Precipitation extremes in the Iberian Peninsula related to NAO and ENSO

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Introduction

On account of their potentially severe socio-economic impact, precipitation extremes are a subject of great interest within the field of climate research. This is even more so when there appear to exist indications that global climate change might bring about an intensification of these extreme phenomena. The prediction of these changes, and of the probability of occurrence of extreme episodes themselves, would clearly benefit from a better understanding of how they are affected by relevant climatic signals such as the North Atlantic Oscillation (NAO) and El Niño-Southern Oscillation (ENSO).

In the present study, we address the influence of NAO and ENSO on wintertime daily precipitation extremes in the Iberian peninsula. By means of a simple compositing technique, we attempt to investigate whether the effects of those two signals show any interrelation, that may reveal an interaction between them.

Data

We analyze daily precipitation data recorded at 39 weather stations located in the Iberian peninsula. Part of these data were provided by the Spanish Institute of Meteorology, and the rest were downloaded from the ECA (European Climate Assessment and Dataset) website at http://eca.knmi.nl. We cover in our analysis a period of 56 years from 1951 to 2006.

To monitor the evolution of NAO we make use of the wintertime NAO index available at the website http://www.cgd.ucar.edu/cas/jhurrell/nao.stat.winter.html. It is a station based index obtained as the difference of normalized sea level pressure between Lisbon (Portugal) and Stykkishomur (Iceland).

The state of the ENSO is checked through the Niño3 index available on a monthly basis at the website http://www.cdc.noaa.gov. Wintertime information is kept by computing the average of the index over December, January and March.

Methodology

First, we examine the phase of the NAO and the ENSO in the years under investigation. We consider these signals are in a positive or negative phase when their values fall outside the range defined by ±0.7 standard deviations around the mean. Years with values within this interval are defined as normal. Next, we form nine classes of winters based on the state of NAO and ENSO: ***NAO+/NIÑO3+***, ***NAO+/NIÑO3normal***,..., and so on (see table below).

After completing a preliminary quality analysis, we separate the wintertime daily precipitation data for the years contained in each of the groups mentioned above. We calculate the 95th percentile of each of these subsamples. With this simple scheme, we try to check whether different states of NAO and ENSO exert an impact on the intensity of extreme daily precipitation values.

Groups of years based on the state of NAO and ENSO

	NIÑO3 (Normal)	***NIÑO3(+)***	***NIÑO(-)***
NAO (Normal)	1951,1952,1953,1954, 1959,1967,1978,1980, 1982,1986,1988,1991, 1997,2002,2003,2004, 2005	1958,1987,1998	1968,1971,1972,1974, 1976,1985,2006
NAO (+)	1957,1961,1975,1981, 1984,1990,1993,1994, 1995,1999	1973,1983,1992	1989,2000
NAO(-)	1960,1962,1963,1969, 1979,1996,2001	1964,1966,1970,1977	1955,1956,1965

Results

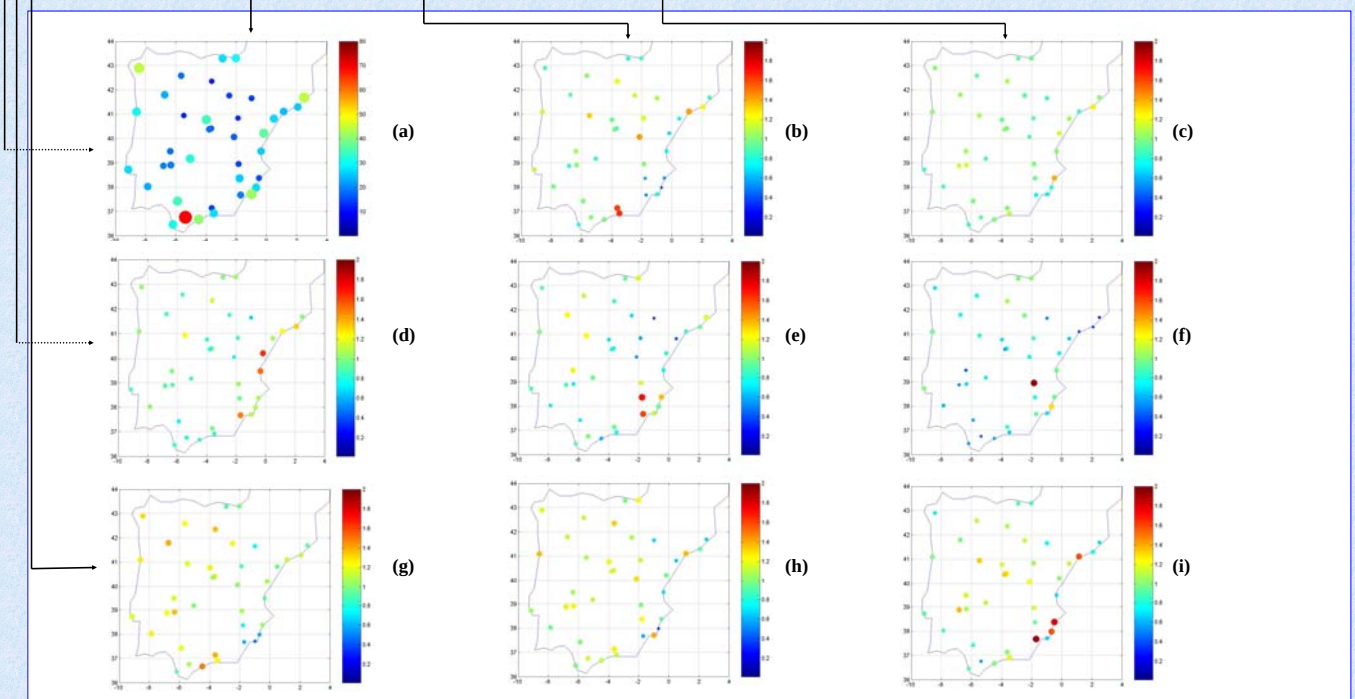
The examination of the 95th percentile (p95) of years with a positive or negative phase of NAO and/or ENSO, in terms of their quotient with the p95 of normal years (see maps below), suggests that, for the period under investigation:

- Under conditions of negative NAO phase, p95 appears to increase in the central and western Iberian peninsula, and to slightly decrease in the Mediterranean coast. This is so when the negative NAO phase coincides with normal or positive ENSO conditions. Under negative ENSO conditions, that structure notably weakens.

- The expected decrease of p95 under positive NAO conditions seems to be enhanced when a negative ENSO phase occurs simultaneously, as compared to the situation with positive or normal ENSO.

- In spite of its impact on the influence of positive or negative NAO conditions on p95, a negative ENSO phase turns out to have little effect when NAO conditions are normal. Positive ENSO conditions affect more noticeably p95 in stations located in the south of the Mediterranean coast.

Our results thus offer some hints that NAO and ENSO impacts on wintertime daily precipitation extremes over the Iberian peninsula might be interrelated and result from the interaction between the two signals. Further analysis is needed to search for the physical mechanism that might explain such interaction. We also expect to establish the relevance of local effects, that could be responsible for some lack of coherence in our findings, as opposed to the influence of the large scale variability.



(a) 95th percentile for normal years ; (b)-(i) Quotient of the 95th percentile for the different classes by the 95th percentile of normal years

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