THE ENSO SIGNAL OVER SOUTHWESTERN EUROPE AND ITS IMPACT ON SPRING RAINFALL

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INTRODUCTION

Climate variability in the Euro-Atlantic sector is hard to forecast. The area is located in the mid-latitude belt, in which the internal variability dominates and the identification of a clear connection between atmosphere and ocean a complex task

The Atlantic part of the Iberian Peninsula is located in middle latitudes of the Northern Hemisphere with great oceanic influence on its climate. This region presents a significant amount of rainfall all over the year, particularly important in its northwestern corner: Galicia (42ºN - 44ºN) the region under study

INTRODUCTION

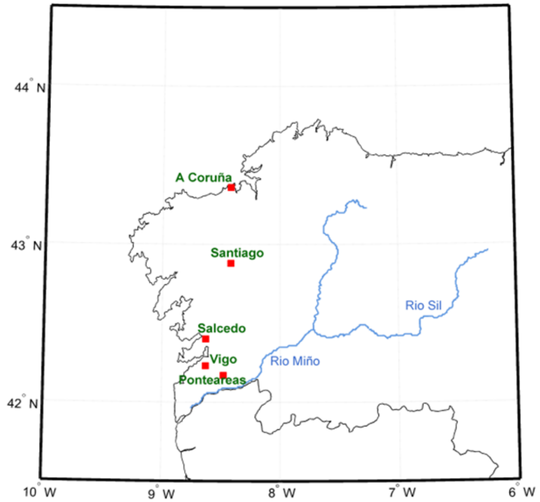
The ENSO has a determinant impact on the tropical regions, it also influences on the extratropical latitudes. The strength of these relations or connections can change with changes in the atmospheric circulation. Between 1976 and 1977, a change in the atmosphere-ocean system was observed in the North Hemisphere. This phenomenon is called *Climate Shift*.

The present work explores the relationship found in a previous work of Lorenzo et al. (2010)* focusing in the linearity and stationarity of the signal and the changes in the dynamics and impacts before and after the *Climate Shift*, hypothesizing possible dynamical mechanisms to explain this change.

** Lorenzo M.N., J.J. Taboada, I. Iglesias and M. Gómez-Gesteira (2010): **Predictability of the spring rainfall in North-west of Iberian from sea surfaces temperatures of ENSO areas**. (Climatic Change) DOI: 10.1007/s10584-010-9991-6.*

DATA

- <u>Precipitation data:</u>
  - *Agencia Estatal de Meteorología* (AEMET)
  - Period: from 1951 to 2006.
  - Five meteorological stations with high correlation



- <u>SST data:</u>
  - Earth System Research Laboratory (ESRL) of NOAA
  - Monthly averaged on a 2º × 2º lat-lon grids
  - Period: from 1951 to 2006.

- <u>SLP, streamfunction and zonal wind, at 200 hPa:</u>
  - Reanalysis data of the NCEP/NCAR
  - Resolution of 2.5º × 2.5º.

- <u>Niño indices:</u>
  - Climate Prediction Center of the NOAA

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METHODS

The monthly rainfall totals are expressed with a rainfall anomaly index*: $NWIPR = 100\sum_{1}^{N}\left(X/\overline{X}\right)$

Months were grouped in seasons: winter(JFM), spring(AMJ), summer(JAS) autumn (OND)

To study the effect of the climate shift, the data has been divided in two subperiods:
- 1951-1977
- 1978-2006

The series were linearly detrended and normalized by the corresponding standard deviation

The Pearson product-moment correlation coefficient

Student's t-test

The study was divided in:
- Years with Niño events (Niño 3>0.4)
- Years with Niña events (Niño 3<0.4)

The extreme events of NWIPR were considered:
- Years with maximum extremes (NWIPR>1)
- Years with minimum extremes (NWIPR<- 1)

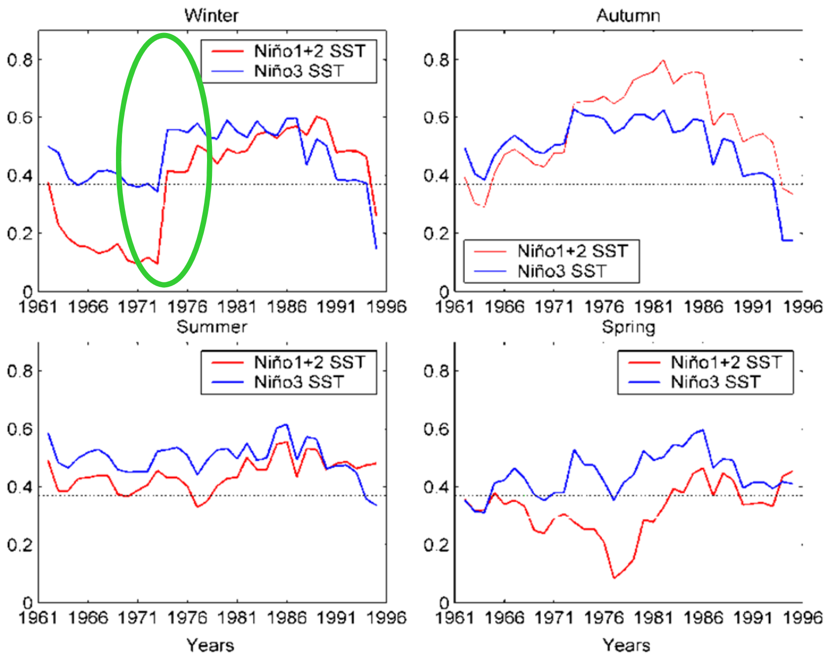
For the analysis of the SST behavior in the years with extreme NWIPR, the anomaly every three months was considered: January to March, February to April, March to May, April to June

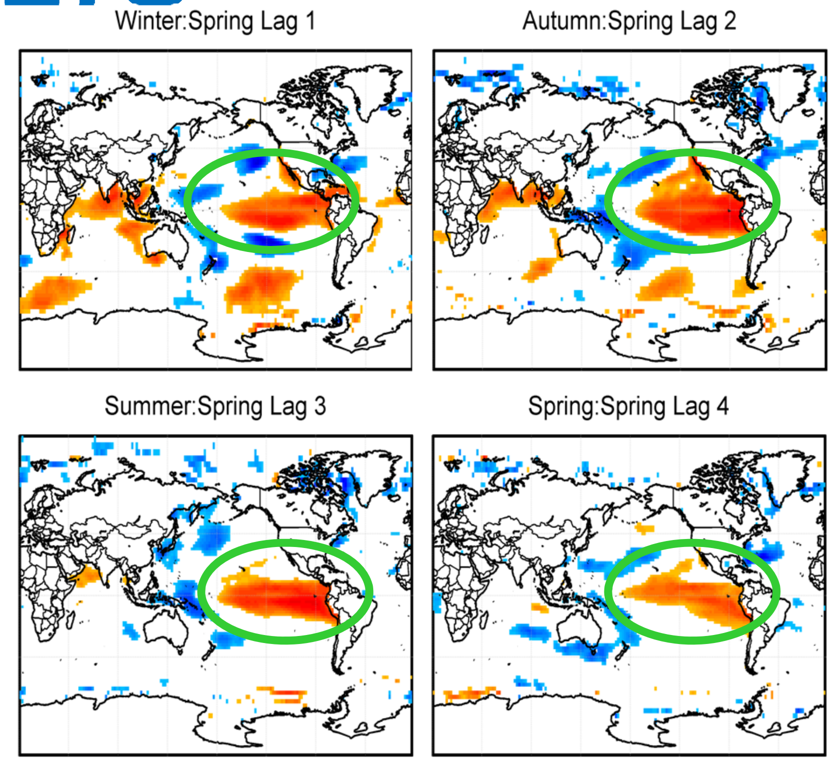
$$SSTA = \overline{SST_{extreme}} - \overline{SST_{period}}$$

*Lorenzo, M.N., I. Iglesias, J.J. Taboada, and M. Gómez-Gesteira (2010), ***Relationship between monthly rainfall in NW Iberian Peninsula and North Atlantic sea surface temperature***, Int. J. Climatol. 30 980-990. DOI: 10.1002/joc.1959.*

RESULTS

Seasonal SSTA:NWIPR correlations of seasonal mean SSTA and rainfall anomalies have been calculated for the 4 seasons. Only spring NWIPR fulfill the finiteness and interdependence criteria for several lags.



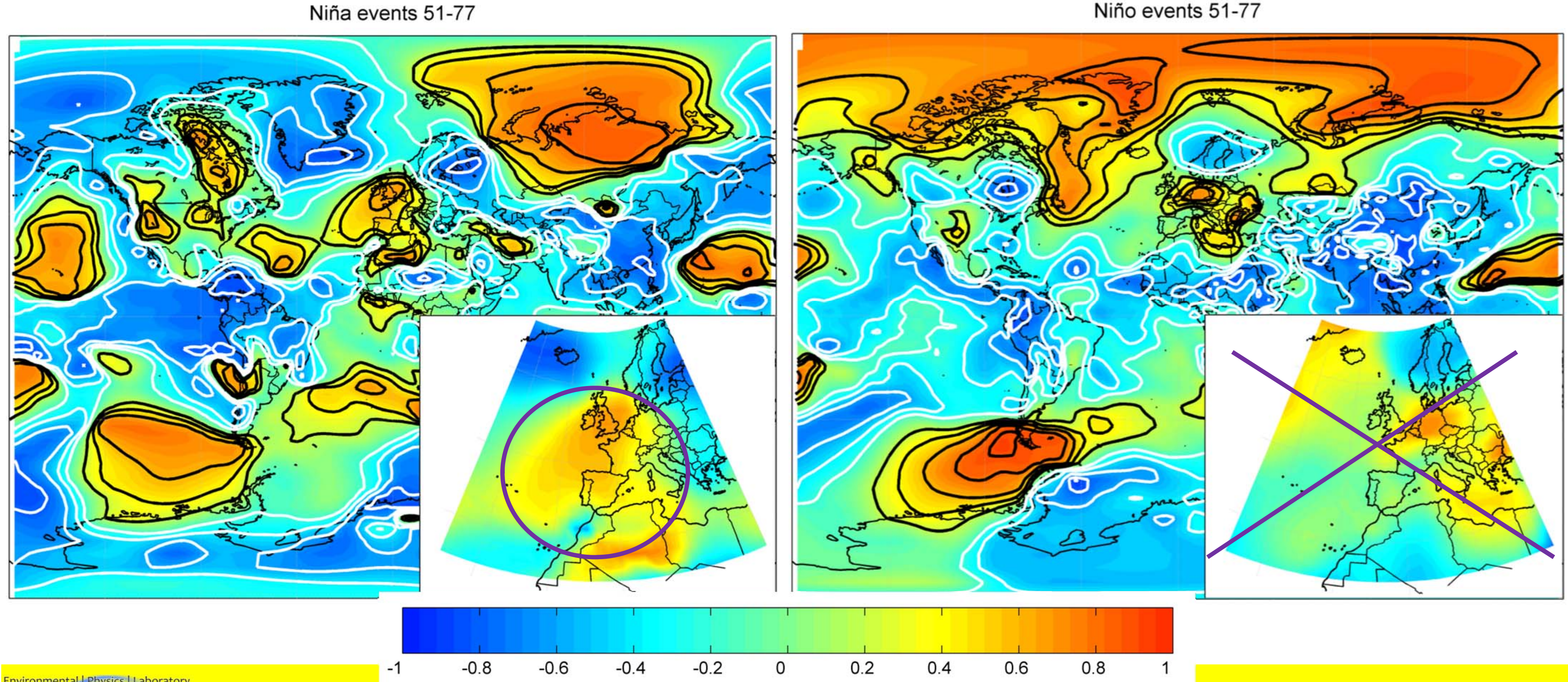


21-year sliding means were used to calculate the evolution of the correlation between Niño3 and Niño1+2 and spring NWIPR.

Lorenzo M.N., J.J. Taboada, I. Iglesias and M. Gómez-Gesteira (2010): ***Predictability of the spring rainfall in North-west of Iberian from sea surfaces temperatures of ENSO areas****. (Climatic Change) DOI: 10.1007/s10584-010-9991-6.*

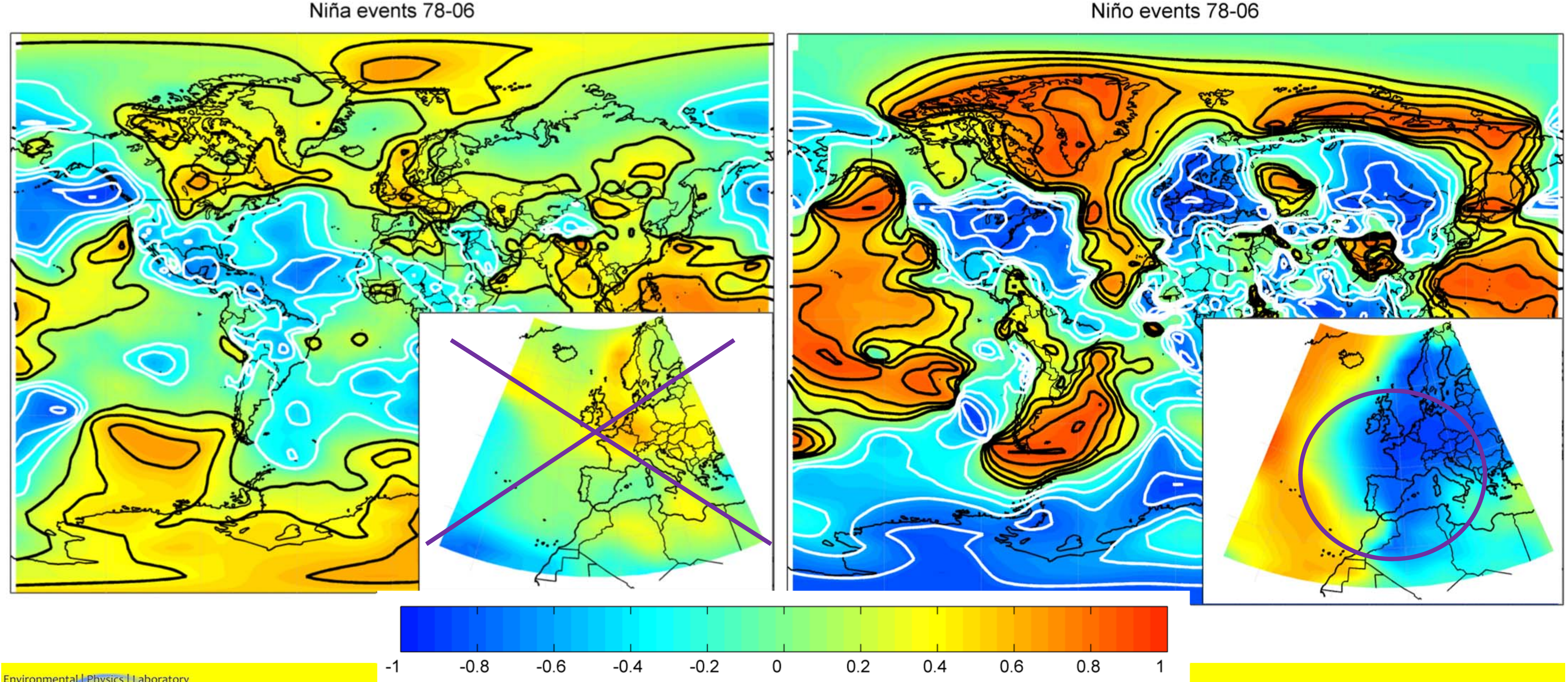
RESULTS

Correlation between winter Niño 3 and spring SLP for Niña events between 1951-1977 (the significant correlations at 90% are outside the interval ±0.551) and Niño events between 1951-1977 (the significant correlations at 90% are outside the interval ±0.609)



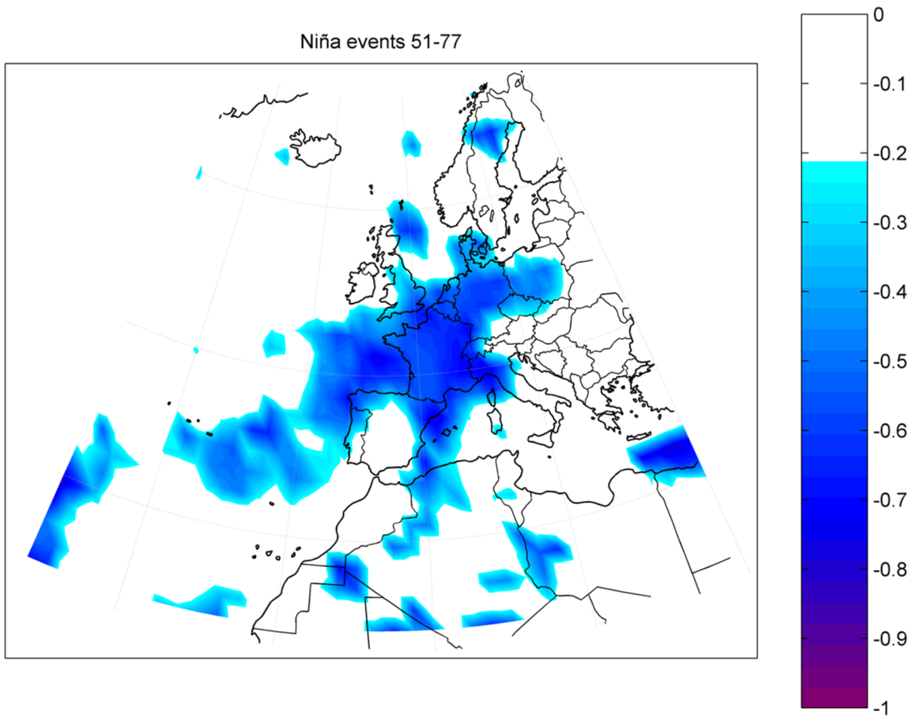
RESULTS

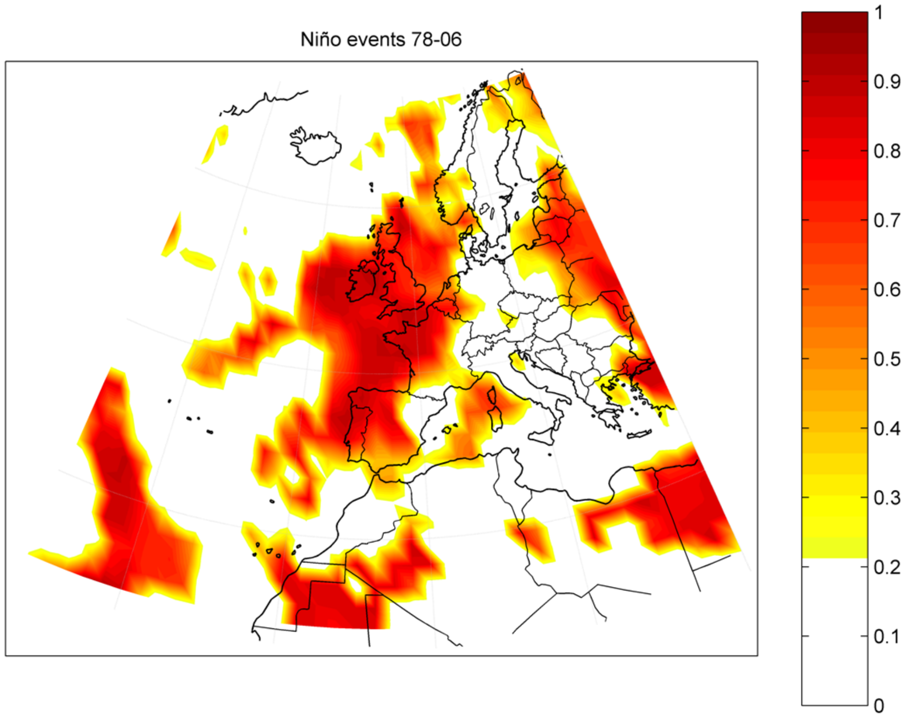
Correlation between winter Niño 3 and spring SLP for Niña events between 1978-2006 (the significant correlations at 90% are outside the interval ±0.472) and for Niño events between 1978-2006 (the significant correlations at 90% are outside the interval ±0.688)



RESULTS

Correlation between winter Niño 3 and spring precipitation (mm/day) for Niña events between 1951-1977 (Significant correlation higher than the 90% are lower than -0.551) and Niño events between 1978-2006 (Significant correlation higher than the 90% are higher than 0.688)





RESULTS

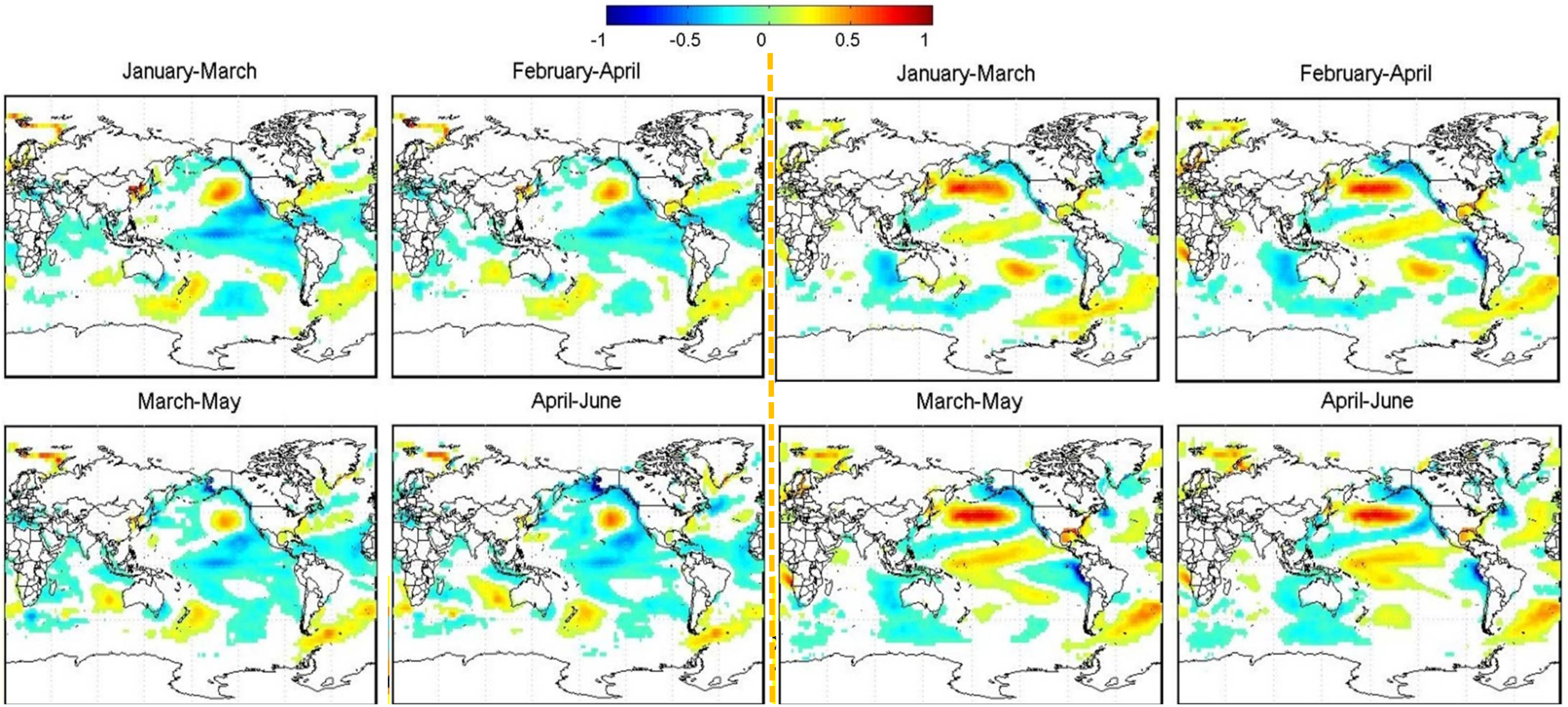
SSTA in the years with minimum or negative NWIPR events:

Before the Climate Shift (1951-1977):

- Formation of Niña event
- General negative SSTA
- Positive SSTA located at North Pacific
- SSTA tripole in the North Atlantic associated to NAO pattern

After the Climate Shift (1978-2006):

- Cannot distinguish an ENSO pattern
- The pattern seems to be the PDO pattern in the cool phase
- General positive SSTA
- SSTA tripole in the North Atlantic is more distorted



RESULTS

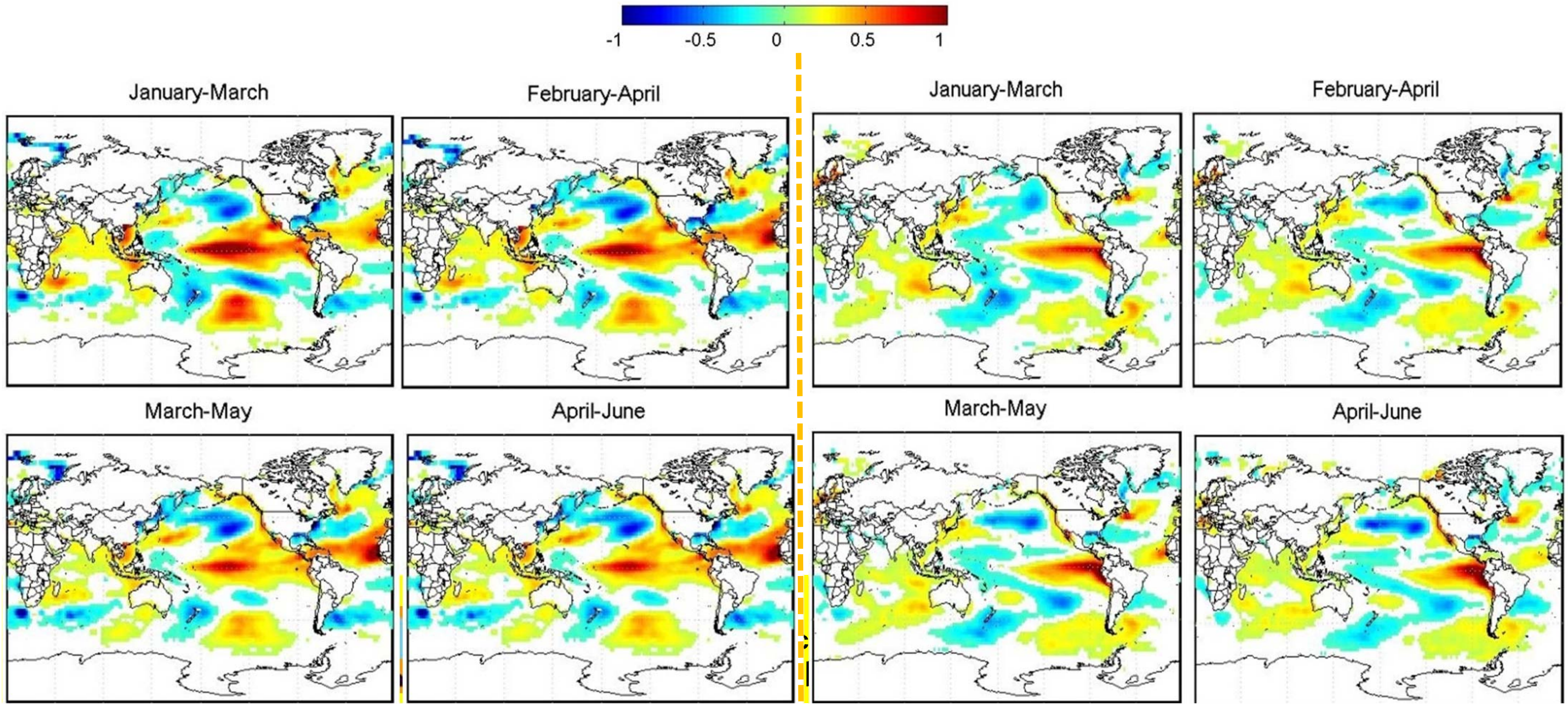
SSTA in the years with maximum or positive NWIPR events:

Before the Climate Shift (1951-1977):

- Positive SSTA at the centre of the Equatorial Pacific, which can suggest a Niño event in the last stage
- Positive SSTA in subtropical north Atlantic

After the Climate Shift (1978-2006):

- Formation of a Niño event in the Equatorial Pacific
- Positive anomalies in subtropical north Atlantic



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RESULTS

In order to understand how the ENSO signal is transmitted to European regions the analysis of the streamfunction and the zonal wind at 200 hPa were made

In this way the situation of the top of the troposphere can be followed

For all the pictures the streamfunction *(m^2/s)* will be represented in blue (positive) and green (negative) contours and the zonal wind *(m/s)* in shadows

RESULTS

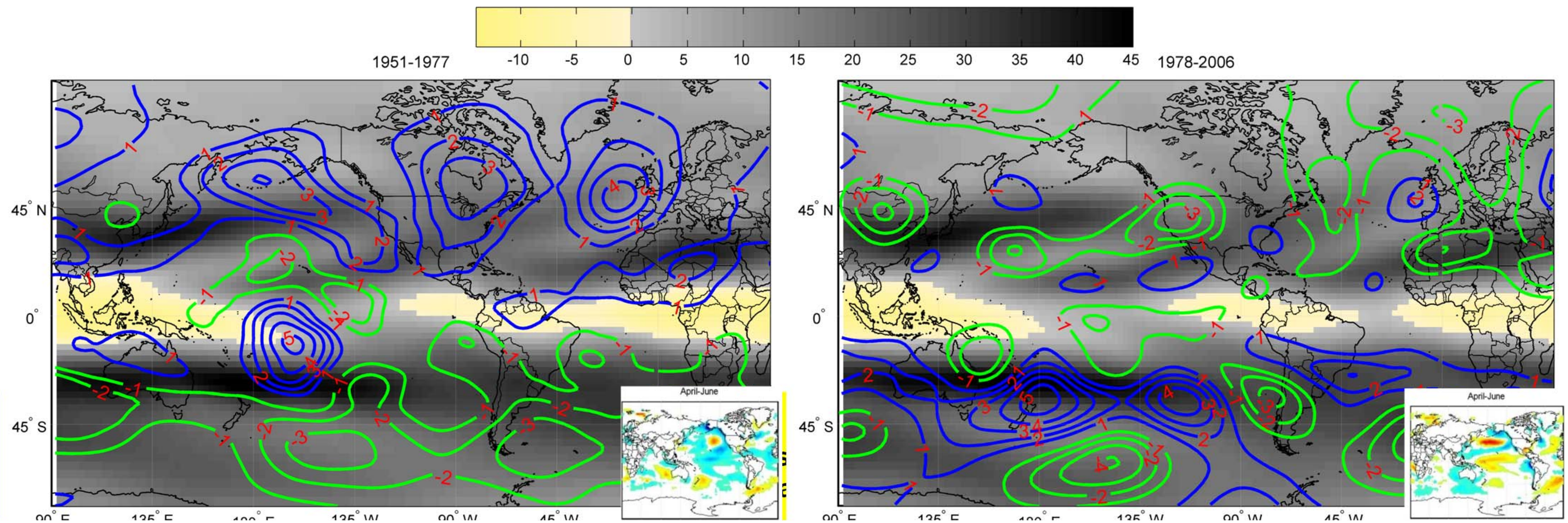
Minimum rainfall events of NWIPR (Niñas):

Between 1951 and 1977:

- Strong extratropical signal
- Streamfunction positive anomalies over Europe
- Baroclinic response to Niña event and barotropic response in the extratropics (Rossby wave)

Between 1978 and 2006:

- Generalised weaker centres
- The centres over the Iberian Peninsula are weaker than the ones of the previous figure
- This explain the absence of significant correlations between the winter Niña events and the spring SLP
- No clear pattern



RESULTS

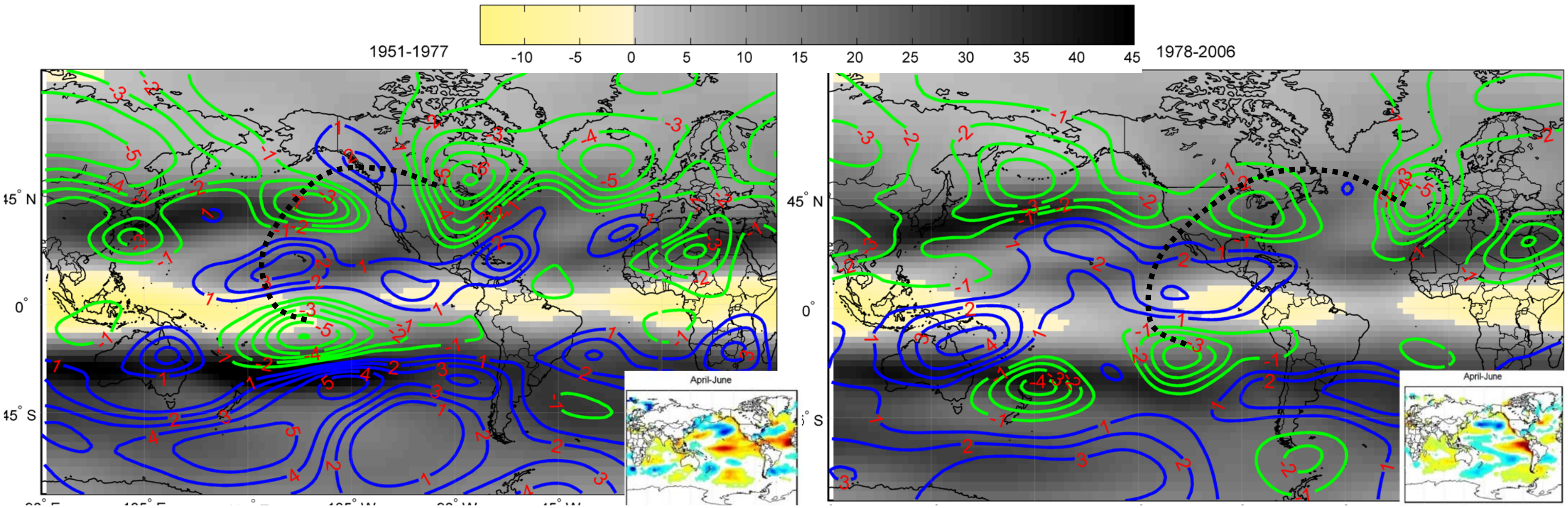
Maximum rainfall events of NWIPR (Niños):

Between 1951 and 1977:

- Europe and North Africa under weak streamfunction anomaly centres
- Justify the absence of significant correlations with the Niño events
- Arch pattern (Rossby wave) from central Pacific to Canada. (dashed black line)
- Its position not allows the arrival of the ENSO signal to the southwest Europe

Between 1978 and 2006:

- Positive streamfunction centre near South America
- The arch pattern (dashed black line) starts eastwards in comparison with the previous figure
- Rosbby wave reaches the southwest Europe with a negative streamfunction centre



CONCLUSIONS

It was demonstrated that the ENSO events have influence in the Southwest of Europe. A link between the winter ENSO events and the spring rainfall in Galicia was demonstrated.

The climate shift affects the teleconnections with the ENSO signal:

- Before the climate shift the Niña events produce dry springs in the southwest corner of the European country while the Niño events did not affect.
- After the climate shift the Niño events produce humidity springs in the region under study while the Niña events are not relevant.

Different Niños produce different extratropical response. The NWIP is under the extratropical response after the climate shift

No clear Niña extratropical response after the climate shift while before the climate shift the NWIP lays under the influence of this extratropical response.

Next step: perform sensitivity experiments with AGCMs prescribing the SSTs.

THANK YOU FOR YOUR ATTENTION

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