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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cospectral analysis of high frequency signal loss in eddy covariance measurements" *by* A. Wolf and E. A. Laca

Anonymous Referee #1

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This paper presents some interesting and potentially useful results. The authors are attempting to use simple forms of the high frequency spectral transfer functions to correct cospectra. I appreciate that the authors are trying to do in this paper, but I have some concerns that I think should be addressed before publication. My specific (major and minor) comments are listed below.

Major Comments

There are several aspects to my major concern.

1 The functional form of the transfer function $H_x(f)$ is not correct. Equation (5) states (after a simple mathematical inversion) that $H_x^{-1}(f) = 1 + 2\pi f \tau_{wx}$. But for a true first-order instrument $H_x^{-1}(f) = 1 + (2\pi f \tau_{wx})^2$. The incorrect form may be useful for correcting fluxes, but not necessarily for correcting cospectra.

2 Nevertheless, there is a related concern. Most of the transfer functions related to spectral attenuation (e.g., line averaging, instrument separation, etc.) are not necessarily first order. So that even $H_x^{-1}(f) = 1 + (2\pi f \tau_{wx})^2$ is itself an approximation. In general the true high frequency transfer functions tend to decay faster than a first-order $H_x(f)$.

3 For scalar fluxes the practical consequence of either of these approximations is (at a minimum) that the high frequency end of the cospectra is likely to be undercorrected, so that the (frequency-weighted) inertial subrange will decay faster than the expected -4/3 law. These approximations to the true $H_x(f)$ can also cause the cospectral shape in the midrange frequencies (i.e., near the frequency weighted spectral maximum) to be somewhat distorted as well.

4 Finally, there is a generic problem with employing the transfer function approach to correcting cospectra. Namely that as the frequency f increases $H_x(f)$ approaches 0. So that at some point (instrument-dependent frequency) there is the real danger that correcting the cospectra [dividing the cospectra by $H_x(f)$ or equivalently multiplying by $H_x^{-1}(f)$] will only amplify any potential high frequency cospectral noise.

Minor Comments

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5 Page 13152, line 26 — The authors discuss 'The combined model' without specifically defining what model they are referring to.

6 Page 13154, lines 1-2 — The term 'cospectral gap' refers to a (hypothetical) frequency gap, it does not refer generically to any cospectral 'asymptotic behavior at low frequency'.

7 Page 13154, lines 23-24 — The authors state that 'Theory suggests that all ...'. What theory are the authors referring to?

8 Page 13155, lines 15-16 — The authors state that the they 'present a procedure to correct measurements that are potentially biased'. But there are other ways of accomplishing this type of correction. The authors should answer the following questions: How is their approach different from previous approaches for flux corrections? How does their approach advance the current state of spectral corrections?

9 Section 2.2, Pages 13156-57 — **(A)** The authors indicate that they remove spikes for the raw 10 Hz time series. What method do they use to replace the removed 'spiky' points so as to ensure a uniformly spaced time series for computing the cospectra?
(B) Maximizing the covariance between the scalar sensor and the vertical wind does not necessarily remove all signal asynchrony. It only removes that portion of the asynchrony that can be resolved by a given sampling frequency. In the authors' case this means that there still could be an asynchrony of ± 0.05 s (= $\pm 0.5/f_{samp}$). Do the authors include a transfer function for this potential cause of cospectral attenuation? Is this issue even important for their study, or is the

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sampling frequency high enough to ensure that it is of little consequence?
(C) Equations (2), (3), and (4) are in error. The time constants on the right hand side of these equations (i.e., τ_{IRGA}, etc) should all be squared (τ^2_{IRGA}, etc). But note my (major) comments 1-4 above concerning the appropriateness of this method for correcting cospectra.

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