

Interactive comment on “Atmospheric Processing of Iron in Mineral and Combustion Aerosols: Development of an Intermediate-Complexity Mechanism Suitable for Earth System Models” by Rachel A. Scanza et al.

Anonymous Referee #1

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General comments

Parameterizations and simplifications in atmospheric processing of iron in aerosols are required for multi-decadal and centennial simulations. The authors presented a comprehensive modeling study of labile iron, assuming fast iron dissolution rates in cloudy grid boxes by applying “in-cloud” iron dissolution rates. The work conducted in this paper may contribute to improve our understanding of iron cycle, although more works will be required to improve the atmospheric processing of iron in aerosols. I have some comments and questions to improve this paper. In particular, there are many

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tuning parameters which should be clarified for future studies, although the paper is well written.

Specific comments

Abstract

p.1., l.19, p.9, l.27, and p.16, l.25: Please rephrase “within range of the observational mean”, as you explained “less than 1 signifies an underestimation” in p.11, l.32.

p.1., l.25, p.10, l.13, and Table 5a: This contradicts to the main conclusion from previous version (Luo et al., 2008). Figure S1 indicated the underestimates of iron below 15S, suggesting the omission of optimization of dust emissions. Since the total iron in combustion aerosols are emitted following Luo et al. (2008), you must predict lower dust emissions in the Southern Hemisphere. After you switched the coupled simulation to the off-line simulation, how did you scale the dust emissions? Since the dust emissions strongly depend on the meteorology, you needed to optimize the dust emissions. If you did not, please clarify the omission of optimization of dust emissions and the underestimates of iron below 15S.

1 Introduction

p.2, l.5: typo, HNLC.

p.3, l.13 and p.5, l.8: More recent study developed an iron dissolution scheme that reduced the number of mineral tracers for implementation in Earth system models (Ito and Shi, 2016).

2 Methods

p.4, l.15: Please clarify the link between three source modes and the size distribution across dust bins in p.4, l.18.

p.4, l.24: Please specify the sub-time step for multiple in-cloud cycles for aerosols and clarify the contact time of aerosols with cloud droplets.

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p.6, l.25: Please show the results of pH from REF and SS5.

p.6, l.29 and Figure 1: Please correct the unit in Figure 1. The iron dissolution rates from Eq. (3) at oxalate concentration = 0 are higher than those from Eq. (1). However, the iron dissolved at oxalate concentration = 0 is already considered in FeRR. Please show the comparison of Fe solubility estimated using equations (1) and (3) from illite at oxalate concentration = 0 with Fig. S2 in Ito and Shi (2016). If you assume fast iron dissolution rates in cloudy grid boxes, please clarify it.

p.7, Eq. (2) and p.8, Eq. (4): How did you determine the scaling factor of 15?

p.7, l.8: Please show the comparison of oxalate from REF and SS2 with observations, assuming that oxalate remains in the particulate phase upon cloud evaporation. Please clarify if you assume high oxalate concentration in the aerosols in cloudy grid boxes.

p.8, l.14: Since these values strongly depend on the meteorology, you needed to optimize the tuning parameters (see the comments on p.8, l.18 and p.11, l.24). If you did not, please clarify the omission of optimization.

p.8, l.18: How did you determine the scaling factor of 5?

p.8, l.23: Guo et al. (2016) and Weber et al. (2016) excluded dust events and reported high acidity for fine particles. Please see Extended Data Figure 1 in Weber et al. (2016). The pH estimate is higher than 3 even though SO₄ concentration is higher than Na concentration. I strongly recommend simulations with lower pH for combustion aerosols but higher pH for dust than REF in future studies.

p.8, l.28: How did you estimate preindustrial chemistry and dust sources assuming present day climate conditions?

3 Results

p.10, l.7: This is not the reason of the overestimates and underestimates (see the comments on p.1., l.25, p.10, l.13, and Table 5a).

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p.11, l.5 and p.13, l.1: Why did you estimate higher iron solubility (i.e., overestimate) in the finest particle size bin off the coast of North Africa? The value is higher than the initial iron solubility for dust aerosols in Table S2d. However, the initial iron solubility for the finest particle size bin should be higher than that. Please show the emissions in finest particle size bin as in Table S2d.

p.11, l.21, Tables 3 and 7: What is tau?

p.11, l.24: Please indicate the values for “larger errors”. The underestimates suggest the omission of optimization (see the comment on p.8, l.14).

p.13, l.30, Figure 8: Figures 8 (a) and (c) indicate the ratios of 2 over most regions. Did you set up the maximum ratios in your plots? Please correct it.

p.14: Please rephrase preindustrial “chemistry”. This is confusing, because the chemistry depends on the meteorology.

Acknowledgments

p.17, l.16: D. H. is co-author.

Tables

p.21, Table 1: Please revise it to clarify the differences between REF and SS4.

References

Guo, H, et al. Fine particle pH and the partitioning of nitric acid during winter in the northeastern United States, *J. Geophys. Res. Atmos.*, 121, 10355–10376, 2016.

Ito, A., and Shi Z.: Delivery of anthropogenic bioavailable iron from mineral dust and combustion aerosols to the ocean, *Atmos. Chem. Phys.*, 16, 85–99, 2016.

Luo, C., Mahowald, N., Bond, T., Chuang, P. Y., Artaxo, P., Siefert, R., Chen, Y., and Schauer, J.: Combustion iron distribution and deposition, *Global Biogeochem. Cy.*, 22, GB1012, 2008.

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Weber, R. J., Guo, H., Russell, A. G., and Nenes, A.: High aerosol acidity despite declining atmospheric sulfate concentrations over the past 15 years, *Nat. Geosci.* 9, 282–285, 2016.

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