



Climate Change

C3S User Learning Services

Portugal

CDS data use in Panoply and R/QGIS

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PLAN

I Data Analysis with R

II Data Analysis with QGIS

III Data Visualisation with Panoply





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I Data Analysis with R

R is a free software environment for statistical computing and graphics - <https://www.r-project.org/>

```
# Info & tutorial
# https://www.youtube.com/watch?v=roMf6xzB9NI
# http://geog.uoregon.edu/bartlein/courses/geog607/Rmd/netCDF\_01.htm
# http://geog.uoregon.edu/bartlein/courses/geog490/week04-netCDF.html

# Loading packages
library(ncdf4) # package for netcdf manipulation
library(raster) # package for raster manipulation
library(rgdal) # package for geospatial analysis
library(ggplot2) # package for plotting
library(sf) # package for sf objects
library(openxlsx) # package for xlsx data
```

Script is available :
https://github.com/Batis007/C3S_Data_use



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I Data Analysis with R

2mT_40years.nc_metadata - Notepad

File Edit Format View Help

File 2mT_40years.nc (NC_FORMAT_64BIT):

1 variables (excluding dimension variables):

short t2m[longitude,latitude,time]
scale_factor: 0.00176319797961702
add_offset: 257.703670097788
_FillValue: -32767
missing_value: -32767
units: K
long_name: 2 metre temperature

3 dimensions:

longitude Size:1440
units: degrees_east
long_name: longitude
latitude Size:721
units: degrees_north
long_name: latitude
time Size:481
units: hours since 1900-01-01 00:00:00.0
long_name: time
calendar: gregorian

2 global attributes:

Conventions: CF-1.6
history: 2019-04-23 17:18:56 GMT by grib_to_netcdf-2.10.0: /opt/ecmwf/eccodes/bin/



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I Data Analysis with R

```
#Loading all the dimensions
lon <- ncvar_get(nc_data, "longitude")
lon = ifelse(lon < 360, -(360 - lon), lon)
lat <- ncvar_get(nc_data, "latitude", verbose = F)
t <- ncvar_get(nc_data, "time")

t2m.array <- ncvar_get(nc_data, "t2m") # store the data in a 3-dimensional array

t2m.array <- t2m.array - 273.15 # Transform K in C
dim(t2m.array)

#Fill NA values

fillvalue <- ncatt_get(nc_data, "t2m", "_Fillvalue")
fillvalue

nc_close(nc_data)
t2m.array[t2m.array == fillvalue$value] <- NA
```



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I Data Analysis with R

RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

Go to file/function Addins

```
Netcdf_to_raster_project.R  
64  
65 # calculate mean of brick  
66 r_brick <-  
67 brick(  
68   t2m.array,  
69   xmn = min(lat),  
70   xmx = max(lat),  
71   ymn = min(lon),  
72   ymx = max(lon),  
73   crs = CRS(  
74     "+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs+ towgs84=0,0,0"  
75   )  
76 )  
77 mean <- calc(r_brick, fun = mean, na.rm = T)  
78 plot(mean)  
79 mean <- t(mean)  
80 #mean <- flip(mean, direction = 'y')  
81  
82 # Plot Map  
83 plot(mean)  
84  
85
```

78:2 (Untitled) R Script

Console Terminal Jobs

```
C:/Users/Eduardo/OneDrive - Universidade de Aveiro/UA/Projects/2 - PhD MDR project/R Projects/datasets/  
+ brick(  
+   t2m.array,  
+   xmn = min(lat),  
+   xmx = max(lat),  
+   ymn = min(lon),  
+   ymx = max(lon),  
+   crs = CRS(  
+     "+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs+ towgs84=0,0,0"  
+   )  
+ )  
> mean <- calc(r_brick, fun = mean, na.rm = T)  
> plot(mean)  
>
```

Environment History Connections

Global Environment

Data

fillvalue	List of 2
mean	Formal class RasterLayer
nc_data	List of 14
r_brick	Large RasterBrick (13497120 elements, 103 Mb)

values

datasets	"C:/Users/Eduardo/OneDrive - Universidade de Aveir...
lat	num [1:721(1d)] 90 89.8 89.5 89.2 89 ...

Files Plots Packages Help Viewer

Zoom Export Publish

20
0
-20
-40



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I Data Analysis with R

RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

Go to file/function Addins

Netcdf_to_raster_project_for_upload.R

```
76 |
77 # Plot Map
78 plot(mean)
79
80 # Save map
81 setwd(outputs)
82 writeRaster(x = r, filename = "ncdf_testfinal.tif", driver = "GeoTiff")
83
84 #Crop map and plot again
85 r1 <- crop(mean, extent(-180,-0.25,-90,90))
86 r2 <- crop(mean, extent(-360,-180,-90,90))
87
88 #Change the extent of r1
89 r <- raster()
90 bb <- extent(-180,-0.25,-90,90)
91 extent(r1) <- bb
92 r1 <- setExtent(r1, bb, keepres=TRUE)
93
94 #Change the extent of r2
95 r <- raster()
96 bb <- extent(-0.25,180,-90,90)
97 extent(r2) <- bb
76:1 (Untitled) R Script
```

Environment History Connections

Global Environment

Data

fillvalue	List of 2
mean	Large RasterLayer (1038240 elements, 7.9 Mb)
nc_data	List of 14
r_brck	Large RasterBrick (13497120 elements, 103 Mb)

Values

datasets	"C:/Users/Eduardo/OneDrive - Universidade de Aveir...
lat	num [1:721(1d)] 90 89.8 89.5 89.2 89 ...

Files Plots Packages Help Viewer

Zoom Export Publish

```
+ xmx = max(lat),
+ ymn = min(lon),
+ ymx = max(lon),
+ crs = CRS(
+   "+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs+ towgs84=0,0,0"
+ )
+ )
> mean <- calc(r_brck, fun = mean, na.rm = T)
> plot(mean)
> mean <- t(mean)
> # Plot Map
> plot(mean)
>
```



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I Data Analysis with R

RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

Go to file/function Addins

Netcdf_to_raster_project_for_upload.R x

```
83
84 #Crop map and plot again
85 r1 <- crop(mean, extent(-180,-0.25,-90,90))
86 r2 <- crop(mean, extent(-360,-180,-90,90))
87
88 #Change the extent of r1
89 r <- raster()
90 bb <- extent(-180,-0.25,-90,90)
91 extent(r1) <- bb
92 r1 <- setExtent(r1, bb, keepres=TRUE)
93
94 #Change the extent of r2
95 r <- raster()
96 bb <- extent(-0.25,180,-90,90)
97 extent(r2) <- bb
98 r2 <- setExtent(r2, bb, keepres=TRUE)
99
100 #Join r1 and r2
101 r <- merge(r1,r2, overlap = TRUE)
102 plot(r)
103
104
```

104:1 (Untitled) R Script

Console Terminal Jobs

C:/Users/Eduardo/OneDrive - Universidade de Aveiro/UA/Projects/2 - PhD MDR project/R Projects/datasets/

```
> extent(r1) <- bb
> r1 <- setExtent(r1, bb, keepres=TRUE)
>
> #Change the extent of r2
> r <- raster()
> bb <- extent(-0.25,180,-90,90)
> extent(r2) <- bb
> r2 <- setExtent(r2, bb, keepres=TRUE)
>
> #Join r1 and r2
> r <- merge(r1,r2, overlap = TRUE)
> plot(r)
>
```

Environment History Connections

Global Environment

Object	Class	Size
fillvalue	List of 2	
mean	Large RasterLayer (1038240 elements, 7.9 Mb)	
nc_data	List of 14	
r	Large RasterLayer (1038240 elements, 7.9 Mb)	
r_brick	Large RasterBrick (13497120 elements, 103 Mb)	
r1	Large RasterLayer (518399 elements, 4 Mb)	
r2	Large RasterLayer (519841 elements, 4 Mb)	

Files Plots Packages Help Viewer

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I Data Analysis with R

```
RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function Addins
Netcdf_to_raster_project_for_upload.R*
103
104
105 #Extract polygon
106 setwd(datasets)
107 PT <- readOGR("Portugal_distritos.shp")
108 cropped <- crop(x = r, y = extent(PT))
109 plot(cropped)
110 plot(PT, add=TRUE)
111
112 masked <- mask(x = r, mask = PT)
113 cropped <- crop(x = masked, y = extent(PT))
114 plot(cropped)
115 plot(PT, add=TRUE)
116
117 #Save Plot
118 setwd(outputs)
119 writeRaster(x = r, filename = "ncdf_pt.tif", driver = "GeoTiff")
120
121
122
123
124
111:1 (Untitled) R Script
Console Terminal Jobs
C:/Users/Eduardo/OneDrive - Universidade de Aveiro/UA/Projects/2 - PhD MDR project/R Projects/datasets/
> #Extract polygon
> setwd(datasets)
> PT <- readOGR("Portugal_distritos.shp")
OGR data source with driver: ESRI Shapefile
Source: "C:/Users/Eduardo/OneDrive - Universidade de Aveiro/UA/Projects/2 - PhD MDR project/R Projects/datasets/Portugal_distritos.shp", layer: "Portugal_distritos"
with 18 features
It has 15 fields
Integer64 fields read as strings: ID_0 ID_1 CCN_1
> cropped <- crop(x = r, y = extent(PT))
> plot(cropped)
> plot(PT, add=TRUE)
>
```

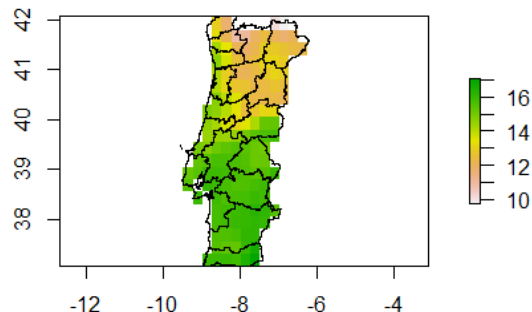
Environment History Connections

Global Environment

cropped	Formal class RasterLayer
fillvalue	List of 2
masked	Large RasterLayer (1038240 elements, 7.9 Mb)
mean	Large RasterLayer (1038240 elements, 7.9 Mb)
nc_data	List of 14
PT	Large SpatialPolygonsDataFrame (18 elements, 6.5...
r	Large RasterLayer (1038240 elements, 7.9 Mb)
r_brick	Large RasterBrick (12407120 elements, 102 Mb)

Files Plots Packages Help Viewer

Zoom Export Publish





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I Data Analysis with R

RStudio interface showing a script for data analysis and a data table.

Script Content:

```
122 |  
123 |  
124 #Extract values by location  
125 #Load coordinates points  
126 BOT <-  
127 read.xlsx(  
128   '03-06-2019_netcdf_coords_to_extract.xlsx',  
129   sheet = 1,  
130   startRow = 1,  
131   colNames = TRUE  
132 )  
133 #Prepare a data frame  
134 BOT1 <-  
135 data.frame(  
136   id = BOT$id,  
137   genus = BOT$genus,  
138   sp = BOT$sp,  
139   lat = BOT$lat,  
140   lon = BOT$lon  
141 )  
142  
143 #Clean data  
144 BOT1 <- BOT1[complete.cases(BOT1), ] # remove NA cells  
145 BOT2 <- data.frame(lon = BOT1$lon, lat = BOT1$lat)  
146  
147 # make BOT spatial  
148 coordinates(BOT2) <- ~lon + lat  
149
```

Console Output:

```
C:/Users/Eduardo/OneDrive - Universidade de Aveiro/UA/Projects/2 - PhD MDR project/R Project  
> #Clean data  
> BOT1 <- BOT1[complete.cases(BOT1), ] # remove NA cells  
> BOT2 <- data.frame(lon = BOT1$lon, lat = BOT1$lat)  
>  
> # make BOT spatial  
> coordinates(BOT2) <- ~lon + lat  
> |
```

Data Table:

	id	genus	sp	lat	lon
1	1	Diplodia	Diplodia sp1.	40.95081	-7.082681
2	2	Diplodia	Diplodia sp1.	40.95081	-7.082681
3	3	Diplodia	Diplodia sp1.	40.57794	-8.739585
4	4	Diplodia	Diplodia sp1.	40.58716	-8.737692
6	6	Diplodia	Diplodia sp1.	40.66437	-8.609283
7	7	Diplodia	Diplodia sp1.	40.66437	-8.609283
9	9	Diplodia	Diplodia sp1.	40.66437	-8.609283
10	10	Diplodia	Diplodia sp1.	40.66437	-8.609283
12	12	Diplodia	Diplodia sp1.	40.71252	-8.548174
13	13	Diplodia	Diplodia sp1.	40.71252	-8.548174
14	14	Diplodia	Diplodia sp1.	40.71252	-8.548174
15	15	Diplodia	Diplodia sp1.	40.71252	-8.548174
16	16	Diplodia	Diplodia sp1.	40.71247	-8.548183
17	17	Diplodia	Diplodia sp1.	40.71247	-8.548183

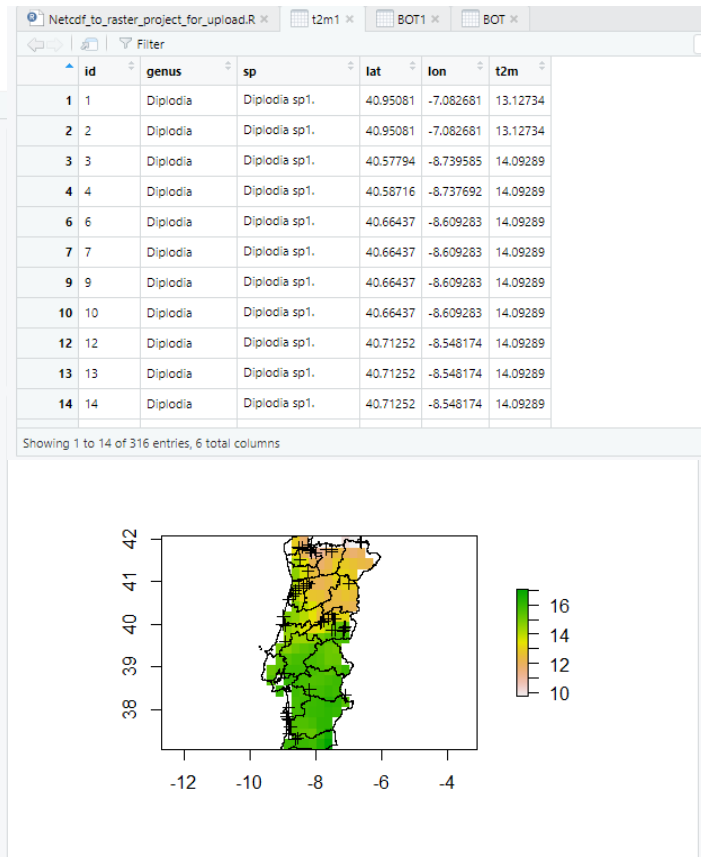
Showing 1 to 17 of 316 entries, 5 total columns



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I Data Analysis with R

```
RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function Addins
Netcdf_to_raster_project_for_upload.R t2m1 BOT1 BOT
#Clean data
142 BOT1 <- BOT1[complete.cases(BOT1), ] # remove NA cells
143 BOT2 <- data.frame(lon = BOT1$lon, lat = BOT1$lat)
144
145 # make BOT spatial
146 coordinates(BOT2) <- ~lon + lat
147
148 # get the clim data
149 t2m <- extract(r, BOT2)
150 t2m1 <- cbind(BOT1, t2m)
151 # Check the NA values for modeling
152 t2m1 <- t2m1[complete.cases(t2m1),] # remove NA cells
153
154 #Plot
155 plot(cropped)
156 plot(PT, add=TRUE)
157 plot(BOT2, add=TRUE)
158
159 #Save data
160 setwd(outputs)
161 write.xlsx(rp_wc1, "data_points.xlsx")
162
163
164
164:1 (Untitled) R Script
Console Terminal Jobs
C:/Users/Eduardo/OneDrive - Universidade de Aveiro/UA/Projects/2 - PhD MDR project/R Projects/datasets/
> view(rp_wc1)
> # get the clim data
> t2m <- extract(r, BOT2)
> t2m1 <- cbind(BOT1, t2m)
> # Check the NA values for modeling
> t2m1 <- t2m1[complete.cases(t2m1),] # remove NA cells
> view(t2m1)
> #Plot
> plot(cropped)
> plot(PT, add=TRUE)
> plot(BOT2, add=TRUE)
>
```





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II Data Analysis with QGIS

Loading netcdf data

Invert the colour ramp here

The screenshot shows the QGIS interface with a project titled "Untitled Project - QGIS". The main map area displays a grayscale visualization of data. A context menu is open over the map, with the "Properties..." option highlighted. A red arrow points from this menu to the "Layer Properties" dialog box on the right.

The "Layer Properties" dialog box is open to the "Symbology" tab. The "Band Rendering" section is active, showing the "Render type" set to "Singleband pseudocolor". The "Band" is "Band 1: time=1034376 (hours since 1900-01-01 00:00:00)". The "Min" value is 7.88867 and the "Max" value is 13.9452. The "Color ramp" is set to a sequential color ramp. A blue arrow points to the "Color ramp" dropdown menu, with the text "Invert the colour ramp here" above it.

The "Min / Max Value Settings" section shows a table of values and their corresponding colors:

Value	Color	Label
7.88867	Blue	7.89
9.4028025	Green	9.4
10.916935	Yellow	10.9
12.4310675	Orange	12.4
13.9452	Red	13.9

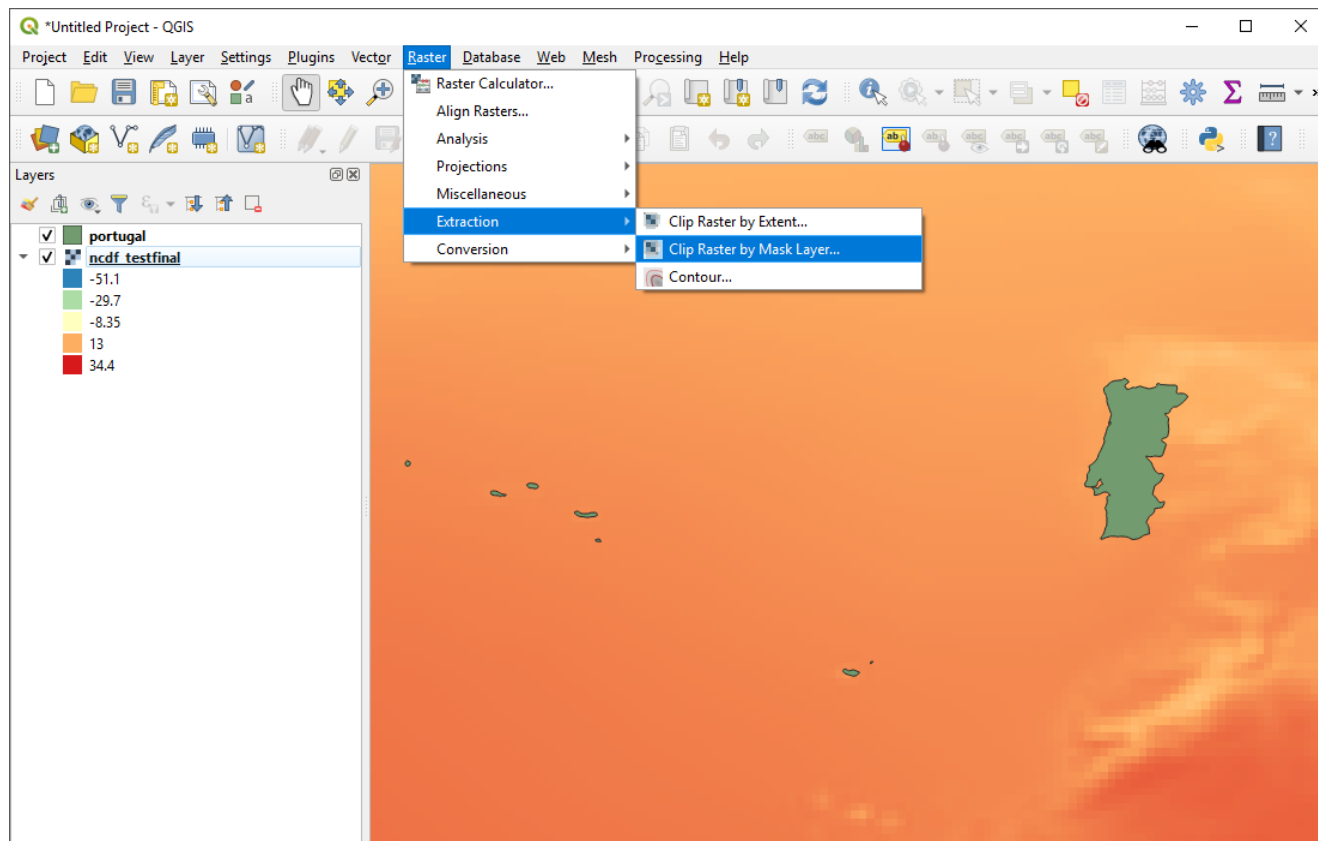
The "Mode" is set to "Continuous" and the "Classes" are 5. The "Color Rendering" section is also visible at the bottom.



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Change

II Data Analysis with QGIS

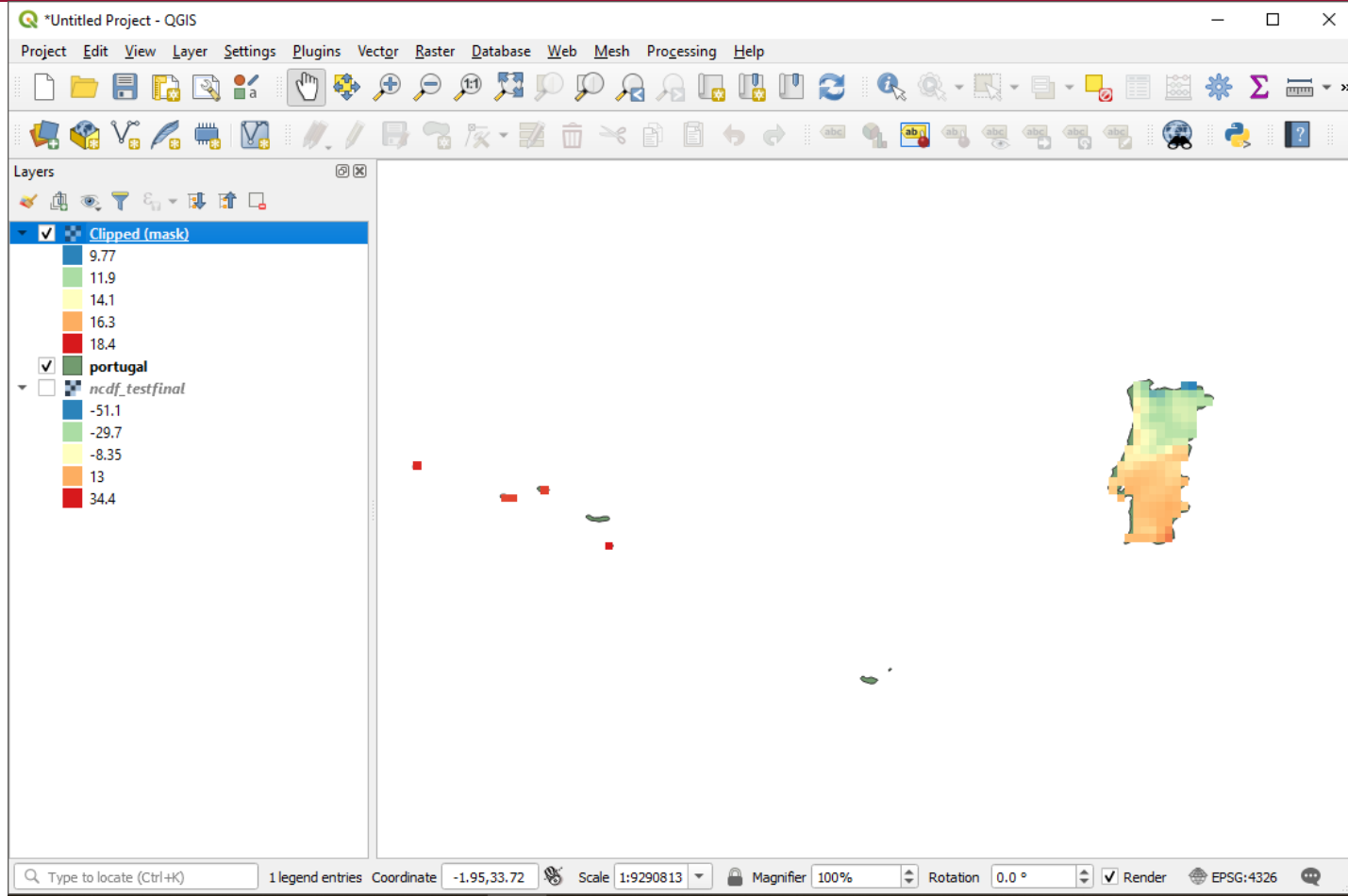
Clip data with a shapefile





Climate
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II Data Analysis with QGIS

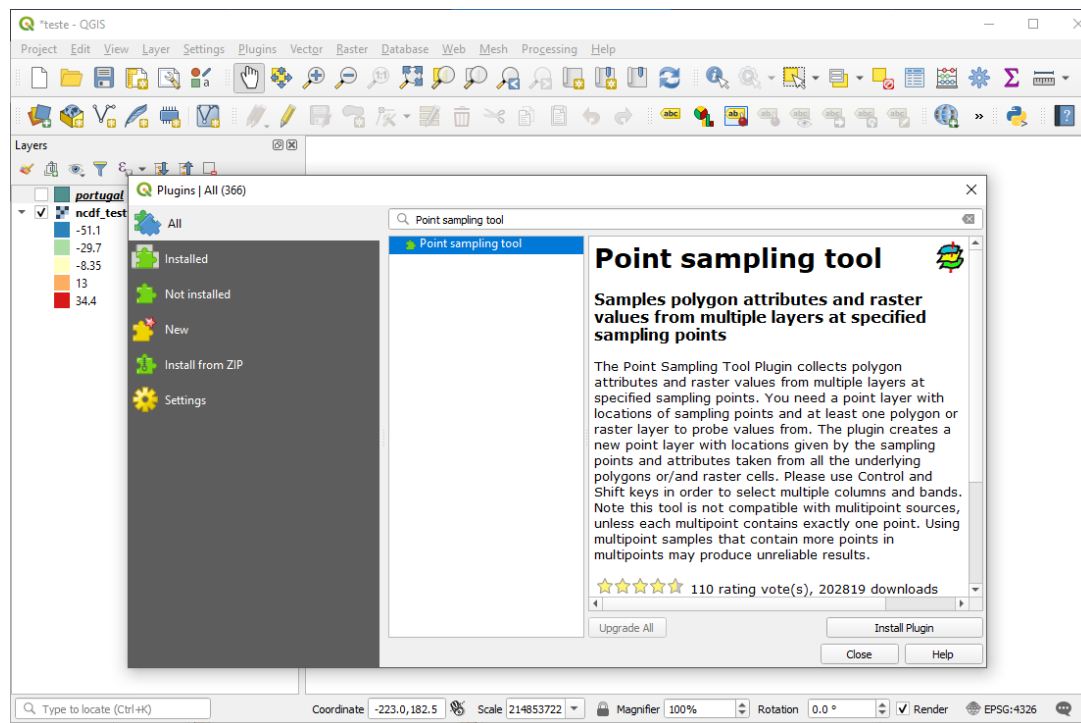




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II Data Analysis with QGIS

Extract raster values with a list of points location





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II Data Analysis with QGIS

Data Source Manager | Delimited Text

File name: rsidade de Aveiro\JA\Projects\2 - PhD MDR project\R Projects\datasets\03-06-2019_netcdf_coords_to_extract_clean.csv

Layer name: 03-06-2019_netcdf_coords_to_extract_clean Encoding: UTF-8

File Format

- ☒ CSV (comma separated values)
- ☐ Regular expression delimiter
- ☐ Custom delimiters

Record and Fields Options

Geometry Definition

- ☒ Point coordinates X field: lon Y field: lat
- ☐ Well known text (WKT)
- ☐ No geometry (attribute only table) ☐ DMS coordinates

Geometry CRS: EPSG:4326 - WGS 84

Layer Settings

Sample Data

	id	genus	sp	lat	lon	Host
1	1	Diplodia	Diplodia sp1.	40.950815	-7.082681	Quercus suber
2	2	Diplodia	Diplodia sp1.	40.950815	-7.082681	Quercus suber
3	3	Diplodia	Diplodia sp1.	40.577030	-8.730585	Quercus suber

Close Add Help



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II Data Analysis with QGIS

QGIS *teste - QGIS

Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help

Manage and Install Plugins... Python Console Ctrl+Alt+P Analyses Point Sampling Tool

Layers

- 03-06-2019 netcdf coords to extrac...
- portugal
- ncdf_testfinal
 - 51.1
 - 29.7
 - 8.35
 - 13
 - 34.4

Point Sampling Tool

General Fields About

Layer containing sampling points:
03-06-2019_netcdf_coords_to_ex

Layers with fields/bands to get value:
03-06-2019_netcdf_coords_to_e
03-06-2019_netcdf_coords_to_e
03-06-2019_netcdf_coords_to_e
03-06-2019_netcdf_coords_to_e
03-06-2019_netcdf_coords_to_e
ncdf_testfinal: Band 1 (raster)

Output point vector layer:
t2m
☒ Add created layer to the map

Status:
Complete the input fields and pres

t2m.gpkg :: Features Total: 315, Filtered: 315, Selected: 0

	fid	ncdf_testf
1	61	12.1350679397583
2	60	12.1350679397583
3	63	12.1350679397583
4	62	12.1350679397583
5	57	12.1350679397583
6	56	12.1350679397583
7	59	12.1350679397583
8	58	12.1350679397583
9	53	12.1350679397583
10	52	12.1350679397583
11	55	12.1350679397583
12	54	12.1350679397583
13	49	13.43402004241...
14	48	12.59439659118...
15	51	12.1350679397583
16	50	13.43402004241...

Show All Features

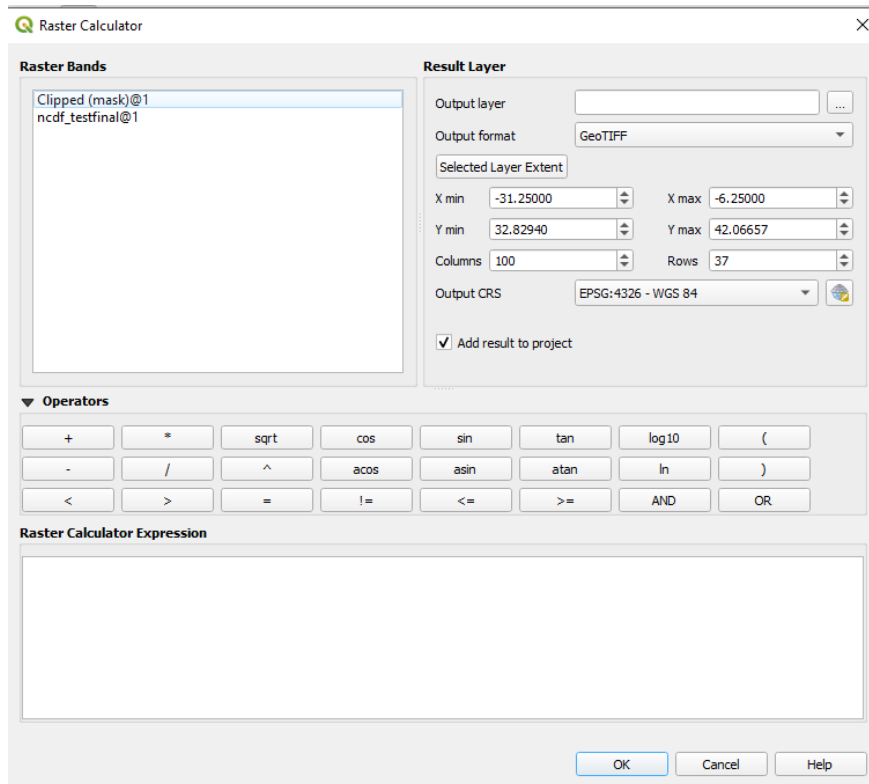
Coordinate: -13.67,36.36 Scale: 1:4365768 Magnifier: 100% Rotation: 0.0°

European Commission



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II Data Analysis with QGIS



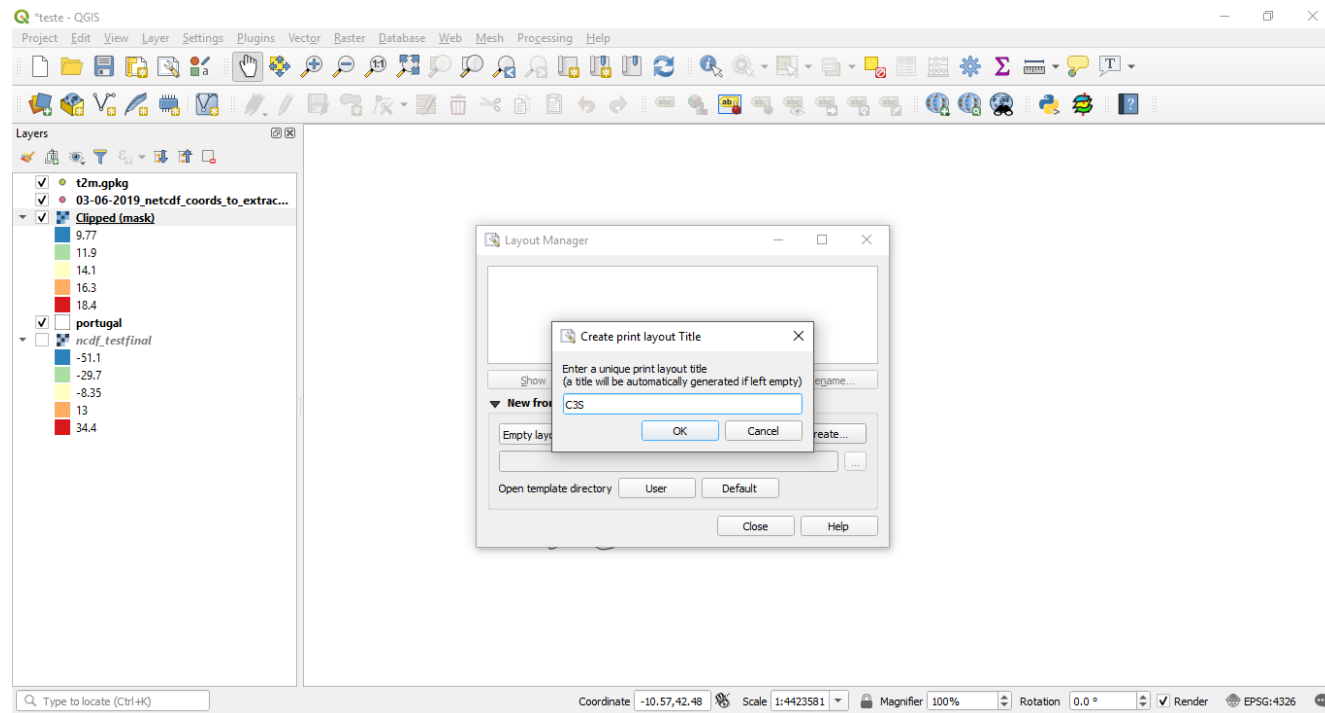
You can use the raster calculator to do operations between one or more raster layers



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II Data Analysis with QGIS

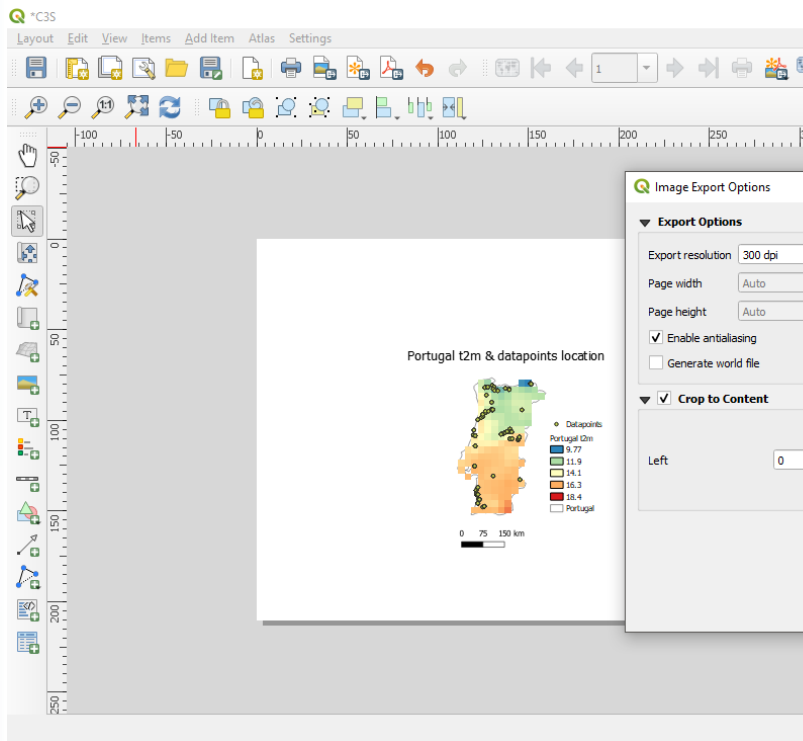
Export map as a image



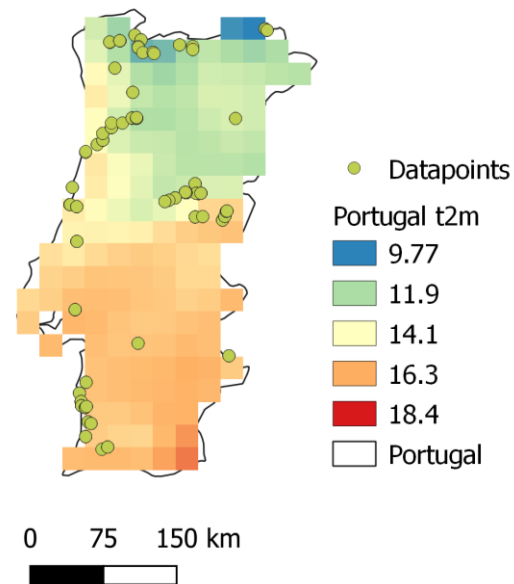


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II Data Analysis with QGIS



Portugal t2m & datapoints location





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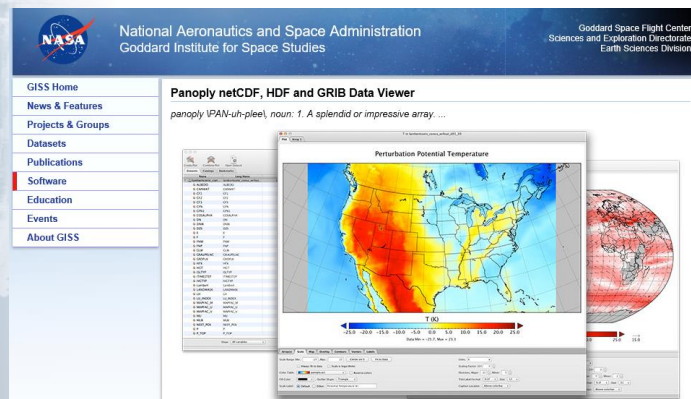
III Data Visualisation with Panoply

Panoply plots geo-referenced and other arrays from netCDF, HDF, GRIB, and other datasets.

Panoply is a cross-platform application that runs on Macintosh, Windows, Linux and other desktop computers.

Download

<https://www.giss.nasa.gov/tools/panoply/download/>

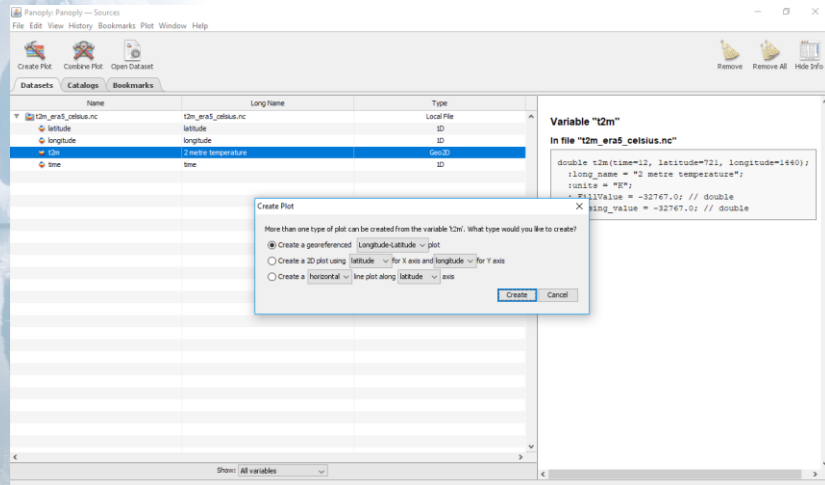




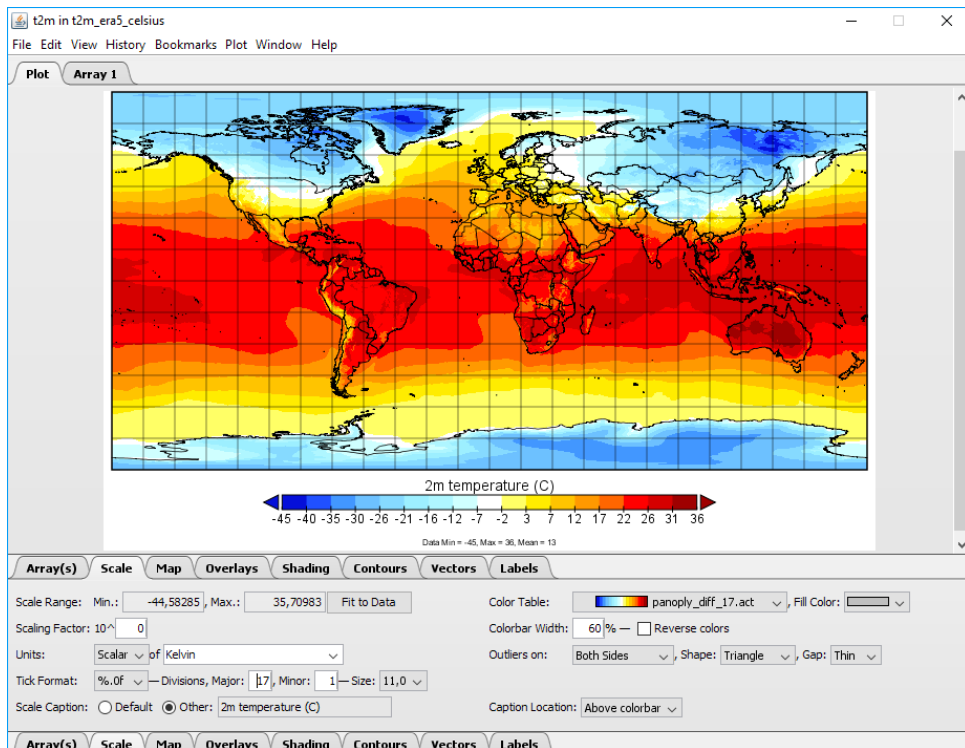
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III Data Visualisation with Panoply

Create Plot



Visualize and customize plot

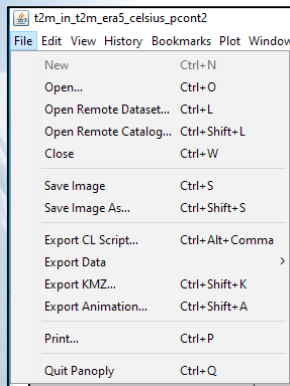




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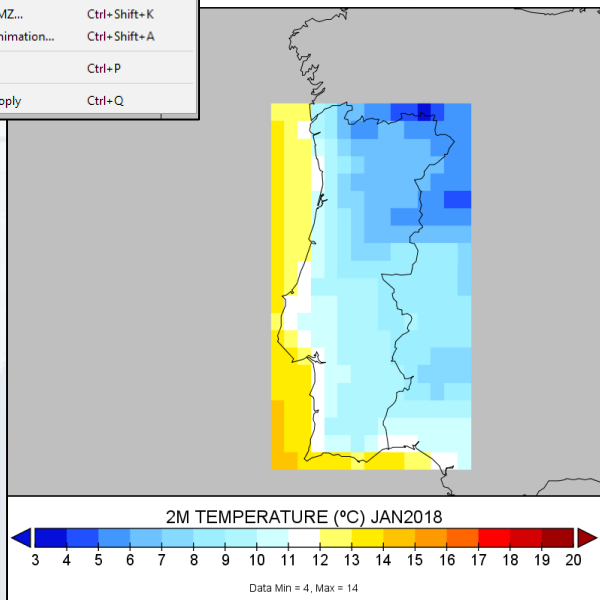
III Data Visualisation with Panoply

Export plot



To image

2 metre temperature



To kml

