observed in 2025 compared to 2024, resulting in lower water use efficiency (GPP / ET).

[Discussion] The lower LUE in 2025 can be attributed to stronger stomatal limitation that suppressed GPP under high PPFD during the first half of July, when 2025 was drier than 2024 with little precipitation. The higher RE and ET in 2025 compared to 2024 were likely due to higher air temperature and increased evaporative demand from higher vapor pressure deficit.

To better understand the difference in RE between 2024 and 2025, future work should analyze chamber-measured soil fluxes in relation to variations in soil temperature and volumetric water content

[Acknowledgment] This work was supported by Cabinet Office grant in aid “Evolution to Society 5.0 Agriculture Driven by IoP (Internet of Plants),” Japan

Day 1, 11:20~11:40

Improving Tree Height Estimation from Spaceborne Full-Waveform Altimetry in the 2000s over Hokkaido, Japan

Long Nguyen Duc [1*], Tomomichi Kato [2,3*], Masato Hayashi [4]

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[2] *Research Faculty of Agriculture, Hokkaido University, Sapporo, Hokkaido, 060-8589, Japan*
[3] *Global Center for Food, Land, and Water Resources, Research Faculty of Agriculture, Hokkaido University, Sapporo 060-8589, Hokkaido, Japan.*
[4] *Biodiversity Division, National Institute for Environmental Studies (NIES), Tsukuba, Ibaraki 305-8506, Japan.*
[*] Corresponding author (e-mail: tkato@agr.hokudai.ac.jp)

Introduction

NASA's ICESat-1 operated from 2003 to 2009, employing full-waveform laser altimetry to monitor ice sheet mass balance, estimate forest structure, and generate digital terrain models in remote regions. The data collected by ICESat-1 is invaluable for assessing forest structure during the 2000s, providing critical insights into canopy height, biomass distribution, and overall forest health. By using ICESat-1 data from this period and current LIDAR data, we can track forest changes over time, facilitating long-term assessments of forest dynamics and enabling better-informed management and conservation strategies. Although numerous equations have been proposed to estimate tree height from ICESat-1 data, most have been applied uniformly across all waveform types, disregarding potential structural differences in waveform characteristics.

In this study, we aim to classify ICESat-1 waveforms into distinct categories and develop height estimation models tailored to each waveform type. Using these models, we ultimately generate a spatially explicit tree height map for the entire Hokkaido region during the 2000s.

Methodology

We used cloud-free and saturation-free ICESat-1 GLAS data (Release-34; GLAH01 and GLAH14) from the NSIDC and airborne LiDAR data from 2003 to 2009 in Hokkaido, excluding observations during winter due to snow cover. We obtained geolocated footprint locations from the GLAH14 Global Land Surface Altimetry Data Product. To account for systematic pointing errors, footprint geographic positions were refined by matching the ICESat 1 waveform with ALS simulated waveform.

We first classified the ICESat-1 waveforms into six distinct types. For each waveform type, a specific tree height estimation model will develop. These six models were then compared with existing height estimation formulas and validated against ALS-derived tree height data. Finally, the selected models were applied to generate a spatially explicit tree height map for the Hokkaido region during the 2000s.

Expectied result:

- The development of a robust classification framework for ICESat-1 waveform data, enabling the identification of distinct waveform types.
- The establishment of tree height estimation models tailored to each of the six classified waveform types, enhancing the accuracy of ICESat-1–derived height retrievals.
- The generation of a spatially explicit forest height map for Hokkaido during the 2000s based on ICESat-1 observations.

Developing an AI Model for Bamboo Forest Type Identification

Aiko Wakamatsu[1*], Noriko Kurata[1], Takeshi Ise[2]

[1] Yamaguchi Prefectural University
[2] Kyoto University
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１．研究背景

近年、放置された竹林の拡大は、生物多様性の低下や在来植生の減退などの里山の荒廃を引き起こし、深刻な社会的・環境的課題となっている（岡田ほか, 2020）。竹は繁殖力が極めて強く、各自治体は放置竹林の対応に苦慮している。福岡県筑紫野市では伐採・整備推進のための補助金の導入、大分県別府市では竹細工としての活用促進施策といった竹害対策が進められているが、これらの施策は場当たり的であり、人手不足や高コスト、さらに伐採後の持続的管理が大きな課題として残されている。

日本の竹林の 9 割以上はモウソウチク・マダケ・ハチクの 3 種によって構成されているが、これらの竹種はそれぞれ異なる利用価値を有している。モウソウチクはたけのこの市場流通量が最も多く、材質が強固なため建材・足場・垣根などに利用されてきた。マダケはしなやかで強靭であり、割竹への加工が容易であることから、建築資材、籠、茶道具など幅広い日用品に活用されている。ハチクはたけのこのアクが少なく食味に優れることに加え、特有の白みがかった色調が好まれ、庭園の装飾材や景観材、さらには尺八などの楽器材料としても利用されてきた。このように、竹は種類によって利用用途が大きく異なるため、資源利用による竹林の適正管理を推進するには、種の正確な判別と竹種ごとの分布の可視化が不可欠である。

２．研究の目的

本研究の目的は、国内に広く分布する主要な竹類であるモウソウチク・マダケ・ハチクの 3 種を、可視光リモートセンシングデータと画像判別 AI を用いて高精度で判別することである。これにより、従来困難とされてきた「種レベルでの竹林分布の把握」が可能となり、竹種の分布マップが作成できる。その結果、拡大が特に懸念される種や地域の監視と管理が実現するとともに、竹資源の活用を目指す。

３．研究対象地と研究方法

山口県は全国で第 4 位、本州では最大の竹林面積を有しており、放置竹林の拡大が地域的課題となっている。本研究では、特に竹林面積の多い山口県宇部市および美祢市を対象地域とする。研究方法として、入手が容易で低コストな可視光リモートセンシングデータに対し、画像判別 AI 技術である「こま切れ画像法（Chopped Picture Method: CPM, Ise et al., 2018）」を適用する。また、AI 解析の精度を検証するため、現地調査を実施し、ドローンによる空撮映像の取得と、地上での竹林状況の確認調査を併せて行った。


ドローンでの竹林の撮影


竹林の現地調査

４．今後の研究

山口県から高解像度のオルソ画像を入手し、竹林の教師画像取得を行う。現地での検証を行い、AI 竹林判別の精度を評価する。

Day 1, 12:00~12:20

AI-based vegetation classification in forests

Maho FUJINAKA[1*], Noriko Kurata[1], Takeshi Ise[2]

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１．研究背景

「林業」は人間の生活基盤を支える重要な産業である。しかし近年、林業は収益性の低下、山間地域の過疎化や高齢化による労働人口の減少などを背景に、衰退の危機に直面している。林業分野において植生を把握することは極めて重要であるが、現地調査による手作業での植生判別は精度確保が難しく、多大なコストと労力を要するという課題がある。一方、AI（人工知能）を用いた植生判別が実用化すれば、作業の属人性を減らし、誰もが容易に精度の高い植生分析を行うことが可能になる。本研究では、伊勢武史先生が開発された AI 植生判別技術「こま切れ画像法（Chopped Picture Method：CPM）」を林業分野に応用し、森林資源把握の効率化と精緻化を図る。これにより、「低コスト」「省力化」「高精度」という 3 条件を同時に満たす新たな森林資源観測技術の実現を目指す。

２．本研究の目的と方法

本研究の目的は、AI 植生判別技術「こま切れ画像法（CPM）」を用いて、植生をスギ、ヒノキ、二次林、竹、その他（家屋・農地・道路等を含む）の 5 種類に分類することである。研究対象地は山口県の滑山国有林とする。まず、国土交通省が無償で提供する航空写真を用いて、各植生タイプに対応する教師画像を取得し、AI モデルを構築した。AI の精度向上のため、教師画像の枚数調整や学習条件の最適化を繰り返し実施した。さらに、AI による分類結果の精度を検証するため、ドローンによって対象地域の空撮を行い、詳細な植生分類図を作成した。この正確な植生分類図と AI 判別結果を比較することで、AI の識別精度を定量的に評価した。

３．結果

AI 植生判別技術「こま切れ画像法（Chopped Picture Method）」による解析の結果、植生の判別精度は 93%であった。分類の凡例は、ヒノキを黄緑、スギを緑、竹林をグレー、二次林を黒、その他（家屋・農地・道路等）を白として示した。図１は対象地域の航空写真、図２は AI による分類結果である。図２の通り、細部にわたる竹林の分布も正確に抽出されており、AI による高精度な判別が確認できた。

図１．航空写真

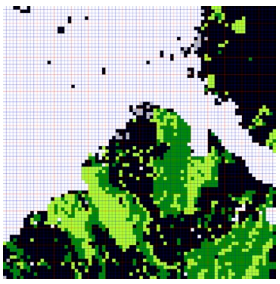

図２．AI 分析の結果

４．考察

本研究では、AI の構築作業を植生や AI 技術を専門としない文系学生が担当したが、それでも高精度な結果が得られたことから、本手法の操作性の高さと実用性の高さが示唆された。AI の精度向上において最も重要であったのは、教師画像の収集段階で誤った情報（以下「不純物」）を含めないことである。不純物が含まれると、AI が誤学習を起こし、最終的な分類精度に悪影響を及ぼす。また、教師画像の画質の粗さや、ファイルごとの枚数の偏りも AI 学習結果を左右する要因であるため、画質の高い画像を均等に収集することが精度向上に不可欠であった。今後の課題としては、AI が判別しにくい地域的特徴（例：混交林や影の多い地域など）を明らかにし、誤判別の要因を特定することで、より汎用的かつ高精度な植生判別モデルの構築を目指す。

AI-Based Analysis of Changes in Homestead Woodlands in the Tonami Plain, Toyama, Japan

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富山県小矢部市・高岡市・砺波市・南砺市に広がる砺波平野は、水田景観の中に民家が点在する特徴的な散居景観で知られている。各民家を取り囲む屋敷林は、スギやケヤキなどの高木層やカキやサザンカなどの中低木層からなり、環境緩和機能や木材や食料の供給機能を有してきた。しかし近年、砺波平野における屋敷林の減少や衰退が懸念されている。その要因としては、生活形態や生業の変化、農業形態の変化、維持費用の増大などが挙げられている。

屋敷林の減少や衰退は地域の伝統的景観のき損や文化の消失につながる可能性があるが、このような屋敷林の変化を広域・長期にわたって定量的に調査した事例は少ない。そこで本研究では、深層学習 AI（classification, 画像分類）を応用し、航空写真を基に屋敷林の変化を解明することを目的とした。

砺波平野の面積はおよそ 220 km^2 であり、このような広大な地域全域を航空写真の目視で調査するのは現実的ではない。そこで、屋敷林の変化調査のために深層学習 AI を応用した手法構築を行った。

まず、小矢部市・高岡市・砺波市・南砺市にわたる広域地域を対象として、国土地理院が提供する地理院タイルから、1975 年および 2019 年の航空写真を取得した。これらの航空写真をもとに、「屋敷林」と「その他」の領域についてそれぞれ教師データを取得し、「こま切れ画像法（Chopped Picture Method）」により植生を判別する深層学習モデルを構築した。このモデルを用いて、対象地域全域の屋敷林を識別し、識別結果を QGIS Desktop 3.28.11 に取り込み、屋敷林等のポリゴン面積を算出した。

1975 年および 2019 年の面積の算出結果を下表に示す。1975 年から 2019 年の間に、対象地域全域で屋敷林等の半数以上が失われていることが明らかとなった。識別結果の精度検証は今後の課題であるものの、相当数の屋敷林が砺波平野全体で減少したことがうかがえる。特に、高岡市および小矢部市で減少率が高く、この地域では屋敷林保全活動が十分に行われていないことが一因と考えられた。一方、砺波市および南砺市では減少率が比較的少ないことが判明した。この地域では、「散居景観を活かした地域づくり協定」により屋敷林保全活動に補助金を交付するなど、屋敷林保全に行政単位で取り組んでおり、それらの施策が一定の効果を上げている可能性が示唆された。

表　市ごとの屋敷林等の面積変化と減少率

年代	小矢部市	高岡市	砺波市	南砺市	全体
1975	1181325.301	1109384.5	3057439.211	1486257.188	6834406.199
2019	530838.0075	453673.2366	1480025.016	679233.4881	3143769.748
減少率(%)	55.1	59.1	51.6	54.3	54.0

Day 1, 14:00~14:20

Visualization of Dynamic Global Vegetation Models Using Unity: Development and Evaluation of SEIB-Explorer

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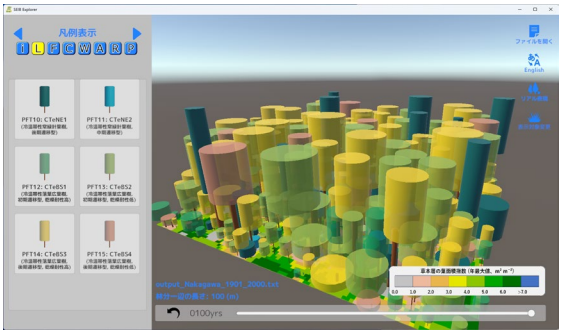
Understanding vegetation-climate interactions is essential for predicting ecosystem dynamics under global change. Dynamic Global Vegetation Models (DGVMs) play a key role in simulating such interactions, yet their increasing complexity poses challenges for interpretation and interdisciplinary collaboration. Visualization can help bridge this gap by making model behavior more accessible and intuitive.

In this study, I developed an interactive visualization tool using the UNITY game engine, designed to support the analysis and communication of DGVM outputs. The tool enables users to explore vegetation dynamics in a 3D spatial environment, incorporating individual-based interactions and basic climate variables.

I conducted a user evaluation of the prototype with participants from various fields. Survey results indicated that the interface and design were generally well-received, particularly in terms of ease of operation and visual appeal. However, several users pointed out the need for improved representation of seasonal transitions and external environmental interactions. Future development will address these aspects to enhance realism and scientific utility.

Beyond research applications, intuitive and engaging visualizations have broader potential: they can facilitate public understanding, support education, and foster pathways to real-world implementation, including policy-making and commercial use. I argue that improving the transparency and communicability of DGVMs is not only valuable for scientific progress, but also critical for connecting vegetation modeling with societal needs.

(a)  (b) 

(a) Screenshot of SEIB-Explorer in the standard display mode. The simulation represents the 100th year of forest development starting from bare ground under the repeated climate conditions of 1901–2000 in a mixed conifer–broadleaf forest region of northern Hokkaido. (b) Screenshot of SEIB-Explorer in the "realistic" display mode. The only difference from (a) is the display mode; the same simulation output is shown from the same viewpoint.

Reference

佐藤 永. 陸域生態系シミュレーションにおける可視化の役割と課題：DGVM を対象とした直感的ツール開発と利用評価. *日本生態学会誌* (in press).

H. Sato. The Role and Challenges of Visualization in Terrestrial Ecosystem Simulation: Development and Evaluation of an Intuitive Tool for DGVMs. *Jpn J. Ecol.* (in press).

Day 1, 14:20~14:40

Evaluating photosynthetic acclimation effects on global carbon–climate interactions using MIROC-ES2L

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Approximately 30% of anthropogenic CO_2 emissions are absorbed by the terrestrial ecosystems through photosynthesis, and accurate estimation of the carbon uptake is crucial for projecting future climate change. While photosynthesis initially increases with rising CO_2 (fertilization effect), observations indicate that photosynthetic capacity declines after several days to weeks under elevated CO_2 (CO_2 acclimation), and that the optimal temperature for photosynthesis shifts with growth temperature (temperature acclimation). Despite these findings, conventional land surface models typically employ fixed parameter values, implicitly assuming that photosynthetic processes are maintained at the same rates in the future regardless of environmental changes.

Our research aims to (1) incorporate CO_2 and temperature acclimation processes into the terrestrial ecosystem model VISIT (Ito and Inatomi, 2012), a sub-component model of the Earth System Model MIROC-ES2L (Hajima et al., 2020), (2) quantify the feedback effects of photosynthetic acclimation to environmental changes on the climate, and (3) assess the impact of the photosynthetic acclimation model on future climate projections.

We implemented two empirical models of photosynthetic acclimation, proposed by Kumarathunge et al. (2019) for temperature and Poorter et al. (2022) for CO_2, into VISIT. As a preliminary experiment, we conducted standalone VISIT simulations with and without acclimation functions, validated against gross primary production (GPP) data from sites with long-term flux tower observations. In MIROC-ES2L, after a spin-up run under 1850 conditions, we plan to conduct historical experiments (1850 to 2014) and future projections (2015 to 2100) based on the SSP1-2.6, SSP3-7.0, SSP5-8.5 scenarios with prescribed CO_2 emissions.

The results of standalone VISIT simulations with acclimation showed a lower interannual trend of GPP compared to those without acclimation, resulting in better agreement with observational datasets. These findings suggest that models without photosynthetic acclimation may overestimate future carbon accumulation. This research highlights the importance of representing photosynthetic acclimation processes in Earth system models for more realistic future climate predictions.

Interannual Variation of Summer Precipitation in Mongolia: Case Studies from 2016 and 2020

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Mongolia is an inland country characterized by a semi-arid climate, where land surfaces strongly influence diurnal cycle of precipitation. In northern Mongolia, summer (June-August) precipitation accounts for about 60% of the annual precipitation. Summer precipitation there exhibits large interannual variation, but the mechanisms behind this variation are not clear. Therefore, this study aims to understand the mechanisms of interannual variation of summer precipitation, focusing on precipitation caused by cyclonic disturbances and surface processes.

This study investigates summer precipitation from 2014 to 2023. To understand precipitation characteristics, we use monthly mean precipitation from PREC/L and 3-hourly precipitation from MSWEP[1]. Additionally, to clarify characteristics of atmospheric circulation fields, we use horizontal wind and geopotential height from ERA5[2].

In the Khentii Mountain (47–51°N, 106–115°E) in northern Mongolia, summer precipitation was lowest in 2016 and highest in 2020 during 2014–2023. Afternoon precipitation (11:00–20:00) accounts for 55.2% of total summer precipitation in 2016 and 63.8% in 2020. The number of afternoon precipitation days is 57 days in 2016 and 64 days in 2020. On the other hand, afternoon precipitation tended to occur after heavy rain days caused by cyclonic disturbances passing over Mongolia in both 2016 and 2020, which is probably associated with convective activity triggered by surface heating.

Analysis of atmospheric circulation fields at 850 hPa showed that westerly winds prevailed on the southern side of Khentii Mountains in 2020. These winds turned northward on the eastern side of the mountains, bringing heavy precipitation to the northeastern part of Khentii Mountains in 2020. While high-pressure anomalies at 300 hPa dominated over Mongolia in 2016, low-pressure anomalies prevailed there in 2020. Thus, the differences in summer precipitation between 2016 and 2020 can be explained by atmospheric circulation fields, and these are likely attributed to the number of cyclonic disturbances passing over this region. The detailed results will be presented in the workshop.

We will conduct a more detailed analysis of land surface processes including soil moisture and further investigate synoptic-scale atmospheric circulation pattern to comprehensively understand the mechanisms of interannual variation in the region.

References:

[1] Beck et al., Bulletin of the American Meteorological Society, 100, 473–500, 2019.
[2] Hersbach et al., Copernicus Climate Change Service (C3S) Climate Data Store (CDS), 2023. DOI:10.24381/cds.adbb2d47 (accessed on 10-09-2025

Day 1, 15:10~15:30

Evaluation of Land-Atmosphere Interactions in Interior Alaska Using a Regional Climate Model

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1. Introduction

Arctic and boreal regions are experiencing rapid warming associated with increasing greenhouse gases and polar amplification. The rapid warming impacts on terrestrial processes, leading to permafrost thaw, increased wild fires, vegetation shifts, and changes in biogeochemical cycles. Such environmental changes could result in feedback to the reginal climate through land-atmosphere interactions including surface energy and water balances.

To accurately elucidate changes in land-atmosphere interactions associated with these shifts in land surface processes, it is essential to evaluate their consequent impacts on reginal weather using the land surface model with precise parameterization. The objective of this study is to elucidate the role of land surface processes on the interactions between boreal ecosystems and the atmosphere. We parametrized a land surface model using multisite observations across boreal ecosystems and perform analyses using a coupled land surface-atmosphere modeling system.

2. Methods

We used the Noah land surface model with multiparameterization options (Noah-MP) and the Weather Research and Forecasting (WRF) model. The parameterization was performed for a black spruce forest (US-Uaf) and a young birch forest (US-Rpf) near Fairbanks, AK. We parameterized the model using site meteorological data in offline simulations for improving the performance on sensible heat flux (H), latent heat flux (LE), ground heat flux (G), soil temperature, soil moisture, and snow depth.

The WRF model domain was configured with a parent domain (d01) and a one-way nested child domain (d02), both centered on Fairbanks. The simulation was driven by meteorological forcing using ERA-5 for July 2024. The geographical input for the land grid, including topography and land use, was generated using the WPS V4 Geographical Static Data.

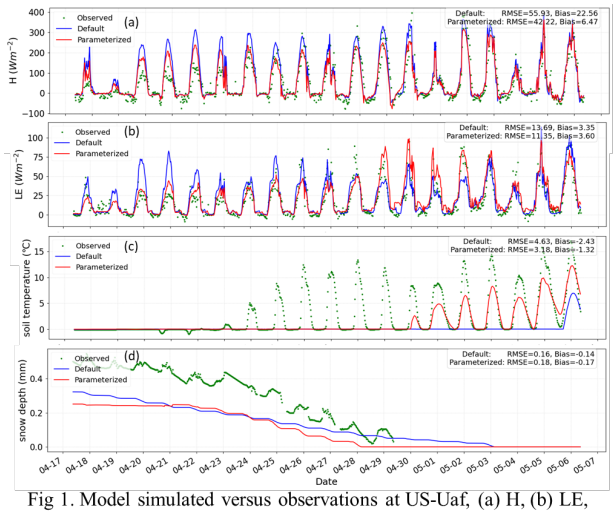

Fig 1. Model simulated versus observations at US-Uaf, (a) H, (b) LE, (c) top 5 cm soil temperature, and (d) snow depth. Root-mean-square errors and bias were shown for default and parameterized model.

3. Results and Discussion

The parameterized Noah-MP improved for H, LE, snow depth, and timing of snow accumulation and snowmelt, but had low bias on soil temperature (Fig. 1). With the default parameterization, both H and LE were overestimated, but the model performance was improved with the parameterization for canopy height, canopy wind absorption, maximum carboxylation rate at 25 ℃ (VC_{MAX25}), and stomatal conductance, and LAI. Among these parameters, VC_{MAX25} played a strongest role on LE, reducing VC_{MAX25} from 60 to 38 μmol m^{-2} s^{-1} effectively mitigated the overestimation of LE. Performance in H was improved with parameterzations for surface roughness length.

In early spring, snowmelt was overestimated, but soil temperatures were underestimated (Fig. 2). After calibrated parameters related to snow compaction and density, performance on the timing of the snow disappearance was improved. Future work will need to focus on improving the permafrost scheme to enhance the reproducibility of both the snowpack and the soil thermal environment.

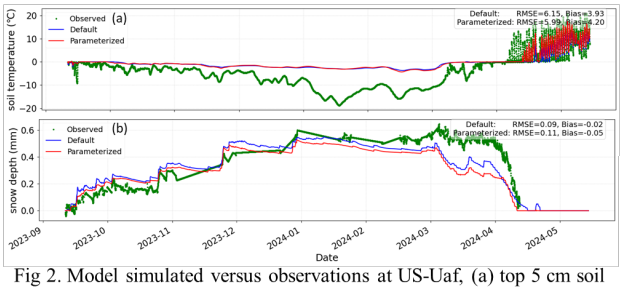

Fig 2. Model simulated versus observations at US-Uaf, (a) top 5 cm soil temperature, and (b) snow depth.

Day 1, 15:30~15:50

Energy and Water Balance in Managed Urban Green Spaces

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Introduction: The urban heat island phenomenon has intensified with urbanization and poses a critical challenge for the development of sustainable cities. The cooling effects provided by urban green spaces have attracted attention. To quantitatively evaluate these cooling effects, it is essential to understand the mechanisms of energy and water exchange between urban green spaces and the atmosphere.

In this study, we conducted eddy covariance measurements at an abandoned farmland within an urban area, where regular mowing is implemented, to clarify the factors driving the energy and water balance. Using the meteorological measurements, vegetation surveys, and measurements of leaf area index (LAI), we evaluated the cooling effect of a managed urban green space and investigated the impact of mowing management by comparison with urban sites.

Methodology: Observations were conducted in a weedy grassland on a former citrus orchard and on the roof of a building at Osaka Metropolitan University. Mowing was conducted approximately once a month. Sensible heat flux (H) and latent heat flux (LE) were measured by the eddy covariance method. Vegetation surveys were conducted just before each mowing, and the LAI for each plant species was determined using the destructive sampling method. LAI was also measured every one to two weeks using a plant canopy analyzer.

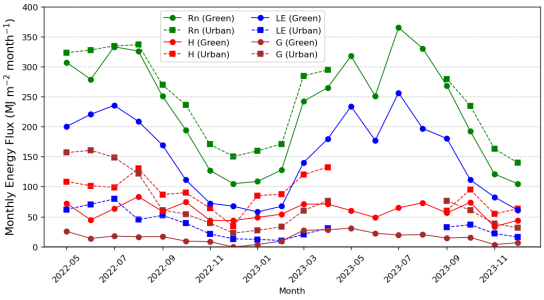

Figure 1. Monthly cumulative daytime (08:00-16:00) net radiation (Rn), sensible (H) and latent heat (LE) fluxes, ground heat flux (G) in grassland and urban sites (Data are missing from May to August 2023)

Results and Discussion: During the daytime, more than 50% of the net radiation (Rn) was partitioned into latent heat flux in the grassland (Fig. 1). The grassland partitioned at least twice as much energy into LE compared to the urban site, whereas Rn was partitioned to H and G in the urban site. The turbulent fluxes (H + LE) exceeded the available energy (Rn − G) in the grassland, especially in the afternoons during spring and autumn. Considering greater H in surrounding urban areas, these results suggest the horizontal heat advection from the surroundings to the grassland, resulting in an oasis effect.

Regarding the annual water balance, over 80% of the annual precipitation was consumed by evapotranspiration (ET). Among the factors driving ET, Rn was found to be the dominant control throughout the year (Fig. 2), exhibiting a stronger correlation with ET than canopy conductance or VPD owing to the decoupling.

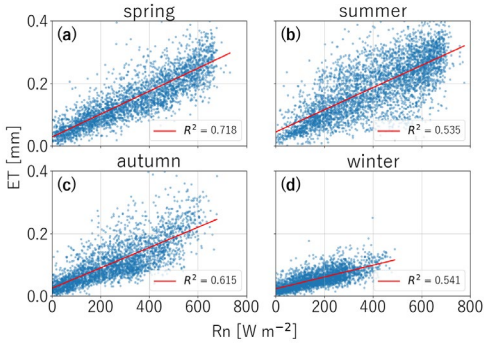

Figure 2. Scatter plots between daytime (08:00–16:00) net radiation (Rn) and evapotranspiration for each season

Canopy conductance decreased after mowing but recovered with vegetation regrowth. In contrast, the magnitude of ET reduction following mowing was influenced by precipitation events around the mowing event. The average ratio of LE to Rsd (shortwave radiation) decreased from 0.446 to 0.372 when comparing the three days before and after mowing. When precipitation (≥20 mm) occurred within three days before to one day after mowing, the average ratio of LE to Rsd only slightly decreased from 0.470 to 0.437, whereas under dry conditions it declined from 0.433 to 0.327.

Conclusion: The oasis effect may induce horizontal heat advection, potentially resulting in a large LE. ET is primarily driven by Rn. Canopy conductance decreased by mowing, while ET showed little decrease by mowing but was mainly governed by precipitation events.

Day 1, 15:50~16:10

Change in Evapotranspiration in a Black Spruce Forest in Interior Alaska from 2003 to 2025

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Objectives: Evapotranspiration (ET) is a key process linking the water, energy, and carbon cycles in terrestrial ecosystems. Recent studies suggest that increased precipitation has enhanced CO_2 uptake in interior Alaska, where warming and hydrological changes are accelerating. However, few studies have evaluated multi-decadal variability in ET required for evaluating energy, water, and biogeochemical cycles in high latitude. In this study, we investigated two decades of ET and its controlling factors in a black spruce forest underlain by permafrost in interior Alaska.

Materials and methods: Continuous observations of eddy-covariance fluxes and meteorological variables have been conducted from 2003 to 2025 at the mature black spruce forest (US-Uaf; 64°52′ N, 147°51′ W). The site is located on the campus of the University of Alaska Fairbanks and underlain by ice-rich permafrost, with dense understory and *Sphagnum* moss cover. The mean maximum LAI was about 2 m^2 m^{-2}, and the mean annual air temperature and precipitation were −3.8 °C and 342 mm yr^{-1}, respectively. We evaluated long-term trends in growing-season (May–September) cumulative ET, and daytime ET (09:00–12:00, 12:00–15:00, 15:00–18:00), using the Mann–Kendall test. The factors controlling variability of ET were analyzed in relation to vapor pressure deficit(VPD), canopy conductance(gc), gross primary productivity(GPP) air temperature, and precipitation.

Results and Discussion: The growing season ET tended to increase ($p = 0.11$; Fig. 1). This trend could be explained by an increased surface soil moisture—from an average of 4.8% during 2007–2015 to 18.1% during 2016–2024—and increased GPP (+9.2 g C m^{-2} yr^{-2}, $p = 0.01$). The growing season increase in ET was attributed to an increased afternoon ET in July and September (15:00–18:00; $p < 0.05$). The increased ET in September was explained by an increased gc ($p < 0.02$), possibly due to prolonged growing season. In contrast to the growing season, no clear trend was observed in ET during the non-growing season.

During the midday in the growing season (11:00–15:00), growing season mesn gc were negatively correlated to those in VPD($p < 0.01$; Fig. 2). In the latter half of the study period (2015–2024), we observed a decrease in VPD, which was accompanied by a corresponding increase in gc. This shift was associated with widespread increased relative humidity in interior Alaska($p < 0.01$), because relative humidity by the ERA5 reanalysis increased in across interior Alaska, likely change in atmospheric transport and associated advection of water vapor. These results suggest that wetter and more humid conditions have reduced atmospheric water demand.

Future work: The growing season ET in the black spruce forest increases by 0.73 mm yr^{-1} from the two decades. The increased ET was explained by increased soil moisture, increased GPP, decreased VPD, and increased gc. Future work will include linear perturbation analysis to further elucidate the mechanisms controlling ET, partitioning ET into evaporation and transpiration components, and examining these changes in the context of the ongoing hydrological shifts in Alaska.

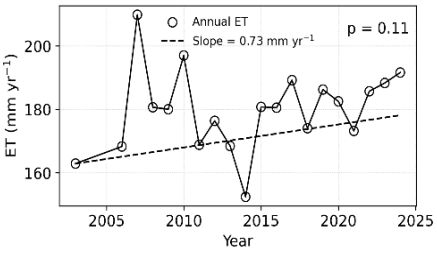

Fig.1. Growing season ET (May–September). Dashed line shows the trend; 2004 and 2005 were excluded due to long data gaps.

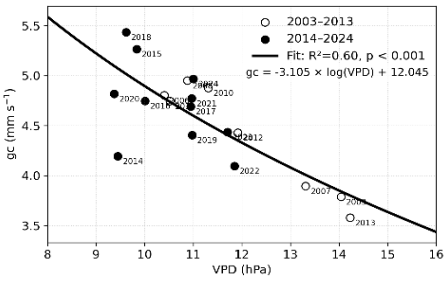

Fig.2. Relationship between mean midday (11:00–15:00) canopy conductance (gc) and vapor pressure deficit (VPD) during the growing season from 2003 to 2024.

Day 1, 16:10~16:30

Effects of Weed Management on Partitioning Evapotranspiration

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Objectives: Evapotranspiration (ET) is the water vapor exchange between the atmosphere and biosphere. ET consists of two components of evaporation (E) and transpiration (T). Partitioning ET is crucial for understanding the water cycle and biosphere-atmosphere interaction. In this study, water vapor fluxes measured by the eddy covariance (EC) method are partitioned using three methods, and the dynamics of their contributions are investigated.

Materials and methods: The observation was conducted at a grassland in Osaka Metropolitan University, where, weed management through mowing is conducted approximately once a month. We partitioned ET using three methods of FVS, uWUE, and TEA methods. The FVS method partition ET and CO_2 exchange based on Monin Obukhov similarity theory in turbulent transfer of water vapor and CO_2 during the half hour. The uWUE method used a linear relationship between ET and GPP for dry canopy during which water use efficiency (WUE) under given vapor pressure deficit was determined. The contribution of T to ET is calculated from determined and instantaneous WUE. The TEA method trains a random forest regression to make predictions of GPP/T during dry periods, and apply the predicted values to each time period.

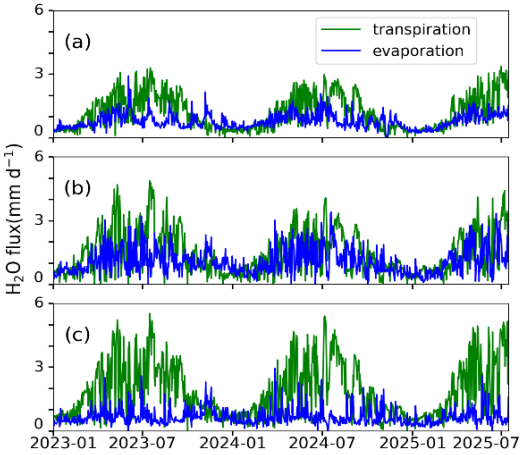

Fig.1.Daily T and E fluxes (a) FVS method (b) uWUE method (c) TEA method

Results and Discussion: From June to September, T accounted for approximately 67.4% of the ET by FVS, 61% by uWUE, and 80.5% in TEA (Fig. 1). Mowing reduced the 3-day total T in mid-summer by only 27% based on FVS, 44.3% based on uWUE, and 42.2% based on TEA (Fig. 2), smaller than expected because all the weeds were removed and GPP substantially decreased. The FVS method failed to estimate the reduction in T associated with moving, possibly because the method assumes negative CO_2 flux during the daytime. Positive CO_2 flux in daytime just after mowing lead to incorrect estimation of T in FVS. The three methods, showed that T did not drop to zero after the mowing, indicating that plant activity persisted through residual grasses. It is thought that the roots actively draw up water and nutrients to help the plant regrowth, and this T might increase quickly due to the recovery.

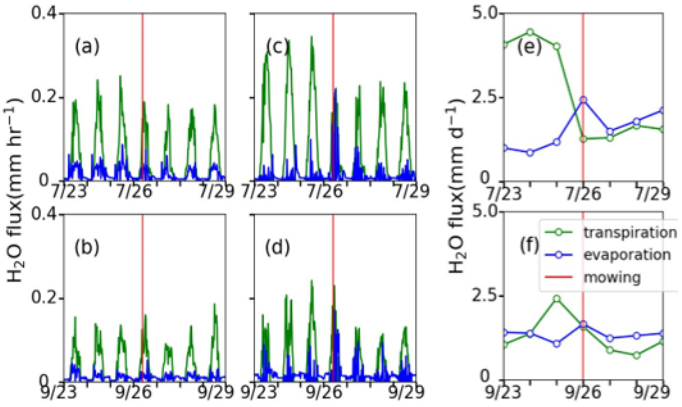

Fig2. Half-hourly (in (e), (f), daily) T and E flues before and after mowing during the mid-summer (a, c, e) and the late summer (b, d, f) in 2023 based on the FVS method (a, b), TEA method (c, d), and uWUE method (e, f).

Conclusions: In this study, we partitioned ET into T and E by using three methods and examined the effects of seasonal variations and mowing. The partitioned fluxes showed the greater contributions of T to ET (54-86%) in summer and less contributions of T (34-65%) in winter. When comparing the three methods, the TEA method estimated the largest contribution of T, that is consistent with previous studies. Mowing decreased T, but T from residual grasses could have contributed 61-81% of ET during the summer.

Day 1, 16:40~17:00

Unraveling Blue Carbon: Toward the Assessment of an Uncertain Carbon Sink

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Objectives: With the continuous increase in carbon dioxide, the conservation and restoration of ecosystems that act as carbon sinks have become critical issues. Among the ocean's carbon sinks, carbon stored in areas directly influenced by human activity is referred to as Blue Carbon (mainly coastal vegetations). While the importance of Blue Carbon is growing toward achieving carbon neutrality, quantifying the Blue Carbon remains challenging. In particular, seaweed, often categorized as Emerging Blue Carbon, lack sufficient data on carbon sequestration compared to other Blue Carbon ecosystems such as seagrass, mangroves and salt marshes. In Japan, seaweed beds are considered the most crucial component of Blue Carbon. Therefore, we initiated a project to evaluate the status of Blue Carbon across seaweed beds nationwide in Japan.

Methods: Japanese coastal sea includes wide environment from cold to warm waters, and this variety means that findings obtained across Japan are expected to be applicable to various seaweed beds globally. Additionally, Japan benefits from numerous marine stations located along its coastlines. By utilizing these facilities as bases, nationwide coastal surveys become feasible. This project collaborated with Tara Ocean Japan, which conducts surveys of Japan's marine ecosystems and environment, and JAMBIO, a network organization connecting Japanese marine stations, to implement a nationwide survey of seaweed beds.

Results and Discussion: In addition to collecting fundamental ecological information such as biomass and biodiversity for each ecosystem, we are proceeding with analyses of photosynthesis and the fate of organic matter. The results from the 2024 survey indicated that the photosynthesis of large seaweed like kelp is considerably greater than that of smaller algae or seagrass beds. This finding suggests that the decline of kelp species due to ocean warming could have severe consequences for coastal carbon cycling. We plan to continue our surveys in 2025, compiling results from 11 marine sites nationwide to undertake a comprehensive clarification of the status of Blue Carbon.

Day 1, 17:00~17:20

Carbon Dynamics and Their Environmental Factors in Spring-Fed Wetlands A ~Case Study at Ananomiya~

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湿地は炭素を大量に貯留し、温室効果ガスの放出に重要な役割を果たすことが知られている。日本における湧水湿地は、地下水の湧出によって常に新鮮な水が供給され（富田, 2018）、通常の湛水湿地とは異なる水環境を有するものであるが、その炭素動態は十分に解明されていない。本研究では、湧水湿地における土壌炭素量および CO_2 フラックスの空間的・季節的パターンを明らかにし、微地形や環境因子が炭素動態に与える影響を評価することを目的とした。

調査は、東京大学農学部附属生態水文学研究所・穴の宮試験流域内の湧水湿地において実施した。調査地は、環境が異なる源頭部（9m²）と、その下流部でイネ科植物が優占する湿地部（50m²）の 2 つに区分した。源頭部はさらに林縁部・沼地部・草本部の 3 区画に分けた。CO_2 フラックスは、源頭部では各区画の差異を比較するためチャンバー法を用い、10 分間の CO_2 濃度変化から算出した。湿地部では広域のガス交換特性を把握するため、渦相関法を用いて連続観測を行った。土壌炭素量は、源頭部では各区画で 5 箇所から表層 5 cm を採取し平均値を算出した。湿地部では上流・中流・下流の 3 地点で 30 cm ライナーを用い、深度別に炭素量を算出した。さらに、気温、地温、日射量、土壌含水率を環境因子として測定し，Boosted Regression Trees（BRT）解析によりフラックスへの影響度を評価した。

その結果、土壌炭素量は流下方向に沿って増加する傾向を示し（図 1，表 1）、湧水の供給が土壌炭素の移動・分布に寄与している可能性が示唆される（Fensham et al.,2004）。また、湿地部では深度 5 cm 以下で炭素量が極めて少なく、約 100 年前まではげ山であったという土地履歴と照らし合わせると堆積が進みにくい環境であることが示唆された。フラックスの結果（図 3）では、源頭部の値は湿地部に比べ全体的に小さく、林縁部ではばらつきが大きい一方で、沼地・草本部ではほぼ 0 に近い値を示した。渦相関法による湿地部のフラックスの値は、夏季に高く、冬季に 0 へと収束する季節変動が明瞭にみられた。BRT 解析の結果、気温がフラックスに最も強く影響する要因として抽出され、次いで土壌水分や日射が寄与した。これらの結果から、土壌呼吸は表層で主に生じており、そのため地温よりも気温の変化がフラックス変動をより強く反映したと考えられる。

総合すると、穴の宮湧水湿地では、CO_2 フラックスの季節変動は気温によって支配される一方で、空間的な差異は湧水分布や水文条件の不均一性によって形成されていることが明らかとなった。したがって、湧水湿地における炭素動態は、気候要因よりも湧水によって生じる局所的な水文環境に強く依存していると考えられる。

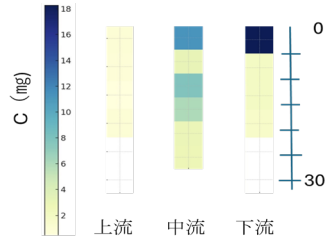

図1. 湿地部・土壌炭素

	林縁	沼地	草本
2024	32.6±11.1	57.6±30.6	90.7±57.9
2025	73.4±37.7	46.8±1.8	80.8±12.8

表1. 源頭部・土壌炭素（g/m²）

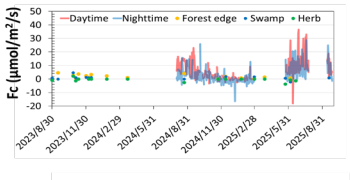

図2. フラックス結果

Day 1, 17:20~17:35

Atmospheric CO_2 Growth Response to the Three-year Consecutive La Niña Events during 2020-2023

Hibino SATO [1*], Masayuki KONDO [1]

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This study investigates the response of the atmospheric CO_2 growth rate during the recent triple-dip La Niña events from 2020 to 2023. The CO_2 growth rate, defined as the annual change in atmospheric CO_2 concentration, reflects both climatic variability—such as ENSO—and anthropogenic impacts on ecosystems. Typically, La Niña events are associated with a reduced CO_2 growth rate due to enhanced terrestrial carbon uptake. However, compared with the strong anomaly of –1.09 PgC yr^{-1} in 1999, the anomalies during the 2020–2022 La Niña years were –0.263, –0.593, and +0.061 PgC yr^{-1}, indicating a much weaker reduction in CO_2 growth.

To assess the underlying drivers, a bottom-up approach has been used to estimate the CO_2 growth rate by summing the annual fluxes of major components that comprise the growth rate: fossil fuel emissions (E_{FOS}), fire emissions (E_{FIRE}), land-use change emissions (E_{LUC}), ocean sink (S_{OCEAN}), and land sink (S_{LAND}), expressed as:

$$CO_2 \text{ growth rate} = E_{FOS} + E_{FIRE} + E_{LUC} + S_{OCEAN} + S_{LAND}$$

While the Global Carbon Budget estimates these components based on ensemble averages of process-based model simulations, this study employs statistical combinations of independent component datasets (>2,000 combinations) to generate multiple CO_2 growth rate estimates. Rather than treating dataset differences as uncertainties, this approach interprets them as alternative representations of the CO_2 growth rates, allowing identification of the dominant contributors to interannual CO_2 variability associated with ENSO phases.

By identifying combinations that closely reproduce observed atmospheric CO_2 growth rates and conducting spatial analyses of these components, the study provides new insights into the mechanisms governing CO_2 growth rate variability during the triple-dip La Niña, emphasizing the complex interactions between regional carbon fluxes and global climate variability.

Current activities of Seto Inland Sea Carbon-neutral Research Center, Hiroshima University

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The Seto Inland Sea Carbon-Neutral Research Center was established in FY2023 that strongly promotes carbon neutrality (CN) in order to contribute to solving international environmental problems, focusing on the biodiversity of unique inland sea environments.

The Center is composed of three research divisions. The Sustainability Division oversees these three divisions and aims to promote the societal implementation of innovative technologies developed by the Center. It also conducts quantitative understanding of global carbon cycle through highly accurate estimation and monitoring of greenhouse gas (GHG) emissions from land and ocean, advances climate change predictions, and conducts research and proposes effective actions internationally, centered on data science and digital transformation. The Blue Innovation Division develops CO_2 absorption and sequestration technologies in marine ecosystems, CO_2 utilization technologies using highly proliferative algae, and promotes education and research on carbon changes due to ocean acidification. The Green Innovation Division estimates the carbon storage capacity of satoyama forests using terrestrial plants suitable for sustainable carbon fixation, establishes technology for direct atmospheric CO_2 fixation by microorganisms, and promotes education and research on carbon recycling.

The Center also oversees three field research facilities in island and coastal areas: the Miyajima Natural Botanical Garden, the Mukaishima Marine Biological Laboratory, and the Takehara Fisheries Research Station.

There are not many research organizations that combine GHG research with innovation in carbon recycle and carbon reduction technologies. We encourage you to take advantage of our research capabilities, facilities, and fields to tackle this urgent issue in an interdisciplinary manner.

Declining Methane Emissions from Oil & Gas: Uncovered by Atmospheric Observation in Western Siberia

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Methane (CH_4) emissions from the oil and gas (O&G) sector account for approximately 20% of anthropogenic emissions. Russia is a significant emitter and is regarded as one of the largest contributors to CH_4 emissions from the O&G sector. However, estimated emissions vary significantly between bottom-up (BU) approaches (inventories) and top-down (TD) approaches (atmospheric inversion models), and there is no consensus on whether the trend is increasing or decreasing. The National Institute for Environmental Studies (NIES) operates atmospheric measurements of CH_4 and CO_2 concentrations through the Japan-Russia Siberian Tall Tower Inland Observation Network (JR-STATION). We selected three sites in Western Siberia for three primary reasons: (1) Western Siberia is a major source region of CH_4 emissions from the O&G sector in Russia; (2) the observation towers are located near O&G facilities (extraction sites and pipelines); and (3) the sites are located over 200 km away from urban areas, thereby minimizing potential interference from local anthropogenic activities. For analyzing CH_4 and CO_2 variations near the ground, we utilized nighttime data (20:00–05:00) during the winter season (December, January, and February) to reduce the effects of CH_4 emissions from wetlands in Western Siberia, biospheric CO_2 fluxes, and atmospheric dilution by vertical mixing. Our analysis reveals a nighttime accumulation of excess CH_4 and CO_2 (ΔCH_4 and ΔCO_2, calculated by removing the global upward trends of CH_4 and CO_2 from atmospheric observation data) in response to decreasing temperatures, with a strong linear correlation (p-value < 0.01) between the variabilities of ΔCH_4 and ΔCO_2 during winter. This pattern motivates the hypothesis that an increase (or decrease) in the ratio of $\Delta CH_4/\Delta CO_2$ may reflect a corresponding increase (or decrease) in CH_4 emissions from the O&G sector in Western Siberia. This ratio has declined from 2005 to 2021 at two sites located several hundred kilometers apart, indicating a reduction in CH_4 emissions from O&G facilities in Western Siberia, assuming that wintertime biospheric CO_2 fluxes have remained constant. Integrating national scale estimates from BU and TD datasets with observational data shows consistent declining trends in both the Community Emissions Data System (CEDS) and the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS), aligning with the observed reductions in emissions. As of 2019, CEDS indicates a reduction of 2.3 Tg/year compared to 2006, while GAINS shows a decrease of 2.8 Tg/year as of 2020.

Day 2, 09:50~10:05

Greenhouse Gas Budget Estimations of Papua New Guinea for 2000-2019

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Global warming has intensified in recent decades, mainly owing to anthropogenic greenhouse gas (GHG) emissions. To mitigate this issue, many countries ratified the Paris Agreement, with each signatory setting their own nationally determined contributions (NDCs). For countries to achieve their NDC targets, it is essential to establish an accurate GHG budget at the national level. This study aims to estimate the greenhouse gas budget of Papua New Guinea (PNG) for the period 2000-2019 and to evaluate the current status of PNG with respect to its NDC goals. The national GHG budget was assessed using a bottom-up approach that integrated anthropogenic and natural components of CO_2, CH_4, and N_2O fluxes that arise from multiple sectors. Our analysis indicates that PNG functions as a net CO2 sink, with natural sink components playing a dominant role in the GHG budget. The vegetation sink flux provided substantial CO2uptake by PNG. Additionally, a relatively large amount of carbon removal and transport associated with chemical weathering and river export represent characteristic features of PNG's carbon dynamics. These processes are likely influenced by the country's geological features, including its extensive volcanic mountains and river systems. Despite these characteristics, one of the NDC goals of PNG is to reduce annual emissions from deforestation and forest degradation by 10 Tg CO_2eq by 2030, relative to 2015 levels. While emissions from forest land-use change (FLUC) are not significant enough to affect overall net sink, they are steadily increasing. Despite the net GHG sink demonstrated in this study, PNG will need to strengthen regulations and policies addressing FLUC if it chooses to achieve its NDC target. Future research should focus on reducing uncertainties in budget estimates and monitoring the impact of socioeconomic change on PNG's ability to meet its climate commitment.

GHG Budget Assessment of Myanmar for 2000-2019

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Climate change caused by greenhouse gas (GHG) emissions is one of the most serious global environmental problems. The Paris Agreement requires all countries to monitor and reduce their GHG emissions to limit global warming to below 1.5°C. To make effective policies, it is important to know each country's GHG budget, which is the net balance between emissions and absorption. Regional GHG budgets have been assessed in the 2nd phase of the REgional Carbon Cycle Assessment and Processes (RECCAP-2), which identified Southeast Asia as a major net GHG source (Kondo et al., 2025). However, country-scale budgets are still necessary to support the national policies. Myanmar, a developing country in Southeast Asia, has large forest areas and relatively low fossil fuel use, however its overall GHG balance remains unclear. This study aims to assess Myanmar's national GHG budget from 2000 to 2019 and identify the main sectors contributing to emissions and sinks.

This study was conducted using data obtained in the RECCAP-2 framework (Ciais et al., 2023). Fossil fuel emissions were obtained from the Global Carbon Budget, CEDS, and EDGAR databases. Land-use change was derived from BLUE, OSCAR, Houghton & Castanho, and fire emissions were obtained from GFED5, FINNv2.5, QFED2.5, and GFAS1.2. CH_4 and N_2O emissions from the agriculture and waste sectors were collected from FAOSTAT and EDGARv8.0. All fluxes were converted to CO_2-equivalent (CO_2eq) using the 100-year Global Warming Potential (GWP100) values from the IPCC Sixth Assessment Report, allowing for a comparison between different gases.

The gross GHG emissions of Myanmar during 2000–2019 were estimated at 792.65 ± 192.36 TgCO_2eq, including CO_2 (628.73 ± 191.71 TgCO_2), CH_4 (108.24 ± 5.16 TgCO_2eq), and N_2O (55.67 ± 14.93 TgCO_2eq). The gross sinks were −367.95 ± 33.57 TgCO_2eq, resulting in a net emission of 424.70 ± 195.27 TgCO_2eq. The largest CO_2 sources were fires (33.4%) and deforestation (33.1%), while major CH_4 emissions originated from rice cultivation (4.2%) and livestock (3.0%). Emissions from fossil fuels (oil, gas, and coal) accounted for only 2.54% of the total emissions. These findings show that Myanmar was a net source of GHGs during this period, mainly due to fires, land-use changes and agricultural activities.

In future research, we will compare these results with Myanmar's Nationally Determined Contribution (NDC) to evaluate its progress toward climate goals and provide policy recommendations for effective GHG mitigation.

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Day 2, 10:35~10:55

Trends for Glacial Lake Outburst Floods in High Mountain Asia, 1961–2023

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2 Graduate School of Innovation and Practice for Smart Society, Hiroshima University
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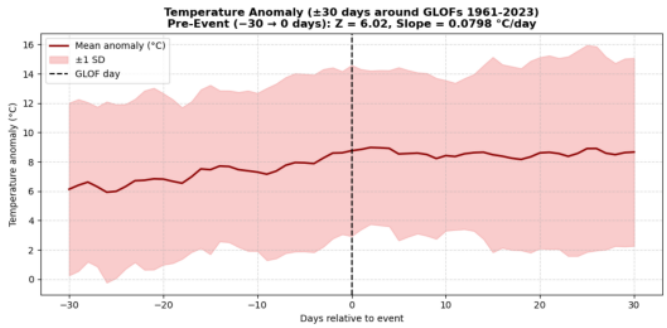
Mountains cover over one-fifth of the Earth's land surface and support nearly half of humanity through vital ecosystem services. Climate change is transforming mountain environments, intensifying hazards such as avalanches and glacial lake outburst floods (GLOFs). These changes have severe implications for downstream communities, ecosystems, and infrastructure.

High Mountain Asia (HMA), also known as the Third Pole, contains over 95,000 glaciers and about 30,000 glacial lakes whose number and area grew by +5.9% and +6.8%, respectively, between 1990 and 2015. Between 1833 and 2024, 754 GLOFs were recorded in this geologically young, seismically active region. This research (in progress) builds on and extends a 2023 study on the GLOF inventory by integrating detailed climatological variables and trends from CRU-TS 4.08 and ERA5-Land datasets to identify long-term relationships between HMA sub-regions, GLOF drivers, and lake elevations, alongside temperature and precipitation time series.

Figure 1: Temperature anomaly relative to 1961-2023 for +/- 30 days around GLOF events (source ERA5-Land)



Preliminary results show the following:
(1) an increasing GLOF occurrence from lakes above 4,000 m compared to those below;
(2) positive temperature anomalies in the 30 days preceding GLOF events regardless of the triggering driver; and
(3) a positive precipitation trend in the 30 days prior to precipitation-driven events.

This study provides preliminary evidence that GLOF activity in High Mountain Asia is influenced by climatic factors. More GLOFs now originate above 4,000 m, reflecting glacier retreat and expansion of glacial lakes. These trends point to enhanced thermal and melt-driven instability in the region. The combination of climatological, hydrological, and geomorphological data can be used to refine risk models. Such insights will support more effective early warning and adaptation strategies for mountain communities, governments, and other stakeholders.

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Day 2, 10:55~11:15

Net balance of volcanic GHG uptake and release

Masayuki Kondo [*1],

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Volcanic eruptions and activity are known to release sulfur dioxide (SO_2), hydrogen fluoride (HF), formyl radical (HCO), and especially carbon dioxide (CO_2). Historically, CO_2 emissions from volcanoes have played an important role in the dynamics of the Earth's surface. Volcanic activity in the past has been extremely large-scale, from the time of primitive organisms to the time of trilobites and reptiles. Furthermore, volcanic activity in these eras is believed to be the cause of past extinction crises. Volcanic ashes emitted by large-scale volcanic eruptions blocked solar radiation, causing global cooling and threatening the survival of surface organisms. Second, CO_2 released into the atmosphere by eruptions is thought to have caused rapid global warming, contributing to the extinction crisis.

However, current CO_2 emissions from volcanic activity have been reported to be significantly smaller than those from fossil fuel combustion. Current estimates suggest that global emissions from volcanic activity account for only a few percent of the 35 gigatons of CO_2 emitted from fossil fuel combustion. However, direct estimation of CO_2 emissions from volcanic activity is difficult, and no established method currently exists. Previously, the common approach was to estimate the CO_2 to SO_2 ratio (CO_2/SO_2) for each volcanic belt and then convert it to CO_2 emissions using relatively easy-to-estimate SO_2 measurements. However, new sensors deployed lately have revealed that CO_2/SO_2 ratio methods significantly underestimate CO_2 emissions from volcanic activities.

In this study, we reexamine the scale of CO_2 emissions from volcanic activity and propose an integrated estimation scheme for CO_2 absorption and absorption due to volcanic activity, taking into account the indirect impact of volcanic activity on the carbon cycle through vegetation. This may lead to an opportunity to reconsider the impact of volcanic activity on the carbon cycle, which has previously been underestimated.