



UNIVERSITÄT
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MAX PLANCK INSTITUTE
FOR BIOGEOCHEMISTRY



CloudFerro

Can Sentinel-2 help characterize the land management effect on the impact of drought followed by heavy precipitation in European agroecosystems?

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Jędrzej Bojanowski, Fabian Gans

ITS2.6/BG10.9 EGU26-13636

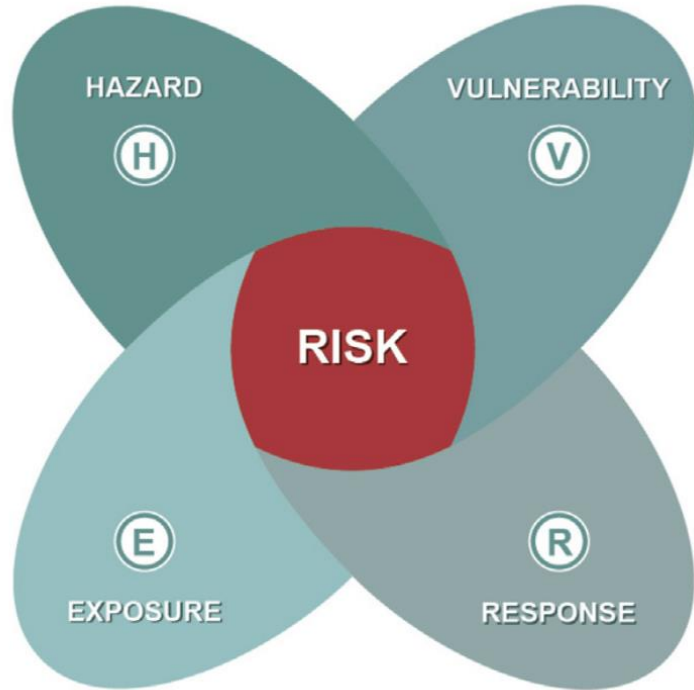




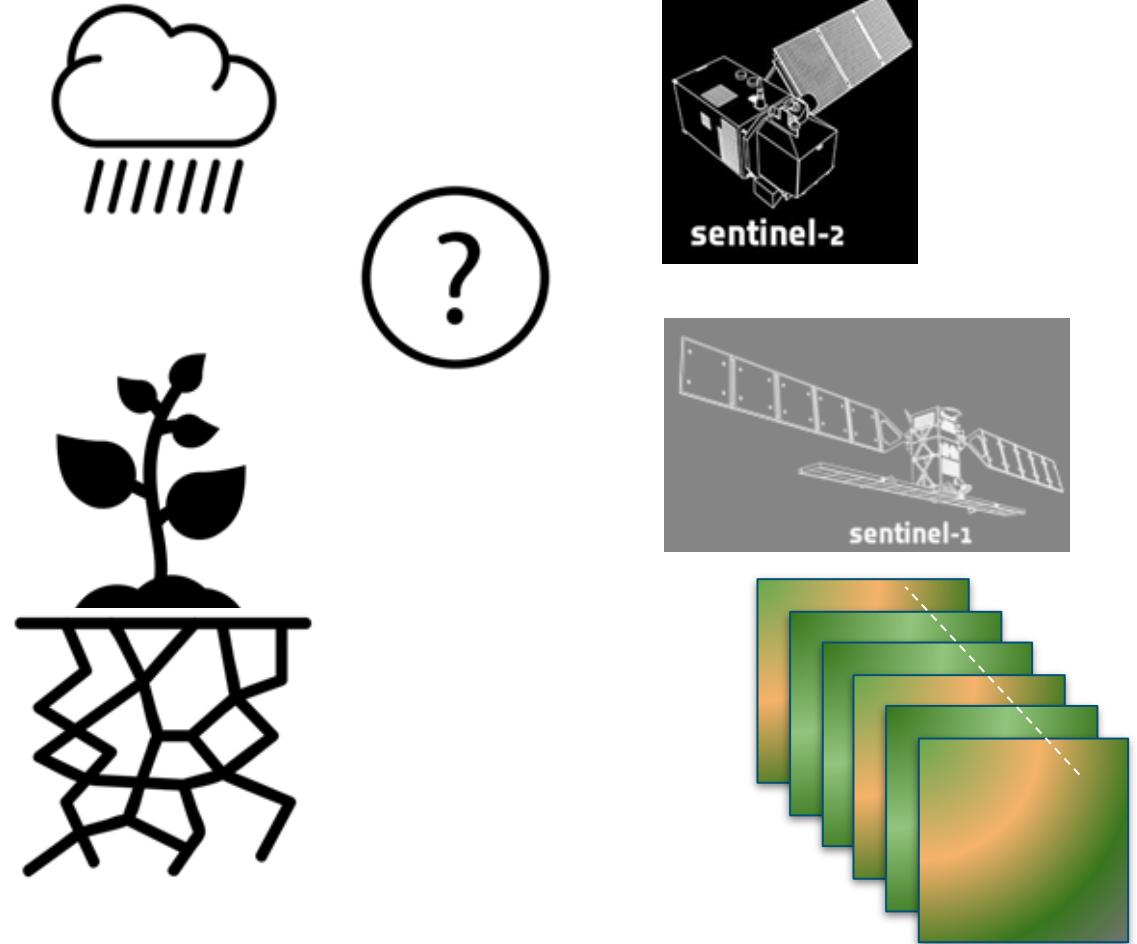
08/05/2026 EGU26 – 13636 – Weynants et al.
Photo by [Jebulon](#) CC BY SA



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Simpson et al, 2021



kNDVI times series (*Camp-Valls et al, 2021*)



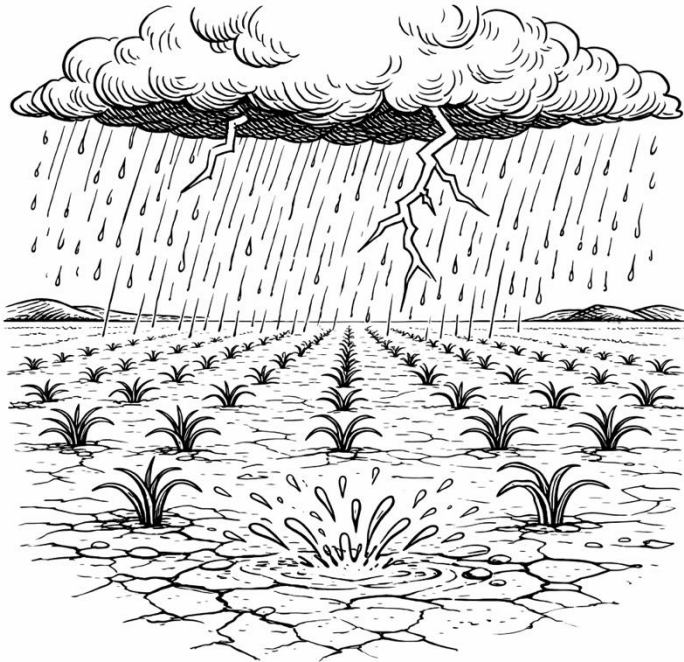
Case study hypothesis



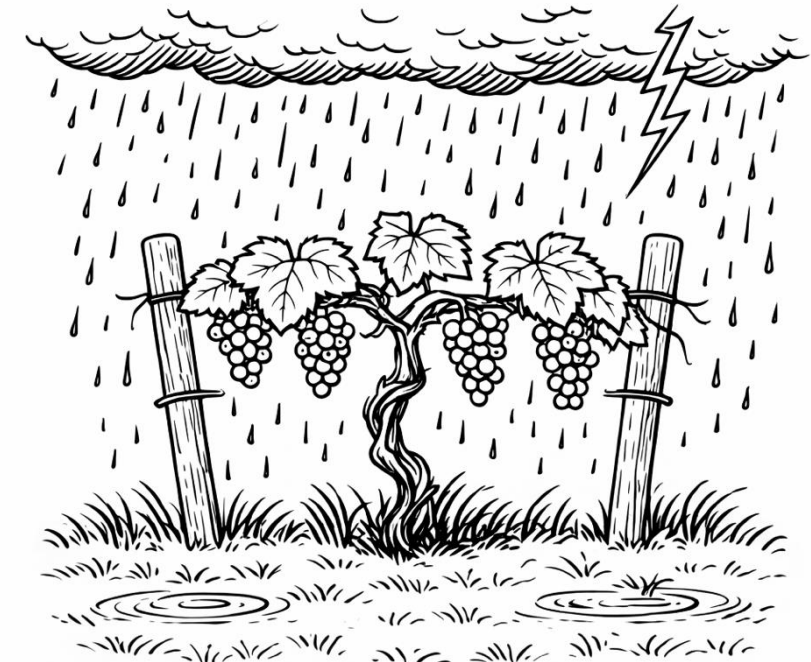
Rationale:

- Soil cover
- retains soil moisture during drought
 - improves soil structure → limits runoff when the heavy precipitation falls.

Annual crop



Permanent crop



Drawings created with Copilot



Data sources



DOI [10.5281/zenodo.15705050](https://doi.org/10.5281/zenodo.15705050)

- ARCEME-DHP (2015-2023)
- Based on **ERA5-Land** time series of daily precipitation and potential evapotranspiration



- Database of sustainable land management technologies
- Point data



- High Resolution Layers (2017-2023)
- Expert crop products



Sentinel data cubes



The screenshot shows the GitHub repository page for 'ARCEME / datacubes-processor'. The main content area displays the 'README' file with the title 'ARCEME Data Cube Pipeline - Usage Guide'. Below the title, there are tags for 'License MIT' and 'python 3.11+'. The right sidebar shows the user profile for 'mkluczek Marcin Kluczek', a 'Languages' section with a bar chart showing 'Python 98.7%' and 'Dockerfile 1.3%', and a 'Suggested workflows' section.

- 2 years
- 10x10 km
- ESA WorldCover (Planetary Computer)
- Sentinel-2-L2A (CDSE)
- Spectral indices: kNDVI (SpectralIndices.jl)

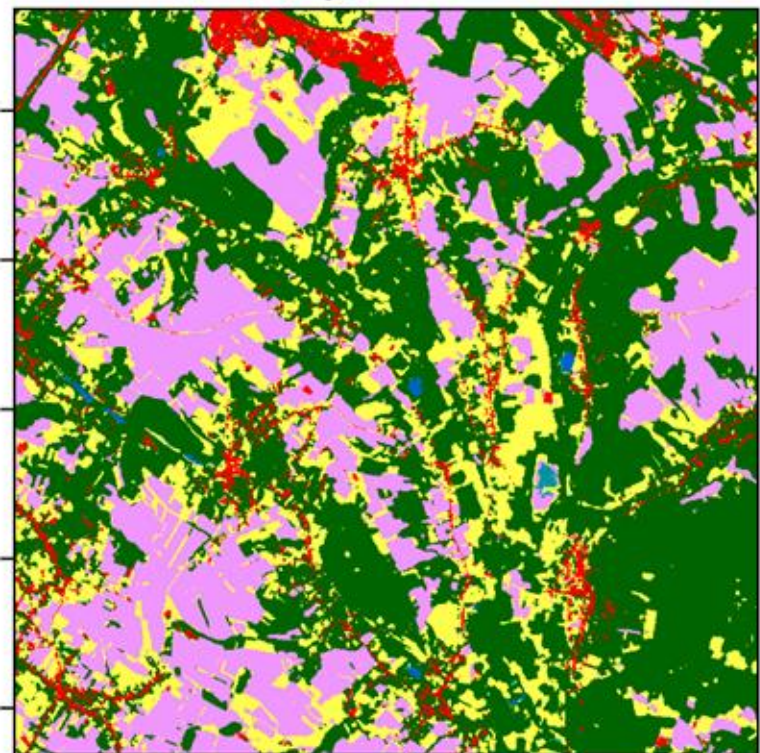


Example 1 : Effect of bare soil duration before annual crop



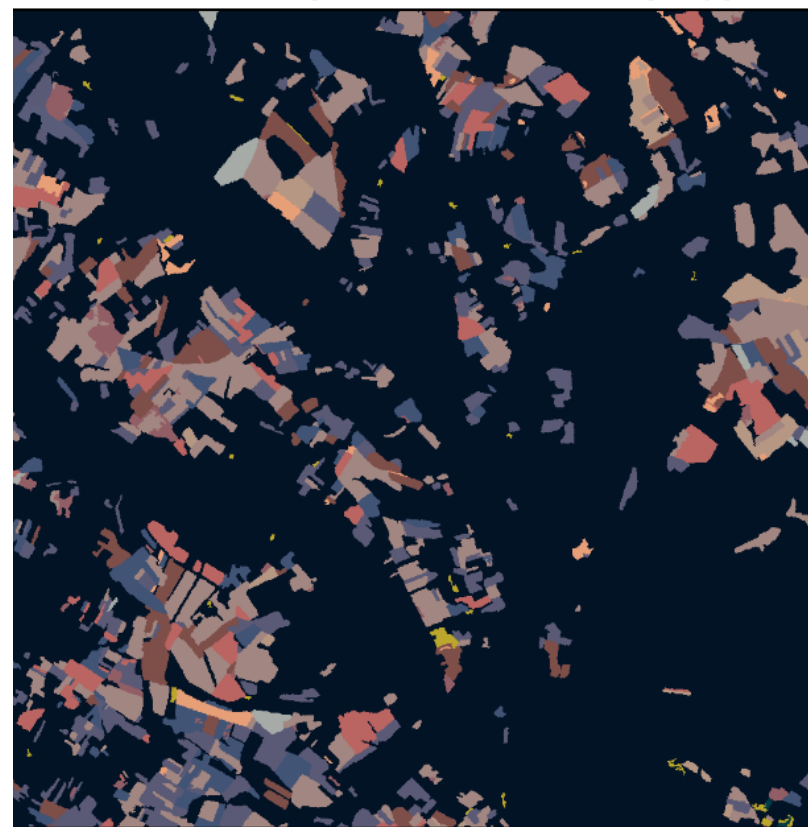
WOCAT: No tillage field trial in Belgium

wocat_966_dhp_41959 - Land Cover



- Moss and lichen
- Mangroves
- Herbaceous wetland
- Permanent water bodies
- Snow and Ice
- Bare /sparse vegetation
- Built-up
- Cropland
- Grassland
- Shrubland
- Tree cover

wocat_966_dhp_41959 - Main Crop Type



- Nuts
- Fruits
- Olives
- Grapes
- Flax cotton and hemp
- Rapeseed
- Soybeans
- Sunflower
- Sugar Beet
- Potatoes
- Dry Pulses
- Fresh Vegetables
- Other cereals
- Rice
- Maize
- Barley
- Wheat
- No cropland



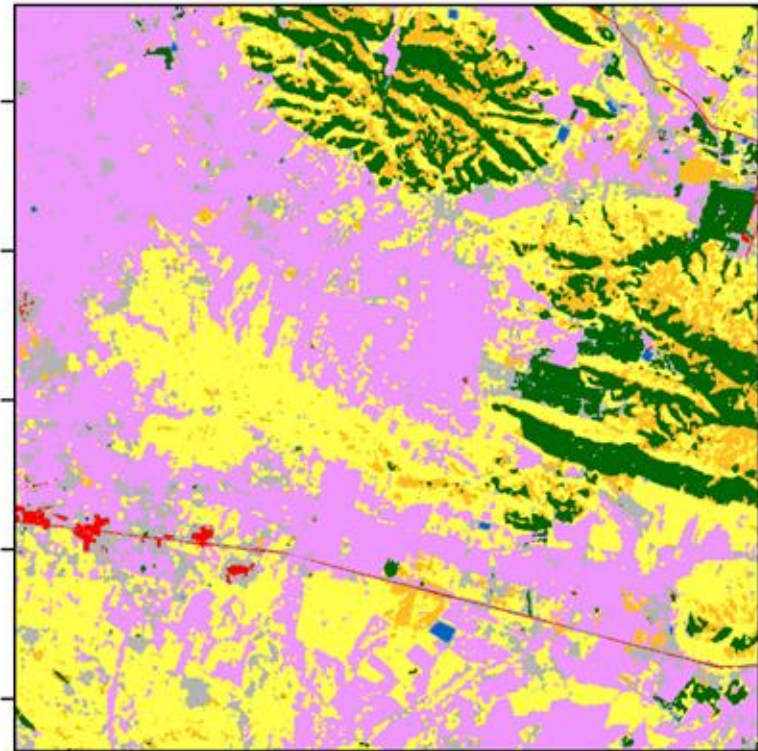


Example 2 : Effect of grass cover in vineyards



Eastern Spain

86806_dhp - Land Cover



- Moss and lichen
- Mangroves
- Herbaceous wetland
- Permanent water bodies
- Snow and Ice
- Bare /sparse vegetation
- Built-up
- Cropland
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- Shrubland
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86806_dhp - Main Crop Type



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Example 2 : Effect of cover in vineyards

Physiological effect of average winter kNDVI in Year before and Year after event

ANOVA

Group: winter kNDVI < or > median

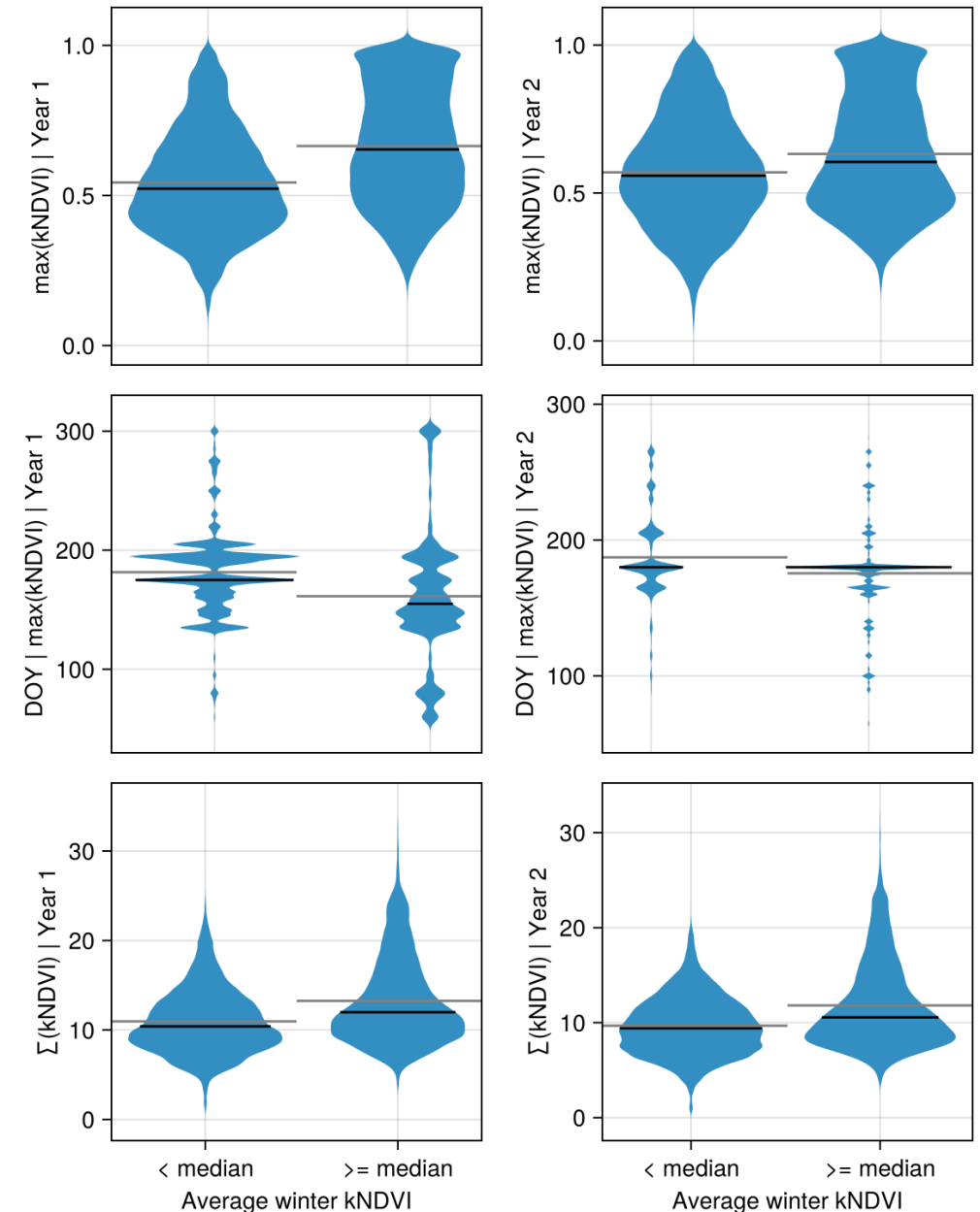
H0: equal means of

- max(kNDVI)
- DOY|max(kNDVI)
- sum(kNDVI)

H1: reject H0

- max(kNDVI)
- DOY|max(kNDVI)
- sum(kNDVI)

Effect in agreement with intuition





From our two examples

- No negative physiological effect of bare soil duration on maize subjected to heavy precipitation following dry conditions just after emergence.
- Positive effect of average winter kNDVI, as indicator of grass cover, on vineyards



Future work



→ Land management effect

- Systematise analyses for annual and permanent crops
- Include effect of timing of extreme in seasonal cycle
- Include slope and aspect
- Upscale

→ Flood followed by drought

→ Dry and hot extremes

Thank you!

Questions?



NH6.1 EGU26-14030
room 1.31/32
Friday 12:05



Adaptation and Resilience to Climate Extremes and
Multi-hazard Events

Email: arceme@lists.uni-leipzig.de

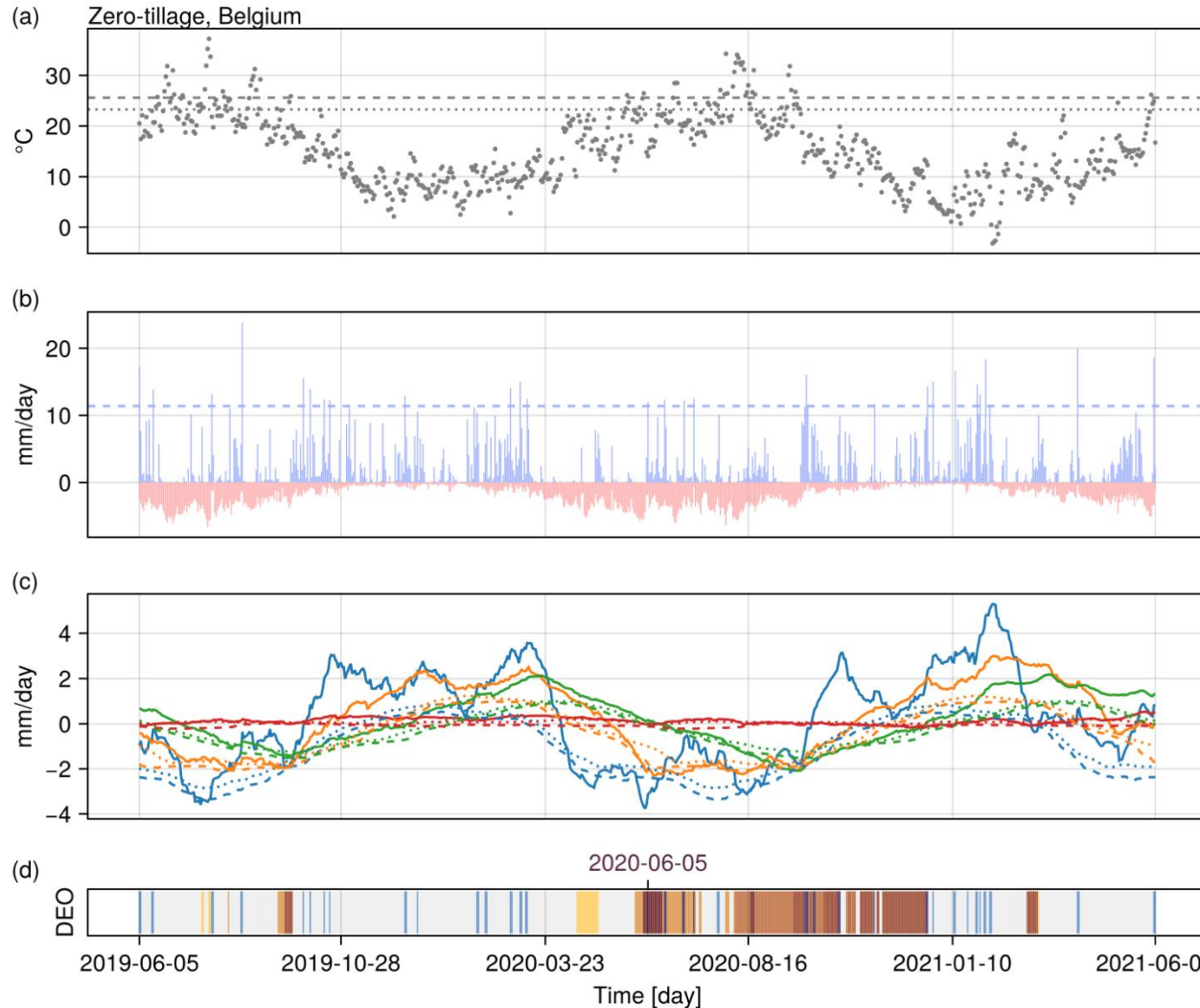
Web: <https://rsc4earth.de/project/arceme/>

Funding: European Space Agency (ESA)

Grant Number: 4000137109/22/I-EF



Example 1 : Effect of bare soil duration before annual crop

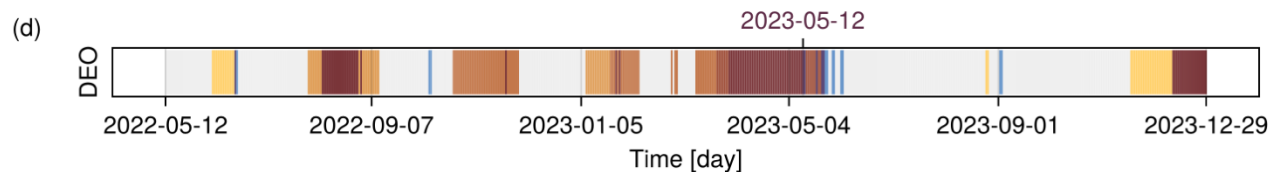
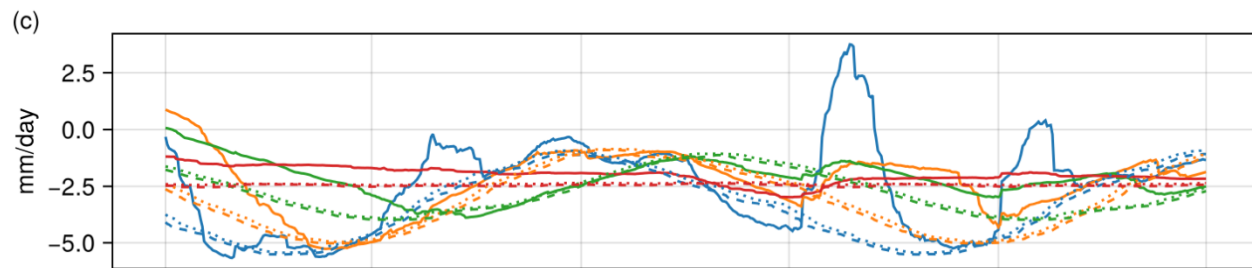
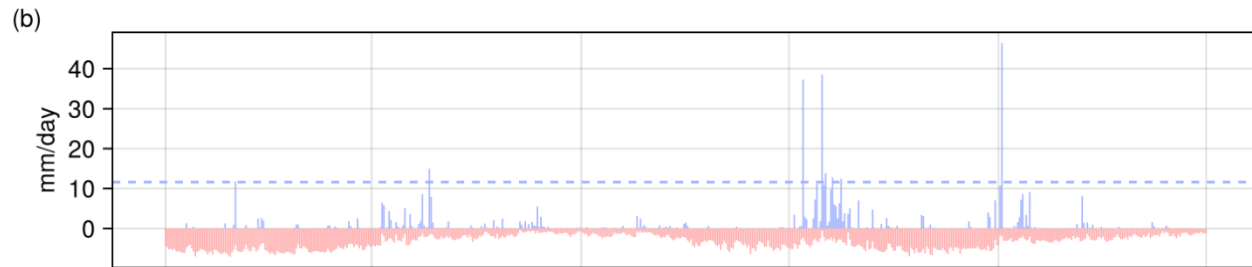
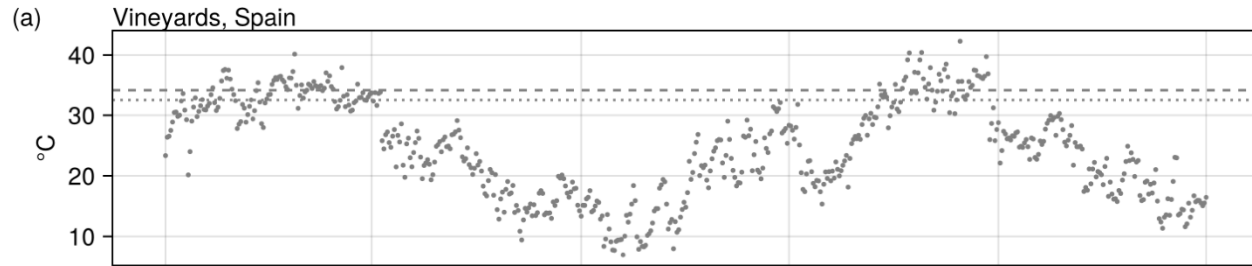


- Max. temp. at 2m
- 90th percentile
- - - 95th percentile
- Total precipitation
- - - HP threshold
- Ref. evapotransp.
- pei_30
- pei_90
- pei_180
- pei_360
- pei_30 10th percentile
- - - pei_30 5th percentile

- dry* & HP
- dry & HP
- dry* (30 & (90 | 180 | 360))
- dry (360) on the day
- dry (180) on the day
- dry (90) on the day
- dry (30) for last 5 days
- heavy precipitation (HP)
- no extreme or no data



Example 2 : Effect of grass cover in vineyards

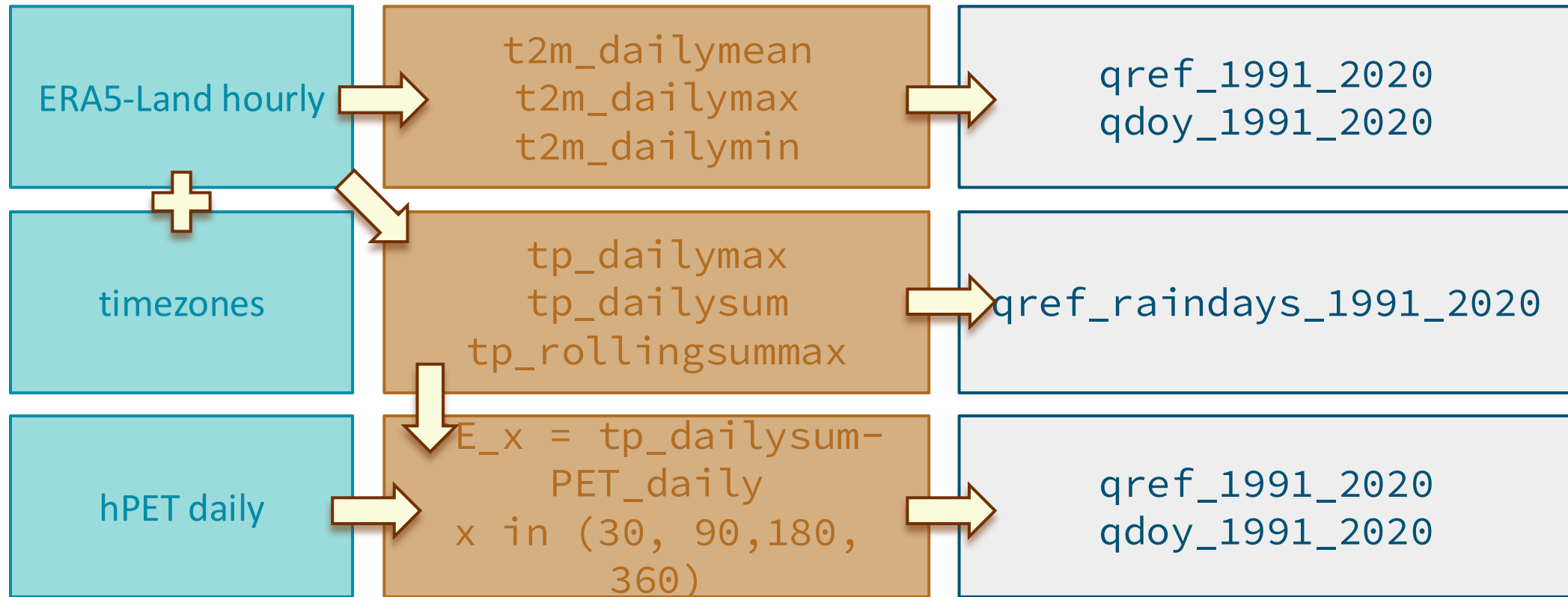


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Climate input data and intermediate data cubes



t2m hourly 2m air temperature
tp hourly total precipitation
PET Reference Evapotranspiration

q quantile
ref whole reference period
doy day of year in reference period



Meteorological events



PE	Precipitation – Reference Evapotranspiration
q	quantile
doy	day of year

Drought followed by Heavy Precipitation (DHP)

Drought: evaporative stress over previous 90, 180, 360 days (PE)

Local threshold:

→ $PE_x < q_{doy}0.05$

+ $PE_{30} < q_{doy}0.05$ in previous 5 days

Heavy precipitation: daily maximum of moving sum over 24h (MP)

Local threshold: $MP > q_{0.95}$ raindays

+ *Global threshold:* $MP >$ global weighted mean of $q_{0.75}$ over land (5.13 mm/day)

Drought and Heat (DH)

Drought: evaporative stress over previous 30, 90, 180 days (PE)

Local threshold: $PE_x < q_{doy}0.05$

Heat: daily max (min) 2m temperature

Local threshold: $T_{max} > q_{0.95}$ & $T_{min} > q_{0.95}$

Flood followed by Flood (FD)

Drought: evaporative stress over previous 90, 180, 360 days (PE) in the following 3 to 12 months

Local threshold: $PE_x < q_{doy}0.05$

Flood: reported EM-DAT flood



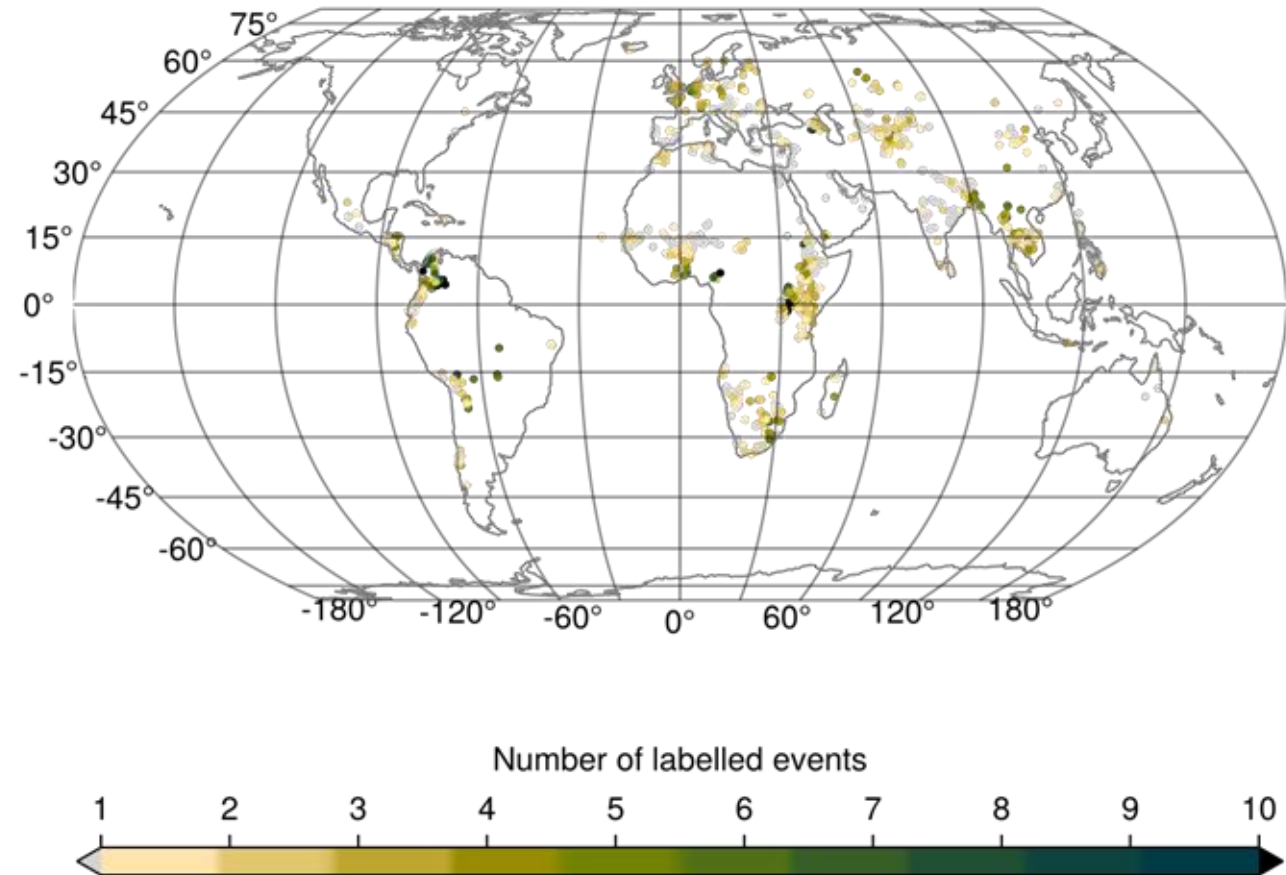
Selection of WOCAT technologies



API access to database

Selection of technologies:

- main purpose
- land use
- ecological impacts
- disaster coping

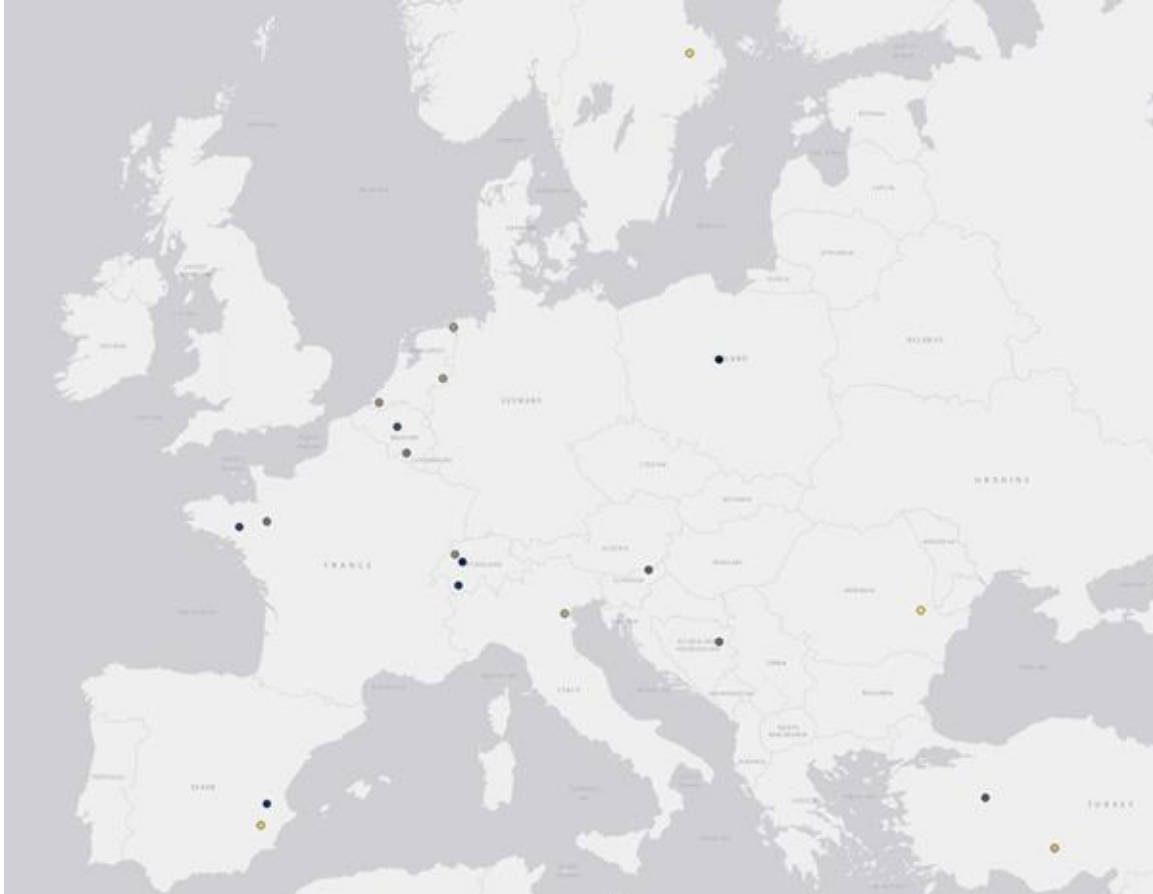




WOCAT + High Resolution Layers

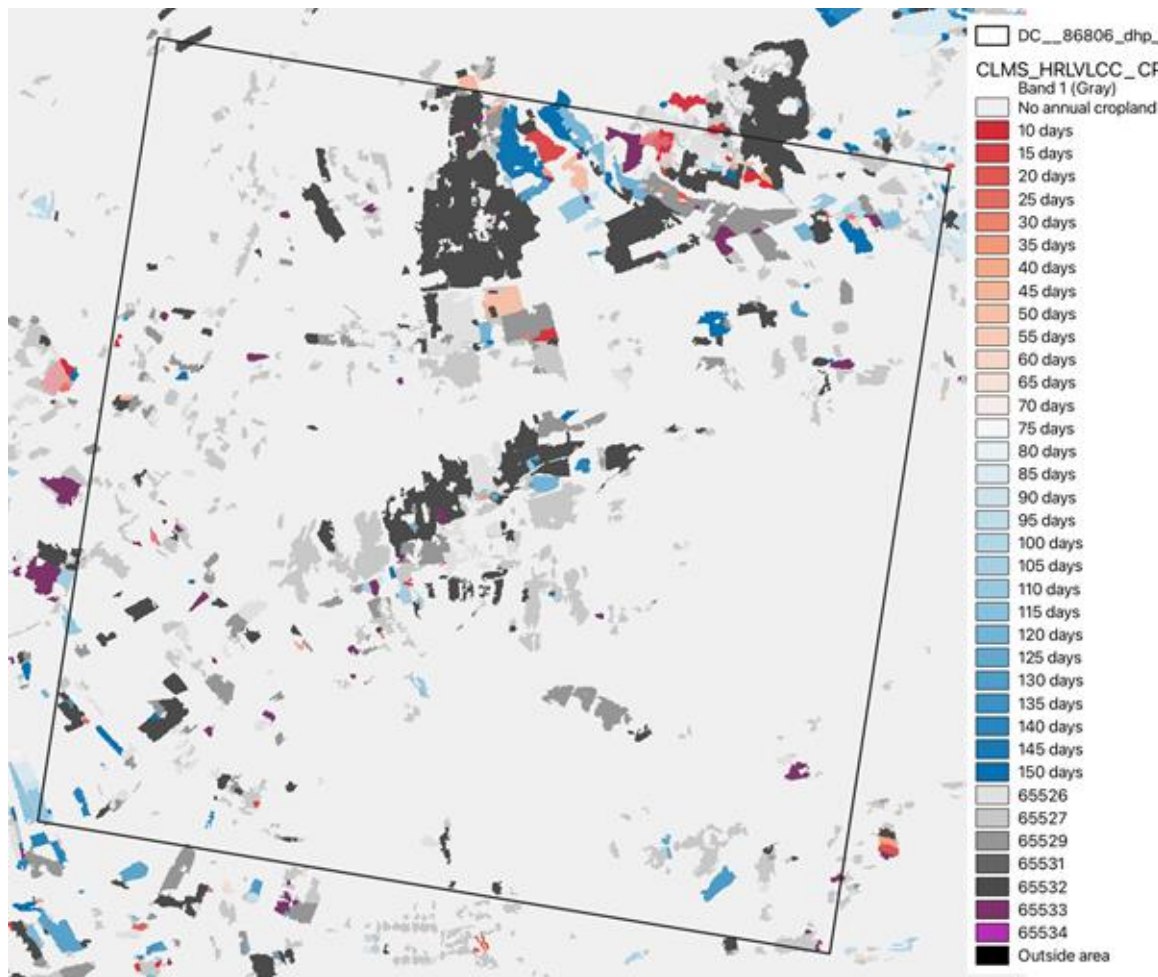


Subset of selected WOCAT technologies





Copernicus Land Monitoring : High Resolution Layers



HRL Cropland layers (raster 10 m), Europe, yearly (2017-2023)

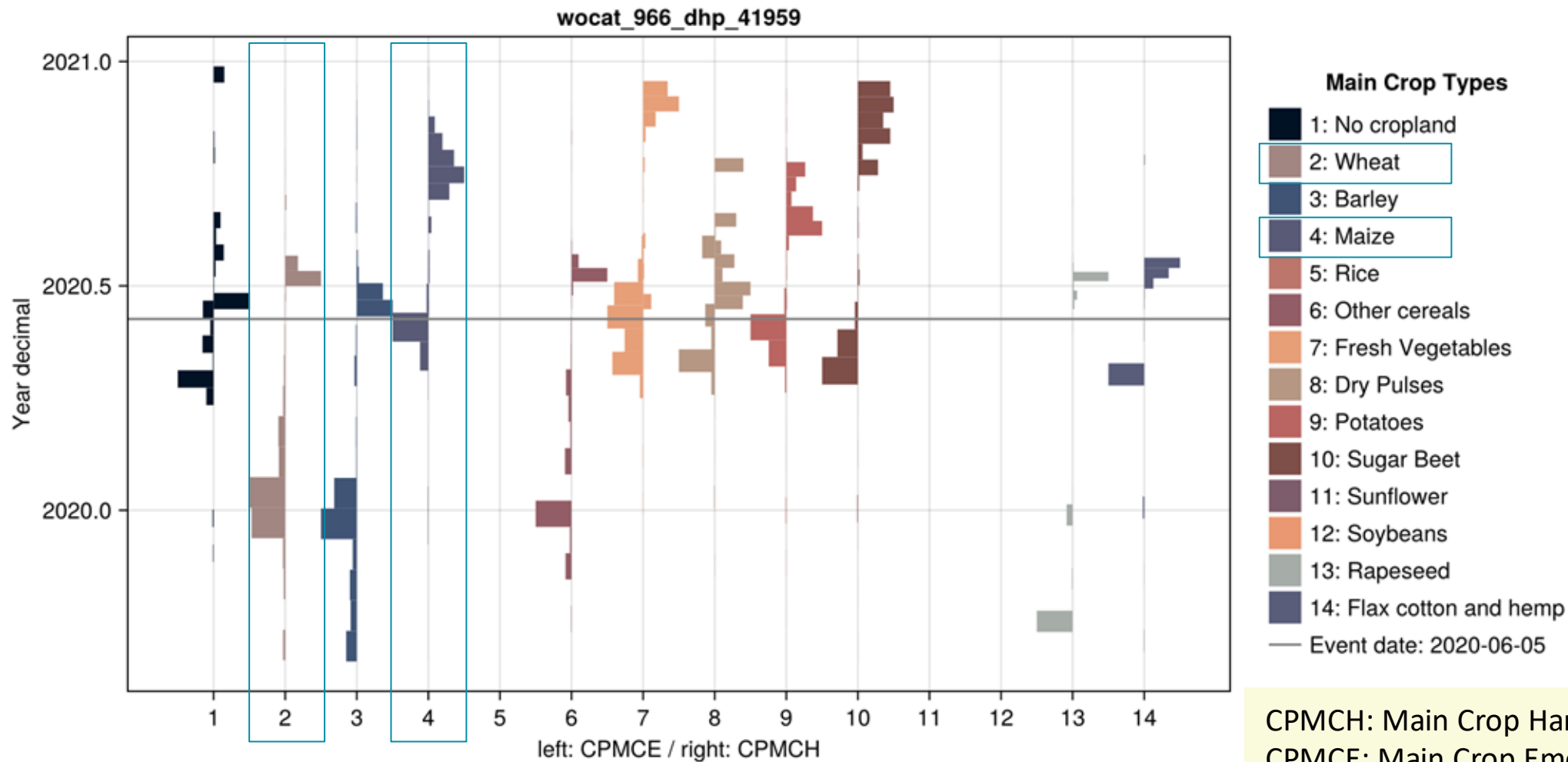
- Crop types CTY
- Main Crop Harvest CPMCH
- Main Crop Emergence CPMCE
- Main Crop Duration CPMCD
- **Bare Soil Before CPBSB**
- Bare Soil After CPBSA
- Secondary Crops Type CPSCT
- Secondary Crops Emergence CPSCE
- Secondary Crops Duration CPSCD
- Fallow Land Presence CPFLP
- Fallow Land Duration CPFLD



HDA API



Example 1 : non-inversion field trial (Belgium)



CPMCH: Main Crop Harvest Date
 CPMCE: Main Crop Emergence Date



Example 1 : non-inversion field trial (Belgium)



“Fingerprint”:
average over all pixels in the class

