El Niño influence on the Basque Country

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Abstract

El Niño-Southern Oscillation (ENSO) is the dominant global climate mode at interannual timescales and the main source of predictability. Several studies point out that El Niño influence over European North Atlantic sector is consistent and statistically significant (Brönnimann et. al, 2007; García-Serrano et. al, 2011). Some hypotheses show that this influence, which lacks of stationarity, seems to be modulated by multidecadal oscillation of the anomalous Sea Surface Temperature (SST) over the Atlantic and Pacific basins (AMO and PDO respectively). A recent study has found how that the main El Niño teleconnection over European rainfall takes place in late winter and spring (February-March-April), being modulated by the Atlantic Multidecadal Oscillation (AMO), while in fall is the Pacific Decadal Oscillation (PDO) which appears to modulate this teleconnection. The authors of this study show the North of Spain (where the Basque Country region is located) as a transition zone of this teleconnection, so a better analysis of the ENSO-rainfall link in this particular peninsular region needs to be clarified in order to achieve its predictability.

The present study focuses on a thoroughly analysis of the behaviour of El Niño influence on different variables - as anomalous rainfall, minimum and maximum temperature- in different seasons over the region of the Basque Country. This work is performed analysing a high resolution gridded dataset over Spain, El Niño climate indices and Sea Surface Temperature dataset.

The results of this study show a non-stationary relationship between Basque Country rainfall, minimum and maximum temperature, and El Niño. This relation depends on the Pacific region considered and seems to be maximum in summer.

Introduction

The main motivation of this work is the López-Parages and Ródriguez-Fonseca (2012) study, where the influence of El Niño over European rainfall is analysed. The authors show the leading mode of the rainfall variability in Europe presents opposite behaviour in the middle of the region and in the north of the Iberian Peninsula, and in the Mediterranean. Moreover, they show that this leading mode is connected with El Niño. In that study was found El Niño influence is not the same not only in different 3-months seasons but in different year periods as well. For instance, in October, November and December, for the period 1942-1969 , a relationship between rainfall and El Niño was found, however, for the period 1970-2007, it does not seem to appear this relation (López-Parages and Rodríguez-Fonseca, 2012).

Therefore, the behaviour in the north of the Iberian Peninsula is more similar to the rest of Europe than to the Mediterranean. Because of that, the Basque Country is an important region to focus the analysis of rainfall behaviour and its relationship with El Niño phenomenon.

In this study, we have thoroughly analysed the rainfall, minimum and maximum temperature, in the zone of the Basque Country, using observational databases and extending to all possible 3-months seasons of the year. In the same way, the possible connection between the rainfall, minimum and maximum temperature and El Niño indices (El Niño 1.2 and El Niño 3), in different time periods, has been analysed.

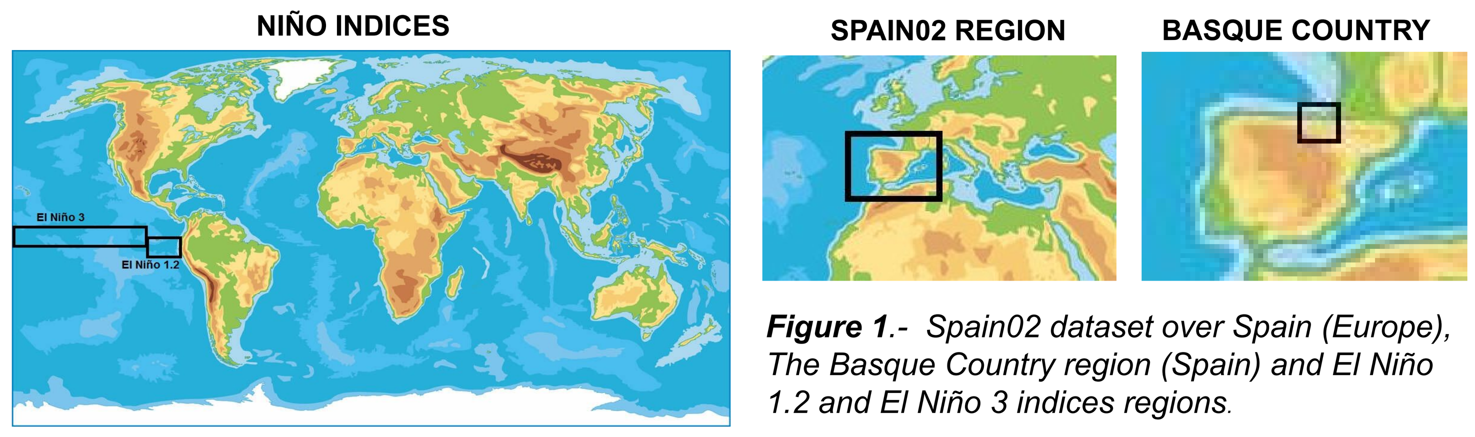

***Figure 1**.- Spain02 dataset over Spain (Europe), The Basque Country region (Spain) and El Niño 1.2 and El Niño 3 indices regions.*

Data

Observations of rainfall, minimum and maximum temperature in the Basque Country zone. Source of data: Spain02 gridded precipitation dataset (Herrera et al., 2012). This dataset covers a Spain gridded domain with a 0.2 x 0.2 lat-long resolution. In present study, Basque Country is the selected region [42.2ºN-43.4ºN, 3.6ºW-1.6ºW]. See Figure 1.

Sea Surface Temperature , in the period 1950-2007. HadISST (Hadley Centre Sea Ice and Sea Surface Temperature) dataset is used. 1º X 1º lat-long resolution.

Niño indices. El Niño 1.2 and El Niño 3, come from NOAA, available at (http://www.esrl.noaa.gov/ psd/data/climate indices/list/). Niño 1.2 index corresponds to the area further east [10ºS-0, 90ºW-80ºW] and El Niño 3 to a more western zone [5ºS-5ºN,150ºW-90ºW] of the tropical Pacific (Fig.1).

Method

The average of 12 possible 3-months seasons of each year, from January-February-March (JFM) to December-January-February (DJF), is calculated for every dataset and then the climatology of each season is subtracted, obtaining the 3-months anomaly throughout the year.

A correlation analysis between different variables is done. In addition, horizontal regression maps (correlation maps) are computed projecting (correlating) several anomalous fields onto different time indices.

Results and Discussion

We start by examining 20-year moving window correlations between anomalous rainfall, minimum and maximum temperature in the Basque Country and El Niño 1.2 and El Niño 3 indices in 3-months seasons of the year. The results for the rainfall are in agreement with López-Parages and Rodríguez-Fonseca (2012) study.

Rainfall and El Niño (Fig. 2 and 3):

A change in the behaviour is found, in late winter-spring (February-March-April, FMA) and in fall (October-November-December, OND), from positive phase to negative in FMA and from negative phase to positive in OND. The turning point of this change is approximately in 1976, at which time many authors (Venrick et al., 1987) mention the Climate Shift associated with the Pacific Decadal Oscillation (PDO). Nevertheless, in summer (July-August-September, JAS) the behaviour of the correlation does not change and it is positive in all the period. Moreover, it is in summer when the correlations are higher, above 0,5 (in red line) and exceeding 0,7 in the period 1974-1977.

According to the rainfall correlations, in April-May-June (AMJ), and OND seasons, we have taken into account the opposite behaviour before Climate Shift and after. In spring, the projection from 1950 to 1970 shows statistically significant relationship (little black dots) in the Equatorial Pacific over El Niño region, with a positive deviation of the SST anomaly (Fig. 3). However, it does not appear (Fig. 3) a relationship in the period after the Climate Shift (1976-2006). These results agree with the highest correlations found in AMJ (Fig. 2), which correspond with the first years of the study. The same projection in summer, in the period 1958-2002, shows statistically significant relationship in a wide region of the central and eastern Pacific (Fig. 3). Finally, in fall, although none of the two analysed periods (1950-1970 and 1976-1996) shows statistically significant relationship, the period after the Climate Shift has a clearer signal in the area of El Niño (Fig. 3).

Temperatures and El Niño (Fig 2, 4 and 5):

The same change of behaviour found in the rainfall, appears. In this case, this change focuses specially between late spring (AMJ) and early fall (September-October-November, SON), when, in addition, the correlations are highest, in maximum temperature case, reaching 0,8 (Fig. 2). In late spring-summer (May-June-July, MJJ) another behaviour change can be seen in the last years of the analysed period.

The minimum and maximum temperature projections onto SST are studied in different periods and seasons. For maximum temperature two periods in JAS season are analysed, from 1959 to 1978 and from 1980 to 2006. In the first period the results show statistically significant relationship in a wide area of El Niño region (Fig. 4), while in the second period, after the Climate Shift, do not (Fig. 4). On the other hand, in MJJ season three different periods are analysed, presenting statistically significant relationship in El Niño region, in the first and in the third one (Fig. 4), in agreement with the highest correlations (Fig. 2).

Regarding minimum temperatures, the correlations exceed 0,5 in summer, not only in the period before the Climate Shift, but after as well (Fig. 2). Analysing the projections in JAS in the periods 1959-1978 and 1979-2006, the results show statistically significant relationship in the region of the central and eastern Pacific associated with El Niño, obtaining a negative deviation of the anomalous SST in the first period and positive deviation in the second one (Fig. 5). In SON season case, the same two periods are analysed and in the second one, after Climate Shift, when the correlations are higher, a statistically significant relationship is found (Fig. 5).

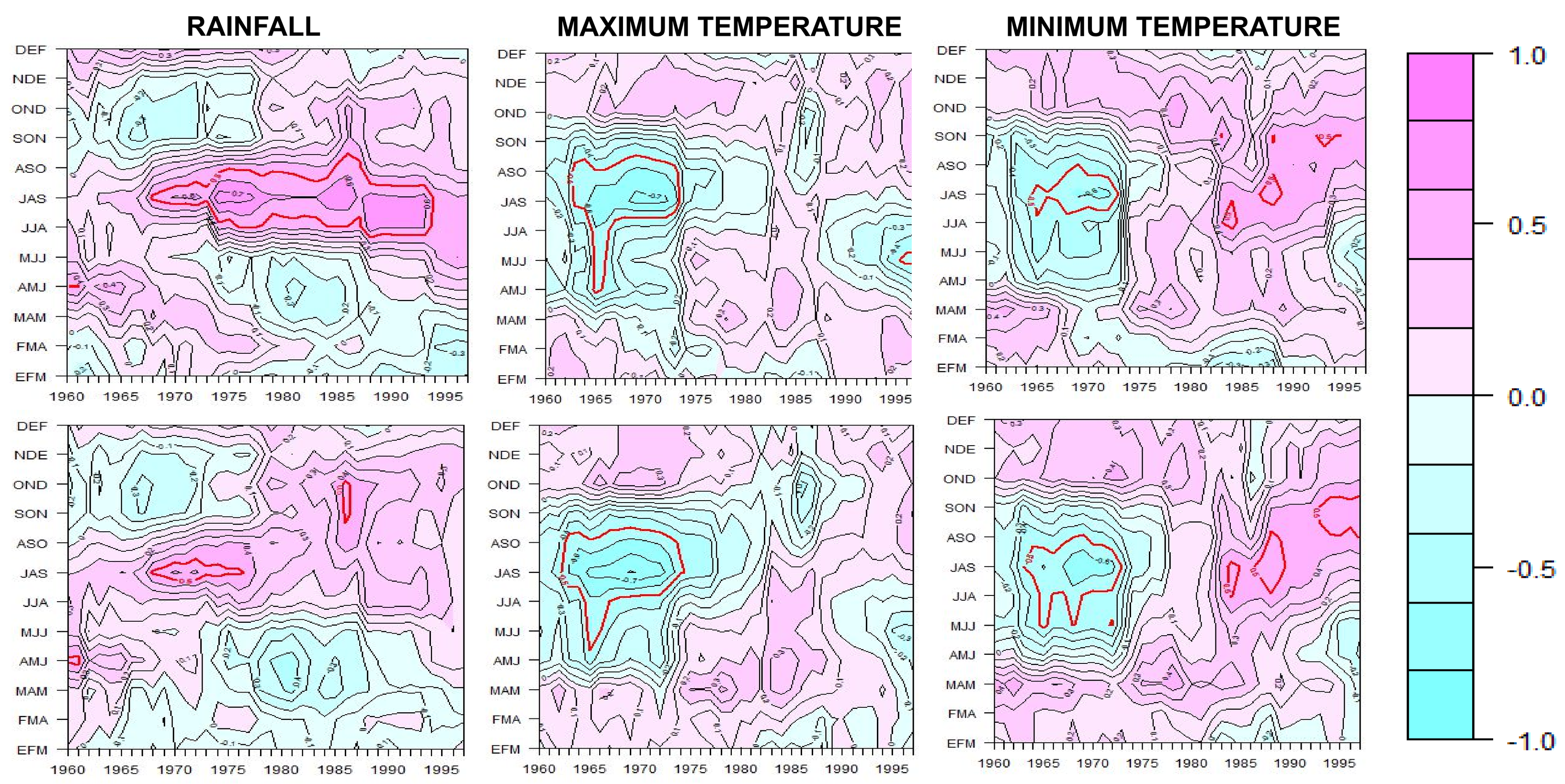

***Figure 2**.- 20-year moving window correlations between anomalous rainfall, maximum temperature and minimum temperature in the Basque Country, in the 12 possible 3-months seasons of the year, and El Niño 1.2 (top) and El Niño 3 (down). Red line delimits the seasons and periods of time with significant correlations.*

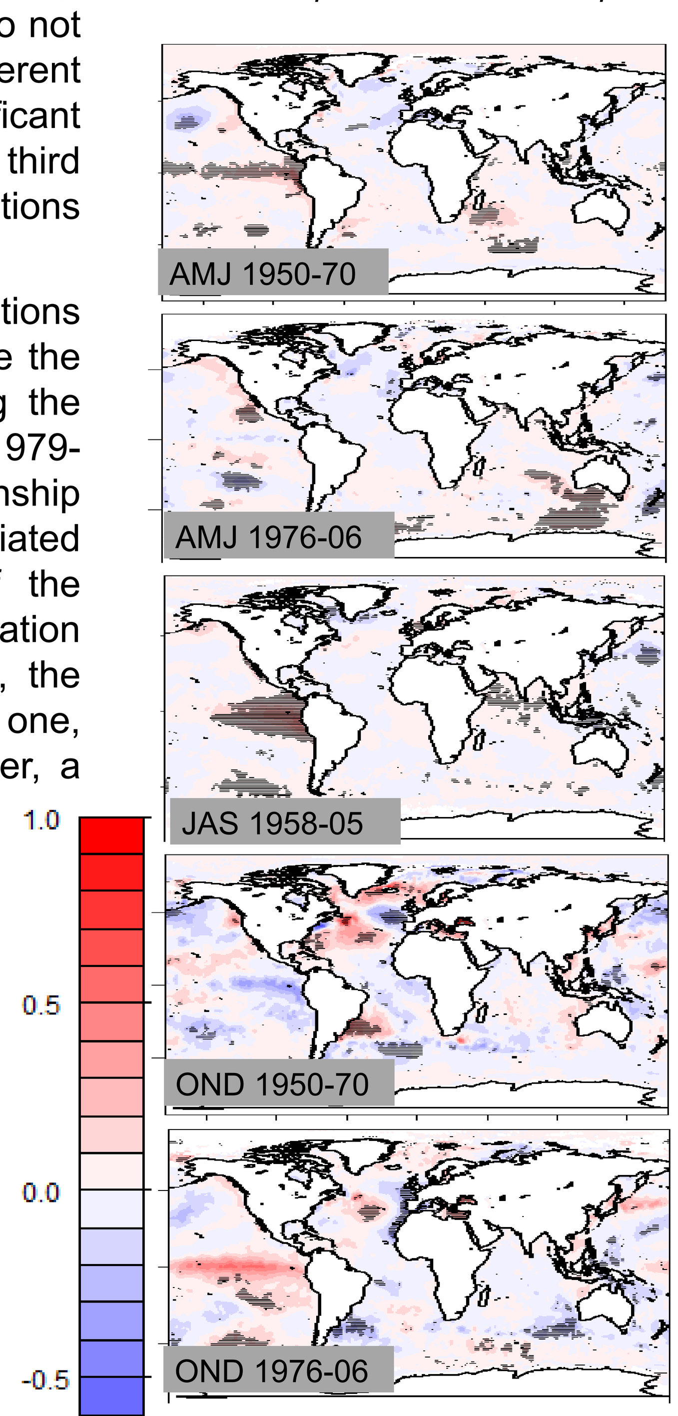

***Figure 3**.- Rainfall projections onto SST in AMJ 1950-70, AMJ 1976 - 06, JAS 1958-05, OND 1950-70 and OND from 1976-06.*

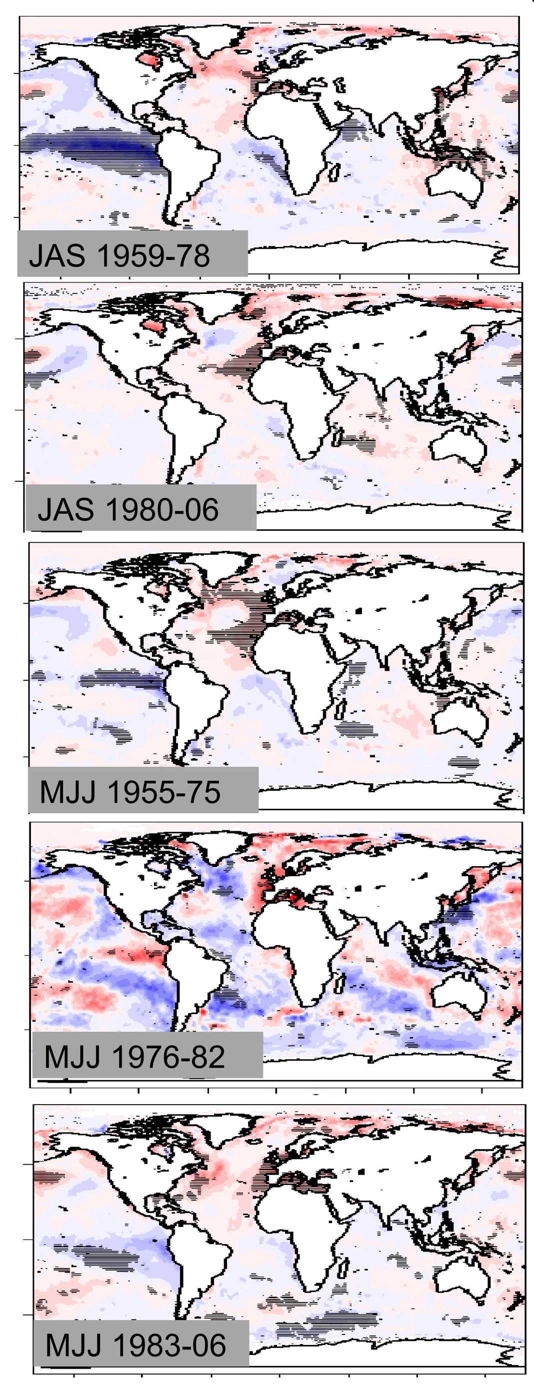

***Figure 4**.- Maximum temperature projections onto SST in JAS 1959-78, JAS 1980-06, MJJ 1955-75, MJJ 1976-82 and MJJ 1983-06.*

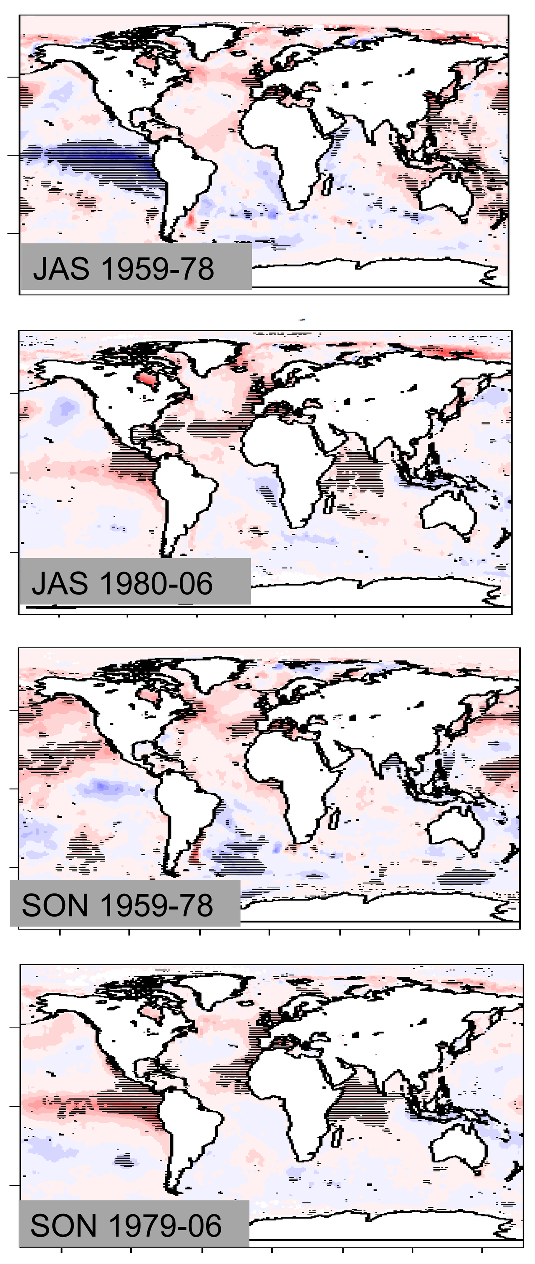

***Figure 5**.- Minimum temperature projections onto SST in JAS 1959-78, JAS 1980-06, SON 1959-78 and SON 1979-06.*

Conclusions

- ✓ We can conclude that in summer El Niño influence over the variability in the rainfall, maximum and minimum temperature in the Basque Country is important.
- ✓ El Niño (La Niña) produces increased (decreases) rainfall in the Basque Country in all the studied period. Nevertheless, regarding minimum and maximum temperature, the behaviour is opposite in the periods before and after the Climate Shift (1976).
- ✓ In the period previous to the Climate Shift El Niño (La Niña) produces decreased (increased) temperature, while in the period later it, El Niño (La Niña) produces increased (decreased) temperature in the Basque Country.
- ✓ In spring and in fall, the behaviour of the variability in all the variables is opposite in the years before and after the Climate Shift.
- ✓ In the case of rainfall, there is an increase (decrease) with El Niño in the first period in spring (fall) and in the second period there is a decrease (increase) with it.
- ✓ Regarding minimum and maximum temperature, in the first period the temperature decreases (increases) with El Niño (La Niña) and in the second one, increases (decreases) with El Niño (La Niña).

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