CPUE standardisation with sdmTMB

Case study : Spanish trawlers targetting Mauritanian shrimps

CPUE standardisation with sdmTMB

What are the characteristics of these data ?

CPUE standardisation with sdmTMB

What are the characteristics of these data ?

- They arise from the ecological process of interest (= they are **conditionnal** on the ecological process)

- **Noisy** (= they are not perfect observations of the ecological process)

- **Sparse** (= they do not cover the full area and some hypothesis need to be set to predict the ecological process between the sampled locations = **covariables**)
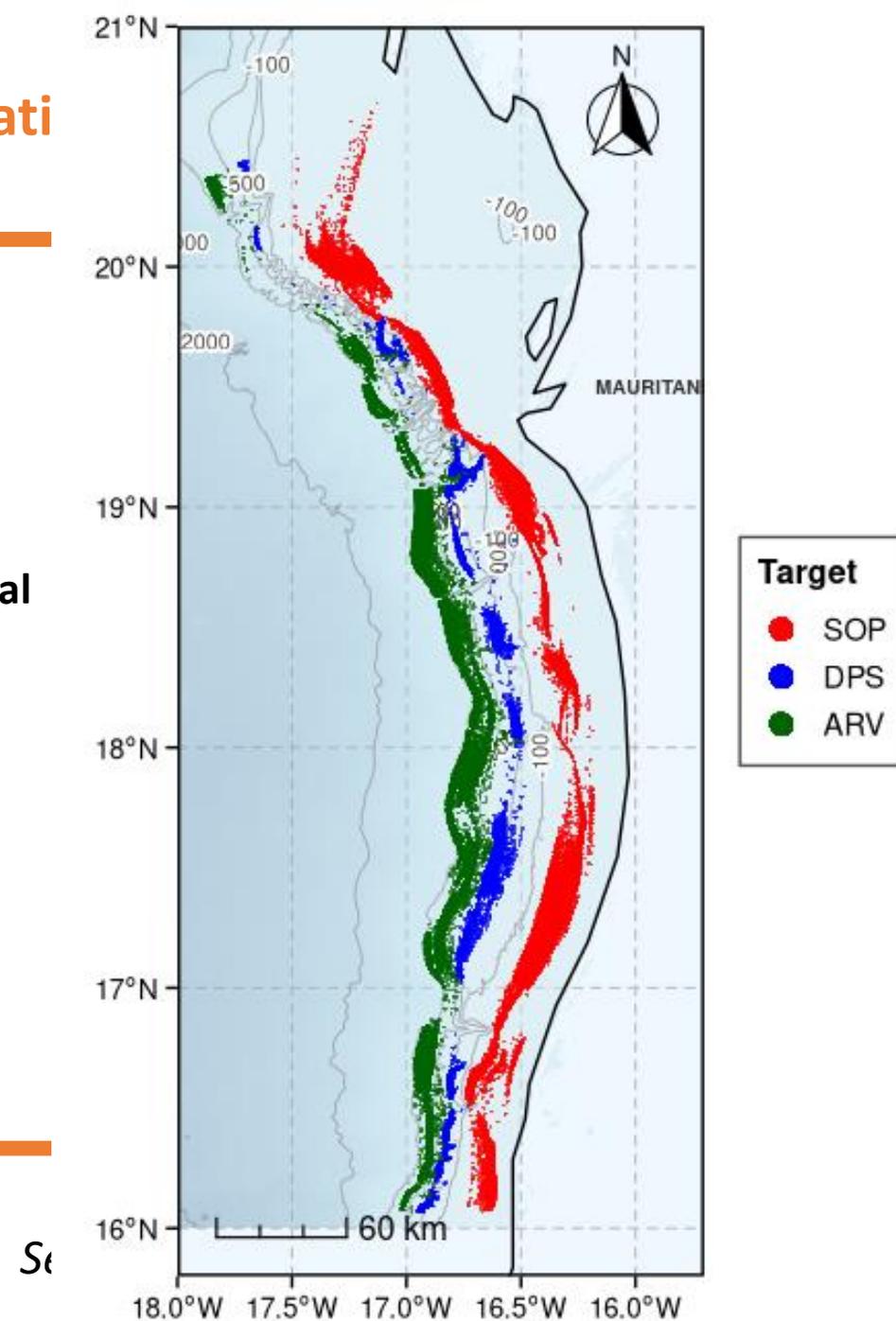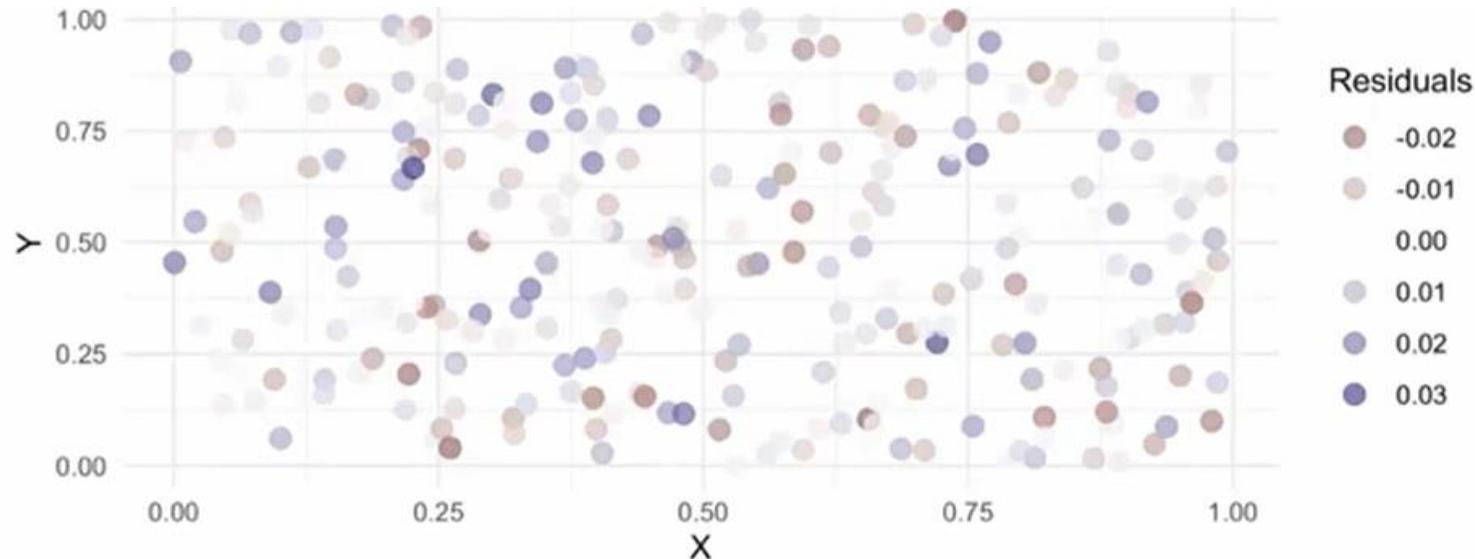
CPUE standardisation with sdmTMB

- Ecological data often have spatial attributes
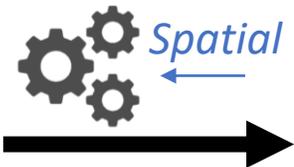
Spatial covariates

- Ideal modelling process → Residuals are uncorrelated

CPUE standardisation with sdmTMB

Spatial covariates

- **Ideal** modelling process ⟶ Residuals are **uncorrelated**

CPUE standardisation with sdmTMB

Spatial covariates

- **Real** modelling process ➡ Residuals are **correlated…**

CPUE standardisation with sdmTMB

Spatial covariates

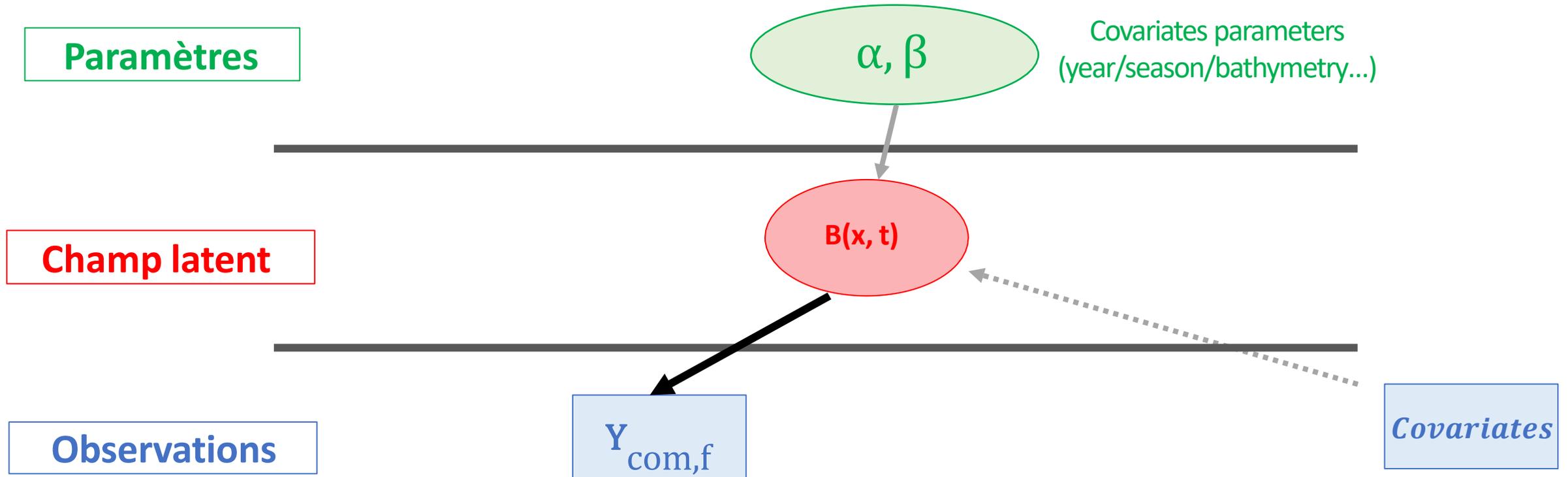**Real** modelling process ⟶ Residuals are **correlated...**
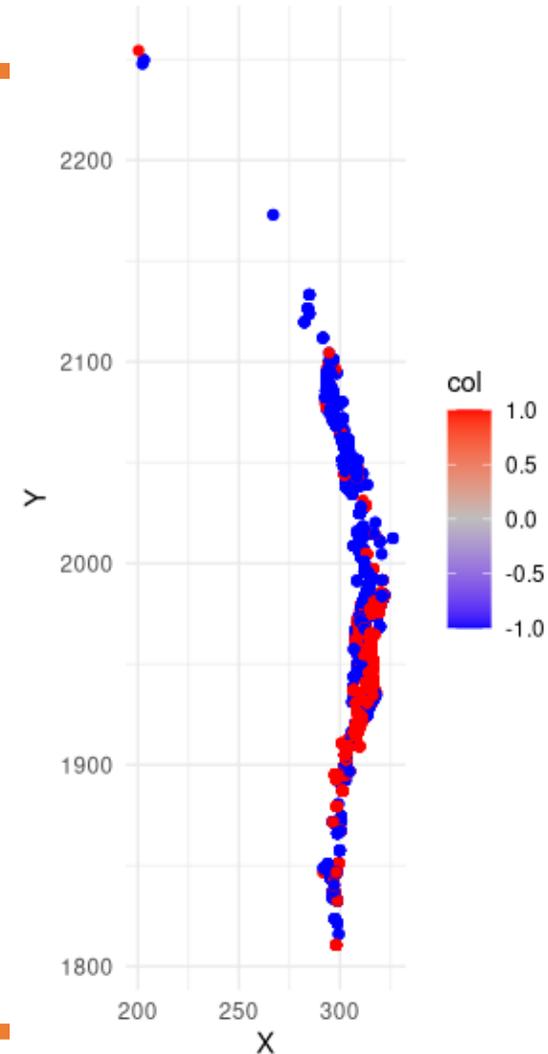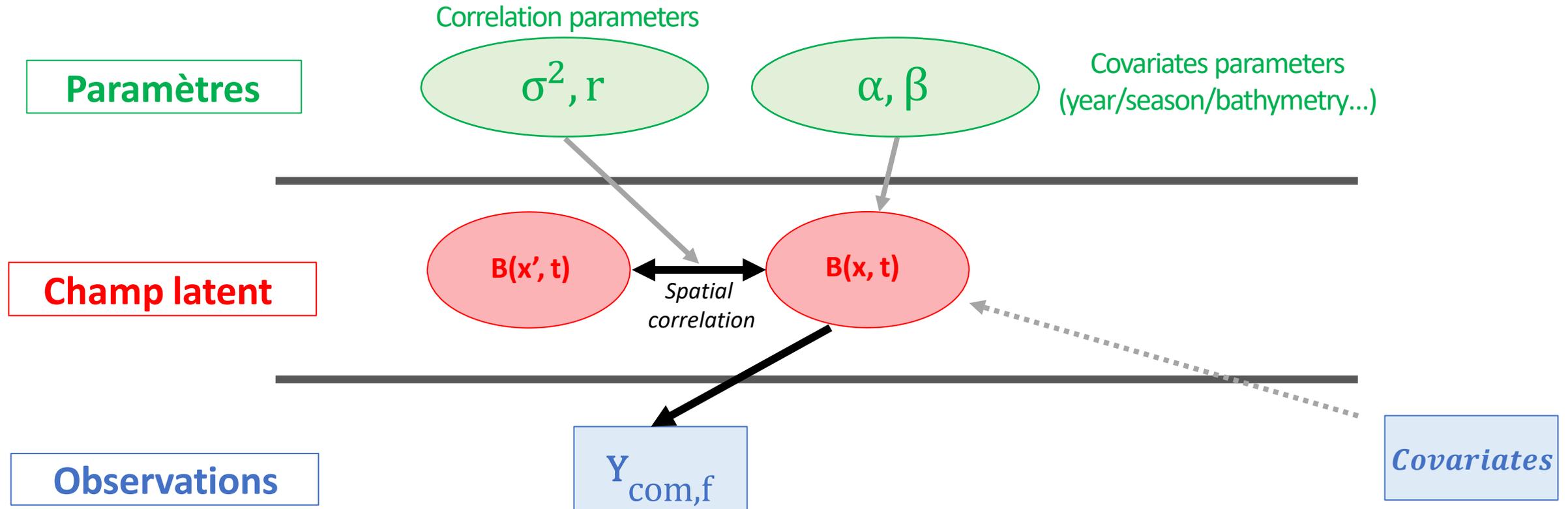
CPUE standardisation with sdmTMB

- Need to approximate all spatial variables missing from model
    - Temperature
    - Substrat
    - Oceanic currents
    - Competitions on habitats
    - …
  → **Hierarchical modelling** and **Random Field**

CPUE standardisation with sdmTMB

Paramètres

α, β

Covariates parameters
(year/season/bathymetry...)

Champ latent

B(x, t)

Observations

$Y_{com,f}$

Covariates

CPUE standardisation with sdmTMB

Correlation parameters

Covariates parameters
(year/season/bathymetry...)

Paramètres

$$\sigma^2, r$$

$$\alpha, \beta$$

Champ latent

B(x', t)

B(x, t)

Spatial correlation

Observations

$$Y_{com,f}$$

Covariates

CPUE standardisation with sdmTMB

$$Y | \delta, \beta \sim \mathcal{L}(\boldsymbol{S}, \sigma^2)$$

$$f(\boldsymbol{S}) = \boldsymbol{X} \cdot \beta + \boldsymbol{\delta}$$

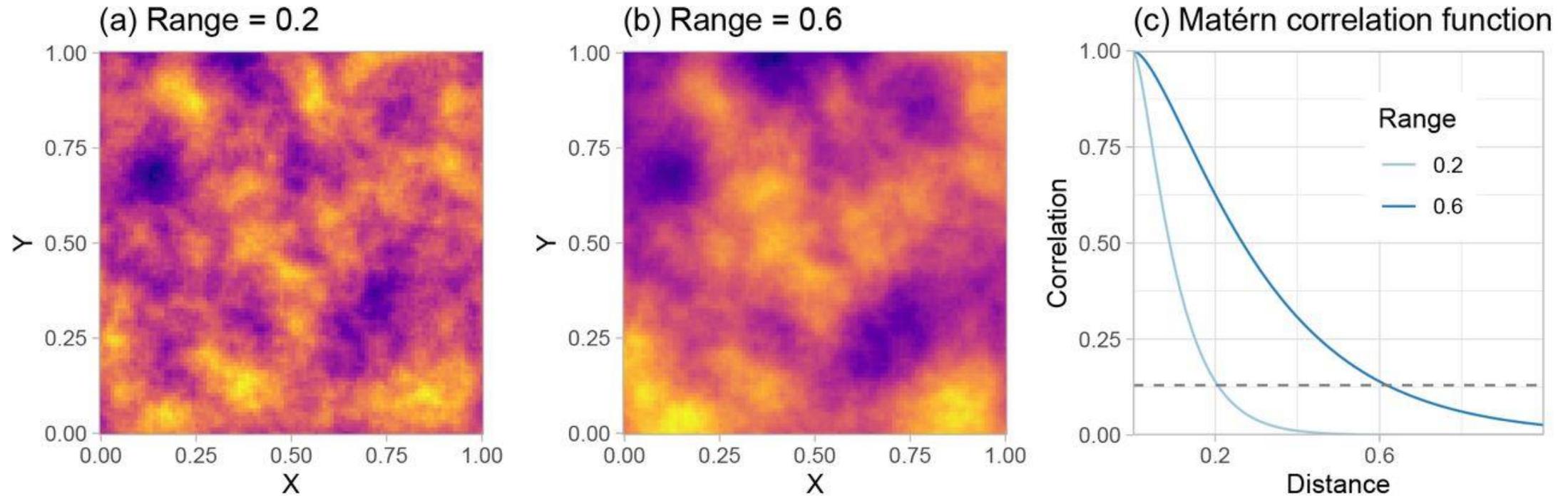$$\boldsymbol{\delta} \sim \mathcal{MG}(0, \boldsymbol{\Sigma})$$

The key element is the covariance matrix $\boldsymbol{\Sigma}_{(n \times n)}$

CPUE standardisation with sdmTMB
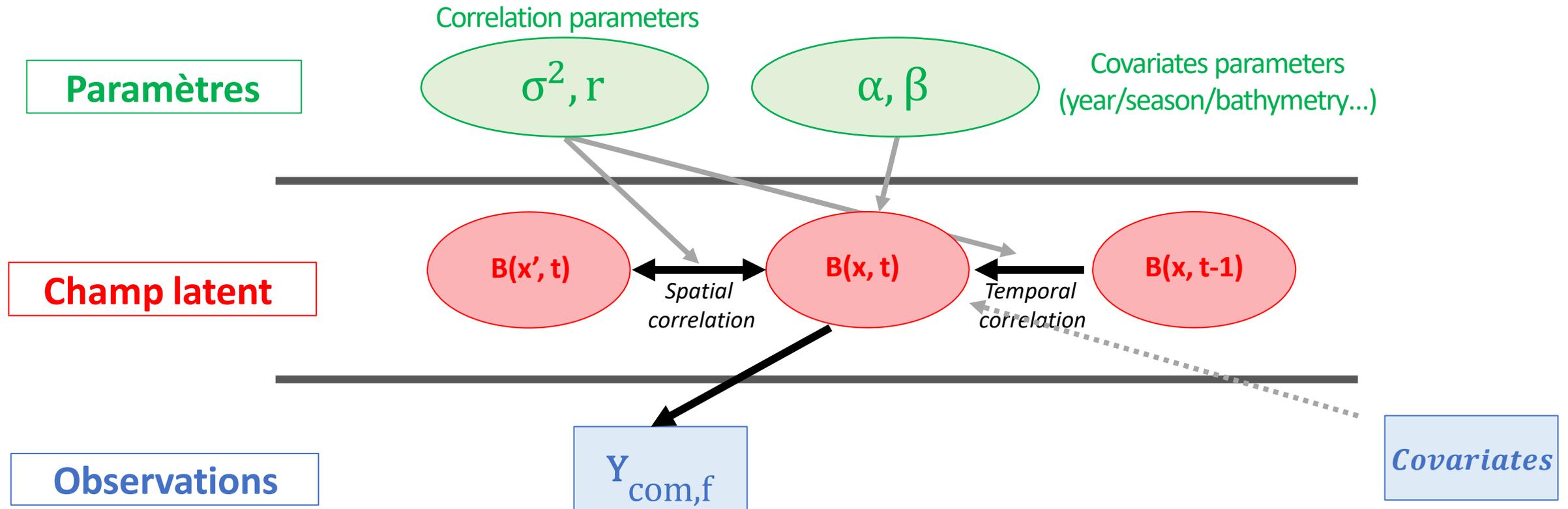
$$\Sigma = \begin{pmatrix} Var[\delta_1] & Cov[\delta_1, \delta_2] & \cdots & Cov[\delta_1, \delta_n] \\ Cov[\delta_2, \delta_1] & Var[\delta_2] & \ddots & \vdots \\ \vdots & \ddots & \ddots & \vdots \\ Cov[\delta_n, \delta_1] & \cdots & \cdots & Var[\delta_n] \end{pmatrix}$$
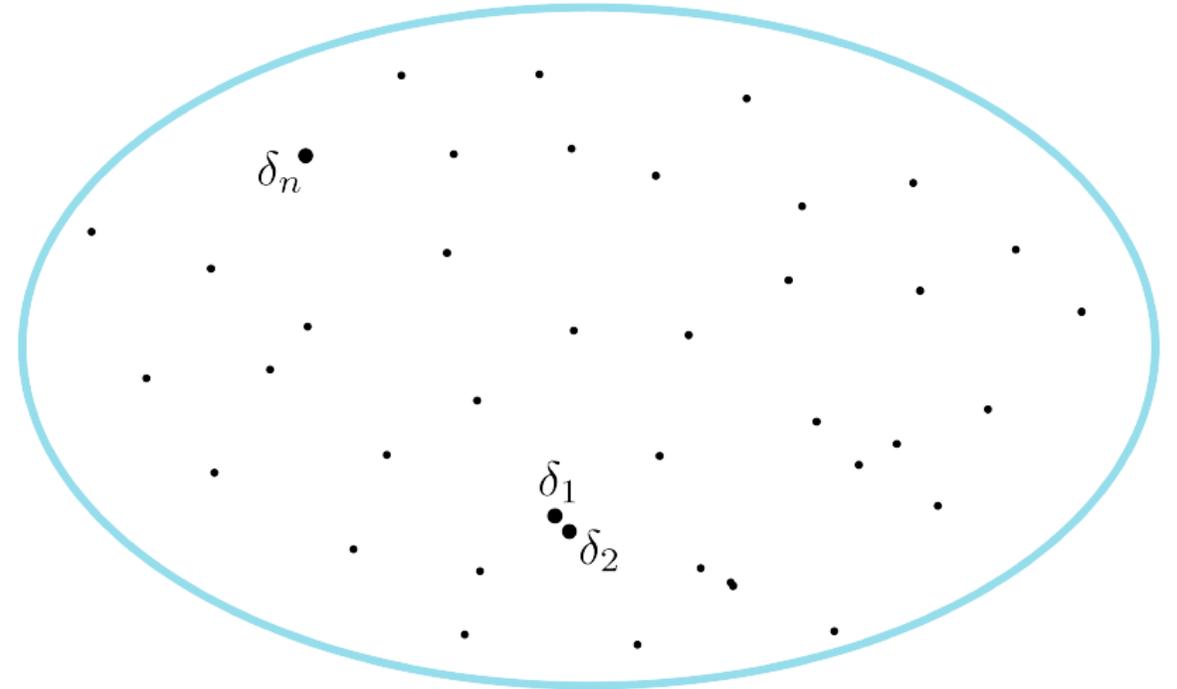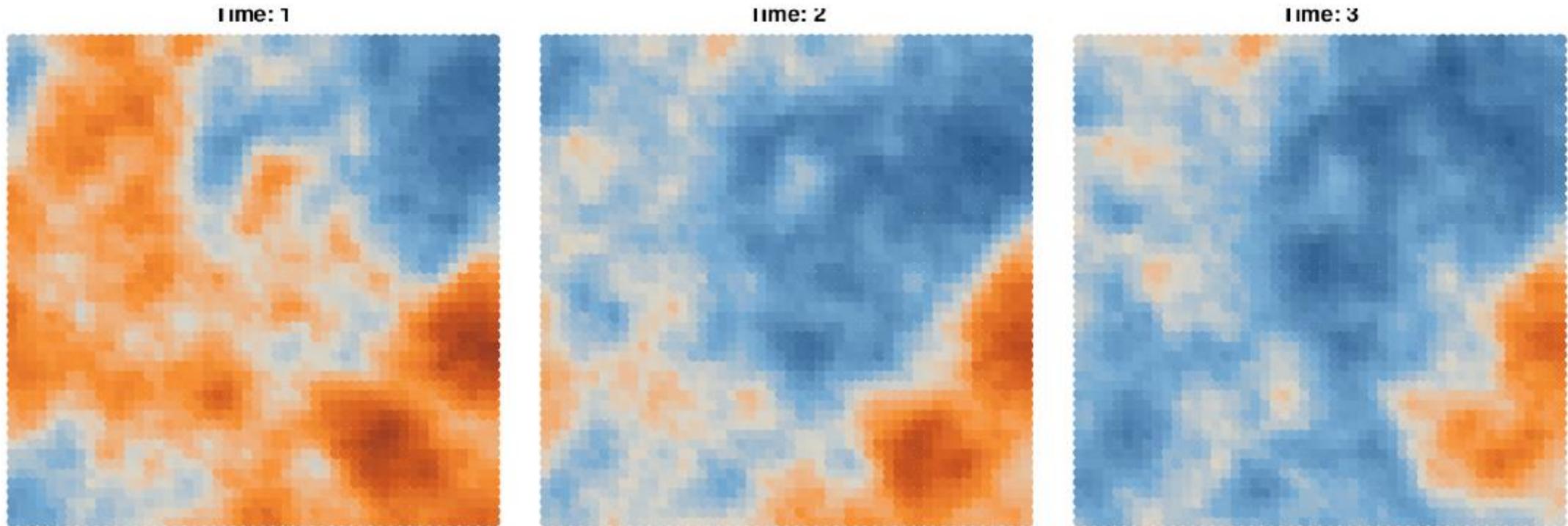
CPUE standardisation with sdmTMB

CPUE standardisation with sdmTMB

CPUE standardisation with sdmTMB

CPUE standardisation with sdmTMB

Abondance

CPUE = Effet navire + Effet habitat + Champ spatial + Champ spatio-temporel

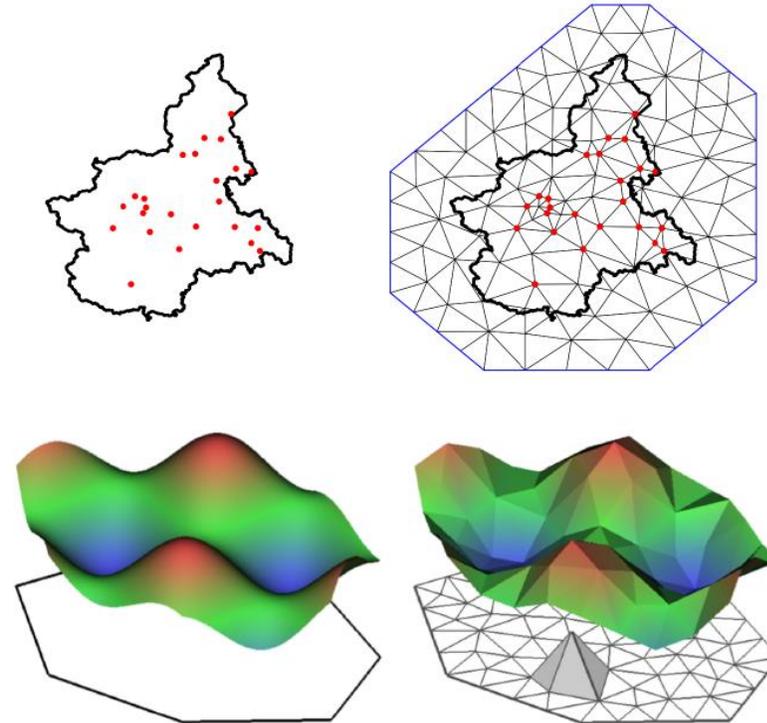- Stratégies de pêche
- Engin
- Comportements des pêcheurs
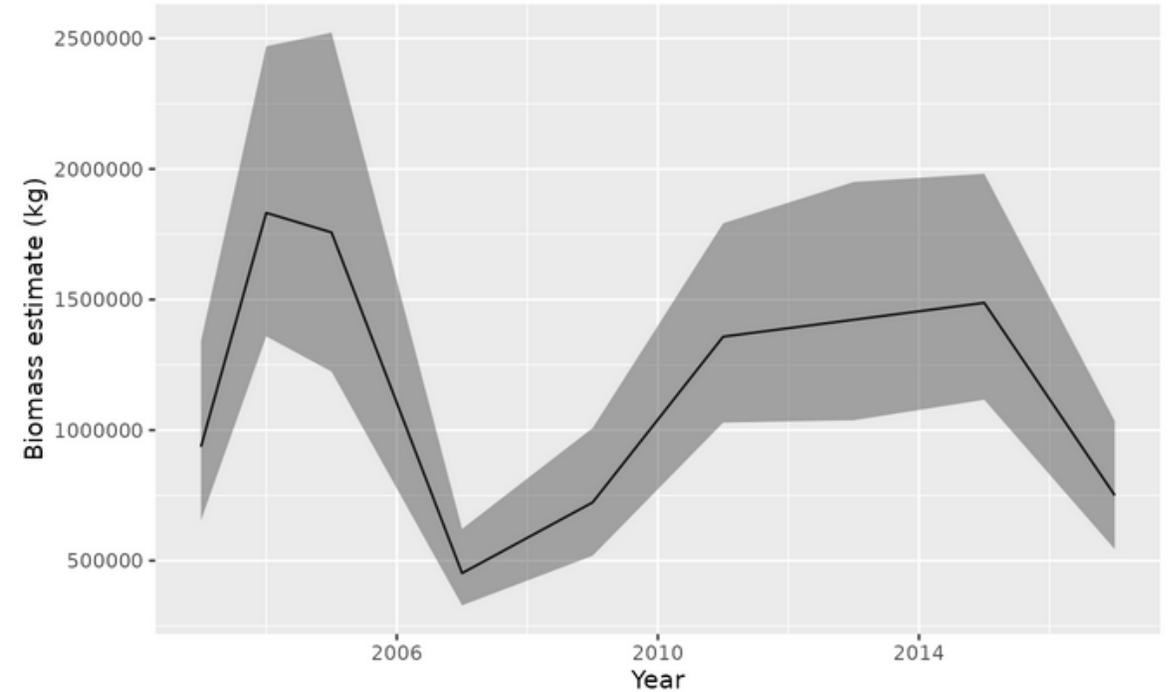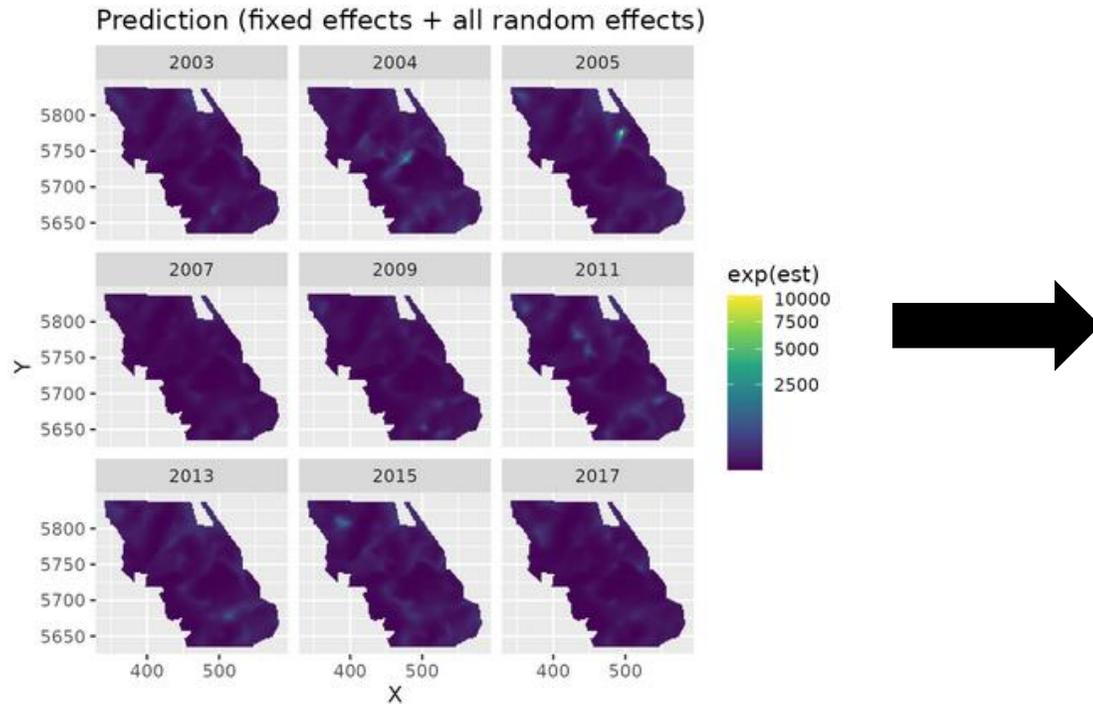- …

- Profondeur
- Température
- Substrat
- …

- Processus non mesurés
- Structure géographique persistante

- Déplacement du stock

CPUE standardisation with sdmTMB
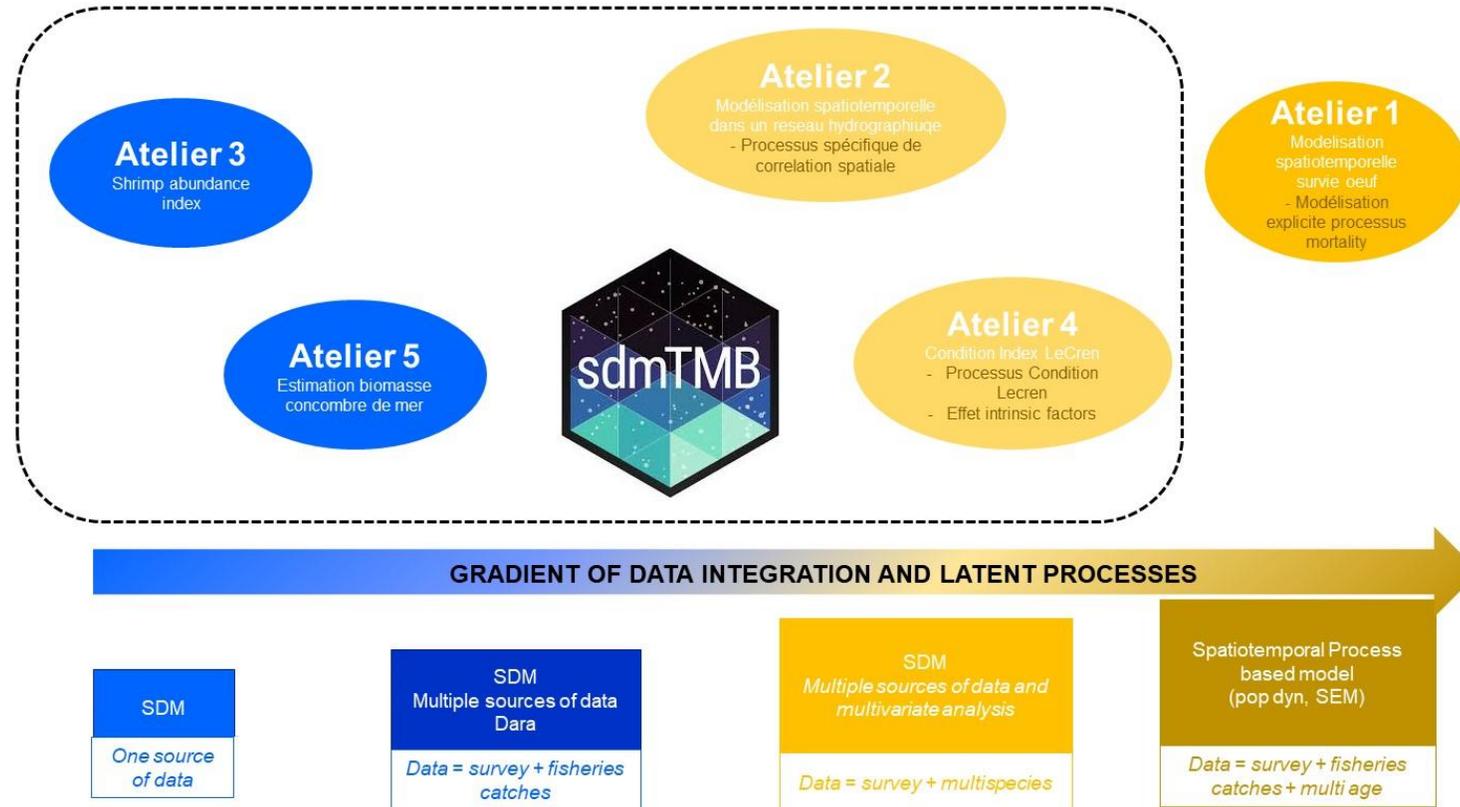
CPUE standardisation with sdmTMB

Case study : Spanish trawlers targetting Mauritanian shrimps

Case study : Spanish trawlers targetting Mauritanian shrimps

Groupe de travail sur les Modèles Spatio-Temporels
Rennes le 2-3 février

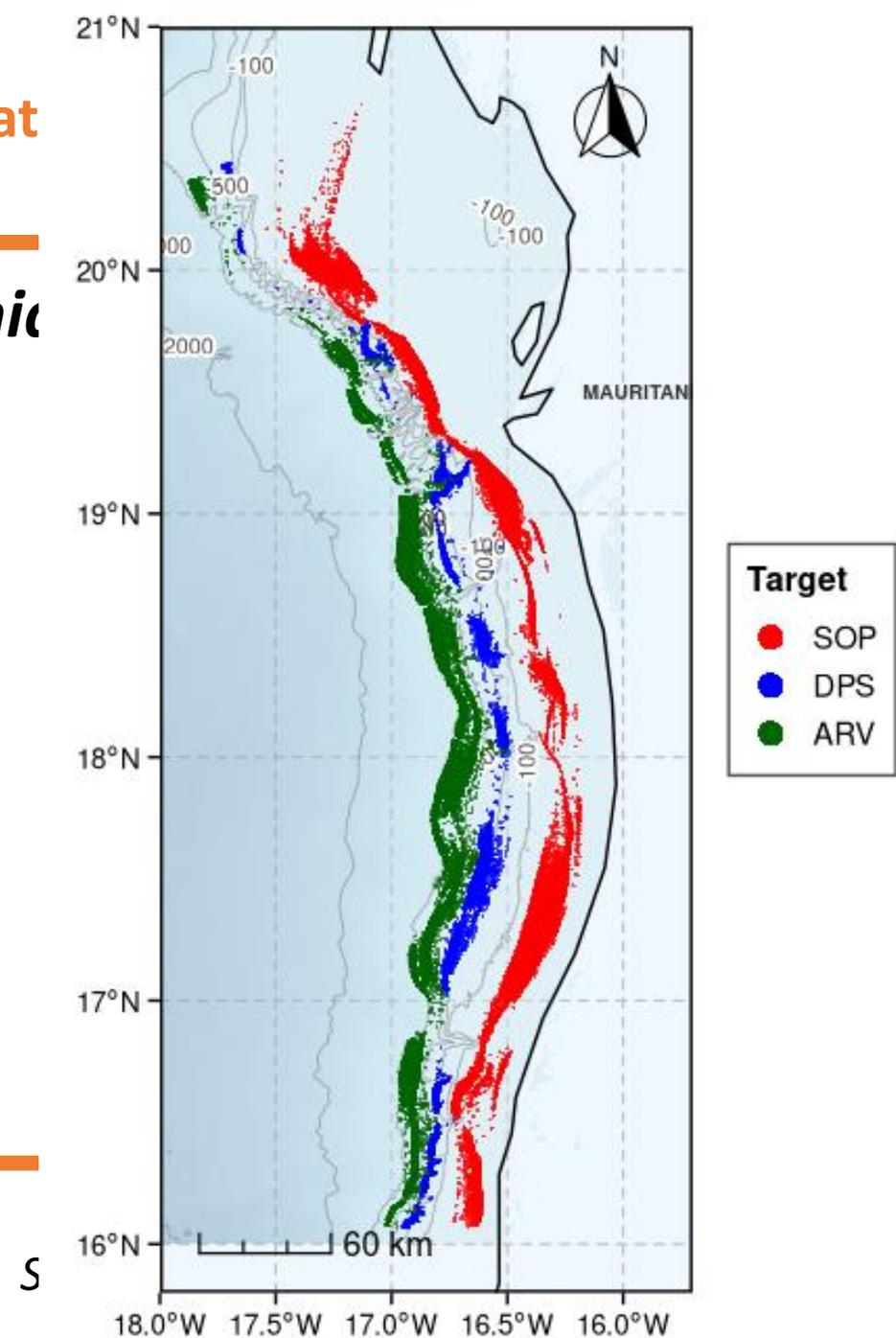## Case study : Spanish trawlers targetting Mauritanian shrimps

Case study : Spanish trawlers targetting Mauritani

1. **Data assumptions**

- Species distribution do not overlap :
  - *Penaeus notialis -* **PEN** : 10-80m
  - *Parapenaeus longirostris –* **DPS** : 150-350m
  - *Aristeus varidens –* **ARV** : 400-1000m

- No zeros at the moment in the dataset

- VMS Centroid

- Catch are modelled using Effort as an offset

Case study : Spanish trawlers targetting Mauritanian shrimps
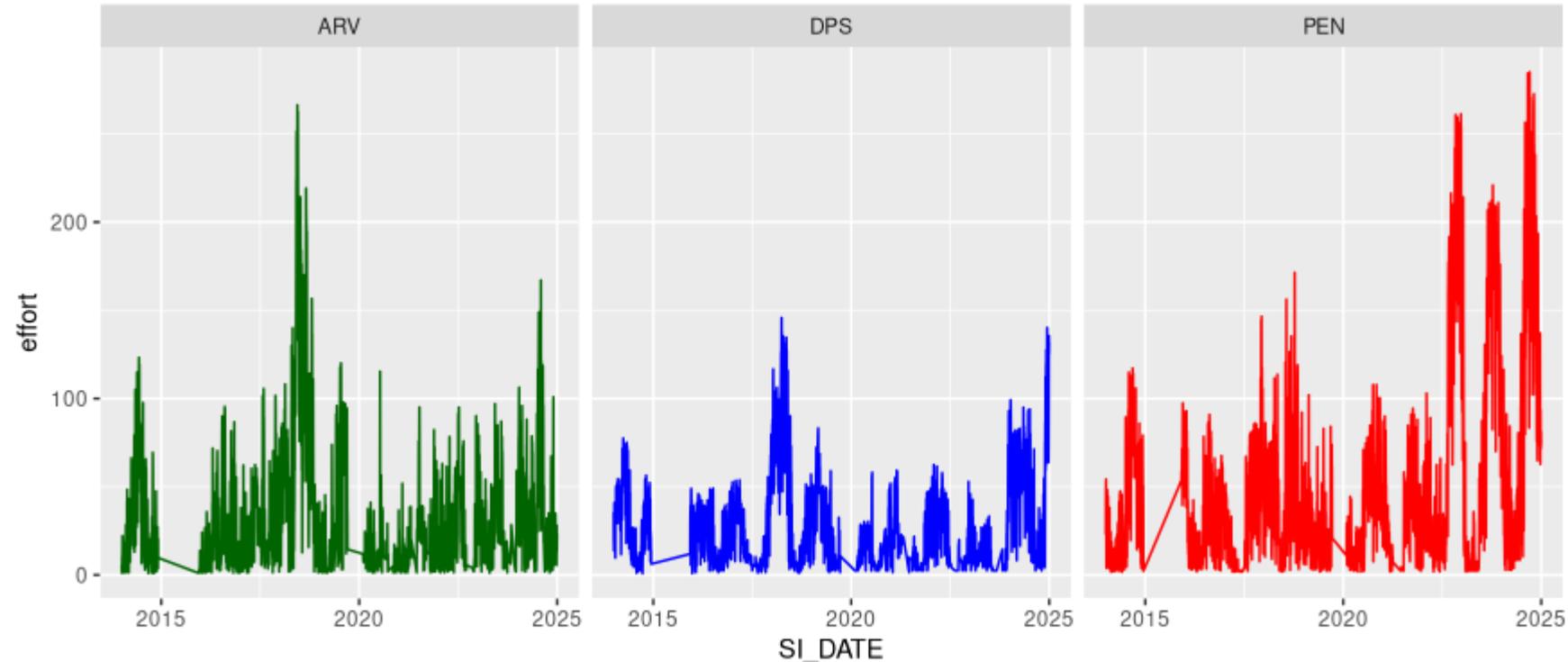
2. Data available

- 2014-2024

- Daily effort & catch

- 20 vessels

- 3 metiers

Case study : Spanish trawlers targetting Mauritanian shrimps

2. Data available

Effort (heures pêchées)
➔ Variations intrannuelle
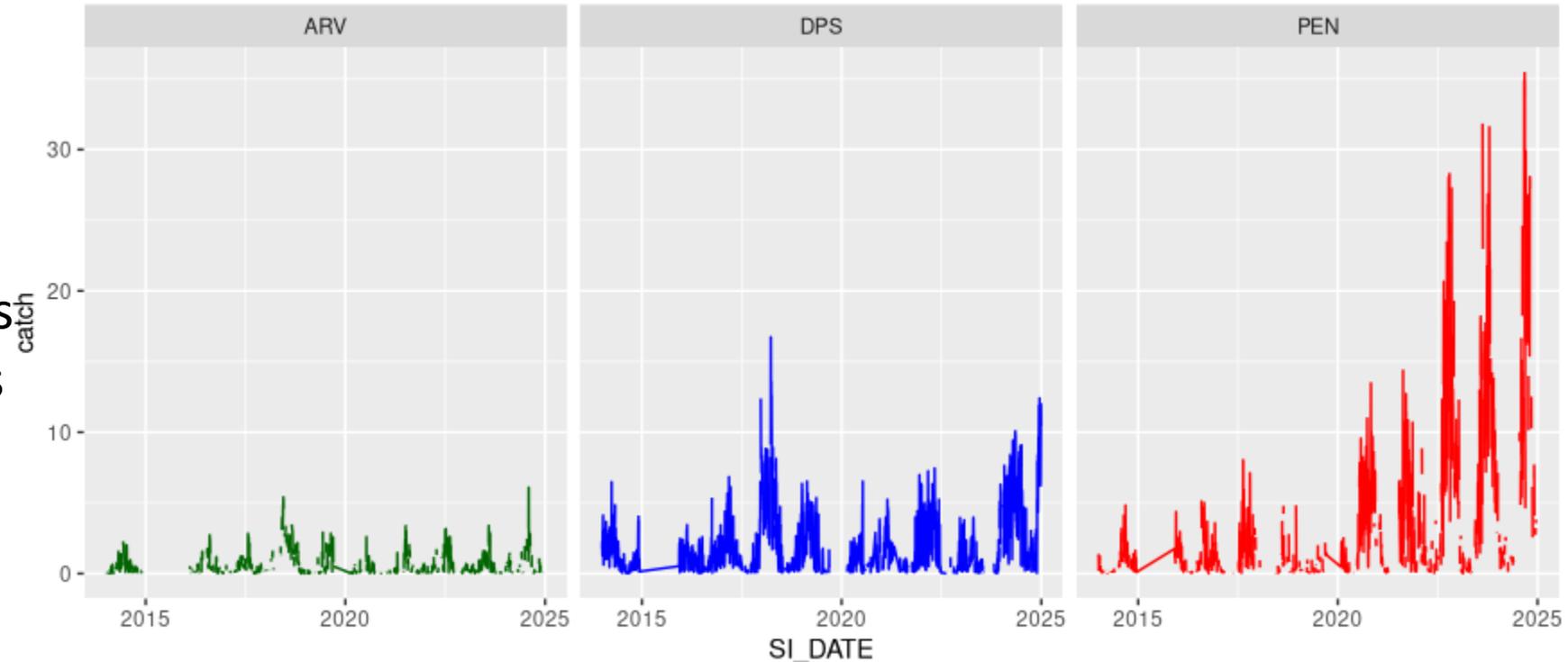➔ Variations interannuelles
➔ Variations entre espèces

Case study : Spanish trawlers targetting Mauritanian shrimps

2. Data available

Captures (tonnes)
➔ Variations intrannuelle
➔ Variations interannuelles
➔ Variations entre espèces

Case study : Spanish trawlers targetting Mauritanian shrimps
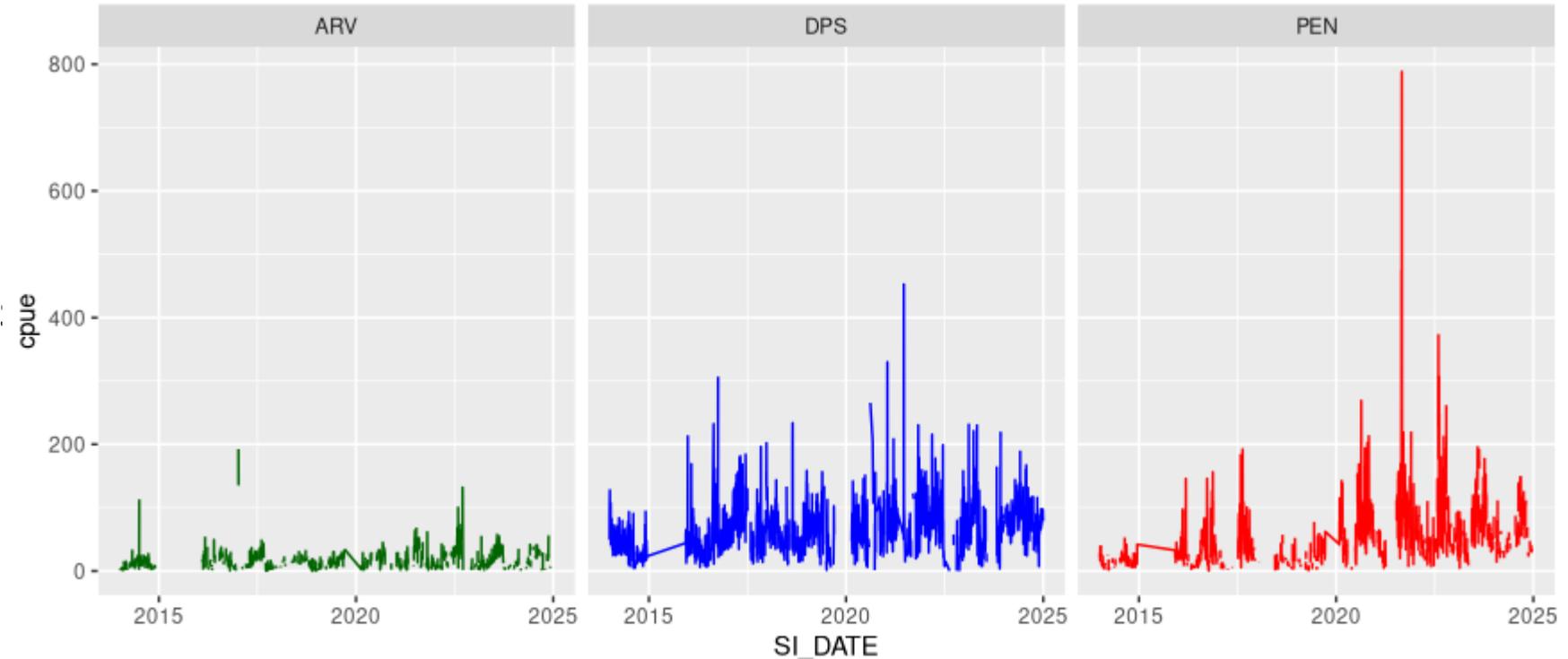
2. Data available

Cpue (kg/heure pêchée)
➔ Variations intrannuelle
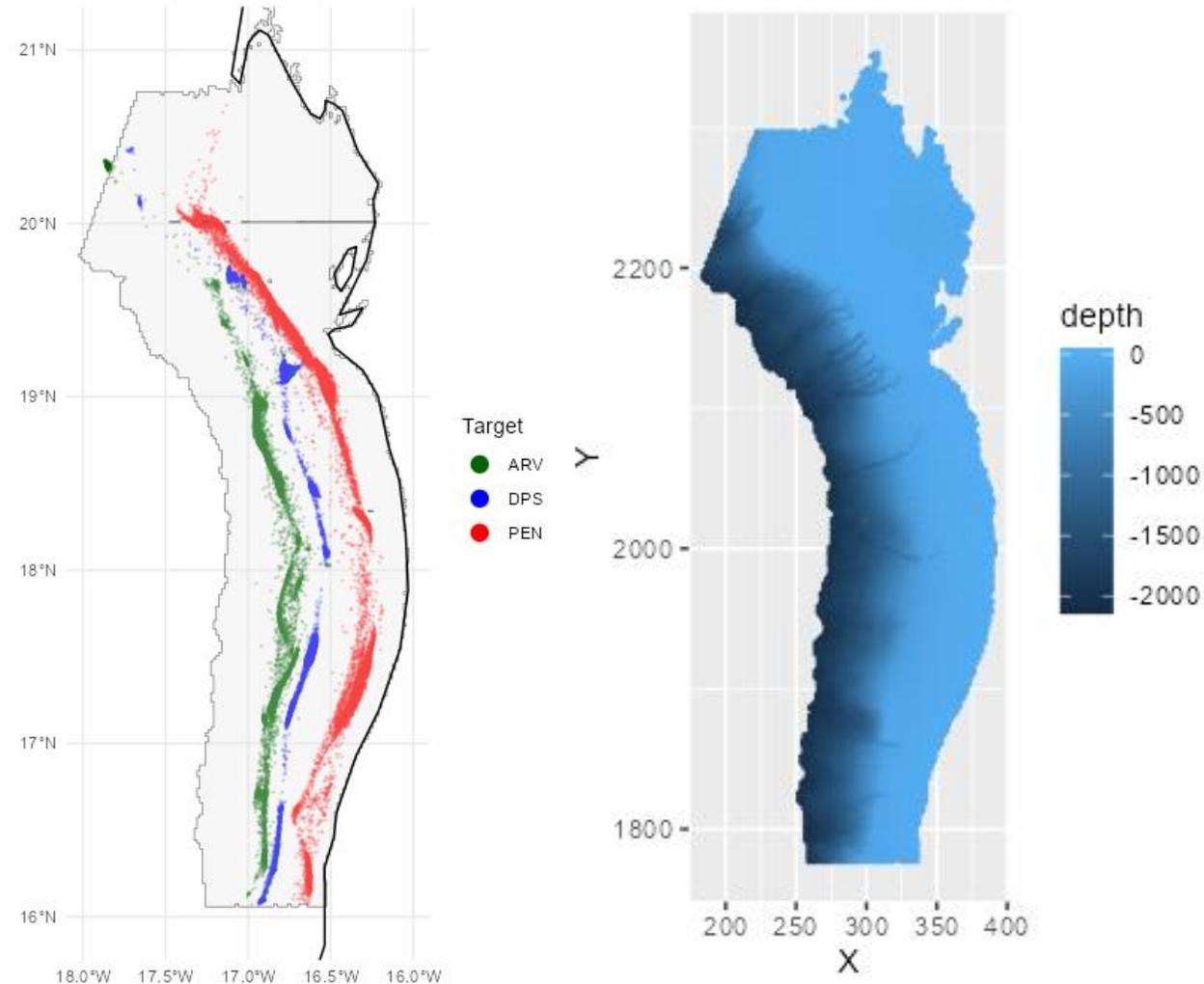➔ Variations interannuelles
➔ Tendance à la diminution sur les années récentes ?

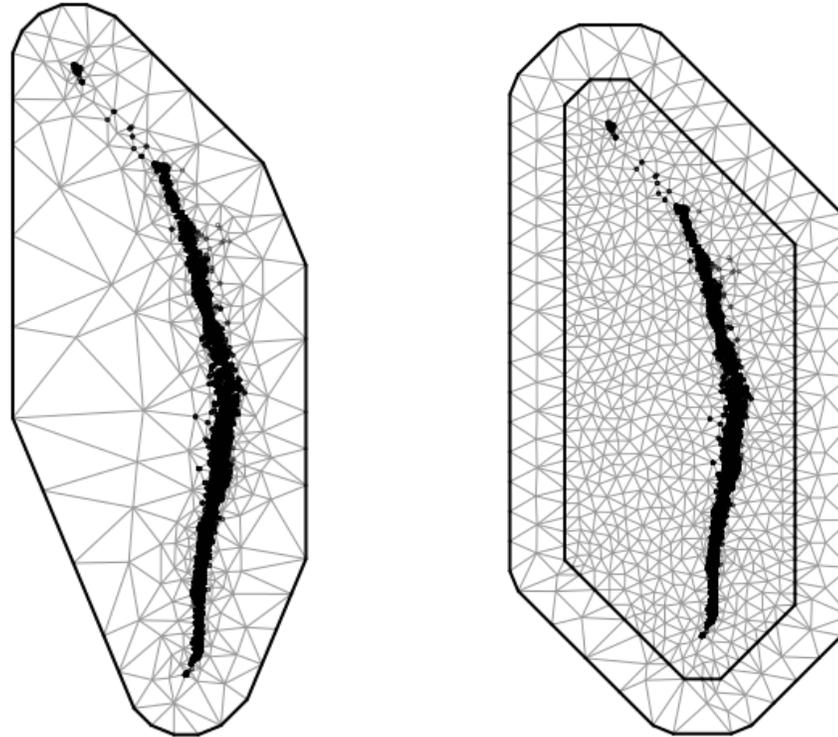# Case study : Spanish trawlers targetting Mauritanian shrimps

2. Data available
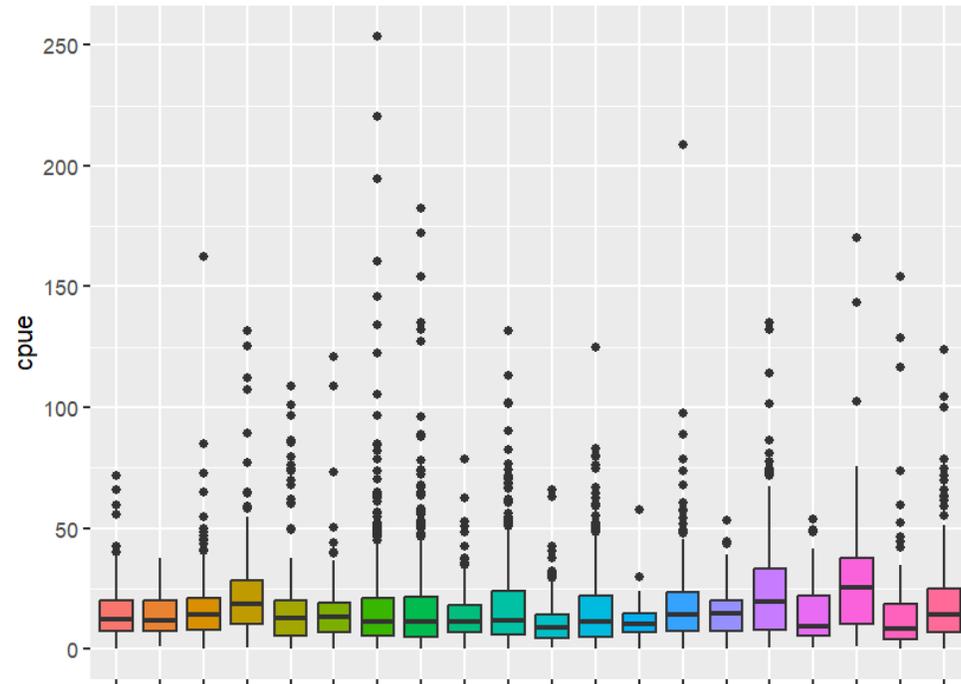
- Grille de prédiction
- Bathymétrie

Case study : Spanish trawlers targetting Mauritanian shrimps

3. Préparation de la 'mesh'

Case study : Spanish trawlers targetting Mauritanian shrimps
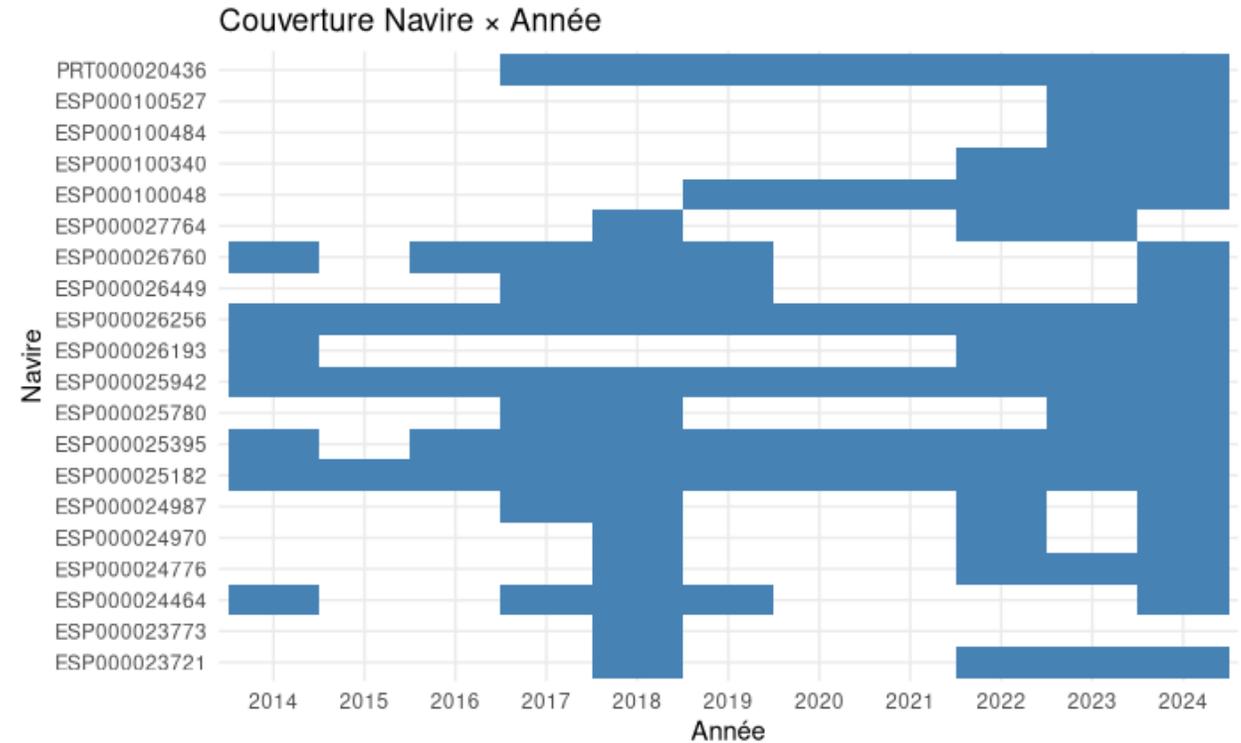
4. Sélection des co-variables

Case study : Spanish trawlers targetting Mauritanian shrimps

4. Sélection des co-variables

Couverture Navire × Année

Case study : Spanish trawlers targetting Mauritanian shrimps

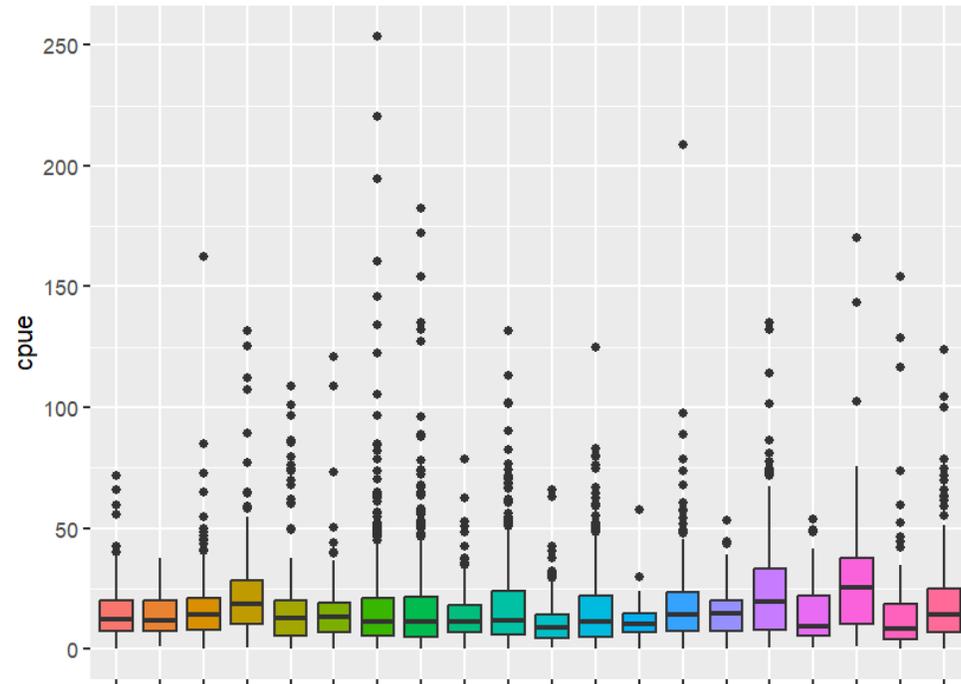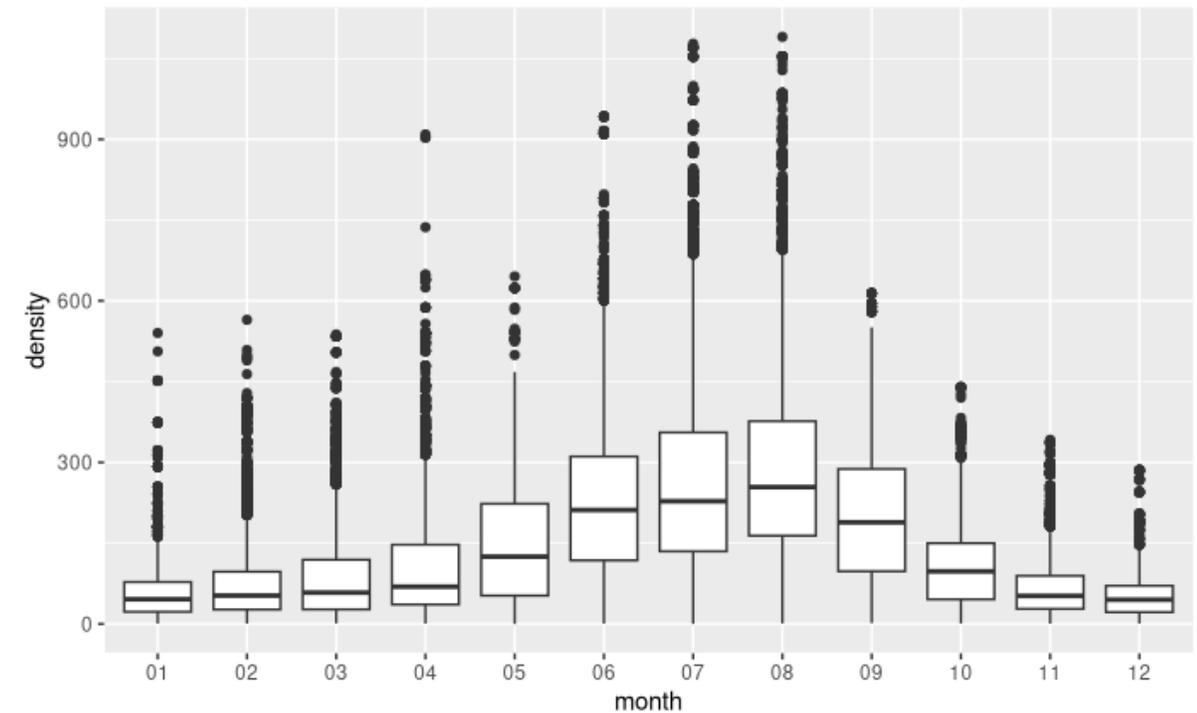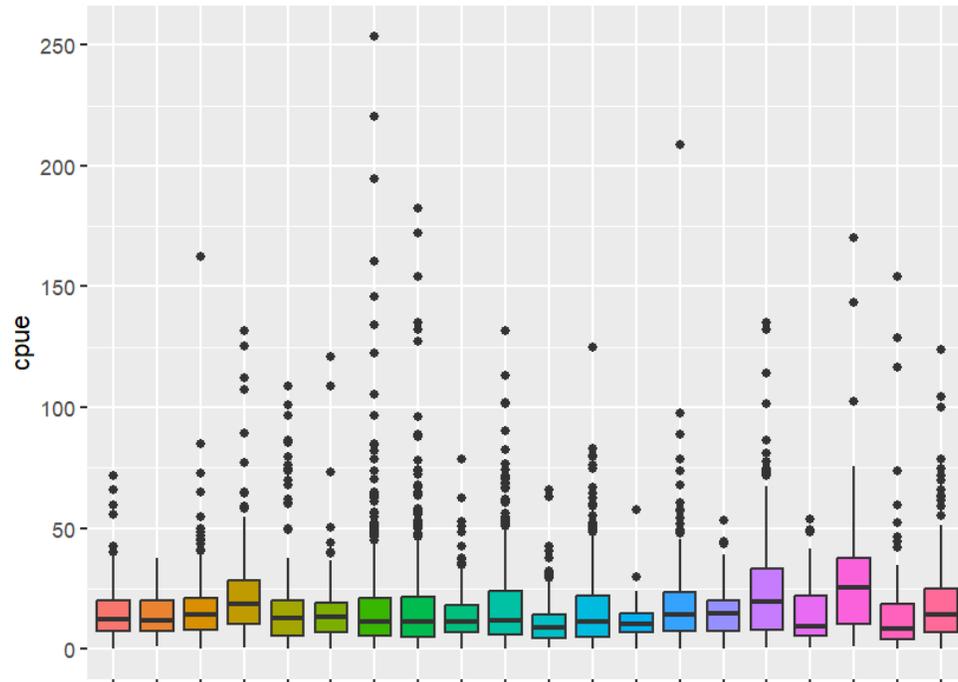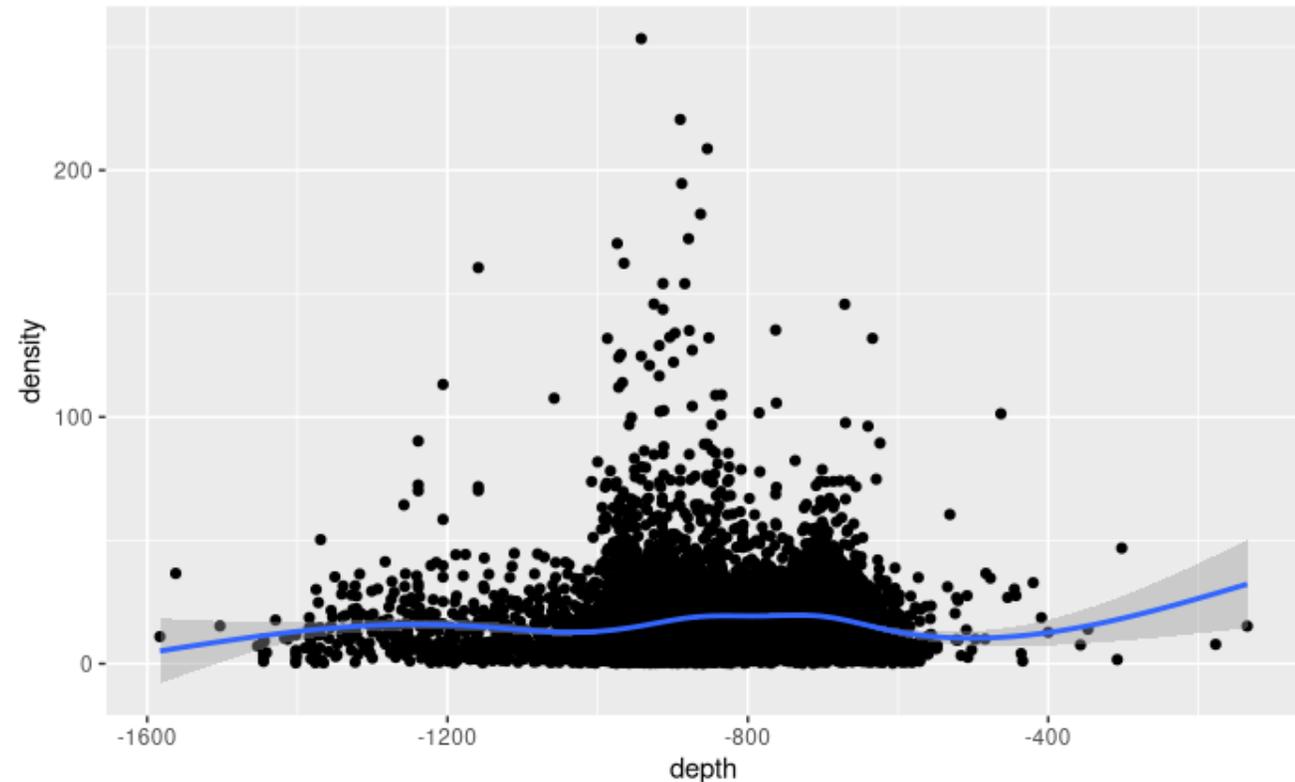## 4. Sélection des co-variables

Case study : Spanish trawlers targetting Mauritanian shrimps
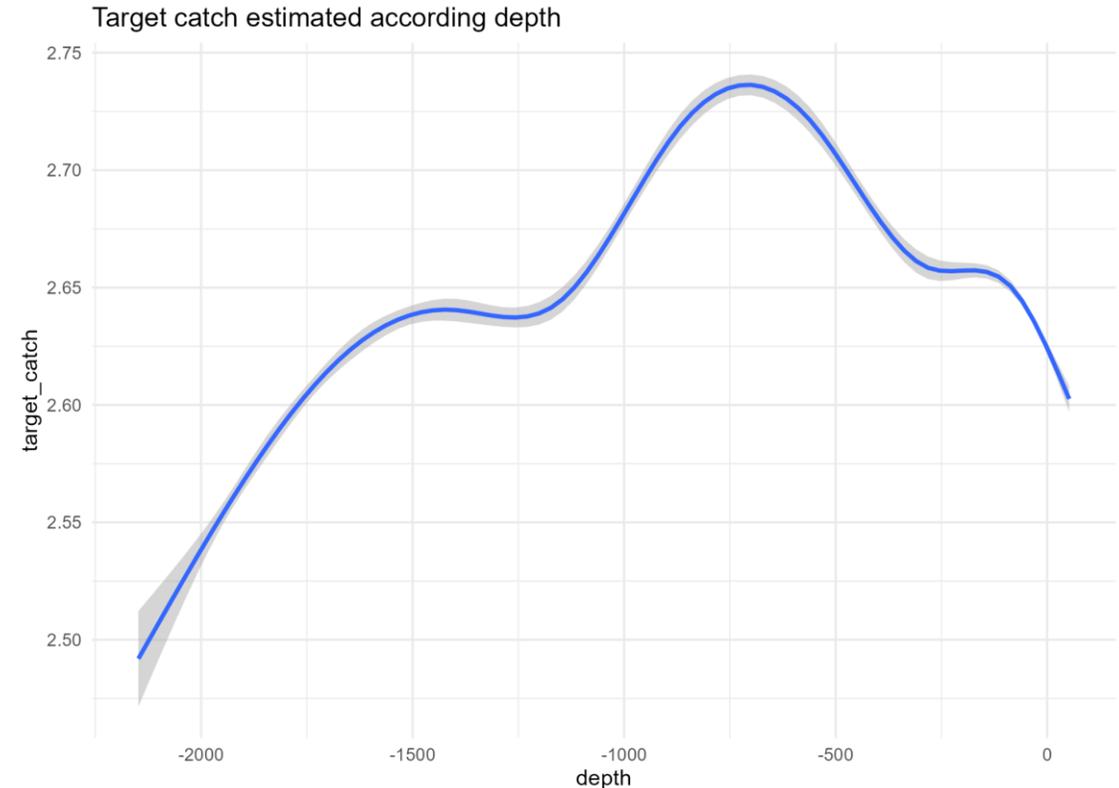
4. Sélection des co-variables

Case study : Spanish trawlers targetting Mauritanian shrimps

4. Sélection des co-variables

L'effet de la bathymétrie n'est pas
correctement modélisée in fine :
Attendue = [-1000m ; -400m]

➔ Problématiques liées à la fixation des
   centroïdes ?
➔ Résolution de grille de bathymétrie ?
➔ Manque de zéros ?

Target catch estimated according depth

Case study : Spanish trawlers targetting Mauritani

1. **Hypothèses de bases**

- Species distribution do not overlap :

  Penaeus notialis - **PEN** : 10-80m
  Parapenaeus longirostris – **DPS** : 150-350m
  Aristeus varidens – **ARV** : 400-1000m

- No zeros at the moment in the dataset

- ~~VMS Centroid~~ ➔ **ping VMS**
  (36 000 obs => 380 000 obs)
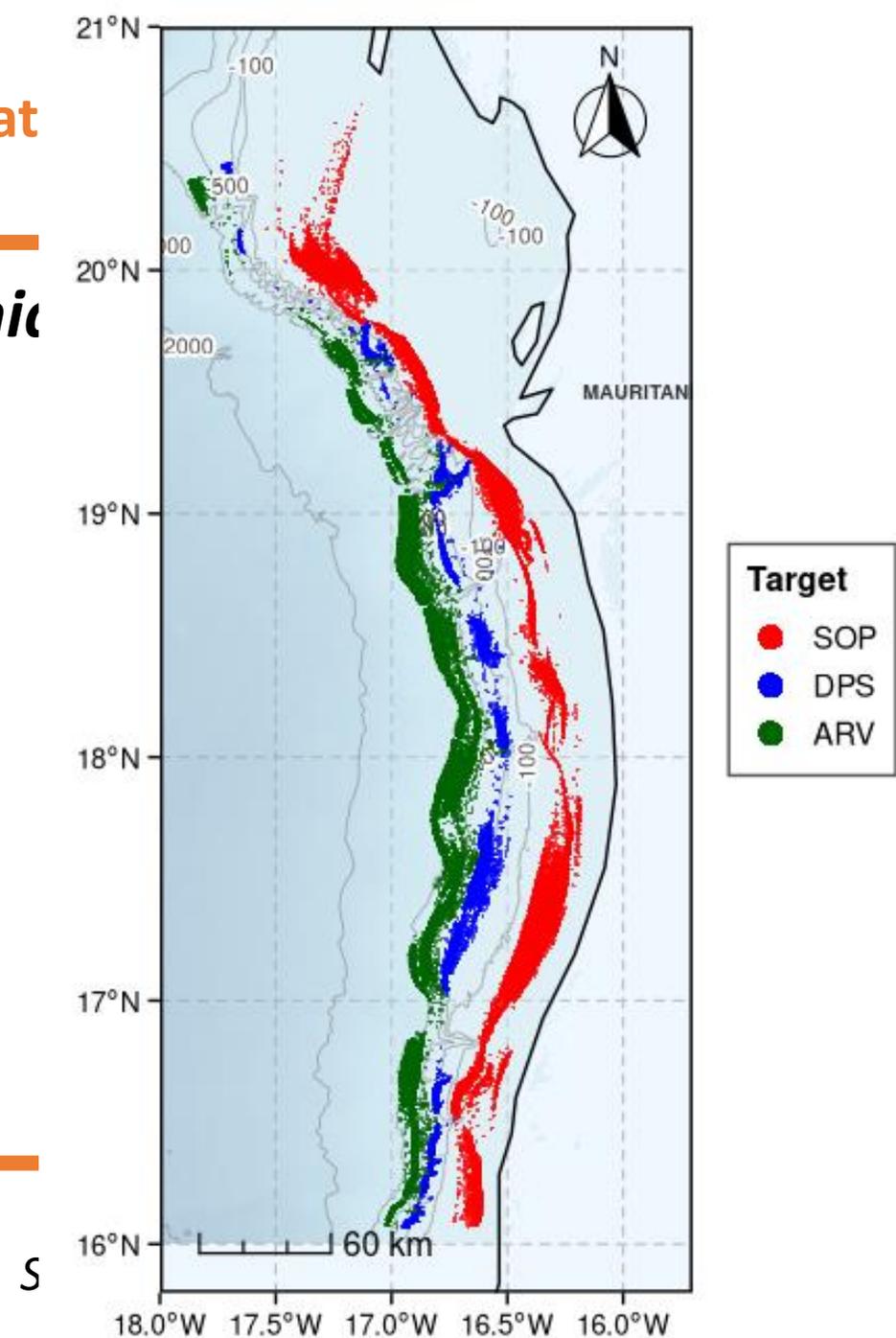
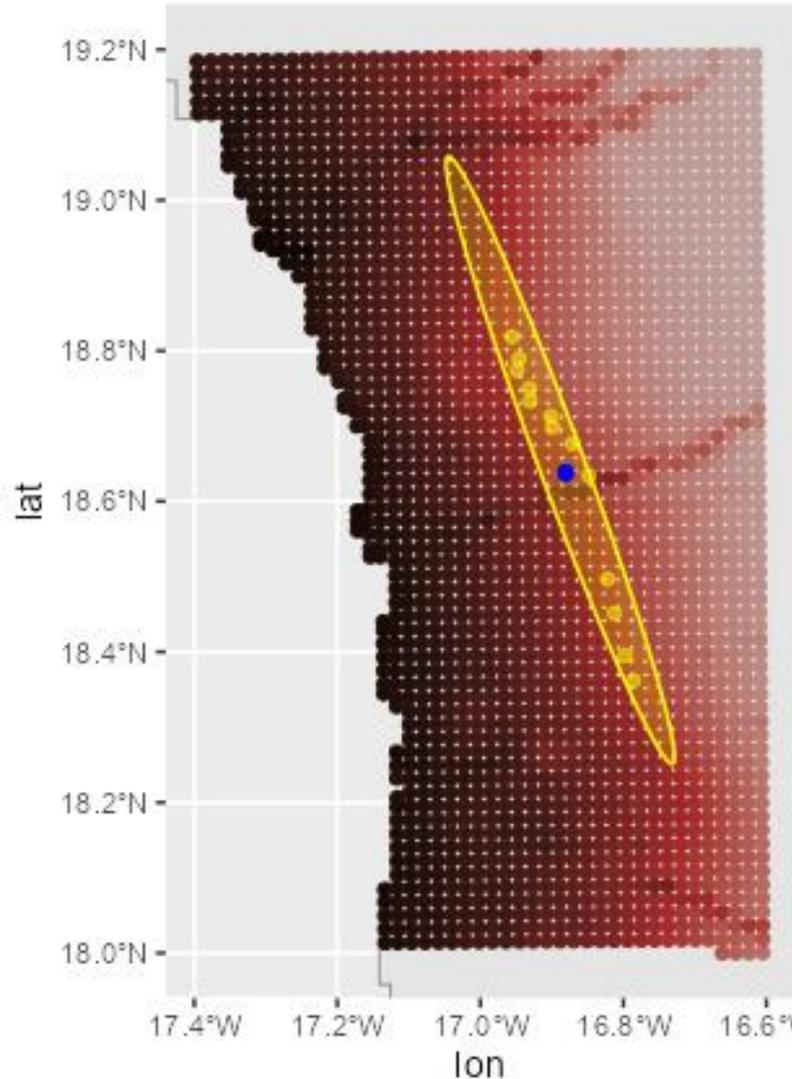- Catch are modelled using Effort as an offset

Case study : Spanish trawlers targetting

1. **Hypothèses de bases**

- Species distribution do not overlap :
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    - *Aristeus varidens* – **ARV** : 400-1000m

- No zeros at the moment in the dataset

- ~~VMS Centroid~~ ➔ **ping VMS : catch reallocation**
(36 000 obs => 380 000 obs)

- Catch are modelled using Effort as an offset
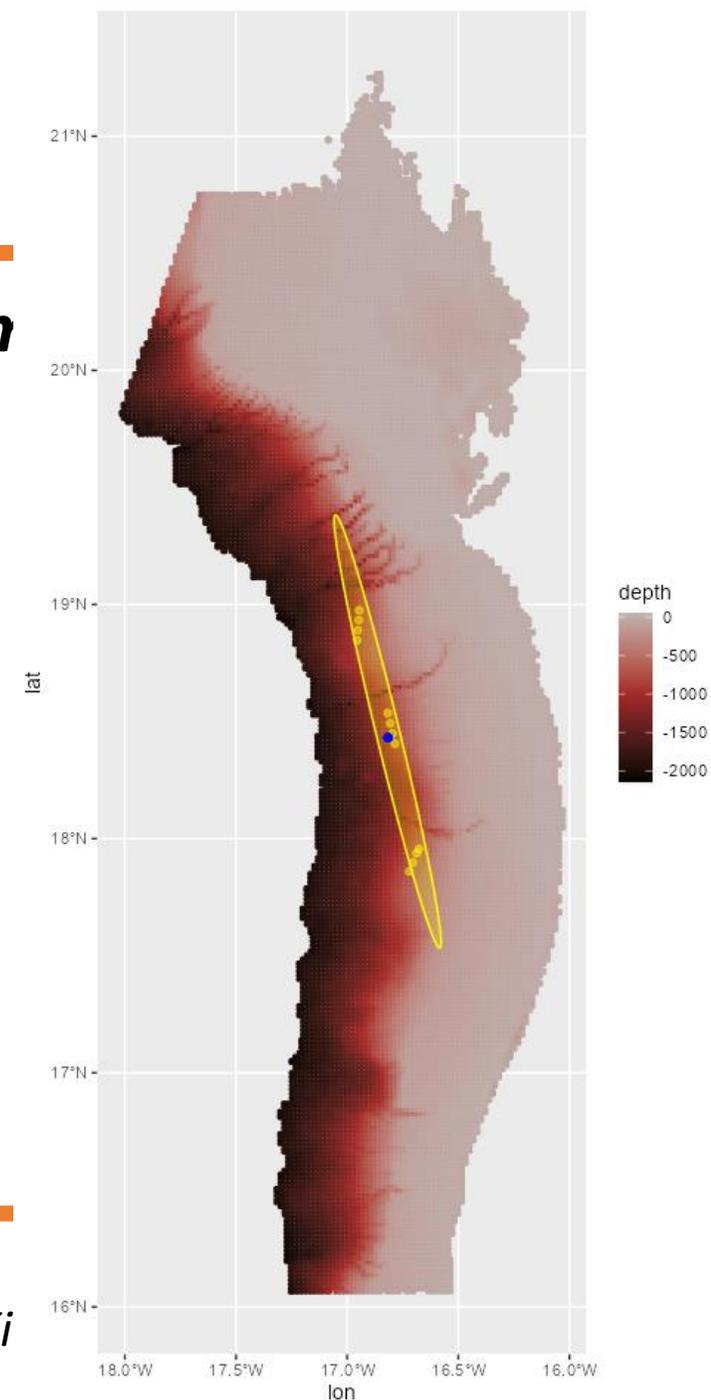

Sénégal - Kick
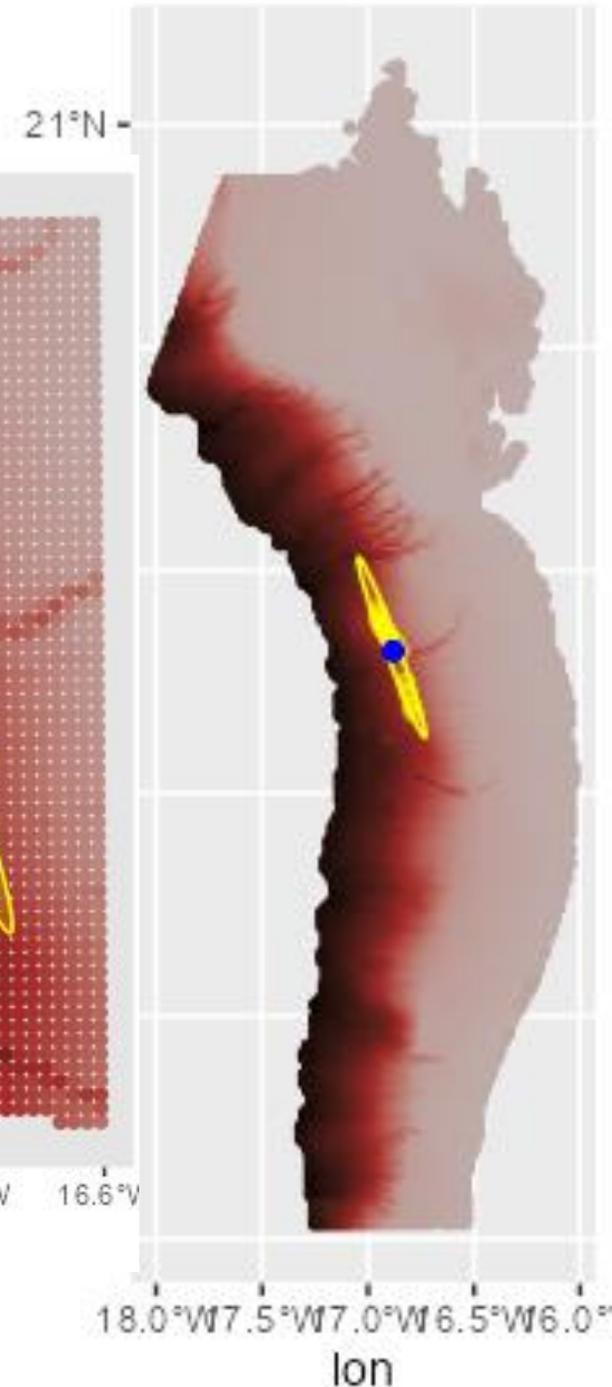
Case study : Spanish trawlers targetting Mauritanian shrim

1. **Hypothèses de bases**

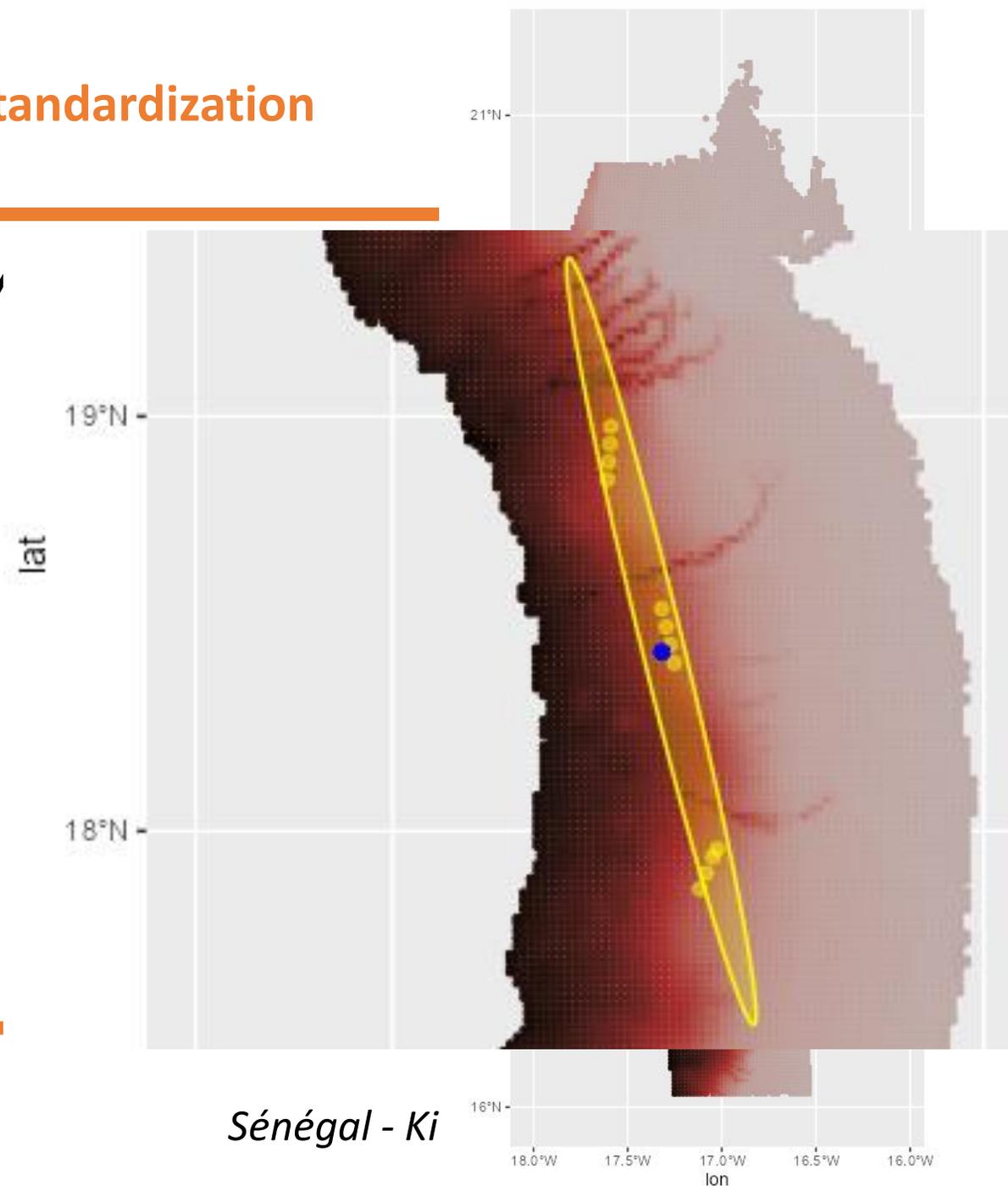   ➔ Les activités de pêche durant une journée peuvent être très éloignées spatialement

Sénégal - Ki

Case study : Spanish trawlers targetting M

1. ## **Hypothèses de bases**

   ➔ Les activités de pêche durant une journée
   peuvent être très éloignées spatialement
   ➔ Mauvaise assignation de la bathymétrie
   en conservant le centroïde
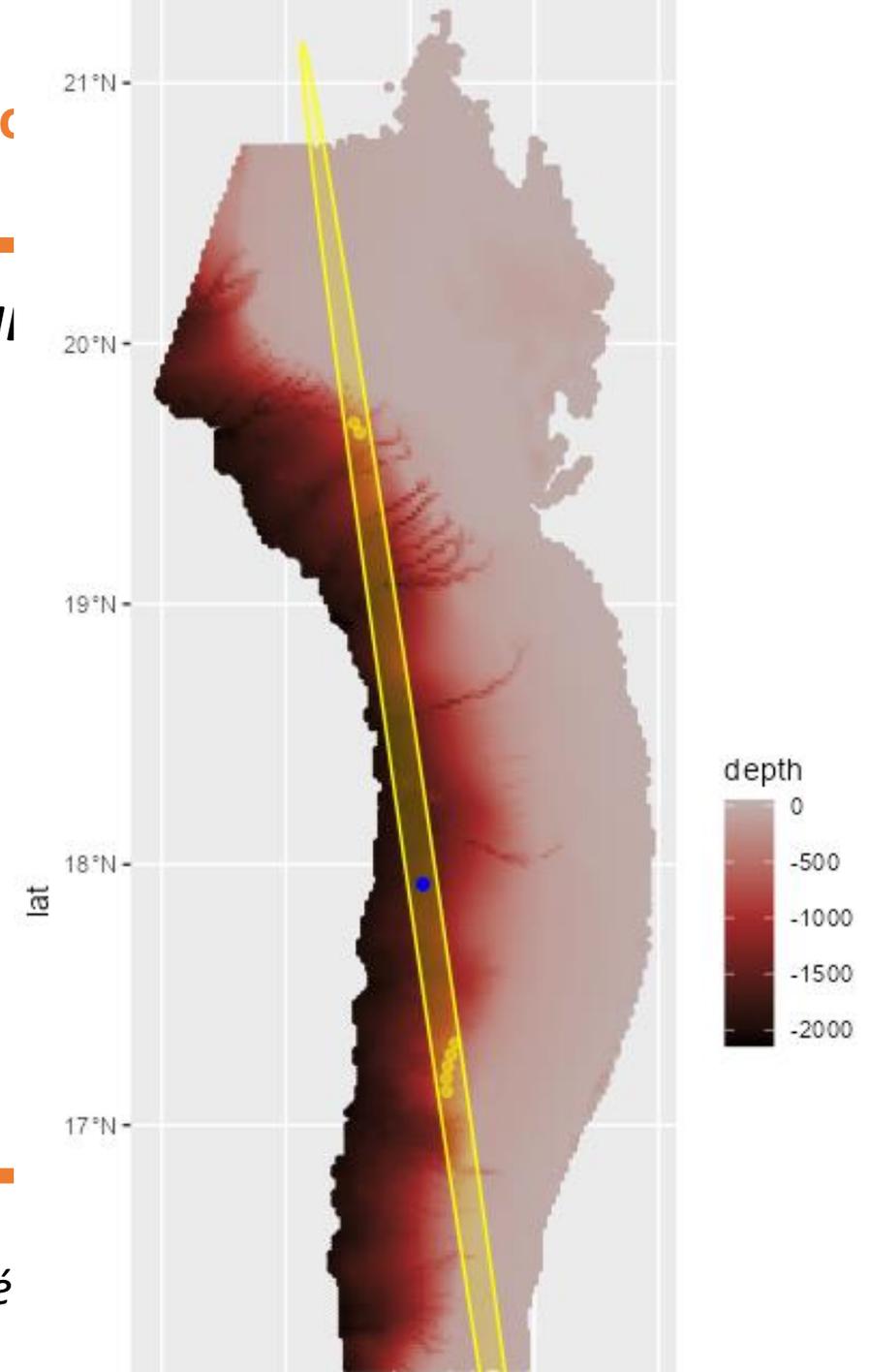   ➔ Problème pour modèle spatial

Sénégal - Ki

Case study : Spanish trawlers targetting Mauritaniar
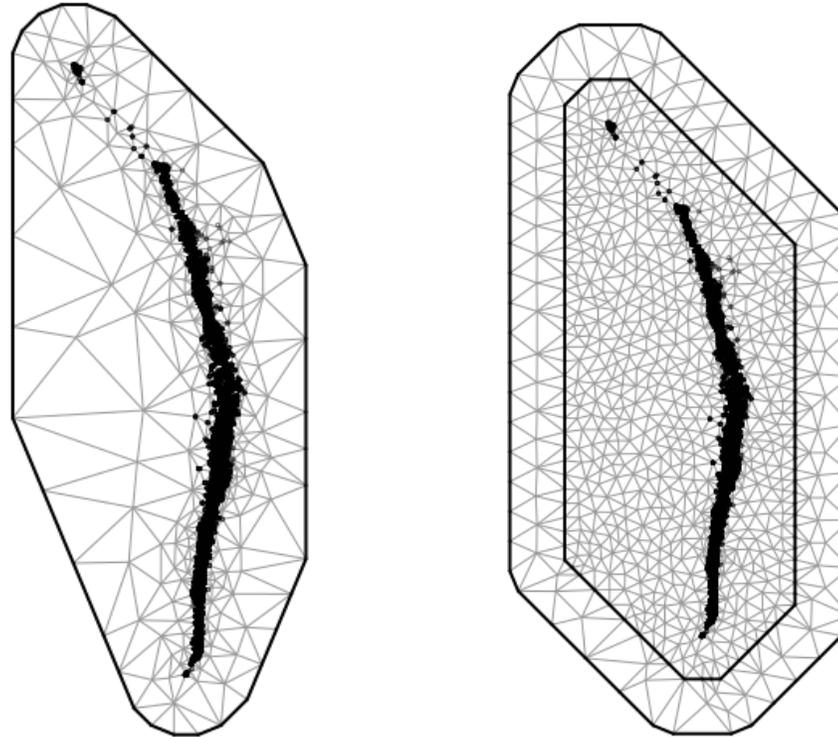
1. **Hypothèses de bases**
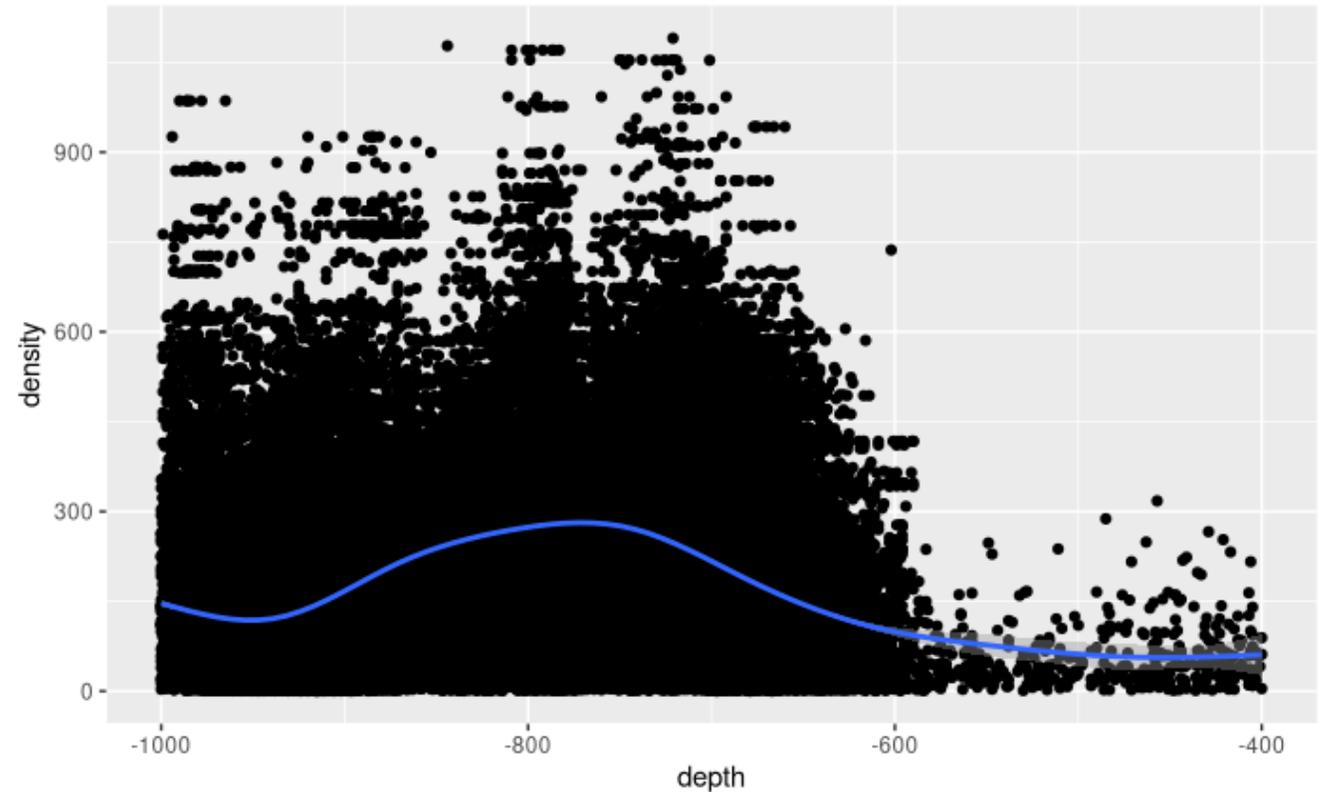
    ➔ autre exemple (plus évident)

Case study : Spanish trawlers targetting Mauritanian shrimps

3bis. Préparation de la 'mesh'

Case study : Spanish trawlers targetting Mauritanian shrimps

4bis. Sélection des co-variables

Case study : Spanish trawlers targetting Mauritanian shrimps

5. Résultats préliminaires

```
Model_0 <- sdmTMB( data = data_model,
formula = response ~ 0 + as.factor(year) + (1|VE_REF) + s(depth, k = 5),
offset = log(data_model$predicted_eff),
time = "year",
spatial = "off",
spatiotemporal = "off",
mesh = mesh,
family = Gamma(link = "log"))
```
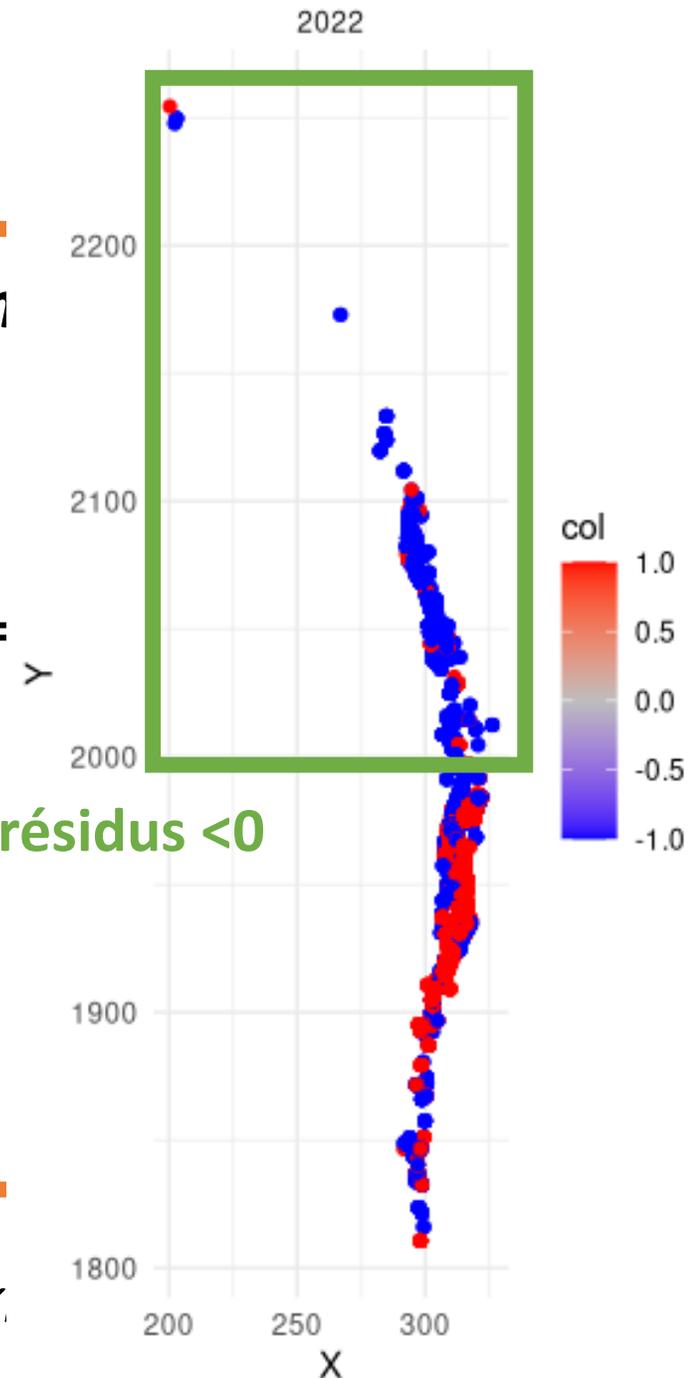
Case study : Spanish trawlers targetting Mauritanian shrin

5. Résultats préliminaires

Model_0 <- sdmTMB(data = data_model,
formula = response ~ 0 + as.factor(year) + (1|VE_REF) + s(depth, k =
offset = log(data_model$predicted_eff),
time = "year",
spatial = "off",
spatiotemporal = "off",
mesh = mesh,
family = Gamma(link = "log"))

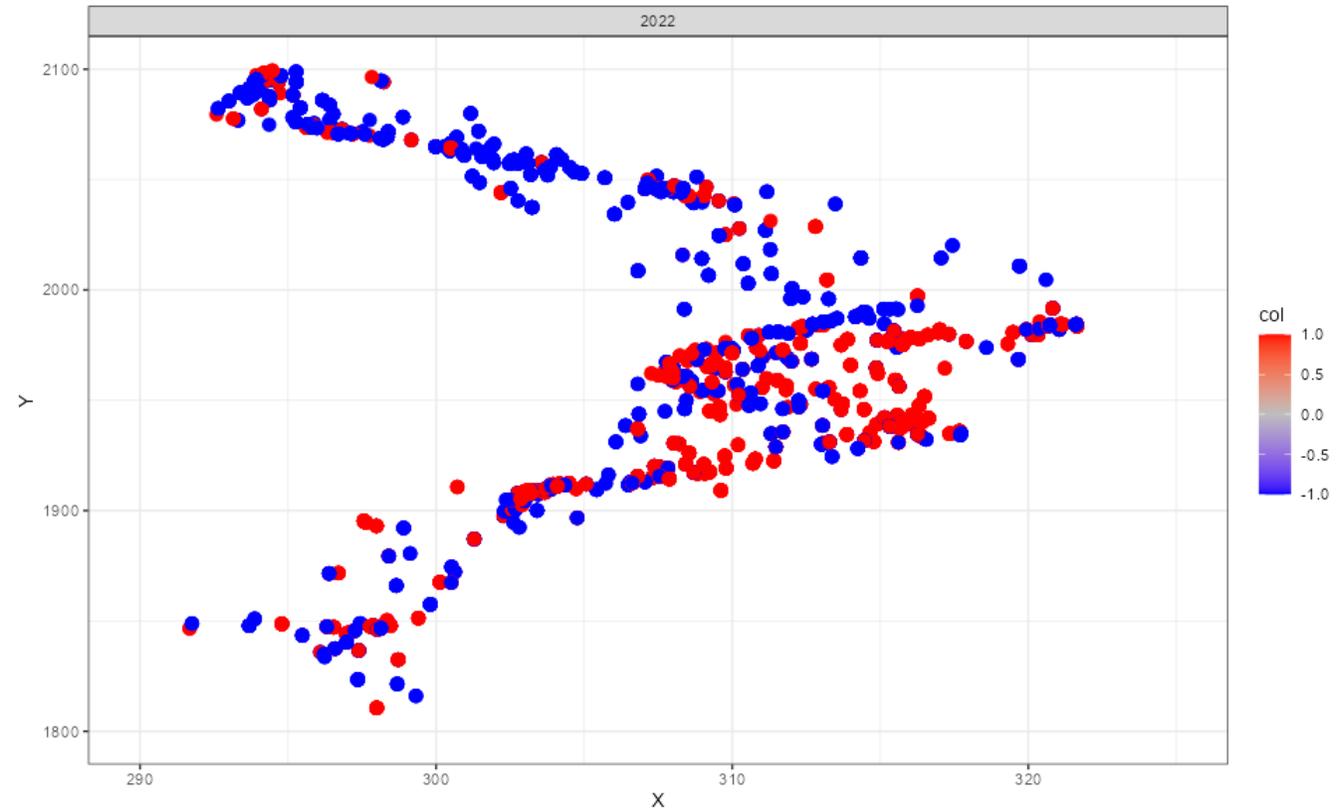**80 % résidus <0**

Sénégal - K.

Case study : Spanish trawlers targetting Mauritanian shrimps

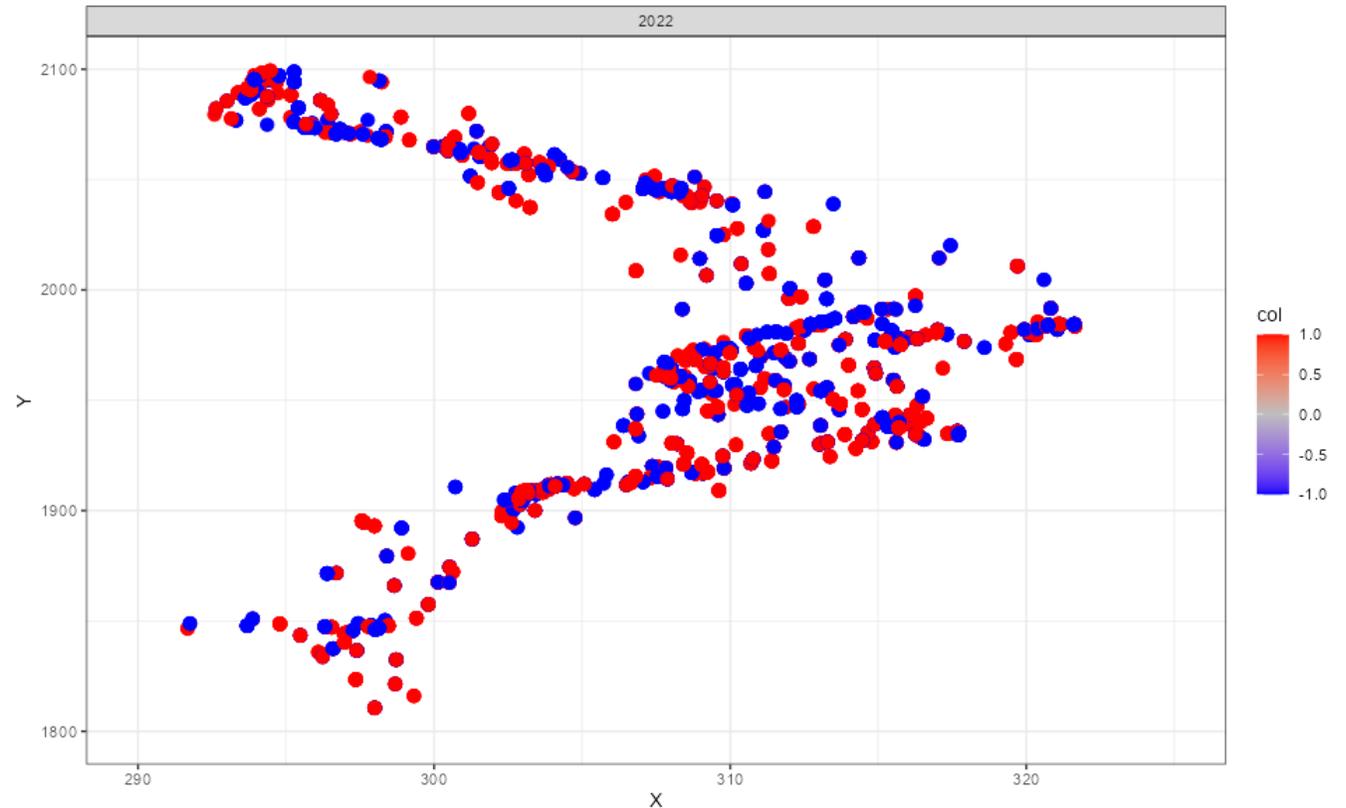## 5. Résultats préliminaires

Model_0

AIC = 713 000

Case study : Spanish trawlers targetting Mauritanian shrimps

5. Résultats préliminaires

Model_1
spatial = "on",
spatiotemporal = "on"

AIC = 647 000

Case study : Spanish trawlers targetting Mauritanian shrimps

5. Résultats préliminaires
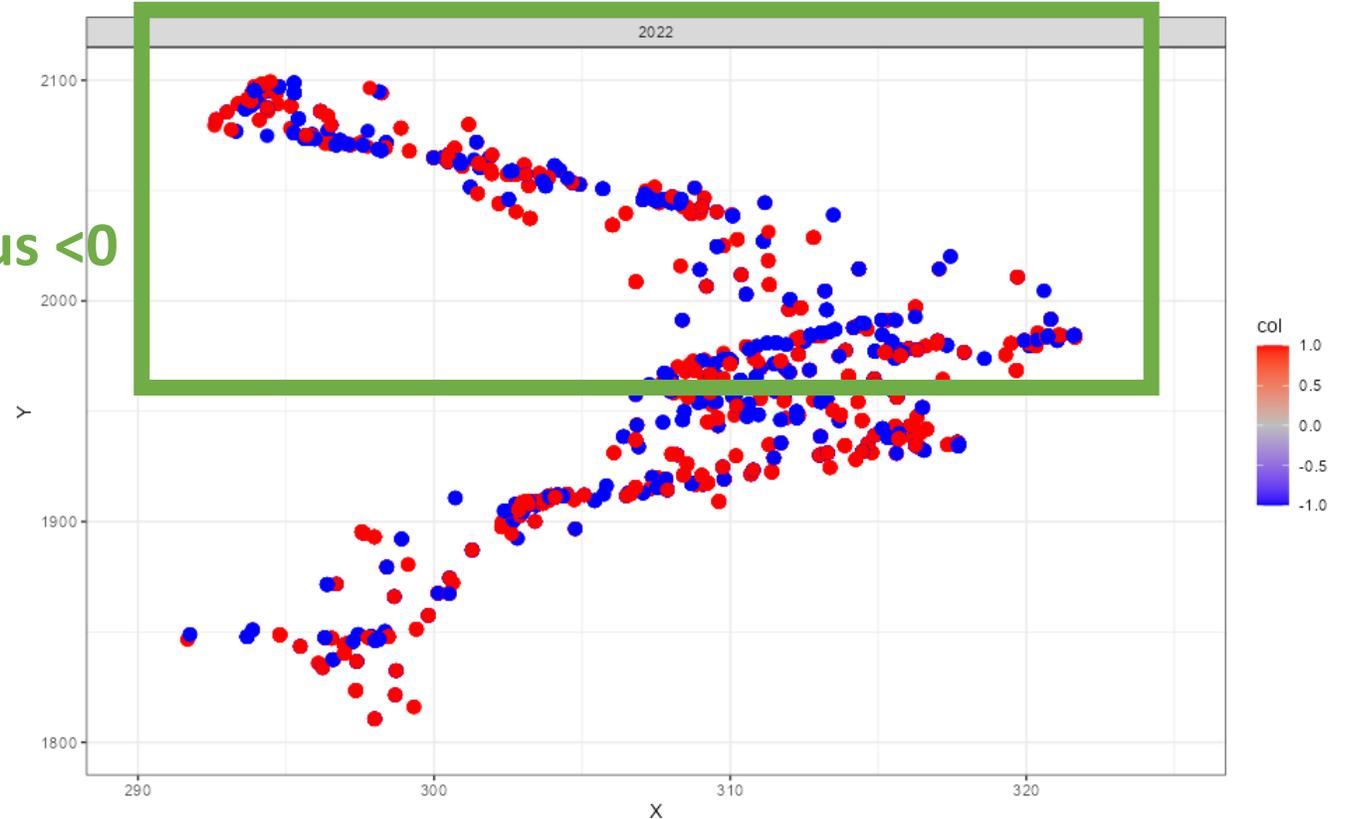
Model_0

80 % résidus <0

AIC = 713 000

Case study : Spanish trawlers targetting Mauritanian shrimps

5. Résultats préliminaires

Model_1

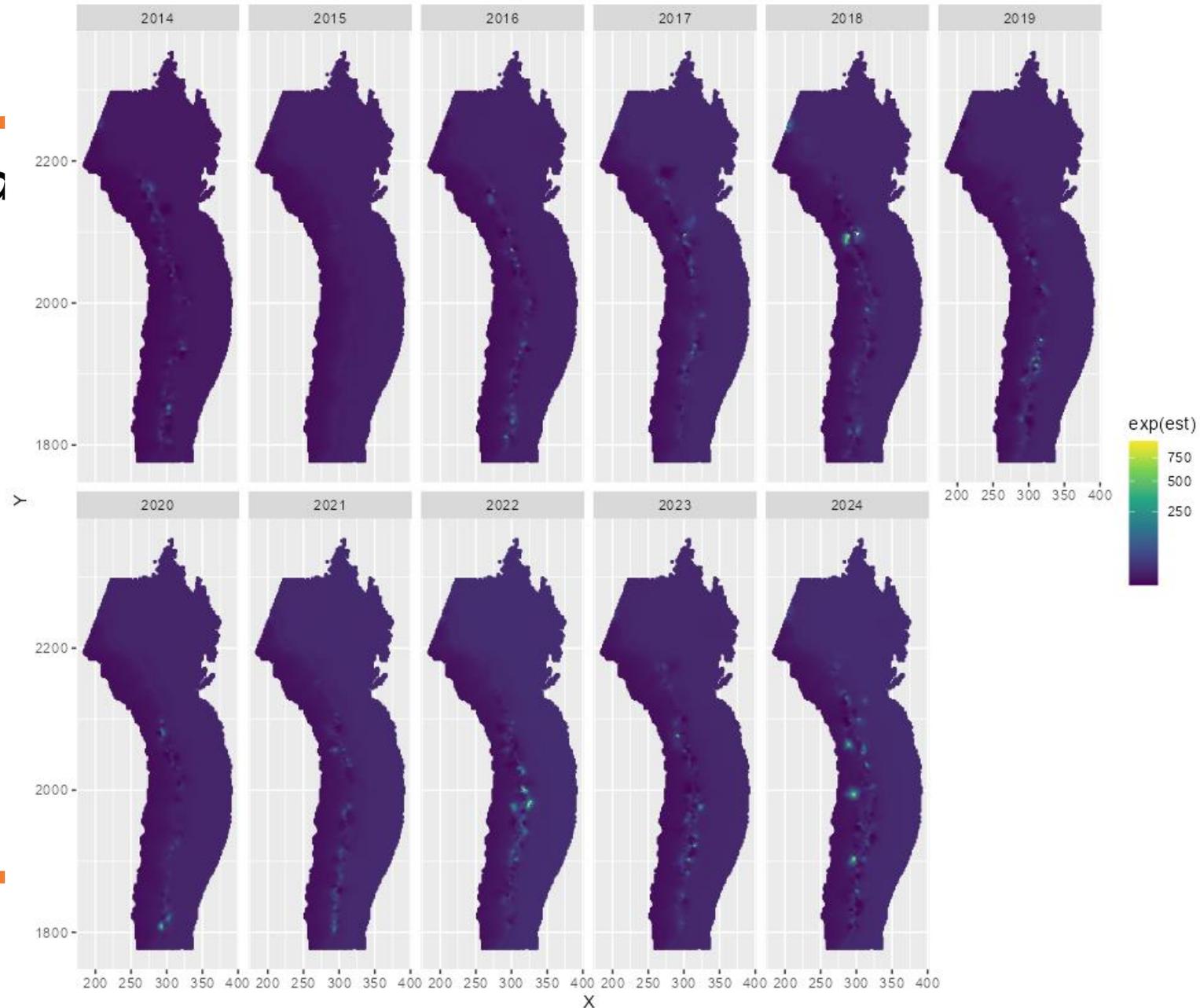**AIC = 647 000**

50 % résidus <0

Case study : Spanish trawlers ta

5. Résultats préliminaires

![CSIC - Consejo Superior de Investigaciones Científicas logo]
![Instituto Español de Oceanografía 1914 logo]
![L'INSTITUT agro - Pôle Halieutique, mer & littoral logo]

Merci de votre attention !