

# CDDIS Data Center Report for 2021–2022

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**Abstract** This report summarizes activities during the years 2021 through 2022 and the future plans of the Crustal Dynamics Data Information System (CDDIS) with respect to the International VLBI Service for Geodesy and Astrometry (IVS). Included in this report are background information about the CDDIS, the computer architecture, archive contents, and future plans for the CDDIS within the IVS.

## 1 General Information

The Crustal Dynamics Data Information System (CDDIS) has supported the archiving and distribution of Very Long Baseline Interferometry (VLBI) data since its inception in 1982. The CDDIS is a central facility that provides users access to data and derived products to facilitate scientific investigation. The full CDDIS archive of GNSS (GPS, GLONASS, Galileo, etc.), laser ranging, VLBI, and DORIS data is available online for remote access. Information about the system is available via the web at the URL <https://cddis.nasa.gov>. In addition to the IVS, the CDDIS actively supports other IAG services including the International GNSS Service (IGS), the International Laser Ranging Service (ILRS), and the International DORIS Service (IDS), as well as the International Earth Rotation and Reference Systems Service (IERS), and the IAG's observing system, the Global Geodetic Observ-

ing System (GGOS). The current and future plans for the CDDIS support of the IVS are discussed below.

The CDDIS is one of NASA's Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Centers (DAACs) (see <https://earthdata.nasa.gov>); EOSDIS Data Centers serve a diverse user community and are tasked to provide facilities to search for and access science data and products. The CDDIS is also a regular member of the International Science Council (ISC) World Data System (WDS, <https://www.worlddatasystem.org>) and the Earth Science Information Partners (ESIP, <https://www.esipfed.org>).

## 2 System Description

The CDDIS archive of VLBI data and products is accessible to the public through encrypted ftp at [gdc.cddis.eosdis.nasa.gov](ftp://gdc.cddis.eosdis.nasa.gov) and https at <https://cddis.nasa.gov/archive>. Anonymous ftp access was deprecated in November 2020.

### 2.1 File Submissions

The CDDIS utilizes an https-based protocol method for the delivery of files from suppliers of data and products. The validation is performed through the EOSDIS Earthdata Login system, the same system used for access to the CDDIS real-time caster. The file uploads can be performed through a webpage interface

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**Table 1** IVS data and product directory structure.

Directory	Description
<b>Data Directories</b>	
vlbi/ivsdata/db/yyyy	VLBI database files for year yyyy
vlbi/ivsdata/ngs/yyyy	VLBI data files in NGS card image format for year yyyy
vlbi/ivsdata/vgosdb/yyyy	VLBI data files in vgosDB format for year yyyy
vlbi/ivsdata/aux/yyyy/ssssss	Auxiliary files for year yyyy and session ssssss These files include log files, wx files, cable files, schedule files, correlator notes.
vlbi/ivsdata/swin/yyyy	VLBI SWIN files for year yyyy
<b>Product Directories</b>	
vlbi/ivsproducts/crf	CRF solutions
vlbi/ivsproducts/eopi	EOP-I solutions
vlbi/ivsproducts/eops	EOP-S solutions
vlbi/ivsproducts/daily_sinex	Daily SINEX solutions
vlbi/ivsproducts/int_sinex	Intensive SINEX solutions
vlbi/ivsproducts/trf	TRF solutions
vlbi/ivsproducts/trop	Troposphere solutions
<b>Project Directories</b>	
vlbi/ITRF2013	IVS contributions to the ITRF 2013 efforts
vlbi/ITRF2014	IVS contributions to the ITRF 2014 solution
vlbi/ivs-pilotbl	IVS Analysis Center pilot project (baseline)
<b>Other Directories</b>	
vlbi/ivscontrol	IVS control files (Master Schedule, etc.)
vlbi/ivsdocuments	IVS document files (solution descriptions, etc.)
vlbi/raw	Raw VLBI data
vlbi/ivsformats	IVS File Format Definitions

or a command line application that can perform an http “post” operation, which is more commonly used for scripting. This process allows data suppliers to authenticate through the Earthdata Login system and provide their files through https to CDDIS for ingest into the archive. More information on the CDDIS file upload system, including an FAQ, is available at URL: [https://cddis.nasa.gov/About/CDDIS\\_File\\_Upload\\_Documentation.html](https://cddis.nasa.gov/About/CDDIS_File_Upload_Documentation.html).

## 2.2 File Ingest Processing

Starting in 2018, the CDDIS worked with the GSFC VLBI staff to transition code for processing incoming VLBI-related files into a new, common file ingest software. This new common ingest software would be shared with the other IVS global Data Centers to ensure that a common quality control (QC) and metadata process was shared across the global Data Centers. In late 2020, CDDIS moved its entire VLBI ingest process to this new collaborative process. Several changes were made to enable more rapid acceptance of new

data/product files by the incorporation of data definition files (DDFs). These DDFs are unique to each file type and specify a range of QC and metadata requirements for each file type. This, in turn, is parsed by the ingest software to determine the QC and metadata actions to accomplish for each incoming file before acceptance into the archive.

## 3 Archive Contents

The CDDIS has supported GSFC VLBI and IVS archiving requirements since 1979 and 1999, respectively. The IVS Data Center content and structure is shown in Table 1 (a figure illustrating the flow of information, data, and products between the various IVS components was presented in the CDDIS submission to the IVS 2000 Annual Report). As described above, the CDDIS has established a file upload system for providing IVS data, product, and information files to the archive. Using specified filenames, Operation and Analysis Centers upload files to this system. Automated archiving routines peruse the directories

and move any new data to the appropriate public disk area. These routines migrate the data based on the file-name DDFs to the appropriate directory as described in Table 1. Software on the CDDIS host computer, as well as all other IVS Data Centers, facilitates equalization of data and product holdings among these Data Centers by placing all new received data/products into a RECENTS directory for action by the other Data Centers. The performance of mirroring was scheduled to begin again between the IVS Data Centers located at the CDDIS, the Bundesamt für Kartographie und Geodäsie in Leipzig, and the Observatoire de Paris in late June 2021, and mirroring is now being performed.

The public file system in Table 1 on the CDDIS computer consists of a data area, which includes auxiliary files (e.g., experiment schedule information and session logs) and VLBI data (in the database, NGS card image, and new vgosDB formats). A products disk area was also established to house analysis products from the individual IVS Analysis Centers as well as the official combined IVS products. A documents disk area contains format, software, and other descriptive files.

#### 4 Significant New Data Sets

CDDIS in late 2019 began to work with GSFC VLBI staff to archive the VLBI Level 1 correlator output files (SWIN). Because these files were previously only housed at each individual correlator, there was a significant risk that data files could be lost. Therefore, CDDIS working with the IVS created a request for NASA HQ to fund the expansion of CDDIS operations to perform quality control on this data set and archive it. In the summer of 2020, hardware was procured and installed, and by late 2020, most of the QC and ingest software had been developed. CDDIS began accepting these data in March 2021. The archiving of this data set has been slower than expected with several correlators still not pushing their full dataset collection to CDDIS.

#### 5 Accessing the CDDIS Archive

The CDDIS has a large international user community; over 530k unique hosts accessed the system in 2022. Today, users access the CDDIS archive through any-

mous encrypted ftp and https. As per U.S. Government and NASA directives, the CDDIS moved users away from reliance on anonymous ftp and terminated all unencrypted ftp on 1 November 2020. The CDDIS has configured servers to utilize protocols that allow two new methods for system access: https (browser and command line) and ftp-ssl (command line). The https protocol is as efficient as ftp transfer and is without the firewall/router issues of ftp. The access to the CDDIS archive through both methods continues to present the same directory structure as the old, unencrypted ftp. Archive access through the https protocol utilizes the same NASA single sign-on system, the EOSDIS Earthdata Login utility, as is used for the file upload. Before using the https protocol to access the CDDIS archive, new users must initially access the webpage <https://cddis.nasa.gov/archive> to establish an account and authorize access; this page will then redirect the user to the Earthdata Login page. Earthdata Login allows users to easily search and access the full breadth of all twelve EOSDIS DAAC archives. Earthdata Login also allows CDDIS staff to know our users better, which will then allow us to improve CDDIS capabilities. Once an account is established, the user has all permissions required to access the CDDIS archive using the https protocol, via a web browser or via a command line interface (e.g., through cURL or Wget) to script and automate file retrieval. In addition, ftp-ssl access, an extension of ftp using TLS (transport layer security), can be used for scripting downloads from the CDDIS archive. The ftp-ssl is the option most similar to standard unencrypted anonymous ftp. As with https, ftp-ssl will satisfy U.S. Government/NASA requirements for encryption. Examples on using these protocols, including help with the cURL and Wget commands, are available on the CDDIS website; users are encouraged to consult the available documentation at [https://cddis.nasa.gov/About/CDDIS\\_File\\_Download\\_Documentation.html](https://cddis.nasa.gov/About/CDDIS_File_Download_Documentation.html) as well as various presentations on these updates to the CDDIS archive access (see Section 7 below and <https://cddis.nasa.gov/Publications/Presentations.html>).

## 6 System Usage

During the 2021–2022 time period, over 11,000 distinct users accessed the CDDIS to retrieve VLBI-related files. These users, which include other IVS Data Centers, downloaded over 27.4 Tbytes (9.0 M files) of VLBI-related files from the CDDIS in this two-year period.

## 7 Future Plans

The CDDIS staff will continue to work closely with the IVS Coordinating Center staff to ensure that our system is an active and successful participant in the IVS archiving effort. A major area of focus will be the continued modifications to the CDDIS ingest processing software to accommodate all incoming VLBI-related files.

The staff is also testing providing a WebDAV (Web Distributed Authoring and Versioning) interface to provide another method for accessing the CDDIS archive. If feasible for CDDIS, this interface method would allow users to securely connect to the CDDIS archive as if it were a local drive on their computer.

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