Assessing the collection of soil moisture estimates in the scope of AgriSens Demmin 4.0:

Comparison of in-situ measurements and AMBAV model results

Kristin Haßelbusch, Falk Böttcher, Antje Lucas-Moffat,

Eva Falge, Johannes Kaiser and Mathias Herbst

AgriSens
DEMMIN 4.0

Gefördert durch
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Projektträger
Bundesanstalt für Landwirtschaft und Ernährung

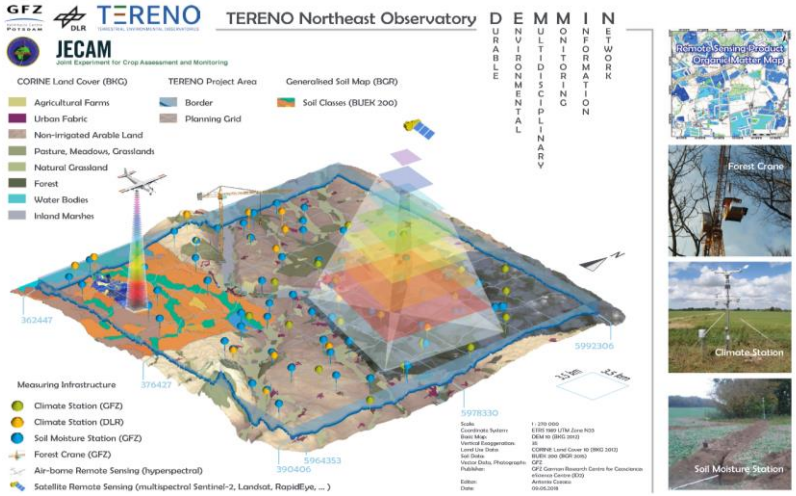
AgriSens Demmin 4.0

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Remote sensing for crop farming

- Identify applications for remote sensing data
- Find criteria for reliability and accuracy
- Promote the use in crop production





Role of DWD:

- Provide agrometeorological data and expertise
- Validate and improve models with field campaign and station measurements with **focus on soil moisture**
- Evaluate potentials for integration of remote sensing data

Soil moisture estimates

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Stations with capacitive soil moisture sensors → ADCON SM1

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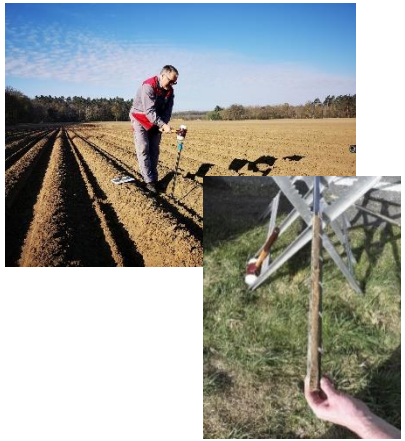
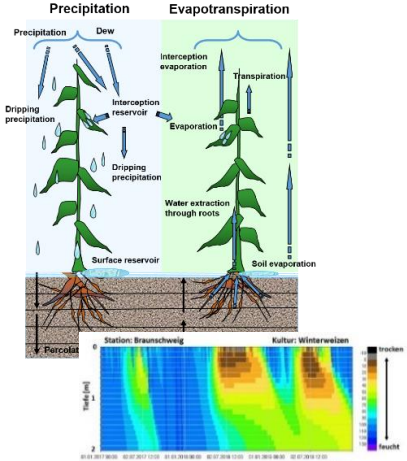
https://www.adcon.com/download/leaflet-sm1-soil-moisture-sensor/

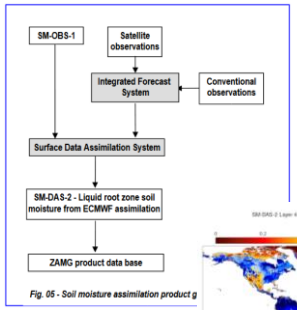
Gravimetric measurement with a boring rod



DWD in-house SVAT model AMBAV



Satellite images assimilated into a Land Surface Model → SM-DAS-2 (H14)



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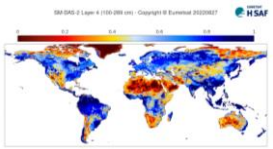

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Soil moisture estimates

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	ADCON SM1 sensor	Gravimetric samples	AMBAV	SM-DAS-2 (H14)
Temporal resolution	Hourly	~Monthly	Hourly	Daily
Spatial resolution	Sparse, ~2-8 km distance between stations	Sparse, sampling points only on dedicated fields	Depending on meteorological and soil map input → here 1x1 km	0.225°x0.225°
Soil vertical resolution	Sensors in 10cm spacing up to 1m depth	Layers of 10cm up to 60cm depth	Layers of 10cm up to 2m depth	4 layers: 0-7cm, 7-28cm, 28-100cm, 100-289cm
Unit	Volumetric soil water content (not calibrated)	Volumetric soil water content	Volumetric soil water content	Soil wetness index
Crop-specific?	Installed under grass	Yes	Yes	No, mixture of land use

→ How well do these estimates agree in space and time?

AMBAV vs. ADCON SM1 sensors

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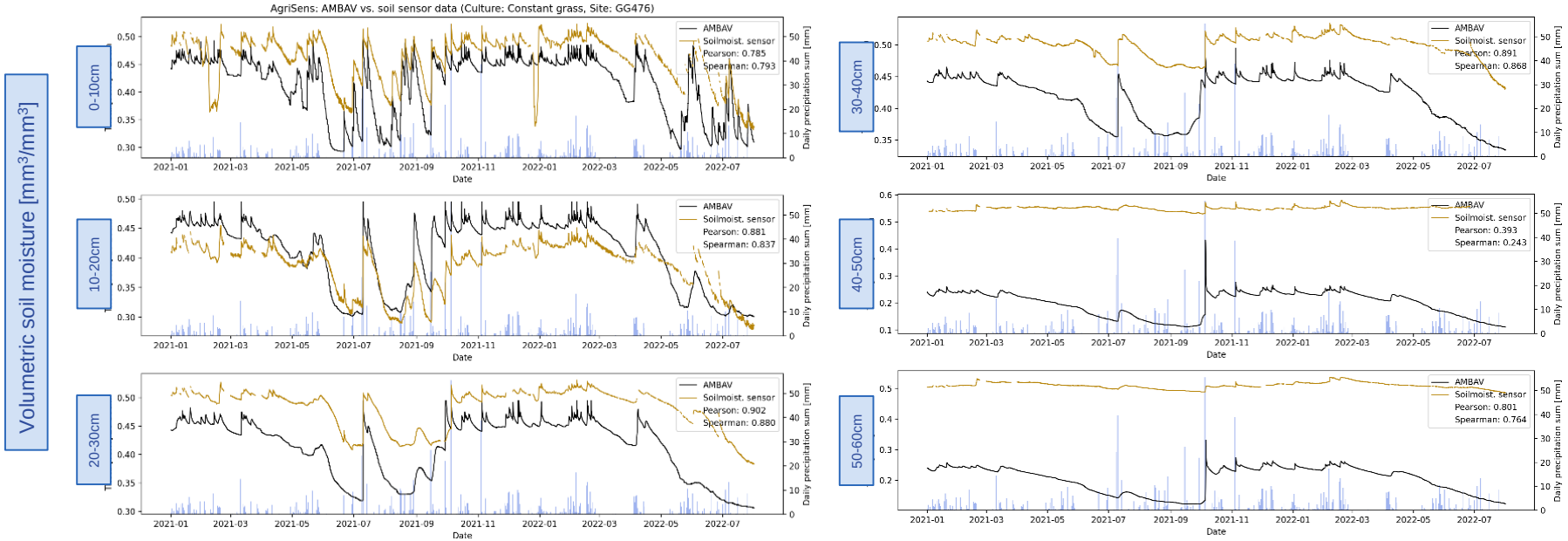
- AMBAV with FAO constant grass parametrization



AMBAV vs. ADCON SM1 sensors

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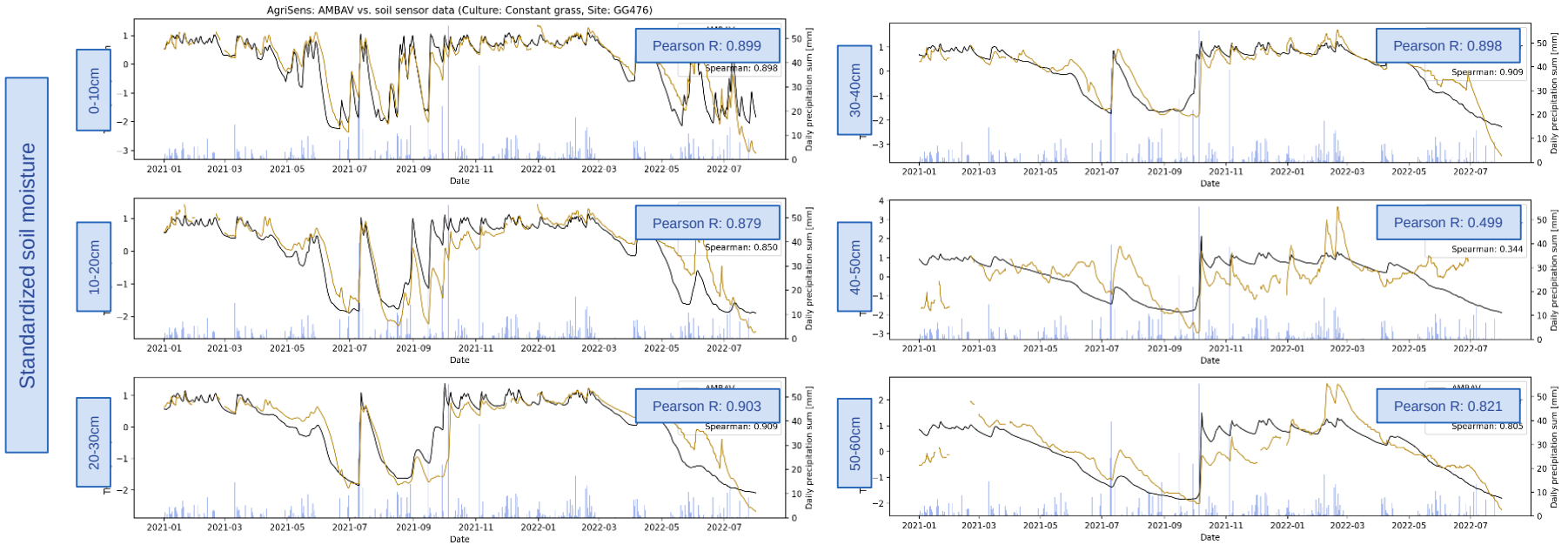
- AMBAV with FAO constant grass parametrization
- Sensors are not calibrated, standardization for visual comparison → $\tau' = \frac{\tau - \overline{\tau}}{\sigma(\tau)}$
- Pearson correlation coefficient as evaluation metric



AMBAV vs. ADCON SM1 sensors

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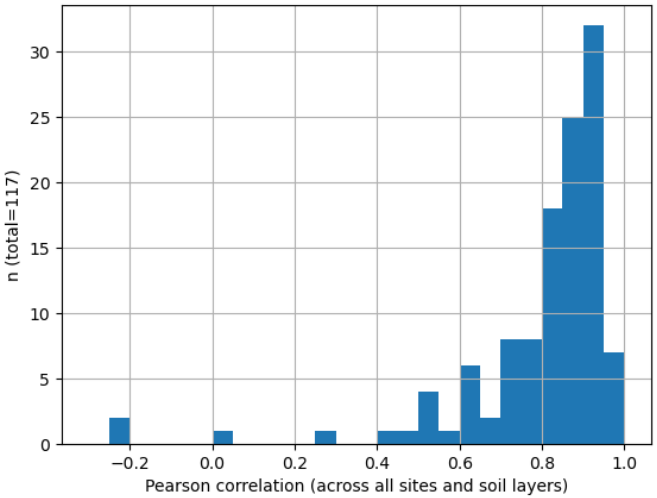
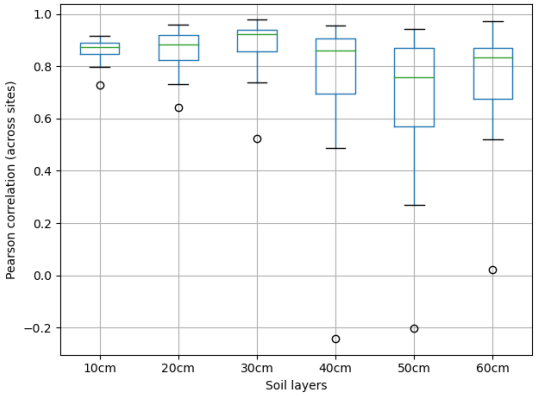
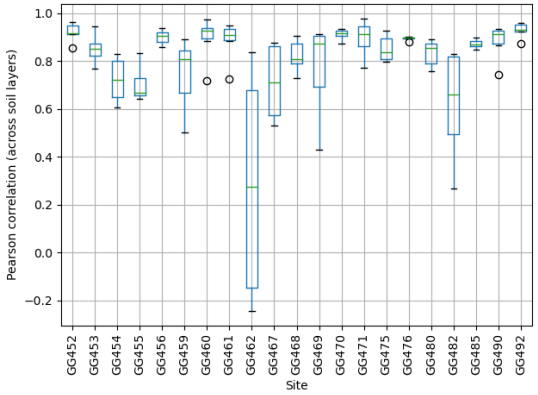
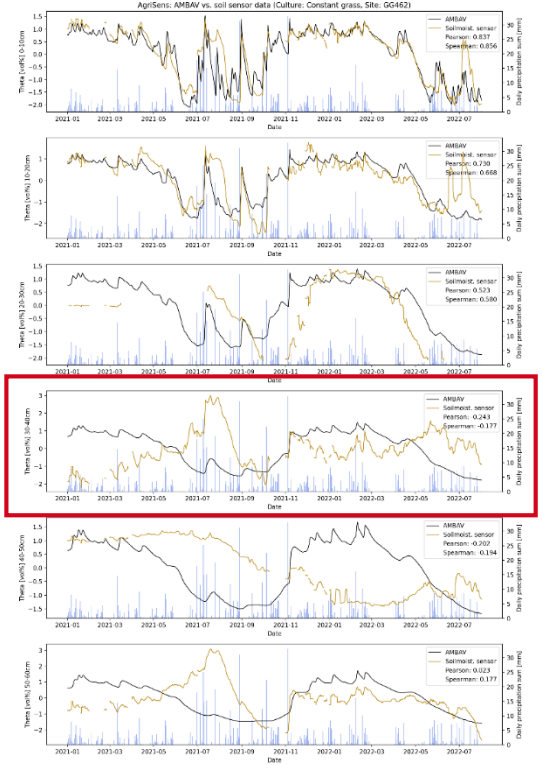
Distribution of Pearson correlation coefficient for 21 sites and the upper 6 soil layers







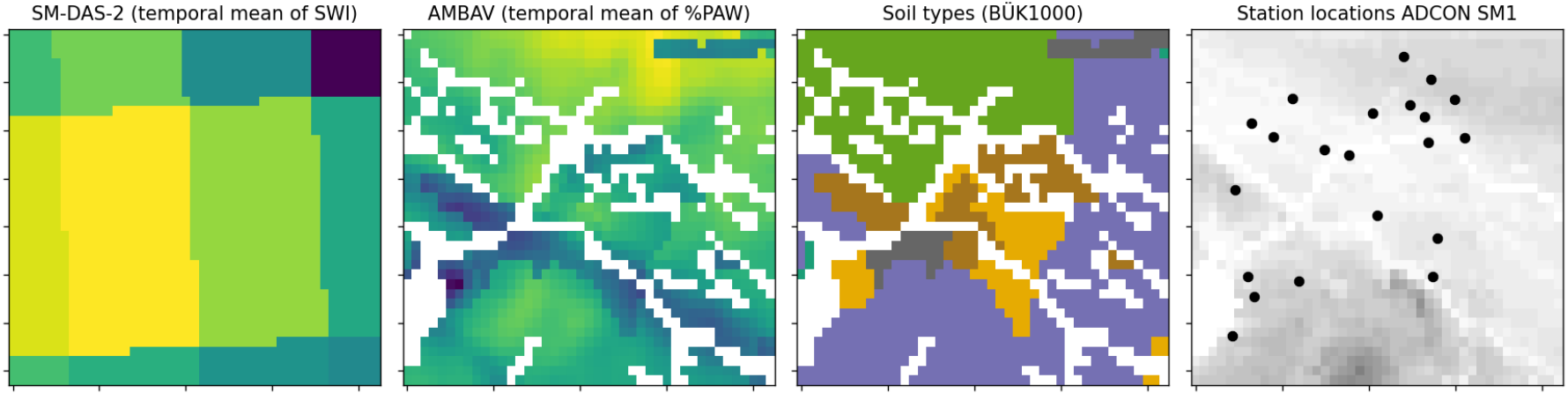


- High percentage with good agreement (R > 0.8) → similar temporal dynamics
- Agreement is better in upper soil layers
- Some outliers with low (or even negative) correlation
- Model can be used to check measuring system

AMBAV vs. SM-DAS-2 vs. ADCON SM1

- Gridded AMBAV simulations for main crop types for project region → average over crop types
- Transform AMBAV and SM-DAS-2 to same vertical and horizontal resolution
  → 37x43 km grids with 1 km resolution

Spatial distribution for upper soil layer (0-7 cm)



- SM-DAS-2 product misses most of the local structure in the project region
- For AMBAV plant available water (%PAW) the structure is defined by soil map and atmospheric conditions

AMBAV vs. SM-DAS-2 vs. ADCON SM1

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Frost events: Eliminated artefacts in sensor and satellite data

Spatial mean

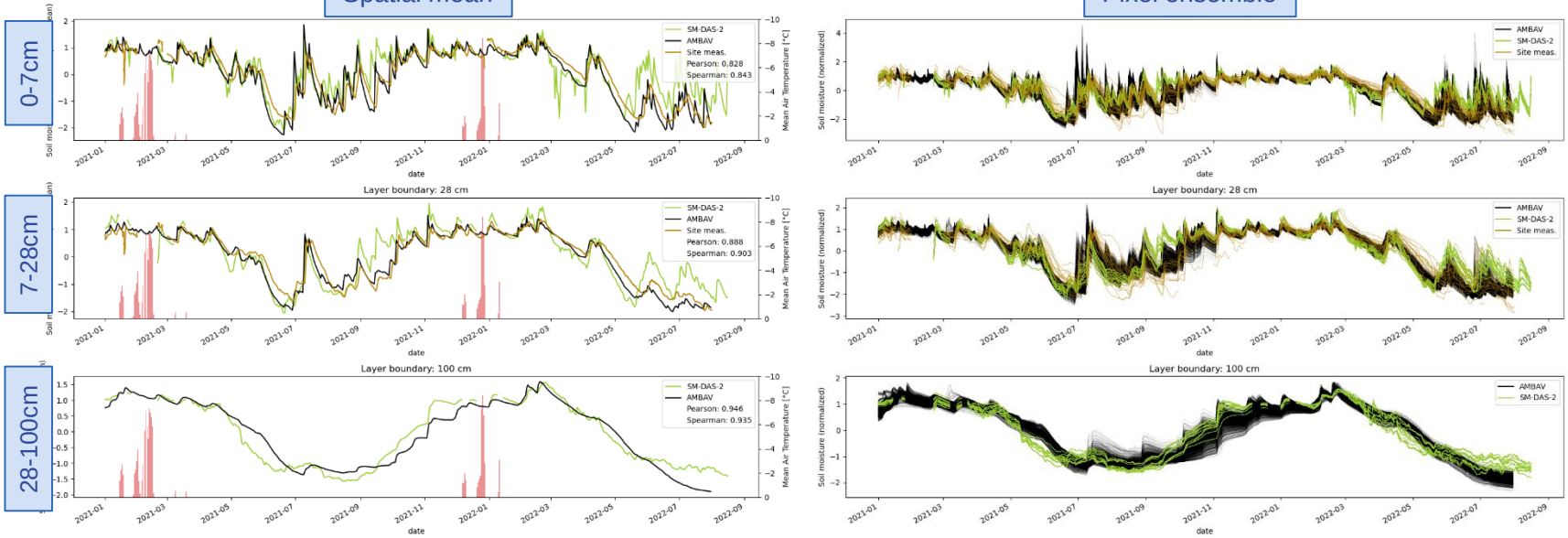
Pixel ensemble

Standardized soil moisture

0-7cm

7-28cm

28-100cm



- Good agreement of temporal dynamics of all three estimates
- Higher spatial variability represented in AMBAV
- Because of coarse resolution no immediate benefit from SM-DAS-2, but useful as reference for soil moisture dynamics for larger regions

AMBAV vs. Gravimetric samples 2022

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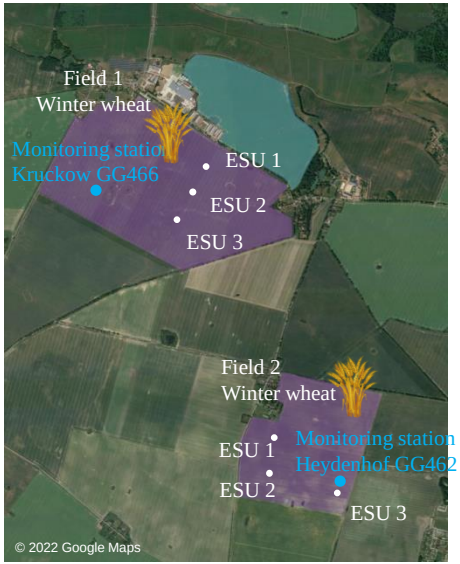
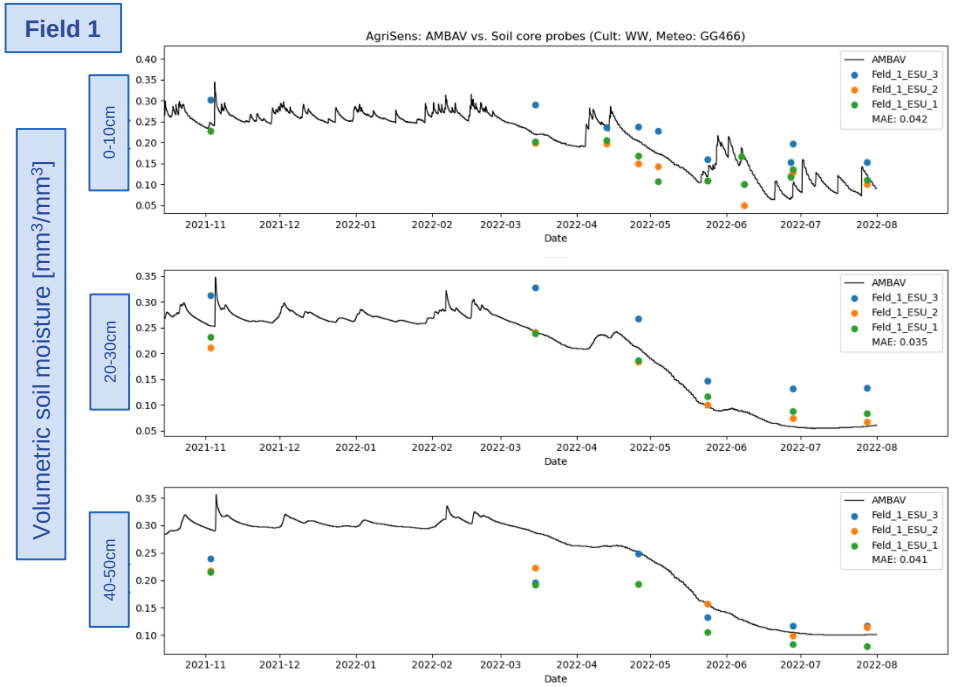
- Sampling on winter wheat fields at monthly intervals
- Soil hydraulic parameters were determined in the lab for the top 30cm



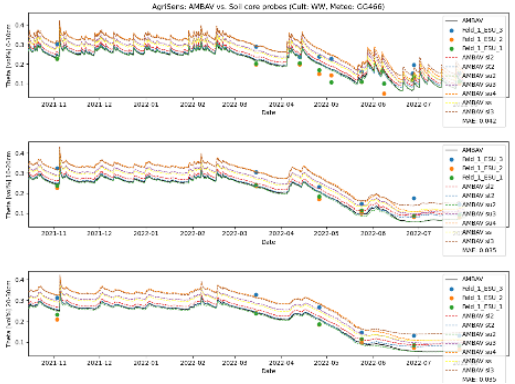


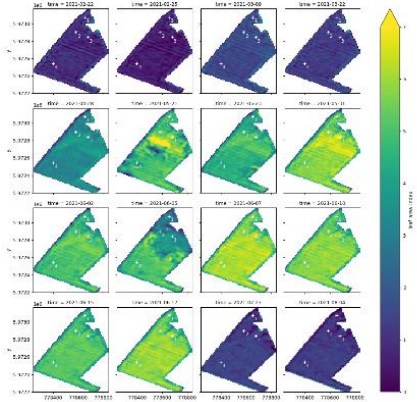
- Comparison of absolute volumetric soil moisture values → model calibration and validation
- Good agreement especially in upper soil layers
- Model covers periods between gravimetric samples
- Model lacks spatial heterogeneity that can be seen in samples → combination with remote sensing data?
- Soil type selection for AMBAV remains difficult

Future activities

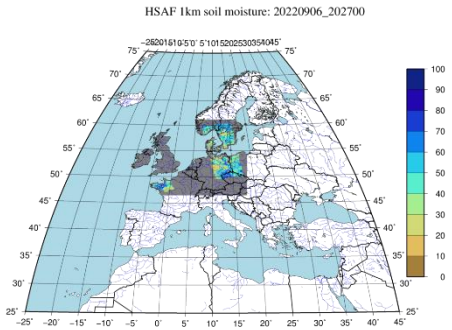
- CRNS measurements to bridge gap in spatial scale (at AgriSens as well as at DWD sites)
- AMBAV ensemble calculations for similar soil types to get uncertainty range
- Assimilate remote sensing data of vegetation state into model to better capture spatial heterogeneity
- Review further remote sensing soil moisture products







Data provided by JKI working group “Remote sensing and sensor technology”



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Thank you for your attention



Contact:

kristin.hasselbusch@dwd.de

falk.boettcher@dwd.de

Project homepage:

https://www.agrisens-demmin.de

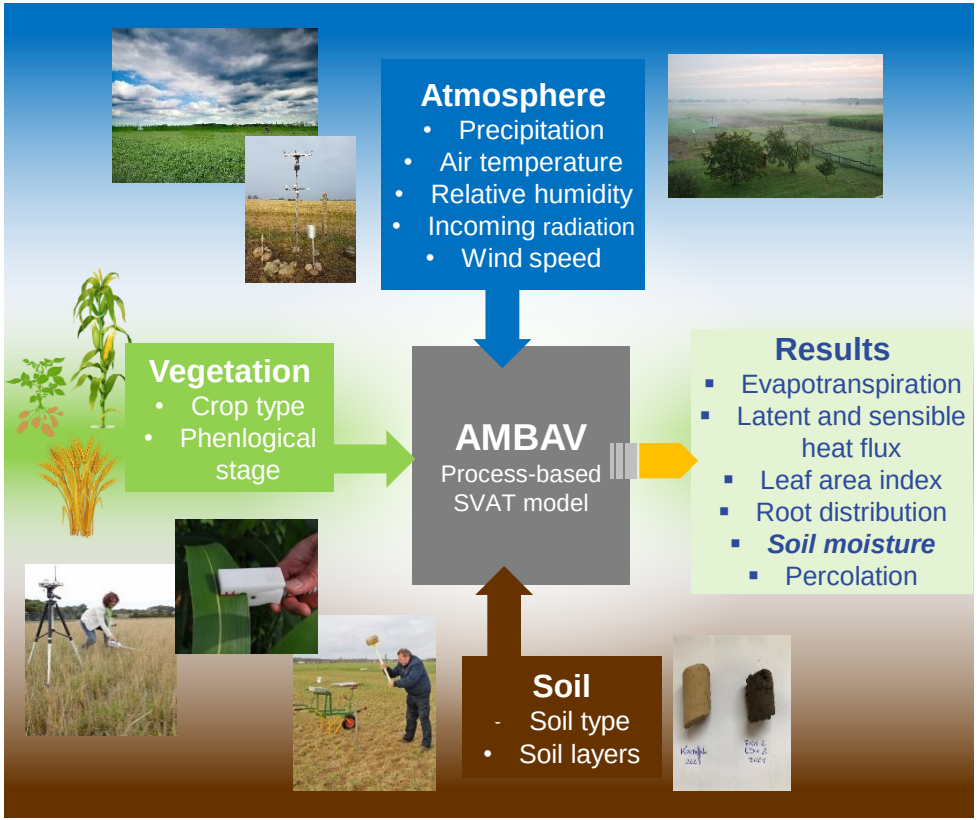
Bodenfeuchteviewer (interactive soil moisture viewer):

https://www.dwd.de/bodenfeuchteviewer

SVAT model: AMBAV

AMBAV = *Agrarmeteorologische Berechnung der aktuellen Verdunstung* = Agrometeorological calculation of the current evaporation

- The **AMBAV** model is a DWD in-house development
- Modelling of **evapotranspiration** and **soil water balance**
- Results are distributed to stakeholders in agriculture and policy



AMBAV vs. ADCON SM1 sensors

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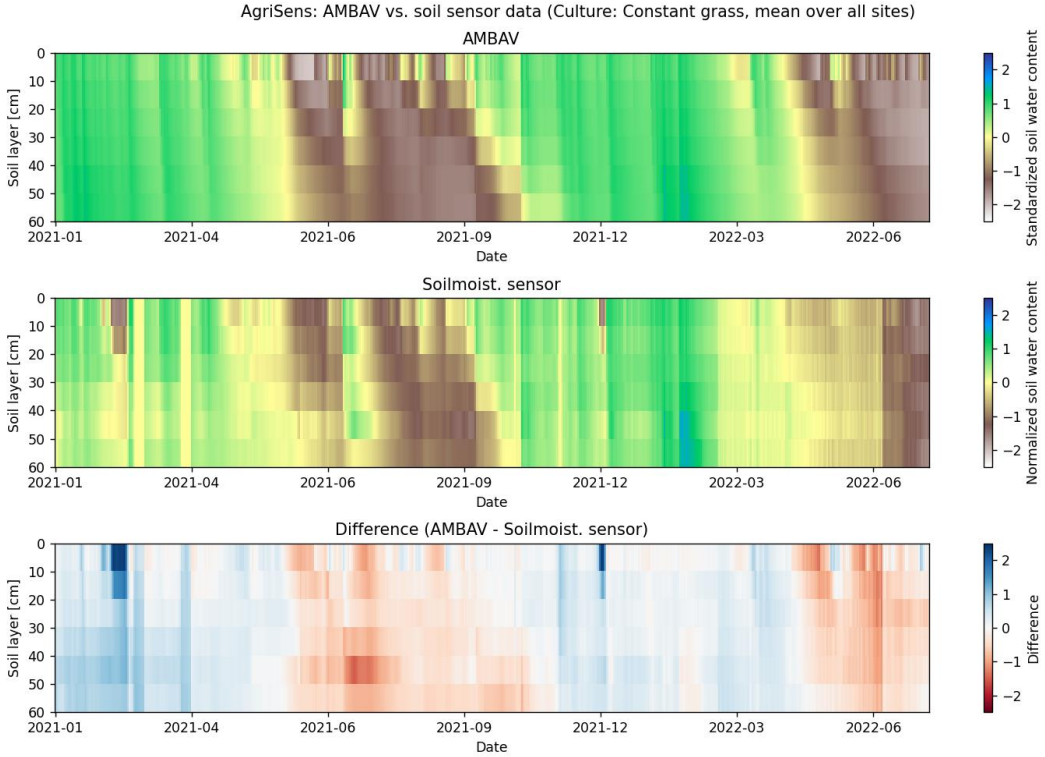
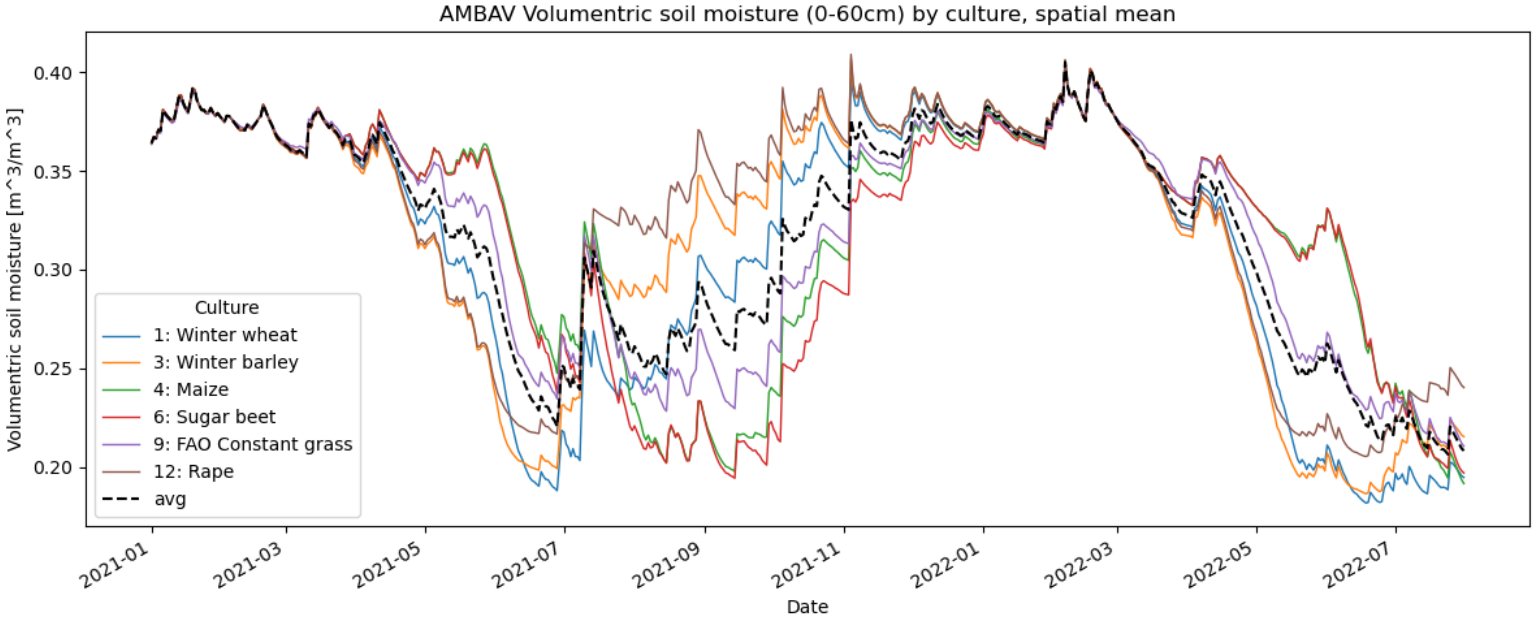
Average soil moisture course (across all sites)



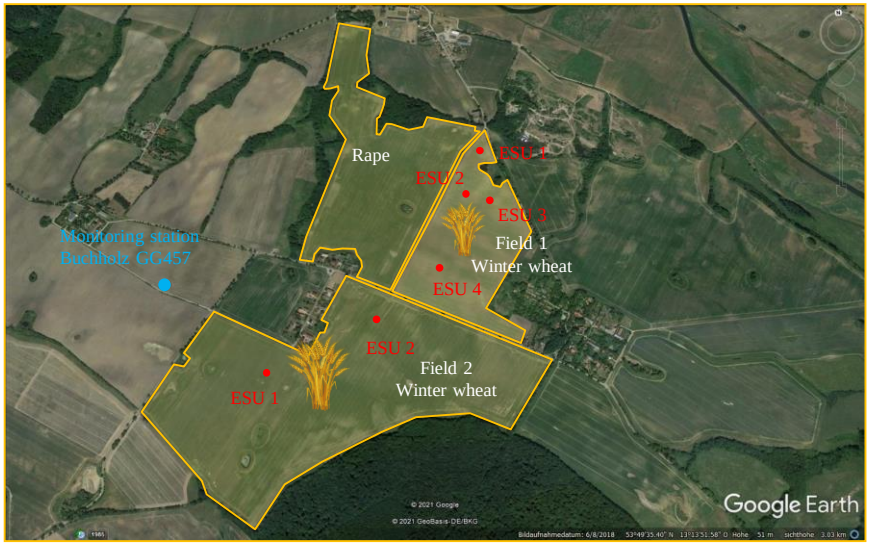
Gridded AMBAV simulations

- Gridded AMBAV result based on interpolated meteorological station data and soil map (BÜK1000)
- Identification of main crop types in region via DLR crop type map (make up ~65% of land use)



AMBAV vs. Gravimetric samples 2021

- Sampling on winter wheat fields at monthly intervals
- AMBAV applied using soil type Sl2



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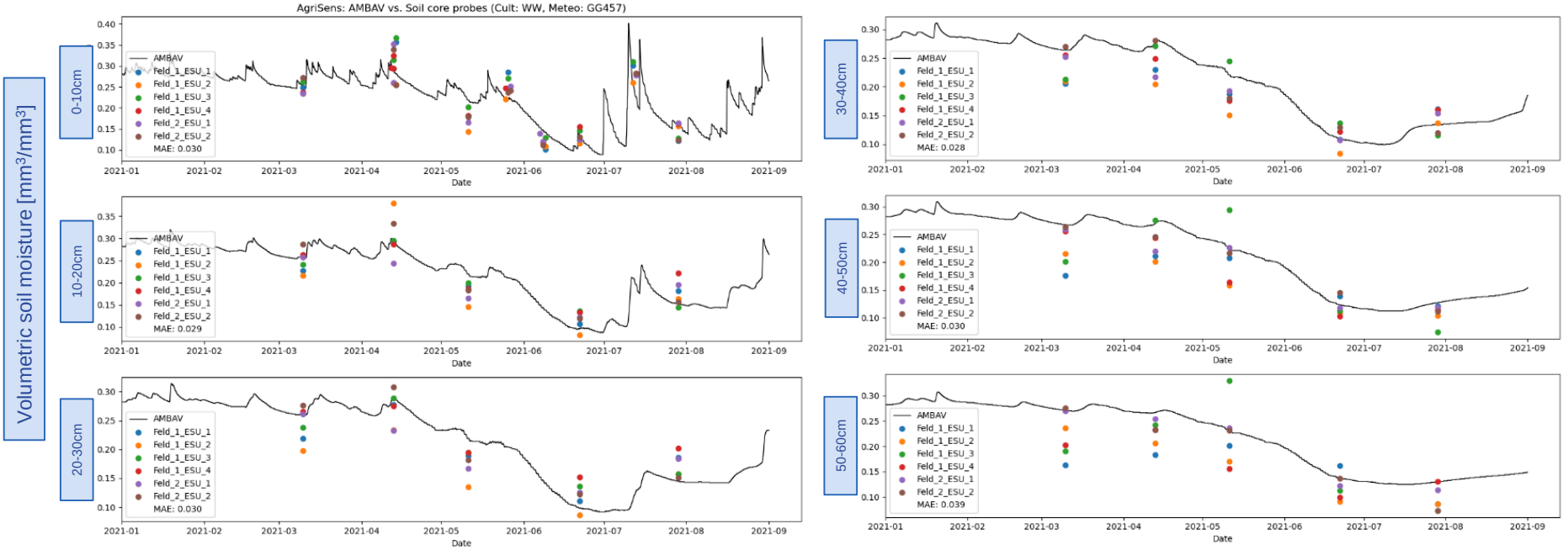

AMBAV vs. Gravimetric samples 2022

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Field 2

