

2024 Australian Agronomy Conference

Optimising Rice Crop Management: Harnessing Near-Real Time Growth Curves

2024-10-23

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Mark Groat
Peter McDonnell



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Primary Industries





Real-time remote-sensing based monitoring for the rice industry

Outputs:

1. detection of water application dates per field
2. phenology dates (PI, flowering)
3. real-time growth curves with benchmarking
4. grain moisture prediction
5. automated rice mapping,
6. yield forecasts,
7. benchmarking of productivity vs crop management

Rice crop monitoring concept

- Near real-time imagery
 - Sentinel-2, < 5 day revisit, 10 bands with 10-20m resolution



European Space Agency, 2015

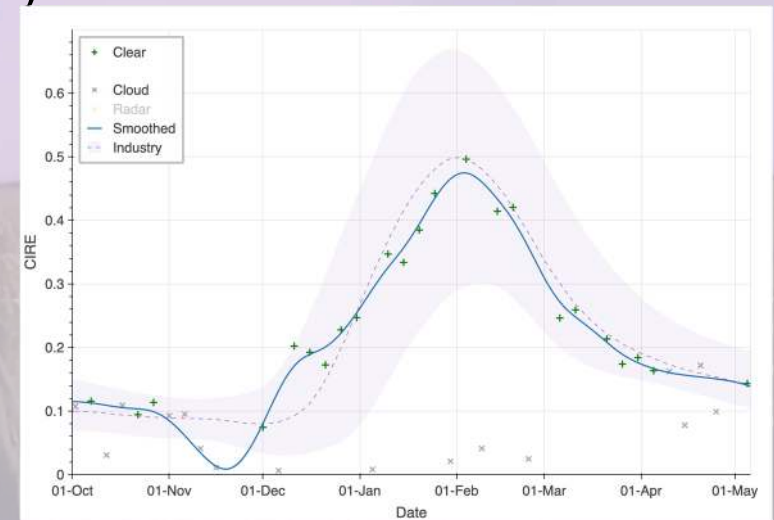
Rice crop monitoring concept

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- Vegetation indices sensitive to field management and crop status
 - Biomass (NDVI), water (LSWI), nitrogen (CIRE)



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- Growth curves
 - Time-series of VIs for each paddock
 - Benchmarked against industry averages




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- Growth curves
 - Time-series of VIs for each paddock
 - Benchmarked against industry averages
- Challenges
 - Diversity of planting dates, temperatures, varieties
 - Cloud
 - Atmospheric effects, satellite angles and differences

Example: 2022 rice

Growth curves Zones **Map** Phenology Summary About

Earth Engine Apps



Layers Map Satellite

NDVI @ 10-Jan.

Zones

1	2	3	4	5
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Pixels Show

0.2	0.6	1
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[Download geojson](#)

Updated: 30-Aug-24

Year: 2022

Farm:

Paddock: B12 : V071 [1]

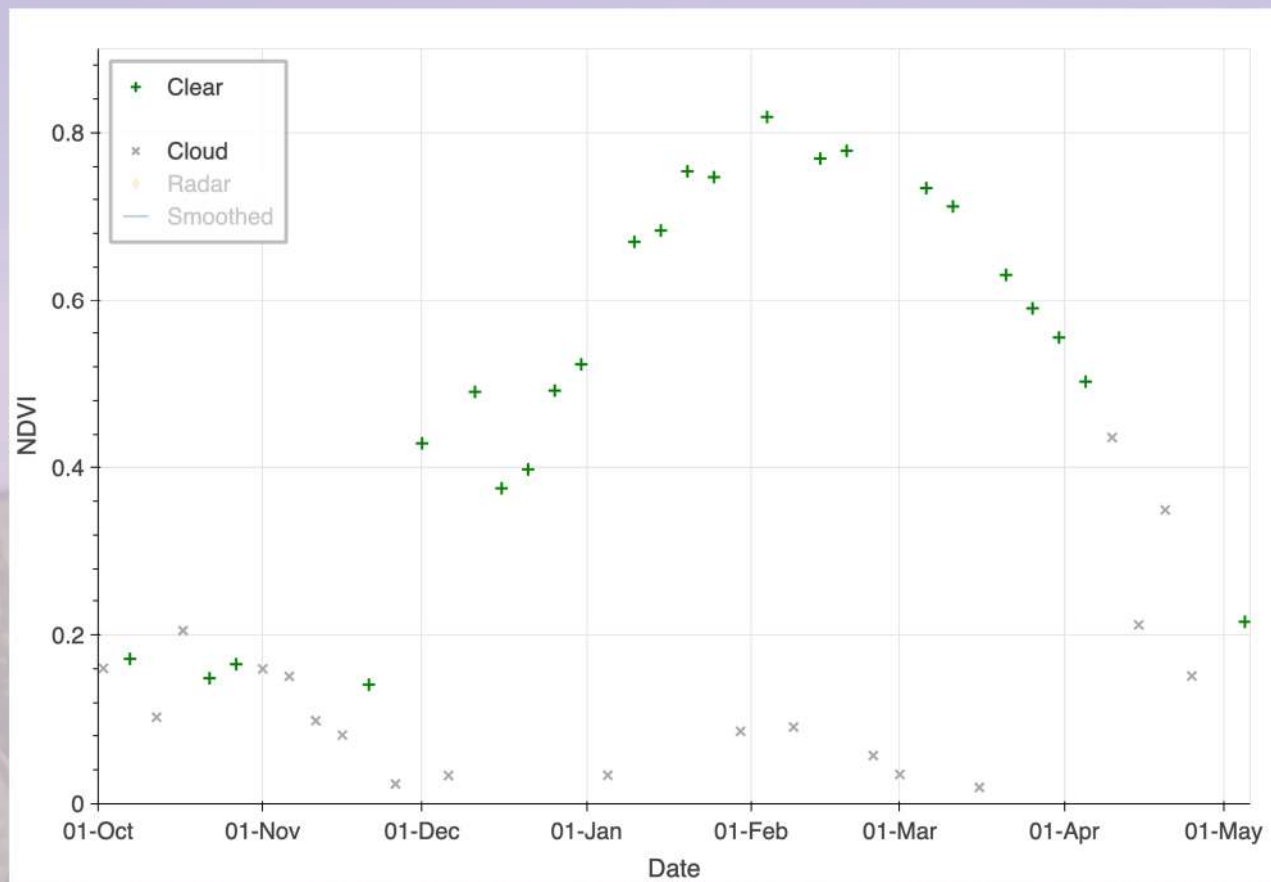
Index: NDVI

Date: 10-Jan +

Date DAFL

Google Keyboard shortcuts Imagery ©2024 Airbus, CNES / Airbus, Maxar Technologies 100 m Terms Report a map error

NDVI time series

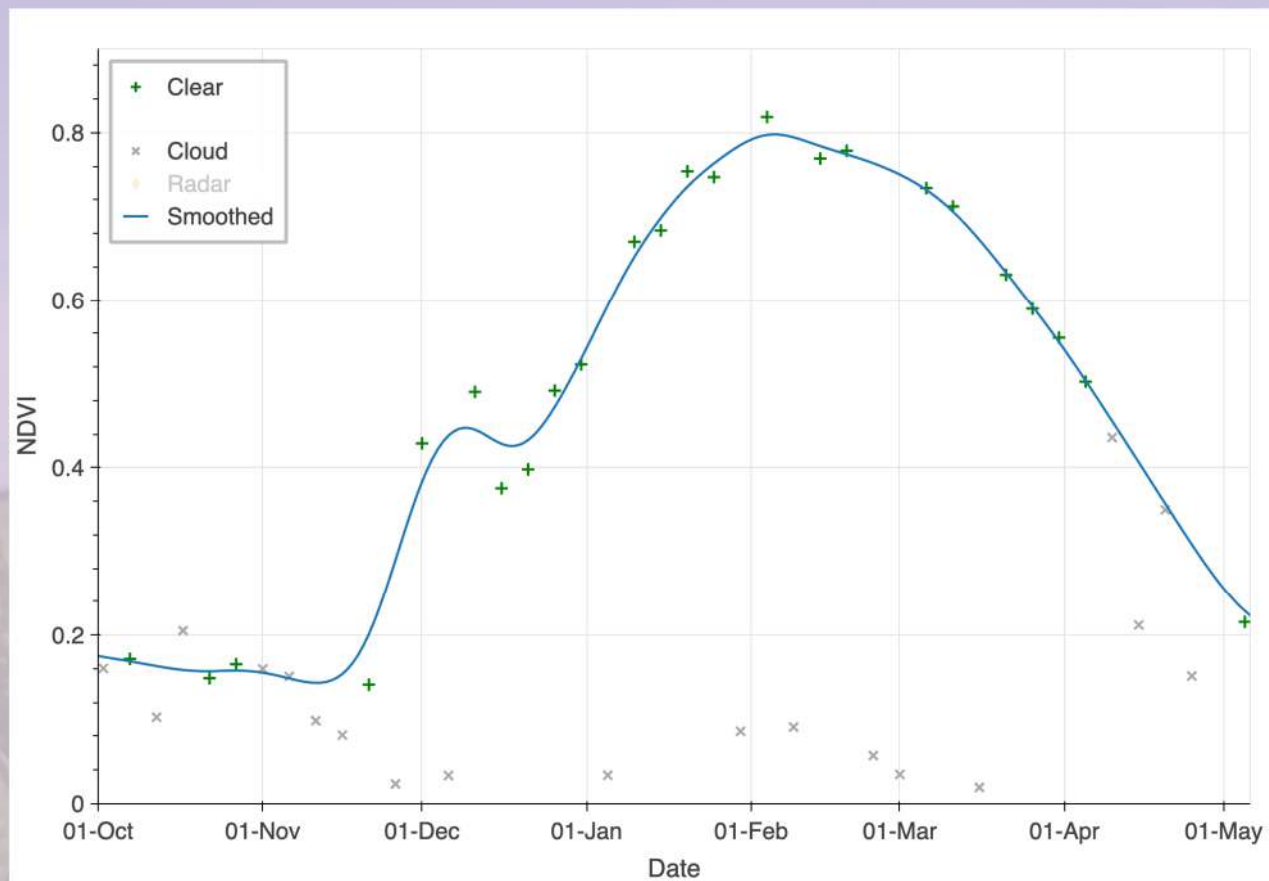


$$NDVI = \frac{(NIR - R)}{(NIR + R)}$$

Raw observations

- Cloud
- Noise

NDVI time series

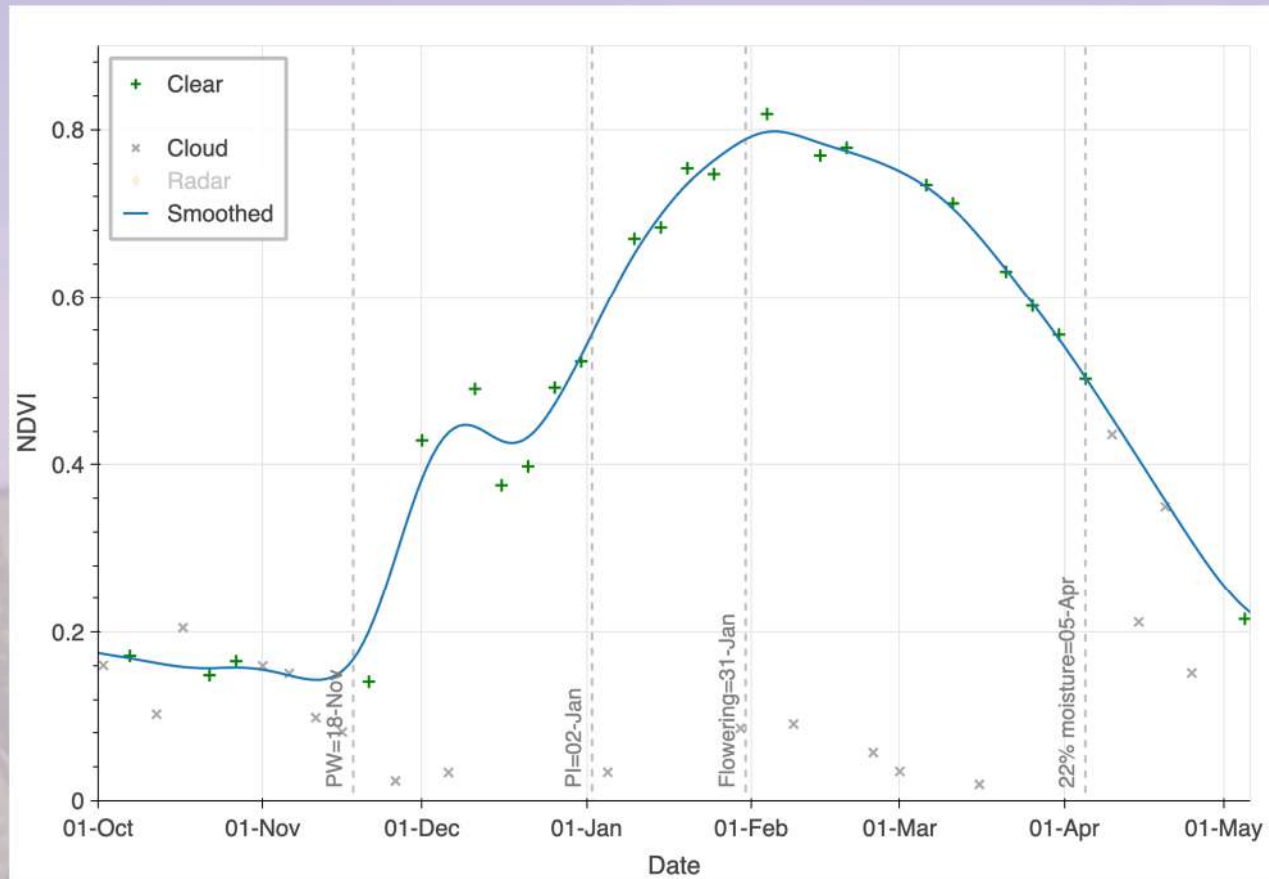


Filter cloudy images

Smooth

- Whittaker, better for real-time than Savitzky-Golay

NDVI time series



Rice predictive models

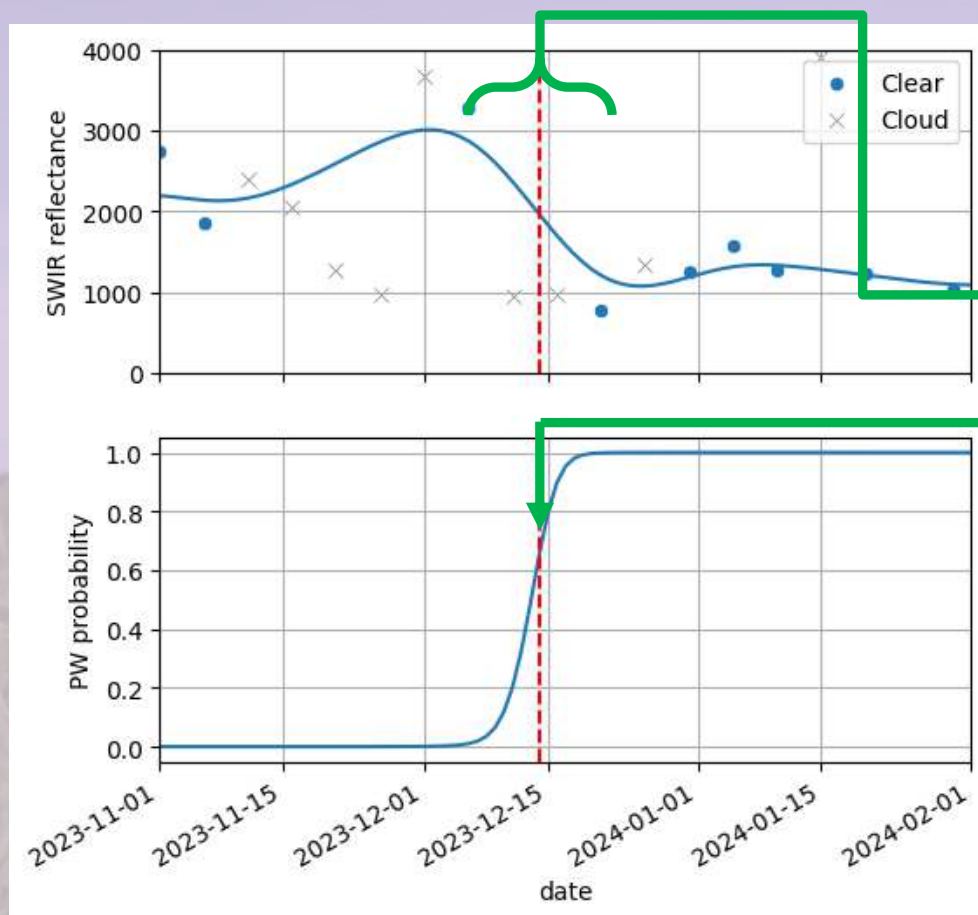
- Permanent water (flooding)
- Panicle initiation
- Flowering
- Grain moisture (22% best harvest date)

PW (ponding) detection



Rice ponding date detection in Australia using Sentinel-2 and Planet Fusion imagery

James Brinkhoff^a, Rasmus Houborg^b, Brian W. Dunn^c

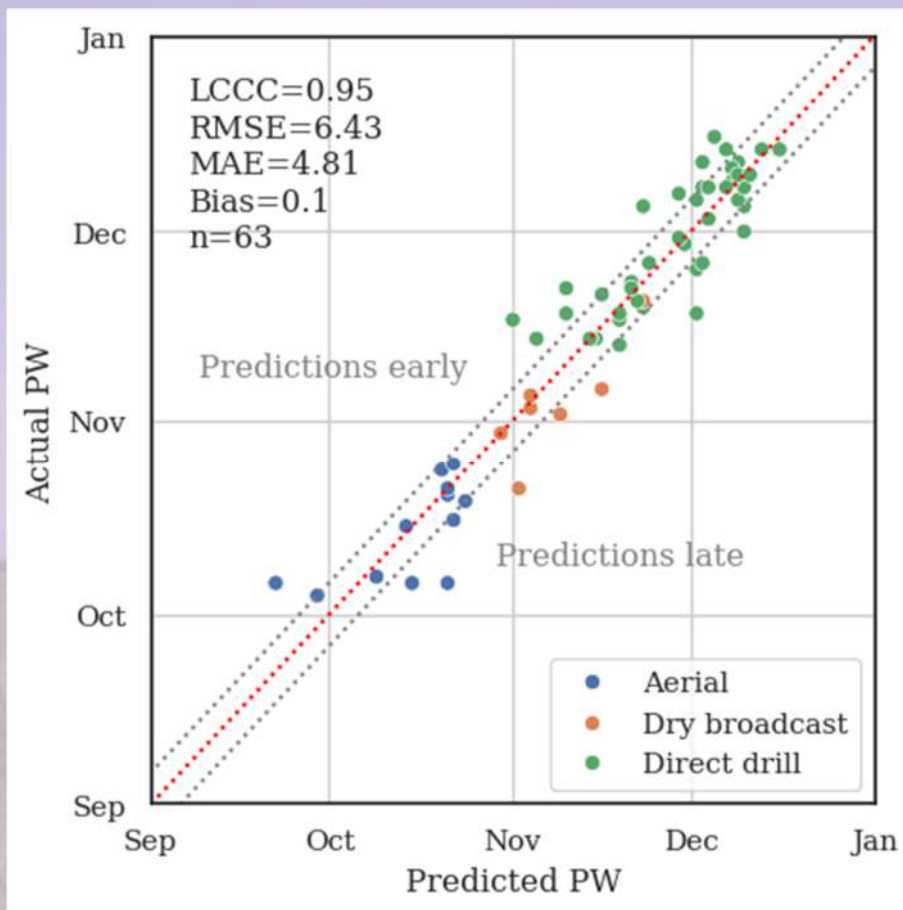


ML PW model

Takes time window of Sentinel-2 observations.

Estimates probability of PW at each date.

PW (ponding) detection (2024 val)



4.8 days MAE

Predicting rice phenology and optimal sowing dates in temperate regions using machine learning

James Brinkhoff¹ | Sharon L. McGavin¹ | Tina Dunn² | Brian W. Dunn²

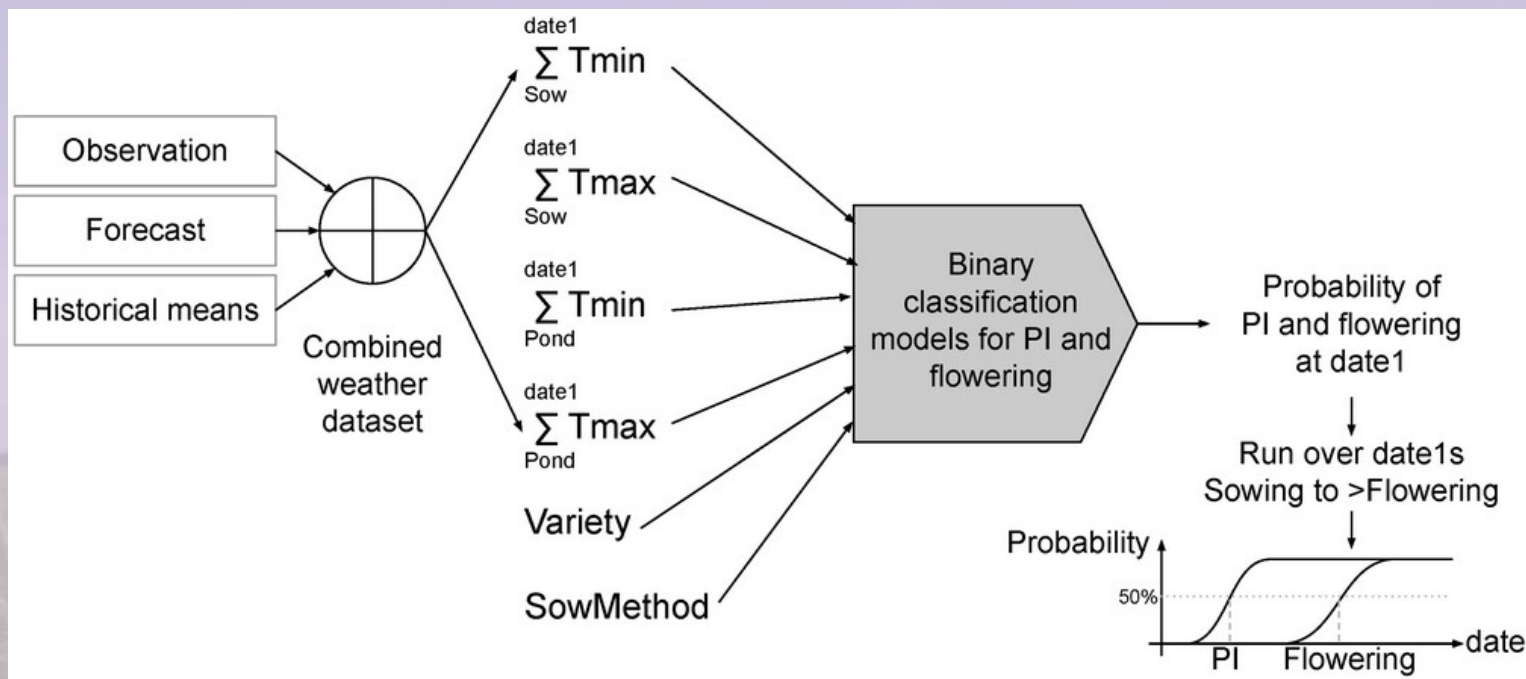
¹Applied Agricultural Remote Sensing Centre, University of New England, Armidale, NSW, Australia

²New South Wales Department of Primary Industries, NSW, Australia

Abstract

Crop phenology modeling often involves determining variety-specific growing degree day thresholds, or parameterizing mechanistic crop models. In this work, we

Phenology models



Phenology models (2024 val)

Trained using 380 observations from 2013-2023

ORIGINAL ARTICLE

Special Section: Machine Learning in Agriculture

Predicting rice phenology and optimal sowing dates in temperate regions using machine learning

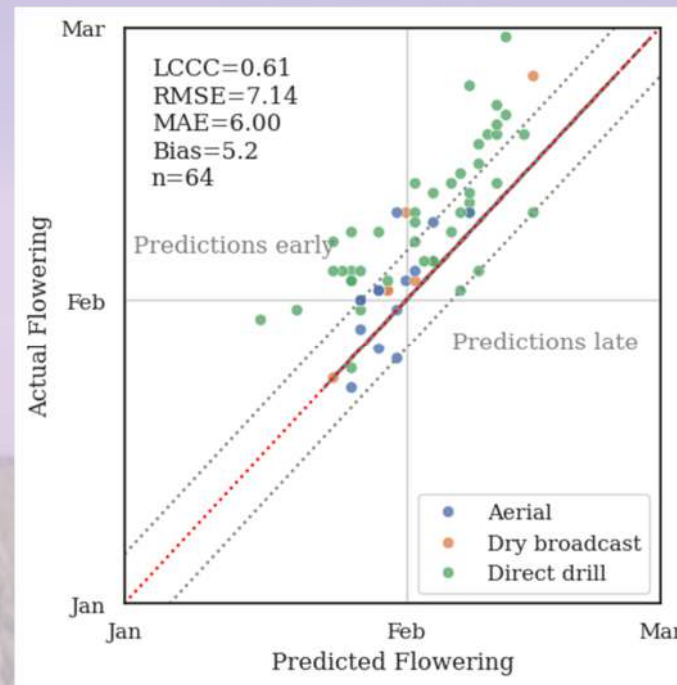
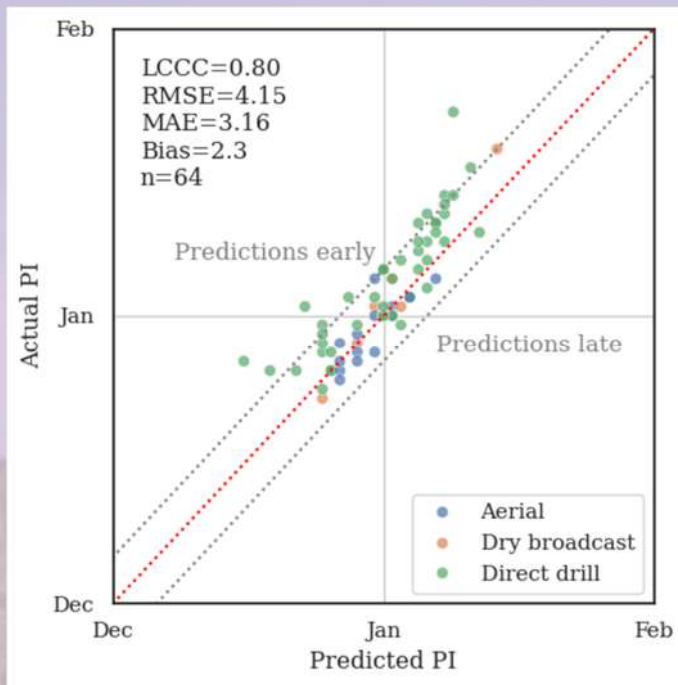
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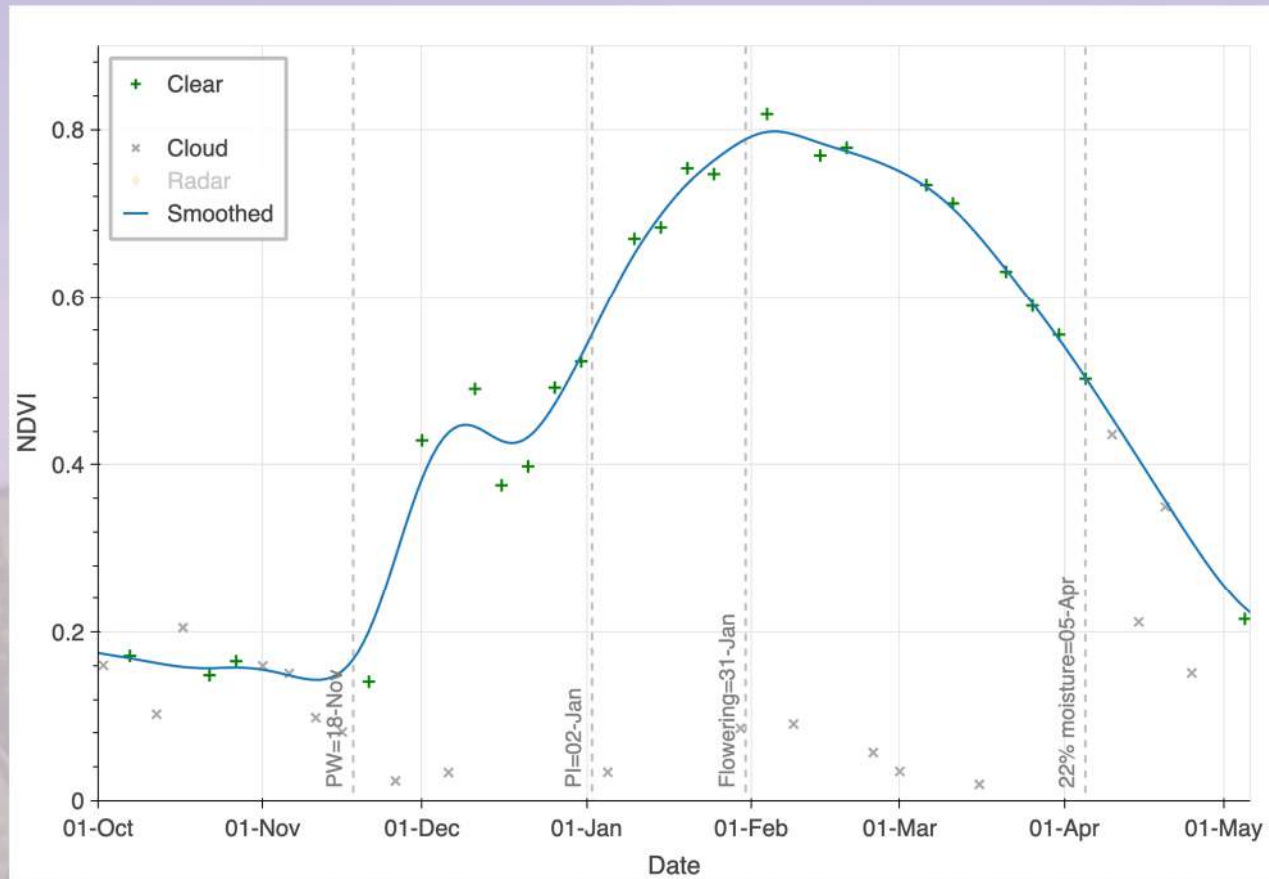
Abstract

Crop phenology modeling often involves determining variety-specific growing degree day thresholds, or parameterizing mechanistic crop models. In this work, we



Weather-based,
no information
about biomass/N

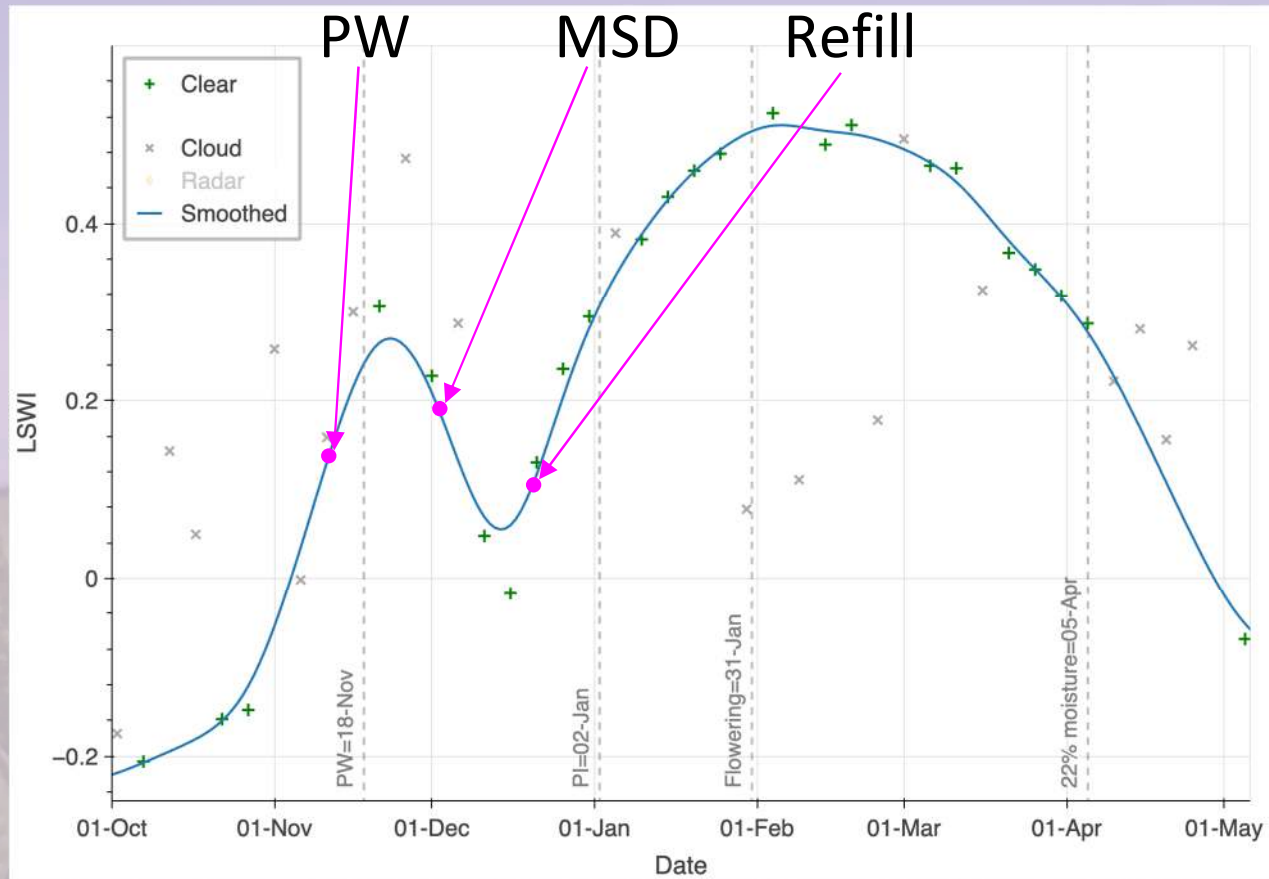
NDVI time series



Rice predictive models

- Permanent water (flooding)
- Panicle initiation
- Flowering
- Grain moisture (22% best harvest date)

LSWI time series



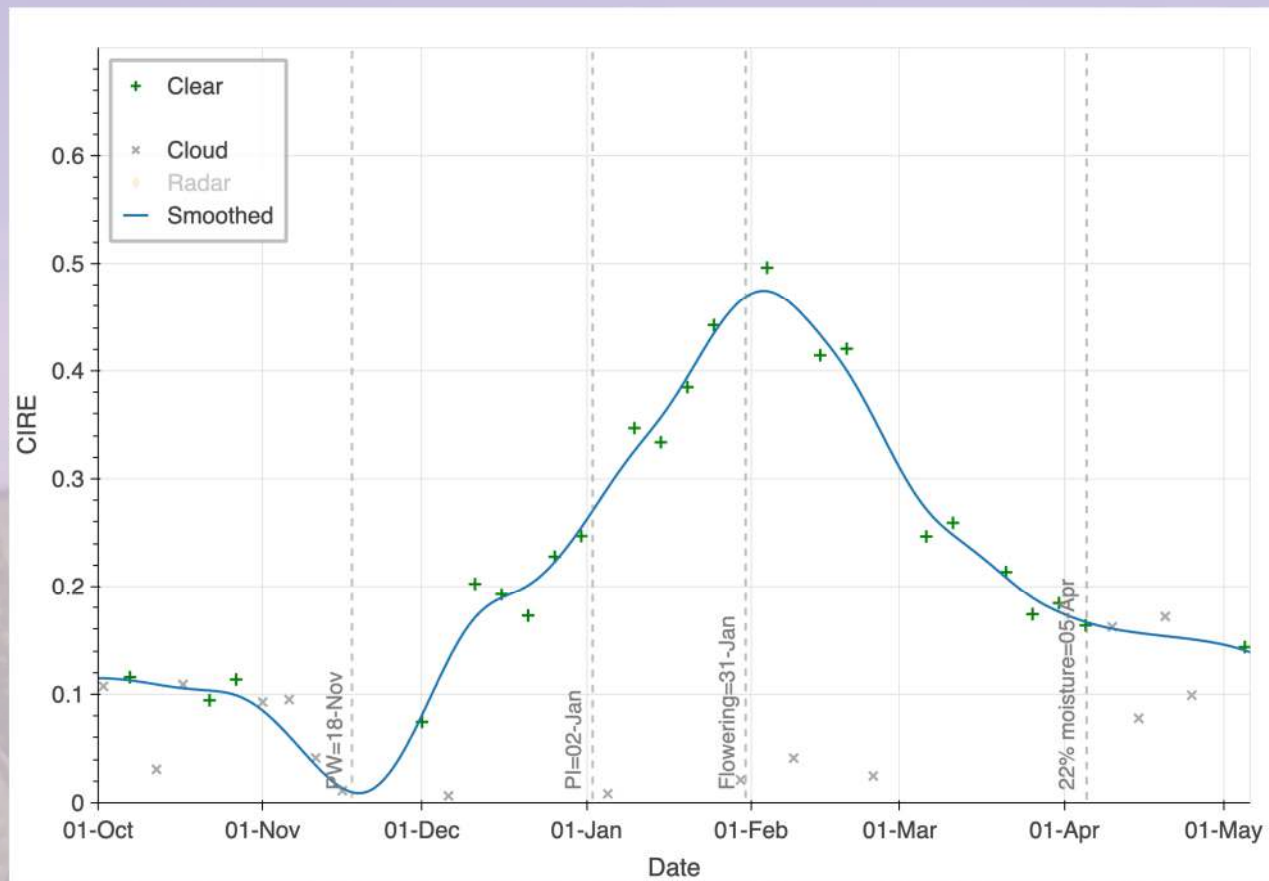
$$\text{LSWI} = \frac{(\text{NIR} - \text{SWIR})}{(\text{NIR} + \text{SWIR})}$$

PW = ponding

MSD = mid-season drain

Time-series trajectories
useful to monitor water
management

CIRE time series

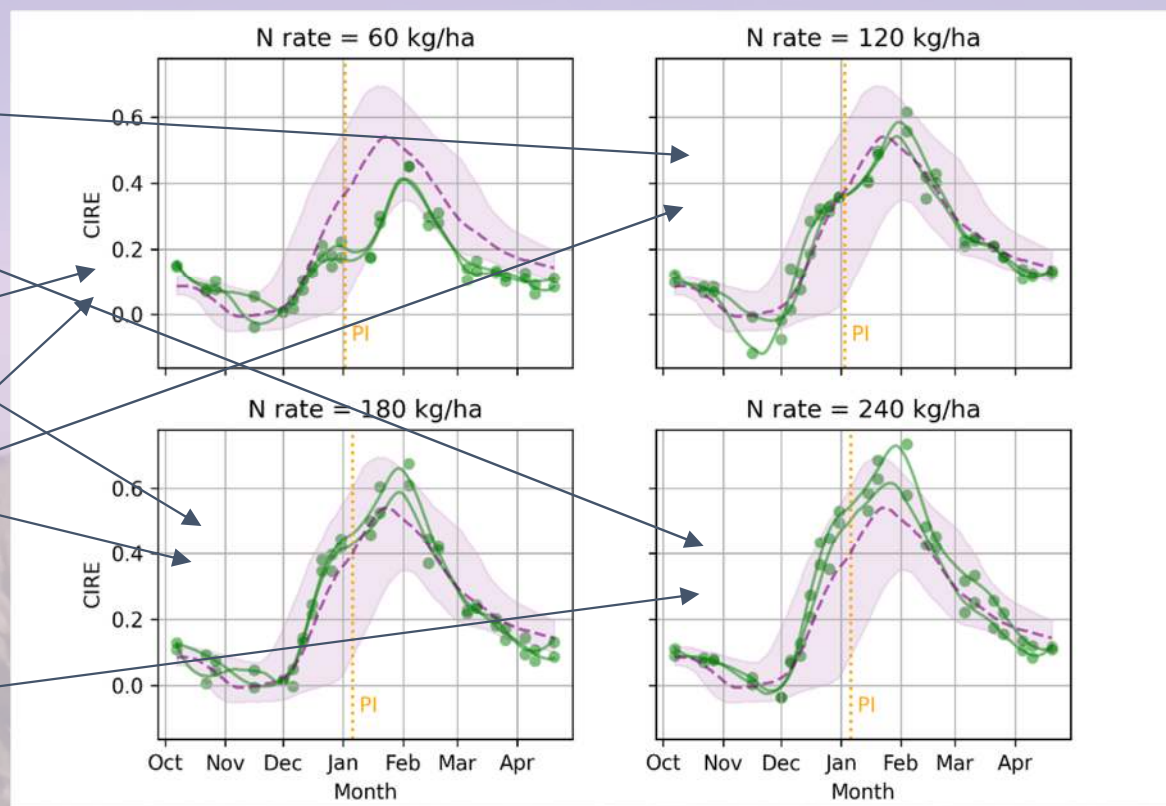
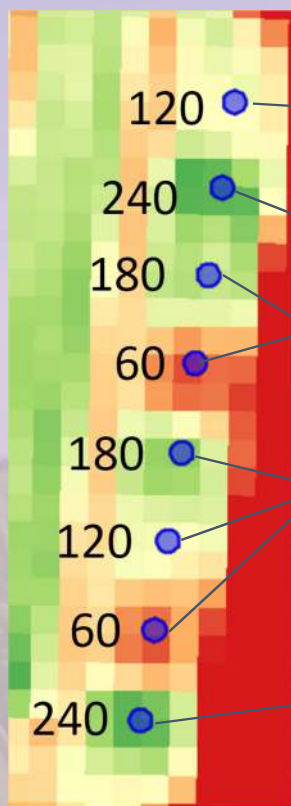


$$\text{CIRE} = \text{NIR}/\text{RE} - 1$$

Sensitive to chlorophyll

-> N status

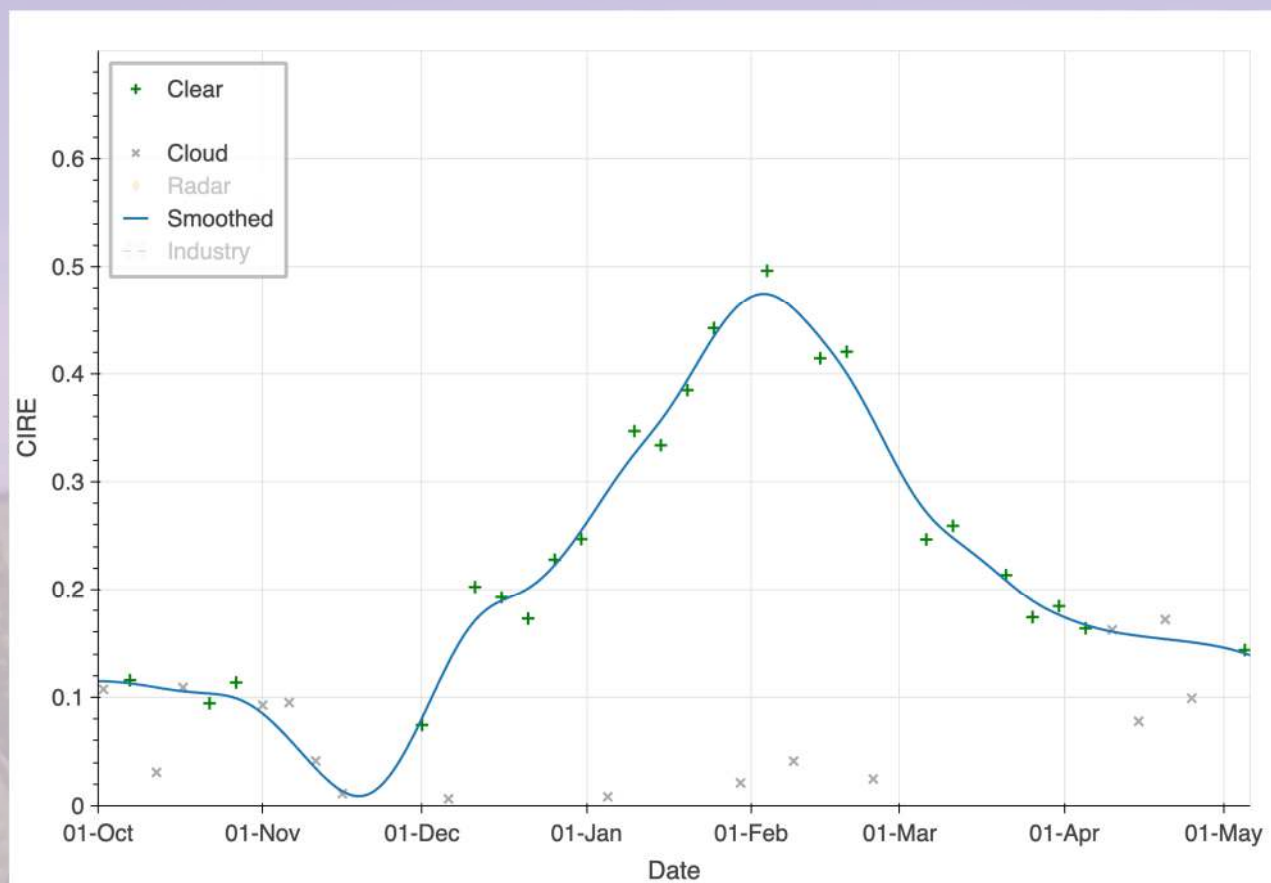
CIRE -> nitrogen uptake example



Industry-wide growth curves

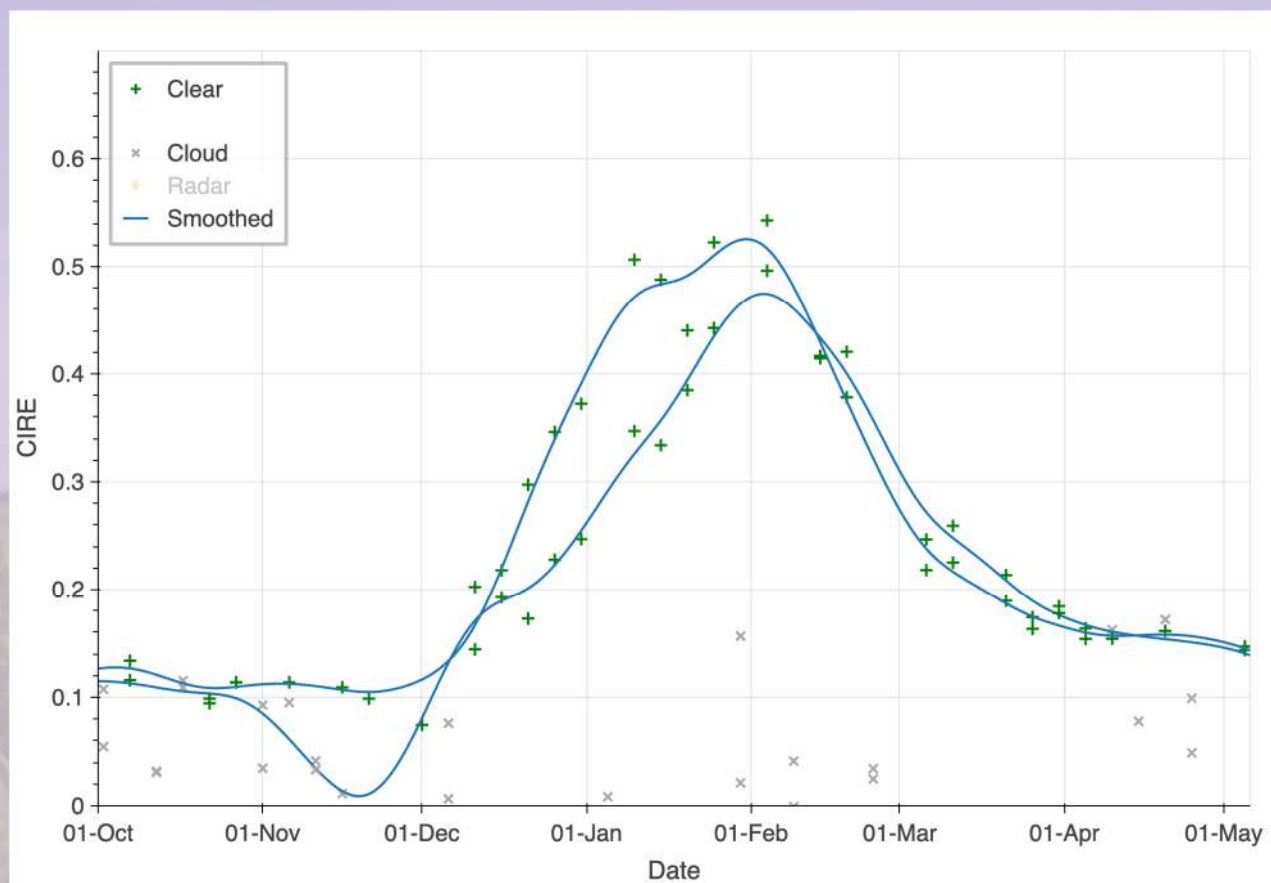
Industry-wide growth curves

1 paddock



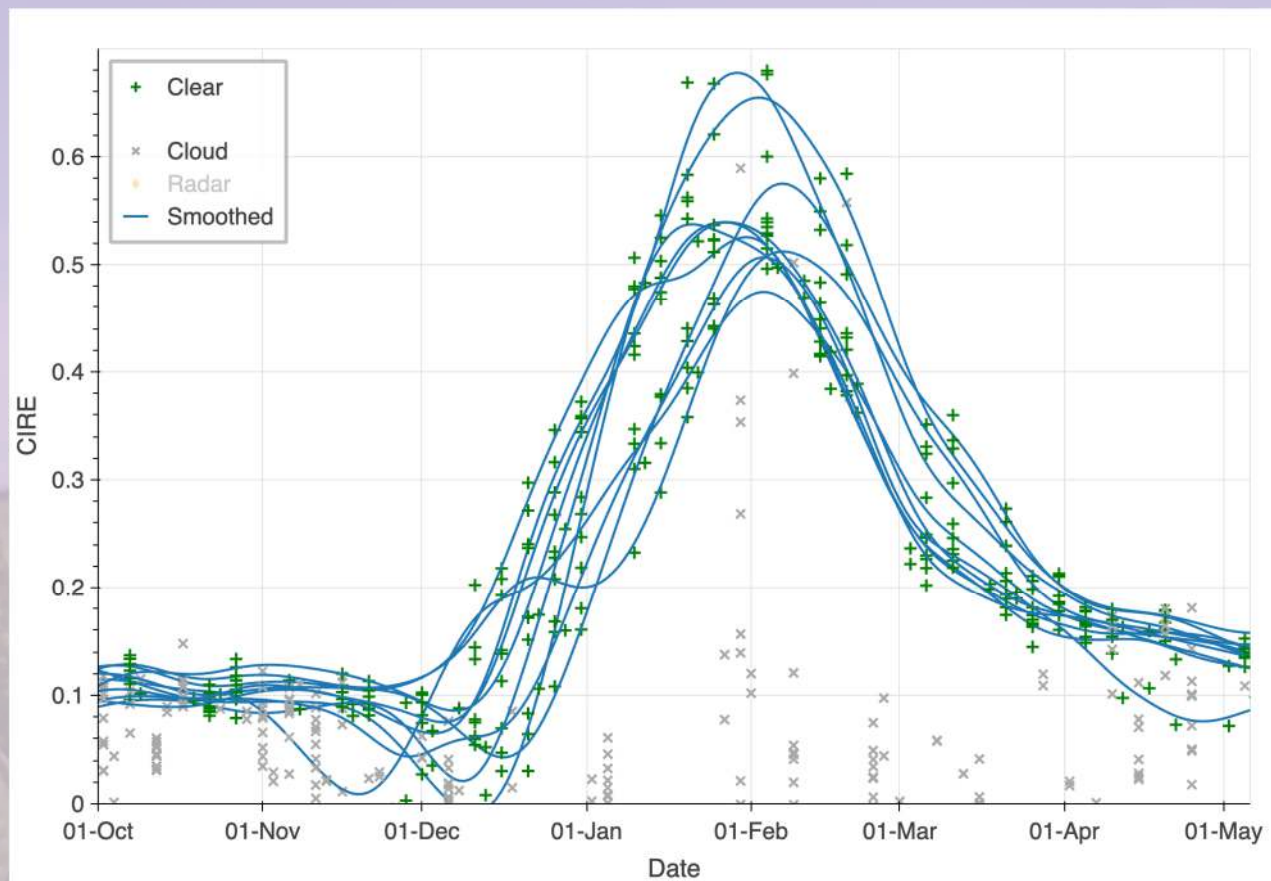
Industry-wide growth curves

2 paddocks

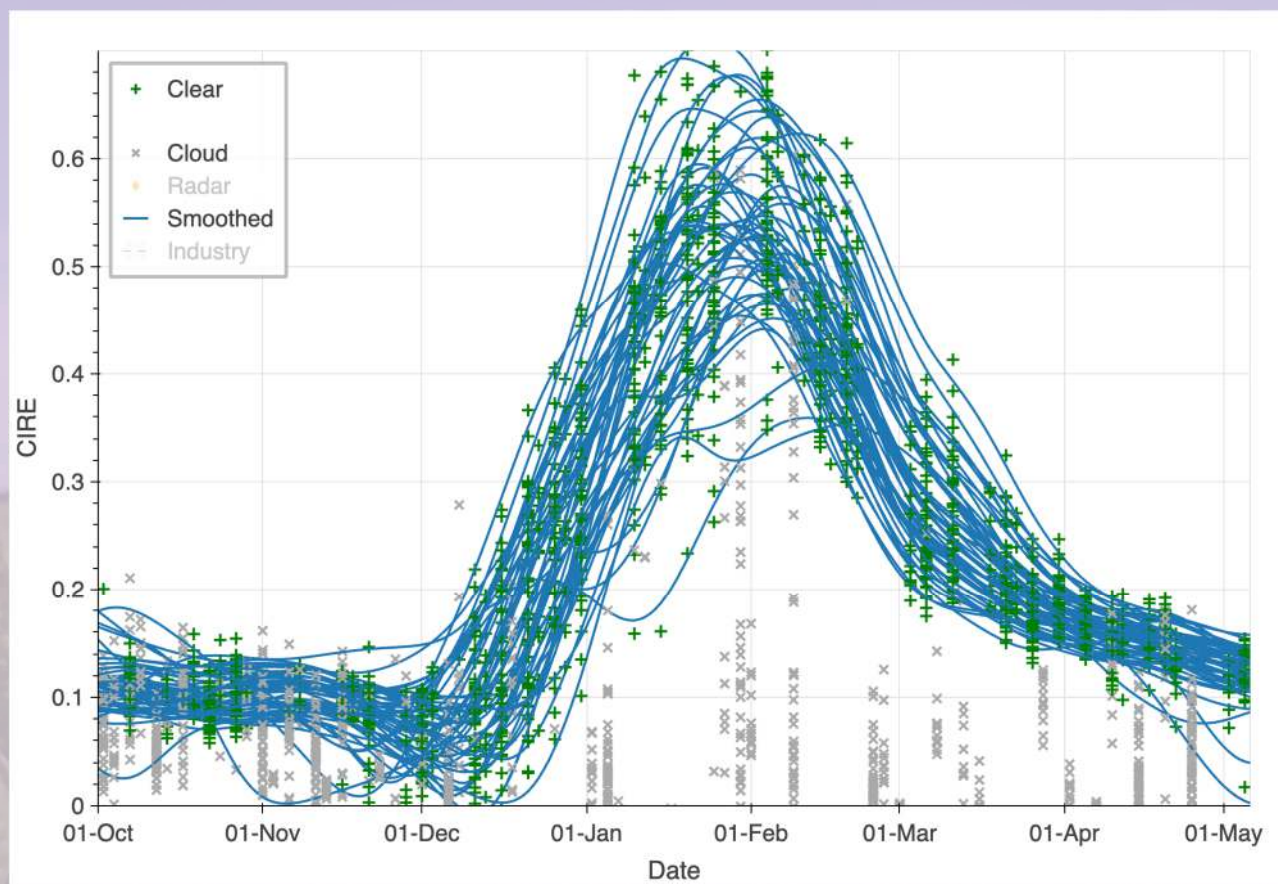


Industry-wide growth curves

10 paddocks

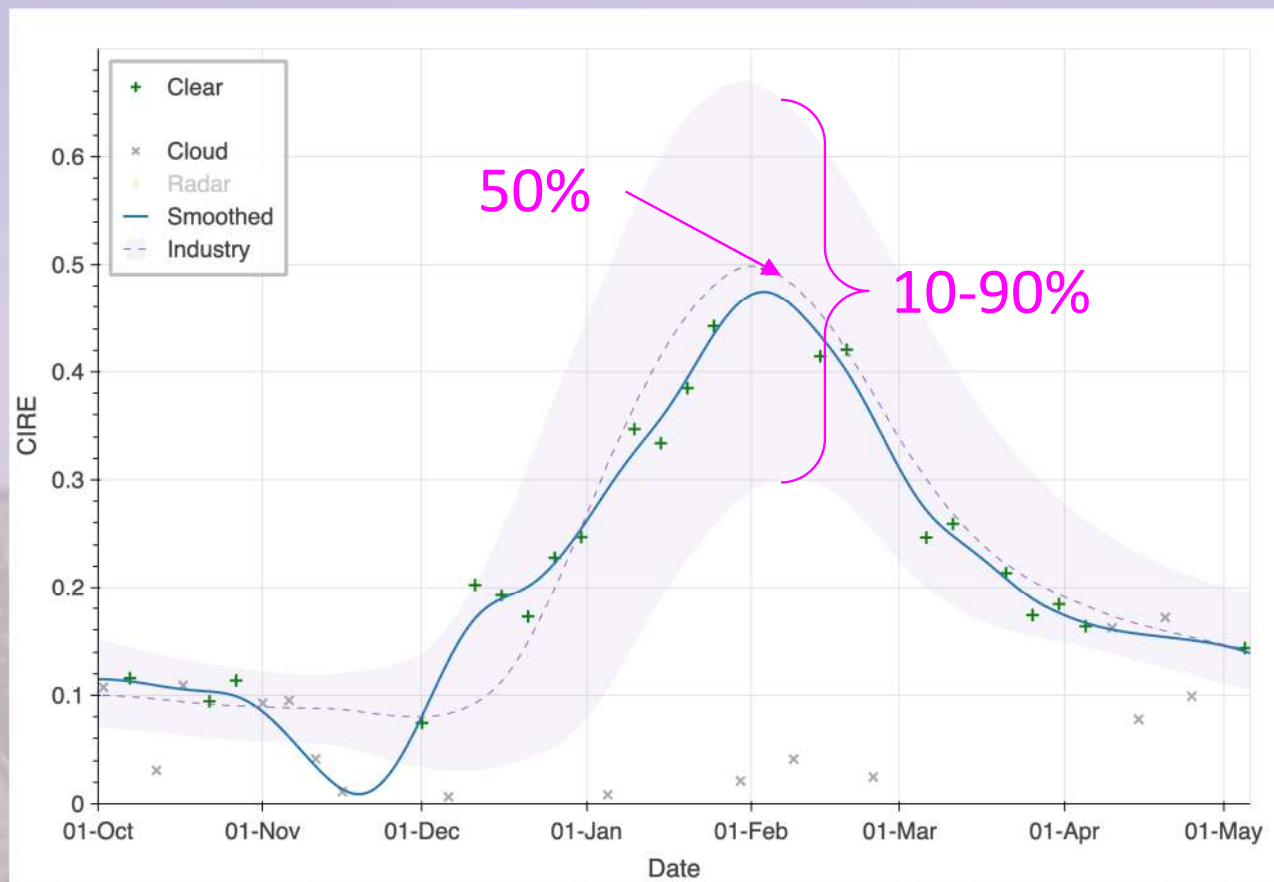


Industry-wide growth curves



50 paddocks

Industry-wide growth curves

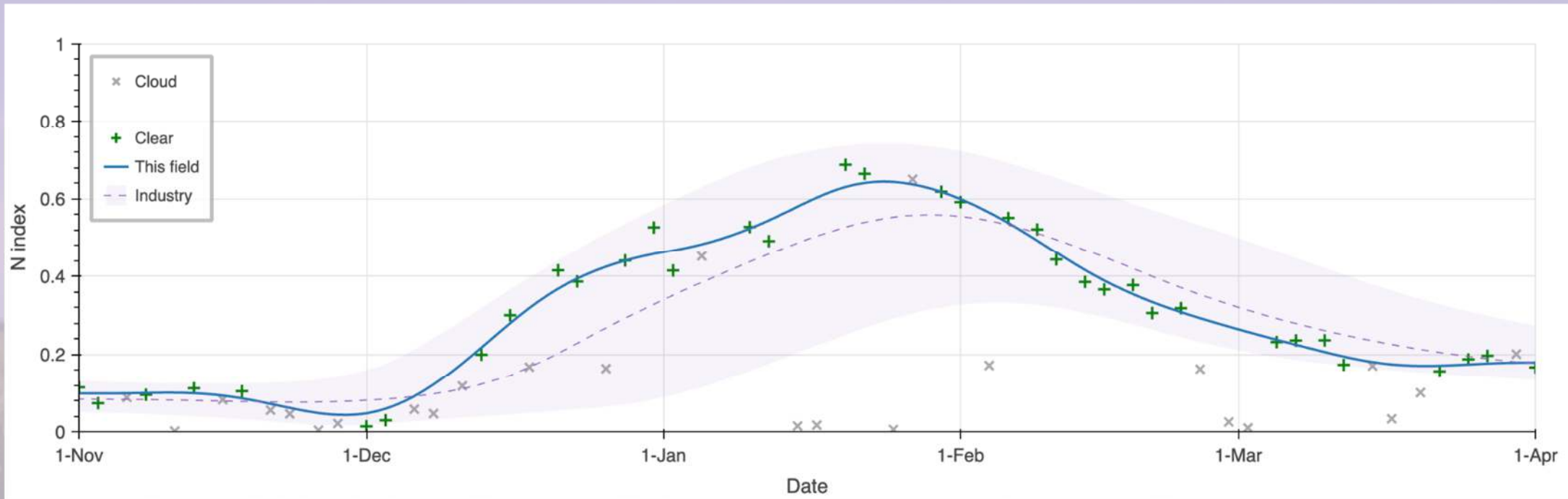


Benchmark current crop against all similar crops from previous seasons

9,500 paddocks (CY18-24)

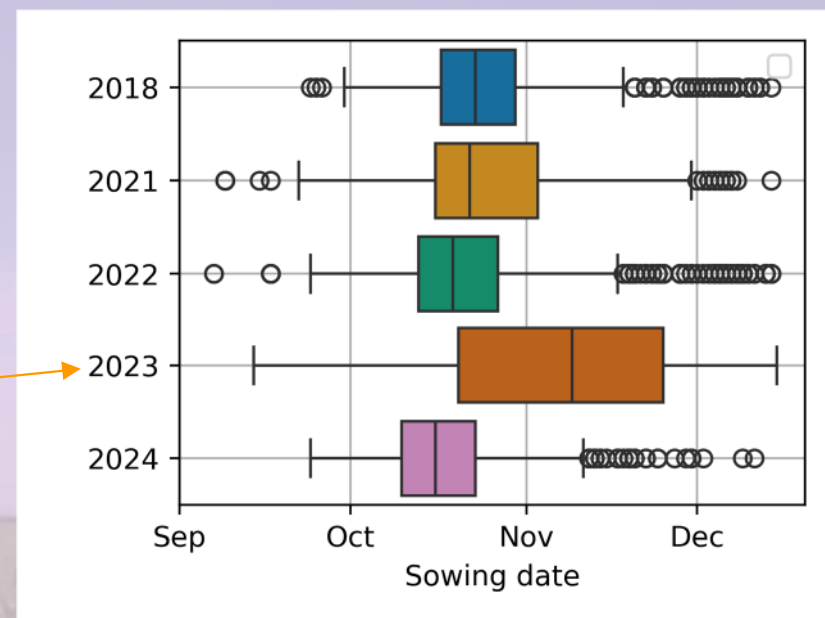
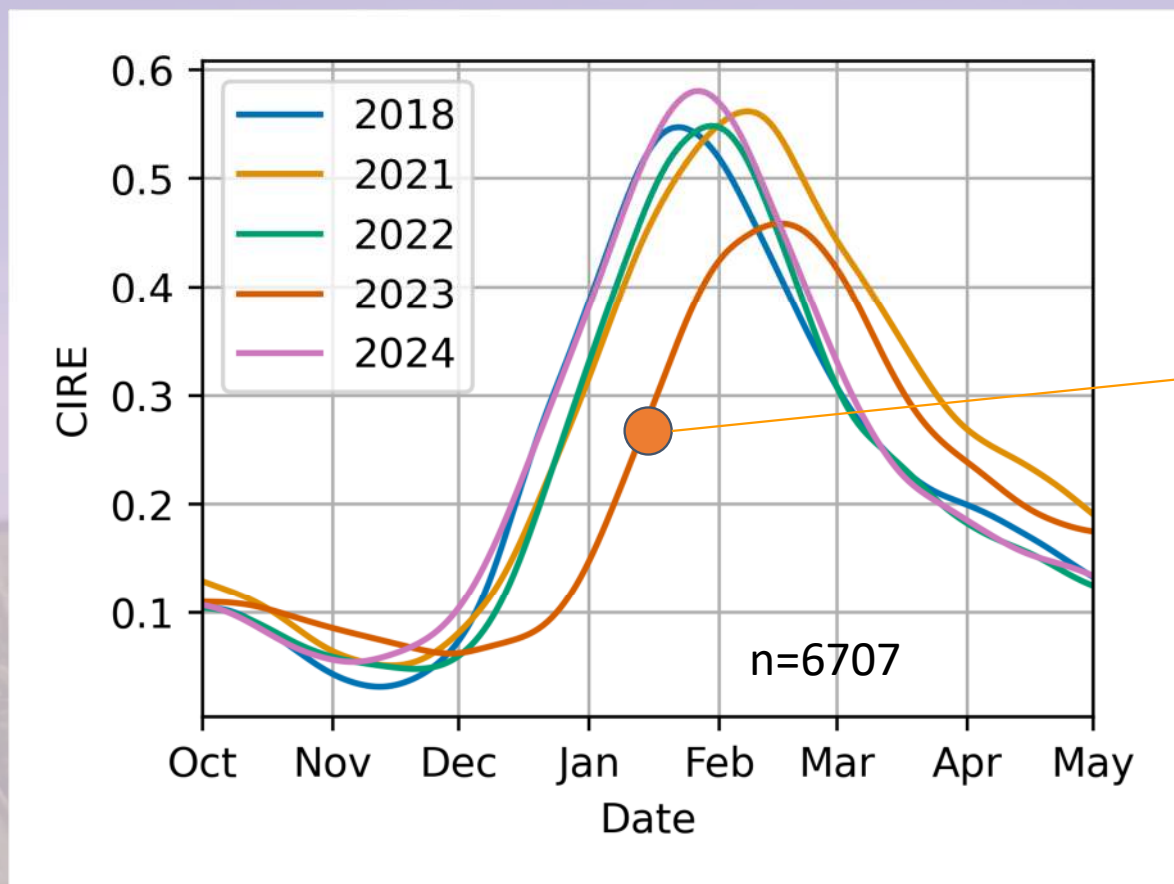
Grouped by region, sowing method, variety

In season crop monitoring

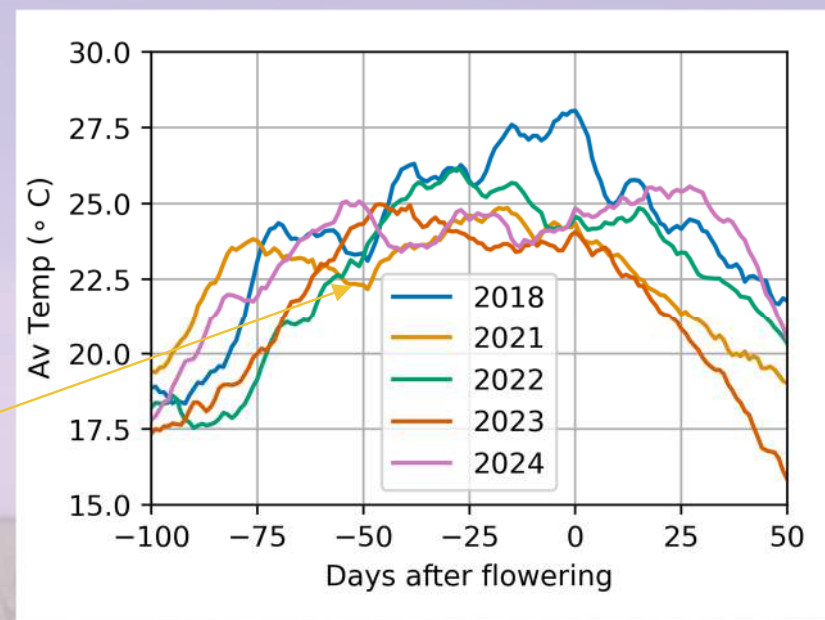
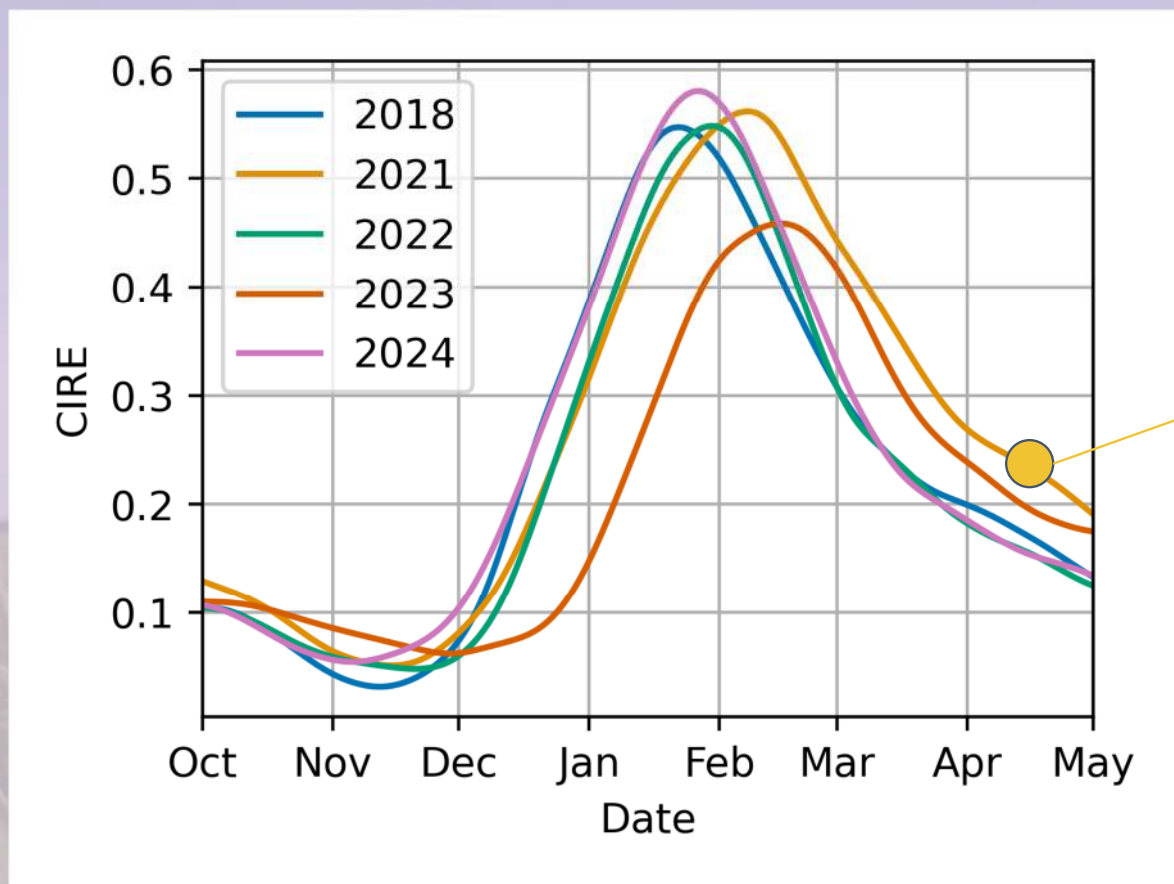


Allows tracking of crop status against industry
in near-real time

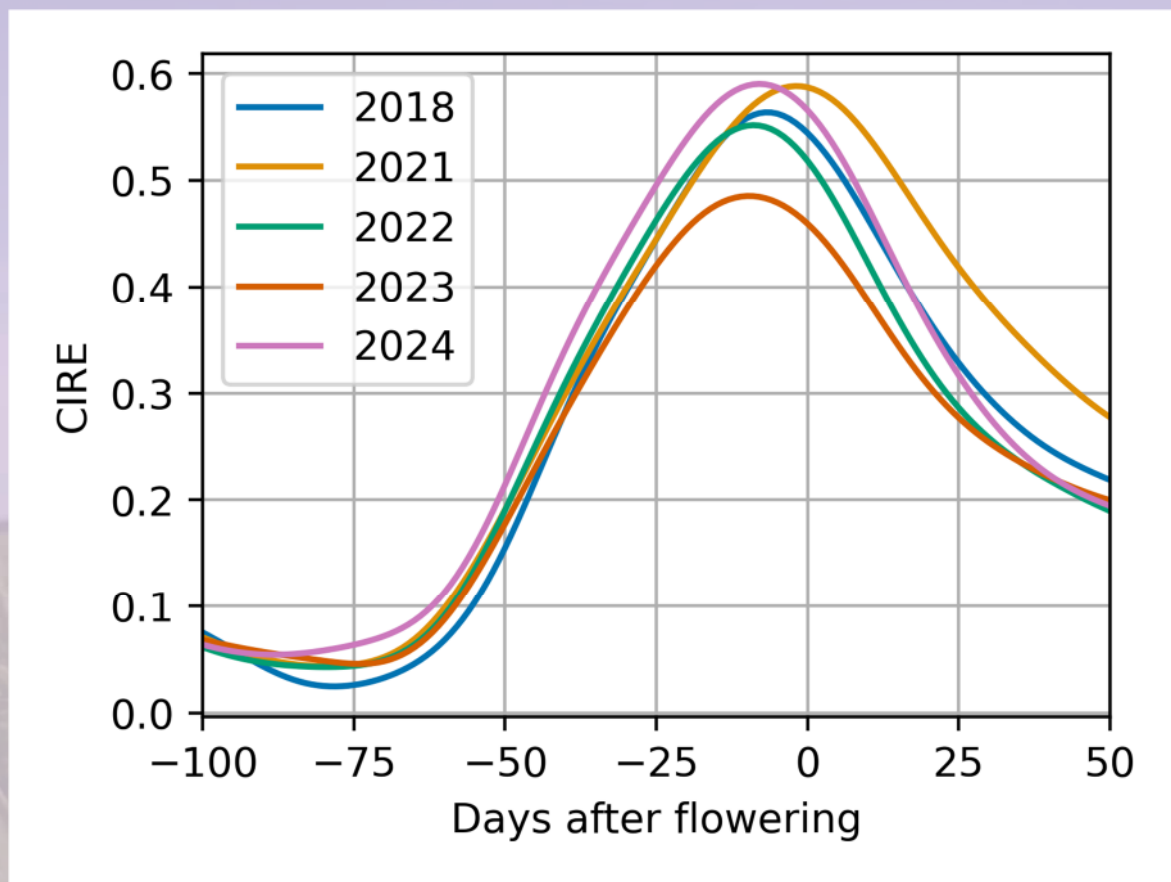
Industry-wide analysis - per season



Industry-wide analysis - per season



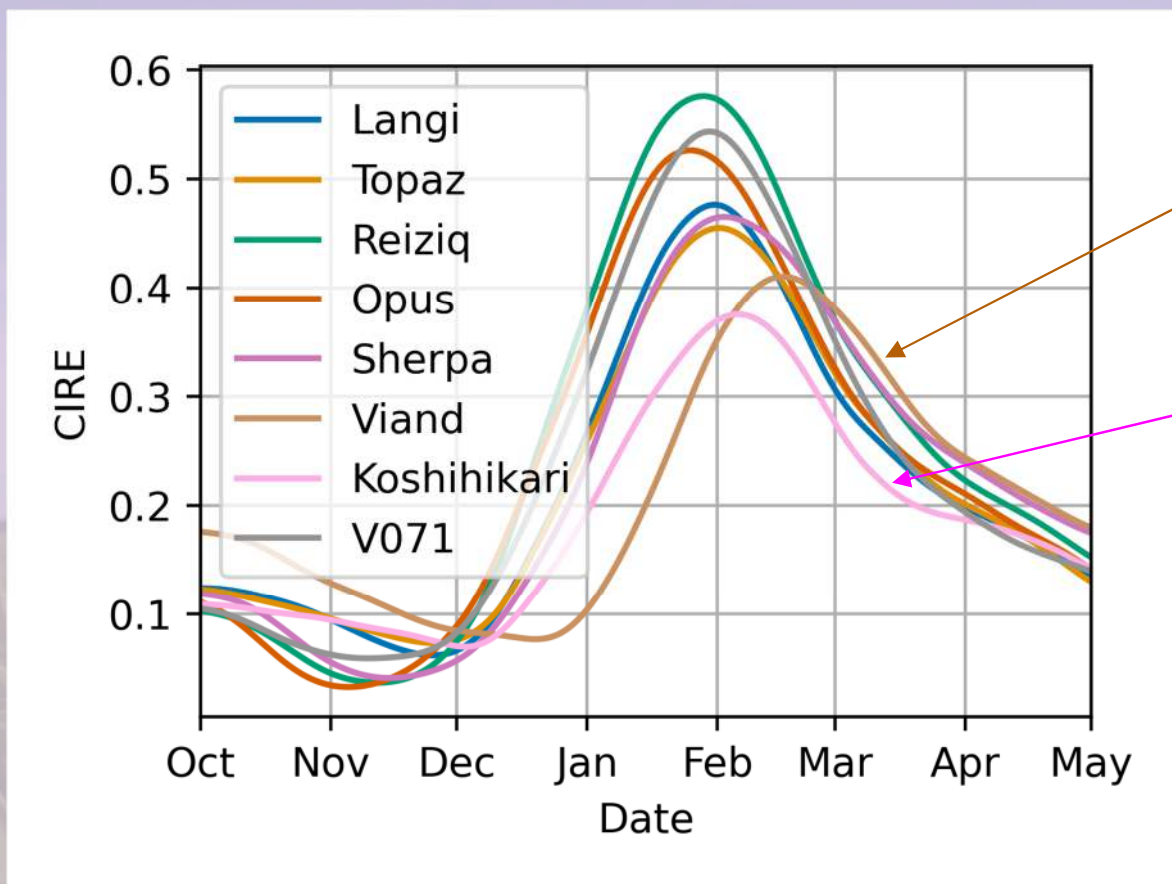
Industry-wide analysis - per season - vs DAFL



This combines both phenology (late/early) and canopy (high/low)

Normalise to flowering date, to remove phenology

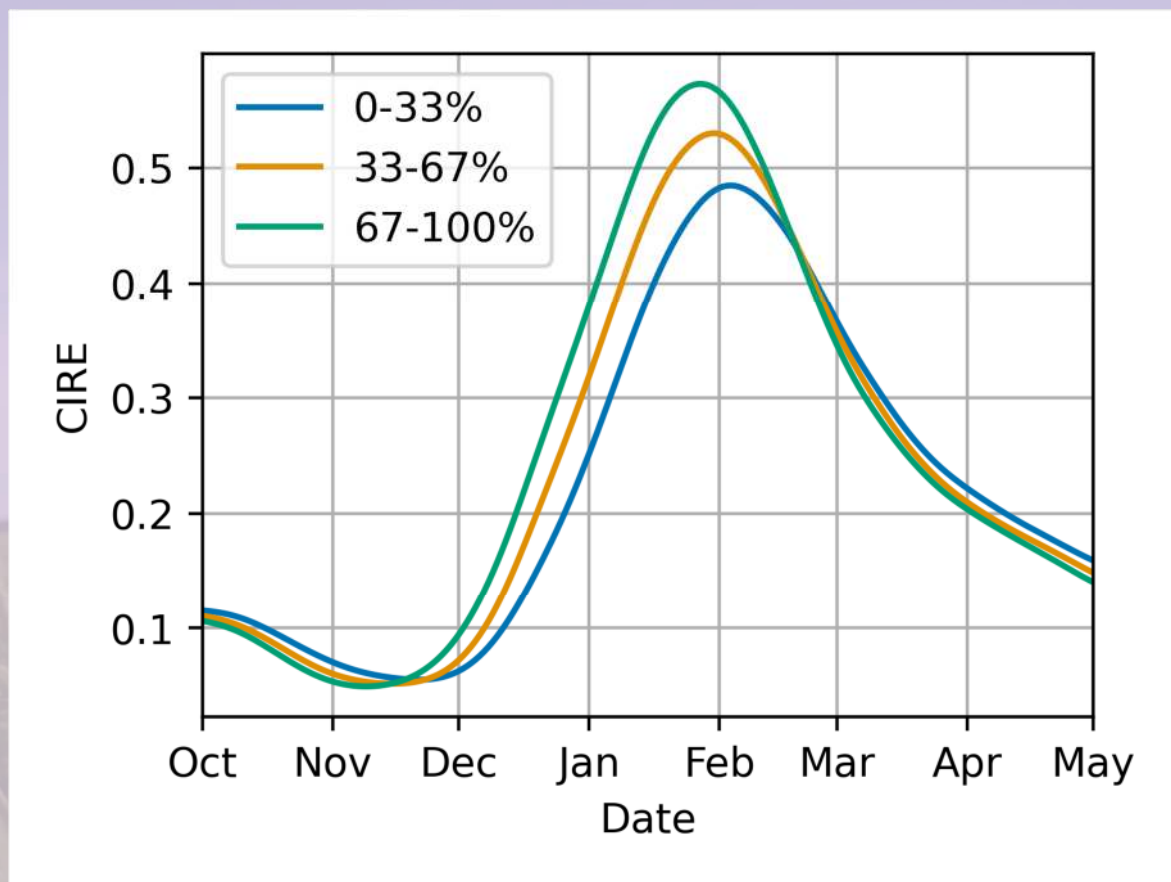
Industry-wide analysis - per variety



Viand - short-season variety often planted late

Koshihikari - short-grain variety susceptible to lodging

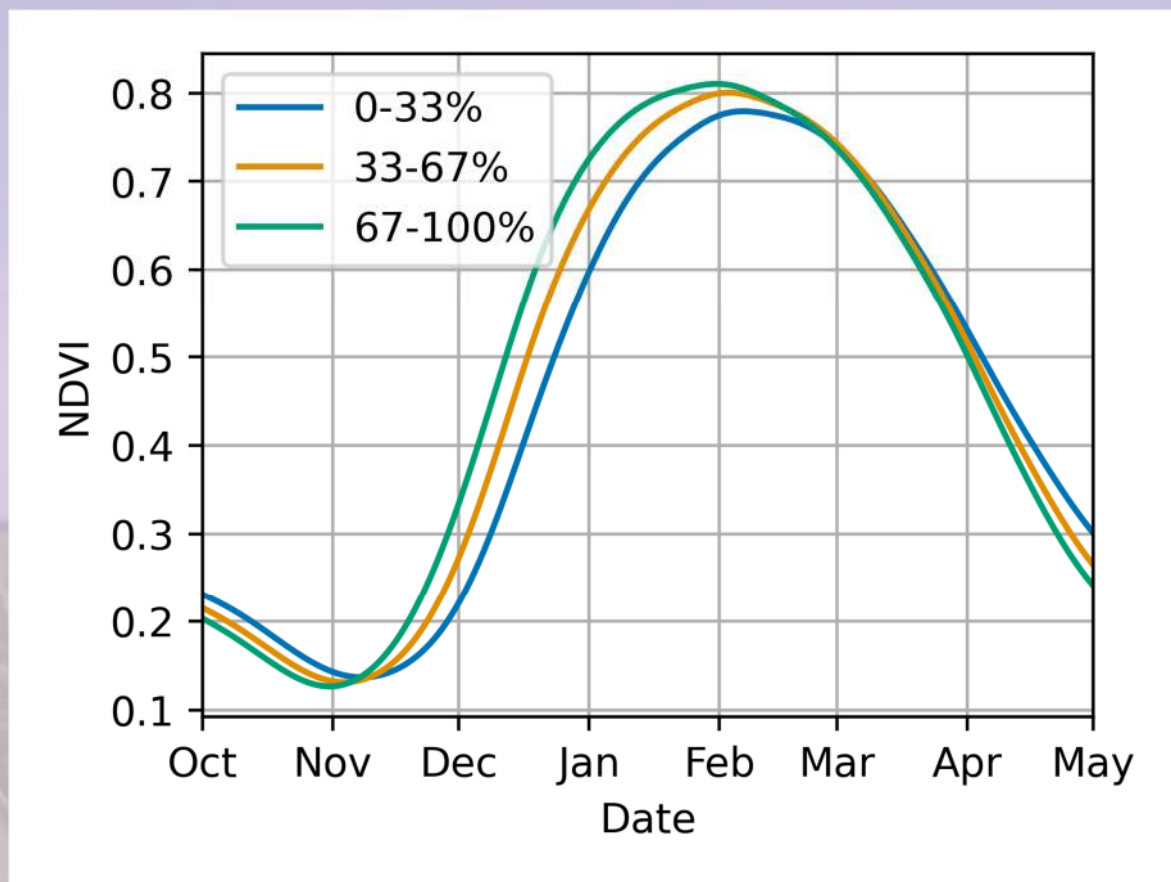
Industry-wide analysis - per yield group



Split crops into three groups
-> low, mid, high yield

High yielding crops tend to be earlier and have higher CIRE

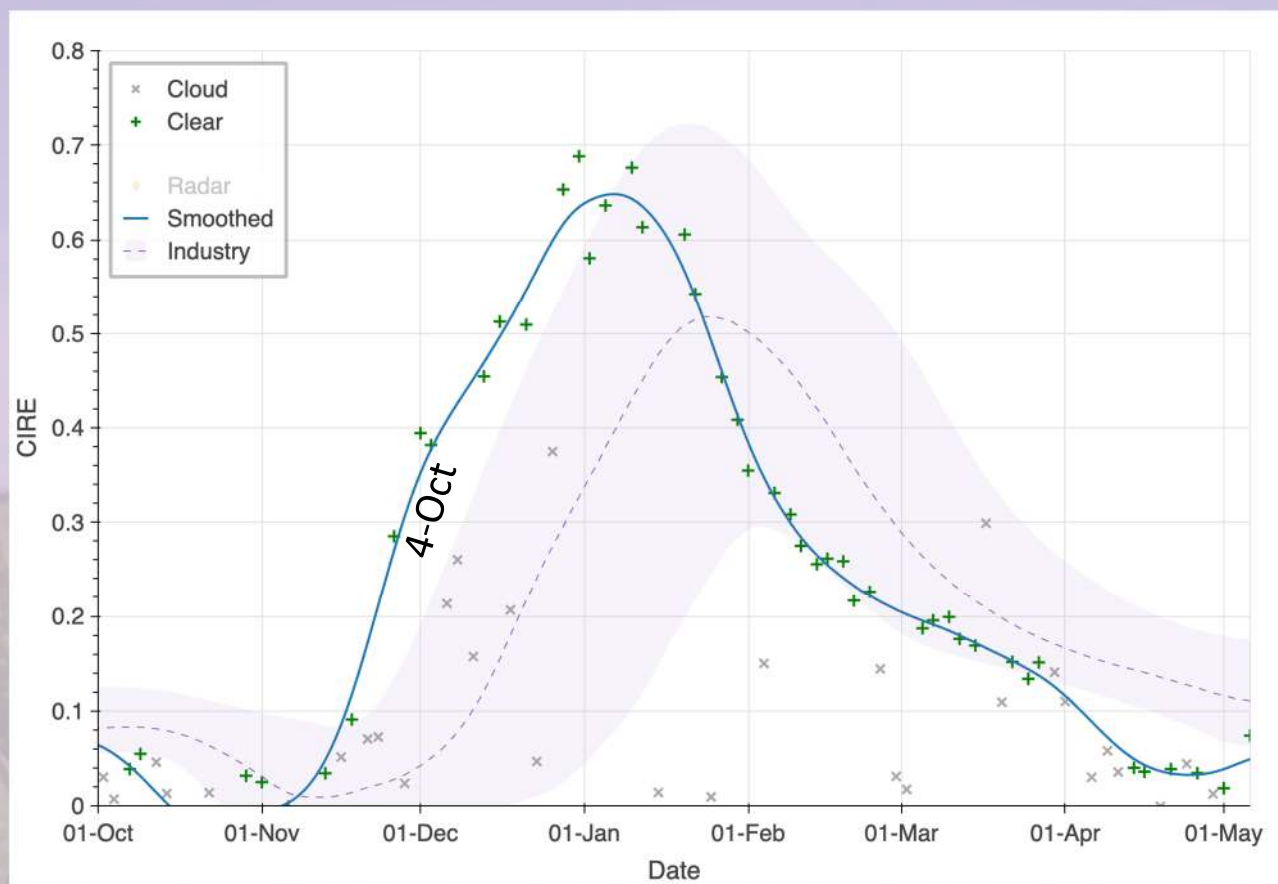
Industry-wide analysis - per yield group - NDVI



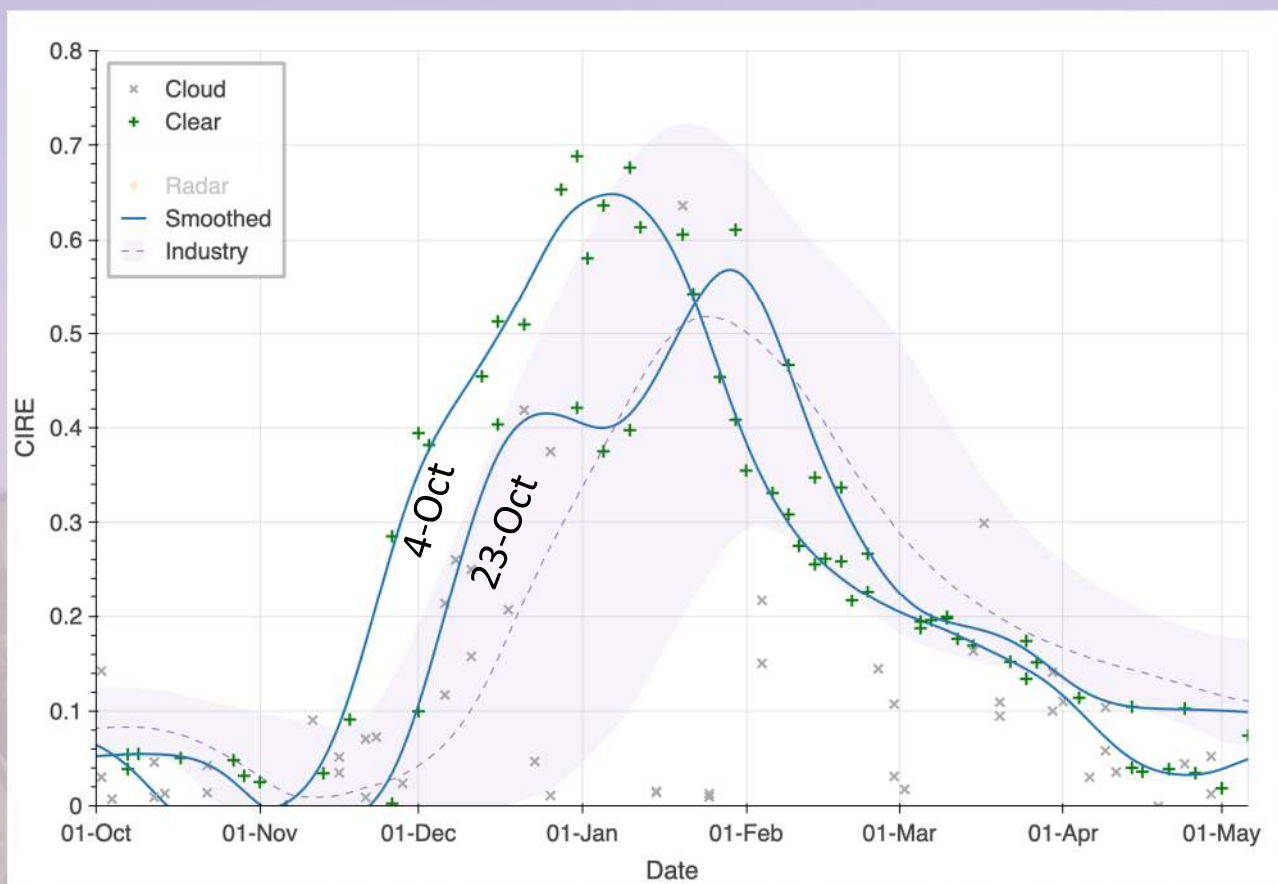
Split crops into three groups
-> low, mid, high yield

NDVI much less sensitive to yield variation

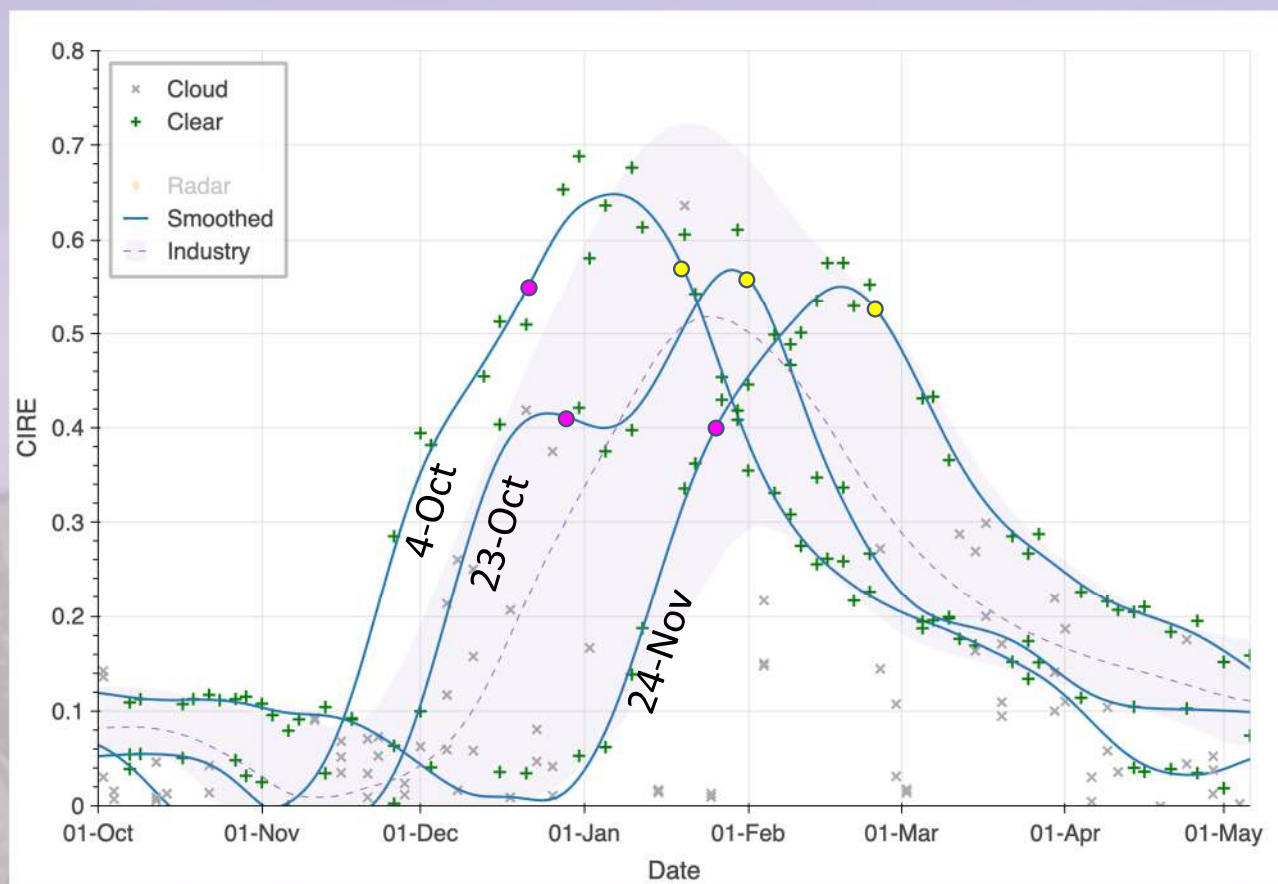
Challenge 1: different planting dates



Challenge 1: different planting dates



Challenge 1: different planting dates?

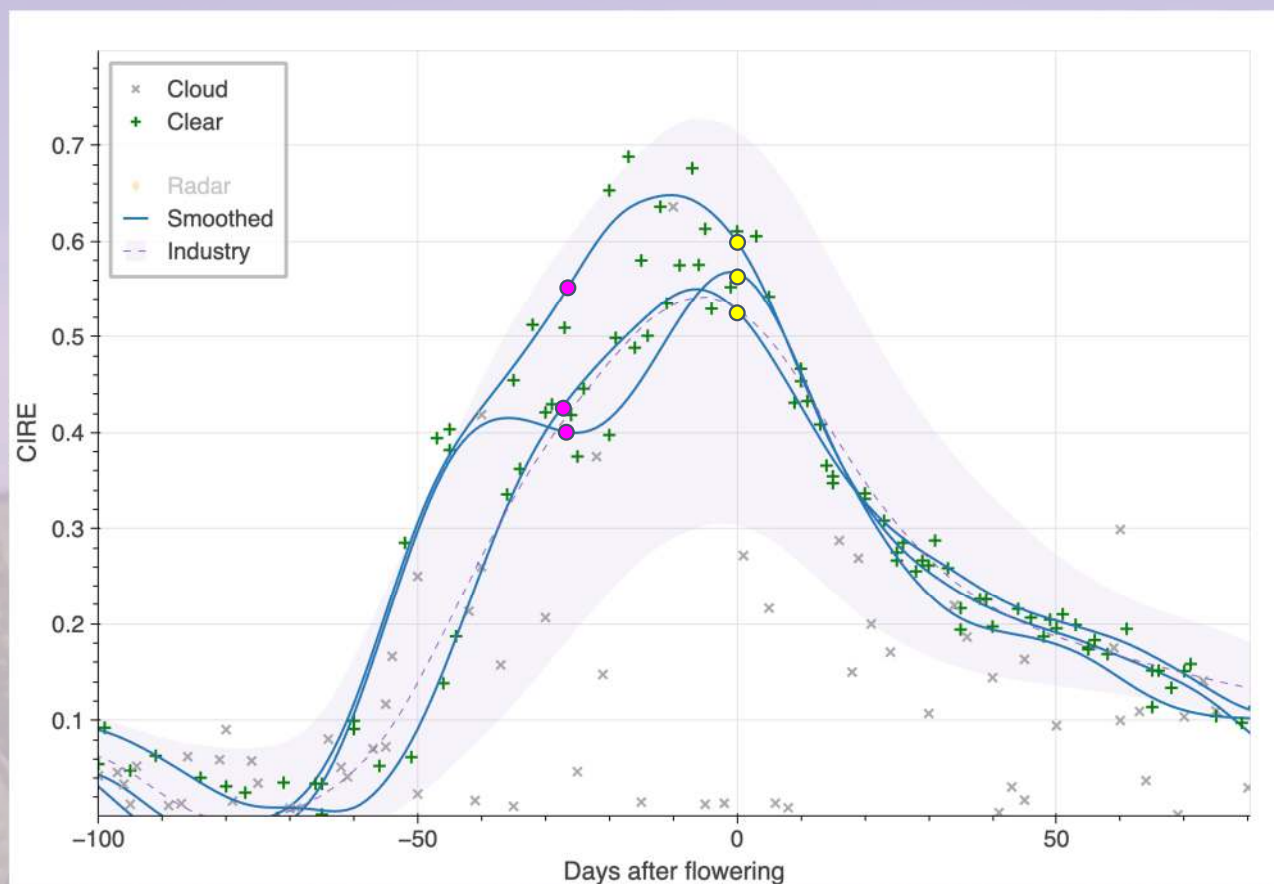


- PI dates

- Flowering dates

Can't compare with industry stats to e.g. make mid-season N decision

But, what about different planting dates?

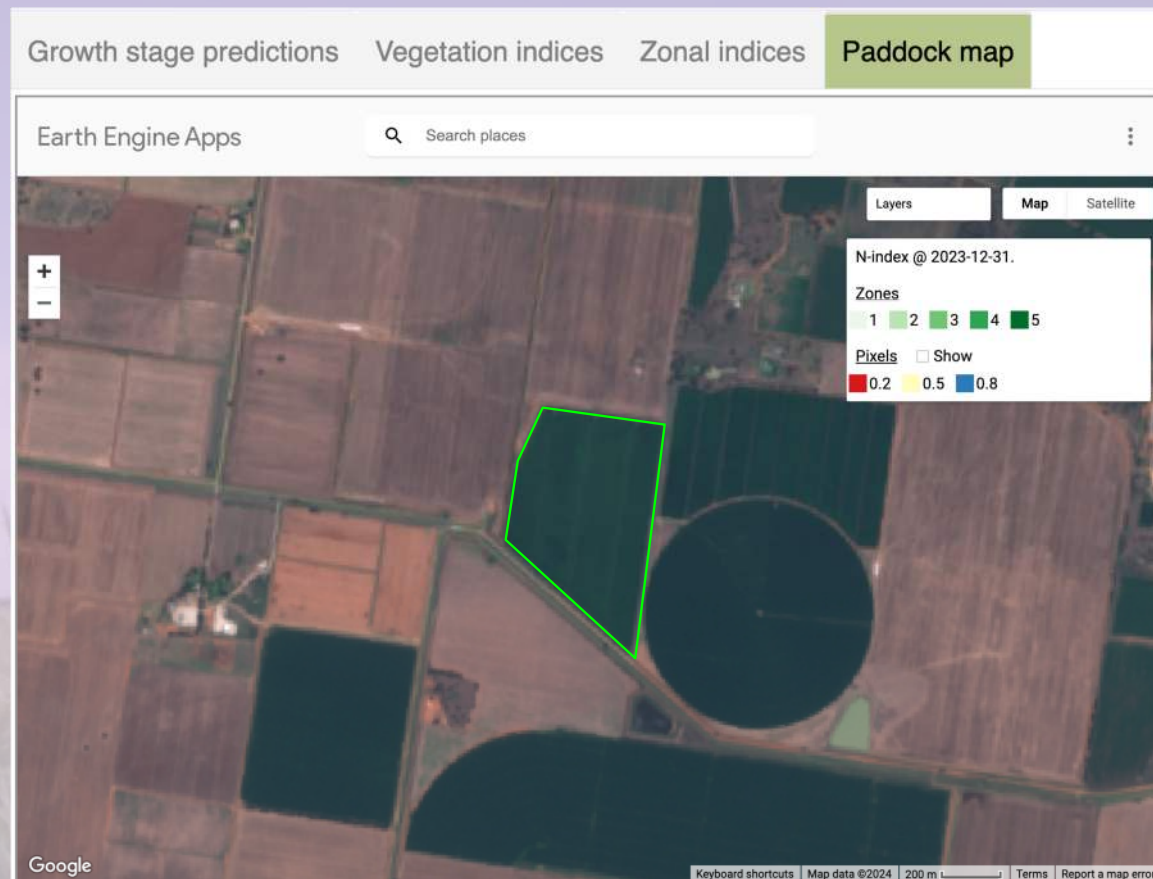
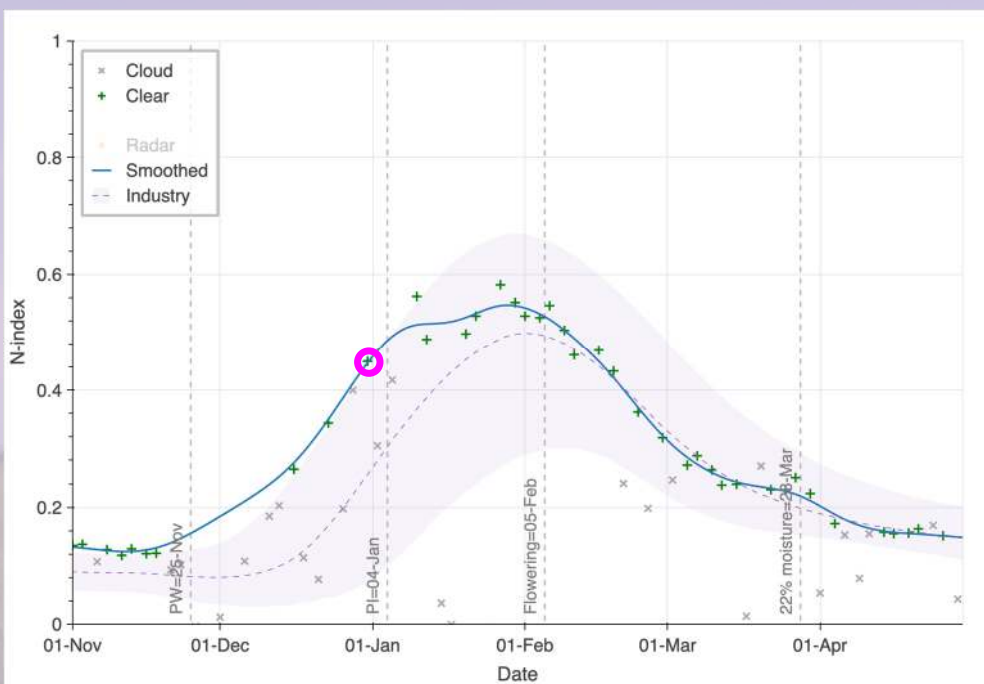


- PI Dates

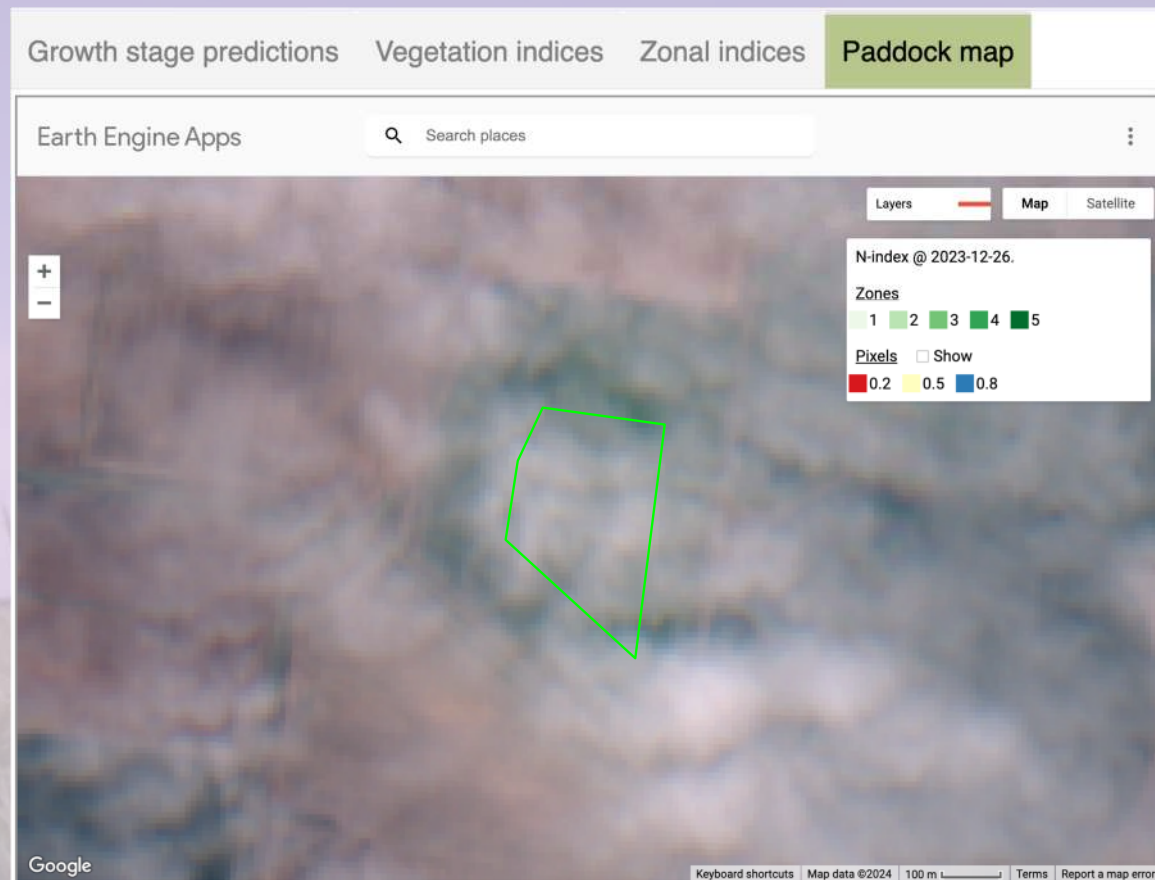
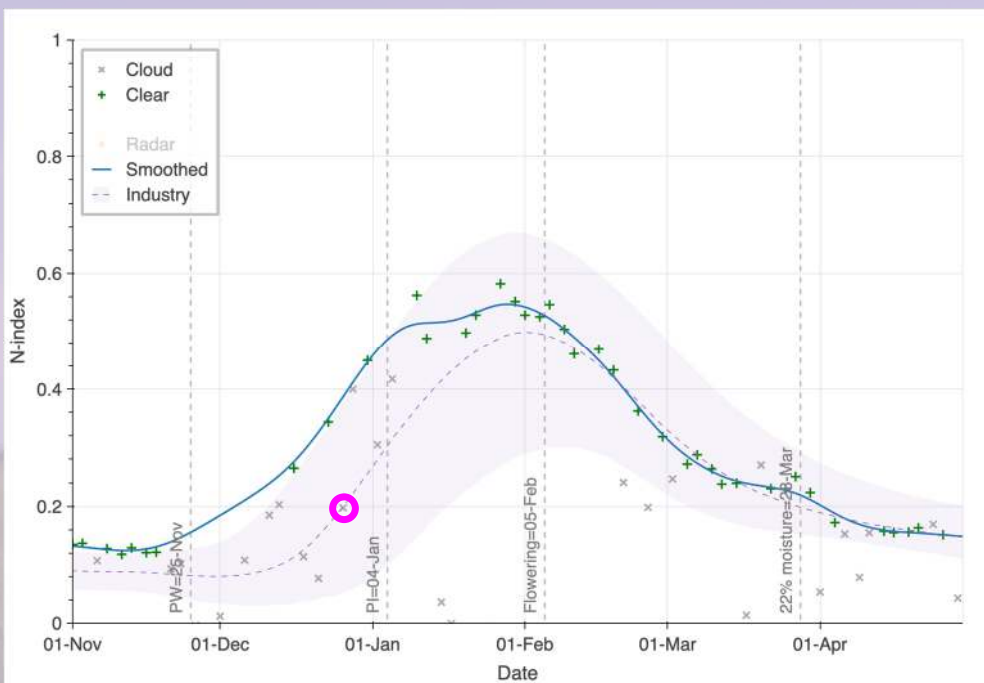
- Flowering date

Removes effect of phenology, so comparing only chlorophyll -> N

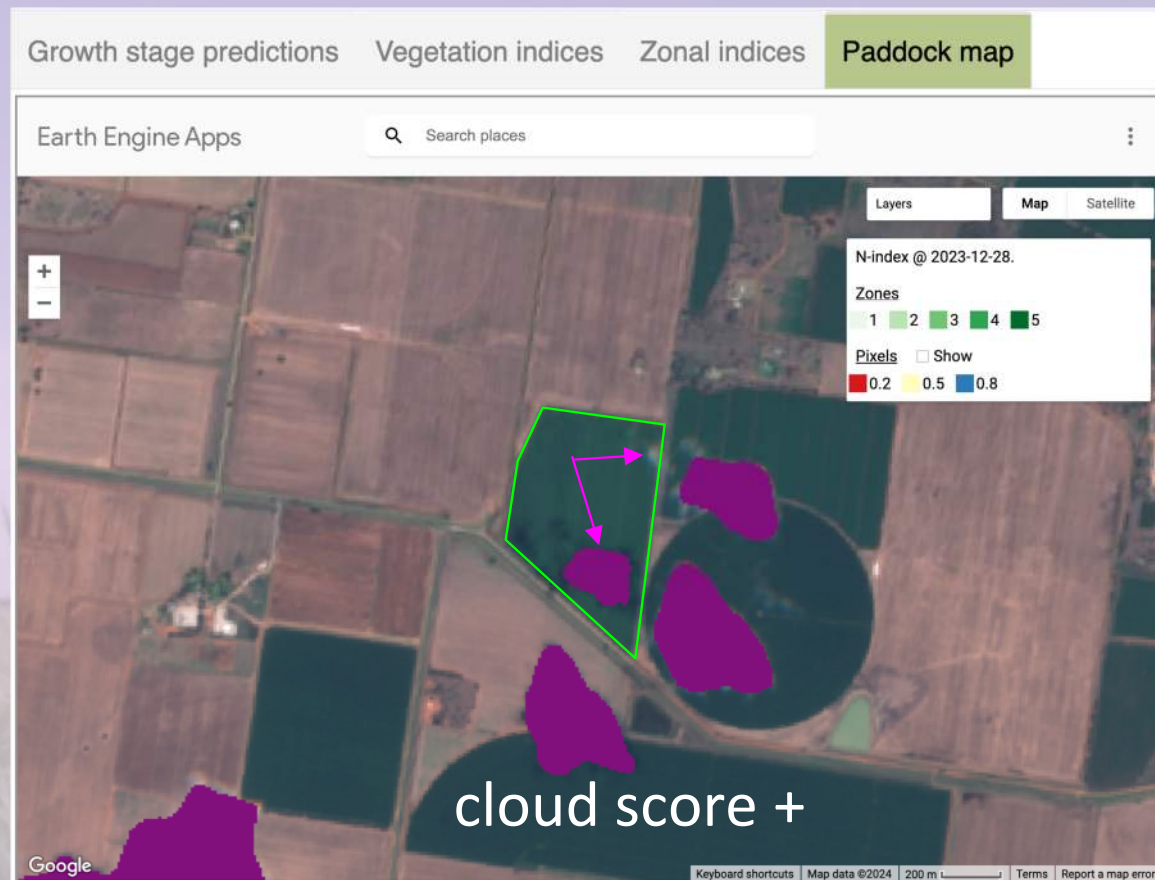
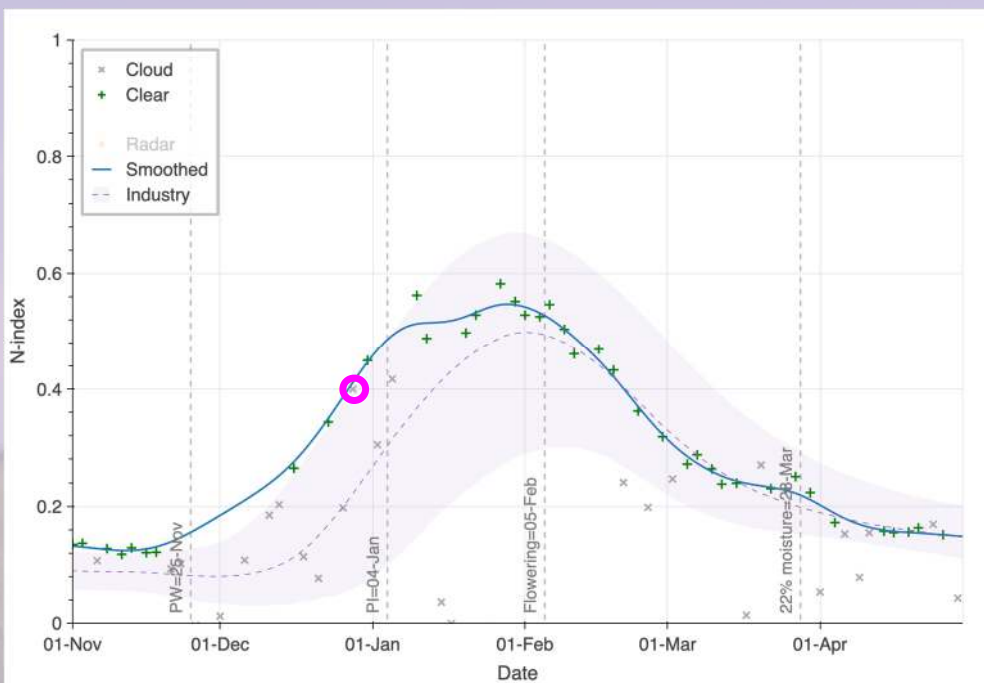
Challenge 2: Cloud



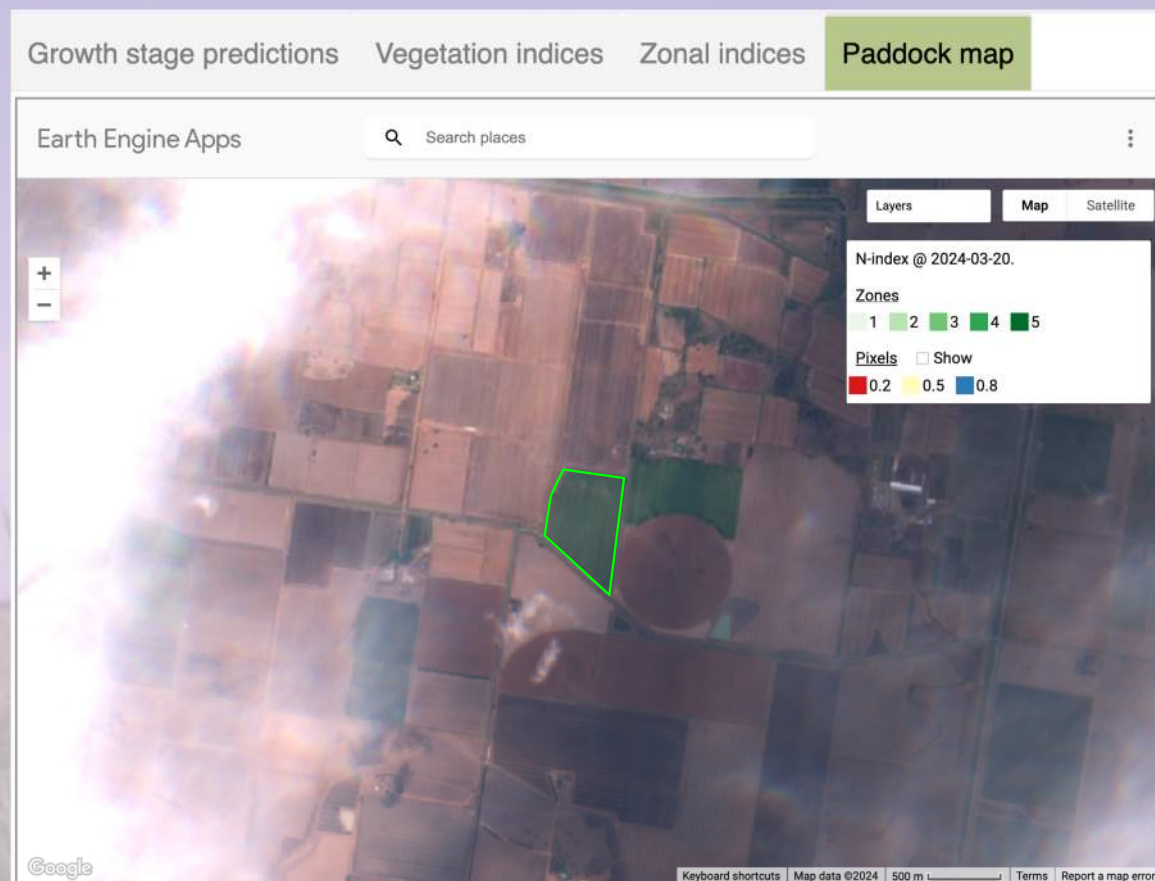
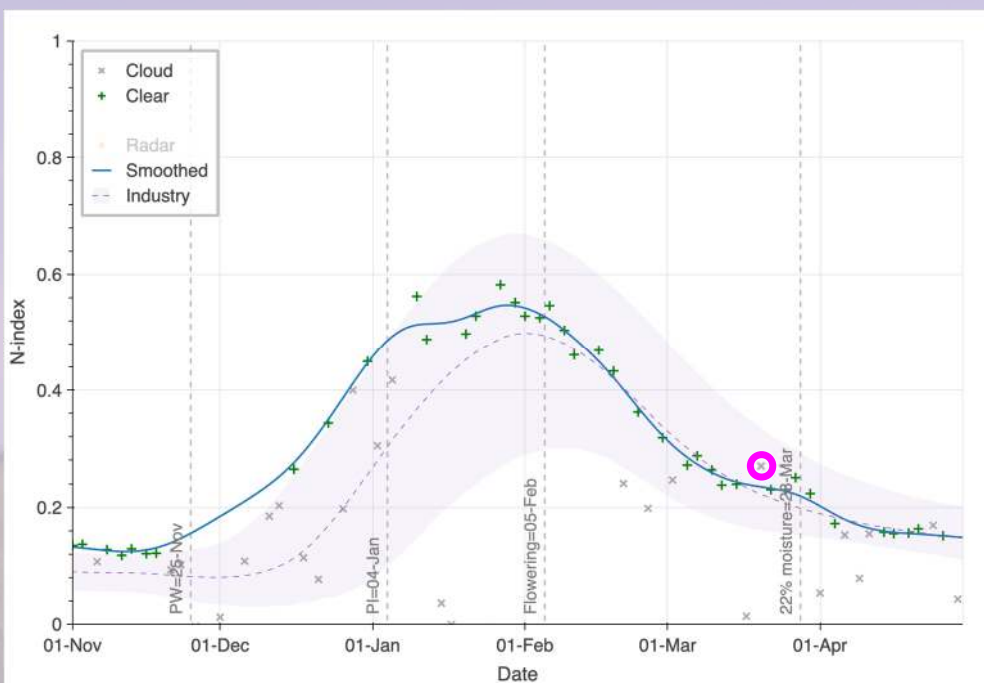
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Challenge 2: Cloud

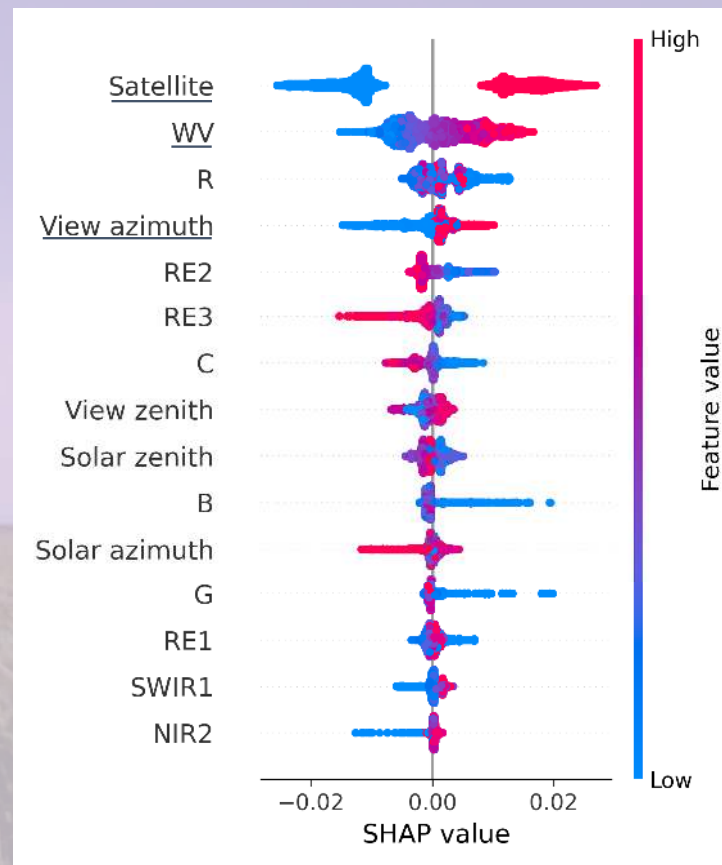
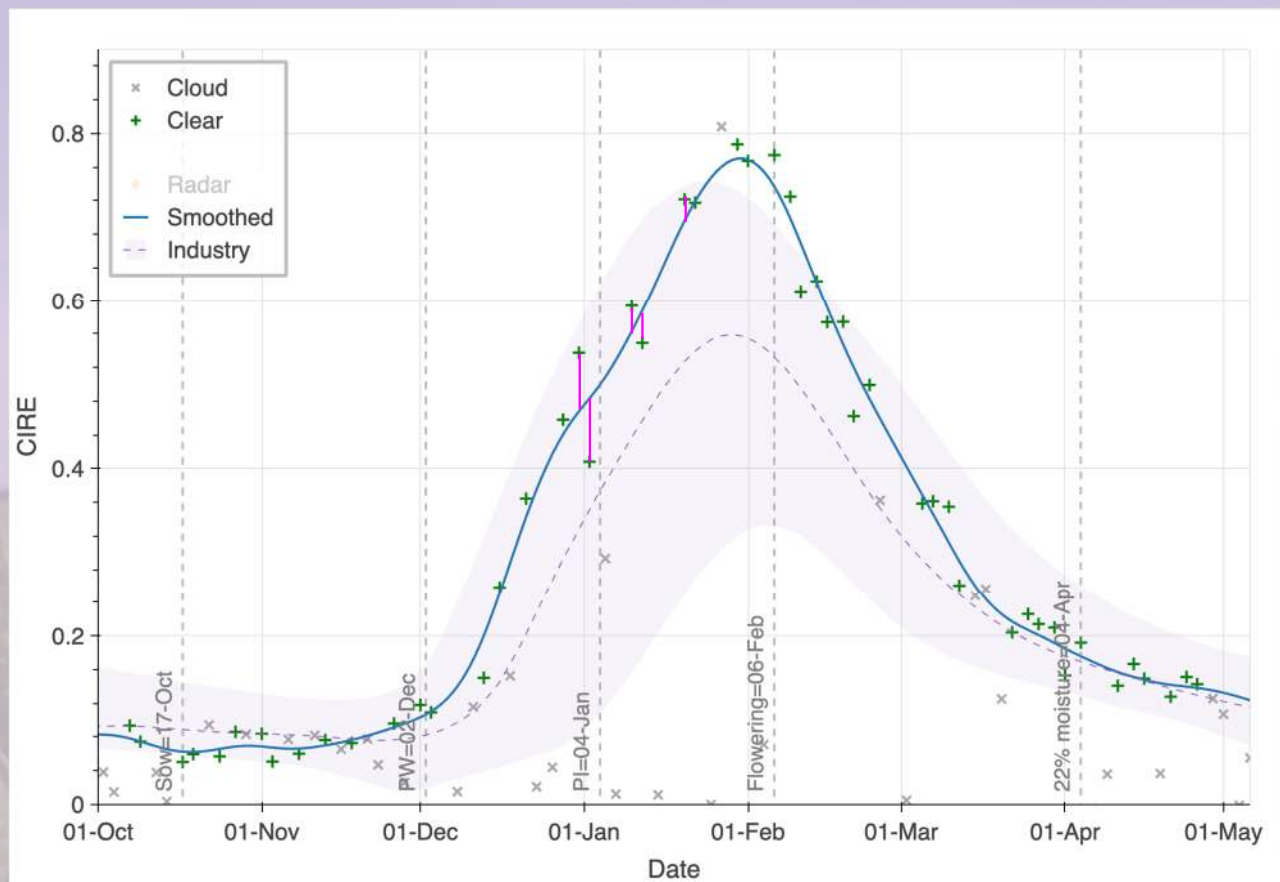


Challenge 2: Cloud



Sometimes makes indices increase!

Challenge 3: atmosphere, sensor, angle



Conclusion

- Real-time growth curves concept
 - Analyse industry-wide performance
 - Manage crop in-season by benchmarking
- Constant improvement in satellites and algorithms
 - Crop phenology vs management and environment
 - Cloud and image imperfections

