Nonlinear Processes
in Geophysics
Discussions

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Interactive comment on "Can irregularities of solar proxies help understand quasi-biennial solar variations?" *by* A. Shapoval et al.

Anonymous Referee #3

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Abstract is too long and could benefit from removal of many details. In reading the abstract, it is unclear if all the discussion is about sunspot number or aa or both. Yes, they say that both are considered in the first sentence, but the reader might be reminded of this important parallel a few sentences later, just to make sure that this is clearly understood. Also, the last sentence of the abstract is confusing. To say that the irregularity index of WN can be linked to the quasi-biennial oscillation (QBO) doesn't seem right. As the sentence is written, it sounds like the authors are saying that QBO might cause irregularity in sunspot number (WN), but I think they mean the opposite, that irregularity WN might cause the QBO.

Introduction (page 159, line 12), I don't know that anybody can accurately predict that Schwabe solar cycle. Indeed, several recent papers have reviewed the many predic-

tion methods (both physics based and phenomenological). In particular, some recent papers describe the cycle-to-cycle change in average sunspot number as indistinguishable from a random walk. The authors should review the literature on this subject, starting with a google of recent publications.

The authors report the identification of a half-Schwabe cycle, maybe with period 5.5 years, in which the sunspot number is most "irregular" at solar cycle minimum and maximum. Their analysis of Lyapanov exponents and imbedded dimension, etc. Is not something I'm familiar with, so let me ask a simple question. Could this "irregularity" in sunspot number be simply measured in terms of a normalized variance in the data? I say "normalized" because it would need to be normalized by average sunspot number in order to tease out effects (as reported in this manuscript) occurring at sunspot maximum and minimum. So, maybe sigma/mu would be the formula (calculated with independent non-overlapping intervals and without smoothing). This would, I think, be more intuitive, and it is certainly easy to calculate. If this shows something similar to a "half-Schwabe" cycle, then the follow-on question for these authors would be: Why use a complicated mathematical method to show something that sigma/mu also shows?

I wonder whether or not the reported half-Schwabe cycle is an artifact of relative uncertainty in sunspot number count when the absolute number is small. This uncertainty might result in large sigma/mu. At the same time, at sunspot maximum, large sigma/mu might result from higher levels of solar activity (giving greater relative variance). I note that some of the formulae in the manuscript involve logarithms. Would this represent an appropriate normalization for sigma/mu as might be described in terms of log-normal statistics?

The manuscript is really mostly focused on sunspot number; the geomagnetic index aa is kind of given short shrift. What is not clear, to me, is whether or not the half-Schwabe cycle is significantly present in the aa data. Looking at Figure 10 I see some anomalies in the (blue) irregularity index for aa, but these are not nearly as pronounced as they are in Figure 1 for sunspot number. Still the authors seem to report (page 175)

some consistency. I don't see it, however, and I would, therefore, like to encourage the authors to exercise a bit of skepticism about the consistency between the sunspot and aa results. If, after such an exercise, they still find consistency, then tell us more about it.

Normally, in a statistical analysis, one consider the "significance" of reported results by comparison against a null hypothesis. How would significance be assessed for an analysis using Lyapanov exponents and imbedded dimensions, etc.? Can the skepticism inherent in such an approach please be considered here?

And, finally, I think this manuscript would benefit from focusing on just one thing, the possible existence of a half-Schwabe cycle. I find the QBO discussion to be overly speculative and distracting from the main point of the manuscript. Are all the figures necessary? Can the presentation be presented in more succinct terms?

Interactive comment on Nonlin. Processes Geophys. Discuss., 1, 155, 2014.

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