# AUGMENTED OBSERVATION STRATEGY IN THE COASTAL ZONE TO FEED NUMERICAL TWINS OF THE OCEAN IN RIVER IMPACTED AREAS


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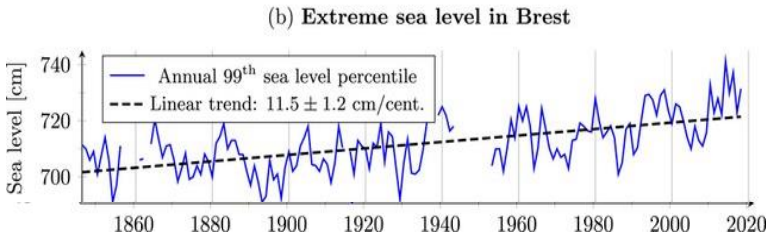
1 LOPS, IFREMER, BREST, FRANCE
2 PHYTNESS, ARGENTON, FRANCE
3 IRSN, LA SEYNE SUR MER, FRANCE
4 CEFREM, PERPIGNAN, FRANCE
5 IMEV, VILLEFRANCHE, FRANCE
6 LSCE, GIF SUR YVETTE, FRANCE
7 RDT-SIIM, BREST, FRANCE
8 RDT-LDCM, BREST, FRANCE


*17 June 2025*

# Observation of the coastal zone : high spatial and temporal variability

**Meso-scale processes**

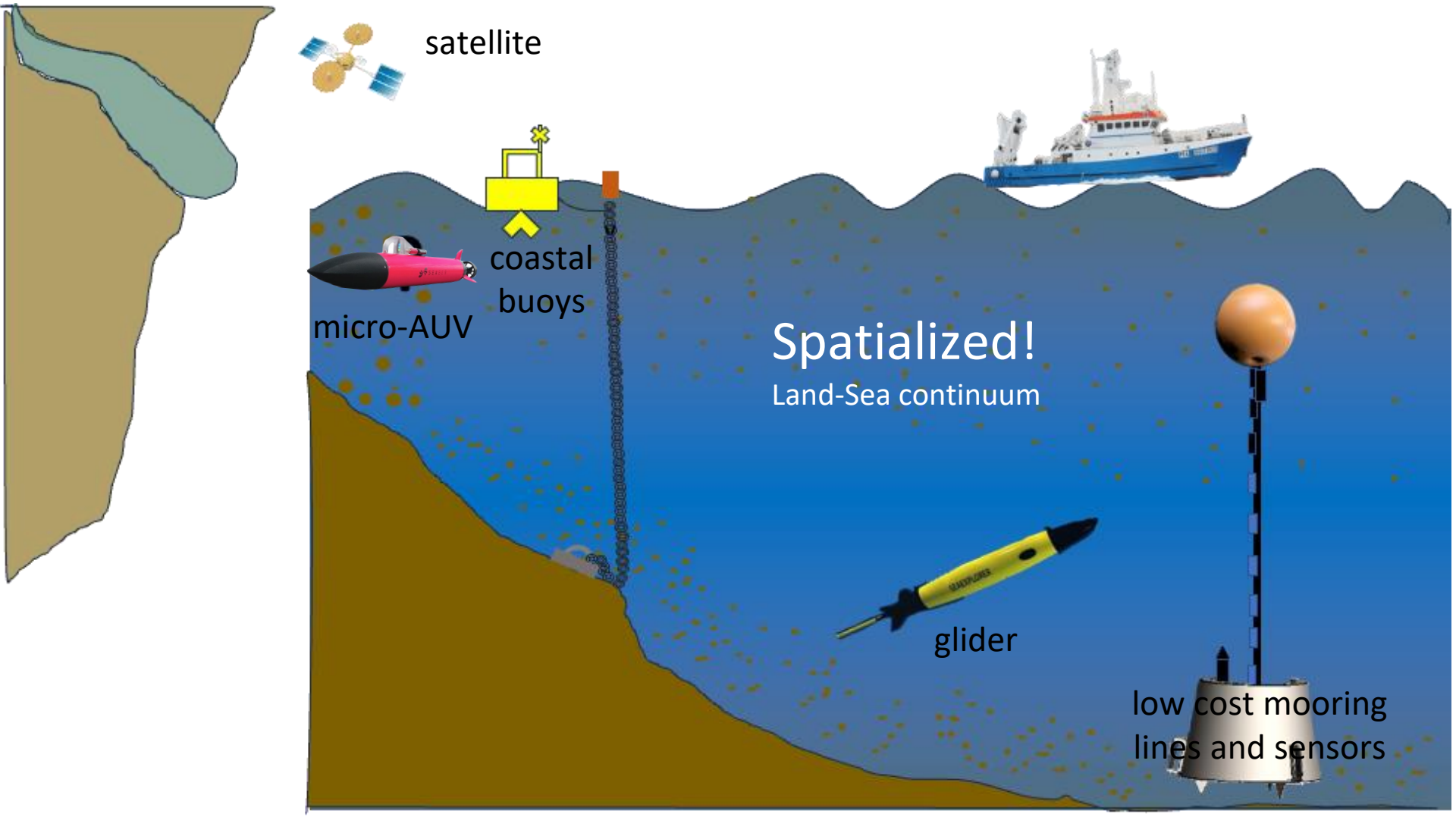
- measures of physico-chemical parameters with a good spatial/time resolution/coverage
- measures of **trends and extremes**




*(Reinert et al., 2021)*

**=> these scales are undersampled with current observation networks**

# Observation of the coastal zone



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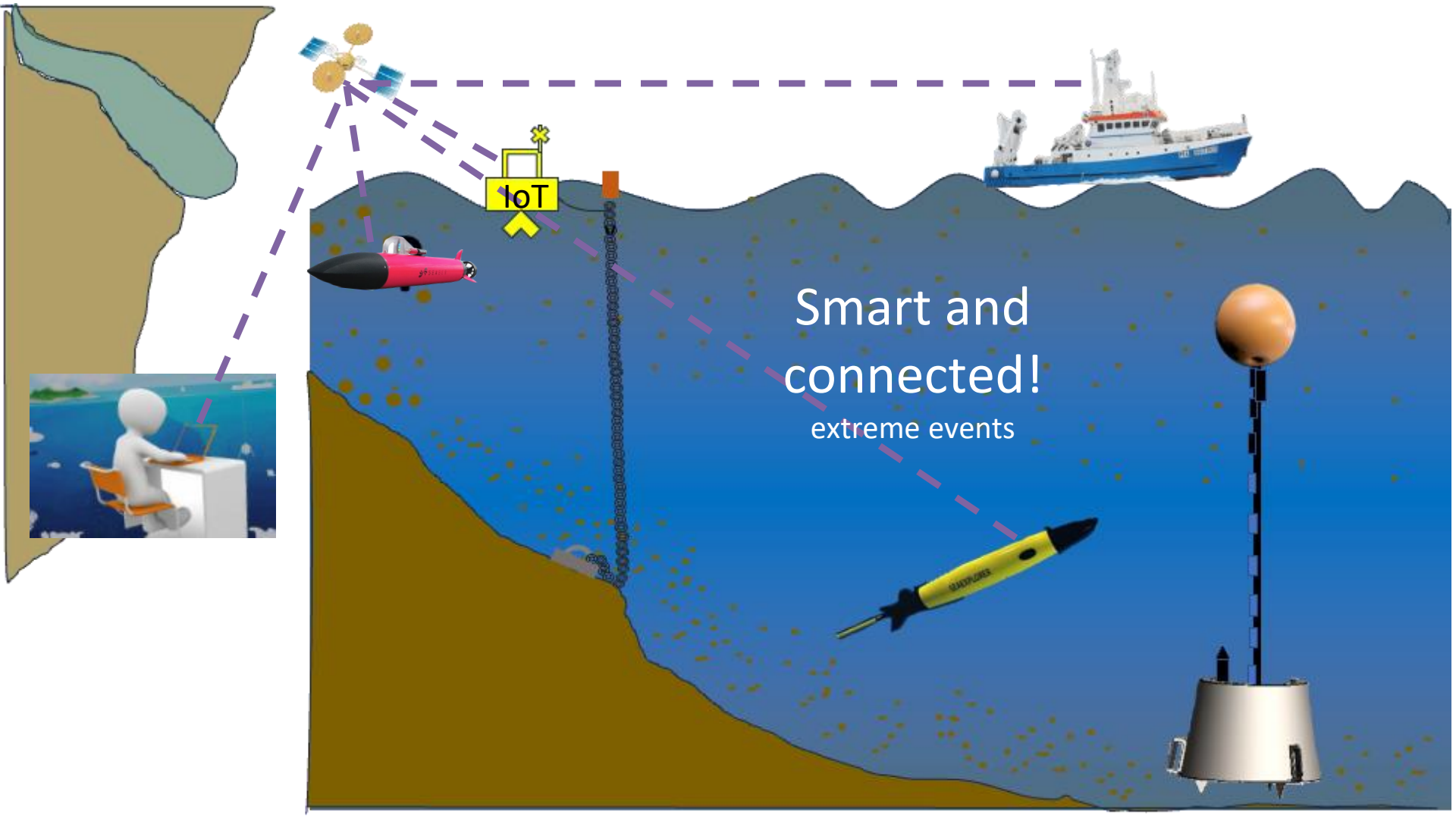

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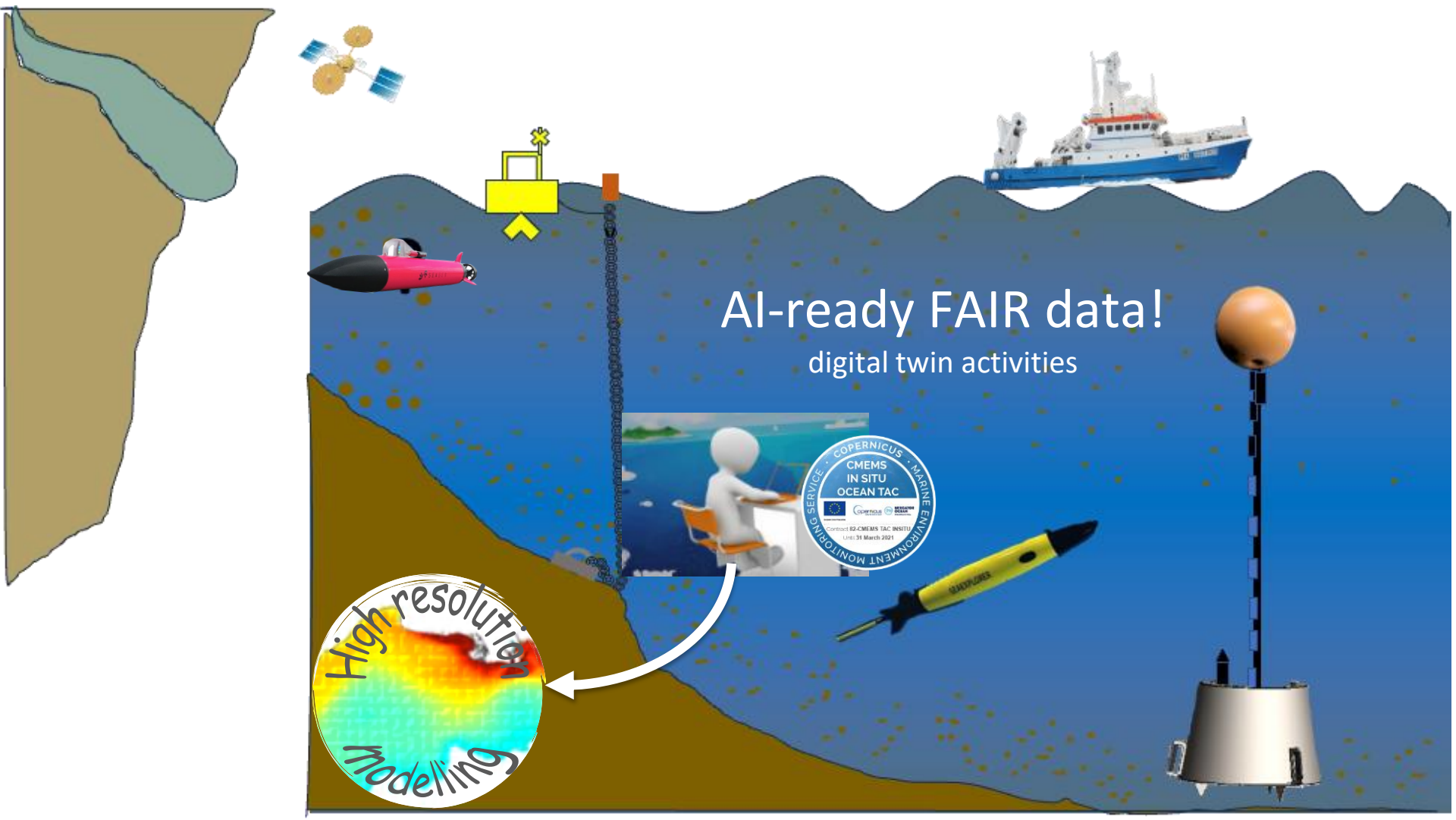
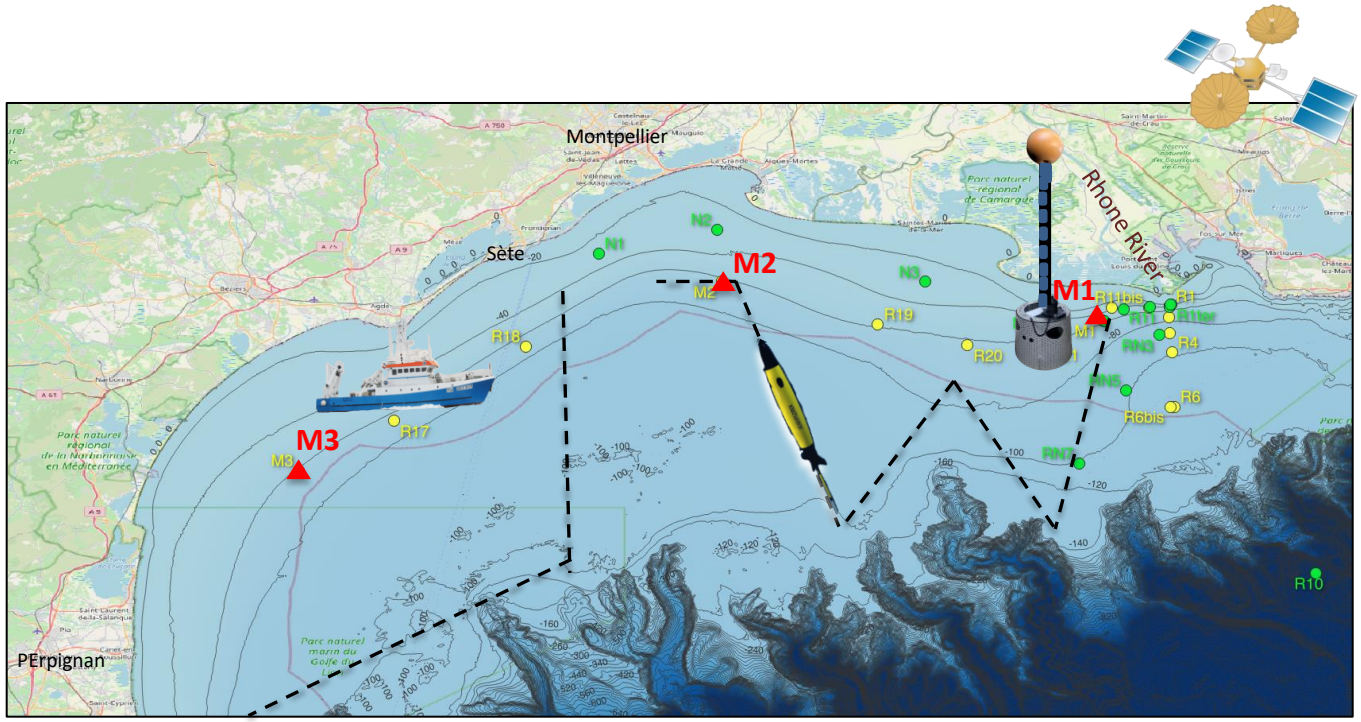


# **Spatialization of time series**: the RIOMAR-RIGOL experiment

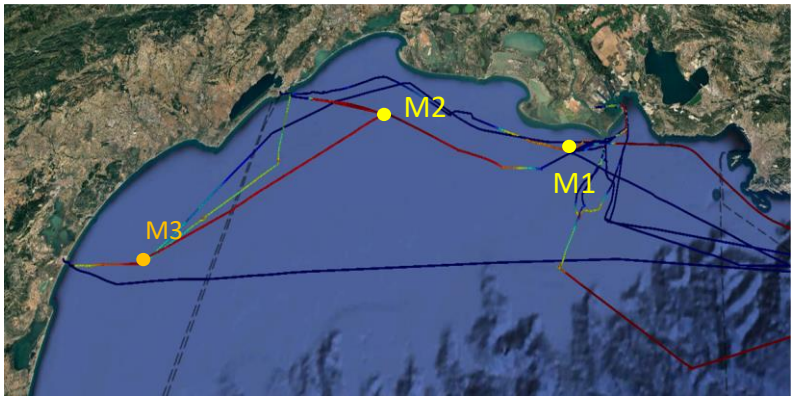



- **18 January-13 April 2024**
- RV Téthys2

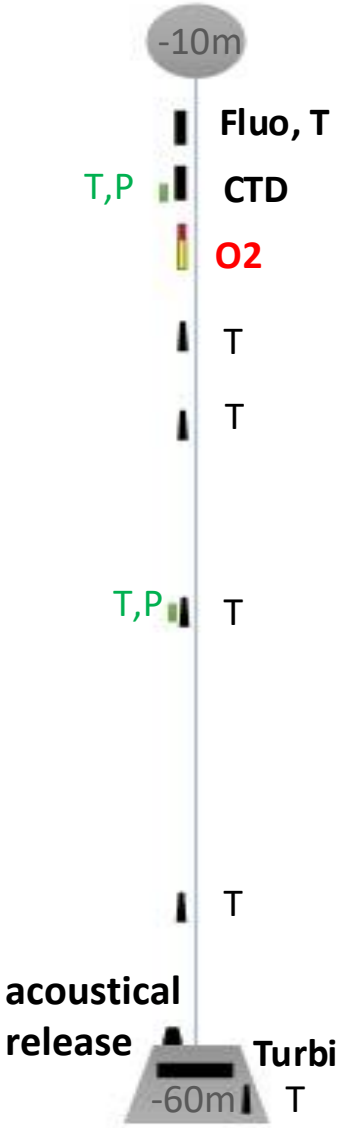
A multi-systems strategy to sample over the shelf :

- radials during oceanographic cruise (hydrology, biogeochemistry, contaminants)
- dedicated satellite images
- glider deployments (January-February)
- **Mastodon2D moderate cost mooring lines at 3 locations**

# **Spatialization of time series**: the RIOMAR-RIGOL experiment



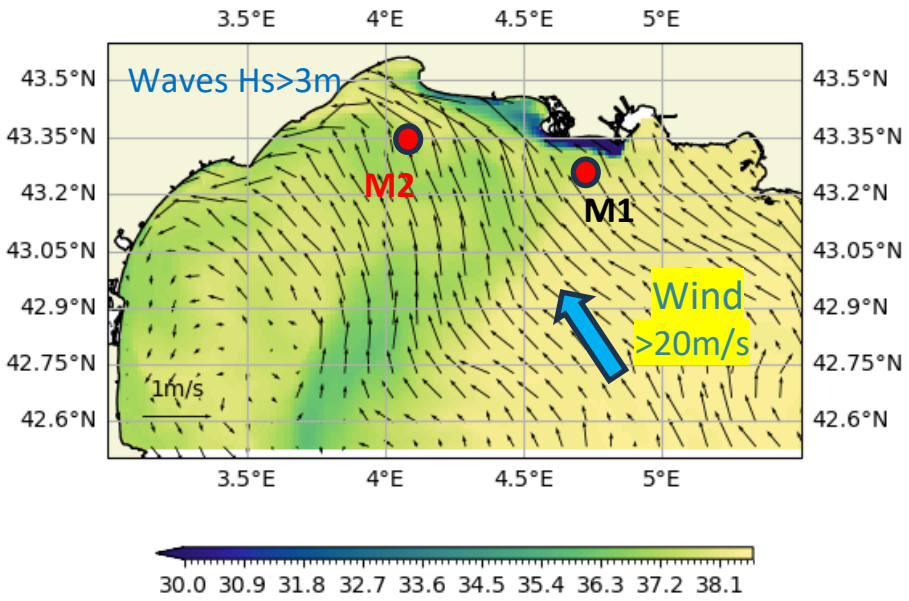

2 MASTODON-2D mooring lines recovered : M1, M2



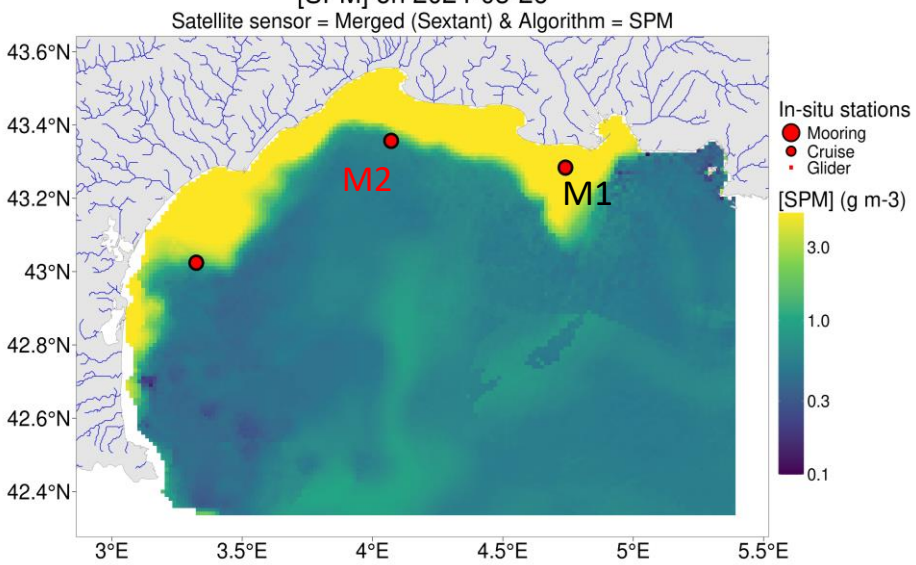

# **Spatialization of time series**: the RIOMAR-RIGOL experiment

## Impact of a southeast storm

Surface S and UV MENOR model
2024-03-26 12:00




Suspended Particulate Matter



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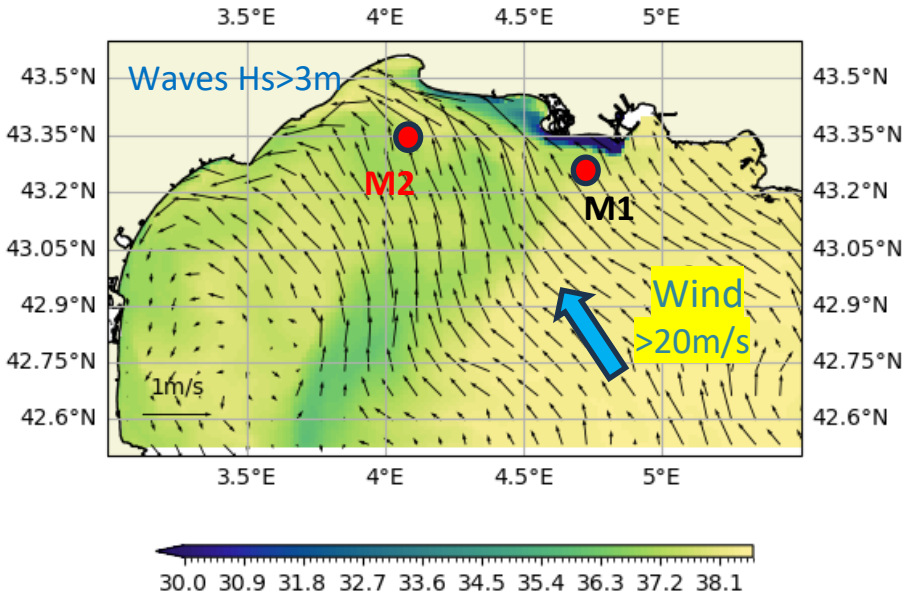


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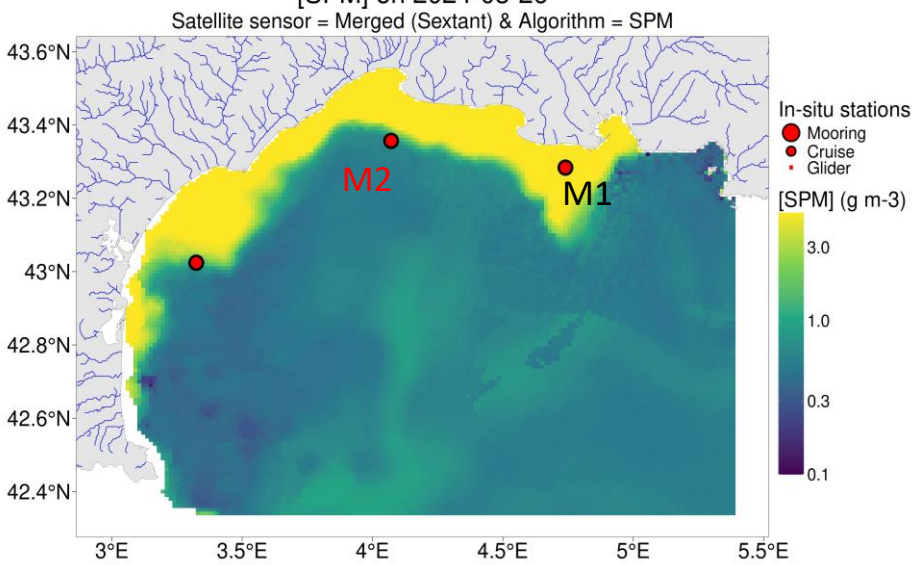
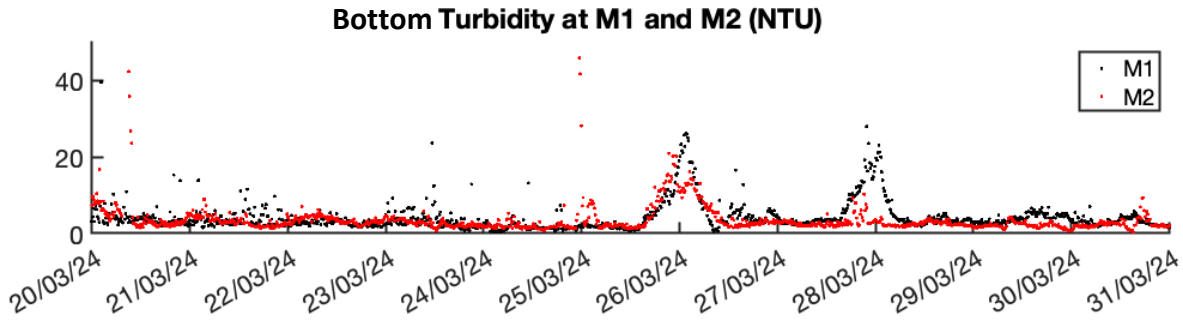



=> the Mastodon2D mooring data bring new information (spatialization, processes)

# **Spatialization in the coastal zone**: use of a micro-AUV

YUCO-CTD (Legato3)

- Rapid deployment with limited resources
- Intuitive mission programming
- WaterLinked DVL => Nav. accuracy < 2%
- **10h autonomy**
- Max depth : **300m**
- Coast : ~60.000€
- Payload :

RBR Legato3 CTD

- Additional sensor :
  O2 (Odo fast)
  turbidity ( Seapoint)

(MICO project)

Navigation (2 m/s):

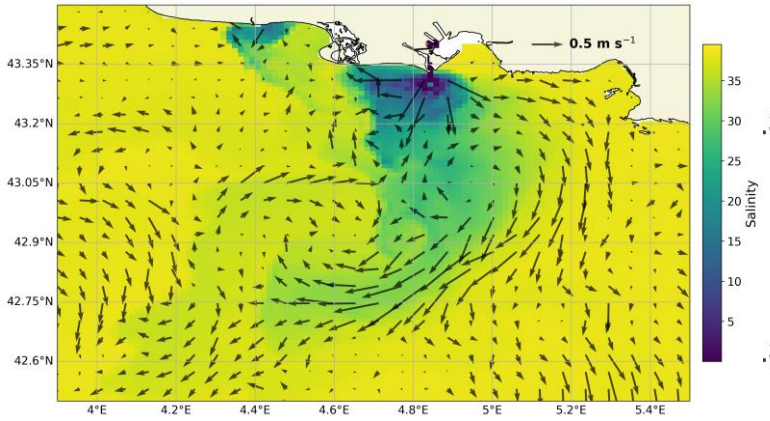
- constant depth/altitude
- along saw-tooths
- helical descent

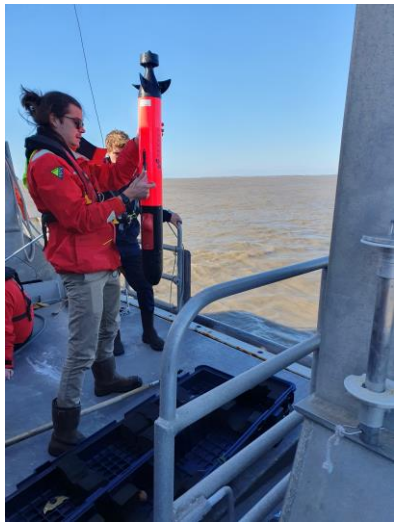
# **Spatialization in the coastal zone**: Rhone River plume

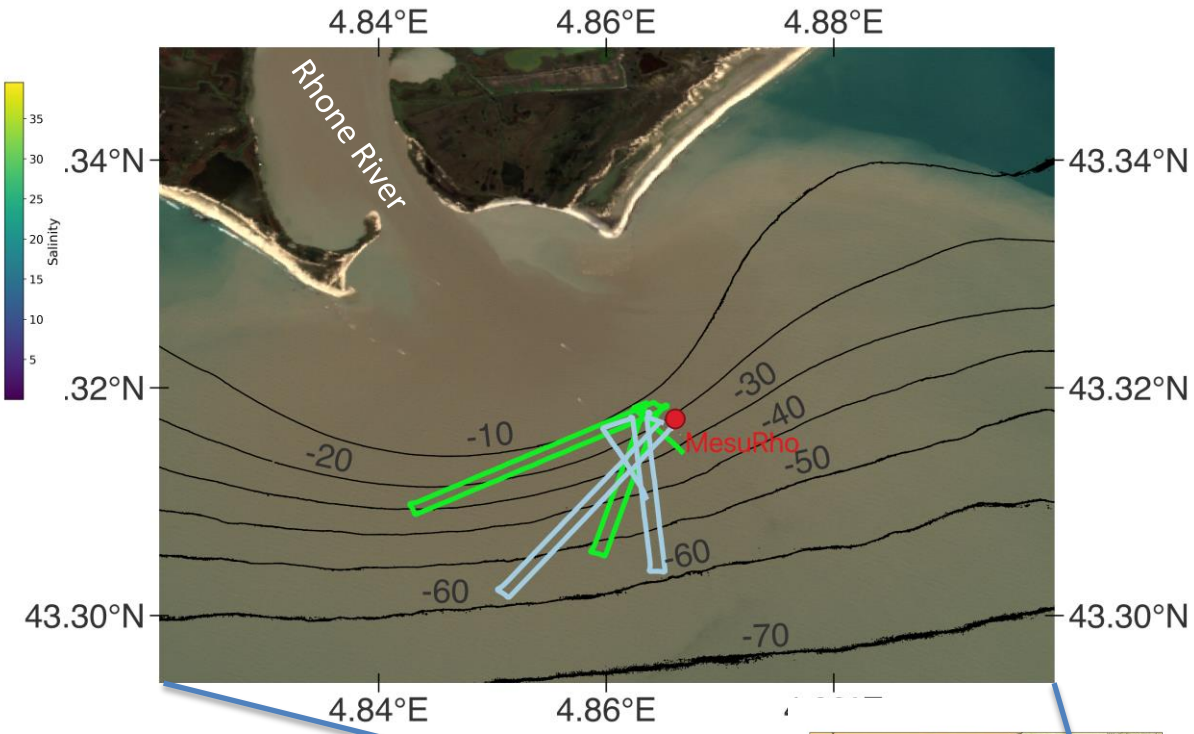
- Coastal boat cruise: RIOMAR RIOSB2

- **Flood: river flow >3500 m3/s (4 days)**
- Weak winds < 5m/s

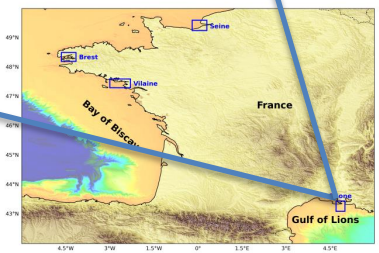
Model salinity and currents






$w_{Yuco}$=0,2m/s



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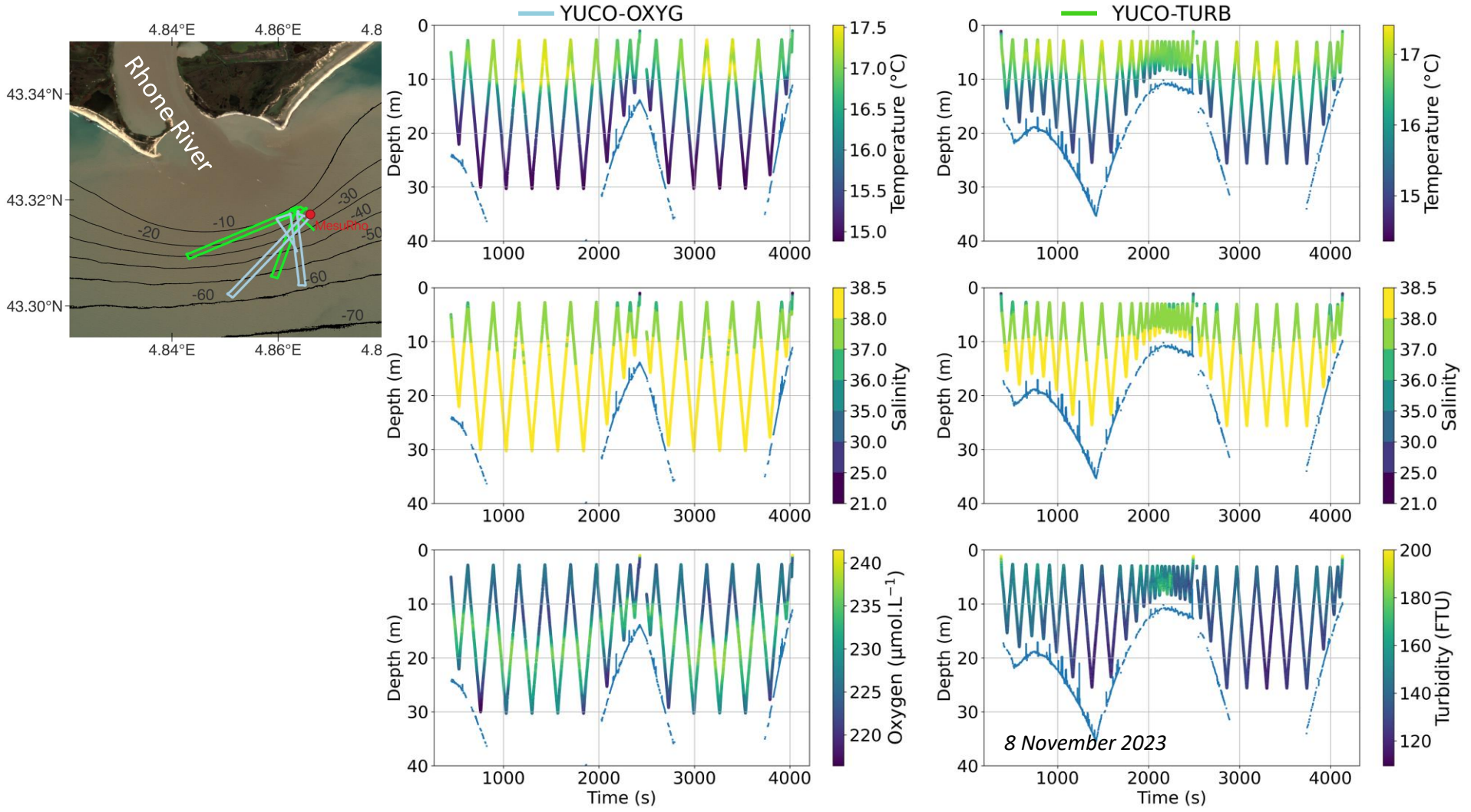
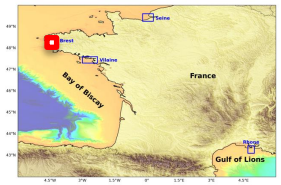
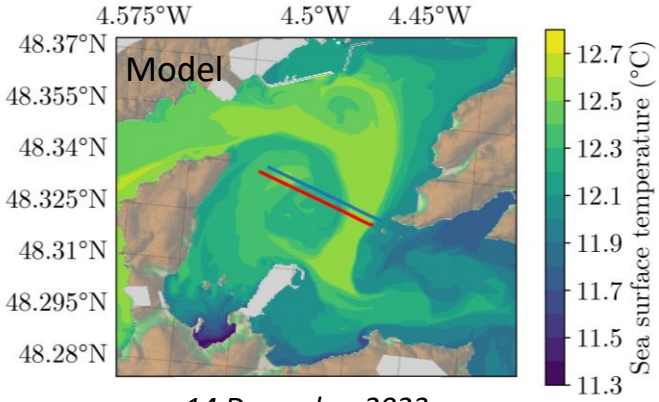



=> plume (low S & T) thickness of 2m, influence over 10m

=> higher turbidity close to the mouth, subsurface O2 maximum

# **Spatialization in the coastal zone** :
## influence of a small river in the Bay of Brest




*14 December 2023*

*Aulne River (Bay of Brest)*

- Deployment of two YUCOs in parallel, at 250m distance, depth=2m
- A tidal eddy is evidenced on surface T

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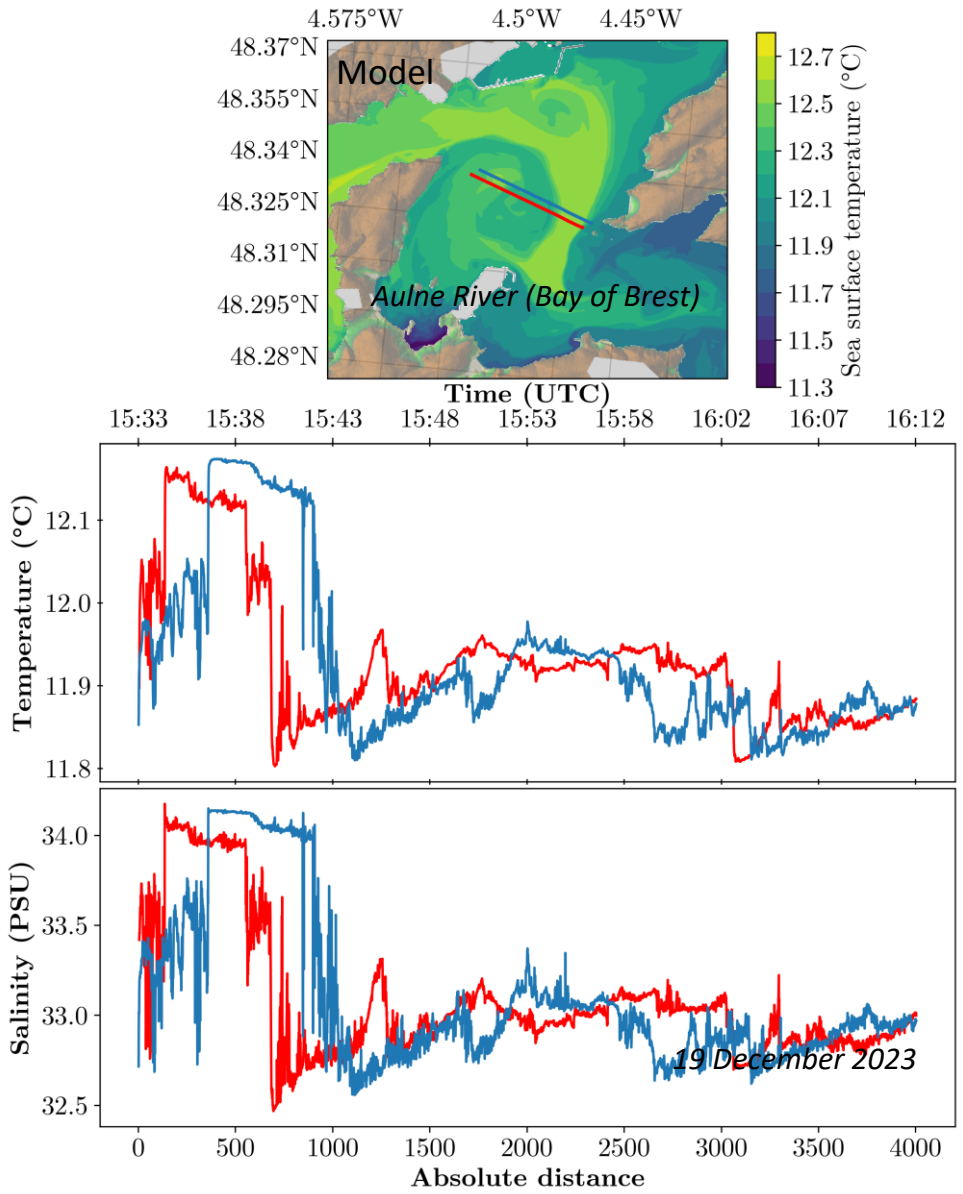


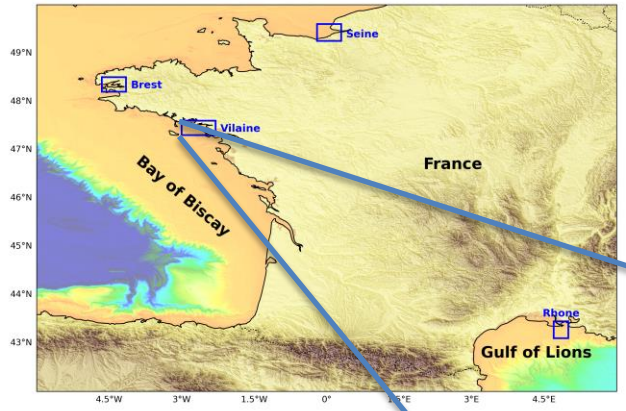

- Deployment of two YUCOs in parallel, at 250m distance, depth=2m
- A tidal eddy is evidenced on surface T

=> the YUCOs'measured T is consistent with the modeled surface gradient

=> Measurements confirm the presence of a tidal eddy

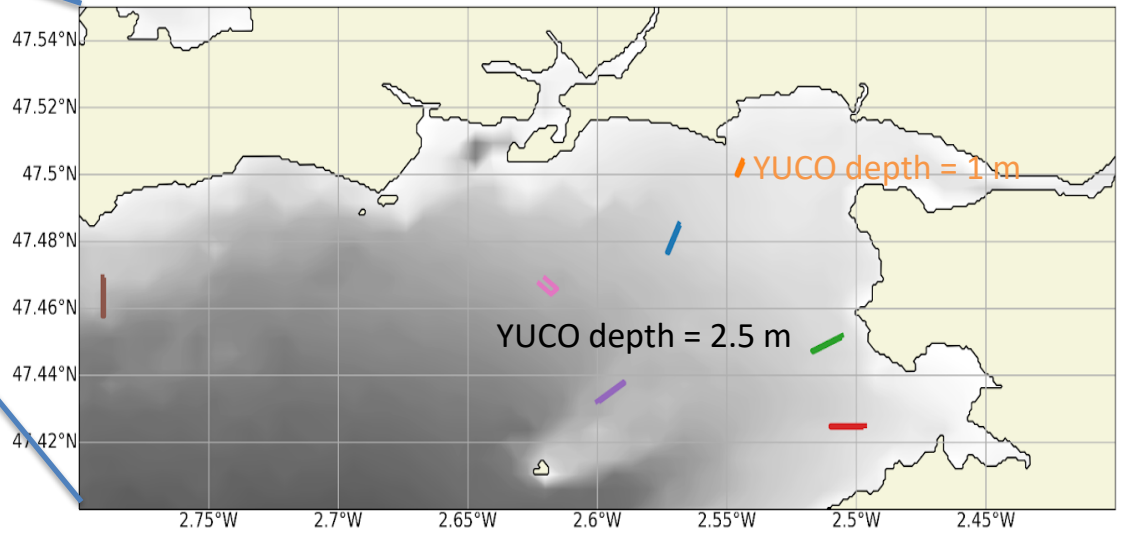
=> These data will enable to validate and refine the model performance

# **Spatialization in the coastal zone** : representativeness of fixed stations off the Vilaine River



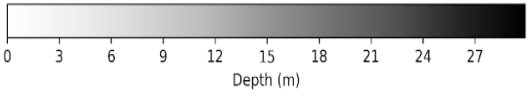


Bay of Vilaine (24 August 2022)



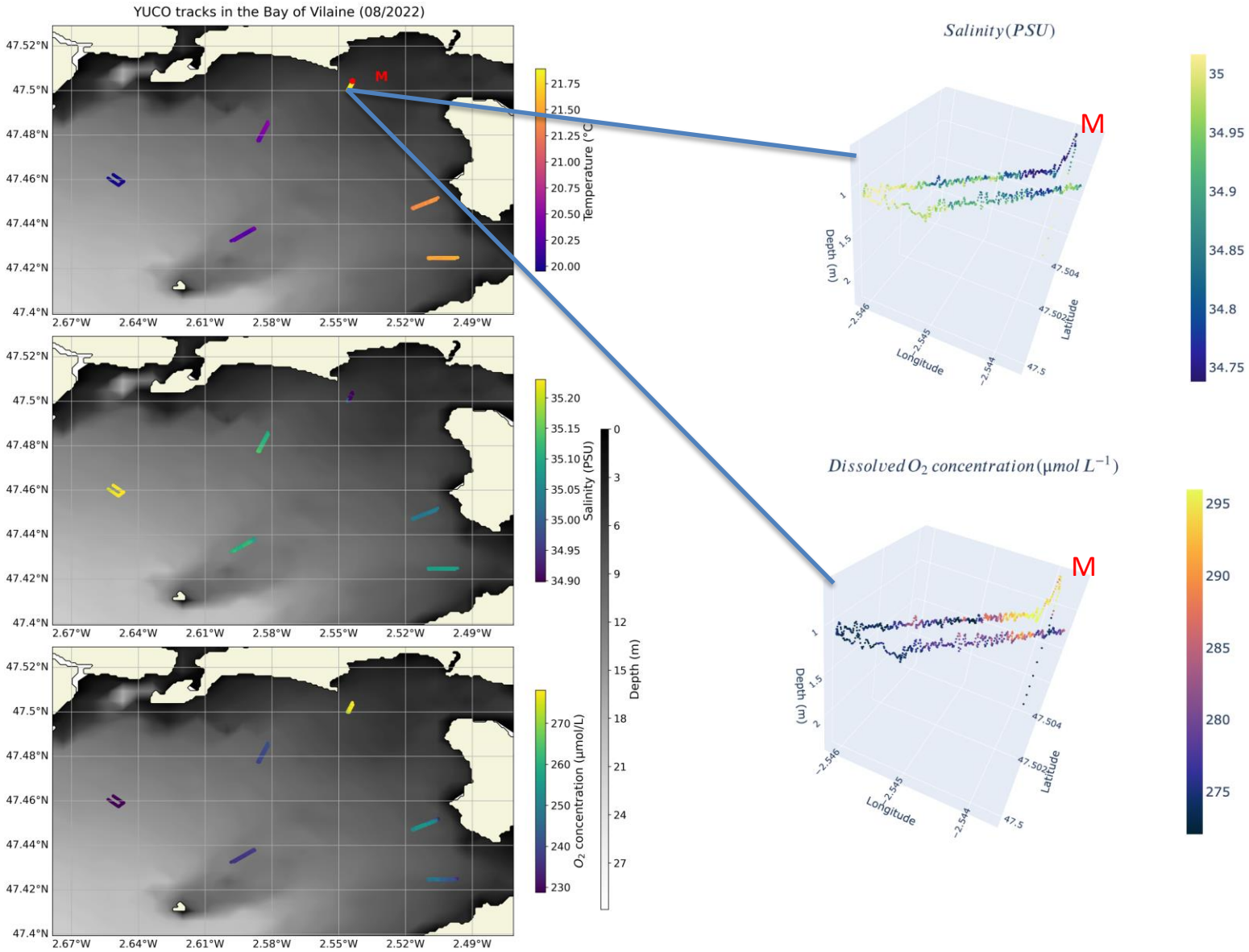

Forcings :

- **Low Vilaine river flow** (0,32 $m^3/s$)
- Low influence of the Loire river from the south




6 round trips (1-2km) at 2m.$s^{-1}$, constant depth

# **Spatialization in the coastal zone** : representativeness of fixed stations off the Vilaine River



# **Smart observation** of extreme events by coastal buoys


- **COAST-HF stations** are equiped with probes for meteo-oceano physical and biogeochemical measurements
- Sampling period : 20-30 minutes

Extreme events at the MesuRho station: NW and SE wind storms, Rhone River floods or heatwaves

=> **Adaptive sampling strategy**
for salinity, turbidity, oxygen…

# **Smart observation** of extreme events by coastal buoys


- 5 COAST-HF stations equiped with **COSTOF2** (COmmunication and STOrage Front-end)
- COSTOF2 allows for oversampling when a threshold is reached

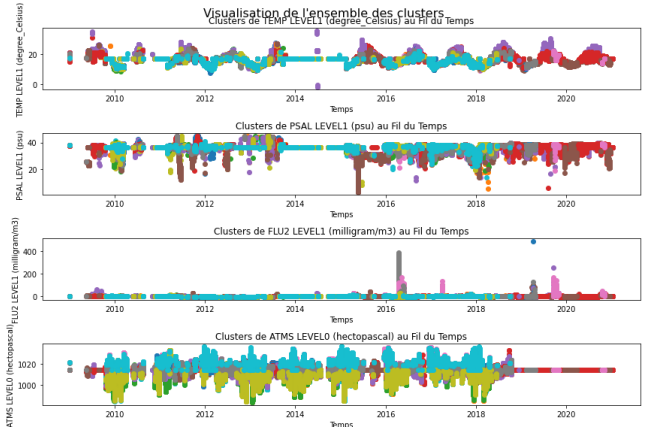
BUT

COSTOF2 only allows for 2 conditions on the data values to trigger oversampling!

# **Smart observation** of extreme events by coastal buoys

- Addition of a low-power on-board computer (Raspberry-Pi4) to the COSTOF2 for:
  - data-preprocessing (data cleaning, normalization, choice of variables)
  - event detection (trained model on existing time series: clustering, neural networks…)
  - mimic a sensor as COSTOF2 input to trigger an alarm for oversampling

Clustering at the MesuRho station (k-means)




=> work on system integration and models

# CONCLUSION

Recently developed technologies will enable to move toward augmented observatories.

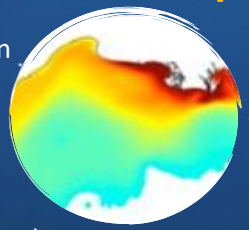
In the framework of PPR RIOMAR and Horizon Europe LandSealot, we have identified interesting tools to be used for future observation strategies in river impacted areas :

- **moderate cost mooring lines (acoustic Mastodon-2D)** equiped with low/middle cost sensors => improved spatial and temporal coverage
- **micro-AUVs** deployments in the coastal zone (5-30m) complementary to gliders over the shelf => toward the development of a resident coastal AUV for operational purpose
- **smart observation** on coastal buoys to focus on extreme events while lowering our ecological impact (Costof2 experiment)

# NEXT STEPS

- **use the new data collected (Mastodon2D lines, micro-AUV) :**
  - to improve model initialization and parameterization
  - to provide fine-scale process dynamics (AI-ready FAIR data)
- **toward a full smart observation strategy :**
  - oversampling during events of interest
  - data not stored when no variation to save energy and disc space
  - including all real-time data (buoys, gliders, boats, drifters, satellite, river flow, meteo/oceano model forecasts)
  - connecting observation with operational models

**Coastal ocean coupled model**




**Augmented observations**

**Integration**

**Digital twin of the ocean**