

# MIGRALION : a large-scale research program to gather knowlegde on spatial and vertical distribution of seabirds and migratory birds in the Gulf of Lion with multiple data types



Coline Canonne, Maud Quérroué, Sébastien Roques, Valentin Lauret, Louis Schroll, Victor Cat, Nicolas Courbin, Yann Planque, Jocelyn Champagnon, Olivier Duriez, Aurélien Besnard

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MED-Ocean webinar :

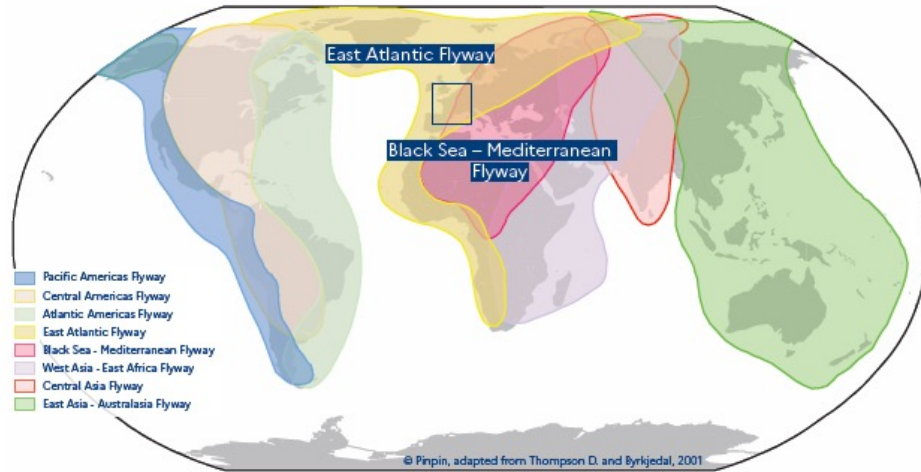
« *Sustainable seas, safer skies: Lessons from MIGRALION in the Mediterranean* »

25/06/2026

# Introduction



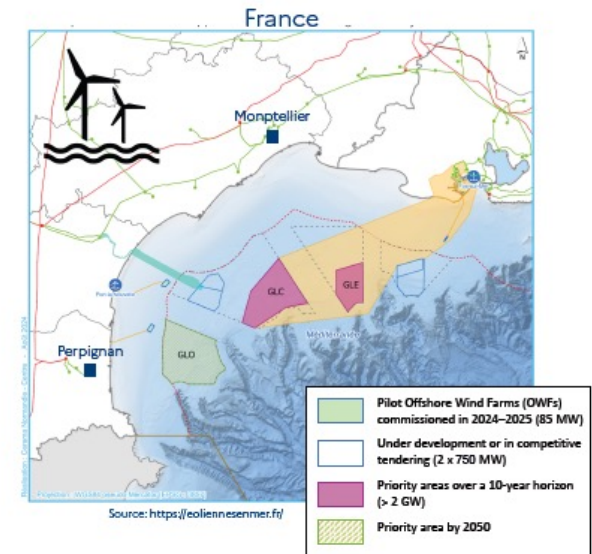
France is a **crossing point** of two major migration routes for avifauna



The **Gulf of Lion** (Mediterranean Sea) holds **major importance** for avian migration



Floating **offshore wind farms** are set to be developed over the coming years



**Avifauna can be impacted by offshore wind energy** (collision, habitat modification, barrier effect...) But **high knowledge gaps** on the use of the Gulf of Lion by avifauna...

# Introduction

Organized in different workpackages (2022-2025)

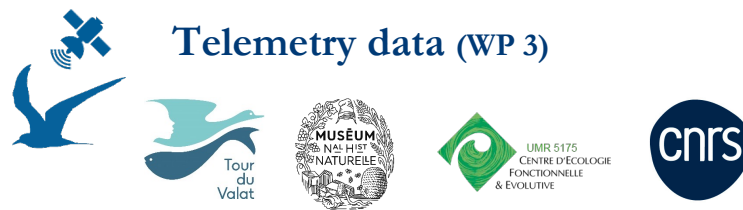
Existing knowledge (WP 1)



Project management (WP 2)



Telemetry data (WP 3)



At-sea Visual and radar surveys (WP 4)



Coastal radar (WP 5)

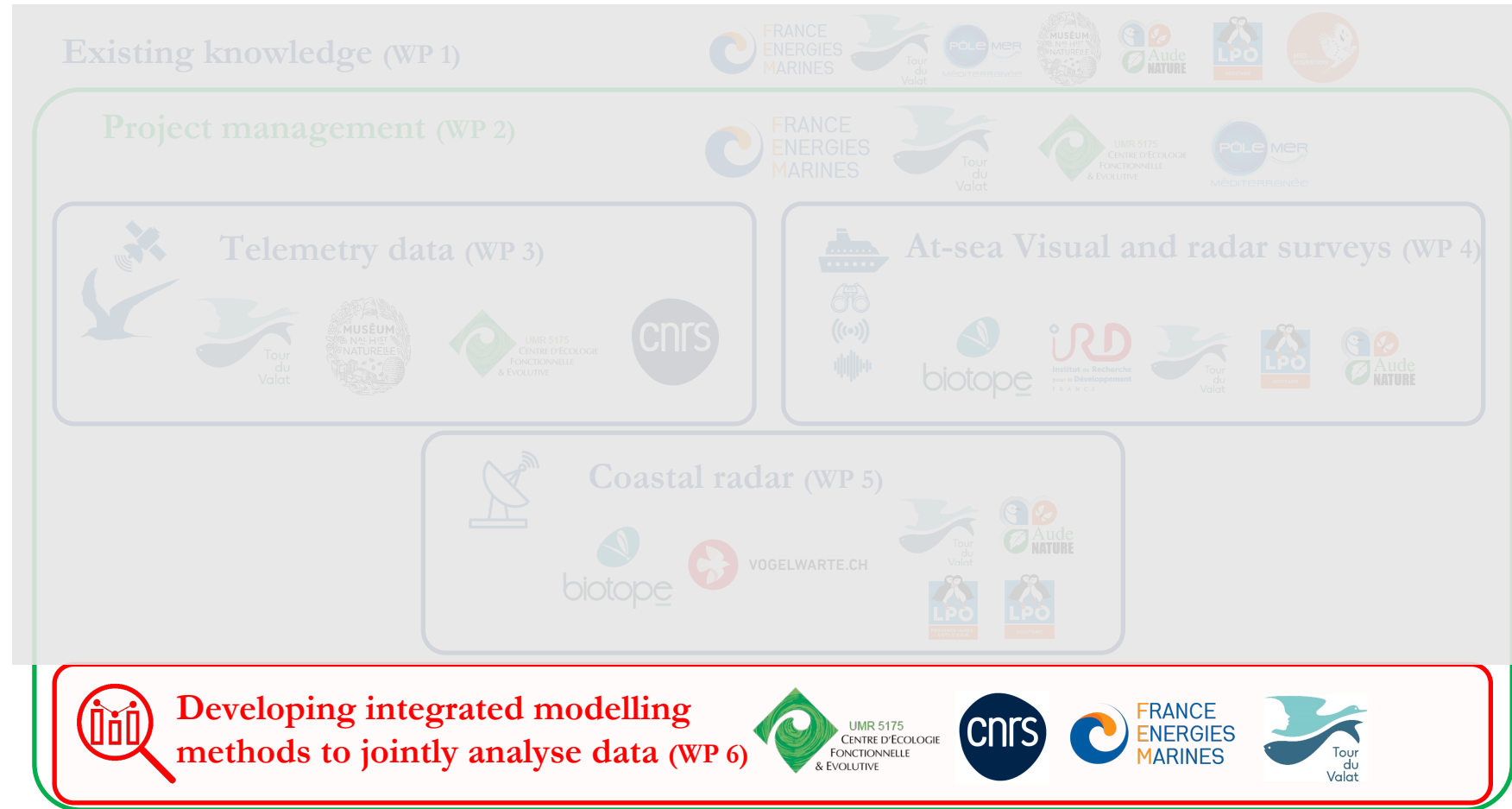


Developing integrated modelling methods to jointly analyse data (WP 6)



# Introduction

Organized in different workpackages (2022-2025)



# Main questions

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1) How seabirds are spatially distributed through the Gulf of Lion ?



2) How migratory birds movements are spatially distributed over the Gulf of Lion ?



3) What is the vertical distribution of migratory birds flight height?



→ How do these insights inform the spatial planning of wind farms and the risk assessment for birds?

# Introduction

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## Telemetry data



## At-sea visual observations



## Coastal ornithological radars



## At-sea radar echoes



# Integrated modelling

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- Jointly model different data types to estimate space-use or habitat selection
- Allow to use the information contained in each data types
- Sampling features of each data types are crucial
- Migralion project required statistical developments to combine these heterogeneous data types (Lauret et al 2025)



# Main questions

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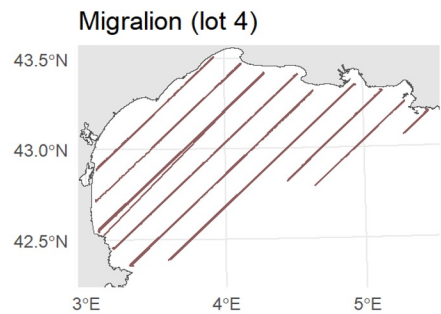
3) What is the vertical distribution of migratory birds flight height?



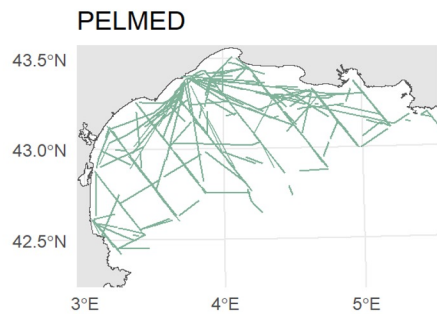
→ How do these insights inform the spatial planning of wind farms and the risk assessment for birds?

# Seabirds distribution

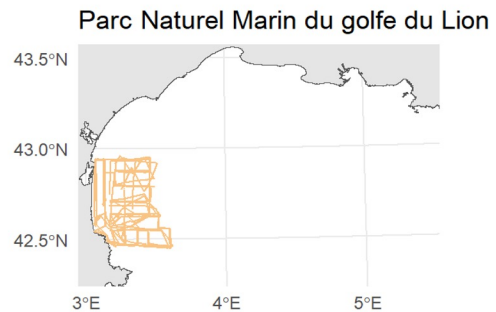
At-sea visual counts (65 000 individuals of more than 20 species)



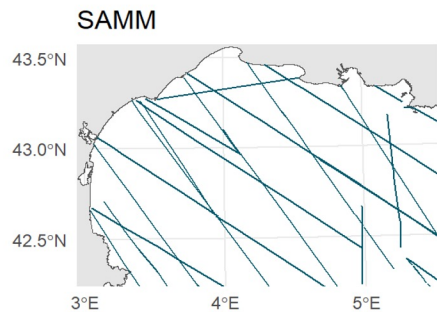
30 jours de suivi en automne et printemps (2022-2024)



100 jours de suivi en été (2017-2021)



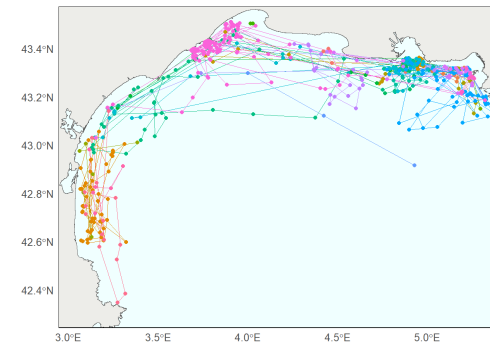
81 jours de suivi toute l'année (2019-2024)



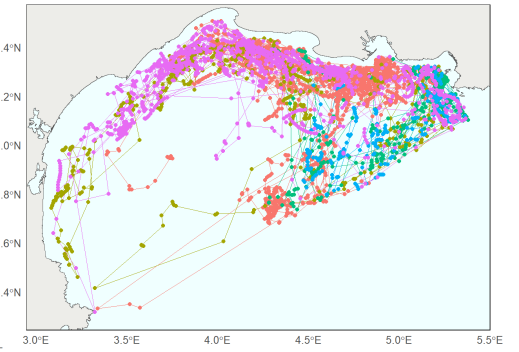
21 jours de suivi en hiver (2019)

4 species equipped with GPS

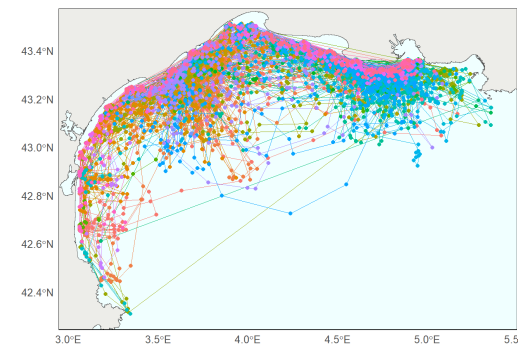
Yellow-legged gull  
(non breeding period)



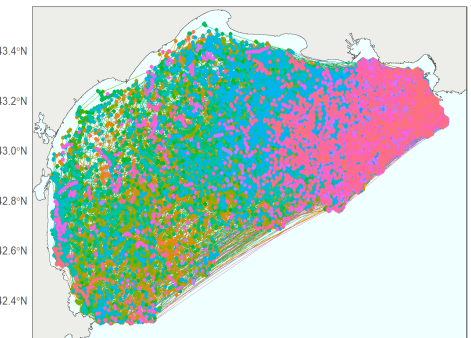
Yelkouan shearwater  
(non breeding period)



Sandwich tern  
(breeding period)



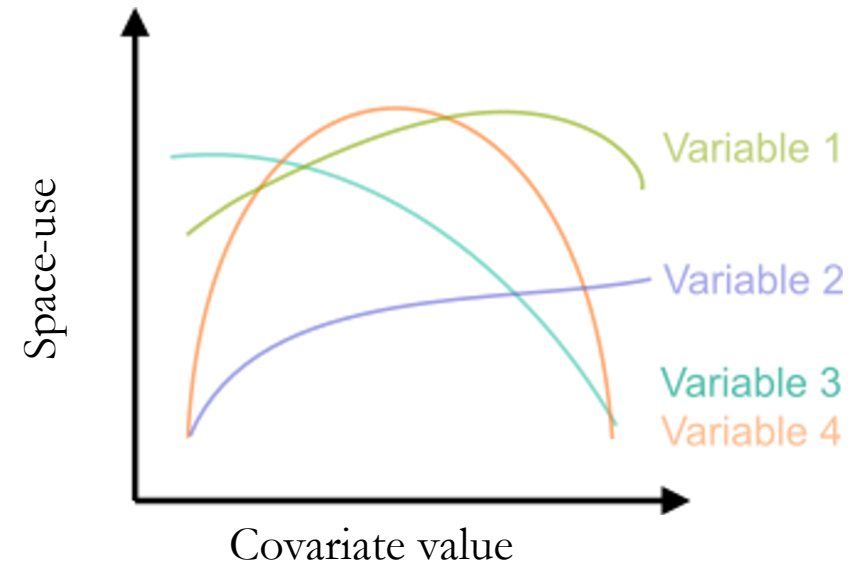
Scopoli's shearwater  
(breeding period)



# Seabirds distribution

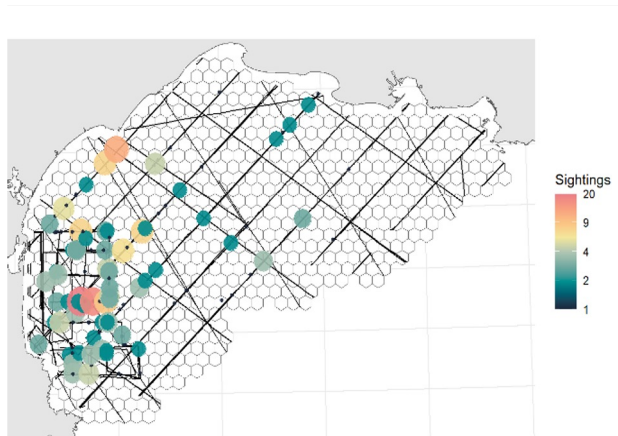
How can space use be estimated from these data?

Through modelling, by exploring **relationships** between **spatial variables** and **observation data**.

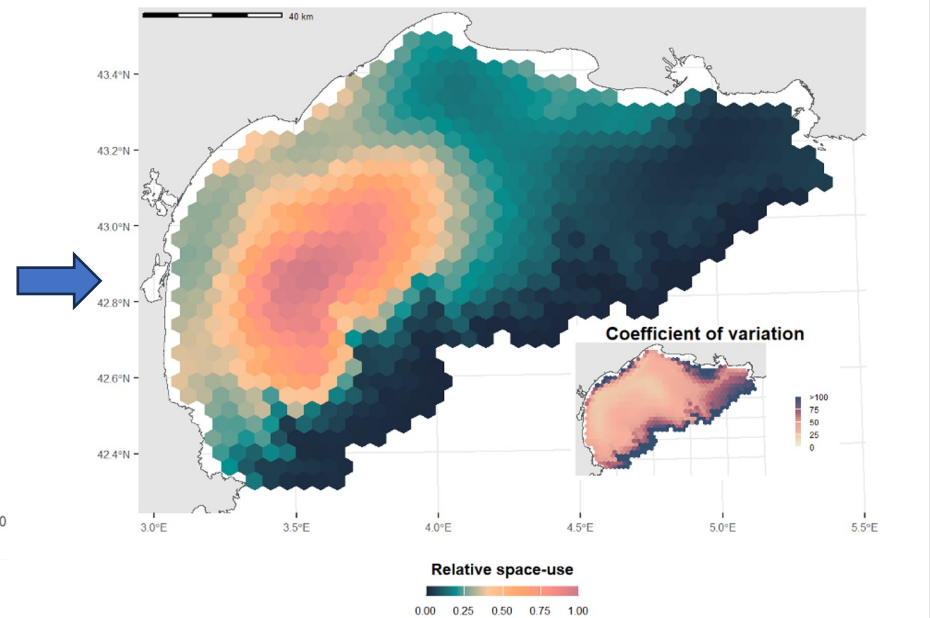
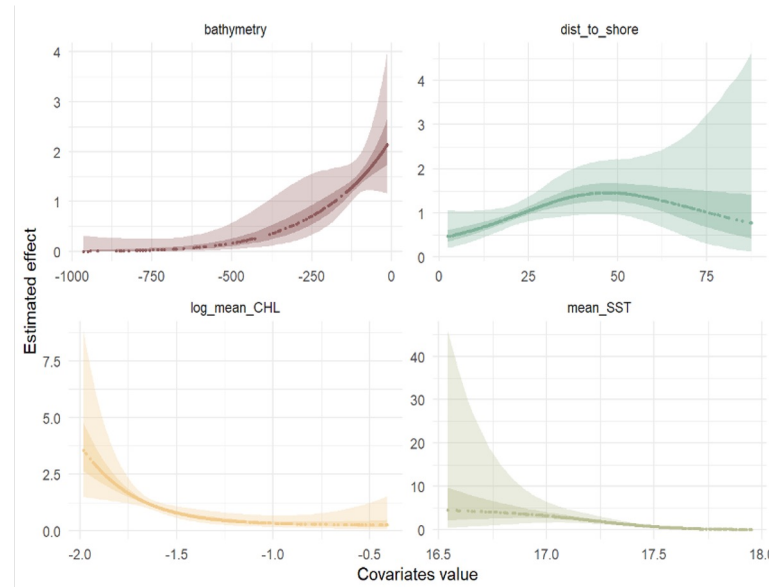


# Seabirds distribution

## Example on count data only

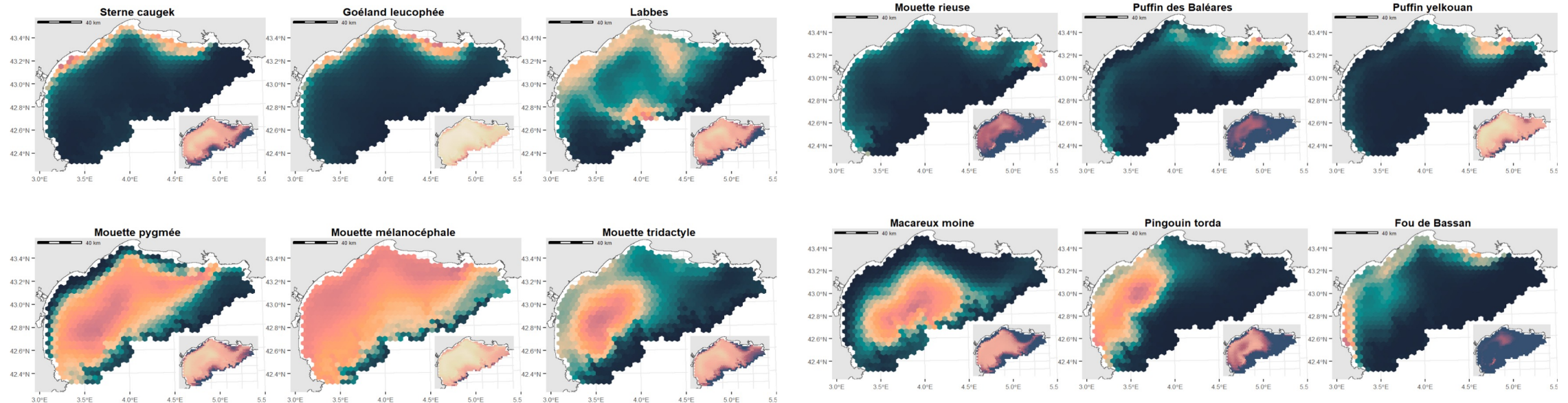


Exemple ·  
Espèce : Kittiwake  
Période : Novembre-Avril

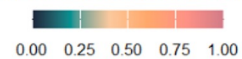


# Seabirds distribution

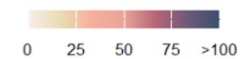
This analysis was repeated for each species during breeding and non-breeding season  
→ Seabirds space-use maps for each species and each period



Utilisation relative de l'espace



Coefficient de variation



# Seabirds distribution

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- A lot of information: One map per species and per season
- To facilitate the reading of these maps and decision-making: synthesizing the maps based on **species vulnerability**

# Seabirds distribution

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**Vulnerability = Collision risk x Displacement risk x Conservation score**

- Flight altitude
- Nocturnal activity
- % time spent in flight
- Manoeuvrability

- Sensitivity to disturbance related to wind farms
- Foraging specialisation score

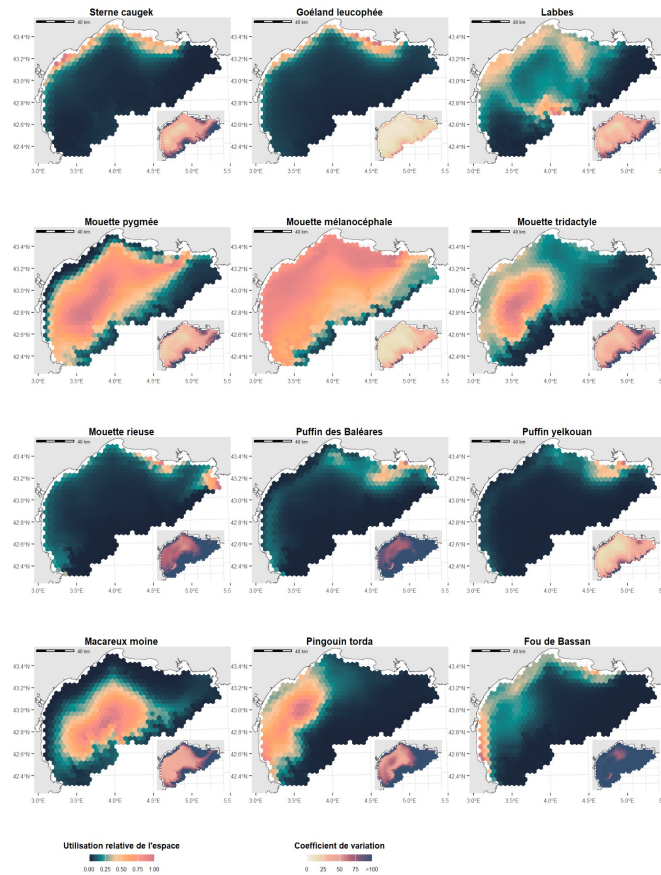
- Conservation status
- Representativity

- OFB and GISOM. *Identification et priorisation de la responsabilité de chaque sous-région marine pour les enjeux ornithologiques*. (2020)
- Bradbury, G., Trinder, M., Furness, B., Banks, A. N., Caldow, R. W., & Hume, D. (2014). Mapping seabird sensitivity to offshore wind farms. *PloS one*, 9(9), e106366.
- Furness, R. W., Wade, H. M., & Masden, E. A. (2013). Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of environmental management*, 119, 56-66.

# Seabirds distribution

- For each period:

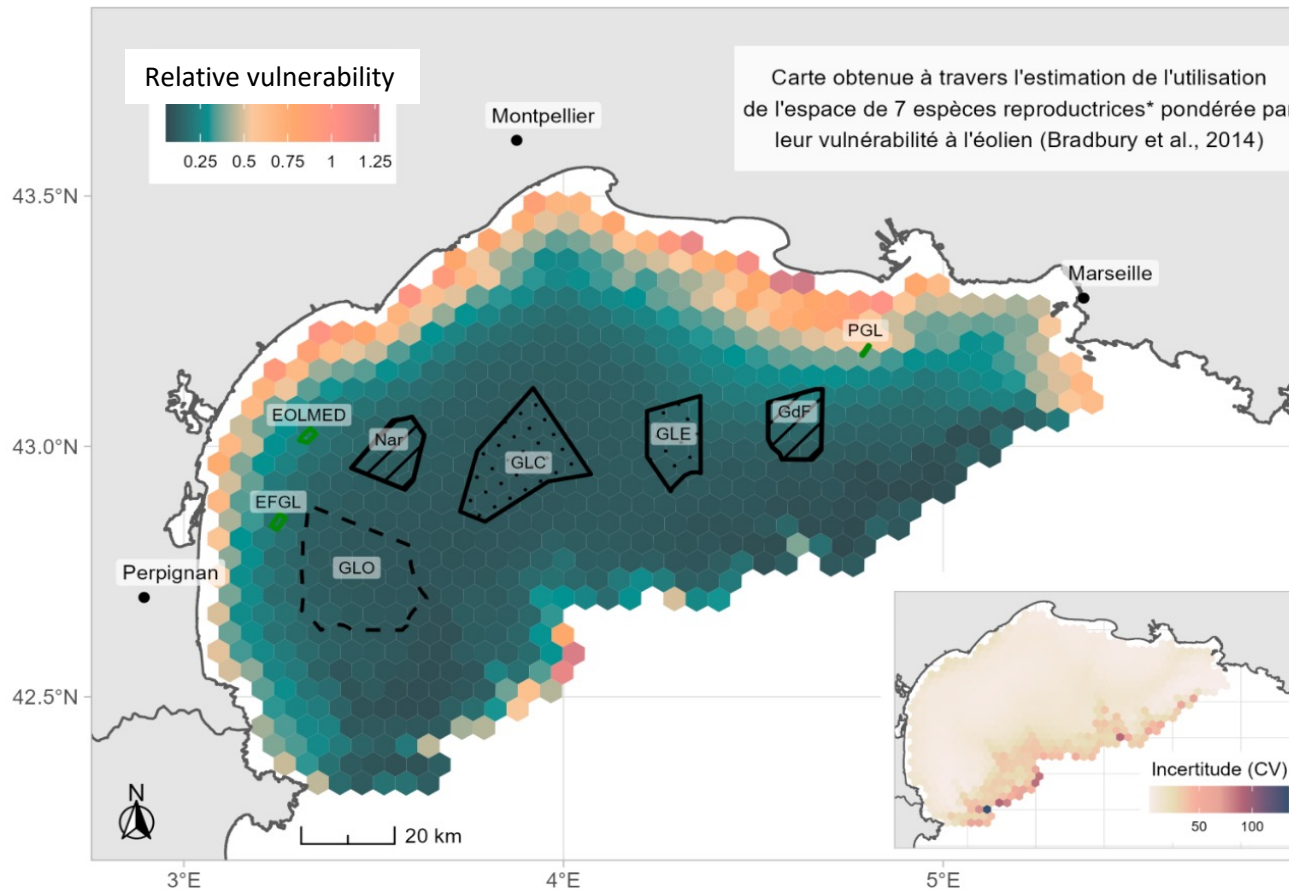
$\Sigma$



X species vulnerability

# Seabirds distribution

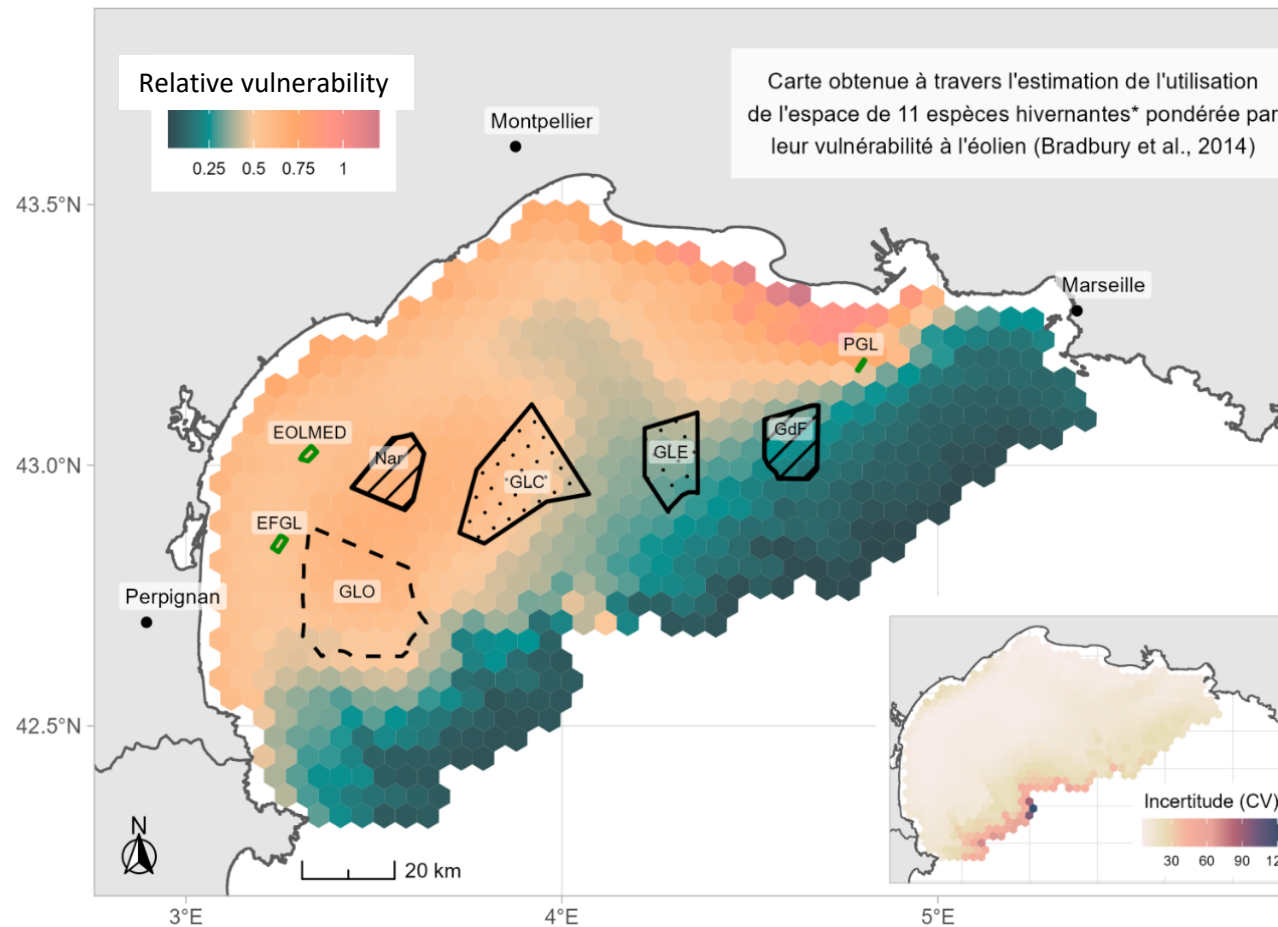
## Breeding



- High vulnerability areas close to the coast
- Consistent with the location and biology of the various larid colonies in the Gulf of Lion
- High uncertainty areas in the far offshore zones (little or no sampling)

# Seabirds distribution

## Wintering



- Major overlap area in the west of the Gulf of Lion
- Area of interest for Little Gull, Kittiwake, Alcids
- Uncertainty still high far offshore of the area (little or no sampling)

# Seabirds distribution

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- The combination of several programs enabled the estimation of the distribution of most regular seabird species in the Gulf of Lion
- Wind energy vulnerability highly contrasted depending on the season
  - Coastal during the breeding season
  - In winter: major area in the west of the Gulf, within planned offshore wind farm zones
- Gulf of Lion: a key area for many wintering species (Little Gulls, Black-legged Kittiwakes, Atlantic Puffins, Razorbills, etc.)

# Migratory birds offshore space-use

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# Migratory birds offshore space-use

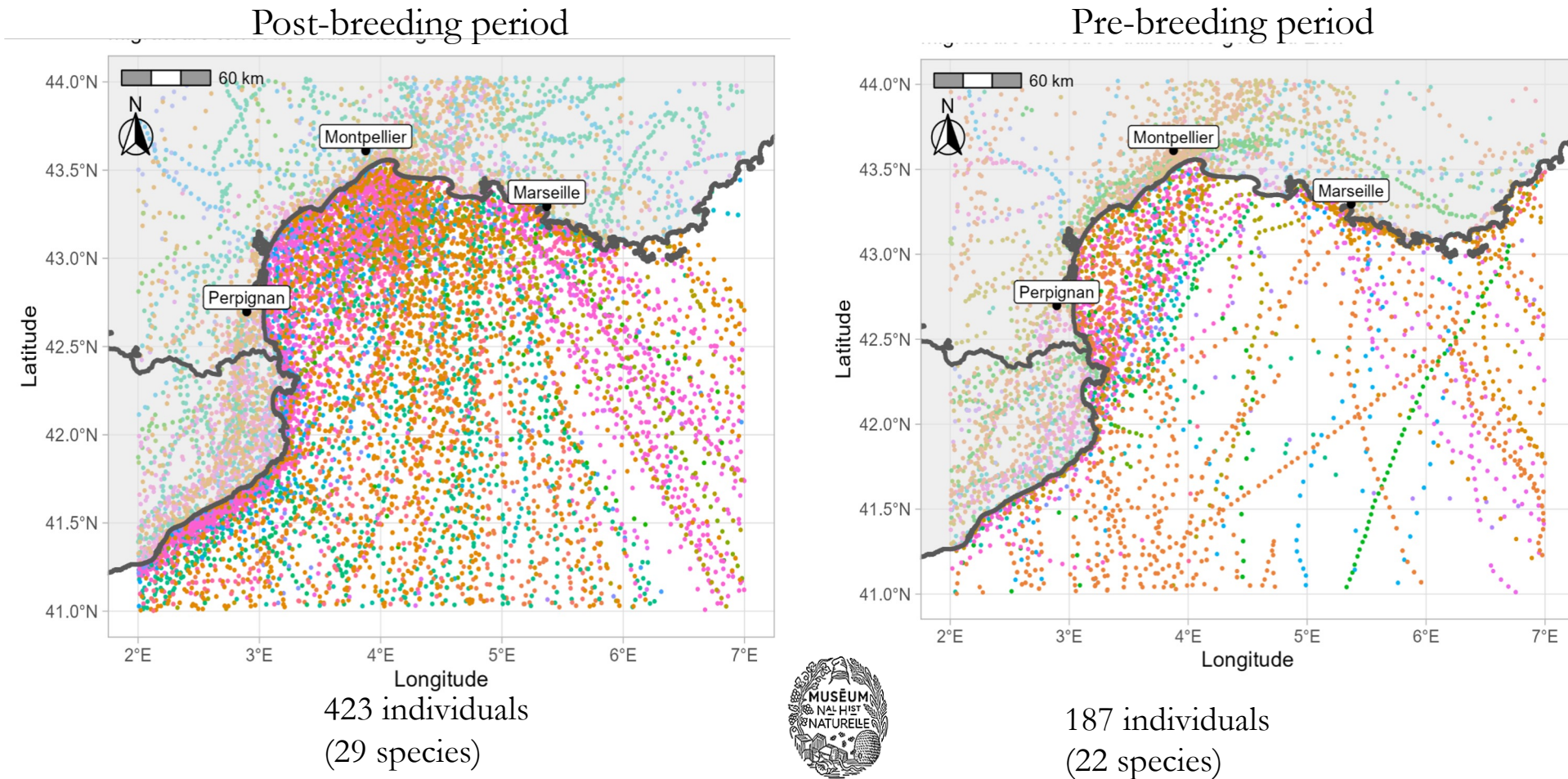
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- The Gulf of Lion is at the core of a migratory corridor
- Lack of knowledge about migratory birds offshore migratory movements
- Some species minimize over-water movements while some are known to engage long offshore migratory flights
- The goal is to estimate a spatially explicit offshore migration intensity for the whole community of migratory birds

# Migratory birds offshore space-use

## Telemetry data

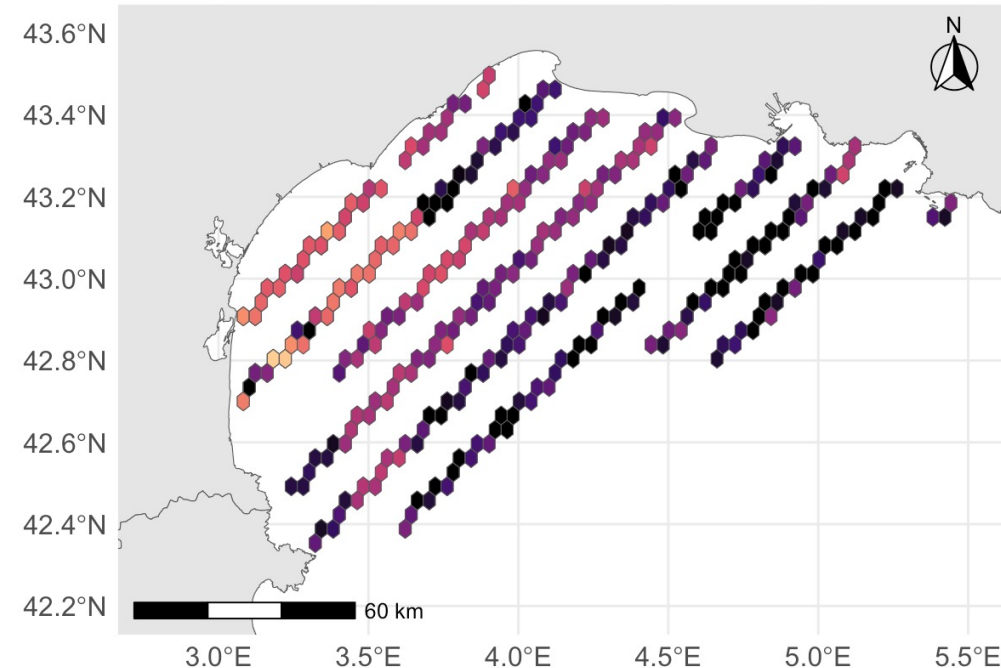
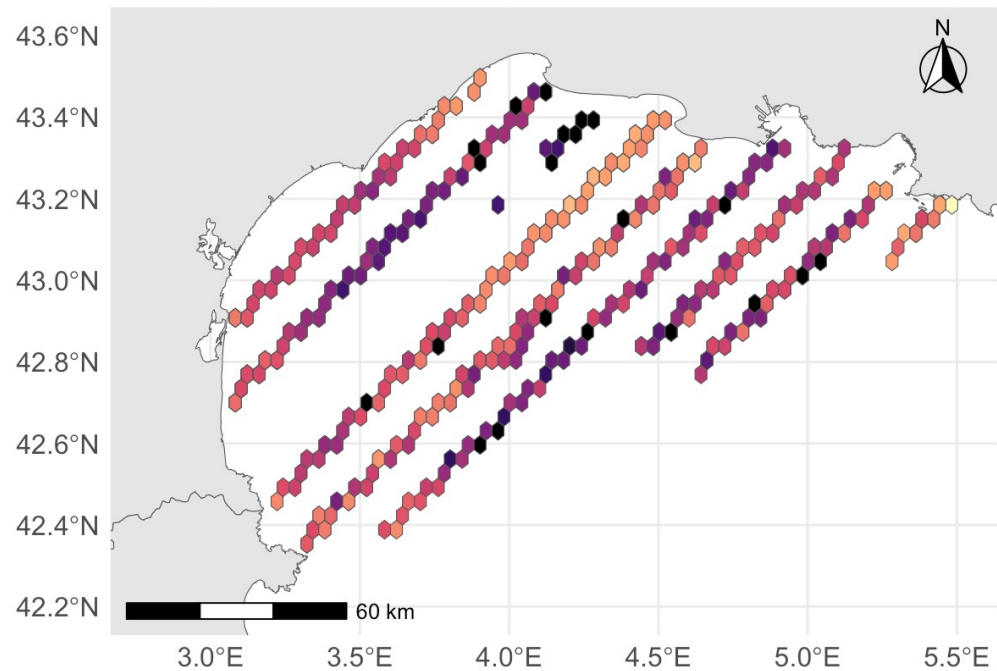


# Migratory birds offshore space-use

## At-sea radar data (number of echoes)

Post-breeding period

Pre-breeding period



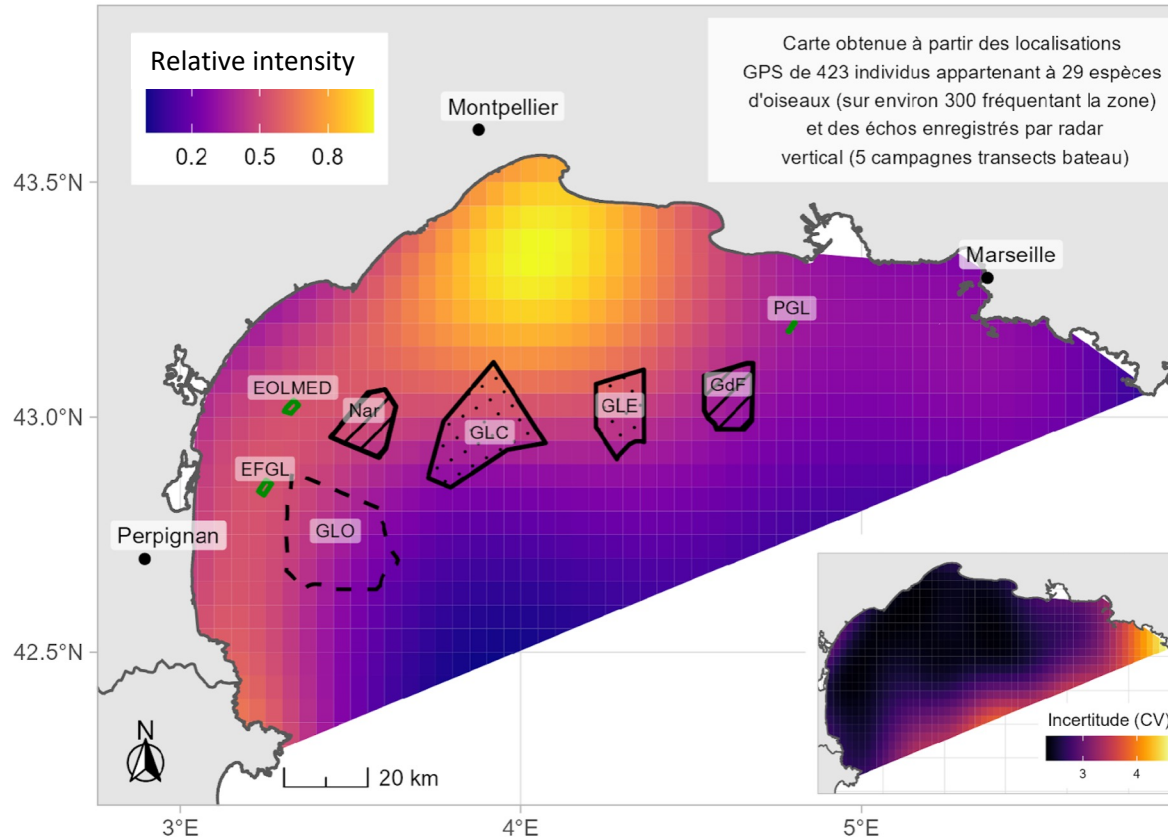
# Migratory birds offshore space-use

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- The two datasets were jointly model to estimate migratory birds offshore space-use during pre and post breeding migration period
  - Substantial modelling developments
  
- No vulnerability analysis (taxonomic resolution, non-existing in the literature)

# Migratory birds offshore space-use

## Post-breeding period

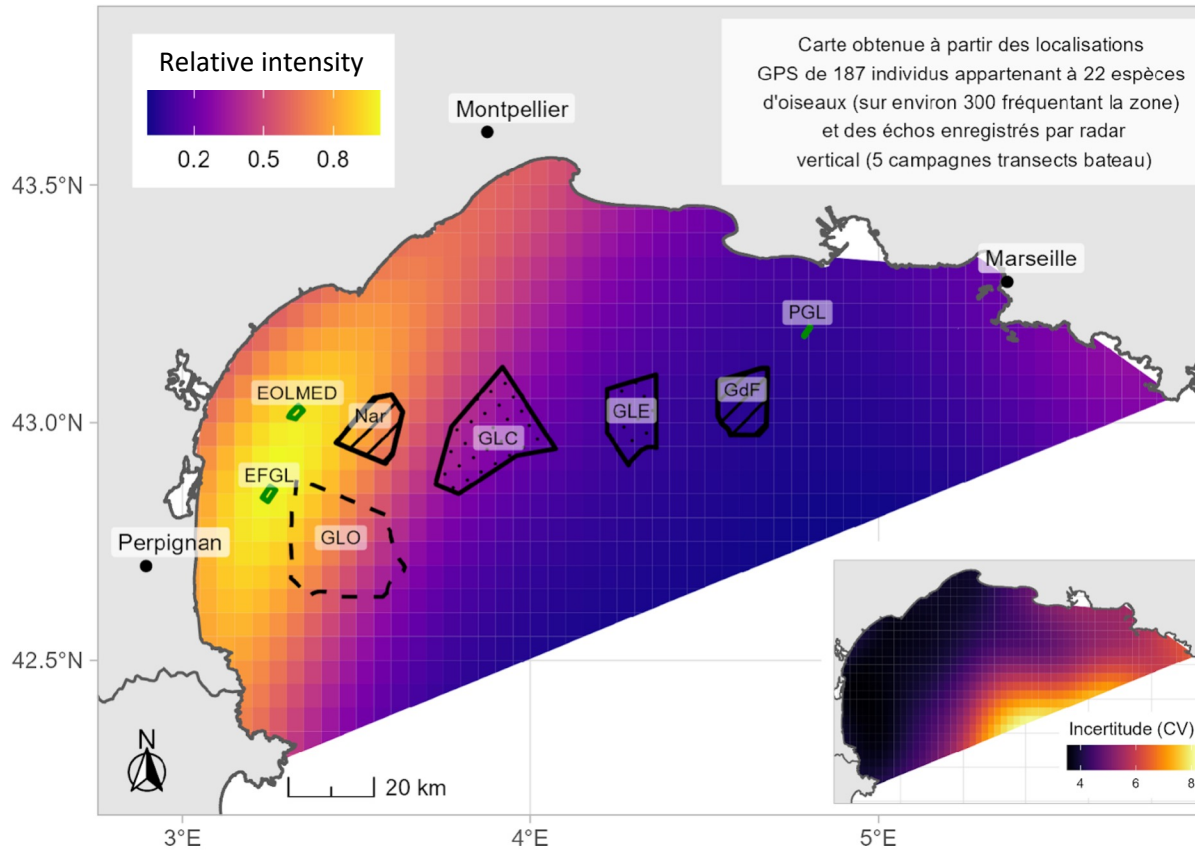


*Cold colors do not mean no migration (relative scale)*

- Wide coastal band towards the west
- Highest intensity in the north of the Gulf of Lion
- Some spreads of migration in the east

# Migratory birds offshore space-use

## Pre-breeding period



*Cold colors do not mean no migration (relative scale)*

- Highest intensity in the west close to the coast
- Overlap with future offshore windfarms
- Less intensity in the eastern part

# Migratory birds offshore space-use

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- First maps of offshore bird migration through integrated modelling
  - More migration intensity in the western part of the Gulf
  - Overlap with future offshore windfarms projects
- These maps do not measure collision risks

# Flight-height distribution

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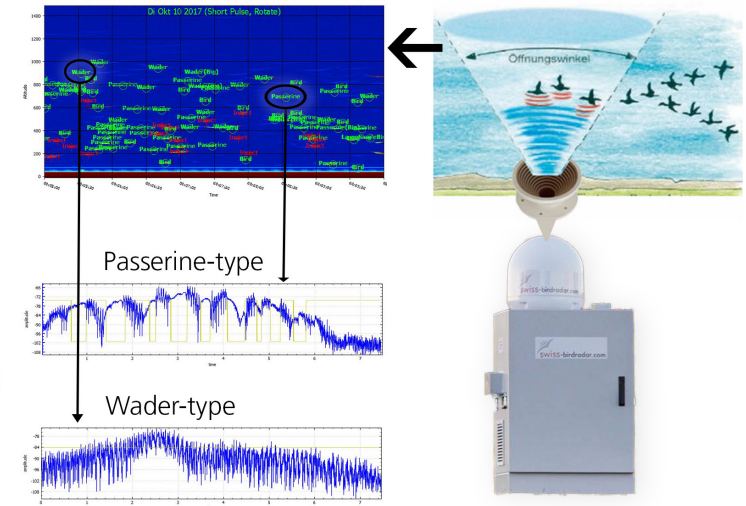
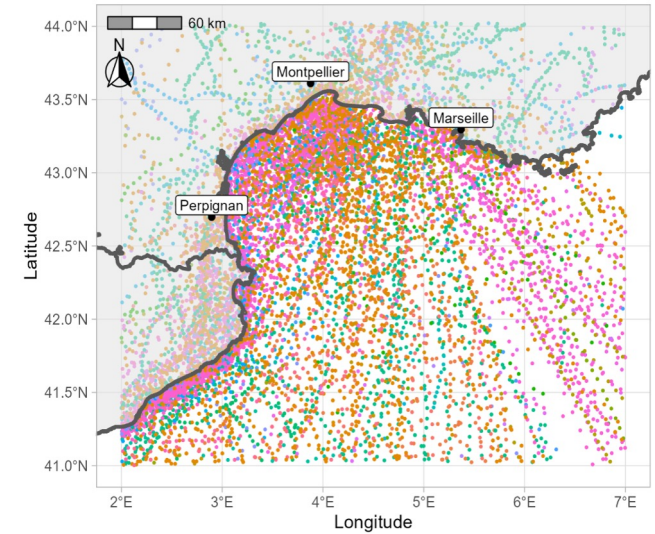
# Flight-height distribution

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- Overland flight height cannot be transposed
  - Different environmental conditions (wind, thermals, no landing possibilities)
- Estimating flight-height distribution taking into account measurement error (Ross-smith et al 2016)
- Estimate distribution overlap with the height of wind turbines

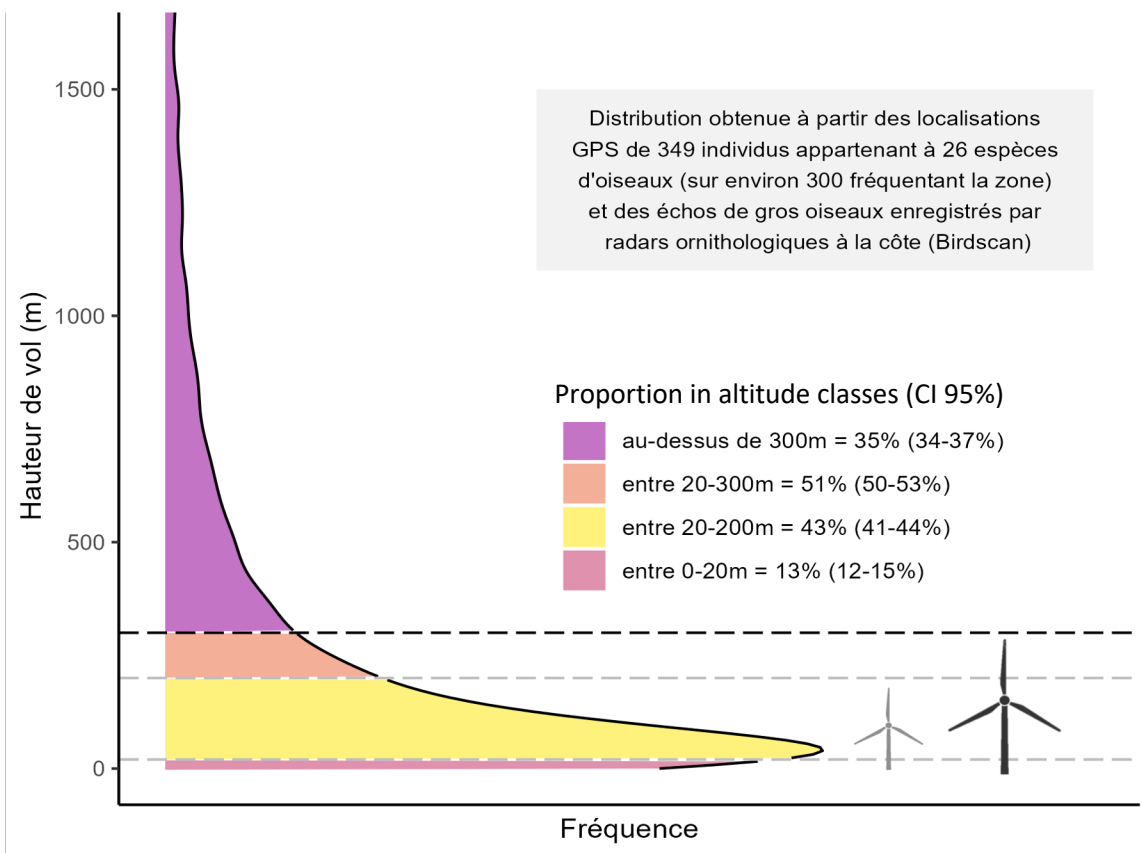
# Flight-height distribution

- Altitude data for each GPS location
- Ornithological radars set on the coast



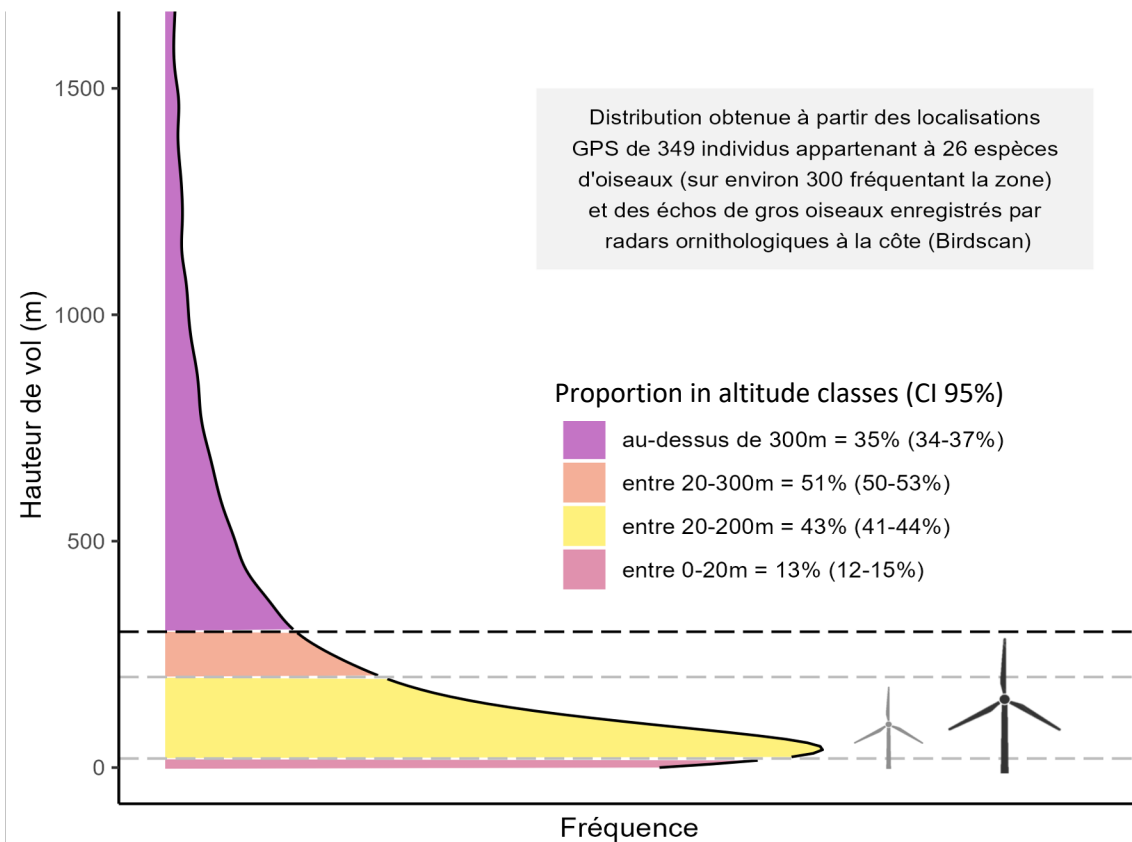
# Flight-height distribution

## Post-breeding migration

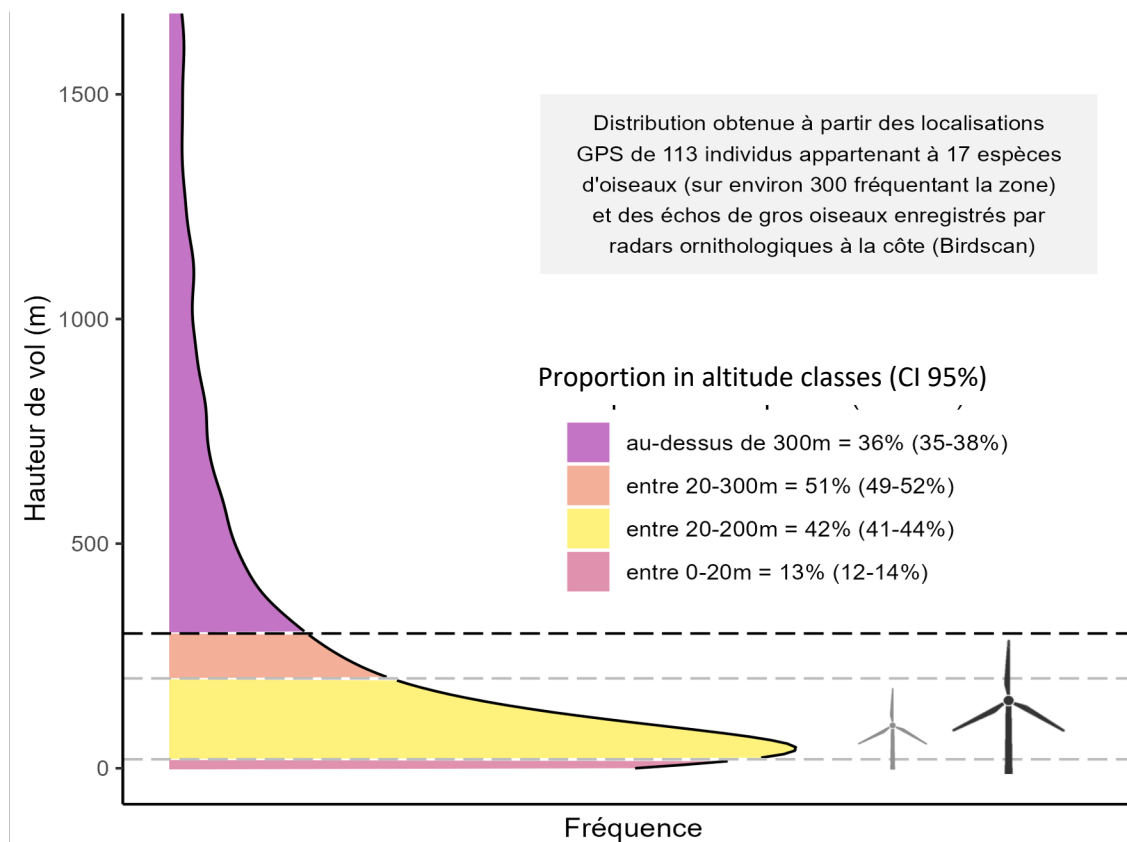


# Flight-height distribution

## Post-breeding migration

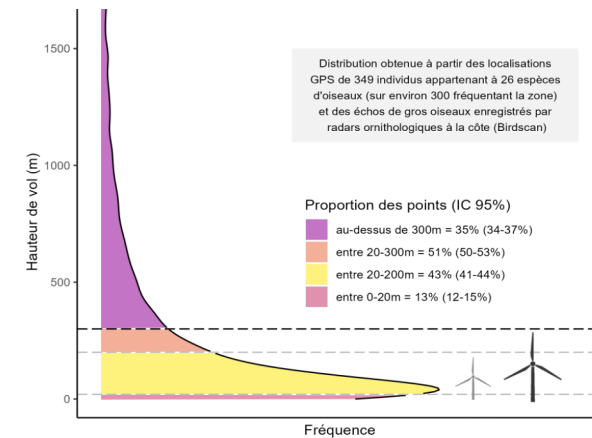


## Pre-breeding migration



# Flight-height distribution

- More than half of the time is spent at at-risk altitude (>60% between 0-300m)
- No evidence for substantial differences between migration periods
- Distance to the coast effect (not shown here), depending on species



# Project Summary

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- Large scale offshore research program with integrated modelling of different data types
- Many new information on birds distribution through the Gulf of Lion
- Substantial statistical developments
- Useful results for large scale spatial planning of offshore windfarms
- Not designed to measure impacts but acquire knowledge

# Future directions

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- Evaluate impacts on seabirds and migratory birds
- Specifically estimate and model population dynamics with future impacts and additive pressures
- Collect more data on small birds and bats
- Same project for the Atlantic and Channel (results summer 2027)



# Thanks for your attention

- All information on <https://www.eoliennesenmer.fr/observatoire/migralion>
- Click on “Synthèse finale” : French and English summaries of the research program

