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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of a deep convection on sulfate transport and redistribution" *by* V. Spiridonov and M. Curic

Anonymous Referee #1

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The manuscript "The impact of a deep convection on sulfate transport and redistribution" by V. Spiridonov and M. Ćurić represents a three-dimensional compressible cloud chemistry model and numerical results obtained using this model in the simulation of sulfate transport and redistribution by deep convection. The results are original and the topic is of great interest in the scientific community. However, the modeling results reported in this manuscript are problematic, as indicated below. In addition, the manuscript is poorly presented. While it has been apparently improved compared to its earlier versions, a large part of the manuscript is still ambiguous and self-contradictory. The manuscript needs rewriting before it can be considered for publication in *Atmospheric Chemistry and Physics*.

Specific Comments:

1. Are the ‘Summer’ and ‘Spring’ cases ‘continental polluted’ or ‘continental non-polluted’?

2. The authors claimed that they found good agreement between the calculated and observed pH, sulfate concentration and wet deposition. But the initial profiles of chemicals and aerosols were taken from Taylor (1989b, Table 4 in this manuscript), which were obtained in the USA. How these data from USA are representative of the situations in Macedonia? In addition, there is no direct evidence can be found in this manuscript to support the authors’ statement.

3. Only oxidation of S(IV) by O_3 and H_2O_2 was included in the liquid phase chemical reactions, which would lead to an increase in the acidity of the cloud and rain water and to a decrease in the pH value. How could the pH value in the simulated cloud water reach greater than 8 (Table 6)?

4. The authors stated ‘The role of the ice phase in dynamical and microphysics development of clouds is found to be important’ (line 7-8, page 404 and line 18-19, page 406), but no model results were provided about this issue.

5. The authors indicated that both 3D and 2D simulations were conducted, but no results from 2D runs can be found.

More Detailed Comments:

Title:

Romove ‘a’ from ‘a deep convection’.

Abstract:

1. Line 4-5: The chemical components are formulated in terms of continuity equations for different chemical species in the aqueous phase within the cloud.

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Comment: Why ONLY in the aqueous phase are formulated in terms of continuity equations? How are about the chemical species in gas phase and ice phase?

2. Line 6-7: Their evolution in this model came from not only by the processes of advection and turbulence transport, but also the chemical reactions and microphysical transfers.

   Comment: Awkward writing.

3. Line 7-8: The model includes a method of kinetic uptake limitations.

   Comment: Please check in textbooks or other publications to see how it is expressed.

4. Line 8-10: Gases with low solubility ($H^* < 10^3$ mol dm^{-3} atm^{-1}) are in Henry's law equilibrium with temperature dependence of Henry's law coefficients.

   Comment: How the high soluble gases, such as H_2O_2, are treated? It cannot be found in the entire context.

5. Line 12-13: The present model contains explicit treatment of SO_2 and O_3, a kinetic method of gas uptake as well as an improved microphysical parameterization scheme.

   Comment: In a sentence mentioned above it is said that low solubility gases are in Henry's law equilibrium, but here, O_3, a low solubility gas, is said to be treated explicitly using 'a kinetic method of gas uptake'. It needs to be clarified.

6. Line 13-15: The primary objective of this model is to study the impact of the deep convection on the pollutant transport, redistribution and deposition.

   Comment: It should be the objective of this study, not this model.

7. Line 15-17: It is done through chemical reactions, oxidation, scavenging of aerosol particles and transfer via microphysical transitions among water categories.

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Comment: It needs to be rewritten.

8. Line 19: Romove ‘manifested as a flashflood’.

9. Line 20: ‘transboundary dust transport’: I don’t understand what it is.

10. Line 20-22: Remove ‘distribution’ from between vertical and profiles. Another point raised about the inconsistency between these initial conditions and the model results has already been indicated in ‘Specific comments’.

11. Line 25-27: It stimulates the impact of scavenging processes and microphysical conversions, pollutant redistribution and wet deposition.

    Comment: It needs to be clarified. In addition, ‘microphysical transitions’, ‘microphysical conversions’, ‘microphysics transformation’, etc. are used at different places. It should be clarified.

12. the last paragraph of Abstract: Not clear. It needs to be rewritten.

Because too many problems exist in the text, only the most important comments are briefly listed for the rest sections.

1. Introduction:

1. Line 17-20: Severe ..., rapid evolution and dissipation processes.

   Comment: Need to be rewritten.

2. Line 21-24: The interactions ... hydrometers.

   Comment: Need to be rewritten.

3. Line 27: Remove ‘formulations’.

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4. Line 2, p388: Remove ‘, ignoring ... processes.’

5. Line 7: Remove ‘The’ before Crutzen and ‘study’ after (2000)’.

6. Line 10: Add ‘gases with’ between ‘of’ and ‘various’.

7. Line 13-15: Rewrite.

8. Line 21-22: ‘Our second ... experiments.’

   Comment: Need to be rewritten.

2. Model formulation and description

1. Line 23, p389- Line 3, p390: ‘Besides the ... Janc 1997).

   Comment: Which distributions were actually used in this study?

2. Line 3-6, p390: Need to be rewritten.

3. Line 10-18: Need to be rewritten.

4. Line 19-24: Need to be rewritten.

5. page 392: Which formula was actually used in this study, Eq. (8) or (9)? I am confused.

   Two different symbols were used for effective Henry’s law coefficient.

   ‘R the universal gas constant’ was repeated for 3 times in this single paragraph! Other parameters also needs to be checked.

6. Line 12, p393: ‘scavenging of SO_4^{-2} by Brownian diffusion of cloud water and cloud ice’.

   Comment: This is completely wrong.

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7. Line 13-19: Needs to be rewritten.

8. Line 22-23: ‘The chemical reactions expressed through equilibrium reactions and dissociation and corresponding coefficients are listed in Table 2’

   Comment: Needs to be rewritten.

9. Line 26-27, p393: ‘The gaseous phase reactions are of importance of long-range transport studies Eliassen et al. (1982)’

   Comment: Not clear.

10. Line 1, p394: Add ‘it’ before ‘may be’.

11. Line 5-6: ‘That is the same assuming that the normal second derivatives vanish at the boundaries’

    Comment: Needs to be rewritten.

12. Line 6-7: ‘Lateral boundaries are opened and the time-dependant so the disturbances can pass through by minimal reflection (Duran, 1981)’.

    Comment: Not clear, needs to be rewritten.

13. Line 15-17: ‘the mass transformation part related to microphysical processes, oxidation, reduction, dissociation or other aqueous phase reaction terms’.

    Comment: What does ‘reduction’ mean? What ‘other aqueous phase reaction terms’ are included besides dissociation and oxidation?

3. Numerical experiments

1. Line 22-23, p395: ‘The simulations are initialized using an observed horizontal homogeneous initial field of potential temperature...’

   Comment: Needs to be rewritten.

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2. Line 26, p395: ‘week inversion’ should be ‘weak inversion’?

4. Model results

1. Line 26, p397: ‘The existing clouds in subsequent simulation time are primarily broken cirrus clouds’.

   Comment: Fig.4 shows that two third of the clouds appeared at 120 min had cloud top lower than 5 km. Are these cirrus clouds?

2. Line 9-14, p400: The analyses of the results by Taylor (1989b) and Tremblay and Leighton (1986) are not convincing.

3. Line 15-16, p400: ‘A three-dimensional simulation of sulfate transport and redistribution Transboundary dust transport on 3 April 2000 (Spring Case)’

   Comment: This subtitle is really confusing.

4. Line 7, p401 and elsewhere: What is (SO_4^{-2}-S)?

5. Line 2, p402: Remove ‘more than’ from ‘It is more than obvious’.

6. Line 3, p402: What is ‘conductivity’?

7. p402: The comparison and analysis are ambiguous.

8. Line 17-18, p403: ‘This percent number is slight higher for continental polluted background and distinguishes 130%’.

   Comment: Needs to be rewritten.

9. Line 24-26, p403: ‘For global model runs in the study by Crutzen and Lawrence (2000), the the soluble gas abundances in the upper troposphere were about 80-90% and 10-20% of the insoluble tracers.’

   Comment: Not clear.

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10. Line 8-11, p404: Not clear.

11. Where are the results from 2D runs?

5. Summary and conclusions

1. Line 17-19, p405: Not clear.

2. Line 21-22, p405: 'The effects of buoyancy and wind shear intensify the turbulent flow field and diffusion.'

   Comment: Where does this come from?

3. Line 24-25, p405: 'Ice processes stimulate the impact scavenging and micro-physical conversions and transfer of pollutant mass among water categories.'

   Comment: Needs to be clarified.

4. Line 14: 'Kinetic gas uptake limitations method leads to lower gas scavenging by cloud drops, for a factor of 2 to 3, while for rainwater distinguishes factor 3 to 5.'

   Comment: Needs to be rewritten.

5. Line 19-22, p406: This paragraph is very confusing.

Tables and Figures

Comment: Most of the captions need to be clarified or rewritten.

Interactive comment on Atmos. Chem. Phys. Discuss., 2, 385, 2002.