



GEONETC

International MSc Educational Programme in
Environmental Management and Modelling

VEGETATION PHENOLOGY

4. MEDIUM RESOLUTION TIME SERIES



UNIVERSITY OF TWENTE.



UNIVERSITY OF
DUHOK



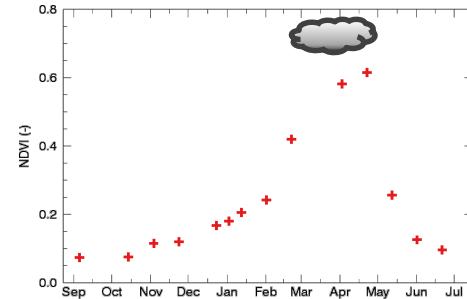
زانکوون سهلاحددین - شههولیبر
Salahaddin University-Erbil

MEDIUM RESOLUTION SENSORS

sensor	platform	spectral range	number of bands	resolution	swath width	repeat coverage	launch
AVHRR	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

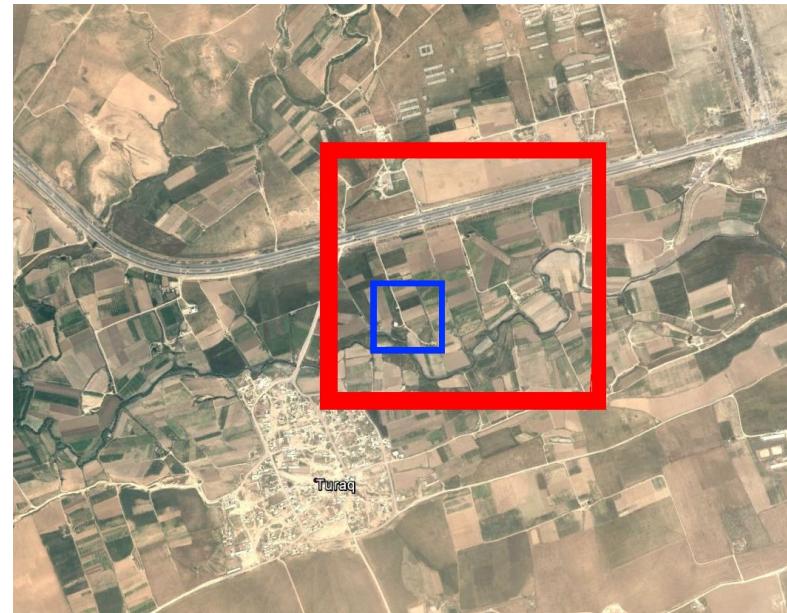
WHY MEDIUM RESOLUTION FOR PHENOLOGY?

- 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



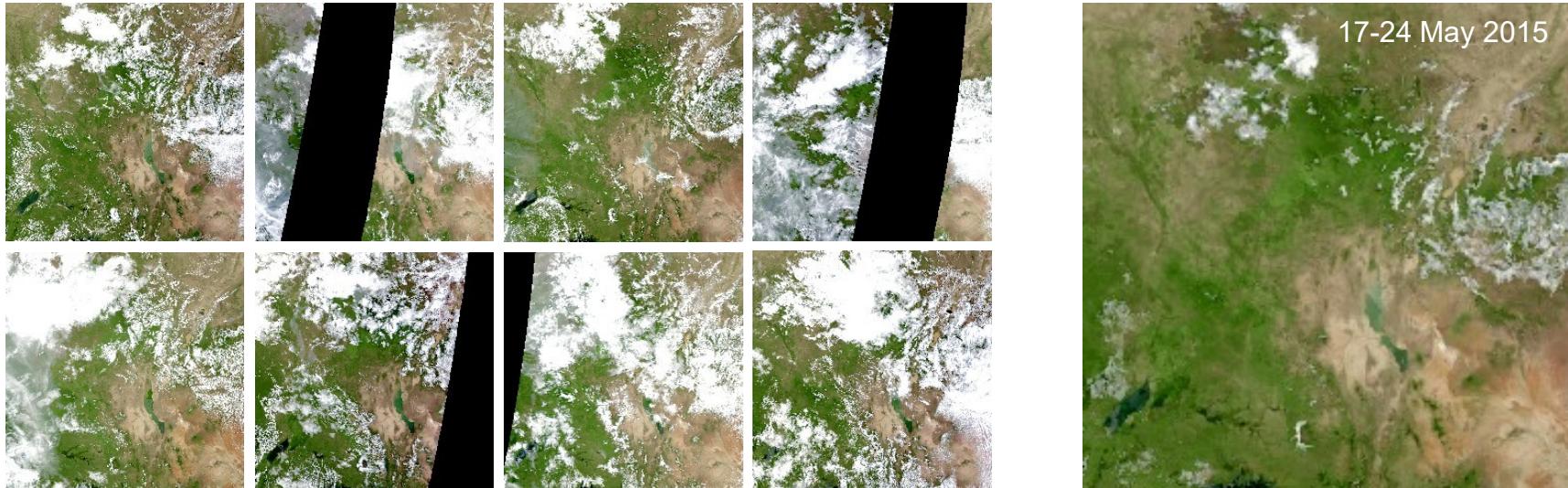
DRAWBACKS OF MEDIUM-RESOLUTION

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



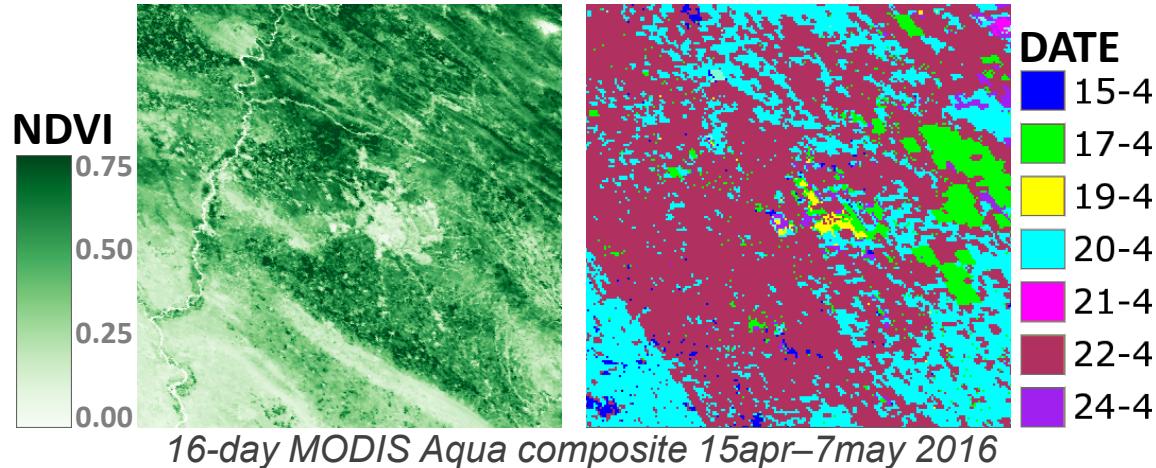
COMPOSITE PRODUCTS

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



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)



PRODUCTS

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

The screenshot shows a table comparing different vegetation index products:

product	AVHRR - NDVI3g	SPOT VEGETATION	MODIS
Data range	Jul 1981 – Dec 2011	Apr 1998 – May 2014	February 2000 - present
Time step	15 days	10 days	16 day (eMODIS 10 day)
Resolution	8 km	1 km	250m

AVHRR - NDVI3g

SPOT VEGETATION

MODIS

VITO vision on technology

belspo

esa

EARTHDATA

LAND

MO

Grid

product

Data range

Time step

Resolution

Description

The MOD13Q1 Version 6 product provides the MODIS-derived Normalized Difference Vegetation Index (NDVI) which is referred to as the continuity index. The first vegetation layer is the existing National Oceanic and Atmospheric Administration-Advanced Very High Resolution Radiometer (NOAA-AVHRR) derived NDVI. The second vegetation layer is the Enhanced Vegetation Index (EVI), which has improved sensitivity over high biomass regions.

The grid consists of 4,800 rows and 4,800 columns of 250 meter pixels. The algorithm chooses the best available pixel value from all the acquisitions from the 16 day period. The criteria used is low clouds, low view angle and the highest NDVI/EVI value.

Along with the Vegetation layers and the two QA layers, the HDF file will have MODIS Reflectance bands 1 (Red), 2 (NIR), 3 (Blue), and 7 (MIR), as well as four observation layers. Validation at stage 3 has been achieved for all MODIS products.

MOD13Q1, Acquired April 23, 2009, Tile H11V05, Southeast US

DOI: 10.5067/MODIS/MOD13Q1.006

proba-v

Collections

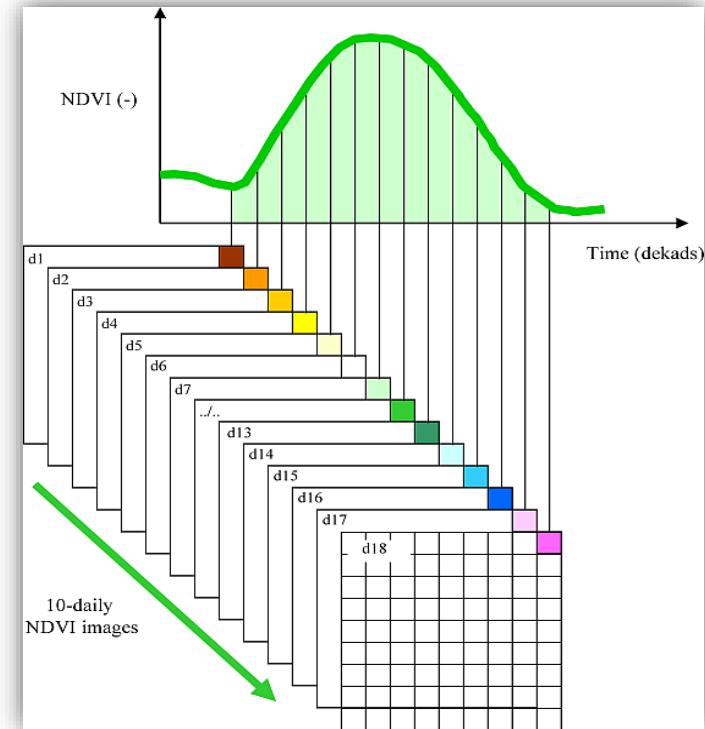
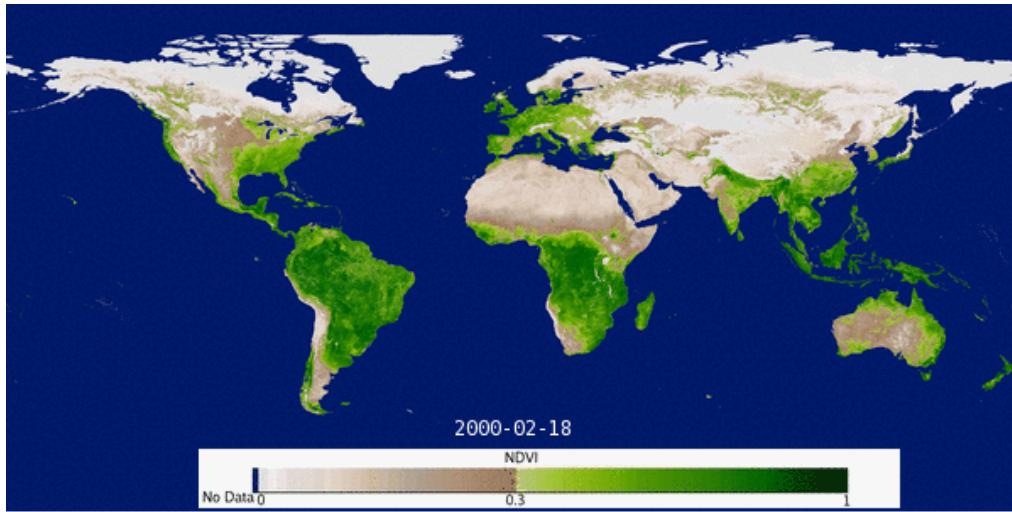
proba-v

Collections

proba-v

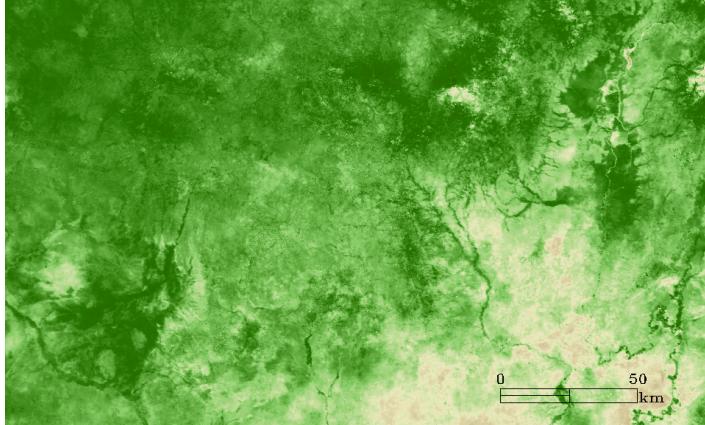
Collections

TIME DOMAIN



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
		00	Climatology
		01	Low
		10	Intermediate
		11	High
6-7	Aerosol Quantity	0	No
6-7	Aerosol Quantity	1	Yes
8	Adjacent cloud detected	0	No
8	Adjacent cloud detected	1	Yes
9	Atmosphere BRDF Correction	0	No
9	Atmosphere BRDF Correction	1	Yes
10	Mixed Clouds	0	No
10	Mixed Clouds	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
14	Possible snow/ice	1	Yes
15	Possible shadow	0	No
15	Possible shadow	1	Yes

TEMPORAL FILTERING

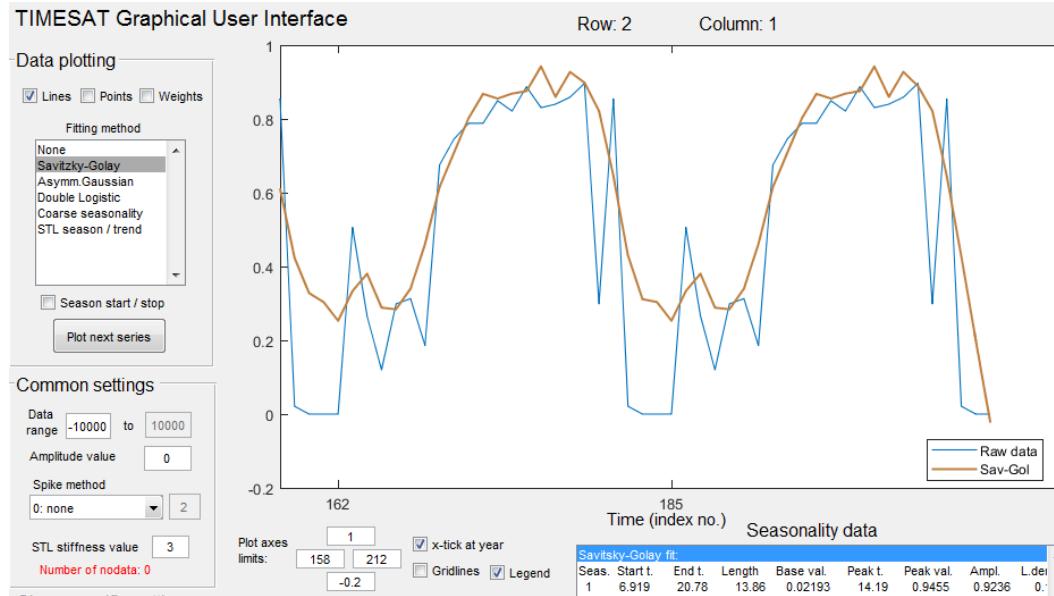
- Filtering / smoothing in the time domain (per pixel)
 - many approaches

Savitzky-Golay



TEMPORAL FILTERING

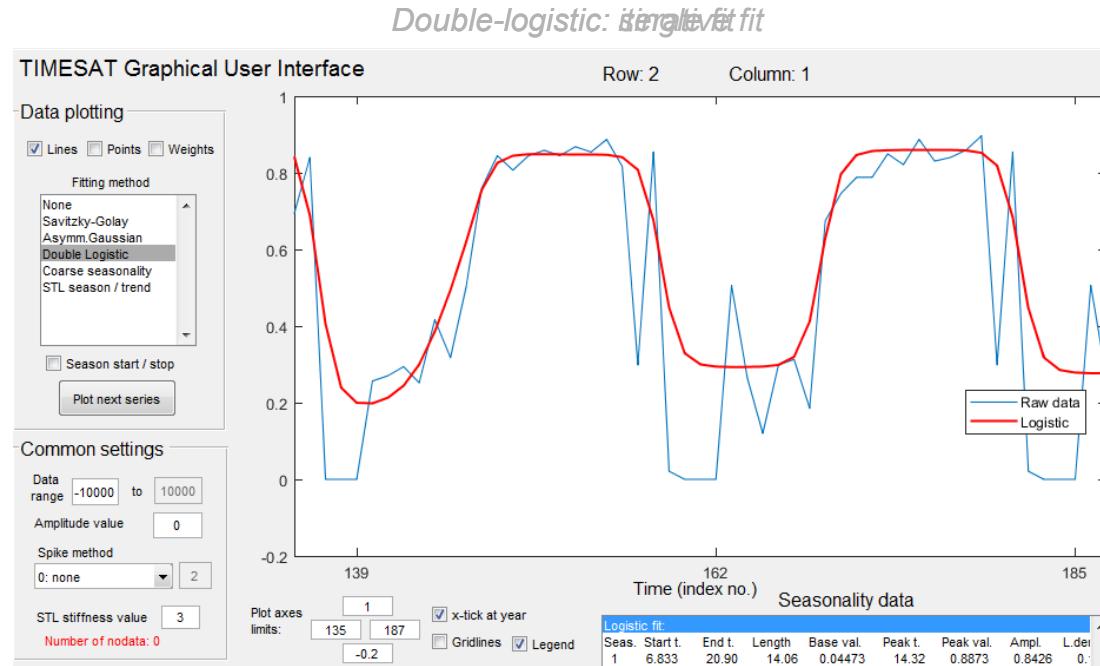
- More confidence in larger VI values: iteration
 - upper-envelope fitting



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