



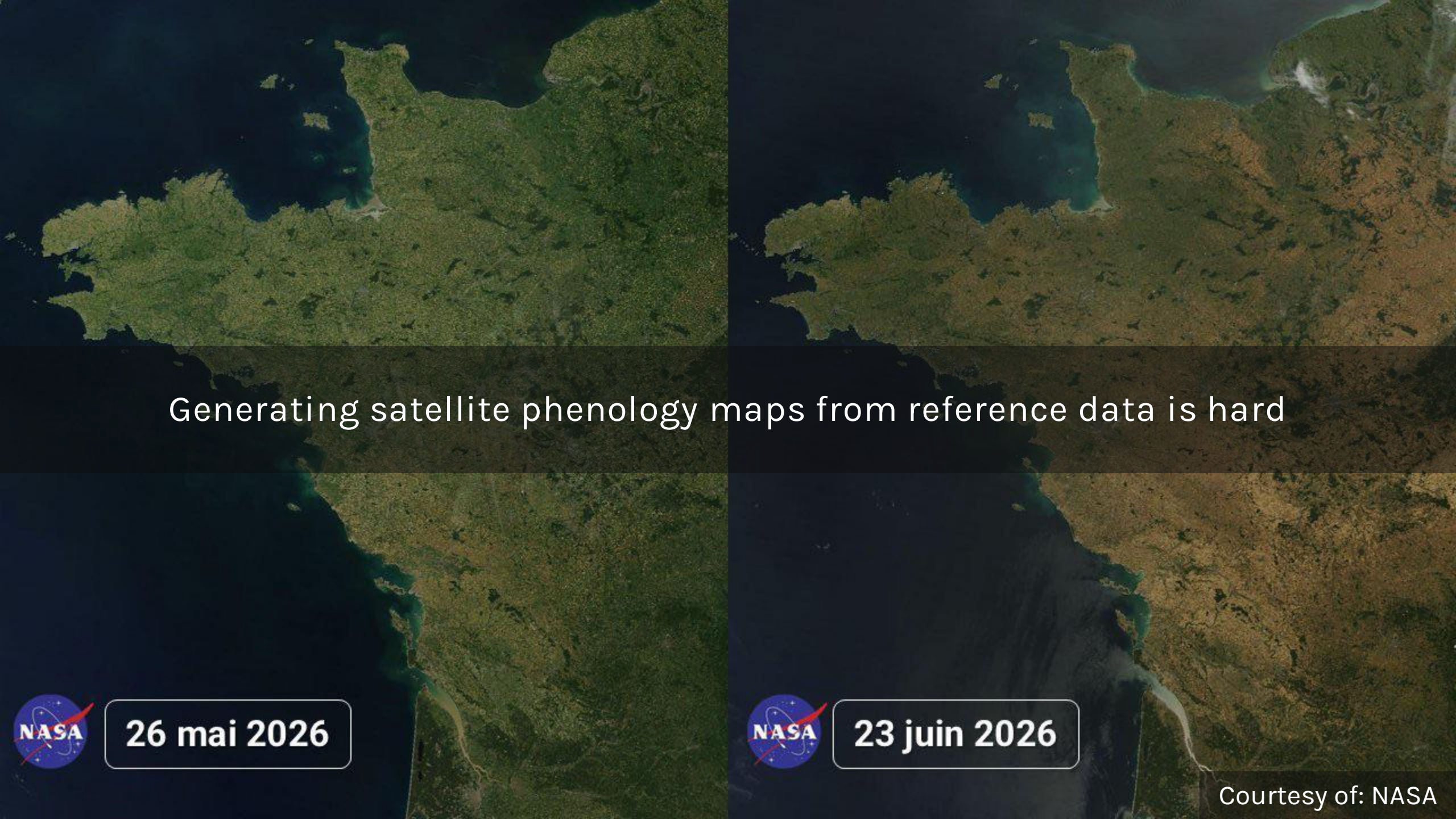
Timely Crop Phenology Prediction from Field-Level Imagery and Satellite Time Series with Vision-Language Models

Stefano Maurogiovanni | PhD Retreat | 13.10.2026



UNIVERSITY
OF TWENTE.



The image is a composite of four satellite images of a coastal region, arranged in a 2x2 grid. The top-left image shows a lush green landscape. The top-right image shows a landscape with some brown patches. The bottom-left image shows a landscape with some brown patches. The bottom-right image shows a landscape with some brown patches. The text "Generating satellite phenology maps from reference data is hard" is centered over the images.

Generating satellite phenology maps from reference data is hard



26 mai 2026



23 juin 2026

Courtesy of: NASA

Phenology of a vegetated field

Early stages



■ Sowing — 09.11.2024



■ Emergence — 26.05.2025

Phenology of a vegetated field

Greening



■ Green-up — 02.06.2025



■ Vegetation peak — 19.06.2025

Phenology of a vegetated field

Late stages

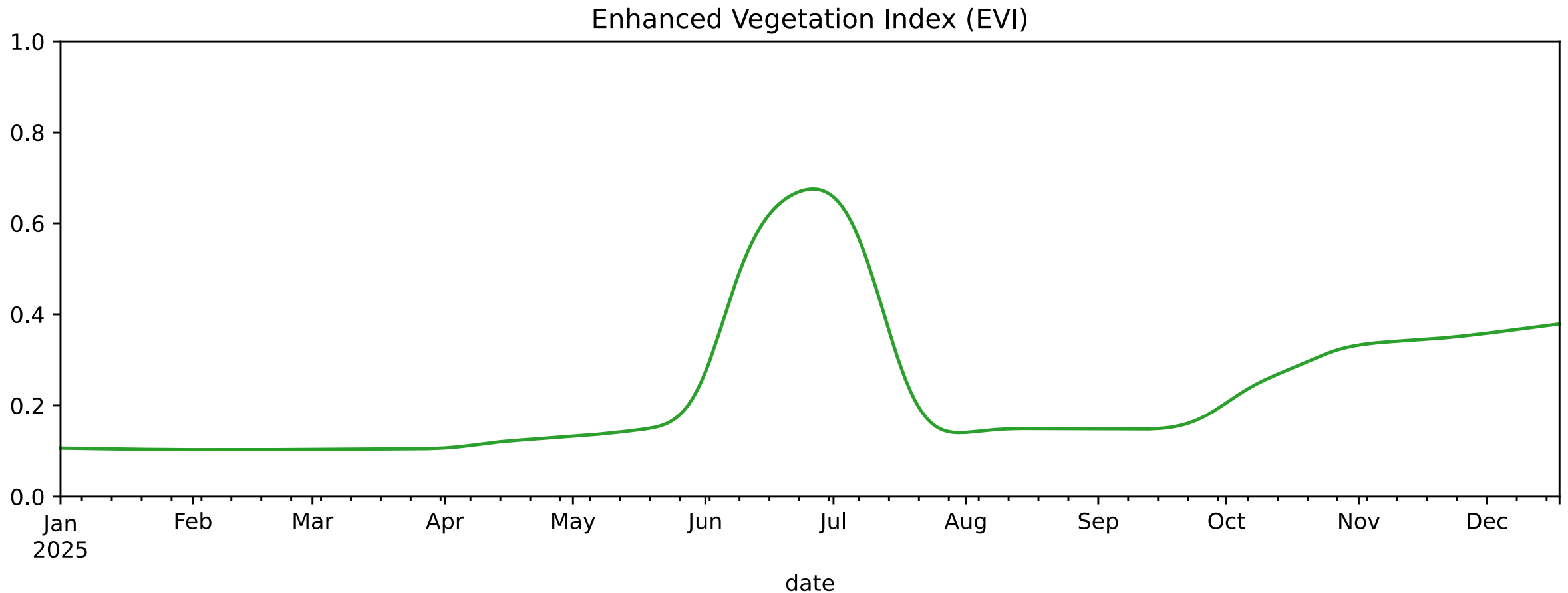


■ Senescence — 01.08.2025

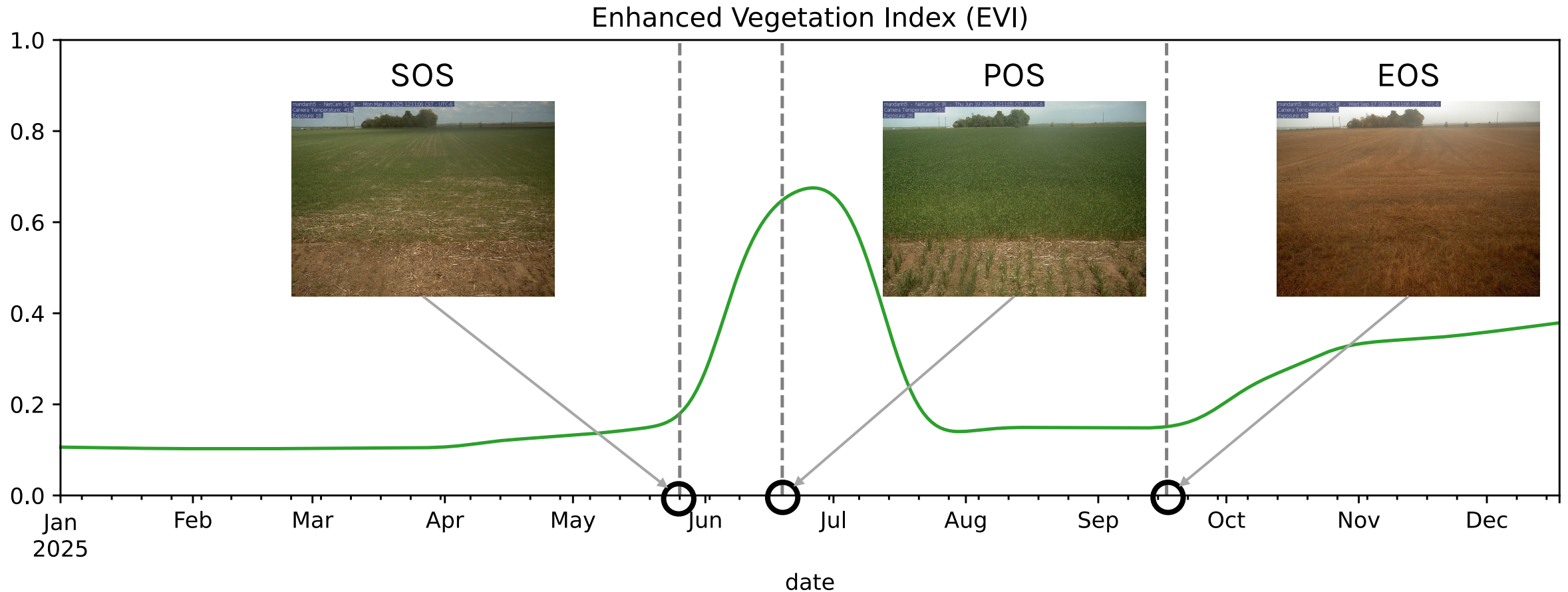


■ Post-harvest — 17.09.2025

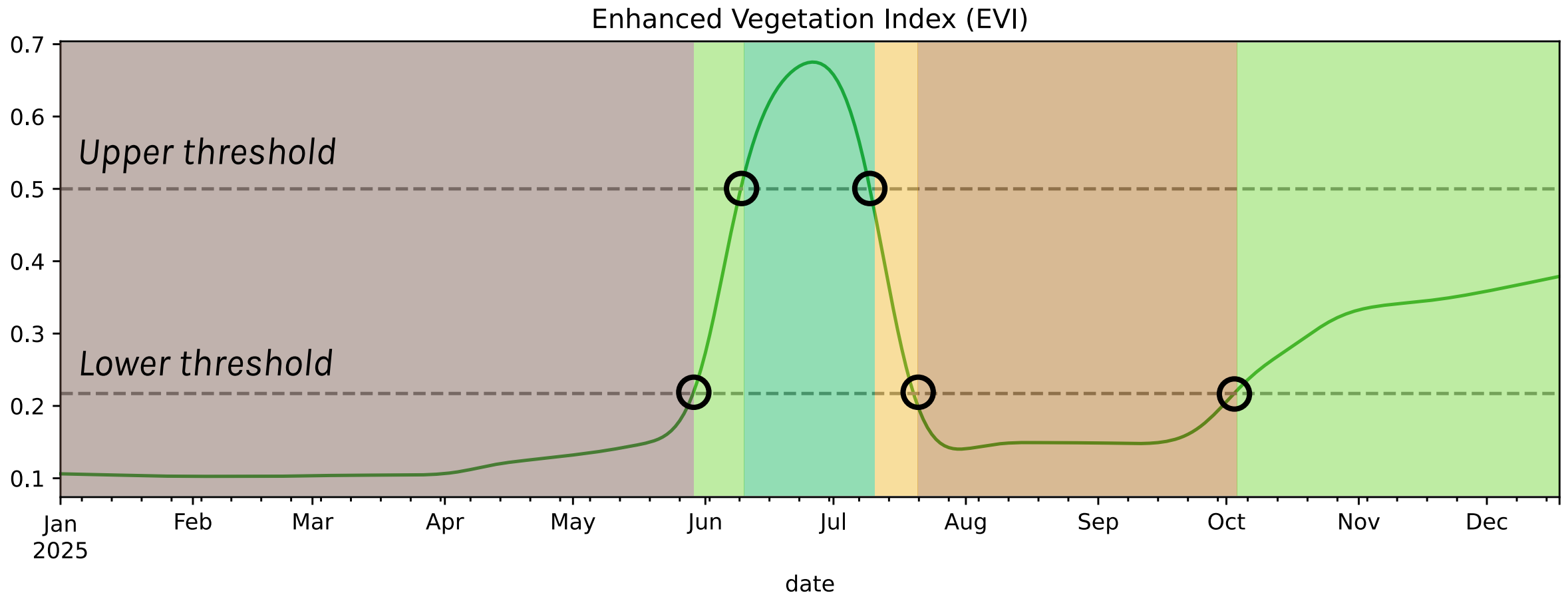
Land Surface Phenology (LSP) from satellite imagery is predicted from vegetation index timeseries



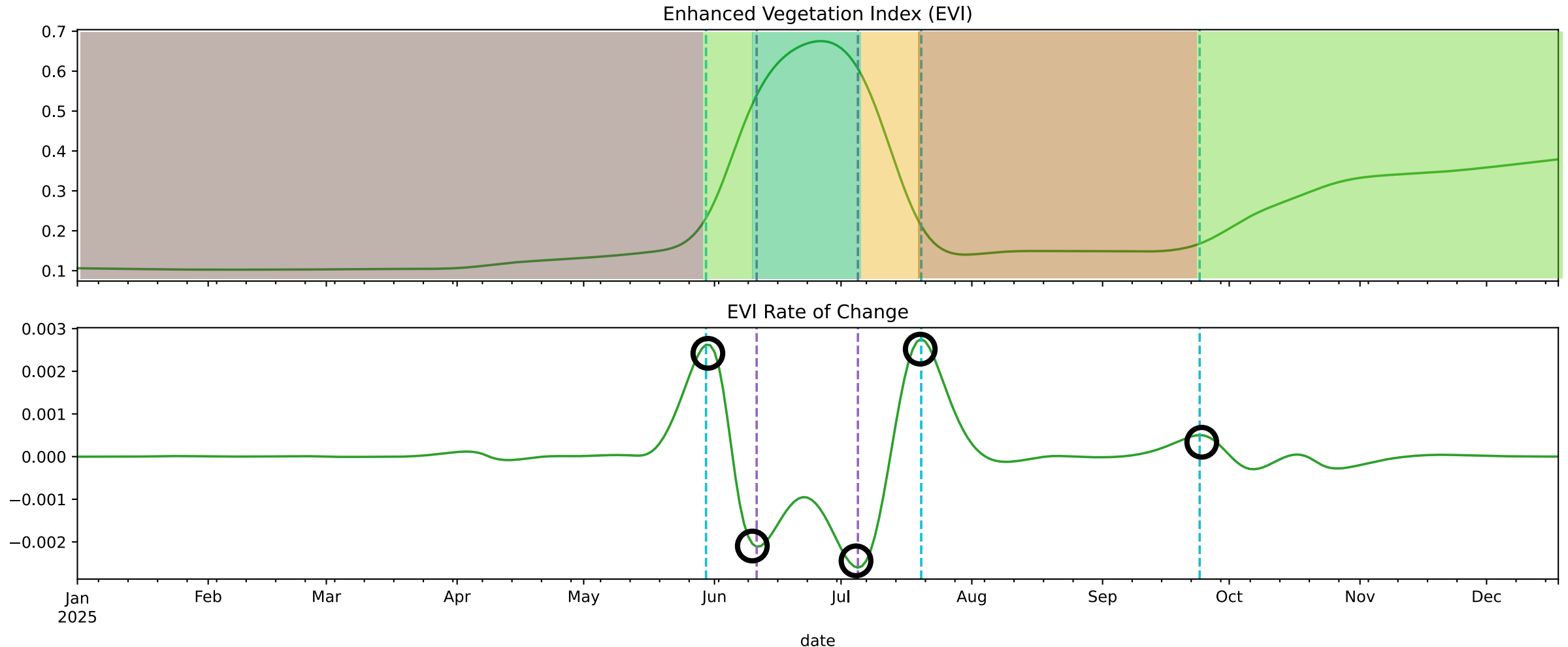
Start Of Season (SOS), Peak Of Season (POS) and End Of Season (EOS) dates are common LSP indicators



LSP classification methods based on thresholding vegetation index values

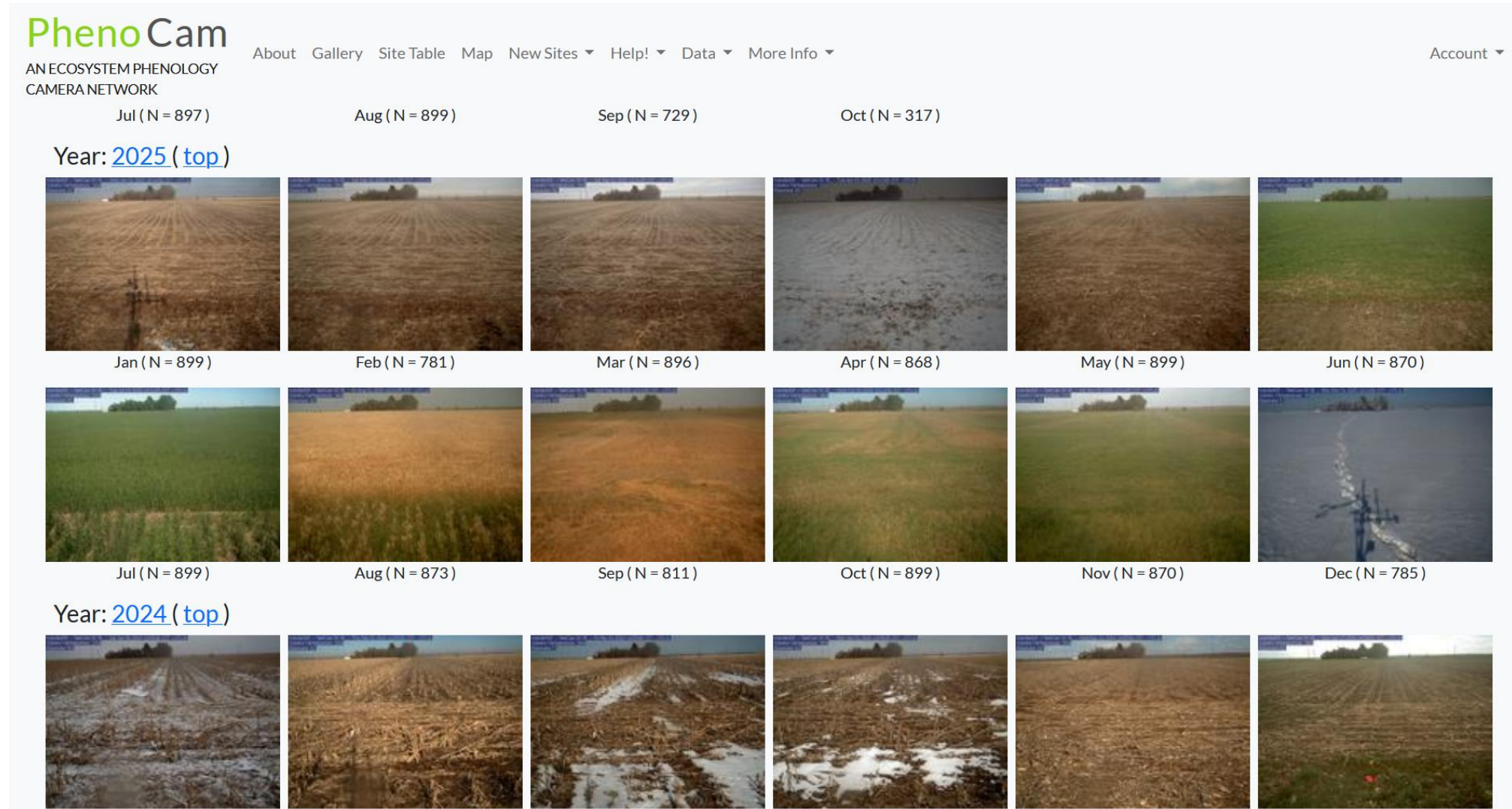


LSP classification methods based on change detection in vegetation index trends



Zhang, Xiaoyang, et al. 2003. "Monitoring Vegetation Phenology Using MODIS."
Remote Sensing of Environment 84 (3): 471-75. [https://doi.org/10.1016/s0034-4257\(02\)00135-9](https://doi.org/10.1016/s0034-4257(02)00135-9).

The PhenoCam Network

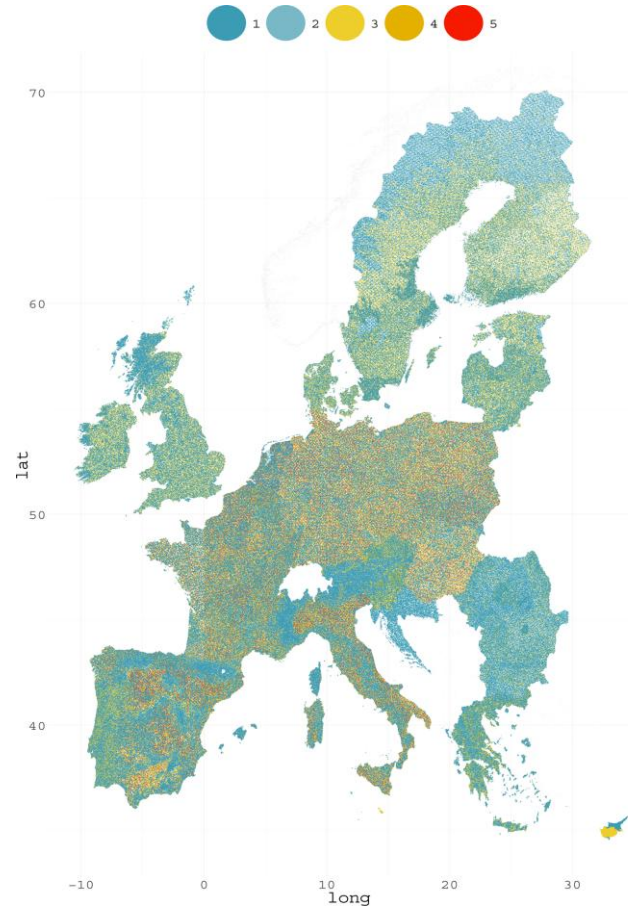


+700
locations
+60 M
photos
+40
variables
18
years

LUCAS records and openly distributes *in-situ* LCLU data and photos across Europe from 2006



(a)



+650 K

locations

+5.4 M

photos

+100

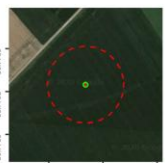
variables

6

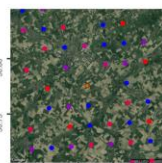
iterations



(b)



(c)



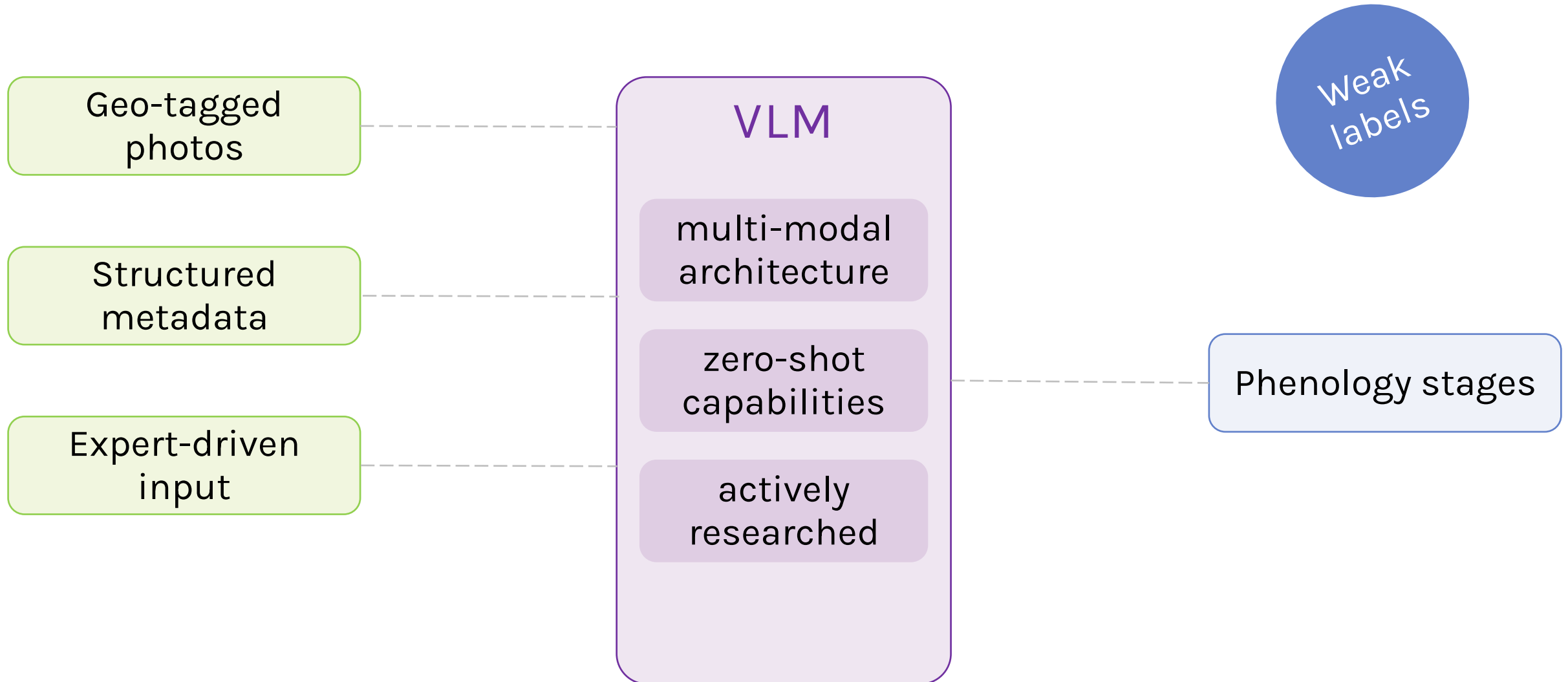
(d)



(e)

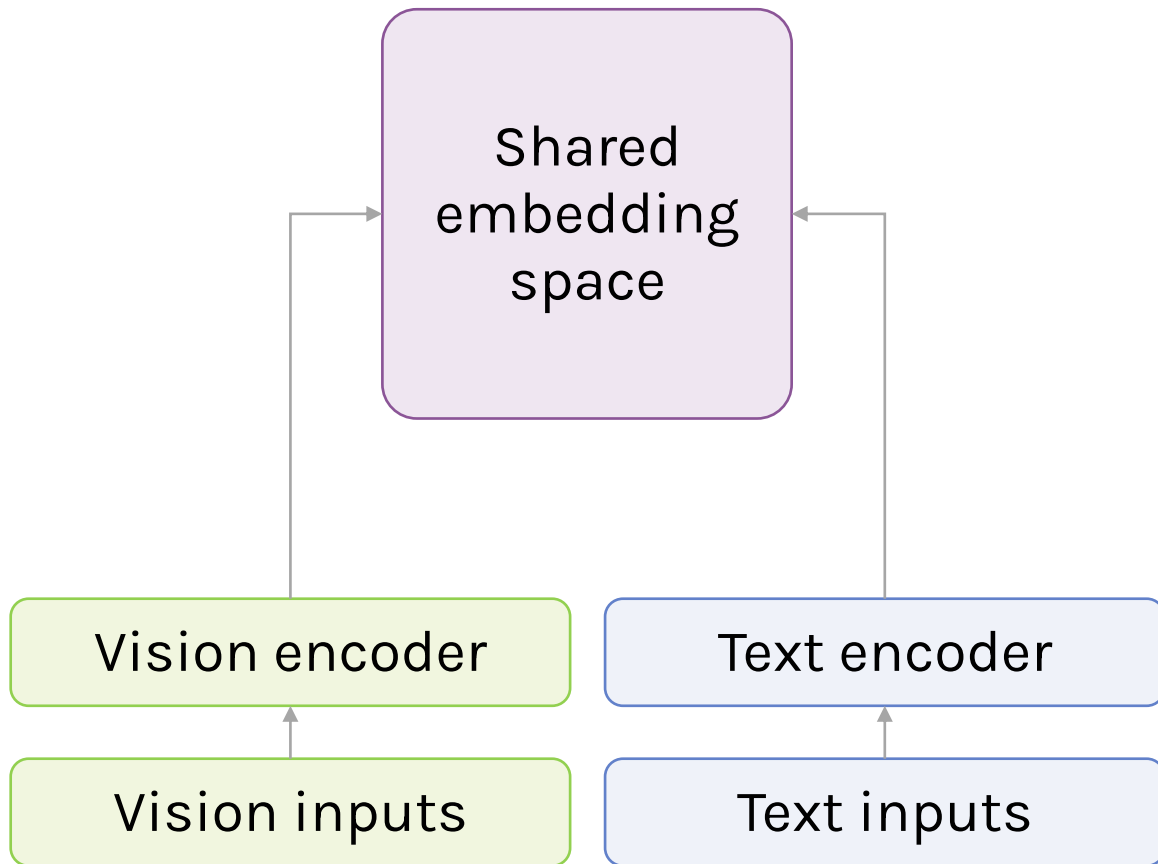
d'Andrimont, R., et al. (2020). Harmonised LUCAS in-situ land cover and use database for field surveys from 2006 to 2018 in the European Union. *Sci Data* 7, 352 (2020). <https://doi.org/10.1038/s41597-020-00675-z>

Leveraging zero-shot capabilities of vision-language models (VLMs)



Contrastive VLMs are best suited for closed-ended tasks

Contrastive (CLIP-like)



- ✓ Best fit for closed-ended classification tasks
- ✓ Already pretrained on many diverse data
- ✓ Zero-shot capabilities



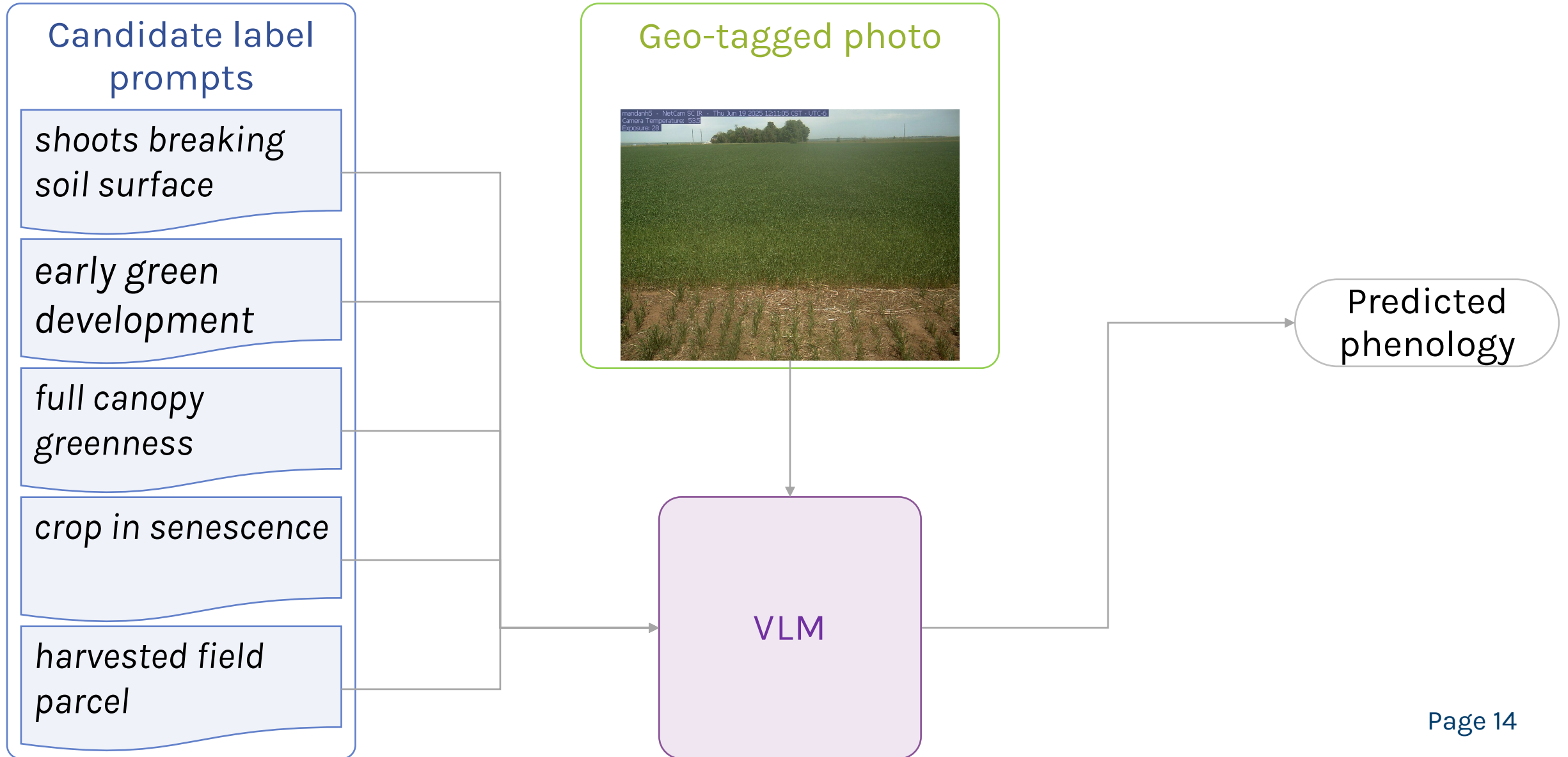
Meta CLIP 2

Chuang, Y., et al. (2025).

Meta CLIP 2: A Worldwide Scaling Recipe.

ArXiv, abs/2507.22062.

VLM zero-shot phenology classification



Classifiers agreement

Sample	Manual	Threshold	Change detection	VLM
mandanh5_2024_06_17_150228	emergence	emergence	emergence	post-harvest
mandanh5_2024_06_17_201105	emergence	emergence	emergence	post-harvest
mandanh5_2024_06_20_074106	emergence	emergence	emergence	post-harvest
mandanh5_2024_06_21_131105	emergence	emergence	emergence	post-harvest
mandanh5_2024_06_21_151106	emergence	emergence	emergence	post-harvest
mandanh5_2025_05_07_151105	emergence	emergence	emergence	vegetation-peak
mandanh5_2025_05_07_191106	emergence	emergence	emergence	post-harvest
mandanh5_2025_05_12_174105	emergence	emergence	emergence	vegetation-peak
mandanh5_2025_05_13_164105	emergence	emergence	emergence	vegetation-peak
mandanh5_2025_05_17_194105	emergence	emergence	emergence	post-harvest
mandanh5_2024_07_09_114105	green-up	emergence	emergence	vegetation-peak
mandanh5_2024_07_09_191106	green-up	emergence	emergence	post-harvest
mandanh5_2024_07_12_204106	green-up	emergence	green-up	vegetation-peak
mandanh5_2024_07_15_124105	green-up	green-up	green-up	vegetation-peak
mandanh5_2024_07_19_204105	green-up	green-up	green-up	vegetation-peak
mandanh5_2025_05_23_201105	green-up	emergence	emergence	vegetation-peak
mandanh5_2025_05_26_121106	green-up	emergence	emergence	vegetation-peak
mandanh5_2025_05_30_201105	green-up	green-up	green-up	vegetation-peak
mandanh5_2025_06_02_121105	green-up	green-up	green-up	vegetation-peak
mandanh5_2025_06_08_111106	green-up	green-up	green-up	vegetation-peak

Classifiers agreement

Sample	Manual	Threshold	Change detection	VLM
mandanh5_2024_10_01_124105	post-harvest	post-harvest	post-harvest	post-harvest
mandanh5_2024_11_08_081105	post-harvest	post-harvest	post-harvest	post-harvest
mandanh5_2024_11_09_121105	post-harvest	post-harvest	post-harvest	post-harvest
mandanh5_2024_11_19_164105	post-harvest	post-harvest	post-harvest	post-harvest
mandanh5_2025_09_06_141105	post-harvest	post-harvest	post-harvest	post-harvest
mandanh5_2025_09_09_191106	post-harvest	post-harvest	post-harvest	post-harvest
mandanh5_2025_09_17_151106	post-harvest	post-harvest	post-harvest	post-harvest
mandanh5_2025_09_20_171106	post-harvest	post-harvest	post-harvest	post-harvest
mandanh5_2024_09_10_151106	senescence	senescence	senescence	post-harvest
mandanh5_2024_09_10_191107	senescence	senescence	senescence	senescence
mandanh5_2024_09_13_084106	senescence	senescence	senescence	senescence
mandanh5_2024_09_18_184106	senescence	post-harvest	post-harvest	post-harvest
mandanh5_2024_09_20_191107	senescence	post-harvest	post-harvest	post-harvest
mandanh5_2025_07_19_121106	senescence	senescence	senescence	senescence
mandanh5_2025_07_22_121106	senescence	post-harvest	post-harvest	senescence
mandanh5_2025_07_31_201106	senescence	post-harvest	post-harvest	senescence
mandanh5_2025_08_01_121105	senescence	post-harvest	post-harvest	senescence
mandanh5_2025_08_09_121106	senescence	post-harvest	post-harvest	senescence
mandanh5_2024_07_31_204106	vegetation-peak	vegetation-peak	vegetation-peak	vegetation-peak
mandanh5_2024_08_05_151105	vegetation-peak	vegetation-peak	vegetation-peak	vegetation-peak
mandanh5_2024_08_21_191105	vegetation-peak	vegetation-peak	vegetation-peak	vegetation-peak
mandanh5_2024_09_02_071106	vegetation-peak	vegetation-peak	vegetation-peak	vegetation-peak
mandanh5_2024_09_08_111105	vegetation-peak	senescence	senescence	post-harvest
mandanh5_2025_06_15_201106	vegetation-peak	vegetation-peak	vegetation-peak	senescence
mandanh5_2025_06_19_121105	vegetation-peak	vegetation-peak	vegetation-peak	vegetation-peak
mandanh5_2025_06_22_201106	vegetation-peak	vegetation-peak	vegetation-peak	vegetation-peak
mandanh5_2025_06_30_121105	vegetation-peak	vegetation-peak	vegetation-peak	vegetation-peak
mandanh5_2025_07_04_071107	vegetation-peak	vegetation-peak	vegetation-peak	vegetation-peak

VLM zero-shot misclassifications



- Emergence (manual annotation)
- Post-harvest (VLM)



- Emergence (manual annotation)
- Vegetation peak (VLM)

Ongoing and future work

Enable detailed phenology classification from satellite and field-level imagery



Better candidate label
prompts engineering



Integration of temporal
and spatial information



Finetuning on a curated
phenology dataset

Stay tuned!



UNIVERSITY
OF TWENTE.



AgroVision

About

People

Publications

AgroVision

AI and Remote Sensing for precision agriculture.

AgroVision provides automated, high-quality reference data for agriculture by integrating geo-tagged field photos and remote-sensing time series with weather and soil information.

News and Highlights

- [23 June 2026]: The AgroVision project is presented during the “Fishbowl discussion on Foundation Models” segment of the [ESA Φ-Week Summit](#).
- [07 May 2026]: The paper “From Satellite Data and Geo-Tagged Field Photos to Reliable Agricultural Reference Data” is presented at [EGU](#).
- [20 April 2026]: The paper “From Satellite Data and Geo-Tagged Field Photos to Reliable Agricultural Reference Data” is accepted for oral presentation at [IGARSS](#).
- [20 April 2026]: The paper “Combining VLM and Geo-Tagged Field Photos for Scalable Agricultural Reference Data” is accepted for oral presentation at [IGARSS](#).



AgroVision project

<https://agrovision-project.github.io>



AgroFusion dataset

<https://zenodo.org/records/21641411>

This work is supported by the AgroVision project, “An Innovative Foundation Model for the Fusion of Satellite Image Time Series and Field Photos into Comprehensive Agricultural Reference Data”, funded by the European Space Agency (ESA) Φ-Lab under contract No: 4000147606.