NOAA's Big Data Project

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National Oceanic and Atmospheric Administration
U.S. Department of Commerce

U.S. Committee on the Marine Transportation System (CMTS) Webinar

April 20, 2018

Outline

- Introduction to NOAA Open Data
- What is the Big Data Project (BDP)?
- Findings and lessons-learned from 2015-2018
- Challenges for the BDP related to ocean data
- Goals and future direction of the BDP

Our mission

To understand and predict changes in climate, weather, oceans, and coasts, to share that knowledge and information with others, and to conserve and manage coastal and marine ecosystems and resources.

Science

9

Key focus areas

NOAA's diverse mission extends from the surface of the sun to the depths of the ocean

Service

12,000

Total number of NOAA personnel worldwide

Dedicated to the understanding and stewardship of the environment.

Stewardship

6,773

NOAA scientists and engineers

Studying and monitoring our evolving planet

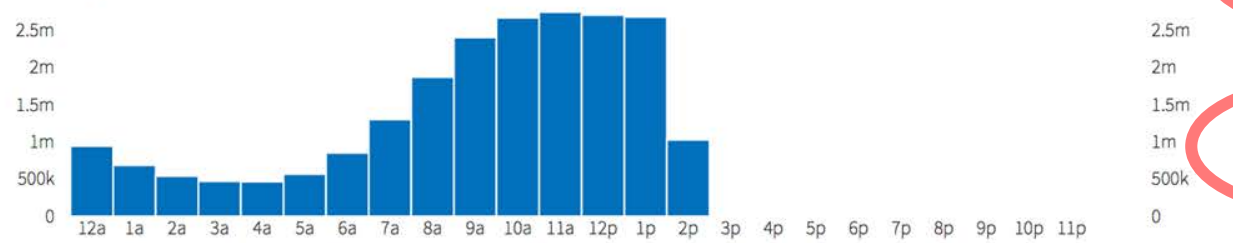
analytics.usa.gov | All Participating Websites | About this site | Data

296,920

people on government websites now

Visits Today

Eastern Time



Visits in the Past 90 Days

There were **2.83 billion** visits over the past 90 days.

Devices

Desktop	52.4%
Mobile	41.7%
Tablet	5.8%

Based on rough network segmentation data, we estimate that **less than 5%** of all traffic across all agencies comes from US federal government networks.

Much more detailed data is available in **downloadable CSV and JSON**. This includes data on combined browser and OS usage.

Browsers

Chrome	44.6%
Safari	29.1%
Internet Explorer	11.6%
11.0	10.6%
7.0	0.7%
10.0	0.1%
9.0	< 0.1%
8.0	< 0.1%
Other	< 0.1%

Operating Systems

Windows	43.2%
10	20.9%
7	18.8%
8.1	2.4%
Other	1%
iOS	27.1%
Android	19.6%
Macintosh	8.3%

Top Pages

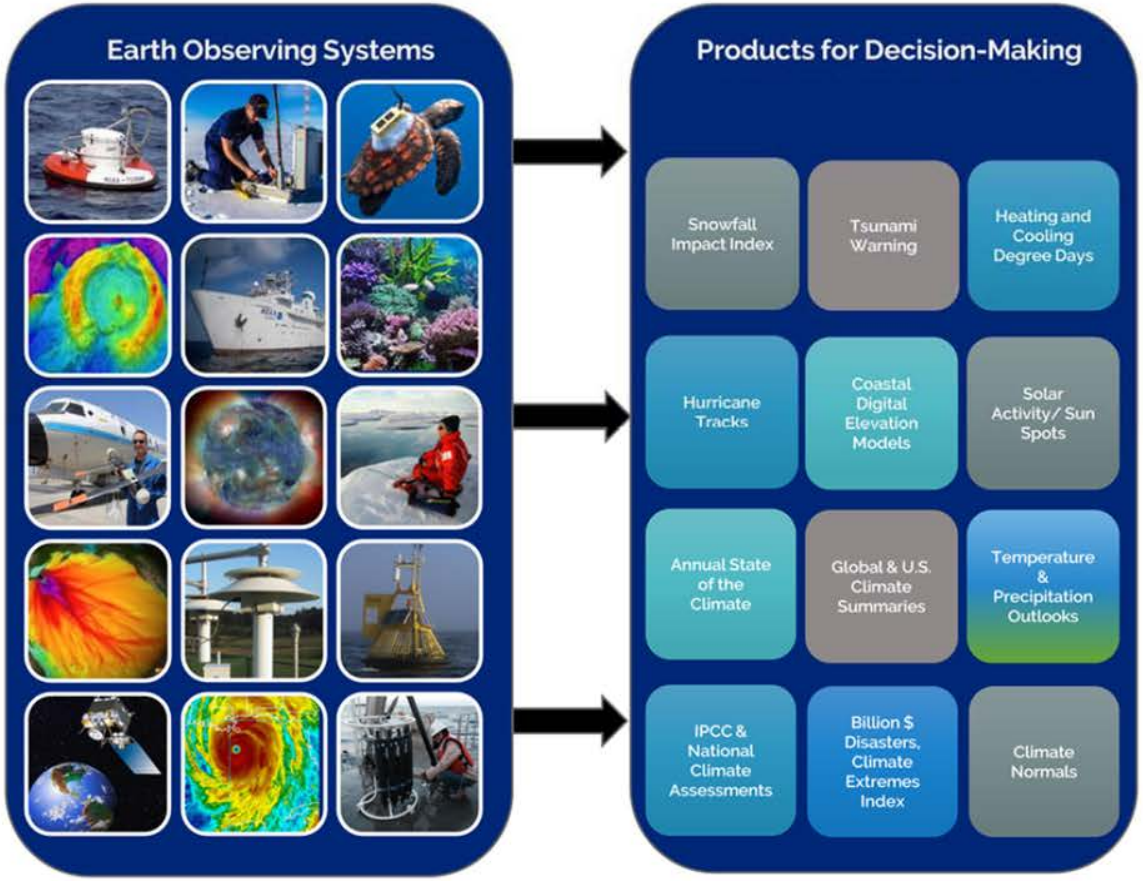
Now | 7 Days | 30 Days

Visits over the last month to domains, including traffic to all pages within that domain. We only count pages with at least 1,000 visits in the last month. Download the full dataset.

tools.usps.com	148,989,204
irs.gov	124,981,590
sa.www4.irs.gov	102,960,162
forecast.weather.gov	50,821,128
medlineplus.gov	39,234,310
usps.com	29,283,627
cdc.gov	28,605,471
weather.gov	23,271,299
reg.usps.com	21,495,802
ssa.gov	18,426,541
m.usps.com	17,523,430
usajobs.gov	14,264,328
uscis.gov	13,920,861
travel.state.gov	13,215,271
nasa.gov	12,480,053
nps.gov	11,745,932
egov.uscis.gov	9,609,410
informeddelivery.usps.com	7,982,054
ceac.state.gov	6,827,652
fda.gov	6,360,185

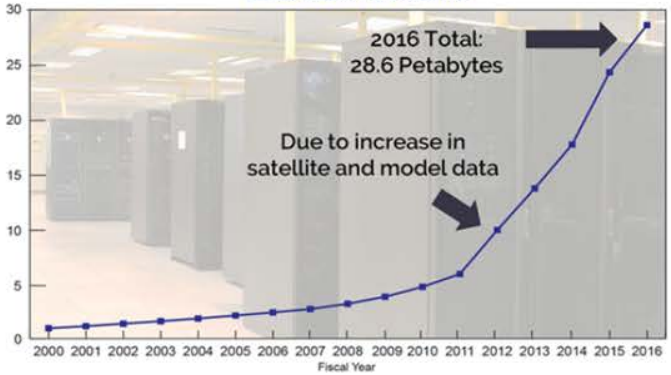
NOAA has been doing Data Science and "Big Data" for many years…

Data Science



High Performance Computing

National Center for Environmental Information Data Archive Volume

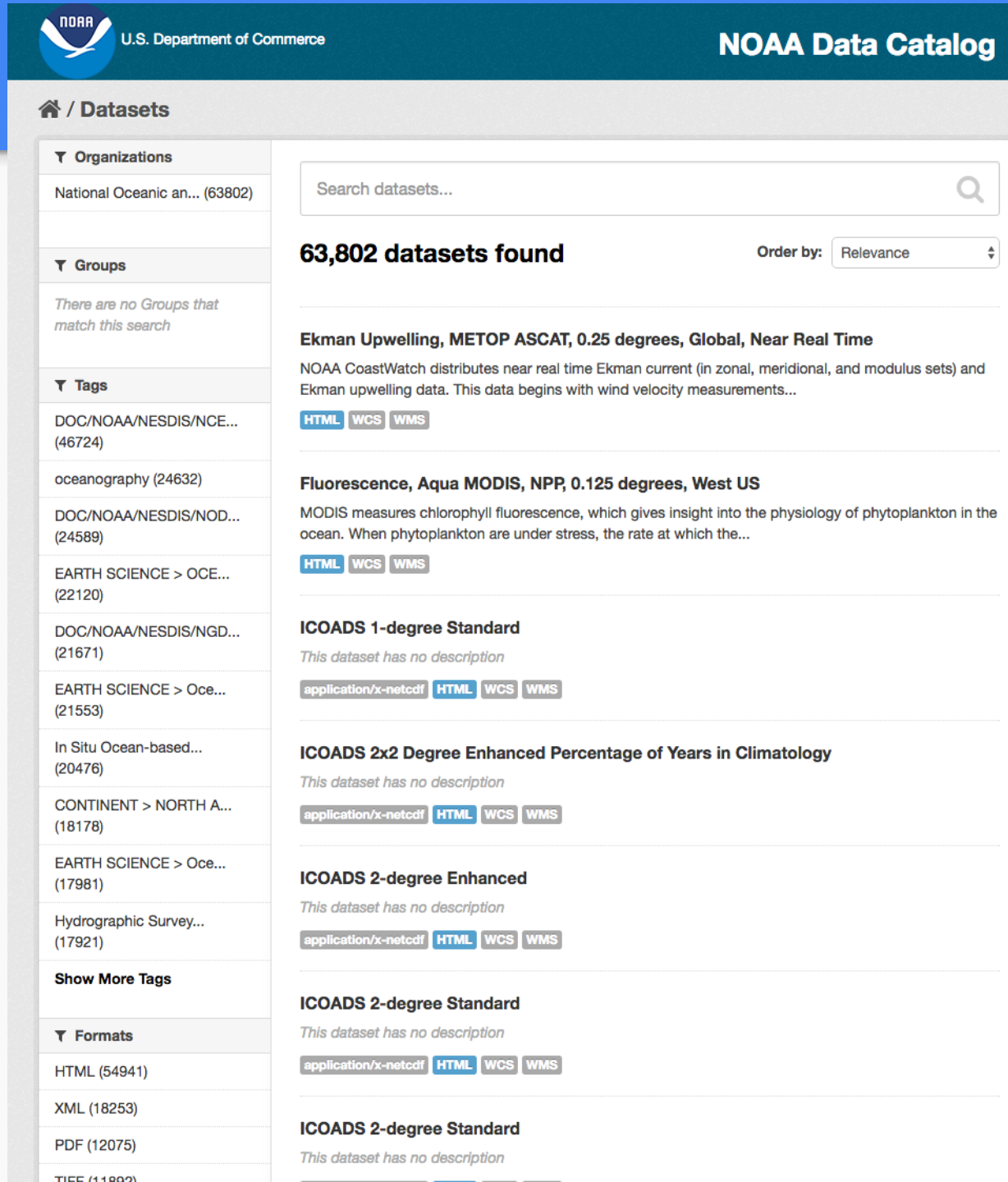


How much data do we have?

- ~70,000 open datasets
- 30 PB archived data
- ~200 PB of modeled and other data

- Weather
- Climate
- Ocean
- Coasts
- Fisheries
- Ecosystems
- Charts & Maps

- Almost all are Full and Open Data
- Most are accessible via internet today



UN WMO Resolution 40

WORLD METEOROLOGICAL ORGANIZATION
WEATHER CLIMATE WATER

Please visit our public website:
http://public.wmo.int

Home

WMO>WWW >WWW Operational Information Service (OIS)

Resolution 40 (Cg-XII)

"WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities"

THE CONGRESS,

Noting:
(1) Resolution 23 (EC-XLII) — Guidelines on international aspects of provision of basic and special meteorological services,

(2) Resolution 20 (EC-XLVI) — WMO policy on the exchange of meteorological and related data and products,

(3) Resolution 21 (EC-XLVI) — Proposed new practice for the exchange of meteorological and related data and products,

(4) Resolution 22 (EC-XLVI) — WMO guidelines on commercial activities,

(5) The report to Twelfth Congress of the chairman of the Executive Council Working Group on the Commercialization of Meteorological and Hydrological Services, established at the request of Eleventh Congress by the Executive Council in Resolution 2 (EC-XLIII) — Working Group on the Commercialization of Meteorological and Hydrological Services,

Recalling:
(1) The general policies of the Organization, as set down in the Third WMO Long-term Plan (1992–2001) adopted by Eleventh Congress, which include, inter alia, that Members should reaffirm their commitment to the free and unrestricted international exchange of basic meteorological data and products, as defined in WMO Programmes (Third WMO Long-term Plan, Part I, Chapter 4, paragraph 127),

(2) The concern expressed by Eleventh Congress that commercial meteorological activities had the potential to undermine the free exchange of meteorological data and products between national Meteorological Services,

Considering:
(1) The continuing fundamental importance, for the provision of meteorological services in all countries, of the

WORLD WEATHER WATCH
CBS Meetings
Reports of Meetings
OPERATIONAL INFORMATION SERVICE
WWW OIS Newsletter
Current News
Newsletter Archive
Observing Stations
WMO No 9 - Volume A
Radiosonde Catalogue
RBSNs/RBCNs
Bulletins TTAAii CCCC
WMO No 9 - Volume C1
Routeing Catalogues
Additional Data/Product
TAC/TDCF
Bulletin Comparisons
T1T2A1A2ii Data Designators
Transmission Programmes
WMO No 9 - Volume C2
Marine
WMO No9 - Volume D
GMDSS
WMO No 47
Data Buoys
Monitoring
Data Quantity
Data Quality
FOCAL POINTS
BEST PRACTICES
CONTACT US...

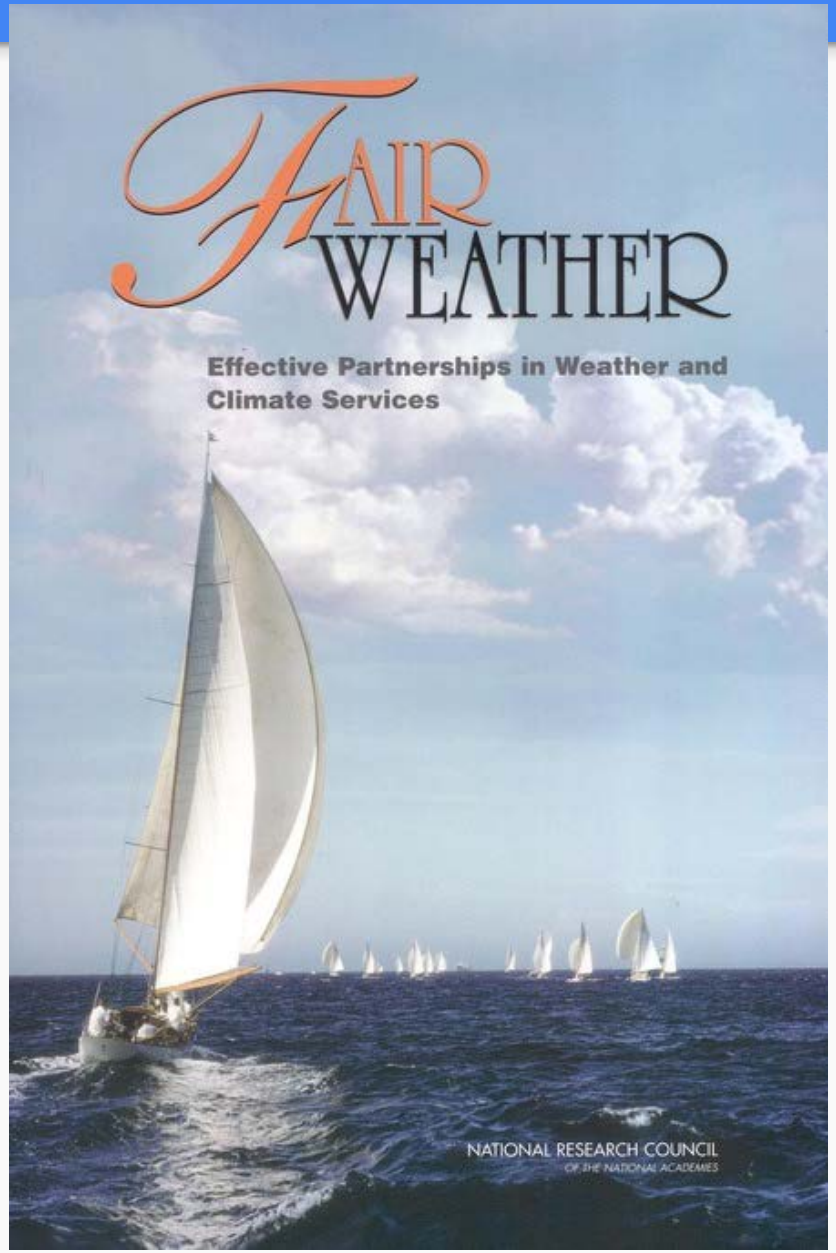
(1) Members shall provide on a free and unrestricted basis essential data and products which are necessary for the provision of services in support of the protection of life and property and the well-being of all nations…

Fair Weather Study, National Academies of Science 2003

- Debate about roles & responsibilities among NOAA, commercial weather interests, and academic researchers concerning the provision of data and services drove a study by the National Academies of Science in 2003 called the "Fair Weather" report.

- Focused on effective Partnerships and how data should be shared for the benefit of all.

"Recommendation 5. The NWS should make its data and products available in Internet-accessible digital form. Information held in digital databases should be based on widely recognized standards, formats, and metadata descriptions to ensure that data from different observing platforms, databases, and models can be integrated and used by all interested parties in the weather and climate enterprise."



NOAA Partnership Policy

NOAA's participation in the environmental information enterprise is founded on:

- Mission connection
- Consultation
- Open information dissemination
- Equity
- Recognition of Roles of Others

http://www.noaa.gov/work-with-us/partnership-policy

National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Policy on Partnerships in the Provision of Environmental Information

NAO 216-112: Policy on Partnerships in the Provision of Environmental Information

Policy

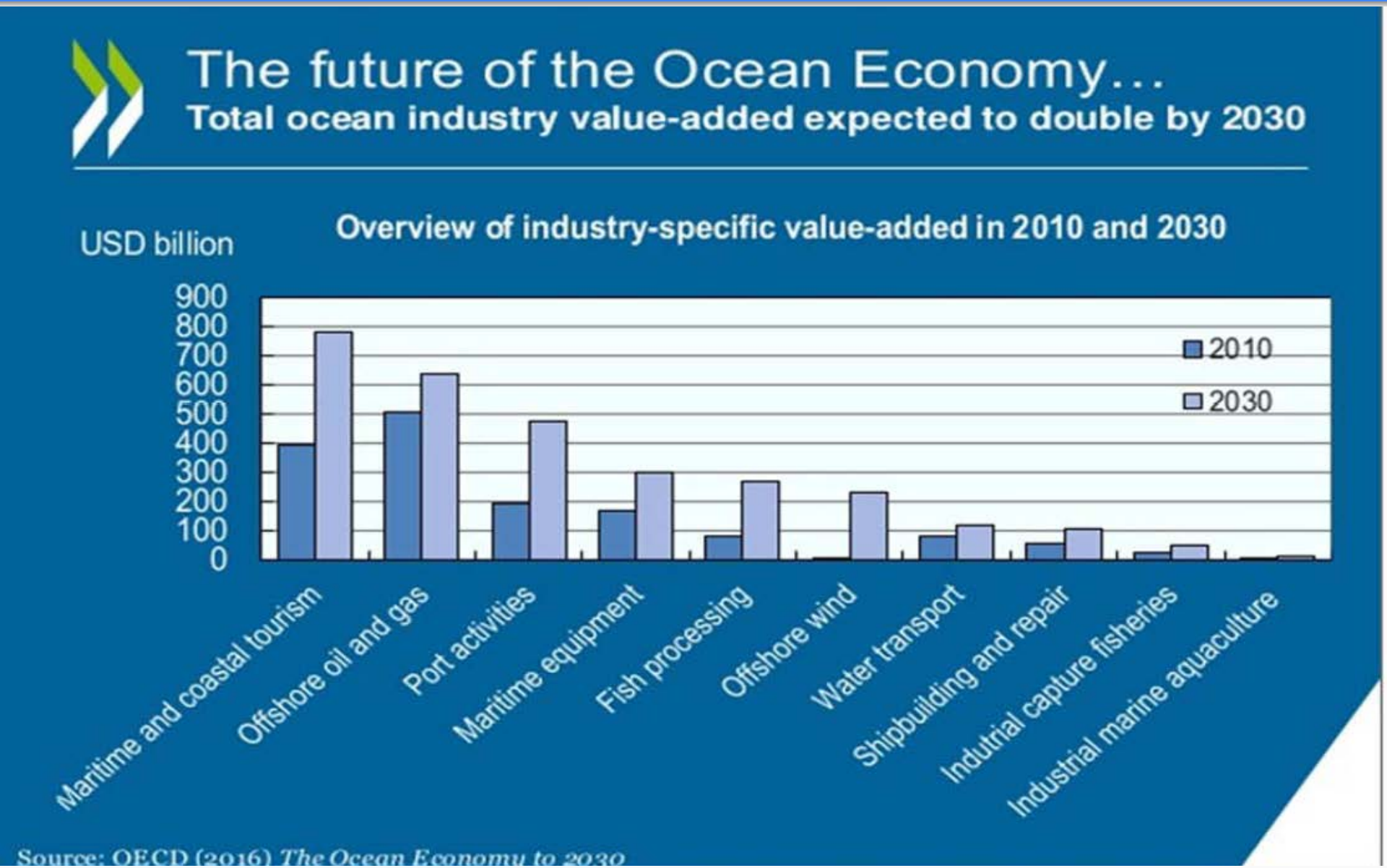
The National Oceanic and Atmospheric Administration (NOAA) Policy on Partnerships in the Provision of Environmental Information strengthens the

About our agency

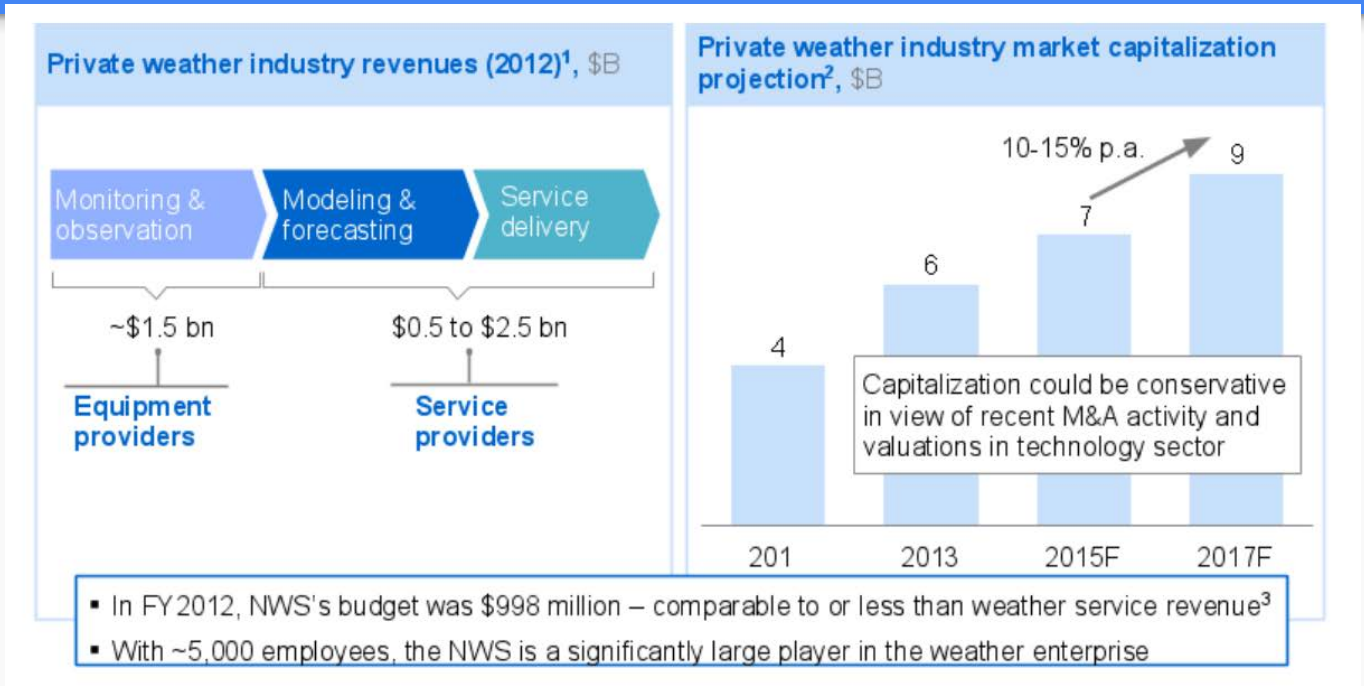
Mission & vision

Our commitment to science

The Value of the "Blue Economy"



The Value of the "Weather and Climate Enterprise"



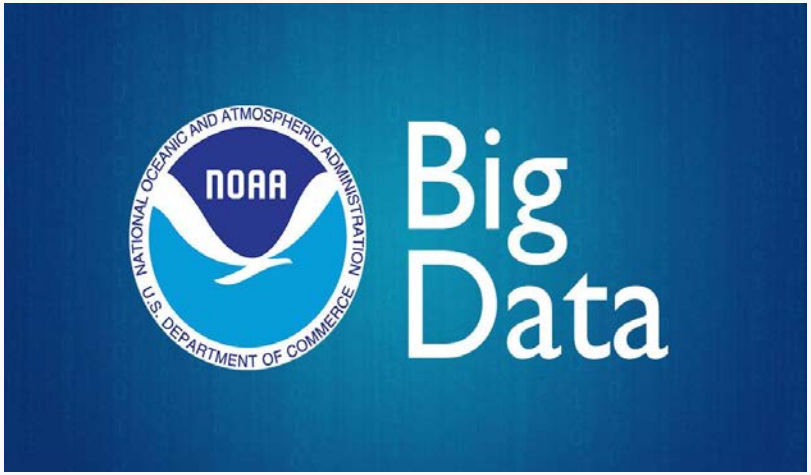
"While most companies remain privately held, making it difficult to confirm the size of the private weather industry, <u>its market capitalization is estimated at $7B</u> and predicted to grow 10-15 percent annually as it continues to serve consumers, businesses, and governments both in the U.S. and abroad. AccuWeather, for example, has begun to serve consumers and businesses in China, and other companies have worked with governments in developing countries to build out their weather infrastructure. Through acquisitions, large companies like Panasonic, IBM, and Monsanto (which was recently purchased by Bayer) have entered the weather space in the past five years..."

https://www.weather.gov/media/about/Final_NWS%20Enterprise%20Analysis%20Report_June%202017.pdf

Obstacles to Effective Use of Open Data

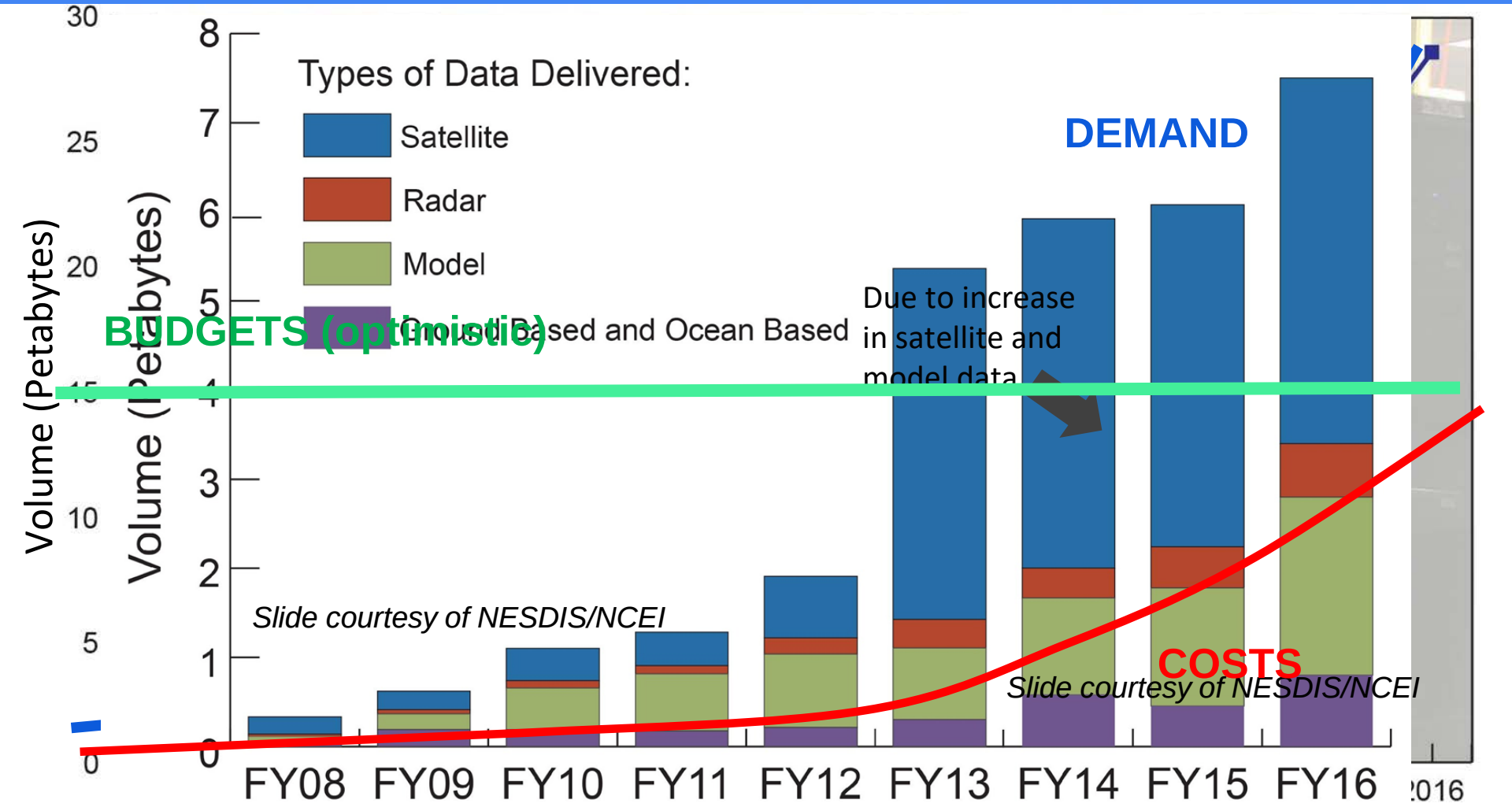
1. **Technical – how to distribute so much data?**
2. **Understanding – how can these technical data be widely understood?**

Idea: Let's try to leverage the value of the data to take down these obstacles…



Increasing Volume and Demand for NOAA Data

NOAA/NCEI's Environmental Data Archive



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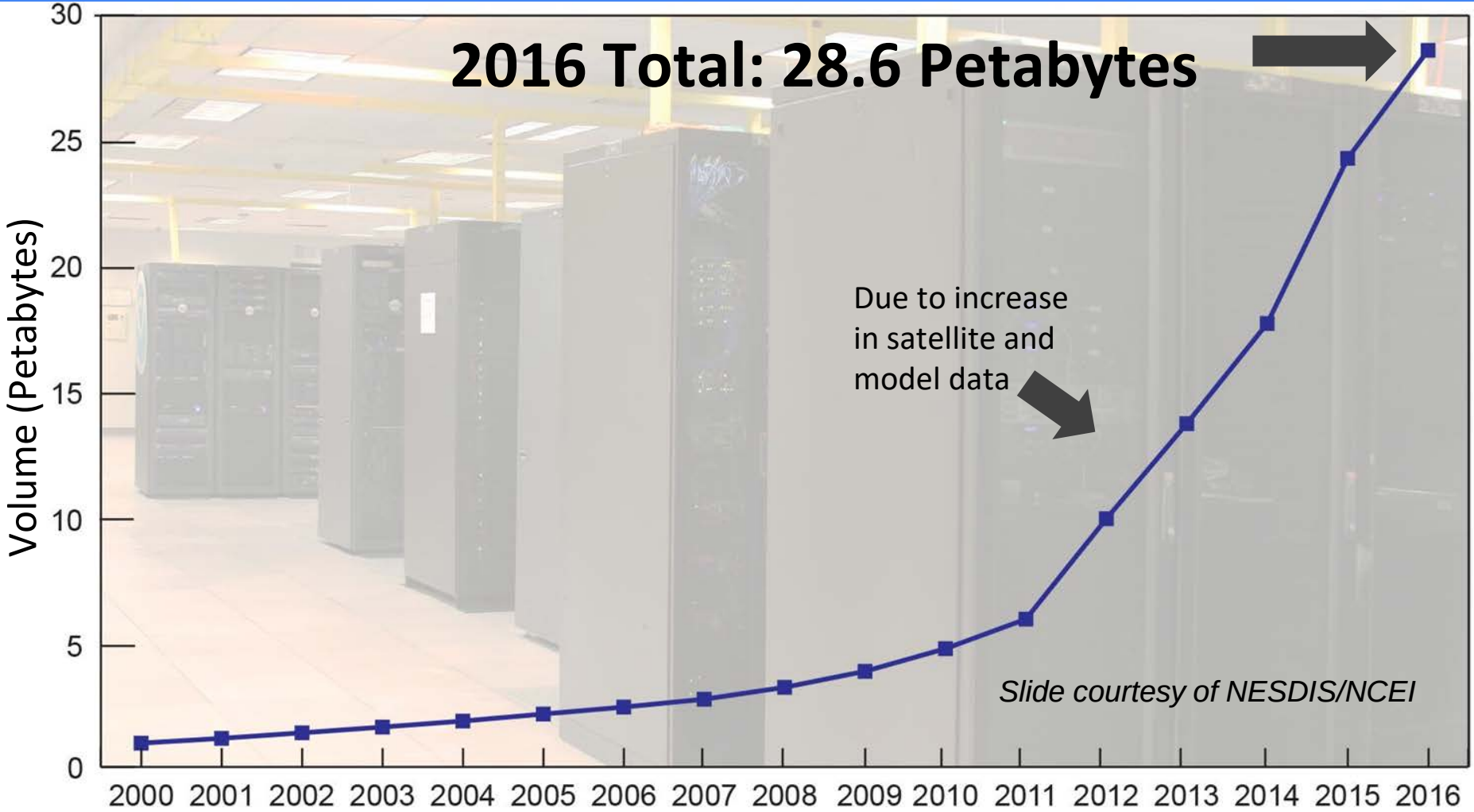

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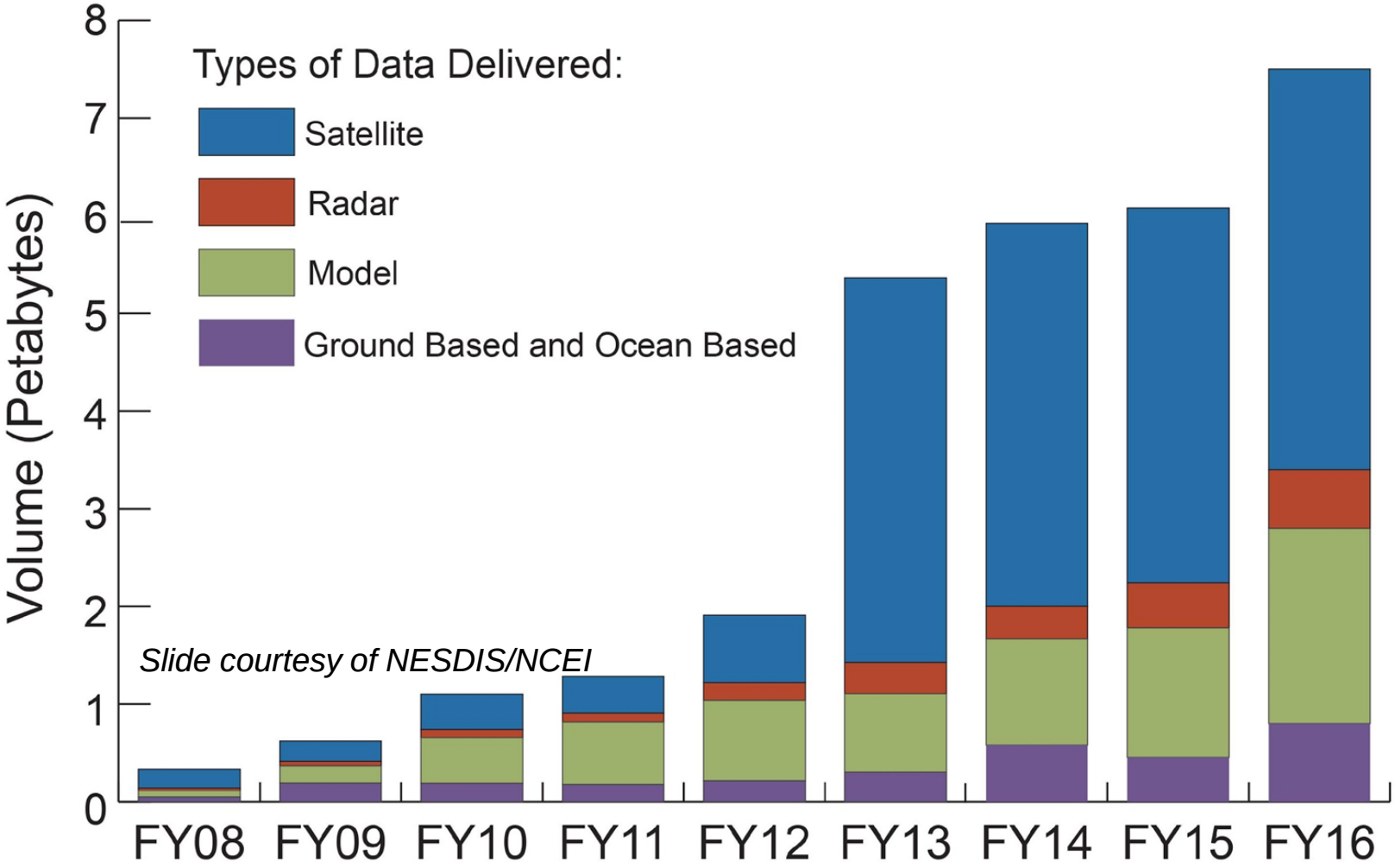

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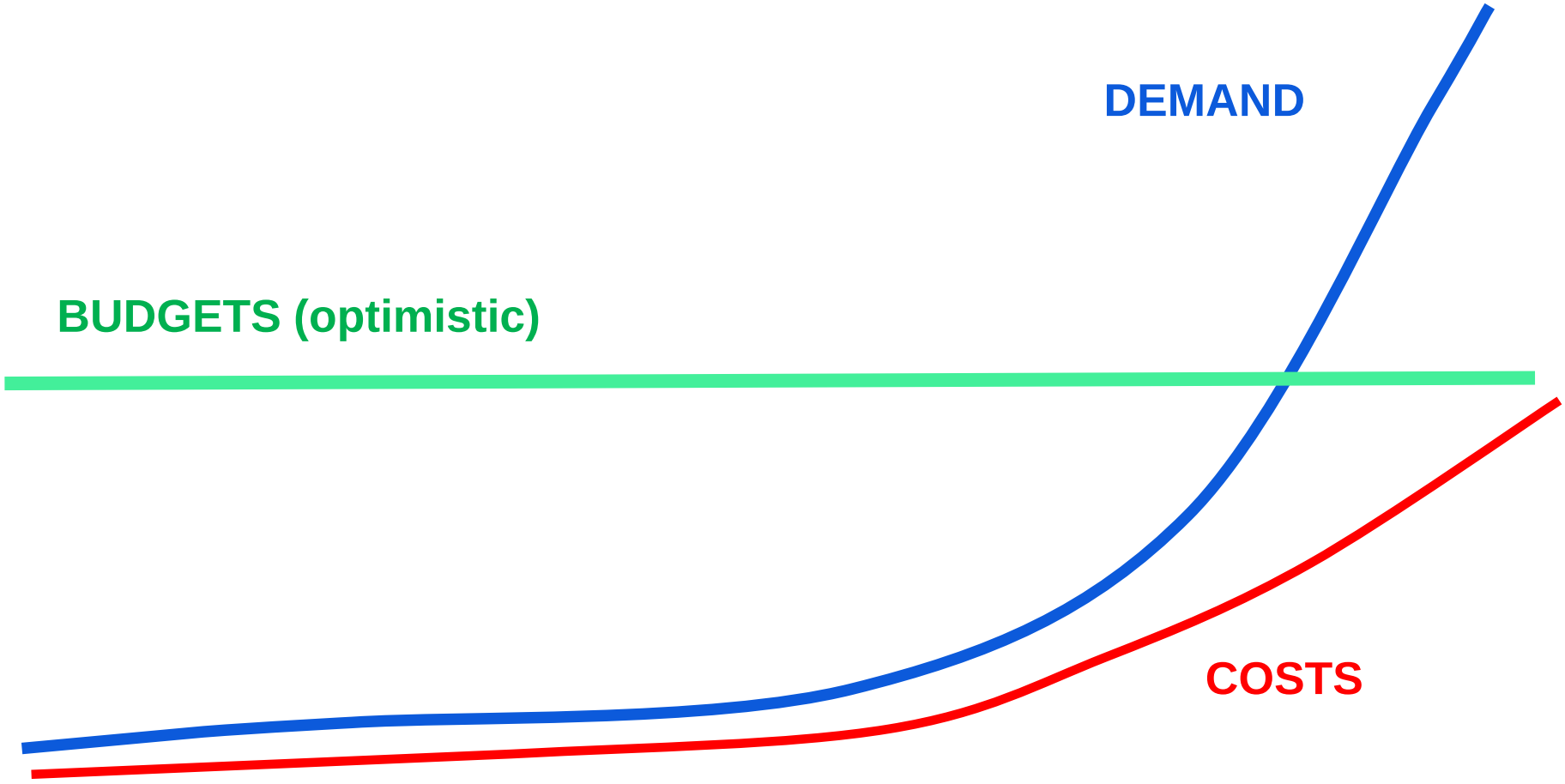
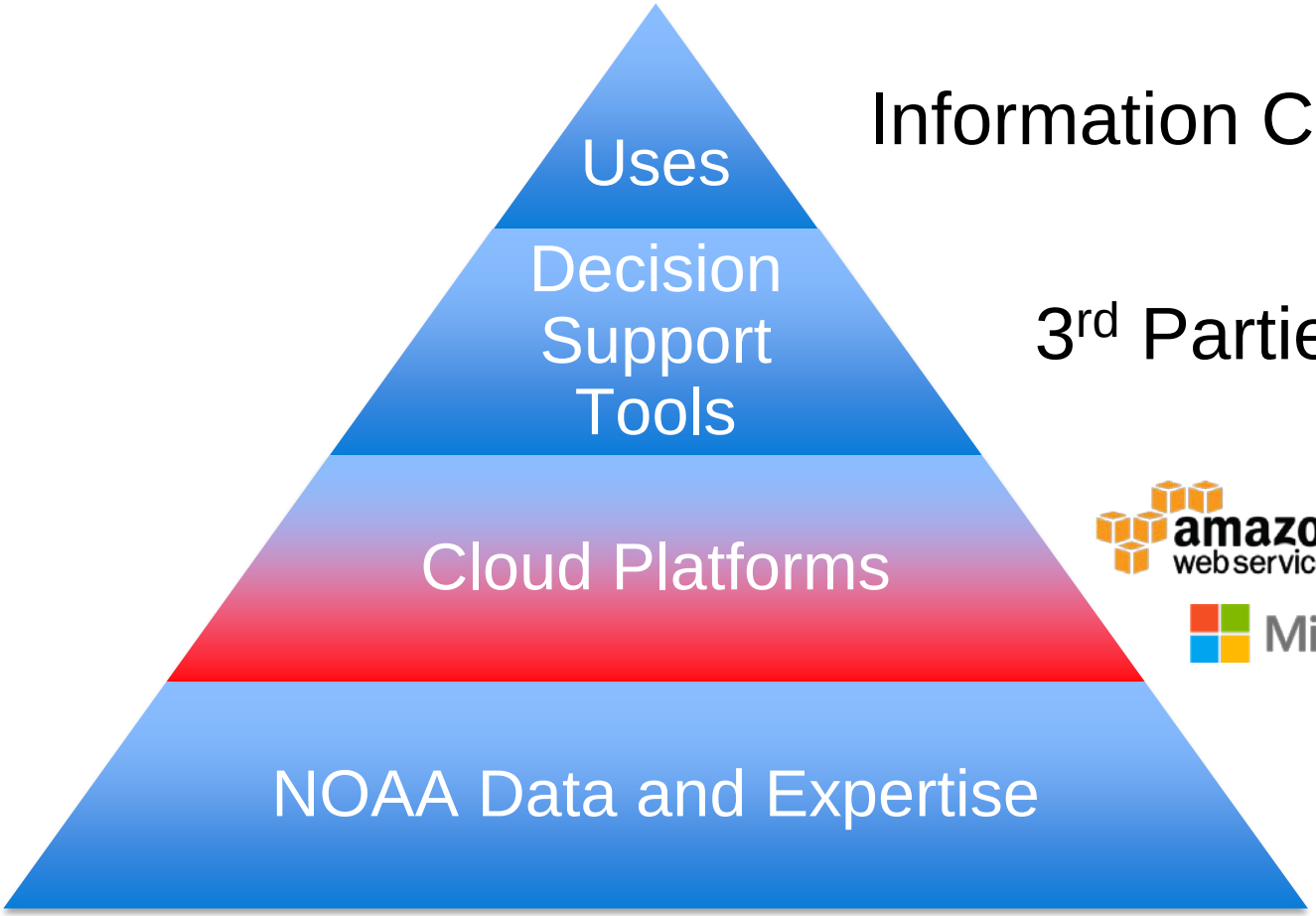
NOAA/NCEI's Environmental Data Archive



Industry Builds What is Needed to Support its Users



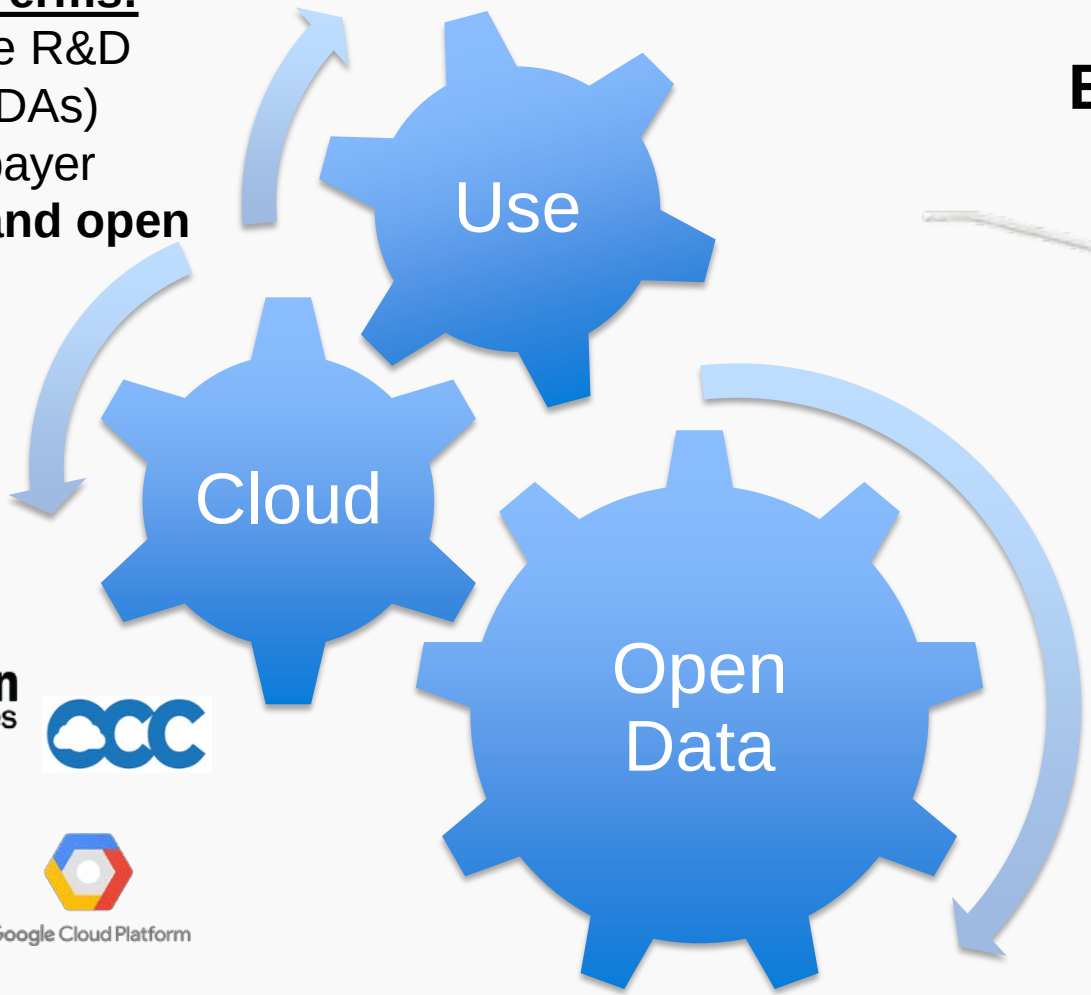
Information Consumers

3rd Parties

A Value-Driven Open Data Ecosystem

Collaboration Terms:

3 Year Cooperative R&D Agreements (CRADAs)
No net cost to taxpayer
Data remain full and open

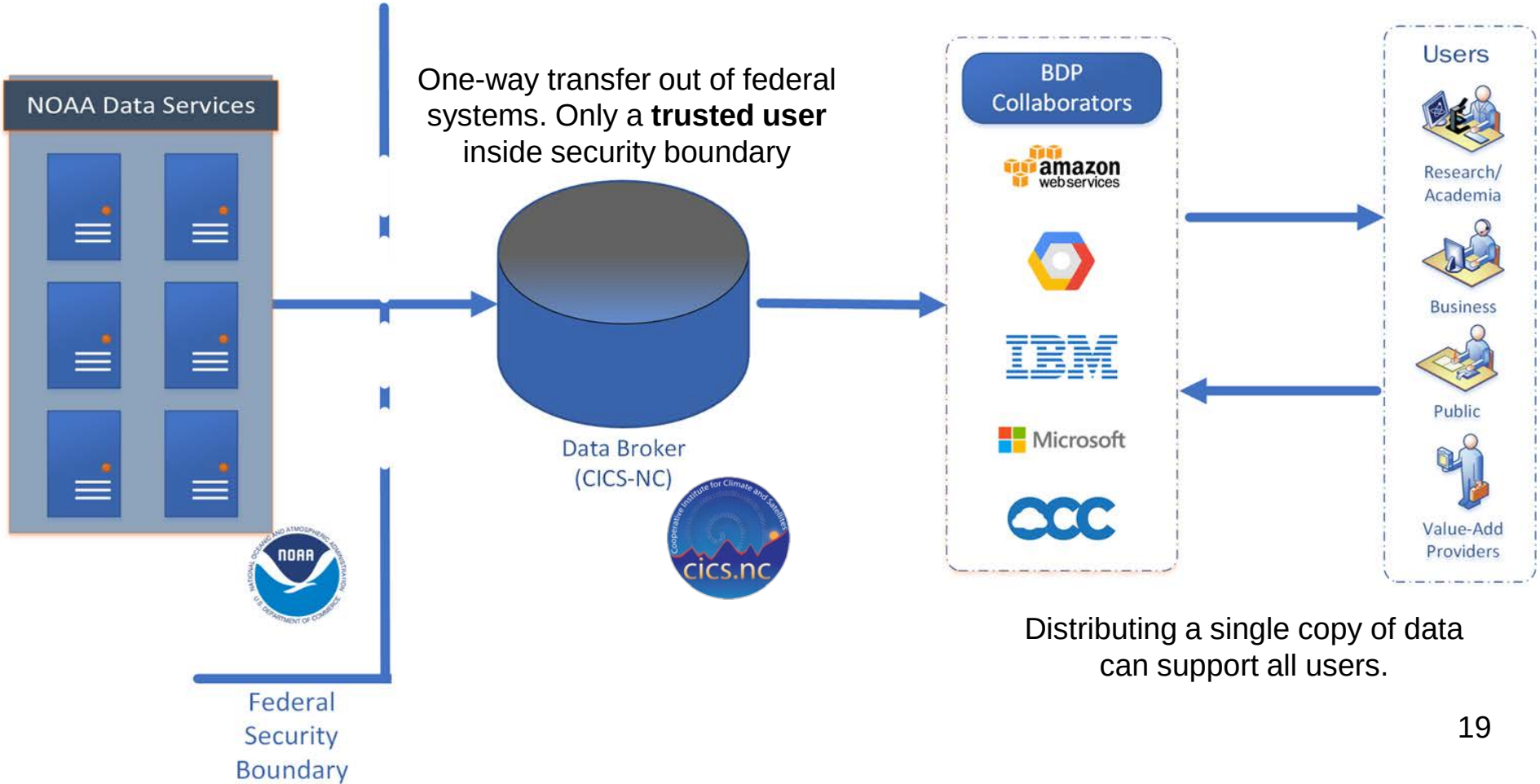


Expertise

amazon web services
CCC
Microsoft
IBM
Google Cloud Platform
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NOAA Big Data Project

Single Copy Services Many -- Use Data in Place



Distributing a single copy of data can support all users.

Big Data Project Collaborators' Data Offerings

- **AWS**
  - https://aws.amazon.com/noaa-big-data/
  - **https://registry.opendata.aws/**
- **Google Cloud Platform**
  - https://cloud.google.com/bigquery/public-data/
  - https://explorer.earthengine.google.com/#index
- **IBM - PaaS**
  - https://noaa-crada.mybluemix.net/
- **Microsoft** (No public-facing services to date)
- **Open Commons Consortium**
  - http://edc.occ-data.org/

AWS and Weather Radar

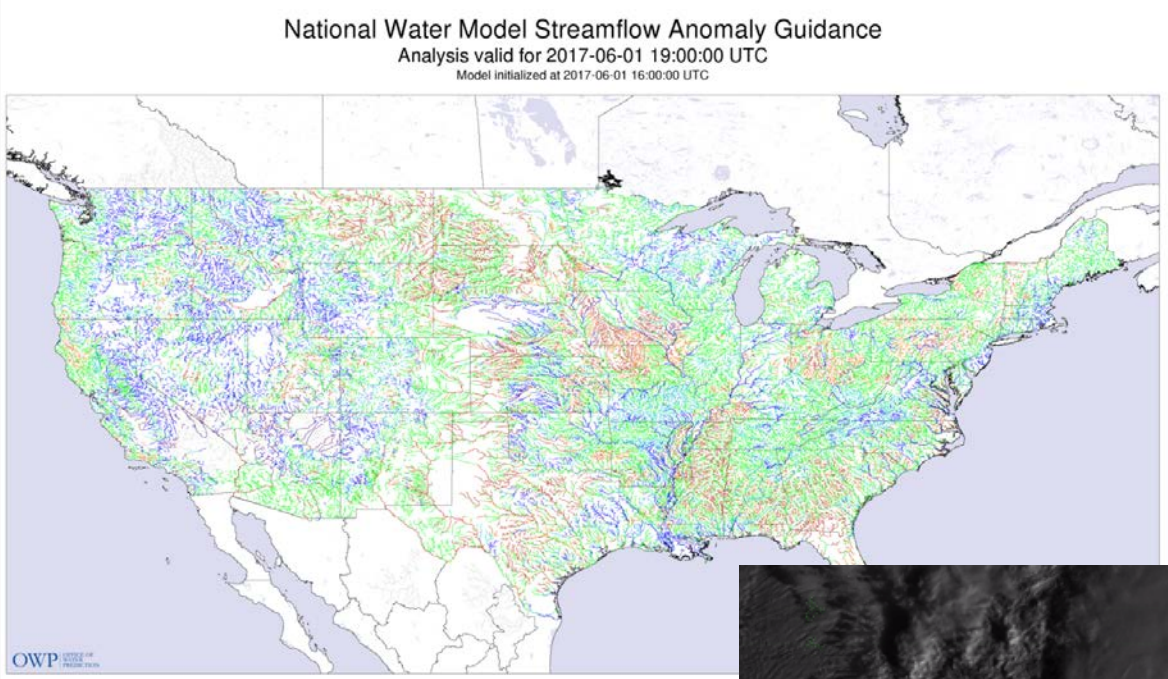
Entire NEXRAD 88D Weather Radar Archive transferred to AWS, Google and OCC in Oct 2015 (~ 300TB, 20M files)

Following AWS service release:

- Increased usage (2.3 times), 50% reduction on NOAA servers.
- New uses – bird migration, mayfly studies

- 80% of NOAA NEXRAD data orders are now served by AWS.
  - *(Ansari et al, 2017 BAMS)*

New Datasets



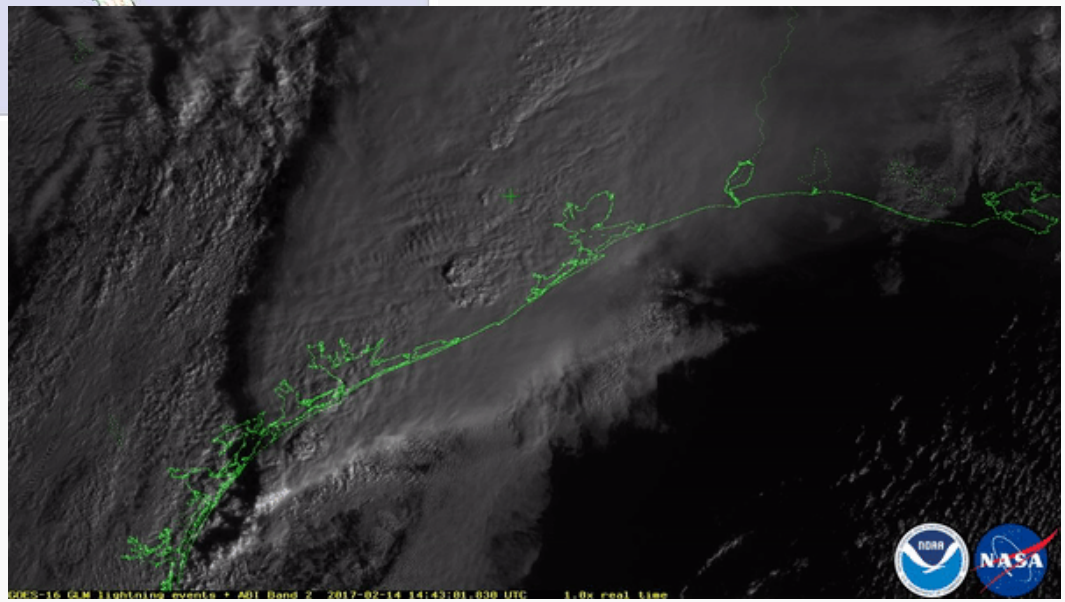
National Water Center: http://water.noaa.gov/tools/nwm-image-viewer

National Water Model:

- 23-year reanalysis
- Real-time forecasts

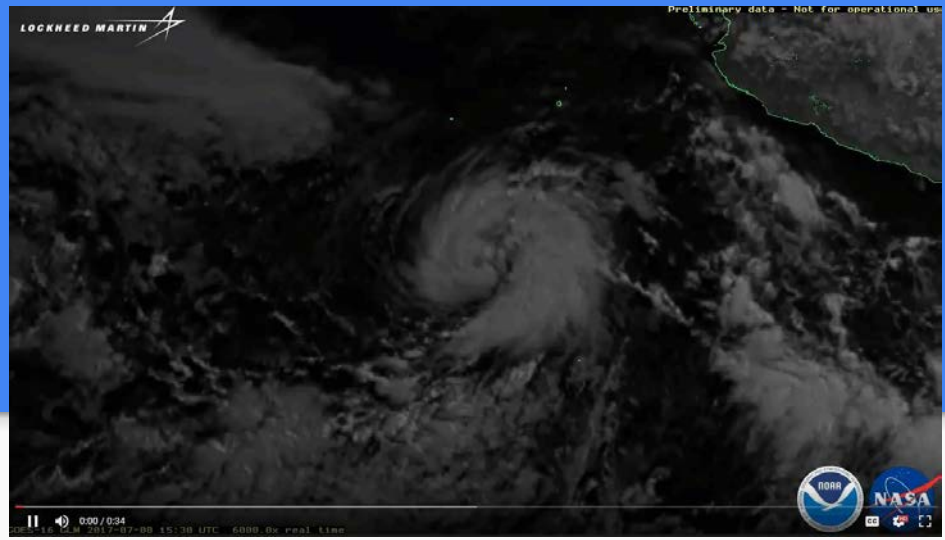
Provisional GOES-16:

- Now: Imagery
- L1b ABI Products
- L2 products
- Lightning Mapper (GLM)



NOAA NESDIS: https://www.nesdis.noaa.gov/content/flashy-first-images-arrive-noaa%E2%80%99s-goes-16-lightning-mapper

BDP and GOES-16



Overview of BDP Activity

Cooperative Institute for Climate and Satellites – North Carolina

- Providing GOES-16 data from NOAA/NESDIS Ground System (PDA) to Collaborators.

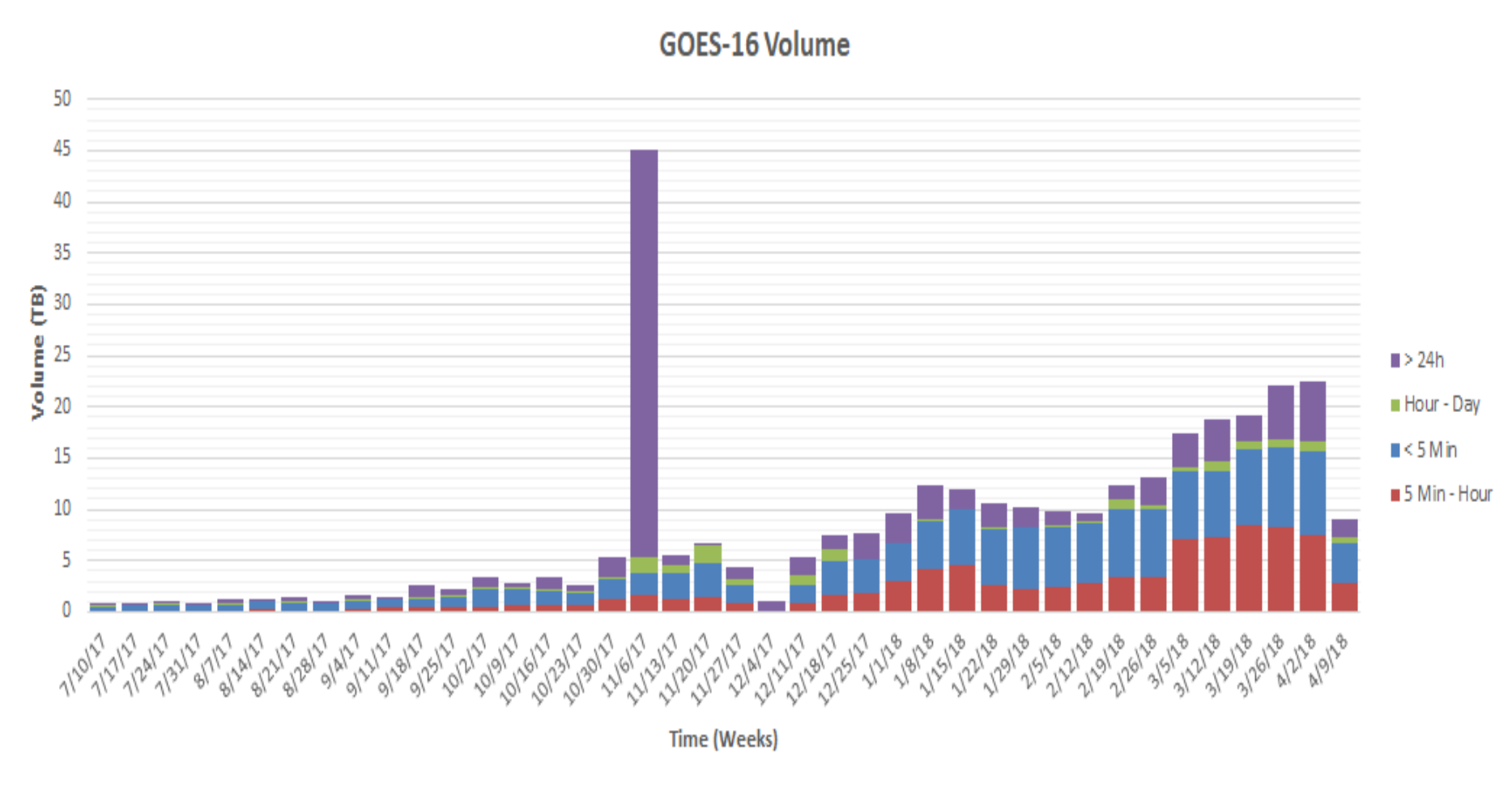
1 source, 5 validated feeds to the CRADA Collaborators

- Timing - As fast as they appear at NOAA/NESDIS distribution point
- Latency - Single hop through CICS-NC systems, w/checksums
- Impact - Minimal load on NOAA's operational systems and networks

Observed additional latencies from CICS-NC transfer from NOAA Ground System to BDP Collaborator platforms

- Maximum additional latency: 2 to 3 min (full disk ABI, Band 2)
- **Typical Range of additional latency: 4.5 to 5.5 seconds**

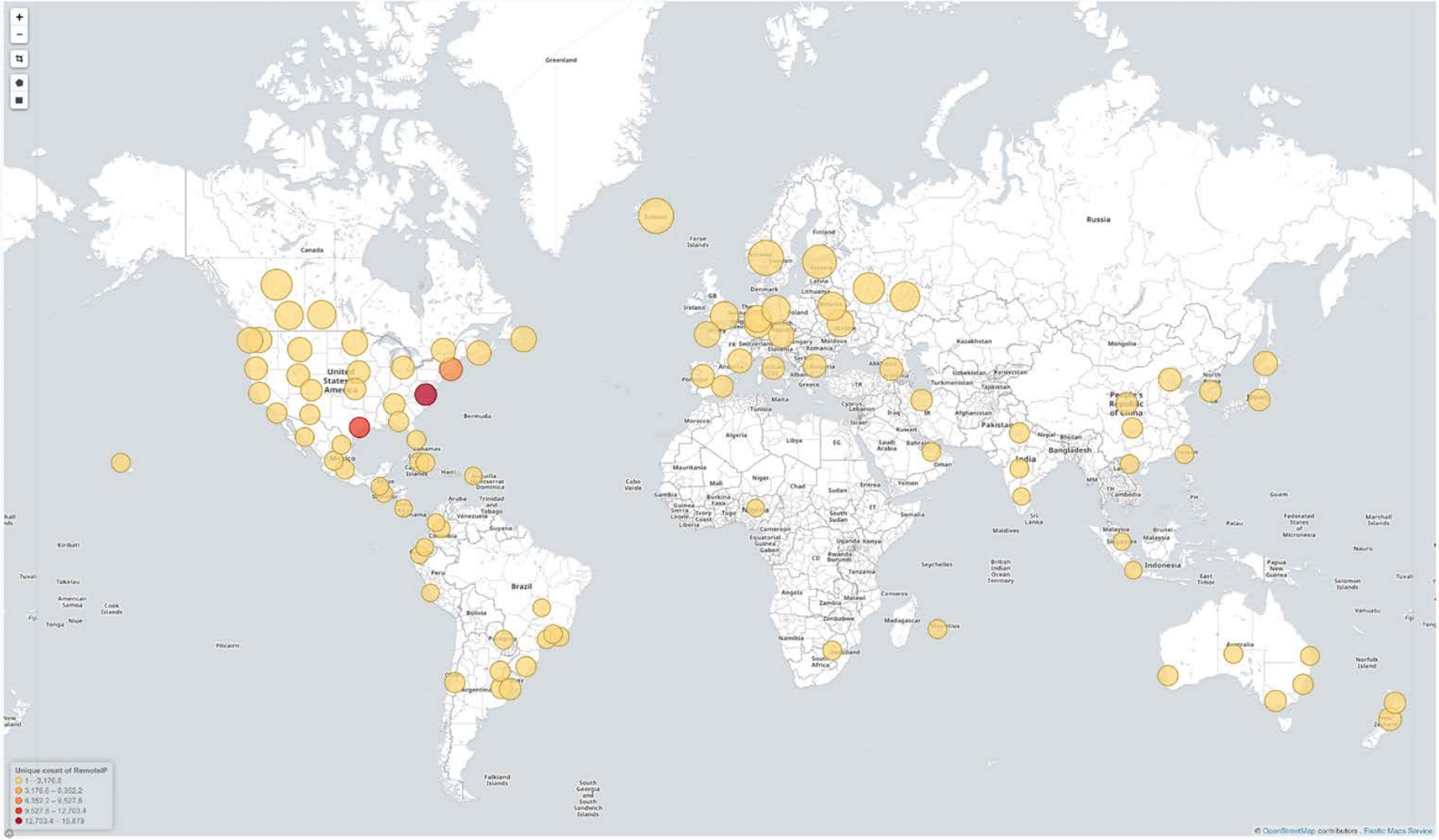
GOES-16 AWS Accession Volume by Age



Age is the time from observation. Accession is anytime the data are read.

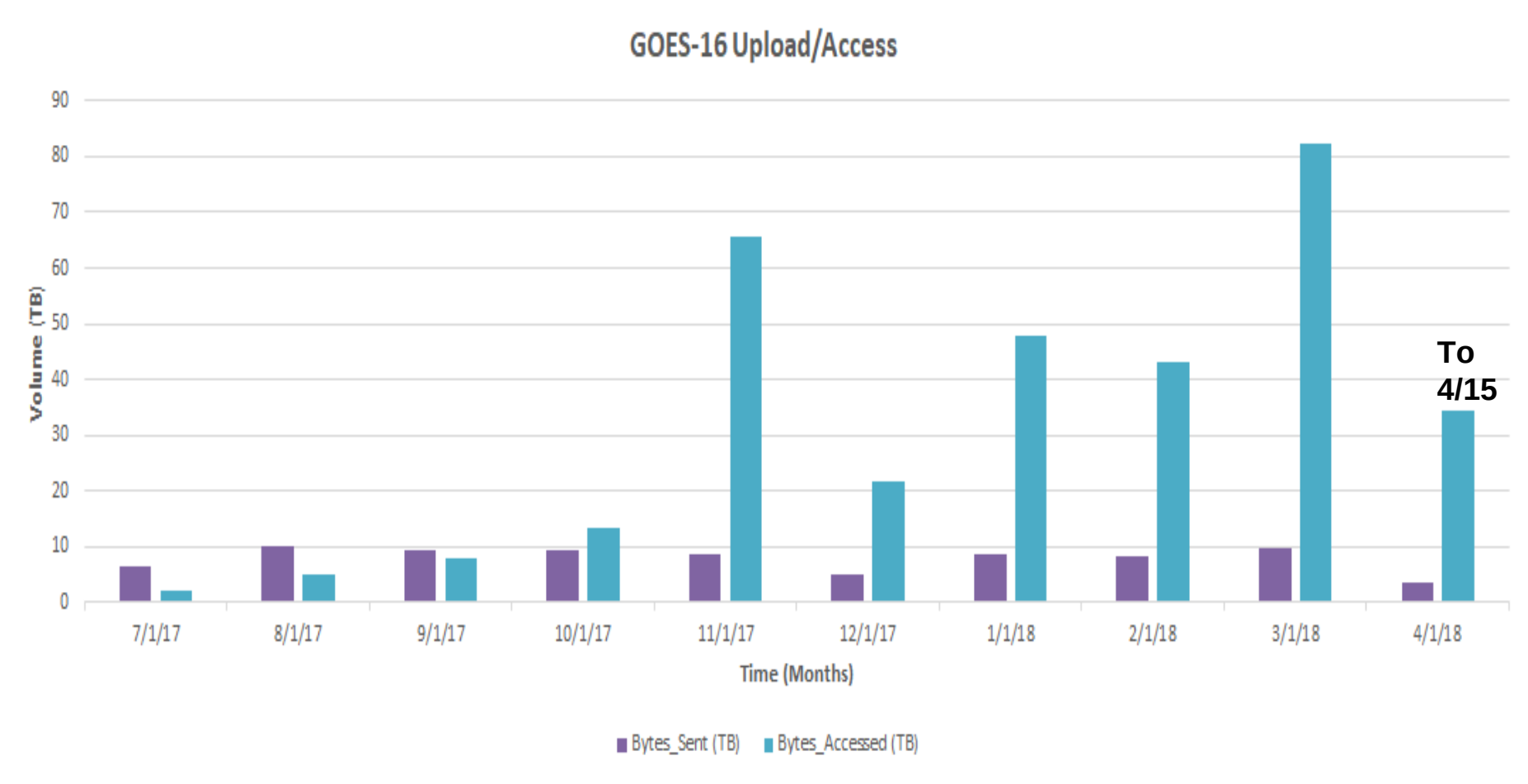
Courtesy of Otis Brown and Jonathan Brannock, CICS-NC, NC State Univ

GOES-16 AWS Accession Locations



Courtesy of Otis Brown and Jonathan Brannock, CICS-NC, NC State Univ

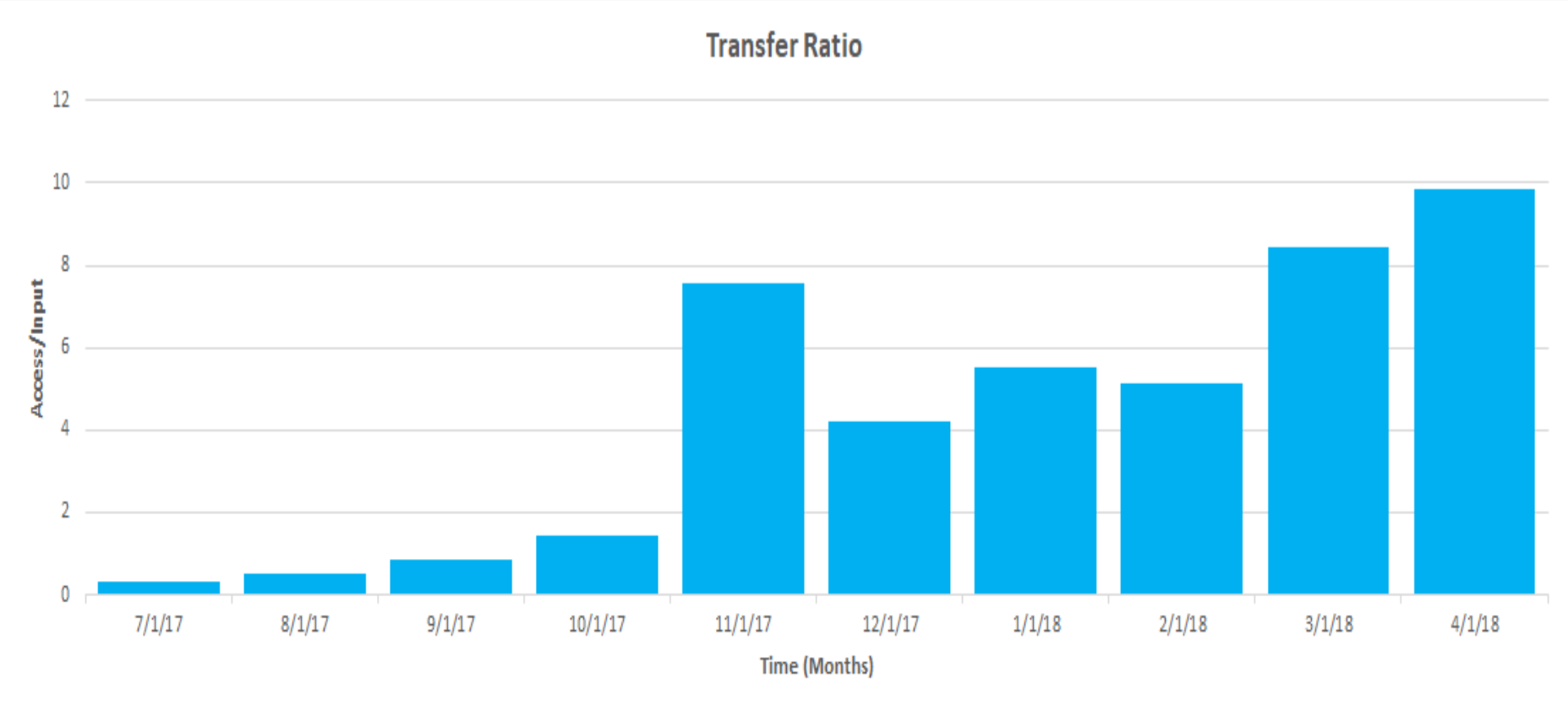
GOES-16 AWS Access History



Note: April 2018 is only a half-month, from 4/1-4/15

Courtesy of Otis Brown and Jonathan Brannock, CICS-NC, NC State Univ

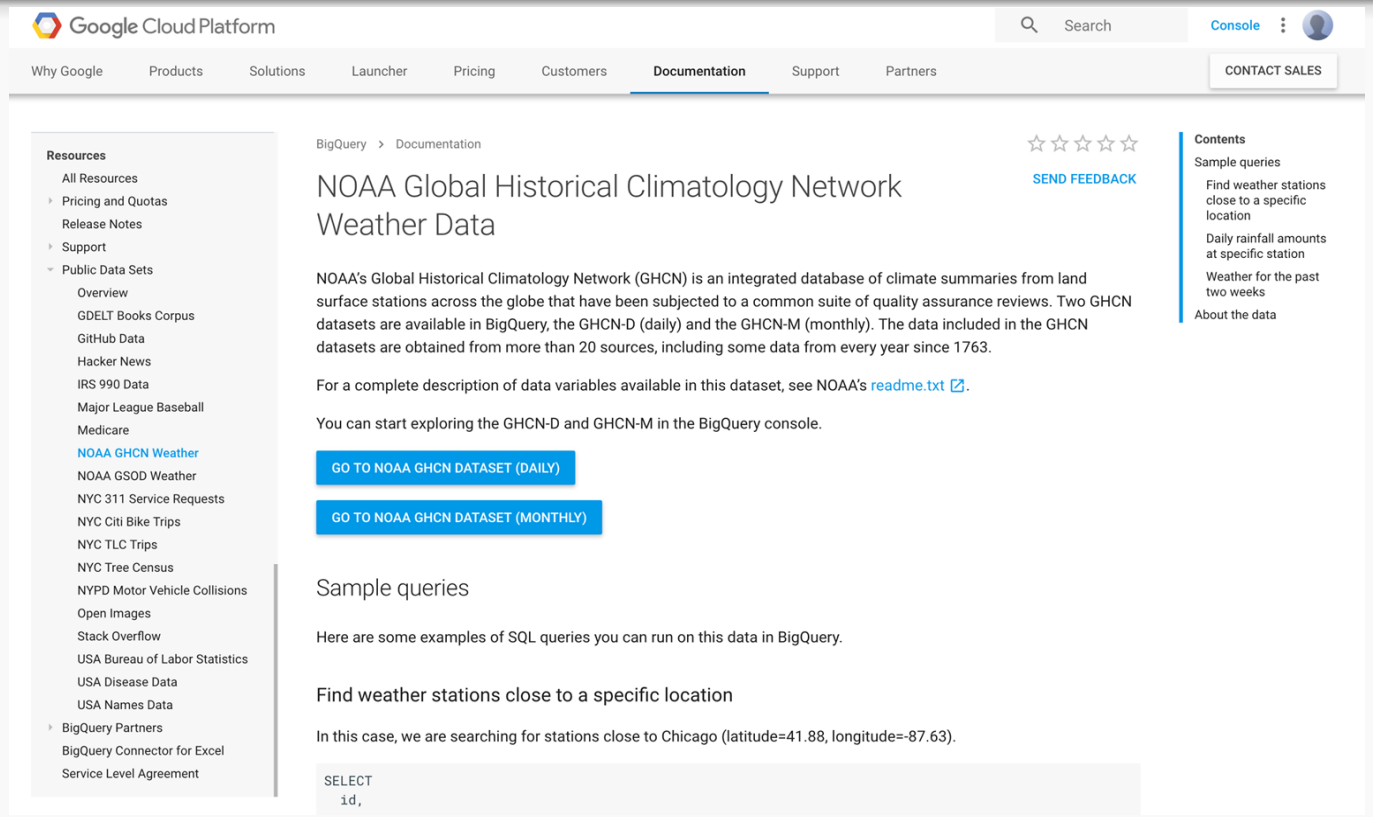
GOES-16 AWS Access Multiplier



From a single Collaborator's platform, 10x the stored volume is being accessed by the public.

Courtesy of Otis Brown and Jonathan Brannock, CICS-NC, NC State Univ

Climate Data in Google BigQuery



- **1.2 PBs** of climate and weather data accessed through Google BigQuery, in **4 months**
  - 30-100x of NOAA deliveries in that time
- Google Cloud Platform
  - GOES-16 (began July 2017)
  - National Water Model data
  - NEXRAD Level 2

https://cloud.google.com/bigquery/public-data/noaa-ghcn

NOAA Climate Data in Google Earth Engine

Google Earth Engine

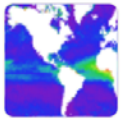
NOAA CDR

Explorer

NOAA CDR PATMOSX V53: Cloud Properties, Reflectan... - open in workspace
NOAA - Every day from 1979 to 2018
This dataset provides high quality Climate Data Record (CDR) of multiple cloud properties along with Advanced Very High Resolution Radiometer (AVHRR) bri...

NOAA CDR AVHRR Leaf Area Index and FAPAR Version 4 - open in workspace
NOAA - Every day from 1981 to 2018
The NOAA Climate Data Record (CDR) of AVHRR Leaf Area Index (LAI) and Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) dataset contains dervi...

NOAA CDR AVHRR Surface Reflectance Version 4 - open in workspace
NOAA - Every day from 1981 to 2018
The NOAA Climate Data Record (CDR) of AVHRR Surface Reflectance contains gridded daily surface reflectance and brightness temperatures derived from the Advan...

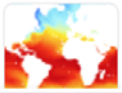


NOAA CDR AVHRR Aerosol Optical Thickness: Daily A... - open in workspace
NOAA - Every day from 1981 to 2017
The NOAA Climate Data Record (CDR) of Aerosol Optical Thickness (AOT) is a collection of global daily 0.1 degree derived data from the PATMOS-x AVHRR level-2...

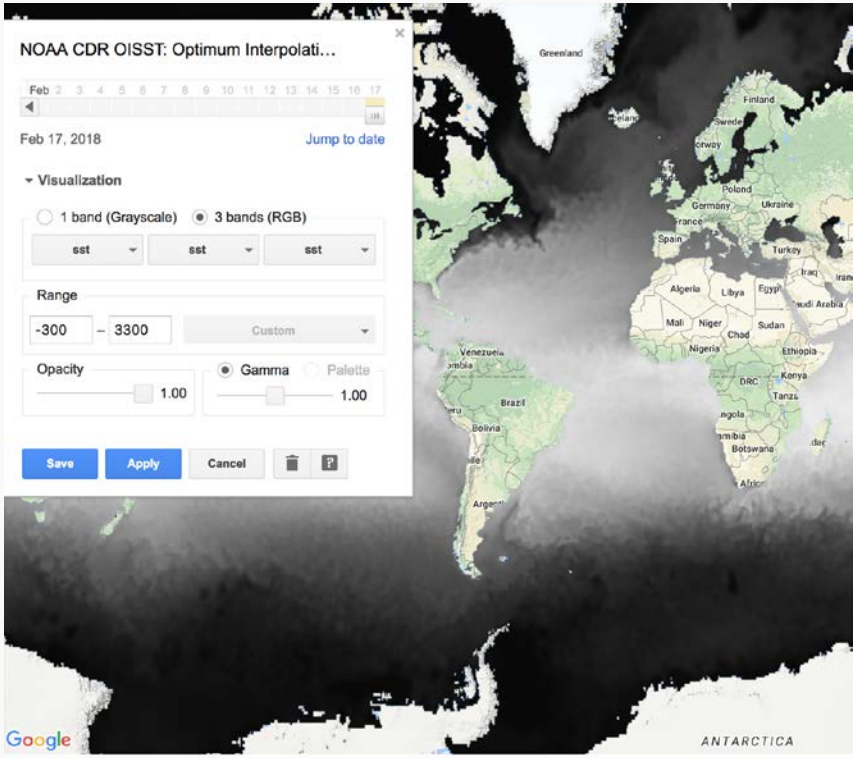
NOAA CDR AVHRR Normalized Difference Vegetation I... - open in workspace
NOAA - Every day from 1981 to 2018
The NOAA Climate Data Record (CDR) of AVHRR Normalized Difference Vegetation Index (NDVI) contains gridded daily NDVI derived from the NOAA AVHRR Surface Ref...

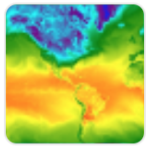
NOAA CDR GRIDSAT-B1: Geostationary IR Channel Bri... - open in workspace
NOAA - Every day from 1980 to 2018
This dataset provides scientific researchers a high quality Climate Data Record (CDR) of global infrared measurements from geostationary satellites. ...

NOAA CDR Ocean Heat Fluxes V2 - open in workspace
NOAA - Every day from 1988 to 2017
The Ocean Heat Fluxes dataset is part of the NOAA Ocean Surface Bundle (OSB) and provides high quality Climate Data Record (CDR) of the air/ocean heat flux...



NOAA CDR Near-surface Atmospheric Properties V2 - open in workspace
NOAA - Every day from 1988 to 2017
The Near-surface Atmospheric Properties dataset is part of the NOAA Ocean Surface Bundle





CFSV2: NCEP Climate Forecast System Version 2, 6-Hourly Products
NOAA NWS National Centers for Environmental Prediction (NCEP)
The National Centers for Environmental Prediction (NCEP) Climate Forec
fully coupled model representing the interaction between the Eart...

OCC's Environmental Data Commons

http://edc.occ-data.org/

The OCC Environmental Data Commons

Repository for environmental public data sets of scientific interest, hosted as part of the Open Science Data Cloud Ecosystem

GOES 16

NEXRAD

Tools | Notebooks

Tampa Bay Times

A matter of miles

How the slightest shift kept Hurricane Irma from turning into an even worse disaster

By NATHANIEL LASH and NEIL BEDI

Times Staff Writers

Sept. 20, 2017

Scroll down

↓

IBM PaaS
Earth Systems Data Portal

IBM NOAA EARTH SYSTEMS DATA PORTAL
For Earth, Space, and Weather Data

Create Account | Log In

HOME | OVERVIEW | GET STARTED | NOAA DATA

Get Started >> REST API Download

ACCESS DATA VIA REST API

Downloading RAP Data Files Via REST API

The following documentation utilizes **cURL** to download a NOAA RAP weather file. The parameters, shown below in **blue**, must be configured by the user.

```
curl --request GET \
 --url https://api.us.apiconnect.ibmcloud.com/jmsalaiusibmcom-poc/noaa-data/rap/{yyyymmdd}/{tt00}/{0ff} \
 --user "username:password" \
 --output "local file directory/rap_130_#1_#2_#3.grb2"
```

https://noaa-crada.mybluemix.net/

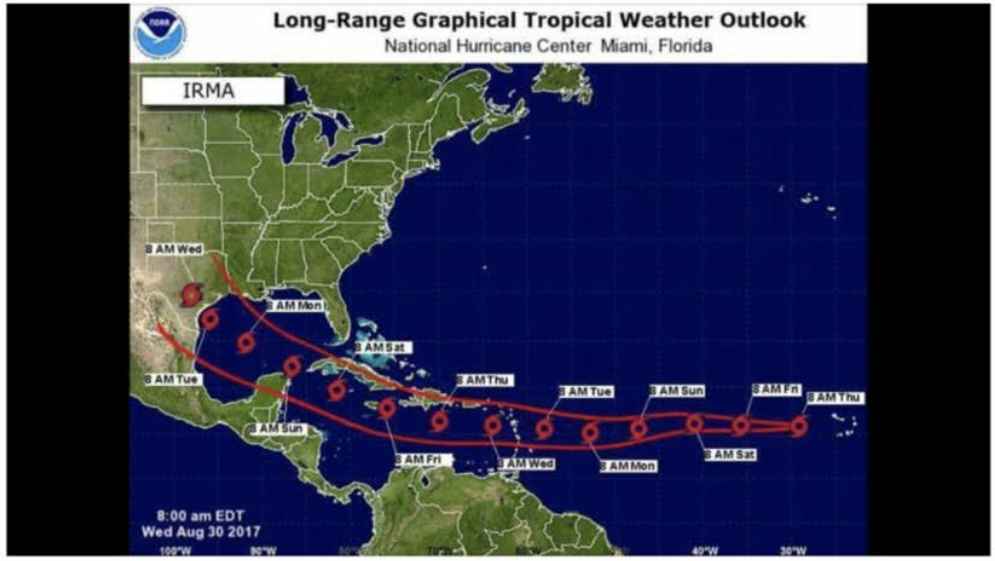
Ensuring Data Authenticity

- Users trust NOAA data they access from NOAA sites
- What about outside NOAA?
  - Collaborators' sites?
- Example: Fake Irma forecast

Nearly 40,000 shares on this fake Irma forecast on Facebook. There is no actual threat to any land in next 5 days.
pic.twitter.com/hwmuE5UwKn
10:11 AM - Sep 1, 2017

[redacted]

Everyone needs to pay attention to Hurricane Irma. Shes predicted to come through mexico hit us and everything inbetween up to Houston. Shes already a Category 2 and hasnt even got into warm water yet.



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Ocean Data Challenges for BDP

- Ocean data have proven to be more difficult to move to Collaborators than weather and climate data.
- Why? Different market.
- Establishing an understanding of the data.

- Approach the problem differently, as a whole?
- Move multiple datasets to address many questions.
- "Ocean data platform" concept – focus on community.

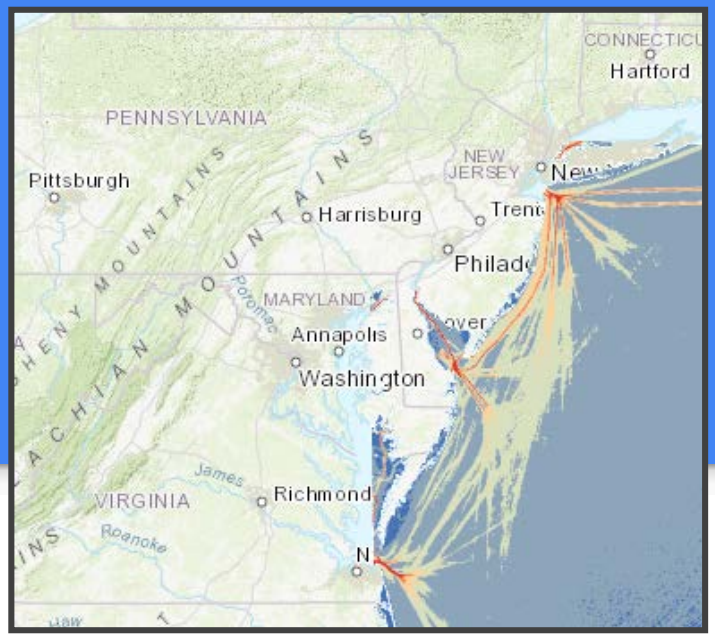
Ocean Data Platform: Data + Skill

Publish NOAA Datasets, such as:

- Coastal observations
  - Water levels, currents, tides, winds, waves, air gap, bathymetry
- Model outputs
  - Coastal regional models, ocean models
- Fisheries data
  - Catch, trawl data
- Vessel/traffic data
- Acoustics, ‘Omics data, eDNA
- Satellite data

<u>Encourage others to bring Skills: Will users bring their code and tools and work collaboratively on a common platform?</u>

AIS Data



- USCG collects and maintains data
  - Roughly 1 – 2TBs per year
- Currently available through MarineCadastre.gov
  - Ongoing collaboration between NOAA and BOEM
  - AIS data from 2009-2014 currently available, with 2015-2017 to be available this summer
- Smaller vessel data (VMS system) available through NOAA
- Currently discussing ways ahead with both BDP Collaborators and NOAA Marine Cadastre personnel

Future Direction for the BDP

- NOAA is concluding the CRADA / Experimental Phase of the project in Apr 2019.
  - All BDP Collaborators are still engaged.
  - Gathering requirements from inside NOAA.
- What is the proper business model to sustain the Partnerships & public data access on the commercial cloud?
- What is the optimal service model?

Summary

- **NOAA** has a proud history of government **open data leadership** and **partnerships** with industry and academia.

- NOAA is **collaborating with industry** through the Big Data Project CRADA to learn how to make NOAA's open data **accessible and widely usable** at no net cost to the US taxpayer.
  - **Increased access levels** for NOAA open data
  - **Higher Levels of Service** to the data consumer
  - **Reduced loads** on NOAA access systems

- NOAA is seeking:
  - **Sustainable partnership model** to enable enhanced, cloud-based access to all of NOAA's open data.

Questions?

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#NOAABigData

http://www.noaa.gov/big-data-project