Overview of the Crustal Dynamics Data Information System

CDDIS

Carey E. Noll
Manager, CDDIS
NASA GSFC
Greenbelt, MD 20771

Maurice Dube
Raytheon
Lanham, MD 20706

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Outline

- Space Geodesy Program at NASA
- CDDIS Overview
- Archive Contents
- Introduction to the IGS
- IGS Data and Products
- IGS Benefits to Users
Space Geodesy Program

The Techniques

Past:
- Mini-Track
- Doppler

Present:
- SLR
- LLR
- VLBI
- GPS
- GLONASS
- DORIS
- PRARE

Future:
- Interferometric SAR
- GPS Arrays (Ground, Space
- Laser Altimetry
- Seafloor Geodesy

Its Science Contributions

- Earthquake Processes
- Ocean Circulation
- Atmospheric Circulation
- Sea Level
- Plate Tectonics
- Lithosphere Processes
- Gravity
- Land and Ice Topography
- Post-Glacial Rebound
- Ocean Tides
- Atmospheric Tides
- Solid Earth Tides
- Core Dynamics
- General Relativity
- Fundamental Physics
- Astrophysics

The U.S. Involvement

- NASA
- NOAA
- USGS
- USNO
- Many Major Universities Institutes

The Foreign Involvement

- Over 80 Countries
- Cooperative Operations
- Shared Data
- Joint Campaigns
- Joint Technology Development Programs
Space Techniques

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.

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. Distance between and positions of observing stations
3. Earth rotation, orientation, polar motion, 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
3. Earth rotation

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.
The CDDIS was established in 1982 as a dedicated data bank to archive and distribute all Crustal Dynamics Project-acquired data and information about these data.

CDDIS continues to serve as the archive and distribution center for space geodesy data, particularly GPS, laser, DORIS, and VLBI data.

CDDIS has served as a global data center for the International GPS Service (IGS) since its start in June 1992, providing on-line access to data from over 160 globally-distributed sites daily.

CDDIS also serves as a data center for GPS and DORIS in support of the International Earth Rotation Service (IERS) and for the International GLONASS Experiment (IGEX’98), a test service similar to IGS.

CDDIS provides on-line archive of TOPEX/Poseidon (SLR and DORIS) and ERS-2 (SLR) data for near real-time access by POD analysis centers.

Selected data sets are accessible to scientists through ftp and WWW; general information about all data are accessible via WWW.
CDDIS Introduction

(Continued)

- Use of the ORACLE data base management system (DBMS) provides flexibility for storing and accessing diverse data sets
- On-line archive consists of ORACLE data base and GPS, SLR, VLBI, and DORIS data sets (over 100 Gbytes on-line, many Gbytes near-line); off-line archive consists of GPS, SLR, DORIS, and VLBI magneto-optical disks and magnetic tapes
- CDDIS currently operational on dedicated DEC AlphaServer 4000 running UNIX; archive of data to CD-ROM for accessibility through jukebox underway
- CDDIS issues bimonthly bulletin and organizes and generates space geodesy site catalogue and personnel directory
- FTP: cddisa.gsfc.nasa.gov
  WWW: http://cddisa.gsfc.nasa.gov/cddis_welcome.html
  email: noll@cddis.gsfc.nasa.gov
dube@cddis.gsfc.nasa.gov
CDDIS Archive Contents

- **GPS**
  - Temporal coverage: 1990 through present
  - Data volume:
    - On-line: 50 Gbytes + 300 Gbyte jukebox
    - Off-line: 500 Gbytes

- **GLONASS**
  - Temporal coverage: 1998 through present
  - Data volume:
    - On-line: 5 Gbytes
    - Off-line: n/a

- **SLR**
  - Temporal coverage: 1976 through present
  - Data volume:
    - On-line: 5 Gbytes
    - Off-line: 200 Gbytes

- **VLBI**
  - Temporal coverage: 1979 through present
  - Data volume:
    - On-line: 18 Gbytes
    - Off-line: 100 Gbytes

- **DORIS**
  - Temporal coverage: 1992 through present
  - Data volume:
    - On-line: 5 Gbytes
    - Off-line: 100 Gbytes
Introduction to the IGS

- The main mission of the International GPS Service (IGS) is to provide a service to support geodetic and geophysical research activities through GPS data and data products.
- The IGS has been an operational service since 1994 (test service since 1992).
- The IGS provides near real-time access to GPS data from a global network of sites.
- The current network consists of nearly 200 globally distributed sites.
- The GPS data sets are used by the IGS to generate products on a routine basis.
- Over 80 global institutions and organizations contribute to the IGS activities.
- The distributed nature of the IGS data flow is an efficient method for providing near real-time data availability to global community.
- The IGS is an approved service of the International Association of Geodesy (IAG) and is also a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS).
Components of the IGS

- Network of global tracking stations
- Data Centers
  - Operational data centers download data from tracking stations
  - Regional data centers provide access to data from a geographic region
  - Global data centers provide access to data and products to IGS and user community
- Analysis Centers and Associate Analysis Centers
  - Analyze GPS data on an operational basis
  - Produce IGS products
- Analysis Center Coordinator
  - Generates combined, official IGS products
- Central Bureau
  - General management of the IGS
- Governing Board
Flow of IGS Data, Products, and Information

Central Bureau

Analysis Center Coordinator

Analysis Centers

Global Data Centers

Operational/Regional Data Centers

GPS Stations

User Community

IGS Components
User Component
GPS Data
Data Products
Information
IGS Stations and Data

◆ IGS Tracking Stations:
  – Permanently occupied
  – Continuously tracking
  – Equipped with high-precision dual-frequency P-code receiver
  – Operate at 30-second sampling rate
  – Linked electronically for download of data on a timely basis
  – Ideally, single day’s worth of data forwarded to data center within 1-2 hours after end of UTC day
  – Subset of sites provide hourly data within 15 minutes

◆ IGS Data:
  – Daily files containing range observation and broadcast ephemerides
  – Meteorological data from a few sites
  – RINEX format at data centers
  – Files available in compressed (UNIX compression) format at data centers; further compaction used for internal data transmissions
  – Approximately 0.6 Mbytes/site/day (RINEX, compressed)
IGS Data Products

- Seven IGS analysis centers and nine associate analysis centers generate IGS products on a routine basis.

- IGS products now available:
  - Combined IGS orbit (10 day delay; approaching 5 cm accuracy)
  - Combined IGS ERP (pole 0.2-0.7 milliarcsecond, LOD 50 microseconds/day accuracy)
  - Rapid orbits (1 hour delay; 10 cm accuracy)
  - Predicted orbits (1 hour prior to observation day; 50 cm accuracy)
  - Global annual station position solutions (3 mm to 1 cm accuracy)

- IGS products mainly used for geodetic studies, e.g., plate tectonics, earthquake displacements, Earth orientation, etc.
IGS Data Products
(Continued)

- Proposed IGS products include atmosphere measurements to aid in weather forecasting, etc.
- IGS network 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
- Ionosphere products -- Total electron content (TEC)
  - Could aid in calibration of altimeter data
  - Correct single frequency GPS data
- The GPS signal is sensitive to the refractive index of the atmosphere, which is a function of pressure, temperature, and moisture
- Troposphere products -- Precipitable water vapor
  - Derived from zenith path delays
  - Dependent upon meteorological sensors at GPS sites
  - Could aid in validation of EOS products
IGS -- Benefits to Users

- Open access to all IGS data and data products
- High quality GPS data
  - Global network
  - Common, receiver-independent format (RINEX)
  - Continuously available in a timely fashion
  - Interpolation to “higher” sampling rate can be achieved through software
- GPS ephemerides
  - More accurate than broadcast orbits by at least an order of magnitude
- GPS site positions
  - IGS site positions precisely-determined
  - User data can be tied to global reference frame
- Ties to regional networks
  - CORS, SCIGN
  - Other countries