Retrieval of Ozone Column Content from Airborne Sun Photometer Measurements during SOLVE II: Comparison with SAGE III, POAM III, TOMS and GOME Measurements

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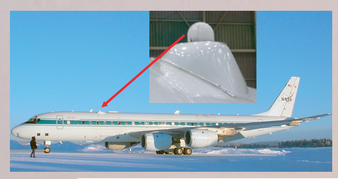
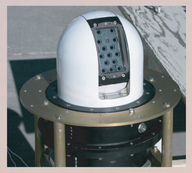
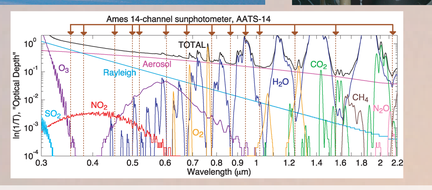
INTRODUCTION and METHOD:

During the Second SAGE III Ozone Loss and Validation Experiment (SOLVE II), the 14-channel NASA Ames Airborne Tracking Sunphotometer (AATS-14) was mounted on the NASA DC-8 and successfully 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 data by using a weighted linear least squares method (King and Byrne, 1976). For each AATS-14 measured TOD spectrum, this method iteratively finds the ozone column content that yields the best match between measured and calculated TOD. The calculations assume the known Chappuis ozone band shape (see below) and a three-parameter AOD shape (quadratic in log-log space). Seven of the AATS-14 channels (each employing an interference filter with a nominal full-width at half maximum bandpass of ~5 nm) are within the Chappuis band, with center wavelengths between 452.9 nm and 864.5 nm. One channel (604.4 nm) is near the peak, and three channels (499.4, 519.4 and 675.1 nm) have ozone absorption within 23-40% of that at the peak. For the typical DC-8 SOLVE II cruising altitudes of ~8-12 km and the background stratospheric aerosol conditions that prevailed during SOLVE II, absorption of incoming solar radiation by ozone comprised a significant fraction of the aerosol-plus-ozone optical depth measured in the four AATS-14 channels centered between 499.4 and 675.1 nm (see below). Typical AODs above the DC-8 ranged from 0.003-0.008 in these channels. For comparison, an ozone overburden of 0.3 atm-cm (300 DU) translates to ozone optical depths of 0.009, 0.014, 0.041, and 0.012, respectively, at these same wavelengths.





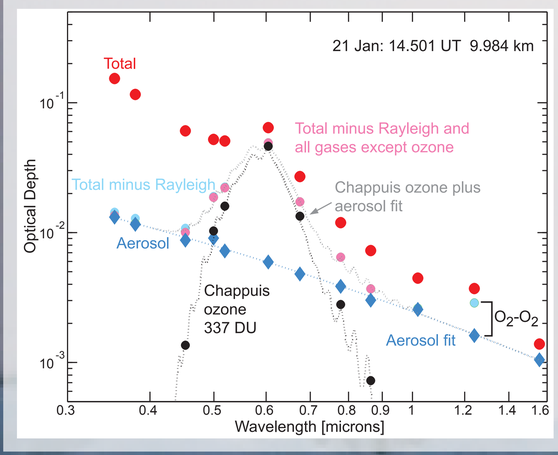


Below, we compare AATS-14 values of ozone column content with temporally and spatially near-coincident values derived from measurements acquired by the Stratospheric Aerosol and Gas Experiment III (SAGE III) and the Polar Ozone and Aerosol Measurement III (POAM III) satellite sensors. We also compare AATS-14 ozone retrievals during selected DC-8 latitudinal and longitudinal 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 this comparison, the amount of ozone in the column below the aircraft is estimated by combining SAGE and/or POAM data with high resolution, fast response in-situ ozone measurements acquired during the DC-8 ascent at the start of each science flight.

SUMMARY and CONCLUSIONS:

- AATS-14 measurements on the DC-8 during SOLVE II have been analyzed using least squares methodology to retrieve values of columnar ozone above aircraft altitude. The technique exploits the differential absorption at AATS-14 channels located within the Chappuis ozone absorption band and assumes a known AOD spectral shape (quadratic in log-log space).
- AATS-14 columnar ozone retrievals have been compared with measurements by SAGE III and POAM III for four coincident occultation events, each. AATS values agree with corresponding satellite values to within 30 DU for all events, including five events where the agreement is better than 10 DU.
- Values of overlying columnar ozone retrieved from AATS-14 measurements aquired during extended horizontal transects by the DC-8 during three flights have been compared with corresponding near-coincident TOMS and GOME total ozone column retrievals. Results are found to be mutually consistent, especially when the amount of ozone below the aircraft is estimated from data obtained by a fast response in-situ ozone sensor (FastOz) during aircraft ascent (21 Jan).
- AATS-14 ozone retrievals have been compared directly with FastOz measurements during the DC-8 descent (12.4-1.1 km altitude) into Edwards AFB on 6 Feb. Corresponding layer ozone values agree to within ~12 DU for the 12.4-1.1 km layer. Profiles of ozone number density are in agreement considering the coarser vertical resolution of the AATS-differentiated vertical profile.

RETRIEVAL METHODOLOGY



For aerosol results see Russell, Livingston et al., Poster 13, Friday AM

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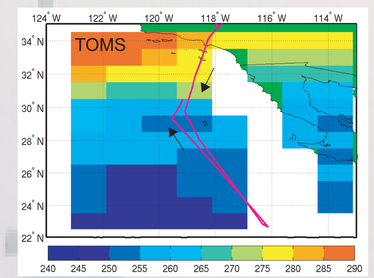

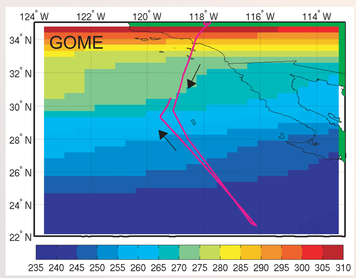

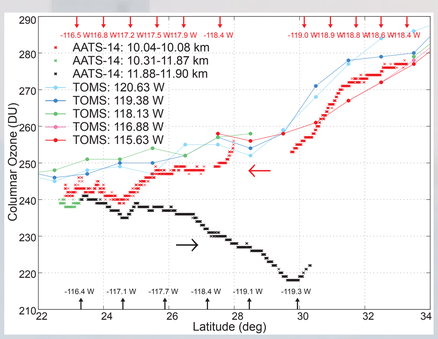

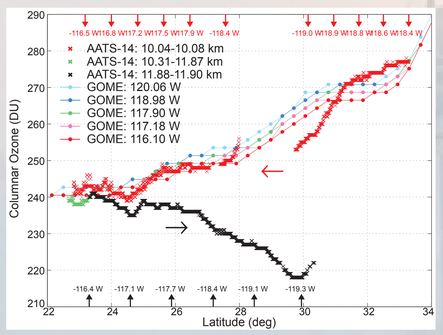

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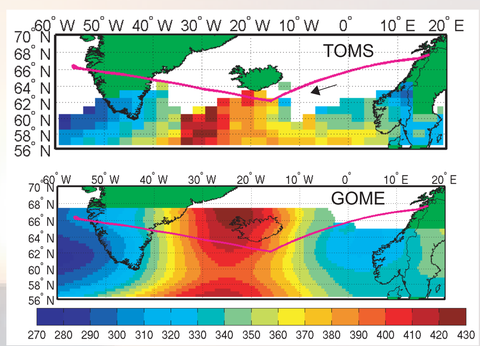

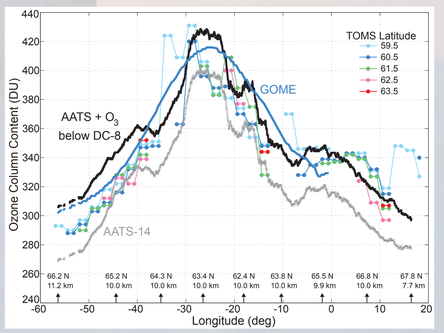

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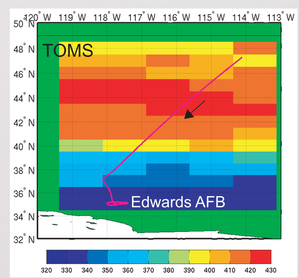
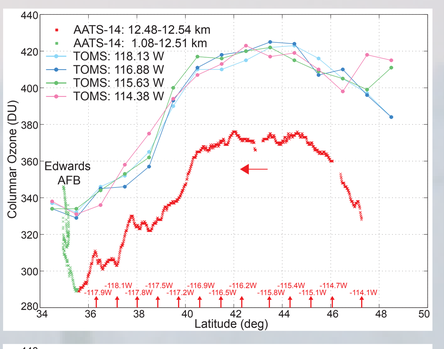
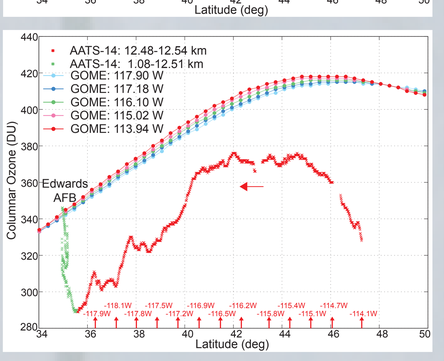
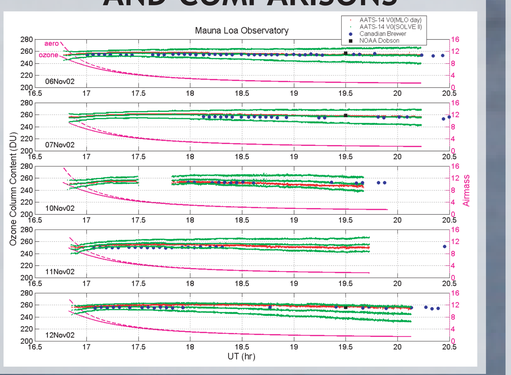






MAUNA LOA CALIBRATION AND COMPARISONS



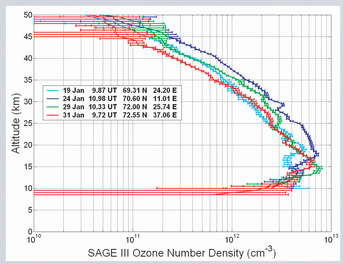
COMPARISONS WITH SAGE III and POAM III

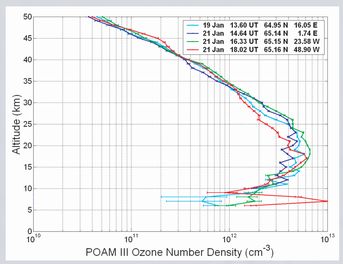
AATS-14/ SAGE III Coincidences

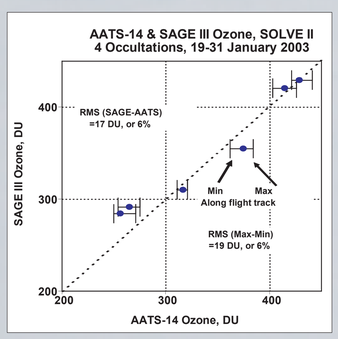
DATE	SAGE UT	SAGE Lat	SAGE Lon	AATS UT	Separation (km)
19 Jan	9.87	69.31 N	24.20 E	9.69-9.80	39-99
24 Jan	10.98	70.60 N	11.01 E	10.60-10.89	7-205
29 Jan	10.33	72.00 N	25.74 W	10.13-10.43	59-100
31 Jan	9.72	72.55 N	36.90 W	9.39-9.81	81-150

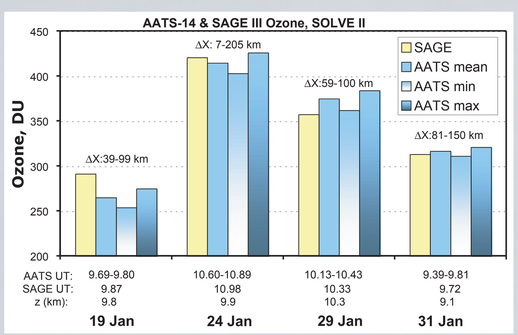
AATS-14/ POAM III Coincidences

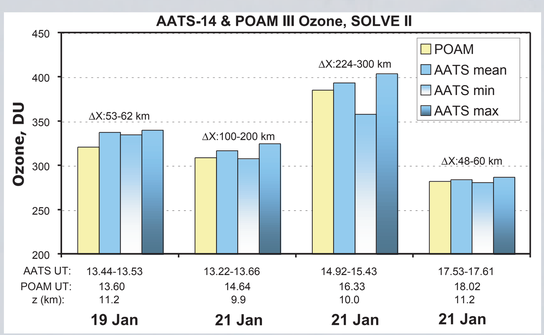
DATE	POAM UT	POAM Lat	POAM Lon	AATS UT	Separation (km)
19 Jan	13.60	64.95 N	16.05 E	13.10-13.22	34-59
21 Jan	14.64	65.14 N	1.74 E	13.22-13.66	138-200
21 Jan	16.33	65.15 N	23.58 W	14.92-15.43	251-300
21 Jan	18.02	65.16 N	48.90 W	17.53-17.61	52-60











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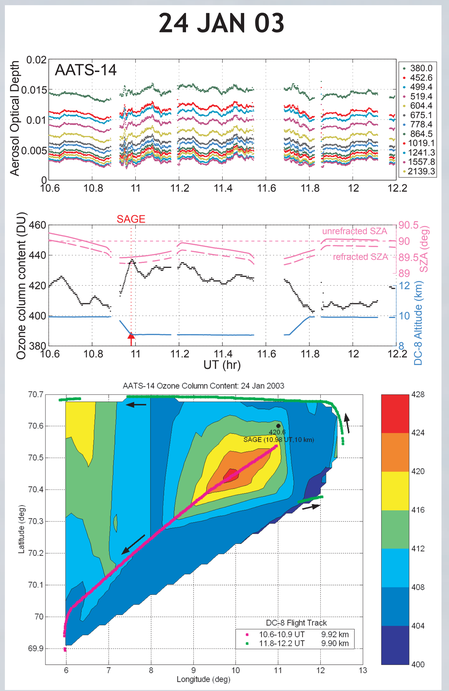
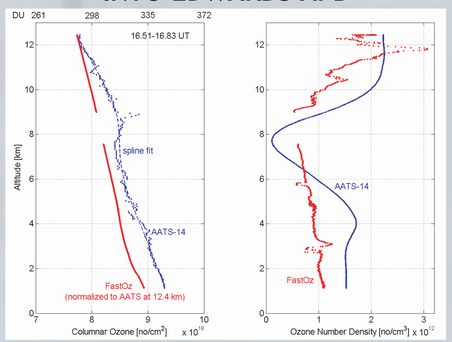


COMPARISON WITH FASTOZ DURING DC-8 DESCENT INTO EDWARDS AFB



REFERENCE

King, M. D., and D. M. Byrne, A method for inferring total ozone content from the spectral variation of total optical depth obtained with a solar radiometer, *J. Atmos. Sci.*, *33*, 2242-2251, 1976.