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Machine Learning for Crop Type Identification using Country-wide, Consistent Sentinel-1 Time Series

BiDS 2019, 19-21 Feb 2019, Munich (DE)

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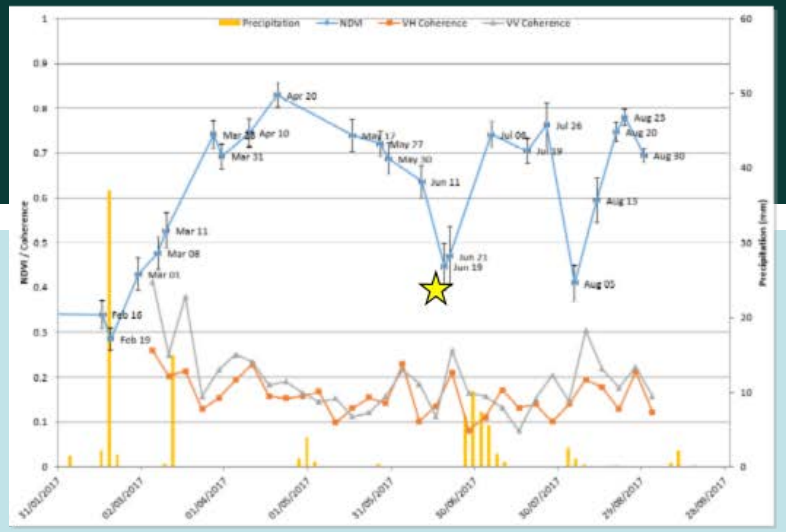
Context

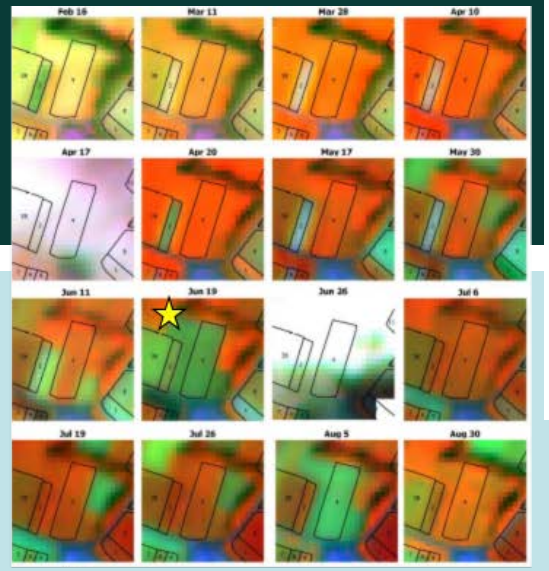
Remote sensing data have been used for EU Common Agricultural Policy monitoring and control for 25 years.

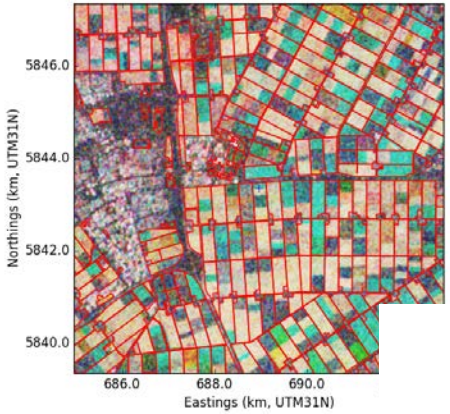
Member States use on the spot checks (OTSC) to verify compliance of the farmer's area aid application. Remote sensing used as major OTSC method.

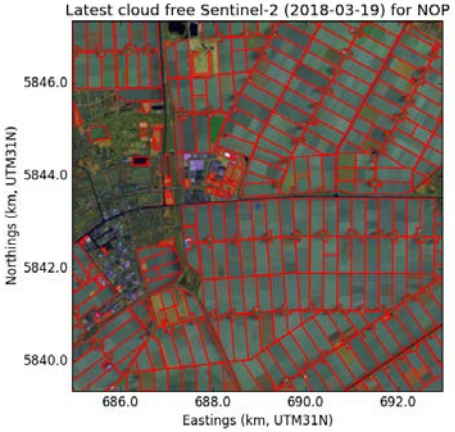
New EU-wide availability of Sentinel-1 and -2 data combined with mature, high quality land parcel identification systems, allow new sampling approaches.

Full country high resolution (10-20 m), high density (5-6 days) time series with 100K-5M parcels per "Paying Agency", requires Big Data Analytics.

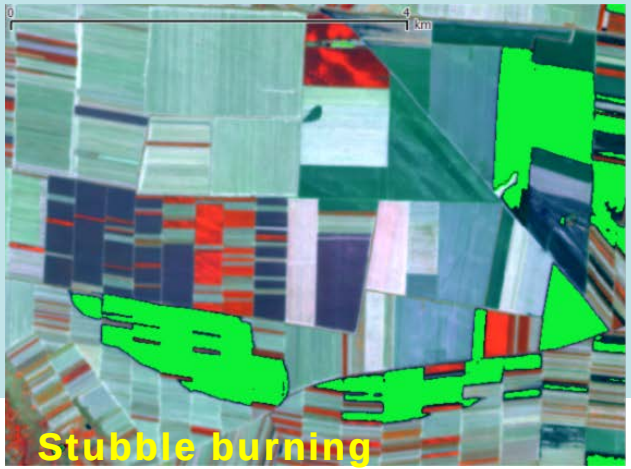


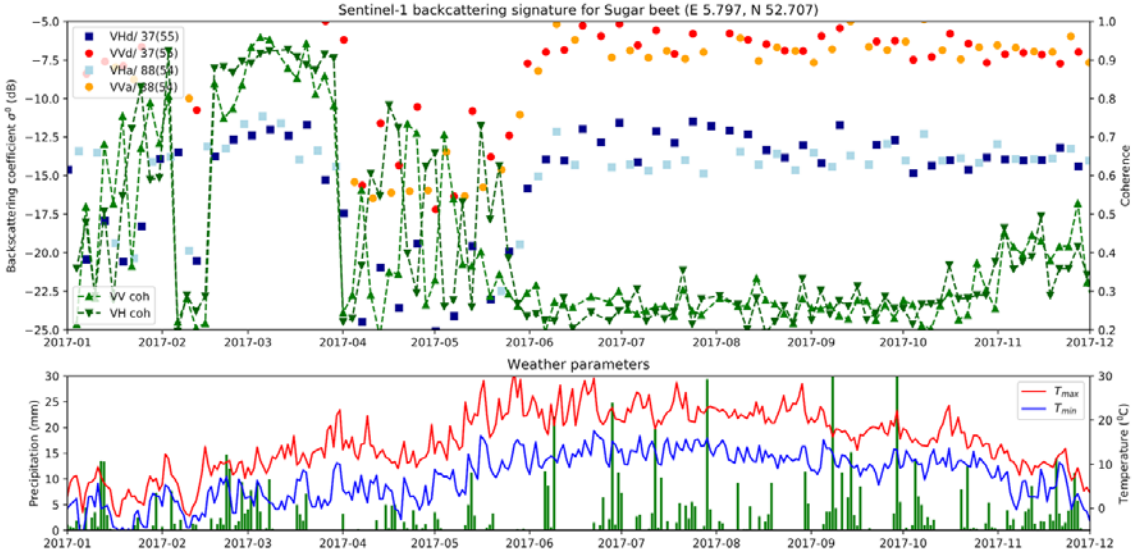




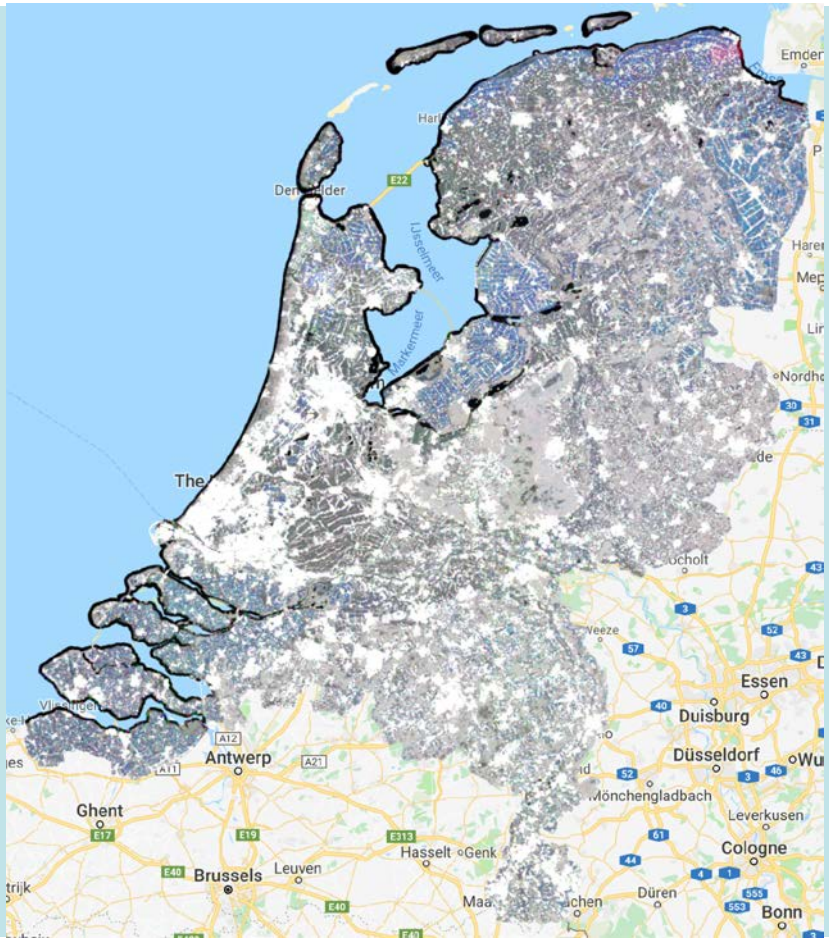


Sensor = S1 and S2; *zone* = region; *relevant period* = Apr-Sep; *practice of interest* = grassland mowing;





Copernicus Sentinel-1



S-1 provides calibrated, consistent time series

2-8 acquisitions per 6 days, 4 for most EU

Weekly country mosaics

Easy in Google Earth Engine

Alternative: interpolated signatures per parcel

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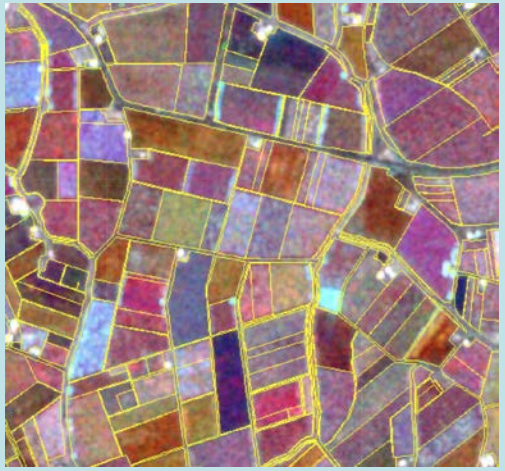
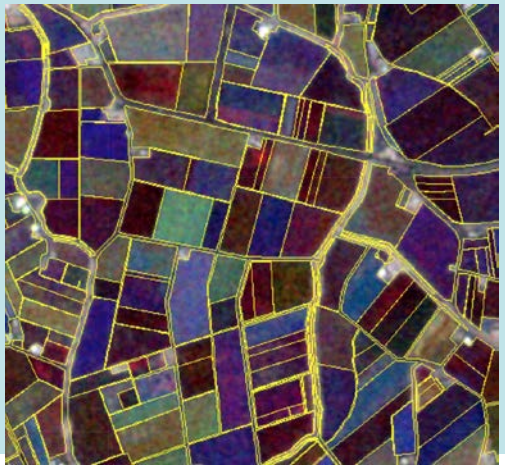
Machine learning





Extract time series stack for all (approx. 700,000) vectors.

Weekly (Apr-Aug) mean VV, VH, declared crop as feature vector.

In this study, select only arable crops (170K), making up 95% of arable crop area (eliminate minor crops) and > 0.3 ha.

Split in 20% training, 80% testing (5 times).

Run tensorflow (tflearn) DNN with 2 fully connected 32 node layers, softmax activation and gradient descent.

100 epochs (<5 mins on a 8 core Intel Xeon E3-1505M v6 @ 3.00 GHz, with 64 GB RAM).

Machine learning

Crop	MAI	POT	WWH	SBT	ONI	SBA	FLO	sum	PA
MAI	**65260**	374	135	55	52	74	95	66045	98.8
POT	362	**26126**	41	77	25	12	75	26718	97.8
WWH	142	37	**15492**	7	25	125	12	15840	97.8
SBT	134	818	11	**12502**	38	3	67	13573	92.1
ONI	360	86	148	65	**4439**	136	67	5301	83.7
SBA	430	23	316	6	54	**3974**	21	4824	82.4
FLO	203	131	94	331	7	19	**2807**	3592	78.1
sum	66891	27595	16237	13043	4640	4343	3144	**135893**	
UA	97.6	94.7	95.4	95.9	95.7	91.5	89.3		

OA single classification 96.1%

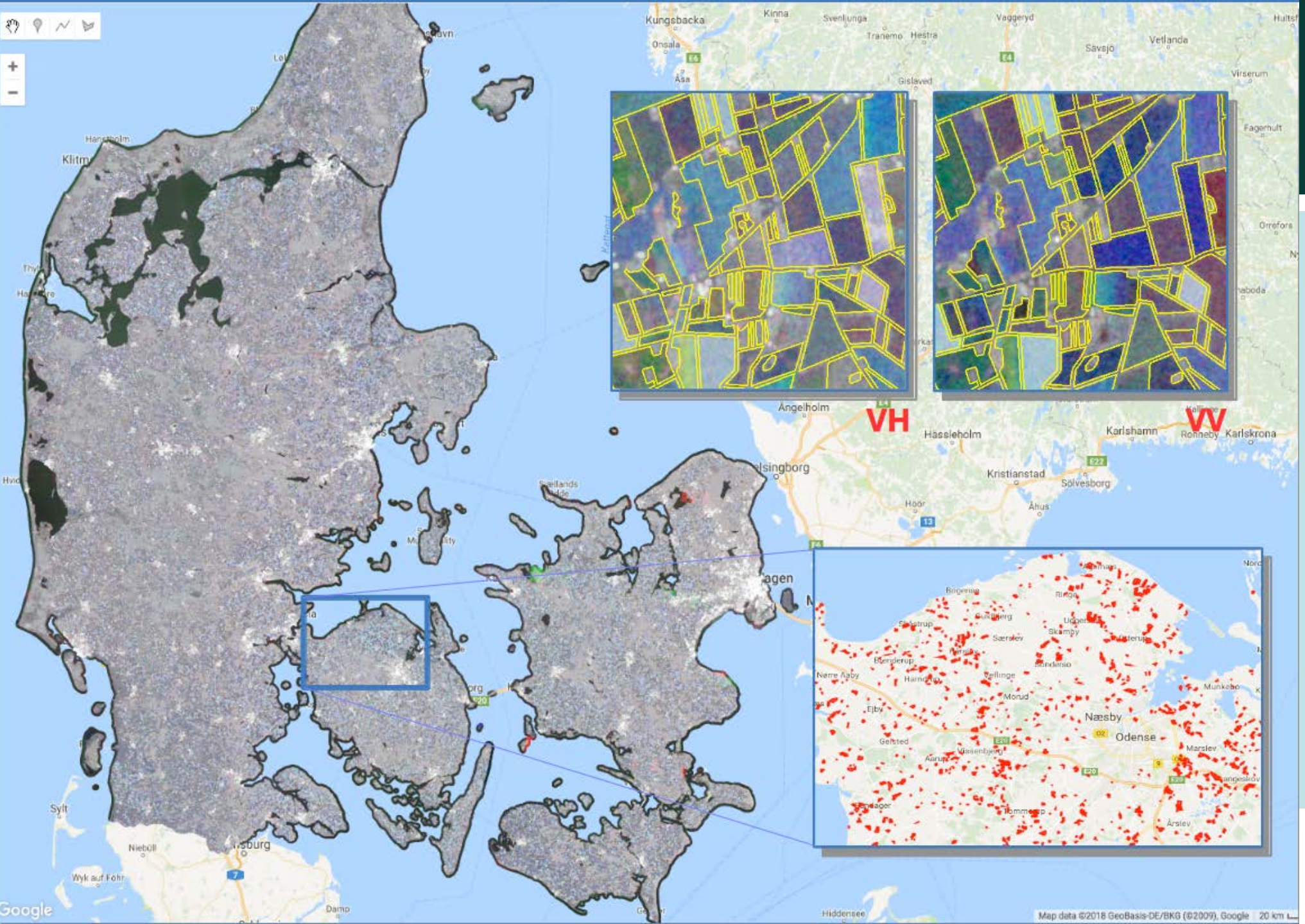
Compare predicted label, 4 times

4% “outliers”

(i.e. approx. 6800 parcels)

Categorization (size, shape, confusion, yellow, impact)

Links to automatic report generation



On **DIAS**:

S1: 1750 images in 2018

1M agricultural parcels with declared practice

Machine learning applied to S1 time series

Identify “outliers”

Follow up with S1 coherence and S2 analysis

Automated reporting

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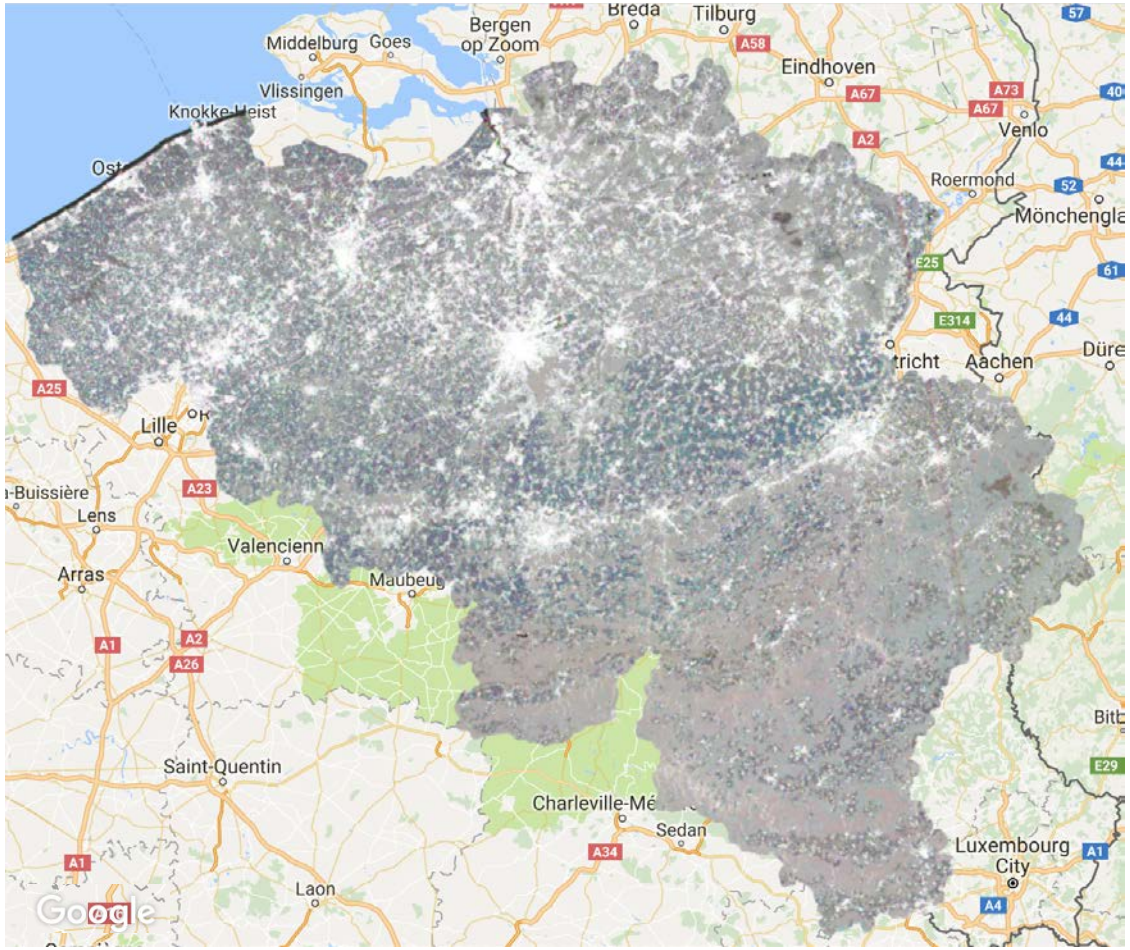

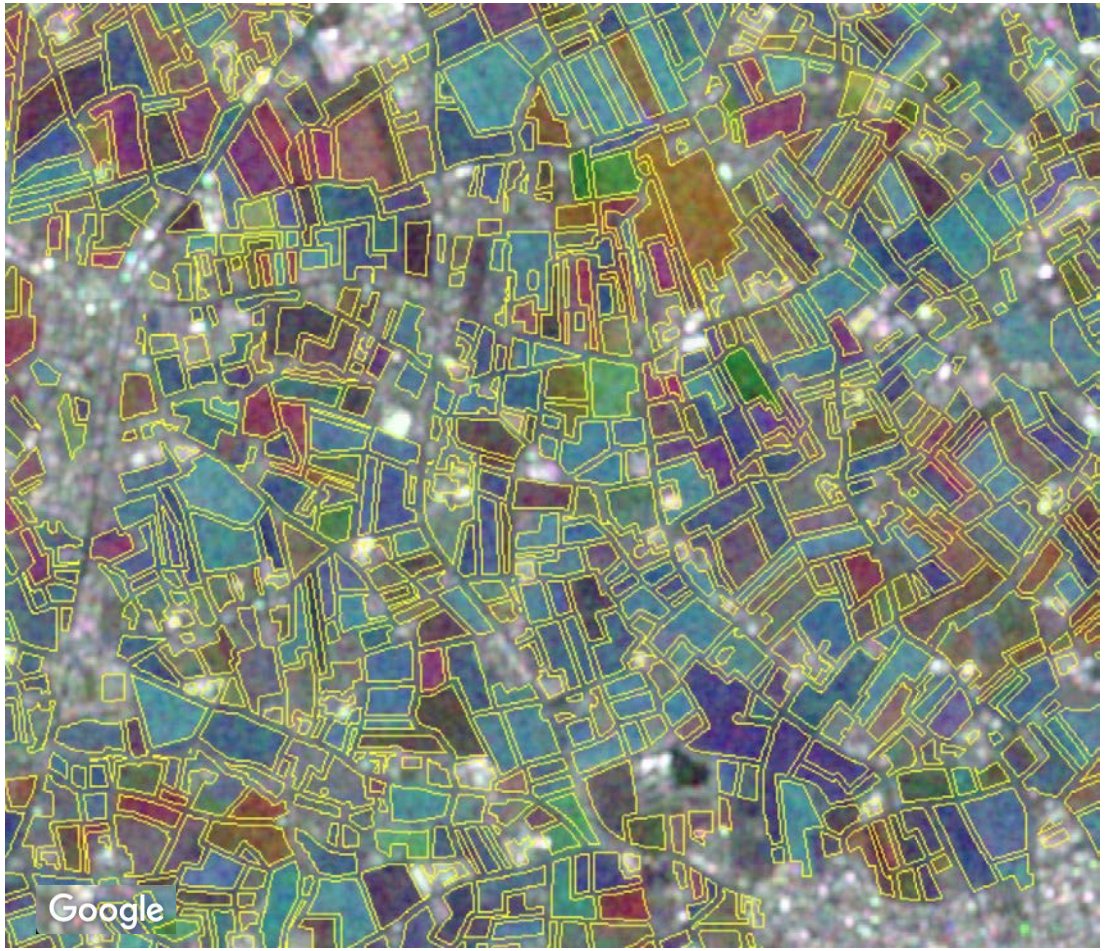

- National Land Parcel Identification Systems (trend towards open access!)
- Tests developed on Google Earth Engine now migrating to Copernicus DIAS
- Large potential of data re-use in other national application contexts

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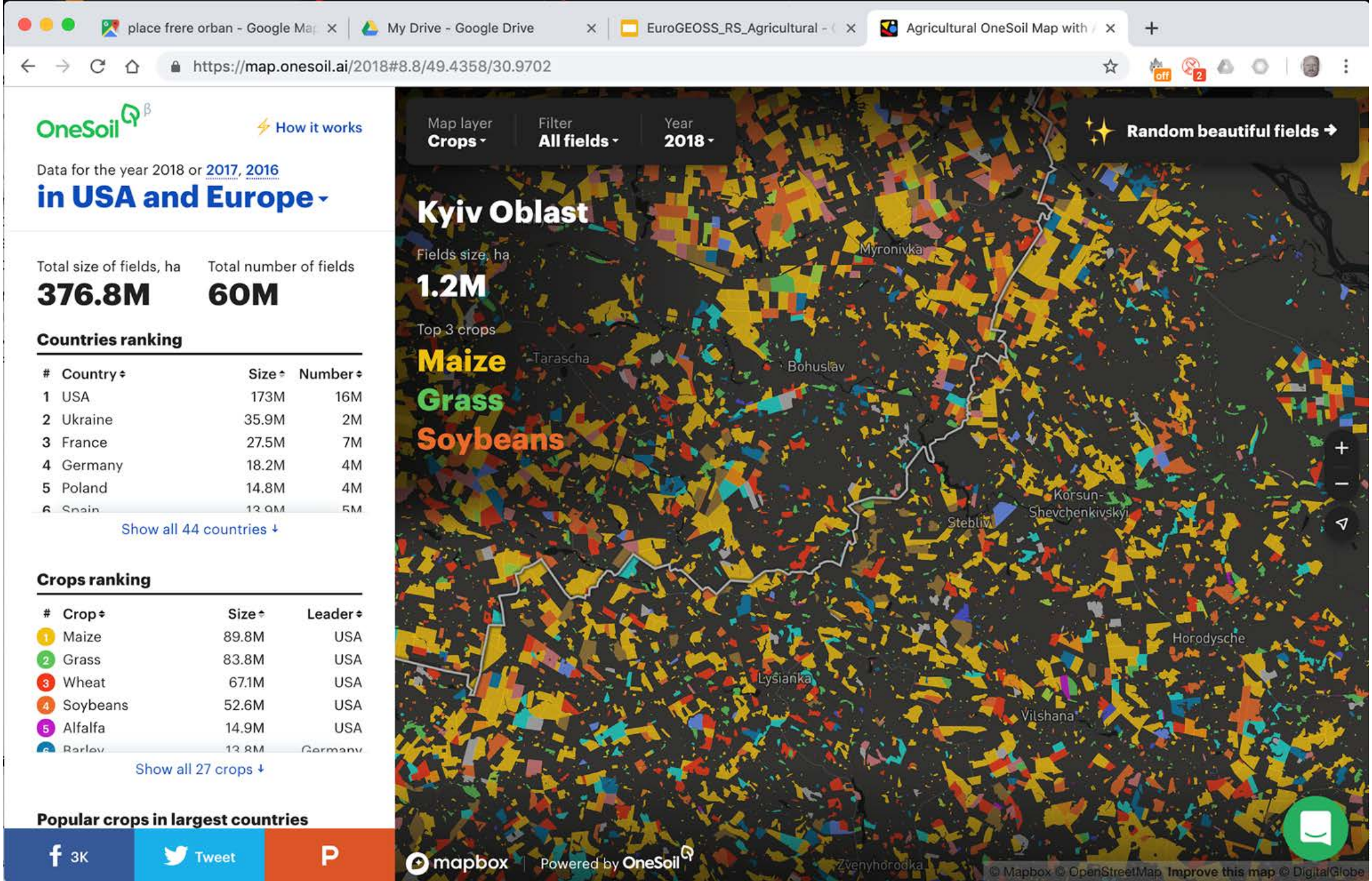
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EuroGEOSS_RS_Agricultural -
Agricultural OneSoil Map with
https://map.onesoil.ai/2018#8.8/49.4358/30.9702
OneSoil β
How it works
Data for the year 2018 or 2017, 2016
in USA and Europe
Total size of fields, ha
376.8M
Total number of fields
60M
Countries ranking
Country Size Number
1 USA 173M 16M
2 Ukraine 35.9M 2M
3 France 27.5M 7M
4 Germany 18.2M 4M
5 Poland 14.8M 4M
6 Spain 13.9M 5M
Show all 44 countries
Crops ranking
Crop Size Leader
1 Maize 89.8M USA
2 Grass 83.8M USA
3 Wheat 67.1M USA
4 Soybeans 52.6M USA
5 Alfalfa 14.9M USA
6 Barley 13.8M Germany
Show all 27 crops
Popular crops in largest countries
3K
Tweet
Map layer Crops
Filter All fields
Year 2018
Random beautiful fields
Kyiv Oblast
Fields size, ha
1.2M
Top 3 crops
Maize
Grass
Soybeans
Myronivka
Tarascha
Bohuslav
Korsun-Shevchenkivskyi
Stebliv
Horodysche
Lysianka
Vilshana
Zvenyhorodka
mapbox
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ASAP - ANOMALY HOTSPOTS OF AGRICULTURAL PRODUCTION

DE - Bayern

Choose another region

SELECT SATELLITE

Sentinel 1

TARGET PERIOD

01 Jun 2018 | 30 Jun 2018

COMPARISON YEAR

2018

CLOUD FILTERING

Optimized masking

Get map Layers

POINT

11.67069 | 48.83146

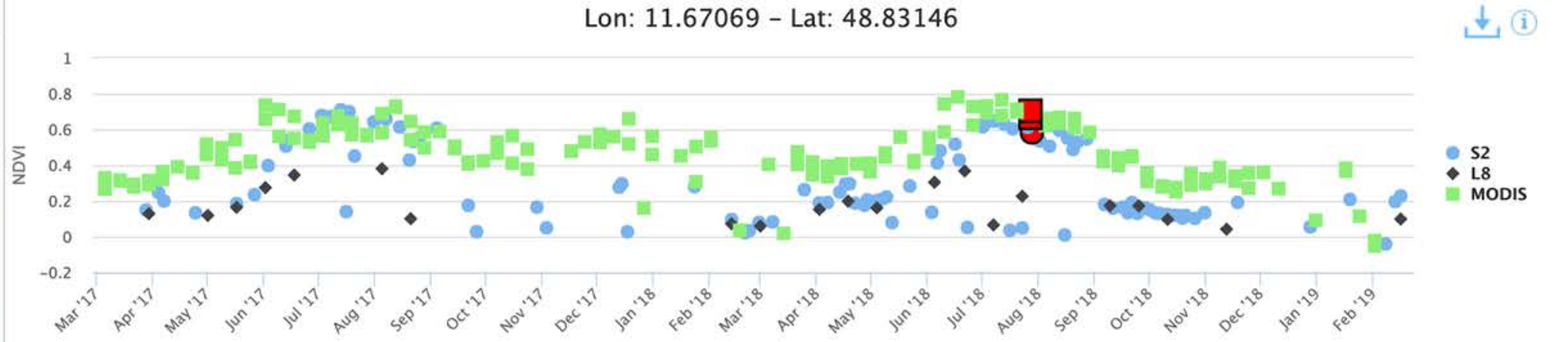
TIME PERIOD

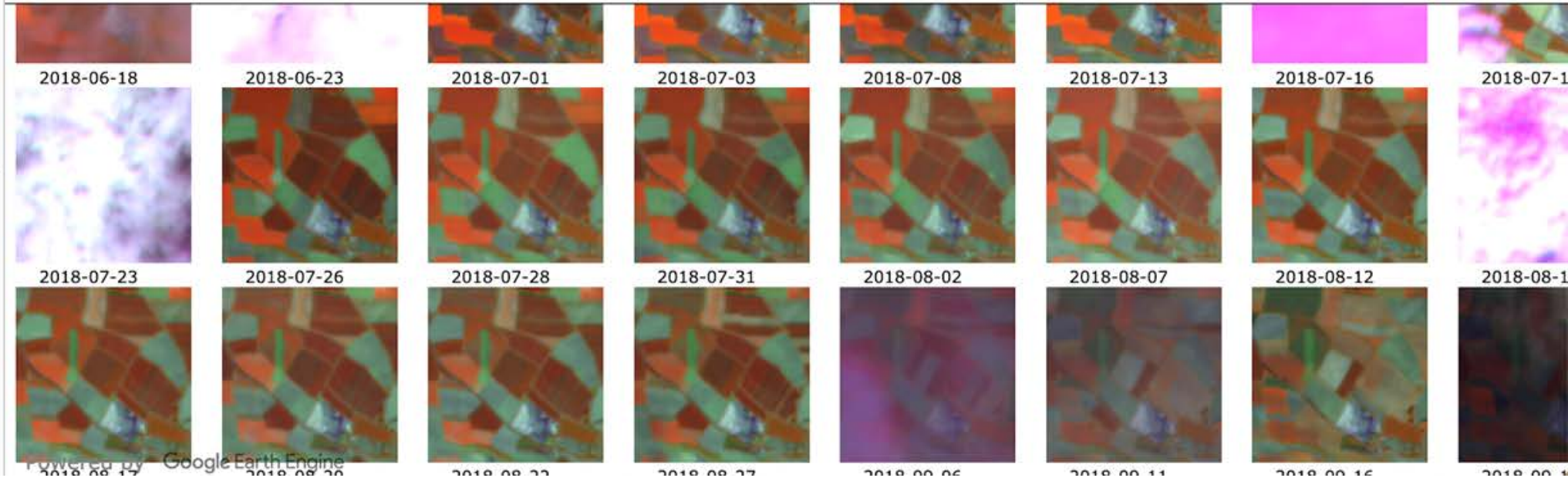
01 Mar 2017 | 19 Feb 2019

Get profiles and chips

MAP-1 | MAP-3 × | STATS-2 × | STATS-3 ×

Get Link





Powered by Google Earth Engine

DE - Bayern

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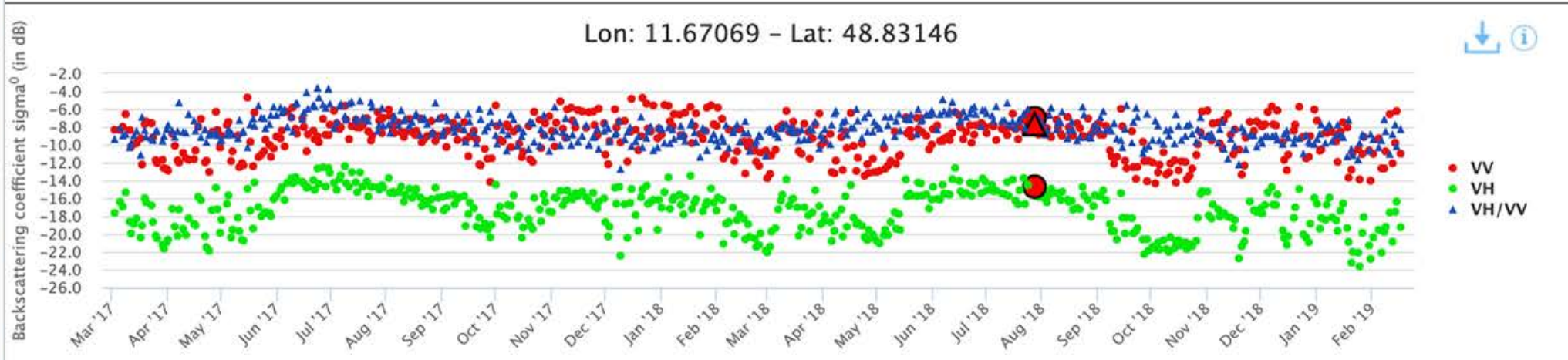

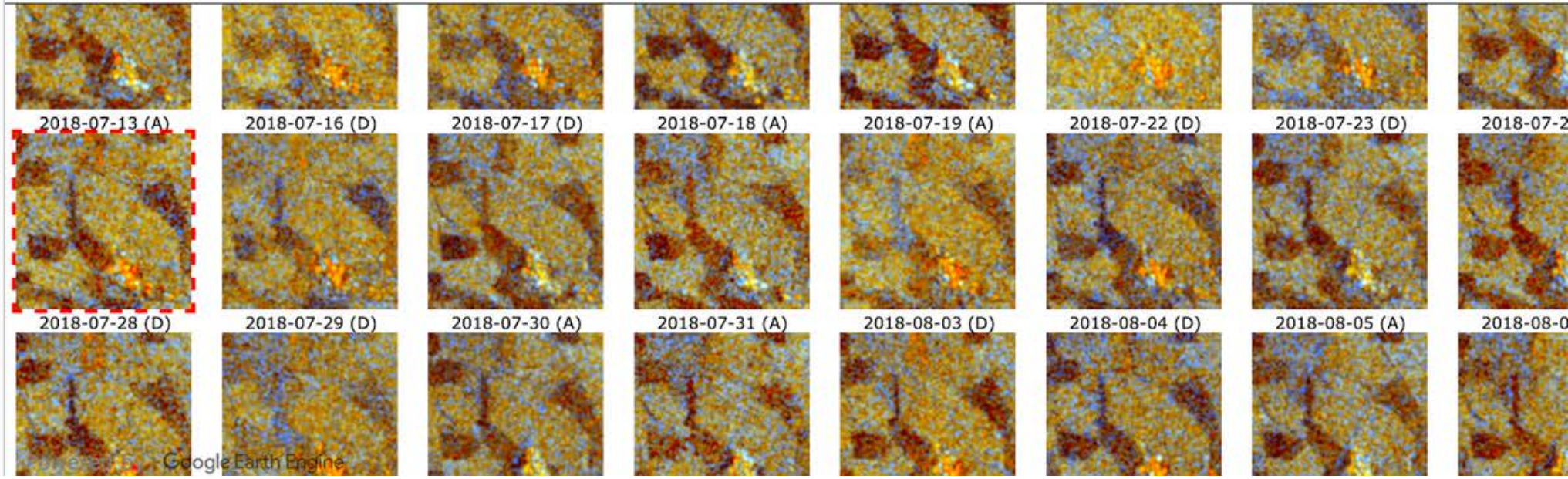

Open!

- Copernicus Sentinel data are **full, free and open**.
- The land parcel identification system is **open access** in several EU Member States, and will increasingly open up in others (DG AGRI legal opinion).
- The code to extract data from GEE and tensorflow code is **open** (see paper, reference [4])
- Docker-swarm based DIAS tests will be **open**.

We need more open data on crop phenology.

Next steps

- “Checks by Monitoring” is part of CAP Regulation since May 2018.
- 5 Member States have opted for monitoring, for some schemes, in 2019.
- Probably the fastest ever track from conception to CAP policy implementation.

- Onboarding Member States on DIAS.
- Further work on classification improvement (outlier reduction).
- Transfer learning: across agro-ecological regions, across seasons (**LPS19**).
- Crop phenology analysis: markers, time-invariance, anomaly detection (e.g. summer 2018).

Data collected in the growing season 2018

SONY

350 000 Pictures

NIKON

4056 Pictures

FIELD DATA

LPS session D.2.08

Thanks!

Any questions?

Contact guido.lemoine@ec.europa.eu

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