



The future of crop yield monitoring without MODIS

NOAA's Satellite Applications Symposium Series: Land/Agriculture



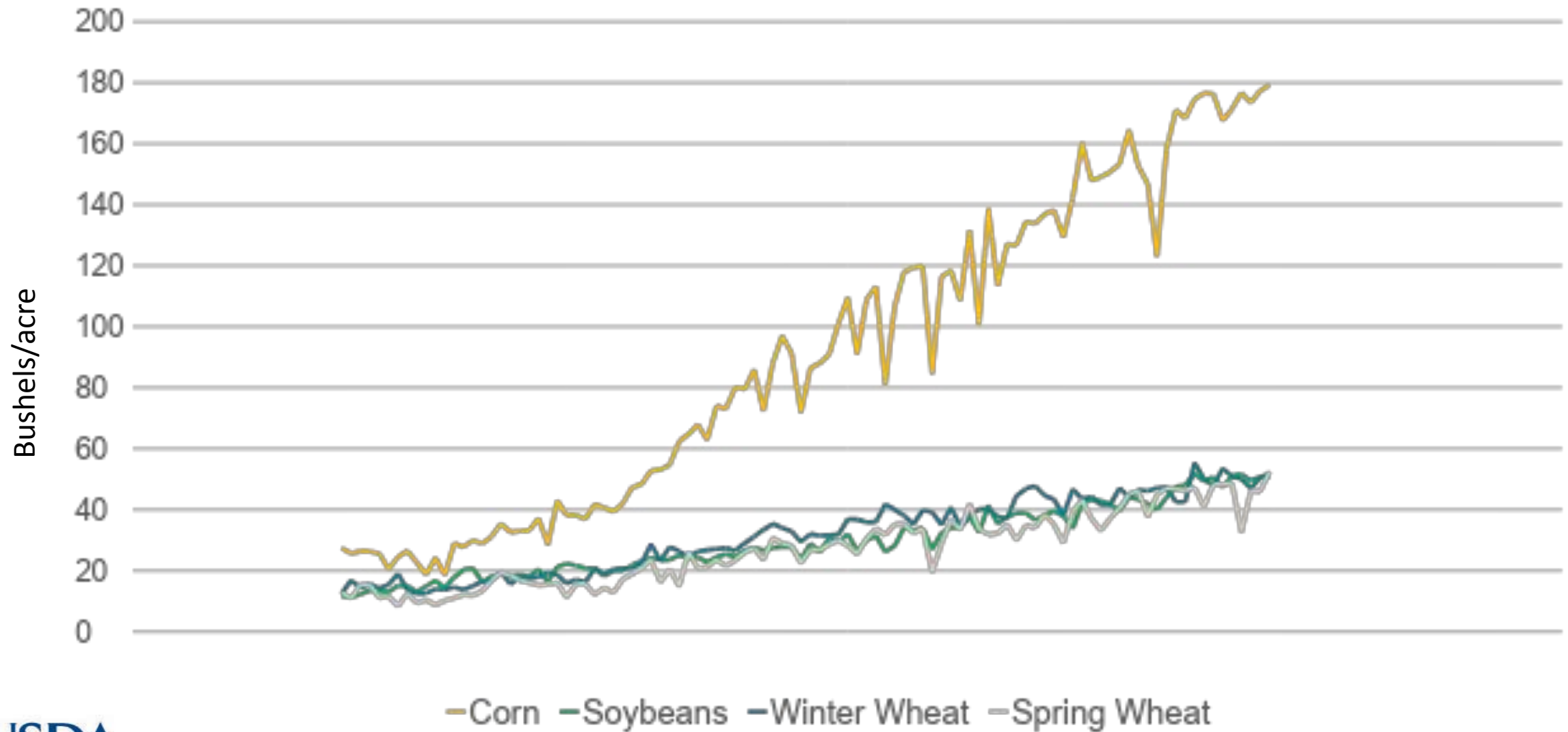
David Johnson, Geographer | david.m.johnson@usda.gov

May 20, 2025 | College Park, Maryland



100-year crop yield trends over the United States

2





ISSN: 1936-3737

Crop Production

Released August 12, 2024, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Special Note

NASS reviewed planted and harvested acreage estimates in this report for barley, corn, cotton, dry edible beans, oats, peanuts, rice, sorghum, soybeans, sugarbeets, and wheat (winter, other spring, and Durum) using all available data, including the latest certified acreage from the Farm Service Agency (FSA). All States in the estimating program for these crops were subject to review and updating. Detailed estimates can be found on pages 6, 8, 9, 11, 12, 13, 15, 16, 18, 22, 25, 26, 29, and 30.

Corn Production Down 1 Percent from 2023

Soybean Production Up 10 Percent from 2023

Cotton Production Up 25 Percent from 2023

Winter Wheat Production Up 1 Percent from July Forecast

Corn production for grain is forecast at 15.1 billion bushels, down 1 percent from 2023, which if realized would be the third highest production for grain on record for the United States. Based on conditions as of August 1, the yield is forecast at a record high 183.1 bushels per acre, up 5.8 bushels from last year's final estimate of 177.3 bushels. Total planted area, at 90.7 million acres, is down 1 percent from the previous estimate and down 4 percent from the previous year. Area harvested for grain is forecast at 82.7 million acres, down 1 percent from the previous forecast and down 4 percent from the previous year.

Soybean production for beans is forecast at a record high 4.59 billion bushels, up 10 percent from 2023. Based on conditions as of August 1, yields are expected to average a record high 53.2 bushels per acre, up 2.6 bushels from 2023. Area harvested for beans in the United States is forecast at 86.3 million acres, up 1 percent from the previous forecast and up 5 percent from 2023.

All cotton production is forecast at 15.1 million 480-pound bales, up 25 percent from 2023. Based on conditions as of August 1, yields are expected to average 840 pounds per harvested acre, down 59 pounds from 2023. Upland cotton production is forecast at 14.6 million 480-pound bales, up 24 percent from 2023. Pima cotton production is forecast at 553,000 bales, up 75 percent from 2023. All cotton area harvested is forecast at 8.63 million acres, up 34 percent from 2023. All cotton planted area totaled 11.2 million acres, down 4 percent from the previous forecast but up 9 percent from 2023.

All wheat production for grain is forecast at 1.98 billion bushels, down 1 percent from the previous forecast but up 9 percent from 2023. Based on August 1 conditions, yields are expected to average 52.2 bushels per harvested acre, up 0.4 bushel from the previous forecast and up 3.6 bushels from 2023. Area harvested for grain is forecast at 37.9 million acres, down 2 percent from the previous forecast but up 2 percent from 2023.

Winter wheat production is forecast at 1.36 billion bushels, up 1 percent from the July 1 forecast and up 9 percent from 2023. As of August 1, the United States yield is forecast at 53.2 bushels per acre, up 1.2 bushels from last month and up 2.6 bushels from last year's average yield of 50.6 bushels per acre. Area expected to be harvested for grain or seed totals 25.6 million acres, down 1 percent from the *Acreage* report released on June 28, 2024, but up 4 percent from 2023.

Hard Red Winter production, at 776 million bushels, is up 2 percent from last month. **Soft Red Winter**, at 342 million bushels, is down less than 1 percent from the July forecast. **White Winter**, at 243 million bushels, is up 4 percent from last month. Of the **White Winter** production, 19.3 million bushels are **Hard White** and 224 million bushels are **Soft White**.


Durum wheat production is forecast at 76.9 million bushels, down 14 percent from the previous forecast but up 30 percent from 2023. Based on August 1 conditions, yields are expected to average 38.1 bushels per harvested acre, down 4.6 bushels from the previous forecast but up 1.1 bushels from 2023. Area expected to be harvested for grain or seed totals 2.02 million acres, down 4 percent from the *Acreage* report but up 26 percent from 2023.

Other spring wheat production for grain is forecast at 544 million bushels, down 6 percent from the previous forecast but up 8 percent from last year. Based on August 1 conditions, yields are expected to average 52.6 bushels per harvested acre, down 0.5 bushel from the previous forecast but up 6.6 bushels from 2023. If realized, the United States yield would be a record high. Area harvested for grain or seed is expected to total 10.3 million acres, down 5 percent from the *Acreage* report released on June 28, 2024, and down 6 percent from 2023. Of the total production, 499 million bushels are **Hard Red Spring** wheat, up 7 percent from 2023.

This report was approved on August 12, 2024.

Secretary of Agriculture
Designate
Jason Hafemeister


Agricultural Statistics Board
Chairperson
Lance Honig



MODIS

MODERATE RESOLUTION IMAGING SPECTRORADIOMETER

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Tropical Cyclone Filipo

In March 2024, low wind shear in the Mozambique Channel allowed Tropical Cyclone Filipo to strengthen off the coast of southeast Africa...

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Data

The MODIS Data section contains everything from ATBDs to Product Descriptions to Product ordering information, including from Direct Broadcast data providers. Visit the Data section for more information.

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Disciplinary Teams


Atmosphere




Land




Ocean



Calibration



Web Curator: Brandon Maccherone
NASA Official: Shannell Frazier

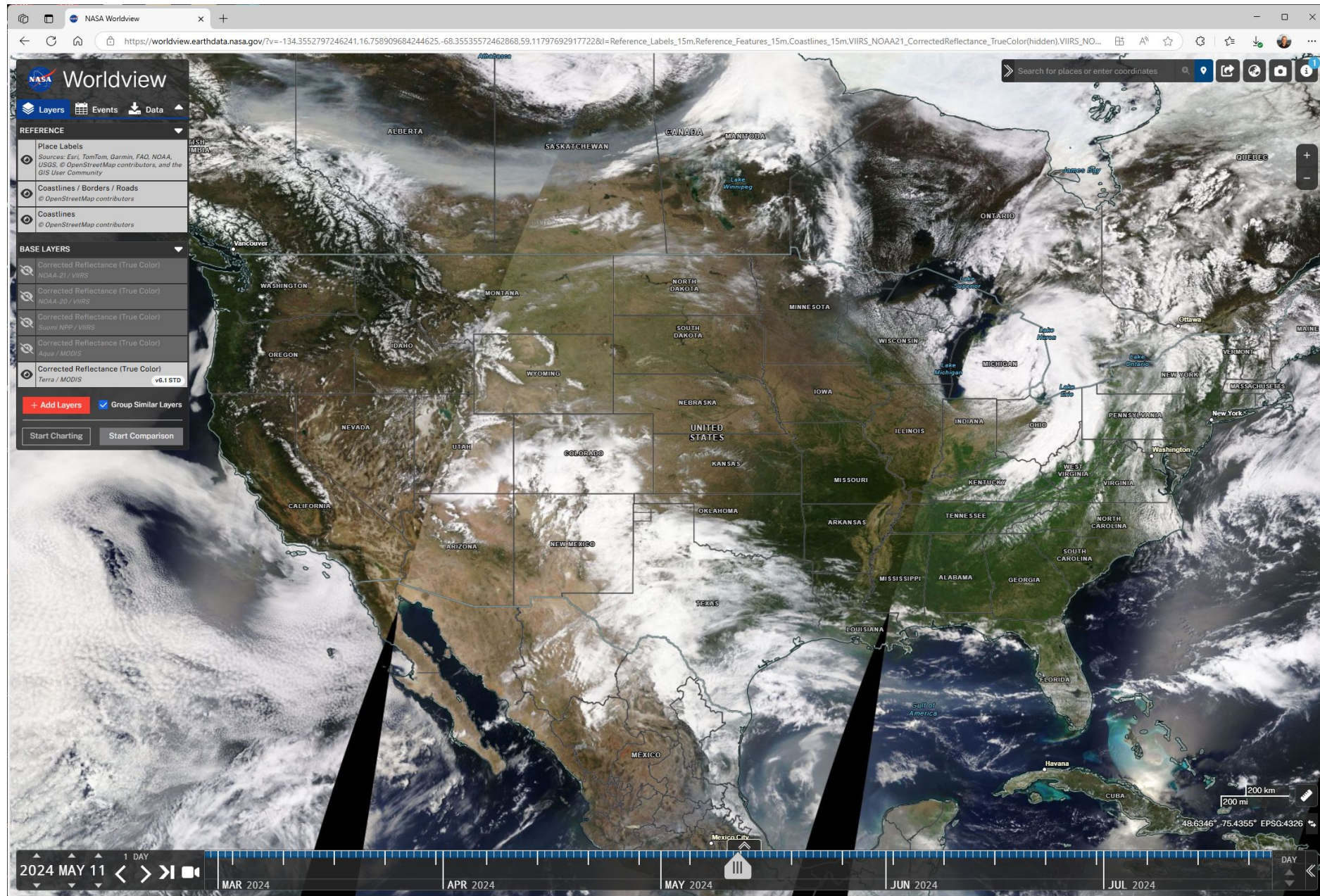


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Daily observations from Terra MODIS

5

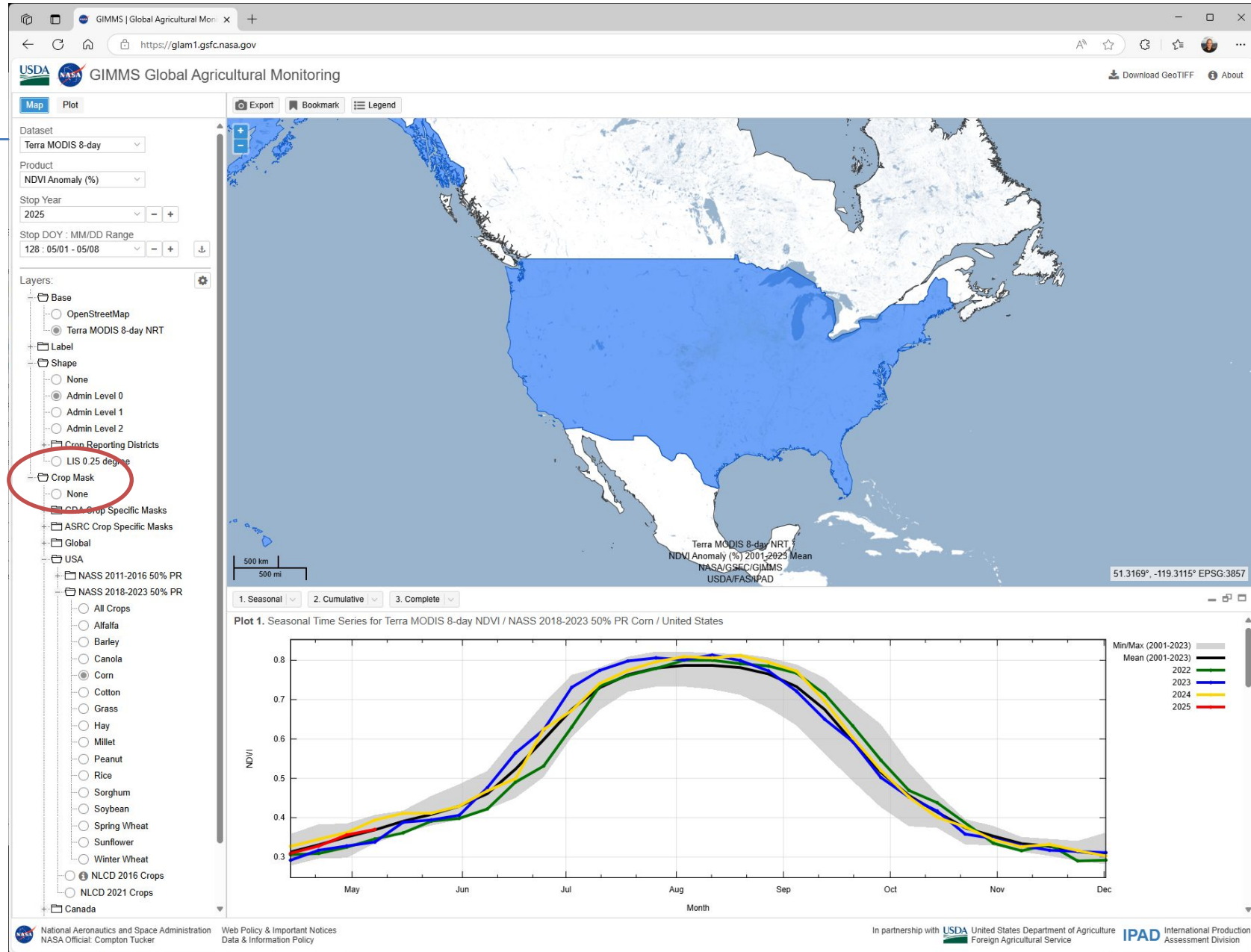


GIMMS Global Agricultural Monitoring (GLAM)

6

Terra MODIS 8-day 250-meter
Aqua MODIS 8-day 250-meter
NPP VIIRS 8-day 500-meter
NOAA-20 VIIRS 8-day 500-meter
Sentinel-3 OLCI 10-day 300-meter

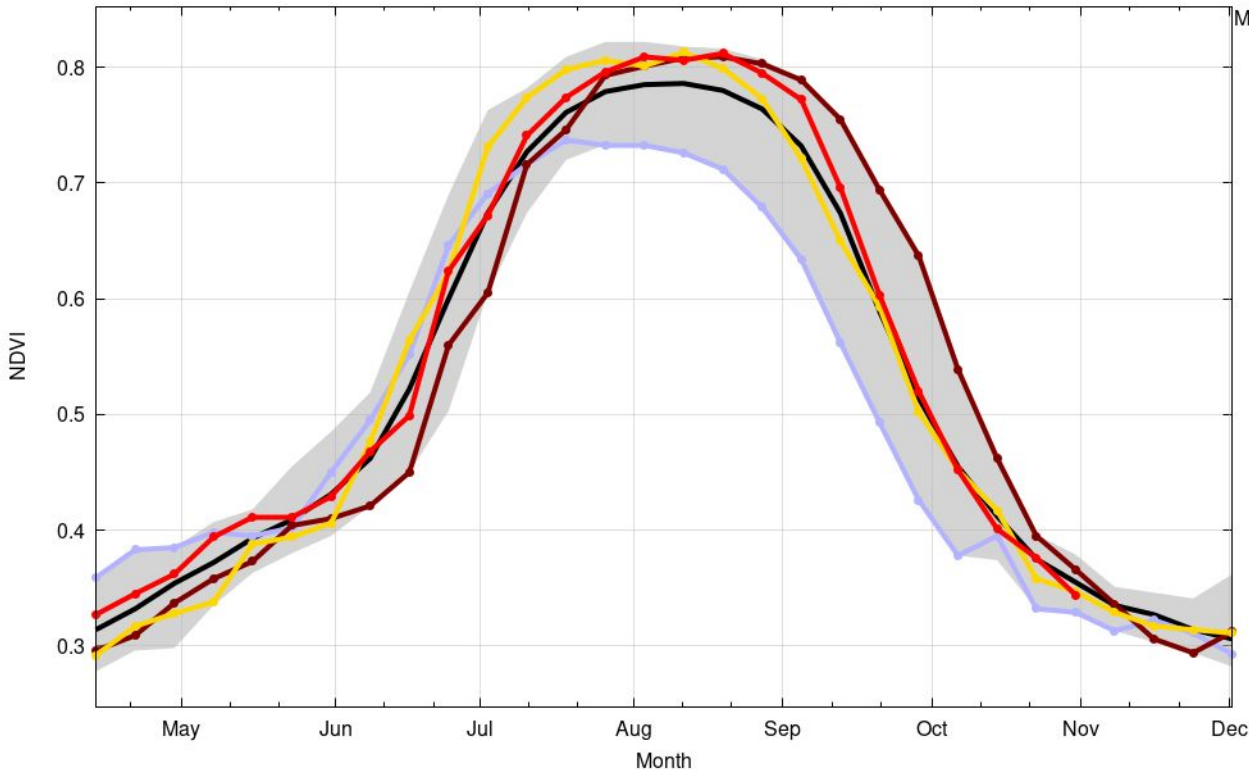
glam1.gsfc.nasa.gov



Normalized Difference Vegetation Index (NDVI)

7

Terra MODIS NDVI 8-day
United States



Sat Terra EOS AM
Product MODIS NDVI 8-day
Mask USDA-NASS-CDL_2018-2023_corn-50pp
Shape ADM
Unit United States

NASA/GSFC/GIMMS
USDA/FAS/IPAD

ndvi - Google Search

https://www.google.com/search?q=ndvi%0D%0A&sca_esv=581841001&source=hp&ei=h-ZRZfqwN6idkPIP3MWWkAo&fils...

About 15,900,000 results (0.27 seconds)

NDVI is used to quantify vegetation greenness and is useful in understanding vegetation density and assessing changes in plant health. NDVI is calculated as a ratio between the red (R) and near infrared (NIR) values in traditional fashion: $(NIR - R) / (NIR + R)$

United States Geological Survey (.gov)
https://www.usgs.gov/landsat-missions/landsat-norma...

Landsat Normalized Difference Vegetation Index - USGS.gov

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People also ask

What does the NDVI measure?

The Normalized Difference Vegetation Index (NDVI) is a measure of the amount and vigor of vegetation on the land surface and NDVI spatial composite images are developed to more easily distinguish green vegetation from bare soils.

United States Department of Agriculture (.gov)
https://ipad.fas.usda.gov/Definitions/spotveg

Normalized Difference Vegetation Index (NDVI)

Normalized difference vegetation index

The normalized difference vegetation index is a widely-used metric for quantifying the health and density of vegetation using sensor data. It is calculated from spectrometric data at two specific bands: red and near-infrared. The spectrometric data is usually sourced from remote sensors, such as satellites. Wikipedia

Data range: +1.0 to -1.0 usgs.gov

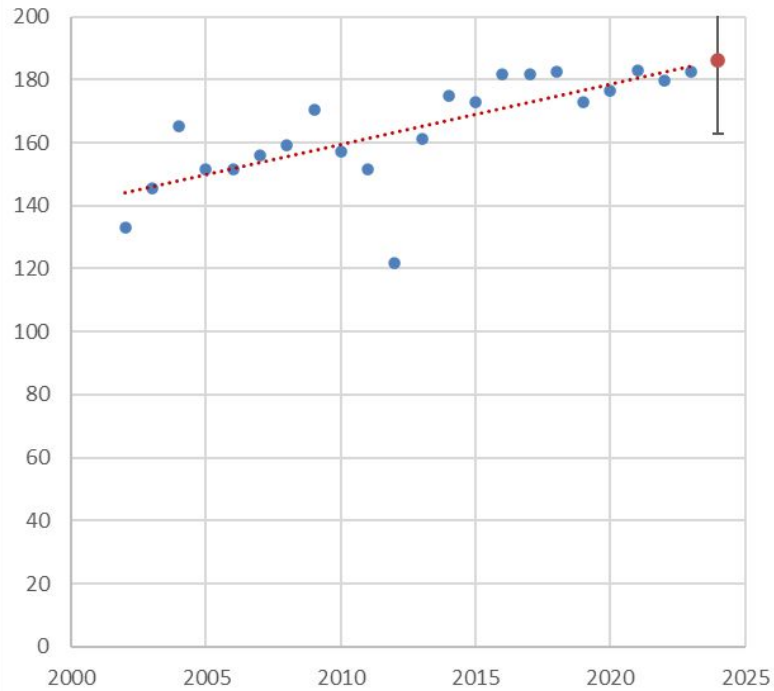
50% NIR 5% Red NDVI = 0.72
40% NIR 30% Red NDVI = 0.14

-1 -0 0 -0.33 0.33-0.66 0.66+

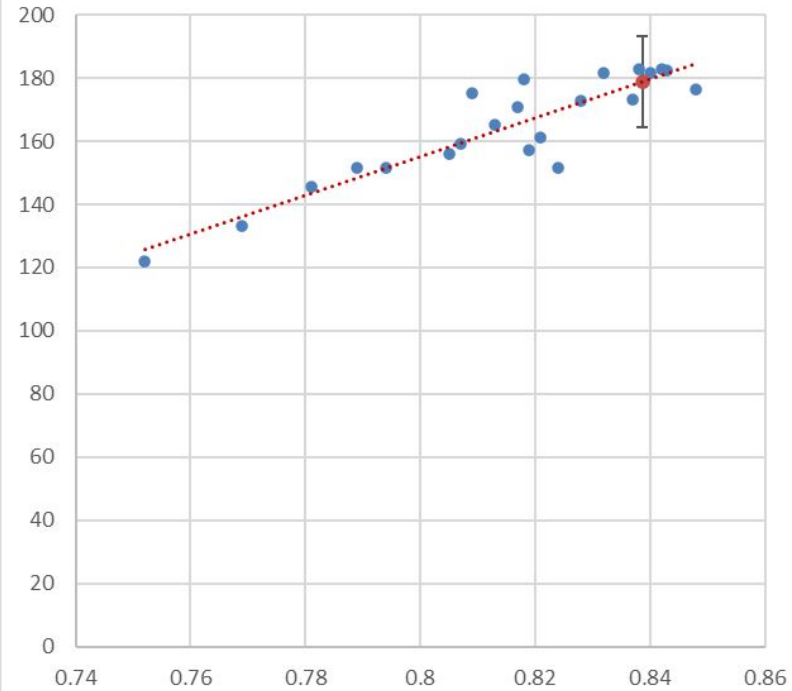
Shrub and grasslands Desert forest Maximum density



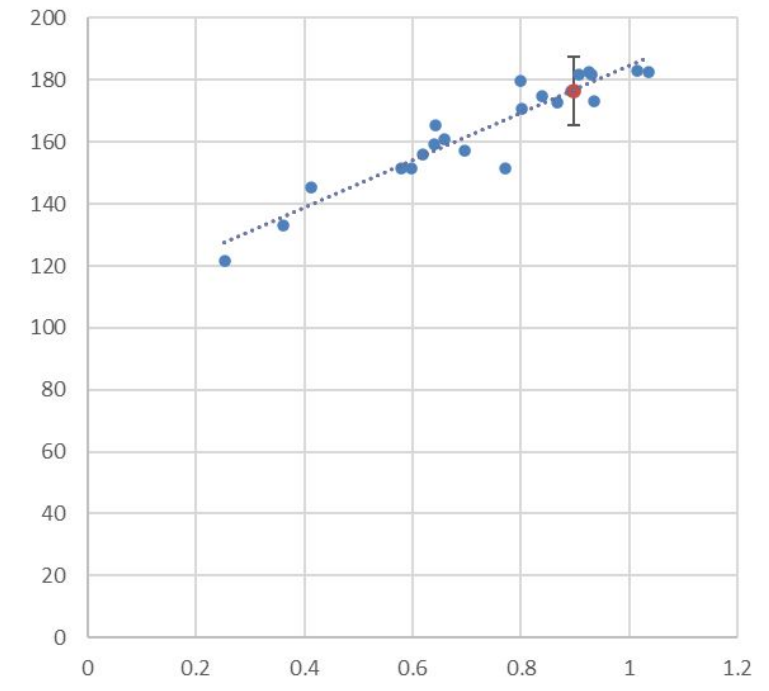
Trend



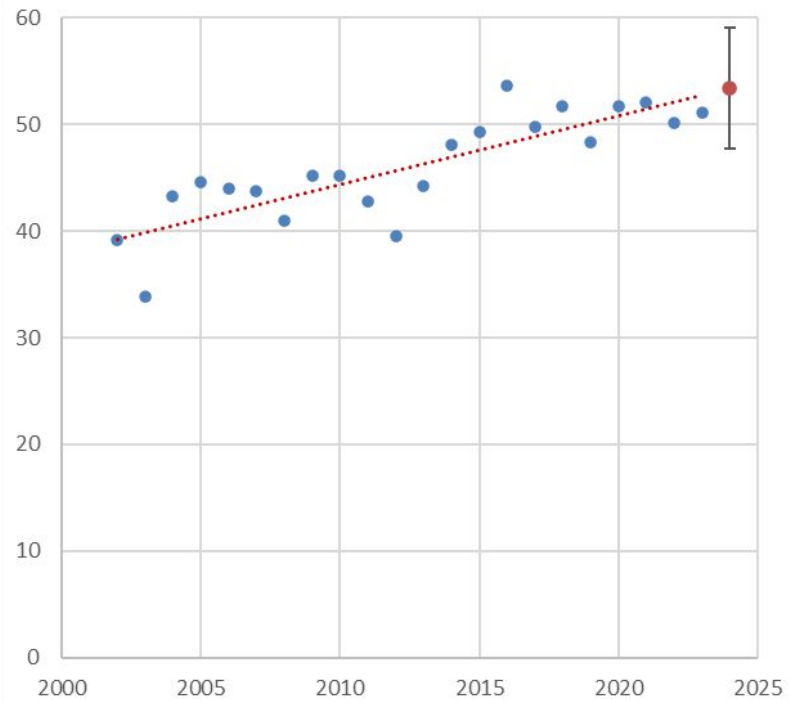
Max NDVI



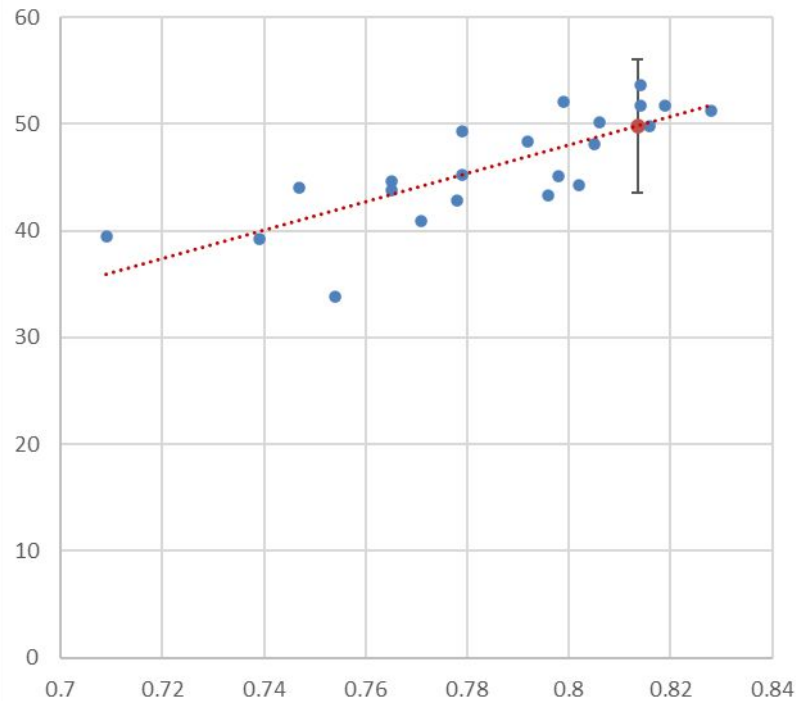
Integrate NDVI



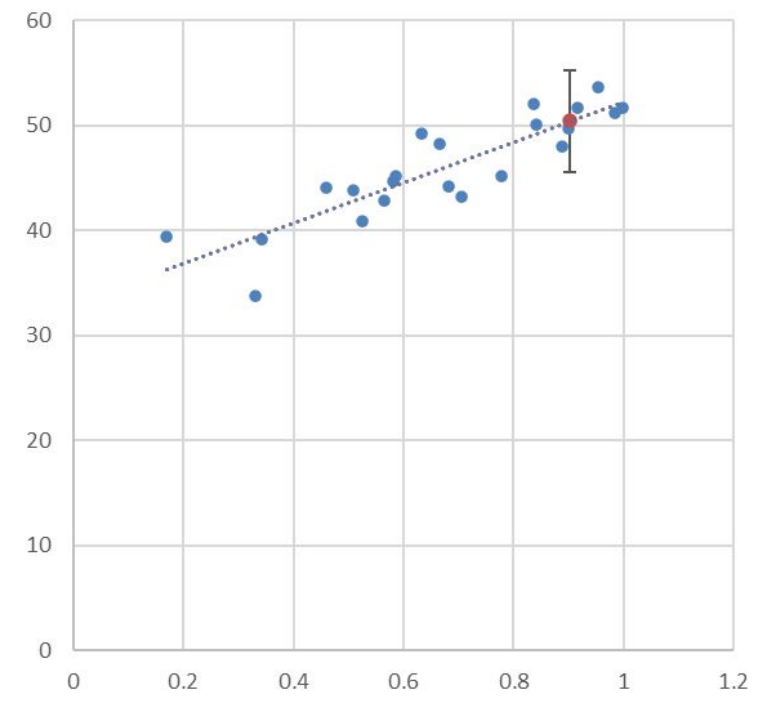
Trend



Max NDVI

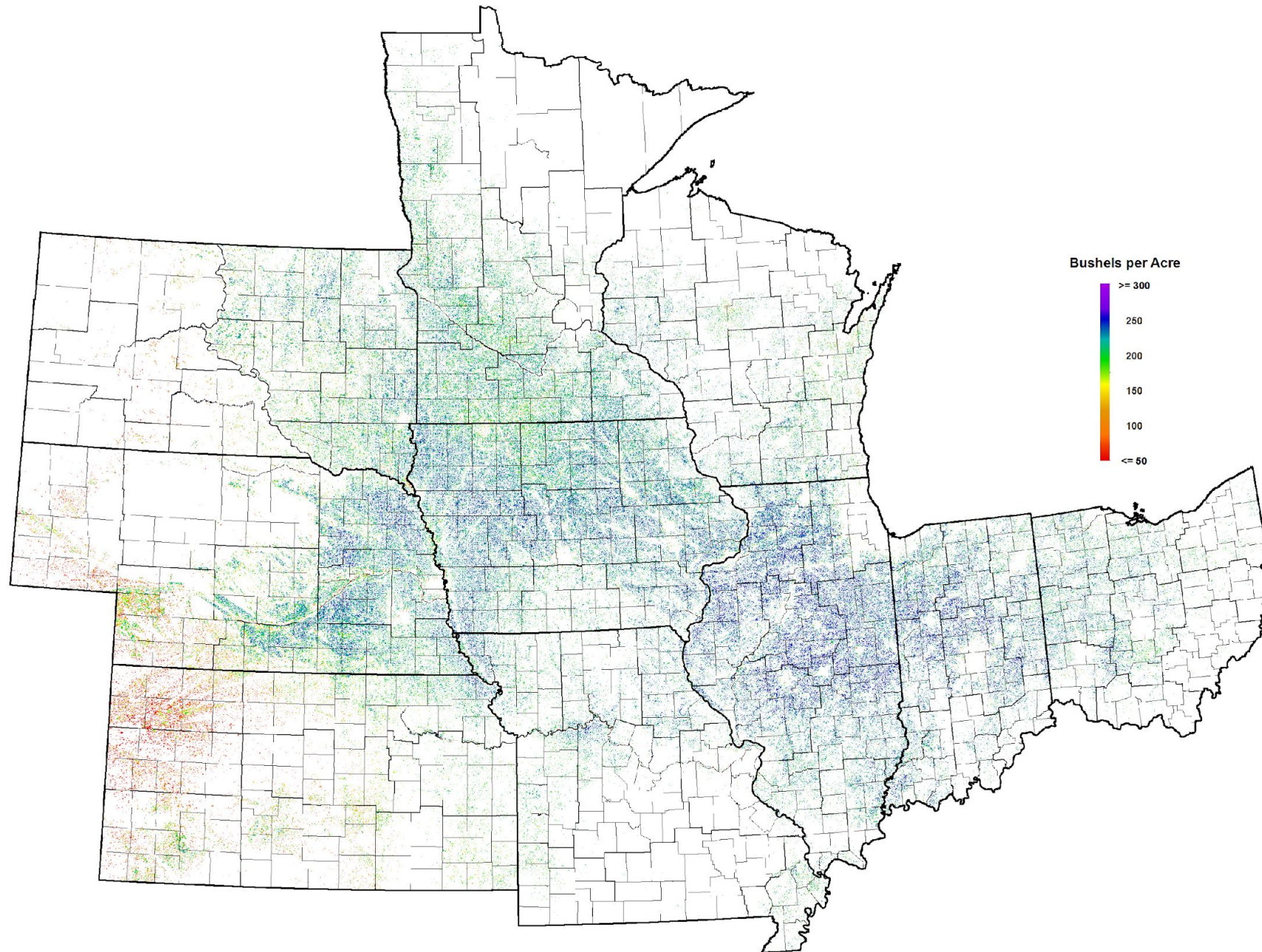


Integrate NDVI

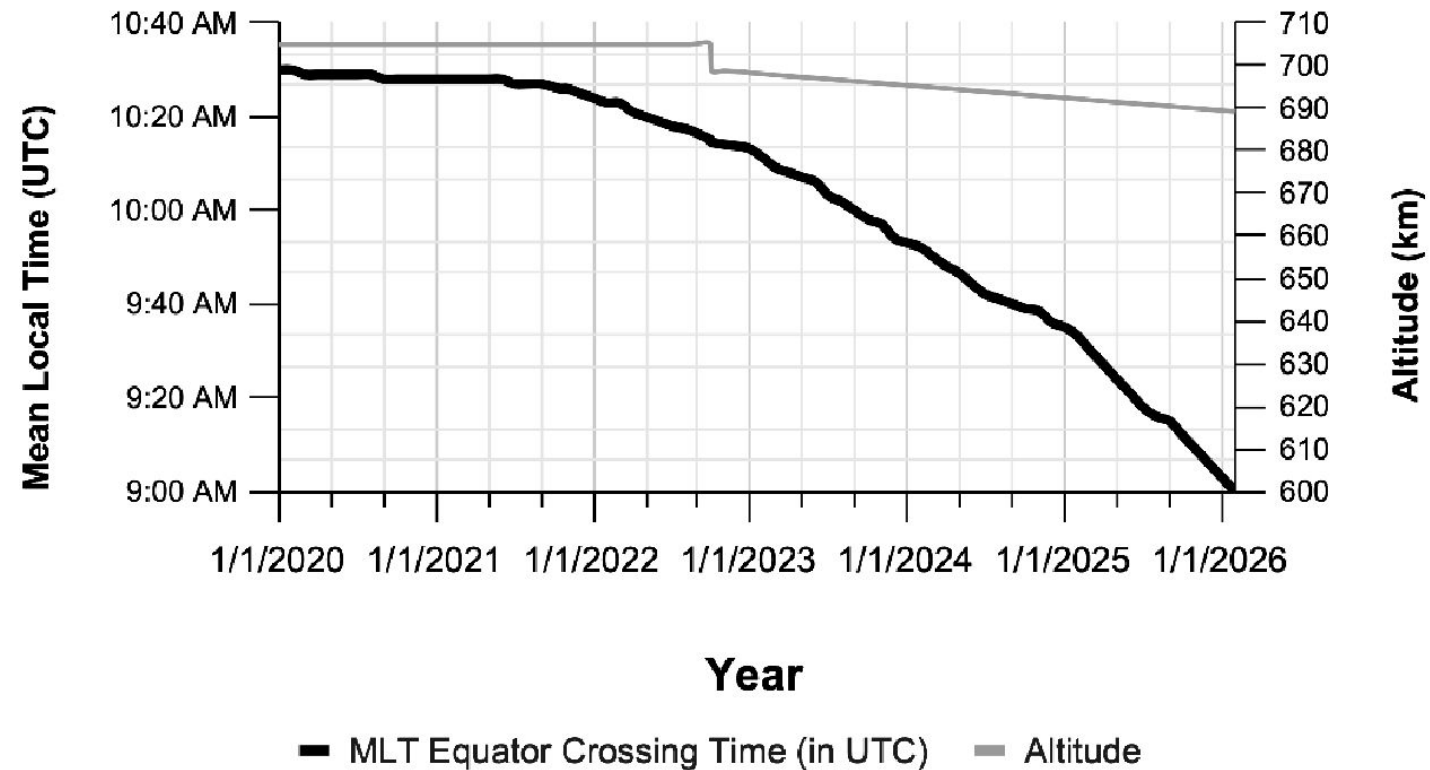


MODIS-based 2024 corn yield map

10

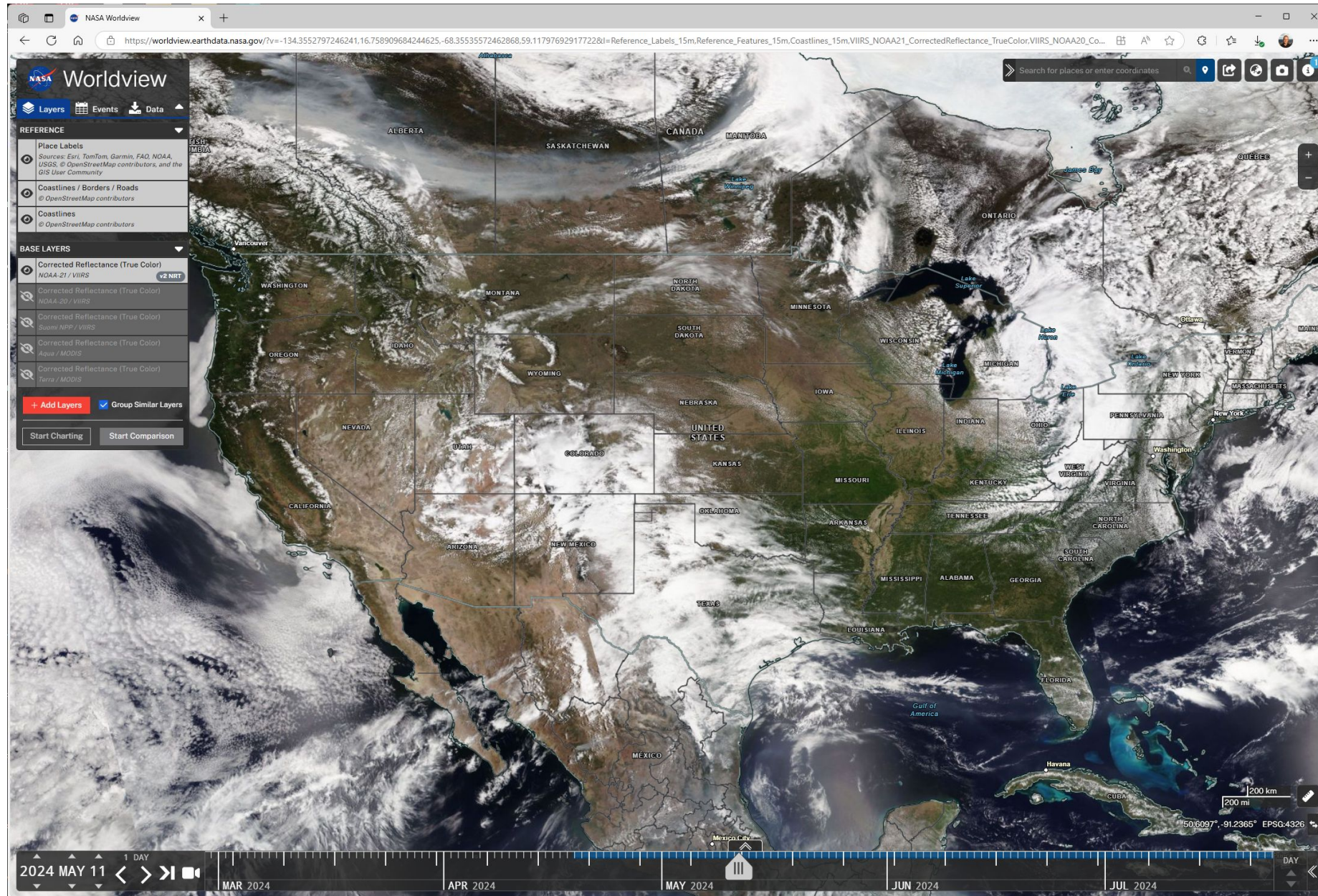


Estimated Future Changes to Terra's Equator Crossing Time and Altitude



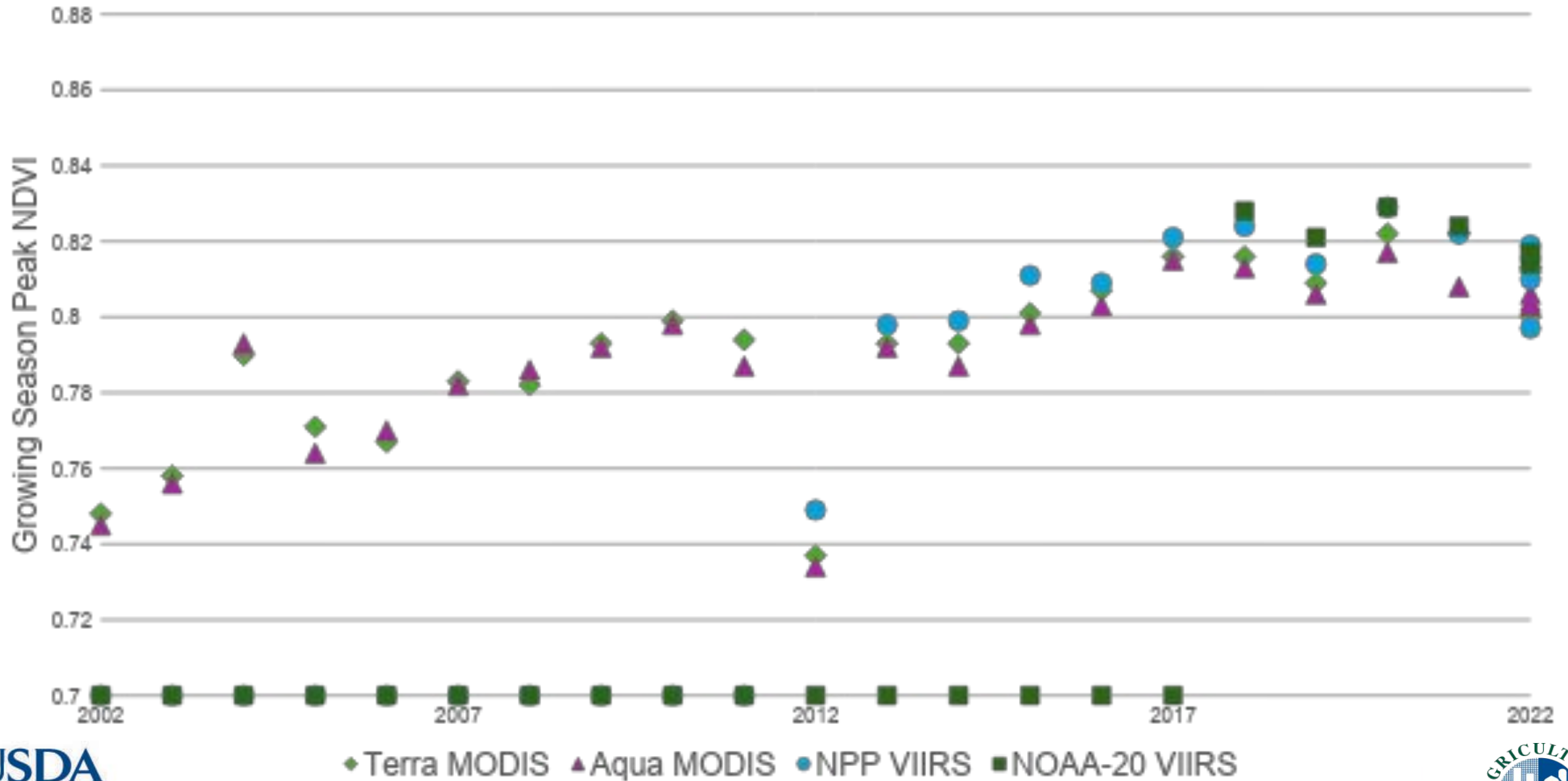
Daily observations from NOAA-21 VIIRS

12



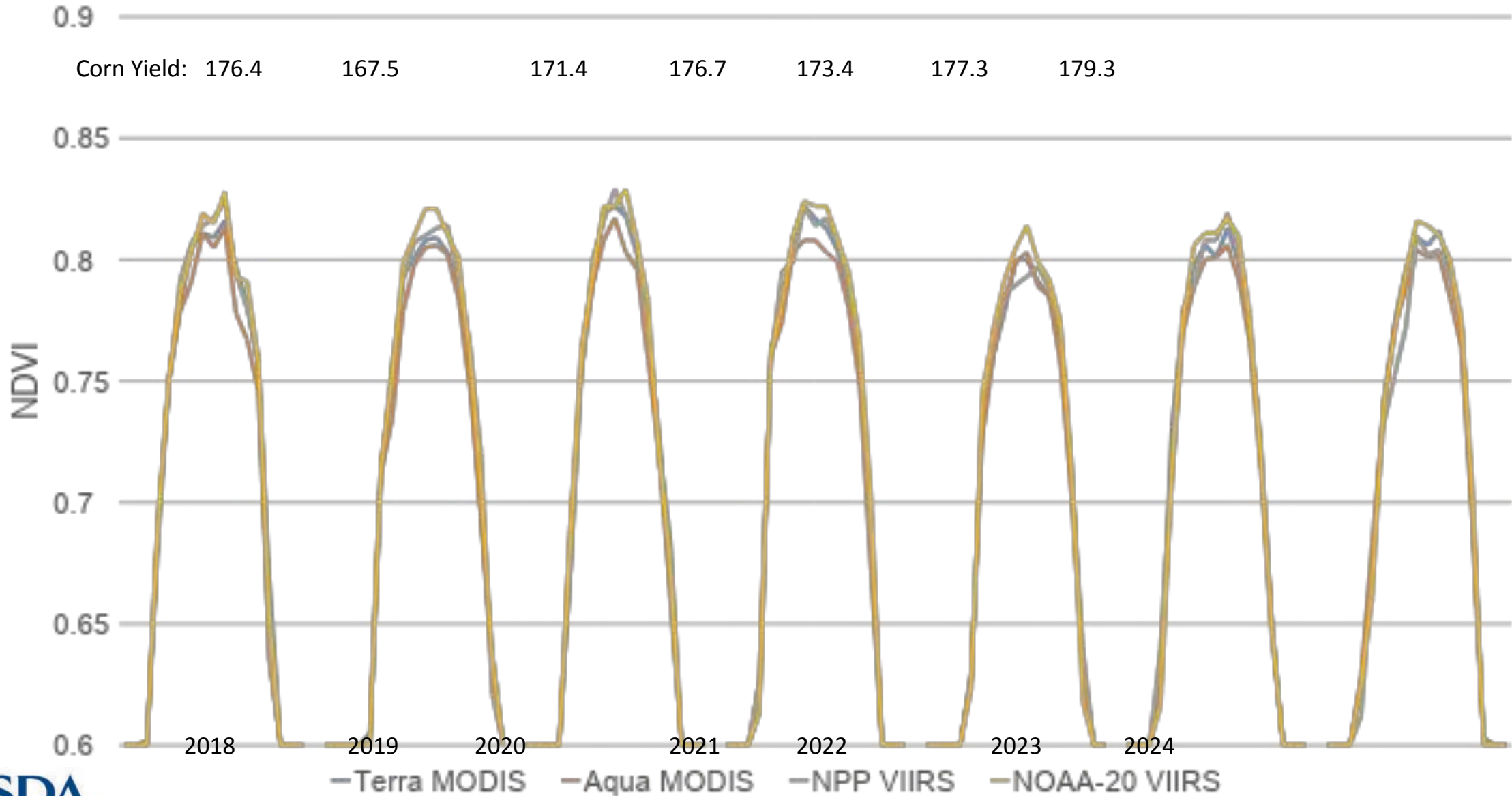
Seasonal peak NDVI of MODIS vs VIIRS (over US Corn Belt)

13



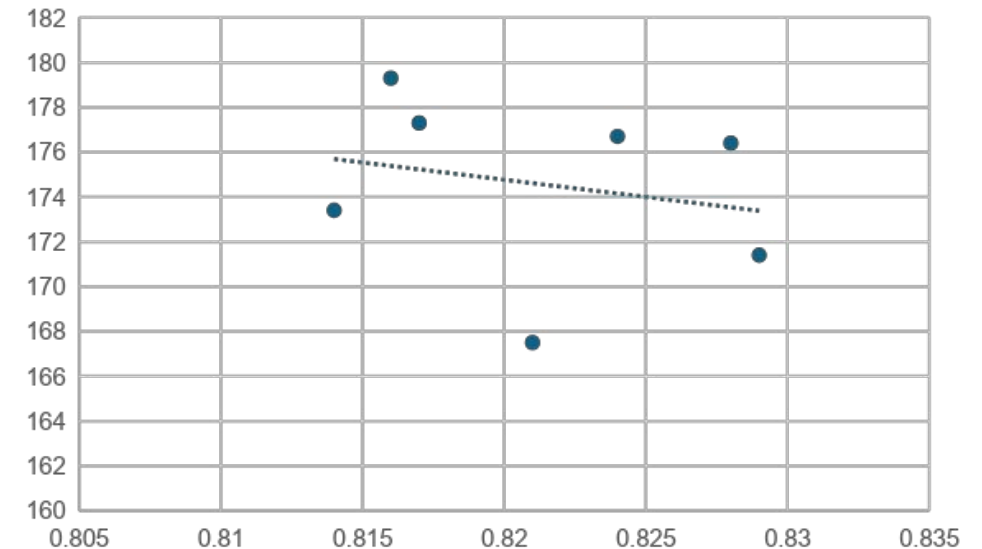
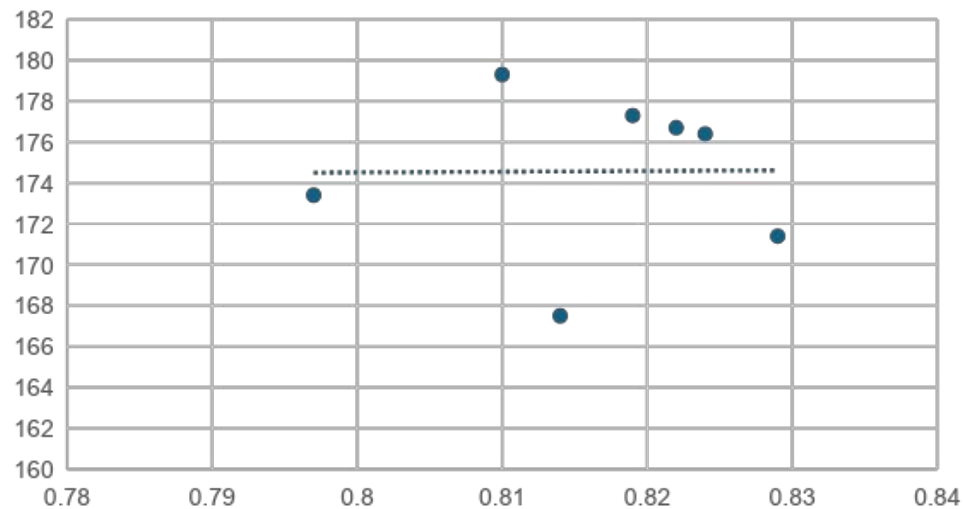
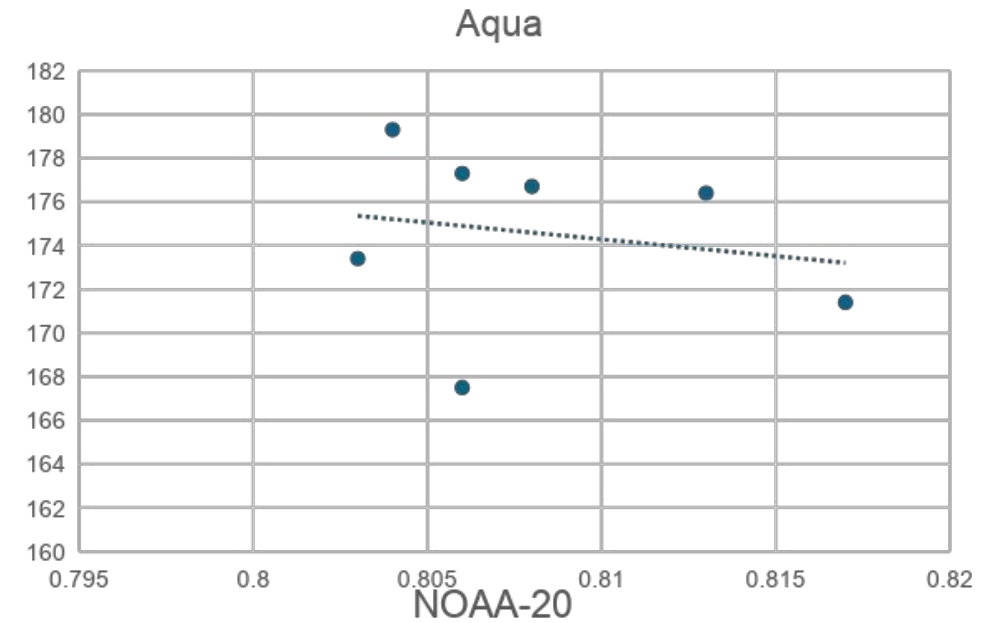
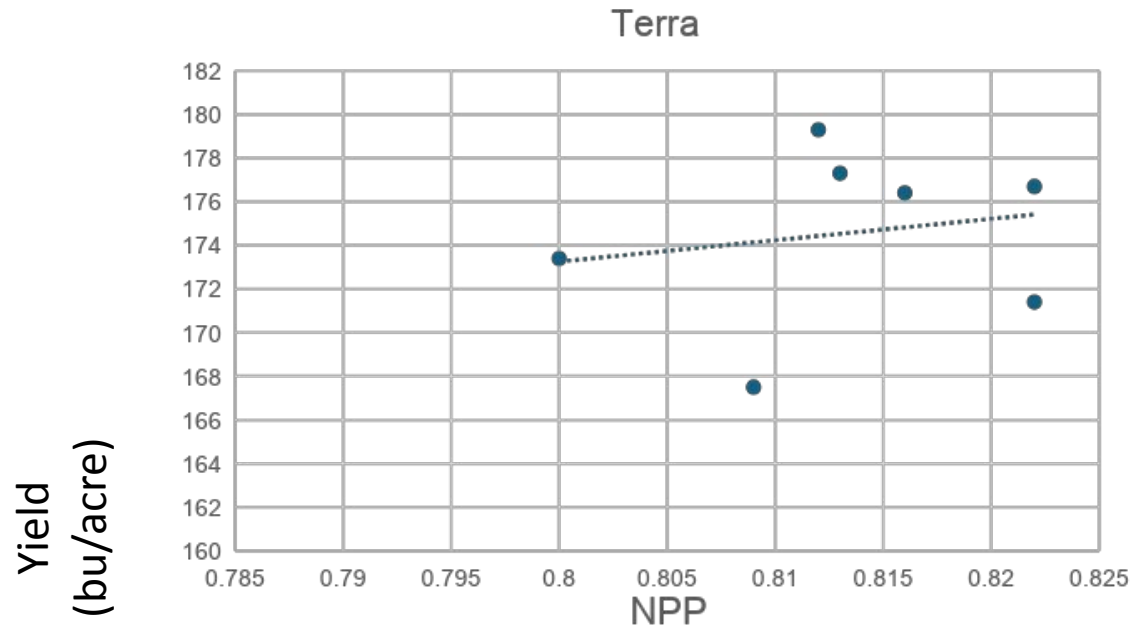
8-day NDVI time series comparison (over Corn Belt)

14

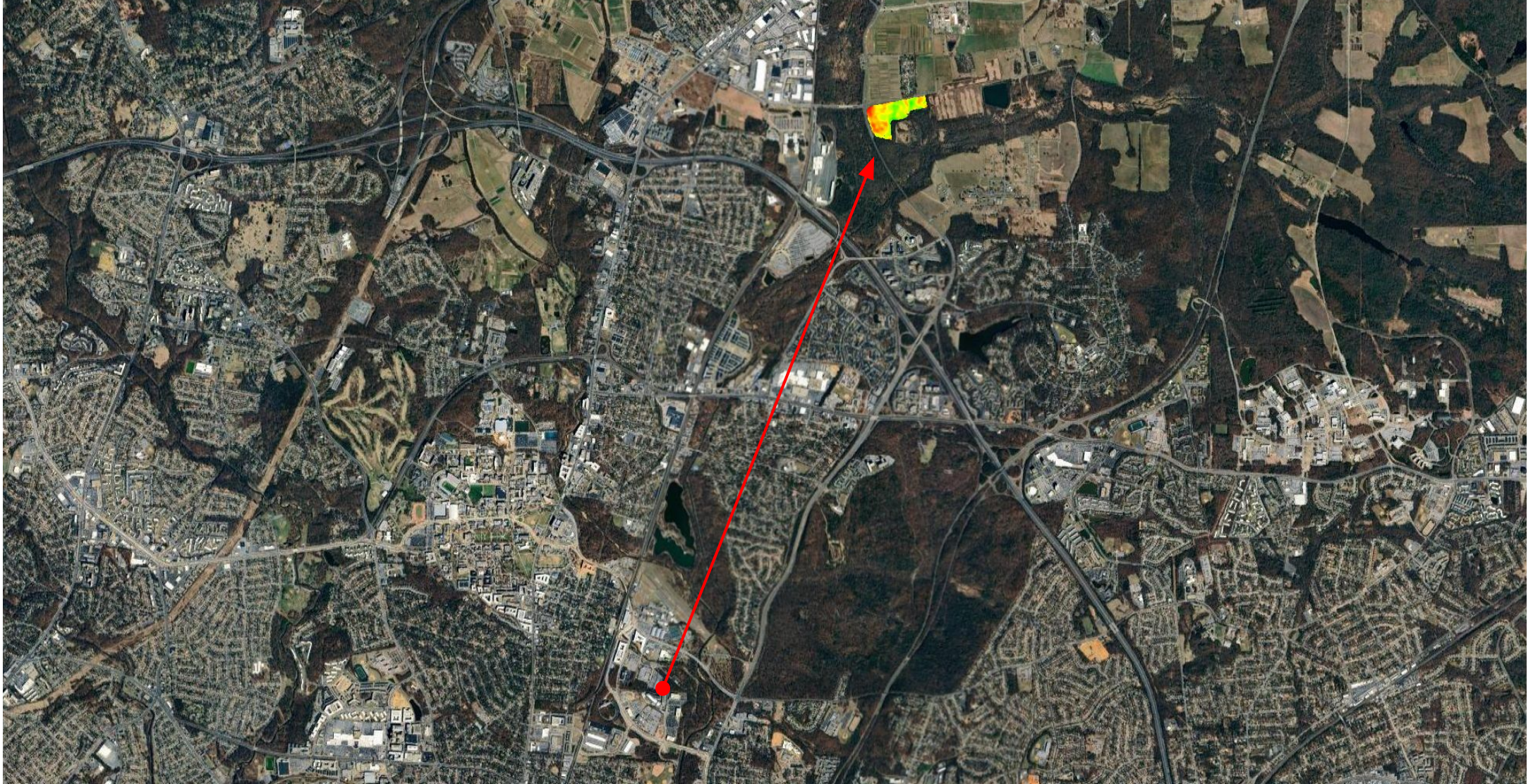


2018 - 2024 NDVI vs Corn Yield by sensor

15

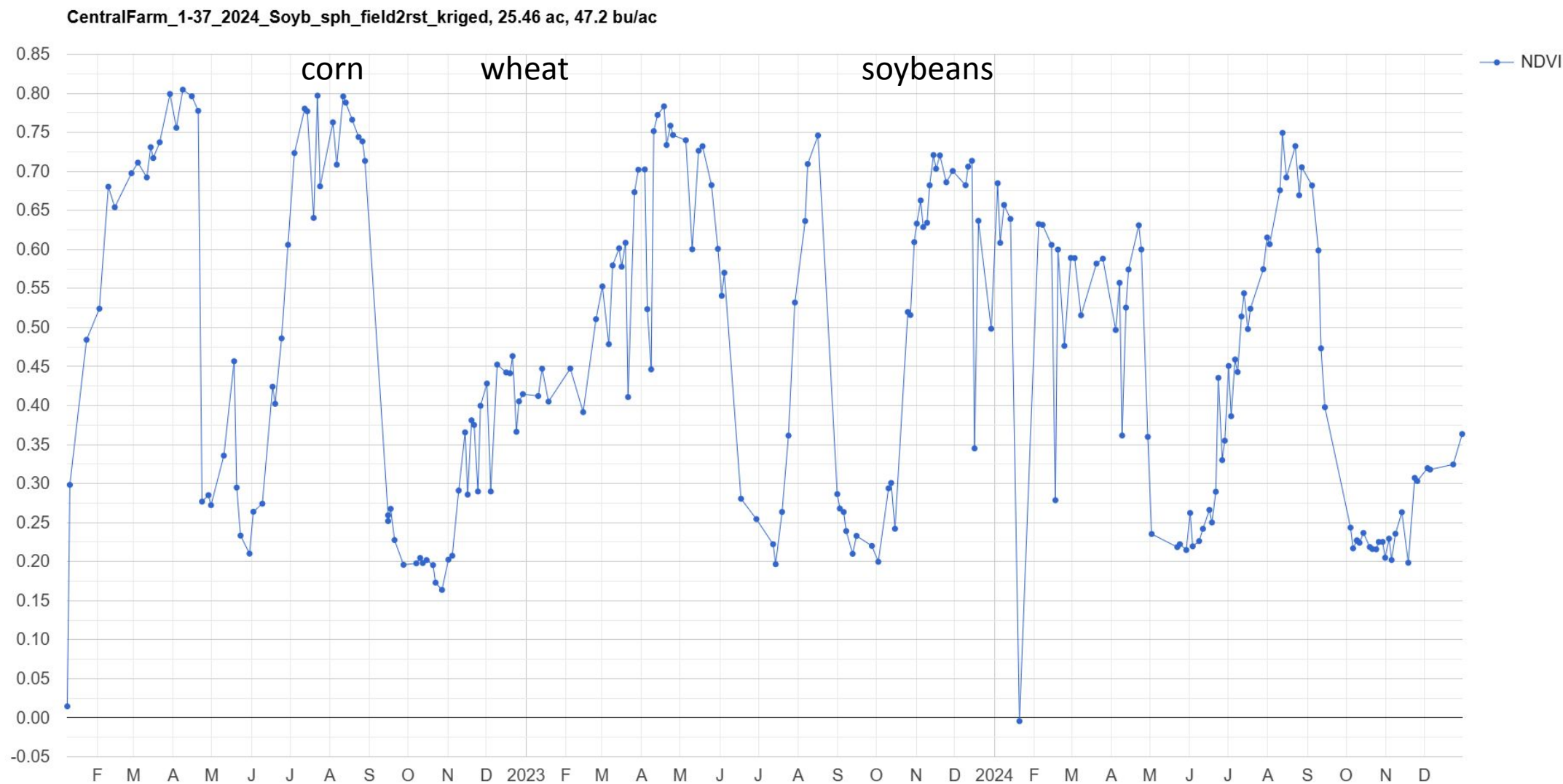


USDA Beltsville Agricultural Research Center (BARC) - Field #37 ¹⁶



Sentinel-2 10m 3-year NDVI time series over Field #37

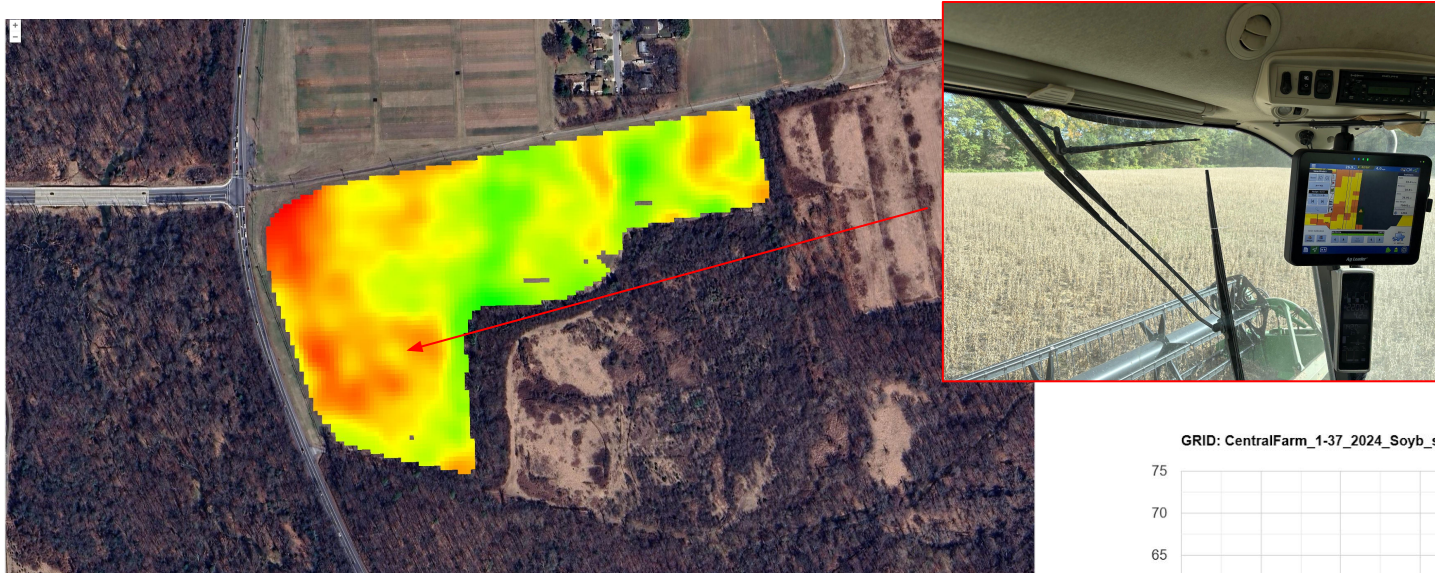
17



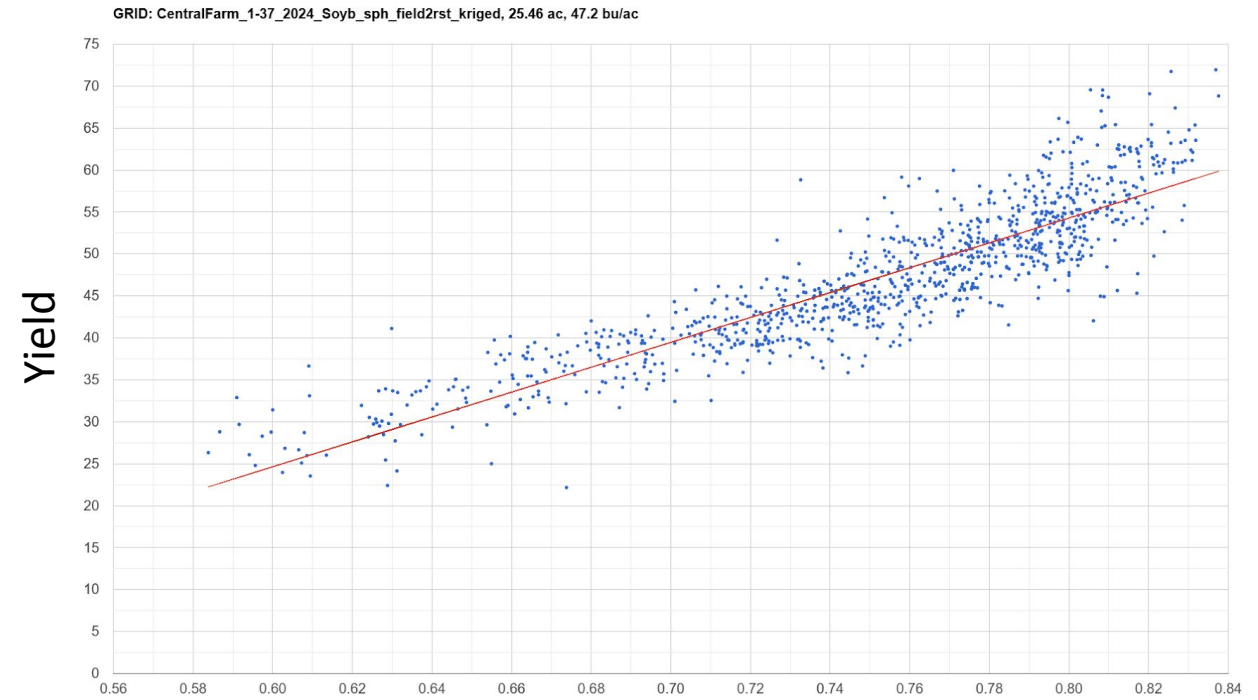
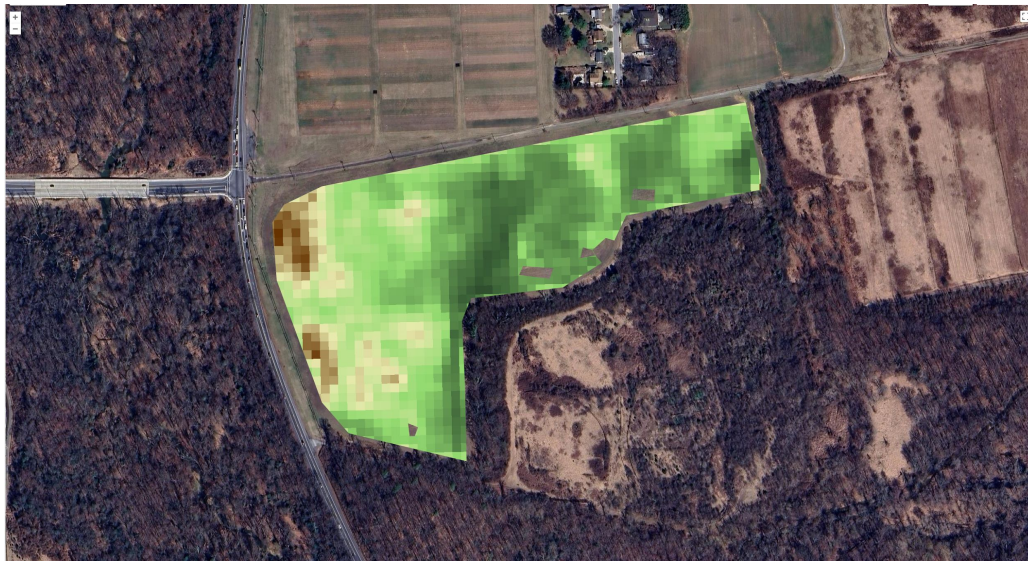
BARC soybean field #37, 2024

18

Yield



NDVI



NDVI

BARC soybean field #37, 2017

19

Yield

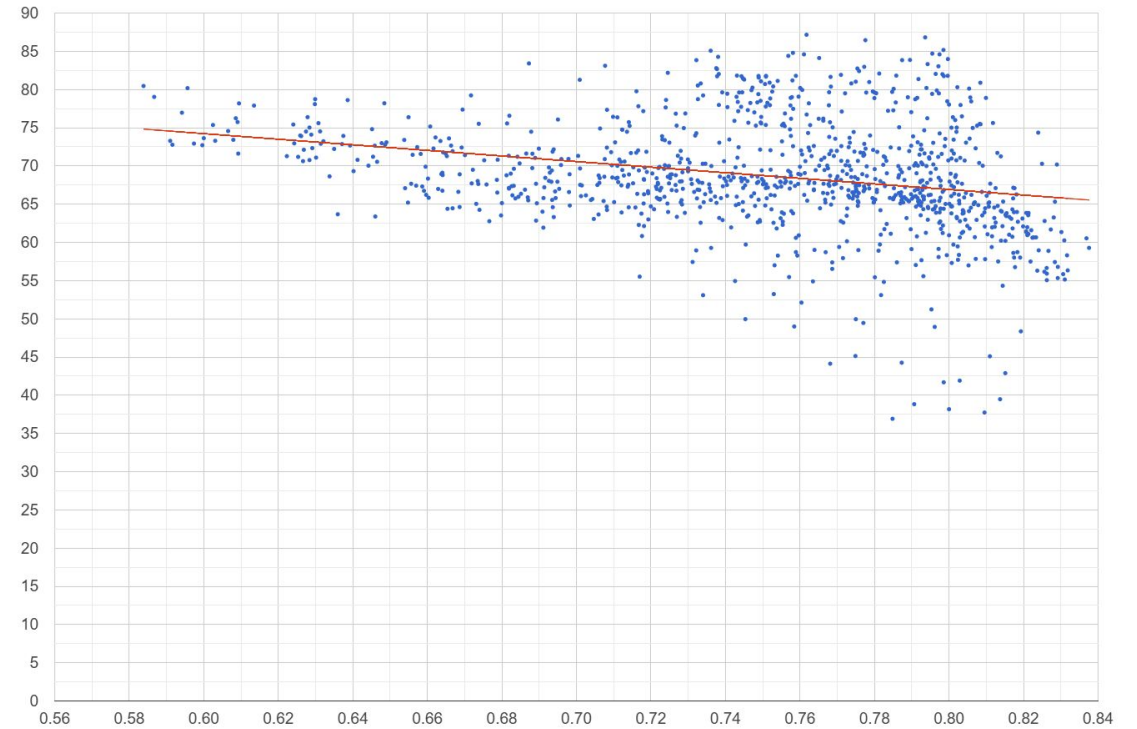


NDVI



GRID: CentralFarm_1-37_2017_SOYB_sph_field2rst_kriged, 25.41 ac, 68.3 bu/ac

Yield

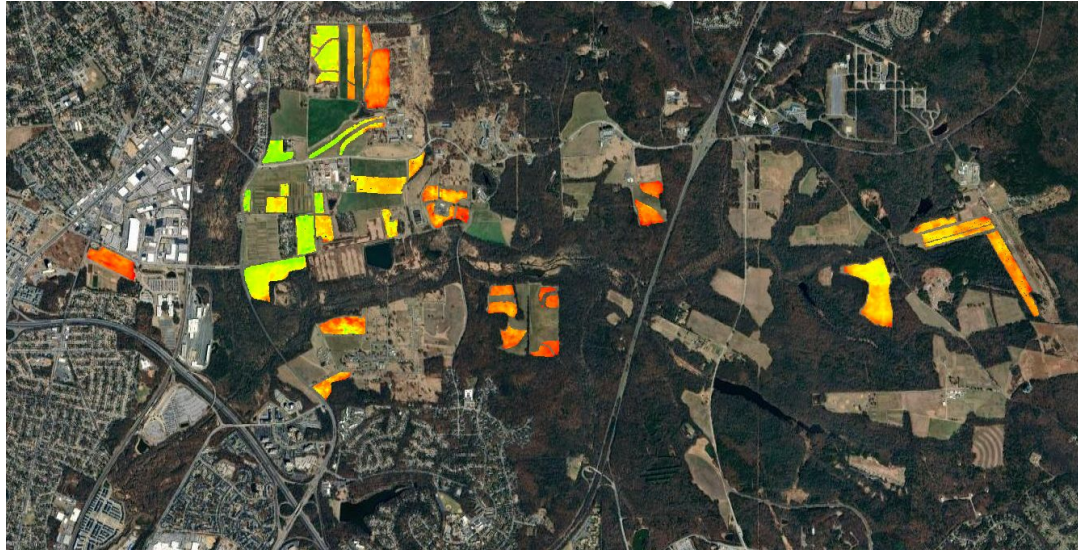


NDVI

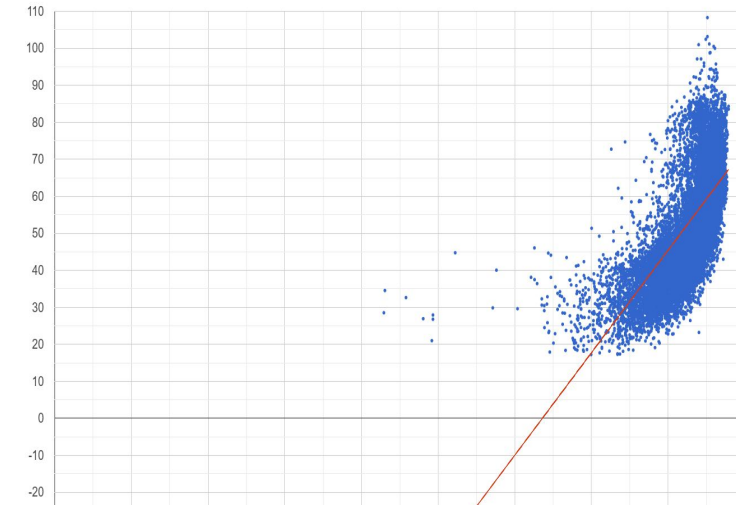
All BARC Soybeans fields combined

20

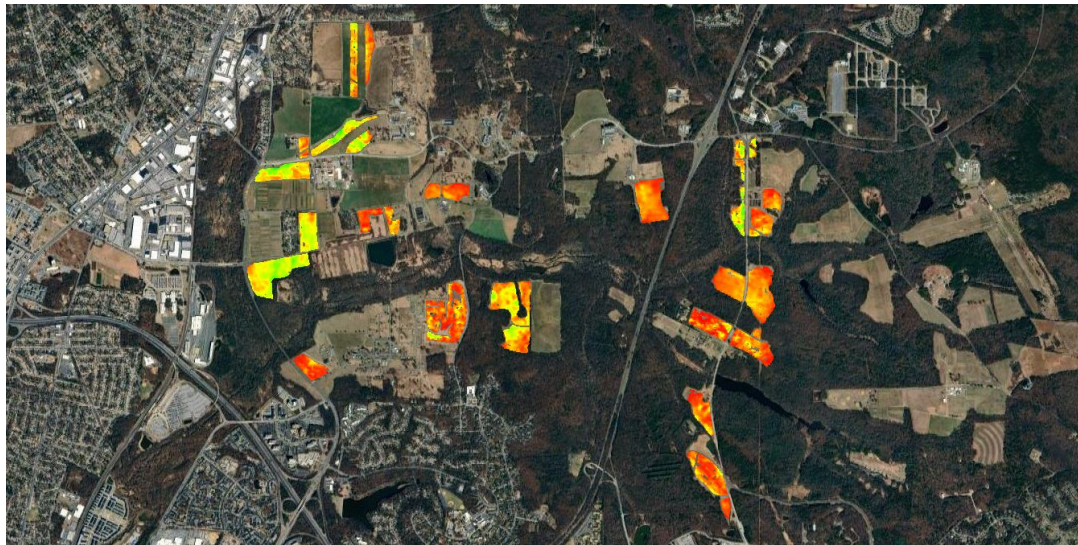
2017



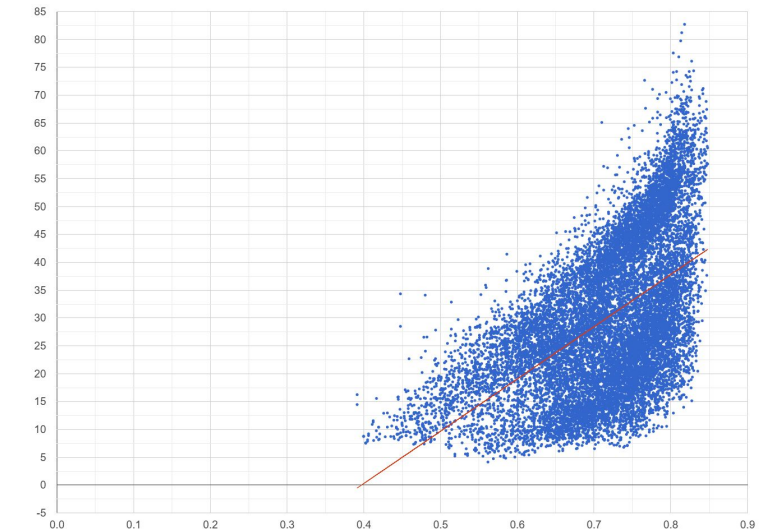
GRID: All BARC soybeans 2017, 302.15 ac, 52 bu/ac



2024



GRID: All BARC soybeans 2024, 290.43 ac, 29.5 bu/ac

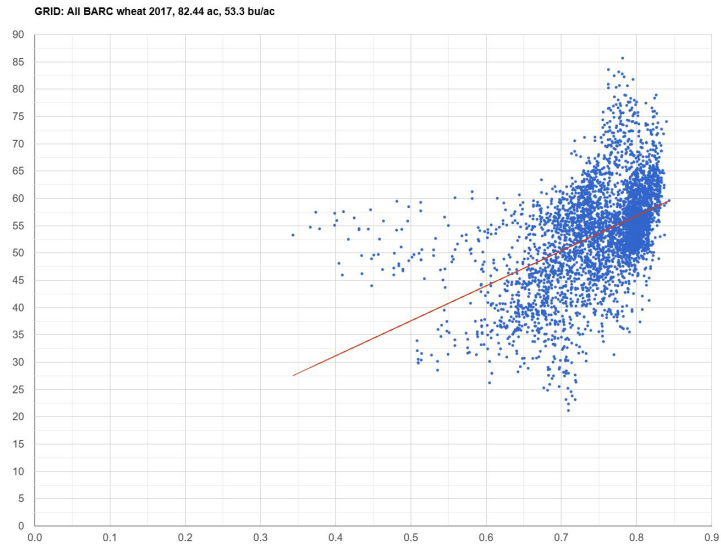


All BARC Wheat and Corn

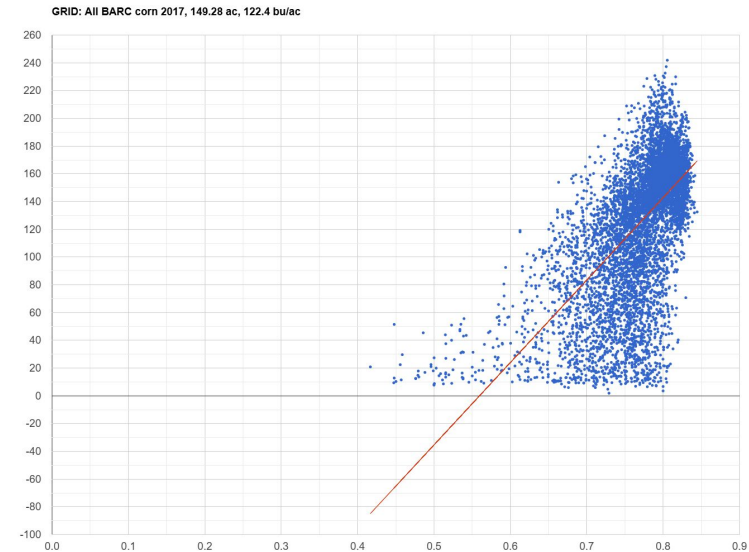
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2017

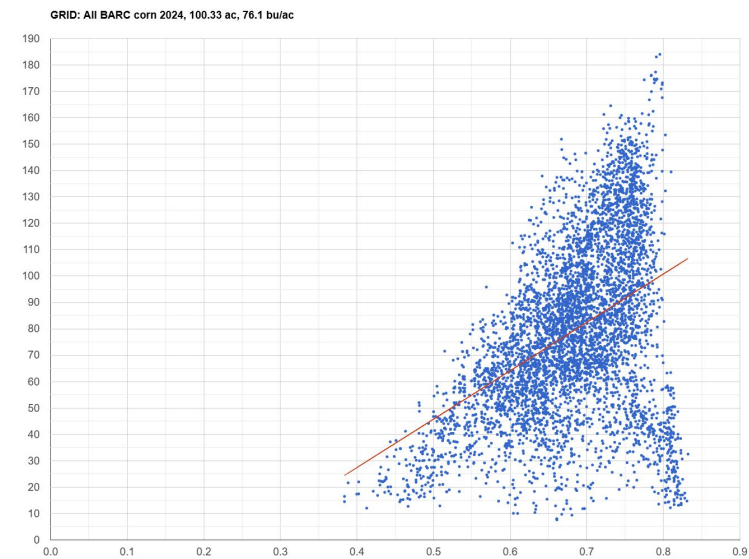
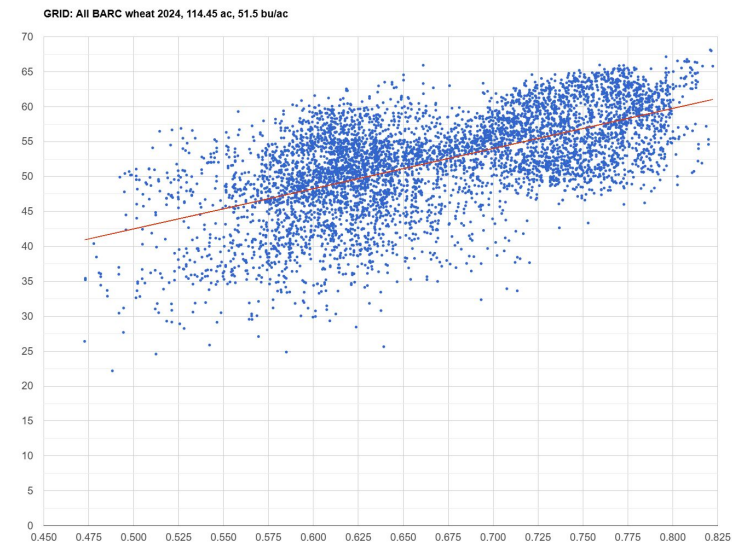
wheat



corn



2024



Peak NDVI

Peak NDVI



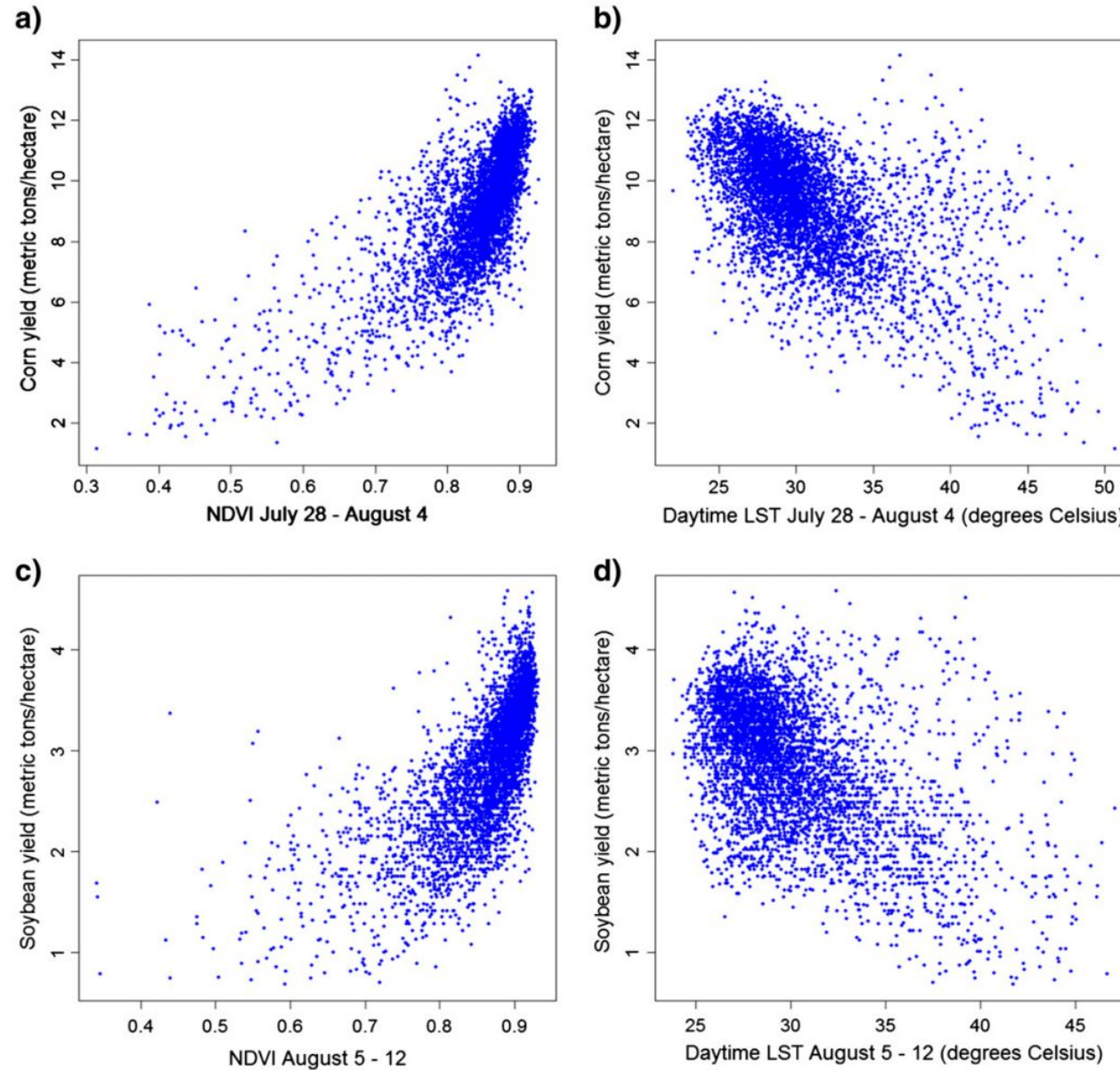
Is any of this new?

22

D.M. Johnson / Remote Sensing of Environment 141 (2014) 116–128

Normalized
Difference
Vegetation
Index

Land
Surface
Temperature!!!





Terra and Aqua MODIS truly at end of life and drifting out of proper orbit

- but MODIS-like imagery is already available via VIIRS
- Contemporary NDVI-based crop yield models are struggling
- must look beyond the red and near-infrared reflectance channels
 - need to reinvigorate research leveraging thermal data

VIIRS offers opportunities

- thermal bands at 750m instead of MODIS's 1km
- complete daily global coverage

GEO-XO will offer additional opportunities

- products must be
 - generated consistently
 - ready-to-use and easy-to-use
 - available with low latency