The manuscript is a thorough modeling analysis of the role of aerosol liquid water (ALW) on radiation, photolysis, and heterogeneous chemistry and how these individual effects can feed back onto surface PM2.5 concentrations in North China Plain in winter. The strength of the paper is that it estimates the contribution of each factor separately in a modeling framework and thus leads to quantitative understanding of the importance of ALW on winter haze in China. My following comments ask the authors to provide more details on the modeling experiments as these are the foundations of this work.

Line 208-212: Describe in more details how the sensitivity simulations were performed. For each simulation, which are the specific mechanisms involving ALW that were turned off and how? For example, for the ARF simulation, one can turn off the hygroscopic growth of aerosols or alternatively not count the ALW in the AOD calculation. Which way did the authors take? For the role of aqueous/heterogeneous reactions, I presume the authors turned off these reactions in the model, but did the authors allow for the hygroscopic growth of aerosols? As the subsequent analysis and discussion rely on these sensitivity simulations, how they were performed in the WRF-Chem model should be described in sufficient details. Furthermore, the estimate of these effects is likely model dependent which further warrants a good description on the modeling experiments.

Line 213 and other places where f terms are used: Explain what f_{alw} is. Is it the same as f_{base}? I would think so. Then the notation could be made more intuitively understandable to change it to f_{base} throughout. For example, $f_{alw-rad0}$ should be $f_{base-rad0}$, then the difference between f_{base} and $f_{base-rad0}$ represent the radiative effect.

About the figures: many figures have multiple panels but almost all the captions do not provide a clear description what each panel shows; for examples, Figures 6, 7, 9, 10, 11, 13, 14, 18, and 19. The standard practice is to include panel numbers (a, b, c, d, etc.) in the figure caption next to the description of the data shown in each panel.