



Remote sensing and citizen science observatories: a promising partnership for phenology monitoring

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Phenology and Climate Change

Nature has its own rhythms, daily rhythms, seasonal rhythms...Plants and animals also present their own rhythms...migratory periods of birds, hibernation period for some mammals, or specific reproductive periods....



Phenology and Climate Change

These rhythms are driven by internal factors but also by environmental factors affected by climate change



Changes in the rhythm of nature are recognized as a useful proxy for detecting climate change and a very interesting source of data for scientists investigating its effects on the natural ecosystems.

phe·nol·o·gy *noun*

The scientific study of periodic biological phenomena, such as flowering, breeding, and migration, in relation to climatic conditions.

Phenology and Climate Change

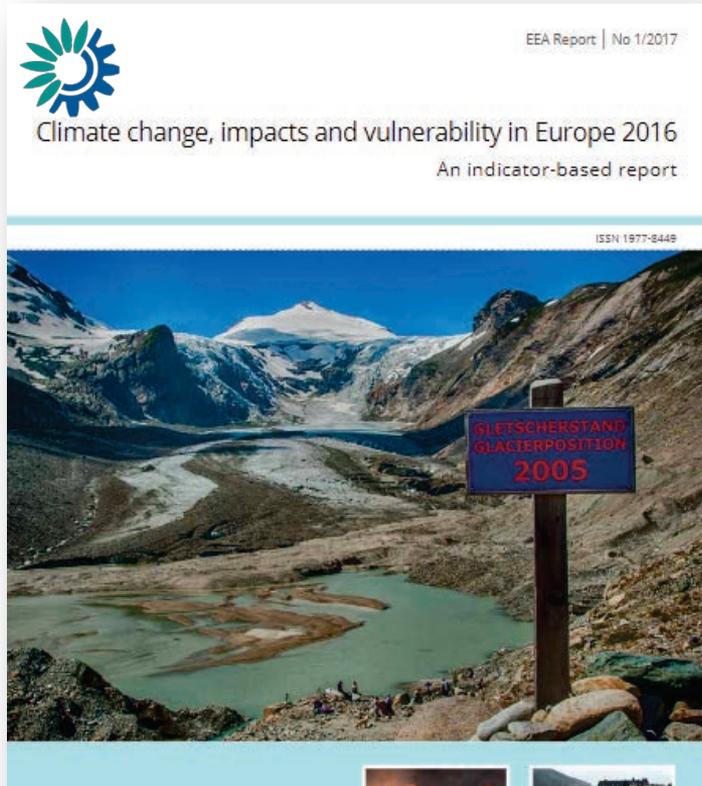
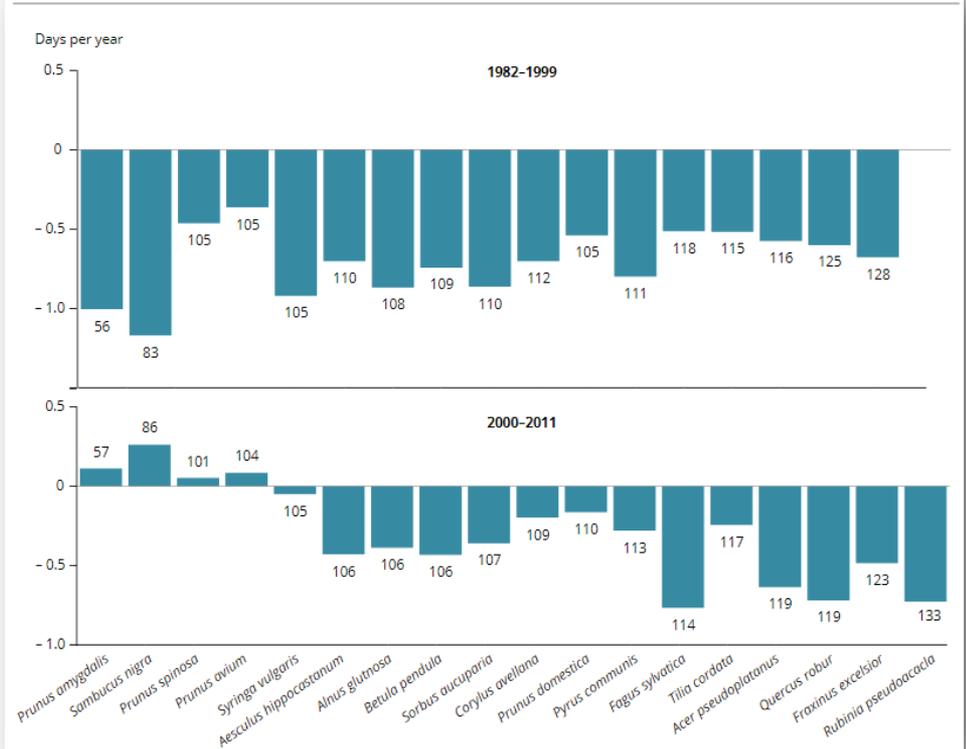


Figure 4.16 Species-specific trends of spring leaf unfolding during the two periods 1982-1999 and 2000-2011

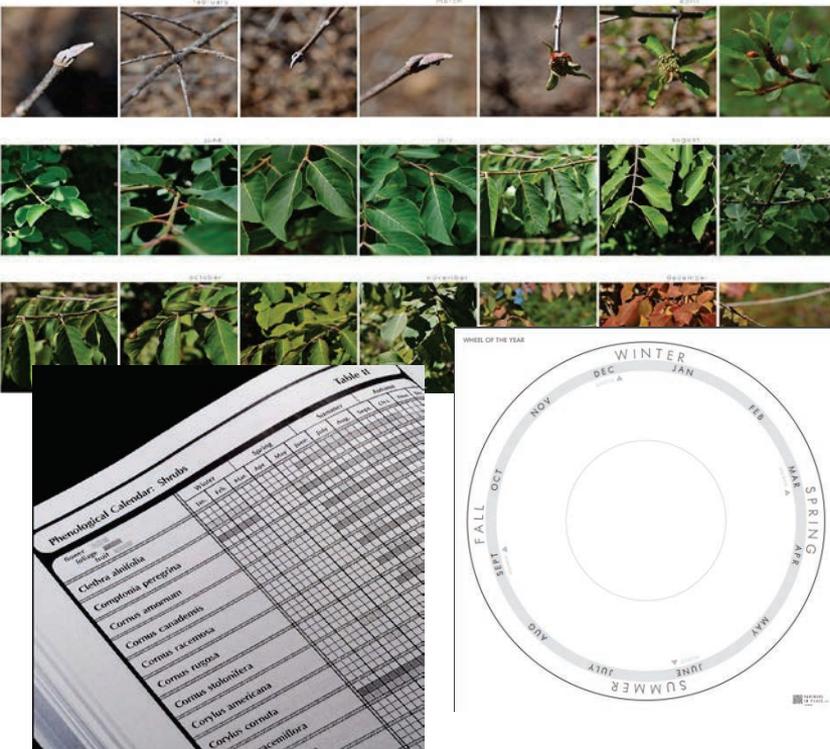


European policy indicator:

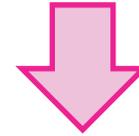
Leaf unfold is up to 1 day early per year!



Traditional monitoring systems:



- Paper-based
- Reduced number of species
- Close to observers home



- ✘ Reduced number of observations
- ✘ Not representative across biomes

Phenology as Citizen Science

Not too long ago, some phenology monitoring networks appeared:

CATALUNYA
(north-east of Iberian Peninsula)

- ✓ FENOCAT initiative
from the Catalan
Meteorological Service



- ✓ RitmeNatura
Citizen Science
observatory

RitmeNatura.cat 

EUROPE

- ✓ Pan European
PEP725 Phenology
DataBase

Pan European  PEP725 Phenology DB

- Citizen science observatory (H2020 Ground Truth 2.0) to collect phenological data in Catalunya
- Data stored in iNaturalist.org
- Monitors 12 species and specific phenophases
- Real-time searchable data for scientists, managers
- Correlated with the effects of climate change



Phenology

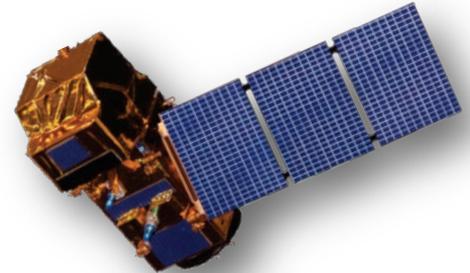
✓ Improve number of observations

✗ Not representative across biomes

What can scientists do to increase the collection of vegetation phenology data at global level?



Use new technologies such as
REMOTE SENSING

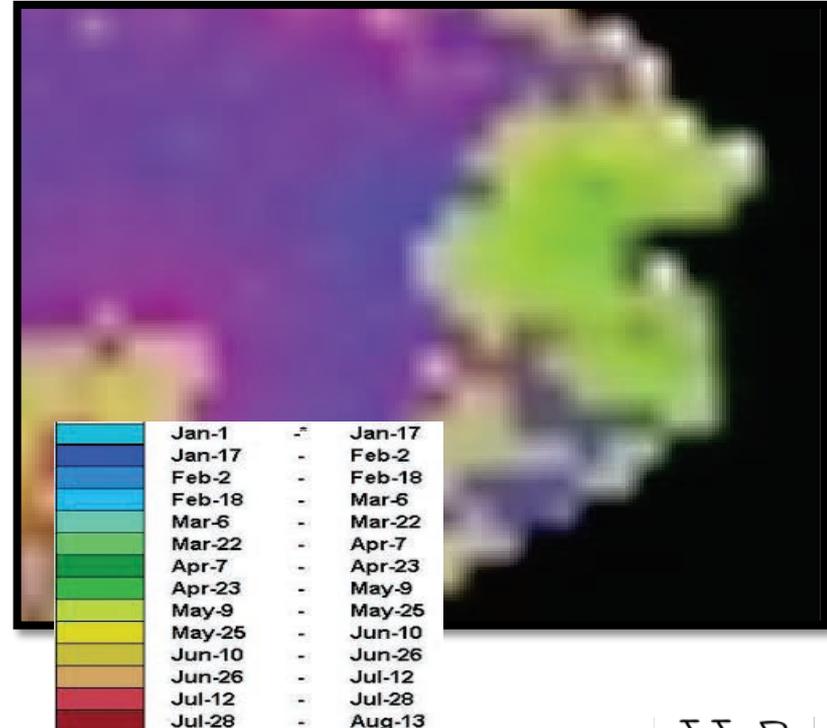


Phenology and Remote Sensing

Medium resolution optical satellites: (e.g. MODIS)

- ✓ Daily data
- ✓ Appropriate spectral configuration for vegetation monitoring
- ✓ Global coverage
- ✗ Spatial resolution too coarse

10 000 trees in one pixel !

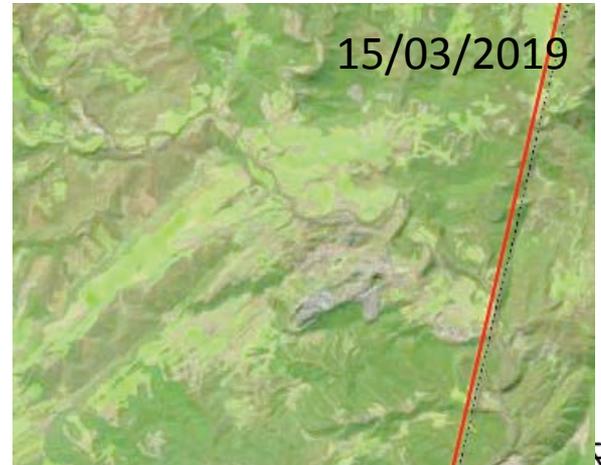


Phenology and Remote Sensing

High resolution optical satellites:

LANDSAT:

- ✓ Appropriate spectral configuration for vegetation monitoring
- ✓ 30 m spatial resolution
- ✓ Global coverage
- ✗ Revisiting period too low (16 days)

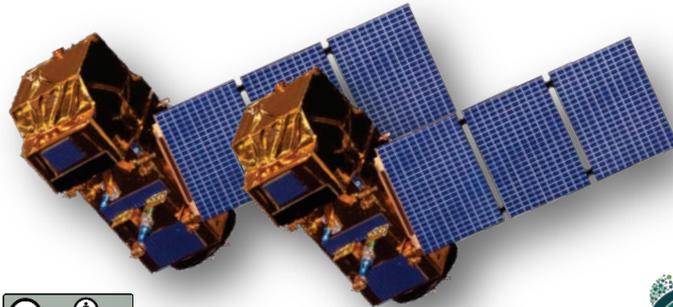


Phenology and Remote Sensing

High resolution optical satellites:

SENTINEL 2A and 2B:

- ✓ Appropriate spectral configuration for vegetation monitoring
- ✓ 10 m spatial resolution
- ✓ Revisiting period between 3 and 5 days
- ✓ Global coverage



Still....

IN SITU Observations

=/=

METHODOLOGY

=/=

REMOTE SENSING

Observations



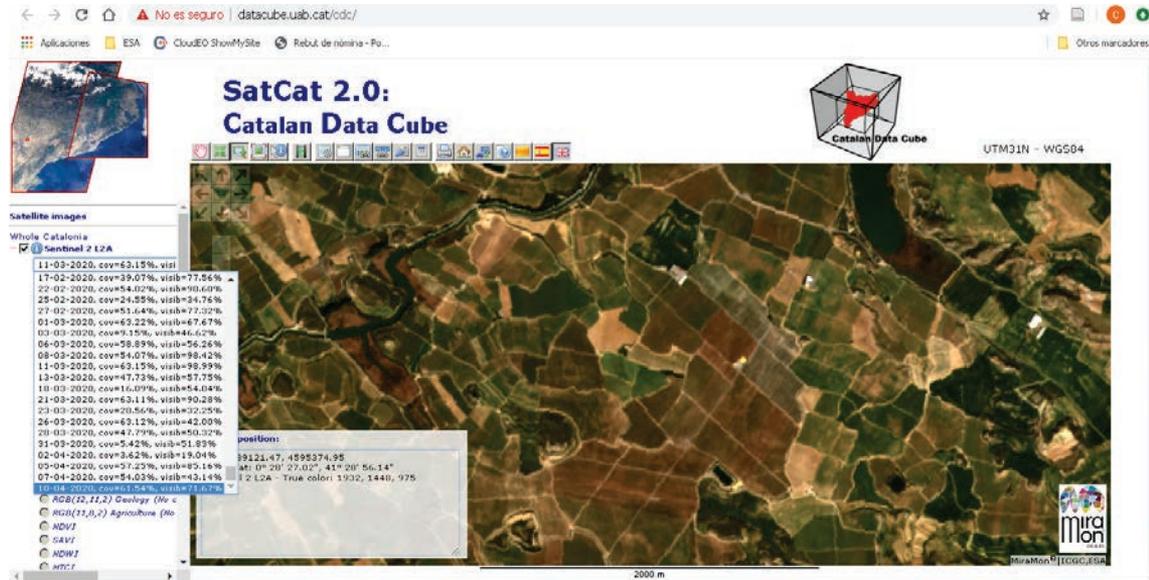
Hardly comparable



- PhenoTandem Project innovation approach :
 - co-designing a new observation protocol with citizen scientists
 - aiming at making in-situ observations interoperate with remote sensing products
 - by selecting the areas and habitats where traditional phenological in-situ observations done by volunteers can also be well monitored by Sentinel 2 images
 - Tested in Catalunya

PhenoTandem Approach

- Catalan Data Cube of Sentinel-2 data
 - Solution for storing big data products
 - Analysis ready data
 - Interoperable
 - Visualization and analysis through WMS



PhenoTandem Approach

- Co-designed selection of species of interest and definition of observable phenophases (in-situ and from space)



- Leaf development
- Flowering
- Senescence
-

PhenoTandem Approach

- Identification of large vegetation areas with clearly differentiated phenophases, such as Peach Trees



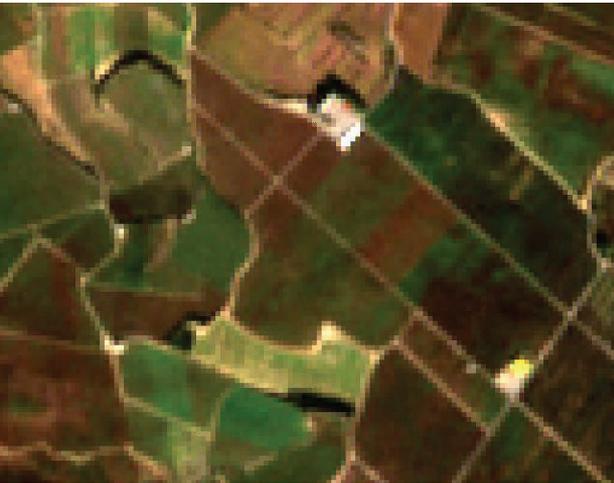
PhenoTandem Approach

- Time series analysis of Sentinel-2 data

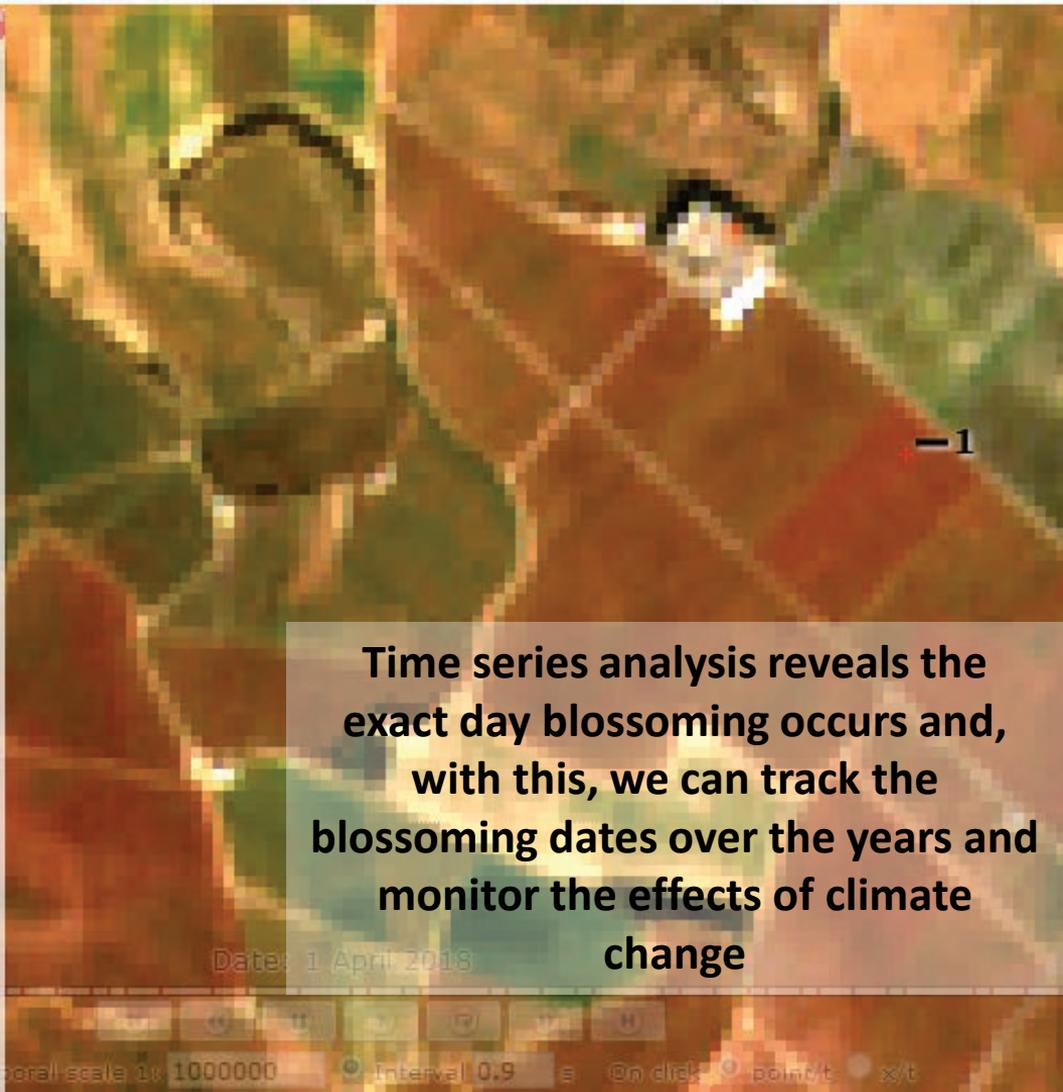
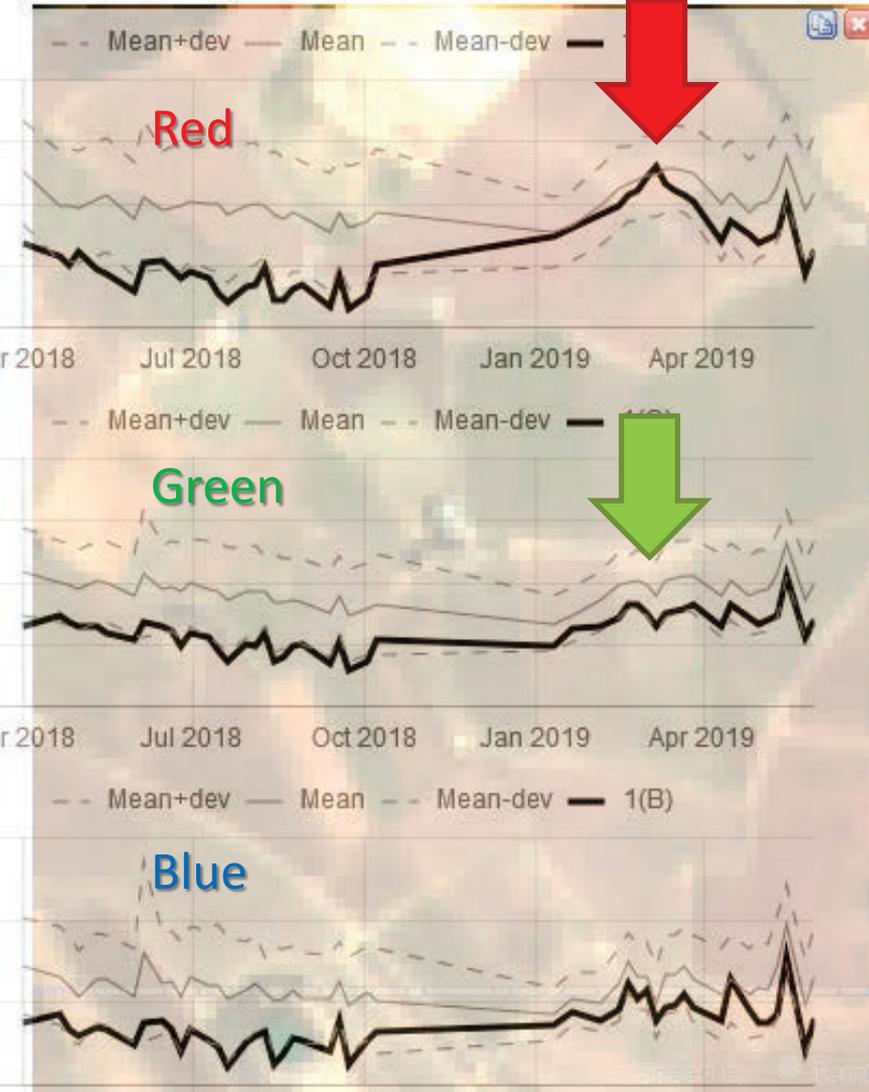
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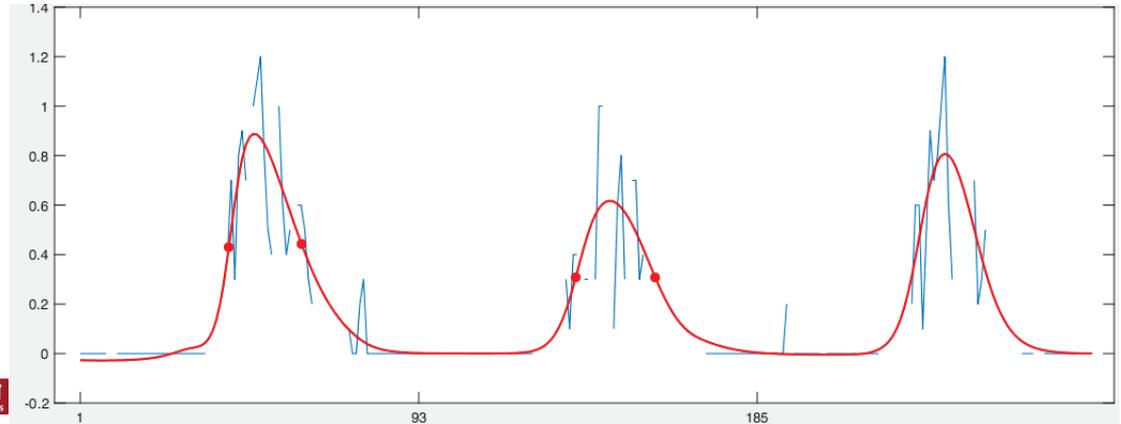
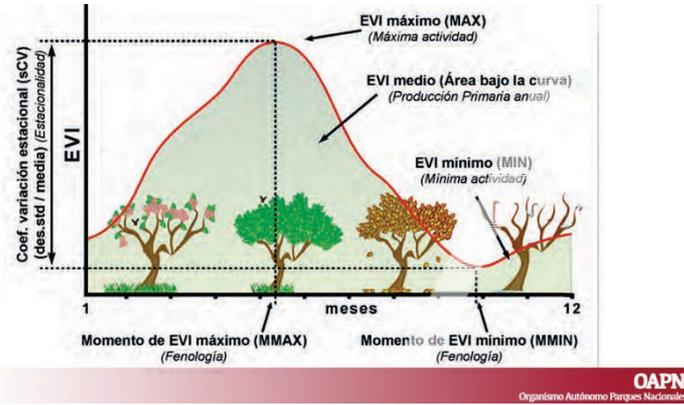


• In March 2019, S2 clearly captured the change in those areas



PhenoTandem Approach

- Time series analysis of Sentinel-2 data

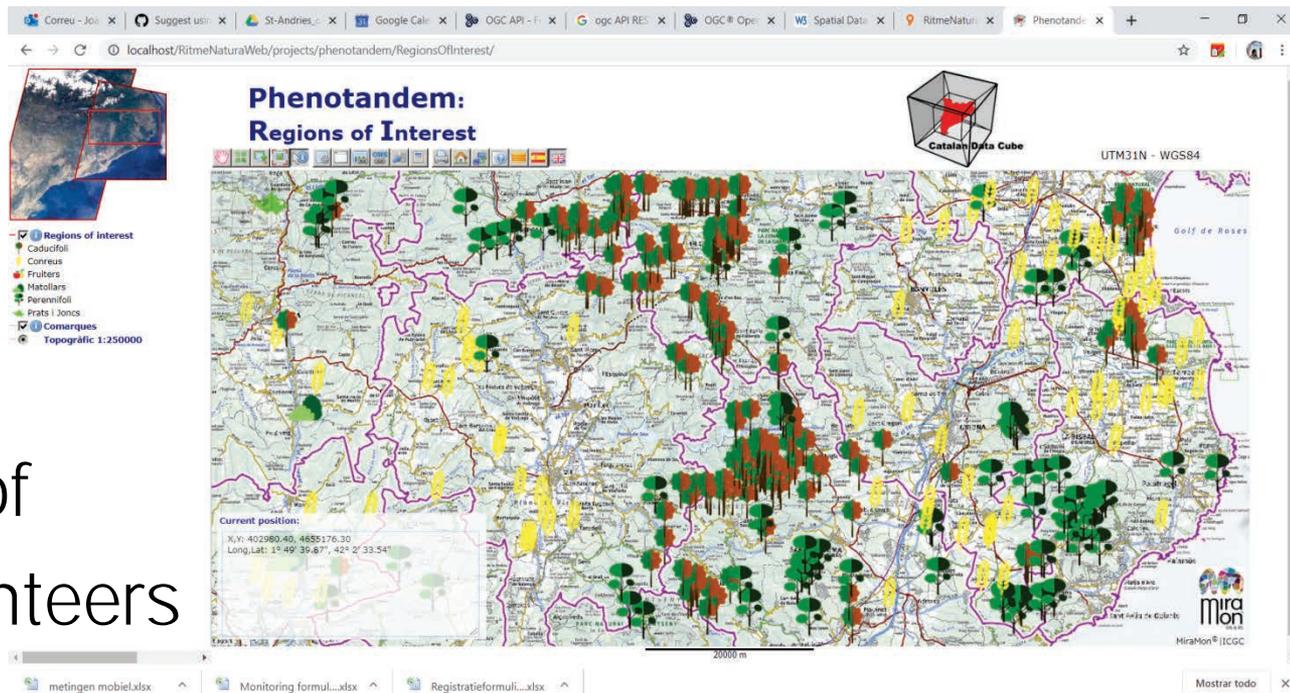


- Computation of phenology products and Ecosystem Functional Types

PhenoTandem approach

- Final selection of in-situ areas of interest to be visited by observers during spring and autumn campaigns

• Engagement of RitmeNatura.cat  volunteers



PhenoTandem Approach

- Volunteers register observations through **iNaturalist.org** app
- After the campaign, in-situ observations and Sentinel-2 data will be combined to calibrate and validate remote sensing phenology products



Conclusions

- Monitoring vegetation phenology requires good coverage of data but also good quality specific in-situ information
- Remote sensing can provide the spatial, temporal and spectral resolutions suitable for vegetation phenology monitoring but...
- ...still need of in-situ data for calibration.

Conclusions

- Guided citizen science can be a useful approach to collect in-situ data for phenology monitoring
- Together, RS and CS, are a good partnership for powerful phenology monitoring



Thank you!

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