

# Easy data access and visualization using the ERDDAP data server

Cara Wilson & Dale Robinson

NOAA CoastWatch West Coast Node (WCN)

STAR Seminar

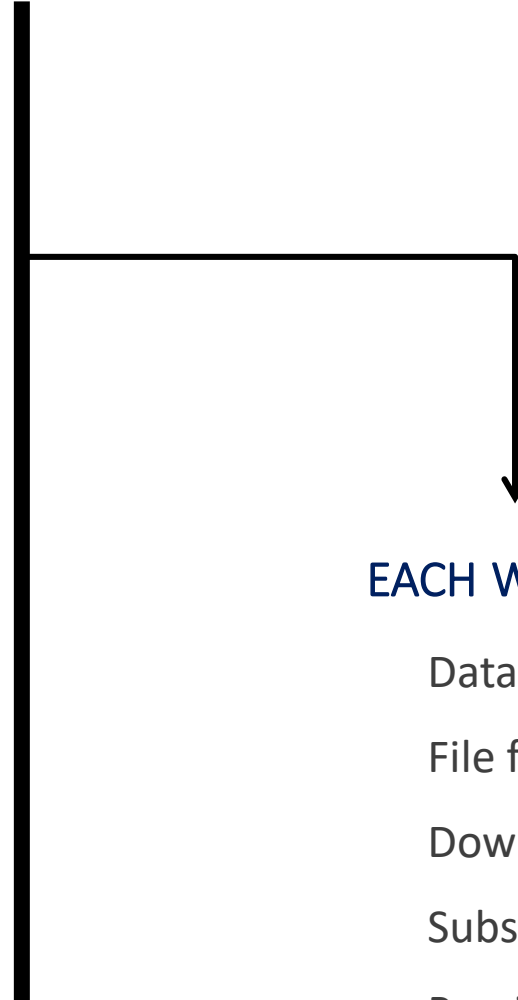
August 22, 2019



# Accessing satellite data can be challenging

## A SHORT LIST OF DATA SERVERS

NOAA CoastWatch Central Operations  
NOAA Center for Satellite Applications and Res.  
NOAA Office of Satellite and Products  
NOAA National Centers for Environmental Info.  
NOAA Comprehensive Large Array-data  
Stewardship System (CLASS)  
NASA Jet Propulsion Laboratory PO.DAAC  
NASA Ocean Biology (OB.DAAC)  
NASA Goddard Space Flight Center  
European Space Agency  
EUMETSAT  
Japan Aerospace Exploration Agency



## EACH WITH ITS OWN

Data products  
File formats  
Download protocols  
Subsetting abilities  
Previewing abilities



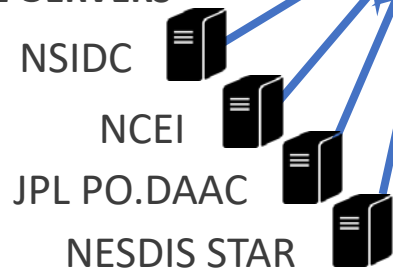
# ERDDAP – designed to make data access easier

## DATA AGGREGATION

### LOCAL STORAGE

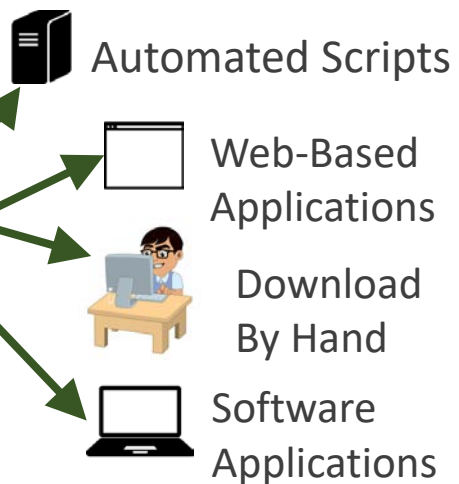


### REMOTE SERVERS



ERDDAP

## DATA DISTRIBUTION



### ERDDAP provides a simple, consistent way to:

- Subset datasets temporally and spatially
  - Download data in > 30 formats
  - Access data within analysis tools (R, Matlab, python...) using urls which completely define the data request
  - Machine-to-machine data exchange
- 
- ERDDAP developed at SWFSC/ERD by Bob Simons
  - ~80 ERDDAPs exist worldwide
  - Over a dozen different ERDDAPs in NOAA
  - ERDDAP is one of the recommended data servers in NOAA's Data Access Procedural Directive

# NOAA ERDDAPs

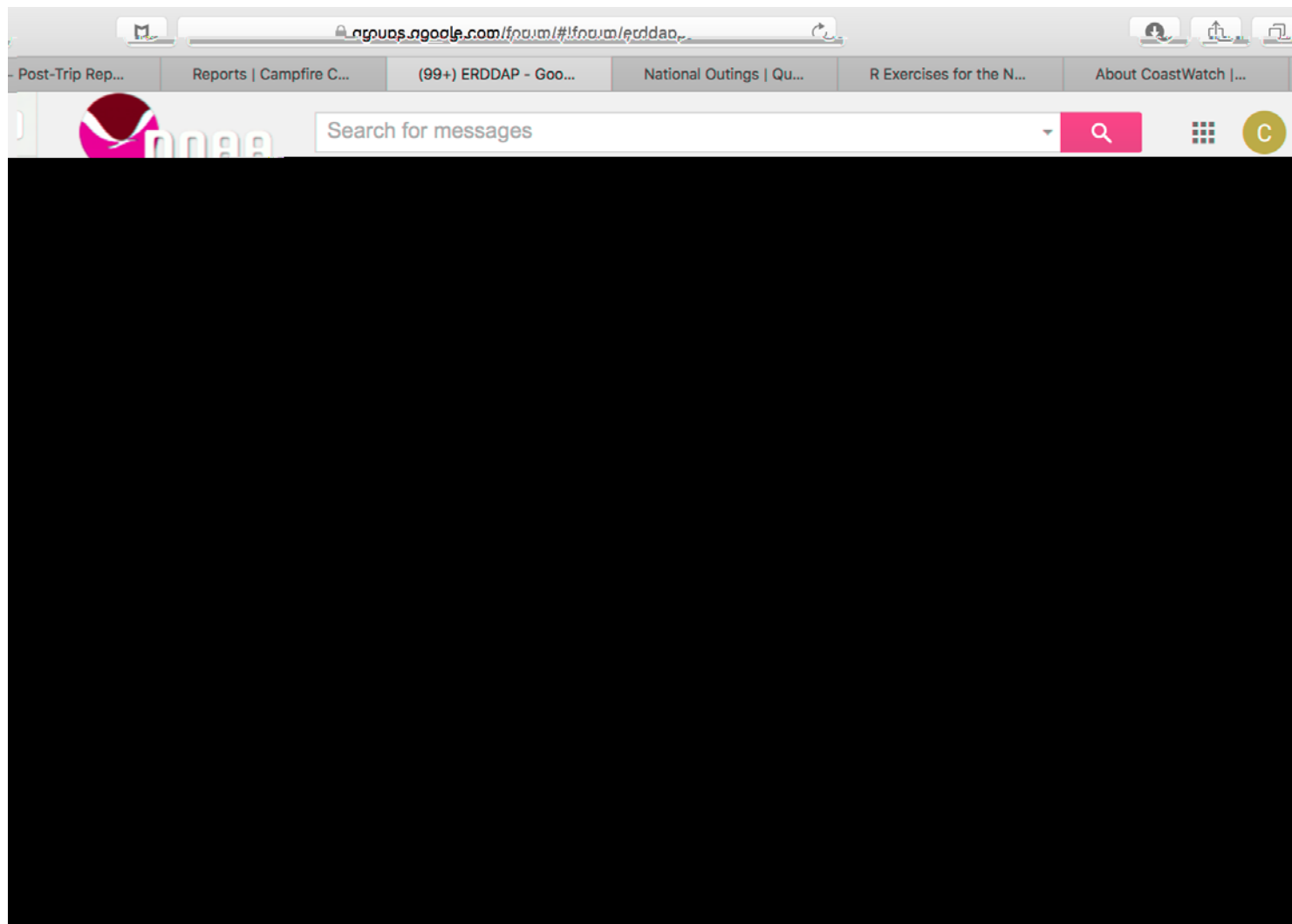
- [CoastWatch-Central Ops](#)
- [CoastWatch-West Coast Node \(WCN\)](#)
- [CoastWatch-PolarWatch](#)
- [CoastWatch-Caribbean/Gulf of Mexico](#)
- [CoastWatch-Pacific Node](#)
- [CoastWatch-Great Lakes Node](#)
- [NOAA Unified Access Framework](#)
- [NOAA NCEI](#)
- [NOAA NCEI](#)
- [NOS CO-OPS](#)
- [NMFS NEFSC](#)
- [OAR PMEL](#)
- [NOAA Observing System Monitoring Center](#)
- [NOAA IOOS Sensors](#)
- [NOAA IOOS National Glider Data Assembly Center](#)
- [NOAA IOOS CeNCOOS](#)
- [NOAA IOOS NERACOOS](#)
- [NOAA IOOS PacIOOS](#)
- [NOAA IOOS SCCOOS](#)
- [NOAA IOOS SECOORA](#)



# ERDDAP Google Group for Admins

<https://groups.google.com/forum/#!forum/erddap>

- Active ERDDAP user's group
- Aimed at administrators



# The ERDDAP interface is functional (not beautiful)



## ERDDAP > List of All Datasets

1392 matching datasets, listed in alphabetical order. View page: 1 (current) 2 .

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	W M S	Source Data Files	Access-ible	Title	Sum-mary	FGDC, ISO, Metadata	Back-ground Info	RSS	E mail	Institution	Dataset ID
	set	data	graph			public	* The List of All Active Datasets in this ERDDAP *		M	background			NOAA NMFS SWFSC E...	allDatasets
data			graph			public	AMSRE Model Output, obs4MIPs NASA-JPL, Global, 1 Degree, 2002-2010, Monthly		F I M	background	RSS		Remote Sensing Sy...	jplAmsreSstMon
data			graph	M		public	AMSRE Model Output, obs4MIPs NASA-JPL, Global, 1 Degree, 2002-2010, Monthly, Lon+/-180		F I M	background	RSS		Remote Sensing Sy...	jplAmsreSstMon_LonPM180
		data	graph		files	public	AN EXPERIMENTAL DATASET: Underway Sea Surface Temperature and Salinity Aboard the Oleander, 2007-2010		F I M	background	RSS		NOAA OAR AOML	nodcPJJU
	set	data	graph			public	Animal Telemetry Network (ATN)		F I M	background	RSS		Animal Telemetry ...	gtoppAT
data			graph	M		public	Aquarius Sea Surface Salinity, L3 SMI, Version 5, 1.0°, Global, 2011-2015, 3-Month		F I M	background	RSS		NASA/GSFC OBPG	jplAquariusSSS3MonthV5
data			graph	M		public	Aquarius Sea Surface Salinity, L3 SMI, Version 5, 1.0°, Global, 2011-2015, 7-Day		F I M	background	RSS		NASA/GSFC OBPG	jplAquariusSSS7DayV5
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data			graph	M		public	Aquarius Sea Surface Salinity, L3 SMI, Version 5, 1.0°, Global, 2011-2015, Monthly		F I M	background	RSS		NASA/GSFC OBPG	jplAquariusSSSMonthlyV5
data			graph		files	public	Audio data from a local source.		M	background	RSS		???	testGridWav
	set	data	graph		files	public	Audio data from a local source.		M	background	RSS		???	testTableWav
data			graph	M		public	AVHRR Pathfinder Version 5.3 L3-Collated (L3C) SST, Global, 0.0417°, 1981-present, Daytime (1 Day Composite)		F I M	background	RSS		NCEI	nceiPH53sst1day
data			graph	M		public	AVHRR Pathfinder Version 5.3 L3-Collated (L3C) SST, Global, 0.0417°, 1981-present, Nighttime (1 Day Composite)		F I M	background	RSS		NCEI	nceiPH53sst1day
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data			graph	M	files	public	C-HARM 1-Day Advanced Forecast: Pseudo-Nitzschia, cellular domoic acid, and particulate domoic acid probability, California and Southern Oregon coast		F I M	background	RSS		UCSC, UCSD	charmForecast1day
data			graph	M	files	public	C-HARM 2-Day Advanced Forecast: Pseudo-Nitzschia, cellular domoic acid, and particulate domoic acid probability, California and Southern Oregon coast		F I M	background	RSS		UCSC, UCSD	charmForecast2day
data			graph	M	files	public	C-HARM 3-Day Advanced Forecast: Pseudo-Nitzschia, cellular domoic acid, and particulate domoic acid probability, California and Southern Oregon coast		F I M	background	RSS		UCSC, UCSD	charmForecast3day
data			graph	M	files	public	C-HARM Nowcast: Pseudo-Nitzschia, cellular domoic acid, and particulate domoic acid probability, California and Southern Oregon coast		F I M	background	RSS		UCSC, UCSD	charmForecast0day
	set	data	graph			public	CalCOFI Continuous Underway Fish-Egg Sampler		F I M	background	RSS		NOAA SWFSC	erdCalCOFIcufes
	set	data	graph			public	CalCOFI Cruises		M	background	RSS		NOAA SWFSC	erdCalCOFicruises





# The ERDDAP interface is functional (not beautiful)



## ERDDAP > List of All Datasets

Good metadata is crucial for data discoverability

1392 matching datasets, listed in alphabetical order. View page: 1 (current) 2 .

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## ERDDAP > List of All Datasets

Easy to serve data from other institutions. Full credit is given to the source.

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	set	data	graph			public	CalCOFI Cruises		M	background	RSS		NOAA SWFSC	erdCalCOFicruises



# WCN's data catalog has ~1,000 satellite datasets

ERDDAP  
Easier access to scientific data

ERDDAP > griddap > Make A Graph

Dataset Title: **Aquarius Sea Surface Salinity, Version 2, Global, 3-Month**

Graph Type: surface  
X Axis: longitude  
Y Axis: latitude  
Color: sss

degrees\_north: 89.5 to -89.5  
degrees\_east: -179.5 to 179.5

Sea Surface Salinity (psu)  
Aquarius Sea Surface Salinity, Version 2, Global, 3-Month  
(2013-09-21T00:00:00Z)  
Data courtesy of NASA/GSFC OBPFG

Optional:  
Then set the File Type: .htmlTable and Download the Data or an Image  
or view the URL: [\(http://coastwatch.pfeg.noaa.gov/erddap/griddap/jplAquariusSSS3Month.htmlTable?sss\(2013-09-21T00:00:00Z\)\)](http://coastwatch.pfeg.noaa.gov/erddap/griddap/jplAquariusSSS3Month.htmlTable?sss(2013-09-21T00:00:00Z))  
(Documentation / Bypass this form) (File Type information)

Distributed via our ERDDAP Server

ERDDAP makes it easy to get the data you need.

0.5 – 1.0 million data requests per day



# WCN data catalog has non-satellite data (~400 datasets)

## **In Situ Measurements**

- Animal Telemetry Network
- ARGO floats
- TAO/TRITON, RAMA, & PIRATA Buoys
- IOOS In Situ Sensors
- Glider Data
- Global Temperature and Salinity Profile Programme
- HF Radar Currents
- GLOBEC Northeast Pacific
- NOAA CO-OPS Sensors
- NDBC buoys

## **Field Sampling**

- CalCOFI
- California Fish Landings
- Farallon Island Seabirds
- NWFSC Habitat Use
- SWFSC Rockfish

## **Underway Data**

- NOAA Vessels
- UNOLS Vessels

## **Models, Climatologies**

- OSCAR Sea Surface Velocity
- SODA Model

## **Models, Climatologies (cont.)**

- NOAA Coastal Relief Model
- NOAA RTOFS Forecast Model
- NOAA RTOFS Nowcast Model
- NOAA World Ocean Atlas
- NOAA Seafloor Topography
- SWFSC Upwelling Index
- Navy NAVGEM Model
- Navy NOGAPS Model
- NCEP/NCAR Reanalysis
- USGS Topography
- NASA/NOAA CCMP Wind Atlas
- Navy HYCOM Model
- Navy FNMOC Forecast Model



# Allows automated processes via RESTful services

## Example of a URL data request

Base URL: <https://coastwatch.pfeg.noaa.gov/erddap/griddap/>

Dataset ID: `erdVHsstaWS3day`

File Type: `.largePng (.nc, .mat, .json, .geotif, .kml, .csv...)`

Variable: `?sst`

Time range: `[(2016-10-21T12:00:00Z):1:(2016-10-21T12:00:00Z)]`

Altitude: `[0.0]`

Latitude Range: `[(41.75):1:(30.86)]`

Longitude Range: `[(-128.25):1:(-114.75)]`



# Today's "Introduction to ERDDAP" tutorial is online

## Online ERDDAP tutorial

- Developed by WCN for the NOAA satellite course
- Walks users through using ERDDAP
- Demonstrates visualizing both gridded and tabular datasets

I will demo parts of the tutorial today

The screenshot shows a web browser window displaying the NOAA Satellite Course: Introduction to ERDDAP tutorial. The page title is "NOAA Satellite Course: Introduction to ERDDAP" and the authors are "Cara Wilson and Dale Robinson". The date is "16 May 2019". The page is titled "Preface" and contains the following text:

These exercises are materials for the NOAA Satellite Training Course offered each year by regional nodes of NOAA's CoastWatch program. They demonstrate the features of the ERDDAP data servers and hands-on training on how to use the feature. Participants will subset and download data, create mapped images, visualize wind vector fields, and generate timeseries and Hovmöller diagrams.

Suggested software includes a text editor like Notepad or TextEdit and the netCDF file viewer Panoply ([www.giss.nasa.gov/tools/panoply/](http://www.giss.nasa.gov/tools/panoply/)).

Additional course materials are available at these locations:

- R tutorials ([coastwatch.pfeg.noaa.gov/projects/r/](http://coastwatch.pfeg.noaa.gov/projects/r/)),

The page also features a table of contents on the left side, listing the following sections:

- 1 Introduction
  - 1.1 What is ERDDAP
  - 1.2 List of ERDDAP servers
- 2 Exploring the data catalog
  - 2.1 Finding datasets on ERDDAP
  - 2.2 Gather information about a d...
- 3 Visualization and download data
  - 3.1 ERDDAP "Make A Graph" fea...
  - 3.2 Subsetting the area and sele...
  - 3.3 Setting the file format
  - 3.4 Download the image
  - 3.5 Refining the data request
  - 3.6 Try this on you own
- 4 Automating ERDDAP requests
  - 4.1 Deconstructing the URL
  - 4.2 Using the URL in the URL
  - 4.3 Using the URL in the URL
  - 4.4 Changing the file type in the ...
  - 4.5 Full client browser searching lang...
  - 4.6 Additional training and resour...
- 5 Timeseries and Hovmoller diagrams

<https://coastwatch.pfeg.noaa.gov/projects/erddap/>



# rerddapXtracto tools help R users extract data from ERDDAP

- R package written by Roy Mendelssohn (SWFSC/ERD), based on code originally written by Dave Foley for Matlab
- Developed based on user needs identified from the NOAA satellite courses
- Uses the rerddap and plotdap R packages
- All packages are on cran
- Three main functions are within rerddapXtracto:
  - rxtracto**: extracts data along xyt points (e.g. tagged animals, ship stations, etc.)
  - rxtractogon**: extracts data within a user-supplied polygon
  - rxtracto\_3D**: extracts data from a 3-dimensional (latitude, longitude and time)
- Will work on any dataset on any ERDDAP

<https://coastwatch.pfeg.noaa.gov/xtracto>  
<https://github.com/rmendels/rerddapXtracto>



# An rerddapXtracto tutorial is available online

CoastWatch R Examples

Preface

NOAA CoastWatch/OceanWatch ...

CoastWatch West Coast Regional...

1 Introduction

## R Exercises for the NOAA Satellite Course

Cara Wilson and Dale Robinson

20 April 2019

### Preface

The following exercises are intended to help you learn the basics of NOAA's CoastWatch program. They demonstrate techniques to extract data from servers using the `extracto` library written in R.

#### NOAA CoastWatch/OceanWatch Program

NOAA CoastWatch/OceanWatch provides easy access for everyone to global and regional satellite data for monitoring and protecting ocean and coastal resources and for understanding environmental change in ecosystems, weather, and climate.

the data onto a map

this on your own

CoastWatch

- 1.1 Exercise Book contents
- 1.2 RerddapXtracto R package
- 2 Extract data within a boundary
  - 2.1 Install packages and load libr...
  - 2.2 Load sanctuary boundary coo...
  - 2.3 Extract data within a boundary
  - 2.4 Set the options for extraction
  - 2.5 Extract data and mask NUL...
- 3 Matchups to ship or animal tracks
  - 3.1 Install required packages and ...
  - 3.2 Load XYZ coordinates
  - 3.3 Select the dataset and downl...
  - 3.4 Extract the satellite data
  - 3.5 Plot t
  - 3.6 Try th

<https://coastwatch.pfeg.noaa.gov/projects/r/>



# Live Demonstration

- Visualize the N. Pacific SST 'Blob'
- Visualize a N. Pacific Chlorophyll bloom
- Hurricane Jose (Sept 2017)
- BGC-Argo data on PolarWatch ERDDAP
- Search for datasets across all ERDDAPs

<https://irishmarineinstitute.github.io/search-erddaps/>

<https://coastwatch.pfeg.noaa.gov/erddap/download/SearchMultipleERDDAPs.html>

<https://coastwatch.pfeg.noaa.gov/projects/erddap/>

