Institutional Forcings on Agricultural Landscapes in Post-Socialist Europe:

Diachronic Hotspot Analysis of CAP Influences on Agricultural Land Use in Romania 2002-2024

Monika Tomaszewska, Geoffrey Henebry, Elizabeth Mack : *Michigan State University, US*

Igor Sîrodoev, Mirela Paraschiv, Andrei Schvab : *Ovidius University of Constanța, RO*

Ioan Ianoş : *University of Bucharest, RO*

Center for Global Change and Earth Observations
MICHIGAN STATE UNIVERSITY

UNIVERSITY OF BUCHAREST
VIRTUTE ET SAPIENTIA

LCLUC
LAND-COVER AND LAND-USE CHANGE

LCLUC Science Team Meeting

02-04 APR 2024 Gaithersburg, MD

Institutional Forcings on Agricultural Landscapes in Post-Socialist Europe:

Diachronic Hotspot Analysis of CAP Influences on Agricultural Land Use in Romania 2002-2024

The Common Agricultural Policy (CAP) is a very large and complicated suite of policy instruments that influences agricultural activities across the EU.

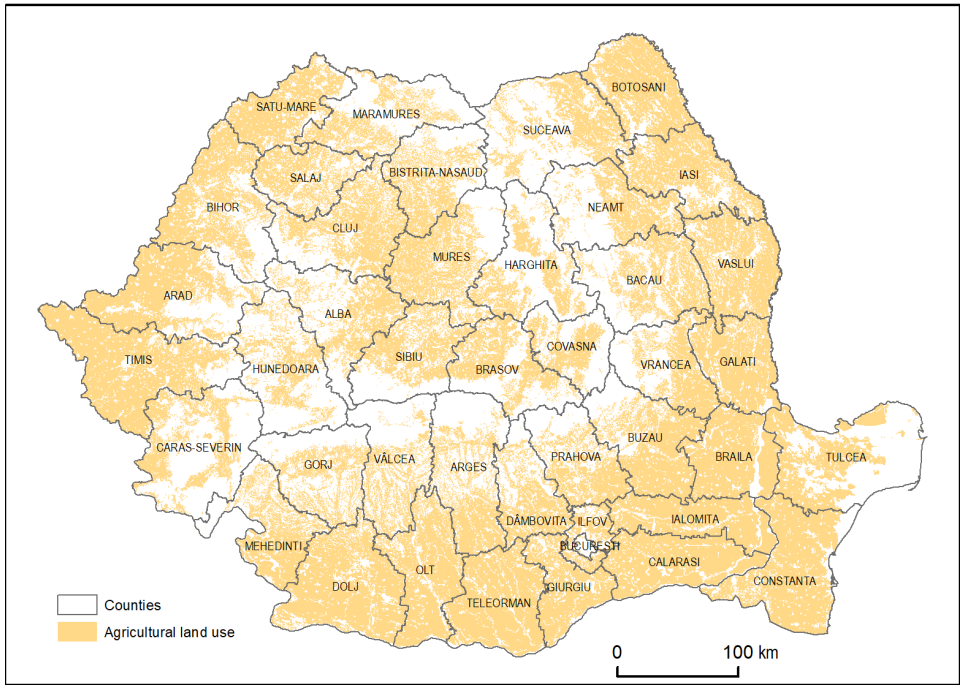
CAP programs include livelihood payments to farmers, environmental protections, rural development projects, and other incentives.

We seek to understand how the diffusion of innovation—here CAP program enrollments and payments—work to influence land use change.

Institutional Forcings on Agricultural Landscapes in Post-Socialist Europe:

Diachronic Hotspot Analysis of CAP Influences on Agricultural Land Use in Romania 2002-2024

Agricultural land use in Romania in 2018



Romania is a highly agricultural country (~58% of the land area) with agriculture the basis of the economy in much of the country. With a 2022 per-capita GDP of US$15,790, it is one of the poorer nations in the EU.

The Common Agricultural Policy (CAP) is a very large and complicated suite of policy instruments that influences agricultural activities across the EU.

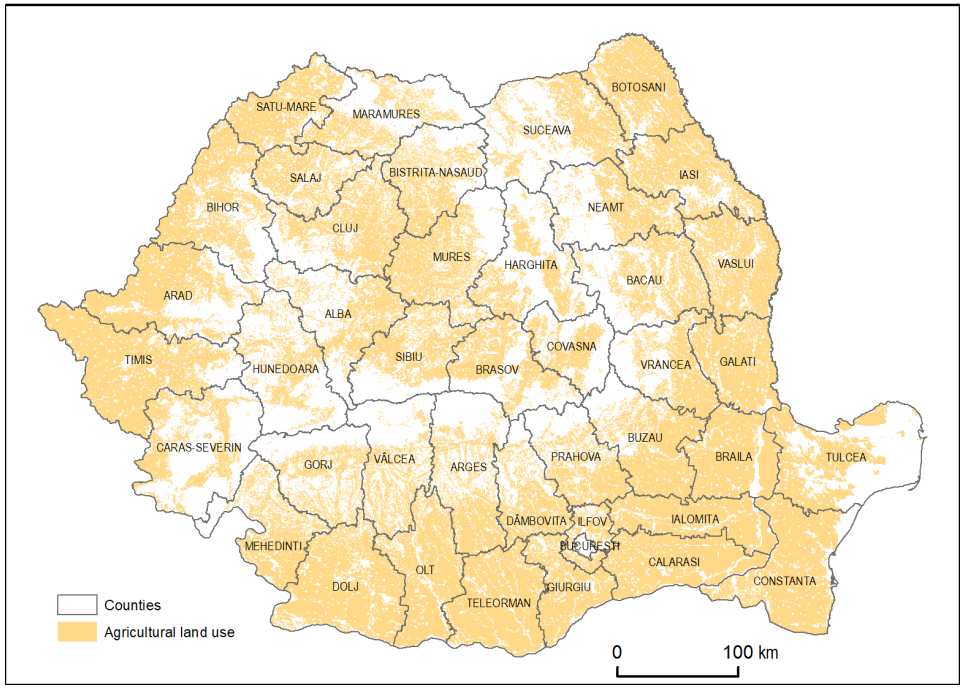
CAP programs include livelihood payments to farmers, environmental protections, rural development projects, and other incentives.

We seek to understand how the diffusion of innovation—here CAP program enrollments and payments—work to influence land use change.

Institutional Forcings on Agricultural Landscapes in Post-Socialist Europe:

Diachronic Hotspot Analysis of CAP Influences on Agricultural Land Use in Romania 2002-2024

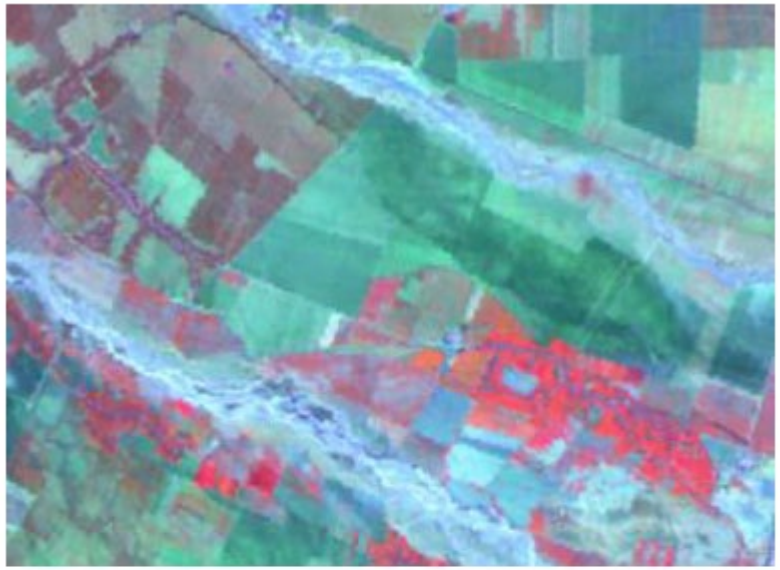
Agricultural land use in Romania in 2018



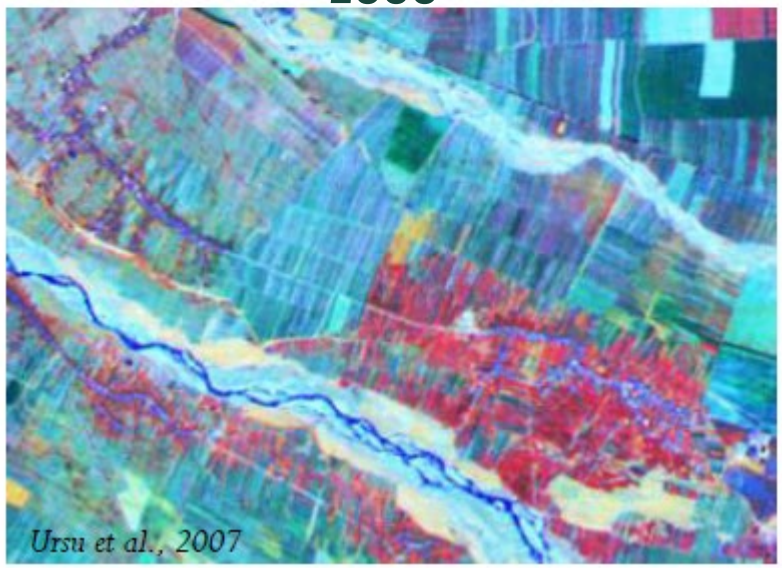
Romania's post-socialist land reform resulted in highly fragmented patterns of crop production.

There have been changes in crop composition and spatial patterns since its EU entry in 2007.

1987



2000

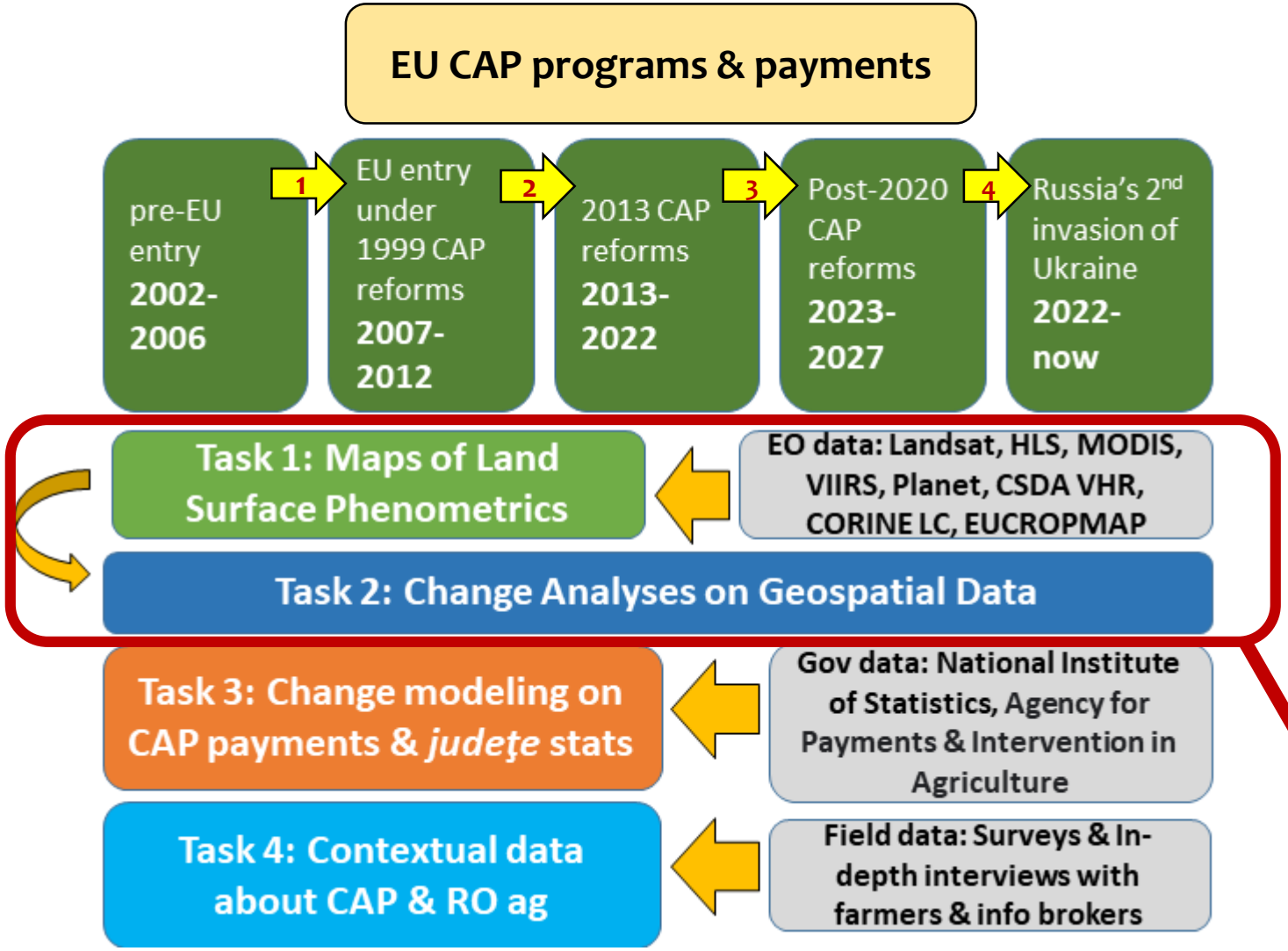


Land fragmentation due to restitution

Institutional Forcings on Agricultural Landscapes in Post-Socialist Europe:

Diachronic Hotspot Analysis of CAP Influences on Agricultural Land Use in Romania 2002-2024

Overview of the project concept & workflow



The Common Agricultural Policy (CAP) is a very large and complicated suite of policy instruments that influences agricultural activities across the EU.

CAP programs include livelihood payments to farmers, environmental protections, rural development projects, and other incentives.

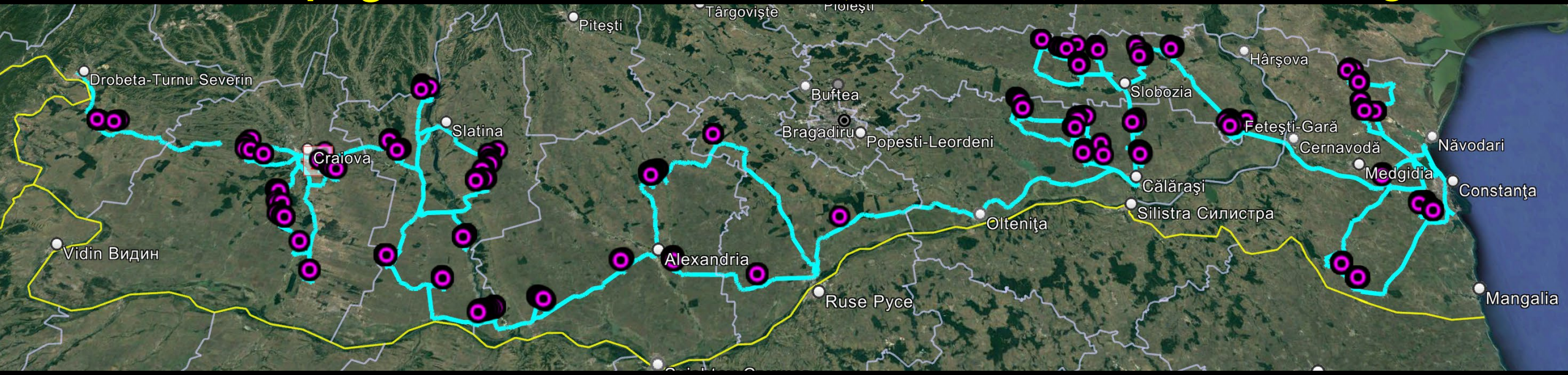
We seek to understand how the diffusion of innovation—here CAP program enrollments and payments—work to influence land use change.

We propose a diachronic hotspot analysis for Romania that focuses attention on agricultural land use changes following four triggering events:

1. **Romania's entry into the EU and the CAP in 2007;**
2. **the 2013 CAP reforms;**
3. **the "post-2020" CAP reforms, which are necessarily convolved during the duration of this project with**
4. **the manifold repercussions of the Russian invasion of Ukraine starting in February 2022.**

Today's focus is on our work to date addressing the first two tasks

2023 Field Campaign in Southern Romania: 8 *județe* in 14 days → 26JUN through 09JUL



Field points by *județ* arranged west to east

Județ	#
MEHEDINȚI	55
DOLJ	86
OLT	170
TELEORMAN	116
GIURGIU	26
IALOMIȚA	185
CĂLĂRAȘI	137
CONSTANȚA	274
Total points	1049

Household & Commercial Farm Surveys, and In-depth Interviews

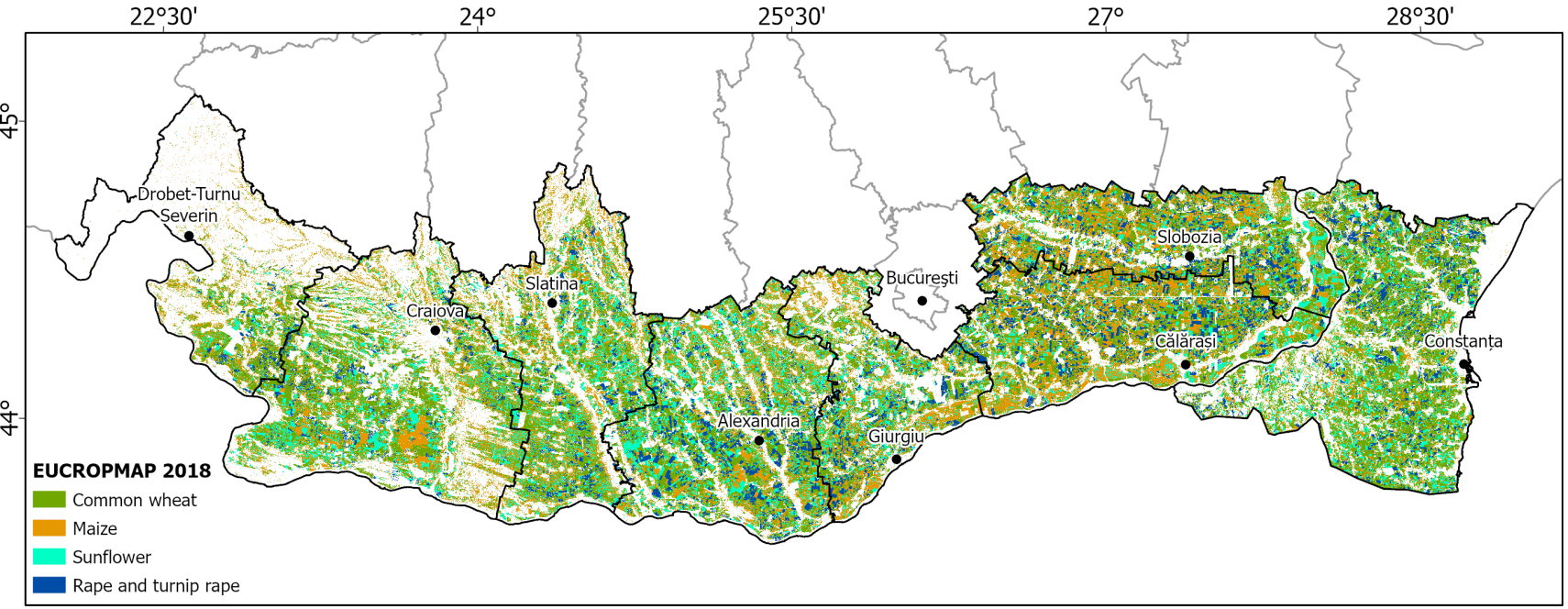
Social surveys by *județ* arranged west to east

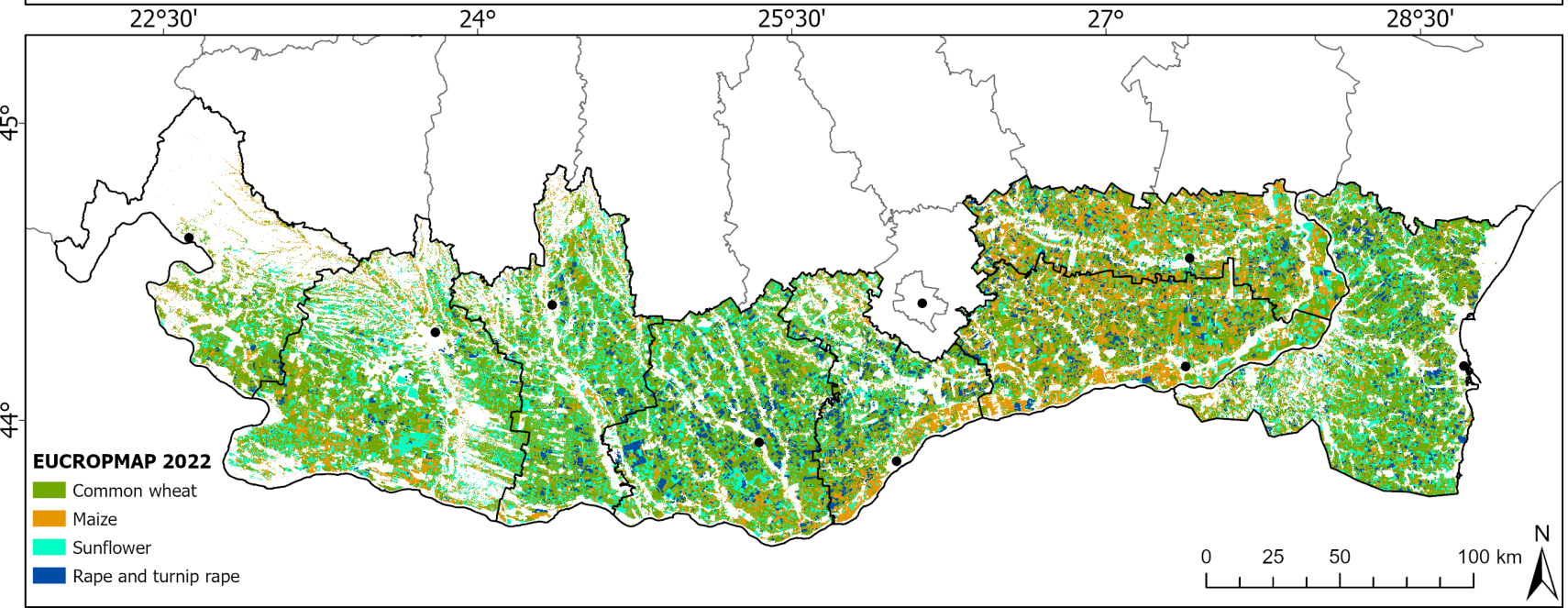
Județ	#
MEHEDINȚI	17
DOLJ	197
OLT	157
TELEORMAN	126
GIURGIU	57
IALOMIȚA	125
CĂLĂRAȘI	181
CONSTANȚA	135
Total surveys	995

Selected Survey Questions

- How long have you owned your farm? What is the approximate size of your farm in hectares?
- What types of crops do you grow on your farm?
- What resources would be helpful to you in applying for European money?
- Are the European funds enough to increase the profitability of your farm?
- How have European funds changed your farming practices?
- Have you adopted any innovative farming practices? Where did you hear about these practices?
- How likely are you to try new technologies? Describe why or why not.
- Please describe changes in the demand for your farming products in the last 5 years.
- How has the war in the Ukraine impacted your farm?

European Union Crop type Map (EUCROPMAP), but nothing like the CDL !





European Union does not have a product like the CDL, an annual crop type map

EUCROPMAP was prepared by JRC for 2018 and 2022

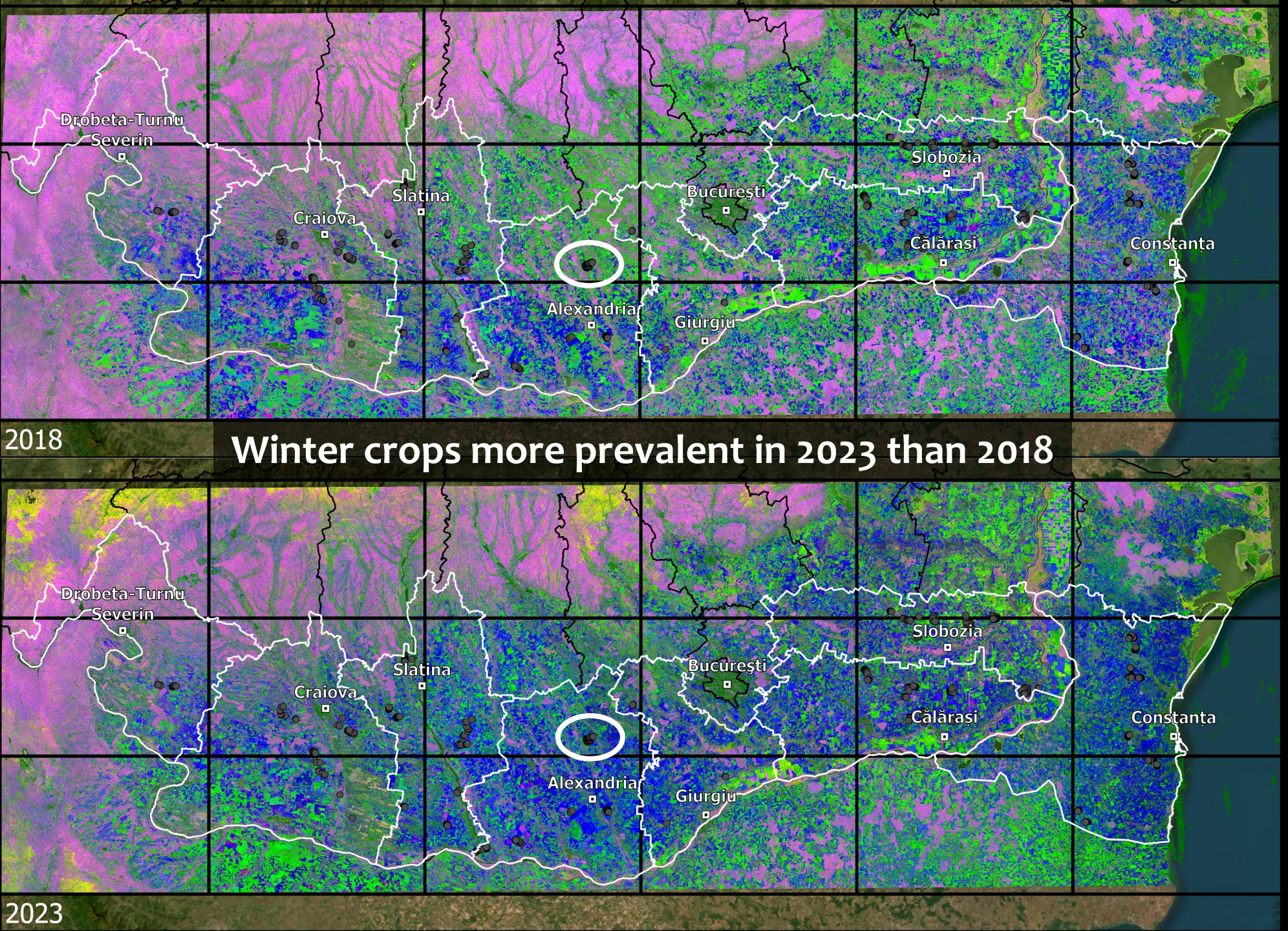
Based on Sentinel-1 and LUCAS Copernicus in-situ observations

According to **EUCROMAP** between 2018 and 2022, **maize area decreased 22%**, while according to **RO National Institute of Statistics** maize area increased 1%.

	EUCROPMAP			RO National Institute of Statistics		
	Maize (km²)		%diff	Maize (km²)		%diff
Judeţ	2018	2022	2018-2022	2018	2022	2018-2022
MEHEDINŢI	338	192	-43	512	430	-16
DOLJ	1,082	648	-40	850	758	-11
OLT	943	455	-52	899	561	-38
TELEORMAN	972	500	-49	657	612	-7
GIURGIU	754	524	-31	444	467	+5
IALOMIŢA	1,089	1,299	+19	842	1,175	+40
CĂLĂRAŞI	1,305	1,386	+6	1,023	1,259	+23
CONSTANŢA	630	548	-13	563	589	+5
TOTAL	7,113	5,552	-22	5,790	5,851	+1

According to **EUCROMAP** between 2018 and 2022, **rapeseed (rape & turnip rape) area decreased 27%**, similar to **RO National Institute of Statistics: 26%.**

	EUCROPMAP			RO National Institute of Statistics		
	Rapeseed (km²)		%diff	Rapeseed (km²)		%diff
Judeţ	2018	2022	2018-2022	2018	2022	2018-2022
MEHEDINŢI	81	30	-63	87	64	-27
DOLJ	269	114	-58	301	173	-42
OLT	292	223	-24	238	202	-15
TELEORMAN	599	560	-7	592	418	-29
GIURGIU	286	309	+8	271	279	+3
IALOMIŢA	538	315	-41	628	400	-36
CĂLĂRAŞI	640	388	-39	681	492	-28
CONSTANŢA	599	464	-23	448	373	-17
TOTAL	3,303	2,402	-27	3,246	2,401	-26



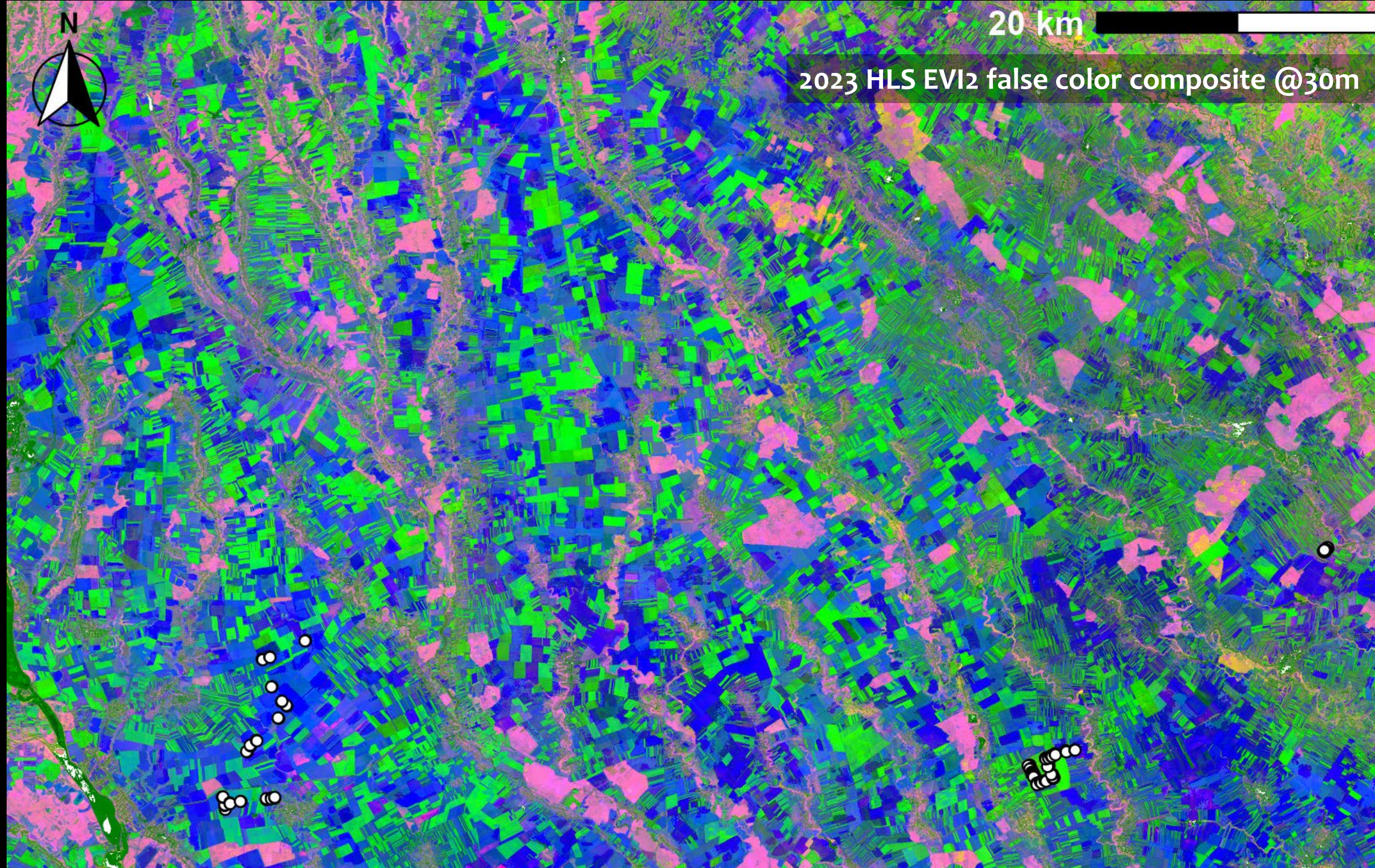
Using dense time series of HLS @ 30m to reveal winter & summer crops across southern Romania in 2018 & 2023

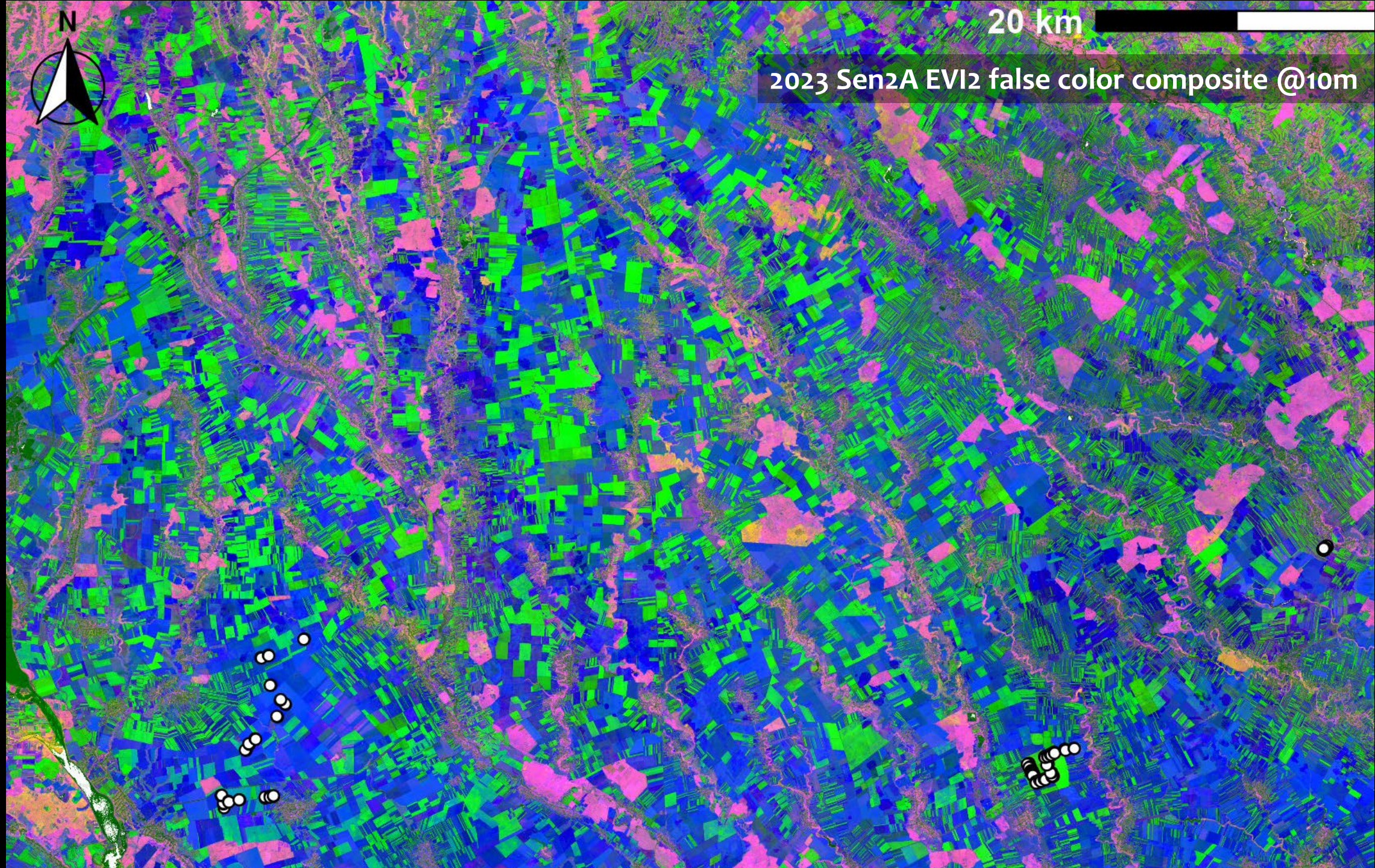
Magentas indicate forested areas

Greens indicate Summer crops (maize, sunflower, soy)

Blues indicate Winter crops (wheat, barley, rapeseed)

Yellows indicate very low spring EVI2 due to snow or persistent clouds at higher elevations

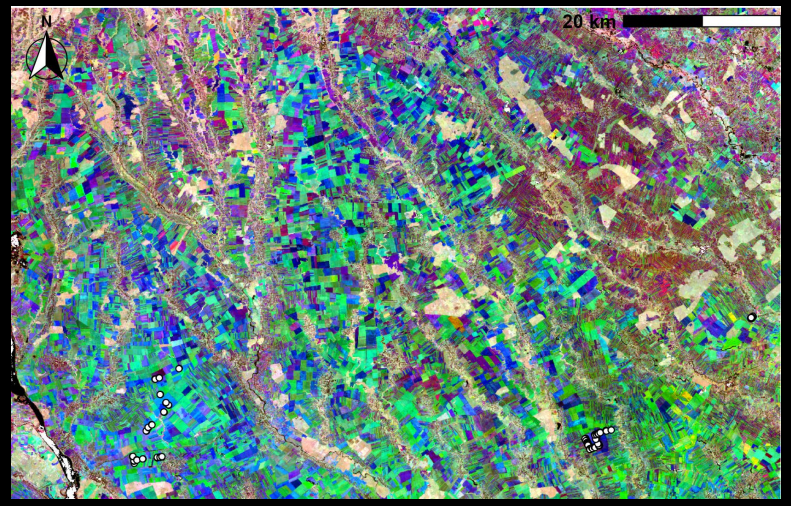

N
20 km
2023 HLS EVI2 false color composite @30m


N
20 km
2023 Sen2A EVI2 false color composite @10m

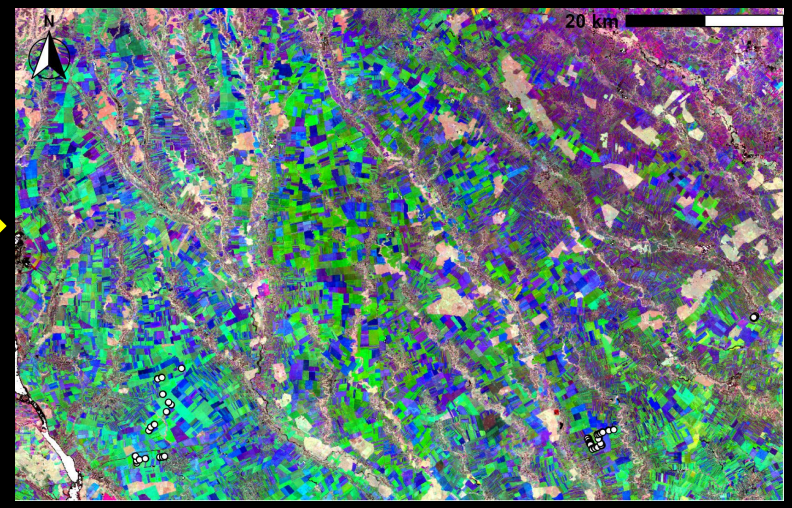
False Color Composites displaying seasonality @ 30m reveal cropland spatial heterogeneity of

- winter crops (greens),
- summer crops (cyans & blues),
- cover & forage crops (yellows & magentas), and
- persistent vegetation (tans & greys)

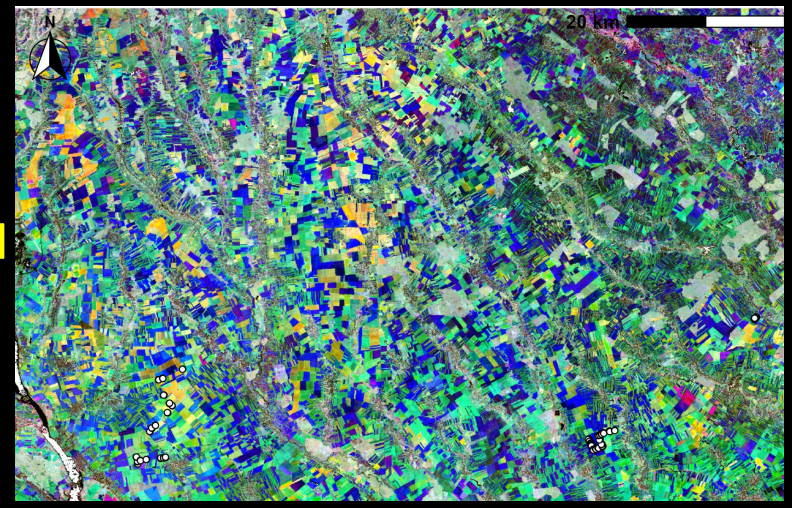
2018-2019



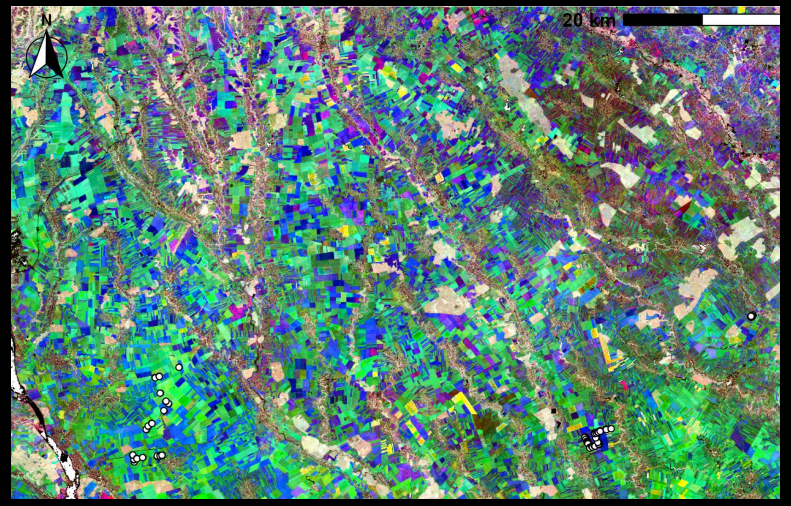
2019-2020



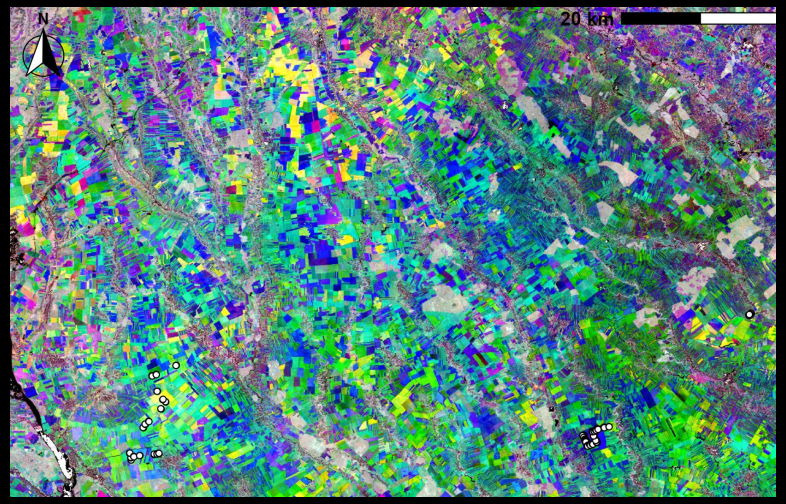
2020-2021



2021-2022



2022-2023



Characterizing cropland LSPs using accumulated growing degree-days (AGDDs) of different base temperatures

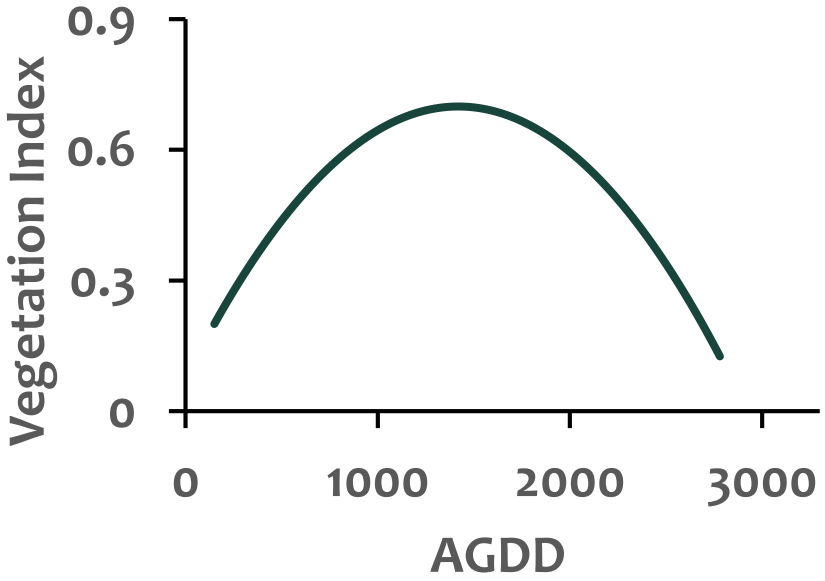
base temperature (°C)	example crops
0	Perennial crops (alfalfa, native hays)
4	Winter/Spring crops (wheat, barley, rapeseed, sunflower)
10	Summer crops (maize, soy)

LST products: [MOD21A2 & MYD21A2 C6.1] & [VNP21A2 & VJ121A2]

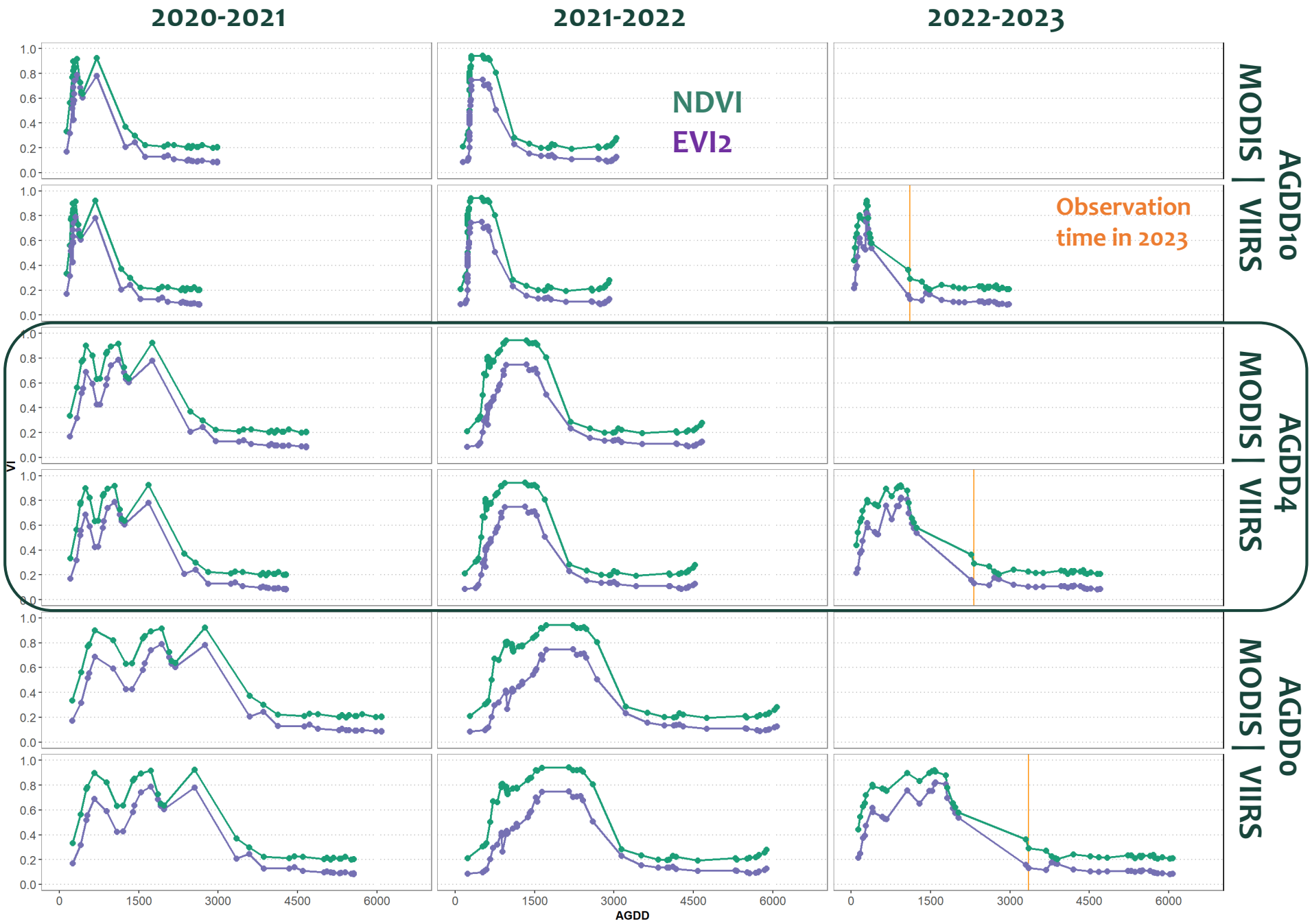
$$AvgLST_t = (maxLST_t + minLST_t)/2$$

$$AGDDbt_t = AGDDbt_{t-1} + [max(AvgLST_t - bt, 0)]*8$$

Calculate AGDD0, AGDD4, AGDD10 starting at 01OCT of previous year to capture winter crops



Rape_and_turnip_rape P229C1 Teleorman

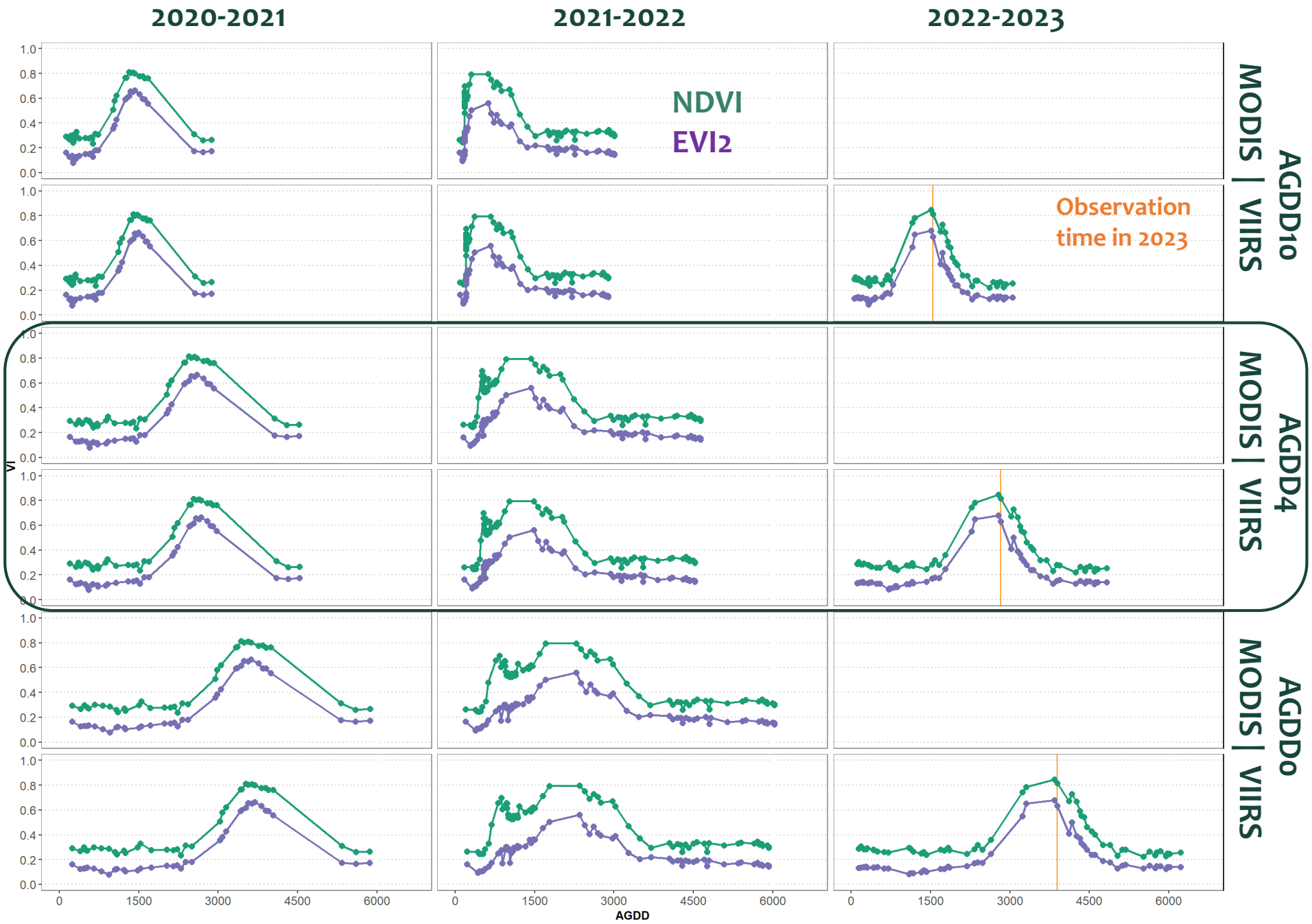


Teleorman

- Rapeseed in 2023
- Dried

03JUL23

Sunflower P200C2 Teleorman

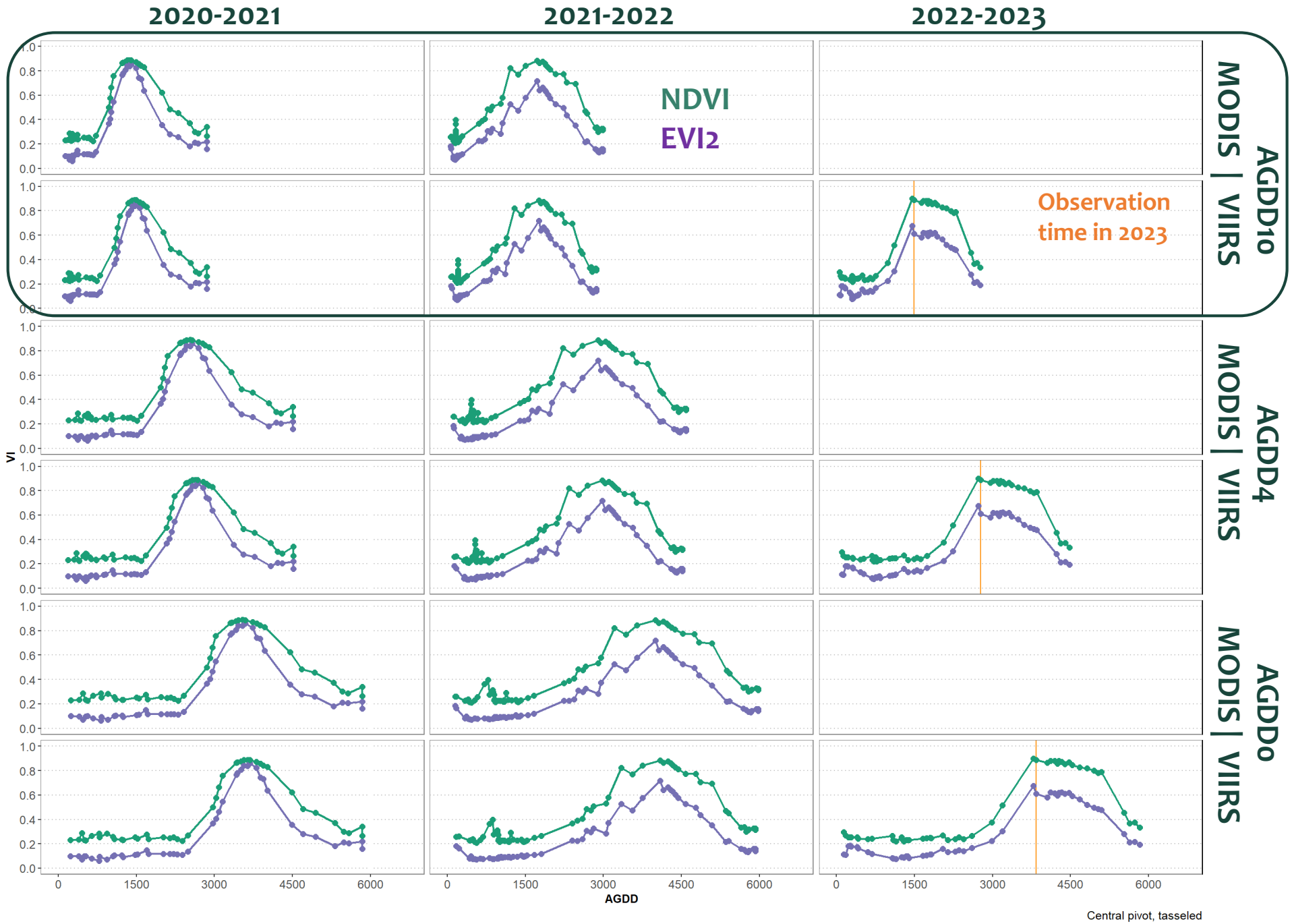


Teleorman

- Sunflower in 2023
- Full flower

02JUL23

Maize P197C1 Teleorman



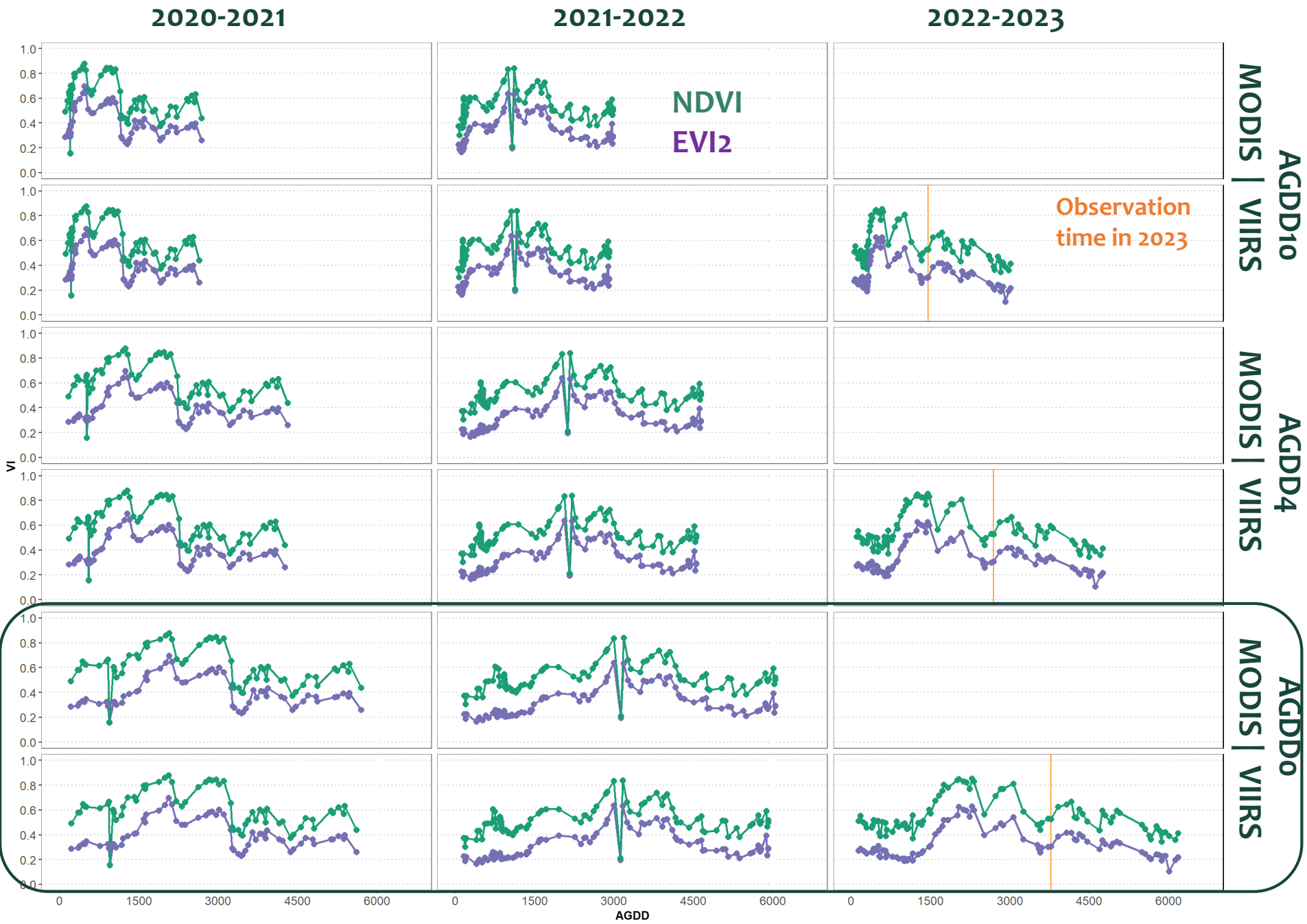
Teleorman

- Maize in 2023
- Center Pivot Irrigation
- Tasseled

02JUL23

Central pivot, tasseled

Alfalfa P182C1 Teleorman



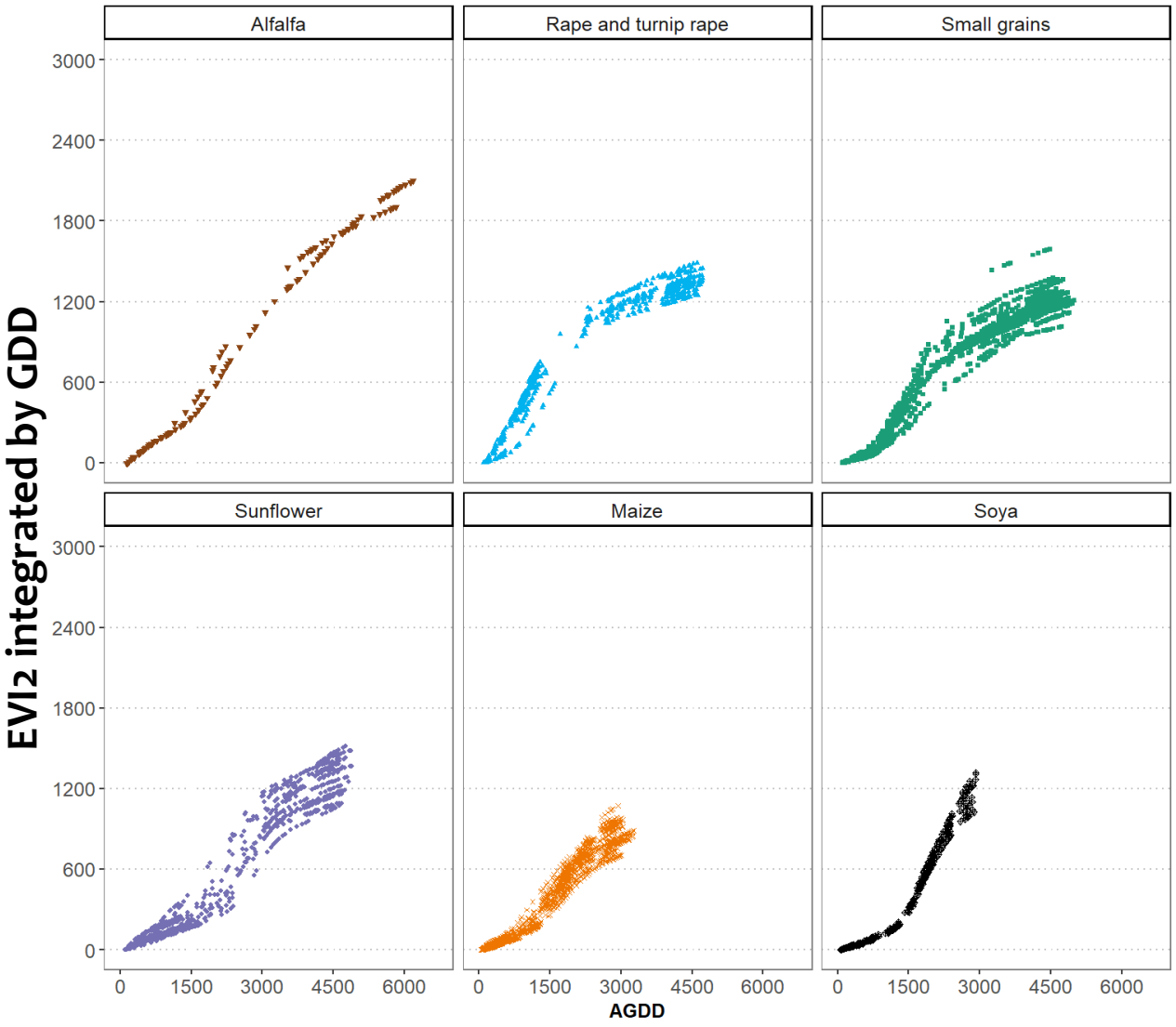
Teleorman

- Alfalfa
- Rainfed

01JUL23

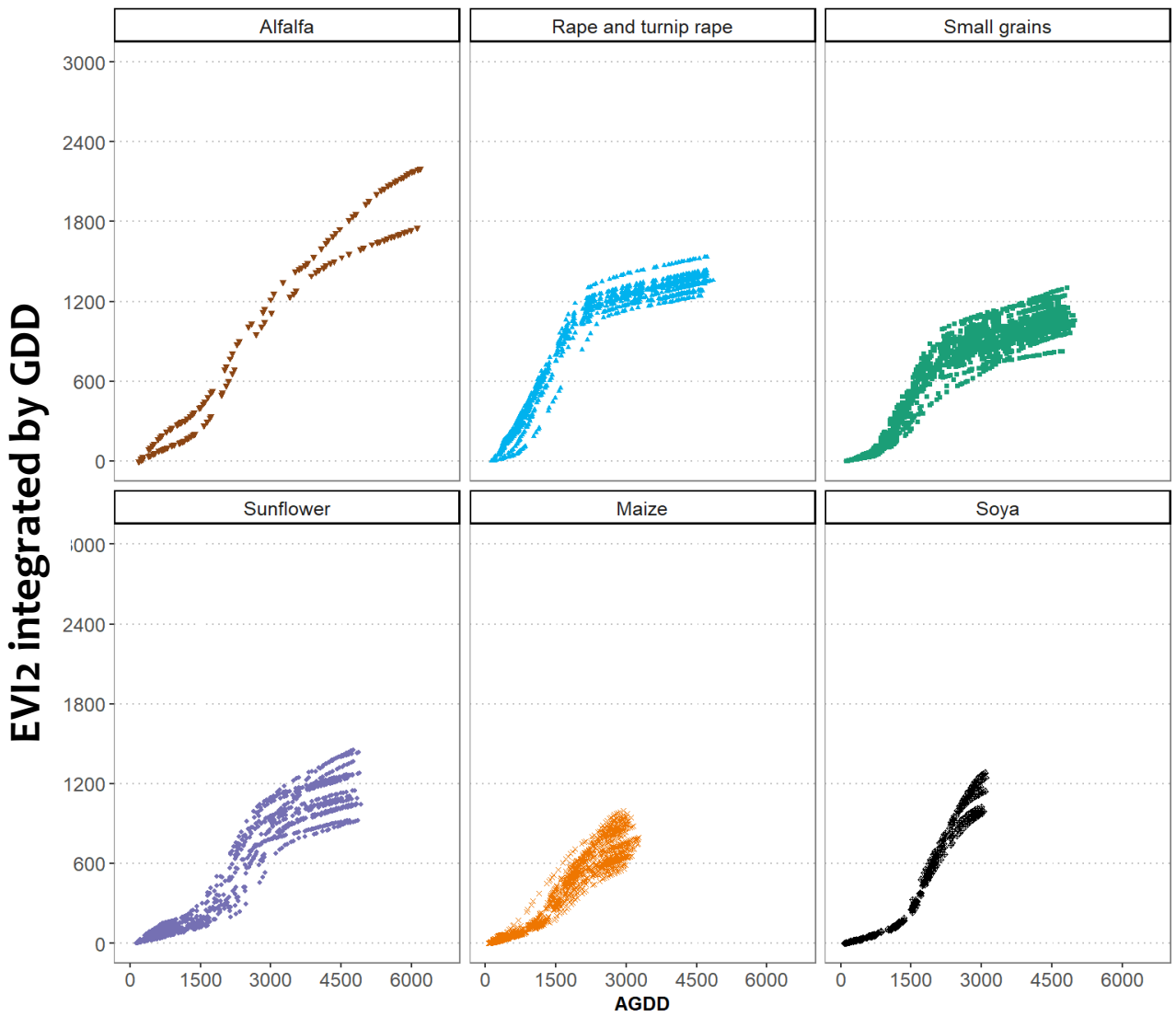
Teleorman: 01OCT22 - 30SEP23

HLS @ 30m



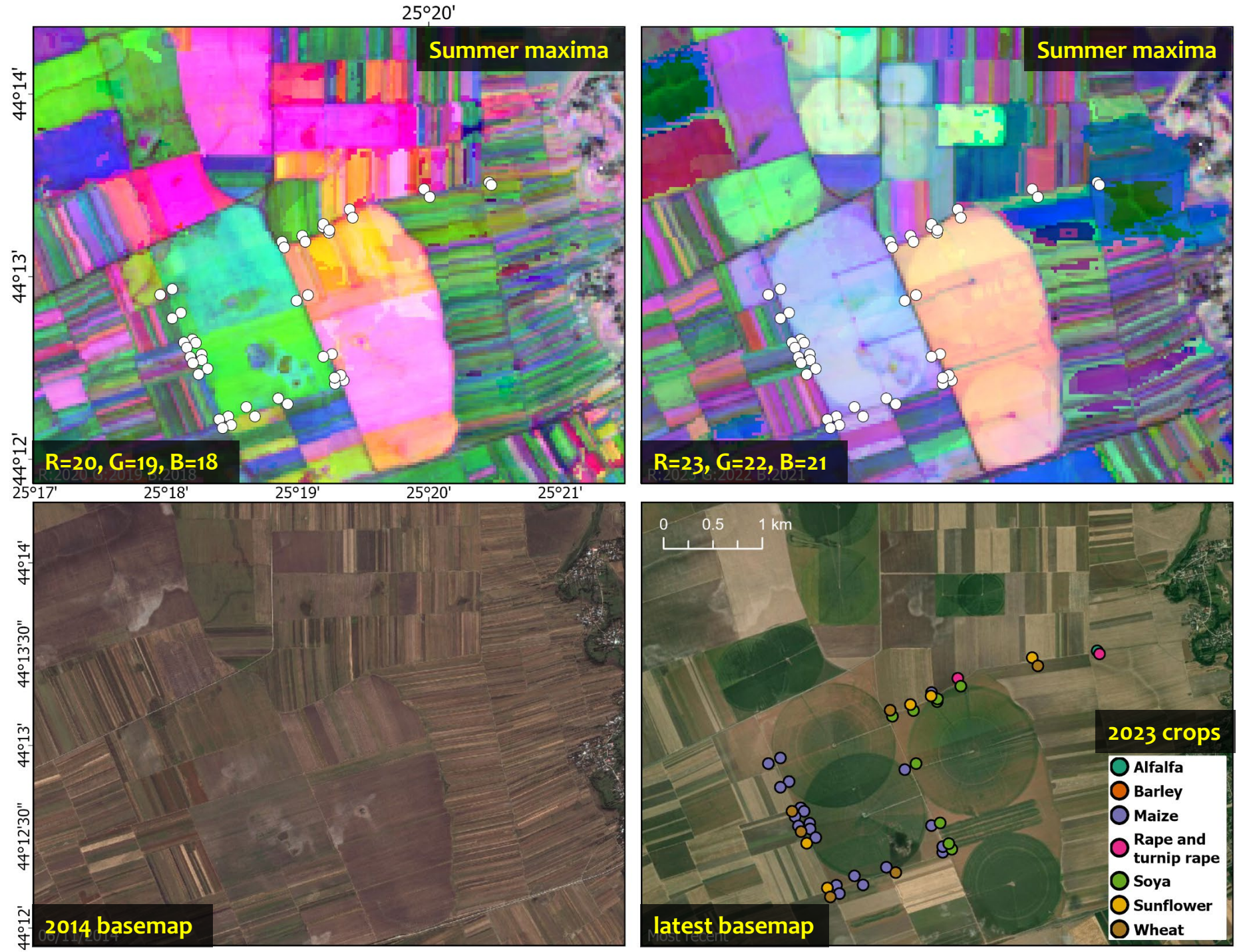
Teleorman: 01OCT22 - 30SEP23

SEN2A @ 10m



Integrated cropland LSPs selected from 116 sampling points across Teleorman at two spatial resolutions

Increased spatial resolution increases LSP variation!



Hotspot of change in space & time

Recent field consolidation and installation in northern Teleorman of center pivot irrigation systems for cultivation of maize and soy – facilitated through CAP funding

Next steps:

- Gather ground data during 2024 field campaign in western Romania (Oradea to Timişoara)
- Iterative fitting using the Convex Quadratic LSP model: $\mathbf{VI=\alpha+\beta AGDD+\gamma AGDD^2}$
- Characterization of cropland changes by *județe* and comparison with extant data and products
- Tuning of cropland LSPs in recent period (2015-2023) before projecting back to the era of sparser data

Thank you!

Research supported, in part, by the NASA LCLUC program as project 80NSSC23K0535

Thanks!