An Overview of the CDDIS Archive and Commitment to FAIR Data

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Abstract

The Crustal Dynamics Data Information System (CDDIS) is a central hub for space geodesy data, serving as a Distributed Active Archive Center (DAAC) within NASA's Earth Observing System Data and Information System (EOSDIS). Among many other organizations, the CDDIS fosters collaboration within the International Association of Geodesy (IAG) and the International Earth Rotational Reference Systems Services (IERS), to provide critical data for geodetic and geophysical research. To these ends, the CDDIS operates as a primary resource for geometric data for the broader scientific community by operating archival and distribution services for data products generated using 4 core techniques: 1) the Global Navigation Satellite System (GNSS), 2) Satellite Laser Ranging (SLR), 3) Very Long Baseline Interferometry (VLBI), and 4) Doppler Orbitography and Radio-positioning Integrated by Satellite (DORIS). This vast collection maintained by CDDIS empowers researchers to study Earth's rotation, crustal deformation, sea level change, and more. Additionally, the CDDIS operates as the Global Data Center for IAG services, provides uploader and user support, and engages with scientific communities inside and outside of NASA.

As an EOSDIS DAAC, and carrying a close relationship to the IAG, CDDIS upholds the FAIR (Findability, Accessibility, Interoperability, and Reusability) principles to ensure the discoverability, usability, and long-term value of its data archive. This commitment allows the CDDIS to serve as a data archive and data provider to the broader scientific community. This poster provides an overview of the data types in the CDDIS archive and its dedication to FAIR data stewardship.

FAIR Stewardship[3]

Findable

Findable: Data should be easy to find with clear metadata and identifiers

Earthdata Search
Earthdata Search provides a visual tool for scientists and engineers to search for data available from all the DAACs. The CDDIS currently has more than 270 collections which users can find by narrowing down the "Organization" to the CDDIS. For more information on how to narrow down your search, please see the Interoperable section.

Earthdata Search:

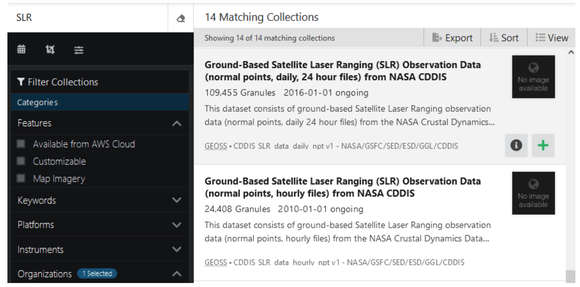

Figure 1: Earthdata search – the CDDIS SLR collections

Accessible

Accessible: Data should be openly available and retrievable by humans and machines

On October 2020, the CDDIS began offering archive access via HTTPS (while maintaining ftp-ssl access) to support human and computer readability. Access requires an Earthdata account which can be created for free. The archive can be accessed via browser and command line.

To navigate via browser:

For more information on archive access and download via command line:

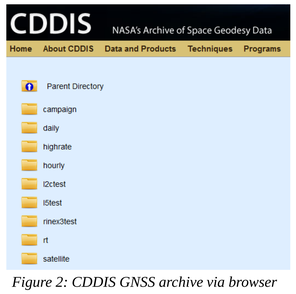

Figure 2: CDDIS GNSS archive via browser

Interoperable

Interoperable: Data should allow for integration with other datasets

To ensure interoperability with other DAACs, the CDDIS follows the Global Change Master Directory (GCMD) structure and keywords to provide insight into its data and products. This allows for clearer connections between different DAACs and their data/products and is primarily used for Earthdata Search.

Full list of GCMD Structure:

Earth Science Keywords Structure

The Earth Science Keywords have a six-level keyword structure with the option for a seventh uncontrolled field. Category and Topic levels define how the keywords are organized and the associated Earth science discipline within the hierarchy. The Term and Variables levels define the subject area, measured variables/parameters, and the hierarchical-type relationship for the subject area.

Keyword Level	Example
Category	Earth Science
Topic	Atmosphere
Term	Weather Events
Variable Level 1	Subtropical Cyclones
Variable Level 2	Subtropical Depression
Variable Level 3	Subtropical Depression Track
Detailed Variable	*(Uncontrolled Keyword)*

Figure 3: Screenshot from the GCMD website

Reusable

Reusable: Data should be well-described and licensed for reuse

The CDDIS ensures the reusability of its data and products by ensuring they can be cited via Digital Object Identifiers (DOIs). DOIs can be added to references in papers and publications to ensure traceability. The DOIs can be found on the CDDIS website by selecting the "Data and Products" tab, followed by the specific data or product you wish the cite.

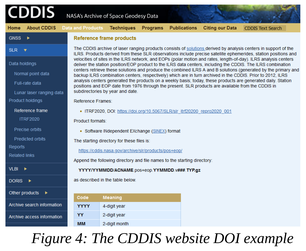

Figure 4: The CDDIS website DOI example

CDDIS Data and Products[4]

Global Navigation Satellite System(GNSS)

- Globally, there are over 500 GNSS ground receivers that detect, decode, and process signals from GNSS satellites (Figure 5).
- The GNSS ground receivers process signals from the GPS constellation, Global Navigation Satellite System (GLONASS), and other GNSS satellite systems.

Figure 5: Map of GNSS ground stations[1]

- With analysis, data from the receivers and the satellites can be used to monitor changes in receiver locations over time. This provides necessary information to study tectonic plate movement, displacements from Earthquakes, and determine Earth's orientation.

Satellite Laser Ranging (SLR)

- Globally, there are over 40 SLR ground stations which project short-pulse lasers.
- The short-pulse lasers from ground stations are reflected from retroflectors that are equipped on over 40 SLR target satellites.
- The two-way time of flight between the ground stations and retroflectors can be analyzed in conjunction with other data to precisely determine components of Earth's gravitational field, Earth's orientation parameters, and lunar ephemerides.

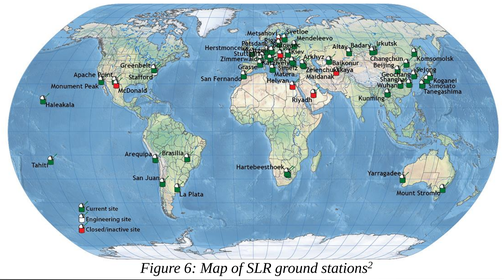

Figure 6: Map of SLR ground stations[2]

Very Long Baseline Interferometry (VLBI)

- The arrival time of radio wavefronts emitted from quasars are measured at one or many of over 40 VLBI Earth-based antennas.
- Analytical techniques can be used to build an inertial reference frame from this data. The inertial reference frame defines the precise positions of the VLBI antennas to a few millimeters and the positions of a quasar to fractions of a milliarcsecond.

Figure 7: Map of VLBI antenna

Doppler Orthography and Radio-positioning Integrated by Satellite (DORIS)

- Globally, around 60 DORIS beacons transmit dual-frequency Doppler radio signals.
- DORIS receivers on satellites measure either, 1) the Doppler shift or 2) the phase shift of the DORIS beacon radio signals. These data can be used to help monitor deformations on the solid Earth, crustal deformation at tide gauges, and variations in the hydrosphere.
- CryoSat-2, HY-2A, Jason-2, and Jason-3 are among satellite missions that support or have supported DORIS.

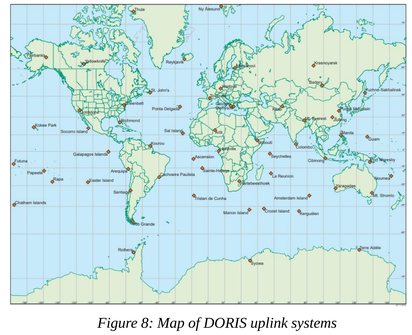

Figure 8: Map of DORIS uplink systems

References

(1) International GNSS Service – Enabling the highest-accuracy usability of openly available GNSS data & products. (n.d.).
(2) ILRS home page. (n.d.). https://ilrs.gsfc.nasa.gov/
(3) GO FAIR initiative. (2022, January 21). FAIR principles - GO FAIR. GO FAIR. https://www.go-fair.org/fair-principles/
(4) C. Noll, The Crustal Dynamics Data Information System: A resource to support scientific analysis using space geodesy, Advances in Space Research, Volume 45, Issue 12, 15 June 2010, Pages 1421-1440, ISSN 0273-1177, DOI: 10.1016/j.asr.2010.01.018.