The AmeriFlux Network at 25: Innovation, Discovery, and Community

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October 19, 2023

BERKELEY LAB

AMERIFLUX MANAGEMENT PROJECT

U.S. DEPARTMENT OF ENERGY | Office of Science

AmeriFlux

- Network success built on continuity *and* innovation
- BER investment pivotal
- Growing opportunities ahead

AMERIFLUX

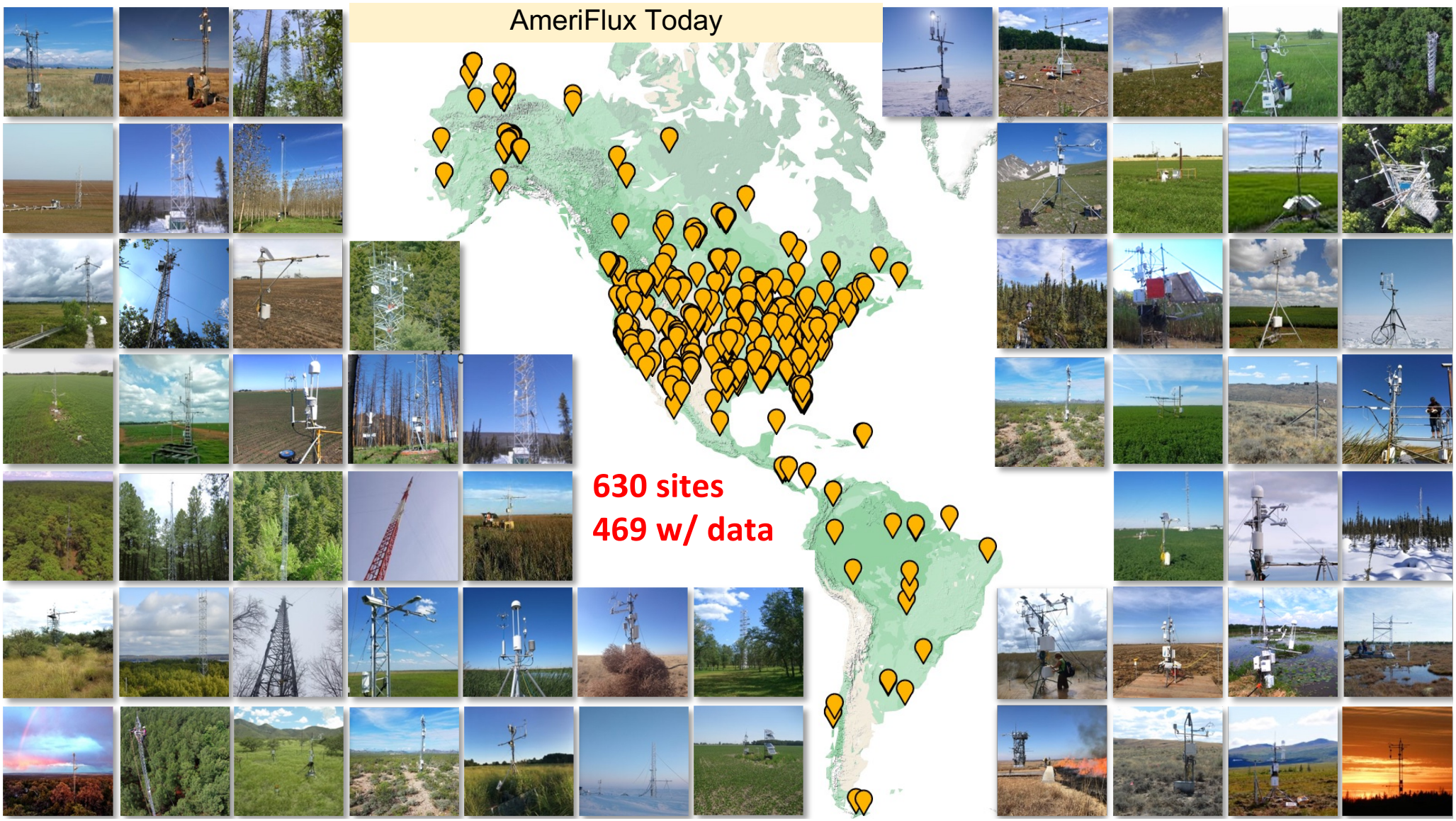
AmeriFlux is a network of sites and scientists measuring ecosystem-atmosphere exchange using the eddy covariance method, and the larger community using these data

AmeriFlux observations

Fluxes of:
CO_2
CH_4
Latent heat
Sensible heat
N_2O

Plus ecological and biophysical variables like surface roughness and albedo

24/7, direct measurements, ecosystem scale

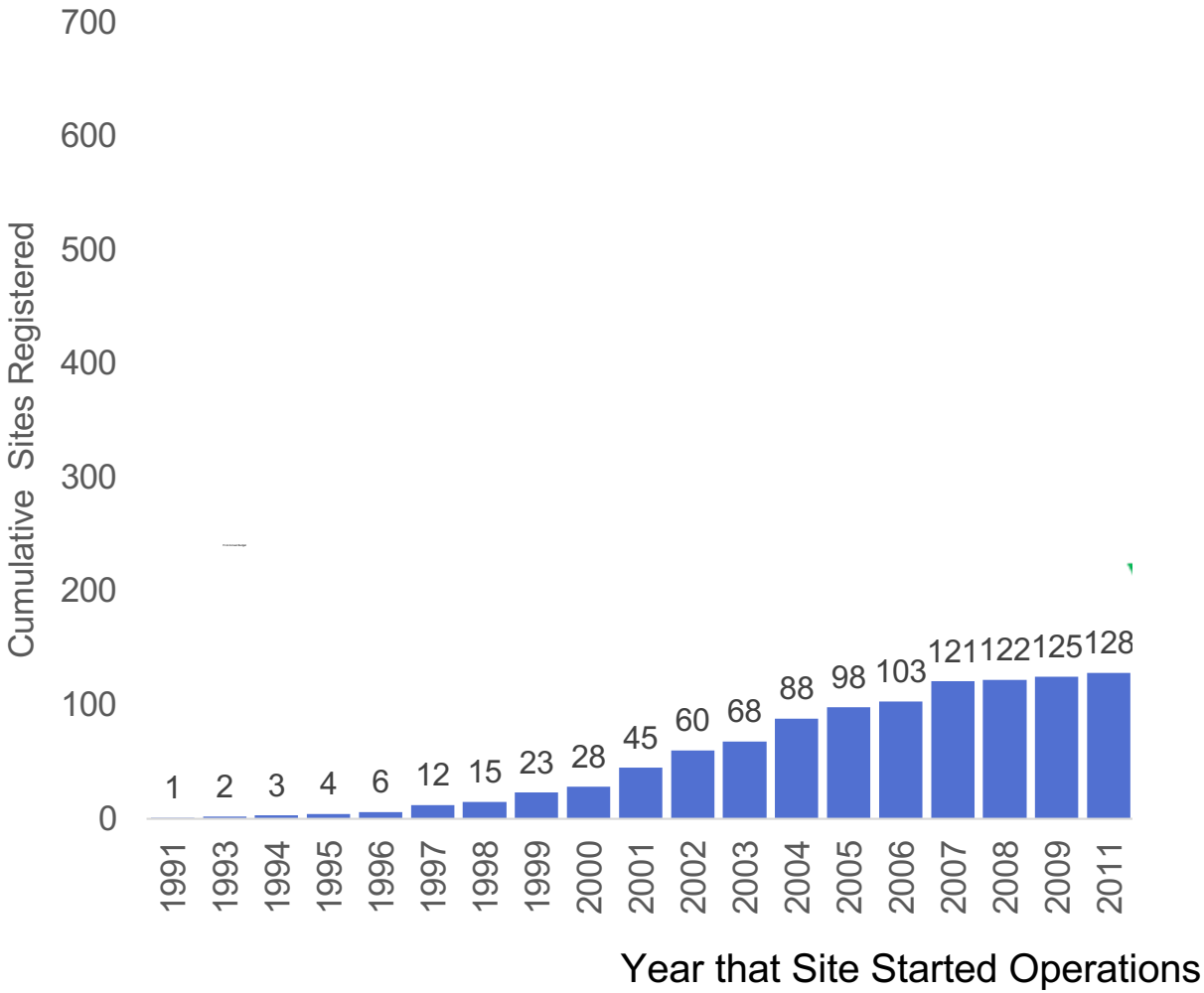

AmeriFlux Today
630 sites
469 w/ data

People and Partners

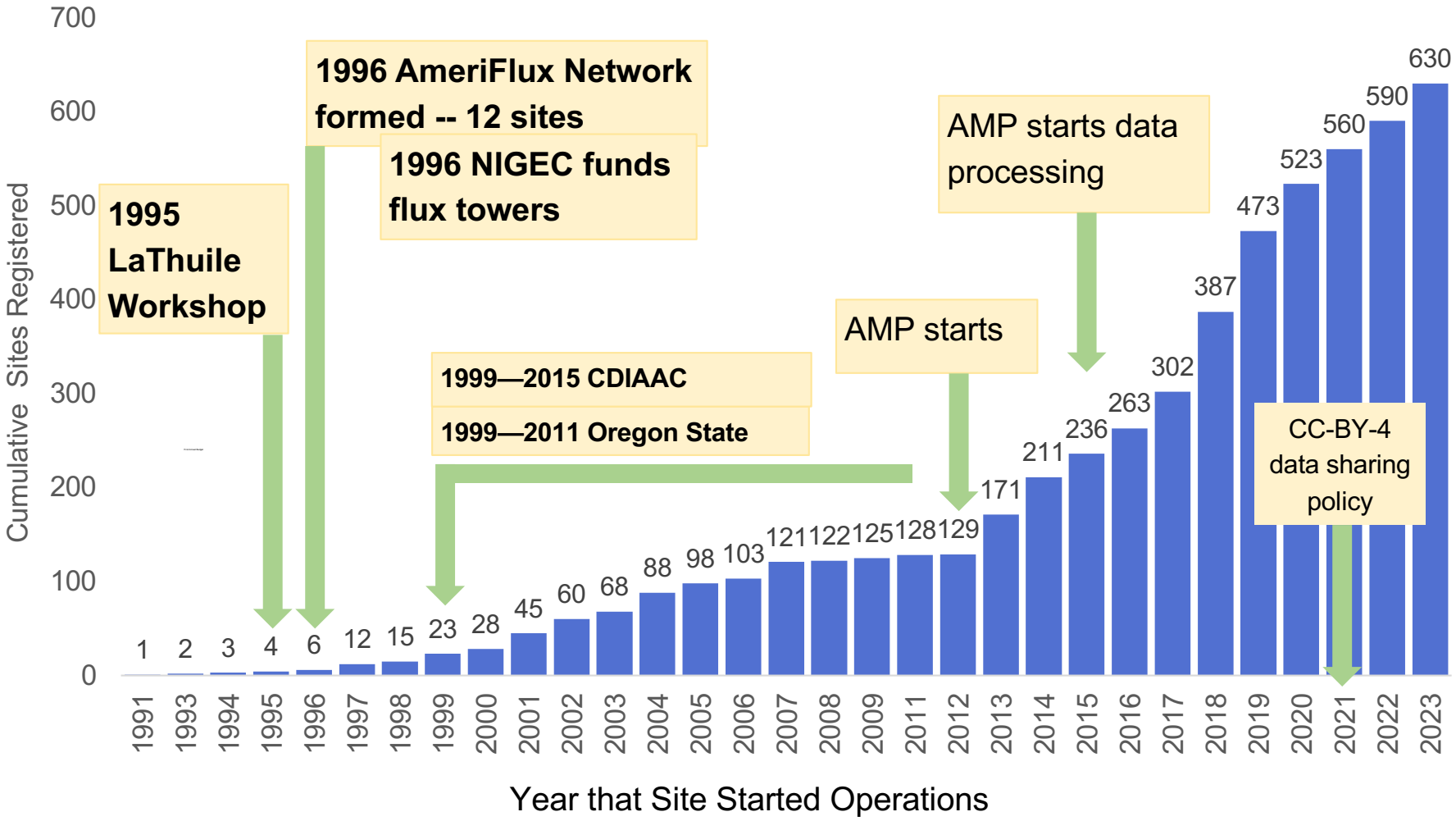
AMERIFLUX

MexFlux, BrazilFlux, OzFlux, & more

DOE support has been pivotal for AmeriFlux



DOE support has been pivotal for AmeriFlux



AmeriFlux

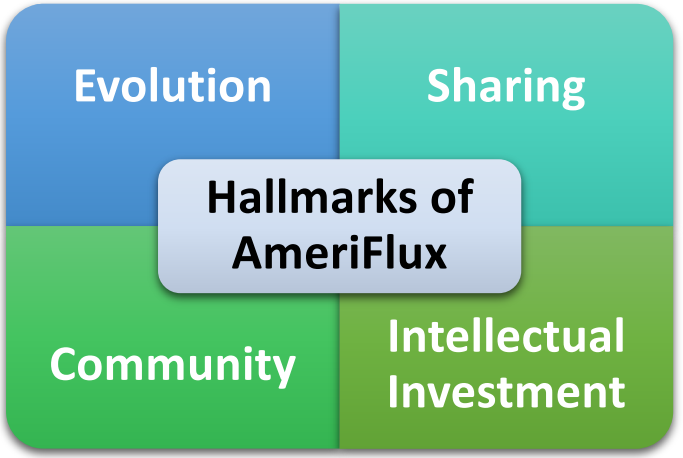
- Bottom-up network. Started before there was standardized instrumentation and continues to use site-specific instrumentation.
- AmeriFlux is described as a “Coalition of the Willing” because sites “opt-in,” and volunteer to share data
- Functions as a community: sharing knowledge, collaborating, and networking with regional networks around the world

“know thy site”
- Ray Leuning

Network Challenges in 2011

As the network grew, several challenges became apparent:

- How to maintain long time series of data
- Ensuring comparability among sites' data
- How to grow and revitalize the network
- Infrastructure versus scientific support from funding agencies
- Annual meeting planning



Answer: DOE Funded AmeriFlux Management Project (AMP) after a competitive solicitation

- AMP was established by DOE in 2012. AmeriFlux had <100 active sites.
- Since then, network has grown 5-fold in sites (630) and 10-fold (>10,000) in community participation

Slide from Dan Stover, presentation to OMB May 2023, adapted

AMP Goals

Sustain and Extend	Sustain and extend the long-term datasets of carbon, water, and energy fluxes at sites spanning the climate and ecosystems of the Americas
Maximize	Maximize the quality, quantity, and standardization of AmeriFlux data for fair community use
Enable	Enable and expand the network's impact as a virtual "facility" for basic research and Earth System Model (ESM) improvement to address critical societal needs
Strengthen	Strengthen the growing flux community, stakeholder, and connect to regional networks worldwide though careful outreach

Slide from Dan Stover, presentation to OMB May 2023

AmeriFlux Management Project

Data Support

Tech Support

Community

Core Sites

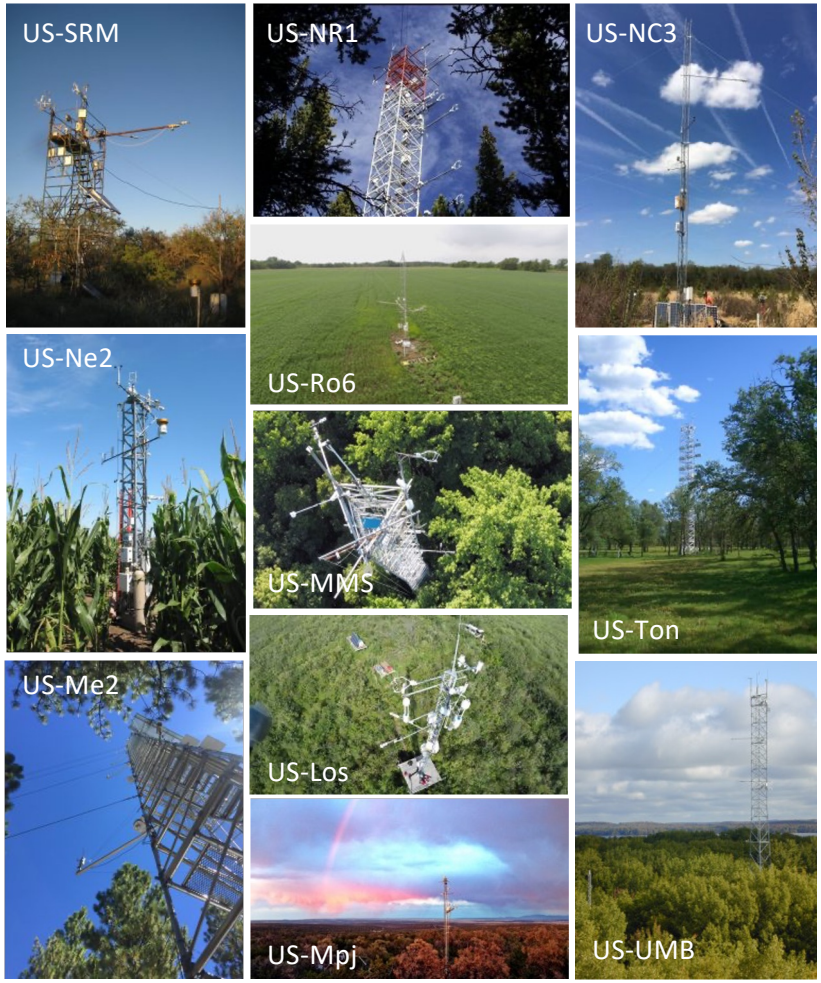
Margaret Torn, Deb Agarwal, Sébastien Biraud, Trevor Keenan, Christin Buechner

You-Wei Cheah, Housen Chu, Sigrid Dengel, Stephen Chan, Danielle Christianson

Gilberto Pastorello, Fianna O'Brien, Koong Yi, Sy-Toan Ngo, André Santos,

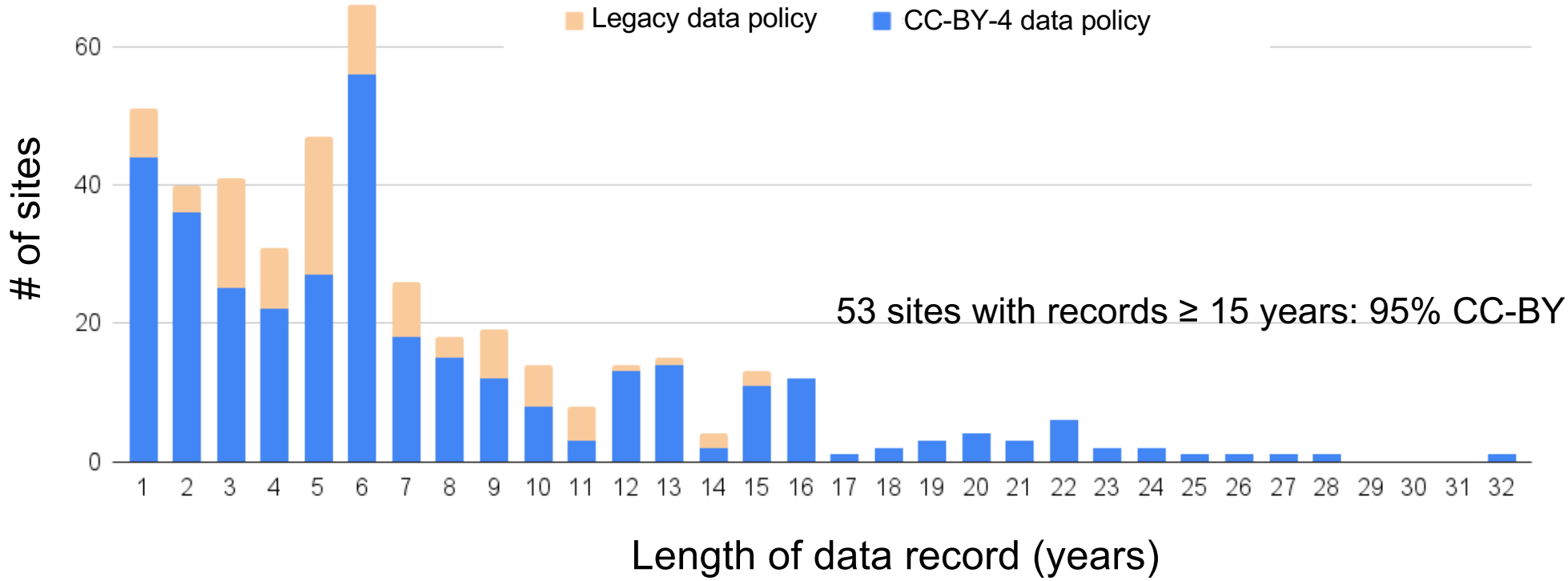
Maintaining long time-series: AmeriFlux Core Sites

- AMP supports 13 core site contracts, 42 sites
- High quality, continuous data



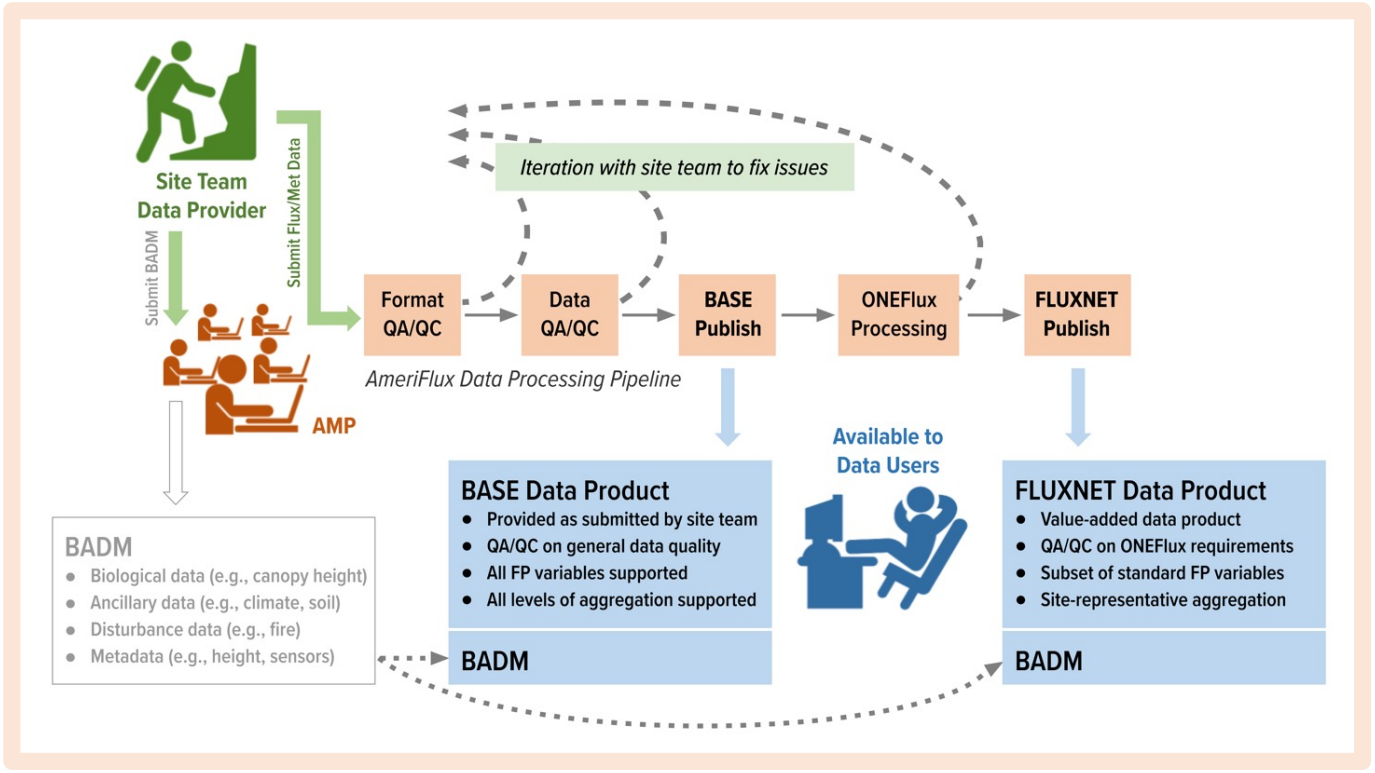
Long time series: more than 100 sites have data records >10 y

Open data sharing: 75% of sites opted for CC-BY license



AMP Data Support
Providing quality assured, standardized data

AMP flux data workflow



AMP throughput 2017-2022

Received 6,200 flux files.

Sent 5,000 Format and Data QA/QC reports

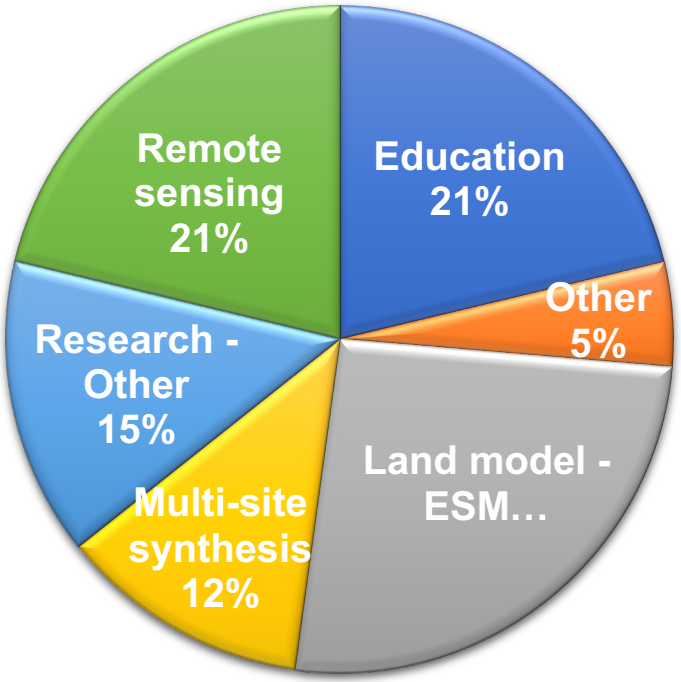
265 sites were published for first time

Time from submission to publication median ~1.5 mos for updates (compared to 12-24 months before AMP)

We receive data from ~200 sites each year and generate >600 Format and 400 Data QA/QC reports yearly (2020-2022).

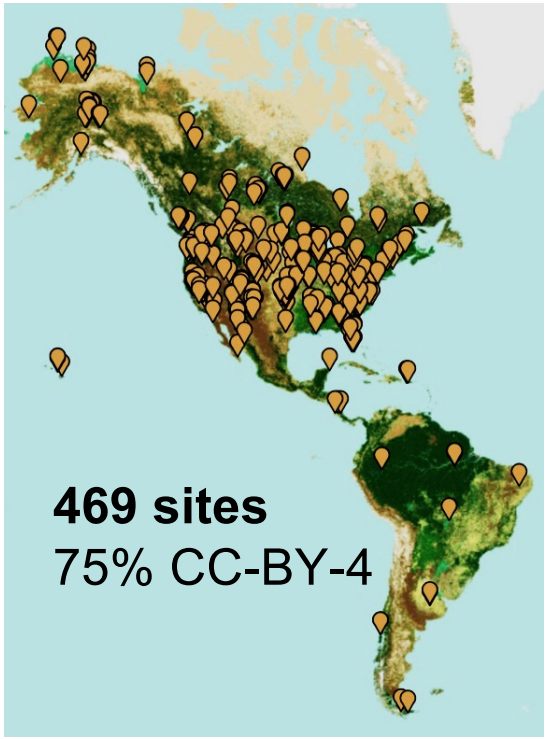
AMP Data Support
Professional, user-friendly data portals

Data Intended Use



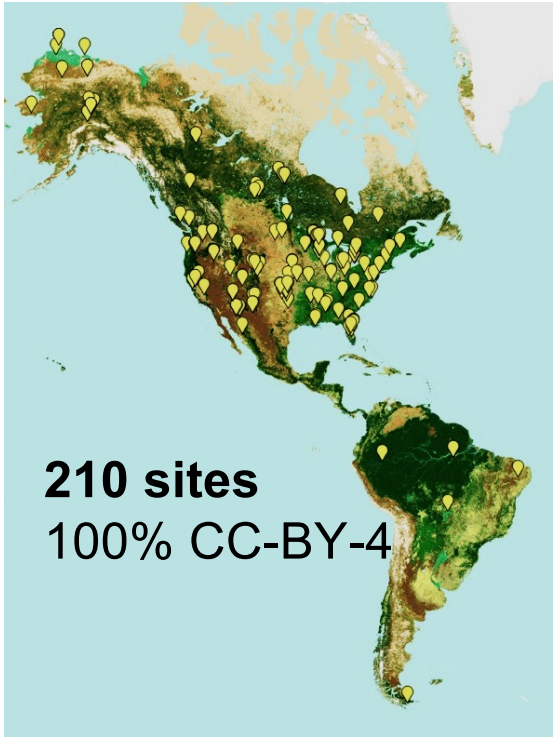
Data used in
> 30 countries

BASE data



34,000 downloads
5,700 individuals

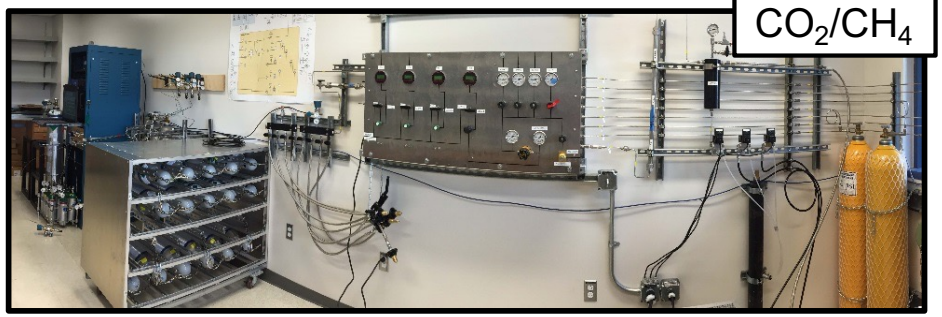
FLUXNET data



30,000 downloads
7,500 individuals

AMP Technical Support
Ensure high quality, interoperable measurements

- Provide calibrated PAR sensors
- Provide CO_2 and CH_4 calibration standards
- Loan spare instruments to minimize gaps
- Enhance site technology:
  - Remote communications
  - Portable Profile System
  - Leaf area index sensor
  - Dew point generator



AMP Technical Support
Site Visits

>180 site visits completed

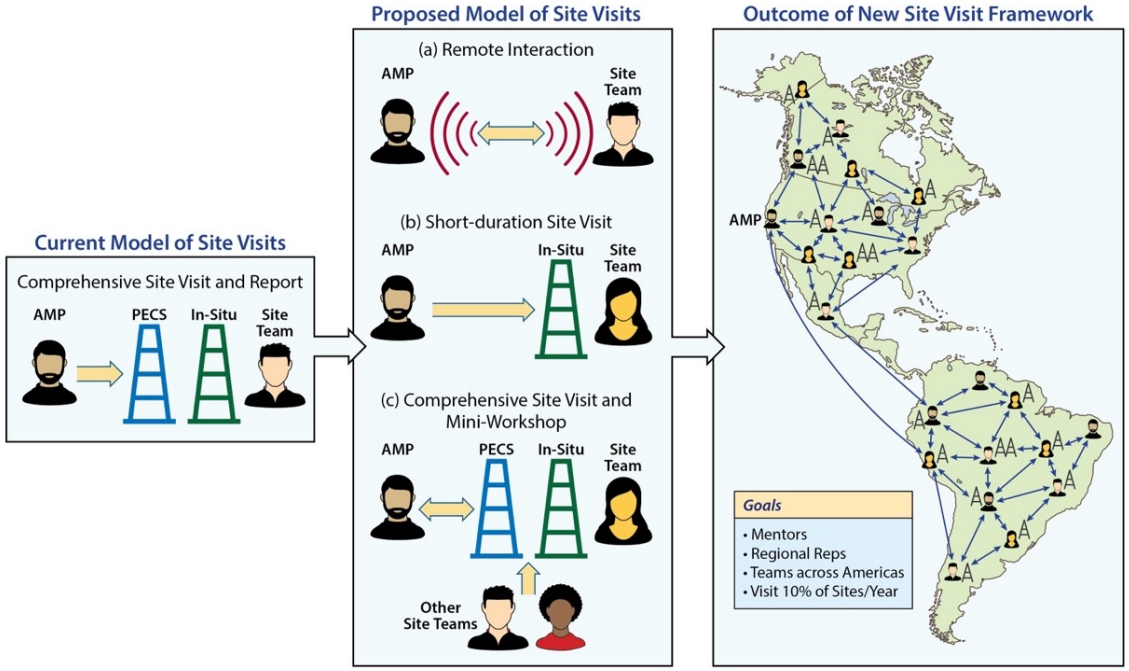
Two-week side-by-side comparison
followed by detailed analysis

Silas Little

AMP Technical Support
Site Visits – Scaling to Site Visit 2.0

- Gold-file analysis
- Regional mini-workshops
- Short site visits
- Webinars

Silas Little



Tech: Rapid Response Systems (RRS)

- Loan of eddy covariance and micrometeorological systems for up to three years
- Allows scientists to take advantage of special opportunities and growth areas (e.g., urban)

Burned-unburned sites, NM

Wetland succession & Hurricane Irma, FL

Supporting BER priorities across programs

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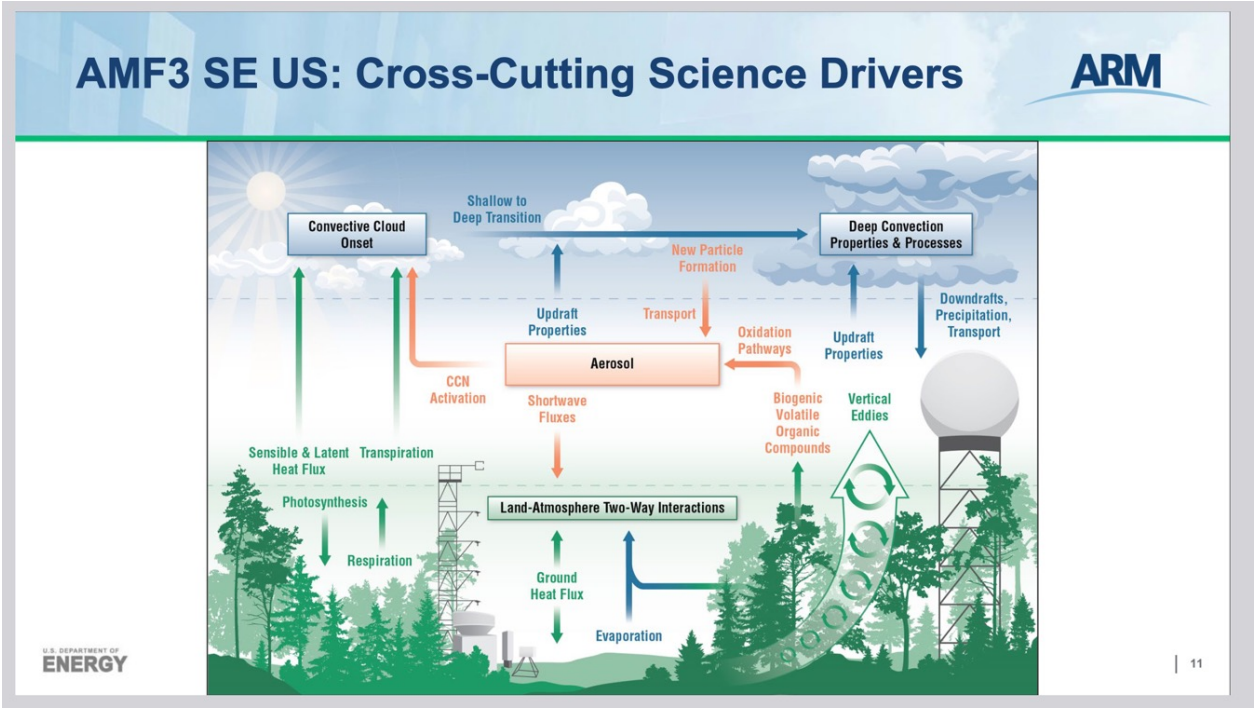
Urban Integrated Field Laboratories

U.S. Department of Energy | Office of Science | Biological and Environmental Research Program

AMP is making three RRS systems available for urban research. Includes methane sensor LI-7700.

AMP is hosting workshop on *Land-Atmosphere Exchanges in Urban Landscapes* Chicago, November 2023.

Supporting BER priorities across programs



AMP has a new program to provide an eddy flux system for ARM campaigns. For Southeast US, this includes profiling system.

Loaned RRS for SAIL campaign

ction and Outreach

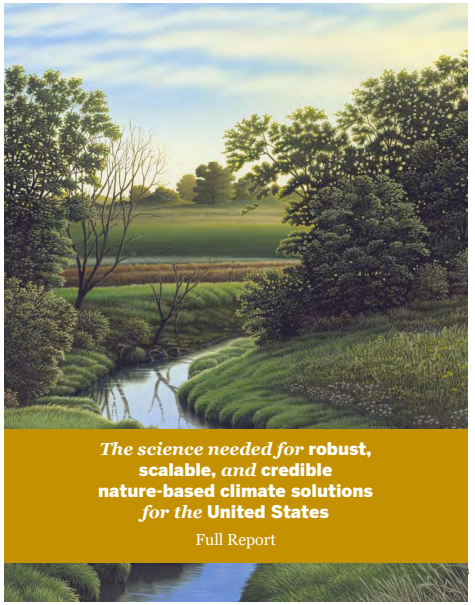
Community Interaction and Outreach

- Early Career Network, DEI Committee, working groups
- International participation (> 32 countries participating in 2020 annual meeting)
- Website (100,000's "real" visits, > 80 countries)
- Registered members (mailing list and downloading) > 14,000

AMP:

- Set norms
- Facilitate community activities
- Provide resources
- Maintain cohesion and common knowledge base, while growing the community

Say "Yes!"

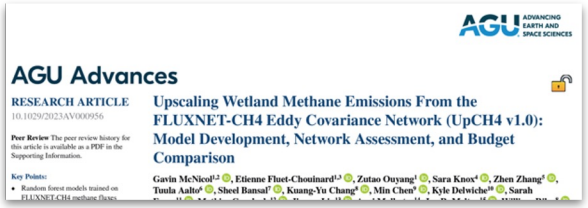


Innovation
AmeriFlux Theme Years for Network Action

2018-2020

2021-2022

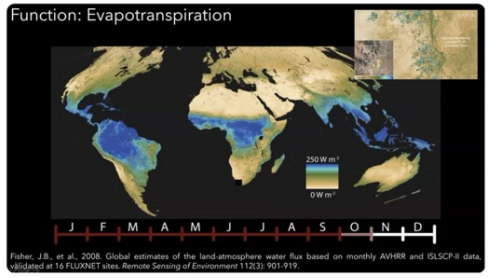
2022-2024



AGU Advances

RESEARCH ARTICLE
10.1029/2023AV000956

Upscaling Wetland Methane Emissions From the FLUXNET-CH4 Eddy Covariance Network (UpCH4 v1.0): Model Development, Network Assessment, and Budget Comparison



Year of Remote Sensing Tutorial Series #1: Theory of remote sensing as it applies to fluxes

AmeriFlux
528 subscribers
Subscribe
18
Share

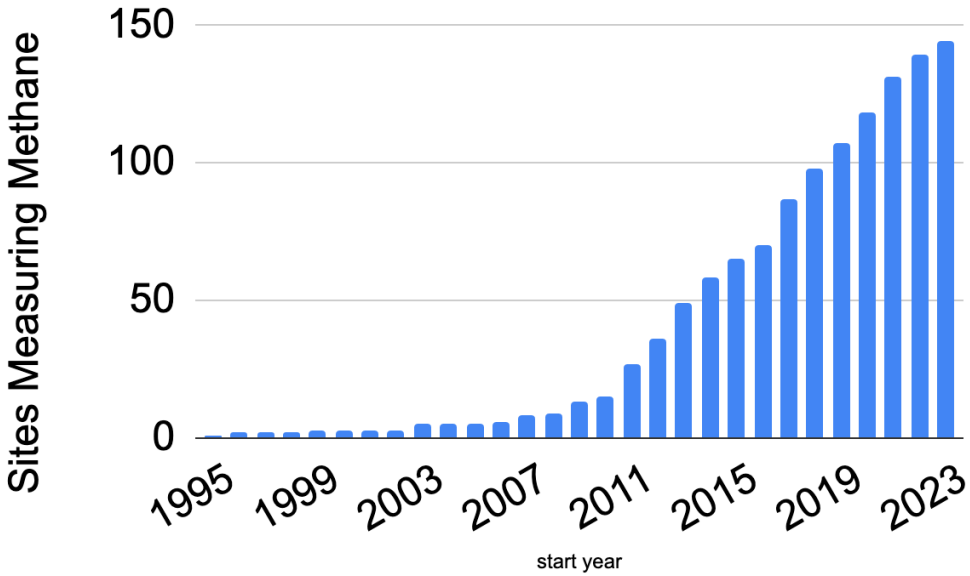
Innovation

Rapid growth in sites measuring methane

DOE supported SBIR to Southwest Sciences, Inc for prototype.

In 2009, LI-COR launched the LI-7700 Open-Path CH_4 Analyzer.

Today, 125 AmeriFlux sites measure CH_4 by eddy covariance.



Innovation

Development of N_2O sensor for eddy flux

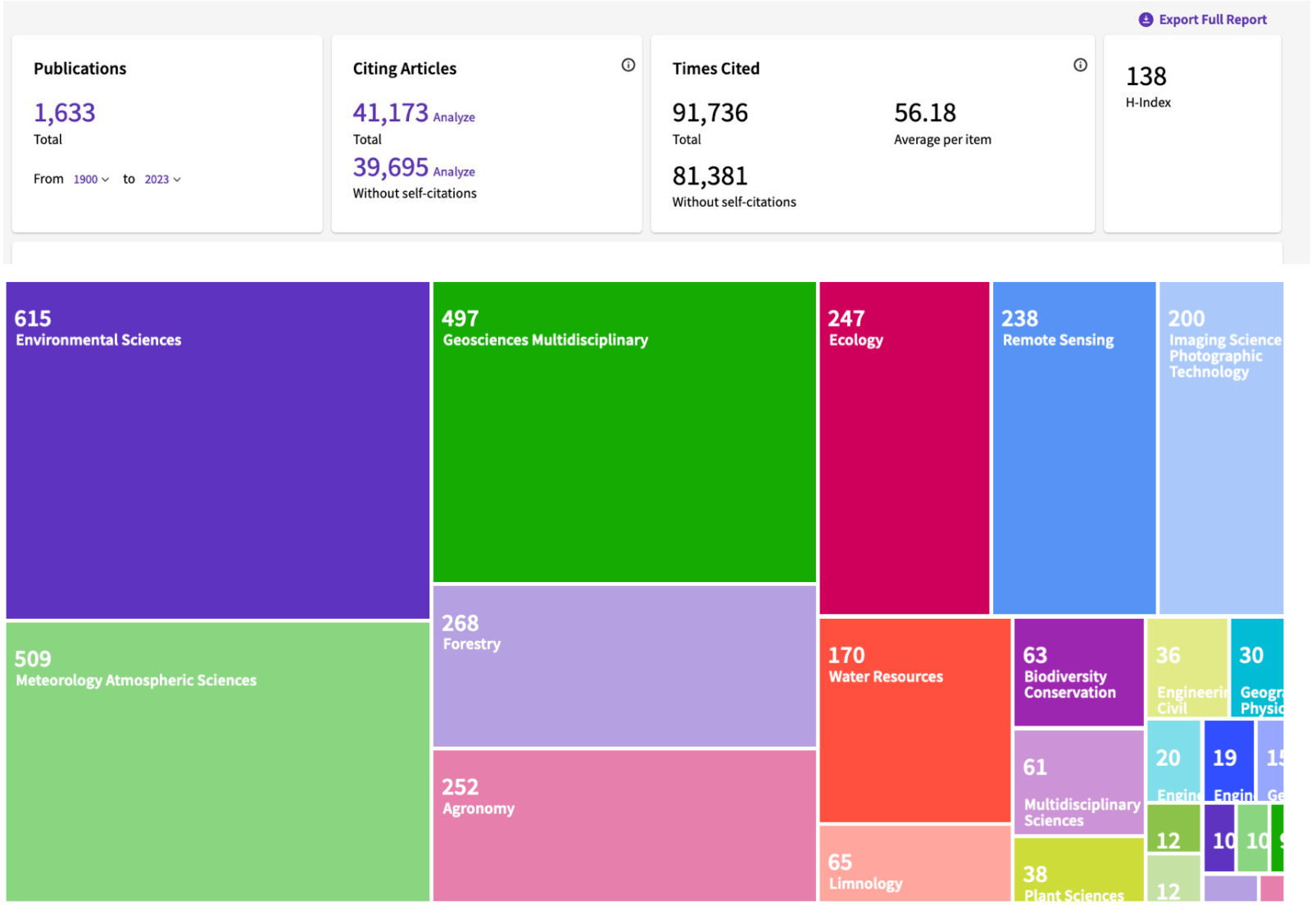
DOE supported SBIR to Southwest Sciences, Inc for prototype.

Photo: Stephen Chan

SBIR/STTR DE-FOA-0000969 for development of N_2O sensor in 2014

AMP has been testing units in the field for the past two years.

"AmeriFlux" in Web of Science



AmeriFlux Research

31 years of data at Harvard Forest: The terrestrial carbon sink

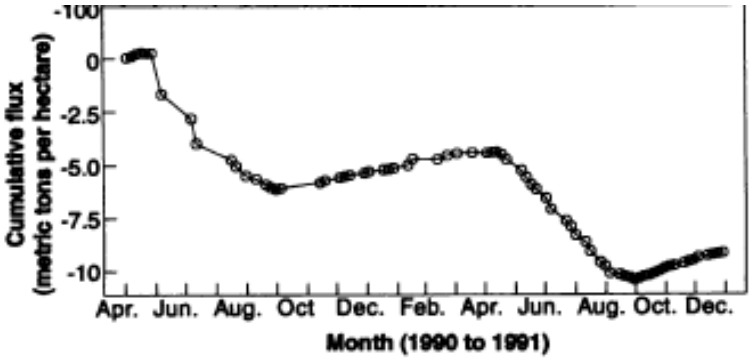
Bill Munger, Harvard Forest

1993

Science
AAAS

Net Exchange of CO_2 in a Mid-Latitude Forest

S. C. WOFSY, M. L. GOULDEN, J. W. MUNGER, S.-M. FAN, [...], AND F. A. BAZZAZ +3 authors Authors Info & Affiliations



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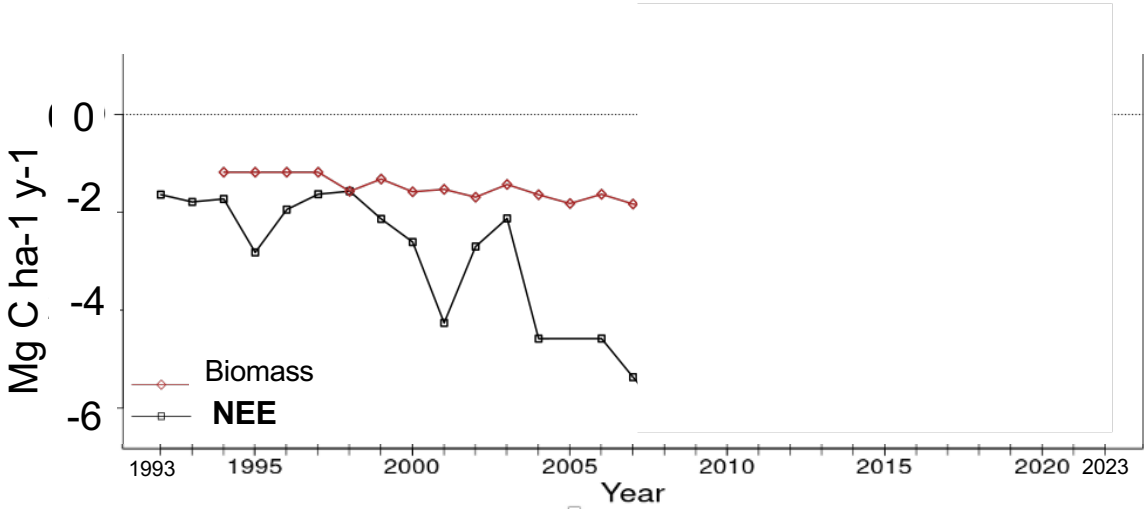
2023

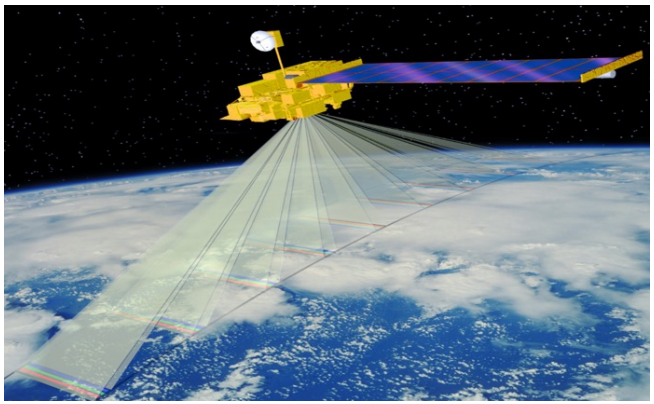


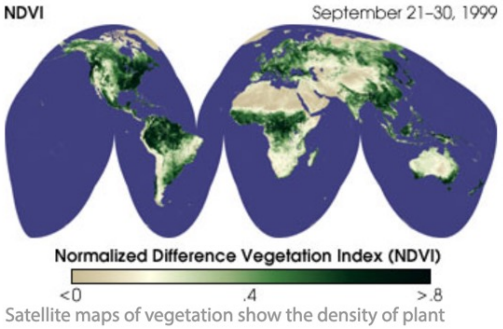
AMERIFLUX

AmeriFlux Research

Satellite validation and global scaling

AmeriFlux sites were the original validation network for Terra MODIS products (>10,000 journal citations).





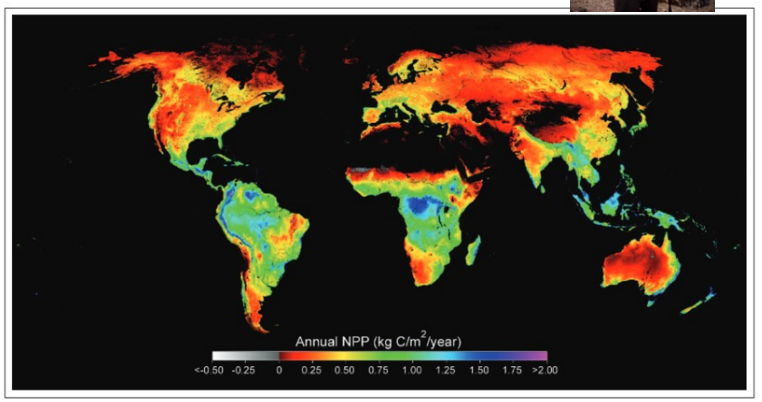


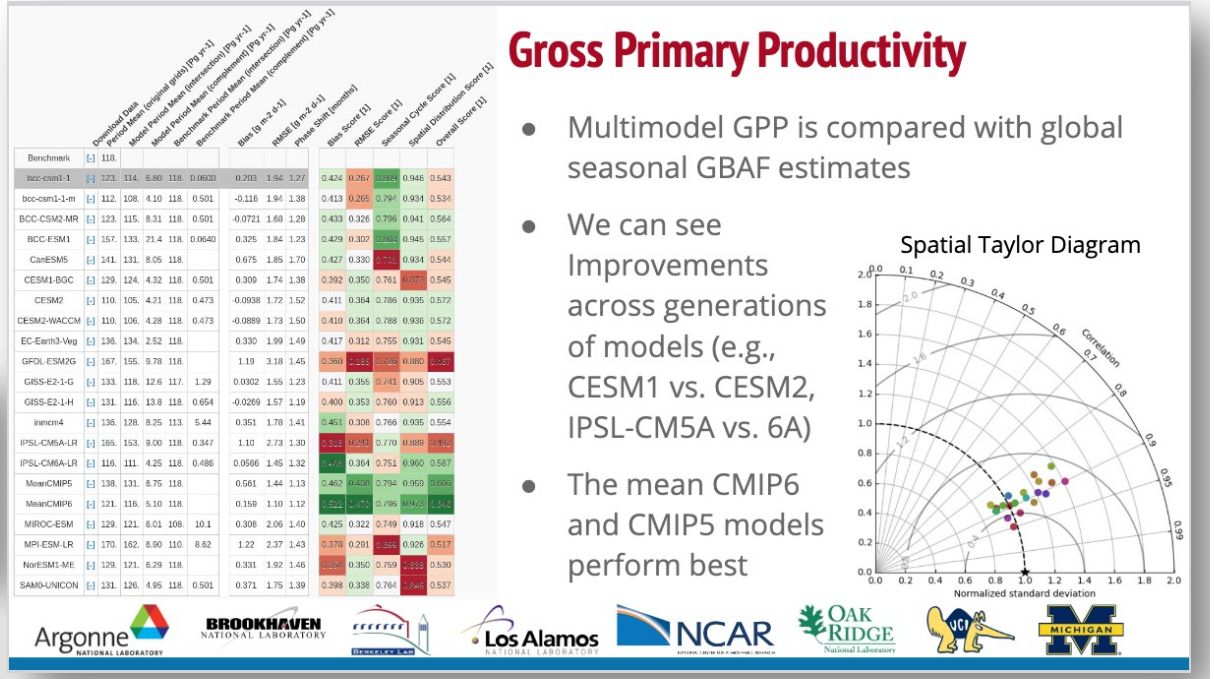
Figure 5. Global terrestrial net primary production (NPP) over 110 million square kilometers for 2002, computed from MODIS (Moderate Resolution Imaging Spectroradiometer) data.

New satellite missions continue to rely on AmeriFlux e.g., Ecostress

AmeriFlux Research

Earth system model development

The FLUXNET product is the premier evaluation and parameterization data set



Journal Articles Biogeosciences Year : 2023

Global evaluation of terrestrial biogeochemistry in the Energy Exascale Earth System Model (E3SM) and the role of the phosphorus cycle in the historical terrestrial carbon balance

Xiaojuan Yang (1) , Peter Thornton (1) , Daniel Ricciuto (1) , Yilong Wang (2, 3) , Forrest Hoffman (1)

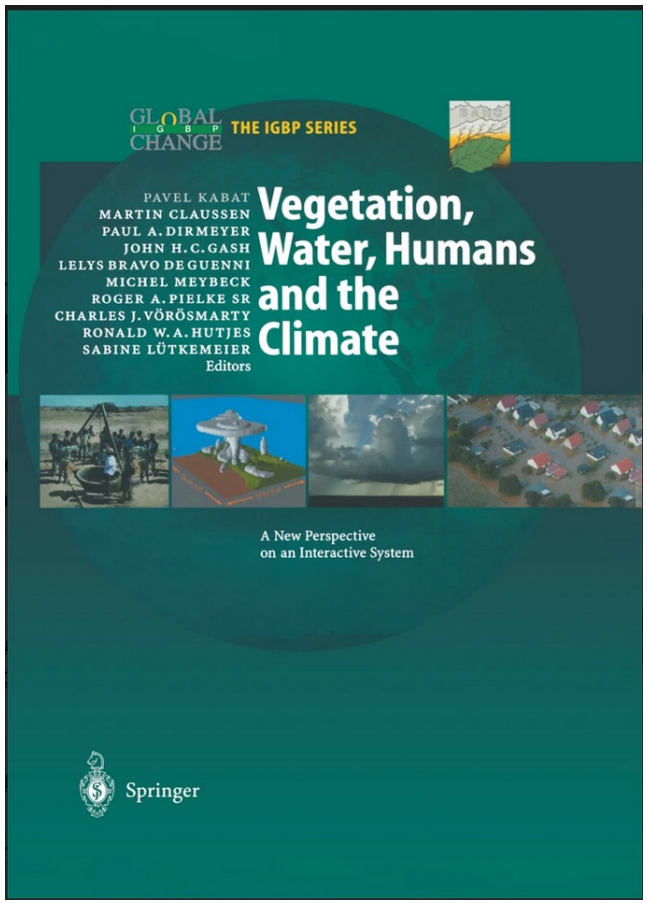
Evaluating model uncertainties in daily to seasonal carbon, water and energy cycling across a latitudinal transect using a combination of ensemble analysis and benchmarking

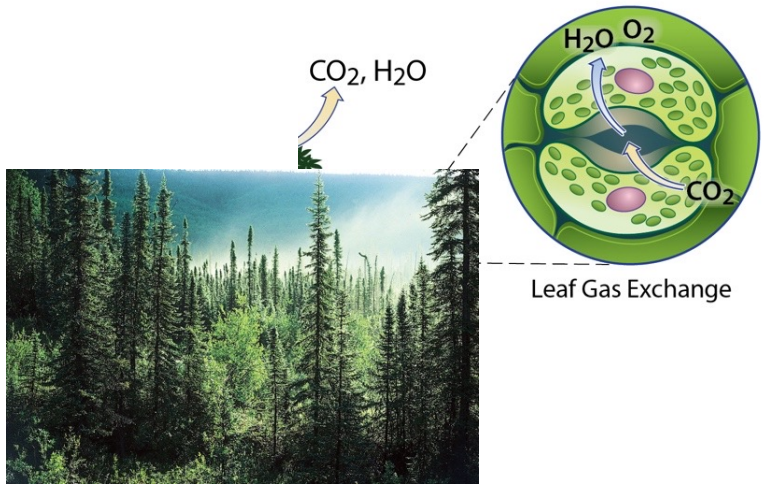
Show affiliations

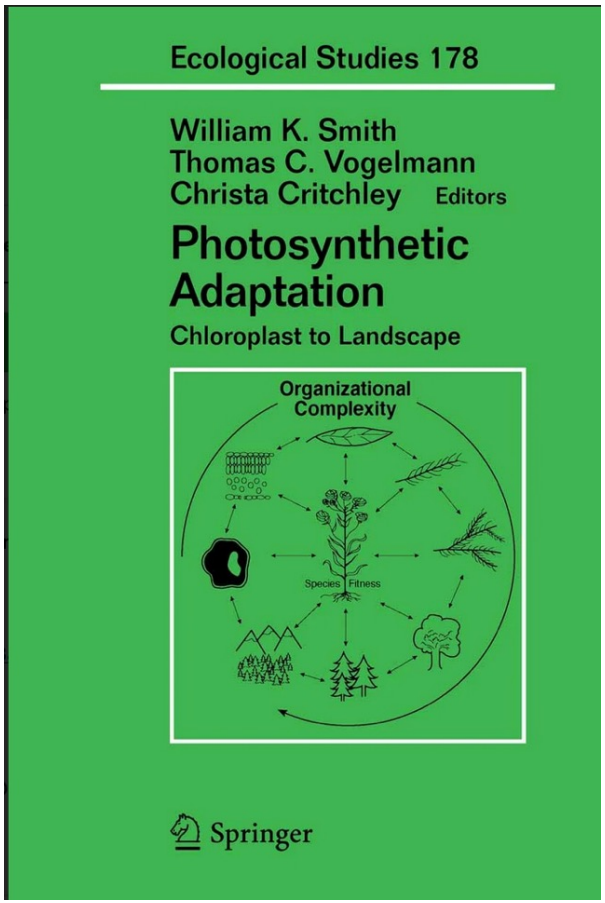
Serbin, S. ; Collier, N. ; Kumar, J. ; Hoffman, F. M.

AmeriFlux Research

Boreal Forests are Green Deserts



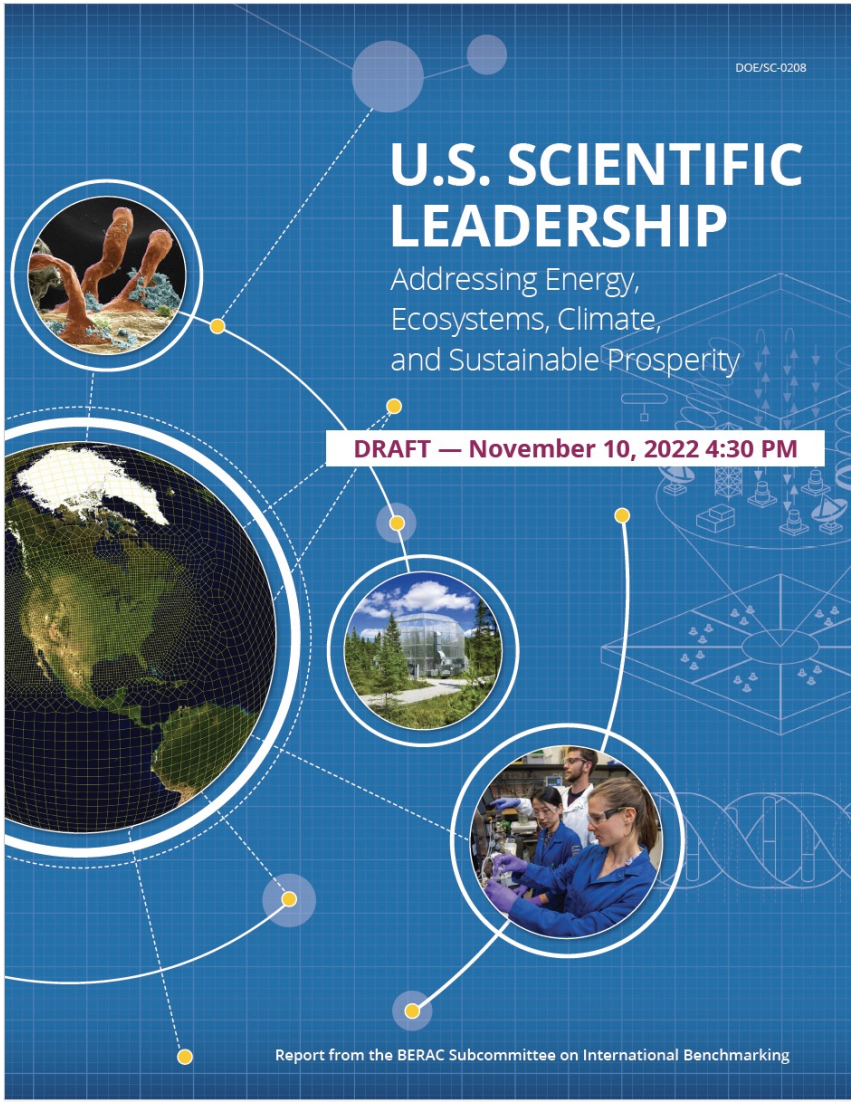




AMERIFLUX

Internationally recognized in:

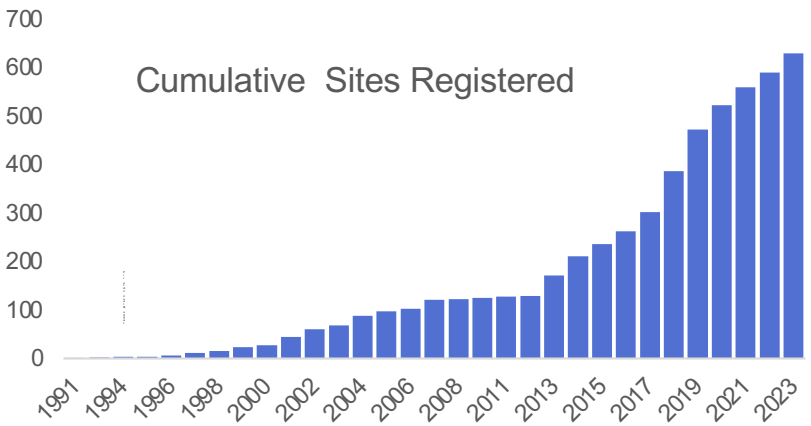
- Environ System Science
- Climate Science
- Enabling Infrastructure
- Integrative Science



BERAC. 2022. U.S. Scientific Leadership Addressing Energy, Ecosystems, Climate, and Sustainable Prosperity: Report in Brief from the BERAC Subcommittee on International Benchmarking. M. McCann and P. Reed, eds. Biological and Environmental Research Advisory Committee. https://doi.org/10.2172/1959345.

Some challenges looking ahead

- Meeting growing demand for services
- Managing growing costs under flat funding
- Achieving fair citation credit for data providers
- Expanding engagement
  - Balancing consistency vs innovation, nimbleness vs robustness

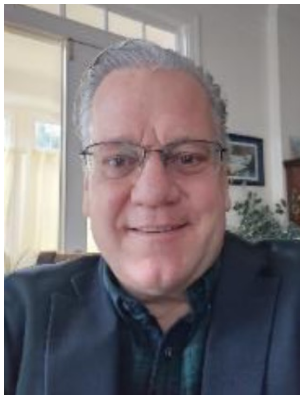


The AmeriFlux Management Project is supported by the BER ESS and Data Management Programs

Dan Stover

Brian Benscoter

Gil Bohrer



Jay Hnilo

Thank you

Margaret Torn

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U.S. DEPARTMENT OF ENERGY | Office of Science

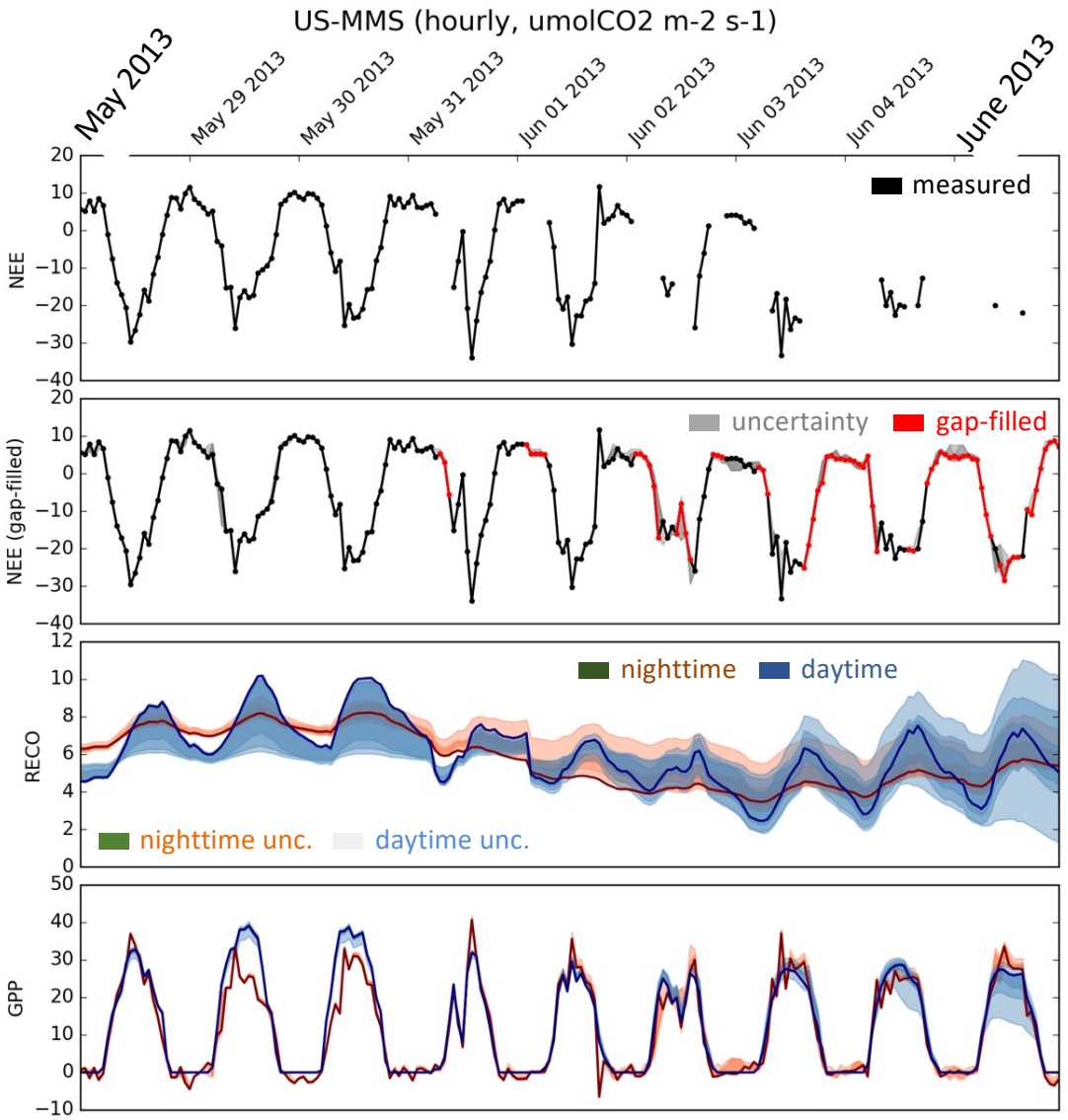
FLUXNET PRODUCT

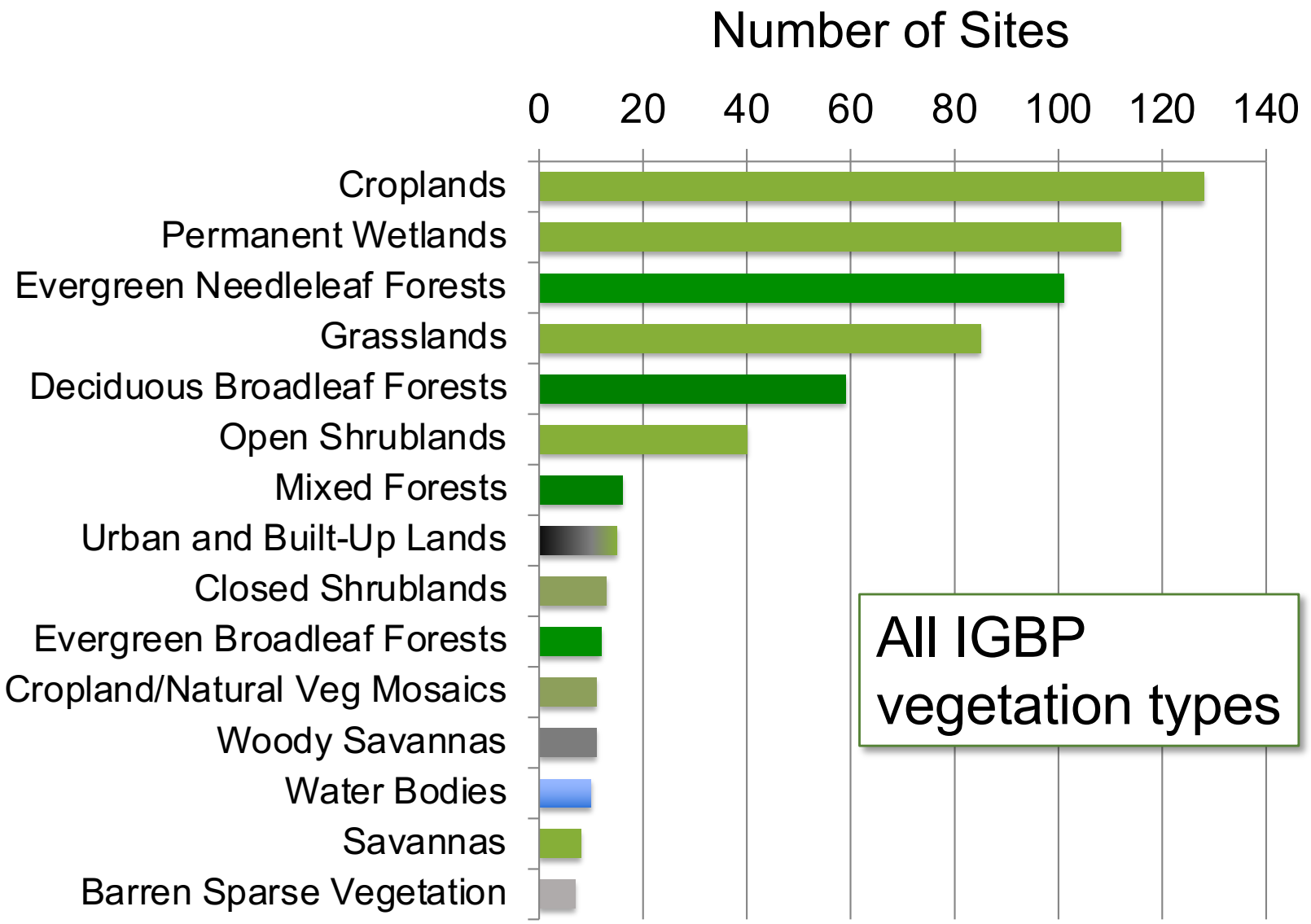
BASE product:
net ecosystem exchange
(NEE)

Gap-filled NEE

Ecosystem respiration
(Reco)

Gross Primary
Productivity (GPP)




Number of Sites
0
20
40
60
80
100
120
140
Croplands
Permanent Wetlands
Evergreen Needleleaf Forests
Grasslands
Deciduous Broadleaf Forests
Open Shrublands
Mixed Forests
Urban and Built-Up Lands
Closed Shrublands
Evergreen Broadleaf Forests
Cropland/Natural Veg Mosaics
Woody Savannas
Water Bodies
Savannas
Barren Sparse Vegetation
All IGBP vegetation types