

Scientific Data Stewardship: Leveraging Foundational Data Sets for Environmental Applications

Krisa M. Arzayus, Ph.D.

Deputy Director (acting), NCEI Center for Coasts, Oceans and Geophysics (CCOG)

November 30, 2016



NOAA Satellite and Information Service | National Centers for Environmental Information

Driving Value-Creating Decisions From Data





Maximizing the Return on Investment on Collected Data



CCOG Partnerships



Tiers of Stewardship

6: National Services and International Leadership Maturity · Lead, coordinate, or implement scientific stewardship activities for a community or across Matrix disciplines Model Establish highly specialized levels of data services and product assessments Stewardship 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 Maturity Distill, combine, or analyze products and data to create new or blended scientific data products of Data **3: Scientific Improvements** Improve data quality or accuracy with scientific quality assessments, controls, warning flags, and corrections evels 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 minting DOIs

NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION

Tiers of Services Description

- 1. Long-Term Preservation and Basic Access:
- Preserve data, creating the minimal metadata adequate for basic discovery and DOI Minting
- Verify the <u>safequarding</u> of the dataset over its entire life cycle
- Provide basic access to the original data
- Serve as expert advisors on data formats, conventions, metadata creation, and standards for data providers
- Coordinate support agreements to establish sustainable means to archive data

Examples: Comprehensive Large Array-data Stewardship System (CLASS) Satellite Archive, Meteorological Assimilation Data Ingest System (MADIS), Archive Management System (AMS), Rolling deck to Repository (R2R)

2. Enhanced Access and Basic Quality Assurance

- Create <u>complete metadata</u> to enable automated quality assurance and statistics collection
- Provide <u>enhanced data access</u> through specialized software services for users and applications

Examples: OPeNDAP/THREDDS, Climate Data Online (CDO), National Operational Model Archive and Distribution System (NOMADS), Bathymetric and Hydrographic WebMap Services, Jason xGDR Quality Monitoring system

- 3. Scientific Improvements
- Improve data quality or accuracy with scientific quality assessments, controls, warning flags, and corrections
- <u>Reprocess datasets</u> to new, improved versions or formats and distribute to users

Examples: International Surface Temperature Initiative (ISTI), Climate Raw Data Record (C-RDR), Global Temperature and Salinity Profile Program (GTSPP), Processed 1-minute DART and tide data for tsunami research

Tiers of Service Description

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 <u>new or blended scientific products</u>

Examples: International Best Track Archive for Climate Stewardship (IBTrACS), World Magnetic Model (WMM), Hurricane Satellite (HURSAT) Data, Seamless topographic-bathymetric digital elevation models / 3DCZ (DEM), International Comprehensive Ocean-Atmosphere Data Set (ICOADS), Regional Climatologies, International Atlases, World Ocean Database (WOD), VIIRS & DMSP Nighttime Light and Fire Products

5. Authoritative Records

- Combine multiple time series into a single, intercalibrated data product
- Authoritatively establish the quality, uncertainties, and provenance for a data product
- Ensure the product is <u>fully documented, reproducible</u>, and its production methods are transparent by preserving the data, metadata, algorithms, and workflows used in creating the product

Examples: Ocean Heat Content, World Ocean Atlas (WOA), Climate Data Records (CDRs), Climate Normals

- 6. National Services and International Leadership
- · Lead, coordinate, or implement scientific stewardship activities for a community or across disciplines
- Establish or provide <u>highly specialized levels of data services and product assessments</u> based on information products and scientific knowledge

Examples: Group for High Resolution Sea Surface Temperature (GHRSST), Long-Term Stewardship and Reanalysis Facility, Development and Implementation of XBT Fall Rate Corrections, National Integrated Drought Information System (NIDIS), National Climate Assessment (NCA), World Ocean Assessment



CCOG's Foundational Datasets

Oceanographic Datasets

- International Comprehensive Ocean Atmosphere Data Set (ICOADS)
- Extended Reconstructed Sea Surface Temperature (ERSST)
- Optimally Interpolated SST (OISST)
- World Ocean Database (WOD)
- Gulf of Mexico Data Atlas
- Ocean & Coastal Mapping Data, Products & Services

Space Weather

• Space Weather Assets

Geophysical Datasets

- Magnetic Field Products
- Digital Elevation Model

Ocean & Coastal Mapping Data, Products & Services Integrated Ocean & Coastal Mapping (IOCM)

Mandated by 2009 Ocean and Coastal Mapping Integration Act (PL 111-11)

- Map Once, Use Many Times
 - Leverages limited national mapping resources
- Smart Business Practice

Tiers of Stewardsh

- Protect Mapping Investments
- Rough estimated ROI for Multibeam is ~2000%
- Increase Accessibility of Data to:
 - Protect life and property
 - Support healthy and resilient coastal communities
 - Provide for safe and efficient marine transportation
 - Speed disaster response and recovery
 - Inform decisions and improve understanding
 - Research and mitigate climate changes







Ocean & Coastal Mapping Data, Products & Services Foundational Data Streams

Provide sustainable stewardship, discovery, access, and product development for marine geophysical and hydrographic data collected on NOAA, academic and international vessels.

Develop pilot projects to extend capabilities to additional data streams and scope the effort needed to implement in an operational capacity.



Who are the users of OCM data, products and services?



Ocean & Coastal Mapping Data



Gulf of Mexico Data Atlas

gulfatlas.noaa.gov

A collection of digital maps showing regional climatologies and baseline data to support Ecosystem Based Management, RESTORE Science Program objectives

Over 60 contributors from federal and state agencies, NOAA line offices, academia



2015 Top 20 Most Visited Topics



Gulf of Mexico Data Atlas Topics

- \rightarrow Direct links back to source data
- \rightarrow ISO metadata for each dataset
- \rightarrow Searchable map catalog

→ Maps images are available as WMS and through REST services, can be dynamically ingested by mapping applications and websites (data.gov, geoplatform.gov, ArcGIS)

Gulf of Mexico Data Atlas

DATA PROVIDERS

- National Sea Grant Office
- National Estuarine Research Reserve System
- NOAA Fisheries
- National Center for Environmental Information
- Office of Oceanic and Atmospheric Research
- Coastal Services Center
- National Ocean Service

Other Federal Agencies

- US Geological Survey
- Bureau of Ocean Energy Management
- Environmental Protection Agency

Gulf State Agencies

- Florida Fish and Wildlife Conservation Commission
- Florida Department of Environmental Protection
- Mississippi Department of Marine Resources
- Alabama Department of Conservation & Natural Resources
- Louisiana Department of Wildlife & Fisheries
- Gulf States Marine Fisheries Commission

International Partners

 Mexico- Comision Nacional para el Conocimiento y Uso de la Biuodiversidad (CONABIO)

Academic Institutions

- Mississippi State University
- University of South Alabama- Dauphin Island Sea Lab
- Texas A & M University- Harte Research Institute
- University of South Florida
- University of Southern Mississippi
- University of Colorado- Institute of Arctic and Alpine Research

- ✓ Data provided by federal, state, academic, institutions
- Validated against community
- accepted, standard references
 ✓ QA/QC methods and procedures are fully described
- Digitally accessible from a national archive or recognized source
 - Standard file formats
 - ISO compliant metadata for every dataset
 - Redily reusable as Web Mapping Services



Central point of access to regional data, providing the building blocks Research,

- Restoration,
- Resilience,
- Resource management



Who are the users of GoM Data Atlas?



Tiers of Stewardship

International Comprehensive Ocean Atmosphere Data Set (ICOADS)



Scope: The world's most extensive surface marine & meteorological data collection (akin to GHCN over land); a foundational dataset for climate monitoring & studies (e.g. ERSST ...)

Objective: Stewardship, archive & service of ICOADS





ICOADS – A Foundational Database



ICOADS – A Critical Marine Foundation for All-Types of Products and Services



Who are the users of ICOADS?



ICOADS – A Foundational Database

Centennial-Scale Extended Reconstructed Sea Surface Temperature (ERSST)

Scope: Authoritative centennial global sea surface temperature dataset for climate change research, assessment & monitoring

Tiers of Stewardshin

Objective: Monthly production & dissemination; development to remain state-of-the-science & authoritative

Major Ongoing Improvements:

- Updated SST bias corrections
- Methods to include data from Argo floats
- Using ICOADS R3.0
- Comprehensive data error estimates
- Updated SST corrections using new sea ice datasets



Who are the users of ERSST?



In situ SST from 1854, updated monthly



NCEI Space Weather

Mission: Provide Long-Term Scientific Stewardship for NOAA Space Weather (SWx) Data and Information

Supporting NOAA's satellite acquisition, pre/post launch operations and space environmental monitoring

- Manage the 30+ year historical record of space environmental data from GOES and POES (also DMSP).
- Develop ground processing algorithms for producing operational space weather products for GOES-R.
- Assume responsibility for the satellite sensor cal-val and monitor in-flight performance and calibration (SWx).
- Plan for the acquisition and archive of DSCOVR space weather products.
- Cross-LO team NESDIS/NGDC and NWS/SWPC







Who are the users of Space Weather Products?



Serving NOAA Satellite Data Since 1974

Conclusions

- NCEI stewards and produces a broad range of foundational datasets.
- Each of these data sets has been developed to serve distinct user communities.
- Several products are interdependent on each other, adding value along the way for the designated user communities they serve.

CICS-MD and NCEI Partnership

- Zhankun Wang- NCEI-TSG database development
- Sheekela Baker-Yeboah: Scientific stewardship of ocean satellite data
- James Reagan- Global near-surface salinity patterns over 20-50 year time periods
- Brian Beck- Government data management policies as recommendations for all scientists



BACK-UPS



Optimally Interpolated SST (dOISST)



Tiers of Stewardship



Characteristics:

- Complete (gap-free) SST, ice and error fields
- Blend of *in situ* + satellite data daily global coverage on a ¼° grid

Types:

- AVHRR-only (from, 1981; CDR support)
- AVHRR+AMSR (from 2002; inactive)

Production schedule

- Preliminary produced every day in near real time (1-day delay)
- Replaced by final (science quality) after 2 weeks

Status:

Version 2 released was Nov 2008 AVHRR+AMSR inactive Code rejuvenation longer than expected

Supports Operations, Modelling, Research and Management



120F

1 2 O W

NOAA 1/4° dOISST

Global climate forecasting	Unusual phenomena (warm blob)	Ecological and population models
1/4° Blended SST Climatology	Hurricane development	Phytoplankton primary production
Data quality control	Oceanic CO2 processes	Resource management
Ancillary Data for Satellite Algorithms	Diurnal SST and fluxes	Research

dOISST- A Foundational Dataset for Operations, Modelling, Research and Management



Who are the users of dOISST?



In situ and satellite SST blend from 1981, updated daily

World Ocean Database (WOD)



Tiers of Stewardship

0° 30°E 60°E 90°E 120°E 180° 150°W 120°W 90°W 60°W 30°W 0° 90°N 60°N 30°N 0° 30°S 60°S 90°S 0° 30°E 60°E 90°E 120°E 180° 150°W 120°W 90°W 60°W 30°W 0° 90°N 60°N 30°N 0° 30°S 60°S 90°S 0° 30°E 60°E 90°E 120°E 180° 150°W 120°W 90°W 60°W 30°W 0° 90°S WOD: World's largest publicly available uniform format quality controlled ocean profile database

Time Series of Oceanographic Profile in World Ocean Database (WOD)

Global Temperature and Salinity Profile Programme (GTSPP) unique source 2014 near-real time data (XBT, CTD, pinniped, glider) in WOD

1) Temperature	
2) Salinity	
3) Oxygen	
4) Phosphate	
5) Nitrate	
6) Nitrate + Nitrite	
7) Silicate	
8) Chlorophyll	
9) pH	
10) Alkalinity	
11) pCO ₂	
12) TCO ₂	
13) Plankton	
14) CFCs 11, 12, and 113	
15) Tritium	
16) Helium (noble gas)	
17) ΔHe-3 (isotope)	
18) ΔC-13 (isotope)	
19) ΔC-14 (isotope)	
20) Argon (noble gas)	
11) Neon (noble gas)	
22) O-18 (isotope)	
23) Beam Attenuation Coefficient (transmissivity)	

Jariahlas in M

Who are the users of the WOD?



World Ocean Database

Magnetic Field Products (GeoMag)

Magnetic Field Models for Safe Navigation



Tiers of Stewardship







The World Magnetic Model (WMM) is the standard operational magnetic field model

- Updated every 5 years
- Used by DoD, NATO, FAA, NOAA, USGS
- Used by every ship, aircraft and submarine
- Embedded in billions of smartphones and car navigation systems



Magnetic Field Products (GeoMag)



Enhanced Magnetic Model (EMM): 720 degree crustal model



Real-time Disturbance Field Calculator



- Acquire global marine and aeromagnetic data – largest source database in world.
- Developing advanced models to address needs from various business and military users.
- Investigating CrowdMag: 0 to 6 million observations in 6 months



Who are the users of GeoMag?



NOAA Charts

NOS-Hydrographic charting

NOAA Surveyors



Department of Defense

Aircraft/Ship/Submarine navigation Submarine Degaussing

NATO

Aircraft navigation potential missile guidance?

FAA

Aircraft navigation Runway bearing verification Imbedded in navigation equipment as a backup for any GPS failure

USGS

Private Sector and Worldwide

Solar panel industry

Used in solar panel installation for panel orientation

Smart Phones

All smart phones use GeoMag for compass applications

Directional Drilling

Geophysical Exploration

Private Surveyors and Municipalities

Use Magnetic calculator to find lot delineations, Courts have used magnetic calculator data to determine hearing ruling

Satellite Industry



Colorado University

Cooperative Institute for Research in Environmental Science

Swarm Satellite Community

IGRF - International Geomagnetic Reference Field

An international research initiative to further study geomagnetisim and provides widely used geomagnetic reference models

Digital Elevation Models (DEMs)

Maximizing resiliency to tsunami and related disasters by learning from the past to prepare for the future.

NCEI tsunami data archive supports research, forecast, & mitigation

Tiers of Stewardshi



Natural Hazards web map interface: tsunami observing systems, events, and impacts (deaths, \$\$, damages)

U.S. Tsunami Hazard Assessment – Analyze past data to understand future hazard (NOAA/USGS)

Coastal Tide Gauges

- NOS CO-OPS: 1-minute data (15-second & 6-minute)
- NWS Tsunami Warning Centers: 15-second data

NWS/OAR Deep-ocean Assessment & Reporting of Tsunamis (DART[®])

 Real-time / post-process data: algorithms to support research, mitigation, forecast and warning

Quality **historical data** to validate models, assess hazard, mitigate risk

Digital Elevation Models (DEMs)

Integrated bathymetric-topographic digital elevation models – from global to community scale



Sea-level rise & nuisance flooding



Ecosystem management and habitat research



Earth visualization



Spatial planning



Hazard mitigation and community preparedness





Forecast and warning

Who are the users of DEMs?

NWS

Tsunami Program Tsunami Warning Centers COASTAL Act National Tsunami Hazard Mitigation Program

NOA

OAR

PMEL/NCTR

NOS

USGS

USACE

FEMA

Disaster Relief. Appropriations. Act, 2013 -Hurricane Sandy DEMs

States

DEMs created and collaboration with local and state governments in: California, Hawai'i, Alaska, Washington, Oregon, Connecticut, Delaware, Florida, Georgia, Maine, Maryland, Massachusetts, New Jersey, New York, Rhode Island, North Carolina, South Carolina, Virginia, Alabama, Louisiana, Mississippi, Texas, American Samoa, Puerto Rico, U.S. Virgin Islands, Commonwealth of Northern Mariana Islands, Guam GOV cont'd/ INTERNATIONAL

USFWS

Canadian Hydrographic Service

Ocean Network Canada

Countries requesting DEMs

Chile Niue Galapagos (Ecuador) French Polynesia Cook Islands Kiribati



University of Delaware

University of Rhode Island

University of Alaska Fairbanks

University of Puerto Rico

University of Hawai'l at Manoa

University of Texas

Texas A&M Galveston

Digital Elevation Models

CCOG Partnerships

- NCEI stewards foundational datasets that serve as the backbones of earth and space science applications
- CCOG has extensive working partnerships across NOAA, the federal government, and internationally
- CCOG's portfolio encompasses all of our tiers of stewardship, from basic data archive and preservation to developing quality controlled datasets and authoritative data products
- CCOG works with partners across NOAA and the federal government, as well as with international communities

