

## ***Interactive comment on “Eddy Covariance flux errors due to random and systematic timing errors during data acquisition” by Gerardo Fratini et al.***

### **Anonymous Referee #2**

Received and published: 19 May 2018

#### General comments:

The manuscript titled, “Eddy Covariance flux errors due to random and systematic timing errors during data acquisition”, by Fratini and co-authors describes an important, typically overlooked, source of error in eddy covariance resulting from timing issues and synchronization of EC instruments. The authors present a very clear and well-reasoned approach to quantify the potential magnitude of flux errors resulting from both random and systematic timing issues. Overall, the submission is sound and advances the state of EC methodology. However, a few suggestions to improve the manuscript are described below.

#### Specific comments:

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1. The opening of introductory section was too abbreviated. Recommend additional description/background of the EC method including additional references. The definition of synchronicity could be improved. For example, an EC system with a fixed, known lag would be considered asynchronous by this definition but not one that leads to flux error in the context of this manuscript.
2. The manuscript has no explicit discussion of data triggering for digital data acquisition. This reviewer interpreted that all descriptions of digital data communications referred to streaming data. A brief discussion of triggering for data acquisition should be included in the Introduction, particularly as it relates to synchronizing data streams and timing errors.
3. The manuscript (section 1.2) describes open digital communication protocols including serial and Ethernet (packet-based) but do not address SDM (Synchronous Device for Measurements) communications. SDM is a very commonly used data communication protocol for collecting EC measurements and eliminates many of the timing errors described in the manuscript through clock synchronization. The authors should include a discussion of this protocol and which timing errors are applicable.
4. Considerable differences in flux errors (1 vs. 11%) were found between two sites given the same STE ( $180 \mu\text{s/s}$ ). The explanation given was differences in the flux contribution in the frequency domain (cospectrum, see Figure 7) which is reasonable given the differences in observation height. In Fig 7, the cutoff frequency (transfer function) appears to differ between these two sites. However, in the text and as shown in Figure 6, the authors state that the transfer functions across sites were similar. Could this discrepancy be clarified?
5. One the main points made in the manuscript is that timing errors cannot be corrected or detected a posteriori. Given that the authors frame timing errors in the context of a low pass filter, it seems reasonable (assuming of spectral similarity between  $w'T'$  and  $w'c'$ ) that timing errors would be accounted for and corrected by spectral correction

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methods that consider cospectra shape. Of course, such an approach could not differentiate between the source of signal loss (timing error, inlet tube attenuation, sensor separation, etc). The proposed approach assumes no timing error in the  $w'T$  which is reasonable if calculated from a single SAT.

6. The manuscript would be strengthened if the findings were placed in the context of other sources of EC errors and uncertainties, particularly for fluxes of gas species. For example, one could apply the timing-error transfer function to the gas cospectra in concert with transfer functions of other spectral losses to illustrate relative contributions.

Technical corrections:

Page 1, Line 30: Consider using specifications in place of specs

Page 2, Line 17: Use consistent spelling of analyzer throughout manuscript

Page 2, Line 27: Replace others with other

Page 4, Line 39: Missing reference to (Hewlett Packard 1997)

Page 5, Line 21: Acronyms (TCP) should be spelled out prior to use.

Page 7, Line 2: Incorrect symbol to denote range

Page 8, Line 9: 30 minute (not minutes) file

Page 8, Line 10: Incorrect symbol to denote range

Page 8, Line 24: Aand should be and.

Page 9, Lines 19-20: use consistent spelling for serial protocol used; previously authors used RS-232.

Page 9, Line 23: Acronyms (OS) should be spelled out prior to use.

Page 10, Line 4: Native or naive?

Page 10, Line 12: Change to "thank".

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Page 16: Clarify the figure and/or caption to denote that panel (a) illustrates transfer functions from a single site (IT-CA3).

Page 20, Line 32: Authors cite the discussion version of Langford et al., 2015. Consider the final version (doi:10.5194/amt-8-4197-2015)?

Page 21, Line 15: This reference (Smith 2002) was not cited in manuscript

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Interactive comment on Biogeosciences Discuss., <https://doi.org/10.5194/bg-2018-177>, 2018.

**BGD**

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