IDS Data Flow Coordination (2018)

Patrick Michael/NASA GSFC

Introduction

Two data centers support the archiving and access activities for the IDS:
- Crustal Dynamics Data Information System (CDDIS), NASA GSFC, Greenbelt, MD USA
- l'Institut National de l'Information Géographique et Forestière (IGN), Marne la Vallee France

These institutions have archived DORIS data since the launch of TOPEX/Poseidon in 1992.

Flow of IDS Data and Products

The flow of data, products, and information within the IDS is similar to what is utilized in the other IAG geometric services (IGS, ILRS, IVS) and is shown in Figure 1. IDS data and products are transmitted from their sources to the IDS data centers. DORIS data are downloaded from the satellite at the DORIS control and processing center, SSALTO (Segment Sol multi-missions d'ALTimétrie, d'Orbitographie et de localisation précise) in Toulouse, France. After validation, SSALTO transmits the data to the IDS data centers. IDS analysis centers, as well as other users, retrieve these data files from the data centers and produce products, which in turn are transmitted to the IDS data centers.

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
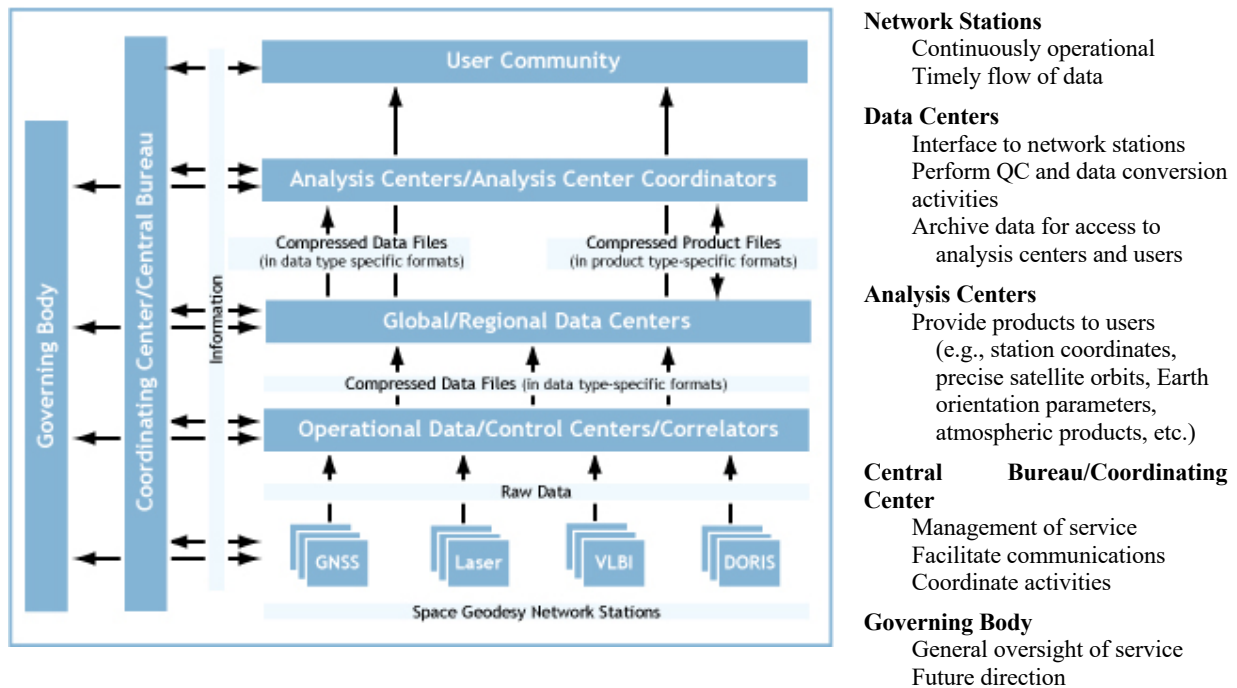General oversight of service
Future direction

Figure 1. Routine flow of data and information for the IAG Geodetic Services

The IDS data centers use a common structure for directories and filenames that was implemented in January 2003. This structure is shown in Table 1 and fully described on the IDS website at *https://ids-doris.org/struct-dc.html*. The main directories are:

- *doris/data* (for all data) with subdirectories by satellite code
- *doris/products* (for all products) with subdirectories by product type and analysis center
- *doris/ancillary* (for supplemental information) with subdirectories by information type
- *doris/campdata* (for SAA-corrected data) with subdirectories by satellite code
- *doris/cb_mirror* (duplicate of the IDS Central Bureau ftp site) with general information and data and product documentation (maintained by the IDS Central Bureau)
- *doris/general* (for miscellaneous information and summary files)

The DORIS mission support ground segment group, SSALTO, and the analysis centers deliver data and products to both IDS data centers (CDDIS and IGN) to ensure redundancy in data delivery in the event one data center is unavailable. The general information available through the IDS Central Bureau ftp site are mirrored by the IDS data centers thus providing users secondary locations for these files as well.

Table 1. Main Directories for IDS Data, Products, and General Information

Directory	File Name	Description
Data Directories		
/doris/data/*sss*	*sss*data*MMM.LLL*.Z	DORIS data for satellite *sss*, cycle number *MMM*, and version *LLL*
	sss.files	File containing multi-day cycle filenames versus time span for satellite *sss*
/doris/data/*sss*/sum	*sss*data*MMM.LLL*.sum	Summary of contents of DORIS data file for satellite *sss*, cycle number *MMM*, and file version number *LLL*
/doris/data/*sss*/yyyy	*sss*rx*YYDDD.LLL*.Z	DORIS data (RINEX format) for satellite sss, date YYDDD, version number *LLL*
/doris/data/*sss*/yyyy/sum	*sss*rx*YYDDD.LLL*.sum	Summary of contents of DORIS data file for satellite *sss*, cycle number *MMM*, and file version number *LLL*
/doris/data/yyyy	*yyddd*.status	Summary file of all RINEX data holdings for year *yy* and day of year *ddd*
Product Directories		
/doris/products/2010campaign/	*ccc/cccYYDDDtuVV.sss*.Z	Time series SINEX solutions for analysis center *ccc*, starting on year *YY* and day of year *DDD*, type *t* (m=monthly, w=weekly, d=daily) solution, content *u* (d=DORIS, c=multi-technique), and solution version *VV* for satellite *sss*
/doris/products/eop/	*cccWWtuVV*.eop.Z	Earth orientation parameter solutions for analysis center *ccc*, for year *WW*, type *t* (m=monthly, w=weekly, d=daily), content *u* (d=DORIS, c=multi-technique), and solution version *VV*
/doris/products/geoc/	*cccWWtuVV*.geoc.Z	TRF origin (geocenter) solutions for analysis center *ccc*, for year *WW*, type *t* (m=monthly, w=weekly, d=daily), content *u* (d=DORIS, c=multi-technique), and solution version *VV*
/doris/products/iono/	*sss/cccsssVV.YYDDD*.iono.Z	Ionosphere products for analysis center *ccc*, satellite *sss*, solution version *VV*, and starting on year *YY* and day of year *DDD*
/doris/products/orbits/	*ccc/cccsssVV.bXXDDD.eYYEEE*.sp1.*LLL*.Z	Satellite orbits in SP1 format from analysis center *ccc*, satellite *sss*, solution version *VV*, start date year *XX* and day *DDD*, end date year *YY* and day *EEE*, and file version number *LLL*
/doris/products/sinex_global/	*cccWWuVV*.snx.Z	Global SINEX solutions of station coordinates for analysis center *ccc*, year *WW*, content *u* (d=DORIS, c=multi-technique), and solution version *VV*
/doris/products/sinex_series/	*ccc/cccYYDDDtuVV*.snx.Z	Time series SINEX solutions for analysis center *ccc*, starting on year *YY* and day of year *DDD*, type *t* (m=monthly, w=weekly, d=daily) solution, content *u* (d=DORIS, c=multi-technique), and solution version *VV*
/doris/products/stcd/	*cccWWtu/cccWWtuVV*.stcd.*aaaa*.Z	Station coordinate time series SINEX solutions for analysis center *ccc*, for year *WW*, type *t* (m=monthly, w=weekly, d=daily), content *u* (d=DORIS, c=multi-technique), solution version *VV*, for station *aaaa*
Information Directories		
/doris/ancillary/quaternions	*sss/yyyy/*qbody*YYYYMMDDHHMISS_yyyymmddhhmiss.LLL*	Spacecraft body quaternions for satellite *sss*, year *yyyy*, start date/time *YYYYMMDDHHMISS*, end date/time *yyyymmddhhmiss*, and version number *LLL*
	*sss/*qsolp*YYYYMMDDHHMISS_yyyymmddhhmiss.LLL*	Spacecraft solar panel angular positions for satellite *sss*, year *yyyy*, start date/time *YYYYMMDDHHMISS*, end date/time *yyyymmddhhmiss*, and version number *LLL*
/doris/cb_mirror		Mirror of IDS central bureau files

DORIS Data

SSALTO deposits DORIS data to the CDDIS and IGN servers. Software at the data centers scans these incoming data areas for new files and automatically archives the files to public disk areas using the directory structure and filenames specified by the IDS. Today, the IDS data centers archive DORIS data from seven operational satellites (CryoSat-2, HY-2A, Jason-2, Jason-3, SARAL, Sentinel-3A, and Sentinel-3B); data from future missions will also be archived within the IDS. Historic data from Envisat, Jason-1, SPOT-2, -3, -4, -5, and TOPEX/Poseidon, are also available at the data centers. A summary of DORIS data holdings at the IDS data centers is shown in Table 2. The DORIS data from select satellites are archived in multi-day (satellite dependent) files using the DORIS data format 2.1 (since January 15, 2002). This format for DORIS data files is on average two Mbytes in size (using UNIX compression). SSALTO issues an email notification through DORISReport once data are delivered to the IDS data centers.

Table 2. DORIS Data Holdings Summary

Satellite	Time Span	Data Type
CryoSat-2	30-May-2010 through present	Multi-day, RINEX
Envisat	13-Jun-2002 through 08-Apr-2012	Multi-day
HY-2A	01-Oct-2011 through present	Multi-day, RINEX
Jason-1	15-Jan-2002 through 21-Jun-2013	Multi-day
Jason-2	12-Jul-2008 through present	Multi-day, RINEX
Jason-3	17-Feb-2016 through present	RINEX
SARAL	14-Mar-2013 through present	Multi-day, RINEX
Sentinel-3A	23-Feb-2016 through present	RINEX
Sentinel-3B	01-May-2018 through present	RINEX
SPOT-2	31-Mar through 04-Jul-1990	Multi-day
	04-Nov-1992 through 14-Jul-2009	
SPOT-3	01-Feb-1994 through 09-Nov-1996	Multi-day
SPOT-4	01-May-1998 through 24-Jun-2013	Multi-day
SPOT-5	11-Jun-2002 through 30-Nov-2015	Multi-day
TOPEX/Poseidon	25-Sep-1992 through 01-Nov-2004	Multi-day

DORIS phase data from CryoSat-2, HY-2A, Jason-2, Jason-3, SARAL, and Sentinel 3A and -3B are also available in the format developed for GNSS data, RINEX (Receiver Independent Exchange Format), version 3.0. These satellites have the newer, next generation DORIS instrumentation on board, which is capable of generating DORIS data compatible with the RINEX format; future satellites will also utilize this type of DORIS receiver. These data are forwarded to the IDS data centers in daily files prior to orbit processing within one-two days (typically) following the end of the observation day. Data from Jason-3 and Sentinel 3A and -3B are only available in the RINEX format.

In the fall of 2012, the IDS Analysis Working Group requested a test data set where data from stations in the South Atlantic Anomaly (SAA) were reprocessed by applying corrective models. Data in DORIS V2.2 format from the Jason-1 satellite (cycles 104 through 536, Jan. 2002 through Jun. 2013) have been submitted to the IDS data centers; a set of SPOT-5 data (cycles 138 through

501, Dec. 2005 through Nov. 2015) have also been submitted and archived. These files are archived at the IDS data centers in campaign directories, e.g., at CDDIS:

ftp://cddis.nasa.gov/doris/campdata/saacorrection/ja1
ftp://cddis.nasa.gov/doris/campdata/saacorrection/sp5
https://cddis.nasa.gov/archive/doris/campdata/saacorrection/ja1
https://cddis.nasa.gov/archive/doris/campdata/saacorrection/sp5

DORIS Products

IDS analysis centers utilize similar procedures by putting products to the CDDIS and IGN servers. Automated software detects any incoming product files and archives them to the appropriate product-specific directory. The following analysis centers (ACs) have submitted products on an operational basis to the IDS; their AC code is listed in ():

- European Space Agency (esa), Germany
- Geoscience Australia (gau) (historic AC)
- Geodetic Observatory Pecny (gop), Czech Republic
- NASA Goddard Space Flight Center (gsc) USA
- Institut Géographique National/JPL (ign) France
- INASAN (ina) Russia
- CNES/CLS (lca historically, grg starting in 2014) France
- CNES/SOD (sod) France (historic AC)
- SSALTO (ssa) France

A solution (designated "ids") produced by the IDS combination center from the individual IDS AC solutions started production in 2012. IDS products are archived by type of solution and analysis center. The types and sources of products available through the IDS data centers in 2005-2017 are shown in Table 3. This table also includes a list of products under evaluation from several DORIS analysis centers.

Table 3. IDS Product Types and Contributing Analysis Centers

Type of Product	ACs/Products										
	ESA	GAU*	GOP	GRG**	GSC	IDS	IGN	INA	LCA**	SOD*	SSA
Time series of SINEX solutions (sinex_series)	X	X	X	X	X	X	X	X	X	X	X
Global SINEX solutions (sinex_global)				X			X		X		
Geocenter time series (geoc)							X	X	X		
Orbits/satellite (orbits)				X	X					X	X
Ionosphere products/satellite (iono)											X
Time series of EOP (eop)							X	X			
Time series of station coordinates (stcd)	X		X	X	X	X	X	X	X		X
Time series of SINEX solutions (2010campaign)		X	X		X		X	X	X		

*Note: GAU and SOD historic solutions
**Note: CNES/CLS transitioned their AC acronym from LCA to GRG in 2014.

Supplementary DORIS Information

In 2009 an additional directory structure was installed at the IDS data centers containing ancillary information for DORIS data and product usage. Files of Jason-1, -2, and -3 satellite attitude information were made available through the IDS data centers. Two types of files are available for each satellite: attitude quaternions for the body of the spacecraft and solar panel angular positions. The files are delivered daily and contain 28 hours of data, with 2 hours overlapping between consecutive files. Analysts can use these files in processing DORIS data to determine satellite orientation and attitude information.

Future Plans

The CDDIS and IGN provide reports that list holdings of DORIS data in the DORIS format. The IDS data centers will also investigate procedures to regularly compare holdings of data and products to ensure that the archives are truly identical.

IDS Data Centers (2018)

Crustal Dynamics Data Information System (CDDIS)
Patrick Michael, Carey Noll/NASA GSFC

Introduction

The CDDIS is a dedicated data center supporting the international space geodesy community since 1982. The CDDIS serves as one of the primary data centers for the following IAG services, projects and international groups:

- International DORIS Service (IDS)
- International GNSS Service (IGS)
- International Laser Ranging Service (ILRS)
- International VLBI Service for Geodesy and Astrometry (IVS)
- International Earth Rotation and Reference Frame Service (IERS)
- Global Geodetic Observing System (GGOS)

The CDDIS is one of NASA's Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Centers (DAACs); EOSDIS data centers serve a diverse user community and are tasked to provide facilities to search and access science data and products. The CDDIS is also a regular member of the International Council for Science (ICSU) World Data System (WDS).

Operational Activities

At the end of 2018, the CDDIS has devoted nearly 119 GB of disk space (64GB or ~54% for DORIS data, 31GB or ~26% for DORIS products, and 23GB or ~19% for DORIS ancillary data and information) to the archive of DORIS data, products, and information. During the past year, users downloaded approximately 6100 Gbytes (3.4M files) of DORIS data, products, and information from the CDDIS.

In 2017, CDDIS developed all new software to automate the ingest of data submitted by SSALTO and in 2018 add product ingest as well. This new software is a significant improvement over the previous process and performs a full range of quality-checks and metadata extraction. The software uses these new checks and metadata to generate a summary file for each data file. All incoming DORIS data have its metadata extracted and stored in a local database. These metadata, which includes satellite, time span, station, and number of observations per pass, and are utilized to generate data holding reports on a daily basis.

The CDDIS provides a file that summarizes the RINEX-formatted data holdings each day. Information provided in the status file includes satellite, start and end date/time, receiver/satellite configuration information, number of stations tracking, and observation types. These files are accessible in yearly sub-directories within the DORIS data subdirectory on CDDIS, *ftp://cddis.nasa.gov/doris/data* or *https://cddis.nasa.gov/archive/doris/data*.

Recent Activities and Developments

During 2017, the CDDIS developed all new software to handle the ingest of GNSS, SLR, and DORIS data and in 2018 the software was upgraded to handle products as well. This new software allows for more automated operation, much improved quality-checks, and a new metadata extraction process and storage method all leading to improved efficiency in processing incoming data. CDDIS's goal is that all incoming files are quality-checked, metadata extracted, and processed into the archive within 30 seconds of being received. A schematic diagram of the current CDDIS architecture is shown in Figure 1.
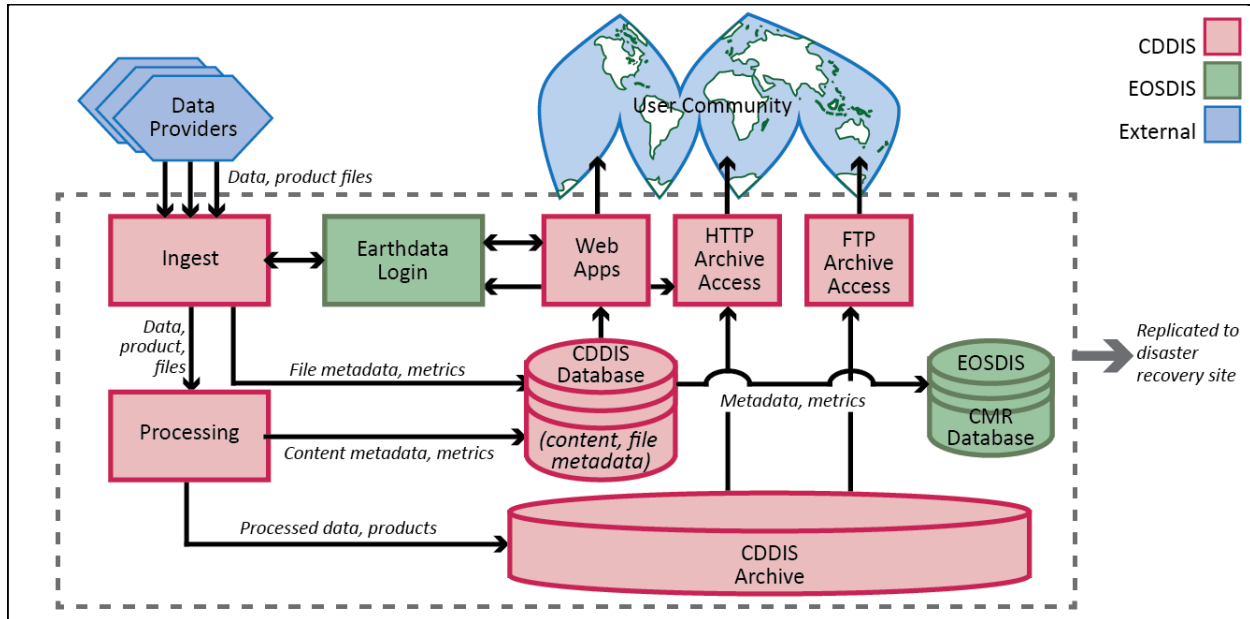

Figure 1: System architecture overview diagram for the new CDDIS facility installation within the EOSDIS infrastructure.

Future Plans

The CDDIS staff will continue to interface with the IDS Central Bureau (CB), SSALTO, and the IDS analysis centers to ensure reliable flow of DORIS data, products, and information. Enhancements and modifications to the data center will be made in coordination with the IDS CB.

The CDDIS has established Digital Object Identifiers (DOIs) for several of its GNSS data sets; website "landing" pages have been established for these published DOIs. DOIs for additional items, including DORIS data and products, are under development and review prior to registering and implementation.

The CDDIS continues to review and update its ingest procedures to both decrease latency of file delivery to the public archive and to continually improve quality control checks to all incoming data and products. In addition, CDDIS has made it's archive fully available through https and will soon add ftp-ssl access as well.

IN response to increased Information Technology (IT) security requirements from both the U.S. Government and NASA, CDDIS will be forced to remove anonymous ftp access to its archive in the fall of 2020. CDDIS strongly suggests that the science community begin moving to https or ftp-ssl to ensure that they are able to continue to download the needed data and products for their operations come fall 2020.

Contact

Carey Noll, CDDIS Manager	Email:	Carey.Noll@nasa.gov
NASA GSFC	Voice:	301-614-6542
Code 61A	Fax:	301-614-6015
Greenbelt, MD 20771		
USA		

Patrick Michael, Deputy CDDIS Manager	Email:	Patrick.Michael@nasa.gov
NASA GSFC	Voice:	301-614-5370
Code 61A	Fax:	301-614-6015
Greenbelt, MD 20771		
USA		

WWW:	*https://cddis.nasa.gov*
Archive access:	*ftp://cddis.nasa.gov/doris*
	https://cddis.nasa.gov/archive/doris
Technical support:	*support-cddis@earthdata.nasa.gov*