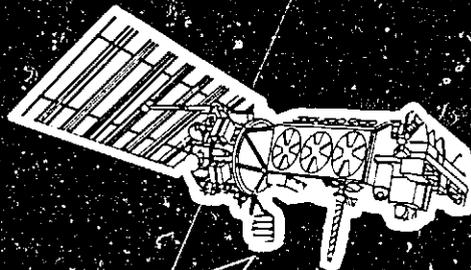


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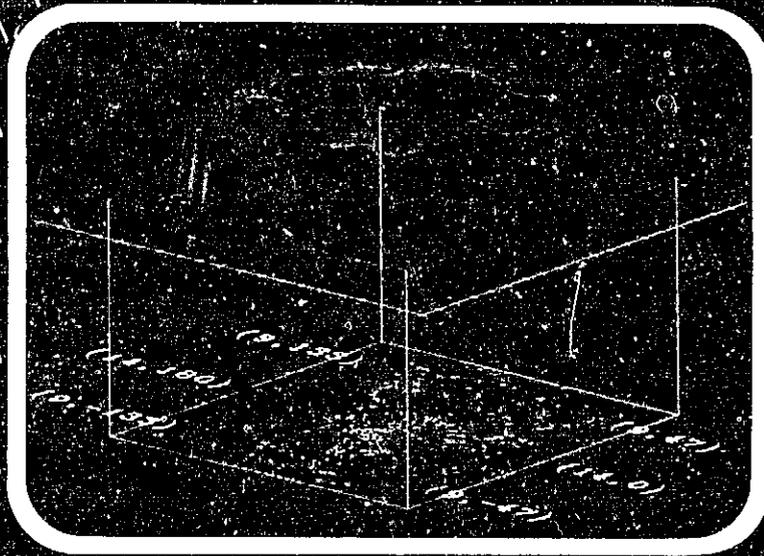
PILOT CLIMATE DATA SYSTEM



(NASA-CR-174321) PILOT CLIMATE DATA SYSTEM
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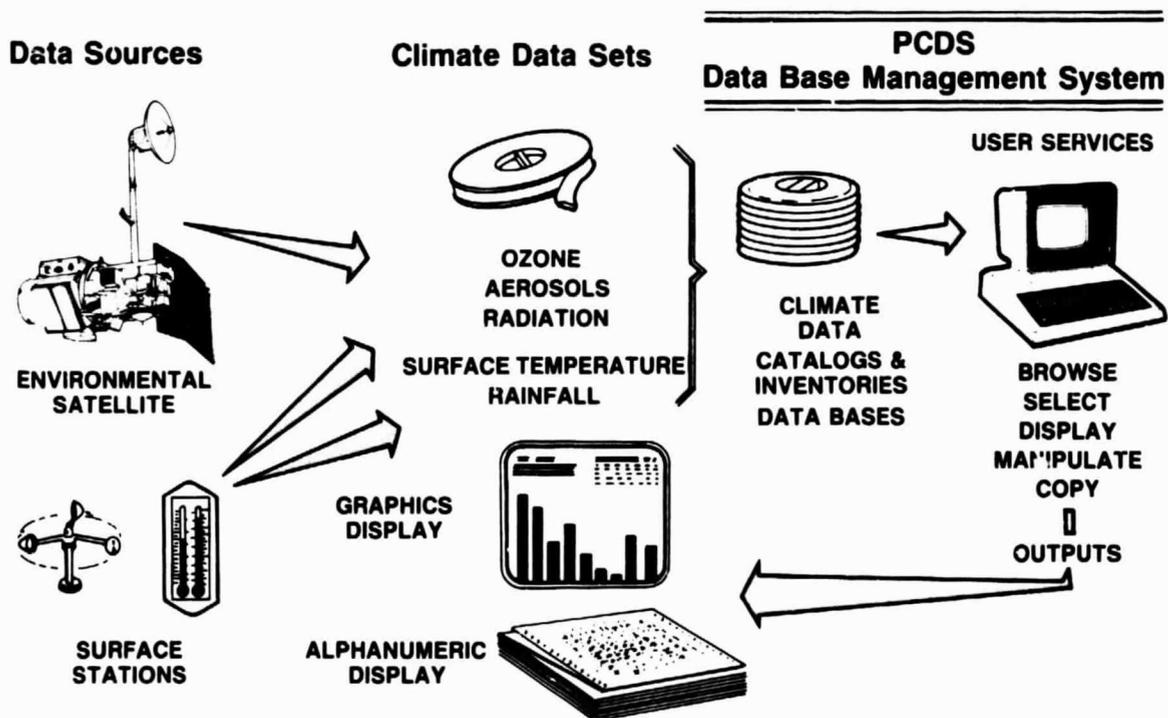
NASA
National Aeronautics and
Space Administration

Pilot Climate Data System

Overview

During the late 1970s, a number of U.S. government, international, and academic reports emphasized the need for a national and world climate program, as well as a climate monitoring system. These efforts culminated with Congress passing the National Climate Program Act in 1978. The National Aeronautics and Space Administration (NASA) has been a major participant in climate research for several decades through spacecraft and instrument development, and data handling, preparation, and analysis. It is logical that part of NASA's response to this congressional mandate was the establishment of a usable climate data base for environmental satellite measurements and other atmospheric parameters.

PILOT CLIMATE DATA SYSTEM



Today, the climate research community has access to an unprecedented collection of environmental satellite and related ground and atmospheric measurements. The climate scientist frequently spends countless hours tracking down the availability, status, location, and accessibility of desired data sets before beginning actual research. NASA's Goddard Space Flight Center (GSFC) has developed the Pilot Climate Data System (PCDS) as a significant aid in supporting the climate scientist by providing a comprehensive data management and analysis capability.

The PCDS is designed to be an interactive, easy-to-use, on-line, generalized scientific information system. It efficiently provides uniform data catalogs, inventories, and access methods, as well as manipulation and display tools for a large assortment of Earth, ocean, and atmospheric data for the climate-related research community. Programs conducted by NASA-sponsored investigators, such as climate, weather, and severe storm research (e.g., cloud and land-surface climatology), can be supported by the system.

Researchers can employ the PCDS to scan, manipulate, compare, display, and study climate parameters from diverse data sets. Data producers can use the system for validating and archiving data, or for maintaining account records and data inventory. Information on data demands can be used by managers for planning data processing and analysis activities. In addition, academic researchers, who may be working with limited budgets, can obtain quick access to selected portions of larger data sets.

The following topics are presented in this brochure:

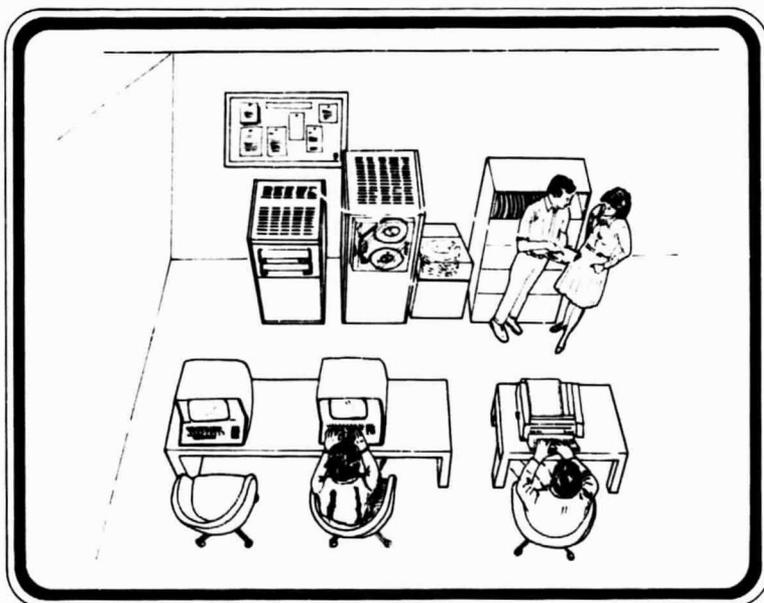
**Pilot Climate Data
System Highlights**

System Implementation

Subsystems

Data Sets

Summary



Pilot Climate Data System

Highlights

- **Effective Data Service:**
 - Interactive
 - On-line Information on Availability of Data Sets
 - Rapid Output for the Desired Data Set Subsets
 - Easy and Convenient to Use

- **Applications:**
 - Climate Research Projects
 - Statistical Climatology
 - International Satellite Cloud Climatology Project
 - Global Ozone Distribution
 - Earth Radiation Budget Studies
 - Land-Surface Climatology
 - Solar Flux
 - Other Research
 - Continental Vegetation Indices
 - Middle Atmospheric Electrodynamics
 - Distribution of Gravity/Magnetic Anomalies

- **Key Software Features:**
 - On-line Catalog of Available Climate-Related Data
 - On-line Inventory of Data Available Through the PCDS
 - Sophisticated Retrieval/Archival Support for Actively Used Data Sets
 - Uniform User Interface
 - Utilities that Allow Data Manipulation
 - Statistical Evaluation
 - Subsetting of Large Volume Data Streams
 - Merging of Selected Data Sets
 - Data-Independent Storage Structure

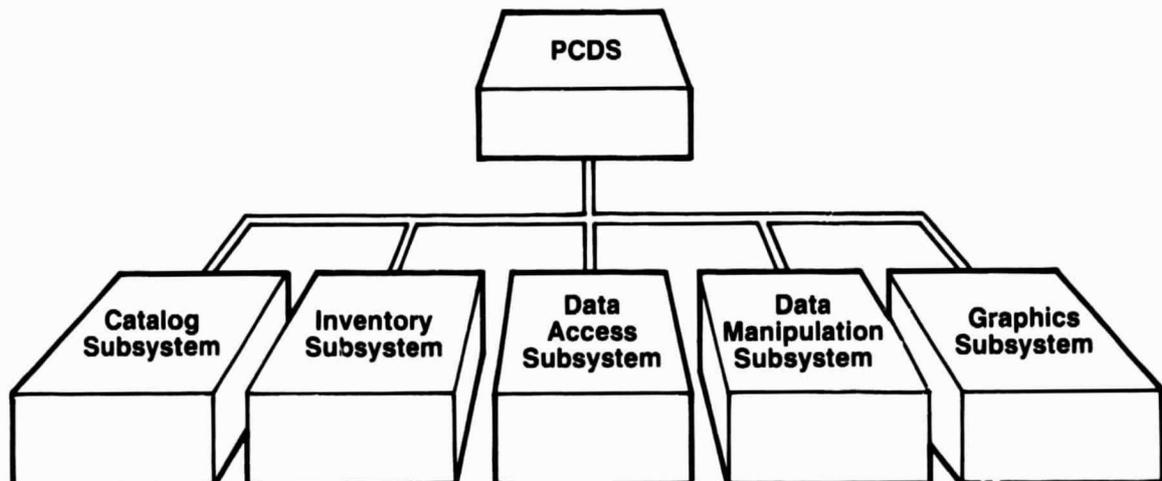
- **State-of-the-Art Graphics:**
 - Multiple Two-Dimensional and Three-Dimensional Data Representations
 - High Performance Device-Independent Software
 - Publication/Presentation Quality Products

System Implementation

The PCDS is implemented on a Digital Equipment Corporation VAX-11/780-based computer system located at Goddard Space Flight Center in Greenbelt, Maryland. For cost effectiveness, the PCDS design integrates existing technology, including several commercial software packages, with GSFC-developed software. These system components are integrated under a unified user-friendly, menu-driven interface for novice users, with extensive on-line help capabilities, and a command language for experienced users. Furthermore, the system was designed so new software or updates can replace or enhance each software component.

Subsystems

The user services are provided within the PCDS by five subsystems: CATALOG, INVENTORY, DATA ACCESS, DATA MANIPULATION, and GRAPHICS.



Catalog Subsystem

The PCDS Catalog Subsystem provides a central source of on-line information about many climate-related data sets and associated sensor measurements. The data sets contained in the PCDS Library, as well as other climate data archives, are described in the Catalog. Descriptions include information on data type, source, processing status, availability, quality, and references for further information. Currently, this subsystem describes about 150 climate-related data sets, with details on both existing and planned data sets and products. The information is at a fairly high level of aggregation (e.g., all Backscatter Ultraviolet (BUV) radiance measurements from the Nimbus-4 satellite could comprise one data set) and enables a user to determine whether or not to retrieve data. This archive information, containing the availability and location of data, is provided in a standard format. Users may employ keywords to query summary descriptions of the data sets, or they may browse detailed descriptions as they would a book.

Data Sources and Parameters Currently Described in the Catalog Subsystem

SOURCES

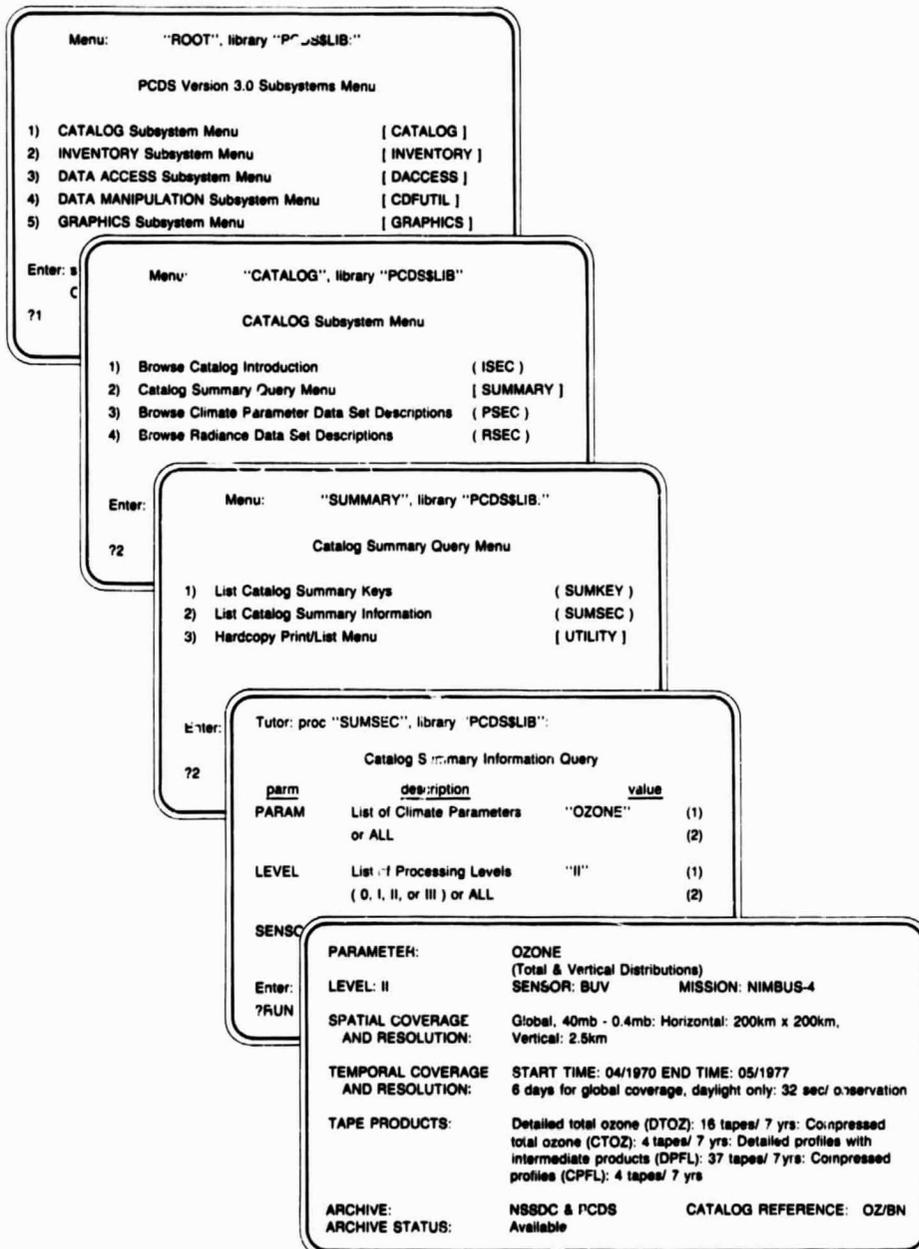
AEM-2	Nimbus-7
FGGE	NOAA analyses
GOES (1-6)	NOAA missions
ITOS-1	NMC analyses
LANDSAT	OSTA-1
Nimbus-4	SEASAT
Nimbus-5	TIROS-N
Nimbus-6	WMO surface stations

PARAMETERS

Albedo	Radiation budget
Carbon dioxide	Sea ice concentration
Chlorophyll concentration	Sea surface elevation
Cloud cover	Sea surface temperature
Forest cover	Snow coverage
Geopotential height	Solar flux
Humidity	Stratospheric aerosols
Ice sheet	Surface pressure
Nitric acid	Temperature
Nitrogen dioxide	Wave height
Ozone	Weather variables
Precipitation	Wind speed

Catalog Capabilities

A catalog listing for ozone from Nimbus-4 is displayed below as it would appear to the user by using the appropriate menu options. Each insert represents a terminal screen display with sequential query responses from top to bottom.



Inventory Subsystem

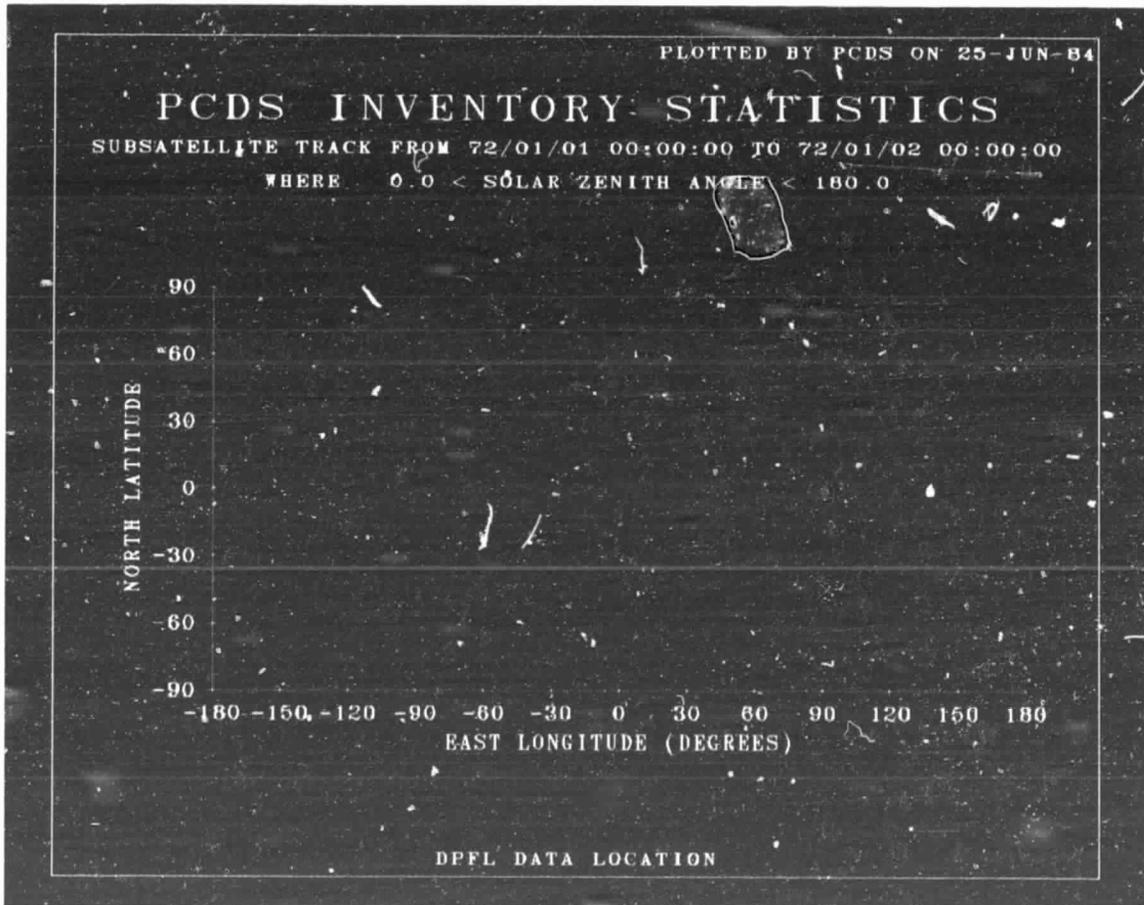
The Inventory Subsystem allows a user to obtain detailed information about temporal coverage and data volume for available data sets. This information is useful for refining data selection, so that a user can acquire a particular subset of data via the Data Access Subsystem. Detailed information is available about different kinds of data sets, (e.g., an image, orbital strip, or physical file could comprise one data set). It should be noted that only data sets currently existing within the PCDS Library, which are referenced in the back of this brochure, are included in this subsystem.

A user can easily query the Inventory by specifying keywords. These keyword entries help streamline information from the software, providing the user with maximum details in as few words as possible. The Inventory Subsystem allows a user to examine the Inventory data base and generate tabular or graphical displays. The graphics capability provides displays of data coverage or data rates. A display of data coverage for Nimbus-4 BUW for January 1, 1972, is shown to the right. More detailed information can be obtained as a user progresses through the subsystem's options. The interactive, on-line user access to the Catalog and Inventory Subsystems via the computer terminal is augmented by the option to save information for future reference or later printing.

Inventory Capabilities

- **Describe the data holdings of the PCDS and support keyword queries of its contents**
- **List available climate parameters and data types**
- **List a summary of the data types**
- **List tapes/files by data type**
- **Provide a history of the tape Inventory**
- **Graphically summarize the Inventory contents**

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Data Access Subsystem

A user can select data subsets by time, geographic area, and type of data by using the Data Access Subsystem. Although data sets are generally maintained in the PCDS Library in the original tape format, this subsystem permits the user to copy the original data or transfer portions of a data set into a special PCDS format called the Climate Data File (CDF). The function of locating, reading, and translating data for the creation of a CDF is performed by special software that is transparent to the user. To select the proper tapes and files without user involvement, the Data Access Subsystem employs the PCDS Inventory as a reference.

Data Access Capabilities

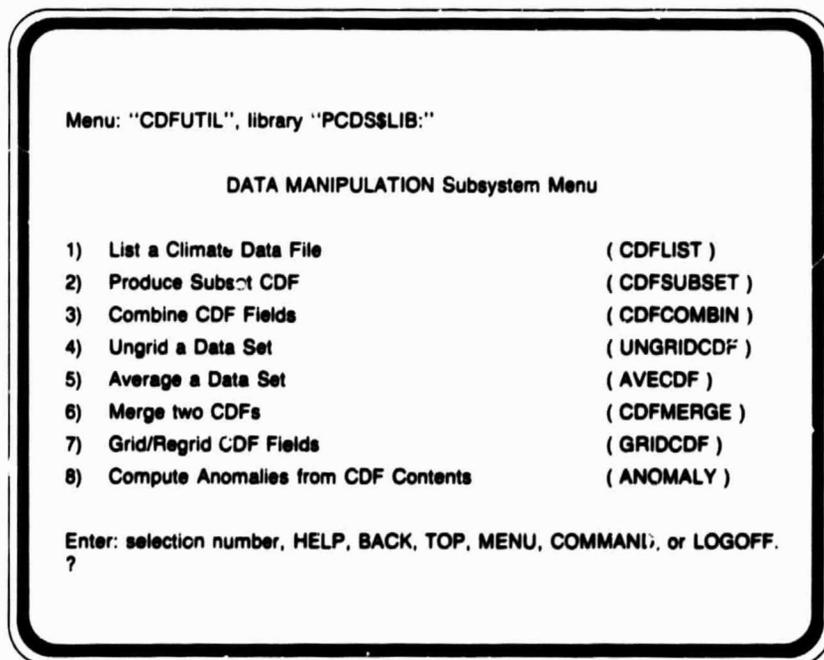
- **Provide uniform access to PCDS data for subset selection on spatial or temporal criteria and employ the PCDS Inventory to locate data**
- **Copy, list or subset a PCDS data set**
- **Support production of data subsets on magnetic tape or disk**
- **Create a data-independent Climate Data File**
- **Provide access services with software and location of data transparent to the user.**

Data Manipulation Subsystem

The Data Manipulation Subsystem provides numerous functions for those data sets that are in the CDF format. These functions permit data modification for various applications, such as transfer of data to another computer or use with the Graphics Subsystem. Most importantly, this utility package supports parallel analyses on heterogeneous data. Such flexibility is critical for interdisciplinary climate research.

Data Manipulation Capabilities

The data manipulation menu detailing the eight options as displayed to the user is shown below.



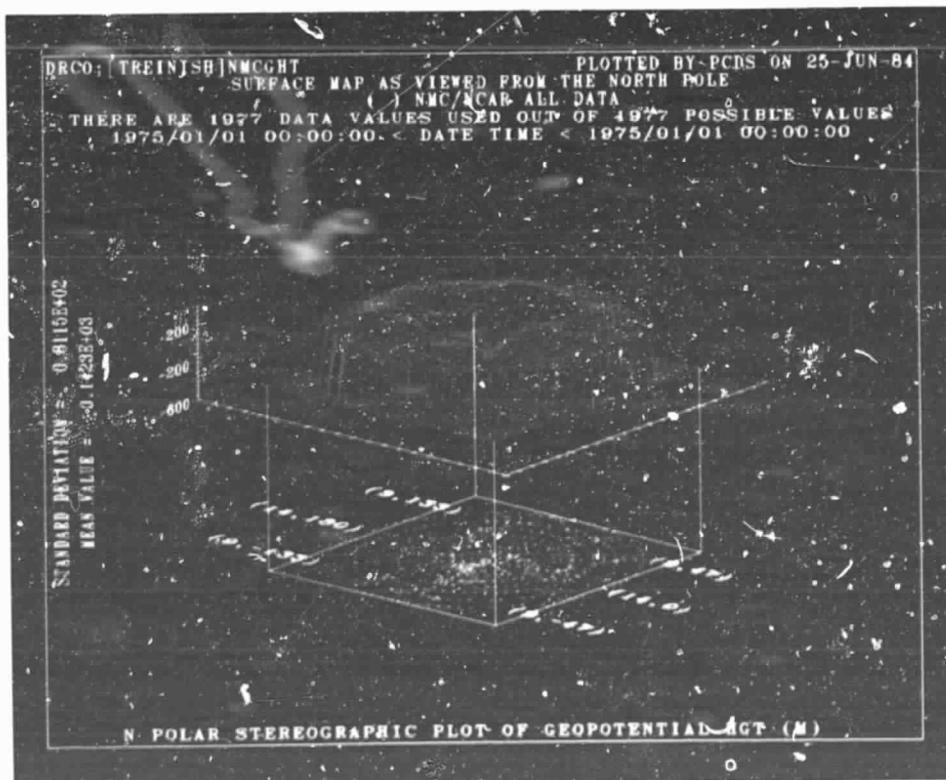
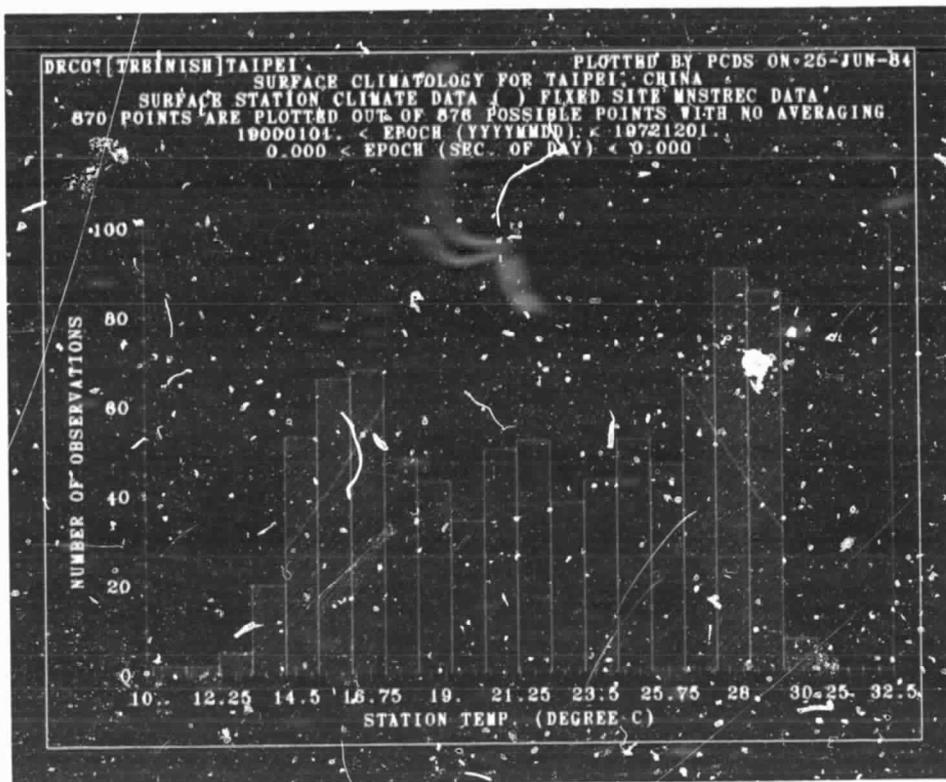
Graphics Subsystem

Extensive data representation techniques are available within the Graphics Subsystem for those data sets in the CDF format. For example, data can be displayed in two- and three-dimensional formats, and text charts can be generated. This subsystem is designed to be highly flexible and can provide displays on a wide variety of hardware. The user can employ low-cost graphics terminals for quick-look displays or access more sophisticated terminals for displaying more complex data. High quality, hard copy products suitable for publication also can be produced. Two data displays, illustrating some of the PCDS graphics capabilities, are shown to the right. The upper display shows the statistics for 72 years of surface temperatures recorded at Taipei, China. The lower figure shows a geopotential height distribution over the North Pole.

Graphics Capabilities

- Provide graphical representation of any data stored within a data-independent Climate Data File including non-PCDS data sets
- Create two-dimensional representations of data
- Create three-dimensional representations of data
- Create text charts
- Provide post-processing of graphical displays
- Generate graphic displays on several hardware systems

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Data Sets

The PCDS currently provides direct support to climate researchers at Goddard Space Flight Center and other institutions. Incorporation of new data sets, continued improvements, and additions to the system are anticipated in response to user requirements. At present, the PCDS fully supports data from the following experiments:

- First Global Atmospheric Research Program (GARP) Global Experiment (FGGE)
- Applications Explorer Mission-2 Stratospheric Aerosol and Gas Experiment (SAGE)
- Nimbus-4 Backscatter Ultraviolet (BUV)
Selective Chopper Radiometer (SCR)
- Nimbus-5 Electrically Scanning Microwave Radiometer (ESMR)
Selective Chopper Radiometer (SCR)
- Nimbus-7 Earth Radiation Budget (ERB)

Limb Infrared Monitor of the Stratosphere (LIMS)

Scanning Multichannel Microwave Radiometer (SMMR) formatted for FGGE:

- Sea Surface Temperature
- Sea Surface Wind Speed
- Total Atmospheric Water Vapor
- Sea Ice Concentration

Solar Backscatter Ultraviolet (SBUV)

Stratospheric and Aerosol Measurement (SAM II)

Temperature and Humidity Infrared Radiometer (THIR)

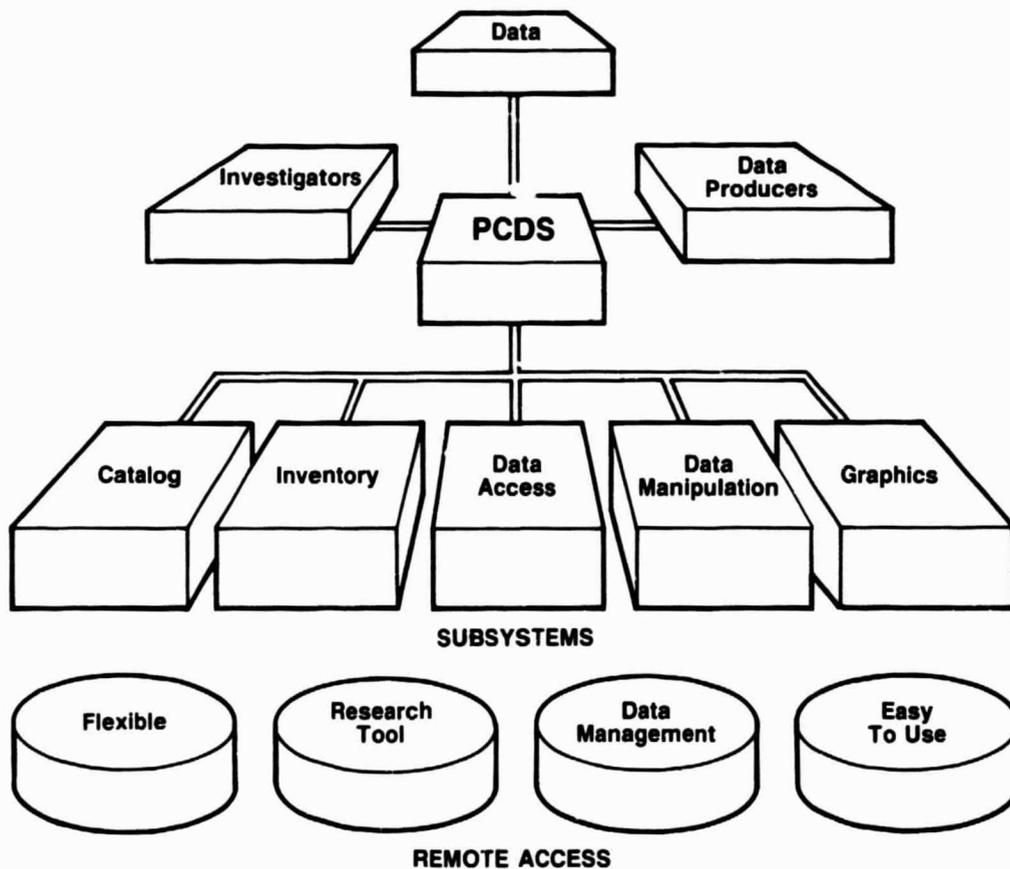
Total Ozone Mapping Spectrometer (TOMS)

- Middle Atmosphere Electrodynamics (MAE)
- National Meteorological Center Daily Analysis of Atmospheric Parameters
- National Oceanic and Atmospheric Administration (NOAA) Heat Budget Data
- World Monthly Surface Station Climatology

The International Satellite Cloud Climatology Project (ISCCP) is generating several new data sets that will contain parameters of great interest to the climate research community. Some of these data sets will be archived in the PCDS for availability to NASA's climate researchers.

Summary

This synopsis of NASA's Pilot Climate Data System outlines the extensive data management and analysis facilities available to climate researchers. The strengths of the PCDS include: easy use, flexibility, and user freedom from the necessity to know data formats or programming languages. The ability to invoke numerous application packages frees the user from the burden of writing his or her own software.



The PCDS provides state-of-the-art data management techniques to support comprehensive scientific research. In addition to supporting large data sets from many different sources, it will serve as a model for future systems. It is anticipated that these future data management systems will be integrated into larger network facilities serving many different scientific disciplines.