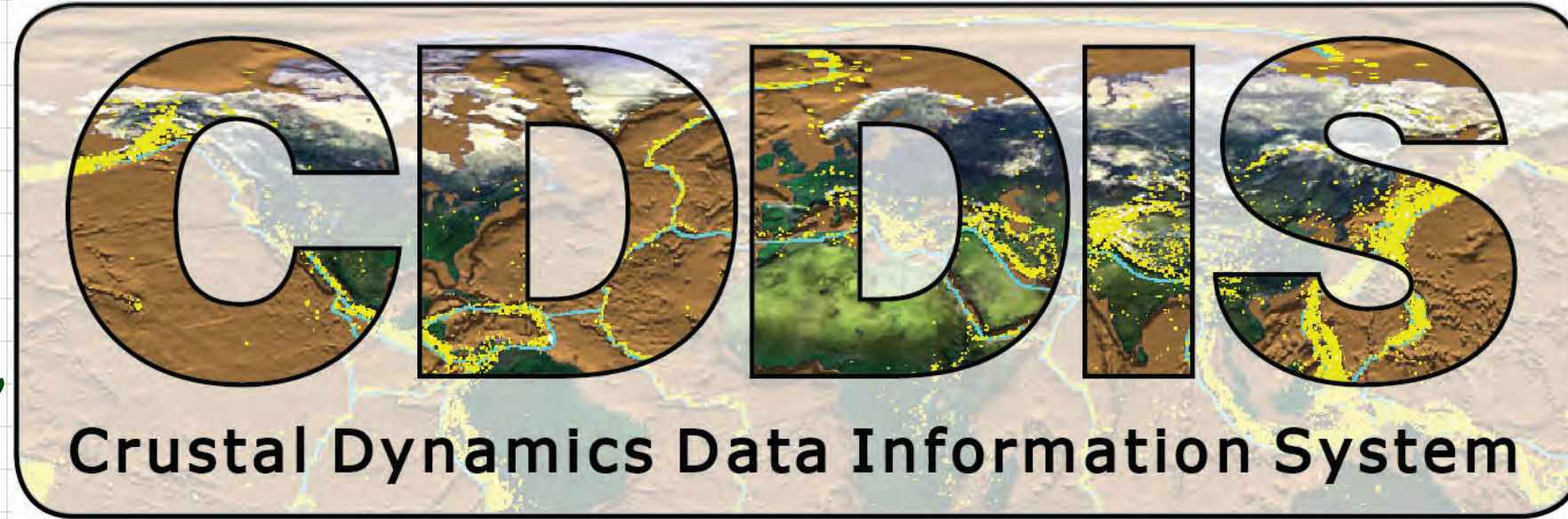
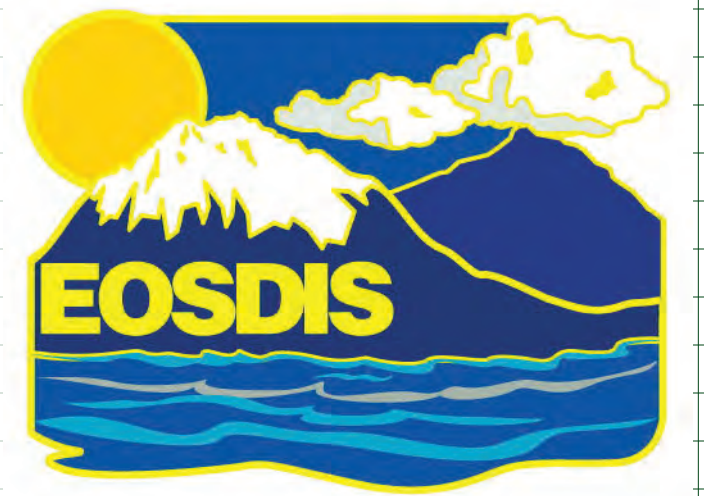


# Crustal Dynamics Data Information System



## NASA's Active Archive of Space Geodesy Data and Derived Products

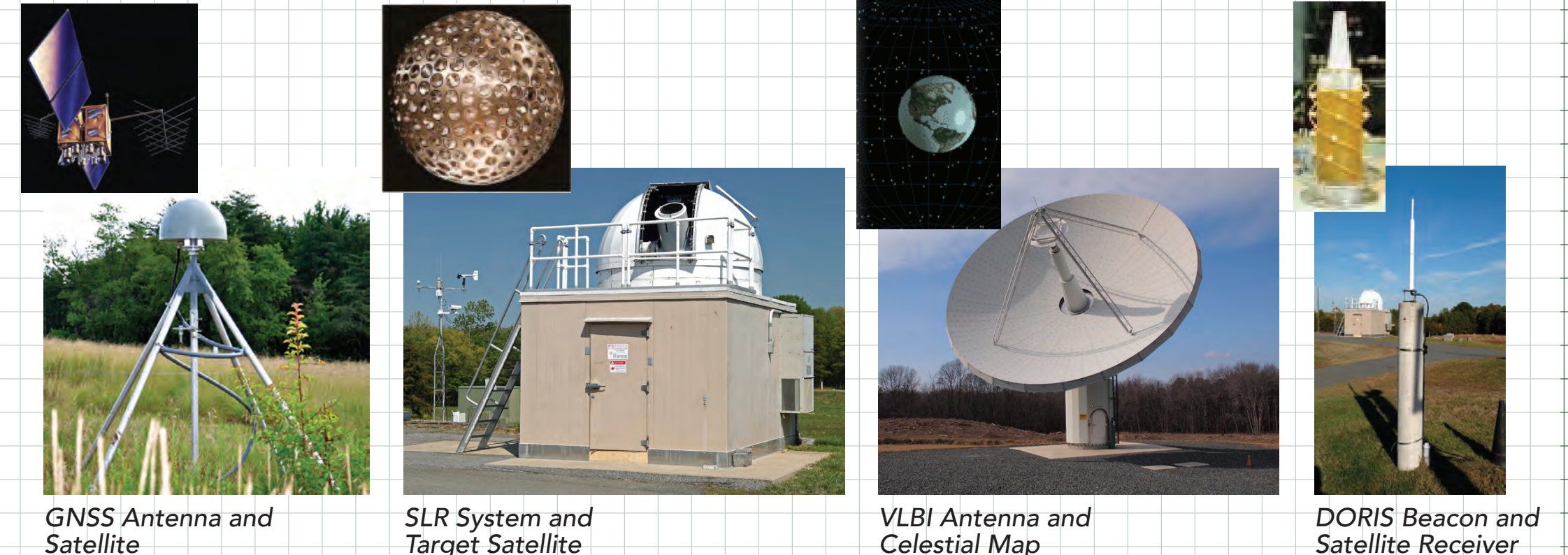
Our vision is to provide first-class, robust archive, distribution, and real-time services for space geodesy data, products, and information to the global scientific research community.

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### Background

- Crustal Dynamics Data Information System (CDDIS) is NASA's active archive of space geodesy data, products, and information (Global Navigation Satellite System/GNSS, Satellite Laser Ranging/SLR, Very Long Baseline Interferometry/VLBI, and Doppler Orbitography and Radio-positioning Integrated by Satellite/DORIS)
- CDDIS is one of 12 Distributed Active Archive Centers (DAACs) within NASA's Earth Observation System Data and Information System (EOSDIS)
- CDDIS became a regular member of WDS in March 2013
- Largest CDDIS user community comes from the services within the International Association of Geodesy (IAG)
- Contents of the CDDIS archive are utilized for geodetic studies, e.g., plate tectonics, earthquake displacements, Earth orientation, Earth's surface deformation, Earth's gravity field, etc.
- CDDIS archive also plays an interdisciplinary role in supporting the derivation of a Terrestrial Reference Frame (the foundation for virtually all airborne, space-based and ground-based Earth observations), precise orbit determination (POD) for NASA/international missions, atmospheric studies, etc.

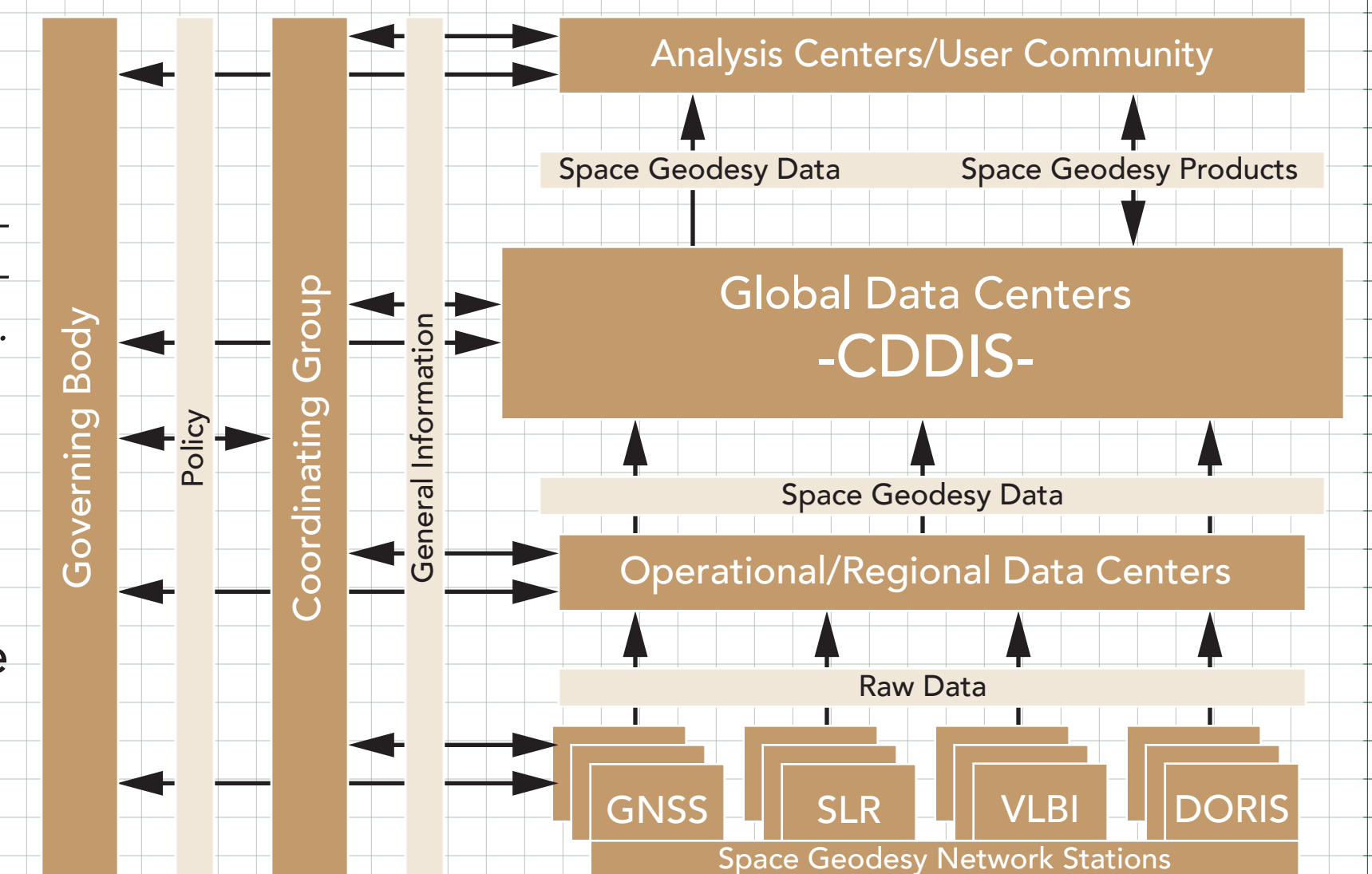


Systems located at NASA Goddard Space Flight Center, Greenbelt MD.

### User Community

- Contents of CDDIS archive are freely available to an international scientific community
- CDDIS has extensive partnerships through the IAG serving as one of the primary data centers for the geometric services and its observing system, GGOS (Global Geodetic Observing System)
  - + International GNSS Service (IGS)
  - + International Laser Ranging Service (ILRS)
  - + International VLBI Service for Geodesy and Astrometry (IVS)
  - + International DORIS Service (IDS)
- Services are the principal user community for the CDDIS and function as cooperating federations dedicated to a particular type of data (e.g., GNSS, SLR, VLBI, or DORIS)
- Services provide data and products on an operational basis to geodesy analysts as well as a broader scientific community and are examples of a successful model of community management, many international organizations leveraging their respective limited resources to all levels of service functionality
- Analysis centers supporting the services produce derived products (e.g., positions of observing stations, Earth orientation parameters, precise satellite orbits, etc.) for use by a broader scientific community

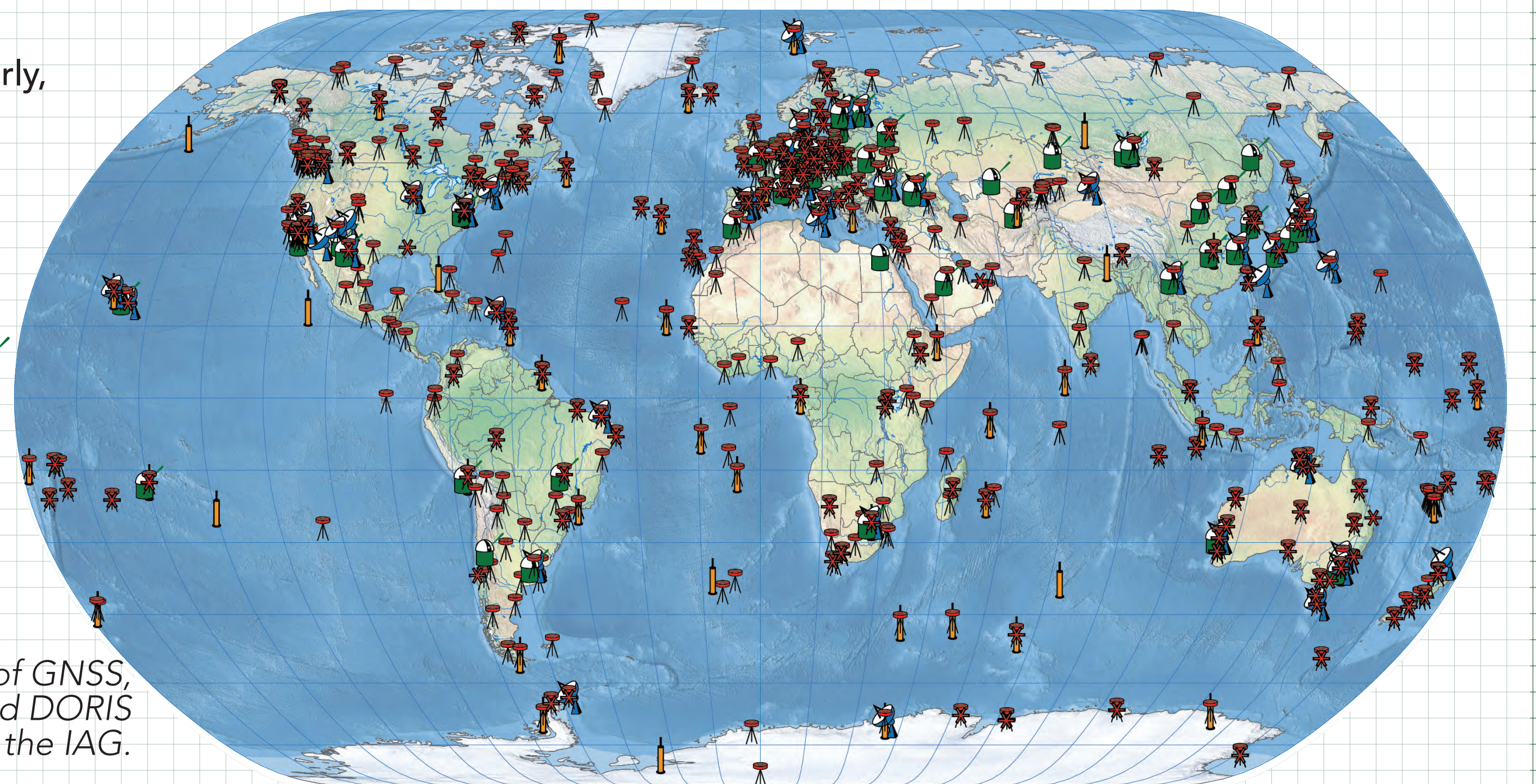
Flow of data and information utilized by the geometric services of the IAG.



### CDDIS Archive Contents

- Data:
  - + Stations in the GNSS, SLR/LLR, VLBI, and DORIS networks generate point data on a multi-day, daily, hourly, and/or sub-hourly basis
  - + GNSS: 570+ sites tracking GPS, GLONASS, and new GNSS (Galileo, QZSS, Beidou, others)
  - + Laser Ranging (SLR and LLR): ~40 sites tracking 90+ satellites (including the Moon)
  - + VLBI: 45 sites
  - + DORIS: 58 sites tracking 6 satellites
- Products:
  - + Precise network station positions (for terrestrial reference frame)
  - + Satellite orbits (for POD)
  - + Station and satellite clocks (for timing)
  - + Earth rotation parameters
  - + Positions of celestial objects (for celestial reference frame)
  - + Atmospheric parameters (Ionosphere TEC, Troposphere ZPD) ...
- Real-time activities:
  - + CDDIS now operationally streaming real-time GNSS data and derived products in support of the IGS Real-Time Service (RTS)
  - + Data from nearly 200 global sites and 40 derived product streams

- GNSS site
- Real-time GNSS site
- SLR site
- VLBI site
- DORIS site



The global network of GNSS, SLR, VLBI, and DORIS sites supporting the IAG.

### Success

- CDDIS is viewed as a key component of the IAG and its geometric services
- Recent accomplishments:
  - + CDDIS broke previous data distribution records by 30% in calendar year 2015, distributing nearly 130 Tbytes from over 1.2 billion files
  - + Over 3.1 Tbytes from over 37.8M files were added to the archive in 2015
  - + Real-time streaming of GNSS data and derived products now operational to support precise point positioning (PPP) and related applications, such as time synchronization and disaster monitoring, at global scales for scientific and hazard detection applications

### Best Practices

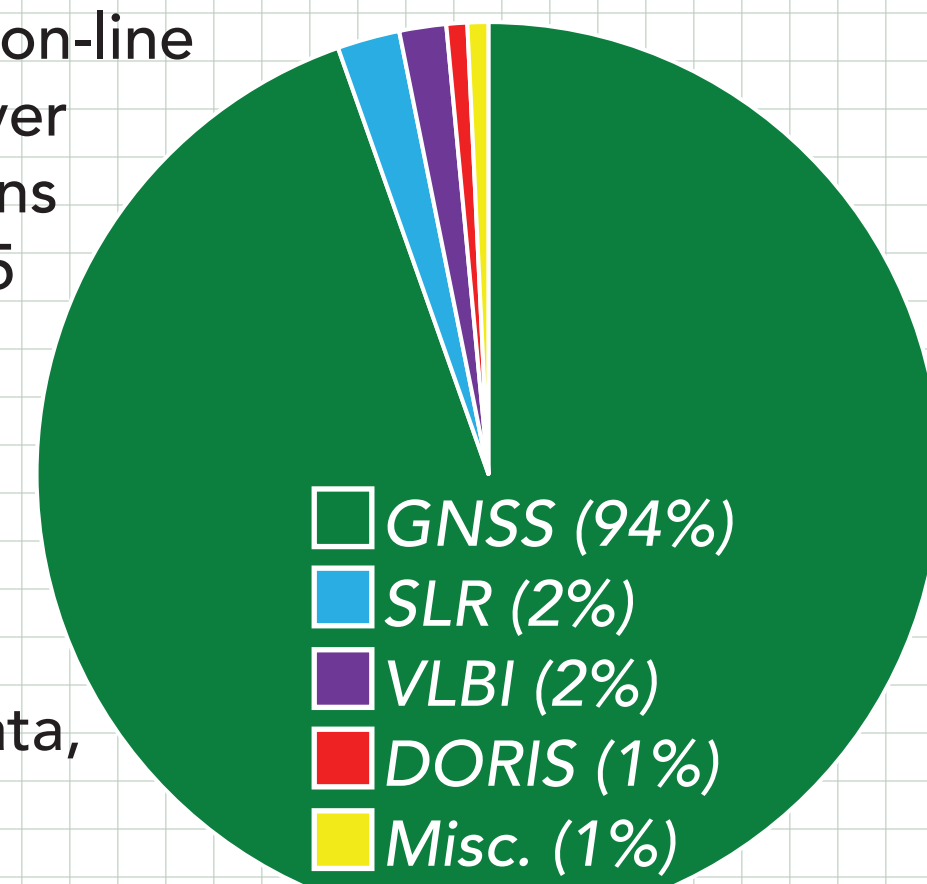
- General:
  - + CDDIS partnerships with the geometric services of the IAG are the driving force behind CDDIS operations, providing infrastructure for populating CDDIS archive
  - + CDDIS supported by a community of international experts in the scientific research fields of space geodesy and related disciplines.
  - + CDDIS participates in the yearly EOSDIS customer satisfaction surveys, to assess its effectiveness in supporting research community
  - + CDDIS (as a NASA EOSDIS DAAC) conforms to U.S. Federal Government Policy on free and open access to scientific data
- Data management:
  - + Consistent ingest process for data QC and metadata extraction
  - + Metadata available to catalogs beyond CDDIS (e.g., EOSDIS, GGOS, etc.)
  - + Data discovery applications to assist users in finding data based on spatial, temporal, site, and/or target parameters and browsing information about these parameters
- Technical infrastructure:
  - + New hardware infrastructure based on virtual machine environment for reliability and expandability
  - + Implementation of new data upload process for secure receipt of files from components of the IAG services

### Challenges

- Installation and operation of new hardware infrastructure to keep pace with archive growth and satisfy NASA security requirements
- Modernization of legacy software
- Implementation of new data upload process and adoption by entire data supplier community
- Consolidation of metadata across diverse data types and processing levels

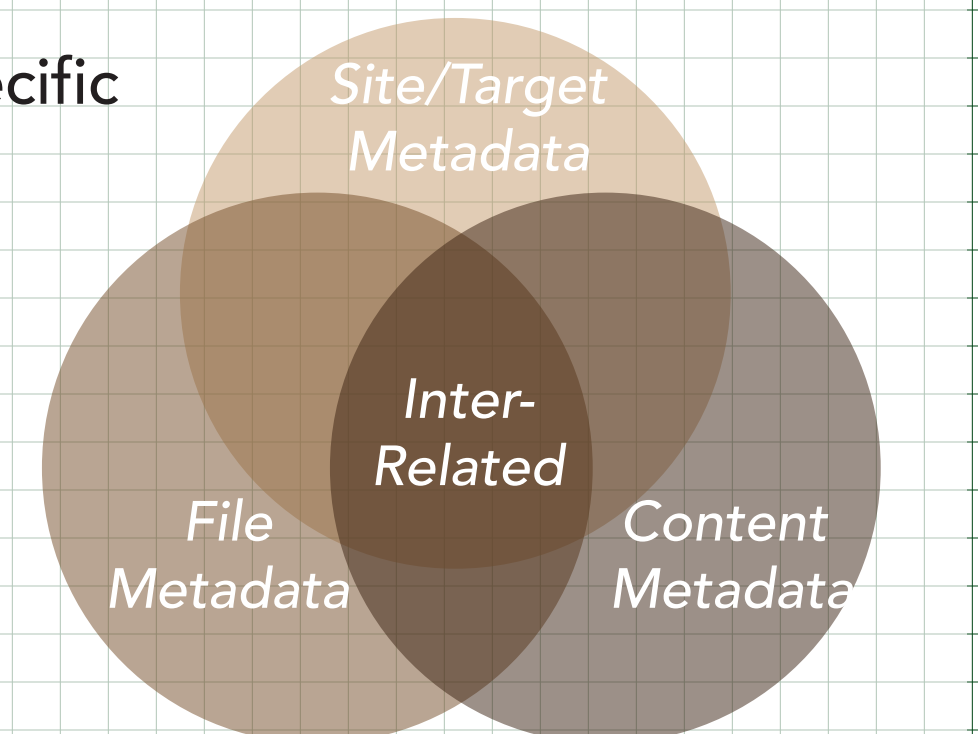
### Archive Statistics

- All CDDIS data and derived products are available on-line
- CDDIS contains data and derived products from over 1500 observing sites located at about 1000 locations around the world, going back in time as far as 1975
- File size is typically <2Mb/data "granule", <10Mb/derived product "granule"
- Total archive size: ~15.7Tb
- Ingest rate: ~9.5Gb (90K files)/day
- Distribution rate: ~475Gb (~4.4M files)/day
- Data (L1, L1B), products (L2) derived from these data, and information about data and products
- Multi-day, daily, hourly, sub-hourly
- Varying latencies (minutes, hours, days)
- Archive is updated with new data/product files on varying time scales, dependent on the data type, from a sub-daily basis to weekly basis



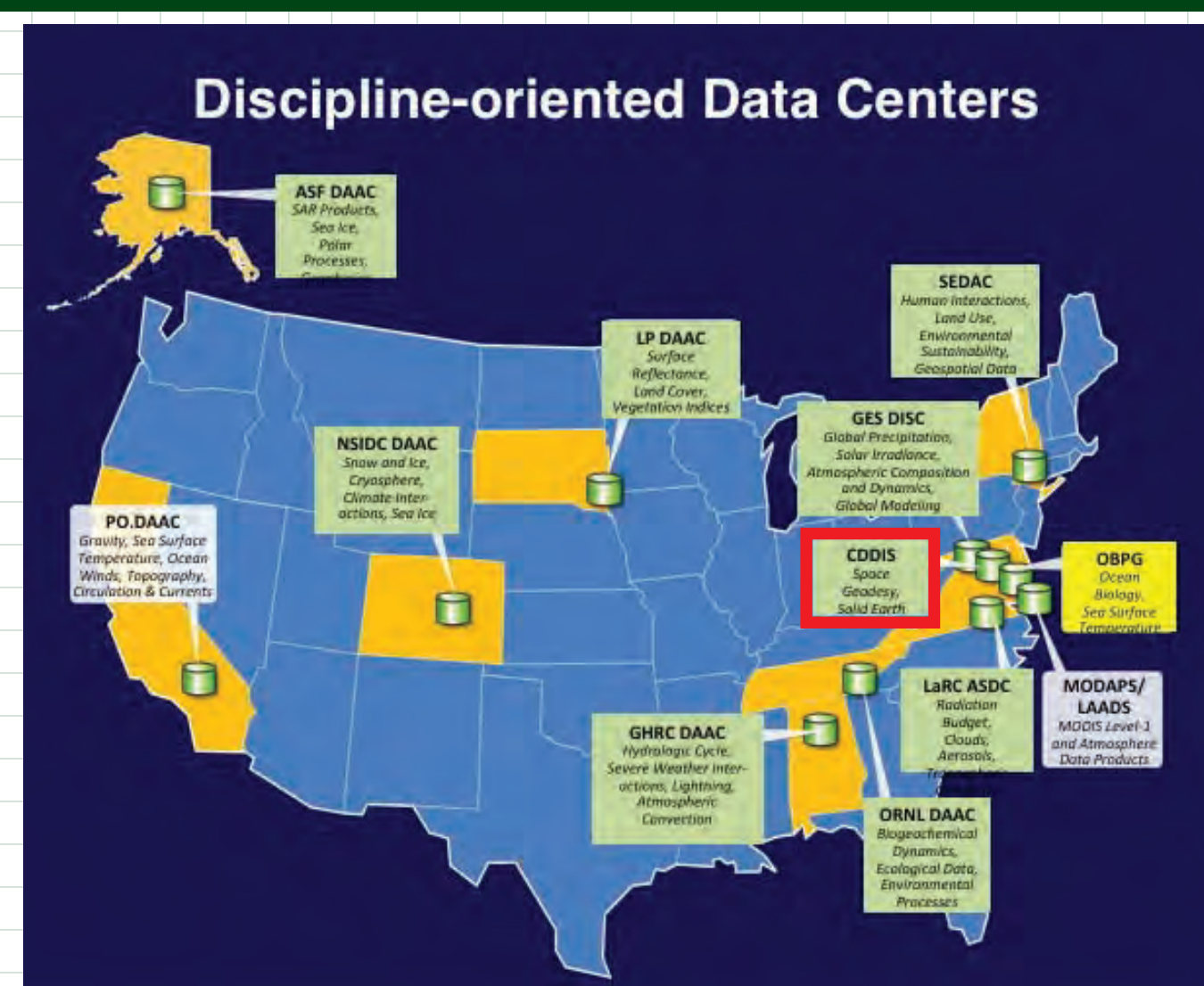
### Metadata

- Non-standard (across archive) metadata, data type (GNSS, SLR, VLBI, DORIS) specific
- Extracted from incoming files (granules)
- Categories:
  - + File (granule) content (data and derived products)
  - + File (granule) information (size, source, etc.)
  - + Site and target (e.g., satellite) information
- Satisfies multiple requirements for metadata interoperability:
  - + Internal (e.g., managing the archive)
  - + EOSDIS (e.g., provide content metadata to search applications, provide distribution/ingest information to metrics applications, provide metadata to community portals)
  - + Geodesy community (provide space geodesy metadata to GGOS portal, contribute to community metadata schema development)
- Data Discovery: Two data discovery applications now operational on CDDIS website
  - + Site Log Viewer – browse information about space geodesy network sites
  - + Archive Explorer – find data of interest based on spatial, temporal, site, and/or target parameters



### About EOSDIS

- EOSDIS, a network member of WDS, is a distributed system, with major facilities at Distributed Active Archive Centers (DAACs) located throughout the United States.
- EOSDIS DAACs process, archive, document, and distribute data from NASA's past and current Earth-observing satellites and field measurement programs.
- DAACs provide reliable, robust services to users whose needs may cross the traditional boundaries of a science discipline, while continuing to support the particular needs of users within the discipline communities.



### More Information/Feedback

- Data and products are acquired as part of NASA's Earth Science Data Systems and archived and distributed by the Crustal Dynamics Data Information System (CDDIS):  
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.
- The staff welcomes feedback on the CDDIS; contact Carey Noll (Carey.Noll@nasa.gov)

