

# The Crustal Dynamics Data Information System (CDDIS) – Updates and Future Developments

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# WHAT IS CDDIS?

The Crustal Dynamics Data Information System (CDDIS) is one of NASA's Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Centers (DAACs). For over 40 years, CDDIS has supported the space geodesy community by providing continuous, long-term, public access to Global Navigation Satellite System (GNSS), Satellite Laser Ranging (SLR), Very Long Baseline Interferometry (VLBI), and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) data and derived products required for a diverse variety of scientific studies. CDDIS is funded by NASA but cooperates extensively with the international community in support of Earth science research. CDDIS serves as one of the primary data centers and core components for the geodetic services established under the International Association of Geodesy (IAG). In particular, the system has supported the International GNSS Service (IGS) as a global data center since 1992.

Doto Tymo	Number of Sites				Vol.	# files	Directory
Data Type	V2	<b>V</b> 3	V2+V3	Unique	vot.	# files	Directory
Daily	281	438	160	558	1,729 GB	1.3M	/gnss/data/daily
Hourly	171	359	133	397	713 GB	14.6M	/gnss/data/hourly
High-rate	118	307	109	316	20 TB	34.2M	/gnss/data/highrate

Table 1. Summary of GNSS data archive at CDDIS for 2023.

Sample Rate	<b>Data Format</b>	<b>Available Online</b>
30 sec.	RINEX V2	Since 1992
30 sec.	RINEX V3	Since 2016
30 sec.	RINEX V2	Since 2005
30 sec.	RINEX V3	Since 2016
1 sec.	RINEX V2	Since 2001
1 sec.	RINEX V3	Since 2016
10 sec.	RINEX V2	2002-2012
	30 sec. 30 sec. 30 sec. 30 sec. 1 sec. 1 sec.	30 sec. RINEX V2 30 sec. RINEX V3 30 sec. RINEX V2 30 sec. RINEX V3 1 sec. RINEX V2 1 sec. RINEX V3

Table 2. Summary of IGS GNSS data sets available at CDDIS

Data Type	Number Distributed
GNSS Highrate D	187+ million
GNSS Hourly D	175+ million
GNSS Hourly P	72+ million
GNSS Daily D	65+ million
GNSS Hourly N	60+ million

Table 3. Subset of IGS GNSS data sets distributed by CDDIS in 2023, organized by number distributed

# NATURAL HAZARDS: GNSS GUARDIAN NEAR REAL-TIME IONOSPHERIC TOTAL ELECTRON CONTENT (TEC) PRODUCT

Developed at NASA's Jet Propulsion Laboratory (JPL), the GNSS-based Upper Atmosphere Realtime Disaster Information and Alert Network (GUARDIAN) is near real-time (NRT) ionospheric monitoring software (Martire et al, 2023). Its main products are NRT total electronic content (TEC) time series, allowing users to explore ionospheric TEC perturbations due to natural and anthropogenic events on Earth. The NRT GUARDIAN time series are validated against well-established post-processing methods. Currently, time series are computed for more than 90 GNSS ground stations distributed around the Pacific Ring of Fire, which monitor the four main GNSS constellations - GPS, Galileo, BeiDou Navigation Satellite System (BDS), and Global'naya Navigatsionnaya Sputnikovaya Sistema (GLONASS).

### **Uses**:

- Earthquake
- USGS Tsunami Watch Volcanic Eruptions
- Geomagnetic Storms

The product is stored in the CDDIS archive. To support latency needs for the NRT data, CDDIS shifted from processing at scheduled intervals to processing files via a queueing system that processes files as they are uploaded, reducing latency times to a minimum. In addition to the change in upload procedures, CDDIS has also updated their processing software to simplify the planned transition

for CDDIS to the Earthdata Cloud.

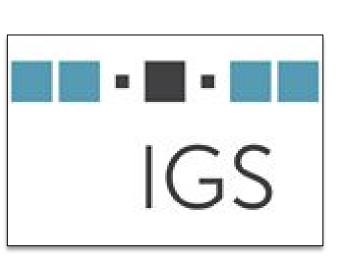
**GUARDIAN** Website

P1: 010









General class Load Balancer Initial File Checks Middleware Technique specific class Driver (technique specific) DDF Identification Internal QC (DDF specific) Error Database insertion 

← Fatal Error? External QC (DDF specific) not applicable for all Database insertion Metadata Extraction (dataset specific) CMR insertion

Figure 1. CDDIS Processing V4 Software Flow Diagram

# GNSS REAL-TIME (NTRIP) SYSTEM STATUS AND LATENCIES

CDDIS has real-time Networked Transport of Radio Technical Commission for Maritime Services (RTCM) via Internet Protocol (NTRIP) streaming software for receipt and transmission of real-time GNSS data and product streams in support of the IGS Real-Time Service. The available product streams consist of GNSS orbit and clock corrections.

#### Use:

- Precise point positioning
- Time synchronization
- Disaster monitoring





CDDIS has been supporting GNSS real-time data streaming since 2018 via the CDDIS NTRIP Caster broadcaster. This year, to provide additional usability and clarity to users, CDDIS created a real-time map showing which streams are active and their latencies. **CDDIS NTRIP Caster** 

### **CDDIS Real-Time Streams**

More information about the real-time streams available through the CDDIS NTRIP Caster can be viewed at the links in the QR Codes to the right.

Stream Latencies



active data streams

**CDDIS NTRIP Caster** inactive data streams



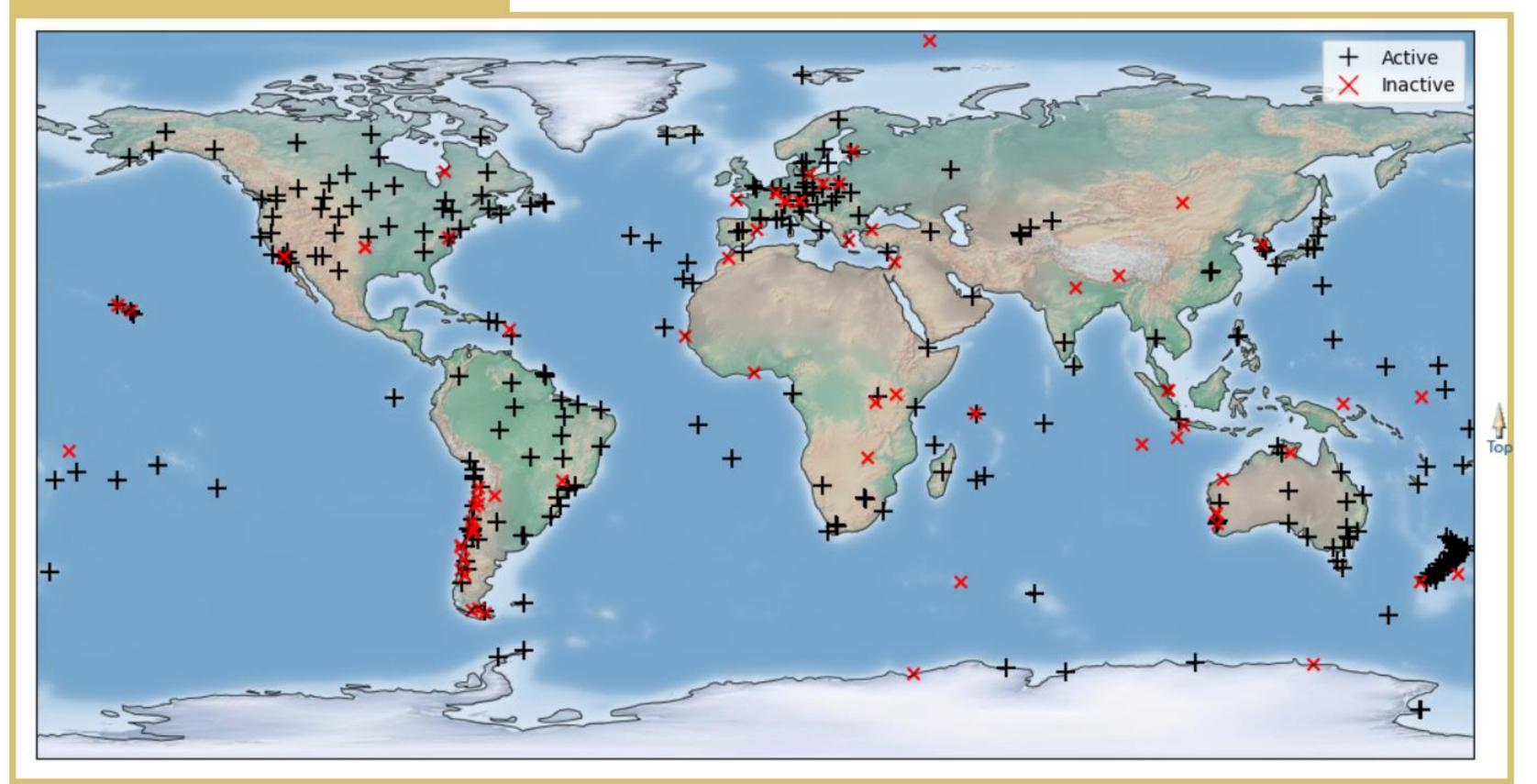


Figure 2. Example of CDDIS Real-Time Steam Latencies Map

## CDDIS AND OPEN SCIENCE

### **Open Science at NASA**

NASA is making a long-term commitment to building an inclusive open science community over the next decade. Open-source science is a commitment to the open sharing of software, data, and knowledge (algorithms, papers, documents, ancillary information) as early as possible in the scientific process.

### **Principles of Open Science:**

Open Accessible Science: Data, tools, software, documentation, and publications should be accessible to all (under the FAIR principles - findability, accessibility, interoperability, and reusability).

All CDDIS data is already public and open to all users. We do not have restricted or limited access data. The science community that CDDIS has traditionally relied on to create data products is not open source software, nor can CDDIS make it open, as it is not CDDIS controlled. In many ways, CDDIS has been doing Open (Accessible) Science for a long time.



CDDIS also participates with NASA's Earth Science Data and Information System (ESDIS) Standards Coordination Office (ESCO) to ensure that documentation regarding geodesy standards is provided for

Open Transparent Science: Scientific process and results should be visible, accessible, and understandable.

The space geodesy community has relied on open access and open standards for over 40 years and is maintained by the community to allow any and all users to see and understand the file formats used.

**Open Inclusive Science:** Process and participants should welcome participation by and collaboration with diverse people and organizations.

CDDIS has had regular interaction and collaboration with organizations including the IGS, International DORIS Service (IDS), International Laser Ranging Service (ILRS), International VLBI Service (IVS), Global Geodetic Observing Service (GGOS), and the International Union of Geodesy and Geophysics (IUGG). These collaborations have been in place for many decades, and members of CDDIS have participated in several working groups, and every served as working group leads.





# CDDIS AND THE CLOUD

CDDIS was originally slated to transition to NASA's Earthdata Cloud (via Amazon Web Services) by 2026 as part of NASA's goals for Open Science. CDDIS was recently put into a pause for efforts moving to the Earthdata Cloud. Users are still able to download data to their servers and the original archive structure will still be maintained.

Once CDDIS has shifted to the Cloud, users will have access to the following benefits:

- Access to full features on Earthdata Search including searchability and download directly from Earthdata
- Ability to work with CDDIS data and products in the cloud downloads will no longer be required, reducing the need to invest in on-premises resources
- Easier identification of collocated data from across NASA's DAACs
- Access to new tools for subscribing to and analyzing data

### **CURRENT AND FUTURE DEVELOPMENTS**

CDDIS ReadMe files are used to provide an overview of files available in our archive. CDDIS has started listing all of the subdirectories under the respective technique including the corresponding landing page. The landing pages contain information about the data/products including information on how to cite the data via DOIs. These changes are currently being applied to the GNSS subdirectories and will be updated within the next couple of weeks. The current ReadMe file for GNSS subdirectories can be seen in Figure 3 below

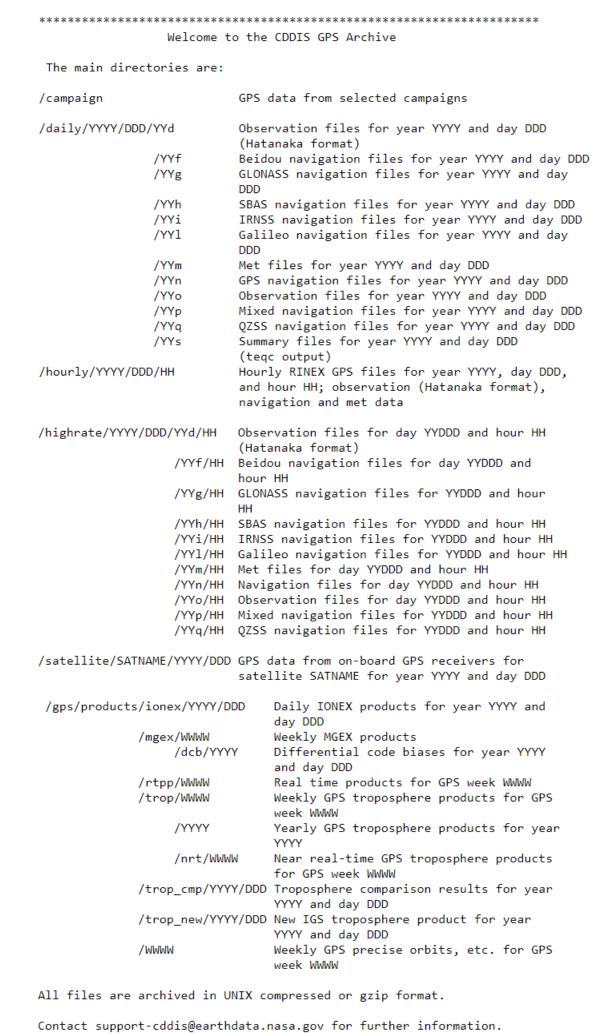


Figure 3. Screenshot of the GNSS README File

The CDDIS website is undergoing a transition through the Web Unification Project, managed by NASA's ESDS. CDDIS will be moving from the current website (located at cddis.nasa.gov) to NASA's new Earthdata website (located at earthdata.nasa.gov). This transition is scheduled for the

Spring of 2025 and will result in a unified landing page design for all of the DAACs. An example of what the current landing page prototype looks like can be seen in Figure 4. As 50% of CDDIS data distribution is through our web access, we greatly value our users and appreciate any

feedback regarding this new landing page design. Please provide all feedback to the email address support@earthdata.nasa.gov with the topic of "CDDIS".

CDDIS is also updating the way our data collections are managed, with plans to make each of the IGS GNSS stations as its own data collection within the CDDIS archive, with its own DOI and its own landing page. This will address recent concerns regarding data citations and will highlight the data available at each of the IGS GNSS stations.

CDDIS recently uploaded GeoJSON files for IGS GNSS station locations to Esri's ArcGIS Online (see the map of the stations in Figure 5). The files are freely available for download to the public.



Figure 5. Map of IGS GNSS stations created from a GeoJSON file that is now readily available for public download with Esri's ArcGIS Online.

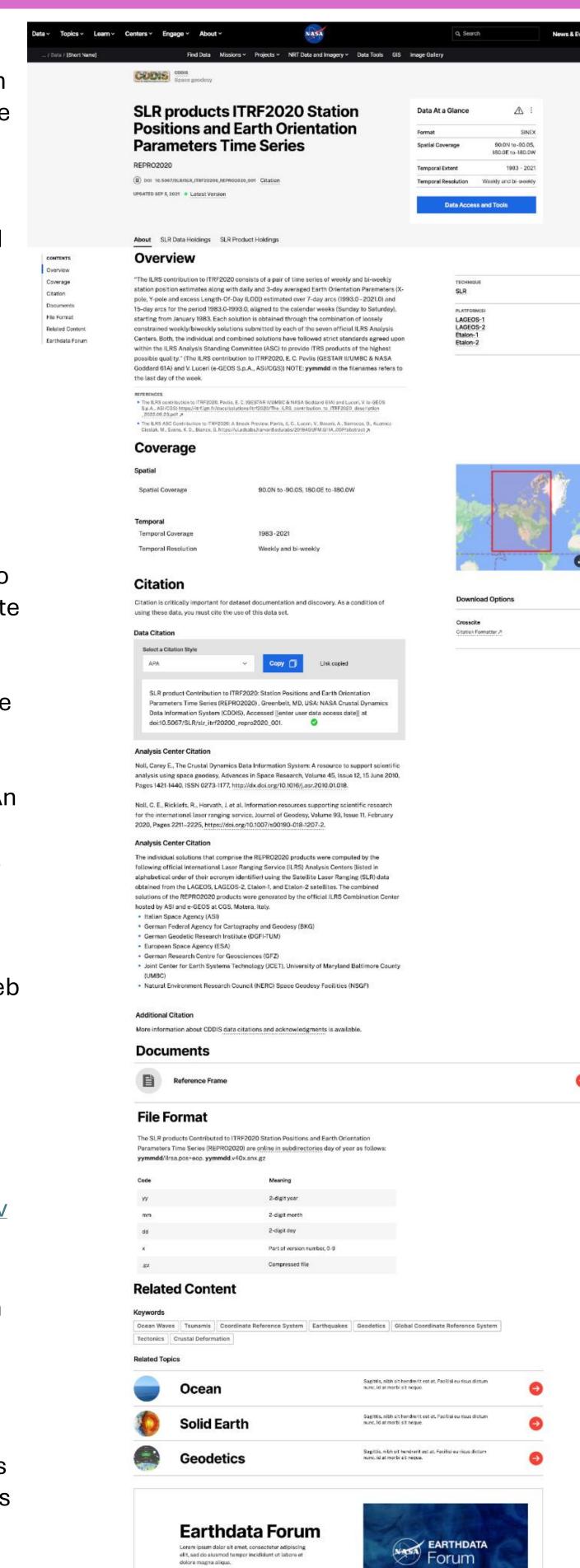


Figure 4. Screenshot of a prototype landing page

Download the GeoJSON file for IGS GNSS station locations:

