NASA Reference Publication 1215

1989

Nimbus-7 Data Product Summary

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SECTION 1

INTRODUCTION

The Nimbus-7 mission is currently the single most significant source of experimental data from Earth orbit relating to atmospheric and oceanic processes. It includes eight experiments that are providing a wealth of long-term global data on the state of the lower, middle, and upper atmosphere (including ozone), snow and ice, the interaction between the oceans and the atmosphere, and marine resources. Nimbus-7 data products are providing a long-term view of the variations in the climate of the Earth.

The Nimbus-7 satellite has a vantage point that is 955 kilometers (km) above the Earth. Its 104-minute orbit is circular and synchronous with the Sun, as the satellite travels near the North and South Poles. A given point on the Earth is viewed twice in every 24-hour period, once in sunlight and once in darkness. This orbit allows the Nimbus-7 experiments to measure the surface or atmospheric events on a global scale, revealing features not observable from the surface of the Earth.

Data products are available in the form of magnetic tape and/or microfilm. Most of the magnetic tape products are contained on 9-track 1600 bpi tapes. Some condensed data sets are available at a density of 6250 bpi. These data sets are described in the appropriate sections. Descriptions of individual data products are presented in the following sections. Instructions for obtaining these products along with relevant documentation are presented in Section 10. A brief summary of the scientific experiments on Nimbus-7 is presented in Table 1.1. Table 1.2 lists the Nimbus-7 management personnel and members of the various instrument teams.

After an unprecedented 9 years in orbit, three of the experiments are still functioning successfully, and several more years of operation are anticipated.

Table 1.1

Summary of Nimbus-7 Experiments

Sensor	Channel Wavelengths	Scientific Parameters	Applications	Film and Tape Output Products
CZCS	0.44, 0.52, 0.56, 0.67, 0.75, 11.5 μm	Temperature Spectral Radiances Chlorophyll Sediment	Geodynamics of coastal regions Chemical and thermal pollution studies Fishery resources Deep ocean monitoring Oil spill monitoring	2-minute images
ERB	10 solar viewing channels covering 0.2 - 50 μm 12 Earth viewing channels covering 0.2 - 50 μm	Earth fluxes Solar fluxes Zonal insolation	Climatology Ocean/atmosphere dynamics Weather modeling Terrestrial reflectance studies	Daily, monthly, and seasonal world grids Monthly and seasonal contour maps Zonal statistics
LIMS	6.25, 6.75, 9.65, 11.35, 15.25, 1 broad channel 13.2 - 17.2 μm	Gas concentrations and temperature profiles in the stratosphere	Atmospheric pollution monitoring Photochemical studies Atmosphere gas dynamics Climatology	Daily atmosphere profile Daily, monthly, and seasonal contour maps and atmospheric cross-sections
SAMS	9 channels defined by gas cell modulation 4.1 - 15.0 μm and 25 - 100 μm	Gas concentrations and temperature profiles in the stratosphere and mesosphere	Atmospheric pollution monitoring Photochemical studies Atmosphere gas dynamics Climatology Wind dynamics	Daily atmosphere profile Daily, monthly, and seasonal contour maps and atmospheric cross-sections
SAM II	1 μm	Aerosol extinction and extinction profiles, and stratospheric optical depth	Atmospheric sources and sinks Earth radiation budget studies Aerosol injection dynamics	Daily aerosol profiles Daily and seasonal contour maps
SBUV/ TOMS	12 fixed wavelengths from 0.255 - 0.380 μm and continuous scan from 0.160 - 0.400 μm	O_3 profiles Total atmospheric O_3 Solar irradiances Terrestrial radiances	O_3 dynamics/modeling Climatology and meteorology O_3 solar relationships	Daily profiles of O_3 Daily, monthly, and seasonal contour maps Solar spectra Zonal O_3 statistics
SMMR	6.6, 10.7, 18.0, 21.0, 37.0 GHz (frequency) Vertical and horizontal channel	Sea-ice parameters Ocean surface conditions Snow parameters Atmospheric water amount	Ocean dynamics Ice dynamics Ocean/atmosphere interactions Cryospheric dynamics Climatology and weather modeling	Orbital observations Bi-daily and monthly color contour maps
THIR	6.75 μm, 11.5 μm	Surface temperature Cloud top temperature Cloud amount	Effects of cloudiness on other Nimbus-7 instruments data	Daily montages of temperature

Table 1.2

Participants in the Nimbus-7 Project

PROJECT MANAGERS:

Ronald Browning:	1977 - 1979
Charles MacKenzie:	1979 - 1983
Albert J. Fleig:	1983 - 1985
Edward J. Hurley:	1985 - 1988
Arnold G. Oakes	1988 - Present

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Table 1.2

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Table 1.2

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Dr. H. Lee Kyle, NASA/GSFC

SECTION 2

COASTAL ZONE COLOR SCANNER (CZCS)

The CZCS is a multispectral line scanner consisting of five channels in the visible wavelength region and one thermal channel in the infrared. The visible channels provide data on solar energy and water color as affected by the absorption and scattering of radiation due to chlorophyll, sediment, and waste materials. The infrared channel provides data on water temperature in coastal waters, open oceans, and within ocean currents.

CZCS observations are important for a number of reasons. Since phytoplankton comprise the bottom of the food chain in the ocean, a determination of the chlorophyll content also provides some measure of the total biological activity, data of importance to both marine science and the fisheries industry. Separate measurements of the organic and inorganic content of the ocean over time allow an assessment of the effects of sedimentation and pollution (and varying ocean temperatures) on marine life.

The CZCS scans an area of approximately 1.1 million square kilometers in 2 minutes. Scanning in the forward direction is provided by the satellite's orbital motion, and successive transverse scan lines are timed to produce contiguous scans. Details of the CZCS instrument and its operation are given in the Nimbus-7 Users' Guide (Hovis, 1978). A brief description of the output data products is provided below. Because of power requirements, the CZCS was operated intermittently, with observation periods of 2-10 minutes, up to a maximum possible daily total of 2 hours per day. Investigators should obtain a catalogue of available CZCS observations from the National Climatic Data Center (NCDC) at NOAA/NESDIS (see Section 10). The CZCS ceased effective operation during the first week in December 1986.

2.1 Tape Products

2.1.1 CRTT (CZCS Radiance and Temperature Tape)

This tape contains up to three 2-minute scenes of CZCS data from all six channels in the form of raw instrument counts, radiances (from the prelaunch calibration algorithms), and a temperature look-up table for data from the thermal channel (channel 6). The data are geodetically located. Corrections for atmospheric effects and instrument degradation are not made on the CRTT. Therefore, users of the CRTT may apply their own calibration algorithms and data processing schemes to extract information such as pigment concentration, subsurface radiance, etc.

2.1.2 CRCST (Calibrated Radiance Chlorophyll Sediment Tape)

This tape contains calibrated radiances consisting of aerosol radiance from channel 4 and subsurface radiances from channels 1, 2, and 3; temperature pigment concentration; diffuse attenuation coefficient; and housekeeping data (land/cloud flags, etc.) for a 2-minute scene.

2.2 Microfilm Products

Level 1 and 2 imagery is also available on microfilm. The imagery is arranged chronologically by geographic location, with each 35 mm reel containing up to 500 scenes.

2.2.1 Level I Film

Each piece of film is a 241 mm x 241 mm negative display of the six channel radiances for a single scene (approximately 2 minutes of CZCS data) on the CRTT. The purpose of the film, also available as a positive transparency or print, is to give the user an indication of the data reposing on the tape, the quality of the data, cloud cover, geographic coverage, and oceanographic phenomenon of interest. It is not, in general, intended for use in detailed analysis.

2.2.2 Level II Film

Each Level II film product is a set of two 8 x 10 inch negative displays of four images for each scene that show pigment concentration, aerosol radiance, subsurface radiance (channel 1), and diffuse attenuation. The Level II film is also available as a positive transparency or print, and, if the user has an image processing system, the CRCST may be used to generate color coded imagery. Pigment concentration and diffuse attenuation coefficient are displayed on one 8 x 10 inch film, and the aerosol radiance and subsurface radiance are displayed on a second 8 x 10 inch film.

SECTION 3

EARTH RADIATION BUDGET (ERB)

The Earth Radiation Budget (ERB) instrument aboard Nimbus-7 is an experiment for providing measurements of radiation entering and exiting the Earth-atmosphere system. The objectives of ERB are 1) to obtain accurate measurements of solar irradiance, monitor its variation in time, and observe the temporal variation of the solar spectrum; and 2) to determine the Earth radiation budget from simultaneous measurements of the incoming solar radiation and the outgoing Earth-reflected and Earth-emitted radiation.

The ERB experiment is a 22-sensor radiometer designed to provide long-term accurate records of this absorption and emission process on a global scale. There are three instrument groups: a 10-channel solar telescope; a four-channel, fixed wide-field-of-view (WFOV) Earth-viewing array; and an eight-channel, Earth-viewing, narrow-field-of-view (NFOV) scanning radiometer. The solar telescope measures both the total solar irradiance and several broad spectral bands. Of particular note is the highly accurate, self-calibrating channel 10c, which measures the total solar irradiance. The Earth-viewing channels are wide spectral band sensors that measure the total reflected solar irradiance and the total emitted outgoing longwave radiation. The albedo, average outgoing radiation and the net radiation are calculated from these quantities. The NFOV scanner instrument scans biaxially and thus can observe the same region from several different angles within a few minutes. The NFOV data are used both to determine the Earth radiation budget parameters and to establish top-of-the-atmosphere bidirectional reflectance patterns for various types of scenes.

Beginning on November 16, 1978, the ERB instrument operated on a 3-days ON, 1-day OFF cycle, with a few minor interruptions of this schedule until September 1983. Since then, the ERB has operated full-time with the following exceptions: 3-days ON, 1-day OFF cycle for 7 months spanning the summer of 1984; only solar data taken for April 10 - June 23, 1986; 1-day on full, solar data only on second day cycle during summer of 1987 (all changes due to varying power demands of other Nimbus-7 experiments). The ERB parameters are calculated both on a regional basis (500 km x 500 km) and on a zonal basis (4.5° wide latitude bands circling the Earth). Daily, cyclic (6-day), monthly, and seasonal mean values of the ERB parameters (outgoing longwave radiation, reflected energy, albedo, and net radiation) are derived. Due to budgetary limits, only the MAT tapes and the solar data (SEFDT solar only, and ESAT) are available for data periods after the winter of 1986/87.

3.1 Tape Products

3.1.1 MAT (Master Archive Tape)

All MATs are 9-track, 6250 bpi tapes. There are 3 data days per tape. The MAT contains all the ERB data plus associated housekeeping data on instrument temperatures. All data are presented as raw digitized readings and as calibrated radiances and irradiances at satellite altitude. The latitude and longitude of the center of each pixel of Earth data are given. The MAT is the only product containing all of the scanner data. (The scanner failed on June 22, 1980, so there are only 20 months of scanner data.) However, the calibration of none of the data is optimum. Optimization of the Earth flux data is done in the SEFDT, MATRIX, and SRT programs by applying linear calibration adjustments to the MAT radiances and irradiances. Solar data are optimized in the SEFDT starting from the raw counts.

3.1.2 SEFDT (Solar and Earth Flux Data Tape)

The SEFDT contains calibration optimized wide-field-of-view (121° unencumbered FOV) Earth irradiances (at satellite altitude) and solar channel (extraterrestrial solar irradiation) data. The latitude and longitude of the Earth pixels are given. The solar channel data are restricted to the vicinity of the Sun-viewing period of the orbit. Both raw counts and calibrated radiances and irradiances are given. Filter degradation in the narrow spectral band solar channels has not been corrected. There is one 1600 bpi tape per month. Three WFOV calibration schemes were used to correct Earth flux data. For the first 19 months, the calibration was tied directly to the calibration of the longwave NFOV channels. Following the

failure of the scanner, an interim scheme was used during the next 41 months. From month 61 on, a final, optimized scheme was used. The first 5 years of WFOV data have been reprocessed using this optimized procedure. Data requests received prior to the fall of 1988 may have been filled with some of the preliminary data products.

3.1.3 MATRIX (Mapped Data Matrix Tape)

The MATRIX tape contains regional Earth radiation budget products at the top of the atmosphere. These include emitted longwave radiation, albedo, and net radiation calculations on a daily, 6-day, and monthly basis. The MATRIX tape also contains reflected shortwave radiation at the satellite's altitude. Separate WFOV and scanner data are presented on the older MATRIX tapes. The present MATRIX tapes contain only WFOV data. The scanner data have been reprocessed and reside on the separate SAB MATRIX tape (see Section 3.1.11). The Earth is divided into 2,070 fixed target areas, each approximately 500 km x 500 km, and results are given for each target area viewed during a specific period. Sampling population and other statistics are given. Day, night, and average results are presented. There is one tape per month. The WFOV Earth flux data were corrected, applying the same calibration algorithms used in the SEFDTs.

3.1.4 SAVER (Seasonal Average Tape)

The SAVER tape is similar to the MATRIX tape, but it contains 3-month or seasonal averages. There is one tape per 3-month period. The seasons are defined such that the winter season contains data from December through February, the spring season contains data from March through May, etc. For budgetary reasons these tapes exist only for data years 3-7 and for the first quarter of year 8 (December 1980 to February 1986).

3.1.5 ZMT (Zonal Means Tape)

The ZMT contains zonal mean data derived from SEFDT, MATRIX, and SAVER tapes. The target areas are each 4.5 degrees of latitude wide, so there are 40 latitude zones from pole to pole. There is one ZMT per 6-month period. For budgetary reasons these tapes exist only for data years 3-7 (December 1980 to November 1985).

3.1.6 DELMAT (Post MAT Calibration Tape)

After the scanner failure, new calibration adjustment algorithms were developed for the WFOV channels based on the stable total (0.2m - 50m) WFOV channels 11 and 12. The DELMAT tapes contain the short-term calibration adjustment quantities to be used in SEFDT and MATRIX WFOV calibration optimization after the scanner failure. There is one DELMAT per month. For each MATRIX tape there is a corresponding DELMAT tape.

3.1.7 STRT (Subtarget Radiance Tape)

A secondary purpose of the Nimbus ERB Experiment was the collection of better data concerning the reflectance characteristics of typical Earth scenes as seen from satellite altitudes. This information is needed to refine satellite remote sensing capabilities for monitoring the Earth's radiation budget and many other environmental parameters. To this end, the Nimbus ERB scanner was designed to view a given scene from several different directions within a 2 or 3 minute time period. Each of the MATRIX 2,070 ERB target areas is divided into nine subtarget areas. The scanner radiances are quality-controlled, calibration-optimized, and sorted into subtarget areas. In addition, the radiances are defined in terms of time, and solar and satellite view angles as seen from the target area. The target areas are also defined in terms of the following properties:

a. Topography - type of terrain and vegetation on a target area basis

b. Geography - land, water, snow, and ice data on a subtarget area basis

c. Cloud - clear, low, middle, and high cloud data on a subtarget area basis

Cloud data come from the Nimbus-7 THIR scanner and are taken simultaneously with the ERB scanner data. There is a potential of 388 data days (November 16, 1978 to June 22, 1980), but only 272 data days will be included in the first archive data sets, which cover slightly more than 1 year of data. There is one STRT (6250 bpi) tape per 6 data-day period.

3.1.8 ESAT (ERB Solar Analysis Tape)

ESAT is a summary tape containing a complete solar data set free of the Earth flux data and other information on the SEFDTs not used by the solar community. It contains calibrated orbital and daily averaged solar data from the SEFDTs and solar tapes processed at Eppley Laboratory. The solar data on ESAT include gamma angle, Earth-Sun distance, channel 3 and 10C temperatures, channel 1-10 irradiances, cosine-corrected channel 10C irradiance, and solar activity indicators. One 6250 bpi tape contains the first 89 months of solar data. Additional data will be added on a yearly basis as they become available.

3.1.9 EMST (ERB Matrix Summary Tape)

The EMST contains all the monthly world grid Earth radiation budget products from the MATRIX tapes. One 6250 bpi tape contains the first 5 years of data done with the old calibration. A second tape contains the better-calibrated data for years 3 through 8. In early 1989 the first tapes will be withdrawn and the final EMST will contain all available MATRIX monthly fields. Additional data will be added on a yearly basis as they become available.

3.1.10 Scene Radiance Tapes (SRT)

The SRTs are 9-track, 6250 bpi tapes that contain calibration-adjusted ERB narrow field-of-view (scanner) radiances sorted geographically into subtarget areas (STAs) (about 166 km x 166 km). In each STA the radiances are sorted in 85 solid angle bins comprising the upward hemisphere seen at the STA. For storage purposes on the tape, symmetry about the principal sun plane is assumed, thus reducing the solid angle bins to 49 on a half orbit (ascending or descending node) basis. The products are STA bin averages and populations for longwave, shortwave, and bidirectional reflectances; mean azimuth and satellite zenith angle for the observations in each bin; and the solar zenith angle at the subtarget area. There are three tapes per month for 13 months (May 1979 - May 1980).

3.1.11 Sorting into Angular Bins (SAB) MATRIX Tape

This is a 9-track, 6250 bpi tape. It contains monthly averaged albedos, outgoing longwave radiation, and net radiation for the 2,070 fixed MATRIX target areas (each about 500 km x 500 km) for 13 months, May 1979 - May 1980. The products are constructed from the ERB scanner measurements on the SRTs by integrating (summing) the radiances for each target area. Daily products are present for 4° latitude zones (each 4 1/2° in width). Also present are the daily zonal and target area monthly averaged radiances in each of the 49 angular bins.

3.2 Microfilm Products

All microfilm products have been withdrawn from the archive.

SECTION 4

LIMB INFRARED MONITOR OF THE STRATOSPHERE (LIMS)

The Limb Infrared Monitor of the Stratosphere (LIMS) experiment has made global atmospheric measurements of the vertical distribution of temperature and several important trace gases involved in the chemistry of ozone. LIMS is one of two experiments (SAMS is the other) onboard the Nimbus-7 satellite that, for the first time, have provided simultaneous measurements of temperature and trace gases. Such measurements are needed for studies of chemical processes in the atmosphere. LIMS measured both day and night vertical radiance profiles for six radiometer channels. Inversion of these radiances provided high-resolution vertical profiles of temperature, and of ozone, water vapor, nitric acid, and nitrogen dioxide mixing ratios for the stratosphere (10 km - 50 km). The temperature and ozone profiles extend through the lower mesosphere to 65 km for temperature and ozone.

The LIMS operated essentially without flaw during its entire design lifetime of 7-1/2 months, returning 7,000 vertical radiance profiles a day for each of the six channels over the 64° South to 84° North latitude range. It has also demonstrated improvements in infrared detector performance and inversion algorithm (data reduction techniques) development, and has shown the potential of the Limb Emission Sounder for future long-term observations of minor trace gases.

4.1 Tape Products

4.1.1 RAT (Radiance Archival Tape)

The RAT contains Earth-located radiances, housekeeping information, instrument status, and data quality information. The radiances are calibrated but not corrected for instrument effects such as field-of-view, electronic delay, spacecraft motion, etc. There are 203 RAT tapes (1600 bpi), one per day of data. The format is described in the Nimbus Observation Processing System (NOPS) Requirement Document No. NG-34, LIMS Radiance Archival Tape (RAT). The data cover from October 26, 1978 through May 30, 1979, minus 15 off days.

4.1.2 LAIPAT (Inverted Profile Archival Tape)

The LAIPAT contains the corrected radiance profiles at intervals from 64° South to 84° North. It also contains the following physical quantities as a function of pressure: temperature and ozone, water vapor, nitric acid, and nitrogen dioxide mixing ratio profiles. In addition, Earth-location, time, cloud top, and housekeeping information are included. There are a total of 36 LAIPAT tapes (1600 bpi) containing from 2 to 6 days of data each. The format description of these tapes is contained in NOPS Requirements Document No. NG-35, LIMS Inverted Profile Archival Tape. The data cover the period from October 26, 1978 through May 28, 1979. There are about 1,000 reduced scans (vertical profiles each of temperature, ozone, water vapor, nitric acid, and nitrogen dioxide as a function of pressure) per day.

4.1.3 LAMAT (Map Archival Tape)

The LAMAT contains LIMS results in the form of daily global maps at 18 pressure levels (0.05, 0.1, 0.2, 0.4, 0.5, 0.7, 1, 1.5, 2, 3, 5, 7, 10, 16, 30, 50, 70, and 100 mb). These maps are stored in the form of Fourier coefficients for each latitude zone, pressure level, and product. There are 38 latitudes spaced at 4° intervals from 64° South to 84° North. The coefficients are developed using an optimal-estimation Kalman filter technique. The values at synoptic times of 0000 GMT and 1200 GMT are stored on tape. Separate analyses using the ascending (day) side of the orbit (Nimbus-7 followed a Sun-synchronous orbit), the descending (night) side, and combined sides are written to tape. This procedure allows diurnal variations to be studied. There are nine LAMATs containing maps for 23 to 30 days each. The format description of these tapes is contained in NOPS Requirement Document NG-52, LIMS Map Archival Tape. Maps are determined for every day in the October 26, 1978 to May 28, 1979 period.

In general, only temperature and ozone are mapped at all 18 pressure levels. The other species maps stop at altitudes where signal-to-noise values become inadequate for data reduction. In addition, the

analyses at 70 mb and 100 mb are often missing at tropical latitudes, because clouds render the results unreliable.

4.1.4 LASMAT (Seasonal MAT)

This tape contains weekly and monthly means of the MAT data. A description of the format of this tape is contained in NOPS Requirements Document NG-53, LIMS Summary Map Archive Tape.

4.2 Microfilm Products

There are no microfilm products for this instrument.

SECTION 5

STRATOSPHERIC AEROSOL MEASUREMENT II (SAM II)

The Stratospheric Aerosol Measurement II (SAM II) experiment, the first satellite experiment to monitor stratospheric aerosols globally, determines the effects that such aerosols have on radiation balance and climate in the polar regions. These aerosols, generally composed of sulphuric acid-water droplets, volcanic ash, and other submicron and micron particulate matter, are suspended in the stratosphere 18 km to 20 km above the Earth's surface. Scientists speculate that these aerosols, interacting directly with solar and infrared radiation, affect radiation balance, climate, and heterogeneous chemistry in the stratosphere.

The SAM II data have been instrumental in the development of a polar stratospheric aerosol climatology, monitoring seasonal variations and long-term changes due to volcanic intrusions. The frequency of polar stratospheric cloud occurrence was discovered to be orders of magnitude greater than the previously reported visual sightings of nacreous clouds and has resulted in a detailed study of their formation mechanism and potential impact on polar night chemistry and climate. The delay in arrival of volcanic material in the polar region from eruptions at lower latitudes has also provided key information on atmospheric dynamics.

The SAM II is a single-channel radiometer that measures the attenuation of solar radiation through the Earth's atmosphere during spacecraft sunrise and sunset. The spectral bandpass is centered at a wavelength of 1 m where the dominant extinction (absorption and scattering) of solar radiation is due to the aerosols suspended in the atmosphere. Thus, SAM II provides an altitude profile of aerosol extinction with a 1 km vertical resolution for each sunrise/sunset event from cloud tops to approximately 35 km. The high-noon Sun-synchronous Nimbus-7 orbit allows SAM II measurements only in the polar regions from 64° S to 80° S latitudes.

Additional information on the SAM II experiment appears in the Nimbus-7 User's Guide. Information on SAM II observations, data validation, and analyses can be found in the works listed in the Bibliography.

5.1 Tape Products

5.1.1 RDAT (Radiance Data Archive Tape)

The RDAT contains the basic radiance data for each SAM II sunrise or sunset event as a function of time and Earth-location. There are 12 RDATs per year, each covering a 1-month period and written on a 9-track, 1600 bpi magnetic tape.

5.1.2 BANAT (Beta Aerosol and Number Density Archive Tape)

The SAM II BANAT tape contains altitude profiles of the aerosol coefficient of extinction, molecular coefficient of extinction, and total extinction ratios, along with the corresponding error bars, for each sunrise/sunset event. There are 12 BANATs per year, each covering a 1-month period and written on a 9-track, 1600 bpi magnetic tape.

5.2 Microfilm Products

There are no microfilm products for this instrument.

5.3 Graphics Products

Selected graphics products are available in a series of NASA Reference Publications entitled SAM II Measurements of the Polar Stratospheric Aerosol. Each volume contains 6 months of weekly averages for aerosol extinction profiles and isopleths, temperature isopleths, and average optical depth.

SECTION 6

STRATOSPHERIC AND MESOSPHERIC SOUNDER (SAMS)

The SAMS is a 12-channel infrared radiometer containing seven pressure-modulated gas cells and six detectors. It observes thermal emission and solar resonance fluorescence from the atmospheric limb.

SAMS provides data on the vertical concentrations of water vapor, nitric oxide, nitrous oxide, methane, and carbon monoxide in the stratosphere and mesosphere. Resonant scattering of solar radiation by water vapor, carbon dioxide, carbon monoxide, and nitric oxide is also measured. The global temperature profiles of the upper atmosphere are determined by SAMS channels tuned to carbon dioxide. SAMS measurements are used to study dynamical phenomena, especially waves and stratospheric warmings, the atmospheric water vapor (including the production of water vapor by methane oxidation), and nitrogen photochemistry in the stratosphere.

The experiment performed well for the period from December 1978 to June 1983, during which time over 2 million vertical profiles of temperature and composition were measured. The individual profiles have been combined into global two- and three-dimensional maps for study and comparison with computerized numerical models of the atmosphere.

The status of temperature and constituent information is as follows:

a. Temperature retrievals have been carried out for the period from December 24, 1978 to June 9, 1983 except when data quality was poor or when the instrument was having scan problems. This information is archived at NSSDC on GRID-T tapes.

b. The carbon monoxide channel signal-to-noise ratio was poor, but retrievals were carried out.

c. Nitric oxide in the pressure modulator cell suffered from chemical contamination, resulting in data from this channel that are of little value.

d. A limited set of retrievals has been obtained from the 2.7 micron water vapor channel and should provide water concentration in the 65 km to 90 km region. The information is limited to January, April, July, and October 1979, but processing is under way to produce similar products for all of 1979.

e. The water vapor rotation band is the primary water vapor channel, which should produce zonal means and global distributions of water from 15 km to 60 km. However, retrieved profiles to date have failed to satisfy validation criteria. Studies are currently being undertaken in an attempt to solve this problem. Preliminary processing of zonal mean fields for 1979 and 1980 has been completed and similar processing of the remainder of data is proceeding. These data only illustrate the qualitative behavior of the water distribution and will not be archived at NSSDC.

f. Nitrous oxide and methane have been retrieved from SAMS radiances for the period from January 1, 1979 to December 31, 1981 and this information is archived at NSSDC on a single ZMT-G tape.

A detailed description of the SAMS experiment and calibration is given in the Nimbus-7 User's Guide (Drummond *et al.*, 1978), the Nimbus-7 SAMS User's Guide, and in papers listed in the Bibliography. The references also provide information on retrievals of temperature and composition.

6.1 Tape Products

6.1.1 RAT (Radiance Archive Tape)

The RAT contains data frame by frame along the orbit: uncalibrated and calibrated radiances, SAMS

housekeeping information, derived tangent point pressures, relevant spacecraft attitude and orbit information, and retrieved temperature profiles at 2.5° intervals along the tangent track. Each tape holds data for 8 calendar days, for which there are normally 6 days of data. Apart from the retrieved temperatures, these tapes are not expected to be useful to most users. They would be necessary for any attempt to re-retrieve any of the profiles. Such a task would require extensive knowledge of spectroscopy and radiative transfer.

The SAMS operated in various modes, which were combinations of scanning height, channels enabled, and pressure modulator pressure. The mode normally changed within one orbit of 0000 GMT. Standby days, when the SAMS is not operating, which occurred every fourth day, also began and ended at this time. The data are organized into "nominal days", each beginning and ending at a mode change or entry or exit from standby, and, therefore, correspond to just one mode. They are normally about 24 hours long but can range from 8 to 36 hours. Periods longer than 36 hours in one mode are divided into approximately 24-hour sections, changing at 0000 GMT. A document containing a tabular listing of mode, orbit ranges, and special problems for each nominal day accompanies the tapes.

6.1.2 GRID-T (Gridded Retrieved Temperature)

GRID-T tapes contain two kinds of data blocks -- block type 7402 and block type 7403 (see below).

The complete retrieved temperature data set consists of four 9-track, 6250 bpi tapes with approximately 1 calendar year of data per tape. Data coverage starts on December 24, 1978 and ends June 9, 1983.

6.1.2.1 Data Block Type 7402

Data block type 7402 contains retrieved temperatures averaged over day and night at 62 pressure levels, spatially distributed over the Earth's surface in a grid with a resolution of 2.5° (latitude) x 10° (longitude). The pressure levels range from 1.4 to 13.6 in $\ln(P_0/P)$, every 0.2. P_0 is 1,000 mbar and P is the pressure in mbar. The latitude ranges from 50° South to 67.5° North. Zonal mean and climatological values are also given.

6.1.2.2 Data Block Type 7403

Block type 7403 contains 2-1/2° x 10° (latitude/longitude) grids extending from 50° South to 67.5° North. Each block contains temperatures or temperature errors averaged over day and night at 10 pressure levels: 100, 30, 10, 3, 1, 0.3, 0.1, 0.03, 0.01, and 0.003 mbar.

6.1.3 ZMT-G (Zonal Means Tape - Gas)

The ZMT-G tape contains blocks of zonal mean retrieved mixing ratios of methane and nitrous oxide at 31 pressure levels averaged over 24-hour (day and night) periods. The latitude zones start at 50° South and increment by 2.5° up to 67.5°. The methane and nitrous oxide channels cannot function simultaneously, so that only one will be available for any given nominal day. The mixing ratios as well as the mixing ratio errors are given starting at $\ln(P_0/P) = 3.0$ every 0.2 in $\ln(P_0/P)$ up to 9.0, where $P_0 = 1013.25$ mbar and pressure is measured in mbar.

The entire methane and nitrous oxide data set resides on a single 9-track, 6250 bpi tape. Data coverage begins January 1, 1979 and ends December 30, 1981.

6.2 Microfilm Products

There are no microfilm products for this instrument.

SECTION 7

SOLAR BACKSCATTER ULTRAVIOLET/TOTAL OZONE MAPPING SPECTROMETER (SBUV/TOMS)

Ozone is an essential component of the atmosphere of the Earth; it serves as a shield, protecting life on Earth from the harmful effects of the ultraviolet radiation of the Sun. Ozone is also a sensitive tracer of atmospheric dynamics and is an important source of information for analysis of upper air motions. A delicate balance now exists between the creation and destruction of ozone in the atmosphere. For scientists to understand this balance -- to guard against upsetting this balance through man-made perturbations -- ozone concentrations and distributions are being measured and mapped.

The Solar Backscatter Ultraviolet/Total Ozone Mapping Spectrometer (SBUV/TOMS) experiments measure the amount of ozone in the Earth's atmosphere and map the global distribution of ozone. The experiments measure incident solar ultraviolet radiation and ultraviolet radiation backscattered from Earth and its atmosphere. The two portions of the experiment share supporting electronics. The ratio of backscattered to incident radiation is used to infer ozone amount. The SBUV experiment measures at 12 discrete wavelengths and periodically makes continuous scans of wavelengths ranging between 160 nm and 400 nm, so that the UV solar flux and Earth radiance measurements are available as a byproduct of the SBUV ozone measurement. SBUV is the only source of global information about the height distribution of ozone in the atmosphere. It makes nominally 1,300 measurements used to infer total ozone and the ozone profile along the suborbital track each day in a 200 km field-of-view. The TOMS maps the distribution and transport of ozone daily on a worldwide scale. It measures radiation at six wavelengths, scanning across the Nimbus-7 suborbital track, and gives 200,000 total ozone measurements daily in a 50 km field-of-view at nadir. TOMS is the only source of high-resolution global information about the total ozone content of the atmosphere.

Corrections for an instrument change, based upon an analysis of the SBUV and TOMS instruments, have been applied to the data; however, appreciable uncertainty about the instrument behavior remains, and the archived data should not be used directly in trend determination without addressing errors and uncertainties of instrumental origin.

Data coverage began November 1978. SBUV coverage was continuous until February 1987. Starting February 13, 1987, the fraction of measurements flagged for dark current chopper out of synchronization increased appreciably. Because this problem may introduce errors into the retrieved ozone, the affected data are on separate tapes from the earlier SBUV data and are distributed with a note discussing the problem in greater detail. As of this writing, TOMS coverage was continuous through July 1988, and measurements were continuing.

7.1 Tape Products

7.1.1 RUT (Raw Unit Tape)

The RUT contains Earth-located radiances and irradiances (uncorrected/uncalibrated), housekeeping information, instrument status, and support data from outside sources (snow/ice, terrain height, and cloud information). The RUT is the fundamental archival tape but is not expected to be of significant use to most investigators.

7.1.1.1 RUT-S (RUT-SBUV)

There are 52 RUT-S tapes (9-track, 6250 bpi) per year for the SBUV.

7.1.1.2 RUT-T (RUT-TOMS)

There are 52 RUT -T tapes (9-track, 6250 bpi) per year for the TOMS.

7.1.2 HDSBUV and HDTOMS (High-Density SBUV and High-Density TOMS)

These two products are the fundamental ozone data sets for the SBUV and TOMS.

7.1.2.1 HDSBUV

The HDSBUV tape contains total ozone, reflectivity, ozone mixing ratios, and layer ozone amounts scan by scan and orbit by orbit. The mixing ratios are given at 19 pressure levels (0.3, 0.4, 0.5, 0.7, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 7.0, 10, 15, 20, 30, 40, 50, 70, and 100 mbar); and the layer ozone amounts are given for 12 layers (0 to 0.24, 0.24 to 0.49, 0.49 to 0.98, 0.98 to 1.95, 1.95 to 3.9, 3.9 to 7.8, 7.8 to 15.6, 15.6 to 31, 31 to 62, 62 to 125, 125 to 250, and 250 to 1,000 mbar, in matm-cm).

It also contains measured radiances (calibrated and corrected) for all channels together with various diagnostic information about the retrievals. There are four HDSBUV tapes (9-track, 6250 bpi) per year, each covering 13 weeks of data. This tape could be of use to an investigator who wants to know more about the performance of the retrieval algorithm or wants to develop algorithms, but it is expected that most users will prefer the CPOZ tape.

7.1.2.2 HDTOMS

The HDTOMS tape contains the total ozone, reflectivity, and measured radiances (calibrated and corrected) for the TOMS channels. Data are given for each of the TOMS 35 samples, scan by scan and orbit by orbit. There are 18 HDTOMS tapes (9-track, 6250 bpi) per year, each containing 3 weeks of data.

7.1.3 CPOZ (Compressed Ozone Tape)

The CPOZ tape is a condensed version of the HDSBUV. It contains Earth-located total ozone, reflectivity, radiances, mixing ratios at 19 levels, and ozone amounts in the same 12 layers as the HDSBUV. Only the good quality data contained in the HDSBUV have been included on the CPOZ. The CPOZ tape is expected to be the most convenient SBUV product for investigators. There are four CPOZ tapes (9-track, 1600 bpi) per year, each covering 3 months of data. As complete CPOZ calendar years become available, the four quarterly tapes are merged into a single yearly CPOZ.

7.1.4 ZMT (Zonal Means Tape)

A ZMT contains zonal ozone means on a daily, weekly, monthly, and quarterly basis.

7.1.4.1 ZMT-S (Zonal Means Tapes for SBUV)

The ZMT-S contains averages of total ozone and mixing ratios for the same 19 levels described under HDSBUV for 10° latitude zones centered from 80° South to 80° North. Standard deviations, maximum and minimum value in the zone, and number of samples are also given. This tape would be of interest to investigators who want to study the spatial and temporal variations of ozone at various levels. There is only one (9-track, 1600 bpi) tape per year for SBUV.

7.1.4.2 ZMT-T (Zonal Means Tapes for TOMS)

This product has been discontinued and removed from the archives. The data in any copies that may be in circulation do not represent the current validated product.

7.1.5 Matrix-T (TOMS MATRIX)

This product has been discontinued and removed from the archives. The data in any copies that may be in circulation do not represent the current validated product.

7.1.6 GRIDTOMS (Gridded TOMS)

The GRIDTOMS tapes contain daily high resolution (1° latitude by 1-1/4° longitude at the equator) gridded total ozone and reflectivity values. The data set is derived from the Nimbus-7 Ozone-T data set (HDTOMS) by selecting and averaging only good total ozone in the ascending part of an orbit (error codes 0 and 1).

An entire year's data are contained in a single 6250 bpi, 9-track tape; however, interim quarterly tapes are produced to make recent data available more rapidly.

7.1.7 SUNC (Spectral Scan Solar Irradiance) Tape

The SUNC tapes contain calibrated solar irradiance measurements for wavelengths from 160 to 400 nm, at 0.2 nm intervals. The instrument slit function is triangular, with a 1.1 nm bandpass. Normally, solar irradiance is measured once a day, with three scans at the northern terminator of one orbit. For much of the satellite lifetime, solar irradiance was not measured one day in every four. Also, there have been periods during which the solar irradiance measurements were made at the northern terminator of every orbit. The tapes contain individual scan measurements, orbital averages for the days on which solar irradiance was measured in more than one orbit, daily 0.2 nm averages, maximum and minimum values and standard deviations, and daily 5 nm averages. Concurrent scan, orbital, daily, and 27-day average solar irradiances at 340 nm measured by the photometer also appear on the tape. The tapes are 9-track, 6250 bpi, and each contains 1 year of data.

7.1.8 EARTH (Spectral Scan Earth Radiance) Tape

The EARTH tapes contain calibrated Earth radiance measurements for wavelengths from 200 to 400 nm, at 0.2 nm intervals. They also contain measurements by the photometer of the reflectivity at 340 nm. The instrument slit function is triangular, with a 1.1 nm bandpass. Normally, the instrument is devoted to continuous scan Earth radiance measurements every 24th day. The tape also contains the daily average spectral scan solar irradiances on each day with Earth radiance measurements; if good quality solar irradiance data are not available on that day, data from the latest preceding day with good solar irradiance values appear. The tapes are 9-track, 6,250 bpi and each contains 1 year of data.

7.1.9 SBUV Polar Stereographic Contours

Each SBUV Polar Stereographic Contours (PSC) tape contains daily and monthly averages of global, synoptic analyses of the total ozone and ozone mass mixing ratio at 0.4, 1, 2, 5, 10, and 30 mb for 1 year of data.

7.2 Microfilm Products

Microfilm products for SBUV/TOMS have been discontinued and removed from the archives. The data in any copies that may be in circulation do not represent the current validated product.

SECTION 8

SCANNING MULTICHANNEL MICROWAVE RADIOMETER (SMMR)

Nearly two-thirds of the surface of the Earth consists of open or ice-covered oceans. In these regions, one is able to derive several geophysical parameters that are important for the understanding of global weather and climate from SMMR radiances. These parameters are related to the air-sea interaction, atmospheric energetics, and the dynamics of the circulations of the atmosphere and the oceans. Along with 4 years of Nimbus-5 ESMR data, the SMMR data set is the only long-term microwave data set available for studying climatic changes. One of the principal advantages of using SMMR is that microwave remote sensing can be done globally for both day and night through non-precipitating clouds, whereas visible or infrared signatures of the ocean surface are difficult to detect in the presence of clouds. Over the oceans, one can derive the sea surface temperature (SST), sea surface wind speed, and the atmospheric (column-integrated) water vapor content. Rainfall rate and atmospheric liquid water content can be estimated, but it is difficult to properly validate these retrievals against ground-truth data. The sea-ice parameters that can be determined are sea-ice concentration, sea-ice surface temperature, and multi-year ice fraction. Observations of the SST and sea ice are used by climatologists to determine the heat balance in the polar regions and to develop and assess global climate models. In the past, SMMR sea-ice maps have been provided to the Naval Polar Oceanographic Center (NPOC) on a near real-time basis. In addition to retrievals over ocean areas, SMMR retrievals over land areas have yielded precipitation rate, soil wetness, snow cover properties and extent, and vegetation density.

The SMMR instrument measures microwave radiation from the Earth's surface and the surrounding atmosphere at five frequencies (6.6, 10.7, 18, 21, and 37 GHz) in both the horizontal and vertical polarization. The band width at each frequency is 250 MHz. These brightness temperatures are used to derive the retrieved geophysical quantities. This is done with physical models that describe how the brightness temperatures depend upon the geophysical parameters. The 6.6 GHz and 10.7 GHz channels are the most sensitive to surface quantities (SST and sea surface wind speed), whereas the 18, 21, and 37 GHz channels are more sensitive to atmospheric water vapor and liquid water content. Sea-ice parameters have been found using the 18 GHz and 37 GHz channels. Since the spatial resolution of the instrument is proportional to wavelength, the grid resolutions for SST, windspeed, water vapor, and ice parameters are 156 km, 98 km, and 60 km, respectively.

The Nimbus-7 spacecraft is in a Sun-synchronous polar orbit with local noon (ascending) and local midnight (descending) equator crossings. The SMMR instrument is forward viewing and scans 390 km to either side of the orbital track. It is operated every other day so that it maps the entire globe every 6 days. A combination of oval instantaneous FOVs (fields of view) and the integration times of the radiometers yields roughly circular beam spots with the following diameters: 6.6 GHz to 148 km, 10.7 GHz to 91 km, 18 GHz to 55 km, 21 GHz to 46 km, and 37 GHz to 27 km. The antenna beam scan lies along a conical surface with a 42 degree half-angle so that the distance to the surface of the Earth is constant over the scan. The angle of incidence at the Earth's surface is approximately 50 degrees.

By observing a hot and cold reference source, the instrument is calibrated in flight. A radio frequency termination at the ambient temperature serves as the hot reference, and deep space, viewed by a special antenna horn, provides a cold reference. This two-point reference system allows for the conversion of the measured antenna counts to the observed radiances. Radiances are computed with a calibration equation from a radiometric signal from the Earth's surface, hot and cold calibration counts, and several instrument temperatures in the SMMR microwave circuitry. This calibration equation was developed using prelaunch calibration data.

There are several steps in the calculation of radiances from FOV antenna count measurements: calibration, correction for polarization mixing, binning of FOV data into grids, and antenna pattern correction.

Following an initial check out period, the SMMR has been in continuous alternate-day operation since November 1978, except for a special operation period from April 1986 to June 1986 during which data were collected daily but only over the polar regions. In March 1985, the 21 GHz radiometer was turned off; however, the steady long-term drift behavior of the 21 H channel changed in May 1983. The other channels have drifted a few hundredths of a degree/month over the first 7 years.

On July 30, 1987, the Nimbus Observation Control Center (NOCC) reported an increase in the amplitude of the rate measuring package (RMP-A, the "Air-Bearing" Gyro) high-resolution telemetry. A team was formed to investigate the problem. Initial analysis indicated that the consequences of the problems could be loss of the spacecraft attitude control, damage to other instruments, and/or damage to the spacecraft itself if the problem worsened. However, before comprehensive analysis of the problem could be made, the severity of the problem increased so quickly that it was decided to turn the SMMR off. The SMMR was turned off on August 21, 1987 and turned back on starting August 25, 1987, looking straight forward without scanning. The instrument operated continuously every day, instead of the 2-day on/off cycle, until July 6, 1988, when it was turned off permanently.

The SMMR TAT data have been generated for all the available data with no change of data format. All footprint Earth locations were calculated with zero scan angle. Neither TCT nor CELL-ALL data have been produced since the new mode of operation started.

8.1 Tape Products

8.1.1 TAT (Antenna Temperature Tape)

TATs contain antenna counts, housekeeping data, FOV location data, spacecraft ephemeris, and attitude data. Each TAT contains 3 days of data on a 6250 bpi tape. TAT data are not expected to be of significant use to most investigators.

8.1.2 CELL-ALL

CELL-ALL tapes contain calibrated temperatures binned into Earth-located cells with spatial resolutions of 156 km x 158 km, 97.5 km x 98.5 km, 60 km x 60.6 km, and 30 km x 30.3 km. In addition, 30-scan averages of housekeeping data and calibration counts are written on each tape. Each tape (1600 bpi) contains 3 days of data. The data on these tapes are used to derive geophysical parameters such as SST and sea ice concentration.

8.1.3 PARM-LO (Parameters of Land-Ocean, e.g., SST, Water Vapor, and Wind Speed)

PARM-LO tapes contain land/ocean geophysical parameters as computed from the CELL-ALL tapes. These parameters are computed for Earth-located cells with spatial resolutions of 156 km, 97.5 km, and 60 km. Each tape (1600 bpi) contains 6 days of data.

8.1.4 PARM-SS (Parameters of Sea Ice, Snow, Ice on Land, SST, and Wind Speed)

PARM-SS tapes contain sea ice/ice sheet geophysical parameters as computed from the CELL-ALL tape. These parameters are computed for Earth-located cells with spatial resolutions of 156 km, 97.5 km, and 60 km. Each tape (1600 bpi) contains 6 days of data.

8.1.5 PARM-30 (Parameters of 37 GHz Channel, 30 km Resolution)

PARM-30 tapes contain values of sea-ice concentration computed from the CELL-ALL tapes. This parameter is computed for 30 km cells in the polar regions. Six days of data may fit into one or two (1600 bpi) PARM-30 tape(s).

8.1.6 MAP-LO (Mapped Form of PARM-LO)

MAP-LO tapes contain 6-day and monthly averages of geophysical parameters (SST, total water vapor, sea surface winds, etc.) mapped into a Mercator projection. One tape (1600 bpi) contains approximately 1 month of data. This product is available for the first 5 years of data.

8.1.7 MAP-SS (Mapped Form of PARM-SS)

MAP-SS tapes contain 6-day and monthly averages of sea ice/ice sheet geophysical parameters projected on polar stereographic grids. One tape (1600 bpi) contains approximately 1 month of data. This product is available for the first 5 years of data.

8.1.8 MAP-30 (Mapped Parameters of 37 GHz Channel Data Tape)

MAP-30 tapes contain 6-day averages of 37-GHz brightness temperatures (30 km resolution) projected on polar stereographic grids. One tape (1600 bpi) contains approximately 1 month of data. This product is available for the first 5 years of data.

8.1.9 PARMAP (Mapped Parameters from PARM-LO and PARM-SS)

PARMAP tapes contain 6-day averages of sea-ice parameters, SST, sea surface wind speed, and total water vapor on 1/2° x 1/2° latitude-longitude grid. One tape (6250 bpi) contains approximately 4 months of data. This product is available for years 6 and 7.

8.1.10 TCT (Calibrated Temperature Tape)

TCTs contain the calibrated temperatures with the footprint spatial resolution. Each tape consists of 6 days of data.

8.1.11 Half-Degree TCT Map Tape

Half-Degree TCT Map tapes contain 6-day averages (ascending and descending orbits separated) of TCT brightness temperatures for all channels mapped onto a 1/2° x 1/2° grid. Each tape contains 1 month of data.

8.1.12 Quarter-Degree TCT Map Tape

Quarter-Degree TCT Map tapes contain 6-day averages (ascending and descending orbits separated) of TCT brightness temperatures of 37-GHz channels mapped onto a 1/4° x 1/4° grid. Each tape contains 3 months of data.

8.1.13 Colorado River Basin Snow Parameter Atlas

The Colorado River Basin Snow Parameter Atlas tape contains a gridded map of a function of the microwave radiances called the gradient ratio, which can be used to infer the spatial distribution of snow water equivalent in area snowpack. The map has a spatial resolution of approximately 0.2° (latitude) by 0.2°(longitude) and covers the area from 32° to 46°N latitude and from 105° to 120°W longitude. Each map contains 6 days of daytime or nighttime data, with overlaps between the orbital swaths. Data are available for seven winters, starting in 1978/79 and ending in 1984/85, covering the months of December through May for each winter.

8.2 Microfilm Products

8.2.1 MATRIX-LO (Mapped Land-Ocean Data Film)

MATRIX-LO color film products (105 mm) are maps of 6-day and monthly averages of land/ocean geophysical parameters in Mercator projection. Each map corresponds to one 6-day or monthly average on the MAP-LO tape. The first 5 years of data are available.

8.2.2 MATRIX-SS (Mapped Sea Ice and Snow and Ice on Land Data Film)

MATRIX-SS color film products (105 mm) are maps of 6-day and monthly averages of sea ice/ice sheet geophysical parameters in polar stereographic projection. Each map corresponds to one 6-day or monthly average on the MAP-SS tape. The first 5 years of data are available.

8.2.3 MATRIX-30 (Mapped 37-GHz Channel Data Film)

MATRIX-30 color film products (105 mm) are maps of 6-day averages of 37-GHz brightness temperatures in polar stereographic projection. Each map corresponds to one 6-day or monthly average on the MAP-30 tape. The first 5 years of data are available.

8.3 Floppy Diskette Products

The Colorado River Basin Snow Parameter Atlas, described in Section 8.1.13, is available on 5 1/4" floppy diskettes in ASCII format.

SECTION 9

TEMPERATURE HUMIDITY INFRARED RADIOMETER (THIR)

The Temperature Humidity Infrared Radiometer (THIR) subsystem, also flown on Nimbus-4, Nimbus-5, and Nimbus-6, measures the radiation of the Earth and senses moisture and clouds in the atmosphere. The resulting THIR data dramatically portray clouds speeding through narrow wind currents (jet streams) and converging in areas of maximum temperature contrast to create storms.

The THIR is a two-channel scanning radiometer that provides data for both day and night portions of the Nimbus-7 orbit. The 10.5 μm to 12.5 μm (11.5 μm) "window" channel furnishes images of cloud cover and temperatures of the cloud tops, land, and ocean surfaces. The 6.5 μm to 7.0 μm (6.7 μm) channel delivers information on the moisture and cirrus cloud content of the upper troposphere and stratosphere, and the location of jet streams and frontal systems. The THIR subsystem provides continuous reference data for use by the other Nimbus-7 experiments on cloud cover and atmospheric moisture content. Detailed descriptions of the instrument characteristics, calibration, and data are given in the THIR Data User's Guide, available from the NSSDC.

Starting in April 1979, a total of 6 years of continuous data have been processed to create a global cloud climatology data set. This data set was generated from THIR 11.5 μm radiances together with the ultraviolet reflectivity derived from the Total Ozone Mapping Spectrometer (TOMS), climatological temperature lapse rate, and concurrent surface temperature and snow/ice information from the Air Force 3D-nephanalysis (cloud) archive. The cloud data consist of total cloud amount; cloud amounts at low, middle, and high altitudes; cirrus and deep convective clouds; and cloud and clear-sky radiances.

The primary merit of the THIR cloud data set is that because the observed radiances used for this cloud data are from the same instrument during 6 continuous years, April 1979 through March 1985, it represents the most homogeneous satellite-derived cloud data set available.

9.1 Tape Products

9.1.1 CLDT (Calibrated - Located Data Tape)

The CLDT is a 9-track, 1600 bpi tape that contains radiance values for the 6.7 μm and 11.5 μm channels, Earth-location information, and engineering and housekeeping data. Normally, there is 1/2 day of data on each tape.

9.1.2 NCLE (New Clouds - ERB Tape)

The NCLE tape contains the amount, mean, and root-mean-square (rms) deviations of clouds observed in each of three altitudes (i.e., low, middle, and high) for each of the ERB subtarget areas. The 11.5 μm and 6.7 μm radiances and 0.37 μm reflectivities associated with the clouds are also presented. NCLE is an improved version of the CLE tape made using a cloud retrieval algorithm based on the TOMS UV reflectivity and THIR IR radiances. In contrast, cloud information on the old CLE tapes was solely based on the THIR IR measurements.

The New Clouds-ERB (NCLE) tape is a 9-track, 1600 bpi tape. Each data file contains 1 day of data. Each orbit of data is processed such that the THIR samples are placed into ERB subtarget bins, each target being a grid of about 166 km x 166 km. After all possible THIR samples for the orbit have been accumulated, the subtarget area bins are written in ascending sequence. Each tape contains 1 week of data.

9.1.3 BCLT (Clouds - TOMS Tape)

THIR BCLT tapes contain the same information as the THIR CLE tape, but for each TOMS instantaneous field of view (IFOV) instead of ERB STA. The details of content and format are described in the THIR Data User's Guide. The new version (improved cloud estimation) of CLT is called BCLT. There is one tape per week, but the 6-year set is incomplete. The time periods available are April 1, 1979 - March 20, 1980; November 7, 1982 - August 28, 1983; and November 6, 1983 - November 4, 1984.

9.1.4 C-MATRIX (Cloud Matrix)

This is a 9-track, 6250 bpi tape. Each C-MATRIX tape contains 1 year of data generated from weekly NCLE tapes. Each tape contains data for 119 statistical parameters. These include daily (local noon and local midnight) and monthly mean estimates of total, low, middle, and high altitude cloud amount, and window radiance, as well as other statistics related to the spatial and temporal variability of these quantities. These parameters are computed for the 2,070 Earth Radiation Budget (ERB) target areas, which completely cover the Earth, each with an area of approximately 500 km^2. Zonal, hemispheric, and global statistics are also included on the C-MATRIX tape.

9.2 Microfilm Products

9.2.1 World Montage

Individual swaths of THIR data are assembled and recorded on a 241 mm film for each day in gray-scale fashion. Day and night data are displayed on separate films for both 6.7 μm and 11.5 μm channels.

SECTION 10

INSTRUCTIONS FOR OBTAINING NIMBUS-7 DATA AND DOCUMENTS

Researchers within the United States may obtain data and documents for all instruments except CZCS by contacting

National Aeronautics & Space Administration
Goddard Space Flight Center
National Space Science Data Center (NSSDC)
Code 633
Greenbelt, Maryland 20771

Researchers outside the United States may obtain data and documents for all instruments except CZCS by contacting

National Aeronautics & Space Administration
Goddard Space Flight Center
Director, World Data Center A for Rockets and Satellites
Code 630.2
Greenbelt, Maryland 20771

CZCS data may be obtained from

U.S. Department of Commerce
NOAA/NESDIS/NCDC
Satellite Data Services Division (E/CCGI)
World Weather Building, Room 100
Washington, D.C. 20233

The NSSDC will furnish limited quantities of data to qualified domestic users without charge. The NSSDC may establish a nominal charge for production and dissemination if a large volume of data is requested. When ordering data from either NSSDC or the World Data Center, a user should specify why the data are needed, the subject of the work, the name of the organization with which the user is affiliated, and any Government contracts under which the study may be supported. Each request should specify the experiment data desired, the time period of interest, plus any other information that would facilitate handling of the data request.

A user requesting data on magnetic tapes should provide additional information concerning the plans for using the data, i.e., what computers and operating systems will be used. In this context, the NSSDC is compiling a library of routines that can unpack or transform the contents of many of the data sets into formats that are appropriate for the user's computer. NSSDC will provide, upon request, information concerning its services.

If additional information is needed, please contact

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LIST OF ACRONYMS, INITIALS, AND ABBREVIATIONS

BANAT	Beta Aerosol and Number Density Archive Tape
BCLT	Basic Clouds - TOMS Tape
BRUT-S	Basic Raw Unit Tape - SBUV: Uncalibrated Radiance Data from Solar Backscatter Ultraviolet
BRUT-T	Basic Raw Unit Tape - TOMS Uncalibrated Radiance Data from Total Ozone Mapping Spectrometer
C-MATRIX	Cloud Matrix
CELL	SMMR tapes containing calibrated brightness temperatures binned into Earth-located cells
CELL-ALL	Synonymous with CELL
CLDT	Calibrated - Located Data Tape
CLE	Clouds - ERB Tape
CLT	Clouds - TOMS Tape
CPOZ	Compressed Ozone Tape
CRCST	Calibrated Radiance Chlorophyll Sediment Tape
CRTT	CZCS Radiance and Temperature Tape
CZCS	Coastal Zone Color Scanner
DELMAT	Post Mat Calibration Tape
EARTH	SBUV Earth radiance measured in spectral scan mode
EMST	ERB Matrix Summary Tape
ERB	Earth Radiation Budget
ESAT	ERB Solar Analysis Tape
ESMR	Electrically Scanning Microwave Radiometer
FOV	Field of view
GRID-T	Gridded Retrieved Temperature
GRIDTOMS	Tapes containing daily high resolution gridded total ozone and reflectivity values, derived from HDTOMS

HDSBUV	6250 bpi version of Ozone-S (High Density SBUV)
HDTOMS	6250 bpi version of Ozone-T (High Density TOMS)
IFOV	Instantaneous field of view
LAIPAT	LIMS Inverted Profile Archival Tape
LAMAT	LIMS Map Archival Tape
LASMAT	LIMS Seasonal Master Archive Tape
LIMS	Limb Infrared Monitor of the Stratosphere
MAP-30	Mapped parameters of 37 GHz channel data tape
MAP-LO	Mapped form of PARM-LO
MAP-SS	Mapped form of PARM-SS
MAT	Master Archive Tape
MATRIX	Mapped data matrix tape
MATRIX-30	Mapped 37 GHz channel data film
MATRIX-LO	Mapped land-ocean data film
MATRIX-SS	Mapped sea ice and snow and ice on land data film
MATRIX-T	TOMS Matrix
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center
NCLE	New Clouds-ERB
NFOV	Narrow field of view
NOAA	National Oceanic and Atmospheric Administration
NOCC	Nimbus Observation Control Center
NOPS	Nimbus Observation Processing System
NPOC	Naval Polar Oceanographic Center
NSSDC	National Space Science Data Center
OZONE-S	Non-archival SBUV tape containing total ozone, reflectivity, ozone mixing ratios, and layer ozone amounts

OZONE-T	A non-archival TOMS tape containing total ozone, reflectivity, and calibrated radiances
PARM	SMMR tape containing geophysical parameters on the CELL grid
PARM-30	SMMR tape containing 37 GHz brightness temperature on the CELL grid
PARM-LO	SMMR tape containing land-ocean parameters as computed from the CELL-ALL tape
PARM-SS	SMMR tape containing sea ice/ice sheet parameters as computed from the CELL-ALL tape
PARMAP	SMMR tape containing mapped parameters from PARM-LO and PARM-SS
PSC	Polar Stereographic Contours
RAT	Radiance Archival Tape
RDAT	Radiance Data Archive Tape
RMP-A	Rate Measuring Package-Amplitude
rms	root mean square
RUT	Raw Unit Tape
RUT-S	RUT-SBUV
RUT-T	RUT-TOMS
SAB	Sorting into Angular Bins
SAM II	Stratospheric Aerosol Measurement II
SAMS	Stratospheric and Mesospheric Sounder
SAVER	ERB Seasonal Average Tape
SBUV	Solar Backscatter Ultraviolet
SCUT-S	Non-archival radiance and irradiance data from SBUV
SEFDT	Solar and Earth Flux Data Tape
SEFDT-DAILY	SEFDT data for 1 day
SEFDT-MONTHLY	SEFDT data for 1 month
SEFDTFIX	Final SEFDT tape beyond month 22 of Nimbus-7 operations

SMMR	Scanning Multichannel Microwave Radiometer
SRT	Scene Radiance Tape
SST	Sea Surface Temperature
STA	Subtarget Area
STRT	Subtarget Radiance Tape
SUNC	SBUV solar irradiance measured in continuous scan mode
TAT	Antenna Temperature Tape
TCT	SMMR Calibrated Radiance Tape
THIR	Temperature Humidity Infrared Radiometer
TOMS	Total Ozone Mapping Spectrometer
WFOV	Wide field of view
ZMT	Zonal Mean Tape
ZMT-G	Zonal Mean Tape - Gas
ZMT-S	Zonal Means Tapes for SBUV
ZMT-T	Zonal Means Tapes for TOMS

INDEX

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National Aeronautics and Space Administration

Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA RP-1215		

4. Title and Subtitle	5. Report Date
Nimbus-7 Data Product Summary	February 1989
	6. Performing Organization Code: 636

7. Author(s)	8. Performing Organization Report No.
Arnold G. Oakes, Daesoo Han, H. Lee Kyle, Gene Carl Feldman, Albert J. Fleig, Edward J. Hurley, and Barbara A. Kaufman	89B00074
	10. Work Unit No.

9. Performing Organization Name and Address	11. Contract or Grant No.
Goddard Space Flight Center Greenbelt, MD 20771	NAS5-29386
	13. Type of Report and Period Covered: Reference Publication

12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code
National Aeronautics and Space Administration Washington, DC 20546-001	

15. Supplementary Notes

Arnold G. Oakes, Daesoo Han, H. Lee Kyle, Gene Carl Feldman, Albert J. Fleig -- Goddard Space Flight Center -- Greenbelt, MD

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16. Abstract

Data sets resulting from the first nine years of operations of the Nimbus-7 Satellite are briefly described. After a brief description of the Nimbus-7 Mission, each of the eight experiments on-board the satellite (Coastal Zone Color Scanner (CZCS), Earth Radiation Budget (ERB), Limb Infrared Monitor of the Stratosphere (LIMS), Stratospheric Aerosol Measurement II (SAM II), Stratospheric and Mesospheric Sounder (SAMS), Solar Backscatter Ultraviolet/Total Ozone Mapping Spectrometer (SBUV/TOMS), Scanning Multichannel Microwave Radiometer (SMMR) and the Temperature Humidity Infrared Radiometer (THIR)) are introduced and their respective data products are described in terms of media, general format, and suggested applications. Extensive references are provided. Instructions for obtaining further information, and for ordering data products are given.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Nimbus-7, CZCS, ERB, LIMS, SAM II, SAMS, SBUV/TOMS, SMMR, THIR, Earth observations, climate, solar constant, atmospheric structure, Earth radiation budget, ozone, chlorophyll, sea ice, aerosols	Unclassified - Unlimited Subject Category 42

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of pages	22. Price
Unclassified	Unclassified	112	A06

NASA FORM 1626 OCT 86

NASA-Langley, 1989