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HALLE-WITTENBERG


# Application oriented monitoring of agrarian ecosystems and localization of droughts - a question of data integration

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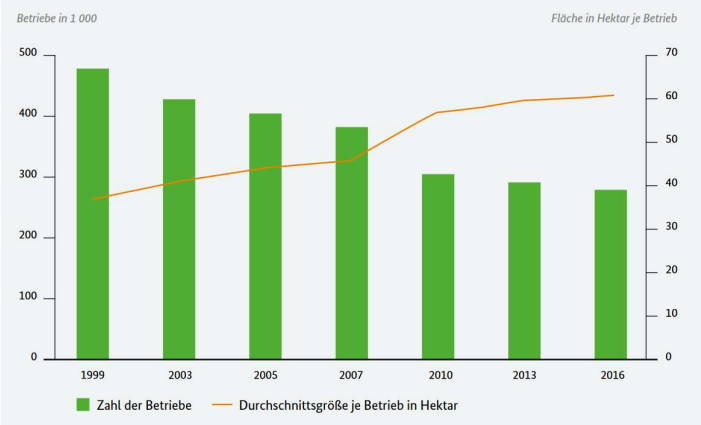
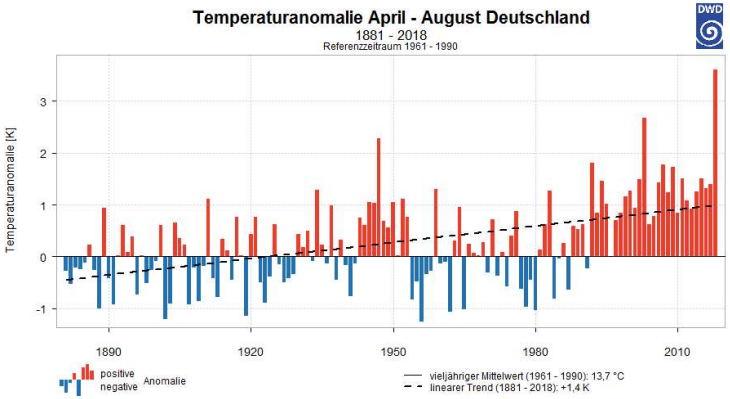
# Immense pressure on agrarian ecosystems

- Task: Economic, social and ecological sustainability
- Ongoing changes increase vegetation periods, provide more $CO_2$ for production, but also more $O_3$, increased number of extreme events (Gömann et al. 2017)
- Major requirements for agricultural sector: Improved monitoring, scientific analysis and consultancy

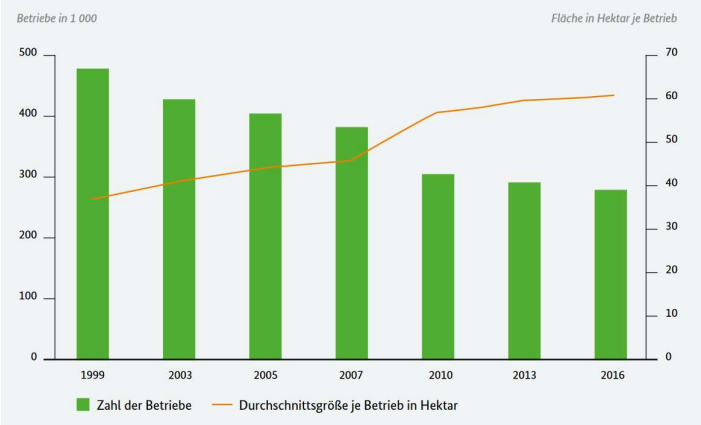



Increasing farm size, www.bmel.de



# Immense pressure on agrarian ecosystems

- Remote sensing can be very helpful monitoring tool

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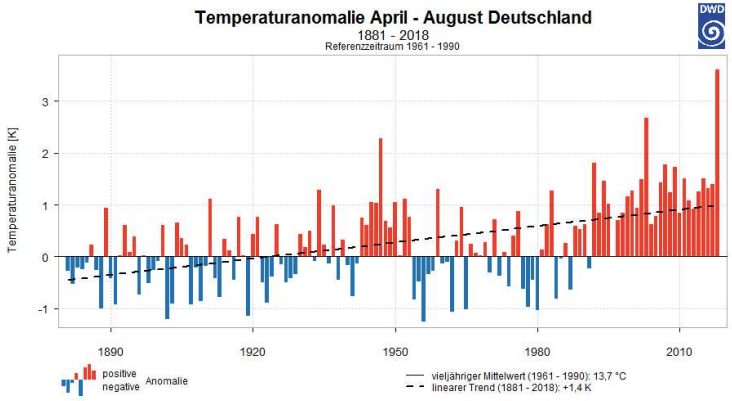
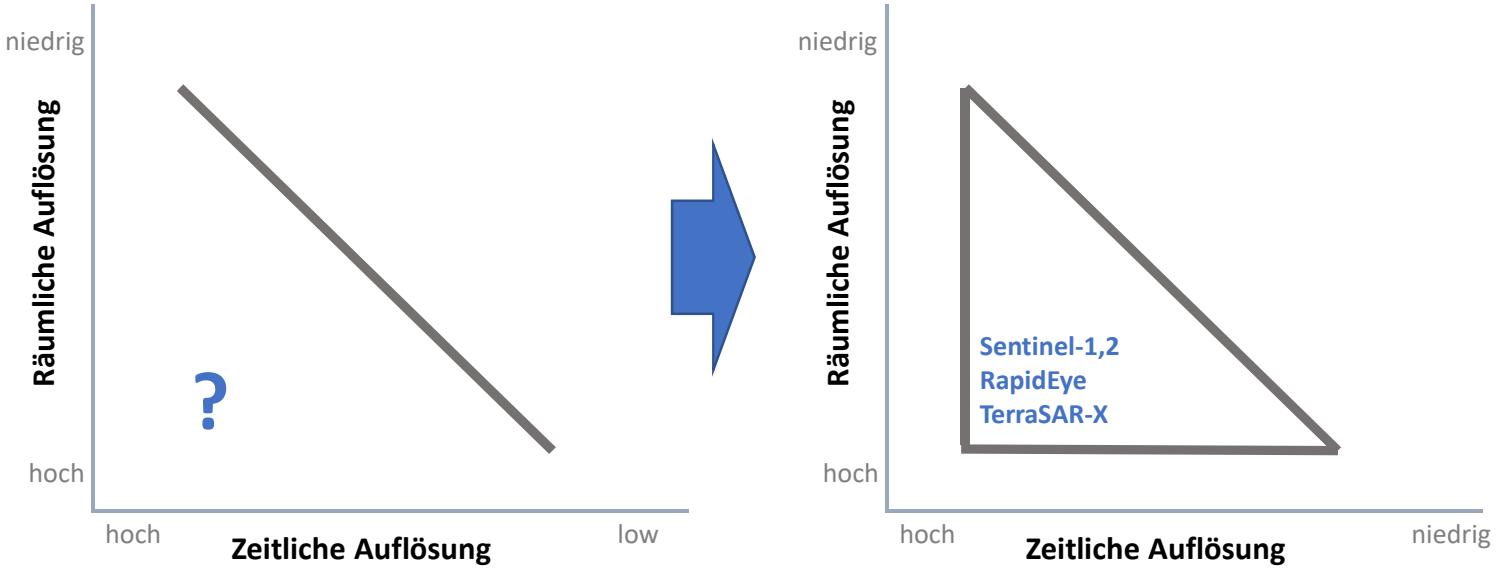


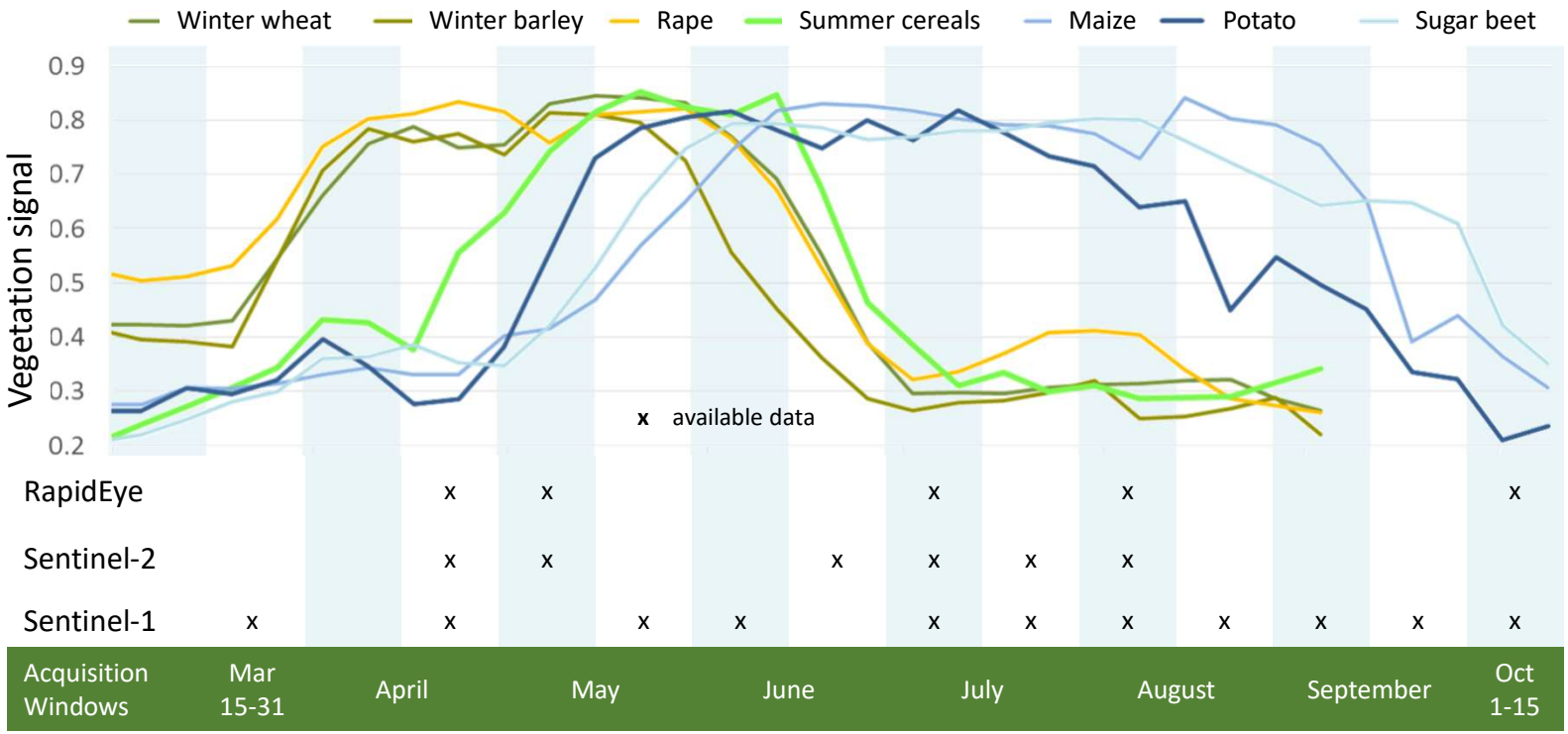
# New technical opportunities




Vor 20 Jahren

heute

# Multi- “sensor/temporal/stage” analysis




0.914

0.895

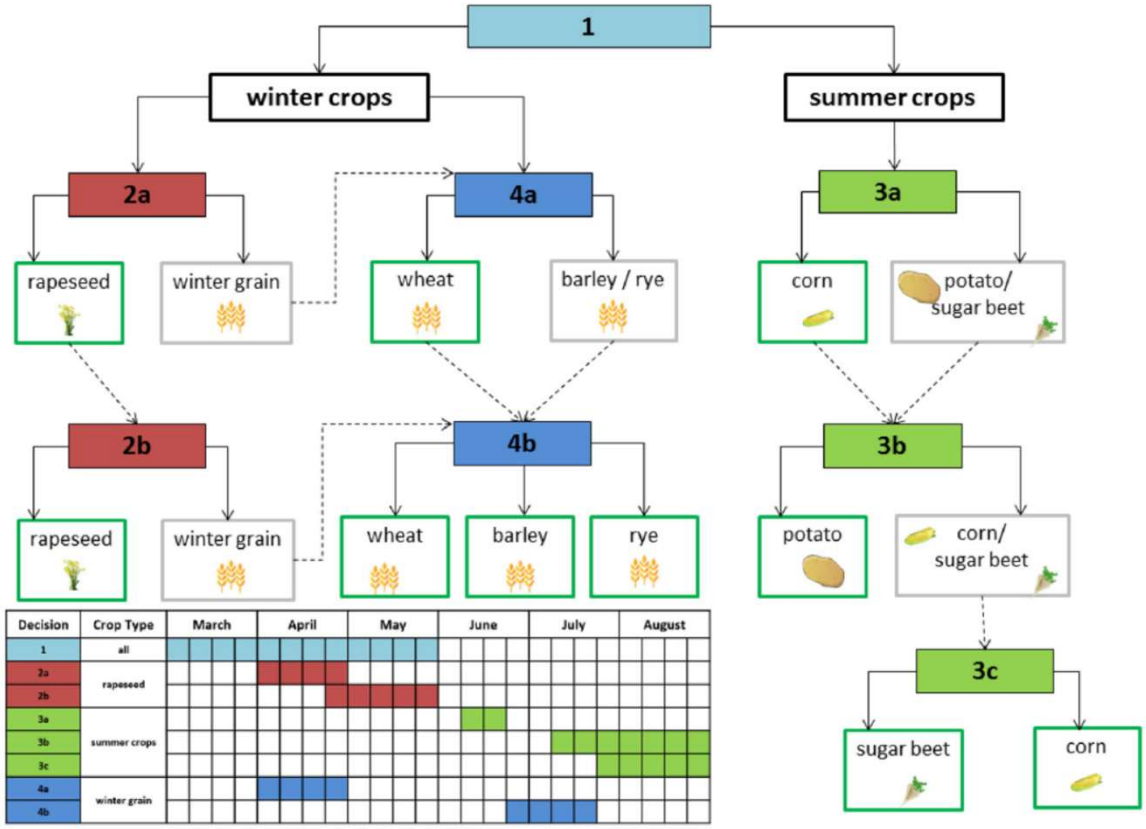
0.892

Example: Cropland in the TERENO Harz/Central German Lowland Observatory

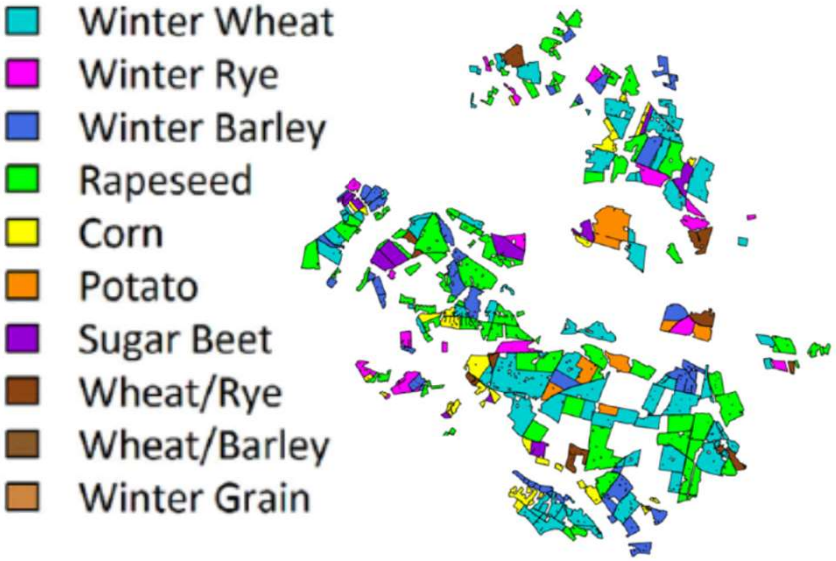


x available data

# Innovative sequential masking

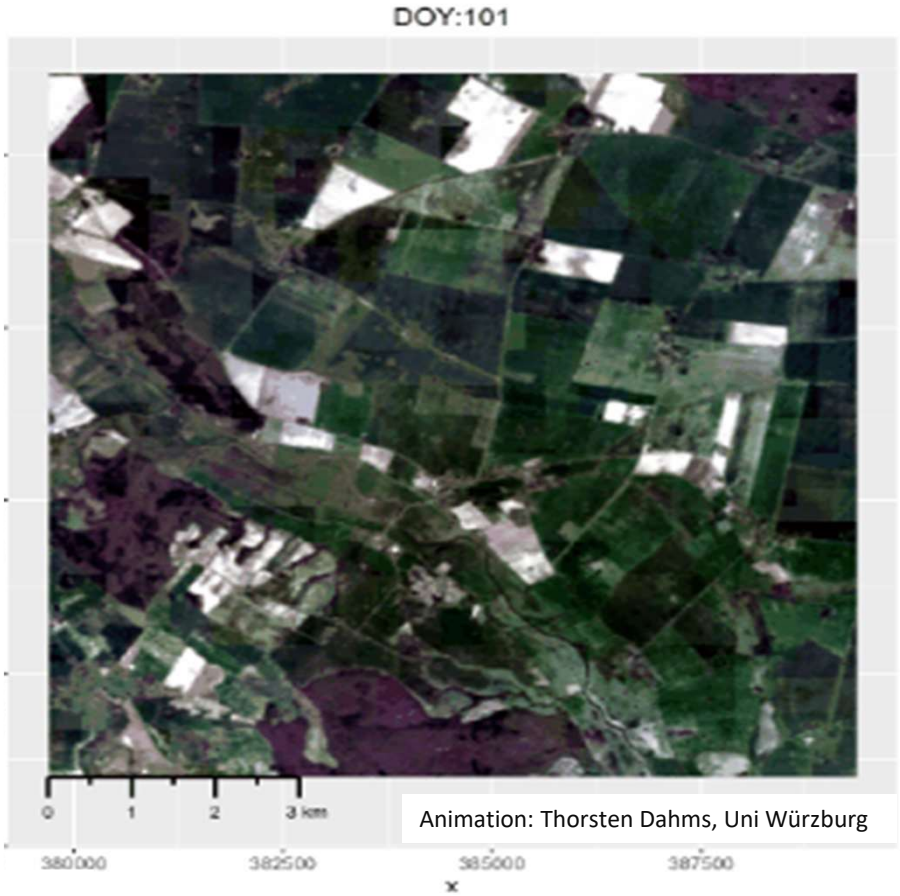



Crop map of TERENO DEMMIN 2018




Heupel, K., Spengler, D., & Itzerott, S. (2018). A Progressive Crop-Type Classification Using Multitemporal Remote Sensing Data and Phenological Information. *PFG - Journal of Photogrammetry, Remote Sensing and Geoinformation Science*, *86*(2), 53–69.

# Dense time series of remote sensing information



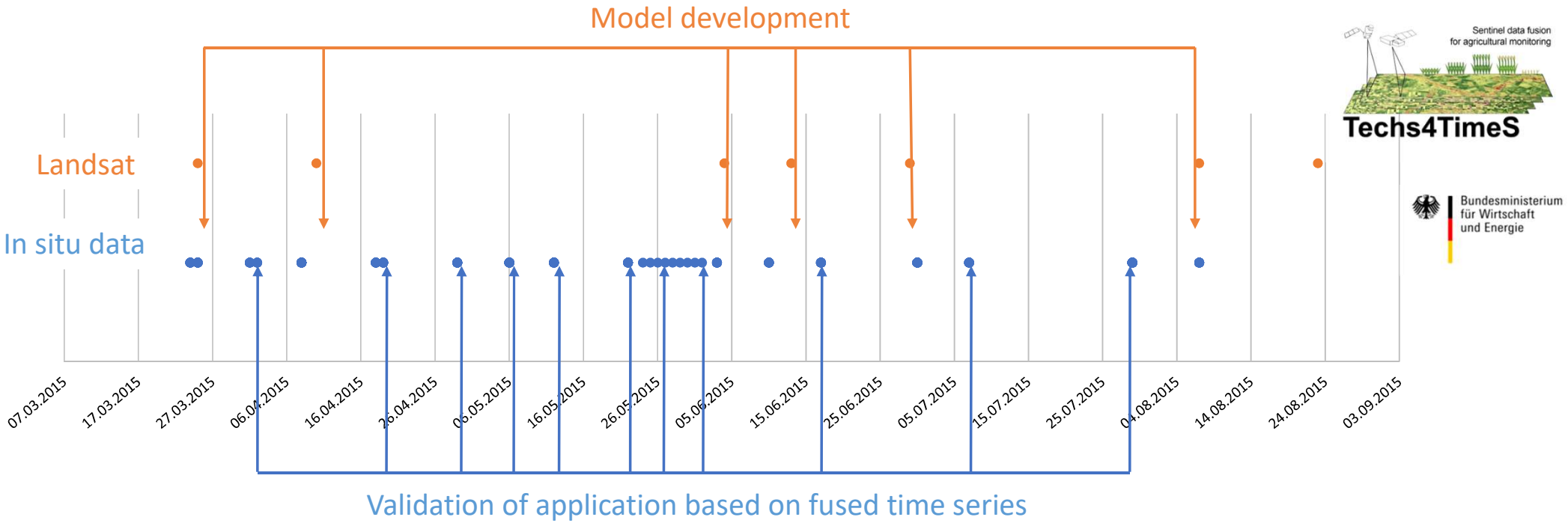

Animation: Thorsten Dahms, Uni Würzburg

Techs4TimeS
Sentinel data fusion for agricultural monitoring

Bundesministerium für Wirtschaft und Energie

Gao, F., Masek, J., Schwaller M. and Hall, F. On the blending of the Landsat and MODIS surface reflectance: predict daily Landsat surface reflectance. IEEE Transactions on Geoscience and Remote Sensing. 44 (8): 2207-2218. 2006.

# Dense observations of biophysical parameters




Sentinel data fusion for agricultural monitoring

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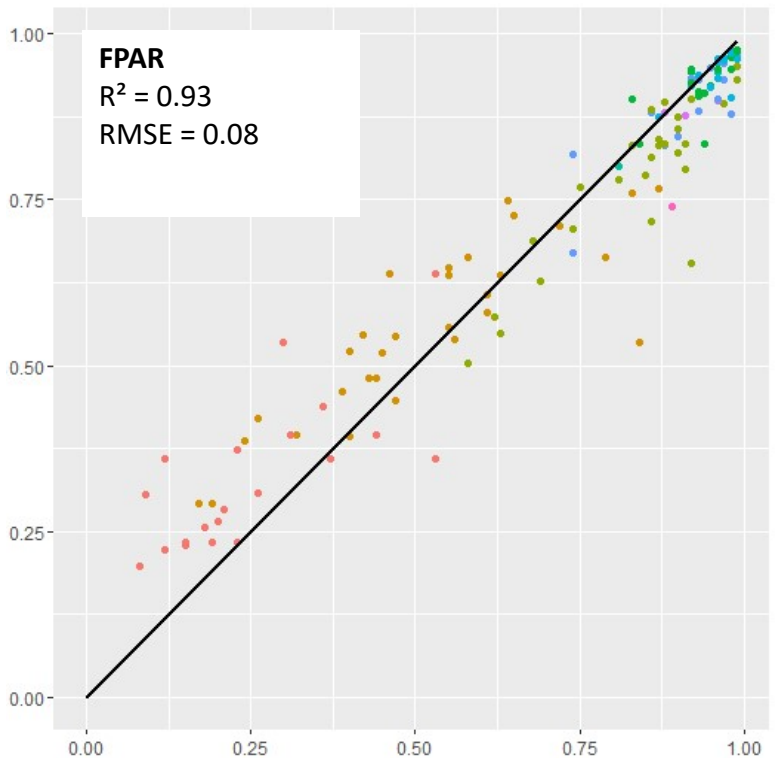
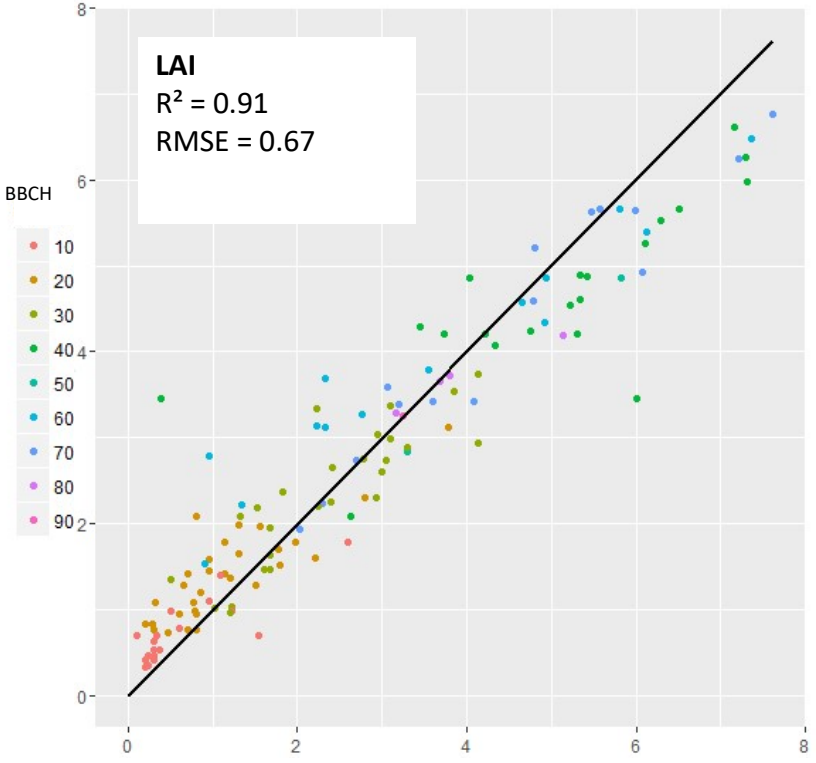
Bundesministerium für Wirtschaft und Energie

PhD Thorsten Dahms, Uni Würzburg

# Example FPAR/LAI of Winter Wheat




**Measured (x-axis) vs. Modelled biophy. Parameter (y-axis)**

Techs4TimeS
Sentinel data fusion for agricultural monitoring

Bundesministerium für Wirtschaft und Energie

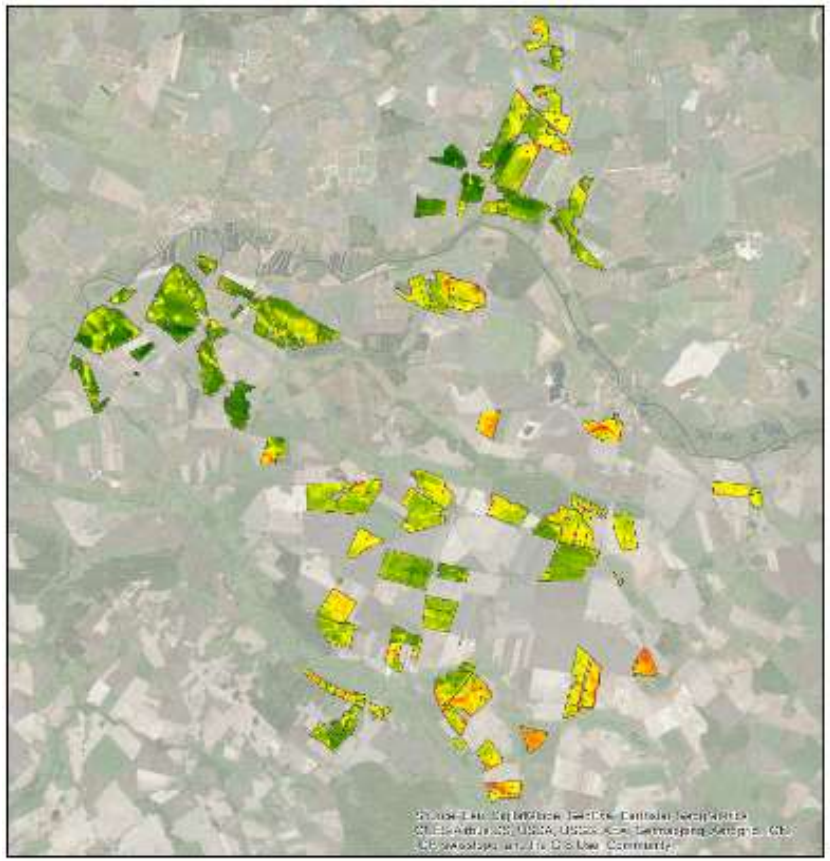
PhD Thorsten Dahms, Uni Würzburg



Dahms, T., Seissiger, S., Conrad, C., Borg, E. (2016): Modelling Biophysical Parameters Of Maize Using Landsat 8 Time Series. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences XLI(B2): 171-175.

Dahms, T., Conrad, C., Babu, D.K., Schmidt, M., Borg, E. (2017): Derivation of biophysical parameters from fused remote sensing data. 2017 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Fort Worth, TX, 2017, pp. 4374-4377

# Site-specific biomass modelling and yield estimations



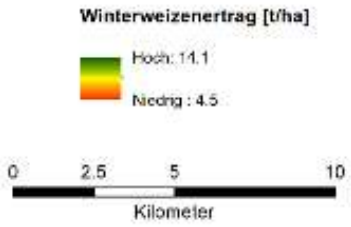
Utilization of a light use efficiency model:

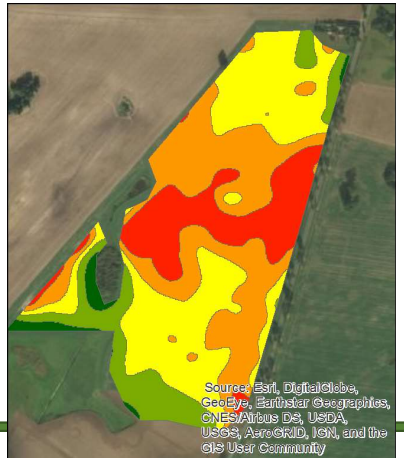
Integration of remote sensing-based biophysical parameters with climate data and crop-specific information

Application:

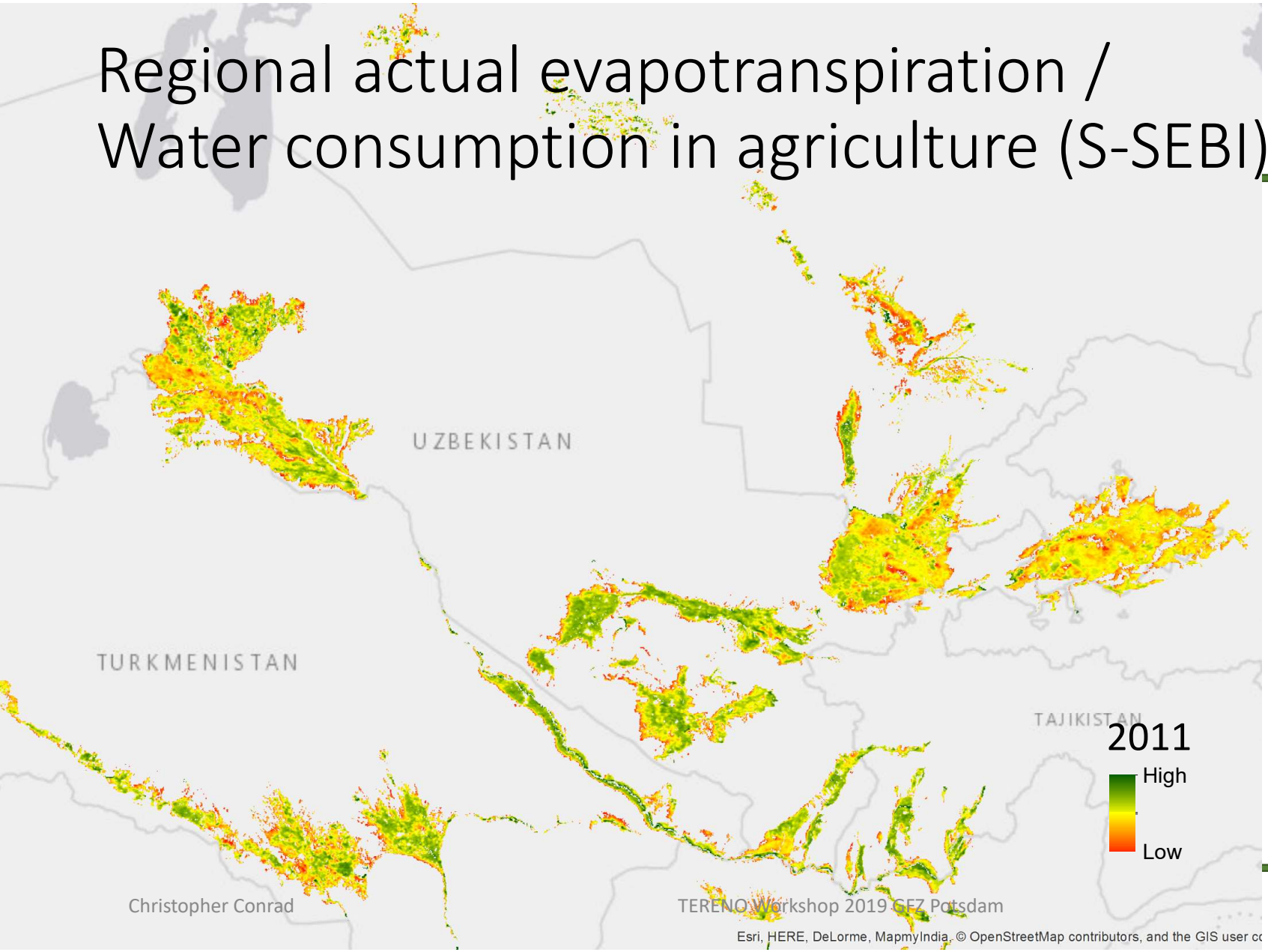
Yield level map
(based on multi-annual data)

- Support of soil sampling and fertilization



# Regional actual evapotranspiration / Water consumption in agriculture (S-SEBI)



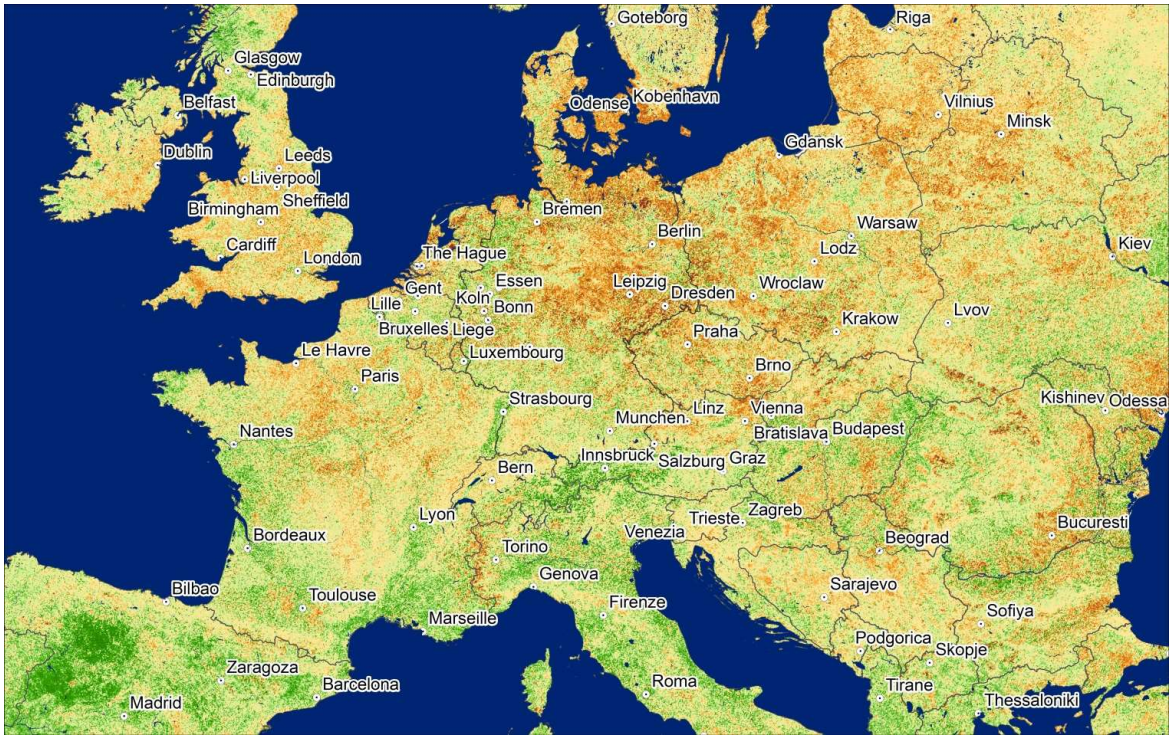

CAWA

Auswärtiges Amt

Schönbrodt-Stitt, S.; Conrad, C.; Dimov, D.; Ergashev, I.; Löw, F.; Morper-Busch, L.; Muminov, S.; Ruziev, I.; Schorcht, G.; Solodky, G.; Sorokin, D.; Stulina, G.; Toshpulatov, R.; Zaitov, S.; Kitapbayev, A.; Unger-Shayesteh, K. (2018): **The WUEMoCA Tool for Monitoring Irrigated Cropland Use and Water Use Efficiency at the Landscape Level of the Aral Sea Basin.** In: Novel Methods and Results of Landscape Research in Europe, Central Asia and Siberia, Vol. 4 Optimising Agricultural Landscapes, 4 (72), 351 - 356.

Gunther Schorcht, Greenspin

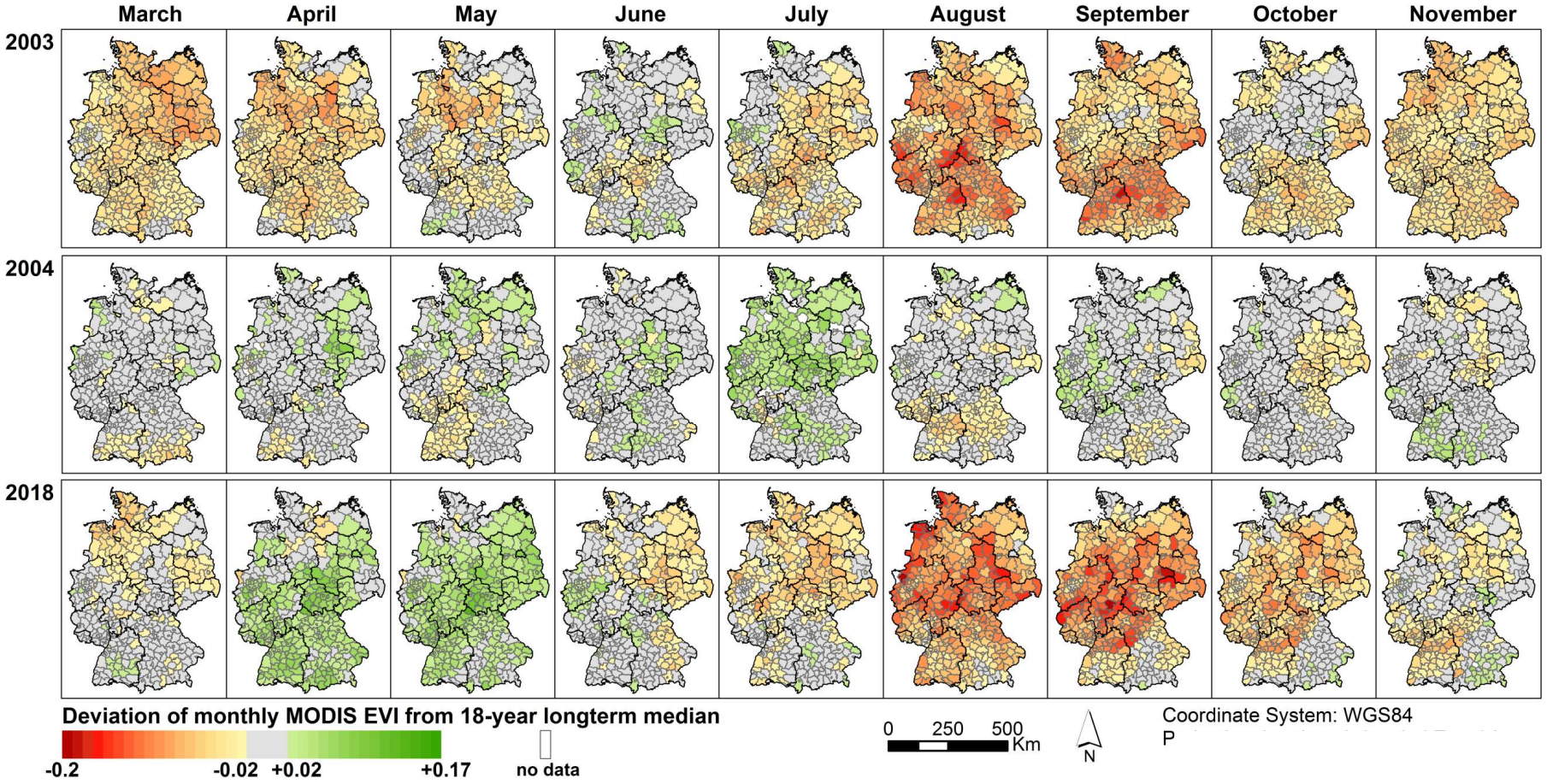
# Drought year 2018




Deviation of the vegetation signal in June 2018 from the medium-term average (19 years of MODIS) Source: Sophie Reinermann, DLR


Impact of severe drought and heat wave
Sources: „Mitteldeutsche Zeitung“ and „Volksstimme“ 2018

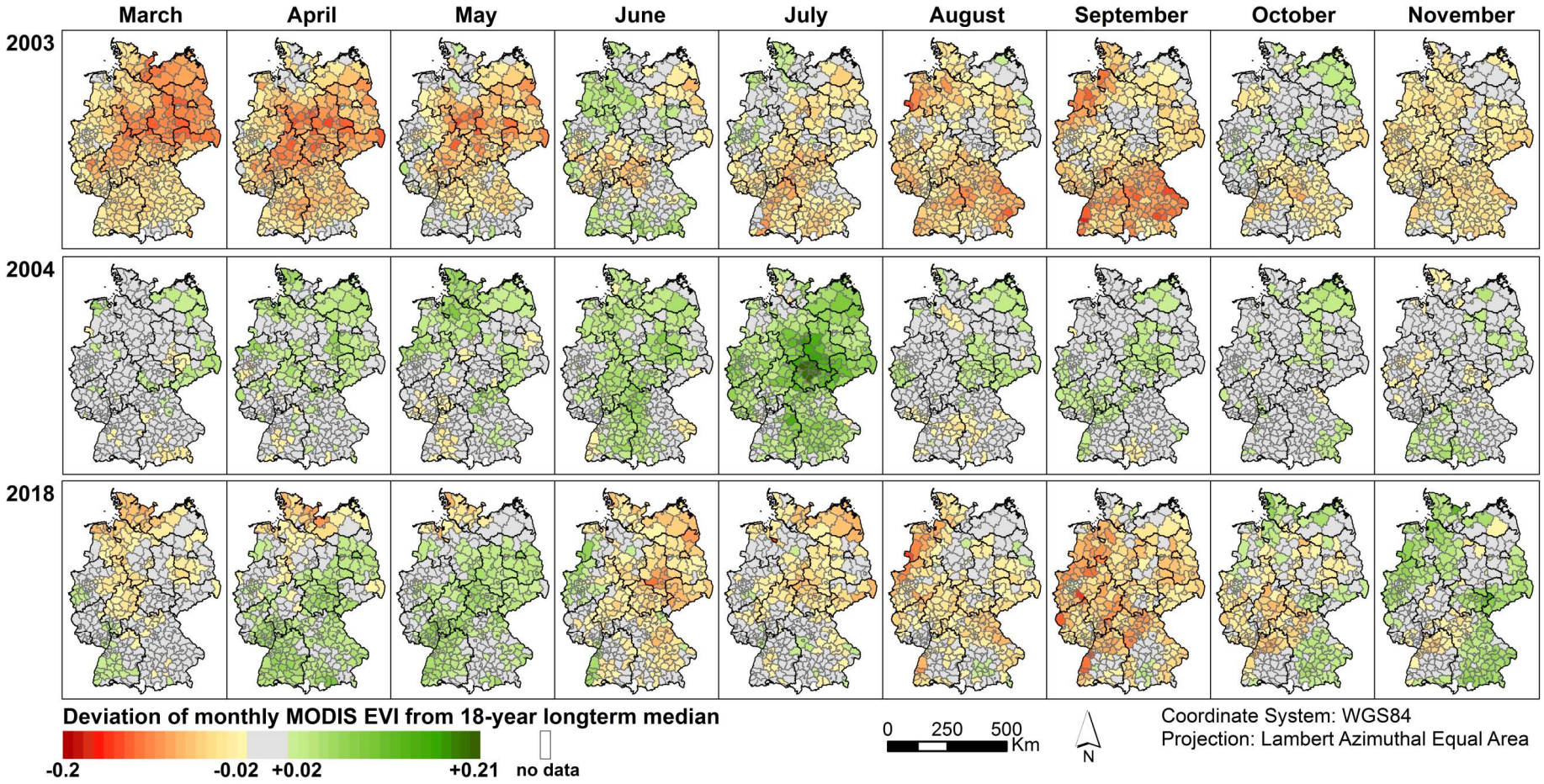
# Spatial pattern of EVI anomalies in Germany CORINE class grassland






Reinermann et al. (2019)

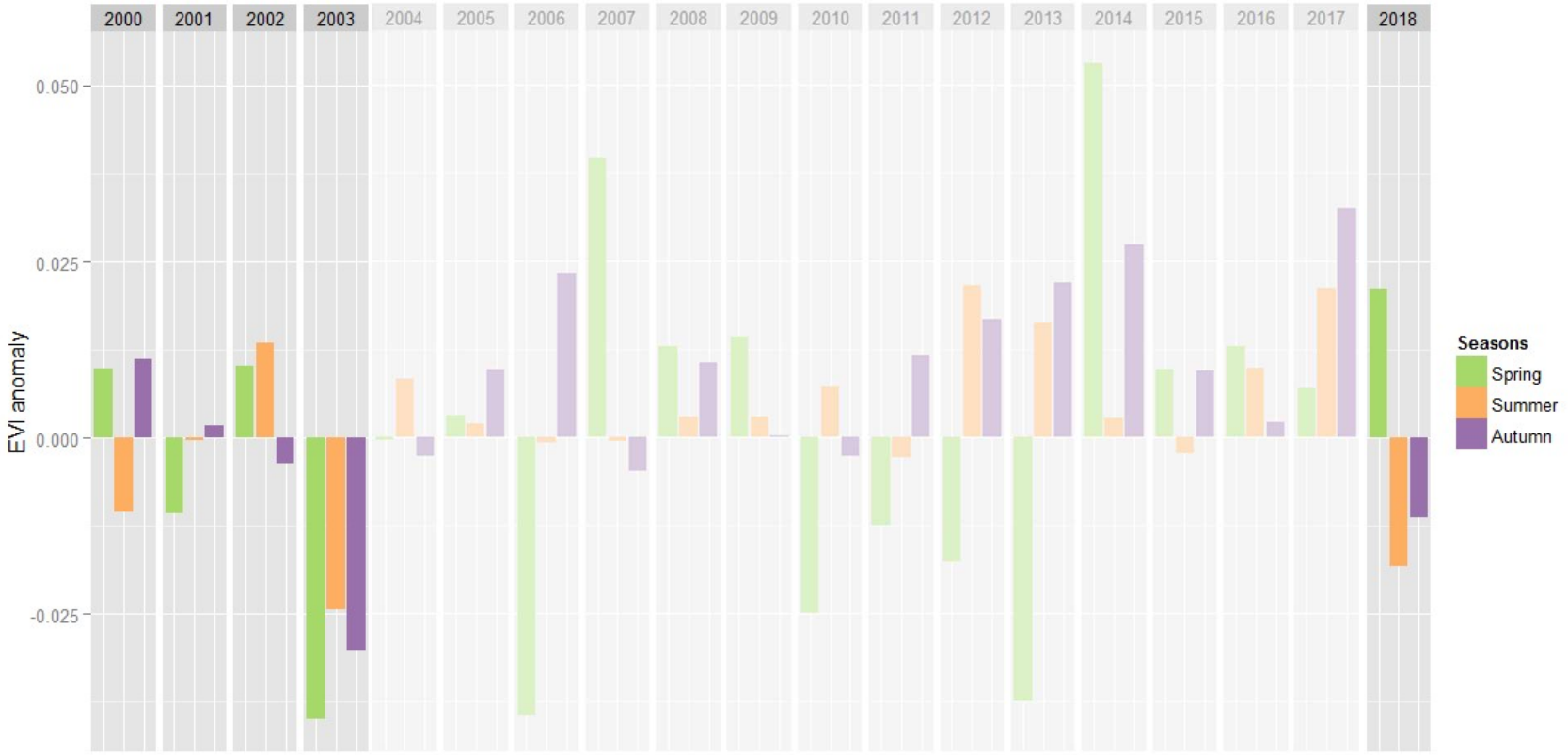
# Spatial pattern of EVI anomalies in Germany CORINE class cropland






Reinermann et al. (2019)

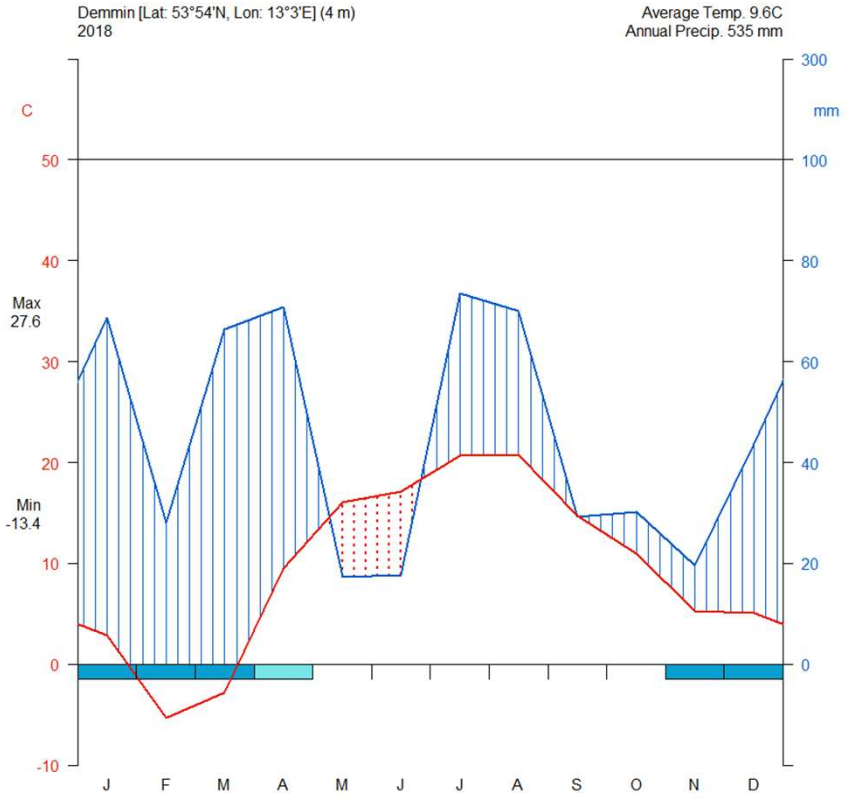
# Temporal pattern of EVI anomalies in Germany

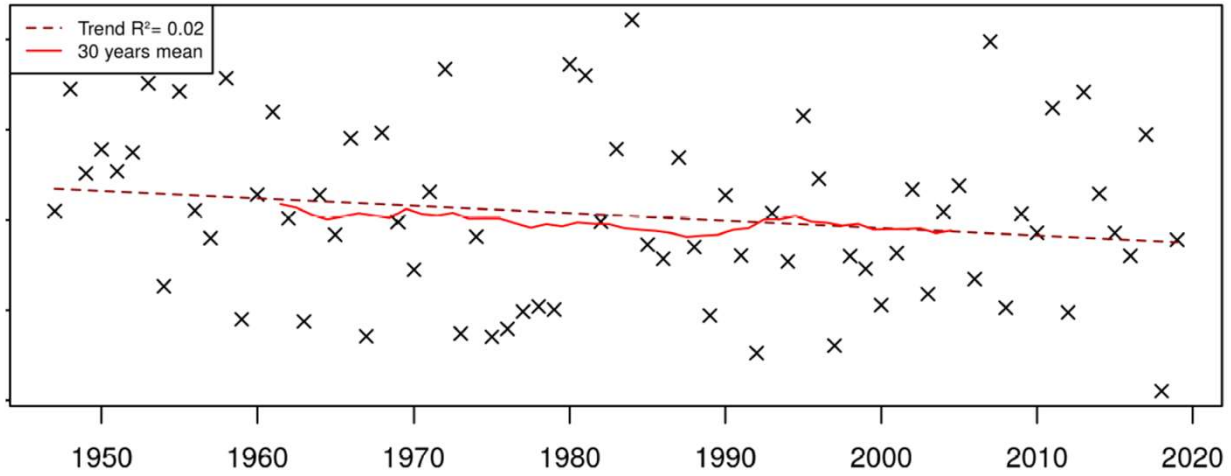



Reinermann, S., Gessner, U., Asam, S., Kuenzer, C., & Dech, S. (2019). The Effect of Droughts on Vegetation Condition in Germany: An Analysis Based on Two Decades of Satellite Earth Observation Time Series and Crop Yield Statistics. *Remote Sensing*, *11*(15), 1783. https://doi.org/10.3390/rs11151783

Source: Sophie Reinermann, DLR

# What happened? Example DEMMIN

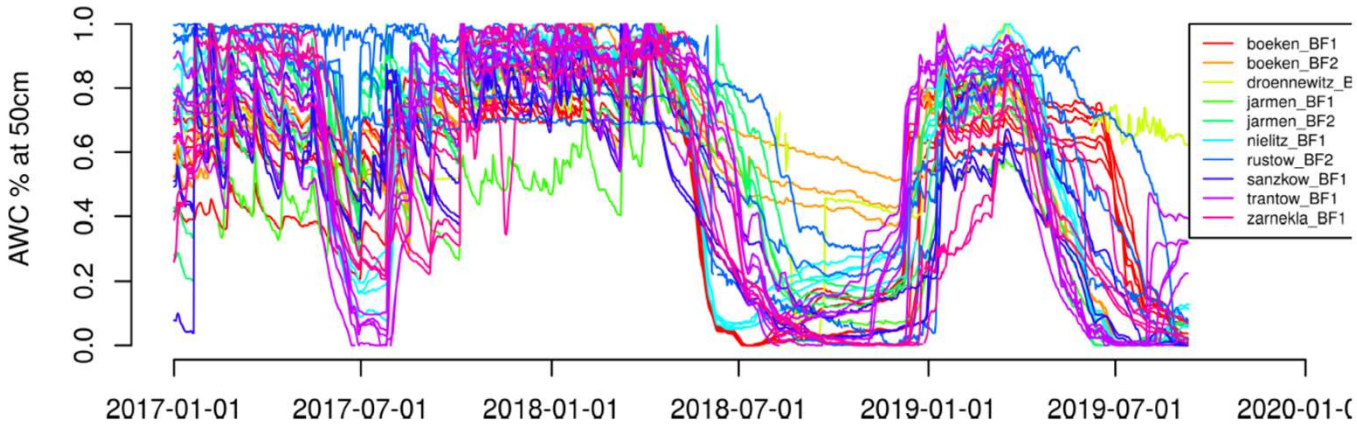



- Late spring drought visible in DEMMIN data

Christian Hohmann, GFZ

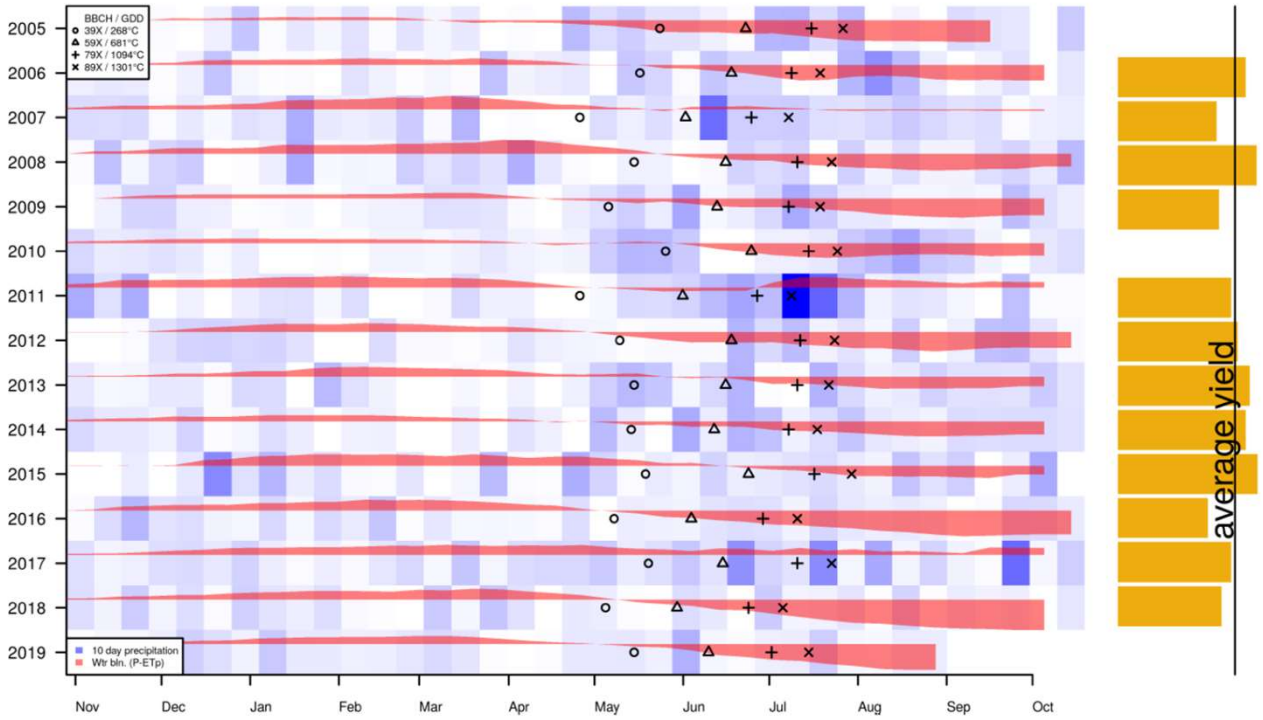
# What happened? Example DEMMIN




Available water capacity measured through soil moisture sensors in the field:
Moist year ⇔ dry year,
Source: Christian Hohmann, GFZ

- Dry storages
- Reduced yields

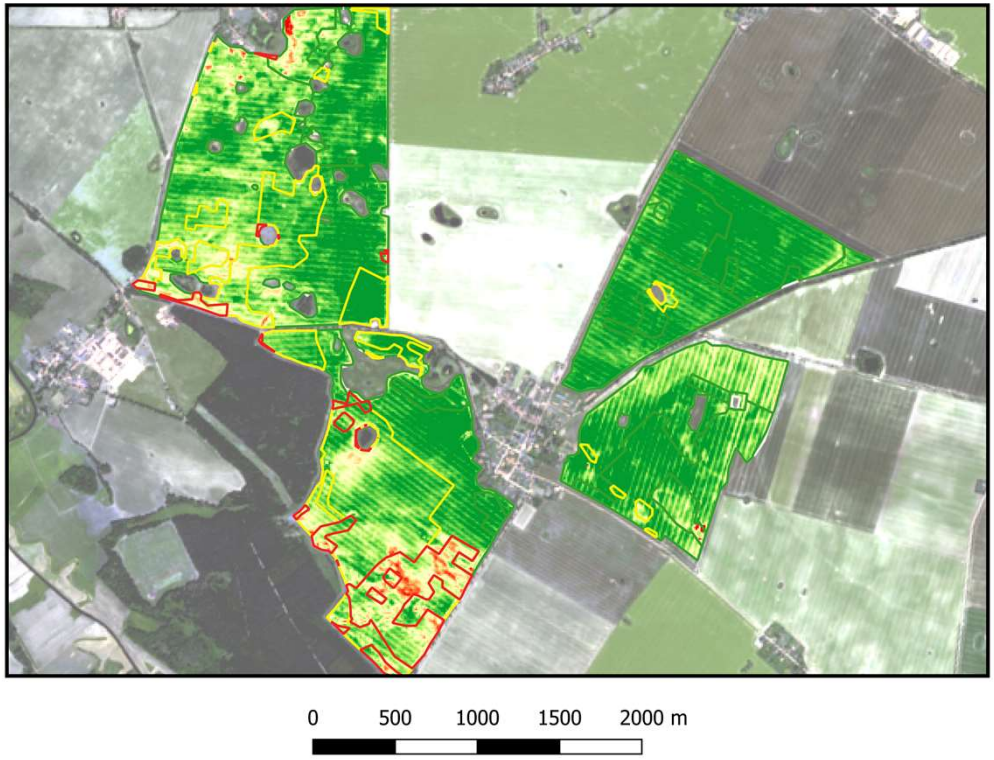
# What happened? Example DEMMIN




- 2016 lower yields than in 2018?

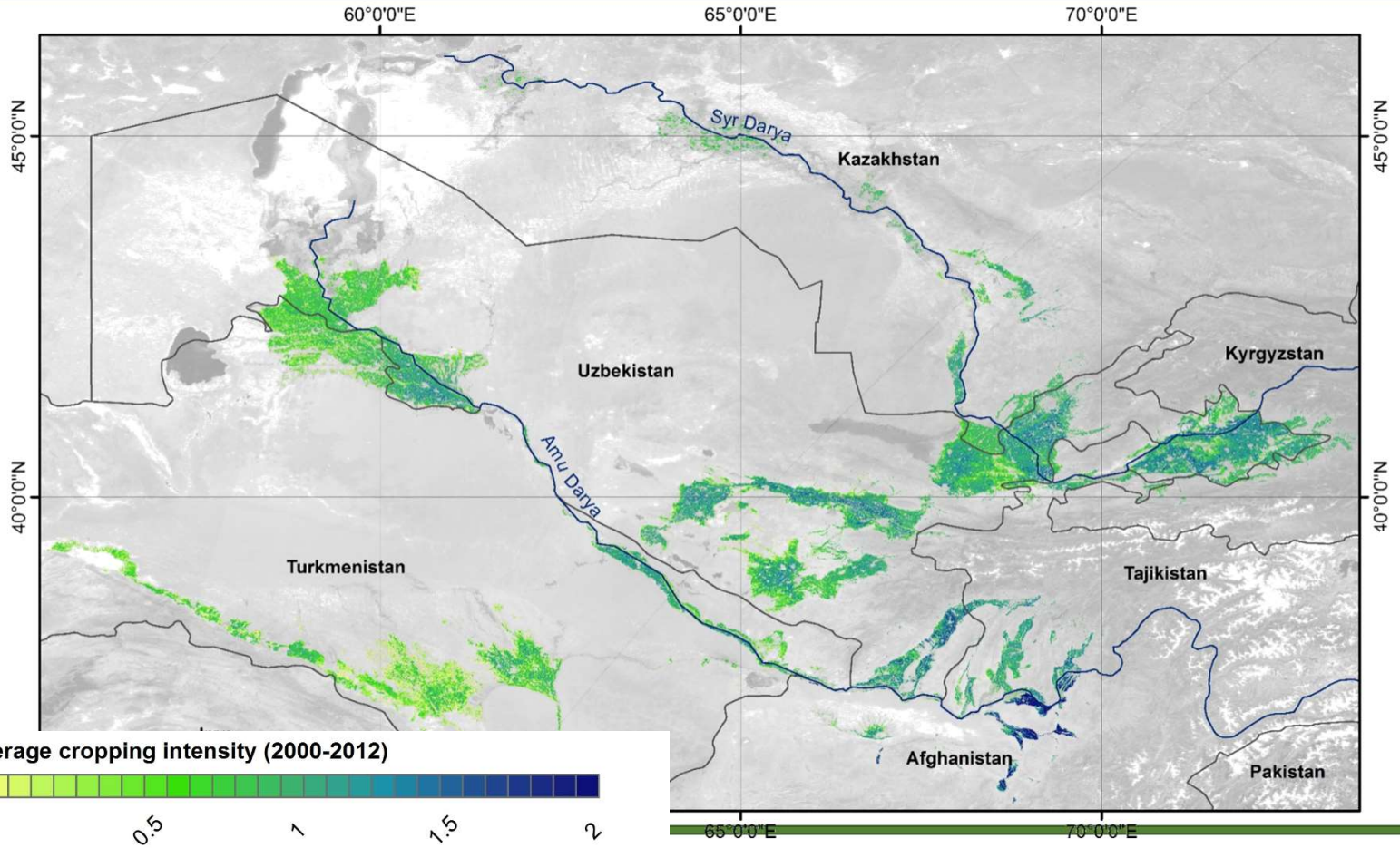
Wheat yields of two farmers in DEMMIN in comparison to the climatic water balance
Source: Christian Hohmann, GFZ

# What happened? Example DEMMIN




- High diversity of biomass develpment on the fields
- Influence of soil texture (and field capacity) on crop growth (LAI)

# Example: Average Cropping Intensity in the Aral Sea Basin 2000-2012 (MODIS)




CAWA

Auswärtiges Amt

0 50 100 200 300 Kilometers

N

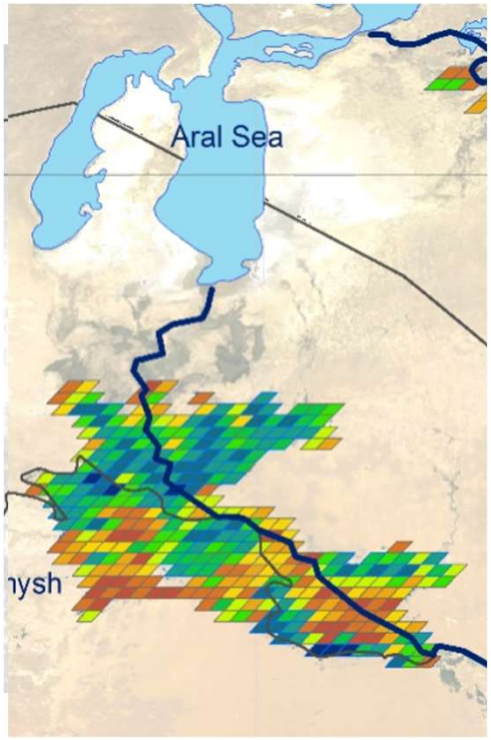
Background: MODIS data of 2010

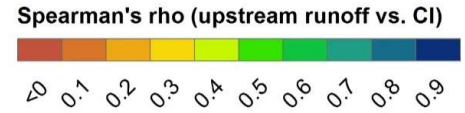
**Average cropping intensity (2000-2012)**

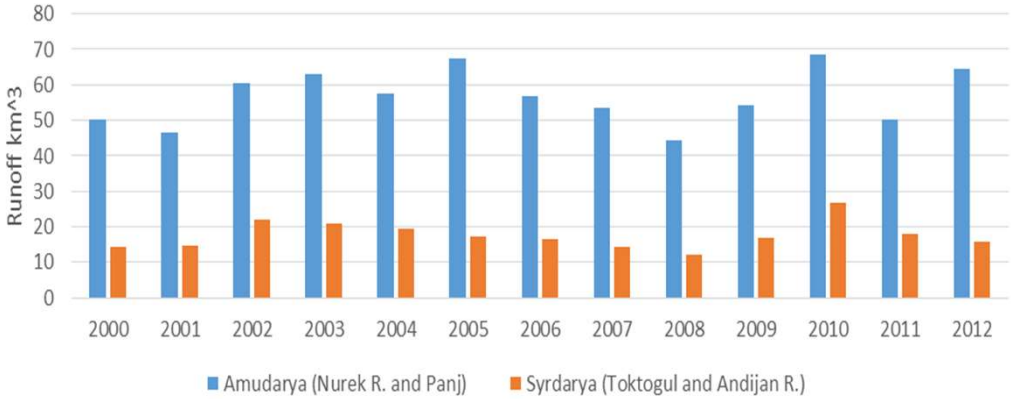
0 0.5 1 1.5 2

Conrad, C., Schönbrodt-Stitt, S., Löw, F., Sorokin, D., & Paeth, H. (2016). Cropping intensity in the Aral Sea Basin and its dependency from the runoff formation 2000-2012. *Remote Sensing*, *8*(8), 1–26.

# The dependency of cropping intensity from natural runoff



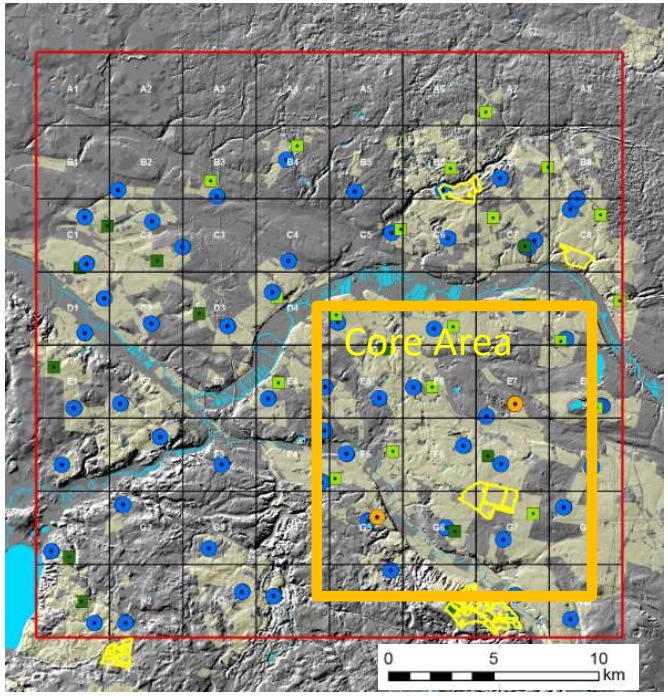




Source SIC-ICWC Regional Information System on Water and Land Resources in the Aral Sea basin (CAREWIB). http://www.cawater-info.net

Conrad, C. et al. (2016)

# Data integration – ecological in situ data

DEMMIN is the German validation site for remote sensing products in an agricultural landscape





- Bodenfeuchtemessstation
- Klimastation (GFZ)
- Klimastation (DLR)
- Phänologie-Stationen (DWD)

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

**Excellent RS data basis**

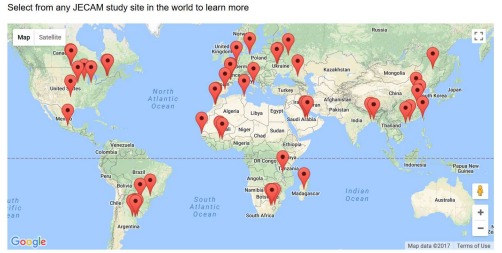
**Environmental measurement network:**

- **~40 meteorological stations**
- **~6 Soil moisture observation points**

**Eddy Covariance System**

**Lysimeter station**

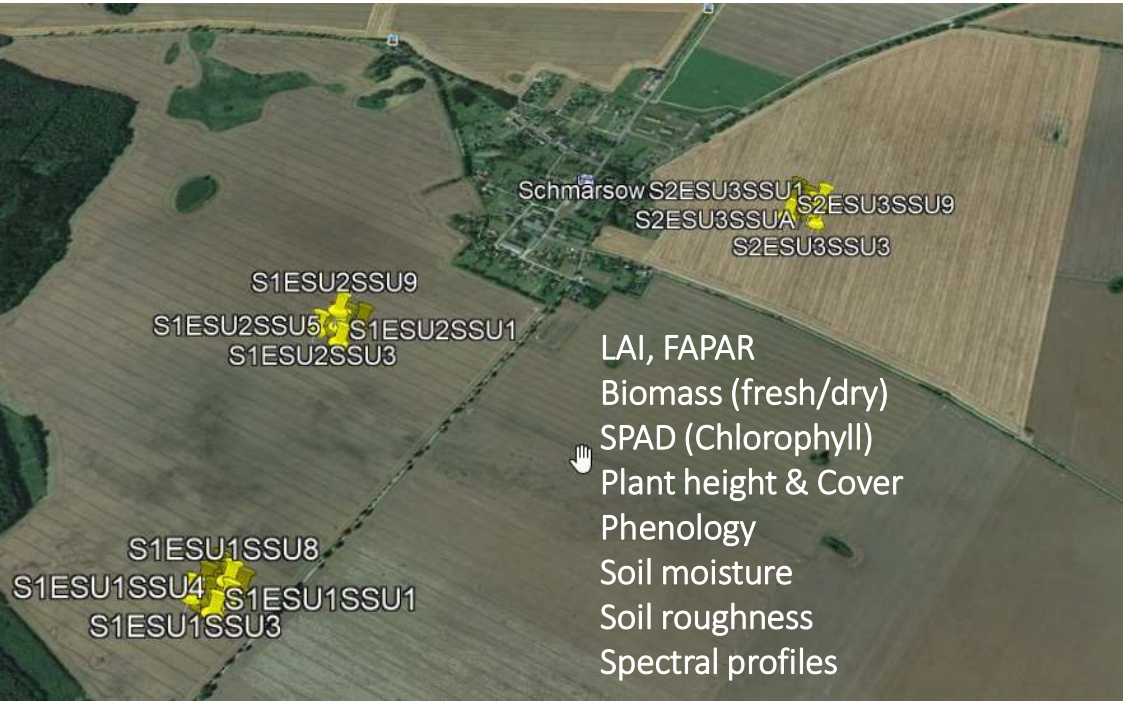
**Soil maps, phenological observations (DWD)**

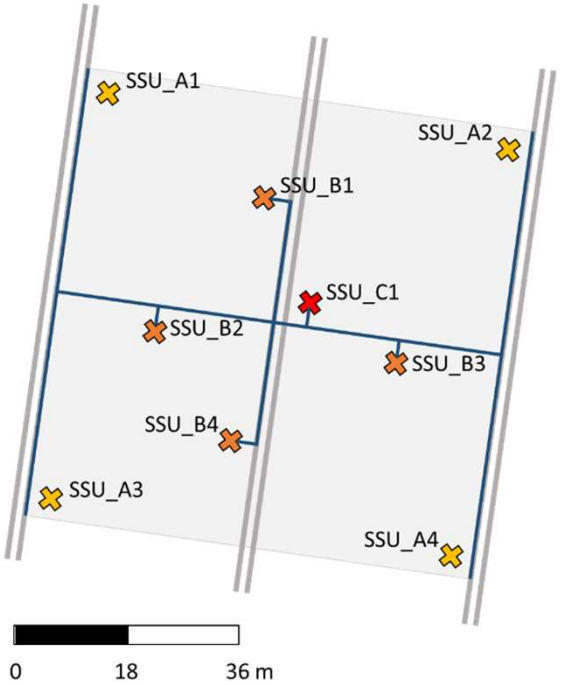



JECAM
Joint Experiment for Crop Assessment and Monitoring

www.jecam.org

# Data integration – ecological in situ data




Tractor lane
Walking path
Elementary sampling unit (ESU)
Secondary sampling unit (SSU) belonging to
Group A
Group B
Group C

Hochschule Neubrandenburg
University of Applied Sciences

- Standardized data aquisition (Reader)
- Field lab with leaf scanner and dry oven
- Field data pool (LAI 2200, …)

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Julius-Maximilians-UNIVERSITÄT WÜRZBURG

# Summary and conclusions

- New technical possibilities for Agricultural Monitoring improved the options for deriving soil and vegetation status as well as energy, water and gas exchange at the land surface, or phenological changes.
- The data allow assessments of climate impacts, but also farming practices or ecosystem services.

- Data integration is essential for
  - Modeling of parameters (increase accuracy)
  - Validation
  - Driver analysis/understanding reasons
  - Services for real applications

# Conclusions

Even through drought detection appears to be simple (NDVI@work):

- Vegetation signals are composite of various factors, e.g. agricultural practices
  - in Germany for instance increased EVI at the end of the drought year 2018 may be attributed to increased cultivation of intermediate crops
  - In future: irrigation?

- more detailed analyses are methodological challenging and require improved integration of geodata:

  ⇒Scientific Earth system modeling

  ⇒Risk assessments

  ⇒Early warning systems

**Strengthen University Cooperation with TERENO**

# Contributors to this presentation:


- Sophie Reinermann, Dr. Sarah Asam, Prof. Dr. Erik Borg, DLR
- Christian Hohmann, Dr. Daniel Spengler, Dr. Sibylle Itzerott, GFZ
- Thorsten Dahms, Uni of Würzburg
- Jakob Zabel, Uni Halle-Wittenberg

Many colleagues, project members, data providers, etc.

**Thank you for your attention!**

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# Thank you for your attention!

Application oriented monitoring of agrarian ecosystems and localization of droughts
- a question of data integration

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