GEONETC
International MSc Educational Programme in Environmental Management and Modelling

VEGETATION PHENOLOGY

6. PHENOLOGY FROM SATELLITES (2)

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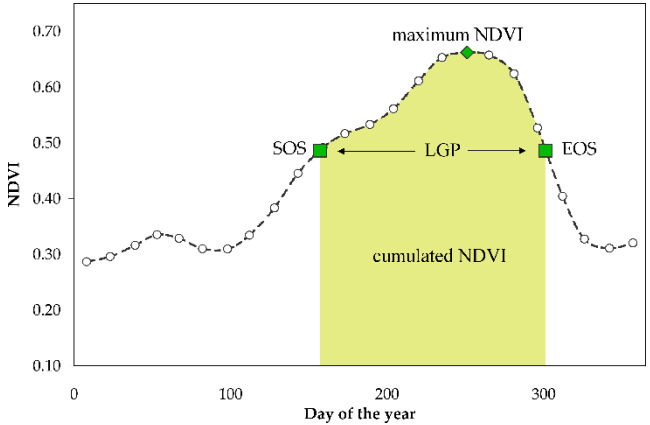
STEPS TO EXTRACT PHENOLOGY

- Per pixel time series → sometimes aggregates of pixels (admin units, fields)
  - Knowledge of vegetation season (single/double)
  - Data filtering / model fitting (lecture 4)
  - Extraction of parameters (per season) 
  - Iterate over years/seasons

- Image:
  - Loop over pixels
  - Note: season definitions can be variable…

EXTRACTION OF SEASONALITY PARAMETERS

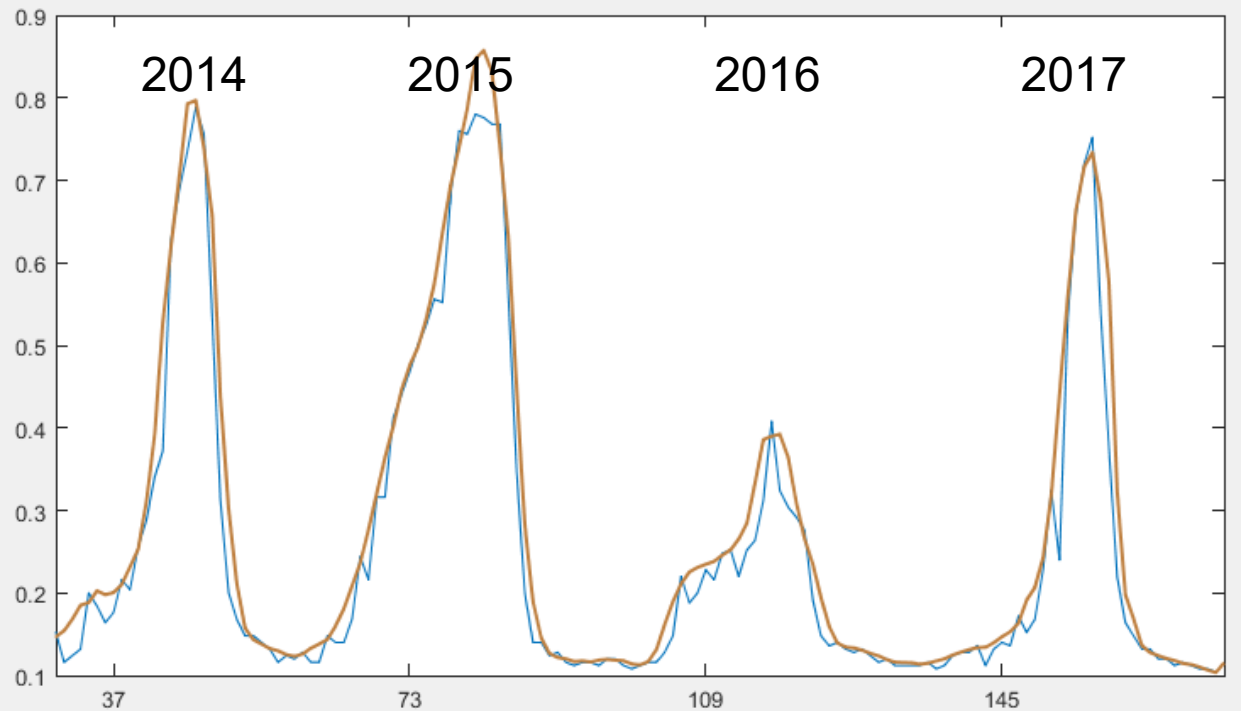
- Key dates: start and end of season (SOS / EOS)
  - Other parameters follow from that
- Many approaches → main categories:
  - Threshold methods
  - Derivatives
  - Model fit + use of model coefficients
- For each category, many options exist
- Not a single best approach: depends on data/application/link ground data



FURTHER READING:
de Beurs KM, and GM Henebry. 2010. Spatio-temporal statistical methods for modeling land surface phenology. In: Hudson IL, MR Keatley (Eds.), Phenological research: methods for environmental and climate change analysis. Springer, Dordrecht, The Netherlands, pp. 177-208..

ILLUSTRATION AREA (TEL ESQEF, TALL ASQAF, TESQOPA, تل اسقف, تەل ئەسقەف)

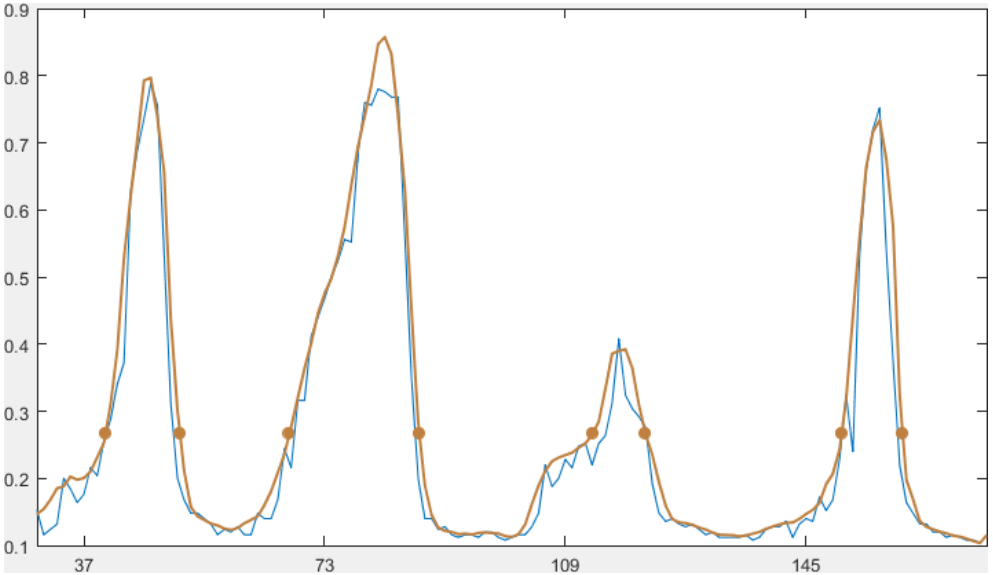
TIME SERIES – PROBA-V 1KM



THRESHOLD METHODS

TIMESAT
A software package to analyse time-series of satellite sensor data

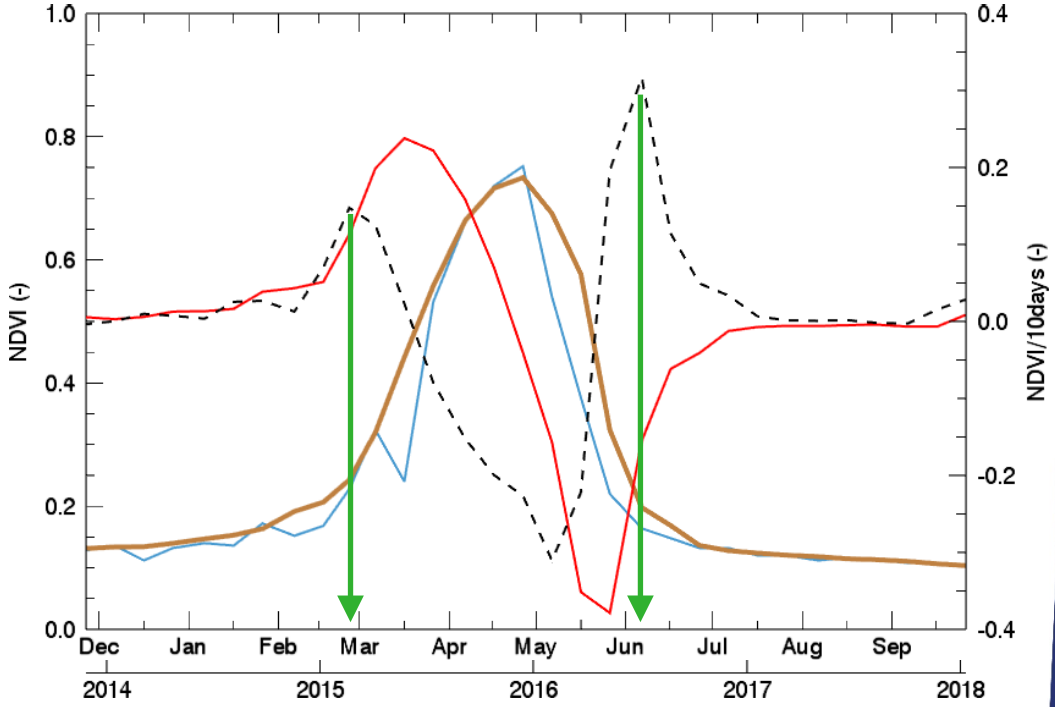
- Seasonal amplitude
- Absolute value
- Relative amplitude
  - changes per pixel



start: 80% of amplitude (increasing)
end: 20% of amplitude (decreasing)
(seasonality is determined from min/max whole time series)

DERIVATIVES

- Greatest increase/decrease VI
- Difficult to apply when green-up is not abrupt
- Also, second derivative:
  - when is the increase fastest (acceleration of greenness)



COEFFICIENTS DERIVED FROM FITTED MODELS

- Lecture 4: many models can be fit to NDVI data
  - Example logistic model *(fit separately to green-up and senescence)* :

$$NDVI(t) = \frac{c}{1 + e^{a+bt}} + d$$

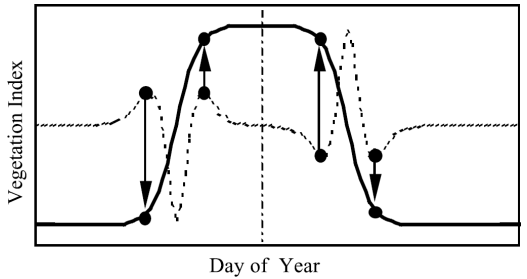
a and b: rate of VI change
c: maximum VI
d: minimum VI

  - Formal derivation of rate of change in curvature:

$$K' = b^3 cz \left\{ \frac{3z(1-z)(1+z)^3\left[2(1+z)^3 + b^2c^2z\right]}{\left[(1+z)^4 + (bcz)^2\right]^{\frac{5}{2}}} - \frac{(1+z)^2\left(1+2z-5z^2\right)}{\left[(1+z)^4 + (bcz)^2\right]^{\frac{3}{2}}} \right\}$$

with $z = e^{a+bt}$

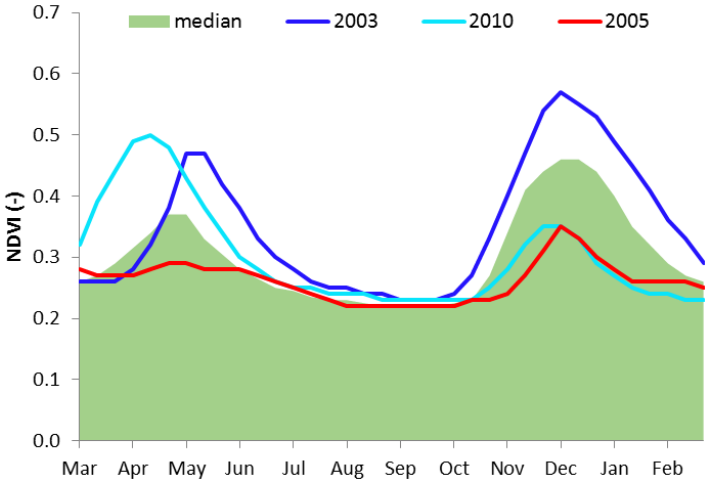
- MODIS phenology product: MCD12Q2



Zhang et al. 2003. Monitoring vegetation phenology using MODIS. Remote Sensing of Environment, 84: 471-475.

NOTES

- Several more approaches exist
  - Combination of approaches, e.g.:
    - Fit a model to the VI-data
    - But then apply threshold (TIMESAT)
- Seasons do not always fit calendar years
- Possible to have multiple seasons in a year



SUMMARY

- Many approaches exist to extract phenology from VI time series
  - Applicability depends on data / application / link to ground observations
- Main categories (but not exhaustive!):
  - Threshold
  - Derivatives
  - Coefficients from fitted models
- For each approach, many options exist (e.g. threshold value)
- Not a single best approach: depends on data/application/link ground data