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Atmospheric Chemistry and Physics Discussions

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

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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 N2O5. If the aerosols are already deliquencent, as the RH increase, the liquid water content (LWC) will increase, and the gas-particle partitioning of both NH3 and HNO3 will be influenced. Indeed, the final result might be that more HNO3 partitioned on the pariticle phase and increasing the LWC, until a new equilibrium is reached that with more LWC and higher particle-phase NO3- fraction. However, this process should be viewed as a new “equilibrium” driven by the elevated RH, and not “formation” of HNO3. In this sense, there’s no so-called “mutual promotion formation” concept. A lot of factors could influence this equilibrim, including aerosol acidity, activity and phase partitioning, but in any sense, there’s no "formation" in terms of total HNO3 in the system.

Moreover, the authors seems to argue that that although gas-phase NH3 and HNO3 are also “supersaturated” under dry conditioned (in comparison with the equilibrium dissociation constant of NH4NO3 (Kp) under dry conditions), their condensation loss is “limited by its uptake rate”. Once the aerosols get deliquescent, the update rate would be accelerated and more NO3- 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 NO3 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 “mutural promotion formation” is that, the uptake by N2O5 under high RH is so important that it contributed signicantly to the total HNO3. This is not shown in this study. I would suggest to distinguish the relative contribution of HNO3 partitioning and N2O5 uptake on the final enhancement of particle-phase NO3-.

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Discussion paper