EGU General Assembly 2020

Monitoring Mediterranean grass phenology from digital terrestrial camera and Sentinel-2 vegetation indices in an oak-grass savanna ecosystem

M.P. González-Dugo, P.J. Gómez-Giráldez, M.J. Pérez-Palazón, M.J. Polo

Andalucía se mueve con Europa

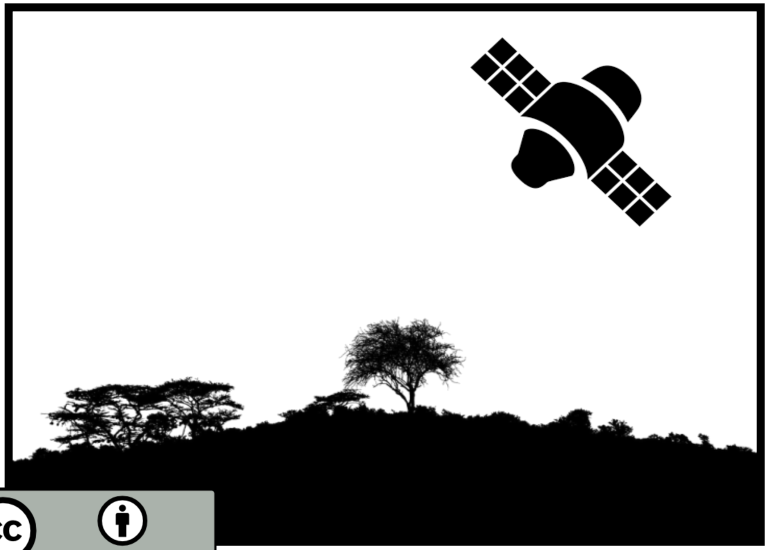
IFAPA Instituto de Investigación y Formación Agraria y Pesquera

DFH Dinámica Fluvial e Hidrología UNIVERSIDAD DE CÓRDOBA

Junta de Andalucía
INSTITUTO DE INVESTIGACIÓN Y FORMACIÓN AGRARIA Y PESQUERA
Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional

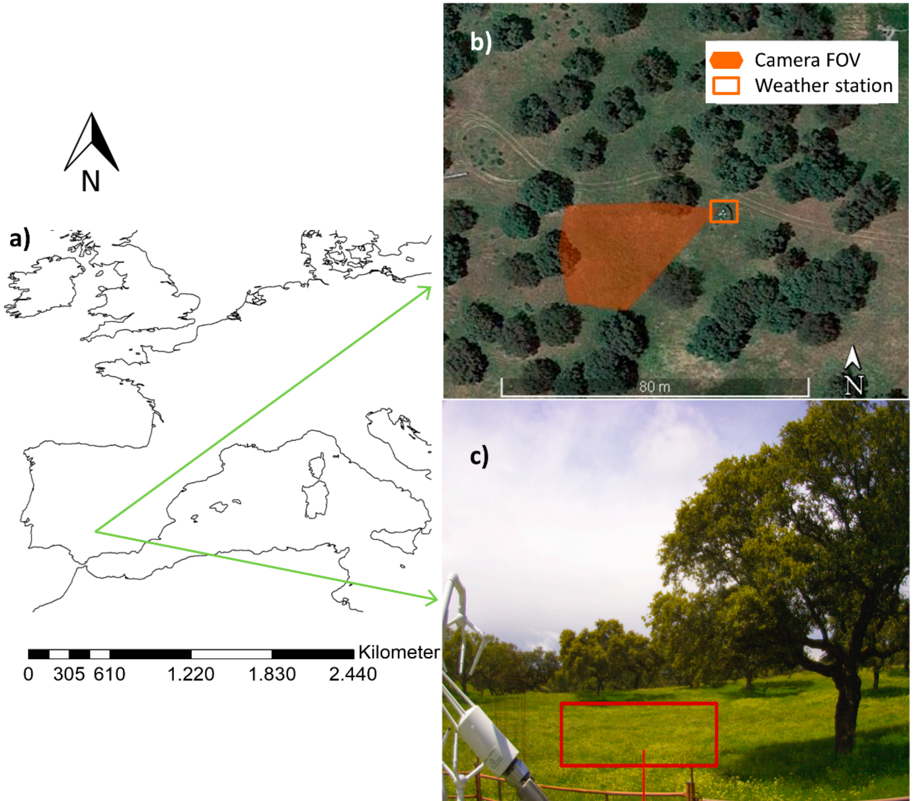
Introduction & objective



- → Annual grasslands are an essential component of Mediterranean oak savannas, the most extensive agroforestry system in Europe. They provide important ecological services and are the primary source of fodder for livestock and wildlife.
- → Monitoring its phenology is key to adequately assess the impacts of global warming on different time scales and identify pre-critical states in the framework of early warning decision making services.
- → The natural variability of the climatic-hydrological regime in these areas and the usually complex spatial patterns of the vegetation, with sparse distribution and multiple layers, encourage the exploitation of available data from remote sensing sources.

Objective: To explore the potential of the Sentinel-2 (S2) satellites to monitor the phenological changes obtained by a digital camera over Mediterranean grasslands using a variety of vegetation indices derived from broadband and narrowband, taking advantage in the latter case of the new possibilities offered by the red-edge bands of S2; and study the relationship between satellite VIs and the hydrological state of the system, providing insight on their ability to monitor grassland phenology

Study site



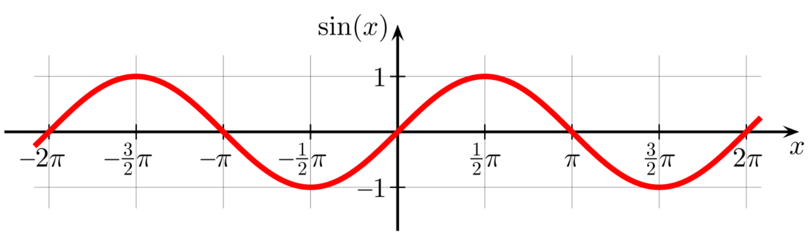
Green Chromatic Coordinate

$$GCC = \frac{G}{R + G + B}$$

Sta. Clotilde experimental site (Cardeña, Spain)
895 mm average rainfall
735 m.a.s.l.
Winter temp. below 0 °C
Summer temp. above 40 °C
CC5MPX Camera
Field of view (FOV): 790 m^2

50 % Amplitude method:

→ Start of season (SOS): 50% amplitude reached
→ Peak of season (POS): maximum
→ End of season (EOS): 50% amplitude on the right of the peak
→ Fitting values to double logistic function

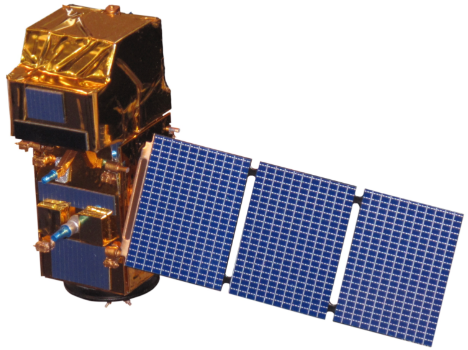


Study period:December 2017 – May 2019

IFAPA Instituto de Investigación y Formación Agraria y Pesquera

Methodology

EGU General Assembly



Vegetation indices
- EVI
- EVI2
- GCCs
- GNDVI
- IRECI
- MTCI
- NDVI
- S2REP
- SAVI

Statistical analysis with GCC:
- Pearson Matrix correlation
- Principal Component Analysis (PCA)

Applying 50% amplitude method to most representative indices

Study period: December 2017 – May 2019

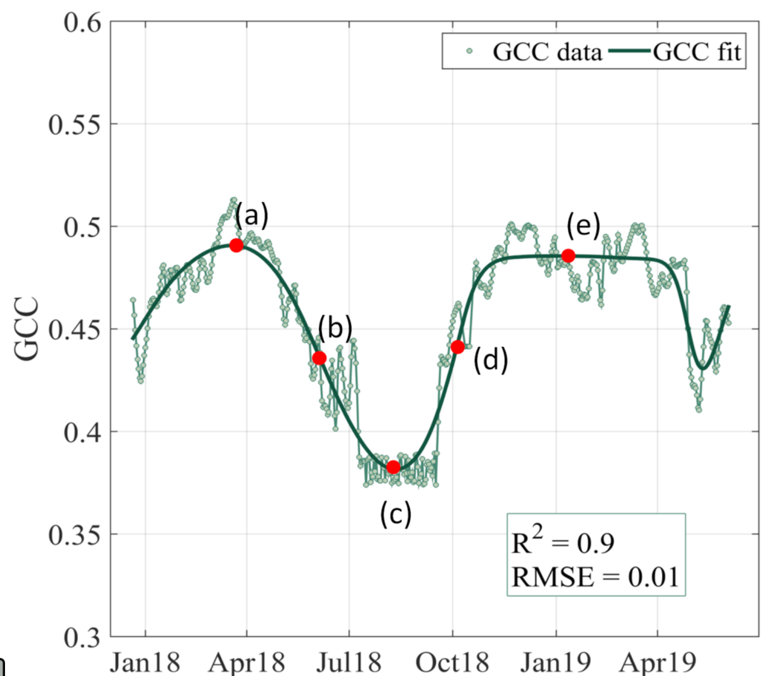
Analysis satellite phenology – Soil Moisture

→ Soil moisture from ENVIROSCAN probe
→ Most representative index
→ 50% amplitude method

Extended period: December 2017 – May 2019

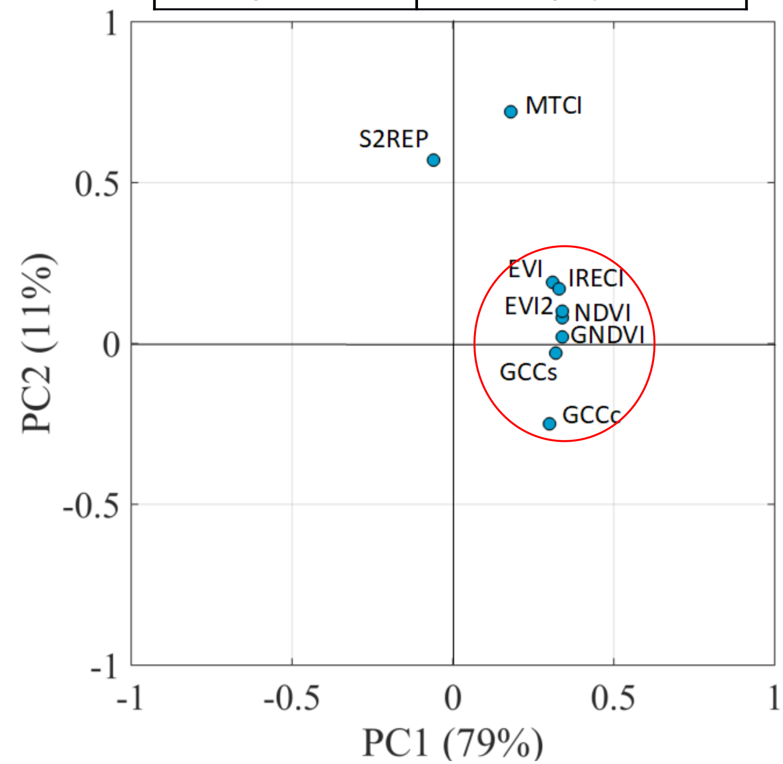
Results

(a) POS 1 | (b) EOS | (c) Baseline | (d) SOS | (e) POS 2

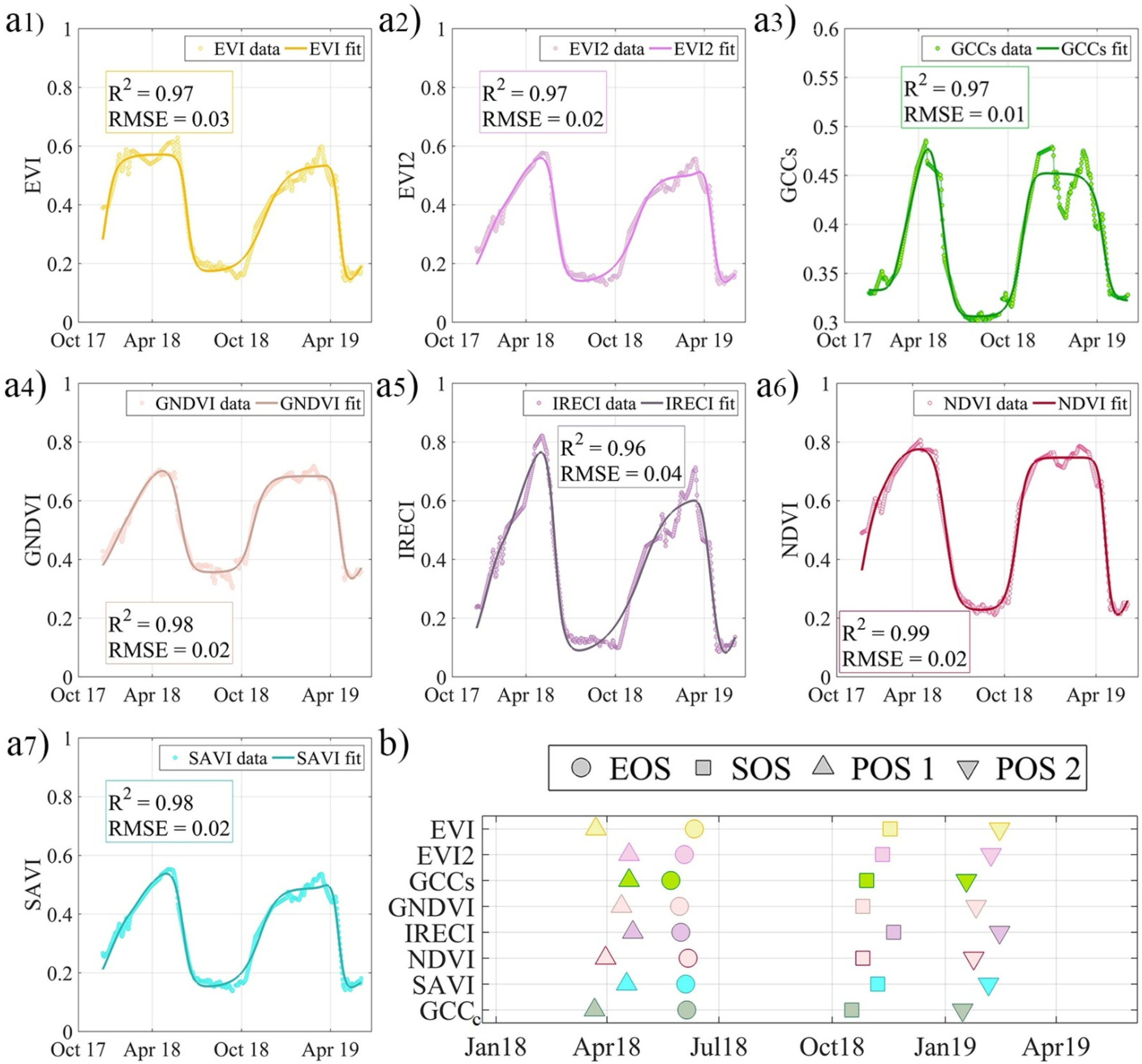


Pearson matrix correlation

Variable	r (GCCc)
EVI	0.72*
EVI2	0.77*
GCCs	0.79*
GNDVI	0.82*
IRECI	0.71*
MTCI	0.52*
NDVI	0.83*
S2REP	-0.44*
SAVI	0.78*



Results



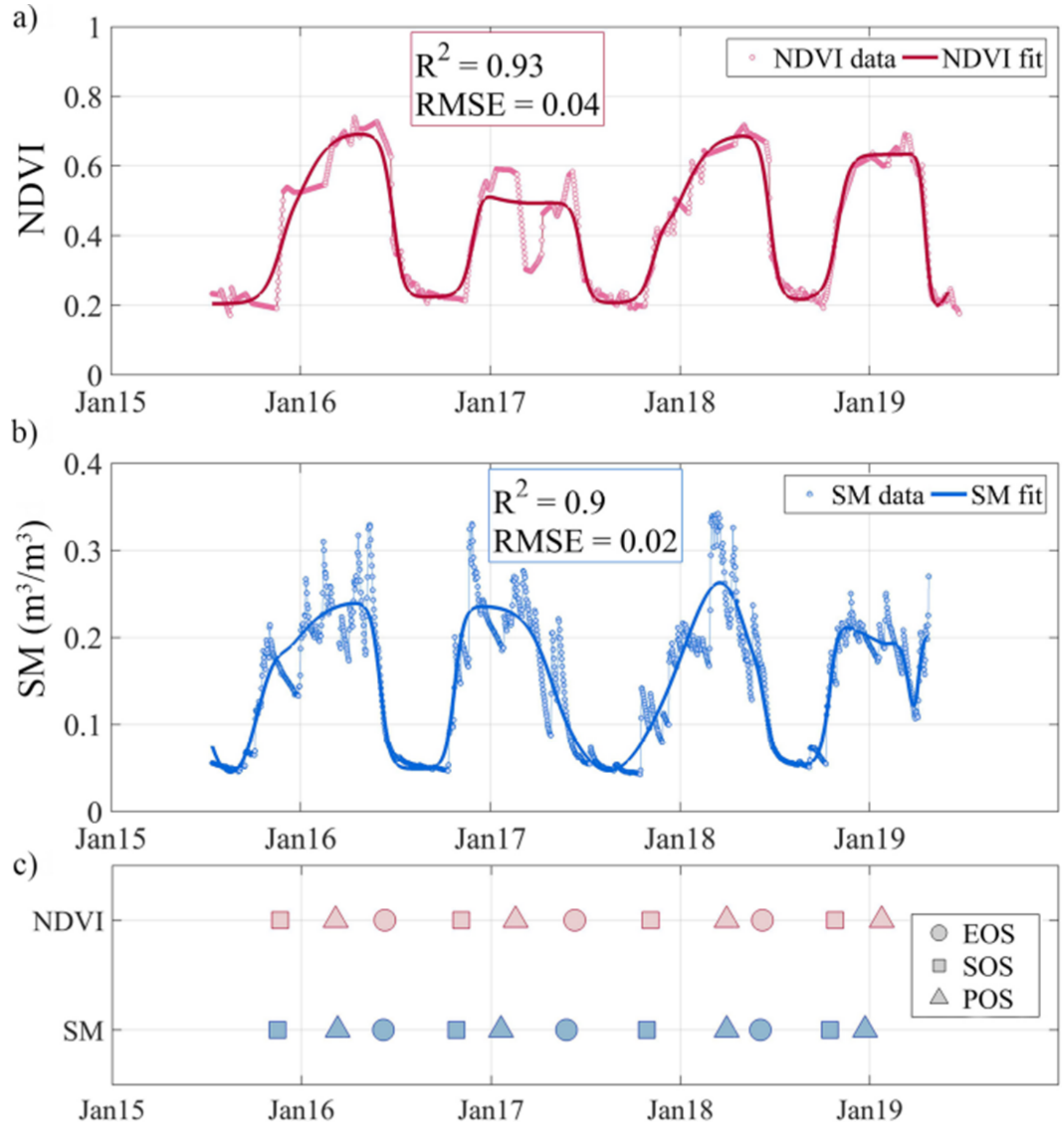
a1)
EVI data
EVI fit
R^2 = 0.97
RMSE = 0.03
EVI
a2)
EVI2 data
EVI2 fit
R^2 = 0.97
RMSE = 0.02
EVI2
a3)
GCCs data
GCCs fit
R^2 = 0.97
RMSE = 0.01
GCCs
a4)
GNDVI data
GNDVI fit
R^2 = 0.98
RMSE = 0.02
GNDVI
a5)
IRECI data
IRECI fit
R^2 = 0.96
RMSE = 0.04
IRECI
a6)
NDVI data
NDVI fit
R^2 = 0.99
RMSE = 0.02
NDVI
a7)
SAVI data
SAVI fit
R^2 = 0.98
RMSE = 0.02
SAVI
Oct 17 Apr 18 Oct 18 Apr 19
b)
EOS SOS POS 1 POS 2
EVI
EVI2
GCCs
GNDVI
IRECI
NDVI
SAVI
GCCc
Jan18 Apr18 Jul18 Oct18 Jan19 Apr19

Extended period

The marked and mostly synchronized seasonality of both variables can be observed.

In general, an average delay between 3 and 10 days can be noted in NDVI with respect to SM.

The highest differences were found in POS of 2016/2017. During that year, the grassland was plowed and sown in the middle of February.



Conclusions

→ The estimation of phenology using field measured GCCc and the 50% amplitude method corresponded well with the visual inspection

→ NDVI was the satellite index that best reproduced the behavior of GCCc, with the highest correlation (r = 0.83) and less than 10 days of difference for all the phenological parameters studied

→ NDVI and SM behavior during the four growing seasons showed a high synchronization

→ This results suggest the possibilities of monitoring the hydric state of the soil using the phenological parameters obtained from S2 NDVI under certain conditions

Thank you for your attention

Acknowledgements: SensDehesa (PP.PEI.IDF201601.16) project cofunded at 80% by the European Regional Development Fund (ERDF), Operative Program of Andalusia 2014-2020 and additional support was provided by the project "Control and early warning of critical ecohydrological states in areas of Dehesa and high mountains through terrestrial photography", funded by the Biodiversity Foundation, Spanish Ministry of Agriculture, Fisheries, Food, and Environment.

IFAPA Instituto de Investigación y Formación Agraria y Pesquera

Junta de Andalucía

INSTITUTO DE INVESTIGACIÓN
Y FORMACIÓN AGRARIA Y PESQUERA
Consejería de Agricultura, Ganadería,
Pesca y Desarrollo Sostenible

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional