



R and ERDDAP

NOAA CoastWatch Satellite Course

Last Update: Apr 14, 2021



The R Software Package

- R is a language and environment for statistical computing and graphics
- Available at <https://www.r-project.org/about.html>
- Software is free
- Thousands of different R packages exist to do specialized functions



rerddapXtracto package

- R package written by Roy Mendelsohn (SWFSC/ERD), based on code originally developed by Dave Foley for Matlab
- 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 enter a url to change the ERDDAP accessed)



Notebooks using rerddapXtracto

02-sanctuary uses the `rxtractogon` function to download satellite data within the boundaries of a user-supplied polygon, in this case the Monterey Bay (or the Olympic Coast) sanctuary

03-xyt_matchup uses the `rxtracto` function to extract satellite data along the coordinates of a user-supplied telemetry track, in this case from a tagged marlin

03-xyt_matchup uses the `rxtracto` function to extract satellite data for a survey grid that spans the dateline

04-Timeseries_Chl uses the `rxtracto_3d` function to download a bunch of chlorophyll datasets, spatially average them, and plot their timeseries

05-SSTBuoy uses the `tabledap` function in `rerddap` to download SST data from NDBC buoys and the `rxtracto` function to extract satellite SST from those same buoy locations

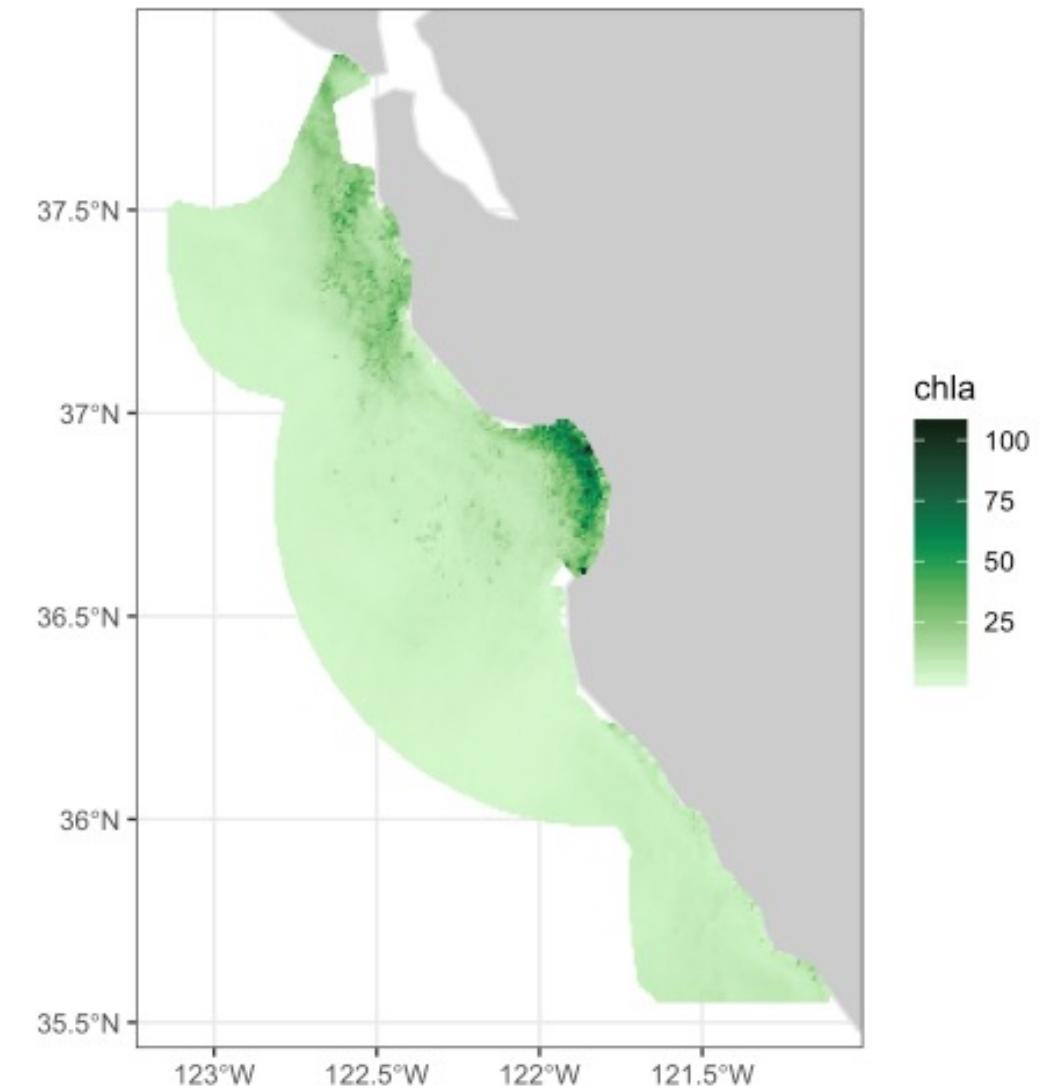
06-TurtleWatch uses `rxtracto_3d` function to import SST data and apply a temperature threshold to look at turtle habitat

08-ProjectedData uses base functions to work with a projected sea ice dataset on the PolarWatch ERDDAP

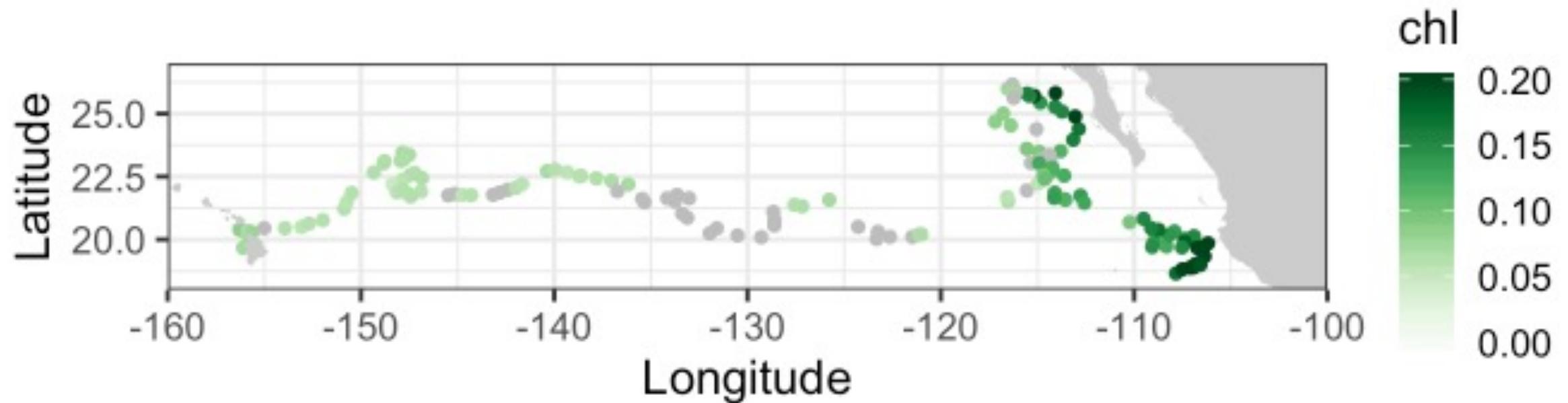


02-Sanctuary.RMD

- **rxtractogon** function used to read in data within the boundaries of the Monterey Bay Sanctuary
- Chlorophyll is selected as the satellite dataset
- Produces a map of data just within the polygon



03-xyt_matchup.RMD

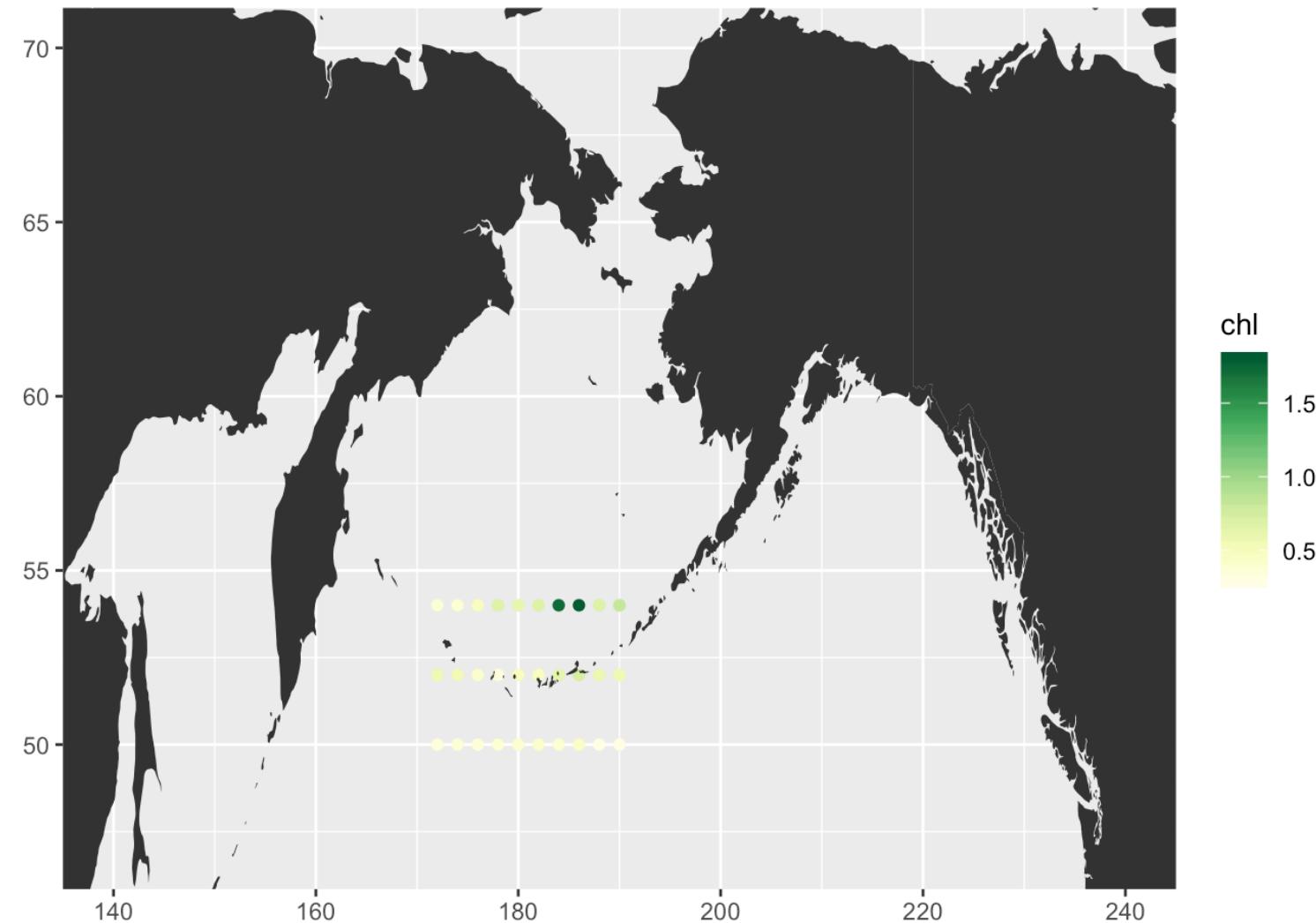


- The telemetry file (lat, lon and time) of a tagged marlin is read in
- Chlorophyll is selected as the satellite data
- **rxtracto** function used to extract satellite values around the tagged points
- Plots the track with points color-coded by chlorophyll value



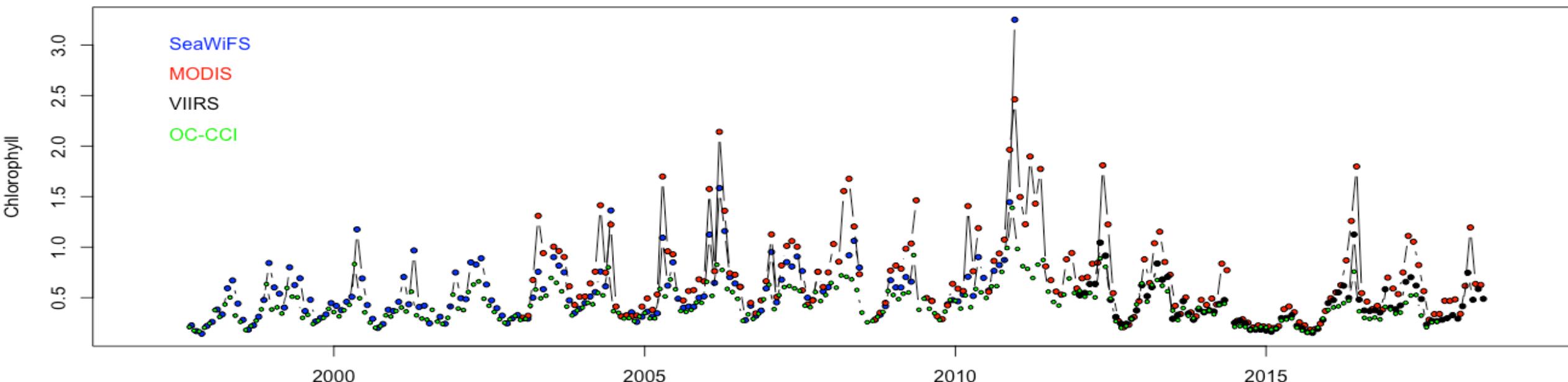
03-xyt_matchup.RMD

- A survey grid of stations that cross the dateline is created
- **rxtracto** function used to extract satellite values for the survey grid
- Stations are mapped across the dateline



04-Timeseries.RMD

120-115 W, 31-34 N

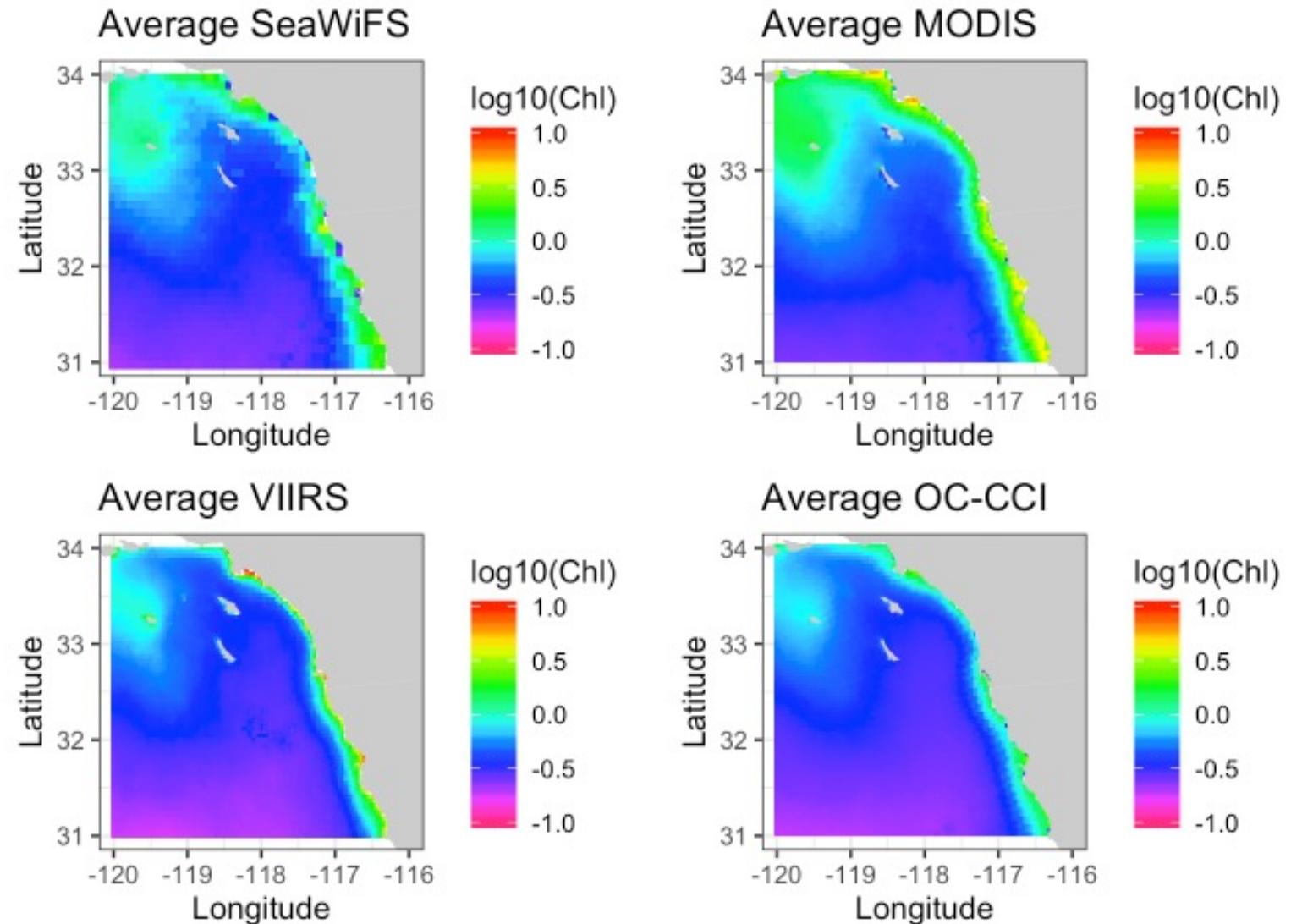


- **`rxtracto_3D`** function used to download 3D cubes (lat, long and time) of 4 different chlorophyll datasets: SeaWiFS, MODIS, VIIRS, and OC-CCI
- Each dataset is spatially averaged into a timeseries
- Each dataset is temporally averaged into a map



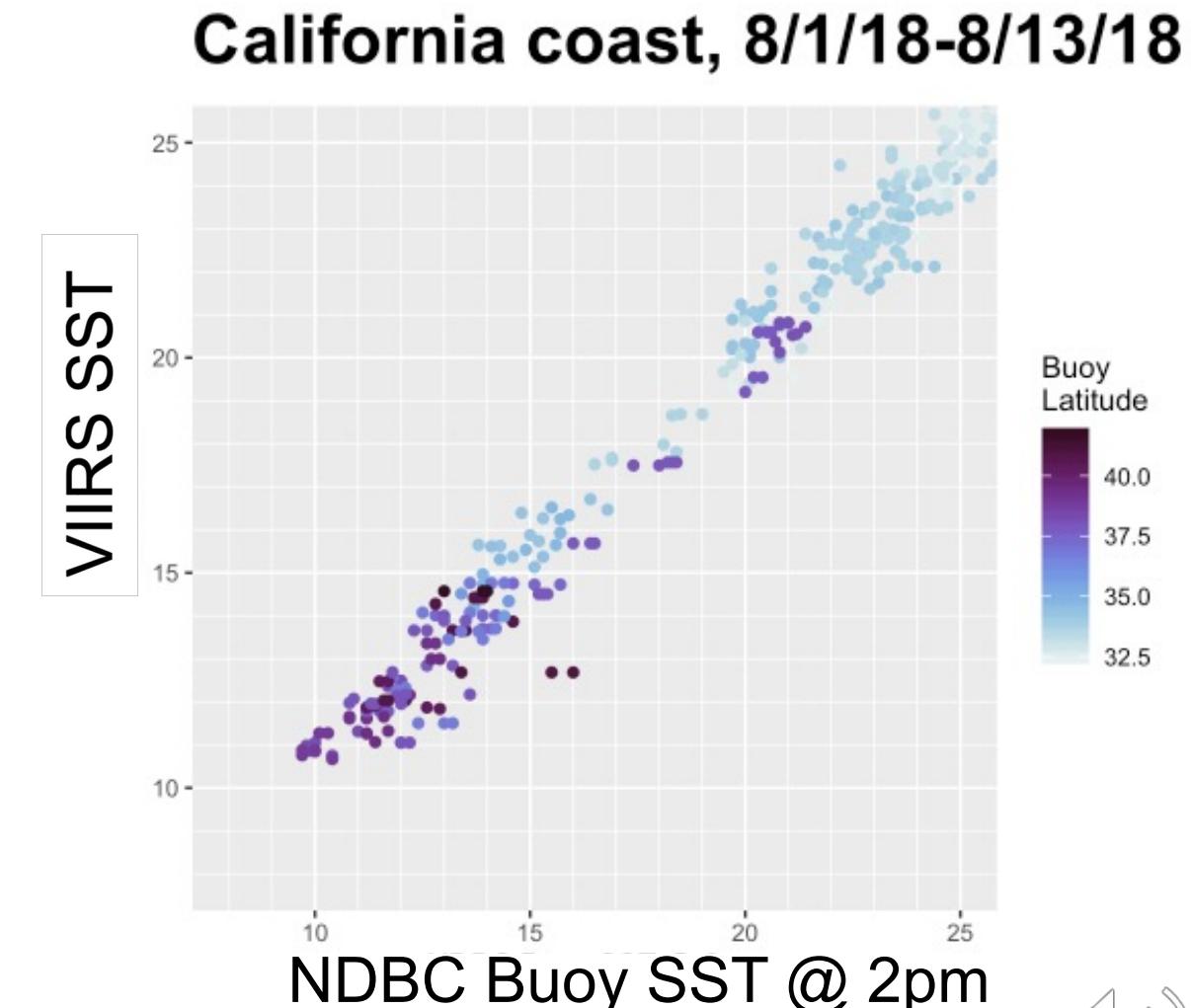
04-Timeseries.RMD

- **rxtracto_3D** function used to download 3D cubes (lat, long and time) of 4 different chlorophyll datasets: SeaWiFS, MODIS, VIIRS, and OC-CCI
- Each dataset is spatially averaged into a timeseries
- Each dataset is temporally averaged into a map



05-SSTBuoy.RMD

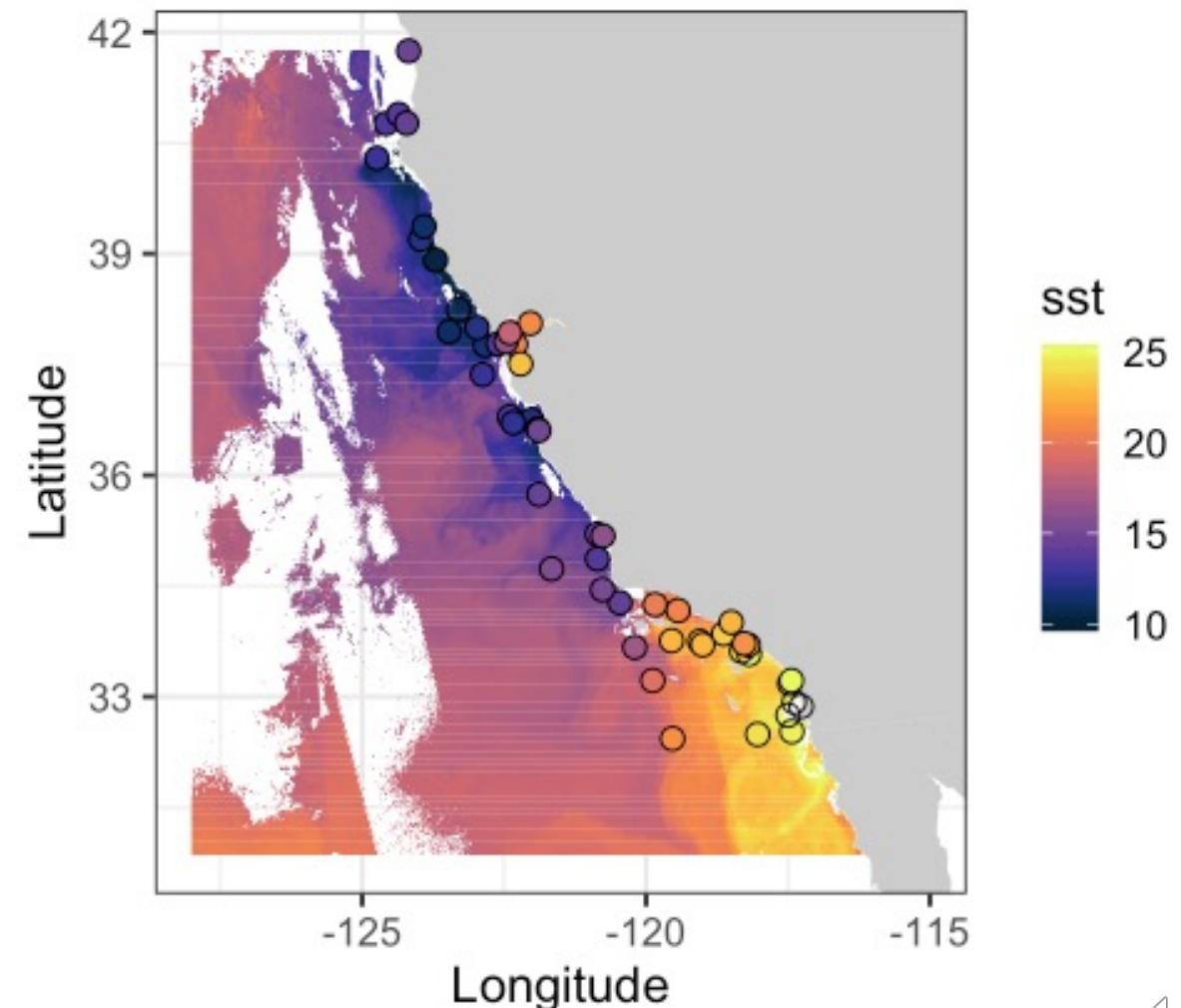
- uses the `tabledap` function in `rerddap` to download SST data from NDBC buoys
- the **`rxtracto`** function is used to extract satellite SST from those same buoy locations
- The satellite and buoy SSTs are plotted
- Buoy SST data are overlain on a map of satellite SST



05-SSTBuoy.RMD

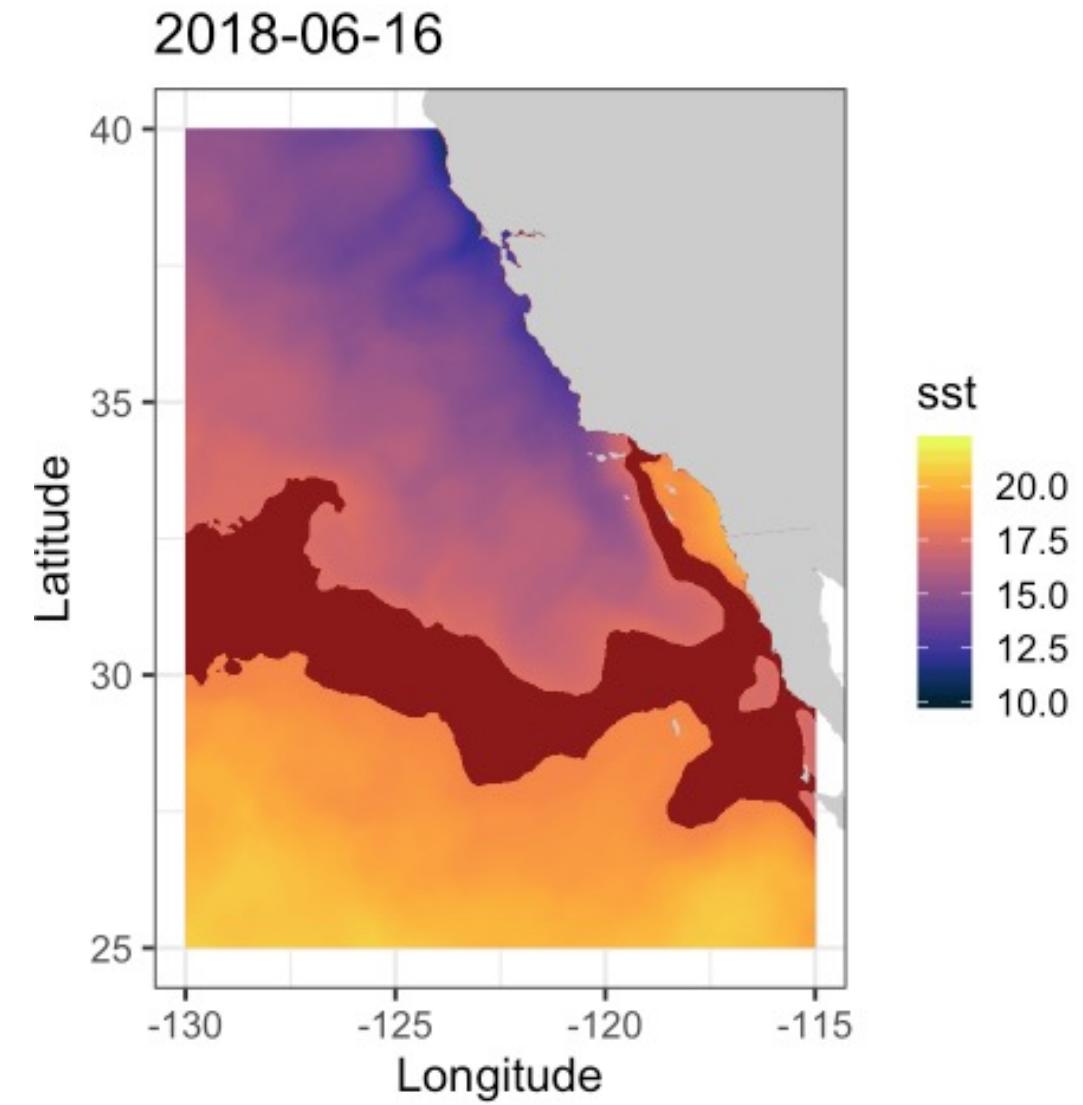
- uses the `tabledap` function in `rerddap` to download SST data from NDBC buoys
- the **`rxtracto`** function is used to extract satellite SST from those same buoy locations
- The satellite and buoy SSTs are plotted
- Buoy SST data are overlain on a map of satellite SST

VIIRS and NDBC buoy SST
2018-08-05



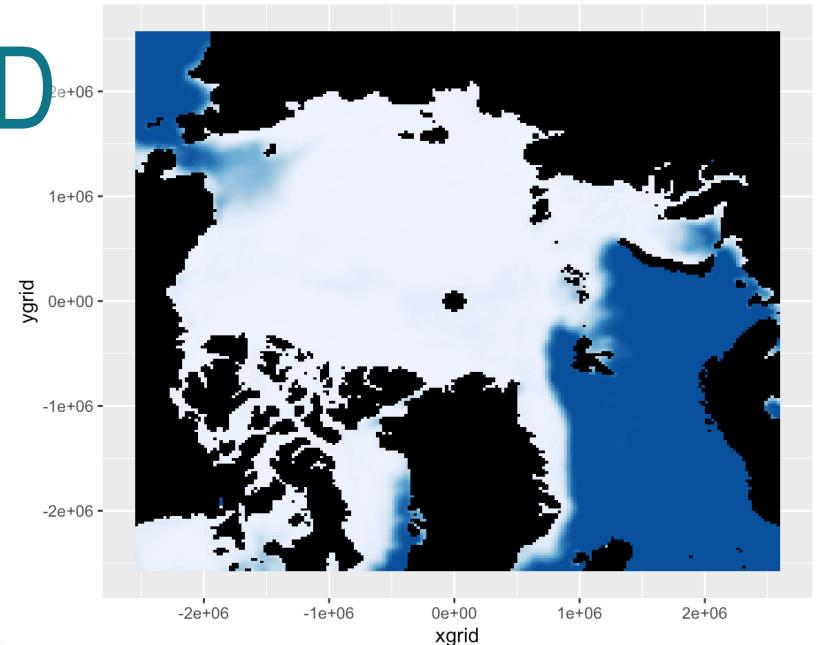
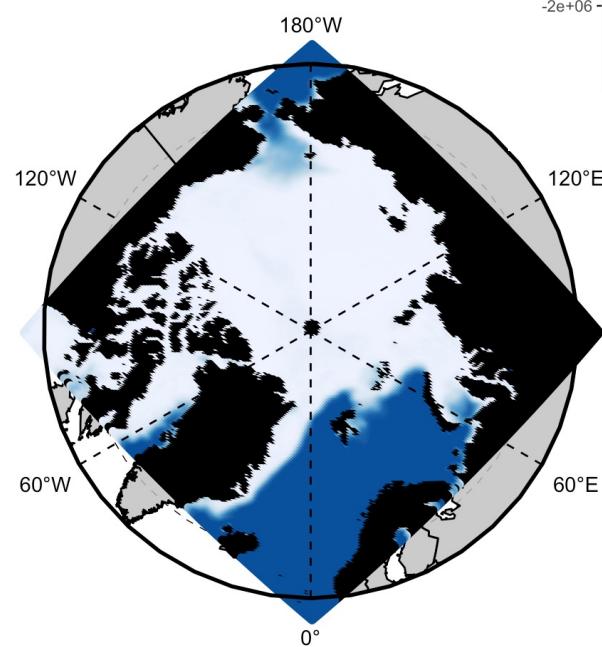
06-TurtleWatch.RMD

- Uses **rxtracto_3D** to import SST data from ERDDAP
- Identifies potential turtle habitat assuming a specific temperature range
- Uses ggplot graphics to make map



08-Mapping_Projected_Datasets.RMD

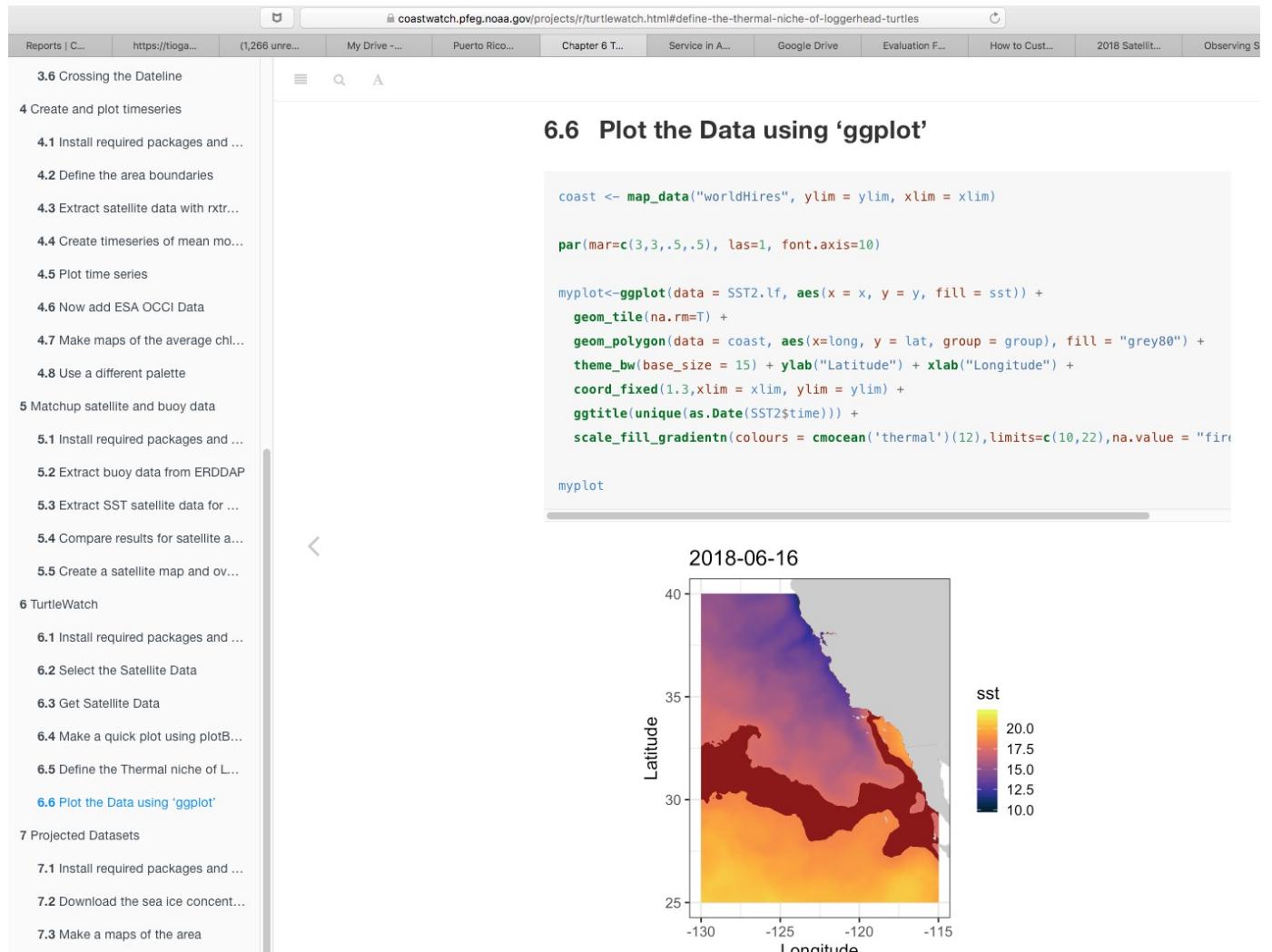
- Shows how to download the associated latitude/longitude grid of a projected dataset and get the desired indices (defined by lat & lon) of the projected dataset
- Makes several different maps of the downloaded data



Online R Tutorial

All these scripts are available online, along with the output generated by them.

Also available on GitHub:
https://github.com/CoastWatch-WestCoast/course_lessons/



The screenshot shows a web browser window with the URL coastwatch.pfeg.noaa.gov/projects/r/turtlewatch.html#define-the-thermal-niche-of-loggerhead-turtles. The page displays a sidebar with a table of contents for an R tutorial. The main content area shows an R script titled "6.6 Plot the Data using 'ggplot'" and a resulting heatmap plot.

Table of Contents:

- 3.6 Crossing the Dateline
- 4 Create and plot timeseries
 - 4.1 Install required packages and ...
 - 4.2 Define the area boundaries
 - 4.3 Extract satellite data with rxr...
 - 4.4 Create timeseries of mean mo...
 - 4.5 Plot time series
 - 4.6 Now add ESA OCCI Data
 - 4.7 Make maps of the average chl...
 - 4.8 Use a different palette
- 5 Matchup satellite and buoy data
 - 5.1 Install required packages and ...
 - 5.2 Extract buoy data from ERDDAP
 - 5.3 Extract SST satellite data for ...
 - 5.4 Compare results for satellite a...
 - 5.5 Create a satellite map and ov...
- 6 TurtleWatch
 - 6.1 Install required packages and ...
 - 6.2 Select the Satellite Data
 - 6.3 Get Satellite Data
 - 6.4 Make a quick plot using plotB...
 - 6.5 Define the Thermal niche of L...
 - 6.6 Plot the Data using 'ggplot'
- 7 Projected Datasets
 - 7.1 Install required packages and ...
 - 7.2 Download the sea ice concent...
 - 7.3 Make a maps of the area

R Script (6.6 Plot the Data using 'ggplot'):

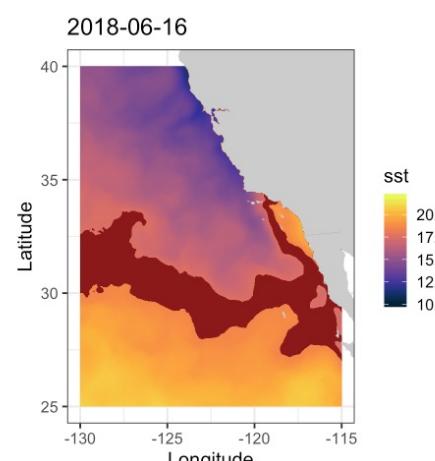
```
coast <- map_data("worldHires", ylim = ylim, xlim = xlim)

par(mar=c(3,3,.5,.5), las=1, font.axis=10)

myplot<-ggplot(data = SST2.lf, aes(x = x, y = y, fill = sst)) +
  geom_tile(na.rm=T) +
  geom_polygon(data = coast, aes(x=long, y = lat, group = group), fill = "grey80") +
  theme_bw(base_size = 15) + ylab("Latitude") + xlab("Longitude") +
  coord_fixed(1.3,xlim = xlim, ylim = ylim) +
  ggtitle(unique(as.Date(SST2$time))) +
  scale_fill_gradientn(colours = cmocean('thermal')(12),limits=c(10,22),na.value = "firebrick4")

myplot
```

Heatmap Plot (2018-06-16):



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



Online Tutorials

Introduction to ERDDAP

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

Using the R package rerddapXtracto

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

Working with netCDF file and satellite data with ArcGIS

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

