

Interactive comment on “Mutual promotion effect between aerosol particle liquid water and nitrate formation lead to severe nitrate-dominated particulate matter pollution and low visibility” by Yu Wang et al.

Anonymous Referee #2

Received and published: 22 November 2019

This study presented observation results and theoretical calculations, and thereby proposed the so-called “mutual promotion effect between aerosol particle liquid water and nitrate formation”. This study focused on an interesting topic, and is presented in a relatively clear way. However, the major problem I see is the confusion between “equilibrium” and “formation”. I would recommend this manuscript for publication in ACP only if the following concerns can be nicely addressed.

As described above, this study kind of mixed up the concept of “equilibrium” and “formation”. Now let’s assume a system without N_2O_5 . If the aerosols are already del-

C1

iquescent, as the RH increase, the liquid water content (LWC) will increase, and the gas-particle partitioning of both NH_3 and HNO_3 will be influenced. Indeed, the final result might be that more HNO_3 partitioned on the particle phase and increasing the LWC, until a new equilibrium is reached that with more LWC and higher particle-phase NO_3^- fraction. However, this process should be viewed as a new “equilibrium” driven by the elevated RH, and not “formation” of HNO_3 . In this sense, there’s no so-called “mutual promotion formation” concept. A lot of factors could influence this equilibrium, including aerosol acidity, activity and phase partitioning, but in any sense, there’s no “formation” in terms of total HNO_3 in the system.

Moreover, the authors seems to argue that that although gas-phase NH_3 and HNO_3 are also “supersaturated” under dry conditioned (in comparison with the equilibrium dissociation constant of NH_4NO_3 (K_p) under dry conditions), their condensation loss is “limited by its uptake rate”. Once the aerosols get deliquescent, the uptake rate would be accelerated and more NO_3^- will be present onto the particle phase. I agree this process may happen during the initial dry-wet transition periods, but what’s the timescale? I would say that the system would transfer from the “rate-limited regime” under dry conditions to “equilibrium-controlled regime” soon after this transition, on the scale of hours. Afterwards, as I described above, the apparent increase in NO_3 is only a result of equilibrium moving due to RH variations, if there’re no influences from other factors. In this sense, I don’t get the where the “mutual promotion” lies in – if it’s referring merely to those several hours, I won’t consider it as an important process in the haze development.

The only way that I would agree the concept of “mutual promotion formation” is that, the uptake by N_2O_5 under high RH is so important that it contributed significantly to the total HNO_3 . This is not shown in this study. I would suggest to distinguish the relative contribution of HNO_3 partitioning and N_2O_5 uptake on the final enhancement of particle-phase NO_3^- .

C2

