

Dear Dr. **Xiaohong Liu**

Thank you very much for your feedback and bringing the typos and grammar errors in our manuscript to my attention. I appreciate your thorough review and commitment to maintaining the high standard of GMD. I have addressed all the mentioned issues and revised the manuscript to assure the quality and readability. All the revisions are listed as follows:

1. Some grammar errors regarding the manuscript and supplementary materials.

Response: We corrected all the errors accordingly and posted the manuscript and the Supplement with Check Changes turned on.

2. “radiuses” should be “radii” in Table S1.

Response: We have fixed the typo.

3. “Duste” should be “Dust” in Table S2.

Response: We have fixed the typo.

4. “BCs” is boundary conditions or black carbon?

Response: “BCs” is boundary conditions. To avoid confusion, we add the full spelling of BC (black carbon) in Table S2.

In addition to above typos, we have paid close attention to our manuscript and the Supplement and further corrected other typos and grammar errors (in blue and italic) as follows:

Manuscript part:

1. Abstract has be rewritten as *“Two-way coupled meteorology and air quality models, which account for aerosol–radiation–cloud interactions, have been employed to simulate meteorology and air quality more realistically. Although numerous related studies have been conducted, none compared the performances of multiple two-way coupled models in simulating meteorology and air quality over eastern China. Thus, we systematically evaluated annual and seasonal meteorological and air quality variables simulated by three open-sourced, widely utilized two-way coupled models (Weather Research and Forecasting (WRF)–Community Multiscale Air Quality (WRF–CMAQ), WRF coupled with chemistry (WRF–Chem), and WRF coupled with a regional chemistry-transport model named CHIMERE (WRF–CHIMERE)) by validating their results with surface and satellite observations for eastern China in 2017. Although we have made every effort to evaluate these three coupled models under configurations as*

consistent as possible, there are still unavoidable differences in the treatments of physical and chemical processes in them. Our thorough evaluations revealed that all three two-way coupled models reasonably captured the annual and seasonal spatiotemporal characteristics of meteorology and air quality. Notably, the roles of aerosol–cloud interaction (ACI) in improving the models’ performances were limited compared to those of aerosol–radiation interaction (ARI). The sources of uncertainties and bias among the different ACI schemes in the two-way coupled models were identified. With sufficient computational resources, these models can provide more accurate air quality forecasting to support atmospheric environment management and deliver timely warning of heavy air pollution events. Finally, we proposed potential improvements of two-way coupled models for future research.”.

2. Lines 109-114: “One-year long-term simulations in eastern China were examined using the two-way coupled WRF-CMAQ, WRF-Chem, and WRF-CHIMERE models, with and without enabling ARI and/or ACI, and with 27-km horizontal grid spacing (there were 110, 120, and 120 grid cells in the east–west direction, and 150, 160, and 170 in the north–south direction for WRF-CMAQ, WRF-Chem, and WRF-CHIMERE, respectively).” has been rewritten as “*One-year simulations of meteorology and air quality in eastern China were examined using the two-way coupled WRF–CMAQ, WRF–Chem, and WRF–CHIMERE models with and without enabling ARI and/or ACI, as well as with a 27 km horizontal grid resolution (the east–west direction comprised 110, 120, and 120 grid cells, and the north–south direction 150, 160, and 170 grid cells for the WRF–CMAQ, WRF–Chem, and WRF–CHIMERE models, respectively).*”.

3. Line 118: “version 1.5 (FINN v1.5)” has been revised as “*version 1.5 (FINN v1.5)*”.

4. Line 137: “0.0001 s⁻¹, 0.0001 s⁻¹, and 0.00001 s⁻¹, respectively” has been revised as “*0.0001, 0.0001, and 0.00001 s⁻¹, respectively*”.

5. Caption for Table 2: “Table 2. Summary of scenarios setting in three coupled models.” has been revised as “*Table 2. Summary of scenario settings in the three coupled models.*”.

6. Line 233: “Multi-model” has been revised as “*Multimodel*”.

7. Line 332: “LT 08:00 and 20:00” has been revised as “*08:00 and 20:00 LT*”.

8. Line 337: “5th, 25th, 75th, and 95th percentiles” has been revised as “*the 5th, 25th, 75th, and 95th percentiles*”.

9. Line 372: “Table 3; Figures 5, S9, S12–S14” has been rewritten as “*Table 3 and Figs. 5, S9, and S12–S14*”.

10. Line 374: “relative poor” has been revised as “*relatively poor*”.
11. Line 462: “conversion of liquid to ice” has been rewritten as “*conversion of liquid water to ice*”.
12. Lines 481-485: “When only ACI or ARI and ACI are enabled, the online calculation of prognostic CDNC is performed in WRF–Chem and WRF–CHIMERE using the maximum supersaturation (Abdul-Razzak and Ghan, 2002; Chapman et al., 2009; Tuccella et al., 2019)” has been revised as “*With enabling only ACI or both ARI and ACI effects, prognostic CDNC is online calculated in the two-way coupled WRF–Chem and WRF–CHIMERE models when cloud maximum supersaturation is greater than aerosol critical supersaturation (Abdul-Razzak and Ghan, 2002; Chapman et al., 2009; Tuccella et al., 2019).*”.
13. Lines 485-488: “Although we have obtained preliminary quantitative results of the ACI effects on regional precipitation, CF, and LWP, it should be kept in mind that several limitations in representing ACI effects still exist in state-of-the-art two-way coupled models;” has been rewritten as “*Although we have obtained preliminary quantitative results of the ACI effects on regional PREC, CF, and LWP, we acknowledge that several limitations still exist regarding the representation of the ACI effects in state-of-the-art two-way coupled models.*”.
14. Line 488-489: “a lack of consideration of the responses” has been revised as “*a lack of consideration for the responses*”.
15. Line 501: “Multi-model” has been revised as “*Multimodel*”.
16. Lines 517-519: “As shown in Table 4 and Figs. 6–7, WRF-CMAQ underestimated annual and seasonal (except for autumn) PM_{2.5} concentrations with NMBs ranging from –9.78% to –6.39% and –17.68% to +5.17%, respectively.” has been rewritten as “*Table 4 and Figs. 6–7 reveal that WRF–CMAQ underestimated the annual and seasonal (except for autumn) PM_{2.5} concentrations, with NMBs of –9.78% to –6.39% and –17.68% to +5.17%, respectively.*”.
17. Line 649: “sections 4.1 and 4.2” has been revised as “*Sections 4.1 and 4.2*”.
18. Line 661: “aerosol species group” has been revised as “*aerosol species groups*”.
19. Line 662-664: “7 (294.6, 303.2, 310.0, 316.4, 333.1, 382.0 and 607.7 nm), 4 (300, 400, 600 and 999 nm), and 5 (200, 300, 400, 600, and 999 nm) effective wavelengths” has been revised as “*seven* (294.6, 303.2, 310.0, 316.4, 333.1, 382.0, and 607.7 nm), *four* (300, 400, 600, and 999 nm), and *five* (200, 300, 400, 600, and 999 nm) effective wavelengths”.

20. Lines 702, 704 and 706: “hour per day” has been revised as “*h per day*”.

21. In Table 5: “hour” has been revised as “*h*”.

Supplement part:

1. Lines 6-8: “Most models tended to underestimate annual and seasonal Q2 (−0.57 to −0.18 g kg^{−1} and −1.16 to +0.20 g kg^{−1}, respectively), and the underestimations were most significant in summer.” has been rewritten as “*Most models exhibited a tendency to underestimate annual and seasonal Q2, with MBs ranging from −0.57 to −0.18 g kg^{−1} and −1.16 to +0.20 g kg^{−1} in WRF-Chem and WRF-CHIMERE, respectively.*”.

2. Lines 11-14: “Compared with simulations that did not have aerosol feedbacks enabled, WRF-CMAQ_ARI and WRF-CHIMERE_ARI increased the negative biases of annual and seasonal Q2, with the former being more significant (Fig. 3 and Table S3).” has been rewritten as “*In contrast to simulations without enabling aerosol feedbacks, the negative biases in annual and seasonal Q2 simulated by WRF-CMAQ_ARI and WRF-CHIMERE_ARI were amplified, and the WRF-CMAQ_ARI simulations exhibited bigger negative biases (see Fig. 3 and Table S3).*”.

3. Lines 19-22: “All simulated results had the highest correlations in winter and the lowest in summer, because the convective activity was enhanced in summer and the models struggle to effectively capture this.” has been rewritten as “*All simulated results presented the highest correlations in winter and the lowest in summer and the possible reasons are due to much more convective activities in summertime, which are not accurately captured in all coupled models.*”.

4. Lines 55-57: “the entrainment layer was further considered in the ACM2 scheme for PBLH calculations (Xie et al., 2012).” has been revised as “*different to the YSU scheme, ACM2 considers the entrainment layer in the PBLH calculation (Xie et al., 2012).*”.

5. Lines 58-62: “Meanwhile, all correlations of the three models at 20:00 LT (R = 0.3–0.4) were better than those at 8:00 LT (R = 0.1–0.2), because the gradient of the rapid increase in PBLH in the morning was larger than that of the gradual decrease in PBLH at night, and hence more difficult to accurately simulate.” has been rewritten as “*Meanwhile, all correlations of PBLH simulated by the three coupled models at 20:00 LT (R = 0.3–0.4) were better than those at 08:00 LT (R = 0.1–0.2), which indicated that the PBL schemes in these models were able to calculate PBLH after PBL collapsing slightly better than before PBL developing and more observations with better spatiotemporal resolutions are needed to further evaluate the models’ performance.*”

6. Lines 66-69: “As shown in Fig. 3 and Table S3, the effects of aerosol feedbacks on MB and RMSE were larger than that on R. Considering that the MBs of PBLH are important for the simulation of air quality, the MBs were further analyzed here.” has been rewritten as “*As shown in Fig. 3 and Table S3, the effects of aerosol feedbacks on MB and RMSE of PBLH were greater than on R. Considering that the MBs of PBLH are important for accurately simulating regional air quality, the MBs were further analyzed here.*”.
7. Lines 82-83: the three coupled models performed well for the shortwave radiation at *the* top of the atmosphere (*SRTOA*) and longwave radiation at *the* top of the atmosphere (*LRTOA*).
8. Lines 108-109: “These gaps had been filled by Zhang et al. (2021) in CMAQ v5.3 but not incorporated into the official released versions.” has been rewritten as “*Recently, Zhang et al. (2021) addressed these gaps in CMAQ version 5.3 but related modules had not been integrated into the latest officially released version (version 5.4).*”.
9. Line 129: Gao et al. (2018) also showed that all two-way coupled models, except the WRF-Chem version from the University of Iowa *modelling* group, tended to underestimate SO₂ (−54.77 to 4.50 μg m^{−3}) over the North China Plain during January, 2013.
10. Line 155: “*normalized gross error (NGE)*” has been added.
11. Title of Table S3: “*NGE*” has been added. “at LT 08:00 and 20:00” has been changed to “*at 08:00 and 20:00 LT*”.
12. Title of Table S4: “evaluation” has revised as “*statistical*”.
13. In Table S4: “*N/A*” has been added.
14. Footnote of Table S2: “unspeciated particulate matter in” has been revised as “*particulate matter that can not be speciated into*”.
15. In Table S6: “in term of” has been revised as “*in terms of*”.
16. Title of Table S7: Microphysics variables used in the two-way coupled WRF-CMAQ, WRF-Chem and WRF-CHIMERE models with enabling ACI effects compared to *those* without aerosol feedbacks.

Thank you again for your valuable suggestions and we really appreciate your help! Please let me know if we need to make any further revisions to improve the quality of our paper.

Sincerely yours,

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We would like to thank the reviewer for the constructive comment really helping to improve this manuscript. Below, we address the comment in full detail. Following the Reviewers' comment in black, please find our point-to-point responses in blue. Hereafter, all new added or modified sentences are marked in blue and italic in this response.

Anonymous Referee #2

In the abstract, this sentence is not clear to this reviewer, please clarify:

"The impacts of aerosol-cloud interaction (ACI) on model performances' improvements were limited compared to aerosol-radiation interaction (ARI), and several possible improvements on ACI representations in two-way coupled models are further discussed and proposed."

Response: We rewrote this sentence as follows.

Notably, the roles of aerosol–cloud interaction (ACI) in improving the models' performances were limited compared with those of aerosol–radiation interaction (ARI). The sources of uncertainties for ACI schemes in the two-way coupled models were further pointed out.

The sources of uncertainties and bias in meteorology and air quality simulated by the two-way coupled models with considering ARI and ACI effects were further pointed out.

Furthermore, as commented by the editor, all the typos had been fixed. The language quality of both the manuscript and supplementary materials has been improved.