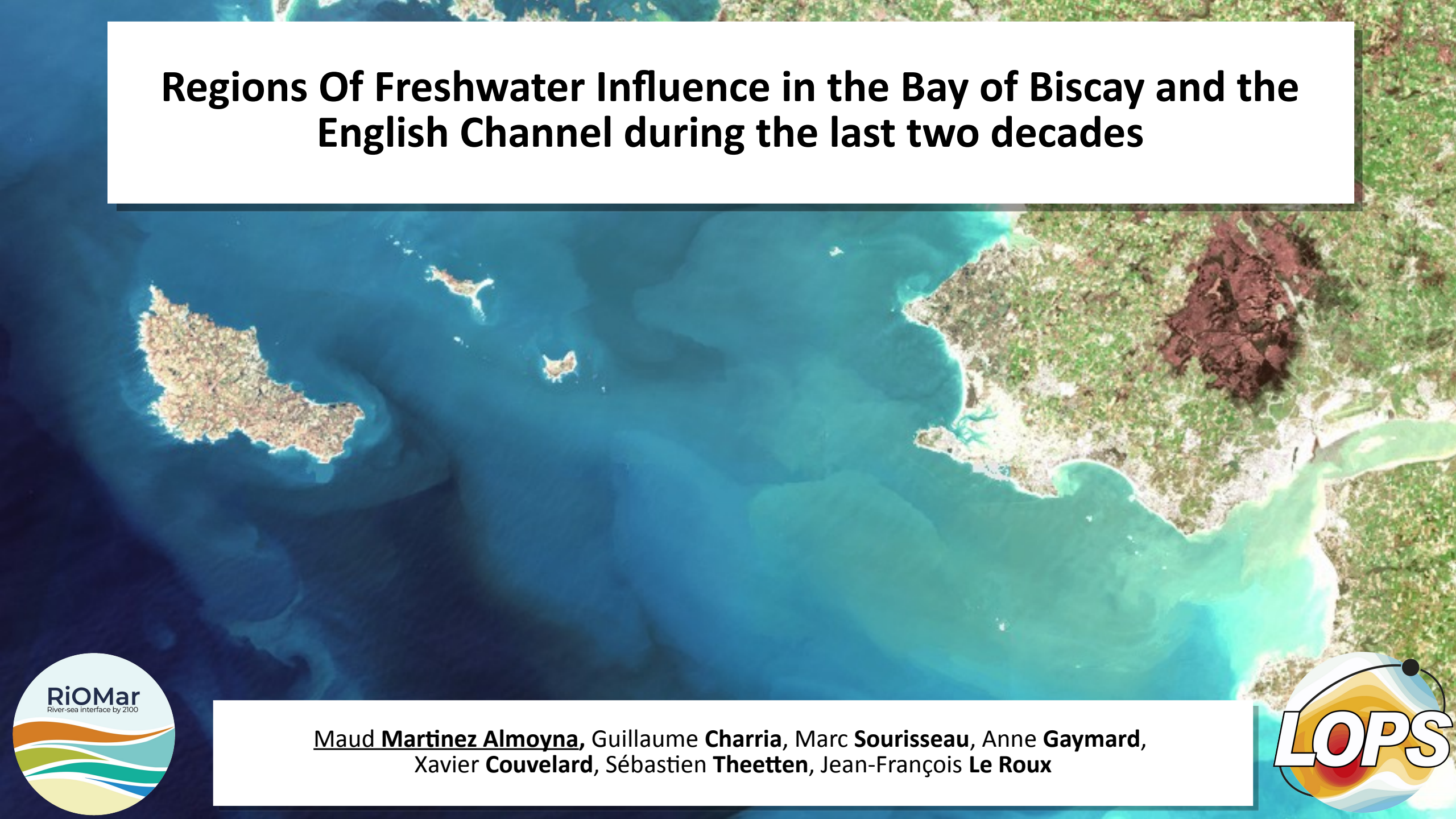
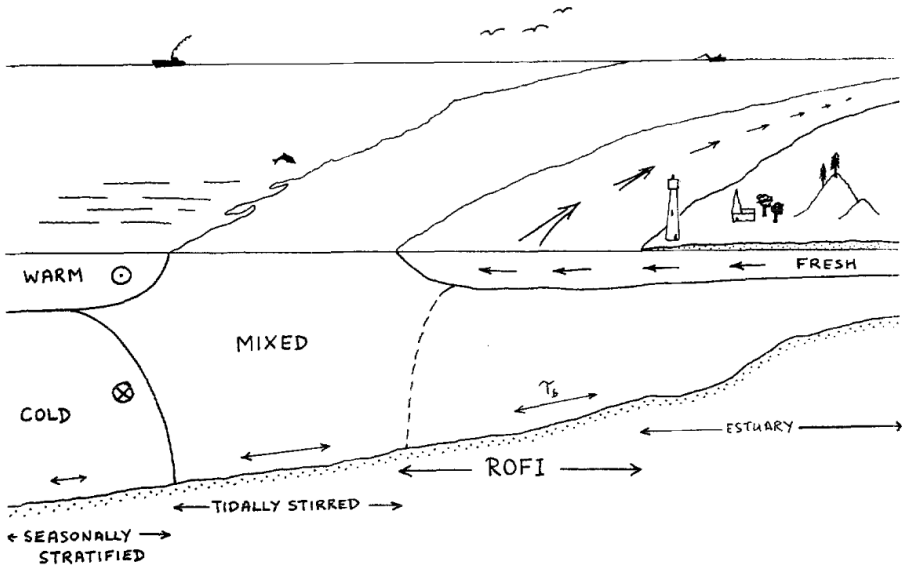
Regions Of Freshwater Influence in the Bay of Biscay and the English Channel during the last two decades



Maud **Martinez Almoyna**, Guillaume **Charria**, Marc **Sourisseau**, Anne **Gaymard**, Xavier **Couvelard**, Sébastien **Theetten**, Jean-François **Le Roux**

Regions Of Freshwater Influence (ROFIs)



Schematic of the characteristic regimes of shelf and estuary (Simpson, 1996)

In the core of the land-ocean continuum,

Form complex areas,

Vulnerable to combined **climatic** and **human stressors**

Three regions of interest

Three main rivers, three regions of influence :

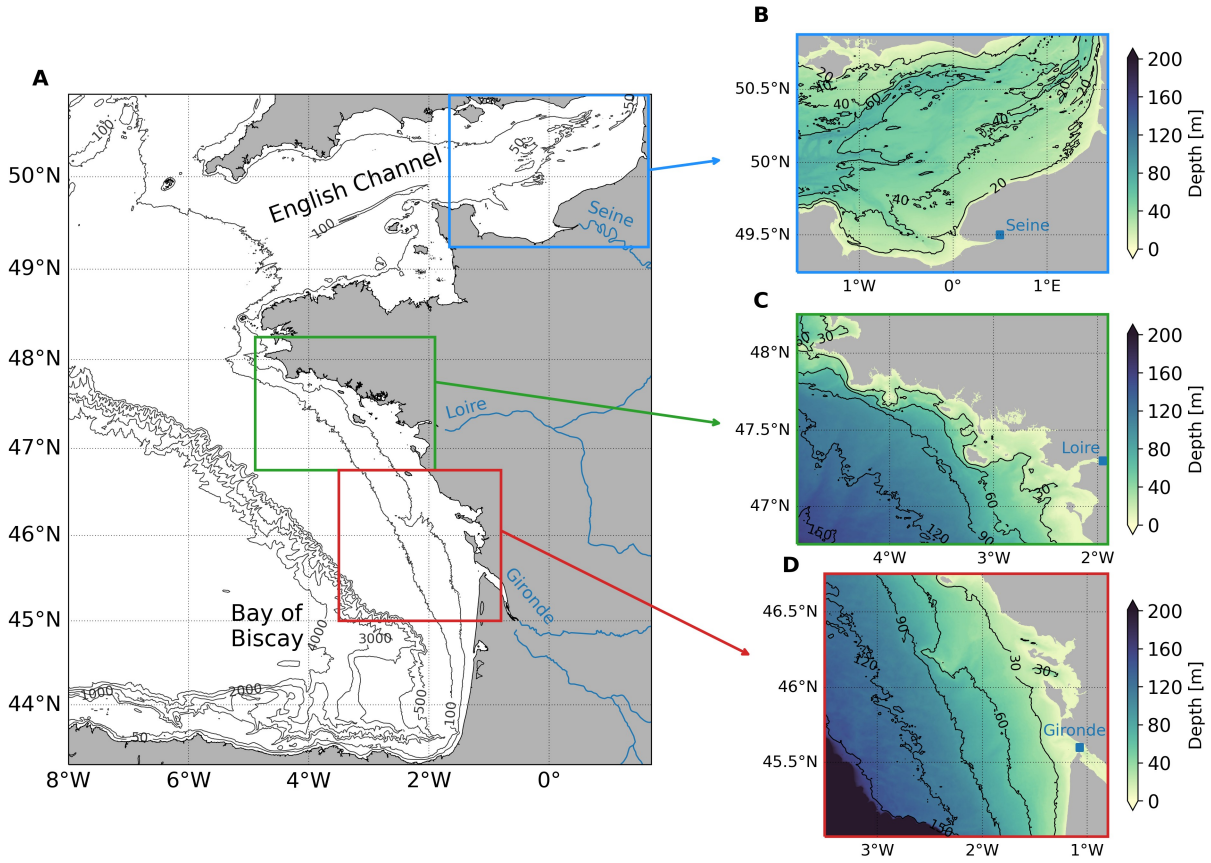
In the English Channel :

- **Seine**, mean runoff **490 $m^3.s^{-1}$**

In the Bay of Biscay :

- **Loire**, mean runoff **760 $m^3.s^{-1}$**

- **Gironde**, mean runoff **730 $m^3.s^{-1}$**



Three regions of interest

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In the English

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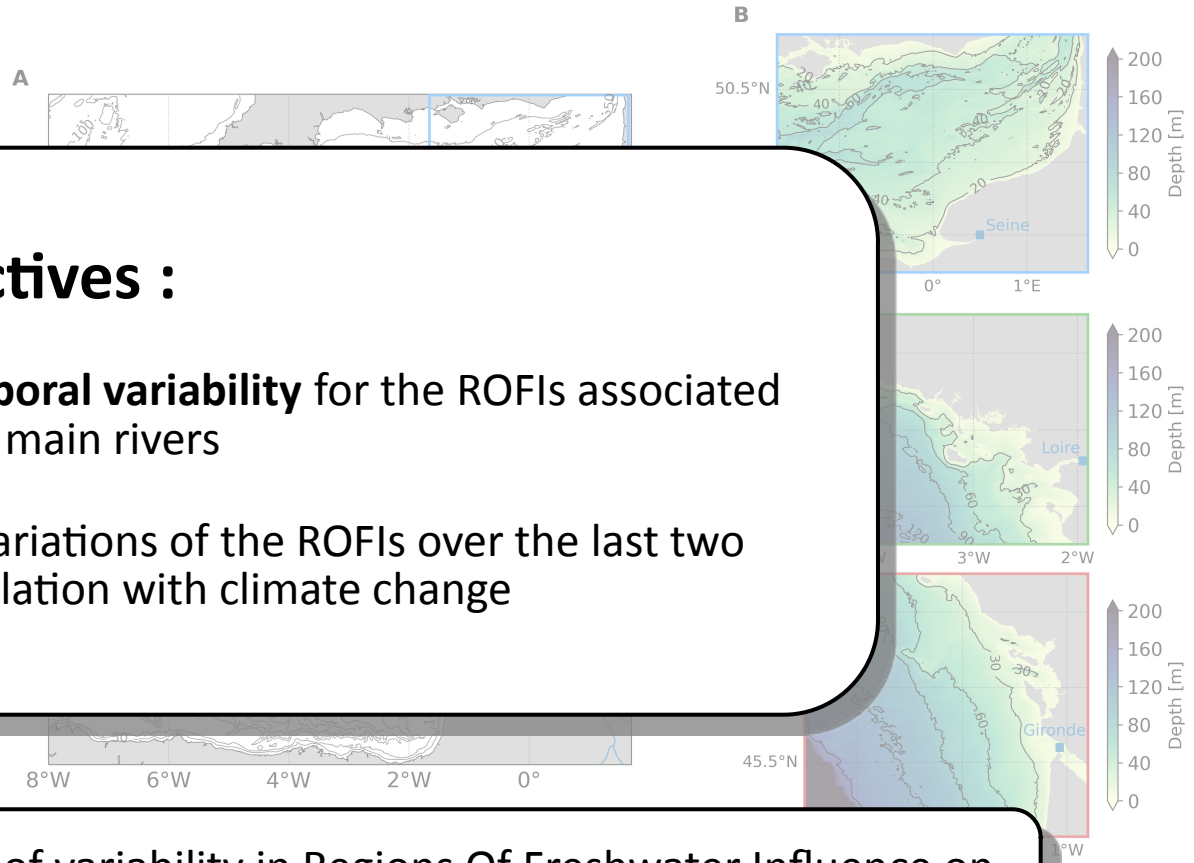
In the Bay of B

- **Loire**, mean

- **Gironde**, mea



Objectives :

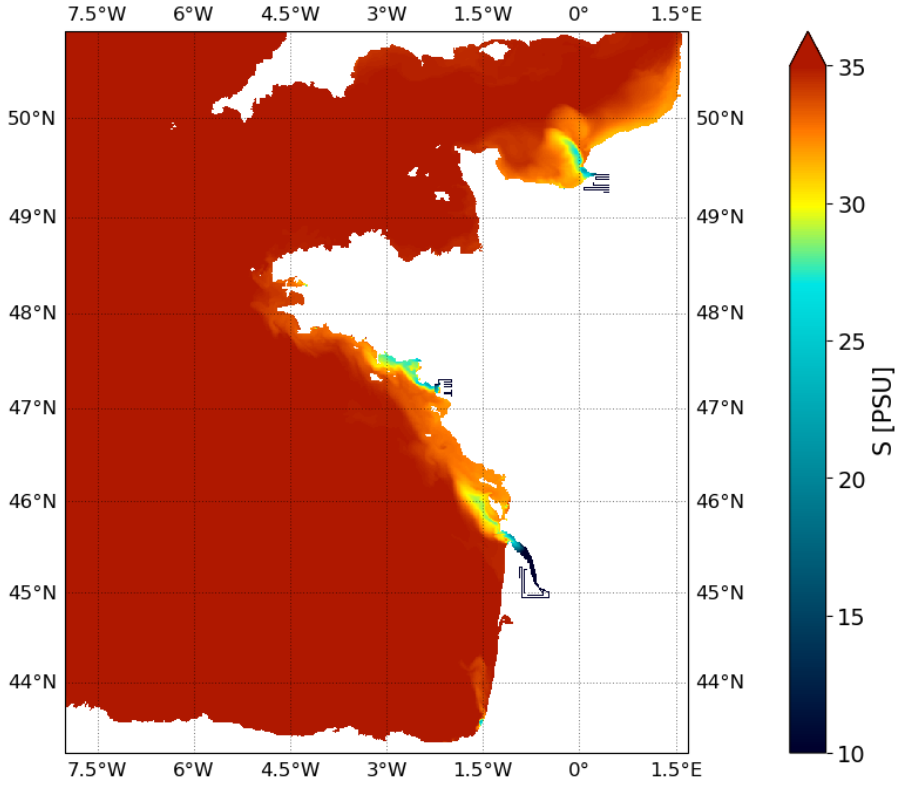
To identify the **dominant scales of temporal variability** for the ROFIs associated with the 3 main rivers

To characterise and understand the variations of the ROFIs over the last two decades (2000-2020) in relation with climate change

M. Martinez Almoyna *et al* (2025), Temporal scales of variability in Regions Of Freshwater Influence on the French continental shelf over two decades, *Journal of Marine Systems*

Realistic numerical simulation

GAMAR configuration



Simulation based on **CROCO** numerical model, with horizontal resolution of **1km** on **40 vertical sigma levels**.

Domain : 43.3°N - 50.9°N / 8°W - 1.7°E

Hourly saved between 2000 and 2020 (spin-up during year 2000)

Forcings :

- 23 rivers forced with runoff data of SHAPI stations from Hydro-France database and data from EMODnet network.
- Athmospheric forcings : Era5 global reanalysis, Hersbach *et al*, 2020
- Boundaries :
  - Tidal forcings : global ocean tide atlas FES2014, Lyard *et al*, 2021
  - Open boundary conditions : GLORYS12V1 reanalysis, E.U. Copernicus Marine Service Information (CMEMS), 2024

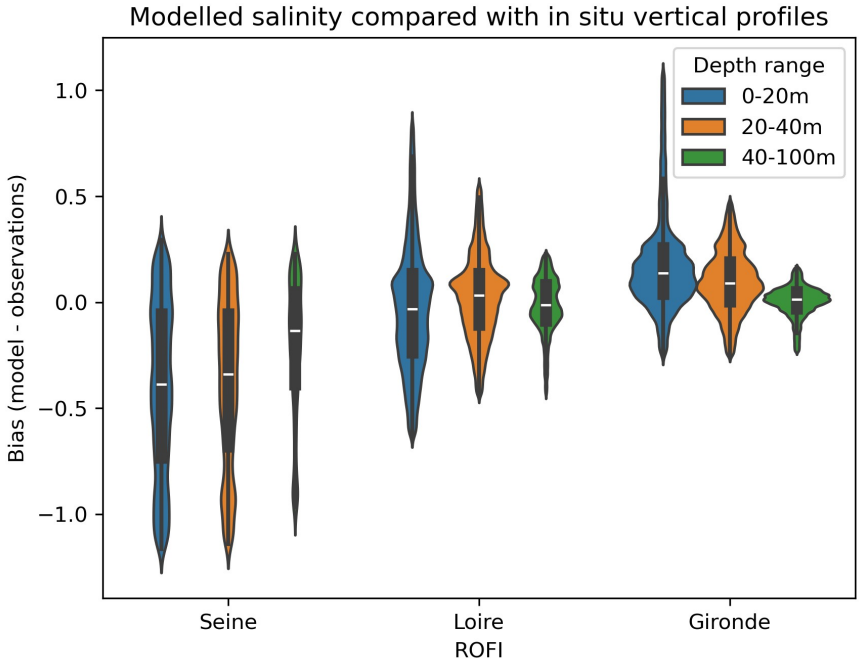
Simulation assessment

Temperature : comparison with *Odyssea L4 Copernicus* satellite product
(E.U. Copernicus Marine Service Information (CMEMS), 2023)
and timeseries from the *COAST-HF* network (Farcy *et al*., 2019)

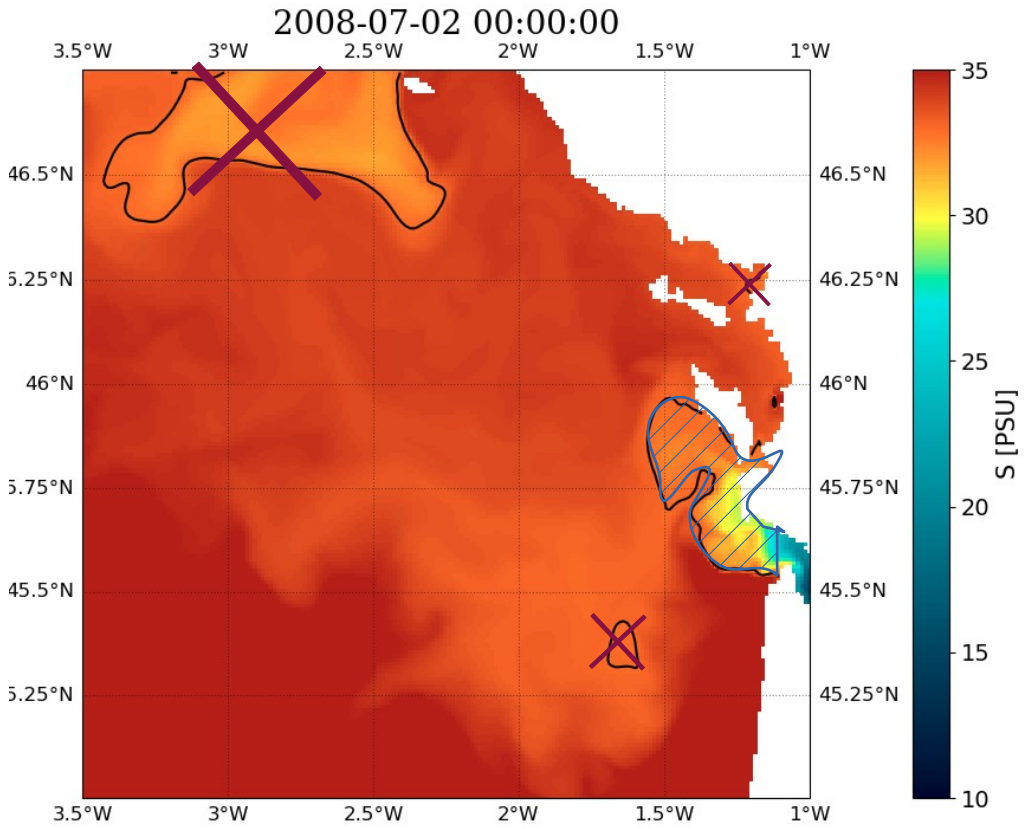
Salinity : comparison with *in-situ* profiles from the *CORA-IBI* database
(Szekely *et al*, 2017)
and timeseries from the *COAST-HF* network (Farcy *et al*., 2019)

Tides : comparison with tide gauge measurements

Salinity bias



ROFI identification criteria



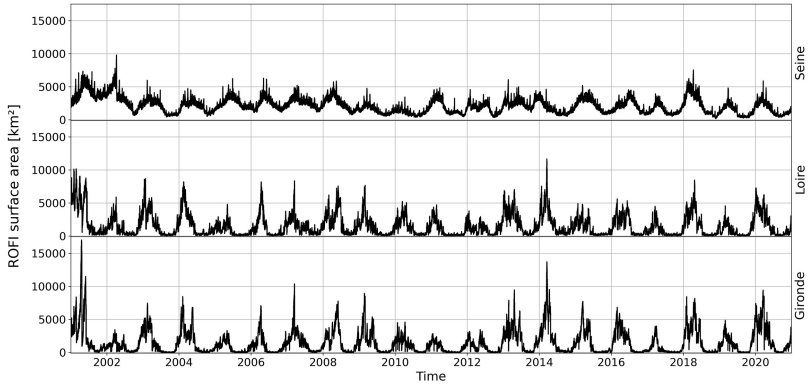
- Area where sea surface salinity is **below 33 psu**

- **Surface connected to the estuary** (for Loire and Gironde ROFIs)

ROFI charaterisation

Characteristics : surface area, depth, equivalent freshwater volume and salinity distribution

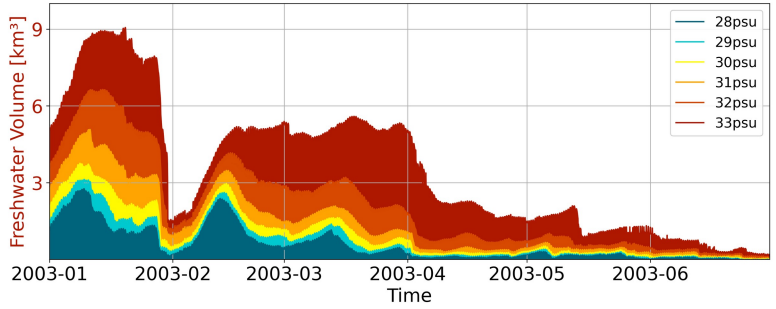
ROFI surface area



Freshwater volume distribution in salinity classes

$$V_f(s_A) = \iiint_{s<s_A} \frac{s_0 - s}{s_0} dV$$

Hetland, 2005



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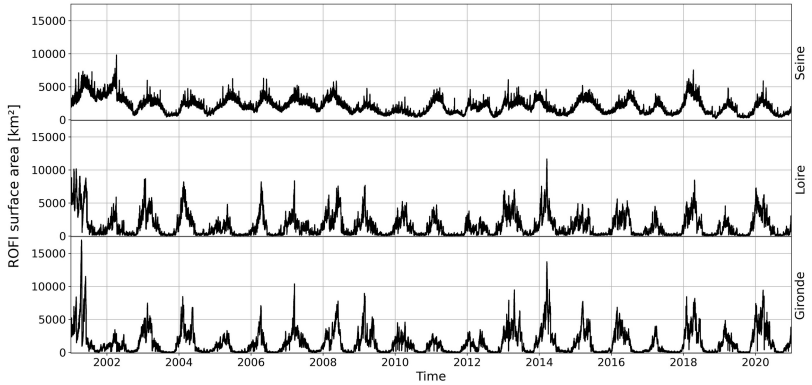

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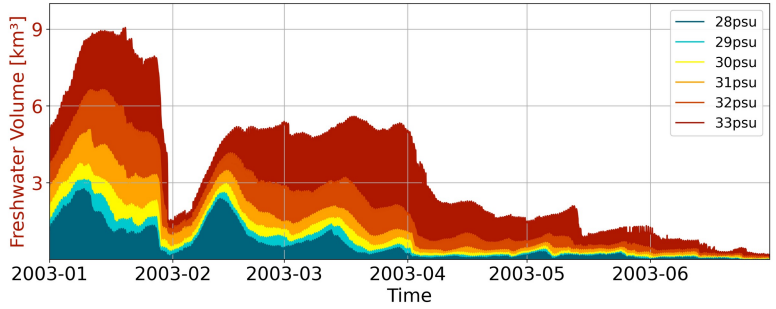
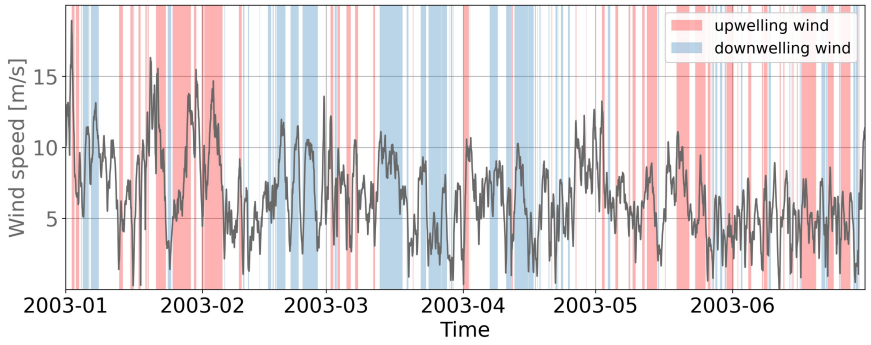
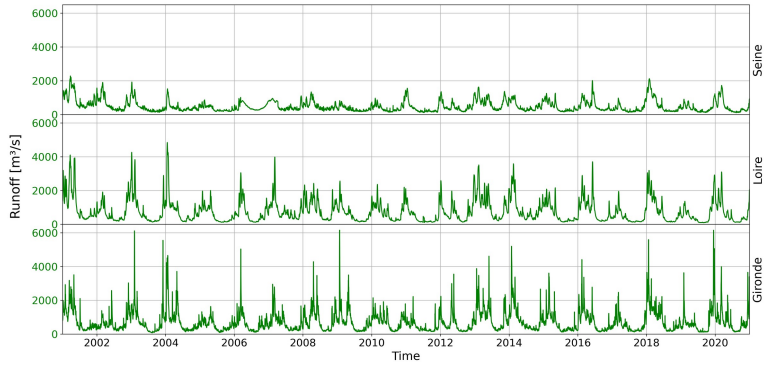


Forcings : runoff, wind, tide

Wind speed and direction



River runoffs

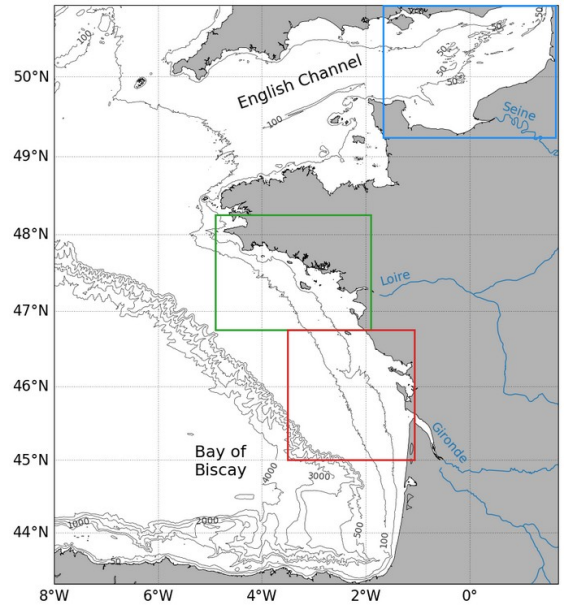


Which time scales of variability ?

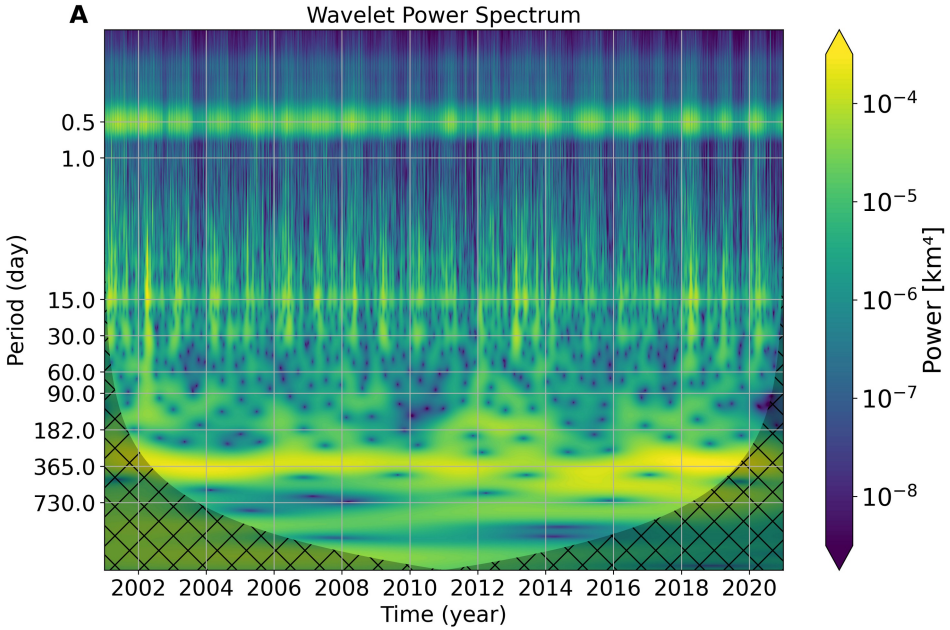
From diurnal and semidiurnal timescales … to interannual timescale

Two contrasted regimes: Seine *vs* Gironde + Loire

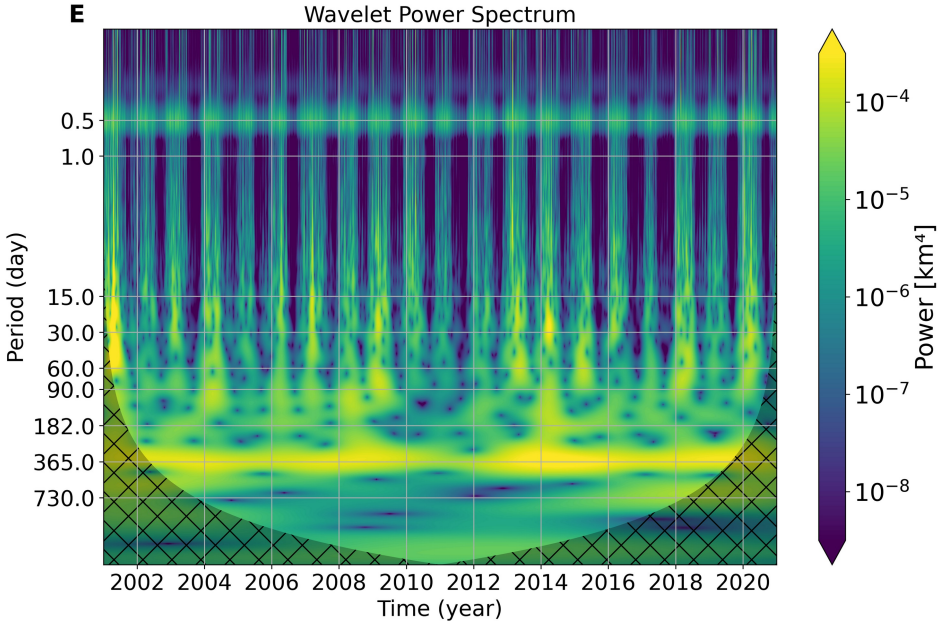
Exceptional years – e.g. 2001 et 2014



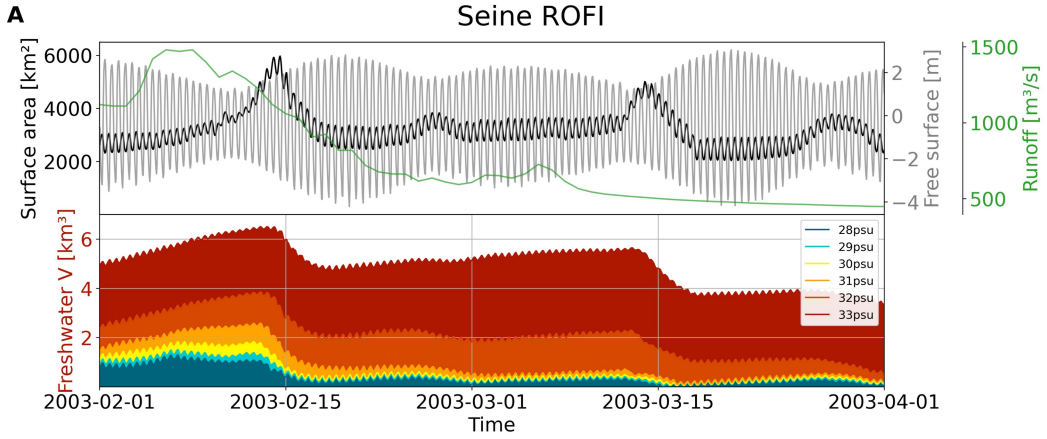
Seine ROFI



Gironde ROFI



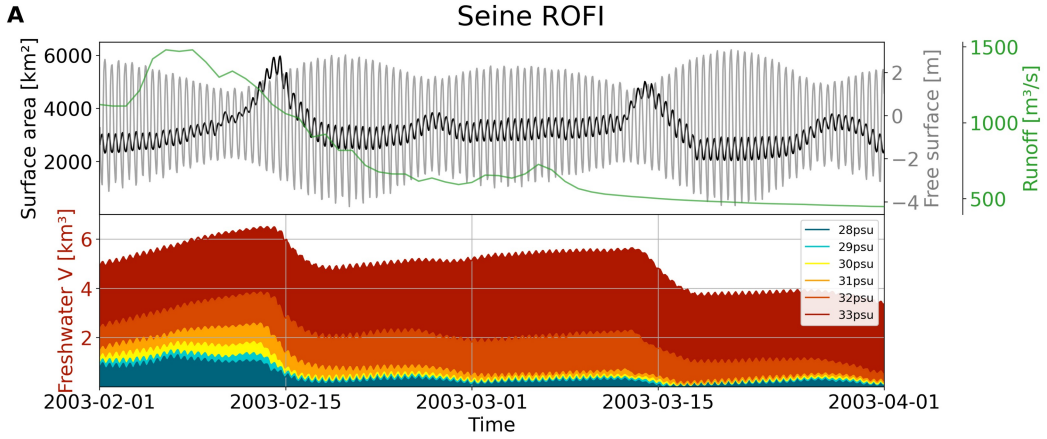
Weekly and monthly scales



ROFI evolution punctuated by tidal amplitude cycles

Delayed response to flood events

Weekly and monthly scales



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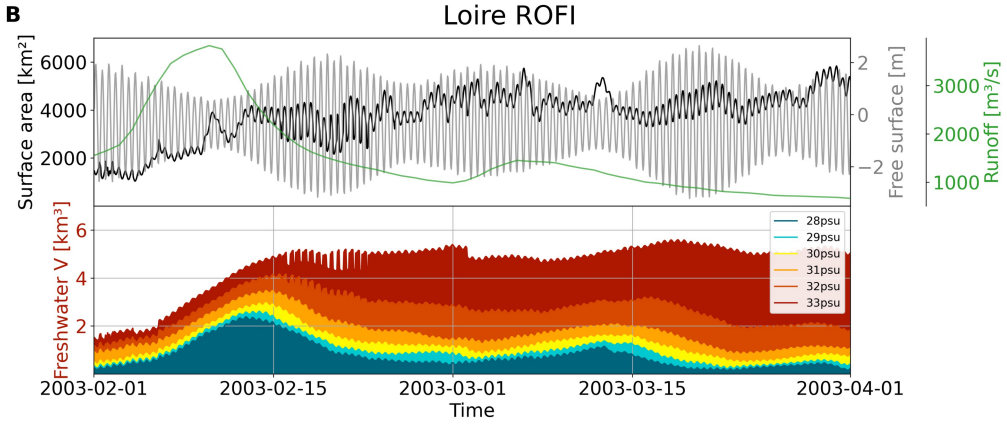
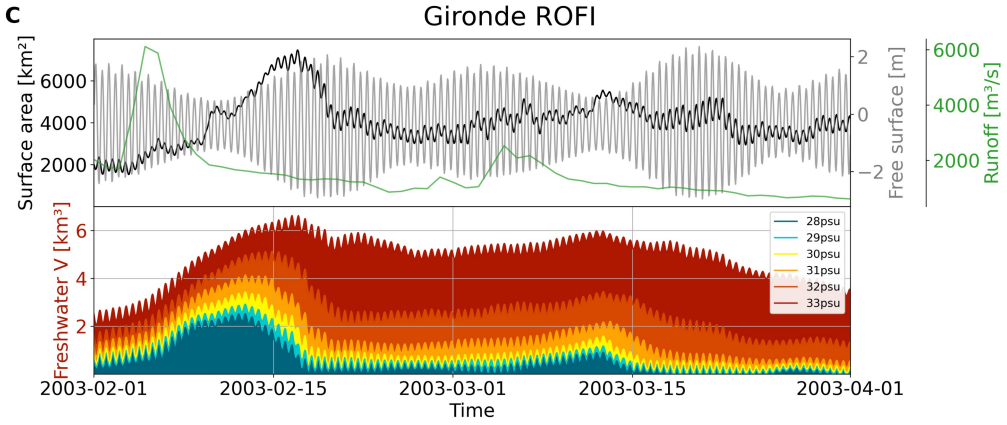
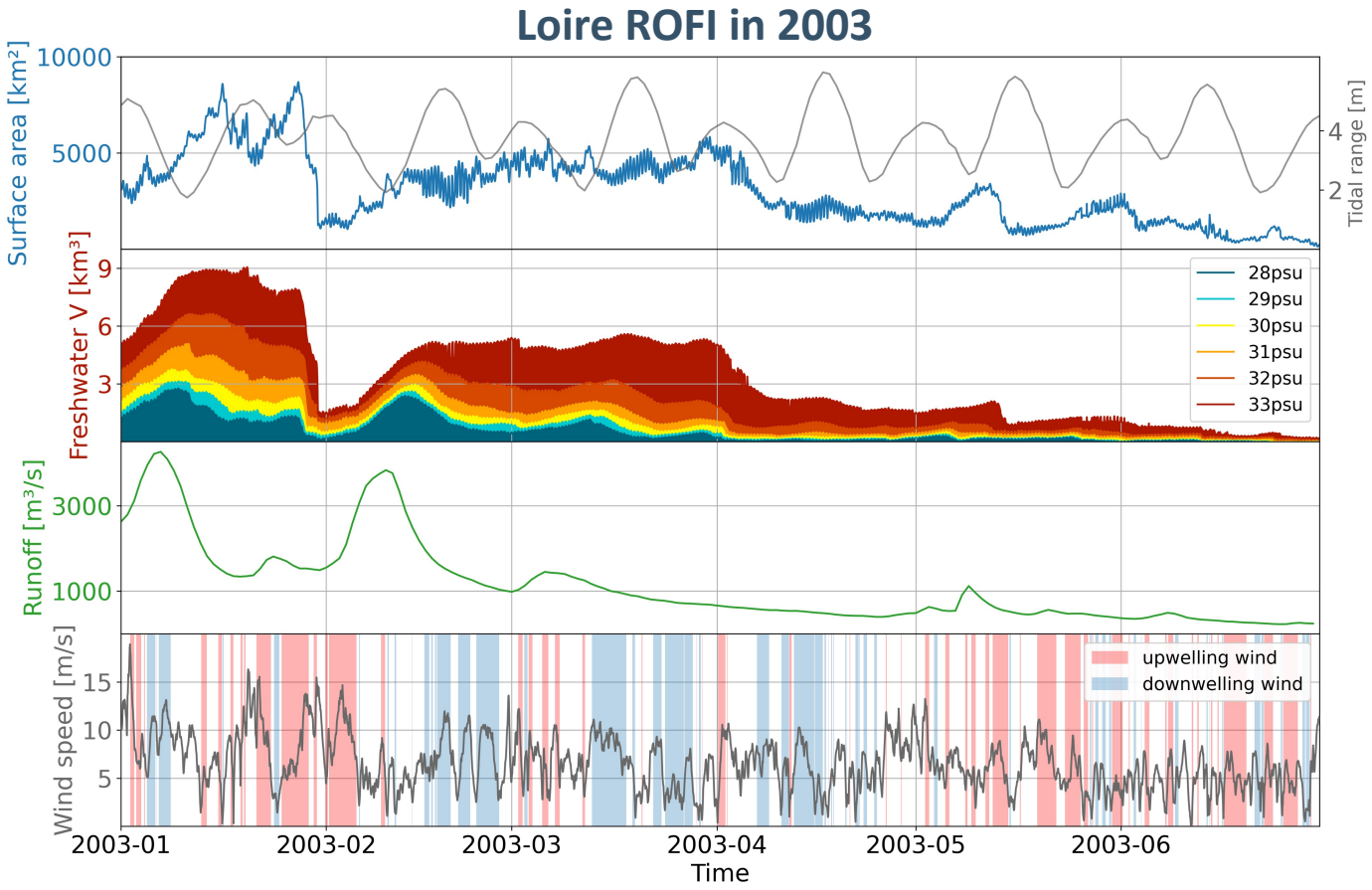


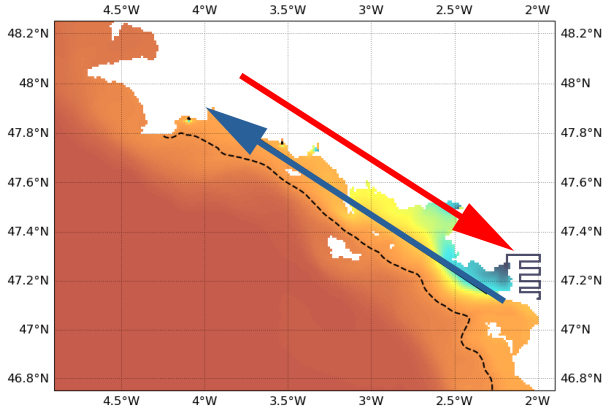
Rapid ROFI response to changes in runoff

Low tidal impact on a weekly and monthly scales



Impacts of wind events





Wind directions favourable to upwellings or downwellings

Wind favourable to **upwellings** :

- **offshore** extension
- **dispersion** into coastal ocean

Wind favourable to **downwellings** :

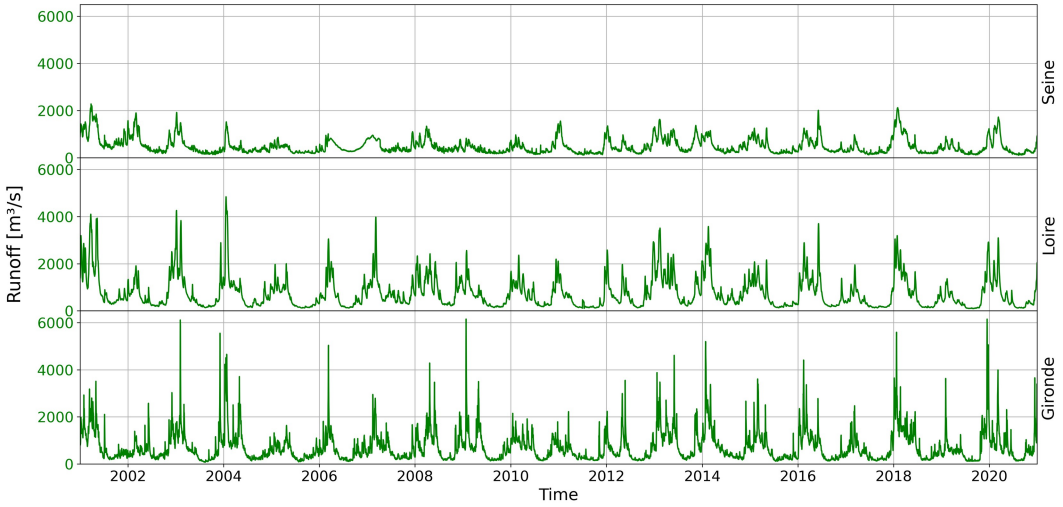
- ROFI constrained **along the coast**
- **persistence** over time

High interannual variability ...

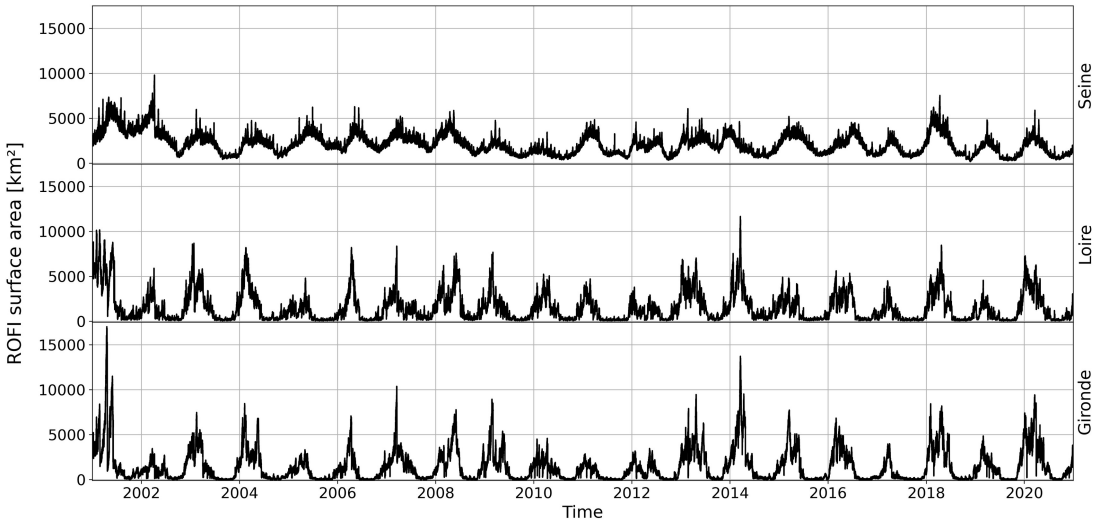
Significant interannual variability, strongly correlated with **runoffs**.

Slight **downward trend** in the extent and freshwater of the Seine and Loire ROFIs.

River runoffs



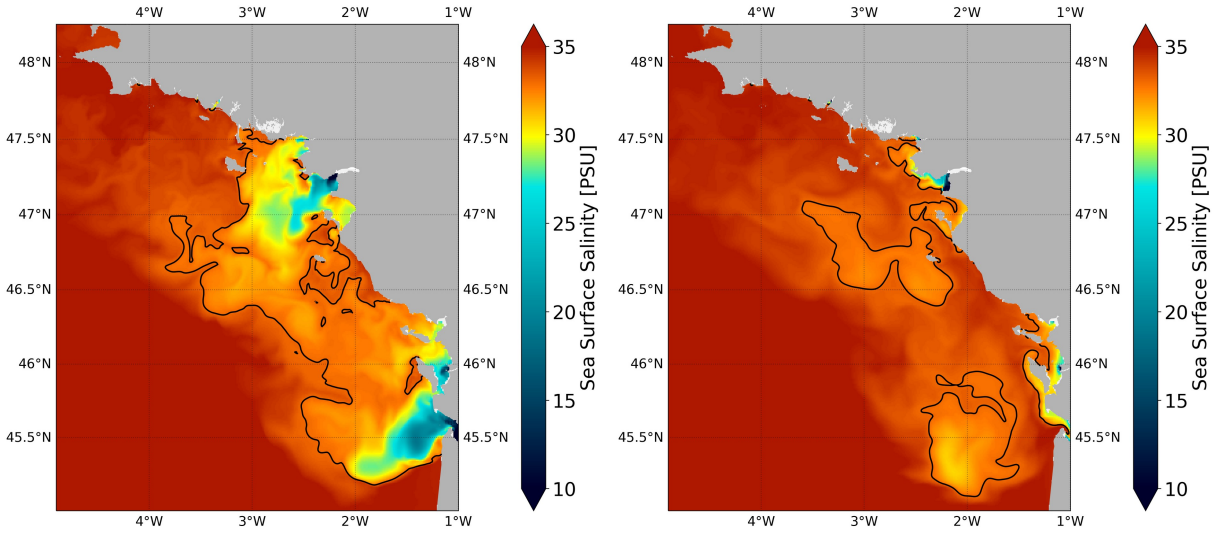
ROFI surface area



With some extreme years for the ROFIs

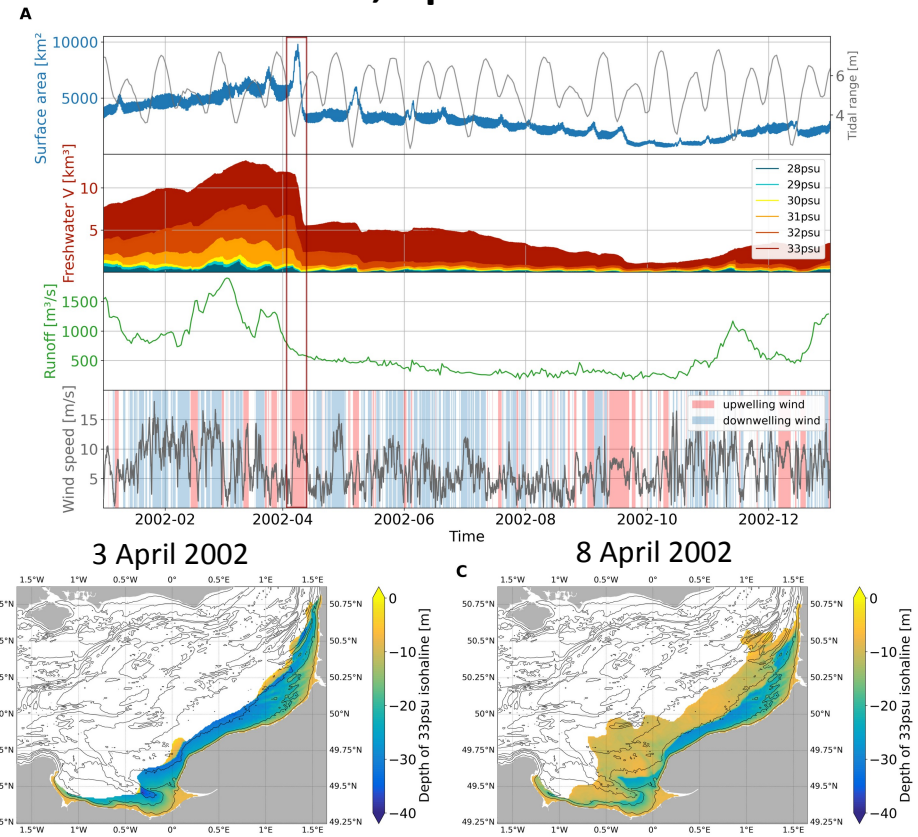
A combination of remarkable forcings during certain years causing a particular dynamic of the ROFI

Bay of Biscay, April 2001



Sea surface salinity

Seine, April 2002

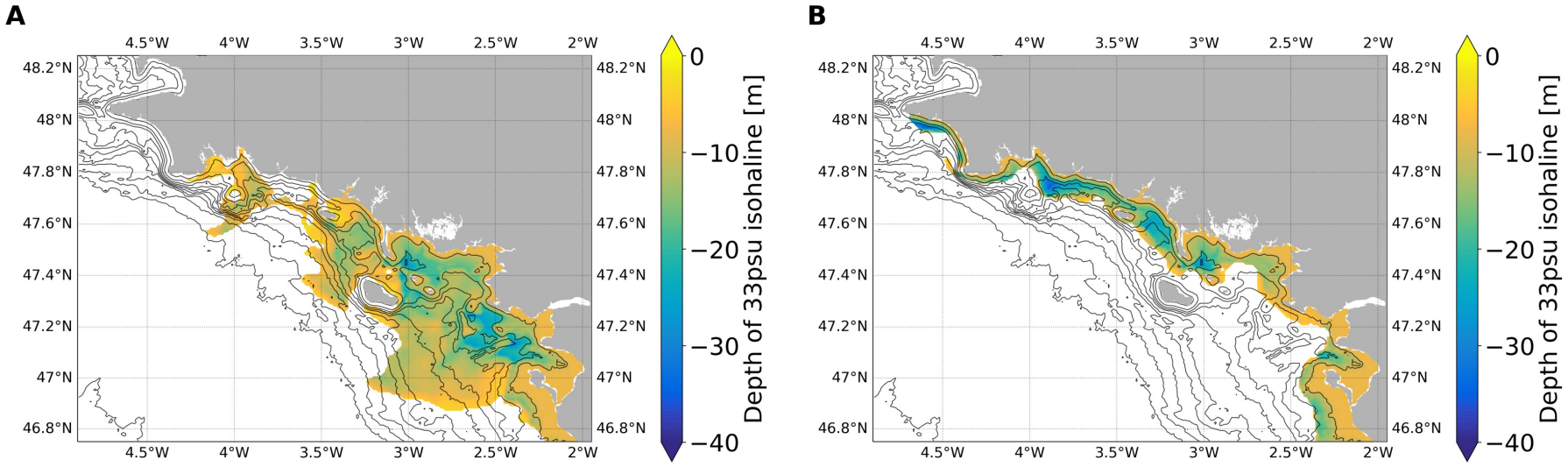


Conclusions

Dominant scales of temporal variability for ROFIs over the period 2000-2020: from the semi-diurnal cycle to interannual variations

Different dominant processes and forcings for the 3 ROFIs **(Seine vs Gironde + Loire)**

Slight trends in the evolution of the characteristics of the ROFIs (decrease in runoffs and ROFI extensions) modulated by interannual variability linked to a set of **specific years** in terms of combinations of factors (wind conditions, runoffs and tides).



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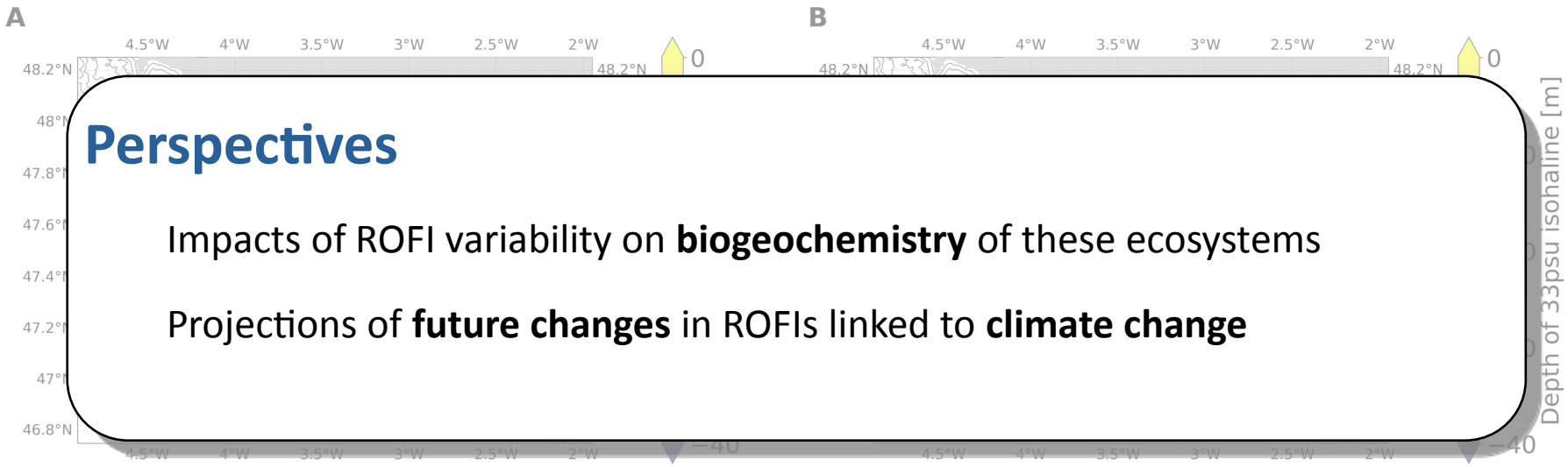

Perspectives

Impacts of ROFI variability on **biogeochemistry** of these ecosystems

Projections of **future changes** in ROFIs linked to **climate change**

Thank you for your attention

maud.martinez.almoyna@ifremer.fr

M. Martinez Almoyna *et al* (2025), Temporal scales of variability in Regions Of Freshwater Influence on the French continental shelf over two decades, *Journal of Marine Systems*