BCO-DMO's

Biological & Chemical Oceanography Data Management Office

migration to ERDDAP

ESIP Marine Data Cluster
24 October 2019

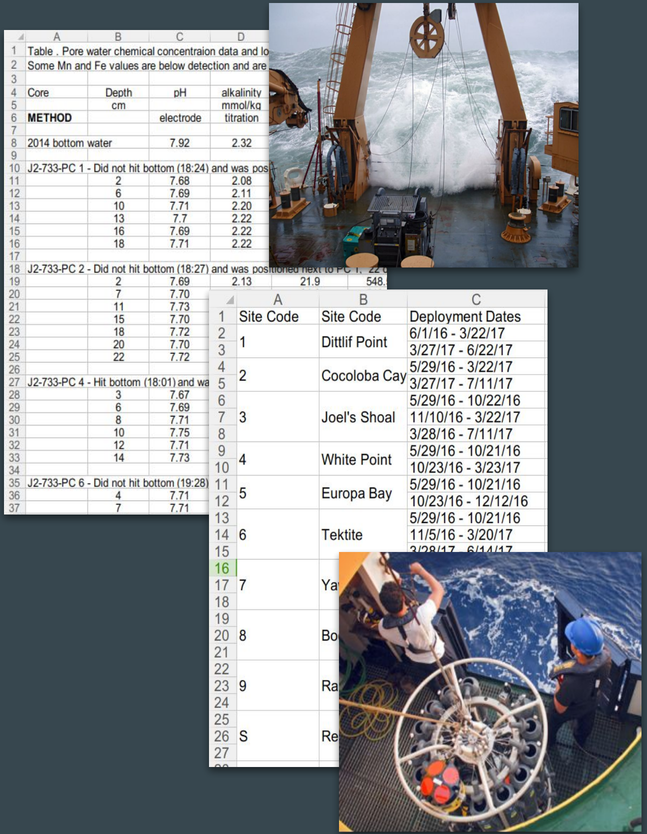
Mathew Biddle

WOODS HOLE OCEANOGRAPHIC INSTITUTION 1930

NSF

Outline

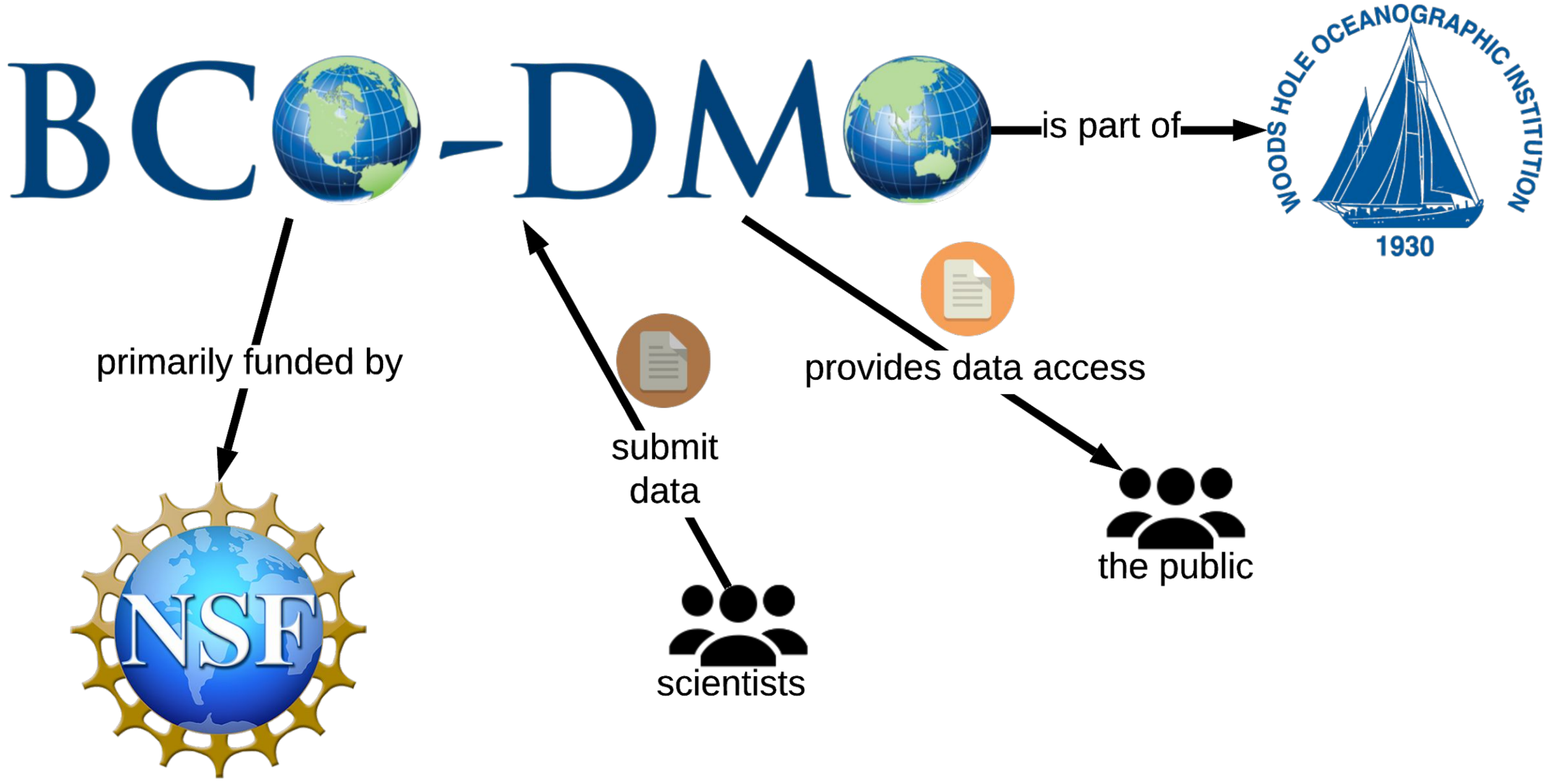
1. Intro/overview of BCO-DMO
2. How do we meet FAIR recommendations?
3. Our current data serving system
4. Why ERDDAP?
5. Background on ERDDAP
6. How have we deployed it?
7. Gotchas during migration
8. Future



BCO-DMO Background

- Established in 2006, through the merging of the two data management office's for the U.S. GLOBEC and JGOFS projects.
- The Biological and Chemical Oceanography Data Management Office (BCO-DMO) is funded by the U.S. National Science Foundation (NSF) to provide data management services to NSF-funded projects in Biological and Chemical Oceanography and the Division of Polar Programs Antarctic Organisms and Ecosystems program at no cost to the investigators.
- We now manage data from over 1,000 projects from researchers (PIs) across the U.S. studying a wide variety of scientific domains.

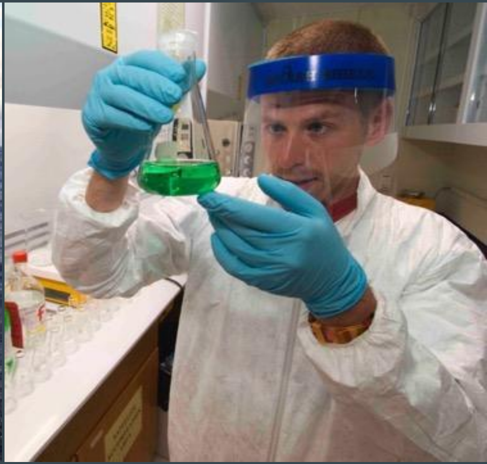
Who are we?



BCO-DMO: Biological and Chemical Oceanography Data Management Office

Mission

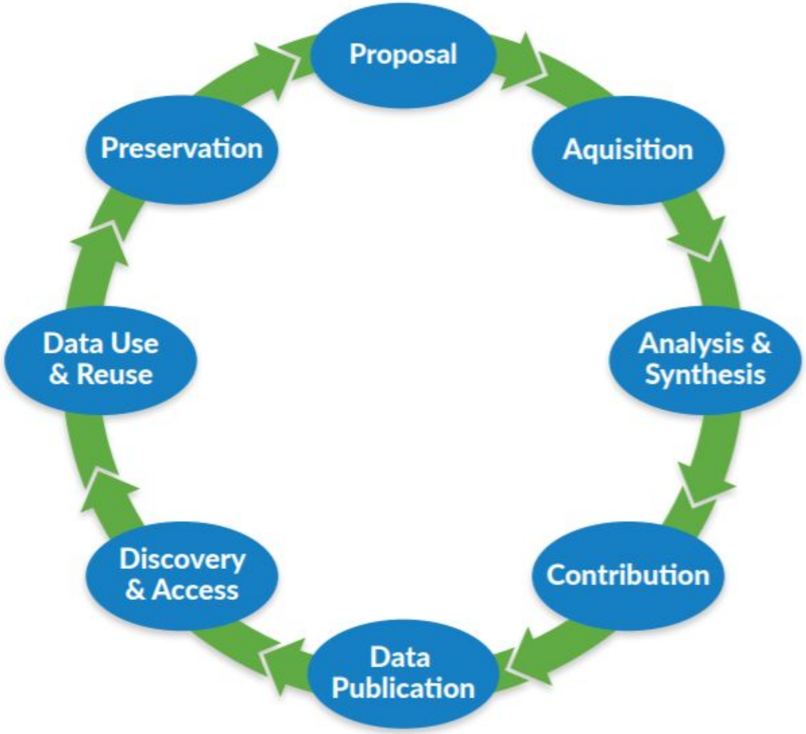
To work with principal investigators to curate and serve data and information from research projects funded by the National Science Foundation's Biological and Chemical Oceanography Sections and the Division of Polar Programs Antarctic Organisms and Ecosystems program.

Data Management Philosophy / Strategy

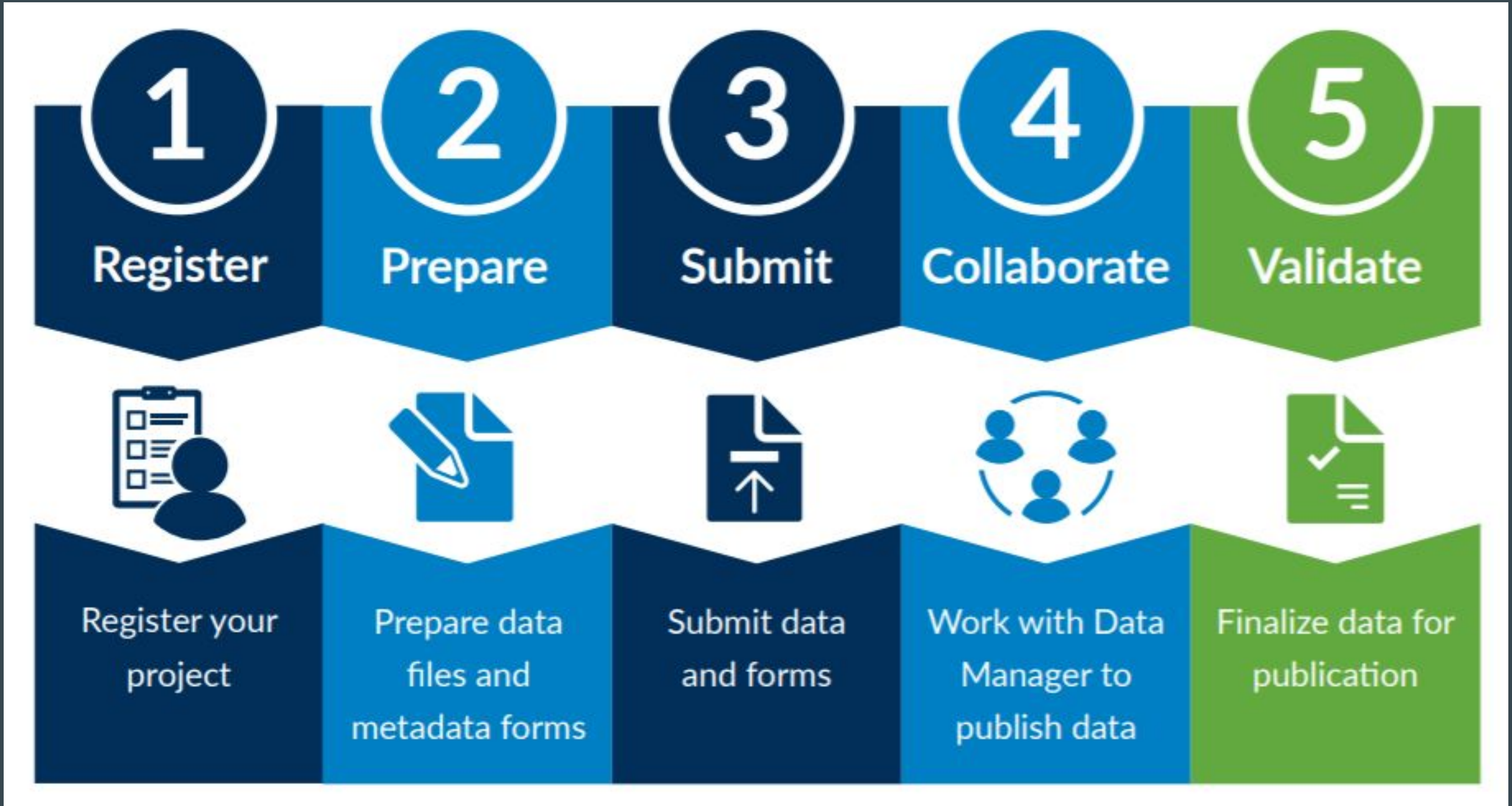
- Keep the barriers to metadata/data submission low
  - No prescribed metadata/data formats
- Preserve as much of the PI-supplied information as possible, including:
  - parameter names
  - parameter units
  - specific parameter formatting

BCO-DMO supports data stewardship throughout the data lifecycle

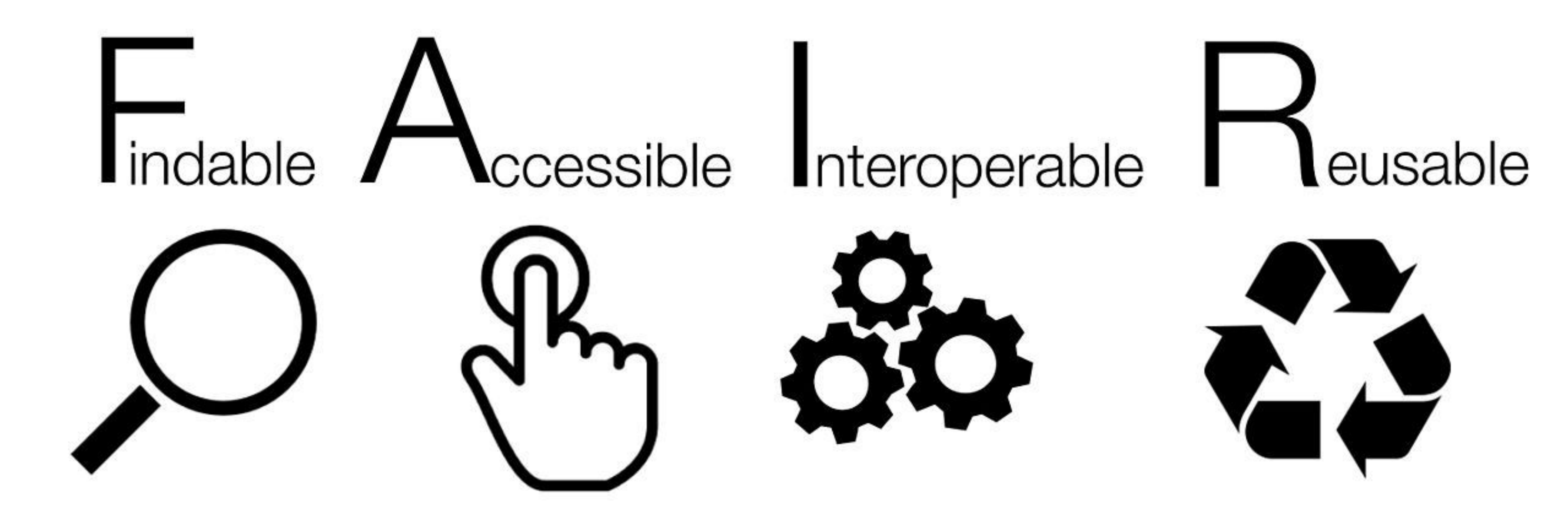


- Provide guidance on data formatting and standards;
- Apply gross QC (e.g lat/lon error checking);
- Capture and record metadata;
- Make data and metadata available online (restricted or public access as appropriate);
- Ensure final archive of data in appropriate national data center;
- Provide Data Management Planning template;
- Assign dataset digital object identifiers (DOIs).

Data submission process



Making Data FAIR



Original article describing FAIR data principles: Wilkinson, M.D., et al. (2016) The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3, 160018, https://doi.org/10.1038/sdata.2016.18

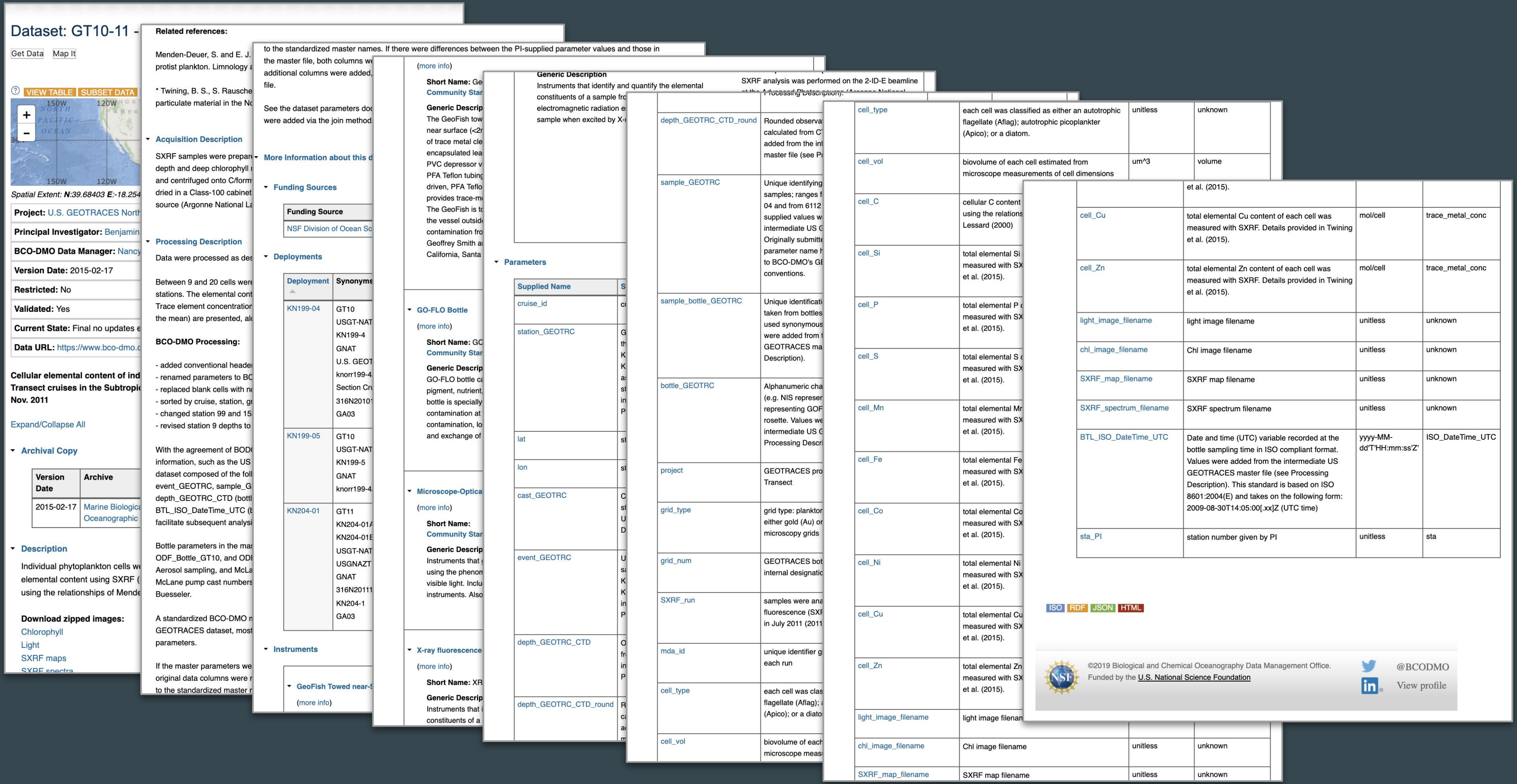
Article more specific to FAIR in our domain: Stall, S., et al. (2018), Advancing FAIR data in Earth, space, and environmental science, *Eos*, 99, https://doi.org/10.1029/2018EO109301

Accomplishing FAIR alignment

1. Building robust metadata
2. Aligning vocabularies
3. Creating machine actionable information (LOD)
4. Harmonizing data into common formats

among other activities…

Metadata



Dataset: GT10-11 -
Get Data
Map It
VIEW TABLE
SUBSET DATA
Project: U.S. GEOTRACES North
Principal Investigator: Benjamin
BCO-DMO Data Manager: Nancy
Version Date: 2015-02-17
Restricted: No
Validated: Yes
Expand/Collapse All
Archival Copy
Description
Download zipped images:
Chlorophyll
Light
SXRF maps
cell_Cu
total elemental Cu content of each cell was measured with SXRF. Details provided in Twining et al. (2015).
mol/cell
trace_metal_conc
cell_Zn
total elemental Zn content of each cell was measured with SXRF. Details provided in Twining et al. (2015).
mol/cell
trace_metal_conc
light_image_filename
light image filename
unitless
unknown
chl_image_filename
Chl image filename
unitless
unknown
SXRF_map_filename
SXRF map filename
unitless
unknown
SXRF_spectrum_filename
SXRF spectrum filename
unitless
unknown
BTL_ISO_DateTime_UTC
Date and time (UTC) variable recorded at the bottle sampling time in ISO compliant format. Values were added from the intermediate US GEOTRACES master file (see Processing Description). This standard is based on ISO 8601:2004(E) and takes on the following form: 2009-08-30T14:05:00[.xx]Z (UTC time)
yyyy-MM-dd'T'HH:mm:ss'Z'
ISO_DateTime_UTC
sta_PI
station number given by PI
unitless
sta
ISO
RDF
JSON
HTML
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@BCODMO
View profile

Current data serving system

/BCO/GEOTRACES/NorthAtlanticTransect/cellular_trace_elements_v2_joined ---- Level 2

Directory | Documentation | Download & Other Operations

Level 0 | Next Level | Flat Listing

```
# Please note that data may not be final, pending intercalibration results and
# further analysis. If you are interested in following changes to US GEOTRACES
# NAT data, there is an RSS feed available via the BCO-DMO US GEOTRACES
# project page.
#
#   GT10-11 - cellular element quotas
#   B. Twining (Bigelow)
#   version 2 (2015-02-17):  revised station 9 depths: sample 5636 from 50m to 28m and 5638 from 28m to 50m.
#                            replaces version 2015-02-10.
#   Sorted by cruise, station, grid#
#
========================
cruise_id  project
------------------------
KN199-04   NAZT
========================
station_GEOTRC  sta_PI  lat      lon       cast_GEOTRC  event_GEOTRC
------------------------
5               5       31.0021  -21.9999  1            2084
========================
depth_GEOTRC_CTD  depth_GEOTRC_CTD_round  sample_GEOTRC  sample_bottle_GEOTRC  bottle_GEOTRC  grid_type  grid_num   SXRF_run  mda_id  cell_type  cell_vol  cell_C    cell_Si   cell_P
------------------------
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30.7              31                      5331           24                    GF-1           Au         5331c-up   2011r2    181     Aflag      7.79      1.24E-13  1.39E-16  9.36E-16
30.7              31                      5331           24                    GF-1           Au         5331c-up   2011r2    186     Aflag      6.71      1.08E-13  1.90E-16  8.04E-16
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30.7              31                      5331           24                    GF-1           Al         5331d-low  2011r2    353     Aflag      83.25     1.14E-12  nd        3.60E-15
101.3             101                     5337           18                    GF-7           Al         5337a-low  2011r2    268     Aflag      43.1      6.17E-13  nd        1.50E-15
101.3             101                     5337           18                    GF-7           Al         5337a-low  2011r2    269     Aflag      12.57     1.94E-13  nd        1.10E-15
101.3             101                     5337           18                    GF-7           Al         5337a-low  2011r2    270     Aflag      287.61    3.67E-12  nd        1.20E-13
101.3             101                     5337           18                    GF-7           Al         5337a-low  2011r2    271     Aflag      389.16    4.87E-12  nd        1.40E-13
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101.3             101                     5337           18                    GF-7           Au         5337a-up   2011r2    241     Aflag      9.85      1.54E-13  1.11E-16  4.94E-16
101.3             101                     5337           18                    GF-7           Au         5337a-up   2011r2    242     Aflag      14.07     2.15E-13  1.41E-16  1.54E-15
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101.3             101                     5337           18                    GF-7           Au         5337a-up   2011r2    259     Aflag      136.94    1.83E-12  1.59E-16  4.87E-16
========================
station_GEOTRC  sta_PI  lat      lon       cast_GEOTRC  event_GEOTRC
------------------------
9               9       17.3505  -18.2545  2            2164
========================
depth_GEOTRC_CTD  depth_GEOTRC_CTD_round  sample_GEOTRC  sample_bottle_GEOTRC  bottle_GEOTRC  grid_type  grid_num  SXRF_run  mda_id  cell_type  cell_vol  cell_C  cell_Si  cell_P
```

Dataset: GT10-11 - cellular element quotas

Get Data | Map It

Cite This Dataset

DOI:10.1575/1912/bco-dmo.641155

VIEW TABLE | SUBSET DATA | CSV | TSV | GeoJSON | MATLAB | netCDF | ODV

al Extent: N:39.68403 E:-18.2545 S:17.3505 W:-69.8139 Temporal Extent: 2010-10-01 - 2011-11-30

ject: U.S. GEOTRACES North Atlantic Transect (U.S. GEOTRACES NAT)

icipal Investigator: Benjamin Twining (Bigelow Laboratory for Ocean Sciences)

-DMO Data Manager: Nancy Copley (Woods Hole Oceanographic Institution, WHOI BCO-DMO)

sion Date: 2015-02-17

tricted: No

dated: Yes

rent State: Final no updates expected

a URL: https://www.bco-dmo.org/dataset/549122/data

ular elemental content of individual phytoplankton cells collected during US GEOTRACES North Atlantic sect cruises in the Subtropical western and eastern North Atlantic Ocean during Oct and Nov, 2010 and 2011

nd/Collapse All

rchival Copy

Version Date	Archive	Persistent Identifier	Date Assigned
2015-02-17	Marine Biological Laboratory/Woods Hole Oceanographic Institution Library (MBLWHOI DLA)	10.1575/1912/bco-dmo.641155	2016-03-29

escription

dividual phytoplankton cells were collected on the GEOTRACES North Atlantic Transect cruises were analyzed for emental content using SXRF (Synchrotron radiation X-Ray Fluorescence). Carbon was calculated from biovolume ing the relationships of Menden-Deuer & Lessard (2000). Trace metal concentrations are reported.

ownload zipped images:

nlorophyll

ght

XRF maps

SXRF spectra

Current data serving system

/BCO/GEOTRACES/NorthAtlanticTransect/cellular_trace_elements_v2_joined ---- Level 2

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Level 0 | Next Level | Flat Listing

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#   Sorted by cruise, station, grid#
#
=========================
cruise_id  project
-------------------------
KN199-04   NAZT
=========================
station_GEOTRC  sta_PI  lat      lon       cast_GEOTRC  event_GEOTRC
-------------------------
5               5       31.0021  -21.9999  1            2084
=========================
depth_GEOTRC_CTD  depth_GEOTRC_CTD_round  sample_GEOTRC  sample_bottle_GEOTRC  bottle_GEOTRC  grid_type
-------------------------
30.7              31                      5331           24                    GF-1           Au
30.7              31                      5331           24                    GF-1           Au
30.7              31                      5331           24                    GF-1           Au
30.7              31                      5331           24                    GF-1           Au
30.7              31                      5331           24                    GF-1           Au
30.7              31                      5331           24                    GF-1           Au
30.7              31                      5331           24                    GF-1           Au
30.7              31                      5331           24                    GF-1           Au
30.7              31                      5331           24                    GF-1           Au
30.7              31                      5331           24                    GF-1           Au
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30.7              31                      5331           24                    GF-1           Al
30.7              31                      5331           24                    GF-1           Al
30.7              31                      5331           24                    GF-1           Al
30.7              31                      5331           24                    GF-1           Al
30.7              31                      5331           24                    GF-1           Al
30.7              31                      5331           24                    GF-1           Al
101.3             101                     5337           18                    GF-7           Al
101.3             101                     5337           18                    GF-7           Al
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101.3             101                     5337           18                    GF-7           Au
101.3             101                     5337           18                    GF-7           Au
=========================
station_GEOTRC  sta_PI  lat      lon       cast_GEOTRC  event_GEOTRC
-------------------------
9               9       17.3505  -18.2545  2            2164
=========================
depth_GEOTRC_CTD  depth_GEOTRC_CTD_round  sample_GEOTRC  sample_bottle_GEOTRC  bottle_GEOTRC  grid_type  grid_num  SXRF_run  mda_id  cell_type  cell_vol  cell_C  cell_Si  cell_P  c
```

```
cruise_id  project  station_GEOTRC  sta_PI  lat      lon        cast_GEOTRC  event_GEOTRC  depth_GEOTRC_CTD  depth_GEOTRC_CTD_round  sample_GEOTRC  sample_
cell_type  cell_vol  cell_C    cell_Si   cell_P    cell_S    cell_Mn   cell_Fe   cell_Co   cell_Ni   cell_Cu   cell_Zn  light_image_filename  chl_im
BTL_ISO_DateTime_UTC
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
152.57     2.02E-12  0.00E+00  5.92E-14  3.54E-14  1.70E-17  3.51E-16  1.40E-17  nd        nd        2.13E-17  2011r2_170_BF.jpg     2011r2_170_FL.jpg
21T17:15:00.00Z
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
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KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
5.21       8.47E-14  2.56E-16  1.04E-15  1.76E-15  5.44E-19  5.45E-18  3.49E-19  nd        nd        3.15E-18  2011r2_172_BF.jpg     2011r2_172_FL.jpg
21T17:15:00.00Z
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
9.07       1.43E-13  nd        2.65E-15  2.73E-15  8.62E-19  4.27E-18  5.04E-19  nd        nd        2.00E-18  2011r2_173_BF.jpg     2011r2_173_FL.jpg
21T17:15:00.00Z
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
3.26       5.45E-14  3.70E-16  1.33E-15  1.03E-15  8.54E-20  4.90E-18  2.34E-19  nd        nd        1.46E-18  2011r2_174_BF.jpg     2011r2_174_FL.jpg
21T17:15:00.00Z
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
6.87       1.10E-13  3.94E-16  1.68E-15  7.54E-15  6.25E-19  8.53E-18  1.35E-19  nd        nd        4.48E-17  2011r2_175_BF.jpg     2011r2_175_FL.jpg
21T17:15:00.00Z
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
5.85       9.45E-14  1.63E-16  1.23E-15  1.03E-15  1.65E-19  3.99E-18  1.81E-19  nd        nd        2.36E-18  2011r2_176_BF.jpg     2011r2_176_FL.jpg
21T17:15:00.00Z
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
3.71       6.16E-14  1.64E-16  5.79E-16  4.54E-16  1.47E-19  1.34E-18  1.59E-19  nd        nd        1.02E-18  2011r2_178_BF.jpg     2011r2_178_FL.jpg
21T17:15:00.00Z
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
6.93       1.11E-13  4.11E-17  8.38E-16  1.05E-15  2.51E-19  2.40E-18  2.40E-19  nd        nd        1.90E-18  2011r2_179_BF.jpg     2011r2_179_FL.jpg
21T17:15:00.00Z
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
10.48      1.63E-13  1.62E-16  3.19E-15  1.83E-15  4.64E-19  3.93E-18  3.61E-19  nd        nd        4.70E-18  2011r2_180_BF.jpg     2011r2_180_FL.jpg
21T17:15:00.00Z
KN199-04   NAZT     5                5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
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6.71       1.08E-13  1.90E-16  8.04E-16  1.01E-15  1.62E-19  2.66E-18  5.79E-20  nd        nd        1.56E-18  2011r2_186_BF.jpg     2011r2_186_FL.jpg
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83.25      1.14E-12  nd        3.60E-15  nd        nd        nd        nd        2.30E-17  5.26E-17  8.34E-18  2011r2_353_BF.jpg     2011r2_353_FL.jpg
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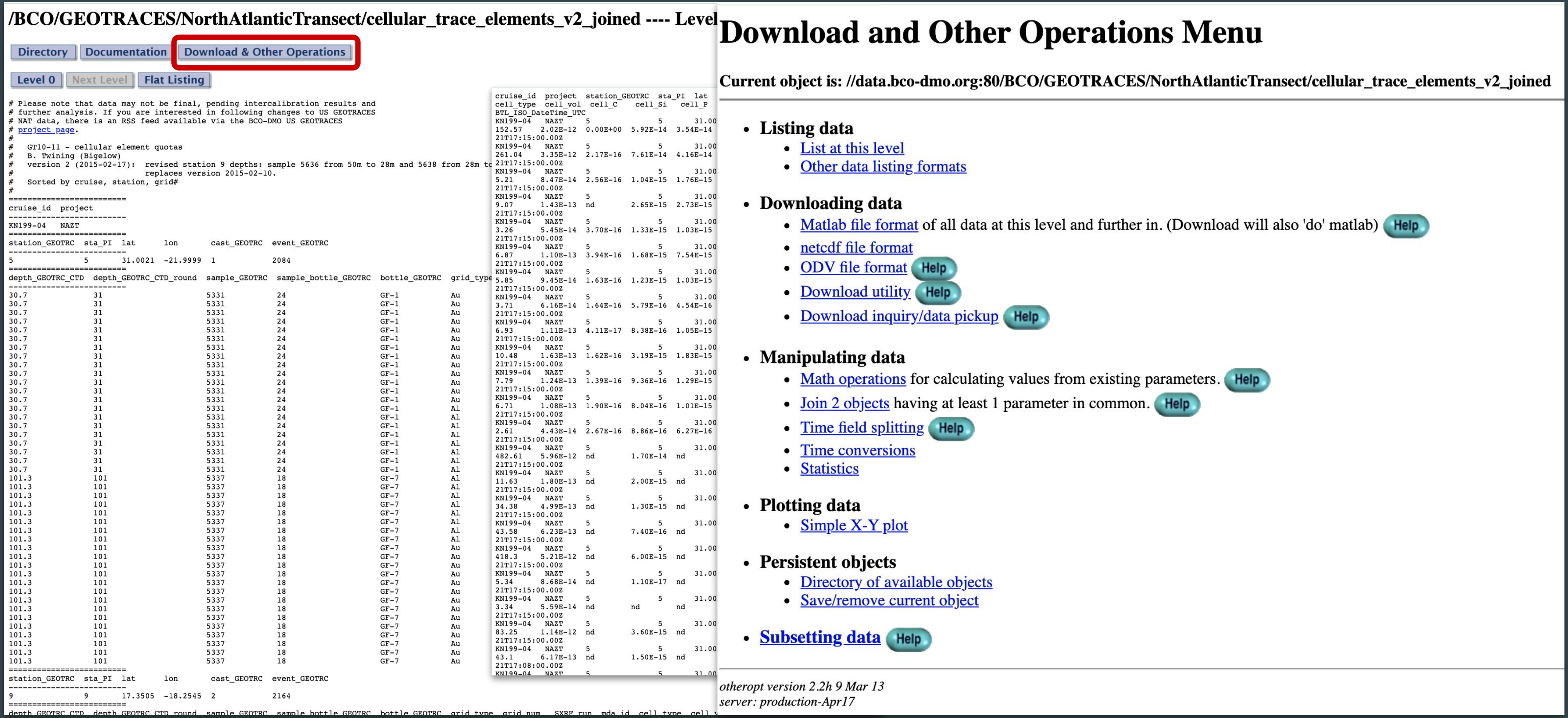
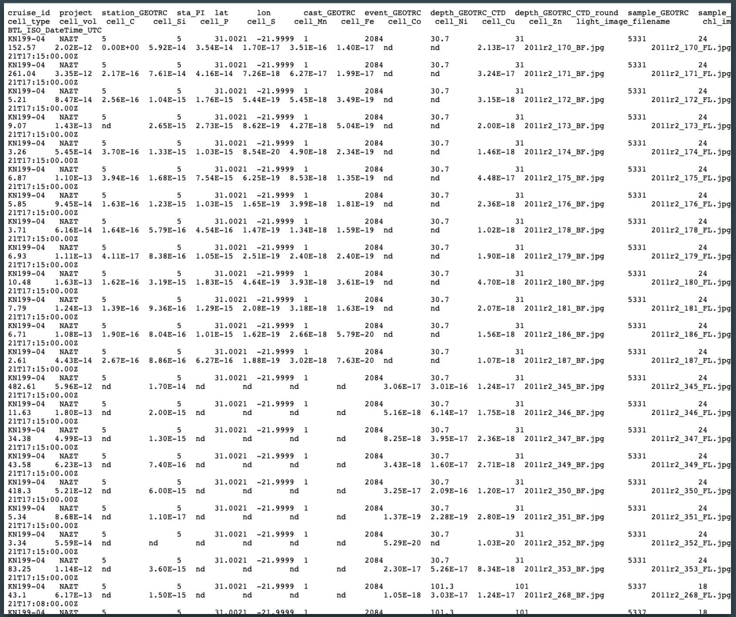
Current data serving system



Synthesis activities



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cell_type  cell_vol  cell_C    cell_Si   cell_P    cell_S    cell_Mn   cell_Fe   cell_Co   cell_Ni   cell_Cu   cell_Zn   light_image_filename      chl_im
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KN199-04   NAZT     5               5       31.0021  -21.9999  1            2084          30.7              31                      5331           24
6.71       1.08E-13  1.90E-16  8.04E-16  1.01E-15  1.62E-19  2.66E-18  5.79E-20  nd        nd        1.56E-18  2011r2_186_BF.jpg          2011r2_186_FL.jpg
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2.61       4.43E-14  2.67E-16  8.86E-16  6.27E-16  1.88E-19  3.02E-18  7.63E-20  nd        nd        1.07E-18  2011r2_187_BF.jpg          2011r2_187_FL.jpg
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482.61     5.96E-12  nd        1.70E-14  nd        nd        nd        nd        3.06E-17  3.01E-16  1.24E-17  2011r2_345_BF.jpg          2011r2_345_FL.jpg
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11.63      1.80E-13  nd        2.00E-15  nd        nd        nd        nd        5.16E-18  6.14E-17  1.75E-18  2011r2_346_BF.jpg          2011r2_346_FL.jpg
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34.38      4.99E-13  nd        1.30E-15  nd        nd        nd        nd        8.25E-18  3.95E-17  2.36E-18  2011r2_347_BF.jpg          2011r2_347_FL.jpg
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43.58      6.23E-13  nd        7.40E-16  nd        nd        nd        nd        3.43E-18  1.60E-17  2.71E-18  2011r2_349_BF.jpg          2011r2_349_FL.jpg
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418.3      5.21E-12  nd        6.00E-15  nd        nd        nd        nd        3.25E-17  2.09E-16  1.20E-17  2011r2_350_BF.jpg          2011r2_350_FL.jpg
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5.34       8.68E-14  nd        1.10E-17  nd        nd        nd        nd        1.37E-19  2.28E-19  2.80E-19  2011r2_351_BF.jpg          2011r2_351_FL.jpg
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3.34       5.59E-14  nd        nd        nd        nd        nd        nd        5.29E-20  nd        1.03E-20  2011r2_352_BF.jpg          2011r2_352_FL.jpg
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83.25      1.14E-12  nd        3.60E-15  nd        nd        nd        nd        2.30E-17  5.26E-17  8.34E-18  2011r2_353_BF.jpg          2011r2_353_FL.jpg
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43.1       6.17E-13  nd        1.50E-15  nd        nd        nd        nd        1.05E-18  3.03E-17  1.24E-17  2011r2_268_BF.jpg          2011r2_268_FL.jpg
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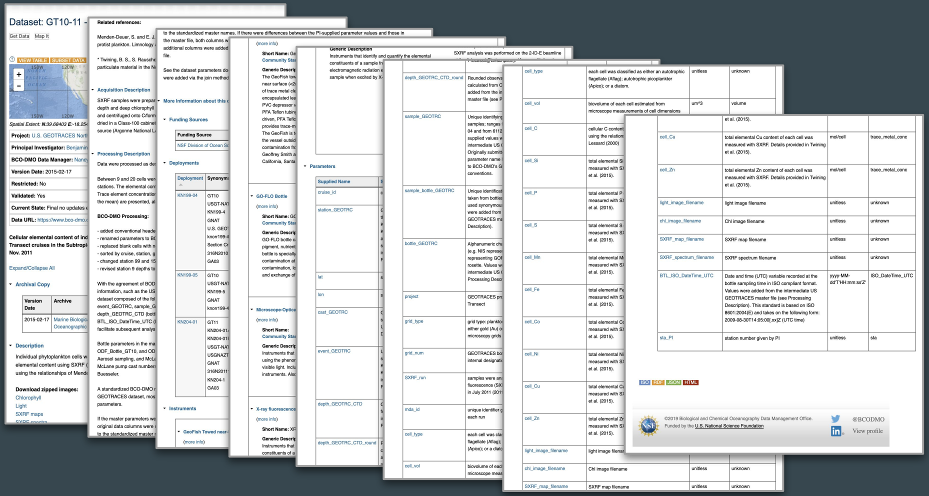


How do we make it easier for scientists to use the data?

- ✓ Reduce time from data discovery to research.
- ✓ Provide the data in multiple file formats.
- ✓ Provide a coupled metadata+data product.
- ✓ Provide web accessible urls for automated data access.

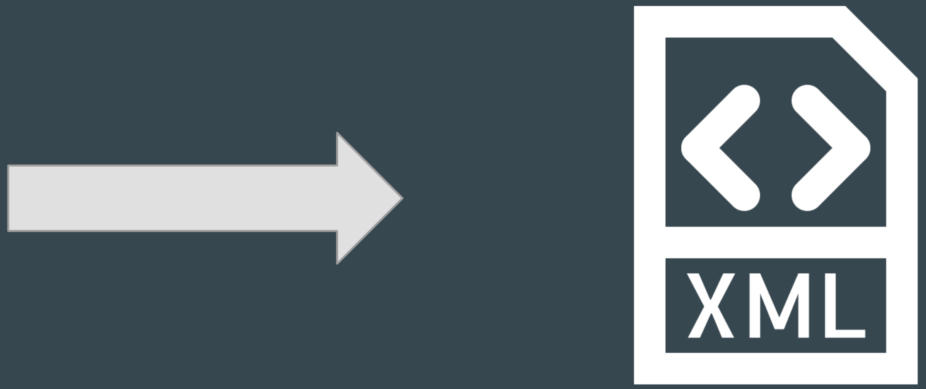
ERDDAP!

What is ERDDAP? (simple)

- ERDDAP is a NOAA developed **data server**
- middle-man that facilitates **open** and **accessible** data download in a variety of formats applicable to various communities.
- **Accepts a variety of file formats** on the backend (ASCII text, netCDF, compressed files, image files, audio files, and others)
- Allows for **data and metadata** coupling and download
- Provides **web accessible urls** for advanced data download and subsetting via other software packages

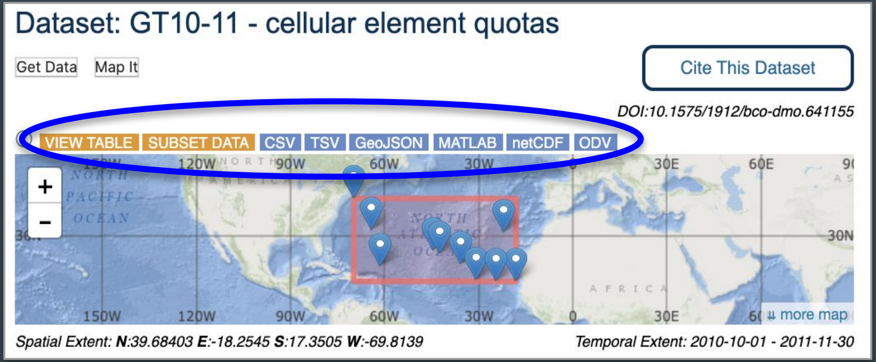
Loading a dataset into ERDDAP

ERDDAP



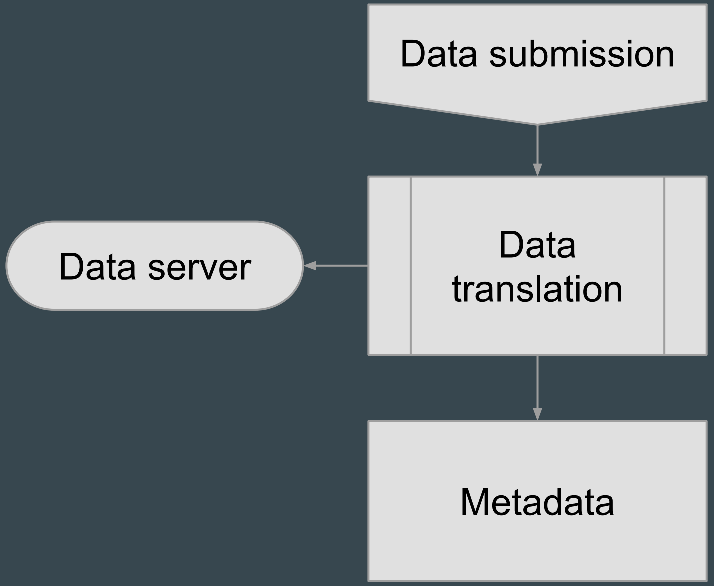
BCO-DMO's current deployment strategy

- Loading datasets that have a **DOI**
  - Translated to ASCII TSV files
  - Robust metadata record
  - Appropriately identified latitude, longitude, depth, and time variables (if applicable).
- Providing **direct download links** on the dataset metadata pages to commonly used data file formats within our community.
- Serving only the **most recent version** of the data

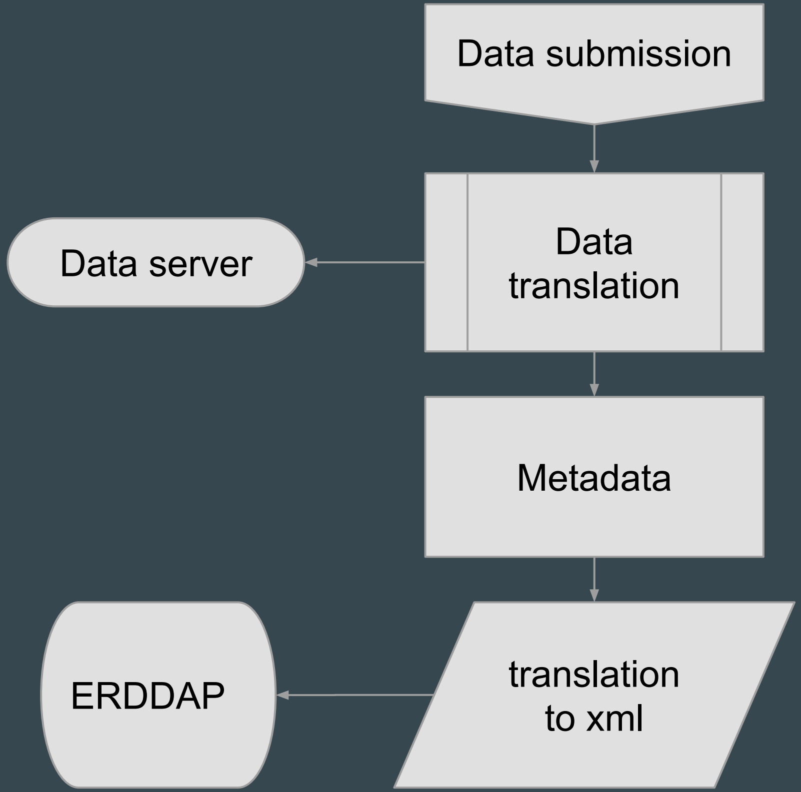


Our migration process

Current D.M. process



ERDDAP D.M. process



Gotchas during development

- Legacy metadata
- Procedural changes in metadata development
- Identifying latitude, longitude, depth, and time variables
- Dealing with time variables
- Populating a netCDF like key value pair metadata structure with hierarchical metadata
  - projects, deployments, people, instruments, etc...
- ERDDAP's trouble with large ASCII files (11GB)

Future

- Upgrade to ERDDAP v2.*
  - Deals with ASCII files much more efficiently
  - Allows for data restriction using ORCiD and Google
  - Adds AWS S3 cloud capability
- Continue migrating our DOI'ed datasets via automated process
- Serve data via legacy service and ERDDAP side-by-side
- Migrate completely to ERDDAP for data serving
- Develop specialized access portals?

Additional Resources

- ERDDAP Bible: https://coastwatch.pfeg.noaa.gov/erddap/download/setup.html
- ERDDAP Docker container: https://github.com/axiom-data-science/docker-erddap
- Quick ERDDAP deployment: https://github.com/ioos/erddap-gold-standard
- BCO-DMO Jupyter Notebooks: https://github.com/BCODMO/Data-Use-Examples/tree/master/jupyter
- 2017-08-31 ESIP Tech Dive: "ERDDAP lightning talks"
  https://www.youtube.com/watch?v=2-ydBByYB0M&t=1564s

Thank you

Questions?

Demo?

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