

SatGrass: An Operational Satellite-Based System for Daily Grassland Yield and Forage Quality Estimation in Austria

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 Federal Ministry
Agriculture and Forestry, Climate
and Environmental Protection,
Regions and Water Management



RAUMBERG GUMPENSTEIN
RESEARCH & DEVELOPMENT

Partner in Research, development, and implementation



 AREC
Raumberg-Gumpenstein
Agriculture



GeoSphere
Austria



Why do we need grassland monitoring?

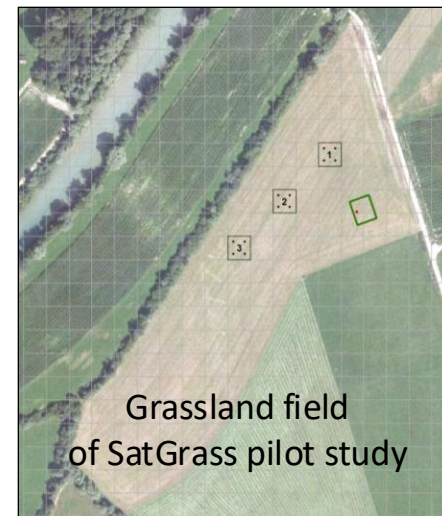
A major land-use system

- Key forage base for ruminant livestock
- Dominant in Alpine, mountain and marginal regions
- Closely linked to regional food systems and rural landscapes
- **Yield and forage quality are mostly unknown:** field and regional scale.
- **Estimations and even measurements are difficult :**
 - Permanent grassland consists of many species
 - Several cuts per year with different utilisation intensities
- **Benefits** of knowing more about grassland yield:
 - Basis for optimisation of grassland management
 - Needed for statistics, consulting, risk management, climate change adaptation, etc.
 - Proxy for evaluation of biodiversity



SatGrass: Pilot Study – Research – Application

- 2018 – 2020: **Pilot study** at AREC Raumberg-Gumpenstein
- 2021 – 2023: Large-scale **research project**, funded by FFG-ASAP
(Austrian Space Application Programme)
- 2024 – 2026: ESA & BMLUK: SatGrass **implementation project**
- **8 years of interdisciplinary research:**
Grassland management – Remote sensing – Meteorology
 - **Cooperation between agricultural practise and science:**
190 farms, ÖAG, Maschinenring, Landwirtschaftskammer
AREC, BOKU University, TU Vienna, GeoSphere Austria
 - **Satellite data – databases and processing – smartphone app:**
Remote sensing – Data management – user participation



In situ Data Sampling Campaign

Scientific consensus: reliable grassland models require comprehensive and representative **reference data**

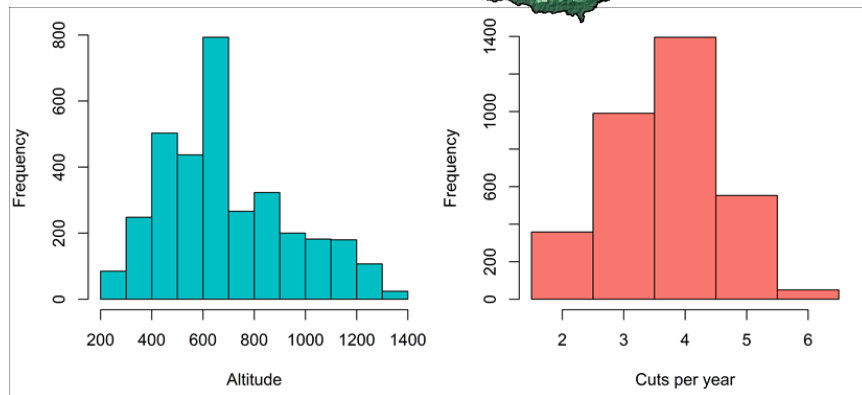
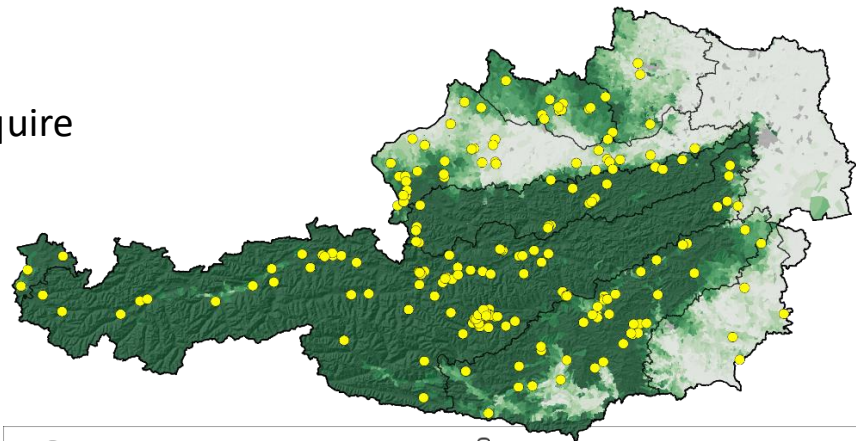
- Data collection period: **2018–2023**

- > **1,100** cut recordings
- > **5,000** valid observations
- > **200** sites

- Standardised data collection by

- Scientific staff
- Technical staff
- Well-trained farmers
- Agricultural education centres

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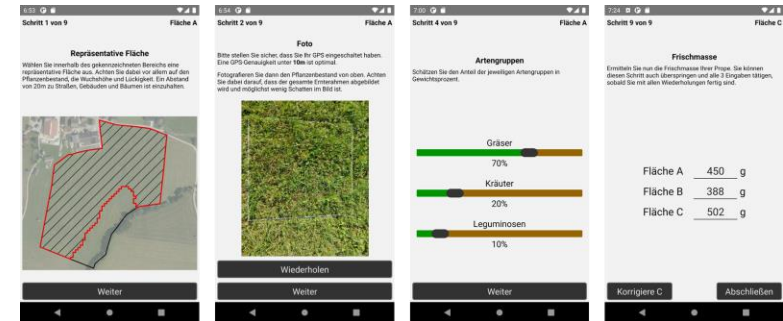


Data quality: Step-by-step-guidance, instructions and data input

Field surveys were conducted by our SatGrass app:

- **Quality assurance:** Standardised procedures are essential for a large number of data collectors
- **Security and logistic:** Data were transferred from the smartphone to our server
- **Training:** Data collectors got introductions every year

Some screenshots from the smartphone app



Collected parameters: Threefold replicated, each for 1 m²:

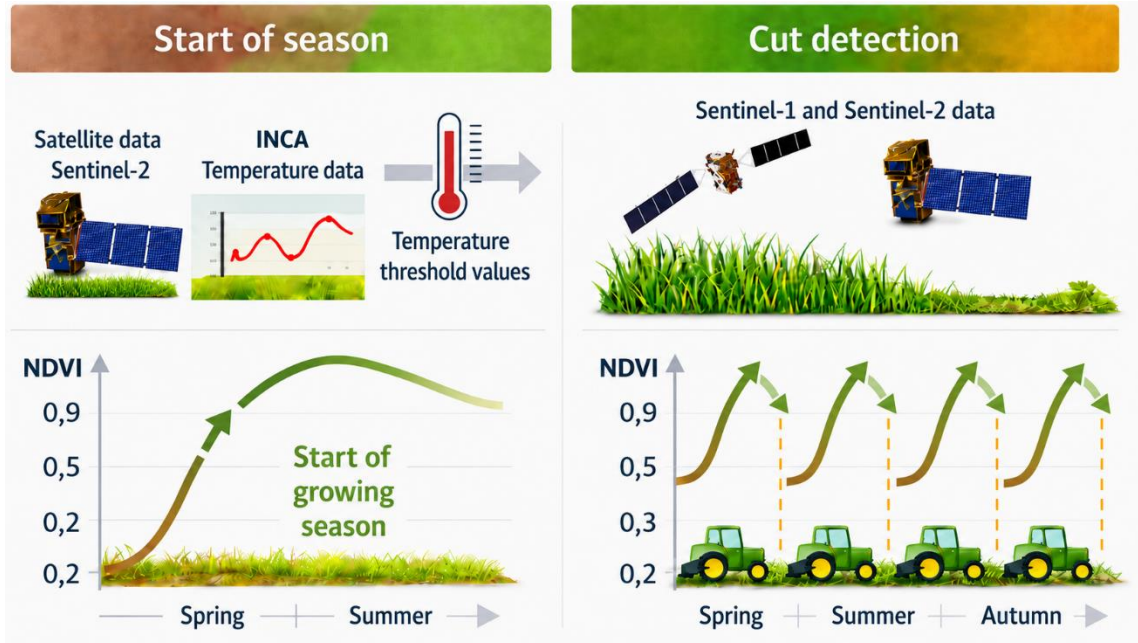
- Vegetation cover and species group ratio
- Georeferenced photo of the sampled squaremeter
- Crop height (ruler and Rising Plate Meter)
- Leaf Area Index (AccuPAR LP-80)
- Fresh matter weight
- Dry matter yield (mixed sample of 3 replicates)
- Wet chemical analysis (mixed sample of 3 replicates)



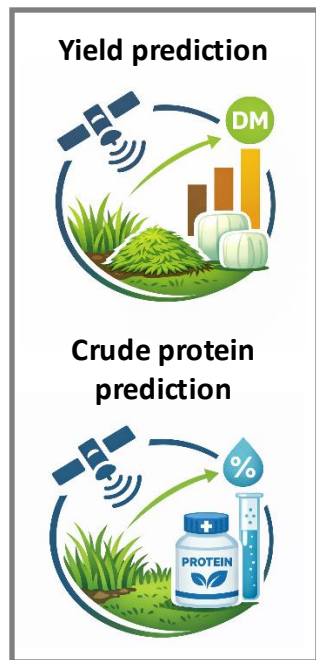
Models for Start of Season and Cut Detection

SatGrass operates on field and growth level

View from Satellite:



XGBoost for yield and quality (crude protein) model



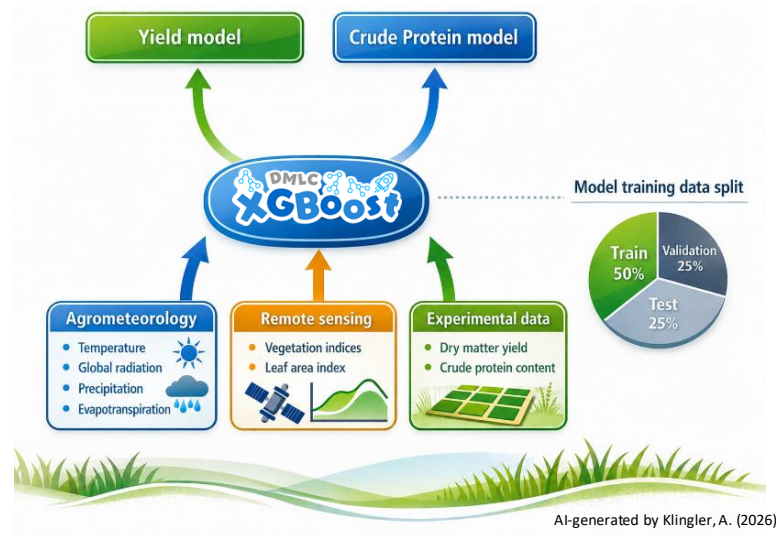
- Klingler, A.; Dujakovic, A.; Vuolo, F.; Mayer, K.; Gaier, L.; Pötsch, E.M. and Schaumberger, A. (2025): **Prediction of grassland yield in Austria: A machine learning approach based on satellite, weather, and extensive in situ data.** European Journal of Agronomy 170, 127701, <https://doi.org/10.1016/j.eja.2025.127701>.

AI models: ANN & XGBoost

- Learn nonlinear patterns from satellite, weather and grassland data

Strict training data split

- Location-based split by farm
 - Separate training and test locations
- Realistic assessment of model performance and robustness



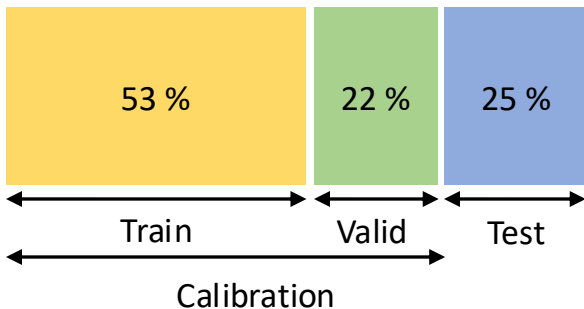
Statistical analysis: Datasplit, calibration and test

Prevention overfitting: Modell should not run with training data

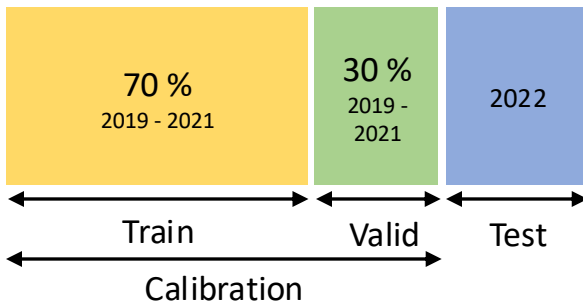
Effective Hyperparameter-Tuning: Optimisation through a validation set

Realistic evaluation of model performance: Independent test data

Stratified datasplit by **fields**



Stratified datasplit by **years**

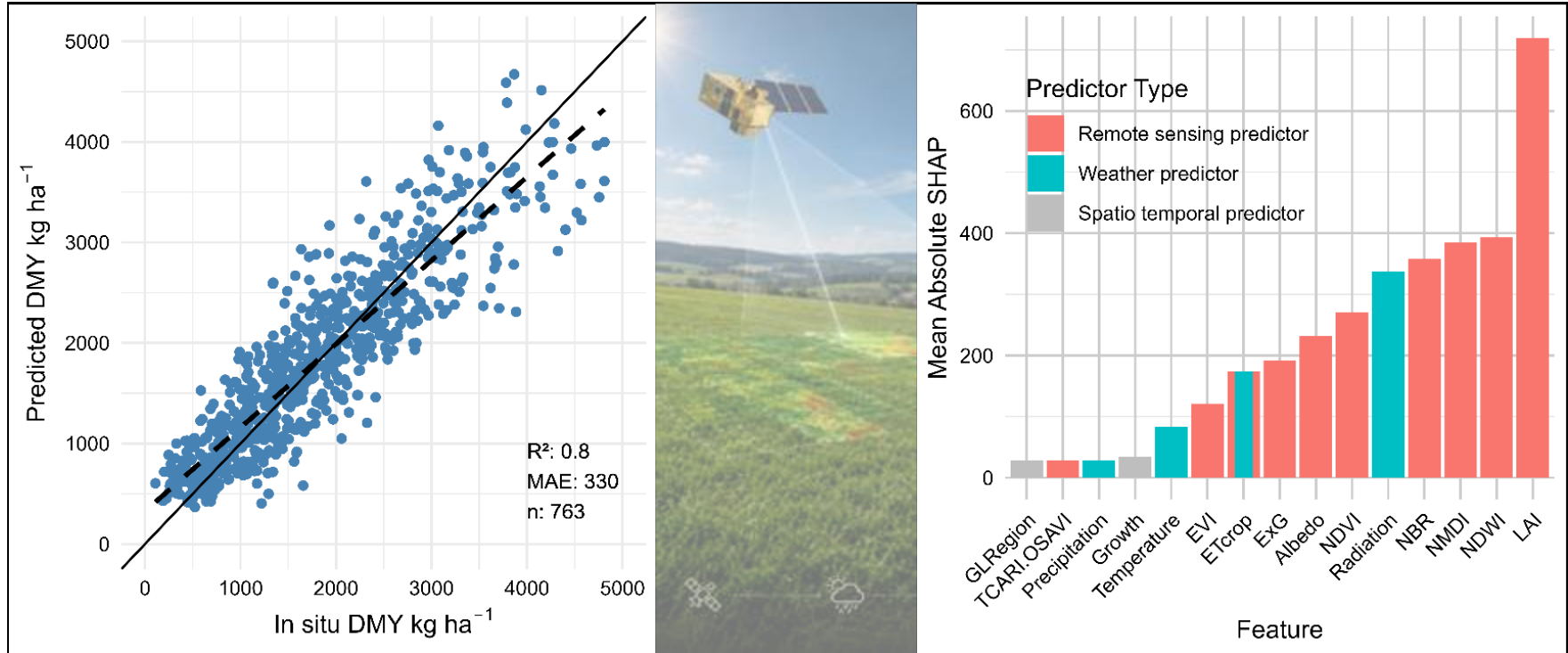


Model objectives:

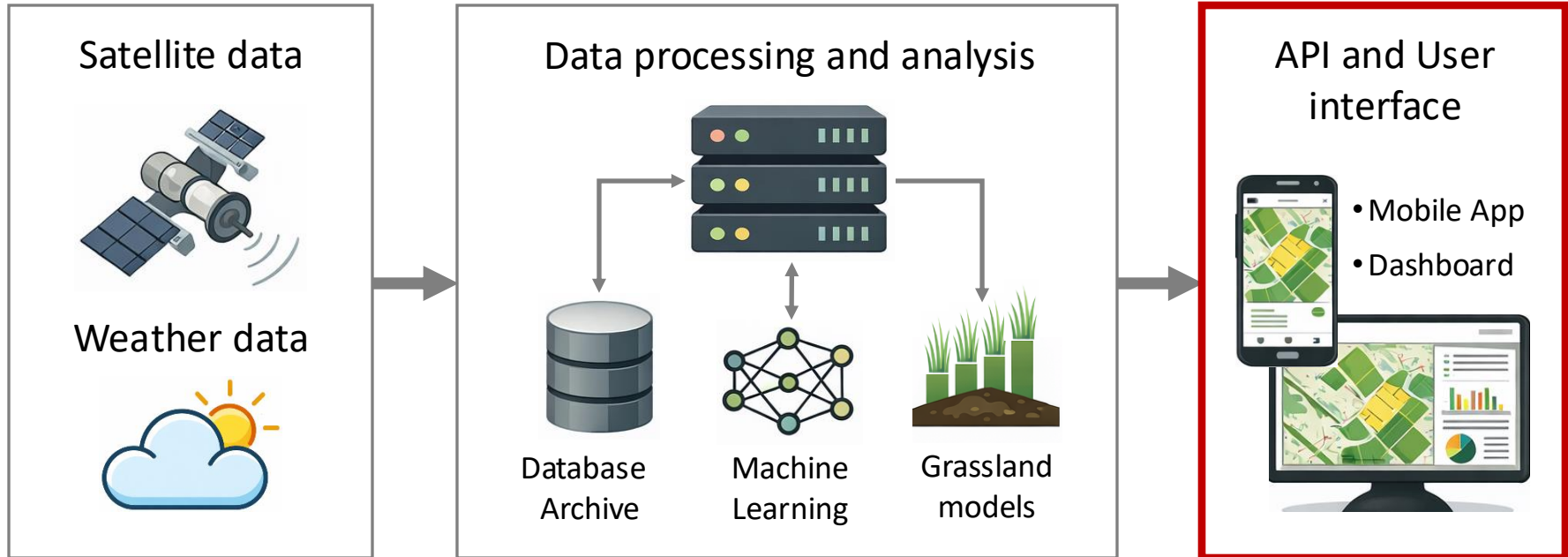
Robust results of near-real-time yields and forage quality in high accuracy for any

- Years
- Regions (in Austria)
- Weather
- Cut-systems

Model for DM yield estimation and its predictors



Basic data – Processing – Query of yield and quality – SatGrass application





Live demo: app.satgrass.at



SatGrass

Satellite-based grassland monitoring in Austria



Daily updated information
on yield, crude protein content and growth



Satellite, weather and AI data
support decisions on the
optimal cutting time



**Maps, growth curves and
a digital harvest diary**
in one web app



Free for farmers
in Austria



Yield



Feed quality



Harvest diary



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