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## ***Interactive comment on “Cumulative areawise testing in wavelet analysis and its application to geophysical time series” by J. A. Schulte***

**Anonymous Referee #1**

Received and published: 15 October 2015

This manuscript proposed a statistical methodology for wavelet analysis that further improves the geometric test previously developed by the author (Schulte et al. 2015). The proposed methodology tried to address the binary decision suffered by geometric test. The manuscript therefore might have an important contribution to the documentation of significant tests for wavelet analysis. However, owing to its poor readability, it is far from ready for publication. Some suggested changes have been included in the specific comments. The author should further revise the rest of the manuscript. In particular, the author should pay extra attention on how to better convey his ideas/knowledge to the readers. In its present form, the manuscript cannot be recommended for publication. Yet, the author is strongly encouraged to resubmit the manuscript after substantial modification.

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## General comments:

1) The manuscript is lengthy and poorly constructed. The linkage between sections and subsections is weak. Some materials have been repeated again and again in the manuscript, making it very boring. Simplification to the manuscript is strongly recommended to enhance its readability.

2) The main focus of the manuscript is on the cumulative areawise test. The author should put more effort to highlight it. Including a higher proportion of text for introducing this new test may help. The ratio of the summary of existing significant test to the new test is about 1:1 now. The author is advised to increase the proportion for the new test, at least to a ratio of 1:2.

3) Some materials do not contribute much to the understanding of the test. It gives a feeling that the author tries to insert everything he knows. The author is suggested to make good use of the citation concept. Readers are expected to refer to previous publications for details of some less important information.

4) Sentences are tedious. The author should try to keep the sentences simple but precise.

5) The inclusion of four different climatic oscillation indices as examples does not seem necessary. The author should try demonstrating the techniques using one or two examples. Alternatively, the author may also demonstrate the test using other wavelet techniques, e.g. wavelet coherence (also refer to other comments).

6) The Nonlinear Processes in Geophysics is a journal for the publication of researchers on nonlinear processes in geophysical applications. Therefore, the geophysical applications should not be only an example.

## Specific comments:

1) Page 1228, lines 10-15: The examples used and their results are not the most important message of the paper. The sentences “The new testing procedure was applied. . .

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was found in the 2-7 year period band for the Nino 3.4 index” is suggested to be removed or simplified to one sentence, e.g. “The new testing procedure is demonstrated by applying to various climatic oscillation indices”.

2) Page 1228, line 17: First paragraph of introduction does not seem necessary. It contains too much information about wavelet applications. The main focus of this manuscript should be on the significant test. The author should give one or two sentence brief introduction about wavelet and then connect it to the second paragraph.

3) Page 1229, lines 13-14: The sentence “In geophysical applications, for example, red noise is typically chosen as the null hypothesis.” can be removed, as this piece of information appears in section 2.2.

4) Page 1229, line 19-21: The sentence “Despite the insights gained. . . simply due to multiple testing” can be reformed to “Despite the insights gained from the statical procedure, Marauen and Kurths (2004) showed that it can lead to many spurious results due to multiple testing.”

5) Page 1229, line 23-27: The summary on the areawise test developed by Maraun et al. (2007) can be more precise. The author may refer to the abstract of Manraun et al. (2007).

6) Page 1229, line 24-27: Please remove the sentence “though dramatically reduce the number of spurious results”.

7) Page 1230, lines 3-10: This paragraph can be simplified and merge with the precise paragraph. Emphasizing the difference between the areawise test and geometric test should be good enough, as areawise test has just been introduced. The sentence “Like the areawise test, . . . allows patches at different periods to be compared simultaneously” does not seem necessary.

8) Page 1230, line 17: Could real be a better word than present in “In the present case”?

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9) Page 1230, lines 11-28: This paragraph is supposed to state clearly the objective of the manuscript. However, it is poorly written and the objective is ambiguous. Putting the last few sentences “This test has the important feature that the significance of the wavelet power. . . a consistent statistical construction” at the end of this paragraph does not seem appropriate.

10) Page 1231 lines 2-5: The author may consider deleting “including the sensitivity of the geometric test. . . to the development of the new testing procedure”

11) Page 1231 line 11: Why is wavelet analysis under Section 2? It is not a significant test.

12) Page 1231 lines 12-18: Is there any special reason to include a long paragraph introducing Morlet, Paul and Dog wavelets? It is understood that the cumulative area-wise test is demonstrated using different wavelets in section 4, but their results do not seem to be different. The author is advised to pick one for demonstration purpose.

13) Page 1231 lines 12-18: The author actually may consider removing the introduction of wavelet analysis. The readers should already have some basic knowledge about wavelet analysis before reading a paper related to its significant test.

14) Page 1233 lines 8-9: The sentence “In spectral analysis, . . . against a noise background” can be removed.

15) Page 1234 lines 3-23: This paragraph basically introduces the example and data used. The author should include a section introducing the data used before section 2. Including all these in section 2 makes the manuscript very messy. Please refer to Grinsted et al. (2004).

16) Page 1234 line 24: To simplify the manuscript and give it a better structure, the author should consider introduce all existing significant tests first and then demonstrate them all together using one or two example. Some comparisons can be easily made as well.

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17) Page 1234 line 24: If there is no special reason to include four examples, the author should consider use one or two examples to demonstrate all the significant tests. Actually, using idealized examples may also be a possible way of demonstration.

18) Page 1235: Why is areaswise test by Maraun et al. (2007) left out in section 2? It is a little bit weird, as the author did introduce it in introduction.

19) Page 1237 line 4: What is the purpose of including a sensitivity test for geometric test corresponding to different pointwise significant level? Are these results previously been documented? If not, it shouldn't be put in Section 2, which is supposed to be a summary of existing significant tests.

20) Pages 1231-1238: The author may consider to reconstruct Section 2 by first give a summary on pointwise test, and then introduce areawise test, with emphasis on its improvement to pointwise test. Further, geometric test may be introduced as a simplified version of areawise test. And then conclude the section with special stress on the bainary decision problem suffered by areawise and geometric test and demonstrations of different significant test.

21) Page 1241 lines 17-18: It is confusing to refer cumulative areawise test as areawise test, as readers may mess it up with the areawise test developed by Maraun et al. (2007).

Other comments:

In author's previous paper (Schulte et al. 2015), it was mentioned that the geometric test has an advantage of applying to other wavelet applications, e.g. wavelet coherence (Grinsted et al. 2012), partial wavelet coherence and multiple wavelet coherence (Ng and Chan 2012). Is the new cumulative areawise test also applicable to these wavelet applications? If yes, it would be good to include this piece of information in this manuscript as well. Also, the authors may consider demonstrating the cumulative areawise using wavelet coherence, which should be of great interest to many readers.

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## References:

Grinsted, A., Moore, J. C., and Jevrejeva, S.: Application of the cross wavelet transform and wavelet coherence to geophysical time series, *Nonlin. Processes Geophys.*, 11, 561–566, doi:10.5194/npg-11-561-2004, 2004.

Maraun, D., Kurths, J., and Holschneider, M.: Nonstationary Gaussian Processes in Wavelet Domain: Synthesis, Estimation, and Significance Testing, *Phys. Rev. E*, 75, 016707, doi:10.1103/PhysRevE.75.016707, 2007.

Ng, E. K. W. and Chan, J. C. L.: Geophysical Applications of Partial Wavelet Coherence and Multiple Wavelet Coherence, *J. Atmos. Oceanic Technol.*, 29, 1845–1853, 2012.

Schulte, J. A., Duffy, C., and Najjar, R. G.: Geometric and topological approaches to significance testing in wavelet analysis, *Nonlin. Processes Geophys.*, 22, 139–156, doi:10.5194/npg-22-139-2015, 2015.

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