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Ocean Science
Discussions

Interactive comment on "Temporal energy partitions of Florida extreme sea level events as a function of Atlantic multidecadal oscillation" *by* J. Park et al.

J. Park et al.

jpark@sfwmd.gov

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On behalf of the authors, I would like to thank the reviewer for their enlightening review of the manuscript and suggestions provided. In particular, their questions on the nature of the assumed non-stationarity have revealed a semantic error in the use of the term stationarity, which has been corrected and improves the accuracy of the presentation. J Park.

1) "owing to the transient nature of such events a Fourier decomposition will (or may?) poorly represent the event power as a function of frequency. . ."

"the wavelet transform typically does not (or may not?) provide the degree of spectral

resolution afforded by Fourier analysis. . ."

Thank you for the correction, such tradeoffs are variable, the suggested phrasing is more accurate and has been changed in the manuscript.

2) "The nonstationarity of the underlying temporal process is implicitly assumed. . . Is such nonstationarity proven to be inherent in the ocean context? Or is quasi-stationary?"

The reviewer raises an excellent point here, and returns to it in comment 4). Please refer to the text following comment 4) below for a unified response.

3) "MODWT may be generalized to allow any arbitrary dyadic partition of the frequency interval using wavelet packets [Selesnick I W 2002 The design of approximate Hilbert transform pairs of wavelet bases IEEE Trans. Signal Process. 50 1144–52]. Relevant transform is known as the MODHWPT"

Thank you for bringing this work to our attention. The reviewer clearly has a broader and deeper knowledge of wavelets than any of the authors. Having briefly reviewed the Selesnick paper, it suggests methodology for 'spectral factorization' which facilitates a wavelet packet transform (with nearly linear phase filter properties). An advantage of the method is the simple algorithm for transformation of an arbitrary wavelet into an approximate Hilbert transform pair which can then be used for the packet transforms.

Although the transformation is simple enough, we do not have the expertise to modify our current wavelet toolbox (wavelets package of the R statistical computing program), or a full enough understanding of the proposed method to intelligently implement it. Nonetheless, the suggestion of a wavelet packet transform to better characterize the temporal behavior of the surge events is a good one. We will investigate the availability of this tool for a packet analysis as follow-on work. However, we do believe that the results presented in this paper with the conventional MODWT are valid and support the conclusions.

4) “Classical univariate and bivariate statistics in the spectral domain (e.g., power spectrum, coherence, phase) can be calculated from the analytic wavelet coefficientsâĂŤthus producing a scale-by-scale time-varying spectral analysis. .... The assumption of block stationarity, or a smoothly varying spectrum, is common when estimating time-varying spectral characteristics in either the frequency or wavelet domain.”

The reviewer raises an excellent point challenging the assertion of non-stationarity. After all, we did compute sample means of event energy and active intervals, and used those to suggest event dependence on AMO at Key West. Indeed we have implicitly assumed some form of stationarity for these ensemble averages to have meaning.

Concerning the data analyzed, extreme tidal surges, we ensured that each event was forced by a distinct meteorological event, however, whether-or-not the underlying energy and temporal characteristics of the events can be considered stationary was not explicitly addressed. When dealing with timeseries data, one can resort to autoregressive models to estimate the unit root (KPSS test, Dickey–Fuller test) against a null hypothesis of stationarity. However, we are dealing with discrete events (point process instead of AR) which render such tests problematic.

Fortunately, existing literature cited in the manuscript provides analysis which indicates weak stationarity of surge events. As discussed in the introduction, the paper by Woodward & Blackman (2004) finds that regional event statistics are dependent with respect to trends in regional climate indices, and that generally, events are weakly stationary with respect to global mean sea level rise. Additionally, Zhang et al. (2000) found that changes in event energy and durations at North America east coast stations are weakly stationary over the Twentieth century.

As the author who penned the term ‘non-stationary’ (Park), I inappropriately used ‘non-stationary’ in a temporal-sense to convey the transient nature of the events. The accepted definition of stationarity as statistical moment invariance across ensembles was not followed, rather, I should have used ‘transient’ or such. This was a semantic error

on my part. I am relieved that the reviewer has pointed it out. To remedy this, the use of ‘non-stationary’ has been replaced with transient. We have also noted our assumption of weak stationarity in the event energies and intervals as supported by the work of Woodward & Blackman (2004) and Zhang et al. (2000).

Woodworth, P.L., and D.L. Blackman: Evidence for systematic changes in extreme high waters since the mid-1970s. J. Clim., 17, 1190–1197, 2004.

Zhang, K., Douglas, B. C., Leatherman, S. P.: Twentieth-Century Storm Activity along the U.S. East Coast, J. Climate, 13: 1748-61, 2000.

5) “The sampling rate for the test time series (in Reviewer’s opinion) may ensure that there is a fine grid of sub-second observations. Relevant block stationarity imposed thereof on scales can be calculated by the authors and hence, any implicit limitations imposed by the sampling rate of the data (that can be detected) have to be elucidated.”

The sampling rate was 1 observation per hour. The event duration (length of time the variance of the non-tide residual exceeded the 99.5 percentile for consecutive samples) median was approximately 25 hours, with a range from 6 to 106 hours. Since the mother wavelet is LA(8) and the minimum temporal scale is 4 hours, there should be adequate sampling of the process variance at all scales. From the Nyquist perspective (even though we do not estimate Fourier components) the highest analytic temporal scale (inverse frequency) would be 2 hours. Again, there should be sufficient detail in the hourly sample interval to resolve variances to scales approaching 4 hours. Nonetheless, a higher sampling rate would clearly benefit both energy and temporal estimates.

Interactive comment on Ocean Sci. Discuss., 7, 501, 2010.