Project EDDIE: Remote Sensing of Plants and Topography in R

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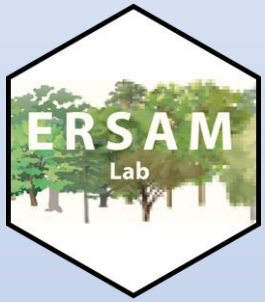
SERC Meet the Author 2021

Department of Geography,
Environment, and Spatial Sciences
MICHIGAN STATE UNIVERSITY



Who is this module for? (or where has it been taught?)

- Taught in an upper-level (3rd & 4th year +) Remote Sensing course where students have worked with gridded (raster) data, concepts like NDVI, and digital elevation models.
- 15 students on computers pre-loaded with R, RStudio, and all the data.
- Some students have done coding before this course, by now in the course all have seen R before.
- Taught online due to COVID (so less interactive that I would have hoped).

Big Ideas

- Vegetation patterns are influenced by the environment they grow in.
- Relationships in big data contexts are often messy.
- Different relationships can be found in different places, but large-scale patterns are also interesting (like, patterns of patterns).

What is NEON?

- NEON = National Ecological Observatory Network

Operated by Battelle

https://www.neonscience.org/

Images from https://www.flickr.com/people/neonsciencedata/

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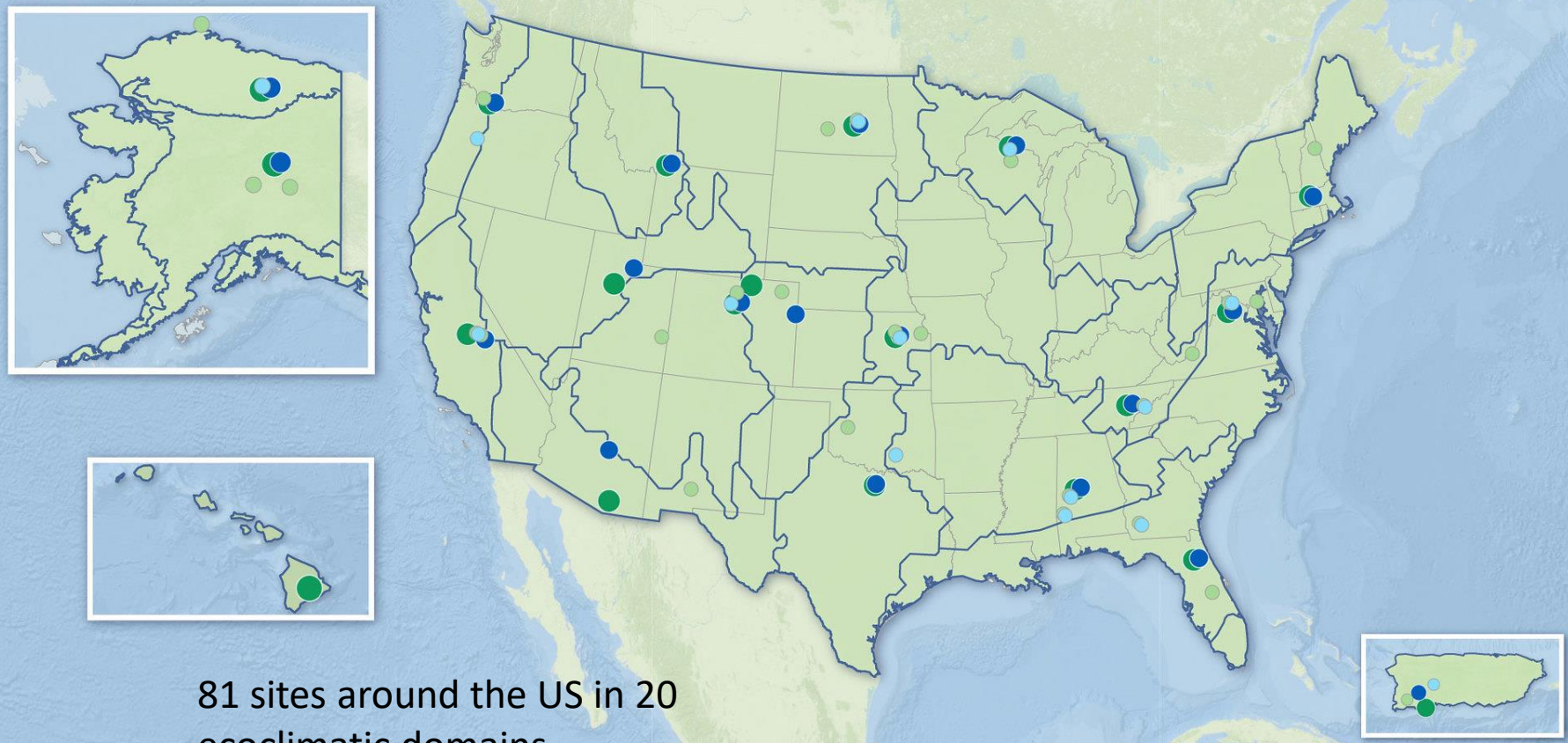

81 sites around the US in 20 ecoclimatic domains

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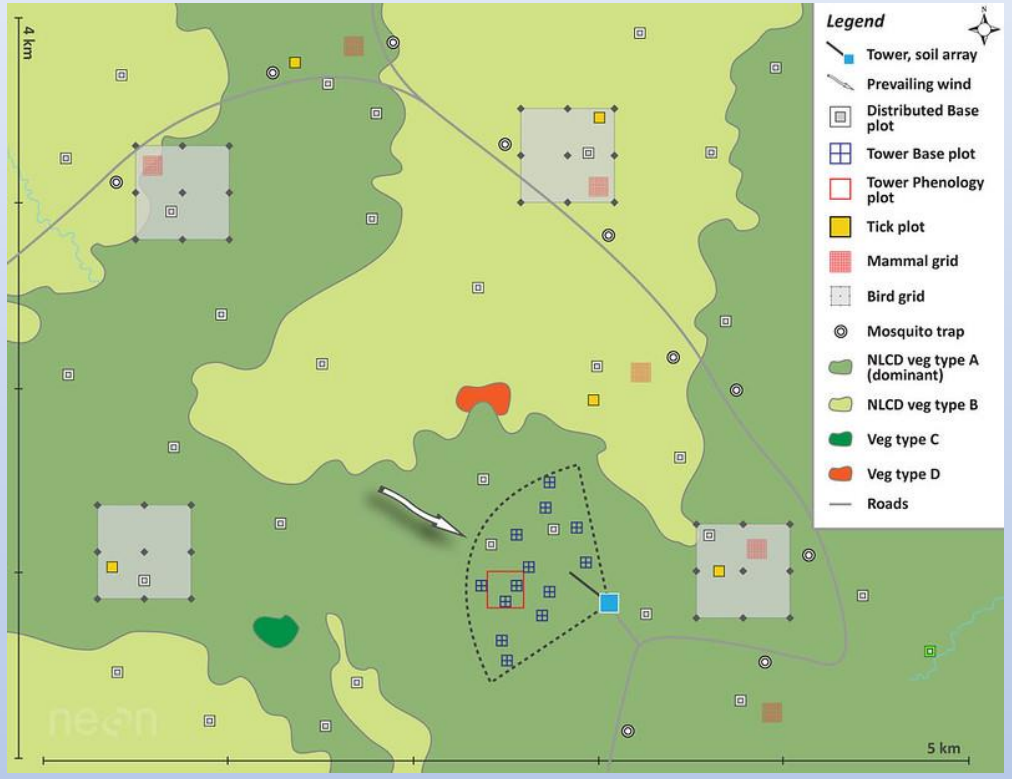

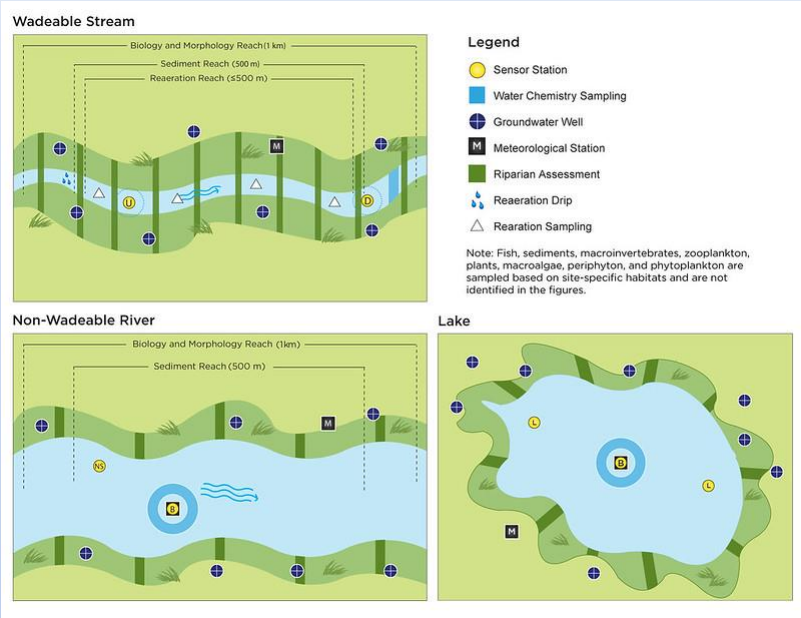

NSF | neon Operated by Battelle

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What is NEON?

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NEON Airborne Observation Platform -> hyperspectral (leaf and soil properties) and lidar (vertical structure and topography)

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Module Example: NEON remote sensing in R

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environmental data-driven inquiry & exploration

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    - EDDIE Macrosystems
    - EDDIE Environmental Data
      - Assessment
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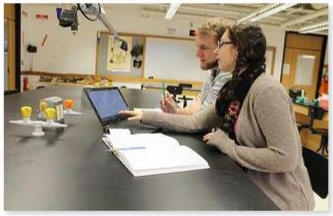
Project EDDIE: Environmental Data-Driven Inquiry & Exploration

Jump to Project Goals / About Large Data Sets / Data Sources / References / Project Support

Scientists are increasingly using sensor-collected, high-frequency and long-term datasets to study geological and environmental processes. Our interdisciplinary team of faculty and research scientists has developed flexible classroom modules that aim to expose undergraduate students to such real-world experiences. These modules utilize large, long-term, high-frequency and sensor-based datasets that can be used in a variety of introductory, mid-level, and advanced courses that meet a series of pedagogical goals, allowing students to: (i) manipulate large datasets to conduct real-world, inquiry-based investigations; (ii) develop reasoning about statistical variation; and (iii) become excited about first-hand experiences with the scientific process. Each module requires students to collect data from online sources, such as discharge and water quality data from the US Geological Survey, ecosystem carbon dioxide flux data from FLUXNET, lake temperature data from the Global Lake Ecological Observatory Network, and seismic data from the Incorporated Research Institutions for Seismology.

Project Goals



Our objective is to develop stand-alone modular classroom activities for undergraduate students using large long-term and high-frequency datasets framed by the following pedagogical goals:

1. Develop skills required to manipulate large datasets.
2. Conduct inquiry-based investigations.
3. Develop students' reasoning about statistical variation.
4. Engage students in authentic scientific discourse.
5. Foster conceptions about the nature of environmental science.

What are Large Data Sets?

https://serc.carleton.edu/eddie/enviro_data/index.html

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Module Example: NEON remote sensing in R

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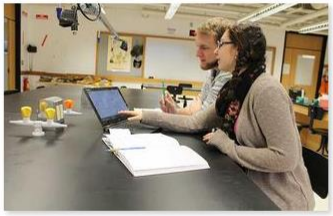

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    - Statistical Vignettes
    - Video Collection
    - Community-Contributed Resources
    - How the Community is Using EDDIE Materials
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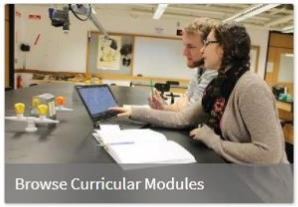
Teaching Materials

Project EDDIE has developed a variety of teaching materials -- from short video tutorials and statistical vignettes to classroom activities, take a look at the collections below to find ready-to-use materials that can be adopted as is, or adapted to fit your course.



EDDIE-Developed materials include:

- **Ready-to-use curricular modules**, which use large publicly available online datasets that contribute to improved student quantitative reasoning. Ranging from one class period to a week, these materials have been pilot-tested and include all materials needed to complete the activities.
- **Statistical Vignettes** that utilize brief lectures, supporting materials, and an engaging story-line with diverse characters to help guide students and teachers through the relevant theoretical background. Statistical vignettes are designed to help students address statistical misconceptions and improve their quantitative reasoning skills.
- The **EDDIE Teaching video & tutorial collection** includes brief tutorials for software, including R, Excel, and EDDMapS, quantitative skills (regression), and teaching best practices.

Community Contributions

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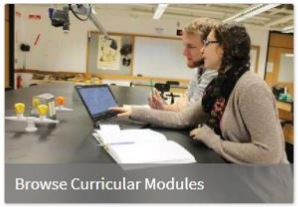

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Ready-to-use curricular modules

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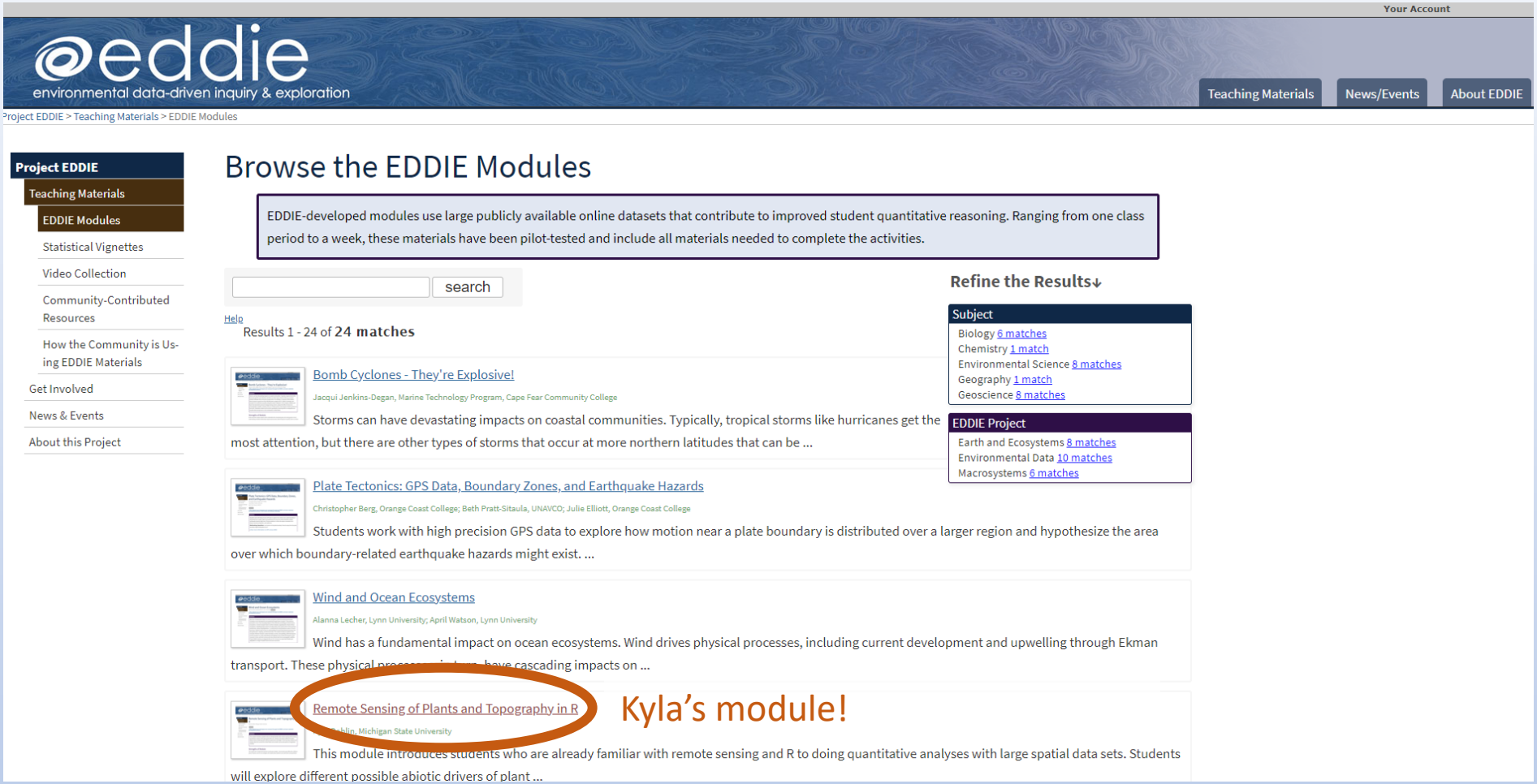


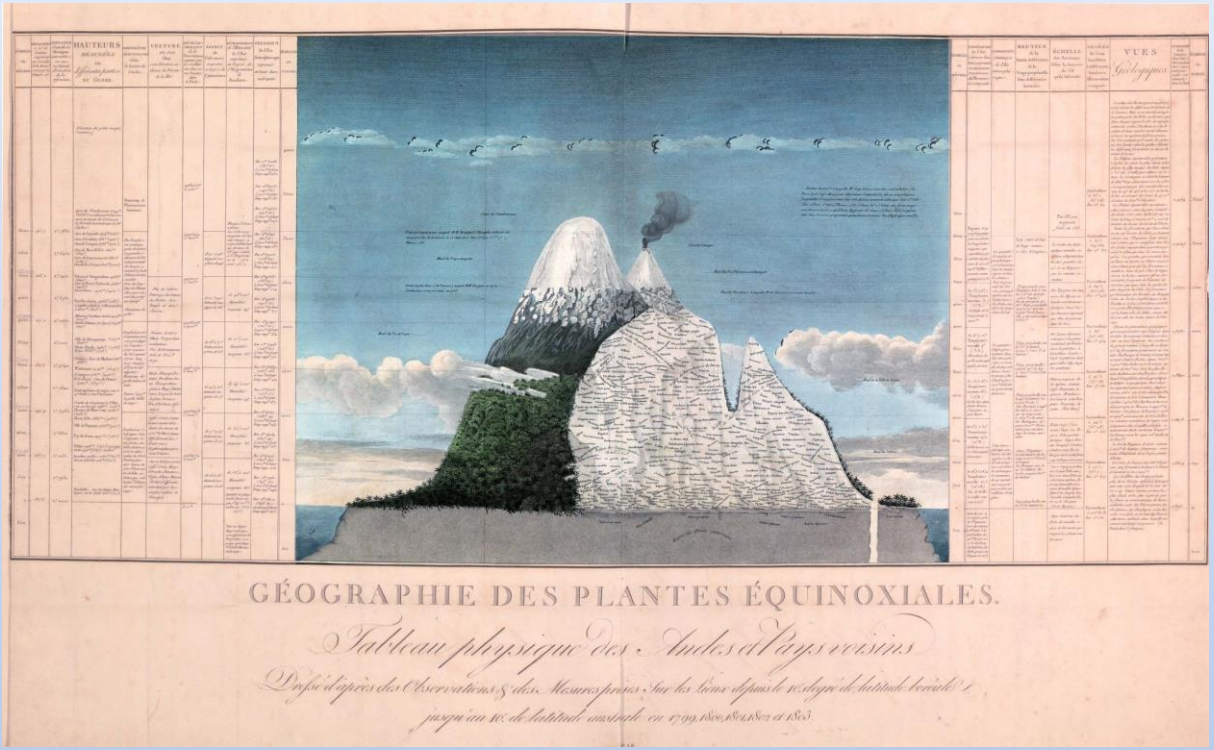
https://serc.carleton.edu/eddie/teaching_materials/eddie_modules.html

Module Example: NEON remote sensing in R

Go to the module and check it out!
https://serc.carleton.edu/eddie/teaching_materials/modules/remote_sense_plant_topo.html

Module Example: NEON remote sensing in R

Powerpoint introduces NEON, along with concepts like environmental filtering, NDVI, slope, aspect, and correlation.

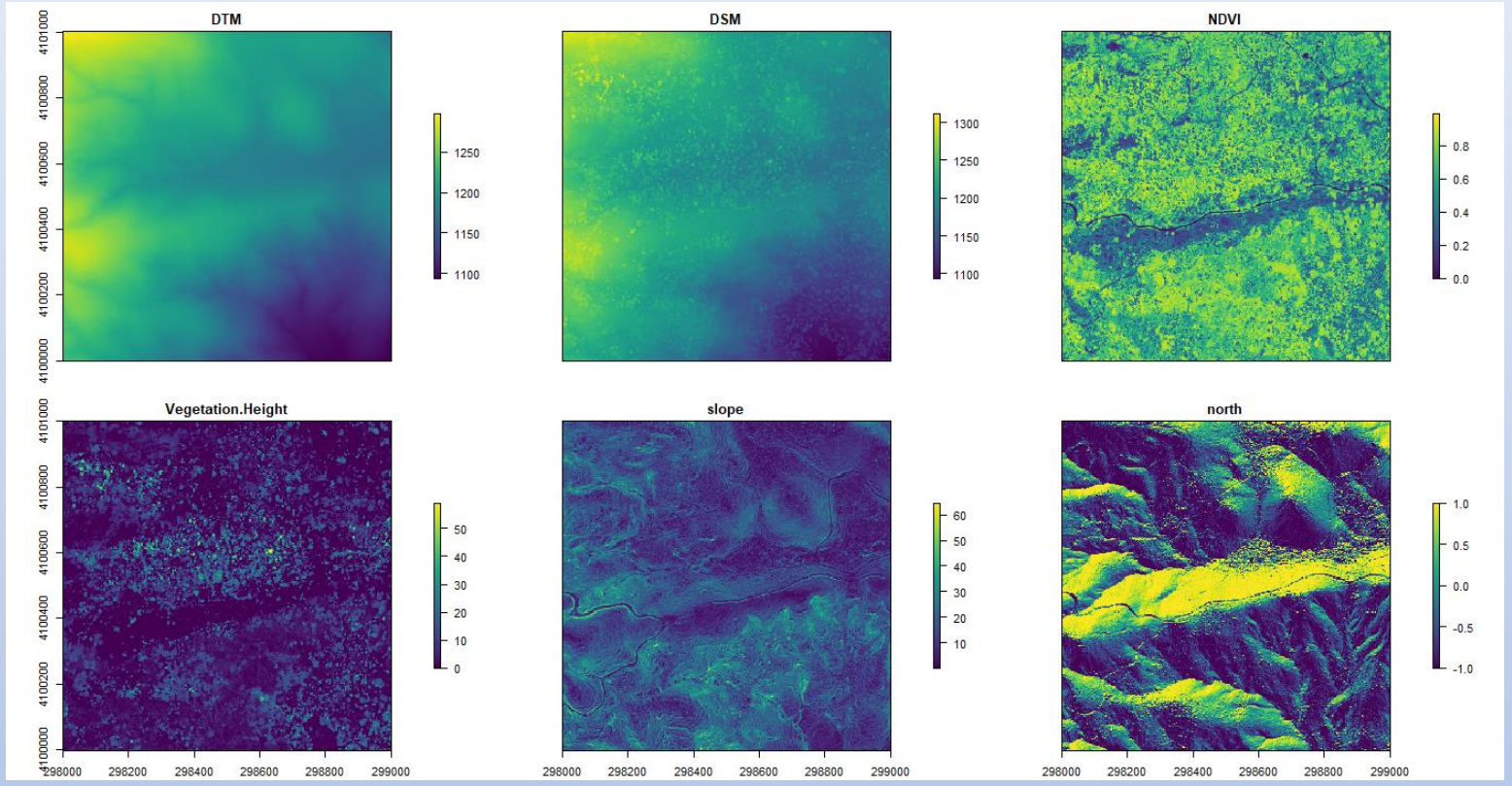


Humboldt & Bonpland 1807 – Chimborazo in Ecuador

Module Example: NEON remote sensing in R

A

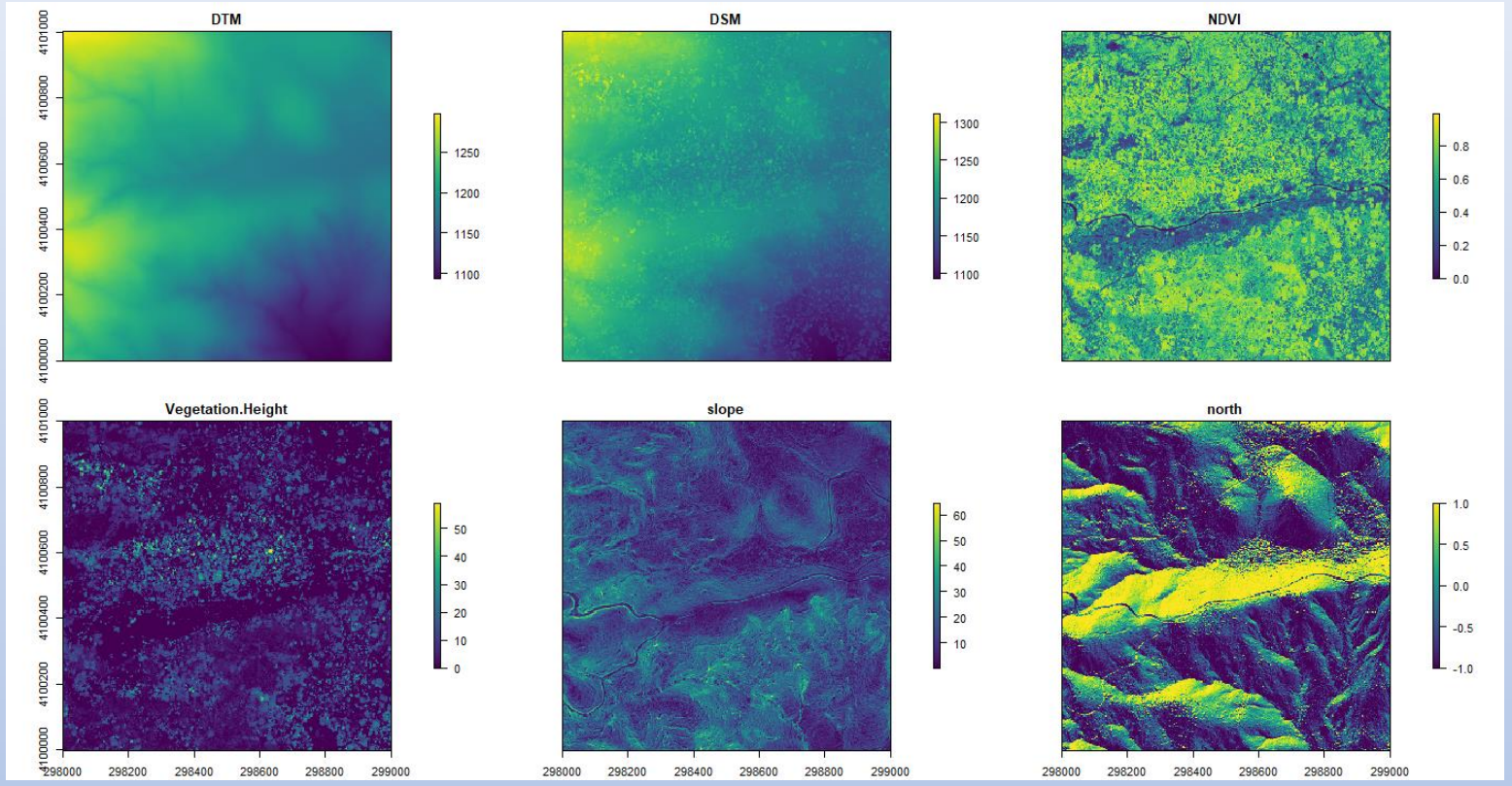
Students read in the raster data layers: digital terrain model (DTM), digital surface model (DSM), and NDVI, then calculate veg height, slope & aspect, and plot (1 km^2 tile from the Soaproot Saddle NEON site in California from 2018).



Module Example: NEON remote sensing in R

A

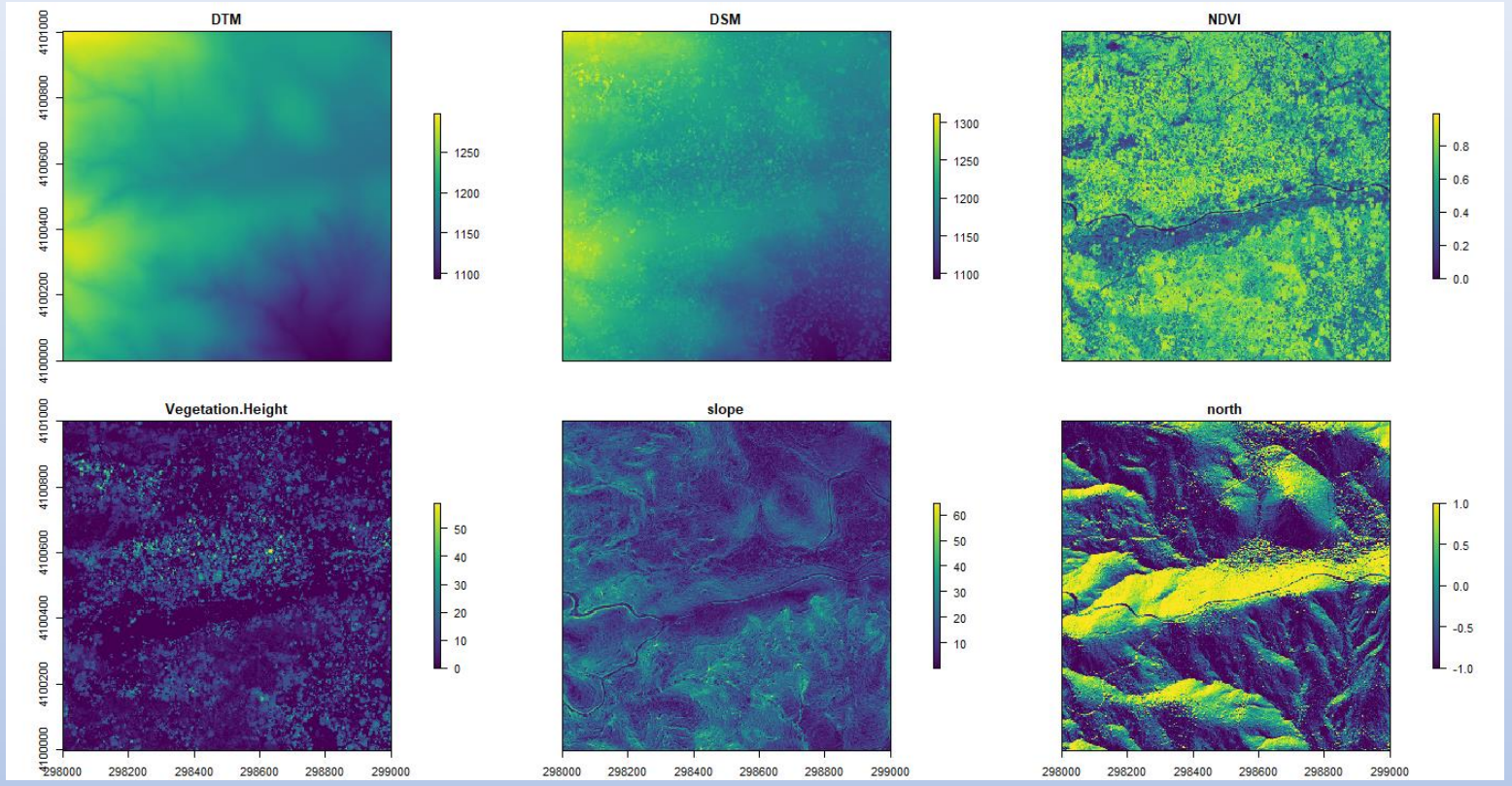
Based on these images, students make predictions of what topographic variables might be related to vegetation at this site (ideally through in-class discussion).



Module Example: NEON remote sensing in R

A

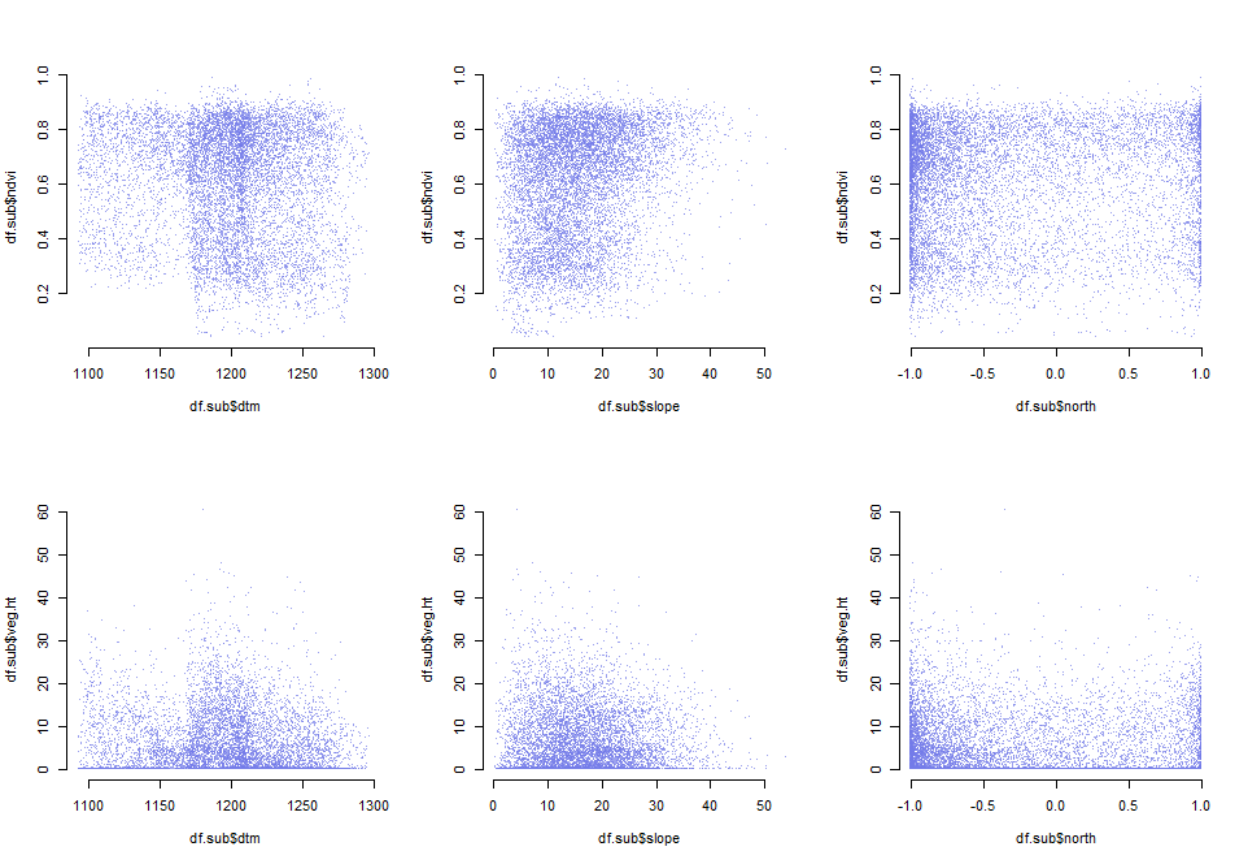
Even though this is only 1 km^2, because this is 1 m resolution data, that means there are 1,000,000 pixels, and 6,000,000 data units! (Big Data!!!)



Module Example: NEON remote sensing in R

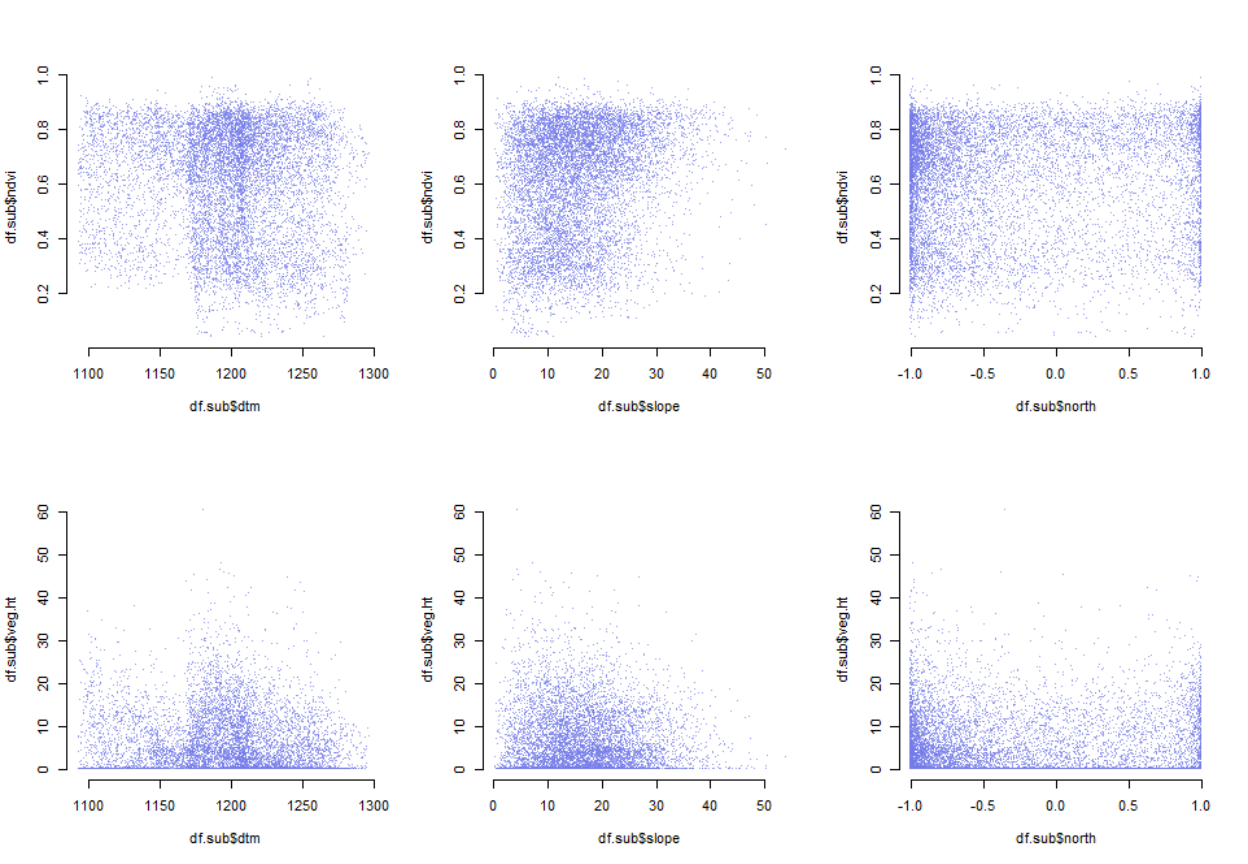
B

Students take a 1% subsample (10,000 pixels – still a lot!) and generate scatterplots of relationships.



Module Example: NEON remote sensing in R

B Students reflect on these plots and try to visually estimate relationships. Many students noted that these are very messy and not at all like the "clean" examples they've seen of regression scatter plots.



Module Example: NEON remote sensing in R

B

Students calculate correlations, and, surprise!, there are some strong-ish correlations, and ALL of them are significant.

		DTM	Slope	Northness
NDVI	R	-0.097	0.204	0.031
	p-value	< 0.001	< 0.001	< 0.001
Veg Height	R	-0.123	0.054	0.050
	p-value	< 0.001	< 0.001	< 0.001

Module Example: NEON remote sensing in R

B

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		DTM	Slope	Northness
NDVI	R	-0.097	0.204	0.031
	p-value	< 0.001	< 0.001	< 0.001
Veg Height	R	-0.123	0.054	0.050
	p-value	< 0.001	< 0.001	< 0.001

This led several students to reflect on the usefulness of p-values when working with large data sets.

Module Example: NEON remote sensing in R

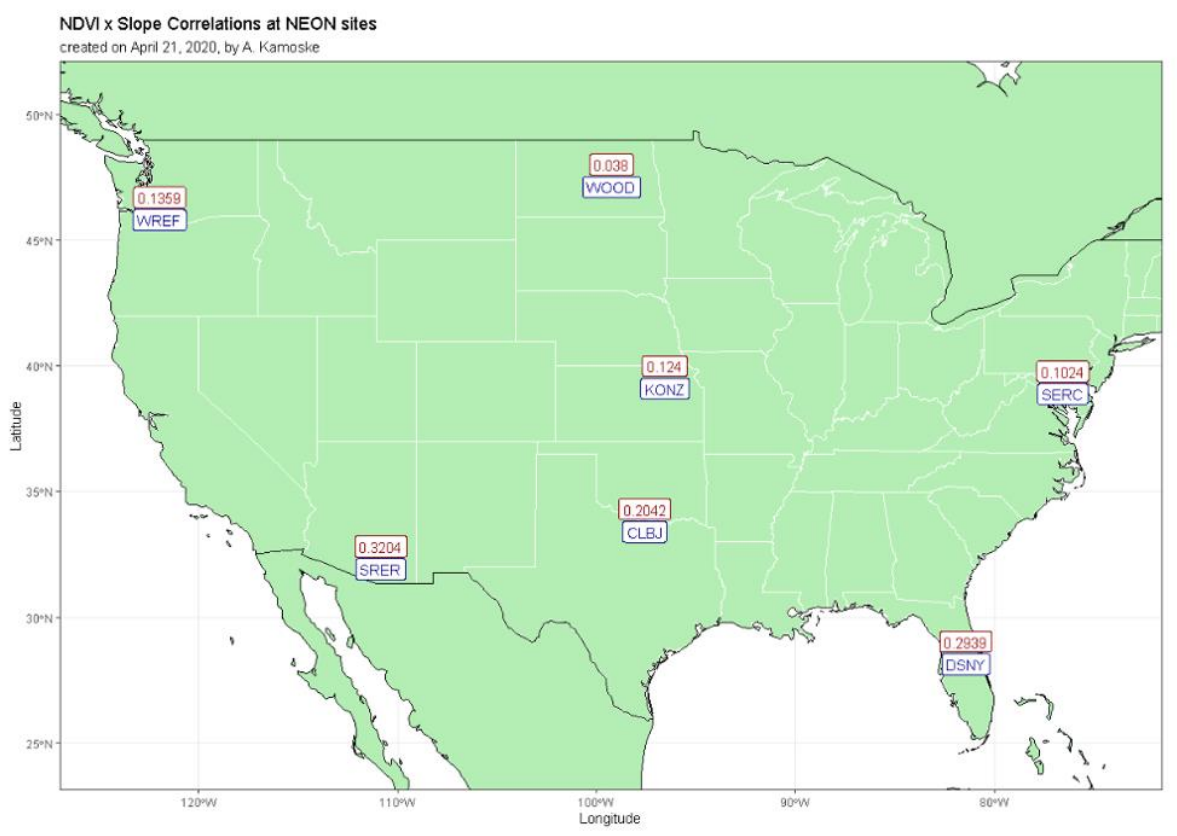
C

Students discuss which relationship they think is most interesting, then do the same calculations at a different NEON site (data is pre-packaged on the EDDIE site) and report the relationship to the instructor so they can be plotted across the US either by hand or via R code.

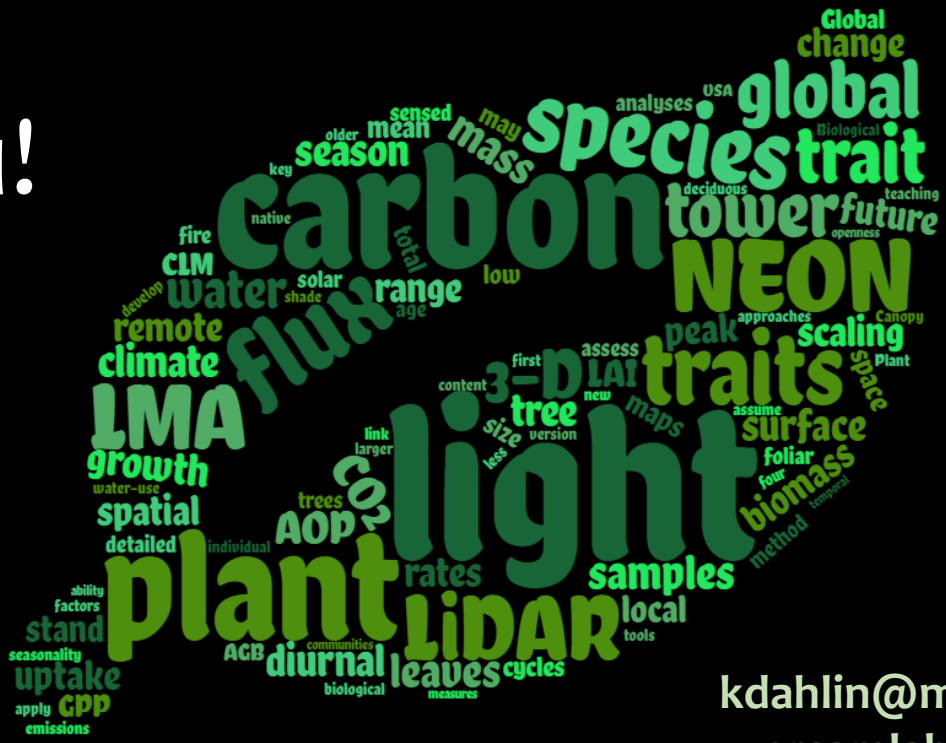
Module Example: NEON remote sensing in R

C

Once all data are reported, a discussion of the macroscale patterns can happen – are correlations stronger in some parts of the US than others? Why might that be?



Thank you!



ERSAM Lab Members (past & present)

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Aaron Kamoske
Gloria Desanker
Donald Akanga
Meicheng Shen
Manaswini Ganjam

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