Trending agricultural research using satellite and other remote sensing data

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GeoXO
GEOSTATIONARY EXTENDED OBSERVATIONS

USGEO
United States Group on Earth Observations

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Current Earth Observation Assessment

Contact for further enquiries

Assessment | Data Explorer User Guide

Overview and Methodology

Explains the structure and content of EOA 2023, highlighting the ways in which it can provide value to users.

Report

Agriculture and Forestry

The Agriculture and Forestry SBA includes sectors that provide food and shelter for the Nation and water supplies that impact farmland, rangeland, and forests. Societal benefits accrue from improved short- and long-term decision-making by farmers, ranchers, foresters, rangeland managers, natural resource and watershed managers, and researchers.

Note: USGEO updated the Agriculture & Forestry SBA Report, Annex, and Data Explorer in December 2024 to accurately reflect current Earth Observation Inputs and Programs.

Report | Data Annex | Navigator

Earth Observation Assessment

Earth Observation Input	Enhance Food Supply	Understand current agricultural production, production trends, and risk [AF-1-1]	Improve soil health, increase carbon uptake and storage, and reduce trace gas emissions from soil by promoting soil conservation practices [AF-1-2]	Improve resilience of agricultural productivity to empower climate smart agriculture [AF-1-3]
Geostationary Operational Environmental Satellite - R Series (GOES-R) Advanced Baseline Imager	Moderate	Moderate	Moderate	High

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Earth Observation Assessment

Earth Observation Input	Increase the efficiency of irrigation, fertilizers, and pesticides by encouraging sustainable and precision agriculture [AF-1-4]	Manage environmental and human health risks associated with fertilizers and pesticides [AF-1-5]	Support forage assessment and management for animal production [AF-1-6]	Improve ecosystem condition to support diverse agricultural pollinators [AF-1-7]
Geostationary Operational Environmental Satellite - R Series (GOES-R) Advanced Baseline Imager	Moderate	Supplemental	Supplemental	High

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Uses of Satellite Data for Agricultural Research

Crop Monitoring and Health Assessment
- Environmental Stress Detection
- Pest and Invasive Species Detection
- Yield Forecasting
- Phenology/Emergence

Resource Management
- Precision Agriculture
- Soil Moisture/Evapotranspiration Estimation
- Tillage/Residue

Land Use and Land Cover Estimation
- Acreage Estimation
- Land Degradation
- Mapping

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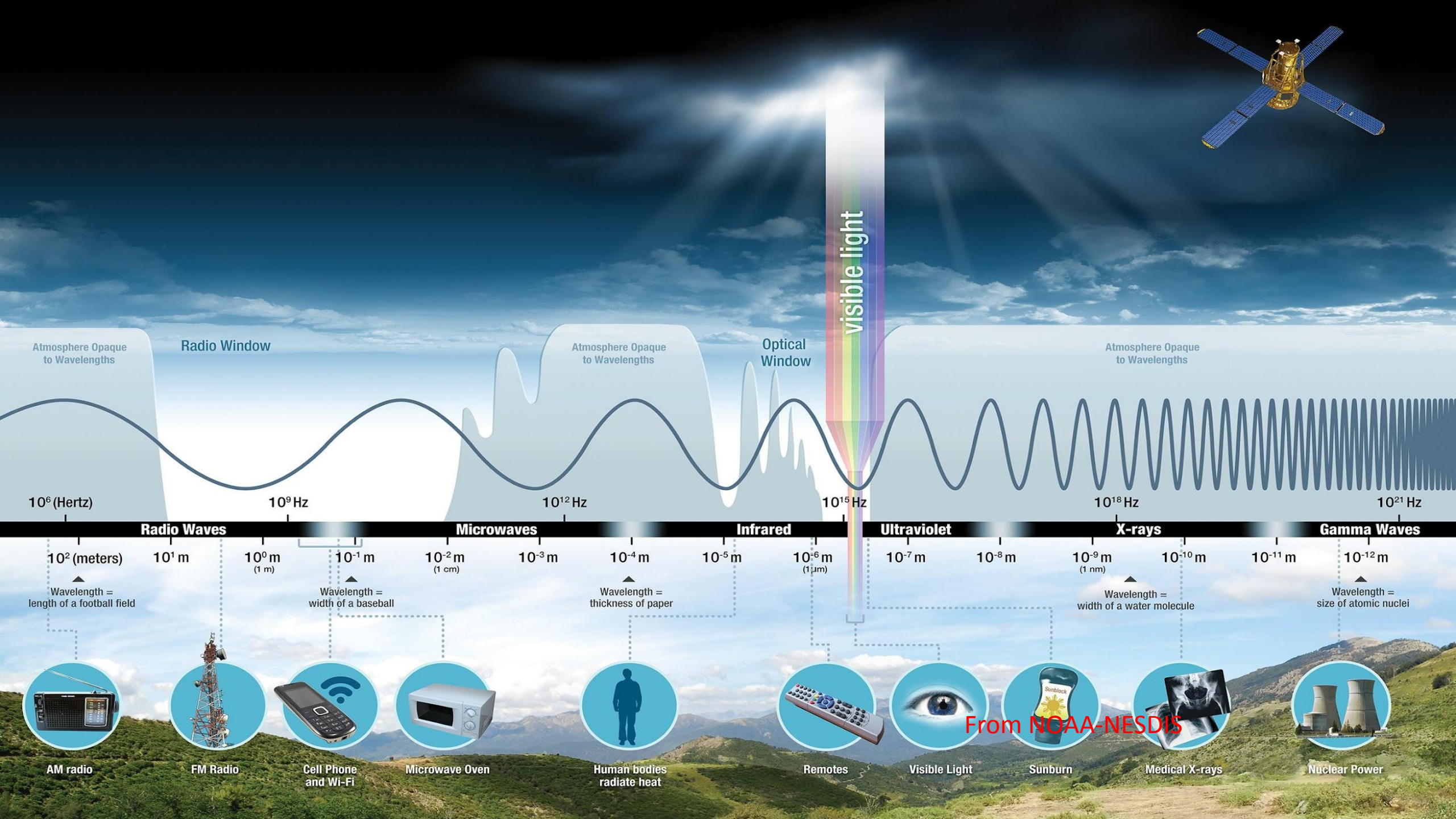
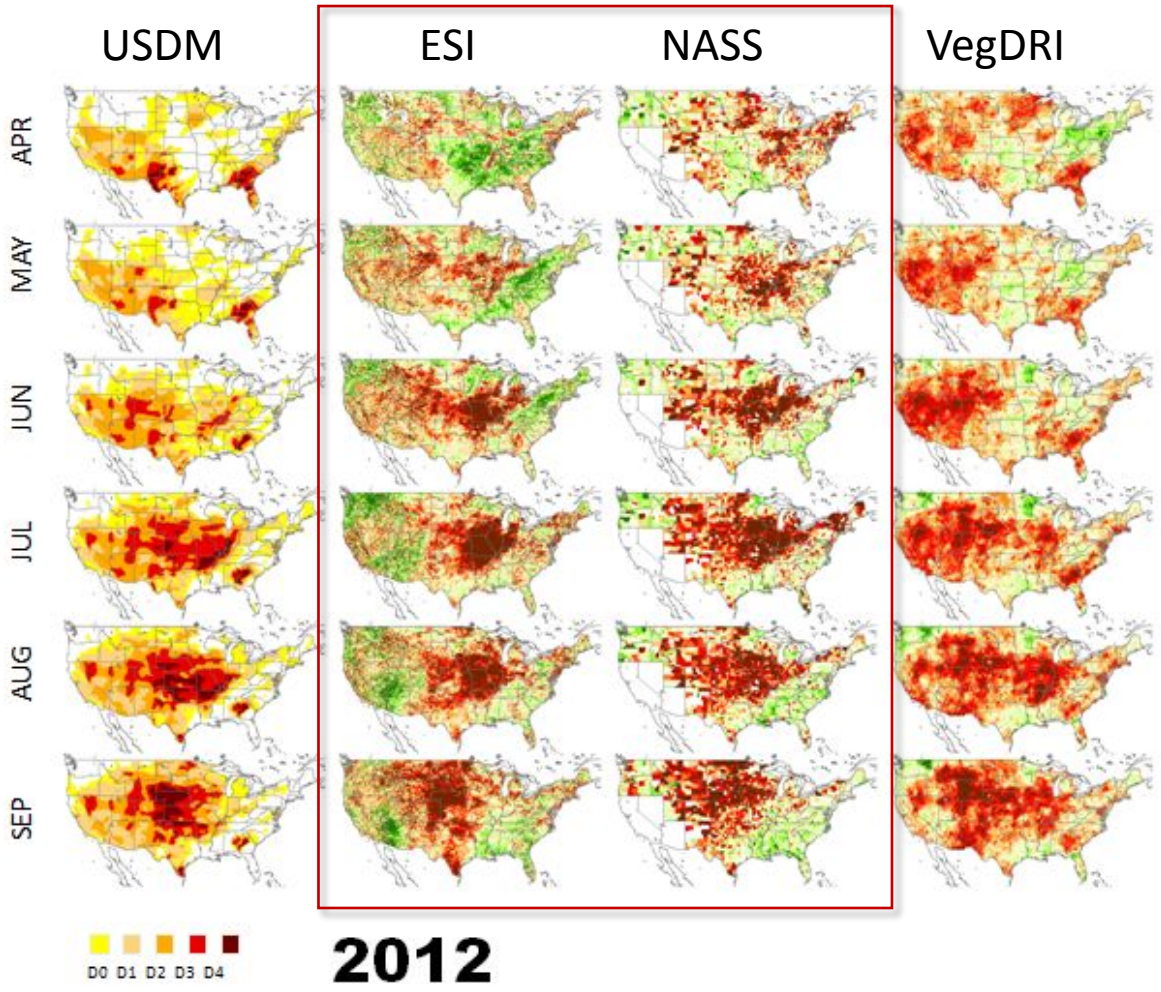
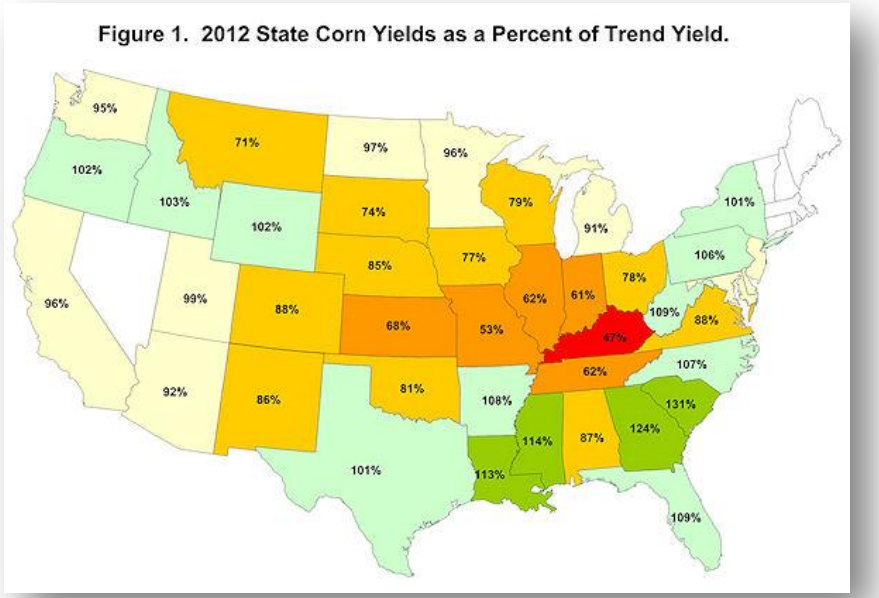

Atmosphere Opaque to Wavelengths
Radio Window
Atmosphere Opaque to Wavelengths
Optical Window
visible light
Atmosphere Opaque to Wavelengths
10^6 (Hertz)
10^9 Hz
10^12 Hz
10^15 Hz
10^18 Hz
10^21 Hz
Radio Waves
Microwaves
Infrared
Ultraviolet
X-rays
Gamma Waves
10^2 (meters)
10^1 m
10^0 m (1 m)
10^-1 m
10^-2 m (1 cm)
10^-3 m
10^-4 m
10^-5 m
10^-6 m (1 μm)
10^-7 m
10^-8 m
10^-9 m (1 nm)
10^-10 m
10^-11 m
10^-12 m
Wavelength = length of a football field
Wavelength = width of a baseball
Wavelength = thickness of paper
Wavelength = width of a water molecule
Wavelength = size of atomic nuclei
AM radio
FM Radio
Cell Phone and Wi-Fi
Microwave Oven
Human bodies radiate heat
Remotes
Visible Light
Sunburn
Medical X-rays
Nuclear Power
From NOAA-NESDIS

ALEXI: Atmosphere-Land Exchange Inverse

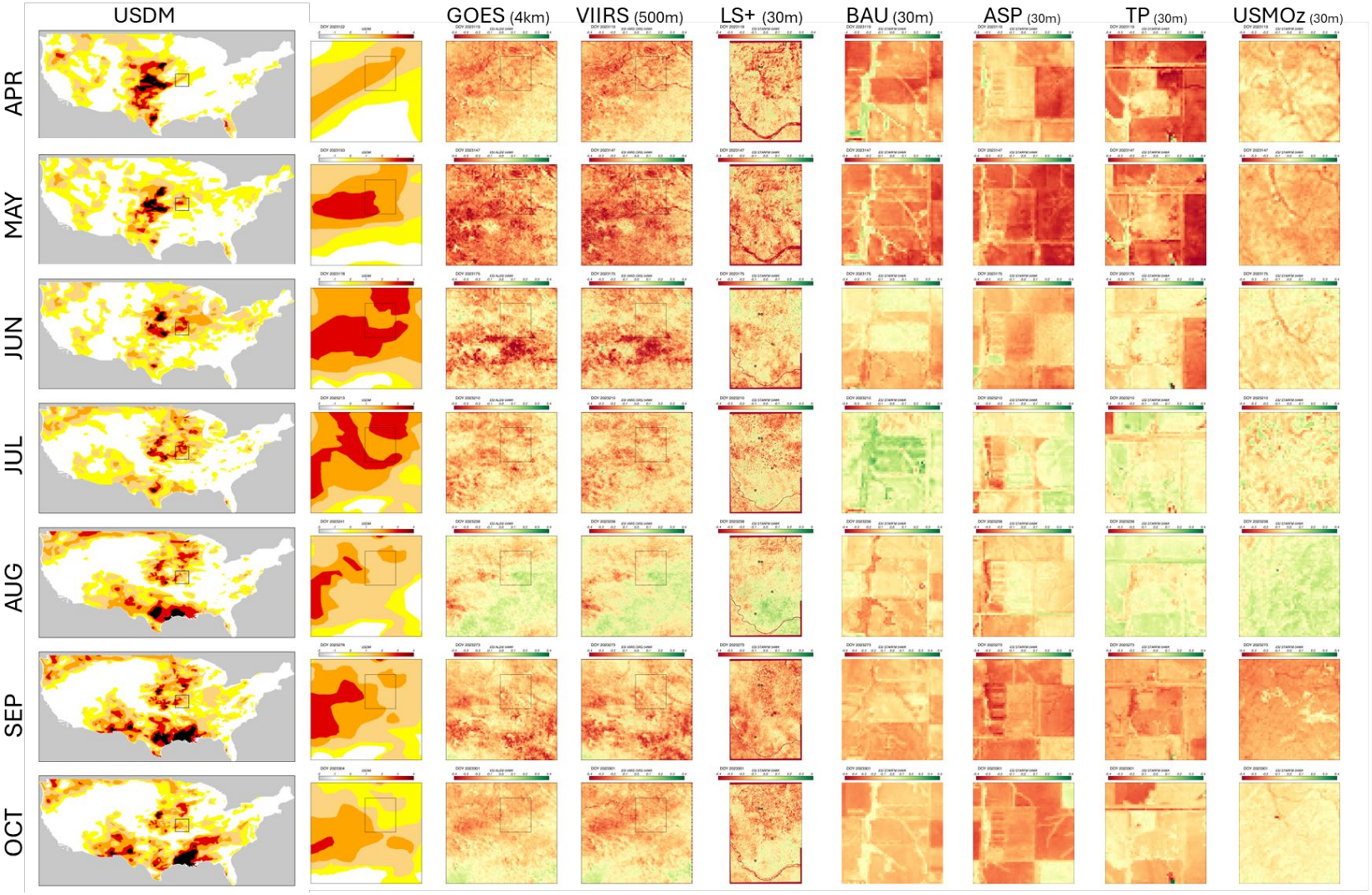
Surface energy balance using GOES morning surface temperature rise (4km, daily)

2012 FLASH DROUGHT



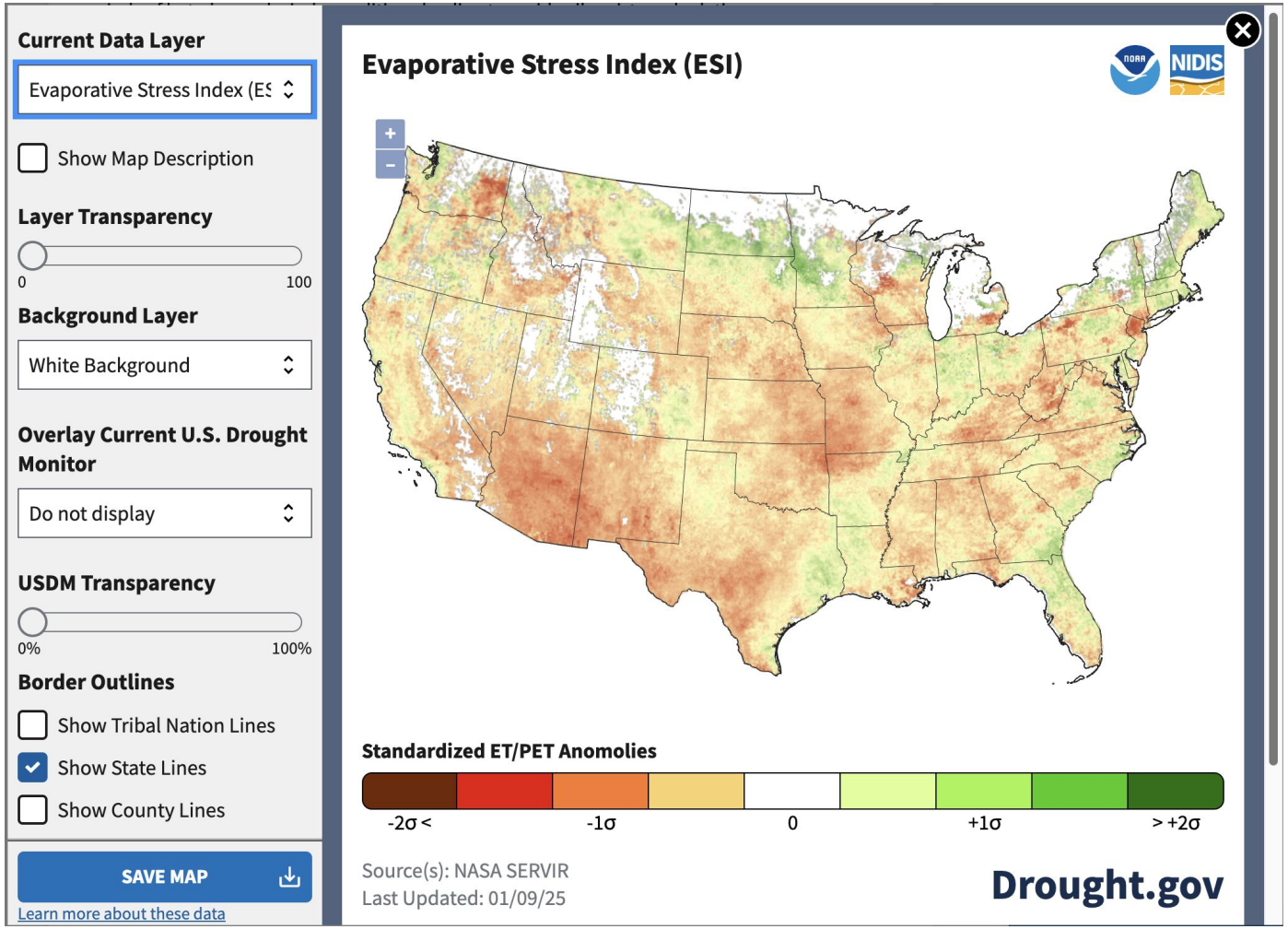


USDM: US Drought Monitor
ESI: Evaporative Stress Index
NASS: National Ag Statistics Service (county-level observers)
VegDRI: NDVI-based


USDM
GOES (4km)
VIIRS (500m)
LS+ (30m)
BAU (30m)
ASP (30m)
TP (30m)
USMOz (30m)
APR
MAY
JUN
JUL
AUG
SEP
OCT
2023

With a 1km thermal channel on GeoXO and sharpening to 250m with the shortwave bands, Evapotranspiration could be scaled down to 250m and ultrafine temporal resolution.

Sub-hour, sub-field Evapotranspiration would provide fast crop stress imagery.



Mapping winter cover crops within the season using remote sensing

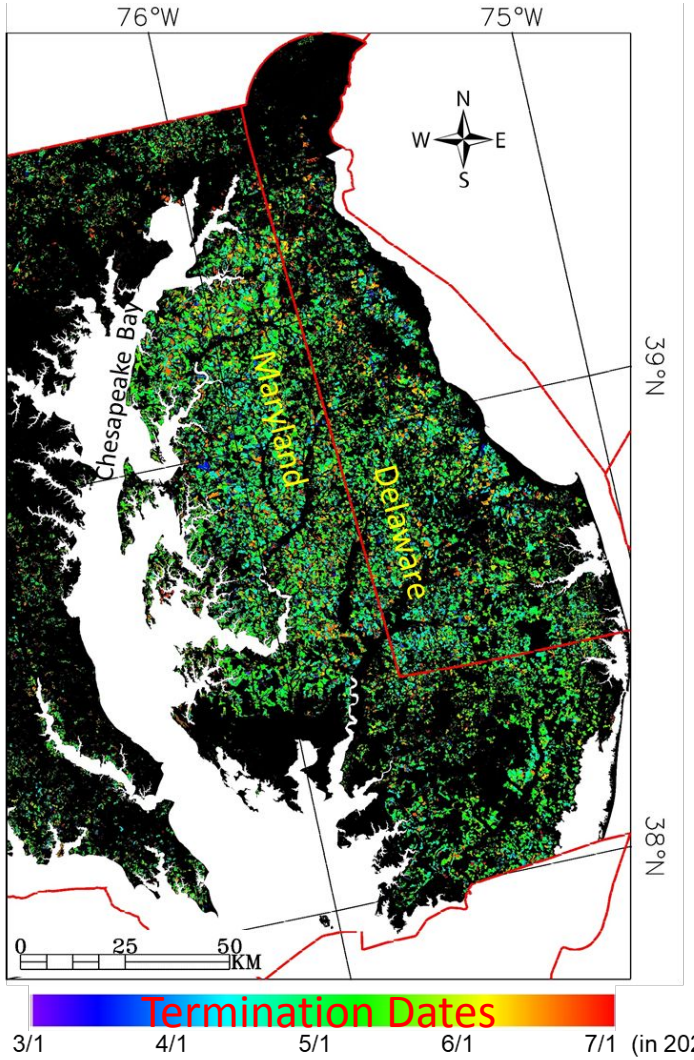
- Winter cover crops (WCC) improve soil health and water quality. However, we lack a detailed in-season WCC map. Additionally, distinguishing WCC from natural vegetation and commodity crops is a challenging task.
- HRSL scientists have developed a new phenology-based method to identify agricultural and incentive WCC using the Harmonized Landsat and Sentinel-2 (HLS), either during or after the WCC growing season.
- Early-season detection yields promising results, with WCC producers' accuracy > 90% and overall accuracy > 80%

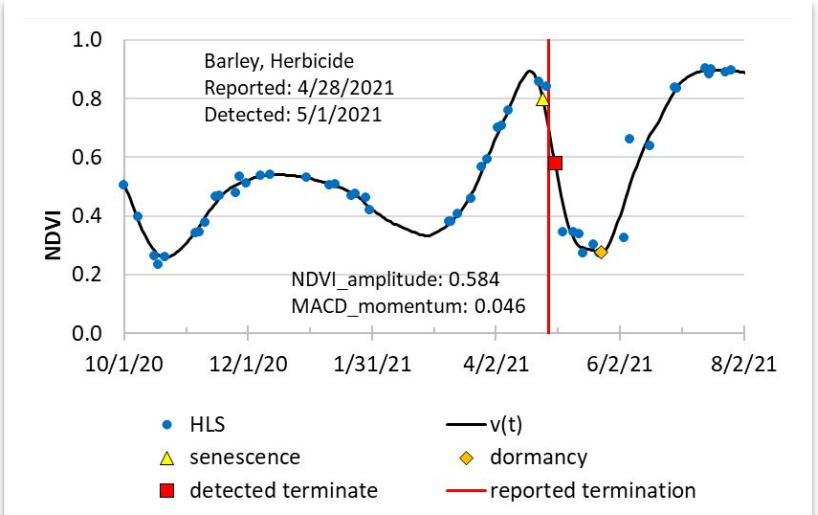
The 2024-2025 WCC identified using HLS until March 1, 2025 (in-season), with red and blue polygons indicating agricultural WCC and non-WCC observed from the ground.

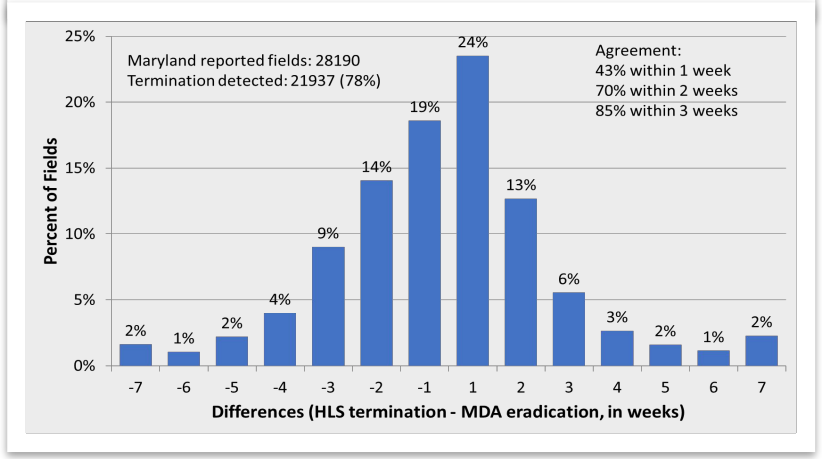
Planting and termination dates for winter cover crops

- Maryland and Delaware winter cover crop cost-share programs use cover crop planting and termination dates to determine incentive payments
- Planting and termination dates must be collected and confirmed in a timely manner for each enrolled field. The verification process is labor-intensive and time-consuming
- ARS and USGS scientists used harmonized Landsat and Sentinel-2 (HLS) data to detect cover crop emergence and termination dates for Maryland operational incentive programs since 2020. Reports are provided bi-weekly

USGS NASA LCLUC Program

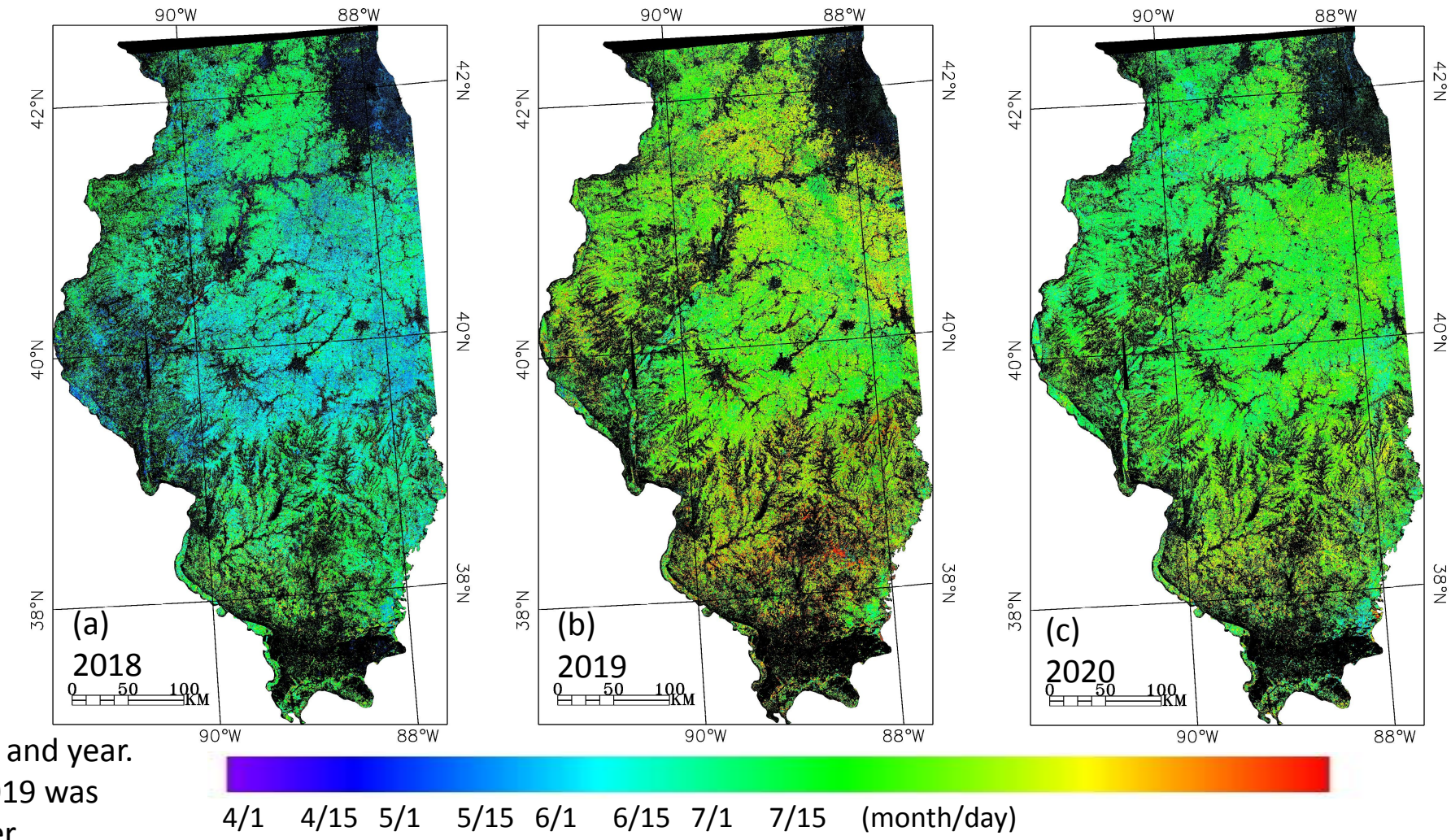




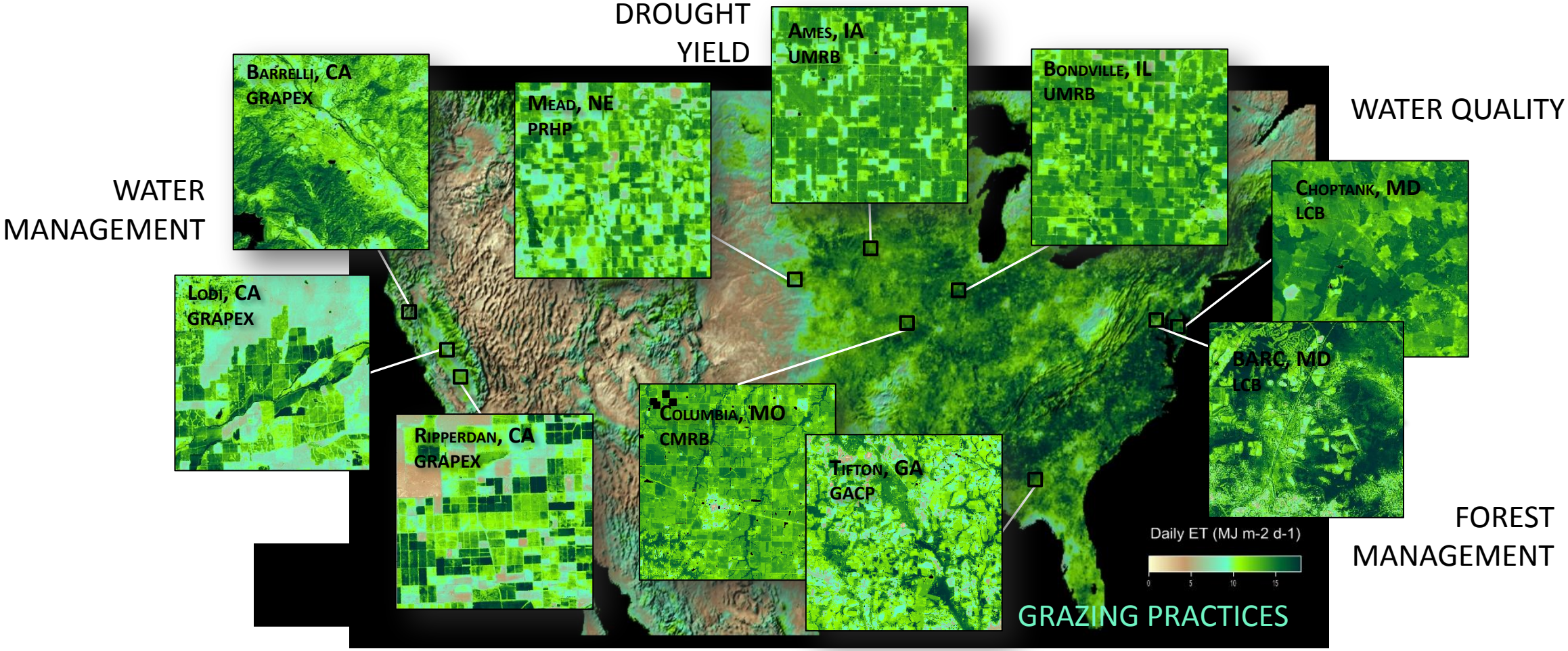


Mapping crop emergence within the season

- Crop emergence (VE) is a critical stage for crop development and crop growth modeling
- HRSL scientists developed a Within Season Emergence (WISE) algorithm to detect crop emergence in the early growing season using the harmonized Landsat and Sentinel-2 (HLS)
- Crop emergence dates have been used for improving crop condition monitoring and yield estimation



Crop emergence dates vary by location and year. In Illinois, the delayed emergence in 2019 was due to historically cool and wet weather.



USDA-ARS Long-Term Agroecosystem Research (LTAR) Sites