GEONETC
International MSc Educational Programme in Environmental Management and Modelling

VEGETATION PHENOLOGY

4. MEDIUM RESOLUTION TIME SERIES

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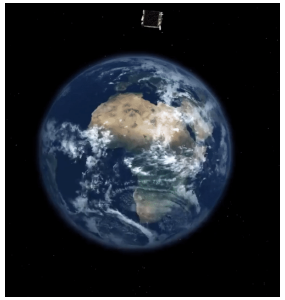
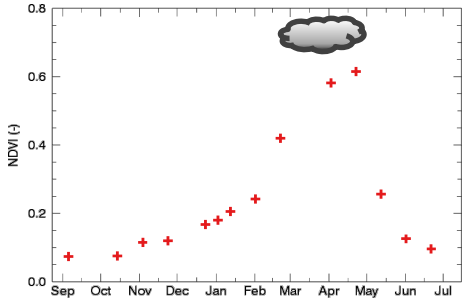
MEDIUM RESOLUTION SENSORS

sensor	platform	spectral range	number of bands	resolution	swath width	repeat coverage	launch
AVHHR	NOAA POES 6-19	VIS, NIR, MWIR	5	1100m	2400km	12 hours	1978
AVHRR	METOP	VIS, NIR, SWIR, MIR	5	1100m	2400km	12 hours	2007
SEAWIFS	Orbview-2	VIS, NIR	8	1100m 4500m	1500km 2800km	1day	1997-2010
VEGETATION	SPOT 4, 5	VIS, NIR, SWIR	4	1100m	2200km	1day	1998-2014
MODIS	Terra/Aqua	VIS, NIR, SWIR, TIR	36	250-1000m	2330km	<2days	1999
MERIS	ENVISAT	VIS, NIR	15	300m 1200m	1150km	<3days	2000-2012
Suomi NPP	VIIRS	VIS, NIR, SWIR, TIR	22	375m 750m	3040km	1 day	2011
PROBA-V	PROBA-V	VIS, NIR, SWIR	4	300m 1000m	2250km	1 day	2013
SENTINEL 3	OLCI	VIS, NIR, SWIR	21	300m	1270km	<2 days	2016

WHY MEDIUM RESOLUTION FOR PHENOLOGY?

- Very frequent coverage
  - capture seasonal variation
  - clouds



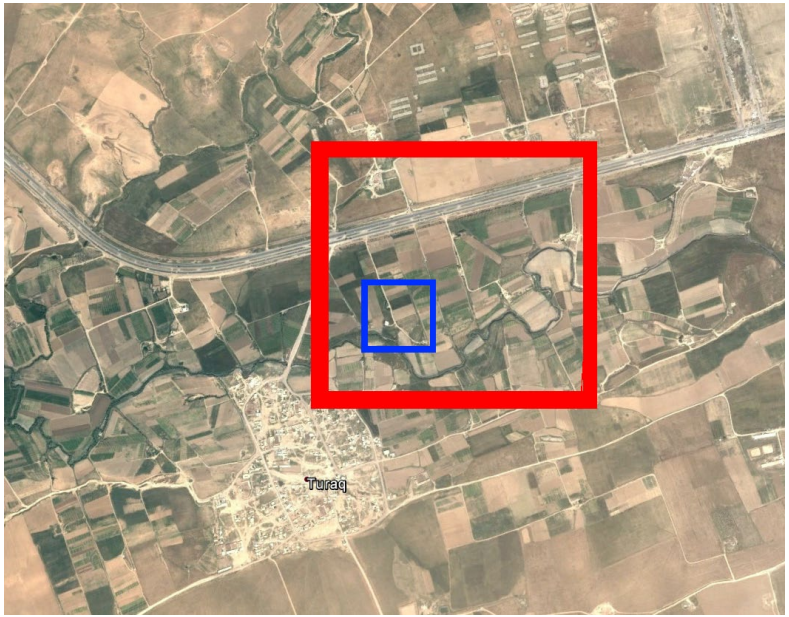


- Free global imagery
  - cover large areas at low cost and reasonable data volumes

- Long consistent time series
  - variability/trends & link to climate

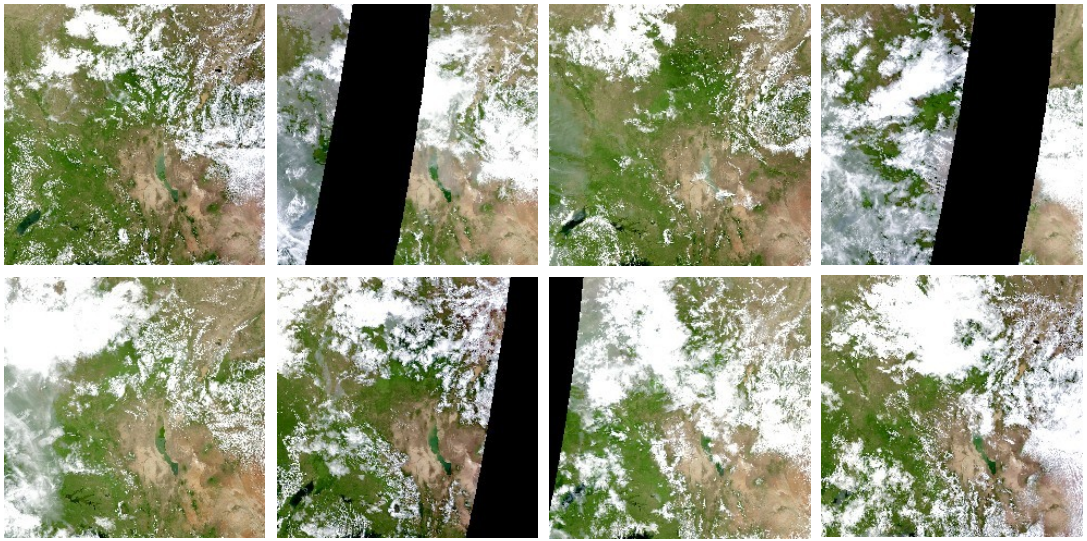
DRAWBACKS OF MEDIUM-RESOLUTION

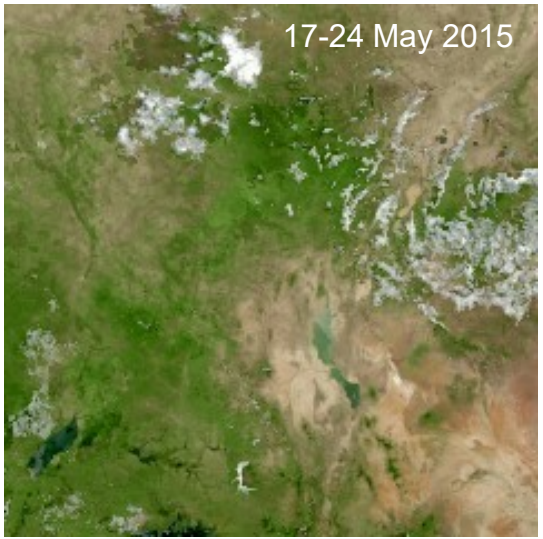
- Fields or vegetation patches are often smaller in size
- Spectral information comes from multiple surfaces
  - makes interpretation more difficult



COMPOSITE PRODUCTS

- Combine multi-day acquisitions in a single product
- ‘Best observation’ per pixel → suppress clouds

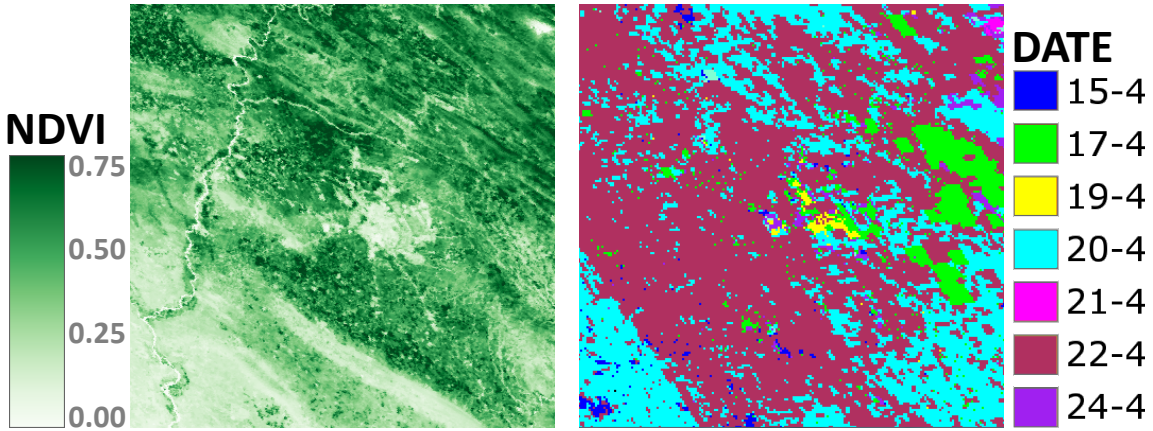




MODIS surface reflectance for 10x10° tile in East Africa

TEMPORAL COMPOSITING

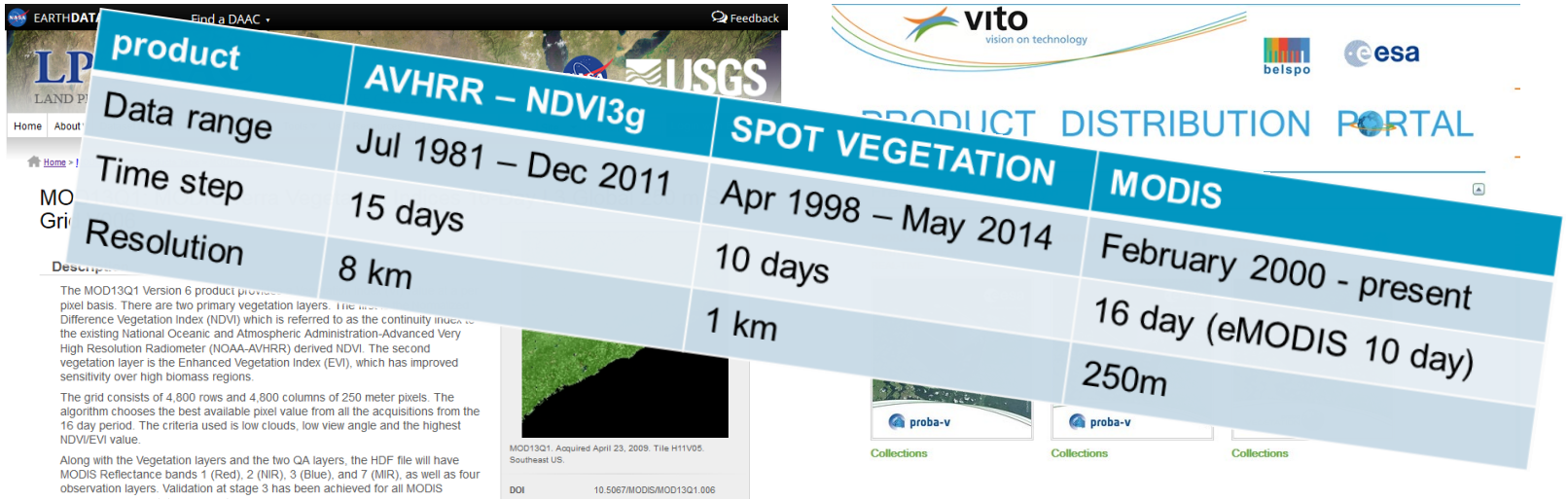
- What is the “best observation” in an 8-16 day window?
  - Maximum value composite (MVC) → maxNDVI as NDVI is small for clouds
- Date of observation used can differ between adjacent pixels
  - Effect on phenology estimation
  - Use observation date (if available)



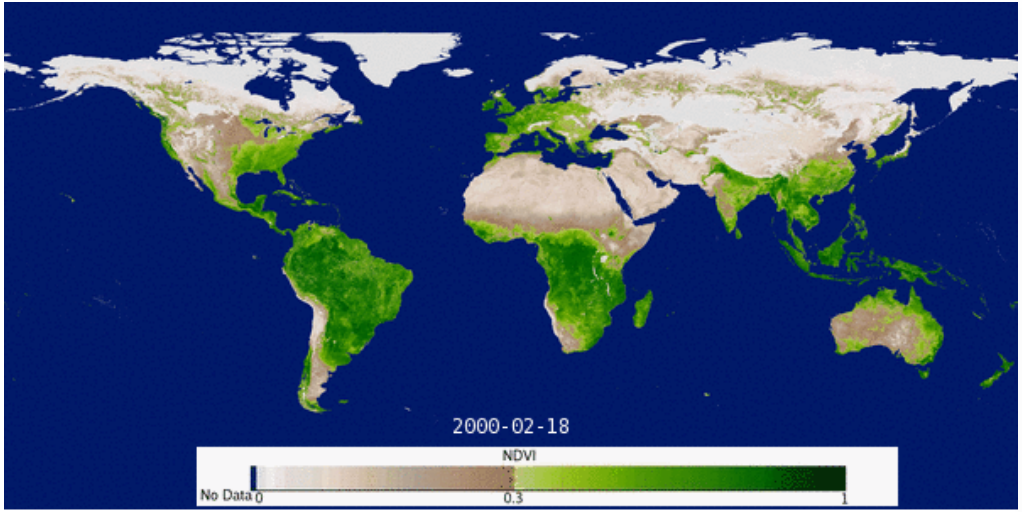
16-day MODIS Aqua composite 15apr–7may 2016

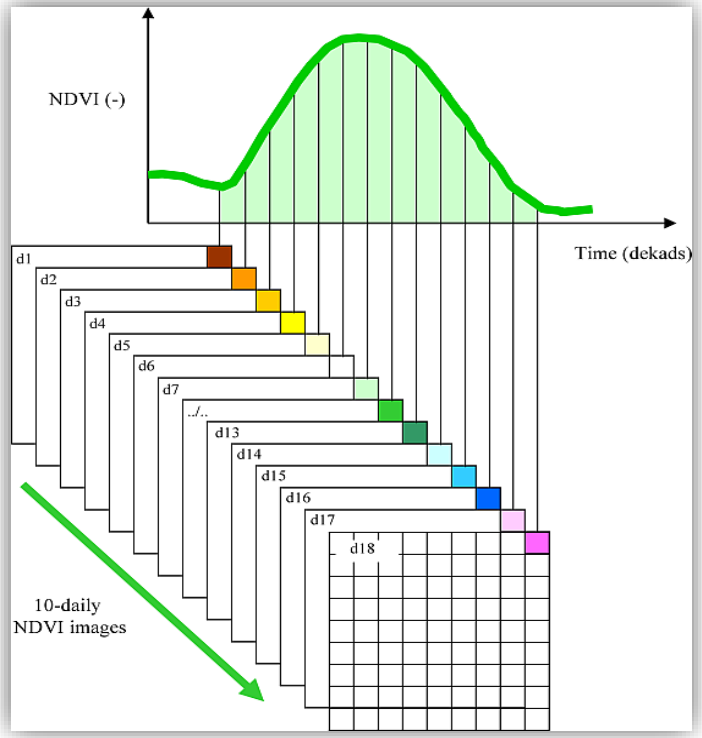
PRODUCTS

- Surface reflectance products (atmospheric correction applied)
  - Calculate a vegetation index
- Vegetation index products



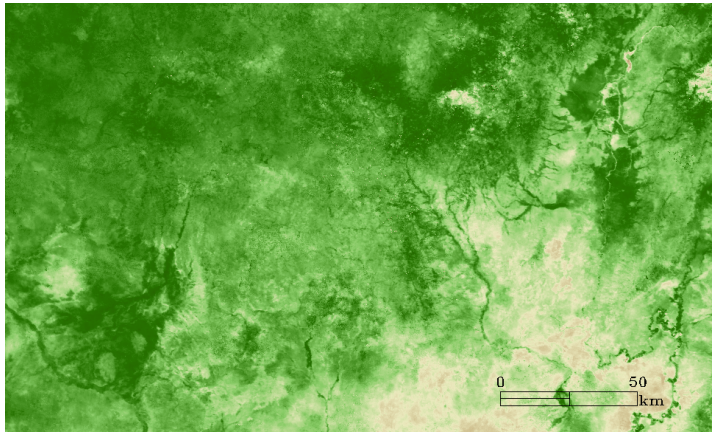
TIME DOMAIN


2000-02-18
NDVI
No Data
0
0.3
1


NDVI (-)
Time (dekads)
d1
d2
d3
d4
d5
d6
d7
../..
d13
d14
d15
d16
d17
d18
10-daily
NDVI images

COMPOSITE QUALITY

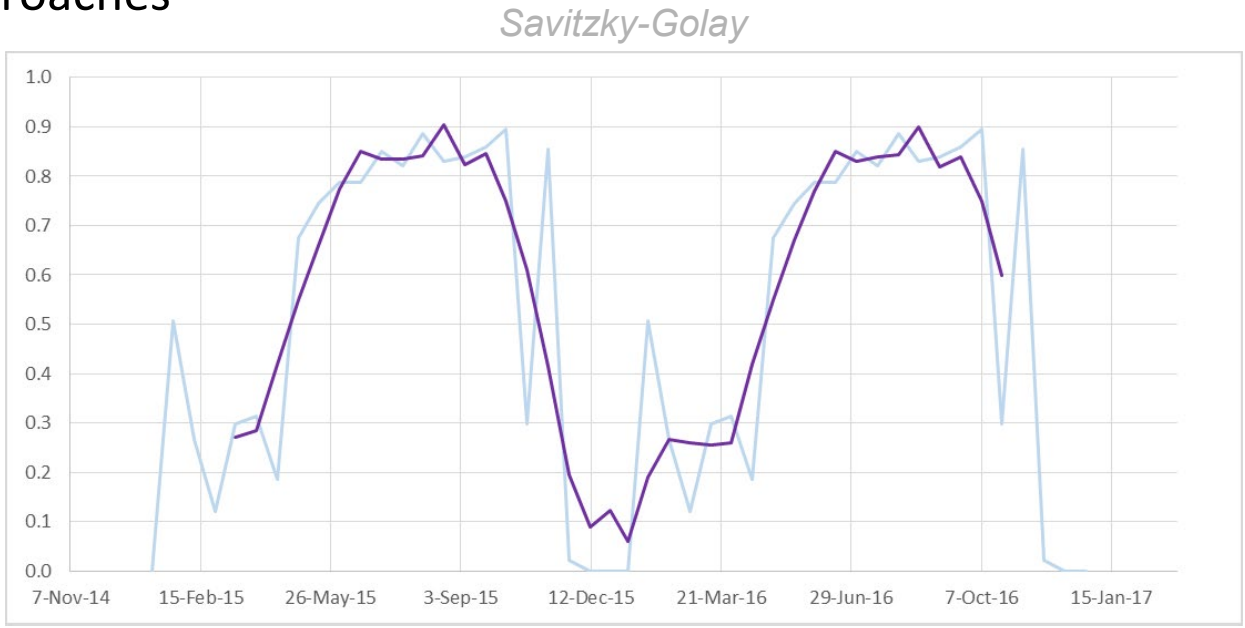
- Remaining clouds and atmospheric vapor
  - cause reductions of VI
  - partially known and flagged
    - but not always perfect
  - reduced NDVI ≠ less green vegetation



Bits	Parameter Name	Value	Description
0-1	VI Quality (MODLAND QA Bits)	00	VI produced with good quality
		01	VI produced, but check other QA
		10	Pixel produced, but most probably cloudy
		11	Pixel not produced due to other reasons than clouds
2-5	VI Usefulness	0000	Highest quality
		0001	Lower quality
		0010	Decreasing quality
		0100	Decreasing quality
		1000	Decreasing quality
		1001	Decreasing quality
		1010	Decreasing quality
		1100	Lowest quality
		1101	Quality so low that it is not useful
		1110	L1B data faulty
		1111	Not useful for any other reason/not processed
6-7	Aerosol Quantity	00	Climatology
		01	Low
		10	Intermediate
		11	High
8	Adjacent cloud detected	0	No
		1	Yes
9	Atmosphere BRDF Correction	0	No
		1	Yes
10	Mixed Clouds	0	No
		1	Yes
11-13	Land/Water Mask	000	Shallow ocean
		001	Land (Nothing else but land)
		010	Ocean coastlines and lake shorelines
		011	Shallow inland water
		100	Ephemeral water
		101	Deep inland water
		110	Moderate or continental ocean
		111	Deep ocean
14	Possible snow/ice	0	No
		1	Yes
15	Possible shadow	0	No
		1	Yes

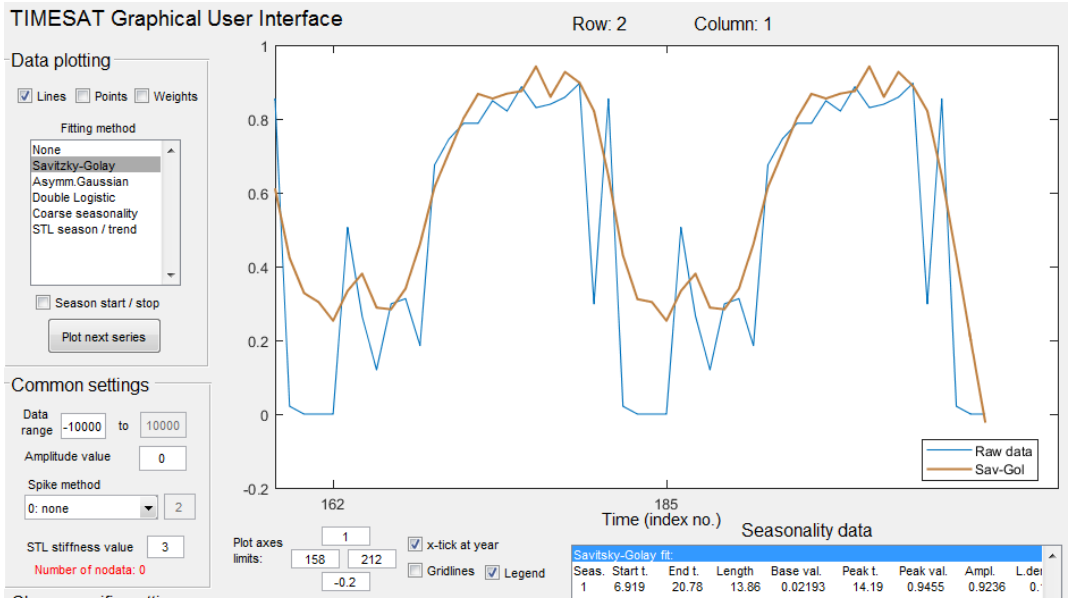
TEMPORAL FILTERING

- Filtering / smoothing in the time domain (per pixel)
  - many approaches



TEMPORAL FILTERING

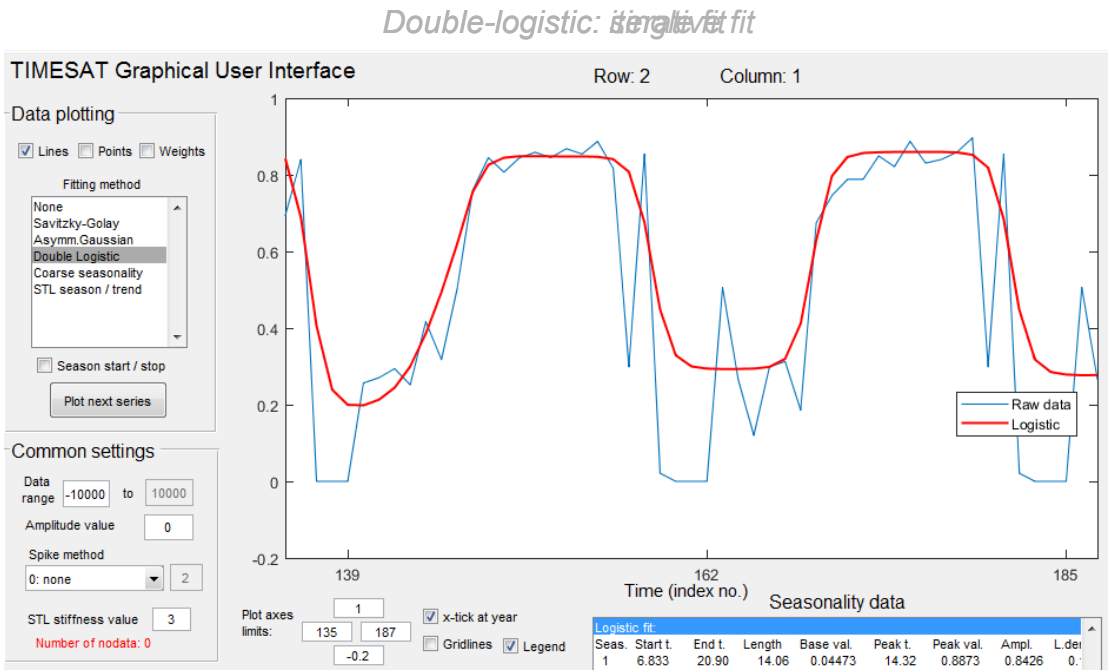
- More confidence in larger VI values: iteration
  - upper-envelope fitting



Chen et al. 2004. A simple method for reconstructing a high-quality NDVI time-series data set based on the Savitzky-Golay filter. Remote Sensing of Environment, 91: 332-344.

TEMPORAL FILTERING

- Other options, for example fit a function to entire season



SUMMARY

- Medium resolution imagery provides frequent imagery (daily)
  - Capture seasonal variability in presence of clouds
- Composites combine images in a 8-16 day window
  - Retain best quality pixel in time domain
- Free products include:
  - Surface reflectance (to calculate VIs)
  - Vegetation index
- Products often have quality information (on cloud presence etc…)
- Temporal filtering can further reduce atmospheric effects in composites