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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of the East Asian summer monsoon on long-term variations in the acidity of summer precipitation in Central China" *by* B. Z. Ge et al.

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Reply to Referee 2

We appreciate referee 2 for reviewing our manuscript and giving the valuable comments. Following are our response to the comments.

Comment 1: On Page 19597, Line 20, why is the emission inventory of 2000 used for MC? Same as the meteorological dataset of 2000 for EC? No explanation is given in the manuscript.

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Reply to comment 1: We used 2000 inventory and 2000 meteorological dataset which are based on the two reasons: Firstly, the time of modeling cases should be within our study periods (1992-2006); Secondly, the influence of pollutants emission for MC and that of meteorological factors for EC should be minimized. In 2000, the pH of precipitation over China reached the highest value , and the summer monsoon was at the modest strength. The weakest precipitation acidity in 2000 reflects probably the weakest emissions, and the modest strength of summer monsoon suggests that the influence of meteorological factors related to monsoon is close to the average. Therefore, the year 2000 is ideal for our purpose. We will add this in the end of section 2.2 in our revised manuscript.

Comment 2: On Page 19598, Line 10, modeled SO42- and NO3- are compared with EANET for stations Hongwen in Xiamen and Guanyinqiao in Congqin (See Table 1 and Fig. 1, and later discussion in Section 3). Why not to directly compare with observation data of CMA-ARMN? Besides, since the focused regions are the Central China and Yangtz River, comparison made for these regions would be more meaningful.

Reply to comment 2: The observation data of CMA-ARMN is absolutely the best choice for our modeling validation. However, this dataset only contains pH value and conductance of precipitation in most of stations which can not meet our comparison process. In our revised manuscript, we add two GAW station comparisons with our modeled results, and Linan (one of the GAW station) is near Yangtz River. Unfortunately, there is no data available for comparison in the Central China, only Chongqin and Linan are close to this region.

Comment 3: On Page 19602, Line 1, a typo of “SE”? It should be “SC”. Reply to comment 3: We will remove this mistake in our revised manuscript.

Comment 4 : On Page 19602, Line 24, how to define the solid (high MI) and dashed (low MI) lines? The year of 2001 and 1993 is very close to the solid and dashed lines, respectively. They are hard to be defined!

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Reply to comment 4: We use 20 percent of normal value “1” as the range of defining high MI and low MI years, which is 1.2 as the lowest line for high MI year and 0.8 as the highest line for low MI year respectively. The value of MI in 2001 and 1993 is 1.176 and 0.835 respectively, and these two years are out of range. So, we exclude these two year for calculation in section 3.2.1. This will be added in section 3.2.1 of our revised manuscript.

Comment 5: The concentration unit used in Table 1 is not consistent with Figs. 8, 11 and 12. The former unit is more commonly used and easier for comparison. Similar expression can be found in the contents.

Reply to comment 5: We will modify the concentration unit in Figs. 8, 11, 12 and the contents for unification.

Comment 6: On Page 19604, Lines 6-16, the assumption of “the differences in the simulated SO42- and NO3- concentrations result in corresponding changes in the precipitation acidity in Central China,” should be based on the linearity of former two ions with pH. Obviously, this point is not demonstrated and clarified in the manuscript. The summer monsoon contribution of 65% is obtained based on modeled sulfate and nitrate ions, thereby, deducing a contribution of 0.22 to pH difference. Is it the average over the Central China? Then, this average contribution is used to compare with the observed pH change in Fig. 3b (a typo of Fig. 1b in manuscript). Instead of regional average, why not to directly use the grid average to compare the observed pH pointwise? Then, the range of pH changes for all points (stations) due to corresponding sulfate and nitrate can be obtained.

Reply to comment 6: There are three reasons that we take use of the two ions (SO42- and NO3-) to denote the changes of pH in Central China. Firstly, there is no Ca2+, Mg2+ ions in the Regional Emission Inventory in Asia (REAS). So, we can not simulate the concentration of cations in precipitation and consequently can not simulate the pH value of precipitation well. Secondly, in most of the years, precipitation in Central China

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was acidified, contributions of sulfate and nitrate are the two most important factors of the acidification. We just supposed that there exited a linearity correlation between sulfate and nitrate with the pH instead. This is pointed out on Page 19604, Lines 5-8 "Assuming that the differences in the simulated SO42- and NO3- concentrations result in corresponding changes in the precipitation acidity in Central China". Finally, summer monsoon often affect the transport of sulfate and nitrate in southeastern coast regions into Central China, while alkaline substances in China originate mainly from northwest of China and hence do not significantly influence the precipitation acidity in Central China. In addition, the detailed influence of sulfate and nitrate on the pH is not our point in this manuscript, and this may be our next objection. We will consider the three points mentioned above in our revised manuscript. The second question is that we should use the grid average to compare the observed pH pointwise, and show the range of pH changes for all points (stations). In our manuscript, we calculate the contribution of summer monsoon using the average over the Central China, since it may get rid of some singular value, such as the changes of pH which is not significant. But for obtaining the range of pH changes influenced by summer monsoon, station-by-grid is undoubtedly the best way. According to this, we have compared 19 observation stations to modeled result in Central China and obtained 12 useful stations (the other 7 stations do not have the significant changes in pH). The range of summer monsoon contributions for sulfate and nitrate are 17.3%-95.35% and 16.23%-71.79%, and the contributions for pH is 0.12-0.42, about 8.25%-32.16% of the observed pHVWA changes during 1992-2006. This will be included in section 3.2.1 in our manuscript.

Comment 7: Following Comment 6, in Table 1, the bias between observed and modeled sulfate and nitrate is shown. Then, how can we evaluate the summer monsoon contribution only considering the modeled two ions?

Reply to comment 7: Factually, only sulfate and nitrate may not interpret the changes of acid rain over China. Excepted the two anions mentioned above, some cations, such as Ca2+, Mg2+ and ammonium ions should be considered when we focused

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on the precipitation acidity. However, summer monsoon often affects the transport of sulfate and nitrate from southeastern coast regions to Central China, while the source of cations are mainly aerosol from northwest of China, which is less influenced by summer monsoon. So, as we focused on the summer monsoon contribution on the precipitation acidity in Central China, the two dominantly anions (sulfate and nitrate) are facility to meet our purpose.

Comment 8: On Page 19604, Lines 20-24, it is an incomplete sentence. Reply to comment 8: We revised this sentence like " Figure 9 shows that the spatial patterns of left of first SVD eigenvectors (LFSE), which stands for the correlations between pHVWA and time coefficient of rainfall in China, and right of first SVD eigenvectors(RFSE), which stands for the correlations between rainfall and time coefficient of pHVWA inChina." in our revised manuscript.

Comment 9: On Page 19605, Line 2, "velocity" can be replaced by "rate". Reply to comment 9: We will revise this word in our manuscript.

Comment 10: Heading of Section 3.3 is suggested to change to "Characteristics of modeled SO42- and NO3- . . . . . ." Reply to comment 10: We accept this suggestion, and will revise the title of Section 3.3 in our manuscript.

Comment 11: Many important references cited are in Chinese which would not be easily found. Reply to comment 11: The 'PDF' and the website of these Chinese papers are listed in attachment 1.

Comment 12: In Table 1, one decimal digit for the mean, std and error should be enough to read. Reply to comment 12: We will get rid of one decimal digit and left only one decimal for the mean value, since the mean value of sulfate and nitrate are almost more than two digits, the second decimal are too small to influence the total value.

Comment 13: Incomplete caption of Fig. 1. Reply to comment 13: We have revised this caption like "Time series of modeled and observed monthly volume-weighted mean

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concentrations of sulfate and nitrate for EANET sites and GAW background stations ".

Comment 14: Unit is missing in Fig. 12. Reply to comment 14: We will add the Unit in the caption of Fig. 12 in our revised manuscript.

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