

Nonlin. Processes Geophys. Discuss., referee comment RC1
<https://doi.org/10.5194/npg-2021-27-RC1>, 2021
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Comment on npg-2021-27

Anonymous Referee #1

Referee comment on "Characteristics of intrinsic non-stationarity and its effect on eddy-covariance measurements of CO₂ fluxes" by Lei Liu et al., Nonlin. Processes Geophys. Discuss., <https://doi.org/10.5194/npg-2021-27-RC1>, 2021

General comments

The authors present how to identify and study intrinsic non-stationarities of turbulent fluxes. As the authors note, this topic has not received as much attention in the literature as the identification of nonstationarities in the non-turbulent flows or external drivers. In particular, the identification of averaging timescales for which intrinsic nonstationarities make the estimation of turbulent fluxes erroneous is an interesting contribution. I can recommend publishing the article after minor revisions. Generally, I think the authors can spend more time on physical interpretations (indicated below in the specific comments).

Specific comments

One major concern about the analysis: Lines 62-75: As far as I can tell, the definition of the segments of length "s" implies that not the same data is used for calculating F(s) for each "s" as "N" is not a multiple for all "s". How does this affect the results, in particular, for larger s (for instance, $s > N/2$)?

Another concern is that, although being a reasonable approximation to the observations, the simple OU process could be fit better through some extensions (as mentioned in lines 144-145). Why are they not tested in this study? At the very least the physical reasons for the difference between the observations and the OU should be discussed? These physical insights should inform the extensions the OU requires in order to fit the data better.

Lines below indicate where paper could benefit from clarifications, further explanations, or physical interpretations

Line 7: "... we find that the average time should be..." - Do you mean the average time for eddy covariance measurements?

Lines 11-18: The first paragraph and the first two lines of the second paragraph are not related to the rest of the paper. The paper deals with quantifying the intrinsic non-stationarity of carbon fluxes. Such quantification is not related to climate change nor does a better understanding of it allow for reductions in anthropogenic greenhouse gas emissions. In particular, lines 17-18 are unclear how a better understanding of the CO₂ transport is helpful in reducing the CO₂ reductions. I guess the authors refer to air quality

and not reduction in CO2 emissions.

Lines 93-94: "The time series seriously contaminated by high-frequency white noise are also removed?" Why? How does white noise affect the analysis?

Line 103: Why do you choose these Reynolds averaging timescales? In particular, 6 seconds is not a standard value to decompose the turbulent fluxes from the mean flow.

Line 110: "The crossover scale in the case with 6 seconds is smaller than that in cases with 900 and 300 seconds." - what does this tell us? What is the physical interpretation?

Lines 114-115: "Results indicate that the IN is a small-scale phenomenon which is intimately related to the inertial sub-range turbulence" - Isn't that expected?

Lines 133-134: "..., although the fluctuation exponent of data seems to be greater at large scales and less at small scales, compared to the OU process." What does this tell us? What are the physical reasons for that behaviour?

Technical corrections:

Line 4: "widespread" sounds as if a spatial analysis has been done which is not the case. I suggest using "common".

Correct the citation style. At most places the references should be (Author, year), e.g. line 15

Lines 63: "m is a positive integer" - I guess $2 \leq m \leq N$? This goes back to general comment about the accuracy of estimating $F(s)$ as s gets large

Line 84: "The data were..." suggestion: "Carbon dioxide turbulent fluxes were ..."

Lines 91-93: Hard to understand the 2 sentence: "The quality control methods, proposed by Vickers and Mahrt and including spikes..." Do you mean: "The quality control methods proposed by Vickers and Mahrt (1997) are applied to remove problematic data with spikes, dropouts, ..."?

Figure 3: coordinate the colors between the different subplots such that 6 sec, 300 sec, or 900 sec have the same color in each subplots

Line 115: "The choice of very small Reynolds ..." - word missing (averaging timescales?)