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The incorporation of size-resolved aerosol processes in Polair3D

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Atmospheric particulate matter has been connected to a number of negative effects ranging from acid rain to visibility reduction. As a result, many governing bodies have begun to impose increasingly stringent standards for PM. However, in order to determine effective strategies to control atmospheric aerosols and meet these standards, models that accurately describe the important processes which affect the aerosol size/composition distribution are crucial. The treatment of aerosol processes has recently been added to the three-dimensional chemical transport model, Polair3D. Recent improvements to the gas-phase only version of Polair3D include the addition of both a Modal Aerosol Model (MAM) and a size-resolved aerosol model (SIREAM), along with the Carnegie Mellon University Variable Size-Resolution aqueous phase chemistry Model (VSRM). This presentation will focus primarily on the latter two additions.

Polair3D is a three-dimensional Eulerian model that treats the chemical transformations and transport of major gas phase and particulate pollutants. Advection, diffusion, deposition, emission, and chemical production are calculated so that the temporal and spatial evolution of a three dimensional grid of pollutants can be generated. Inputs to SIREAM within Polair3D include the gas phase precursors to the considered aerosol species, the aerosol size/composition distribution at the beginning of the timestep, and meteorological information. Outputs from the aerosol module include new gas phase concentrations and the updated aerosol size/composition distribution. If cloud liquid water content is above a given threshold for a cell, the VSRM cloud chemistry module is called.

The Size Resolved Aerosol Model (SIREAM) treats nucleation, condensation/evaporation, and coagulation for a given aerosol distribution. The size range is approximated by a discrete user-specified number of size sections or “bins”, and composition is assumed to be uniform within each of these bins. The model can be run in fully equilibrium, fully dynamic, or hybrid modes. Major anthropogenic and biogenic, primary and secondary, inorganic and organic species are treated. The user can specify the range of diameters considered, number of size bins, which processes to simulate, and the invocation of certain simplifying assumptions (e.g., neglect of the Kelvin effect, instantaneous equilibrium) in order to choose the best combination of accuracy and efficiency for a given application.

In this presentation the formulation of the newly added size resolved aerosol processes and their incorporation into Polair3D will be outlined. Preliminary results in the three dimensional domain (Lille and Europe) are reasonable. Trends and values correspond well between the modeled and observed values for aerosol species. These results will be presented along with the future direction of aerosol treatment in Polair3D.