0.1 Response to Reviewer 3 Comments

Dear reviewer:

We appreciate the time and effort that you have dedicated to providing your insightful comments on our paper. We have been able to incorporate changes to reflect most of the suggestions provided by you. We have highlighted the changes within the manuscript.

Specific comments:

1 **Line 5 and Line 139: If this paper could provide more cases or results on several days with various rain intensities (containing light rain, moderate rain, and heavy rain) would make the conclusion more convincing.**
Thank you for pointing this out. We agree with this comment and we would like to investigate more on several days with various rain intensities in this proof-of-concept study. Unfortunately, we don't have heavy-rain data. However, this is the first study to sample the Doppler spectrum very fast up to 3 kHz and normalize each spectrum by its peak value to suppress Doppler signals generated by raindrops. Before this study, we have already conducted another field measurement with one continuous-wave lidar for quite a short period [Jin et al., 2022]. In this study, we compared three-hour data and the results are promising. We added some outlooks in the Conclusion part "The tendency is that the more it rains, the stronger the bias and the more the rain-suppressing normalization is reducing the bias. For moderate rain intensity (we do not have a heavy rain period in our data), the range of the bias is reduced from the interval 0.1 to 0.4 ms^{-1} to 0.0 to 0.1 ms^{-1}. The suggested method in this study could also be investigated for rain events (containing heavy rain) on several days and also for pulsed Doppler lidars even though their measurement volume is quite larger than that of the continuous-wave lidars. Further investigations could also attempt to retrieve the falling velocity and the size distribution of raindrops using the fast Doppler spectra.".

2 **Line 100: How do the 0.35 ms of the raindrops' beam transit time calculate? Please clarify.**
Thank you for pointing this out. In **L102**, we wrote: "The shortest beam transit time can be determined based on large raindrops' maximum downfall speed of 9 ms^{-1} from the disdrometer measurement in Fig. 6b, the beam width (twice of the beam waist w_0), and the elevation angle of a lidar. For lidar #1 with a beam width of 1.12 mm and an elevation angle of 57.9°, the shortest beam transit time is 0.234 ms $= 1.12/(9 \cdot \cos(57.9°))$, while it is 0.362 ms $= 3.14/(9 \cdot \cos(15.3°))$ for lidar #3 with a beam width of 3.14 mm and an elevation angle of 15.3°. Most often, however, raindrops' transit time is longer than the aforementioned shortest time if their paths are away from the lidar focus and if they fall slower. In this study, it is reasonable to set the spectral sampling frequency to 3 kHz so that the sampling period for a spectrum (0.333 ms) is shorter than the beam transit of

raindrops [see Jin et al., 2022, Fig. 5b]. Therefore, the rare instances where a raindrop resides in the beam could be identified and suppressed based on the lidar measurements.".

3 **Line 158: "... where the line-of-sight speed is away from zero." Please clarify and explain the reason for this processing.**
Thank you for this comment. We agree with this comment and explained it in **L195**. The explanation is "However, this procedure will not work if the wind velocity is around zero, since the wind Doppler signal would be present on both sides of the zero frequency bin. Then a real, atmospheric Doppler signal would be included in the background spectrum rather than the real background noise. Therefore, in the case of lidar #1 where the line-of-sight velocity fluctuates around zero (the vertical line at frequency bin 257 corresponding to the zero-Doppler shift in Fig. 8), a background spectrum is calculated for a period where the line-of-sight speed is away from zero.".

4 **Line 169: This paper mentioned the rain spectrum with a high value of PSD and a narrow peak. However, considering the strong attenuation of laser energy caused by the raindrops, sometimes the PSD of rain spectra gets weak and has the nearly same magnitude as the aerosol spectrum. How to distinguish the wind and rain in these cases?**
You have raised a good point. That is the limitation of our method because we could not distinguish the two signals with similar magnitude. Therefore, there is still a bias between lidar data and sonic data after applying this rain-suppressing method. But the bias is reduced. The research objective of this study is to reduce the adverse impact of raindrops when measuring wind velocities by normalizing the fast Doppler spectra with their peak values.

5 **Is this method proposed in this paper also suitable for pulsed Doppler lidar?**
Thank you for this comment. It could be investigated with pulsed Doppler lidar even though this would be difficult. We added several sentences in the Conclusion part as "The suggested method in this study could also be investigated for rain events (containing heavy rain) on several days and also for pulsed Doppler lidars even though their measurement volume is quite larger than that of the continuous-wave lidars. Further investigations could also attempt to retrieve the falling velocity and the size distribution of raindrops using the fast Doppler spectra.".

6 **This paper evaluates the performance of this method under several rain intensities. How about the influence of horizontal velocity on the results? Because a big raindrop will break up more small raindrops with high wind speed.**
Thank you for this comment. You have raised a good point. We would like to evaluate the influence of horizontal velocity on the retrieved wind velocities. However, in our study, we investigated a method to reduce the influence of raindrops in wind velocity measurements by CW lidars and how this proposed rain-suppressing normalization method performs in

reducing the bias compared to sonic data. Further experiments may be able to shed light on this issue.

Bibliography

L. Jin, N. Angelou, J. Mann, and G. C. Larsen. Improved wind speed estimation and rain quantification with continuous-wave wind lidar. In *Journal of Physics: Conference Series*, volume 2265, page 022093. IOP Publishing, 2022.