

FLUXNET Community Council Newsletter

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April, 2024 FCC Issue No. 3

FLUXNET Community Council Welcome Letter

FCC Issue No. 3, April 2024



Dear FLUXNET Community,

This edition of our newsletter celebrates the dedicated efforts of the FLUXNET working groups, focused on Education, Outreach, Open Source Code, CH_4/N_2O , and Data Integration.

Education has always been a cornerstone of FLUXNET's mission, and the Education Working Group been busy bringing it to the forefront. Check out the new 'Education' tab on www.fluxnet.org, which now hosts FluxCourse materials both in English and en Español. The Outreach Working Group's efforts have been equally ambitious, spearheaded by initiatives that aim to bridge the gap between flux science and the public. Particularly exciting is a new initiative to host artist residencies at flux towers, using flux data to visualize environmental change. The Open Source Code Working Group is working on an upcoming webinar series and the launch of a new website dedicated to coding best practices and open-source development, the CH₂/N₂O Working Group is developing accessible guidelines and sharing open-access resources, and the Date Integration group is working to increase the accessibility and useability of FLUXNET resources. Thank you to everyone involved in these working groups for your dedication, and for inspiring us all with your work. And a special thanks to Minseok Kang for highlighting these efforts, and many more, throughout this issue.

Trevor Keenan, Chair, FLUXNET Community Council

FLUXNET Community Council Members





(from top left: Trevor Keenan, Kyle Delwiche, Rose Cleverly, Dennis Baldocchi, Shuli Niu, Gregor Feig, Kazuhito Ichii, Minseok Kang, Natalia Kowalska, Jorge Pérez-Quezada, Stefan Metzger, Caitlin Moore, David Moore, Magna Moura, Débora Regina Roberti, Jacob Nelson, Kim Novick, Dario Papale, Tonantzin Tarin, Vincent Odongo, Gabriela Shirkey) 2

Flux science from around the world

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Flux measurements at Lake Suwa

Inland waters influence the local meteorology through its unique surface energy balance, and it is known that including its effect in atmospheric simulation is important to predict the local weather. Inland waters are also an important component of terrestrial exchanges regarding of areas greenhouse gases, especially CH₄. We started eddy covariance observation at a shallow eutrophic lake, Lake Suwa, located in central Japan in 2015, and a CH, analyzer was added to the system in 2016.

We developed a method to partition the eddy covariance net CH, flux into diffusive and ebullitive fluxes, two important pathways of CH, emission. The method is based on the wavelet decomposition and local scalar dissimilarity caused by ebullition, i.e., sudden increases in CH₄ concentration, is detected. Applying the method, we exhibited that the partitioned fluxes showed known environmental dependences: wind speed dependence of diffusive flux and low-pressure trigger ebullitive on flux. We also



The observation mast installed at Lake Suwa. Campbell CSAT3 sonic anemometer and Li-Cor LI-7700 CH_4 analyzer are used for the flux observation.



Students sampling a sediment core. The sediment core was used in an incubation experiment for CH_a production.

revealed that accumulations of dissolved CH_4 and bubbles in water and sediment, respectively, need to be considered to explain the short-term variation in fluxes.

Another interesting feature of Lake Suwa is the presence of CH_4 bubble seeps within and around the lake. Geological CH_4 of about 30,000 years old is stored below clay layers deep in the ground and the CH_4 seeps through the sediment layer. One such seep spot is located in the flux footprint, enabling



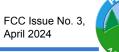
Seep spots identified as unfrozen lake surface

seep spots identified as unfrozen lake surface in winter. Such seeps are known to exist in the littoral zone of Lake Suwa.

us to quantify the CH₄ emission from the seep as well. Seasonally, the emission from the seep decreased as the total static pressure increased in fall, suggesting that high pressure at the lake bottom physically suppressed the bubble release from the sediment pores.

Our 2015-2018 data are available in <u>AsiaFlux (site ID: SWL)</u> or <u>FLUXNET-CH₄ (site ID: JP-Swl)</u> database, and data up to 2022 will be included in a coming JapanFlux database. The program code for the flux partitioning is also available from the link below. <u>https://science.shinshu-u.ac.jp/~hiwata/program.html</u>

Interested in featuring your science in our next FLUXNET newsletter? Email us at fluxnet.cc@gmail.com.



ICOS

- <u>ICOS Science Conference 2024</u> will be held from September 10th to 12th, 2024, at Versailles Palais des Congrès, France, and online.
- In November 2023 the General Assembly of ICOS agreed on the funding of ICOS network and services for the 2025-2029 period. Currently the Ecosystem ICOS network counts 103 stations.
- The flux and meteo data until December 2023, including a product fully compliant with the FLUXNET2015 and other networks using ONEFlux, are published in the ICOS Carbon Portal.

OzFlux

- OzFlux recently appointed a new Director, Prof. Stefan Arndt (University of Melbourne) and a new Chair, Prof. Elise Pendall (University of Western Sydney) to its steering committee. OzFlux thanks its outgoing Director Dr. Rose (Jamie) Cleverly and Chair Dr. Helen Cleugh for their dedication and service in these roles.
- The Terrestrial Ecosystem Research Network (TERN <u>https://www.tern.org.au/</u>) that operates many of the OzFlux tower sites has received a funding extension until mid 2028 and currently develops a new business plan.
- The Australian federal government has announced a new Zero Net Emission in Agriculture CRC. This 10-year research program will address how to reduce emissions in the agriculture sector, and flux towers will be an important component in the research and demonstration on farms of the CRC

ChileFlux

• The carbon fluxes monitoring stations located at the Senda Darwin Biological Station, in the Chiloé island in southern Chile, have completed 10 years of measurements. These towers are monitoring a peatland and an old-growth forest. On the occasion, the country's Minister of the Environment, Maisa Rojas, accompanied by the Minister of Rural Affairs, Agrarian Reform and Islands of Scotland, Mairi Gougeon, visited the facilities and learned about their operation and their main results. Also on the occasion, the Chilean minister socialized at a press point the bill for the environmental protection of peatlands that is ready to become law, recognizing this pioneering study site in investigating these wetland ecosystems in Chile. The Scottish delegation included scientists from the Nature Agency (NatureScot); the Royal Society for the Protection of Birds (RSPB); and the UK Center for Ecology & Hydrology (UKCEH) (link)



- The AsiaFlux 2024 Conference "Ecosystem flux measurements for carbon neutralization" will be held at China University of Geosciences, Wuhan, from October 28 to November 1, 2024 to strengthen academic communication and cooperation on ecosystem carbon flux monitoring and carbon storage assessment.
- We are pleased to announce the release of an updated dataset for the Takayama deciduous broadleaf forest site (<u>TKY</u>, covering the years 1998 to 2021) and Jambi oil palm plantation site (<u>JOP</u>, 2014-2020), now available on the <u>AsiaFlux Database</u>.

MexFlux

- MexFlux has recently achieved a significant milestone by being recognized as a National Laboratory by the Mexican science council (Consejo Nacional de Humanidades Ciencia y Tecnología, CONAHCYT). This designation as the LNC-MexFlux provides us with access to grants for funding for the upcoming years and offers the opportunity to expand our community, ensuring the continued operation of our sites.
- Moreover, we are actively developing the Spanish Fluxcourse tailored for the Latin American audience. Enhancing collaboration with the AmeriFlux community can be achieved by implementing a "train the trainers" program in Mexico.
- Notably, three MexFlux sites participated in monitoring fluxes during the solar eclipse on April 8th, fostering increased collaboration among research groups across North America.

AmeriFlux

- Workshop registration for "Remote Sensing and Fluxes Upscaling for Real-world Impact" is now open. Sign up here!
- The community working group about Solar Eclipse Impact on Ecosystems has been connecting groups in or near the path of totality of the April 8, 2024 solar eclipse to gather detailed data during this celestial event. Look out for their forthcoming blog post and AGU session!
- The 2024 AmeriFlux Annual Meeting will take place in Berkeley, CA, Sept 4-6. All career stages are welcome! Virtual participation in plenary sessions will be free. Look for more information on session themes, travel stipends and logistics.
- To stay up to date on AmeriFlux events and opportunities, subscribe to the mailing list.



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The FLUXNET Education Working group is proud to introduce the new 'Education' tab on the FLUXNET website. This tab contains the beginnings of an archive of presentations, lectures, and educational materials covering various topics related to the work being done by the FLUXNET community. The materials currently available are from the 2022 edition of <u>Fluxcourse</u> along with videos from other FLUXNET and regional network activities

In addition to the original English versions of these materials, versions <u>translated into Spanish</u> are also available. This work is the culmination of efforts by members of the newly formed <u>FLUXNET Education Working group</u>, who have been working for the past year to organize and translate materials for a wider audience of the flux community. The committee is also open to translation into different languages depending on interest and availability of individuals to contribute to these efforts.

The committee thanks all authors who have contributed materials and agreed to make them publicly available. While this is a good starting point, we recognize that lectures are being given on flux related content in various languages across the globe. We invite flux educators to contribute presentations or other materials, particularly in languages other than English, so we can highlight them or link to them via the new Education tab on the FLUXNET website. If you are interested in contributing to this effort please fill out this <u>survey</u>.



Ana Maria Restrepo Acevedo and Tyler Roman *Working Group Leads*

FLUXNET Working Groups: Outreach

Our mission is to create and enhance opportunities for disseminating flux science to broad audiences and inspire the flux community to actualize change.

In 2023, the Outreach working group initiated dynamic conversations.

Community Growth:

We successfully recruited passionate individuals from different countries and career stages. Working group members' diverse expertise and shared enthusiasm and commitment have enriched our collaborative environment.

Strategic Meetings:

Monthly meetings, continuously held serve as a cornerstone for idea consolidation and strategic planning. These sessions provided a platform for brainstorming, sharing insights, and refining our planned outreach activities.

Conference Presence:

Our commitment to sharing ideas extended to major conferences, including FLUXNET 2023, Ameriflux 2023, Asiaflux 2023, and AGU 2023. We held forums to reshape and reform our approach to outreach and action items based on feedback and insights from the broader scientific community.





April 2024

FLUXNET Working Groups: Outreach

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In 2023 the FLUXNET Outreach Working Group initiated exciting initiatives and motivated remarkable momentum

Activities in Development:

Outreach Material Templates: Streamlining communication through visually engaging and informative materials using vocabulary that a broader audience can easily understand. Compiling, translating and adapting new and existing materials written in English into other languages.
Glossary & Semi-Technical Bridge Publication: Offering a list of plain language equivalents to flux technical terms, concepts, and references to make flux science clear and easy to understand for non specialists. Producing dynamic guides and linking to online glossaries and websites.
Podcast: Exploring new public avenues for hosting conversations and fostering discussions between scientists and stakeholders about the role, needs, opportunities, and barriers of flux observations. Connecting to science podcast producers to expand flux science awareness.
Artist Residencies at Flux Towers: An innovative project blending art and science to empower society to feel and understand environmental change via various artistic mediums.

Funding Supplement for Piloting Creative Outreach:

A major milestone was securing an outreach funding supplement from the Accelerating Research through International Network-to-Network Collaborations program (AccelNet) at the National Science Foundation. This funding supplement will support four FLUXNET artist residencies in collaboration with the Patricia Valian Reser Center for the Creative Arts (PRAx) at Oregon State University.

We extend our gratitude to all working group members for their dedication and collaborative spirit. Here's to another year of growth and impact advancing outreach and making a lasting difference in the flux community!







Maricar

Aquilos





... and others

Jason Kelley

Maoya Su Bassiouni

Sung-Ching (Nick) Lee Carlos Roman Emma Reich Cascon Robert Shortt Shiqin Shu

FLUXNET Working Groups: Open Source Code

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The Open Source Code Working Group has a <u>new website</u>, where we have been working on a <u>resources guide</u> about coding best practices and open-source code development. Our website is <u>open-source</u> and we welcome <u>contributions</u> from the community!

We are excited to announce that we will be launching a webinar series starting in the 2nd week of May about coding and open-source code development! The webinar series will cover a variety of topics, including:

- Version control
- Coding best practices
- Software citation
- Working on open-source projects
- Software documentation
- Code testing and CI/CD
- Dependency management
- Improving code performance

Our first webinar will be about Git/GitHub, with no prior knowledge required. We will get beginners up and running with the basics of version control, for both individual and collaborative coding. Sign up with <u>this form</u> or email <u>mescyphers@gmail.com</u>. Materials from the webinars will be archived on our website.

The Open Source Code Working Group welcomes new members! If you would like to get involved, please fill out <u>this form</u> or email <u>missik.2@osu.edu</u>.

FLUXNET Working Groups: CH₄ and N₂O

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Purpose

Develop guidelines for CH_4/N_2O data processing that are accessible to new scientific investigators, will facilitate the inclusive growth of the FLUXNET CH_4/N_2O community, and lead to improved standardization of community data products.

Objectives

- Develop CH₄/N₂O pre-processing and post-processing QCQA protocols.
- Compile and share open-access resources for reproducible data processing.
- Identify key CH₄/N₂O flux ancillary variables and promote their use.
- Guide new CH_4/N_2O PIs with recommendations for best practices.

Progress

We identified commonly used, free, software licensed software tools (e.g., EddyPro; LI-COR Biosciences, 2017) as well as publicly available codebases in R, Python, and MATLAB developed and maintained by individual lab groups across the community (e.g., fluxgapfill, Irvin et al. 2023)

We have begun to develop best practices, some of which are prescriptive (e.g., cross-validation requirements to assess gap-filling model performance), but many of which are descriptive (e.g., identifying and filtering out true CH_4/N_2O flux outliers requires an investigator to review their site-specific time series dynamics).

Next Steps

We will synthesize existing literature and FLUXNET-CH4 data to identify the key ancillary variables that must be included for working with CH_4/N_2O flux data.

Next we will distill findings into a best practices document that provides accessible guidelines and an assessment of our community's state-of-knowledge for each of the following key CH₄/N₂O topics:

- local scale science enabled by CH₄/N₂O measurement;
- site selection; measurement systems and maintenance protocols;
- the scientific value of ancillary variables and sensor selection;
- high frequency data pre-processing and 30 min flux data post-processing workflows;
- access to global scale science enabled by FLUXNET data and community.

Leads





Xiangmin Sara Knox Sun Kyle Delwiche Gavin McNicol

Members

Ana Meijide Anam M. Khan Alex Valach Bhaskar Mitra Bruna Winck Christian Wille David Miller David Trejo Fa Li George Burba Jiangong Liu June Skeeter Kaido Soosaar Katerina Machacova Katja Klumpp Khue Vu Kuno Kasak

Lukas Hörtnagl Natalia Kowalska Natascha Kljun Otto Briner Paulina Englert Pedro Heriq-Coimbra, Praveena Krishnan Qi Jia Sun Rafael Stern Ren Zhi Guo Santosh S. Palmate Shannon Brown Stefan Metzger Stephen Chan Sung-Ching Lee Ted Scott Ülo Mander

FLUXNET Working Groups: CH_4 and N_2O

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Post-Processing Focus Topic: USTAR AND FCH4

Problem: Low USTAR conditions are filtered out during standard CO_2 post-processing due to insufficient turbulence for reliable EC flux measurement. A key consideration is whether this filtering step will bias FCH4 observations in EC data by systematically removing low fluxes. This is because several CH_4 transport mechanisms, such as plant-mediated flux, may increase as wind speed/USTAR increases. Lukas Hörtnagl has been exploring this topic further. He presented the following analysis:

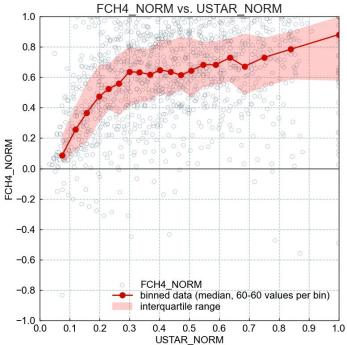
Normalized (max) FCH4 vs normalized (max) USTAR across 60 EC sites

Data: 60 sites from FLUXNET-CH4 Community Product (pre-USTAR filtering)

- FCH4 and USTAR data were binned (20 bins), normalized and aggregate
- The units can be understood as percentiles, e.g., 0.5 = 50th percentile = median, etc.
- Generally, FCH4 increases (emission) up to the 30th %ile of USTAR;
- There is a clear (aggregated) relationship between FCH4 and USTAR
- Some sites deviate from this pattern, see here for plots for individual sites
- The same analysis for N₂O was inconclusive due to low data availability

Next steps:

- How could we check for CH₄ advective fluxes with the data available?
- Explore USTAR as a driver vs. as a way to filter low turbulence conditions?
- Run USTAR detection algorithm on FCH₄ and compare to CO₂ thresholds
- Use other turbulence statistics for filtering, like the stationarity of w.
- Try to collect more data for N₂O and then do the same as for CH₄.



plot: Lukas Hörtnagl (holukas@ethz.ch) | link to Jupyter notebook

Included sites: AT-Neu, BR-Npw, BW-Gum, BW-Nxr, CA-SCB, CA-SCC, CH-Cha, CH-Dav, CH-Oe2, DE-Dgw, DE-Hte, DE-SfN, DE-Zrk, FI-Si2, FI-Sii, FR-LGt, HK-MPM, ID-Pag, IT-BCi, JP-BBY, JP-Mse, JP-SwI, KR-CRK, MY-MLM, PH-Rlf, RU-Ch2, RU-Che, RU-Cok, RU-Fy2, RU-Vrk, SE-Deg, SE-St1, UK-LBT, US-A03, US-A10, US-Bi1, US-Bi2, US-CRT, US-DPW, US-EDN, US-EML, US-Ho1, US-HRA, US-HRC, US-Ivo, US-LA1, US-LA2, US-Los, US-Myb, US-NGB, US-ORv, US-OWC, US-PFa, US-Sne, US-Srr, US-StJ, US-Tw1, US-Tw3, US-Tw4, US-Tw5, US-Twt, US-Uaf, US-WPT /

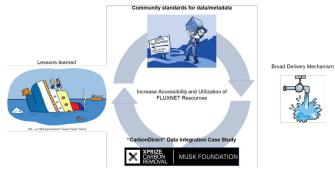
FLUXNET Working Groups: Data Integration

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From where we started in 2022 ...

Translate scientific discovery and technological advances into societal benefits



... and where we are now ...

- <u>Meta/data rubric</u>: Coordinate survey w/ software committee & circulate
- <u>Implement major rubric elements</u>: Matrix template for Committee cross-connectivity, list of non-central data resources, portals
- <u>Case studies</u>: CarbonDew Community of Practice; conference sessions, workshops, pods; support grant proposals

... over what we considered ...

Community standards for data/metadata





- <u>Leadership succession</u>: Jake Nelson take over from Stefan Metzger
- Open for input, participation and co-leads:



Leads: Stefan Metzger, Jake Nelson et al.

FCC Secondment Adventures

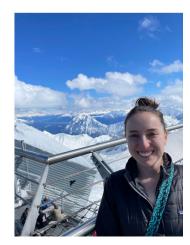
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The FLUXNET Secondment program launched in 2022, continues to send U.S. based early-career scientists abroad to study at host institutions. The Secondment program is designed to increase international connections between scientists using eddy covariance data and to therefore strengthen the FLUXNET network, while also supporting early-career scientists. Full write ups from all secondees can be found here: https://fluxnet.org/fluxnet.econdment-recipients/, with some highlights below.



Sophie Ruehr (with Mukund Rao) shows off a new automatic dendrometer used in her Secondment work on ecosystem reliance on soil moisture and deep subsurface waters. Sophie worked with Drs Poyatos and Mencuccini at CREAF in Barcelona, Spain.



Justine Missik stands atop Germany's highest peak during her Secondment at Dr. Nadine Rühr's lab. Justine worked on improving the stress mechanics in the FETCH canopy transpiration model.



Lewis Kunik studied the biophysical dynamics of the semi-arid Yatir forest in Israel with Dr. Dan Yakir. Lewis collected SIF (solar-induced fluorescence) data to look at forest heat and drought response.



Emma Reich evaluated photosynthesis-transpiration decoupling across timescales and ecosystems at Max Planck in Jena, Germany, working with Drs. Nelson and Lee. Emma got to visit the Leinefelde (DE-Lnf) flux tower site.



Greetings to all members of the FLUXNET community! As we continue to foster collaboration and support among early career scientists within our network, we are thrilled to share the highlights and upcoming opportunities within the FLUXNET Early Career Scientist Network (ECN).

• Join the ECN Committee: Call for New Members

The FLUXNET ECN committee is actively seeking new members to join our vibrant team, particularly volunteers from under-represented regional networks. If you have a passion for serving the early career flux community and are interested in organizing workshops/seminars, writing blogs/spotlights for researchers and flux towers, or managing social media and email lists, we would love to hear from you. Please express your interest by filling out this <u>Google form: Join ECN Committee</u>.

• Workshop: Energy Balance Closure Analysis with Dr. John Volk

On March 6th, ECN successfully hosted a workshop featuring Dr. John Volk, the creator of the "flux-data-qaqc" python package. This valuable tool focuses on the post-processing of flux data, specifically for Energy Balance Closure Analysis. Participants had the unique opportunity to learn directly from an expert in the field, gaining insights and skills in utilizing this sophisticated software for their research and projects.

• Year in Review: FLUXNET ECN at AGU Town Hall

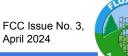
During the recent AGU meeting on December 11th 2023, Jiangong Liu presented an insightful annual summary at the FLUXNET Town Hall. This presentation showcased the diverse array of events and activities organized by the ECN over the past year. Our initiatives aim to enrich the professional and academic journeys of early career scientists by providing platforms for networking, learning, and collaboration.

Stay Connected

For those who wish to stay updated with the latest news and events from ECN, we invite you to join our email list by signing up <u>here</u>. You can also follow us on our social media platforms for real-time updates: Twitter/X (@Fluxnet_ecn) and LinkedIn Group.

As we look forward to another year filled with engaging activities and growth opportunities, we thank each of you for your continued support and enthusiasm for the FLUXNET ECN. Together, we can make a significant impact in the field of ecosystem research and beyond.

FLUXNET Member Spotlight



Sarawak Tropical Peat Research Institute Environment Research Division

In the heart of Sarawak, Malaysia, the Sarawak Tropical Peat Research Institute (TROPI) stands at the forefront of environmental science, investigating the vital links between tropical peatland ecosystems and greenhouse gases (GHGs) such as CO_2 , methane (CH₄) and nitrous oxide (N₂O). Since 2011, Sarawak is notable because it is the only state in Malaysia that has three flux towers that have been in operation for over a decade. These towers are located in Maludam National Park, Naman Oil Palm Plantation in Sibu and Cermat Ceria Plantation in Betong. In addition, the tower in Maludam National Park has been hailed for providing comprehensive and systematic documentation of a tropical peat swamp forest worldwide.

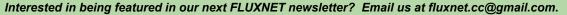
The Institute's Environment Research Division is dedicated to comprehensive field research utilising advanced techniques to measure greenhouse gas emissions. These include Eddy Covariance Systems, Soil respiration chambers and Tree Stem Chambers. Research work by the institute covers three different peatland environments: an undrained peat swamp forest, an immature oil palm plantation and a mature oil palm plantation.

In addition to our work on GHG, we conduct comprehensive hydrological research on peatlands, exploring water table fluctuations, drainage patterns and the influences of precipitation. The primary focus is to quantify the carbon balance of these ecosystems and understand how they respond to climate change and anthropogenic influences.

Our collaborative network includes researchers from Asia, Europe, and America, ensuring a broad and international approach to our research endeavors to understanding the carbon balances and the functioning of Asian terrestrial ecosystems.

Members of Environment Research Division (left to right): Joseph Waili, Frankie Kiew (PhD), Wong Guan Xhuan (PhD, leader), Agusten Rabar, Eddy James









Want to learn more or get involved?

Sign up for the mailing list (<u>https://fluxnet.org/community/join/</u>), and/or email <u>fluxnet.cc@gmail.com</u>

Join one of our active committees by emailing the committee lead (see here)

Key upcoming events

The FLUXNET Workshop 'The Great Thermal Bake-off' will be held from August 13th to 16th, 2024, at NAU for a hands-on workshop aimed at enhancing temperature measurement precision and standardization (link).

Another FLUXNET Workshop 'FLUXNET-CH4 V2.0: Towards a more global characterization of methane-emitting sites' will be announced soon.

Funding Acknowledgements



We would like to acknowledge and thank the National Science Foundation's Accelerating Research through International Network-to-Network Collaborations (NSF AccelNet) program for their funding support. About the Editor



Minseok Kang studies biosphere-atmosphere interactions based on eddy covariance measurements (link). He is a lead scientist of KoFlux, the Korean flux monitoring network, and serves as the Vice Chair of AsiaFlux.