

Aplicaciones de la signatura espectrotemporal óptica y radar en ámbito forestal



Cristina Gómez

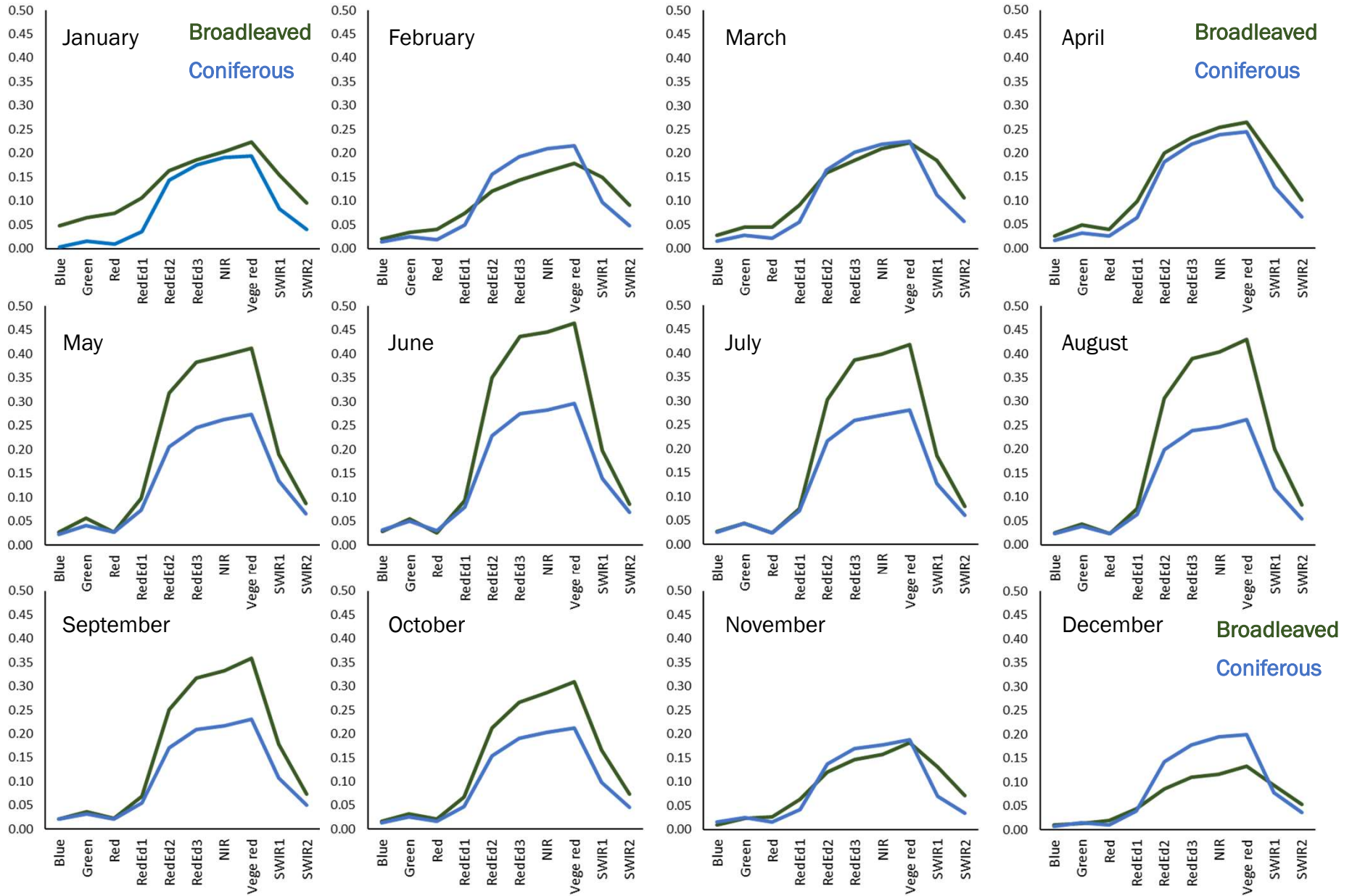
cgomez@uva.es



Las nuevas tecnologías aplicadas al conocimiento de los ecosistemas.
CENEAM. 19-21 de abril de 2023



Por qué la signatura espectral a lo largo del tiempo?



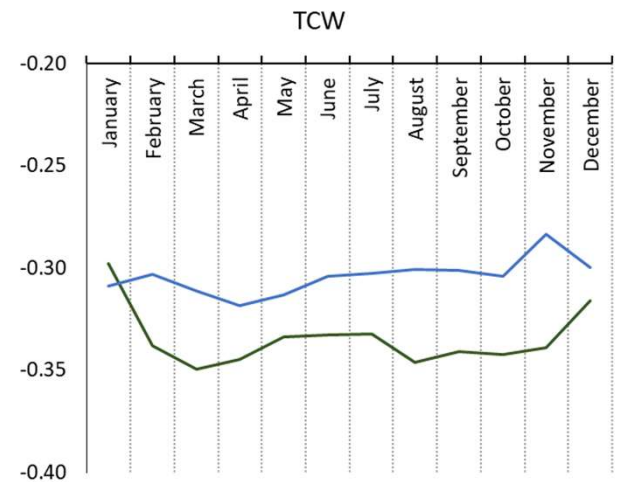
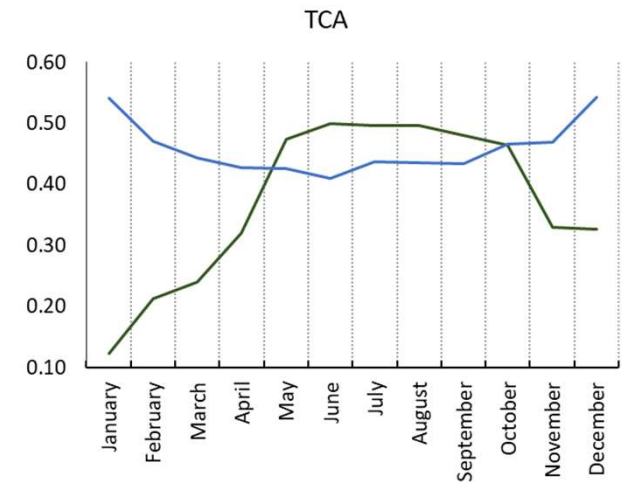
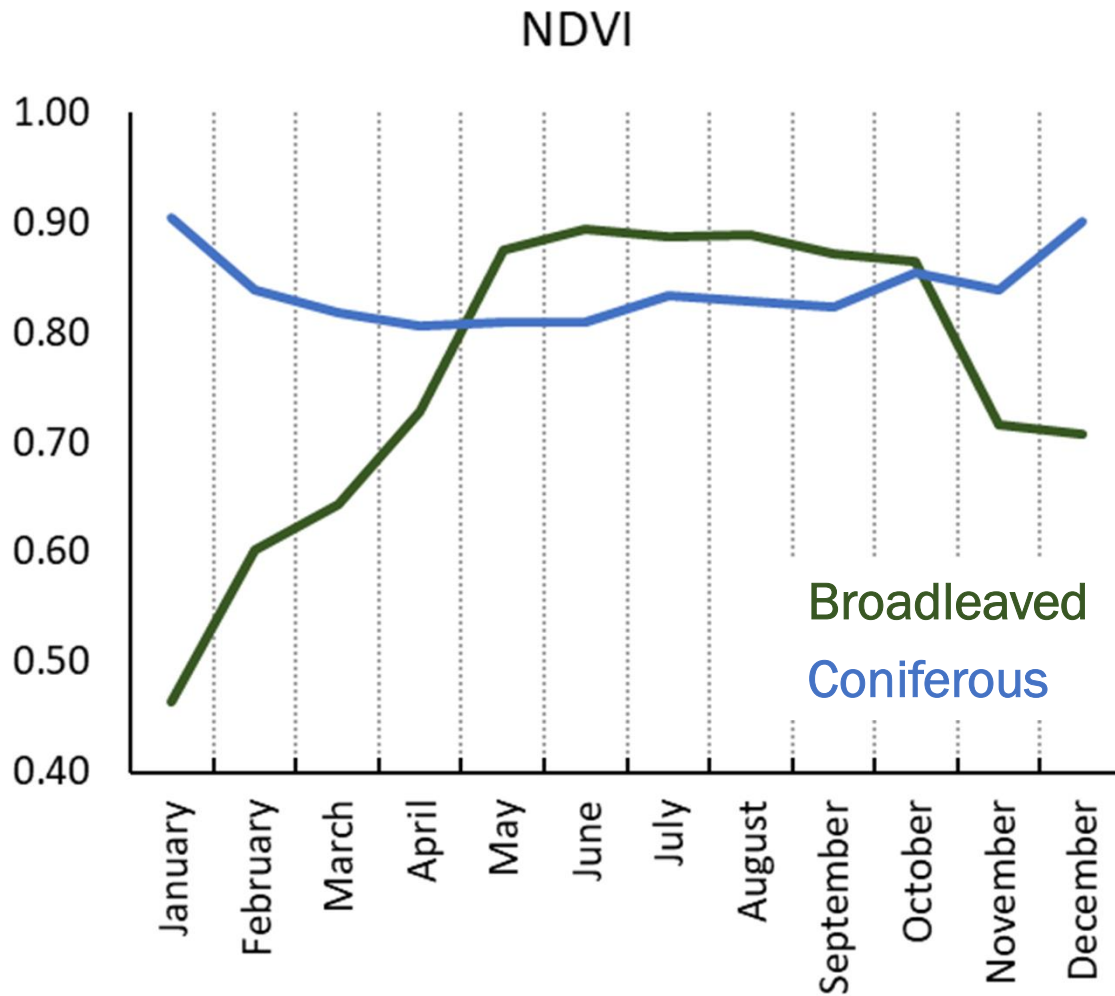
Sentinel-2 reflectance

Source: Iyán Tejjido

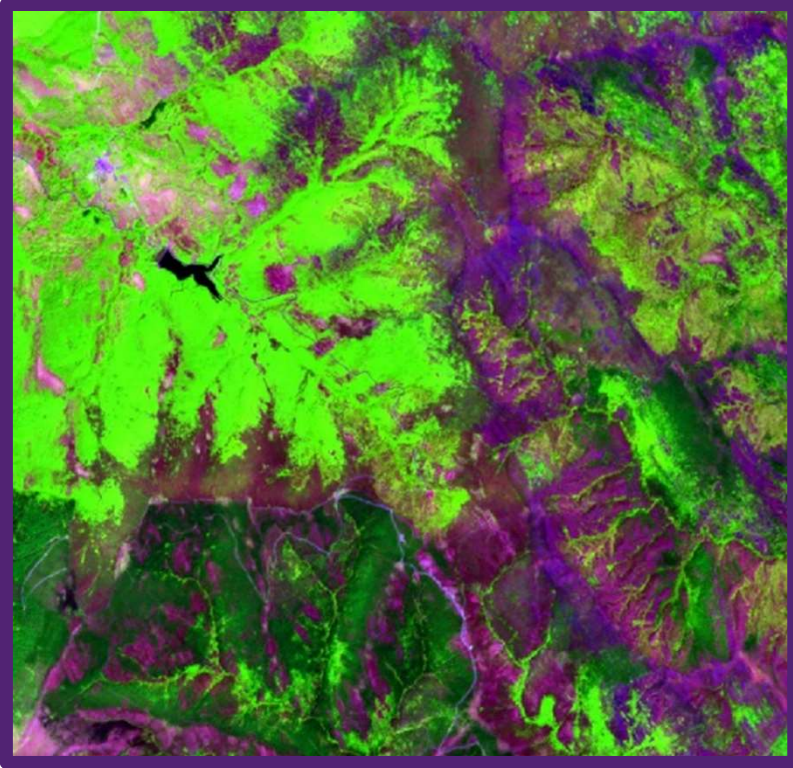
Por qué la signatura espectral a lo largo del tiempo?

$$\text{NDVI} = (\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red})$$

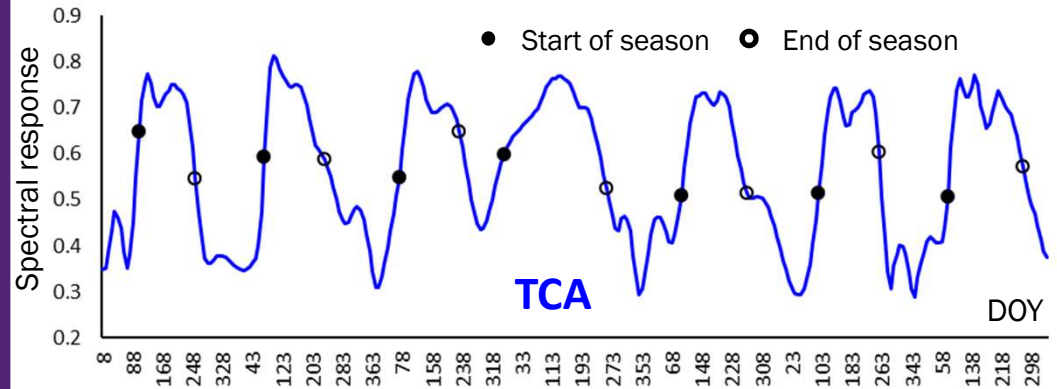
$$\text{TCT} = f(\text{visible}, \text{NIR}, \text{SWIR})$$



Por qué la signatura espectral a lo largo del tiempo?



Sentinel-2 animation year 2017
Visualization R/G/B: 11/8/4



Spectro-phenology

Time series for characterization of land cover

Time series for identification / characterization of processes of change

Por qué la signatura espectral a lo largo del tiempo?

Data availability

Landsat: 45/year

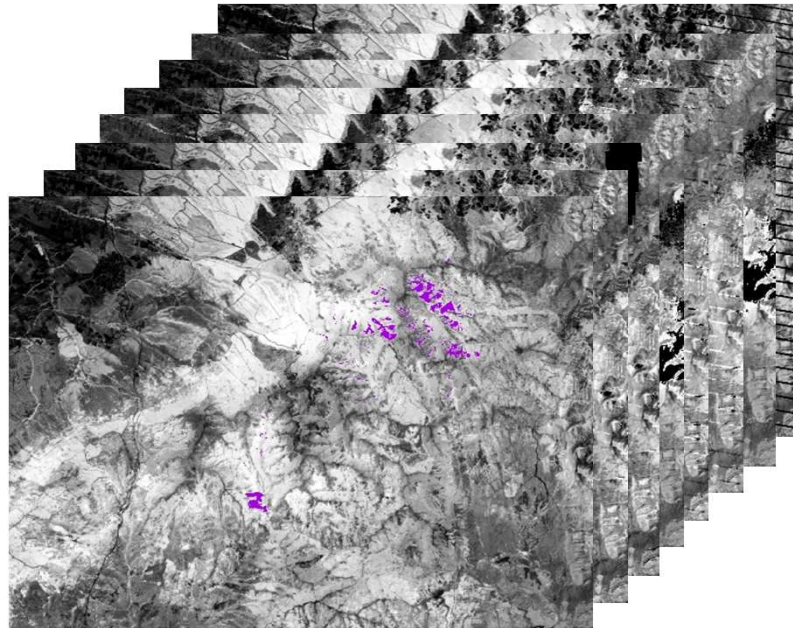
Sentinel-2: ~145/year

MODIS: ~365/year

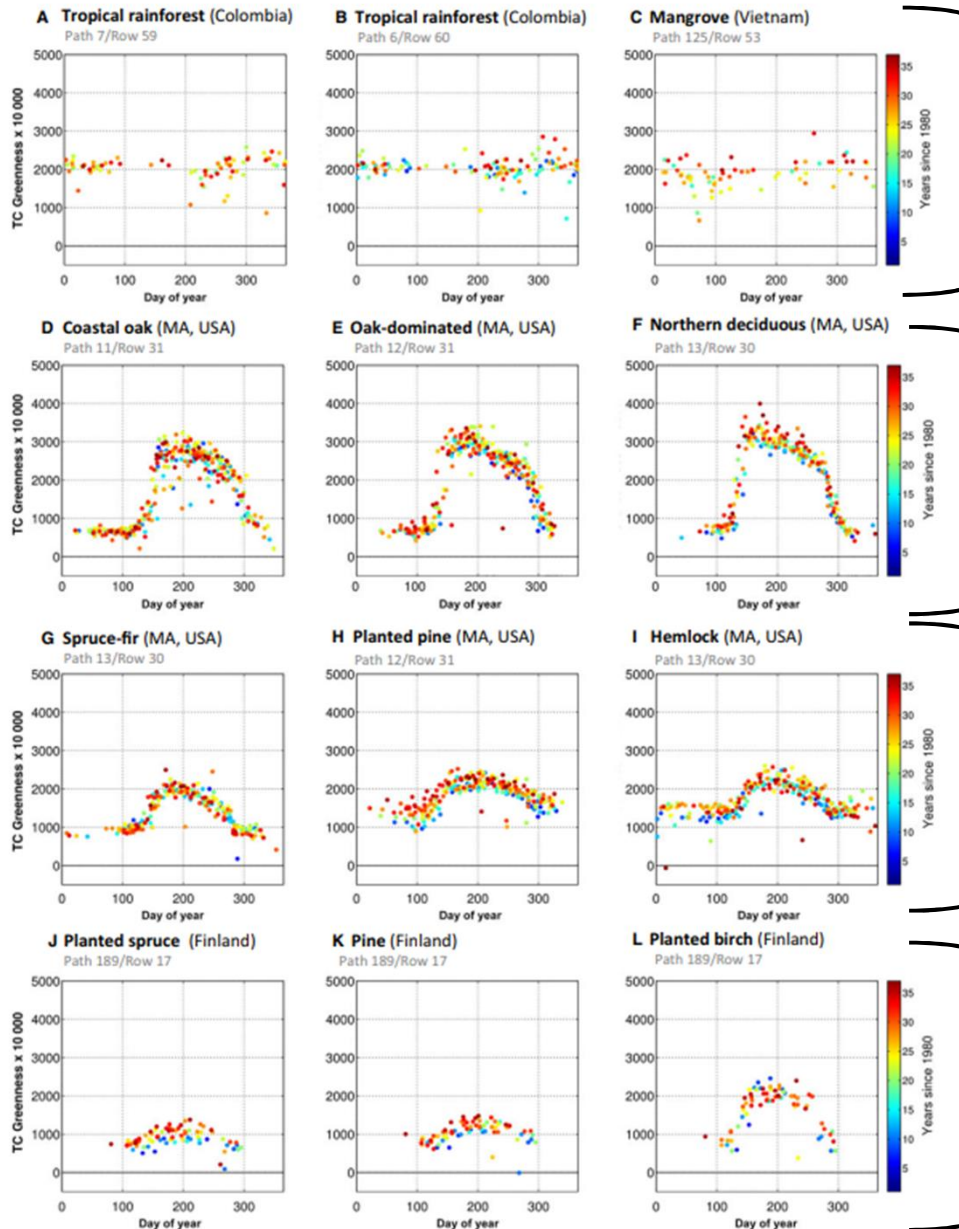
ALOS PALSAR: ~26/year

Sentinel-1: ~60/year

TDX / TSX / PAZ: ~60/year



Por qué la signatura espectral a lo largo del tiempo?



Tropical ecosystems

Deciduous broadleaved

Natural conifers

Planted conifers

Remote Sensing in Ecology and Conservation

Open Access

ZSL
LET'S WORK
FOR WILDLIFE

ORIGINAL RESEARCH

From imagery to ecology: leveraging time series of all available Landsat observations to map and monitor ecosystem state and dynamics

Valerie J. Pasquarella¹, Christopher E. Holden¹, Les Kaufman^{2,3} & Curtis E. Woodcock¹

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²Department of Biology, Boston University, Boston, Massachusetts 02215

³Moore Center for Science and Oceans, Conservation International, 2011 Crystal Drive, Arlington, Virginia 22202

Aplicaciones de la signatura espectrotemporal óptica y radar en ámbito forestal

Heladas tardías

Sanidad forestal

Identificación de especies

Servicios ecosistémicos productivos

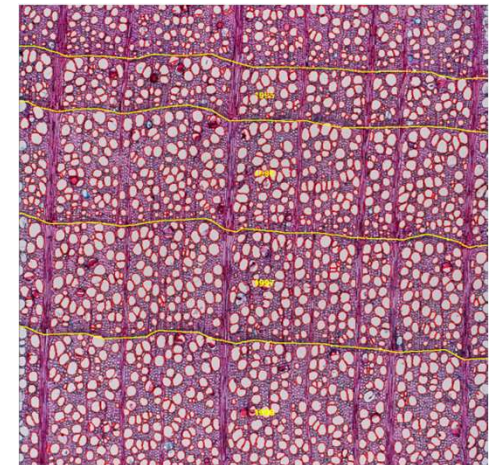
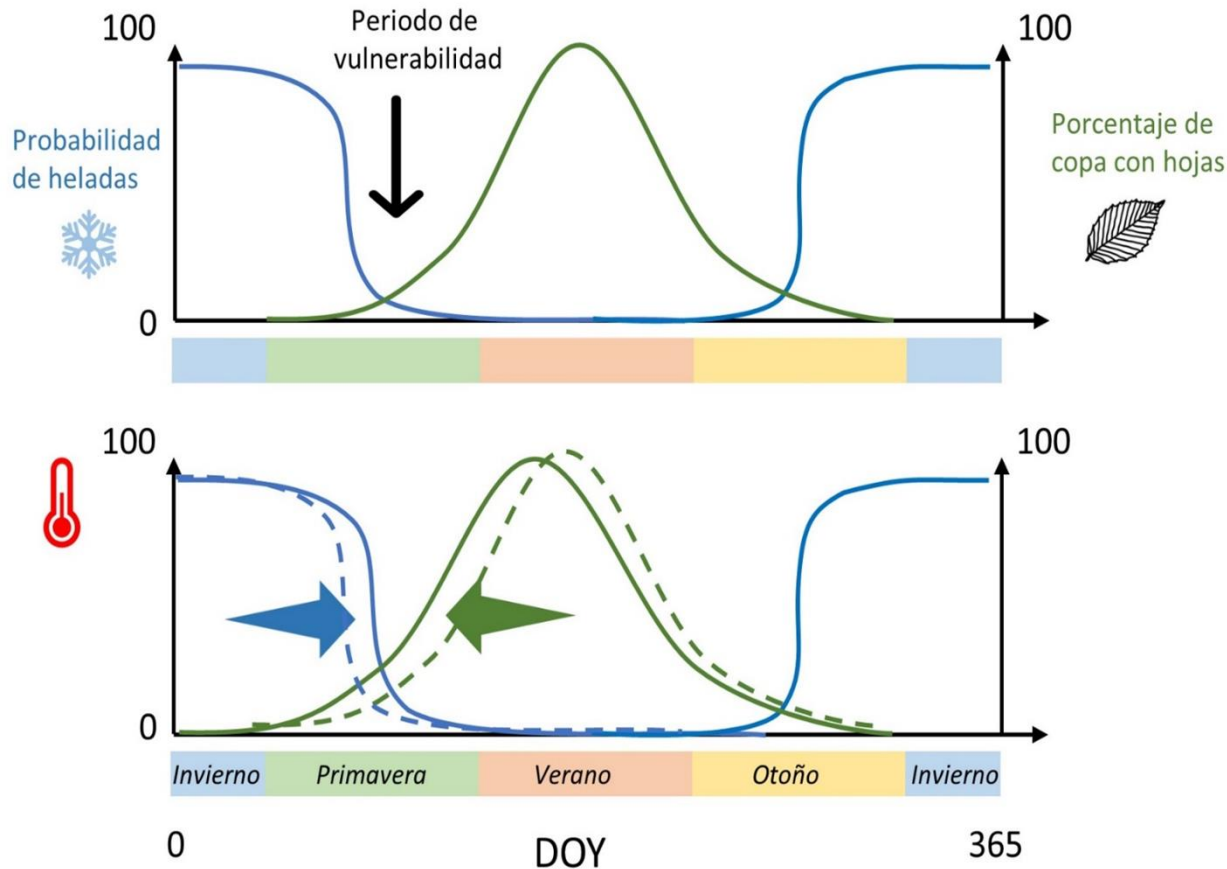


Natural Resources
Canada

Heladas tardías



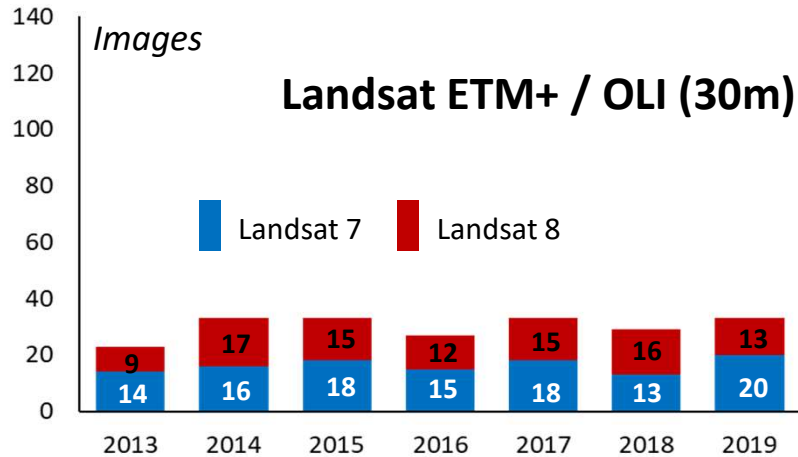
Deciduous species vulnerability to late frost



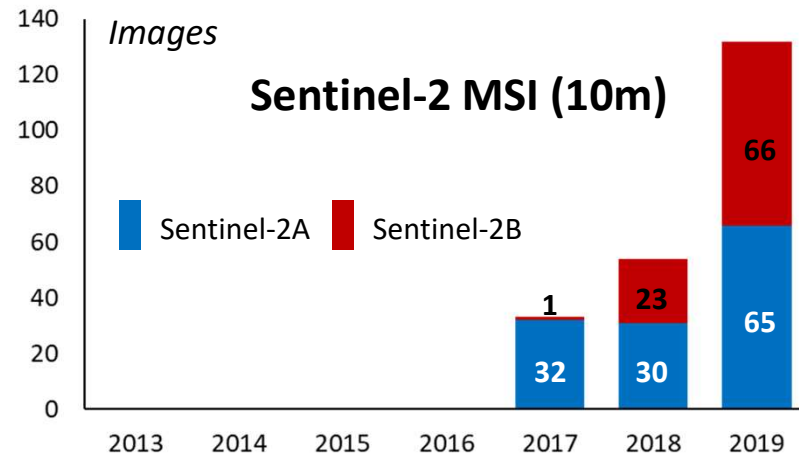
- Consecuencias
- Fenología tardía
 - Corto período de crecimiento
 - Impacto en la reproducción
 - Crecimiento secundario reducido

Heladas tardías

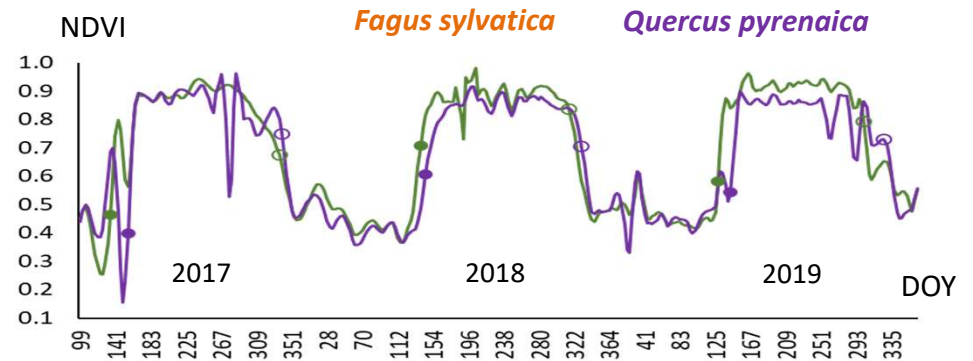
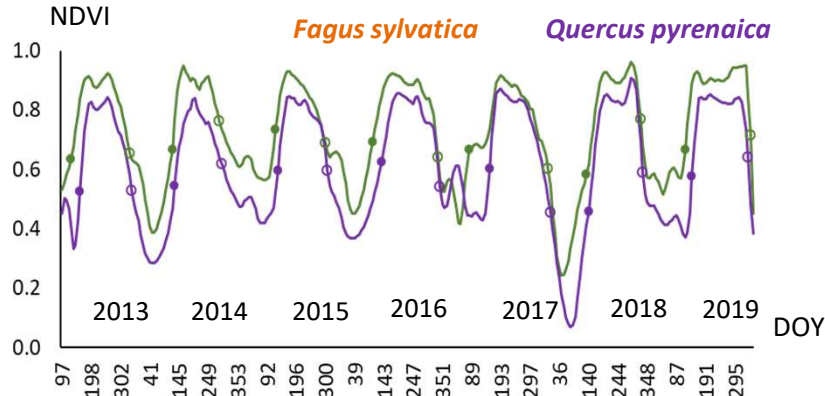
Sistema Central



211 images
30 / season
 April 2013 – December 2019
 Collection 1 level 2



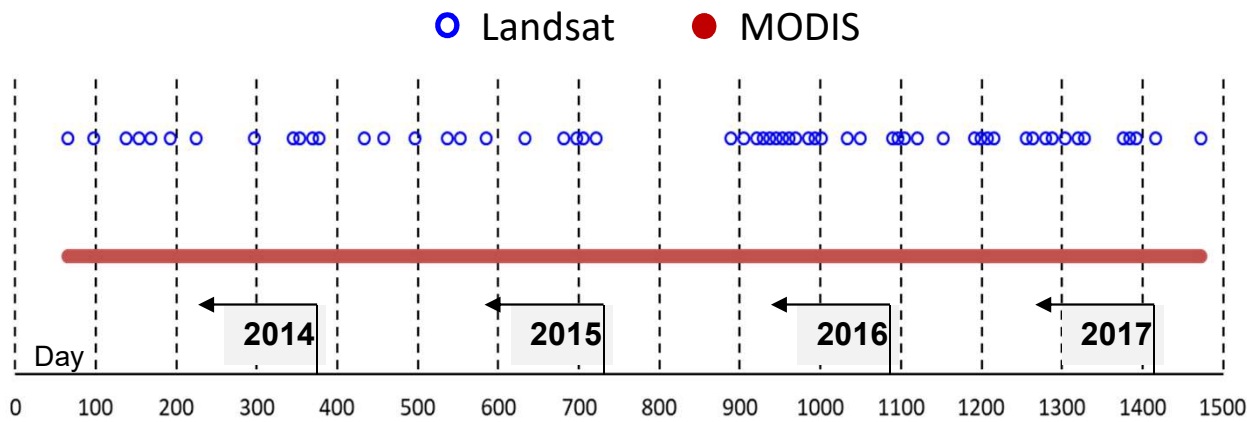
217 images
70 / season
 April 2017 – December 2019
 MSIL2A



- *SOS: Fagus sylvatica* earlier than *Quercus pyrenaica*
- *Length: Fagus sylvatica* longer than *Quercus pyrenaica*

Heladas tardías

Sistema Central



Landsat ETM+ / OLI level 2
58 images (15/season)

Red, NIR

Cloud free

MODIS MOD09GQ V6

1472 images (365/season)

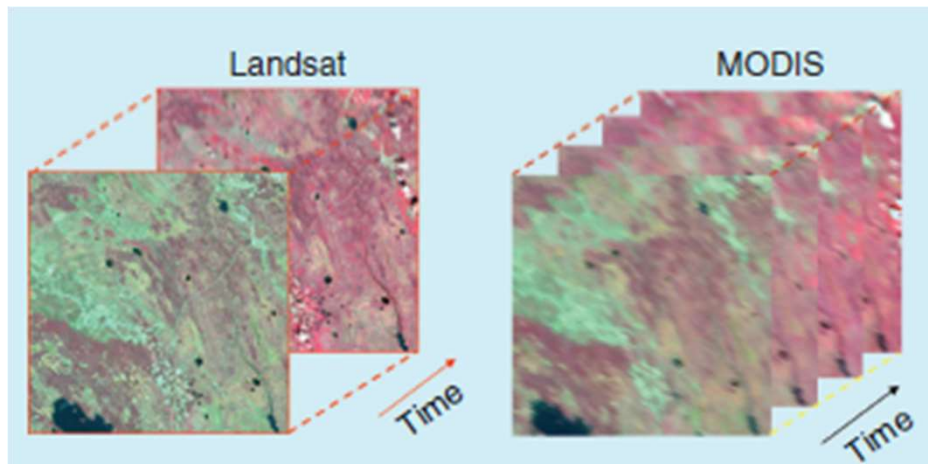
Band 1 (red, 620-670 nm)

Band 2 (NIR, 841-876 nm)

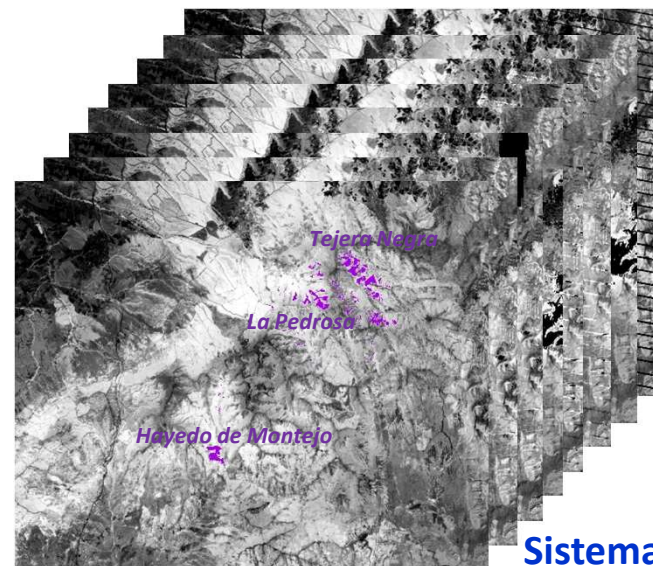
Quality band

6 March 2014 - 12 January 2018

STARFM (Spatial and Temporal Adaptive
Surface Reflectance Model)



Source: Gao et al. 2015



Sistema Central

Heladas tardías

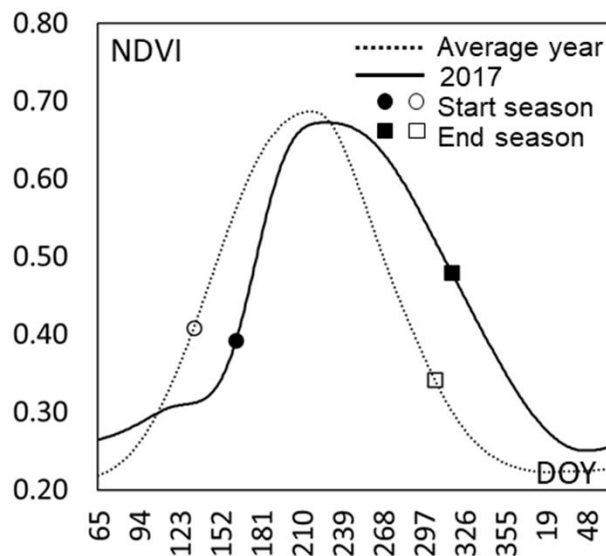
SPECTROPHENOLOGY WITH LANDSAT – MODIS FUSION. Phenological Parameters

2017 / *average 2014-2016*

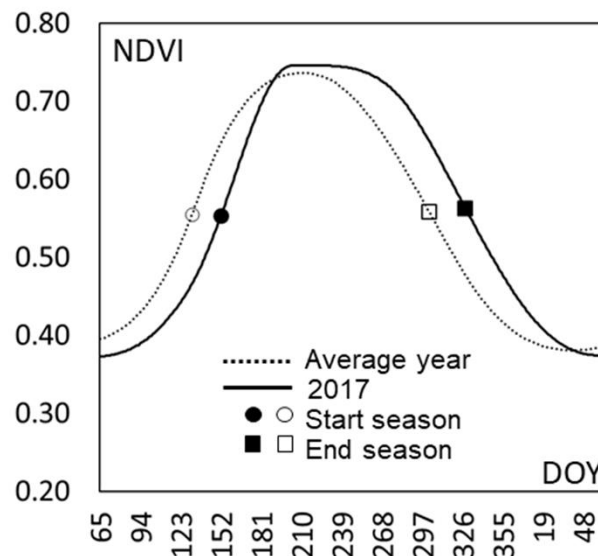
Sistema Central

- Later SOS
- Later EOS
- Later peak time
- *Length

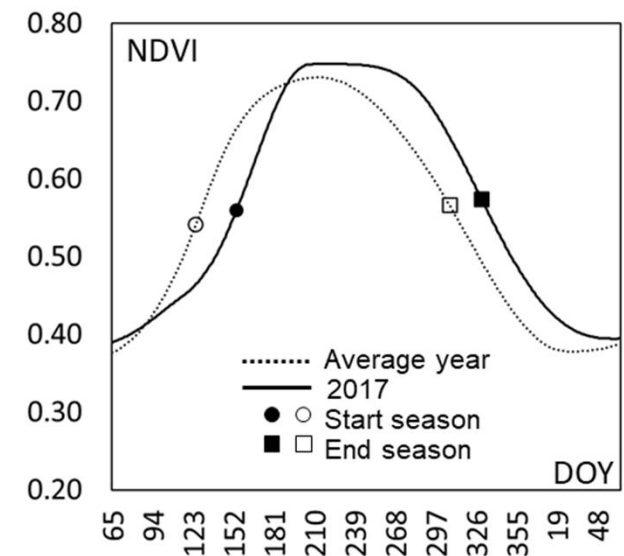
	Overall forest	<i>Fagus sylvatica</i>	<i>Quercus petraea</i>
SOS	163 / 133 (+30)	152 / 131 (+21)	154 / 125 (+29)
EOS	317 / 305 (+12)	328 / 302 (+26)	330 / 307 (+23)
Length	154 / 172 (-18)	176 / 171 (+5)	176 / 182 (-6)
Peak time	232 / 209 (+23)	234 / 211 (+23)	238 / 213 (+25)



Overall forest



Fagus sylvatica



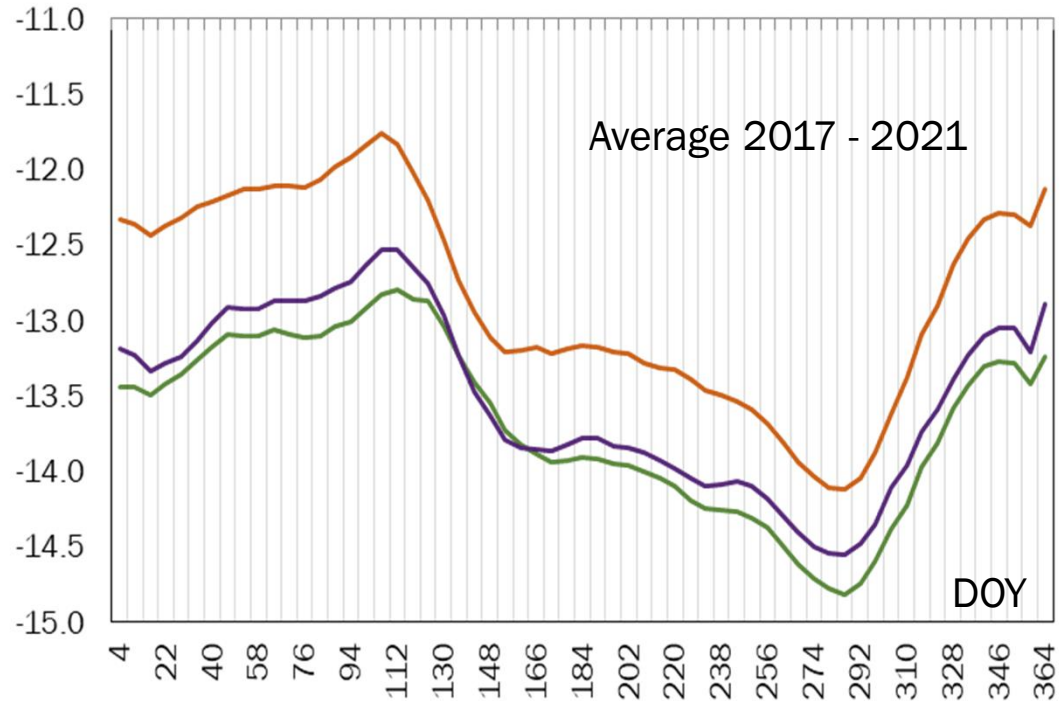
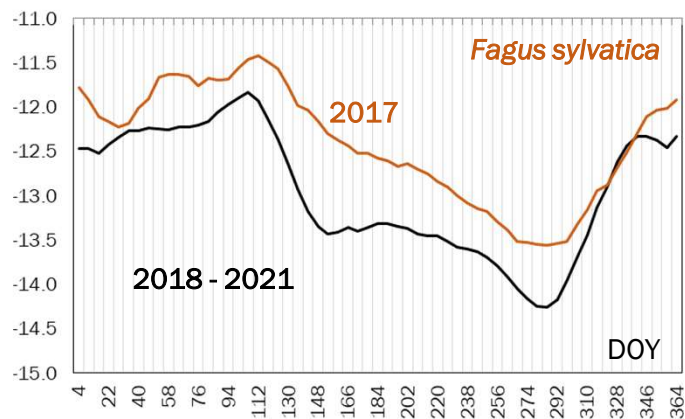
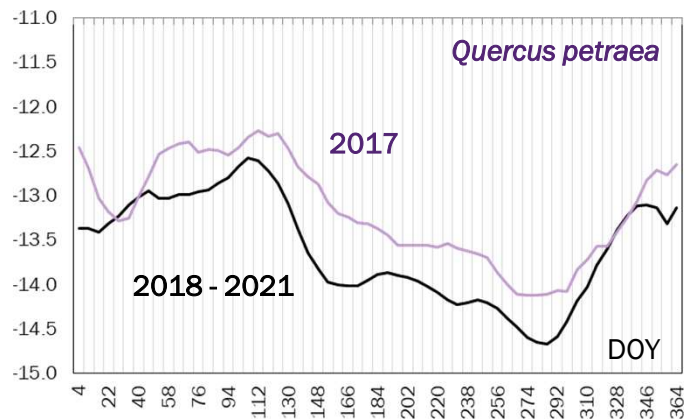
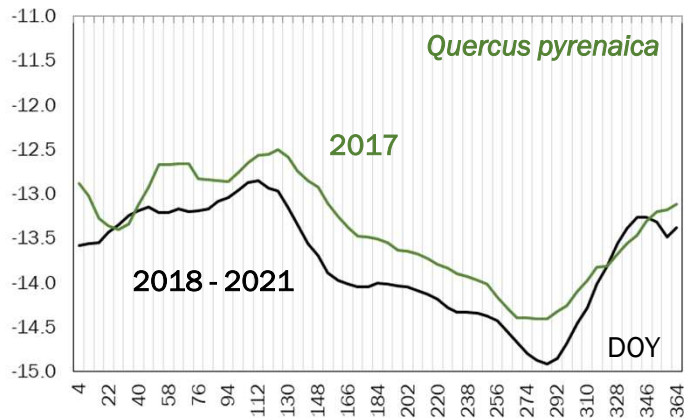
Quercus petraea

Gaussian fitting

Heladas tardías

Sistema Central

Backscattering VH Sentinel-1

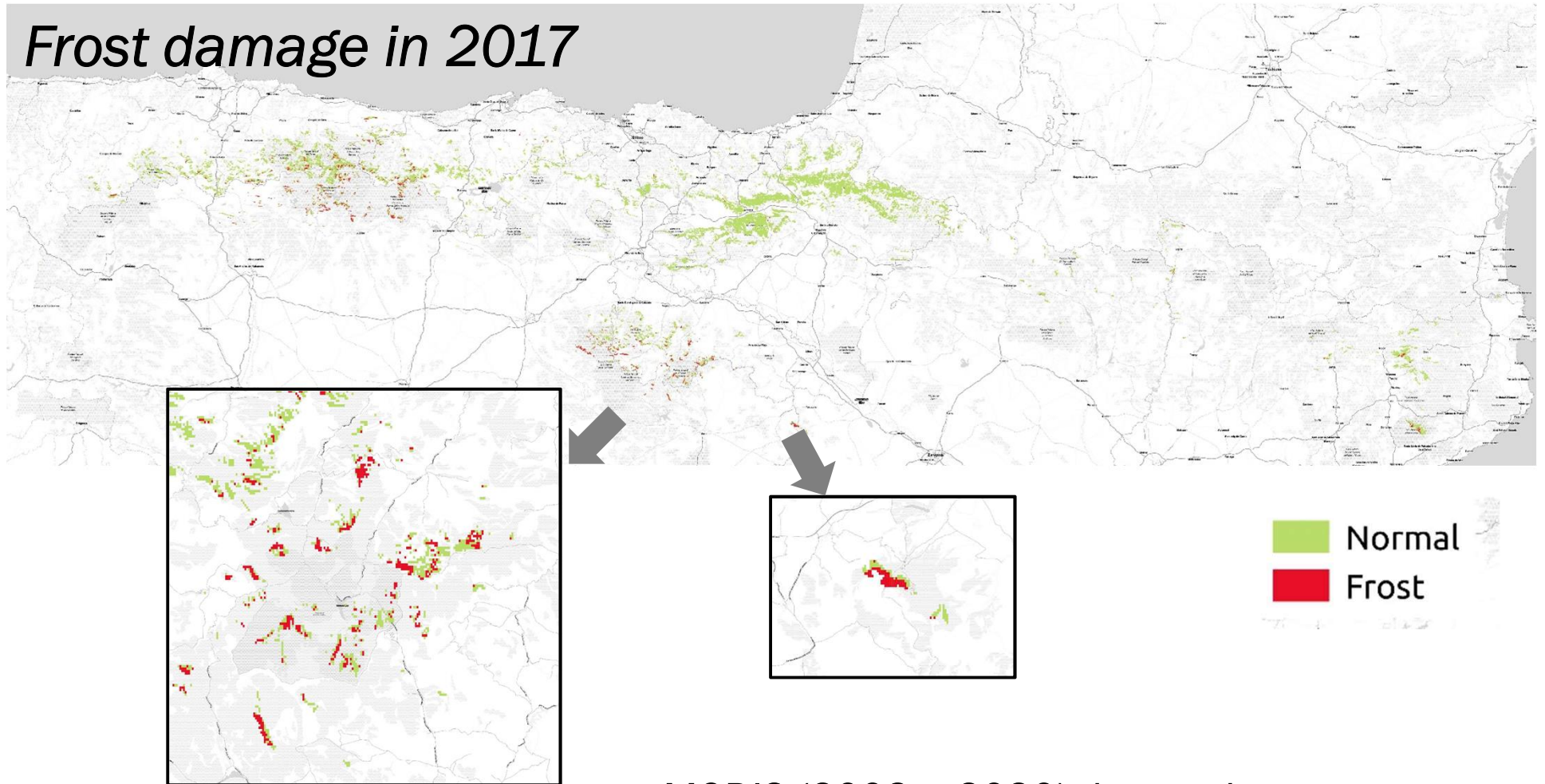


Quercus pyrenaica *Quercus petraea* *Fagus sylvatica*

Heladas tardías

Norte de España

Frost damage in 2017

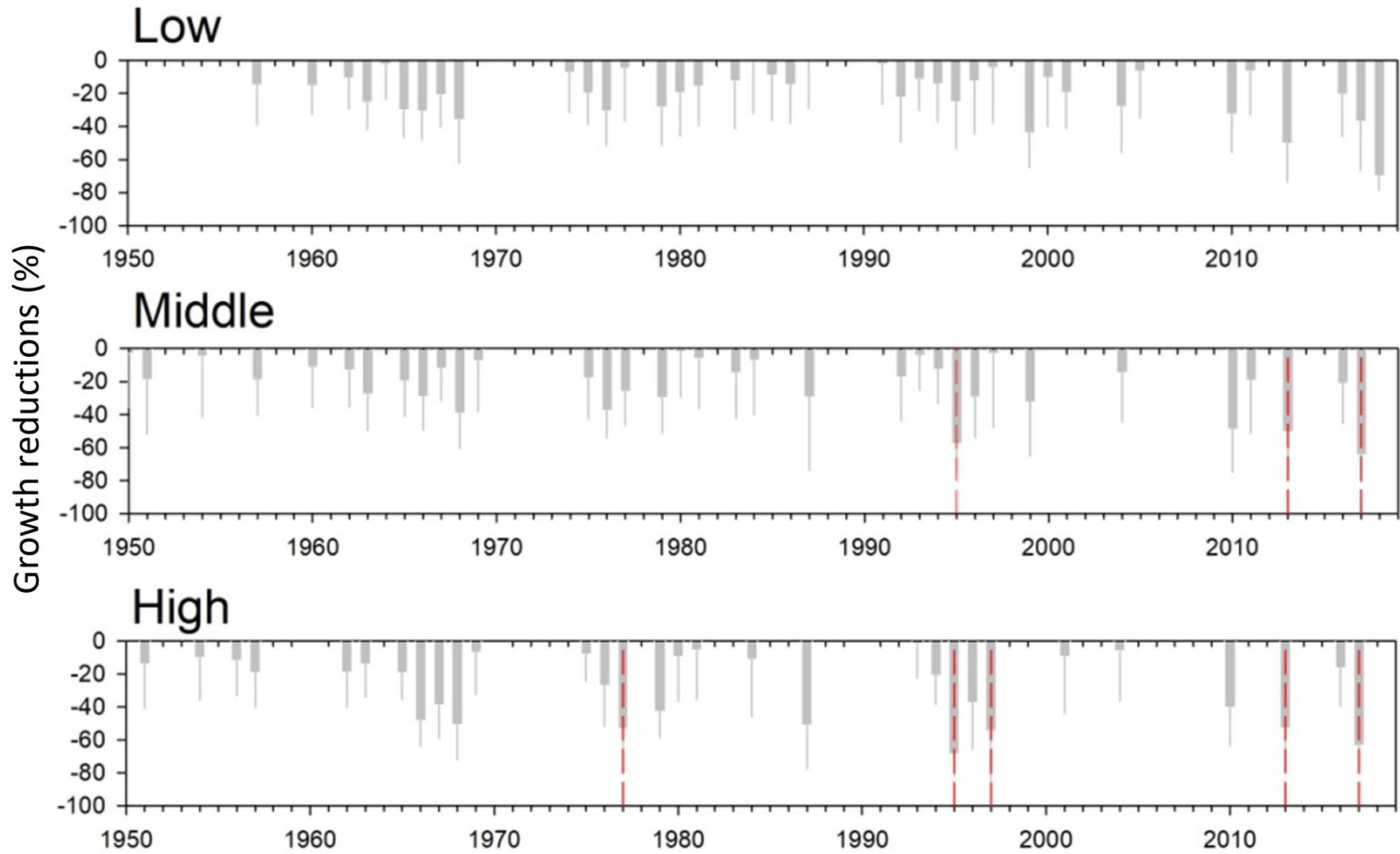


MODIS (2003 – 2020) time series pattern
Classification with SVM

Heladas tardías

Norte español

Growth reduction with altitude



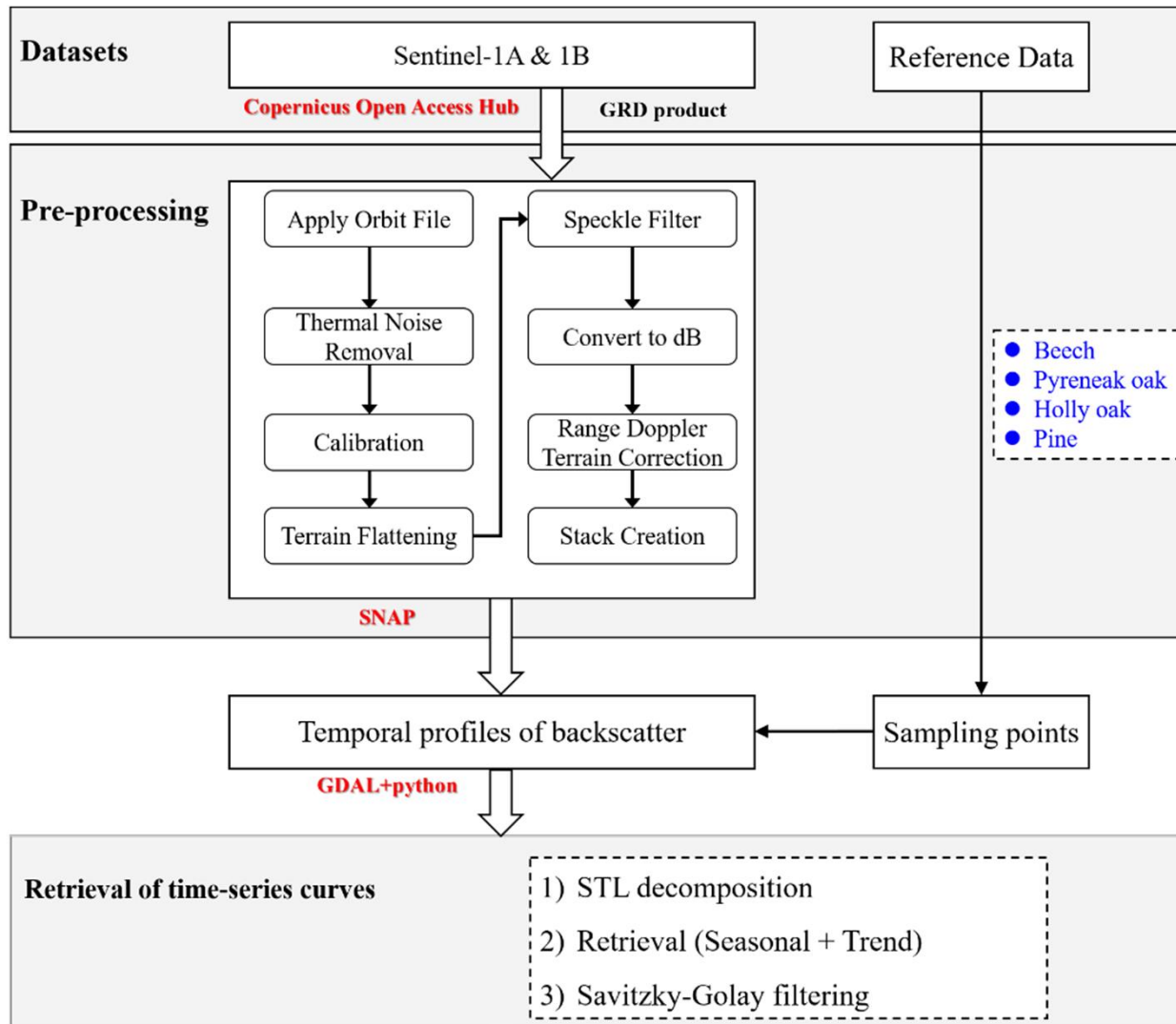
Heladas tardías



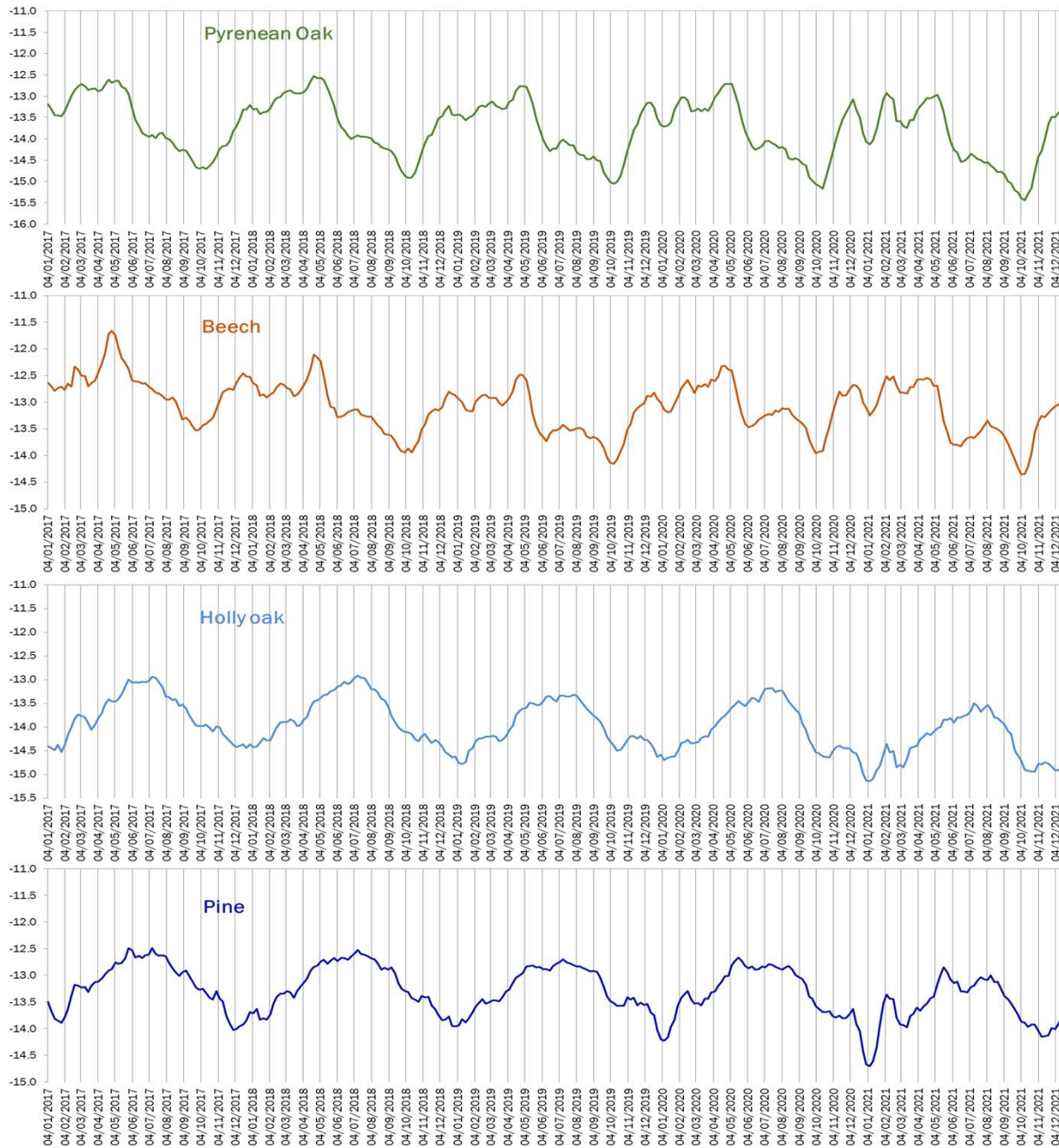
Identificación de especies



Synthetic Aperture Radar



Identificación de especies



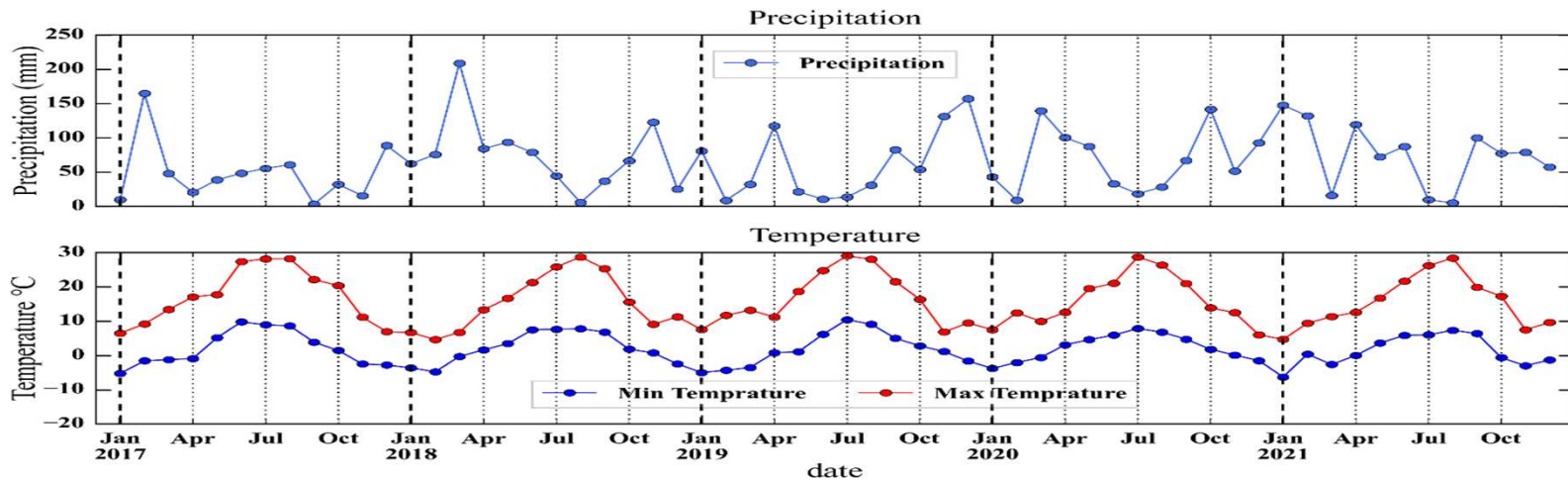
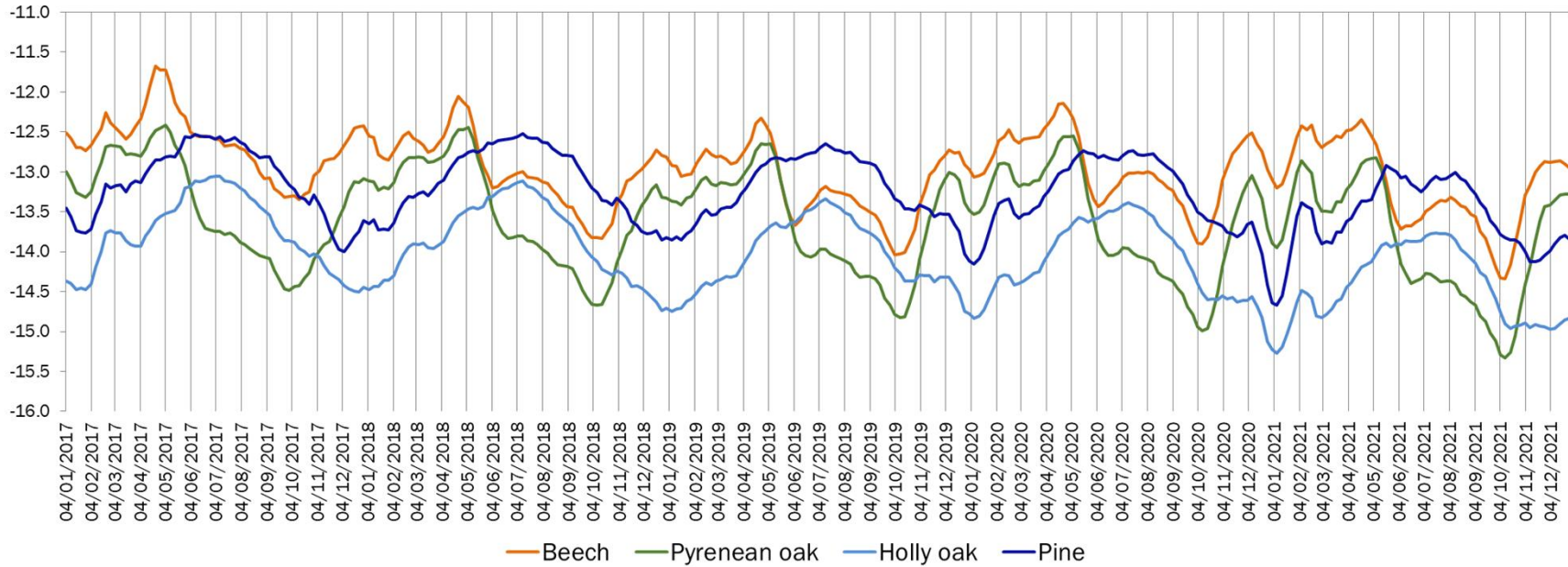
Deciduous

> Intensity in winter

Evergreen

> Intensity in spring-summer

Identificación / caracterización signatura de especies

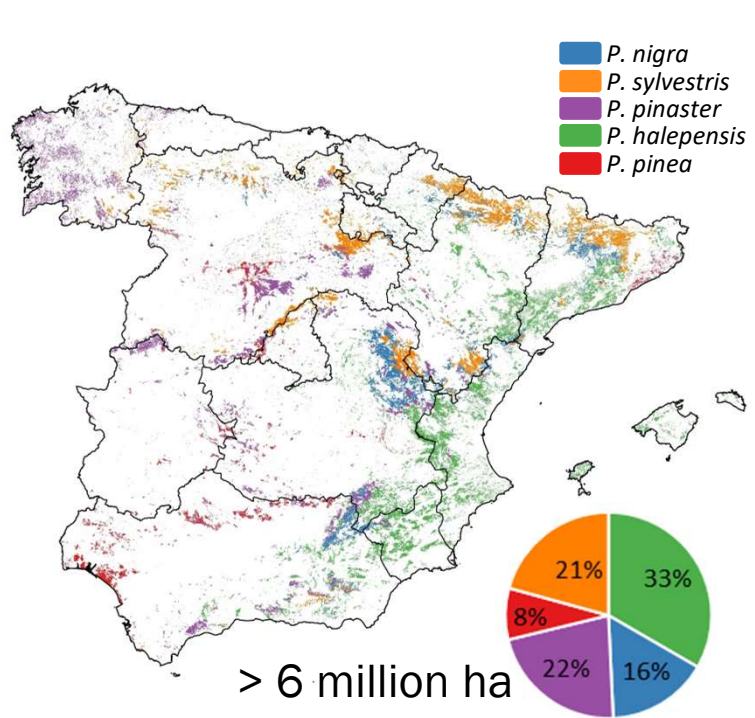


Identificación de especies

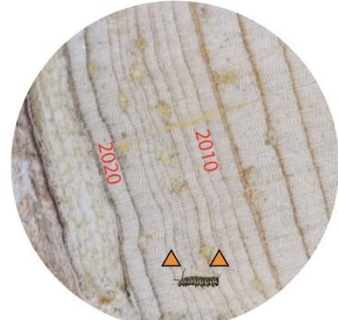
Sanidad forestal



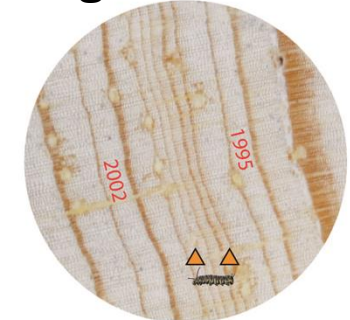
Procesionaria del pino (*Thaumetopoea pityocampa*)



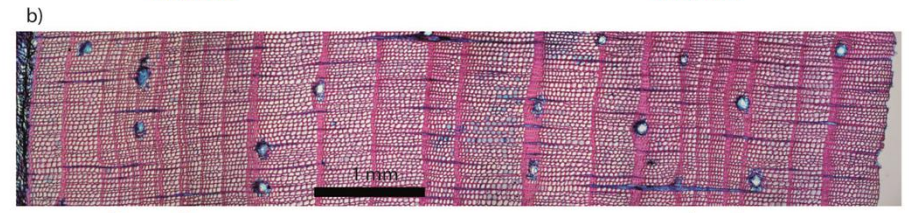
Tree-ring chronologies



outbreak2



outbreak1



outbreak2

outbreak1

- Growth reduction
- > Vulnerability to other factors
- Habitat loss

Objetivos

- **Map** historical and current processionary **damage**
- Identify factors of vulnerability (**climatic, structural**)
- Developing an **early warning + monitoring tool** (RS & AI)

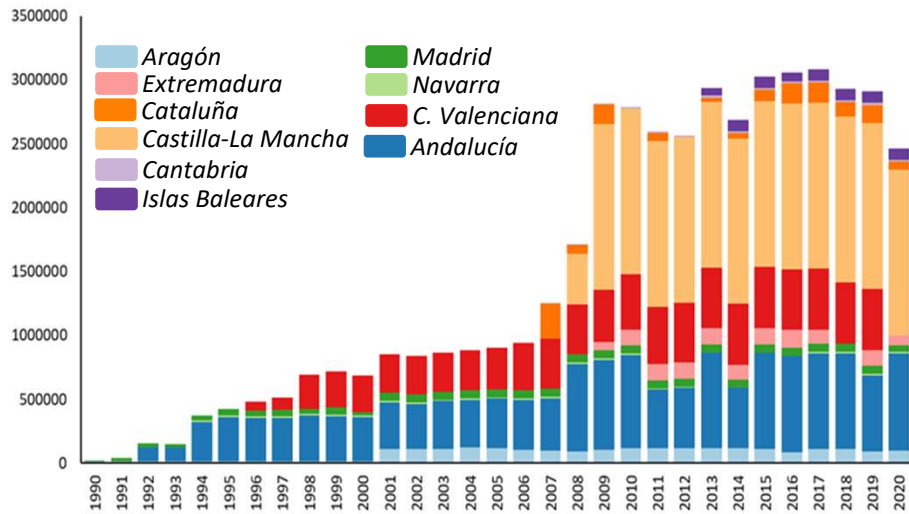
OUTBREAK (VA171P20) funded by Junta de Castilla y León Government

PROWARM (PID2020-118444GA-I00) funded by MCIN/ AEI /10.13039/501100011033

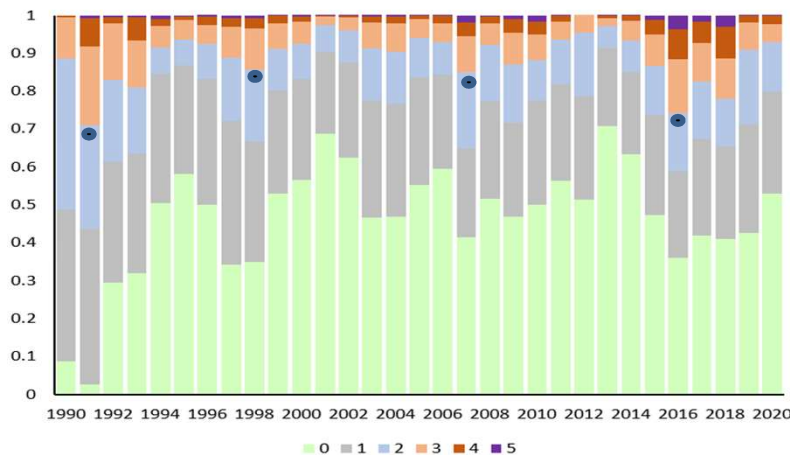
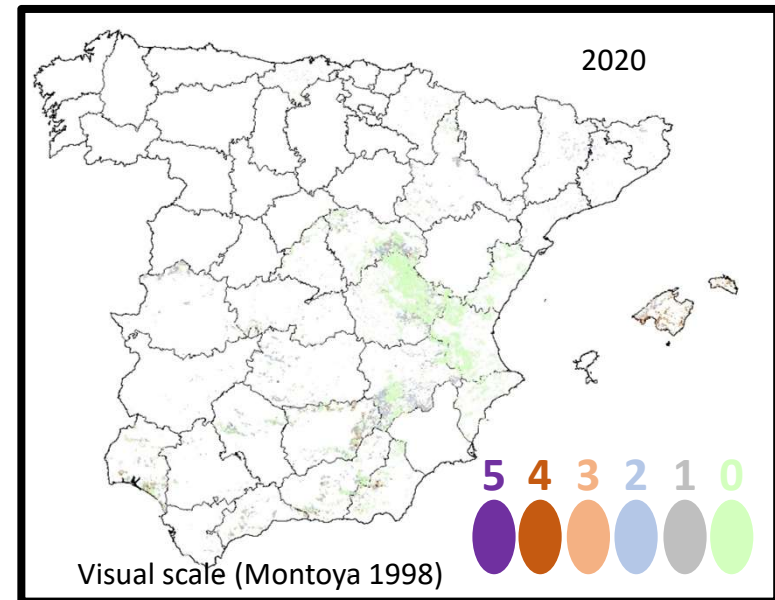
Monitoring programs

Extensive harmonized reference database

Area monitored annually



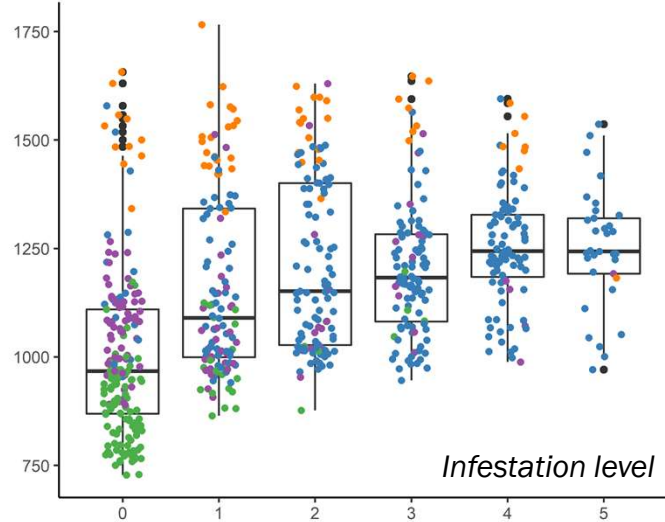
> 4×10^6 ha sampled / currently > 2.5×10^6 ha



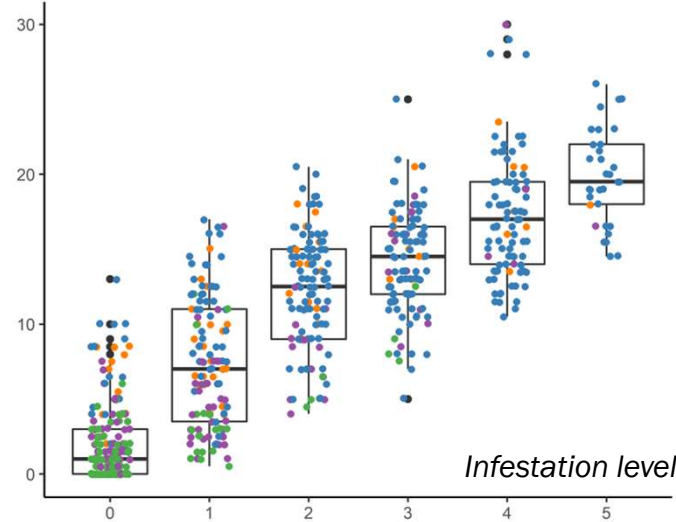
- **Heterogeneity** of stands
- Large **size** (~ 150 ha)
- Evaluation **consistency**
- Timing

Vulnerabilidad

Altitude (m)

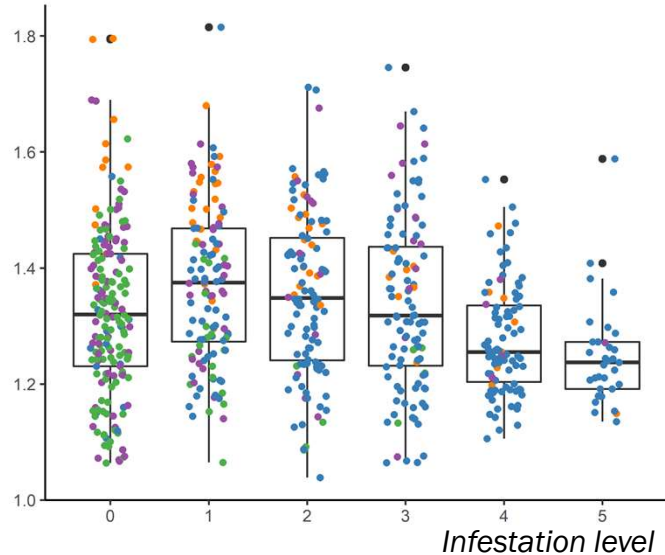


Cumulative infestation (2009-2017)

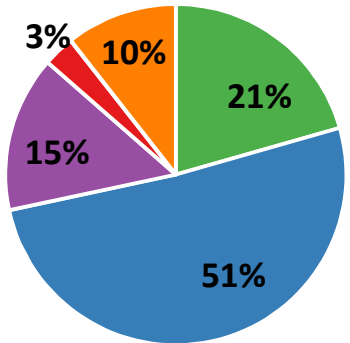
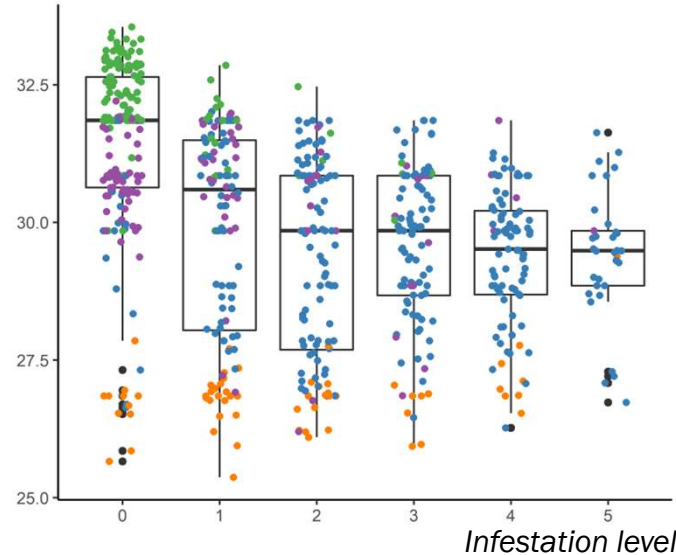


- *P. sylvestris*
- *P. pinaster*
- *P. pinaster*
- *P. nigra*
- *P. pinea*

Structural diversity (Rumple)



Tmax July

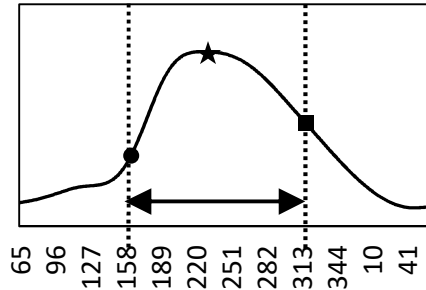


ROI: Cuenca
 > 457000 ha
 Date: 2017

Towards an early detection tool

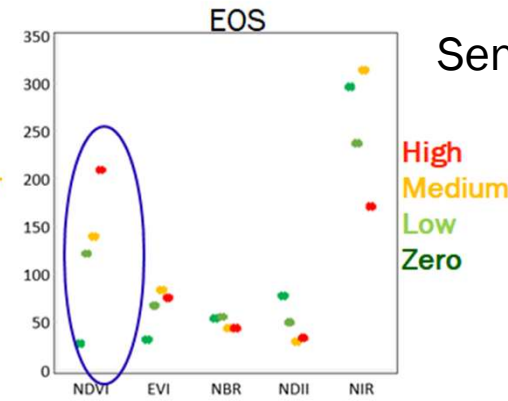
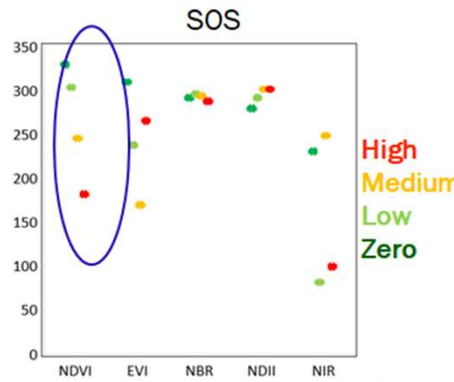
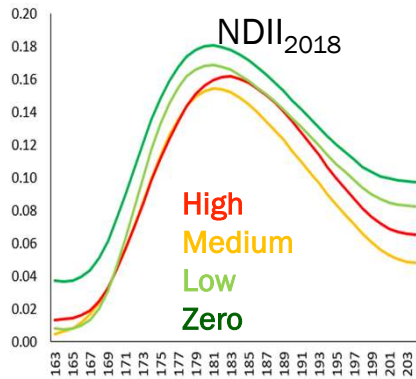
PHENOLOGICAL PARAMETERS

- SOS: Start Of Season ●
- EOS: End Of Season ■
- Season Length ↔
- Peak time ★

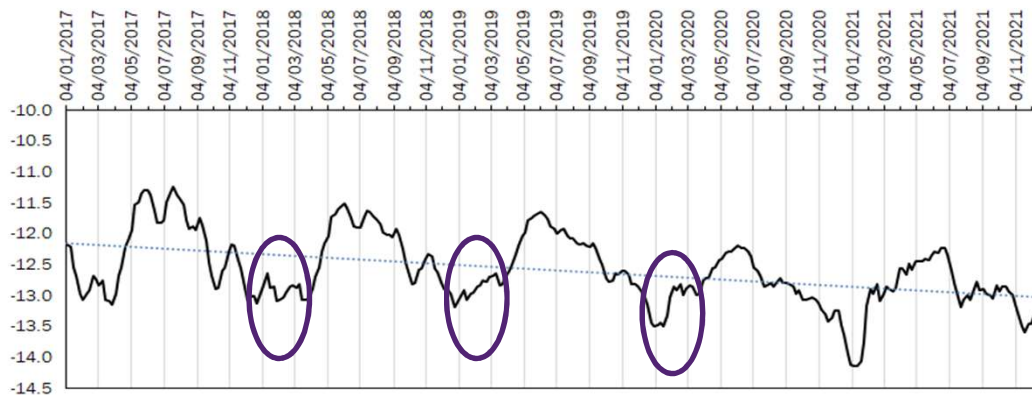


Data: dense time series (Sentinel-2, Landsat)

Tool: identify pattern and deviation from “expected”



Sentinel-2



Sentinel-1
VH intensity



Servicios productivos

Optical + climate data



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Agricultural and Forest Meteorology

journal homepage: www.elsevier.com/locate/agrformet



Primary productivity and climate control mushroom yields in Mediterranean pine forests



José Miguel Olano^{a,*}, Raquel Martínez-Rodrigo^{a,b}, José Miguel Altelarra^c, Teresa Ágreda^d, Marina Fernández-Toirán^a, Ana I. García-Cervigón^e, Francisco Rodríguez-Puerta^{a,b}, Beatriz Águeda^{a,b}

^a EIFAB – iuFOR. Universidad de Valladolid, Campus Duques de Soria, E-42004 Soria, Spain

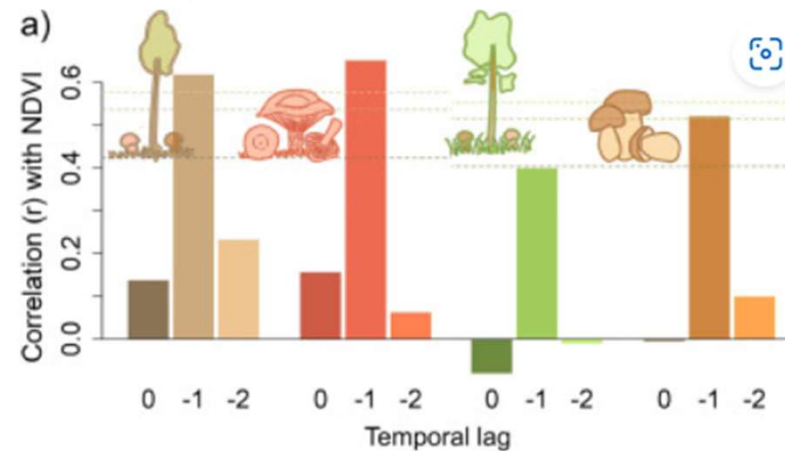
^b fóra forest technologies, Campus Duques de Soria, E-42004 Soria, Spain

^c Fundación Cesefor, Calle C, E-42005 Soria, Spain

^d Fundación Parque Científico de la Universidad de Valladolid, Campus Duques de Soria, E-42004 Soria, Spain

^e Department of Biology and Geology, Rey Juan Carlos University. C/ Tulipán s/n, E-28933 Móstoles (Madrid), Spain

Climate data
Landsat NDVI series
Mushroom yields



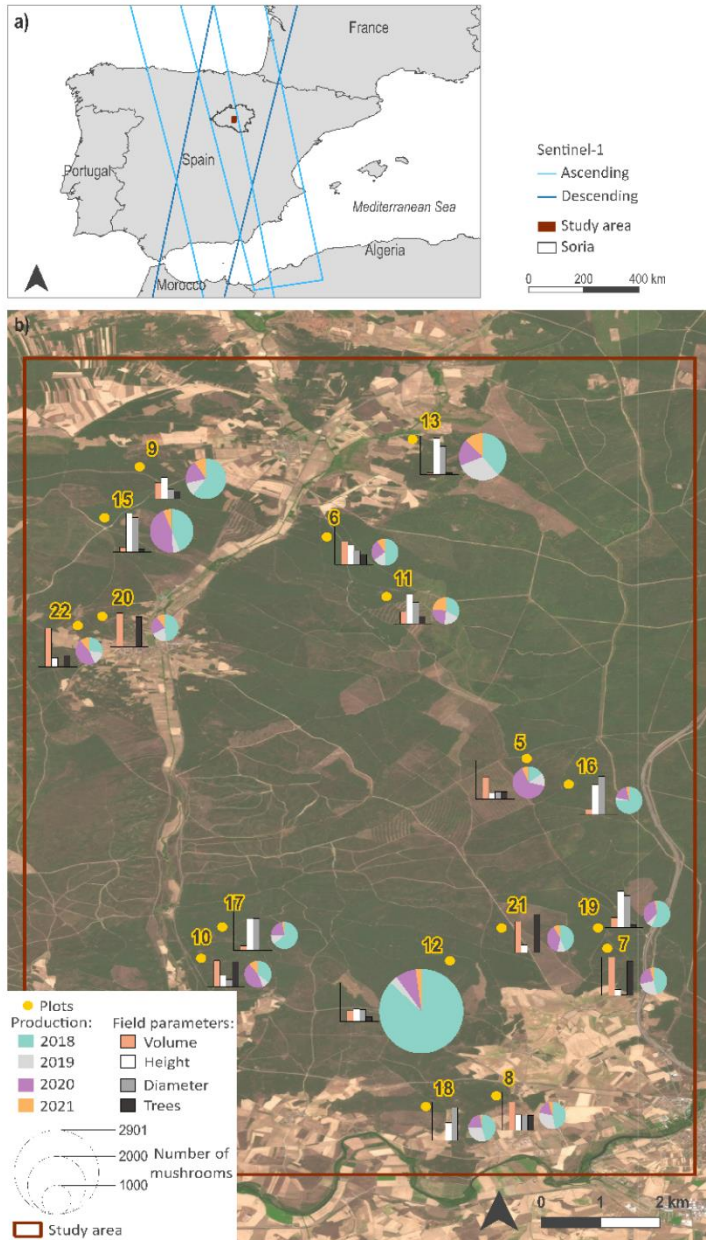
Mushroom yield influenced by previous year net primary production

Servicios ecosistémicos productivos

SAR + climate data

Sentinel-1 time series (2017-2021):

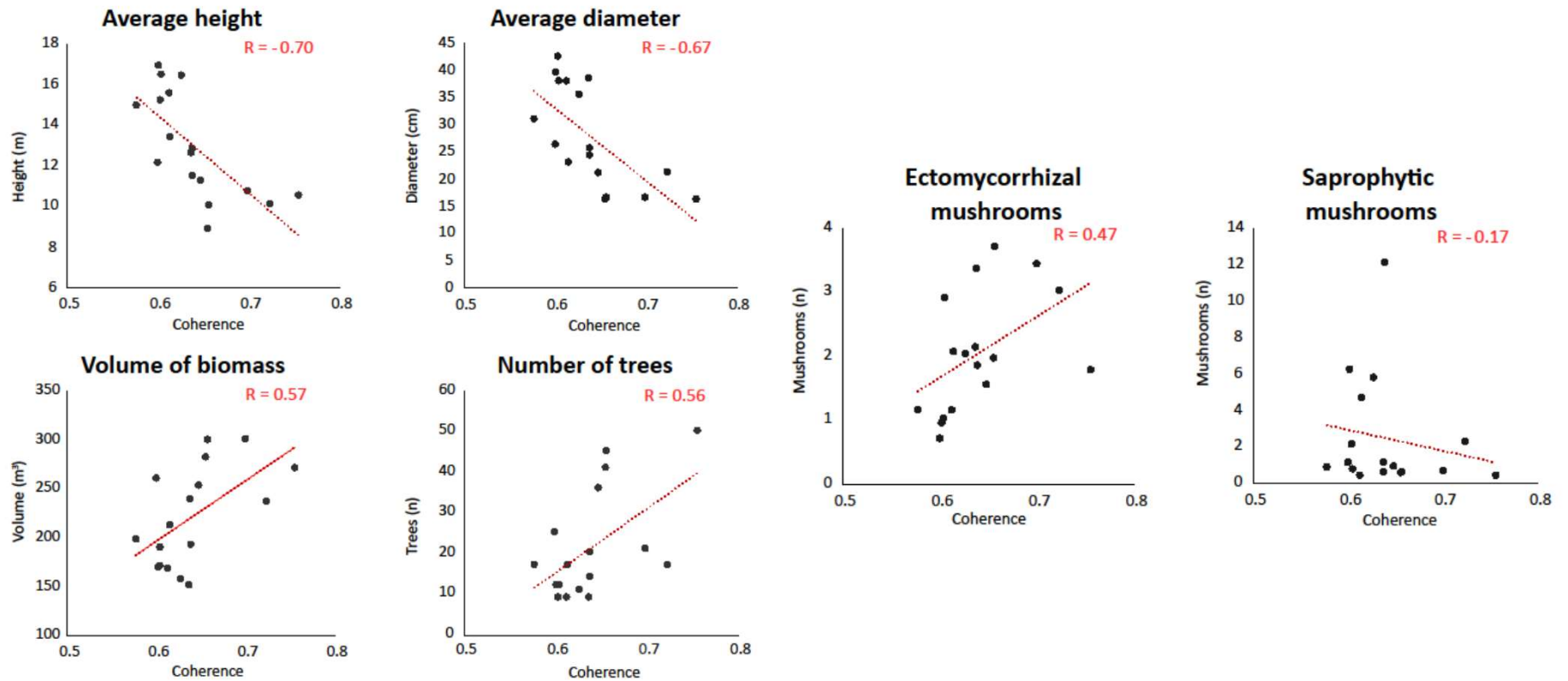
Interferometric coherence VV
Intensity (VV, VH)



Servicios ecosistémicos productivos

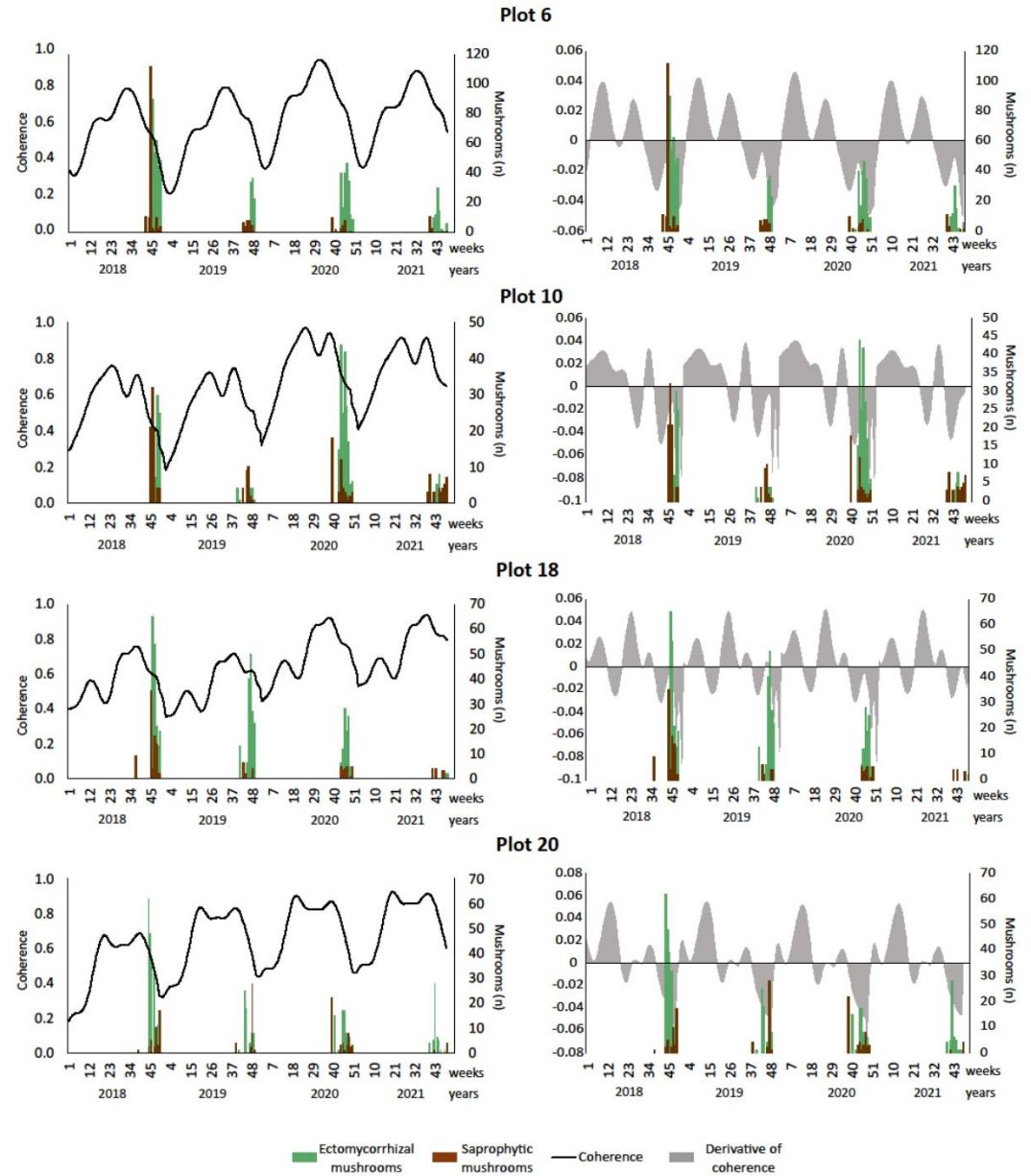
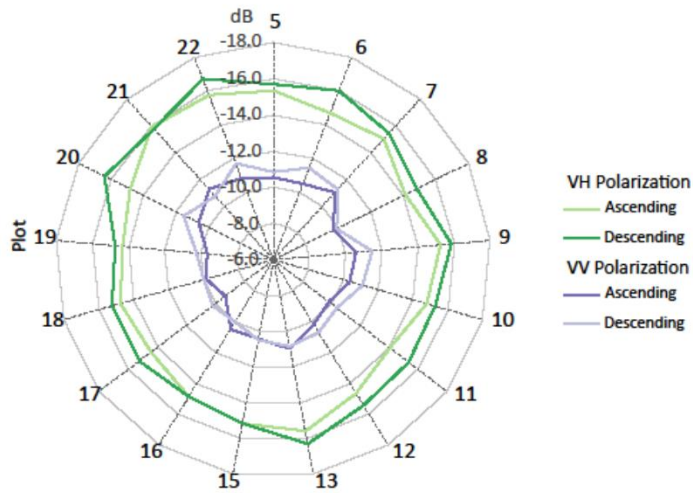
SAR + climate data

Interferometric coherence VV



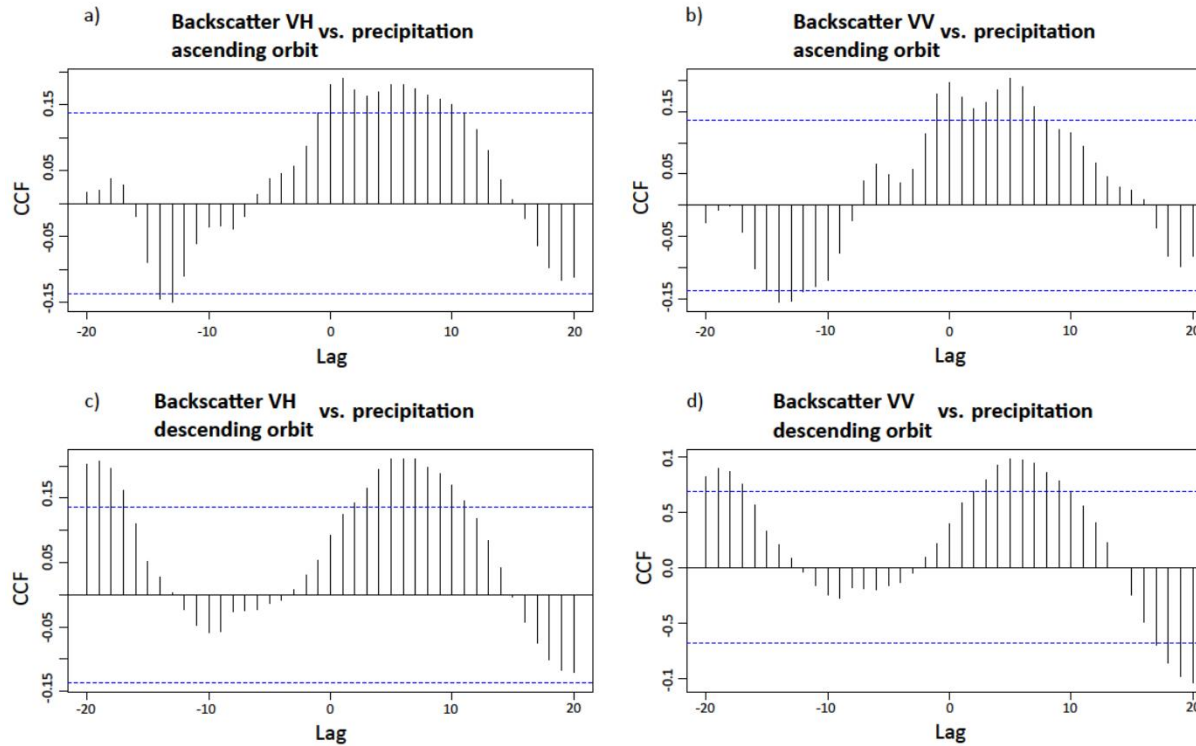
SAR + climate data

Intensity

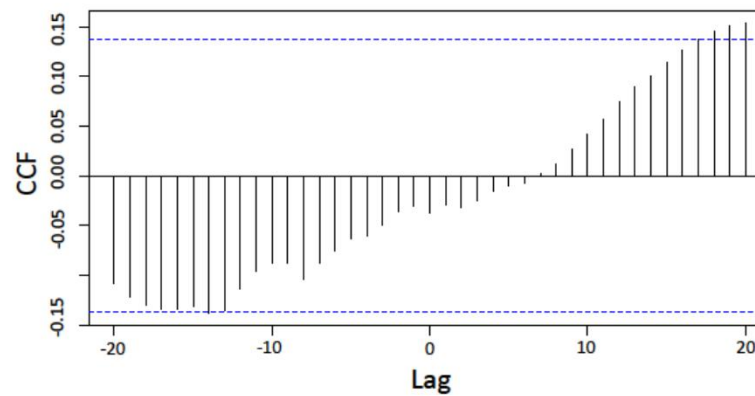


Servicios ecosistémicos productivos

SAR + climate data



Coherence vs. precipitation



¿Y otras aplicaciones?

Resin production

Carbon sinks

Characterization of habitat dynamics

Cartography of fire severity and recovery

Characterization of landscape processes of change

Species dynamics



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Las nuevas tecnologías aplicadas al conocimiento de los ecosistemas.
CENEAM. 19-21 de abril de 2023



Reflexiones

Necesidad de datos de campo

Sinergias entre datos de distinto tipo

Herramienta RS avanzada

Reto de integración con otros datos

Reto de modelización



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