The Crustal Dynamics Data Information System
CDDIS — NASA's Space Geodesy Data Archive

Carey Noll and Maurice Dube
NASA GSFC

Global GPS, GLONASS, SLR, VLBI, and DORIS Networks

What is Space Geodesy Data?

GPS

Global Positioning System
Source: Military satellites equipped with precise clocks transmitting satellite messages such as ephemeris, clock offsets, etc.
Instrument: Dual frequency GPS receiver and antenna
Observable: Station to satellite pseudorange, phase delay
Yield: 1. Precise satellite ephemerides
2. Relative positions of and distances between observing stations
3. Earth rotation, orientation, polar motion, etc.
4. Time/frequency synchronization

GLONASS

GLObal NAvigation Satellite System
Source: Russian military satellites equipped with precise clocks transmitting satellite messages such as ephemeris, clock offsets, etc.
Instrument: GLONASS receiver and antenna
Observable: Station to satellite pseudorange, phase delay
Yield: 1. Precise satellite ephemerides
2. Relative positions of and distances between observing stations
3. Earth rotation, orientation, polar motion, etc.

SLR

Satellite Laser Ranging
Target: Satellite equipped with corner cubes
Instrument: Ground-based short-pulse laser transmitter
Observable: Round-trip pulse time-of-flight to satellite
Yield: 1. Satellite orbit
2. Positions of and distance between observing stations
3. Earth rotation, orientation, polar motion, etc.

VLBI

Very Long Baseline Interferometry
Source: Quasar (microwave frequencies)
Instrument: Radio telescope equipped with X- and S-wideband receivers
Observable: Difference in signal arrival times
Yield: 1. Correlated delay and delay rate of simultaneous observations as a function of time
2. Positions of and distance between observing stations
3. Earth rotation, orientation, polar motion, atmospheric angular momentum, etc.

DORIS

Doppler Orbitography and Radiolocation Integrated by Satellite
Target: Satellites equipped with DORIS receiver and uplink hardware
Instrument: Beacon transmitting radiofrequency signals
Observable: Doppler shift on radiofrequency signals
Yield: 1. Precise satellite ephemerides
2. Positions of observing stations

Introduction to the CDDIS

The CDDIS is a dedicated data center supporting the international space geodesy community since 1982. 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.

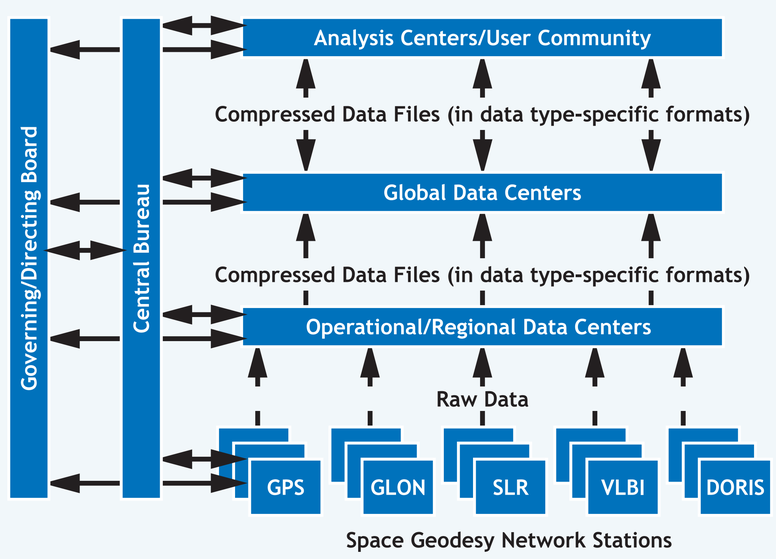
CDDIS serves as one of the primary data centers for the following services within the International Association of Geodesy (IAG):

- International GPS Service (IGS)
- International Laser Ranging Service (ILRS)
- International VLBI Service for Geodesy and Astrometry (IVS)
- International Earth Rotation Service (IERS)
- International GLONASS Pilot Project (IGLOS-PP)
- International DORIS Service (IDS)

The CDDIS is operational on a dedicated computer facility located 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 via anonymous ftp and the web.

As in past years, the year 2000 saw another increase in the usage of the CDDIS. On average, 1.5M files totaling over 150 Gbytes in size were downloaded from the on-line CDDIS each month. Over 5,400 distinct hosts in over seventy countries accessed and downloaded data from the CDDIS last year. Furthermore, over 150 users accessed the CDDIS on a daily basis to download data. 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.

Data Flow for International Services



Network Stations
- Continuously operational
- Timely flow of data

Data Centers
- Interface to network stations
- Perform QC and data conversion
- activities
- Archive data for access to analysis
- centers and user community

Analysis Centers
- Provide products to user community
- (e.g., station coordinates,
- precise satellite orbits,
- atmospheric products, etc.)

Central Bureau
- Management of service
- Facilitate communications and
- coordinate activites

Governing/Directing Board
- General oversight of the service
- Future direction

CDDIS Data Holdings

GPS

- Temporal coverage: 1990 through present
- Data volume: On-line: 100 Gbytes
  +300 Gbyte jukebox
  Off-line: 200 Gbytes

GLONASS

- Temporal coverage: 1998 through present
- Data volume: On-line: 25 Gbytes
  Off-line: N/A

SLR

- Temporal coverage: 1976 through present
- Data volume: On-line: 10 Gbytes
  Off-line: 20 Gbytes

VLBI

- Temporal coverage: 1979 through present
- Data volume: On-line: 30 Gbytes
  Off-line: 30 Gbytes

DORIS

- Temporal coverage: 1992 through present
- Data volume: On-line: 5 Gbytes
  Off-line: N/A

Interdisciplinary Uses of CDDIS Data

The majority of CDDIS data sets are utilized for geodetic studies, such as plate tectonics, earthquake displacements, seismisity 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 will be 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 will be 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 will start in the summer of 2001. The CDDIS will retrieve, reformat, archive and provide access to data from a ground network of forty to fifty low-latency GPS receivers operating at a one-second sampling rate. The CDDIS will also archive data from GPS flight receivers on board the CHAMP and SAC-C satellites. Analysts will retrieve these data to produce precise orbits of the 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 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.

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.

For Further Information:

Carey Noll
Manager, CDDIS
NASA GSFC
Greenbelt, MD 20771
noll@cddis.gsfc.nasa.gov

Maurice Dube
Raytheon ITSS
Lanham, MD 20706
dube@cddis.gsfc.nasa.gov

CDDIS Web Site:
http://cddis.nasa.gov or *http://cddisa.gsfc.nasa.gov*

CEN 04/05/2001