Reply to Referee:

The authors would like to thank the Referee for the comments and suggestions. Below we present our detailed reply and discussion.

General comments:

1. “This issue is most likely the reason why the "psd" results are biased. The correct formulas to use are in two of your references (Frehlich et al. and Sharman et al.) including a maximum likelihood (ML) EDR estimation method from the latter reference.”

“T*he glaring issue is that when you calculate the energy dissipation rate (EDR) from the simulated data, you are not using the correct model spectrum. When sampling and using a finite window's worth of data, the average power spectrum will be the expected periodogram, not the theoretical spectrum (in this case the "-5/3rds" one). This is most likely the reason your "psd" results are biased. Therefore, it is anticipated correction will show that your method - in its current form - is inferior to existing method*”

In the revised version that we sent on the 6th of June we addressed the previous comment of the Referee (sent on the 9th May): “Furthermore, they do not address practical issues inherent in digital signal processing: spectral bias due
to finite temporal windows, aliasing due to temporal sampling, as well as sensor bias and noise.”
Hence, we aimed to present the sensitivity of the results on the different types of error, without using any corrections. In the suggested reference, instead of the theoretical von K\'arm\'an model, “the periodogram of the computed windowed von K\'arm\'an autocorrelation function” is ued. This function already accounts for the bias errors, hence, one cannot expect the “uncorrected” number of crossing to perform better than the bias-corrected spectral methods. Moreover, as written by Sharman et al. “In the case of commercial aircraft the details of the filtering are often not known, and the empirical parameter γ in Eq. (16) is used to account for these effects.” Hence, using the peridogram for a {\it a priori} known filter does not provide a universal solution to the problem.

We argue, analogous bias corrections as presented in Sharman et al. could be proposed for the number of crossing methods. However, the aim of our manuscript was to introduce the number of crossing aproaches for signals with spectral cut-offs. We also addressed, as the Reviewer requested in the first review, different types of errors which may influence the results. We agree that the issue of bias-correction can be important, however, it is beyond the scope of the present paper.

In the second revision we addressed the method presented in Sharman et al. and clearly pointed out that it accounts for the effects of the filtering window.

2. “*The correction will be very important in that the results of your simulations now show bias in the standard psd approach, which will expectedly be corrected. It is noted that this standard approach has already much less scatter than the new suggested method. (See for example, Fig 8.)*”

In fact, as seen in Fig. 8 of the manuscript, the method based on the number of crossings has a larger scatter than the psd method, at least for the chosen range of filter cut-offs. We

investigated this problem in order to address the Referee objections. It follows from our study that the scatter in ϵ_{NCF} depends on the value of filter cut-offs In the fitting range. In the revised version we compare results for short signals (from 2^8 points) and short fitting range $f=[16 18]$ using the number of crossings and power spectrum methods. We found the standard deviation of ϵ_{NCF} comparable with the psd method.
The detected number of crossings is larger for higher cut-offs. Hence, especially for the case of short signals, the statistics are reproduced better if larger $f_{cut}’s$ are considered.

3. “*Therefore, it is anticipated correction will show that your method - in its current form - is inferior to existing methods*. ”

We find such statement unfair. The EDR retrieval methods based on the power spectral density were investigated in numerous works, including the suggested reference of Sharman et al. We proposed, for the first time, alternative approaches for signals with moderate resolutions, based on the number of crossings and it was the main subject of the manuscript. Moreover, we showed that the new method responds differently than psd method to errors introduced by the filter, which in principle is an advantage – two methods used in parallel give better understanding of possible imperfections of EDR retrievals. In the revised version we also address the issue of a larger scatter, which, for short signals and short fitting ranges depends on the f_{cut} values in the fitting range. The number of crossings statistics are calculated with a higher accuracy for higher f_{cut} values.
In our opinion such results can increase the number of possible future investigations and better retrievals of EDR.

Detailed changes:

page 1, line 23: We wrote “frequencies” as we referred to the measured time-series. In the new version we write:

“Using the Taylor's hypothesis, the measured time series can be converted into a spatial signal and the sampling frequency will correspond to scales which are typically $2-3$ orders of magnitude larger than the Kolmogorov scales.”

page 3, line 1: we wrote that k_1 is measured in rad/m.
line 30: instead of “stationary signal” we write “homogeneous velocity signal, converted to time series $u(t)$ with the use of Taylor's hypothesis.”

page 4, line 3: In Section 2 we addressed previous EDR retrieval methods. We only referred to proposal of Fairall et al., 1980; where filter effects were not accounted for. We wrote “Assuming that the filter is perfect, i.e. it is a rectangle in the frequency space, after the filtering...” As for the method proposed in the manuscript, we discuss the issue of frequency response characteristics in Section 4.1.

page 5, line 12: We defined k_c k c as the characteristic wavenumber along the longitudinal direction

page 10, line 5-10: We address the Referee's objection about the Gaussianity of the signal. In fact, according to the work of Rice (1945) the Gaussianity of the signal itself is a necessary, but not a sufficient condition. However, as follows from the study of

Sreenivasan et al. (1983), the Rice formula was satisfied with a good accuracy even for strongly non-Gaussian pdf's of a signal and its derivative.

Page 10, line 12: We address the Referee comment “but how does it potentially effect your results? Your cutoff frequencies go above 10 Hz, so how can the results for those cases be acceptable?”

For the signals from POST we use cut-off frequencies up to 5 Hz. We wrote:
“However, as the highest cut-off frequencies used in the present study are 5 Hz, it should not affect our results.”

Page 11, lines 10-15: We reformulated the beginning of chapter 4.2, we write that the signal-to-noise ratio becomes significant at higher frequencies.

We reformulated Section 4.2.

Page 20, line 3 and 7. As we changed the method of calculating integrals in Eq. (35), using non-uniform grids, results for ϵ_{NCR} changed (were improved).

We reformulated conclusions. We note that when writing about advantages of the original number of crossing method we referred to the work of Poggi and Katul (2010) where this method was used for EDR estimation inside canopies.