SeaLex - The SEA as a Long term socio-ecological EXperiment

WP3 - Numerical models of past coastal hydrological processes

- 17 novembre 2021 -

ISblue

The interdisciplinary graduate school for the blue planet

Simuler la dynamique 3D du golfe de Gascogne durant différentes périodes caractéristiques de l'holocène

(par exemple: Holocene thermal optimum (9-6 ka BP) versus Neoglacial (from 4.2 ka BP), Bond events)

Afin de contextualiser, interpréter, spatialiser, … les différentes observations (WP2, WP1)

WP3 - Numerical models of past coastal hydrological processes: les objectifs

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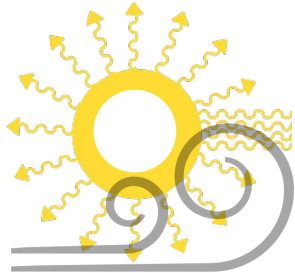(par exemple: Holocene thermal optimum (9-6 ka BP) versus Neoglacial (from 4.2 ka BP), Bond events)

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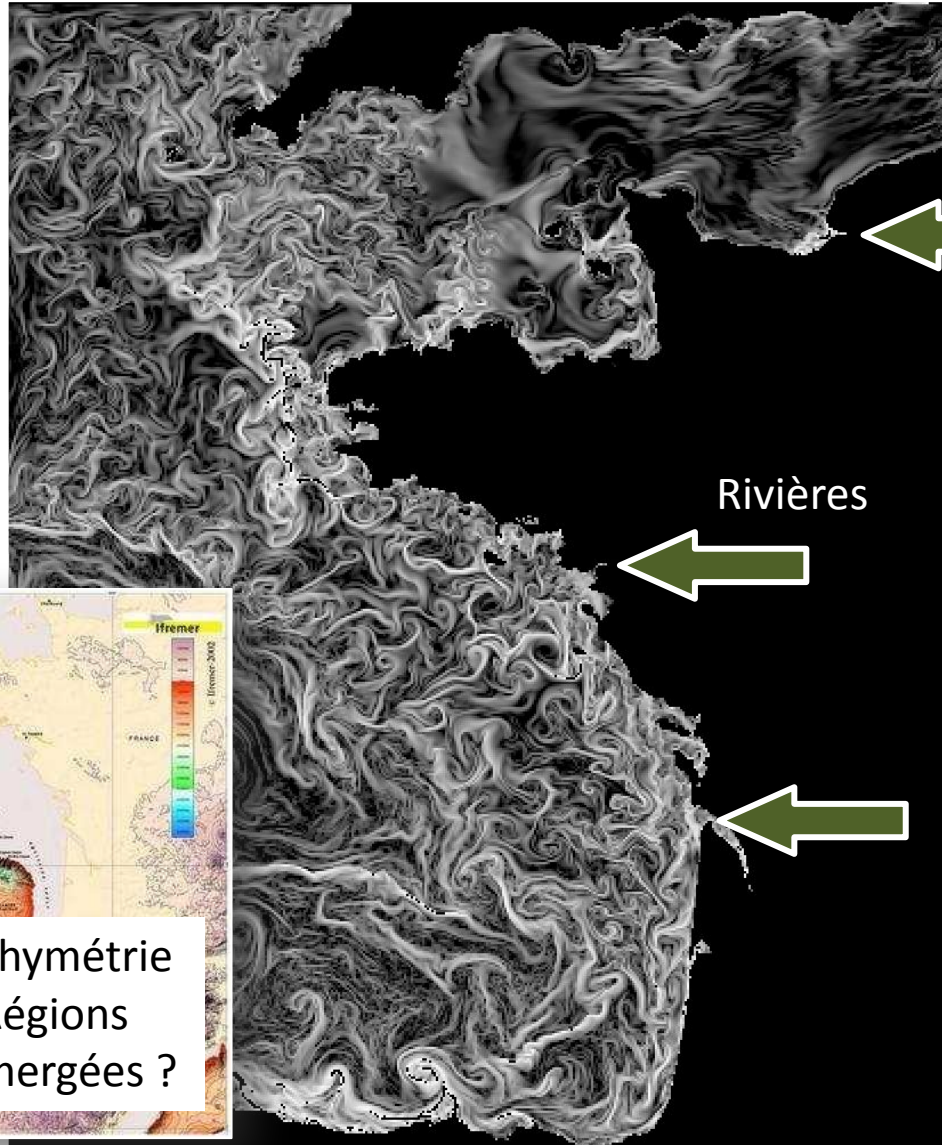
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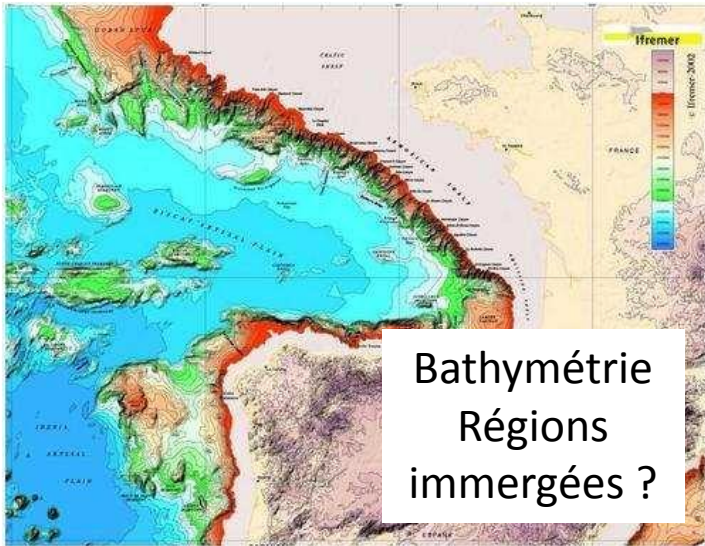
Les ressources (soutien ISblue)**:** post-doc (1 an)

La modélisation hydrodynamique:
les contraintes

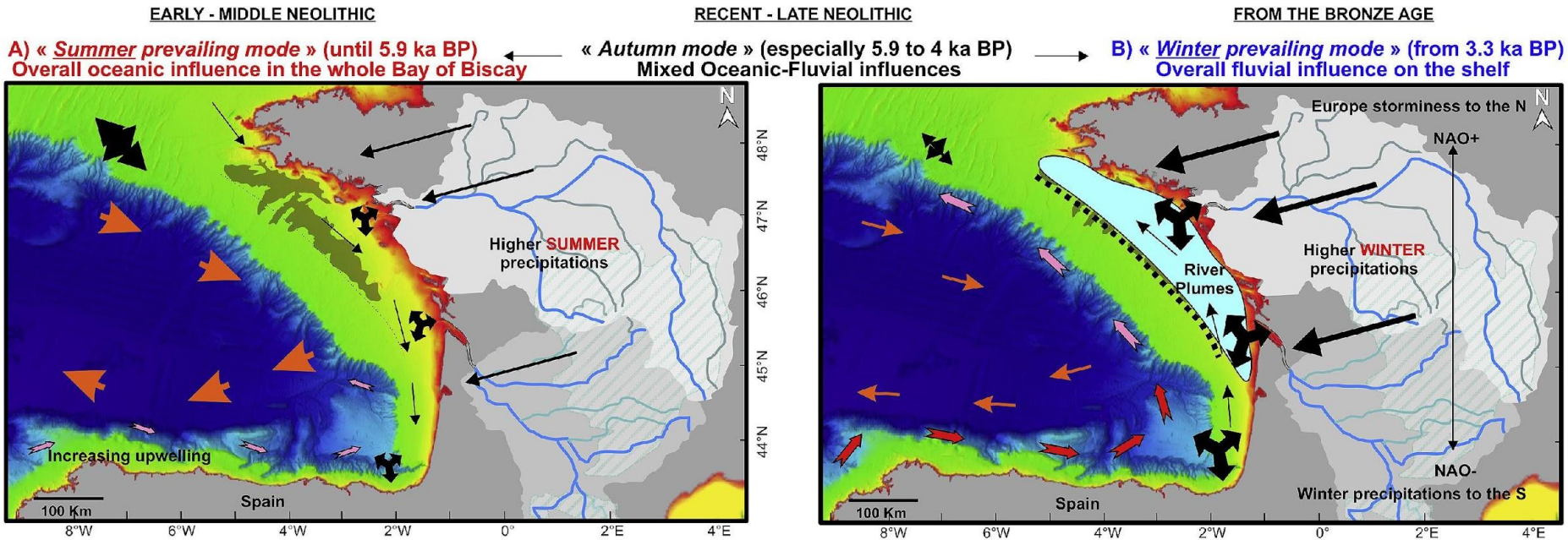Forçages atmosphériques

Dynamique grande échelle

Rivières

Fronts océaniques de surface (CROCO 400m résolution)

Bathymétrie Régions immergées ?

Apport des observations (WP2)

Les observations devront permettre d'affiner les scenarios des simulations
(en complément des connaissances sur ces périodes passées)

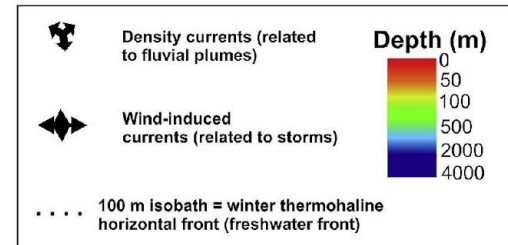(Exemple à partir de données palynologiques - Penaud *et al.,* 2020

Background (Adam Ayouche)

BEFORE

NOW

PHD PHYSICAL OCEANOGRAPHY

Postdoc SEALEX

River plumes in the Bay of Biscay: vertical mixing and instabilities

Past vs Present coastal processes in the Bay of Biscay

Issues

- Understand the influence of past climatological events during the Holocene period (3, 5 & 9 ka BP) on coastal circulation in the Bay of Biscay

- Compare the past and present time dynamics in the Bay of Biscay and the interaction between the general coastal circulation, rivers and the large-scale forcings

Limitations

- Missing informations during the Holocene period such as riverine temperatures, wind activity and the limited available proxies in the Bay of Biscay (e.g. sea temperature, salinity)

- Uncertainties related with the model approximations

How ?
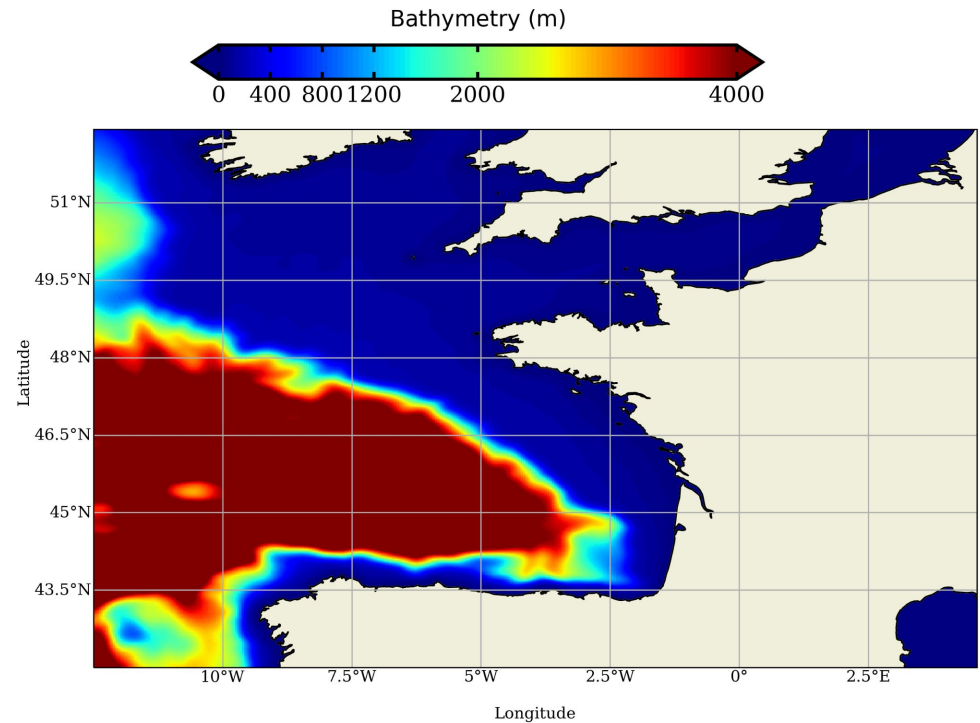
- *Understand the influence past climatological events during the Holocene period (3, 5 & 9 ka BP) on coastal processes in the Bay of Biscay*

- *Compare the past and present time dynamics in the Bay of Biscay and the interaction between the general circulation, rivers and the ambient environment*

01 Numerical modelling

02 Lagrangian floats

Bathymetry (m)

Numerical Modelling

Rivers

4 simulated rivers (Adour, Gironde, Loire, Seine)
River discharge: daily from Banque Hydro France
Temperature and Salinity: Annual from BOBBY CLIM

EMODnet Bathymetry

CROCO

Numerical model solving PE equations

Horizontal resolution: 2.5 km

Vertical resolution : 32 sigma layers stretched at the surface

Bottom friction; Logarithmic drag law

Initial & Lateral conditions

Tracers: Temperature and Salinity
Currents: zonal & meridional
Barotropic: sea surface height
Climatological data or other numerical models
→ Climatological data or other numerical models (hourly, daily or monthly)

Surface conditions

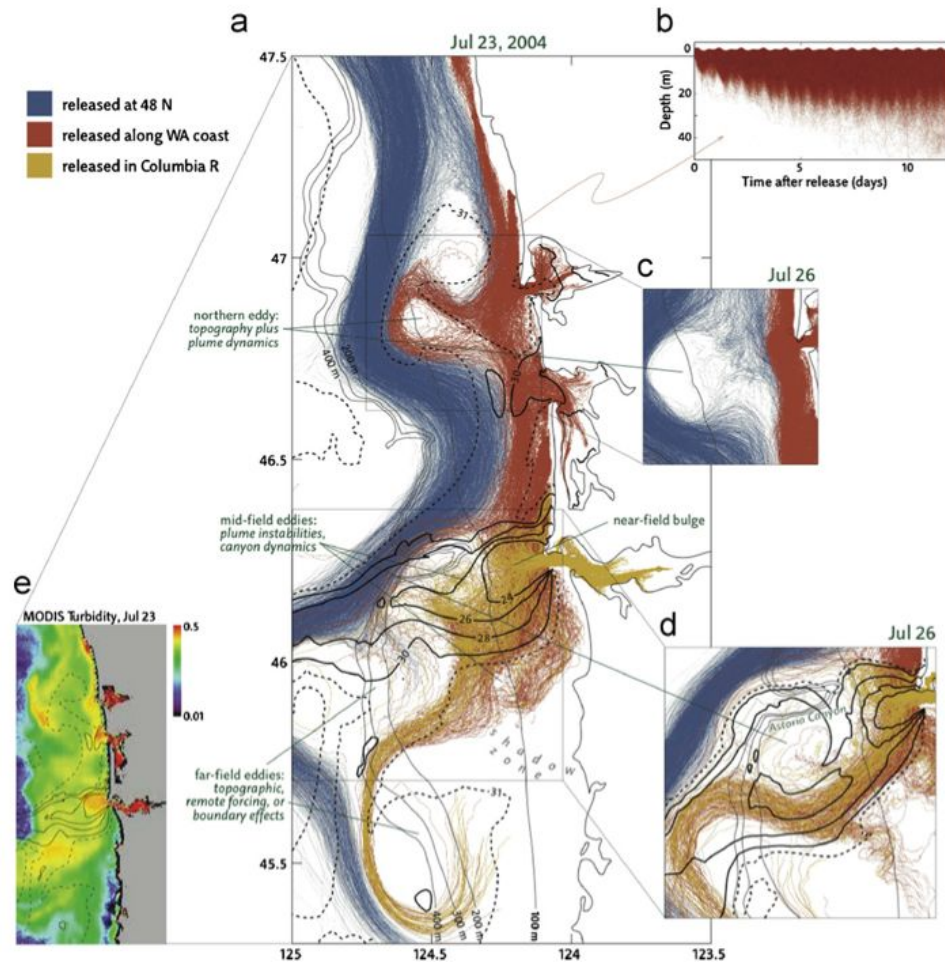**Heat fluxes, precipitations, SST, SSS & SAT (ERA-Interim)**

frequency: hourly, daily or monthly

Lagrangian floats

Lagrangian floats (OceanParcels)

3D Advection of Water parcels using numerical model outputs (flow fields)

3D Advection of Water parcels using numerical model outputs (flow fields)

Columbia River

Banas et al. CSR 2009 - https://www.sciencedirect.com/science/article/pii/S027843430800 1052

Outputs: lagrangian floats positions and depths (x,y,z)

Fig. 3. Looped-flow particle trajectories from July 23 (a) and July 26 (insets c,d). Thin black contours show the bathymetry (100, 200, 300, 400 m) and thick black contours surface salinity (24, 26, 28, 30 psu as solid lines; 31 psi as a dotted line: compare Fig. 2b). The Washington-coast-release particles from July 23 (a, red trajectories) are also shown in a depth-vs.-time plot (b). A satellite image of turbidity from July 23 (courtesy of R. Kudela, http://oceandatacenter.ucsc.edu/RISE/) is also shown (e), with salinity contours from (a) overlaid for comparison.

Strategy

I. **4 years of spin-up** for the past (3 ka, 5 ka & 9 ka BP) & present (2008) time

    The past simulations are based on Air (Baldini et al., 2019) & Sea surface temperatures differences (MD95-2002 & PP10-07 records), past precipitations (VK0358bis record & Baldini et al., 2019), Relative sea level (Penaud et al., 2020) & Insolation at 47°N
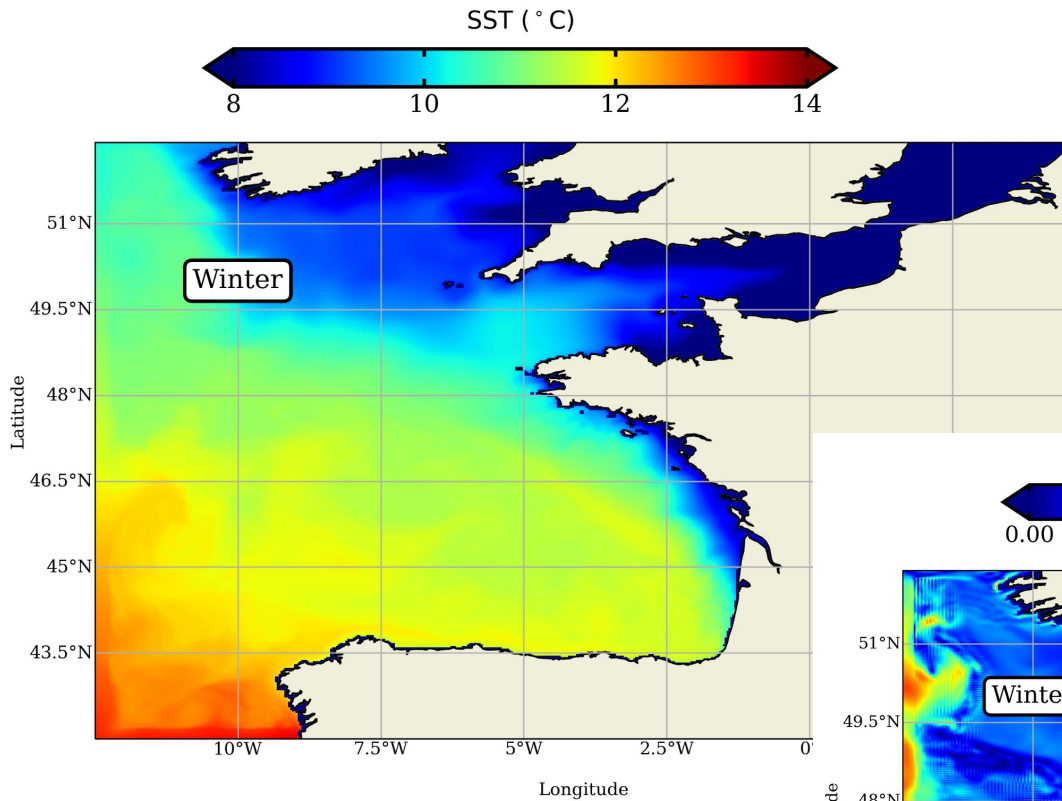
    Run on datarmor HPC (MPI 16*28 ~ 448 procs → 22 h walltime)

II. **Simulated Fifth year** daily outputs for the past & present time

    Run on datarmor HPC (MPI 16*28 ~ 448 procs → 7 h walltime & 277 GB storage)

III. Run **OceanParcels** on daily numerical model outputs from different positions (Adour, Gironde, Loire, Iberian Poleward Current) ~ 20000 parcels (Run on eos HPC → 2 h walltime & 1GB storage)
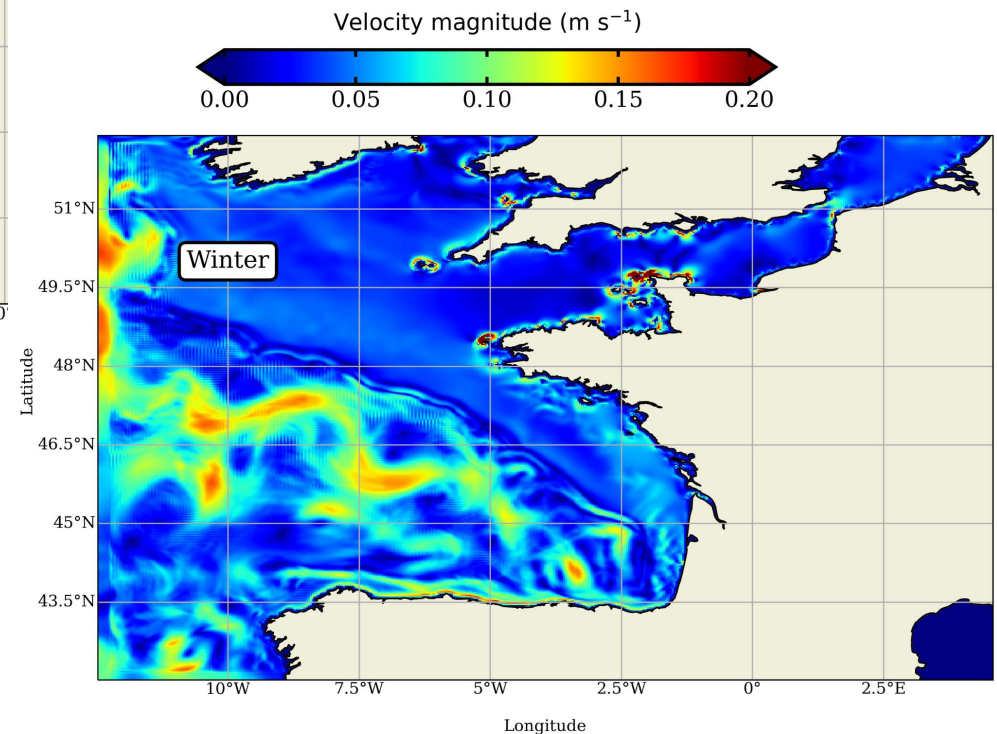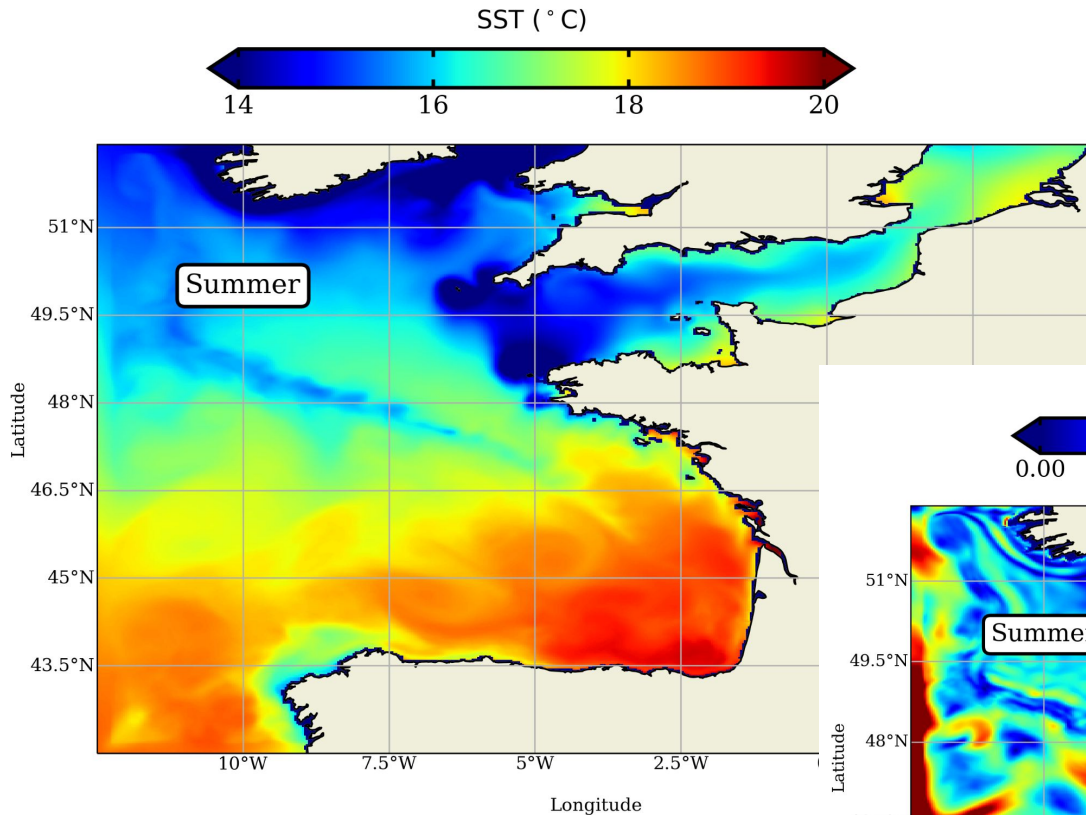
Some results (Present 2008 - Winter)

Moderate river discharge > 1000 m3/s

Density currents intensified in winter due to the Loire and Gironde runoffs

Moderate/weak turbulent activity (IPC and the deep part of the Bay of Biscay)
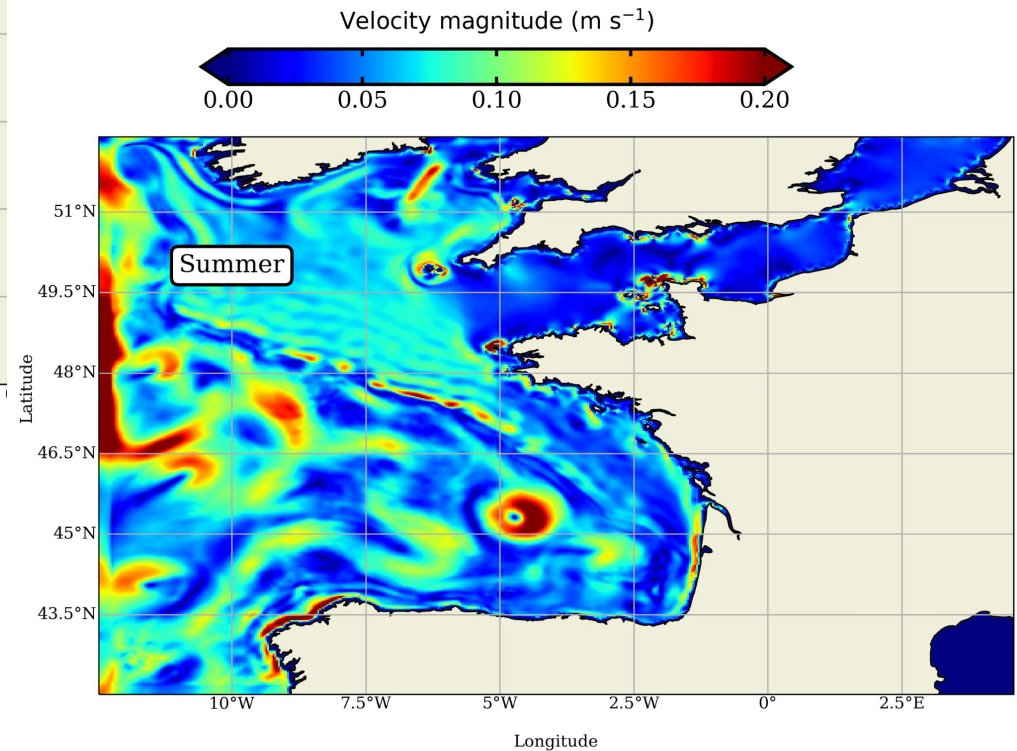
Some results (Present 2008 - Summer)

SST (°C)

Summer

Velocity magnitude (m s^{-1})

Summer

Weak river discharge < 200 m3/s

Density currents weakened in summer due to the Loire and Gironde runoffs

Strong/Moderate turbulent activity (IPC and eddies in the deep part of the Bay of Biscay)

Lagrangian floats (Iberian Poleward Current)

Perspectives

❖ **Validation** of the present time numerical model using in-situ observations (SST, ADCP currents) → Quantify the uncertainties of the numerical model.

❖ Simulations of the Bay of Biscay during the **Holocene periods** using Temperature proxies, Net Heat fluxes and precipitations amount (linked to river discharge).

❖ **Dispersion and concentration of lagrangian floats** for the present and past events and their link to surface conditions (SST, SAT, Heat fluxes, RSL) and river discharge intensity.

Merci pour votre attention !