We appreciate all the great efforts and constructive comments from the reviewers. We have revised the manuscript carefully according to the reviewers' comments and suggestions. Our point-by-point responses and changes are appended below in blue fonts.

Anonymous Referee #2

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The manuscript presents the results of lidar observations of wave like variations of wind velocity vector vertical and horizontal components in the boundary layer of atmosphere obtained during the field experiment in August-September 2018 in the location of Anqing, China. The experimental results are accompanied by the results of model numerical simulation of the wind field disturbed by the topographical objects. Based on the obtained experimental and computational results the conclusions about mechanism of generation of wave variations of wind velocity are formulated in the manuscript.

Major comments:

1) The general goal of the study is not clear from the manuscript. It may be proposed that this goal is study of atmospheric waves arising under conditions of stable thermal stratification in the boundary layer of atmosphere. But only one event of atmospheric wave on 4-5 September is analyzed in the manuscript with the use of information about the profile of temperature in height. Moreover, even for that event there is no data on temperature profile measured with the radiozonde at 19:15 on 4th September in the manuscript. To improve understanding of this issue, it may be useful to present the temperature profiles in height during all the period of field experiment and carry out the analysis of frequency of wave events not only with taking into account the magnitudes of wind velocity and wind shear, as it is presented in Fig. 6, but also with consideration of the temperature stratification.

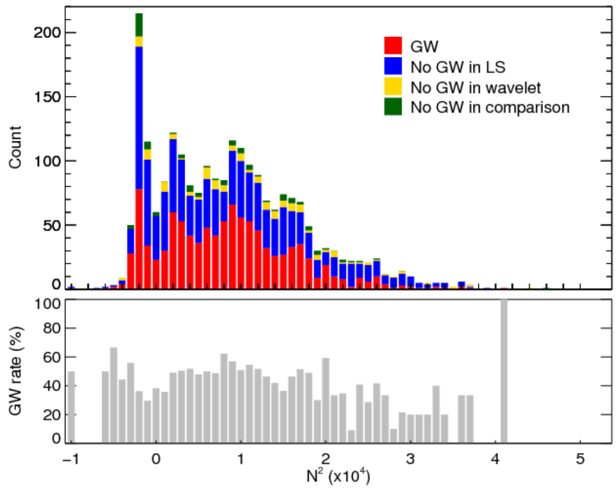

Figure R1. The histograms of GWs occurrence with squares of buoyancy frequency (upper panel). GWs occurrence rate versus buoyancy frequency (bottom panel).

Response: We revised the manuscript to make the goal of this study more clearly. The temperature profile measured with the radiosonde at 19:15 on 4th September in the revised Fig. 5. We had considered the temperature stratification N_2 before submit the manuscript. The result shows that there is not any significant relation between the frequency of wave events and temperature stratification as shown in Fig. R2.

However, the method of GW identification is simple and rough, not serious. As replied in major comment 8 to **Anonymous Referee #1**, we deleted the related text of GW identification and frequency of wave events in the revised manuscript due to following reason:

"During the revision, we reconsidered this part of GW identification. We present this part to demonstrate the relation between GW occurrences and background wind. However, on the one hand, this relation has been studied in several previous studies (Mahrt, 2014) and can be also analyzed in Sect. 4.2. On the other hand, the method if GW identification described in Appendix B is simple and rough, not serious as discussed in Appendix B. Therefore, we decided to delete these text and figure related to GW identification during the whole field campaign in the revised manuscript. The same to the Appendix B. This deletion will not affect the analysis and result of this work. At the same time, this deletion will also help us concentrate on the analysis of the unique long-lived ducted GW."

2) The representativeness of the estimates of the mean wind velocity. As mentioned in line 6 on p.4, measurement duration of radial velocity in one direction is 10 s during this experiment. For used in the experiment scanning geometry such duration of measurements is insufficient in order to obtain statistically justified estimates of the mean wind velocity components. Actually, it is well known that integral spatial scale of wind turbulence is proportional to the height under ground in the lower atmosphere and can reach a few hundreds of meters at the heights 600-2000 m. To obtain statistically justified estimate of the mean velocity, the velocity fluctuations caused by the turbulent inhomogeneities of all the scales up to hundreds of meters must be averaged. Even for observed in the experiment maximal velocity 10 m/s in order to average velocity fluctuations caused by the turbulent inhomogeneities of velocity field of such spatial scales it requires few hundreds seconds, at least.

Response: We totally agree that "To obtain statistically justified estimate of the mean velocity, the velocity fluctuations caused by the turbulent inhomogeneities of all the scales up to hundreds of meters must be averaged." We have checked the raw radial wind in both north beam and west beam. The ducted wave motions are still significant. In addition, turbulence activity is relatively weak in the nocturnal residual layer. As shown in Fig. 2, wave motions are significant without average, though smoothed perturbation will be better in Fig. 7f. Hence, the turbulence inhomogeneities and average will not affect the result of this work. Though the amplitude of zonal/meridional wave motions may be affected due to the turbulence and wave motions.

3) What is the reason of variations of wave period in Figs 3, 4? Model calculations in Fig. 8 do not reproduce wave period variations. It may be useful to compare the experimental and calculation results in more detail by combining the experimental and

calculated data in one plot. It is difficult to compare and understand the results in Figs. 8b, 8c.

Response: The variation of the wave period may be caused by turbulence and the change of background winds. The reason why model calculations do not reproduce wave period variation may be due to stable boundary condition in the model, while lidar observed wind may be affected by many reasons, such as terrain, weather system and so on. Thanks for the suggestion of the comparation. We think that a time-height cross section of vertical wind perturbation would be better with more information. Therefore, we added a panel of comparation of vertical wind perturbation at 1.0 altitude from both observation and simulation results in revised Fig. 8.

Changes: Fig. 8.

4) The code used for numerical modeling must be described in more detail. As it can be proposed, some version of the program CFD Fluent was used in the modeling. Accordingly to Eqs. (2), (3), it is required to set a lot of input turbulent parameters in order to perform the modeling using that code. None of these input parameters is determined experimentally. At least, there is no information about that in the manuscript. If so, there is no any base for quantitative comparison of the experimental and computational results and conclusions about the mechanism of wave generation.

Response: The description of numerical simulations is reorganized with more details in Sect. 4.1. The input turbulent parameters recommended by OpenFOAM are applied (https://www.openfoam.com/documentation/guides/latest/api/classFoam_1_1RASModels_1_1RNGkEpsilon.htm). The default model coefficients of RNG k-ε are: $G_{1\epsilon} = 1.42; G_{2\epsilon} = 1.42; G_{3\epsilon} = -0.33; \alpha_k = 1; \alpha_\varepsilon = 1.22$.

Changes: Page 9, line 26 to page 10, line 18. "In this paper, the input turbulent parameters recommended by OpenFOAM are applied. The default model coefficients of RNG k-ε are: $G_{1\epsilon} = 1.42; G_{2\epsilon} = 1.42; G_{3\epsilon} = -0.33; \alpha_k = 1; \alpha_\varepsilon = 1.22$.

To simplify the numerical simulation processes, a two-dimensional (2D) rectangle computational domain is applied in this study. with 70 km in horizontal and 5 km in vertical from sea level. The upper interface extended to 5 km is set as symmetric condition to prevent the influence of upper interface on the region concerned that below 2 km. On this condition, zero gradient is set for all vertical physical variables, and the vertical velocity is set as zero. The vertical height of the first layer of grid cells is 5 m. The spatial resolution is approximately 20 m in both horizontal and vertical. The total number of computational grid cells is 875,000. The velocity-inlet is westerly and constant in the west boundary of the computational domain. The easterly interface is set as pressure-outlet boundary to improve reversed flow. The topography is set as no-slip wall condition. A rough-wall function is adopted, of which the formula is as follows (Ren et al., 2018):

$$\frac{u}{u^*} = \frac{1}{K} In(\frac{Ez_c}{Ck_s}) \quad (4)$$

where E=9.793 is the wall constant, C = 0.327 is a roughness constant, K≈0.4 is the von Karman constant, k_s is the roughness height, z_c is the distance to the cell center of the first wall adjacent cell, u is the velocity in the cell center, u^* is the friction velocity.

The simulation is run with a time step of 0.5 s.

The CFD cases conducted in this study are used to reveal the influence of topography and wind shear on the generation of the persistent GWs. The thermal field is assumed to be uniform in a horizontal plane. Temperature profile from radiosonde on 5 September is applied in this model. In this work, buoyant flows are developed with low velocity and small temperature variations. As a result, the Boussinesq model is used in this work, which considers only the effect of buoyancy in gravity terms. The Boussinesq approximation can be used instead of a constant density. This model treats density as a constant value ρ_{ref} in all solved equations, except for the gravity and buoyancy term in the momentum equation. The density ρ is approximated as:

$$\rho = \rho_{ref} - \rho_{ref}\beta\left(T - T_{ref}\right) \quad (5)$$

where β is the thermal expansivity, T_{ref} is a reference temperature."

Minor comments:

1) Temperature profile curves in Fig.5 should be identified.

Response: The temperature profile from radiosonde can be easily identified. We know that a shift of each temperature profile from ERA5 would be better. Nevertheless, the vertical structure of the temperature profiles can be still identified without a shift. An inversion layer is obvious under 0.5 km altitude.

2) Parameter N in line 14, p.7 should be expressed by formula.

Response: Added.

3) Resolution of wind and temperature experimental data in height should be indicated.

Response: Added.

4) Magnitudes of âˇDOA, and âˇDOB in Fig.8 and Table 2 must be indicated.

Response: It may be assumed that âˇDOA (âˇDOB) is h_{A} (h_{B}).

Changes: Page 10, line 23. "The maximum elevation of A and B are approximately 250 m and 600 m, respectively."

References:

Mahrt, L.: Stably Stratified Atmospheric Boundary Layers, Annual Review of Fluid Mechanics, 46, 23-45, 10.1146/annurev-fluid-010313-141354, 2014.

Ren, H., Laima, S., Chen, W.-L., Zhang, B., Guo, A., and Li, H.: Numerical simulation and prediction of spatial wind field under complex terrain, Journal of Wind Engineering and Industrial Aerodynamics, 180, 49-65, 2018.