This article addresses a well identified but poorly solved problem, namely the effect of atmospheric boundary layer stability (ABLS) on the dry deposition of particles. Indeed if it has been noted that the dry deposition velocities of particles are higher in unstable conditions, no convincing physical demonstration of the reasons for this increase in deposition velocities has been proposed and consequently no parameterization of this effect exists until now. This paper addresses this issue.

The idea behind this paper is based on the fact that much of the particle deposition is induced by turbulent diffusion which is related to turbulent shear stress and that turbulent shear stress (both its average value and its fluctuations) are related to the stability of the atmospheric boundary layer, with unstable conditions resulting in higher turbulent shear stress and, more importantly, larger fluctuations. Because the dry deposition velocity does not depend linearly on the shear stress and because existing models describe the deposition velocity only as a function of the average shear stress (or average friction velocity), the effect of fluctuations in the shear stress is not properly accounted for.

To address this question, the authors perform 35 runs of a sophisticated Large Eddy Simulation (LES) model corresponding to various stability, wind speed and roughness conditions. This approach is well adapted to the problem and the results are convincing and important.

The results clearly show that under unstable conditions, especially when the wind speed is low, the shear stress shows a strong variability around its mean value, whereas under neutral or stable conditions, with strong wind speed, this variability is strongly reduced. The authors then look at the consequences of these results on dry deposition velocities. The results are clear: in stable or neutral conditions, there is no impact of the stability on the calculated deposition velocities; these are identical whether or not the fluctuations in shear stress induced by the stability conditions are taken into account. On the other hand, for unstable conditions, the deposition velocities integrating the shear stress fluctuations are nearly 50% higher than those based on the average shear stress value are.

The demonstration is convincing and clearly points out that the turbulent fluctuations of the shear stress are responsible for the increase in deposition velocities under unstable conditions.

The authors will then develop a parameterization allowing to take into account this effect in the dry deposition modules. The first step is to define the probability distribution function of the shear stress. The authors demonstrate that this distribution can be correctly reproduced by Weibull distributions and determine a relation allowing the calculation of the parameters of these distributions as a function of, in particular, the Monin-Obukhov length and the average friction speed. Finally, they apply the improved dry deposition model and show that taking into account the effects of instability leads to a significant increase in the deposition velocity of particles between 0.1 and about 2 µm in size.

This paper is highly interesting and provides physical basis for the understanding of the effect of the ABLS on particle dry deposition. The paper is complete since it does not only explain the role played by ABLS but it proposes a parameterization that can be used into dry deposition modules to account for its effects. The paper is well written, concise, correctly illustrated with the correct references.

I think the impact of this article is greater than the title suggests. Indeed, the work developed concerns all types of particles and not only dusts. A title like *LES study on turbulent particles deposition and its dependence on atmospheric boundary-layer stability: application to dust* could better reflect the real content of the work. In any case, I highly recommend publishing this article in ACP with minor revisions.

Minor comments:

Line 24: Gregory (1945) is not in the reference list

Line 35: a review paper by Fowler et al. (Atmospheric Environment 43, 5193-5267, 2009) should be cited. I think that the authors could have benefit to have a look at paragraph 7.6.1.3 (understanding the effect of stability and leaf properties on deposition velocities, p5258).

Lines 39-40: the transition to dust is not well done, especially it is not clear why it is necessary to discuss about dust here. As mentioned before, and except if I miss something, the conclusions of the paper apply to any types of particles.

Line 81: TKE (Turbulent Kinetic Energy)

Line 88: R_a is not defined

Line 112: change "grand" in "ground"

Line 146: How are the rebound and collection efficiency computed? At least add a reference

Line 226: 1-c and 1-f instead of 1a-c and 1d-f

Line 227: the choice of 1.46 µm for the particle size should be explained in few words

Line 242: Li et al., 2020 and not 2020a

Line 274: it should be useful for the reader to know how $1/L_o$ is computed in the simulation and also to give its value in table 2 (with only figure 4, it is not easy to connect $1/L_o$ to the other parameters)

Line 333: again I think that the conclusion is not specific to dust

Line 353: the authors mention that change in surface roughness may affect the variation of the shear stress. They have simulations for two different roughness lengths and have provided in Appendix a figure similar to figure 3 but for z_o=0.76 mm. Even, if the wind speed are not exactly the same, they could discuss a little more how change in roughness changes or not the pdf of shear stress.

Line 377: author contributions. Change YPS in YP to be consistent with the name of the authors used after the title.

Lines 419-420: delete this reference not cited in the text

Lines 435-436: delete this reference not cited in the text

Lines 443: change 2020a by 2020

Lines 444-445: this reference is in duplicate