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Geoscientific Model Development Discussions

Interactive comment on "Atmospheric dissolved iron deposition to the global oceans: effects of oxalate-promoted Fe dissolution, photochemical redox cycling, and dust mineralogy" *by* M. S. Johnson and N. Meskhidze

Anonymous Referee #1

Received and published: 2 May 2013

General comments

Numerical predictions of atmospheric dissolved iron deposition to the ocean are highly uncertain. The authors presented a comprehensive modeling study of Fe dissolution including the effects of organics, radiation, and mineralogy. Their estimate of dissolved Fe deposited to global ocean is consistent with previous studies, when the hematite is the major iron deposited to the oceans. The paper is generally well written and the work conducted in this paper may contribute to improve the understanding of iron cycle. I can recommend it for publication in GMD, although more works will be required to improve

the treatment of the organics associated with iron-containing mineral aerosols. I have some questions and comments to improve the clarification of the paper.

Specific comments

Abstract

The model simulations were carried out using three different minerals for a range of the uncertainty. Please present the range of dissolved Fe deposited to global ocean.

Methods

2.2.3 Mineral dissolution kinetics

When you set the Fe content to 3.5%, how did you treat the dissolution/precipitation reactions of hematite, goethite, and illite in the proton-promoted dissolution mechanism? For example, how did you estimate the Fe dissolution rate from the illite dissolution rate (mol m^{-2} s^{-1})? How did you calculate the reaction activity quotients for these reactions? For instance, when you used illite as the main Fe-containing mineral, how did you consider the backward reactions for illite and iron dissolutions?

Please list the values for m (empirical parameter), A (specific surface area of mineral), W (weight fraction of the mineral in dust), and Keq (equilibrium constant) used for goethite dissolution.

How did you convert the units when you calculated the linear fit? How did you consider the Fe dissolution kinetics of oxalate-coated minerals and the pH effect on the solubility of oxalate-coated minerals?

My major concern is the extrapolation method of oxalate-promoted Fe dissolution based on the laboratory experiments with only 1 hour of contact time (Paris et al., 2011). The oxalate-promoted Fe dissolution rate in your model is constant with time and pH, which is apparently contradicted to the laboratory measurements (e.g., Xu and Gao, 2008). Please show the comparison of the Fe dissolution rates for higher pH

values with time.

2.2.4 Kinetic modeling of photochemical/chemical reactions of Fe in the presence of oxalate

Please separate paragraphs for SMVGEAR II and ISORROPIA from the introduction of past studies. Please explain the role of each module at first in each paragraph, and then explain what you modified.

How did you treat the hydroperoxyl radical uptake from the gas phase in aerosol and cloud water? Did you use the same scheme as in Mao et al. (2013)?

Please list the temperature-dependent cross sections for each spectral intervals used in the Fast-J.

3.1 Atmospheric concentrations of oxalate

It would be beneficial to discuss oxalate concentrations in dust aerosols, since the focus of this study is on the dust. You mention that oxalate concentrations below 100 ng m^{-3} have a negligible impact. It may be helpful to show the global surface level concentration for oxalate in dust and total.

3.2.3 Comparison of model results with observations

Figure 6 and Table 5: Please show the results with illite and goethite for a range of the uncertainty.

3.2.4 Oxalate-promoted Fe dissolution

Two effects of oxalate-promoted Fe dissolution and photochemical redox cycling are involved in this comparison. First, organic ligands promote Fe dissolution. Second, redox cycling between Fe(III) and Fe(II) changes the aqueous-solid saturation state with respect to Fe(III). Please clearly separate these two effects when you discuss the results.

Technical corrections

Correct the citation of Heald et al. (2004) to Heald et al. (2006).

Figures 3, 4, 7 and 9: Correct April to May.

Tables 2 and 5: Present the units.

Table S1: Add [between j1 and Fe.

Interactive comment on Geosci. Model Dev. Discuss., 6, 1901, 2013.