Tropospheric Aerosol Radiative Forcing Observational eXperiment (TARFOX)
Langley DAAC Project/Campaign 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.

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1. Project/Campaign Overview:

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 (see Section 3).

Name of Project/Campaign:

Tropospheric Aerosol Radiative Forcing Observational eXperiment (TARFOX)

Project/Campaign Introduction:

See Project/Campaign Overview.

Project/Campaign Mission Objectives:

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).

Discipline(s):

Earth Science
Atmosphere

Geographic Region(s):

U.S. eastern seaboard

Detailed Project/Campaign Description:

See TARFOX Home Page.

2. Data Availability:

Data Type(s):

All TARFOX data currently archived at the DAAC are in Native format.

Input/Output Media:

Data are available by FTP or on media.

Proprietary Status:

There is no proprietary status for the data sets currently on-line at the Langley DAAC.

3. Data Access:

Data Center Location:

Langley DAAC User and Data Services Office
NASA Langley Research Center
Mail Stop 157D
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Associated Costs:

There is no cost associated with this data.

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7. Glossary and Acronyms:

EOSDIS Acronyms (PDF).

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