Responses To Referee #2

We greatly appreciate all the comments, which helped us to improve the paper. Our point-by-point responses are detailed below in italics.

This manuscript attempts to evaluate the performance of three dry deposition schemes, i.e., two uni-directional schemes and one bi-directional scheme, by incorporating them into a Lagrangian Transport air quality model. The authors validated the modeling results using a weekly average data in a regional scale during two seasons. The modeling results can generally reproduce observational data, but different schemes appear to have the best performance in different concentration ranges. The authors rationalized the difference between modeling results and observational values. The comparative study is very useful for research community select these schemes for regional air quality modeling and the interpretations sound scientific. This reviewer has a few specific comments before it can be accepted for publishing in GMD.

1) Page 6088, lines 7-13, why the assumption is necessary for the intercomparison among modeling results?

Response: The assumption is necessary for the intercomparison among the three schemes because it can make sure the difference of modeled results are predominantly caused by the use of different schemes, instead of by processes other than dry deposition such as chemical process, emission, transport, etc. Without this assumption, model results could be more significantly altered by a process than dry deposition. In such a case, the schemes cannot be appropriately evaluated by comparing modeled results from those schemes. This assumption seems to be valid here since no systematic bias was found if considering the three schemes together over the whole model domain.

2) Page 6089, lines 1-3 "Figure 3 also shows that all three schemes considerably underestimated NH3 concentrations at sites with high observed concentrations, and overestimated NH3 concentrations at sites with low observed concentrations." Does this mean the assumption mentioned above is invalid?

Response: While all three schemes considerably underestimated NH_3 concentrations at sites with high observed concentrations, and overestimated NH_3 concentrations at sites with low observed concentrations, we can see from Fig.3 and Table 3 that the overestimations and underestimations are generally within a reasonable range that is close to or better than that obtained by other studies, indicating that modeled NH_3 concentrations were not significantly deviated by any process. Based on this, we do not believe that the identified statement means the assumption is invalid.

3) Page 6089, lines 13-14, "all schemes tended to underestimate NH3 concentrations for sites with high observed concentrations". To this reviewer, intensive agriculture zones usually have accident emissions of NH3 associated with the use of fertilization and manure. This is not surprised that the modeling results underestimate NH3 concentration in those intensive agriculture zones. No emission inventory includes those accident emissions. This reviewer suggested removing those episodic concentrations of NH3 at sites in intensive agriculture zones for the comparison between the observational data and modeling results.

Response: As mentioned in Sect. 3.2, the emission inventory used in this study includes a special agricultural NH_3 emissions to represent emissions from farming practices and livestock. While we agree with the Reviewer that some accident emissions associated with the use of fertilizer and manure were probably not included in the emission inventory, those accident emissions cannot be verified due to a deficiency of related observations. Considering that the NH_3 concentrations at those agricultural sites were also used in the other sections of the paper, we do not think it is necessary to remove them.

4) Page 6090, lines 26-30, and P6091, lines 1-2; even the reference is cited, the reviewer strongly suggested the authors elaborated more for Taylor diagrams, e.g., "Simulated patterns that agree well with observations will lie closer to the reference point marked "observed" on the x axis in a Taylor diagram. From Fig. 6, we can see all schemes did not differ substantially for agricultural sites and for all sites." What are criteria for the statements?

Response: Figure 6 has been removed according to the comments of the Reviewer #1.

5) Fig. 5, to this reviewer, It appears that the modeling results by ZBE at forest sites after the mid of October agree very well the observations, but they are systematically higher than the observations before mid of October? Also, at agriculture sites, from the mid of August to the mid of October, the ZBE's modeling results are consistent with the observations, but no other times. This should be explained.

Response: We thank the Reviewer for this comment. The following statements have been added in Line 11 on Page 6090:

"The modeled results by ZBE agree well with the observations at the forest sites after the middle of October and at the agricultural sites from the middle of August to the middle of October. Since temperatures has a decreasing trend which generally starts from August and NH_3 concentrations were overall overestimated before those periods of time, the good agreement at those periods of time is likely due to the reduced stomatal and soil compensation points in the ZBE

scheme which decreases exponentially with decreasing temperature."

6) From the mid of October to the November, it is a fertilization season for the next year agriculture activity. This could be a very important reason for underestimation of NH3 by three schemes and the reason should be considered.

Response: Although we cannot quantify its importance due to lack of required information, we do believe that the fertilization from the middle October to the November for the next year agricultural operation is a possible reason for underestimation of NH_3 by three schemes. To acknowledge this, the following text in Lines 18-20 on Page 6090:

"A big difference between modeled and observed NH_3 concentrations, however, may suggest that the decrease in the NH_3 emissions after October was probably overestimated."

has been changed to

"A big difference between modeled and observed NH_3 concentrations, however, may suggest that the NH_3 emissions were underestimated after October, presumably as a result of neglecting possible fertilization from October to November for the next year agricultural activity."

7) This reviewer suggested the authors added Scattering plot between modeling results by ZBE using the minimum and maximum emission potentials and observational data.

Response: Scatter plots between modeling results by ZBE using the minimum and maximum emission potentials and observational data have been added in Fig. 8. The following text has been added in Line 22 on Page 6093 to reflect this change:

"Using maximum emission potentials not only greatly overestimated the observation, but also significantly reduced the correlation between modeled and observed NH_3 concentrations."

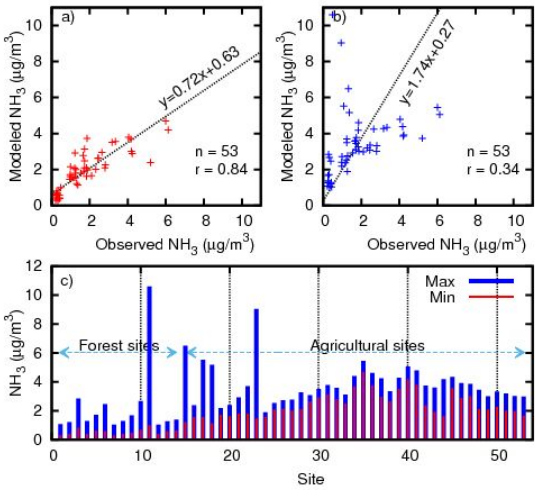

Fig. 8. Modeled average NH_3 concentration using the set of a) minimum emission potentials (red) and using the set of b) maximum emission potentials (blue) for 53 measurement sites (c) and their correlations with the observations (a and b). The use of minimum emission potentials is the default.