CDDIS 2002 Global Data Center Report

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1 Introduction

The Crustal Dynamics Data Information System (CDDIS) has supported the International GPS Service (IGS) as a global data center since 1992. The CDDIS activities within the IGS during 2002 are summarized below; this report also includes any changes or enhancements made to the CDDIS during the past year. General CDDIS background and system information can be found in the CDDIS data center summary included in the *IGS 1994 Annual Report* (Noll, 1995) as well as the subsequent updates (Noll, 1996, Noll, 1997, Noll, 1998, Noll, 1999, and Noll, 2001).

2 System Description

The CDDIS archive of IGS data and products are accessible worldwide through anonymous ftp. The CDDIS is located at NASA's Goddard Space Flight Center (GSFC) and is accessible to users 24 hours per day, seven days per week.

2.1 Computer Architecture

The CDDIS is operational on a dedicated UNIX server. All GPS data and product files are archived in a single filesystem, accessible through anonymous ftp, and are stored in UNIX compressed format. At present, nearly 400 Gbytes of on-line disk space is devoted to the storage of daily GPS tracking data and products. GPS data since 1995 and IGS products since 1992 are available on-line.

3 Archive Content

As a global data center for the IGS, the CDDIS is responsible for archiving and providing access to both GPS data from the global IGS network as well as the products derived from the analyses of these data.

3.1 GPS Tracking Data

The GPS user community has access to the on-line and near-line archive of GPS data available through the global archives of the IGS. Operational and regional data centers provide the interface to the network of GPS receivers for the IGS global data centers. Nearly forty of these IGS data centers make data available to the CDDIS from selected receivers on a daily (and in some cases hourly and/or sub-hourly) basis. The CDDIS also accesses the archives of the other two IGS global data centers, Scripps Institution of Oceanography (SIO) in La Jolla California and the Institut Géographique National (IGN) in Paris France, to retrieve (or receive) data holdings

not routinely transmitted to the CDDIS by an operational or regional data center. Over 87K station days from 313 distinct GPS receivers were archived at the CDDIS during the past year; a complete list of these sites can be found at URL *ftp://cddisa.gsfc.nasa.gov/pub/reports/gpsdata/cddis_summary.2002*. Table 1 below summarizes the types of GPS data archived at the CDDIS.

3.1.1 Daily GPS Data Files

Once the daily RINEX data files arrive at the CDDIS, these data are quality-checked, summarized, and archived to public disk areas in daily subdirectories; the summary and inventory information are also loaded into an on-line data base. These metadata are utilized to generate various reports on data holdings and data latency.

The CDDIS daily GPS tracking archive consists of observation (in both RINEX and "compact" RINEX format), navigation, and meteorological data, all in compressed (UNIX compression) RINEX format. Furthermore, summaries of the observation files are generated by the UNAVCO quality-checking program TEQC (Estey 1999) and are used for data inventory and quality reporting purposes. During 2002, the CDDIS archived data on a daily basis from an average of 280 stations. One reason for the large increase in stations is that as of June 11, 2002, GPS+GLONASS receiver data were archived in what was previously a GPS-only directory structure in the CDDIS archive. This new archive structure for the IGS regional and global data centers was mandated by the Central Bureau under recommendation from the IGLOS-PP. In 2002, the CDDIS GPS archive of daily GPS data files totaled over 31 Gbytes in volume (compact RINEX format only); this figure represents data from over 87K observation days. Of the 280 or more sites archived each day at the CDDIS, not all are of "global" interest; some, such as those in Southern California, are regionally oriented. The CDDIS receives data from these sites as part of its NASA archiving responsibilities.

At this time, the CDDIS on-line archive of daily GPS data contains data from January 1995 through the present. Prior to mid-2002, these data are available in compact RINEX only; later data are archived in both compact RINEX and uncompacted RINEX formats. As the disks supporting this archive fill up, older, uncompact RINEX observation data are deleted. However, in recent weeks, the GPS data are typically only available in compact RINEX format due to severe disk space constraints on host *cddisa.gsfc.nasa.gov*.

The majority of the data delivered to and archived in the CDDIS during 2002 was available to the user community within six hours after the observation day. Nearly sixty percent of the data from the global sites delivered to the CDDIS were available within three hours of the end of the observation day.

3.1.2 Hourly GPS Data Files

Since 2000, many IGS operational/regional data centers transmit hourly data files to the global data centers. Within minutes of receipt, the files are archived to separate subdirectories (*/gps/nrtdata*) by day and hour on the CDDIS. These data are retained on-line for three days. After that time, the hourly data files are deleted; the daily file, transmitted through normal channels with a typical delay of one to two hours, will have been received and archived already and thus the hourly data are of little use. Furthermore, to ensure the most rapid delivery of these data to the user community, no validation or checks on data quality are performed. In 2002, approximately sixty percent of these hourly data files were available to the user community

within twenty minutes of the end of the hour. Over 160 sites (both GPS and GLONASS+GPS) transmitted hourly data files to the global data centers in 2002.

The site-specific ephemeris data files for each hour are decompressed and then appended to a single file that contains the orbit information for all GPS satellites for the day up through that hour. This merged ephemeris data file, named *hourddd0.yyn.Z* (where *ddd* is the day of year and *yy* is the year), is then copied to the daily subdirectory in the hourly filesystem (*/gps/nrtdata/yyddd*). At the end of the day, this file is copied to the corresponding subdirectory under the daily filesystem (*/gps/gpsdata/yyddd/yyn*) and renamed to *brdcdd0yyn.Z*. Users can thus download this single daily file instead of all broadcast ephemeris files from the individual stations.

3.1.3 High-Rate GPS Data Files

In May of 2001, the CDDIS began the archive of high-rate (typically one-second) GPS data in support of the IGS Pilot Project for Low Earth Orbiting (LEO) Missions. The data are made available to the CDDIS from four principal sources, JPL, GFZ, NRCan, and ESA as well as other operations centers (e.g., ASI, GOPE, UNB, etc.). The RINEX data are archived in files containing fifteen minutes of data using the filenaming convention *ssssdddhmi.yyt.Z* where *ssss* is the monument name, *ddd* is the day of year, *h* is the hour (a-z), *mi* is the minute (00, 15, 30, 45), *yy* is the year, and *t* is the file type (d, m, n). On average during 2002, the CDDIS archived high-rate data from 52 sites totaling approximately 250 Mbytes per day, and a total of 90 Gbytes for the year.

3.2 Meteorological Data

The CDDIS currently receives meteorological data from over fifty sites. The meteorological data provided are dry temperature, relative humidity, and barometric pressure at thirty minute sampling intervals. These data are stored on CDDIS with the daily GPS observation and navigation data files in parallel subdirectories.

3.3 LEO GPS Data

The CDDIS proposed to serve as a data center supporting the IGS Pilot Project for Low Earth Orbiting (LEO) Missions in 2000. In 2002, the CDDIS established an archive of space-borne GPS receiver data from selected missions (e.g., SAC-C and CHAMP); future missions supported will include Jason-1, GRACE, and ICESat.

3.4 IGS Products

The seven IGS data analysis centers (ACs) retrieve the GPS tracking data on a daily basis from the global data centers to produce daily orbit and clock products as well as weekly Earth rotation parameters (ERPs) and station position solutions; the seven IGS associate analysis centers (AACs) also retrieve IGS data and products to produce station position solutions. The CDDIS archives the products generated by both types of IGS analysis centers. These files are delivered to the CDDIS by the IGS analysis centers to individual user accounts, copied to the central disk archive, and made available in compressed format on the CDDIS by automated routines that execute several times per day. The IGS Analysis Coordinator then accesses the CDDIS (or one

of the other global analysis centers) on a regular basis to retrieve these products and derive the combined IGS orbits, clock corrections, and Earth rotation parameters as well as to generate reports on data quality and statistics on product comparisons. The CDDIS currently provides on-line access through anonymous ftp or the web to all IGS products generated since the start of the IGS Test Campaign in June 1992.

Regional Network Associate Analysis Centers (RNAACs) routinely generate station position solutions for regional networks in Software INdependent EXchange (SINEX) format. The three Global Network AACs (GNAACs) perform a comparison of these files and submit the resulting SINEX files to the CDDIS. The GNAACs also access the SINEX files from the IGS ACs and RNAACs and produced comparison and combined, polyhedron station position solutions. The CDDIS provides "short-SINEX" files, designated with an *.ssc* extension, for all AC and AAC SINEX files. These files contain the site information from the SINEX file but no matrices. All RNAAC solution files are also stored in the weekly IGS product subdirectories. The official IGS combined weekly SINEX solutions and cumulative combined SINEX solutions generated by the IGS Reference Frame Coordinator are also available in the weekly IGS product subdirectories.

Both the rapid (designated IGR) and the predicted orbit, clock and ERP (designated IGP) combined products generated by the IGS Analysis Coordinator continued to be available through 2002. Furthermore, a new product, the IGS ultra-rapid combination (designated IGU) were made available twice daily. The IGS global data centers, including the CDDIS, download the rapid, predicted, and ultra-rapid products from the Analysis Coordinator and made them available in a timely fashion to ensure their usefulness to the user community.

The CDDIS also continued to archive combined troposphere estimates in directories by GPS week (i.e., */gps/products/wwww/trop,* where *wwww* is the GPS week number). Global ionosphere maps of total electron content (TEC) from the IONEX AACs were also archived in subdirectories by day of year (i.e., */gps/products/ionex/yyyy* where *yyyy* is the four-digit year). The CDDIS archived products generated by the individual analysis centers contributing to the IGS LEO Pilot Project (LEO-PP). Thirteen AACs have thus far submitted products for review by the LEO-PP analysis coordinator; these files are archived in subdirectories by AAC within filesystem */gps/products/leopp*.

3.5 Supporting Information

Daily status files of GPS data holdings, reflecting timeliness of the data delivered as well as statistics on number of data points, cycle slips, and multipath continue to be generated by the CDDIS. By accessing these files, the user community can receive a quick look at a day's data availability and quality by viewing a single file. The daily status files are available through the web at URL *ftp://cddisa.gsfc.nasa.gov/pub/reports/gpsstatus/*. The daily status files are also archived in the daily GPS data directories.

Ancillary information to aid in the use of GPS data and products are also accessible through the CDDIS. Weekly and yearly summaries of IGS tracking data (both daily and high-rate) archived at the CDDIS are generated on a routine basis and distributed to the IGS user community through IGS Report mailings. These summaries are accessible through the web at URL *ftp://cddisa.gsfc.nasa.gov/pub/reports/gpsdata* and *ftp://cddisa.gsfc.nasa.gov/pub/reports/igshrdata.* The CDDIS also maintains an archive of and indices to IGS Mail, Report, Network, and other IGS-related messages.

4 GLONASS Data and Products

During 2002, the CDDIS continued as a global data center for GLONASS data and products in support of the IGLOS-PP Call for Participation issued in 2000. The CDDIS archived GLONASS data from over fifty sites. As of June 2002, data from GPS+GLONASS receivers are archived within the GPS directory structure to improve data retrieval for the user community; data from GLONASS-only receivers continue to be archived in the */igex/data* filesystem. GLONASS products from three analysis centers (BKG, ESA, and MCC) as well as the Analysis Coordinator (at the Technical University of Vienna) were also made available to the public. GLONASS products are accessible via anonymous ftp in the filesystem */igex/products*.

4 System Usage

Figures 1 through 3 summarize the monthly usage of the CDDIS for the retrieval of GPS and GLONASS data and products for 2002. Figure 1 illustrates the amount of GPS and GLONASS data retrieved by the user community during 2002, categorized by satellite (GPS or GLONASS) and type (daily, hourly, high-rate). Nearly forty million files were transferred in 2002, with an average of over three million files per month. Furthermore, nearly 170K GPS product files were retrieved each month from the CDDIS; less than 1,000 GLONASS product files were retrieved each month. Figures 2 and 3 illustrate the profile of users accessing the CDDIS IGS archive during 2002. Most accesses were through network gateways, which did not yield sufficient information about the user. Figure 3 displays the usage information by geographic region; the majority of CDDIS users are from hosts in North America.

5 Publications

The CDDIS staff attended several conferences during 2002 and presented papers on or conducted demos of their activities within the IGS, including:

- Noll, Carey E. "2001 IGS Data Center Reports", 2001 IGS Annual Report (submitted in 2002)
- Noll, Carey E. "CDDIS 2001 Global Data Center Report", 2001 IGS Technical Report (submitted in 2002)
- Noll, Carey E., "The CDDIS Data Center – NASA's Space Geodesy Data Archive", EOS Transactions American Geophysical Union, May 2002.
- Noll, Carey E. "Current Status of IGS Data Centers" IGS Network, Data, and Analysis Center Workshop, Ottawa, Canada, April 2002, in press.
- Noll, Carey E. and Maurice Dube. "The IGS Global Data Center at the CDDIS – an Update" IGS Network, Data, and Analysis Center Workshop, Ottawa, Canada, April 2002, in press.

Electronic versions of these and other publications can be accessed through the CDDIS on-line documentation page on the web at URL *http://cddisa.gsfc.nasa.gov/reports.html*.

6 Future Plans

The AlphaServer 4000 computer supporting the CDDIS has been operational for over five years. In 2003, a Linux-based system (and backup server) will be procured. Over four terabytes of RAID storage and a dedicated tape backup system will also be purchased for this new computer facility. Migration to the Linux operating system will begin in late 2003.

7 Contact Information

To obtain more information about the CDDIS IGS archive of data and products, contact:

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NASA GSFC	WWW:	*http://cddisa.gsfc.nasa.gov/cddis_welcome.html*
Greenbelt, MD 20771		*http://cddis.nasa.gov*

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9 References

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Table 1: GPS Data Summary

Data Type	Sample Rate	Avg. No. Sites/Day	Avg. Volume/Day	Total Volume/Year	Data Format	Available On-line
Daily GPS	30 sec.	260 (1)	90 Mb	31 Gb	RINEX and compact RINEX (2)	Since 1995 (3)
Hourly GPS	30 sec.	160 (1)	70 Mb	350 Mb	Compact RINEX	Last 5 days
High-rate GPS	1 sec.	50	250 Mb	90 Gb	Compact RINEX	Since May 2001
LEO GPS	10 sec.	2 (4)	2 Mb	750 Gb	Compact RINEX	Since 2002

Notes: (1) Includes data from GPS+GLONASS sites
(2) Amount of non-compact RINEX data available on-line dependent upon available disk space
(3) Some older data migrated to temporary disk areas until more disk space available; data since 1992 archived in CDDIS
(4) Indicates number of LEO satellites

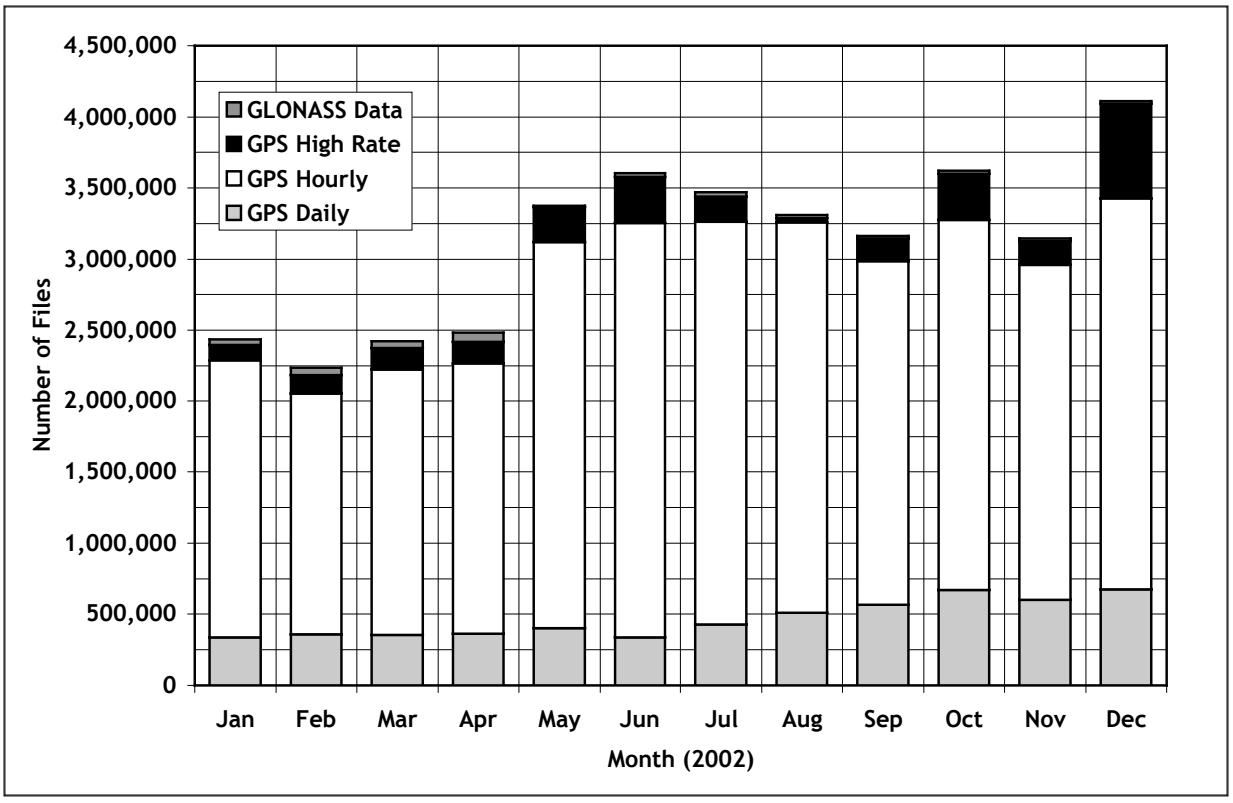

Figure 1: Number of GPS data files transferred from the CDDIS in 2002

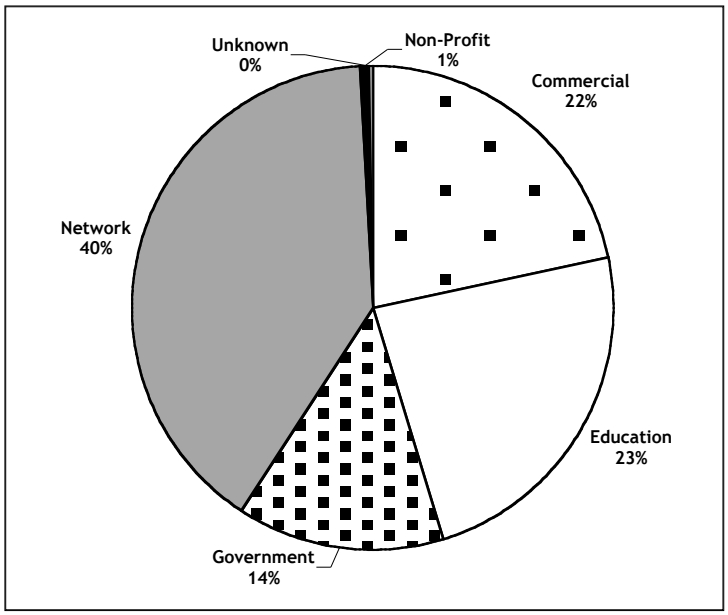

Figure 2: Distribution of IGS users of the CDDIS in 2002

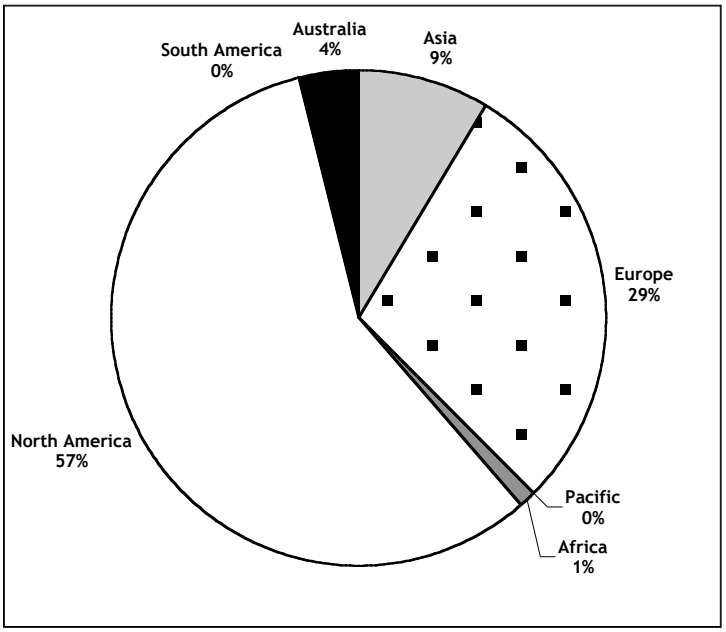

Figure 3: Geographic distribution of IGS users of the CDDIS in 2002