National Aeronautics and Space Administration

Midwest
Water Resources II

Evaluating Evapotranspiration with NASA Earth Observations and *In Situ* Observations to Understand Water Balance in Midwest Agriculture

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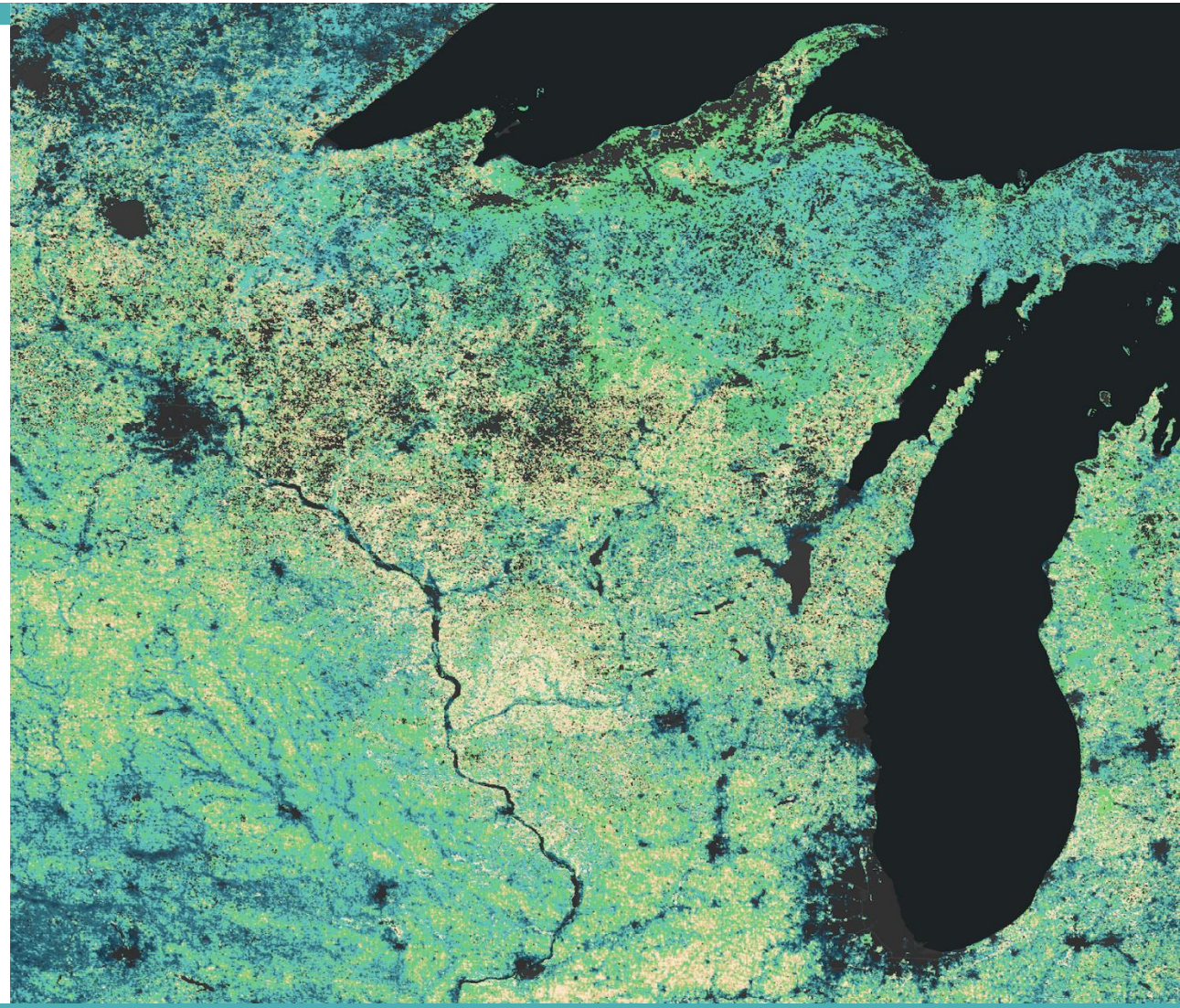


Presentation Overview

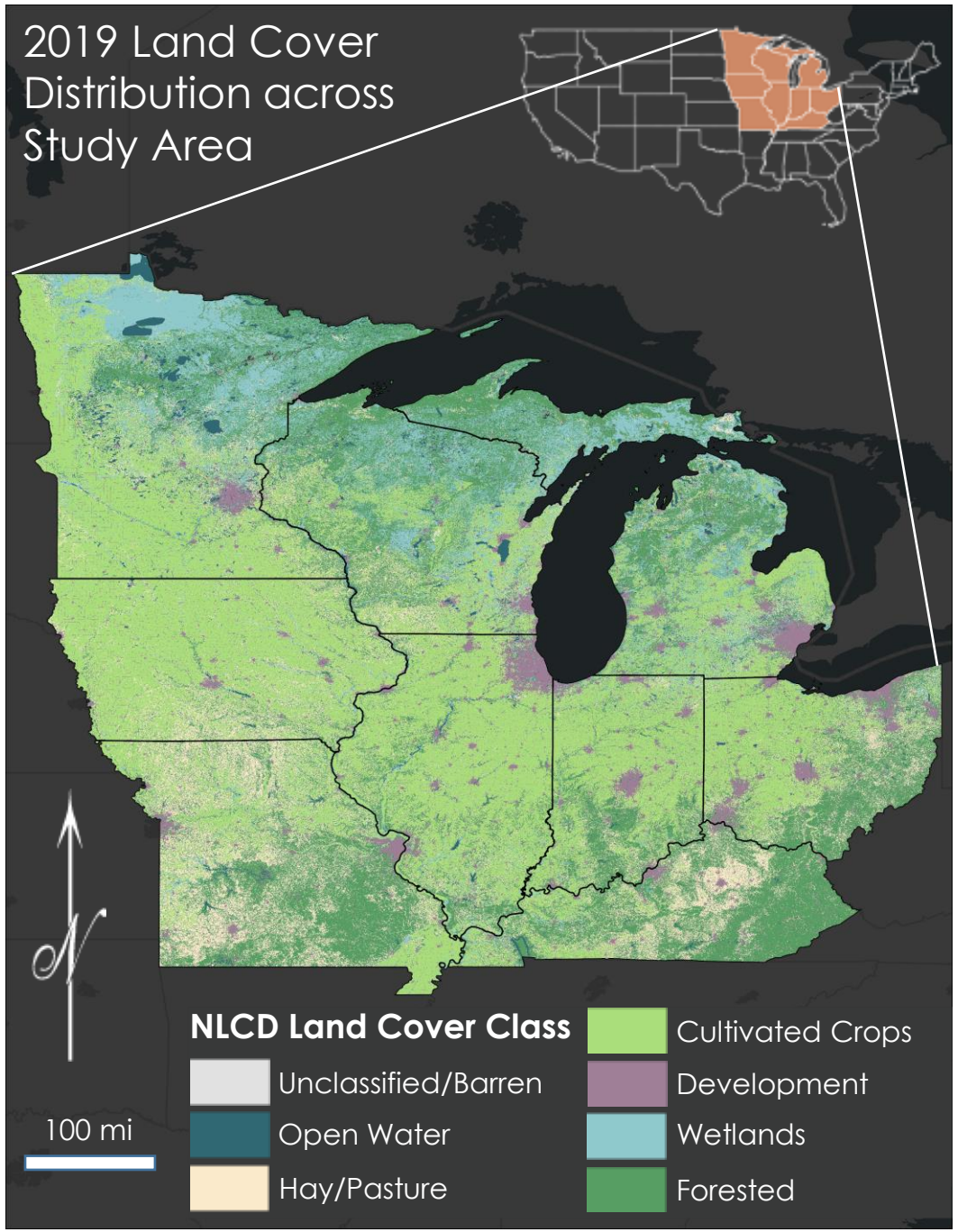
- **Background**
  - Study Area & Period
  - Evapotranspiration (ET)
  - Community Concerns
  - Project Partners
  - Project Objectives
  - Satellites & Data Products
- **Methods & Results**
  - Workflow
  - Reference ET Analysis
  - Case Study: 2012 Drought
- **Conclusions & Limitations**
  - Acknowledgements

Image Credit: Monika Baumgartner

Study Area & Period

- **Midwestern states in study area:**
  - Minnesota
  - Michigan
  - Illinois
  - Missouri
  - Iowa
  - Indiana
  - Ohio
  - Wisconsin
  - Kentucky

- **Study Period**
  - January 2001 – December 2020



Evapotranspiration

ET is the process by which water re-enters the atmosphere

Actual ET (**aET**) is the amount of water removed from the Earth's surface under "**true" physical conditions**

Reference ET (**refET**) is the total water loss possible if there are **no water limitations** for an environment

Image Credit: NASA

Community Concerns

- ET variability during droughts can influence…
  - **growing seasons**
  - **precipitation patterns**
  - **extreme weather**
- Changes in climatic trends can negatively impact **agricultural productivity** and efficiency
- Current ET Measurements = Unpredictable
  - emphasizes importance of **validation** for understanding of regional water variability

Image Credit: Ben Woloszyn; Alena Mozhjer

Partners

End Users

USDA, Midwest Climate Hub

Minnesota Department of Agriculture, Pesticide and Fertilizer Management Division

Collaborators

National Integrated Drought Information System

Michigan State University, Department of Geography, Environment, and Spatial Sciences

Illinois State Water Survey

Objectives

1. Evaluate remotely sensed ET products with *in situ* observations to assess product suitability across the Midwest

2. Analyze and illustrate ET during the 2012 drought throughout the Midwestern Region

3. Spatially produce statistical validation maps for *in situ* sites

Satellites & Data Products

Tool

- NASA EO: Terra MODIS
  - Moderate Resolution Imaging Spectroradiometer
- Ameriflux

→ **Actual ET**

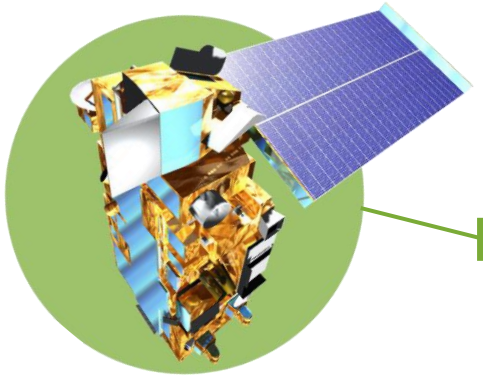
Product Comparison

- gridMET
  - University of Idaho's Gridded Meteorological Dataset
- Enviro-weather
- Illinois Climate Network

→ **Reference ET**

Image Credit: NASA, AmeriFlux

Study Period



Terra MODIS

Present

gridMET

January 2001

Present

Enviro-weather

Present

AmeriFlux

January 1996

Present

ICN

January 1990

Present

Image Credit: AmeriFlux, NASA

Overview of Methodology

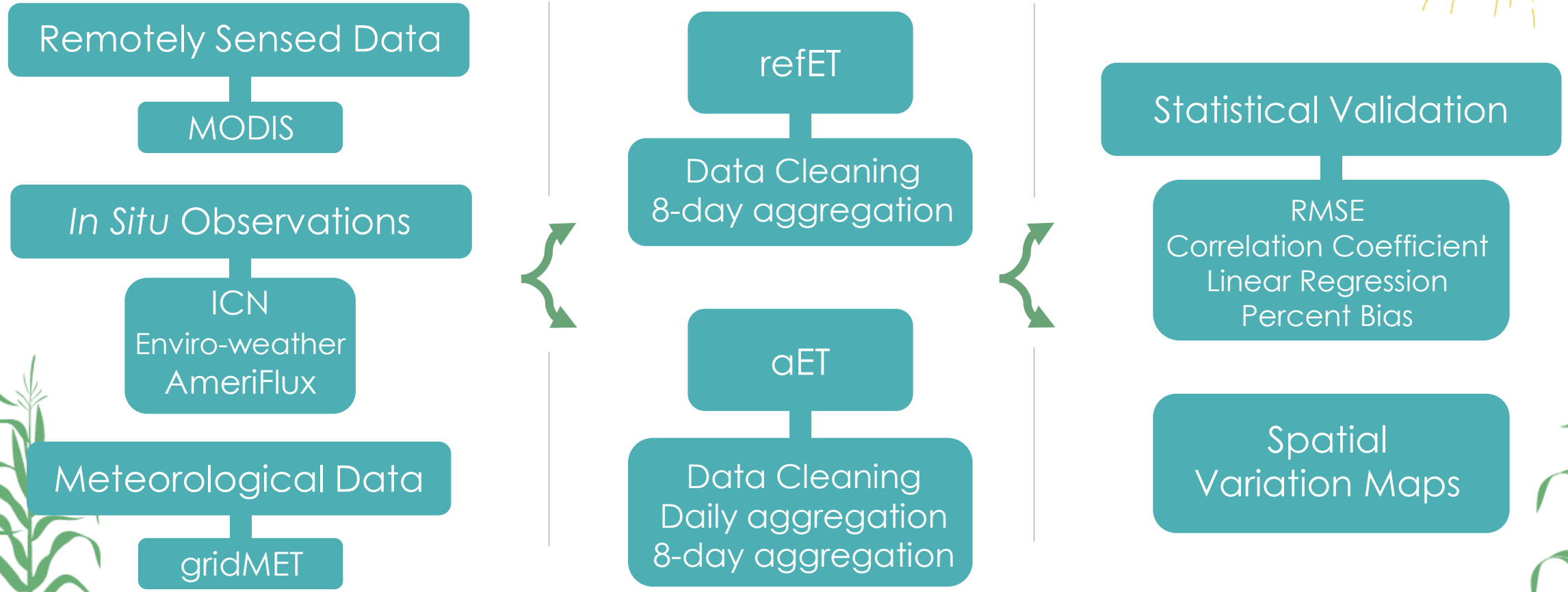
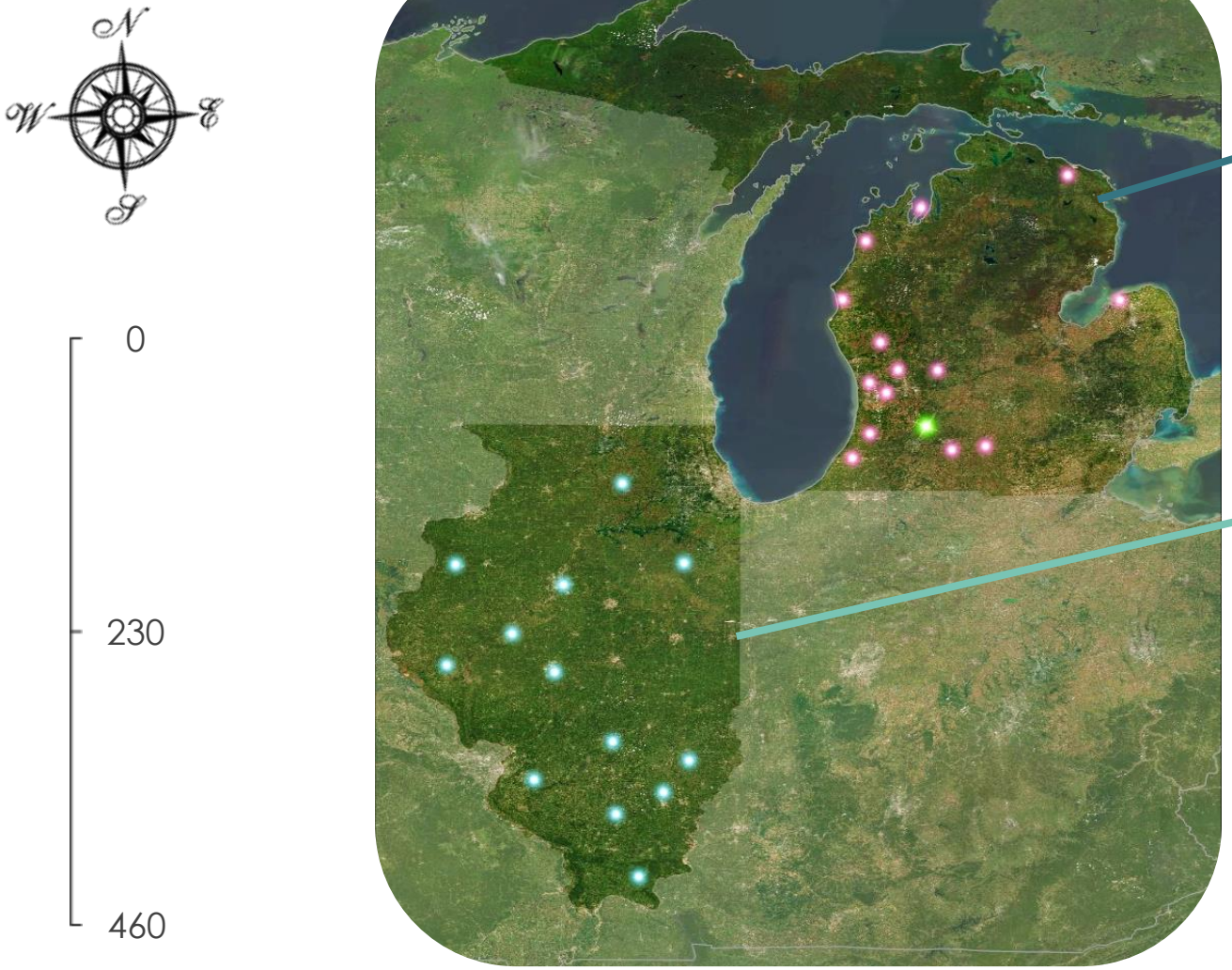


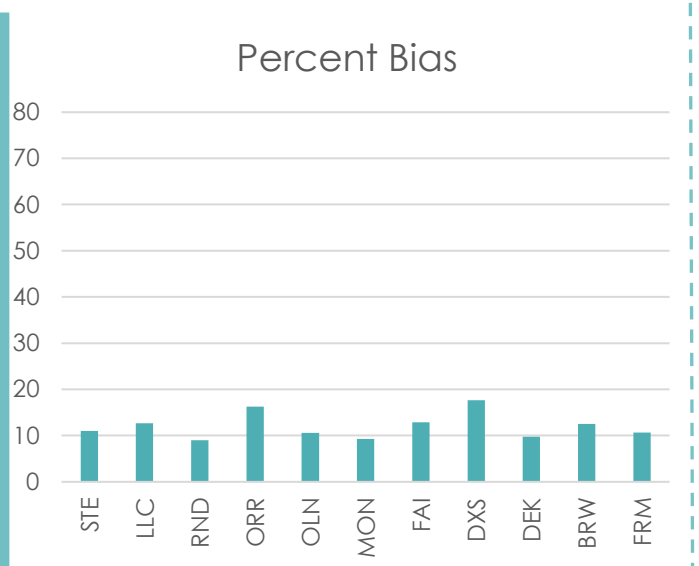
Image Credit: DEVELOP Team

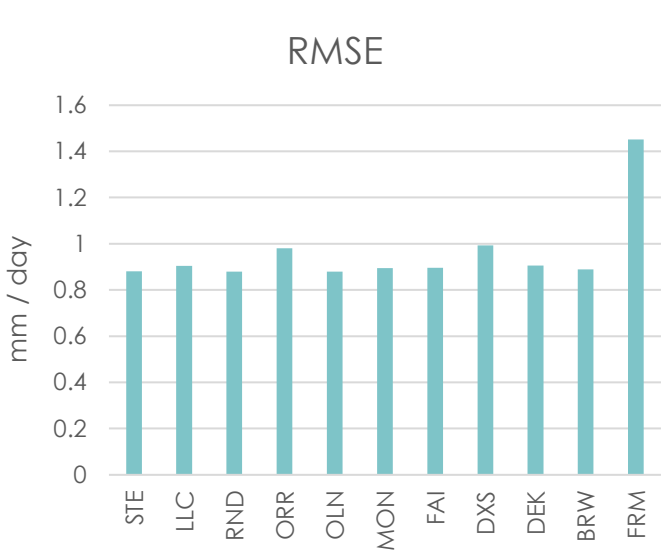
refET & aET Analyses

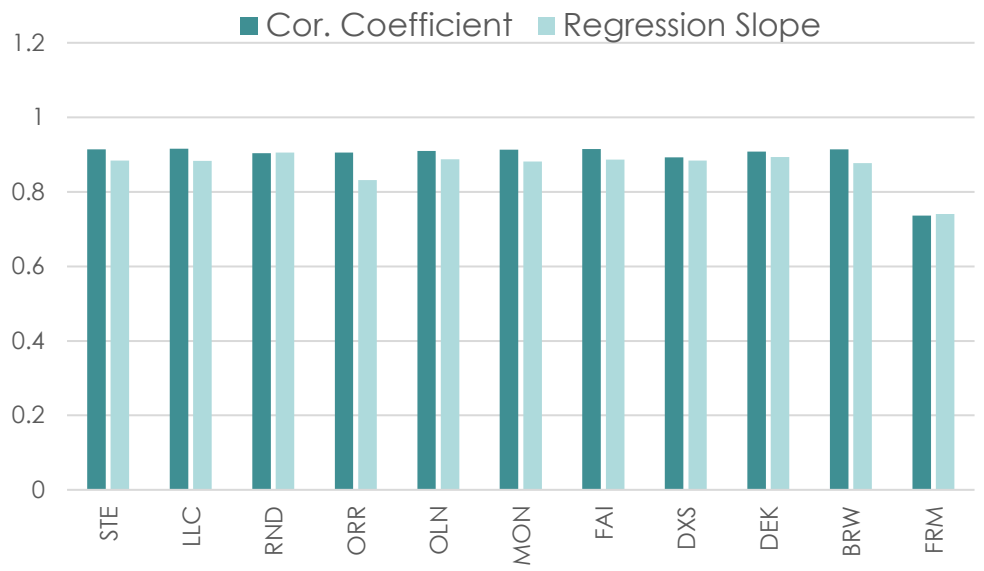


RefET Results: gridMET & *In Situ* Statistics

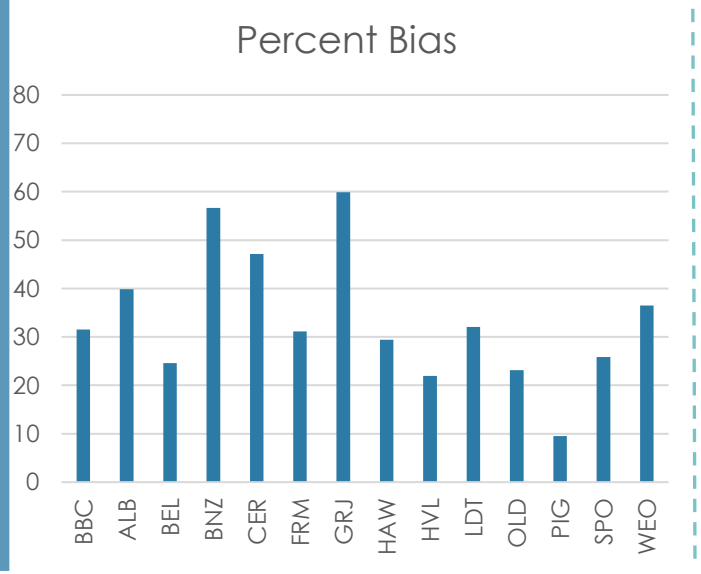
ICN

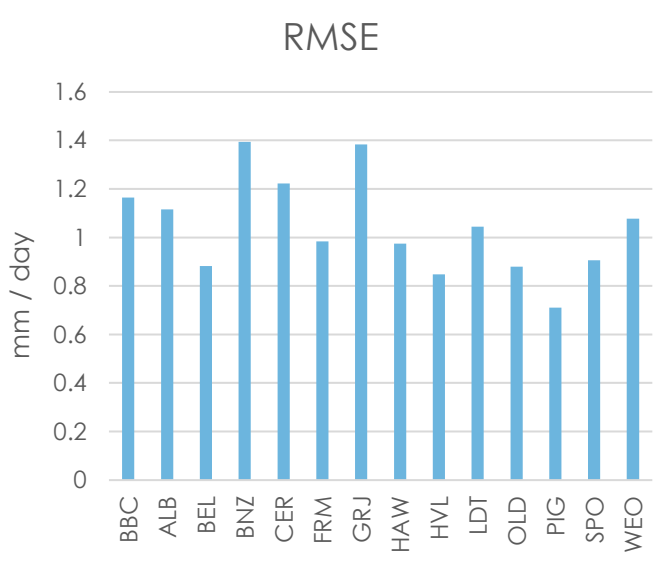


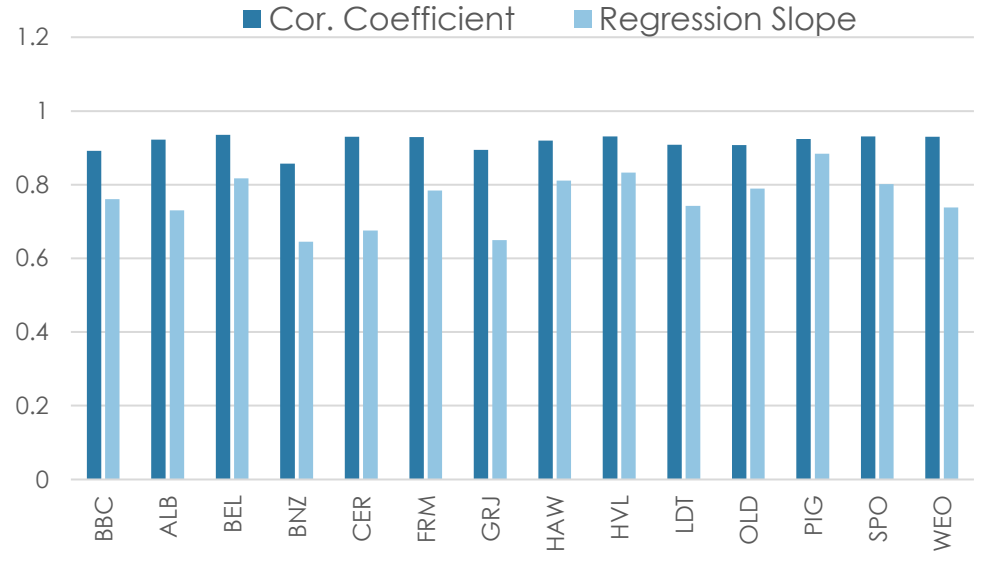




Enviro-Weather





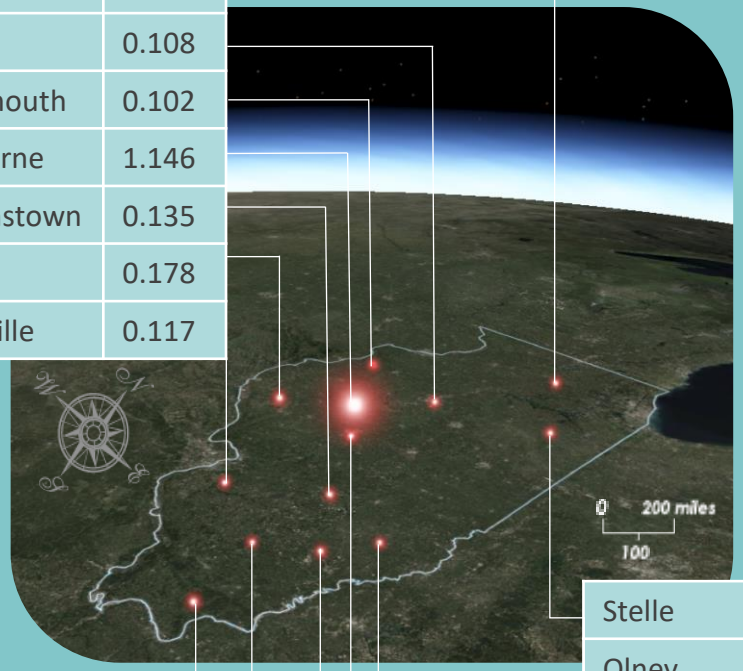


refET Results

ICN

Percent Bias

Location	% Bias
DeKalb	0.103
Peoria	0.108
Monmouth	0.102
Kilbourne	1.146
Brownstown	0.135
Perry	0.178
Belleville	0.117

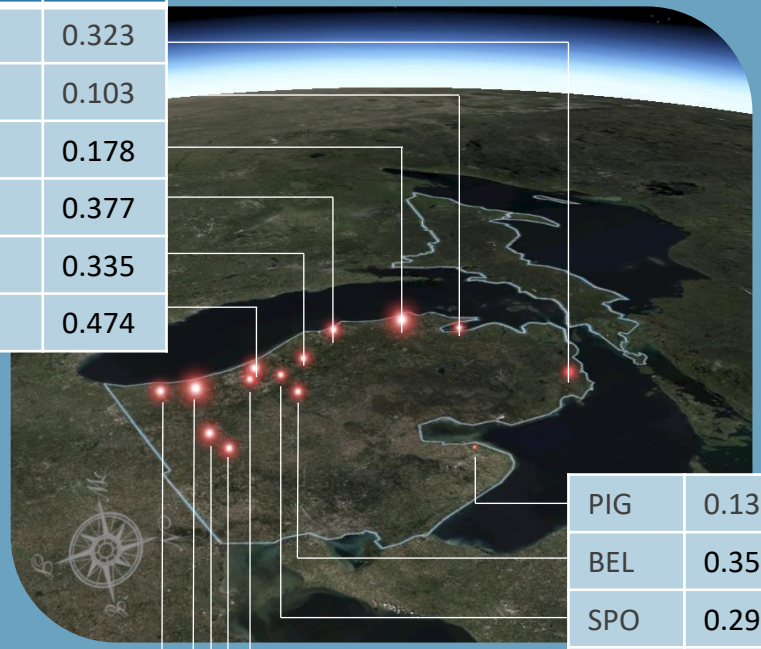


Stelle	0.113
Olney	0.105
Springfield	0.131
Fairfield	0.135
Rend Lake	0.098
Dixon Springs	0.186

Enviro-weather

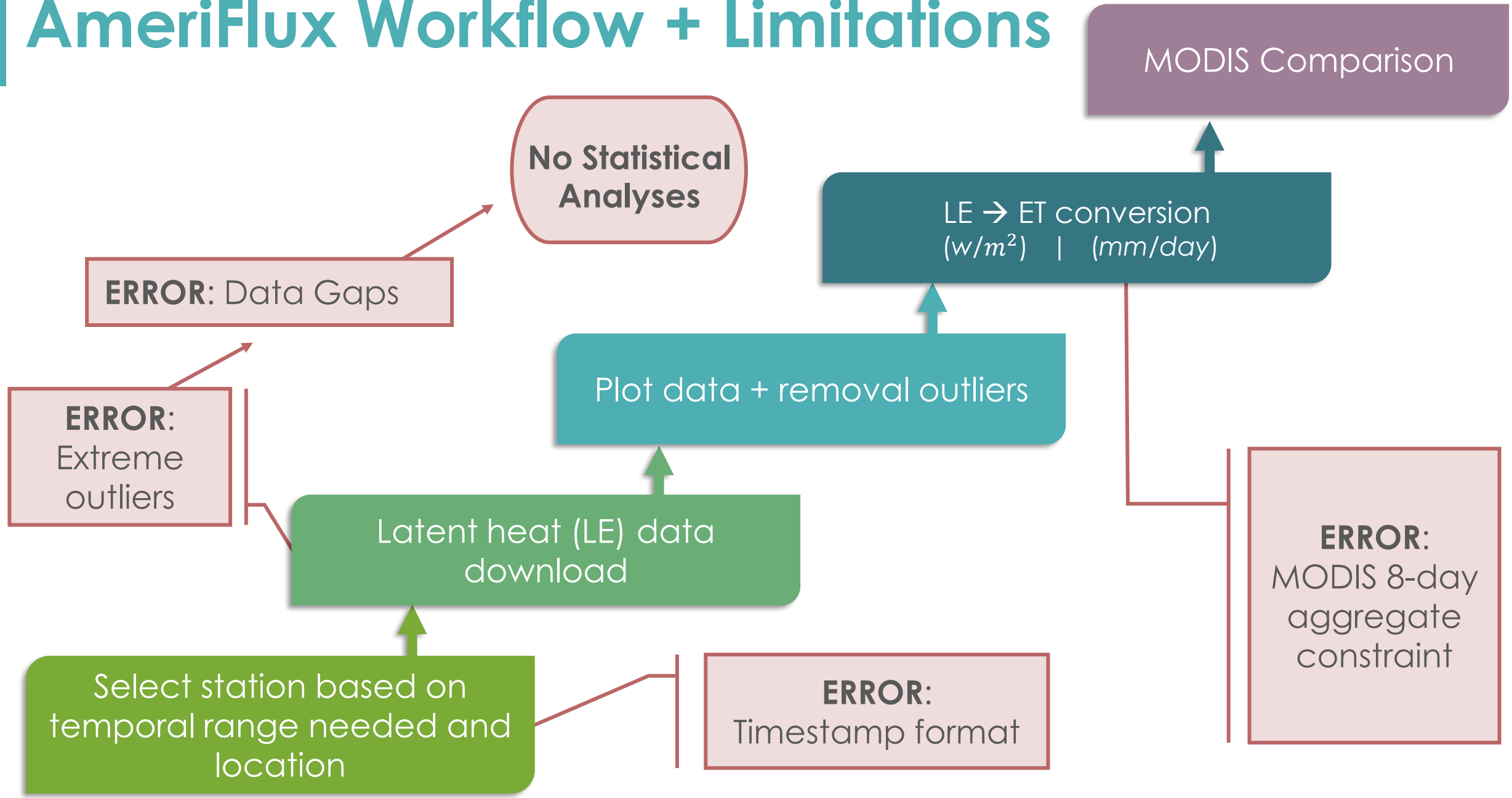
Percent Bias

Location	% Bias
HAW	0.323
OLD	0.103
BNZ	0.178
LDT	0.377
FRM	0.335
WEO	0.474

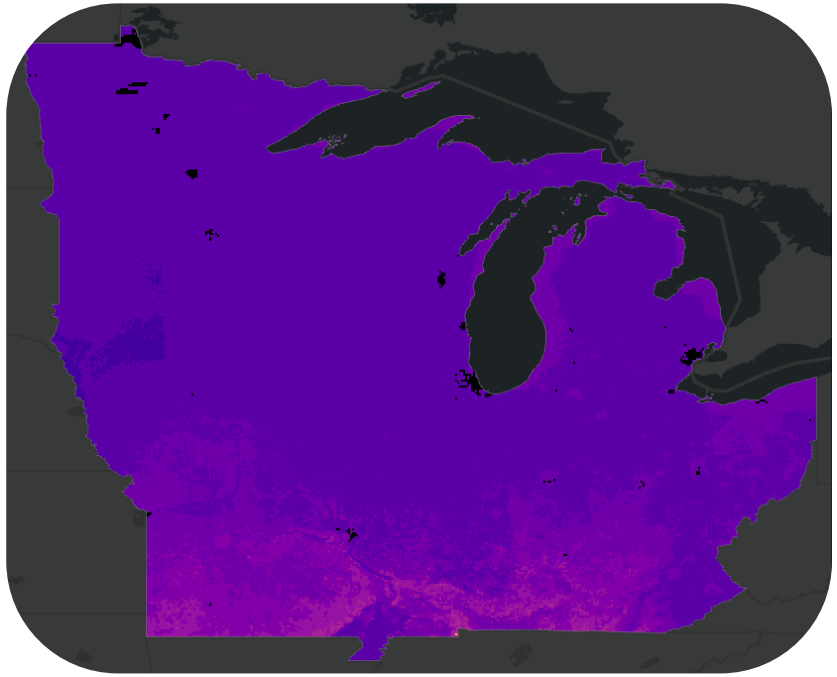


PIG	0.135
BEL	0.353
SPO	0.291
HVL	0.332
ALB	0.399
CER	0.469
GRJ	0.693
BBC	0.113

AmeriFlux Workflow + Limitations

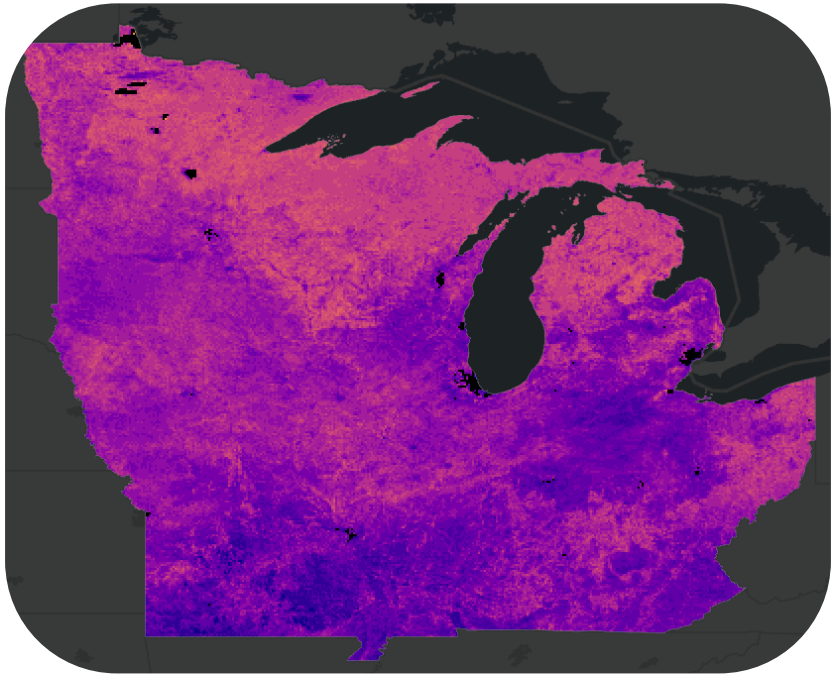


2012 Case Study MODIS: aET



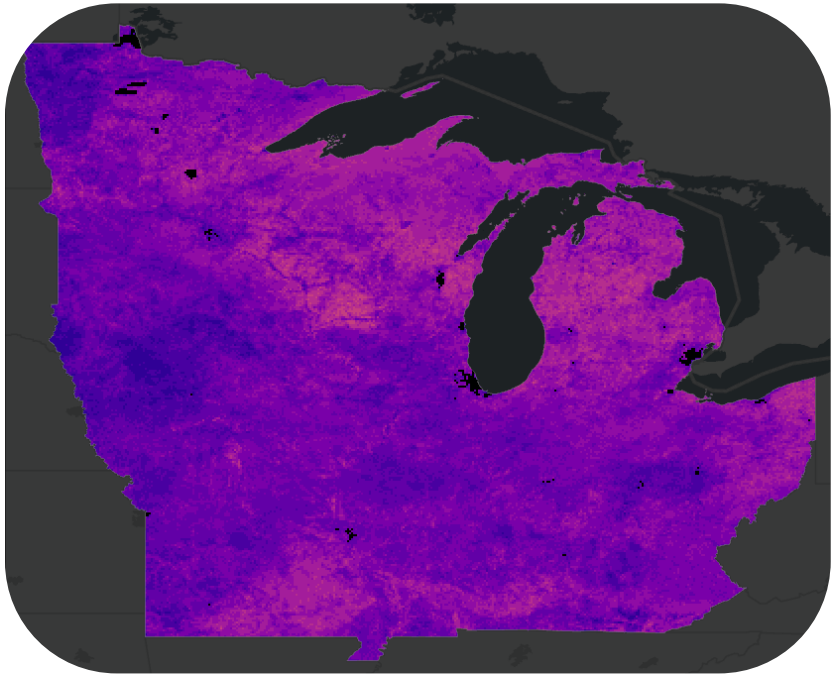
April

Pre-Flash Drought



June

Flash Drought



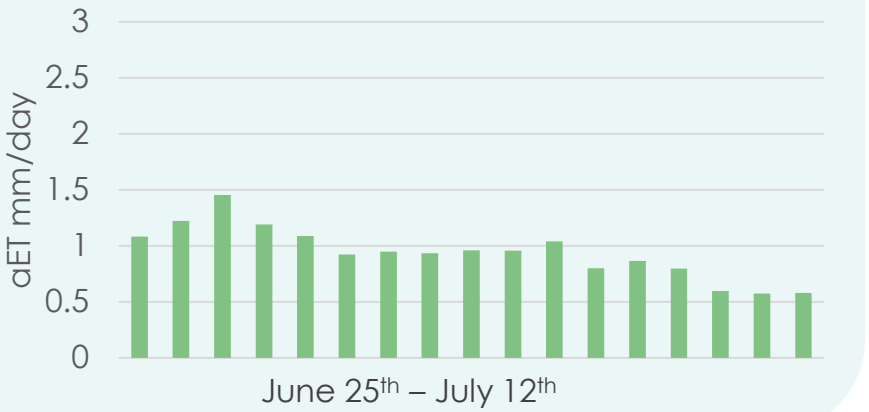
August

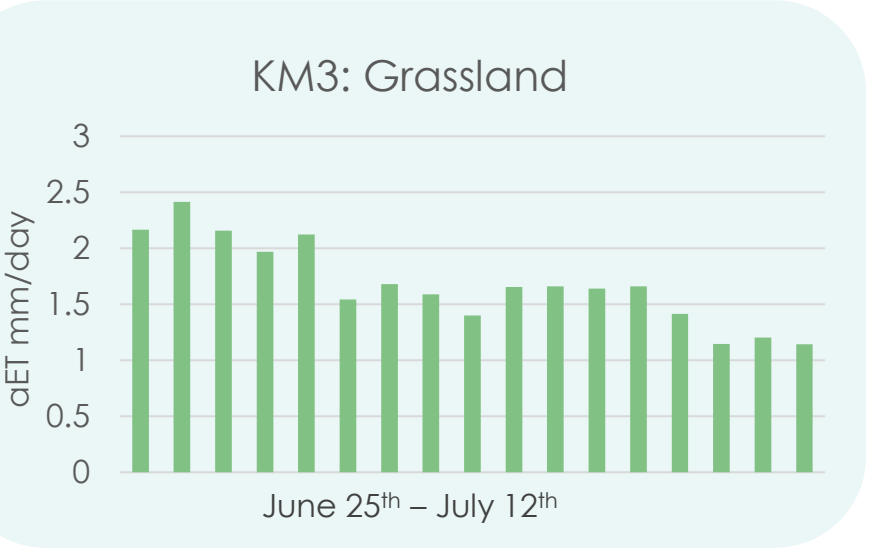
Post-Flash Drought

0 7 14 21 28 35 42 49 56 63 70+

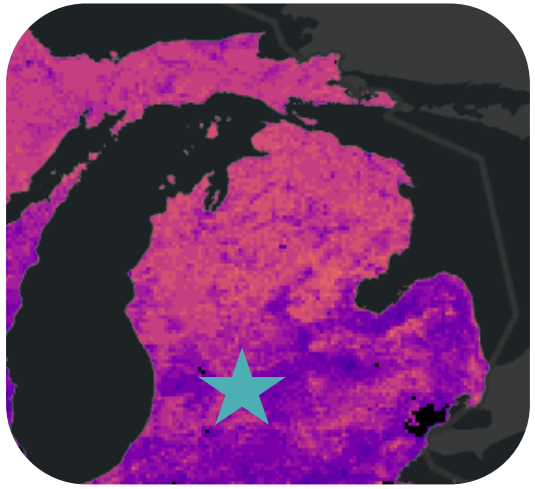
(mm / 8-day)

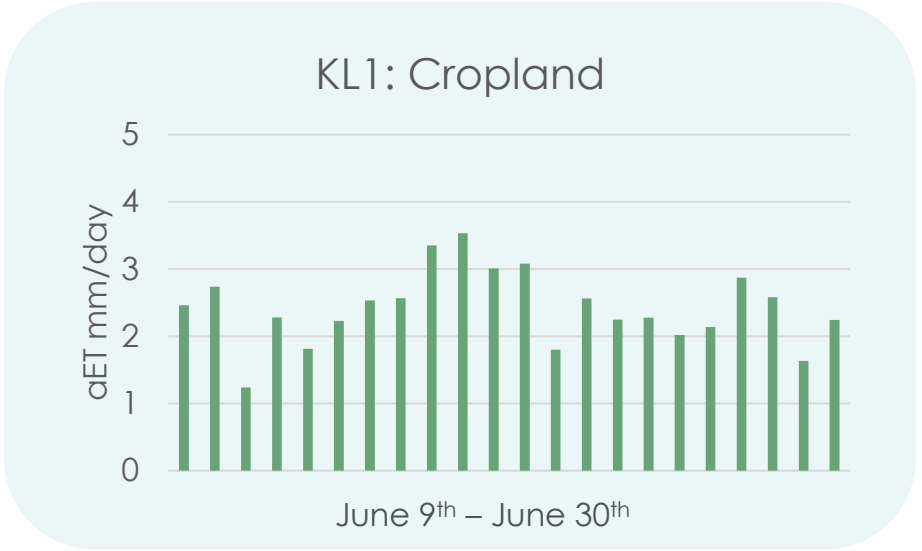
2012 Case Study: aET

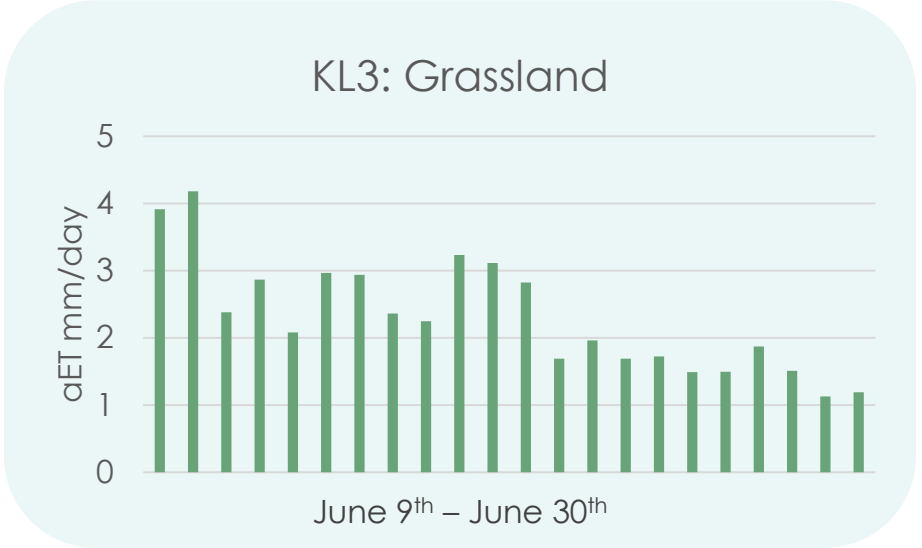




Michigan
AmeriFlux Sites

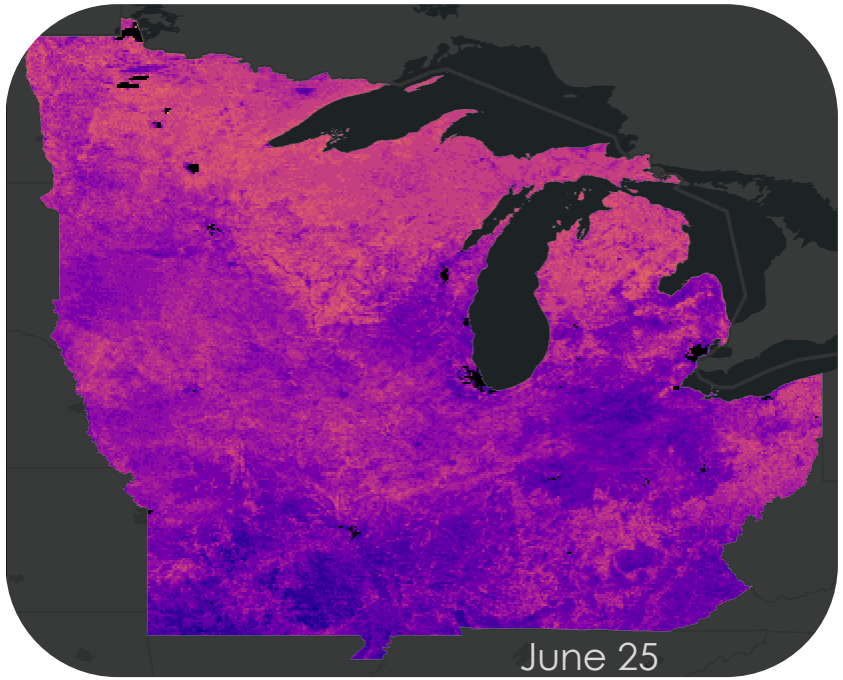






2012 Case study: aET

MODIS → aET



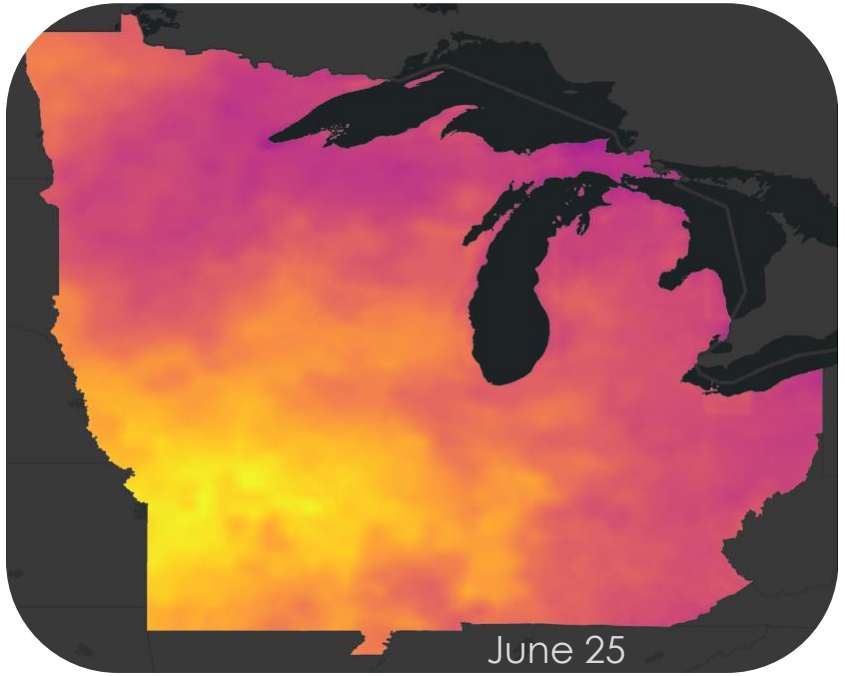
70+

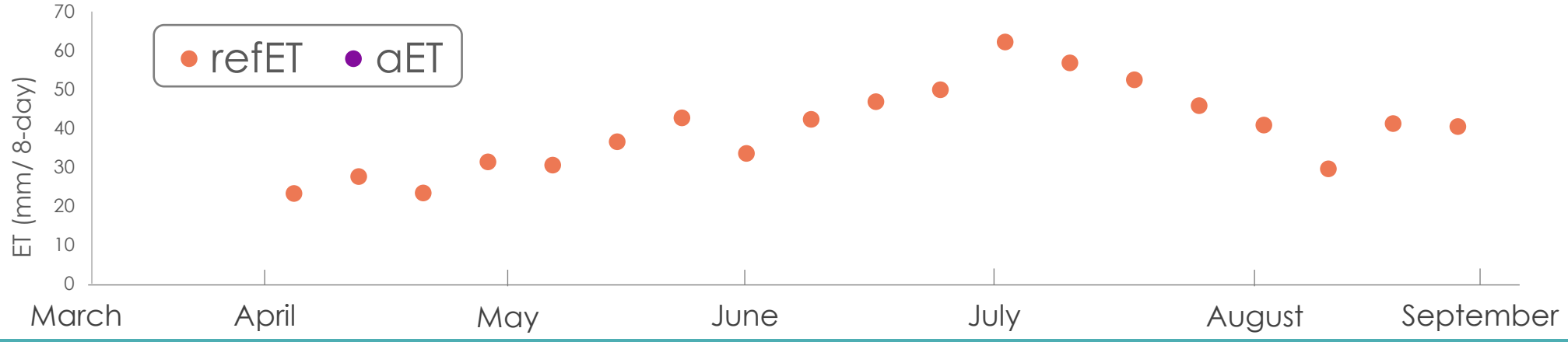
0

(mm/ 8-day)

100 mi

gridMET → refET





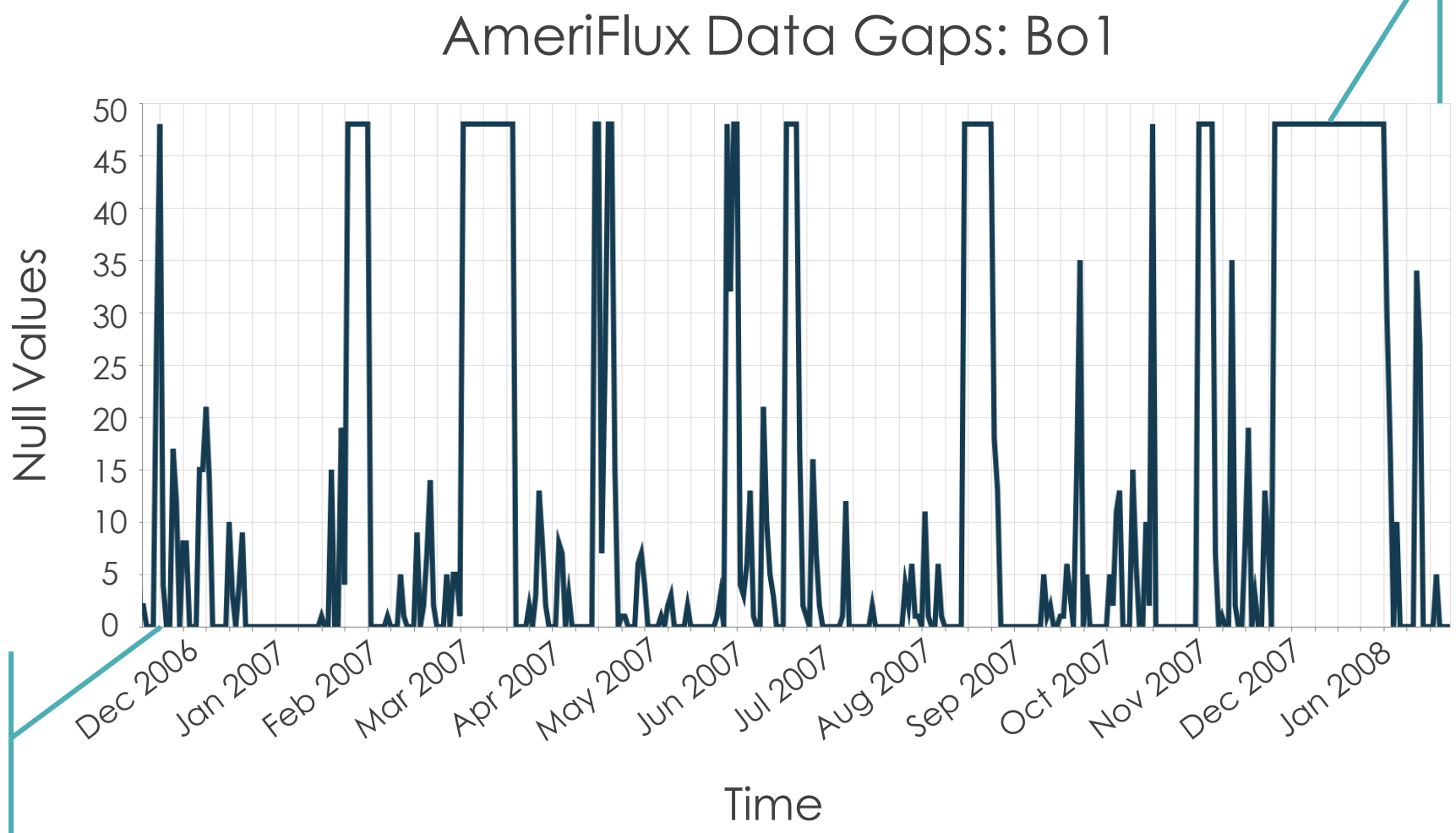
Errors & Uncertainties

- **Varying resolutions across datasets**
  - Spatial
    - MODIS – 500 m
    - gridMET – 4 km
  - Temporal
    - MODIS – 8-day summation
    - gridMET – daily

- **AmeriFlux data uncertainty**
  - Temporal gaps
  - Outlier values at night

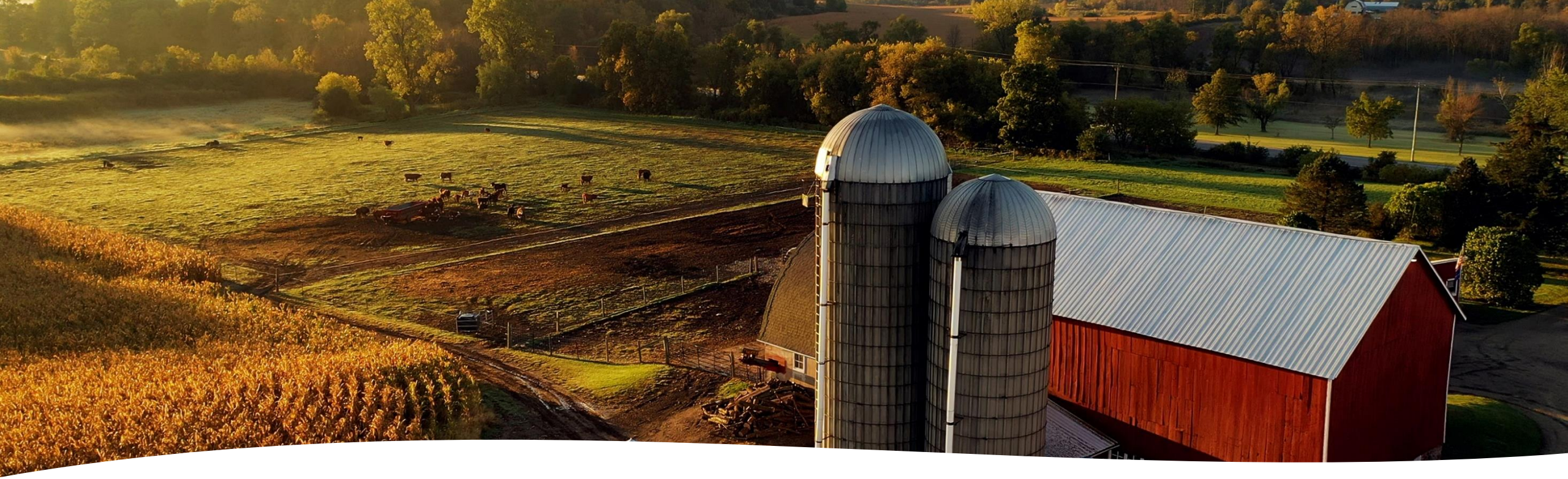
Image Credit: United Soybean Board (top); Alena Mozhjer (bottom)

Limitations



1 month missing data

32.6% of data were missing



Future Work

- Compare additional remotely sensed ET data sources
  - Open ET
  - Landsat
- Quantify ET based on crop type

Image Credit: Alena Mozhjer

Conclusions

- Strong **statistical correlation** between gridMET and refET *in situ* sites
- **2012 flash drought** case study matched remotely sensed data
- **Bias variation** across *in situ* sites

Image Credit: Kenneth Keifer

ACKNOWLEDGEMENTS

Project Partners

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