

Atmos. Chem. Phys. Discuss., referee comment RC2
<https://doi.org/10.5194/acp-2021-531-RC2>, 2021
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Comment on acp-2021-531

Anonymous Referee #2

Referee comment on "Atmospheric measurements at Mt. Tai – Part II: HONO budget and radical ($\text{RO}_x + \text{NO}_3$) chemistry in the lower boundary layer" by Chaoyang Xue et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-531-RC2>, 2021

General comments:

HONO and related parameters were measured at the foot of Mt. Tai in the summer 2018. 0-D box model coupled with the MCM were used to explore the budget of HONO, OH, RO_x and NO₃ radical chemistry. The homogeneous reaction of NO and OH has been adopted as the default HONO source in the box model and account for 12%-15%. The family constraint was used in this Model scenario to correct for interferences of NO₂ measurements. Large amount of unknown source of HONO appeared especially on the noontime. Then many sources of HONO were discussed and added in the models. Corrected NO₂, direct emission, heterogeneous reactions of NO₂, and photolysis reactions were considered in the model. Another part of the manuscript studied the Radical chemistry. The authors gave very detailed consideration on the sources of HONO, and some corrected methods were suggested. These results is meaningful for the development of HONO investigation.

There also existed some problems the authors need to improve the manuscript. The manuscript had two parts, one was about the sources of HONO, the other was about the radical chemistry. The connection between these two parts was not very tightly. The first part, more focused on the sources of HONO which had some relationship with OH radical, but how about NO₃? I suggested the authors gave some descriptions on the connection between these two parts. For example, the significant of first part was that model was corrected more accuracy and could give more accurate results of radicals, such as RO_x, NO₃? Some relationship of HONO in NO₃ chemistry?

Specific comments:

- The logical of Introduction was not very well. The authors should give more discussions between the relationship of the investigation of HONO sources and radical (RO_x + NO₃)

chemistry.

- More detailed information of foot site should be presented especially the real environment around the site, which were very useful for the analysis of HONO sources.
- In 3.1.2. Since the NO₂ concentration is not credible by using thermo 42i, how did authors prove that the model results of NO₂ correction were reliable. Additionally, the interference could be as high as +75% after adding HNO₃ in model simulation, which corrected NO₂ was used, consider HNO₃ or not? If not, please give the explanation on why not considered HNO₃ interference? By the model results, PAN had most impact on the NO₂ concentration, how accuracy about the model results of PAN, have compared with observation PAN?
- What's the meaning of Fig S3? NO_z*??? Line 223, also NO_z*?
- In 3.2.2.1. What was the correlation between \hat{HONO}/\hat{NO}_x data in table 4 and HONO/NO_x data in Fig 5. In Fig 5, the phenomenon of "the observed HONO/NO_x is convergent as NO/NO₂ increases" was unclear, this was not convincing for the further correction on \hat{HONO}/\hat{NO}_x . There were definitely different meanings for \hat{HONO}/\hat{NO}_x and HONO/NO_x, why authors choose NO_x concentrations?
- Give the explanation of why HONO from direct emission (HONO_{emi}) is likely significantly overestimated with a constant \hat{HONO}/\hat{NO}_x because of different lifetimes of HONO ($\tau(\text{HONO})$) and NO_x ($\tau(\text{NO}_x)$) in the daytime. Please give the more reasonable explanation of the modified factor of $\frac{\delta_{\text{HONO}}(\delta_{\text{HONO}} - \delta_{\text{HONO}} \mu_{\text{HONO}})}{\delta_{\text{NO}_x}(\delta_{\text{NO}_x} - \delta_{\text{NO}_x} \mu_{\text{NO}_x})}$ in equation 3, and detail information on the calculation of $\frac{\delta_{\text{HONO}}(\delta_{\text{HONO}} - \delta_{\text{HONO}} \mu_{\text{HONO}})}{\delta_{\text{NO}_x}(\delta_{\text{NO}_x} - \delta_{\text{NO}_x} \mu_{\text{NO}_x})}$.
- The observation site is special, how to choose NO₂ uptake coefficient on aerosol surfaces and ground surfaces? what's the reasonable? Why the γ_a was larger than γ_{a_dark} ? As shown in Eq-5, photo-enhanced effects had been considered. Similar question also appeared on the γ_g and γ_{g_dark} . Please give the explanation for the higher value of γ_a and γ_g .
- MLH values have great impact on the simulation results, so the reasonable MLH value was very important. Why 50 m was good? please combined the real environment and give the reasonable discussions.
- Line 380: how HONO_{emi} was included in the model? The HONO_{emi} was not the production rate data by Eq-2 and Eq-3.
- Line 534: what's the percentage of HONO contribution to OH radical not considering only HONO and O₃ photolysis? From Fig 10, there were many sources in production of OH, and HONO not the most important sources.
- I can't understand why put the foot and summit of Mt. Tai together in the title, through the two part manuscripts, the Part I was the results on the summit of Mt. Tai, while Part II was the results on the foot of Mt. Tai. the comparison of these two sites was only given some discussions in this manuscript 3.3.5, but these discussions had no new sights and meaning. Furthermore, the analysis methods were different in these two parts. I suggested the authors revised the title, this manuscript was "Atmospheric Measurements at Mt. Tai-Part II: HONO Budget and Radical (RO_x + NO₃) Chemistry in the Lower Boundary Layer".