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Earth System
Dynamics
Discussions

# *Interactive comment on* "Power-law behavior in millennium climate simulations" *by* S. V. Henriksson et al.

**Anonymous Referee #3**

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Henriksson et al. investigate the power-law behavior of atmospheric and sea-surface temperature variability, focusing on interannual to multidecadal time scales. More specifically, the authors evaluate the power-law behavior of multiple GCM simulations, which incorporate "internal variability" and a range of different external forcings. The results from the different simulations are then compared with power-law estimates derived from instrumental data. In principle, this approach provides the opportunity to better constrain the key factors responsible for observed stochastic weather/climate variability and their regional heterogeneity, and it has the potential to be a powerful tool. The spatial ("gridpointwise") evaluation is a particularly interesting application.

However, there are a number of substantial problems in the presentation and documentation that must be addressed before this work can be further evaluated for publication.



This review specifically focuses on issues related to the statistical analyses, central to the interpretation of the presented results.

1. In the power spectrum plots, please include confidence intervals for the power estimates. This information will aid in evaluating the statistical significance of the spectral results. Related to this issue, when averaging over all possible windows for the final power spectrum estimate (as indicated on Pg. 395, line 15), it is important to recognize that one is averaging over many statistically dependent results (see Harris, 1978 for details on "overlap correlation" for specific types of windows). The authors should indicate what corrections (e.g., for confidence intervals) are used to account for the statistical interdependence of the calculated spectra. Also, please show the spectral bandwidth resolution on the power spectrum plots.

2. Please use consistent (and conventional; e.g., cycles/year) units for the frequency axis. The current presentation makes evaluation of the results unduly difficult.

3. Please indicate the methodology used to generate the 95% confidence intervals for the "best fit" beta results.

4. At present it is not possible to evaluate the statistical significance of the "gridpointwise" best fit beta results presented in Figures 8 and 9. Please incorporate a statistical significance evaluation in the figures.

Finally, note that the spectral methodology used in this study was introduced by Welch (1967), and it is known as "Welch's Overlapping Segment Analysis" or "Welch overlapped section averaging" (WOSA). At present, no attribution is made to Welch for the method, and the language sometimes gives the impression that it is new (see reference to Henriksson et al., 2012 on line 11; also see line 17, "we also compare our method to an earlier result").

Additional comments:

Pg. 395 line 4: Here and at other locations in the manuscript, the term "amplitude" is

incorrectly used in the place of “power”.

Pg. 396 line 26 – pg. 397 line 6: As presented, this passage is too vague. Please be more specific about the analyses that have been done, or remove this passage altogether. Also, it is relevant to note that Pelletier (1998, 2002) has presented a theoretical explanation for the power-law shape of the atmospheric temperature spectrum.

Pg. 397 line 22: The “error term” is more commonly referred to as “residuals”.

Pg. 399 lines 6-7: The “gridpointwise” analysis deviates from the frequency range approach used in the global mean temperature assessment. To give a sense of the impact of the new approach, please discuss the results obtained when analyzing mean temperature in the same manner.

Pg. 400 lines 17-18: Here the authors note, “This raises confidence in our method as compared to the multitaper method”. Theoretical studies have conclusively demonstrated the overall advantages of the multitaper method for power spectrum estimation (e.g., see Percival and Walden, 1993). The agreement of the WOSA and multitaper method results for one empirical example does not guarantee good agreement for all other analyses conducted in this study. I encourage the authors to check their other key results using the multitaper method.

Figures 8-9: Please use a consistent color scale for all plots. Also, why not present the results for the unforced simulations as well?

References Cited: Harris, F.J., 1978, Proc. IEEE, v. 66, p. 51-83.; Pelletier, J.D., 1998, EPSL, v. 158, p. 157-164.; Pelletier, J.D., 2002, PNAS, v. 99, p. 2546-2553.; Percival, D.B., and Walden, A.T., 1993, Cambridge University Press, 583 pp.; Welch, P.D., 1967, IEEE Trans. on Audio Electroacoustics, v. AU-15, p. 70–73.

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Interactive comment on Earth Syst. Dynam. Discuss., 3, 391, 2012.