Response to anonymous referee #1's interactive comment on the manuscript "A new parameterization of dust dry deposition over rough surfaces"

We much appreciate the critical and insightful comments from anonymous referee. This critique has motivated us to examine and revise the manuscript. The details of responses are shown as following.

1. The study states that the new scheme is an improvement compared to existing ones and compared the model results with Slinn and Slinn (1980) and Slin (1982). Note that the model of Slinn and Slinn (1980) was developed for water surfaces, not for smooth or rough land surfaces. Thus, the comparison of Slinn and Slinn (1980) shown in Figure 1 does not make sense to me.

Response: our paper focuses on the study of physical mechanics of dry deposition processes. For Slinn and Slinn (1980) scheme, it was indeed developed for water surface. But in theory, the work has no difference from that for smooth surface, except for particle-growth process. So, this model would clearly under predict the rate of deposition over smooth surface, if particles growth were not included. In figure 1, it is reasonable to employed Slinn and Slinn (1980) scheme for predicting deposition velocity on smooth surface, such as sticky wood and sand surface.

2. The study stated that earlier models predict reasonable deposition velocity over smooth surfaces but underpredict over rough surfaces. Note that the model of Zhang et al. (2001) actually predicts reasonable deposition velocity over rough surfaces and possibly overprecits deposition velocity over smooth surfaces (as shown in Petroff and Zhang, 2010). If the study really wants to demonstrate that earlier models are not suitable for rough or smooth surface, it should include comparisons with some of these earlier models (codes of these models should be available from those authors).

Response: the conclusion comes from the comparison between experimental data and schemes of Slinn. We also note that Zhang et al. (2001) and Petroff and Zhang (2010) actually predict reasonable deposition velocity over rough surfaces and possibly over-predict deposition velocity over smooth surfaces (Zhang et al., 2001), through adjusting the coefficient of relevant collection efficiency but more physical explanation for the surface collection process. We believe that it could achieve good agreement between scheme results and measurements, by appropriately selecting of the adjustment coefficient. That is an efficacious method to improve the prediction precision for a certain surface. But it is no possible to get adjustment coefficients for all surfaces. And we need to expose the physical reason behind the change of surface collection efficiency which has been point out in Petroff and Zhang (2010). According to our proposal, the collection efficiency of isolated obstacle and the collection of whole surface should be distinguished. And one of the purposes of our work is to propose the relationship between these two variables. But anyway, we will improve the expressions and consider adding comparisons with more models in the revised version.

3. The study took wind-tunnel measurements as the basis for evaluating their new scheme and a few existing schemes. Field flux measurements suggested much higher deposition velocity than chamber or wind-tunnel measurements, especially over rough tall surfaces (e.g., forests). This

study should first assess if the wind-tunnel measurements used here represent the real-world situation. Are the deposition velocities values from wind tunnel measurements similar to filed generated ones under similar (canopy, friction velocity) conditions? This should be briefly discussed in the paper. 4. Most collection efficiencies proposed in this new scheme are the same as or similar to those used in literature. But the final formulas in this scheme are actually more complex. It should be realized that a more complex scheme does not warrant more accurate results due to more input parameters involved (which had potential of introducing more uncertainties).

Response: the wind-tunnel measurements only can partly represent the real-world situation. But the situation in wind-tunnel is simple and is known well. We firstly test the schemes under this simple situation and then will extend to complex field situation in future. According to the comment, some briefly discussion will be add in page 4.
We knew that the collection efficiencies of obstacle are normally based on studies on particle collection by isolated obstacle. But in dust deposition model, the thing we really interested in is the collection efficiencies for whole surface. And these two variables are generally confused in existing model. The work of Petroff and Zhang (2010) actually pointed out the collection efficiency of surface is influenced by not only the size of obstacles but also the distribution of these surface collectors. But the relevant physical mechanisms are not exposed in that work. To obtain the relationship between collection efficiency of whole surface and collection efficiency of isolated obstacle, we reveal the interactions for the surface roughness elements in analogy to the drag partition theory. That is the main improvement of our new scheme. The new input parameters required by our scheme, such as frontal area index and roughness cover could be estimated well from the wind profile, based on the theory proposed by Shao and Yang (2008). These two parameters are necessary to describe more physical processes and to improve the rationality and precision of dust dry deposition scheme.

4. “Dust” is typically referred to road or soil derived particles in literature and is mostly in coarse particles. Secondary aerosol particles do not belong to dust. The scheme developed here applies to all sizes of particles and is not limited to dust particles. I would recommend replacing “dust” by “aerosol” or “particle” throughout the text.

Response: the comment will be considered in the revised version.

5. Editorial comments. Only some examples are given and the authors should proofread the whole paper. P8064. L1: the first sentence of the abstract is not appropriate and does not reflect the status of all the existing schemes. Abstract: The abstract could summarize some quantitative results to demonstrate it improvement to exiting schemes. L15: “in the absence of precipitation” should be deleted since dry deposition happens all the time even (and generally faster) during precipitation. L17-18: the method is commonly called “inferential method”, dry deposition velocity (or resistance) are parameters of this method. P8065. L1: first sentence repeats information in previous page and is not needed. L9 and L16: use “firstly”, “secondly”. P8067. L10 repeats L23 in the previous page.

Response: we will improve the manuscript according to the above suggestions.