

# **CDDIS SUMMARY FOR THE 2001 LTP ANNUAL REPORT**

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## **Introduction**

The CDDIS is a dedicated data center supporting the international scientific community as NASA's space geodesy data archive since 1982. This data archive was initially conceived to support NASA's Crustal Dynamics Project; since the end of this successful program in 1991, the CDDIS has continued to support the science community through an RTOP from NASA's Solid Earth and Natural Hazards program, HQ Code YS. The CDDIS provides easy and ready access to a variety of data sets, products, and information about these data. The CDDIS archive includes Global Positioning System (GPS), GLObal Navigation Satellite System (GLONASS), Satellite Laser Ranging (SLR), Very Long Baseline Interferometry (VLBI), and Doppler Orbitography and Radiolocation Integrated by Satellite (DORIS) data and products. The specialized nature of the CDDIS lends itself well to enhancement to accommodate diverse data sets and user requirements. Information about the system is available at <http://cddisa.gsfc.nasa.gov>.

The CDDIS serves as one of the primary data centers for the following services within the International Association of Geodesy (IAG):

- International GPS Service (IGS) and its diverse pilot projects and working groups
- International Laser Ranging Service (ILRS)
- International VLBI Service for Geodesy and Astrometry (IVS)
- International Earth Rotation Service (IERS)
- International DORIS Service (IDS)

The CDDIS is operational on a dedicated computer facility located in Building 33 at NASA GSFC. This computer facility hosts web sites for the CDDIS, the ILRS, and several other GSFC facilities. The majority of the CDDIS data holdings are accessible through anonymous ftp and the web.

As in past years, the year 2001 saw another increase in the usage of the CDDIS. On average, 2.2M files totaling over 250 Gbytes in size were downloaded from the CDDIS archive each month. Furthermore, over 150 users accessed the CDDIS on a daily basis to download data. Nearly ninety countries accessed and downloaded data from the CDDIS last year. Over 120 institutions in over sixty countries supply data to the CDDIS on a daily basis for archival and distribution to the international user community.

## **Interdisciplinary Uses of CDDIS Data**

The majority of CDDIS data sets are utilized for geodetic analysis, such as plate tectonics, earthquake displacements, seismicity studies, volcano monitoring, Earth

orientation, atmospheric angular momentum, etc. This archive of GPS, SLR, VLBI, DORIS, and GLONASS data are utilized to precisely determine station positions and velocities of the network stations and thus are used to maintain the terrestrial reference frame, the set of points which realize an ideal reference system. As a consequence, user data from single points or dense regional networks can be tied to this global reference frame.

The IGS and ILRS have been generating precise satellite ephemerides on a routine basis for many years. Precise orbits available from the CDDIS for GPS satellites have accuracies of five cm. SLR and DORIS data retrieved from the CDDIS archive are utilized in precise orbit determination (POD) efforts for several international oceanography missions, including TOPEX/Poseidon, ERS-1/2; in the near future, JASON and ENVISAT will join this list of missions deriving precise orbits from SLR and/or DORIS data. GPS flight receiver data, as well as SLR data, are also utilized for POD efforts for international geophysical missions such as GFO-1 and CHAMP and the future GRACE and ICESat missions.

The GPS network within the IGS consists of globally distributed, continuously operating stations with dual-frequency P-code receivers. By using these two frequencies, the effects of the ionosphere can be determined and used to correct positional measurements. Current ionosphere products derived from GPS data and available through the CDDIS include the vertical total electron content (TEC). The TEC product can be used in the calibration of altimeter data and to correct single frequency GPS data. In 2001, a special campaign was conducted by the IGS to study the effects of the solar maximum on the ionosphere, particularly in the polar and equatorial regions. High-rate data from the global GPS network were archived at the CDDIS for a one-week period during April in support of this activity.

The GPS signal is sensitive to the refractive index of the atmosphere, which is a function of pressure, temperature, and moisture. Both space- and ground-based GPS meteorology can contribute to global climate research. Troposphere products generated by IGS analysis centers include precipitable water vapor, derived from zenith path delays. The results are dependent upon meteorological sensors collocated at the GPS sites, and can be a valuable tool in the validation of other meteorological products.

### **New Thrusts for the CDDIS**

In 1999, the IGS issued a Call for Participation in the Low Earth Orbiters (LEO) Pilot Project; this activity started in the spring of 2001. The CDDIS has established procedures to retrieve, reformat, archive and provide access to data from a ground network of approximately forty low-latency GPS receivers operating at a one-second sampling rate. In 2002, the CDDIS will begin the archive of data from GPS flight receivers on board several low-Earth orbiting satellites. Analysts will retrieve these data to produce precise orbits of these LEO platforms, which will aid in the generation of other products, such as temperature and water vapor profiles in the neutral atmosphere and ionosphere imaging products. The IGS LEO Pilot Project will test the ability of the

various components of the IGS infrastructure to support near real-time acquisition, dissemination, and processing of GPS data.

The CDDIS will begin support of another IGS Pilot Project in 2002, the GPS Tide Gauge Benchmark Monitoring Pilot Project (TIGA-PP). The CDDIS submitted a successful proposal to serve as an archive for data from continuously-operated GPS receivers located at or near tide gauge instruments. The pilot project aims to establish and maintain new geodetic ties to tide gauge systems to aid in climate change studies. The primary product of the analysis will be a time series of coordinates for analyzing vertical motions of tide gauges and tide gauge benchmarks. The realization of the scientific objectives of the pilot project will aid scientific research in many areas, particularly NASA research in geodesy and geophysics within the Solid Earth and Natural Hazards program and altimetry and sea level research programs.

Efforts are also underway to increase the size of the on-line archive of the CDDIS. A 600-platter CD-ROM jukebox will provide access to the archive of older GPS data. The CDDIS computer facility will also be augmented with a second 500 Gbyte RAID disk array as well as a dedicated tape backup system.

### **Staffing and Funding**

The CDDIS staff consists of one civil servant and three Raytheon ITSS contractors. Carey Noll has a BA in Mathematics; Maurice Dube, lead contractor, has a PhD in Physics.

### **Outreach**

In the spring of 2001 Carey Noll served as a judge at the Glenn Dale Elementary School science fair. She also gave presentations on STARSHINE-3 project, SLR, and GPS to three fifth grade science classes at Holy Trinity Episcopal Day School. These presentations were a follow-up to a class project suggested by Ms. Noll that allowed the students to polish mirrors which were later installed on the STARSHINE-3 satellite.

### **Publications in 2001**

C. Noll and M. Dube, "The Crustal Dynamics Data Information System CDDIS -- NASA's Space Geodesy Data Archive, at Science Data Centers Symposium, Pasadena, CA, March 2001.

C. Noll and M. Dube, "The IGS Global Data Center at the CDDIS - an update", Physics and Chemistry of the Earth (26A)6-8, Elsevier Science Ltd, 2001.

C. Noll, "Current Status of and Backup Plans for Flow of IGS Data and Products", Physics and Chemistry of the Earth (26A)6-8, Elsevier Science Ltd, 2001.

C. Noll, "IGS Data Center Report", 1999 IGS Annual Report, JPL Publication 400-978, 2001.

C. Noll, "CDDIS Global Data Center Report", 1999 IGS Technical Reports, edited by K. Gowey, R. Neilan, A. Moore, JPL Publication, in press, 2001.

C. Noll, "IGS Data Center Report", 2000 IGS Annual Report, JPL Publication, in press.  
 C. Noll, "CDDIS Global Data Center Report", 2000 IGS Technical Reports, edited by K. Gowy, R. Neilan, A. Moore, JPL Publication, in press.  
 C. Noll, "CDDIS Data Center Summary for the 2000 IVS Annual Report", International VLBI Service for Geodesy and Astrometry 2000 Annual Report, edited by N. R. Vandenberg, NASA/TP-2001-209979.  
 C. Noll, "CDDIS ILRS 1999 Global Data Center Report", 1999 ILRS Annual Report, edited by M. Pearlman and L. Taggart, NASA/TP-2000-209969.  
 C. Noll, "CDDIS ILRS 2000 Global Data Center Report", 2000 ILRS Annual Report, edited by M. Pearlman and L. Taggart, in press, NASA/TP-2001-209987.  
 G. Tavernier, et.al., "International DORIS Service on Web", EOS Transactions, American Geophysical Union, December 2001.  
 G. Tavernier, et.al., "Report of Coordination Centers, DORIS", CSTG Progress Report 2000, December 2001.

### **Acronyms**

CDDIS	Crustal Dynamics Data Information System
CHAMP	CHAllenging Mini-Satellite Payload
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
ENVISAT	ENVIronmental SATellite
ERS	European Remote Sensing Satellite
GFO	GEOSAT Follow-On
GLONASS	Global'naya Navigatsionnay Sputnikovaya Sistema (Global Navigation Satellite System)
GPS	Global Positioning System
GRACE	Gravity Recovery And Climate Experiment
IAG	International Association of Geodesy
IDS	International DORIS Service
IERS	International Earth Rotation Service
IGS	International GPS Service
ILRS	International Laser Ranging Service
IVS	International VLBI Service for Geodesy and Astrometry
LEO	Low Earth Orbiter
POD	Precision Orbit Determination
RAID	Redundant Array of Inexpensive Disk
SLR	Satellite Laser Ranging
STARSHINE	Student Tracked Atmospheric Research Satellite for Heuristic International Networking Experiment
TOPEX	Ocean TOPography Experiment
TEC	Total Electron Content
VLBI	Very Long Baseline Interferometry

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