THE CDDIS

The Crustal Dynamics Data Information System (CDDIS) is a dedicated data center supporting the international space geodesy community, providing easy and ready access to a variety of data sets, products, and information about these data. The data center was established in 1982 as a dedicated data bank to archive and distribute all Crustal Dynamics Project-acquired data and information about these data. Today, the CDDIS continues to serve as the NASA archive and distribution center for space geodesy data, particularly Global Navigation Satellite System (GNSS, currently GPS and GLONASS), laser ranging, Very Long Baseline Interferometry (VLBI), and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) data. The specialized nature of the CDDIS lends itself well to enhancement to accommodate diverse data sets and user requirements. All data sets and metadata extracted from these data sets are accessible to scientists through ftp and the Web; general information about each data set is accessible via the Web.

The data archive supports NASA's space geodesy activities within the Science Mission Directorate. The CDDIS data system and its archive have become increasingly important to many national and international programs, particularly several of the operational services within the International Association of Geodesy (IAG). The CDDIS serves as one of the primary data centers for the following IAG services:

- International GNSS Service (IGS)
- International Laser Ranging Service (ILRS)
- International VLBI Service for Geodesy and Astrometry (IVS)
- International DORIS Service (IDS)
- International Earth Rotation and Reference Systems Service (IERS)

Operations centers collect raw data from network stations, reformat these data, and deposit the resulting files to incoming ftp drop-off areas on the CDDIS host computer. All data are processed to ensure data integrity and to extract pertinent metadata. Data are then copied to public directories and made available to the user community through anonymous ftp and the Web. The metadata (primarily temporal and spatial parameters) are loaded into a relational database for data tracking and query purposes. Users can query this information to learn more about the CDDIS data holdings by location and time period. The metadata are also utilized by the CDDIS staff to monitor data holdings and data integrity.

The CDDIS is operational on a dedicated server with over three Tbytes of on-line RAID disk storage. A tape subsystem is utilized for system backups. In 2004, over five million files totaling over 515 Gbytes in size were downloaded each month from the CDDIS on-line archive. More than 2,000 organizations in over 100 countries accessed and downloaded data from the CDDIS last year. Over 130 institutions in over sixty countries supply data to the CDDIS on a daily basis for archival and distribution to the international user community.

INDIGO

The CDDIS is an active participant in the project INDIGO, Inter-service Data Integration for Geodetic Operations. The goal of INDIGO is to develop tools for uniform access to the heterogeneous space geodetic data systems now supporting the IAG services, particularly the IGS, ILRS, and IVS. User interface and access to geodetic data and information holdings will be streamlined and seamless utilizing web-based services.

INDIGO Web site: http://indigo.nasa.gov

For More Information:

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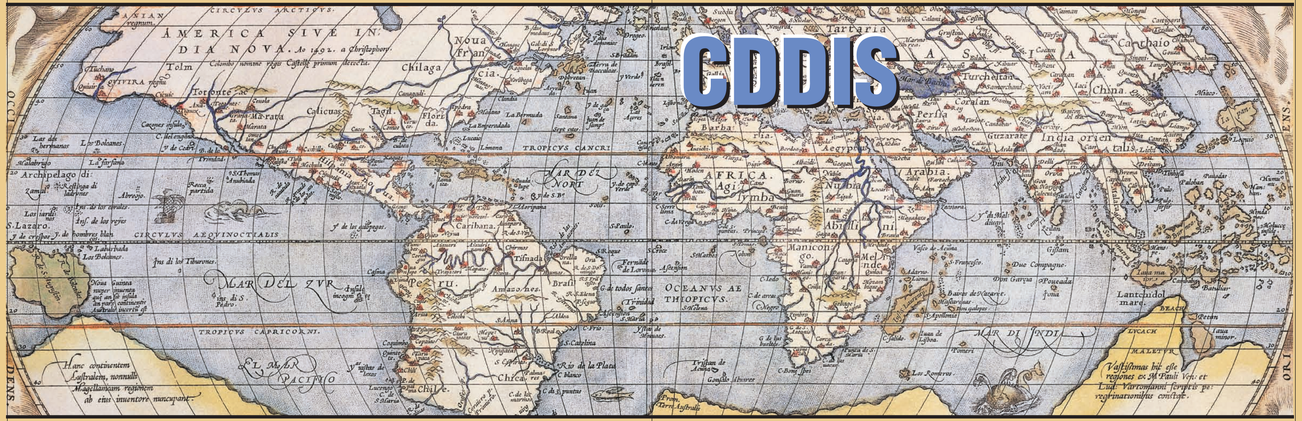
CDDIS Web site: http://cddis.nasa.gov
or
http://cddis.gsfc.nasa.gov



www.nasa.gov
NP-2005-11-734

International Laser Ranging Service

THE CRUSTAL DYNAMICS DATA INFORMATION SYSTEM: NASA'S ARCHIVE OF SPACE GEODESY DATA

National Aeronautics and Space Administration

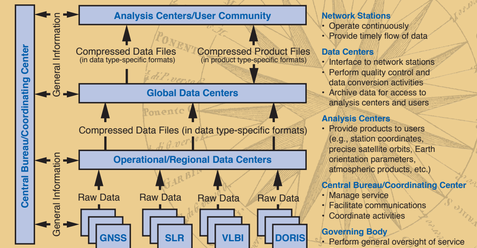
INTRODUCTION

Since 1982, the Crustal Dynamics Data Information System (CDDIS) has supported the archive and distribution of geodetic data products acquired and utilized by NASA programs. These data include GNSS (Global Navigation Satellite System), laser ranging (both to artificial satellites and to the Earth's moon), VLBI (Very Long Baseline Interferometry), and DORIS (Doppler Orbitography and Radiolocation Integrated by Satellite).

SPACE GEODESY

Geodesy is the science of the measurement and mapping of the Earth's surface, its gravity field, and geodynamic phenomena such as polar motion. Space geodesy consists of the observational and computational techniques that solve these geodetic problems using precise measurements to, from, and between orbiting satellites, the moon, planets, and quasars.

The majority of data sets available through the CDDIS are utilized for geodetic studies in plate tectonics, earthquake displacements, volcano monitoring, Earth orientation, atmospheric angular momentum, among others. This archive of GNSS, laser ranging, VLBI, and DORIS data are utilized to precisely determine station positions and velocities of the network stations and thus are used to maintain the terrestrial reference frame. This set of points realize an ideal reference system for Earth science applications, such as remote monitoring of sea level, sea surface topography, crustal deformation, and time-varying gravity from space. Furthermore, long-term monitoring of global change can be accomplished through this stable coordinate system. User data from single points or dense regional networks can be tied to this global reference frame.



Network Stations
- Operate continuously
- Provide timely flow of data

Data Centers
- Interface to network stations
- Perform quality control and data conversion activities
- Archive data for access to analysis centers and users

Analysis Centers
- Provide products to users (e.g., station coordinates, precise satellite orbits, Earth orientation parameters, atmospheric products, etc.)

Central Bureau/Coordinating Center
- Manage service
- Facilitate communications
- Coordinate activities

Governing Body
- Perform general oversight of service
- Plan future direction

INTERNATIONAL GNSS SERVICE (IGS)

The main mission of the International GNSS Service (IGS, formerly the International GPS Service) is to provide a service to support geodetic and geophysical research activities through GNSS data and products. This service has been operational since 1994. The current network consists of nearly 400 permanently occupied, globally distributed sites that provide GNSS data to IGS data centers on a daily, hourly, and near-real-time basis. These GNSS data are used by the IGS analysis centers to generate products such as precise satellite ephemerides and satellite and station clock information.

GNSS (GPS and GLONASS) Data:

- Daily files containing 30-second sampled GNSS data in RINEX format
  - 300+ GNSS stations/day
  - Approximately 0.35 Mbytes/site/day in size (compressed)
  - CDDIS GNSS 30-second data archive: January 1992 through present
- Hourly files of 30-second sampled GNSS data in RINEX format
  - 200+ GNSS stations/day
  - Approximately 0.02 Mbytes/site/hour in size (compressed)
  - CDDIS GNSS 30-second hourly data archive: retained for five days (replaced by daily files)
- Fifteen-minute files of one-second sampled GNSS data in RINEX format
  - 80+ GNSS stations/day
  - Approximately 0.45 Mbytes/site/hour in size (compressed)
  - CDDIS GNSS 1-second data archive: May 2001 through present
- Daily files of ten-second sampled satellite-borne GPS receiver data in RINEX format
  - Two satellites (SAC-C, CHAMP); others in future
  - Approximate 2.5 Mbytes/satellite/day in size (compressed)
  - CDDIS satellite-borne GPS data archive: January 2002 through present

GPS satellite

GNSS station in Thule, Greenland
DNSC

IGS Products:

- Precise GNSS satellite ephemerides (<5 cm accuracy)
  - Weekly
  - Rapid and ultra-rapid (sub-daily)
- IGS station and GNSS satellite clocks
  - Weekly (<0.1 ns accuracy)
  - Rapid (~0.1 ns accuracy) and ultra-rapid (~0.2 ns accuracy)
- Earth rotation parameters
- IGS tracking station coordinates and velocities
- Global ionosphere maps of total electron content (TEC)
- Troposphere product consisting of combined zenith path delay (ZPD)
- CDDIS GNSS product archive: June 1992 through present

IGS Web site: http://igscb.jpl.nasa.gov

INTERNATIONAL LASER RANGING SERVICE (ILRS)

Satellite (and lunar) laser ranging uses lasers to measure ranges from ground stations to satellite-borne (and lunar) retroreflectors to the millimeter level. The International Laser Ranging Service (ILRS), operational since 1998, collects, archives, and distributes global satellite and lunar laser ranging (SLR and LLR) data and their related products. These data and products support geodetic and geophysical research activities as well as engineering and operational applications and experimentation. The ILRS provides products important to the International Earth Rotation and and Reference Systems Service (IERS) for the maintenance of an accurate International Terrestrial Reference Frame (ITRF). The ILRS develops the necessary global standards/specifications and encourages international adherence to these conventions.

Retroreflector array on Jason, GFO-1, ICESat, and ADEOS-2

LAGEOS satellite

Laser Data:

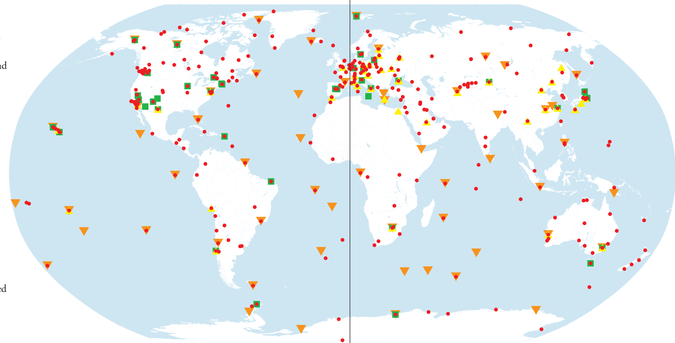
- Available in two forms: original observations (full-rate data) and condensed range observations generated from these original observations collected over several seconds to minutes (normal points) in ILRS-specific formats
- Daily and monthly files containing on-site normal points, sorted by satellite
- Hourly files containing on-site normal points from all satellites, retained for five days
- Daily and monthly full-rate data files from a subset of the global network, sorted by satellite
- Currently, 29 satellites and four sites on the moon are tracked on a routine basis by 40 SLR and LLR stations
- Approximately 1 Mbyte/day on-site normal point data (uncompressed); 2 Mbytes/day full-rate data (compressed)
- CDDIS laser data archive: 1976 through present

ILRS Products:

- Site positions and velocities, utilized for maintaining the ITRF
- Earth orientation parameters (EOPs)
- Precise satellite ephemerides (future)

SLR2000 system at NASA GSFC

ILRS Web site: http://ilrs.gsfc.nasa.gov

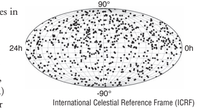


INTERNATIONAL VLBI SERVICE FOR GEODESY AND ASTROMETRY (IVS)

Products generated by the International VLBI Service for Geodesy and Astrometry (IVS) contribute to research in many areas, including solid Earth, tides, studies of the vertical, fundamental astronomy, and VLBI technique improvement. The objectives of the IVS are to provide a service to support geodetic, geophysical, and astrometric research and operational activities, to promote research and development for VLBI, to integrate VLBI into a global Earth observing system, and to interact with users of VLBI products.

VLBI Data:

- VLBI data bases in VLBI-specific formats
- Auxiliary files (e.g., log, met data, schedule, cable info, etc.)
- Currently, over 40 antennas participate in the IVS
- Approximately 2-3 Mbyte data base file (compressed)
- CDDIS VLBI data archive: 1979 through present; most data holdings available on-line



International Celestial Reference Frame (ICRF)

32-meter VLBI antenna in Tsukuba, Japan
GSI

IVS Products:

The VLBI technique contributes uniquely to:

- Definition and realization of the International Celestial Reference Frame (ICRF)
- Monitoring of Universal Time (UT1)
- Monitoring the coordinates of the celestial pole (nutation and precession)

Further significant products are:

- All components of Earth Orientation Parameters (EOP) at regular intervals
- Station coordinates and velocity vectors for the realization and maintenance of the ITRF
- Combined zenith path delay (ZPD)

IVS Web site: http://ivscc.gsfc.nasa.gov

INTERNATIONAL DORIS SERVICE (IDS)

The DORIS system, developed in France by the Centre National d'Etudes Spatiales (CNES), Institut Géographique National (IGN), and Groupe de Recherche en Géodésie Spatiale (GRGS), is based on the measurement of Doppler shifts in radio signals, transmitted by ground beacons to a DORIS receiver on-board the satellite. This uplink system does not require network connectivity for data transmission and allows the network to be remotely monitored. Like GNSS and SLR, precise satellite orbits, positions of and distances between observing stations, and Earth rotation, orientation, and polar motion values can be derived from DORIS measurements. The primary objective of the International DORIS Service (IDS), operational since 2003, is to foster the DORIS technique to support international geodetic, geophysical, and other research and operational activities.

DORIS satellite antenna
CNES

DORIS Data:

- Files containing one "cycle" (~ten days) of data (computed range measurements), sorted by satellite, in DORIS-specific format
- Seven satellites (TOPEX, Jason, Envisat, and SPOT series) have on-board DORIS receivers that receive transmitted signals from a network of 55 beacons
- Approximately 5 Mbyte/satellite/cycle (compressed)
- CDDIS DORIS data archive: 1990 through present (continuous since 1993)

DORIS antenna at NASA GSFC
(SLR2000 in background)

IDS Products:

- Precise satellite ephemerides (future)
- Site coordinates and velocities; position time series
- Earth rotation parameters
- Special products (ionosphere information, time varying geocenter coordinates)

IDS Web site: http://ids.cls.fr

First (SPOT-2, SPOT-4, TOPEX/Poseidon), second (Envisat),and miniaturized second (Jason, SPOT-5) generation on-board DORIS receivers
CNES