Atmos. Chem. Phys. Discuss., 10, C6394–C6398, 2010
www.atmos-chem-phys-discuss.net/10/C6394/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Role of dust alkalinity in acid mobilization of iron" *by* A. Ito and Y. Feng

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Received and published: 13 August 2010

We thank the referee for his/her constructive suggestions for improving the paper.

Specific Comments

Comment: Page 10403, line 16-20 An explanation of why the smaller particles were treated differently from the larger particles is needed.

Response: It would be more appropriate to cite the papers by Capaldo et al. (2000) and Feng and Penner (2007), both of which gave detailed explanations on this matter. We added the two references and the following discussions in section 2.1, third paragraph:

"Since accurately solving the dynamic mass transfer equations over the entire aerosol size range is computationally expensive, Capaldo et al. (2000) developed a hybrid method which applies the thermodynamic equilibrium assumption to the fine aerosol

mode and the dynamic approach to the coarse aerosol mode. Feng and Penner (2007) have demonstrated the importance of using such a hybrid dynamical approach in the calculation of nitrate and ammonium aerosols in global chemical transport models."

Comment: Page 10403, line 17 Diameters < 1.25 microns would include both bins 1 and 2.

Response: In our model, sulfate aerosols are treated in the 5 size bins (<0.05 μm, 0.05–0.63 μm, 0.63–1.25 μm, 1.25–2.5 μm, 2.5–10 μm in radius) and particles in the first two size bins have diameters < 1.25 microns. But other aerosols including mineral dust are treated in 4 size bins (0.–0.63 μm, 0.63–1.25 μm, 1.25–2.5 μm, 2.5–10 μm in radius) in the model. For them, diameter < 1.25 micron only includes the size bin 1.

We now added the following statement in the model description, section 2.1, second paragraph:

"Sea salt and mineral dust aerosols are considered in 4 size bins (radius: <0.63, 0.63–1.25, 1.25–2.5, and 2.5–10μm)."

To avoid the confusion, we now refer particles using their actual size range instead of the bin number. It is modified as follows in section 2.1, third paragraph:

"Specifically, a thermodynamic equilibrium model (Jacobson, 1999) is applied for the gas-aerosol partitioning in the fine mode (radius < 0.63 μm), while the concentrations of gaseous species and aerosols in the coarse aerosol mode (radius > 0.63 μm) are determined by dynamically solving the mass transfer equations."

Comment: Page 10403, line 20-22 It is unclear whether all of your aerosol size bins are internally-mixed or if it is only the smallest two size bins.

Response: Sulfate, sea salt and mineral dust aerosols were assumed to be internally mixed in all of the size bins. This is reflected in the revised text in section 2.1, third paragraph:

“In the thermodynamic equilibrium/mass transfer calculations, sulfate, sea salt and mineral dust aerosols were assumed to be internally mixed in each size bin”

Comment: Are the combustion emissions also internally-mixed (this could also be clarified on page 10406, lines 14-16)?

Response: The iron particles from combustion emissions are externally-mixed, assuming that iron associated with these sources are labile in circumneutral solutions (Schroth et al., 2009). This is reflected in the revised text in section 2.3, last paragraph:

"The combustion-generated iron is assumed to have a labile chemical form in circumneutral solutions, and the iron on the particle surface is readily released into solutions (Schroth et al., 2009). They are assumed to be externally mixed with other aerosols in all of the size bins. We note that, however, internal mixing between dust and biomass burning particles may enhance the combustion-iron solubility (Paris et al., 2010), but the process is still not well known."

Comment: Page 10406, line 10 I would suggest changing this sentence to “iron fractions of combustion emissions” and changing the corresponding caption on Table 2.

Response: This is corrected, as the reviewer suggested.

Comment: Page 10409, line 20 Are there any observational data that suggests that aluminosilicate dusts would be externally-mixed with carbonate dusts in the fine mode? Or that aluminosilicates are found preferentially in the fine mode compared to carbonate dusts?

Response: We refer to the paper by Sullivan et al. (2007) in this sentence. We also added the following text to section 1:

“They showed clear differences in the temporal changes of the secondary acid reaction products between dust particles rich in calcite and aluminosilicates. Their results imply that sulphate is highly associated with aluminosilicate-rich dust while nitrate is mixed with calcium-rich dust. Sulphate-dust peaks in the submicron mode while nitrate-dust

peaks in the supermicron.”

Comment: Page 10410, line 10-12 Do these values represent the range of monthly values, or is it only for the month of April, as the caption for Figure 6 suggests? Similarly, the caption for Figure 6 should be clarified. If it is only for the month of April, it should read “Average soluble iron deposition for the month of April 2001”.

Response: The reviewer is right. This is corrected.

Comment: Page 10411, line 11-12 Please specify that deserts are the dominant source of soluble iron compared to combustion.

Response: This is corrected.

Technical Corrections

Comment: Page 10400, line 21 “dust mobilized from arid regions supplies THE majority of the iron”

Response: This is corrected.

Comment: Page 10401, line 15 “mineral aerosols originating from”

Response: This is corrected.

Comment: Page 10401, line 29 “thorough atmospheric”

Response: This is corrected.

Comment: Page 10403, line 7-8 and 17-19, page 10405, line 26 Line 7 and 8 on page 10403 and line 26 on page 10405 refer to radii but diameters are used on page 10403 lines 17-19. Please be consistent.

Response: The diameters are corrected to radii.

Comment: Page 10403, line 19 Correct the grammar in the second sentence.

Response: This is corrected.

Comment: Page 10403, line 28 “from the air suggest” or “of airborne aerosol measurements suggest”

Response: This is corrected.

Comment: Page 10404, line 5 “assumed to be in thermodynamic equilibrium”

Response: This is corrected.

Additional References

Capaldo, K. P., Pilinis, C., and Pandis, S. N.: A computationally efficient hybrid approach for dynamic gas/aerosol transfer in air quality models, Atmos. Environ., 34, 3617– 3627, 2000.

Paris, R., Desboeufs, K. V., Formenti, P., Nava, S., and Chou, C.: Chemical characterisation of iron in dust and biomass burning aerosols during AMMA-SOP0/DABEX: implication for iron solubility, Atmos. Chem. Phys., 10, 4273–4282, 2010.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 10399, 2010.