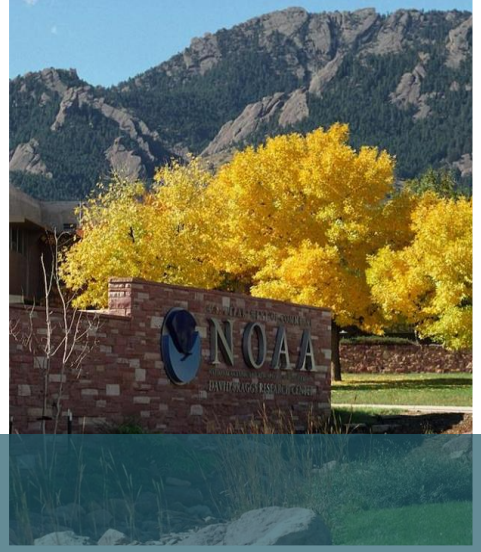
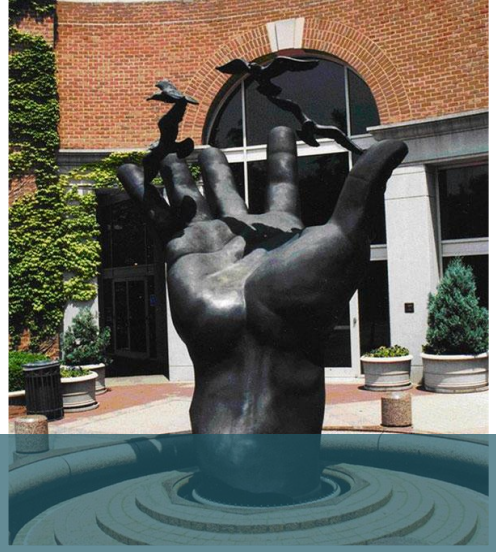




From Prehistoric Ice Cores to Modern Satellite Observations – From the Depths of the Ocean to the Surface of the Sun

Environmental data and services from NOAA National Centers for Environmental Information

Kenneth S. Casey and Heather Brown
NOAA National Centers for Environmental Information

July 2015

NOAA Satellite and Information Service | National Centers for Environmental Information

National Centers for Environmental Information

- Responsible for hosting and providing access to one of the most significant environmental archives on Earth, with comprehensive oceanic, atmospheric, and geophysical data
- From the depths of the ocean to the surface of the sun and from million-year-old sediment records to near real-time satellite images
- Nation's leading authority for environmental information

NCEI Strategic Vision

MISSION

Steward of the Nation's Environmental Information

NCEI is responsible for preserving, monitoring, assessing, and providing public access to the Nation's treasure of environmental data and information. NCEI data and information spans the breadth of weather (atmospheric and space), climate, oceans, geophysical, and coastal disciplines.

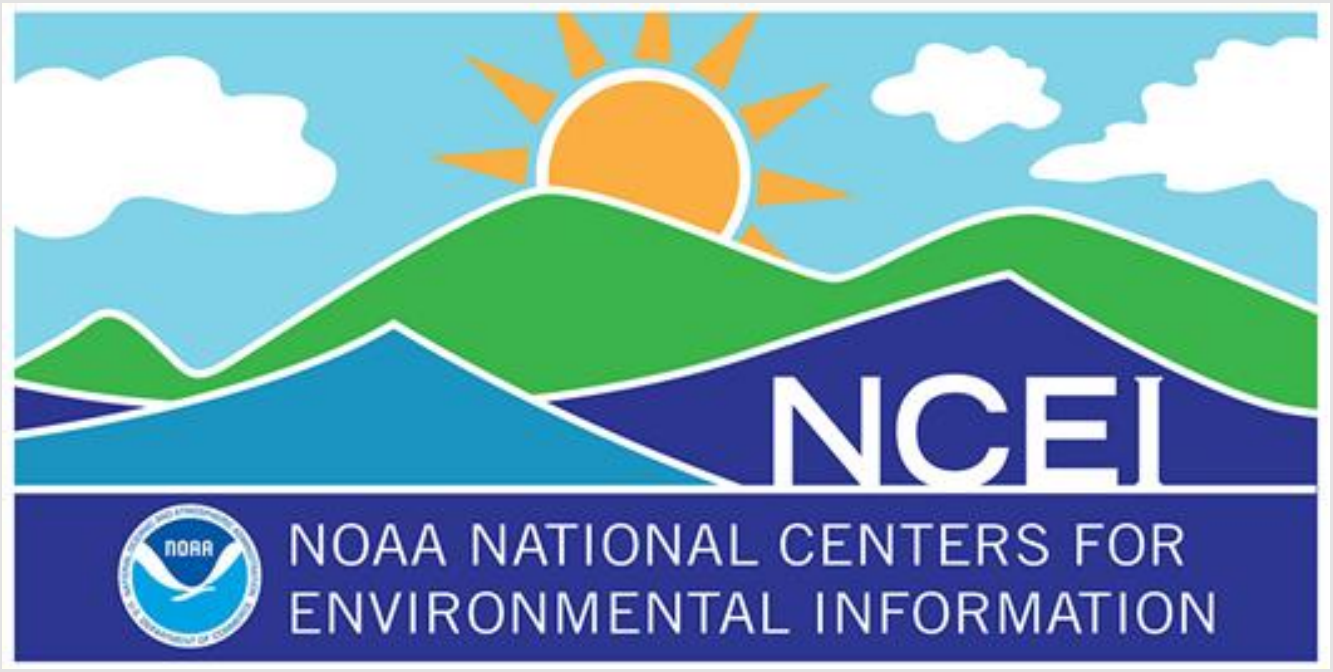
VISION

Be the Nation's Trusted Authority on Environmental Data and Information.

NCEI will be the most comprehensive, accessible, and trusted source of state-of-the-art environmental data, information, and monitoring.

NCEI Slogan

Revealing the Past, Interpreting the Present, and Informing the Future



History of NCEI

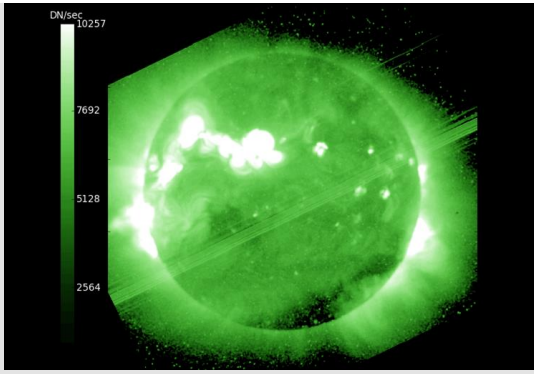
- National Climatic Data Center, Asheville, North Carolina
  - Established in 1951 as the Weather Bureau Records Center
  - Renamed the National Climatic Center in 1970 and the National Climatic Data Center in 1984 to reflect its large collection of weather and climate data
- National Geophysical Data Center, Boulder, Colorado
  - Established in 1965 from the Coast and Geodetic Survey and Central Radio Propagation Laboratory
- National Oceanographic Data Center, Silver Spring, Maryland
  - Established in 1961 as an interagency facility administered by the U.S. Naval Hydrographic Office
  - Included Coastal Data Development, Stennis Space Center, Mississippi (Established in 2000 by NOAA as the coastal division of the National Oceanographic Data Center)

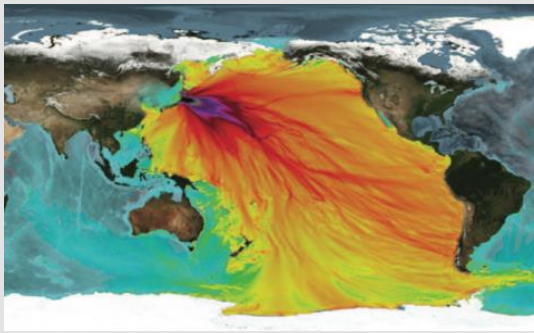
Merger of NOAA Data Centers

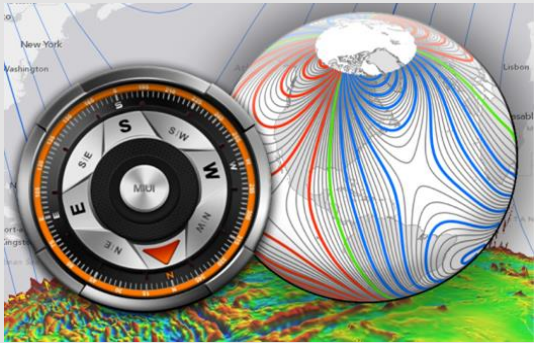
- Part of Strengthening NESDIS
- Approved in the Consolidated and Further Continuing Appropriations Act, 2015, Public Law 113-235
- Build upon the full spectrum of weather/climatic, oceanographic, coastal, and geophysical products and services that the Data Centers previously delivered
- Provide consistent data management capability for all of NOAA

Geophysics

- Nation's geophysical data archive ranging from the surface of the sun to the Earth's seafloor and from the solid earth environment to weather in space
- Data are from satellites, space observations, ships, and models provides information on tsunamis, the U.S. Extended Continental Shelf, coastal Digital Elevation Models, geomagnetism, solar, and terrestrial
- Products and data support safe navigation both in space and on our oceans and coasts including the Arctic and the information needed in tsunami forecasting, sea level rise prediction, and storm surge inundation





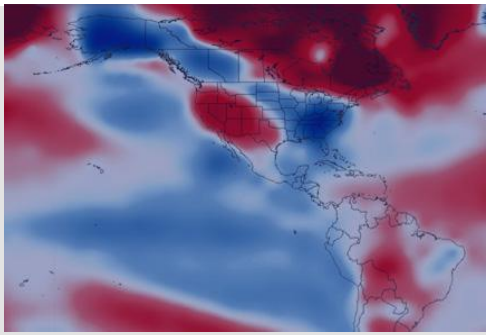


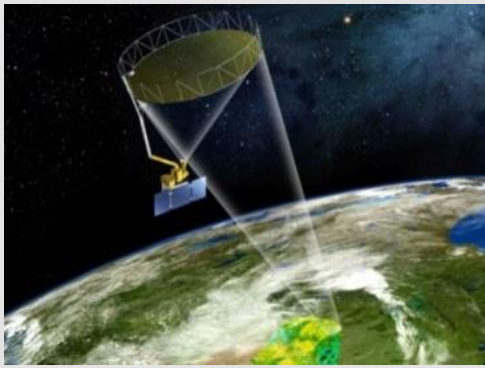
Oceans and Coasts

- World's largest archive of oceanographic and coastal data, ranging from water temperatures dating to the late 1700s to present day ocean salinity, nutrients, waves and currents
- Data are from ocean and coast observations, ships, buoys, satellites, remote sensing, and ocean model simulations
- Products and data are used to answer questions about ocean and coast phenomena, management of coastal and marine resources, natural disasters, and marine transportation

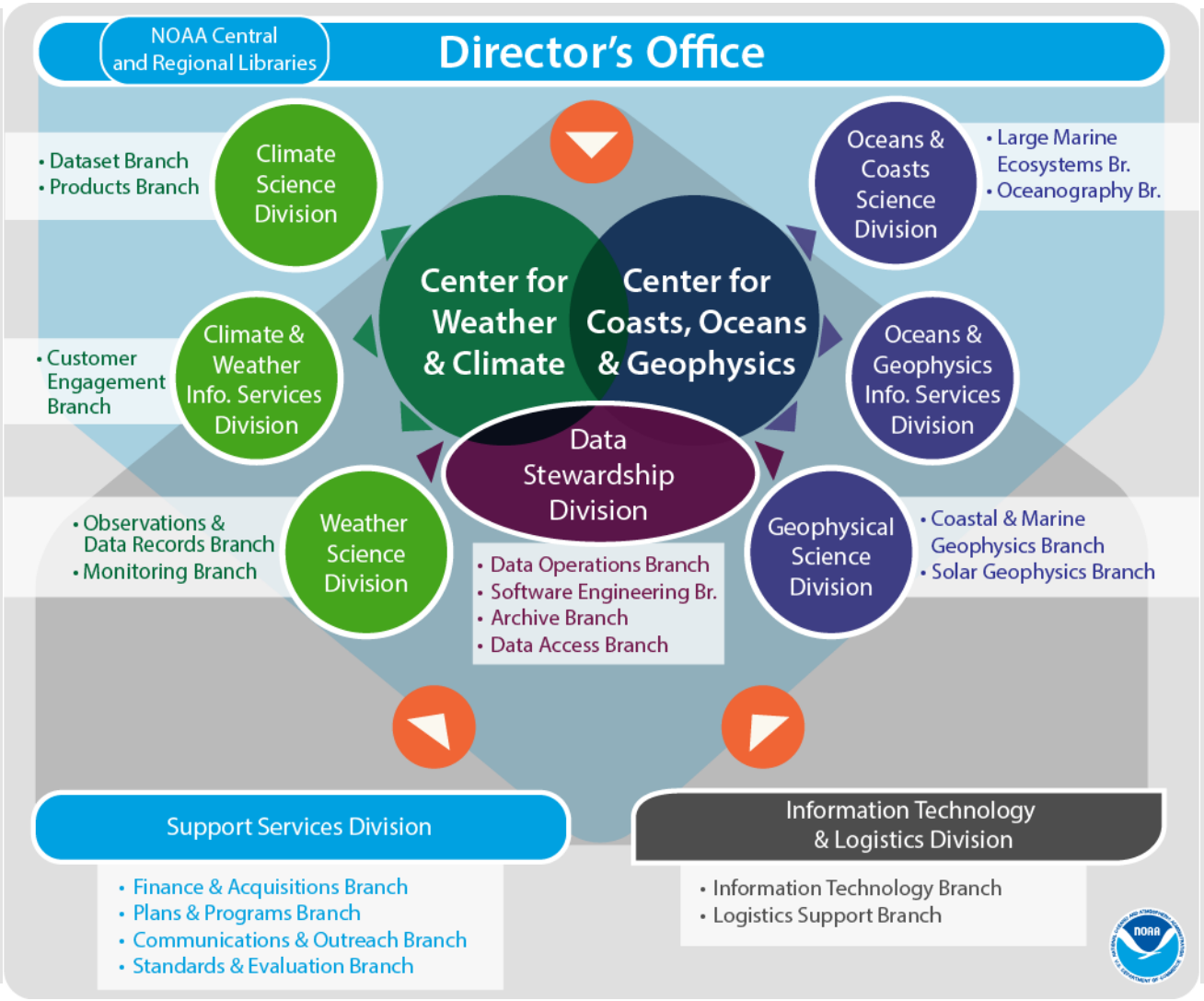
Weather and Climate

- World's largest weather and climate data archive with records ranging from paleoclimatology data to centuries-old journals to data less than an hour old
- Data are from land-based weather and climate stations, ships, buoys, weather balloons, radar, satellites, and comprehensive weather and climate models
- A suite of information products is available to describe the national and global climate and to monitor the state of the weather and climate variations, extremes, and trends

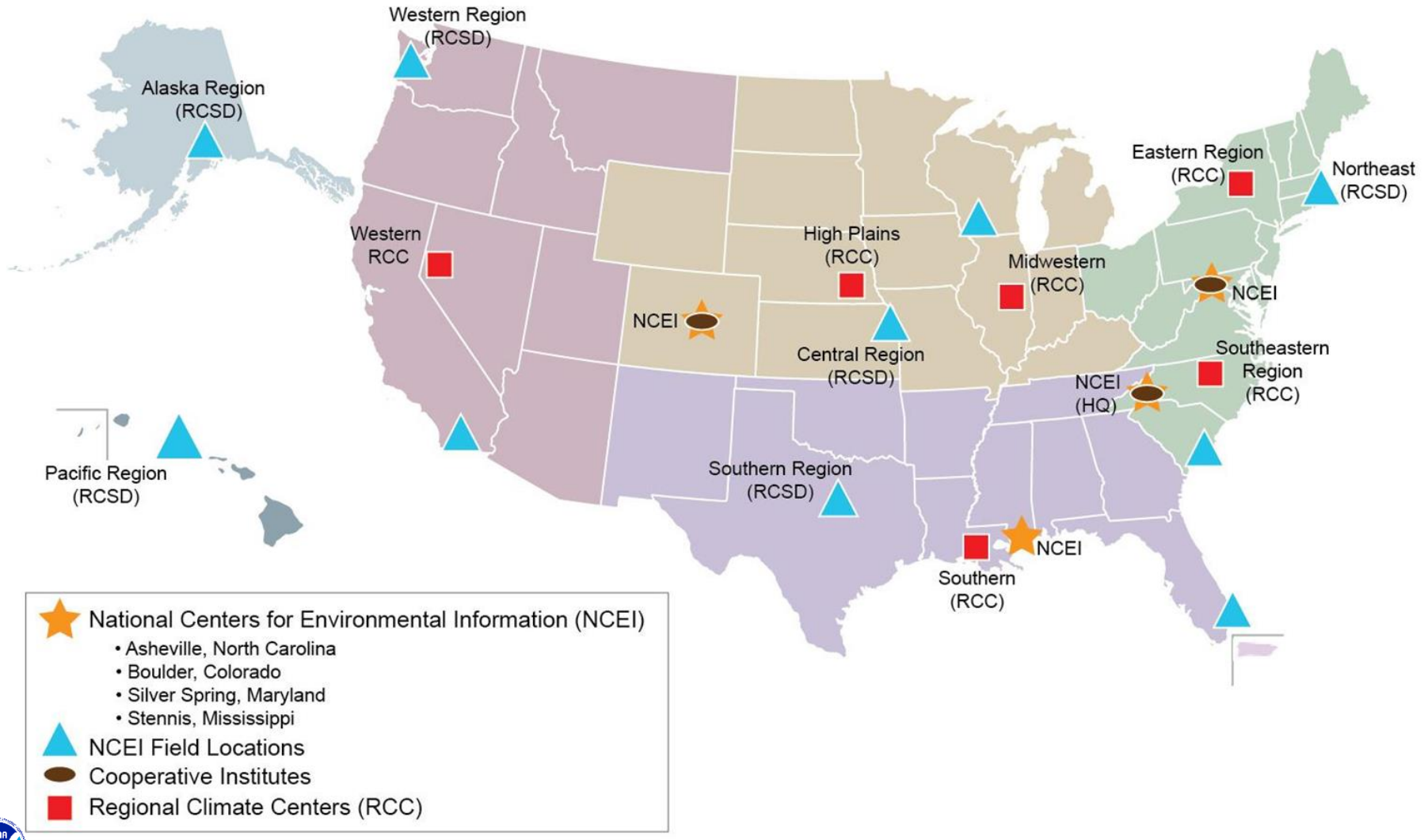




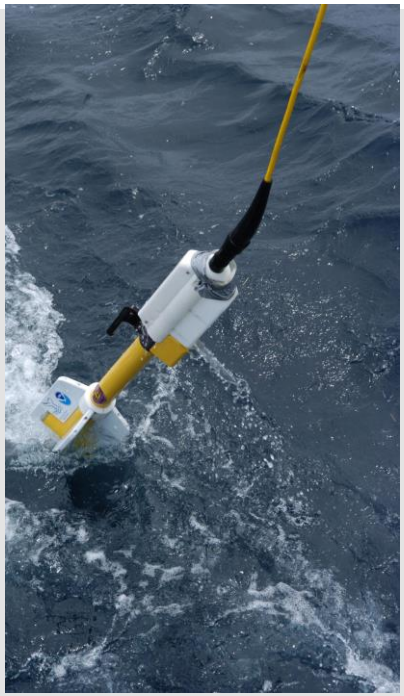
National Centers for Environmental Information (NCEI)
Functional Organization

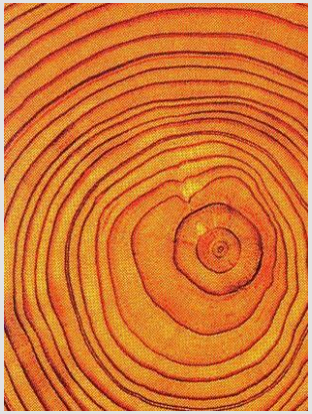


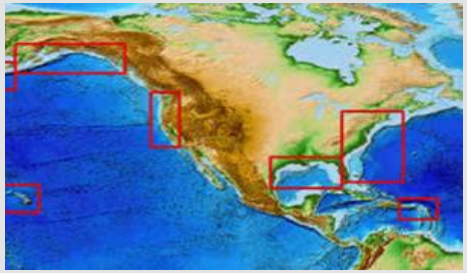
NCEI has a Nationwide Presence



NCEI Ingests and Archives Environmental Data from U.S. and International Sources





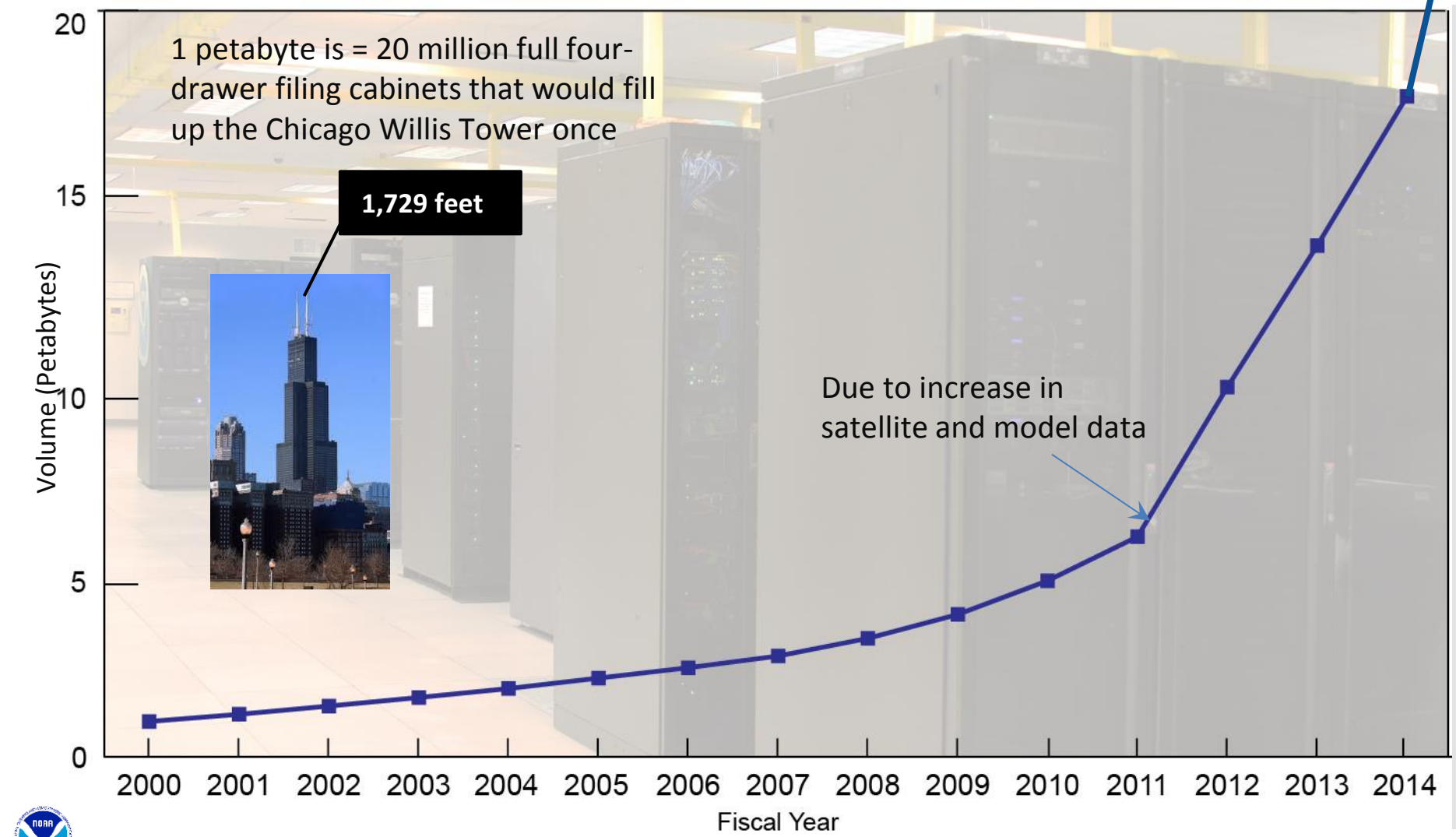


Data spans stone-age to space-age… from the depths of the ocean to the sun … and across the globe

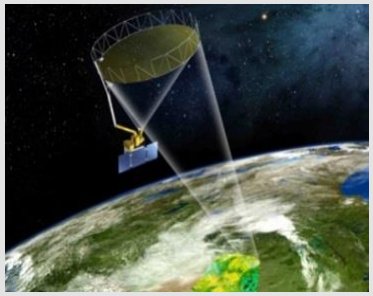
NCEI products span from local to global, and weekly to decadal scales

	Daily/Weekly	Monthly	Seasonal – Annual	Annual to Decadal
Local	Snowfall Impact Index – FEMA, disaster response	Heating & Cooling Degree Days – Energy Sector	Temperature & Precipitation Outlooks – Agriculture	Coastal Digital Elevation Models (DEM) – Hazard Mitigation
Regional	Hurricane Tracks – Emergency Planners	Solar Activity/Sun Spots – Power Distribution	Billion $ Disasters, Climate Extremes Index – Insurance	Climate Normals – Construction, Infrastructure, Agriculture
National & Global	Tsunami Warning – Emergency Managers	Global and U.S. Climate Summaries – Numerous Sectors	STATE OF THE CLIMATE IN 2013 Annual State of the Climate Reports – Scientists	IPCC & National Climate Assessments – Gov't Policymakers

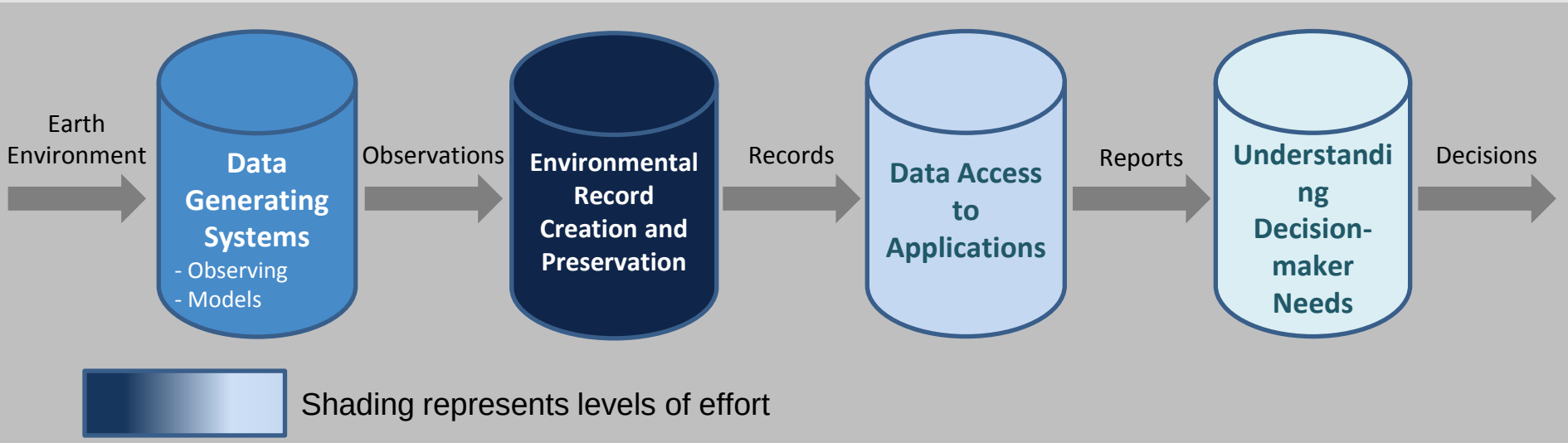
Data Stewardship Volume and Ingest Rate



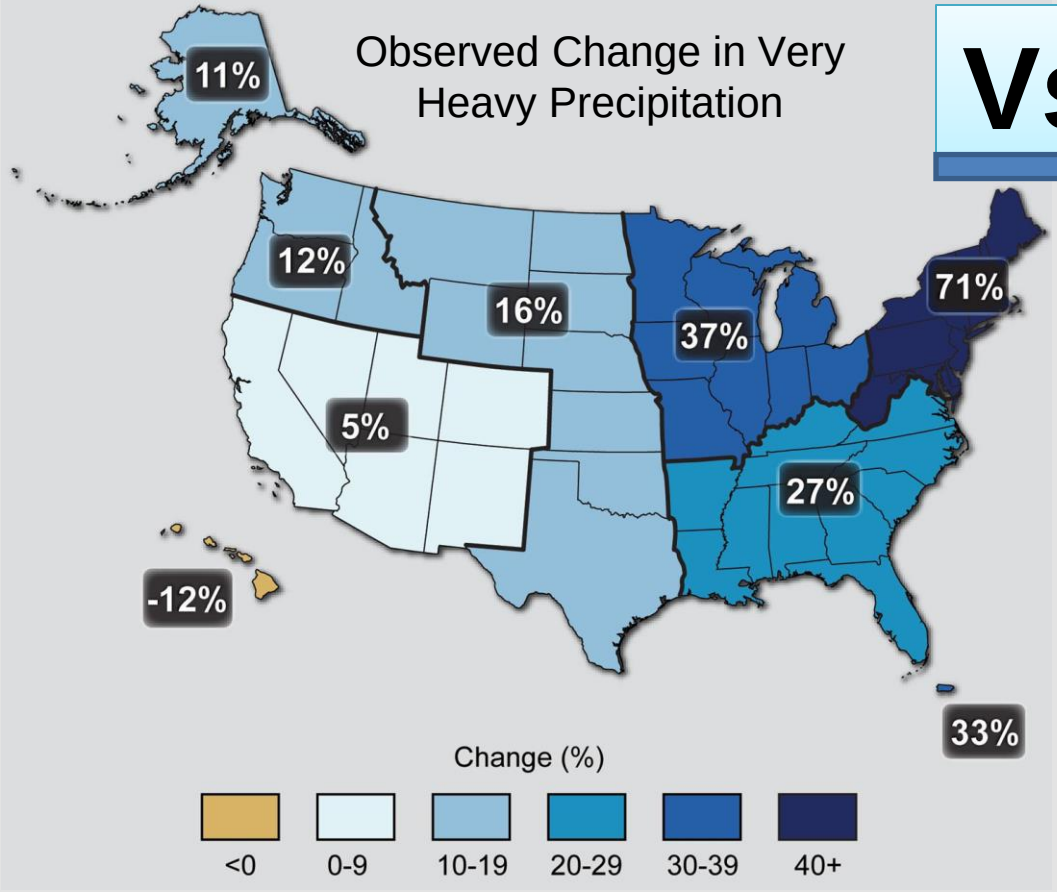
NCEI Supports the Full Information Lifecycle



- Makes foundational investments in environmental information production and preservation
- Supports others' application development and policy/decision-making



Users Increasingly Want Expert Interpretations



Percent changes in the amount of precipitation falling in very heavy events (the heaviest 1%) from 1958 to 2012 for each region. There is a clear national trend toward a greater amount of precipitation being concentrated in very heavy events, particularly in the Northeast and Midwest. (Figure source: updated from Karl et al. 2009).

Vs.

Data Documentation Division Precipitation

LONGITUDE: Optional field given as part of geographic location output option. This value is given in decimated degrees to 4 decimal places. Western hemisphere values are less than 0. The maximum number of characters for this field is 10.

DATE: This is the year of the record (4 digits), followed by month (2 digits), followed by day of the month (2 digits), followed by a space and ending with a time of observation that is a two digit indication of the local time hour, followed by a colon (:) followed by a two digit indication of the minute which for this dataset will always be 00. Note: The subsequent data value will be for the hour ending at the time specified here. Hour 00:00 will be listed as the first hour of each date, however since this data is by definition an accumulation of the previous 60 minutes, it actually occurred on the previous day. 14 characters.

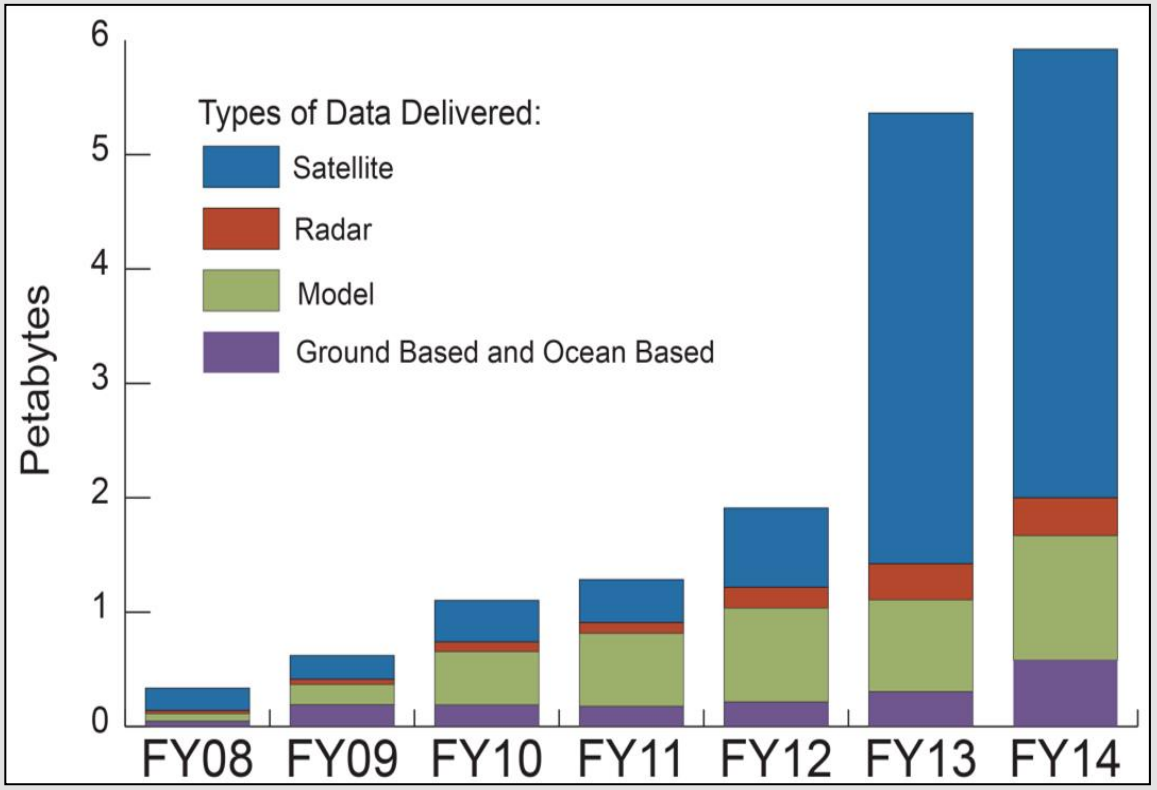
HPCP: The amount of precipitation recorded at the station for the hour ending at the time specified for DATE above given in hundredths of inches. The values 99999 means the data value is missing. The maximum number of characters for this field is 8. Hours with no precipitation are not shown. Note that observational elements listed above that are identified as optional (station name, geographic location and flags) must be added to the data output by means of selecting the appropriate checkbox for them (seen when using the Climate Data Online interface).

Who Are Our Users? NCEI's General User Profile

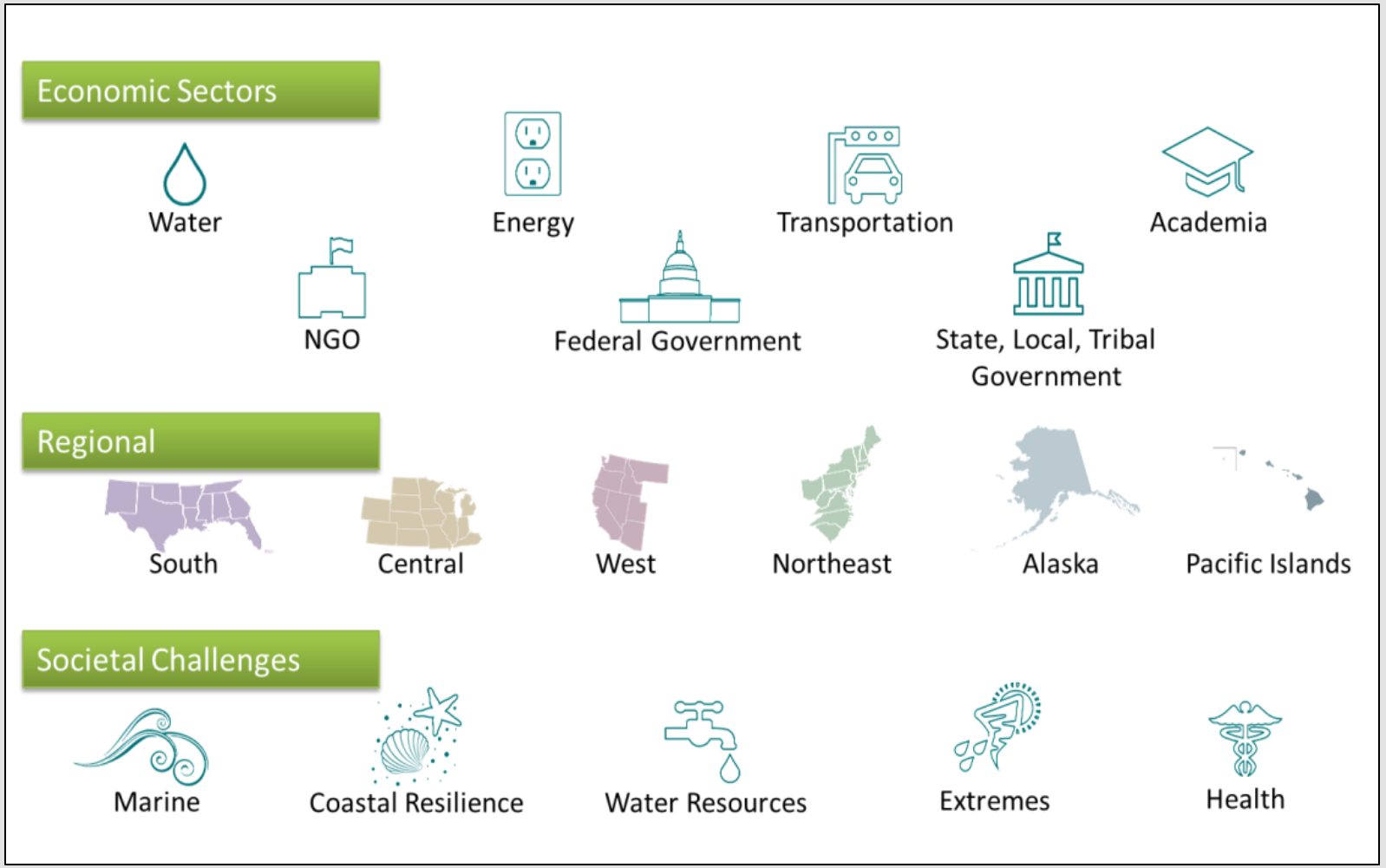
Fraction (%)	Typical User	Data or Info Need	Preferred Format	Access Volume	Access Frequency
~70	General business, media, public	Qualitative	Point-and-click, graphics, assessments	Low	High
~15	Researchers, business consultants	Quantitative	Digital downloads	High	Low
~15	Value-added Providers (database scrapers)	Quantitative	Digital downloads machine to machine	Low	High

NCEI is Responding to an Accelerating User Demand

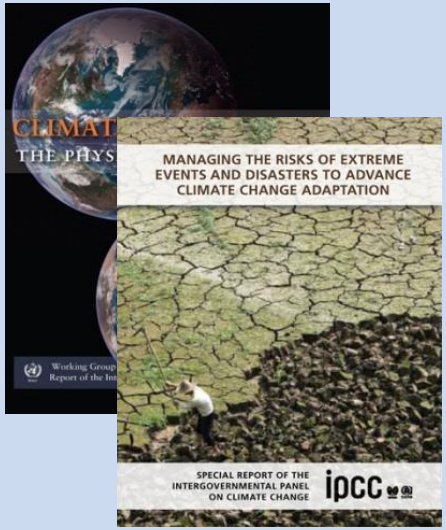
- FY14: served over 6 petabytes (PB) of data
- Providing safe storage of over 23 PB with 4 PB added in FY14
- Servicing over 20,000 personal contacts with users across
  - economic sectors
  - Regions
  - societal challenges
- 2.6 billion web hits in FY14 with 19 million users



NCEI is Responding to a Broad Spectrum of Users

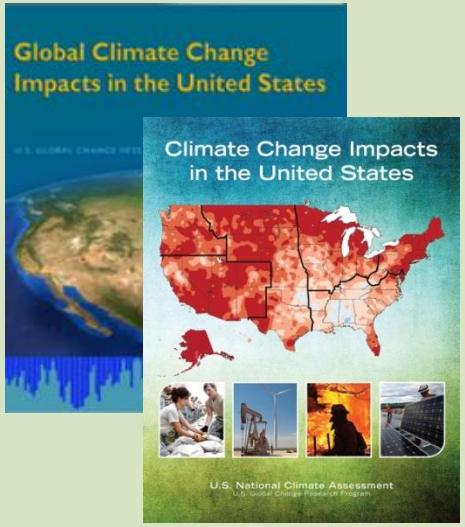


Assessing the Earth
International, National, Annual Assessments



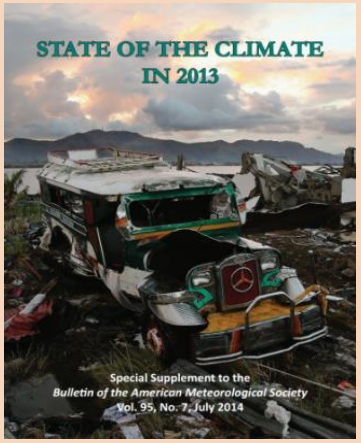
International Assessments

- IPCC Fifth Assessment
- 2 NCEI lead authors on Fifth Assessment Report



National Assessments

- National Climate Assessments
- National Tsunami Hazard Assessment



Annual Assessments

- Bulletin American Meteorological Society (BAMs) State of the Climate Report

Tiers of Stewardship

Levels of Data Stewardship

6: National Services and International Leadership
- Lead, coordinate, or implement scientific stewardship activities for a community or across disciplines
- Establish highly specialized levels of data services and product assessments

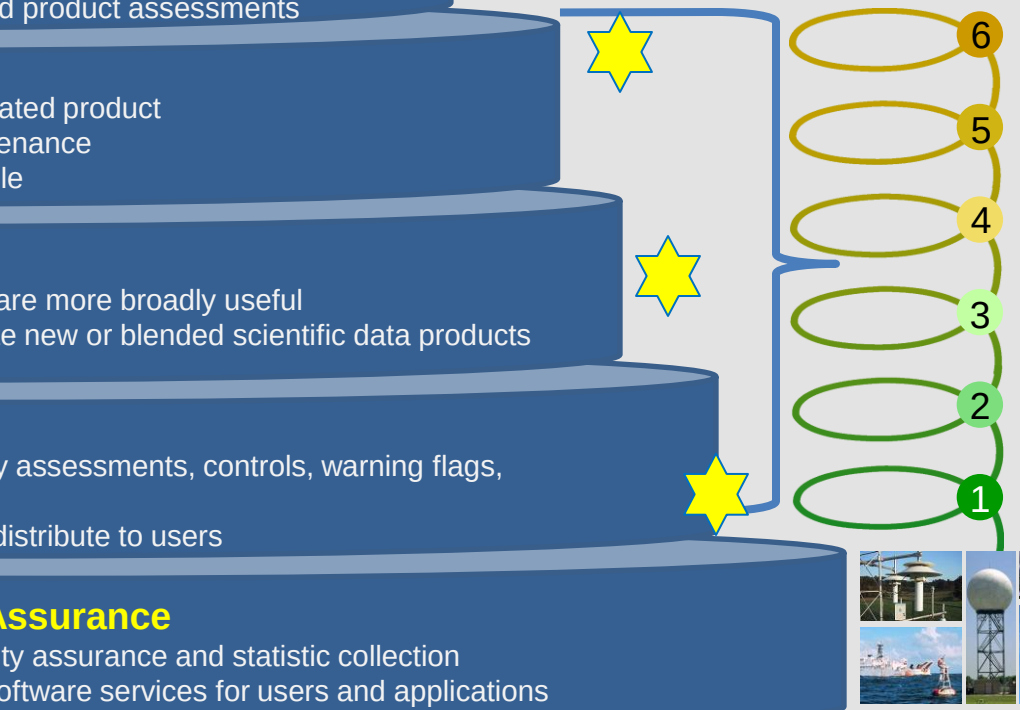
5: Authoritative Records
- Combine multiple time series into a single, inter-calibrated product
- Establish authoritative quality, uncertainties, and provenance
- Ensure products are fully documented and reproducible

4: Derived Products
- Build upon archived data to create new products that are more broadly useful
- Distill, combine, or analyze products and data to create new or blended scientific data products

3: Scientific Improvements
- Improve data quality or accuracy with scientific quality assessments, controls, warning flags, and corrections
- Reprocess data sets to new, improved versions and distribute to users

2: Enhanced Access and Basic Quality Assurance
- Create complete metadata to enable automated quality assurance and statistic collection
- Provide enhanced data access through specialized software services for users and applications

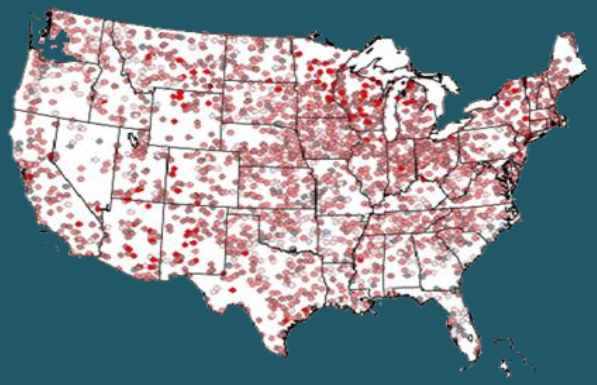
1: Long Term preservation and Basic Access
- Preserve original data with metadata for discovery and access
- Serve as expert advisors on standards for data providers
- Archive only necessary data using appropriate retention schedules
- Safeguard data over its entire life-cycle
- Coordinate support agreements for sustainable data archiving
- Provide data citation services by mining DOIs



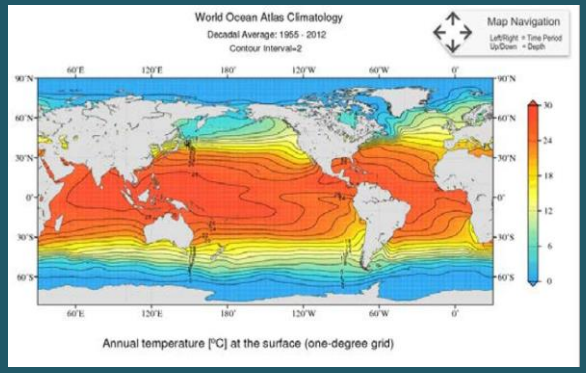
Examples of "Gold Standard" Products

Data Set Maturity Matrix Model Level 6

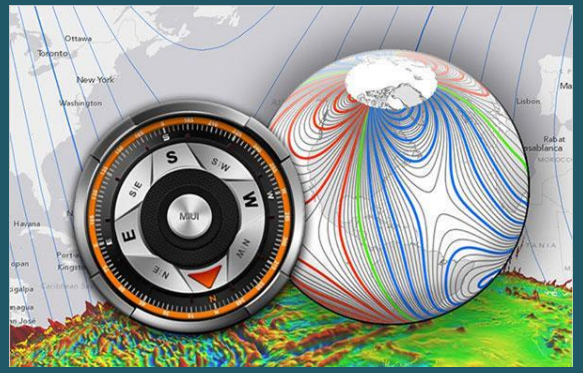
Climate Normals



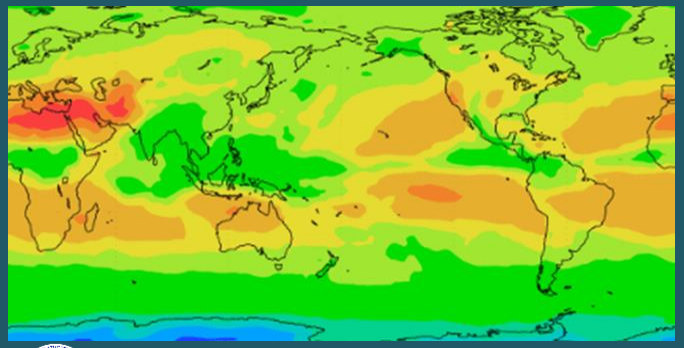
World Ocean Atlas



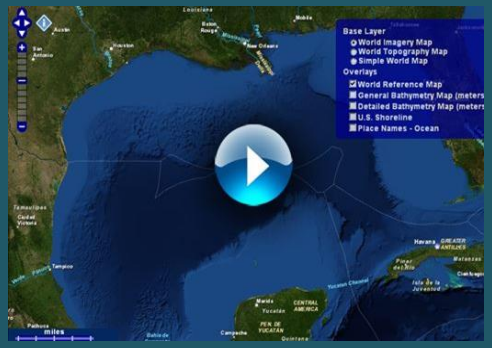
World Magnetic Model



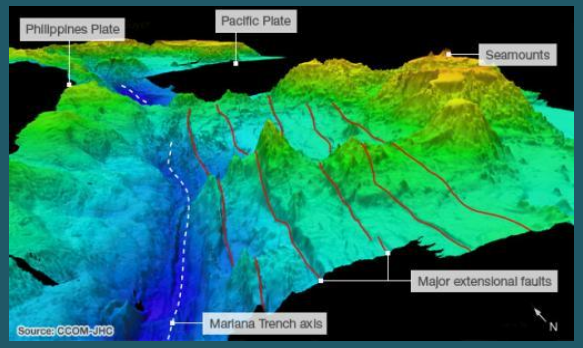
Reference Environmental Data Records



Gulf of Mexico Data



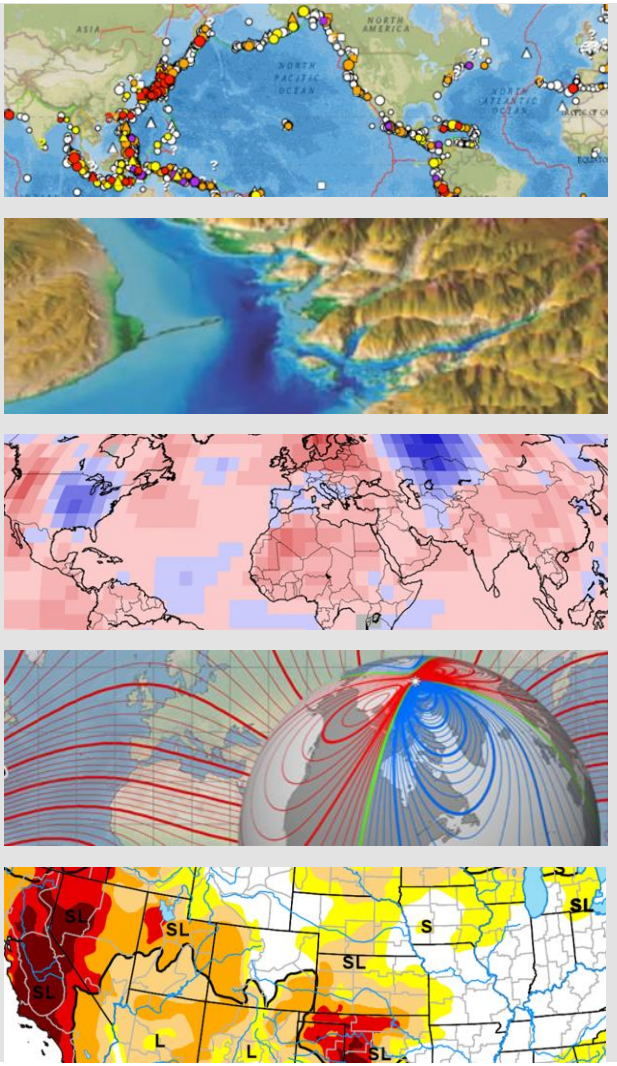
Coasts/Extended Continental Shelf



Value of NCEI

Science, Service, Stewardship

- Comprehensive environmental information across economic/environmental sectors and science disciplines for decision making, planning, and operations
- Timely and authoritative data and information with well described origin and certainty
- Service to a wide-range of customers across government, academia and industry
- Preservation of data and information for future generations



NOAA
National Centers for Environmental Information

www.ncei.noaa.gov

NCEI Climate Facebook: http://www.facebook.com/NOAANCEIclimate
NCEI Ocean & Geophysics Facebook: http://www.facebook.com/NOAANCEIoceangeo
NCEI Climate Twitter (@NOAANCEIclimate): http://www.twitter.com/NOAANCEIclimate
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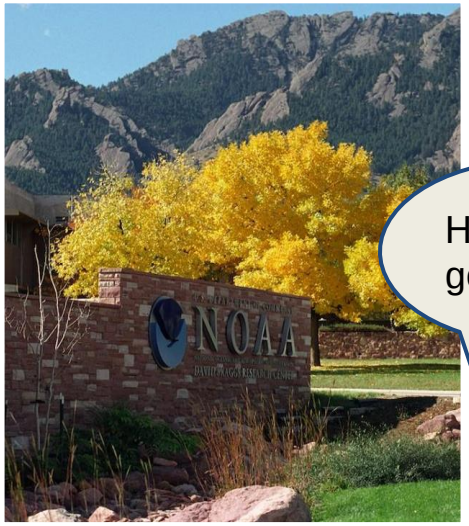
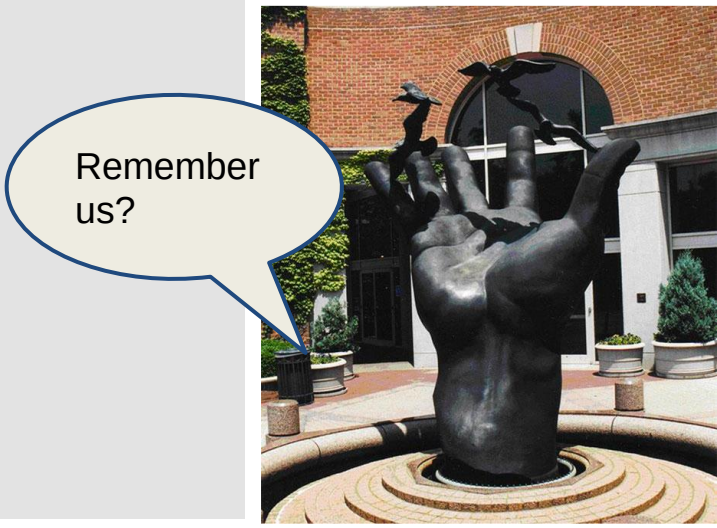
Day in the life of … Stewardship at NCEI

Status Quo…NOAA Data Centers



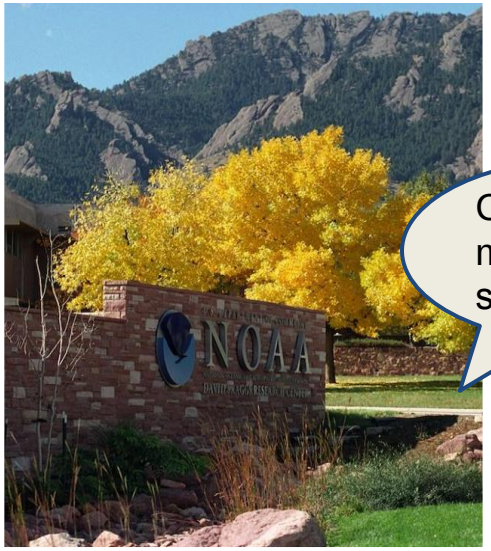


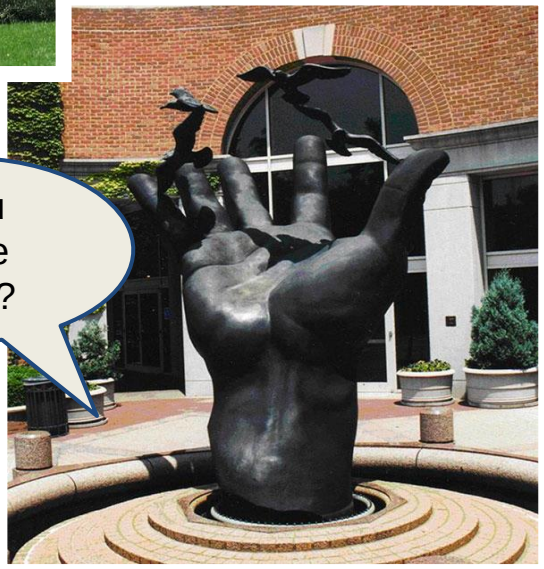
New'ish Paradigm

Stewardship is a **shared** responsibility.

- Stewardship Division provides the tools
- Support Services provide the framework
- Science Centers provide the data quality

Status Quo...NCEI





Changing while maintaining Status Quo?

Chaos & confusion are easy,
Clarity takes wisdom &
hard work

➢Learning what each location does

➢Getting to know each other...personnel moves

➢Focusing on possible synergies

Changing while maintaining Status Quo?

Chaos & confusion are easy,
Clarity takes wisdom &
hard work

➢Tiger Teams

➢Agile approach

➢implementing in small pieces

Meanwhile…Users see?

Providing Clarity

- [NCEI Website]
- Not changing without extensive notification
- implementing in small pieces
- providing training when changes require learning something new

Meanwhile...Users see?

Soo Many tools...

How do we Develop & Maintain "Gold Standard" Reference Datasets?

- Apply a maturity model similar to engineering readiness levels - a practical approach
- Goes beyond measurements of quality to *usability, transparency*, and *understanding*
- Assess products using a "Maturity Matrix" covering seven aspects of data maturity

	Level	Data Use	Code Stability	Metadata & QA	Documentation	Validation	Public Release	Science & Applications
Primarily Operations	6	Unified and coherent record; considered scientifically irrefutable following extensive scrutiny	Homogeneous and published error budget	Provenance tracking and reproducibility; meets international standards	Peer-reviewed product algorithm, validation, processing and metadata	Validated independent cross-checks, open inspection, and continuous interrogation	Publicly available from long-term archives	Used in various published applications and assessments
	5	Unified and coherent record	Stable and reproducible	See below	See below	See below	Source code portable and released; uncertainty estimate	See below
	4	Research and Operations	See above	Provenance tracking and reproducibility; meets international standards	Draft Operational Algorithm Description	See below	Source code released; Data available but of unknown accuracy	See below
Primarily Development	3	Research	Minimal changes expected	See below	Peer-reviewed algorithm and product descriptions	Uncertainty estimated over widely distribute times/location; differences understood	See below	Provisionally used in applications and assessments demonstrating positive value
	2	Research	Some changes expected	Research grade (extensive)	CTD	Uncertainty estimated for select locations/time	Data available but of unknown accuracy	Limited or ongoing
	1	Research	Significant changes likely	Incomplete	Draft concept of Theory Document (CTD)	Minimal	Limited data availability	Little or none

INCREASING REQUIREMENTS

Adapted from AGU EOS 2012 Bates and Privette

Archive Example

Provider asking to archive data

➢NGDC<NCDC<NODC

➢data submission < archive & access

➢Shouldn't MATTER WHERE!!

Future Work

That “hard work” part & TIME

- ➢Cultivating change (externally and internally)
- ➢Creating Synergies
- ➢Lessons learned
- ➢Multipronged approaches
  - ○Measuring success
  - ○Training

NCEI allows for an environment where Stewardship is a <u>shared</u> responsibility

NOAA
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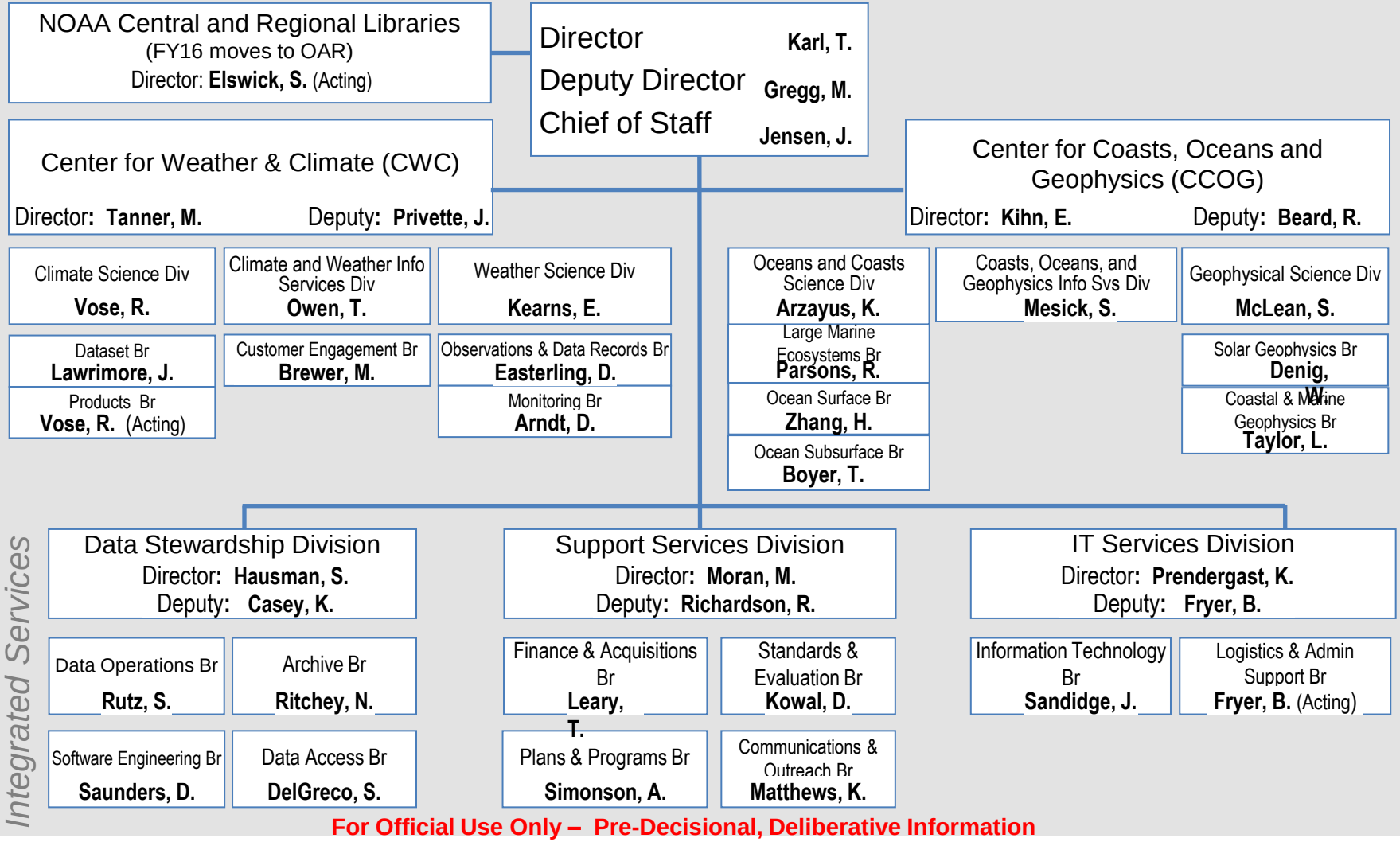
Back up slides

National Centers for Environmental Information (NCEI)

as of 06/01/15

(Post-April Summit Draft Functional Statements)

(For submission to WFM for FY16)



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