General comments

The paper "Turbulent transport extraction in time and frequency and the estimation of eddy fluxes at high resolution" by Gabriel Destouet et al. (egusphere-2024-3243) proposes a framework for the estimation of eddy fluxes based on cross-scalogram smoothing, which can obtain high-resolution fluxes in time and frequency. This framework has been applied to a beech forest site and is demonstrated the agreement with the standard eddy covariance method.

Overall, the paper presents a novel method for turbulent flux estimation and the context is well-organized with detailed mathematical and physical foundations, which fits the scope of AMT. However, the motivation and the interpretation of the outcomes do not come out clearly. Please see my major concerns below.

1. My main concern is the advantages of the HR-TM method compared to the standard eddy covariance method, as it increases computational cost and complexity. This paper points out two limitations of the standard eddy-covariance method, that is, limited temporal resolution and limited frequency resolution. The former leads to fluxes unable to characterize fast dynamics, while the latter may introduce non-turbulent contributions and cause potential biases. To overcome these, the study proposes the HR-TM method for the purpose of estimating fluxes with a high time and frequency resolution.
   For the first limitation, you have increased the temporal resolution of fluxes to 10 min (e.g., Figures 2, 4, and 5). However, 10 min is not a high temporal resolution, and the standard eddy covariance method can also do it. You mentioned in Abstract that the HR-TM method can produce high temporal resolution (1 min) fluxes, but why not show it in Results? Besides, there are clear wave (or oscillation) signals in the time series of 10-min fluxes (Figures 2D, 4, and 5). Is this physical or mathematically generated? I speculate that this oscillation is a mathematical bias introduced by your method. Therefore, the improvement in temporal resolution remains to be clarified.

For the second limitation, the HR-TM method can decompose fluxes into multiple frequency bands and remove the contribution of non-turbulence using the turbulence mask (e.g., Figure 2C) to improve the accuracy of turbulent fluxes. However, the fluxes estimated using the HR-TM method generally agree with that obtained by the standard, especially the comparison in Figures 4 and A2. Therefore, the advantage of the HR-TM method in identifying turbulent transport may be only demonstrated under specific conditions, such as evaluating the flux of passive scalars (e.g., CO_2) and evaluating the vertical transport role of nighttime weak turbulence (Figure A2bC-D). Perhaps you can focus on these conditions to demonstrate the practicality of the HR-TM method.

In my understanding, the main advantage of the HR-TM method is that it can obtain high-resolution fluxes in time and frequency, which can be used to identify turbulent coherent structures (such as microfronts and thermal plumes) and to characterize the role of different coherent structures in the vertical turbulent transport. However, it was not highlighted in the application cases of the HR-TM method.

2. My second concern is the average time and temporal resolution. There are 30 min, 10 min, and 1 min mentioned in the paper, but they are not clearly stated. This would make readers confused. Please see my specific comments 4 &5. It is suggested to indicate the corresponding temporal resolution in each step of Figure 1, instead of the general time variable t which is interpreted as $t = kT_c$. Additionally, is it a great improvement that the average time of turbulence mask is different from that of flux estimation? If not, it is suggested to choose the same average time or to state them more clearly.

Specific comments

1. L3, "fluxes unable to characterise fast dynamics (< 30min) …" I think the expression is not appropriate. Although the average time of 30 min is commonly used to calculate turbulent fluxes by the eddy covariance method, it is not the only one. For weak turbulence, a smaller average time can be adopted, such as 10 min

and 5 min. This practice can also reduce the amount of data discarded because of failing quality tests. If your method can obtain fluxes with a temporal resolution of ~ 1 minute, it possibly can characterize fast dynamics. So, it may be better to change "<30min" to "~1 min", if possible.

2. L257, "… so that most of the sensible heat F_H is preserved" –Why? or what percentage does "most" correspond to in your quantification?
3. L284, "…, and time averaged to form fluxes resolved in time and frequency" – What is the temporal resolution of flux chosen in this study? 10 min?
4. L292-293, There are great doubts about the selection of the average time. Why can't the average parameters of turbulence mask and flux estimation be the same? If I understand correctly, the fluxes, F_u, F_v, and F_w, are first calculated with a temporal resolution of 30 min (Step B) to obtain the turbulence mask (Step C), then they have to be calculated again with a temporal resolution of 10 min if we want to gain an estimation of kinematic fluxes (Step D)? or σ = 10 min only is intended to estimate scalar fluxes? Even so, if a grid (t^*, η^*) is classified as non-turbulent, there will be three grids of flux $F_c(t,\eta)$ being discarded, i.e., ($t^* - T_c$, η^*), (t^*, η^*), and ($t^* + T_c$, η^*). Why not use σ = 10 min directly for the turbulence mask? And you said "…, after step C in Fig. 1, fluxes in time and frequency coordinates have a temporal resolution of 20 Hz" in L318, but the variable t in $F(t,\eta)$ is interpreted as $t = kT_c$ where T_c is the averaging time (L102). Please clarify the choice of average time.
5. Figure 2, again about the selection of the average time. Is it right that the temporal resolution of Figures 2A and 2B is 30 min while the temporal resolution of Figures 2C and 2D is 10 minutes? This specially-designed different average time makes readers confused.
6. L357, there is no dotted line in Figure 2B. It might be also helpful to plot the dotted line in Figure 2A.
7. L374-375, "If the turbulence mask does not cover any frequency bands at a given time, i.e. no turbulence is detected at that time, the calculated flux is undefined". If there is no turbulence mask, can we consider the turbulent flux to be zero?

8. L379-380, " The evolution of τ_w against η presents similar characteristics as the spectrum of the vertical velocity and as the cospectrum of $u \cdot w$". In my understanding, the characteristics of the *w* spectrum and *uw* cospectrum are different (e.g., the slope in the inertial subrange), so how does the evolution of τ_w show similar characteristics as the two?
9. Figure 3, what is the physical meaning of red crosses in Figure 3? It is not mentioned in the main text.
10. Figure 4, which method do you adopt to calculate u*? standard eddy covariance method or cross-scalogram smoothing method?

Technical corrections

1. L101, "*N* is the number of averaging periods ", but there is no variable *N* in Eq. 2.
2. L230, "Reynold’s frozen" – Is that might to be Taylor’s frozen?
3. L260, "…, that means in removes noise"? – There may be typing errors, please check.