



EXPLORING
ECOSYSTEMS'
HEALTH
FROM SPACE

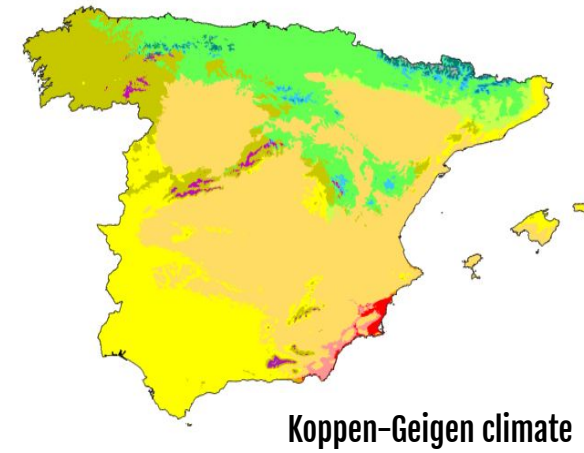


University of Córdoba



51 years
18.646 students
2.882 researchers
4 campus

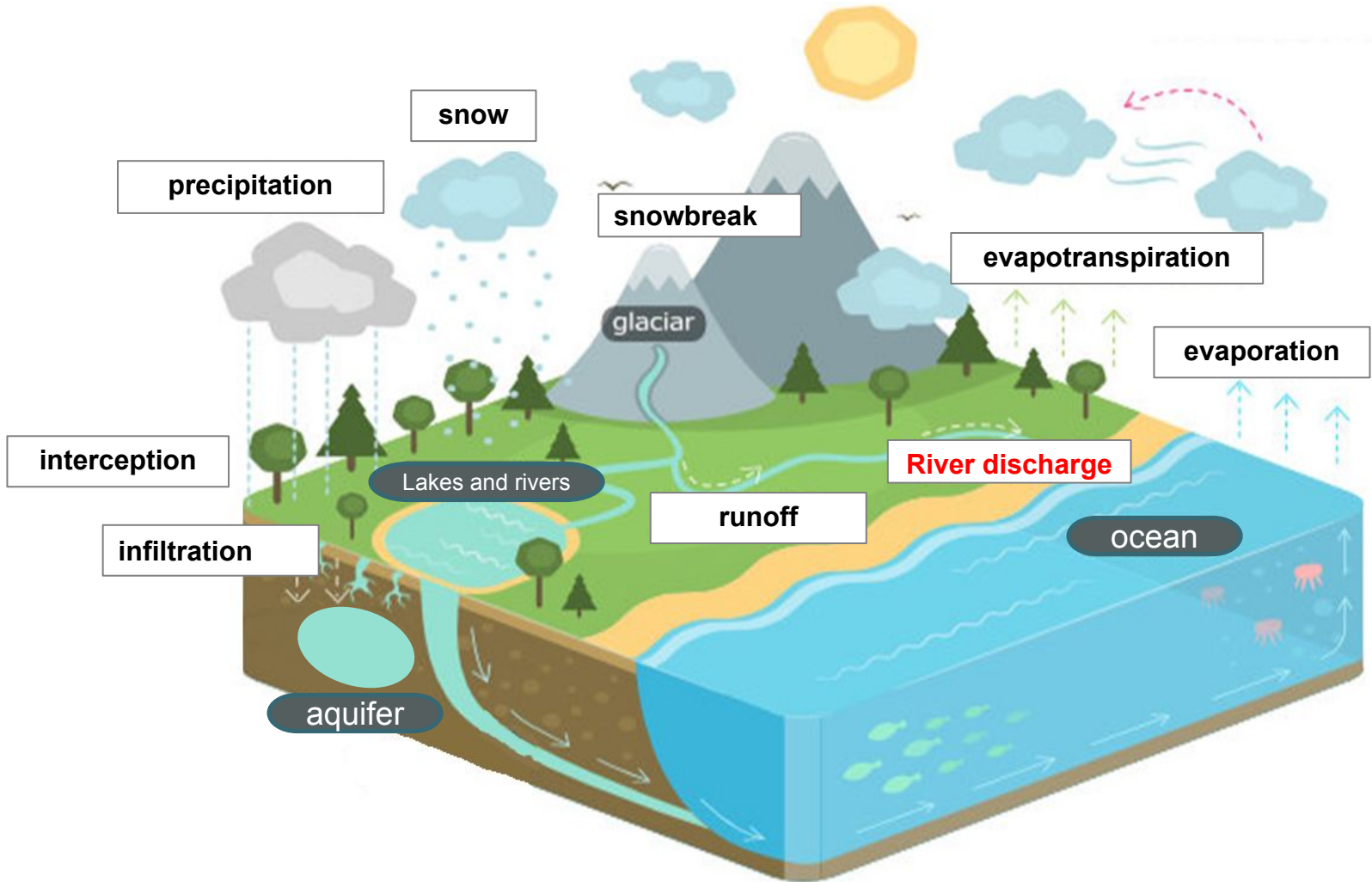
Spain





MONITORING THE HYDROLOGICAL CYCLE

Water ¿How many, where, and until when?



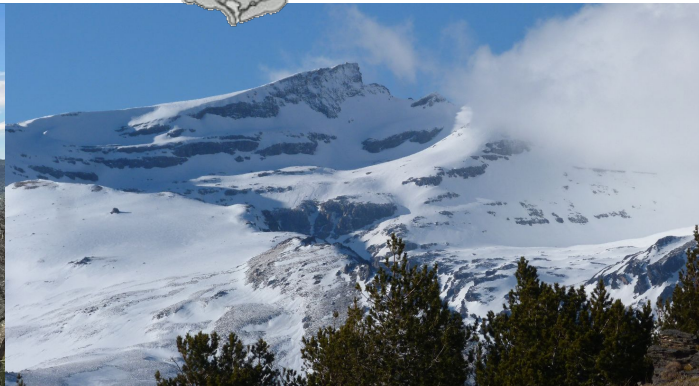
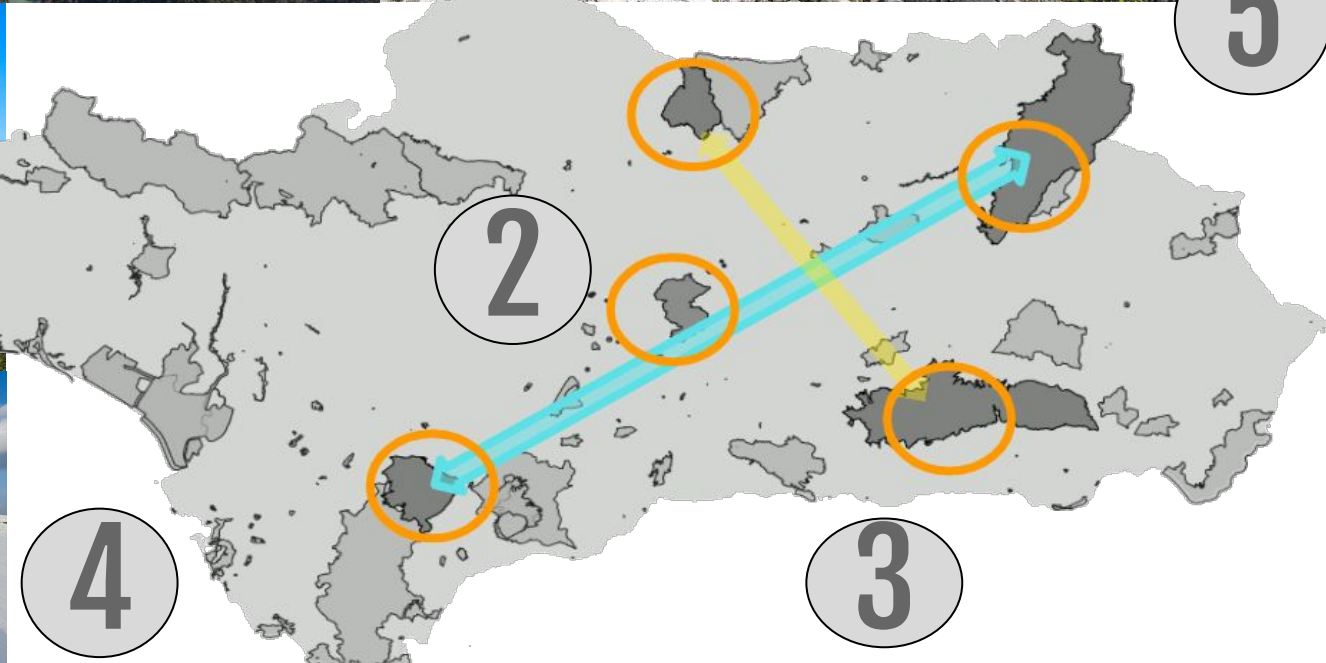
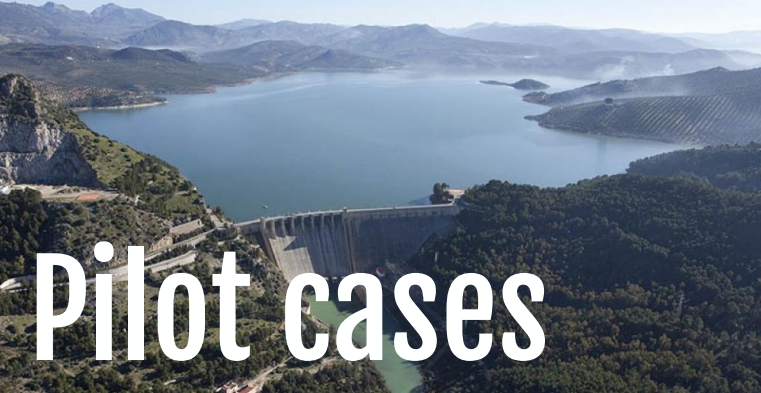
16/1/2017

16/1/2022



Water monitoring in Mountain areas of Andalusia

Pilot cases



How we do it?

Data

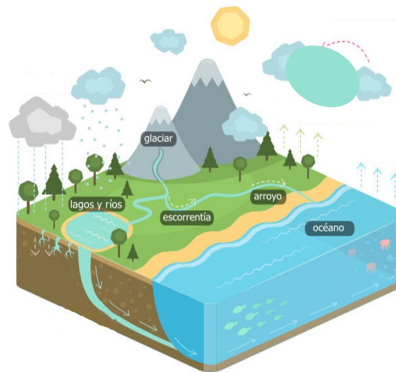
Meteo, Soil,
Vegetation,
Satellites,
Photography...

Which temperature?
How much is raining?
How is the vegetation growing?



(Hydrological) MODELS

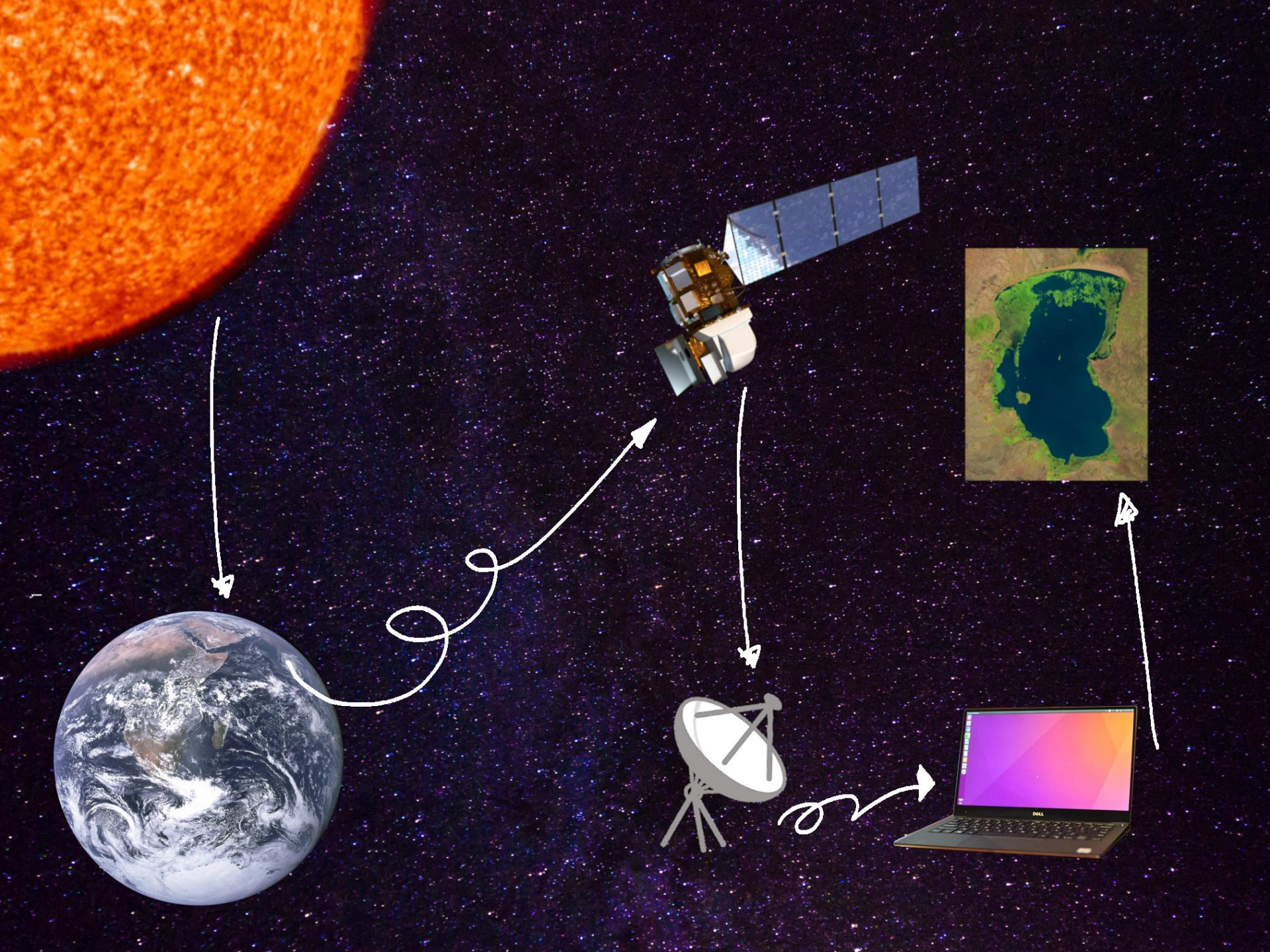
How much water is infiltrated?
How much water the ecosystem
is using?



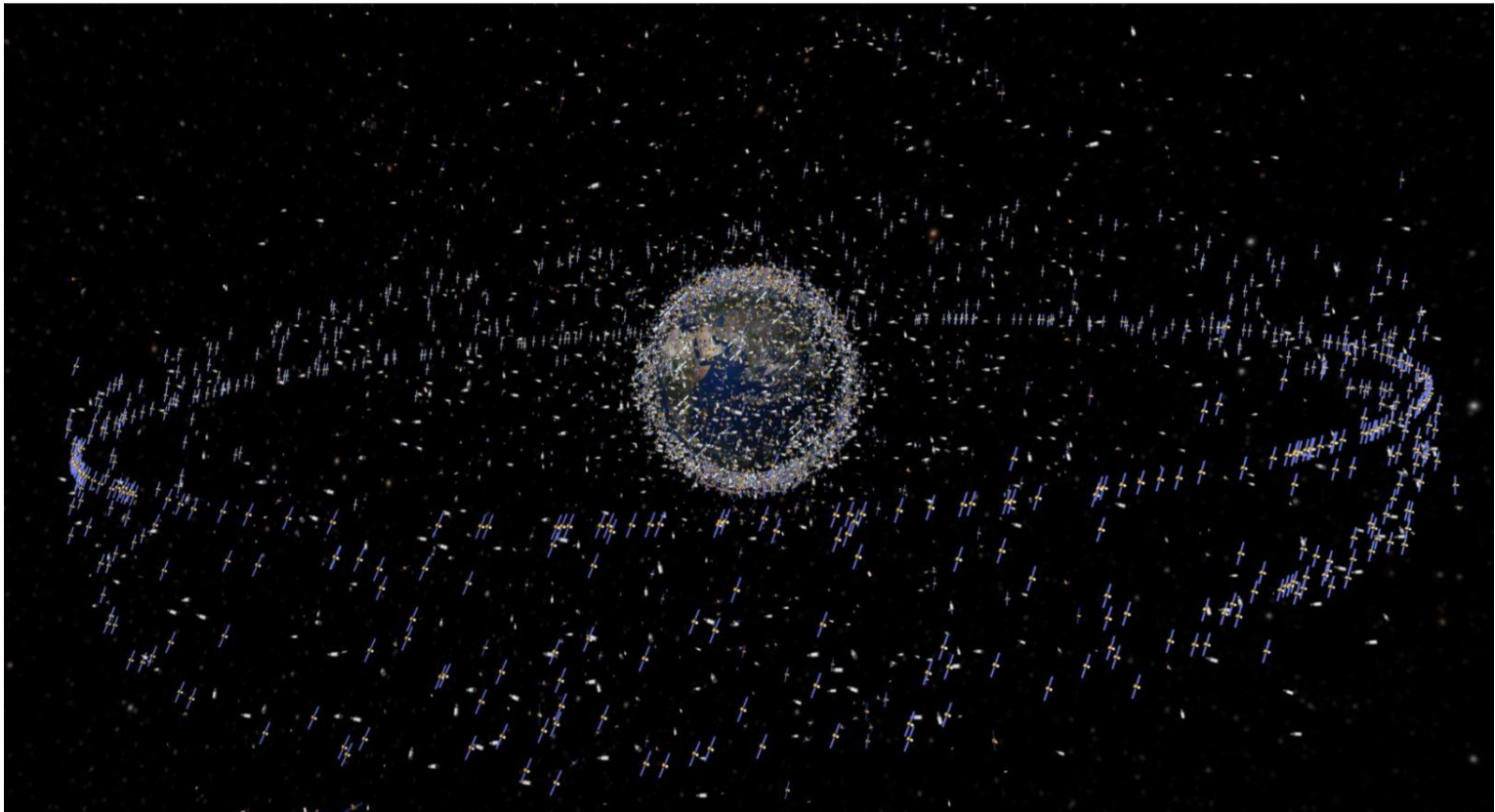
Results

How much is going to rain?
How drought is affecting
vegetation?

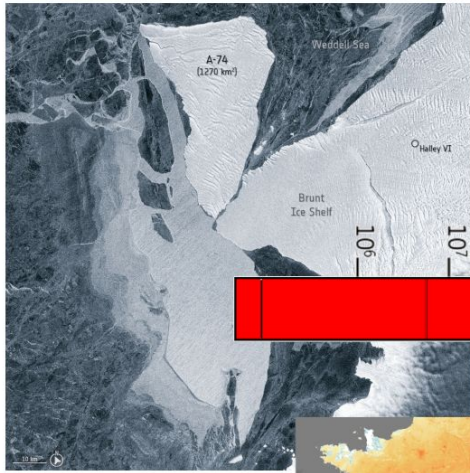




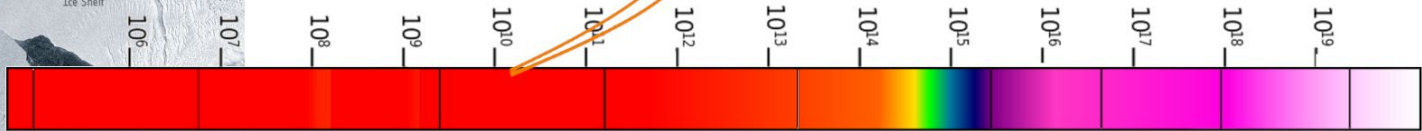
Space Junk



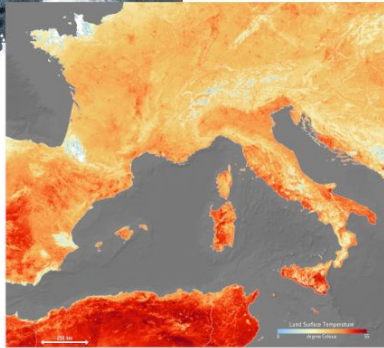
ELECTROMAGNETIC SPECTRUM



Radar/Microwaves, transparent to the clouds, soil humidity



Radio Microondas TIR NIR VIS UV Rayos X



Thermal, surface temperature, water and stress

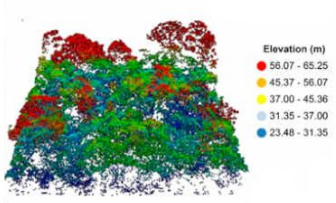
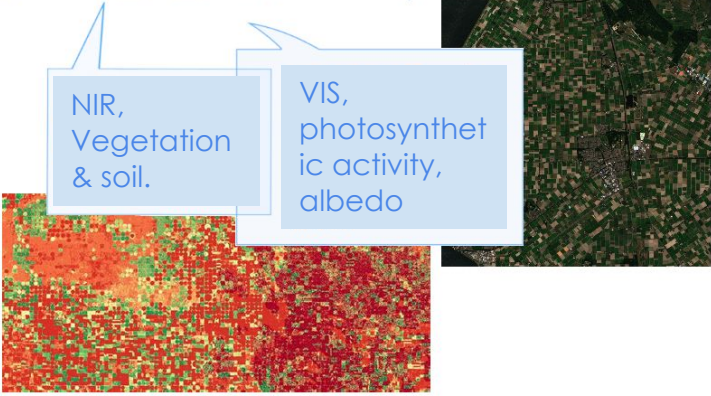


Image courtesy of Singh et al., 2015 (Creative Commons License)

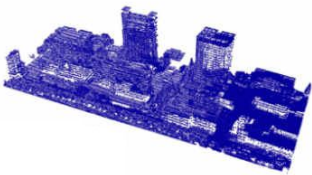
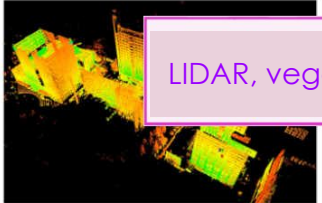
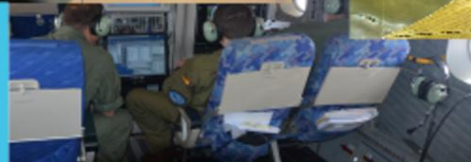
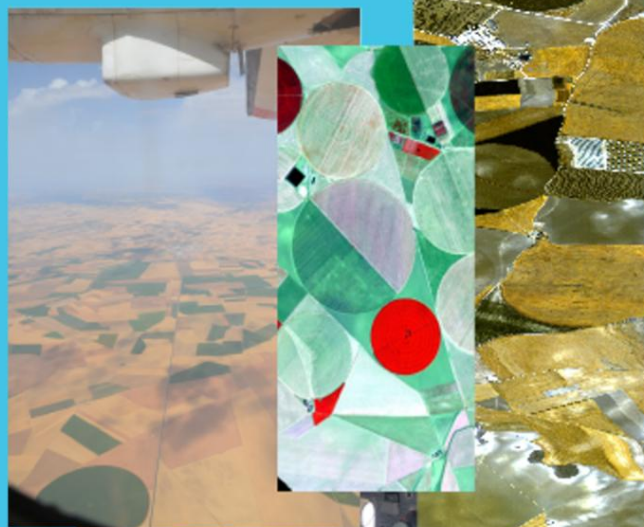
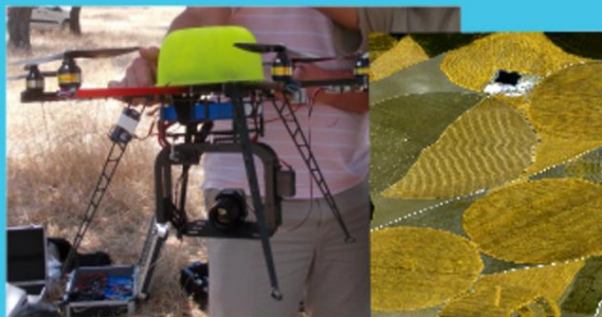
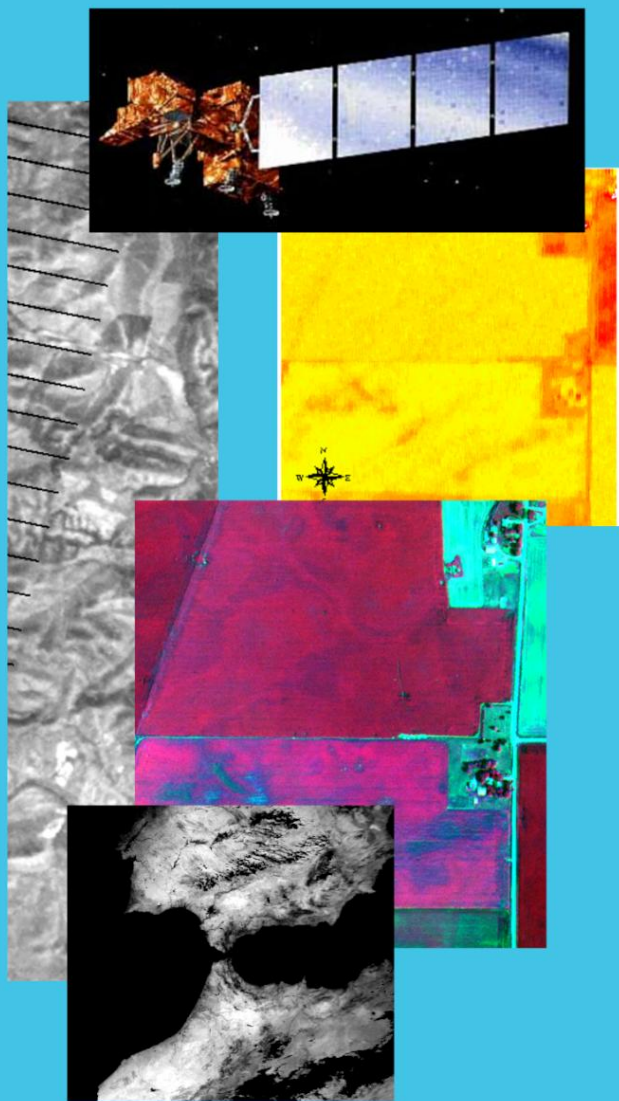


Image courtesy of Cheng et al., 2014 (Creative Commons License)



LIDAR, vegetation structure.

SATELLITE



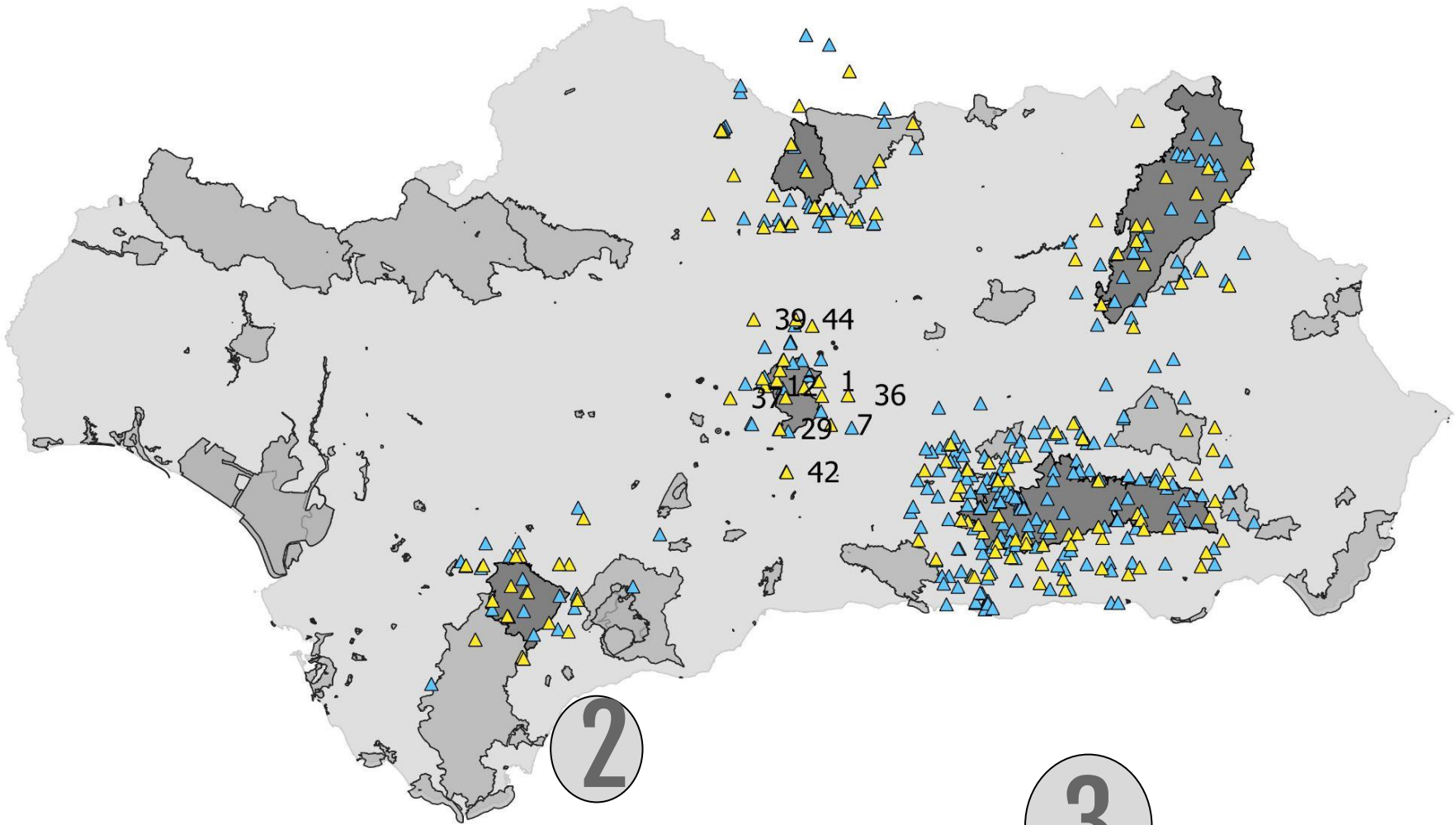
FIELD



AIRBORNE

1

5



2

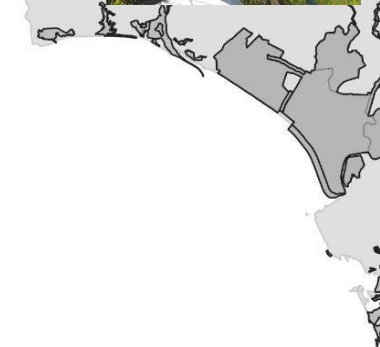
3



1



5



2

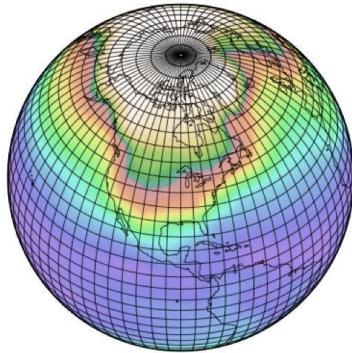
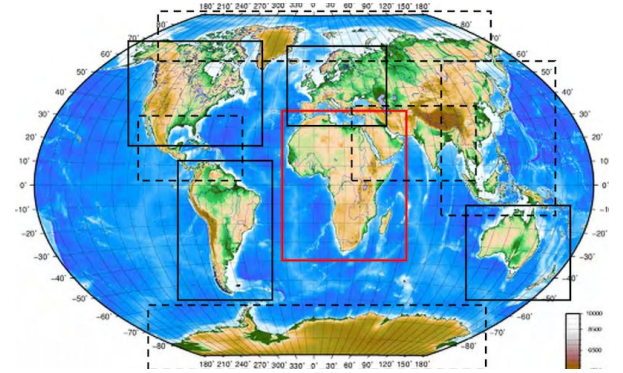


3



39, 44
37, 12, 1, 36
29, 7
42

Uncertain and heterogeneous reality



What will happen?

What's (will) going on?



Day Week Month Season Year Decade ...

What happened?

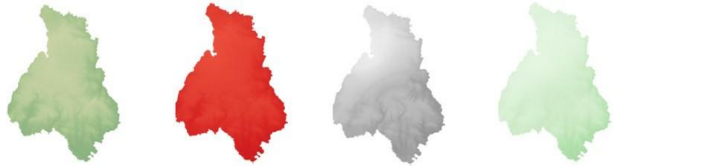
**Meteo
Predictions**

**Seasonal
Predictions**

Proyections long term

Temperature (°C/annual) > 60 yr historical data

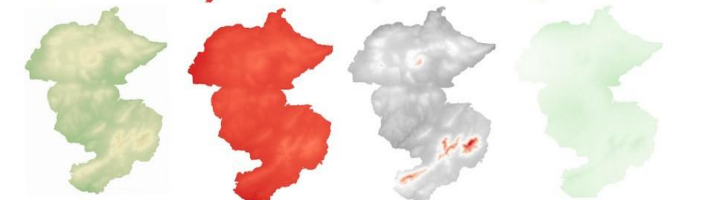
CARDEÑA
MONTORO



CAZORLA



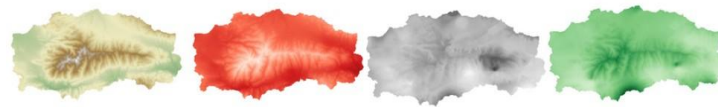
SUBBÉTICA



GRAZALEMA

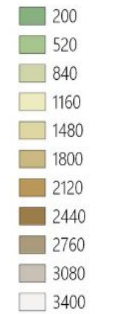


SIERRA
NEVADA

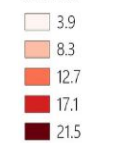


DEM Average Tendency Deviation

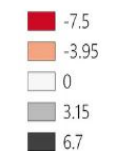
MDT (m.s.m.)



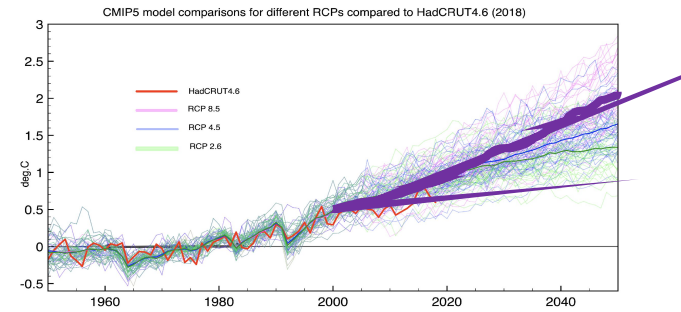
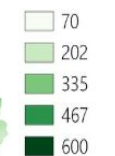
Temperatura media
(°C/año)



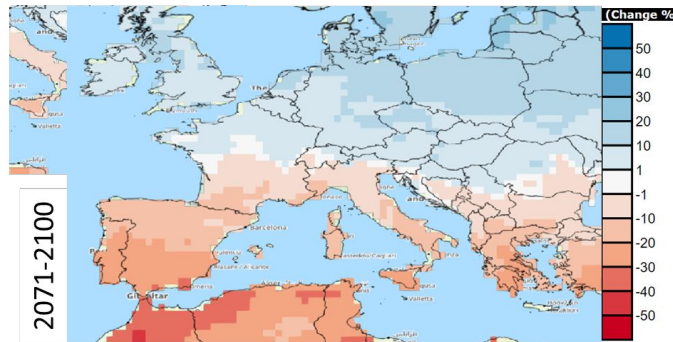
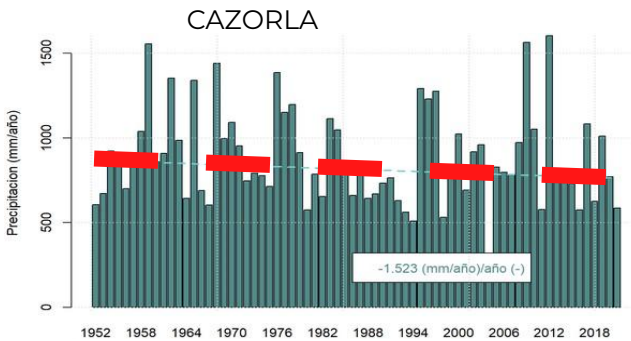
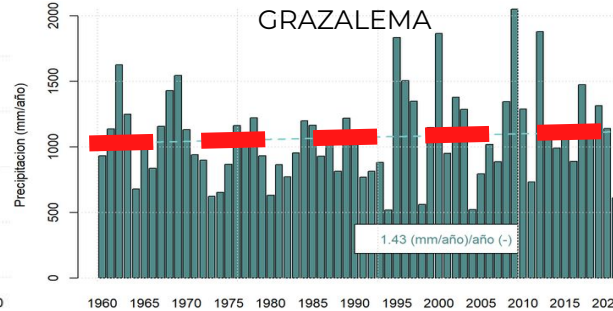
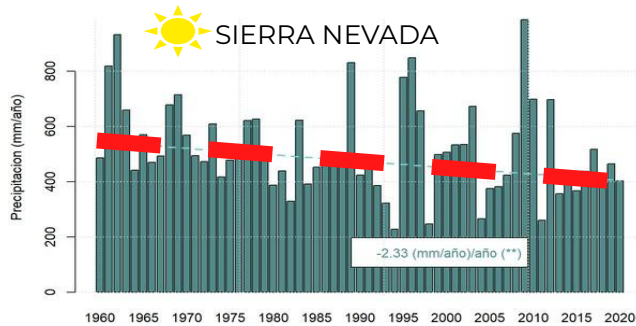
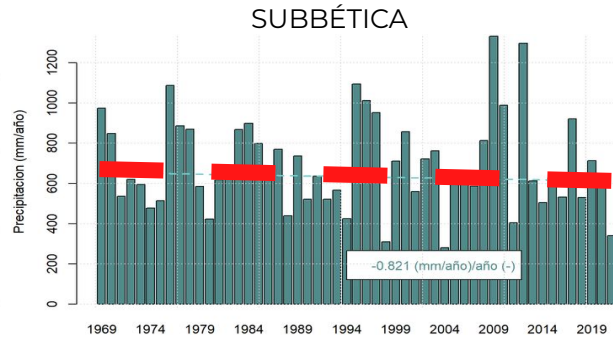
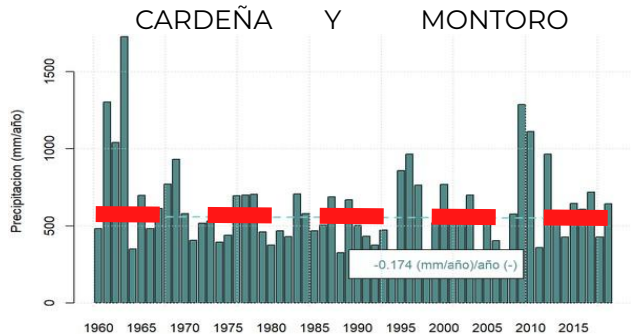
Tendencia
(mm/año)/año



Desviación

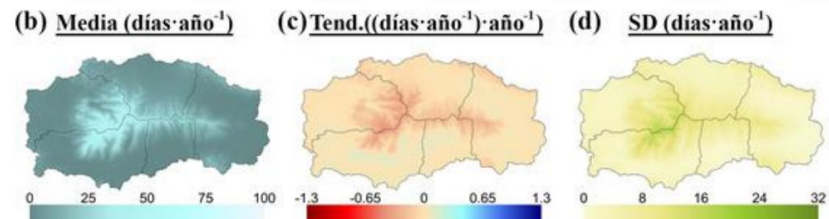
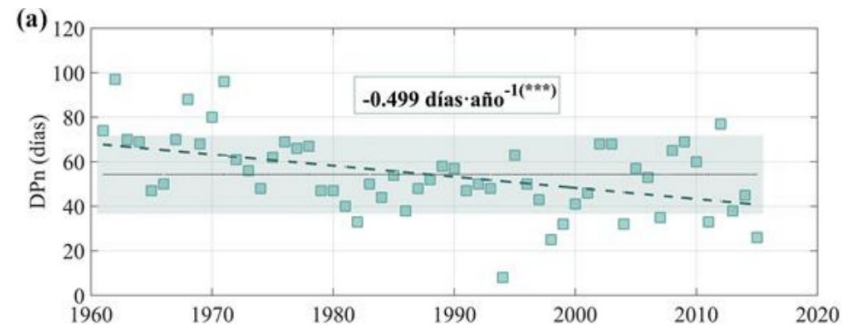
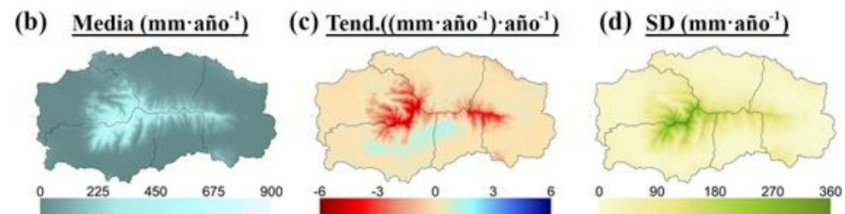
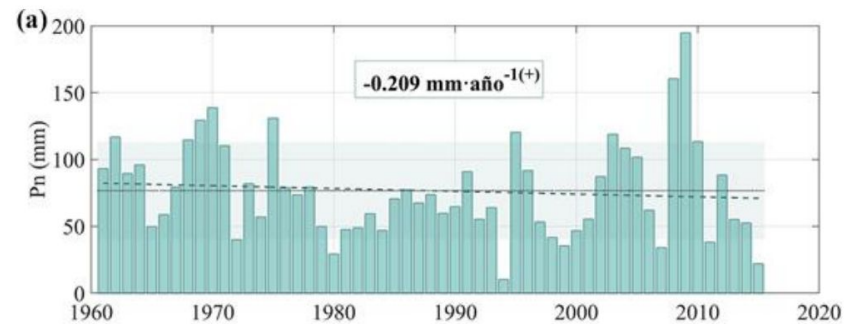


Precipitation (mm/year)



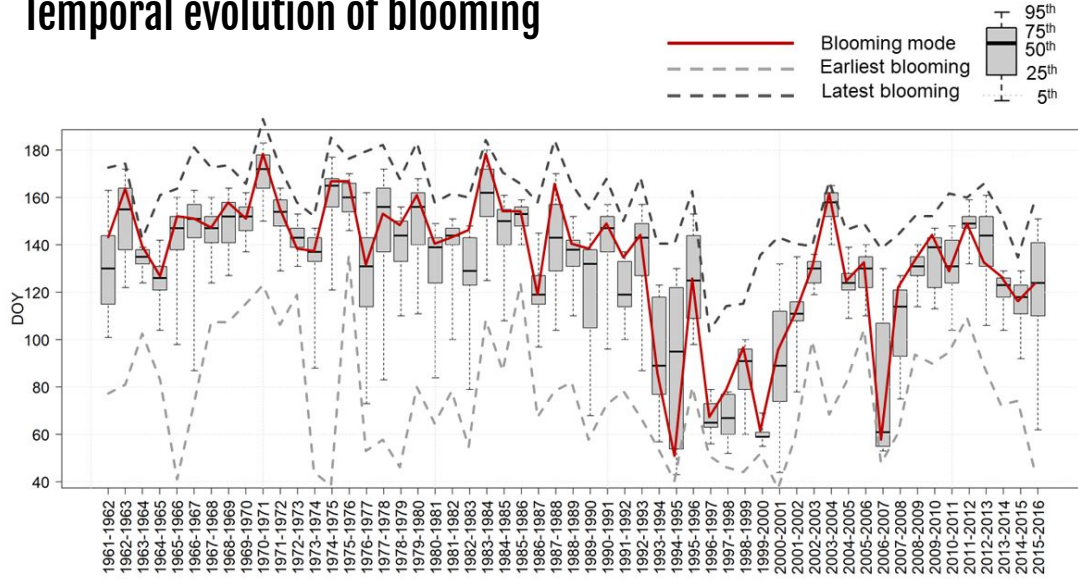
Precipitation RCP 8.5

P Snow (mm/year)



Implications...vegetation

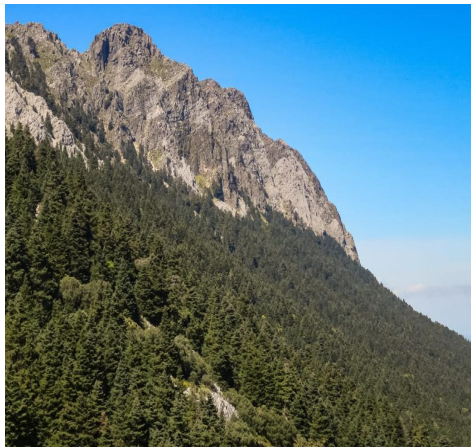
Temporal evolution of blooming



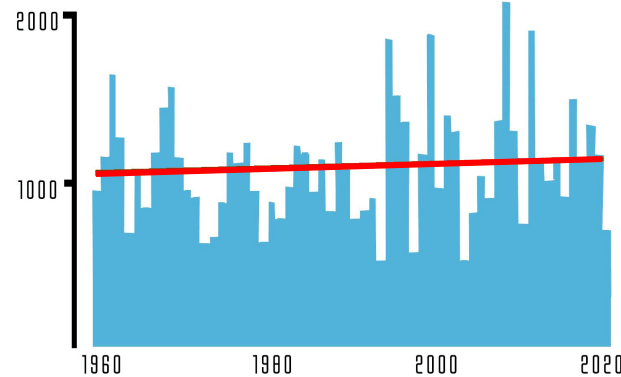
Blooming conditions

From the 1st January

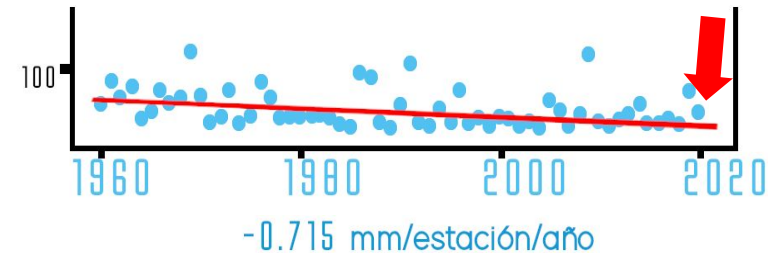
- 30 days with $T_{med\ day} > 6^{\circ}C$
- 26 days with $T_{min\ day} < 4^{\circ}C$



Precipitation mm/year



SUMMER precipitation mm/year

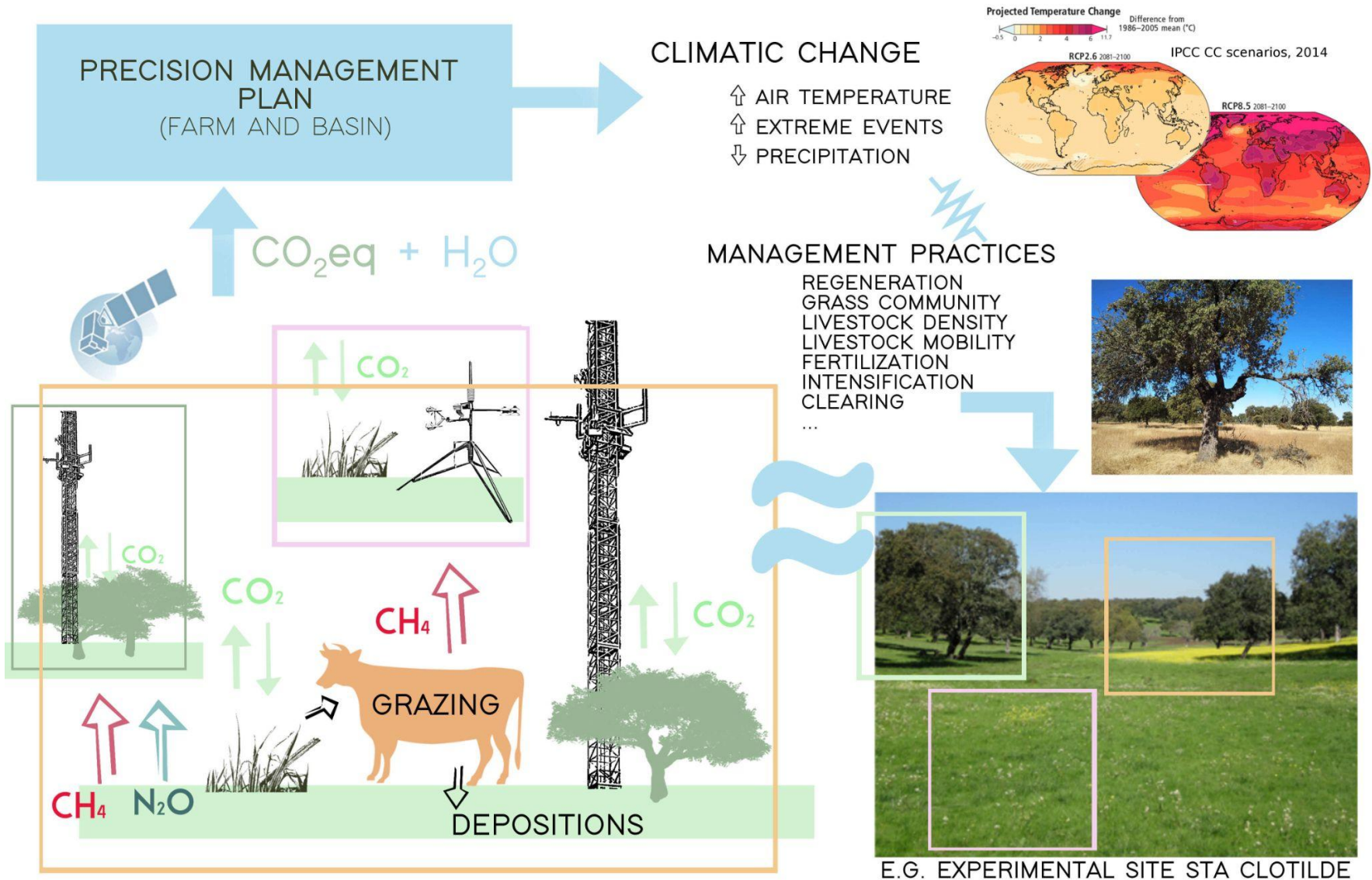




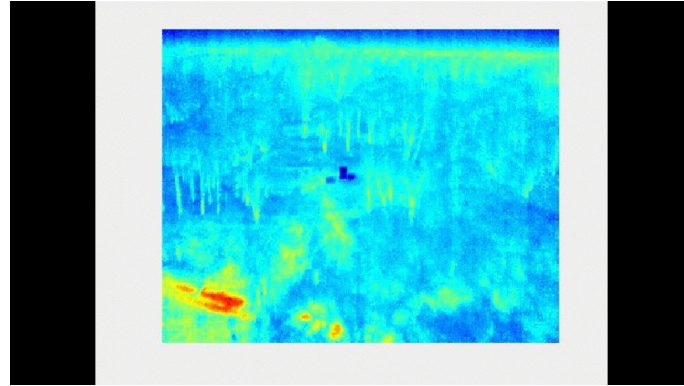
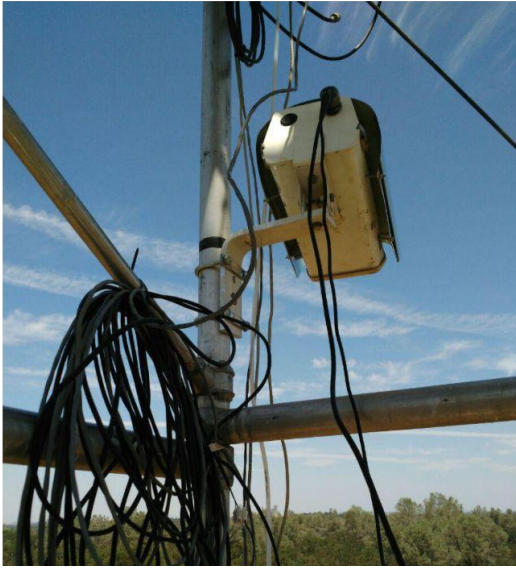
INTEGRATION OF MEASUREMENTS, REMOTE SENSING AND MODELS FOR SAVANNA-TYPE SEMI-ARID SYSTEMS MANAGEMENT.



WHAT ARE WE DOING IN SAVANNA?



What is happening?

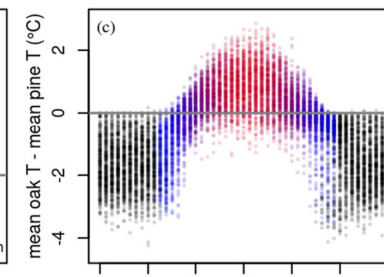
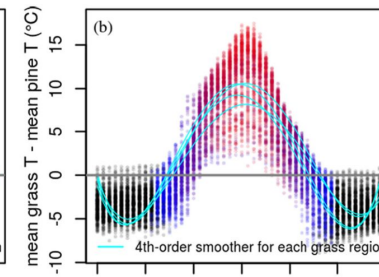
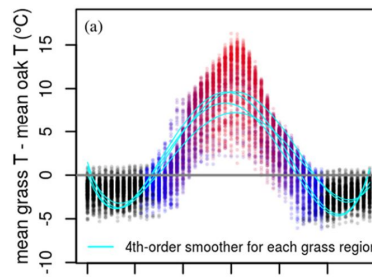
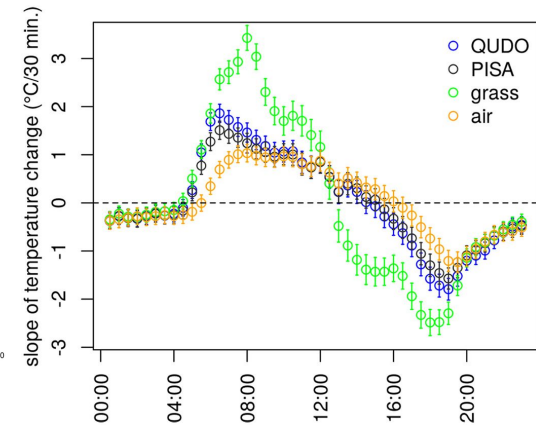
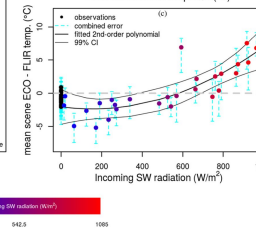
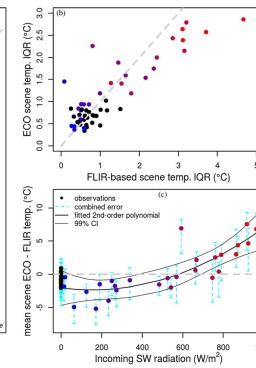
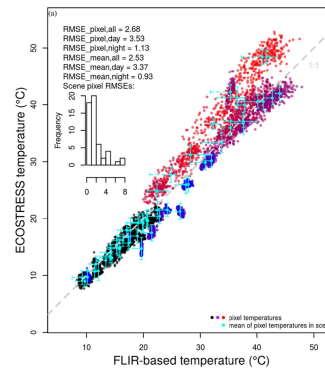
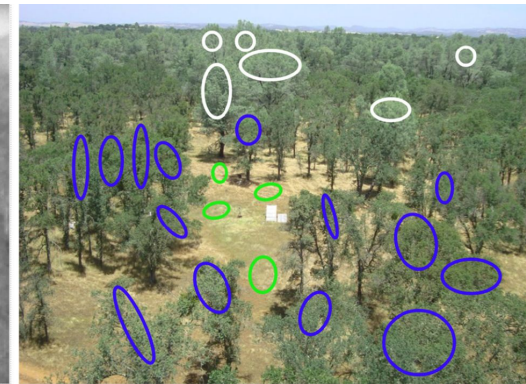
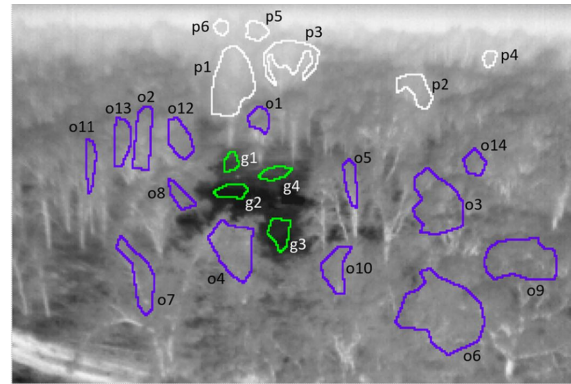


CANOPY TEMPERATURE

Johnston et al., 2021 and 2022

HIGHLIGHTS

- Field-based thermal remote sensing can resolve vertical tree crown temperatures.
- In a woodland savanna, canopy tops are cooler than canopy bottoms at midday.**
- Satellite (ECOSTRESS) and field-based (thermal camera) measurements agree at night.
- During the day, ECOSTRESS and camera temperatures diverge considerably.
- ECOSTRESS/camera mismatch is more related to light than to crown thermal gradients.

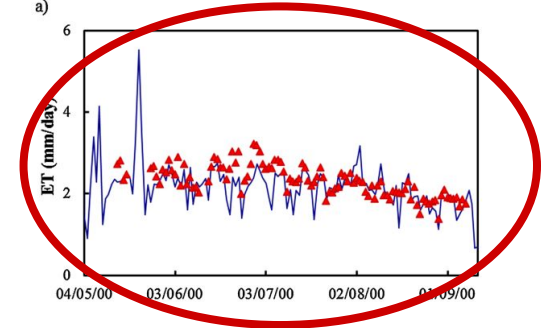
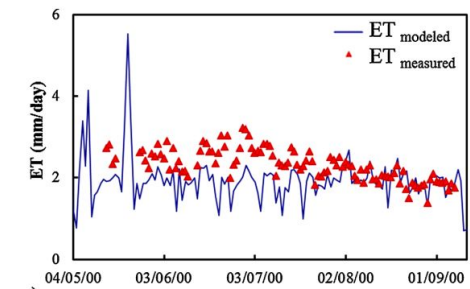
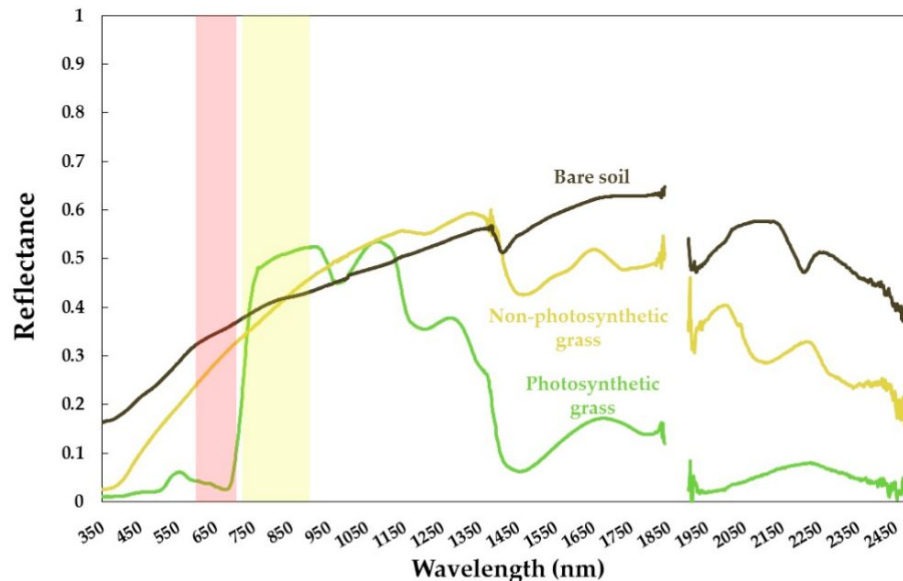


Incoming SW radiation (W/m²)
 0 542.5 1085

Differential spectral response of oak trees influenced the estimation ET.

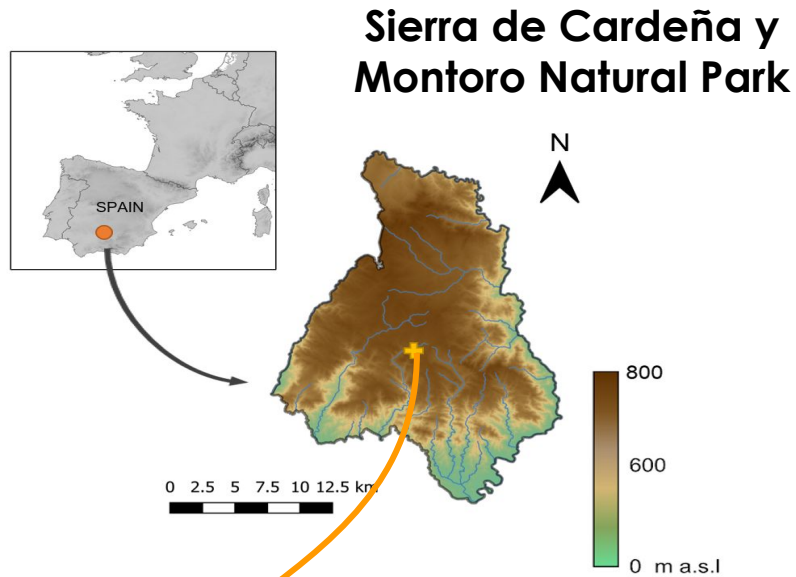
Assumption of non-variability of the spectral properties of the holm oak throughout the year for modeling.

Consider the influence of the dead grass in the ecosystem.



WHEN INCLUDING SPECTRAL CHARACTERISTICS

TERRESTRIAL PHOTOGRAPHY



Santa Clotilde experimental site:

- Terrestrial cameras
- Meteorological station

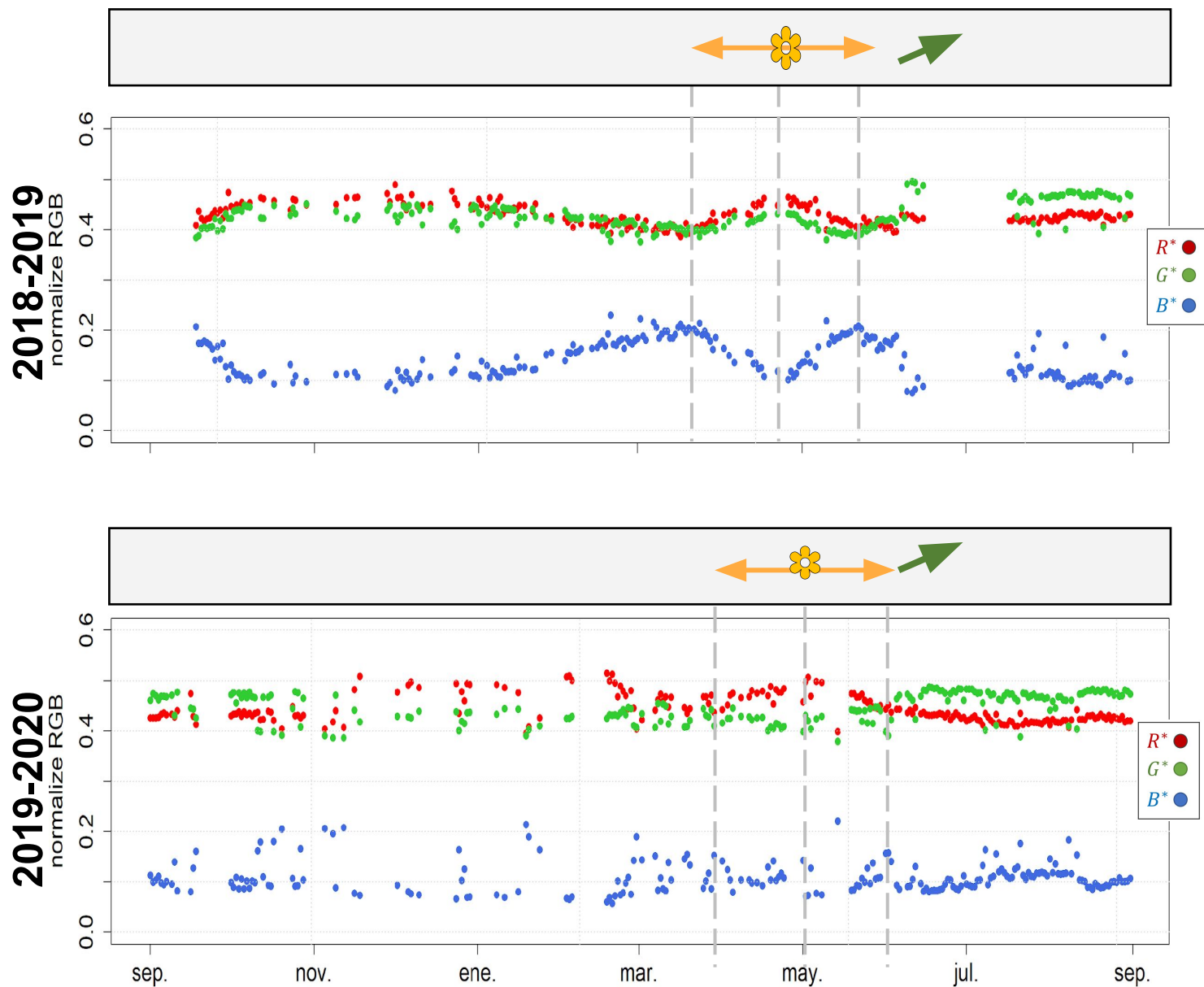


DETAIL SCALE

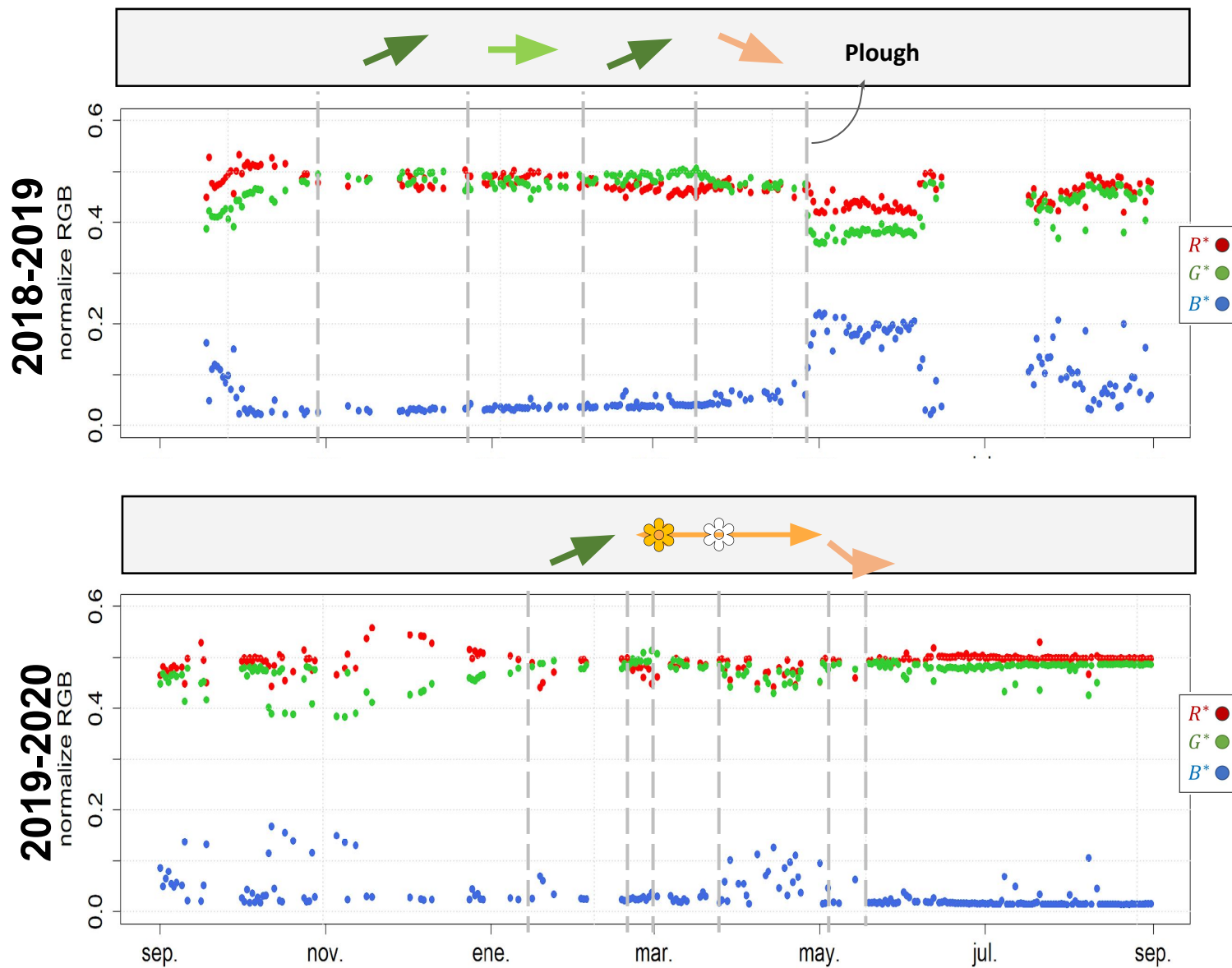


PLOT SCALE

TERRESTRIAL PHOTOGRAPHY: HOLM OAK



TERRESTRIAL PHOTOGRAPHY: PASTURE

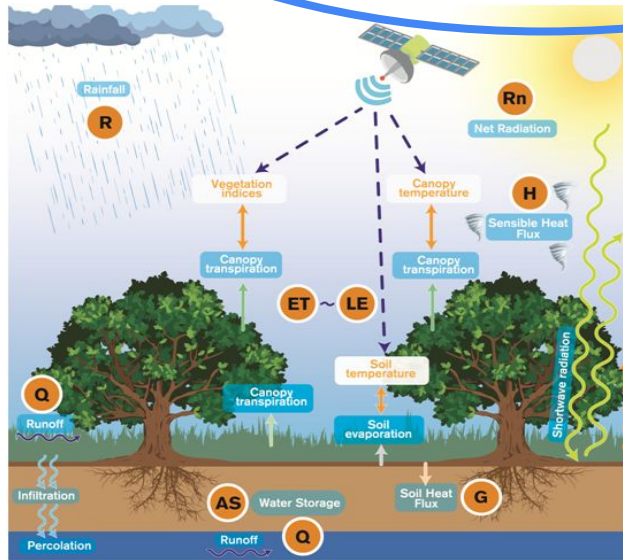


WATER & BIOMASS MODELING

BIOMASS

WATER

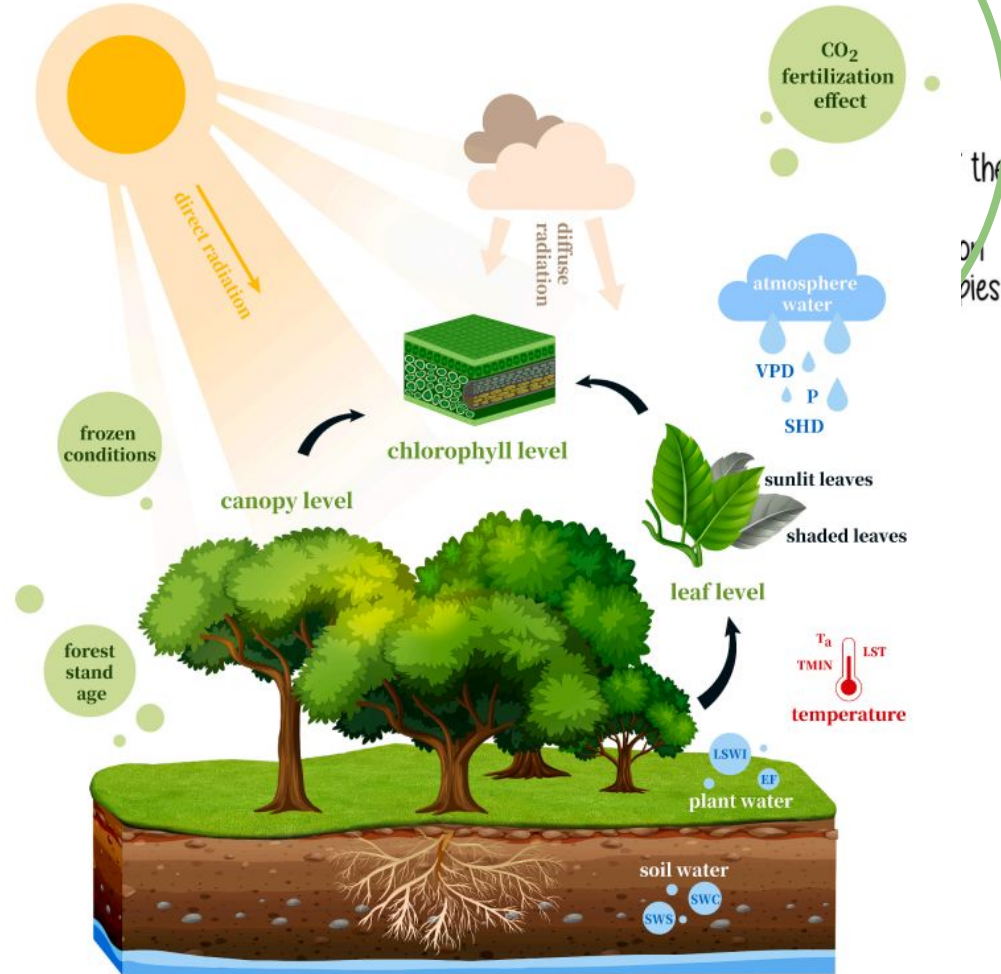
Base	Surface EB	Soil WB	Light use efficiency
Model	Two-Source EB (TSEB) ²³	WIMMod ²⁶	LUE model ²⁷
ED data	Surface thermal data (TIR)		
Other	Meteorological data, vegetati characteristics (VIS/NIR)		
Why?	-Best accounts for partial co cover ^{24, 25} -Strong physical base ⁵		



Water Balance
 $R = ET + Q + AS$

Energy Balance
 $Rn = LE + H + G$

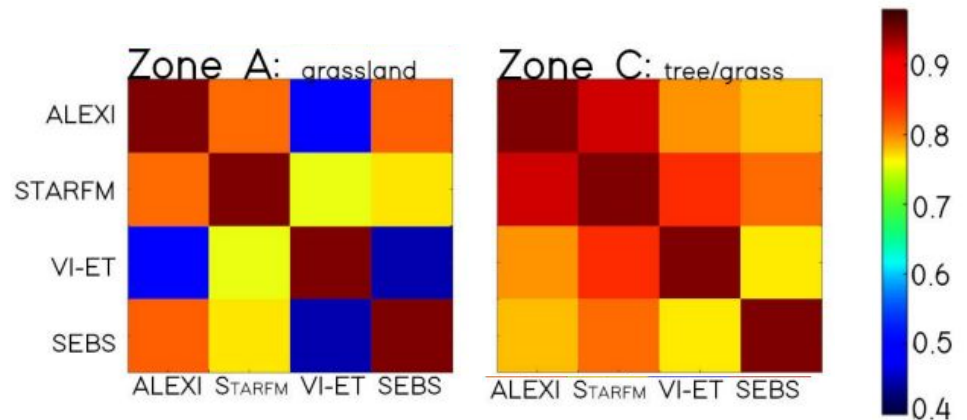
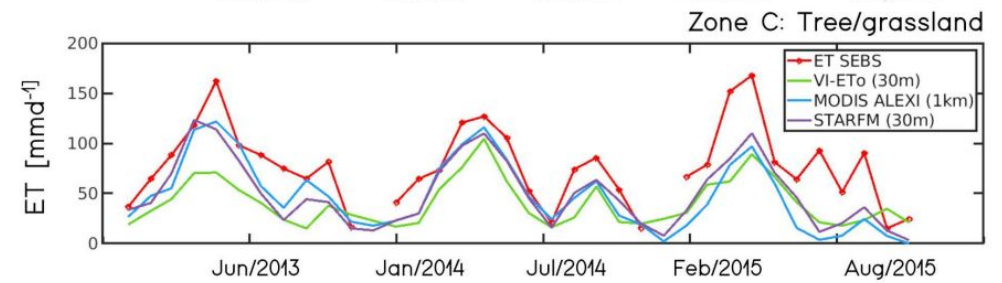
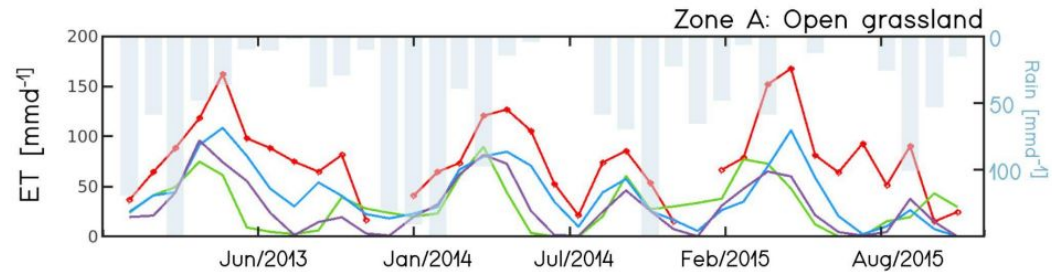
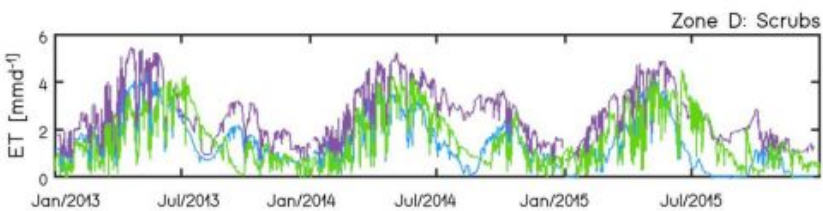
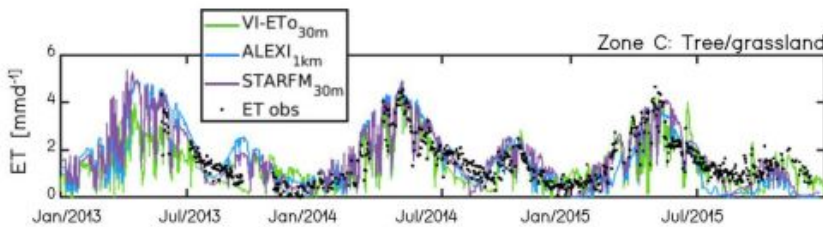
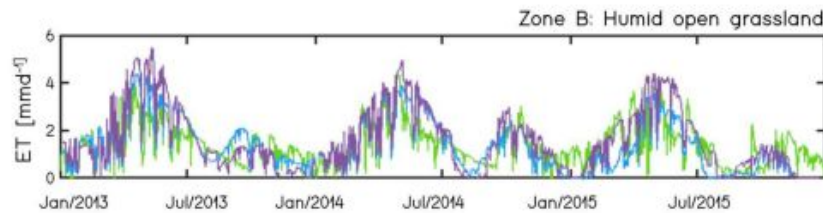
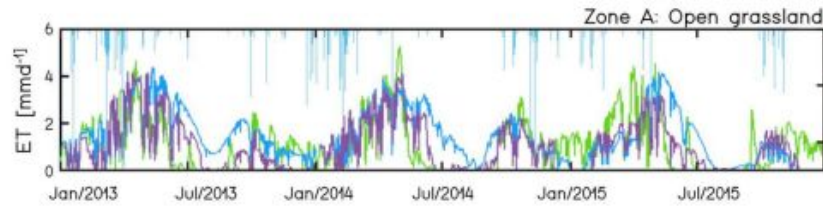
Kc-FA056 approach



Y. Pei et al. 2022.

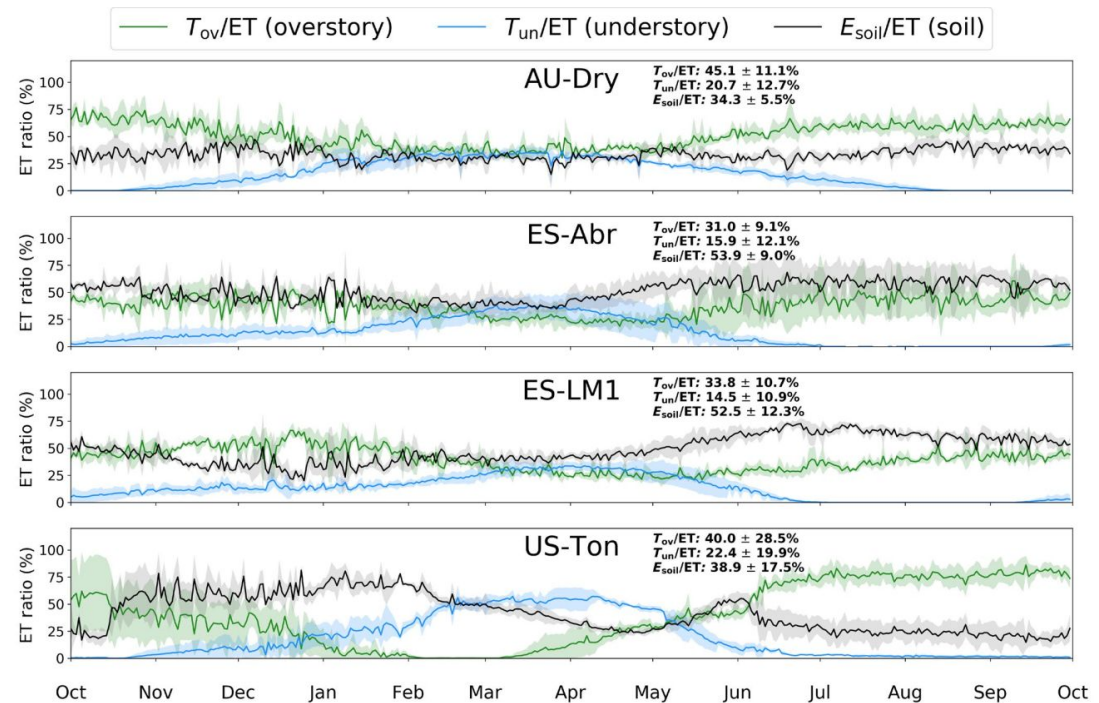
<https://doi.org/10.1016/j.iagrfmet.2022.108905>

WATER > DIFFERENT MODELS AND RESOLUTIONS



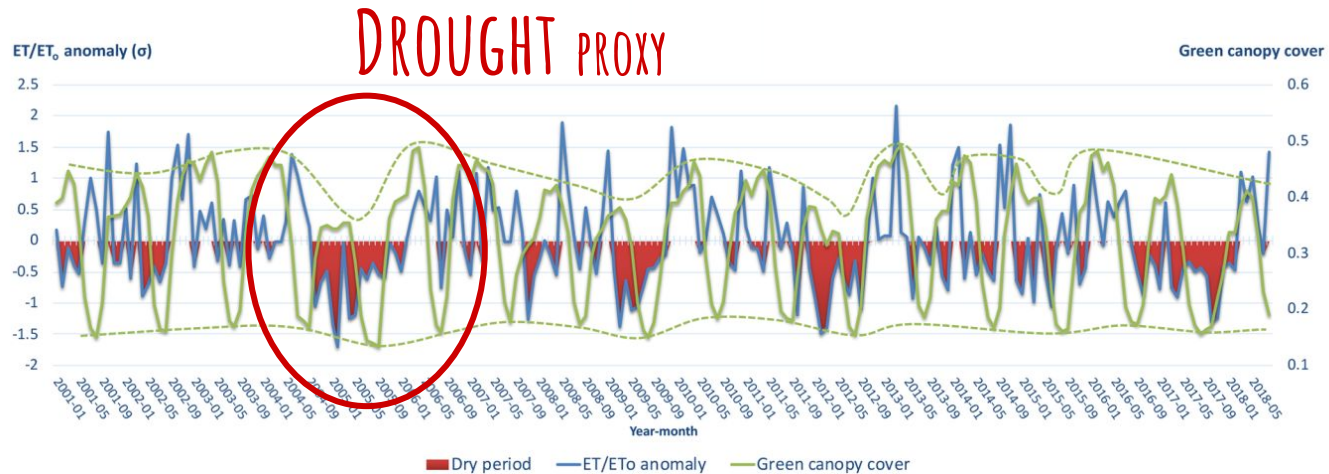
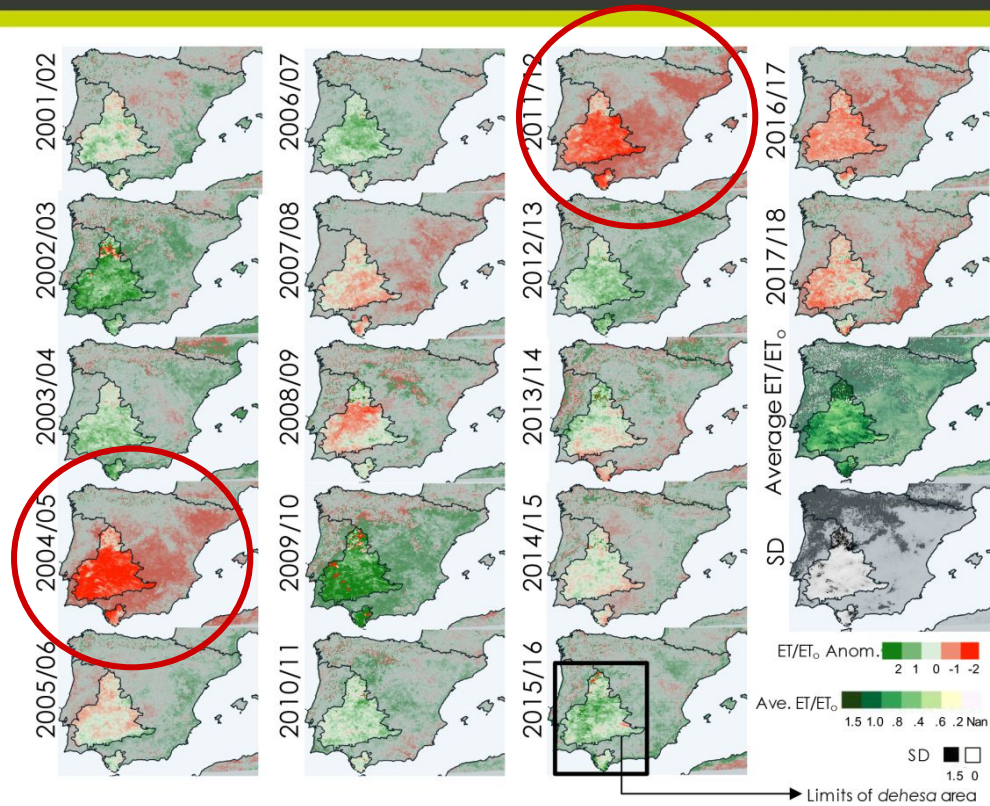
How the architecture of the vegetation affects the model parameterization?

- Monitoring water use in Andalusian dehesa.
- Developing a 3-source model (tree, grass, soil) validated in semiarid savannas worldwide.

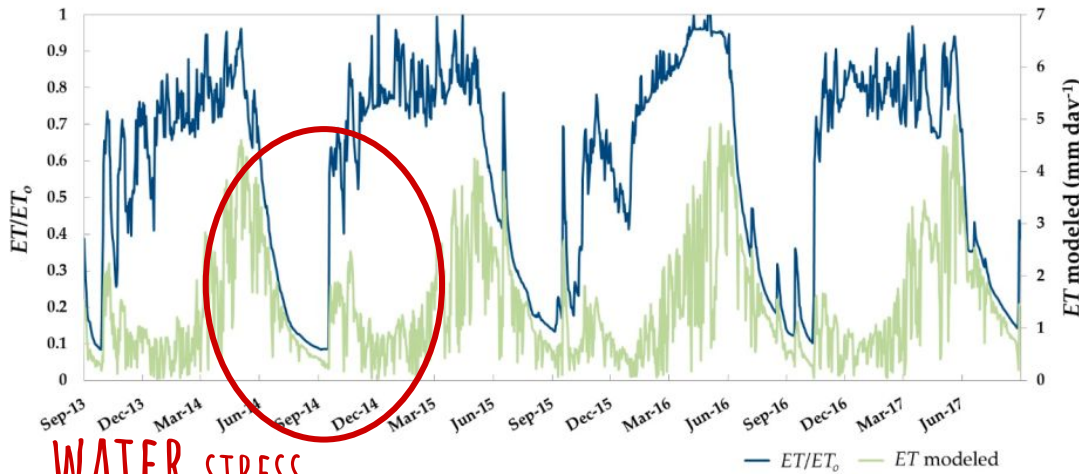


WATER: ENERGY BALANCE

Gonzalez-Dugo et al., 2020

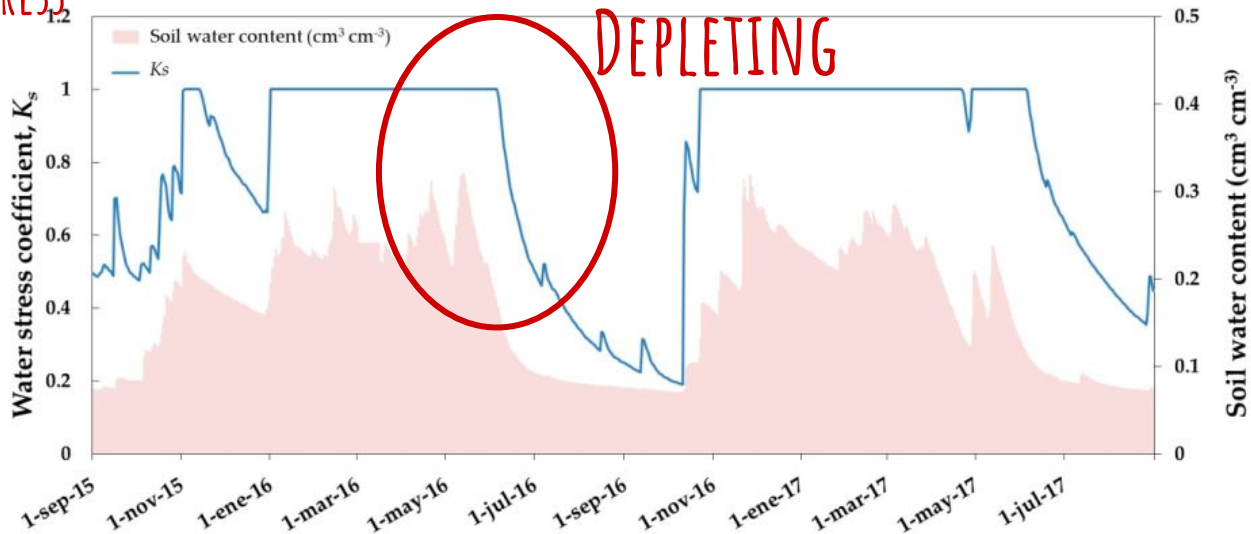


WATER: WATER BALANCE

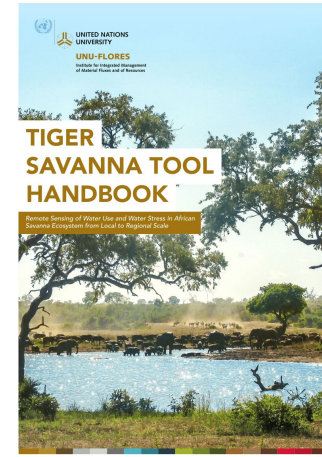


The ET/ET₀ ratio helped to identify periods of water stress, confirmed for the grassland by measured soil water content.

WATER STRESS



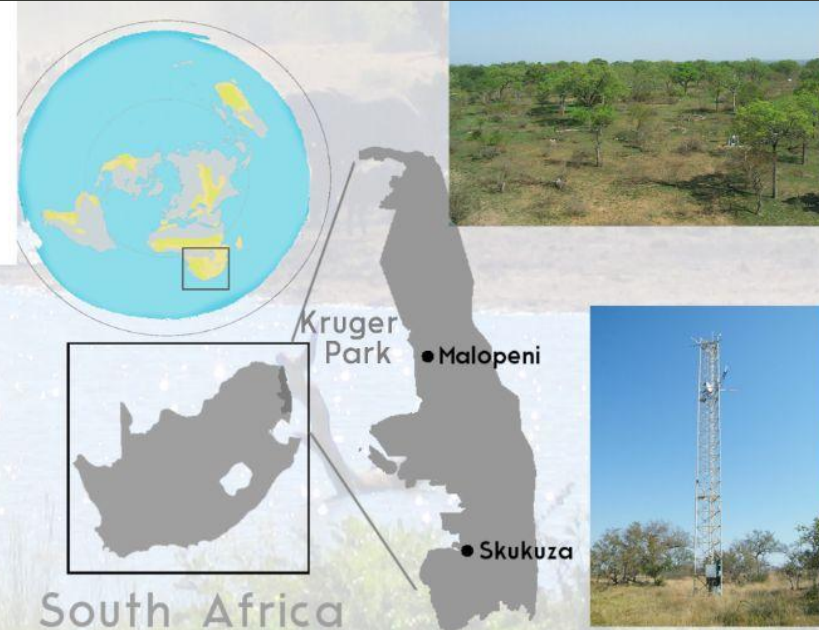
DEPLETING



MONITORING OF SOUTH AFRICAN SAVANNA'S WATER USE & STRESS USING EARTH OBSERVATION

TIGER PROJECT

Savannas are among Africa's most productive multifunctional landscape - supporting wildlife, livestock, crops and livelihoods - but experiencing frequent droughts, aggravated by climate change and other human-induced changes. To maintain ecosystem productivity without reaching the tipping points, while ensuring food security, we should rely on an integrated management and monitoring of resources. The aim of this project is to **map African savannas water use (evapotranspiration-ET) and water stress using Earth Observation data**, to support decision-making at different scales (from local to regional), using as a pilot experience South Africa. The modeling framework was tested during 2010 -2012 with AATSR (thermal data) & SPOT 4/5 (visible and NIR data) satellites and will be next applied with Sentinel 2 & 3 from 2015 to present.



SEE THE SAVANNA ECOSYSTEM CHANGING!!!
STOP MOTION VIDEO FROM THE STUDY AREA



UNITED NATIONS UNIVERSITY
UNU-FLORES
Institute for Integrated Management of Material Fluxes and of Resources



IRTA
INSTITUTO DE INVESTIGACIONES TECNOLÓGICAS EN AGROPECUARIO Y MEDIO AMBIENTE
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WATER > DIFFERENT MODELS AND RESOLUTIONS



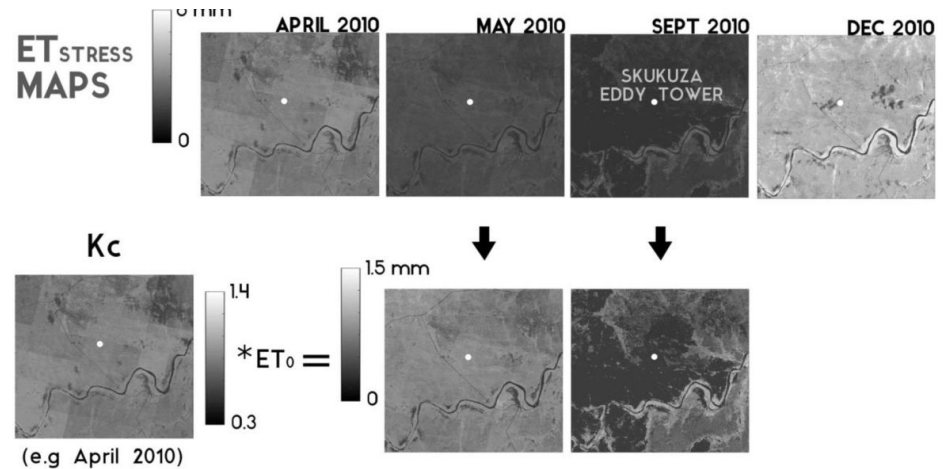
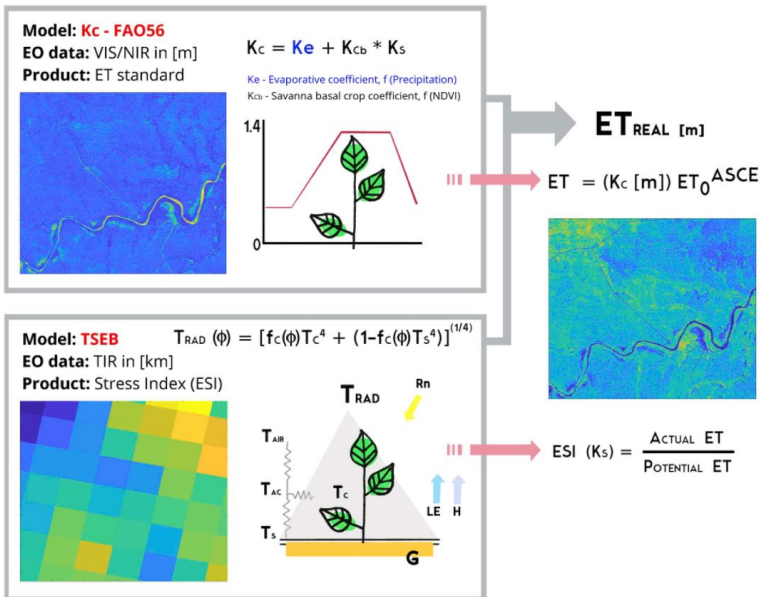
Contents lists available at ScienceDirect

Physics and Chemistry of the Earth

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

Remote sensing of water use and water stress in the African savanna ecosystem at local scale – Development and validation of a monitoring tool

Ana Andreu^{a,b,g,*}, Timothy Dube^c, Hector Nieto^d, Azwitamisi E. Mudau^e,
María P. González-Dugo^a, Radoslaw Guzinski^f, Stephan Hülsmann^g

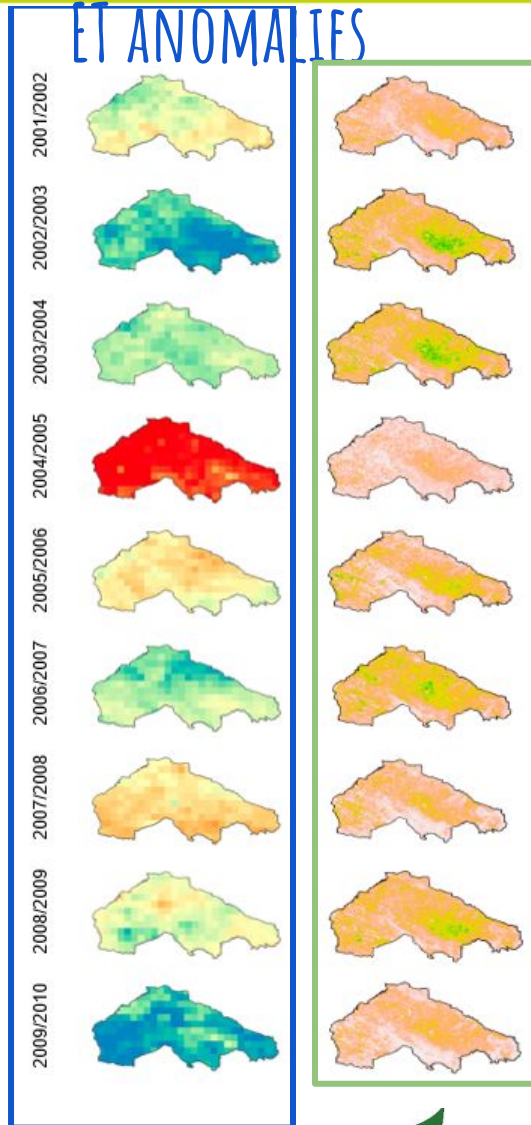


VEGETATION PRODUCTION...IN THE FACE OF DROUGHT

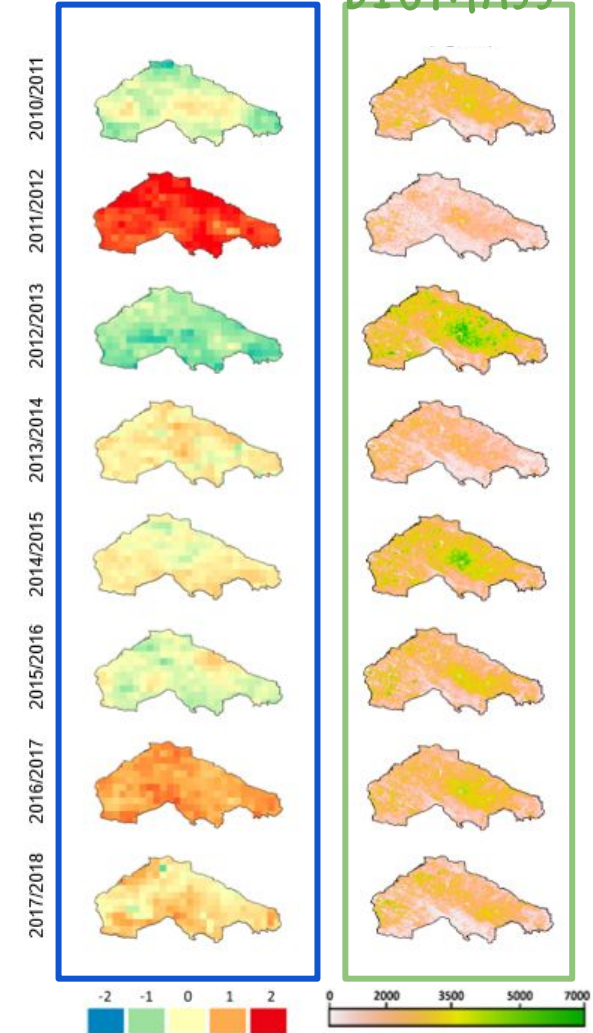


The Unseen Attack of Drought
by Alwyn Biju

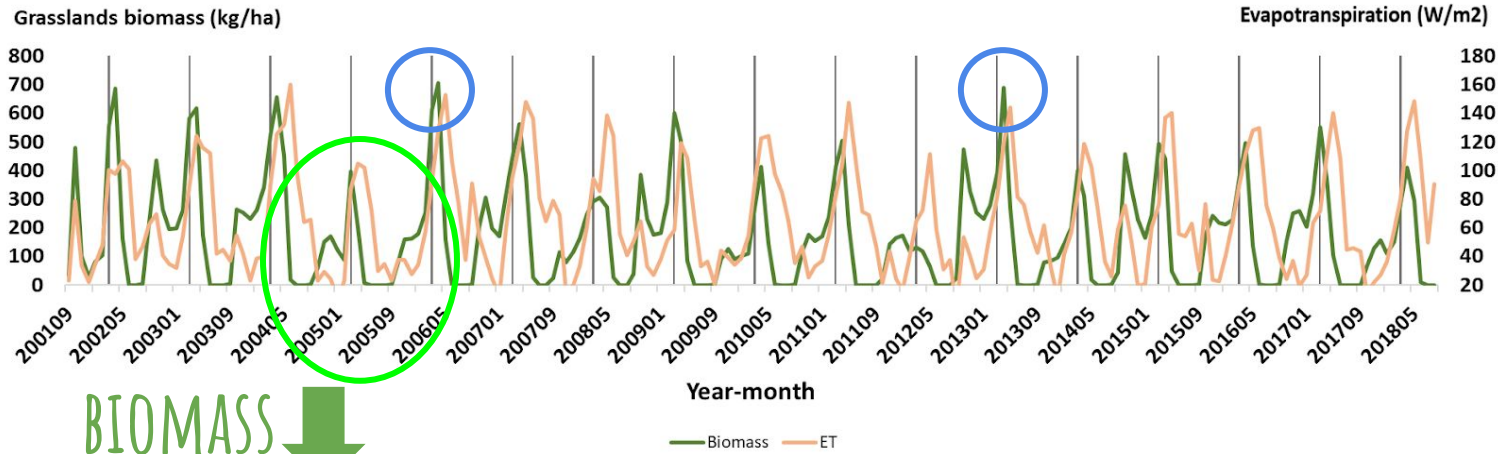
ET ANOMALIES



BIOMASS

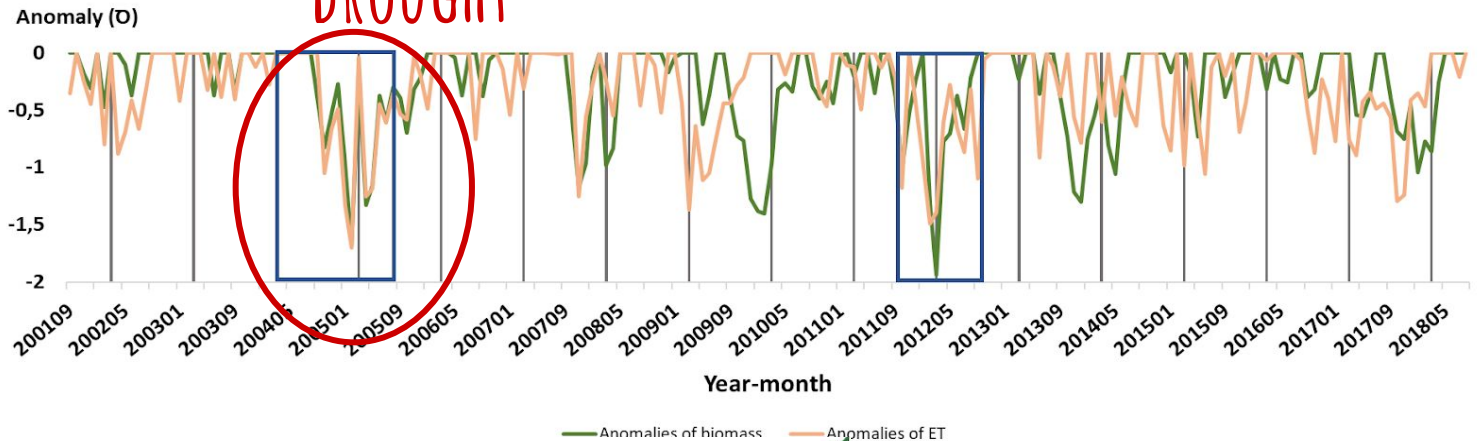


VEGETATION PRODUCTION...IN THE FACE OF DROUGHT



BIOMASS ↓

DROUGHT





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EXCELENCIA
MARIA
DE MAEZTU
2020-2023



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WESTERN CAPE



UNIVERSITY OF THE
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JOHANNESBURG



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Instituto de
Investigación y
Formación Agraria
y Pesquera

Press **Esc** to exit full screen



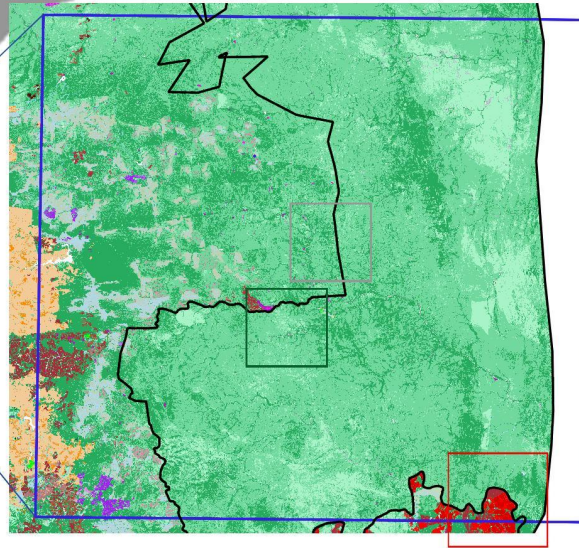
TACTIC: Drought impACT on the vegeTation of South African semlarid mosaiC landscapes. Implications on grass-crop-lands primary production.

VEGETATION PRODUCTION... IN THE FACE OF DROUGHT

South Africa

Land Use map for the Sentinel 2 36JUT Tile

Kruger Park



LEGEND

- SAVANNA
- GRASSLAND
- SCRUBS
- IRRIGATED CROPS
- IRRIGATED ORCHARDS
- WOODLAND
- RAINFED CROPS
- WOODLAND
- URBAN
- EC (middle down box)



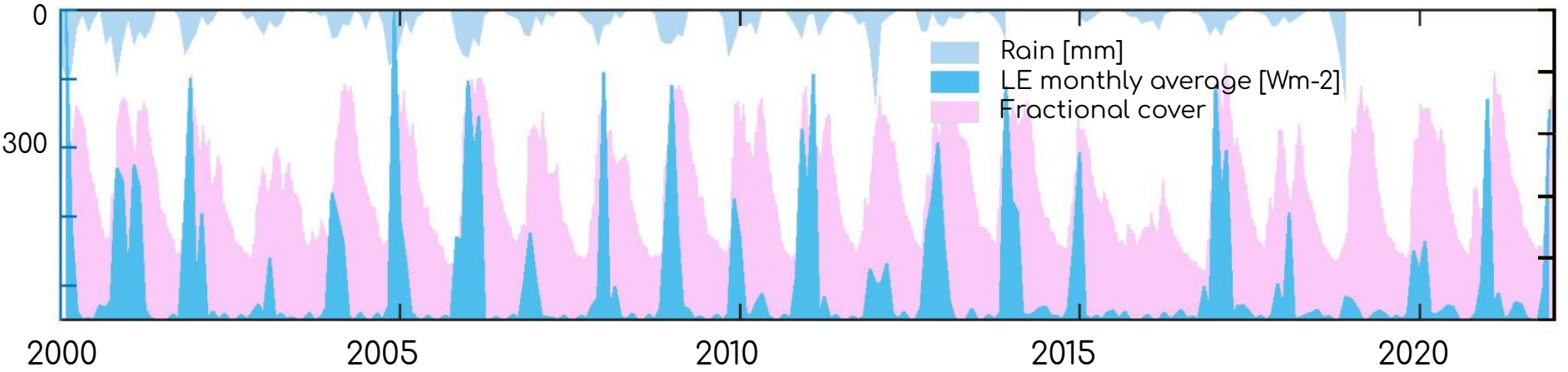
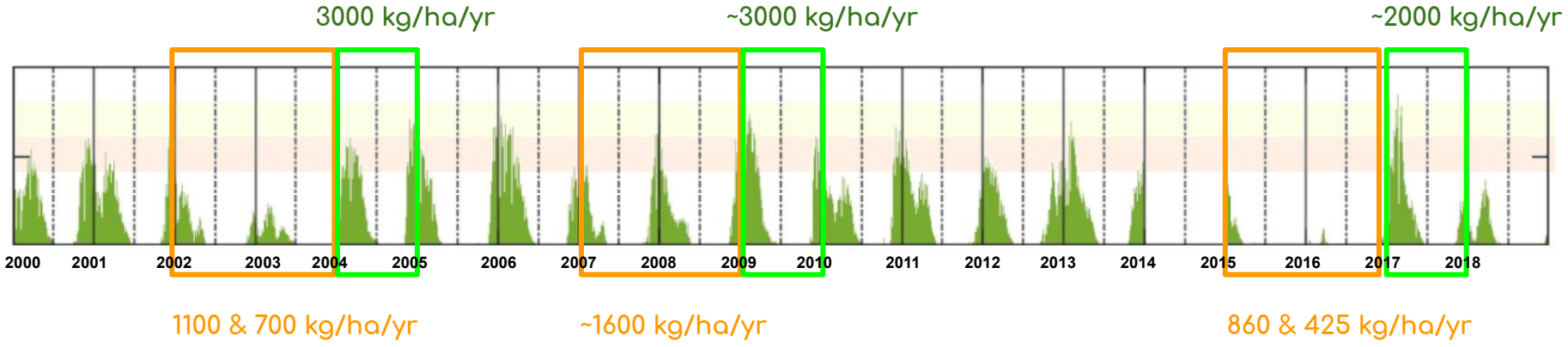
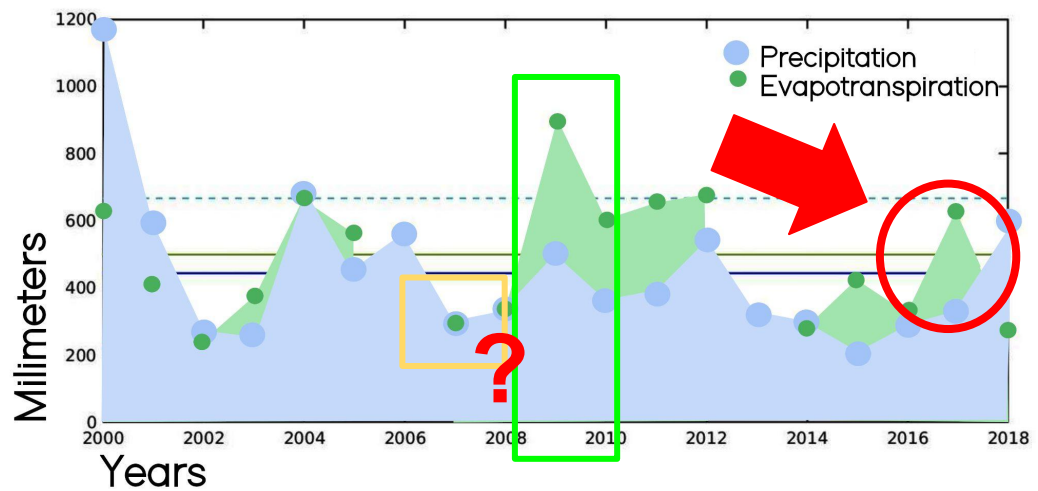
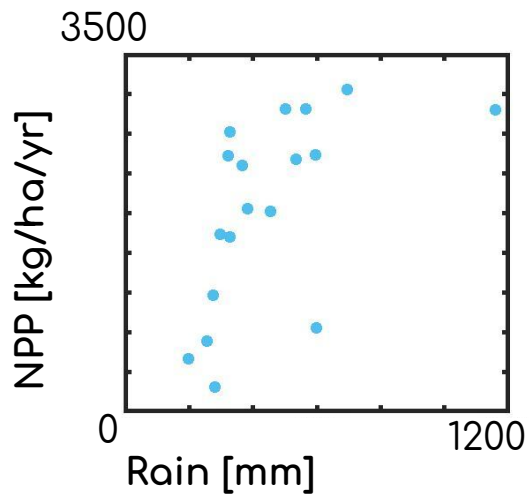
HUNTING RESERVE AREA - RGB S2



SKUKUZA AREA - RGB S2



CROP AREA - RGB S2



Thanks a lot!!

