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Aerosol optical depth measurements by airborne sun photometer in SOLVE II: Comparisons to SAGE III, POAM III and airborne spectrometer measurements

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Abstract. The 14-channel NASA Ames Airborne Tracking Sunphotometer (AATS-14) measured solar- beam transmission on the NASA DC-8 during the second SAGE III Ozone Loss and Validation Experiment (SOLVE II). This paper presents AATS-14 results for multiwavelength aerosol optical depth (*AOD*), including comparisons to results from two satellite sensors and another DC-8 instrument, namely the Stratospheric Aerosol and Gas Experiment III (SAGE III), the Polar Ozone and Aerosol Measurement III (POAM III) and the Direct-beam Irradiance Airborne Spectrometer (DIAS). AATS-14 provides aerosol results at 13 wavelengths λ spanning the range of SAGE III and POAM III aerosol wavelengths. Because most AATS measurements were made at solar zenith angles (*SZA*) near 90°, retrieved *AOD*s are strongly affected by uncertainties in the relative optical airmass of the aerosols and other constituents along the line of sight (LOS) between instrument and sun. To reduce dependence of the AATS-satellite comparisons on airmass, we perform the comparisons in LOS transmission and LOS optical thickness (OT) as well as in vertical OT (i.e., optical depth, *OD*). We also use a new airmass algorithm that validates the algorithm we previously used to within 2% for $SZA<90°$, and in addition provides results for $SZA \geq 90°$.

For 6 DC-8 flights, 19 January-2 February 2003, AATS and DIAS results for LOS aerosol OT at λ=400nm agree to ≤12% of the AATS value. Mean and root-mean-square (RMS) differences, (DIAS-AATS)/AATS, are -2.3% and 7.7%, respectively. For DC-8 altitudes, AATS-satellite comparisons are possible only for λ>440nm, because of signal depletion for shorter λ on the satellite full-limb LOS. For the 4 AATS-SAGE and 4 AATS-POAM near-coincidences conducted 19-31 January 2003, AATS-satellite *AOD* differences were ≤0.0041 for all λ>440nm. RMS differences were ≤0.0022 for SAGE-

AATS and ≤0.0026 for POAM-AATS. RMS relative differences in *AOD* ([SAGE-AATS]/AATS) were ≤33% for λ<~755nm, but grew to 59% for 1020nm and 66% at 1545nm. For λ>~755nm, AATS-POAM differences were less than AATS-SAGE differences, and RMS relative differences in *AOD* ([AATS-POAM]/AATS) were ≤31% for all λ between 440 and 1020nm. Unexplained differences that remain are associated with transmission differences, rather than differences in gas subtraction or conversion from LOS to vertical quantities. The very small stratospheric *AOD* values that occurred during SOLVE II added to the challenge of the comparisons, but do not explain all the differences.

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