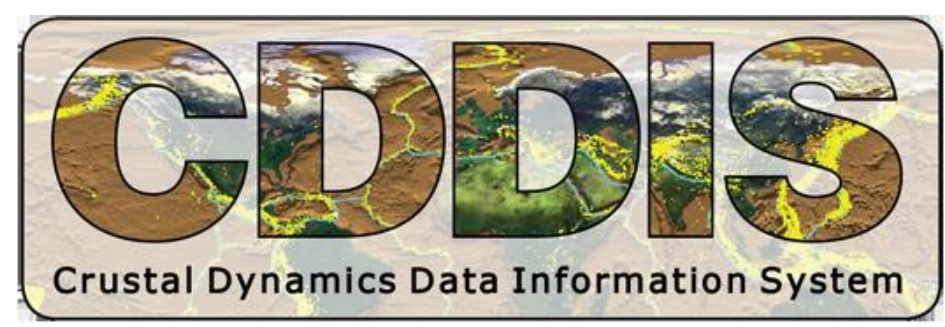


The Crustal Dynamics Data Information System (CDDIS) – Updates and Future Developments

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ABSTRACT

As earth observing services and techniques have flourished, data and products have exponentially grown, like the proliferation of GNSS stations capable of providing real-time data, SLR stations shifting to kHz lasers, and VLBI's implementation of VGOS telescopes. The CDDIS is continually evolving to fulfill the new storage, quality check, and latency requirements that these changes bring, as well as meet new standards such as the shift toward FAIR and open science. These have shaped how the CDDIS develops new software and resources. Beginning next year, the CDDIS will begin to transition their data and products to the AWS cloud, beginning with DORIS data. This poster will highlight the CDDIS's recently updated processing system, new data and products available, and future work.

WHAT IS THE CDDIS?

The CDDIS was established in 1982 and currently supports GGOS as an essential archive for geodetic data and products:

- Global Navigation Satellite Systems (GNSS)
- Laser ranging (satellite, SLR, and lunar, LLR)
- Doppler Orbitography and Radio-positioning Integrated by Satellite (DORIS)
- Very Long Baseline Interferometry (VLBI)

CDDIS - Total number of files downloaded by Country 2023

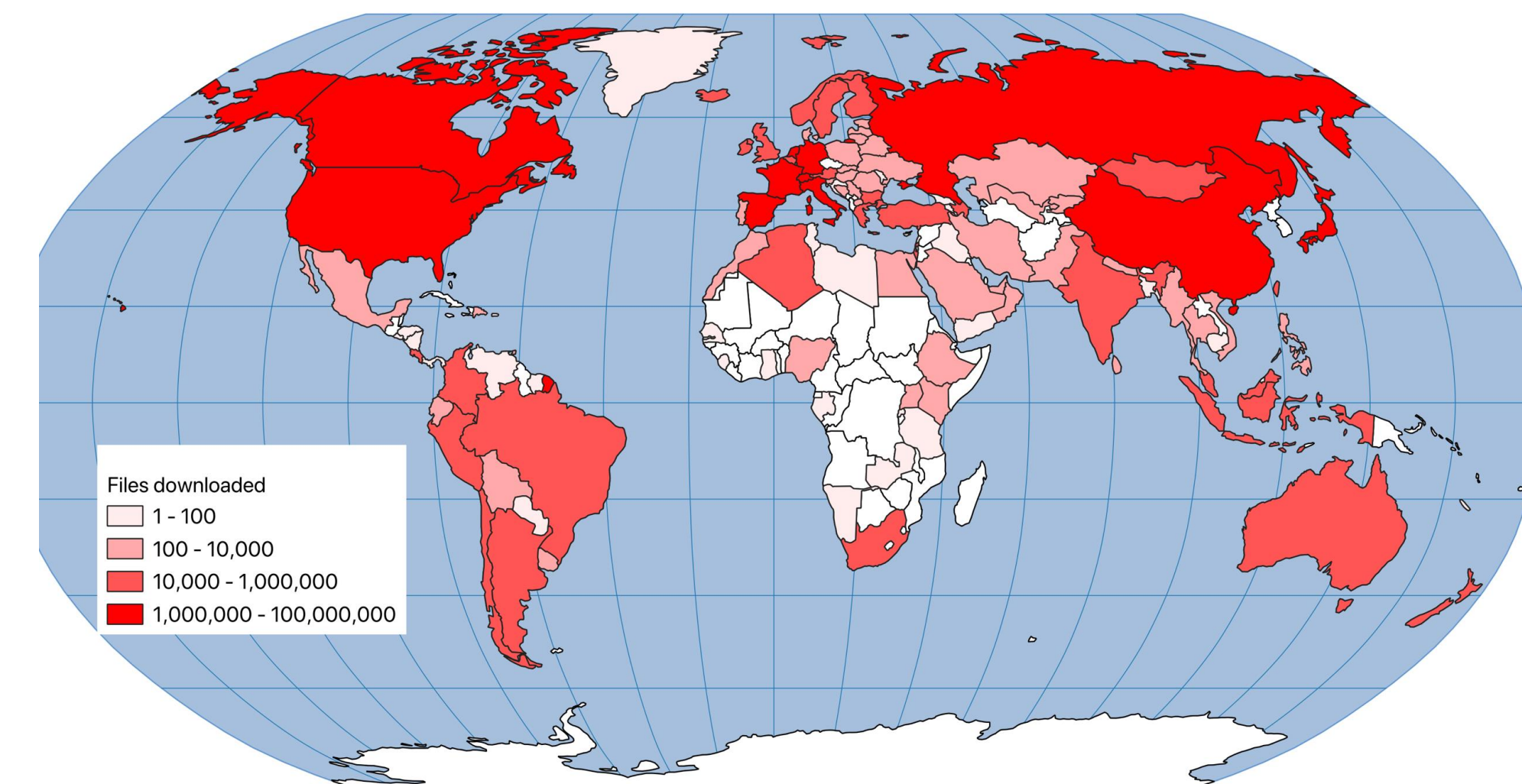


Figure 1: CDDIS Download Statistics for 2023

NATURAL HAZARDS: GNSS GUARDIAN NEAR-REAL-TIME IONOSPHERIC TOTAL ELECTRON CONTENT PRODUCT

Description: 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, BDS, and GLONASS).

- Uses:**
- Earthquake
 - USGS Tsunami Watch
 - Volcanic Eruptions
 - Geomagnetic Storms

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

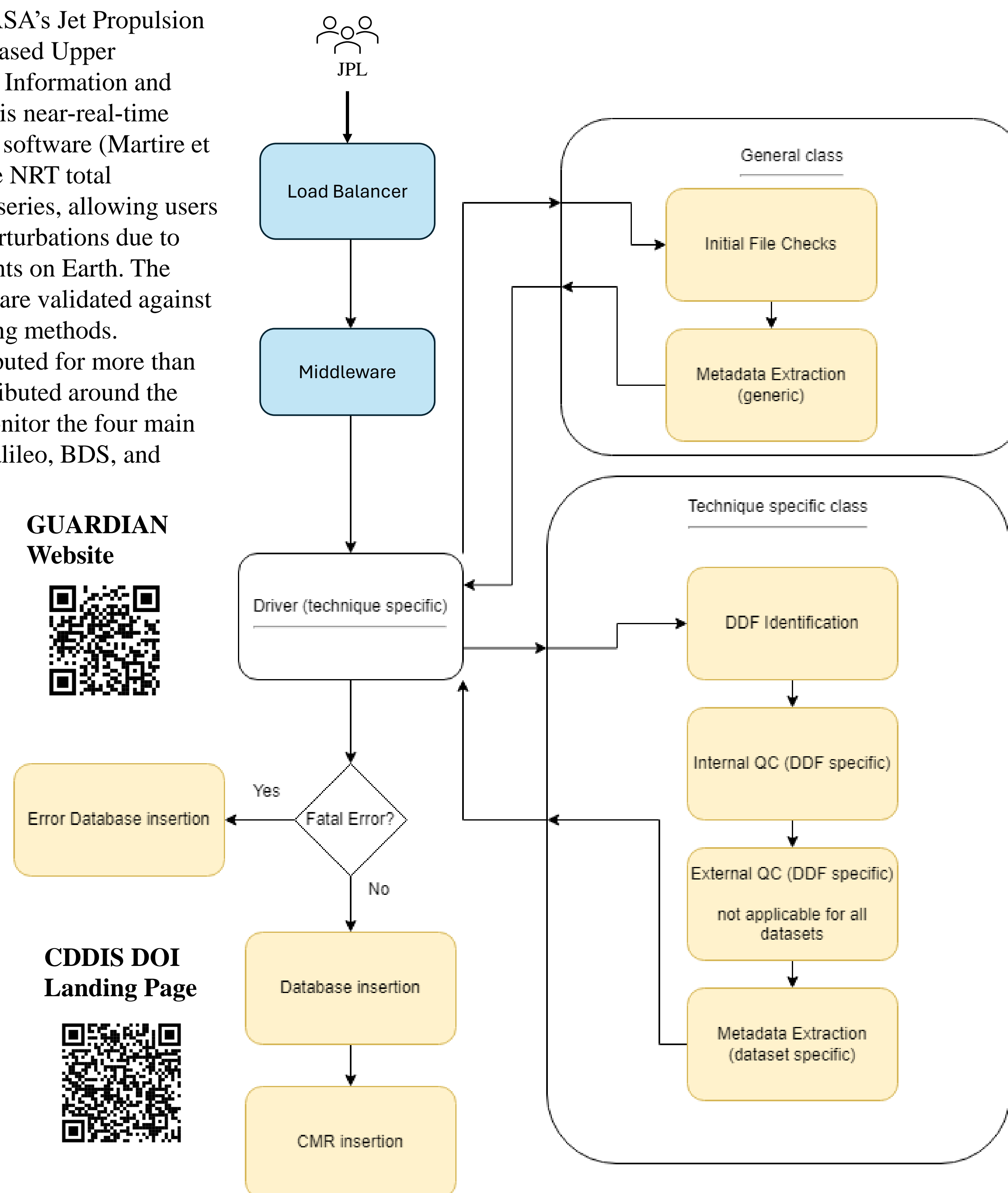


Figure 2: The CDDIS Processing V4 Software Flow Diagram

GNSS REAL-TIME (NTRIP) SYSTEM STATUS AND LATENCIES

Description: The CDDIS has real-time streaming software (NTRIP, Network Transport of RTCM via Internet Protocol) for receipt and transmission of real-time GNSS data and product streams in support of the International GNSS Service (IGS) Real Time Service. The available product streams consist of GNSS orbit and clock corrections

- Use:**
- Precise point positioning
 - Time synchronization
 - Disaster monitoring

CDDIS-Caster NTRIP Broadcaster



Real-time Map



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

CDDIS Real-time Streams

More information about the real-time streams available through the CDDIS caster can be viewed in the following tables:

- CDDIS caster [active data streams](#)
- CDDIS caster [inactive data streams](#)

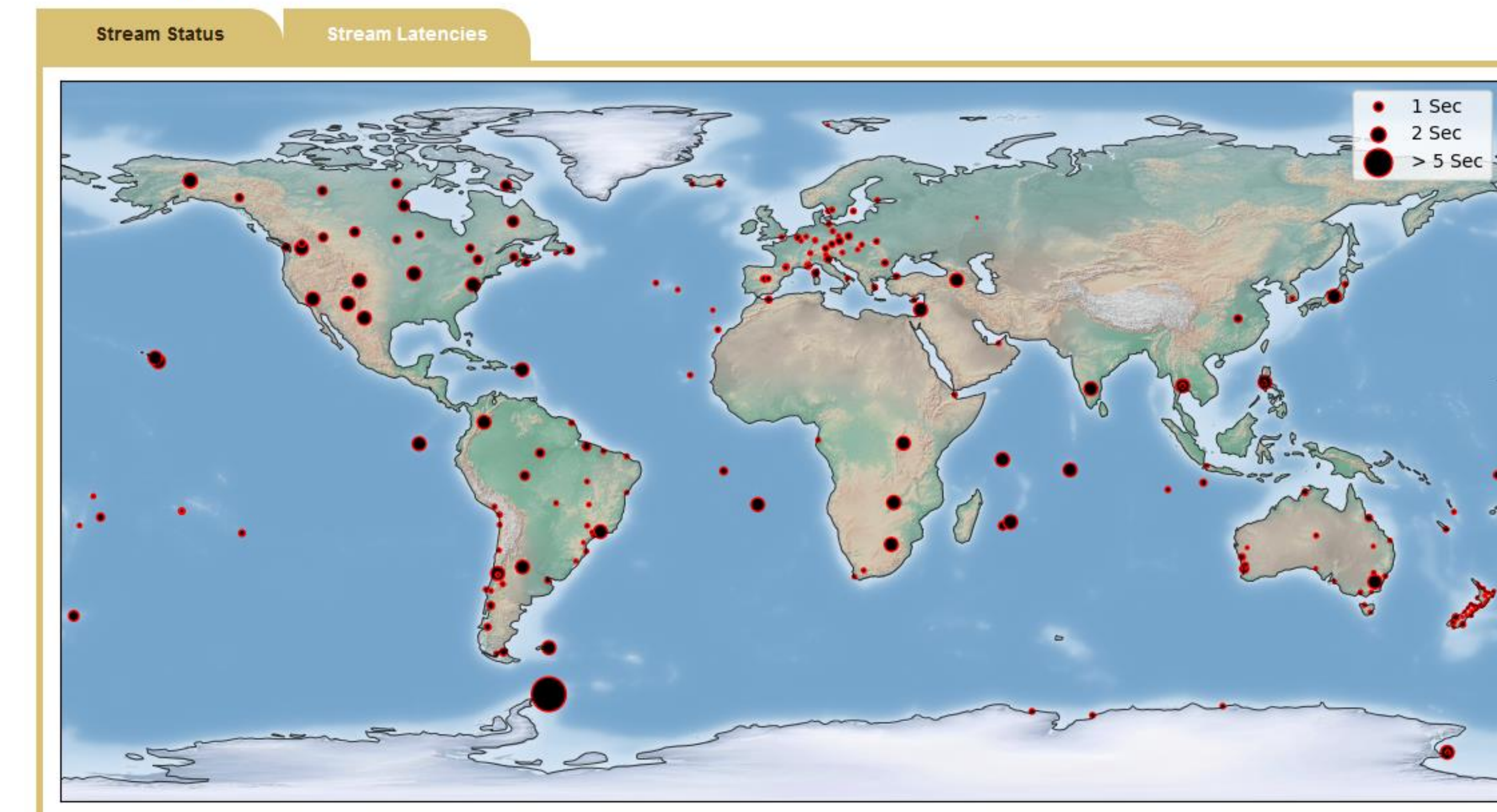


Figure 3: The CDDIS Real-Time Stream Latencies Map

VGOS and SWIN DATA

Description: The VGOS Database is comprised of Very Long Baseline Array (VLBI) level 2 observational and supporting data (including observations, standard deviations, station coordinates, and more) and derived products. They are stored and exchanged in the vgosDB format, the International VLBI Service for Geodesy and Astrometry (IVS) standard format for storing, transmitting, and archiving VLBI data. vgosDB datasets are comprised of NetCDF and ASCII files which contain almost all the information that is required to process a single VLBI session.

The CDDIS also stores the VLBI Distributed FX (DiFX) Level 1A correlator (raw) output as SWIN files. These constitutes the primary VLBI dataset for a given experiment; all other data products are derived from analysis of the primary dataset, including vgosDB. The correlator output is a collection of files that provide the following:

1. Time series of auto-correlations at all the observing stations that participated in the experiment and cross-correlations between all baselines of observing stations
2. Time series of amplitudes and phases of phase calibration signals
3. Correlator control files
4. Auxiliary files created by the correlator and used during correlation
5. The metadata file.

Spectral and temporal resolution is variable.

CDDIS Support:

The CDDIS stores the vgosDB and SWIN files in their archive. Due to the size of the SWIN files (as large as 500 GB) and projected growth as additional correlators upload SWIN data, the CDDIS changed the file upload process to ensure the files are ingested via a separate script and partitions to a different part of the archive. These changes have no visible changes to providers, nor users but ensures the longevity of the software.

CDDIS SWIN DOI Landing Page



CDDIS VGOS DOI Landing Page



CHANGES TO README FILES – FOCUS ON LANDING PAGES

Description: The CDDIS ReadMe files are used to provide an overview of files available in the CDDIS archive. Beginning with SLR, the CDDIS listed all the subdirectories under the technique including corresponding landing page. The landing pages contain through information about the data/products and include information on how to cite the data via DOIs.

Please cite our data!

Primary Directory Structure

Below is a summary of the directory structure with applicable links to Landing Pages with DOIs. Please cite the DOIs in your publications. Please note that directories in bold indicates that the files in the directory are in the most recent format.

Directory	Data/Product and Landing Page
/slr/data/	Full-rate SLR data
/slr/data/fr/	Monthly and daily satellite full-rate files
/slr/data/fr/SNAME/YYYY/	- Monthly: https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_monthly_fr.html - Daily: https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_daily_fr.html
/slr/data/fr/SNAME/YYYY/sum/	Summary of the satellite full-rate files
https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_monthlysum_fr.html	Daily satellite full-rate files
/slr/data/fr/SNAME/daily/SSSS/	- Daily: https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_daily_fr.html
/slr/data/fr/SNAME/npt/	Monthly satellite normal point data and summary files from full-rate
https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_monthlysum_fr.html	Full-rate SLR data (CRD V1 format)
/slr/data/fr_crd/	Monthly and daily satellite full-rate files
/slr/data/fr_crd/SNAME/YYYY/	- Monthly: https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_monthly_fr.html - Daily: https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_daily_fr.html
/slr/data/fr_crd/SNAME/YYYY/sum/	Summary files for the monthly full-rate data
https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_monthlysum_fr.html	Station quarantine data
/slr/data/fr_crd/quarantine/SSSS/	Full-rate SLR data (CRD V2 format)
slr/data/fr_crd_v2/	Monthly and daily satellite full-rate files
/slr/data/fr_crd_v2/SNAME/YYYY/	- Monthly: https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_monthly_fr.html - Daily: https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_daily_fr.html
/slr/data/fr_crd_v2/SNAME/YYYY/sum/	Summary files for the monthly full-rate data
https://cddis.nasa.gov/Data_and_Derived_Products/SLR/slr_data_monthlysum_fr.html	

Figure 4: Partial Screenshot of the SLR README File

NASA EARTH SCIENCE CLOUD MIGRATION

Description: The CDDIS is transitioning to the Earthdata Cloud to fully realize NASA's goals for open science. The primary focus of these efforts is to ensure the accessibility of NASA data by reducing the barriers to entry within the science community while increasing traceability and reproducibility of research.

Once the CDDIS has shifted to the Earthdata 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 the 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 the NASA DAACs
- Access to new tools for subscribing and analyzing data

Please note that, even as the CDDIS transitions to the cloud, users will still be able to download data to their servers and the original archive structure will still be maintained. The NASA EOSDIS is also investing in helping scientists transition to the cloud through training initiatives.

Current Progress:

- The CDDIS has started working with the EOSDIS Ingest and Archive train and have made strides in the following areas:
- Familiarizing themselves with the CUMULUS framework for data ingest, archive, distribution, and metrics which utilizes the AWS cloud
 - Building the components for the CDDIS AWS pipeline for software developers

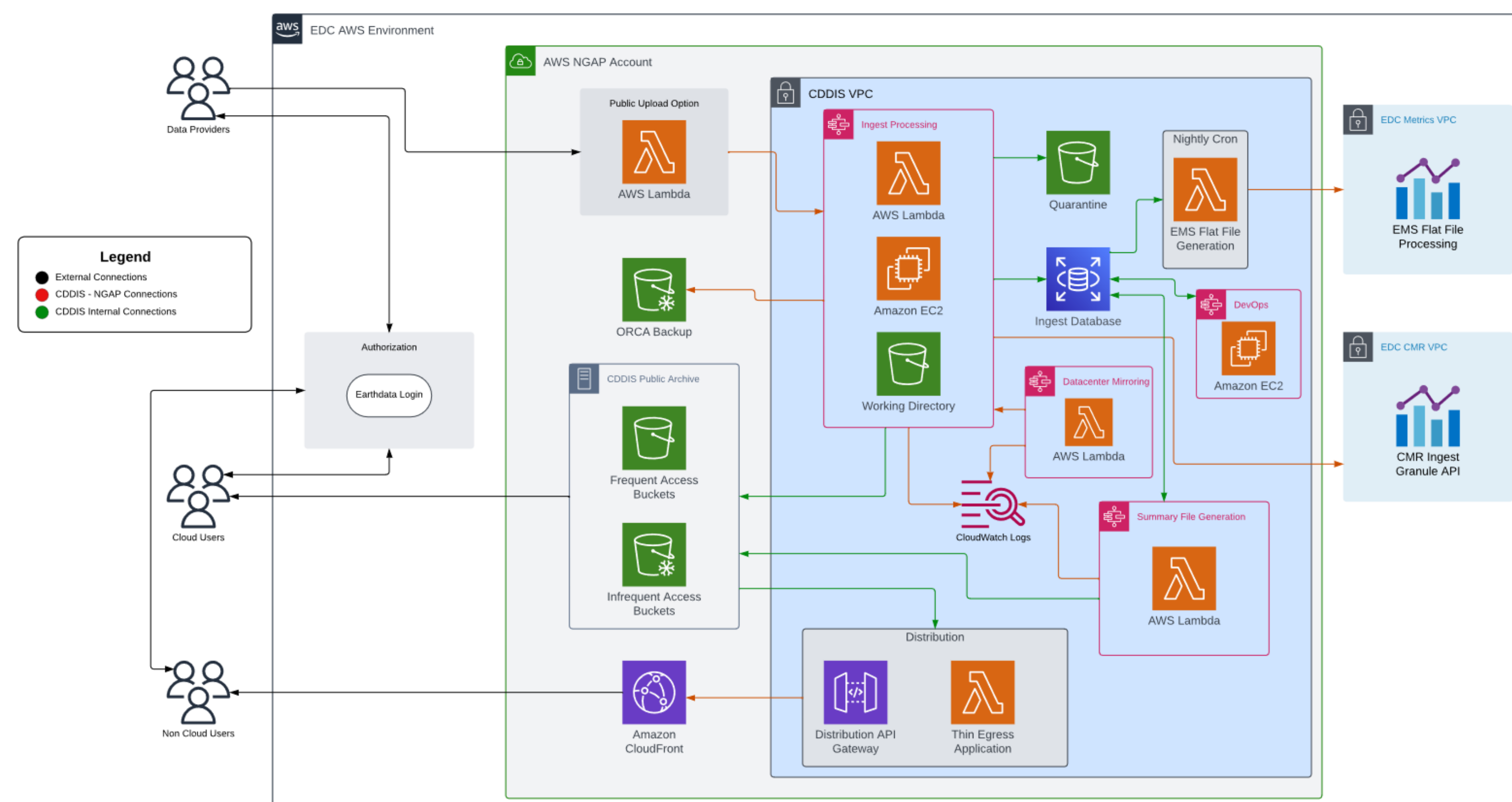


Figure 5: The CDDIS Flow Diagram for onboarding to the Cloud