Data and Workflows for Macrosystems Biodiversity: Climate, Geodiversity, and Disturbance

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Introduction

- ***What drives biodiversity patterns?*** (Fig. 5)
  1. **Internal filters**
     - Biotic interactions
     - Variation within species (intraspecific trait variation), variation among species
  2. **External filters**
     - Environmental & historical contexts
     - Climate
     - Land cover
     - Geodiversity (spatial variation in abiotic features and processes)
       - Disturbance regime
     - Land use history
- NEON lacks comprehensive Disturbance, Geodiversity, and Climate spatio-temporal data products at varying scales.

We are filling these gaps with data products and their reproducible workflows.

For Land Use History and Intraspecific Trait Variation see other posters from this collaborative project.

Methods

In general, develop workflow to produce climate, geodiversity, and disturbance data layers covering the CONUS to extract NEON domain-level and site-level statistics for comparative analysis

Climate:
- Data Sources: PRISM (4km resolution) and CHELSA (1km resolution).
- Process climate data for NEON domains and sites:
- Data available: Tmin, Tmax, ppt, bioclim variable[1].
- Quantify how the distributions of climate variables for site vs. domain overlap.
- Is the domain distribution representative of their sites?

Geodiversity:
- Quantification of landscape heterogeneity
  - Continuous values as opposed to patch-mosaic model
- Geodiv R package[2,3] used to calculate spatial variation of continuous variables
  - Functions allow for local (moving window) and global (entire image) calculation of metrics (Fig. 2)
- 25 gradient surface metrics (surface heterogeneity) on any imagery, such as:
  - Elevation, NDVI, temperature
- 4 categories:
  - Surface roughness, surface value distribution shape, and angular and radial surface texture

Disturbance:
- Data sources: Landsat images, LCAMP Covers[4]
- Apply LandTrendr algorithm using Google Earth Engine to CONUS for disturbance segmentation[5]
- Transform segments into annual data layers
- Apply spatial statistics to characterize disturbance per pixel per year (Fig. 4)
- Secondary classification using random forest models for Forest, Rangeland, and all cover types

Coming soon! CONUS data layers for NEON domain and site analysis

Climate variables

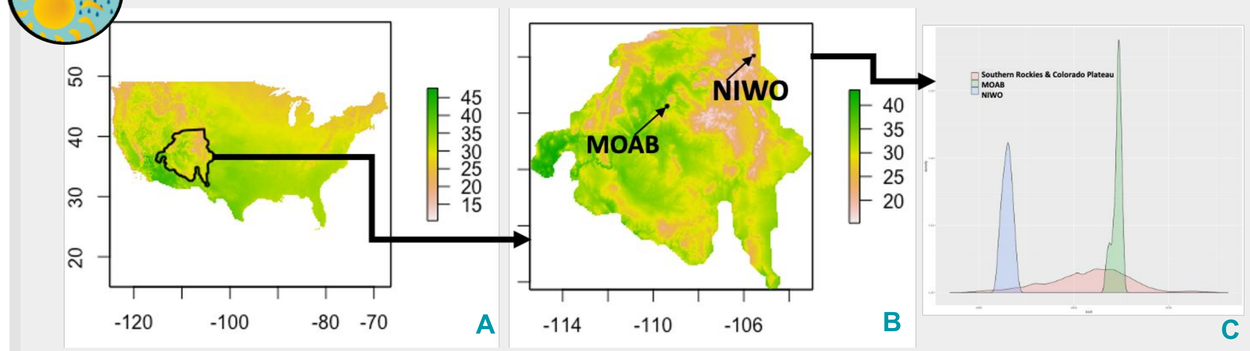

Figure 1. Spatial distribution of max temperature of warmest month in CONUS (A) and Southern Rockies & Colorado Plateau domain (B). The density function of the temperature for Southern Rockies & Colorado Plateau domain and MOAB and NIWO sites are represented in (C) in order to quantify how the distributions of climate variables for site vs. domain overlap.

Geodiversity layers

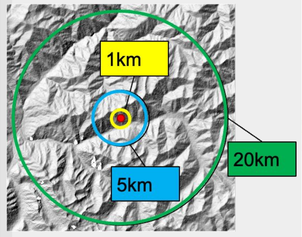

Figure 2. Spatial heterogeneity metrics will be summarized over varying radii surrounding a focal pixel or point.

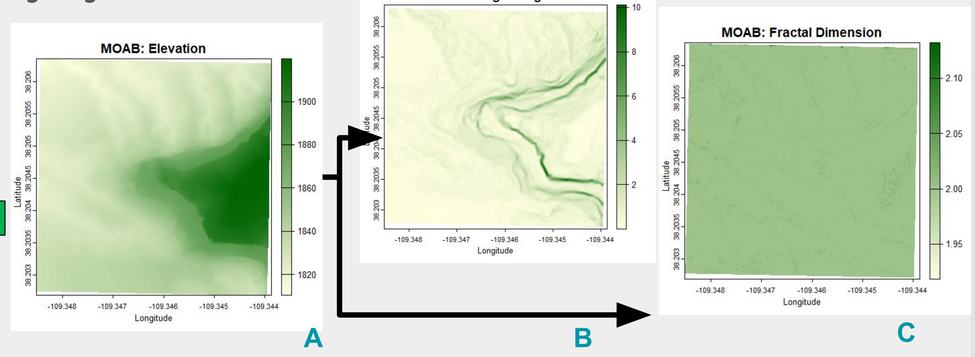

Figure 3. Example of geodiversity metrics calculated from LiDAR-based elevation data (A) for the MOAB NEON site in the Southern Rockies and Colorado Plateau Domain. Average roughness (B) and Fractal dimension (C) are two gradient surface metrics calculated using a moving window. These metrics illustrate different aspects of the variability in elevation at the MOAB site. All geodiversity metrics will also be calculated at the domain scale.

Ecological Disturbance CONUS 1985 to 2021

Disturbance characterization and attribution outputs for each LCMAP 30m pixel for forest rangeland, global cover types:

- values v of landtrendr algorithm for each pixel per year
- spatial stats of 4 pixel (120m radius) neighborhood per year: median(v), stddeviation(v), v / standard deviation(v)
- secondary classification disturbance event binary per pixel per year

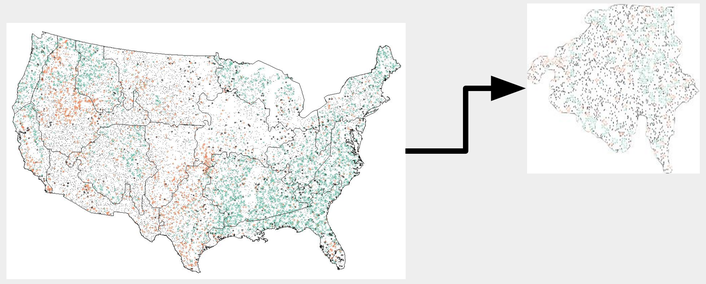

Figure 4. Spatial distribution of disturbances in relation to NEON ecoclimatic domains in the filtered LCMAP reference dataset.

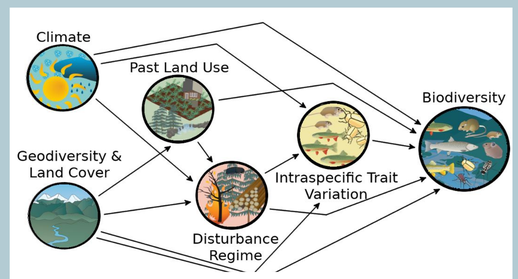

Figure 5. Drivers of biodiversity investigated with this Macrosystems project.

Discussion & Future Directions

These data sets will...
- Provide free, high-quality, and **publicly available data** to the scientific community.
- Allow for the development of streamlined, **reproducible workflows** that can be flexibly adapted to address a wide range of scientific questions.

We will use these data to...
- Determine the effects of geodiversity, disturbance, and climate on patterns of intraspecific body size variation in fish, small mammals, and ground beatles and subsequent impacts on biodiversity.
- Advance understanding of the role of abiotic variability in patterns of biodiversity.
- Compare distributions of climate and other variable across scales: CONUS, domain, sites
- Determine if different disturbance types across different land use types (focus Forest/Rangeland) can be detected using GEE-LandTrendr and secondary RF classification using LCMAP reference data.
- Identify differences if disturbances are classified for LU classes individually or combined.
- Identify effects of using different combinations of spectral bands/indices or including temporal data alone or spatial+temporal?

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https://neon-biodiversity.github.io