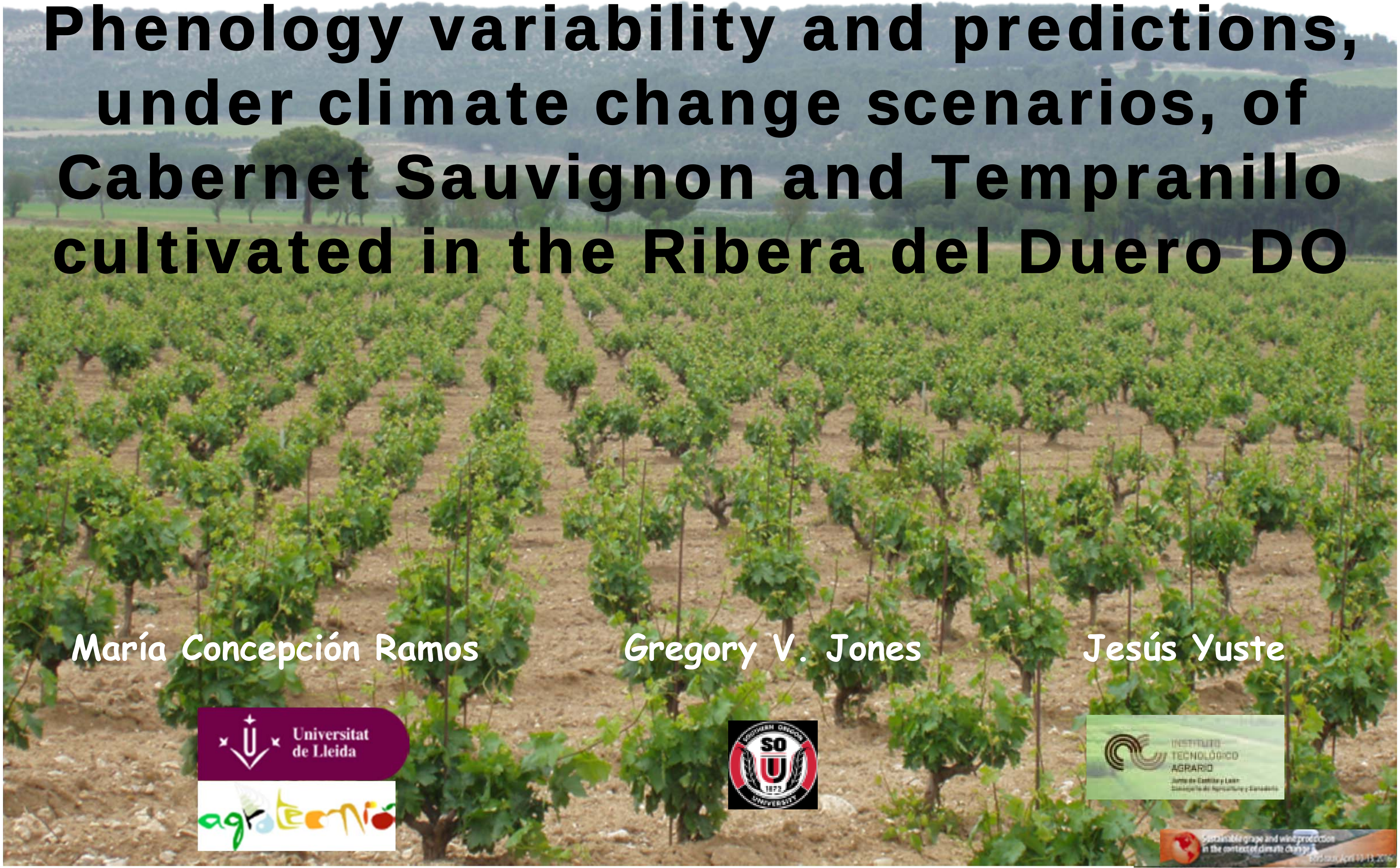
Phenology variability and predictions, under climate change scenarios, of Cabernet Sauvignon and Tempranillo cultivated in the Ribera del Duero DO



María Concepción Ramos

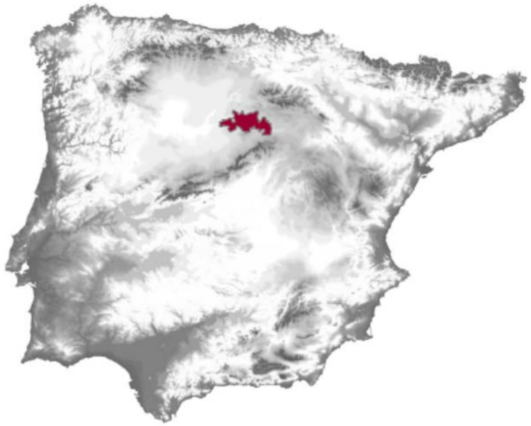
Gregory V. Jones

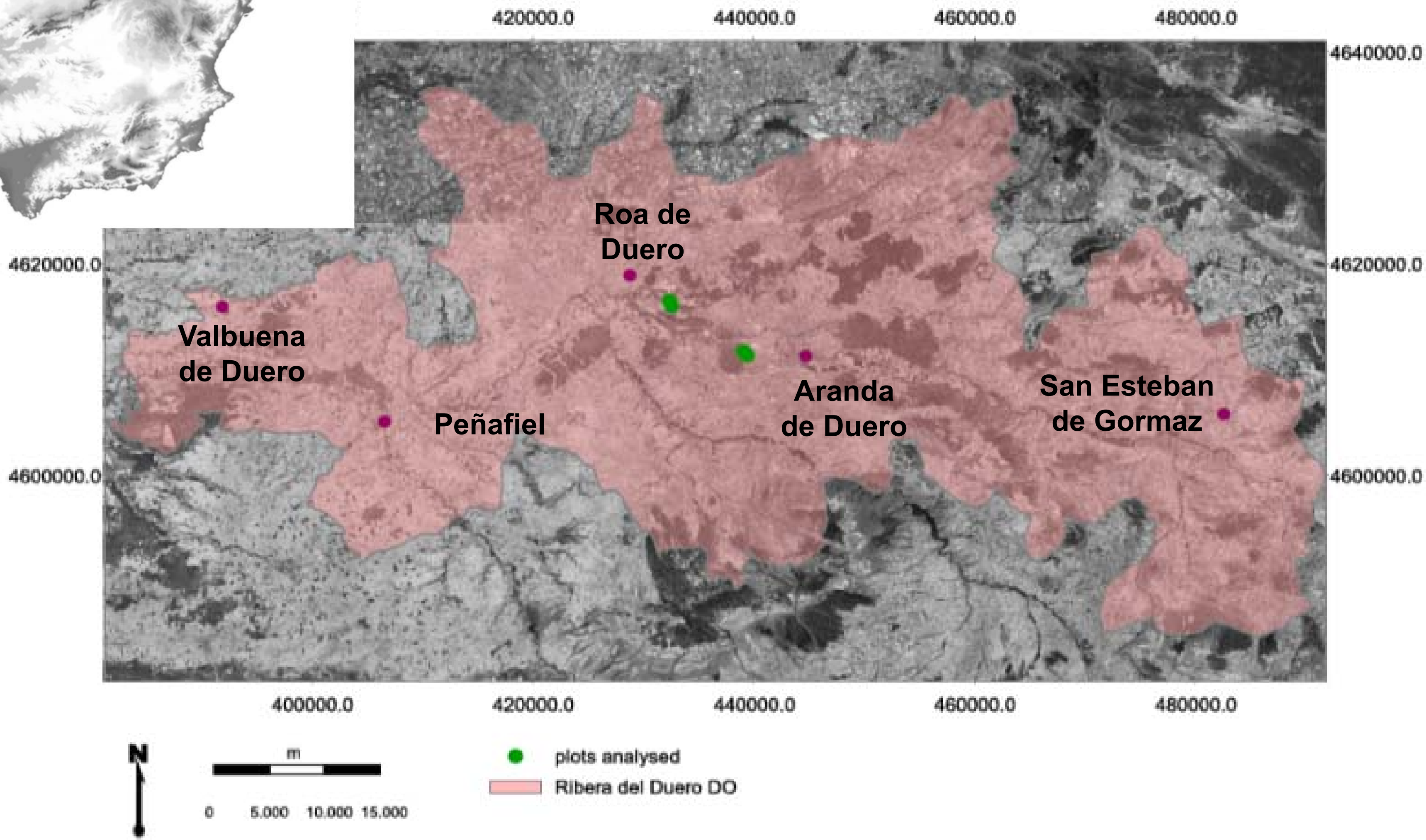
Jesús Yuste

Outline

- General characteristics of the Ribera del Duero DO
- Objectives
- Data and methods
- Results
- Conclusions

Ribera del Duero DO





Total surface: 21,500 ha

115 km along the Duero River

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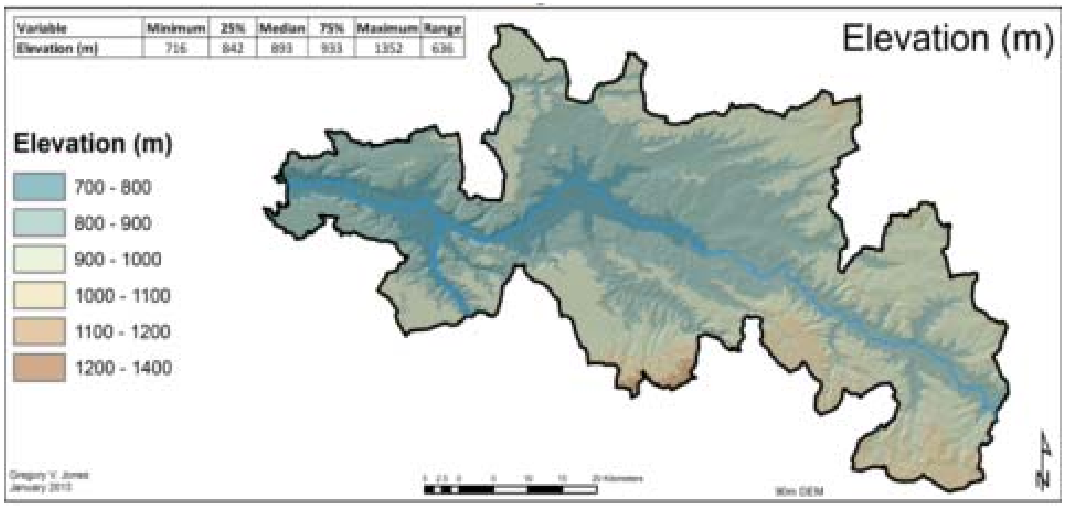
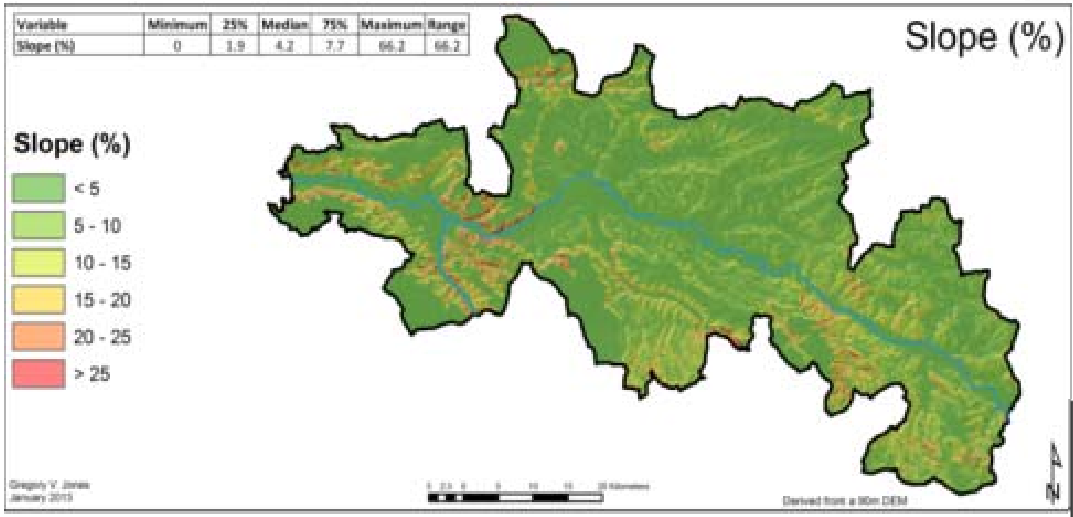
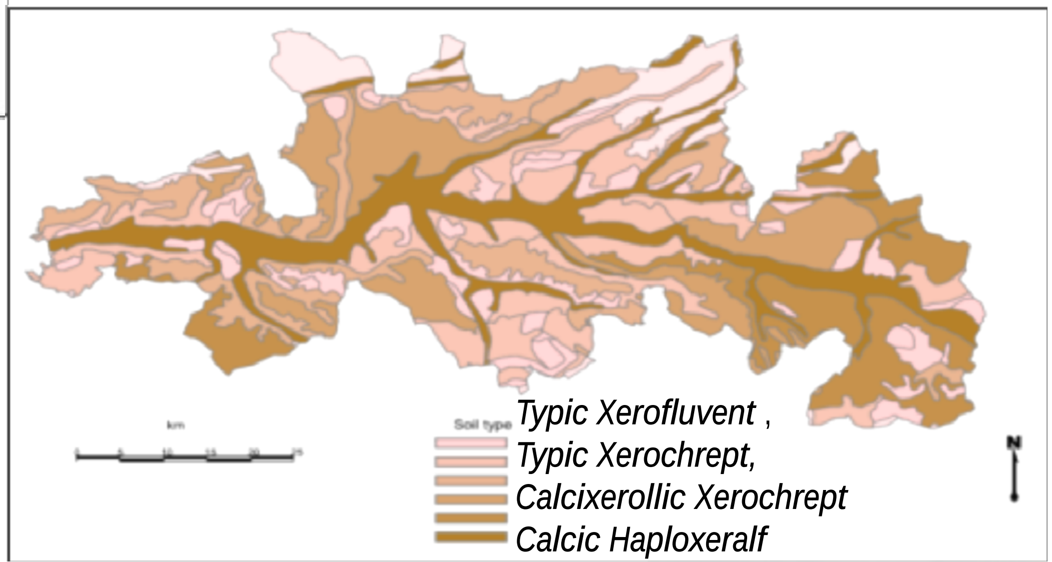
Elevations





Slope

Soils



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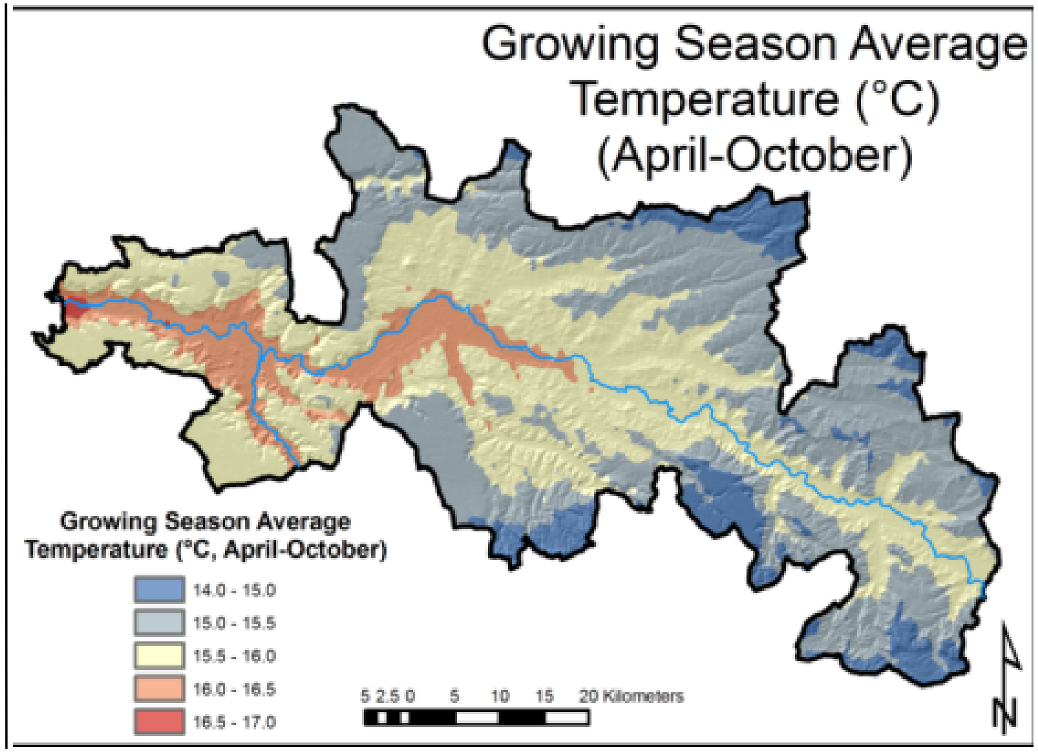
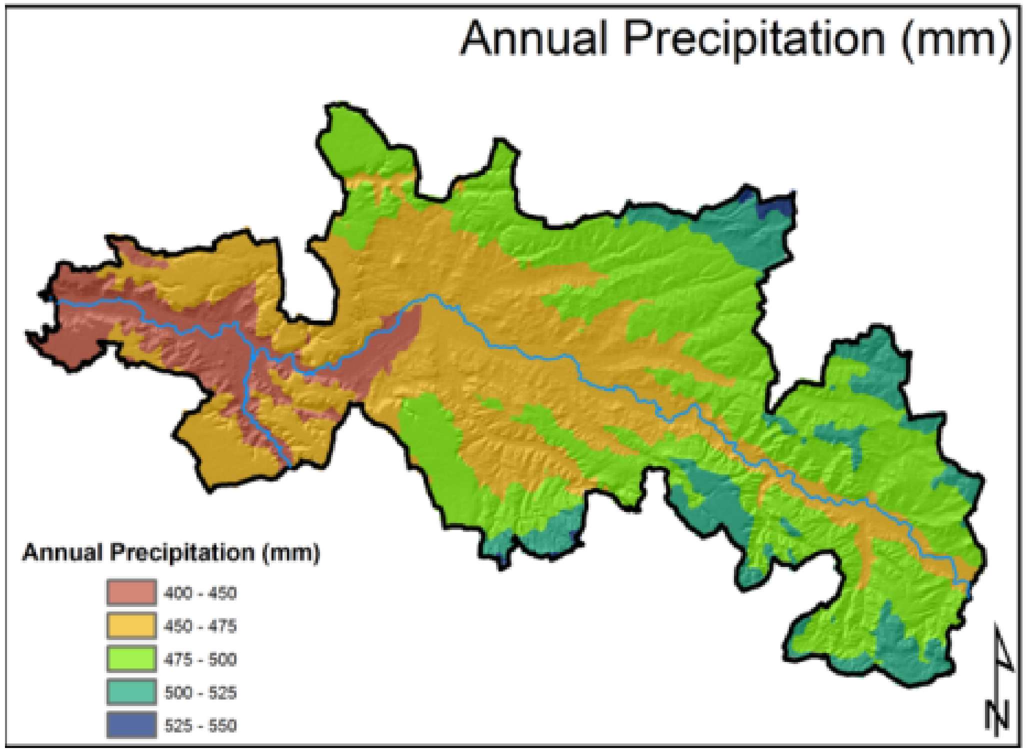




Variable	Minimum	25%	Median	75%	Maximum	Range
Annual Precipitation (mm)	421	463	477	492	542	121
Growing Season Precipitation (mm)	186	211	219	228	251	65
Growing Season Average Temperature (°C)	14.0	15.2	15.6	15.8	16.6	2.6

Grape varieties:

Tempranillo (90%)

Cabernet Sauvignon, Merlot, Malbec, Grenache

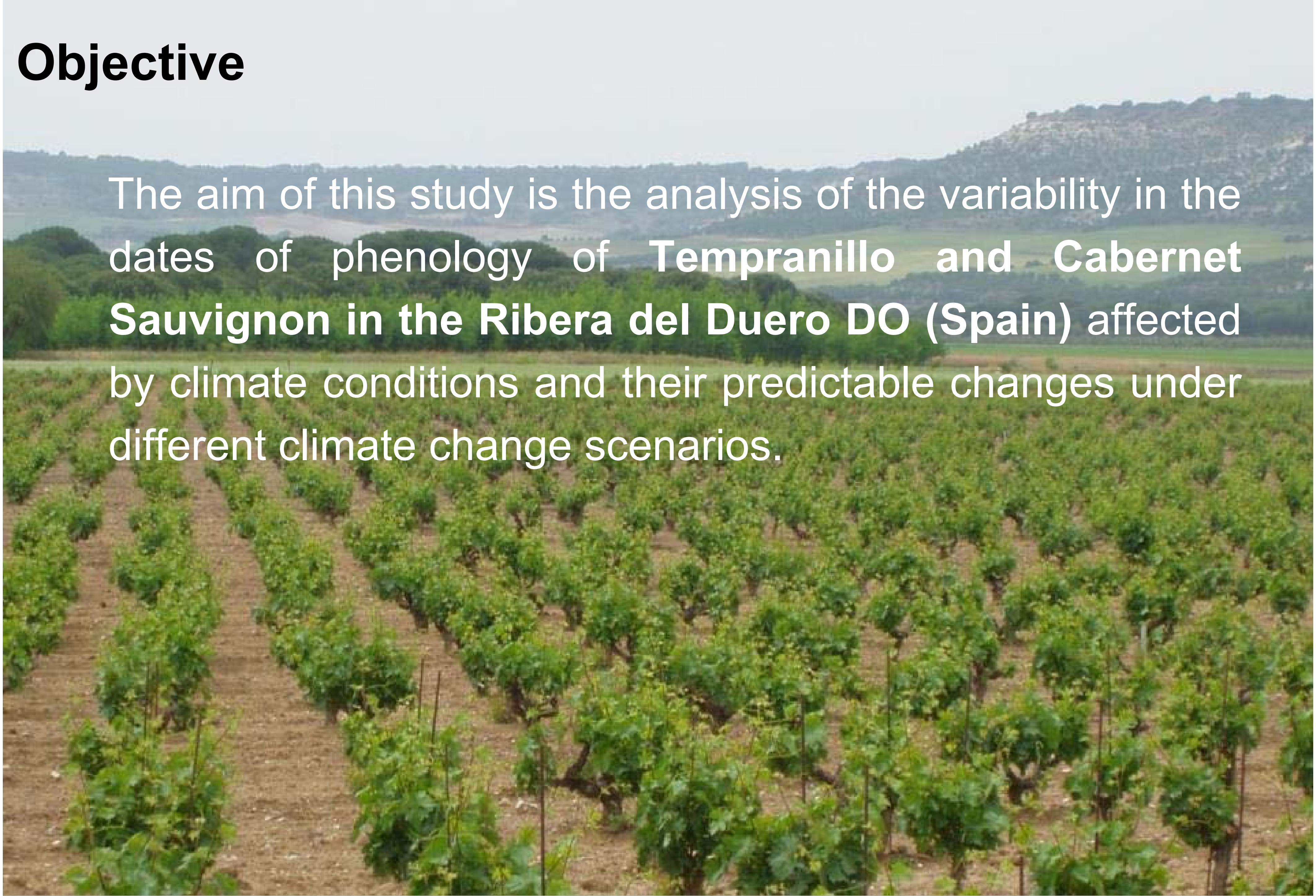
Albillo

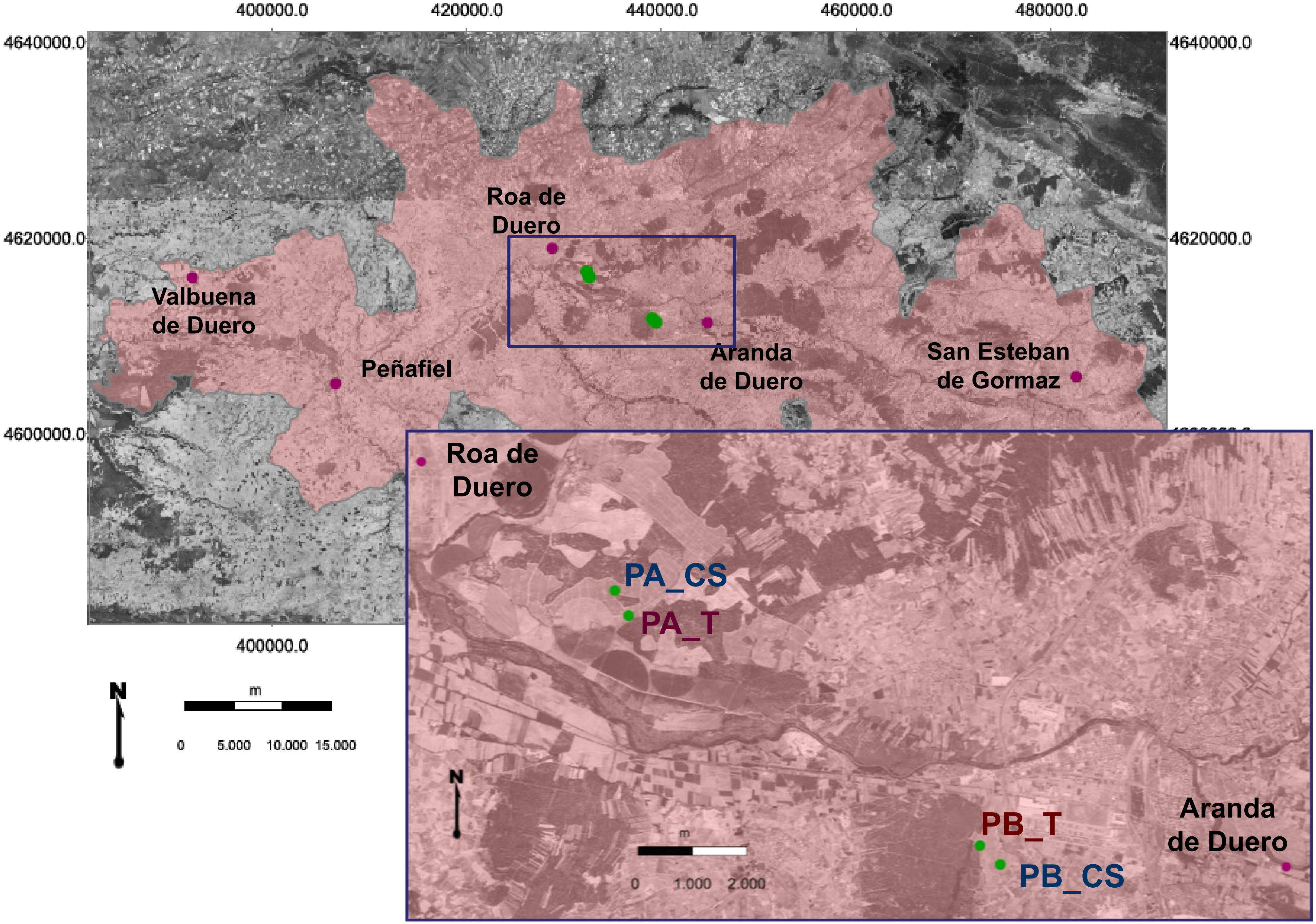
Training system:

Vertical trellis and gobelet

Objective

The aim of this study is the analysis of the variability in the dates of phenology of **Tempranillo and Cabernet Sauvignon in the Ribera del Duero DO (Spain)** affected by climate conditions and their predictable changes under different climate change scenarios.




400000.0
420000.0
440000.0
460000.0
480000.0
4640000.0
4620000.0
4600000.0
Roa de Duero
Valbuena de Duero
Peñafiel
Aranda de Duero
San Esteban de Gormaz
N
m
0 5.000 10.000 15.000
Roa de Duero
PA_CS
PA_T
PB_T
PB_CS
Aranda de Duero
N
m
0 1.000 2.000

Phenology

Phenology Dates
2004-2015

Budbreak
Bloom
Veraison
Harvest

Average dates

Climate

Climate Dates
2004-2015
Aranda de Duero
Roa de Duero

temperature
precipitation
bioclimatic indexes

Average values

Relationships

Phenology dates
-
Climatic variables

Steepwise multiple regression analysis

Change ratios

Climate change scenarios

RCP 4.5
and
RCP 8.5

2030
2050
2070

10 models
Coupled Model Intercomparison Project (CMIP5)

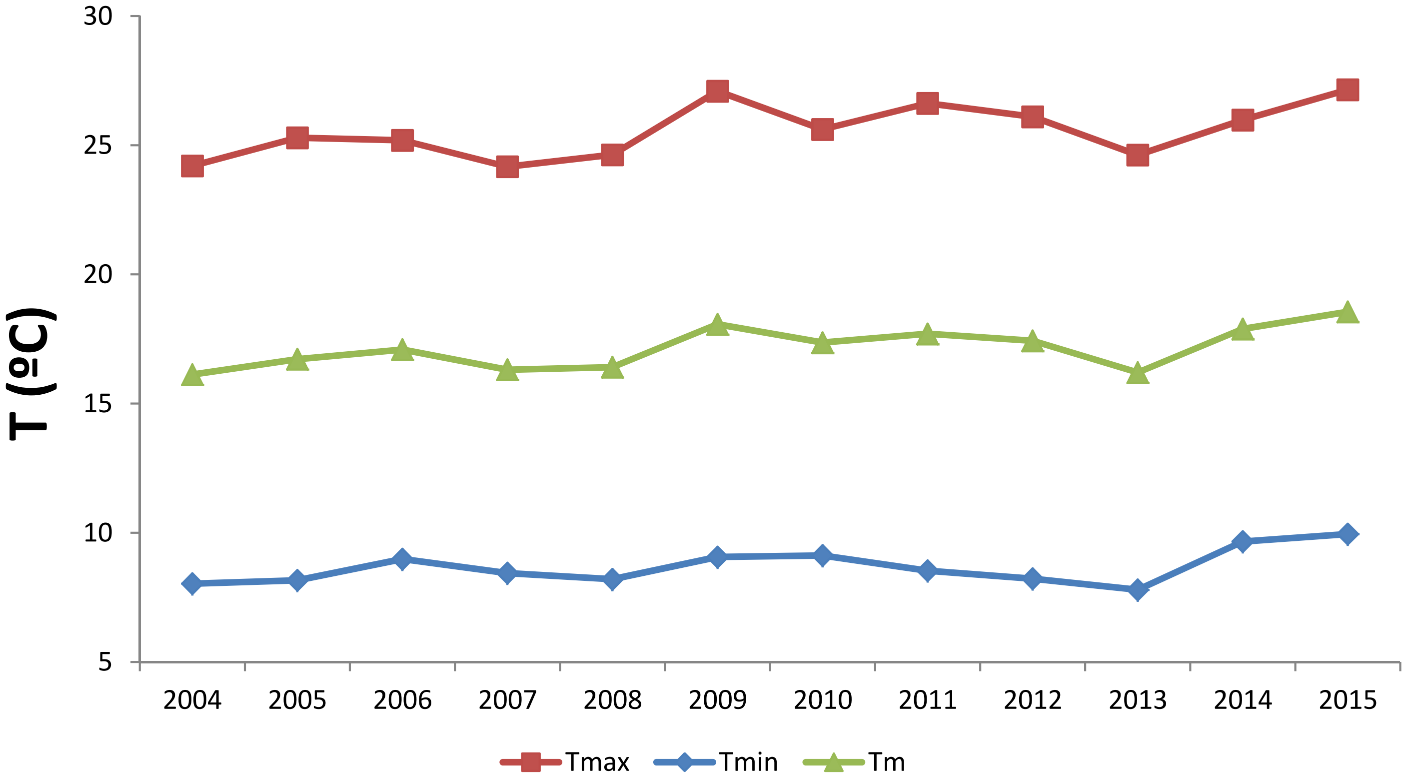
MOROC5
ACCESS1.0
CNRM_M5
INMCM4
MPI-ESM_MR
HadGEM2-CC
CMCC-CM
BCC-CSM1-1
MSI_CGCM1
BNU-ESM

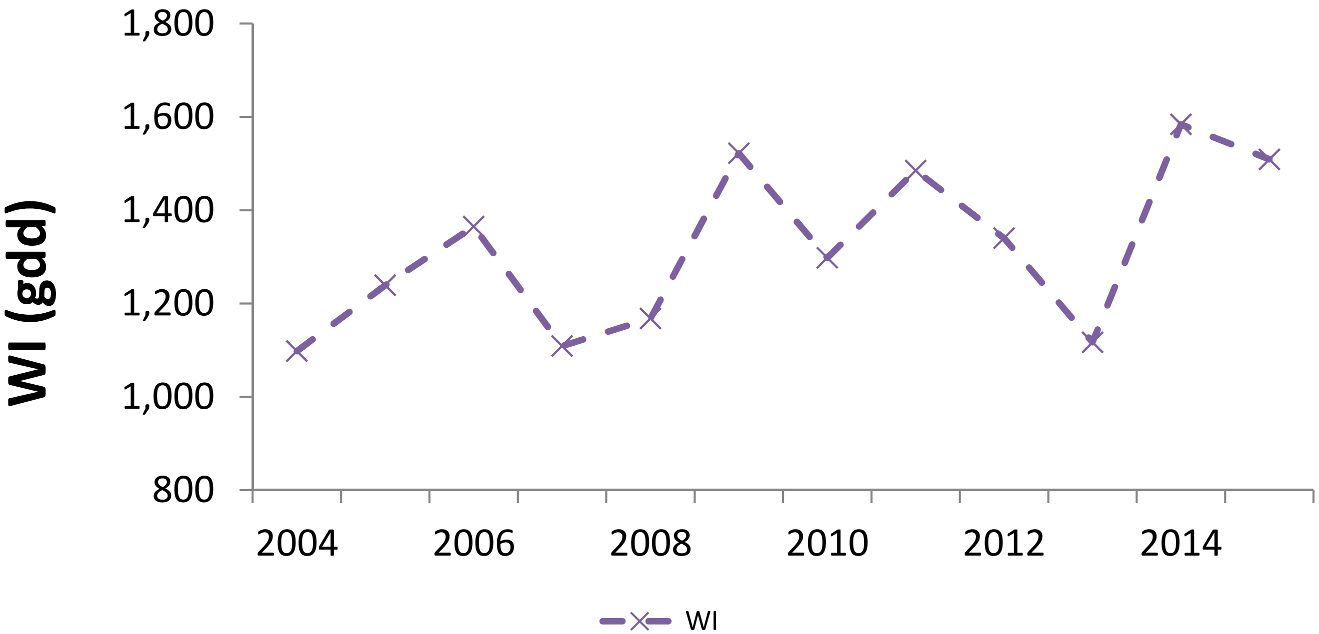
downloaded
at daily time scale

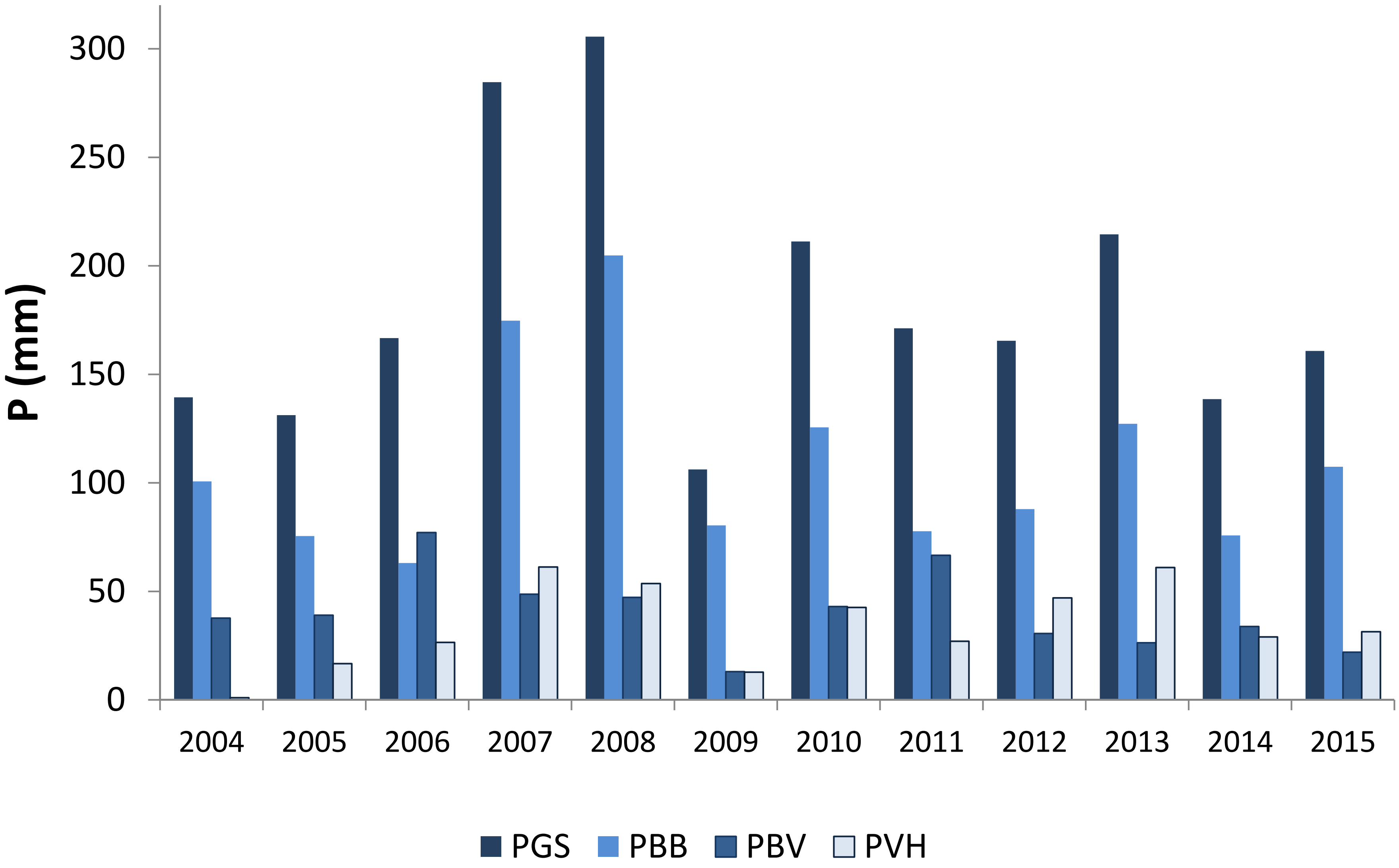
2006-2100
and compared with
1960-2000.

Temperature
(Tmax-Tmin)
&
Precipitation


Results


30
25
20
15
10
5
T (ºC)
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Tmax
Tmin
Tm


1,800
1,600
1,400
1,200
1,000
800
WI (gdd)
2004
2006
2008
2010
2012
2014
WI

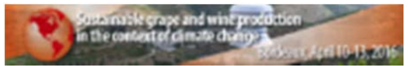

P (mm)
300
250
200
150
100
50
0
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
PGS
PBB
PBV
PVH

Average dates and standard deviation of phenology stages for each variety (period 2004-2013)

	Variety	Elevation (m)	C Budbreak (BB)	I Bloom (BL)	M Veraison (V)	N Maturity (H)
PA_CS	CS	802	24-Apr±5	15-Jun±9	16-Aug±9	10-Oct±6
PB_CS	CS	840	30-Apr±8	18-Jun±9	19-Aug±8	14-Oct±6
PA_T	T	808	26-Apr±8	15-Jun±9	12-Aug±9	2-Oct±8
PB_T	T	820	26-Apr±6	18-Jun±9	14-Aug±8	4-Oct±8

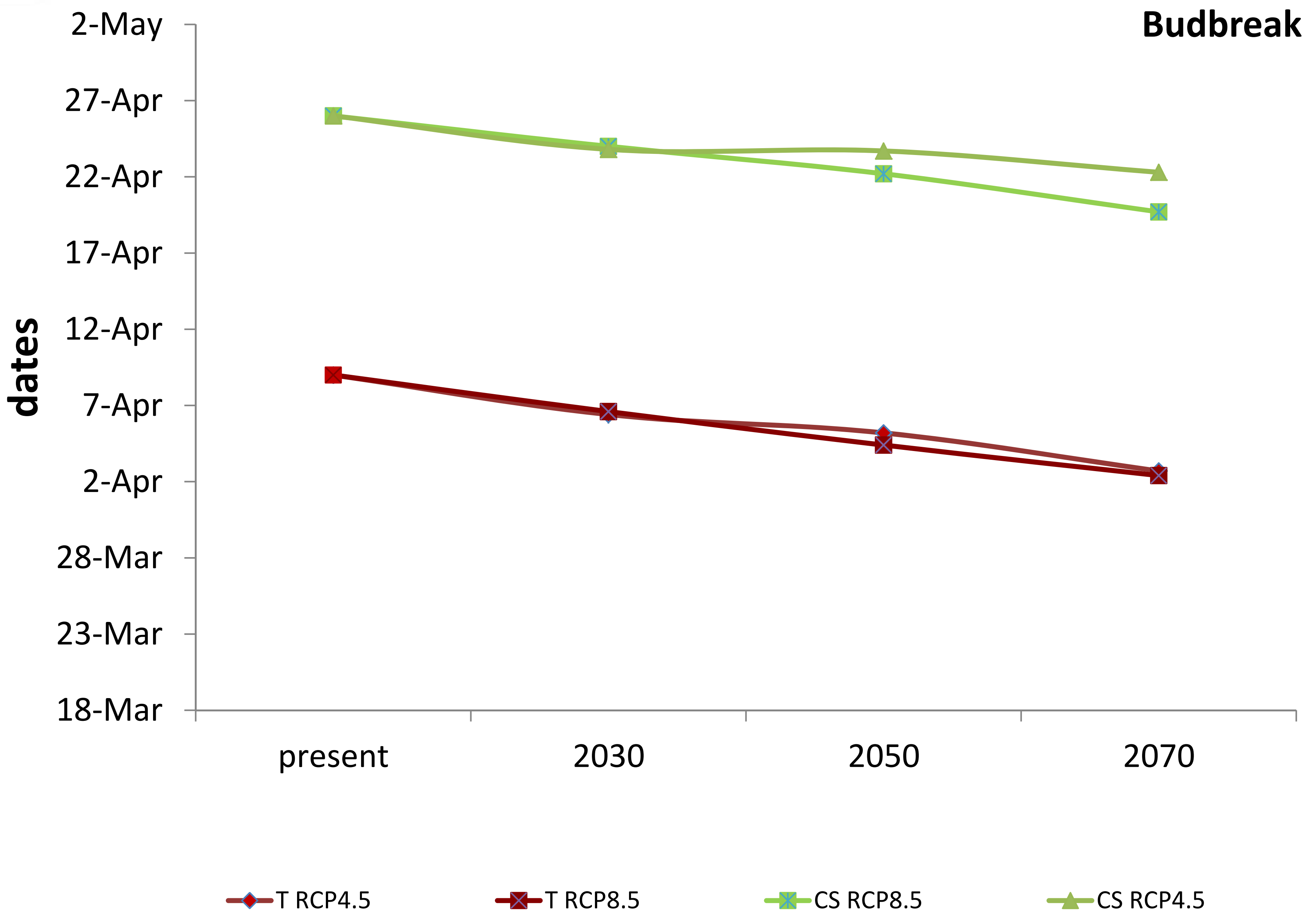
Fits between phenological dates and the temperature variables that showed significant relationships for each plot.

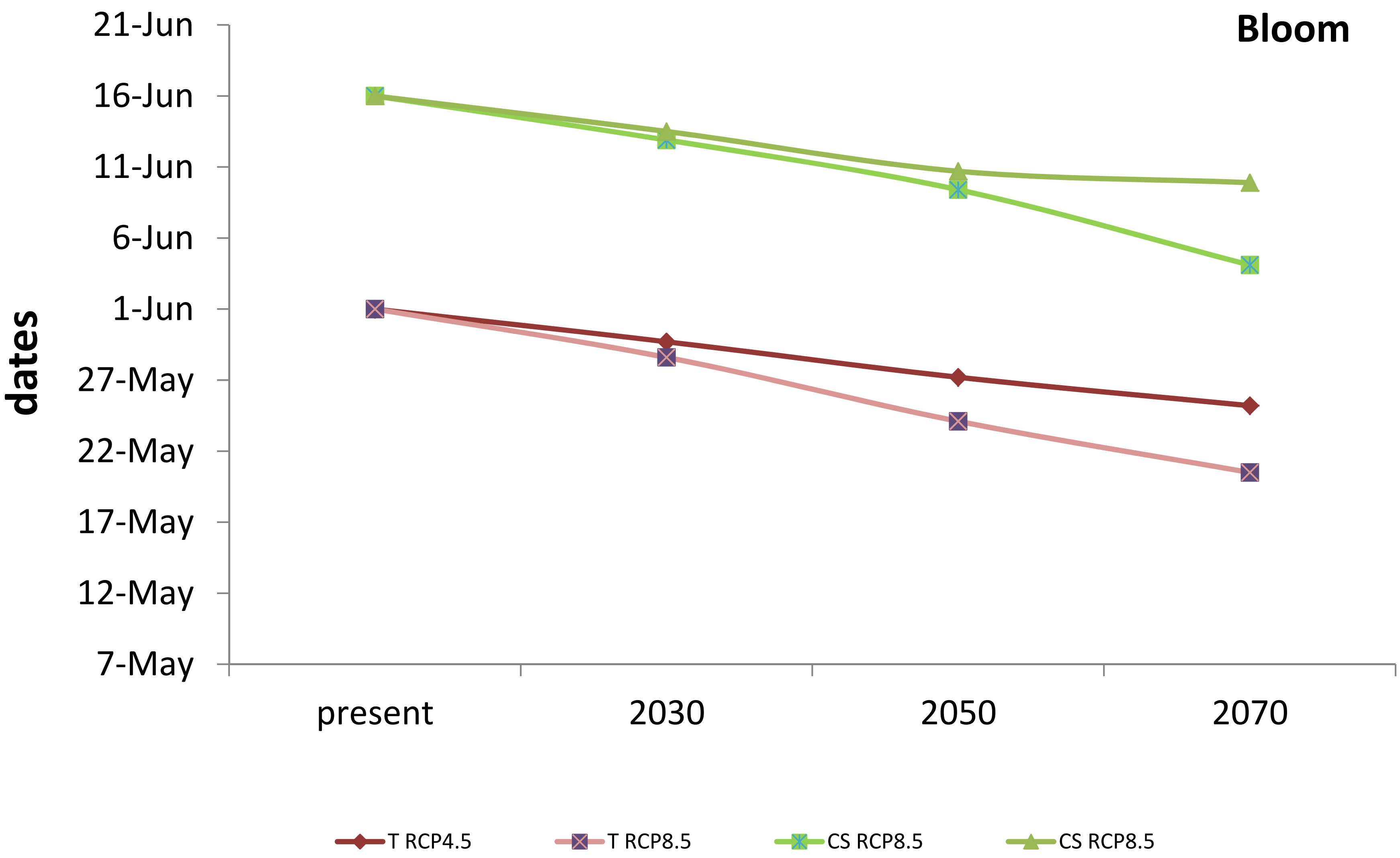
Plot	C Budbreak	I Bloom	M Veraison
PA_CS	$Tmin_{D\_B}$ R^2= 57.81	$Tmin_{B\_BL}$ R^2= 75.66 $(P\text{-}ETc)_{B\_BL}$ R^2= 81.36	$Tmax_{B\_BL}$ R^2= 82.85 $(P\text{-}ETc)_{B\_BL}$ R^2= 83.9748
PB_CS	$Tmin_{D\_B}$ R^2= 45.98	$Tmax_{B\_BL}$ R^2= 68.03 $(P\text{-}ETc)_{B\_BL}$ R^2= 66.03	$Tmax_{B\_BL}$ R^2= 72.63 $(P\text{-}ETc)_{B\_BL}$ R^2= 49.94
PA_T	$Tmin_{D\_B}$ R^2= 76.35	$Tmax_{B\_BL}$ R^2= 60.33 $(P\text{-}ETc)_{B\_BL}$ R^2= 81.05	$Tmax_{B\_BL}$ R^2= 56.14 $(P\text{-}ETc)_{B\_BL}$ R^2= 74.4
PB_T	$Tmin_{D\_B}$ R^2= 73.12	$Tmin_{B\_BL}$ R^2= 76.9 $(P\text{-}ETc)_{B\_BL}$ R^2= 78.00	$Tmax_{B\_BL}$ R^2= 52.44 $(P\text{-}ETc)_{B\_BL}$ R^2= 45.53



Predicted changes in temperature between phenological stages under different climate change scenarios

		RCR4.5			RCP8.5	
	2030	2050	2070	2030	2050	2070
Tmin _B	0.63	0.70	1.12	0.67	1.13	1.89
Tmax_B	0.97	1.35	2.29	1.65	1.87	2.95
Tmin BBL	0.48	1.03	1.19	0.61	1.30	2.34
Tmax BBL	0.83	1.96	2.37	1.11	2.11	3.60


Budbreak
dates
2-May
27-Apr
22-Apr
17-Apr
12-Apr
7-Apr
2-Apr
28-Mar
23-Mar
18-Mar
present
2030
2050
2070
T RCP4.5
T RCP8.5
CS RCP8.5
CS RCP4.5


Bloom
dates
21-Jun
16-Jun
11-Jun
6-Jun
1-Jun
27-May
22-May
17-May
12-May
7-May
present
2030
2050
2070
T RCP4.5
T RCP8.5
CS RCP8.5
CS RCP8.5

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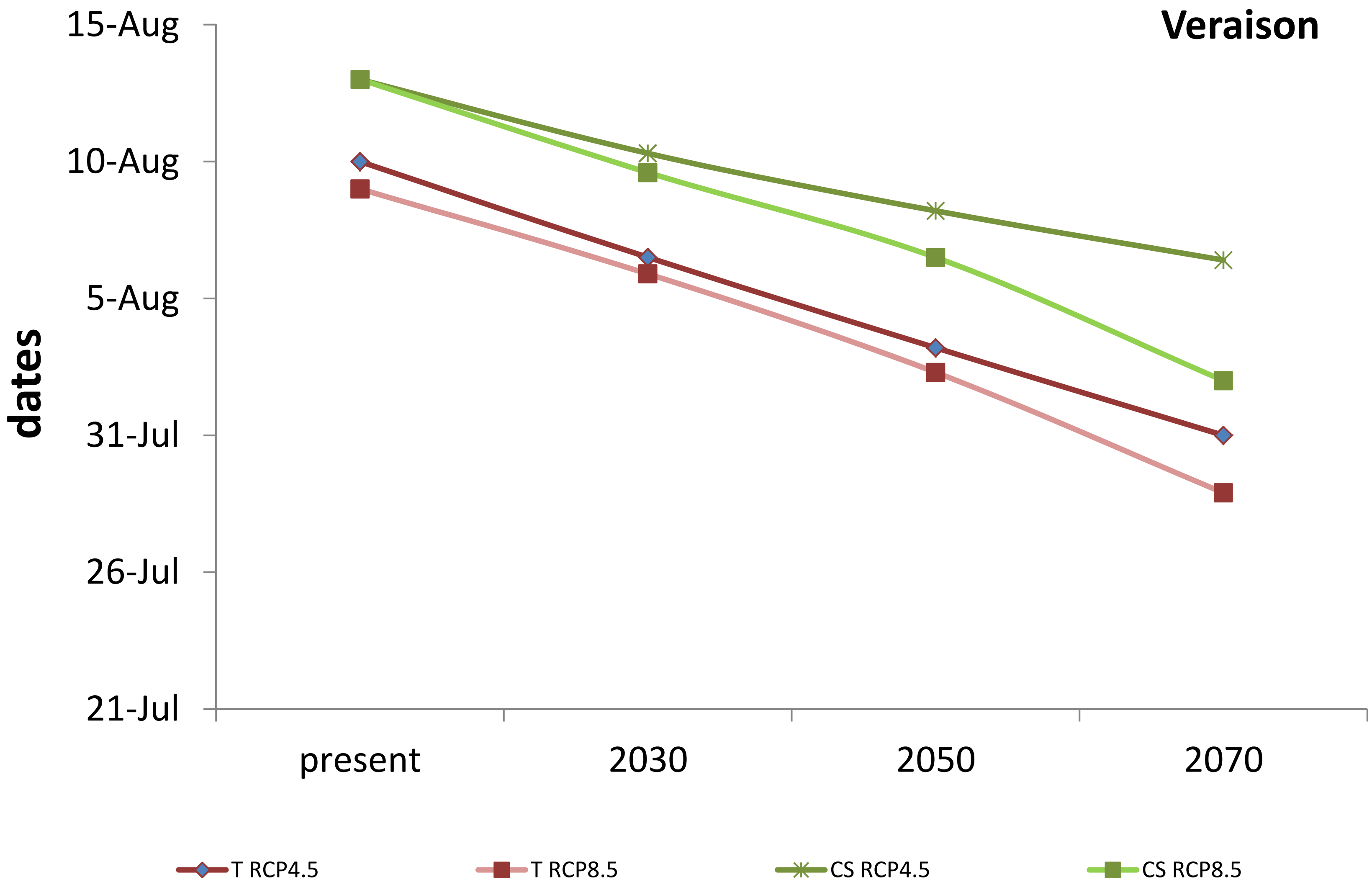

Conclusions

- The results confirmed that maximum and minimum temperatures recorded in spring, in the first stages of the growing season affected all phenological phases. Similarly, water available during that period affects bloom and veraison.

- Both, the increase of temperature and the decrease of water available produce an advance of the phenological phases. The phases that may suffer higher advance may be bloom and veraison, with additional changes in the duration of the period between different phenophases. .

Conclusions

- The projections suggested, more pronounced effects on Tempranillo, which is the main variety cultivated in in the DO and one of the main producer areas worldwide, than in other red varieties such as Cabernet Sauvignon. These projections may have significant repercussions in the wine production in the area and in its quality, which should be also evaluated for a better adaptation of vine management under this new challenge.

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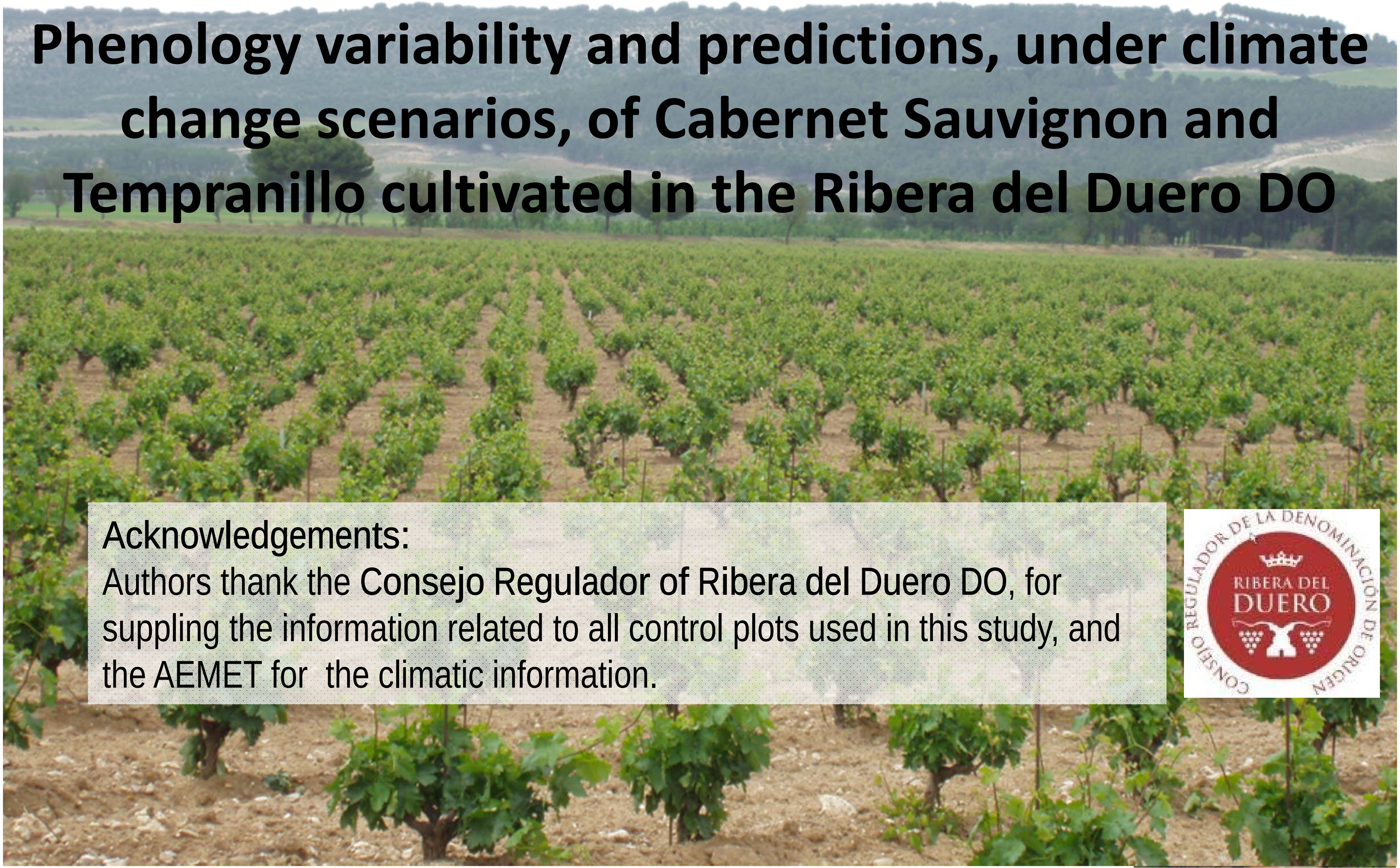

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