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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Is water vapor a key player of the wintertime haze in North China Plain?" *by* Jiarui Wu et al.

Anonymous Referee #3

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The paper used several sensitivity simulations to evaluate the impact of aerosol liquid water on wintertime haze in China. There are some major problems that the authors need to address before it can be considered for publication.

1) The authors did not provide a detailed description of how four sensitivity simulations are conducted, and how the contributions of aerosol water are determined. The methods section is too simple for meaningful evaluation of the results of the paper.

2) Aerosol liquid water content and aerosol composition are mutually influenced. I am concerned that simply comparing base case results with some sensitivity simulations without the aerosol water effect cannot untangle this.

Consider a simple ideal scenario in which particles in the air are pure dry NH4NO3 and

RH increases from 30% to just above the DRH of NH4NO3 (and remains above DRH). When this happens, the particle takes up water. This water can serve as a reaction medium or surface to facilitate the additional formation of secondary aerosols, such as (NH4)2SO4 and NH4NO3 (via aqueous reactions and/or heterogeneous reactions). These additional salt components lead to a further increase of aerosol liquid water content, which provides more reaction volume or surface to form even more aerosol salt components.

Now, how do we quantify the contributions of aerosol liquid water on the formation of SA? If I understand the author's method correctly, it will be determined from a base simulation with all processes and a sensitivity simulation without reactions in the aerosol water. However, this is logically incorrect because the initial water that triggers the subsequent reactions is due to the initial NH4NO3. If I replace NH4NO3 with hydrophobic BC, no water uptake will happen and no SA will form. Could I thus claim that all water and additional SA formed in the base case is due to the initial NH4NO3 seed particles?

The authors need to clearly describe how they solve this chicken-or-egg problem in attributing some effects to aerosol liquid water while the aerosol liquid water content also depends on the composition of the seed particles.

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