Dear Editor,

Thank you very much for the valuable comments and careful reading which improve the manuscript. The responses (blue font) are as follows:

The line numbers below are based on the change-marked version of the revised manuscript.

L97: Please give the full name of PM.
Reply: Revised.

L180-181: Please rewrite this sentence. It should be "transport of pollutants are driven….., and changes of …. provide feedback to ….".
Reply: Revised to "Transport of pollutants are driven by meteorological fields from RIEMS and changes of pollutants exert feedbacks on the dynamic and physical modules".

L183: "chemistry".
Reply: Revised.

L204-206: Is it aerosol liquid water content (ALWC)?
Reply: Yes, revised to "aerosol liquid water content (ALWC)".

L225-228: Are these radius values for dry or wet aerosols?
Reply: These radius values are for dry aerosols.

L279: Remove the word "following" since land surface module and boundary layer module are not described in the following paragraph.
Reply: "following" changed to "subsequently called".

L280: change "account for" to "calculate"
Reply: Revised.

L286-287: It is difficult to understand how the coupling works in the model from this sentence. What was the integration time step of the base model (RIEMS)? At every 2.5 minutes or 30 minutes were the physical variables, e.g., T and J-values, updated for chemical calculations? Was the feedback allowed to occur at every 30 minutes?
Reply: Sorry for the confusion. It is revised to "All the physical modules are called every 2.5 minutes and the transfer of variables between chemical module and radiation/meteorological modules is made every 30 minutes". So, the feedback was allowed to occur at every 30 minutes

L292: “has” ?
Reply: Revised.

L299: The species concentrations are affected by emissions, dynamic transport, and physical and chemical process.
Reply: Revised.

L310: Cloud chemistry should be included in the chemical processes although it is generally taken into account in the cloud module.
What the physical and chemical processes refer to should be clearly clarified from the beginning and used correctly throughout the entire manuscript. It may not be appropriate to consider advection and diffusion as physical processes, which are different from real physical processes affecting aerosols such as condensation and coagulation.
Reply: The description is revised to “chemical processes (gas-phase chemistry, aqueous chemistry, thermodynamic equilibrium and heterogeneous reactions)”, but the contribution of aqueous chemistry is very small during the study period. It’s difficult to clearly distinguish between physical process and dynamic process, but compared with chemical process, it is acceptable to consider “advection and diffusion” as physical processes, and in the process analysis, for clarity and easy understanding, we classify all the processes into two categories: physical and chemical processes, physical processes refer to all the processes (including emission) except chemistry. It might be odd and confused to use three categories as “dynamical, physical and chemical processes”, so we would like to keep the current classification.

L357-359: The definition of the NoAer simulation is not well described, which was also mentioned by Referee#1. It is stated in Line 208-209 that RIEMS-Chem treats 9 aerosol types including sulfate, nitrate, ammonium, black carbon (BC), primary organic aerosol (POA), secondary organic aerosol (SOA), anthropogenic primary PMs ($PM_{2.5}$ and PM_{10}), dust and sea salt. What did you do with these types of aerosols to remove anthropogenic ones considering that some type of aerosols can originate from both natural and anthropogenic sources? It might be more appropriate to use NoAerfeedback or NoFB for this simulation.
Reply: Yes, thanks for the good suggestion, actually, in NoAer, we inactive the feedback of aerosols, NoAer could be misleading, so we change “NoAer” to “NoAFB” throughout the revised version.

L596: Is this section title appropriate considering that Sect. 5 also presents model results?
Reply: Yes, the title is not appropriate, so it is revised to “Aerosol radiative effects and feedbacks”

L805: Again, It might not be suitable to consider emissions as physical process.

Reply: As we explained above, it is acceptable to consider emission release as physical process for brevity.

L855, L903 and L908: How or what can gas-phase chemistry lead to formation of $PM_{2.5}$? The reaction of SO_2 with OH in the gas phase produces H_2SO_4, which is acid gas not sulfate, and need to undergo nucleation or condensation to form sulfate aerosols. Are the formation rates of aerosols (including those in the clean stage stated in Line 843) comparable to the results from previous studies?

Reply: Yes, sulfate is formed through several pathways: one of them is the gas-phase oxidation of SO_2 by OH to form sulfuric acid (H_2SO_4), followed by nucleation or condensation into particulate phase, which is normally regarded as gas chemistry process (Seinfeld and Pandis, 2006; Cheng et al., 2016), so we assign this process to gas chemistry (GAS). So far, the direct field measurements of formation rates of secondary aerosols in this region is not available for this study, but the model simulations for secondary aerosol concentrations have been compared with daily mean observations in Figure 3, which shows a generally good agreement. It needs to be explained here that about 3% of SO_2 emission is assumed to be sulfuric acid, which transform entirely and rapidly to sulfate, and this process is assigned to gas chemistry as well. We clarify the definition of GAS as "the gas-phase oxidation of SO_2 by OH to form sulfuric acid (H_2SO_4), followed by nucleation or condensation into particulate phase" in the revised version.

Cheng, Y., Zheng, G., Wei, C., Mu, Q., Zheng, B., Wang, Z., Gao, M., Zhang, Q., He, K., Carmichael, G., Poschl, U., and Su, H.: Reactive nitrogen chemistry in aerosol water as a source of sulfate during haze events in China, Sci. Adv., 2, e1601530, https://doi.org/10.1126/sciadv.1601530, 2016.

Seinfeld J. H., Pandis S. N.: Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, John Wiley & Sons, Hoboken, NJ, 2006.

L1224-1225: Please rewrite or delete this sentence.

Reply: Deleted.

L1226: Specify what "aerosol effects" refer to or remove "with and without aerosol effects"

Reply: We remove "with and without aerosol effects".

L1325-1327：It is the size distribution pattern, more specifically the distribution shape parameters, was used. See my comments on L225-228 and L1224-1225. Some descriptions in the first paragraph of the conclusions are repeated here. The conclusions can be more concise.

Reply: We delete the description in L1224-1225 to be more concise.