Soil Moisture Prediction

Dr. Onur Yüzügüllü, Dr. Noura Fajraoui, Peter Fröhlich
AgriCircle AG

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Questions

To what degree can we estimate the soil moisture from satellite data?

What is the spatial resolution that we can have with high accuracy?

Can we improve the soil moisture predictions using the DAISY model?

How can we make the predictions better?

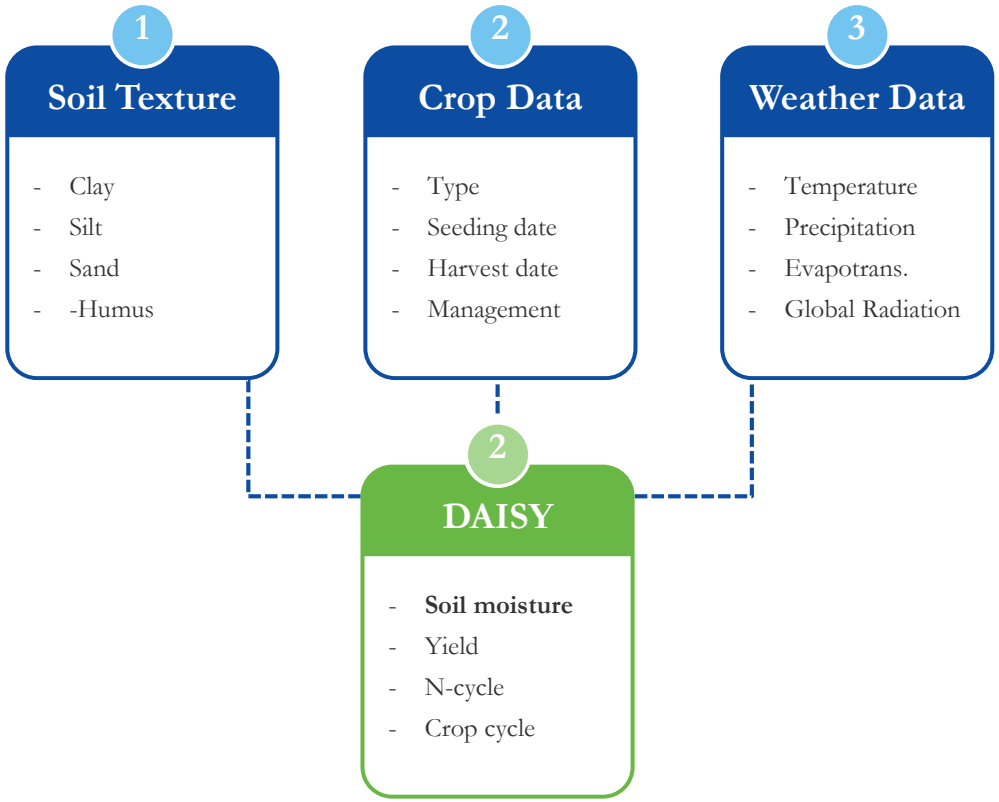
Outline

- Approach components
  - DAISY simulations
  - Soil data
  - Meteorology data
  - Satellite data
- Model development
- Model testing
- Example case
- Conclusions

Approach Components / DAISY Simulations

DAISY is a simulation model for biophysical process that takes place in agricultural areas.

It is capable of conducting simulations for water dynamics, heat and solute transport, nitrogen dynamics, soil organic matter, and crop growth with management.



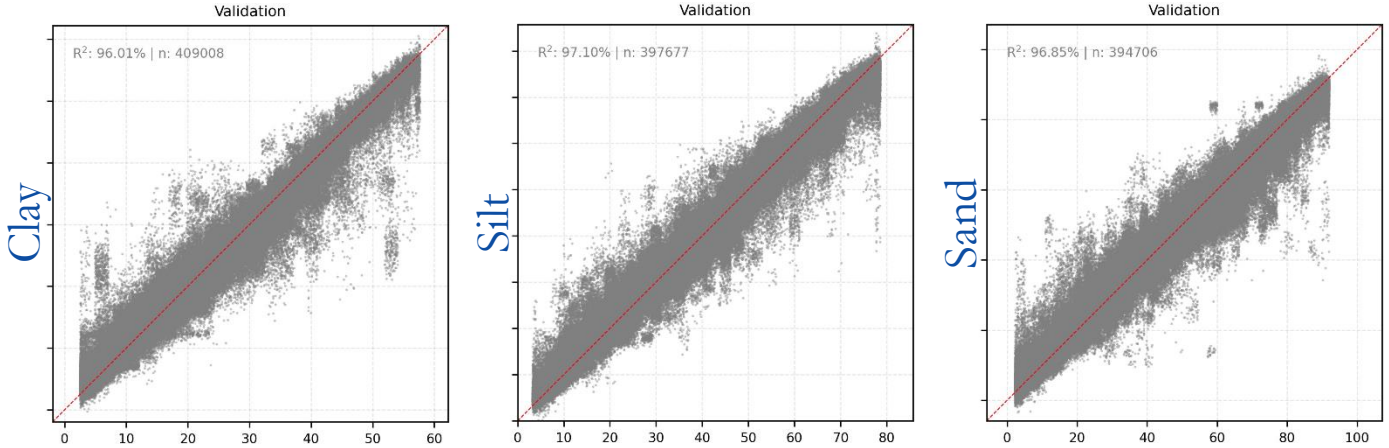
Approach Components / Soil Texture

Soil Database

- AgriCircle collected soil measurements from more than 60K locations in whole world.
- New measurements are included continuously to improve the models.
- Soil maps are utilized by Sentinel-1 and -2, topography and climate.

Soil Texture Prediction Framework

- A multi-booster voting scheme has been developed.
- Included frameworks: LightGBM, AdaBoost, GradBoost, XGBoost



Approach Components / Crop Data

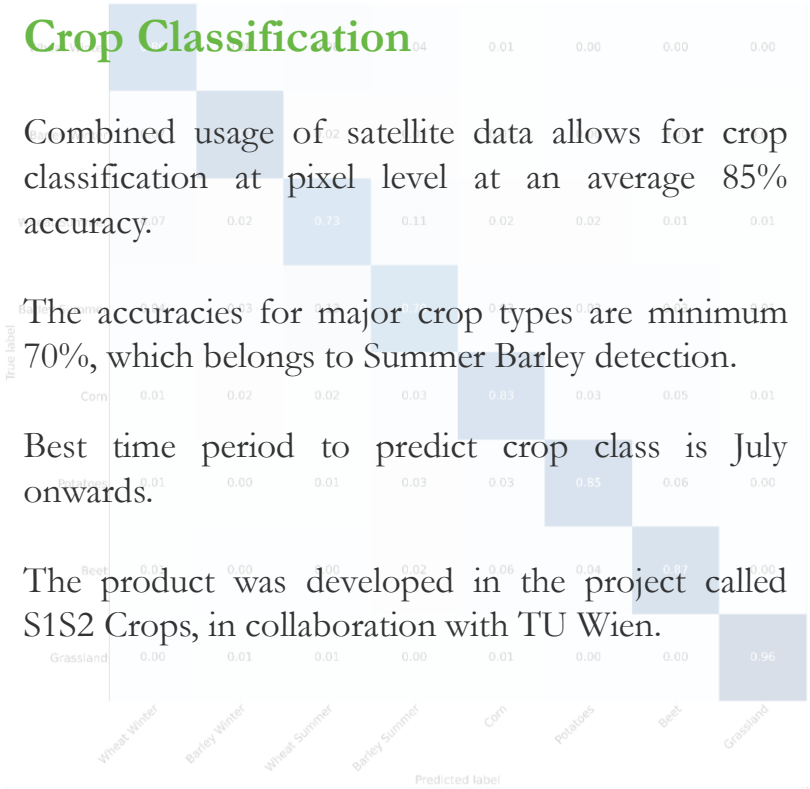
Crop Classification

Combined usage of satellite data allows for crop classification at pixel level at an average 85% accuracy.

The accuracies for major crop types are minimum 70%, which belongs to Summer Barley detection.

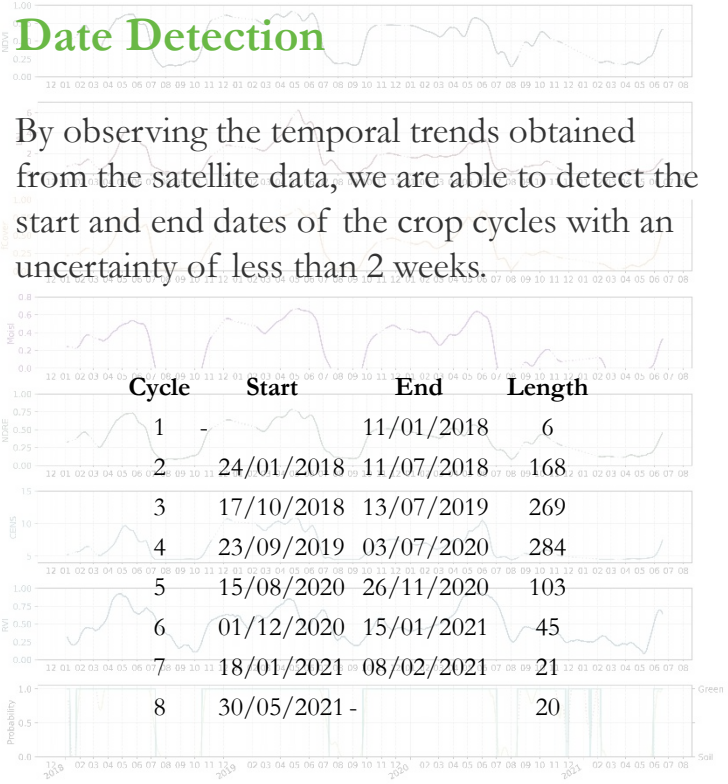
Best time period to predict crop class is July onwards.

The product was developed in the project called S1S2 Crops, in collaboration with TU Wien.



Date Detection

By observing the temporal trends obtained from the satellite data, we are able to detect the start and end dates of the crop cycles with an uncertainty of less than 2 weeks.



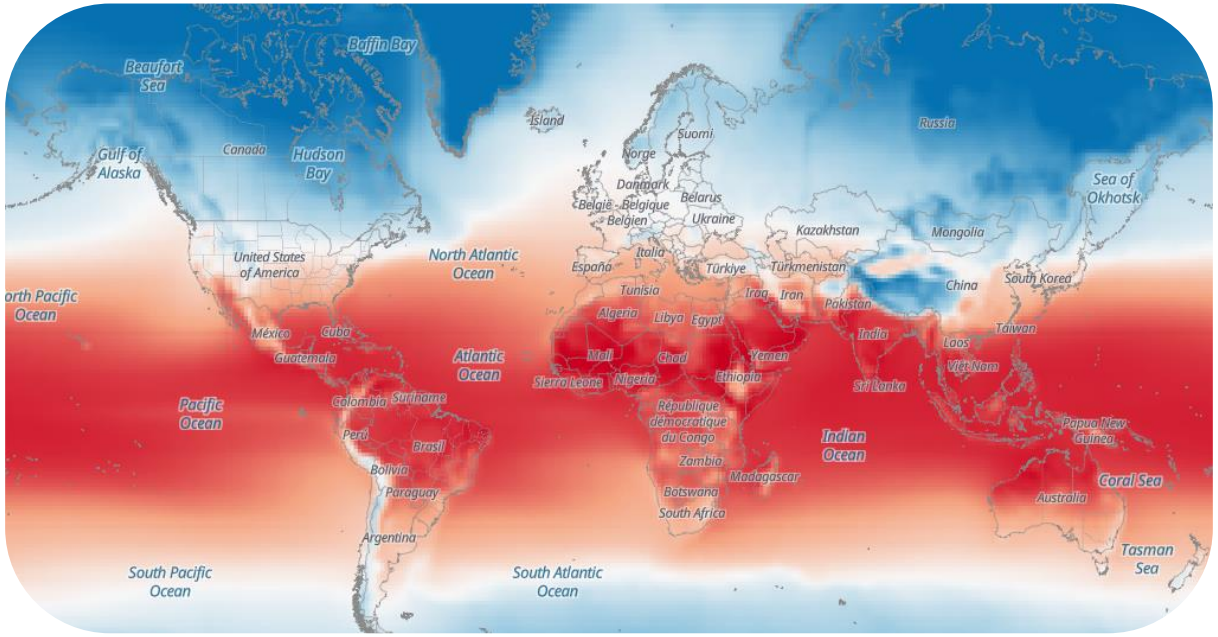
Cycle	Start	End	Length
1	-	11/01/2018	6
2	24/01/2018	11/07/2018	168
3	17/10/2018	13/07/2019	269
4	23/09/2019	03/07/2020	284
5	15/08/2020	26/11/2020	103
6	01/12/2020	15/01/2021	45
7	18/01/2021	08/02/2021	21
8	30/05/2021	-	20

Approach Components / Weather Data

meteomatics

Meteomatics provide the following climate data through its Weather API either in hourly or daily.

- Air temperature
- Soil temperature
- Precipitation
- Global radiation
- Evapotranspiration



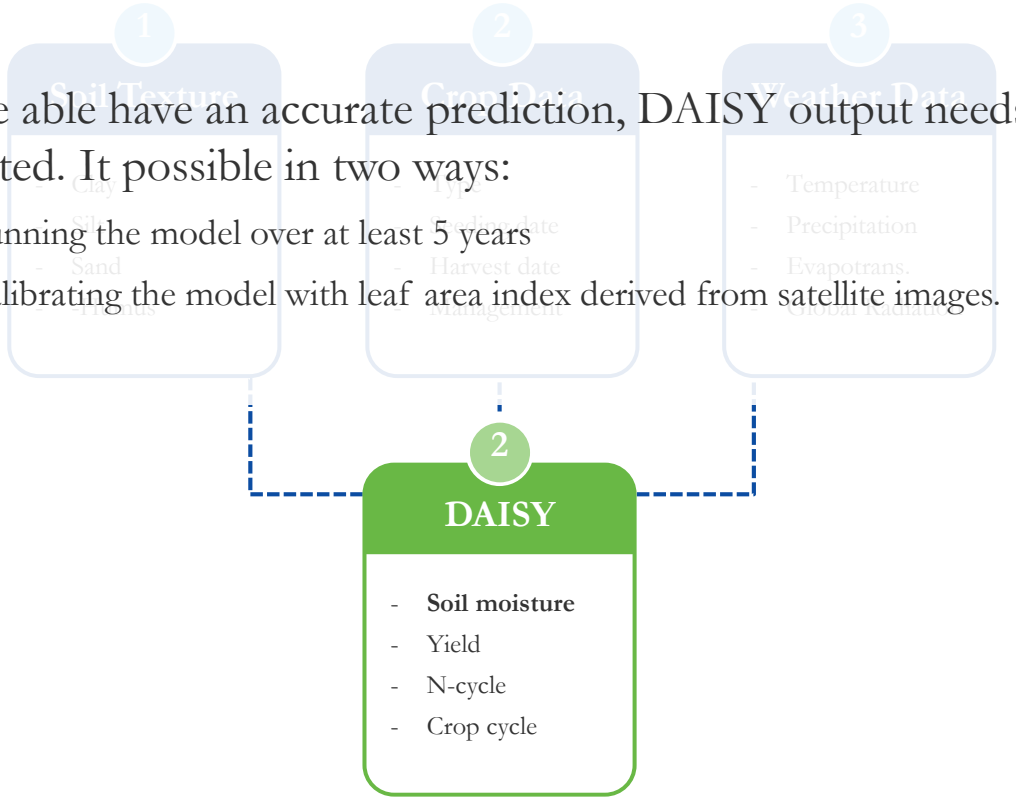
Approach Components / DAISY Simulations

DAISY is a simulation model for biophysical process that takes place in agricultural areas.

It is capable of conducting simulations for water dynamics, heat and solute transport, nitrogen dynamics, soil organic matter, and crop growth with management.

To be able have an accurate prediction, DAISY output needs to be adjusted. It possible in two ways:

- Running the model over at least 5 years
- Calibrating the model with leaf area index derived from satellite images.

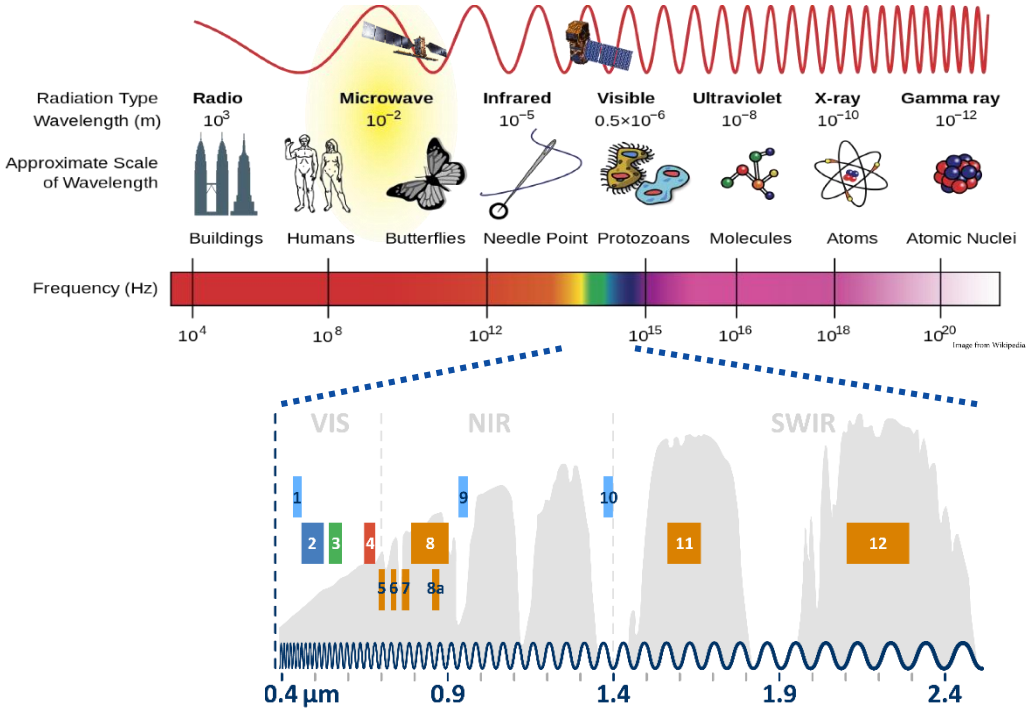


Approach Components / Satellite for Calibration

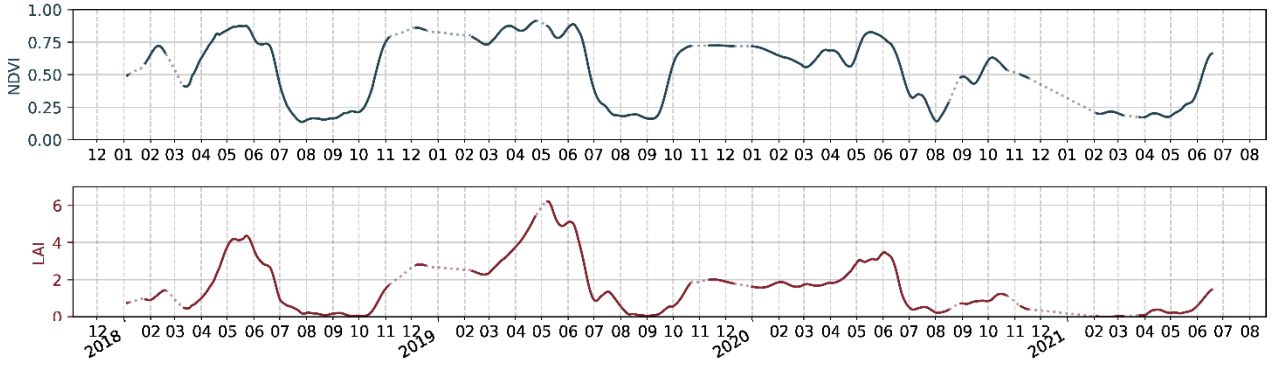
Satellite Data

- Sentinel 1-
C-band SAR
All-weather conditions
10 m resolution
Physical and dielectric properties

- Sentinel 2-
Multispectral data
443 – 2190 nm wave length
10 – 60 m resolution
Spectral properties/reflectance



Approach Components / Leaf Area Index



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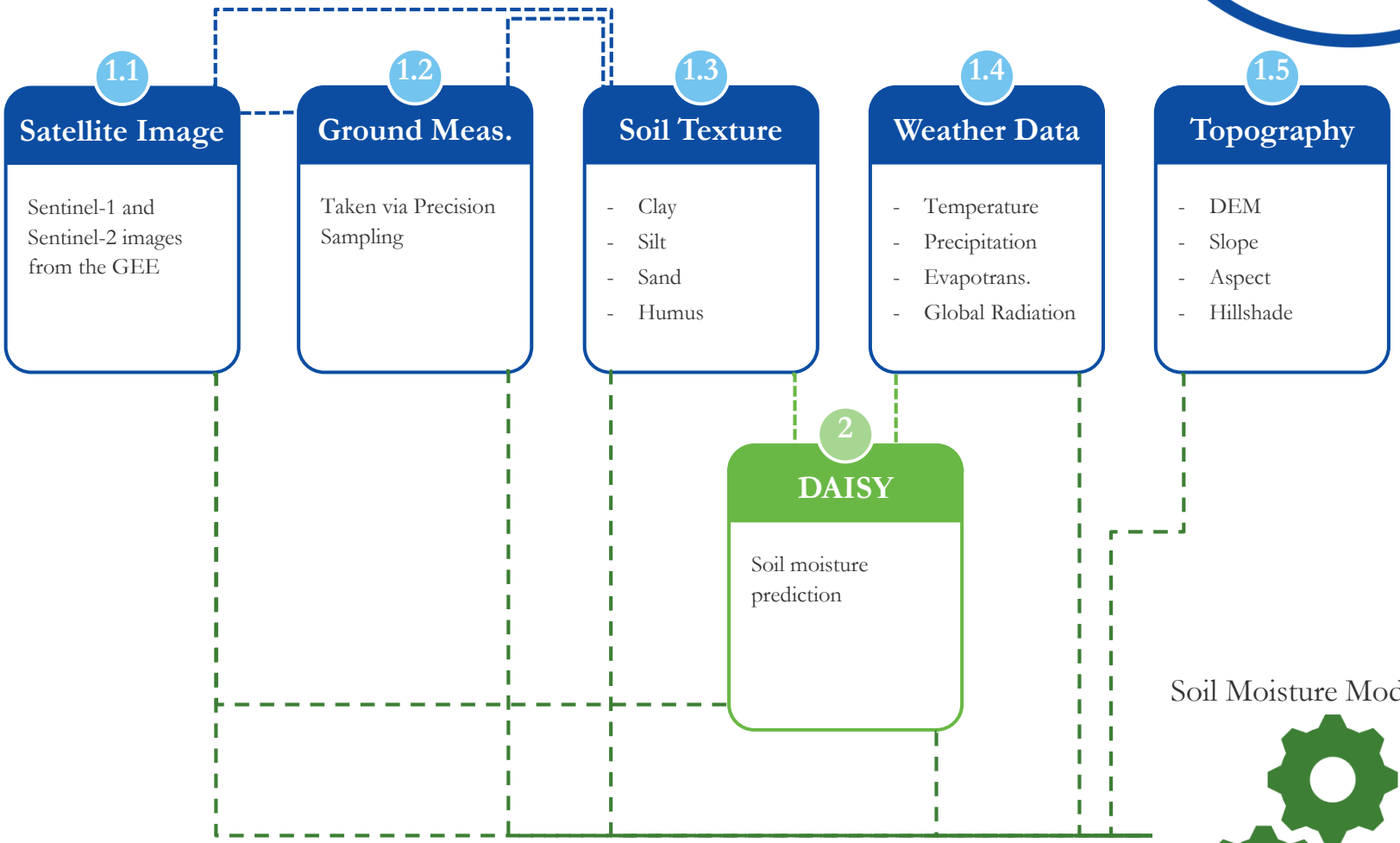
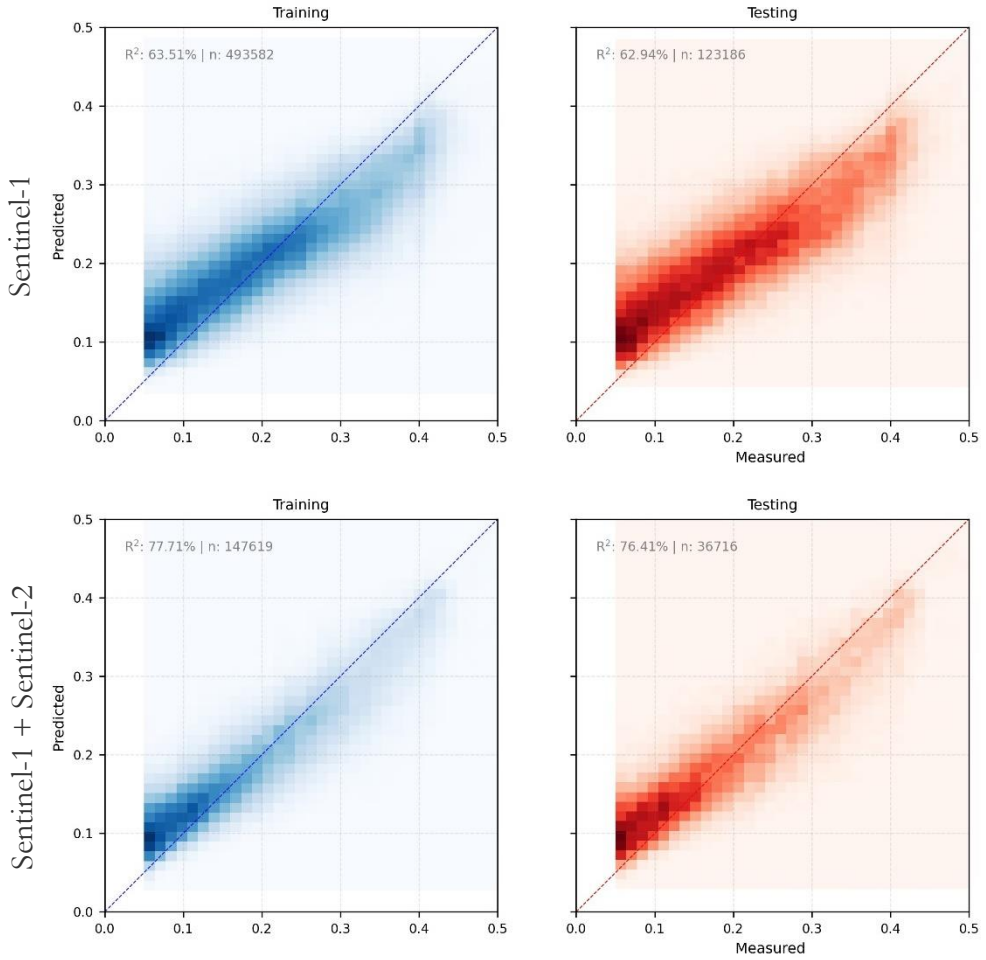
Model Development



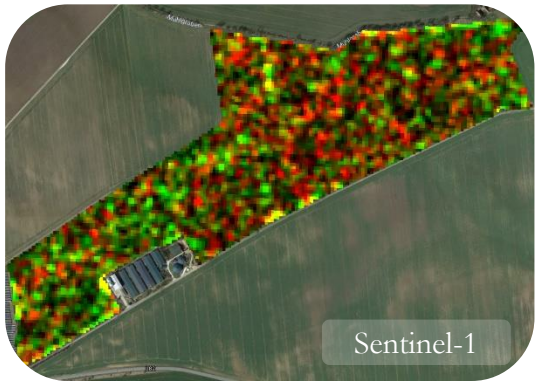
Model Testing

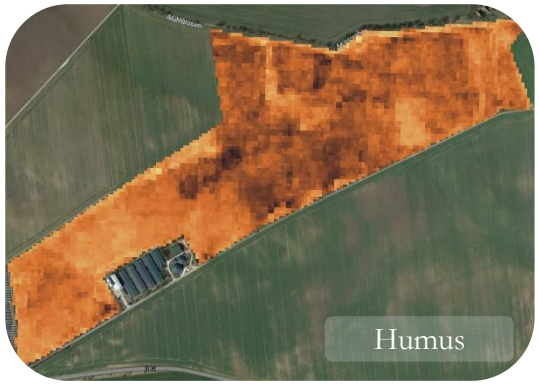
The AgriCircle soil moisture model has been tested with and without Sentinel-2 MSI. The validation analysis showed that:

- The S1 based model has a testing accuracy of 62.94% with an RMSE of 0.1.
- The S1 and S2 based model has a testing accuracy of 76.41% with an RMSE of 0.06.
- Inclusion of the spectral signature improves the accuracy significantly.

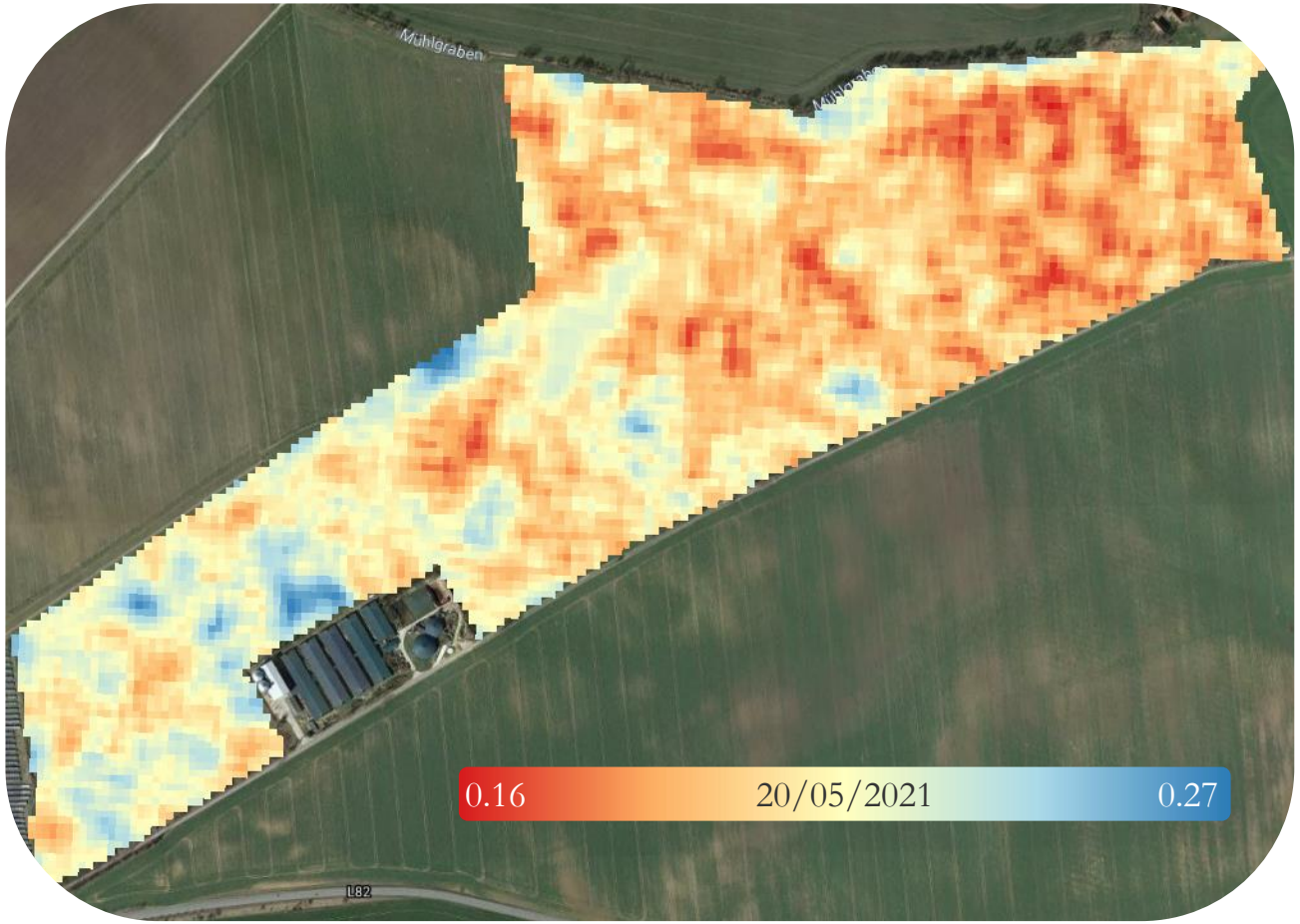


Example Case / Stadtfeld Features





Example Case / Stadtfeld Soil Moisture



Answers

To what degree can we estimate the soil moisture from satellite data?

- With an accuracy of more than 80% and an error of less than 6%.

What is the spatial resolution that we can have with high accuracy?

- Sentinel satellites' spatial resolution of 10 meter.

Can we improve the soil moisture predictions using the DAISY model?

- Inclusion of DAISY improves the prediction accuracy around 5%.

How can we make the predictions better?

- Placing a single soil moisture sensor in the field can improve the model predictions significantly.

We need your votes on the ClimaNow competition

It will take only one minute to vote our Net Zero Farm Project

https://climanow.ch/en/spotlight/149-net-zero-farms/

Thank you!

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