Tropospheric Aerosol Radiative Forcing Observational eXperiment (TARFOX) Langley DAAC Data Set Document

Summary:

Aerosol effects on atmospheric radiation are a leading source of uncertainty in predicting future climate. TARFOX was designed to reduce this uncertainty by measuring and analyzing aerosol properties and effects in the U.S. eastern seaboard, where one of the world's major plumes of industrial haze moves from the continent over the Atlantic Ocean.

The TARFOX Intensive Field Campaign was conducted July 10-31, 1996. It included coordinated measurements from four satellites (GOES-8, NOAA-14, ERS-2, LANDSAT), four aircraft (ER-2, C-130, C-131A, and a modified Cessna), land sites, and ships. A variety of aerosol conditions was sampled, ranging from relatively clean behind frontal passages to moderately polluted with aerosol optical depths exceeding 0.5 at mid-visible wavelengths. Gradients of aerosol optical thickness were sampled to aid in isolating aerosol effects from other radiative effects and to more tightly constrain closure tests, including those of satellite retrievals. Early results from TARFOX include demonstration of the unexpected importance of carbonaceous compounds and water condensed on aerosol in the US mid-Atlantic haze plume, chemical apportionment of the aerosol optical depth, measurements of the downward component of aerosol radiative forcing, and agreement between forcing measurements and calculations. A wide variety of closure studies is currently in progress.

This document provides information for the following data sets:

- **TARFOX_UWC131A_SUNP**: Tropospheric Aerosol Radiative Forcing Observational eXperiment - Ames Sun Photometer flown on University of Washington C-131A aircraft
- **TARFOX_UWC131A**: Tropospheric Aerosol Radiative Forcing Observational eXperiment - University of Washington instrumented C-131A aircraft
- **TARFOX_WALLOPS_MET**: Tropospheric Aerosol Radiative Forcing Observational eXperiment - meteorological data from Wallops ground station
- **TARFOX_WALLOPS_SMPS**: Tropospheric Aerosol Radiative Forcing Observational eXperiment - Scanning Mobility Particle Sizer data taken at Wallops ground station
- **TARFOX_WALLOPS_SONDE**: Tropospheric Aerosol Radiative Forcing Observational eXperiment - Radiosonde data from balloons launched at Wallops ground station

Table of Contents:

1. Data Set Overview:

Data Set Identification:

TARFOX_UWC131A_SUNP:	Tropospheric Aerosol Radiative Forcing Observational eXperiment - Ames Sun Photometer flown on University of Washington C-131A aircraft
TARFOX_UWC131A:	Tropospheric Aerosol Radiative Forcing Observational eXperiment - University of Washington instrumented C-131A aircraft
TARFOX_WALLOPS_MET:	Tropospheric Aerosol Radiative Forcing Observational eXperiment - meteorological data from Wallops ground station
TARFOX_WALLOPS_SMPS:	Tropospheric Aerosol Radiative Forcing Observational eXperiment - Scanning Mobility Particle Sizer data taken at Wallops ground station
TARFOX_WALLOPS_SONDE:	Tropospheric Aerosol Radiative Forcing Observational eXperiment - Radiosonde data from balloons launched at Wallops ground station

Data Set Introduction:

Aerosol particles can change the Earth's radiation budget both directly by scattering and absorption and indirectly by affecting cloud properties. Changing the net flux of radiation above or within the atmosphere changes the energy available for driving climatic processes. Hence, such a net flux change is termed a radiative forcing of climate. Negative forcings tend to cool the climate, and positive forcings tend to warm it. Current estimates of the global, annually-averaged, direct radiative forcing by anthropogenic aerosols (e.g., sulfates, soots, mineral dust, biomass smokes) range from about -0.3 to -1.0 W m^{-2}, with an uncertainty factor of about two. Analogous, but even less certain, estimates for the indirect effect are 0 to -1.5 W m^{-2}. These values are comparable in magnitude, but opposite in sign, to the current estimates of +2.1 to +2.8 W m^{-2} for the forcing caused by increases in greenhouse gases over the past century.

Because of the great spatial variability in aerosol concentrations that results from their short lifetime, there are many regions - principally over and downwind of major source areas - where the best estimates of aerosol negative forcing exceed the greenhouse positive forcing. Some studies show that aerosol effects appear to be present in global and regional twentieth-century temperature records, and that inclusion of aerosol effects in numerical models improves agreement with observed temperature patterns in both time (decadal and diurnal) and space. Although these studies suggest that anthropogenic aerosols can play an important role in determining current and future climates, their results are far from conclusive. Major questions remain about the realism with which models represent the great diversity of actual aerosol properties, processes, and radiative effects. Error analyses show that the uncertainty in the aerosol radiative forcing is unacceptably large - larger, in fact, than the uncertainty in climate forcing by all greenhouse gases released over the past century.

As a result of both the potential importance of aerosols and the large uncertainties in their radiative effects, the International Global Atmospheric Chemistry (IGAC) Project has established a Focus on Atmospheric Aerosols (FAA) and endorsed a series of aerosol field campaigns. TARFOX is the second in the IGAC/FAA series. TARFOX was designed to reduce uncertainties by measuring and analyzing a wide range of aerosol properties and effects in the US eastern seaboard. This is the region where one of the world's major plumes of industrial haze moves from the continent over the Atlantic Ocean.

Objective/Purpose:

The overall goal of TARFOX is to reduce uncertainties in the effects of aerosols on climate by determining the direct radiative impacts, as well as the chemical, physical, and optical properties, of the aerosols carried over the western Atlantic Ocean from the United States. Subsidiary objectives of TARFOX are to:

- Perform a variety of closure studies by using overdetermined data sets to test the mutual consistency of measurements and calculations of a wide range of aerosol properties and effects.
- Use the results of the closure studies to assess and reduce uncertainties in estimates of aerosol radiative forcing, as well as to guide future field programs on this subject.

An important component of the closure studies is tests and improvements of algorithms that retrieve aerosol properties and effects from satellite and aircraft radiometers. The resulting validated algorithms will permit extensions of the TARFOX results to other times and locations that have aerosol properties similar to those of the TARFOX Intensive Field Campaign (IFC).

Summary of Parameters:

TARFOX_UWC131A_SUNP

PARTICULATE OPTICAL DEPTH
RAYLEIGH OPTICAL DEPTH
TOTAL OPTICAL DEPTH

TARFOX_UWC131A

AEROSOL BACKSCATTERING COEFF
AEROSOL SCATTERING COEFF
CONDENSATION NUCLEI
DROPLET CONCENTRATION
EFFECTIVE DROPLET RADIUS
LIQUID WATER CONTENT
OZONE MIXING RATIO
PARTICLE NUMBER CONCENTRATION

TARFOX_WALLOPS_MET

PRESSURE
RELATIVE HUMIDITY
TEMPERATURE
WIND DIRECTION
WIND SPEED

TARFOX_WALLOPS_SMPS

PARTICLE NUMBER CONCENTRATION

TARFOX_WALLOPS_SONDE

ALTITUDE
PRESSURE
RELATIVE HUMIDITY
TEMPERATURE

Discussion:

More detailed information on TARFOX can be obtained from the TARFOX Web Site.

Related Data Sets:

2. Investigator(s):

Investigator(s) Name and Title:

Project Principal Investigator: Philip B. Russell
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Title of Investigation:

Tropospheric Aerosol Radiative Forcing Observational eXperiment (TARFOX)

Contact Information:

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3. Theory of Measurements:

4. Equipment:

Sensor/Instrument Description:

Collection Environment:

Coordinated measurements were made from four satellites (GOES-8, NOAA-14, ERS-2, LANDSAT), four aircraft (ER-2, C-130, C-131A, and a modified Cessna), land sites, and ships. A variety of aerosol conditions was sampled, ranging from relatively clean behind frontal passages to moderately polluted with aerosol optical depths exceeding 0.5 at mid-visible wavelengths. Gradients of aerosol optical thickness were sampled to aid in isolating aerosol effects from other radiative effects and to more tightly constrain closure tests, including those of satellite retrievals.

Source/Platform:

TARFOX_UWC131A_SUNP	UW C131
TARFOX_UWC131A	UW C131
TARFOX_WALLOPS_MET	Ground Station
TARFOX_WALLOPS_SMPS	Ground Station
TARFOX_WALLOPS_SONDE	Ground Station

Source/Platform Mission Objectives:

See the TARFOX Science and Implementation Plan, June 1996.

Key Variables:

TARFOX_UWC131A_SUNP

PARTICULATE OPTICAL DEPTH
RAYLEIGH OPTICAL DEPTH
TOTAL OPTICAL DEPTH

TARFOX_UWC131A

AEROSOL BACKSCATTERING COEFF
AEROSOL SCATTERING COEFF
CONDENSATION NUCLEI
DROPLET CONCENTRATION
EFFECTIVE DROPLET RADIUS
LIQUID WATER CONTENT
OZONE MIXING RATIO
PARTICLE NUMBER CONCENTRATION

TARFOX_WALLOPS_MET

PRESSURE
RELATIVE HUMIDITY
TEMPERATURE
WIND DIRECTION
WIND SPEED

TARFOX_WALLOPS_SMPS

PARTICLE NUMBER CONCENTRATION

TARFOX_WALLOPS_SONDE

ALTITUDE
PRESSURE
RELATIVE HUMIDITY
TEMPERATURE

Principles of Operation:

Sensor/Instrument Measurement Geometry:

Manufacturer of Sensor/Instrument:

Calibration:

Specifications:

Tolerance:

Frequency of Calibration:

Other Calibration Information:

5. Data Acquisition Methods:

6. Observations:

Data Notes:

Field Notes:

See the TARFOX Operations Summary Document, November 1996.

7. Data Description:

Spatial Characteristics:

Spatial Coverage:

Data Set Name	Min Lat	Max Lat	Min Lon	Max Lon
TARFOX_UWC131A_SUNP	36.01	39.78	-76.53	-72.56
TARFOX_UWC131A	36.02	39.79	-76.54	-72.58
TARFOX_WALLOPS_MET	37.85	37.85	-75.48	-75.48
TARFOX_WALLOPS_SMPS	37.85	37.85	-75.48	-75.48
TARFOX_WALLOPS_SONDE	37.85	37.85	-75.48	-75.48

Spatial Coverage Map:

U.S. eastern seaboard

Spatial Resolution:

TARFOX_UWC131A_SUNP: ...
TARFOX_UWC131A: ...
TARFOX_WALLOPS_MET: Point Measurements
TARFOX_WALLOPS_SMPS: Point Measurements
TARFOX_WALLOPS_SONDE: ...

Projection:

Grid Description:

Temporal Characteristics:

Temporal Coverage:

07/10/1996 - 07/31/1996

Temporal Coverage Map:

Temporal Resolution:

TARFOX_UWC131A_SUNP: 3 second
TARFOX_UWC131A: 1 second
TARFOX_WALLOPS_MET: ...
TARFOX_WALLOPS_SMPS: 5 minutes

TARFOX_WALLOPS_SONDE: 2 seconds

Data Characteristics:

Parameter/Variable:

TARFOX_UWC131A_SUNP

PARTICULATE OPTICAL DEPTH
RAYLEIGH OPTICAL DEPTH
TOTAL OPTICAL DEPTH

TARFOX_UWC131A

AEROSOL BACKSCATTERING COEFF
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TARFOX_WALLOPS_MET

PRESSURE
RELATIVE HUMIDITY
TEMPERATURE
WIND DIRECTION
WIND SPEED

TARFOX_WALLOPS_SMPS

PARTICLE NUMBER CONCENTRATION

TARFOX_WALLOPS_SONDE

ALTITUDE
PRESSURE
RELATIVE HUMIDITY
TEMPERATURE

Variable Description/Definition:

Unit of Measurement:

Data Source:

Data Range:

Sample Data Record:

8. Data Organization:

Data Granularity:

A general description of data granularity as it applies to the IMS appears in the EOSDIS Glossary.

Data Format:

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

Data Processing Sequence:

Processing Steps:

Processing Changes:

There are no plans for reprocessing.

Calculations:

Special Corrections/Adjustments:

Calculated Variables:

Graphs and Plots:

10. Errors:

Sources of Error:

Quality Assessment:

Data Validation by Source:

Confidence Level/Accuracy Judgement:

Measurement Error for Parameters:

Additional Quality Assessments:

Data Verification by Data Center:

The Langley DAAC performs an inspection process on this data received by the data producer via ftp. The DAAC checks to see if the transfer of the data completed and were delivered in their entirety. An inspection software was developed by the DAAC to see if the code was able to read every granule. The code also checks to see if every parameter of data falls within the ranges which are included in the granule. This same code extracts the metadata required for ingesting the data into the IMS. If any discrepancies are found, the data producer is contacted. The discrepancies are corrected before the data are archived at the DAAC.

11. Notes:

Limitations of the Data:

Known Problems with the Data:

Usage Guidance:

Any Other Relevant Information about the Study:

12. Application of the Data Set:

To reduce uncertainties in the effects of aerosols on climate by determining the direct radiative impacts, as well as the chemical, physical, and optical properties, of the aerosols carried over the western Atlantic Ocean from the United States.

13. Future Modifications and Plans:

14. Software:

Software Description:

Unavailable at this time.

Software Access:

The software can be obtained through the Langley DAAC. Please refer to the contact information below. The software can also be obtained at the same time the user is ordering this data set.

15. Data Access:

Contact Information:

Langley DAAC User and Data Services Office
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FAX: (757) 864-8807
E-mail: support-asdc@earthdata.nasa.gov

Data Center Identification:

Langley DAAC User and Data Services Office
NASA Langley Research Center
Mail Stop 157D
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FAX: (757) 864-8807
E-mail: support-asdc@earthdata.nasa.gov

Procedures for Obtaining Data:

The Langley DAAC provides multiple interfaces to access its data holdings. The graphical and character user interfaces allow users to search and order data; and web interfaces allow direct access to some data holdings for immediate downloading or placing media orders, for searching the data holdings, and downloading electronically available holdings, and for ordering prepackaged CD-ROMs and videocassettes. All of these methods are easily obtained from the Langley DAAC web site.

Data Center Status/Plans:

The Langley DAAC will continue to archive this data.

16. Output Products and Availability:

17. References:

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18. Glossary of Terms:

EOSDIS Glossary.

19. List of Acronyms:

EOSDIS Acronyms.

20. Document Information:

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