CDDIS Data Discovery

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- Background

- Data description

- User description

- Discovery desirables

Why are we here??

- To provide advice on methods to develop a search/ metadata interface tool for CDDIS to:
  - Aid users in discovery of CDDIS data, products, and information
  - Aid staff in archive management
  - Promote CDDIS data holdings to a larger community (e.g., through metadata standards)

CDDIS Overview

- Crustal Dynamics Data Information System
- NASA's active archive of space geodesy data, products, and information
- CDDIS funded by NASA (through ESDIS) but cooperates extensively with the international community
- Majority of CDDIS archive utilized for geodetic studies, e.g., plate tectonics, earthquake displacements, Earth orientation, etc.
- Plays an interdisciplinary role in supporting derivation of the ITRF, POD for NASA/international missions, atmospheric studies, etc.

Space Geodesy (1/2)

- Data
  - GNSS: 417 sites tracking GPS, GLONASS
  - Laser Ranging (SLR and LLR): 42 sites tracking 35+ satellites
  - VLBI: 45 sites
  - DORIS: 58 sites tracking 6 satellites
- Products
  - Precise network station positions (for ITRF)
  - Satellite orbits (for POD)
  - Station and satellite clocks (for timing)
  - Earth rotation parameters
  - Positions of celestial objects (for CRF)
  - Atmospheric parameters (Ionosphere TEC, Troposphere ZPD)
  - ...

Space Geodesy (2/2)

- Stations in the GNSS, SLR/LLR, VLBI, and DORIS networks generate point data on a multi-day, daily, hourly, and/or sub-hourly basis

- File size is typically <2Mb/data "granule", <10Mb/ derived product "granule"

GNSS: Satellites (GPS-U.S., Russia-GLONASS, future EU-Galileo) equipped with precise clocks transmitting messages such as ephemeris, clock offsets, etc. to ground (and spaced-based) receivers to measure station to satellite pseudorange, phase delay
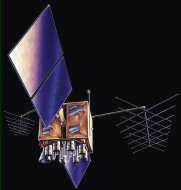
SLR/LLR: Ground-based short-pulse laser transmitting to satellites (or planetary targets) equipped with corner cubes to measure round-trip pulse time-of-flight to satellite

VLBI: Radio telescopes equipped with X/S wideband receivers record signals from quasars to measure difference in signal arrival times

DORIS: Satellites equipped with DORIS receiver and uplink hardware transmit signals to ground beacons to measure Doppler shift on radiofrequency signals

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CDDIS Data: Global Networks

- ● GNSS Site
- ▲ SLR Site
- ■ VLBI Site
- ▼ DORIS Site
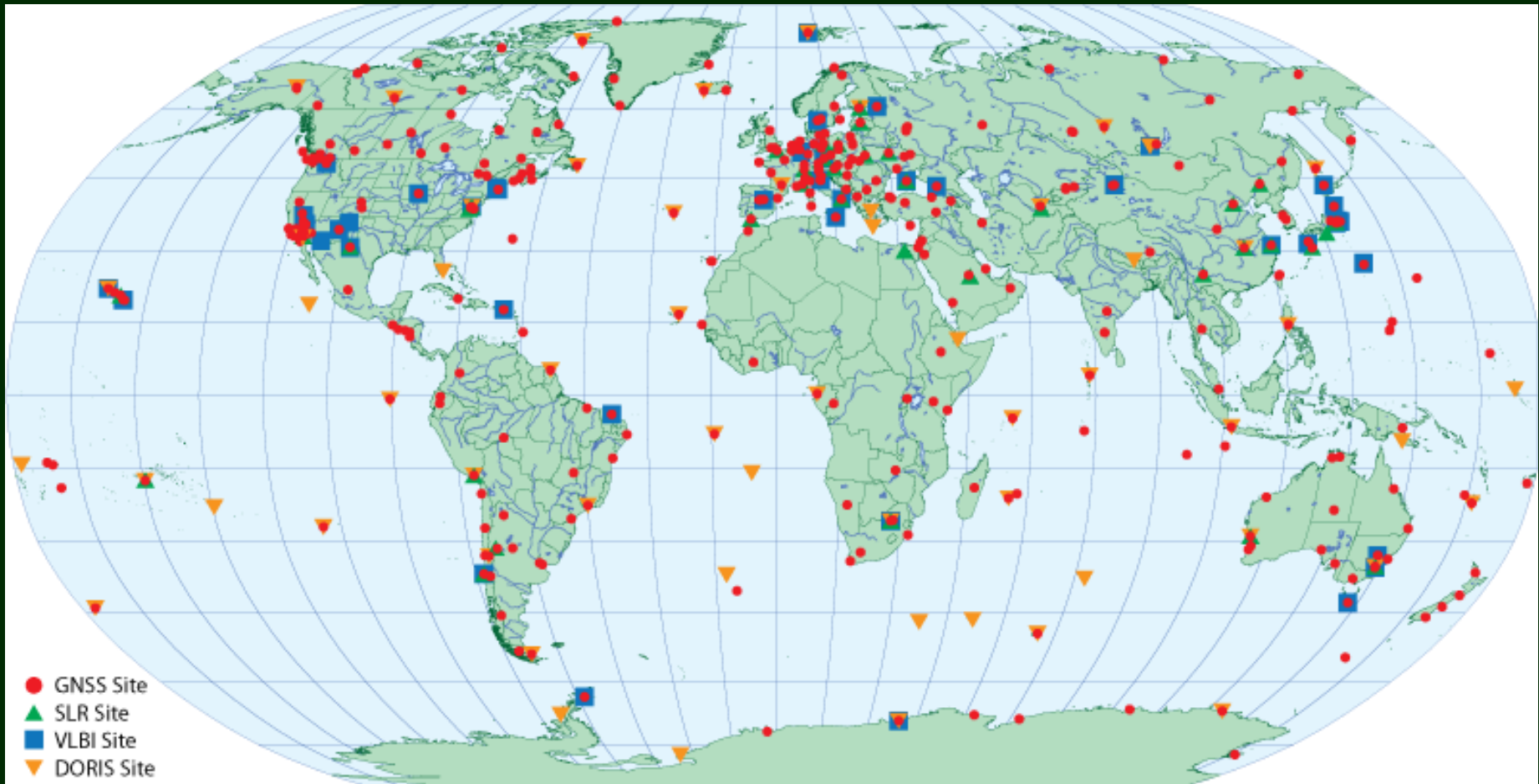
IAG Services

- Services function as cooperating federations dedicated to a particular type of data
- Provide data and products on an operational basis to geodesy analysts as well as a broader scientific community
- Examples of a successful model of community management:
  - develop standards
  - self-regulating
  - monitor performance
  - define and deliver products using pre-determined schedules
- Successful operation through cooperation of many international organizations who leverage their respective limited resources to all levels of service functionality

CDDIS Support of IAG Services

- CDDIS is the principle data center supporting services created under the International Association of Geodesy (IAG):
  - 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 Frame Service (IERS)
- Provides infrastructure for populating CDDIS archive
- Primary user base for CDDIS archive

Flow of Files to/from CDDIS
(Information, Data, Products)
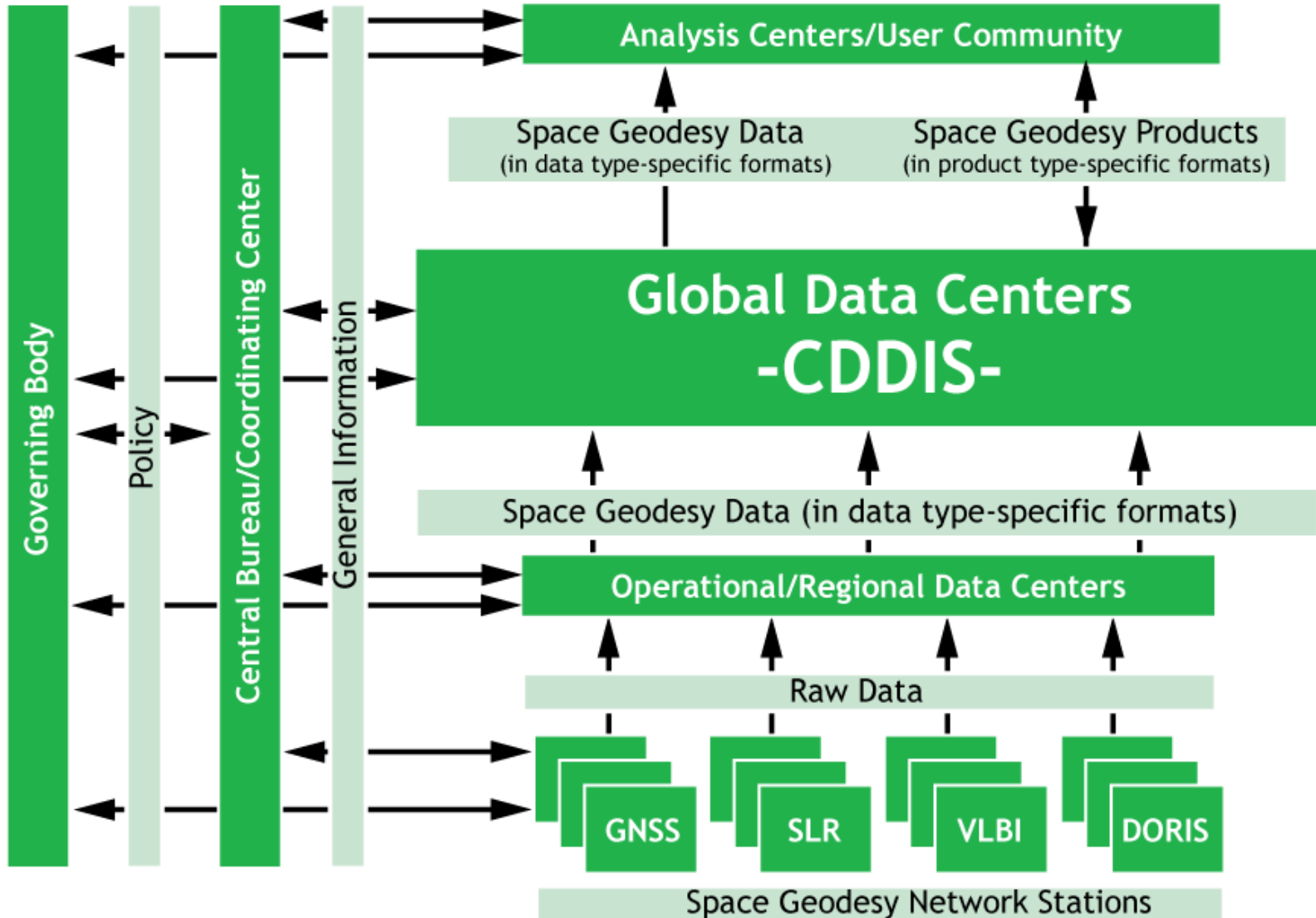
CDDIS Archive

- Archive size: ~5Tb
- Ingest rate: ~2Gb/day
- Distribution rate: ~40Gb/day, 400K files/day
- Files:
  - Data (L1, L1B), products (L2) derived from these data, and information about data and products
  - Multi-day, daily, hourly, sub-hourly
  - Varying latencies (minutes, hours, days)
- Metadata:
  - Non-standard, data type specific
  - Extracted from data (not all products) and loaded into database (Oracle now, MySQL RSN)
  - Internal access to database

CDDIS User Community

- Expert Users

- Production Users

- Novice/Occasional Users

Expert Users

- Majority may be considered "Science Team" type users
  - Analysis Centers supporting IAG services, tasked with providing standard products as per service specifications
  - U.S. and international groups who produce products for use in higher level products (e.g., orbits for GRACE, Jason, etc.; ionosphere/troposphere products for weather models)
- Require continuous access to data for generation of products on pre-determined schedules
- Use scripts to automate retrieval of required files through ftp
- ~40-50% of CDDIS user base

Production Users

- Retrieve files from CDDIS to equalize data holdings among other data centers supporting IAG services
- Use scripts to automate retrieval of required files through ftp
- ~20% of CDDIS user base

Novice/Occasional Users

- Need to explore the contents of the archive by spatial, temporal, platform, or parameter specifications
- Access archive through ftp to:
  - Pick and chose data or products
  - Grab large subsets of data on irregular basis
- Examples:
  - Federal, state, international surveyors who use GNSS reference station data for local measurements
  - Military users who download SLR data for calibration of radars for space debris tracking
  - Managers who need statistics on network data production (metadata search)
  - …
- 30% of CDDIS user base

CDDIS Usage Statistics

- ~9.5 M files, 1.1 Tb/month:
  - Science Users: 4 M files, 440 Gb/month
  - Production Users: 2.5 M files, 310 Gb/month
  - General Users: 3 M files, 300 Gb/month

Data Discovery: Input and Output

- Specify (any/all):
    - Temporal: Year, date/time, range
    - Spatial: Region, lat/lon, range
    - Target: Satellite (SLR, DORIS)
    - Designation: Station name/number/code
    - Parameter: Receiver type (GNSS), event timer (SLR), antenna type (GNSS, VLBI), …
- Results:
    - List of sites satisfying specifications
    - List of data holdings satisfying specifications
    - Metadata relevant to selection
    - …

Example: UNAVCO

http://facility.unavco.org/data/dai2/app/dai2.html

Example: BKG (Germany)

http://igs.bkg.bund.de/

Example: SIO/SOPAC

http://sopac.ucsd.edu/cgi-bin/SITe.cgi

Example: SIO/JPL GPS Explorer
http://geoapp03.ucsd.edu/gridsphere/gridsphere

Background Slides

# Scientific Contributions of the IGS, ILRS, IVS, and IDS

- Terrestrial Reference Frame (TRF):
    - Station positions and velocities: GNSS, SLR, VLBI, DORIS
    - TRF scale and temporal variations: VLBI, SLR
    - Network densification: GNSS
    - Homogenous network distribution: DORIS
- Celestial Reference Frame: VLBI
- Precise Orbit Determination (POD):
    - Accurate satellite ephemerides: GNSS, SLR, DORIS
    - Calibration/validation for remote sensing missions, instruments: SLR, GNSS
    - Sea level monitoring: GNSS, SLR, DORIS
- Earth Orientation Parameters (EOP):
    - Polar motion and rates: VLBI, SLR, GNSS, DORIS
    - Length-of-day: GNSS, SLR, DORIS
    - UT1-UTC and long-term stability of nutation: VLBI
- Atmosphere:
    - Tropospheric zenith delays: GNSS, VLBI
    - Global maps of ionosphere mean electron content: GNSS, DORIS
    - Limb sounding for global profiles of water vapor: GNSS
- Gravity:
    - Static and time-varying coefficients of the Earth's gravity field: DORIS, SLR
    - Total Earth mass: SLR
    - Temporal variations of network origin with respect to Earth center of mass: SLR
- Timing:
    - Station and satellite clock solutions: GNSS
    - Time and frequency transfer between time laboratories: GNSS
- Fundamental Physics:
    - General relativity and alternative theories: SLR/LLR
    - Light bending, time dilation: VLBI

Space Geodesy Data Records

Data Record	Data Set	Processing Level	Granule	Time Span
SLR/LLR	Round trip time of flight (full-rate)	1A	Daily, sub-daily	1975-date
	Round trip time of flight (normal point)	1A	Daily, sub-daily	1991-date
	Station positions	2	Weekly	1992-date
	EOP (polar motion, length of day)	2	Weekly	1992-date
GNSS	Pseudorange and phase observations (RINEX)	1A	Daily, sub-daily	1992-date
	Station positions	2	Weekly	1992-date
	Clocks	2	Weekly, daily, sub-daily	1992-date
	Orbits	2	Weekly, daily, sub-daily	1992-date
	EOP (polar motion and rates, length of day)	2	Weekly, daily, sub-daily	1992-date
	Zenith tropospheric path delay estimates	2	Weekly, daily	1997-date
	Global ionosphere maps	2	Weekly, daily	1998-date
VLBI	Correlated measurement experiment data bases	1A	Daily	1979-date
	Baselines	2	Daily	1979-date
	EOP	2	Daily	1979-date
	Station positions	2	Daily	1979-date
	Source positions	2	Daily	1979-date
	Zenith tropospheric path delay estimates	2	Weekly	2002-date
DORIS	Time-tagged station to satellite range	1A	10-day cycle	1990-date
	Station positions	2	Daily	1993-date
	Derived vertical total electron content (VTEC)	2	Daily	2002-date
	EOP (polar motion, length of day)	2	Daily	2002-date

Supported Missions and Programs
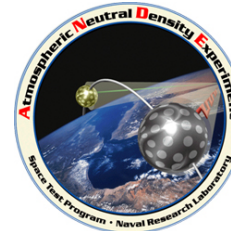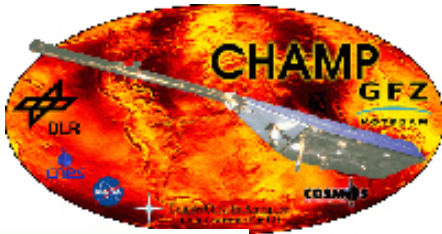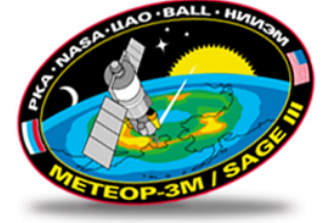
CDDIS Resources

- CDDIS activity in Code 690 (690.1) and co-located with science and technology staff (694 and 698) in Building 33
- Staffing
  - Civil Servants (0.65 FTE)
  - Contractors (2.0 FTE)
  - System administration (0.25 FTE)
- Computer resources
  - Operational server
    - Dell server running Linux
    - Oracle
    - Backup server (currently non-operational)
    - 5+ Tbytes RAID
  - Recently-acquired distributed system
    - Apple Xserves running Mac OS; Dell servers running Linux
    - MySQL
    - Processing, incoming, and outgoing activities on different servers with backup for automated failover
    - 18 Tbytes xSAN
  - Both systems in Building 33

CDDIS Metadata in the GCMD

CDDIS Supplemental Descriptions in the GCMD

Crustal Dynamics Data Information System, Solar System Exploration Division, Goddard Space Flight Center, NASA

Data Center Description

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

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CDDIS Home Page: http://cddis.gsfc.nasa.gov/

**Data Center URL**

URL: http://cddis.gsfc.nasa.gov/

International GNSS Service

Project Description

The International GNSS Service (IGS), formerly the International GPS Service, is a voluntary federation of more than 200 worldwide agencies that pool resources and permanent GPS and GLONASS station data to generate precise GNSS products. The IGS is committed to providing the highest quality data and products as the standard for Global Navigation Satellite Systems (GNSS) in support of Earth science research, multidisciplinary applications, and education. Currently the IGS includes two GNSS, GPS and the Russian GLONASS, and intends to incorporate future GNSS. The IGS collects, archives, and distributes GNSS observation data sets of sufficient accuracy to satisfy the objectives of a wide range of applications and experimentation. These data sets are used by the IGS to generate the data products (high accuracy GNSS satellite ephemerides, Earth rotation parameters, coordinates and velocities of the IGS tracking stations, GNSS satellite and tracking station clock information, timescale products, ionospheric and tropospheric information). In particular, the accuracies of IGS products are sufficient for the improvement and extension of the International Terrestrial Reference Frame (ITRF), the monitoring of solid Earth deformations, the monitoring of Earth rotation and variations in the liquid Earth (sea level, ice-sheets, etc.), for scientific satellite orbit determinations, ionosphere monitoring, and recovery of precipitable water vapor measurements. These activities endeavor to advance scientific understanding of the Earth system components and their interactions, as well as to facilitate other applications benefiting society. The Service also develops the necessary standards and specifications and encourages international adherence to its conventions.

Information provided by http://igs.org
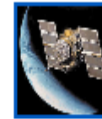
Platform: GPS > Global Positioning System Satellites

▶ Click to view more

Synonymous Platform Names:
▶ Click to view more

Platform-based Instruments:
▶ Click to view more

Orbit
Orbit Altitude: 20,200 km
Orbit Type: MEO > Semi-Synchronous > Navigation

Related Data Sets
View all records related to this platform in GCMD

Description
The Global Positioning System (GPS) Satellite is a system of satellites developed by the US Department of Defense to provide all-weather round-the-clock navigation capabilities for military ground, sea, and air forces. Since its implementation, GPS has also become an integral asset in numerous civilian applications and industries around the globe, including recreational uses (e.g. boating, aircraft, hiking), corporate vehicle fleet tracking, and surveying.

▶ Click to view more

Online Resource:
http://msl.jpl.nasa.gov/Programs/gps.html

Primary Sponsors:
U.S. Department of Defense