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Comment

## ***Interactive comment on “Assessing drought cycles in SPI time series using a Fourier analysis” by E. Moreira et al.***

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Q1. The authors provide only an analysis for December. This should be clearly stated in the abstract and figure captions, and should be better motivated in the text (perhaps in relation to the precipitation climatology). Then, I am asking what happens when a different month of the year is considered like July when the NAO variability is expected to be less. How the results change?

Reply: The computation of the SPI index (Edwards, 2000) in a given year  $i$  and calendar month  $j$ , for a  $k$  time scale requires: 1. calculation of a cumulative precipitation series  $X_{(i,j)}^k$ , ( $i=1, \dots, n$ ;  $j=1, \dots, 12$ ,  $k=1, 2, \dots, 12, \dots$ ) for that calendar month  $j$ , where each term is the sum of the actual monthly precipitation with the precipitation of the  $k-1$

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past consecutive months; 2. fitting of a gamma distribution function  $F(x)$  to the monthly series; 3. computing the non-exceedance probabilities corresponding to the cumulative precipitation values; 4. transforming those probabilities into the values of a standard normal variable, which actually are the SPI values. It results that the SPI time series is independent of the month considered but depends upon the adopted time scale. When  $k = 12$  months the SPI in December includes the effect of precipitation for the previous 11 months of January to November. If one considers the month of July the SPI series is just a shift in time from December to July; however the effects relative to the past December are included. Selecting December relates to the fact that this month is in the middle of the rainy season, thus denoting any effect of lack of precipitation in the previous months. Differently, selecting July, that is in the middle of the dry season, just denotes the effect of the past rainy season. Anyway, the SPI in December or in July belong to the same series. Thus to decompose the time series with the Fourier analysis provides the same sinusoidal series whatever the month taken to start the SPI series, thus the same periods of the obtained sinusoidal series.

The fact that the Fourier analysis refers to December is now better indicated, namely in the abstract and figure captions. The justification for selecting December is now extended with inclusion of the previous summary, which is included in page 3 and 4, lines 233 to 277.

Q2. In the present context, the use of Clustering technique can be considered equivalent to the Varimax rotation? This point should be discussed.

Reply: The rotation of the factors (principal components) allows finding a matrix of loadings more easily interpretable, i.e., allows identifying the contribution of each variable to the principal components in order to interpret each principal component. In the context of the present study, the number of variables is large (74 precipitation time series). After the varimax rotation of the two principal components, the resulting matrix of loadings did not allow the interpretation of those components by visualization. It was not possible identify which locations contribute more to the principal component 1 or to

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the principal component 2. As result, to identify regions with different SPI variability we had to apply a clusters analysis on the PCA loadings. So, in the context of this study, the two methods are not equivalent, with the clustering analysis applied in the continuation of the PCA and varimax rotation, which helped to complete the analysis and to identify regions having similar behavior of droughts; the PCA was initially applied to reduce the dimensionality of the data and extract the principal sources variability, preparing the way to the analysis of clusters.

This subject is discussed lines 272-302.

Q3. I suggest improving Figs. 2b, 4, 5 and 6: the X ticks labels get confused in the plots, while dots do not allow to see the periodic character of the signals.

Reply: done

Q4. In the conclusions the authors point out the simplicity of their method compared to others. What are the other methods? Note that the sentence at page 2746 lines 20–22 is the same as at page 2747 lines 3–5. The concluding section should be improved.

Reply: When we refer to the simplicity of our approach compared to others, we were thinking of about the other approaches cited in the MS: the wavelet transform analysis (Labat, 2006; Prokphoh 2012; Li et al. 2013) and the spectral analysis using the Fast Fourier Transform (Santos et al., 2010, Telesca at al., 2013). Moreover, differently from both these papers, with our approach the spectral analysis is applied individually to each SPI time series and the frequency of the significant cycles is analyzed to each cluster while in both these papers the spectral analysis is carried out on the principal components of the SPI.

In agreement with the reviewer, the Conclusions Section was revised and hopefully improved, including with a clarification on the aspects related to the methodology and advantages relative to other approaches.

The duplicated sentence was removed.

In the new manuscript all the changes are highlighted in red.

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