Claire Lunch

July 20, 2021

Integrating large ecological datasets into undergraduate research and teaching with EREN, NEON, and Project EDDIE

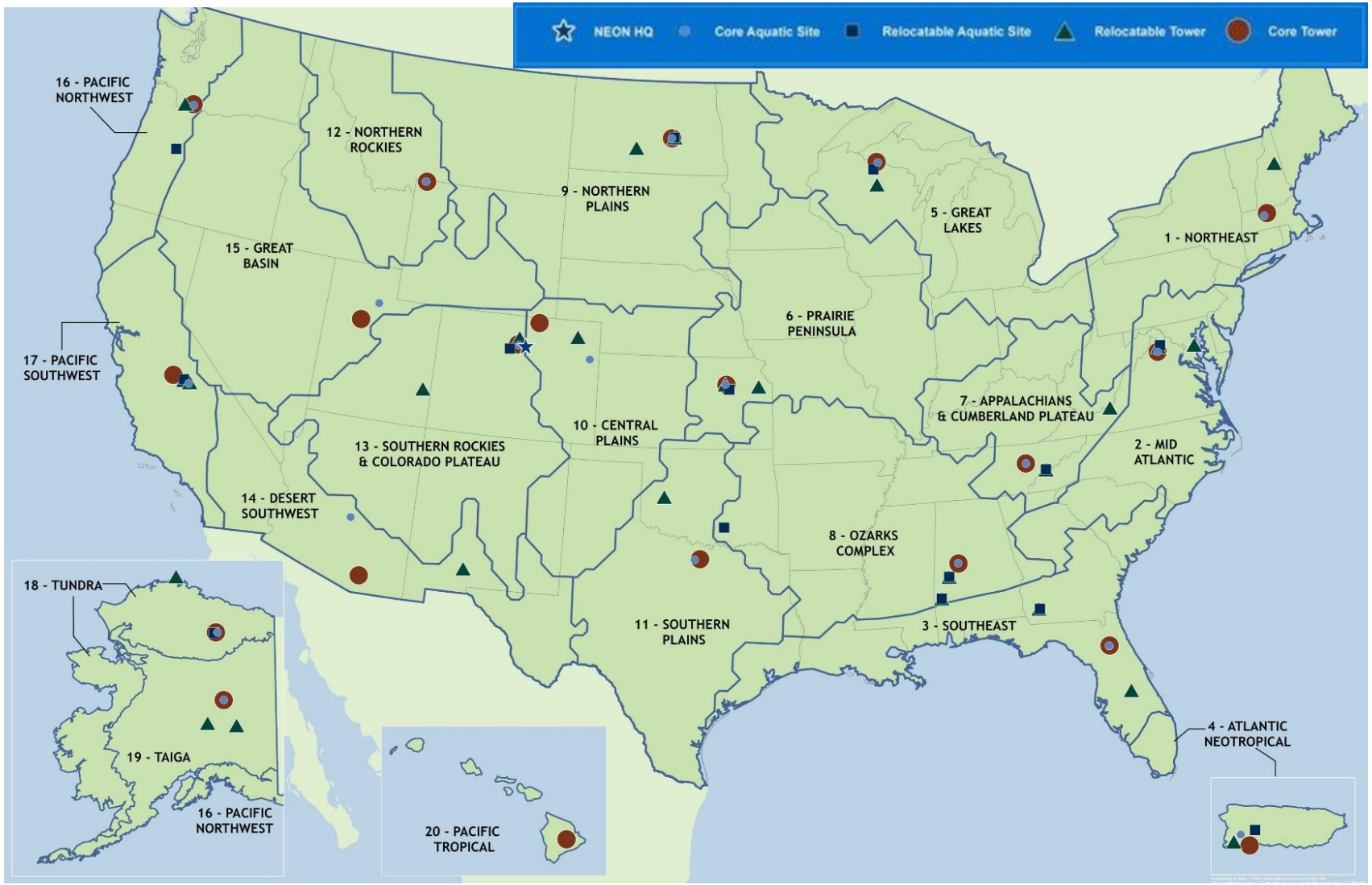
NEON: Data & infrastructure to understand changing ecosystems

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

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

NEON Field Sites



81

FIELD SITES

- 47 terrestrial
- 34 aquatic

Over

180

DATA PRODUCTS

NEON's data collection methods

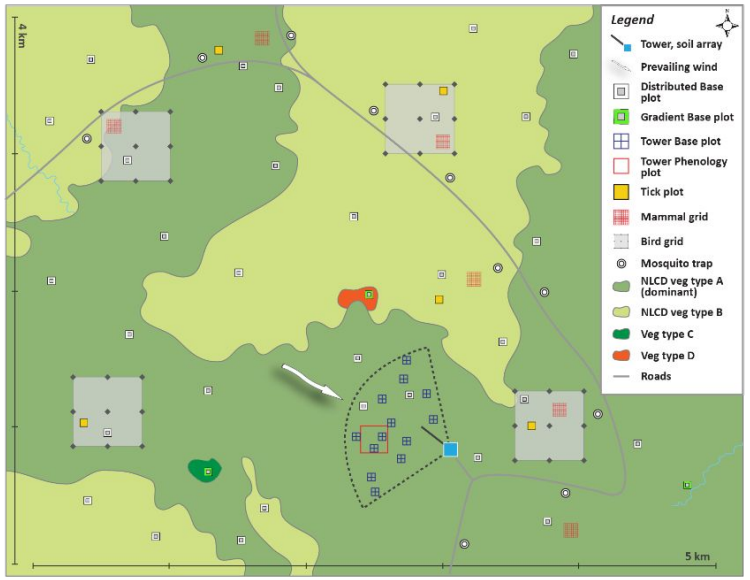
NEON's data collection methods

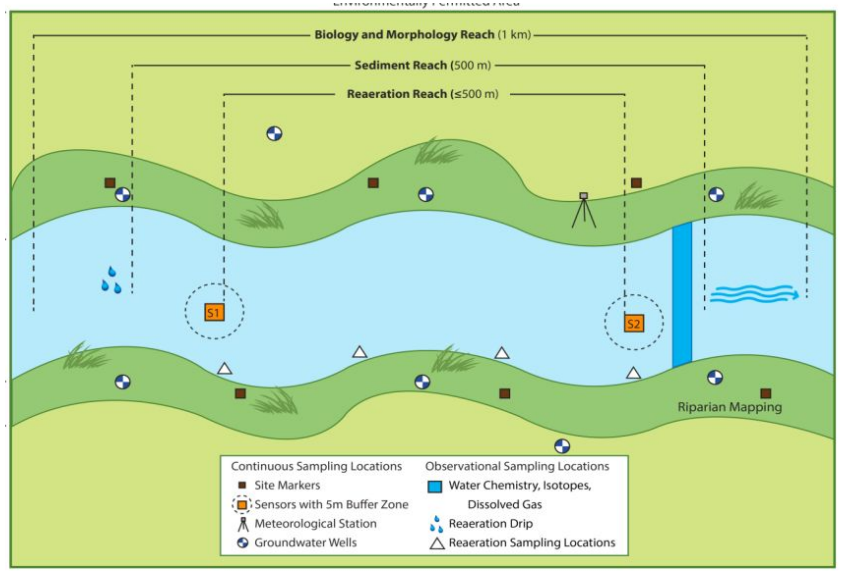
Automated instruments

Observational sampling

Airborne remote sensing

- ✔ These three systems collect data within close proximity of each other at each site
- ✔ Standardized methods are used across all sites
- ✔ Both aquatic and terrestrial sites have all three collection systems





NEON's data collection methods

IS – Instrument Systems

Fixed sensors; data transferred autonomously and continuously, processed in batches

Terrestrial & Aquatic

OS – Observation Systems

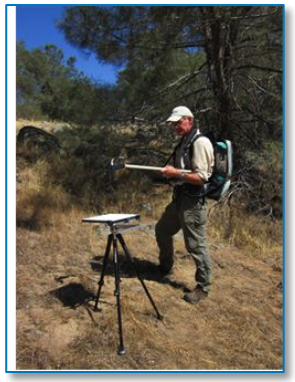
Terrestrial & Aquatic

Data are collected manually; samples sent to external facilities for analysis and/or archive

RS – Remote Sensing

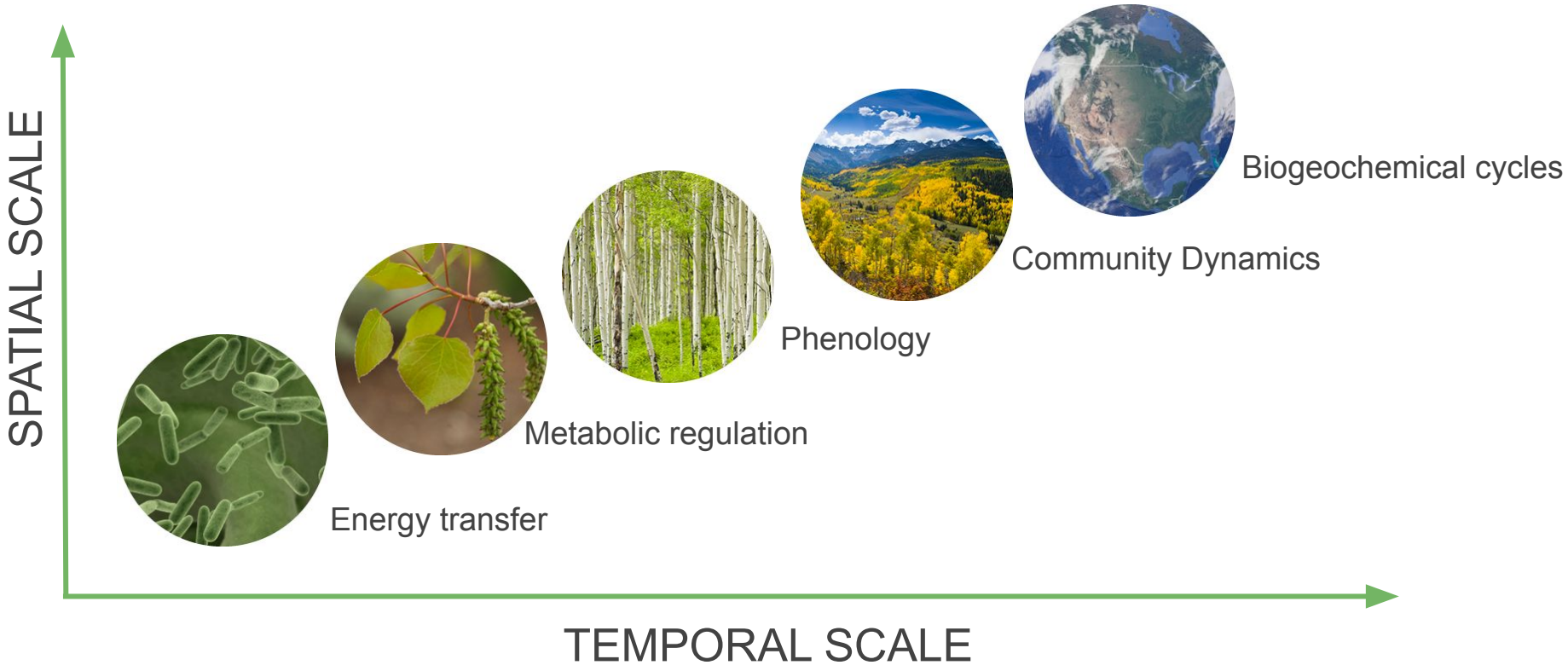
Airborne Platform

Mobile, airborne system; data are recorded electronically and downloaded at a later date



NEON can be used to:

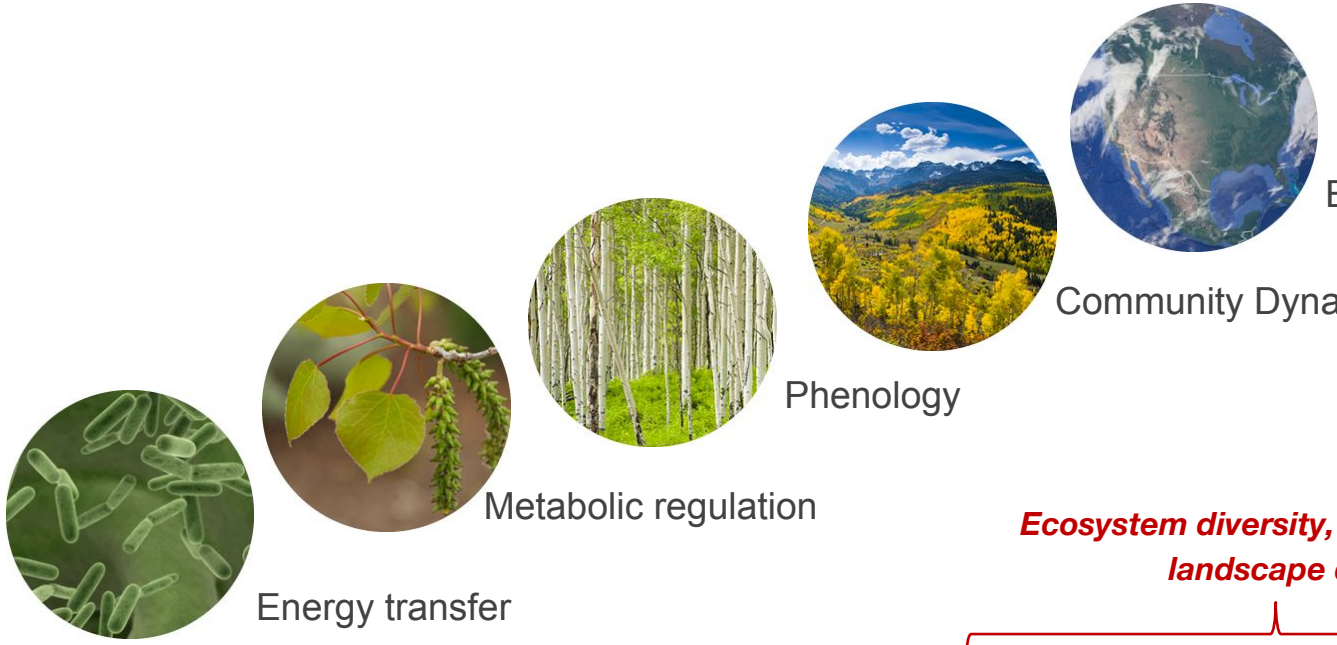
Integrate ecological observations across multiple scales



Modified after Schaepman, et al. 2009

NEON can be used to:

Integrate ecological observations across multiple scales



Ecosystem diversity, process diversity, landscape diversity

Individual – Population – Community – Ecosystem – Landscape

Species diversity, functional diversity, interaction diversity

Genetic diversity

Modified after Schaepman, et al. 2009

Enhance your science with NEON infrastructure

PI Research – Assignable Assets

- Access to **Observational Sampling Infrastructure (staff and resources)**
- Access to **Sensor Infrastructure**
- **Airborne Observation Platform**
- **Mobile Deployment Platforms**

NEON specimens & samples: NEON Biorepository

100,000 specimens & samples/year

65 sample types

- Small mammals
- Fishes
- Ground beetles
- Mosquitos
- Ticks
- Zooplankton
- Benthic macroinvertebrates
- Vascular plants, algae, bryophytes and lichens
- Soil microbes
- Soil
- Dust
- Wet deposition

iDigBio
Integrated Digitized Biocollections

GBIF
Global Biodiversity Information Facility

Arizona State University

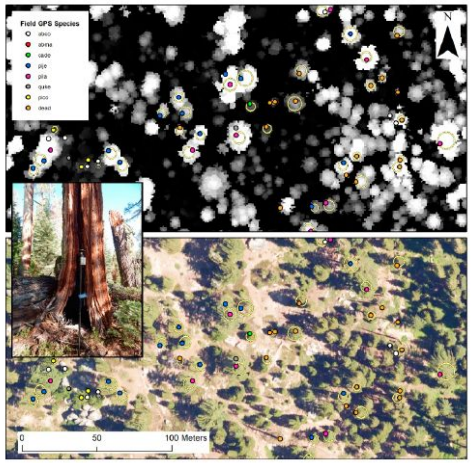
biorepo.neonscience.org

NSF neon Operated by Battelle

Using NEON:

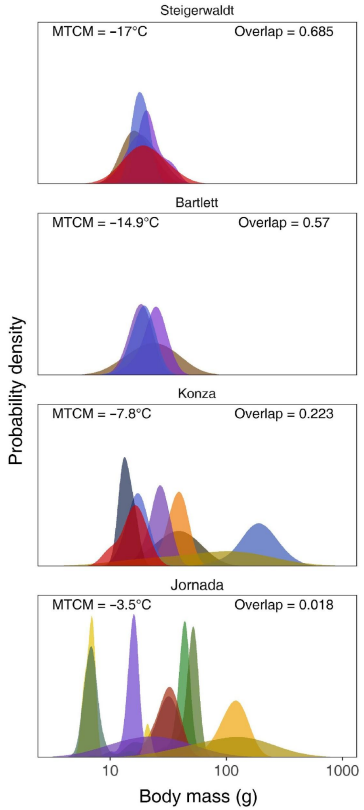
Integrate ecological observations across scales, over time, across disciplines

Tree species identification from hyperspectral reflectance, using NEON vegetation data on the ground as the training set



Fricker, G. A. et al. A Convolutional Neural Network Classifier Identifies Tree Species in Mixed-Conifer Forest from Hyperspectral Imagery. Remote Sensing 11, 2326 (2019).

Increased niche partitioning across climate gradient

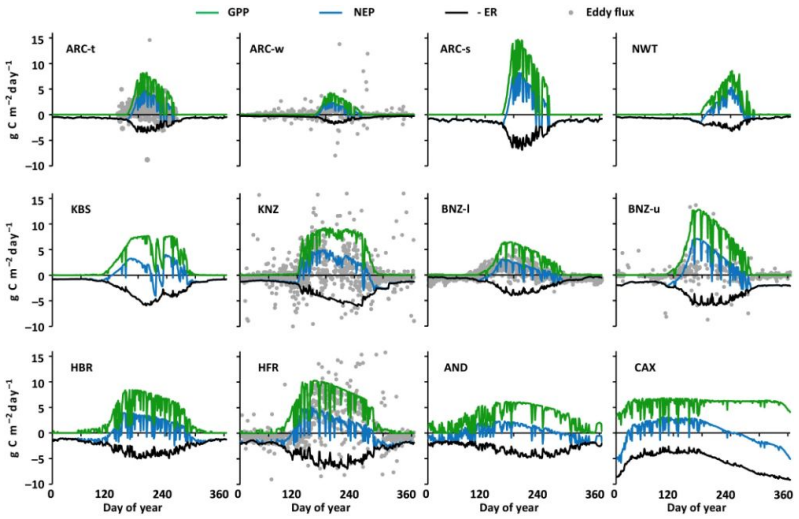


Read, Q.D., Grady, J.M., Zarnetske, P.L., Record, S., Baiser, B., Belmaker, J., Tuanmu, M., Strecker, A., Beaudrot, L. and Thibault, K.M. (2018), Among-species overlap in rodent body size distributions predicts species richness along a temperature gradient. Ecography, 41: 1718-1727. doi:10.1111/ecog.03641

Using NEON:

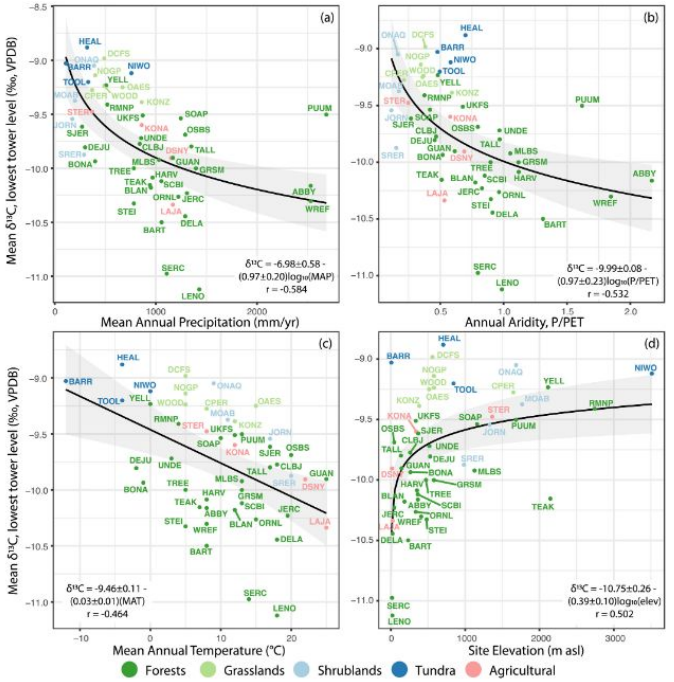
Integrate ecological observations across scales, over time, across disciplines

Modeling nutrient constraints on ecosystem carbon projections from arctic to tropics



Rastetter, Edward B., Kwiatkowski, Bonnie L., Kicklighter, David W., Barker Plotkin, Audrey, Genet, Helene, Nippert, Jesse B., O'Keefe, Kimberly, et al. 2022. " N and P Constrain C in Ecosystems under Climate Change: Role of Nutrient Redistribution, Accumulation, and Stoichiometry." *Ecological Applications* e2684. https://doi.org/10.1002/eap.2684

Climate and ecosystem patterns in atmospheric δ13C

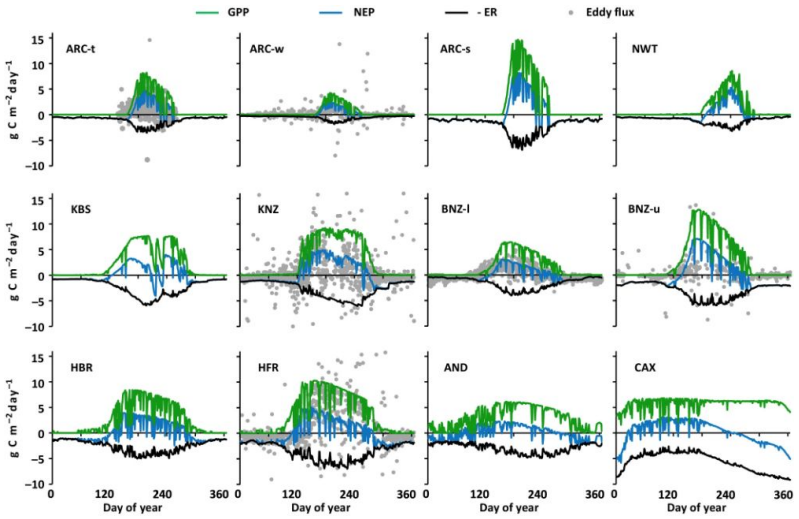


Fiorella, R. P., Good, S. P., Allen, S. T., Guo, J. S., Still, C. J., Noone, D. C., et al. (2021). Calibration strategies for detecting macroscale patterns in NEON atmospheric carbon isotope observations. *Journal of Geophysical Research: Biogeosciences*, 126, e2020JG005862. https://doi.org/10.1029/2020JG005862

Using NEON:

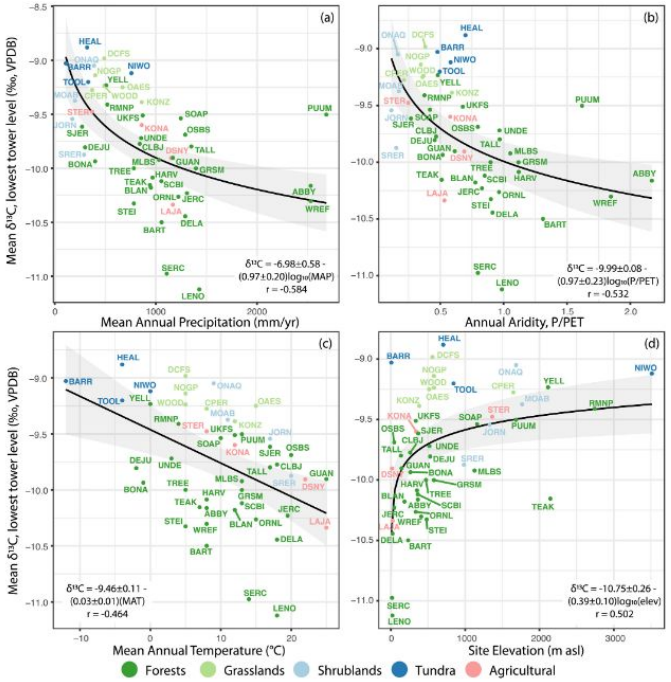
Integrate ecological observations across scales, over time, across disciplines

Modeling nutrient constraints on ecosystem carbon projections from arctic to tropics



Rastetter, Edward B., Kwiatkowski, Bonnie L., Kicklighter, David W., Barker Plotkin, Audrey, Genet, Helene, Nippert, Jesse B., O'Keefe, Kimberly, et al. 2022. " N and P Constrain C in Ecosystems under Climate Change: Role of Nutrient Redistribution, Accumulation, and Stoichiometry." *Ecological Applications* e2684. https://doi.org/10.1002/eap.2684

Climate and ecosystem patterns in atmospheric δ13C



Fiorella, R. P., Good, S. P., Allen, S. T., Guo, J. S., Still, C. J., Noone, D. C., et al. (2021). Calibration strategies for detecting macroscale patterns in NEON atmospheric carbon isotope observations. *Journal of Geophysical Research: Biogeosciences*, 126, e2020JG005862. https://doi.org/10.1029/2020JG005862

https://www.neonscience.org/impact/papers-publications

Operated by Battelle

720.746.4844 | neonscience@battelleecology.org | neonscience.org

Bonus slides: More info about data types

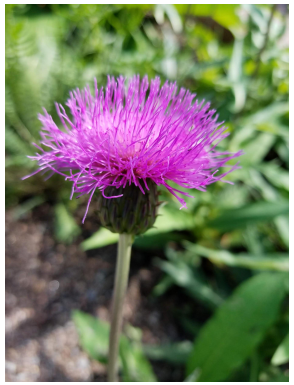
Observational Data

Counts/surveys of target taxa:
- Plants, terrestrial & aquatic
- Ground beetles, mosquitoes, & aquatic invertebrates
- Small mammals, birds, & fish

Biomass/productivity:
- Vegetation structure
- Herbaceous harvest
- Litterfall

Bulk chemistry:
- Soil, water, leaf, litter, root

Microbes:
- Soil, benthic sediment, & surface water
- qPCR, marker genes, and metagenome



Diseases:
- Pathogens in small mammals, ticks, and mosquitoes

Measurement frequency:
- Highly variable, bi-weekly to once per several years

Instrumentation Data - Terrestrial

Eddy covariance:

- CO_2, H_2O & energy fluxes
- CO_2 & H_2O profiles/canopy storage

Atmospheric measurements:

- ^{13}C-CO_2 & ^{18}O-H_2O isotopes
- Dust/particulate deposition
- Radiation, temperature, pressure, precipitation

Soil measurements:

- Temperature, water content, & salinity
- Heat flux
- CO_2 concentration

Measurement frequency:

- Generally 20 Hz, higher for EC and lower for some, such as dust and isotopes
- Published data are usually 1- and 30-minute mean

Instrumentation Data - Aquatic

Atmospheric measurements:

- Small meteorological station at each site
- Radiation, temperature, pressure, precipitation

In-stream sensors:

- Temperature, conductivity, stream stage
- Dissolved oxygen (2-station)
- Nitrate, FDOM, turbidity

Groundwater:

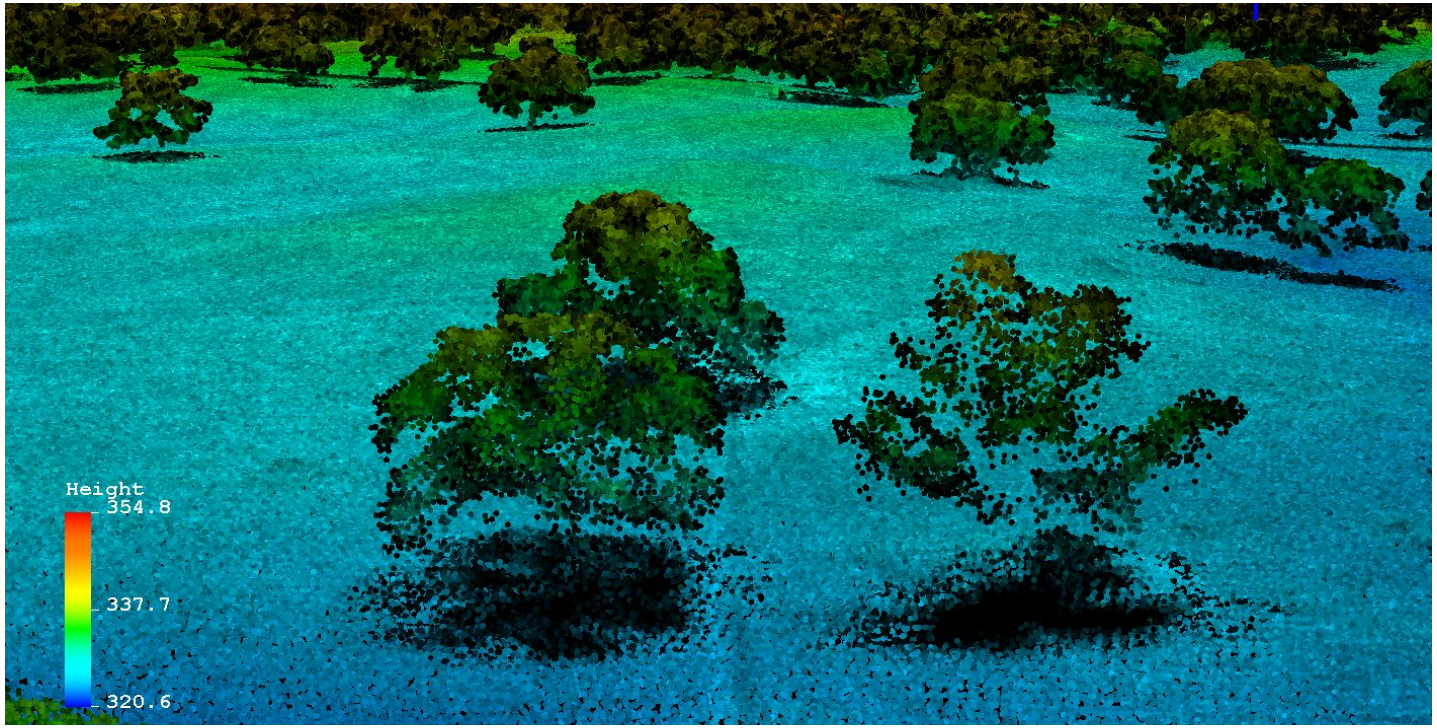
- Elevation, temperature, conductivity

Measurement frequency:

- 20 Hz to once per five minutes

Remote Sensing Data

- High-resolution camera
- LiDAR: Discrete return and waveform
- Hyperspectral: 380-2510nm, 5nm bands; ~1m resolution



<u>Measurement frequency</u>:

- ~3 out of every 4 years at each site (at peak greenness)

Bonus slides: Where to get more info

Data Portal:

- Data catalog
- Data availability
- Details & documentation about each data product
- https://data.neonscience.org/

Code Hub:

- Code resources for working with NEON data
- https://www.neonscience.org/resources/code-hub

Tutorials:

- How to work with NEON data
- How to use NEON code resources
- https://www.neonscience.org/resources/learning-hub/tutorials