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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "Nonlinear analysis of the occurrence of hurricanes in the Gulf of Mexico and the Caribbean Sea" *by* Berenice Rojo-Garibaldi et al.

Anonymous Referee #2

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The paper by Rojo-Garibaldi et al. shows a nonlinear time-series analysis of yearly occurrence hurricane data in the Gulf of Mexico. Yearly data from 1749 to 2012 were used to analyze the deterministic nature of a possible chaotic attractor underlying the time series. To that end, the embedding dimension, time delay, maximum Lyapunov exponents, correlation dimension, etc were calculated using well known techniques.

Concerning the manuscript itself, I am not a native English speaker, but in my opinion the English needs some revision. The Results section is difficult to follow. The amount of information is huge and sometimes it seems that parameters are calculated without rhyme or reason.

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Discussion paper

The paper needs a major revision and cannot be accepted for publication in NPG in its present form. Find below my major concerns and minor comments.

Major items:

Data set description. I found this section quite discouraging as no information on how the time series was built. For example, are you using yearly data? Only landfall hurricane data were used?, If this is not the case, which is the area for hurricane detection? How Fernández et al data were added to HURDAT data base?

So, in the following I will assume that you are using yearly data since 1749 to 2012 (264 data points).

One of my main concerns is that you are using a time series with some trend. You need to show the stationarity of the series. There is a significant body of literature on nonstationary tests that often deals with the division of the time series into several windows where a common statistical property is measured and compared among the different divided parts of the series. You may plot the probability density function for half of the time series and for the full pack, or you may detrend the time series, for example.

The order of figures seems to me quite confusing. For example, the Poincaré map is shown before the embedding dimension is calculated. Taking into account that m is larger than 3, the section obviously does not give any information at all. It is just a cloud of points, but not due to the chaotic nature of the attractor but as it is a 2D projection of an m-1 dimension set.

The obtained embedding dimension m=4 or 5 is said that correspond to a fractal dimension D=2.2 (m=2D). This corresponds a minimum number of data points (Eq.(9)) N>159 which is more than half of the total length of the data set used in this paper. Other authors (Bountis et al. 1993) use a different formula m=2D+1 and N>10**(2+0.4D) which extends the minimum number of data points beyond the actual length of your time series. In resume, your data set is too small for this kind of nonlinear analysis.

Figure(7) should appear before than others, and the slope should saturate for the embedding dimension calculated previously (m=4,5) which is not the case here. Any explanation? What's the difference with Fig.(9)?

In Fig.(9) I cannot understand how the linear fitting is done. Why the lines drawn in panel (a) do not match the slopes marked with points. The saturated values on top of the figures should not be takin into account.

The largest Lyapunov exponent as a function of the embedding dimension m and the time delay tau may show the deterministic nature of the time series. When the dimensionality of the embedding space is reduced, the exponent is expected to increase for a deterministic system because the attractor occupies a larger portion of the available space, which does not happen for a random signal. You may compare your results with a random time series (just move randomly the data points within the time series). I think this is important as your Lyapunov exponents are quite small.

One of the interesting applications of these nonlinear techniques is their use to forecast the hurricane occurrence. This will allow to (1) know if the attractor reconstruction is correct, and (2) compare this method to classical linear time series analysis as ARMA estimators, for example. The first point should be mandatory.

Minor points:

Line 1 page 2. "...have usually been performed with linear-type analyses..." needs a reference.

HURDAT reanalysis project needs a reference.

References to nonlinear analysis along the paper are very old. Please, look for new ones and show other example where these kinds of techniques were applied.

Some of the explanations given along the text, or even formulae in the results section are naïve and should not appear or just referenced. Otherwise, you could move some of them to an Appendix for example.

Along the text time delay is written sometimes as r and in other occasions as tau.

Fig.2 is a mess and does not give any information as it is drawn.

Conclusions section is not admissible. You need to resume and explain why your method is better than others and what is new here. You need to strengthen the deterministic nature of your time series if compared to a random signal. If the time series is deterministic, what is the underlying physics behind this fact?

References:

Bountis, T., L. Karakatsanis, G. Papaioannou, and G. Pavlos, 1993: Determinism and noise in surface temperature time series. Ann. Geophys., 11, 947–959

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