



Easy Online Visualization of Oceanographic Data Using NOAA's ERDDAP Data Servers

Cara Wilson and Dale Robinson

NOAA CoastWatch West Coast Node (WCN)

NOAA CoastWatch Satellite Course

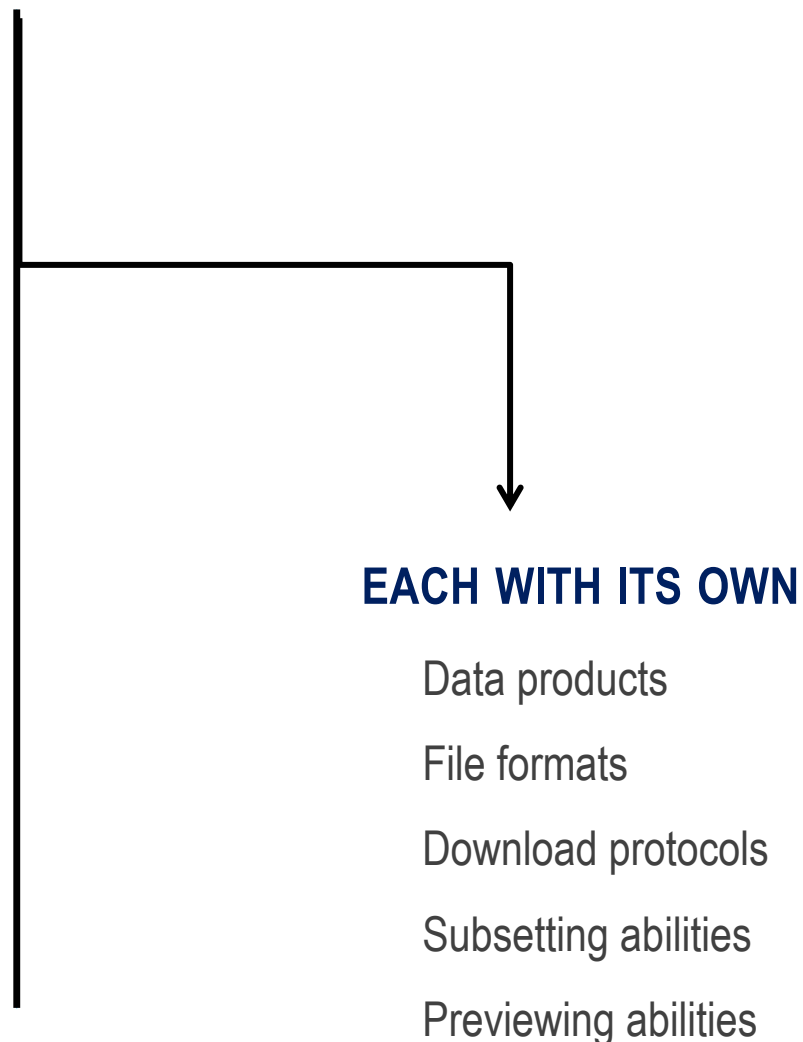
Online Version



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



ERDDAP¹ – designed to make data access easier

DATA AGGREGATION

LOCAL STORAGE

Internal Servers
Database
RAID

REMOTE SERVERS

NSIDC
NCEI
JPL PO.DAAC
NESDIS STAR

DATA DISTRIBUTION

Automated Scripts

Web-Based Applications

Download By Hand

Software Applications



ERDDAP

ERDDAP provides a simple, consistent way to:

- Subset datasets temporally and spatially
- Download data in > 30 formats
- Data requests defined within URLs, allowing:
 - Access data within analysis tools (R, Matlab, python)
 - Machine-to-machine data exchange

Over 80 ERDDAPs exist worldwide

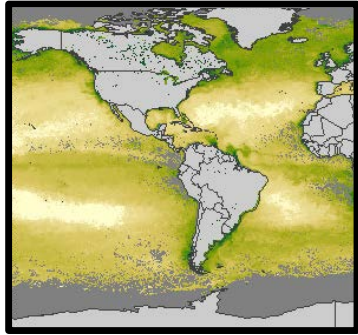
Over a dozen different ERDDAPs in NOAA

ERDDAP is one of the recommended data servers in NOAA's Data Access Procedural Directive

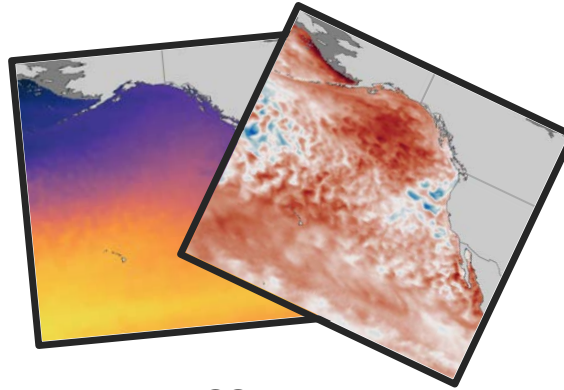
Search for data across multiple ERDDAPs at erddap.com

¹ERDDAP was developed at SWFSC/ERD by Bob Simons

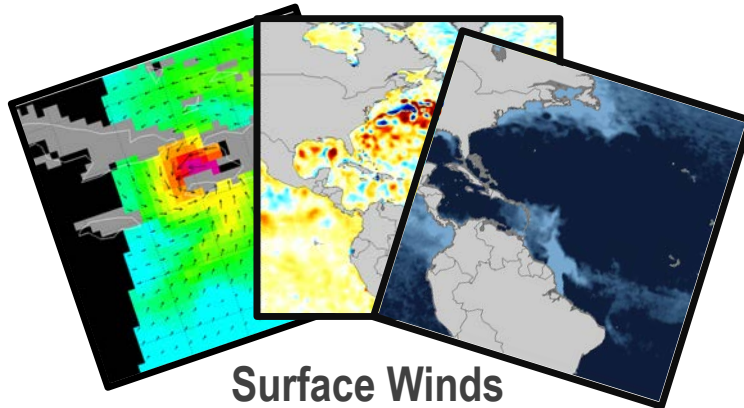
WCN data catalog contains > 1000 satellite datasets



**Chlorophyll
Primary Productivity**



**SST
SST Anomaly**

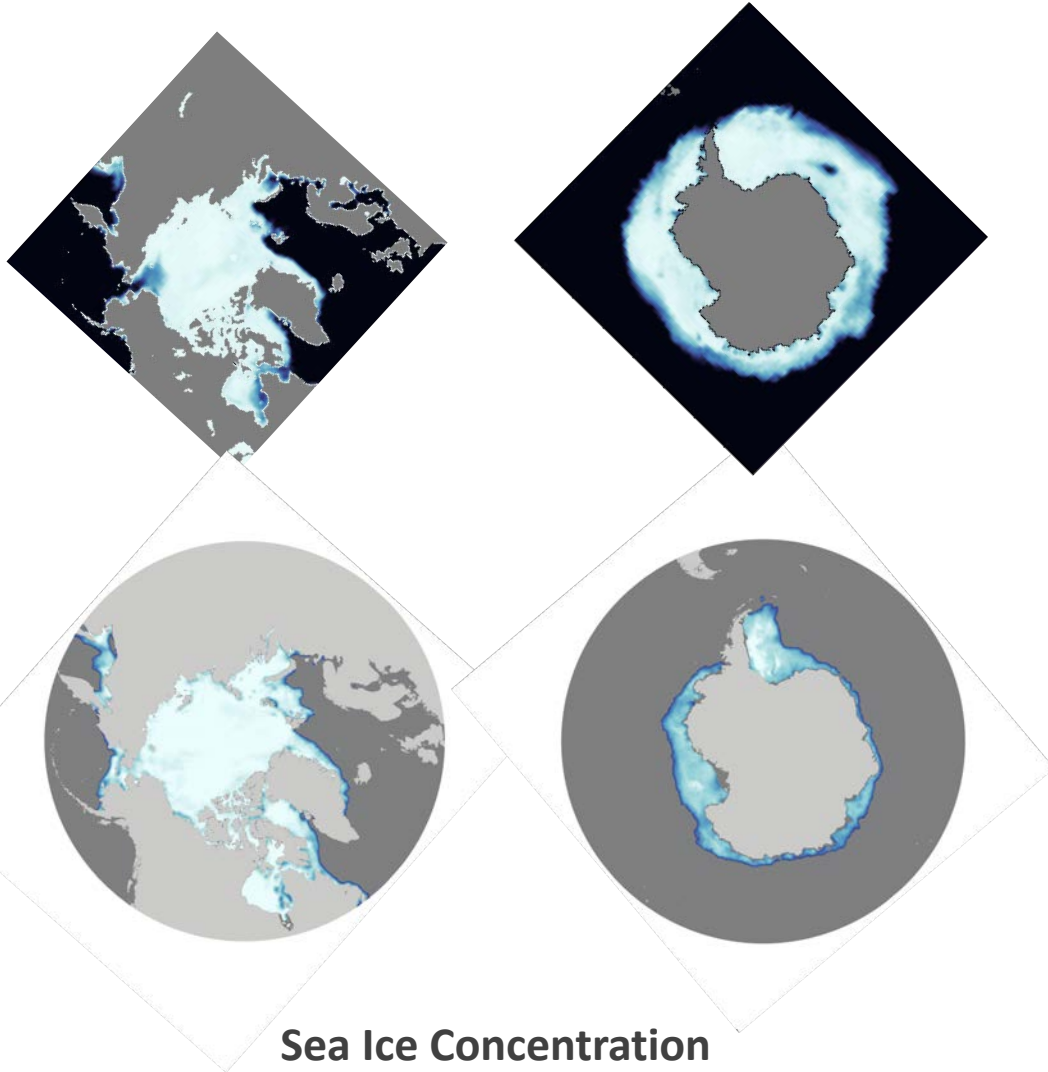


**Surface Winds
Sea Surface Salinity
Sea Surface Height and Anomaly**

0.5 – 1 million data requests per day

- Daily, weekly, and monthly composites
- Blended products
- Interpolated products (gap free)
- All level 3 or 4 products (i.e on a regular XY grid)

PW data catalog contains > 100 satellite datasets



- A curated subset of datasets on the WCN ERDDAP
- Sea Ice datasets
- Projected Datasets
- Sea Ice Pressure Ridge Sail Height (IceBridge)

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



The ERDDAP interface is functionally (not visually) beautiful



ERDDAP

Easier access to scientific data


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			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			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			NOAA OAR AOML	nodcPJJU
	set	data	graph			public	Animal Telemetry Network (ATN)		F I M	background			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			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			NASA/GSFC OBPG	jplAquariusSSS7DayV5
data			graph	M		public	Aquarius Sea Surface Salinity, L3 SMI, Version 5, 1.0°, Global, 2011-2015, Daily		F I M	background			NASA/GSFC OBPG	jplAquariusSSSDailyV5
data			graph	M		public	Aquarius Sea Surface Salinity, L3 SMI, Version 5, 1.0°, Global, 2011-2015, Monthly		F I M	background			NASA/GSFC OBPG	jplAquariusSSSMonthlyV5
data			graph		files	public	Audio data from a local source.		M	background			???	testGridWav
	set	data	graph		files	public	Audio data from a local source.		M	background			???	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			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			NCEI	nceiPH53sstn1day
data			graph			public	AVISO Model Output, obs4MIPs NASA-JPL, Global, 1 Degree, 1992-2010, Monthly		F I M	background			Centre National d...	jplAvisoSshMon
data			graph	M		public	AVISO Model Output, obs4MIPs NASA-JPL, Global, 1 Degree, 1992-2010, Monthly, Lon+/-180		F I M	background			Centre National d...	jplAvisoSshMon_LonPM180
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			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			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			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			UCSC, UCSD	charmForecast0day
	set	data	graph			public	CalCOFI Continuous Underway Fish-Egg Sampler		F I M	background			NOAA SWFSC	erdCalCOFIcufes
	set	data	graph			public	CalCOFI Cruises		M	background			NOAA SWFSC	erdCalCOFIcruises

ERDDAP handles gridded and tabular datasets



ERDDAP

Easier access to scientific data

[log in](#)
Brought to you by [NOAA NMFS SWFSC ERD](#)

ERDDAP > List of All Data

1439 matching datasets, listed in alphabetical order.

Grid DAP Data	Sub- set	Table DAP Data	Make A Graph	W M S	Source Data Files	Acces- sible ?	
	set	data	graph			public	* The List of All Active Datasets in this ERDDAP
data			graph			public	AMSRE Model Output, obs4MIPs NASA-JPL, G
data			graph	M		public	AMSRE Model Output, obs4MIPs NASA-JPL, G
							AN EXPERIMENTAL DATASET: Underway Sea

Two types of data:

- Tabular – access via TableDAP or Subset
- Gridded – access via GridDAP

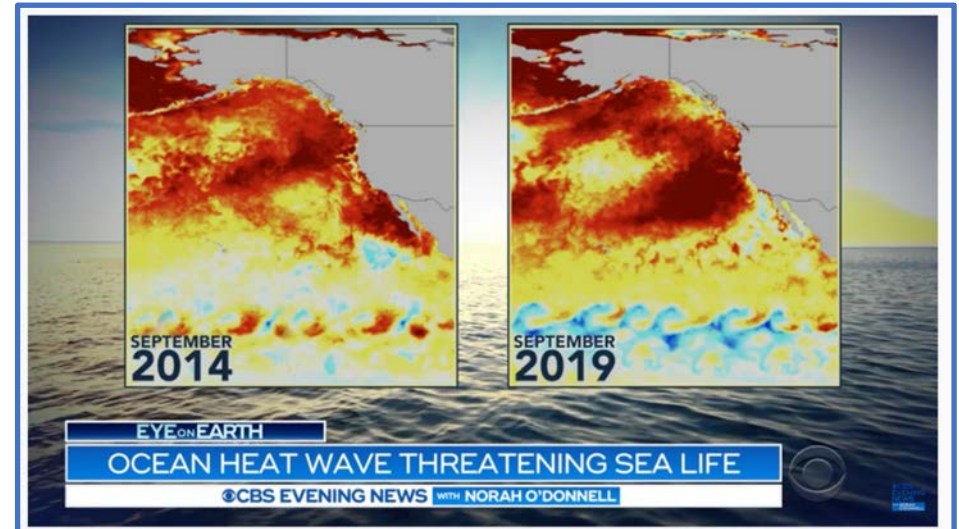
Both data types can be viewed from ‘Make a Graph’



The “Blob” or the Pacific Marine Heat Wave



- Large area with warmer than usual temperatures in the Pacific Ocean
- Has had devastating effects on the marine ecosystem.
- A scientific phenomena that has been reported in the general news



Figures made with ERDDAP!

Online Interface to Modify Graphs

Graph Type:

- Maps (surface)
- Time-series (lines)
- Hovmöller (surface)
- Vectors (vectors)

Color:

- Choose variable in dataset

Scale:


- Choose linear or log

Color Bar:

- Choose from > 40 color palettes

File Type:

- Choose from > 40 file formats (data and graphics)

 **ERDDAP**
Easier access to scientific data

ERDDAP > griddap > Make A Graph

Dataset Title: **NOAA Coral Reef Watch Operational Daily Near-Real-Time Global 5-km Satellite Coral Bleaching Monitoring Products** [RSS](#)

Institution: National Oceanic and Atmospheric Administration (NOAA) (Dataset ID: NOAA_DHW)

Information: [Summary](#) | [License](#) | [FGDC](#) | [ISO 19115](#) | [Metadata](#) | [Background](#) | [Data Access Form](#)

Graph Type: [?](#)

X Axis: [?](#)

Y Axis: [?](#)

Color: [?](#)

Dimensions [?](#) Start [?](#) Stop [?](#)

time (UTC) [?](#) specify just 1 value → 2020-02-10T12:00:00Z [?](#)

latitude (degrees_north) [?](#) 89.975 [+](#) -89.975 [-](#)

longitude (degrees_east) [?](#) -179.975 [+](#) 179.975 [-](#)

Graph Settings

Color Bar: [?](#) Continuity: [?](#) Scale: [?](#)

Minimum: Maximum: N Sections: [?](#)

Draw land mask: [?](#)

Y Axis Minimum: Maximum: Ascending [?](#)

Redraw the Graph (Please be patient. It may take a while to get the data.)

Optional:

Then set the File Type: [?](#) (File Type information)

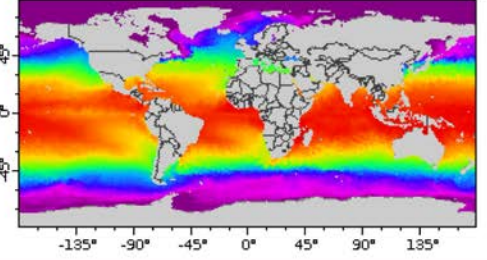
and [Download the Data or an Image](#)

or view the URL: https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW.htmlTable?CRW_

(Documentation / Bypass this form [?](#))

Click on the map to specify a new center point. [?](#)

Zoom:



sea surface temperature (Celsius)
NOAA Coral Reef Watch Operational Daily Near-Real-Time Global 5-km Satellite Coral Bleaching Monitoring Products (2020-02-10T12:00:00Z)
Data courtesy of National Oceanic and Atmospheric Administration (NOAA)

Deconstructing the ERDDAP URL

coastwatch.pfeg.noaa.gov/erddap/griddap/

NOAA_DHW_monthly.largePng?sea_surface_temperature[(2019-09-21T12:00:00Z)]

Example of a URL data request

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

Dataset ID: NOAA_DHW_monthly

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

Data Request Begins ?

Variable: sea_surface_temperature

Time range: [(2019-09-15T12:00:00Z):(2019-09-15T12:00:00Z)]

Latitude Range: [(70):(-10)]

Longitude Range: [(-180):(-100)]

[(70):(-10)][(-180):(-100)]

[https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature\[\(2019-09-15T23:00:00Z\)\]\[\(70\):\(-10\)\]\[\(-180\):\(-100\)\]](https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature[(2019-09-15T23:00:00Z)][(70):(-10)][(-180):(-100)])



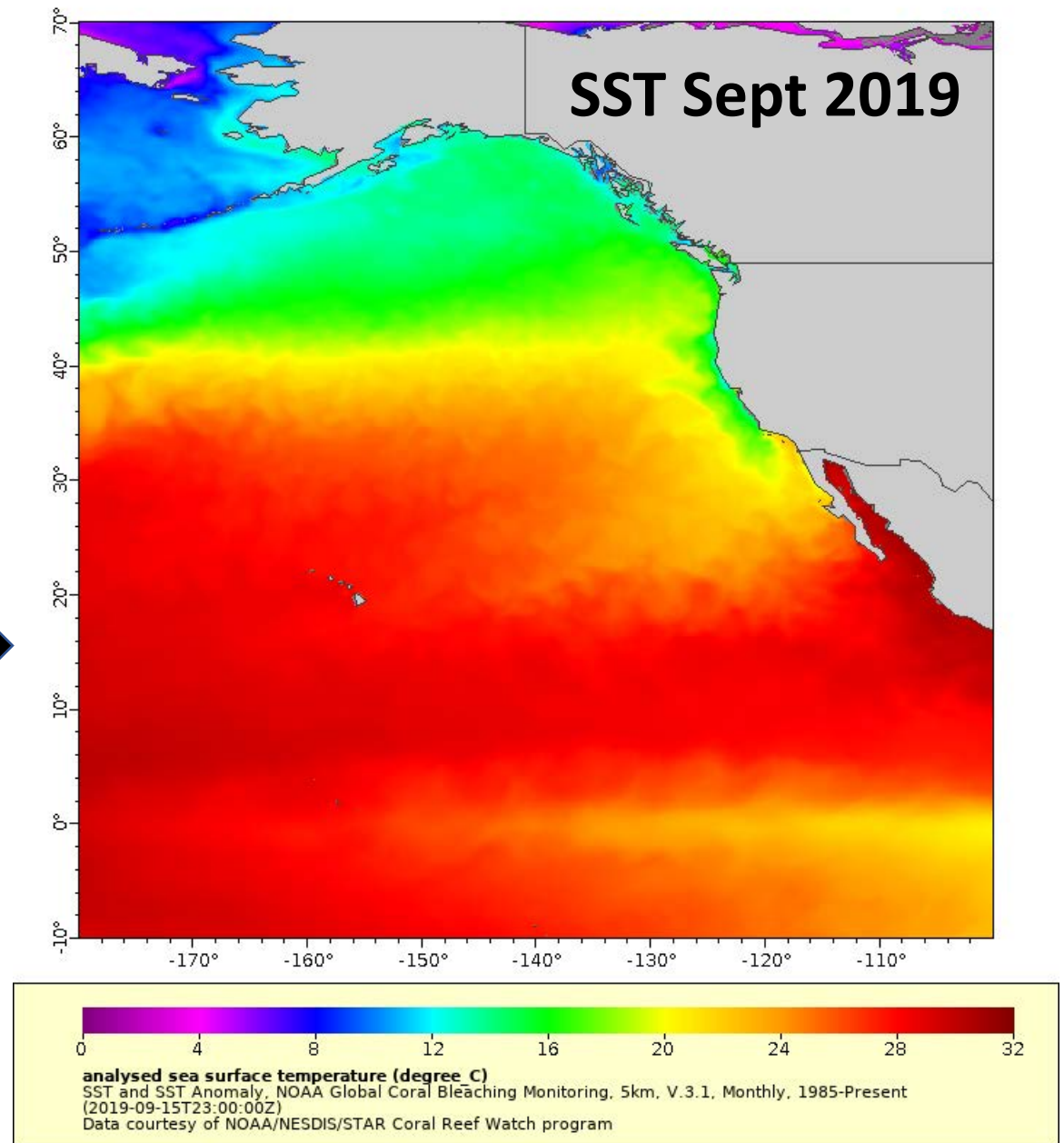
This URL:

[https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature\[\(2019-09-15\)\]\[\(70\):\(-10\)\]\[\(-180\):\(-100\)\]](https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature[(2019-09-15)][(70):(-10)][(-180):(-100)])

Produces this figure →

Note:

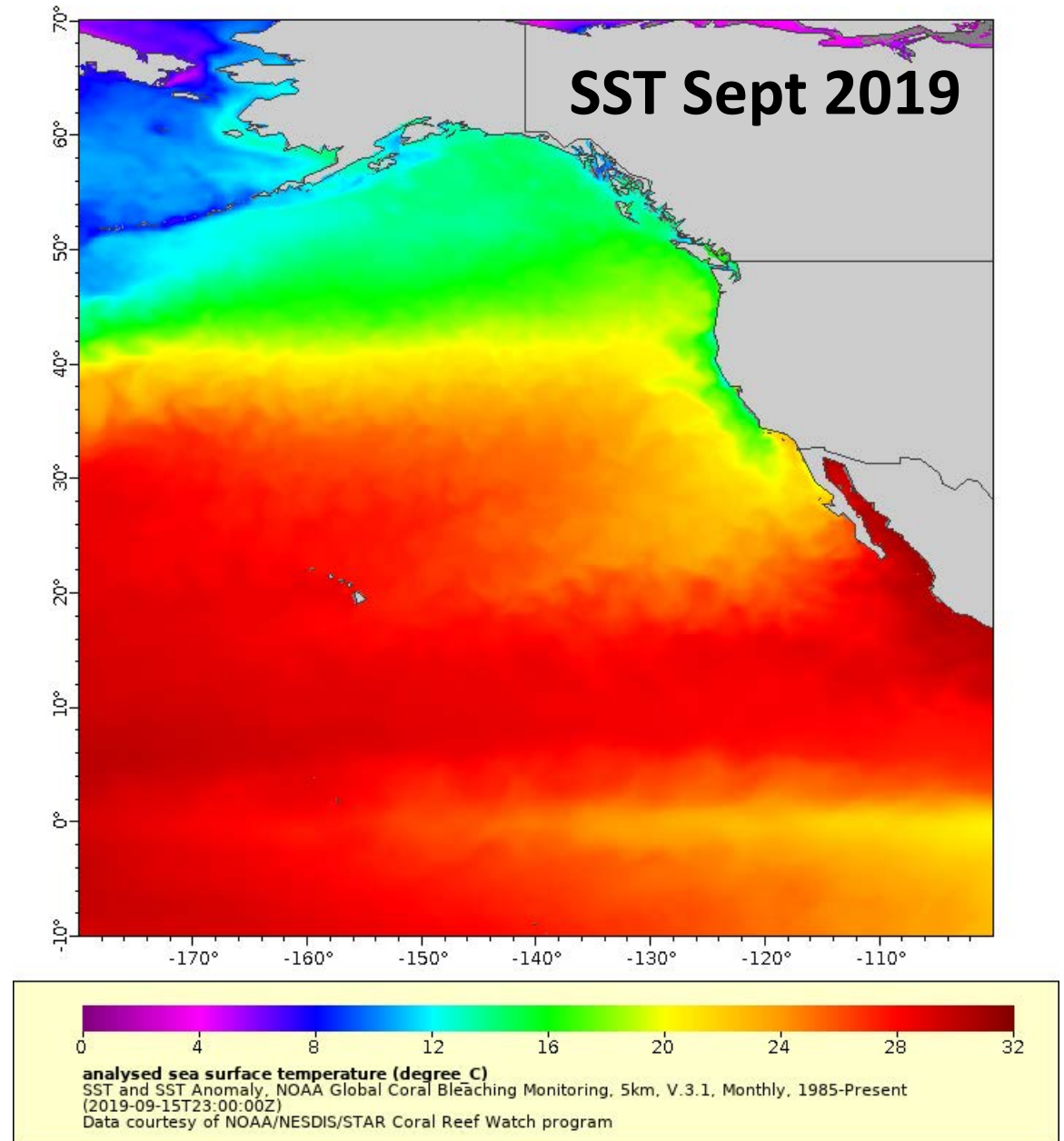
You can download the data in a netCDF file by changing .largePng to .nc in the URL



Change the variable:

[https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature\[2019-09-15\)\]\[\(70\):\(-10\)\]\[\(180\):\(-100\)\]](https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature[2019-09-15)][(70):(-10)][(180):(-100)])

- Change the variable displayed to see the SST anomaly
- For this dataset we will change it to sea_surface_temperature_anomaly

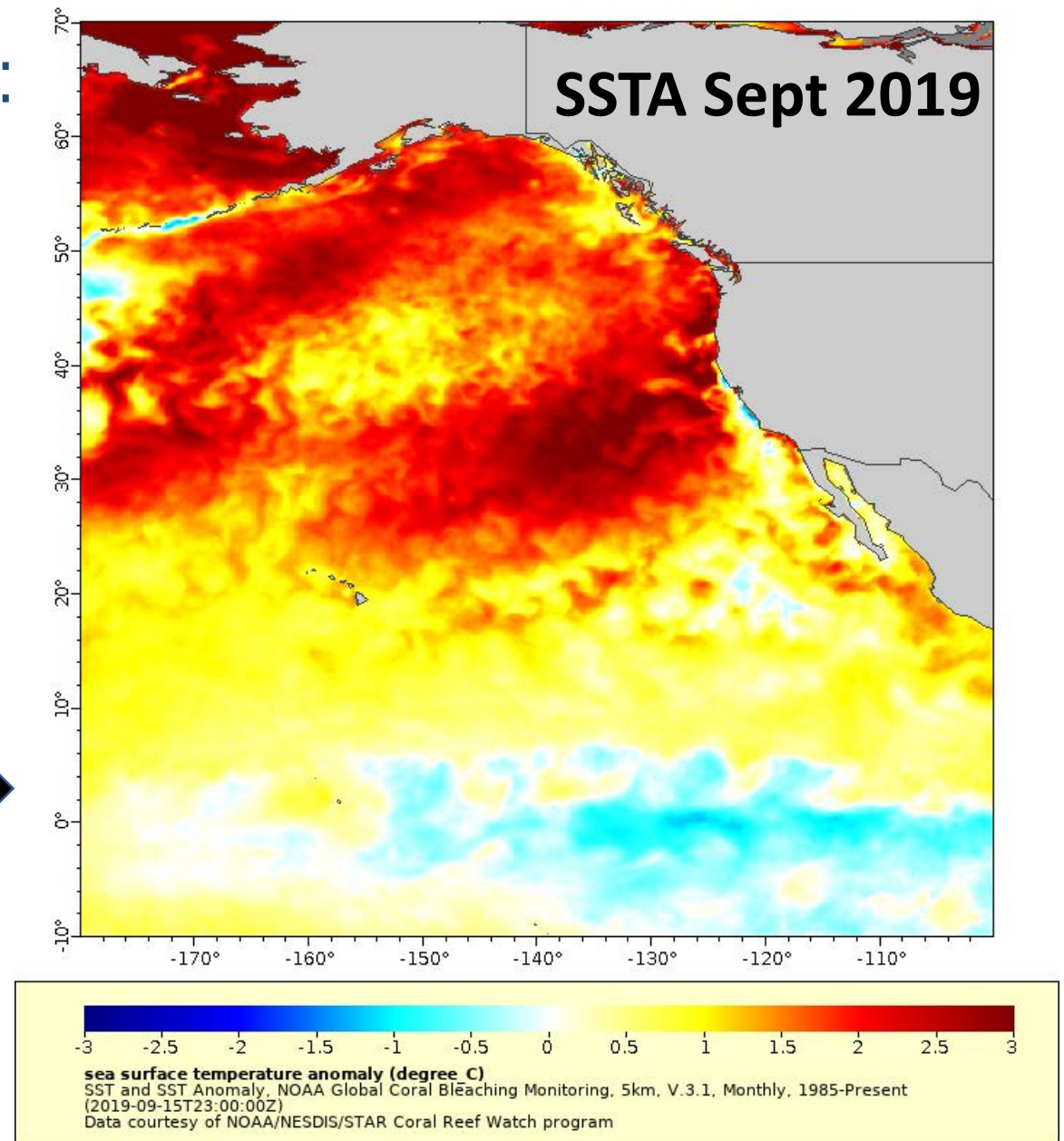


Visualize the Pacific marine heat wave:

[https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature_anomaly\[\(2019-09-15\)\]\[\(70\):\(-10\)\]\[\(-180\):\(-100\)\]](https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature_anomaly[(2019-09-15)][(70):(-10)][(-180):(-100)])

Produces this figure →

This image doesn't look exactly like the images broadcast on the news as those images were made with a daily product, and this image uses a monthly composite product



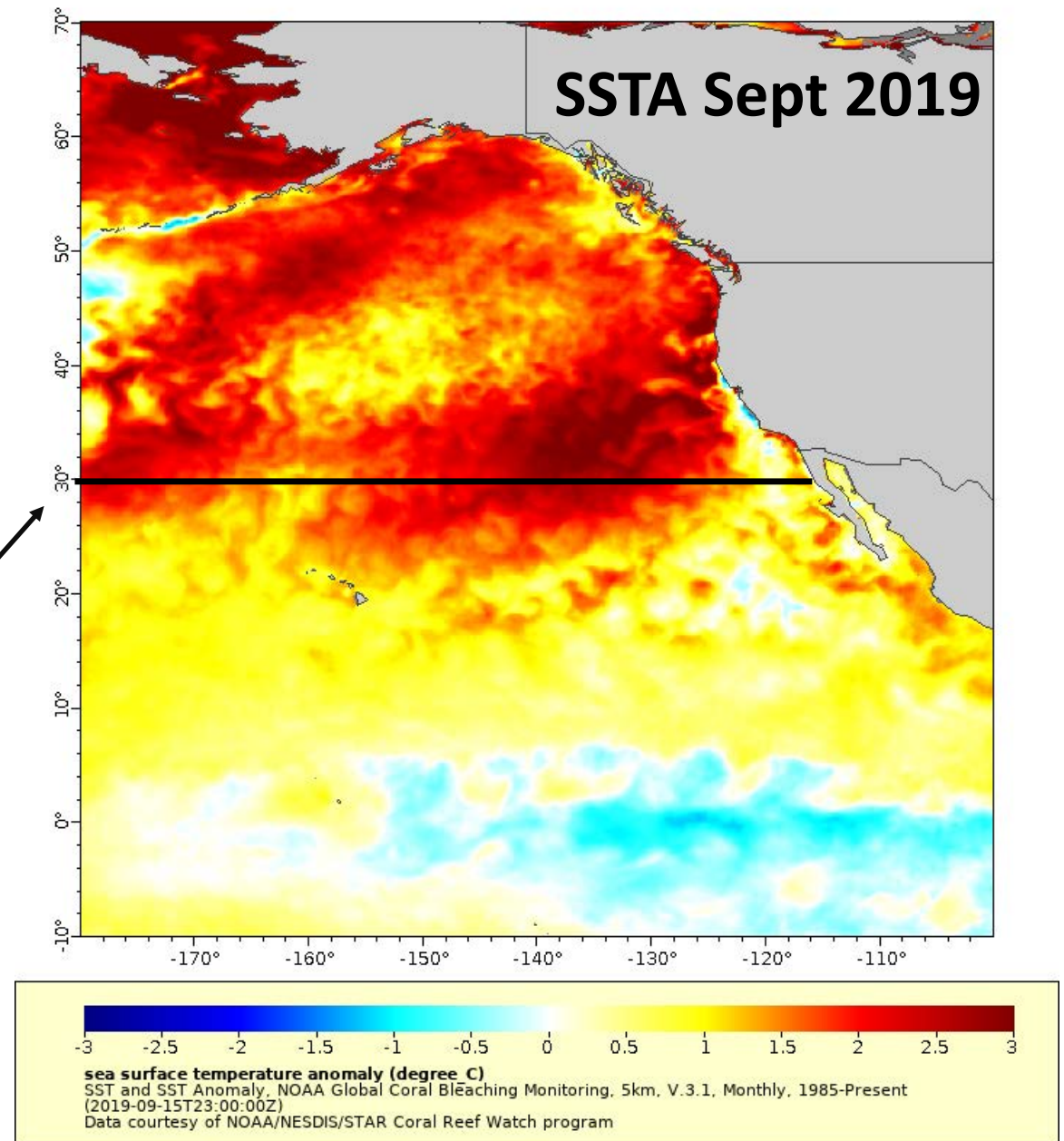
Create a 2D timeseries:

[https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature_anomaly\[\(2019-09-15\)\]\[\(70\):\(-10\)\]\[\(-180\):\(-100\)\]](https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature_anomaly[(2019-09-15)][(70):(-10)][(-180):(-100)])

Next we will examine the temporal evolution of the warm “blob” by making a Hovmöller diagram, a hybrid map with time on one axis, and latitude or longitude on the other. We will make a slice through 30°N.

We can do this by setting the y-axis to time on the “Make a Graph” page:

Graph Type: surface
X Axis: longitude
Y Axis: time
Color: sea_surface_temperature_anomaly

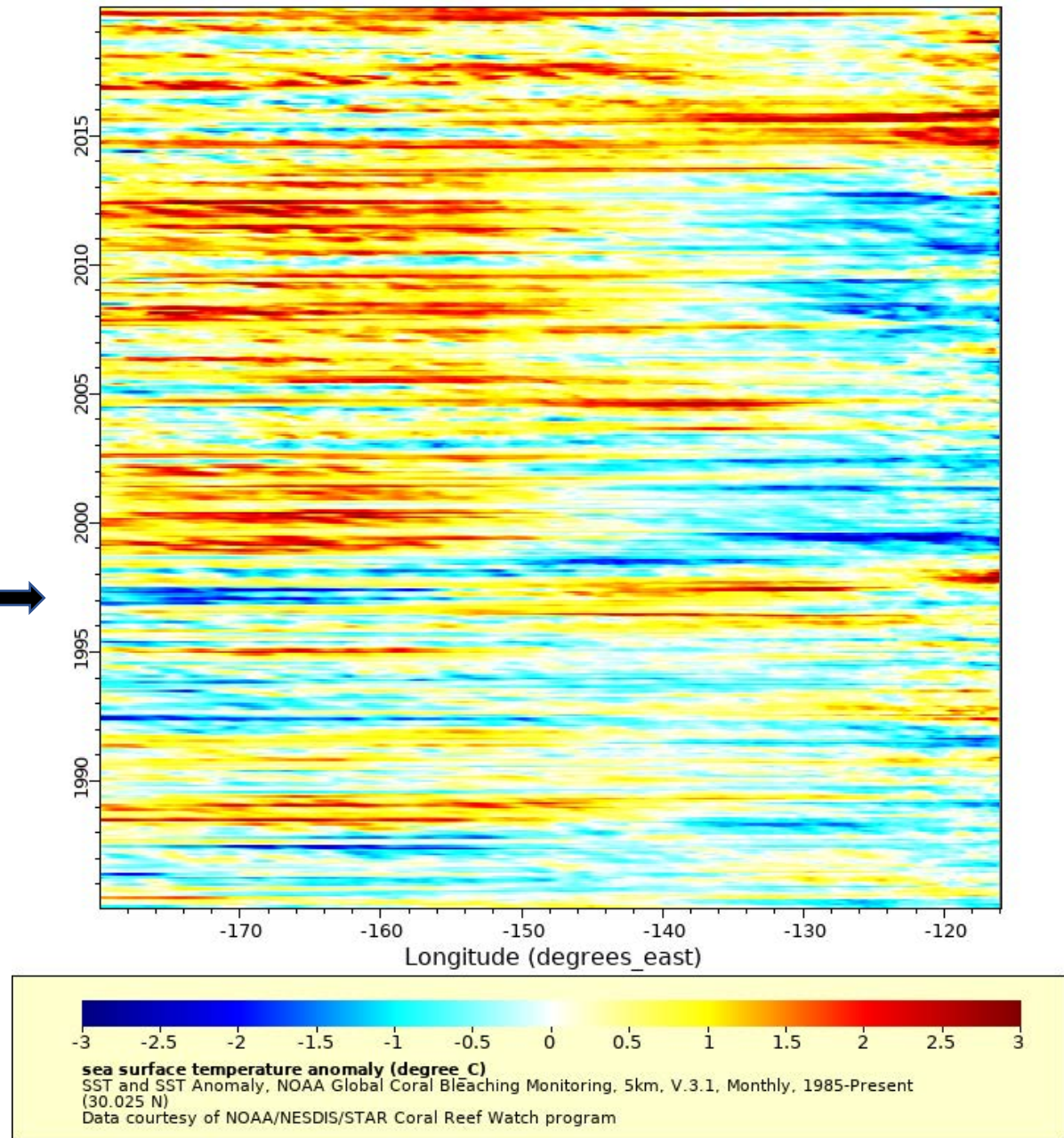


Generate a Hovmöller diagram

[https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature_anomaly\[\(1985-01-15\):\(2019-12-16\)\]\[\(30\)\]\[\(-180\):\(-116\)\]](https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW_monthly.largePng?sea_surface_temperature_anomaly[(1985-01-15):(2019-12-16)][(30)][(-180):(-116)])

Produces this figure →

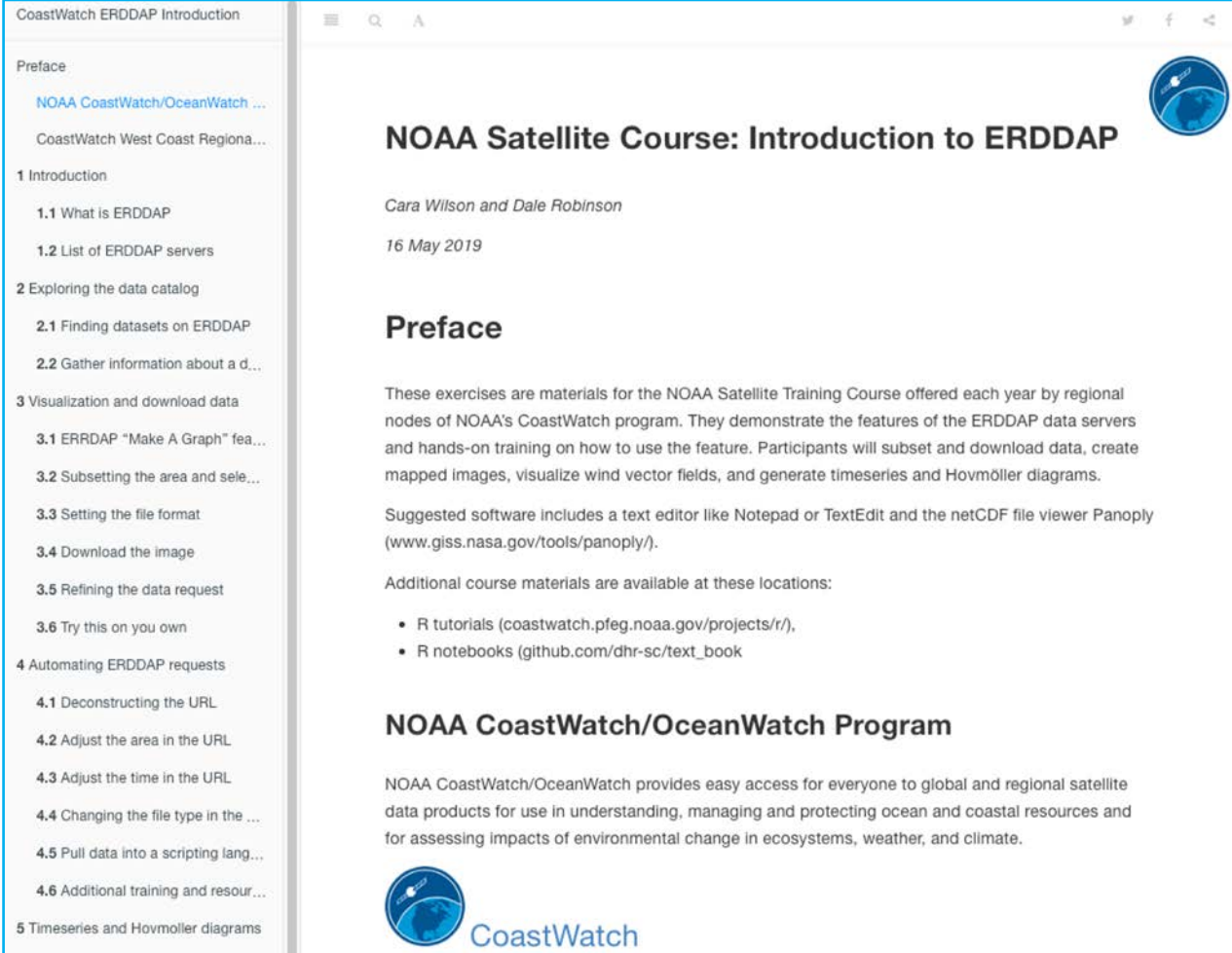
While most of the last 20 years the N. Pacific (at 30°N) has experienced warmer than usual temperatures, only in the past few years has this phenomena spread to coast (east of 120°W).



Online “Introduction to ERDDAP”

Online ERDDAP tutorial

- Developed by CoastWatch West Coast Node for the NOAA satellite course
coastwatch.noaa.gov/cw/user-resources/satellite-data-training-courses.html
- Walks users through using ERDDAP
- Demonstrates visualizing both gridded and tabular datasets



CoastWatch ERDDAP Introduction

Preface

[NOAA CoastWatch/OceanWatch ...](#)

CoastWatch West Coast Regiona...

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 ERRDAP “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 Adjust the area in the URL

4.3 Adjust the time in the URL

4.4 Changing the file type in the ...

4.5 Pull data into a scripting lang...

4.6 Additional training and resour...

5 Timeseries and Hovmoller diagrams

NOAA Satellite Course: Introduction to ERDDAP

Cara Wilson and Dale Robinson

16 May 2019

Preface

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/).

Additional course materials are available at these locations:

- R tutorials (coastwatch.pfeg.noaa.gov/projects/r/),
- R notebooks (github.com/dhr-sc/text_book)

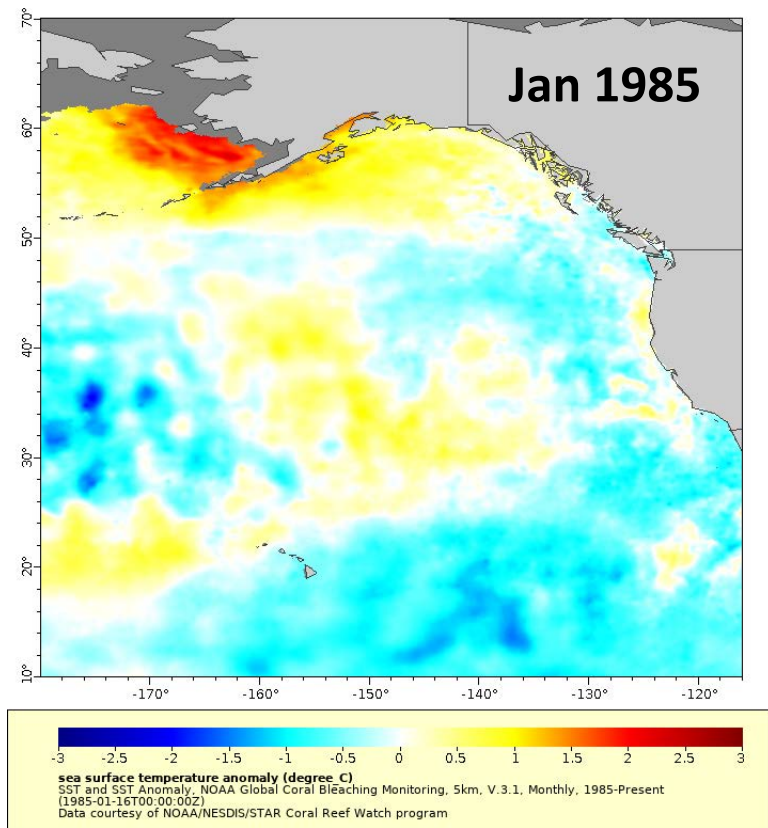
NOAA CoastWatch/OceanWatch Program

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

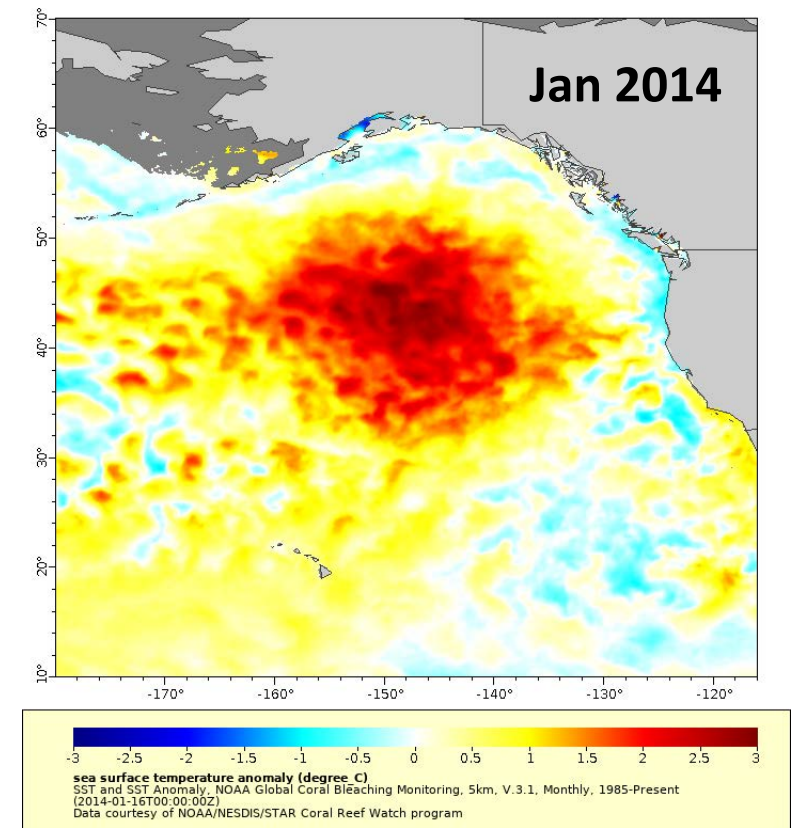
 CoastWatch

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





Questions???



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