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neon  
Operated by Battelle

# NEON: Data and infrastructure to understand changing ecosystems

*A project sponsored by the National Science Foundation and proudly operated by Battelle*

This material is based upon work supported by NSF's National Ecological Observatory Network which is a major facility fully funded by the National Science Foundation



# Agenda

- Introduction to NEON
- Educational Resources
- NEON Publications & Use Cases

# National Ecological Observatory Network (NEON)

*...a continental-scale, long-term (30 year) Observatory, funded by NSF and operated by Battelle*

Enables:

- Analysis: Free and open data and samples on the drivers of and responses to environmental change
- Comparison: Standardized and reliable framework for research and experiments
- Interoperability: Integration with other national and international network science projects



# Why is NEON important for ecology?

NEON provides a highly coordinated national system for monitoring a number of critical ecological and environmental properties at multiple spatial and temporal scales.



Downed trees at The Jones Center at Ichauway

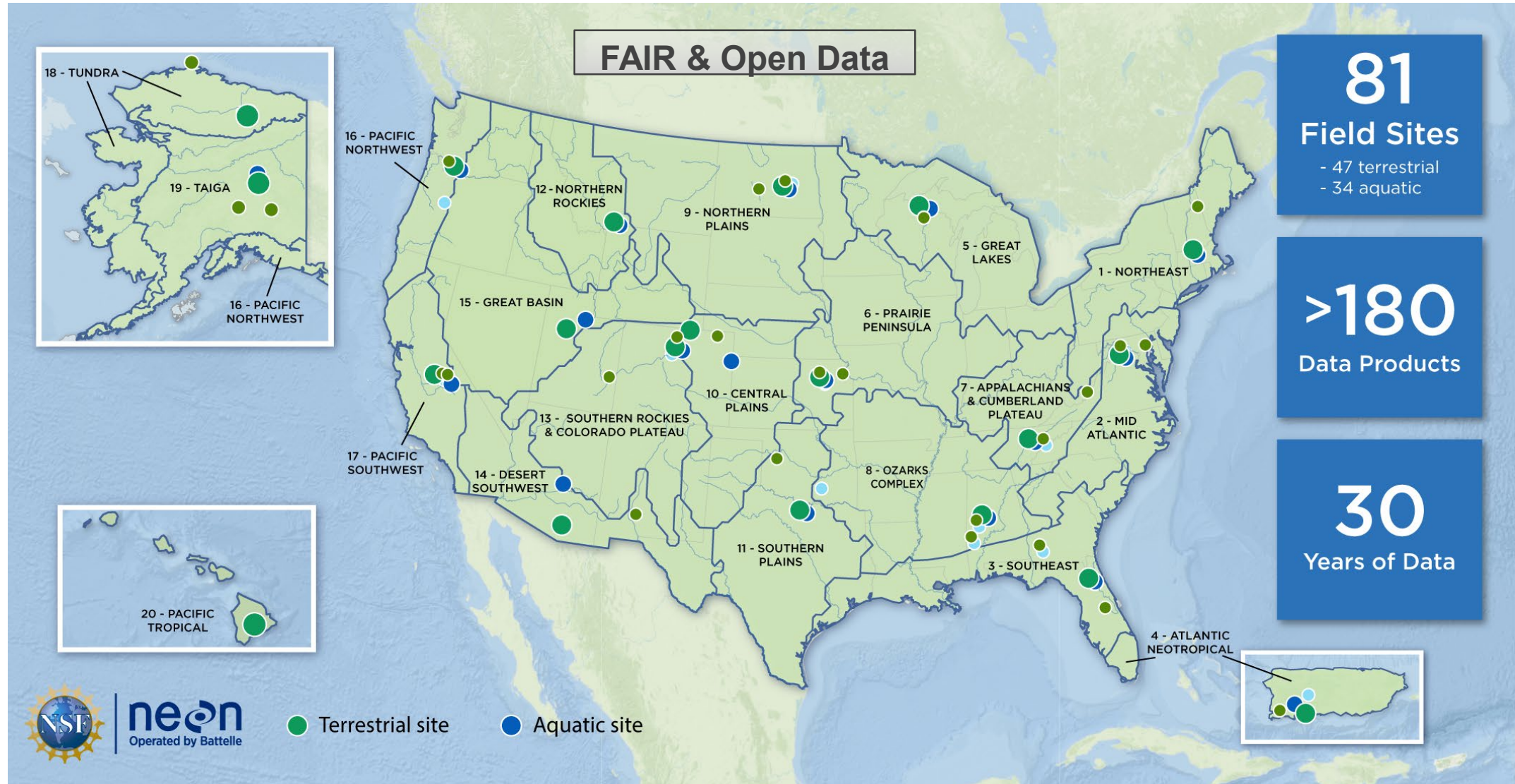


Ice breakup on Oksrukuyik Creek, AK

Fire damage at Great Smoky Mountains field site



# NEON is a distributed Observatory across the U.S.





# NEON data collected via 3 data collection systems

*Standardized, colocated methods across sites*







# Automated instruments: meteorological, soil & water data



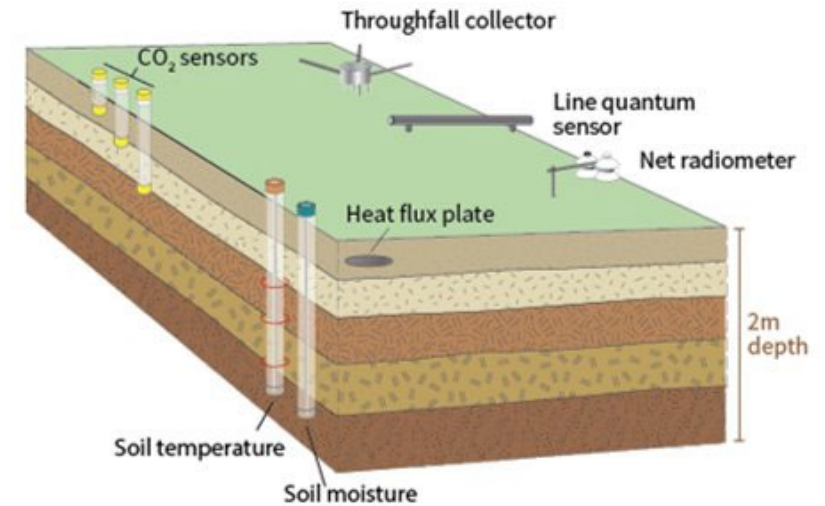
Flux tower at  
terrestrial sites



Micrometeorology  
station at aquatic  
sites



Instruments in the  
ground monitor  
indicators of water  
quality

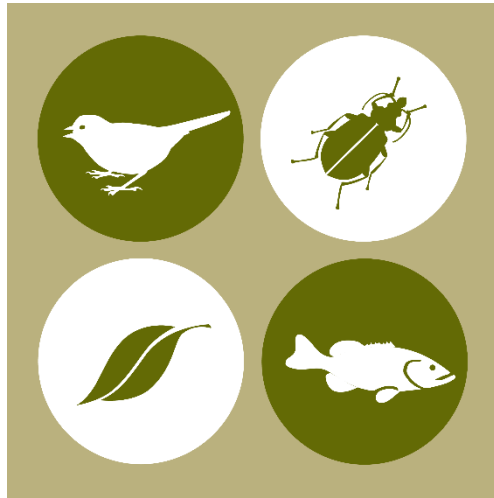


An array of soil plots near the flux  
tower at terrestrial sites collect  
soil health data





# Observational sampling



Terrestrial &  
aquatic organisms



Biogeochemical  
data



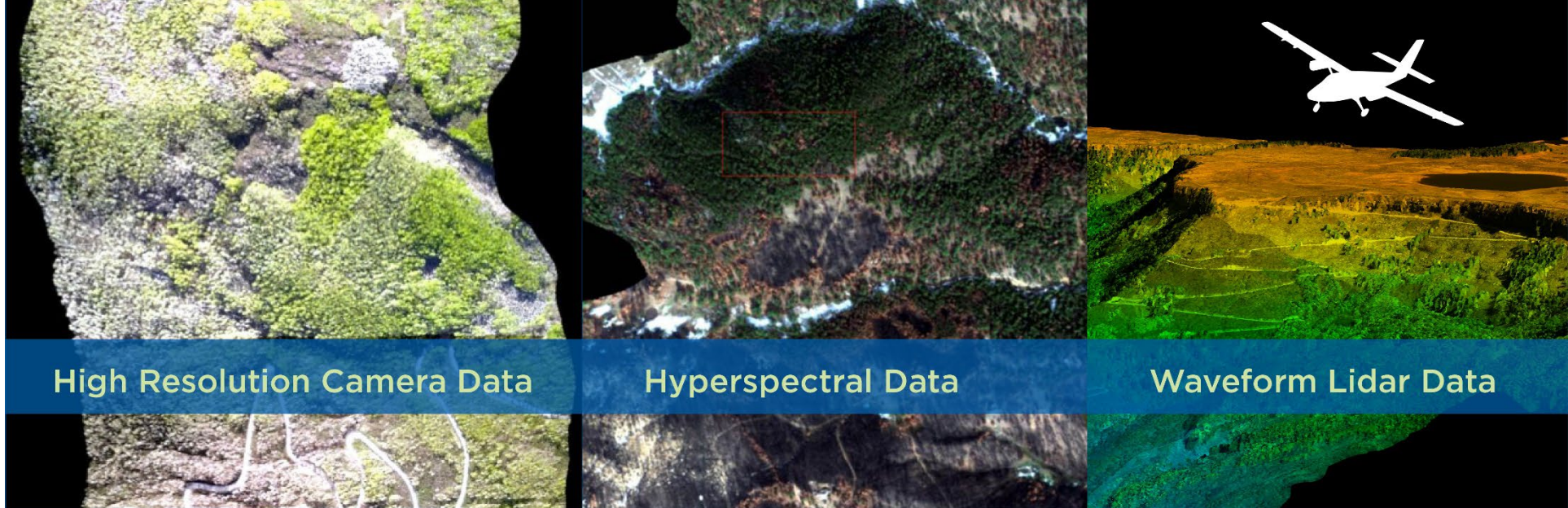
Physical  
Properties





# Airborne remote sensing

## The Airborne Observation Platform (AOP)

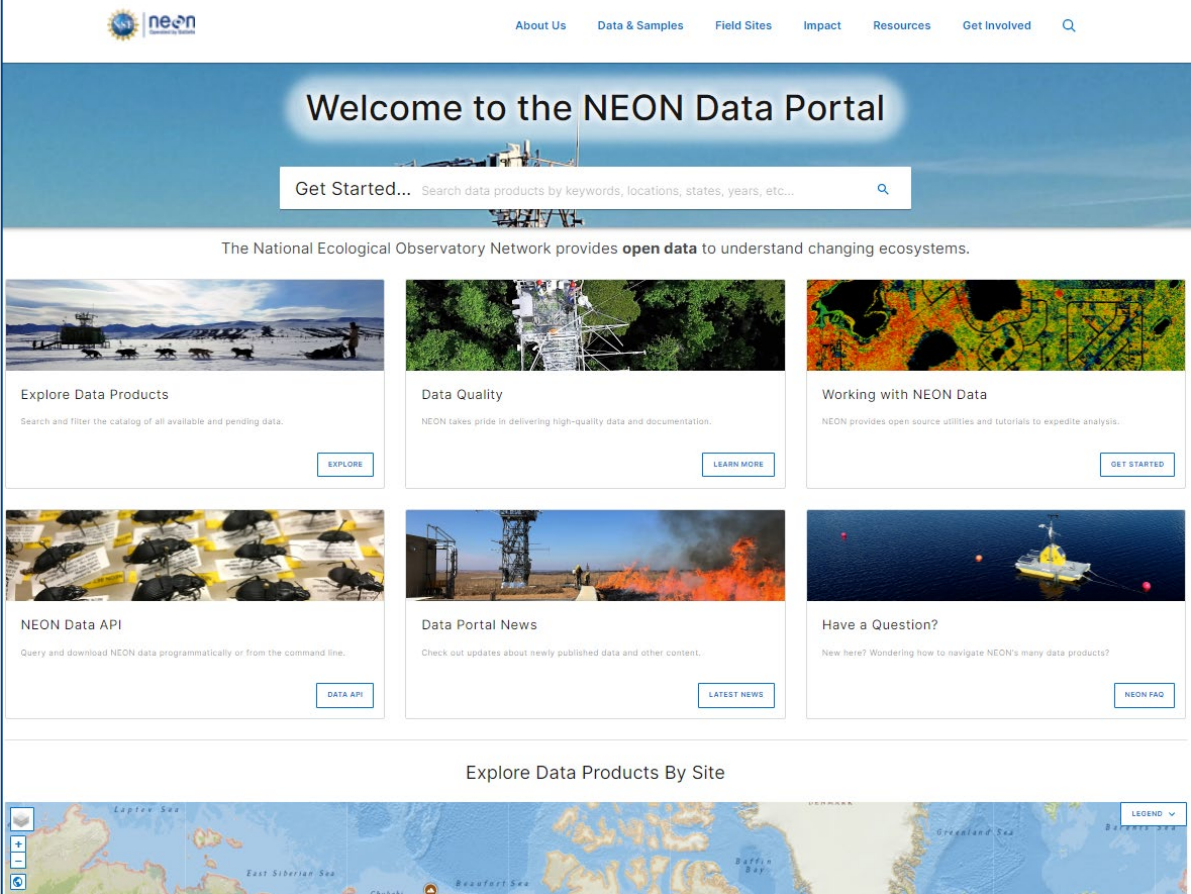


Surveys are conducted at peak greenness over each site



# Data portal: data.neonscience.org

- Explore and download FREE data
- Information on programmatic access to NEON data
  - API
  - Code packages
- Access data product user guides, detailed protocols, and other important documents



The screenshot displays the NEON Data Portal homepage. At the top, the NEON logo is on the left, and navigation links for 'About Us', 'Data & Samples', 'Field Sites', 'Impact', 'Resources', and 'Get Involved' are on the right. A search bar is positioned below the navigation. The main heading reads 'Welcome to the NEON Data Portal'. Below this is a search bar with the placeholder text 'Get Started... Search data products by keywords, locations, states, years, etc...'. A central banner states: 'The National Ecological Observatory Network provides **open data** to understand changing ecosystems.' The page features six content cards arranged in a 2x3 grid. The first row includes 'Explore Data Products' (with an 'EXPLORE' button), 'Data Quality' (with a 'LEARN MORE' button), and 'Working with NEON Data' (with a 'GET STARTED' button). The second row includes 'NEON Data API' (with a 'DATA API' button), 'Data Portal News' (with a 'LATEST NEWS' button), and 'Have a Question?' (with a 'NEON FAQ' button). At the bottom, there is a section titled 'Explore Data Products By Site' with an interactive map of the NEON field sites.





# NEON Assignable Assets Program

Makes available certain components of NEON's infrastructure, scientists, engineers, field ecologists and technicians to members of the community to support their own research or other activities





# Educational Resources

# Data Tutorials

- Self-paced online learning
- Skills & Topic focused, adaptable
- R, Python, Git, & others

<https://www.neonscience.org/resources/learning-hub/tutorials>

## Tutorials

Search by Title

Filter

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[About Hyperspectral Remote Sensing Data](#)

0.25 - 0.5 Hours

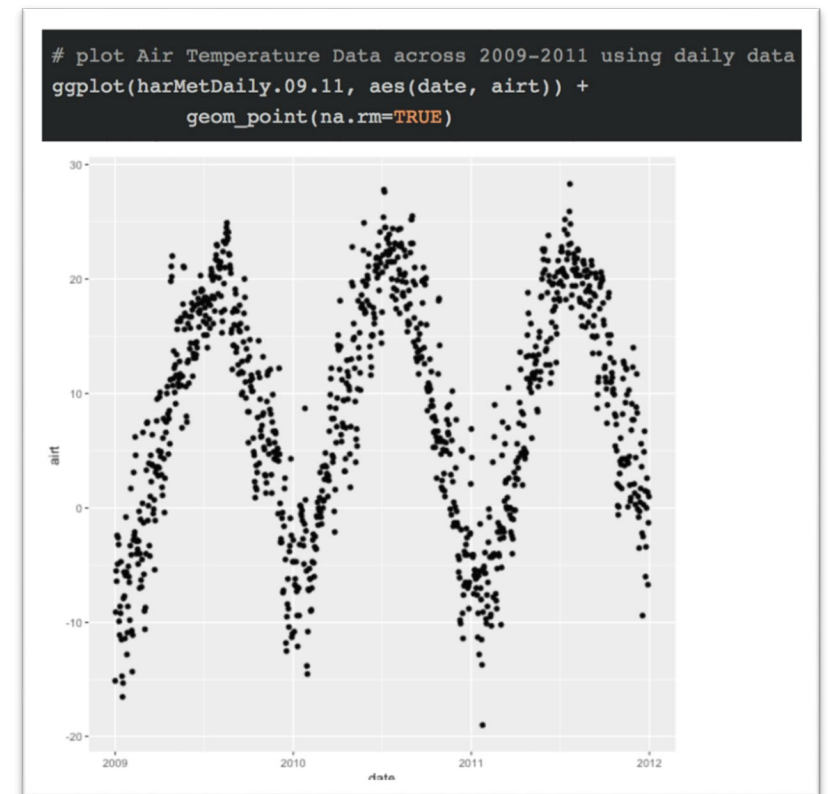
Learn about the fundamental principles of hyperspectral remote sensing data.

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[Access and Work with NEON Geolocation Data](#)

30 minutes

Use files available on the NEON data portal, NEON API, and neonUtilities R package to access the locations of NEON sampling events and infrastructure. Calculate more precise locations for certain



## Download and Explore NEON Data

1 - 2 HOURS

Tutorial for downloading data from the Data Portal and the neonUtilities package, then exploring and understanding the downloaded data



# Code Resources

- Developed by NEON scientists & external researchers
- Open access & available to download on [GitHub](#)
- Three Tiers:
  - Community Contributed Code
  - NEON Certified Code
  - NEON Production Code



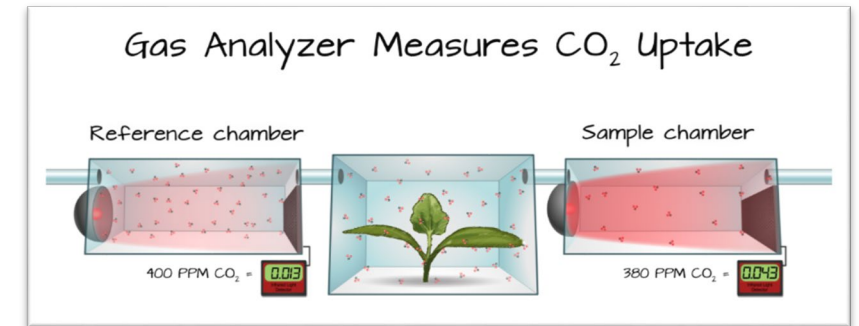
<https://www.neonscience.org/resources/code-hub>

TITLE	DESCRIPTION	TIER	LANGUAGE
eddy4R	eddy4R is a family of open-source packages for eddy-covariance (EC) raw data processing, analyses and modeling in the R Language.	Tier 3: NEON production code	R language

[+ MORE DETAILS](#)

# Teaching Modules

- Instructor developed & led
- Concept focused, with skills built in
- Spreadsheets, R, other data visualization tools
- Faculty notes, presentations, readings, and lesson plans



<https://www.neonscience.org/resources/learning-hub/teaching-modules>

NEON - National Ecological Observatory Network

Powered by QUBES

About NEON and QUBES

Joining the Group

Educational Resources

Products from the NEON Data Education Faculty Mentoring Networks

Featured Resource of the Week



Testing hypotheses about the role of wildfire in structuring avian...

Lesley Bulluck

Version: 2.0

data manipulation, sp...



Mosquito Vector Ecology of the East Coast using NEON

Courtney Company, David Kang

Version: 1.0



Introduction to Data Management and Metadata using NEON aquatic...

Kaitlin Stack Whitney

Version: 1.0

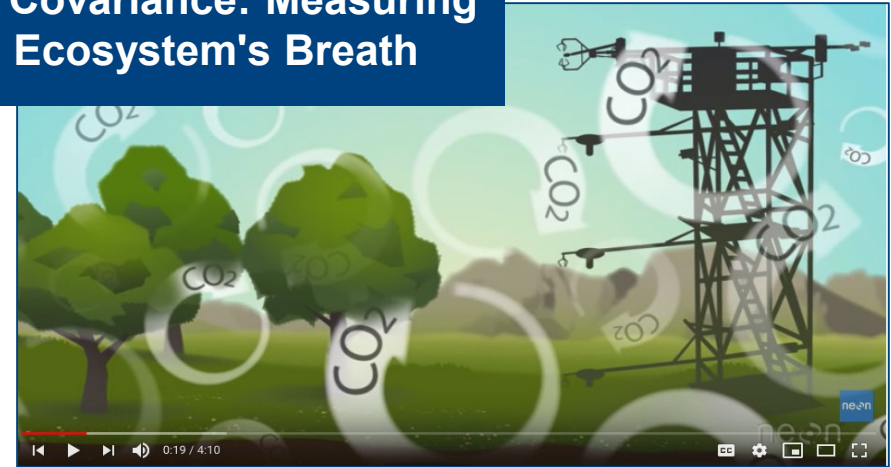


# Science Videos (YouTube)

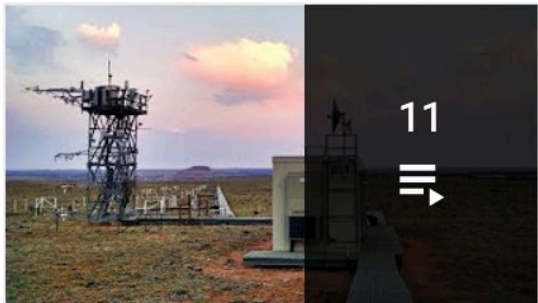
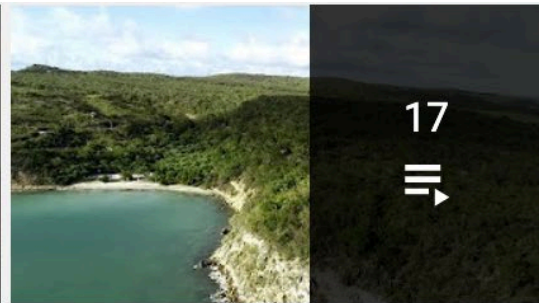
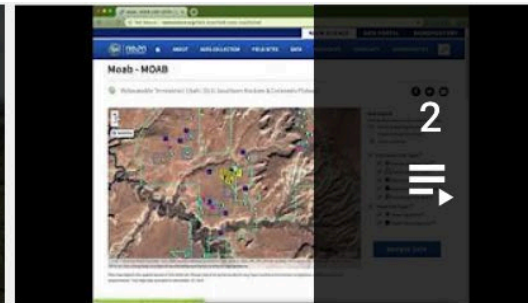
- Cover concepts & techniques related to NEON
- Cover aspects of NEON layout, data collection or data processing
- Cover how to access and work with NEON data

<https://www.youtube.com/NEONScience>

## Eddy Covariance: Measuring an Ecosystem's Breath



Eddy Covariance video shown at public Climate Change event in Valencia, Spain. Captioned and dubbed in Spanish.

		
<b>NEON Science Explained</b>	<b>NEON Field Site Videos</b>	<b>How To Use NEON Tools &amp; Resources</b>

# NEON's Standardized Protocols



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Title: TOS Protocol and Procedure: Litterfall and Fine Woody Debris		Date: 04/24/2019
NEON Doc. #: NEON.DOC.001710	Author: K. Jones	Revision: G



AMERIFLUX



## TOS PROTOCOL AND PROCEDURE: LITTERFALL AND FINE WOODY DEBRIS

PREPARED BY	ORGANIZATION	DATE
Katie Jones	FSU	04/18/2019
Courtney Meier	FSU	09/08/2014

<https://data.neonscience.org/documents>



Research



Community Input (incl. TWGs)



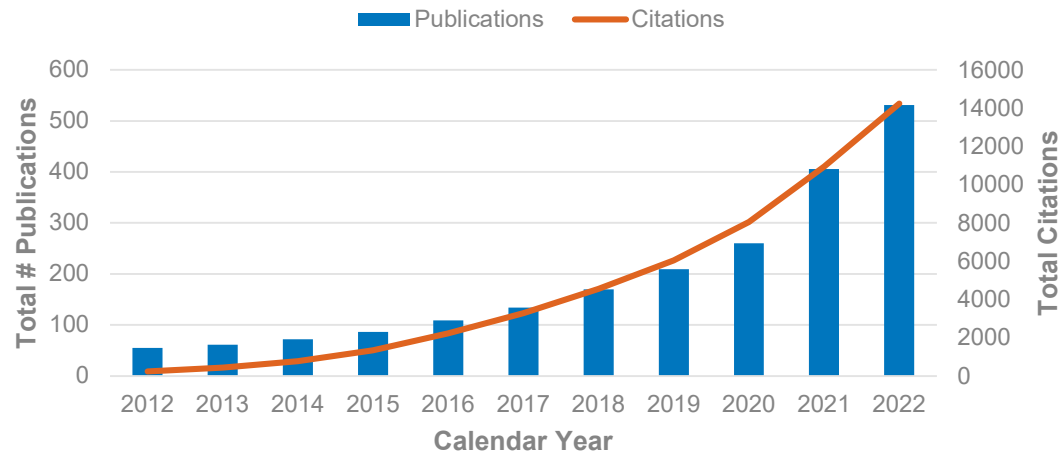
Prototyping



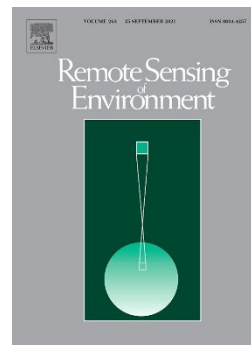
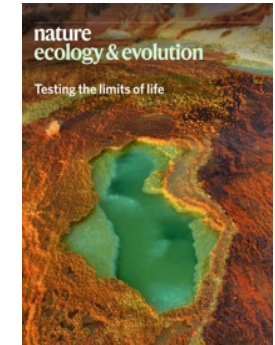
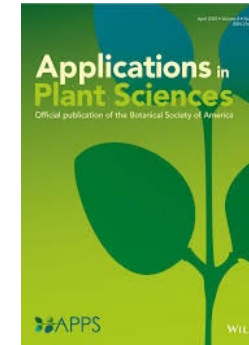
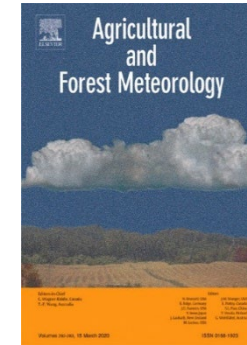
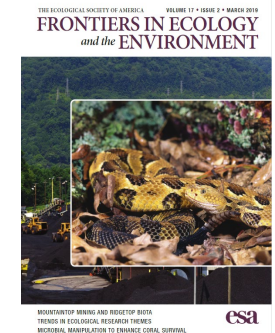
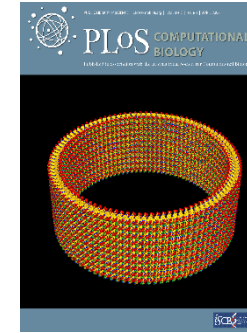
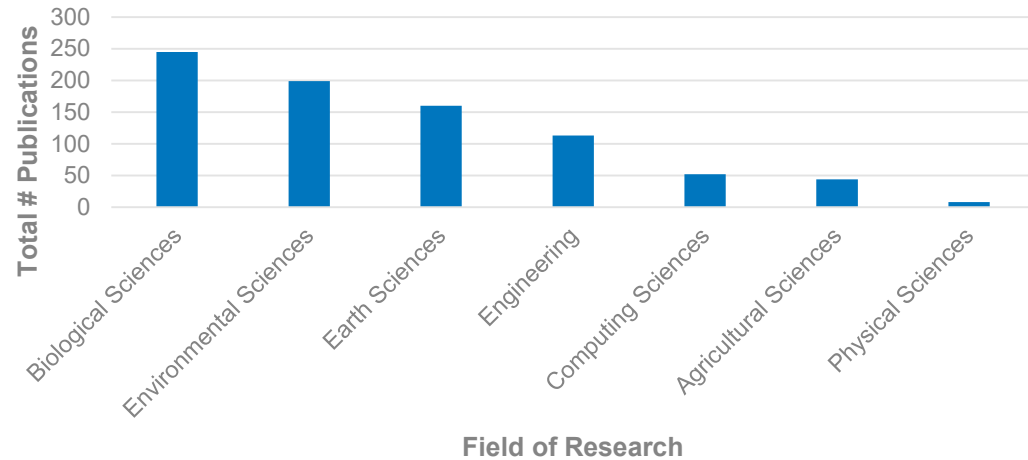
# NEON Publications & Use Cases

# Research enabled by NEON data & specimens

Cumulative Publications and Citations Over Time



Publications by Field of Research (2014-2023)

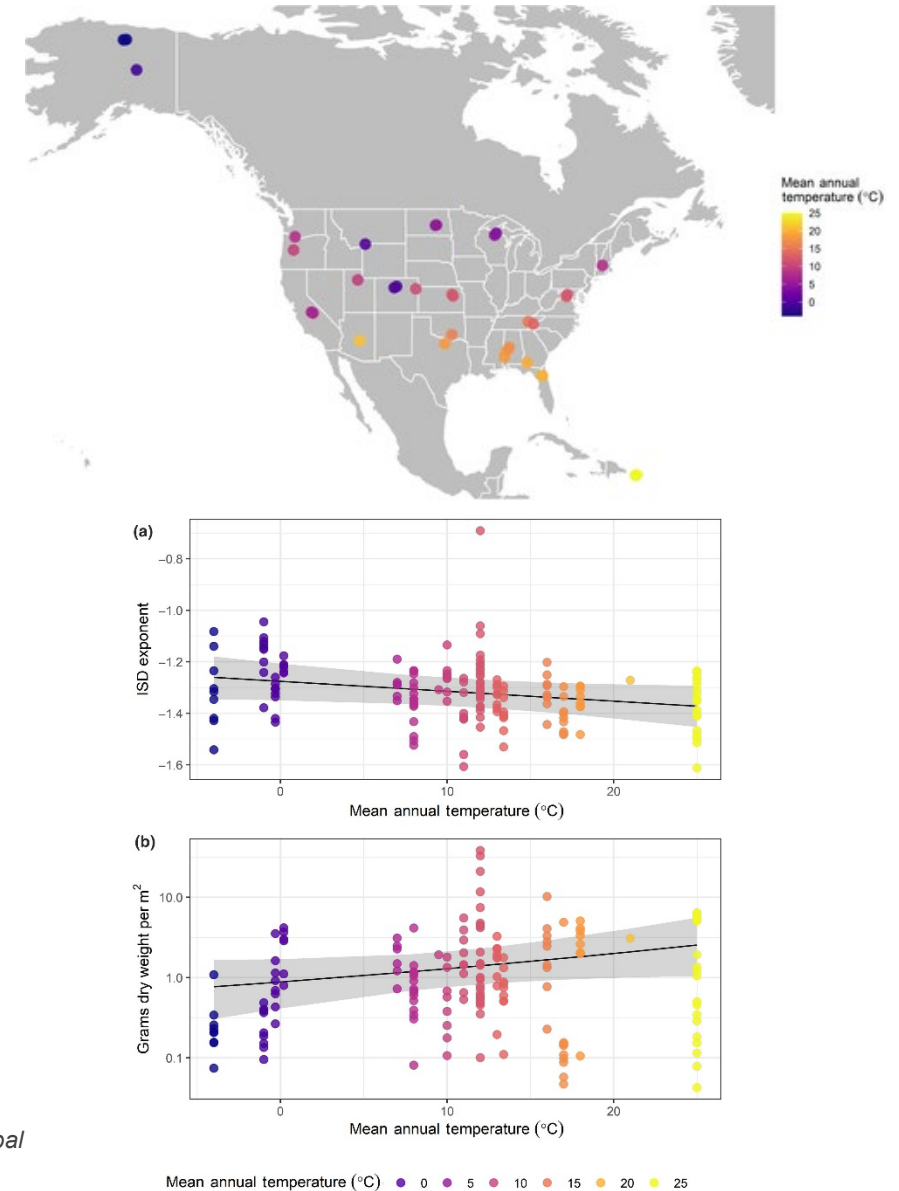




# Data for climate change

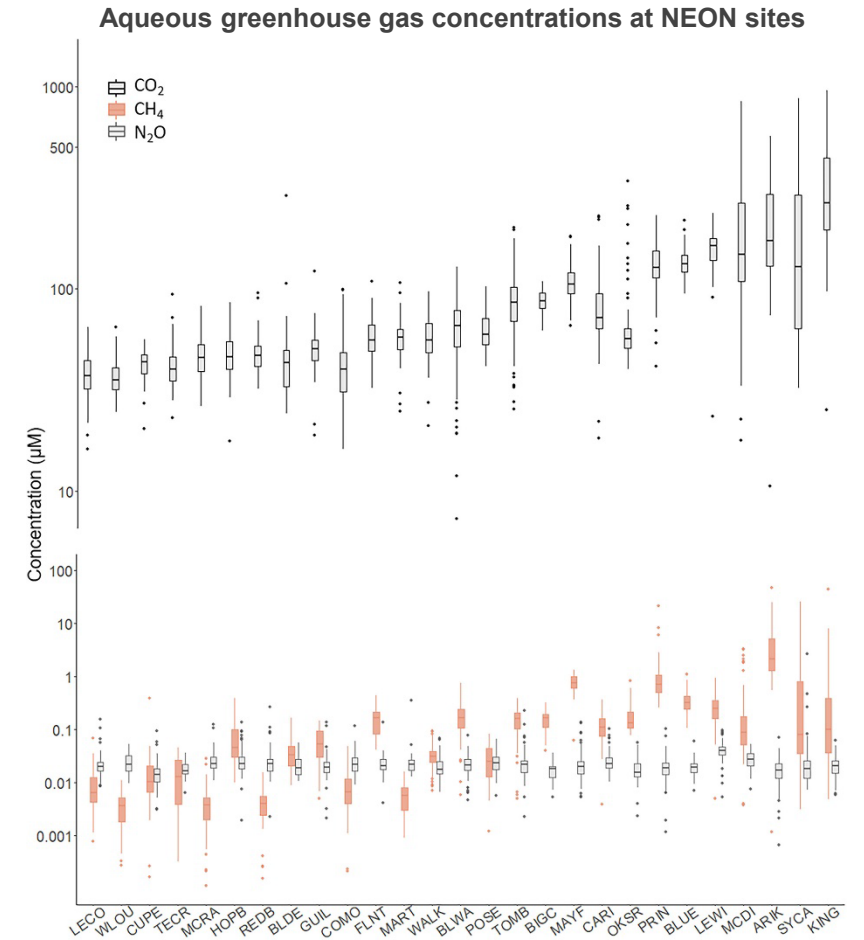
- **Question:** How does abundance, body size, and total community biomass vary with temperature in benthic macroinvertebrates across the US?
- **Results:**
  - The negative relationship between abundance and body size was maintained across sites and environmental gradients (warmer sites have a lower proportion of larger individuals)
  - Total community biomass increased with increasing temperatures and varied substantially per site
  - These results suggest this relationship could be used to assess the ecological condition of stream communities after intense disturbances or temperature anomalies driven by climate change.

Pomeranz, J. P. F., Junker, J. R., & Wesner, J. S. (2022). Individual size distributions across North American streams vary with local temperature. *Global Change Biology*, 28, 848– 858.



# Data for climate change

- **Question:**
  - What are the concentrations and ranges of in-stream CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in NEON streams across the US?
  - How does the relationship between excess CO<sub>2</sub> and dissolved oxygen vary?
- **Goal:** understand variation of drivers of each greenhouse gas at each site
- **Results:**
  - Concentrations of all gases correlated with nutrient supply
  - Low-gradient, warmer, nonperennial and prairie streams had the highest concentrations and variations of greenhouse gases

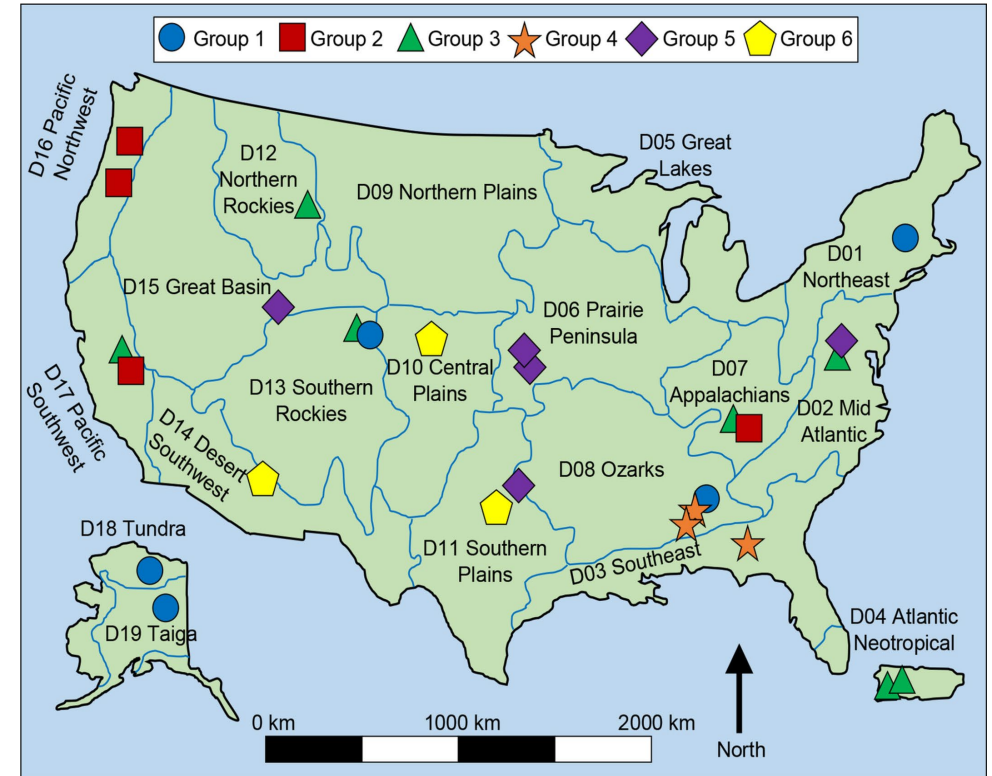


DelVecchia, A. G., Rhea, S., Aho, K. S., Stanley, E. H., Hotchkiss, E. R., Carter, A., & Bernhardt, E. S. (2023). Variability and drivers of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O concentrations in streams across the United States. *Limnology and Oceanography*, 68(2), 394-408.



# Data for climate change

- **Question:** How does surface water chemistry vary across NEON sites?
- **Results:**
  - $\text{Na}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ , and DIC were most likely to vary with stream discharge
  - Larger annual water yields resulted in larger fluctuations in some conservative ions
- **Importance:**
  - Drought could lower DOC delivery to the stream and lower the average chemical complexity of the pool of organic compounds. Increased flooding could lead to a larger percentage of DOC from allochthonous origins, influencing rates of decomposition



Edmonds, Jennifer W., King, Katelyn B. S., Neely, Merrie Beth, Hensley, Robert T., Goodman, Keli J., and Cawley, Kaelin M.. 2022. "Using Large, Open Datasets to Understand Spatial and Temporal Patterns in Lotic Ecosystems: NEON Case Studies." *Ecosphere* 13( 5): e4102. <https://doi.org/10.1002/ecs2.4102>

# Data for natural disasters

## Colorado State University


Prescribed burn @ Konza Biological Station HQ  
Deployment: March 28 – May 22, 2022

Prescribed burn: April 15, 2022



Phase 1 Video: [youtu.be/te3cZvua\\_OE](https://youtu.be/te3cZvua_OE)  
Phase 2 Video: [youtu.be/2FsdvPNw5sA](https://youtu.be/2FsdvPNw5sA)

**Deployment 2**





 **COLORADO STATE UNIVERSITY**

**Critical Wildfire Monitoring Utilizing the NEON MDP with Edge-Computing Cyberinfrastructure**

**Q:** Can edge computing and real-time data acquisition effectively guide sensor placement and human observational sampling during and immediately following disturbance?

Couple the MDP with **high-performance computing resources** to enable responsive and **real-time**, data-driven soil sample collection during and immediately following wildfire activity.

**Phase 1: Testing & Integration**  
Test and integrate SAGE Blade, Wild SAGE Node (WSN), thermal imaging camera, and dust monitor with NEON MDP.



**Phase 2: Deployment to Wildfire**  
Deploy the MDP with integrated SAGE equipment and sensors to a contained wildfire or a controlled burn in Colorado during the 2022 fire year.

AA Project #  
2021-048

Principal Investigator  
Kelly

Lead Institution  
Colorado State University

Requested Services  
MDP

Sites  
Non-NEON locations

Duration  
2-3 Months

Funding Source  
NSF  
RAPID

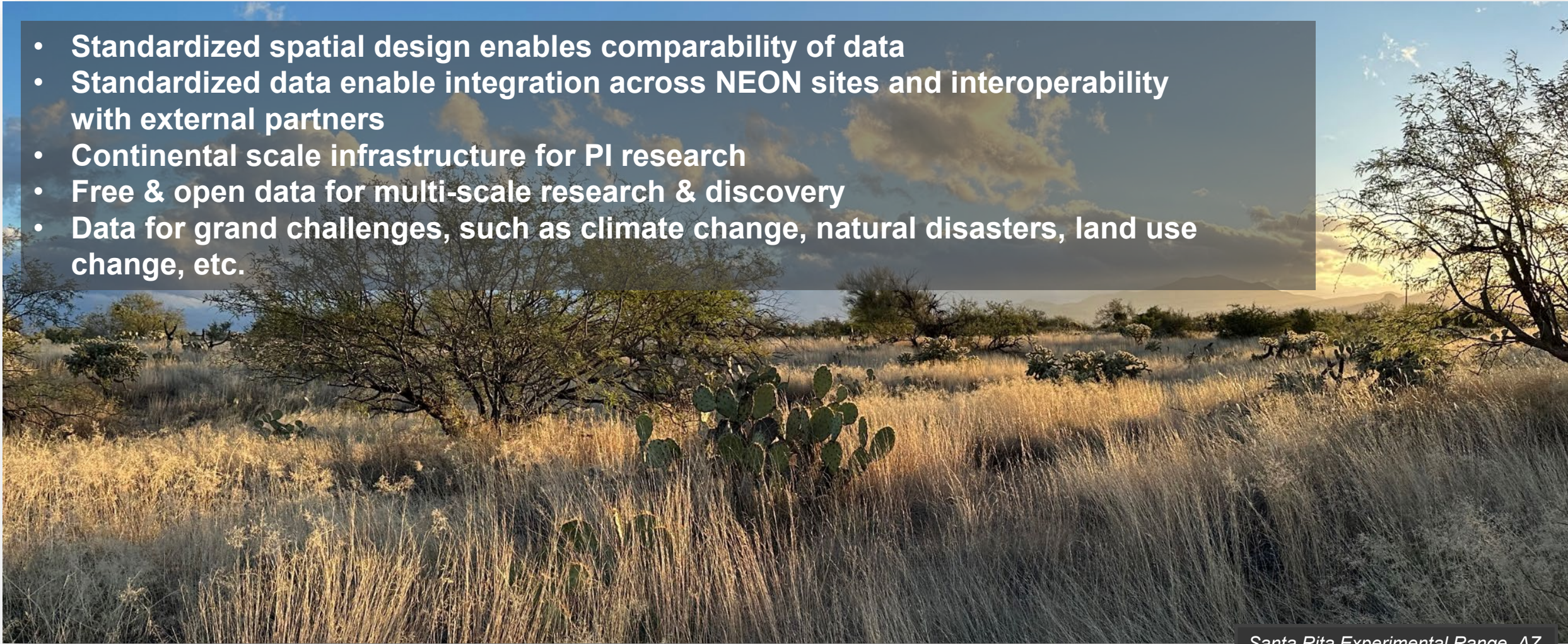
Award Abstract # 2137769

NEON Support Cost  
\$130K



# Why NEON?

- Standardized spatial design enables comparability of data
- Standardized data enable integration across NEON sites and interoperability with external partners
- Continental scale infrastructure for PI research
- Free & open data for multi-scale research & discovery
- Data for grand challenges, such as climate change, natural disasters, land use change, etc.



*Santa Rita Experimental Range, AZ*





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