

Interactive comment on “Analyses of relationship between Loess Plateau erosion and sunspots based on wavelet transform” by P. Gao et al.

Anonymous Referee #1

Received and published: 25 February 2011

General comments

Wavelet transforms provide a powerful suite of methods for the analysis of long environmental time-series, and other data, and good case studies are to be welcomed. However, I have some reservations about this paper.

- i. Wavelets are not a panacea and there should be a rationale for the use of wavelets, as opposed to alternative methods. This should be stated up-front. For example, if the assumption of stationary variance is *a priori* implausible, then a wavelet analysis should be structured to identify evidence of such behaviour and to answer our key questions in the light of it. The introduction to the paper should

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establish a much more focussed objective and set of questions that you are addressing. The current paper fails to do this, and does not provide a clear justification for the choice of analyses that follow.

- ii. Given the above, I do not understand why you think that the continuous wavelet transform (CWT) is most appropriate for your purposes. I would draw your attention to what Percival & Walden (2000) write in their book, which you cite: ‘the CWT is essentially an exploratory data analysis tool that can help the human eye to pick out features of interest.’ They go on to point out that inference from the CWT is hampered by its redundancy in both the time and frequency domains, and advocate subsampling the CWT for proper rigorous inference (i.e. using various kinds of discrete wavelet transform).
- iii. You would be able to address questions about your data, and the relationship to the sunspot cycle, much more effectively and robustly with the suite of methods based on the Maximum Overlap Discrete Wavelet Transform (MODWT) and Maximum Overlap Discrete Wavelet Packet Transform (MODWPT) which Percival & Walden (2000) describe. For example, your computation of correlations for different time periods seems to follow visual inspection of the CWT outputs to decide what the time periods are, but this calls into question the validity of the *p*-values that you quote for the correlations, and the validity of the inferences that they support. The chances are that two independent signals with oscillations in a similar frequency range will appear to be correlated in some time intervals, but it would be questionable to infer an underlying mechanism from this. You need an appropriate procedure to detect changes and to test them robustly against a null hypothesis. I would refer you to the work by Whitcher et al. (2000) and Lark et al. (2004) for examples of how the MODWPT can be used for this purpose. Further more, Whitcher et al. (2000) show how phase shifts between signals can be detected in a MODWPT framework.

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Specific comments

- i. The English language of this paper requires more attention than can be expected of a referee or editor. You should seek the help of a native speaker or linguist. Pay attention to the correct use of articles and parts of verbs.
- ii. Something has gone very wrong with Equation (1). You need something like:

$$W_f(a, b) = |a|^{-\frac{1}{2}} \int_{-\infty}^{\infty} f(t) \overline{\psi\left(\frac{t-b}{a}\right)} dt.$$

- iii. The expression 'wavelet variance' (Equation 3) is generally reserved to variances calculated from discrete wavelet transforms, not least because the orthogonality of the wavelets used in the DWT with respect to dilations and translations allows their wavelet variances to be treated as components in an analysis of variance. This is not the case with the continuous transform.
- iv. It is not clear how you are using the term 'scale' from section 5 onward.
- v. Your presentations of wavelet coefficients, and functions of these (Figures 4, 6, 7, 9–11) do not indicate where these are affected by whatever procedure you have used to handle overlap of the wavelet functions with the ends of the signal. At low frequencies this will be much of the plot.

References

Lark, R.M., Milne, A.E., Addiscott, T.M., Goulding, K.W.T., Webster, C.P. & O'Flaherty, S. 2004. Scale- and location-dependent correlation of nitrous oxide emissions with soil properties: an analysis using wavelets *European Journal of Soil Science* **55**, 601–610.

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Percival D. B. & Walden A. T. 2000. *Wavelet Methods for Time Series Analysis*. Cambridge University Press, Cambridge.

Whitcher, B.J., Gutterp, P. & Percival, D.B. 2000. Wavelet analysis of covariance with application to atmospheric time series. *Journal of Geophysical Research – Atmospheres*, **105** (D11), 14941–14962.