

Summary:

The Stratospheric Aerosol Measurement II (SAM II) experiment flew aboard the Nimbus-7 spacecraft and provided vertical profiles of aerosol extinction in both the Arctic and Antarctic polar regions. The SAM II data coverage began on October 29, 1978 and extended through December 18, 1993 until SAM II was no longer able to acquire the Sun. The data coverage for the Arctic region extends through January 7, 1991, and contains data gaps beginning in 1988 that increase in size each year. The data coverage for the Antarctic region is continuous through December 18, 1993 except for a time period from mid-January 1993 through October 1993. The data gaps for both the Arctic and Antarctic regions are due to an orbit degradation associated with the Nimbus-7 spacecraft.

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1. Project/Campaign Overview:

Name of Project/Campaign:

Stratospheric Aerosol Measurement II, SAM II

Project/Campaign Introduction:

See Summary

Project/Campaign Mission Objectives:

The SAM II instrument, aboard the Earth-orbiting Nimbus-7 spacecraft, was designed to measure solar irradiance attenuated by aerosol particles in the Arctic and Antarctic stratosphere. The scientific objective of the SAM II experiment was to develop a stratospheric aerosol data base for the polar regions by measuring and mapping vertical profiles of the atmospheric extinction due to aerosols. This data base allows for studies of aerosol changes due to seasonal and short-term meteorological variations, atmospheric chemistry, cloud microphysics, volcanic activity and other perturbations. The results obtained are useful in a number of applications, particularly the evaluation of any potential climatic effect caused by stratospheric aerosols.

Discipline(s):

The measurement technique is solar occultation. The spectrometer is activated to take solar irradiance measurements during the periods when the line-of-sight from the SAM II instrument to the Sun has tangent altitudes between sea level and 150 km. It is self-calibrating in that an exoatmospheric measurement is made before a sunset or after a sunrise measurement. Attenuation of sunlight by a species is measured and processed to produce profile data.

Geographic Region(s):

All the points obtained during one day in a given region will be at very nearly the same latitude, but as time progresses, the latitude of the measurements will slowly change with the season by one to two degrees each week. The latitude range for SAM II varies with season. The latitude of the measurements for years 1978 through 1987 gradually moves from the lowest latitude, 64 degrees, at the solstices to the highest latitude, 83 degrees, at the equinoxes. After 1987, the Antarctic coverage gradually moved equatorward and by 1992, the latitude of measurements moved from the lowest latitude, 53.1 degrees at the solstices to the highest latitude, 69.2 degrees at the equinoxes. In the Arctic region, the latitude of measurements by 1991 gradually moved from the lowest latitude, 64 degrees at the solstices to the highest latitude, 86.2 degrees at the equinoxes. The longitude interval for consecutive sunrises or consecutive sunsets is about 26 degrees.



Detailed Project/Campaign Description:

The SAM II instrument is a single-channel Sun photometer employing a cassegrainian telescope and interference filter to define the spectral passband. Solar radiation is reflected off a scan mirror into the telescope with an image of the Sun formed at the slot plate. The instrument's instantaneous field of view, defined by the aperture on the slot plate, is a 30-arc-second circle which produces a vertical resolution on the horizon of approximately 0.5 km. Radiation passing through the aperture is collected with a field lens, passes through an interference filter, and is measured by a silicon photodiode detector. The spectral passband, defined by the interference filter, has a 0.038 micron bandwidth centered at a wavelength of 1.0 micron.

The entire optical and detector system is contained in the azimuth gimbal to allow the instrument to be pointed at the Sun. Prior to spacecraft sunrise or sunset, the instrument is moved (i.e., pointed to the predicted solar acquisition angle). When the Sun enters the instrument field of view, the instrument locks onto the radiometric center of the Sun within +/- arc minute in azimuth and then acquires the Sun in elevation by rotating the scan mirror.

As the Sun sets or rises relative to the Earth's horizon, the elevation mirror scans vertically across the solar disk at a nominal rate of 15 arc minutes per second. The radiometric data are then sampled at a rate of 50 samples per second, digitized to 10-bit resolution, and recorded for later transmission back to Earth for data reduction.

The SAM II instrument uses the Sun as a constant irradiance source (thus is self-calibrating before each sunset or after each sunrise) and measures the radiation that passes through the Earth's atmosphere during a sunrise or sunset.

The photometer assembly scans the Sun at a nominal rate of 15 arc minutes per second. The photometric data are sampled at a rate of 50 samples-per-second and digitized to 10-bit resolution.

The SAM II instrument, along with a number of other sensors, is mounted on the Earth-orbiting spacecraft. The orbital characteristics of this spacecraft determine the frequency and geographic locations of the SAM II measurements. The mode of operation of the SAM II instrument is such that it takes data during each sunrise and sunset encountered. The spacecraft has an orbital period of 104 minutes, which means that it circles the Earth nearly 14 times per day. There is a measurement opportunity for the SAM II each time that the spacecraft enters into or emerges from the Earth's shadow. Consequently, the instrument takes data during approximately 14 sunrises and 14 sunsets each Earth day. The spacecraft was placed in a high-noon, Sun-synchronous orbit; that is, the spacecraft crossed the Equator during each orbit at local noon. In general terms, this means that the orbital plane of the spacecraft was fixed with respect to the Sun, and thus all sunsets occur in the Arctic region and all sunrises occur in the Antarctic region.

In the course of a single day, measurements of the stratospheric aerosol are obtained at 14 points spaced 26 degrees apart in longitude in the Arctic region and similarly for the Antarctic region. All the point obtained during 1 day in a given region are at very nearly the same latitude, but as time progresses, the latitudes of the measurements slowly change with the season by 1 to 2 degrees each week, gradually sweeping out the area from approximately 64.0 to 83.0 degrees. The lowest latitude coverage occurs at the solstices whereas the highest latitudes are measured at the equinoxes.

In the course of 1 week, therefore, the instrument makes about 98 measurements in each region, all in a band of latitude of approximately 1.0 degree. These measurements give a fairly spatially dense set of data points. When the locations of all the measurements obtained in one week are plotted on a geographic set of axes, one finds that the separation between points is only about 4.0 degrees in longitude. In a 6-month period of time, the total number of observations is on the order of 5000.

However, due to an orbit degradation associated with the spacecraft, there has been a change and disruption in the collection of SAM II data beginning in 1987. During the period of time from 1987 through 1993, orbital precession caused the spacecraft to cross the equator earlier than the planned high-noon crossing. This gradually moved the Antarctic coverage equatorward. Initially the Antarctic latitudinal coverage extended from the lowest latitude, 64.5 degrees at the solstices, to the highest latitude, 81.0 degrees at the equinoxes. By 1992 the Antarctic coverage gradually shifted to extend from 53.1 degrees at the solstices, to 69.2 degrees at the equinoxes. In the Arctic region the initial latitudinal coverage extended from the lowest latitude, 64.1 degrees at the solstices, to the highest latitude, 83.0 degrees at the equinoxes. Gradually by 1991 the highest Arctic latitudinal coverage extended to 86.2 at the equinoxes.

The orbital precession also affected the spacecraft orientation and prevented the SAM II instrument from acquiring the Sun for certain periods of time. In the Arctic region many sunset events were lost because an S-band antenna blocked SAM II's view to the Sun. Sunset events were lost for the following periods of time: mid-June through mid-August 1988; mid-March through mid-September 1989; mid-January through September 1990; and from January 7, 1991, through December 1993. In the Antarctic region the SAM II instrument was not able to acquire the Sun for the period of time from mid-January through October 1993. The final 2 months of SAM II data for the Antarctic region were collected during November and December 1993.

2. Data Availability:

Data Type(s):

Atmospheric transmittance data at one wavelength are obtained during solar occultation at each satellite sunrise and sunset. Solar irradiance measurements are made at 1.0 micron. Each record contains eight parameters: vertical profiles of extinction km-1, extinction km-1 uncertainty, extinction ratio, extinction ratio uncertainty, NMC temperature, temperature uncertainty, and pressure as a function of altitude.

Input/Output Media:

The data are available by FTP.
Data are also available on cd-rom.

Proprietary Status:

All data are available to the public.

3. Data Access:

Data Center Location:

Langley DAAC User and Data Services Office
NASA Langley Research Center
Mail Stop 157D
Hampton, Virginia 23681-2199
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Associated Costs:

There is no fee for retrieving this data.

4. Principal Investigator Information:

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5. Submitting Investigator Information:

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- Vol. II - April 1979 to October 1979, NASA RP-1088.
- Vol. III - October 1979 to April 1980, NASA RP-1106.
- Vol. IV - April 1980 to October 1980, NASA RP-1107.
- Vol. V - October 1980 to April 1981, NASA RP-1140.
- Vol. VI - April 1981 to October 1981, NASA RP-1141.
- Vol. VII - October 1981 to April 1982, NASA RP-1164.
- Vol. VIII - April 1982 to October 1982, NASA RP-1165.
- Vol. IX - October 1982 to April 1983, NASA RP-1244.

7. Glossary and Acronyms:

[EOSDIS Acronyms](#) (PDF).

CDC - Control Data Corporation
DAAC - Distributed Active Archive Center
DBMS - Database Management System
EOSDIS - Earth Observing System Data and Information System
ERB - Earth Radiation Budget
GSFC - Goddard Space Flight Center
GUI - Graphical User Interface
IMS - Information Management System
LaRC - Langley Research Center
MET - Meteorological
NASA - National Aeronautics and Space Administration
NMC - National Meteorological Center
NOAA - National Oceanic and Atmospheric Administration
PSC - Polar Stratospheric Cloud
SAGE - Stratospheric Aerosol and Gas Experiment
SAGE I - Stratospheric Aerosol and Gas Experiment I
SAGE II - Stratospheric Aerosol and Gas Experiment II
SAM II - Stratospheric Aerosol Measurement II
UDS - User and Data Service
URL - Uniform Resource Locator

8. Document Information:

- **Document Revision Date:** Sep 25, 1996; May 21, 1997; Nov 24, 1997
- **Document Review Date:** Sep 25, 1996
- **Document ID:**
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