

NASA's Crustal Dynamics Data Information System (CDDIS) and its Support of the IGS, ILRS, IVS, and IDS

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Abstract

The Crustal Dynamics Data Information System (CDDIS) has served as a global data center for the International GNSS Service (IGS) since its start in June 1992, providing on-line access to data from nearly 325 sites on a daily basis. This poster paper will present information about the GNSS data and products archive at the CDDIS. General information about the system, the computer architecture, archive contents, and future plans, and its support of other international space geodesy services (the ILRS, IVS, and IDS) will be discussed.

Introduction

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 CDDIS serves 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.

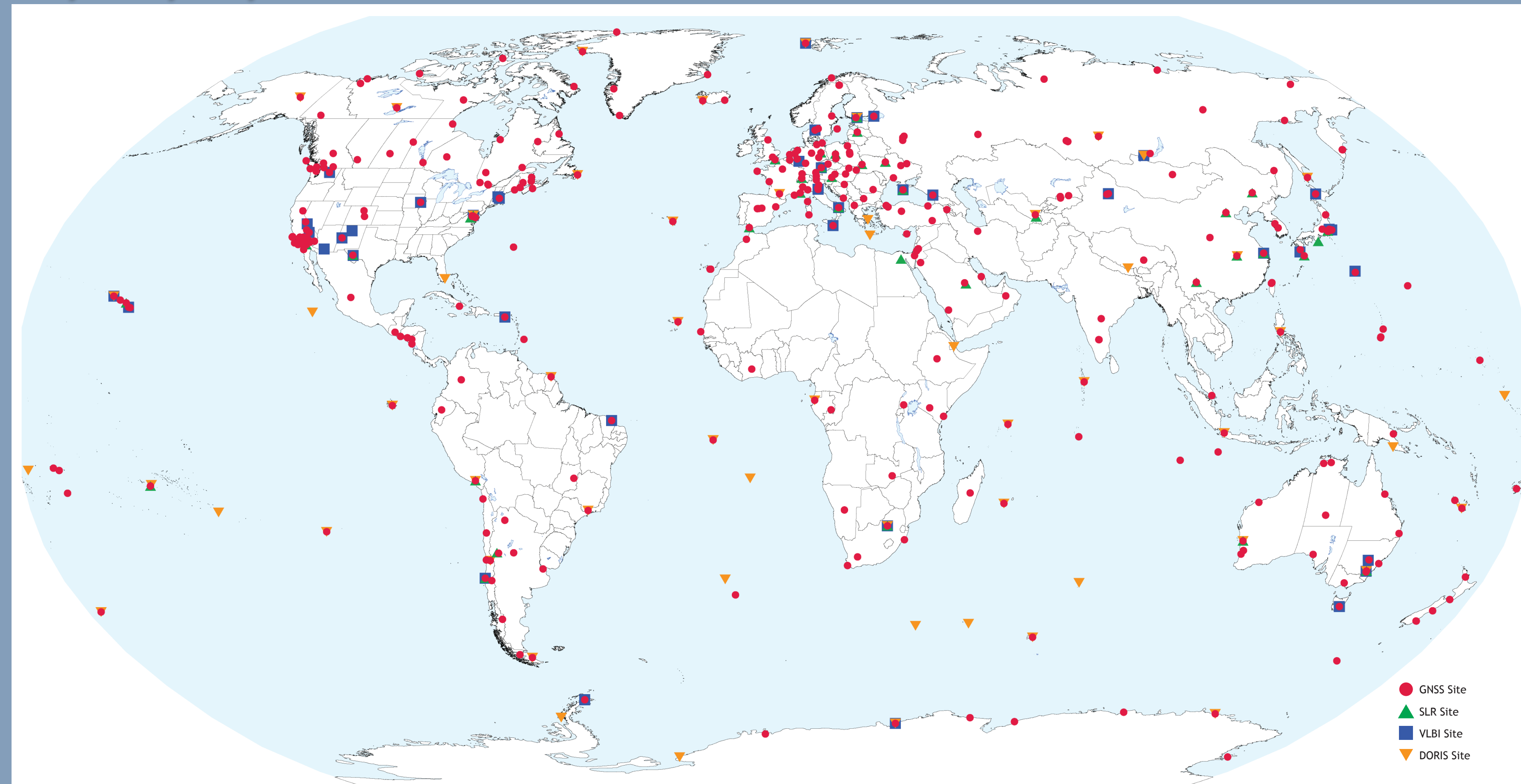
The data archive supports NASA's space geodesy activities within the Science Mission Directorate. The CDDIS data system and its archive have become increasingly important to many national and international programs, particularly several of the operational services within the IAG. The CDDIS serves as 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)

The CDDIS will support the IAG Global Geodetic Observing System (GGOS) project as an underlying archive for the measurement services (IGS, ILRS, IVS, and IDS). Furthermore, the CDDIS will support the GGOS effort by implementing systems that can provide uniform access to heterogeneous space geodetic and in-situ data and information systems.

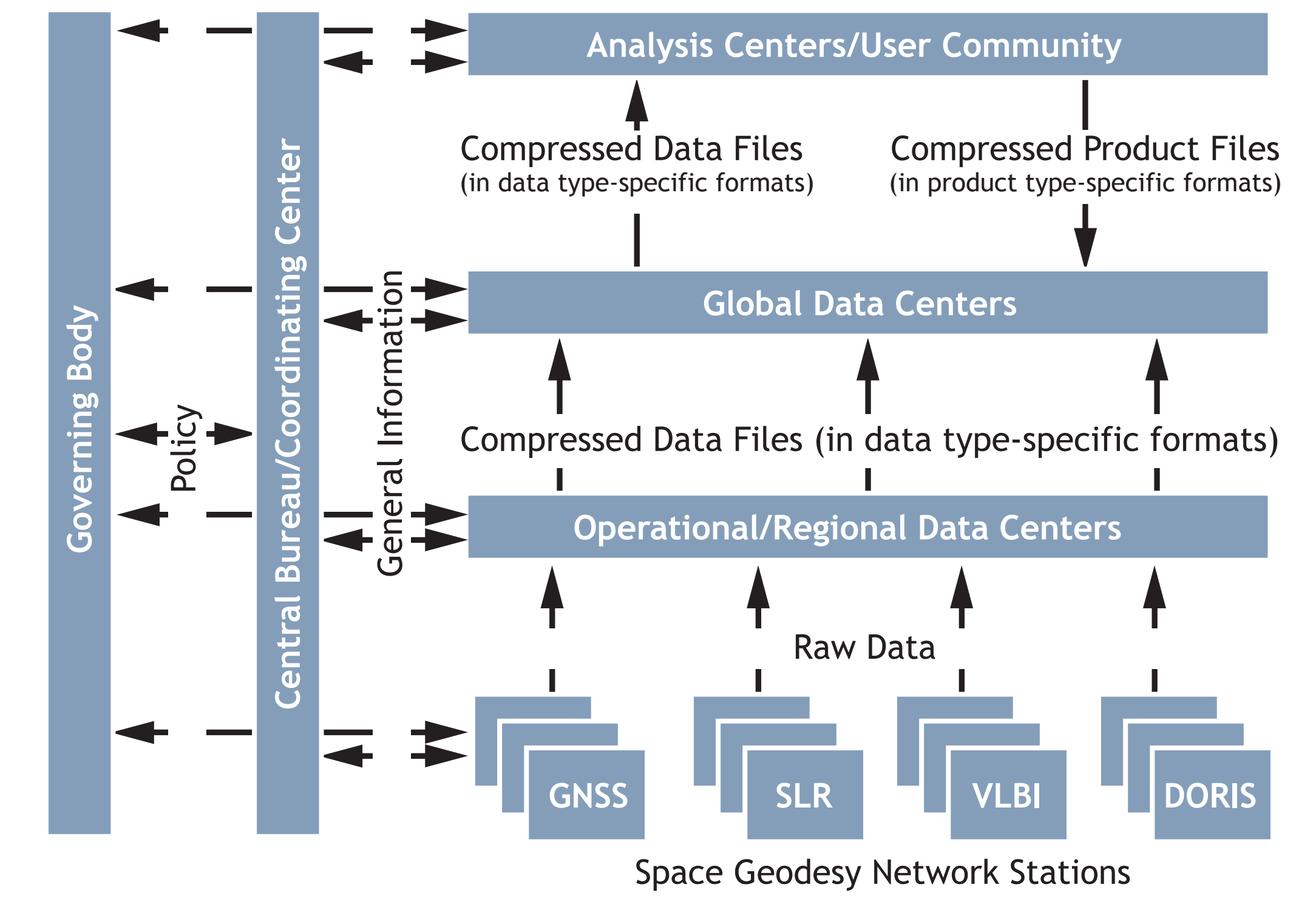
IGS, ILRS, IVS, and IDS Networks



Today, the global geodetic observation networks (within the IGS, ILRS, IVS, and IDS) include 385 GNSS receivers, 44 laser ranging sites, 27 VLBI stations, and 58 DORIS sites. Many locations are co-located sites, supporting more than one of these techniques. The CDDIS serves as the single resource from which the data from all these networks may be accessed as well as higher-level data products derived from the data to support a wide range of Earth science research.

Flow of Data, Product, and Information for IAG Services

Each of these IAG-sponsored services (IGS, ILRS, IVS, and IDS) utilizes a similar structure for the flow of information, data, and products from the observing stations to the user community: Network Stations, Data Centers, Analysis Centers, a Central Bureau or Coordinating Center, and a Governing Body. Participants in service activities, particularly the CDDIS and other data centers, collaborate at all levels to ensure consistency and timely delivery of data and products. The CDDIS is the single global data system that supports all of the geodetic services and thus provides an integrated approach to serving data and products to the international community and the analysts responsible for generation of Earth system products.



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 users

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

Central Bureau/Coordinating Center
Management of service
Facilitate communications
Coordinate activities

Governing Body
General oversight of service
Future direction

CDDIS IGS Data and Product Holdings

GNSS Data:		Sampling	Archive Delay	Format	
Observation, Navigation, Meteorological					
Daily	30 seconds	5 min - days	RINEX		
Hourly	30 seconds	5-15 min	RINEX		
High-rate	1 second	5-15 min	RINEX		
Satellite	10 seconds	1 week	RINEX		
GNSS Products:		Archive Delay	Frequency	Sample Interval	Format
Orbits					
Ultra-rapid	3 hours	4 times/day	15 min	SP3C	
Rapid	17 hours	daily	15 min	SP3C	
Final	13 days	weekly	15 min	SP3C	
Clocks					
Ultra-rapid	3 hours	4 times/day	15 min	SP3C	
Rapid	17 hours	daily	5 min	Clock RINEX	
Final	13 days	weekly	5 min, 30 sec	Clock RINEX	
Positions & velocities	12 days	weekly	weekly	SINEX	
ERP (PM & rates, LOD)					
Ultra-rapid	3 hours	4 times/day	4 times/day	IGS ERP	
Rapid	17 hours	daily	daily	IGS ERP	
Final	13 days	weekly	daily	IGS ERP	
Troposphere ZPD*	30 days	weekly	daily	SINEX_tro	
Ionosphere TEC					
Rapid	<1 day	daily	2 hours	IONEX	
Final	11 days	weekly	2 hours	IONEX	

* PPP-based troposphere combination product

CDDIS GNSS Directory Structure:

Main URL: ftp://cddis.gsfc.nasa.gov

Data subdirectory: /pub/gps/data

GPS+GLONASS Data:

- Daily: /daily/YYYY/DDD/YYT
- Hourly: /hourly/YYYY/DDD/HH
- High-rate: /highrate/YYYY/DDD/YYT/HH
- Satellite: /satellite/SATNAME/YYYY/DDD

GPS Product subdirectory: /pub/gps/products

GPS Products:

- Orbits, Clocks, Positions: /WWW/
- Re-analysis: /WWW/repro#
- Troposphere*: /troposphere/new/YYYY/DDD
- Ionosphere: /ionex/YYYY/DDD

GLONASS Product subdirectory: /pub/glonass/products

GLONASS Products:

- Orbits, Clocks, Positions: /WWW/

WWW=4-digit week
 YYYY=4-digit year
 YY=2-digit year
 DDD=3-digit day of year
 HH=2-digit hour of day
 T=Type of RINEX file (d, g, m, n, o, s)

IGS, ILRS, IVS, and IDS Overview

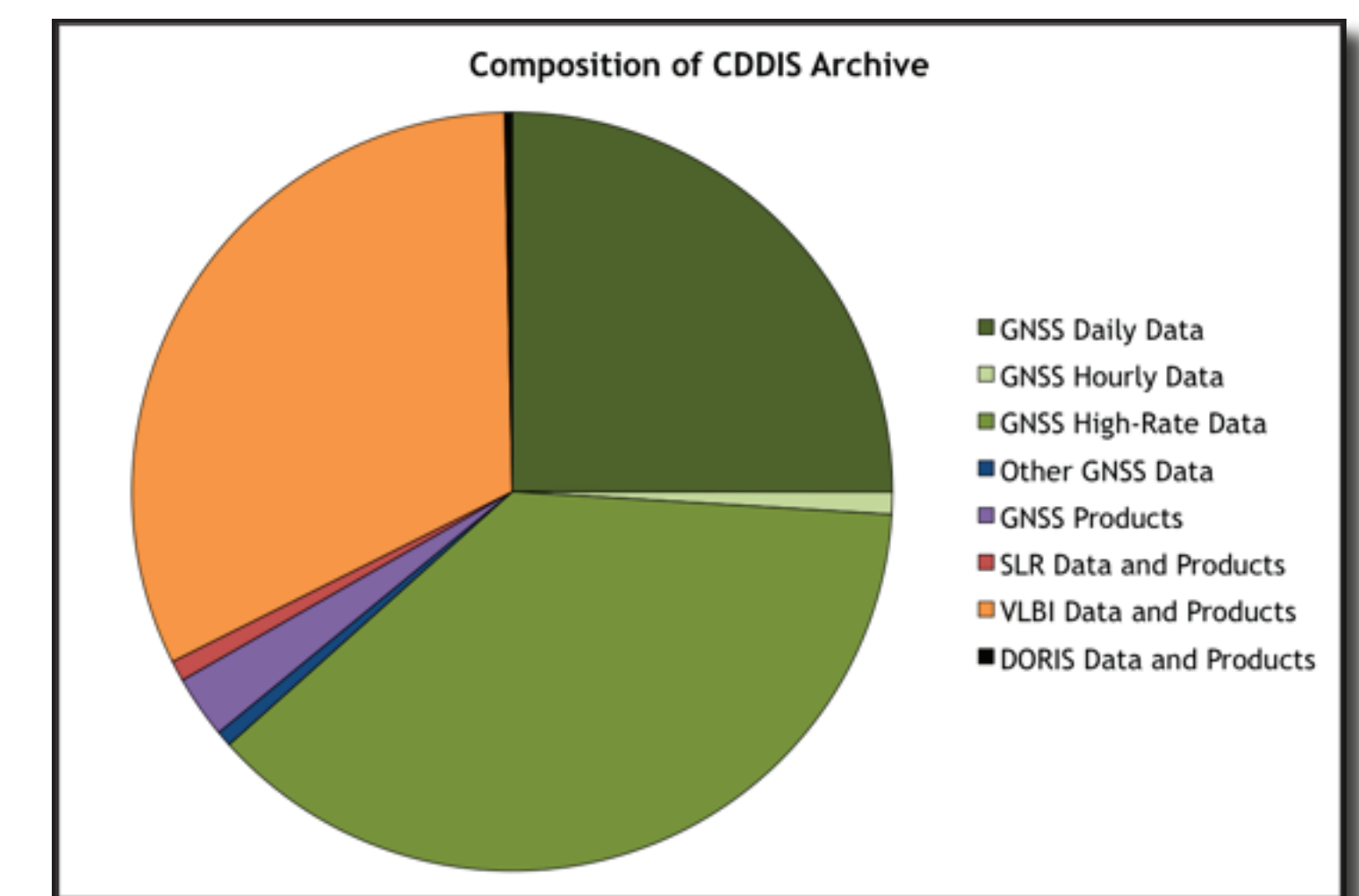
Technique	Target	Instrument	Observable	Derived Products
GNSS 	Satellites (GPS, GLONASS, Galileo) equipped with precise clocks transmitting satellite messages such as ephemeris, clock offsets, etc.	Dual frequency GNSS receiver and antenna	Station to satellite pseudorange, phase delay	<ul style="list-style-type: none"> • Precise satellite ephemerides • Station positions and velocities (input to TRF) • EOP (polar motion and rates, length-of-day) • Station and satellite clock solutions • Zenith tropospheric path delay estimates • Global ionosphere maps
SLR/LLR 	Satellites equipped with corner cubes	Ground-based short-pulse laser transmitter	Round-trip pulse time-of-flight to satellite	<ul style="list-style-type: none"> • Precise satellite ephemerides • Station positions (input to TRF) • EOP (polar motion, length-of-day)
VLBI 	Quasar (microwave frequencies)	Radio telescope equipped with X- and S-wideband receivers	Difference in signal arrival times between two observing antennas	<ul style="list-style-type: none"> • Correlated delay and delay rate of simultaneous observations as a function of time • Station positions, velocities, correlations (input to TRF) • Positions of quasars (input to CRF) • EOP • Troposphere parameters
DORIS 	Satellites equipped with DORIS receiver and uplink hardware	Beacon transmitting radiofrequency signals	Doppler shift on radio frequency signals	<ul style="list-style-type: none"> • Precise satellite ephemerides • Station positions and velocities (input to TRF) • EOP (polar motion, length-of-day) • Derived vertical total electron content

Recent Developments and Future Plans

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 2007, over 11 million files totaling over 1.3 Tbytes 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 140 institutions in over sixty countries supply data to the CDDIS on a daily basis for archival and distribution to the international user community.

In early FY08, NASA Headquarters decided to transfer funding for the CDDIS from the Solid Earth Research Program into the Earth Science Data Systems Core Program, managed through the Earth Science Data and Information System (ESDIS) Project. The move will afford the CDDIS an opportunity to strengthen the data system and integrate information about space geodesy data holdings with EOSDIS and other national and global assets.

By fall 2008, the CDDIS will transition to a new distributed server configuration. Incoming ftp and outgoing ftp and web services will be isolated on separate servers separate from the archive and processing servers. The new system will be configured with over 10 Tbytes of on-line RAID storage with future plans to increase the on-line storage to over 20 Tbytes.



GNSS data and products account for the majority of the CDDIS archive. The size of the VLBI portion is due to a large amount of raw VLBI data. Thus far in 2008, the CDDIS archives approximately 65 Gbytes (over 1.5 million files) per month. In addition, approximately 1.5 Tbytes of data and products (over 11 million files) are retrieved from the CDDIS archive each month.

