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EVALUATING TREATMENTS OF AEROSOL OPTICAL PROPERTIES AND THEIR EFFECT ON RADIATIVE FORCING USING MILAGRO MEASUREMENTS

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ABSTRACT

Global climate model predictions still contain relatively large uncertainties associated with aerosol radiative forcing. Part of this problem may result from the coarse spatial grid spacing employed by global climate models does not permit large gradients in particulates to be resolved and does not account for sub-grid scale variability in non-linear aerosol chemistry. The treatment of aerosol optical properties likely contributes to the uncertainties in radiative forcing as well. For example, a modal approach is typically used to represent the aerosol size distribution in global climate models because of its simplicity and computationally efficiency. More complex treatments for the aerosol size distribution, such as the sectional approach, may become feasible for the next generation of climate models as computational power continues to increase. In this study, we employ a fully-coupled meteorology-chemistry-aerosol model, WRF-chem, to evaluate the predicted optical properties and downwind of Mexico City using both modal and sectional approaches. We also examine the sensitivity of the model predictions to "volume-averaging", "shell-core" and other approaches that employ Mie theory. The impact of the various approaches on predicted aerosol radiative forcing is then quantified. Model performance is assessed by using the extensive measurements from surface-based, aircraft, and satellite platforms made during the MILAGRO field campaign in March 2006. We employ aerosol optical depth measurements at several surface sites as well as those obtained from twice-daily satellite instrumentation, single scattering measurements from surface sites and the G-1 aircraft measurements, and vertical profiles of extinction and backscatter obtained from the NASA Langley Research Center airborne High Spectral Resolution Lidar (HSRL). The lidar measurements provided evidence of multiple layers of particulates and large spatial variability of particulate composition (as determined by depolarization) over central Mexico. To account for particulate variability in the region, the model employs an outer domain with a grid spacing of 12 km that encompasses Mexico and an inner domain with a grid spacing of 3 km that encompasses central Mexico and most of the in-situ measurements.

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