Inter-comparison of aerosol indirect effect on cirrus (ice) clouds under AeroCom

Xiaohong Liu (Xiaohong.liu@pnnl.gov) and Kai Zhang
(Pacific Northwest National Laboratory)
Athanasios Nenes
(Georgia Institute of Technology)

Aerosol radiative forcing on climate remains one of the large uncertainties in the future climate change projection. Among various aerosol forcing mechanisms, aerosol indirect forcing (AIF) on cold cirrus clouds has never been assessed in previous IPCC reports, primarily due to the limited understanding of aerosol-ice-cloud interactions (e.g., through ice nucleation), and due to the missing treatment of these processes in climate models. Limited studies suggested that AIE on ice clouds (ice-AIE) can reach up to 0.5 W m-2 (warming) due to the reduction of ice crystal effective radius (caused by homogeneous and/or heterogeneous freezing of aerosol particles) and the subsequent reduction of fall speed of ice crystals. In recent years there has been substantial progress on laboratory and field measurements as well as parameterization development for the ice nucleation process. We think it is time for an inter-comparison of ice-AIE among GCMs, which can be useful for the next IPCC assessment.

For this inter-comparison (to be carried out under the AeroCom framework) we propose a set of sensitivity experiments to estimate the ice-AIE associated with various ice formation mechanisms. These experiments will consider various cases: 1) homogeneous freezing only, 2) heterogeneous nucleation only, and 3) combined homogeneous and heterogeneous nucleation. The focus will be on anthropogenic sulfate and black carbon. Our ideas of the experimental design will be presented together with initial results from the CAM5 model.