

Interactive comment on “Reconciling North Atlantic climate modes: Revised monthly indices for the East Atlantic and the Scandinavian patterns beyond the 20th century” by Laia Comas-Bru and Armand Hernández

Laia Comas-Bru and Armand Hernández

ahernandez@ictja.csic.es

Received and published: 4 December 2018

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Anonymous Referee #1

We thank the reviewer for their positive and useful comments.

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Response to specific Comments:

1. A main comment would be that I find the title, and subsequent content a bit misleading in that it purports to provide monthly indices, whereas the indices in the paper are seasonal.

Thanks for highlighting something that was not clear in the manuscript. The indices that we provide are monthly indices calculated for seasonal windows (please, see the files uploaded in PANGAEA). To make this clear, we have modified Figures 3 and 4 to show the monthly indices instead of their seasonal averages. See our answer to point 2 below for further clarification.

2. A further methodological point is that it is not at all clear what is meant by “composites” throughout the paper, nor is it clear how these are constructed. I guess it is a combined index using different reanalyses, or do you mean combining monthly indices into seasonal indices? Exactly how these are combined should be made clear. I found this a bit confusing, but it should be straightforward to clarify. Combination of time series from different reanalyses will involve splicing of some sort, and this should be explained clearly.

Indeed, the “composites” have been calculated averaging the reanalyses outputs for their overlapping periods. We have rephrased the methodology section 2.3 to clarify this point:

“Composite series of the NAO, EA and SCA patterns have been calculated for each 3-month season independently. Each individual month was given the average of the available EOF-based series with a confidence interval that corresponds to their standard deviation. The number of EOF-based series used for any given month is provided here along with the composite series. Since the EA and the SCA do not always correspond to the 2nd and 3rd EOF, respectively, a selection of what series to include in each composite based on their spatial patterns was done in advance (see Table 3 for a list of monthly EOFs included in each composite).”

We have also included an explanation sentence in the results section 3.2.1 to avoid confusions:

“Instead, since the correlations amongst datasets are very high (DJF: <0.9; MAM: >0.8; JJA: >0.6; SON: >0.9; Table S3), we have created robust composite series of each climate mode on the basis of their geographical representations as described in Table 3. This was done by averaging the overlapping EOF-based time-series that display either the NAO, EA or SCA (WA for MAM).”

Response to minor comments:

Page 1, Line 34: I would add the recent study by Hall and Hanna, 2018, IJOC, here, to broaden the scope of the literature. This paper also finds inconsistencies in EOFs 2 and 3 for summer.

We have included this reference.

Page 2, Line 6: Other nodes are used, such as Lisbon and Gibraltar, and this should be acknowledged and referenced here.

We agree with the referee and have re-written the sentence to include the main references using Lisbon and Gibraltar.

“The NAO is commonly described by an index calculated as the difference in normalized SLP over Iceland and the Azores (Cropper et al., 2015; Rogers, 1984), Lisbon (Hurrell and van Loon, 1997) or Gibraltar (Jones et al., 1997), but there are a number of robust alternatives to this classical definition of the NAO index such as Empirical Orthogonal Function analysis (EOF; Folland et al., 2009).”

Page 2, line 22: I would be more circumspect here. Although intuitively a positive EA should equate to positive SLP anomalies in line with SCA, the CPC index is based on the reverse of this, and a number of studies take this position (Woollings et al., 2010, QJRMS; Moore et al., 2011 QJRMS; Wulff et al., 2017, GRL; Hall and Hanna, 2018, IJOC among many) so it is incorrect to promote this view of the EA as the standard

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one. It doesn't actually matter, the relationships are the same just inverted. It would be better to state: "Here we take the positive phase of the EA to be "

We have re-written this sentence as suggested:

"Here we use the positive phase of the EA as a strong centre of positive SLP anomalies offshore Ireland."

Page 2, line 29, Again it is appropriate to cite Hall and Hanna, 2018, IJOC

Done.

Page 3, lines 15-20. It is also worth noting that EOFs are statistical constructs and are not always associated with climate physics (Dommenget and Latif, 2002, J. Climate). Also some acknowledgement that the constructed EOFs are influenced by the region selected.

We agree with the reviewer's comment and have modified this paragraph accordingly.

". . . while EOF-based indices better capture the inter-annual variability in an area larger than the exact location of the centres of action (Folland et al., 2009), they are constrained by (i) the accuracy of the reanalysis products from which they are derived; (ii) the non-stationarity of the EOF pattern;(iii) the orthogonality imposed by the EOF technique; (iv) the fact that the constructed EOFs are influenced by the region selected; and (iv) having to repeat the analysis every time an update is required, which may change previously obtained time-series (Wang et al., 2014; Cropper et al., 2015). It is also worth noting that the EOFs are statistical constructs and are not always associated with climate physics (Dommenget and Latif, 2002)"

Pages 3-4 Data section. Were timeseries of station and gridded data assessed and corrected for any inhomogeneities which could arise through artificial means such as changing instrumentation, changes in density of records, etc?

Datasets were already tested for inhomogeneities by their corresponding sources:

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Klein Tank et al. 2002 and MetEireann. We have noted this in the manuscript, where the instrumental data is introduced:

“Datasets were tested for inhomogeneities already by their sources (Table 1).”

For transparency, we have added another supplementary table with the details of all the meteorological stations that were considered, as well as a paragraph in the manuscript to explain the selection procedure:

“A set of meteorological stations were selected according to their proximity to the EA and SCA centres of action shown in our EOF analyses: Ireland for the EA and Norway for the SCA. Only one meteorological station with SLP measurements in Ireland could be used in this study: Valentia Observatory. On the other hand, five Norwegian stations with SLP data were located in the region of interest. The most suitable Norwegian station was further selected according to three criteria: i) length of the record, ii) continuity (i.e. the least missing data, the better) and iii) correlation with the EOF-based SCA time-series. Bergen Florida (Norway) was the station which better fulfilled these criteria. Details of all meteorological stations are available in Table S1.”

Page 4, line 14. It is misleading to state that the common definition of a positive EA is positive SLP anomalies, in view of the comment and references above. Change to something like “our definitions”

We have followed the referee’s suggestion.

“The polarities of the derived EOF time-series have been fixed to correspond to our definitions of the EA and the SCA (see section 1), which coincide with positive centres of action over the Atlantic and Scandinavia, respectively (Figs. 1 and S1-S4).”

Page 4, Line 32. How are the years of the moving windows defined, in reference to the window (start, end, centred-which is not possible with a 30 year window)?

Each time window is defined from i to $i+30$, where i is the oldest year of overlap between the time-series. We have added this text in the methodology section 2.4.

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Page 6, Line 31: Are the composites monthly? They look seasonal to me. It is unclear from the text how the composites are produced. This needs to be explained clearly. This section is unclear, with confusing terminology about monthly time series when the figures show seasonal time series.

Following the first two general comments, we revised this section to avoid misunderstandings. Please see our answers to those comments above.

Page 8. Line 6. What is the 10-year filter? Is it a simple moving average, or some sort of Gaussian filter? The caption just says “bandpass” Can you be more specific?

We have included a brief explanation in the methodology section.

“Decadal variability of the time-series (Section 3.2.3) has been explored after filtering the time-series with a 2nd order low-pass Butterworth filter with a cut-off frequency of 1/10 (as implemented in the “butter” function of Matlab[®] R2018a).”

Page 8, lines 9-10 “...until a decrease towards a minimum starts in c. 1920” It is not clear what is meant by this as from the figure the minimum appears to be reached in 1920.

This point is addressed in the next comment, where we show the revised text.

Page 8, lines 11-14: I don’t find these descriptions particularly convincing when looking at the figure

We agree with the reviewer that this text was not convincing, nor it was clear to the reader. The revised text reads as follows:

“Figures 3 and 4 show that most variability in EAcomp and SCAcomp is observed at inter-annual scales but some decadal variability is also evident in Figure 6. Overall, all 10-yr filtered indices fluctuate around the zero-line with no evident trend, except for one period when both series are persistently positive: during winter at the end of the 19th century (Fig. 6a). During this season, both indices show similar trends

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between 1880 and 1920, when a decoupling occurs. In addition, the SCA experiences a large change of sign during the first three decades of the 20th century. Focusing on spring, we observe different patterns for both the EA and the WA with an EA absolute maximum at c. 1915 and two SCA minima at c.1930 and c.1960.”

Page 8 line 15-16. I am highly sceptical about the reality of the first 20 years or so of the summer SCA figure, with its extreme maxima and minima. I think this is likely to be an artefact of data quality, See ESRL web pages https://www.esrl.noaa.gov/psd/data/gridded/20thC_ReanV2c/opportunities.html There is some evidence of this in Figure 6 panel b) as well.

We thank the reviewer for this information. To highlight the need to be cautious on this section of the data, we have highlighted it in all our figures with a grey band and have also modified the text to make this point clear:

“The extreme absolute minima at the start of the summer SCAcomp record (Fig. 4) seems to result from a low-pressure bias in marine records (Woodruff et al., 2005, Wallbrink et al., 2009) that has affected 20CRv2c fields such as the sea-level pressure from 1851 to c. 1865 (further information on this can be found here https://www.esrl.noaa.gov/psd/data/gridded/20thC_ReanV2c/opportunities.html). Since the 20CRv2c is the only reanalyses dataset covering that early period, we cannot provide an alternative. Instead, this period of low-confidence has been highlighted in all our figures with a grey band.”

Responses to technical corrections

Page 1 line31: remove comma after “attention”

Done.

Page 5 line 29: should it be DJF: $p > 0.9$?

Perhaps we do not understand the referee’s suggestion but we believe the text in Page 5 line 29 is correct.

Interactive comment on Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2018-86>, 2018.

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