Big Data and NOAA Science

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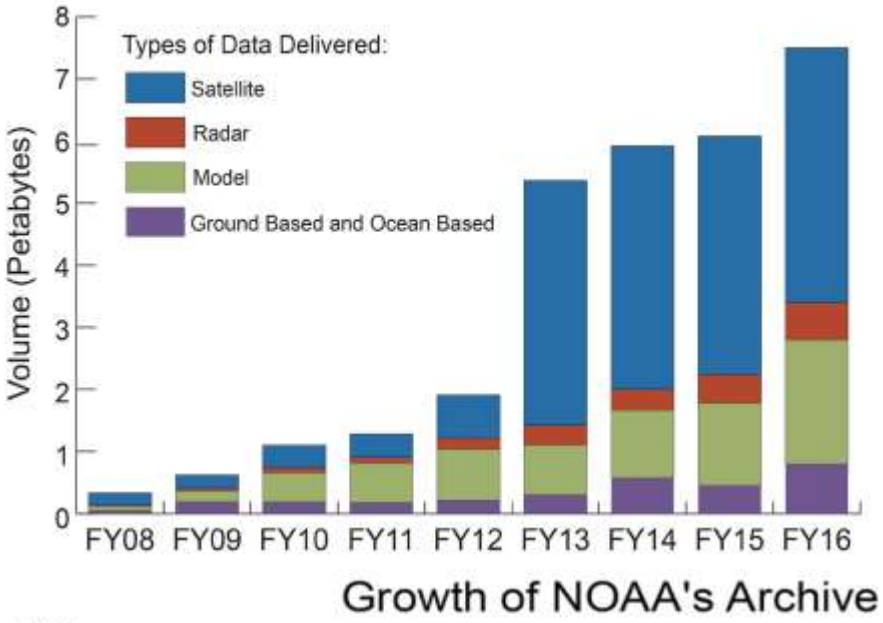
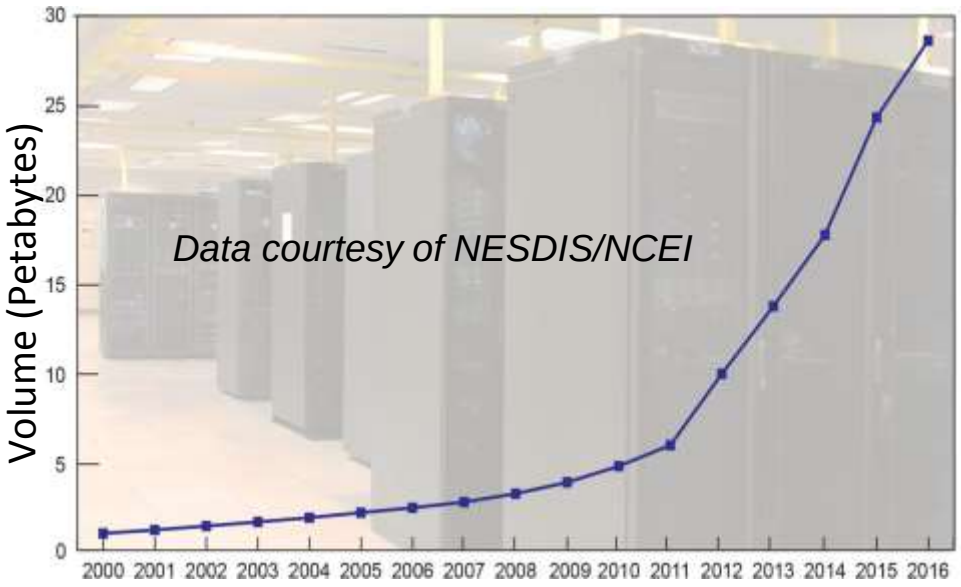
Why is NOAA Interested in Big Data?

- The **volume and velocity** of NOAA observations and model outputs continues to rise exponentially.
- NOAA's **science-based products and services** can benefit from Big Data approaches.
- NOAA data are **increasingly popular and valuable**
  - NOAA struggles to keep up with **demand** for its data.
- Enable new **economic and research opportunities**

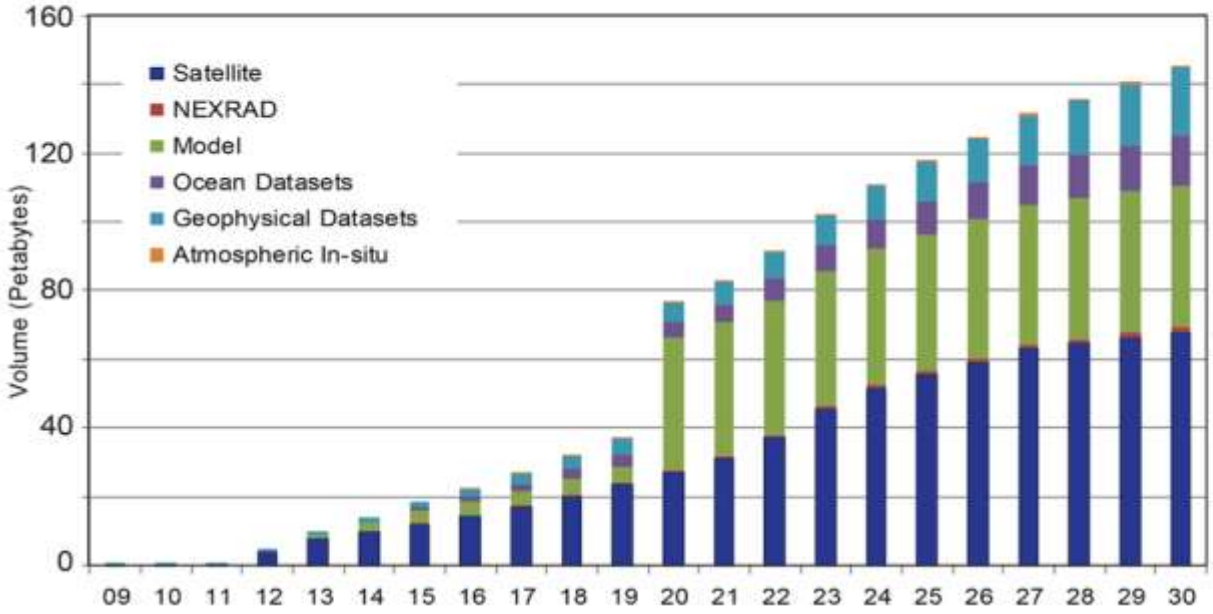
NOAA/NCEI's Environmental Data Archive

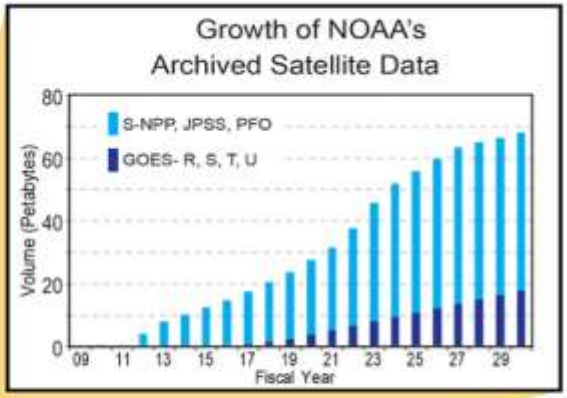


Growth of NOAA's Archive



Data courtesy of NESDIS/NCEI





Some Possible Services and Activities with Big Data implications

Fisheries: Fish catch monitoring, stock and habitat assessment, genomics research, IUU Fishing

Oceans and Coasts: sea level rise, inundation estimates, and disaster response

Weather and Climate: Forecaster Assistance, Model output utilization, V&V, Data assimilation, Multi-model Ensembles, Combining deterministic and probabilistic approaches

Satellite and Archive: Data exploitation, Product retrievals, Cal/Val, Data Quality Assurance, AI/ML training

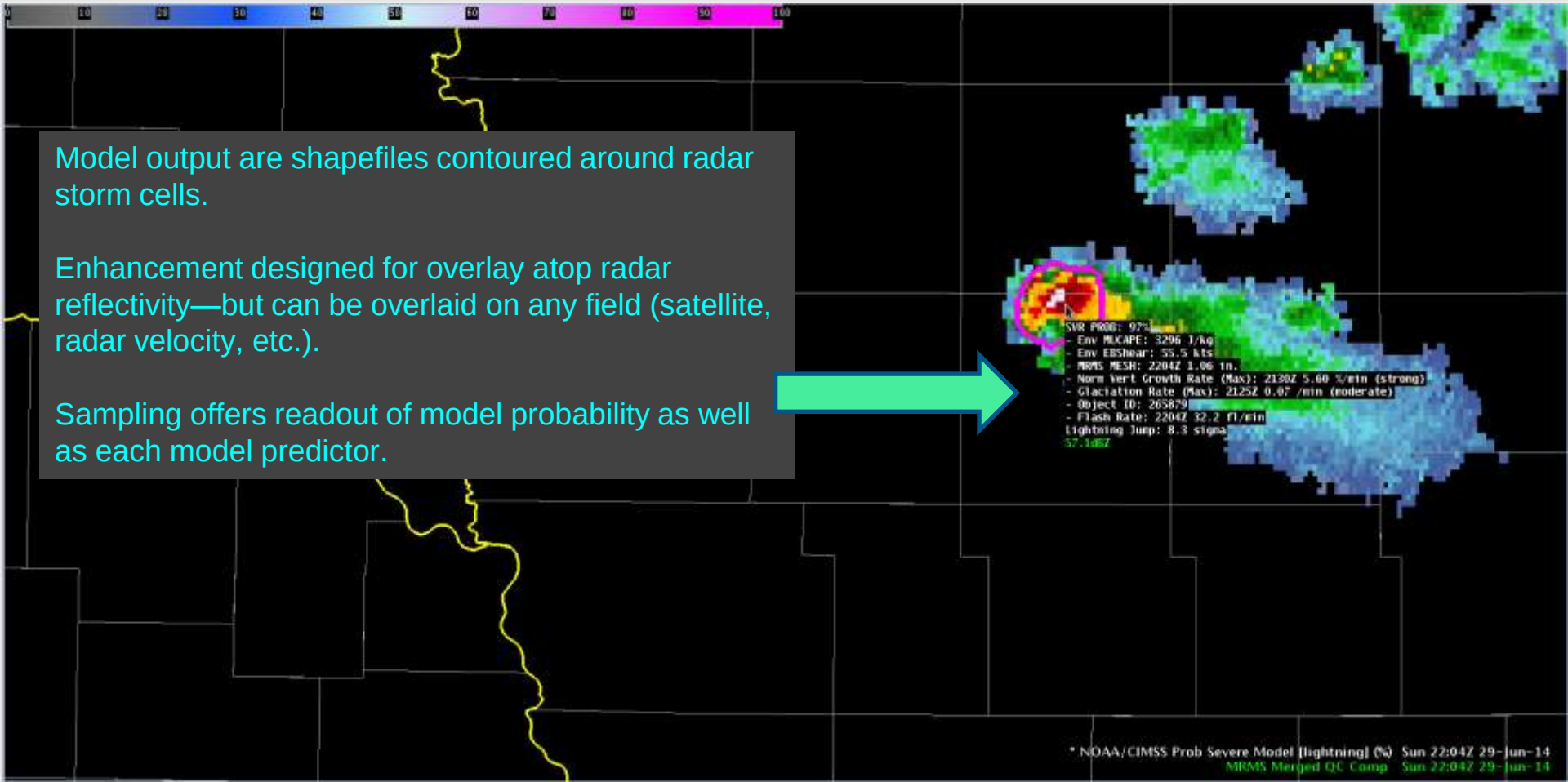
Operations: aircraft/ship logistics, glider/buoy/drone surveys

Use Big Data, AI/ML techniques to aid humans in the delivery of services

Augment Forecasters' skills by providing Big Data and ML/AI applications to help them execute NOAA's Mission

Many data sources and inputs, in a high-stakes environment: satellite, radar, aircraft, balloons, models, meso-nets, IOT, social media, etc.

Example of Enhanced Data Presentation for Services: AWIPS-II and ProbSevere



NOAA Big Data Project

Evaluate partnership opportunities with Cloud Computing industry

- Provide cloud-based access to NOAA's open data
  - Copies of NOAA data accessed from Partners' systems
  - Improved federal cybersecurity posture
- Cost Avoidance for public data access
  - Most popular datasets bring largest burden on NOAA systems
- Better Level of Service to customers
  - Users can utilize data faster without downloading
- **This is not *just* about open data access**
  - **Can accelerate data utilization…**
  - **...and thus improve societal impacts, research and business opportunities**

BDP Basics

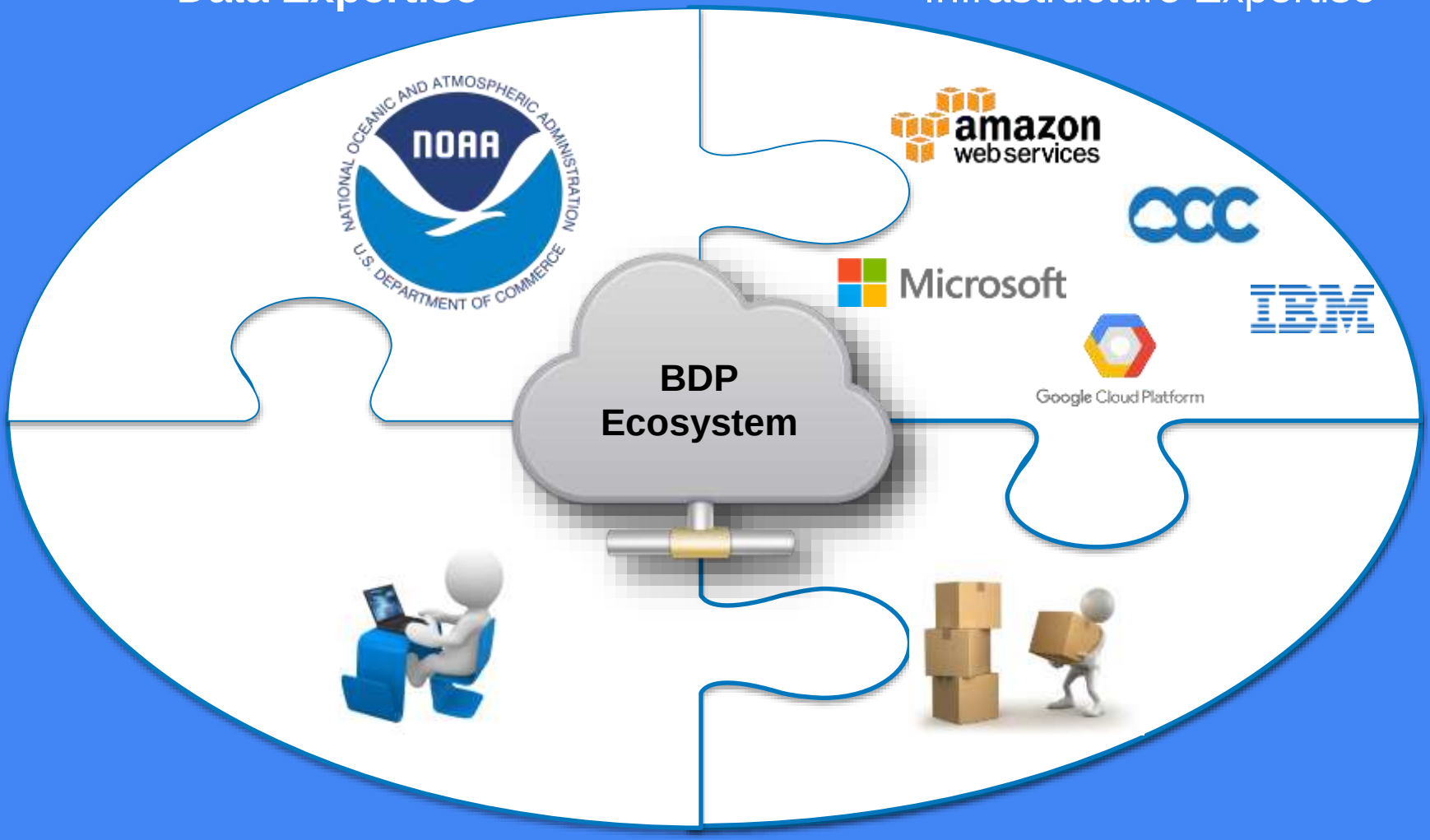
- Cooperative Research and Development Agreements
  - 5 separate but identical 3-year agreements

- Industry provides access to NOAA's open data to all
  - Data remain open, are not to be sold
  - Collaborators monetize services based on data
  - Dropped typical egress charges
  - NOAA provides data and expertise

- Combines 3 powerful resources based on NOAA's open data:
  1. NOAA's science and subject matter expertise
  2. Industry's data storage and access expertise
  3. Cloud's scalable and on-demand processing capability

NOAA
Data **Expertise**

CRADA Collaborators
Infrastructure Expertise



End User
Wider Consumer Community

Third Party Partner
Value-Added Services

Two different examples of how to increase data utilization

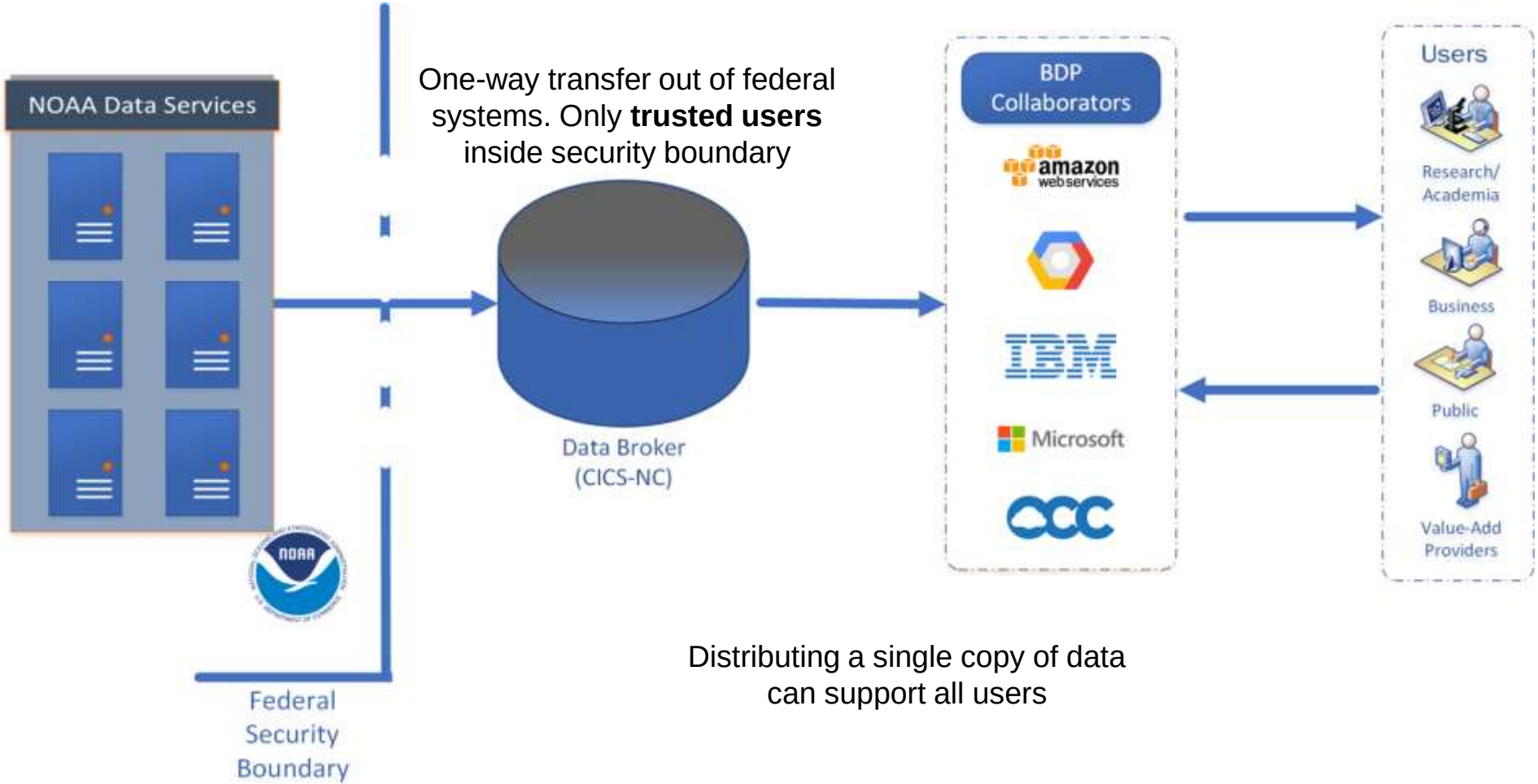
- Weather Radar: NEXRAD on AWS (270 TB)
  - 2.3x increase in usage over past
  - Redirected orders from NOAA to AWS as option for users
  - *Ansari et al, BAMS 2017*

- Climate & Weather: GHCN-M, GSOD on Google (< 0.1 GB)
  - 800,000 data requests between Jan and Apr 2017
  - **1.2 PBs of data delivered**
  - **100x or more increase in usage over the past**
  - No redirects - completely organic utilization by users of the tools
  - Integration of data into existing tools more effective

Who is going to do the integration?

Data Broker Role

One-to-Many, Limited by Cloud Infrastructure Only



GOES-16 BDP Demo Live as of July 12, 2017: Initial Distribution Statistics

Cooperative Institute for Climate and Satellites - North Carolina (CICS-NC) is helping NOAA by providing feeds of the GOES-16 data from the NOAA Ground System (as an authorized user) to the BDP CRADA Collaborators.

- BDP is offering 5 validated feeds to the CRADA Collaborators
  - Timing - as fast as they appear at NOAA distribution point
  - Single bounce of data through CICS-NC systems, w/checksums
  - Minimizes load on NOAA's operational systems and networks

- Observed additional latencies from CICS-NC transfer mechanism
  - 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: 30 sec - 3 min**

Big Data Project Collaborators' Data Offerings

- **AWS**
  - https://aws.amazon.com/noaa-big-data/
- **Google Cloud Platform**
  - https://cloud.google.com/bigquery/public-data/ *(see NOAA listings on left)*
- **IBM**
  - https://noaa-crada.mybluemix.net/
- **Microsoft**
  - No public services to date
- **Open Commons Consortium**
  - http://edc.occ-data.org/

Big Data Project and Open Data Challenges

- How can NOAA best adopt modern Big Data tools?
- How well do we understand the Big Data market?
  - All NOAA's data commercially-viable in this model?
  - The role of researchers in the ecosystem?
- How to sustain data-centric public—private partnerships?
- How to best steward numerous large, complex datasets?
  - Extend NOAA's "brand" on widely distributed data?
  - How to ensure data authenticity at low cost?

Discussion

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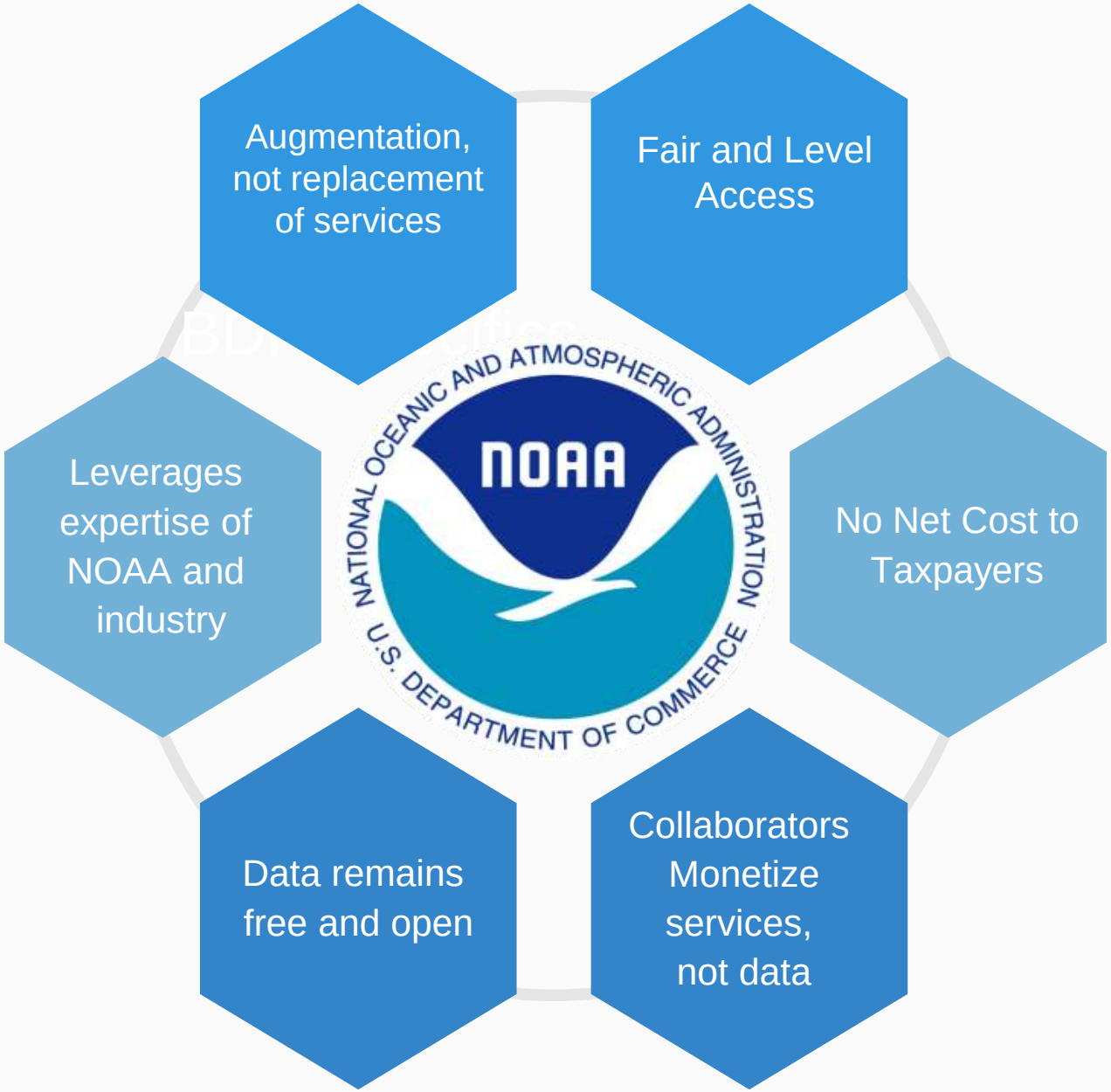
#NOAABigData

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



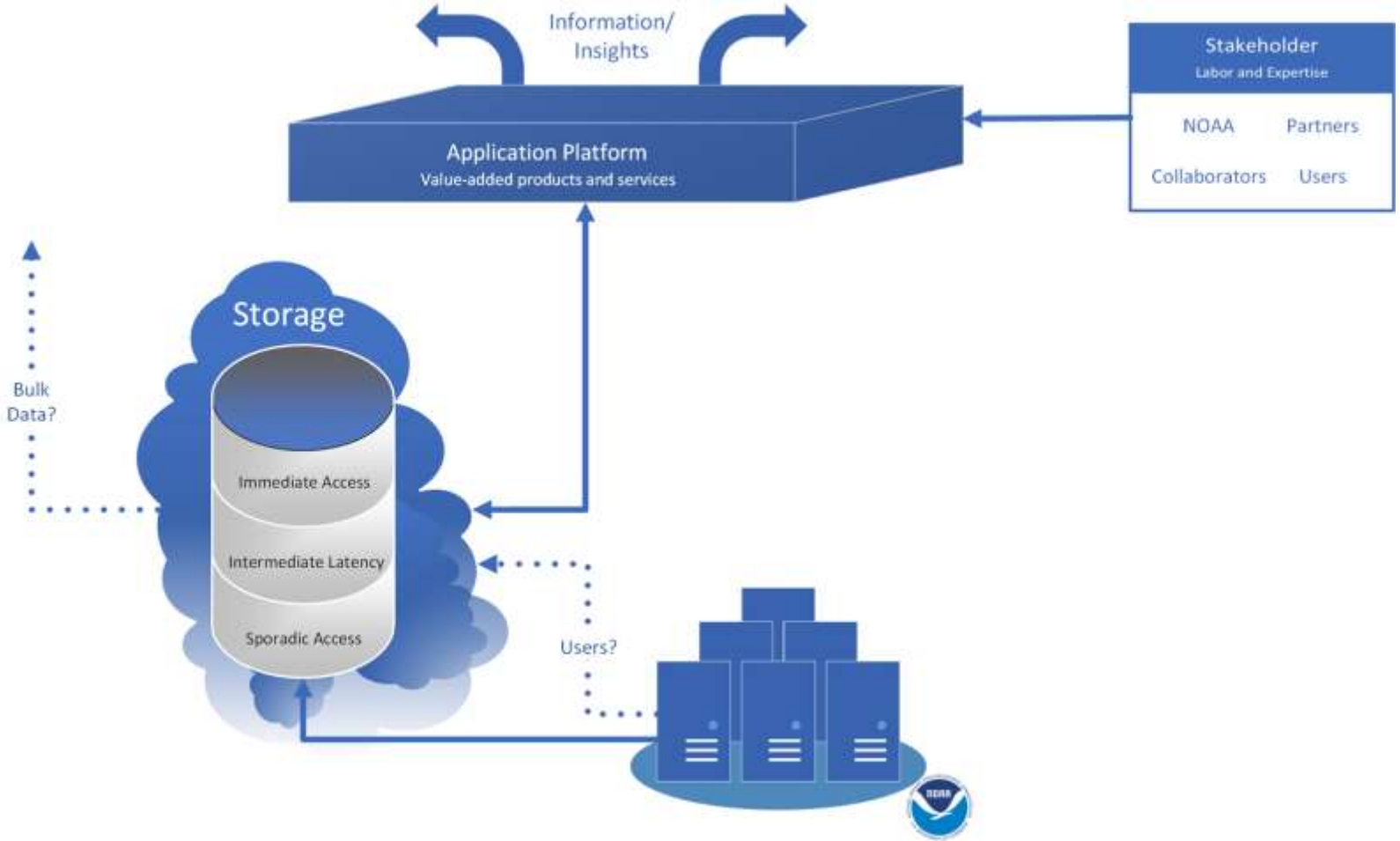
Leverage the value of NOAA's data to increase their utilization

NOAA Datasets in Play…

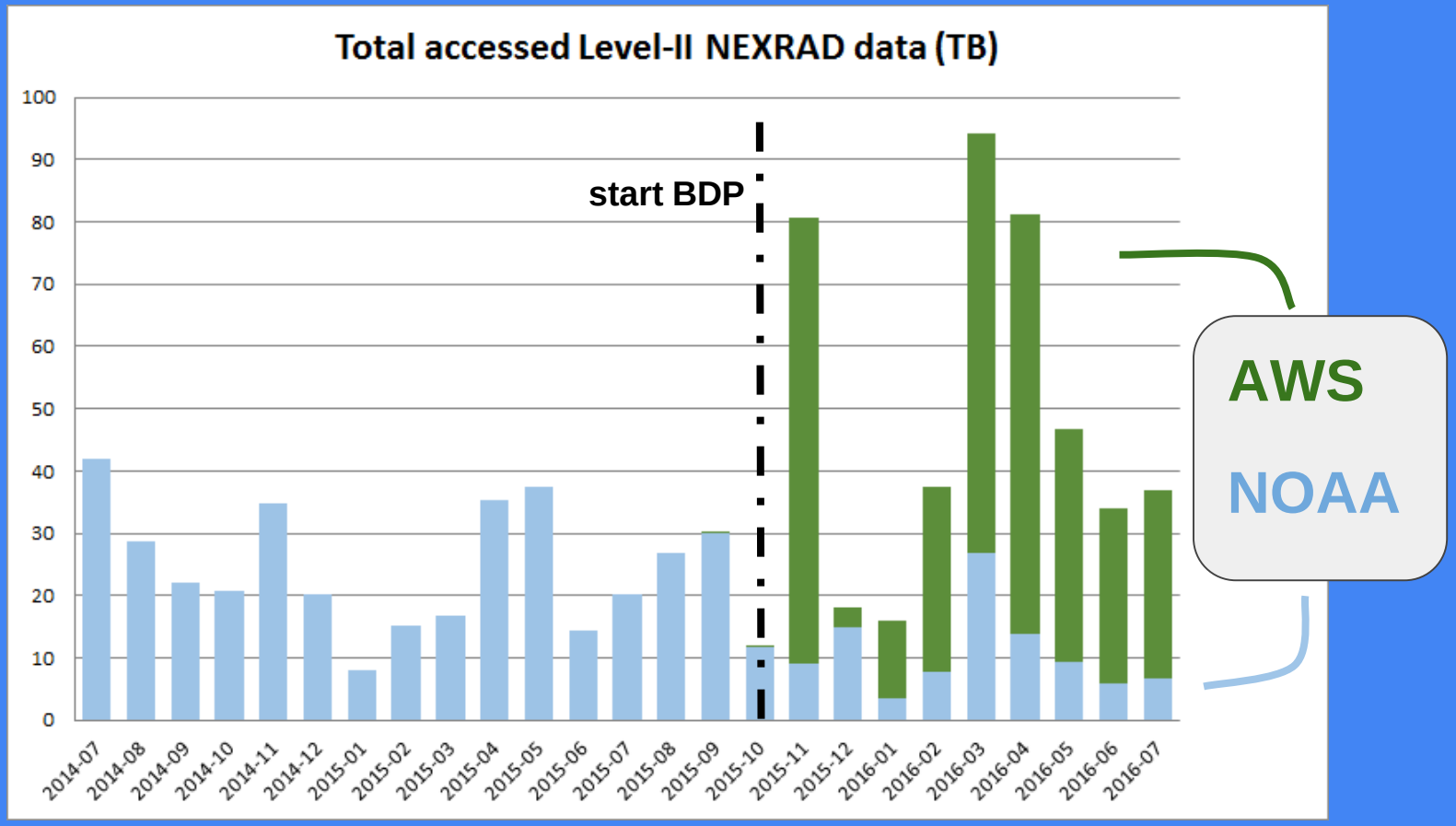
- GOES 13 & 15
- AVHRR
- Disaster Response Platform*
- Ocean Energy Platform*
- Meteorological Assimilation Data Ingest System* (MADIS)
- National Digital Forecast Database*
- NOAA Port/SBN*
- Anonymized Trawl Data
- Anonymized Observer Data
- Sea-level Rise*
- Global Forecast System (GFS)
- Climate Data Records
- North American Multi-Model Ensemble*
- Intermediate Modeling Products*
- Pathfinder Sea Surface Temperature*
- Ocean Bathymetry*
- Multibeam Backscatter*
- GOES-16
- NEXRAD L2
- NMFS Protected Species*
- Essential Fish Habitat
- Rapid Refresh Modeling
- Global Historical Climatology Network - Hourly
- Global Historical Climatology Network - Daily
- Global Surface Summary of the Day
- International Comprehensive Ocean-Atmosphere Dataset (ICOADS)
- Filtered Alert Hub*
- National Water Model
- Climate Forecast System - Version 2 (CFS v2)
- Fisheries Genomics/Meta-Genomics*
- NMFS Commercial Landing Data*
- VIIRS Night Lights Products*
- Multi-Radar/Multi-Sensor (MRMS)*
- Passive acoustic soundings*

* - Indicates activity underway

Increased Usage of NOAA Data via BDP



NEXRAD Weather Radar Data



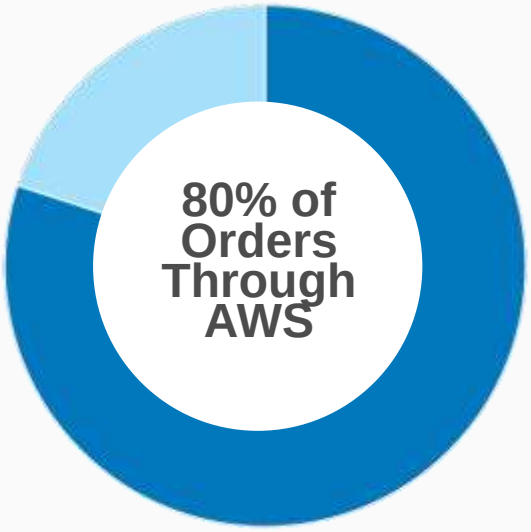
AWS: Oct '15 https://s3.amazonaws.com/noaa-nexrad-level2 **(1991+)**

OCC: Jun '16 http://occ-data.org/NOAANEXRAD/ **(2015+)** *(S. Ansari et al, 2016)*

Example BDP Success Story

NEXRAD Level 2 Radar Data on AWS

NOAA Wins

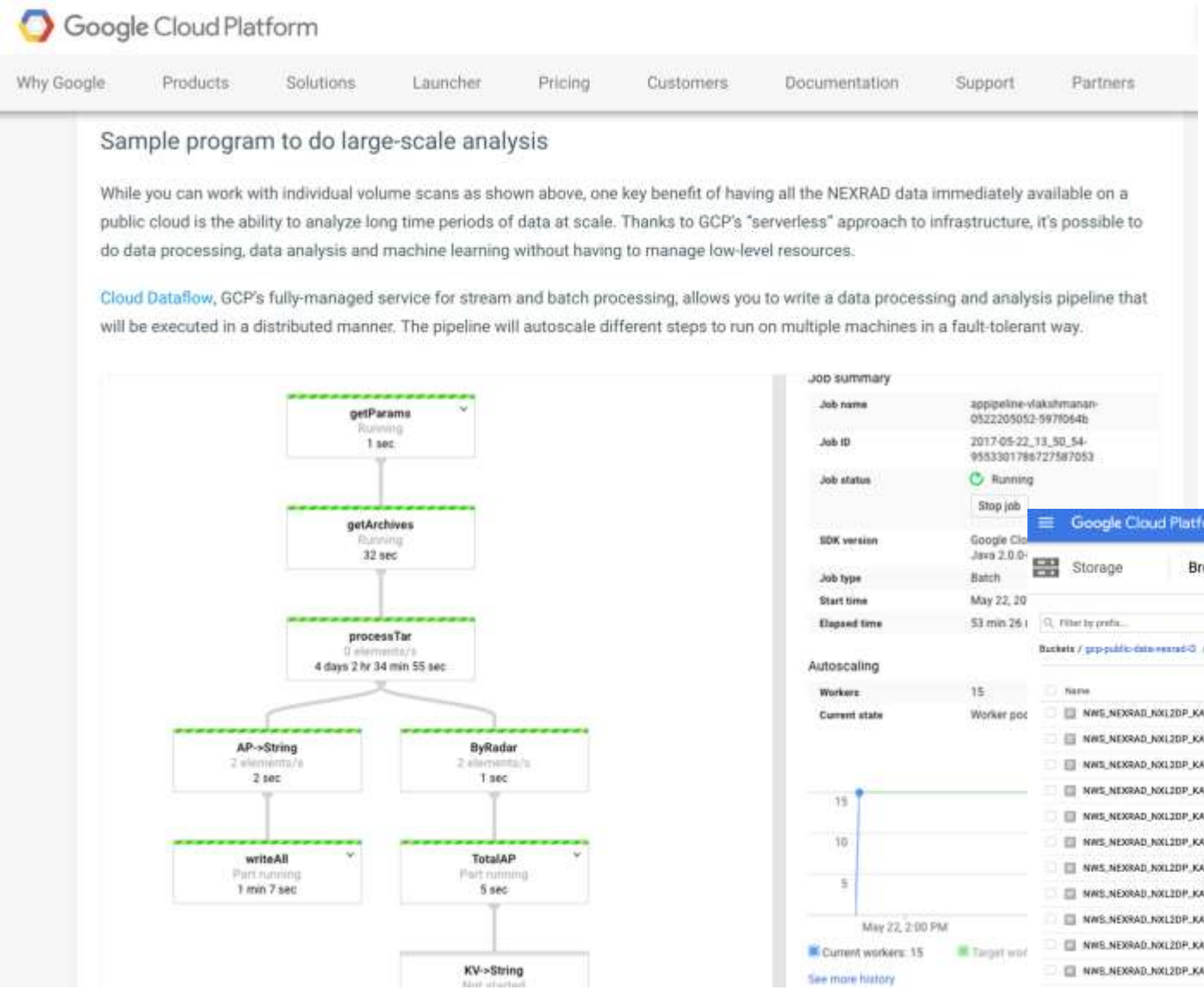


AWS?

End User Wins

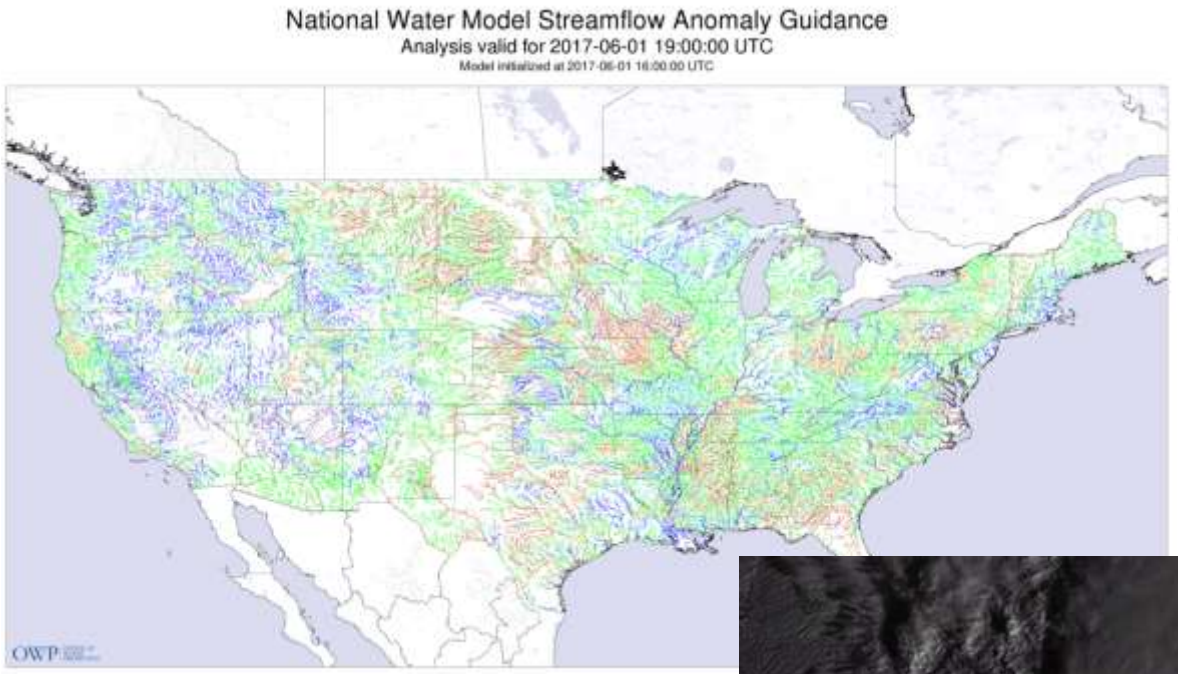
Google NEXRAD Access

https://cloud.google.com/blog/big-data/2017/06/visualization-and-large-scale-processing-of-historical-weather-radar-nexrad-level-ii-data



As of June 15, 2017

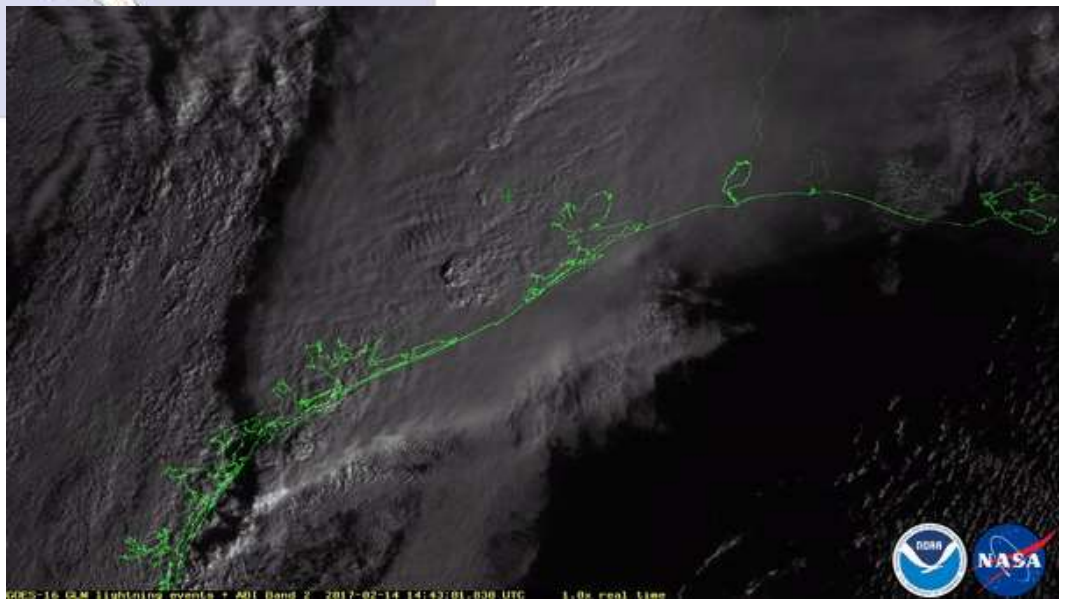
Ongoing and Upcoming Efforts



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

National Water Model:

- 23-year reanalysis
- Real-time forecast



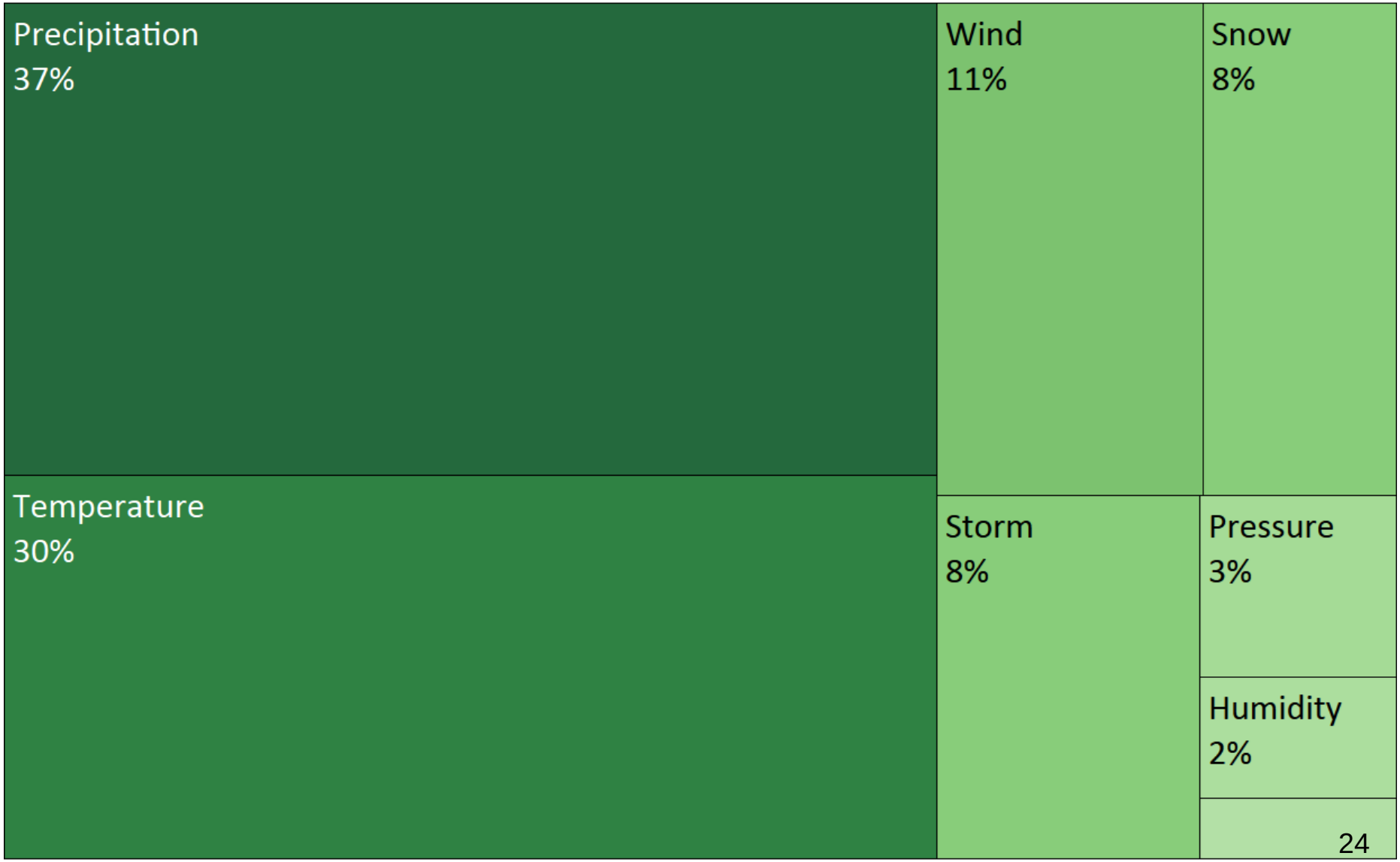
GOES-16:

- Now: L1b ABI Products
- Began July 12, 2017
- Provisional status
- Soon: L2 products (GLM)

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

NCEI User Requests - By Sector

NCEI User Requests - By Theme



Why is NOAA interested in this?

NCEI User Profiles

% of Users	Typical User	Requested Data Type	Preferred Format	How Much?	How Often?	System Impact
70	General business, media, public	Qualitative	Point+Click, visualization assessment	Low	High	**Low**
15	Researchers, business consultants	Quantitative	Digital downloads	High	Low	**High**
15	Value-added Providers (database scrapers)	Quantitative	Machine to machine downloads	Low	High	**High**

Big Data Project Methodology

01

Business Discovery

CRADA Collaborators & any Third-Party Partners work together to identify datasets of interest & develop business cases

02

Initial Technical Discussion

Develop a strategy for data delivery from NOAA to BDP Collaborators

03

In-Depth Data Discussions

Engage NOAA SMEs, BDP Collaborators for technical interchanges

04

Product Development

Collaborators and their Partners create services

- ✦ Develop markets & financial opportunities based on NOAA data
- ✦ Generate revenue and profits

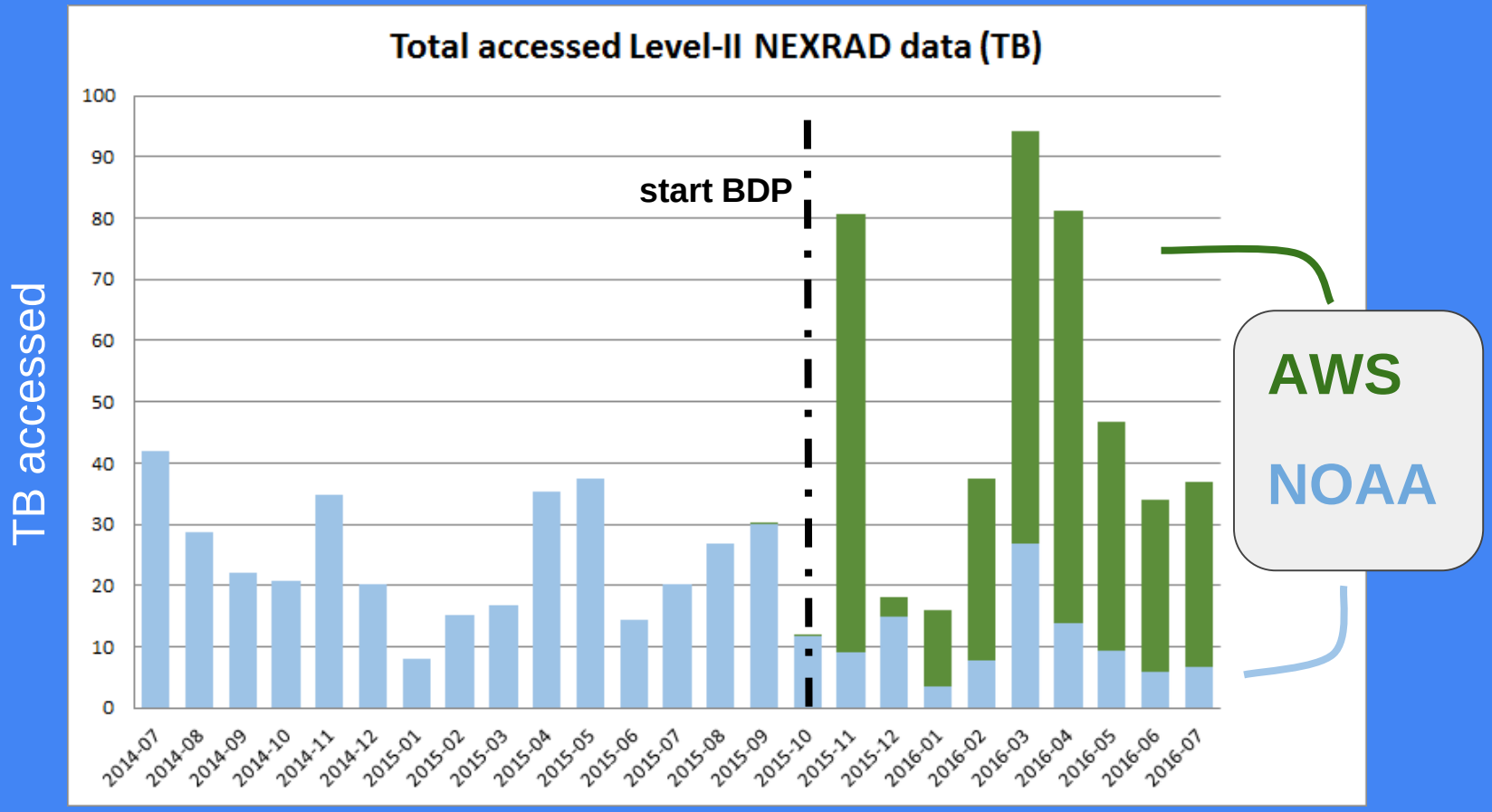
05

Augmented NOAA Services

NOAA continues all of it's existing data services

- No interruption of existing services to customers, but new options
- BDP activities are an augmentation of existing services

NEXRAD Weather Radar Data



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