CONNECTION BETWEEN NAO INDEX AND EXTREME PRECIPITATION IN CONTINENTAL SPAIN

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Introduction

The North Atlantic Oscillation (NAO) index is the main parameter used to determine the atmospheric general circulation in the Northern Hemisphere. It is defined as the pressure difference between the Iceland Low and the Azores High. The balance between both action centers determines the direction and strength of the westerlies and the approximate path of the depressions originated in the North Atlantic.

The aim of this study is to find the connection between the NAO index and the number of episodes with extreme precipitations in continental Spain during the period 1982-2011. The seasonal NAO index has been calculated from the monthly index, obtained from the NOAA website (www.noaa.gov).

Methodology

Forty-five AEMET (Spanish State Meteorological Agency) stations throughout mainland Spain have been selected for the study. Two factors have been considered for doing this selection: the stations must have offered reliable data for the complete period of study and they must not be too close to each other. Then, the criterion to determine which episodes are considered extreme was defined. The distribution of the days with extreme precipitation can be given by the formula:

$$N_{(p)} = N_0 e^{\frac{-p}{\theta}} \qquad (1)$$

where N_0 is the number of rainy days, $N_{(p)}$ is the number of days with precipitation p, and θ is the mean precipitation of the rainy days for a particular weather station. For this study, if a day out of 400 precipitation days (2.5 ‰) can be considered as a day with extreme precipitation, then, the cut-off threshold pc for the extreme precipitation and the number of extreme precipitation days $N_{(pc)}$ are related by:

$$\frac{N_{(pc)}}{N_{(0)}} = e^{\frac{-P_c}{\theta}} = \frac{2{,}5}{1000} \Rightarrow \frac{P_c}{\theta} = l_n \frac{2{,}5}{1000} \Rightarrow \frac{-P_c}{\theta} \approx -6 \Rightarrow p_c = 60 \qquad (2)$$

Therefore, the days considered as extreme precipitation days have been those in which the daily precipitation registered in a weather station equals or exceeds the quantity of six times the average of daily precipitation over the study period (1982-2011). Those days have been considered for the study.

Results

After calculating the Pearson correlation coefficient between the NAO index and the daily extreme precipitation, we have represented the correlation coefficient between both factors in a map for every season (Fig. 1). We have only considered those weather stations which have registered five or more days with extreme precipitations per season.

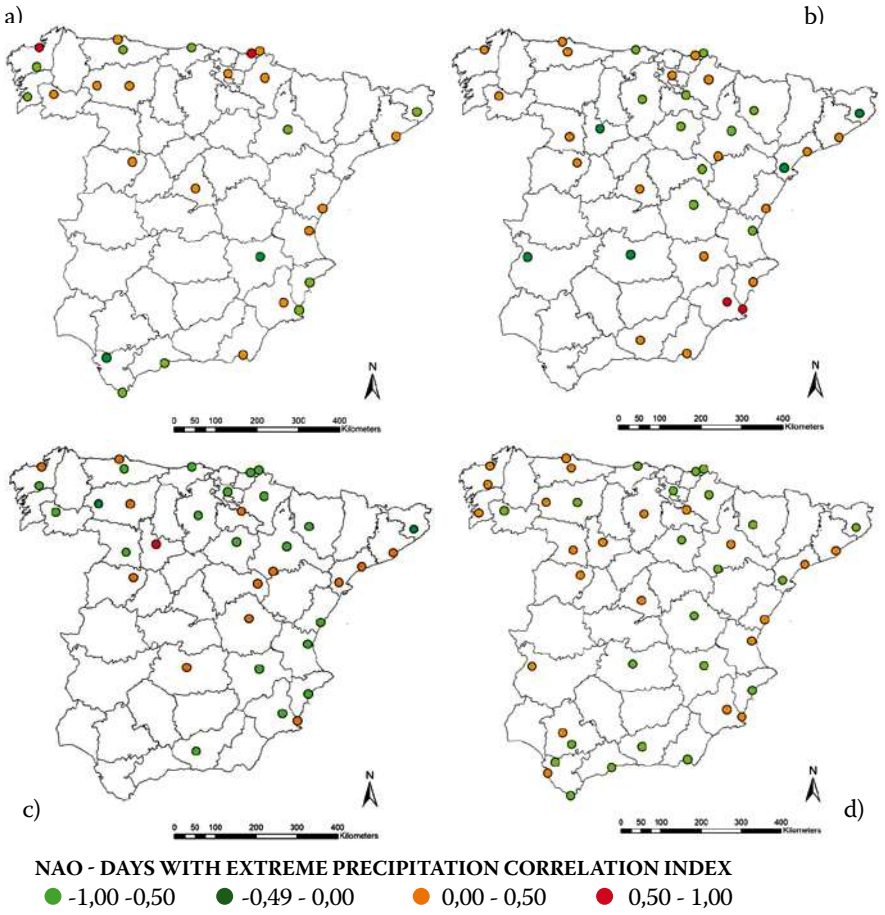

Figure 1. **Spatial distribution of correlation index between the NAO index and the number of days with extreme precipitation in winter (a), spring (b), summer (c) and autumn (d).**

From the maps in the Figure 1 it can be stated that some observatories show negative correlation coefficients, especially in spring (Badajoz, Ciudad Real, Girona, Tortosa and Valladolid weather stations) and summer (Girona and Ponferrada weather stations).

This means there is a correlation between the extreme precipitation and the NAO index in those observatories, although a significant tendency is not observed in the rest ofobservatories. Winter results should be taken cautiously, due to the lack of data in many observatories.

Despite these occasional good correlations, there is not a good correlation between the two variables studied for the whole set of weather stations. The most likely reason is that many of these extreme episodes are generated by convective processes, which produce very intense and localized precipitations, and do not depend on the atmospheric pressure in the Atlantic. Castro et al. (2011), in their study in Spain, considered this as the main reason causing the lack of correlation between NAO monthly index and precipitations in summer and winter.

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