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Scales of variability of black carbon plumes and their dependence on resolution of ECHAM6-HAM

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Prediction of the aerosol effect on climate depends on the ability of three-dimensional numerical models to accurately estimate aerosol properties. However, a limitation of traditional grid-based models is their inability to resolve variability on scales smaller than a grid box. Past research has shown that significant aerosol variability exists on scales smaller than these grid-boxes, which can lead to discrepancies between observations and aerosol models.

The aim of this study is to understand how a global climate model's (GCM) inability to resolve sub-grid scale variability affects simulations of important aerosol features. This problem is addressed by comparing observed black carbon (BC) plume scales from the HIPPO aircraft campaign to those simulated by ECHAM-HAM GCM, and testing how model resolution affects these scales. This study additionally investigates how model resolution affects BC variability in remote and near-source regions. These issues are examined using three different approaches: comparison of observed and simulated along-flight-track plume scales, two-dimensional autocorrelation analysis, and 3-dimensional plume analysis.

We find that the degree to which GCMs resolve variability can have a significant impact on the scales of BC plumes, and it is important for models to capture the scales of aerosol plume structures, which account for a large degree of aerosol variability. In this presentation, we will provide further results from the three analysis techniques along with a summary of the implication of these results on future aerosol model development.