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MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO
AEMet Agencia Estatal de Meteorología

Trends of different agroclimatic parameters in Spain

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State Meteorological Agency of Spain

- In the last twenty years there have been changes in the agricultural activities timing in several crops. Although many of those changes can be explained by changes in species or in harvesting methods, there have also been changes in some of the recorded phenological phases (for instance, in almond tree flowering or the arrival of some migratory birds).

- Although there are numerous studies on the impact of climate change on crop yields or food production, most of them use model projections for fifty or more years of annual averaged temperatures and rainfall, and in many cases it remains still unanswered the question on the convenience of changes in crops or harvesting methods for changes in the near future (next ten years) or for those which have already taken place. In this last case, the first question to deal is to establish whether have been changes and to determine them as accurate as possible.

- The aim of this study was mainly to answer if there have been changes in some agroclimatic parameters, such as mean maximum and minimum temperatures, precipitation, frost days, number of days with maximum temperature exceeding predefined thresholds, sunshine, wind run, evapotranspiration, SPI…. Mainly focused in the vegetative period (February to June, both included).

Study data

- For the trend analysis the daily data of temperature, precipitation, sun hours, wind, for a set of representative meteorological stations in each study zone corresponding to a Spanish climatic zone were used. The gaps in data series were filled.
- The period used in the study was in general from 1960 to 2010: period from February to June (temperature, precipitation, sun hours, wind…).
- **Climatic zones**
- 1. Galicia and Norther coastal zone (meteorological stations: Vigo Peinador, Santiago Labacolla, Oviedo aeropuerto, Bilbao Sondica, San Sebastián Igueldo, Vitoria Foronda).
- 2. Northern Plateau (meteorological stations: León Virgen del Camino, Burgos Villafría, Salamanca Matacán, Valladolid Villanubla).
- 3. Southern Plateau (meteorological stations: Madrid Barajas, Molina de Aragón, Cuenca, Albacete Los Llanos)
- 4. Guadiana and Guadalquivir river basins (meteorological stations: Talavera la Real (Badajoz), Córdoba aeropuerto, Granada Armilla, Sevilla San Pablo, Morón, Jerez aeropuerto, Cádiz).
- 5. Ebro's river basin (meteorological stations: Daroca, Logroño Agoncillo, Zaragoza aeropuerto, Huesca Monflorite, Pamplona, Teruel)
- 6. Mediterranean coastal zone (meteorological stations: Barcelona aeropuerto, Reus, Tortosa, Valencia, Valencia Manises, Alicante El Altet, San Javier (Murcia), Alcantarilla (Murcia), Almería aeropuerto, Málaga aeropuerto).

- **Temperature.**
- Results for mean value of T min and T máx along the vegetative season.
- Results for frost days and number of hot days.
- Results for last frost day

- **Precipitation.**
- Total precipitation
- Number of days with precipitation exceeding predefined tresholds
- Extreme precipitations: Heavy rainfall in different time intervals

- **SPI.**
- Results for drought index (mean areal SPI series).

- **Sun hours.**

- **Water Balance Elements.**
- Climate Water Balance

Trends of daily maximum temperature: 1960-2010 (Vegetative period average)

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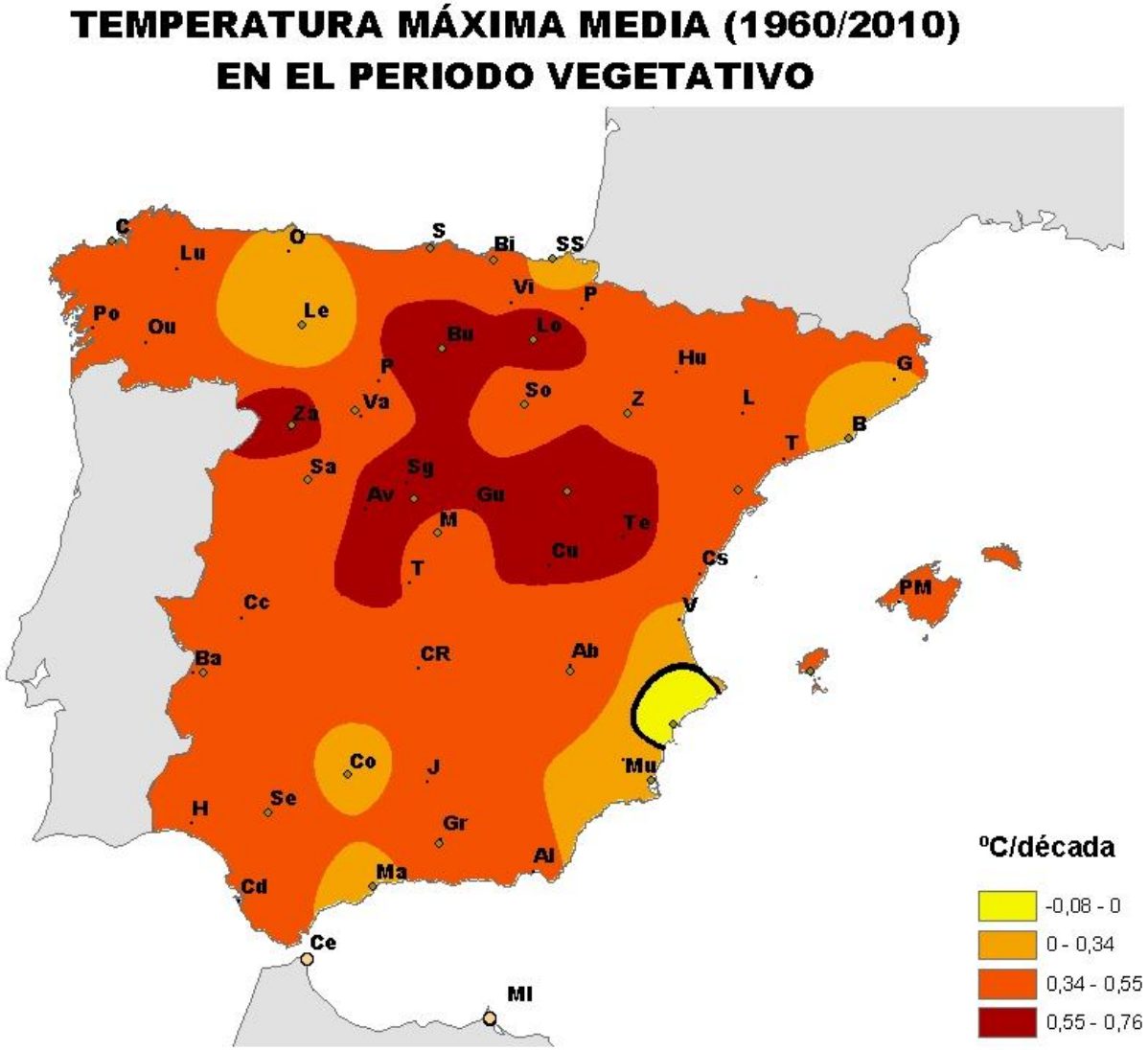

Trends of daily maximum temperature: 1985-2010 (Vegetative period average)

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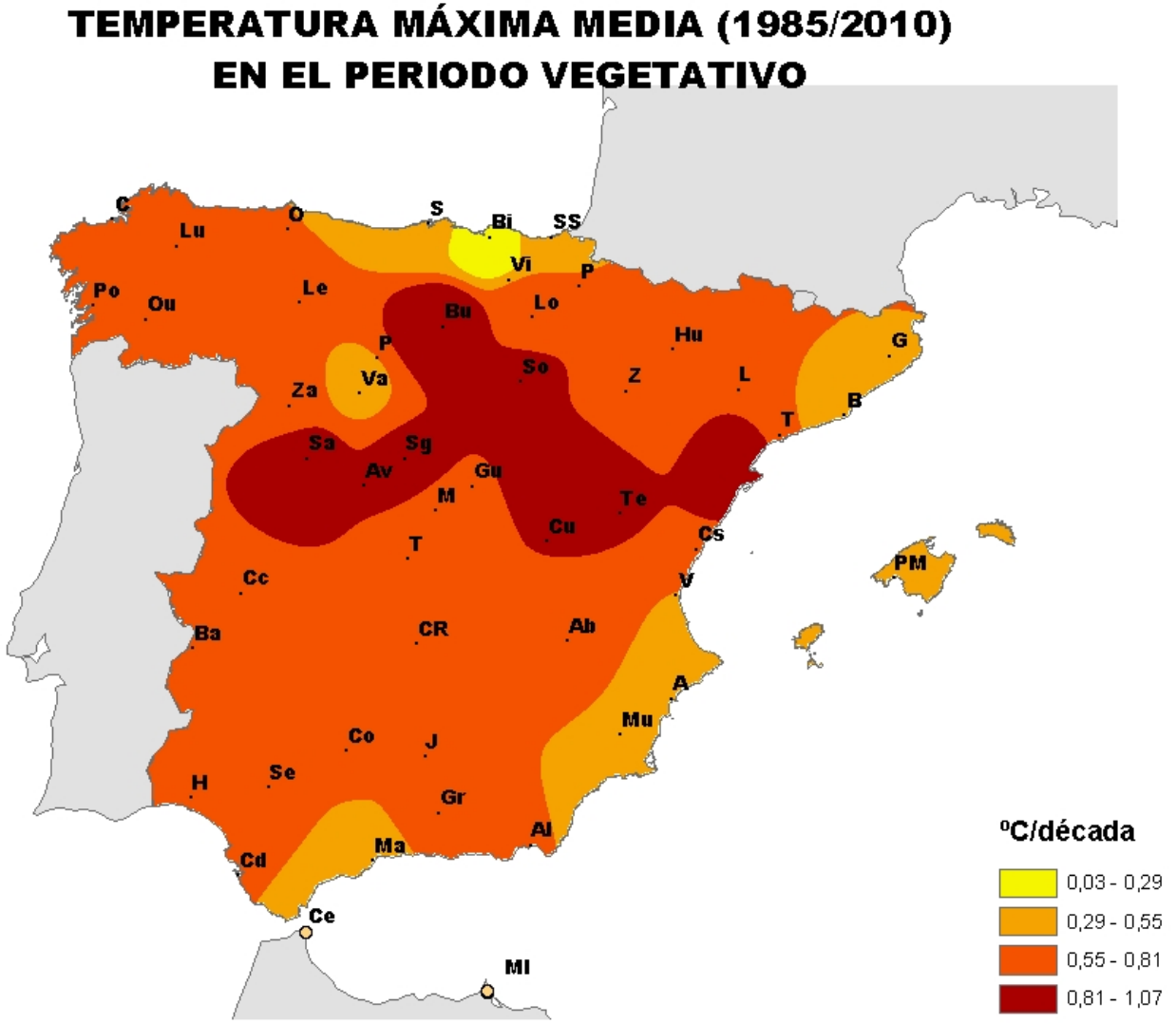

Trends of daily minimum temperature: 1960-2010 (Vegetative period average)

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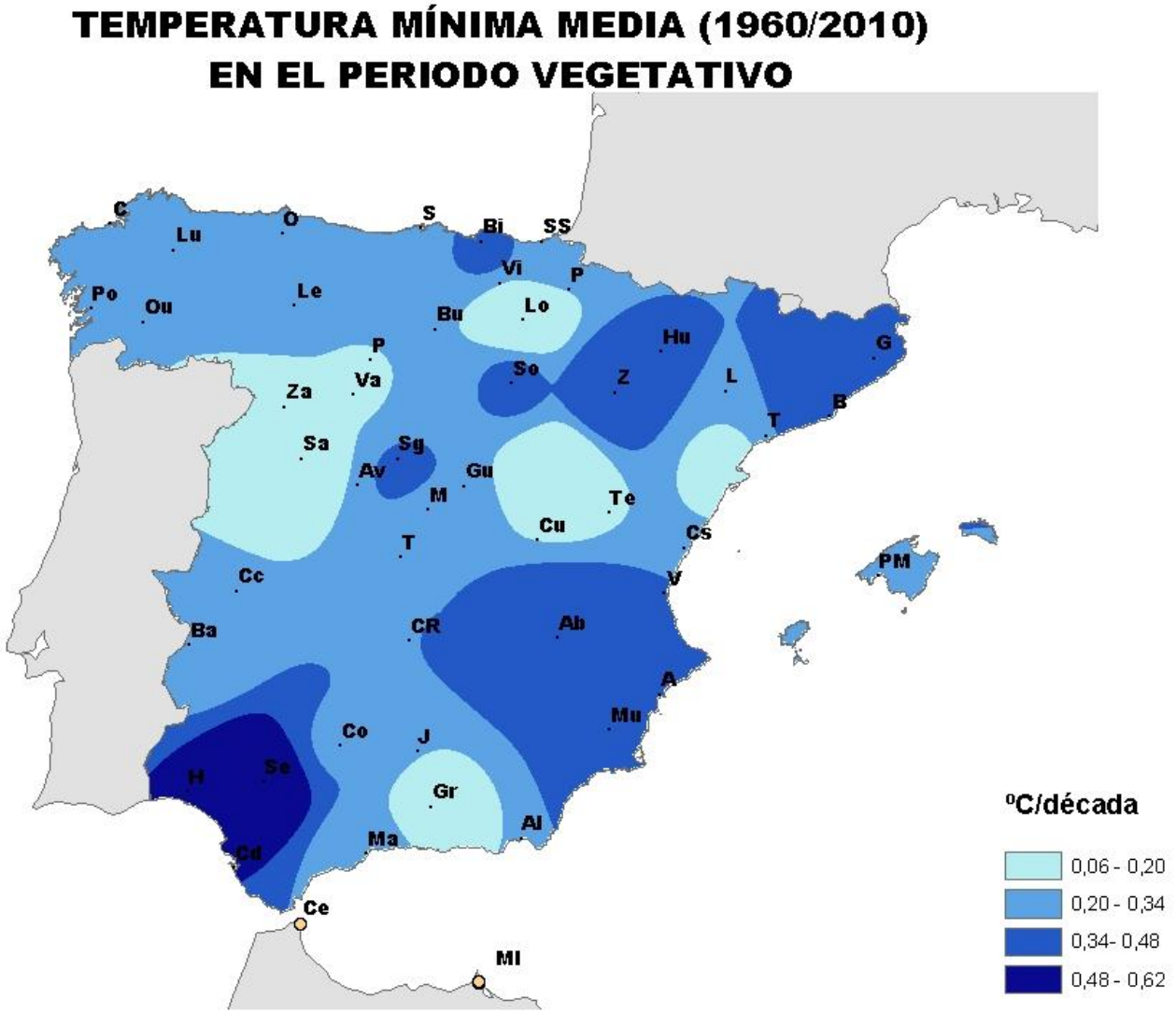

Trends of daily minimum temperature: 1985-2010 (Vegetative period average)

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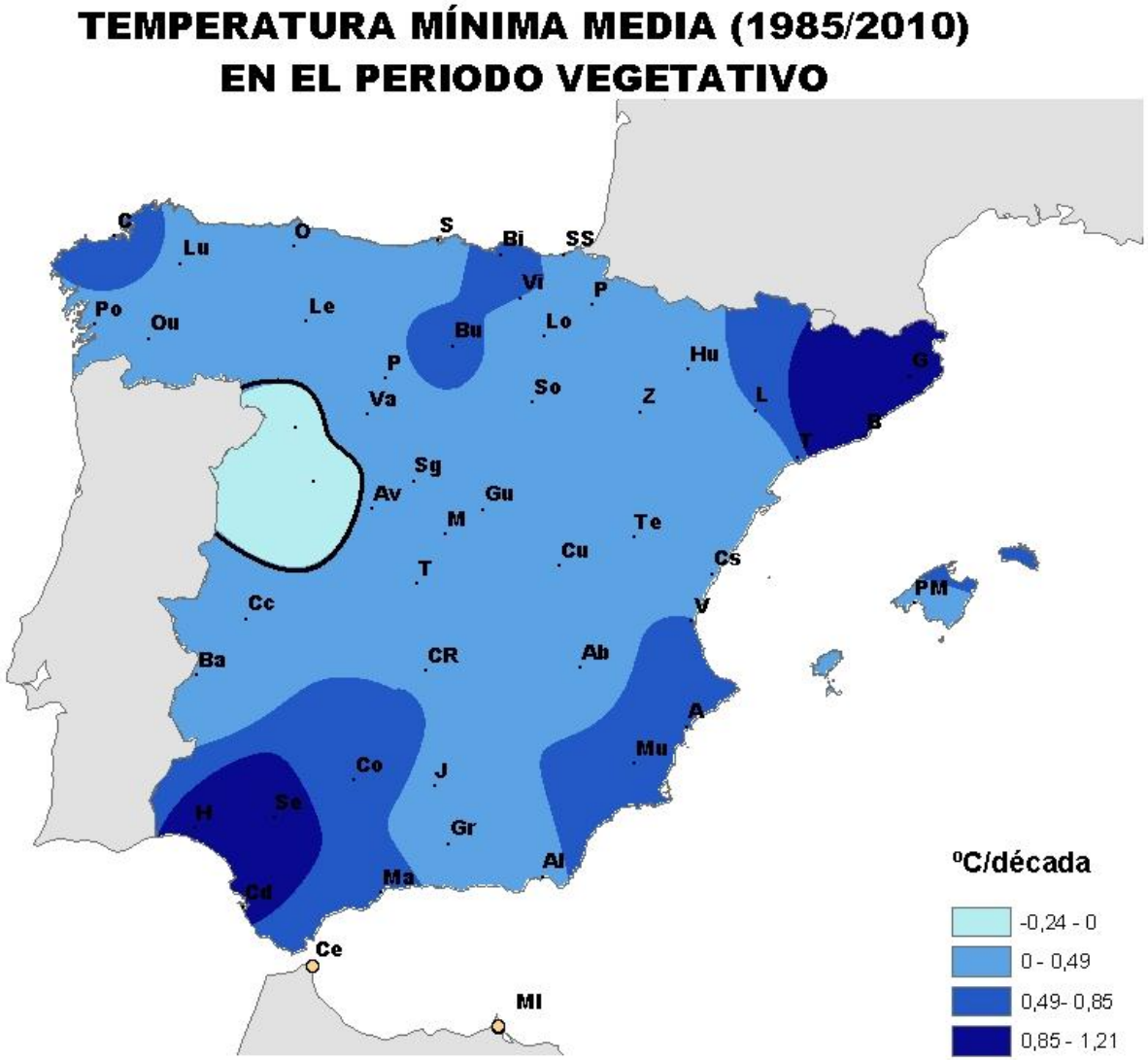

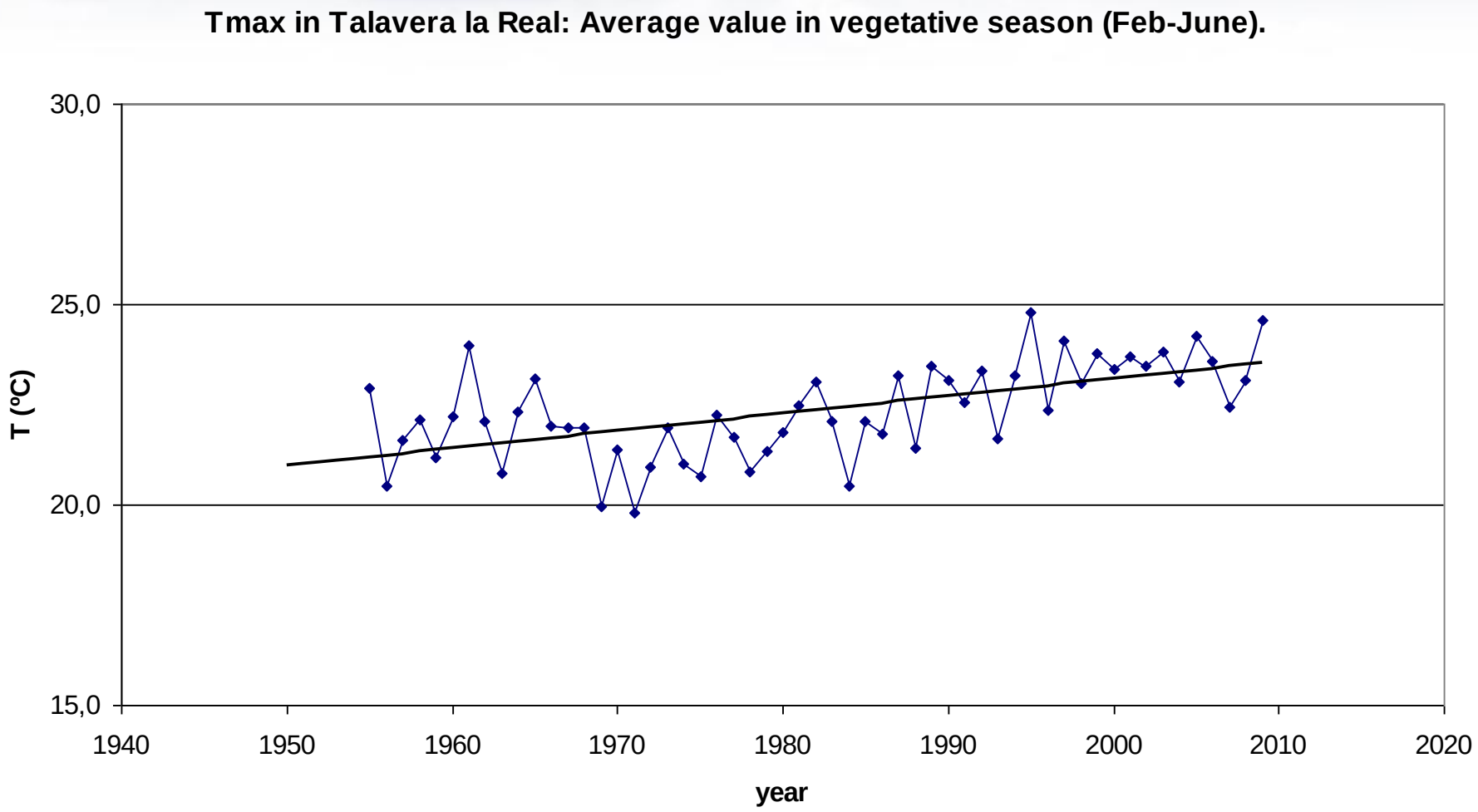
Tmax in Talavera la Real: Average value in vegetative season (Feb-June).
30,0
25,0
20,0
15,0
T (ºC)
1940
1950
1960
1970
1980
1990
2000
2010
2020
year

Number of days with Tmax > 30ºC in Vegetative Season

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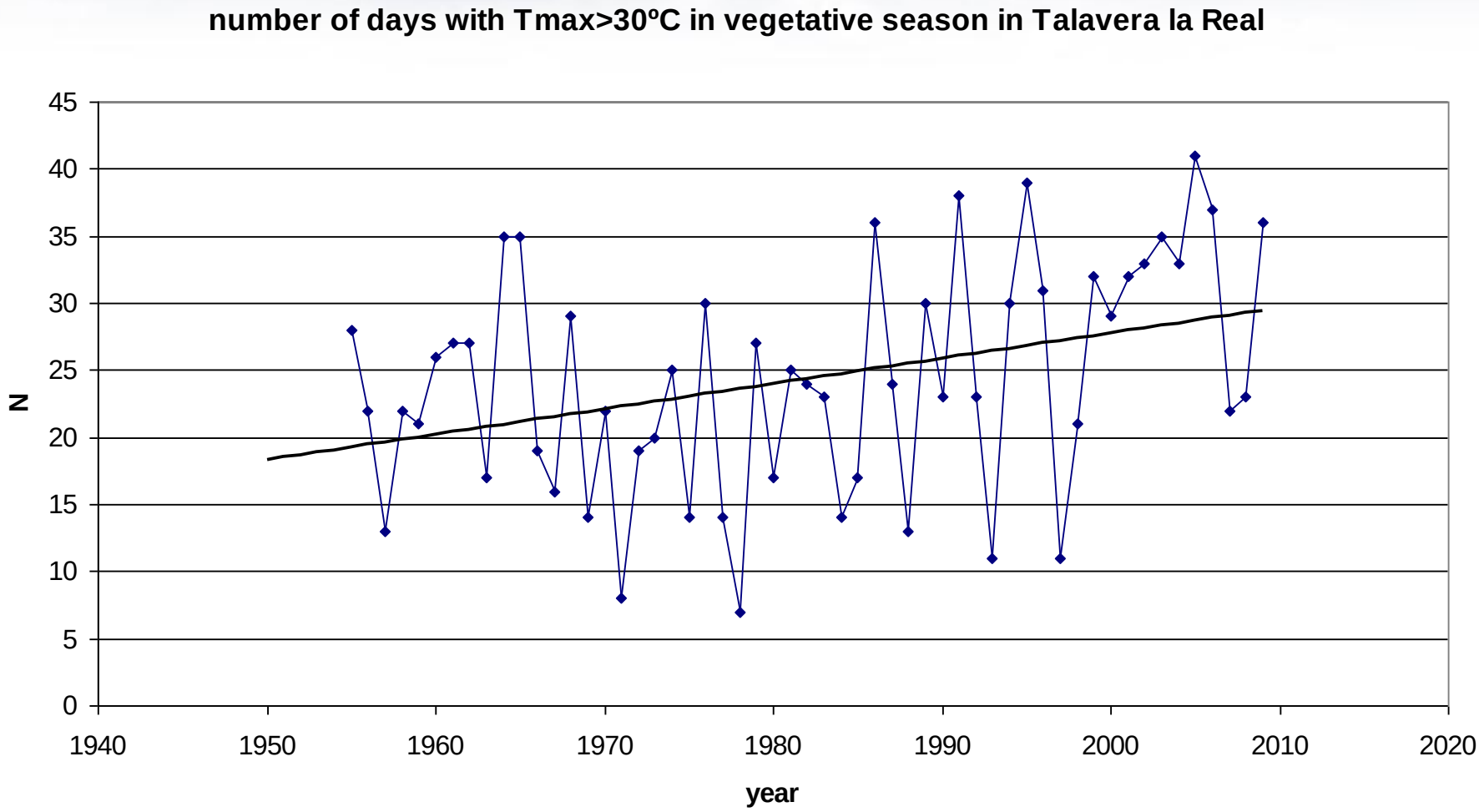
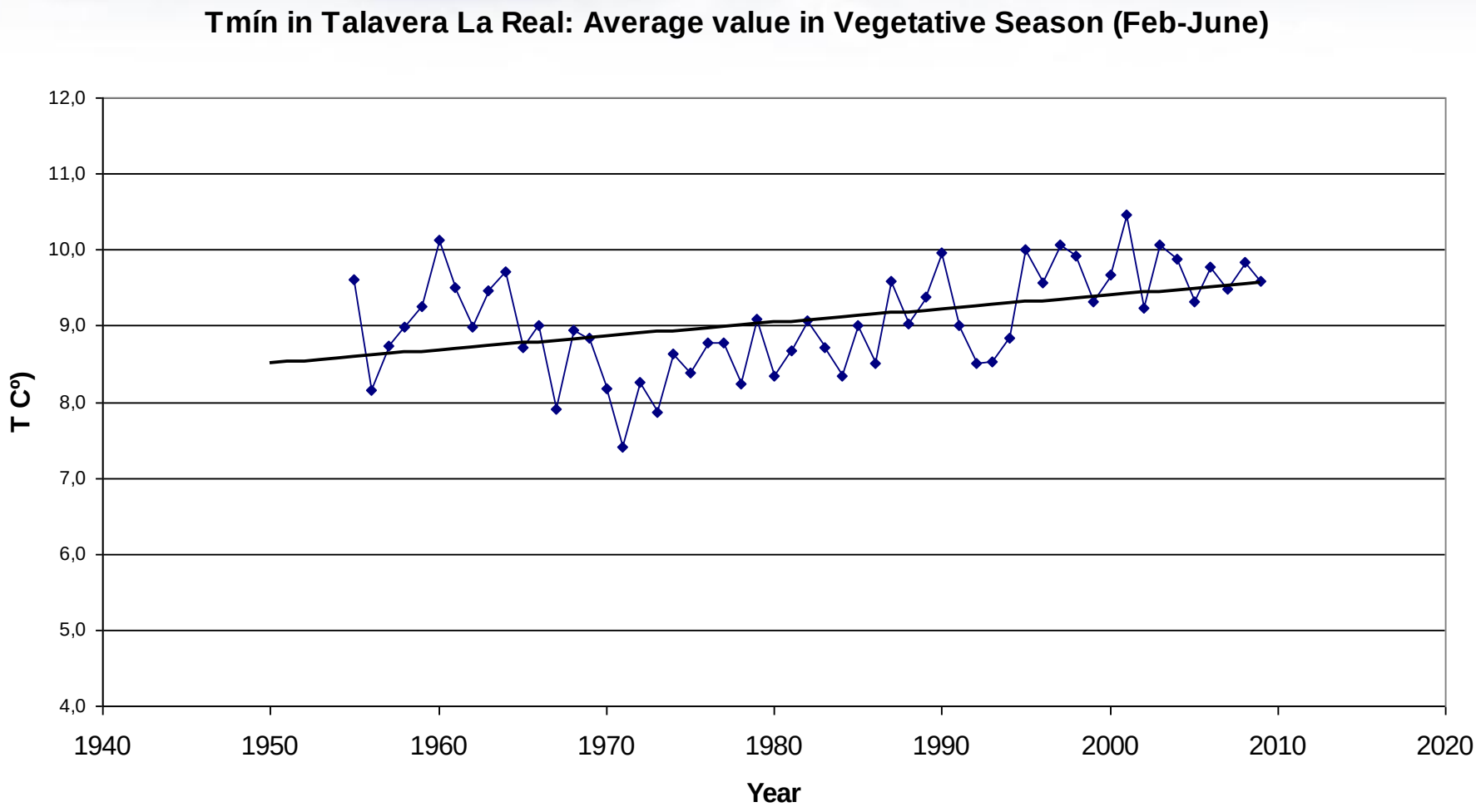
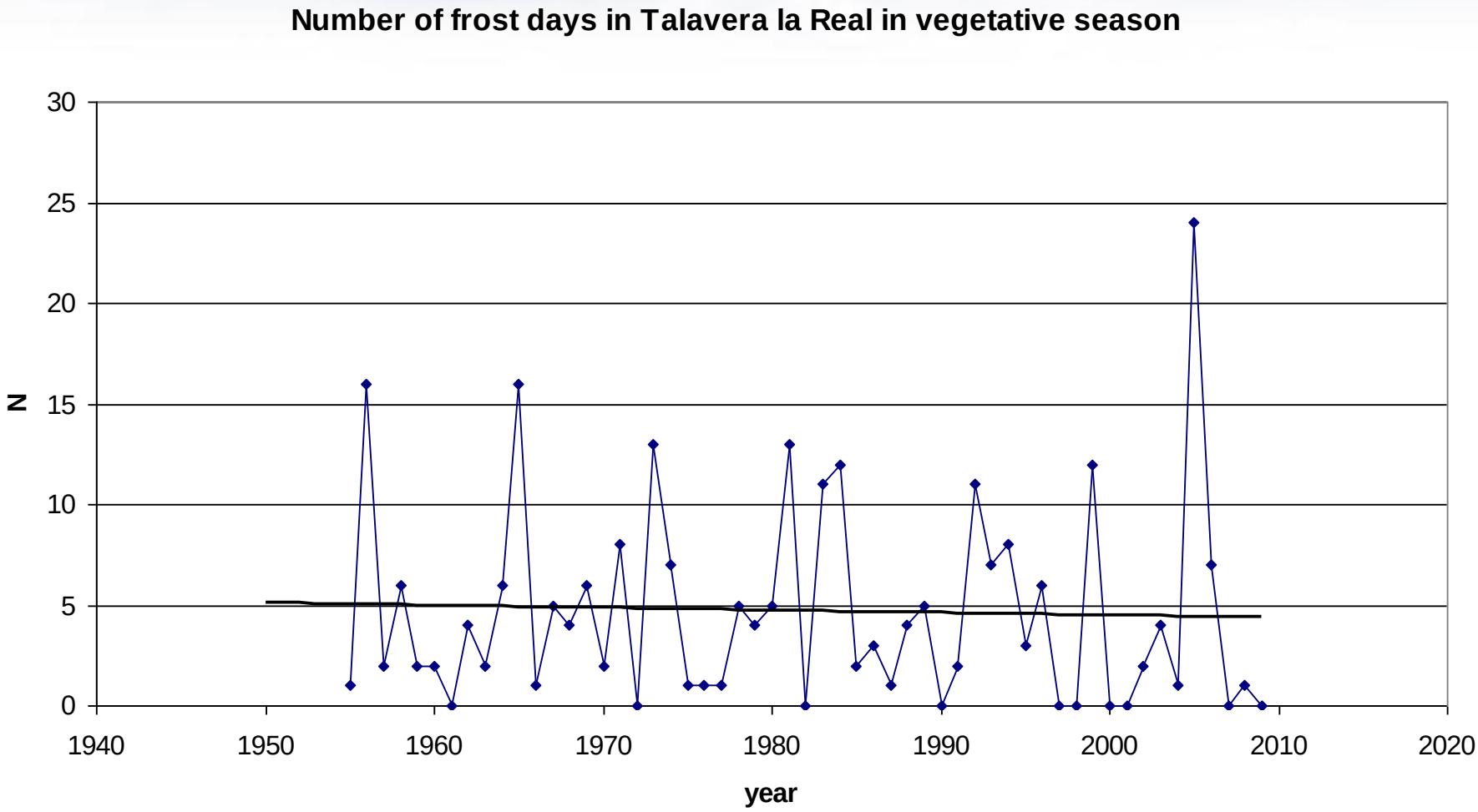
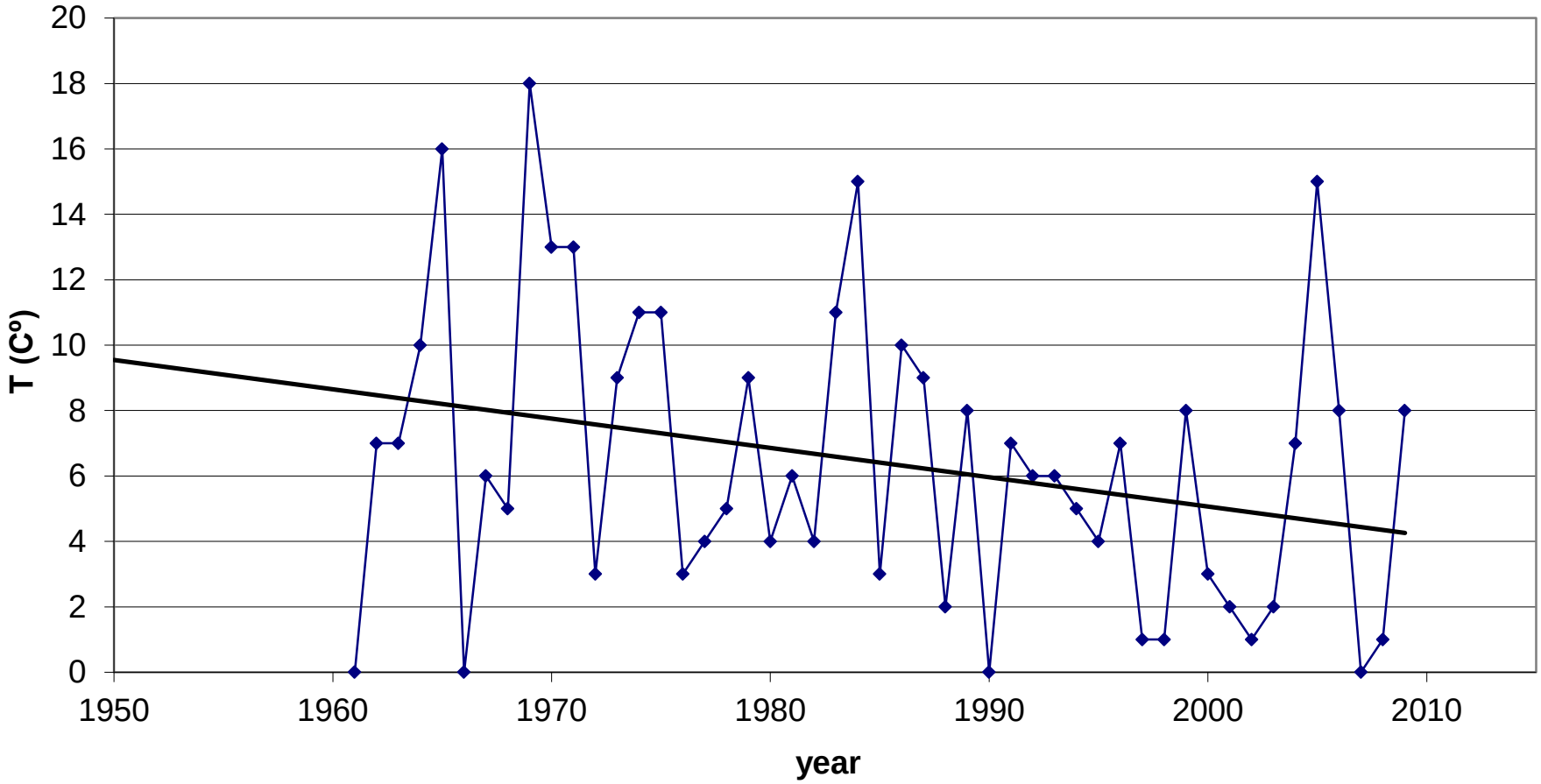


Tmin (average value in vegetative Season)

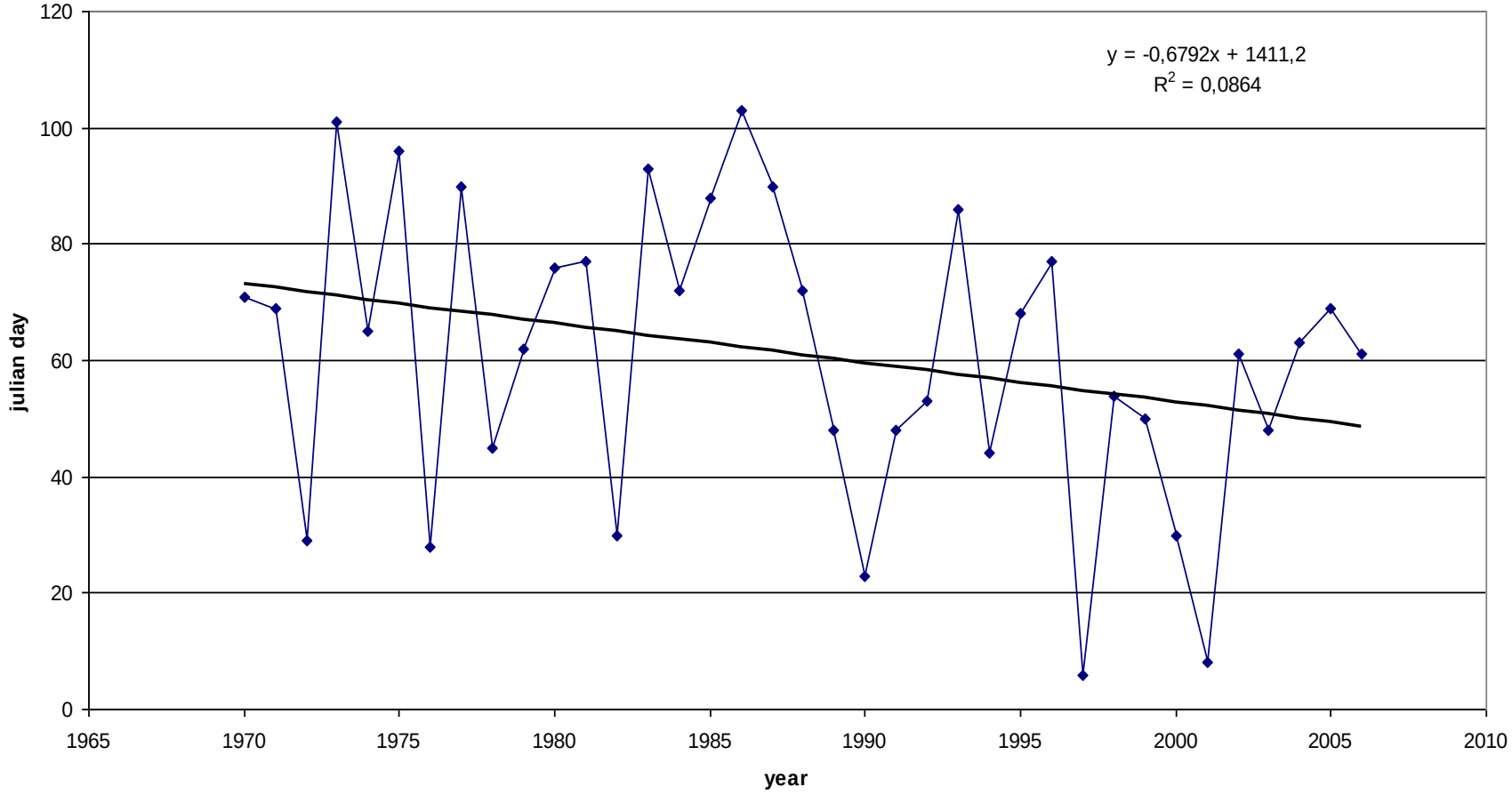



Number of frost days in Talavera la Real in vegetative season
30
25
20
15
10
5
0
N
1940
1950
1960
1970
1980
1990
2000
2010
2020
year

Number of frost days in the vegetative season in Santiago de Compostela



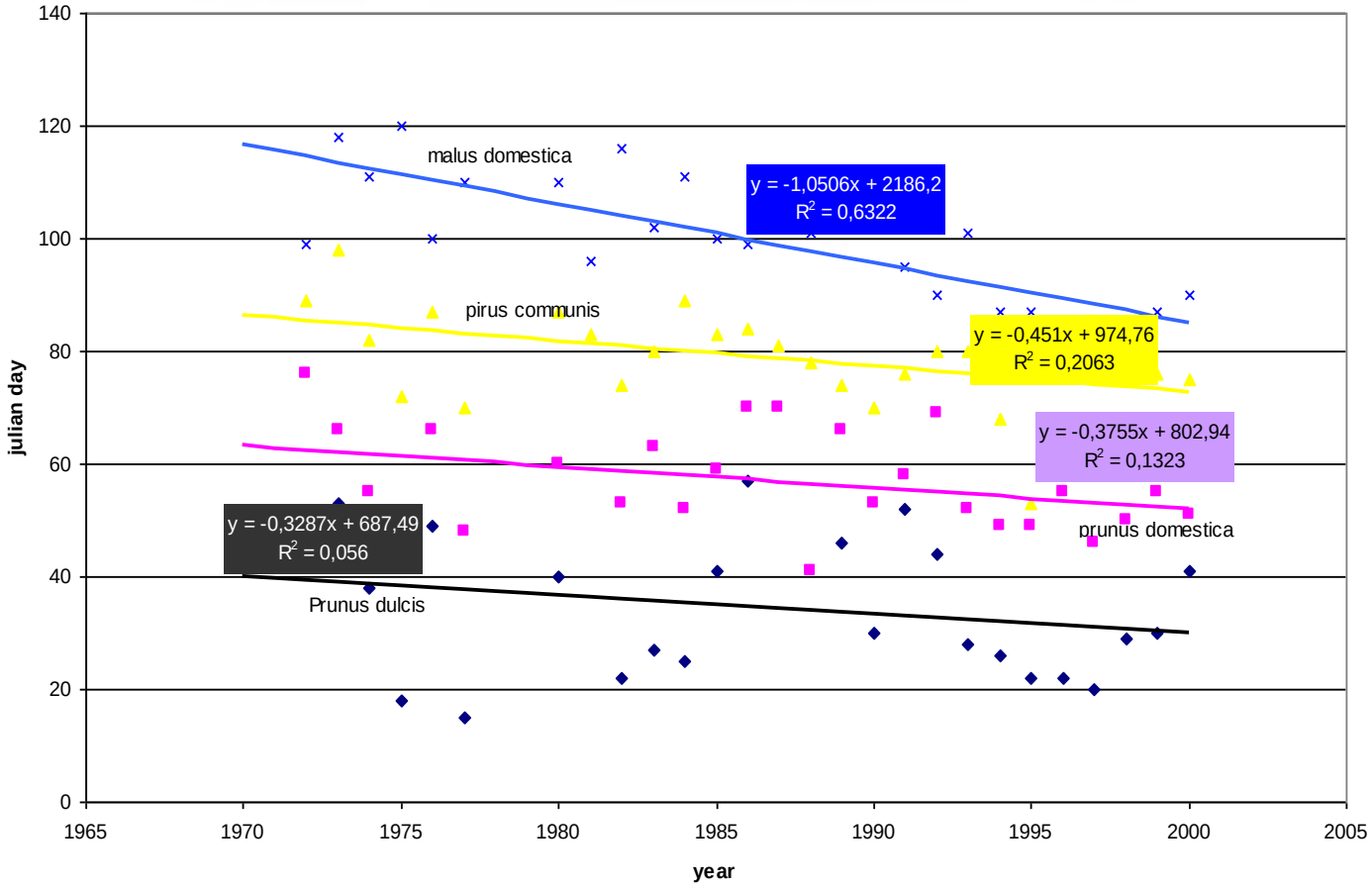
Series of Last frost days in Don Benito (Badajoz): 1970-2006



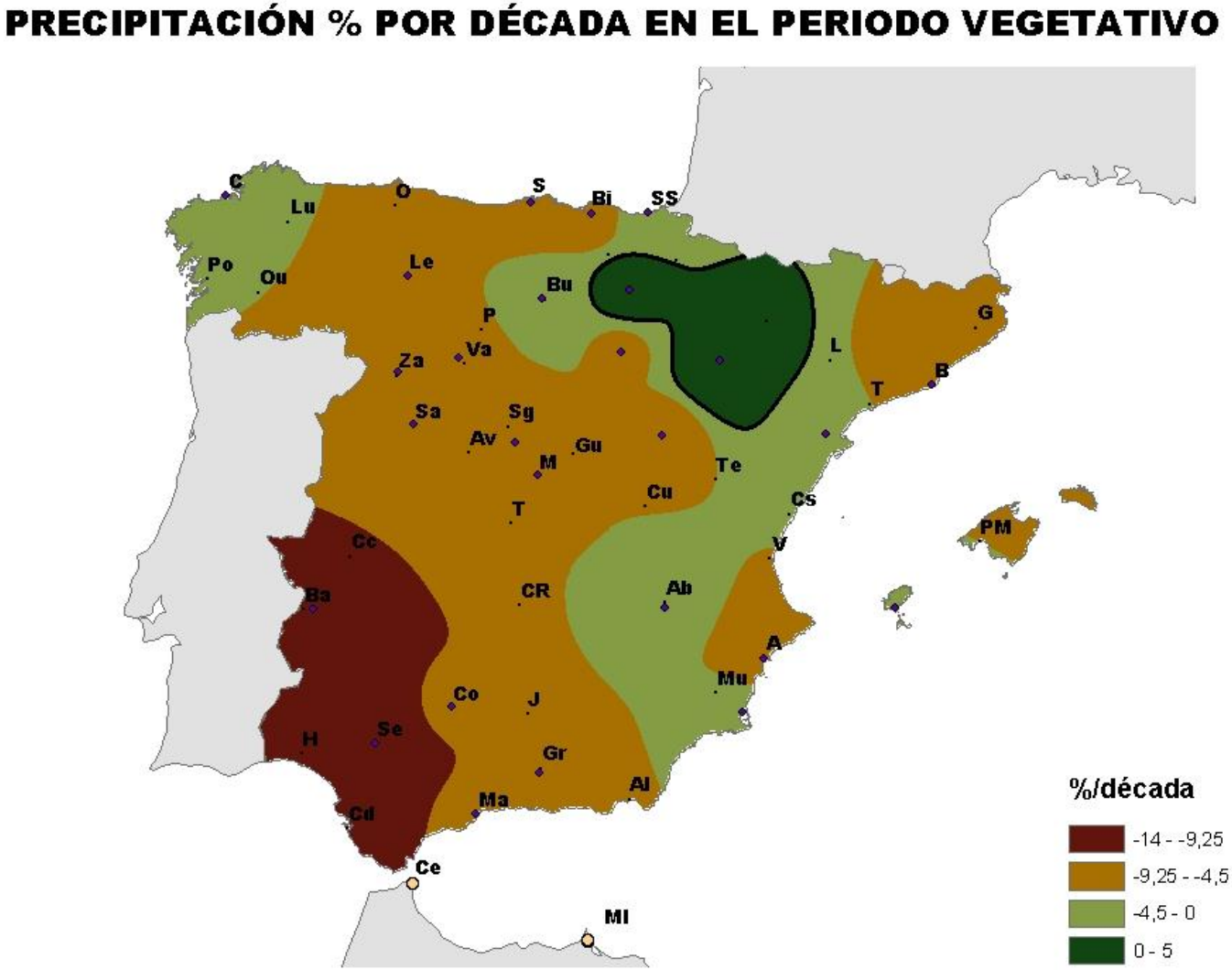
Summary of Results for last frost day

Agricultural Zone	Trend slope (days/ decade) : 1970-2007	Significance level
Don Benito (Extremadura)	-6,80	No sig
Lorca (Murcia)	-10,33	*** (p<0,005)
Liria- Huerta de Valencia (Valencia)	-5,65	No sig.
La Almunia -Zaragoza (Aragón)	-5,65	*(p<0,05)
Manises (Valencia)	-10,35	*(p<0,05)
Segria- Lleida (Catalonia)	-6,82	*(p<0,05)
Ribera de Navarra	-0,75	No sig
Urgell- Lleida (Catalonia)	-4,05	No sig
Mean value for all zones	-6,30	

Trends in phenology in Spain (flowering of fruit-trees in Cardedeu station)



Trends of total precipitation in vegetative periode: 1960-2010



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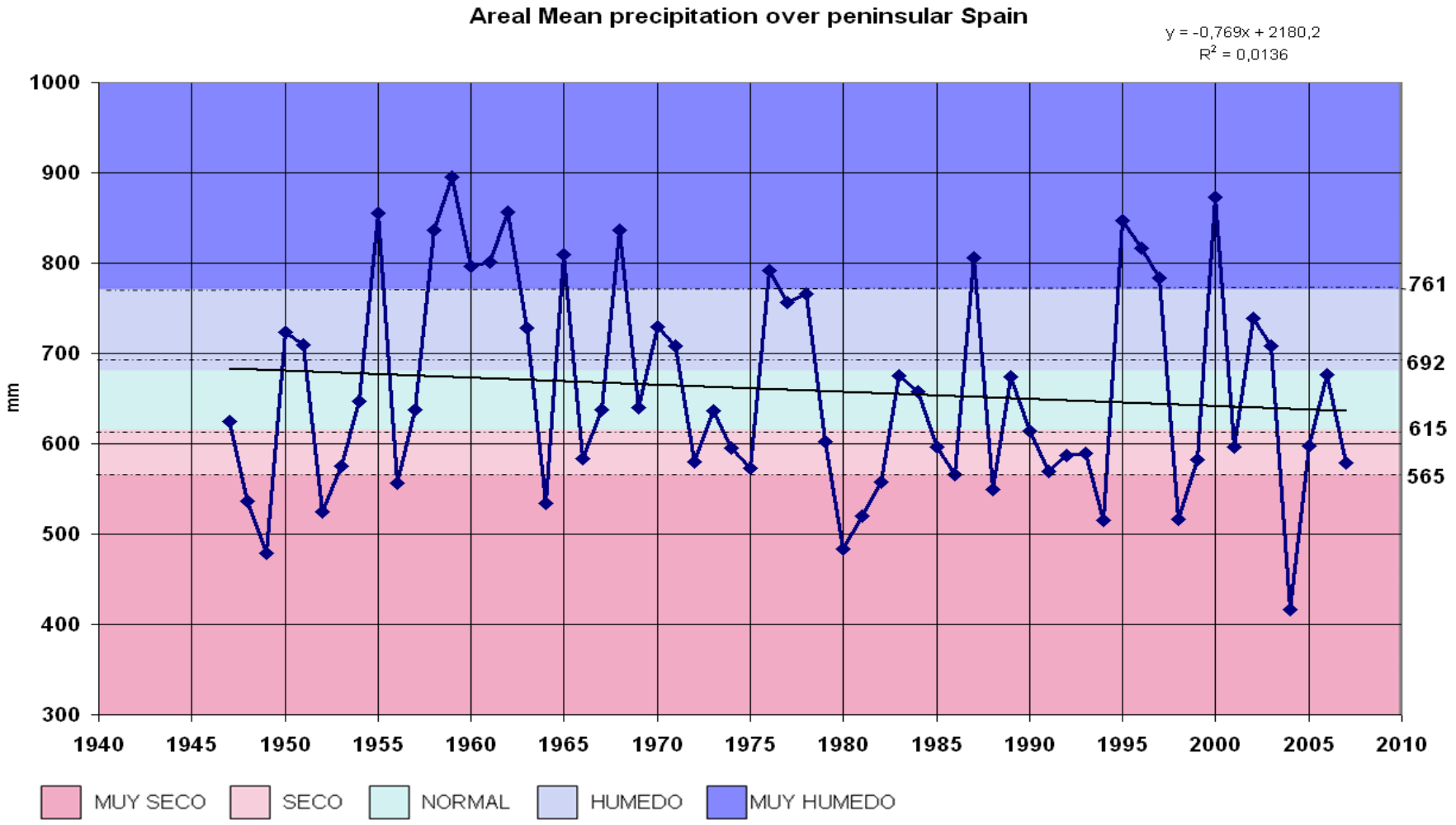
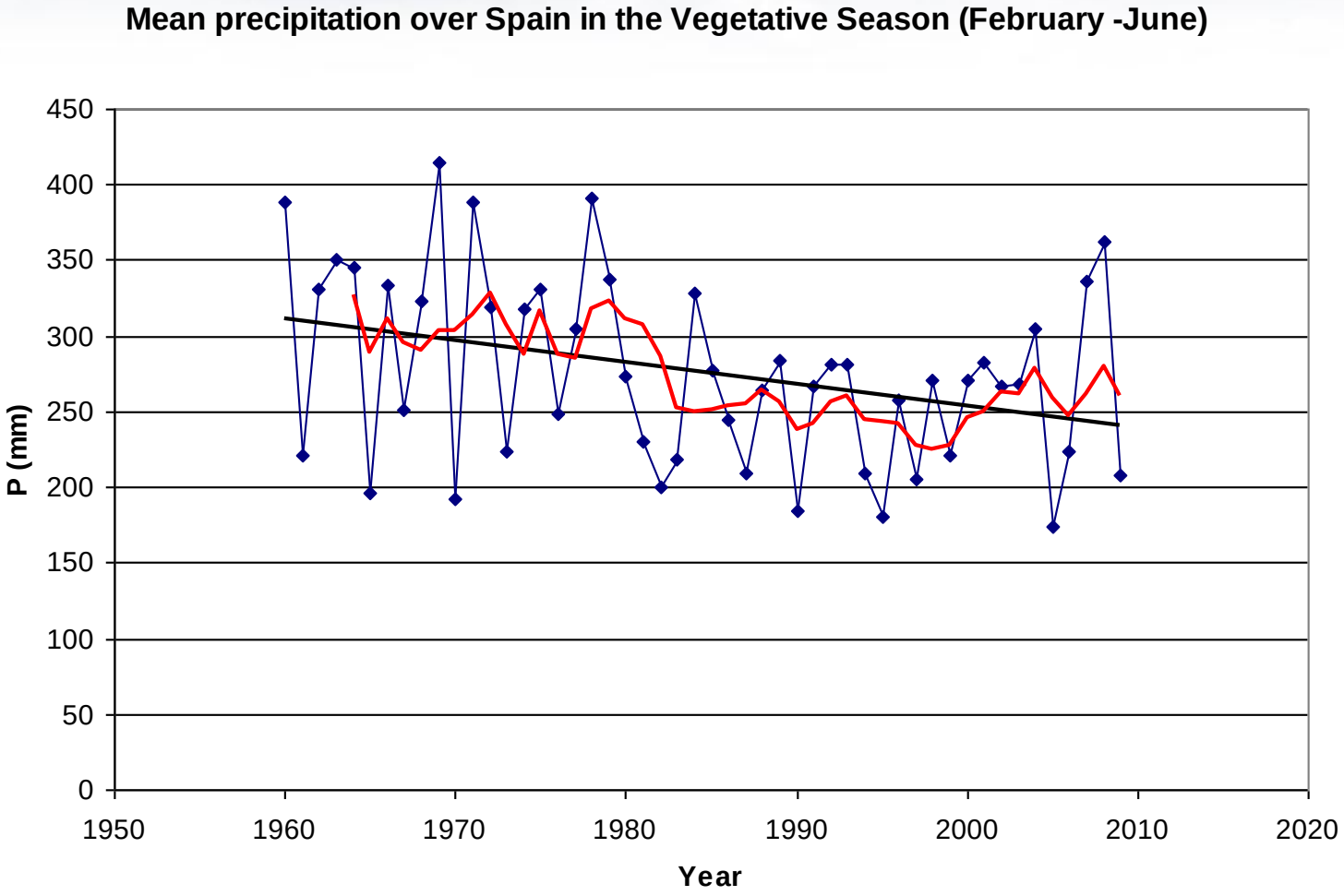
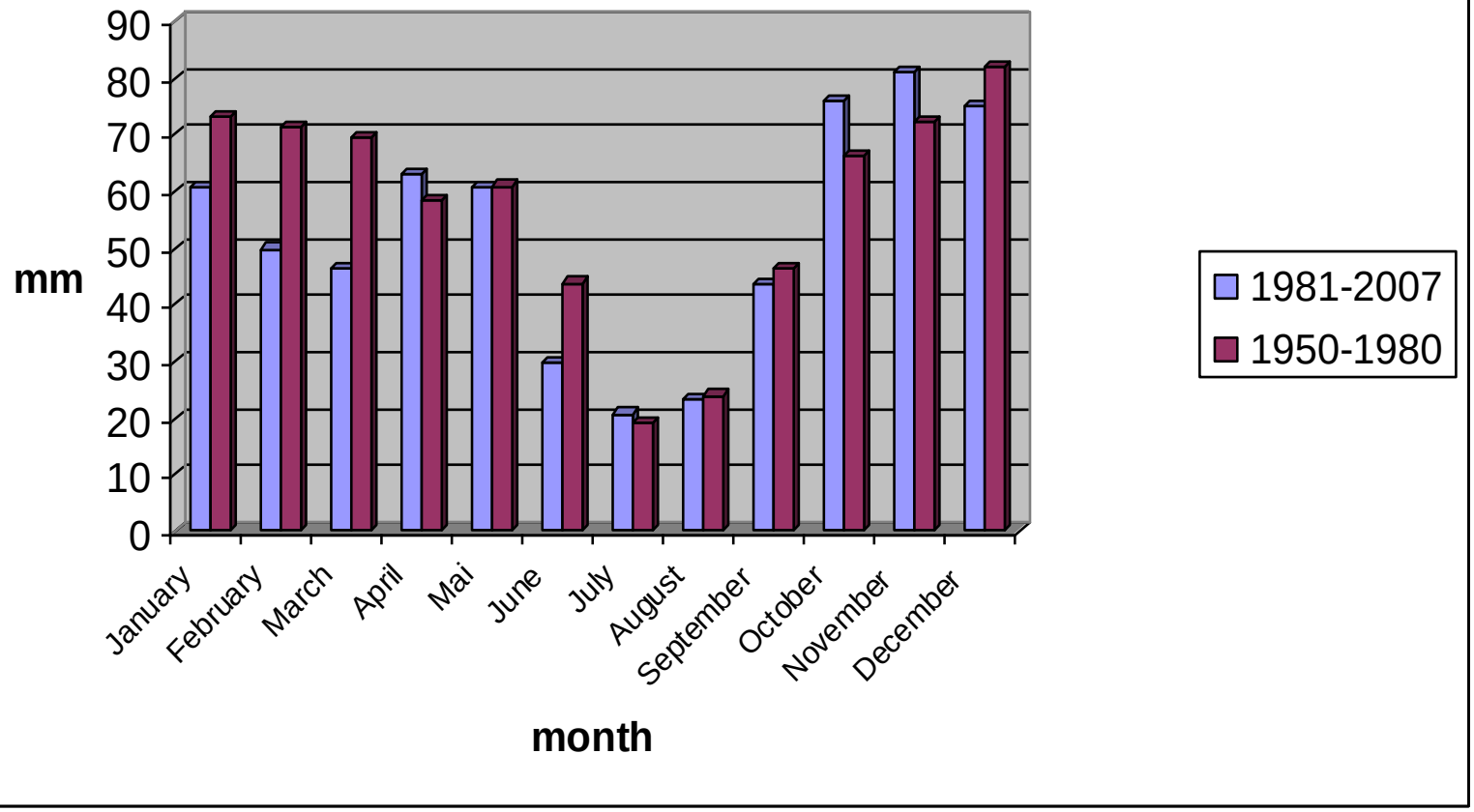


Trends in average precipitation over Spain in vegetative Season



Mean monthly precipitation over the Spanish territory



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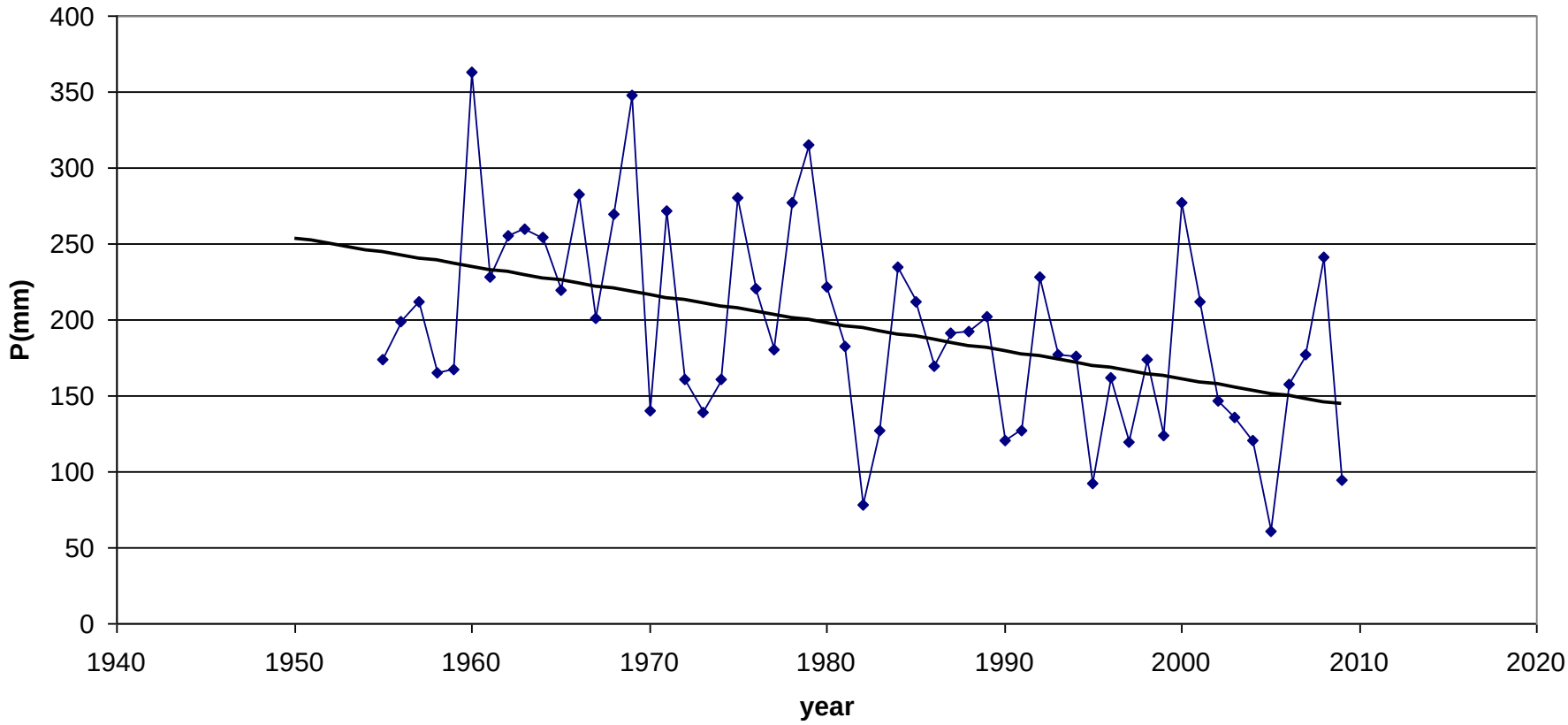
Total precipitation (mm) in the vegetative season in Talavera la Real (Badajoz)



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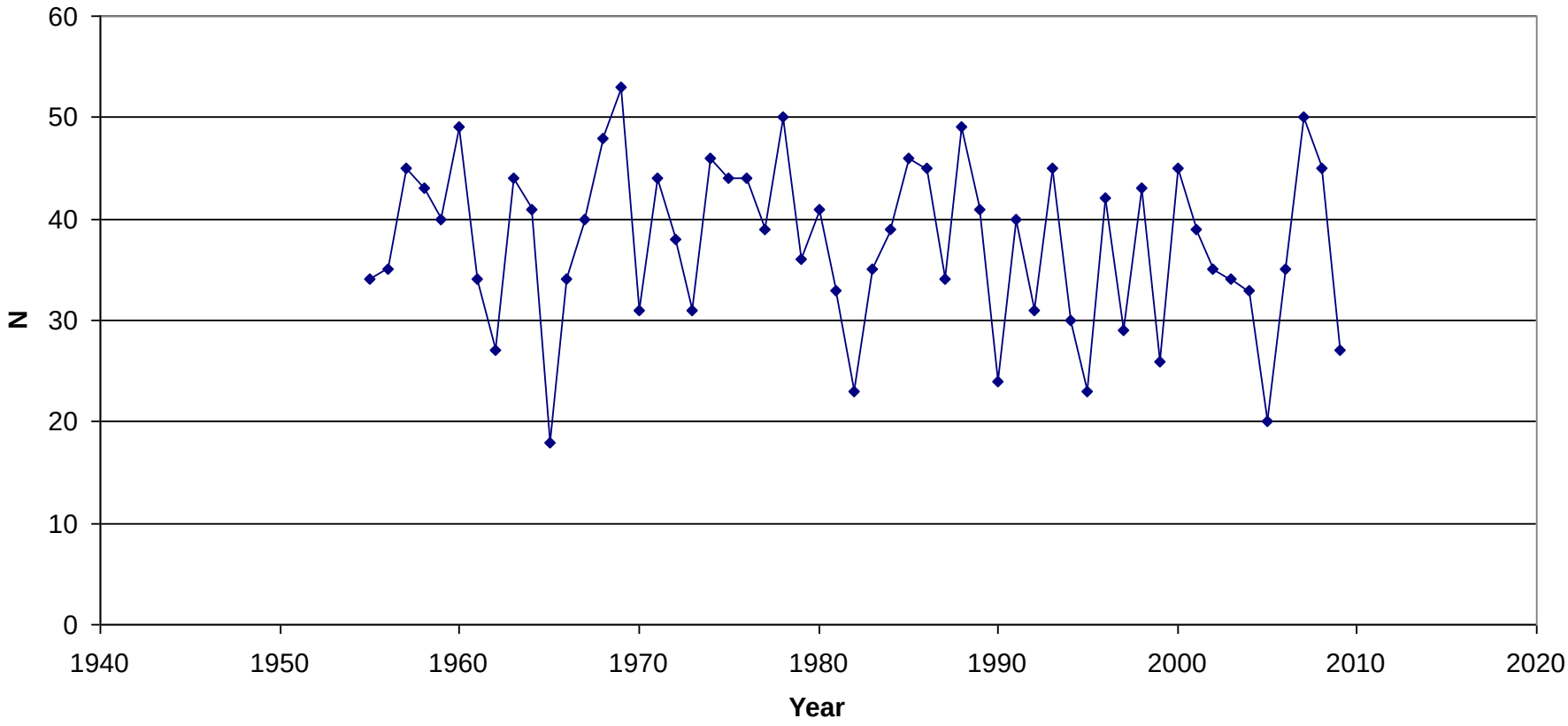
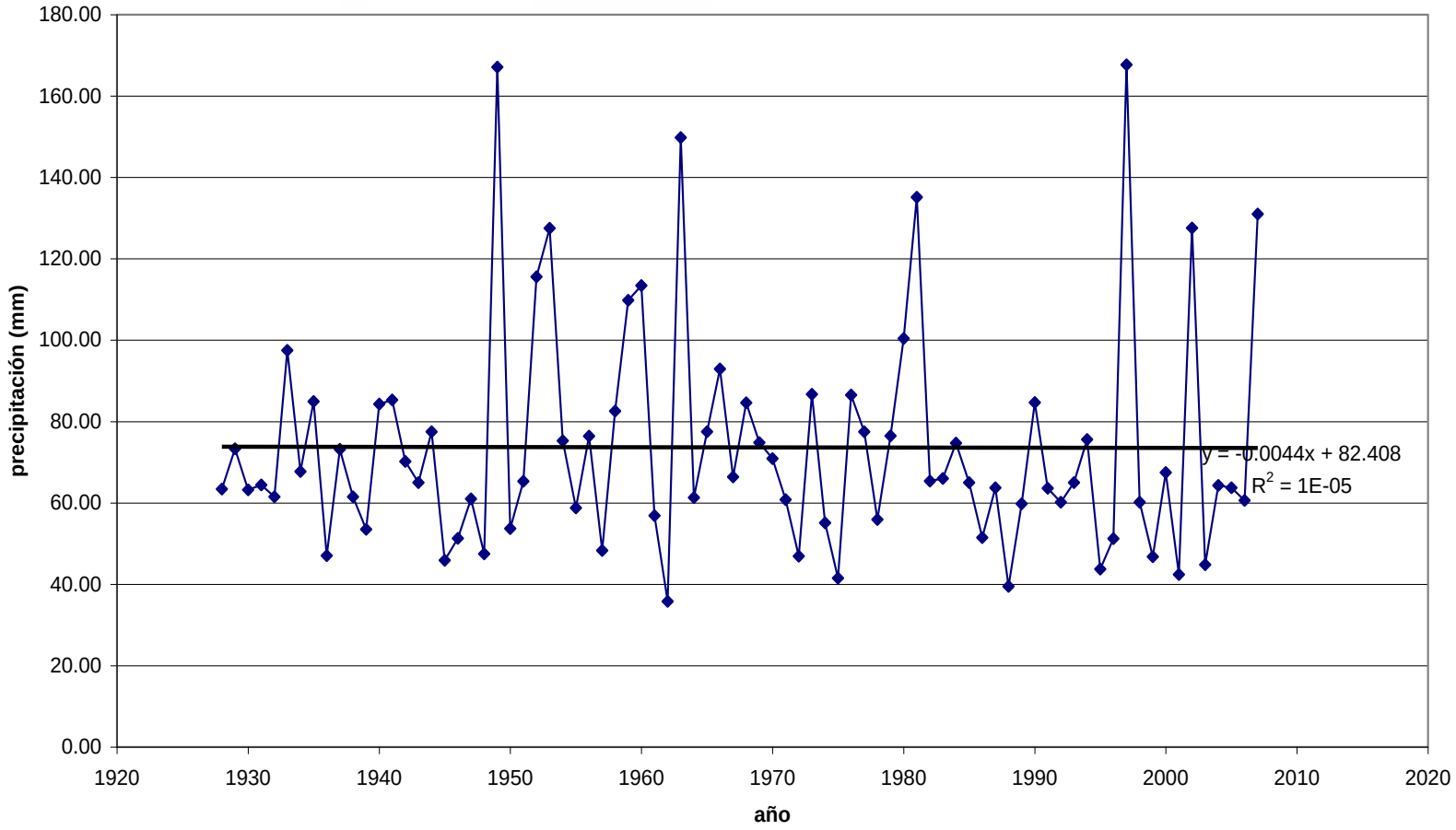
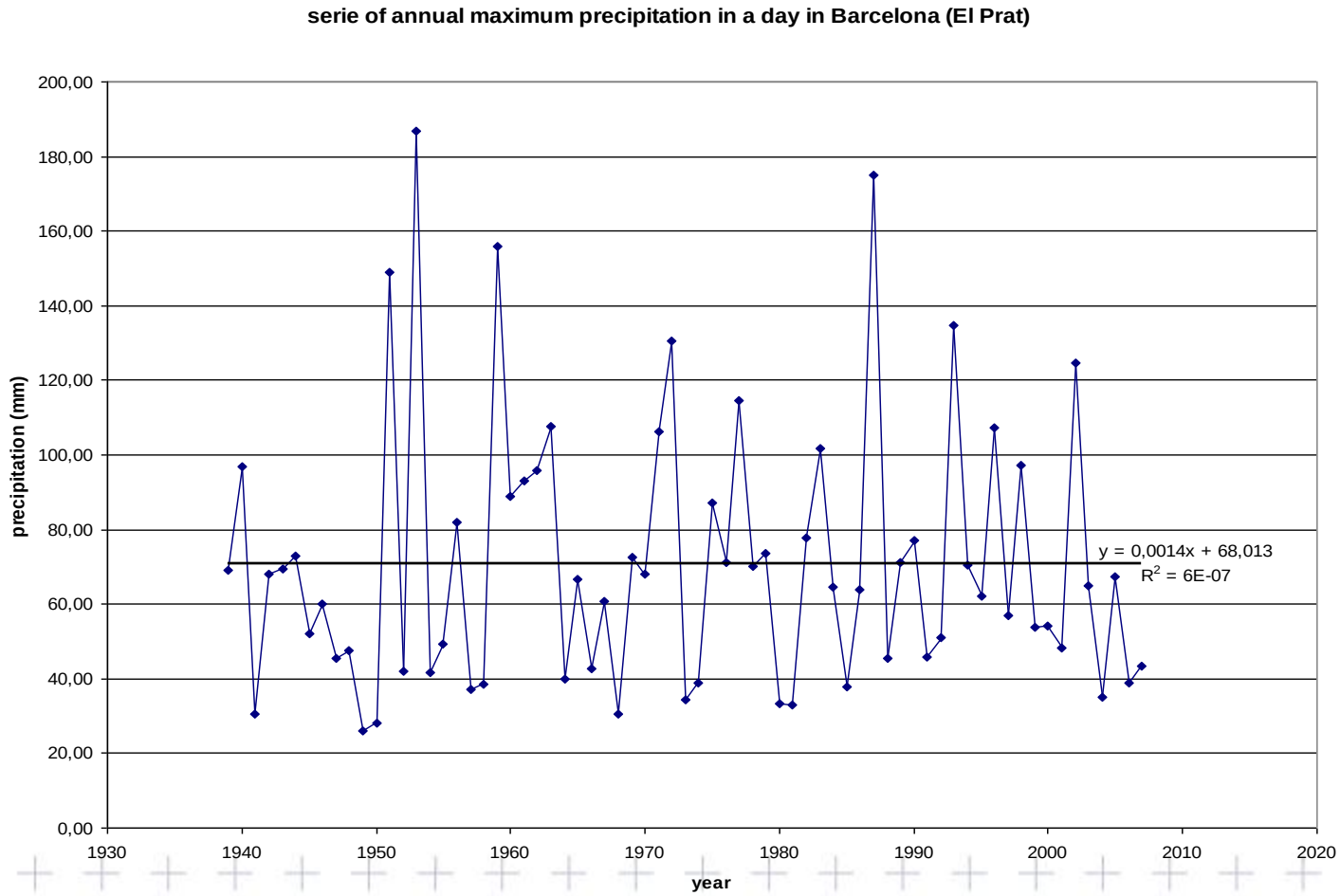
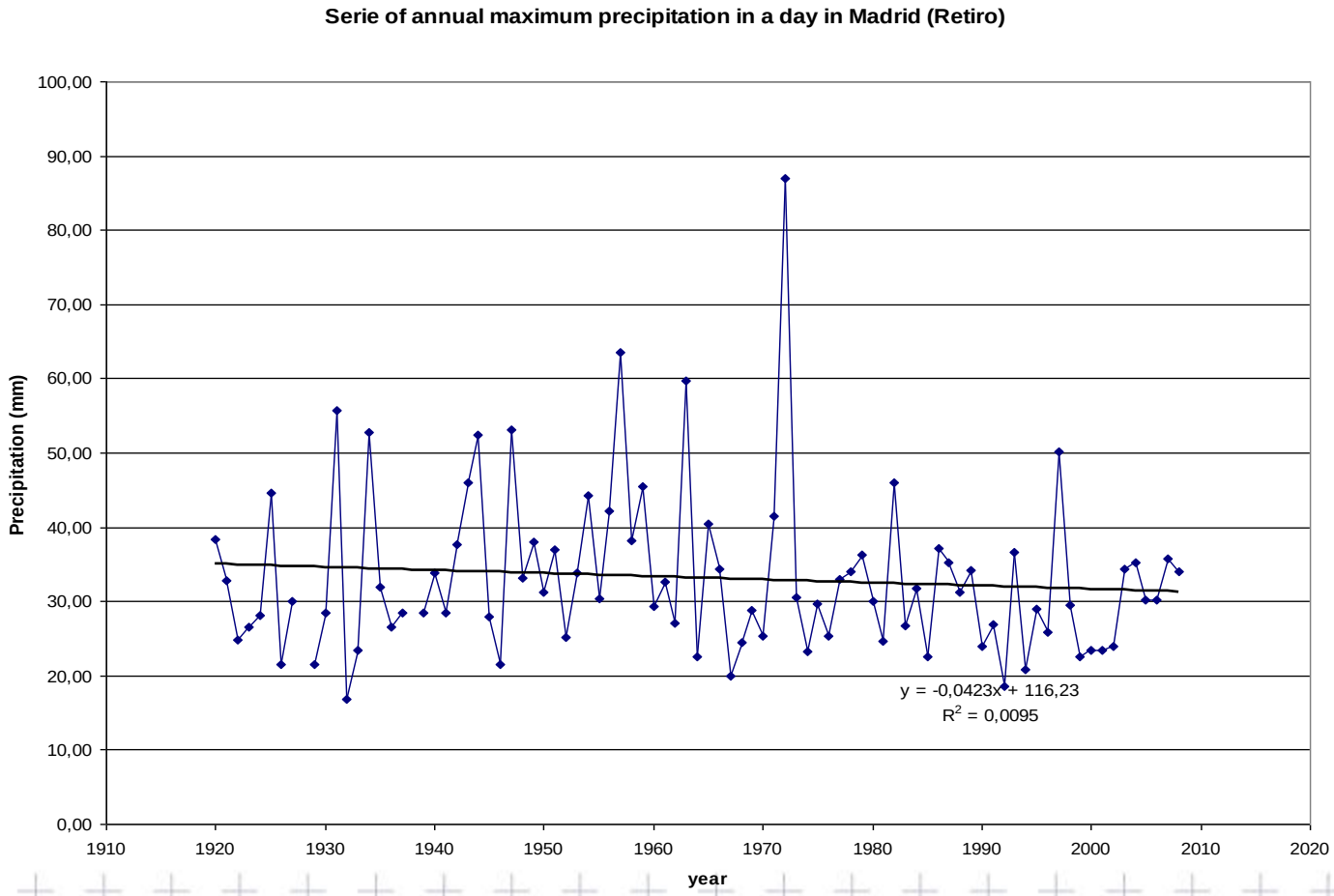
Number of days with precipitation greater than 0,1 mm in Talavera la Real (Badajoz)



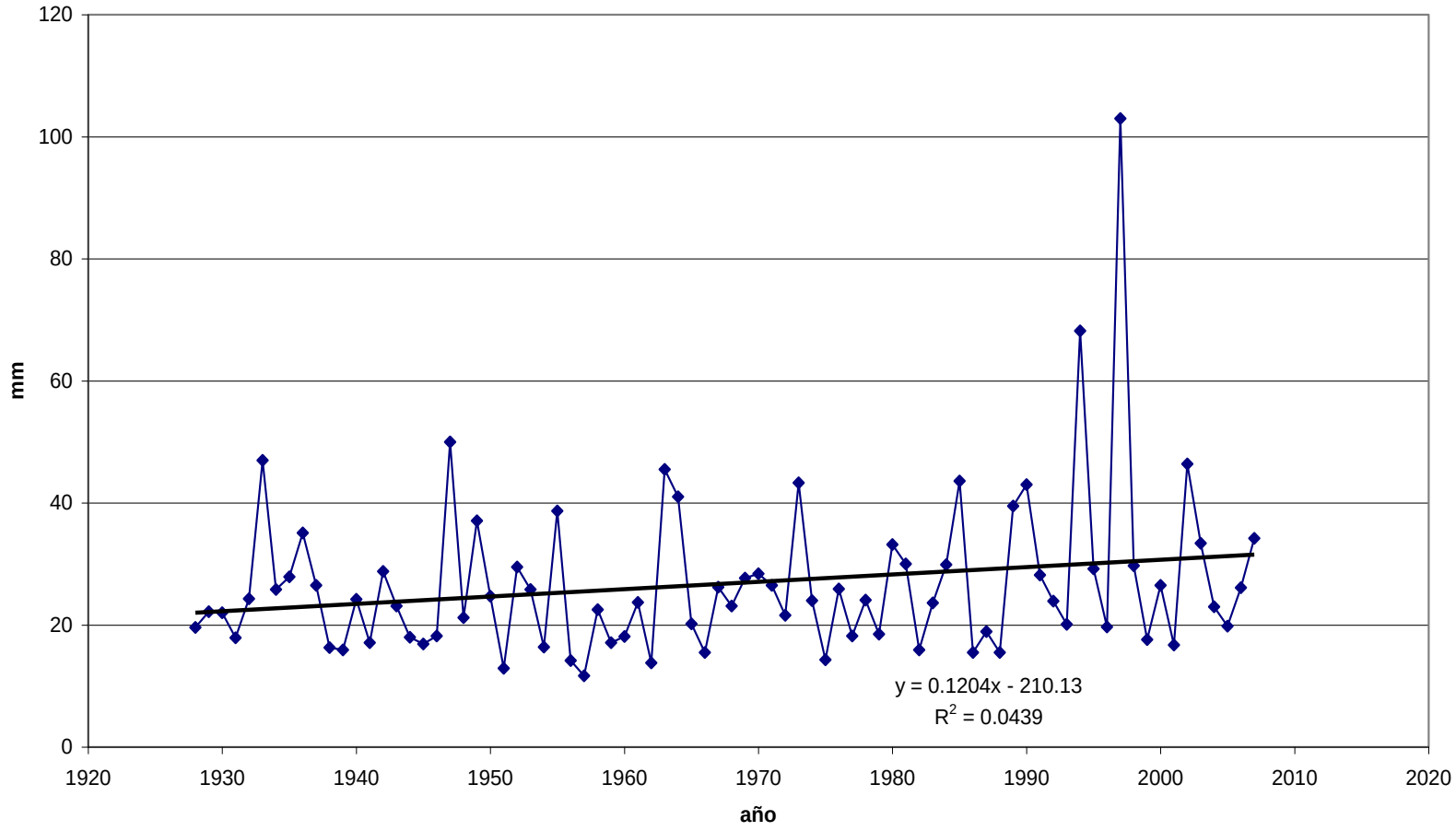
Serie of maximum anual precipitation in a day in San Sebastián-Igueldo



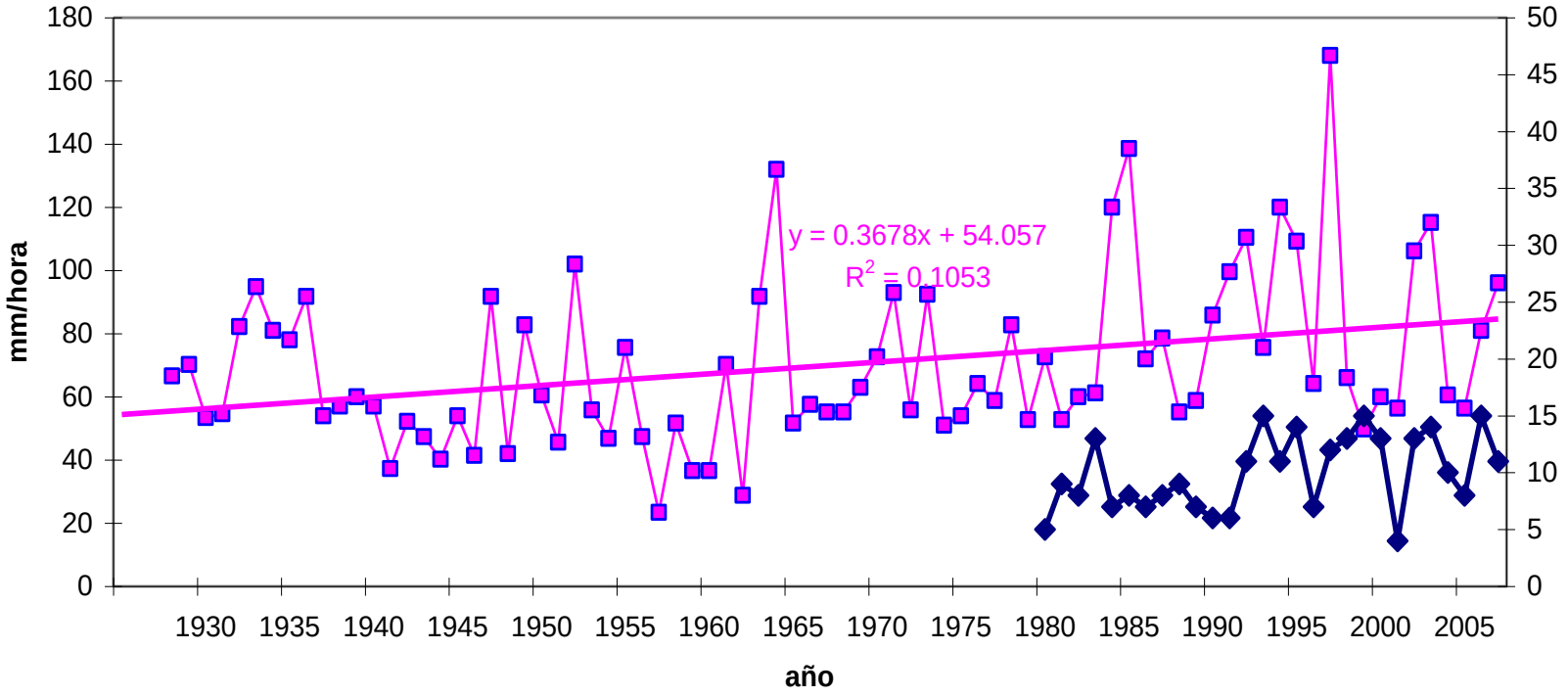

serie of annual maximum precipitation in a day in Barcelona (El Prat)
precipitation (mm)
200,00
180,00
160,00
140,00
120,00
100,00
80,00
60,00
40,00
20,00
0,00
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
year
y = 0,0014x + 68,013
R2 = 6E-07


Serie of annual maximum precipitation in a day in Madrid (Retiro)
Precipitation (mm)
100,00
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
year
y = -0,0423x + 116,23
R2 = 0,0095

Annual maximum values of hourly precipitation in San Sebastian (Pais vasque-North Spain)



serie of annual maximum rainfall intensity in 10 minutes and annual number of rainfall events with I10 > 25 mm/hour (blue line) in S. Sebastian-Igueldo.



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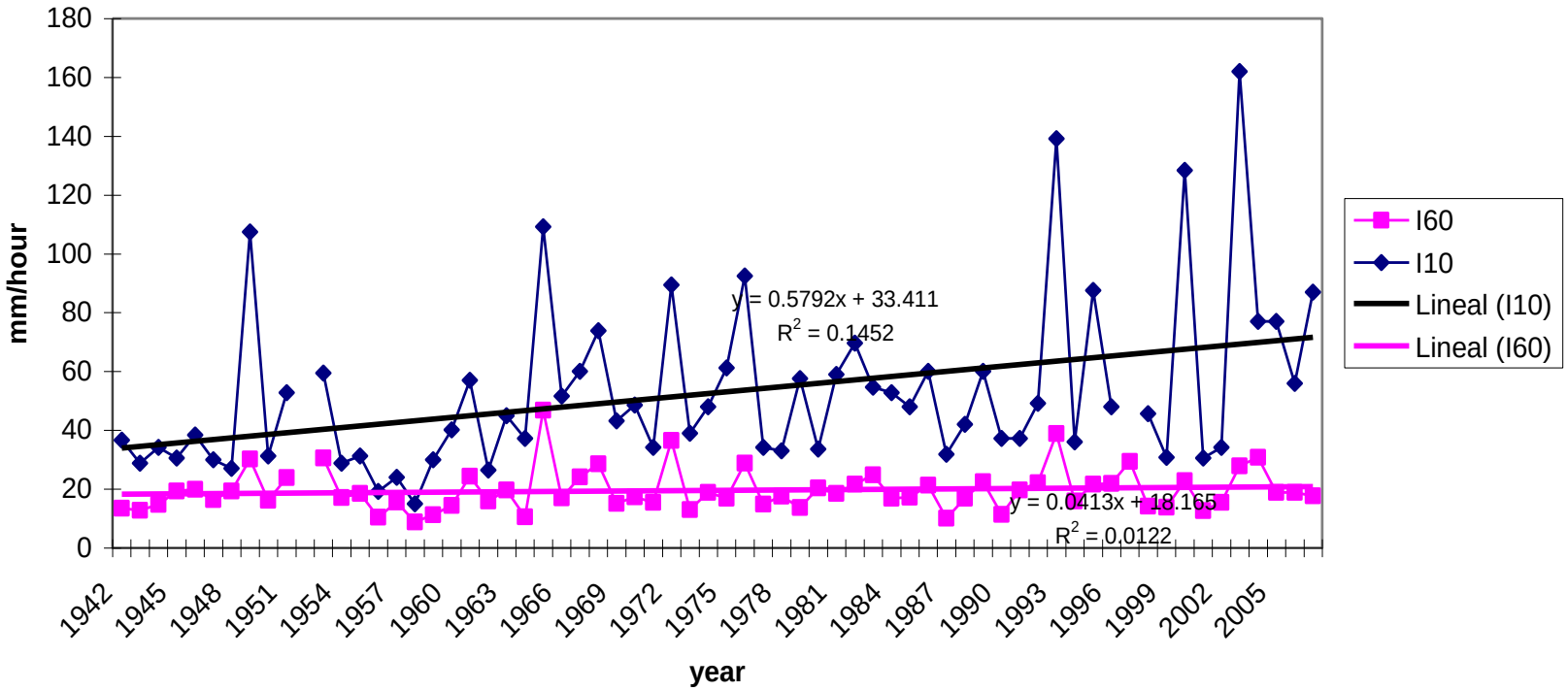
Series of Annual Maximum Intensity of Precipitation in 1 hour (red line) and 10 minutes (blue line) in Santander (North Spain)



Summary results for trends in heavy rainfall
(24 hours)

Station	Trend slope (% variation/ decade) : 1950-2007	Significance level
La Coruña (Galicia)	+1,63	Nosig
San Sebastián (Vasque Country)	-0,06	Nosig
Logroño (la Rioja)	+0.120	Nosig
Barcelona (Catalonia)	+0,20	Nosig
Salamanca (Castille-Leon)	-2,16	Nosig
Cáceres (Extremadura)	+7,37	
Valencia	-1,35	Nosig
Madrid	-0,012	Nosig
Mçalaga (Andalucia)	+1,88	Nosig

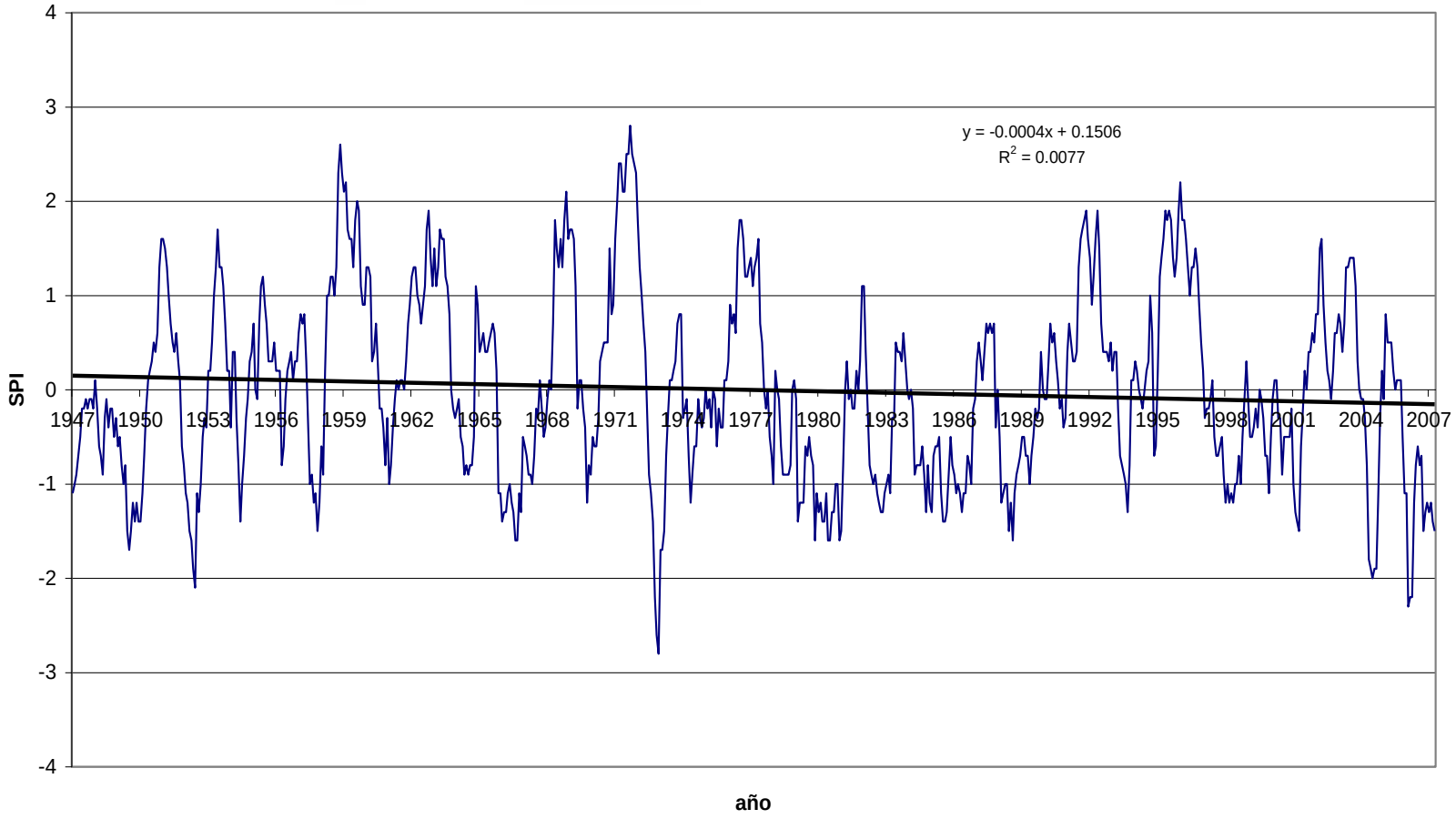
Summary results for trends in heavy rainfall
(1 hour)

Station	Trend slope (% variation/ decade) : 1950-2007	Significance level
La Coruña (Galicia)	+0,64	Nosig
San Sebastián (Vasque Country)	+4,48	Nosig
Logroño (la Rioja)	+5,60	*(p<0,05)
Barcelona (Catalonia)	+2,35	**(p<0,01)
Salamanca (Castille-Leon)	+2,02	Nosig
Cáceres (Extremadura)	+1,63	Nosig
Valencia	+0,27	Nosig
Madrid	+3,04	Nosig
Santander	+2,09	Nosig

Summary results for trends in heavy rainfall
(10 minutes)

Station	Trend slope (% variation/ decade) : 1950-2007	Significance level
La Coruña (Galicia)	-0,66	No sig
San Sebastián (Vasque Country)	+5,25	*(p<0,05)
Logroño (la Rioja)	+5,08	*(p<0,05)
Barcelona (Catalonia)	+2,12	**(p<0,01)
Salamanca (Castille-Leon)	+4,16	No sig
Cáceres (Extremadura)	+8,04	*(p<0,05)
Valencia	+1,08	No sig
Madrid	+4,05	No sig
Santander	+10,97	*** (p<0,005)

Serie of SPI-12 values for Peninsular Spain (mean monthly precipitation)



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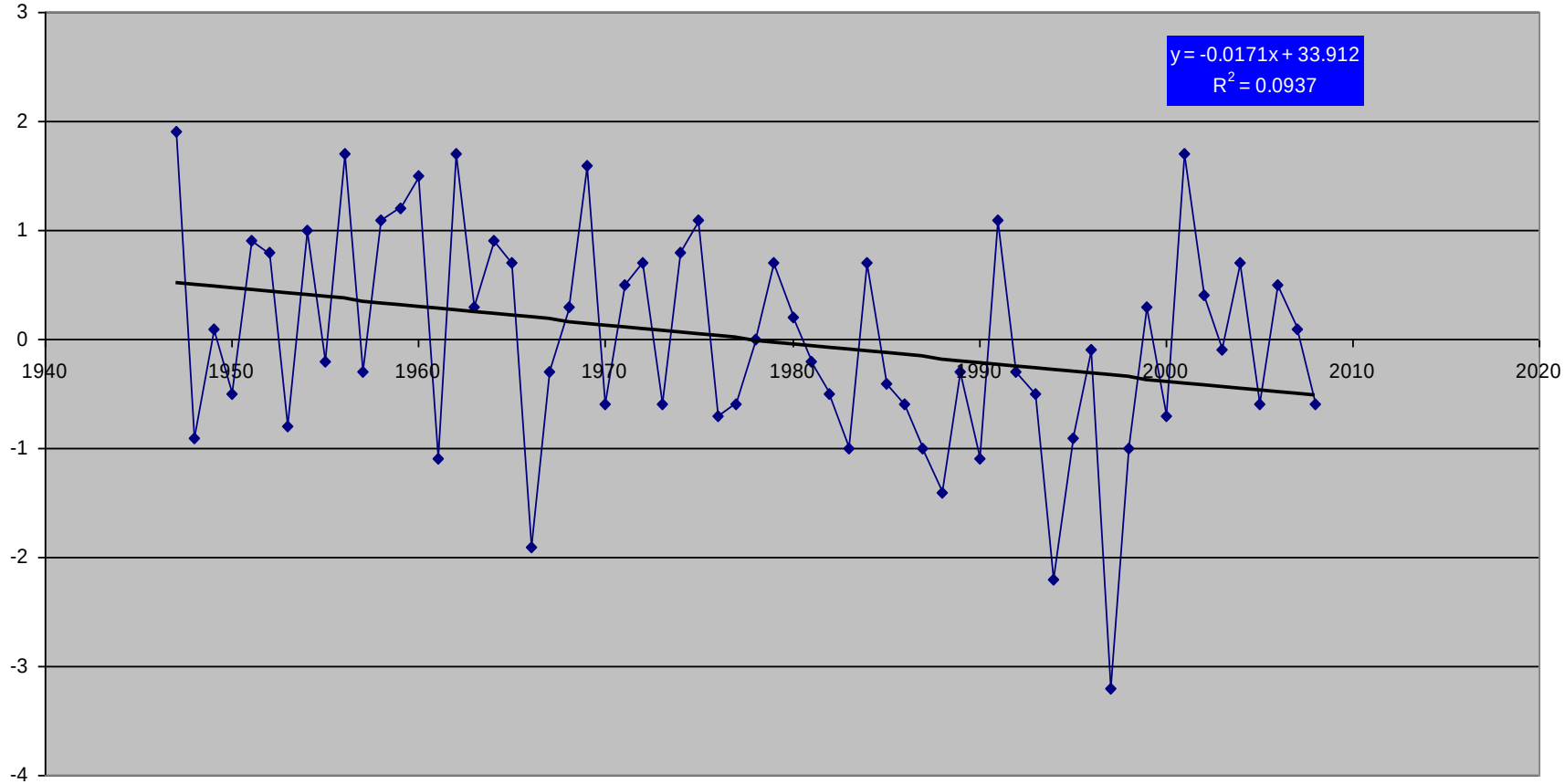
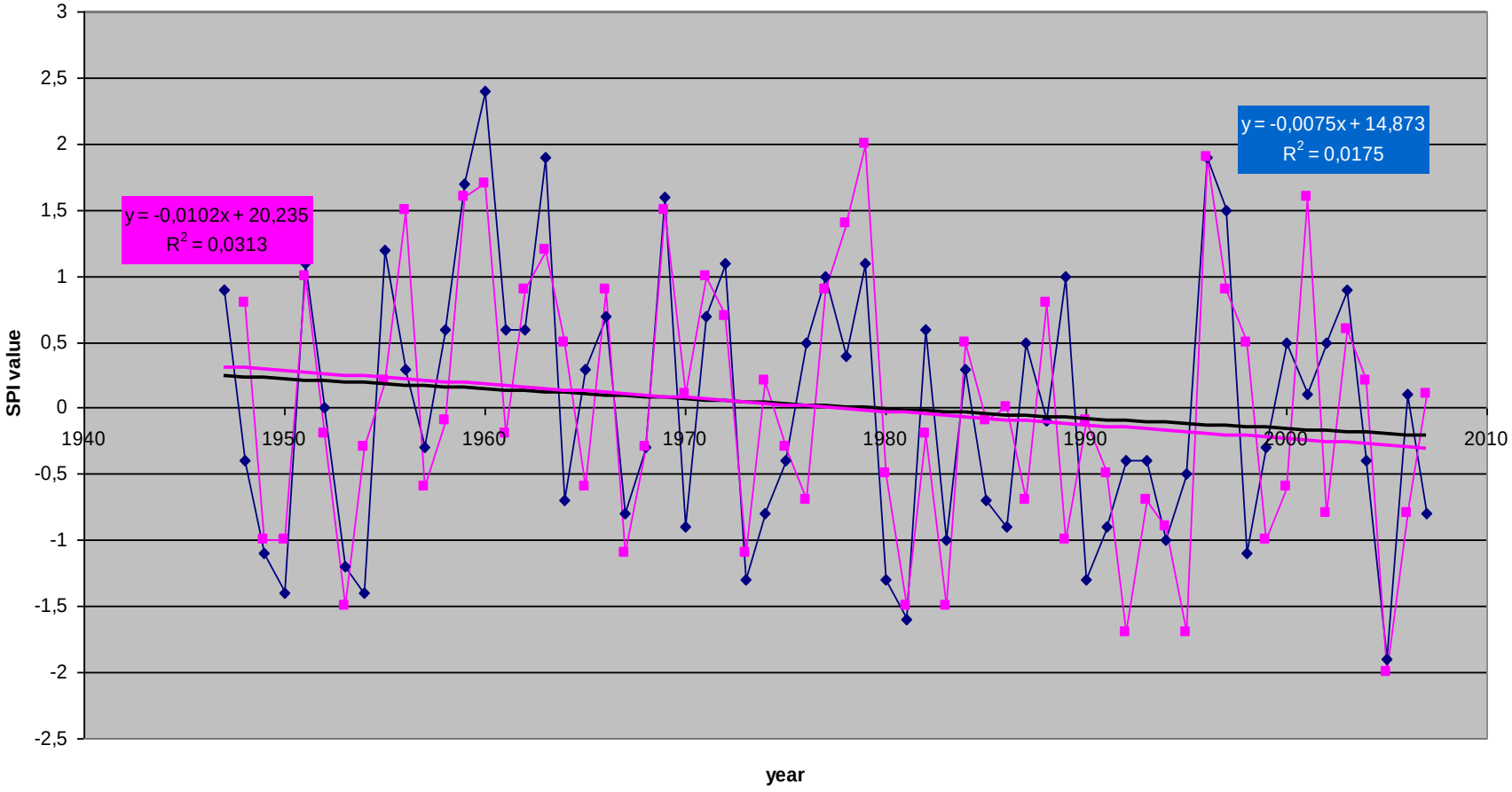
Serie of SPI 1 (31 Marzo) para el conjuunto de España



SPI-12 months (blue line) and SPI 6 (red line) in Mai



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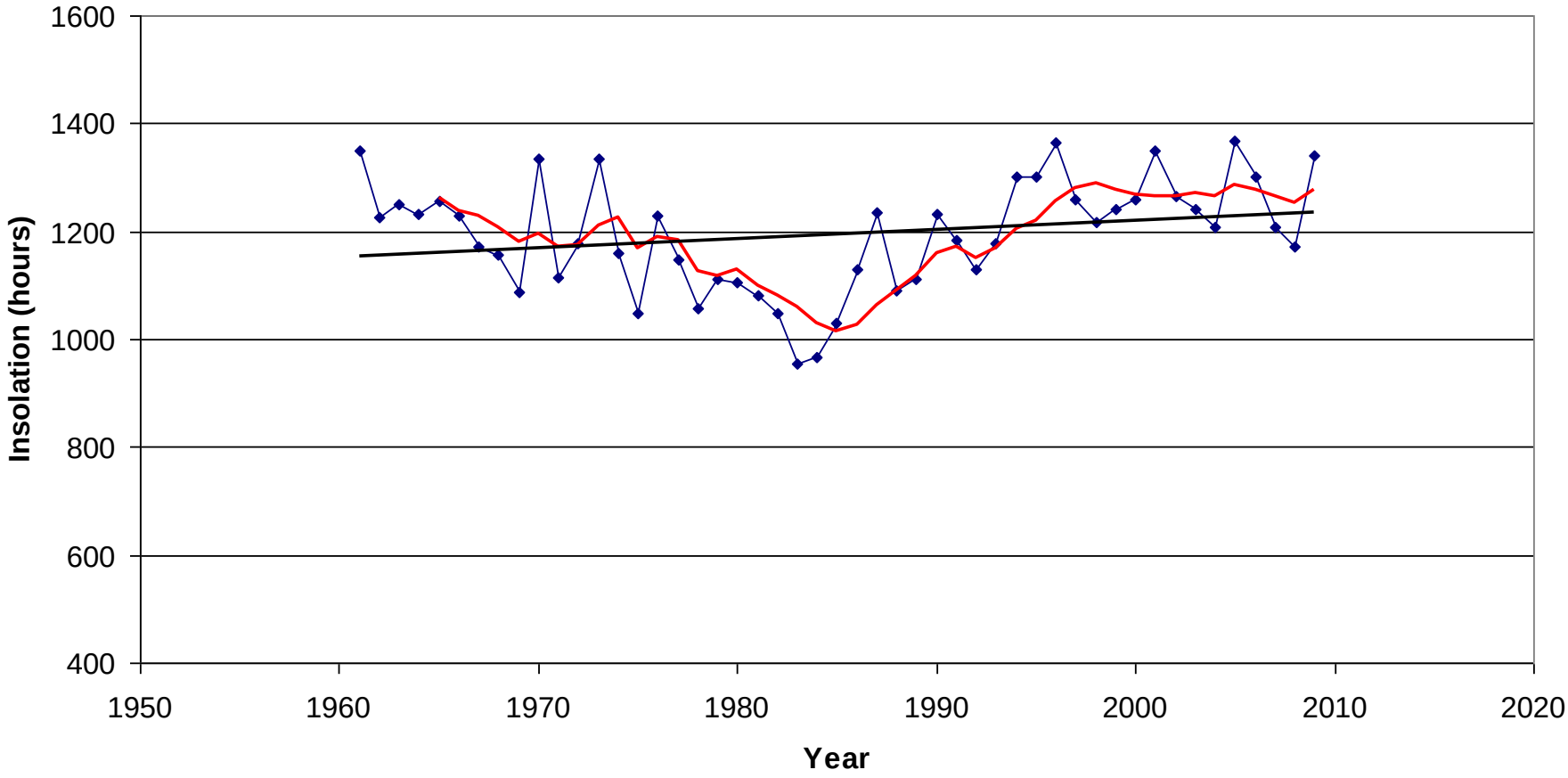
Total Insolation in Zaragoza in Vegetative Season (February- June)



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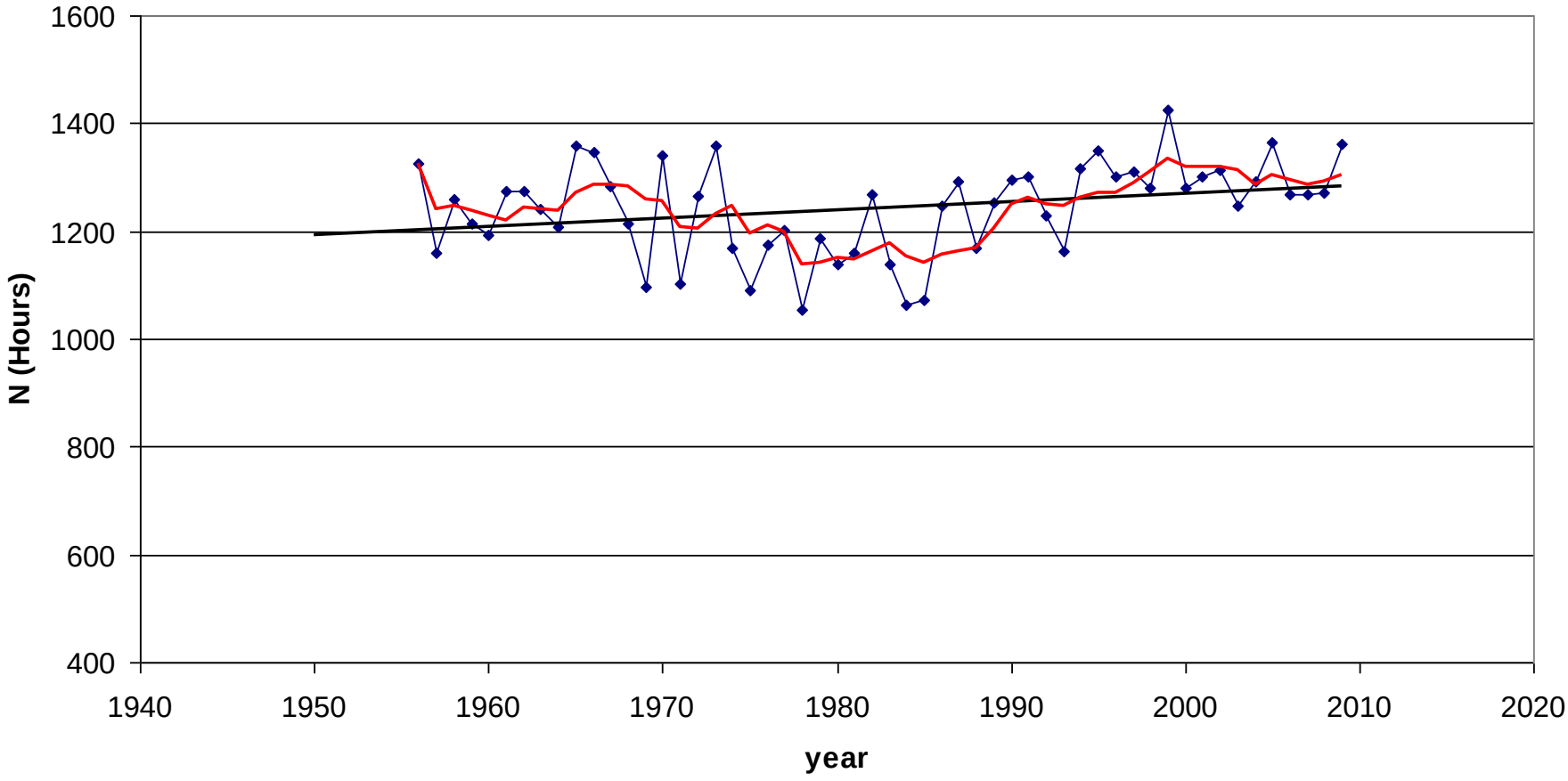
Total Insolation in Vegetative Season in Talavera La Real



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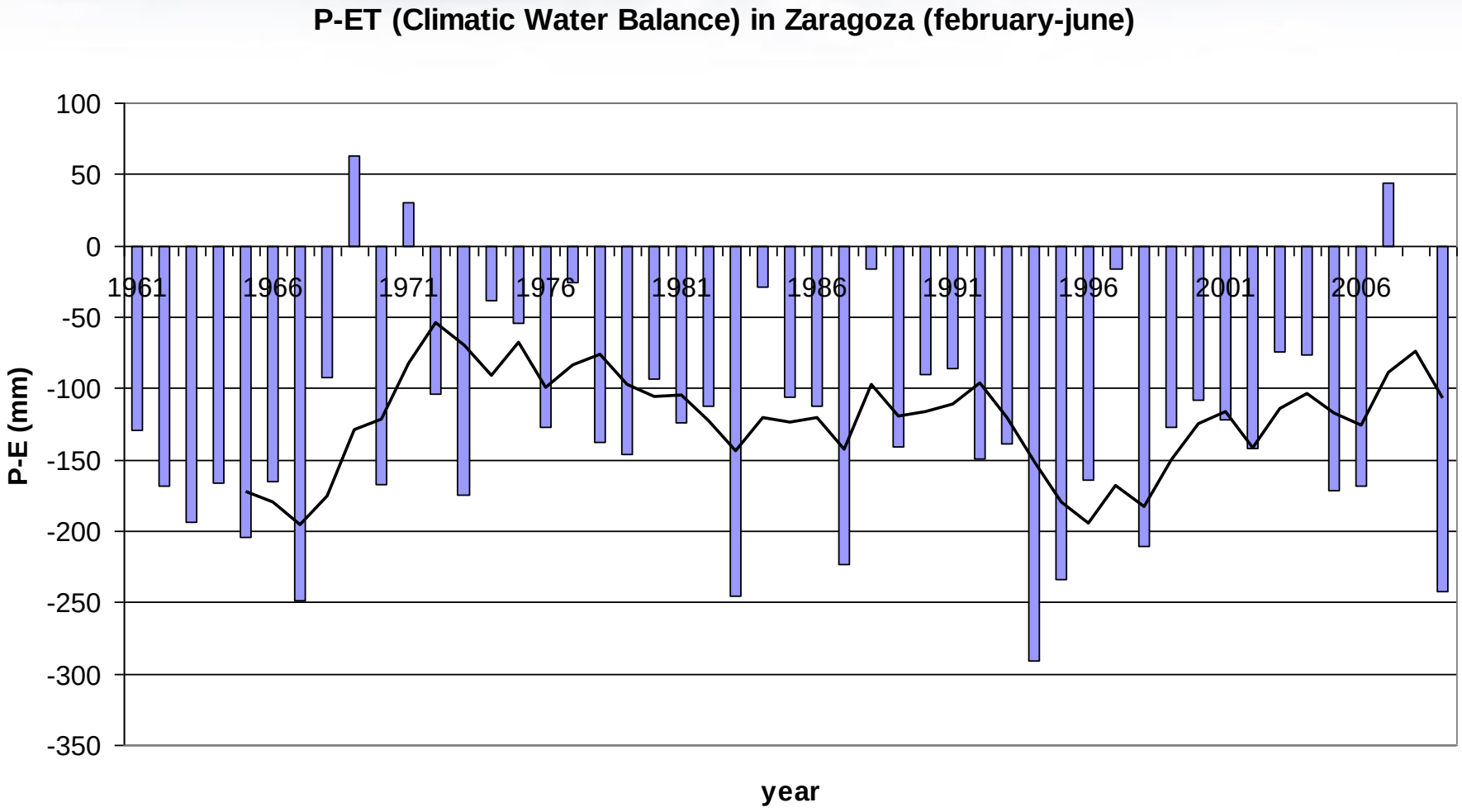

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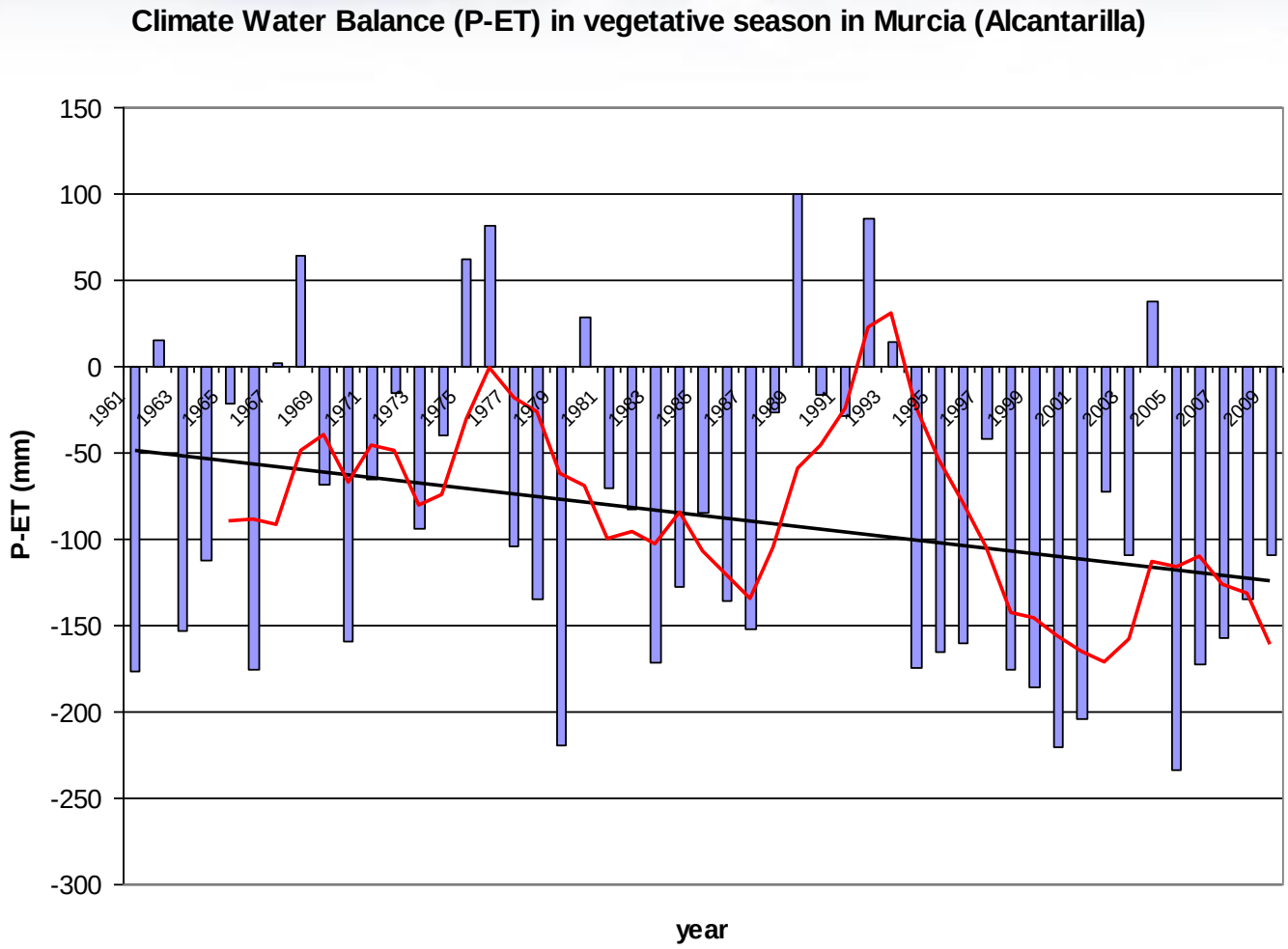

- In the last sixty years there has been an increase of maximum and minimum temperature averages, as much in the annual averages as in the vegetative period averages. Nevertheless, such temperature increases have not been even throughout the whole period, and it amounted from 1º C to 2º C in all zones.

- There have also been increases in the number of hot days (maximum temperature over 30º C) and decreases in the number of frost days (minimum temperature under 0º C) in most of the stations.

- The period of risk of frosts have shortened, and the last frost day occurs earlier, nevertheless flowering occurs earlier too and the number of severe cold spells and their intensity remains the same. The risks of damaging frosts affecting main fruit-trees areas in Spain remains due to the fact that cold spells well into the springtime are still occurring.

- About the amount of precipitation, it can be said that there has been a decrease in the amount of precipitation registered in annual periods as well as in vegetative periods in all the Atlantic basins, while it has remained more or less constant in the Mediterranean basins. The decrease of the amount of precipitation has been small in the northern half of the Atlantic basins and more accused in the southern basins. About the number of days with precipitation and the number of days with thunder storms, there are no trends in Galicia and Northern coastal zone, Northern and Southern Plateaus and the Guadiana and Guadalquivir river basins, but there has been a slight increase in the intensity of short duration showers.

- It is to remark that there has been an accused decrease in the amount of precipitation (around 50%) registered in the months of February and March in the Northern Plateau and Southern Plateaus and in the Guadiana and Guadalquivir river basins. There are increases in the number of days of precipitation, number of days of thunder storms in the Ebro river basin and Mediterranean coastal zone. In the Mediterranean coastal zone there is a decrease in the interannual variability (which is, in general, quite marked). In these zones, there is a slight negative trend for the months of February and March.

- About precipitation intensity (extreme events), the annual series of daily maximum precipitation in a set of Spanish stations do not show significant trends, but in shorter time scales it appears, in some cases, significant trends, particularly in the stations located in north Spain.

- In the first 30 years (1950-1980) of the considered period there is a negative trend in the amount of sun hours, and a positive trend afterwards (1980-2009), to recover in the last decade the annual sun hours of the 50's in Galicia and Northern coastal zone, the Northern and Southern Plateaus, the Guadiana, Guadalquivir and Ebro river basins. In Mediterranean coastal zone there is a slight variation of the pattern. Three periods can be distinguished in this zone. The first, from 1950 to 1985, with a decrease in the number of annual sun hours; a second, from 1985 to 2000, with a marked increase; and a third, the last ten years, in which there is a decrease. Around 2000 the number of annual sun hours recovered the values of the 50's (around 3000), but at present the number is similar to that of the 70's (around 2800).

- The series of Climate Water Balance P- ET show some trends to decreasing values, particularly in central and southern Spain.

- It is difficult to reach a conclusion in the case of wind parameters with long series (wind run and gusts' maximum speed). Their interannual variability is quite high in both parameters. In many stations there seems to be an increase in wind run and a decrease in gusts' maximum speed, but changes have been so marked as to suggest that it was due to changes in the kind of measurement instruments or changes in the placement of the anemometer.

- Finally, it is to remark that spanning the period to the beginning of the XX Century (there are several series of temperature and precipitation in which that can be done, four of them quite reliable), one finds that for temperature trends are positive for the long period as a whole in spite of shorter periods with negative or no trends, while the amount of annual precipitation was bigger in the 60's and 70's and more or less the same in the rest of the period.

¡Thanks for your atention¡