Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 5, 2035-2054, 2005
www.atmos-chem-phys.net/5/2035/2005/

Retrieval of ozone column content from airborne Sun photometer measurements during SOLVE II: comparison with coincident satellite and aircraft measurements

J. M. Livingston[1], B. Schmid[2], P. B. Russell[3], J. A. Eilers[3], R. W. Kolyer[3], J. Redemann[2], S. R. Ramirez[2], J.-H. Yee[4], W. H. Swartz[4], C. R. Trepte[5], L. W. Thomason[5], M. C. Pitts[5], M. A. Avery[5], C. E. Randall[6], J. D. Lumpe[7], R. M. Bevilacqua[8], M. Bittner[9], T. Erbertseder[9], R. D. McPeters[10], R. E. Shetter[11], E. V. Browell[5], J. B. Kerr[12], and K. Lamb[13]

[1]SRI International, Menlo Park, CA, USA
[2]Bay Area Environmental Research Institute, Sonoma, CA, USA
[3]NASA Ames Research Center, Moffett Field, CA, USA
[4]Applied Physics Laboratory, Johns Hopkins University, Laurel, MD, USA
[5]NASA Langley Research Center, Hampton, VA, USA
[6]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, USA
[7]Computational Physics, Inc., Springfield, VA, USA
[8]Naval Research Laboratory, Washington D.C., USA
[9]DLR (German Aerospace Center), Oberpfaffenhofen, Wessling, Germany
[10]NASA Goddard Space Flight Center, Greenbelt, MD, USA
[11]National Center for Atmospheric Research, Boulder, CO, USA
[12]Environment Canada, Cobble Hill, BC, Canada USA
[13]International Ozone Services, Inc., Toronto, ON, Canada

Abstract. During the 2003 SAGE (Stratospheric Aerosol and Gas Experiment) III Ozone Loss and Validation Experiment (SOLVE) II, the fourteen-channel NASA Ames Airborne Tracking Sunphotometer (AATS-14) was mounted on the NASA DC-8 aircraft and measured spectra of total and aerosol optical depth (TOD and AOD) during the sunlit portions of eight science flights. Values of ozone column content above the aircraft have been derived from the AATS-14 measurements by using a linear least squares method that exploits the differential ozone absorption in the seven AATS-14 channels located within the Chappuis band. We compare AATS-14 columnar ozone retrievals with temporally and spatially near-coincident measurements acquired by the SAGE III and the Polar Ozone and Aerosol Measurement (POAM) III satellite sensors during four solar occultation events observed by each satellite. RMS differences are 19 DU (7% of the AATS value) for AATS-SAGE and 10 DU (3% of the AATS value) for AATS-POAM. In these checks of consistency between AATS-14 and SAGE III or POAM III ozone results, the AATS-14 analyses use airmass factors derived from the relative vertical profiles of ozone and aerosol extinction obtained by SAGE III or POAM III.
We also compare AATS-14 ozone retrievals for measurements obtained during three DC-8 flights that included extended horizontal transects with total column ozone data acquired by the Total Ozone Mapping Spectrometer (TOMS) and the Global Ozone Monitoring Experiment (GOME) satellite sensors. To enable these comparisons, the amount of ozone in

the column below the aircraft is estimated either by assuming a climatological model or by combining SAGE and/or POAM data with high resolution in-situ ozone measurements acquired by the NASA Langley Research Center chemiluminescent ozone sensor, FASTOZ, during the aircraft vertical profile at the start or end of each flight. Resultant total column ozone values agree with corresponding TOMS and GOME measurements to within 10-15 DU (~3%) for AATS data acquired during two flights - a longitudinal transect from Sweden to Greenland on 21 January, and a latitudinal transect from 47° N to 35° N on 6 February. For the round trip DC-8 latitudinal transect between 34° N and 22° N on 19-20 December 2002, resultant AATS-14 ozone retrievals plus below-aircraft ozone estimates yield a latitudinal gradient that is similar in shape to that observed by TOMS and GOME, but resultant AATS values exceed the corresponding satellite values by up to 30 DU at certain latitudes. These differences are unexplained, but they are attributed to spatial and temporal variability that was associated with the dynamics near the subtropical jet but was unresolved by the satellite sensors.

For selected cases, we also compare AATS-14 ozone retrievals with values derived from coincident measurements by the other two DC-8 based solar occultation instruments: the National Center for Atmospheric Research Direct beam Irradiance Airborne Spectrometer (DIAS) and the NASA Langley Research Center Gas and Aerosol Monitoring System (GAMS). AATS and DIAS retrievals agree to within RMS differences of 1% of the AATS values for the 21 January and 19-20 December flights, and 2.3% for the 6 February flight. Corresponding AATS-GAMS RMS differences are ~1.5% for the 21 January flight; GAMS data were not compared for the 6 February flight and were not available for the 19-20 December flight. Line of sight ozone retrievals from coincident measurements obtained by the three DC-8 solar occultation instruments during the SAGE III solar occultation event on 24 January yield RMS differences of 2.1% for AATS-DIAS and 0.5% for AATS-GAMS.

Final Revised Paper (PDF, 1632 KB) Discussion Paper (ACPD)

Citation: Livingston, J. M., Schmid, B., Russell, P. B., Eilers, J. A., Kolyer, R. W., Redemann, J., Ramirez, S. R., Yee, J.-H., Swartz, W. H., Trepte, C. R., Thomason, L. W., Pitts, M. C., Avery, M. A., Randall, C. E., Lumpe, J. D., Bevilacqua, R. M., Bittner, M., Erbertseder, T., McPeters, R. D., Shetter, R. E., Browell, E. V., Kerr, J. B., and Lamb, K.: Retrieval of ozone column content from airborne Sun photometer measurements during SOLVE II: comparison with coincident satellite and aircraft measurements, Atmos. Chem. Phys., 5, 2035-2054, 2005. Bibtex EndNote Reference Manager