

# Grassland mowing event detection from multi-sensor time series to evaluate agri-environmental measures

## - *A model comparison exercise* -



Marcel Schwieder, Felix Lobert, Maximilian Wesemeyer, Alice Künzel, Gideon Okpoti Tetteh, Jana Lorenzl, Alexander Gocht, Claas Nendel, Patrick Hostert, Stefan Erasmi

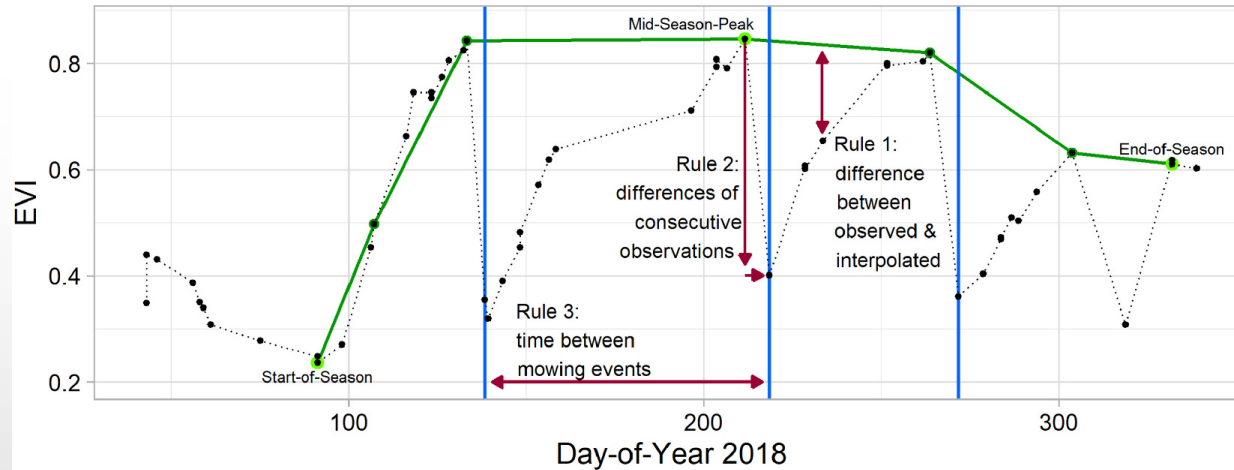


# Grasslands and management impacts

- **Grasslands cover around 30% of Earth terrestrial surface**
- **Account for 70% of the global agricultural area**
- **Approx. one third of the agricultural areas in Europe**
- **Valuable source of feed for livestock**
- **Important ecosystem services**
- **Provision of habitat**

# Grasslands and management impacts

- Management intensity has impacts on ecosystem services
- Information on grassland use intensity is important but lacking
- Remote sensing data enables monitoring of management proxies



(Schwieder et al., 2022)

# Remote sensing based approaches

- Optical or/and Radar time series as input
- Rule based or machine learning approaches

scientific reports

OPEN Exploiting time series of Sentinel-1 and Sentinel-2 to detect grassland mowing events using deep learning in a reject region

Tomislav Tomislavko<sup>1</sup>, Kaupo Voormansik<sup>2,3</sup>, Radwa Elshawi<sup>2,3</sup> & Sherif Sakr<sup>1</sup>

IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING

Observations of Cutting Practices in Permanent Grasslands

Kaupo Voormansik<sup>1,2,3,\*</sup>, Tomislav Tomislavko<sup>1</sup>, Radwa Elshawi<sup>2,3</sup> & Sherif Sakr<sup>1</sup>

remote sensing

Article  
Detection of Grassland Mowing Events for Germany by Combining Sentinel-1 and Sentinel-2 Time Series

Sophie Reinermann<sup>1,\*</sup>, Ursula Gessner<sup>2</sup>, Sarah Asam<sup>2</sup>, Tobias Kienast<sup>1,2</sup> and Claudia Kuenzer<sup>1,2</sup>

remote sensing

Article  
Grassland Mowing Potential and Limitations in the Netherlands

Mathilde De Vroey<sup>\*,†</sup>, Julien Vanhulle<sup>†</sup>, and Peter H. Verburg<sup>1,2</sup>

remote sensing

Article  
Regional Scale Mowing Frequency with Sentinel-2 Time Series

Natalia Kolecka<sup>1,2,3,\*</sup>, Christof Weis<sup>1,2</sup> and Peter H. Verburg<sup>1,2</sup>



Mapping grassland mowing events across Europe using Sentinel-2 and Landsat 8 time series

Marcel Schwieder<sup>a,b,\*</sup>, Maximilian Wesemeyer<sup>a</sup>, David Frantz<sup>a,c</sup>, Kira Pfoch<sup>a,d</sup>, Stefan Erasmi<sup>b</sup>, Jürgen Pickert<sup>e</sup>, Claas Nendel<sup>e,f,g,h</sup>, Patrick Hostert<sup>a,f</sup>



Remote Sensing of Environment

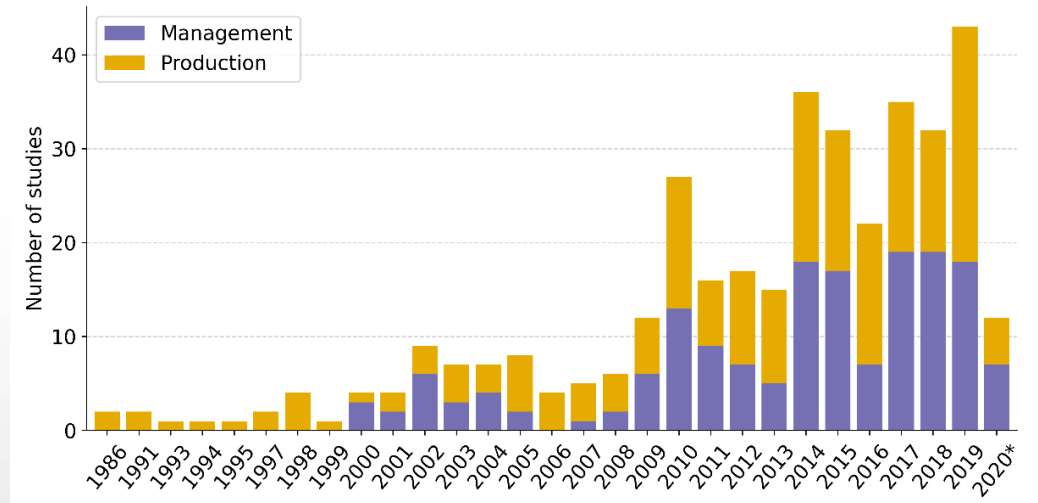
journal homepage: [www.elsevier.com/locate/rse](http://www.elsevier.com/locate/rse)

Mowing event detection in permanent grasslands: Systematic evaluation of input features from Sentinel-1, Sentinel-2, and Landsat 8 time series

Felix Libert<sup>a,\*</sup>, Ann-Kathrin Holtgrave<sup>b</sup>, Marcel Schwieder<sup>a</sup>, Marion Pause<sup>c</sup>, Juliane Vogt<sup>d</sup>, Alexander Gocht<sup>a</sup>, Stefan Erasmi<sup>a</sup>

# Remote sensing based approaches

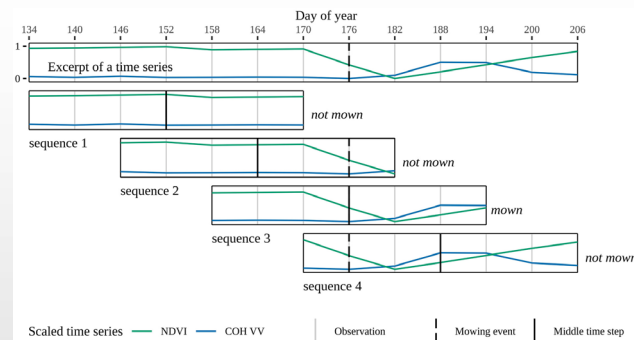
- Increase in quantitative grassland studies
- Results hardly comparable due to differences in
  - Methods
  - Data
  - Pixel or parcel based
  - Extent
  - Region
  - Validation procedure
  - ....



(Reinermann et al., 2020)

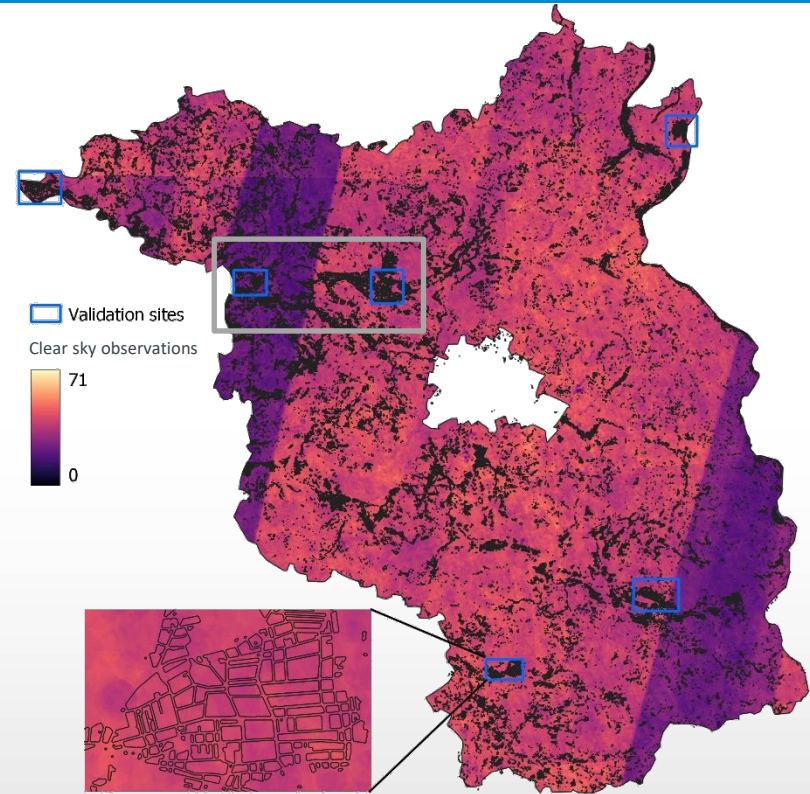
# Model Comparison

- **Sen4Cap**
  - Optical and Radar time series
  - Image on CODE-DE;
- **RBA (S-2/L8; S-2/L8 and S-1)** *(Schwieder et al., 2022)*
  - Rule-based decision with pixel based thresholds
- **1-D CNN** *(Lobert et al., 2021)*
  - Time series sequences (moving window)
  - Independent reference samples



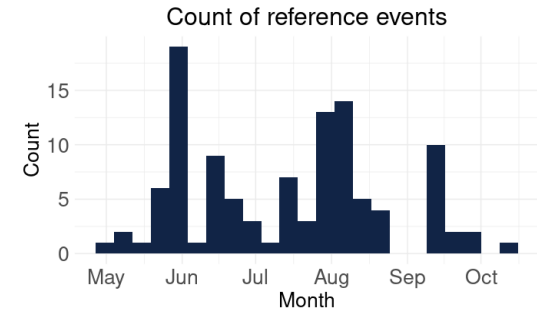
# Model Comparison

- Comparison of available algorithms
- Federal state of Brandenburg Germany
- Approx. 3000km<sup>2</sup> grassland



# Validation Data

- IACS LPIS data for Brandenburg
- PlanetScope/S2/L8 time series for 2020
- QGIS Plugin: Earth Observation Time Series Viewer
- 58 Reference parcels
- Evaluation
  - Confidence thresholds
  - Tolerance of 12 days
  - Timing (date)
  - Count of events



2020-05-26 5bands@10.0m  
2020-05-27 4bands@3:001905025973597m  
2020-06-01 4bands@3:001905025973597m  
2020-06-02 4bands@3:001905025973597m

id	id
19	DEBBLU1568915516_6
20	DEBBLU1568915589_1
21	DEBBLU0268050699_3
22	DEBBLU1568915589_3
23	DEBBLU1568915515_1
24	DEBBLU1568915513_1

100 dates, 23 sensors, 109 source images

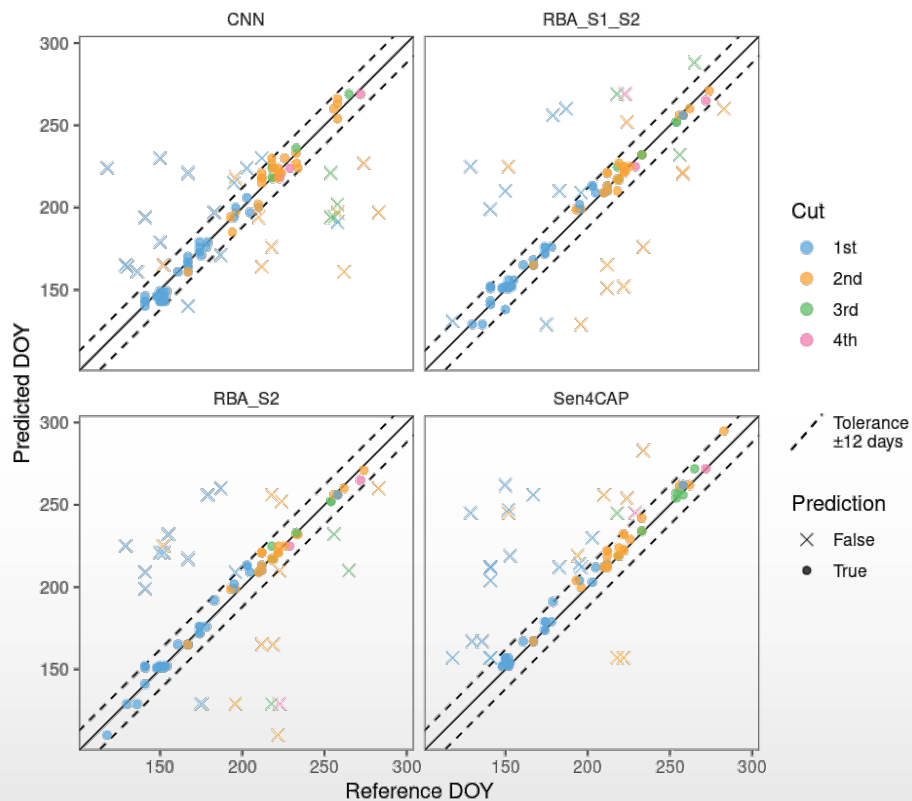
Temporal Profiles Visualization

**LPS Poster: Thursday at 18:26h**  
**„Offline! Visualization and labeling of multi-sensor time series in the field: the EO Time Series Viewer“**

(Jakimow et al., 2020)



# Results



## Overall accuracy\*

	<i>Recall</i>	<i>Precision</i>	<i>F1</i>
CNN	0.72	0.71	0.71
Sen4CAP	0.72	0.66	0.68
RBA_S1_S2	0.75	0.52	0.62
RBA_S2	0.74	0.64	0.69

## Mowing frequency

	<i>MAE</i>	<i>Bias</i>	<i>RMSE</i>	<i>MAPE</i>
CNN	0.65	0.06	0.95	0.42
Sen4CAP	0.74	0.26	1.07	0.51
RBA_S1_S2	1.29	0.93	1.77	0.85
RBA_S2	0.89	0.38	1.29	0.58

## Mowing date\*

	<i>MAE</i>	<i>RMSE</i>
CNN	4.33	5.25
Sen4CAP	3.53	5.00
RBA_S1_S2	3.09	4.28
RBA_S2	3.06	4.22

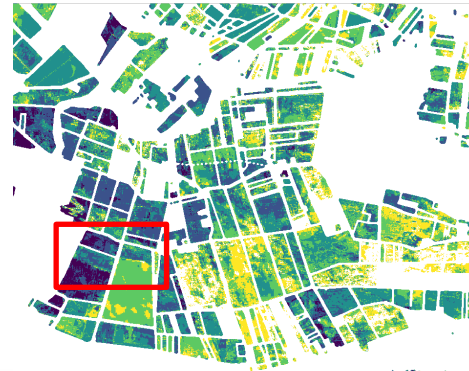
\*12 days tolerance

# Results

CNN



RBA S1\_S2



Sen4CAP\*



*\*without confidence filter*

RBA S2



No. events



# Findings

- **Accuracy metrics are partially comparable between the algorithms**
- **Validation of mowing activities is challenging**
  - Quality of reference data/manual observations
  - Delineation of homogenous areas critical (e.g. site-specific management)
  - Pasture vs. Mowing meadows
- **Choice for one of the approaches depends on requirements of the monitoring purpose, e.g.:**
  - Coverage of large areas (national) → RBA (pixel-based)
  - Near-real time estimates → Sen4Cap
  - ML based time series evaluation → CNN

# Outlook

- **Initial idea to set up a large intercomparison exercise**
- **Additional regional distributed sites for comparison**
- **Additional approaches**
- **Invitation to exchange**

# Special Thanks

**For your attention!**

**Cosmin Udroi (CS-Group) for his „instant“ support!**



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# References

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