Compendium Of NASA Data Base For The Global Tropospheric Experiment's Transport And Atmospheric Chemistry Near the Equator - Atlantic (TRACE-A)

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Hampton, Virginia 23681-0001
COMПENDIUM OF NASA DATA BASE FOR THE
GLOBAL TROPOSPHERIC EXPERIMENT'S
TRANSPORT AND ATMOSPHERIC CHEMISTRY
NEAR THE EQUATOR - ATLANTIC
(TRACE-A)

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SUMMARY

The report provides a compendium of NASA aircraft data that are available from NASA's Global Tropospheric Experiment's (GTE) Transport and Atmospheric Chemistry near the Equator - Atlantic (TRACE-A) conducted in September and October 1992. The TRACE-A experiment afforded the scientific community with the first opportunity to study the atmospheric chemistry and meteorology over the tropical south Atlantic Ocean with emphasis on the impact of continental outflow from South America and Africa to this region. The study was prompted by satellite measurements in the late 1980s which showed a region of seasonally (austral spring or September/October) enhanced tropospheric ozone off the west coast of southern Africa. It was hypothesized that the ozone enhancement was the result of widespread vegetation burning in South America and Africa. TRACE-A flight experiments were conducted from intensive bases in Brazil, South Africa, Namibia, and the Ascension Island. The broad objectives of the TRACE-A experiments were to study chemical processes and long-range transport associated with South American and African continental outflow during periods of widespread vegetation burning, and to understand the ozone enhancements observed over the southern tropical Atlantic Ocean during the September/October time period.
TRACE-A was conducted in coordination with the Southern African Fire-Atmosphere Research Initiative (SAFARI). TRACE-A and SAFARI, coordinated through the International Global Atmospheric Chemistry (IGAC) Project, comprised the core of IGAC's 1992 STARE (South Tropical Atlantic Regional Experiment) initiative whose focus was the impact of biomass burning on the biosphere and atmosphere. TRACE-A included measurements aboard NASA's DC-8 aircraft spanning the South American and African continents and measurements aboard two Brazilian aircraft as well as extensive Brazilian surface station and rawinsonde/ozonesonde measurements within Brazil. SAFARI also included airborne measurements other than the NASA DC-8 and an extensive surface station network of measurements in southern Africa.

The format of this compendium utilizes data plots—time series and altitude profiles—of selective data acquired aboard the NASA/Ames DC-8 aircraft during TRACE-A. The purpose of this document is to provide a representation of aircraft data that are available in archived format via NASA Langley's Distributed Active Archive Center (DAAC). The data format is not intended to support original research/analyses, but to assist the reader in identifying data that are of interest. This compendium is for only the NASA aircraft data. The DAAC archived data bases include numerous supporting data including meteorological observations/products, results from surface studies, satellite observations, and data from sonde releases.
INTRODUCTION

The goal of the NASA Tropospheric Chemistry Program is to develop an understanding of the chemical cycles that control the composition of the troposphere and to assess the susceptibility of the global atmosphere to chemical change. A major component of the NASA program is the Global Tropospheric Experiment (GTE), which consists of a series of field experiments designed to (1) evaluate the capability of instrument techniques to measure, under field conditions, the minute concentrations of key chemical species in the troposphere; and (2) systematically address tropospheric chemistry issues relevant to global change, through airborne sampling expeditions, coupled with modeling and laboratory studies. GTE is primarily an aircraft-based program supplemented by ground-based measurements. Satellite data also play important roles. Space Shuttle observations of tropospheric carbon monoxide distributions have been used to plan and direct the course of expeditions, for example, over tropical rain forests and for continental outflow into the tropical Atlantic Ocean. Landsat land-surface images have facilitated the extrapolation of regional Arctic-tundra measurements into global-scale conclusions. Total Ozone Measurements from Satellites (TOMS) have helped place GTE observed ozone distributions/budgets into a global perspective (temporal and spatial) and to guide intensive aircraft studies over the tropical Atlantic Ocean. Weather data returned by environmental satellites have guided flight planning for research flights. The Distributed Active Archive Center (DAAC) data include many of the satellite, surface, and meteorological products used to support GTE missions or analyses.

The GTE airborne expeditions have focused on studies of the remote global atmosphere in order to provide well-documented baseline measurements of the unperturbed environment and to fully understand the chemical cycles underlying the natural environment. Table I and Figure I summarize GTE missions conducted through 1994. The GTE expeditions have been conducted in a diverse range of environments and with different scientific goals. The Chemical Instrument Test and Evaluation (CITE) series was designed to study
our ability to measure key tropospheric gaseous species by exposing selected instrumentation to a wide range of measurement conditions. The Atmospheric Boundary Layer Experiments (ABLE) were designed to study the emission, chemical processes, and dynamics of the boundary layer, and have been conducted over ecosystems known to have significant influence on the global troposphere. The importance of long-range transport of natural and anthropogenic emissions on the global troposphere has been investigated in the Pacific Exploratory Missions (PEM) and the Transport and Atmospheric Chemistry near the Equator - Atlantic (TRACE-A).

The GTE, managed through the Tropospheric Chemistry Program in the Mission to Planet Earth Office, NASA Headquarters, was initiated in the early 1980s. Implementation of the GTE Project is via a Project Office at the NASA Langley Research Center, Atmospheric Sciences Division.

SYMBOLS AND UNITS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABLE</td>
<td>Atmospheric Boundary Layer Experiment</td>
</tr>
<tr>
<td>CITE</td>
<td>Chemical Instrument Test and Evaluation</td>
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<tr>
<td>CO</td>
<td>carbon monoxide</td>
</tr>
<tr>
<td>CO₂</td>
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<tr>
<td>C₂Cl₄</td>
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<td>CH₄</td>
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<td>DAAC</td>
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<tr>
<td>deg.</td>
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<tr>
<td>dp</td>
<td>dew point temperature, degree Centigrade</td>
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<tr>
<td>Ga.Inst. of Tech.</td>
<td>Georgia Institute of Technology, Atlanta, Georgia</td>
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<tr>
<td>GTE</td>
<td>Global Tropospheric Experiment</td>
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<tr>
<td>H₂O₂</td>
<td>hydrogen peroxide</td>
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</table>
HOCO: formaldehyde
HNO₃: nitric acid
IGAC: International Global Atmospheric Chemistry Program
LaRC: Langley Research Center
MSL: mean sea level
N₂O: nitrous oxide
NASA: National Aeronautics and Space Administration
NP: national park
NO: nitric oxide
NOₓ: nitrogen oxides (nitric oxide + nitrogen dioxide)
NOᵧ: total odd nitrogen
NCAR: National Center for Atmospheric Research
O₃: ozone
PAN: peroxyacetyl nitrate
PEM: Pacific Exploratory Mission
ppbv: parts-per-billion, by volume
ppmv: parts-per-million, by volume
PPN: peroxypropionyl nitrate
pptv: parts-per-trillion, by volume
P. Rico: Puerto Rico
Rel. Humidity: relative humidity, percent
SAFARI: Southern African Fire-Atmosphere Research Initiative
S. Afr: South Africa
STARE: South Tropical Atlantic Regional Experiment
T: air temperature, degree Centigrade
Theta: potential temperature, degree Kelvin
TOMS: Total Ozone Measurements from Satellites
TRACE-A: Transport and Atmospheric Chemistry near the Equator - Atlantic
UK: United Kingdom
The National Aeronautics and Space Administration's TRACE-A conducted in September and October 1992 was a major component of the South Tropical Atlantic Regional Experiment (STARE), a project within the International Global Atmospheric Chemistry (IGAC) program. The focus of the STARE initiative is to study the impact of biomass burning on the biosphere and atmosphere. TRACE-A and its sister component of the 1992 STARE campaign, SAFARI (South African Fire-Atmosphere Research Initiative), had the broad objectives to study the impact of South American and African biomass burning and the impact of long-range transport of burning emissions on the south tropical Atlantic Ocean region. In particular, an objective of TRACE-A was to understand a region of seasonally (September/October) enhanced ozone observed (via satellites) off the west coast of southern Africa. It was hypothesized that the enhanced ozone was the result of widespread burning of vegetation in both South America and Africa.

The centerpiece of NASA's TRACE-A was a series of research flights with the instrumented NASA Ames DC-8. The aircraft operated from four staging areas: Brazil, South Africa, Namibia, and the Ascension Island. The primary bases of operation of Brasilia, Brazil; Johannesburg, South Africa; Windhoek, Namibia; and the Ascension Island were selected to allow sampling of biomass burning emissions from both continents at different ages after emission and during transport over the Atlantic Ocean. From these primary bases, flights covered a latitude range of about 35° N to the Equator and 50° W to 35°E longitude. Table 2 summarizes the flights, and Figure 2 shows the flight regions. Flights 1 and 2, the instrument checkout flights at Ames, are not
included in the table or figure, and the flight tracks for flights 3 and 19 and portions of the flight tracks for flights 4 and 18 are not shown in the figure. Flights 6-7, 10-11, 13-15, and 17 were site-intensive flights based from Brasilia, Johannesburg, Windhoek, and Ascension Island, respectively. Ferry/transit flights included (a) flights 3-5 from Ames to Brasilia (via Key West, Florida and Recife, Brazil); (b) flights 8-9 from Brasilia to Johannesburg (via Rio de Janeiro, Brazil); (c) flight 12 from Johannesburg to Windhoek; (d) flight 16 from Windhoek to Ascension Island; and (e) flights 18 and 19 from Ascension Island to Ames (via San Juan, Puerto Rico). Flights 1-2 were instrumentation verification flights and data are not reported. Flight plans consisted of combinations of controlled rate of ascent or descent spirals, ramp-up or ramp-down flight legs, and constant altitude flight legs selected to meet the scientific objectives of each flight. In general, 7- to 8-hour missions were flown covering an altitude range of 300 meters to about 13 km above mean sea level (MSL). Generally, altitude profiles (spirals or ramps) were flown with ascent/descent rates of 150 to 300 m/min.

The Brasilia-based flights focused on characterizing the chemical composition of air exiting the South American continent over the Atlantic Ocean. Flights 6 and 7 included upwind measurements in biomass burning source regions. Portions of ferry flights 4, 5, and 8 focused on continental outflow along the coast of Brazil. Deployment of the DC-8 aircraft from Ames was delayed ≈6 weeks and the Brasilia flights did not correspond to the time period in 1992 of most widespread burning in South America. However, significant active burning was occurring in the northwestern region of Brazil (see Figure 2 and flight 6 and 7 locations). The Johannesburg- and Windhoek-based flights permitted characterization of African biomass sources as well as air (outflow from and/or inflow to the continent) along both the Atlantic and Indian Ocean coasts of the continent. The 1992 prolonged drought in southern Africa, called by many the worst of the century, resulted in less biomass fauna for the region and, thus, the amount of burning relative to a normal year was much less. However, widespread burning in, north, and west of Zambia
did occur and was clearly visible from DC-8 flights over charred and smoldering areas with reduced visibility (flights 10 and 12). The Ascension Island flights, local (flight 17), arrival (flight 16), and departure (flight 18) provided an assessment of mid-ocean transport of emissions from both continents. These flights, combined with flights from Windhoek parallel to the coast of Africa, and from Brazil, also parallel to the coast, provided, perhaps, the first comprehensive assessment of the chemistry of tropospheric air within, flowing into, and exiting the Atlantic basin in this region. While the primary function of transit/ferry flights was to transport the aircraft between staging areas, portions of each flight were designed to provide additional data for understanding air chemistry within the Atlantic Basin; e.g., the southward dip associated with flight 9 from Rio de Janeiro to Johannesburg.

The core set of measurements aboard the aircraft focused on ozone and ozone precursors. The aircraft data included a suite of chemical measurements which included ozone, nitric oxide, nitrogen dioxide, total odd or "reactive" nitrogen gaseous species, peroxyacetyl nitrate or PAN, peroxypropionyl nitrate, methane, carbon monoxide, carbon dioxide, nonmethane hydrocarbons, fluorocarbons, acetic acid, formic acid, nitric acid, hydrogen and methyl peroxides, and aerosol number/size distribution. Table 3 identifies investigators responsible for the measurements, and Figure 3 shows a schematic of the instrumentation aboard the DC-8.

The TRACE-A DAAC data archive includes (1) data taken aboard the DC-8 aircraft; (2) data measured at surface sites throughout Brazil, (3) sondes released from multiple locations in support of the aircraft flights; and (4) numerous meteorological, land-use, and satellite data products used in flight (field) planning and post-mission analyses. SAFARI data are not archived in the DAAC. The archive does include pre-TRACE (1990-1991) ozonesonde data from coordinated releases at Ascension Island; Brazzaville, Congo; and Natal, Brazil.
The data plots for the TRACE-A are given in Appendix A. For each flight, six pages of time series plots are provided: page 1 -- a pictorial diagram of the flight region/flight plan and time series plots of altitude, temperature (T), dew point temperature (dp), relative humidity, and potential temperature (theta); page 2 -- ozone (O₃), carbon monoxide (CO), carbon dioxide (CO₂), methane, nitrous oxide (N₂O), and benzene; page 3 -- nitric oxide (NO), nitrogen oxides (NOₓ), total odd or "reactive" nitrogen gas species (NOₙ), peroxyacetylnitrate (PAN), and nitric acid; page 4 -- acetylene, ethane, propane, ethylene, and acetone; page 5 -- methyl chloride (CH₃Cl), tetrachloroethylene (C₂Cl₄), methyl chloroform (CH₃CCl₃), hydrogen peroxide (H₂O₂), and formaldehyde (HOCO); and page 6 -- methyl peroxide and fine aerosol (0.3 to 3.1 um diameter). The species were selected to provide the reader with information on both the source characteristics and photochemical history of the air. Figure numbers correspond to flight numbers; e.g., Figure A4.2 represents page 2 of the plots for flight #4. Selected profile plots follow the time series plots as, e.g., Figure A4.7 is the first page of profile plots for flight 4. Profile plot sets include temperature, dew point temperature, ozone, carbon monoxide, and methane data plotted to the same altitude scale. One to four sets of profile plots are provided (format of two sets per page) for each flight. Table 4 summarizes the profiles selected. There are no figures with the prefix of A1 or A2 as flights 1 and 2 (instrument checkout flights) data were not archived. Data plots are in standardized format as discussed in Appendix A. The DAAC archive includes measurements aboard the DC-8 aircraft during TRACE-A which are not plotted in Appendix A.
CONCLUDING REMARKS

This compendium of data from NASA's Global Tropospheric Experiment's Transport and Atmospheric Chemistry near the Equator - Atlantic (TRACE-A) provides only a representation of aircraft data that are available in archived format from NASA Langley's Distributed Active Archive Center (DAAC). The presented data are not intended to support original research/analyses, but serve as an overview of the TRACE-A data and provide some assistance to the reader in identifying data that are of interest and which may be obtained from Langley's DAAC archive. This compendium covers only selected NASA DC-8 aircraft data. The archived data bases include other data measured on board the aircraft as well as numerous supporting data including meteorological observations/products, photochemical modeling products, surface station observations, satellite observations, and sondes releases. GTE-sponsored analyses/results from the TRACE-A expeditions have been submitted (March 1995) to a Special Issue of the Journal of Geophysical Research - Atmospheres.

Questions or information regarding the Langley DAAC archive should be directed to Langley DAAC User and Data Services, Mail Stop 157B, NASA Langley Research Center, Hampton, Virginia 23681-0001. A brief description of the DAAC, log on procedures, and data bases is given as Appendix B.
TABLE 1. GTE Field Expeditions

<table>
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<tr>
<th>Expedition</th>
<th>Date</th>
<th>General Geographic Region</th>
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<tr>
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<td>1984</td>
<td>Barbados, French Guyana</td>
<td>June</td>
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<tr>
<td>ABLE-2A</td>
<td>1985</td>
<td>Amazon Basin</td>
<td>August</td>
</tr>
<tr>
<td>ABLE-2B</td>
<td>1987</td>
<td>Amazon Basin</td>
<td>May</td>
</tr>
<tr>
<td>ABLE-3A</td>
<td>1988</td>
<td>Alaska--Barrow, Bethel, Cold Bay</td>
<td>July/August</td>
</tr>
<tr>
<td>ABLE-3B</td>
<td>1990</td>
<td>Canada--Hudson Bay, Schefferville</td>
<td>July/August</td>
</tr>
<tr>
<td>CITE-1</td>
<td>1983</td>
<td>Hawaii</td>
<td>November</td>
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<tr>
<td>CITE-1</td>
<td>1984</td>
<td>Eastern North Pacific--off the California coast</td>
<td>April</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CITE-2</td>
<td>1986</td>
<td>Western USA</td>
<td>August</td>
</tr>
<tr>
<td>CITE-3</td>
<td>1989</td>
<td>Western North Atlantic--Virginia coast and Western South Atlantic--Brazil coast</td>
<td>August</td>
</tr>
<tr>
<td>PEM West-A</td>
<td>1991</td>
<td>Western Pacific Rim</td>
<td>October</td>
</tr>
<tr>
<td>PEM West-B</td>
<td>1994</td>
<td>Western Pacific Rim</td>
<td>Feb./March</td>
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<tr>
<td>TRACE-A</td>
<td>1992</td>
<td>Brazil, South Atlantic, southwest Africa</td>
<td>September</td>
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### TABLE 2. Summary of the Flights Conducted during the 1992 TRACE-A Expedition  
(All times are GMT)

<table>
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<tr>
<th>Mission Number</th>
<th>Flight Date</th>
<th>Departure Time</th>
<th>Departure Location</th>
<th>Arrival Time</th>
<th>Arrival Location</th>
<th>Purpose</th>
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<td>NASA Ames</td>
<td>2024</td>
<td>Key West, Florida</td>
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<td>4</td>
<td>Sept. 22</td>
<td>1200</td>
<td>Key West</td>
<td>1937</td>
<td>Recife, Brazil</td>
<td>survey &amp; ferry</td>
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<td>Sept. 24</td>
<td>1207</td>
<td>Recife</td>
<td>1900</td>
<td>Brasilia, Brazil</td>
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<td>7</td>
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<td>Brasilia</td>
<td>1922</td>
<td>Brasilia, Brazil</td>
<td>source characterization</td>
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<td>8</td>
<td>Oct. 1</td>
<td>1207</td>
<td>Brasilia</td>
<td>1923</td>
<td>Rio de Janeiro</td>
<td>ferry &amp; continental outflow</td>
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<td>Oct. 3</td>
<td>0736</td>
<td>Rio de Janeiro</td>
<td>1558</td>
<td>Johannesburg, S.Afr.</td>
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<td>1421</td>
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<td>Oct. 11</td>
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<td>1302</td>
<td>Windhoek, Namibia</td>
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<td>Oct. 15</td>
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<td>1504</td>
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<td>1715</td>
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<td>Windhoek</td>
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<td>NASA Ames</td>
<td>ferry</td>
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TABLE 3. Principal Investigators and Institutions Participating in Transport and Atmospheric Chemistry near the Equator - Atlantic

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<tr>
<th>Investigator</th>
<th>Institution</th>
<th>Investigation/Measurement</th>
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<tr>
<td>Bruce Anderson</td>
<td>NASA Langley Research Center</td>
<td>carbon dioxide</td>
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<tr>
<td>John Barrick</td>
<td>NASA Langley Research Center</td>
<td>airborne meteorological/position data</td>
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<td>John Bradshaw</td>
<td>Georgia Institute of Technology</td>
<td>nitric oxide, nitrogen dioxide, total oxides of nitrogen</td>
</tr>
<tr>
<td>Edward Browell</td>
<td>NASA Langley Research Center</td>
<td>ozone &amp; aerosol profiles (remote sensor)</td>
</tr>
<tr>
<td>Gerald Gregory</td>
<td>NASA Langley Research Center</td>
<td>ozone, aerosols (in situ)</td>
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<tr>
<td>Brian Heikes</td>
<td>University of Rhode Island</td>
<td>hydrogen and methyl peroxides, formaldehyde, drop sondes</td>
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<tr>
<td>Dean Lauritsen</td>
<td>NCAR Boulder Laboratory</td>
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<tr>
<td>Sherry Rowland</td>
<td>University of California, Irvine</td>
<td>nonmethane hydrocarbons</td>
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<tr>
<td>Glen Sachse</td>
<td>NASA/Langley Research Center</td>
<td>carbon monoxide, methane, nitrous oxide</td>
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<td>Hanwant Singh</td>
<td>NASA Ames Research Center</td>
<td>PAN, PPN, C2Cl4, CH3ONO2, acetone</td>
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<td>Robert Talbot</td>
<td>University of New Hampshire</td>
<td>HNO3, gas phase organic acids</td>
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TABLE 4. TRACE-A Profiles

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Times are GMT
TABLE 4. Profiles continued.

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Times are GMT
Figure 1: GTE mission sites
Figure 3: Instrument location on the NASA DC-8 aircraft
APPENDIX A: TRACE-A DATA PLOTS

Plots are presented in a standardized format, and the data (unedited) are from the Langley DAAC archive. Relative humidity and potential temperature are calculated from measurements made on the aircraft. In some cases (mostly for moist, boundary layer conditions) relative humidity may exceed 100% (not plotted) as dew point temperature exceeded air temperature by a few degrees (assumed to be the result of instrument measurement/calibration uncertainty). For time series plots, abscissa time scales for a given flight are identical. Ordinate scales for O₃, CO, NO, NOₓ, NOₓ, and fine aerosol are different for some flights. Ordinate scales for all other species are identical among all flights. Ordinate scales were selected to best represent all the data for a specie measured during the flight or expedition; thus, some data may be off-scale. As a result of the software used for the plots and the data archive use of codes (in place of valid data) for data taken (1) during instrument calibration, (2) when measurements were at "detection limit," and/or (3) when measurements were invalid, it is sometimes difficult to distinguish from the plots if data are off-scale or coded as invalid. For example, a symbol without an attached line may either mean that adjacent data are off-scale or have been coded as invalid. Inspection of the other plotted data often provides information which resolves the uncertainty. For profile plots, altitude scales are identical for all plots and the specie scales are those selected for the time series plots. In order to maintain the standardized format, plots for flights in which a specie data were not reported are plotted with the axes and a "NO DATA" entry.

Given below are the beginning page numbers for each flight's sequence of plots:

Flight 3 - page 23
Flight 4 - page 31
Flight 5 - page 39
Flight 6 - page 47
TRACE-A ATLANTIC MISSION: FLIGHT 3

Figure A3.1
TRACE-A ATLANTIC MISSION: FLIGHT 3

Solid = O3
Broken = CO

Figure A3.2
TRACE–A ATLANTIC MISSION: FLIGHT 3

Figure A3.4
TRACE-A ATLANTIC MISSION: FLIGHT 3

Figure A3.5
TRACE–A ATLANTIC MISSION: FLIGHT 3

Figure A3.6
Figure A3.7 29

TRACE (A) ATLANTIC MISSION: FLIGHT 3 PROFILE AT 2015 GMT

- Altitude, Km
- Temperature, C
- Dewpoint, C
- Ozone, ppbv
- CO, ppbv
- Methane, ppbv
TRACE-A ATLANTIC MISSION: FLIGHT 4

Figure A4.1
TRACE-A ATLANTIC MISSION: FLIGHT 4

Solid = O3
Broken = CO

Figure A4.2
TRACE-A ATLANTIC MISSION: FLIGHT 4

Figure A4.3
TRACE–A ATLANTIC MISSION: FLIGHT 4

Figure A4.4
TRACE–A ATLANTIC MISSION: FLIGHT 4

Figure A4.6
Figure A4.7
TRACE-A ATLANTIC MISSION: FLIGHT 5

Figure A5.1

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Figure A5.2
TRACE-A ATLANTIC MISSION: FLIGHT 5

Figure A5.3
TRACE-A ATLANTIC MISSION: FLIGHT 5

Figure A5.4
TRACE-A ATLANTIC MISSION: FLIGHT 5

Figure A5.5
TRACE-A ATLANTIC MISSION: FLIGHT 5

Figure A5.6
TRACE-A ATLANTIC MISSION: FLIGHT 6

Figure A6.1
TRACE-A ATLANTIC MISSION: FLIGHT 6

Solid = O3
Broken = CO

Figure A6.2
TRACE-A ATLANTIC MISSION: FLIGHT 6

Figure A6.3
Figure A6.5
TRACE-A ATLANTIC MISSION: FLIGHT 6

Figure A6.6
TRACE (a) ATLANTIC MISSION: Flight 6 Profiles at 1700 GMT
TRACE-A ATLANTIC MISSION: FLIGHT 7

Figure A7.1
TRACE—A ATLANTIC MISSION: FLIGHT 7

Solid = O3
Broken = CO

Figure A7.2
TRACE-A ATLANTIC MISSION: FLIGHT 7

Figure A7.3
TRACE-A ATLANTIC MISSION: FLIGHT 7

Figure A7.4
TRACE-A ATLANTIC MISSION: FLIGHT 7

Figure A7.5

[Graphs showing concentration over time for different compounds like CH3Cl, C2Cl4, CH3CCl3, H2O2, and HOCl, with a timeline labeled GMT Time from 13 to 20.]
TRACE-A ATLANTIC MISSION: FLIGHT 7

Figure A7.6
Trape (4) Atlantic Mission: Flight 2 Profile At 1815 GMT

Trape (4) Atlantic Mission: Flight 2 Profile At 1415 GMT

NO DATA
TRACE-A ATLANTIC MISSION: FLIGHT 8

Figure A8.1

Solid = T
Broken = dp
TRACE-A ATLANTIC MISSION: FLIGHT 8

Solid = O3
Broken = CO

Figure A8.2
TRACE-A ATLANTIC MISSION: FLIGHT 8

Acetylene, pptv

Ethane, pptv

Propane, pptv

Ethylene, pptv

Acetone, pptv

Figure A8.4

GMT Time
TRACE-A ATLANTIC MISSION: FLIGHT 8

Figure A8.5

NO DATA

67
TRACE–A ATLANTIC MISSION: FLIGHT 8

Figure A8.6
TRACE–A ATLANTIC MISSION: FLIGHT 9

Solid = O3
Broken = CO

Figure A9.2
Figure A9.3
TRACE-A ATLANTIC MISSION: FLIGHT 9

Figure A9.4

Acetylene, pptv

Ethane, pptv

Propane, pptv

Ethylene, pptv

Acetone, pptv

GMT Time

7 8 9 10 11 12 13 14 15 16
TRACE-A ATLANTIC MISSION: FLIGHT 9

Figure A9.5
Figure A9.6
Trace (4) Atlantic Mission: Flight 9 Profile at 1445 GMT

Trace (4) Atlantic Mission: Flight 9 Profile at 0800 GMT
TRACE-A ATLANTIC MISSION: FLIGHT 10

Figure A10.1

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TRACE-A ATLANTIC MISSION: FLIGHT 10

Solid = O3
Broken = CO

Figure A10.2
TRACE-A ATLANTIC MISSION: FLIGHT 10

Figure A10.3
Figure A10.4
Figure A10.5
TRACE–A ATLANTIC MISSION: FLIGHT 10

Figure A10.6
TRACE-A ATLANTIC MISSION: FLIGHT 11

Figure A11.3
TRACE-A ATLANTIC MISSION: FLIGHT 11

Figure A11.4
TRACE-A ATLANTIC MISSION: FLIGHT 11

Figure A11.5
TRACE–A ATLANTIC MISSION: FLIGHT 11

Figure A11.6
TRACE (A) ATLANTIC MISSION: FLIGHT II PROFILE AT 1200 GMT

TRACE (A) ATLANTIC MISSION: FLIGHT II PROFILE AT 0930 GMT
TRACE–A ATLANTIC MISSION: FLIGHT 12

Figure A12.1

95

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TRACE—A ATLANTIC MISSION: FLIGHT 12

Solid = 03
Broken = CO

Figure A12.2
TRACE–A ATLANTIC MISSION: FLIGHT 12

Figure A12.4

Acetylene, pptv

Ethane, pptv

Propane, pptv

Ethylene, pptv

Acetone, pptv

GMT Time
TRACE-A ATLANTIC MISSION: FLIGHT 12

Figure A12.5
TRACE–A ATLANTIC MISSION: FLIGHT 12

Figure A12.6
TRACE-A ATLANTIC MISSION: FLIGHT 13

Figure A13.1
TRACE–A ATLANTIC MISSION: FLIGHT 13

Solid = O3
Broken = CO

Figure A13.2
Figure A13.3
TRACE–A ATLANTIC MISSION: FLIGHT 13

Figure A13.4

Acetylene, pptv

Ethane, pptv

Propane, pptv

Ethylene, pptv

Acetone, pptv

GMT Time
TRACE–A ATLANTIC MISSION: FLIGHT 13

Figure A13.5

CH₃Cl, pptv

C₂Cl₄, pptv

CH₃CCl₃, pptv

H₂O₂, pptv

HOCl, pptv

107
TRACE–A ATLANTIC MISSION: FLIGHT 13

Figure A13.6
TRACE-A ATLANTIC MISSION: FLIGHT 14

Figure A14.1

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TRACE-A ATLANTIC MISSION: FLIGHT 14

Solid = O3
Broken = CO

Figure A14.2
TRACE-A ATLANTIC MISSION: FLIGHT 14

Figure A14.3
TRACE–A ATLANTIC MISSION: FLIGHT 14

Figure A14.4
TRACE-A ATLANTIC MISSION: FLIGHT 14

Figure A14.5
Figure A14.6

TRACE—A ATLANTIC MISSION: FLIGHT 14

CH3OH, Pptv

Aerosol, no./cm³

NO DATA

GMT Time
Figure A14.7

TRACE (A) ATLANTIC MISSION:
FLIGHT 14 PROFILE AT 1330 GMT

TRACE (A) ATLANTIC MISSION:
FLIGHT 14 PROFILE AT 1045 GMT
TRACE-A ATLANTIC MISSION: FLIGHT 15

![Flight Path Diagram]

**Figure A15.1**

- Altitude, km
- Temperature, °C
- Rel. Humidity
- Theta, deg. K

**Graphs:**
- Solid line: T
- Broken line: dp

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TRACE–A ATLANTIC MISSION: FLIGHT 15

Solid = O3
Broken = CO

Figure A15.2
TRACE-A ATLANTIC MISSION: FLIGHT 15

Figure A15.3

[Graphs showing variations of various parameters over time, with axes labeled for each graph.]

121
TRACE–A ATLANTIC MISSION: FLIGHT 15

Figure A15.4
TRACE–A ATLANTIC MISSION: FLIGHT 15

Figure A15.5
TRACE-A ATLANTIC MISSION: FLIGHT 16

Figure A16.1
TRACE-A ATLANTIC MISSION: FLIGHT 16

Solid = O3
Broken = CO

Figure A16.2
Figure A16.3
TRACE-A ATLANTIC MISSION: FLIGHT 16

Figure A16.4
Figure A16.5
TRACE-A ATLANTIC MISSION: FLIGHT 16

Figure A16.6
TRACE-A ATLANTIC MISSION: FLIGHT 17

Figure A17.1

135
TRACE-A ATLANTIC MISSION: FLIGHT 17

Solid = O3
Broken = CO

Figure A17.2
Figure A17.4

TRACE-A ATLANTIC MISSION: FLIGHT 17

Acetylene, pptv

Ethane, pptv

Propane, pptv

Ethylene, pptv

Acetone, pptv

GMT Time
TRACE-A ATLANTIC MISSION: FLIGHT 17

Figure A17.5
TRACE—A ATLANTIC MISSION: FLIGHT 17

Figure A17.6
TRACE (A) ATLANTIC MISSION: FLIGHT 17 PROFILE AT 1430 GMT

TRACE (A) ATLANTIC MISSION: FLIGHT 17 PROFILE AT 1100 GMT
TRACE-A ATLANTIC MISSION: FLIGHT 18

Solid = O3
Broken = CO

03 or CO, ppbv
0
100
200

CO2, ppmv
355
355
345

Methane, ppbv
1725
1600

N2O, ppbv
305
285

Benzene, pptv
50

Figure A16.2

GMT Time
TRACE–A ATLANTIC MISSION: FLIGHT 18

Figure A18.3
TRACE-A ATLANTIC MISSION: FLIGHT 18

Figure A18.4
TRACE-A ATLANTIC MISSION: FLIGHT 18

Figure A18.5
TRACE-A ATLANTIC MISSION: FLIGHT 18

Figure A18.6
Figure A19.1

TRACE—A ATLANTIC MISSION: FLIGHT 19
TRACE-A ATLANTIC MISSION: FLIGHT 19

Figure A19.2
TRACE-A ATLANTIC MISSION: FLIGHT 19

Figure A19.3
TRACE-A ATLANTIC MISSION: FLIGHT 19

Figure A19.4
TRACE–A ATLANTIC MISSION: FLIGHT 19

![Graphs showing gas concentrations over time](image)

Figure A19.5
TRACE-A ATLANTIC MISSION: FLIGHT 19

Figure A19.6
TRACE (A) ATLANTIC MISSION: FLIGHT 19 PROFILE AT 2115 GMT

TRACE (A) ATLANTIC MISSION: FLIGHT 19 PROFILE AT 1430 GMT
APPENDIX B: LANGLEY DAAC DATA ARCHIVE

System Description

The Langley Distributed Active Archive Center (DAAC), located at the NASA Langley Research Center in Hampton, Virginia, is responsible for archiving and distributing NASA science data in the areas of radiation budget, clouds, aerosols, and tropospheric chemistry. This DAAC will also archive some of the data sets which result from the EOS program and other elements of Mission to Planet Earth. The DAAC has developed an on-line computer system which allows the user to log on, search through the DAAC's data inventory, choose the desired data sets, and place an order. Data may be received either electronically (via FTP) or on media such as 4mm tape, 8mm tape, or CD-ROM (prepackaged data sets only).

Log On Procedures

1. Users with an X-Windows terminal (e.g., Motif) or a Sun Open Windows display system with access to Internet, may log onto the system by entering:
   
   xhost + eosdis.larc.nasa.gov
   (or: xhost + 192.107.191.17)
   telnet eosdis.larc.nasa.gov
   login name: ims
   password: larcims

   At the prompts, enter x for the X-Windows interface and then your display name (name of your workstation followed by ":0" or Internet address followed by ":0").

2. Users with access to NCSA Mosaic can use the following URL address:
   
   http://eosdis.larc.nasa.gov/
3. Users without access to a terminal with an X-Windows display system but who have access to Internet may log onto the system by entering:
   
   telnet eosdis.larc.nasa.gov

   login name: ims

   password: larcims

   At the prompt, enter c for the character interface and then press return.

4. Users who cannot access the system or who have any questions concerning the Langley DAAC may contact:

   Langley DAAC User and Data Services
   Mail Stop 157B
   NASA Langley Research Center
   Hampton, VA  23681-0001
   Phone:  (804) 864-8656
   FAX:  (804) 864-8807
   email:  larc@eos.nasa.gov

DAAC Data Bases

1. ERBE (Earth Radiation Budget Experiment)—Data were collected from three satellites (ERBS, NOAA-9, NOAA-10) carrying two ERBE instruments (scanner, nonscanner). The objective is to measure global albedo, fluxes, and solar incidence.

2. ISCCP (International Satellite Cloud Climatology Project)—ISCCP focuses on the study of the distribution and variation of cloud radiative properties. The objective is to improve the understanding and modeling of the effects of clouds on climate and also to elucidate the role of clouds in the radiation balance and improve our knowledge of the long-term global hydrologic cycle.
3. SAGE (Stratospheric Aerosol and Gas Experiment)--SAGE I gathered data concerning the spatial distribution of stratospheric aerosols, ozone, and nitrogen dioxide on a global scale. The goals of SAGE II are to determine the spatial distributions of stratospheric aerosols, ozone, nitrogen dioxide, water vapor, and cloud occurrence by mapping vertical profiles and calculating monthly averages of each.

4. SRB (Surface Radiation Budget)--The SRB data sets were calculated using inputs from ISCCP and ERBE data. They are designed to give global daily and monthly averages of the albedo, irradiance, cloud properties, and meteorology.

5. FIRE (First ISCCP Regional Experiment)--This series of experiments includes aircraft, satellite, and surface-based measurements of cirrus and marine stratocumulus cloud parameters. The purpose of this program is to validate and improve ISCCP data products and cloud/radiation parameterizations used in general circulation models (GCMs).

6. GTE (Global Tropospheric Experiment)--Data were collected primarily from aircraft and ground-based instruments from a variety of areas such as the Amazon Rain Forest and the northern tundra and boreal forest. Many parameters were measured including $O_3$, $CH_4$, PAN, CO, NO, NO$_2$, CO$_2$, and aerosols.

7. MAPS (Measurement of Air Pollution from Satellites)--Data were collected during Space Shuttle flights in 1981, 1984, and 1994. The main pollutant measured was carbon monoxide (CO).

8. SAM II (Stratospheric Aerosol Measurement)--This instrument was flown on board the Nimbus-7 satellite and consisted of a one-spectral channel Sun photometer, centered at 1.0 um, which viewed a small portion of the Sun through the Earth's atmosphere during spacecraft sunrise and sunset. The data obtained from this instrument were used to determine the vertical distribution of stratospheric aerosols in the polar regions of both hemispheres.
This compendium describes aircraft data that are available from NASA's Transport and Atmospheric Chemistry near the Equator - Atlantic (TRACE-A) conducted in September/October 1992. The broad objectives of TRACE-A were to study chemical processes and long-range transport associated with South American and African continental outflow during periods of widespread vegetation burning, and to understand the ozone enhancements observed from satellite data measured over the southern tropical Atlantic Ocean during the September/October time period. Flight experiments were conducted from Brazil, South Africa, Namibia, and the Ascension Island. This document provides a representation of aircraft data that are available from NASA Langley's Distributed Active Archive Center (DAAC). The data format of time series and altitude profile plots is not intended to support original analyses, but to assist the reader in identifying data that are of interest. This compendium is for only the NASA aircraft data. The DAAC data base includes numerous supporting data--meteorological products, results from surface studies, satellite observations, and data from sondes releases.