Coincident Airborne Sunphotometer and Satellite Aerosol Optical Depth Measurements During INTEX/ITCT 2004

AATS-14

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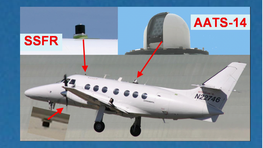
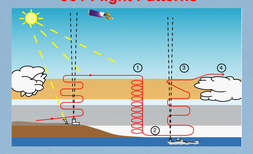


Jetstream-J31 in INTEX/ITCT

Abstract

The NASA Ames 14-channel Airborne Tracking Sunphotometer (AATS-14) measures the direct solar beam transmission at 14 discrete wavelengths (354-2138 nm), and provides instantaneous measurements of aerosol optical depth (AOD) spectra and water vapor column content, in addition to vertical profiles of aerosol extinction and water vapor density during suitable aircraft ascents and descents. During the period 12 July - 8 August 2004, AATS-14 was operated aboard a Jetstream 31 (J31) aircraft and acquired measurements during 19 science flights (~53 flight hours) over the Gulf of Maine in support of the INTEX-NA (INtercontinental chemical Transport EXperiment-North America) and ITCT (Intercontinental Transport and Chemical Transformation of anthropogenic pollution) field studies.

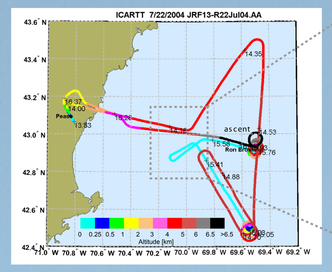
J31 Flight Patterns

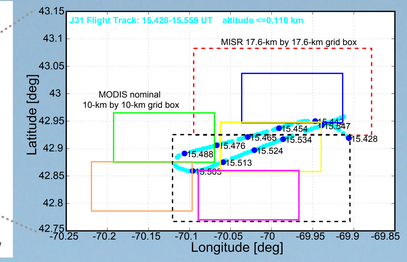


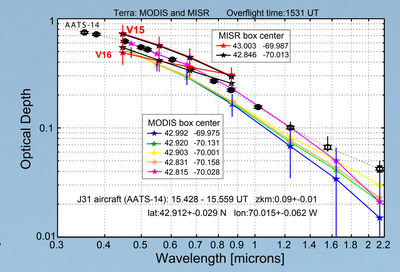
(1) Survey Vertical Profile. (2) MInimum-Altitude Transect. (3) Parking Garage. (4) Above-Cloud Transect.

Because J31 measurements during INTEX/ITCT targeted a variety of science objectives, specific J31 flight patterns were designed to achieve these goals and included a mixture of vertical profiles (spiral and ramped ascents and descents) and constant altitude horizontal transects at a variety of altitudes. One of the primary objectives of the AATS-14 measurements was to provide data for evaluation of aerosol optical depth retrievals derived from coincident measurements by the MODIS (MODerate-resolution Imaging Spectroradiometer) and MISR (Multi-angle Imaging Spectro-Radiometer) satellite sensors. To accommodate these AATS-14 measurements, most J31 flights were designed to include a near sea surface horizontal transect in a region of minimal cloud cover during or near the time of an Aqua (MODIS) and/or a Terra (MODIS and MISR) satellite overpass. During INTEX/ITCT, fourteen J31 flights included segments that were temporally and/or spatially near-coincident with a Terra or an Aqua satellite overpass. In this paper, we compare the AATS-14 and satellite sensor spectral AOD retrievals by examining spatial and temporal variability measured by AATS-14 along the J31 flight paths within the satellite sensor suborbital retrieval boxes.

Comparison of Coincident AATS-14, MODIS, and MISR AOD Retrievals for 22 July Terra Overflight

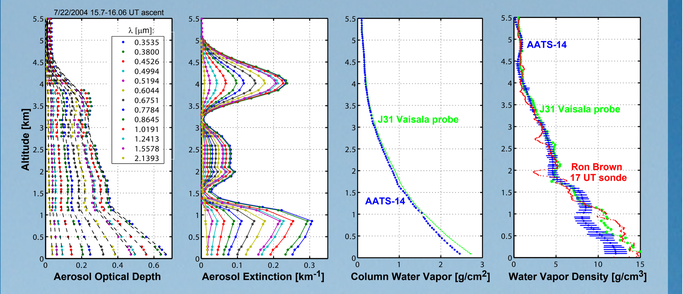






AATS-14 measurements were acquired during a near-surface (~110 m MSL) J31 transect coincident in time and space with a Terra overflight on 22 July. In a rare occurrence, AOD retrievals are available both for MISR and for MODIS measurements during this overflight. AATS-14 AODs represent mean values along the low altitude flight segment, and vertical bars depict the spread (no horizontal ticks), the standard deviation (wide ticks), and the measurement and retrieval uncertainty (narrow ticks). Corresponding vertical bars on the MODIS and MISR AOD values reflect the expected uncertainties in those retrievals. MISR Version 15 and Version 16 AOD retrievals are shown. No AOD contributions from the boundary layer below aircraft altitude have been added to the AATS-14 AOD values.

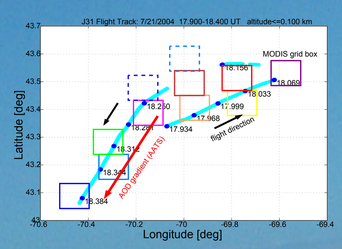
AATS-14 Vertical Profile Measurements for 22 July

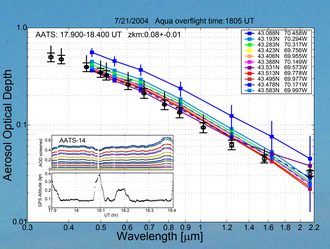


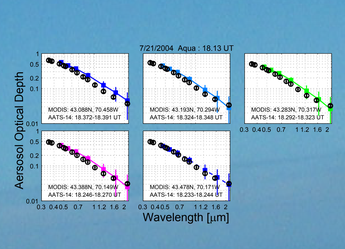
Vertical profiles of aerosol extinction and water vapor density have been derived from the AATS-14 measurements of aerosol optical depth and columnar water vapor, respectively, that were obtained during the J31 ascent (15.7-16.06 UT) immediately following the low altitude horizontal transect during the Terra overpass. The J31 ascent was conducted within a few km of the NOAA Ship Ronald H. Brown, which included a variety of in-situ and remote sensors. The AATS-14 water vapor measurements are shown together with coincident data from a Vaisala humidity probe on the J31 and with near-coincident measurements obtained by a radiosonde launched from the Ron Brown at 17 UT.

AATS-14/MODIS Aerosol Optical Depth Comparisons

21 July







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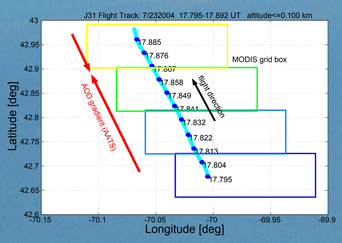
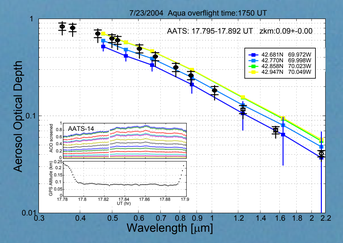
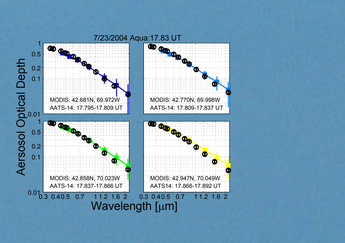
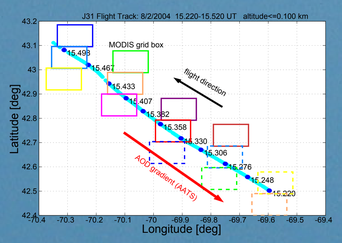
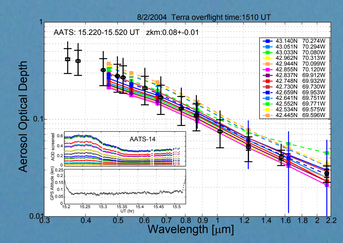


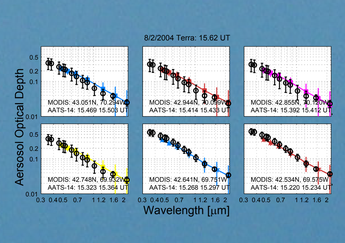




2 Aug



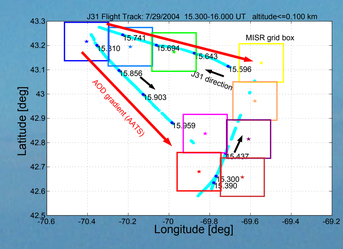


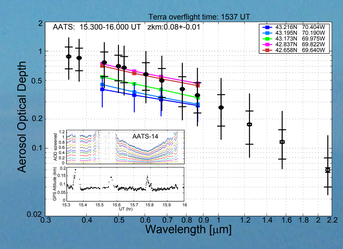


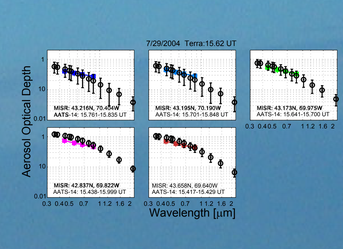
These plots present AATS-14 and MODIS results obtained during Aqua or Terra satellite overflights. For each day, the left frame shows the J31 track for that segment of the aircraft flight when cloud-free AATS-14 AOD measurements were acquired during a low altitude (~80-90 m ASL) horizontal transect; the locations of the MODIS nominal 10-km by 10-km retrieval boxes (uncorrected for longitudinal stretching) are also shown. AATS-14 and MODIS AOD retrievals are shown in the middle frame, with an inset that plots AATS-14 spectral AOD and J31 altitude as a function of time. The MODIS retrievals are color-coded to match the colors of the boxes shown in the left frame. In the right frame, MODIS AOD values within specific MODIS grid boxes are compared with corresponding AATS-14 AOD values within those same boxes. A horizontal AOD gradient was observed by both sensors in each of the three cases.

AATS-14/MISR Aerosol Optical Depth Comparisons

29 July







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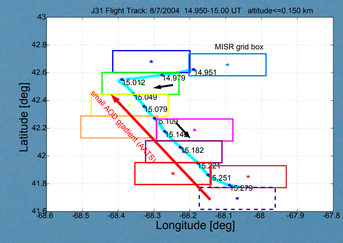

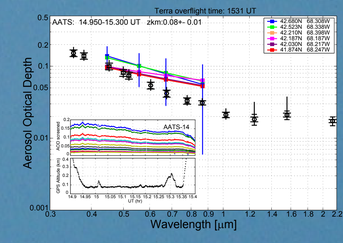

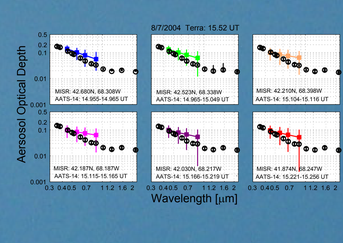

Analogous plots are presented for AATS-14 and MISR data obtained during Terra satellite overflights. The MISR AOD data shown here are MISR Version 16 retrieval algorithm results. AATS-14 AOD values have not been adjusted to account for the amount of boundary layer AOD below aircraft altitude. Subsequent analysis will use coincident near-sea surface measurements acquired from aboard the NOAA Ship Ronald H. Brown during J31 flybys to estimate AOD contributions below aircraft altitude.

Current and Future Analyses

- The magnitudes and shapes of AATS-14 AOD spectra measured during INTEX/ITCT 2004 during Terra overflights are currently being used to evaluate and will be used to update, as necessary, the range of allowable aerosol optical models used in the MISR AOD retrieval algorithm.
- AATS-14 retrievals of aerosol optical depth and extinction during J31 vertical profiling are available for comparison with coincident in-situ and/or lidar measurements from the NASA DC-8 and the NOAA DC-3 aircraft, and the NOAA R/V Ronald H. Brown in aerosol column closure studies.
- AATS-14 retrievals of columnar water vapor and water vapor density during J31 vertical profiling are being compared with water vapor measurements from Vaisala sensors on board the J31 and on balloonsondes launched from the Ron Brown, and with near-coincident AIRS satellite-based measurements.
- AATS-14 spectral AOD data acquired in horizontal AOD gradients have been combined with simultaneous spectral irradiance measurements from a pair of Solar Spectral Flux Radiometers (SSFR) on board the J31 to estimate the direct aerosol radiative forcing [Redemann et al., EGU05-A-05584].

Funding for this research has been provided by the NOAA Atmospheric Chemistry and Climate Program, the NASA Tropospheric Chemistry Program, the NASA Radiation Sciences Program, and the NASA Earth Observing System Inter-Disciplinary Sciences (EOS-IDS) Program.