GEONETC
International MSc Educational Programme in Environmental Management and Modelling

VEGETATION PHENOLOGY

7. PHENOLOGY FROM SATELLITES (3)

ITC UNIVERSITY OF TWENTE.

UNIVERSITY OF DUHOK

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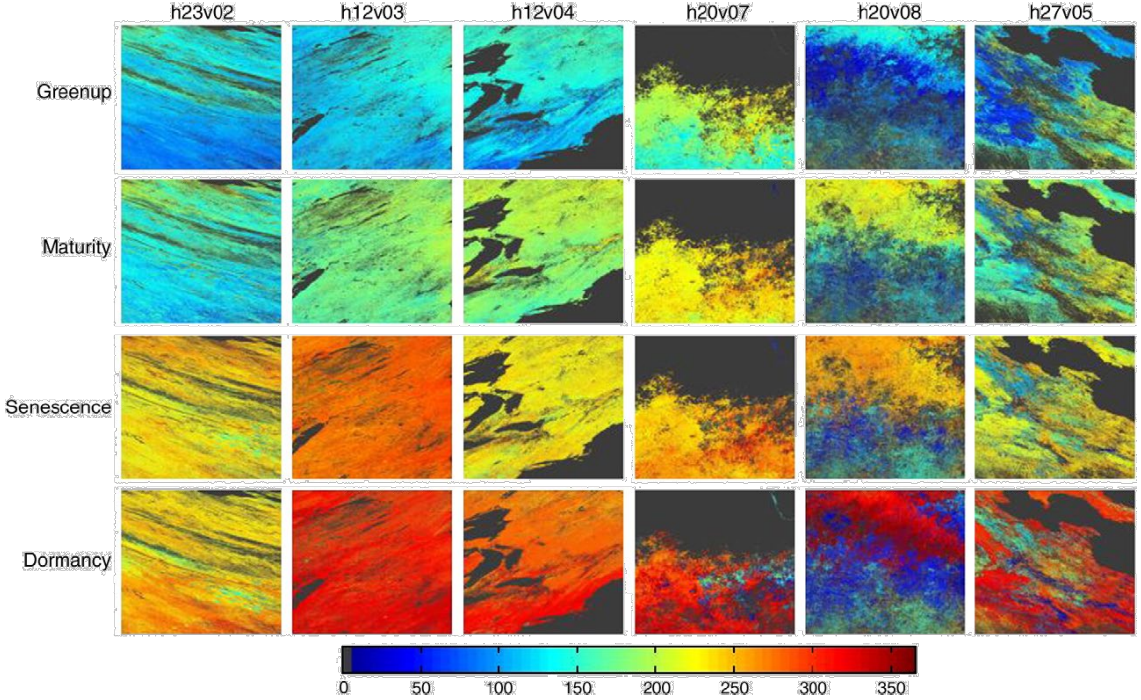
Salahaddin University-Erbil

EXISTING PHENOLOGY PRODUCTS

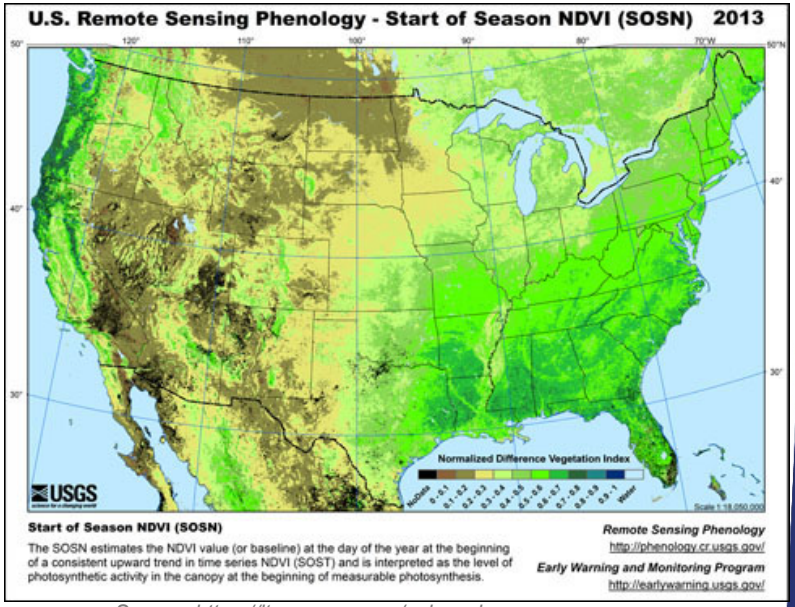
- Boston University / NASA: MODIS land cover dynamics product (MCD12Q2)
  - 500m, global (2001-2012)



Ganguly, et al, 2010. Land surface phenology from MODIS: Characterization of the Collection 5 global land cover dynamics product. Remote Sensing of Environment, 114:1805-1816

EXISTING PHENOLOGY PRODUCTS

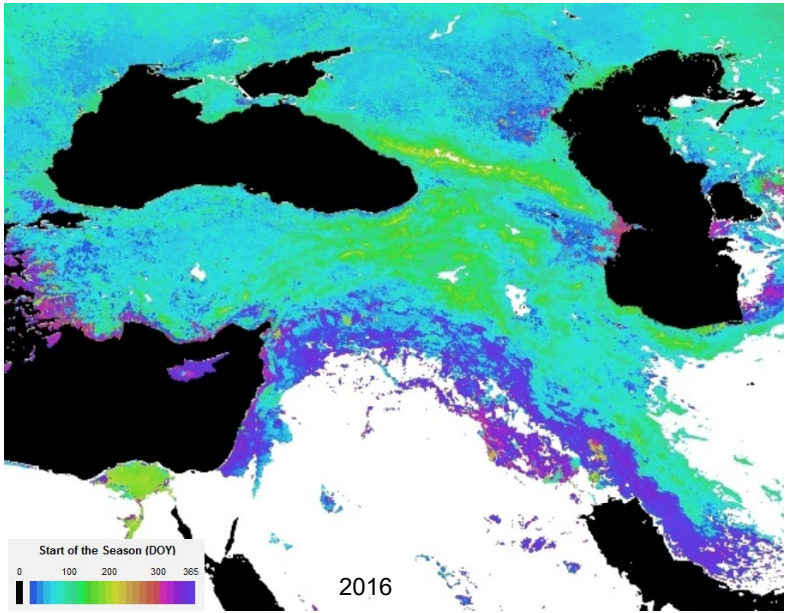
- USGS: Remote Sensing Phenology (RSP) collection
  - eMODIS and AVHRR
  - 250m (2001-2016) and 1km (1989-2014), US only
  - https://phenology.cr.usgs.gov/index.php



Source: https://lta.cr.usgs.gov/avhrr_phen

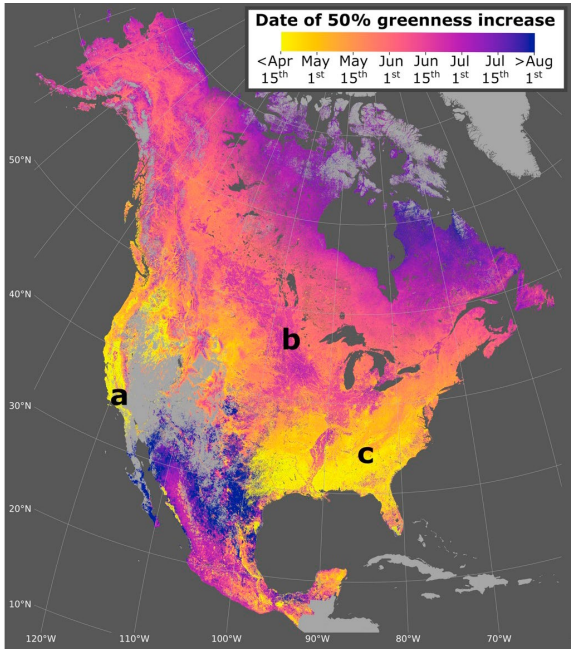
EXISTING PHENOLOGY PRODUCTS

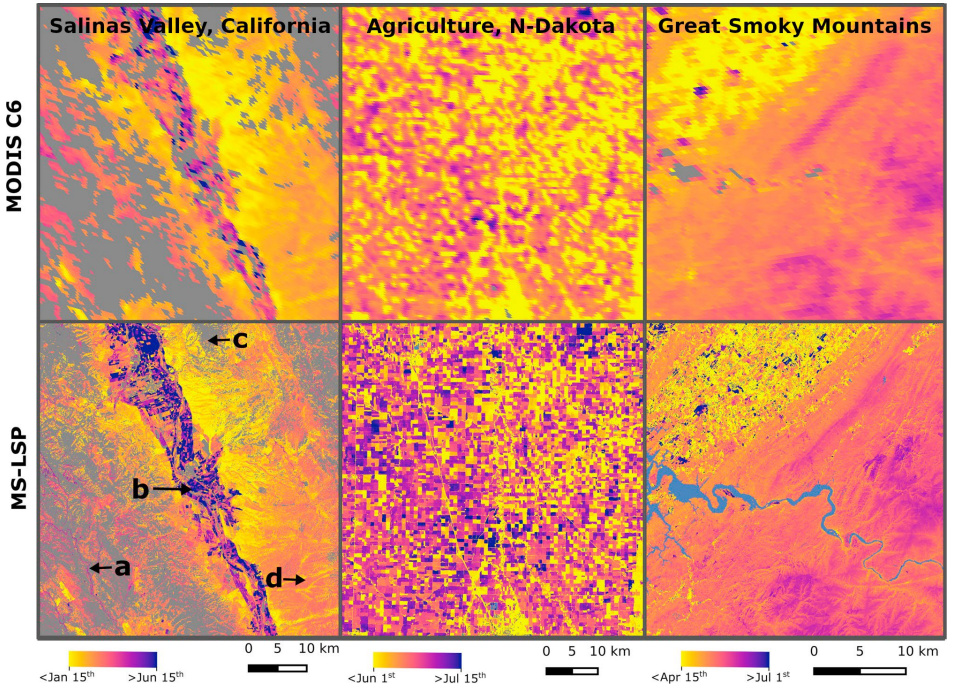
- University of Arizona / NASA: Vegetation Index and Phenology (VIP)
  - 5600m, global (1981-2016)
  - Source: https://vip.arizona.edu/viplab_data_explorer.php (& through NASA)



EXISTING PHENOLOGY PRODUCTS

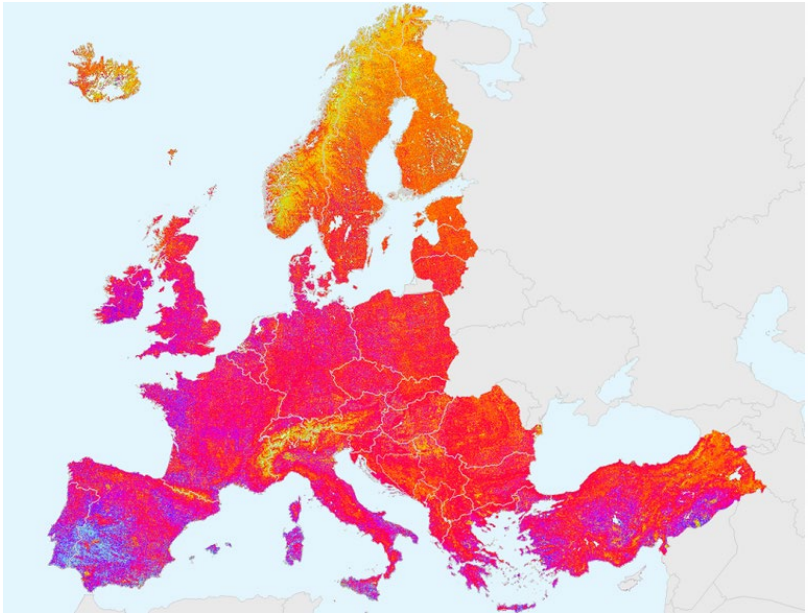
- NASA / Boston University: multi-source LSP
  - 30m, North America
  - https://doi.org/10.1016/j.rse.2020.111685 and https://cmr.earthdata.nasa.gov/search/concepts/C1722122424-LPDAAC_ECS.html

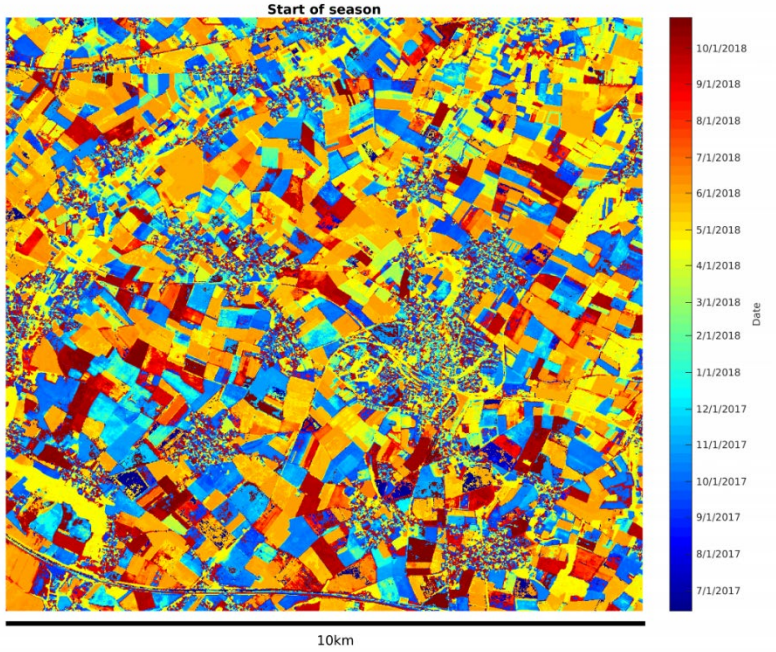




EXISTING PHENOLOGY PRODUCTS

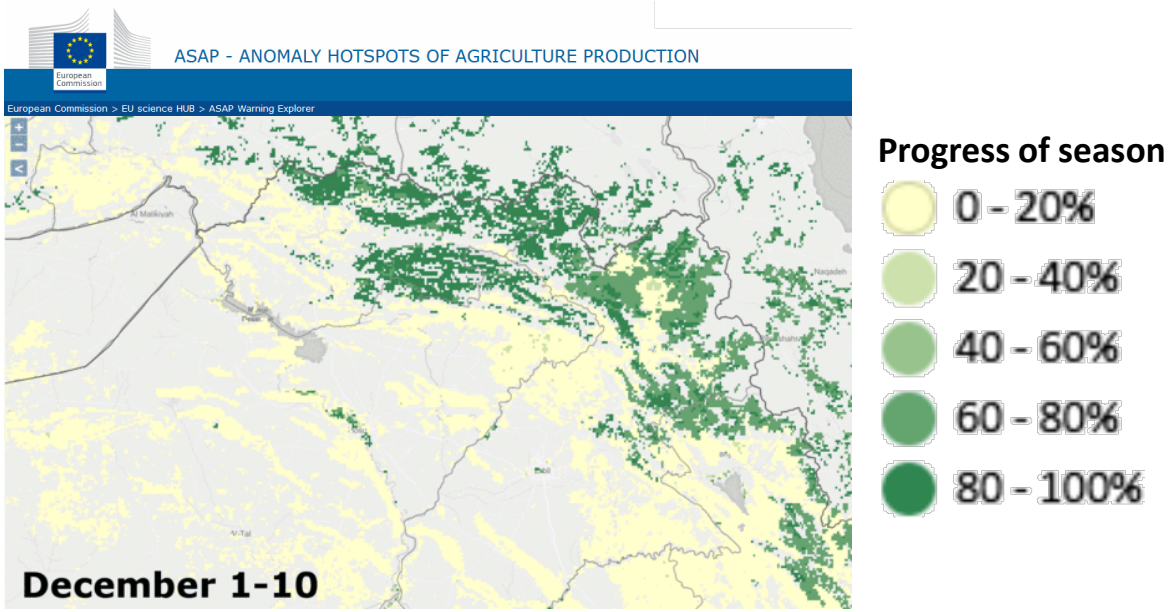
- HR-VPP, commissioned by EEA for Europe as Copernicus service, based on Sentinel-2
  - Released 2-sep-2021, products for 2017 and later
  - https://land.copernicus.eu/pan-european/biophysical-pa





PHENOLOGY EMBEDDED IN EARLY WARNING SYSTEMS

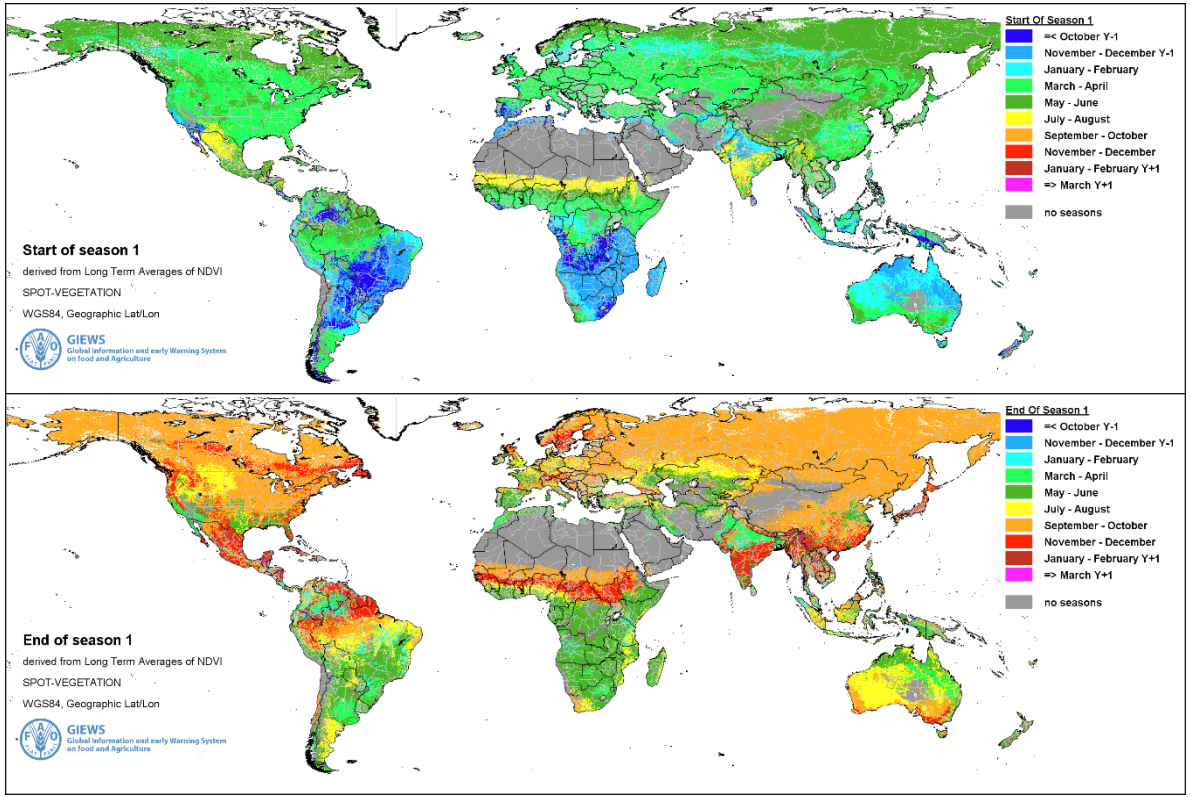
- JRC-ASAP



- phenology (1km multi-annual average) also downloadable for Africa: https://mars.jrc.ec.europa.eu/asap/download.php

PHENOLOGY EMBEDDED IN EARLY WARNING SYSTEMS

- FAO ASIS



WRITING SCRIPTS

- IDL
- MATLAB
- python™
- R
- and many others…

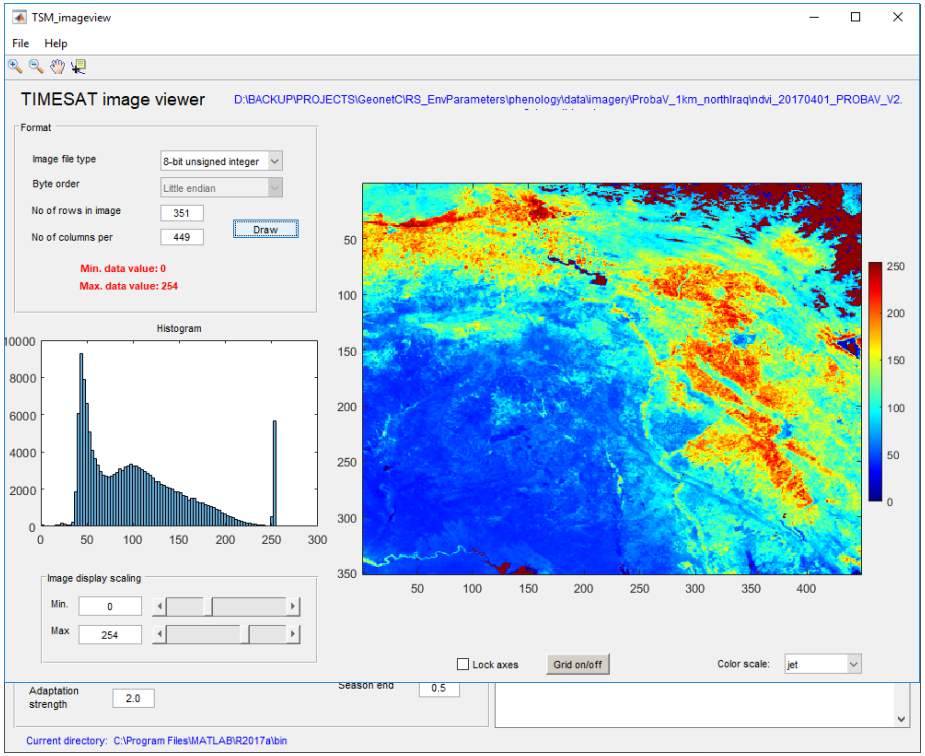
```
; Based on condition start calculating: create LOSline

IF condition[0] ne -1 THEN BEGIN
  ; create LOSline directly
  LOSline[condition] = FIX(EOSline_noNaN[condition] - SOSline_noNaN[condition])
  ; create a bitmap of condition
  bitmap_condition[condition] = 1
  ; for other indicators, we loop over years
  FOR year=yearstart,yearend,1L DO BEGIN                    ; Loop over years
    SOSline_1year = SOSline[*,year-yearstart]
    EOSline_1year = EOSline[*,year-yearstart]
    condition_1year = bitmap_condition[*,year-yearstart]
    ; below gives the 36 values for one and a half year (cycle) for one line
    NDVIline_1year = NDVIline[*,12+offset+24*(year-yearstart):12+offset+12+(24*(year-yearstart+1)-1)]

    FOR i=0,ns-1,1L DO BEGIN                                ; Loop over samples of file
      IF condition_1year[i] eq 1 THEN BEGIN
        dekad_start = FIX(FLOOR((SOSline_1year[i]-1)/15.))-offset     ; in terms of dekads
        dekad_end = FIX(FLOOR((EOSline_1year[i]-1)/15.))-offset       ; in terms of dekads
        NDVIpoint = NDVIline_1year[i,dekad_start:dekad_end]
        nN = N_ELEMENTS(NDVIpoint)
        maxValue = max(NDVIline_1year[i,dekad_start:dekad_end], MOSpoint)
        maxNDVIline[i,year-yearstart]=maxValue
        MOSline[i,year-yearstart]=(MOSpoint+dekad_start+offset)*15
        ; now calculate cumNDVI
        cumNDVIpoint= total(NDVIpoint)
        ; calculate what to extract, because SOS and EOS are sometimes between two periods
        start_fraction_deduct = ((SOSline_1year[i]-1) MOD 15 ) / 15.
        start_interpolvalue = (start_fraction_deduct * (NDVIpoint[1]-NDVIpoint[0])) + NDVIpoint[0])
        start_value_deduct = start_fraction_deduct * (start_interpolvalue + NDVIpoint[0])/2
        end_fraction_deduct = ( EOSline_1year[i] MOD 15 ) / 15.
        end_interpolvalue = (end_fraction_deduct * (NDVIpoint[nN-1]-NDVIpoint[nN-2]) + NDVIpoint[nN-2])
        IF FIX(15* end_fraction_deduct) ne 0 $
          THEN end_value_deduct = (1 - end_fraction_deduct) * (end_interpolvalue + NDVIpoint[nN-1])/2 $
          ELSE end_value_deduct = 0
        cumNDVIline[i,year-yearstart] = cumNDVIpoint - start_value_deduct - end_value_deduct
      ENDIF
    ENDFOR
  ENDFOR
```

SOFTWARE PACKAGES

- Several R-packages:
  - http://greenbrown.r-forge.r-project.org/
  - https://cran.r-project.org/web/packages/phenofit/index.html
- Python:
  - https://github.com/JavierLopatin/PhenoPY & https://pypi.org/project/pyPhenology/
- Google Earth Engine implementation:
  - Descals et al: https://doi.org/10.1109/JSTARS.2020.3039554
- SPIRITS — **S**oftware for the **P**rocessing and **I**nterpretation of **R**emotely **S**ensed **I**mage **T**ime **S**eries
- TIMESAT — *A software package to analyse time-series of satellite sensor data*
- QGIS plugin: VERSAO VegaMonitor
- PhenoSat (http://www.fc.up.pt/PhenoSat/), QPhenoMetrics, PhenoRice, …..

TIMESAT (VERSION 3.3)

- Multiple options for filtering/extraction
- Written in MatLab
- Well-documented
- Graphical user interface
- Two options:
  - Text-file with time series
  - Raster files



SUMMARY

- Various phenology products exist derived from VI time series
- Phenology is embedded in early warning systems
  - E.g. to understand when to monitor crops/rangelands
- Write own code (programming) gives most flexibility
- However, several software packages exist
  - Do they match your needs?
- For illustration and practice, in this course TIMESAT is used