Reply to "Interactive comment on "Technical Note: Multiple wavelet coherence for untangling scale-specific and localized multivariate relationships in geosciences" by W. Hu and B. C. Si " by Referee #2

General Comments

The multiple wavelet coherence methodology presented in the manuscript by Hu and Si represents an important contribution to wavelet analysis. In particular, Hu and Si build upon the previous work of Ng and Chan (2012) to extend multiple wavelet coherence to case of more than two predictor variables. The authors further demonstrate that the new multiple wavelet coherence methodology is better suited for situations where the predictor variables are cross-correlated. The problems with the traditional formulation are clearly stated and consistent with the objective of the paper proposed in the introduction section. Theoretical examples were also presented to highlight the advantages of the new methodology relative to existing ones. I their recommend that the manuscript be accepted after the substantial correction of grammatical errors and the consideration of more specific comments presented below.

Response:

Thank you for the positive comments.

Specific comments

The conclusion section simply summarizes the results of the paper. The authors could consider expanding the conclusion section into a discussion section to comment on limitations of the method. After all, wavelet analysis, while useful, is not a scientific panacea. More specifically, the inclusion of more predictor variables may result in the statistical significance threshold at a particular wavelet scale and time to approach unity, which would impose a limit on how much statistical information can be gained. This phenomenon occurs with the traditional multiple wavelet coherence formulation, where the threshold for 5% significance, for example, is higher than that for bivariate wavelet coherence at a given wavelet scale.

Response:

We agree with you that one of the limitation is that the critical values increase with the number of predictor variables. This is also why the percentage area of significant coherence (PASC) for three predictor variables (z2, z4, and noised z4) are even lower than for only two predictor variables (z2 and z4) when the third predictor variable (noised z4) is not statistically significant to explain the variation of the response variable.

We put this limitation in the conclusion part as " Theoretically, any number of predictor variables can be included in the multiple wavelet analysis. However, the statistical significance threshold usually increases with the number of the predictor variables (Grinsted et al., 2004; Ng and Chan, 2012a), and inclusion of too many predictor variables may result in the statistical significance threshold at particular wavelet scales (e.g., the lowest and largest scales) to approach unity. This would restrict the availability of statistical information."

The author may also consider discussing at least briefly the problem of simultaneously testing multiple statistical hypothesis, as discussed in Maraun and Kurths (2004), Maraun et al. (2007), Schulte et al. (2015), and Schulte (2016). Multiple-testing problem is a major problem in wavelet analysis and therefore merits consideration in a discussion section. Presenting clearly the methodological limitations will better guide the likely interdisciplinary readership in making decisions regarding what analysis tools to implement.

Response:

The multiple-testing problem will be briefly discussed in the conclusion part. "In addition, similar to bivariate wavelet analysis, the new method also suffers from the multiple-testing problem (Maraun and Kurths, 2004; Maraun et al., 2007; Schulte et al., 2015; Schulte, 2016). Therefore, a more robust statistical significance testing method may be beneficial to the new method."

Throughout the manuscript, the authors mention how geoscience data are often nonstationary. Perhaps the term is used too loosely in some instances and is sometimes inconsistent with the strict time series analysis definition. Even white and red-noise processes contain time and scale-localized features in wavelet space, even though theirrespectivestatisticsarestationaryatallorders. Time-andscale-localizedfeatures are evident in the wavelet power spectrum of say, the North Atlantic Oscillation (NAO), even though the statistics of the NAO are consistent with a first-order Markov process (Feldstein,2000). Therefore,insomeinstances,Irecommendchangingtheword“nonstationary” to “transient” or “transitory”.

Response:

We agree. In the introduction, we will make this more clear as " More often than not, geoscience data are transient, consisting of a variety of frequency regimes that may be localized in space or time (Torrence and Compo, 1998; Si and Zeleke, 2005; Graf et al., 2014). The transient characteristics exists widely in non-stationary but also sometimes in stationary processes (Feldstein, 2000)."

At many instances, we will change the "non-stationary" to "transient" when suitable.

Some Technical Corrections

Page 2 Line 3536. Change “geoscience data is” to “geoscience data are”.

Response:

Yes, will change.

Page 2 Line 39. Is it better to say bivariate wavelet coherency rather than “simple wavelet coherency”

Response:

Yes, we will change all throughout the paper.

Page 5, Line 97. Add comma before “respectively”.

Response:

Yes, we will change throughout the paper.

Page9,Line169-171. The sentence can be slightly simplified by changing“ white noise with a mean of 0” to “zero-mean white noise”. Perhaps it is redundant to write that the white noise processes were generated. Authors could consider just saying that white noise was added to the predictor variables.

Response:

We agree. It will be changed to" zero-mean white noises with a mean of 0 and standard deviations of 0.3, 1, and 4 are added to the predictor variables of y2 (or z2) and y4 (or z4).".

Page 9, Lines 171-173. The sentence “The resulting noised series are termed weakly, moderately, 172 and highly noised series respectively, and have a correlation coefficient of 0.9, 0.5, 173 and 0.1 respectively, with their original predictor variable” needs to be rewritten and simplified. Consider breaking the sentence into two separate sentences.

Response:

We will separate it to two sentences. Now, it will look like "The resulting noised series have correlation coefficients of 0.9, 0.5, and 0.1, respectively, with their original predictor variable. Therefore, we will refer them to weakly, moderately, and highly noised series, respectively."

The authors should carefully check for grammatical errors and make similar changes throughout the manuscript.

Response:

Yes, we will do. English check will be made if a chance for revision will be given.

References

Feldstein SB (2000) The timescale, power spectra, and climate noise properties of teleconnection patterns. J Clim 13:4430–4440. doi:10.1175/15200442(2000)0132.0.CO;2 Maraun, D. and Kurths, J.: Cross wavelet analysis: significance testingand pitfalls, Nonlin. Processes Geophys., 11, 505–514, 2004. Maraun, D., Kurths, J., and Holschneider, M.: Nonstationary Gaussian processes in wavelet domain: synthesis,estimation, and significance testing, Phys. Rev. E, 75,doi:10.1103/PhysRevE.75.016707, 2007. Ng, E. K. W. and Chan, J. C. L.: Geophysical applications of partial wavelet coherence and multiple wavelet coherence, J. Atmos. Ocean. Tech., 29, 1845–1853, doi: 10.1175/JTECH-D-12-00056.1, 2012. Schulte, J. A., Duffy, C., and Najjar, R. G.: Geometric and topological approaches to significance testing in wavelet analysis, Nonlin.Processes Geophys., 22, 139–156, doi:10.5194/npg-22-139-2015, 2015. Schulte, J. A.: Cumulative areawise testing in wavelet analysis and its application to geophysical time series, Nonlin. Processes Geophys., 23, 45-57, doi:10.5194/npg-2345-2016, 2016.

Response:

Appreciate for the good references. We will cite them when we make relevant discussion.