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Monitoring grassland growth dynamics using Leaf Area Index from Sentinel-2 data

Precision farming – using new technologies to optimise grassland systems

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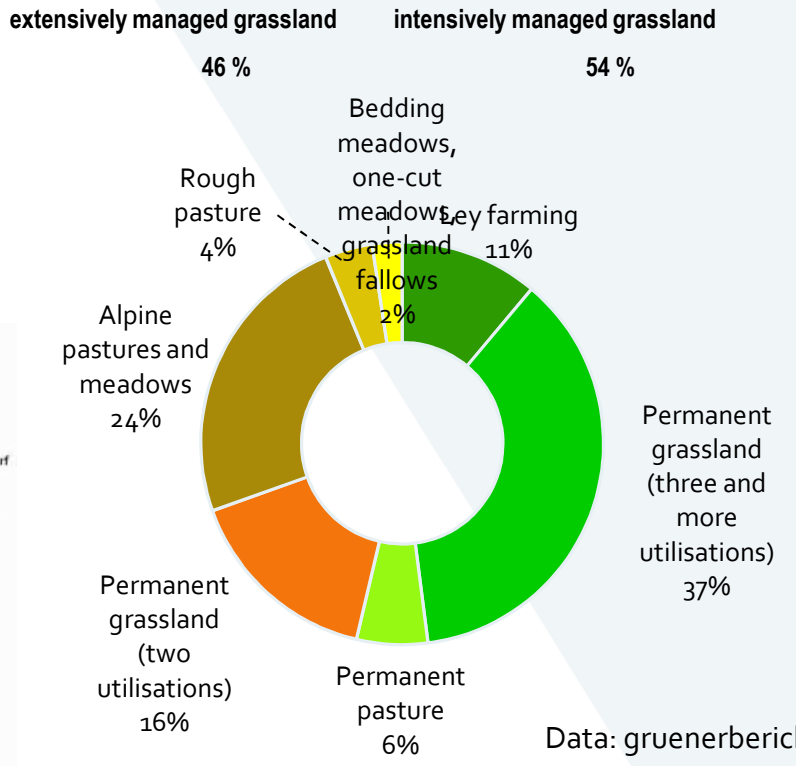
AREC & grassland in Austria

- Ø Temperature: 8.2° C
- Annual precipitation: 1056 mm
- Typical and representative location for grassland in Austria

Grassland area distribution in Austria 2018

Total area: 1.34 million hectare

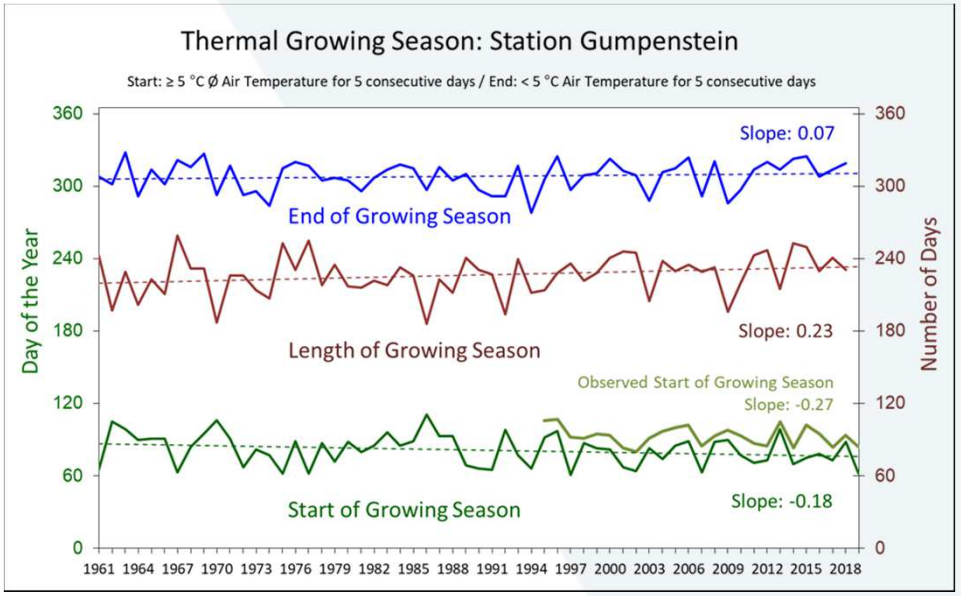


Data: gruenerbericht.at

Grassland growth dynamics

- Complex processes
  - Influenced by:
    - Climatic conditions
    - Site conditions
    - Management
    - Plant community

- Climate change induced shifts of grassland growth dynamics
  - Comprehensive monitoring is needed

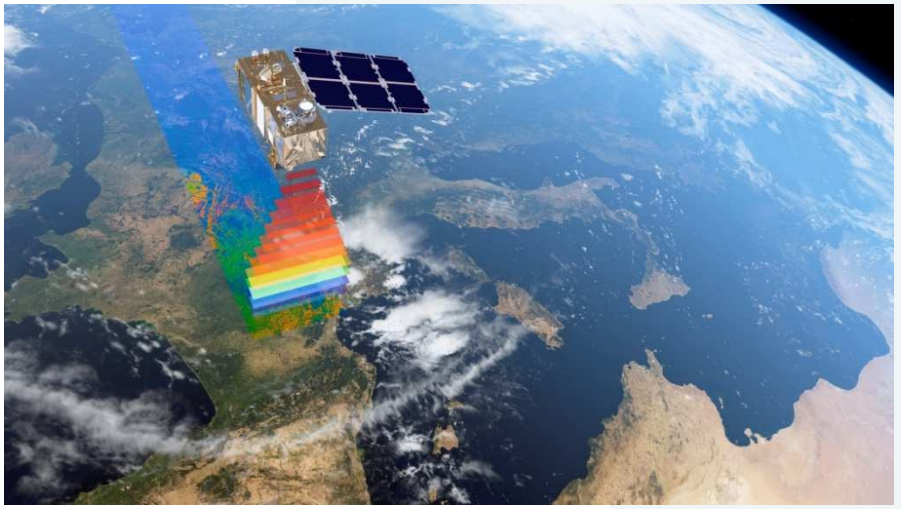


Schaumberger et al., 2019

- 13 days extension of the growing period since the 1960's
  - Strong year to year variation

Sentinel-2

- Part of the EU Copernicus Programme
  - Agro-environmental monitoring
  - Water monitoring
  - Forest and vegetation monitoring
- Free and open data policy
- Two satellites
  - Revisit time: 5 days
  - Orbit height: 786 km
  - Multispectral instruments
    - 13 spectral bands (443 – 2190 nm)
    - Spatial resolution= 10, 20 and 60 m



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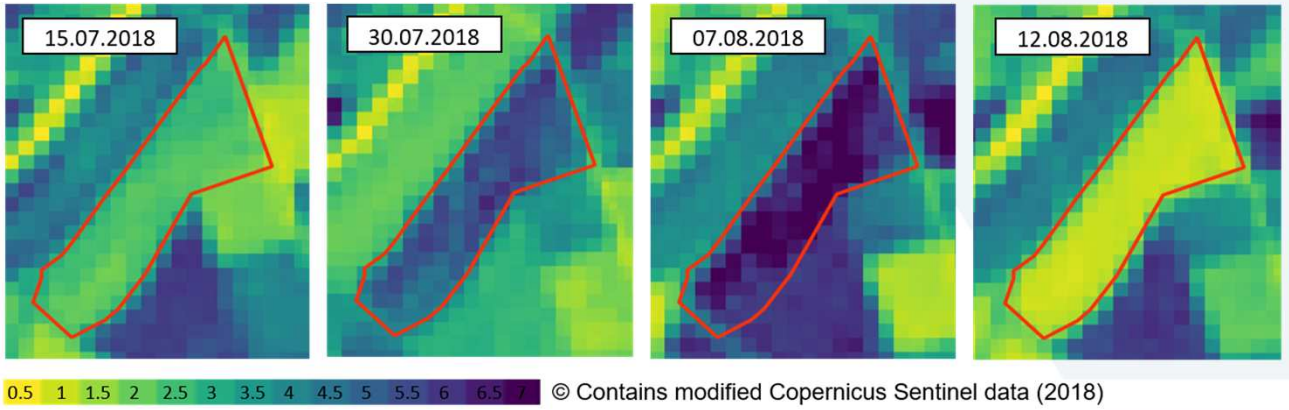
Leaf Area Index (LAI)

- LAI: *plan area of leafs per unit ground area* (Monteith and Unsworth, 2013)
- Suitable for homogenous structures (grassland)
- Key variable for biophysical processes
  - Photosynthesis
  - Transpiration
  - Respiration
  - Interception



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Step 1: LAI measurements

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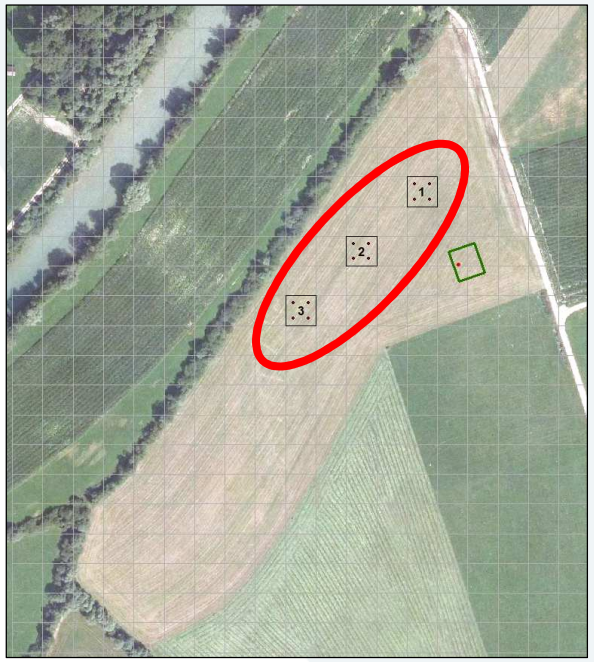
- AccuPAR Ceptometer Model LP-80
- HandySpec Field VIS/NIR 1.7 (tec5)
- AccuPAR measurements and hyperspectral recordings at the same day
- Sentinel 2
- Pre-processed images and products Sentinel-2 Value Adder (Vuolo et al., 2016)
- Training: radiative transfer simulations from the radiative transfer models PROSPECT and SAIL

Conversion of the field spectrometer data with Sentinel-2 Spectral Response Functions

Identical LAI calculation from Sentinel-2 and field spectrometer



Experimental area (4.6 ha) and the subareas 1-3 (20 x 20 m)

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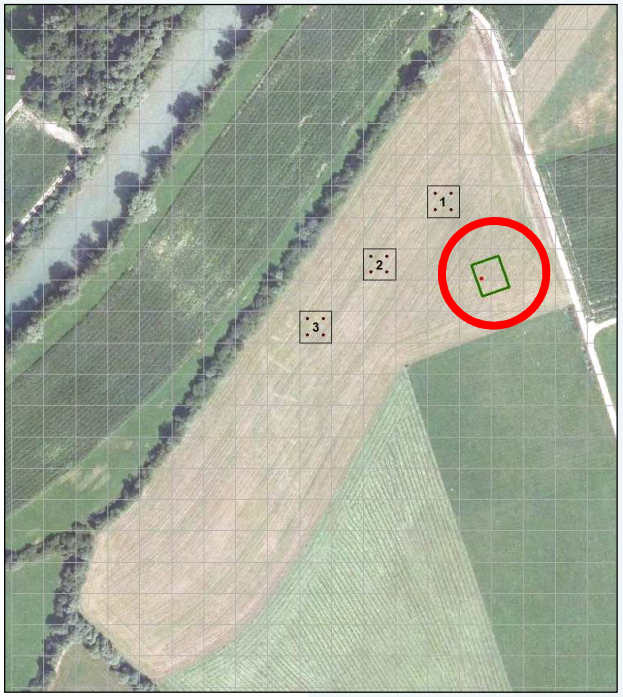
Step 2: Destructive sampling

- Weekly measurements
- LAI measurements
  - AccuPAR Ceptometer Model LP-80
  - HandySpec Field VIS/NIR 1.7 (tec5)
- Botanical survey
- Sward height measurements
- Destructive determination of yield and forage quality



Experimental area (4.6 ha) and the subareas 1-3 (20 x 20 m)

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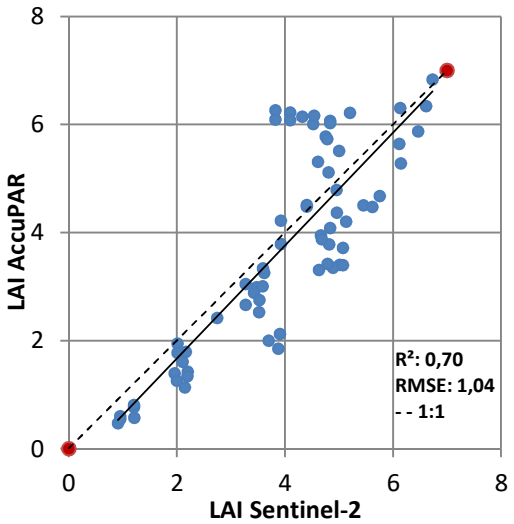
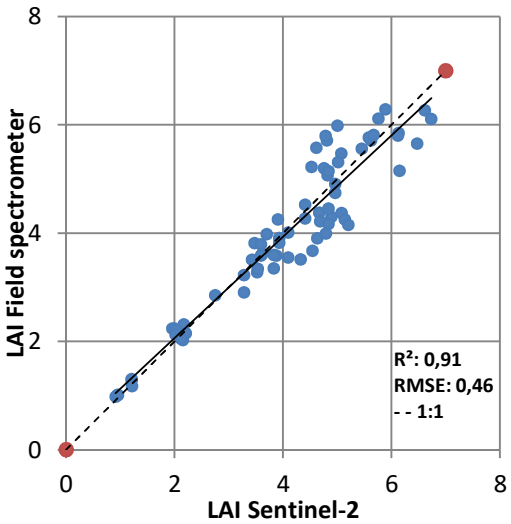
Results: Comparison of the sensors

LAI values: AccuPAR vs. Sentinel-2

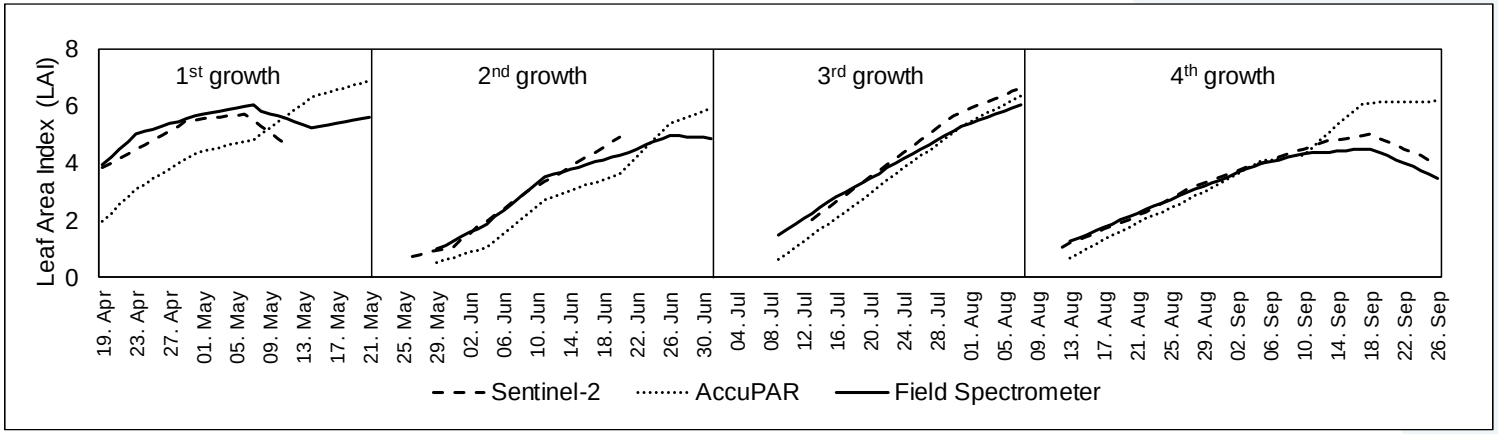


LAI values: Field spectrometer vs. Sentinel-2



- Very strong linear relationship between Satellite- and field spectrometer-LAI
- Slightly lower, but still high relationship between Satellite and AccuPAR

LAI time series



- High correlation of the optical sensors over the entire vegetation period
- Strong increase followed by a saturation of AccuPAR-LAI in advanced growth stages → consistent low PAR
- Significant underestimation of the AccuPAR at the beginning of the first growth
- More homogeneous vegetation structures of the re-growths cause less differences

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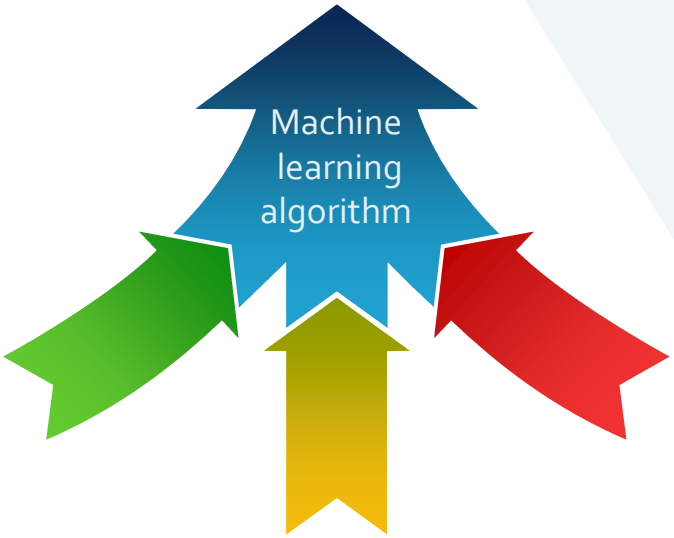
Grassland modelling

Grassland model



Agro-meteorology

- Temperature
- Radiation
- Precipitation
- Evapotranspiration

Remote sensing

- Vegetation indices
- Leaf Area Index (LAI)

Experimental data

- DM yield
- Crude protein
- Digestibility
- Fibre content

Conclusion and outlook

- Basically good correlation of the LAI time series of all three sensors **over the entire vegetation period**
- Possible applications for grassland management
  - Determination of **yield** and **forage quality**
  - Estimation of the optimal **harvest date**
  - Optimisation of **fertilization** and **irrigation**
  - Forage **balances** and **statistics**
  - Disaster management:
    - Monitoring of **droughts** and **floods**
    - Detection of **hail**
  - Decision support for **agricultural policy**
- **Well-prepared** technologies provide **valuable information** and should be used for grassland monitoring

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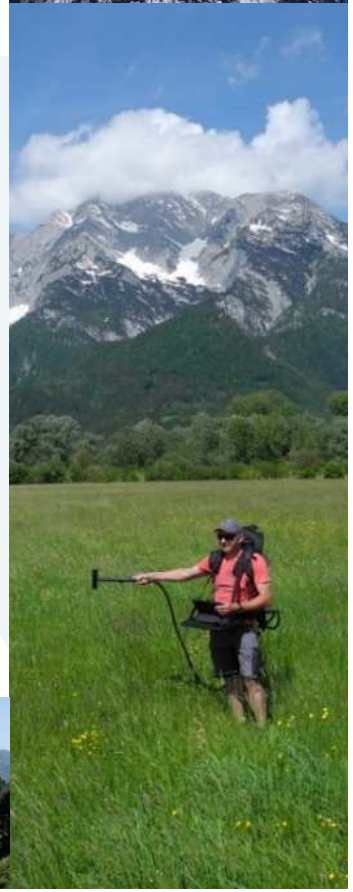

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