Learning more about our Earth:
An Exploration of NASA's Contributions to Earth Science through Remote Sensing Technologies

IEEE UK 2017

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December 8, 2017

EARTH SCIENCE
DATA SYSTEMS

ABSTRACT

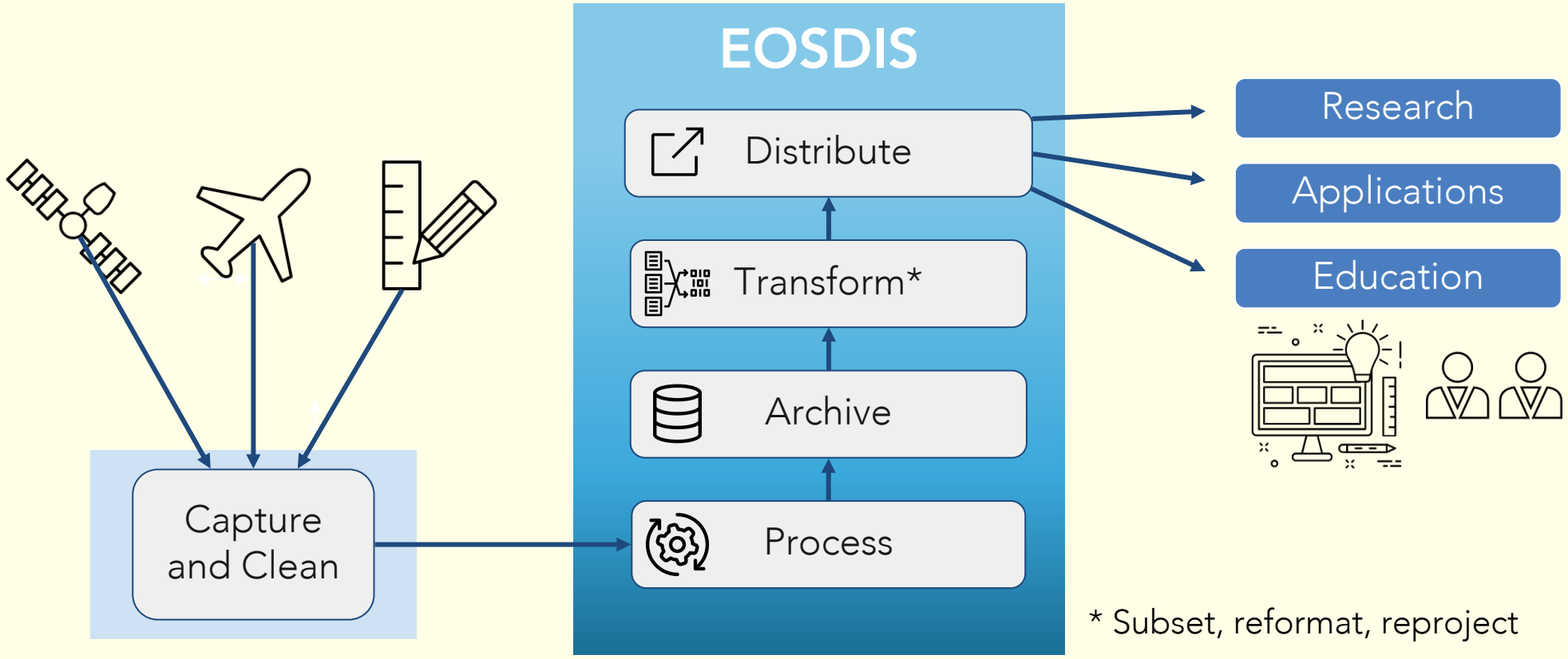
NASA is commonly known for its pioneering work in space exploration and the technological advancements that made access to space possible. NASA is now increasingly known for the agency's research and technologies that support the Earth sciences. This is a presentation focusing on NASA's Earth science efforts told mostly through the technological innovations NASA uses to achieve a greater understanding of the Earth, making it possible to explore the Earth as a system. Enabling this science is NASA's fleet of over two dozen Earth science spacecraft, supported by aircraft, ships and ground observations. NASA's Earth Observing System (EOS) is a coordinated series of polar-orbiting and low inclination satellites for long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans. With the launching of the three flagship satellite missions, Terra, Aqua and Aura, beginning in 1999, NASA's initial Mission to Planet Earth made it possible to measure aspects of the environment that touch the lives of every person around the world. NASA harnessing the unique space-based platform means, fortunately, no planet is better studied than the one we actually live on.


SAGE III (ISS)
2017
LIS (ISS)
2017
CATS (ISS)
2015
SMAP
2015
DSCOVR (NOAA)
2015
Jason-3
2016
CYGNSS
2016
OCO-2
2014
Suomi NPP
2011
GPM
2014
Landsat 8 (USGS)
2013
OSTM/Jason-2
2008
CALIPSO
2006
CloudSat
2006
Aqua
2002
Aura
2004
Terra
1999
SORCE
2003
GRACE (2)
2002
QuikSCAT
1999
Landsat 7 (USGS)
1999

What is EOSDIS in just 4 slides!

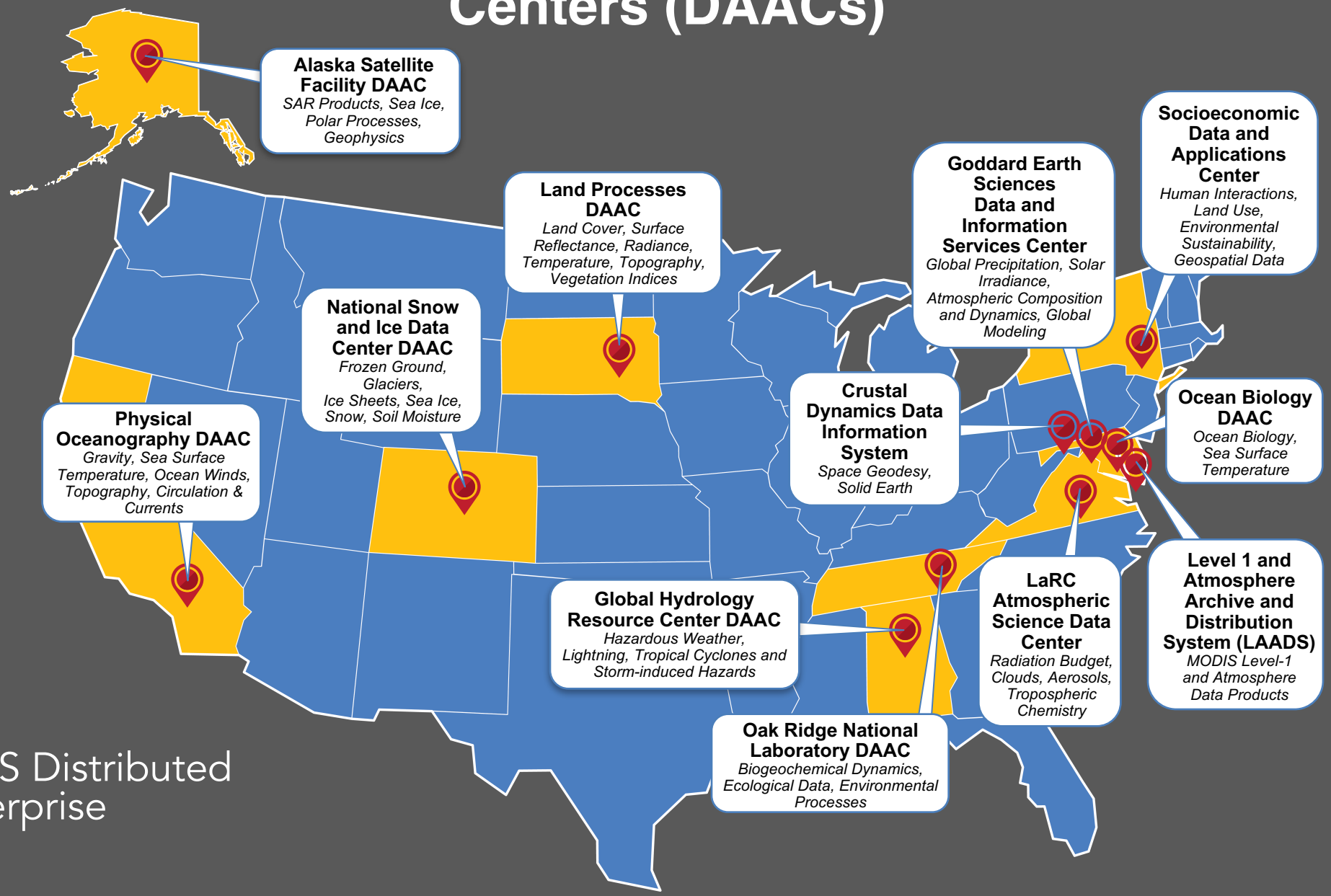
(situational awareness)

EOSDIS is the NASA Data and Information System for Earth Science



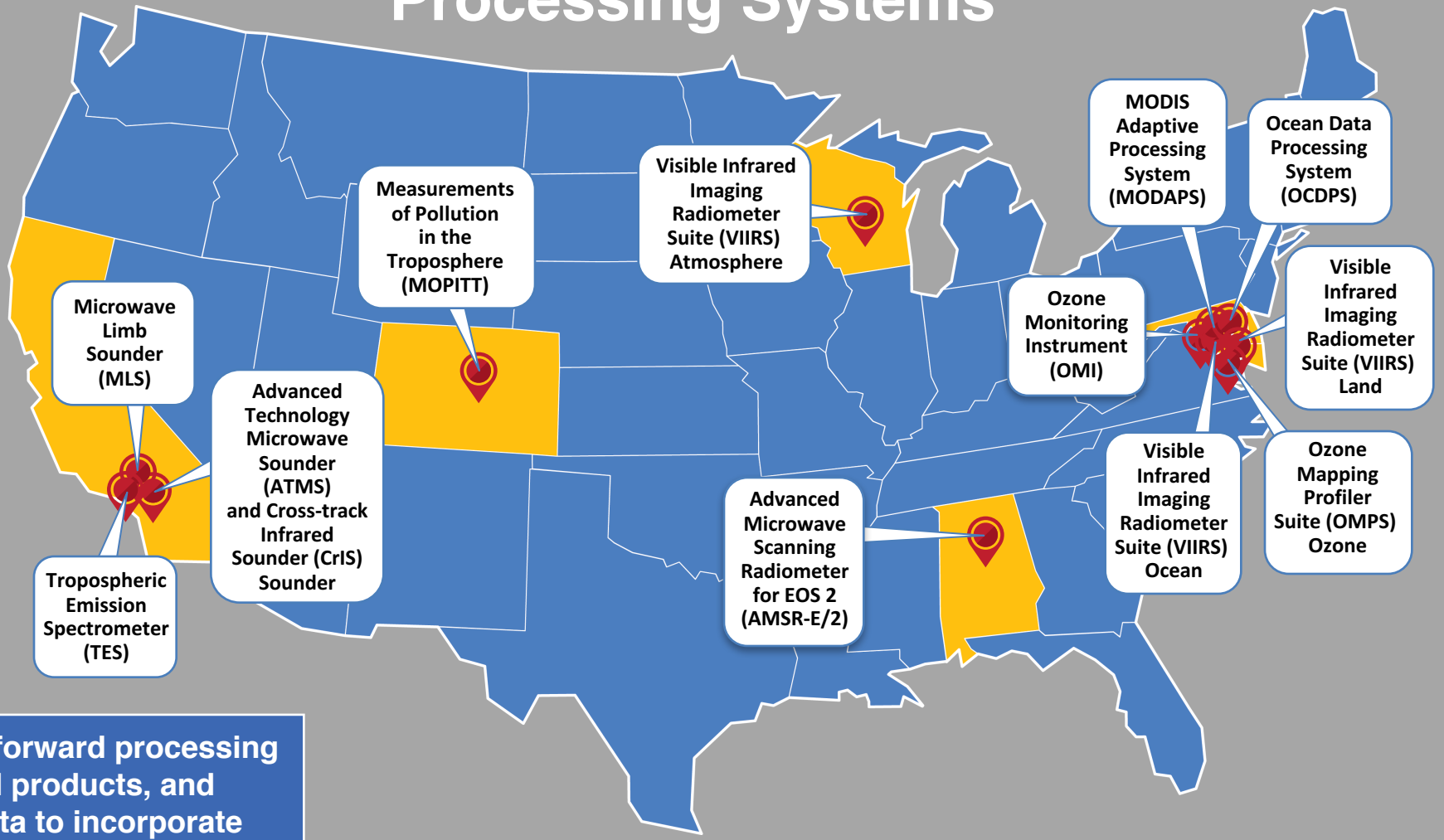
EOSDIS Functions

Distributed Active Archive Centers (DAACs)



The EOSDIS Distributed Enterprise

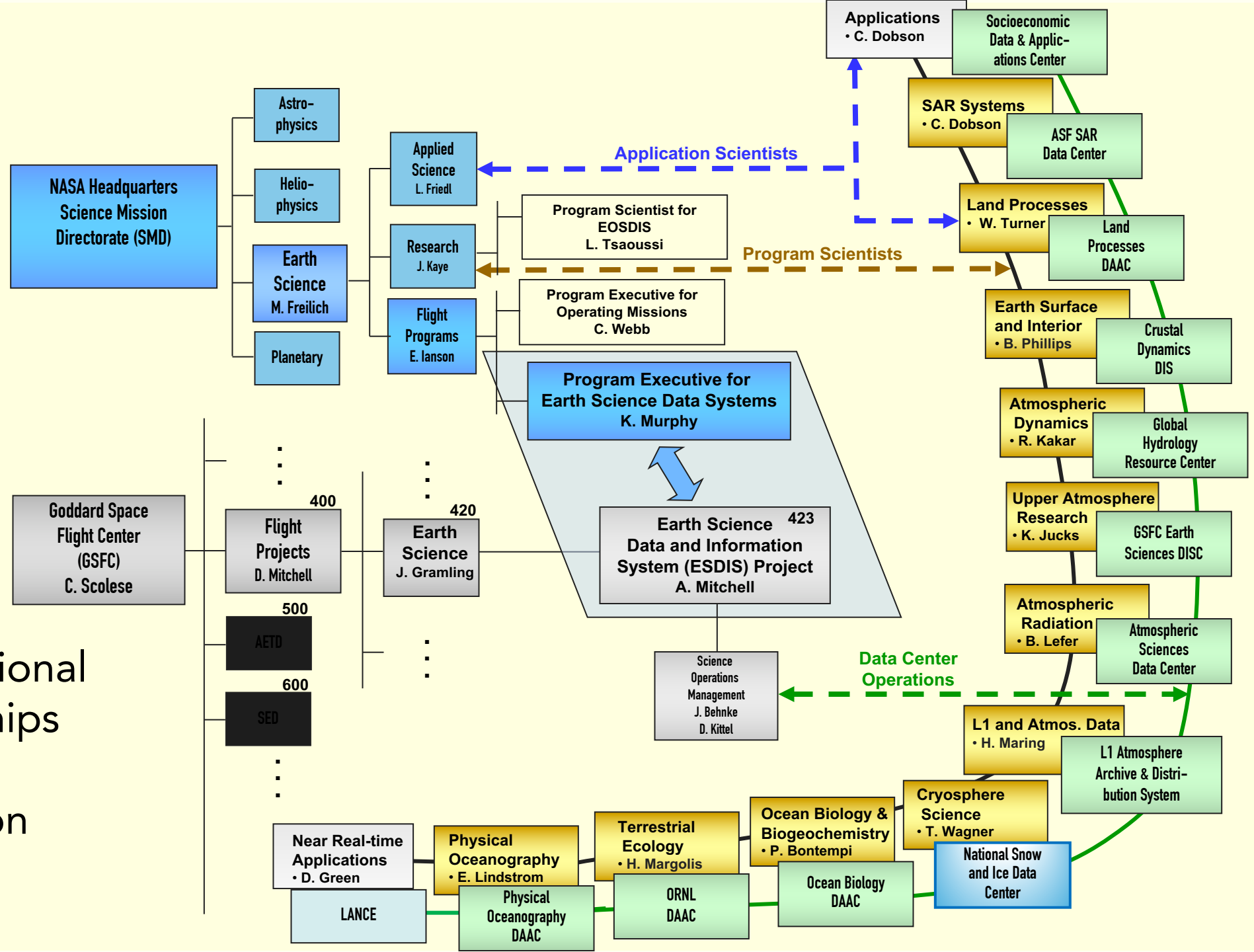
Science Investigator-led Processing Systems



SIPSs perform forward processing of standard products, and reprocess data to incorporate algorithm improvements.

NASA Earth Science and Data Systems

Agency Organizational Relationships and Information Flows



EOSDIS Performance and Reach

EOSDIS NASA's Earth Science Data System

EOSDIS currently has over **24 Petabytes** of accessible Earth science data

Easy access and discovery of data to over **12,500 unique data products**

… of which 95% of granule searches complete in less than **1 Second**

EOSDIS delivered over **1.5 Billion** data products to over **3.2 Million** users from around the world

33,000 Data Collections in the Common Metadata Repository (CMR)

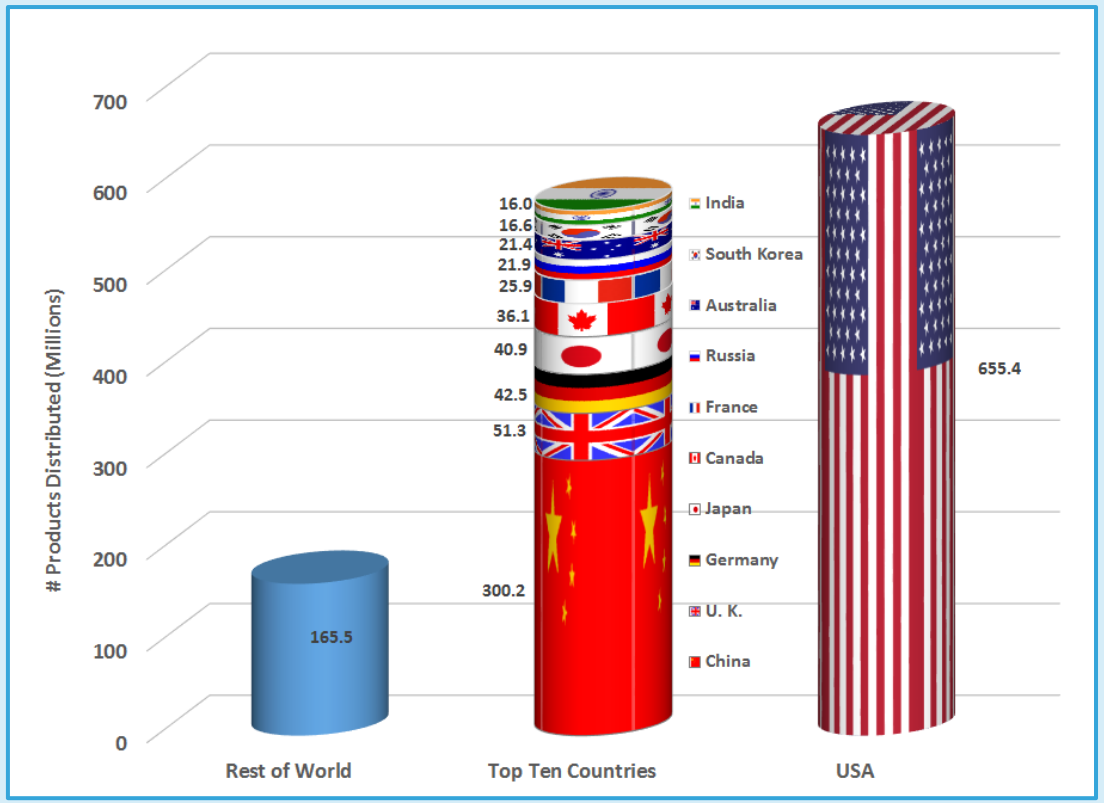
EOSDIS also delivers near-real-time products in under **3 hours** from observation …

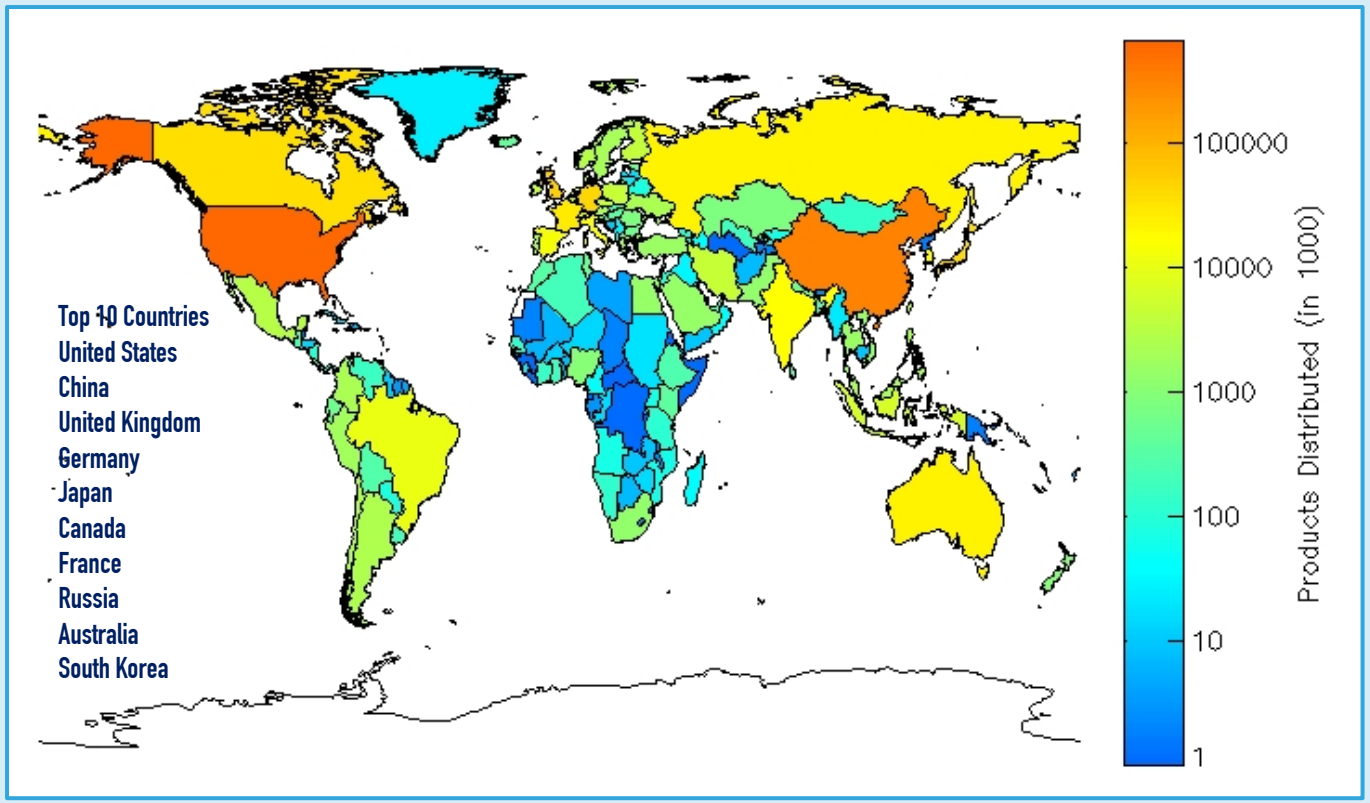
Over 330,000 users have registered with EOSDIS

And Over **380 Million** data granules

American Customer Satisfaction Index (ACSI) survey scoring **78** from **7,505** respondents

2017 EOSDIS Providing Data Across the Globe



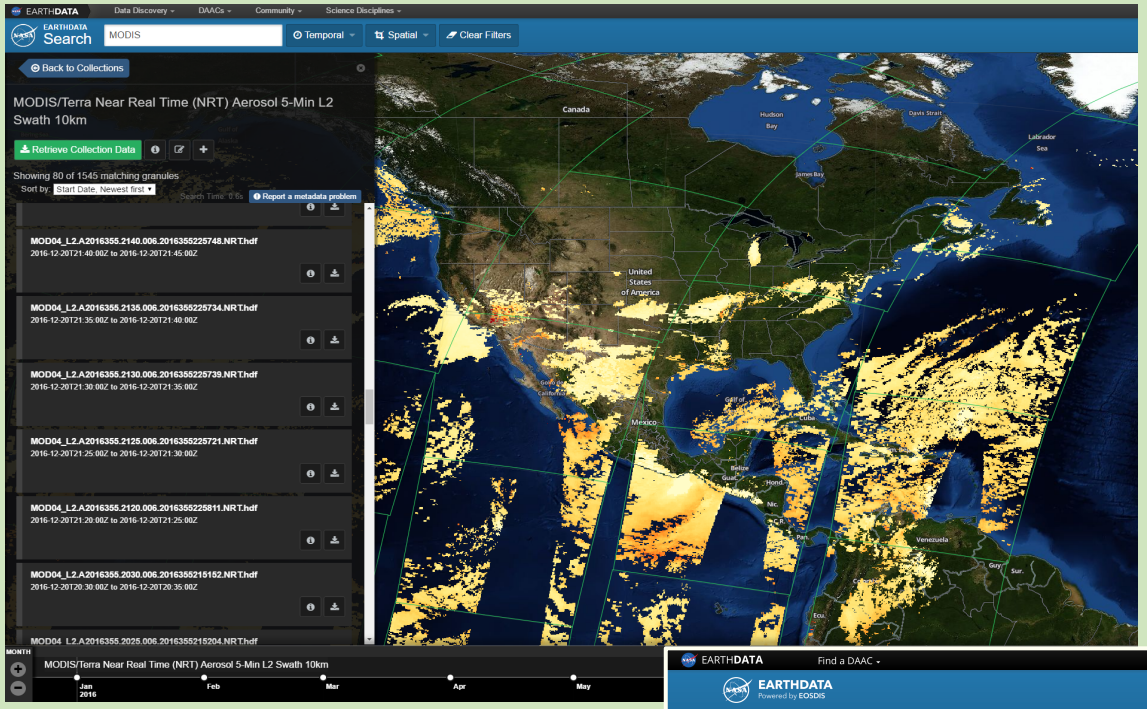


NASA's Earth Science data is distributed globally, the effect of an open data policy now in effect for over 17 years

* Charts report only distribution to the public and do not include distribution to science teams, for data processing or testing

ESDIS/EOSDIS Cross-DAAC Activities

EOSDIS User Interfaces from Earthdata: Helping users discover and visualize EOSDIS Data



Data Centric Users
https://search.earthdata.nasa.gov

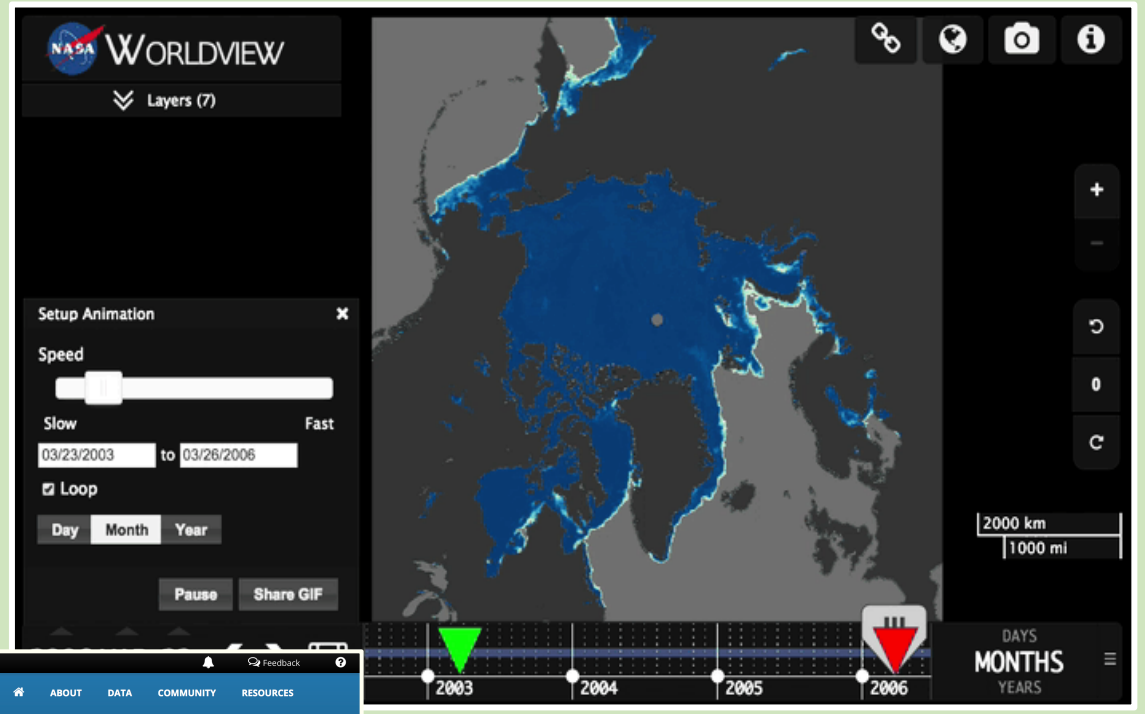
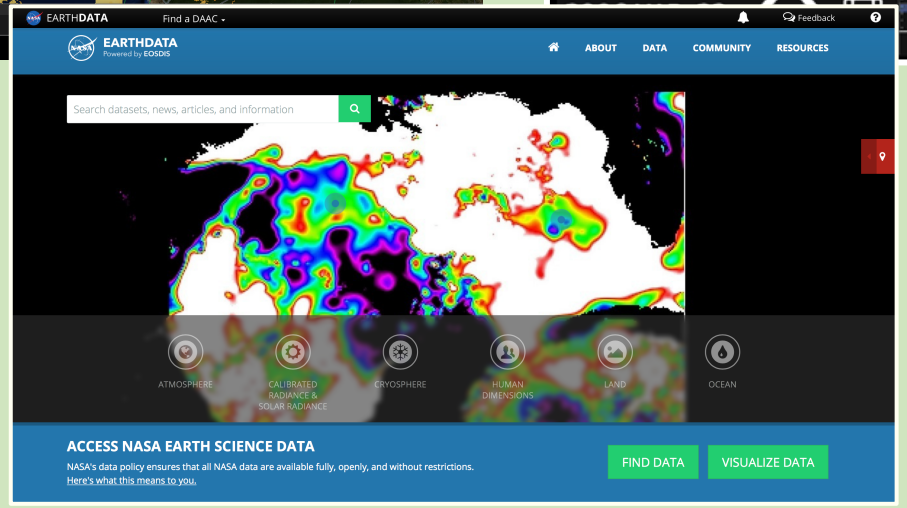


Image Centric Users
https://worldview.earthdata.nasa.gov



NASA's Earthdata Web Site

EARTHDATA
EOSDIS NASA'S EARTH OBSERVING SYSTEM DATA AND INFORMATION SYSTEM

Transitioning to **Earthdata Search**: What to Expect

search.earthdata.nasa.gov

- Variety of search capabilities available including search by science keyword,(e.g., disciplines, parameters), platform and instrument names, collection IDs, etc.
- Temporal and spatial filtering capabilities available.
- Data services, such as spatial subsetting, map reprojection, and choice of output formats available for select data.
- Sub-second search, enhanced data discovery, and increased relevancy with results

Schedule: Reverb Retirement and Full Transition to Earthdata Search

October 11, 2017
Reverb users automatically redirected to Earthdata Search.

Through **November 8-**
option to go back to Reverb

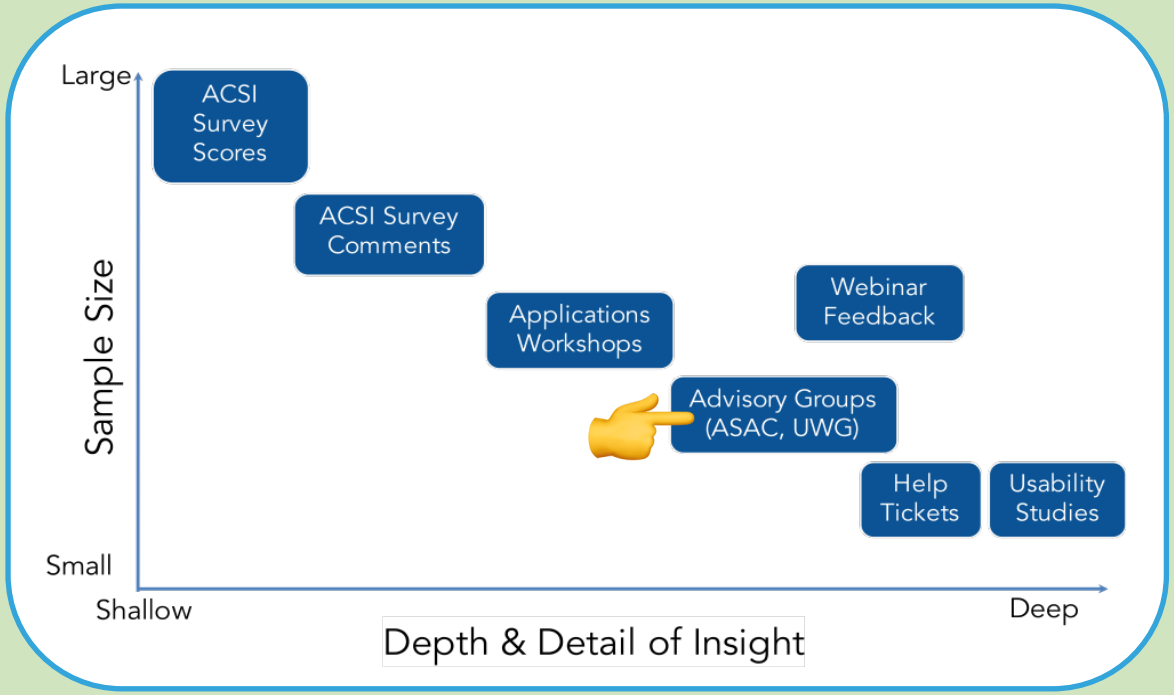
Beginning **December 1**, option to switch back will be remembered once.

Beginning **January 1, 2018**
Reverb will no longer be available.

January 1, 2018-
Earthdata Search replaces Reverb.

OCT. NOV. DEC. JAN.

ESODIS User Needs: How we gather them and what we are doing to address them



ESODIS uses numerous forums, methods and mechanisms for collecting user needs for EOSDIS data and services. There is no one single source that can address the scope of all user needs, therefore ESDIS extracts data at various levels of user engagement that relates a particular portion of the end-to-end user experience.

Rank	Recommendation Description	Score
1	Create getting started guide (video, pdf, print)	12
2	Improve RMA and communication across EOSDIS and DAACs at machine level	11
3	Documentation: improve delivery, coordinate templates of what documentation is delivered, consider DOIs on all documentation for each data product.	11
4	Hold user focus group to address data transformation, perform gap analysis, and find out what users really want	10
5	Have a common interface/seamless services user experience	9
6	Develop a robust download manager compatible with URS 4	7
7	Externally share availablity of services and APIs	7
8	Better (retrievable) metrics on EOSDIS services	7
9	Make OPeNDAP more user friendly (e.g. auto-generate commands)	6
10	Hold user focus group for dynamic browse	4
11	Incorporate chat function for user questions	3
12	Remove 2K granule download limit	3

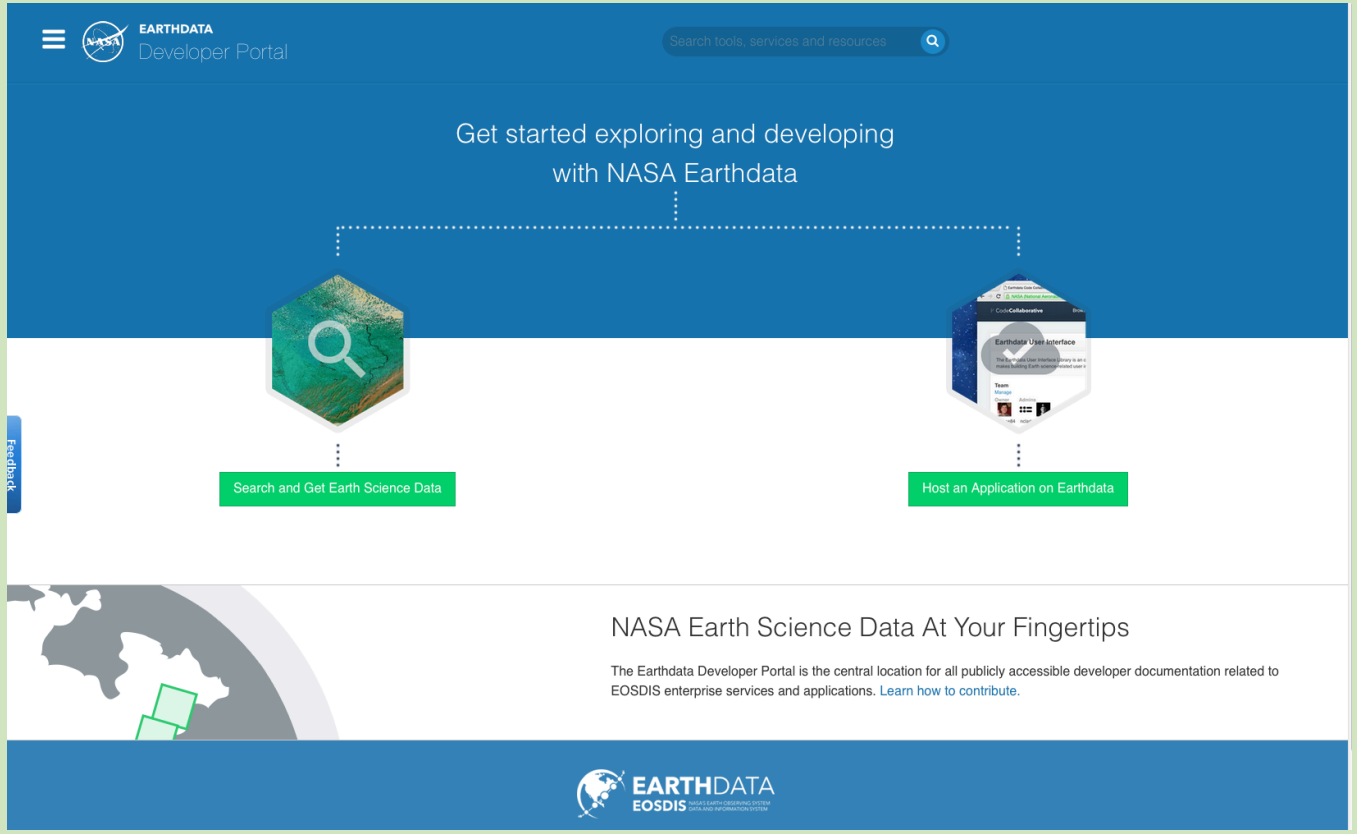
Outcome from the 2016 User Needs TIM, Boulder Colorado. A ranked order of key users needs agreed to by all DAACs.

Following the first UN-TIM ESDIS has been keeping the momentum going on addressing the 12 top-line user needs. To date there has been significant work on Data Transformation across the DAACs. Improving Reliability, Maintainability, and Availability (RMA) is being led by SEDAC. A getting started guide has been created. Making OPeNDAP more user friendly has been taken on by the ESDSWG. Etc!

UFG: Data Transformation - Updates

- We hope this will reveal any patterns that might be useful in creating transformation services that could operate on certain types of data products. For example, can the granule size help predict input multiplicity? What chain of reformatting makes the most sense.
- For example, lossy processes like HDF -> Geotiff might be automatable, whereas processes that require more information than is likely to be found in the original files, such as Binary -> HDF are more problematic. This suggests that chaining could be possible where the transformation is lossy, but not possible in the other direction.
- We have begun documenting detailed information about the chain of transformation processes that are required for some of the 20 use cases we collected;
- **For each use case, we identify each process that had to be completed;**
- **For each process, we identify the exact pre-transformation and post-transformations states of the files that were operated on, including:**
  - **Format**
  - **Granule size (number of variables in a granule, temporal coverage of a granule, spatial coverage of a granule)**
  - **spatial and temporal resolution of the measurements**
  - **projection type**
  - **input multiplicity**
  - **what process was performed immediately preceding the current process**

Enter the Earthdata Developer Portal: to meet the needs of NASA Earth science data systems for the future



- Single Resource for Application Developers for Leveraging EOSDIS Tools and Services
- API Documentation, User Guides, Best Practices, Code Examples, etc.
- Includes API for Common Metadata Repository (CMR) and Global Browse Imagery Services (GIBS), Guide on how to make your own data portal based on Earthdata Search, OPeNDAP guides and code examples for reading EOSDIS data, and more.

https://developer.earthdata.nasa.gov

Keep an eye out for MORE, new content and continuing improvements…

EARTHDATA
EOSDIS NASA'S EARTH OBSERVING SYSTEM DATA AND INFORMATION SYSTEM

COMMUNICATIONS

Social Media

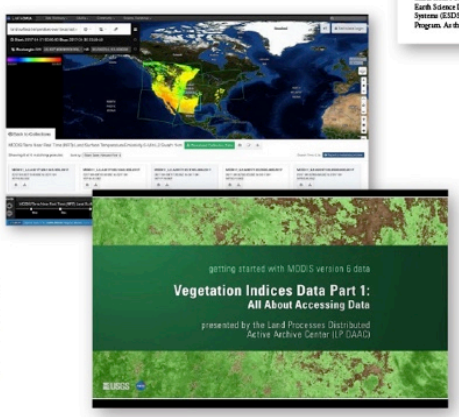
At-a-Glance

Twitter- Over 16k followers
Facebook - Over 29k Likes
Google+ - 203 Followers with 51,274 Lifetime Views
YouTube - 1,170 Subscribers

Webinars & Data Recipes

www.youtube.com/c/NASAEarthdata

- Webinars: Online multimedia based discussions and tutorials led by subject matter experts
- Purpose: To increase awareness, and usage of NASA EOSDIS data, information, services, tools and technologies.
- 2017 to date– 18 webinars with 1,300 participants: 11 DAAC webinars, 3 CEOS WGISS technology webinars and 5 internal ESDIS Cloud webinars.



Newsletter

The **EOSDIS Quarterly Update** features data set and data tool news, and highlights our top stories, featured data images, webinars, data recipes, and data user profiles.

Articles, Data Chats, User Profiles & More!

By the numbers 2017:

35 articles to include: 11 Data Product/Tool Announcement/ Notice, 10 Feature Articles, 10 Data User Profiles, 2 Data Chats, 1 Policy Statement, 1 article published in NASA's The Earth Observer (1): cover Feature Article in volume 29, number 3 (May/June 2017)

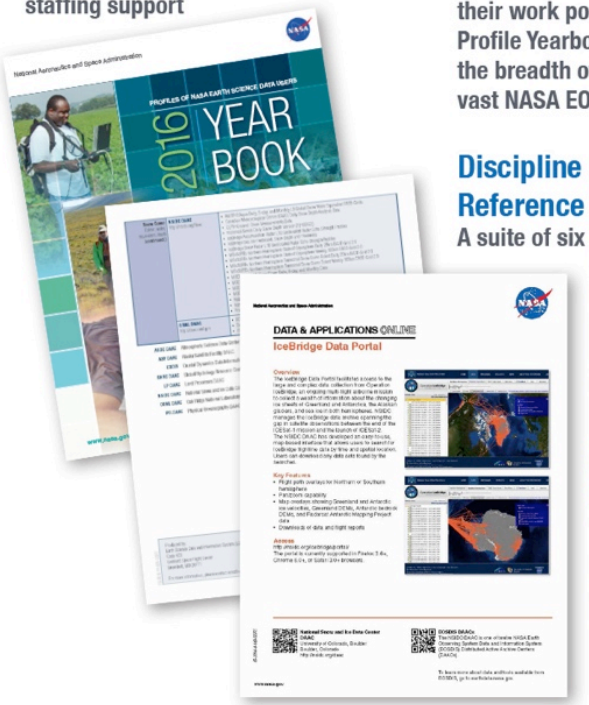
2017 Articles by Type

Technology/Informatics: 3
Data/Tools in Action: 5
Data User Profiles: 10
Standards/Interoperability: 4
News/Announcements: 13

Conferences/ End-User Workshops

Conferences

Plan and organize flash talk speaker program for NASA booth at Fall AGU
Provide staffing support to NASA booth Coordinate/Facilitate DAAC participation in Hyperwall talks
Facilitate NASA exhibit DAAC staffing support



Publications

Team produces a suite of online and some print outreach products ranging that provide the end user with valuable information regarding how to find, access and use NASA EOSDIS data holdings.

User Profile Yearbook

The EOSDIS Data User Profile series showcases these scientists, researchers, managers, and educators along with the data products that make their work possible. Our Data User Profile Yearbook gives you a taste of the breadth of research enabled by the vast NASA EOSDIS data collection.

Discipline Data Set Reference Sheets

A suite of six reference sheets listing key data sets, organized by discipline, parameter/ measurement, and the DAACs from which those data are available

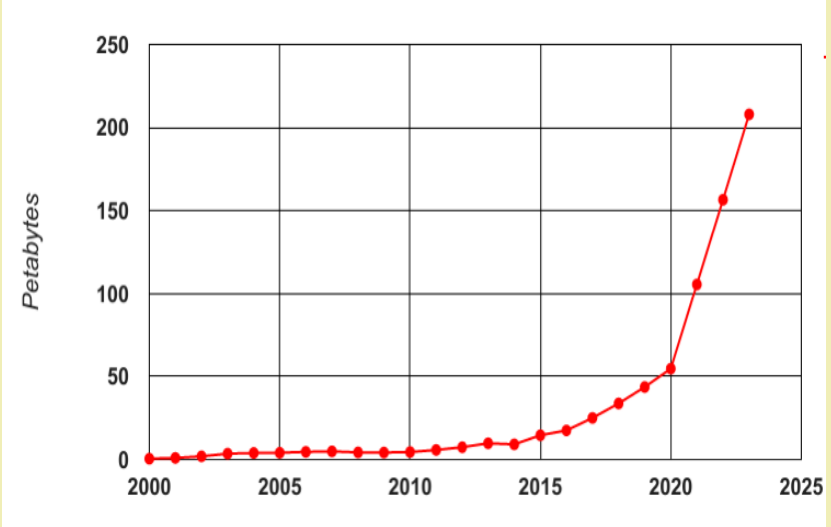
Data Set/Tool Fact Sheets

One-page documents that feature either a data product, data tool or data service.

Near-term things to come

The Next 5 Years:
Mission volumes are set for another paradigm shift

Missions	Launch Date	Daily Data Volume
Sentinel-3B	Nov 2017	128 GB/day
GRACE FO	Feb 2018	19 MB/day
TSIS on ISS	Apr 2018	541 MB/day
ICESat-2	Sept 2018	891 GB/day
ECOSTRESS	2019	585 GB/day
GEDI on ISS	Mar 2019	3.5 GB/day
SWOT	April 2021	15.5 TB/day
TEMPO	2021	1.7 TB/day
NISAR	Dec 2021	86 TB/day
JPSS-2	Oct 2021-Feb 2022	1.7 TB/day
PACE	Jun 2022	3.5 TB/day
TOTAL		114 TB/day



The Big Data Universe, 2016

Amount of data stored in Petabytes
(1 Petabyte = 1 000 000 GB)

Human brain
2.5 PB

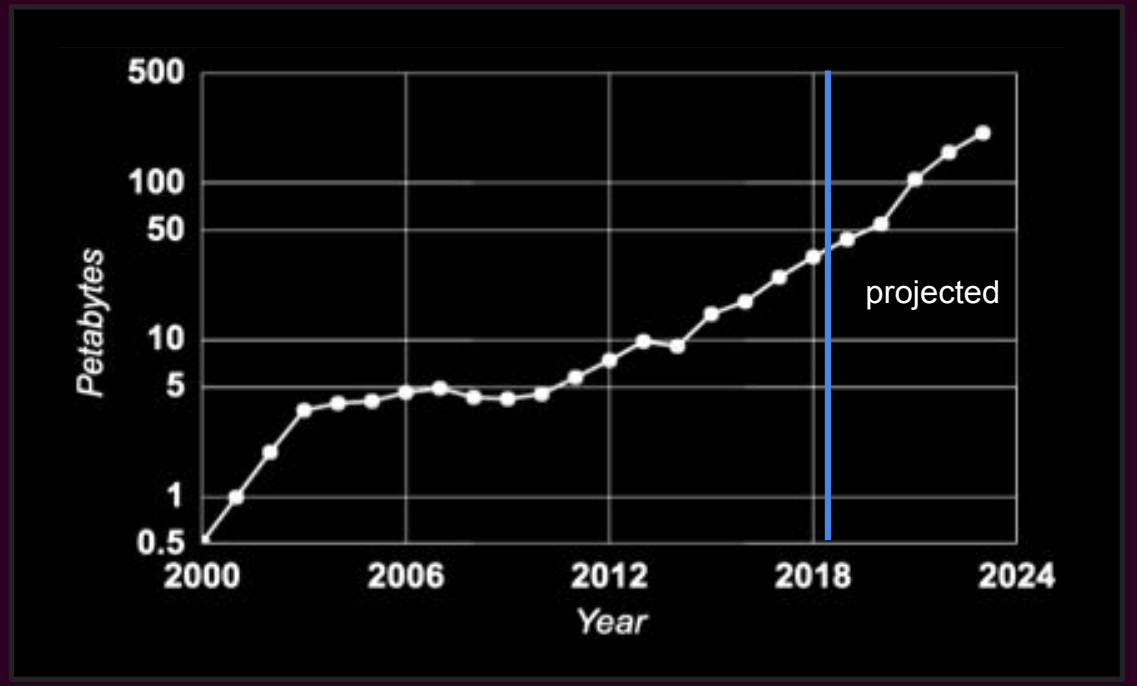
Ebay
90 PB

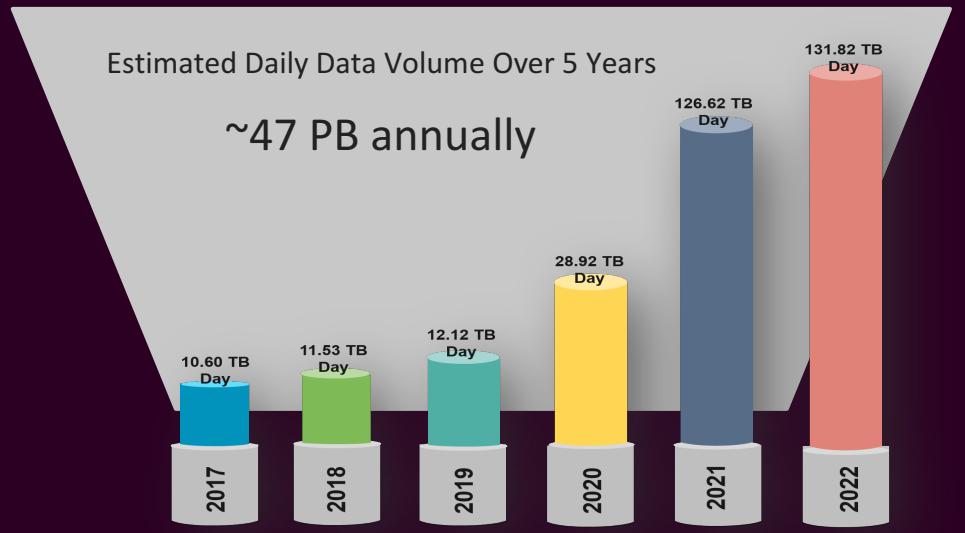
Spotify
10 PB

Facebook
300 PB

Google
15,000 PB
(estimated)

EOSDIS Data Archive Volume (Petabytes) 2000-2017 – and beyond



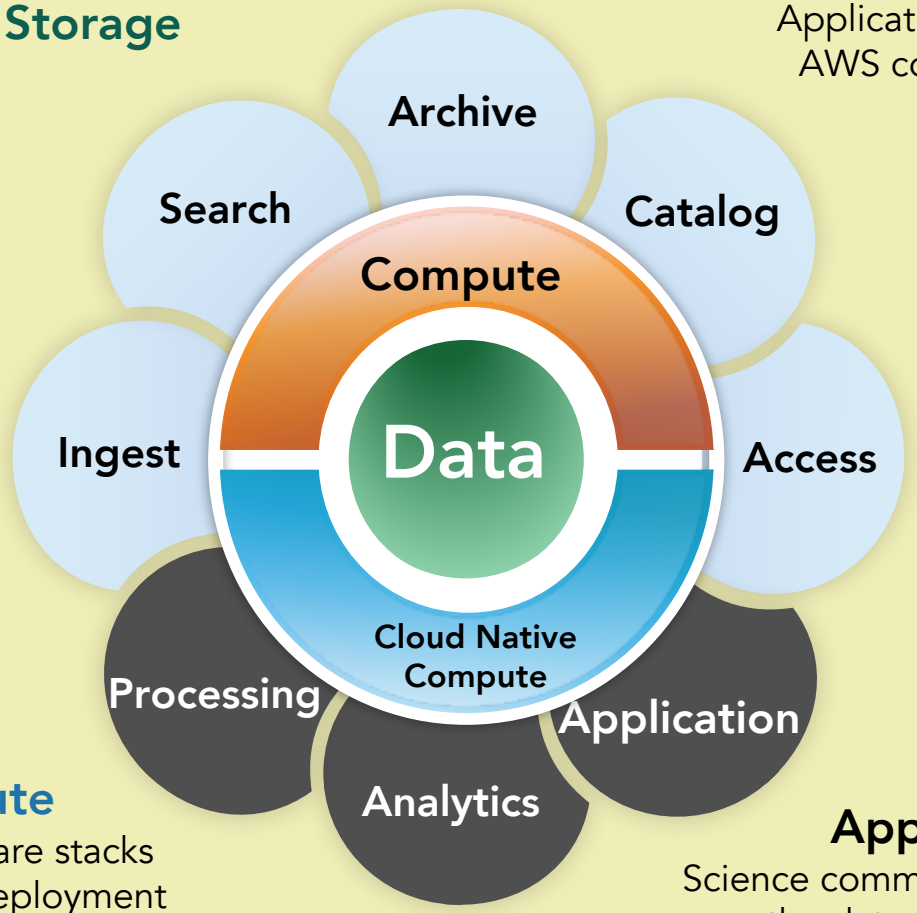


Moving Data Close to Compute:
Explorations of harnessing the Cloud

Large Volume Data Storage
Centralized mission observation & model datasets stored in auto graduated AWS object storage (S3, S3-IA, Glacier)

Scalable Compute
Provision, Access, and terminate dynamically based on need. Cost by use

Cloud Native Compute
Cloud vendor service software stacks and microservices easing deployment of user based applications



EOSDIS Applications & Services
Application and service layer using AWS compute, storage (S3, S3IA, Glacier), and cloud native technologies

Non-ESDIS / Public Applications & Services
Science community brings algorithms to the data. Support for NASA & non-NASA

EOSDIS

Questions?

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