

**Review of “Solar association with winter synoptic situations in the north Atlantic – European sector” by G. Delaygue et al.**

This is an interesting paper, which is worth publishing. Its main idea is that some types of atmospheric circulation occur with an enhanced / lowered frequency under specific phases of solar activity, quantified by aa index, and quasi-biennial oscillation. An interesting idea is an attempt of the authors to reflect the secular component of solar activity; it is typically neglected in analyses of solar-climate links, which in their majority use characteristics of solar activity that describe 11-yr cycle well (sunspot numbers, F10.7), but not its long-term trends. While the paper does not bring breakthrough ideas and findings, its main virtue is a carefulness of statistical analysis.

Nevertheless, there are some aspects of the analysis and statistical evaluation, which are not described with enough precision and ask for clarification, or are to some extent questionable:

- The aa data are smoothed; smoothing always lowers the number of degrees of freedom. The smoothing procedure should be better described and the effect of smoothing on the reliability of results should be discussed. Were the smoothed data interpolated back to daily resolution, as l. 211 suggests?
- The synoptic types are merged into two groups *a posteriori*, only after their association with solar activity is evaluated: types with enhanced frequency under high solar activity (A, W, NW) and under low solar activity (C, N, E, S) are put together and the association with solar activity is examined for these groups. This may degrade assessments of statistical significance. Although some justification for both groups is provided, I do not find it convincing enough, particularly for the inclusion of the A and C types.

Further general comments:

While aa index is certainly related to solar activity, it is primarily descriptor of geomagnetic activity. Hence the focus of the paper on solar activity, advertised in the title and throughout text, may be found confusing or misleading by a reader.

The analysis of 5-day sequences of synoptic types is an interesting approach; it is inconclusive and does not provide any relevant result, however. Therefore, it may be entirely omitted or at least substantially reduced.

Specific and minor comments:

Introduction: You often talk about ‘correlation’ of solar and climate variables. I am not sure if you really mean only correlation (then, why you dismiss those many studies using other tools than correlations) or an association in general (then term ‘association’ or similar may then be more appropriate).

lI. 54-55: The situation described by Salby and Shea in 1991 (that analyzed records typically covered 3 to 4 solar cycles) was true thirty years ago, not today.

The historical excursion on lI. 84-89 (and partly also in following paragraphs) is a bit redundant and remote to the focus of the paper.

l. 96: The origins of Hess-Brezowsky classification go further back in history, at least to 1952.

l. 109: 2016, not 2014.

L. 125: 'Mode of circulation' may associate with teleconnections (modes of low-frequency variability), which I believe you do not have in mind here.

L. 129: 'all studies' is too strong an expression: I am aware of studies that do not use reanalysis data.

Text in ll. 132-134 lacks precision: Which reanalyses are 'classically used'? It is the models used to produce reanalyses, not the reanalyses themselves, that 'do not account for solar cycle forcing'. Furthermore, this claim is at variance with text in parentheses about 20CR and ERA5 (which do account for solar cycle).

A logical jump is on l. 134 from representation of solar signal to (dis)agreement among reanalyses: a start of a new paragraph should be inserted in front of 'this limitation'.

L. 136: Which 'series' do you have in mind?

L. 150: The basics of the 'simplification scheme' can be explained here.

L. 189: 'regress' may not be enough general a word here

L. 192: subtracted from

L. 199: The claim about association of aa index to EPP should be supported by a reference.

L. 211: How was the interpolation done?

Term 'change' in section titles (3.1, 3.1.1 etc.) and text may be confusing as it associates with a process in time. 'Difference', 'association' etc. may be more appropriate.

Most of text on ll. 236-247 is a description of methods and may be more suitably placed in Sec. 2.

The rationale for bootstrap resampling and ways how it was conducted should be described more clearly.

L. 255: is not clear, 'different' from what (twice on the line)

Claims on ll. 273 to 275 seem to contradict each other ('combining QBO and solar conditions does NOT lead to a change in LWT occurrence' versus 'changes are much stronger by combining W-QBO to high solar conditions').

Why are three or four different climatologies shown in Figures 4 and 5?

The legend obstructs parts of graphs in Figs. 4 and 5, which are relevant – please move it away.

I believe the black distributions (climatology) should be the same in the left and right graphs: why are they not?

L. 283: Please be consistent in using abbreviations.

L. 287: This also seems to contradict the claim on l. 273.

L. 315: Fig. 5d

What is the end of the first period on Fig. 5: 1957 (as shown in the heading) or 1961 (in figure title)?

The green distributions (SSW) in Fig. 5 right are not discussed; only a brief mention without reference to this figure is provided in the discussion.

I believe that 'LWTs' should be written when used in plural (e.g. l. 321).

l. 334 and below: A possible, although not likely, alternative explanation may be that atmosphere responds to phases of the solar cycle rather than to the magnitude of the forcing.

l. 363-365: You should consider here that Labitzke et al. did not work with aa index, which is a likely reason for the difference.

Some clarification is needed of term 'synoptic situation' (l. 369 and below) and how it differs from 'synoptic pattern', 'synoptic type', etc. For me, for example, terms 'situation' and 'pattern' are almost equivalent.

L. 373: 'These sequences are used to explore the association of LWT found in Sec. 3.1' – but individual daily LWTs, not sequences, are explored in Sec. 3.1.

l. 373-4: 'also to which synoptic situations correspond these sequences' – something is wrong here.

L. 376: 'LWTs are not randomly associated': (i) 'composed' may be more appropriate here than 'associated'; (ii) but the randomness of composition of sequences is substantially limited by their overlap.

L. 381: 'strongly' – is the link within the two groups of types really strong? Its strength should be quantified in terms of statistical significance: how (un)likely is such a link?

l. 382-3: Causality is not obvious for the last part of the sentence.

L. 389: As one example of situations related to the C+N+E+S group, sequence ASCCC is given; but A is from the other group.

L. 390: ASCCC (too many C's)

L. 394: Reference to Tabs. 1 and 2 is confusing here as the tables show frequencies of individual LWTs, not sequences, which are discussed here.

L. 413: 'significant' in a statistical sense?

'Shortening of Cyclonic persistence' (l. 427) is a likely explanation, but an alternative is also plausible: there may be fewer C sequences without changing their duration.

L. 449: add 'in its positive phase' after 'NAO pattern'.

Discussion on blockings: you may also refer to Barriopedro et al. (2008, J. Geophys. Res. 113, D14118) who investigate the association of solar activity with blocking anticyclones.

L. 462 and below: you may add to the discussion the paper by Huth et al. (2008, Ann. Geophys. 26, 1999-2004) where the association of Hess-Brezowsky types with solar activity is presented.

L. 476: 'primarily' may be too strong here: There are other effects that modulate the strength of the polar vortex than SSWs. Actually, SSWs temporarily destruct the polar vortex rather than modulate it.

L. 479: 'they should hold with SSW' is unclear.

Please check correct spelling of names with diacritic – both in text and the reference list.

Some references are incomplete: volume number and/or pagination are missing.