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Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

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Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Objectives

I-CISK project Guadalquivir Living Lab

OBJECTIVES OF THE PRESENT WORK:

Evaluate the **contribution of remote sensing data as an explanatory variable of the spatial pattern of precipitation**.

Understand the local relationships between climatic variables and others (topography, vegetation response, etc…).

Downscale weather forecasting and climate projection models to the spatial resolution required by the user community.

Produce climate models for locations lacking an established network of weather stations, where remote sensing is the only data source.

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Study Area: Guadalquivir Basin Living Lab (Spain)

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Image 1: Locations of the European I-CISK Living Labs.

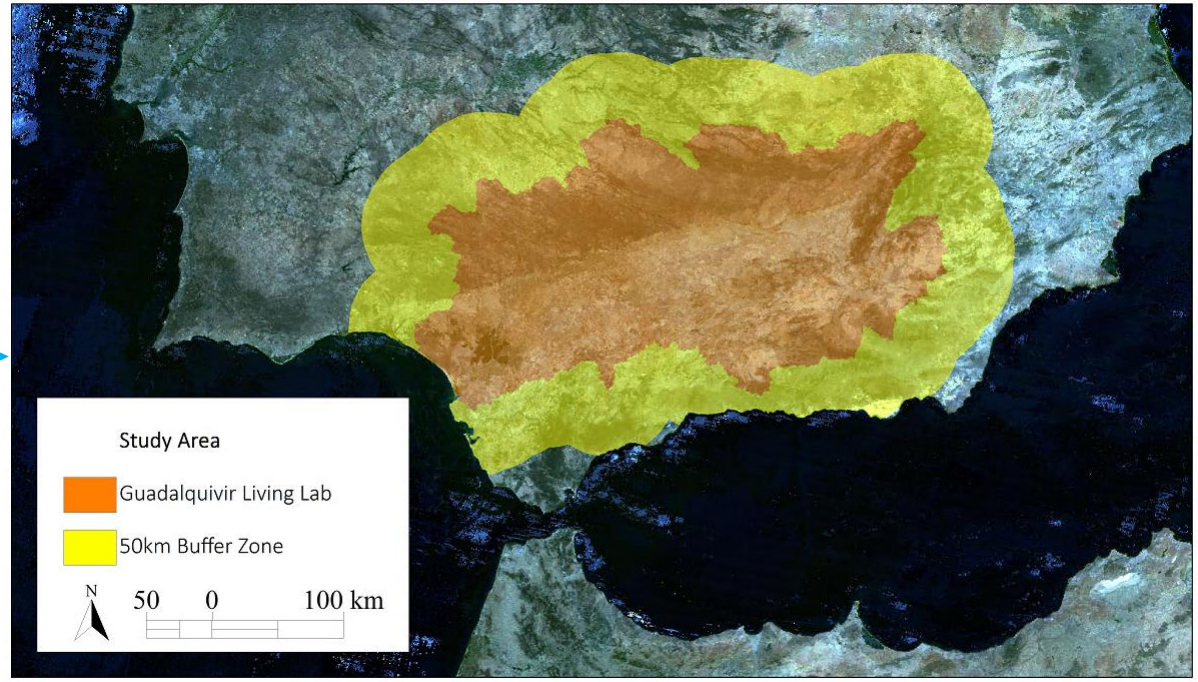
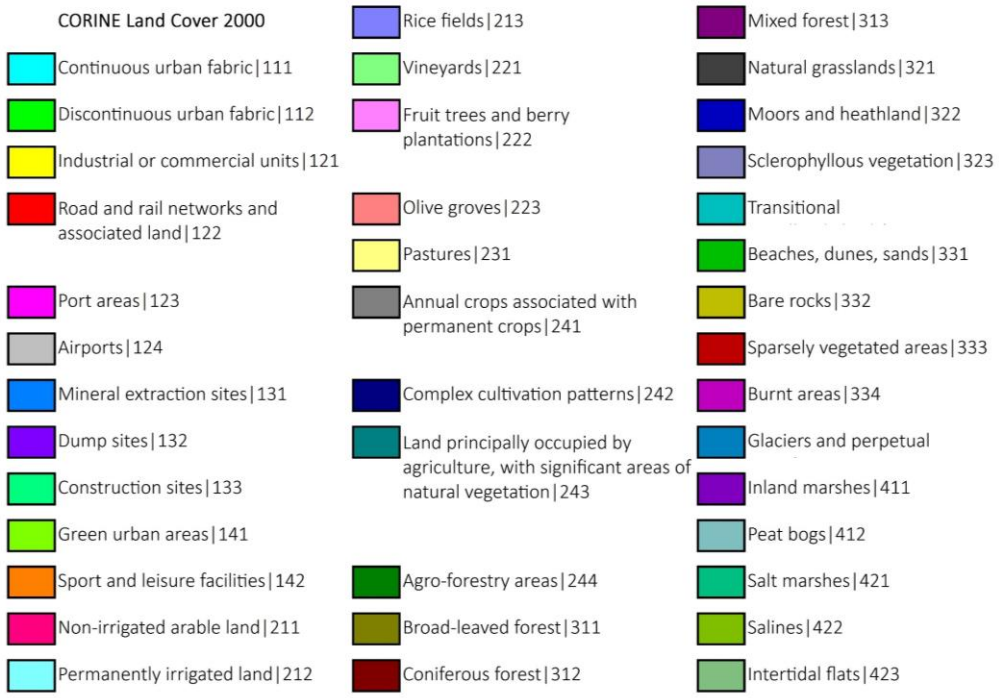


Image 2: Study area of the presented study.

Time Series Analysed: 2000-2019

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Study Area: Guadalquivir Basin Living Lab (Spain)
CORINE land cover 2000



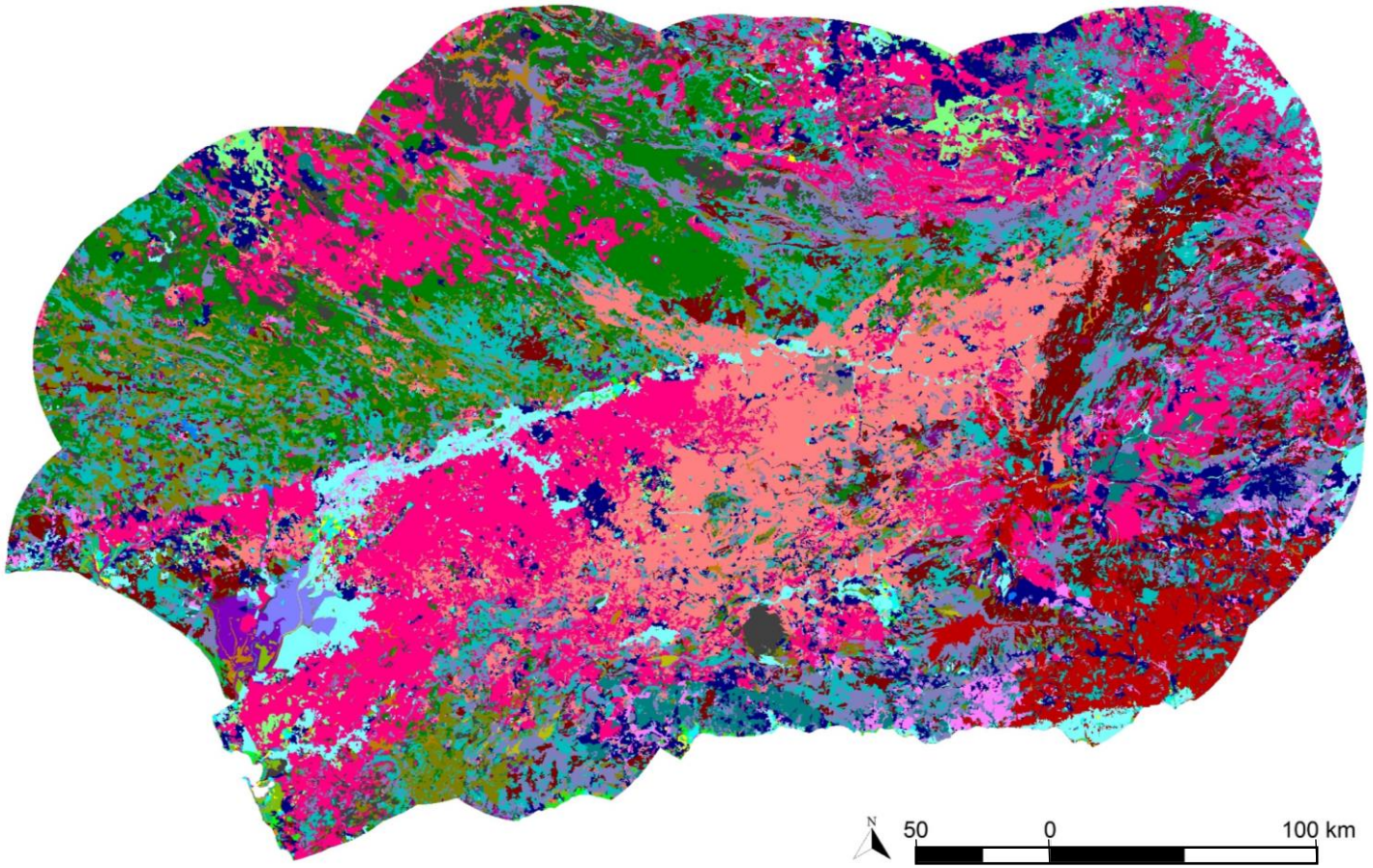


Image 3: CORINE Land Cover 2000 for the study area.

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Study Area: Guadalquivir Basin Living Lab (Spain)

CORINE Land Cover category	Surface ha
Discontinuous urban fabric	28447.64 ha
Industrial or commercial units	17800.57 ha
Road and rail networks and associated land	880.10 ha
Port areas	853.27 ha
Airports	2640.30 ha
Mineral extraction sites	15101.24 ha
Dump sites	1459.68 ha
Construction sites	6944.21 ha
Green urban areas	568.85 ha
Sport and leisure facilities	4266.34 ha
Non-irrigated arable land	2549189.81 ha
Permanently irrigated land	460716.54 ha
Rice fields	39926.51 ha
Vineyards	106030.65 ha
Fruit trees and berry plantations	189613.37 ha
Olive groves	1385900.79 ha
Pastures	139.53 ha
Annual crops associated with permanent crops	17913.27 ha
Complex cultivation patterns	744908.53 ha
Land principally occupied by agriculture, with significant areas of natural vegetation	300989.03 ha

CORINE Land Cover category	Surface ha
Agro-forestry areas	1115049.84 ha
Broad-leaved forest	653045.35 ha
Coniferous forest	754745.26 ha
Mixed forest	88970.65 ha
Natural grasslands	489255.41 ha
Sclerophyllous vegetation	1169106.27 ha
Transitional woodland-shrub	1225695.66 ha
Beaches, dunes, sands	7711.61 ha
Bare rocks	12943.92 ha
Sparsely vegetated areas	436111.29 ha
Burnt areas	3198.41 ha
Inland marshes	38740.52 ha
Salt marshes	12257.01 ha
Salines	13550.33 ha
Intertidal flats	944.50 ha
Water courses	13357.14 ha
Water bodies	70826.63 ha
Coastal lagoons	26.83 ha
Estuaries	5430.86 ha
Sea and ocean	2527.61 ha

Image 3: CORINE Land Cover 2000. Surface by category inside the study area (ha)

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Study Area: Guadalquivir Basin Living Lab (Spain)

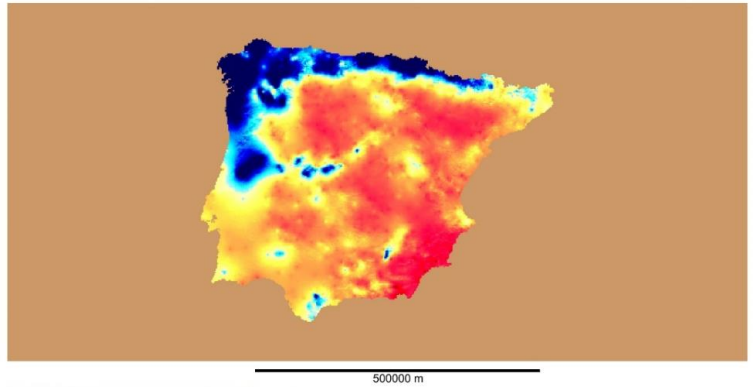
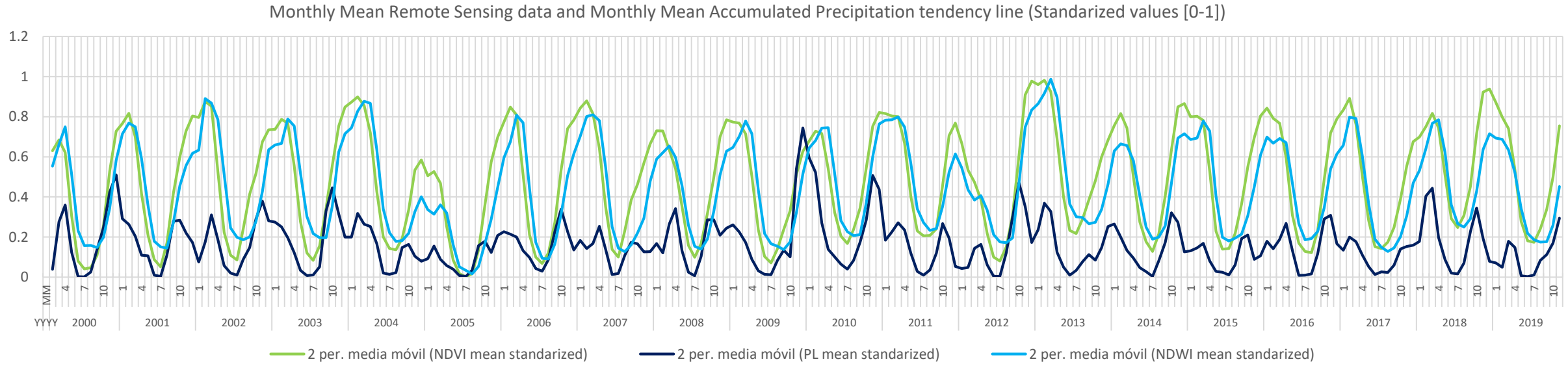


Image 4: Mean total annual precipitation (ref: Climatic Atlas of the Iberian Peninsula).



Graph 1: Precipitation, NDVI and NDWI tendency line follows a pattern with a lag between peaks that are investigated in this study.

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

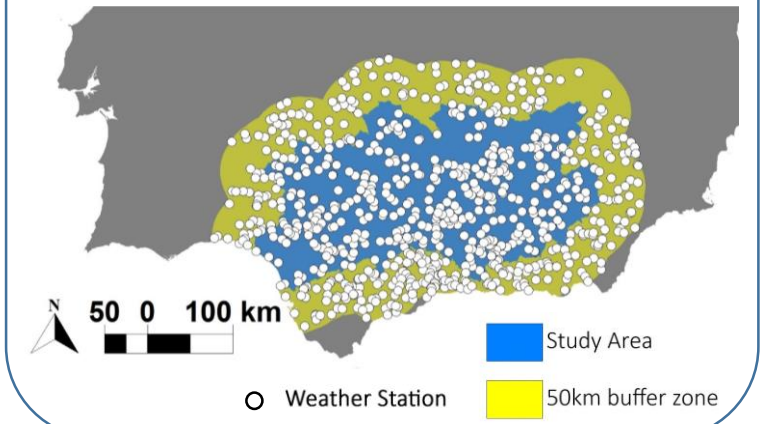
Methodology

Study Area: Guadalquivir Basin (Spain)

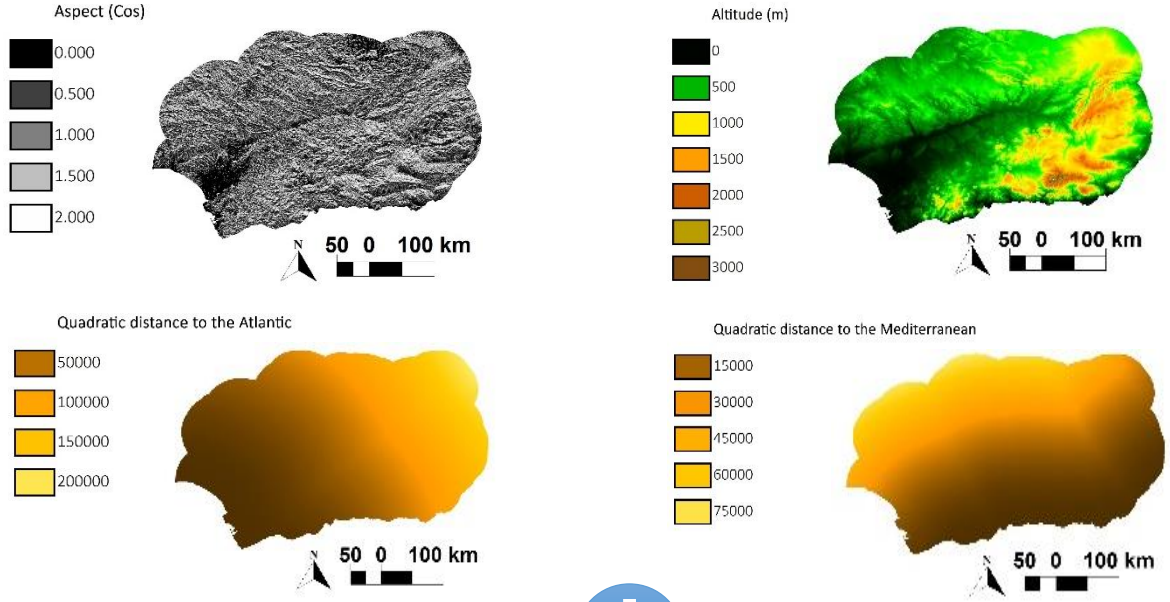
Time Series Analysed: 2000-2019

Dependent Variable

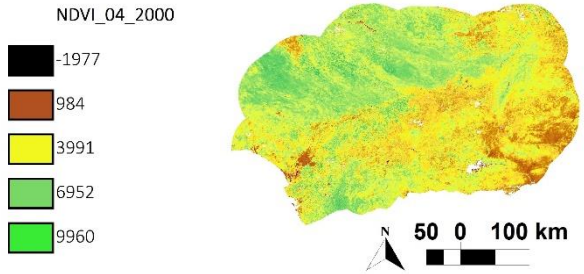
Monthly Total Precipitation



STATIC Independent Variables static



DYNAMIC Independent Variables (Remote Sensing)



MOD13Q1:
- **NDVI**
- **NDVI anomaly**

MOD09A1_h17v05_v061 b2, b6:
- **NDWI**
- **NDWI anomaly**

Different Month lag:
- **0 months**
- **+1 month**
- **+2 months**
- **+3 months**

Multiple Linear regression

Residual Spatial Interpolation

Interpolator: Inverse Distance Weighted (IDW)

Processing Tool
RegMult

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Methodology

NDVI variables

Data adquisition
- MOD13Q1 250m resolution, 16 days product.

Quality filter
- Filter QA: Modland_QA, Internal_Snow_Flag, Mod35_snow, Fire_flag; Cirrus_detected; Cloud_state, Cloud_flag, Aerosol_quality, sur_refl_vzen (<3500)

Monthly aggregation
- Cover overlap second over the first image of the month.

Urban filter
- Filter out urban areas.
- Modal filter to gather NDVI value over urban areas from vegetation located in a 3 pixel window.

→ NDVI

Climatic NDVI
- Monthly mean NDVI value from the time series 2000-2019.

NDVI anomaly
- Expression: (Month NDVI)-(Climatic monthly NDVI)

→ NDVI anomaly

NDWI variable

Data adquisition
- MOD09A1.006 500m resolution, 8 days product.

Quality filter
- Filter QA: Modland_QA, Internal_Snow_Flag, Mod35_snow, Fire_flag; Cirrus_detected; Cloud_state, Cloud_flag, Aerosol_quality, sur_refl_vzen (<3500)

NDWI calculation
- Expression: ([NIR]-[SWIR])/([NIR]+[SWIR])
- NIR:band2, SWIR:b6

Monthly aggregation
- Cover overlap of the 4 images from the month in the order: Week3, Week2, Week1, Week4

Urban filter
- Filter out urban areas
- Modal filter to gather NDWI value over urban areas from vegetation located in a 3 pixel window.

→ NDWI

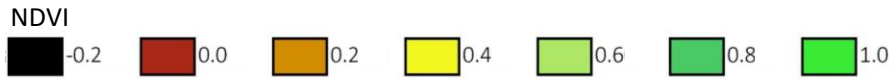
Climatic NDWI
- Monthly mean NDWI value from the time series 2000-2019.

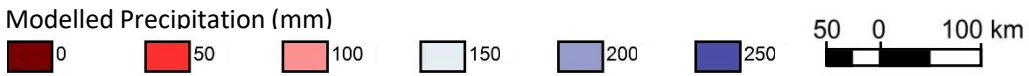
NDWI anomaly
- Climatic monthly NDWI – Month NDWI

→ NDWI anomaly

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Results





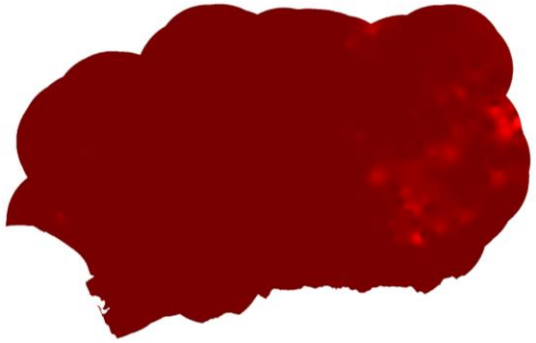
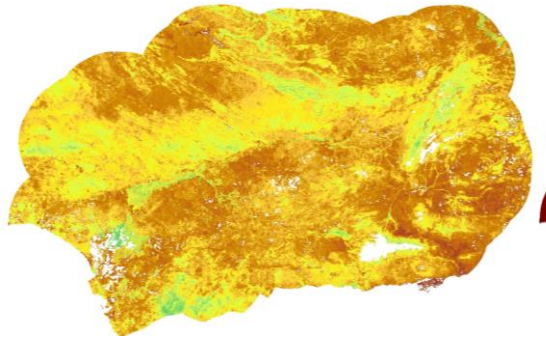
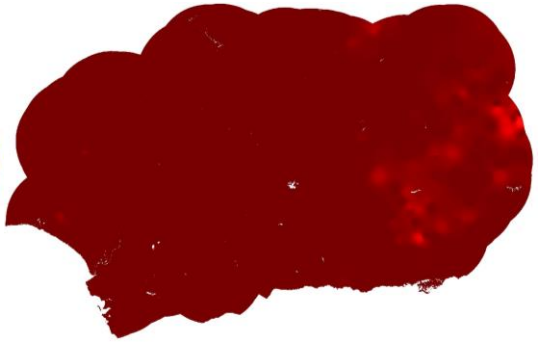
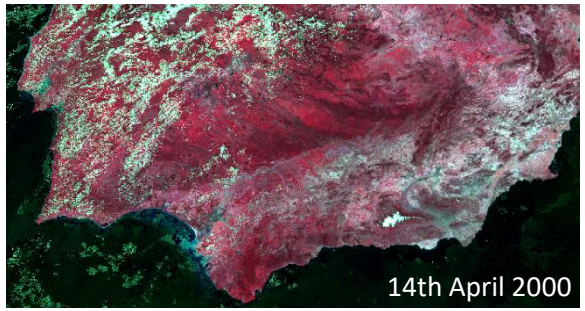
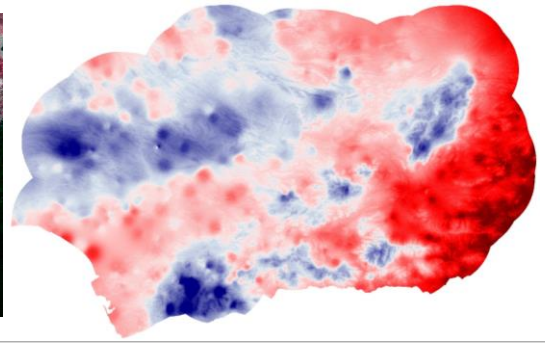
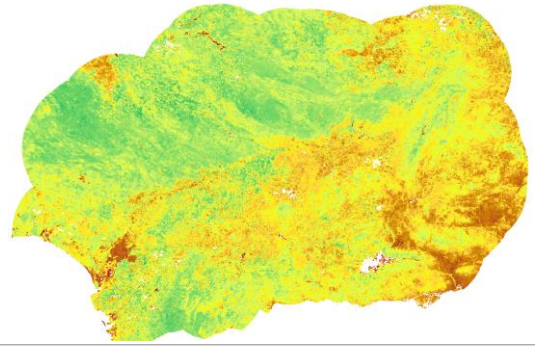
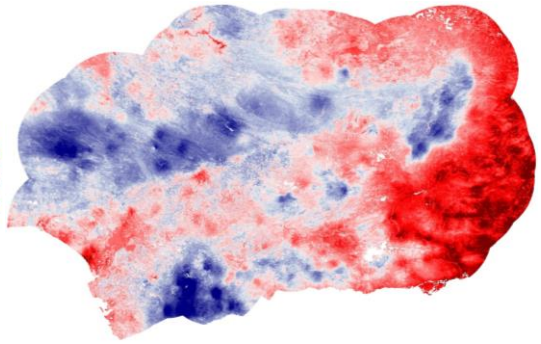
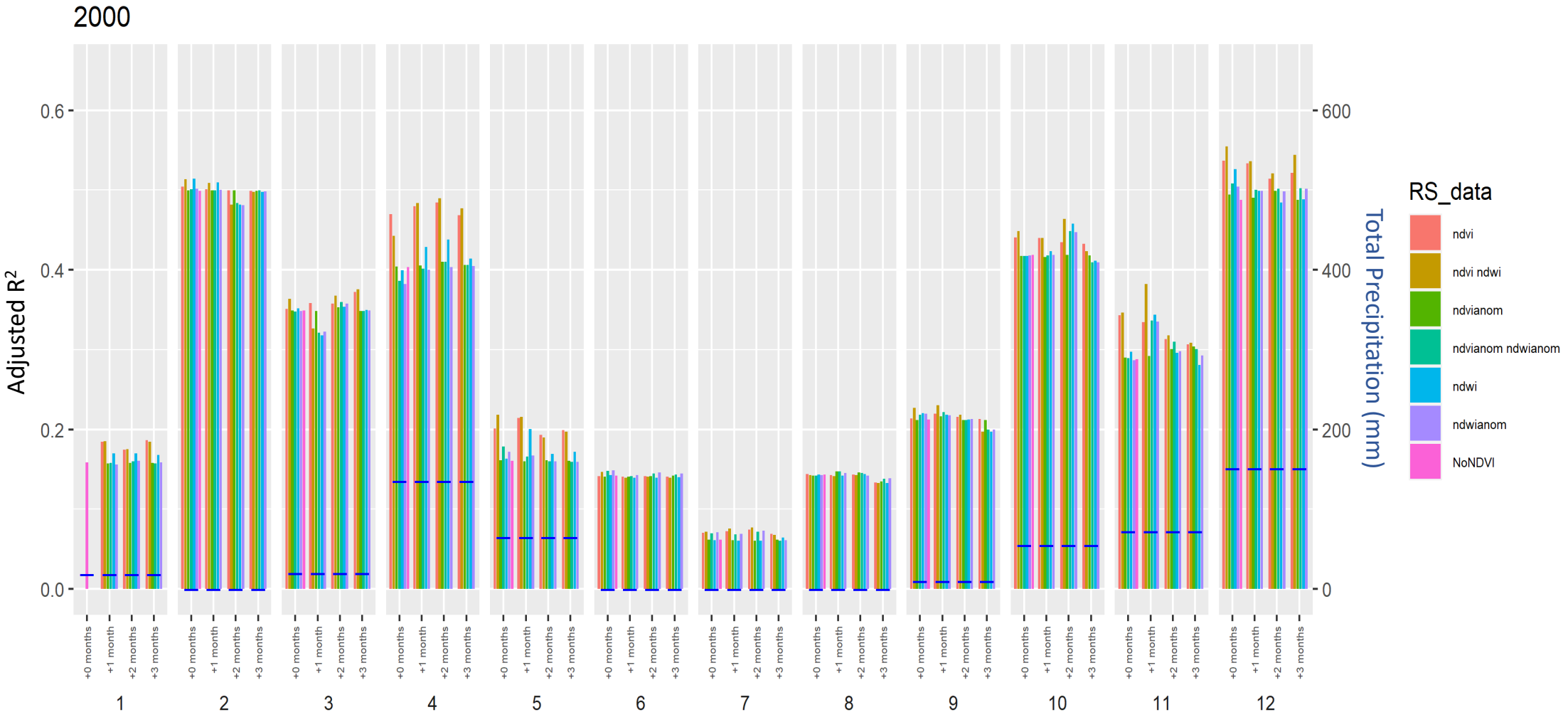
Date	MODIS RGB (623)	Model w/o Dynamic variables	NDVI	Model w/ NDVI
AUG 2000 dry				
Results:	**Mean accumulated precipitation: 6.6mm** Desv. est.: 3	Adjusted R^2: 0.143 RMS: 2.51		Adjusted R^2: 0.144 RMS: 25.184
APR 2000 rainy				
Results:	**Mean accumulated precipitation: 133.2mm** Stand.Dev. : 64.5	Adjusted R^2: 0.403 RMS: 26.99		Adjusted R^2: 0.469 RMS: 29.37

Table 3: Precipitation Models developed with and without NDVI (dynamic variable) for August (dry) and April (rainy) 2000. Model using NDVI offers an improvement on texture and adjusted R^2.

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

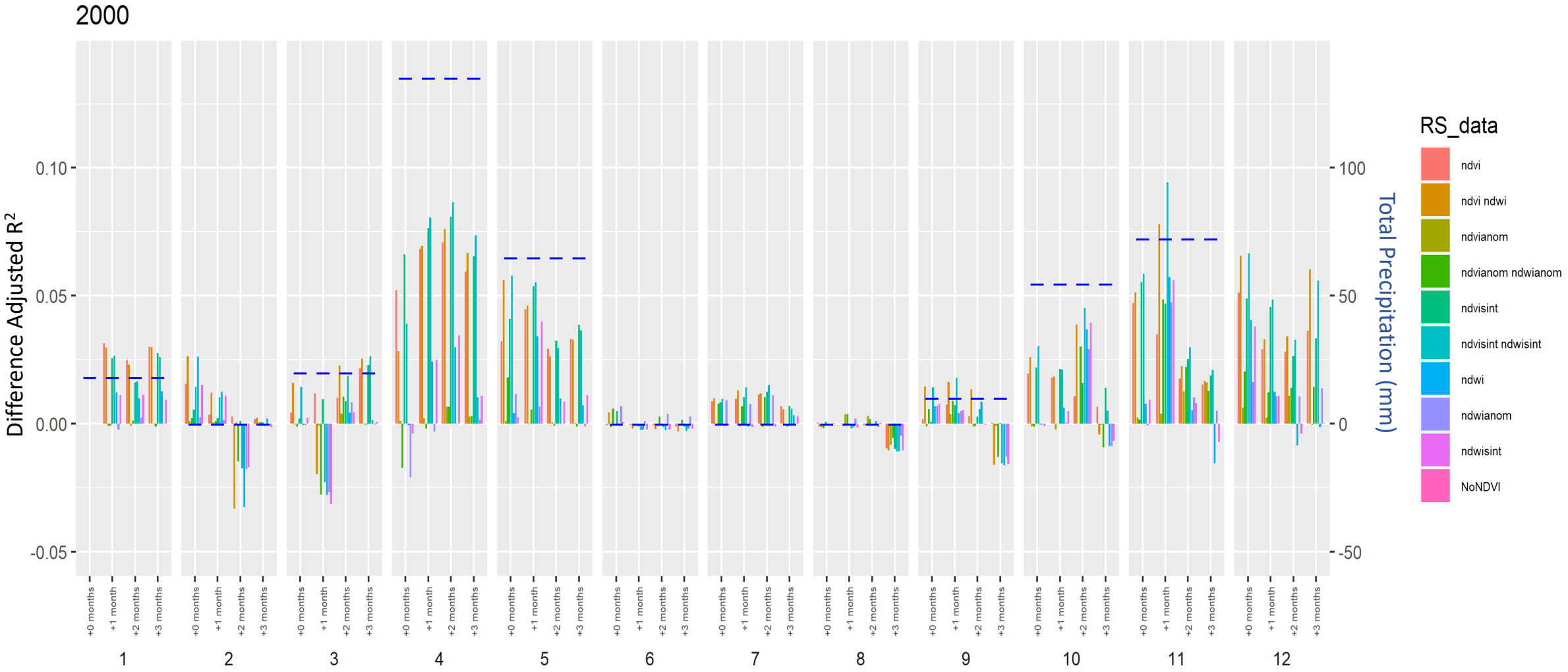
Results



Graph 2: Adjusted R^2 Results from the Regressions performed for year the 2000. In general, using remote sensing data improves the model's adjustment.

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Results

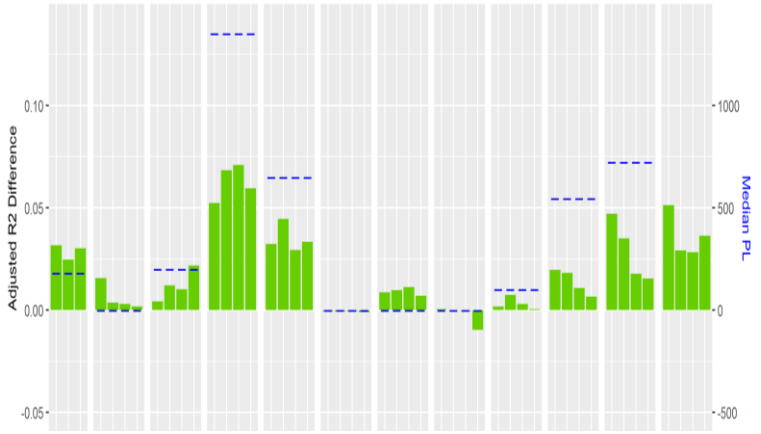
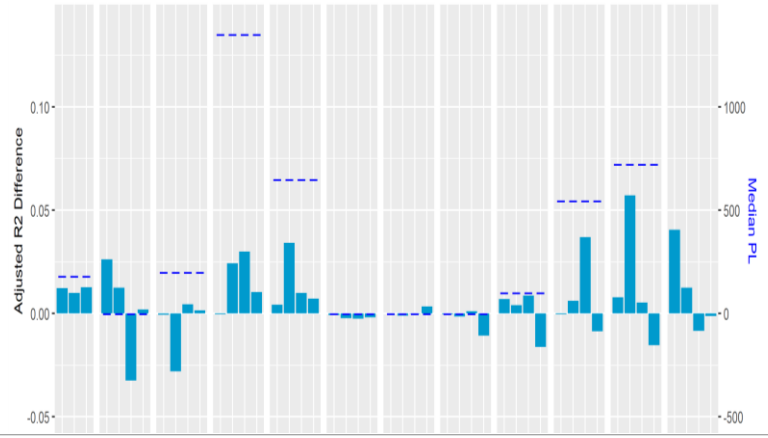
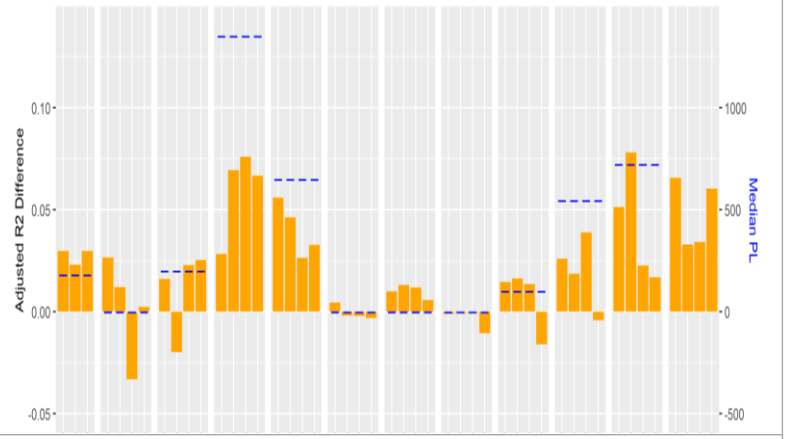
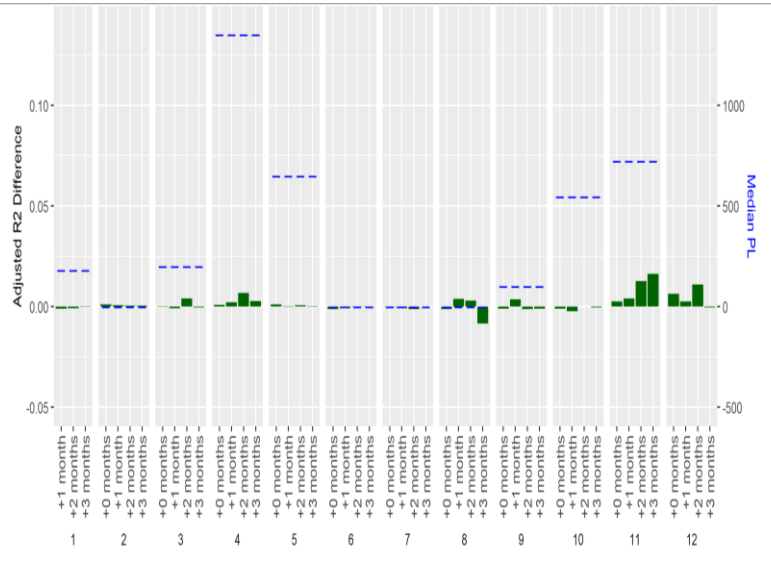
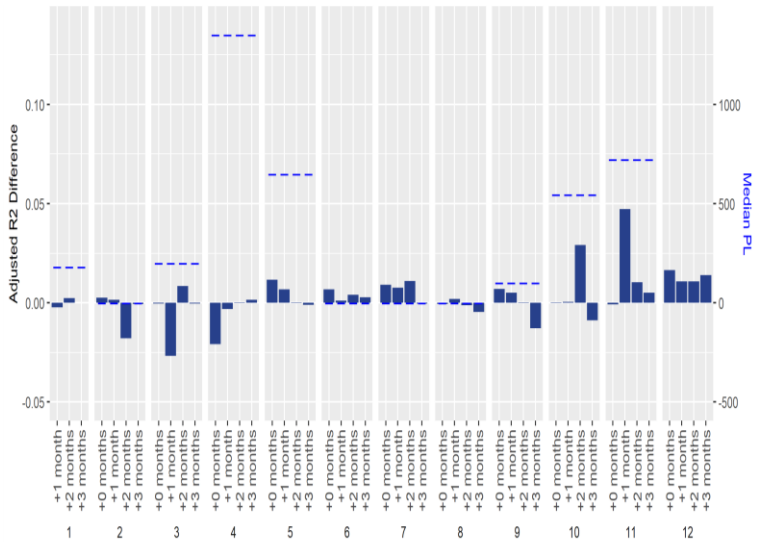
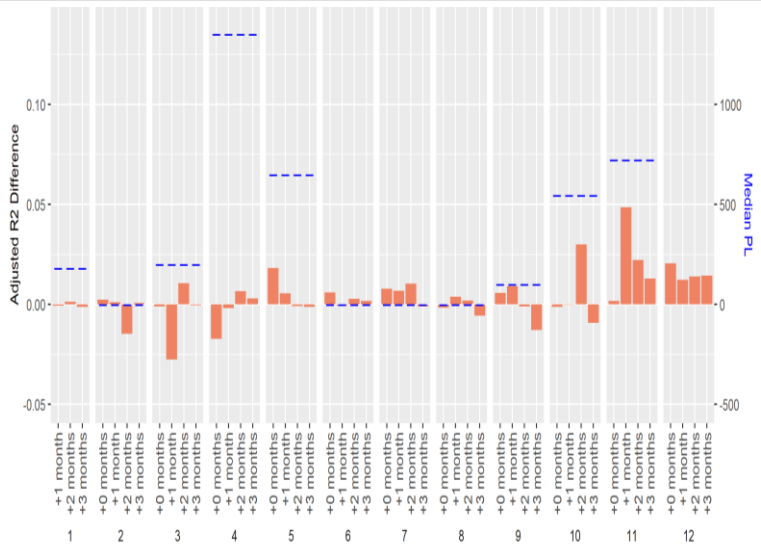


Graph 3: Difference of (Adjusted R^2 Regression with dynamic variable) – (Adjusted R^2 Regression only with Static variables) for the year 2000. In general, using remote sensing data improves the model's adjustment.

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Results

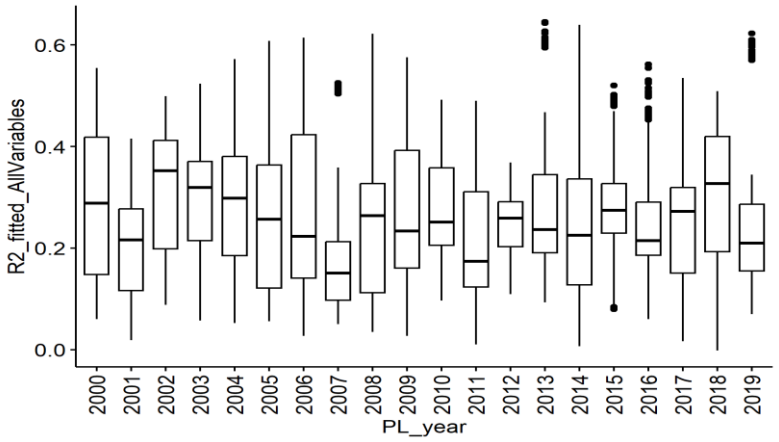
Table 4: Difference Adjusted R^2 values w/dynamic variable minus Adjusted R^2 values w/o dynamic variables obtained for the models developed for the year 2000.

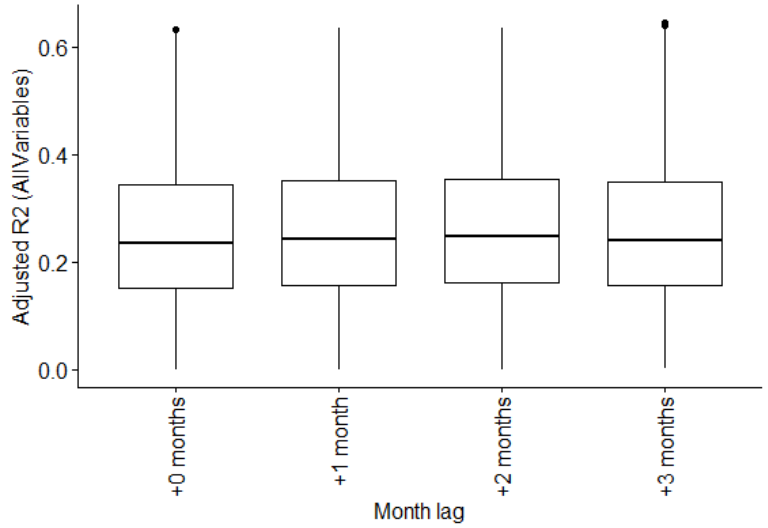
	NDVI	NDWI	NDVI + NDWI
INDEX			
ANOMALY			

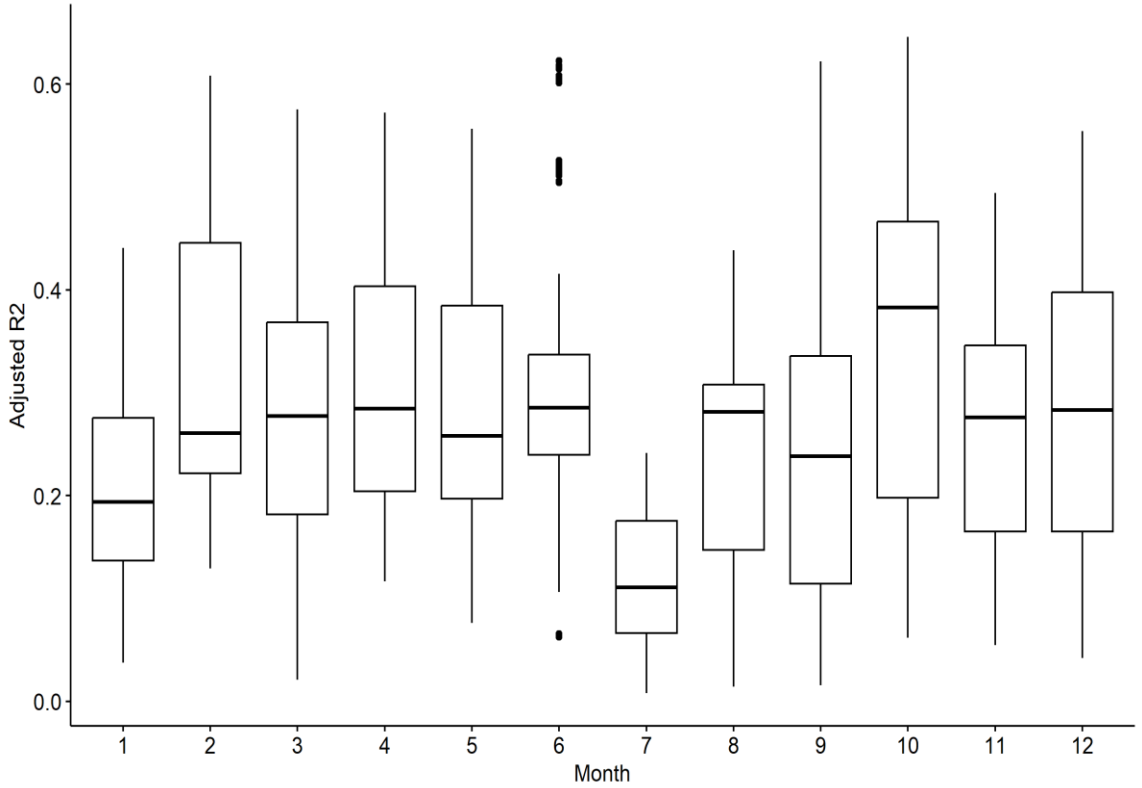
Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Discussion

Graph 4: Box plot of the Adjusted R^2 for the complete time series (2000-2019). Variable year behaves differently.







Graph 5: Box plot of the Adjusted R^2 for the complete time series (2000-2019) sorted by month highlighting a strong seasonal component.

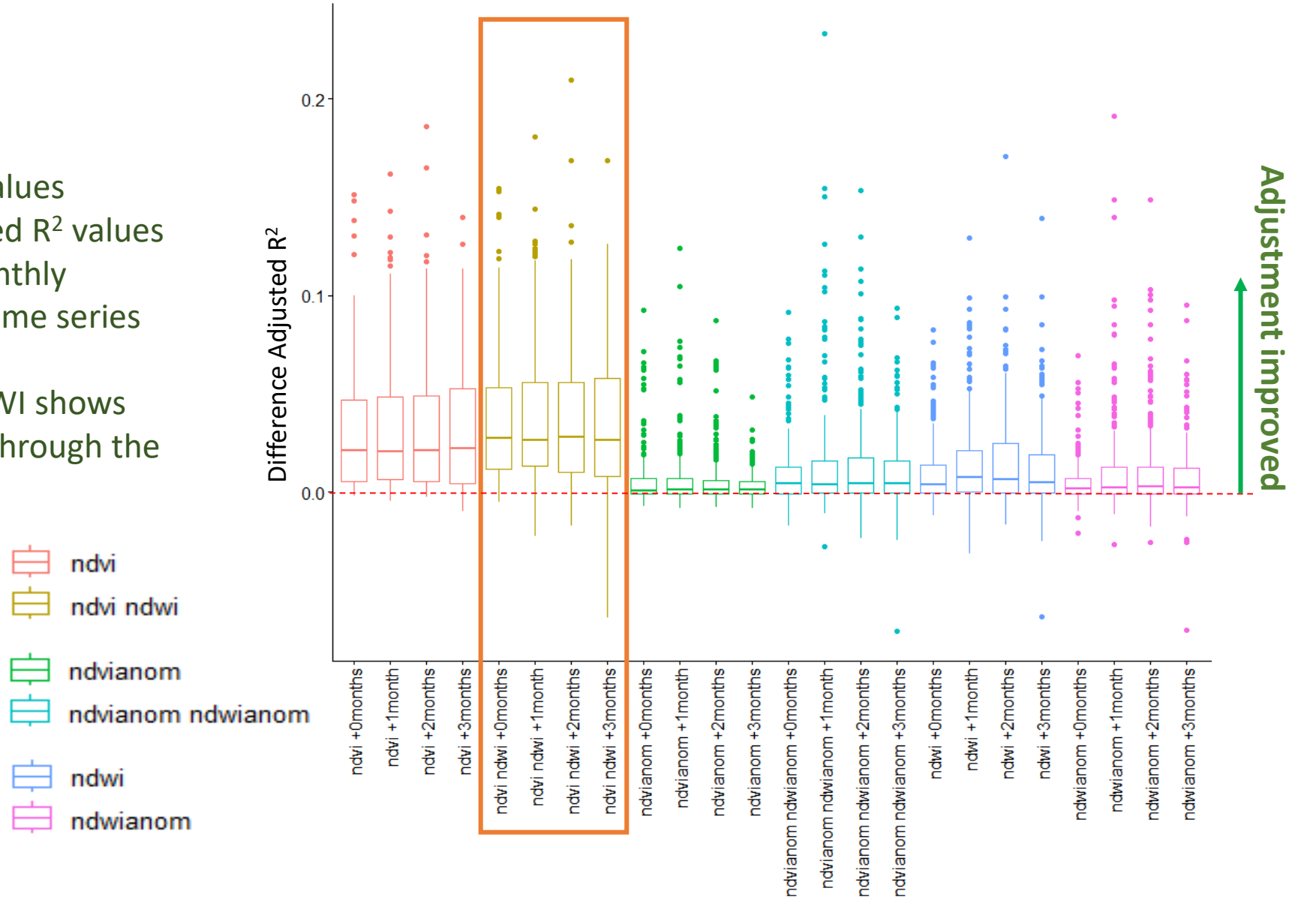
Graph 6: Box plot Adjusted R^2 for the complete time series (2000- 2019) sorted my remote sensing variable time lag. Month +2 is slightly higher but not statistically significant.

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Discussion

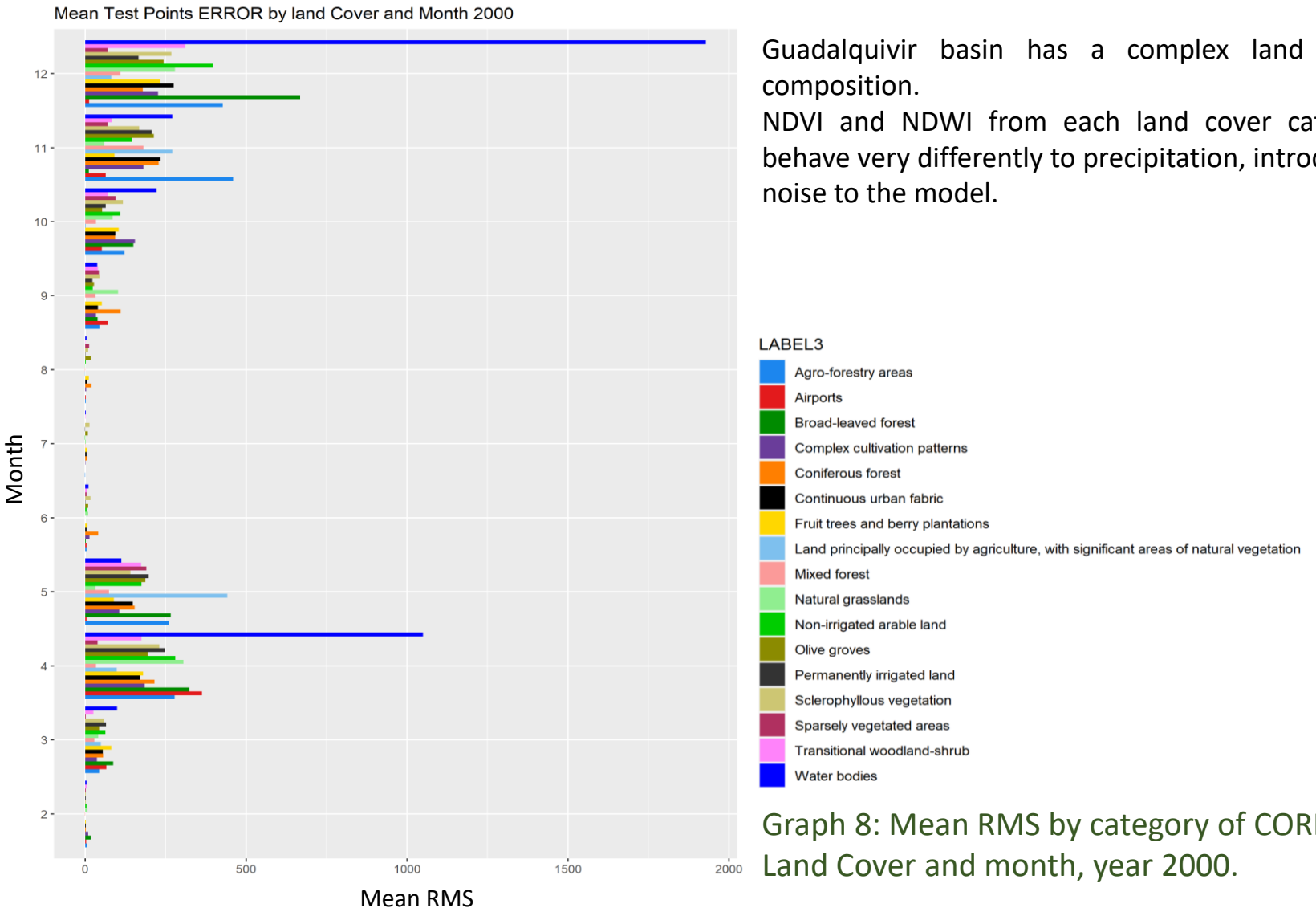
Graph 7: Difference Adjusted R^2 values w/dynamic variable minus Adjusted R^2 values w/o dynamic variables for the monthly models developed the complete time series 2000-2019.

The combination of NDVI and NDWI shows good results but not consistently through the time series.



Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.

Conclusions



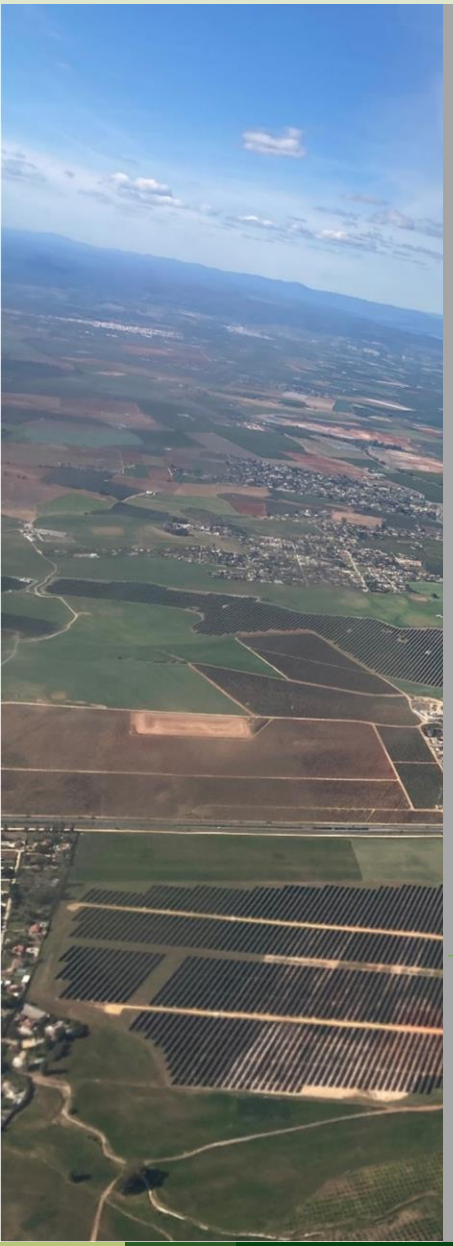
Graph 8: Mean RMS by category of CORINE Land Cover and month, year 2000.

Guadalquivir basin has a complex land cover composition.

NDVI and NDWI from each land cover category behave very differently to precipitation, introducing noise to the model.

Image 5: Aerial image from the study area.

Improvements on the monthly precipitation spatial pattern characterization using a set of remote sensing products.



Thank you for your attention

Questions / Comments?

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