Atmospheric
Chemistry
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Discussions

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Interactive comment on "Effects of mineral dust on global atmospheric nitrate concentrations" *by* V. A. Karydis et al.

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The authors investigated global major inorganic aerosols and the effect of various cations in dust and sea salt on the formation of aerosol nitrate using the ECHAM5/MESSy Atmospheric Chemistry model (EMAC). They further designed a suite of sensitivity experiments to demonstrate systematically the impact of the strength and chemical composition of dust emission in atmospheric nitrate formation. This is an interesting and valuable study. I recommend publishing the paper in ACP after the authors make some minor modifications.

General Remarks: The terminology of "mineral dust" used in the title and discussion is not appropriate. The authors investigate the importance of four cations (i.e. Ca2+,

Mg2+, K+, Na+) in the formation of nitrate and other atmospheric inorganic aerosols. However, these four cations, according to the description of model setup, come from not only mineral dust emission but also sea spray aerosols, and the latter is particularly important for Na+ and Mg2+. It may be worthwhile to introduce an additional sensitivity simulation by turning off dust-only (or sea salt-only) cations and comparing it with the base case simulation to identify contributions from the corresponding aerosol.

The evaluation over North America (NA) using IMPROVE measurement needs to be revisited. IMPROVE measures fine mode nitrate only (i.e. 2.5 μm in diameter, see http://vista.cira.colostate.edu/DatawareHouse/IMPROVE/Data/AEROSOL/Help/IMPROVEVa However, North America, particularly western US, has noticeable coarse mode nitrate (i.e. various nitrate salts) associated with the discussed cations. Cautions should be taken when comparing the model simulation with the IMPROVE measurement. Another useful surface measurement network over NA is CASTNET, which provides measurements of surface nitrate, ammonium, and sulfate.

Specific comments: 1. Page 11526 line 13-14 (abstract): How do the authors know the updated model improves nitrate predictions over remote areas? I do not find this discussion in the paper. 2. Page 11527 line19-23: Logically, "in polluted regions" in line 21 should be moved to the sentence above. 3. Page 11530 line 13-15: Add "compiled from literatures" after "... the main deserts". 4. Page 11530 line 22: Please clarify "lower and middle atmospheric", such as from troposphere to stratosphere (or mesosphere), or from surface to how many km. 5. Page 11531 line 8: What is the difference between MECCA and MESSy2? 6. Page 11531 line 15: How about wet deposition since the authors have described dry deposition and sedimentation? 7. Page 11532 line 4-6: Are these salts treated as independent tracers in dynamic transport and dry and wet depositions? 8. Page 11532 line 19: Please elaborate on "specific input fields". 9. Page 11533 line 19-20: What types of NH3 are included in "natural emission"? 10. Page 11533 line 23-24: How about SO2 emission from volcanic eruption? 11. Page 11533 line 25-26: Check the unit of emissions. Should it be TgNyr-1 or TgSyr-1?

12. Page 11536 line 20: Change "inter-annual average" to "multi-year average". 13. Page 11540 line 9-10: I am not convinced of this sentence with the reasons given by the authors. For example, missing a consideration of water soluble organic acids may help the partitioning favor nitrate aerosol since lab experiments indicated that organic acids can accelerate re-cycle nitrate aerosol back to gas phase nitric acid. 14. Page 11540 line 12-13: The authors can confirm this by comparing the model HNO_3 with measurement. 15. Page 11545 line 11-13: Please elaborate on how the model treats equilibrium in two modes. How does the model divide the two modes? 16. Page 11547 line 17-18: Why is atmospheric dust load not half when emission is cut to half? Are the nitrate salts treated as independent tracers outside ISORROPIA-II? 17. Page 11548 line 1: It would be good if the authors could mark the discussed various deserts on a map. 18. Page 11549 line 27: Change "change" to "reduction". 19. Page 11568 Figure 2: Suggest changing (b) to nitrate aerosol and (c) to fraction of fine mode nitrate to provide more information. 20. Page 11571 Figure 5: Add experiment name after "A positive change corresponds to a decrease".

Technique corrections: 1. page 11529 line 27: Change "have include" to "have included". 2. Page 11531 line 1: Please add the types of observation in "observations and satellite measurements". 3. Page 11546 line 2-3: It is better to have this sentence the same as in Figure 6. 4. Page 11562 Table 1: Change "Dust" to a term such as "other", "remnant", etc.