Overview of the Crustal Dynamics Data Information System

CDDIS

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Science Data Centers Symposium
November 02, 1998

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
- NIMA
- NSF
- USAF
- NRL
- 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

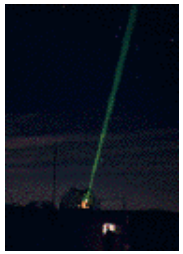
Source: Military satellites equipped with precise clocks transmitting satellite messages such as ephemeris, clock offsets, etc.

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)

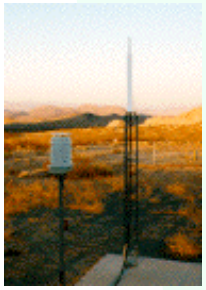
Instrument: Radio telescope equipped with X- and S-wideband receivers

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.

Space Techniques
(continued)

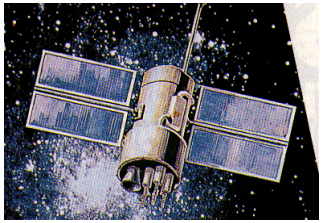
DORIS



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.

Crustal Dynamics Data Information System (CDDIS)

- 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 accessibilty 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

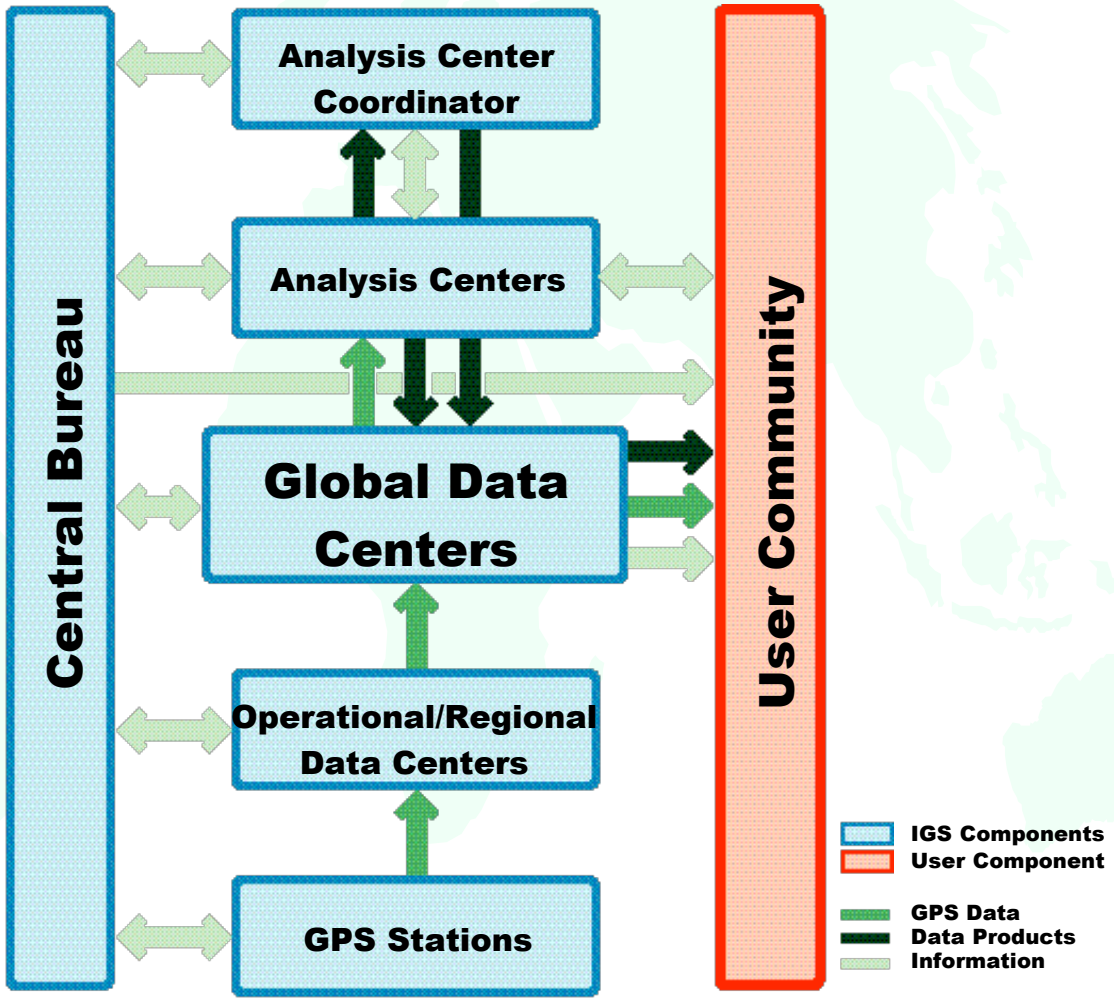
- The main mission of the International GPS Service (IGS) is to provide a service to support geodetic and geophysical research activities through GPS data and data products
- The IGS has been an operational service since 1994 (test service since 1992)
- The IGS provides near real-time access to GPS data 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)

IGS Site Map

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



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