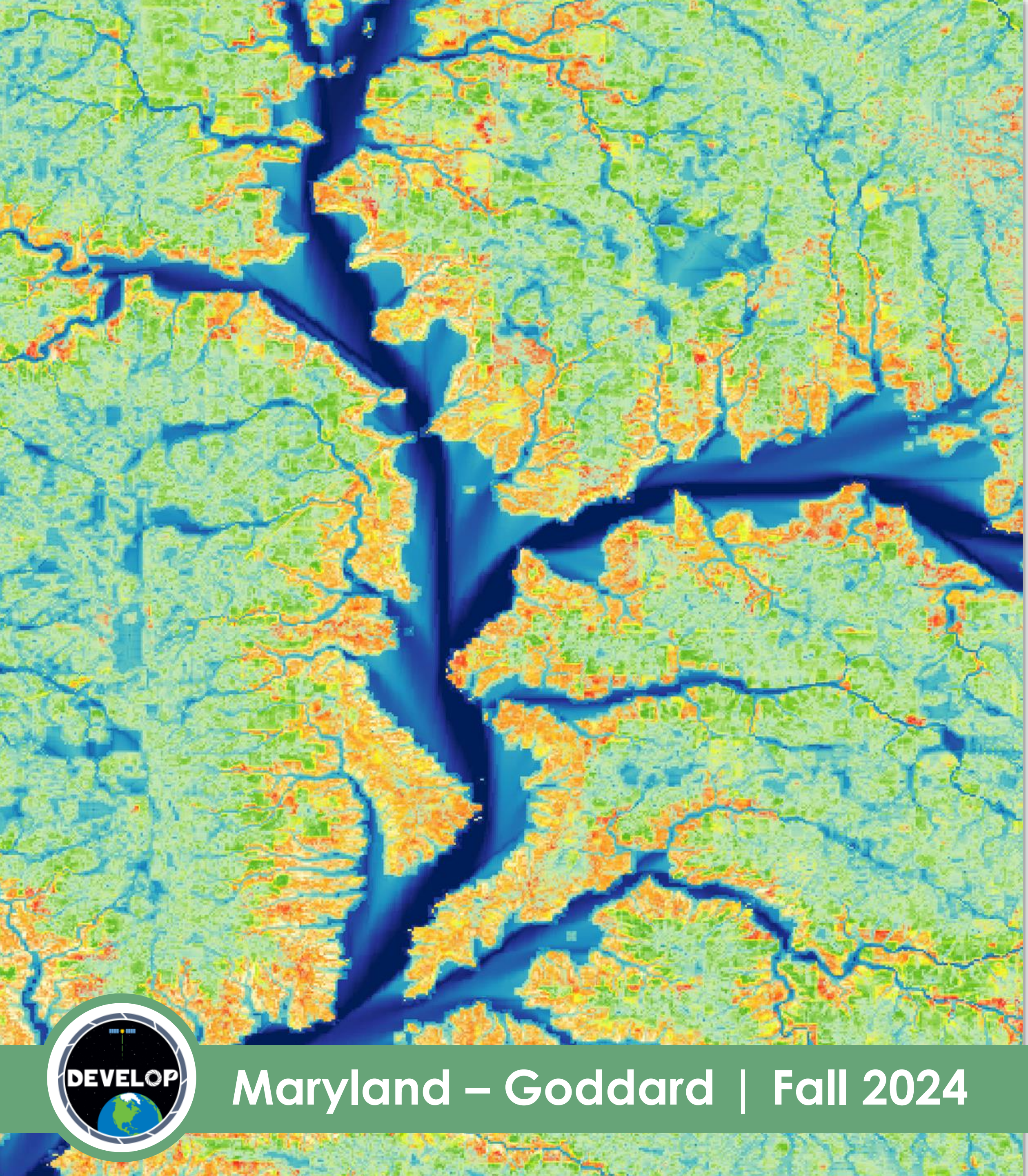

National Aeronautics and
Space Administration

ILLINOIS ECOLOGICAL CONSERVATION

Using Earth Observations to Identify Areas of Oak Decline in Illinois and Investigate Contributing Risk Factors

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DEVELOP

Maryland – Goddard | Fall 2024

Our Team

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Background

Hypothesized Stressors

- Climatic Stress
- Pathogenic Stress
- Herbicide Damage
- Unsuitable Habitat

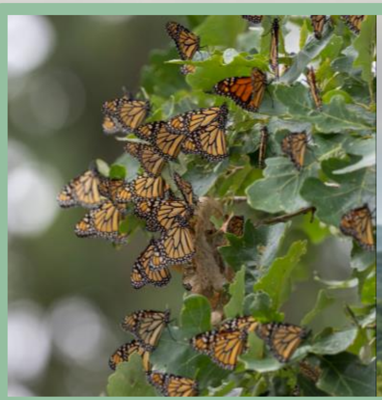
Image Credit: Flora Hamilton

Community Concerns

CO_2

Reduction in oak woodlands means reduction in . . .

1. Ecosystem Processes



2. Critical Habitat
3. Biodiversity

Image Credits: Erik Cooper, Kenneth Cole Schneider, Michael Janke, Becker1999

Community Concerns

- Loss of socioecological benefits (material and immaterial)

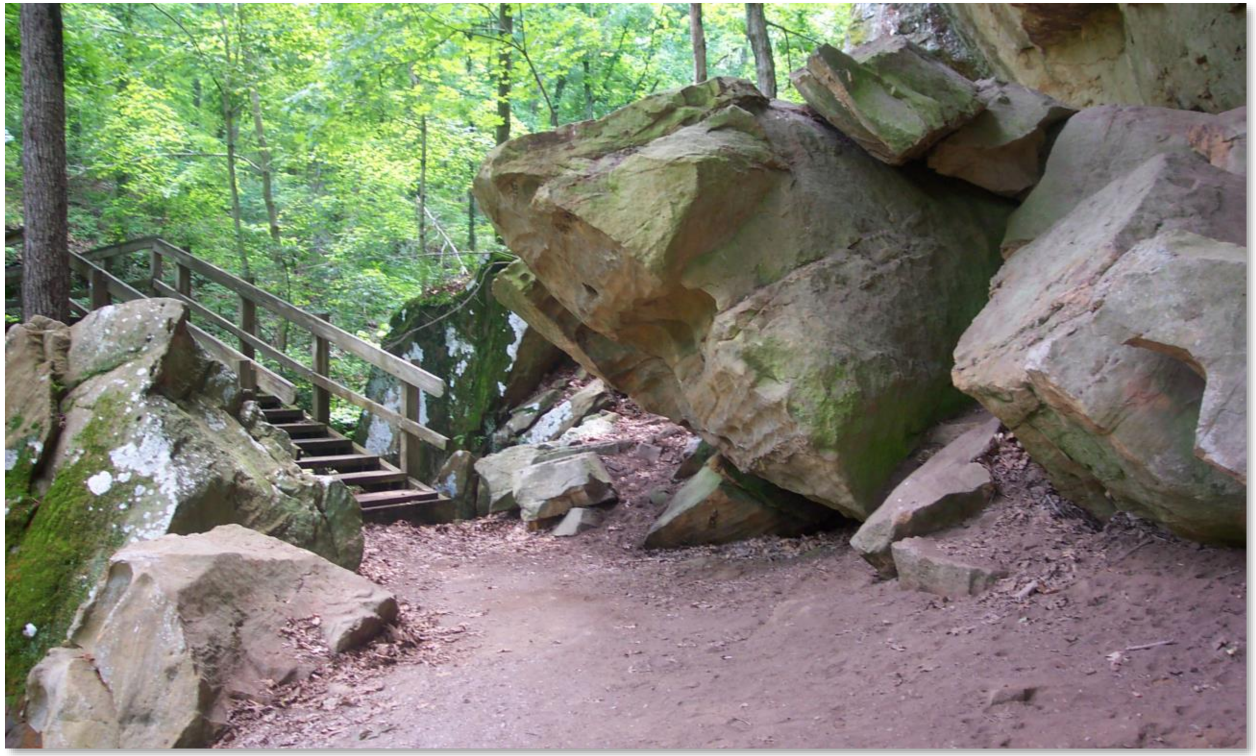


Image Credit: Curtis Abert

- Recreational opportunities
- Cultural connection
- Timber resources
- Clean air & water

Partner

Dr. Fredric Miller
Senior Researcher
Forest Entomologist

Image Credits: Flora Hamilton (left) and Fredric Miller (right)

Objectives

Detect changes in oak tree health through Earth observations

Assess potential risk variables and their relationships to decline in white oak health

Create a present-day oak decline risk map to help the partner prioritize conservation areas

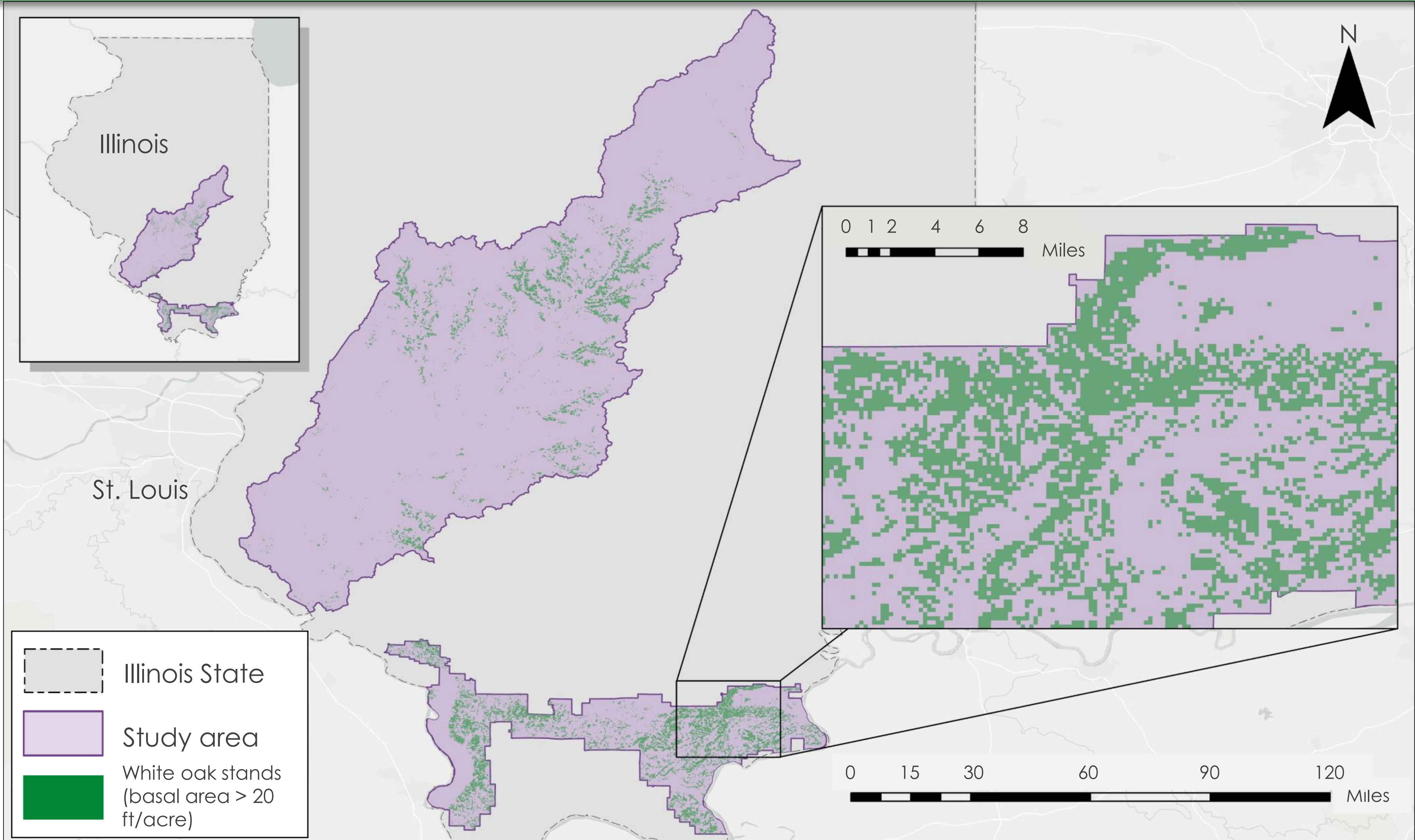
Study Area & Period

Study Area

- Kaskaskia River Basin & Shawnee National Forest (SNF)

Study Period

- 2010 – 2024



Service Credits: Missouri DNR, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS

Earth Observations

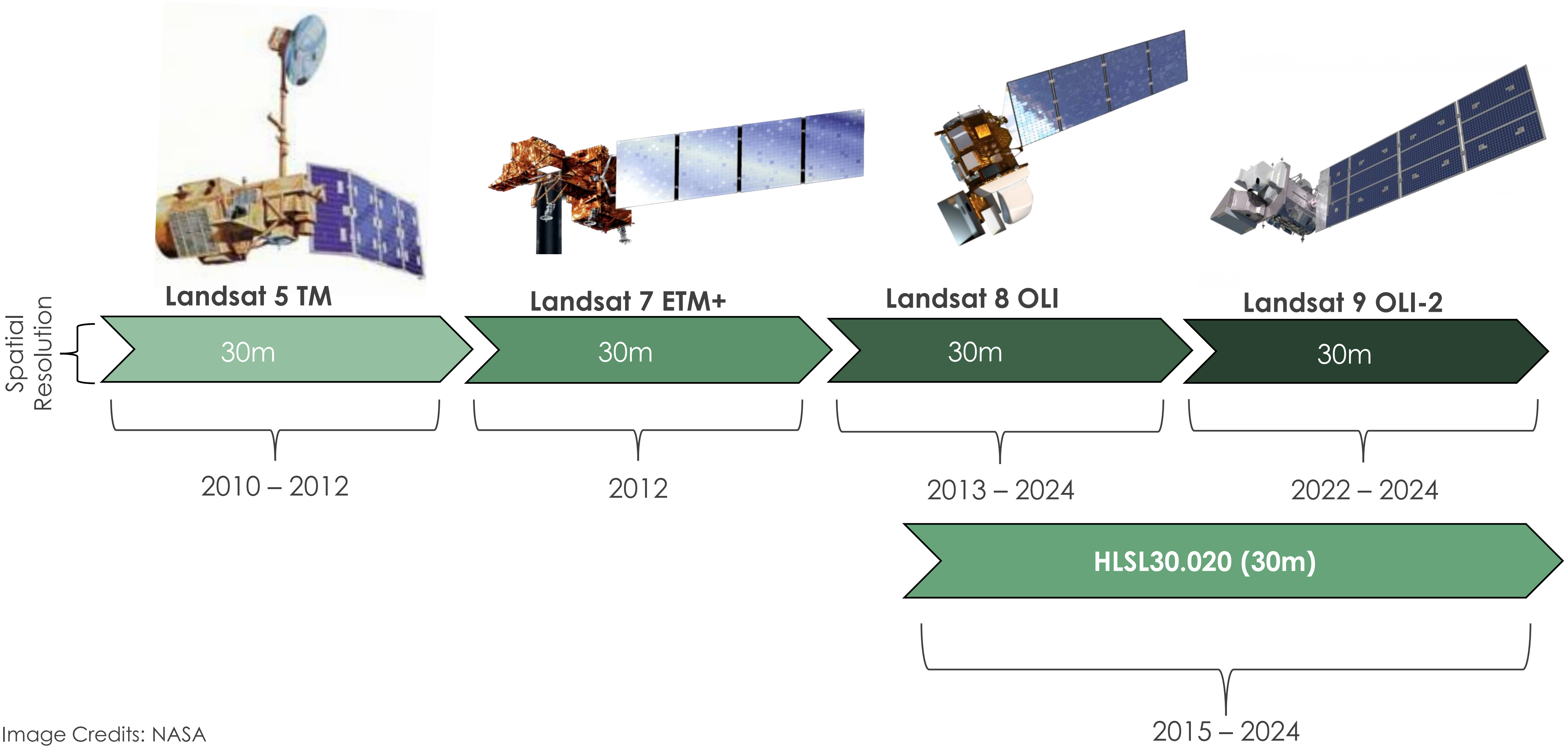
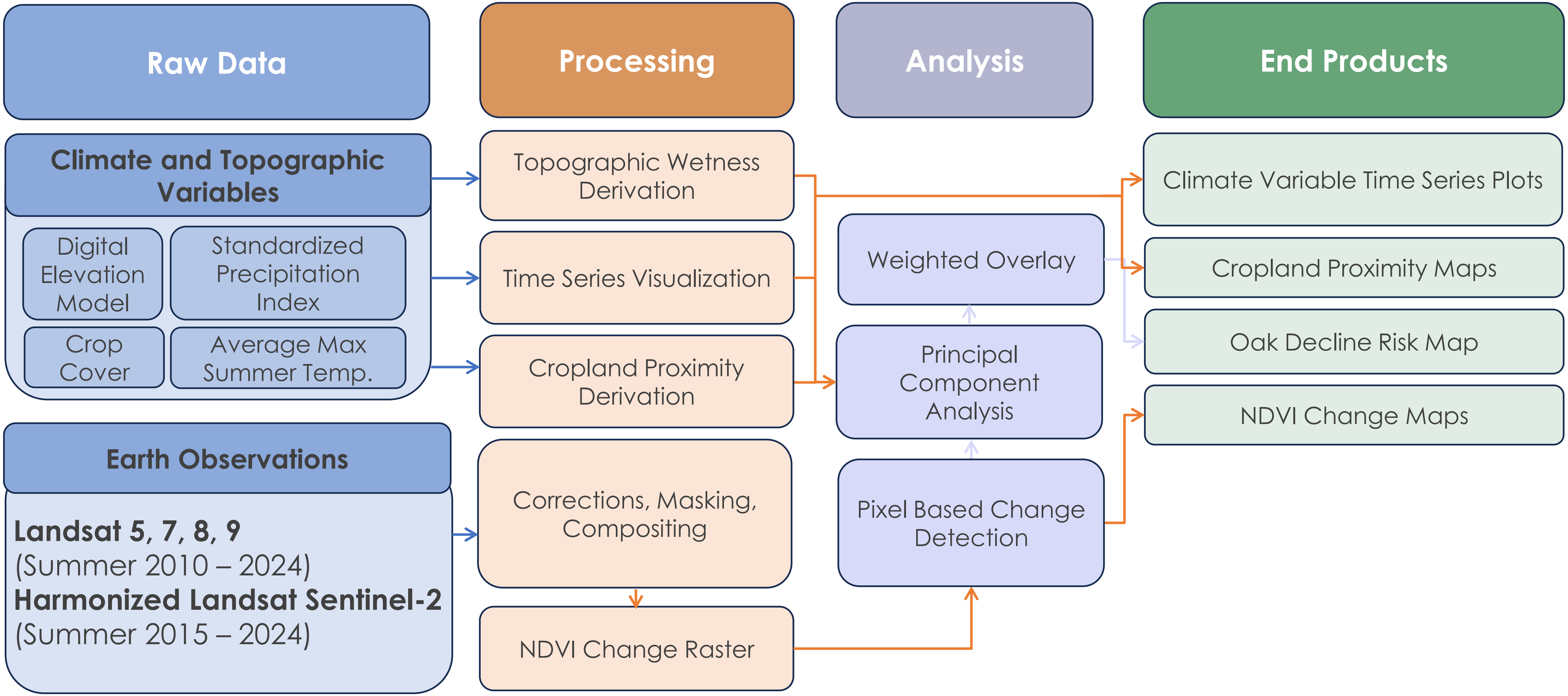


Image Credits: NASA

Overview of Methods



Methods | Data Processing

Topographic

- 30m DEM acquired from the Illinois Geospatial Clearinghouse
  - Variables of interest derived in SAGA GIS

Climate

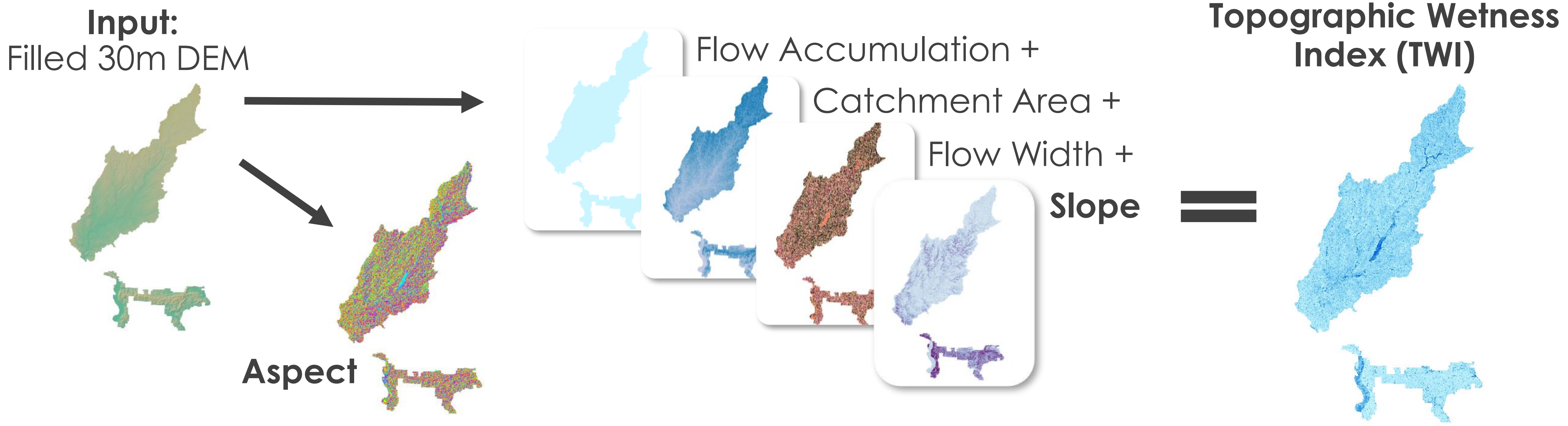
- Drought and precipitation data acquired from Climate Engine
  - Analysis and time series visualization conducted in R Studio

Cropland

- Distances from oak stands to nearby commercial cropland were derived with data from Cropland Data Layer (CDL)

Methods, Analysis & Results | Topographic Variables

Methods

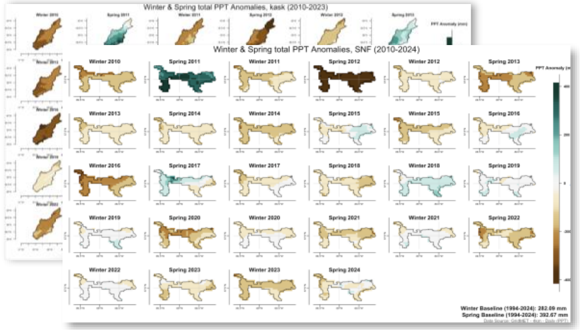


Results **Topographic Variables of Interest:**	**Aspect** = compass direction of terrain	**Slope** = rise & fall of terrain	**TWI** = how water moves & pools across the land surface

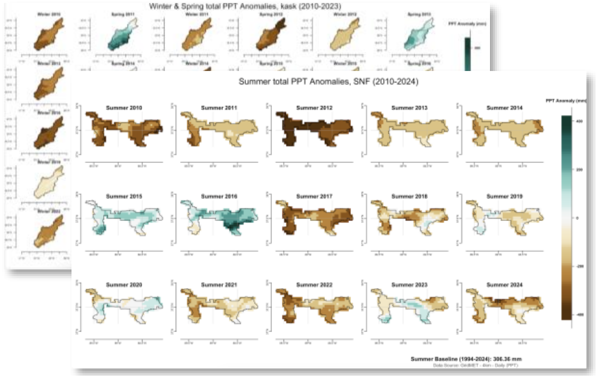
Methods, Analysis & Results | Climate Variable Change Maps

Total Precipitation Anomalies

Winter/Spring Paired Plots

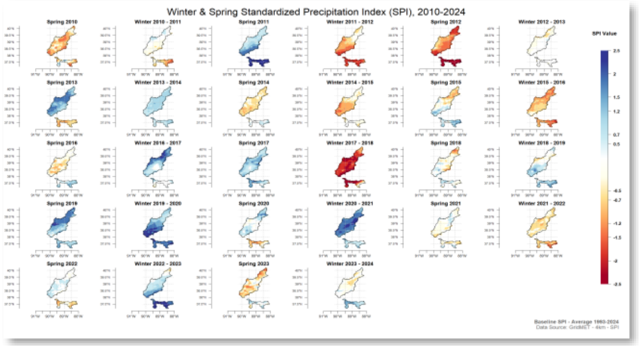


Summer-only Time Series

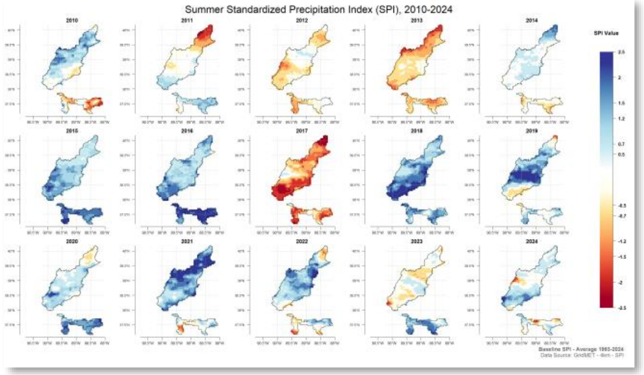


Drought Index

Winter/Spring Paired Plots

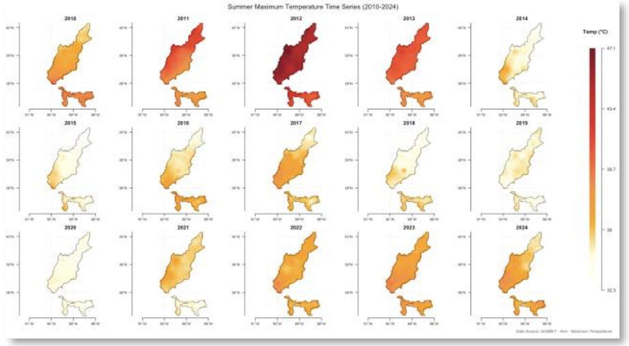


Summer-only Time Series



Maximum Average Summer Temperature

Summer-only Time Series

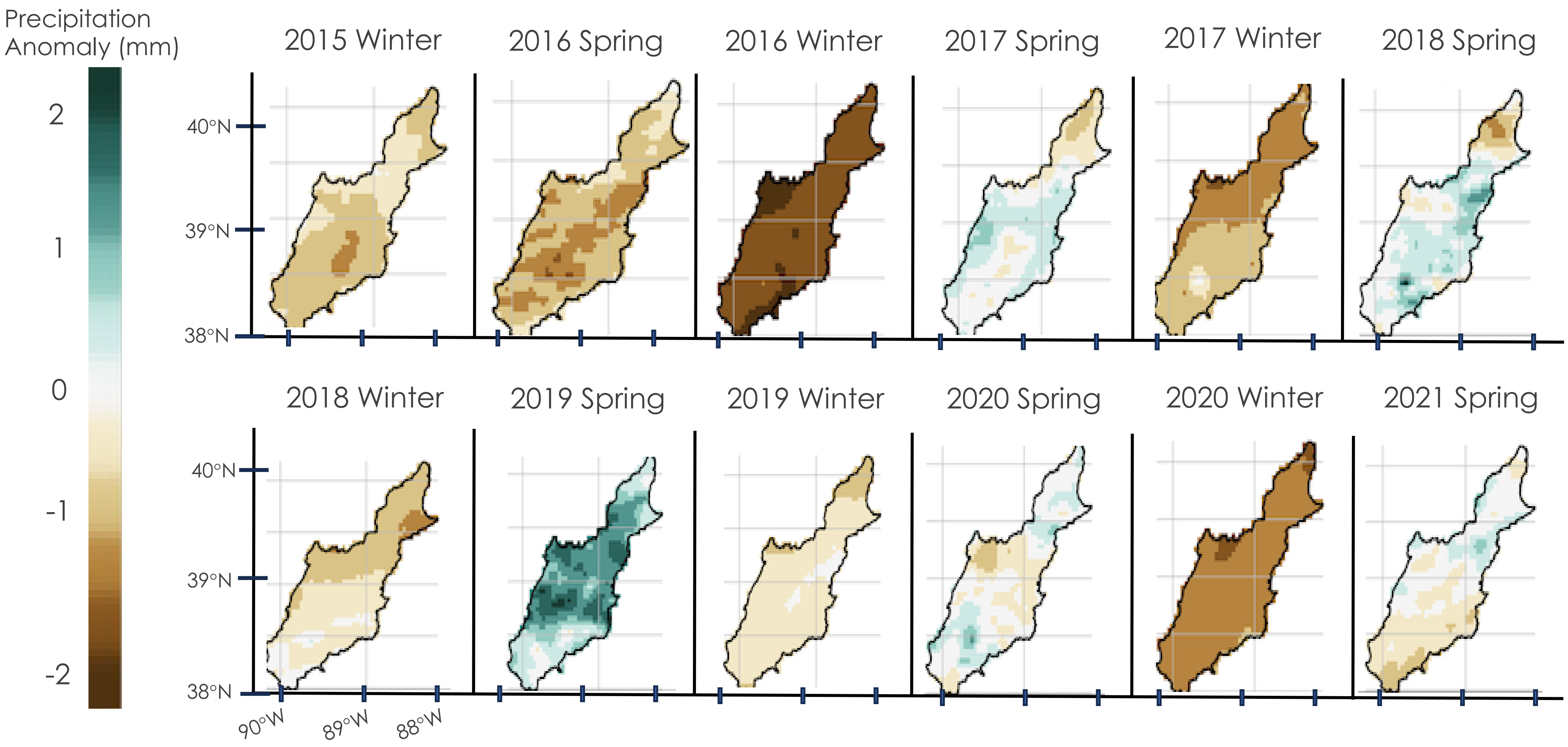


Acquired From Climate Engine Research API

- gridMET 4km Daily
- Total Precipitation
- Standardized Precipitation Index
- Maximum Temperature

Methods, Analysis & Results | Climate Variable Change Maps

Total Precipitation Anomaly: Paired Winter/Spring Example (2018 – 2024)

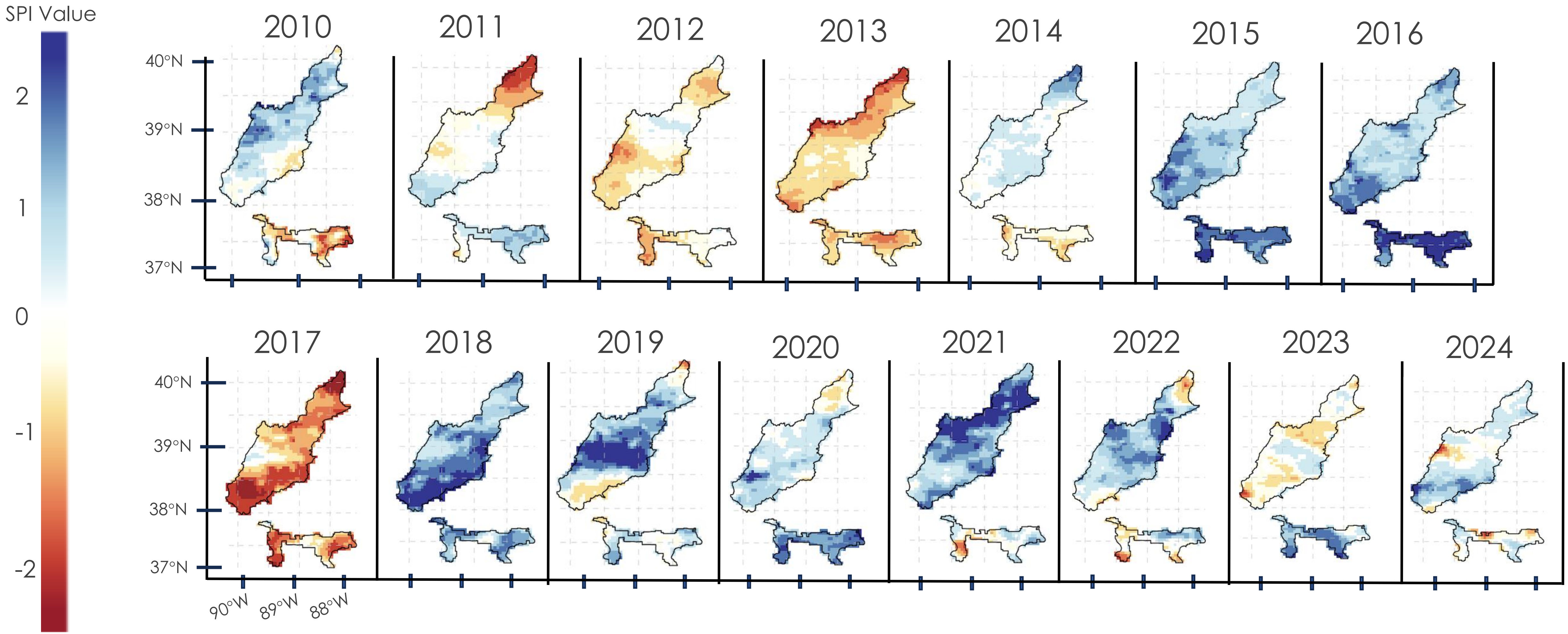


Winter Baseline ('94-'24)
282.09mm

Spring Baseline ('94-'24)
392.67mm

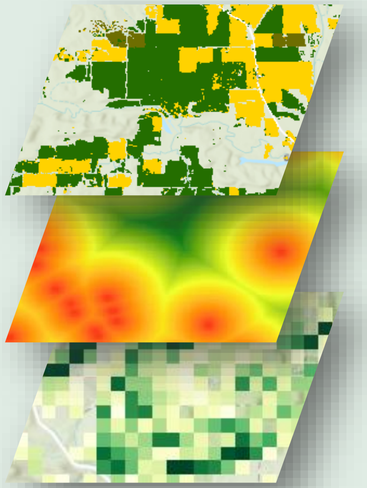
Methods, Analysis & Results | Climate Variable Change Maps

Drought Index (SPI) Seasonal Time Series: Summer Example



Methods, Analysis & Results | Cropland

Method:

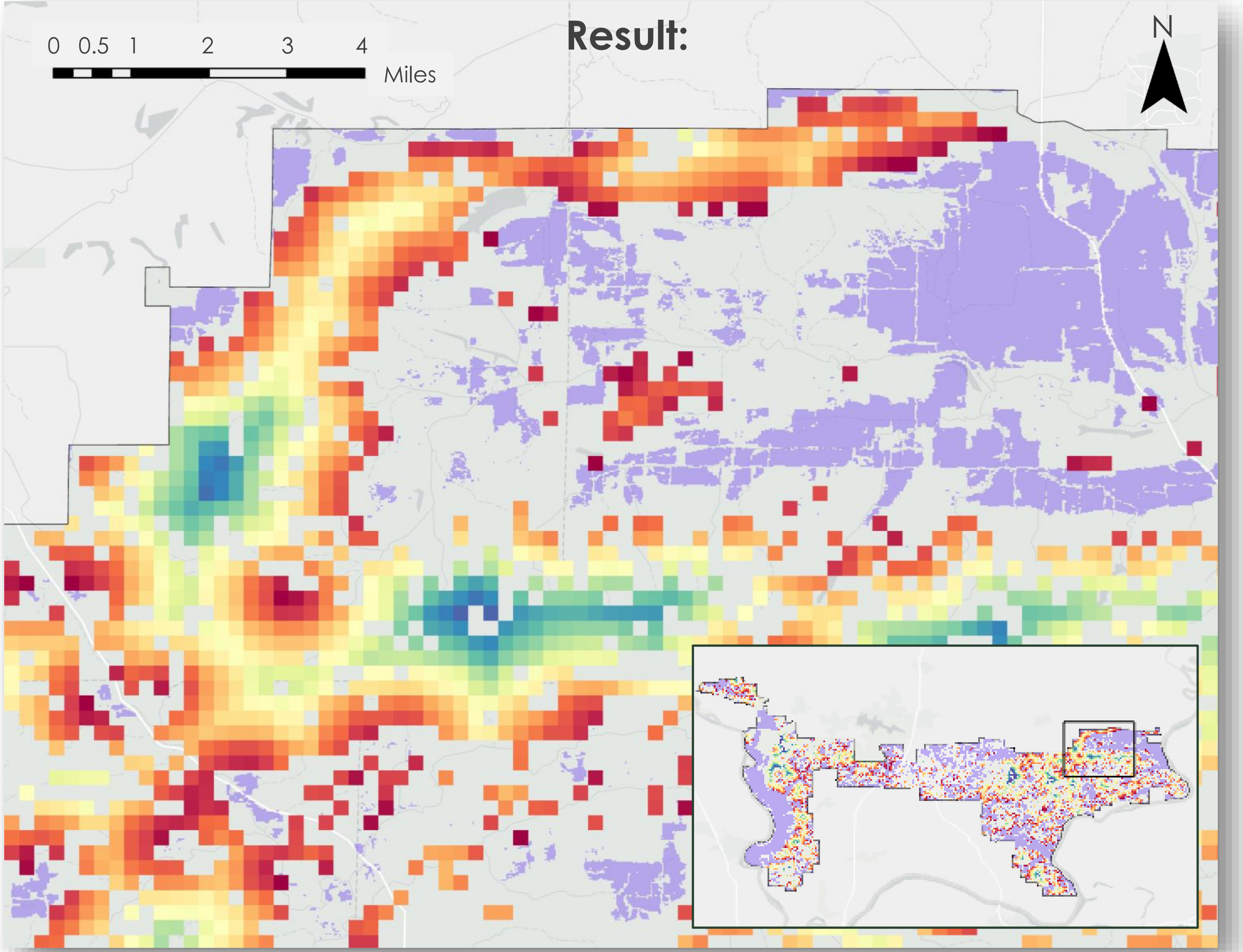


Commodity Crops

Euclidean Distance

Extract & Snap to Oak Stands

Result:



Proximity to Crops (mi)

2.1

1.05

0

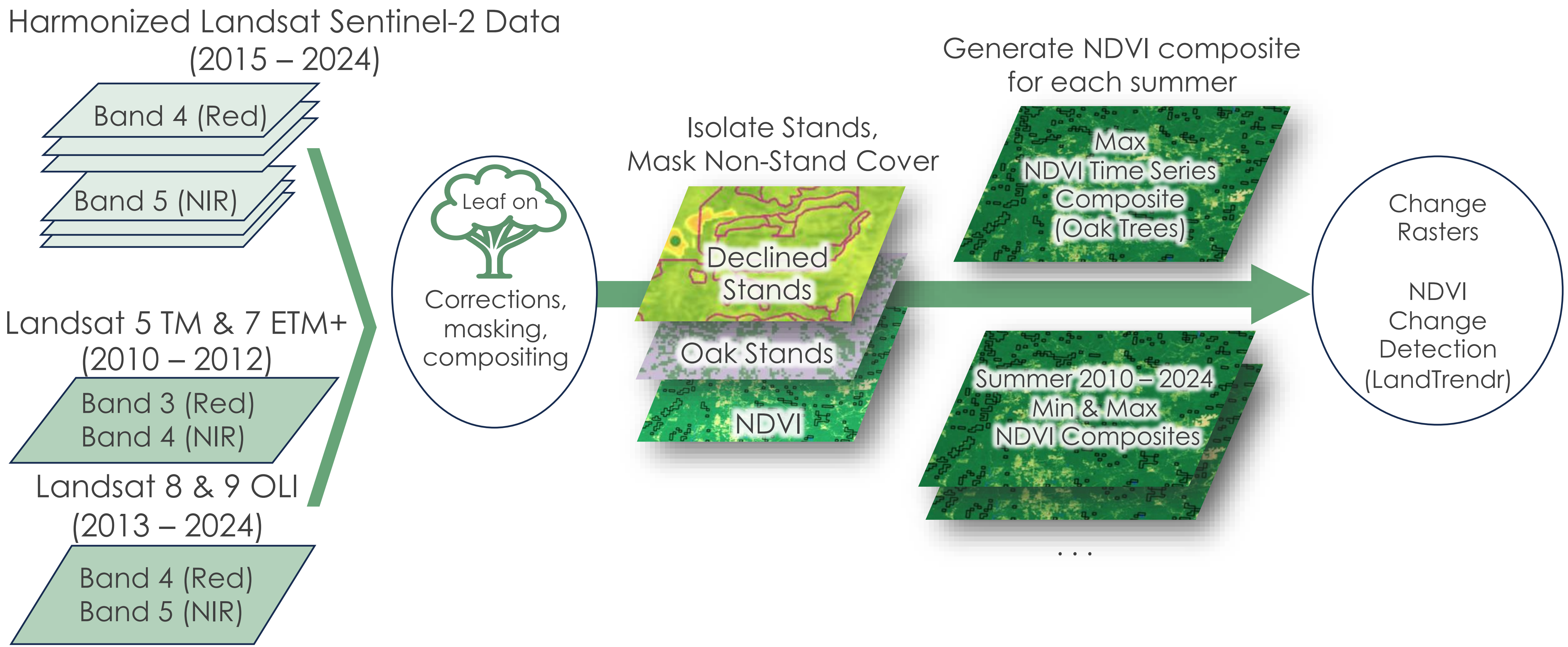
Study Area

Cropland

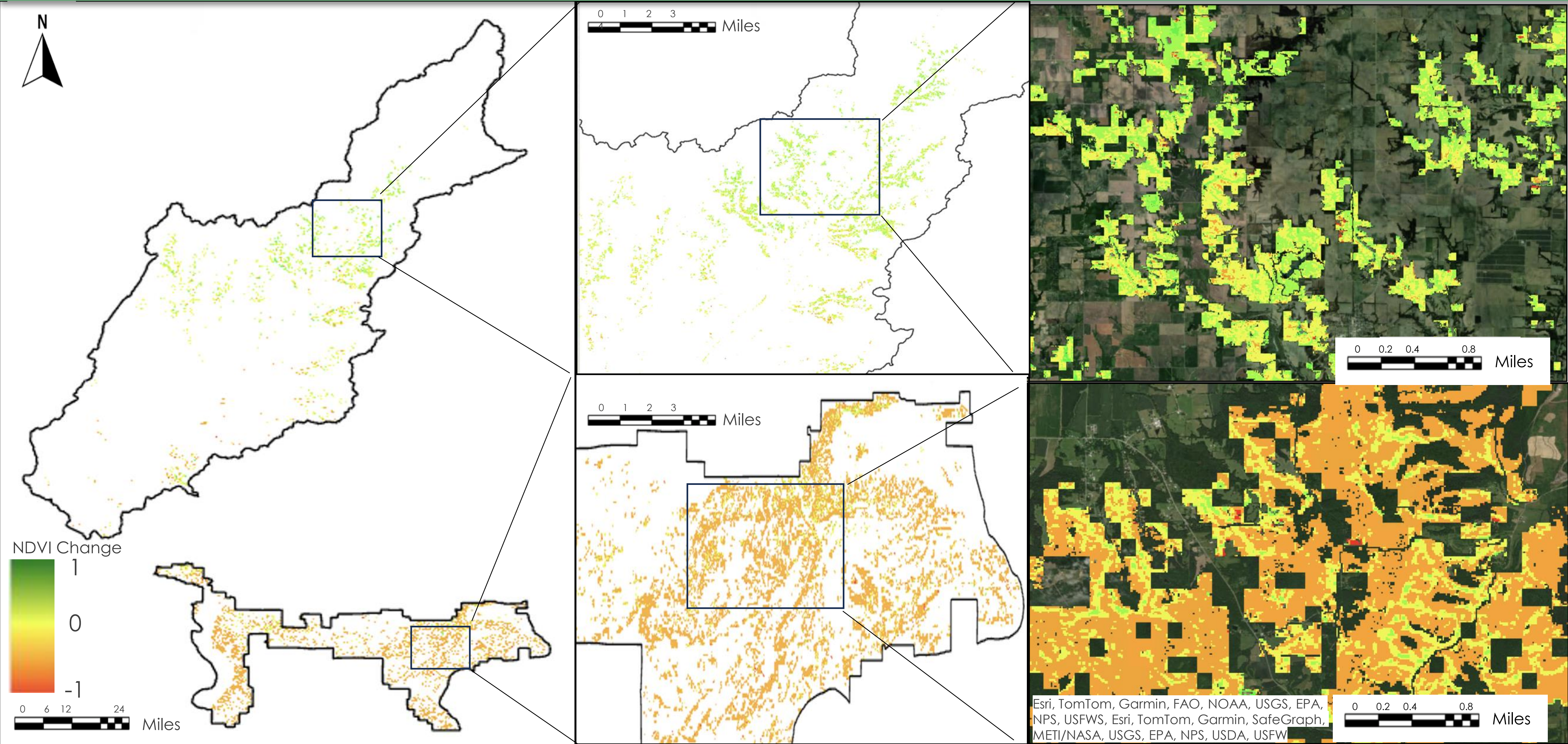
Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NPS, USFWS, SafeGraph, GeoTechnologies Inc., METI/NASA, USDA

Methods | NDVI Change Data Processing

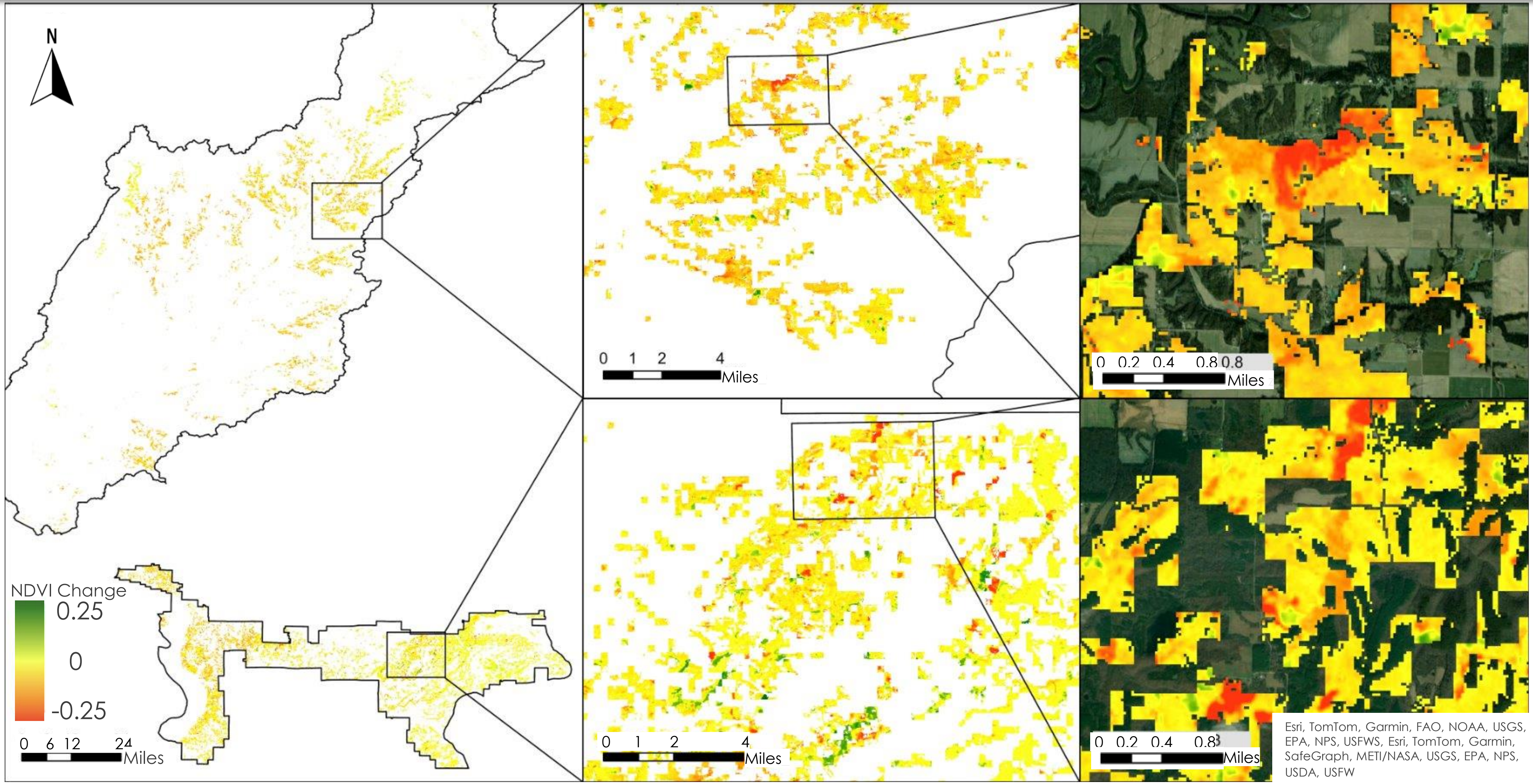
Vegetation Change



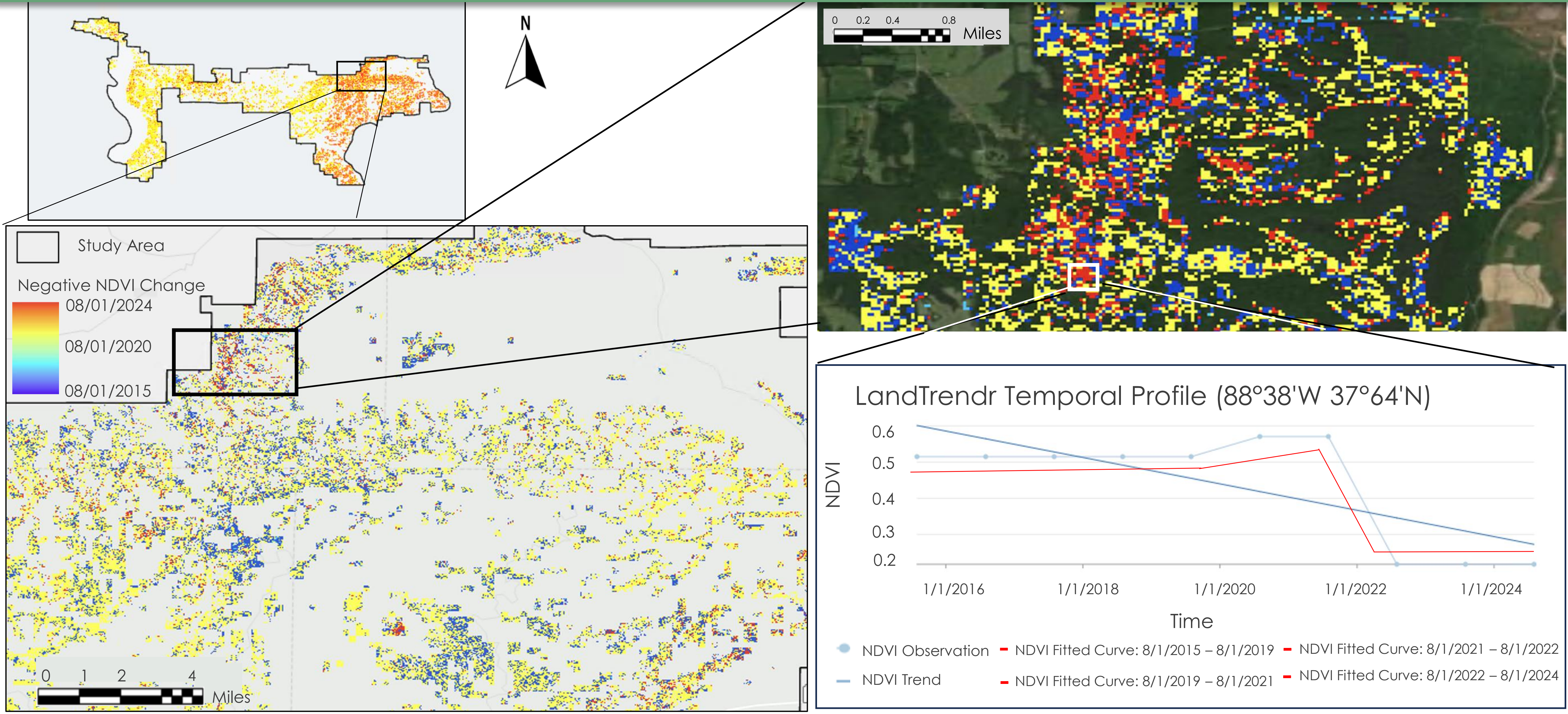
Results | HLS 2023 – 2024 Max NDVI Change



Results | Landsat 2023 – 2024 Min NDVI Change

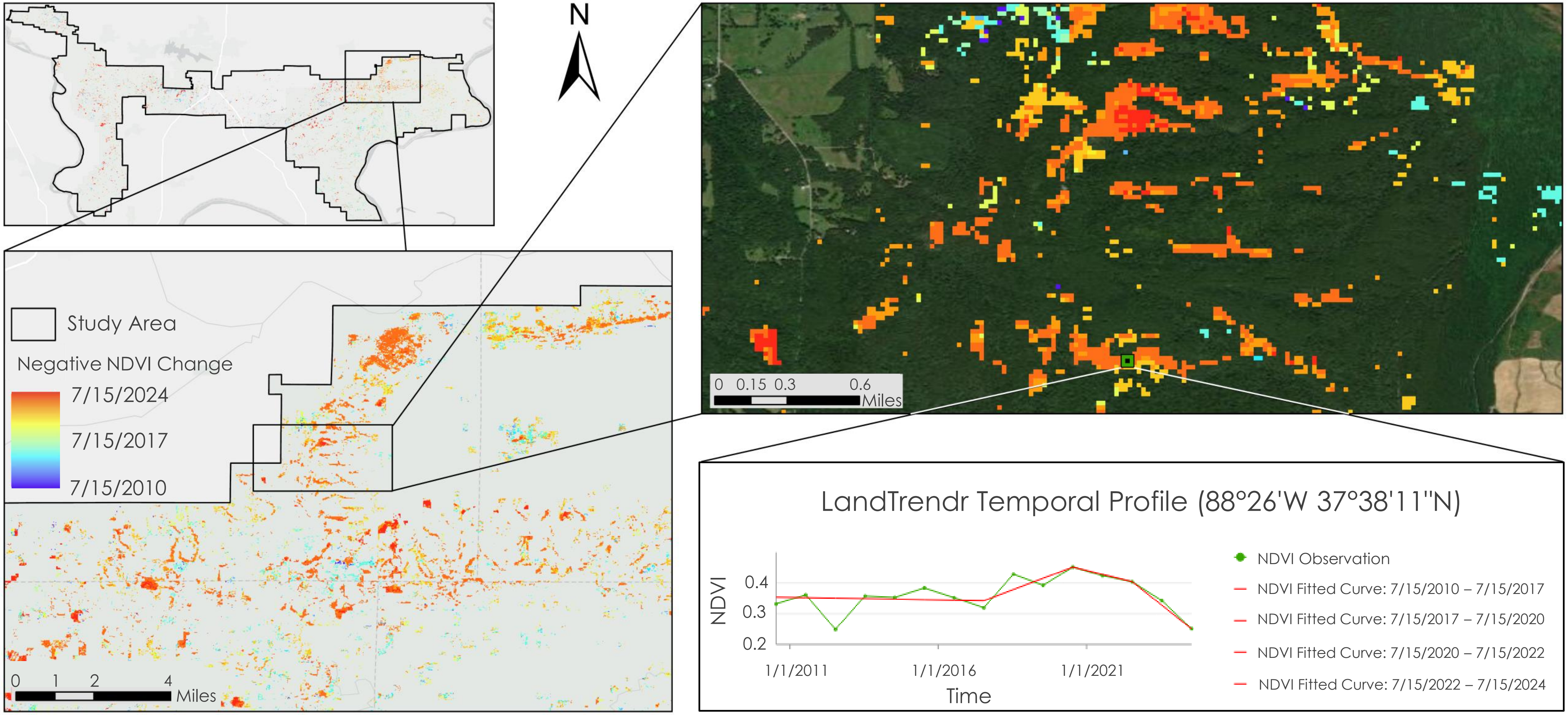


Results | HLS LandTrendr Max NDVI Date Map (negative change)



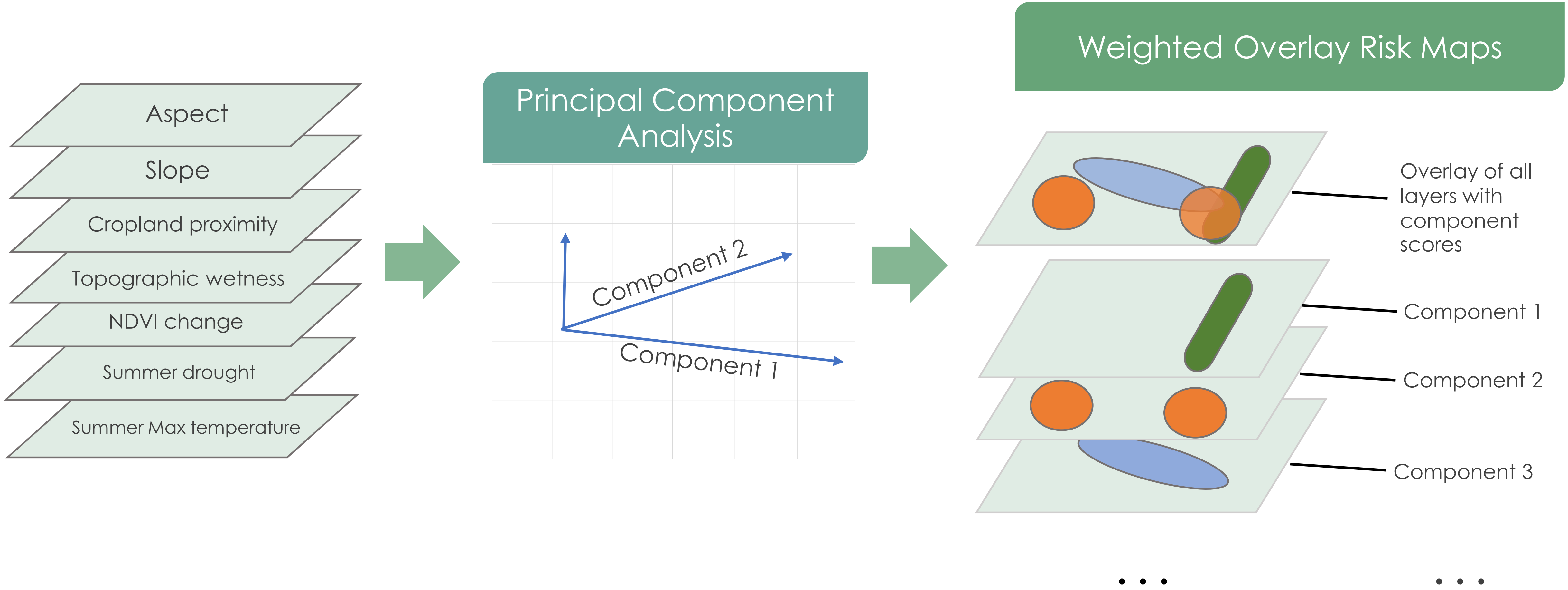
Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NPS, USFWS, Maxar, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USFWS

Results | HLS LandTrendr Min NDVI Date Map (negative change)



Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NPS, USFWS, Maxar, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USFWS

Oak Decline Risk Map Methodology



Results | Oak Decline Risk Map

SNF Boundary

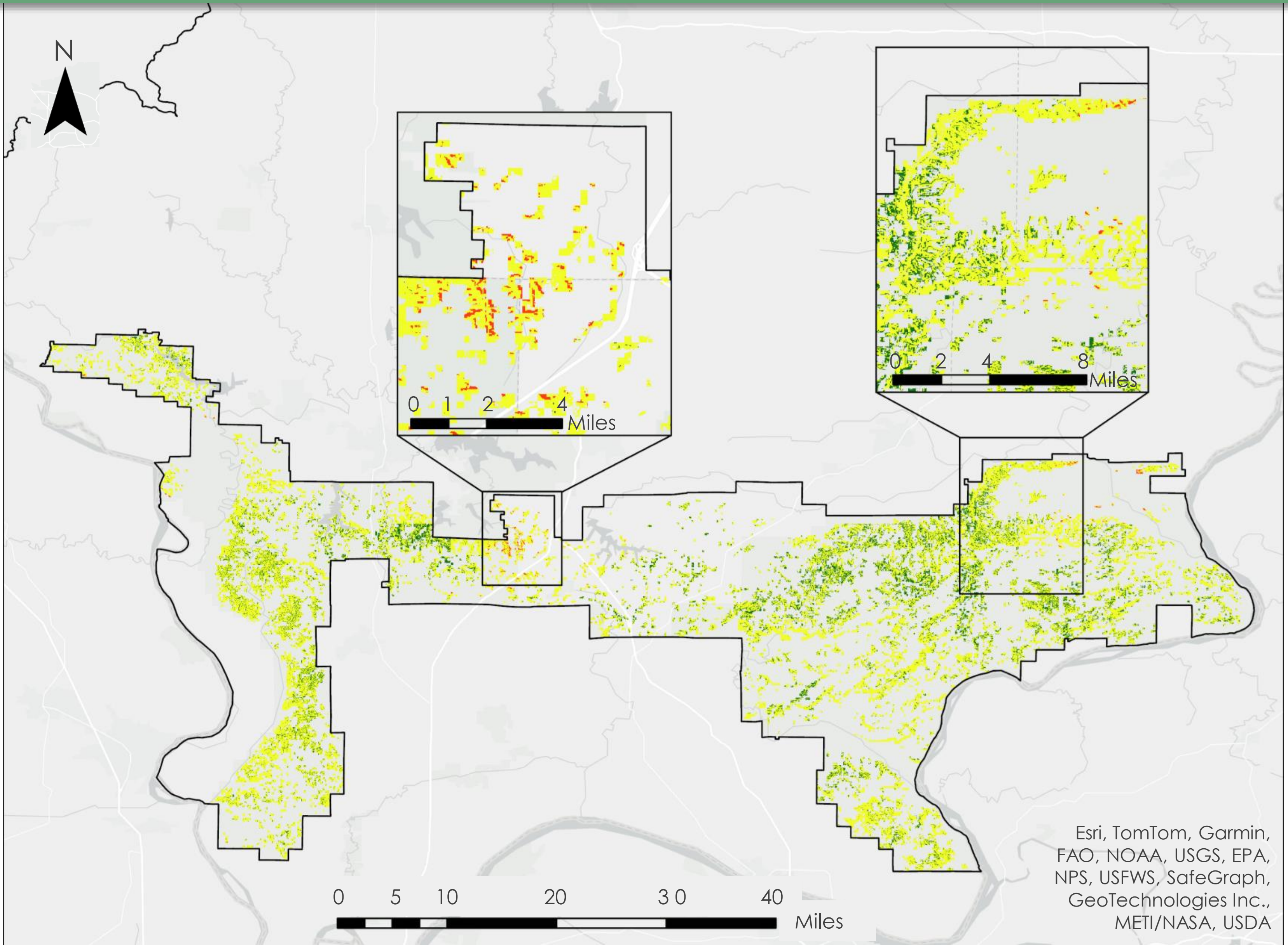
Decline Risk

Low

Moderate

High

- Most area appears low/moderate risk
- Some high risk pockets



Conclusions

- The climatic pattern of dry winters/wet springs can be seen for several years across the study period (i.e., winter 2018 – spring 2019)
- Decreases in NDVI values helped to identify oak stands with potentially declining health & mortality throughout the study areas
- The top 3 decline risk drivers in the SNF identified by the PCA analysis are: slope (~23%), TWI (~19%), and SPI (~15%)
- Much of the oak stands throughout SNF are at moderate risk of decline with some small pockets of high risk (most prominently in the northeast and north central areas of the forest)

Errors & Uncertainties

Max compositing may exclude lower summer NDVI values

Cloud presence and masking

Accuracy assessment of NDVI change maps & LandTrendr analysis needed to validate pixel counts

Potential TWI inaccuracies

Minimal in situ data on white oak decline

Unknowns about herbicide drift and other potential damage agents

Temporal inconsistency from sensors

Data gaps due to clouds & Landsat data absence in 2012

Cloud Icon Credit: Ali hasnain from Noun Project

Feasibility & Partner Implementation

Feasibility

✓ Feasible, with caveats

Need . . .

- In situ data to validate results, including species-specific inventories

Complications . . .

- RWOM is a complex issue with many confounding factors
- Distinguishing between oak wilt and RWOM

Partner Implementation

- Current decline risk model & NDVI change map → inform conservation efforts
- Climate time-series → identify inter-seasonal & annual patterns
- Crop proximity map → furthering the understanding of oak/agriculture relationship

Acknowledgments

- **Partner:** Dr. Fredric Miller (Morton Arboretum)
- **Center Lead:** Isabel Lubitz (Maryland – Goddard)
- **Science Advisors:** Sean McCartney (Science Systems and Applications, Inc.), Joseph Spruce (Analytical Mechanics Associates)
- **Methodology Guidance:** Dr. Kenton Ross (NASA Langley Research Center)
- **Project Coordination:** Marisa Smedsrud (Maryland – Goddard)

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