

Script01: Study area and env. variability

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1 Setup working space

1.1 Clean and loading necessary packages

1.2 Load maps input data

```
# Download shorelines data from:  
#https://ngdc.noaa.gov/mgg/shorelines/data/gshhs/oldversions/version2.3.6/  
gshhs.f.b <- "../Data/maps_envdata/GSHHS_shp/h/GSHHS_h_L1.shp"  
shapename <- read_sf(gshhs.f.b)  
  
# To include costal water bodies (Canet Lagoon) (https://developers.arcgis.com/rest/)  
lagoons <- read_sf(dsn="../Data/maps_envdata/FRA_wat",layer="FRA_water_areas_dcw")
```

1.3 Load environmental data

```
# Load Canet Lagoon data  
D.tmp<-read.csv("../Data/maps_envdata/096_Canet.csv",header=T,sep=",")
```

```
#Extract variables of interest  
D.CANET<-D.tmp[,c("DATE","PARAMETRE_CODE","RESULTAT")]  
names(D.CANET)<-c("DATE","Parameter", "Value") #Rename columns  
D.CANET$Site="Canet" # Add site  
tibble(D.CANET)
```

```
## # A tibble: 192 x 4  
##   DATE             Parameter Value Site  
##   <chr>            <chr>    <dbl> <chr>  
## 1 26.06.01 10:55 CHLA      1.09  Canet  
## 2 26.06.01 11:45 CHLA      5.6   Canet  
## 3 18.07.01 11:00 CHLA      1.99  Canet  
## 4 18.07.01 12:15 CHLA     11.6   Canet  
## 5 22.08.01 11:00 CHLA      2.4   Canet  
## 6 22.08.01 13:05 CHLA     3.68   Canet  
## 7 20.09.01 10:50 CHLA      5.7   Canet  
## 8 24.10.01 10:15 CHLA     12.1   Canet  
## 9 24.10.01 10:50 CHLA     12.5   Canet  
## 10 04.12.01 12:03 CHLA    42.4   Canet  
## # i 182 more rows
```

```
#  
rm(D.tmp) #remove tmp dataframe  
#  
  
# Load SOLA surface data  
D.tmp<-read.csv("../Data/maps_envdata/Somlit_hydro_20241227.csv",header=T,sep=",")  
#Extract variables of interest  
D.SOLA<-D.tmp[,c("DATE","PARAMETRE_CODE","Value")]  
names(D.SOLA)<-c("DATE","Parameter", "Value") #Rename columns
```

```

D.SOLA$Site="SOLA" # Add site
tibble(D.SOLA)

## # A tibble: 1,702 x 4
##   DATE     Parameter Value Site
##   <chr>    <chr>    <dbl> <chr>
## 1 04.01.05 SALI      NA  SOLA
## 2 11.01.05 SALI      NA  SOLA
## 3 18.01.05 SALI      NA  SOLA
## 4 03.03.05 SALI      NA  SOLA
## 5 15.03.05 SALI      NA  SOLA
## 6 26.04.05 SALI     38.2 SOLA
## 7 03.05.05 SALI     37.2 SOLA
## 8 10.05.05 SALI     37.4 SOLA
## 9 17.05.05 SALI     37.5 SOLA
## 10 24.05.05 SALI    37.5 SOLA
## # i 1,692 more rows

## Pooling data frames
D.all=rbind(D.CANET,D.SOLA)
D.all$Parameter<- factor(D.all$Parameter, c("SALI","CHLA")) #Re-order factors
tibble(D.all)

## # A tibble: 1,894 x 4
##   DATE     Parameter Value Site
##   <chr>    <fct>    <dbl> <chr>
## 1 26.06.01 10:55 CHLA     1.09 Canet
## 2 26.06.01 11:45 CHLA     5.6  Canet
## 3 18.07.01 11:00 CHLA     1.99 Canet
## 4 18.07.01 12:15 CHLA    11.6  Canet
## 5 22.08.01 11:00 CHLA     2.4  Canet
## 6 22.08.01 13:05 CHLA     3.68 Canet
## 7 20.09.01 10:50 CHLA     5.7  Canet
## 8 24.10.01 10:15 CHLA    12.1  Canet
## 9 24.10.01 10:50 CHLA    12.5  Canet
## 10 04.12.01 12:03 CHLA    42.4  Canet
## # i 1,884 more rows

```

2 Map sampling sites

2.1 Setting sampling points and important locations

```

labs=data.frame(lon=c(3.083,3.009,3.0137,3.183333), lat=c(43.10,42.965,42.671,42.516667),
                lab=c("Gruissan Lagoon","La Palme Lagoon","Canet Lagoon", "SOLA station"))
places=data.frame(lon=c(3.129,2.984,3.006), lat=c(42.47,42.691,43.180),
                  lab=c("Banyuls sur mer","Perpignan","Narbonne"))
tibble(labs)

```

```
## # A tibble: 4 x 3
```

```

##      lon   lat lab
##    <dbl> <dbl> <chr>
## 1  3.08  43.1 Gruissan Lagoon
## 2  3.01  43.0 La Palme Lagoon
## 3  3.01  42.7 Canet Lagoon
## 4  3.18  42.5 SOLA station

```

```
tibble(places)
```

```

## # A tibble: 3 x 3
##      lon   lat lab
##    <dbl> <dbl> <chr>
## 1  3.13  42.5 Banyuls sur mer
## 2  2.98  42.7 Perpignan
## 3  3.01  43.2 Narbonne

```

2.2 Prepare main map

```

##### Combined map
mainplot<-ggplot() +
  # Plot the GSHHS shapefile
  geom_sf(data = shapename, fill = "gray50", color = NA) +
  # Plot the filtered FRANCE water areas shapefile
  geom_sf(data = lagoons, fill = "white", color = NA) +
  # Set coordinate limits
  coord_sf(xlim = c(2.95,3.55), ylim = c(42.4,42.8), expand = T) +
  # Add points for lagoons and stations
  geom_point(data = labs, aes(x = lon, y = lat), size = 2, col = "black") +
  geom_text(data = labs, aes(x = lon + 0.002, y = lat - 0.01, label = lab), size = 2.8, col = "black") +
  # Add points and labels reference places
  geom_point(data = places, aes(x = lon, y = lat), size = 1.5, col = "white") +
  geom_text(data = places, aes(x = lon + 0.001, y = lat + 0.015, label = lab), size = 2.8, col = "black") +
  # Add labels and customize theme
  theme_bw() + labs(y="Latitude (°N)",x="Longitude (°E)",tag="A")+
  theme(panel.grid.minor = element_blank(),panel.grid.major = element_blank(),
        text = element_text(size = 12), #, family = "ArialMT"
        plot.tag.position = c(0.02, 0.994),plot.tag = element_text(size = 15, face = "bold")) # Moves the

```

2.3 Prepare the zoom-out map

```

insetplot<-ggplot() +
  geom_sf(data = shapename, fill = "gray40", color = NA) +
  # Plot the filtered FRA water areas shapefile
  geom_sf(data = lagoons, fill = "white", color = NA) +
  coord_sf(xlim = c(2.5,4.8), ylim = c(42.4,43.7)) +
  # Customize x and y axis tick marks
  scale_x_continuous(breaks = seq(2.5, 4.8, by = 1)) + # Fewer x-axis ticks
  scale_y_continuous(breaks = seq(42.4, 43.7, by = 0.5)) + # Fewer y-axis ticks
  theme_bw() + ylab("") + xlab("") +

```

```

geom_text(data=places,x=4,y=42.85,label="Gulf of Lyon", size=3.25,col="black")+
theme(panel.grid.minor = element_blank(),panel.grid.major = element_blank())+
theme(text=element_text(size=9))+ #, family="ArialMT"
theme(plot.margin = unit(c(0,0,0,0), "cm")) # ("left", "right", "bottom", "top")

```

2.4 Combining maps

```

plot.with.inset<-ggdraw()>+draw_plot(mainplot)+draw_plot(insetplot, 0.525, 0.5690, 0.45, 0.4)+
  geom_rect(aes(xmin = .73, xmax = .78, ymin = .701, ymax = .771),
            colour = "black", fill = "NA")

```

3 Environmental data from reference sites

```

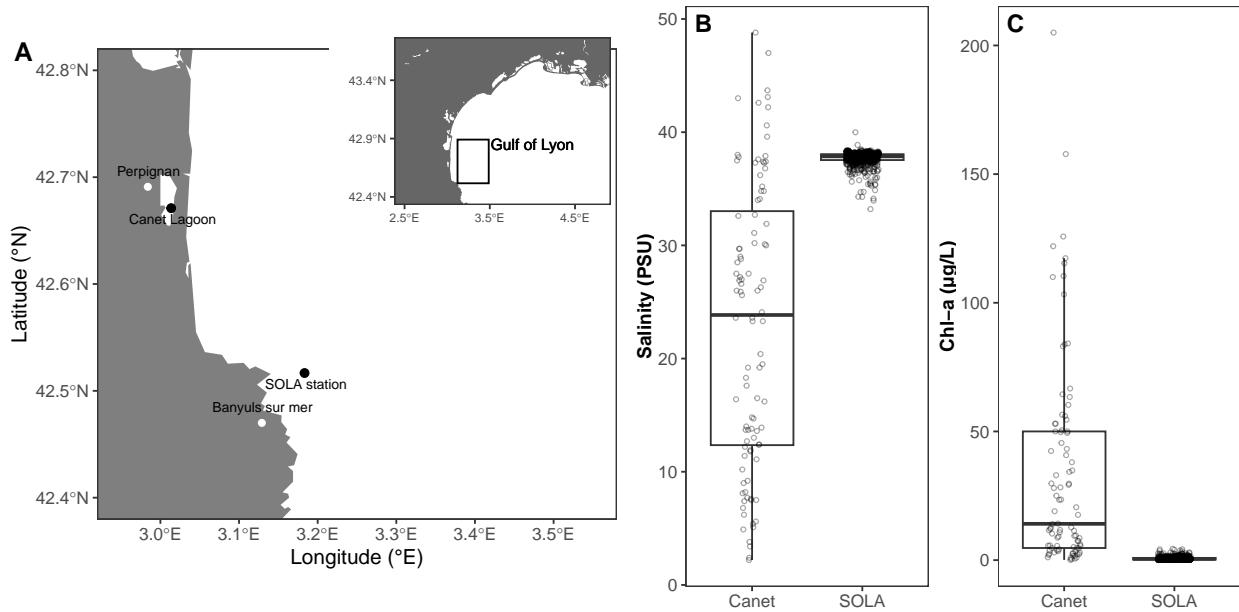
bpplots.01<-D.all%>%
  ggplot(aes(x=Site, y =Value,)) +
  geom_boxplot(outlier.shape = NA)+ 
  geom_jitter(position = position_dodge2(0.3),shape=21,alpha=0.35,size=1)+ 
  facet_wrap(~Parameter,scales="free_y",strip.position ="left",ncol=2,
             labeller = as_labeller(c(SALI = "Salinity (PSU)",
                                       CHLA = "Chl-a (µg/L)")))+ 
  theme_bw()+
  scale_fill_manual(values="grey")+
  xlab(NULL)+ylab(NULL)+ 
  #geom_jitter(position=position_dodge(0.1), aes(colour=(Site)))+
  theme(text=element_text(size=12)) +# family="ArialMT"
  theme(strip.background = element_blank(),
        strip.placement = "outside",strip.text.y = element_text(size=11, face="bold",lineheight = 1.5),
        theme(panel.grid.minor = element_blank(),panel.grid.major = element_blank()))

#Add tag inside
bpplots.01<-tag_facet(bpplots.01, tag_pool = c("B", "C"),open="",close="",size=5)

```

4 Combine maps and environmental data

```
fig1=grid.arrange(plot.with.inset,bplots=.01,nrow=1)
```



4.1 Export Figure 1

```
ggsave(filename = ".../Figures/Figure1_2column.pdf",
       plot = fig1,
       width = 18,
       height = 8,
       units = "cm",
       dpi = 150)
```