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AEROSOL DIRECT RADIATIVE EFFECTS OVER THE NORTHWEST ATLANTIC, NORTHWEST PACIFIC, AND NORTH INDIAN OCEANS: ESTIMATES BASED ON IN-SITU CHEMICAL AND OPTICAL MEASUREMENTS AND CHEMICAL TRANSPORT MODELING AND THEIR RELATION TO DECISION-SUPPORT INFORMATION

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ABSTRACT

Aerosols influence the climate system via scattering and absorption of solar radiation, changing cloud properties and altering precipitation. The largest uncertainty in the radiative forcing of climate change over the industrial era is that due to aerosols (IPCC-2001). This uncertainty arises in part due to the uncertainty in scattering and absorption of shortwave (solar) radiation by aerosols of anthropogenic origin in cloud-free conditions. Aerosols are short-lived and, hence, highly variable on local and regional scales. The forcing by aerosols varies on regional scales and depending on absorption differs can be higher at the surface than at the top of the atmosphere. Aerosols also influence local surface temperature and moisture. Therefore, aerosols impact all five major themes of this workshop: water, ecosystems, coastal issues, energy and air quality.

Reduction in the uncertainty in aerosol's influence on climate and building a better predictive capability are major goals of the CCSP activities. Quantitatively, evaluating the current capability is a distinct milestone in this endeavor. To this end, the measured aerosol properties over three regions of the globe downwind of major urban/population centers were used to calculate the aerosol forcing due to light scattering and absorption. Directly measured aerosol burdens (mass), aerosol extinction optical depth, and aerosol properties were used to calculate the climate forcing via scattering and absorption (change in radiative flux due to total aerosols) and compared against models. In-situ and remotely sensed aerosol properties for each region were used as input parameters to radiative transfer models to constrain the models. The "a priori" and "constrained" model results were then compared. The uncertainties in each step were determined and propagated through the analysis. The results demonstrate that when the radiative transfer models were constrained by observational inputs they have a lower uncertainty than the models with "a priori" parameterizations (e.g., IPCC- 2001), and thus help reduce uncertainty in the estimation of the impact of aerosols on climate.

The results from this study will (i) assist the IPCC (2007) assessment and will (ii) form input into future CCSP activities that will include evaluations of the radiative forcing by aerosols into specific 2007 decision-support information products. The use of observational constraints helps base choices on real world, observationally-vetted, decision tools that are expected to be more quantitative; they also help improve model development for future predictions.