Analysis of Bimodal Aerosol Size Distributions at SGP Using RSS 105 and AERONET CIMEL Data

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Abstract: *Bimodal aerosol retrievals are performed on optical depth data obtained from the RSS 105 and CIMEL located at SGP between 2003 and 2005, and compared to the size distribution retrievals obtained from the CIMEL data using the Dubovik and King [2000] algorithm. Significant differences in how the total aerosol optical thickness (AOT) is separated into coarse and fine modes are observed when the different algorithms are both applied to the CIMEL data, and differences in the measured optical depths between the two devices are noted as well. Climatologies for both devices show strong annual cycles of optical depth for both aerosol modes, with maxima in summer and minima in winter. The cycles of the two modes differ from each other, however, in regard to which summer months show peaks and which show relative minima.*

Need to Improve Aerosol Measurement

IPCC [2007] lists direct and indirect effects as radiative forcing components with greatest uncertainty.

Aerosol size distribution climatology used in GISS GCM does not agree with observations [*Liu et al., 2006*].

Variations in CCN concentration depend mostly on variations in aerosol size distribution [*Dusek et al., 2006*].

Information Limits

Only two or three independent items of information are obtainable from direct-beam data in wavelength range of RSS and CIMEL, assuming a 10% relative error in optical depth measurements [*Box et al., 1996*].

Fine and coarse mode optical depths can be separated. The fine mode effective radius (R_{EFF}) is also retrievable, but with greater uncertainty [*Gianelli et al., 2005*].

Comparing Retrieval Strategies

Optical depth-only algorithm [*Gianelli et al., 2005*]	**Sun and sky radiance measurements [*Dubovik and King, 2000*]**
1. Uses data from 15 wavelengths over full range of instrument	1. Uses data from channels at 440, 670, 870, and 1020 nm
2. Retrieves fine and coarse mode optical depth, and fine mode R_{EFF}	2. Retrieves full size distribution, plus real and complex index of refraction
3. Makes assumptions about remaining quantities	3. Effective radius and variance (R_{EFF} and V_{EFF}) for each mode obtained from size distribution

Table 1: How the retrieval algorithms differ

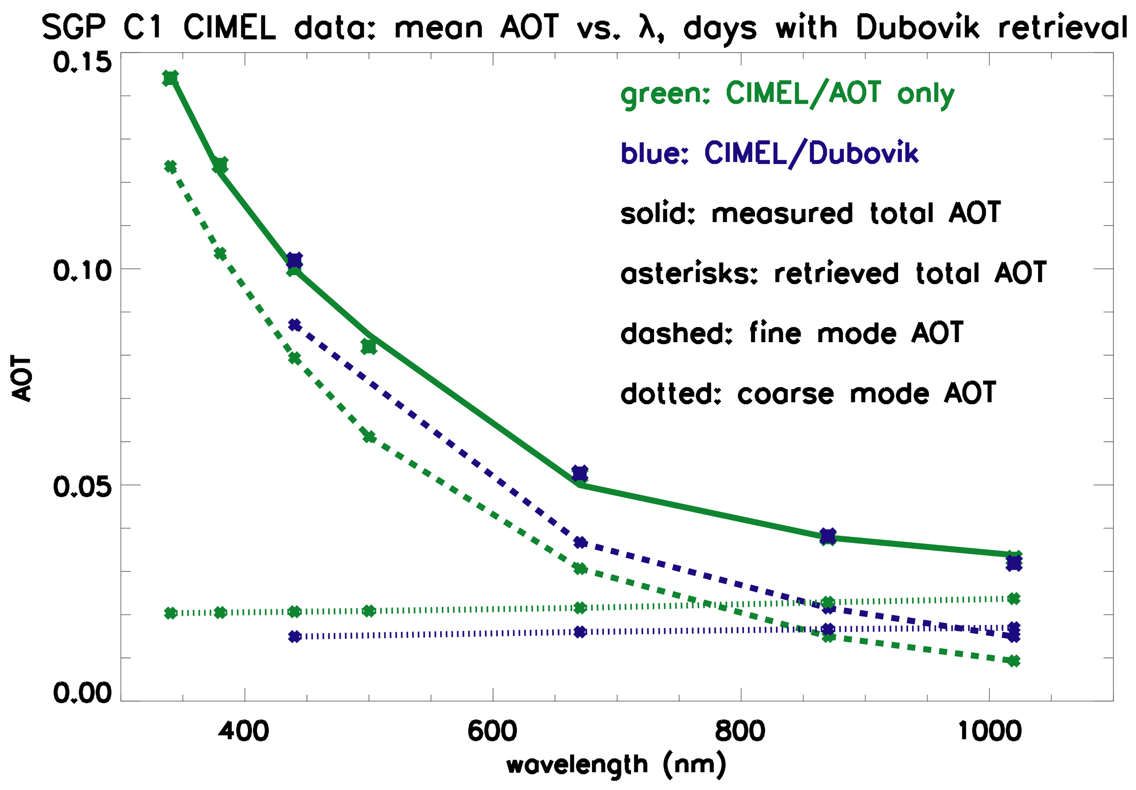

Figure 1: Applying both algorithms to the same data

The Dubovik algorithm attributes more extinction to the fine mode and less to the coarse mode, but the difference between retrieved total AOT and measured AOT is consistent with a bias towards smaller particles.

Comparing Optical Depth-Only Retrieval Results From Both Devices

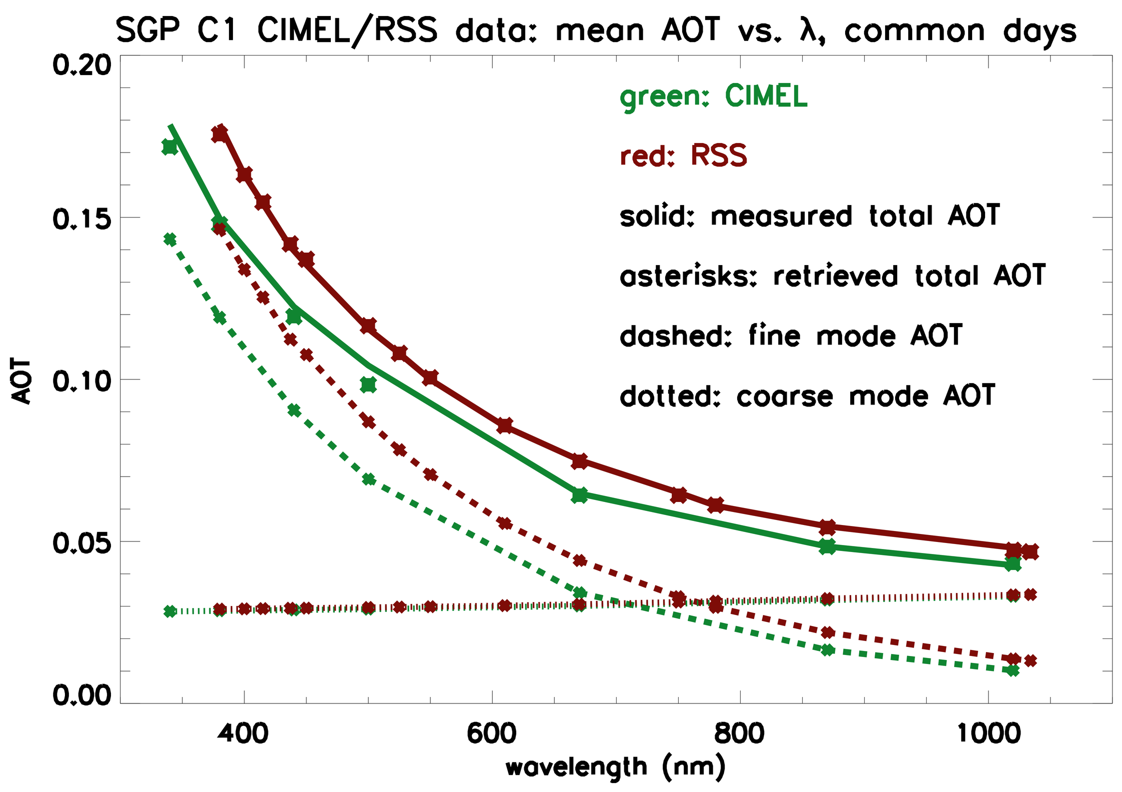

Figure 2: Mean optical depth values (measured and retrieved) for RSS and CIMEL

The RSS measures higher optical depth values than the CIMEL. The difference decreases with wavelength.

The mean coarse mode optical depths agree closely.

The retrieval produces a tighter fit to the RSS data.

Climatologies

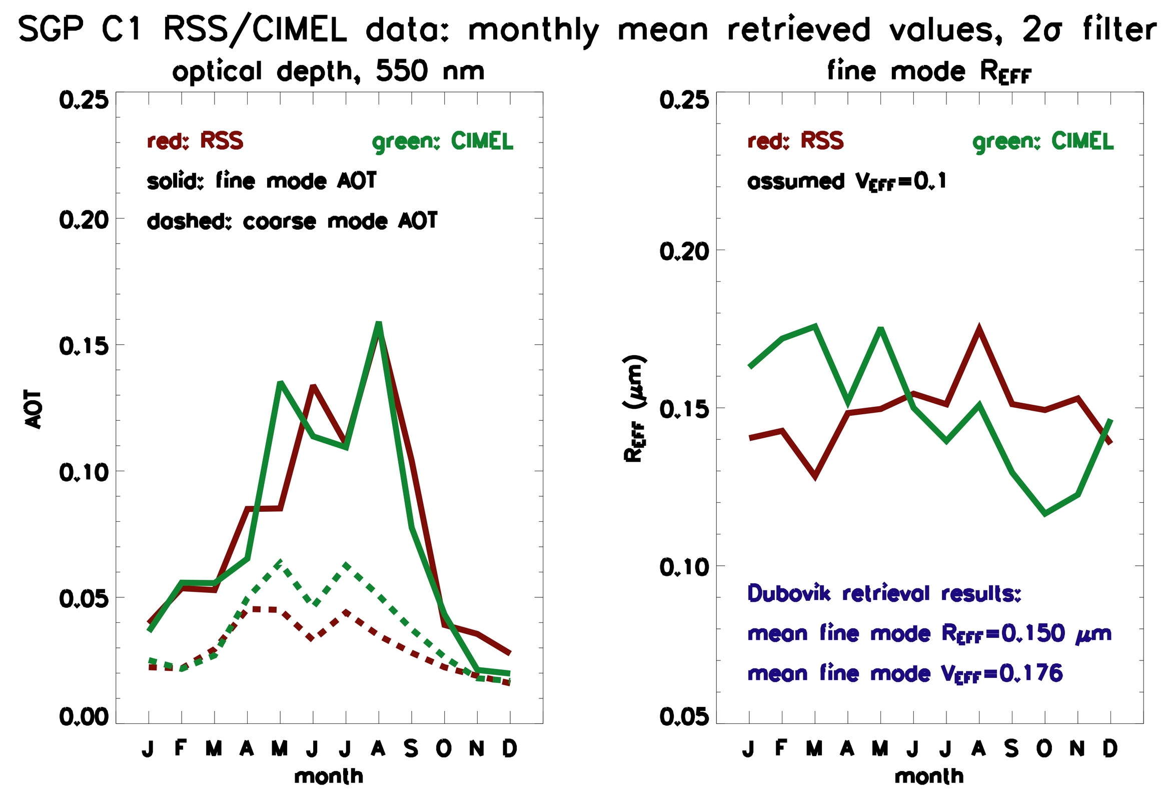

Figure 3: Monthly means of the coarse and fine mode optical depth and fine mode R_{EFF}

Both devices show relative minima for fine mode optical depth in July and coarse mode optical depth in June.

The seasonal cycles for fine mode R_{EFF} do not agree, but the mean values for each retrieval are all ~0.15 microns.

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