Regional comparison and assimilation of GOCART and MODIS aerosol optical depth across the eastern U.S.

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[1] This study compares aerosol optical depths (AOD) products from the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Goddard Chemistry Aerosol Radiation and Transport (GOCART) model and their integrated products with ground measurements across the eastern U.S. from March 1, 2000 to December 31, 2001. The Terra MODIS Level-3 (collection 4) AOD at 0.55 μm has better correlation, but consistently overestimates the values of the Aerosol Robotic Network (AERONET) measurements. GOCART has small biases for a 22-month integration, and slight positive biases appeared for the cold season. These results are also supported by the comparison with the IMPROVE (Interagency Monitoring of Protected Visual Environments) light extinction index. The optimal interpolation improves the daily-scale RMSE from either MODIS or GOCART alone. However, the regional biases in the aerosol products constitute a major constraint to the optimal estimate of AOD. *INDEX TERMS:* 0305 Atmospheric Composition and Structure: Aerosols and particles (0345, 4801); 1640 Global Change: Remote sensing; 3337 Meteorology and Atmospheric Dynamics: Numerical modeling and data assimilation; 5704 Planetology: Fluid Planets: Atmospheres—composition and chemistry. **Citation:** Matsui, T., S. M. Kreidenweis, R. A. Pielke Sr., B. Schichtel, H. Yu, M. Chin, D. A. Chu, and D. Niyogi (2004), Regional comparison and assimilation of GOCART and MODIS aerosol optical depth across the eastern U.S., *Geophys. Res. Lett.*, *31*, L21101, doi:10.1029/2004GL021017.

1. Introduction

[2] Recent developments of satellite remote sensing and chemical-transport models improve the characterization of regional/global distributions of aerosol concentrations [*Kaufman et al.*, 1997; *Chin et al.*, 2002]. Assimilation technique is also developed to maximize the utility of the existing aerosol products [*Yu et al.*, 2003]. These developments have significantly improved our understanding of the global aerosol radiative forcing.

[3] This work compares the AOD from current versions of the Terra Moderate-Resolution Imaging Spectroradiometer (MODIS) retrievals, the Goddard Chemistry Aerosol Radiation and Transport (GOCART) model, and the MODIS-GOCART assimilated products across the eastern U.S. This region features high concentrations of anthropogenic hygroscopic aerosols accompanied by high relative humidity (RH) [*Malm et al.*, 2004], the existence of an extensive ground-based aerosol monitoring network [*Malm et al.*, 2004; *Holben et al.*, 1998], and the reported positive bias of the MODIS AOD during the ACE-Asia field experiment in April 2001 (M. Chin et al., Aerosol distribution in the Northern Hemisphere during ACE-Asia: Results from global model, satellite observations, and Sun photometer measurements, submitted to *Journal of Geophysical Research*, 2004, hereinafter referred to as Chin et al., submitted manuscript, 2004). Therefore, the regional intercomparison is critical for further evaluation and improvement of existing products.

2. Data

2.1. Ground-Based Measurements

[4] The following ground-based *column AOD* and near-surface light extinction index (*Bext*) are used to evaluate the aerosol products in this study.

[5] Aerosol Robotic Network (AERONET) is the ground-based remotely sensed aerosol measurement network equipped with well-calibrated CIMEL Sun photometers [*Holben et al.*, 1998]. The 10 rural sites in the eastern U.S. (including Cartel, GSFC, Cove, Egbert, Chequamegon, Bondville, Walker Branch, Stennis, CART site, and Konza EDC) were carefully chosen to assure adequate data coverage and homogeneous spatial distribution. This study uses the Angstrom exponent coefficient derived from the *Level-2 quality assured daily mean* (*during daytime*) column AOD at 0.5 μm and 0.67 μm for deriving the AOD at 0.55 μm.

[6] The IMPROVE (Interagency Monitoring of Protected Visual Environments) monitoring network measures fine and coarse aerosols in mostly rural areas throughout the United States [*Malm et al.*, 2004]. The network collects *24-hour* PM2.5 and PM10 samples every third day. The PM2.5 samples are analyzed for mass, elemental composition, ions, and organic and elemental carbon, while the PM10 filters are analyzed for mass. The data are sufficient to reconstruct the major aerosol components ammonium sulfate and nitrate, organics, light absorbing carbon and soil, which account for most of the measure fine mass. A near-surface *Bext* (visible broad band) is also calculated from

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