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Evaluation of phenology parameters as proxi for drought measurements

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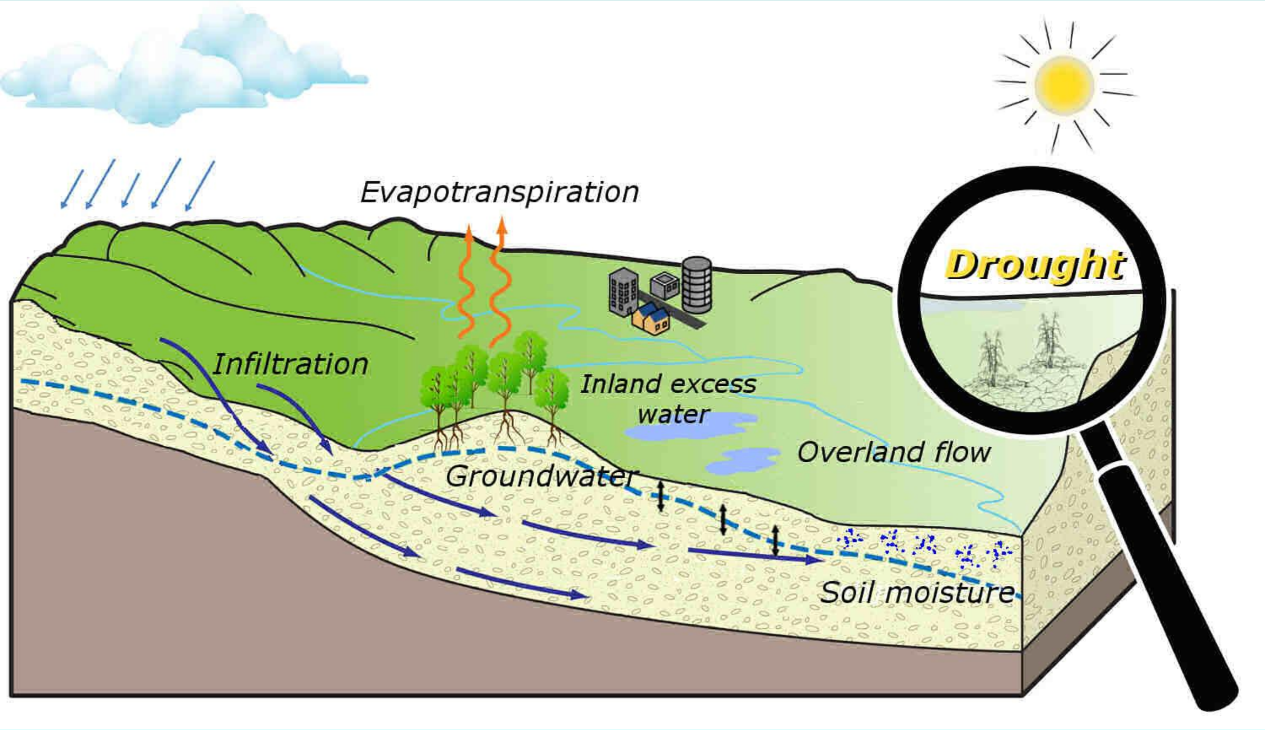
Research at TFGT

Dep. of Physical Geography and Geoinformatics (TFGT)

- Applied multidisciplinary research
- Geoinformatics
- Remote sensing
- Physically based modeling



Climate change in the Carpathian basin

- Predictions until the end of the century:
  - Stable/slight decrease in the yearly amount of precipitation → more and more during extreme events
  - Severe rise in average yearly temperature

Larger susceptibility to drought

Aims

Relation between climate and periodic biological phenomena

- Estimate phenology and productivity parameters based on medium resolution satellite data
- Develop time series to monitor the process of drought
- Evaluate phenology and productivity parameters as proxi for drought measurements
- Automate the workflow

Deciduous forest

Coniferous forest

MOD13Q1 VI Data

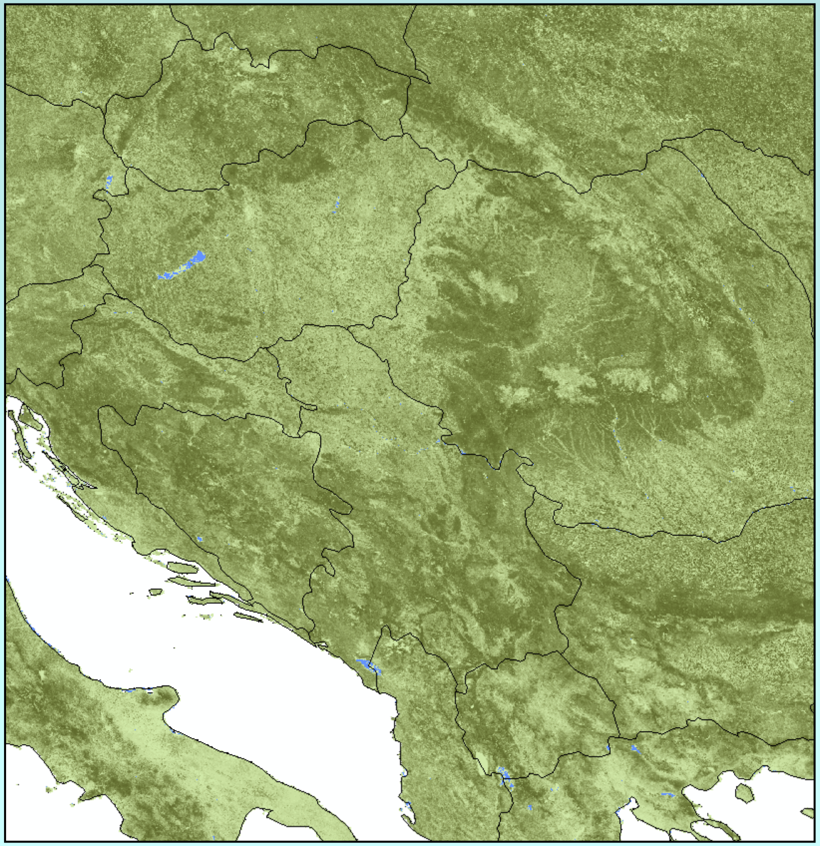
$$NDVI = \frac{\rho_N - \rho_R}{\rho_N + \rho_R}$$

$$EVI = G\frac{\rho_N - \rho_R}{\rho_N + C_1\rho_R - C_2\rho_B + L}$$

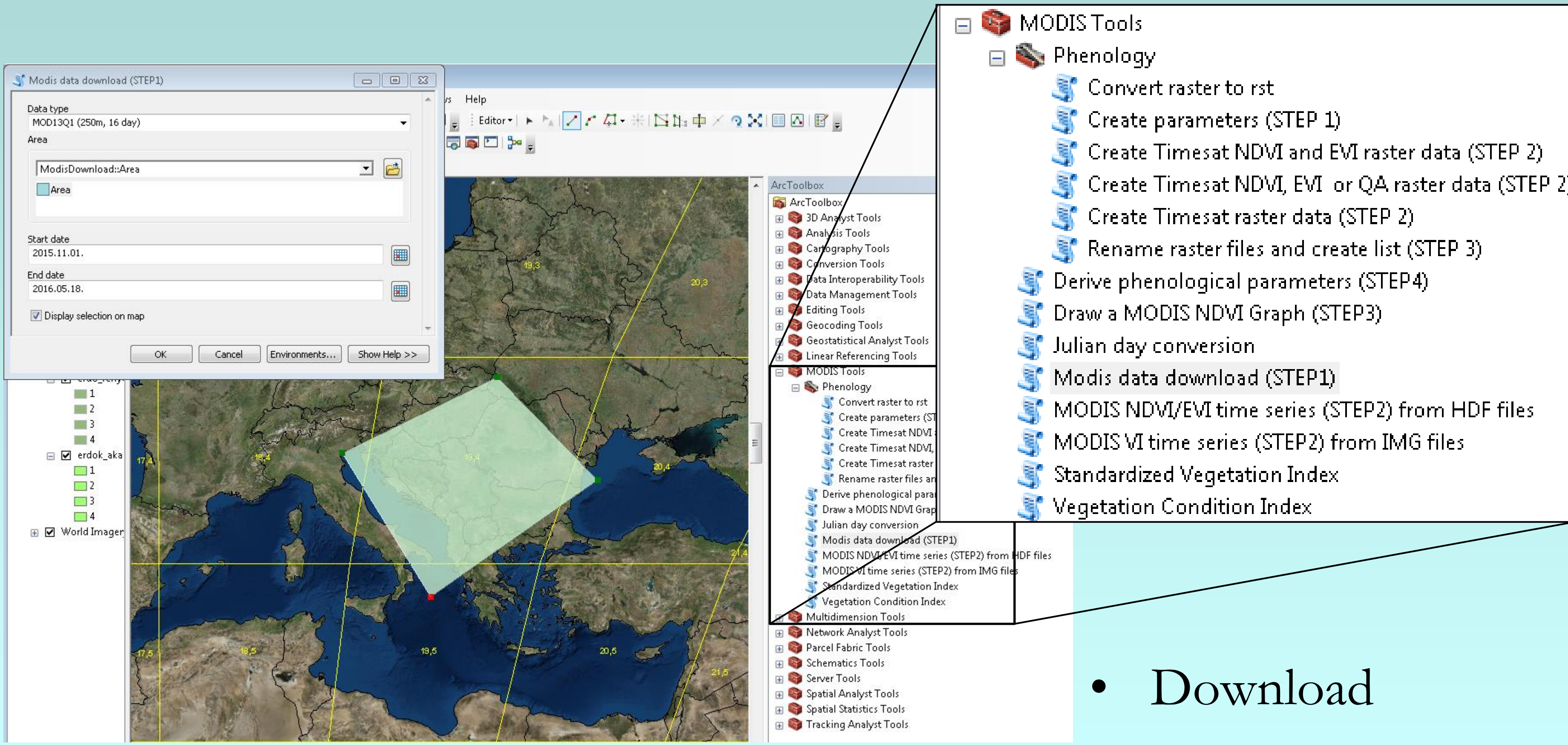
$L = 1$, $C_1 = 6$, $C_2 = 7.5$, $G = 2.5$ (Huete et al 1999)

- Atmospherically corrected base data
- 250 meter spatial resolution
- 16 day maximum value composites (MVC)
- CV-MVC
- QA data

- 23 images per year, 16 years: 368 Images

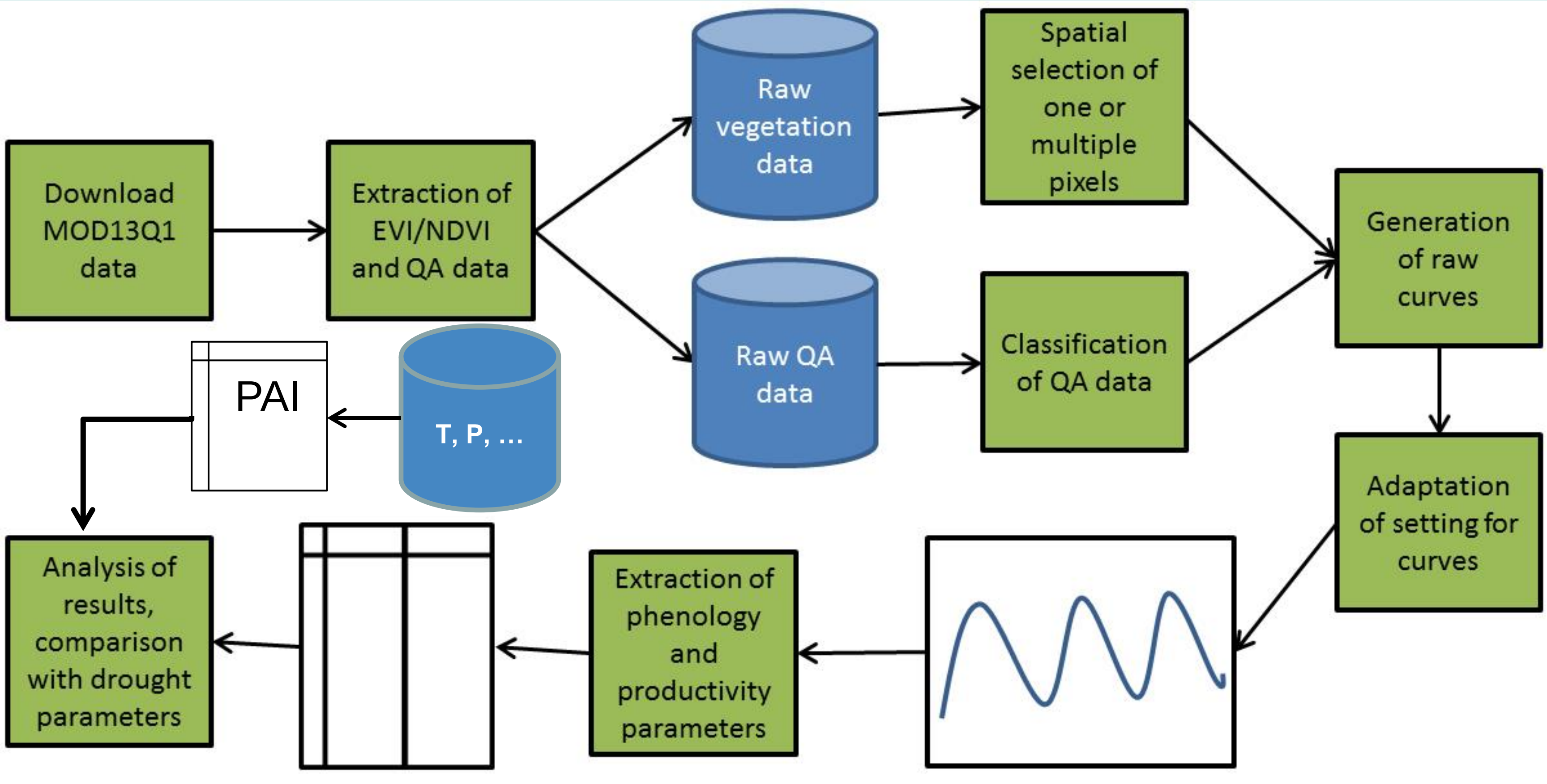


ArcGIS/Python processing tools



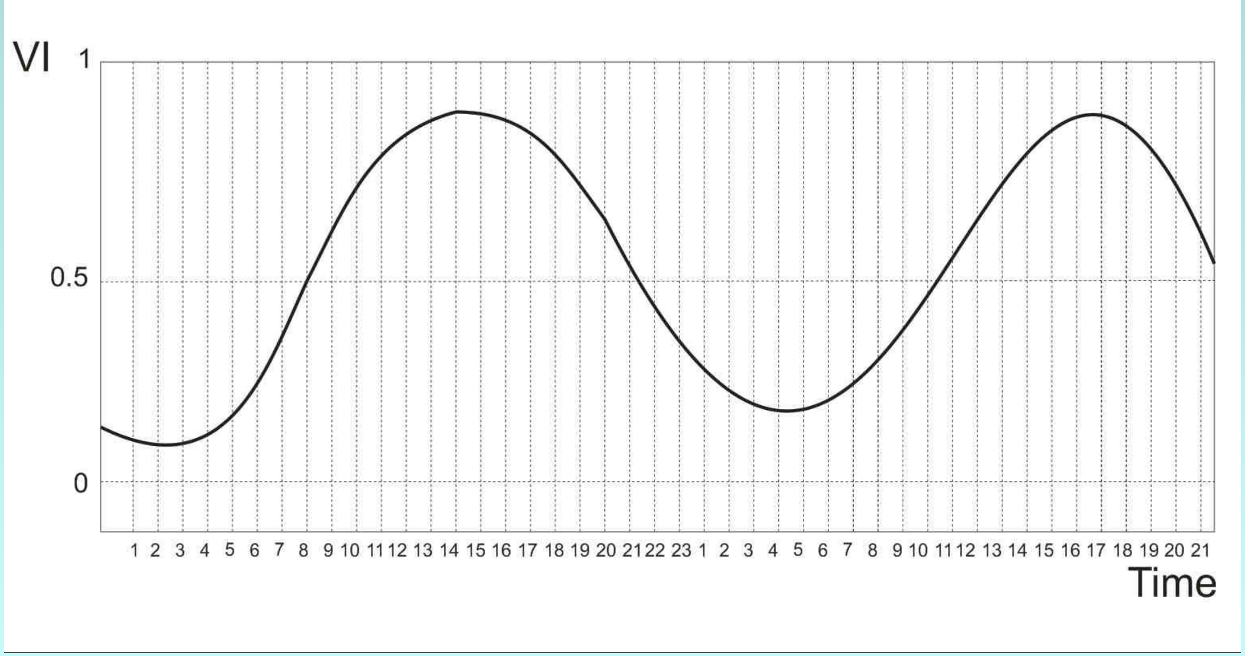
- Download
- Quality selection
- Pixel subsetting

Workflow



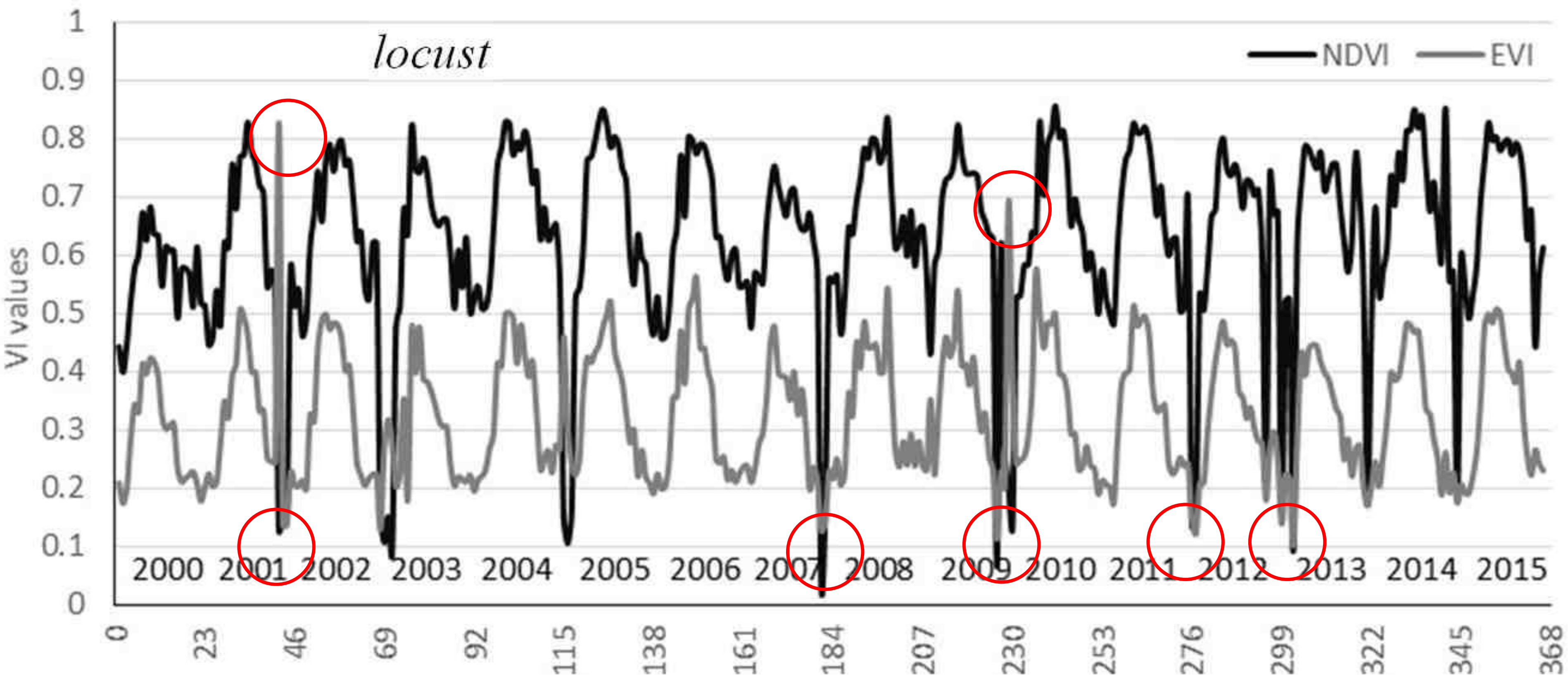
Download MOD13Q1 data
Extraction of EVI/NDVI and QA data
Raw vegetation data
Raw QA data
Spatial selection of one or multiple pixels
Classification of QA data
Generation of raw curves
Adaptation of setting for curves
Extraction of phenology and productivity parameters
Analysis of results, comparison with drought parameters
PAI
T, P, ...

Data preprocessing

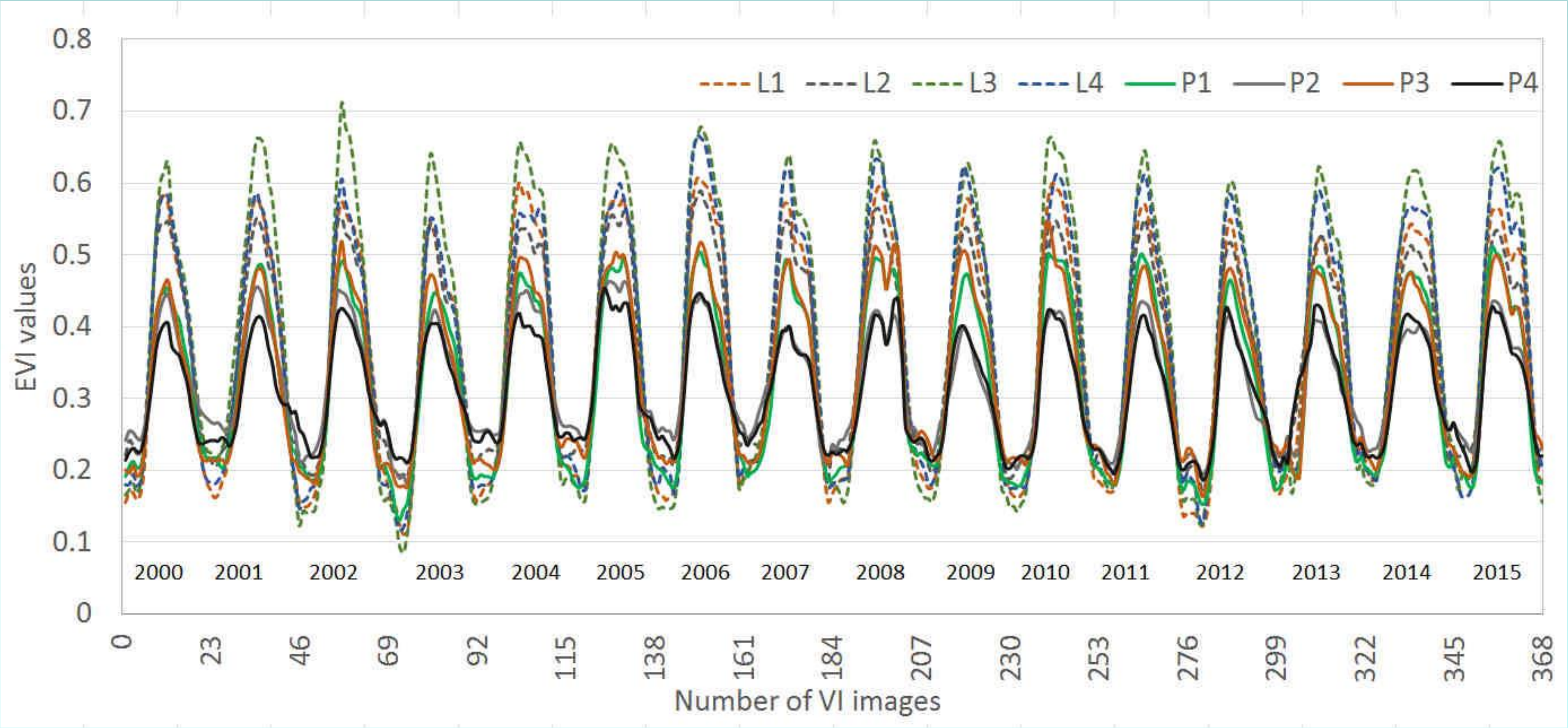


- Outliers removal
- Noice reduction
- Local polynominal fitting with adaptive Savitzky-Golay filter
- Assumption of seasonality

Raw NDVI and EVI data

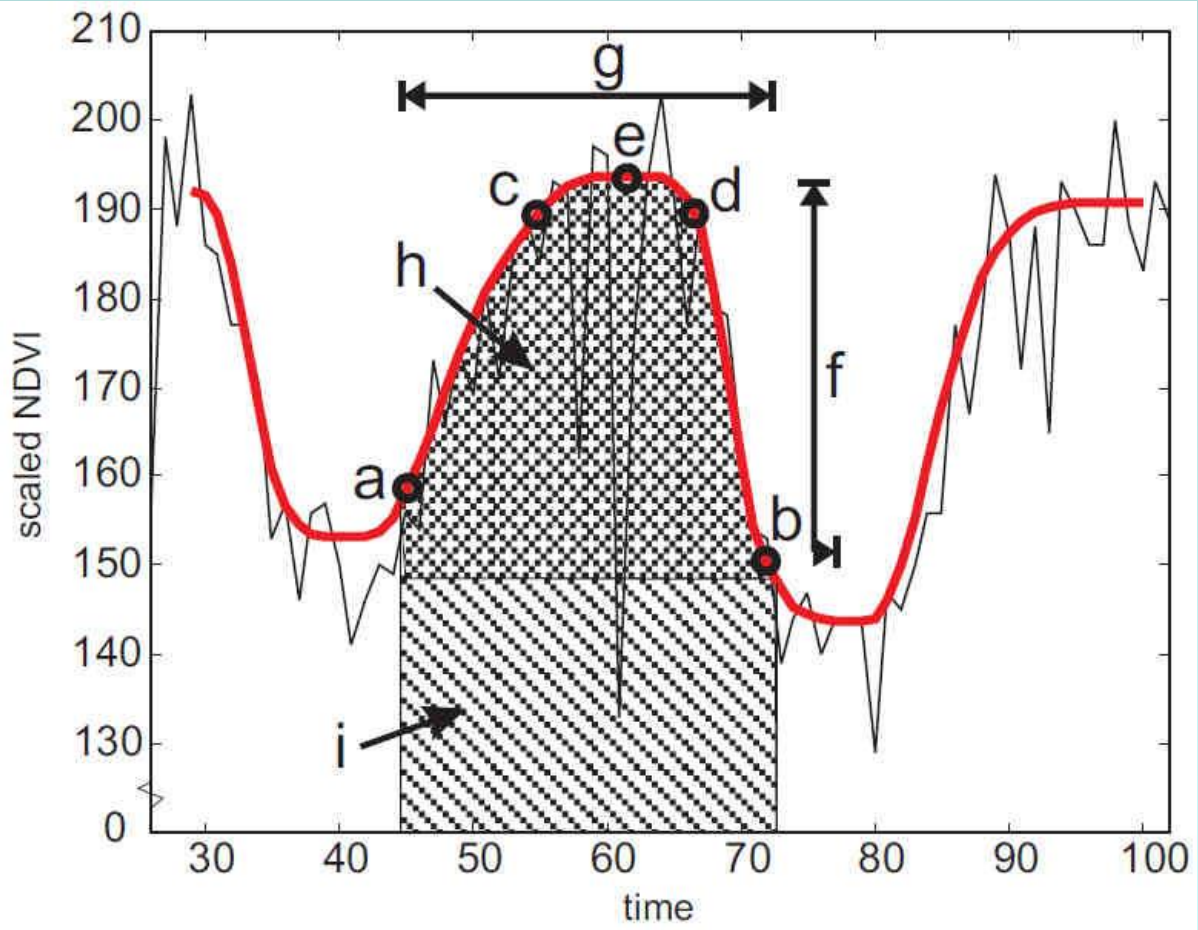


Preprocessed data



- Through the years, the shape of the curves is the same
- Very similar curves
- Locust has larger amplitude than pine

Phenological parameters

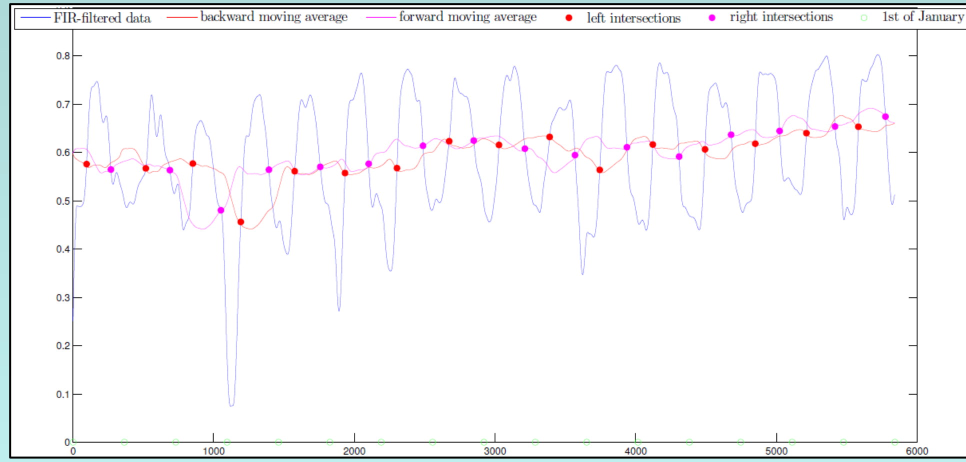


Ekhlundh – Jönsson 2015

a) Season start
b) Season finish
c) 80% level
d) 80% level
e) Maximum level
f) Amplitude of the growing season
g) Length of the growing season
h) Small seasonal integral indicating productivity
i) Large seasonal integral indicating productivity

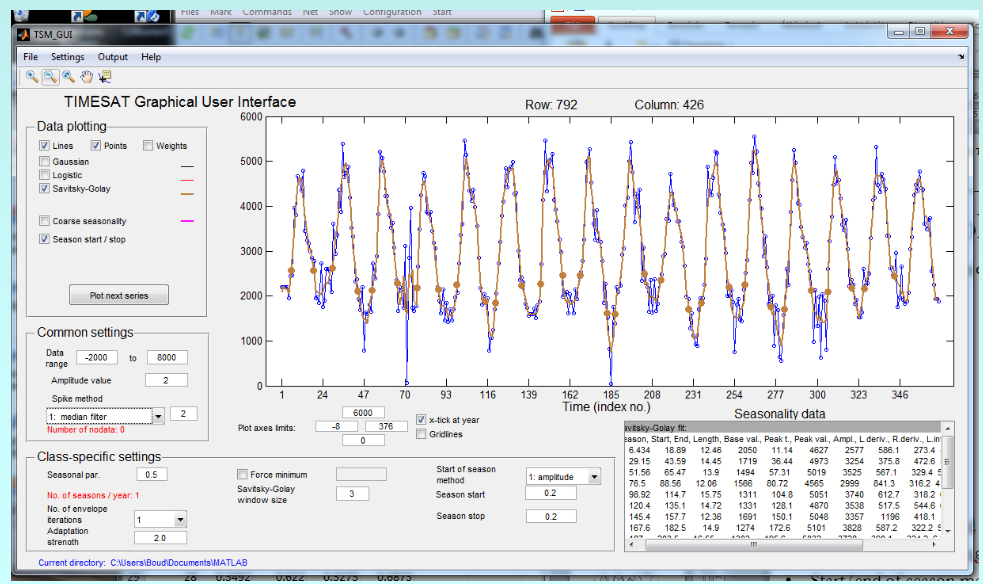
Phenological parameters - calculations

- Own software
  (Noel Majernyik, SZTE Bolyai Institute)
- Timesat v3.2

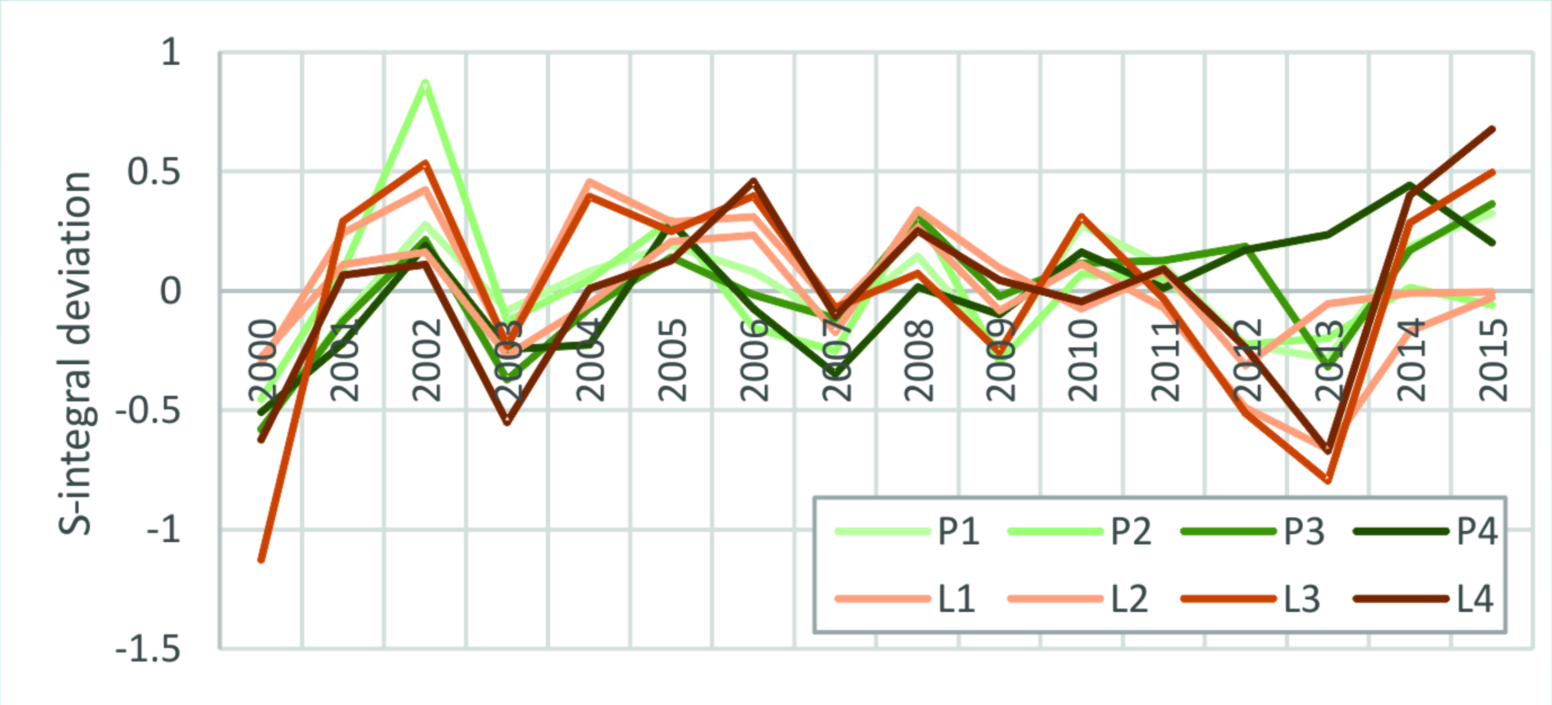


Settings for:

- Data quality
  (to determine the weights)
- Outliers removal (seasonal trend decomposition method)
- Savitsky-Golay fitting method
- Start/end of season method



Deviation of S-integral from the average between 2000 and 2015) for locust (L) and pine (P) forests



- 8 test areas
- Similar patterns
- Higher differences for locust

Pálfai Aridity Index as measurement for drought

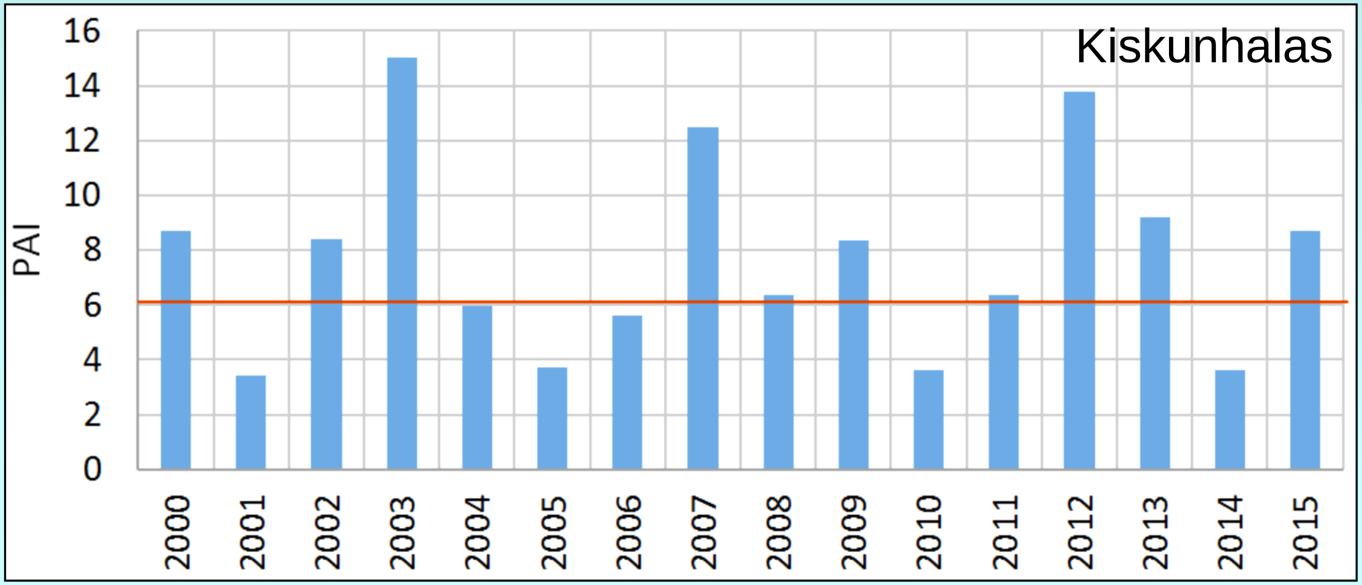
$$PAI_o = \frac{t_{IV-VIII}}{P_{X-VIII}} \times 100 \qquad PAI = k_t \cdot k_p \cdot k_{gw} \cdot PAI_0$$

(ATIVIZIG)

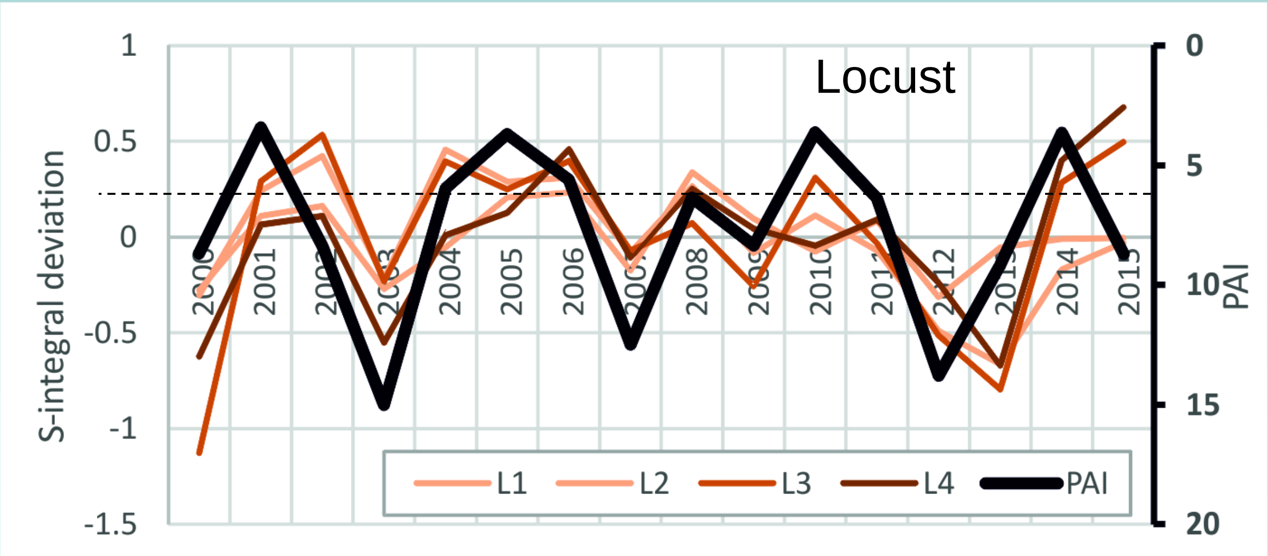
$$k_t = \sqrt[6]{\frac{n+1}{\overline{n+1}}} \quad k_p = \sqrt[4]{\frac{\tau_{\max}}{\overline{\tau}_{\max}}} \quad k_{gw} = \sqrt{\frac{H}{\overline{H}}}$$

Month	w_i
X	0.1
XI, XII	0.4
I,II,III,IV	0.5
V	0.8
VI	1.2
VII	1.6
VIII	0.9
IX	0.1

6-8 moderate drought
8-10 moderate to severe drought
10-12 severe drought
12< extremely severe drought



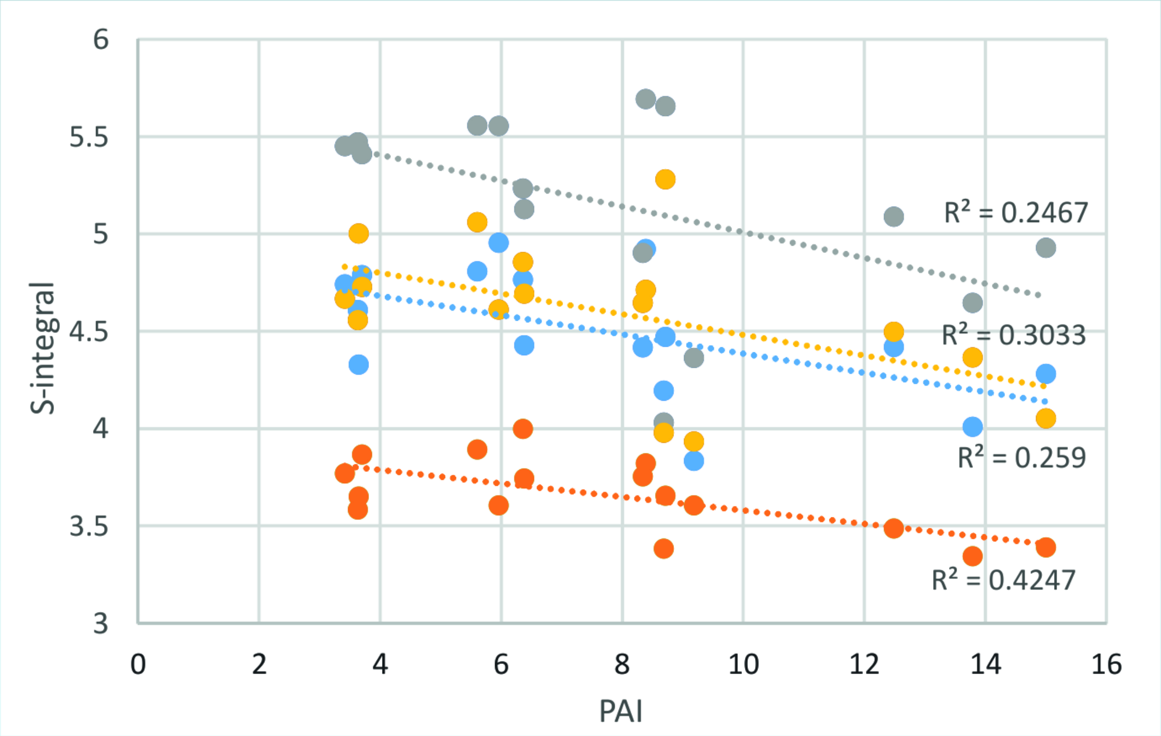
Comparison between the deviation of the s-integral for locust and PAI



- 2000, (2003, 2007, 2009,) 2012 and 2013 years with decreased productivity
- Positive deviations in 2002, 2004, 2005, 2006, 2010, 2014, 2015
- Differences in behaviour for locust after drought years in 2000 and 2003

- Significant coincidence
- Water scarcity
- Sandy soil
- Lowering of the groundwater table
- Amplitude differences due to ecological characteristics and growth patterns

Relationship between vegetation productivity (S-integral) of 4 locust forests and PAI index values



- No clearly quantifiable relationship
- Sometimes impact on following years (2001-2002)

Conclusions and future

- RS data has many opportunities but there is a strong need for development of *filtering methods and methods to generalize* vegetation index datasets
- Data processing was *automated by Python* scripts to improve the processing workflow
- Vegetation productivity parameter and the PAI drought index show a relationship in the study area, but there are *inconsistencies*.
- Future challenges:
  - Study the influence of water shortage and surplus to *different types* of vegetation
  - Relationship between *other parameters and drought indices*:

<u>Phenology parameters:</u>

- Start of season
- End of season
- Maximum level
- Amplitude of growing season
- Length of growing season

<u>Drought indices</u>

Machine learning?

Thank you for your attention!

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