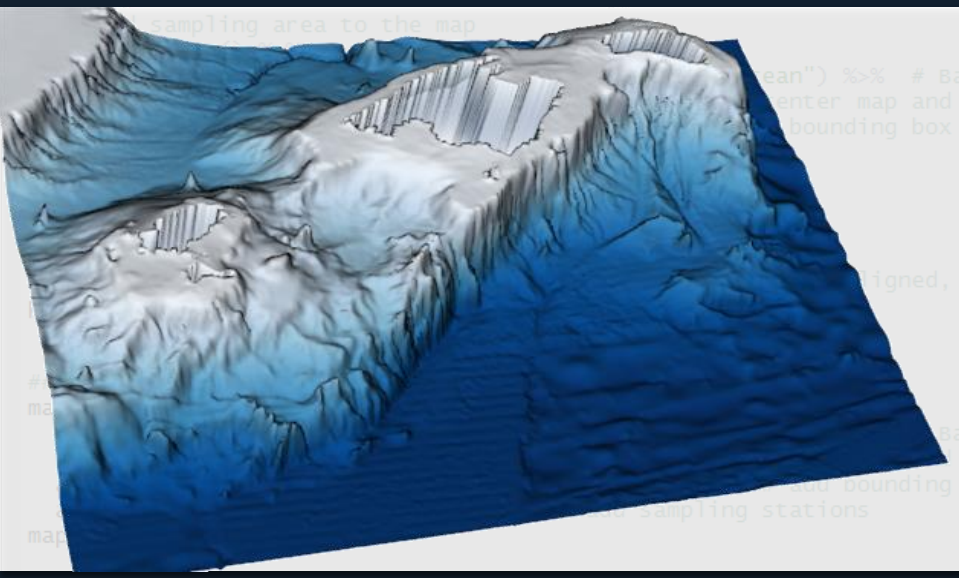
SOCIB Balearic Islands Coastal Observing and Forecasting System



USING R TO WORK WITH MARINE SPATIAL DATA

Dr. David March

Postdoctoral Researcher

https://github.com/dmarch/r-marine

PALMA DE MALLORCA, 26 OCTOBER 2016

www.socib.es

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OUTLINE

- ❑ INTRODUCTION TO MARINE DATA
- ❑ INTRODUCTION TO R
- ❑ LESSON 1: VIRTUAL ECOLOGIST
- ❑ LESSON 2: BENTHIC TERRAIN MODELING
- ❑ LESSON 3: PELAGIC ECOSYSTEMS

```
#### Add sampling area to the map
map <- leaflet() %>%
  addProviderTiles("Esri.OceanBasemap", group="Esri Ocean") %>%  # Base map
  setView(lng=2.8, lat=39, zoom=8) %>%  # Position to center map and zoom level
  addPolygons(data=box, fillColor="transparent")  # add bounding box
map  # plot map

#### Spatial sampling
n = 100
type = "random"  # random, regular, stratified, nonaligned, hexagonal, clustered, Fibonacci
pts <- spsample(box, n, type)

#### Add sampling stations to the map
map <- leaflet() %>%
  addProviderTiles("Esri.OceanBasemap", group="Esri Ocean") %>%  # Base map
  setView(lng=2.8, lat=39, zoom=8) %>%  # Position to center map and zoom level
  addPolygons(data=box, fillColor="transparent") %>%  # add bounding box
  addCircles(data=pts, color = "red")  # add sampling stations
map  # plot map
```

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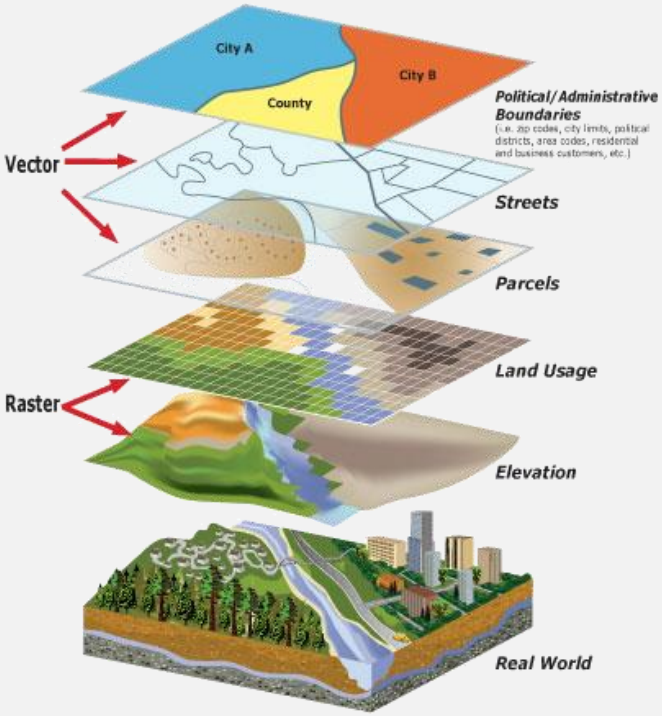
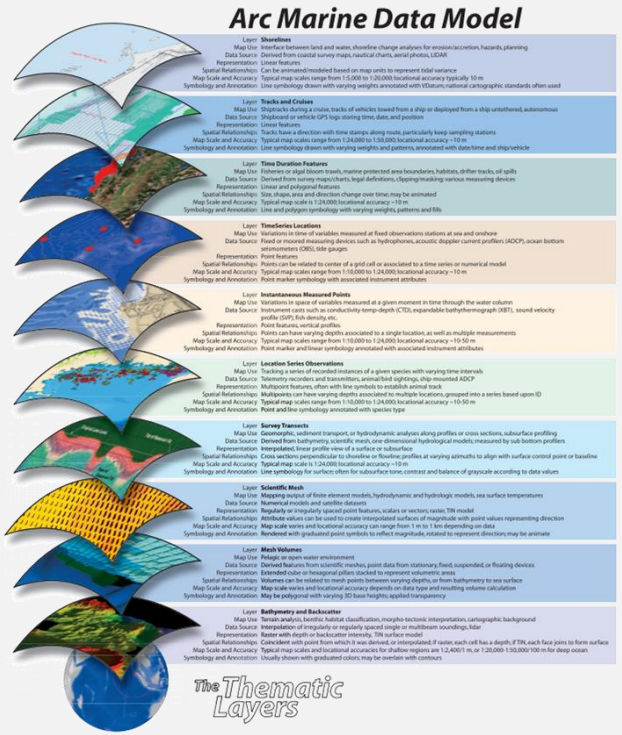
INTRODUCTION TO MARINE DATA

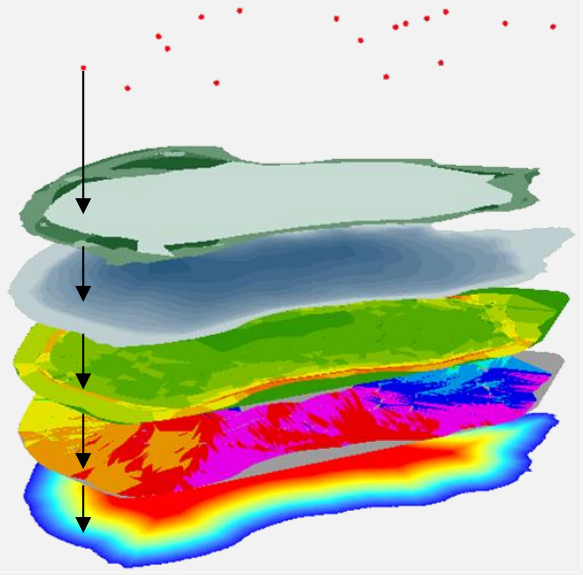
INTRODUCTION TO MARINE DATA - GIS AND MARINE DATA





QUESTION: Which of the two models (raster or vector) fits better your data?

INTRODUCTION TO MARINE DATA – SPATIAL OPERATIONS



Fish positions

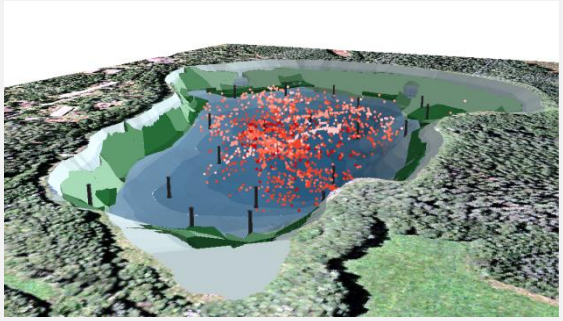
Macrophyte

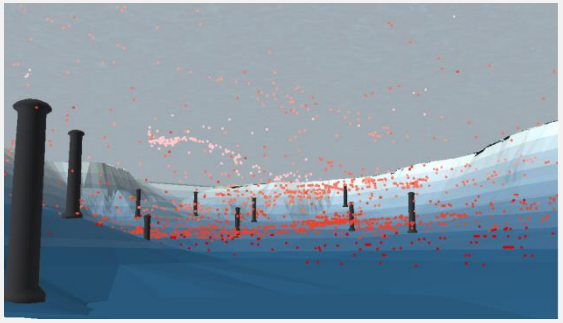
Depth

Slope

Orientation

Distance to shore





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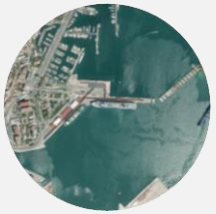
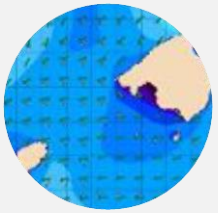
INTRODUCTION TO MARINE DATA – DATA TYPES

FIXED STATIONS
Eg. Buoys, Tide gauges

MOVING PLATFORMS
Eg. Gliders, Argo, Animals

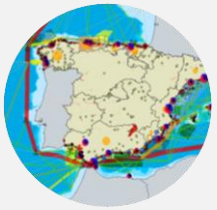


REMOTE SENSING
Eg. Satellite, ROV, Sonar



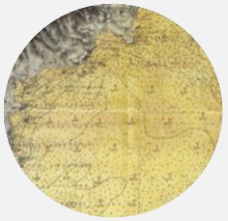
NUMERICAL MODELS
Ej. Waves, currents

BIODIVERSITY
Eg. Benthic, pelagic



HUMAN ACTIVITIES
Eg. Fisheries, aquaculture

LEGISLATION
Eg. MPA, jurisdictions



HISTORICAL DATA
Eg. documents, maps

QUESTION: What kind of data are you working with?

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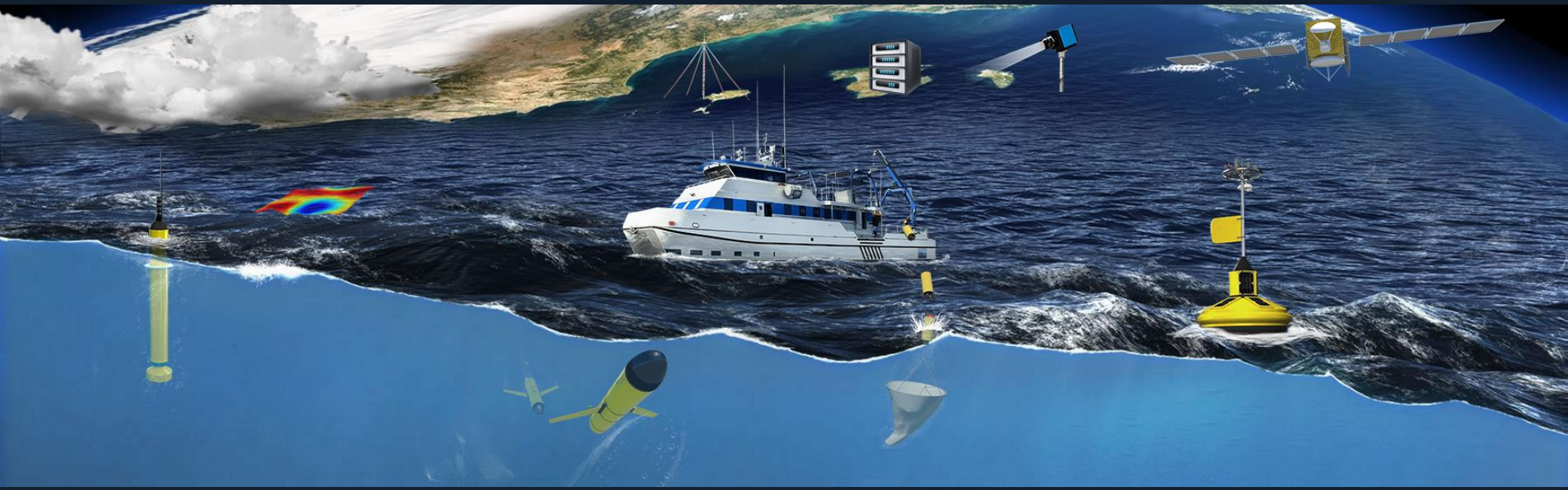
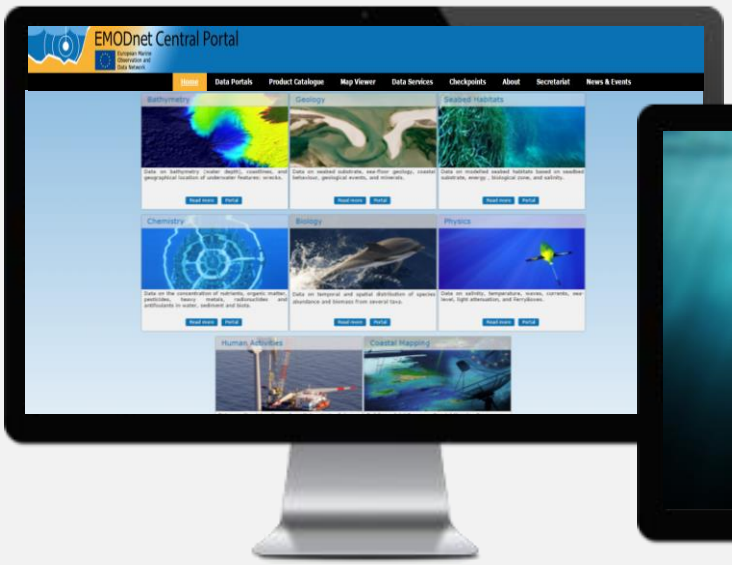
INTRODUCTION TO MARINE DATA – DATA ACQUISITION



Coastal and Ocean Observing Systems like SOCIB (www.socib.es) provide data streams in real time

INTRODUCTION TO MARINE DATA – MARINE OPEN DATA PORTALS



http://www.emodnet.eu

http://socib.es

http://marine.copernicus.eu

QUESTION: Do you know any web portal where you could download a marine dataset?

EXERCISE: Take a closer look to these 3 data portals and try to download a dataset of your interest

INTRODUCTION TO MARINE DATA – COMMON DATA FORMATS

QUESTION: Which electronic data formats do you know?

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INTRODUCTION TO R

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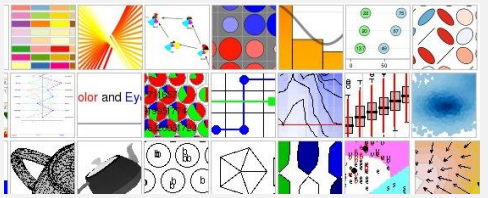
INTRODUCTION TO R - TOOLBOX

IMPORT / EXPORT

Eg. GDAL/OGR, Rcurl, RPostgreSQL

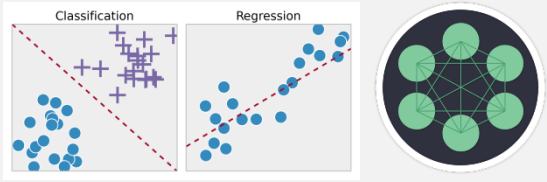
PROCESSING

Eg. Geotools, Proj4, raster



VISUALIZATION

Eg. maptools, plot, igraph



DATA ANALYSIS

Eg. GLM, GAM, MCMC, Boosted Regression Trees, Network Analysis, Simulation, SSM, ….

PARALLEL COMPUTING

Eg. parallel on Xeon X5687 (3.60 GHz quad-core) 64GB RAM

REPORTS & NOTIFICATIONS

Eg. Markdown

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INTRODUCTION TO R – SOME TIPS TO BETTER UNDERSTAND

```
#### Add sampling area to the map
map <- leaflet() %>%
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  setView(lng=2.8, lat=39, zoom=8) %>%  # Position to center map and zoom level
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type = "random"  # options: regular, random, stratified, nonaligned, hexagonal, clustered, Fibonacci
pts <- spsample(box, n, type)


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  addPolygons(data=box, fillColor="transparent") %>%  # add bounding box
  addCircles(data=pts, color = "red")  # add sampling stations
map  # plot map
```

#

comment

?

ask

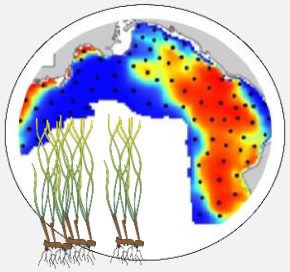
class()

inspect

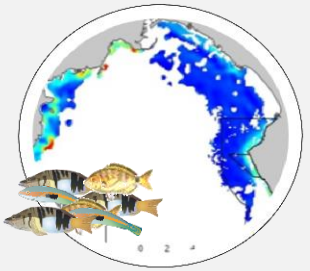
data.frame

your best friend

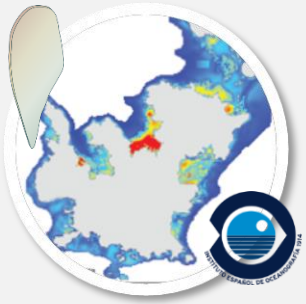
INTRODUCTION TO R – PRACTICAL APPLICATIONS



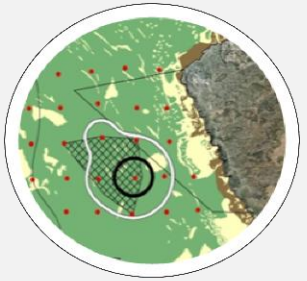
BENTHIC ECOSISTEMS
Bayesian models
March et al. 1013



FISHERIES
Generalized linear mixed model
March et al. 2014



BIODIVERSITY
Regression kriging
Vázquez et al. 2014



ANIMAL TELEMETRY
Home range, wavelets
March et al. 2010, 2011

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LESSON 1
VIRTUAL ECOLOGIST

- ✓ Create your first map
- ✓ Sampling desing
- ✓ Simulate simple distributions
- ✓ Import/export vectorial data

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LESSON 1 – DEFINE YOUR STUDY AREA

You could use a software like Google Earth to get longitude and latitude information about your sampling area

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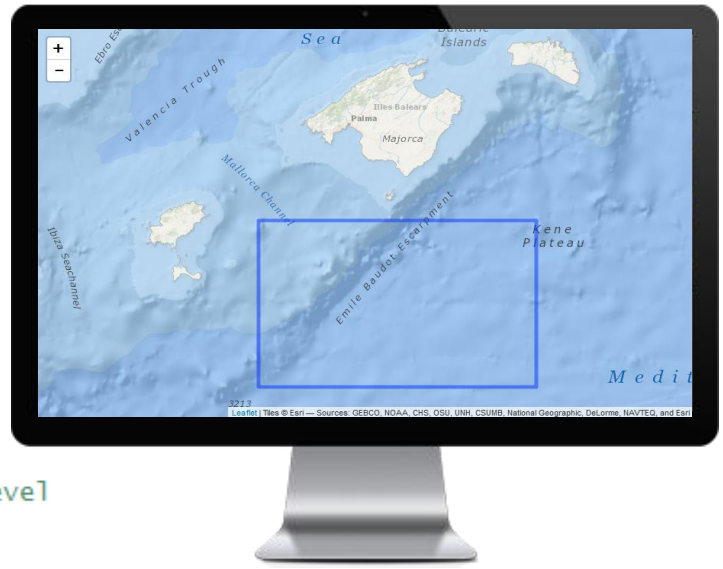
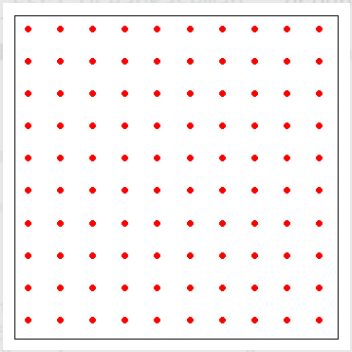
LESSON 1 – CREATE YOUR FIRST MAP

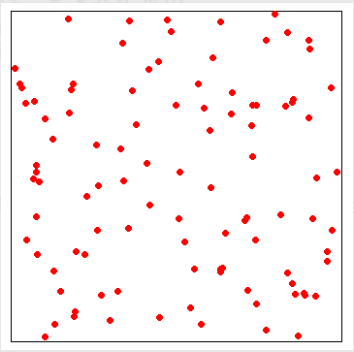
```
#-----------------------------------------------
# Part 1: Create your sampling area
#-----------------------------------------------
# Define your sampling area using a bounding box (x: longitude, y: latitude)
# Note: you can use Google Earth to explore your area, get latitude and longitude,
# and define your own
xmin = 2
xmax = 4
ymin = 38
ymax = 39
e <- extent(c(xmin, xmax, ymin, ymax)) # create extent
box <- as(e, "SpatialPolygons") # coerce to a SpatialPolygons object
plot (box)  # now the plot is not meaningful... we need some base maps
#-----------------------------------------------


#-----------------------------------------------
# Part 2: Create your first map using leaflet
#-----------------------------------------------
#### Add sampling area to the map
map <- leaflet() %>%
  addProviderTiles("Esri.OceanBasemap", group="Esri Ocean") %>%  # Base map
  setView(lng=2.8, lat=39, zoom=8) %>%  # Position to center map and zoom level
  addPolygons(data=box, fillColor="transparent")  # add bounding box
map  # plot map
#-----------------------------------------------
```



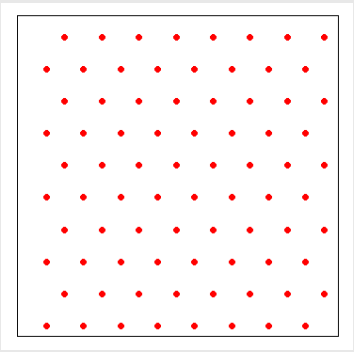
LESSON 1 – SPATIAL SAMPLING DESIGN



regular



random



hexagonal

Use spsample() to generate different sampling designs

EXERCISE: change "n" and "type" and plot the results

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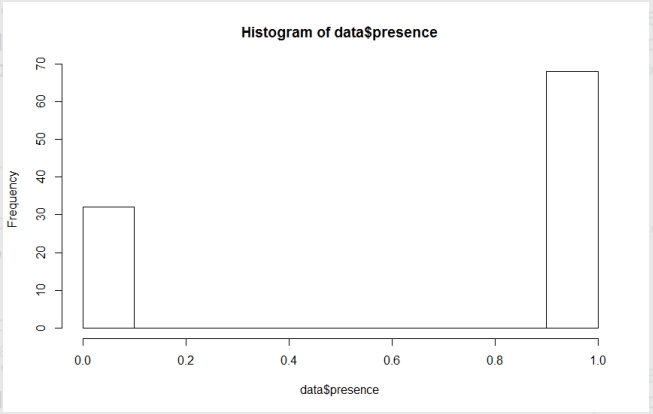
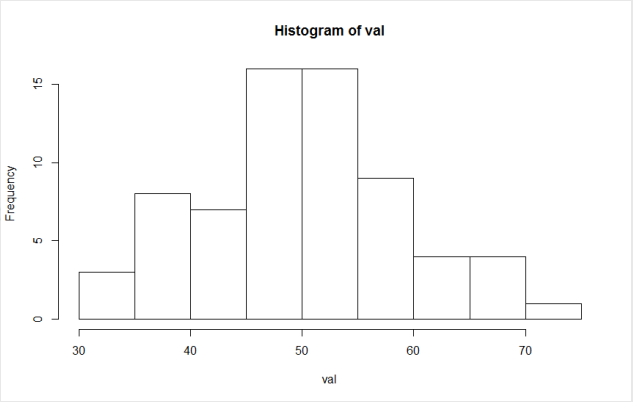
LESSON 1 – SIMULATE DISTRIBUTIONS



binomial



Gaussian

Use rbinom() and rnorm() to generate random numbers of binomial and Gaussian distributions, respectively

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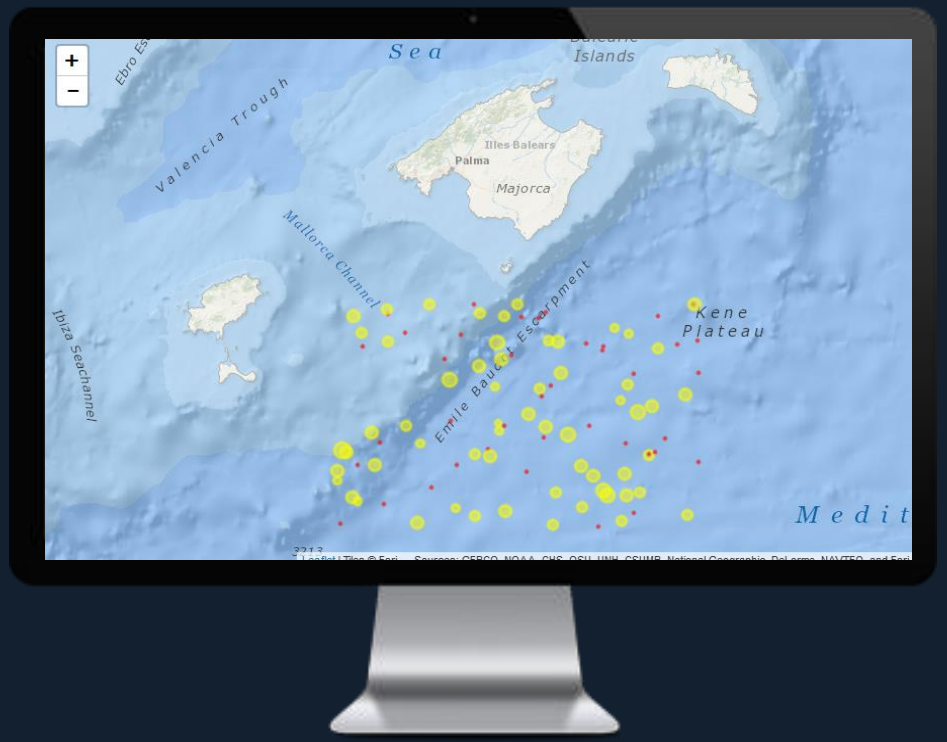
LESSON 1 – MAP YOUR DATA AND EXPORT DIFFERENT FORMATS



EXERCISE: Create a pop-up to display information associated to each sampling station

BONUS: Save your final map as a webpage

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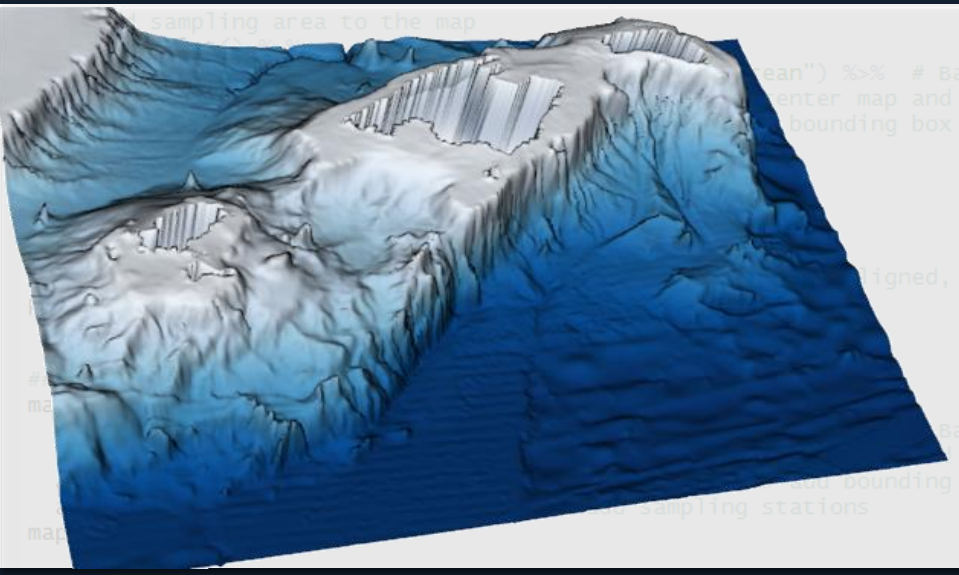

LESSON 2
BENTHIC TERRAIN MODELLING

- ✓ Access EMODnet data portal
- ✓ Conduct terrain analysis
- ✓ Plot your map in 3D
- ✓ Import/export gridded data

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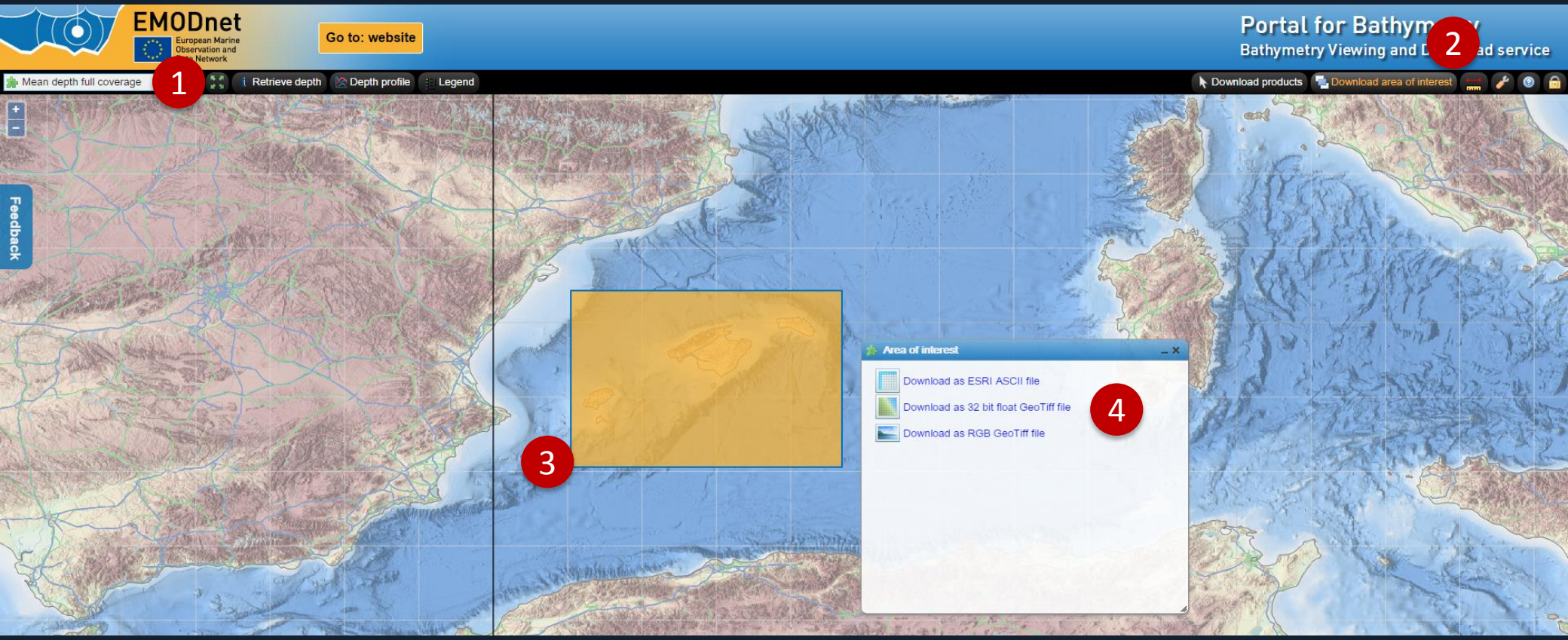
LESSON 2 - DOWNLOAD BATHYMETRY FROM EMODNET



http://portal.emodnet-bathymetry.eu/

1. Select product “Mean depth full coverage”
2. Download area of interest
3. Draw bounding box
4. Download as 32 bit float GeoTiff file

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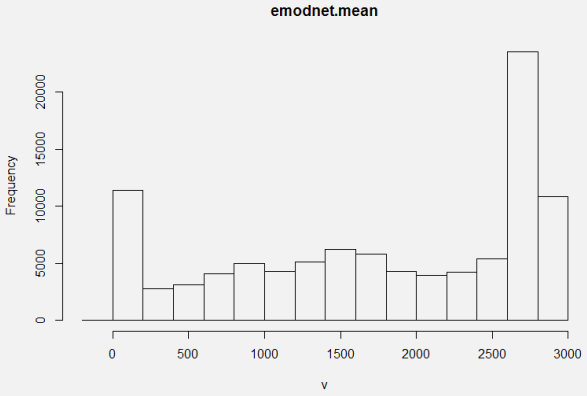
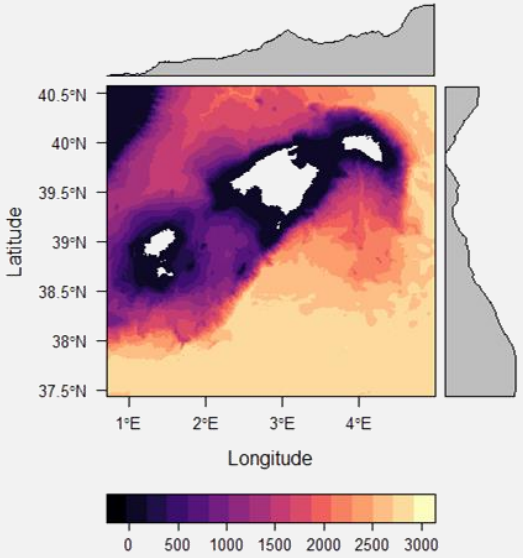
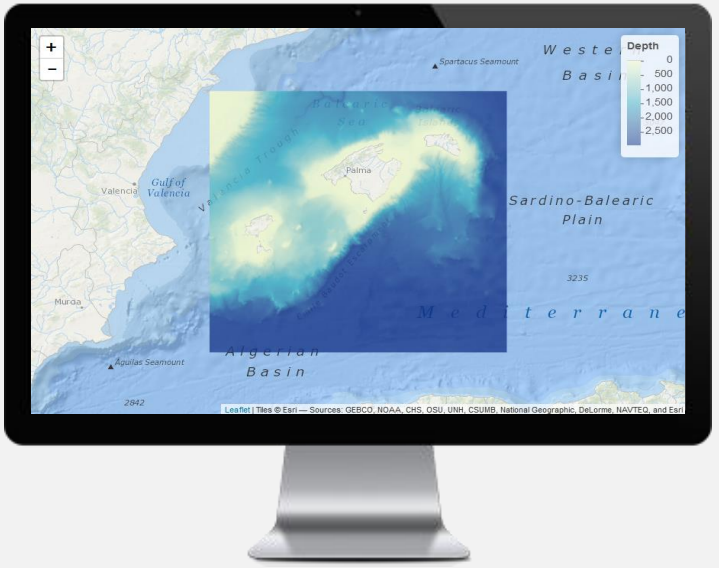
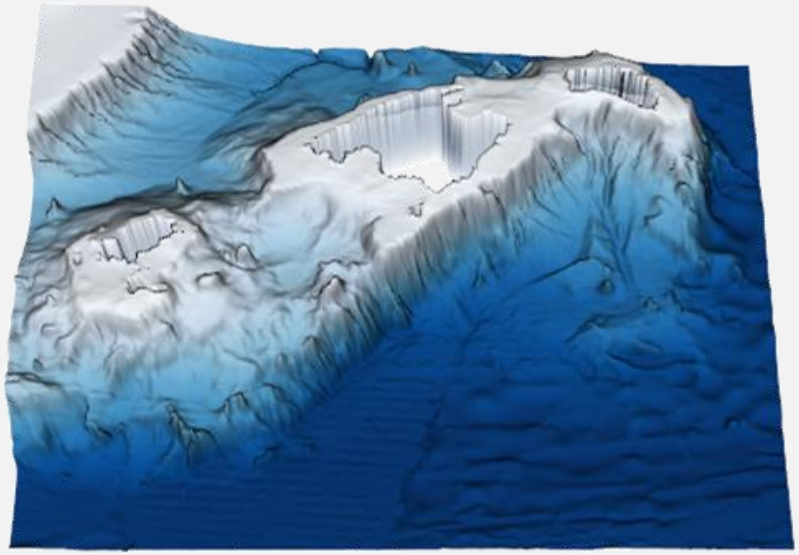
LESSON 2 – INSPECT THE BATHYMETRY AND CREATE YOUR MAP

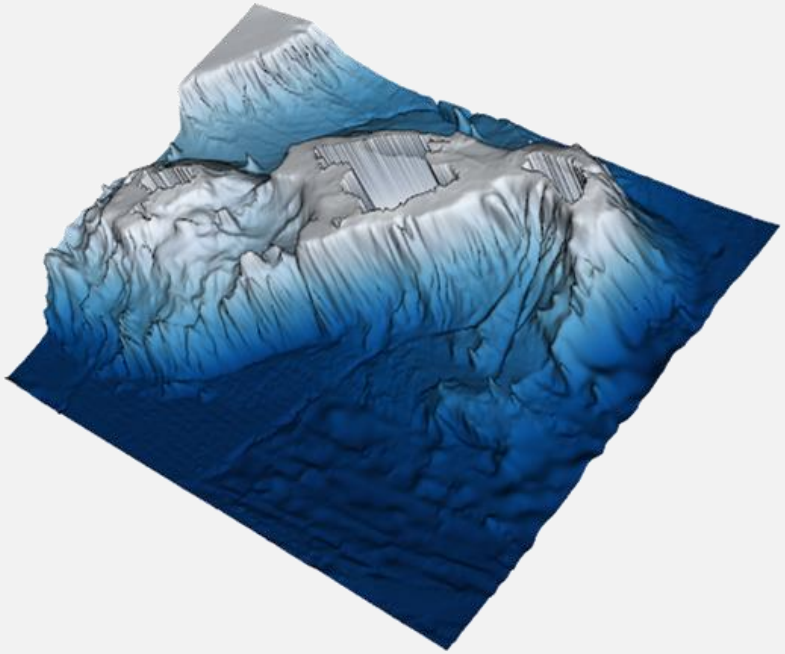






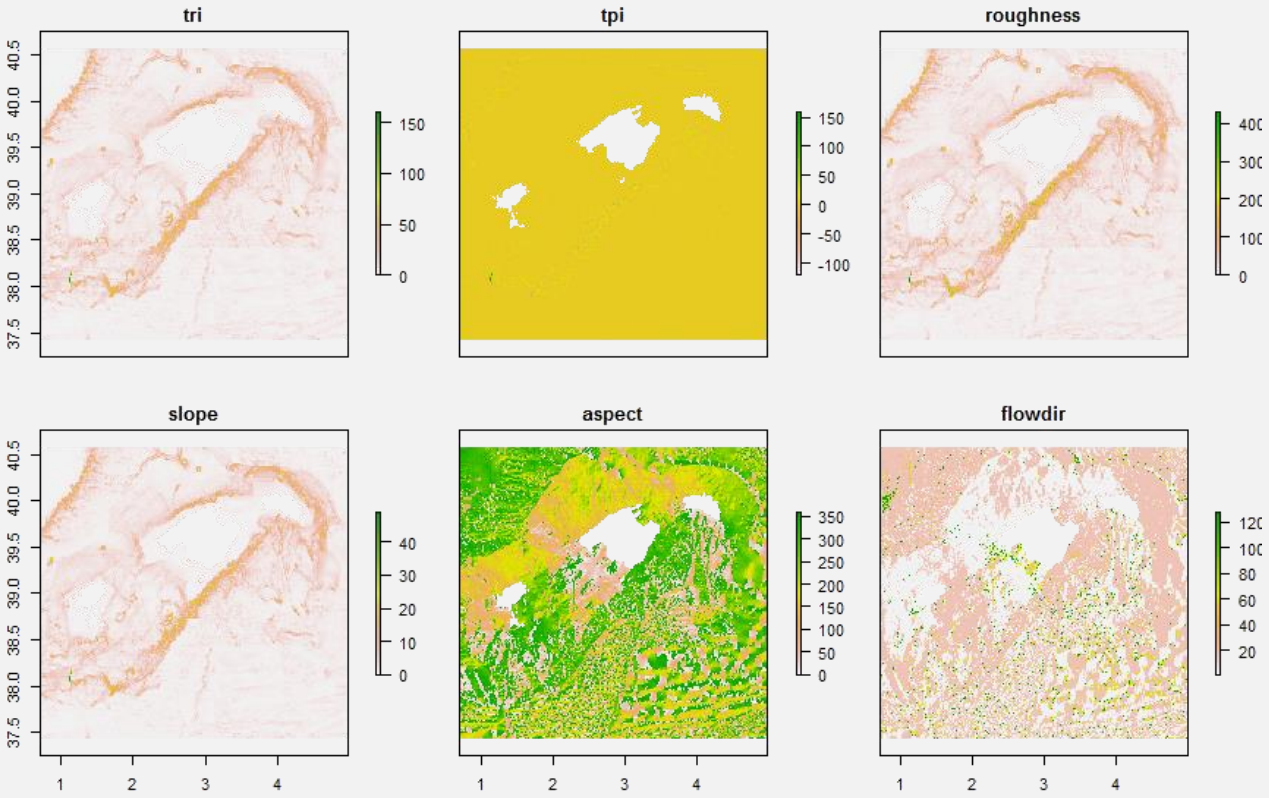
LESSON 3D – 3D PLOT

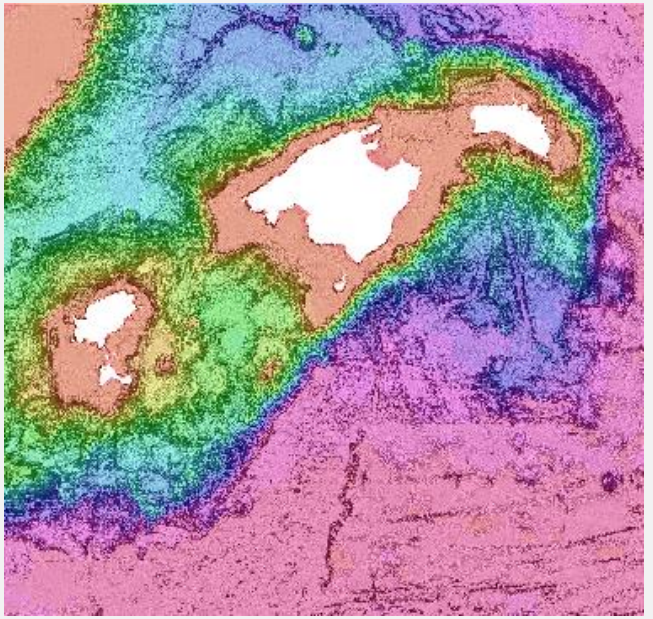




NOTE: Use map algebra to convert to negative values

LESSON 2 - BATHYMETRIC TERRAIN MODELING





Different terrain characteristics can be computed using terrain(). Combine slope and aspect to plot hillshade

EXERCISE: Use Pearson correlation coefficients to assess the correlation between terrain characteristics

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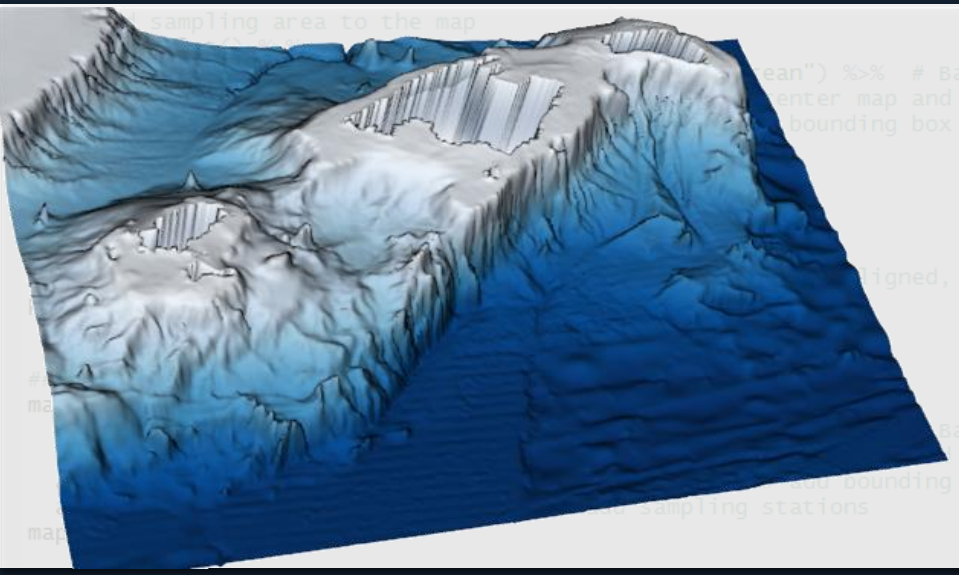
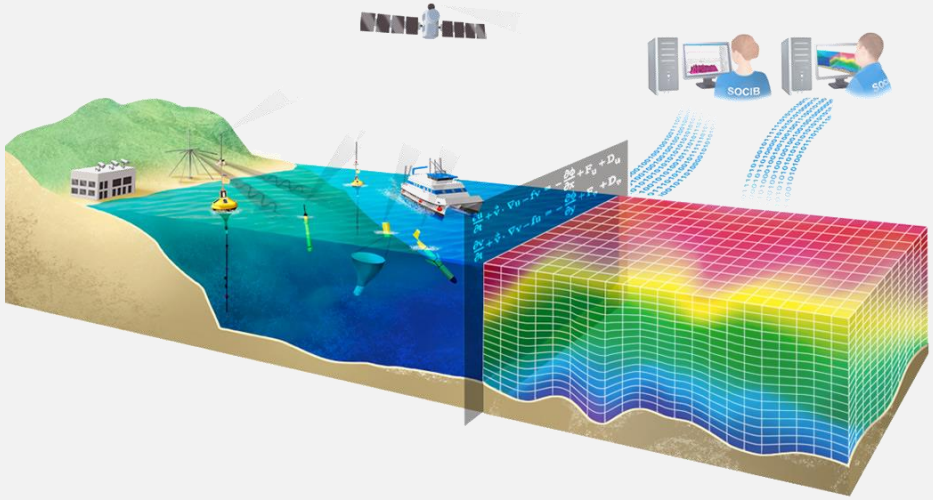


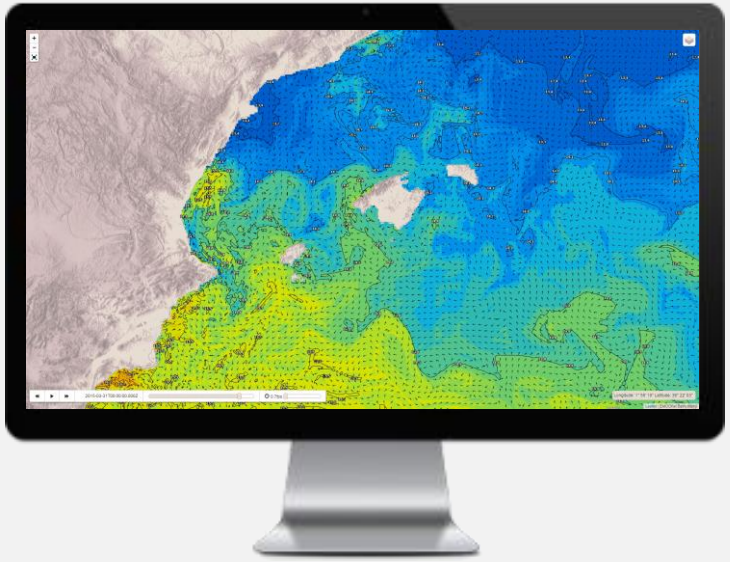
LESSON 3
PELAGIC ECOSYSTEMS

- ✓ Access SOCIB data portal
- ✓ Multidimensional data: ROMS model
- ✓ Spatial operations: overlay
- ✓ Plot time series

SOCIB

LESSON 3 – NUMERICAL MODELS





SOCIB

LESSON 3 - DOWNLOAD WMOP MODEL FROM SOCIB DATA PORTAL

Catalog http://thredds.socib.es/thredds/catalog.html

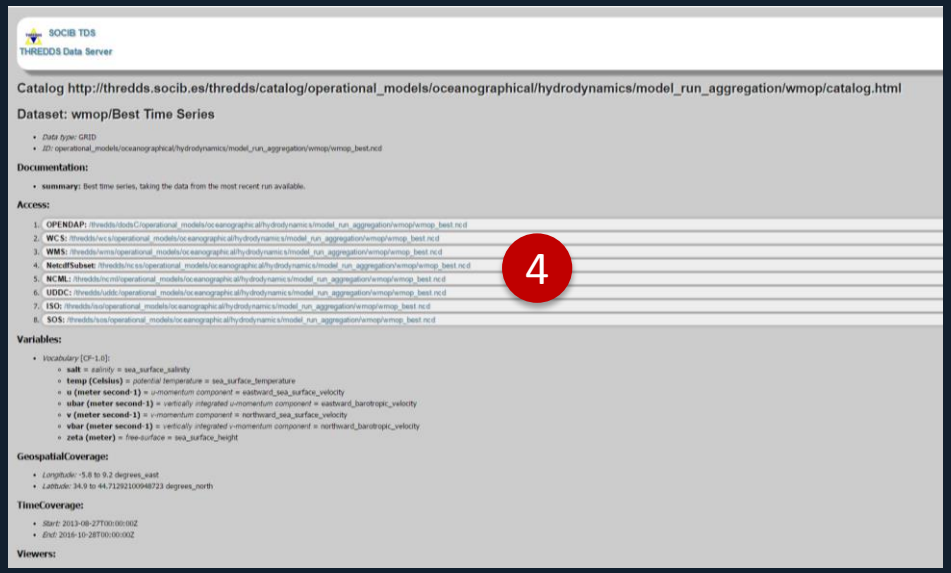
Dataset	Size	Last Modi
SOCIB DATA		
observational		
satellite/		
mooring/		
drifter/		
auv/		
hf_radar/		
research_vessel/		
aggregated_data/		
operational_models		
oceanographical		
hydrodynamics		
wmop/		
model_run_aggregation		
wmop/		

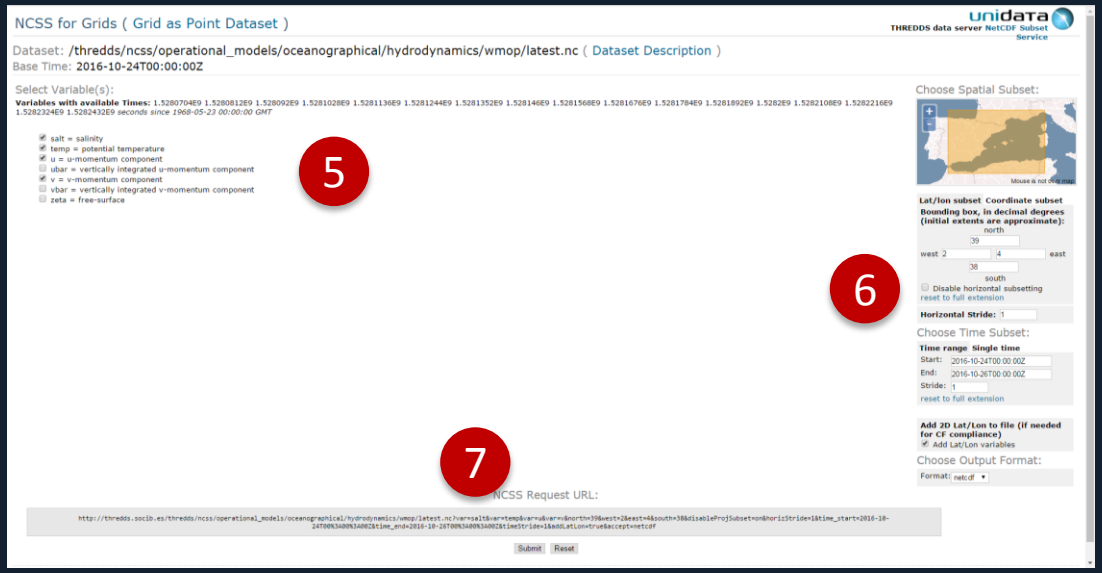
http://www.socib.es

1. Select Data Center
2. Clic on Data Access (THREDDS)
3. Model run aggregation of WMOP > Best Time Series

TIP: You can access directly to SOCIB Thredds catalog using http://thredds.socib.es/

LESSON 3 - DOWNLOAD WMOP MODEL FROM SOCIB DATA PORTAL





8

```
# Get data though NetcdfSubset service from SOCIB (http://thredds.socib.es/thredds)
url <- "http://thredds.socib.es/thredds/ncss/operational_models/oceanographical/hydrodynamics/wmop/latest.nc?var=salt&var
junk <- GET(url, write_disk("data/wmop.nc", overwrite = TRUE))
```

4 Select product “NetcdfSubset”

5 Select variables

6 Choose spatial and time subsets
Add Lat/lon

7 Copy NCSS Request Url

8 Paste url on R code

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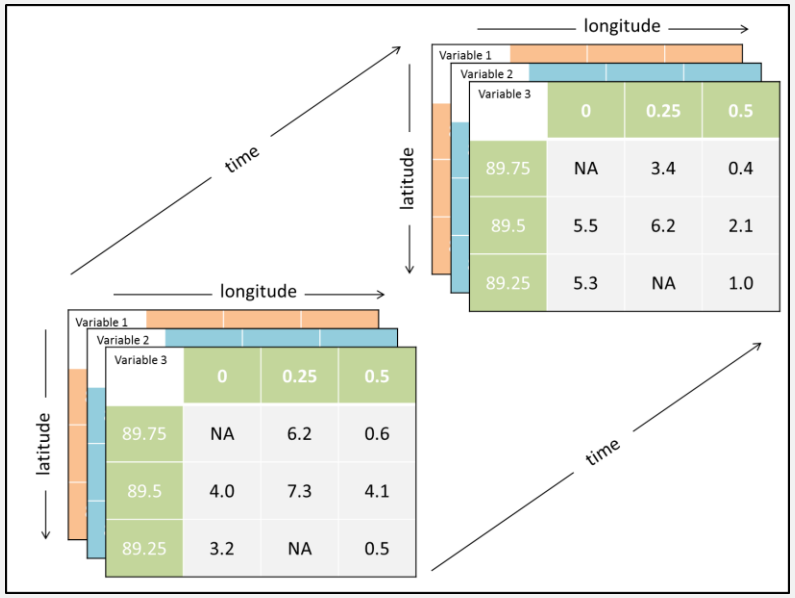
LESSON 3 – INSPECT THE NETCDF



- **Dimensions**

Ex. time, latitude, longitude, height

- **Variables**

Ex. temperature, salinity

- **Attributes**

Ex. metadata, units

QUESTION 1: How many dimensions are in your dataset?

QUESTION 2: What is the purpose of the global attributes?

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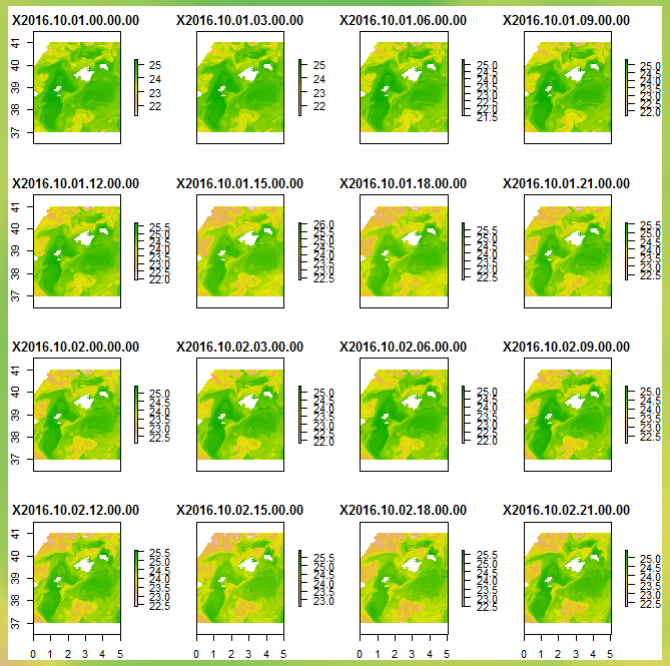
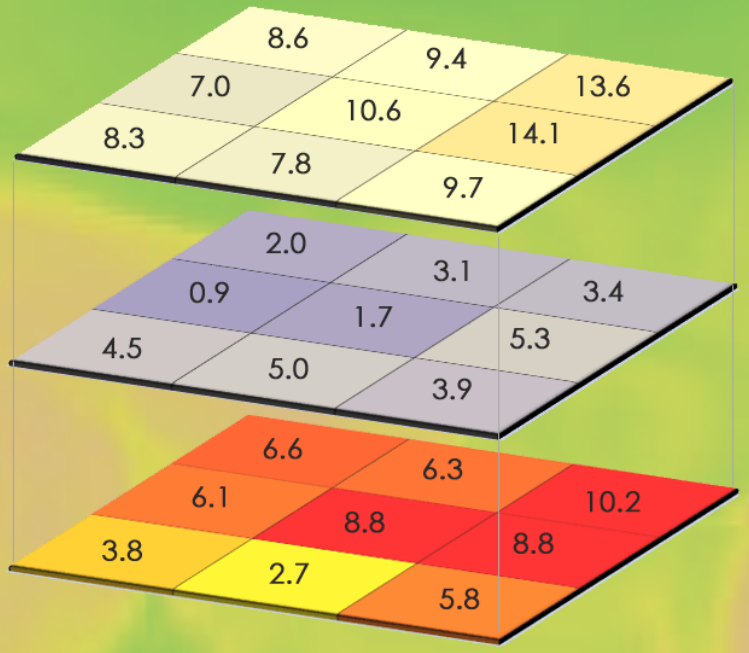
LESSON 3 – MULTIDIMENSIONAL GRIDDED DATA





EXERCISE 1: Calculate daily means for salinity

BONUS: Calculate daily SST anomalies

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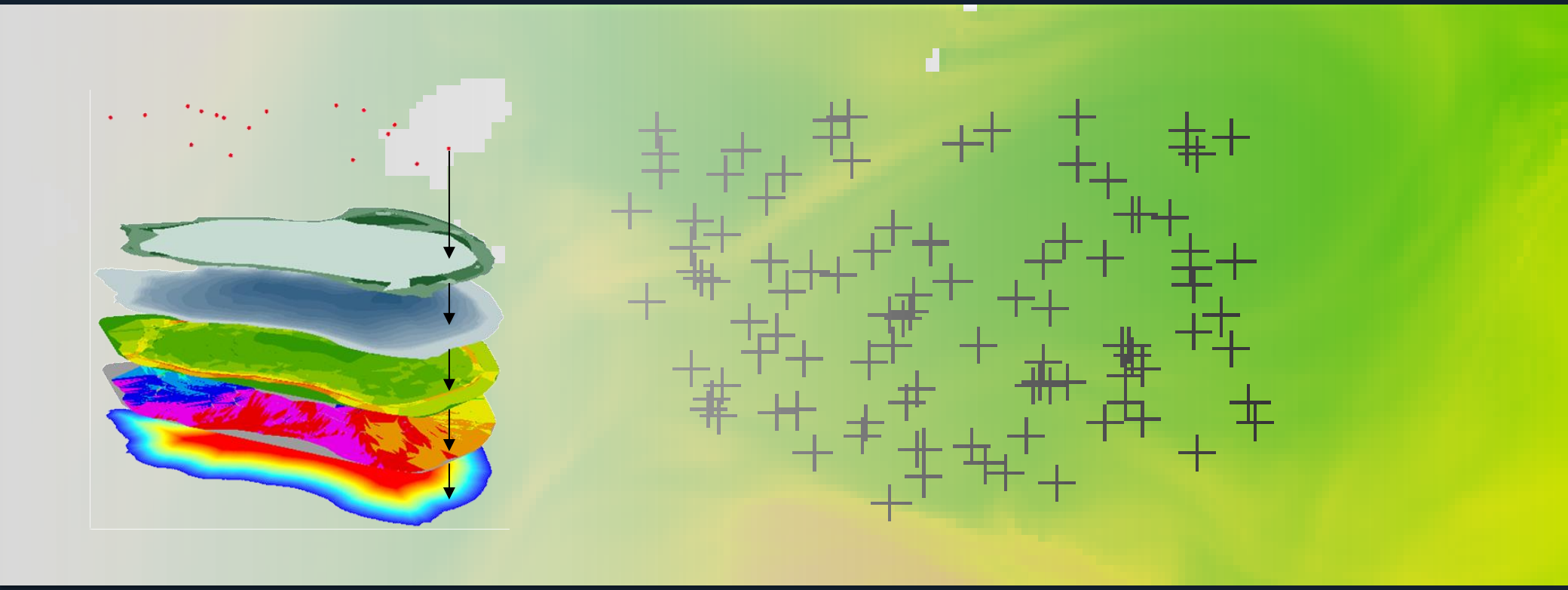
LESSON 3 – INTEGRATE DATA



EXERCISE 1: Integrate mean salinity to sampling stations

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LESSON 3 - TIME SERIES

TIP: NetcdfSubset Service allow to get time series data for a sampling location

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WEB APPLICATIONS WITH SHINY

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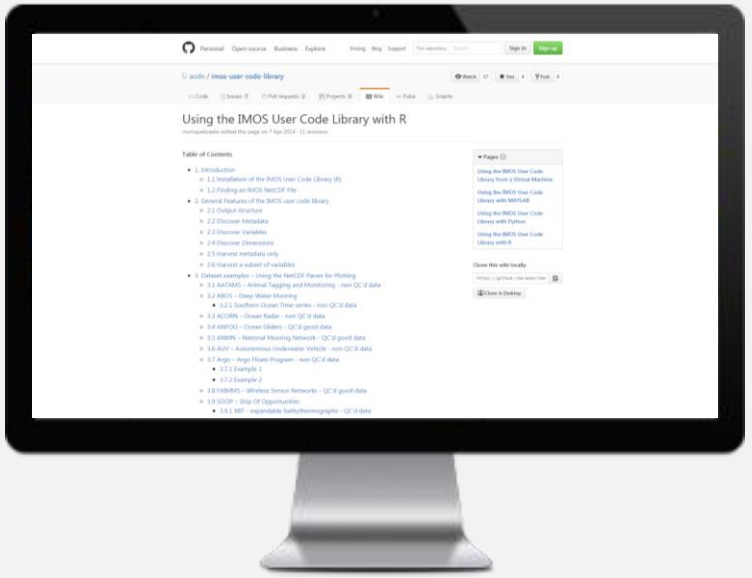
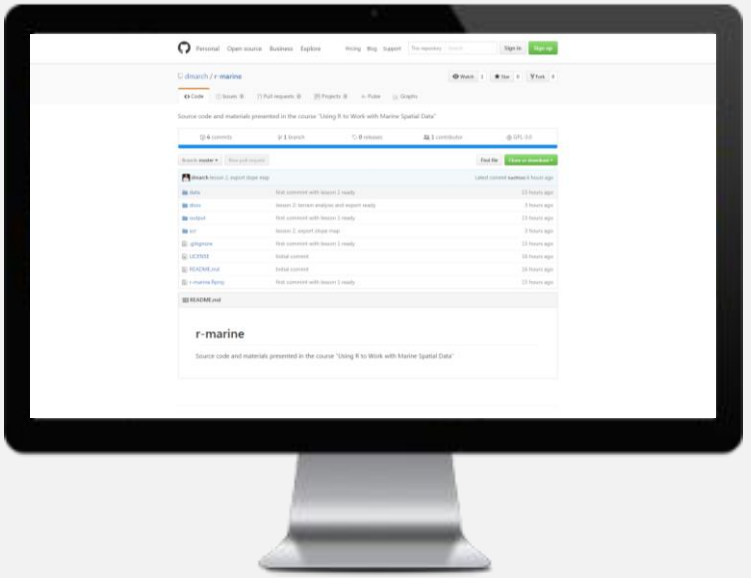
FURTHER REFERENCES - CODE REPOSITORIES



https://github.com/aodn/imos-user-code-library/wiki/Using-the-IMOS-User-Code-Library-with-R



https://github.com/dmarch/r-marine

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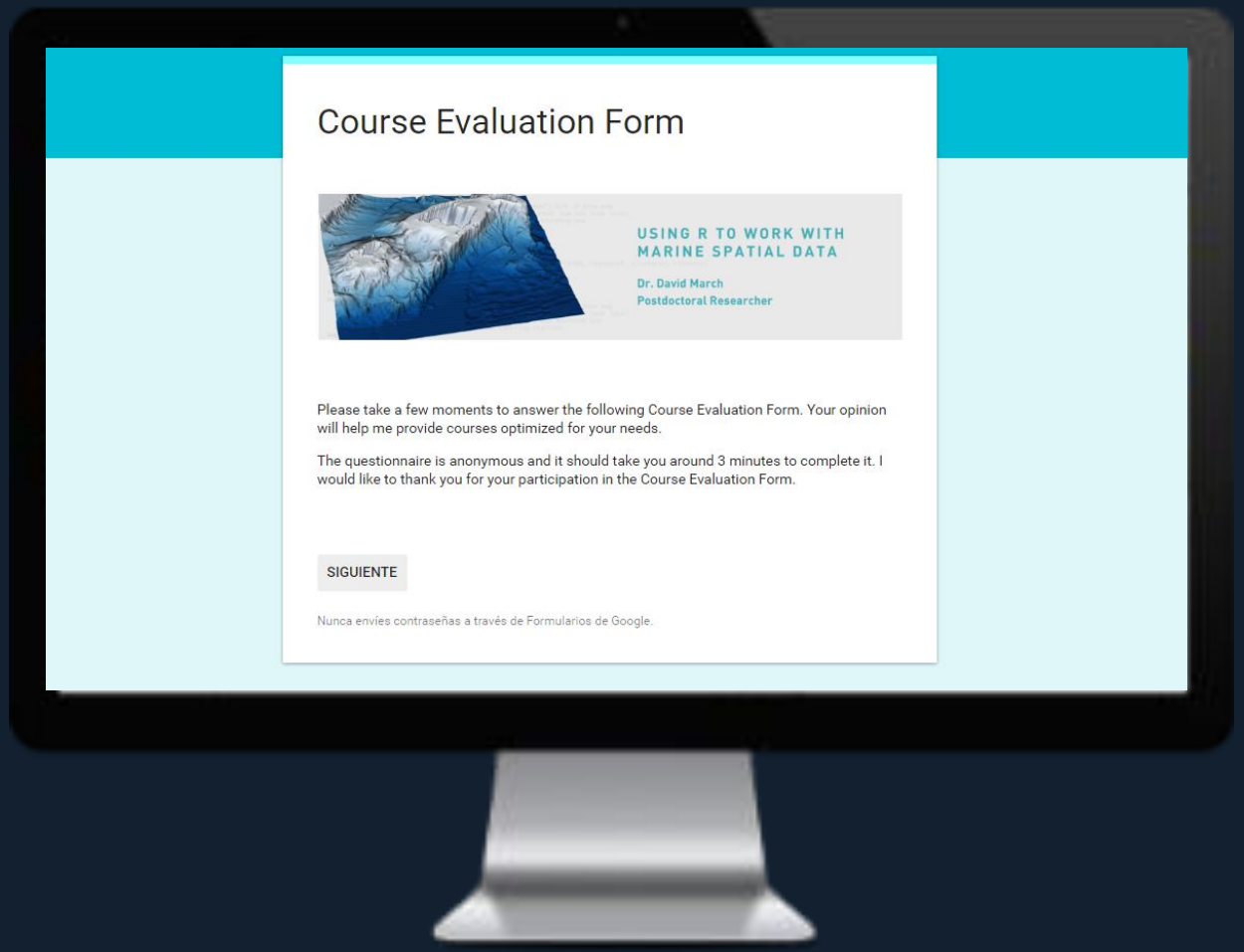
COURSE EVALUATION FORM



https://goo.gl/forms/QfFRNWo7Tbpiu2dx1

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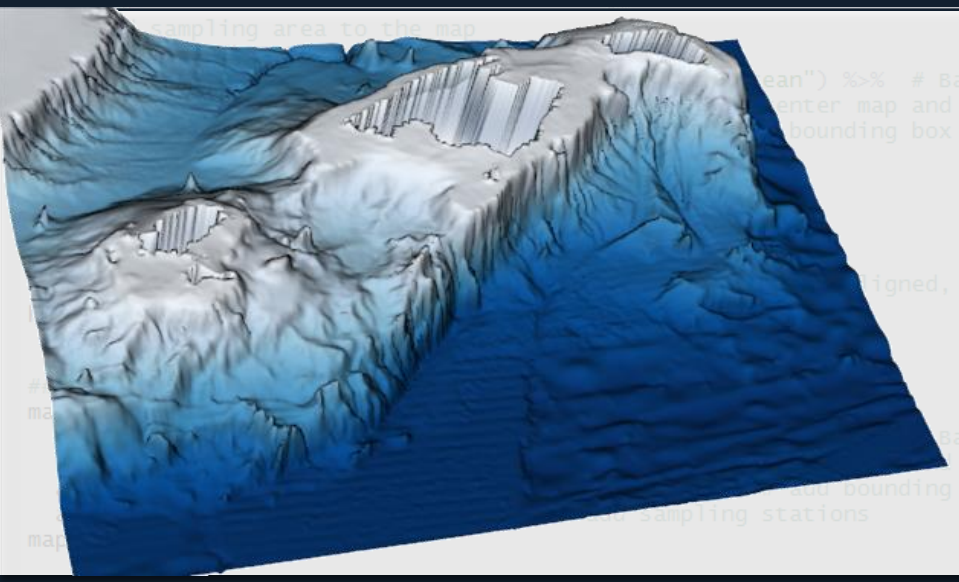

USING R TO WORK WITH MARINE SPATIAL DATA

Dr. David March

Postdoctoral Researcher

https://github.com/dmarch/r-marine

PALMA DE MALLORCA, 26 OCTOBER 2016

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