5.2 AEROSOL MONITORING OVER THE U.S. FROM GOES-8

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1. INTRODUCTION

Aerosols play an important role in the global radiation budget, the hydrologic cycle, aviation and air quality. Therefore, satellite observations of the temporal and spatial distribution of aerosol is an important step toward understanding their impact.

The GOES Aerosol-Smoke Product (GASP) provides aerosol optical depth retrievals over the U.S. at 4 km spatial resolution and 30 minute intervals. The retrieval is performed over ocean and land and is also available once per day for the full disk of the Earth from GOES-East (providing information for South America).

2. DATA

Two data sources are used in this study: observations from the GOES Imager and the Aerosol Robotic Network (AERONET) data, which provides ground-truth aerosol optical depths.

2.1 GOES Data

The GOES Imager measures atmospheric radiance at 5 wavelengths: 3 in the Infrared (two in an atmospheric window and one in a water vapor absorption band), one in the near-infrared (~3.9μm) and one in the visible (0.52-0.72μm FWHM). The aerosol retrieval uses the visible channel to sense aerosols and the remaining channels to discern aerosol from clouds.

2.2 AERONET Data

The AERONET provides the ground truth validation for this research. AERONET is a federation of sun-sky radiometers independently owned with centrally archived data, which can measure aerosol optical depth to an accuracy of ±0.02 (Holben et al., 1998). Data used in this study utilizes only those sites where the data have been cloud filtered as well as post-calibrated (i.e., level 2 data).

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3. AEROSOL RETRIEVAL METHOD

The retrieval of aerosol information from GOES data is a two-step process:

1) Composite the visible images to estimate the surface reflectance, and
2) Use the surface reflectance with an image to retrieve the aerosol optical depth.

These steps are described below.

3.1 Summary of Surface Reflectance Retrieval

The visible imagery is composited to determine the surface contribution to the top-of-the-atmosphere reflectance. For each pixel in the visible image, the darkest observation over the course of some time period is called the composite clear reflectance. By using this value to obtain the surface reflectance, one assumes: that aerosol would increase the reflectance and cloud shadows will be rare. The length of the time period is somewhat subjective. In general, a long enough time period is needed for at least one cloud-free observation. This study uses a two week (i.e., 14 day) period.

A radiative transfer model, the second simulation of satellite signal in the in the solar spectrum (6S) (Vermote et al., 1997), is used to convert the TOA observed reflectance to a surface reflectance. This atmospheric correction removes Rayleigh scattering and gaseous absorption, leaving the Lambertian surface reflectance. This is then used in following calculations to retrieve aerosol optical depth in the subsequent aerosol optical depth retrieval.

3.2 Aerosol Optical Depth Retrieval

The aerosol optical depth retrieval is performed using a GOES visible image and the retrieved surface reflectance (from the previous step). In this retrieval, the optical depth of the continental aerosol model in the 6S radiative transfer model is increased until the theoretical reflectance matches that in the GOES observation.

4. VALIDATION

GOES data available for this study is limited to January through December of 2001 and located over the U.S. The measured optical

depth at AERONET sites are used to validate the retrievals made using the GOES data. There are more than 20 AERONET sites located around the US during that time. The comparison between GOES aerosol optical depth and AERONET is shown in figure 1 grouped by geographic region.

5. SUMMARY

The GOES aerosol optical depth retrieval algorithm compares with ground truth to within ±0.10 for most sites on the East Coast (i.e., Northeast, Mid-Atlantic and oceanic sites). This high accuracy is limited to these regions, because deserts in the Southwest, more agriculture in the Central Plains, and large satellite view zenith angles in the Northwest limit the aerosol signal at the top of the atmosphere. This level of accuracy for most of the US , however, shows distinct possibilities for aiding research toward aerosol impact on weather and climate.

APPENDIX – REAL TIME MONITORING

This aerosol optical depth retrieval algorithm is operating in near real time as an experimental product at NOAA/NESDIS/ORA. Results of the retrievals can be found on the web at: orbit-net.nesdis.noaa.gov/crad3/gasp/RealTime.html

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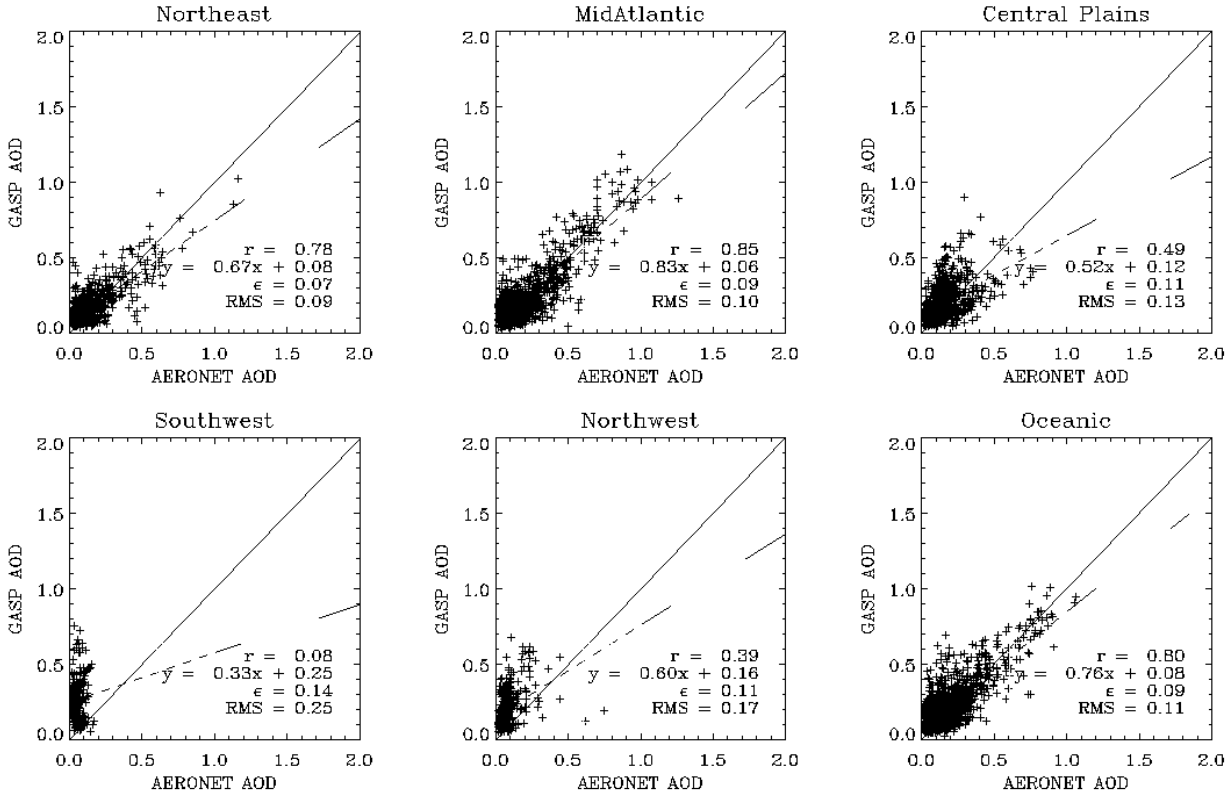

Figure 1 – Validation of the GOES aerosol optical depth (AOD) using the AERONET AOD. Linear regression statistics are provided.