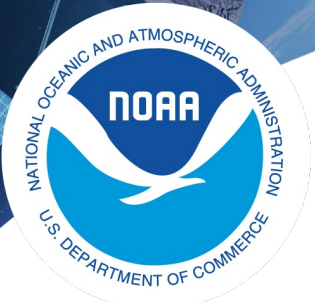




R and ERDDAP

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 Mendelssohn (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_Ch1 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

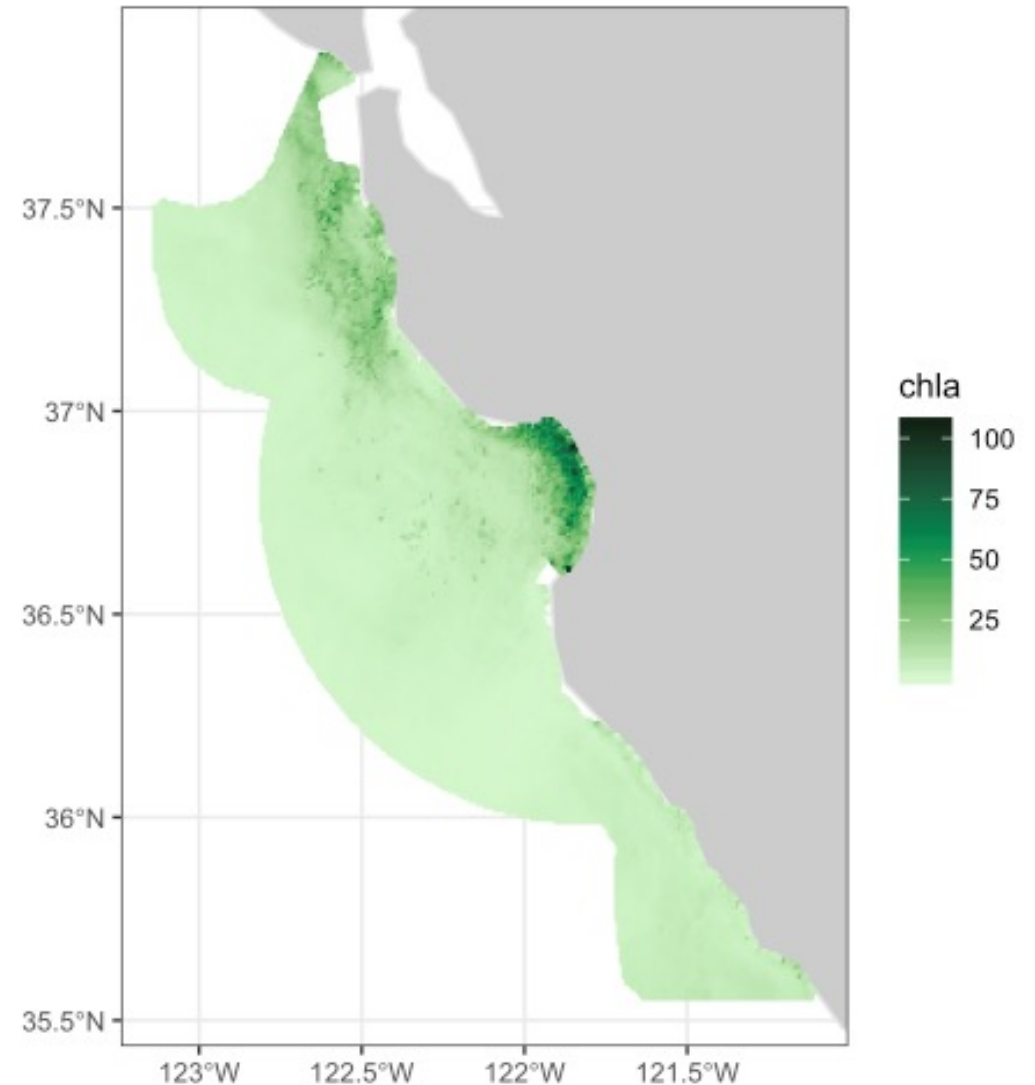
06-TurtleWatch uses **rxtracto_3d** function to import SST data ands apply a temperature threshold to look at turtle habitat

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

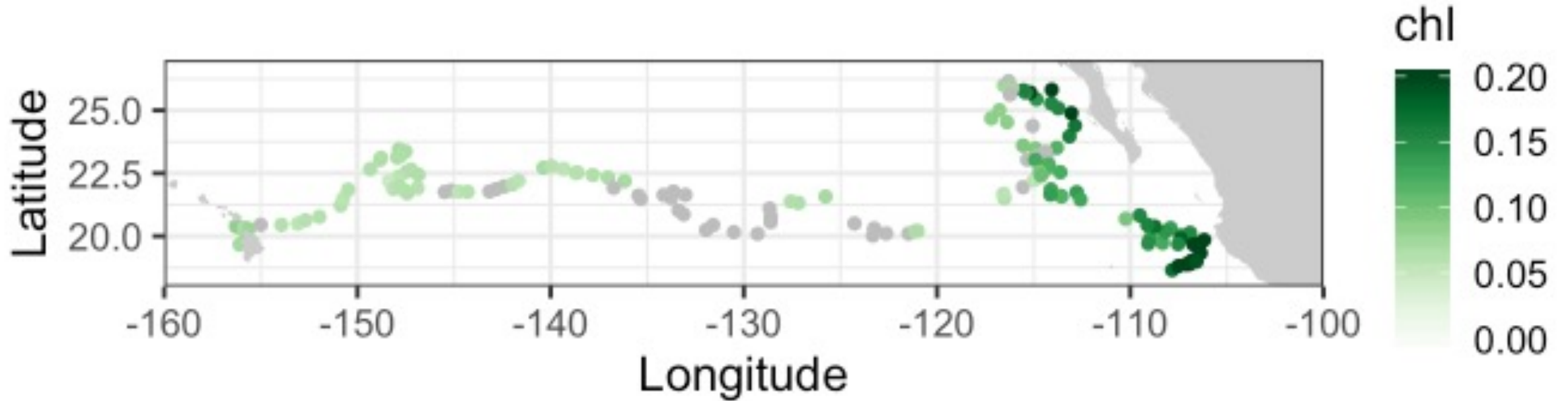


02-Sanctuary.RMD

- **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

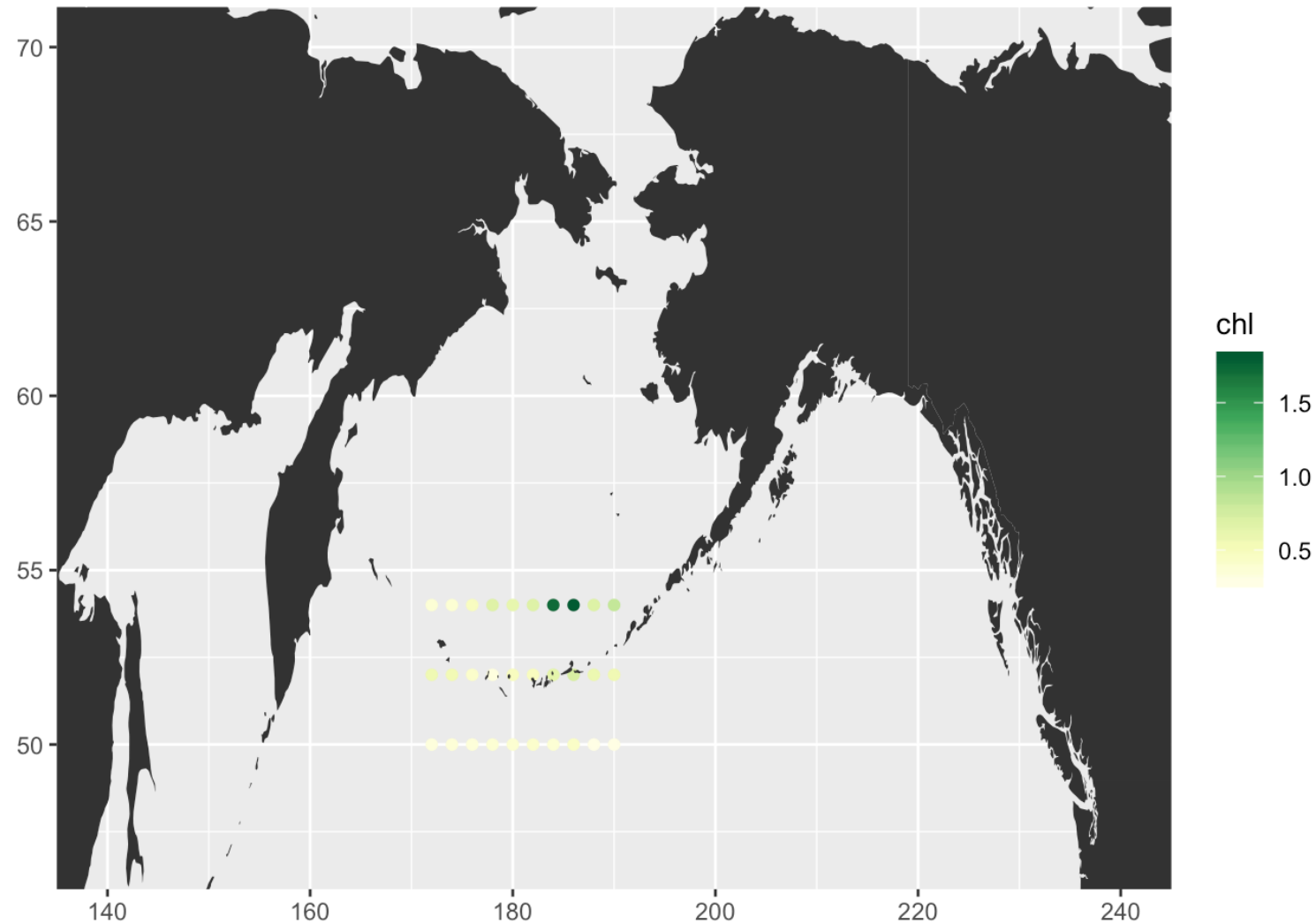


- The telemetry file (lat, lon and time) of a tagged marlin is read in
- Chlorophyll is selected as the satellite data
- **rxtracto** function used to extract satellite values around the tagged points
- Plots the track with points color-coded by chlorophyll value

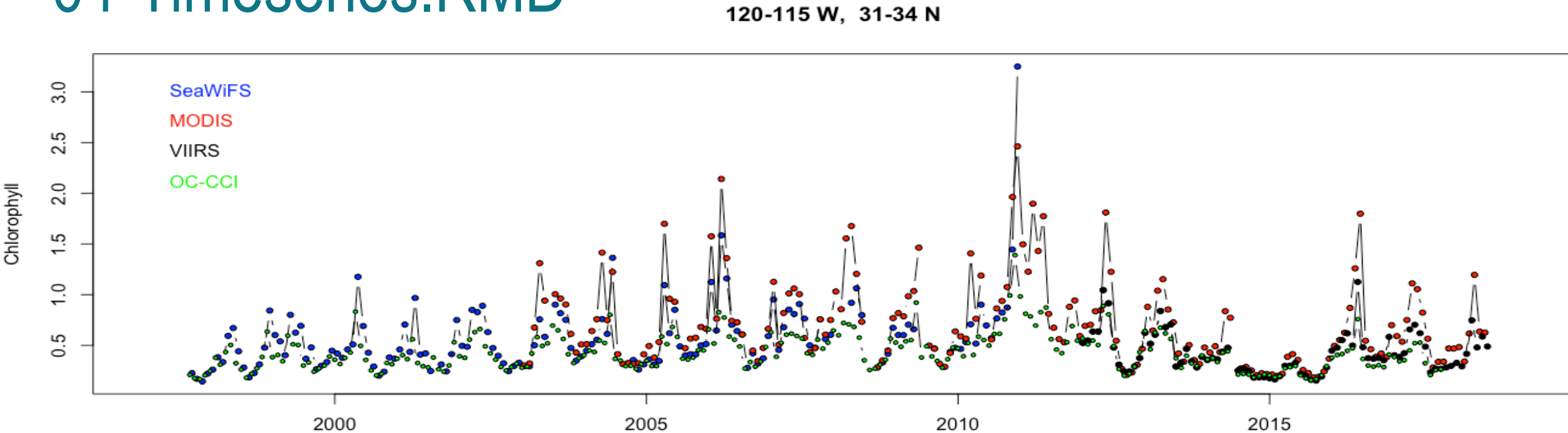


03-xyt_matchup.RMD

- 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

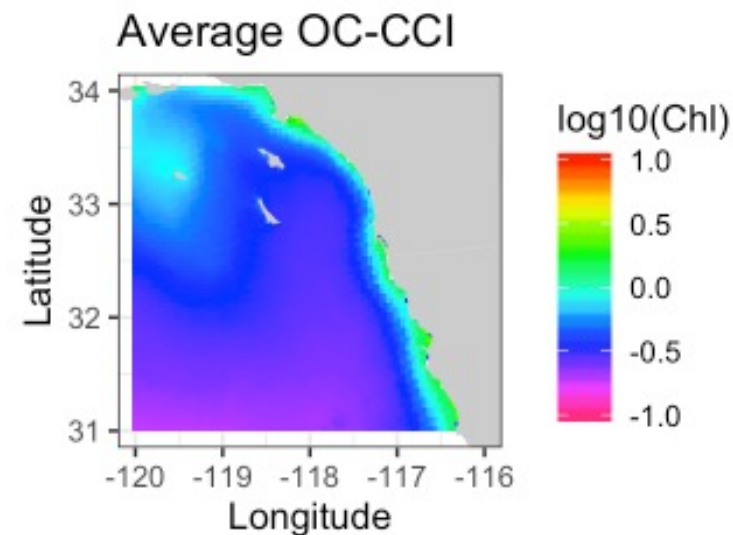
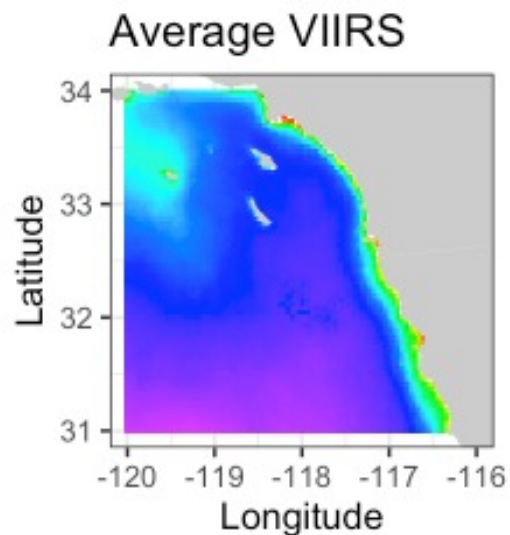
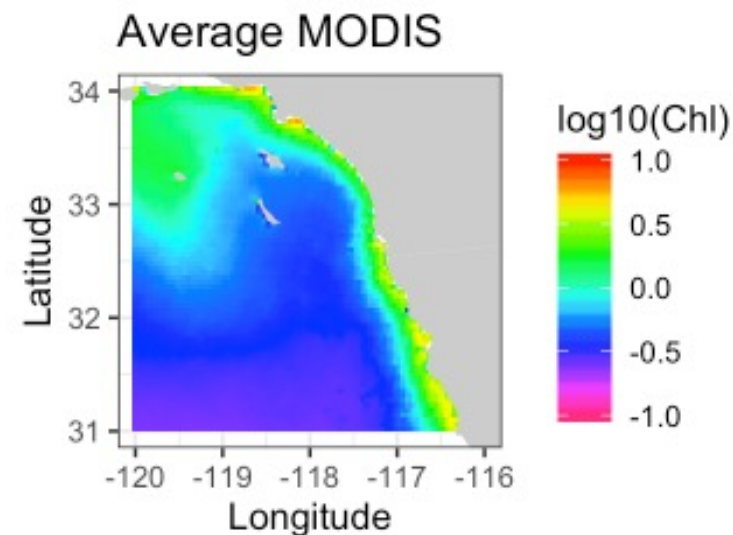
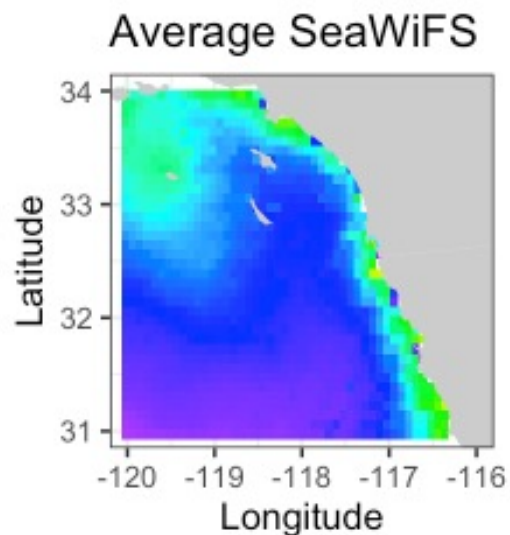


- **rxtracto_3D** function used to download 3D cubes (lat, long and time) of 4 different chlorophyll datasets: SeaWiFS, MODIS, VIIRS, and OC-CCI
- Each dataset is spatially averaged into a timeseries
- Each dataset is temporally averaged into a map



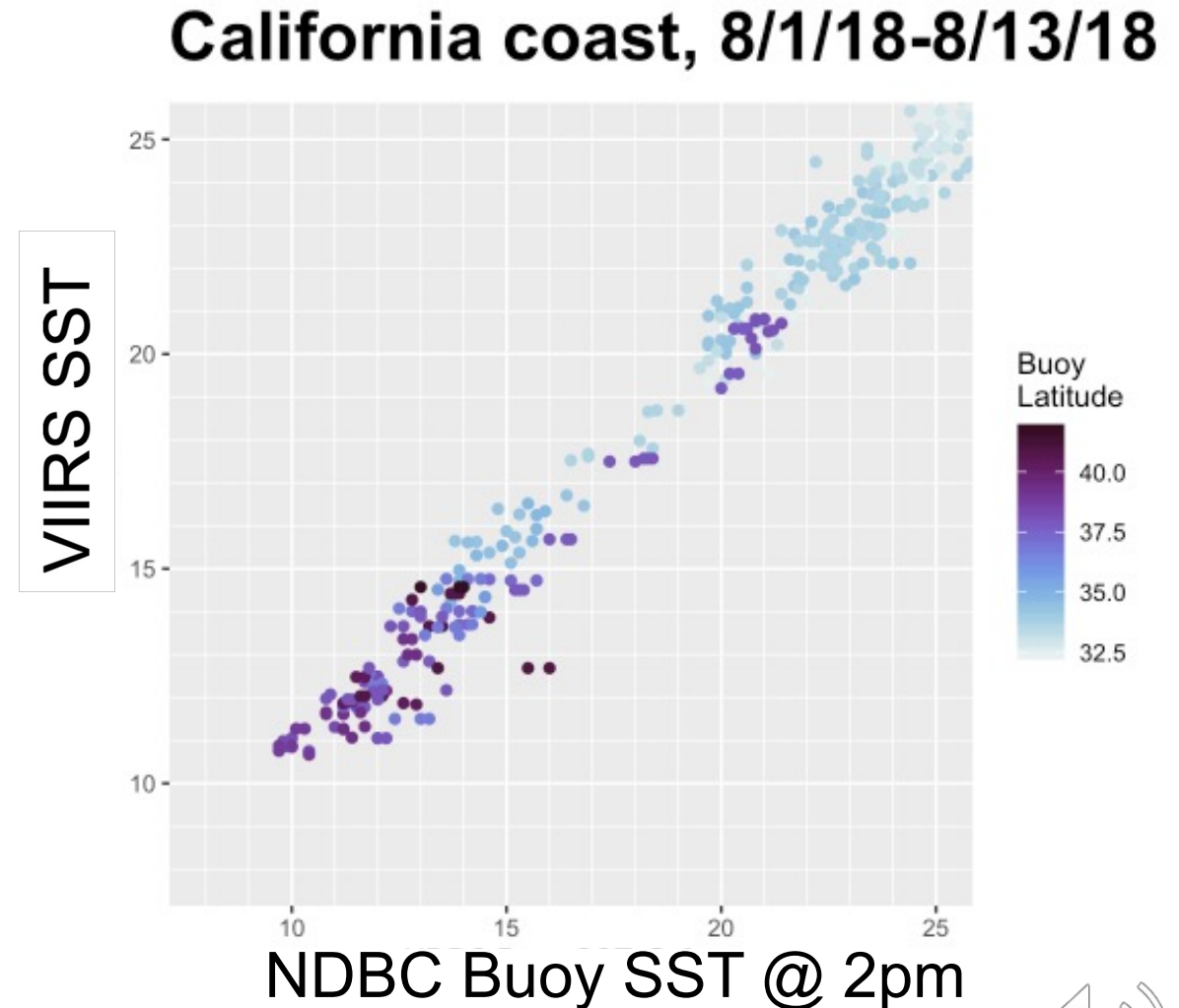
04-Timeseries.RMD

- **rxtracto_3D** function used to download 3D cubes (lat, long and time) of 4 different chlorophyll datasets: SeaWiFS, MODIS, VIIRS, and OC-CCI
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05-SSTBuoy.RMD

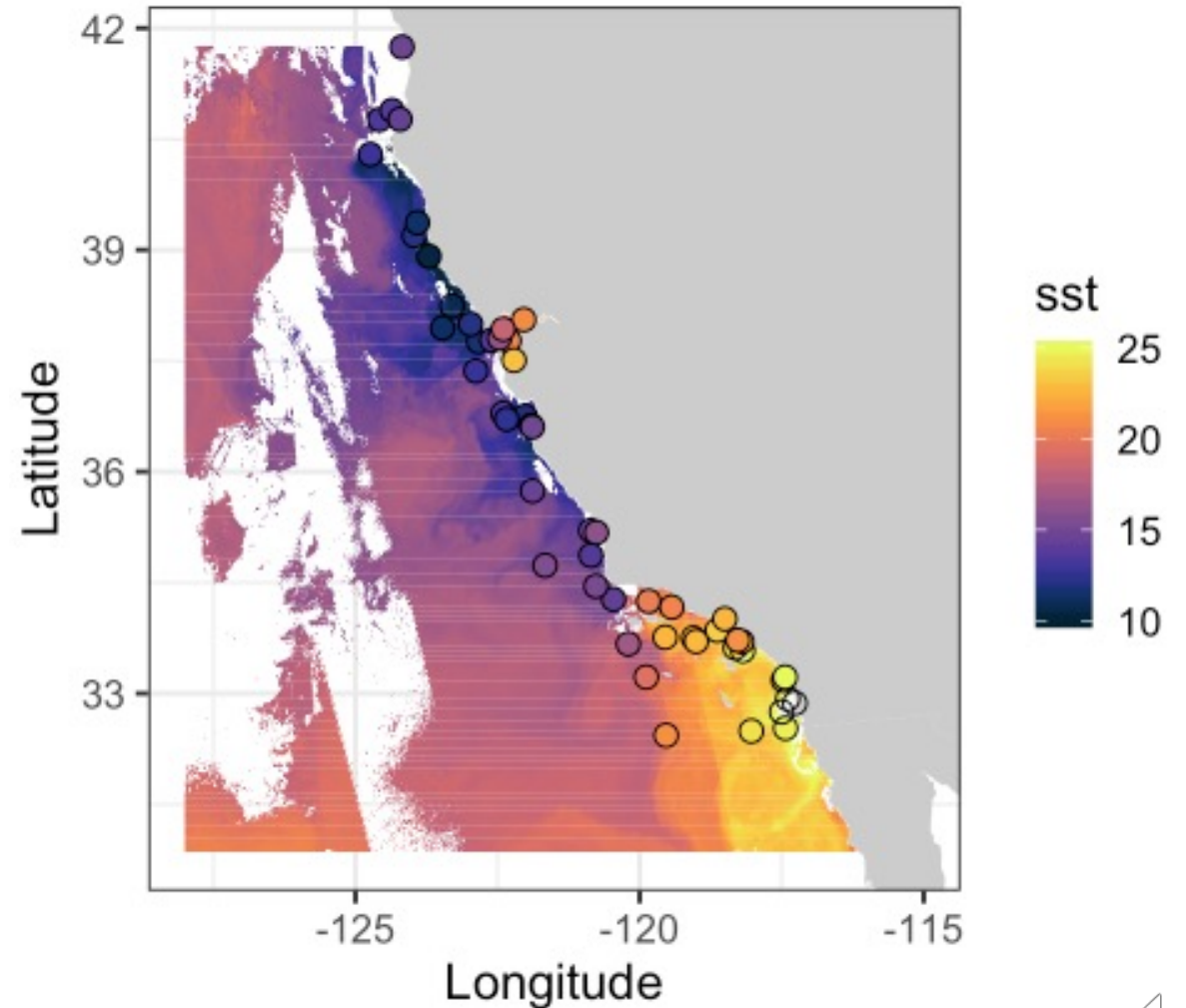
- uses the `tabledap` function in `rerddap` to download SST data from NDBC buoys
- the **`rxtracto`** function is used to extract satellite SST from those same buoy locations
- The satellite and buoy SSTs are plotted
- Buoy SST data are overlain on a map of satellite SST



05-SSTBuoy.RMD

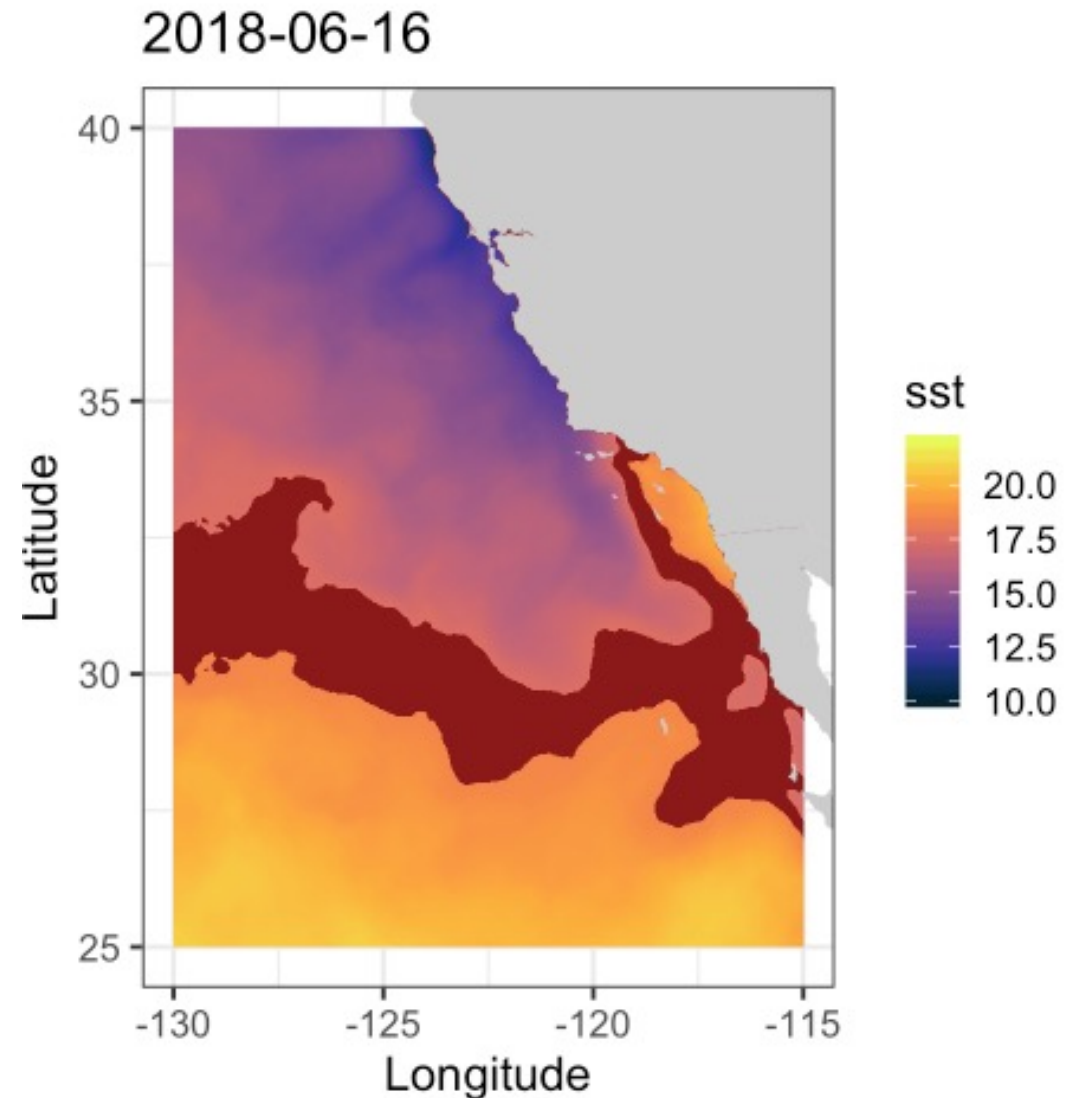
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- The satellite and buoy SSTs are plotted
- Buoy SST data are overlain on a map of satellite SST

VIIRS and NDBC buoy SST
2018-08-05



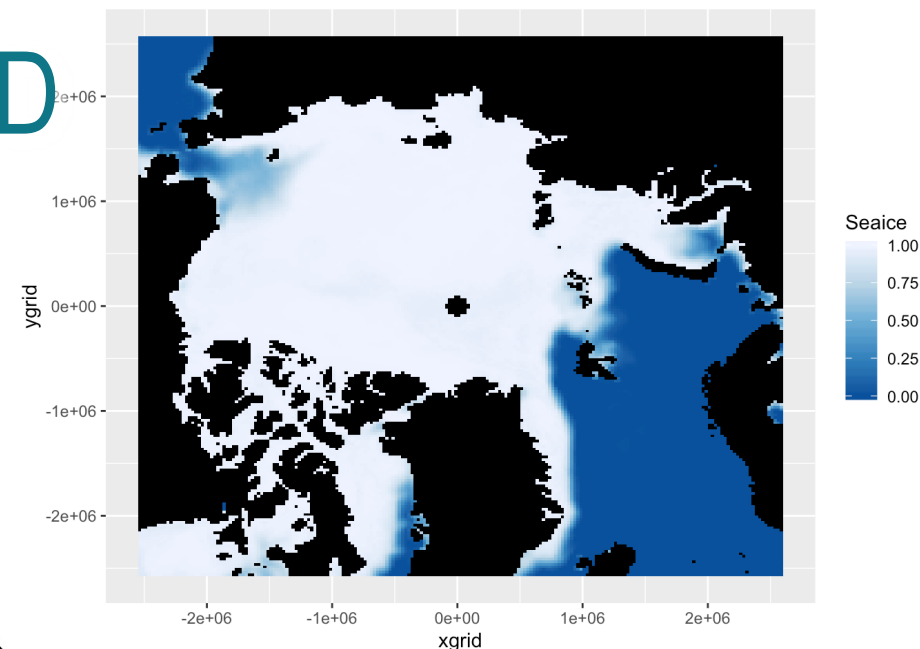
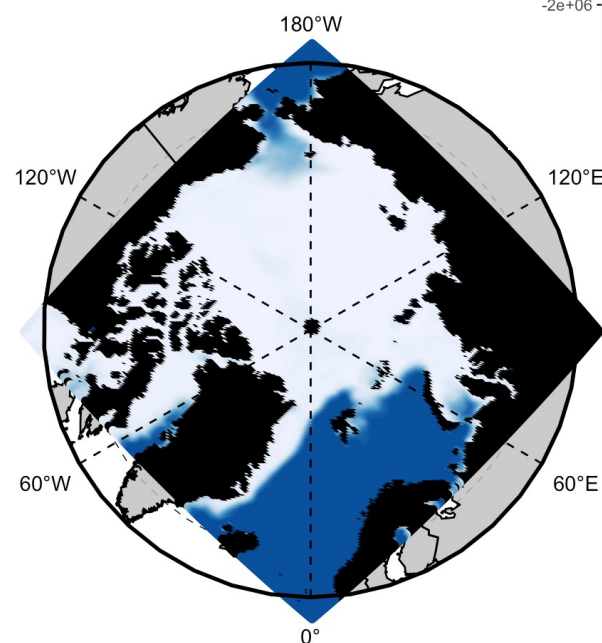
06-TurtleWatch.RMD

- 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

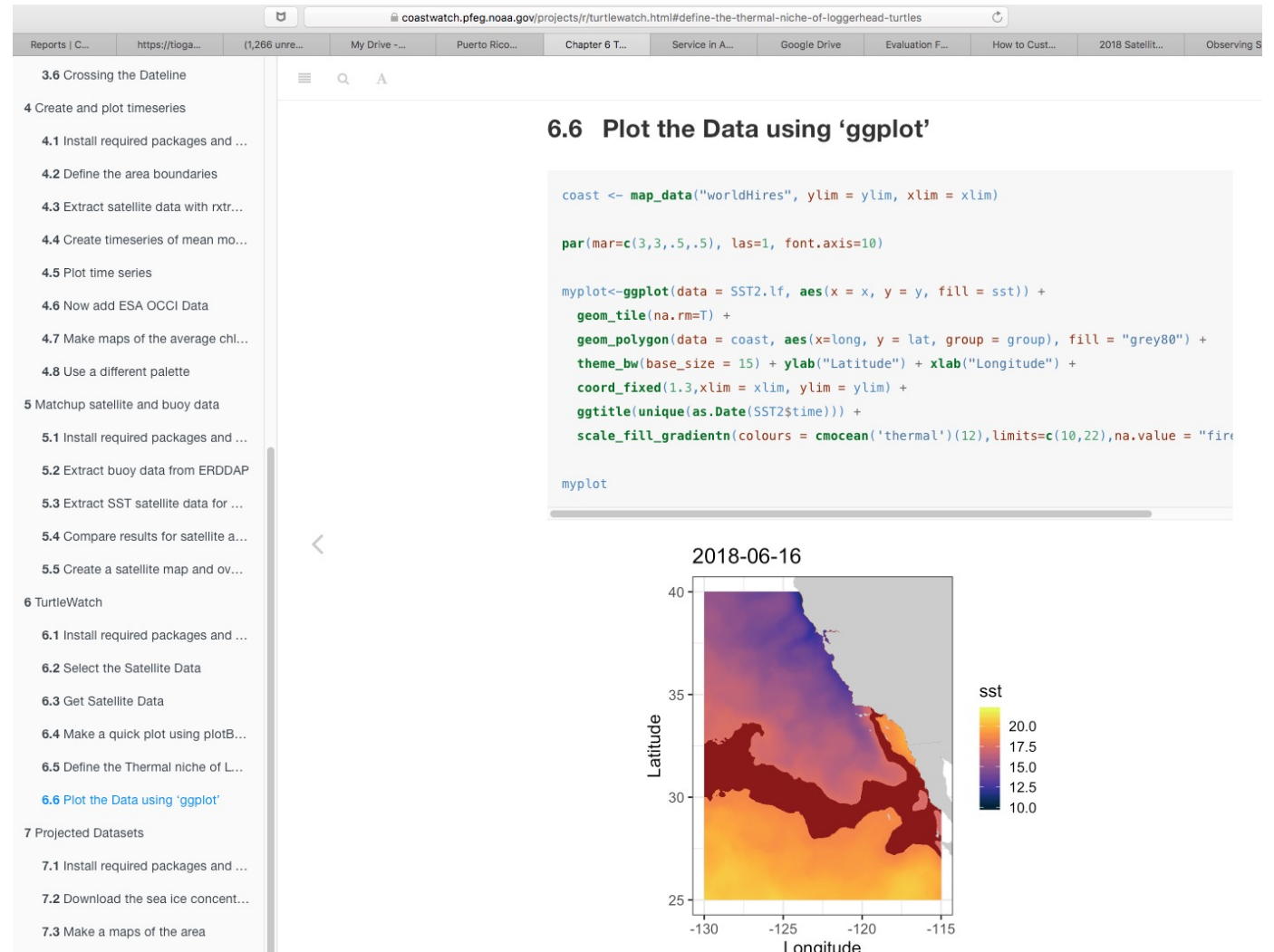
- Shows how to download the associated latitude/longitude grid of a projected dataset and get the desired indices (defined by lat & lon) of the projected dataset
- Makes several different maps of the downloaded data



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 the NOAA CoastWatch R tutorial website. On the left is a sidebar with a list of lessons. Lesson 6.6, 'Plot the Data using 'ggplot'', is highlighted. The main content area on the right displays the R code for this lesson, which uses 'ggplot2' to create a map of Sea Surface Temperature (SST) for June 16, 2018. Below the code is a plot titled '2018-06-16' showing SST data for the West Coast of the United States. The plot has 'Latitude' on the y-axis (ranging from 25 to 40) and 'Longitude' on the x-axis (ranging from -130 to -115). A color scale on the right indicates SST values from 10.0 to 20.0.

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 rxtr...

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

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 = "fire")

myplot
```

2018-06-16

Latitude

Longitude

sst

20.0

17.5

15.0

12.5

10.0

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



Online Tutorials

Introduction to ERDDAP

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

Using the 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/>

