

UNIVERSITY OF TWENTE.

VALIDATION OPTIONS FOR SATELLITE-DERIVED PHENOLOGY

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FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

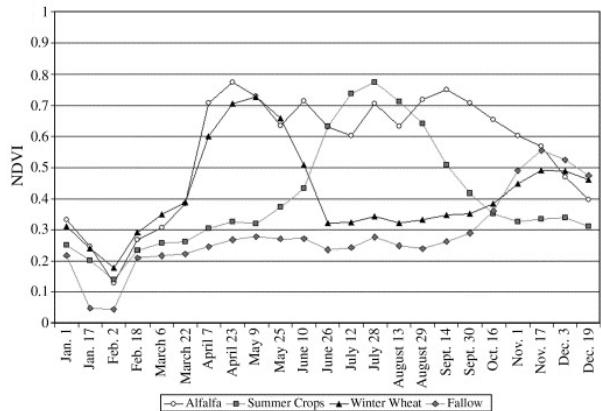


WHAT IS VALIDATION? (AND CALIBRATION!)

- Verifying if results are accurate
- For phenology, it thus matters:
 - what results are we interested in?
 - specific pheno-phases
 - measures of seasonal productivity
 - Is our interest to get absolute values right? Or do we (merely) want a good representation of:
 - spatial variability of a specific phenophase
 - temporal variability of specific phenophase
 - both for spatial/temporal we may want to assess e.g. effects of climate/management, without necessarily requiring absolute values

AGRICULTURE

- What ‘validation’ may we desire?
 - assess simply differences in phenology between crops (classification)

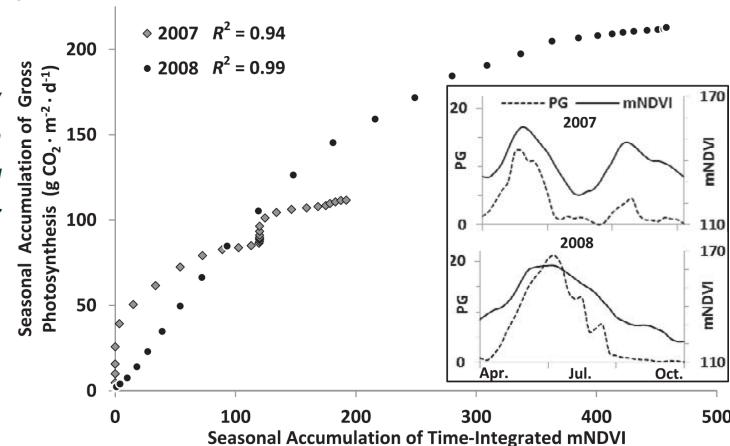
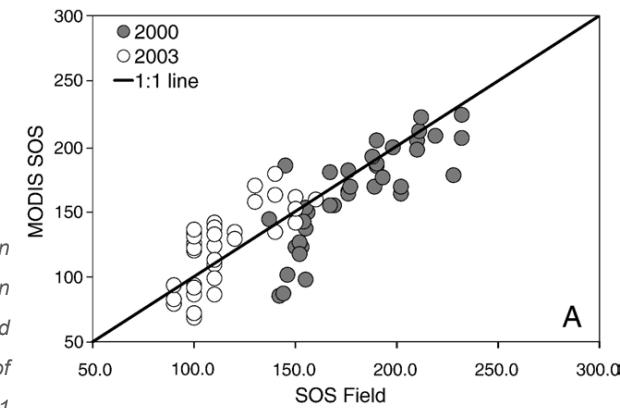


Wardlow et al. 2007. Analysis of time-series MODIS 250 m vegetation index data for crop classification in the U.S. Central Great Plains. Remote Sensing of Environment 108: 290-310

Brown & de Beurs (2008). Evaluation of multi-sensor semi-arid crop season parameters based on NDVI and rainfall. Remote Sensing of Environment 112: 2261-2271

- sowing/emergence dates
- harvest dates
- but also ...
 - other phases
 - yield vs “pheno-derived” productivity

Rigge et al. (2013). Linking phenology and biomass productivity in South Dakota mixed-grass prairie. Rangeland Ecology and Management 66: 579-587





SOURCES OF PRODUCTION REFERENCE DATA

- Measured harvest from field (or within)
- Crop cutting
 - E.g., 1x1 m plots
- Farmer-reported production / area
 - GPS-correction for area... (tendency to round and over-report small areas)
 - Rounded production (e.g., 90 kg bags) → effect on small fields bigger
 - Issues: account for intercropping?
- Official crop statistics
 - Based on various approaches
 - Accuracy/reliability?
 - Often for large admin-units
 - Possible advantage: temporal estimates



Image: [http://www.agritechtalk.org/PET Crops South Sudan compressed.pdf](http://www.agritechtalk.org/PET%20Crops%20South%20Sudan%20compressed.pdf)



NATURAL VEGETATION (FORESTS)

- General link with climate parameters
 - No real validation always, but moments of green-up and senescence & links to climate
 - Spatial or temporal patterns as evidence of change
- Link to vegetation activity / photosynthesis
- Phenophases

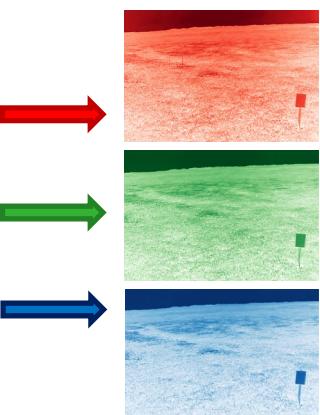


VALIDATION DATA SOURCES

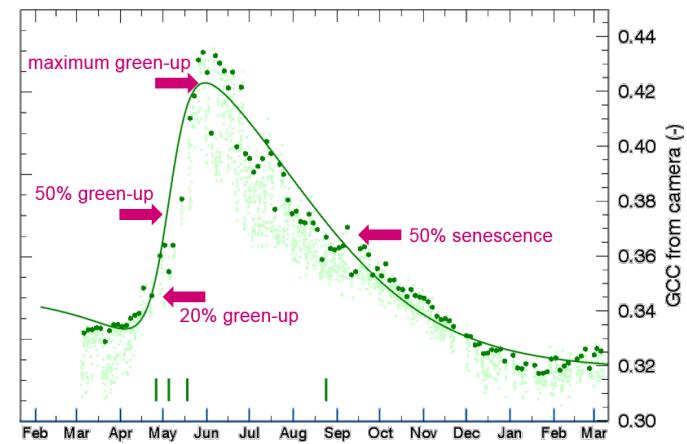
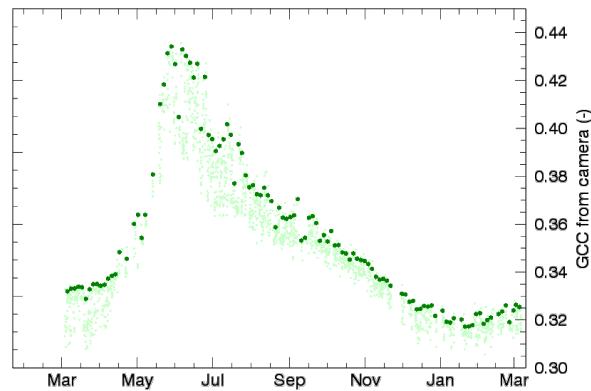
- Farmer reported dates (production)
- Visual observation (of budburst, harvest, etc...)
 - Possibly crowd-sourced
- Flux towers measuring CO₂ exchange → photosynthesis
- In-season biomass measures to get seasonal productivity
 - E.g. through cutting herbaceous layer
- Eyes near the earth surface (cameras)
 - Fine-temporal monitoring of greenness changes with cameras
 - Question: do we miss important parts of the season?
 - How does that affect our fitted models, and retrieved phenology?



DIGITAL REPEAT CAMERAS (1)



$$GCC = \frac{green}{red + green + blue}$$



DIGITAL REPEAT CAMERAS (2)



PhenoCam
AN ECOSYSTEM PHENOLOGY
CAMERA NETWORK
[View Camera](#) [Show in view](#)
Location: University of Twente, Building de Horst, Enschede, the Netherlands, mixed forest
Lat: 52.2375 Lon: 6.8608 Elev(m): 30
Image Count: 28311 Start Date: 2019-06-25 Last Date: 2021-09-15

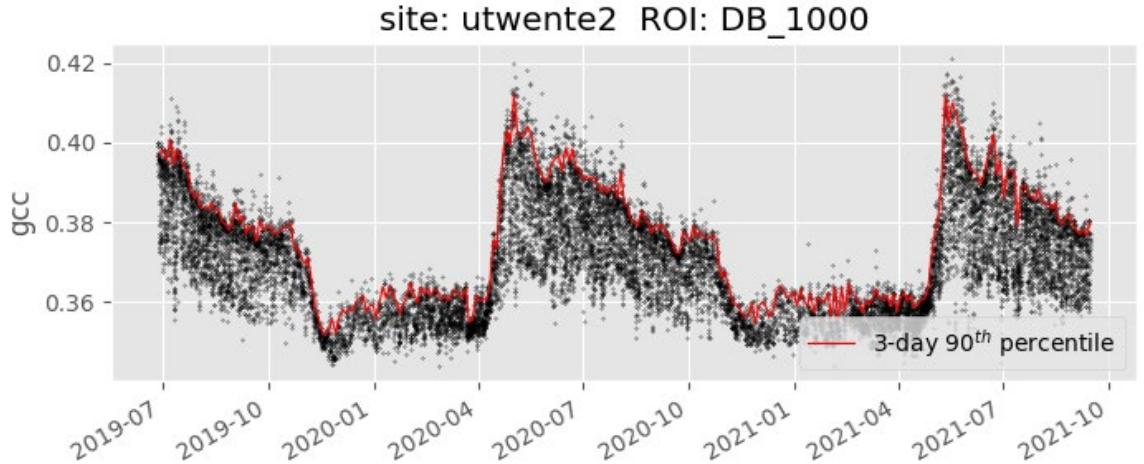
Site Metadata
Utwente2 - NetCam SC IR - Thu Sep 16 2021 12:19:09 CET - UTC-3
Camera Temperature: 41.5
Exposure: 300

[Browse Images](#)

ROI Timeseries:
[ROI Page - DB_1000](#)
[ROI Page - DB_1001](#)

A screenshot of the PhenoCam website. It shows a live view of a forested area, a map of the camera's location in Enschede, the Netherlands, and a timeseries of images from September 11 to 15, 2021. The latest image is highlighted with a red border.

- utwente2 camera: June 2019



DIGITAL REPEAT CAMERAS (3)



Pheno Cam
AN ECOSYSTEM PHENOLOGY
CAMERA NETWORK

Site Name: utwente1 ([show IR view](#))
Location: Campus of University of Twente, Building de Spiegel, (Enschede, Netherlands), mixed vegetation
Lat: 52.2401 Lon: 6.8501 Elev(m): 25
Image Count: 27511 **Start Date:** 2019-06-25 **Last Date:** 2021-09-15

Site Metadata

utwente1 - NetCam 5C IR - Fri Feb 12 2021 12:48:05 CET - UTC+1
Camera Temperature: 16.0
Exposure: 10



Aerial view of a frozen lake with snow-covered banks and surrounding trees. The camera interface includes a zoom control (+/-), a scale bar (5 km, 2 m), and a legend for Google base layers (Satellite, Hybrid, Physical) and overlays (MCD12Q1 2016, NLCD Land Cover 2016).

Browse Images

ROI Timeseries:

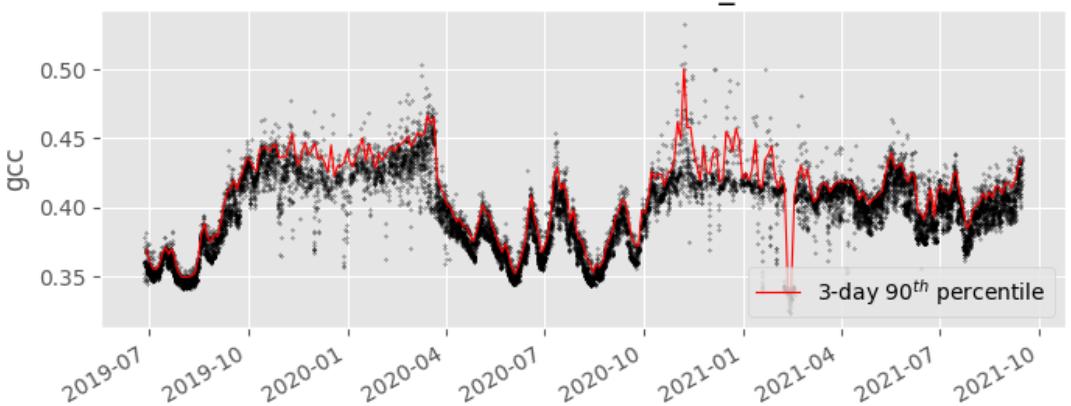
- ROI Page - DB_1000
- ROI Page - GR_1000

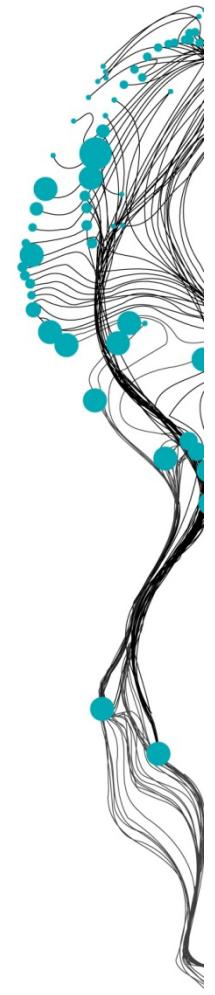
latest image

09/11 (254) 09/12 (255) 09/13 (256) 09/14 (257) 09/15 (258)

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This material is based upon work supported by the National Science Foundation under Grant No. EF-1045029. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. [Contact webmaster](#)

- utwente1 camera: June 2019

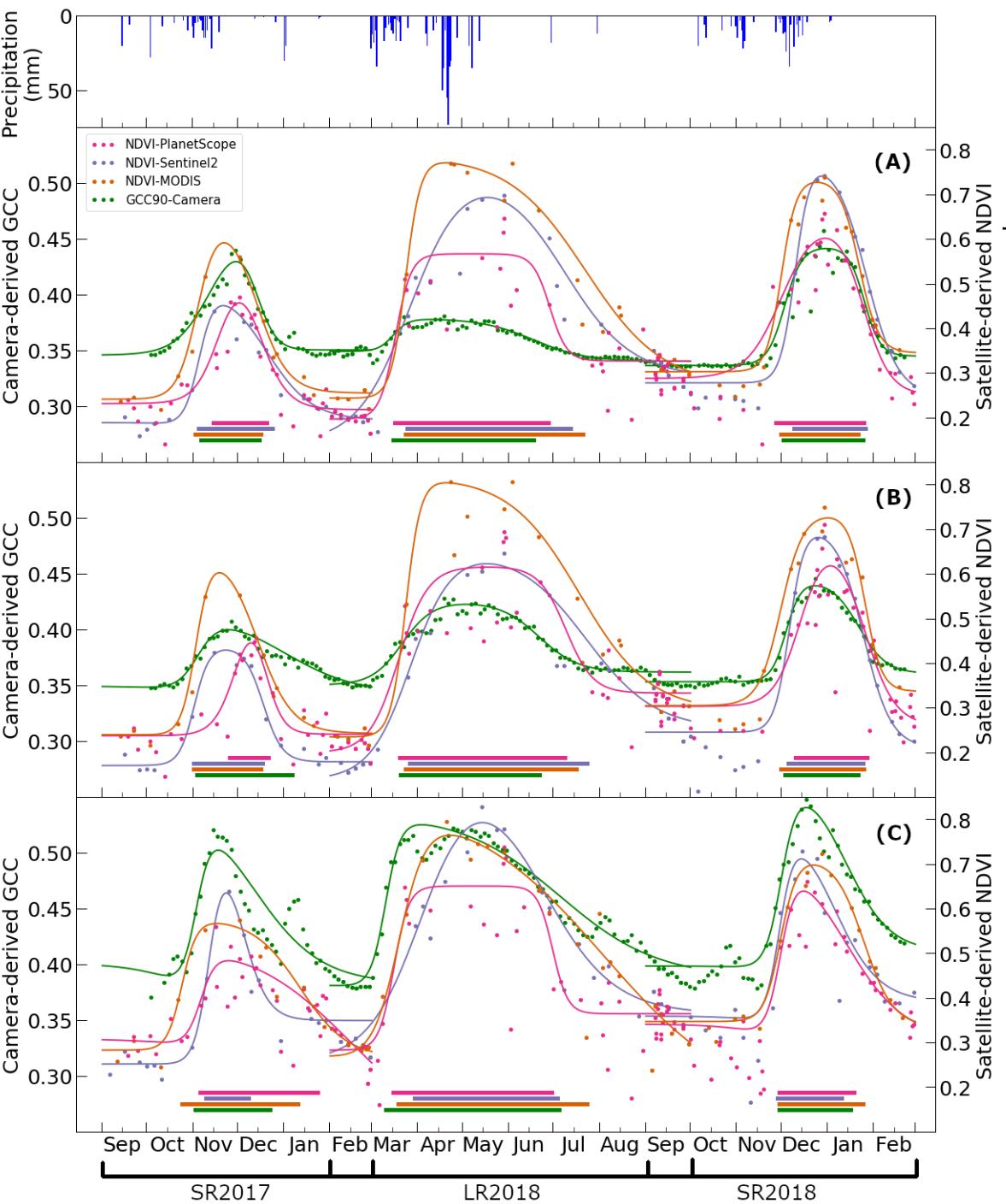




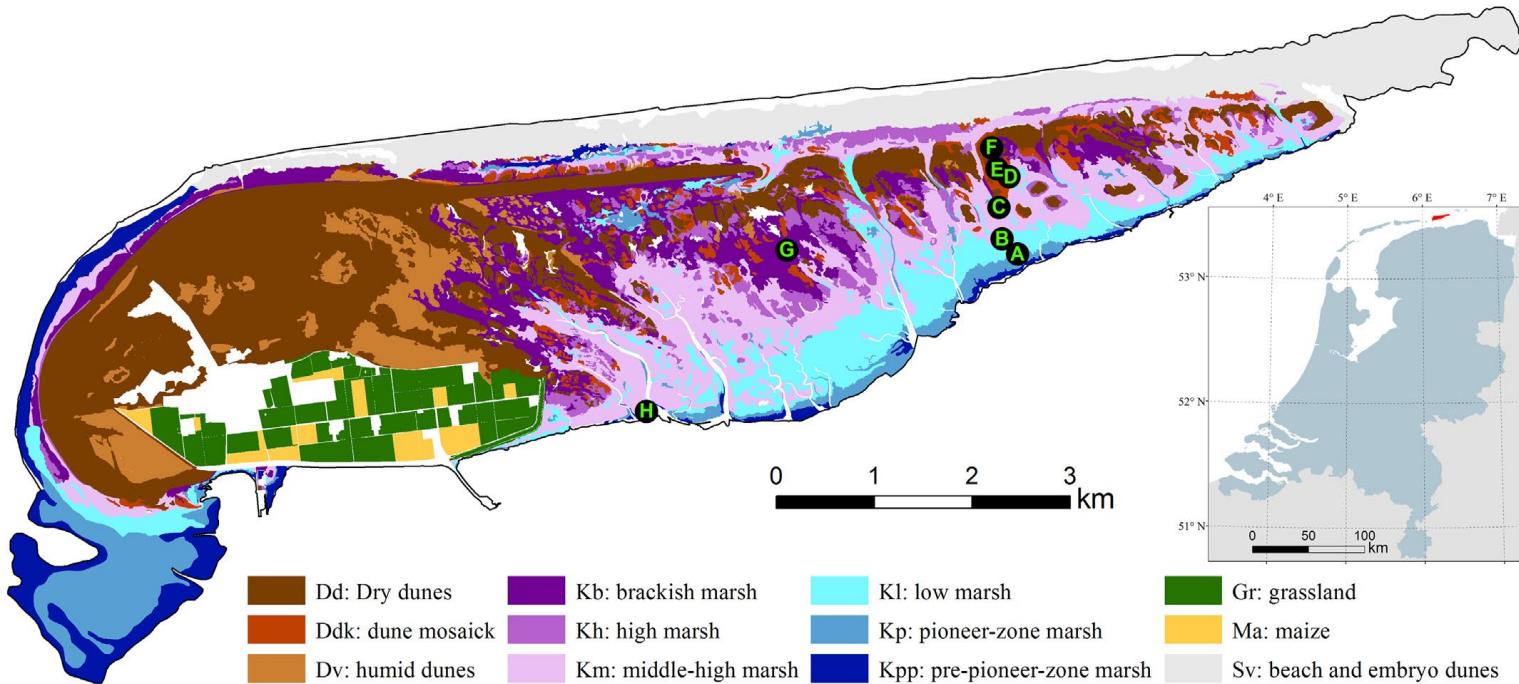
VALIDATION

- Trajectory
- Retrieved dates

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CAMERAS ON SCHIERMONNIKOOG



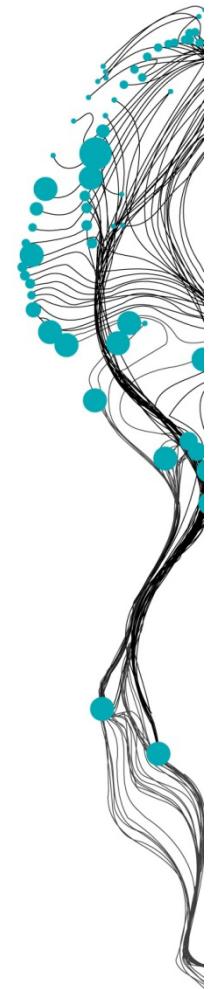
- May 2015: 10 cameras. Now 5 still there...
- Regularly replaced (issues with overexposure, damage, lost)



IMPRESSION

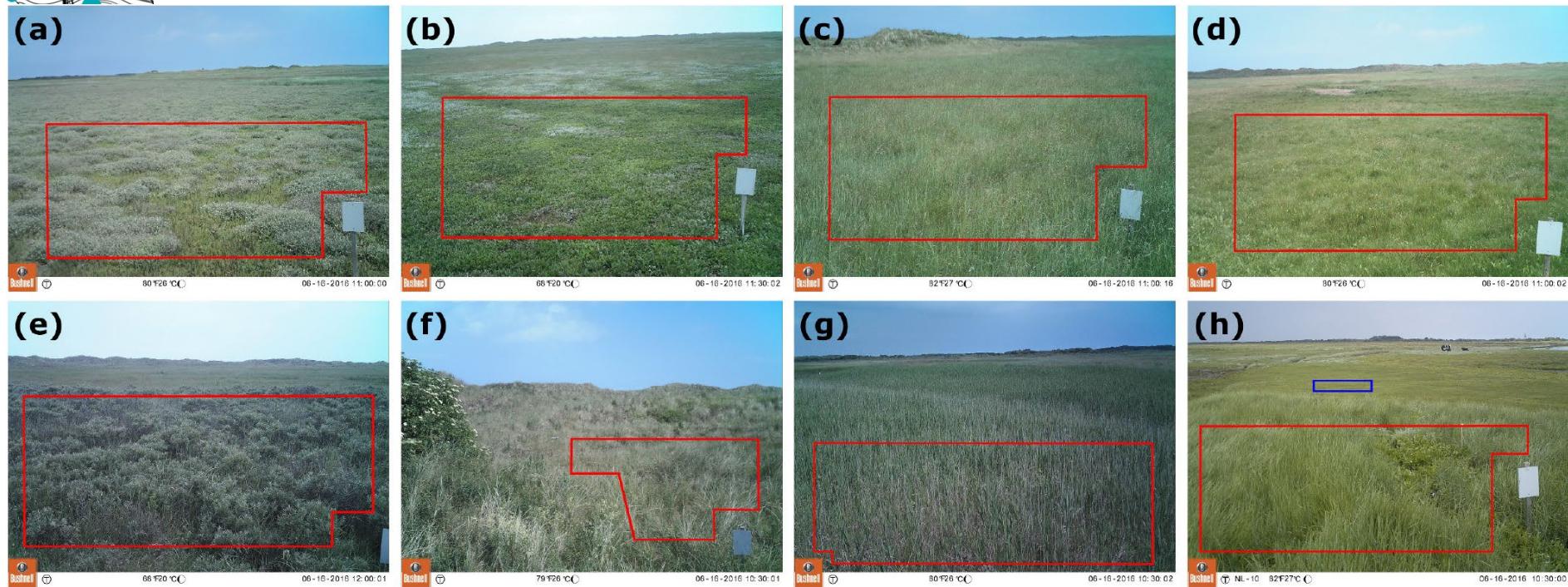




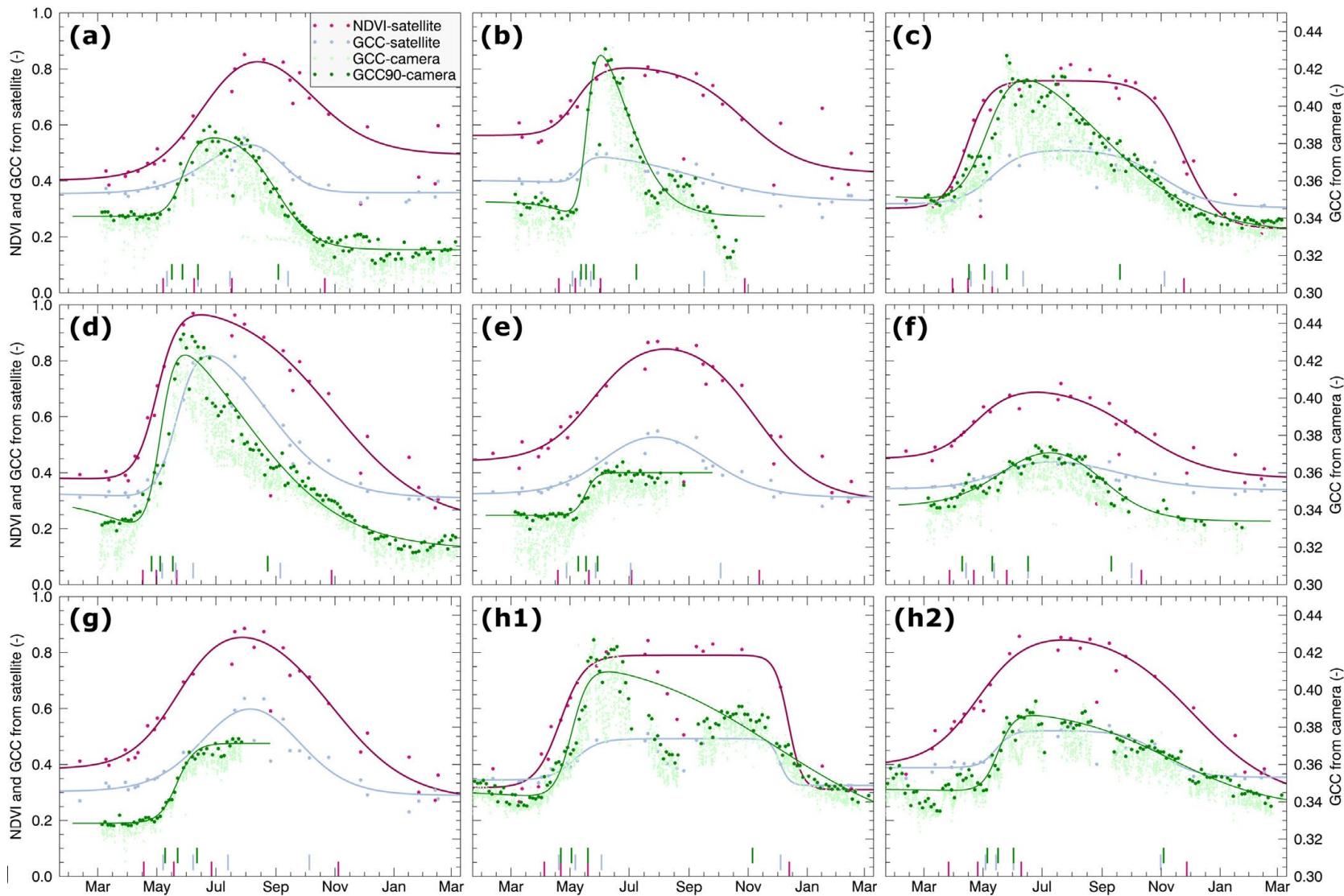


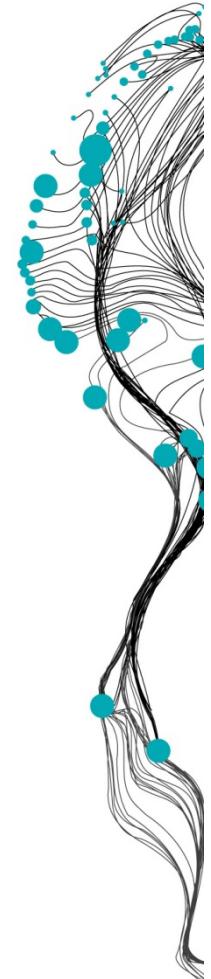


CAMERAS AND ROIS

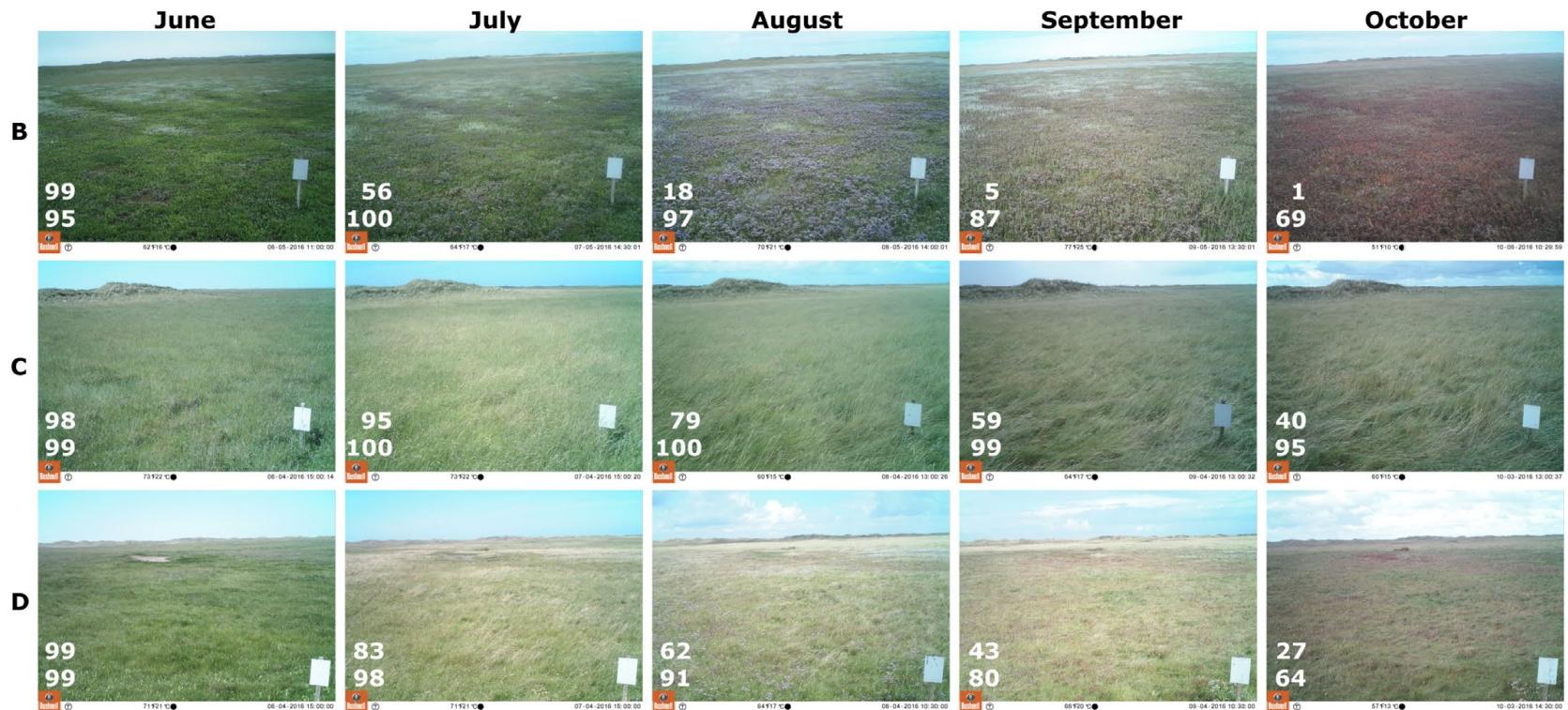


COMPARISON WITH SENTINEL-2

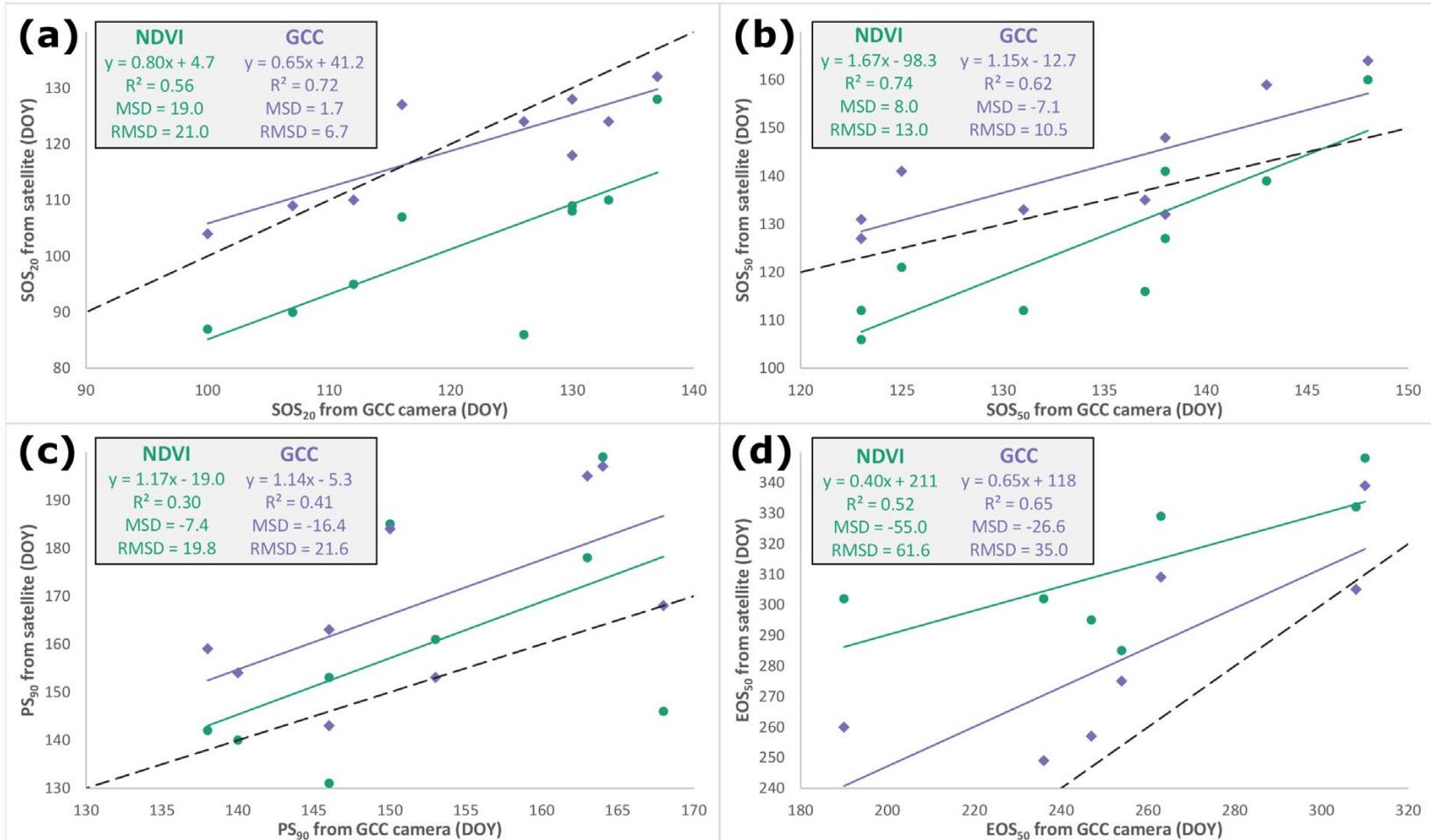




REASON OF EARLIER 'SENESCENCE' IN CAMERA DATA



COMPARISON OF SOS₂₀, SOS₅₀, PS₉₀, EOS₅₀



OPTIONAL EXERCISE



- Gain experience in using camera data to estimate pheno-metrics
- Focus on a site in Bavaria Forest National Park
 - Bushnell camera
- Use of PhenoPix (R package)



Phenopix: A R package for image-based vegetation phenology
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Matthias Forkel^{b,1}, Lisa Wingate^c, Enrico Tomelleri^d, Umberto Morra di Cella^a,
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^c INRA, UMR1394, Paris, France
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^e Harvard University, Department of Organismic and Evolutionary Biology, Cambridge, MA, USA



- Use of tutorial