A Core-Shell box model for simulating Viscosity dependent secondary organic Aerosol (CSVA) and its applications

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Model development and applications

1. RH-dependent kinetic nucleation by H$_2$SO$_4$ hydrate and NH$_3$
   
   Nucleation rates as a function of sulfuric acid vapor concentrations at different RH

2. Identification of SOA composition and particle-phase reactions
   
   Mass spectra of SOA from toluene

3. Size-dependent hygroscopic growth of salts and SOA
   
   Different from the thermodynamic models (e.g., E-AIM or AIOMFAC), the aerosol water is kinetically predicted in the CSVA model, which can be easily coupled to gas-particle partitioning and other chemical processes.

4. Influences of SO$_2$ on SOA formation from toluene
   
   Measured (circles) and modeled (line) particle number and mass concentrations

5. Viscosity-dependent size distribution of SOA
   
   Our model is successfully able to reproduce the evolution of SOA particle size distribution from a one-peak mode into a two-peak mode.

6. Effect of RH on SOA formation
   
   When RH increases from 10% to 70%, the measured SOA mass increases by 67%, and the corresponding modelled SOA mass increases by 69%. This demonstrates that the simulated SOA results are in excellent agreement with the experimental results.

Highlights of CSVA

1. An equation is developed to describe the gas-particle mass transport processes
2. All processes are represented by the form of chemical reactions in the model
3. Aerosol components are determined by mass spectra and master chemical mechanism
4. A humidity dependent homogeneous nucleation model by H$_2$SO$_4$-NH$_3$-H$_2$O is developed
5. Evolution of organic particle size distribution is controlled by viscosity

Acknowledgments

This work was supported by the National Key R&D Program of China (2017YFC0210005) and the National Natural Science Foundation of China (Nos. 41875166, 41875163 and 41375129)

Jia L & Xu Y F. A Core-Shell box model for simulating Viscosity dependent secondary organic Aerosol (CSVA) and its applications. Forthcoming in Science of The Total Environment, 2021