Airborne sunphotometer and solar spectral flux radiometer measurements during INTEX/ITCT 2004

P. B. Russell (1), P. Pilewskie (2), J. Redemann (3), J. Livingston (4), B. Schmid (3), R. Kahn (5), A. Chu (6), J. Eilers (1), J. Pommier (3), S. Howard (3)

(1) NASA Ames Research Center, Moffett Field, CA, (2) LASP/PAOS University of Colorado, Boulder, CO, (3) Bay Area Environmental Research Institute, Sonoma, CA, (4) SRI International, Menlo Park, CA, (5) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, (6) NASA Goddard Space Flight Center, Greenbelt, MD

During the period 12 July – 8 August 2004, the NASA Ames 14-channel Airborne Tracking Sunphotometer (AATS-14) and Solar Spectral Flux Radiometer (SSFR) were operated aboard a Jetstream 31 (J31) aircraft and acquired measurements during nineteen 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. In this paper, we will present results from analyses of those data sets.

AATS-14 measures the direct solar beam transmission at fourteen 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. SSFR consists of separate nadir and zenith viewing hemispheric FOV sensors that yield measurements of up- and downwelling solar irradiance at a spectral resolution of ~8-12 nm over the wavelength range 300-1700 nm.

The objectives of the J31-based measurements during INTEX/ITCT were to provide AOD data for the evaluation of MODIS (MODerate-resolution Imaging Spectroradiometer) and MISR (Multi-angle Imaging Spectro-Radiometer) AOD retrievals, quantify sea surface spectral albedo (which can contribute the largest uncertainty to satellite aerosol retrievals for low aerosol loading), test closure (consistency) among suborbital results, test chemical-transport models using AOD profiles, and assess regional radiative forcing by combining satellite and suborbital results. Specific J31 flight patterns were designed to achieve these objectives, and they included a mixture of vertical profiles (spiral and ramped ascents and descents) and constant altitude horizontal transects at a variety of altitudes. Flight plans often included profiles above the NOAA Ship Ronald H. Brown and, in a few cases, coordination with other mission aircraft – namely, the NOAA DC-3 and the NASA DC-8. Most flight plans included a near sea surface horizontal transect in a region of minimal cloud cover during or near the time of an AQUA (MODIS) and/or 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. The Terra overpasses included four MISR local mode (high spatial resolution retrieval) events. Generally, retrievals of spatially coincident AOD from both MODIS and MISR during Terra overpass were not possible due to the effect of sun glint on the MODIS measurements. However, temporally and spatially coincident AATS-14, MODIS, and MISR AOD measurements were acquired during one overpass. In this paper, we will 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.

Combination of simultaneous spectral AOD measurements from AATS-14 and spectral radiative flux measurements from SSFR in AOD gradients allows derivation of the direct aerosol radiative forcing and an estimation of the aerosol absorbing fraction . During INTEX/ITCT, we observed a total of sixteen AOD horizontal gradients during ten research flights. More than half of the AOD gradients were greater than 0.1 at 499 nm and extended over distances less than 40 km. Preliminary analysis of these gradients revealed cases when a reduction in mid-visible AOD of 0.1 was accompanied by a reduction in downwelling irradiance of more than 9 Wm^{-2} for SSFR flux measurements integrated between 350 and 700 nm. We will examine the implications of such a reduction for instantaneous radiative forcing efficiency and compare the result with values previously reported from ground-based measurements during the Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia) and Indian Ocean Experiment (INDOEX) field campaigns.

Preliminary analysis indicates that the primary contributors to the AODs measured by AATS-14 during INTEX/ITCT were not only the expected anthropogenic aerosol from nearby East Coast sources but, at certain times, smoke that originated from Alaskan and Canadian forest fires. At the time of this writing, there is no evidence that the J31 sensors obtained any measurements through dust transported from Asia or Africa. Previously, however, AATS-14 and SSFR measured Asian dust outflow during the spring 2001 ACE-Asia and the spring 2004 Extended MODIS-_ Validation Experiment (EVE) field campaigns. With the experience gained in ACE-Asia, EVE, and INTEX/ITCT, we look forward to participation in the upcoming INTEX-B campaign that will include a measurement component to study Asian outflow at the U.S. West Coast.