5.006 Evaluating Secondary Inorganic Aerosols in 3-Dimensions.

Early Career Scientist

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Abstract:

The spatial distribution of aerosols and their chemical composition dictates whether aerosols have a cooling or a warming effect on the climate system. Hence, properly modeling the 3-dimensional distribution of aerosols is a crucial step for coherent climate simulations. Since surface networks only give 2-D data, and most satellites supply integrated column information, it is thus important to integrate aircraft measurements in climate model evaluations. In this study, the vertical distribution of secondary inorganic aerosol (i.e. sulfate, ammonium and nitrate) is evaluated against a collection of 14 AMS flight campaigns and surface measurements from 2000-2010 in the USA and Europe. GISS ModelE2 is used with multiple aerosol microphysics (MATRIX, OMA) and thermodynamic (ISORROPIA II, EQSAM) configurations. Our results show that the MATRIX microphysical scheme improves the model performance for sulfate, but that there is a systematic underestimation of ammonium and nitrate over the USA and Europe in all model configurations. In terms of gaseous precursors, nitric acid concentrations are largely underestimated at the surface while overestimated in the higher levels of the model, influenced by strong stratosphere-troposphere exchange. Heterogeneous reactions on dust surfaces is an important sink for nitric acid, even high in the troposphere. At high altitudes, nitrate formation is calculated to be ammonia limited. The underestimation of ammonium and nitrate in polluted regions is most likely caused by a too simplified treatment of the NH3/NH4+ partitioning which affects the HNO3/NO3- partitioning.