AMT-2023-249- Response Letter

Dear Editor and reviewers,

We would like to thank the reviewers and editor for their comments that have allowed us to further clarify some aspects of the manuscript in this revised version. Hereafter, we report reviewers' comments and our replies (*in italics*). For yours and reviewers' convenience we have put the corresponding major changes introduced in red color in the revised version of the manuscript.

Reviewer 2:

The manuscript presents a method to directly determine two atmospheric turbulence parameters – turbulent kinetic energy (TKE) and power component – using measurements from a coherent Doppler wind lidar. Due to my expertise remit, I am unable to justify the novelty of the proposed approach; however, as an experienced academic writer in urban climate, I do find there is room for improvement in this manuscript before potential publication.

Specifically, could the authors please address the following concerns/questions:

1. **Clarify the term "atmospheric turbulence parameters" early on. There are numerous ATPs; for clarity in this work's context, use "power component" in the title and elaborate on this in the introduction.**

Response: *As the reviewer suggests, we have modified the title and the introduction section. The new title is "Directly Measuring the Power-law Exponent and Kinetic Energy of Atmospheric Turbulence Using Coherent Doppler Wind Lidar".*

2. **Figure 1 is not a topographic map - provide more convincing evidence to represent local terrain features.**

Response: *As the reviewer suggests, we have updated the Figure 1.*

The following content can be seen in the revised version:

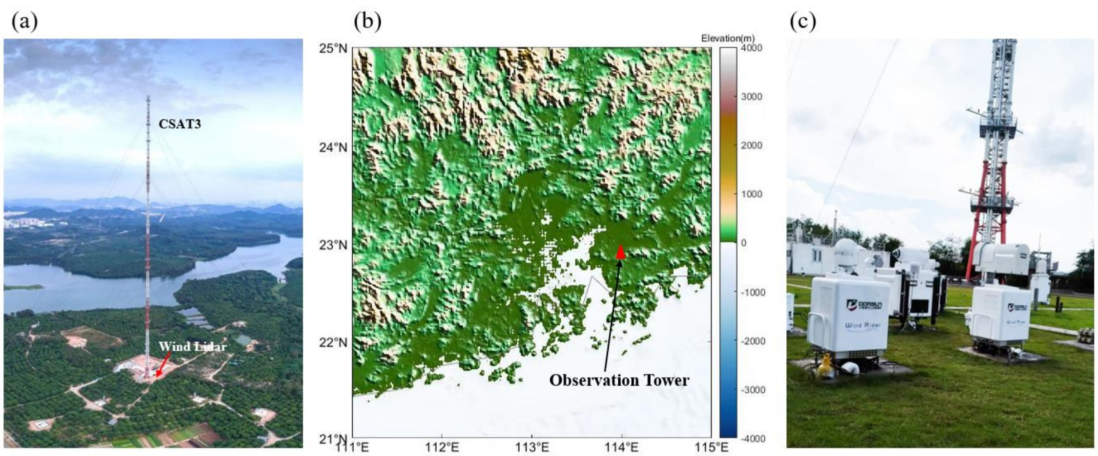

Figure 1. Layout diagram (a), topographic map (b) of the surrounding area of the meteorological gradient observation tower, and installation diagram of the wind lidar below the tower (c).

3. **Table 1: Verify the units of sample frequency and temporal resolution of wind profile data.**

Response: *As the reviewer suggests, we have updated the Table 1.*

4. Section 3.1 lacks essential details about how these parameters were derived from measurements:

- The turbulence power spectrum S

- Turbulent kinetic energy κ

Response: *Thanks for the reviewer's comment. We have modified the texts and added the Equation (7) in revised version.*

The following content can be seen in the revised version:

The slope can be obtained by performing linear fitting on x and log(Sz(f)), which yields the power-law exponent n. The turbulent kinetic energy, κ, in a certain frequency range [f0, f1] can be obtained by

$$\kappa = \sum_{f_0}^{f_1} S_z(f)$$

When κ and n are known, the dissipation rate can be obtained from Equation (2). Therefore, this paper mainly discusses turbulent kinetic energy, κ, and the power-law exponent, n.

5. In section 3.2, when comparing power spectra, justify why measurement heights for wind lidar differ from those used with anemometers.

Response: *Thanks for the reviewer's comment. Due to the spatial resolution of wind lidar data being 30 meters, heights close to 320 meters are either 300 meters or 330 meters. Therefore, we compared the wind speed data of the wind lidar at a height of 330 meters with the ultrasonic anemometer data at a height of 320 meters. As the reviewer suggests, we have modified the texts in revised version.*

6. For figure 2, employ a scatter plot to enhance clarity.

Response: *As the reviewer suggests, we have added a scatter plot in the Figure 2 in the revised version. Figures 2 (d) - (f) provide the correlation coefficients (R) corresponding to Figures 2 (a) - (c), respectively. It can be seen that the correlation coefficients are greater than 0.9 in all three directions.*

The following content can be seen in the revised version:

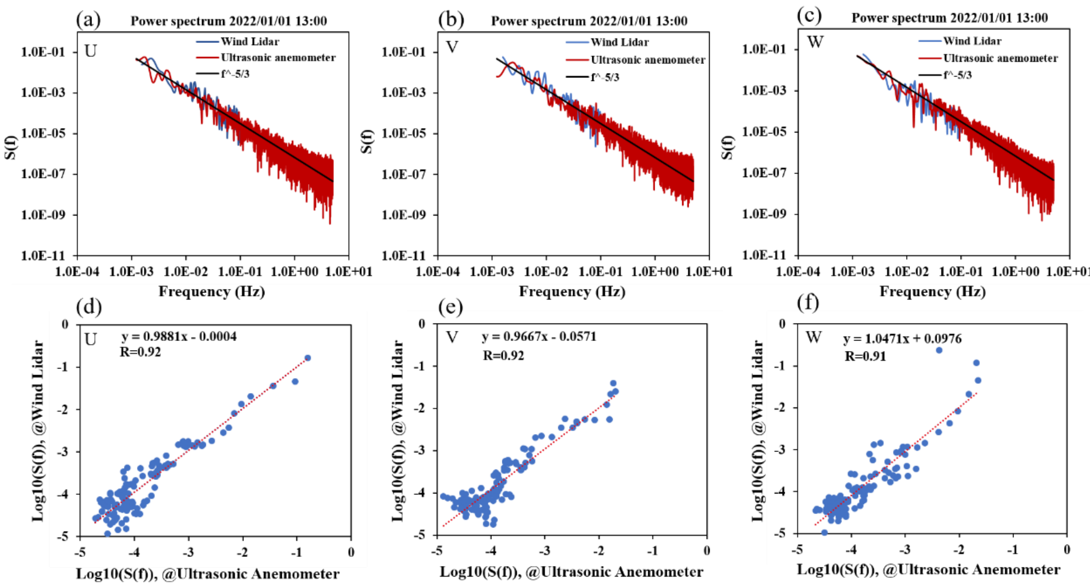

Figure 2. Comparison of the turbulence spectra obtained with the wind lidar and the ultrasonic anemometer in three directions: (a) *U*, (b) *V*, and (c) *W*, and the corresponding correlations (d), (e), and (f).

7. Line 191: "2022 January 1" - Choose an appropriate date format in English.

Response: *As the reviewer suggests, we have modified the texts in revised version. Other similar formats have also been updated.*

8. Line 210: Clarify what is meant by "due to a lack of light."

Response: *Thanks for the reviewer's comment. At night, due to the weakening of solar radiation, the kinetic energy in the vertical direction is suppressed and the power-law exponent increases. As the reviewer suggests, we have modified the texts in revised version.*

9. Figures 3 and 7:

- Specify the temporal resolution of results displayed.

- For panels d, e, and f, narrow down the y-axis range to highlight result variations more effectively.

Response: *As the reviewer suggests, we have added an explanation of time resolution and updated the Figures 3, 5, 7 and 9 in the revised version.*

10. Figures 4, 6, and 8: State which instrument was used for taking measurements in each caption clearly.

Response: *As the reviewer suggests, we have updated the captions of Figures 4, 6 and 8 in the revised version.*

11. Figure 11:

- **Include both: a) number of data points b) linear regression analysis between two methodologies**

- **Omit "kinetic energy" from axis labels.**

- **Standardise plotting ranges on both x and y axes for consistency.**

Response: *As the reviewer suggests, we have updated Figure 11 and added sample size (N) and linear regression analysis in the revised version.*

The following content can be seen in the revised version:

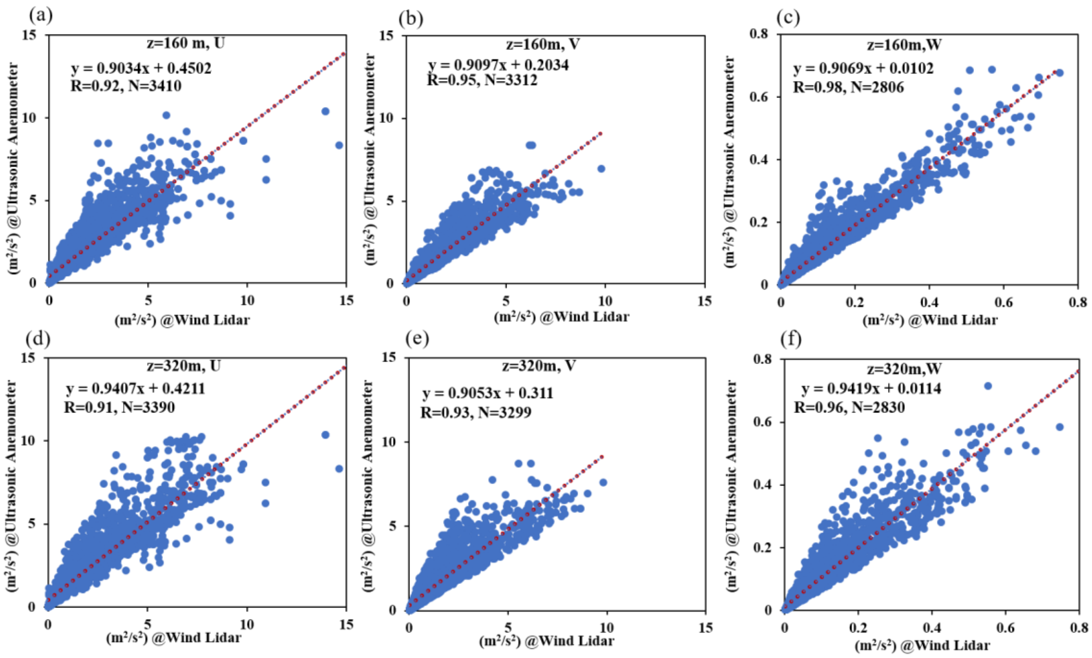

Figure 11. Correlation between the turbulent kinetic energy obtained with the wind lidar and three-dimensional ultrasonic anemometer in the *U*, *V*, and *W* directions at the heights of 160 m (a)–(c) and 320 m (d-(f).

12. In your conclusion section discuss any limitations in the developed approach.

Response: *Thanks for the reviewer's comment. As the reviewer suggests, we have added a discussion on the limitations of the proposed method in the conclusion. The proposed method has some limitations. First, the method based on a spectral analysis that requires the atmospheric turbulence fluctuations to be stable. Next, wind lidar cannot operate during heavy rainfall or snowy weather conditions, so it cannot be guaranteed to be applicable at all times. In addition, due to the maximum observation frequency of 0.2 Hz for wind lidar, the observed scale range of vortex motion is limited. However, the results of this study also indicate that in the inertial subrange, turbulence spectra outside the frequency of 0.2 Hz can be obtained through fitting and extrapolation. We have added the relevant content mentioned above to the text.*

We thank the Editor again for his helpful suggestions.

On behalf of all authors,
Sincerely,
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