A comparison of large-scale atmospheric sulphate aerosol models (COSAM): overview and highlights


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ABSTRACT

The comparison of large-scale sulphate aerosol models study (COSAM) compared the performance of atmospheric models with each other and observations. It involved: (i) design of a standard model experiment for the world wide web, (ii) 10 model simulations of the cycles of sulphur and 222Rn/210Pb conforming to the experimental design, (iii) assemblage of the best available observations of atmospheric SO\textsubscript{4}\textsuperscript{2-} SO\textsubscript{2} and MSA and (iv) a workshop in Halifax, Canada to analyze model performance and future model development needs. The analysis presented in this paper and two companion papers by Roelofs, and Lohmann and co-workers examines the variance between models and observations, discusses the sources of that variance and suggests ways to improve models. Variations between models in the export of SO\textsubscript{2} from Europe or North America are not sufficient to explain an order of magnitude variation in spatial distributions of SO\textsubscript{4}\textsuperscript{2-} aerosol downwind in the northern hemisphere. On average, models predicted surface level seasonal mean SO\textsubscript{4}\textsuperscript{2-} aerosol mixing ratios better (most within 20%) than SO\textsubscript{2} mixing ratios (over-prediction by factors of 2 or more). Results suggest that vertical mixing from the planetary boundary layer into the free troposphere in source regions is a major source of uncertainty in predicting the global distribution of SO\textsubscript{4}\textsuperscript{2-} aerosols in climate models today. For improvement, it is essential that globally coordinated research efforts continue to address emissions of all atmospheric species that affect the distribution and optical properties of ambient aerosols in models and that a global network of observations be established that will ultimately produce a world aerosol chemistry climatology.