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CEDAR DATA BASE COMMITTEE REPORT

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Preface

The CEDAR (Coupling, Energetics and Dynamics of Atmospheric Regions) Data Base began as the Incoherent Scatter Data Base, which started at the National Center for Atmospheric Research (NCAR) in 1985. The Incoherent Scatter Data Base evolved into the CEDAR Data Base in 1989, and has since grown to include data from 36 instruments, 15 models and several geophysical indices. In 1987, the CEDAR Science Steering Committee formed a Data Base Committee to design guidelines for submission of data to the Data Base, and to provide advice for the development and access of a data base system for the contributed measurements. This committee, chaired by R. J. Sica, prepared the *First CEDAR Data Base Report* (NCAR TN-308+STR), which was accepted by the Steering Committee at its meeting during the 1987 Fall AGU. The Executive Summary of that report is included as Appendix A of this report.

At the October 1994 CEDAR Science Steering Committee meeting, the Steering Committee reactivated the Data Base Committee, and asked it to consider a wide range of issues related to the CEDAR Data Base. The Data Base Committee was charged with making recommendations in the following areas:

- Data Format
- Education/Public Interface
- Centralized vs. Distributed
- Rules of the Road
- Utilization Assessment
- Operations and Resources
- Connection with TIMED, ALOMAR, and other Data Bases
- Connection with Upper Atmosphere Research Collaboratory (UARC), telescience applications and the World Wide Web
- Data Archiving

Given the wide geographical distribution of committee members, most of the business of the committee has been carried out by email. To facilitate this, an email exploder was created to enable messages to easily be sent to all committee members. The address is: cedardb@hyperion.haystack.edu. Inclusion in the mailing list is open to anyone interested in actively participating in discussions of Data Base related issues, and the email list may be considered to define membership in the Committee. This list is included as Appendix B of this report. In addition, all members of the CEDAR community have been encouraged to direct their comments and suggestions to the exploder. While all comments relating to the issues covered in this report were considered by the authors, some of the conclusions inevitably do not reflect the views of everyone who contributed to this report.

The CEDAR program, including the Data Base, is funded by the National Science Foundation. However the scope of CEDAR science, and its Data Base, extends beyond the U.S., and is truly global. Many foreign instruments, such as the European EISCAT Incoherent Scatter Radars in northern Scandinavia, contribute data to the Data Base, and approximately 35% of the users of the Data Base are from foreign institutions. The Data Base committee also includes several members from outside the U.S. When we speak of the CEDAR community in this report, we are referring to this broader community of upper atmospheric scientists.

Data Base and related issues will continue to be important to the CEDAR community, and the cedardb mailing list will remain active as a forum for discussion of these topics. Everyone is encouraged to contribute their thoughts and suggestions.

John Holt
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June, 1996

Executive Summary

The CEDAR Data Base has been an important component of the Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) Program throughout its first decade. As CEDAR moves from Phase I and II to Phase III, a reassessment of the Data Base and its function during the next ten years is essential. This reassessment must take into account both the science initiatives identified as the focus of Phase III, and advances in computer and network technology which have so greatly expanded the range of possibilities for applying this technology to the solution of scientific problems. The function of the Data Base has been to collect, organize, preserve, distribute, promote and use data submitted to the Data Base. While this role will remain as important during the second decade of CEDAR as in the first, increased emphasis should now be placed on application of distributed data base techniques, telescience and computer aided collaboration, which were recognized as possibilities at the inception of the Data Base, but have only recently become viable tools for promoting CEDAR science.

The CEDAR Data Base is now primarily a centralized system, with operations centered at the National Center for Atmospheric Research (NCAR). Some data, particularly images, are stored at the institution responsible for collecting the data, with catalogs of this data available from NCAR. Software development for the Data Base has taken place both at NCAR and Millstone Hill, where the more interactive components have been developed. The Millstone Hill software has eventually been installed at NCAR for use by the CEDAR community. However the most recent interface, through the World Wide Web, is available only at Millstone due to security regulations at NCAR. This restriction is being addressed, and direct World Wide Web access to CEDAR data through the NCAR server should be fully functional within the next year. This raises the broader issue of whether a centralized Data Base is needed at all, or whether it would be better to have the data maintained by the data providers themselves. While this may be a viable option in the case of some data providers, the case for retaining a centralized facility seems compelling given the difficulty and expense of implementing a common access mode for data stored at distributed sites, and of ensuring the integrity of that data. This is particularly important with respect to the Long-Term Trends initiative, which will require an extensive, long-term, multi-instrument data base of compatible data, and may also require re-analysis of the raw data.

This need for standards and compatibility remains when we consider how computers and computer networks can contribute to the other CEDAR Phase III science initiatives. For example, telescience can only fulfil its potential when it can efficiently and cost-effectively link a much broader range of data users and providers than is currently the case. Common data formats for telescience and collaboration must be developed and implemented, and these formats should be compatible with the formats used for archiving the data. There will be a need for remote access and control of the Polar Cap Observatory which will be a focus of the CEDAR Phase III Polar Aeronomy and Solar Terrestrial Interactions initiatives, and real-time access to distributed data sets is as crucial to space weather research as it will be to any operational system to which that research will contribute. Given the huge cost of software development and the limited availability of funding, it is imperative that every effort be taken to minimize duplicated effort and maximize compatibility.

As steps toward achieving these goals, the Data Base Committee makes the following specific recommendations regarding the CEDAR Data Base and related computing and networking issues:

1. The CEDAR Data Base should have both centralized and distributed components. The central facility plays important roles in standardizing, collecting, organizing, preserving, distributing, promoting and using the data and models. Technological advances make it possible to shift some of the distribution functions to other sites.

2. Implementation of up-to-date user interface technology should be a priority.

3. The existing CEDAR format should be retained as the primary format for archiving data.

4. The CEDAR format should be extended to include a new byte-array record type to accommodate image data in a variety of standard image formats.

5. Filters should be constructed to convert the CEDAR format to netCDF and HDF, and possibly CDF.

6. CD ROM should be investigated as an alternative medium for archiving and distributing CEDAR data.

7. The CEDAR Rules of the Road should be updated to allow immediate access to CEDAR data over the World Wide Web upon submission of an electronic form in which the data user agrees to read and abide by the Rules of the Road. All accesses to the Data Base through the Web should be logged.

8. The Millstone Hill Data Base server should provide World Wide Web access to CEDAR data stored at NCAR, subject to the Rules of the Road, until the NCAR server is fully functional.

9. The CEDAR user community should be encouraged to use the CEDAR format, or the netCDF and HDF files derived from CEDAR format data by filters, for storage of data and input to data browsers and other locally developed tools, thereby increasing the usefulness of these tools to the entire community.

10. The CEDAR format should be adopted as a standard for telescience and computer collaboration initiatives.

11. Lower level data, such as incoherent scatter autocorrelation functions, should be stored, preferably in a standard format, along with documentation and analysis tools, either at the site or at the CEDAR Data Base, for all new data sets.

12. Consideration should be given to saving lower level data for older data sets in a common format, if available resources permit.

1. Introduction

The CEDAR (Coupling, Energetics and Dynamics of Atmospheric Regions) Data Base began as the Incoherent Scatter Data Base, which began in 1985 at the National Center for Atmospheric Research (NCAR), and evolved into the CEDAR Data Base in 1989. By the end of 1995 it had grown to include data from 36 instruments, 15 models and several geophysical indices. This report discusses the Data Base as it is today, assesses CEDAR community utilization of the Data Base and makes recommendations for its future development.

Section 2 covers the history and current status of the Data Base. In Section 3 we discuss operations and available resources, including personnel and computer facilities. Utilization of the Data Base is covered in Section 4 and Tables 1-4. The format used to store data has remained unchanged since the creation of the Incoherent Scatter Data Base in 1985. This format was designed with incoherent scatter data in mind, and is not entirely satisfactory for certain other data types, such as images. In Section 5 we discuss modifications to the format to accommodate additional types of data, and new requirements such as telescience. Smooth functioning of the Data Base requires that there be clear agreements among the parties involved in acquiring, handling, and using the data. This is covered in the Data Base Rules of the Road. New developments in computer technology, such as the World Wide Web, require a reevaluation of the current Rules of the Road. In Section 6 we recommend a modification to the Rules of the Road which will simplify the procedure for accessing the data through the Web. Education and informing the general public about CEDAR are important functions of the Data Base, and we discuss this in Section 7. In Section 8 we discuss future directions of the Data Base, including telescience and computer aided collaboration. The conclusions of this report are summarized in Section 9.

2. History and Current Status of the CEDAR Data Base

From the inception of the CEDAR program, there has been a great concern among the members of the CEDAR community to make the data collected by the community easily accessible for joint studies. A workshop held at the National Center for Atmospheric Research (NCAR) in February 1982 resulted in a draft *Report on Establishment and Operation of the Incoherent-Scatter Data Base*, edited by Vincent Wickwar. The National Science Foundation (NSF) then established the Incoherent Scatter Radar Data Base at NCAR in 1985. This has evolved into the CEDAR Data Base, which includes many additional ground-based instruments for measuring the properties of the upper atmosphere.

The function of NCAR in the CEDAR Data Base is first of all to archive CEDAR data. This includes the collection, organization and preservation of the data. The Data Base also includes collections of model outputs, and software for empirical models. The second function is data retrieval, which is accomplished using software in either batch or interactive modes. The most basic retrieval process is the cmenu system, which can be interactive or batch. A high priority is given to documentation of the data, models and software in inventory lists and catalogs. Another important contribution of NCAR is the active participation of its scientists in promoting the Data Base through various means. These include the annual CEDAR Workshop, postdocs (this program has now moved away from NCAR), and visitors. The CEDAR Data Base has also been represented in presentations at other meetings. Help is actively available for those who wish to add their data sets to the Data Base. Finally, the scientists at NCAR use the Data Base internally, and so have a direct interest in and can help steer its development.

A packed, integer, 16-bit binary format was created for use in the CEDAR Data Base, and an ASCII counterpart was added later. The Data Base is completely on-line on the CEDAR computer and included 8 GB of data at the end of 1995, from 7 incoherent scatter radars, 4 HF radars, 2 MST radars, 6 MF radars, 1 LF radar, 4 meteor wind radars, 9 Fabry-Perot interferometers, 1 lidar, 5 large models, and various geophysical indices. Ten computer models, such as MSIS90 are also available. In addition, data from 2 imagers are located at their own sites, with videotapes of the images from one of the imagers located at NCAR. Hence, the present Data Base is mostly central, with a distributed component for the imagers. Usage statistics for the first 10 years of the Data Base are given in Table 1 for the various instrument and model categories, while more specific statistics on the rate of data accumulations and requests for each instrument are given in Table 2.

Traditionally, software development for the CEDAR Data Base has taken place at two sites. The data collection and verification, batch processing and basic data retrieval systems have been at NCAR, while the interactive and World Wide Web aspects have been developed by MIT Haystack Observatory, which operates the Millstone Hill incoherent scatter radar. The Millstone Hill system was designed to use the Application Programming Interface (API) of their own Data Base system, which predates that at NCAR. As a result, there are two different file formats, and two different ways to access the data. The logical record format is now identical, but the files are blocked differently at Millstone to enable random access to records. At times, the existence of two slightly different systems has been seen as counterproductive by some in the community, and that is one of the issues to be addressed in this report. We conclude that, since software to convert between the two formats exists, and since there is a variety of complementary programs which expect data in one or the other of the two formats, standardizing on a single format should not be a priority at this time.

The CEDAR Data Base has periodically been reviewed by committees formed by the CEDAR Science Steering Committee. A committee visited NCAR in November 1992 and recommended a revised User Guide and a simpler interface to the data. This led to the User Guide, in June 1993, and the cmenu interface, in May, 1994. The cmenu interface was designed for the lowest common denominator of a dumb terminal, and can be used to access data, ancillary information about data sets, documents and programs. Usage statistics for cmenu are given in Table 3.

Meanwhile, Steve Cariglia of Millstone Hill has developed a World Wide Web interface to browse CEDAR data. It serves as a front end to existing Millstone data retrieval software (isprint) and creates an ASCII flat file containing a selected subset of the data in a data base file. In addition, viewers for plotting data have been constructed. Currently, these viewers are used only to plot real-time Millstone Hill data when the radar is operating, but in the near future they will be interfaced to the full data base by constructing a WWW menu interface similar to that used to create the flat files. This is possible because the real-time analysis program at Millstone outputs its results in CEDAR format, allowing the same browser and viewer software to be used for both real-time and archival data. The Millstone Hill Web site provides an easy way to access both data and CEDAR Data Base documentation. Currently, documents also are available via the High Altitude Observatory (HAO) Web, and it would be desirable to access the data through NCAR as well.

At this time, NCAR access is restricted to those with valid CEDAR logins. At the end of 1995, there were 154 logins from outside NCAR, and 15-20 for staff or past visitors. Logins are necessary since users must agree to certain "Rules of the Road" which include contacting the data providers and offering coauthorship as well as discussing the analysis of the data. This policy and possible modifications are discussed later in this report. A WWW server was installed on the CEDAR computer in late April, 1996, and plans are underway to make it available to the entire CEDAR community and the public by the end of the year. Everyone will be able to retrieve documentation and view sample data plots, but access to the data will be restricted to those with a password. This password will be issued to those with valid CEDAR logins and others who agree to the Rules of the Road.

The CEDAR Data Base is in the NASA Master Directory. Several articles were written for the STEP Newsletter to advertise the CEDAR Data Base, and the anonymous ftp address has been available for a few years. Barbara Emery is a member of the Ionosphere/Thermosphere/Mesosphere section of the NASA Space Physics Data System group, so innovations in the NASA community are known to the CEDAR Data Base group.

3. Operations and Resources

The CEDAR Data Base is located at the National Center for Atmospheric Research (NCAR). Five people are directly involved in the Data Base. Roy Barnes is in the Data Support group of the Scientific Computing Division (SCD). NCAR supports 85% of his time for work on the CEDAR Data Base, while the other 15% is spent on other NCAR Data Support projects. The remaining personnel are located in the High Altitude Observatory (HAO) of NCAR. Barbara Emery is supported by NCAR for 84% of her time for CEDAR Data Base work. This includes organizing the annual CEDAR Workshop and scientific projects using the Data Base, as well as regular work in organizing data, assisting users and managing development of the Data Base. NSF funding for the CEDAR Data Base was $60K in FY1995. This is used to support 2 student assistants, Ken Keelan and Will Golesorkhi, equipment, such as a 9 GB disk purchased in 1995, and some travel for Data Base purposes. Ken is the student systems programmer for HAO. His first priority is the CEDAR computer, but he is utilized in many different ways. His time is entirely charged to CEDAR though, since other, higher paid, computer personnel are not charging any of the time they spend on the CEDAR Data Base and other CEDAR related work to the CEDAR project. Will is the student programmer, who is utilized by the CEDAR Data Base staff. His first task was testing the cmenu facility. His second task was splitting out the ACF's from the EISCAT data files, so that users do not have to copy over large quantities of unneeded data. More recent tasks have been rewriting, revising, and testing empirical models of electric potential and auroral conductance, which have been added to the list of models available via the CEDAR Data Base. The final person involved in the Data Base is Art Richmond, who devotes a small percentage of his time, at no cost, to the oversight of the Data Base personnel and budget. In addition, Art has developed computer programs and tables to implement the apex magnetic coordinate system for Data Base and other uses.

The original computing resources at the start of the Incoherent Scatter Radar Data Base in 1985 were some disk space on an IBM 4341, with access to the CRAY-CA14 and to the data, which were stored on a AMPEX TeraBit Memory (TBM) mass storage system. In early FY1991, a Sun-4/470 server was purchased for the CEDAR Data Base for $48,350, and was opened to outside logins in June 1991. The data were still stored on the IBM mass storage cartridge system and had to be staged from a newer CRAY. In FY1993, three 3-GB disks were purchased for $6897, and the entire data set was put on-line on these disks along with some software to make them appear as 1 disk. Finally, maintenance costs became large for the Sun-4/470, and advances in computing made it possible to support many users on a single, more powerful workstation. Therefore, in late FY1994, a Sun-5/70 was purchased for $5439 along with a $3735 9-GB disk for the data. The three 3-GB disks are still retained in the system. There are about 2.7 GB for logins, including HAO logins of staff that have some association with the CEDAR Data Base. There are also about 2.7 GB for temporary storage, which has proved to be insufficient, about 2.4 GB for /var, and about 8.2 GB for storage of the data. Since the Data Base grows by about 1 GB per year, the next update will not fit on the available storage. Therefore, a second 9 GB disk was ordered in May, 1996 for data and temporary storage. At the end of 1995 there were 154 outside logins on the CEDAR machine. All outside users start with 2 MB of space, which can be increased at any time.

The other resources for the CEDAR Data Base are located at Millstone Hill, where much software has been developed over the years. The original Millstone Hill Data Base system was developed by John Holt. Now Steve Cariglia is responsible for managing, developing and maintaining the Millstone Hill system, known as MADRIGAL.

4. Utilization Assessment

Tables 1-4 contain information on the first 10 years of the Data Base. Table 1 is a summary of the requests and users for the various instrument classes, and a summary of the login use. The requests are tracked by three methods: 1) Filling a data request by Data Base personnel, 2) tracking remote copy's (rcp's) by mostly outside login users, and 3) tracking cmenu use by logins. It is not possible to track all use of the Data Base, especially by NCAR staff or others who use different access programs. However, the internal use of indices and radar data by NCAR staff Barbara Emery and Gang Lu for Assimilative Mapping of Ionospheric Electrodynamics (AMIE) studies has been estimated to be about 75 requests.

Table 2 shows when data for a particular year from a particular instrument (or model) was entered into the CEDAR Data Base, and ends with the number of specific requests and the number of users in the first 10 years. Table 3 shows statistics for cmenu, and Table 4 is a summary and detailed list of deliveries from the Data Base.

At the end of 1995, 871 requests from 187 individuals from 65 different institutions around the world had been filled. Of these requests, 62% were by login users. Approximately 35% of the users are from foreign institutions, and this percentage has remained fairly constant since the beginning of the Data Base. Students did not use the Data Base in any significant way until 1992, but they now account for 30% of the total users, 45% of the users in 1995, and about 65% of the login use. The login use by those at foreign institutions is fairly low, but has increased with the advent of the cmenu interface. There were 154 outside logins at the end of 1995, of which about 37% have been logged on for more than 10 hours per year. In addition, 37 logins have been removed, mostly from those who signed up in the beginning, but never used their account.

All the tables show that the data sets most in demand are from the incoherent scatter radars, with the most people interested in the Arecibo data, followed by Sondrestrom and Millstone Hill. The most requested Fabry-Perot data are from instruments located at the I. S. radars. There is also a strong interest in the Poker Flat data set. Of the 36 instruments in the CEDAR Data Base, 29 have been accessed according to Table 2. The data sets which have not been accessed tend to be available on only a small number of days.

There has been a relatively steady use of the Data Base since its inception, with increases in 1986, 1989, 1992 and 1995, which are either the year of, or the year after major changes in the CEDAR Data Base contents or means of access. Different instruments were added in 1989, while logins were started in 1991 and the cmenu interface was implemented in 1994. The addition of the WWW interface should increase the use of the Data Base even more.

Since August 16, 1994, Millstone Hill data have been available through the World Wide Web (Figure 1). As explained in the discussion of the Rules of the Road, data from other CEDAR instruments can also be made available in this fashion, but until the new Rules of the Road have been implemented, users from sites other than Millstone must be blocked. As of May 13, 1996, there had been 6503 accesses to Millstone data through the Web, approximately 10 per day. Data was downloaded to 124 computers, of which 103 were from outside Millstone Hill. A total of 489 different files were accessed.

5. Data Format

Data format issues were discussed at length in workshops at the 1994 CEDAR Meeting and the incoherent scatter workshop held in conjunction with the US National URSI (International Radio Science Union) Meeting in January, 1995. The consensus of these meetings was that a new format, based on the well-supported netCDF (network Common Data Format), should be adopted.

This new format would have a direct impact on several committee areas of concern. First, the current format was originally designed for incoherent scatter radar data, and is very poorly suited to many other data types, for example, images. A new standard based on netCDF could be applicable to a much broader range of data. Second, the new format would be accessible to many more users than the old format, since it is based on a widely accepted and distributed standard, which is supported by many graphics and analysis packages. Furthermore, because it is based on the universally supported XDR (external data representation) standard, netCDF seems well suited to distributed applications, including distributed data bases, collaboration applications, and telescience applications.

Some concerns about the decision to use netCDF were nevertheless expressed early on. In particular, many users with connections to NASA use the NASA supported CDF (Common Data Format), which is similar in many respects to netCDF, but incompatible. Given the close connection between many CEDAR and NASA programs it was thus clear that it was necessary to take into account the CDF user community, and HDF (Hierarchal Data Format) user community as well, and to encourage the development of software to bridge the gap between the competing formats.

In June 1995, Haystack Observatory and SRI received small grant supplements to begin work on a common framework for telescience, including the netCDF format. The goal for the first year was to produce a filter program to convert old CEDAR Data Base files to netCDF files. Work on this project is for the most part proceeding smoothly. There is, however, a significant problem which was not appreciated at the time of the CEDAR and URSI workshops. Array dimensions for variables stored in a netCDF file are fixed and the same for all records in the file. In the case of radar data, this means that each record must be large enough to hold the maximum number of ranges and the maximum number of parameter types of any record in the file. In many cases, this will result in most records being sparse, since, for example, Barker coded power profile measurements typically have many range gates but few parameters, while F-region spectral measurements typically have relatively few range gates and several parameters. The CEDAR format does not have this problem. For telescience and collaboratory applications this might not be too big a difficulty, since records could be handled individually when transmitted over the network with space allocated only as needed for each record. These could then be expanded before storage in a multi-record netCDF file. The wasted disk space might not be a serious problem if only a few files were being stored, but could be very serious if the netCDF format were used for archiving large amounts of data. A possible option for archiving would be to store data from each experiment mode in a separate file, but this would result in a more complicated data base system than, for example, the Millstone Hill MADRIGAL system.

Another problem with netCDF occurs when large amounts of netCDF data are transferred in and out of the NCAR Cray computers. As mentioned above, netCDF uses the XDR data representation, which helps make the format very portable. However, on computers which do not use the IEEE representation of floating point numbers, the required translation between XDR and the native machine format can be very time consuming. Large scale modelers at NCAR have found that the I/O time of their programs can increase by a factor of two. This may not be too serious a problem for the CEDAR Data Base, since CEDAR data sets are normally relatively small, but this problem nevertheless must be taken into account.

As a result of these problems with netCDF, the Data Base Committee decided that it was not appropriate at this time to convert to netCDF for the CEDAR archive format. The filter now under development at MIT remains a very worthwhile objective, since it provides a mechanism for interfacing so many graphics and analysis packages to the CEDAR format. In fact, since the National Center for Supercomputing Applications (NCSA) offers a netCDF API to their HDF format, this filter will also be capable of converting data from the existing CEDAR format to HDF. CDF remains a problem. Packages to convert between CDF and netCDF or HDF have been discussed, but to our knowledge none exist at this time. A filter to convert from the relatively simple and straightforward CEDAR format to the more standard but more complex formats would probably not be too difficult to implement if a significant number of CEDAR Data Base users would find that useful.

So, we have concluded that the existing CEDAR format should be retained for now. There does not seem to be a better format, at least for existing radar data sets, which are central to the function of the Data Base. The CEDAR format has also proved to be quite satisfactory for many other types of data, such as from Fabry-Perot interferometers. However, the CEDAR format does less well with images. This is a very important limitation, particularly in collaboration and telescience applications, where it is important to have a common protocol and format for transferring data. At this time, a variety of different formats are used for CEDAR image data. For example, the Lunar and Planetary Lab stores spectra from the Space Shuttle GLO experiments in FITS (Flexible Image Transport Format), the Boston University CEDAR Imager uses a simple byte array format, and the Utah State CCD imager uses yet another format.

Even in the case of incoherent scatter data, problems arise when an attempt is made to store the results of full-profile analysis programs such as OASIS at Millstone Hill and GUISDAP at EISCAT. Both of these programs approach incoherent scatter analysis as a statistical inverse problem where the covariance matrix of the searched parameters is fundamental output. These matrices are quite large, a typical size being 500*500. They are, however, sparse. In addition to being symmetrical, so that only a triangular matrix need be retained, they have many zero elements with the zero elements arranged in a somewhat unpredictable manner. Typically, about 30,000 elements might be non-zero. Neither the CEDAR or netCDF formats have an efficient mechanism for representing such a matrix. In the case of CEDAR, the only obvious way is to store both the location and value of each non-zero element as a 16-bit integer, which in the example cited above leads to 120 kilobytes for the matrix, about the same as the total number of elements in the triangular matrix. Another possibility would be to treat the covariance matrix as an image, and apply a compression algorithm to reduce the size. This is possible because eight bits is probably sufficient to represent the off-diagonal elements of the covariance matrix. This has been investigated, and it was found that the compressed sparse matrix will typically require less than 20 kilobytes.

So, the importance of representing both images and the covariance matrices arising from full-profile analysis of incoherent scatter data mandates that whatever format is adopted should support images or, more generally, byte arrays. Unlike netCDF, the existing CEDAR format does not have this capability. However, CEDAR is an extensible format, and it would be easy to implement a new byte-array record type to accommodate these data types. Note that this does not imply a new image format, but only a record type to hold images stored in existing formats, such as GIF or XBM. We recommend that priority be given to accomplishing this task. The level of work required should be significantly less than that required to convert the basic format to netCDF.

Another possible alternative may be to allow new data sets to be in some standard format such as netCDF. This would mean that the converter would not be necessary for such data sets, and would accommodate those who already use netCDF for some storage, like TIGCM outputs. However, it is clear that the converter from the CEDAR format to netCDF is much easier to implement than a converter from netCDF to the CEDAR format. So until a better format solution is found, it seems best to require all the basic data to be in the CEDAR format.

The NCAR and MADRIGAL versions of the CEDAR format only differ in the length of the prologue and in the blocking. The MADRIGAL prologue has four extra words containing time information, which can be used for random access to data collected at a specified time. Since the CEDAR format permits additional words in the prologue, this is not a fundamental difference, and software to parse CEDAR logical records should be able to handle either version. The difference in blocking, also referred to as physical records when the data is stored on tape, is more fundamental.

The NCAR version of the format is the original CRAY COS blocked format (cbf) which was initially necessary on the mass storage device. At NCAR, all CEDAR data is stored in 2-4 places. These are: on-line on the CEDAR computer, on the mass storage device, on original tapes or other media, and on backup tapes or other media. All of these are in cbf format. The cbf format is very robust and has read versions for VAX, PC and other platforms.

The MADRIGAL blocking structure was designed to permit random access to logical records from FORTRAN programs. Blocks are fixed length, and logical records may be broken across blocks. In addition to the logical records, each block contains several pointers to facilitate random access, and a checksum. A portable library of C routines to read and interpret MADRIGAL records has recently been written, and is available through the MIT/SRI/EISCAT Telescience Initiative Web page. Additional routines to form and write MADRIGAL records are planned.

It is relatively easy to convert between cbf and MADRIGAL format and vice versa, and software for this purpose exists. However, the popularity of the WWW interface to the MADRIGAL Data Base shows that many users prefer to receive data in an ASCII flat file format. Plans are underway to use ISPRINT as the flat file access within the cmenu system, converting cbf files to MADRIGAL format on the fly. As is, many users prefer to change the cbf format to the ASCII version if the data set is small. It is also desirable to include the functionality of cmenu into the WWW interface, since cmenu glues together all the necessary information on headers, catalog records, and any known caveats about the observing period to each requested data set. This gives the user all of the available documentation needed to analyze a particular data set.

6. Rules of the Road

Use of data from the CEDAR Data Base is subject to the Rules of the Road for the CEDAR Data Base. The current Rules of the Road and their rationale are as follows:

> Smooth functioning of the Data Base requires that there be clear agreements among the parties involved in acquiring, handling, and using the data. The scientists who submit data have invested considerable time, effort, and expertise in collecting and processing the data for submission to the Data Base. Despite this effort, there are still uncertainties and limitations of the data, making it important for the user to contact the data suppliers early on in a project. The suppliers will help the user understand the characteristics and limitations of the data, and may even be willing to collaborate in prospective studies. It is important that these efforts receive appropriate acknowledgment by users of the data. In addition, the Data Base needs to maintain records to evaluate how it is being used. The following 'Rules of the Road' have been agreed upon to satisfy these needs and to clarify the responsibilities of users.

1. The prospective user must submit an access form to obtain access to the Data Base. Access forms must be updated at least annually. A copy of this form is available via WWW or ftp, and email submission is acceptable.

2. Data obtained from the Data Base are to be shared only with other users who have an up-to-date access form on file with NCAR.

3. The user is required to establish early contact with the organization(s) whose data are involved in the project to discuss the intended usage, in the light of possible data limitations.

4. Before they are formally submitted, draft copies of all reports and publications must be sent

to the contact scientist at the data-supplying organization(s) along with an offer of co-authorship to scientists who have provided data. This offer may be declined.

5. The Data Base and the organizations that contributed data must be acknowledged in all reports and publications.

6. Copies of reports and papers are to be sent to the Data Base so that the Bibliography of Data Base Acknowledgements can be kept up to date.

The rationale for these rules is as valid as ever, and, for the most part, the rules fulfil their function well. It is, however, worth reconsidering Rule 1. This rule specifies the mechanism by which users may gain access to the Data Base, and through which NCAR maintains records of Data Base use. This mechanism works well when the primary means of data transfer is magnetic tape, floppy disk or CEDAR computer login. However, it imposes a substantial constraint on providing easy access to the data through a mechanism such as the World Wide Web which did not even exist at the time the Rules of the Road were written.

Figure 1 illustrates what is possible with a World Wide Web interface to the CEDAR Data Base. All Millstone Hill incoherent scatter data are stored on-line and a hyperlinked list of these data is accessible through the Millstone Hill Web server at http://www.haystack.edu/madrigal/madrigal.html. Selecting one of the listed files brings up the form shown in Figure 1. The form is generated dynamically, and reflects the data actually available in the selected file. Filters and data selection buttons permit the user to select the data of interest, which are returned in the form of an ASCII flat file which may easily be input into analysis or plotting programs. Anyone may download Millstone Hill data in this fashion. The top level data access page requests that anyone who accesses the data follow the CEDAR Rules of the Road, and any data file which is downloaded begins with a header which specifies that use of the data is subject to the Rules.

While Millstone Hill has decided to permit this essentially free access to its data, this access mechanism violates the Rules of the Road, and hence cannot be used to provide access to data from any other source. In fact, many data sets from other instruments are stored on the Millstone data base server, and these do appear on the Web list, but access is blocked for users from outside the local domain. We recommend that Rule 1 be modified to permit electronic submission of an agreement to follow the Rules of the Road. This agreement would then be logged, as would information about all accesses to the data. Logging is a built-in feature of Web servers. After agreeing to the Rules of the Road users would be free to access any data in the Data Base. This is a fundamental change in how permission to access CEDAR data is granted, The CEDAR Science Steering Committee approved this modification of the Rules of the Road at its October, 1995 meeting.

Another unresolved issue is to what extent the Rules of the Road apply to data displays as well as to the datasets themselves. For example, if a user monitors an experiment through UARC, must they first sign an agreement to abide by the Rules of the Road? This is not a simple issue. Some viewers read datasets and produce the display locally, while others produce the display at the server and the user receives only a bitmap. One possibility is to degrade real-time data so that while suitable for viewing it is not of sufficient precision to permit detailed analysis. This issue warrants further consideration.

7. Education and Public Interface

Articles about the CEDAR Data Base have appeared in publications like the STEP Newsletter. In addition, posters about the Data Base have been presented at scientific meetings, and these have helped to educate the scientific community about the CEDAR Data Base. Other very useful educational services are the announcements which are broadcast to the cedar e-mail list, and activities each year at the annual CEDAR Workshop held in Boulder, Colorado. Since 1994, two students have been selected each year to come to NCAR around the time of the annual Workshop to receive training in accessing the CEDAR Data Base as a part of their projects.

The World Wide Web (WWW) provides a powerful mechanism for distributing educational information to the public, and many institutions have developed materials for the public. This is true for NCAR and the various divisions within NCAR, as well as for many of the institutions which provide data to the CEDAR Data Base.

Following is a list of some WWW sites of interest to the CEDAR community.

HAO/NCAR:	http://www.ucar.edu/
CEDAR DB:	http://www.ucar.edu/public/research/tiso/cedar/cedar.html
	http://www.haystack.edu/cedardb.html
GEM DB:	http://www-ssc.igpp.ucla.edu/gem/Welcome.html
	http://igpp.ucla.edu/gem/event_nov93.html
Jicamarca:	http://dartagnan.ee.cornell.edu:8001/radar/jro/jicamarca.html
Arecibo:	http://naic.edu/
Millstone Hill:	http://www.haystack.edu/
EISCAT:	http://seldon.eiscat.no/homepage.html
Sondrestrom:	http://chaos.sri.com/iono/issfsond.html
SuperDARN:	http://sd-www.jhuapl.edu/RADAR/SD_homepage.html
MIT/SRI/EISCAT Telescience Initiative:	http://www.haystack.edu/telescience/
Digisondes:	http://ulcar.uml.edu/
Magnetometers:	http://www.sprl.umich.edu/geomag/
TERRIERS:	http://veebs.bu.edu/terriers.html
Lunar Planetary Lab (GLO)	http://vega.lpl.arizona.edu/
Cornell Space Plasma Physics:	http://dartagnan.ee.cornell.edu:8001/spaceplasma.html
National Geophysical Data Center (NGDC):	http://www.ngdc.noaa.gov/
National Space Science Data Center (NSSDC):	http://www.gsfc.nasa.gov/
OMNI:	http://nssdc.gsfc.nasa.gov/omniweb/ow.html
SPyCAT:	http://nssdc.gsfc.nasa.gov/space/ndads/spycat.html
MIT (IMP-8):	http://web.mit.edu/afs/athena/org/s/space/www/imp.html
UCLA (IMF):	http://www-ssc.igpp.ucla.edu/forms/imp8_form.html
SEL/NOAA:	http://www.sel.noaa.gov/
POLAR (UVI):	http://uvisun.msfc.nasa.gov/POD/POD.html
MSX:	http://bradbury.nrl.navy.mil/msx/spacecraft.html
UARC:	http://www.sils.umich.edu/UARC/

SWARM: http://gandalf.engin.umich.edu:8080/

We hope that these and other sites will continue to consider the public, and provide an educational element in their displays.

8. Future Directions of the Data Base

The CEDAR Data Base had its origins at a time when the concept of a distributed data base system was impractical. Few researchers had easy access to the limited computer networks available at the time, and few data providers had sufficient computational and data storage resources to be able to make substantial amounts of their data available to users in real or near-real time. NCAR played an essential role in providing the necessary computer resources to the community. Most users simply requested copies of the data on tape or other media in order to work on the data at their home institutions. This is still an option, though most users now have logins and remote copy data sets to their own computer. Similarly, the Millstone Hill WWW interface has proved very popular for retrieving Millstone Hill data directly from Millstone.

The rapid growth of computer networking has changed the picture for distributed computing, making it much more attractive. Many institutions are able to keep all or a significant portion of their data on-line, almost everyone has easy access to the Internet, and there are freely available tools like mosaic and netscape to access data over the Internet. As a result, some members of the community have suggested that the centralized CEDAR Data Base be abolished, and all data be distributed from local data bases maintained by data providers.

This would certainly be technically possible, but a majority of the Data Base Committee believes that there remains a need for a central repository. This seems particularly true for key data sets, such as those collected on Coordinated Incoherent Scatter Observation Days. First, identifying these key periods and encouraging or requiring data providers to deposit their data in the Data Base in a timely manner is important. Even more important, the centralized CEDAR Data Base goes far toward ensuring that important data are not lost as a result of changes in data storage media, computers or the departure of the investigator responsible for the data. For smaller data sets, it is also convenient to hold all the data sets from several instruments at a single location. Finally, it is difficult to see how a distributed system, providing transparent access to distributed data sets, could be implemented within the tight constraints of the CEDAR budget.

The recent explosive growth of the Internet, including links to remote sites such as the Sondrestrom Radar, has led to a number of initiatives aimed at exploiting the network to further scientific research and collaboration. Among these are the UARC project of the University of Michigan and SRI, the MIT Haystack Observatory MIDAS distributed data acquisition system, the Unidata Program managed by the University Corporation for Atmospheric Research (UCAR), and the MIT/SRI/EISCAT Telescience Initiative. The particular goals of these projects are quite different, but, in fact, complementary, and making use, as they do, of the same low level network protocols they are in many respects compatible. Until recently, however, there have been few efforts to bridge the gaps between these efforts in order to bring them together so that they can be applied in unison to address scientific problems. A recent step in this direction was the implementation of a Web browser interface to the MIDAS data acquisition system, which provides near-real-time Internet access to Millstone Hill Radar status and data. It is important that we take a further step forward by developing standards and software which will interface incoherent scatter radar and other upper atmospheric data sets to UARC, WWW browsers, and numerous other research tools.

Adoption of the NCAR format as a standard for collaboratory and telescience applications will provide a standard which will permit incoherent scatter radars other than Sondrestrom to provide data through UARC, and will also provide a means of accessing real-time radar and optical data through widely available and platform-independent World Wide Web browsers. One project with this goal is the MIT/SRI/EISCAT Telescience Initiative. Results to date include:

1. CEDAR data display using a CEDAR to netCDF conversion program and commercial visualization programs.

2. Real-time images of Millstone Hill Radar data on the World Wide Web.

3. Simplified construction of WWW data server programs via a C library for handling CEDAR format records and an extension to the tcl scripting language.

4. Universal WWW access to data, even when the user has restricted access to the Internet, through a URL-based data server. CEDAR records are supplied as Web pages.

5. Efficient WWW access to data through a socket-based data server. A connection is established and maintained between the data source and the user's computer.

6. Software infrastructure, in the form of Java classes, for interactive data displays on a Web page.

7. Radar status display applet.

Complete descriptions of these results and the latest status of this project are available at http://www.haystack.edu/telescience.

Since the beginning, the Data Base has emphasized derived atmospheric parameters, such as temperatures, rather than lower-level data, such as incoherent scatter correlation functions. This is the primary reason the Data Base is so small. Reducing the data to derived parameters effects a huge reduction in the data volume.. However, even if the low-level data are not stored at NCAR, there are good reasons for encouraging its preservation, as well as preserving full information on the procedures used to reduce the low-level data to atmospheric parameters. Long-term measurements are important for studying global change and space weather, and indeed the study of long-term variations is one of the four science initiatives identified as central to CEDAR Phase III. However data acquisition and analysis techniques continue to evolve, and it can be difficult to be sure that apparent long-term variations are real and not the result of changes in procedure. We therefore strongly recommend that all investigators, and particularly the Class I clustered facilities, take steps to ensure that low-level data remains available for future analysis.

The CEDAR Data Base is small - 8 GB of data with a growth rate of 1 GB/year. A 9 GB disk can be purchased for less than $4000. The entire data base would fit on 12 CDs, and it would be worthwhile to investigate this option. The cost of a CD ROM writer is now approximately $1000, and the write-once CD masters cost less than $15. This suggests that if CDs are used to store and dispense data within the CEDAR Data Base, they are most likely to be CDs containing data from a single instrument or observatory. Each instrument group would need to approve making a CD, and some instrument groups which produce small quantities of data, such as the Fabry-Perots, might consider putting their data on a single CD. Anyone who receives a CD would have to agree to abide by the Rules of the Road. Also, the question of corrections to older data sets would have to be dealt with. However, since the cost of mastering CDs is relatively small, this could be a good avenue to distribute the data to the community. At present, there is no CD mastering capability within the CEDAR Data Base at NCAR, but this could be developed. Millstone Hill does have a mastering capability, and one option would be to produce a trial CD ROM dataset there before implementing a production capability at NCAR.

9. Conclusions

The CEDAR Data Base has been an important component of the CEDAR Program throughout its first decade. This report provides a reassessment of the Data Base and its function as CEDAR enters its second decade, and moves from Phase I and II to Phase III. This reassessment takes into account both the science initiatives identified as the focus of Phase III, and advances in computer and network technology which have so greatly expanded the range of possibilities for applying this technology to the solution of scientific problems. The function of the Data Base has been to collect, organize, preserve, distribute, promote and use data submitted to the Data Base. While this role will remain as important during the second decade of CEDAR as in the first, increased emphasis should now be placed on application of distributed data base techniques, telescience and computer aided collaboration, which were recognized as possibilities at the inception of the Data Base, but have only recently become viable tools for promoting CEDAR science.

As steps toward achieving these goals, we make the following twelve recommendations:

1. The CEDAR Data Base should have both centralized and distributed components. The central facility plays important roles in standardizing, collecting, organizing, preserving, distributing, promoting and using the data and models. Technological advances make it possible to shift some of the distribution functions to other sites.

2. Implementation of up-to-date user interface technology should be a priority.

3. The existing CEDAR format should be retained as the primary format for archiving data.

4. The CEDAR format should be extended to include a new byte-array record type to accommodate image data in a variety of standard image formats.

5. Filters should be constructed to convert the CEDAR format to netCDF and HDF, and possibly CDF.

6. CD ROM should be investigated as an alternative medium for archiving and distributing CEDAR data.

7. The CEDAR Rules of the Road should be updated to allow immediate access to CEDAR data over the World Wide Web upon submission of an electronic form in which the data user agrees to read and abide by the Rules of the Road. All accesses to the Data Base through the Web should be logged.

8. The Millstone Hill Data Base server should provide World Wide Web access to CEDAR data stored at NCAR, subject to the Rules of the Road, until the NCAR server is fully functional.

9. The CEDAR user community should be encouraged to use the CEDAR format, or the netCDF and HDF files derived from CEDAR format data by filters, for storage of data and input to data browsers and other locally developed tools, thereby increasing the usefulness of these tools to the entire community.

10. The CEDAR format should be adopted as a standard for telescience and computer collaboration initiatives.

11. Lower level data, such as incoherent scatter autocorrelation functions, should be stored, preferably in a standard format, along with documentation and analysis tools, either at the site or at the CEDAR Data Base, for all new data sets.

12. Consideration should be given to saving lower level data for older data sets in a common format, if available resources permit.

APPENDIX A - Executive Summary of the First CEDAR Data Base Report - February 1988

The Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) Program is an international, cooperative effort within the aeronomy community to further our understanding of Earth's upper atmosphere. This program will be highlighted by numerous multi-instrument measurement campaigns and global simulations of the magnetosphere-ionosphere-atmosphere system. To achieve the full scientific benefits of these observations and simulations will require the ability to access large amounts of data from many different instruments and models. This report describes a recommended data base system for the CEDAR program to help establish this access.

Several general principles help to determine the most desirable form for the CEDAR Data Base. Data from the CEDAR program will be collected primarily for research purposes, and much of it will be state-of-the-art, that is, subject to evolving experimental uncertainties and problems, requiring active involvement of the experimenters in its interpretation. The data base must therefore be more than a collection of data, and must take advantage of whatever relevant skills are available in the community. It must be able to handle rapidly expanding data rates, and provide quick and easy access to well-documented data. Specially developed software for data management and analysis should be shared among institutions and scientists. Commercially available software should be taken advantage of when it offers significant advantages in the display and management of data. High-density forms of data storage are becoming available that can offer advantages over 9-track tapes for transferring data. A central data base facility is desirable to act as a focus of data base activities, to store and make widely used data and software, and to provide user services. Rather than raw data, the central facility should store basic and derived geophysical parameters, in order to make the data easy to use. Raw data should be made available directly from the experimenters. Data access through national and international computer networks, as well as by copies on magnetic tape and other media, will be needed. The CEDAR Data Base should also link to relevant information in related data bases maintained by NSA and other organizations. It should help facilitate basic information exchange in the forms of electronic mail, up-to-date lists of scientists, and catalogues of data.

The responsibilities for the CEDAR Data Base should be shared among four principal groups, whose members often overlap: the CEDAR Data Base Committee, the central facility, the data suppliers, and the data users. The Data Base Committee should be the principal coordinating body among the aeronomy community for determining types of data to be included, establishing common data formats and schedules of submission, and for recommending user interfaces with the data base, in terms of access modes and services to be provided. Subcommittee reports addressing these issues are included here as appendices. The central facility should maintain desired data collections and related information, provide catalogue and other information to interested users, collect and develop useful software for data management and analysis, make data and other information accessible for scientific research through mailed copies and online facilities, promote contacts between data users and data providers, and host scientific research using the data. The data suppliers need to help the Data Base Committee determine appropriate data and formats; to process, verify, and document the data and submit it to the central facility; and to interact with users of the data. The data users need to interact with the data suppliers to assure appropriate uses of the data, and to offer coauthorship on publications, and they need to keep the central facility informed of uses made of the data.

Several recommendations are made concerning the implementation of the CEDAR Data Base. The Data Base should be built upon the existing Incoherent Scatter Data Base with the central facility at the National Center for Atmospheric Research (NCAR). The data format currently used for the incoherent scatter data should be adopted for most other types of CEDAR data, although the NASA Standard Format Data Unit (SFDU) should be considered in the future for some applications. The central facility should attempt to obtain a dedicated minicomputer to carry out the online data base functions. This computer should use the UNIX operating system. A portable version of the Millstone Hill data base system would be desirable as a basis of the online system to be developed at the central facility. The central facility should have good connections to the SPAN and NSFnet networks. The Rules of the Road currently in effect for the Incoherent Scatter Data Base should be considered for adoption for the CEDAR Data Base, allowing users broad access to data at the central facility, but requiring them to inform data suppliers about intended uses and to offer coauthorship on publications. The National Science Foundation should support the CEDAR Data Base as a central element of the CEDAR program, and as a long-term community effort. Looking to the future, the CEDAR Data Base should keep on top of relevant developments in distributed data base techniques, telescience techniques, and artificial intelligence.

APPENDIX B - CEDAR Database Committee email Exploder

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Table 1 - Summary of CEDAR Data Base Use through 12/95

This is a list of the use of various instruments, models, and software in the first 10 years of the CEDAR Data Base. The only instruments were incoherent scatter (IS) radars until 1989, when other ground-based instruments were added. F=Foreign, stud=student, login=# requests filled by login users, info=information, docs=documents, S/W=software.

Class	# in Class	1st Yr	# Req (login)	# Users (stud,F)
Info/docs only	-	1985	50 (35)	31 (9,11)
S/W and docs only	-	1985	43 (15)	27 (7, 7)
Indices	5	1986	85 (59)	30 (8, 7)
Small Models	10	1986	21 (9)	15 (4, 7)
Large Model Output	5	1989	62 (15)	38 (9,15)
IS Radars	7	1985	509 (321)	100 (41,26)
MST Radars	2	1989	32 (26)	10 (5, 3)
Fabry-Perots	9	1989	26 (21)	16 (8, 4)
Imagers	2	1989	1 (0)	1 (1, 0)
Lidars	1	1990	14 (12)	4 (2, 1)
MLT Radars	11	1991	13 (12)	8 (6, 2)
HF Radars	4	1991	15 (11)	4 (0, 0)
Total	36instr+5ind+15mod	1985	871 (536)	187 (56,65)
Outside Logins		1991	189	154 (77,34)
Outside Login use > 10 hr/yr		1991	---	65 (37, 9)
rcp/cmenu users		1991/1994	178/283	56 (36, 7)

Table 2 - CEDAR Data Base Data Accumulation Per Year and Total Use Statistics through 12/95

The Incoherent Scatter Radar Data Base started at NCAR in November 1985, and became the CEDAR Data Base in 1989. Base in 1989. The year under 'DB' by the name is the first year the data or model entered the Data Base. The years along the top are years where there is data, while the year under it in columns is the year that data first arrived in the Data Base. The final columns are the number of requests and users who have used the Data Base up through 12/95.

Instrument/Model/1st yr in	DB	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
IMF	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
Kp, Ap, F107, sunspots	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86
Dst	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86
AE	87													87	87	87	87	87
Hemispheric Power Index	88													88	88	88	88	88
Jicamarca IS Radar	85	85	85	85	85													
Arecibo IS Radar	85	86	86	86	86	86	86	86		85	85	85	85				86	86
Millstone Hill IS Radar	85													87	87		87	.
Saint Santin IS Radar	85	88	88	88	88	88	88	88	88	85	85	87	85	85	85	86	86	86
Chatanika IS Radar	85											89	89	89	89	89	85	89
EISCAT IS Radar	86																	
Sondrestrom IS Radar	85																	
Halley HF Radar	94																	
Kapuskasing HF Radar	95																	
Saskatoon HF Radar	95																	
Goose Bay HF Radar	91																	
Halley Fabry-Perot	94																	
Arequipa Fabry-Perot	93																	
Arecibo Fabry-Perot	91															91	91	91
Peach Mountain FPI	94																	
Millstone Hill FPI	90																	
Watson Lake Fabry-Perot	93																	
College Fabry-Perot	90																90	90
Sondre Stromfjord FPI	89																	
Thule Fabry-Perot	91																	
USU CCD Imager	95																	
Millstone Hill Imager	89																	
NCAR TGCM Model Output*	89											94			89			
AMIE Model Output	89																	
Forbes/Vial Solar sd Tides	89																	
Vial/Forbes Lunar sd Tides	93																	
GSWM Solar d/sd Tides	95																	
U of IL lidar	90																	
Arecibo MST Radar	94																	
Poker Flat MST Radar	89														89	89	89	89
Scott Base MF Radar	91																	
Mawson MF Radar	92																	
Christchurch MF Radar	92																	
Adelaide MF Radar	91																	
Collm LF Radar	94																	
Saskatoon MF Radar	91																	
Tromso MF Radar	91																	
Atlanta Meteor Wind Radar	91									91	91	91	91	91	91	91	91	91
Durham Meteor Wind Radar	91													93	93	93	93	93
Christmas Is MEDAC Radar	91																	
Platteville MEDAC Radar	91																	

* 30 of the 31 Model TIGCM Outputs are generic solar min/max runs.

Table 2 - CEDAR Data Base Data Accumulation Per Year and Total Use Statistics through 12/95 - continued

The Incoherent Scatter Radar Data Base started at NCAR in November 1985, and became the CEDAR Data Base in 1989. Base in 1989. The year under 'DB' by the name is the first year the data or model entered the Data Base. The years along the top are years where there is data, while the year under it in columns is the year that data first arrived in the Data Base. The final columns are the number of requests and users who have used the Data Base up through 12/95.

Instrument/Model		83	84	85	86	87	88	89	90	91	92	93	94	95	#req	#user
IMF	88	88	88	88	88	88	90	92	92	92	95	95	95	95	20	10
Kp, Ap, F107, sunspots	86	86	86	86	87	88	90	90	92	92	92	95	95	95	36	19
Dst	86	86	86	92	92	92	92	92	92	95	95	95	95	95	14	6
AE	87	87	89	90	92	95	95								7	3
Hemispheric Power Index	88	88	88	88	88	95	95			95	95	95	95	95	8	6
Jicamarca IS Radar	85		85	85	87	87	89	90	92	92	93	95			49	27
Arecibo IS Radar	85	85	85	86	87	87	89	90	91	92	93	95	95	95	120	56
Millstone Hill IS Radar	85	85	85	86	86	87	90	90	91	92	92		95	95	125	42
Saint Santin IS Radar	85		86	86	88	88									23	18
Chatanika IS Radar	85														7	7
EISCAT IS Radar	86		88	86	86	87	89	90	90	93	93	93	95		35	21
Sondrestrom IS Radar	85	85	85	85	87	87	89	90	93	93	92	95	95	95	150	44
Halley HF Radar	94								95	94	95	95			4	2
Kapuskasing HF Radar	95											95			1	1
Saskatoon HF Radar	95											95			1	1
Goose Bay HF Radar	91						91		92	93	93	95			9	4
Halley Fabry-Perot	94						94	94	94	94	94	94			1	1
Arequipa Fabry-Perot	93	93	93		93		93	93	93						1	1
Arecibo Fabry-Perot	91	91	91	91	91	91	91								1	1
Peach Mountain FPI	94											94	94		1	1
Millstone Hill FPI	90							90	90	92	93	93	95	95	10	9
Watson Lake Fabry-Perot	93									93	93				1	1
College Fabry-Perot	90	90													1	1
Sondre Stromfjord FPI	89	90	90			90	89	95	95	95	95	95	95		8	6
Thule Fabry-Perot	91					91	91	91							2	1
USU CCD Imager	95											95			-	-
Millstone Hill Imager	89					89	89	90	90	94	94	94	95		1	1
NCAR TGCM Model Output	89														23	14
AMIE Model Output	89		89		89										7	3
Forbes/Vial Solar sd Tides*	89						89								25	20
Vial/Forbes Lunar sd Tides*	93											93			-	-
GSWM Solar d/sd Tides	95													95	7	4
U of IL lidar	90							90	94	93	93				14	4
Arecibo MST Radar	94							94							-	-
Poker Flat MST Radar	89	89	89	89											32	10
Scott Base MF Radar	91						91	92	92						1	1
Mawson MF Radar	92		93	93	93	92	93	92	93						1	1
Christchurch MF Radar	92					93									-	-
Adelaide MF Radar	91					92	91	92	93						-	-
Collm LF Radar	94					94	94	94	94				95	95	-	-
Saskatoon MF Radar	91					92	91	92	92						-	-
Tromso MF Radar	91					92	91	92	92						-	-
Atlanta Meteor Wind Radar	91	91	91	91	91	91									4	3
Durham Meteor Wind Radar	91					91	91		92						2	2
Christmas Is MEDAC Radar	91						91	92		93					4	4
Platteville MEDAC Radar	91						91								1	1

* Model Tidal Output is independent of year.

Table 3 - Statistics for cmenu, the CEDAR Data Base User Interface through 5/31/96

month/year:	5/94	6/94	7/94	8/94	9/94	10/94	11/94	12/94	1994
# invocations	8	110	20	13	3	42	4	5	205
# users	2	13	6	3	1	3	2	2	21
# docs	1	25	6	4	2	0	1	4	43
# application s/w	0	8	1	0	2	0	0	1	12
# model s/w	0	1	1	0	1	0	0	0	3
# model output	0	3	1	2	1	0	0	0	7
# indices	0	7	1	0	0	0	0	0	8
# IS radars	5	53	12	9	2	26	4	12	123
# HF radars	0	0	0	0	0	0	0	0	0
# Fabry-Perots	0	4	2	0	0	0	0	0	6
# MST radars	0	12	1	0	0	33	0	0	46
# MLT radars	0	0	2	0	0	0	0	0	2
# Lidars	0	3	0	0	0	0	0	0	3

month/year:	1/95	2/95	3/95	4/95	5/95	6/95	7/95	8/95	9/95	10/95	11/95	12/95	1995
# invocations	5	13	15	15	34	31	49	70	32	18	85	11	378
# users	4	4	5	4	5	10	6	6	3	8	6	2	27
# docs	0	0	3	0	1	8	1	1	0	3	15	9	41
# application s/w	0	2	2	0	0	1	0	2	0	0	21	10	38
# model s/w	0	1	1	7	0	5	1	0	3	0	0	0	18
# model output	3	0	0	0	0	5	0	7	0	2	3	0	20
# indices	4	0	0	1	9	2	4	8	12	2	0	0	42
# IS radars	2	6	14	11	67	8	17	59	24	8	84	11	311
# HF radars	0	0	0	0	0	0	0	0	0	0	0	0	0
# Fabry-Perots	1	0	0	0	0	0	0	5	0	0	3	12	21
# MST radars	0	7	1	3	0	7	26	0	0	0	0	0	44
# MLT radars	3	0	0	0	0	0	0	4	0	5	2	0	14
# Lidars	0	0	0	0	0	0	0	4	0	1	0	0	5

month/year:	1/96	2/96	3/96	4/96	5/96	6/96	7/96	8/96	9/96	10/96	11/96	12/96	1996
# invocations	2	11	15	5	44								77
# users	1	5	3	3	6								12
# docs	3	4	19	2	24								52
# application s/w	3	2	15	2	28								50
# model s/w	0	0	8	0	0								8
# model output	0	1	0	0	0								1
# indices	0	0	0	0	0								0
# IS radars	2	9	9	5	53								78
# HF radars	0	0	0	0	0								0
# Fabry-Perots	0	0	6	0	0								6
# MST radars	0	0	0	0	0								0
# MLT radars	0	0	3	0	0								3
# Lidars	0	0	0	0	0								0

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96

For #p=#persons, s=student, n=non-student, U=from US institution, F=from foreign institution, d=delivery from DB, lg=delivery from login
The GPI contains Kp, Ap, 10.7 cm flux, and sunspot numbers.
The numbers before the models, indices, or instruments indicate #requests/#persons.
The #req data for the logins (lg) are defined as being access days, or 1 #req per user per day, even though some users used many accesses in a single day to get several data sets from one instrument. Also, a request for several instruments is counted as multiple requests.
The numbers before the user names are listed in chronological order of user for a particular instrument, and the numbers after are user #.
The 'info+docs only' column does not include those who only signed the 'Rules of the Road' or received a computer login. When the cmenu interface came on-line in 1994, it became possible to track transfers of documentation, software (s/w), and source models, so these statistics were added even though the users usually received more than 'only' documentation and software. Access of the data by login users, especially internal NCAR logins, is not shown if programs other than cmenu are used to access the data. A good example of this is the getndcs program which will get geophysical indices. However, estimated radar and indices use for AMIE (Assimilative Mapping of Ionospheric Electrodynamics) by Emery and Lu at NCAR are included in this table.

deliv year	DB top, login middle, Total bottom #req	#p	n	s	U	F	only info docs	only s/w docs	s/w models	indices	model output	DB lg #req data	#instr	instruments (#req/#users)
1985	1	1	1	0	0	1	0	0	0	0	0	1	1	1/1ARO
1986	49	25	25	0	14	9	3	7	0	1/1GPI(Kp)	2/1TGCM	36	6	10/9ARO,4/2EIS,5/5JRO,8/6MLH,5/5SON, 4/2STS
TOTAL:	50	25	25	0	14	9	3	7	0	1/1GPI	2/1TGCM	37	6	11/9ARO,4/2EIS,5/5JRO,8/6MLH,5/5SON,
		24 new, 1 old							0/0Tot	1/1Tot	2/1Tot			4/2STS=37/16IS
1987	34	18	18	0	12	6	1	3	2/2(Efld)	3/3GPI	4/3TGCM	21	6	8/7ARO,6/4EIS,2/2JRO,4/4MLH,3/3SON,
	7	1	1	0	1	0				1/1Dst	1/1AMIE	5		3/2STS
	41	19	19	0	13	6						26		
TOTAL:	84	37	37	0	24	13			2/2Efld	4/4GPI	6/3TGCM	58		19/15ARO,10/6EIS,7/7JRO,12/9MLH,8/7SON,
	7									1/1Dst	1/1AMIE	5		7/4STS
	91	12 new, 7 old					4	10	2/2Tot	5/4Tot	7/4Tot	63	6	=63/23IS
1988	44	20	20	0	12	8	1	3	1/1MSIS	2/2GPI	3/3TGCM	30	7	3/3ARO,1/1CHT,3/3EIS,1/1JRO,7/7MLH,
										1/1Dst+1/1AE				10/8SON,5/5STS
										1/1IMF+1/1HP				
TOTAL:	128	51	51	0	30	21			2/2Efld	6/6GPI	9/5TGCM	88		22/18ARO,1/1CHT,13/9EIS,8/8JRO,
	7								1/1MSIS	2/2Dst+1/1AE	1/1AMIE	5		19/16MLH,18/14SON,12/9STS
										1/1IMF+1/1HP				
	135	14 new, 6 old					5	13	3/3Tot	11/6Tot	10/6Tot	93	7	=93/30IS

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96 - continued

deliv year	DB top, login middle, Total bottom #req	#p	n	s	U	F	only info docs	only s/w docs	s/w models	indices	model output	DB lg #req data	#instr	instruments (#req/#users)
1989	54	27	24	3	18	9	3	4	0	5/3GPI	3/2TGCM	32	11	9/7ARO,2/2CHT,2/2EIS,3/2JRO,5/4MLH,
	15	1	1	0	1	0				1/1AE	6/3AMIE	6		10/7SON,2/2STS, 2/2PKR, 1/1CFP,1/1SFP,
	69	28	25	3	19	9				3/1IMF+4/2HP	2/1SDT	38		1/1LTCS(book)
TOTAL:	182	69	66	3	41	28			2/2Efld	11/7GPI	12/7TGCM	120		31/23ARO,3/3CHT,15/9EIS,11/10JRO,
	22								1/1MSIS	2/2Dst+2/1AE	7/3AMIE	11		24/18MLH,28/20SON,14/11STS=126/39IS;
										4/2IMF+5/3HP	2/1SDT			2/2PKR; 1/1CFP,1/1SFP=2/2FPI;
	204	18 new, 10 old					8	17	3/3Tot	24/8Tot	21/11Tot	131	11	1/1LTCS(book)
1990	29	18	12	6	13	5	0	2	2/2MSIS	2/2GPI	3/2TGCM	18	10	5/5ARO,1/1CHT,1/1EIS,3/3MLH,4/4SON,
	4	1	1	0	1	0				2/2IMF	2/2SDT	2		2/1PKR, 1/1MFP,1/1SFP, 1/1UIL, 1/1MIO
	33	19	13	6	14	5						20		
TOTAL:	211	82	74	8	51	31			2/2Efld	13/7GPI	15/9TGCM	138		36/27ARO,4/4CHT,16/10EIS,11/10JRO,
	26								3/3MSIS	2/2Dst+2/1AE	7/3AMIE	13		27/20MLH,32/23SON,14/11STS=140/47IS;
										6/3IMF+5/3HP	4/2SDT			4/3PKR; 1/1MFP,1/1CFP,2/2SFP=4/3FPI;
	237	13 new, 6 old					8	19	5/5Tot	28/10Tot	26/14Tot	151	14	1/1UIL; 1/1MIO; 1/1LTCS(book)
1991	30	21	17	4	13	8	2	0	1/1Efld	2/2GPI	1/1TGCM	20	11	8/7ARO,1/1CHT,5/5EIS,2/2JRO,4/4MLH,
	7	4	3	1	4	0				1/1IMF	2/2SDT	7		1/1SON,1/1STS, 2/2PKR, 1/1ATM, 1/1MFP,
	37	25	20	5	17	8				1/1HP		27		1/1UIL
TOTAL:	241	103	90	13	64	39			3/3Efld	15/9GPI	16/10TGCM	158		44/33ARO,5/5CHT,21/14EIS,13/12JRO,
	33								3/3MSIS	2/2Dst+2/1AE	7/3AMIE	20		31/23MLH,33/24SON,15/12STS=162/56IS;
										7/4IMF+6/4HP	6/4SDT			6/5PKR; 1/1ATM, 2/2MFP,1/1CFP,2/2SFP
	274	21 new, 4 old					10	19	6/6Tot	32/14Tot	29/17Tot	178	15	=5/4FPI; 2/2UIL; 1/1MIO; 1/1LTCS(book)
1992	30	16	12	4	10	6	2	2	1/1MSIS	4/4GPI+2/2Dst	4/4SDT	17	9	31/8ARO,1/1CHT,2/1EIS,4/1JRO,27/8MLH,
	111	13	5	8	13	0				+2/2IMF+1/1AE		104		52/8SON, 2/1STS, 1/1MFP,1/1SFP
	141	28	17	11	22	6				+2/2HP		121		
TOTAL:	271	125	101	24	81	44			3/3Efld	19/12GPI	16/10TGCM	175		75/38ARO,6/6CHT,23/15EIS,17/13JRO,
	144								4/4MSIS	4/4Dst+3/2AE	7/3AMIE	124		58/31MLH,85/32SON,17/13STS=281/70IS;
										9/6IMF+8/6HP	10/8SDT			6/5PKR; 1/1ATM; 3/3MFP,1/1CFP,3/3SFP
	415	22 new, 6 old					12	21	7/7Tot	43/21Tot	33/21Tot	299	15	=7/6FPI; 2/2UIL; 1/1MIO; 1/1LTCS(book)

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96 - continued

deliv year	#req	#p	n	s	U	F	only info docs	only s/w docs	s/w models	indices	model output	DB lg #req data	#instr	instruments (#req/#users)
1993	35	21	16	5	8	13	3	3	0	2/2GPI	8/8SDT	21	10	16/12ARO,2/2EIS,4/4JRO,16/5MLH,18/7SON,
	65	16	6	10	15	1				1/1Dst		60		3/3STS, 4/2GBF, 4/1PKR, 3/2MFP, 11/1UIL
	100	36	22	14	23	13				2/2IMF		81		
TOTAL:	306	144	110	34	89	55			3/3Efld	21/13GPI	16/10TGCM	196		91/47ARO,6/6CHT,25/17EIS,21/16JRO,
	209								4/4MSIS	5/4Dst+3/2AE	7/3AMIE	184		74/34MLH,103/36SON,20/16STS=340/81IS;
										11/6IMF+8/6HP	18/15SDT			4/2GBF; 10/6PKR; 1/1ATM;
														6/5MFP,1/1CFP,3/3SFP=10/8FPI;
	515	21 new, 15 old					15	24	7/7Tot	48/22Tot	41/28Tot	380	16	13/3UIL; 1/1MIO; 1/1LTCS(book)
1994	22	12	10	2	8	4	17	6	1/1MSIS	4/3GPI	2/2TGCM	10	17	14/6ARO,4/3EIS,7/5JRO,13/4MLH,9/7SON,
	83	22	11	11	19	3			2/2HWM		3/3SDT	58		2/2STS, 1/1HHF,1/1GBF, 7/2PKR, 1/1SBF,
	105	32	19	13	25	7			1/1IRI			68		2/1ATM,1/1CIA,1/1PLA,
									1/1IGRF					1/1HFP,1/1AFP,2/2MFP,1/1PFP
TOTAL:	328	167	122	45	106	61			3/3Efld	25/15GPI	18/12TGCM	206		105/52ARO,6/6CHT,29/19EIS,28/20JRO,
	292								5/5MSIS	5/4Dst	7/3AMIE	242		87/36MLH,112/39SON,22/17STS=389/92IS;
									2/2HWM	3/2AE	21/18SDT			1/1HHF,5/3GBF=6/4HF; 17/8PKR;
									1/1IRI	11/6IMF				1/1SBF,3/2ATM,1/1CIA,1/1PLA=6/4MLT;
									1/1IGRF	8/6HP				1/1HFP,1/1AFP,1/1PFP,8/7MFP,1/1CFP,
														3/3SFP=15/11FPI; 13/3UIL; 1/1MIO;
	620	21 new, 11 old					32	30	12/10Tot	52/24Tot	46/33Tot	448	23	1/1LTCS(book)
1995	8	6	5	1	4	2	18	13	1/1IGRF	11/6GPI(1F107)	5/2TGCM	2	22	15/5ARO,1/1CHT,6/2EIS,21/7JRO,38/8MLH,
	244	24	12	12	19	5			2/1IRI	9/4Dst	4/2SDT	161		38/7SON, 1/1STS, 3/2HHF,1/1KHF,1/1SHF,
	252	29	16	13	22	7			2/2HWM	4/1AE	7/4GSWM	163		4/2GBF, 15/3PKR, 1/1MAF,1/1ATM,2/2DUM,
									3/3MSIS	9/6IMF				3/3CIA, 1/1AQF,2/2MFP,1/1WFP,5/3SFP,
									1/1Portny					2/1TFP, 1/1UIL
TOTAL:	336	187	131	56	122	65			3/3Efld	36/19GPI	23/14TGCM	208		120/56ARO,7/7CHT,35/21EIS,49/27JRO,
	536								2/2IGRF	14/6Dst	7/3AMIE	403		125/42MLH,150/44SON,23/18STS=509/100IS;
									3/2IRI	7/3AE	25/20SDT			4/2HHF,1/1KHF,1/1SHF,9/4GBF=15/4HF;
									4/4HWM	20/10IMF	7/4GSWM			32/10PKR; 1/1SBF,1/1MAF,4/3ATM,2/2DUM,
									8/8MSIS	8/6HP				4/4CIA,1/1PLA=13/8MLT;
									1/1Portny					1/1HFP,1/1AQF,1/1AFP,1/1PFP,10/9MFP,
														1/1WFP,1/1CFP,8/6SFP,2/1TFP=26/16FPI;
	872	20 new, 9 old					50	43	21/15Tot	85/30Tot	62/38Tot	611	30	14/4UIL; 1/1MIO; 1/1LTCS(book)
1996	9	7	5	2	5	2	30	22	1/1Apex,1/1Efld	2/1HP	1/1GSWM	1	14	7/5ARO,2/2EIS,2/2MLH,21/3SON,2/1STS,
	109	10	5	5	8	2			2/2IGRF,1/1IRI	2/1GPI	2/2AMIE	44		1/1HHF,1/1KHF,1/1SHF,1/1GBF,1/1FHF,
	117	15	10	5	11	4			1/1IZMIRAN,	2/1Dst		45		1/1WHF,1/1EHF, 1/1ATM, 1/1MFP,3/1SFP
														1/1HMR,1/1HP87
		5 new, 10 old							2/2HWM,2/2MSIS					2 new HF radars

Column headings: DB top, login middle, Total bottom (#req); only info docs; only s/w docs; DB lg #req data.

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96 - continued

Delivery Table Including Names of Users

instr	deliv year	#req DB	#req lg	#p	n	s	U	F	People
ARO	1985	1		1	1	0	0	1	1Ramanamurty1
ARO	1986	10		9	9	0	6	3	2Rasmussen2, 3Winser3, 4Bilitza4, 5Wickwar5, 1Ramanamurty1, 6Sica6, 7Holt7, 8Keohan8, 9Cogger9
EIS	1986	4		2	2	0	2	0	1Wickwar5, 2Hagan10
JRO	1986	5		5	4	1	4	1	1Winser3, 2Bilitza4, 3Sica6, 4Holt7, 5Pingree11
MLH	1986	8		6	6	0	4	2	1Winser3, 2Wickwar5, 3Sica6, 4Gerard12, 5Conkright13, 6Crowley14
SON	1986	5		5	5	0	4	1	1Foster15, 2Heelis16, 3Winser3, 4Sica6, 5Holt7
STS	1986	4		2	2	0	2	0	1Wickwar5, 2Sica6
TGCM	1986	2		1	1	0	1	0	1Wickwar5
GPI (Kp)	1986	1		1	1	0	1	0	1Wickwar5
unfilled	1986	2		2	2	0	2	0	1Rasmussen17 (E reg Ne not T corrected), 2Wickwar5 (no '83 STS)
sw+docs	1986	7		6	6	0	2	4	1Porteneuve18, 2Hunsucker19, 3Fougere20, 4Wilkinson21, 5Oliver22, 6Duboin23
info+docs	1986	3		3	3	0	1	2	1Hapgood24, 2Danielle25, 3McCrea26
NOTE: User 2 and 17 are the same									
ARO	1987	8		7	7	0	3	4	10Giraldez27, 11Tepley28, 12Stening29, 13Hagan10, 14Mahajan30, 1Ramanamurty1, 15Foster15
EIS	1987	4	2	4	4	0	4	0	3Crowley14, 4de la Beaujardiere31, 6Foster15 // 5Emery32
JRO	1987	2		2	2	0	1	1	6Ramanamurty1, 7Foster15
MLH	1987	3	1	4	4	0	3	1	7Giraldez27, 2Wickwar5, 8de la Beaujardiere31 // 9Emery32
SON	1987	1	2	3	3	0	3	0	6Crowley14, 1Foster15 // 7Emery32
STS	1987	3		2	2	0	1	1	3Hedin33, 4Ramanamurty1
AMIE	1987	1		1	1	0	1	0	1de la Beaujardiere31
TGCM	1987	4		3	2	1	3	0	1Wickwar5, 2Wolf34, 3Siskind35
Dst	1987		1	1	1	0	1	0	1Emery32
GPI	1987	2	1	2	2	0	0	2	2Duboin23, 3Stening29 // 4Emery32
E-field	1987	2		2	2	0	1	1	1Fuller-Rowell36, 2Rasmussen17
sw+docs	1987	3		3	3	0	3	0	7Emery32, 8Smith37, 9Melendez38
info+docs	1987	1		1	0	1	1	0	4Siskind35

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96 - continued
Delivery Table Including Names of Users

instr	deliv year	#req DB	lg	#p	n	s	U	F	People
ARO	1988	3		3	3	0	3	0	16Bernhardt39, 17Buonsanto40, 18Hedin33
CHT	1988	1		1	0	1	0	1	1Lilensten41
EIS	1988	3		3	3	0	1	2	7Shen42, 8Danichev43, 9Burnside44
JRO	1988	1		1	1	0	0	1	8Shen42
MLH	1988	7		7	7	0	4	3	10Kozyra43, 11Burnside44, 12Collis45, 13Niciejewski46, 14Shen42, 15Hedin33, 16Kazimirovsky47
SON	1988	10		8	7	1	4	4	8Collis45, 9Buonsanto40, 1Foster15, 10Lester48, 11Shen42, 12Hedin33,13Burnside44,14Lilensten41
STS	1988	5		5	5	0	2	3	5Kozyra43, 6Shen42, 7Kazimirovsky47, 8Danichev43, 9Burnside44
TGCM	1988	3		3	2	1	3	0	4Hedin33, 3Siskind35, 5Burnside44
GPI	1988	2		2	2	0	2	0	5Sica6, 6de la Beaujardiere31
AE	1988	1		1	1	0	1	0	1de la Beaujardiere31
Dst	1988	1		1	1	0	1	0	2de la Beaujardiere31
IMF	1988	1		1	1	0	1	0	1de la Beaujardiere31
HP	1988	1		1	1	0	1	0	1de la Beaujardiere31
MSIS	1988	1		1	1	0	0	1	1La Hoz49
sw+docs	1988	3		3	2	1	2	1	10Tobiska50, 11Hall51, 12Sica6
info+docs	1988	1		1	1	0	1	0	5Wickwar5

NOTE: # 43 was assigned twice!

instr	deliv year	#req DB	lg	#p	n	s	U	F	People
ARO	1989	9		7	6	1	6	1	4Bilitza4, 19Walterscheid52, 5Wickwar5, 20Hunsucker19, 21Gonzalez53, 22Shen42, 23Richards53
CHT	1989	2		2	2	0	2	0	2Fesen54, 3Hedin33
EIS	1989	1	1	2	2	0	2	0	1Wickwar5 // 5Emery32
JRO	1989	3		2	2	0	1	1	9Hunsucker19, 10Pandey55
MLH	1989	3	2	4	4	0	2	2	2Wickwar5, 17Shen42, 18Pandey55 // 9Emery32
SON	1989	7	3	7	6	1	4	3	15Wickwar5, 16Christie56, 17Kirkwood57, 18Virdi58, 19Hunsucker19, 20Shen42 // 7Emery32
STS	1989	2		2	2	0	1	1	10Walterscheid52, 11Pandey55
PKR	1989	2		2	2	0	1	1	1Riddle59, 2Pandey55
CFP	1989	1		1	1	0	1	0	1Hedin33
SFP	1989	1		1	1	0	1	0	1Wickwar5
LTCS book	1989	1		1	1	0	1	0	1Fesen54
AMIE	1989	6		3	3	0	1	2	2Codrescu60. 3Lester48, 1de la Beaujardiere31
SDT	1989	2		1	0	1	0	1	1Gille61
TGCM	1989	3		2	2	0	2	0	6Forbes62, 7Hagan10
AE	1989	1		1	1	0	1	0	1de la Beaujardiere31
GPI	1989	2	3	3	3	0	2	1	5Sica6, 7De Paula63 // 4Emery32
HP	1989	1	3	2	2	0	2	0	2Denig64 // 3Emery32
IMF	1989		3	1	1	0	1	0	2Emery32
sw+docs	1989	4		4	4	0	4	0	13Liang65, 14Wickwar5, 15Bilitza4, 2Hunsucker19
info+docs	1989	3		3	3	0	2	1	6Winick66, 7Murphy67, 8Louro68

NOTE: # 53 was assigned twice!

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96 - continued

Delivery Table Including Names of Users

instr	deliv year	#req DB	lg	#p	n	s	U	F	People
ARO	1990	5		5	4	1	3	2	12Stening29, 24Senior69, 25M Johnson70, 26Tobiska50, 27Roble71
CHT	1990	1		1	1	0	1	0	4Clark-Stanley72
EIS	1990	1		1	1	0	1	0	10Buonsanto40
MLH	1990	2	1	3	2	1	2	1	19Senior69, 20Citrone73 // 9Emery32
SON	1990	3	1	4	2	2	4	0	21Rice74, 22Ruohoniemi75, 23Citrone73 // 7Emery32
PKR	1990	2		1	0	1	1	0	3B Kelley76
MFP	1990	1		1	0	1	1	0	1Citrone73
SFP	1990	1		1	0	1	1	0	2Citrone73
UIL	1990	1		1	0	1	1	0	1Kane77
MIO	1990	1		1	0	1	1	0	1Citrone73
SDT	1990	2		1	0	1	1	0	2Isler78
TGCM	1990	3		2	2	0	2	0	8Szuszczewicz79, 9Buonsanto40
GPI	1990	1	1	1	1	0	0	1	7La Feuille80 // 4Emery32
IMF	1990	1	1	1	0	1	1	0	3M Johnson70 // 2Emery32
MSIS	1990	2		2	2	0	0	2	2La Feuille80, 3Rochon81
sw+docs	1990	2		2	2	0	2	0	13Richards53,14Gavrilov54
ARO	1991	6	2	7	6	1	5	2	17Buonsanto40, 28Azpiazu82, 29Mazaudier83, 30Hickey84, 31Erickson85, 32Ganguly86//33Cariglia87
CHT	1991		1	1	1	0	1	0	5Emery32
EIS	1991	4	1	5	4	1	4	1	11Azpiazu82, 12Hunsucker19, 13Ganguly86, 14Bhattacharya88 // 5Emery32
JRO	1991	1	1	2	1	1	2	0	11Ganguly86 // 12Creamer89
MLH	1991	3	1	4	4	0	3	1	21Azpiazu82, 22Richards53, 23Ganguly86 // 9Emery32
SON	1991	1		1	1	0	1	0	24Ganguly86
STS	1991	1		1	1	0	1	0	12Richards53
PKR	1991	2		2	2	0	1	1	4Canziani90, 5Geller91
ATM	1991	1		1	1	0	0	1	1Canziani90
MFP	1991		1	1	1	0	1	0	2Sipler92
UIL	1991	1		1	1	0	1	0	2Hickey84
SDT	1991	2		2	2	0	1	1	3Maklouf93, 4Reddi94
TGCM	1991	1		1	1	0	1	0	10Earle95
GPI	1991	2		2	1	1	2	0	8Leger96, 9Cornuelle97(F107,SS#)
IMF	1991	1		1	0	1	1	0	4Pi97
HP	1991	1		1	1	0	0	1	4Papitashvili98
E-field	1991	1		1	1	0	0	1	3Zhang99
info+docs	1991	2		2	2	0	0	2	9Abdu100,10Walker101

NOTE: # 97 was assigned twice!

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96 - continued

Delivery Table Including Names of Users

instr	deliv year	#req DB	lg	#p	n	s	U	F	People
ARO	1992	3	28	8	5	3	8	0	34Anderson102, 35Alexander103 // 36K Miller104, 37Haroldsen105, 33Cariglia87, 35Alexander103, 38Hatfield106, 17Buonsanto40, 23Richards53
CHT	1992	1		1	0	1	1	0	6Deng107
EIS	1992	2		1	1	0	1	0	15Anderson102
JRO	1992		4	1	0	1	1	0	13Haroldsen105
MLH	1992	4	23	8	3	5	7	1	24Breen108, 25Anderson102, 26Alexander103 // 27Della-Rose109, 28Haroldsen105, 29Garner110, 26Alexander103, 30K Miller104, 31Dowdy111
SON	1992	4	48	8	2	6	8	0	25Anderson102, 26Mitchell112 // 27Della-Rose109, 28Benson113, 29Engelmann114, 30Garner110, 31Hatfield106, 32Lu115
STS	1992	2		1	1	0	1	0	13Anderson102
MFP	1992		1	1	0	1	1	0	3Dowdy111
SFP	1992	1		1	1	0	0	1	3Rodger116
SDT	1992	4		4	3	1	3	1	5Khattatov117,6Fleming118,7Frankel19,8Ward120
AE	1992		1	1	0	1	1	0	2Della-Rose109
Dst	1992	1	1	2	2	0	1	1	3Shen121 // 4Lu115
GPI	1992	2	2	4	3	1	3	1	8Leger96, 10Zhang99(Kp) // 11Alexander103, 12Lu115
HP	1992		2	2	0	2	2	0	5Della-Rose109, 6Haroldsen105
IMF	1992	1	1	2	2	0	1	1	5Shen121 // 6Lu115
MSIS	1992	1		1	1	0	0	1	4Shen121
sw+docs	1992	2		2	1	1	2	0	15Ryan122,16Rasmussen17
info+docs	1992	2		2	2	0	0	2	11Mosqueda123,12Zhang99
ARO	1993	5	11	12	6	6	9	3	39Mishin124, 40Foerster125, 41Davies126, 42Swartz127, 11Tepley28 // 43Marshall128, 44Drob129, 23Richards53, 37Haroldsen105, 45Gilgut130(?), 46Yang131, 47Reddy132
EIS	1993	2		2	2	0	0	2	16Mishin124, 17Foerster125
JRO	1993	1	3	4	0	4	3	1	14Davies125 // 15Yang131, 12Creamer89, 16Gilgut130(?)
MLH	1993	2	14	5	4	1	3	2	32Mishin124, 33Foerster125 // 22Richards53, 34Zhu133, 9Emery32
SON	1993	5	13	7	4	3	5	2	33Mishin124, 34Foerster125, 35Blanchard134, 22Ruohoniemi75 // 36Yang131, 29Engelmann114, 7Emery32
STS	1993	2	1	3	3	0	1	2	14Mishin124, 15Foerster125 // 16Fesen54
GBF	1993	4		2	2	0	2	0	1Leger96, 2de la Beaujardiere31
PKR	1993		4	1	0	1	1	0	6Drob129
MFP	1993		3	2	0	2	1	1	4Davies126, 5Yang131
UIL	1993		11	1	0	1	1	0	3Gibson135
SDT	1993	8		8	5	3	1	7	4Reddi94, 9Turnbull136, 10Canziani90, 11Tureck137, 12Tutumi138, 13Vincent139, 14Thayaparan140, 15Yamamoto141
Dst	1993		1	1	1	0	1	0	1Emery32
GPI	1993		2	2	2	0	2	0	13K Miller104, 4Emery32
IMF	1993		2	2	2	0	2	0	6Lu115, 2Emery32
sw+docs	1993	3		3	2	1	2	1	17Blanchard134, 18Lathuillere142, 19Swartz127
info+docs	1993	3		3	3	0	1	2	13Rasmussen17, 14Mencaraglia143, 15Academia Sinica144

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96 - continued
Delivery Table Including Names of Users

instr	deliv year	#req DB	#req lg	#p	n	s	U	F	People
ARO	1994	2	12	6	4	2	5	1	48N Miller145, 49Pandey55 // 50Machuga146, 47Reddy132, 51Pesnell147, 52Pasupuleti148, 48N Miller145
EIS	1994		4	3	1	2	3	0	18Golesorkhi149, 19Pasupuleti148, 5Emery32
JRO	1994	1	6	5	1	4	3	2	10Pandey55 // 17Mirick150, 18Sugiyama151, 19Pasupuleti152, 20Kecic153
MLH	1994	2	11	4	2	2	3	1	22Richards53(slides), 18Pandey55 // 35Engelmann114, 22Richards53, 36Pasupuleti148
SON	1994	3	6	6	3	3	5	1	35Blanchard134, 37Solomon154 // 29Engelmann114, 32Lu115, 38Pasupuleti148, 39Stauning155
STS	1994	2		2	2	0	1	1	17N Miller145, 11Pandey53
HHF	1994		1	1	1	0	1	0	1Lu115
GBF	1994		1	1	1	0	1	0	3Emery32
PKR	1994		7	2	0	2	1	1	7Sugiyama151,8Williams156
AFP	1994		1	1	1	0	1	0	1Pesnell147
HFP	1994		1	1	1	0	1	0	1Hedin33
MFP	1994		2	2	0	2	2	0	6Coakley157, 7Williams156
PFP	1994		1	1	0	1	1	0	1Williams156
ATM	1994		2	1	0	1	1	0	2Drob129
CIA	1994		1	1	0	1	1	0	1Williams156
PLA	1994		1	1	0	1	1	0	1Williams156
SBF	1994		1	1	0	1	1	0	1Pasupuleti148
SDT	1994	2	1	3	3	0	2	1	16Fauliot158, 17Huang159 // 18K Miller104
TGCM	1994	1	1	2	2	0	0	2	11Schlegel160 // 12Crickmore161
GPI	1994	2	2	3	2	1	3	0	14Abel162(F107), 15Dunn163(F107,Ap) // 12Lu115
HWM93	1994	2		2	1	1	2	0	1Abel162, 2Dunn163
IGRF	1994		1	1	0	1	1	0	1Pasupuleti148
IRI90	1994	1		1	0	1	1	0	1Abel162
MSIS90	1994	1		1	0	1	1	0	5Abel162
sw+docs	1994	3	3	5	3	2	4	1	20Leger96, 21Pinnock164 // 22Hedin33, 23Mirick150, 24Pasupuleti148
info+docs	1994	0	17	10	5	5	10	0	16Hedin33, 17Mirick150, 18Machuga146, 19Pesnell147, 20Huaman165, 21Lu115, 22Pasupuleti148, 23Williams156, 24K Miller104, 25N Miller145

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96 - continued

Delivery Table Including Names of Users

instr	deliv year	#req DB	#req lg	#p	n	s	U	F	People
ARO	1995	2	17	5	3	2	4	1	49Pandey55//53Straus166, 54O Kelley167, 55Limqueco168, 56McNeil169
CHT	1995		1	1	0	1	1	0	7O Kelley167
EIS	1995		6	2	1	1	1	1	20Rinnert170, Caton171
JRO	1995		21	7	3	4	5	2	21Martinez172, 22Straus166, 23O Kelley167, 24Rinnert170, 25Li173, 26McNeil169, 27Mueller-Wodarg174
MLH	1995		44	9	5	4	8	1	37Braze175, 22Richards53, 38Straus166, 39O Kelley167, 35Engelmann114, 40Rinnert170, 41L Zhou176, 9Emery32, 42Lu115
SON	1995		39	7	3	4	5	2	40O Kelley167, 41Maurits177, 42Stening29, 29Engelmann114, 43Rinnert170, 44Li173, 32Lu115
STS	1995		1	1	1	0	1	0	18Straus166
HHF	1995		3	2	2	0	2	0	1Lu115,2Emery32
KHF	1995		1	1	1	0	1	0	1Emery32
SHF	1995		1	1	1	0	1	0	1Emery32
GBF	1995		4	2	2	0	2	0	3Emery32, 4Lu115
PKR	1995		15	3	1	2	2	1	8Nottberg178, 7Sugiyama151, 9Niska179
ATM	1995		1	1	0	1	1	0	3Li173
MAF	1995		1	1	0	1	1	0	2Martinez172
CIA	1995		3	3	1	2	2	1	2Martinez172, 3Rinnert170, 4Li173
DUM	1995		2	2	0	2	1	1	1Martinez172, 2Mueller-Wodarg174
MFP	1995		2	2	2	0	1	1	8Emery32, 9Rinnert170
WFP	1995		1	1	1	0	1	0	1Emery32
SFP	1995		5	3	2	1	2	1	4Emery32, 5Rinnert170, 6Li173
TFP	1995		2	1	0	1	0	1	1Mueller-Wodarg174
UIL	1995		1	1	1	0	0	1	4Rinnert170
SDT	1995		4	2	0	2	1	1	19Martinez172, 20Mueller-Wodarg174
GSWM	1995	3	4	4	3	1	2	2	1Dao178, 2K Miller104, 3Manson181 // 4Mueller-Wodarg174
TGCM	1995		5	2	1	1	0	2	13Burkey182, 14Mueller-Wodarg174
AE	1995		4	1	1	0	0	1	3Rinnert170
Dst	1995		9	4	3	1	3	1	5Martinez172, 6Rinnert170, 1Emery32, 4Lu115
GPI	1995	1	10	6	3	3	5	1	16Chen183(F107) // 17Martinez172, 18O Kelley167, 19Rinnert170, 4Emery32, 12Lu115
IMF	1995		9	6	3	3	5	1	7Martinez172, 8O Kelley167, 9Engelmann114, 10Rinnert170, 2Emery32, 6Lu115
HWM93	1995		2	2	1	1	2	0	3Richmond184, 4Maurits177
IGRF	1995		1	1	0	1	1	0	2Maurits177
IRI90	1995		2	1	0	1	1	0	2Maurits177
MSIS90	1995		3	3	1	2	2	1	6Stauning155, 7Caton171, 8Maurits177
Portnyagin	1995	1		1	1	0	1	0	1K Miller104
sw+docs	1995	1	12	4	2	2	3	1	20Leger96 // 25Nottberg178, 26Mueller-Wodarg174, 27Li173
info+docs	1995	0	18	6	3	3	4	2	26Straus166, 27Mueller-Wodarg174, 28Stening29, 29Niska179, 30Turek184, 31Li173

Table 4 - Data Deliveries of the CEDAR Data Base through 5/31/96 - continued
Delivery Table Including Names of Users

instr	deliv year	#req DB	#req lg	#p	n	s	U	F	People
ARO	1996	1	18	5	4	1	3	2	49Pandey55 // 57Breen108, 54O Kelley167, 58Picone185, 59Marsden186
EIS	1996		2	2	1	1	2	0	21O Kelley167, 5Emery32
MLH	1996		2	2	0	2	2	0	37Braze175, 39O Kelley167
SON	1996		21	3	1	2	3	0	44Li173, 41Maurits177, 7Emery32
STS	1996		2	1	1	0	0	1	19Breen108
HHF	1996		1	1	1	0	1	0	1Lu115
KHF	1996		1	1	1	0	1	0	2Lu115
SHF	1996		1	1	1	0	1	0	2Lu115
GBF	1996		1	1	1	0	1	0	4Lu115
FHF	1996		1	1	1	0	1	0	1Lu115
WHF	1996		1	1	1	0	1	0	1Lu115
ATM	1996		1	1	0	1	1	0	3Li173
MFP	1996		1	1	1	0	1	0	8Emery32
SFP	1996		3	1	0	1	1	0	6Li173
Dst	1996		2	1	1	0	1	0	1Emery32
GPI	1996		2	1	1	0	1	0	4Emery32
HP	1996		2	1	1	0	1	0	3Emery32
AMIE	1996	2		2	1	1	2	0	4Maurits177, 5Crain187
GSWM	1996		1	1	0	1	0	1	4Mueller-Wodarg174
Apex	1996		1	1	0	1	1	0	1Li173
E-field	1996		1	1	0	1	1	0	4Li173
HMR89	1996		1	1	0	1	1	0	1Li173
HPI87	1996		1	1	0	1	1	0	1Li173
HWM93	1996	1	1	2	0	2	1	1	3Kobea188 // 4Li173
IGRF	1996	1	1	2	0	2	1	1	5Kobea188 // 6Li173
IRI90	1996		1	1	0	1	1	0	3Li173
MSIS90	1996	1	1	2	0	2	1	1	9Kobea188 // 10Li173
sw+docs	1996	2	20	2	1	1	2	0	28Rasmussen17, 27Li173 // 27Li173, 29Picone185
info+docs	1996	1	29	4	3	1	3	1	32Taylor189 (sfc,500,30,10mb plots AO) // 31Li173, 33Breen108, 34Picone185

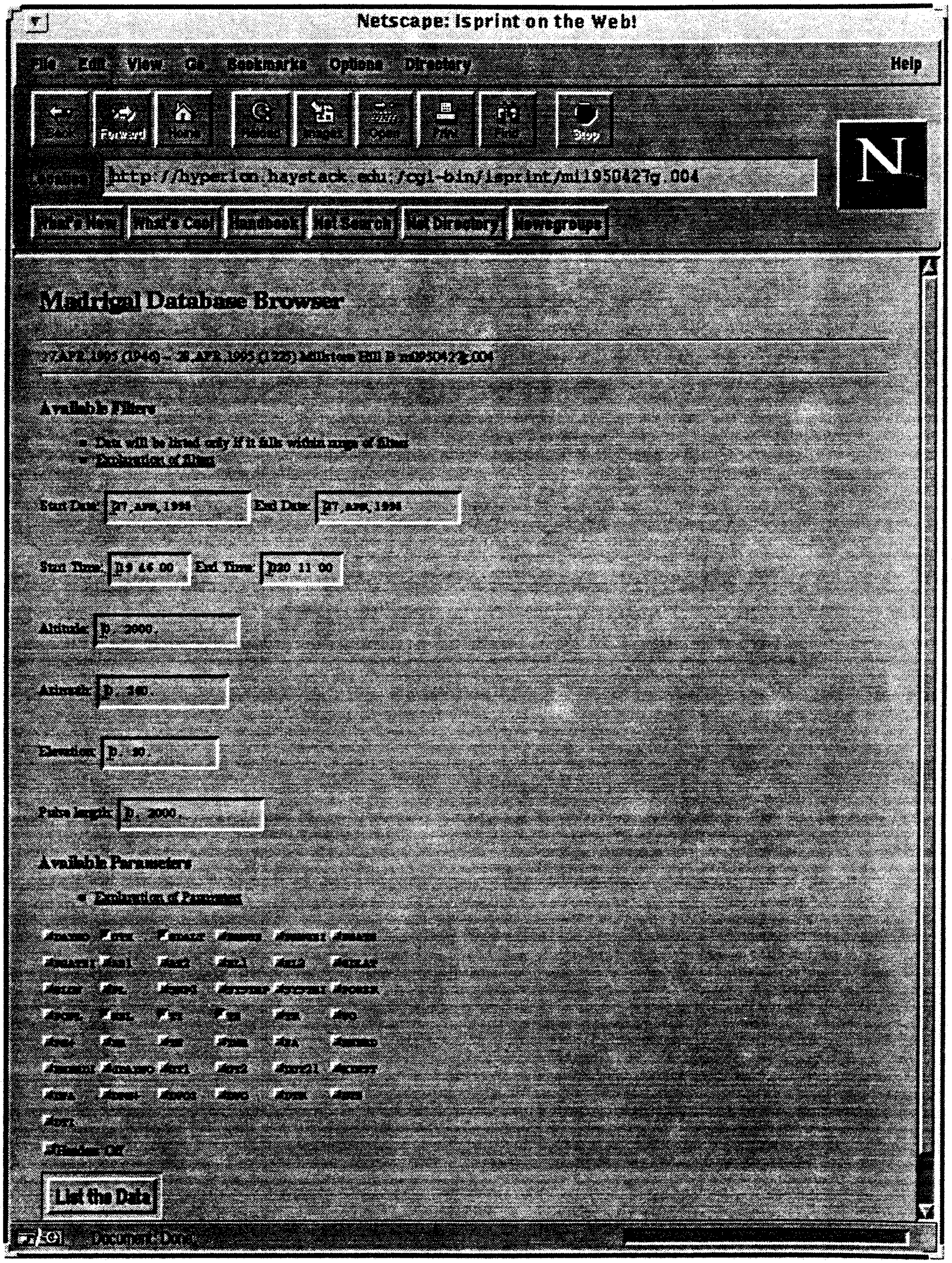

Figure 1. WWW Form Access to the CEDAR Database