Global Tropospheric Experiment Chemical Instrumentation Test and Evaluation-3 (CITE 3) Langley ASDC Data Set Document

Summary

This document provides information on data products obtained during the GTE CITE 3 atmospheric science expedition conducted over the North and South Atlantic Ocean during August and September 1989. The objective of the mission was to evaluate instrumentation for the airborne measurement of sulfur dioxide, hydrogen sulfide, carbon disulfide, dimethyl sulfide and carbonyl sulfide. Measurements were made primarily by investigators' instruments located on the NASA Wallops Electra airborne laboratory. Also provided are a list of principal investigators, a brief summary of measurement techniques and a list of publications.

This document provides information for the following three data sets:

- GTE_CITE3_Elec_Chem
- GTE_CITE3_Elec_Flux
- GTE_CITE3_Merged_Data

Acknowledgment

The investigators involved in the CITE 3 mission were funded by NASA. The funded investigators, their organizations, their grant, agreement or contract numbers were:

Area	Investigator	Organization	Grant
Aircraft	A. R. Bandy	Drexel U	NAG-1-926
	J. Bradshaw	Georgia Tech	NAG-1-818
	S. O. Farwell	U of Idaho	NAG-1-923
	R. J. Ferek	U of Washington	NAG-1-925
	G. L. Gregory	NASA Langley	N/A
	J. E. Johnson	NOAA/PMEL	L-46397C
	G. W. Sachse	NASA Langley	N/A
	E. S. Saltzman	U of Miami	NAG-1-918
	D. C. Thornton	Drexel U	NAG-1-927
Mission Scientist:	D. D. Davis	Georgia Tech	NCC-1-133

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1. Collection Overview

a. Collection Contents

Aircraft data sets are available for each investigation for each flight. Ground-based data are usually available on a daily basis. Airborne measurements were typically obtained at constant altitude during transit flights (i.e. "survey" flights), and over multi-altitudes during flight from the intensive sites. Flight missions were conducted during CITE 3 from August through September 1989. Section 4.b lists the flight dates. The duration, altitude range, ascent and descent rate, and flight path for each mission varied depending on mission objectives and environmental conditions. Ground-based measurements are discussed in Hoell et al., [1993]. The automated ground sites provided daily measurements during the time frame when airborne measurements were being made and weekly averaged samples before and after. Further information about the measurement region and time frame may be found in the Journal of Geophysical Research, Vol. 98, No. D12, December 20, 1993.

Data Set Introduction

This data set contains all of the data submitted to the GTE data archive by the CITE 3 investigators listed in Section 1.d. Included are the atmospheric chemistry, meteorological and navigational data recorded aboard the NASA Wallops Electra airborne laboratory.

Summary of Parameters

The atmospheric species and other parameters measured are listed in Section 4.c and in Hoell et al., [1993]. Also listed for each are the name and affiliation of the principal investigator.

b. Related Data Collections

CITE 3 investigators have individually reported the results of their investigations in the Journal of Geophysical Research, Vol. 98, No. D12, December 20, 1993.

There are data sets available from the Langley ASDC for 13 other GTE missions conducted from 1983 to 2001. See the GTE home page and/or ASDC GTE Data and Information page for a description of the available data.

c. Title of Investigation

Global Tropospheric Experiment Chemical Instrumentation Test and Evaluation-3 (CITE 3)

d. Investigator Name and Title

If the person is known to be retired, deceased or no longer at the organization originally responsible for this experiment, it is noted and the contact information may be omitted. The contact information provided was current during the mission, but may no longer be current.

Electra Intercomparison Measurements Investigators

Investigator Area	Investigator Information
DMS, H_2S	M. O. Andreae Max Plank Institute for Chemistry P. O. Box 3060 D-6500 Mainz Federal Republic of Germany Telephone: 49-6131-305-426 Fax: 49-6131-305-388
SO_2, DMS, CS_2, OCS	A. R. Bandy Department of chemistry Drexel University Philadelphia PA 19104 Telephone: 215-895-2640 Fax: 215-895-1980
SO_2, DMS	R. J. Ferek Department of Atmospheric Sciences AK-40 University of Washington Seattle WA 98195 Telephone: 206-543-7238

SO_2	H. W. Georgii Institute fur Meterologie und Geophysik Feldbergstrasse 47 D-6000 Frankfurt am Main 1 Federal Republic of Germany Telephone: 49-69-798-3377
DMS, CS_2, OCS	J. E. Johnson PMEL/NOAA R/E/PM Bin C15700 Bld. 3 7600 Sand Point Way NE Seattle WA 98115 Telephone: 206-526-6355
DMS, H_2S	E. S. Saltzman (now at U of California-Irvine) Division of Marine and Atmospheric Chemistry Rosensteil School of Marine and Atmospheric Science University of Miami
SO_2, H_2S, CS_2, OCS	D. C. Thornton Department of Chemistry Drexel University Philadelphia PA 19104 Telephone: 215-895-2657 Fax: 215-895-1980

Electra Ancillary Measurements Investigators

Investigator Area	Investigator Information
Aerosol Collection	P. Artaxo Instituto de Fisica Universidade de Sao Paulo Caixa Postal 20516 01498, Sao Paulo, SP Brazil
Airborne Meteorological/Position Data	John D. Barrick MS 483 NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-5831 Fax: 757-864-5841 E-mail: john.d.barrick@nasa.gov
Nitric Oxide, Nitrogen Dioxide, NO_Y, Hydrocarbons	John Bradshaw (Principal Investigator, Deceased) Scott Sandholm (Co-Investigator) Georgia Institute of Technology Earth and Atmospheric Sciences Baker Building, Room 107 923 Dalney Street Atlanta GA 30332-0340 Telephone: 404-894-3895/3824 Fax: 404-894-5073 E-mail: ss27@prism.gatech.edu
Total Sulfur	S. O. Farwell Department of Chemistry University of Idaho Moscow, ID 83483 Telephone: 208-885-6387
In-situ Ozone and Aerosol Size Distribution	Gerald L. Gregory (retired) NASA Langley Research Center
Radon	E. B. Pereira Instituto de Pesquisas Espaciais C.P. 515 12201-Sao Jose dos Campos - SP Brazil Telephone: 55-123-229977
Carbon Monoxide	Glen W. Sachse

	MS 472 NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-1566 Fax: 757-864-8818 E-mail: glen.w.sachse@nasa.gov

e. Technical Contact(s)

The following persons have more specialized knowledge about the data in the data sets or in their field or general knowledge about the mission, its execution and the data sets.

Investigator or Knowledge Area	Investigator and Contact Information	
CITE 3 Mission Scientist	D. D. Davis Georgia Institute of Technology School of Earth and Atmospheric Sciences Room 108 221 Bobby Dodd Way Atlanta GA 30332-0340 Telephone: 404-894-9565 Fax: 404-894-1993	
CITE 3 Program Manager	Robert J. McNeal (retired) NASA Headquarters	
CITE 3 Project Manager	James M. Hoell, Jr. (retired) NASA Langley Research Center	
CITE 3 Instrument Scientist	G. M. Gregory (see prior entry above)	
CITE 3 Mission Meteorologist	Mark Shipham (no longer at LaRC) NASA Langley Research Center	
CITE 3 Expedition Manager	Richard J. Bendura (retired) NASA Langley Research Center	
Brazilian Coordinators	Volker W. J. H. Kirchhoff Instituto de Pesquisas Espaciais C. P. 515 12200 - Sao Jose dos Campos - SP Brazil Telephone: 55-123-229977	B. G. Motta Instituto de Pesquisas Espaciais C. P. 130 59000 - Natal - RN Brazil Telephone: 55-847-2314733
Electra Aircraft Operations and Systems Integration	Roger Navarro (retired) NASA Wallops	
Logistics Coordination	H. A. Thompson (no longer with ST Systems) ST Systems Corp.	
CITE 3 Data Products Manager	Joseph W. Drewry (retired) NASA Langley Research Center	
Sulfur Standards	W. D. Dorko Gas and Particulate Science Division Center for Analytical Chemistry National Institute of Standards and Technology (NIST) B-364 Chemistry Building Rt. 27 and Quince Orchard Road Gaithersburg MD 20899 Telephone: 804-864-5618	

2. APPLICATIONS AND DERIVATION

Potential usage and applications of the described data sets can be seen in the articles that comprise the Journal of Geophysical Research CITE 3 Special Section (Vol. 98, No. D12 December 20, 1993) and the 1990 Fall AGU Meeting.

a. Calculated Variables

For convenience of the users, the calculated variables below are provided.

Mach Number, M:

$$M = \sqrt{5*\left[\left(\frac{Q_c}{P_s}+1\right)^{(2/7)} - 1\right]}$$

M = Mach Number
Ps = Static Pressure
Qc = Differential Pressure

Static Air Temperature, Ts:

$$T_s(°K) = \frac{T_T}{\left[1+M^2*\left(\frac{\gamma-1}{2}\right)\right]}$$

T_S = Static Air Temperature (°K)
T_T = Total Air Temperature (°K)
γ = 1.4, ratio of specific heat of air at constant pressure and volume

True Air Speed, TAS:

$$TAS(kts) = M*a = M*38.96695*\sqrt{T_s}$$

TAS = True Air Speed (knots)
T_S = Static Air Temperature (°K)
M = Mach Number
a = Speed of Sound

Potential Temperature, θ:

$$\theta(°K) = T_s*\left(\frac{1000}{P_s}\right)^{0.2857142}$$

θ = Potential Temperature (°K)
T_S = Static Air Temperature (°K)
Ps = Static Pressure (mb)

Vapor Pressure, e :

e_{water} (mb) = [1.0007 + (3.46 * 10^{-6} * P_S)] * 6.1121* EXP[17.502 * T/(240.97 + T)]

e_{ice} (mb) = [1.0003 + (4.18 * 10^{-6} * P_S)] * 6.1115* EXP[22.452 * T/(272.55 + T)]

e = Partial Pressure of Water Vapor (mb)
P_S = Static Pressure (mb)
T = Static Air Temperature (°C) for Saturation Vapor Pressure
or
T = Dew/Frost Point (°C) for Partial Pressure of Water Vapor

Note:

1. ProjDP of zero or greater should be used to derive the partial pressure of water vapor w.r.t water (e_{water}) and the ProjDP less than zero should be used to derive the partial pressure of water vapor w.r.t ice (e_{ice}).

2. StatTempDegC and ProjDP parameters recorded in the P-3B data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively.

3. TSDEGC and ProjDP parameters recorded in the DC-8 data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively. Also notice in the DC-8 data set there is a redundant static air temperature measurement, TSCALC, which is calculated by DADS. Although TSDEGC and TSCALC track closely they can diverge by ? 1° at the low and high ends of the measurement range.

Specific Humidity, q:

$$q(g/kg) = \frac{0.622*10^3*e}{(P_s - 0.377e)} \qquad q(ppmw) = \frac{0.622*10^6*e}{(P_s - 0.377e)}$$

Mixing Ratio, r:

$$r(g/kg) = \frac{0.622 * 10^3 * e}{(P_s - e)} \qquad r(ppmw) = \frac{0.622 * 10^6 * e}{(P_s - e)}$$

Note:
ppmv = 1.608 * ppmw
ppmw = 0.622 * ppmv

Relative Humidity, %:

w.r.t. water,

$$RH_{water} = \frac{e_{water}}{e_{S_{water}}} * 100$$

w.r.t. ice,

$$RH_{ice} = \frac{e_{ice}}{e_{S_{ice}}} * 100$$

b. Graphs and Plots:

Interested readers should see the Journal of Geophysical Research, Vol. 98, No. D12, December 20, 1993, and documents referenced therein, for plots and the results of analysis of data.

3. DATA DESCRIPTION AND ACCESS

a. Format

See the GTE Data Format Document

b. Data Organization

Granularity

A general description of data granularity as it applies to the IMS appears in the EOSDIS Glossary. Aircraft data sets are generally available for each investigation for each flight. Surface level data are available on a daily basis.

c. Data Collection Status and Plans

All data for the CITE 3 mission is contained in the archive. No additional data products relevant to CITE 3 are anticipated. Hoell et al., [1993] indicates which instruments have measurements for which flights.

d. Data Access

This data is available online through the GTE Data and Information table or on a CDROM via the LaRC ASDC and from the GTE data archive.

e. Data Archive Center

The Atmospheric Science Data Center at NASA's Langley Research Center.

Contacts for Data Center or Data Access Information:

User and Data Services Group
Atmospheric Science Data Center
MS 157D
Langley Research Center
Hampton, VA 23681 USA
Phone: 757-864-8656
Fax: 757-864-8807
E-mail: support-asdc@earthdata.nasa.gov
Internet: http://eosweb.larc.nasa.gov

f. How to Cite the Data Collection

Publication of a portion(s) of the data archive should acknowledge the principal investigator(s) responsible for the data by referencing the appropriate manuscript in the Journal of Geophysical Research, Vol. 98, No. D12, December 20, 1993.

4. DATA CHARACTERISTICS:

a. Study Area

Airborne measurements were made over the north and tropical Atlantic Ocean, as indicated in Hoell et al., [1993]. A more detailed description of the surface level environmental characteristics for the experiment region is provided in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 98, No. D12, December 20, 1993. Additional information may be found in other publications authored by the principal investigators or on the GTE home page.

Spatial Coverage

As discussed in Hoell et al., [1993] flight missions were conducted during August and September 1989. The duration, altitude range, assent and descent rate, and flight path of each mission varied depending on mission objective and environmental conditions. With the CITE-3 payload, the NASA Electra aircraft operated over a nominal altitued range from 0.2 km to 5.5 km. Hoell et al., [1993] schematically shows the variation of airplane flight patterns used during the flights.

	North Atlantic				Tropical Atlantic			
Data Set Name	**Min Lat**	**Max Lat**	**Min Lon**	**Max Lon**	**Min Lat**	**Max Lat**	**Min Lon**	**Max Lon**
Listing of individual PI-files	32N	40N	70W	75W	12S	2N	25W	35W
Listing of merged data files	32N	40N	70W	75W	12S	2N	25W	35W

Spatial and Temporal Resolution

Resolution varies for each measurement. See the individual headers associated with each data file for specific information.

Grid Description

No data gridding or binning of data to a geographic grid occurred during data processing.

b. Temporal Coverage

CITE 3 aircraft missions were conducted from August 22 to September 22, 1989. The dates and times for each mission are given in Hoell et al., [1993]. Ground site measurements were obtained from (date) to (date).

	North Atlantic		Tropical Atlantic	
Data Set Name	**Begin Date**	**End Date**	**Begin Date**	**End Date**
Listing of individual PI-files	August 22, 1989	September 1, 1989	September 12, 1989	September 22, 1889
Listing of merged data files	August 22, 1989	September 1, 1989	September 12, 1989	September 22, 1889

c. Parameter or Variable

Not all of the parameters are in each data set granule. Also, the ranges vary between data sets and between granules within each data set. Species measured are given in Hoell et al., [1993].

Parameter Description

The variables measured are standard atmospheric chemical and meteorological species requiring no further elaboration here.

Unit of Measurement

The units of measure vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 98, No. D12, December 20, 1993.

Parameter Source

The instruments used in making the measurements are listed in Hoell et al., [1993].

Parameter Range

The ranges of data vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 98, No. D12, December 20, 1993.

Sample Data Record

The GTE Data Format Document contains examples of each data set type.

d. Error Sources

The sources of error vary depending on species and measurement environment and are addressed in the papers included in the CITE 3 special section of the Journal of Geophysical Research, Vol. 98, No. D12, December 20, 1993, and/or papers referenced in that publication and readme files and/or header records associated with each data file.

5. USAGE GUIDANCE

a. **Known Problems with the Data**

None reported for the current archive version. See the readme files and header records included with each data set for information provided by the responsible investigator.

b. **Future Modifications and Plans**

The data sets submitted to the ASDC are considered final and no further updates are planned. However, modifications will be considered if requested by the investigators or otherwise justified.

6. ACQUISITION MATERIALS AND METHODS

Details of data acquisition and materials are addressed in the Journal of Geophysical Research CITE 3 Special Section (Vol. 98, No. D12, December 20, 1993) and the 1990 AGU Fall Meeting.

7. REFERENCES

AGU Fall Meeting, San Francisco, CA, 3-7 December 1990.

CITE 3 Special Section, Journal of Geophysical Research, Vol. 98, No. D12, 20 December 1993.

GTE Bibliography

Hoell, J. M., D. D. Davis, G. L. Gregory, R. J. McNeal, R. J. Bendura, J. W. Drewry, J. D. Barrick, V. W. J. H. Kirchhoff, A. G. Motto, R. L. Navarro, W. D. Dorko, and D. W. Owen, Operational Overview of the NASA GTE/CITE 3 Airborne Instrument Intercomparisons for Sulfur Dioxide, Hydrogen Sulfide, Carbonyl Sulfide, Dimethyl Sulfide, and Carbon Disulfide, J. Geophys. Res., Vol. 98, No. D12, 23291-23304, 20 December 1990.

8. ACRONYMS

AGU - American Geophysical Union
ASDC - Atmospheric Science Data Center
CITE - Chemical Instrumentation Test and Evaluation
DADS - Data Acquisition and Display System
DFRC - NASA Dryden Flight Research Center
EOSDIS - Earth Observing System Distributed Information System
GTE - Global Tropospheric Experiment
IMS - Information Management System
LaRC - NASA Langley Research Center
NASA - National Aeronautics and Space Administration
NIST - National Institute of Standards and Technology
NOAA - National Oceanographic and Atmospheric Administration
PMEL - NOAA Pacific Marine Environmental Laboratory
ProjDP - Project Dew Point
TSCALC - Static temperature, calculated by DADS
TSDEGC - Static temperature, measured directly, in Celsius

9. Document Information

- **Creation Date:** November 2003
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- **Identification:**
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