Responses to the reviewer #1' comments

Reviewer #1: The manuscript aims to advance our understanding of the planetary boundary layer (PBL) turbulence and evolution over the Tibetan Plateau (TP) by utilizing high-resolution radar wind profiler (RWP) data. The study demonstrates the spatiotemporal variations and underlying mechanisms of turbulence dissipation rates in the PBL. The authors also provide detailed analyses of how land cover, radiation, and vertical wind shear influence PBL turbulence. Overall, this manuscript is well organized with significant scientific advancement. I recommend the publication of this paper in Atmospheric Chemistry and Physics subject to minor revisions.

Response: We are glad to receive your positive and encouraging comments, which are invaluable in improving the quality of our manuscript. For clarity purpose, here we have listed the reviewer's comments in black plain font, followed by our response in blue italics.

Minor comments:

1. In the methodology section, the authors may include a discussion of the potential uncertainties and limitations of turbulence dissipation rate or boundary layer height from the RWP. It will help readers have a better understanding of the strengths and limitations of RWP measurements.

Response: Good point. Per your suggestion, the potential uncertainties and limitations of turbulence dissipation rate (ε) and boundary layer height from the RWP have been discussed in this revision.

(1) The uncertainties and limitations of turbulence dissipation rate (ε) from the RWP is discussed in section 2.3.1, which is shown as follows.

"One caveat of the above-mentioned methods used to estimate ε lies in its sensitivity to the uncertainty in measuring horizontal wind speed, and the occurrence of negative value of σ_t^2 (resulting in negative ε and invalid retrieval), which is previously documented (e.g., Chen et al., 2021; McCaffrey et al., 2017). Also noteworthy is that ε estimates derived from the RWP lacks validation against in situ ε measurements from

sonic anemometer in the aircraft or tower. This is another factor causing uncertainties that needs to be addressed in the future."

(2) The uncertainties and limitations of PBL height from the RWP is discussed in section 2.3.2, which is shown as follows.

"It is not optimal to retrieve z_i directly from the RWP measurements during nighttime, when the weaker turbulence and greater SNR tend to result in an overestimation of z_i (Duncan et al., 2022). Therefore, the z_i estimation using the ITM algorithm is merely applicable in the daytime convective PBL (Bianco et al., 2008; Collaud Coen et al., 2014). Besides, the presence of clouds is proved to bring about uncertainty in z_i retrievals from the ITM, due to the challenge in identifying the peak from the NSNR profile (Angel et al., 2024). "

References:

Chen, Z., Tian, Y., Wang, Y., Bi, Y., Wu, X., Huo, J., Pan, L., Wang, Y., and Lü, D.: Turbulence parameters measured by the Beijing mesosphere–stratosphere–troposphere radar in the troposphere and lower stratosphere with three models: comparison and analyses, Atmos. Meas. Tech., 15, 4785–4800, https://doi.org/10.5194/amt-15-4785-2022, 2022.

Collaud Coen, M., Praz, C., Haefele, A., Ruffieux, D., Kaufmann, P., and Calpini, B.: Determination and climatology of the planetary boundary layer height above the Swiss plateau by in situ and remote sensing measurements as well as by the COSMO-2 model, Atmos. Chem. Phys., 14, 13205–13221, https://doi.org/10.5194/acp-14-13205-2014, 2014.

Duncan Jr., J. B., Bianco, L., Adler, B., Bell, T., Djalalova, I. V., Riihimaki, L., Sedlar, J., Smith, E. N., Turner, D. D., Wagner, T. J., and Wilczak, J. M.: Evaluating convective planetary boundary layer height estimations resolved by both active and passive remote sensing instruments during the CHEESEHEAD19 field campaign, Atmos. Meas. Tech., 15, 2479–2502, https://doi.org/10.5194/amt-15-2479-2022, 2022.

McCaffrey, K., Bianco, L., and Wilczak, J. M.: Improved observations of turbulence dissipation rates from wind profiling radars, Atmos. Meas. Tech., 10, 2595-2611, *https://doi.org/10.5194/amt-10-2595-2017, 2017.*

Angel A C, Manoj M G. A novel method of estimating atmospheric boundary layer height using a 205 MHz VHF radar. Sci. Total. Environ., https://doi.org/10.1016/j.scitotenv.2023.168109, 907: 168109, 2024.

2. The introduction mentions that "Also, cloud radiative effects are found to be another significant factor to modulate the evolution of daytime PBL turbulence (Bodenschatz et., 2010)." However, the references provided for this issue are insufficient. I suggest the authors include more and acknowledge the previous work on this issue, such as the impacts of cloud radiative forcing on the morning transition from a stable to an unstable boundary layer.

Response: Per your kind suggestion, more previous work on this topic have been cited in this revision, which is shown as follows.

"Except for the above-mentioned thermal and dynamic effects, cloud radiative effect is found to be another significant factor that can dramatically modulate the evolution of daytime PBL turbulence (Bodenschatz et., 2010; Davis et al., 2020). For instance, cloud radiative forcing accounts for the rapid morning transition from stable to unstable PBL, thereby notably affecting the diurnal variation of the PBL (Su et al., 2023). Notably, longwave radiative cooling at the top of stratocumulus clouds can enhance turbulent diffusion within the stratocumulus topped PBL (Sun et al., 2016). A recent observational study suggests that cloud radiative cooling contributed about 32% to turbulent mixing even near the surface (Huang et al., 2020). In other words, cloud radiative processes, including entrainment and radiative cooling, can affect the TKE in the atmosphere (Nicholls et al., 1986; Sedlar et al., 2022; Chechin et al., 2023)."

References:

Chechin, D. G., Lüpkes, C., Hartmann, J., Ehrlich, A., and Wendisch, M.: Turbulent structure of the Arctic boundary layer in early summer driven by stability, wind shear and cloud-top radiative cooling: ACLOUD airborne observations, Atmos. Chem. Phys., 23, 4685-4707, https://doi.org/10.5194/acp-23-4685-2023, 2023.

Davis E V, Rajeev K, and Mishra M K: Effect of clouds on the diurnal evolution of the *atmospheric boundary-layer height over a tropical coastal station. Bound.-Layer Meteor., 175: 135-152, https://doi.org/10.1007/s10546-019-00497-6, 2020.*

Huang, T., Yim, S. H. L., Yang, Y., Lee, O. S. M., Lam, D. H. Y., Cheng, J. C. H., and Guo, J.: Observation of turbulent mixing characteristics in the typical daytime cloud-topped boundary layer over Hong Kong in 2019, Remote Sens., 12, 1533, https://doi.org/10.3390/RS12091533, 2020.

Nicholls, S.: The dynamics of stratocumulus: Aircraft observations and comparisons with a mixed layer model, Q. J. Roy. Meteor. Soc., 110, 783–820, https://doi.org/10.1002/qj.49711046603, 1984.

Su, T. N., Li, Z. Q., and Zheng, Y. T.: Cloud-Surface Coupling Alters the Morning Transition From Stable to Unstable Boundary Layer, Geophys. Res. Lett., 50, 9, https://doi.org/10.1029/2022gl102256, 2023.

Sun, W., Li, L., and Wang, B.: Reducing the biases in shortwave cloud radiative forcing in tropical and subtropical regions from the perspective of boundary layer processes, Sci. China Earth Sci., 59, 1427–1439, https://doi.org/10.1007/s11430-016-5290-z, 2016.

3. The authors use PBL turbulence as the key concept. I suggest the authors mention that the scope of PBL turbulence beyond the current discussions, such as heat fluxes, vertical velocity, entrainment, etc.

Response: Good point! Per your suggestion, we have expanded on the scope of PBL turbulence in section 4, which is shown as follows:

"On top of this, the role of roughness length, vertical velocity, and entrainment remains unknown in the variation and evolution of atmospheric turbulence, which warrants further in-depth studies based on intensive field campaigns, in combination with theoretical analysis and numerical simulation experiments in the future."

Line 33: "large spatial discrepancy" -> "a large spatial discrepancy"

Response: Corrected as suggested.

Line 36: "the difference of" -> "the difference in"

Response: Corrected as suggested.

Line 62: "have great impact" -> "have great impacts"

Response: Corrected as suggested.

Line 69: "the RWP exhibit" -> "the RWP exhibits"

Response: Corrected as suggested.

Line 485: "The slope values of e against VWS is" -> "The slope values of e against VWS are""

Response: Corrected as suggested.