



CoastWatch Tutorials on GitHub













NOAA CoastWatch Satellite Course

Last Update: Aug 8, 2025



Software Tutorials on GitHub

<https://github.com/coastwatch-training/CoastWatch-Tutorials>

	Python-setup	updated py setup readme	last week
	Tutorial1-basics	made edits from V's review	yesterday
	Tutorial2-timeseries-compare-sens...	final edits	18 hours ago
	calculate-seaice-extent	updated calculate-seaice-extent-R	yesterday
	convert-180+180-to-0-360-longitu...	fixed lat typo problem	last week
	create-virtual-buoy-with-satellite-d...	Virtual-buoy-Python	3 hours ago
	define-marine-habitat	Vs edits on python modules	53 minutes ago
	extract-satellite-data-within-bound...	incorporated V's edit in extract-within-boundary-R	6 hours ago
	map-data-with-different-projections	resolved the conflicts in 3 files	last week
	matchup-satellite-buoy-data	#77 corrected warning	4 days ago
	matchup-satellite-data-to-track-lo...	Vs edits on python modules	53 minutes ago
	transform-to-another-map-projecti...	Vs edits on python modules	53 minutes ago

- Each tutorial module is designed to illustrate the process of accessing and manipulating satellite data from the CoastWatch ERDDAP data servers.
- Code is usually available for both R and python (a few in Matlab)
- R folders contain both .md (for internet viewing) and .rmd (for downloading) files

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Tutorial Module Descriptions

- [ERDDAP-basics](#) An introduction to what ERDDAP is and an overview of the different CoastWatch ERDDAP servers. Learn how to visualize and download data from ERDDAP, and how to interpret an ERDDAP url.
- [netcdf-and-panoply-tutorial](#) Learn how to use NASA's Panoply software to open and view netCDF data.
- [Tutorial1-basics](#) Learn to access satellite data from CoastWatch ERDDAP data server and to work with NetCDF files. Visualize sea surface temperature on a map and plot time series data. **R, python and Matlab versions.**
- [Tutorial2-timeseries-compare-sensors](#) Learn common ways to download data from ERDDAP servers to access time-series chlorophyll data from four different satellite datasets and summarize and visualize the data for comparison. **R, python and Matlab versions.**
- [convert-180+180-to-0-360-longitude](#) Work with datasets with -180° to $+180^{\circ}$ longitude values in a region that crosses the antimeridian. Convert the coordinates from $(-180, +180)$ to $(0, 360)$ and visualize data on a map. **Python only.**
- [create-virtual-buoy-with-satellite-data](#) Create a “virtual” buoy using satellite data to fill the gaps in in-situ data collected by a physical buoy. Extract data from a location close to an existing buoy. Clean dataset by removing outliers, and aggregate (resample) to achieve a reduced temporal resolution. Plot time series data. **R and python versions.**
- [extract-satellite-data-within-boundary](#) Extract sea surface temperature satellite data for a non-rectangular geographical region from an ERDDAP server using a shapefile, make maps, and plot a timeseries of the seasonal cycle of SST within the boundary. **R, python and Matlab versions.**
- [matchup-satellite-buoy-data](#) Temporally and geospatially subset satellite data to match with buoy data (tabular), run statistical analysis and produce a map of the satellite data with overlaying buoy data. **R only.**
- [matchup-satellite-data-to-track-locations](#) Extract satellite data along a set of points defined by longitude, latitude, and time coordinates like that produced by an animal telemetry tag, a ship track, or a glider track. **R, python and Matlab versions.**

Most tutorials are available in both R and python, and a few also have a Matlab version

<https://github.com/coastwatch-training/CoastWatch-Tutorials>

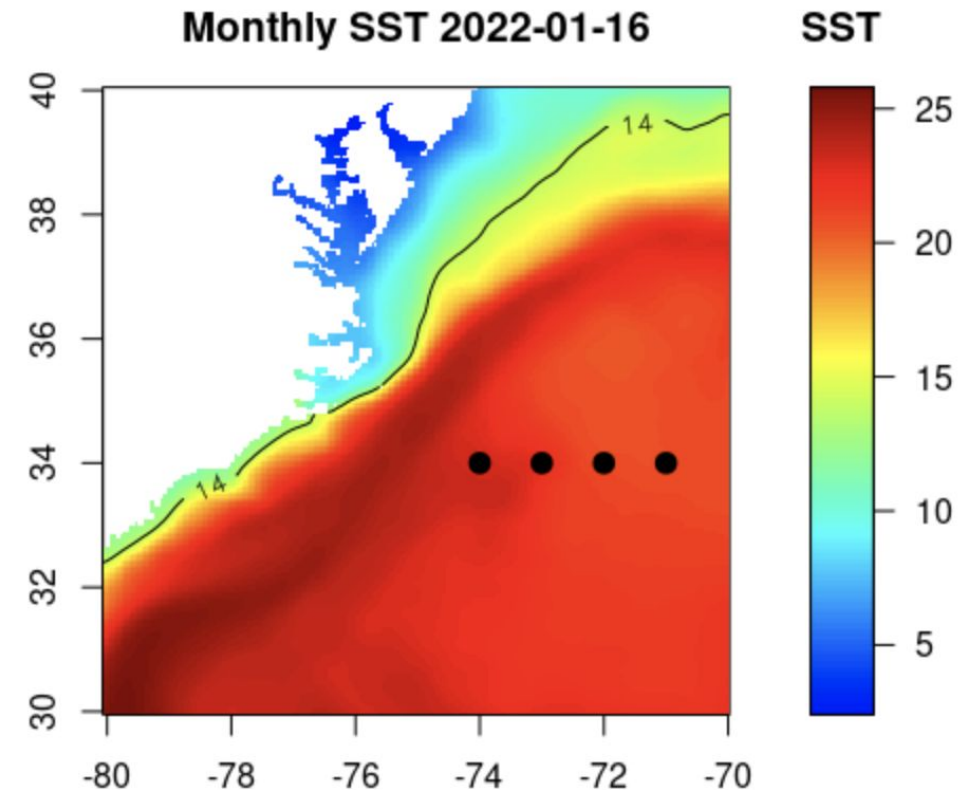
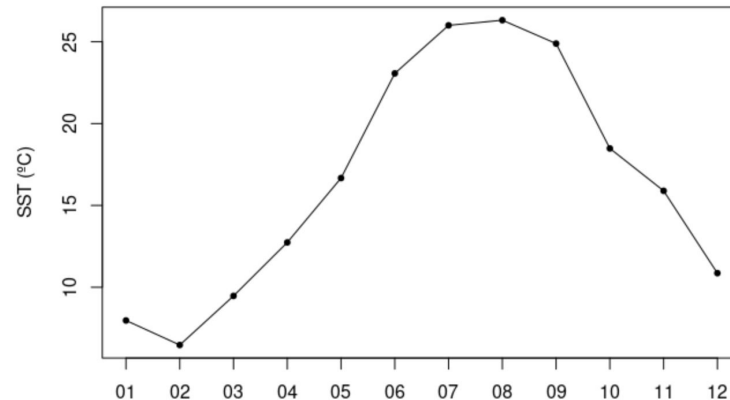


Tutorial1-basics

Learn to access satellite data from CoastWatch ERDDAP data server and to work with NetCDF files. Visualize sea surface temperature on a map and plot time series

Tutorial demonstrates:

- Locating a satellite product in ERDDAP
- Manually changing the constraints
- Copying the URL defining the data request
- Downloading the resulting NetCDF file
- Opening and examining the NetCDF file
- Making basic maps and time series plots

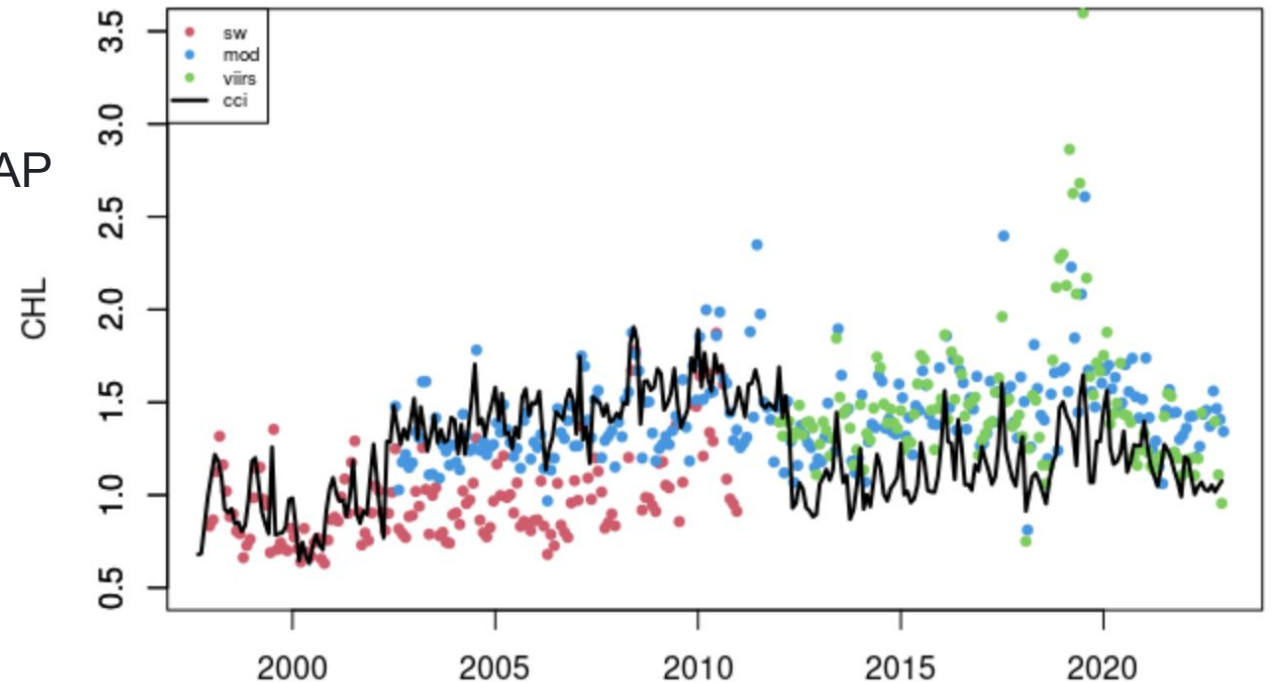
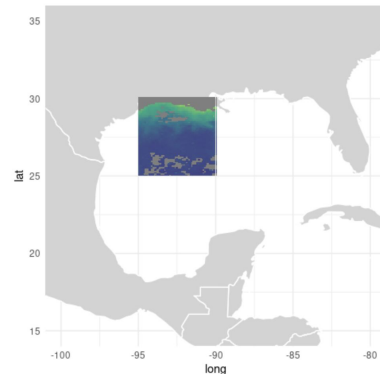


Tutorial2-timeseries-compare-sensors

Learn common ways to download data from ERDDAP servers to access time-series chlorophyll data from four different satellite datasets and summarize and visualize the data for comparison.

Tutorial demonstrates:

- Using **rerddap** to extract data from a rectangular area of the ocean over time
- Retrieve information about a dataset from ERDDAP
- Comparing results from different sensors
- Averaging data spatially
- Producing timeseries plots
- Drawing maps with satellite data

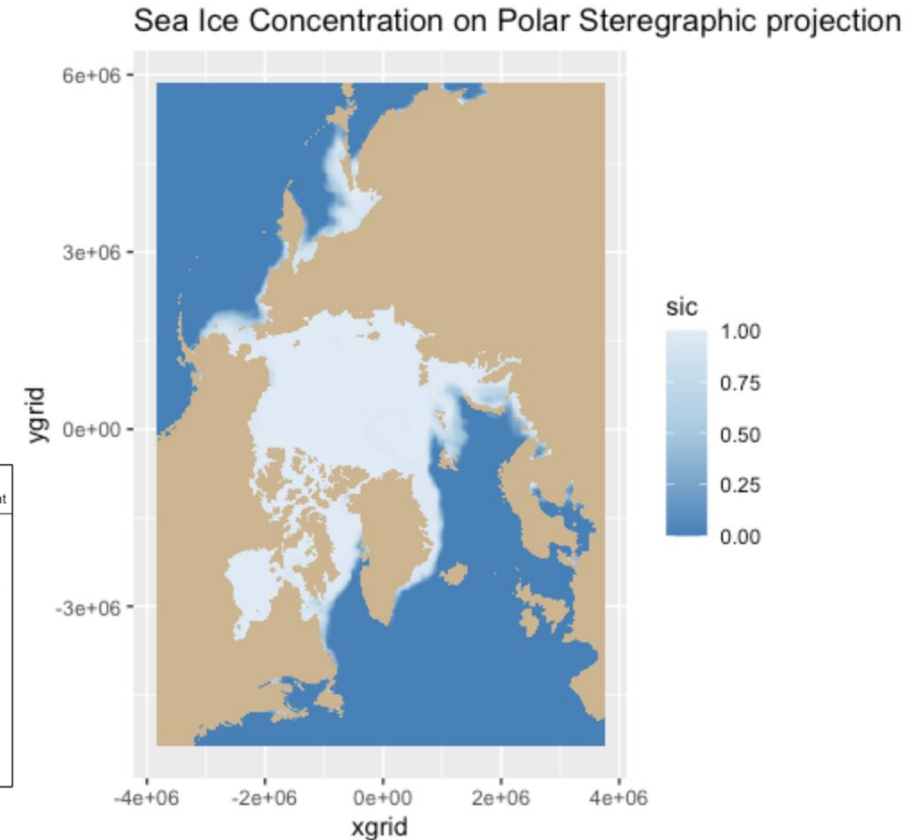
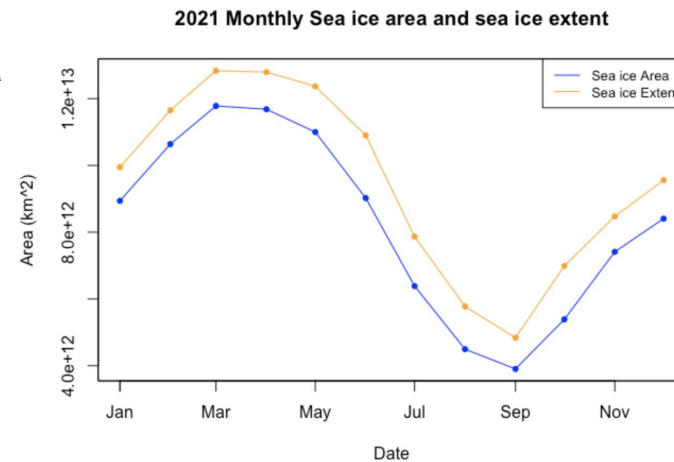


calculate-seaice-extent

View sea ice concentration (SIC) data on a map with the polar stereographic projection. Calculate and compare sea ice area/extent from multi-year SIC datasets.

Tutorial demonstrates:

- Downloading and saving a netcdf file from the PolarWatch ERDDAP
- Accessing satellite data and metadata in polar stereographic projection
- Downloading and adding grid cell area data to a map
- Computing sea ice area and extent using sea ice concentration data
- Plotting a time series of sea ice area and extent



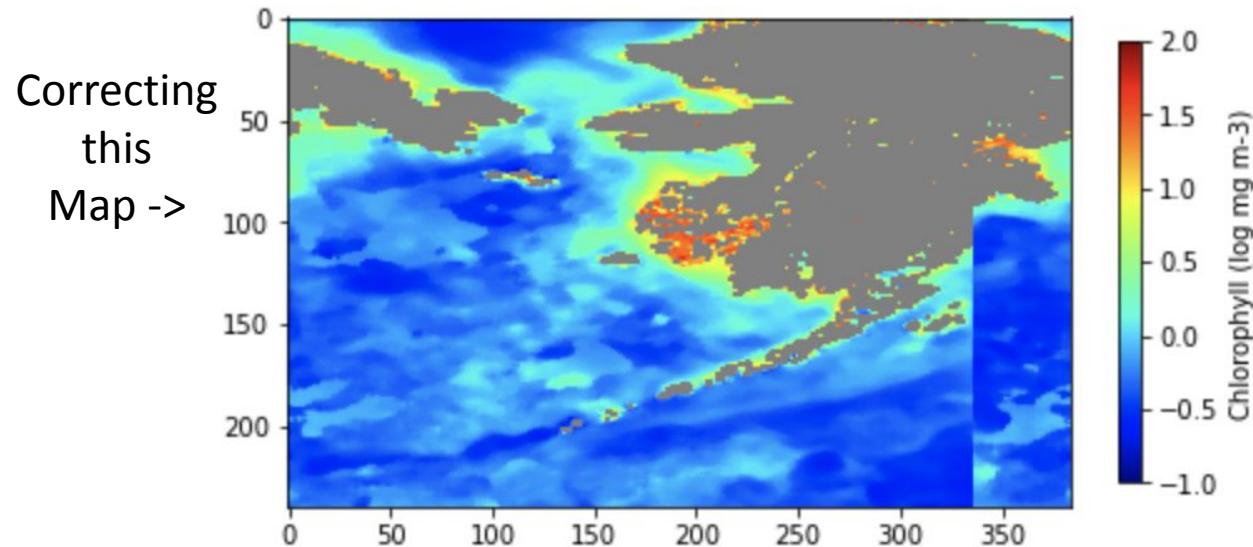
Convert -180+180-to-0-360-longitude

Python only

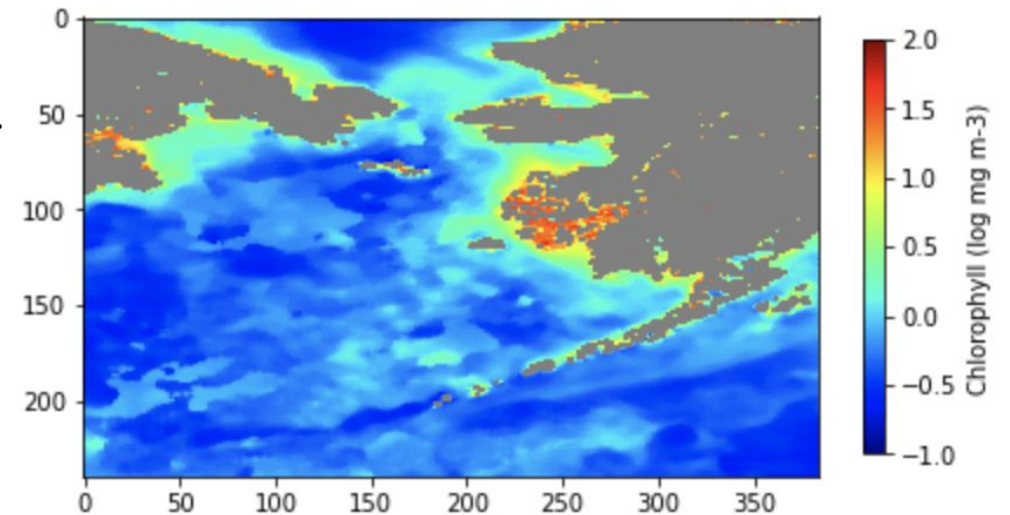
Work with datasets with -180° to $+180^{\circ}$ longitude values in a region that crosses the antimeridian. Convert the coordinates from $(-180, +180)$ to $(0, 360)$ and visualize data on a map

Tutorial demonstrates:

- Downloading data that crosses the antimeridian from a dataset with -180 to $+180$ longitude values
- Converting the data to a 0 - 360 longitude values
- Reordering the longitude axis so that the longitude values are in ascending order



To this Map ->

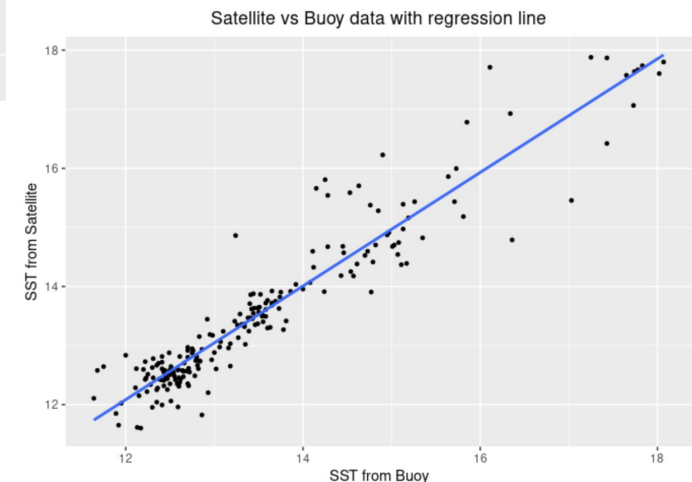
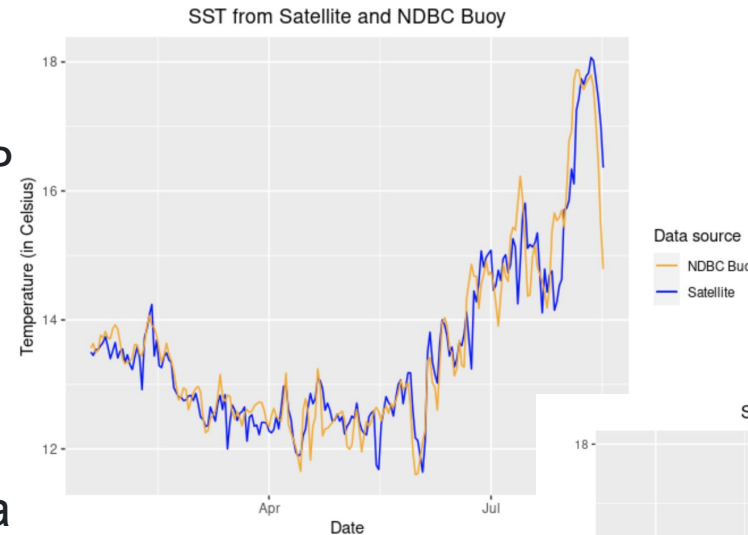


create-virtual-buoy-with-satellite-data

Create a “virtual” buoy using satellite data to fill the gaps in in-situ data collected by a physical buoy. Extract data from a location close to an existing buoy. Clean dataset by removing outliers, and aggregate (resample) to achieve a reduced temporal resolution

Tutorial demonstrates:

- Downloading the satellite and buoy data from ERDDAP
- Visualizing the datasets
- Reshaping the satellite data into a buoy data format
- Resampling buoy data (aggregation) to match satellite data temporal resolution
- Validating the satellite data with the actual buoy data
- Performing a linear regression of satellite vs. buoy data
- Creating a scatter plot of satellite vs. buoy data with the regression line

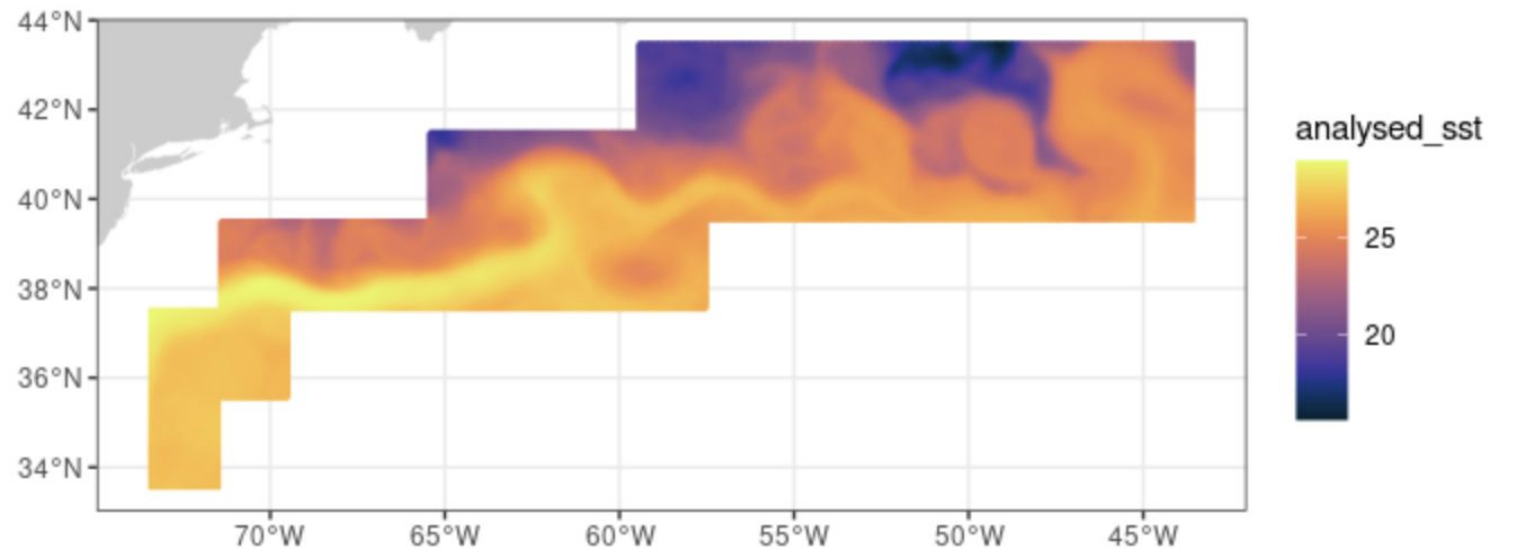


extract-satellite-data-within-boundary

Extract satellite data for an non-rectangular geographical region from ERDDAP using a shapefile, make maps, and plot a timeseries of the seasonal cycle of data within the boundary.

Tutorial demonstrates:

- Using **rerddapXtracto** package to extract data from a polygon
- Downloading data from ERDDAP
- Visualizing data on a map

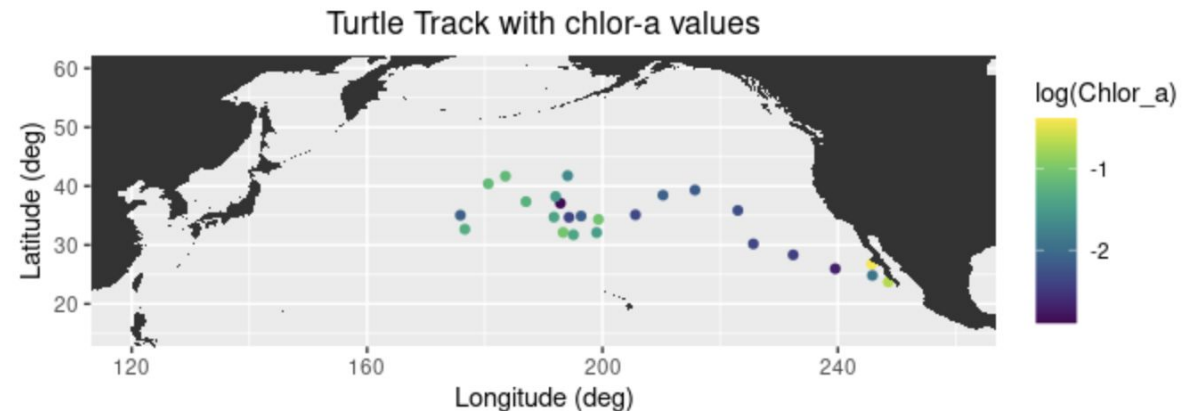
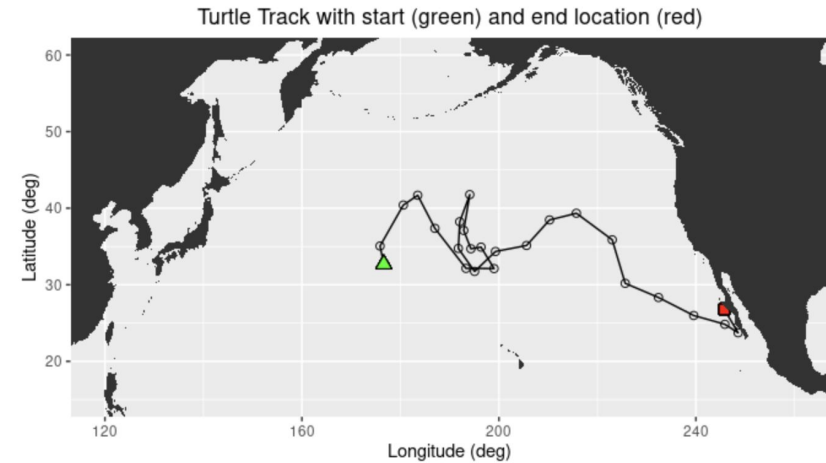


matchup-satellite-data-to-track-locations

Extract satellite data along a set of points defined by longitude, latitude, and time coordinates like that produced by an animal telemetry tag, a ship track, or a glider track.

Tutorial demonstrates:

- Importing track data in csv file to data frame
- Using **rerddapXtracto** package to extract satellite data associated with xyt points
- Plotting the latitude/longitude points onto a map
- Extracting satellite data from an ERDDAP data server along a track
- Plotting the satellite data onto a map

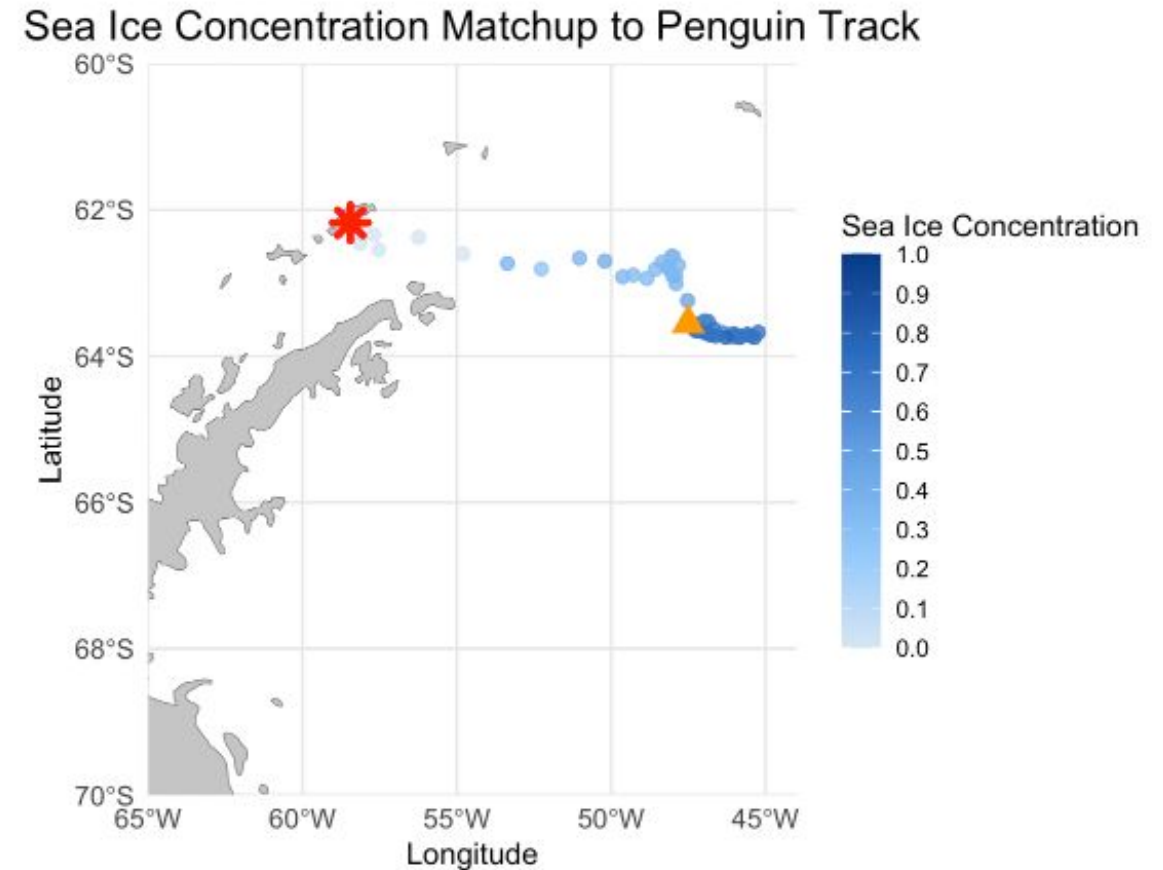


matchup-polar-data-to-track-data

Match up telemetry data (a set of moving x, y, t points) to projected data by converting the projection of the trackpoints

Tutorial demonstrates:

- Accessing satellite data from PolarWatch ERDDAP
- Changing the projection of a dataset
- Using rerddapXtraco with a projected dataset

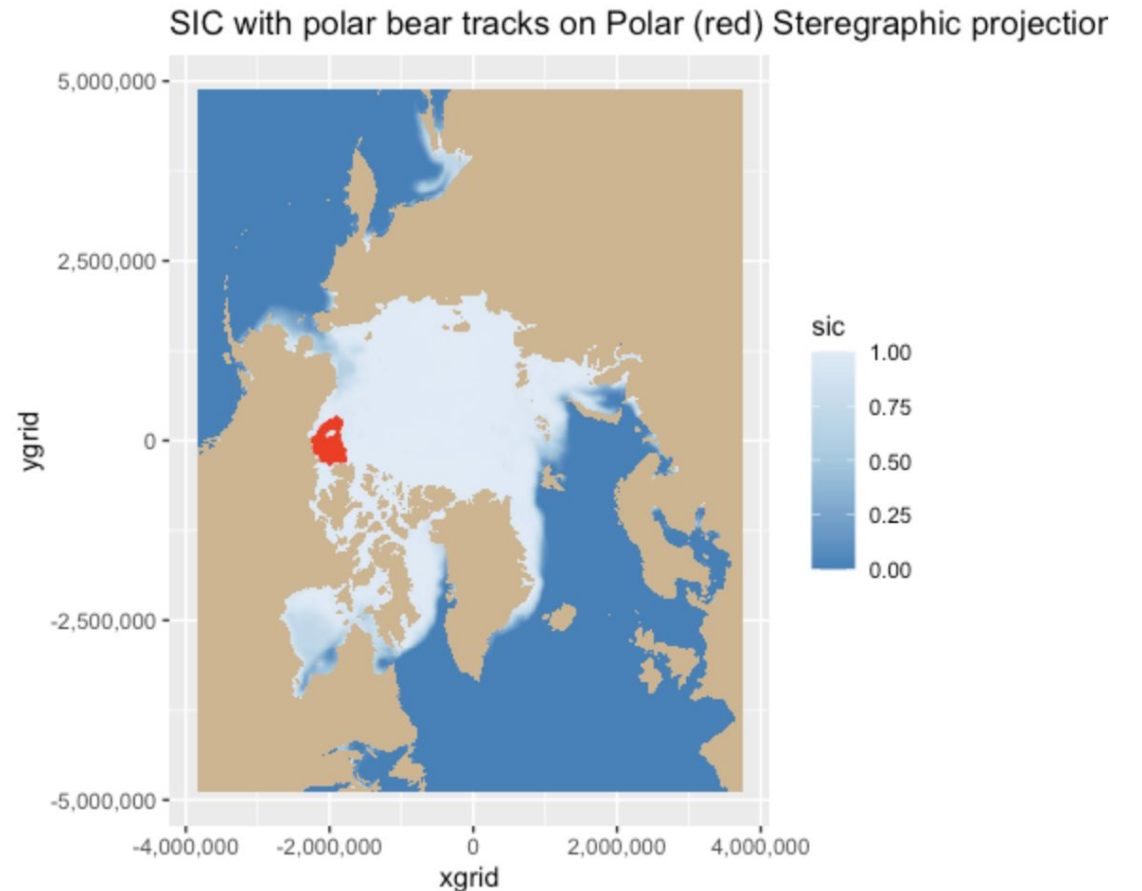


map-data-with-different-projections

Download and examine a polar stereographic projected dataset, plot the data on a projected map. Add animal track data with geographical coordinates onto the projected map.

Tutorial demonstrates:

- Accessing satellite data from ERDDAP
- Making a projected map
- Adding projected data
- Adding geographical data



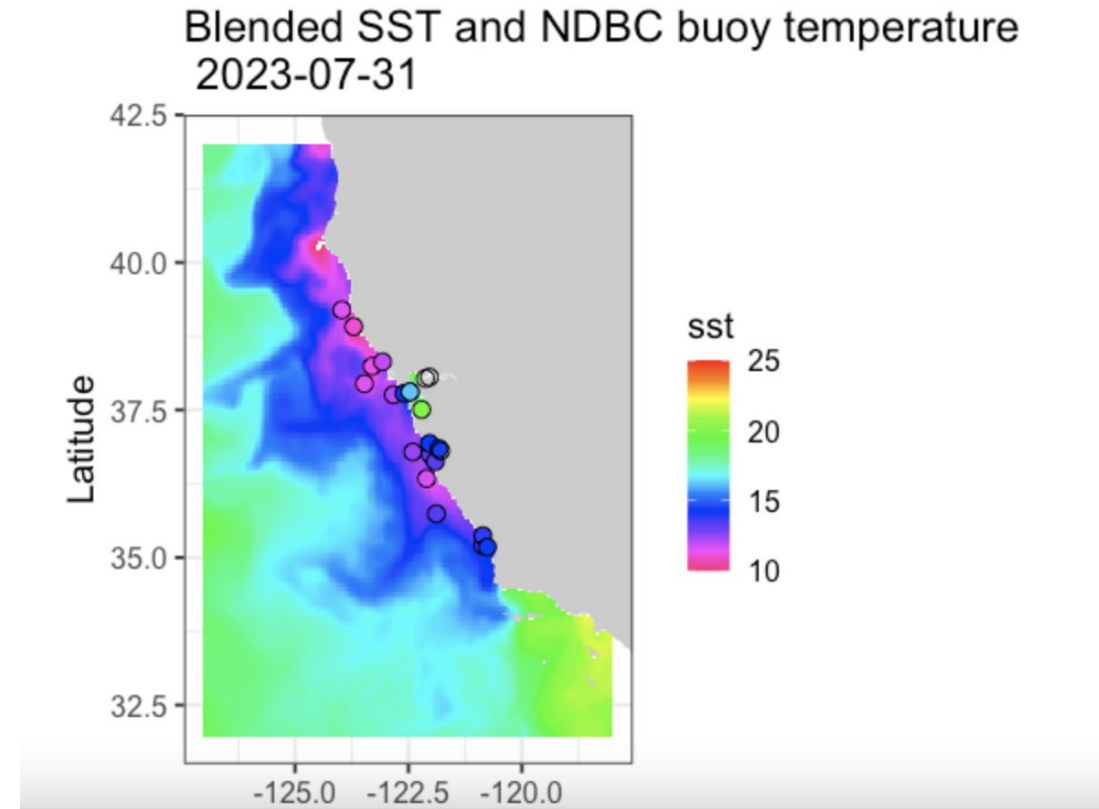
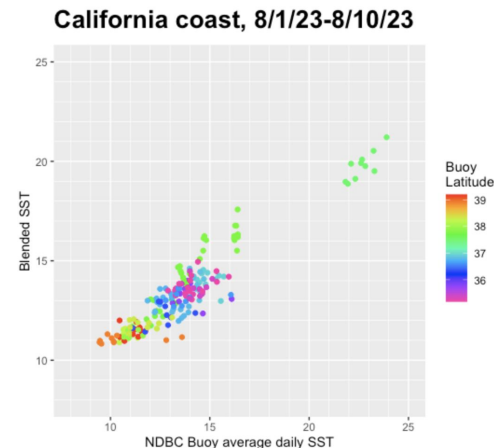
matchup-satellite-buoy-data

R only

Temporally and geospatially subset satellite data to match with buoy data (tabular), run statistical analysis and produce a map of the satellite data with overlaying buoy data.

Tutorial demonstrates:

- Downloading tabular data (buoy data) from ERDDA
- Retrieving information about a dataset from ERDDAP
- Matching satellite data with the buoy data
- Running statistical analysis to compare buoy and satellite data
- Producing satellite maps and overlaying buoy data

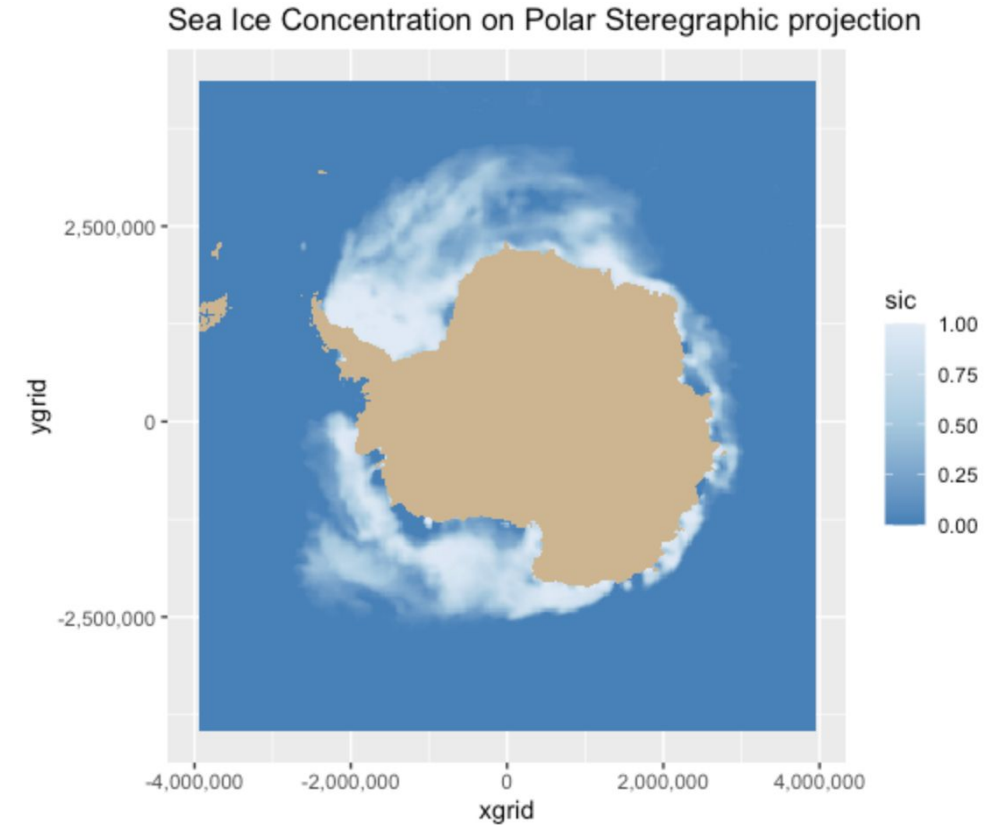
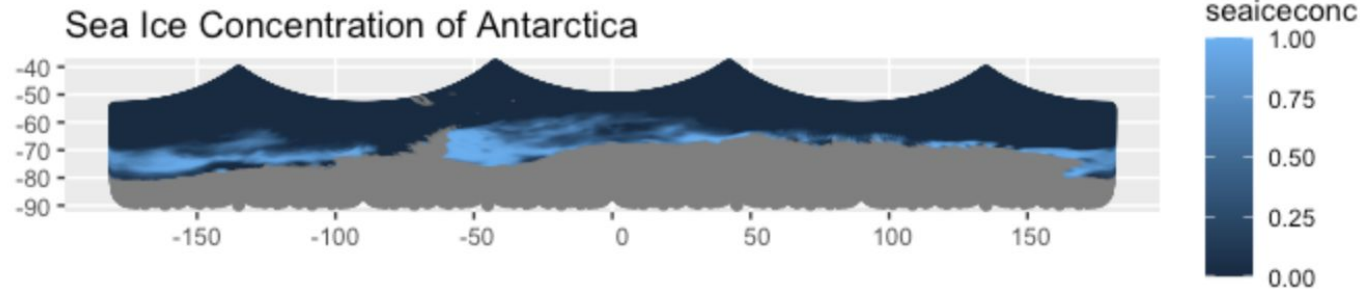


Transform-to-another-map-projection

Access satellite data with polar stereographic coordinates and transform it into a different coordinate system using EPSG code.

Tutorial demonstrates:

- Downloading a netcdf file from PolarWatch ERDDAP
- Accessing satellite data and metadata in polar stereographic projection
- Converting netcdf data into a dataframe
- Transforming coordinates using EPSG codes
- Mapping data using the transformed coordinates



rerddapXtracto package

- R package written by Roy Mendelssohn (SWFSC/ERD)
- Uses the rerddap and plotdap packages
- erddap, plotdap and rerddapXtracto are all available on cran
- rerddapXtracto contains several functions:
 - rxtracto**: extracts a variable along xyt points (i.e. a tagged animal)
 - rxtractogon**: extracts a variable within a user-supplied polygon
 - rxtracto_3D**: extracts a 3-dimensional (latitude, longitude and time) cube of a variable
 - plotTrack**: plots the results from rxtracto (including creating animations)
 - plotBox**: plots the output from rxtracto_3D
- Will work on any dataset on any ERDDAP (option to change the default ERDDAP)
- <https://github.com/coastwatch-training/CoastWatch-Tutorials/blob/main/R-help/troubleshooting-rerddapXtraco.md>