Measurements and Calculations of Solar Spectral Radiative Effects by Aerosols during PRIDE, SAFARI 2000 and ACE-Asia

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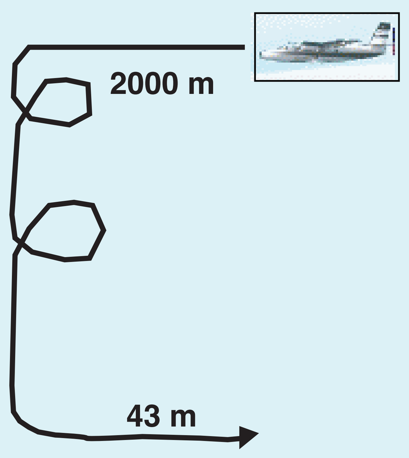
ABSTRACT

We have made measurements of the spectral solar radiative flux and optical depth during three field experiments: PRIDE, SAFARI 2000 and ACE Asia. The measurements were made on aircraft above and below the aerosol layers. By subtracting the spectral net flux above and below the layer we can compute the flux divergence (absorption) of the layer. We then made predictions of a detailed radiative transfer model for several specific days. By comparing the predictions and the measurements we then estimate the single scattering albedo of the aerosol. The SAFARI 2000 single scattering albedo shows a decrease with wavelength representative of small black carbon particles. The PRIDE and ACE Asia single scattering albedo results show an increase with wavelength representative of mineral dusts. We can use the aerosol radiative properties combined with satellite measurement of the optical depth to estimate the regional aerosol forcing.

Determining Aerosol Absorption

- Measure upwelling and solar downwelling spectral fluxes (using SSFR) at several levels above, below, and with dust layers
- Determine net spectral flux at each level
- Determine flux divergence (absorption) for each layer
- Determine the aerosol optical depth with the Ames Airborne Sunphotometer (AATS-14)
- Estimate the aerosol single scattering albedo by comparison to the model predictions



Solar Spectral Flux Radiometer (SSFR)

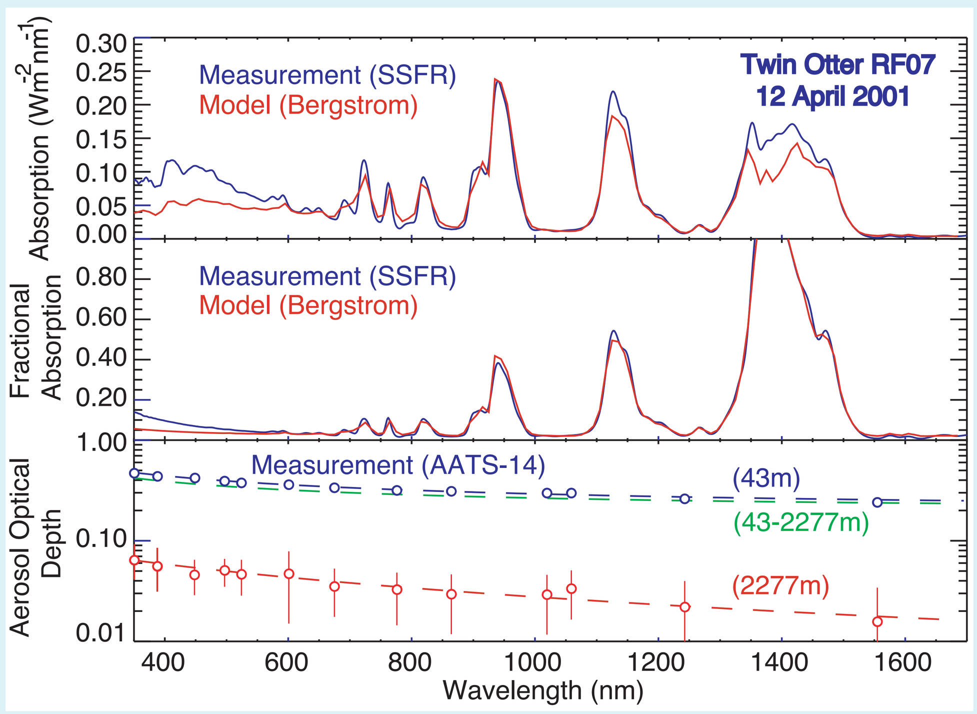
- wavelength range: 300 nm to 1700 nm
- spectral resolution ~ 8-12 nm
- simultaneous zenith and nadir viewing
- Accuracy: 3-5%; precision: 0.5%

Model Characteristics

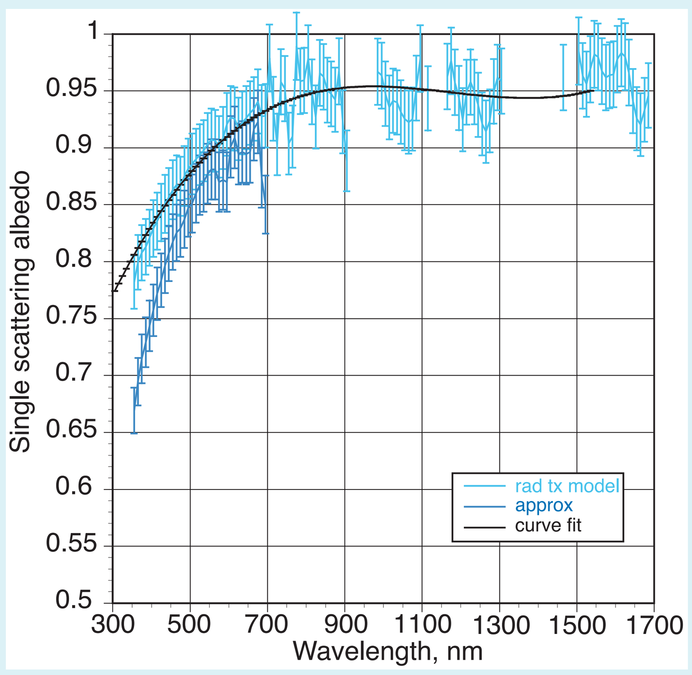
- 300 - 1700 nm in 10 nm intervals
- k distribution; 16 g points per interval
- instrument filter function (correlation in g space)
- Kurucz solar source function (correlation in g space)
- HITRAN with Giver corrections, LBLRTM
- DISORT spectral surface reflection

ACE-Asia

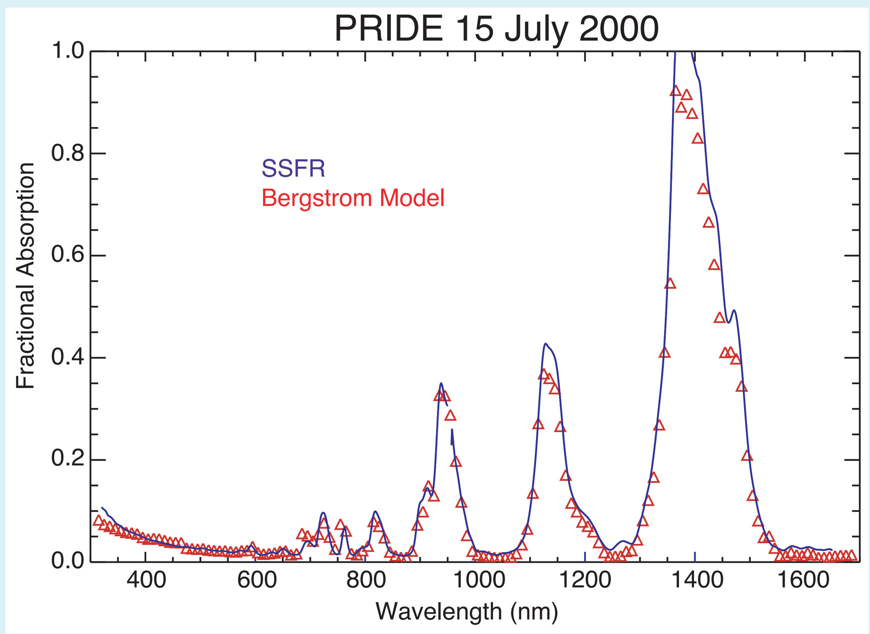
Absorption

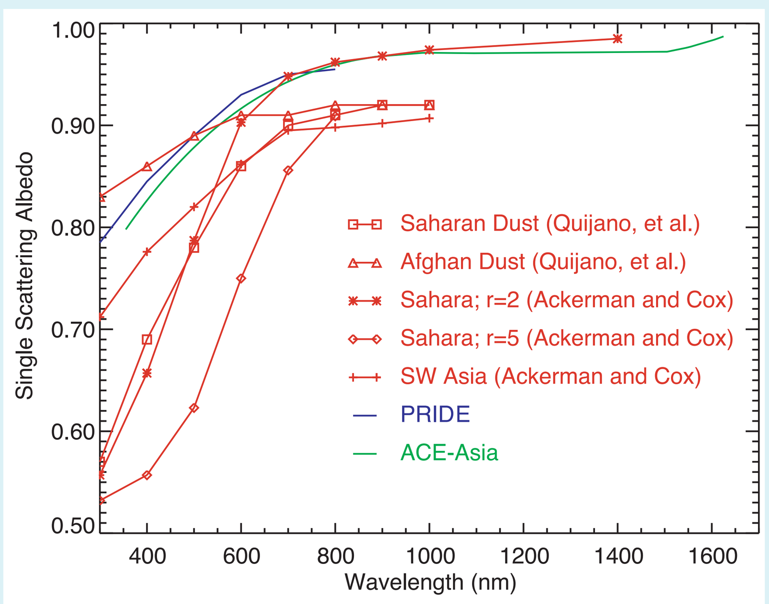


Single Scattering Albedo



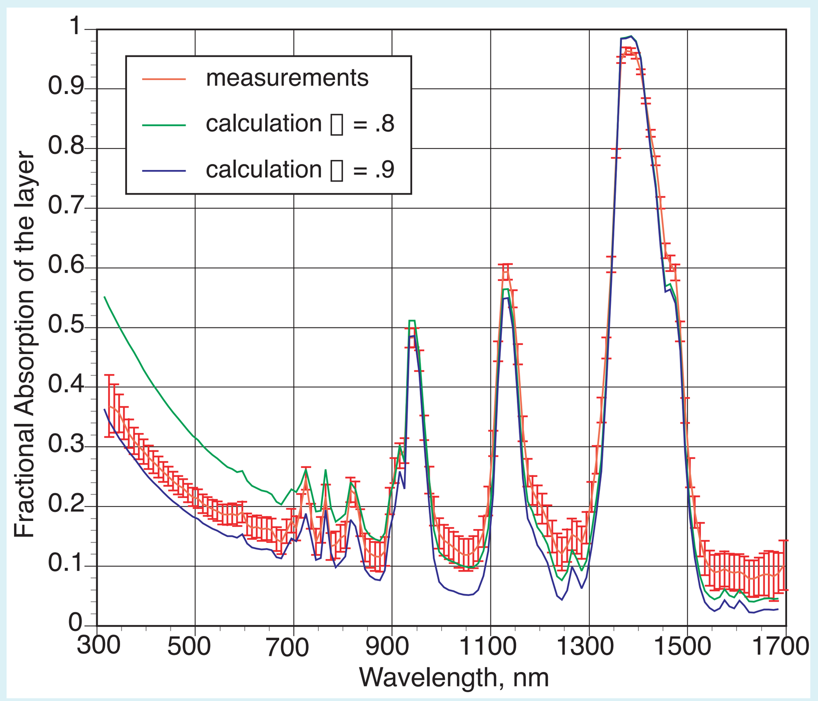
PRIDE

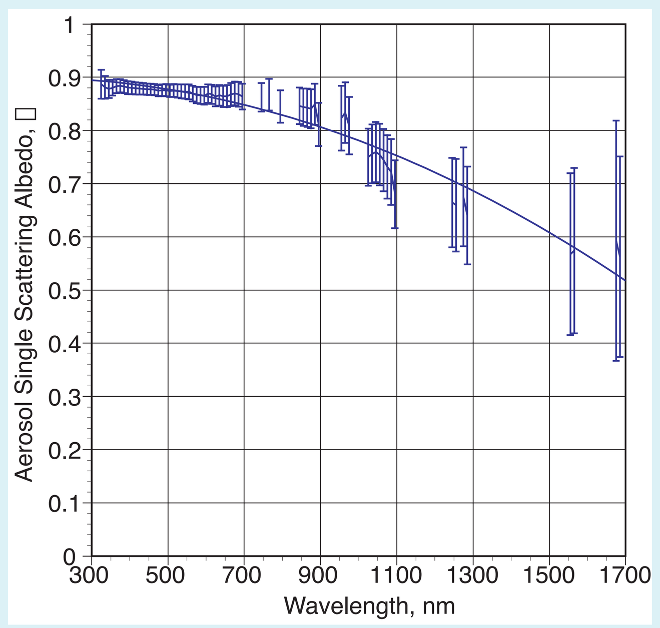




The decrease in the SSA with wavelength is indicative of small black carbon particles, see Sokalik et al 2001

SAFARI, 2000





The decrease in the SSA with wavelength is indicative of small black carbon particles, see Bergstrom et al 2001

Aerosol Radiative Forcing

(a) April 2001 monthly mean AOD at 865 nm derived from SeaWiFS radiances using the algorithm of Hsu et al. (2002). (b) 24h- average, cloud-free direct shortwave aerosol radiative forcing at the surface in Wm^{-2}, derived from total aerosol optical depth shown in (a). The radiative calculation assumes an aerosol model of dust over pollution aerosols. The relative amounts of dust and pollution aerosols are adjusted pixel-by-pixel to force model Angstrom exponent to equal the Angstrom exponent derived from the 4-wavelength SeaWiFS radiances by Hsu et al.(2002).