1.1 OVERVIEW OF ACE-ASIA SPRING 2001 INVESTIGATIONS ON AEROSOL-RADIATION INTERACTIONS

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## 1. INTRODUCTION

In spring 2001 the Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia) made extensive measurements from land, ocean, air and space platforms. A primary objective was to quantify the interactions between aerosols and radiation. This talk presents illustrative results from each type of platform, with initial assessments of regional aerosol radiative forcing obtained by combining satellite and suborbital results.

## 2. ILLUSTRATIVE RESULTS

Results to date include:

- AERONET sun-sky radiometry at 13 stations in the region yielded time series of multiwavelength aerosol optical depth (AOD), Angstrom exponent, single-scattering albedo (SSA) at 440 and 870 nm, and size distribution. Results from Beijing (e.g., Figure 1) and the Kosan, Korea supersite show marked anticorrelation between AOD and Angstrom exponent (caused by transient dust events), dust volume-size modes peaking at diameters near 8 microns, and dust SSA exceeding pollution SSA.

- Measurements of photosynthetically active radiation (PAR) in Yulin, China, combined with simultaneous aerosol measurements and radiative transfer calculations, yielded a 24-h average downward surface radiative forcing efficiency of -27 W m$^{-2}$ (400-700 nm) per 500-nm AOD. (See Figure 2.)

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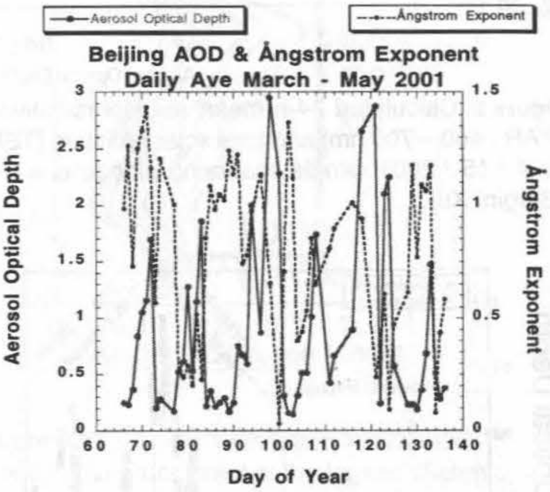


**Figure 1**. Aerosol optical depth (AOD) and Angstrom exponent from AERONET radiometry at Beijing during ACE-Asia Spring 2001 (Holben, Lu et al.).

- The R/V Brown cruise from Honolulu to Sea of Japan sampled an AOD gradient, with AOD(500 nm) varying between 0.1 and 1.1 (see Figure 3). In situ measurements of scattering and absorption showed that adding dust to pollution increased SSA(550 nm), typically from ~0.91 to ~0.97 for RH=55%. FTIR measurements of downwelling longwave radiance revealed aerosol effects in the 8-12 micron window, including signatures during a strong pollution event in early April (see Figure 4). Longwave forcing estimated from radiance measurements was ~2 to 9 W m$^{-2}$ (Vogelmann et al., 2002).

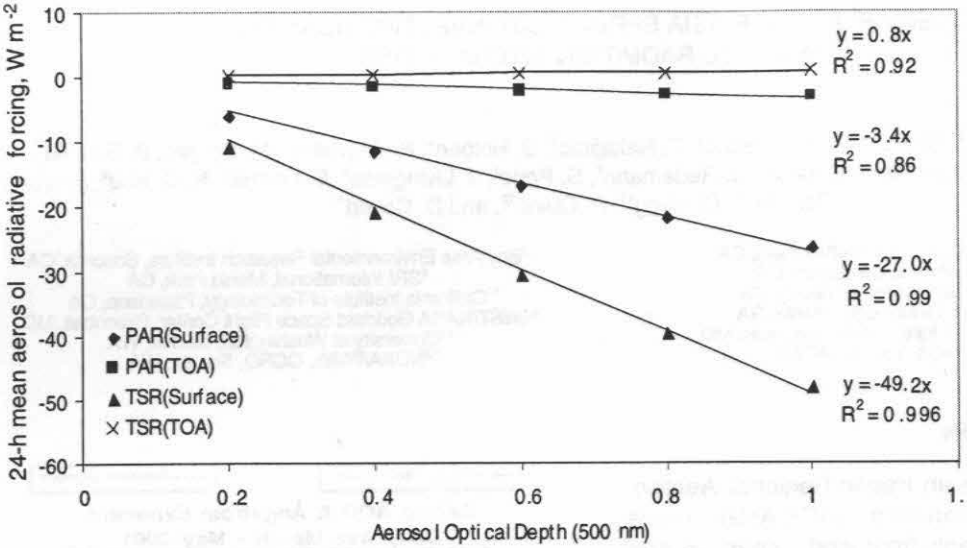


**Figure 2.** Calculated 24-h mean aerosol radiative forcing efficiency for photosynthetically active radiation (PAR , 400 – 700 nm) and total solar radiation (TSR, 0.2 – 4.0 μm) at surface and top of atmosphere (TOA) on 4 / 15 / 2001 (single scattering albedo ω = 0.93 , asymmetry factor g = 0.8, surface albedo $\alpha_s$ = 0.3) (Bergin, Xu).

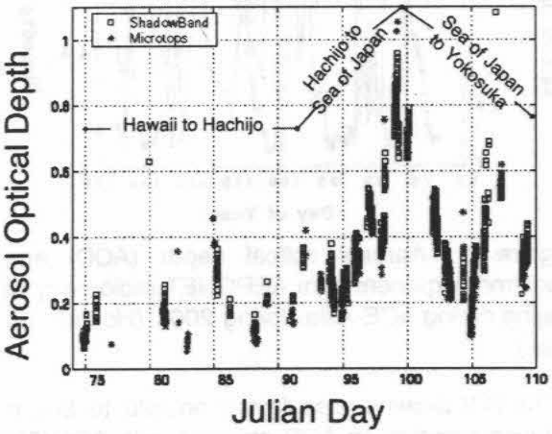


**Figure 3.** Aerosol optical depth measured by solar photometry aboard RV Ron Brown (Markowicz, Flatau et al.).

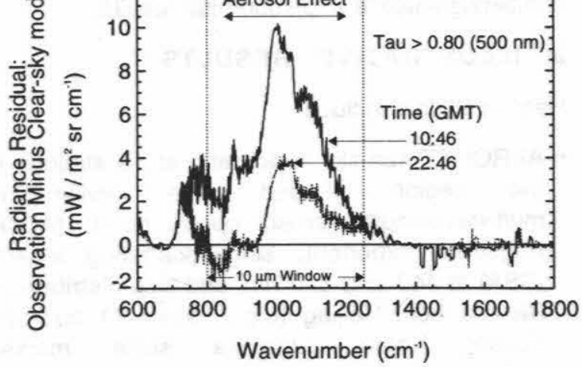


**Figure 4.** Aerosol effect on longwave radiance from FTIR measurements aboard RV Ron Brown, April 9 (Vogelmann et al. 2002).

- Vertical profiles of aerosol extinction from airborne sunphotometry and total-direct and diffuse spectral fluxes showed wavelength dependence that often varied strongly with height, in accord with the frequent layering of dust-dominated over pollution-dominated aerosols (e.g., Figure 5 and Redemann et al., 2002). Comparisons between sunphotometric extinction profiles and those from in situ measurements (size distribution and size-resolved composition, or scattering and absorption) showed good agreement in aerosol layer heights, but some differences in extinction and AOD, which are still being studied (e.g., Redemann et al., 2002; Wang et al., 2002).

- Solar spectral flux radiometry from different altitudes yielded absorption spectra for intervening atmospheric layers. Combining these with AOD spectra yields best-fit aerosol single scattering albedo spectra (e.g., Figure 6 and Pilewskie et al., 2002).

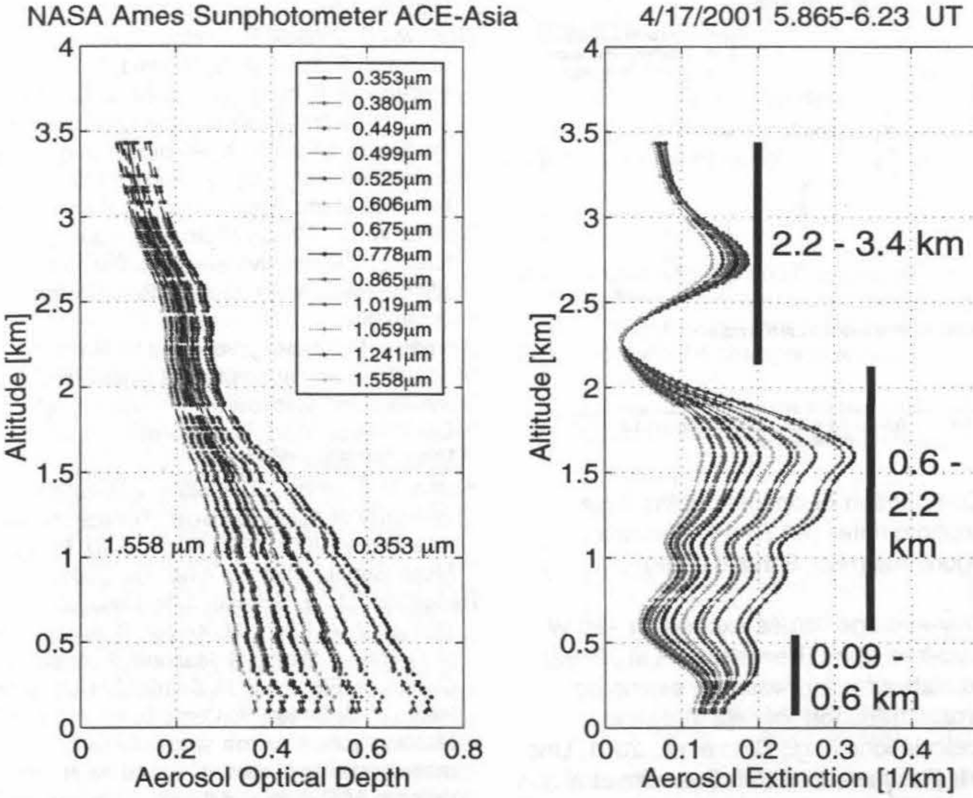


**Figure 5.** Aerosol optical depth and extinction profiles from AATS-14 on Twin Otter, 4/17/2001. Wavelengths of optical depth and extinction coefficients are in the order listed in the legend (Schmid, Redemann, Livingston).

- Visible, near-IR, and total solar fluxes combined with AOD give radiative forcing efficiencies at surface and aloft (e.g., Valero et al., 2002).
- An advanced SeaWiFS retrieval (4 wavelengths, 440 to 860 nm) produces AOD values over water that agree with airborne sunphotometer measurements to <~0.04, a considerable improvement over the standard 2-wavelength SeaWiFS algorithm (see Figure 7).
- Combining monthly-average satellite AOD fields with aerosol intensive properties from suborbital measurements yields estimated aerosol forcing maps for the ACE-Asia region. For example, April 2001 standard SeaWiFS AODs combined with a model of dust over pollution yield a plume of surface shortwave radiative forcing east of China

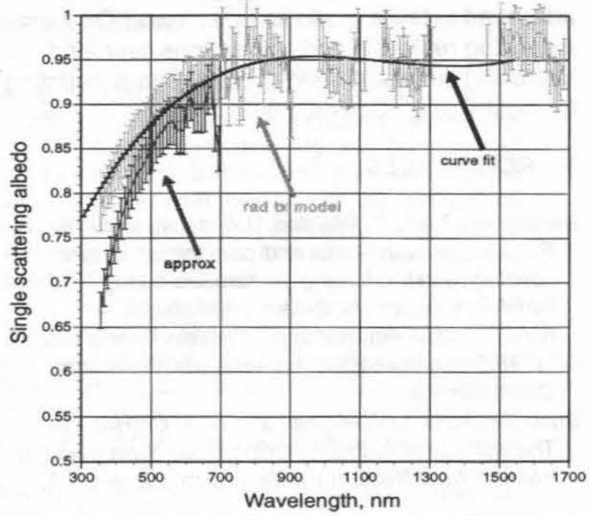


**Figure 6.** Aerosol single scattering albedo spectra derived from measured flux and AOD spectra on Twin Otter flight RF07, 12 April 2001 (Bergstrom, Pilewskie, Schmid).

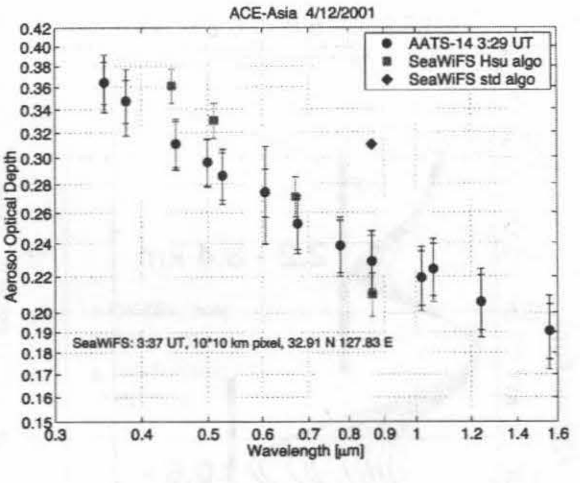


**Figure 7.** Comparison of optical depths from airborne sunphotometer (AATS-14) and two SeaWiFS algorithms (Hsu, Schmid et al.).

with monthly-average values exceeding –20 W $m^{-2}$ for cloud-free skies (Bergstrom et al., 2002). Regional radiative forcing was also estimated using chemical transport models that include radiative calculations (e.g., Chin et al., 2001; Uno et al., 2001; Rasch et al., 2001; Bucholtz et al., 2002)

Primary paths toward improved radiative forcing estimates include better characterizing dust, pollution, and mixed aerosol longwave and shortwave properties, validating and using more advanced satellite products (e.g., from EOS Terra), extending retrievals and calculations over land, improving surface albedo spectra, and accounting for clouds (e.g., Collins, 2002).

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