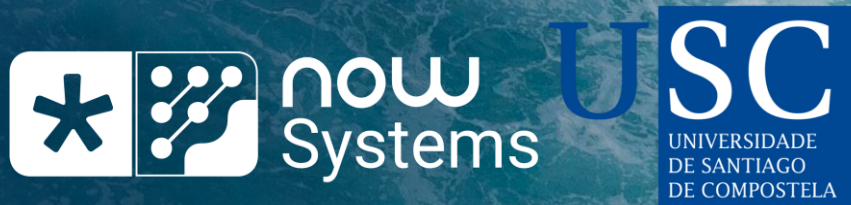


AGORA

Advanced Forecasting in Galicia: Preserving the Ocean and its Resilience

Lagrangian transport model sensitivity to wave–current interaction processes



AXENCIA
GALEGA DE
INNOVACIÓN

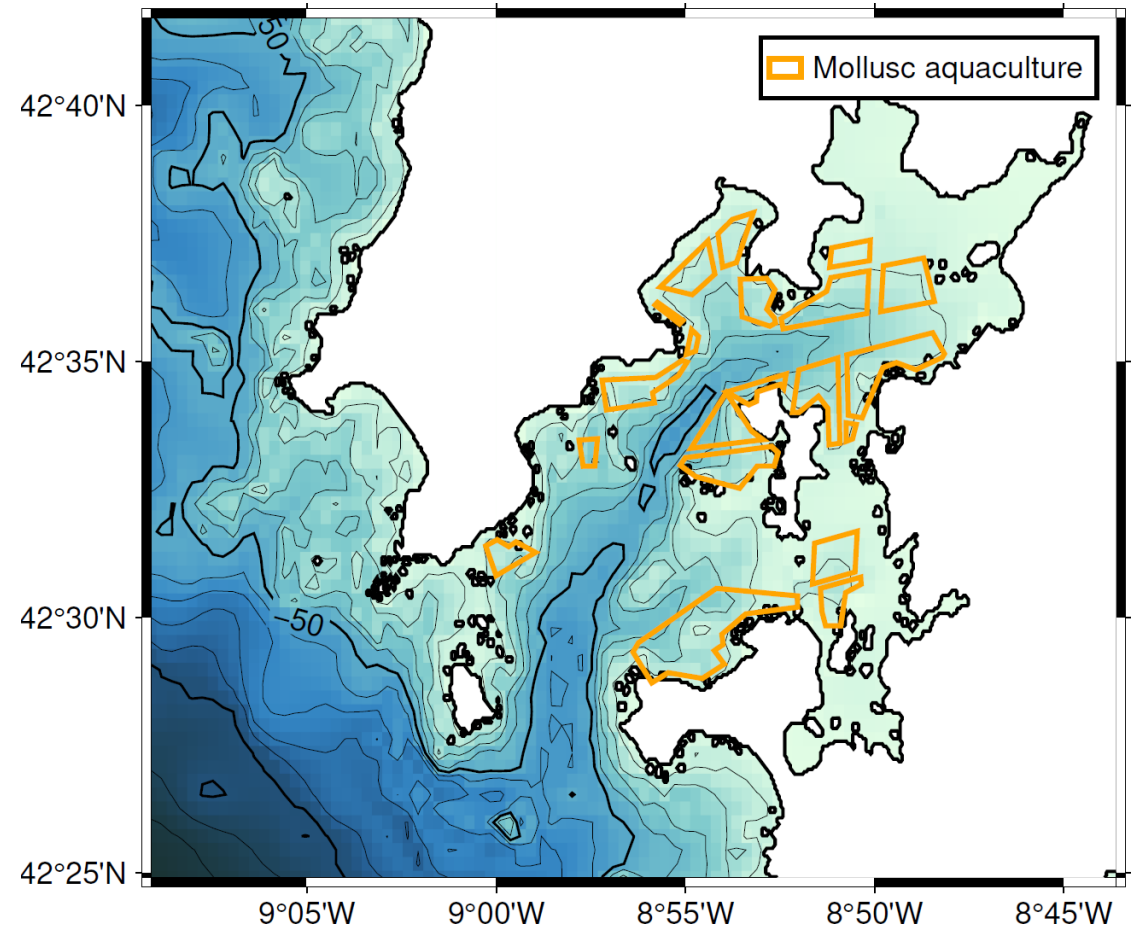
Programa de Doutoramentos industriais 2023

Arousa Estuary

Highly productive system

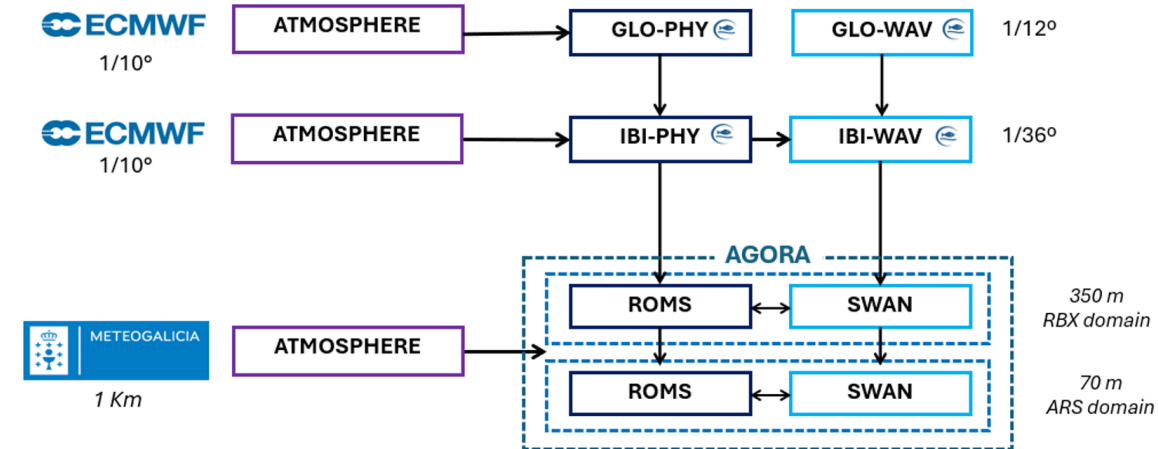
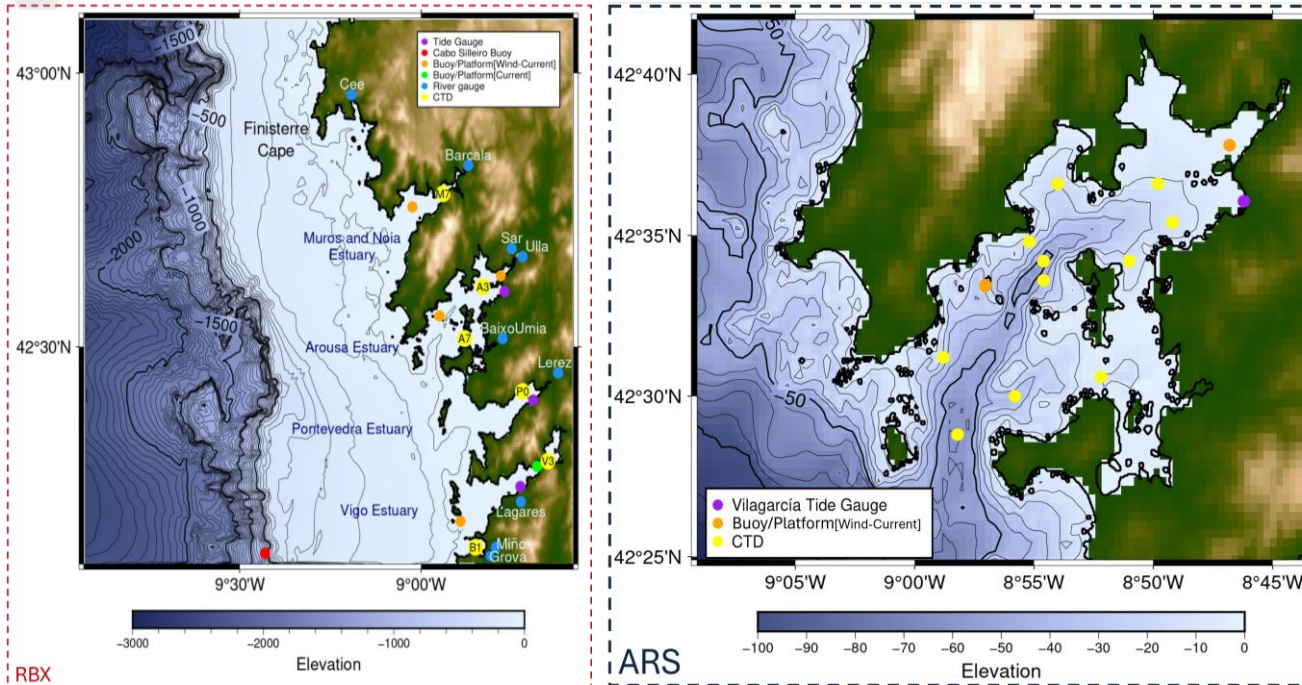
High organic carbon loading

Low diversity and biomass of
benthic community



The use of **modelling systems** makes it possible to analyse and optimise the **drainage plans**.

AGORA forecasting system



Focused on accurately reproduce:

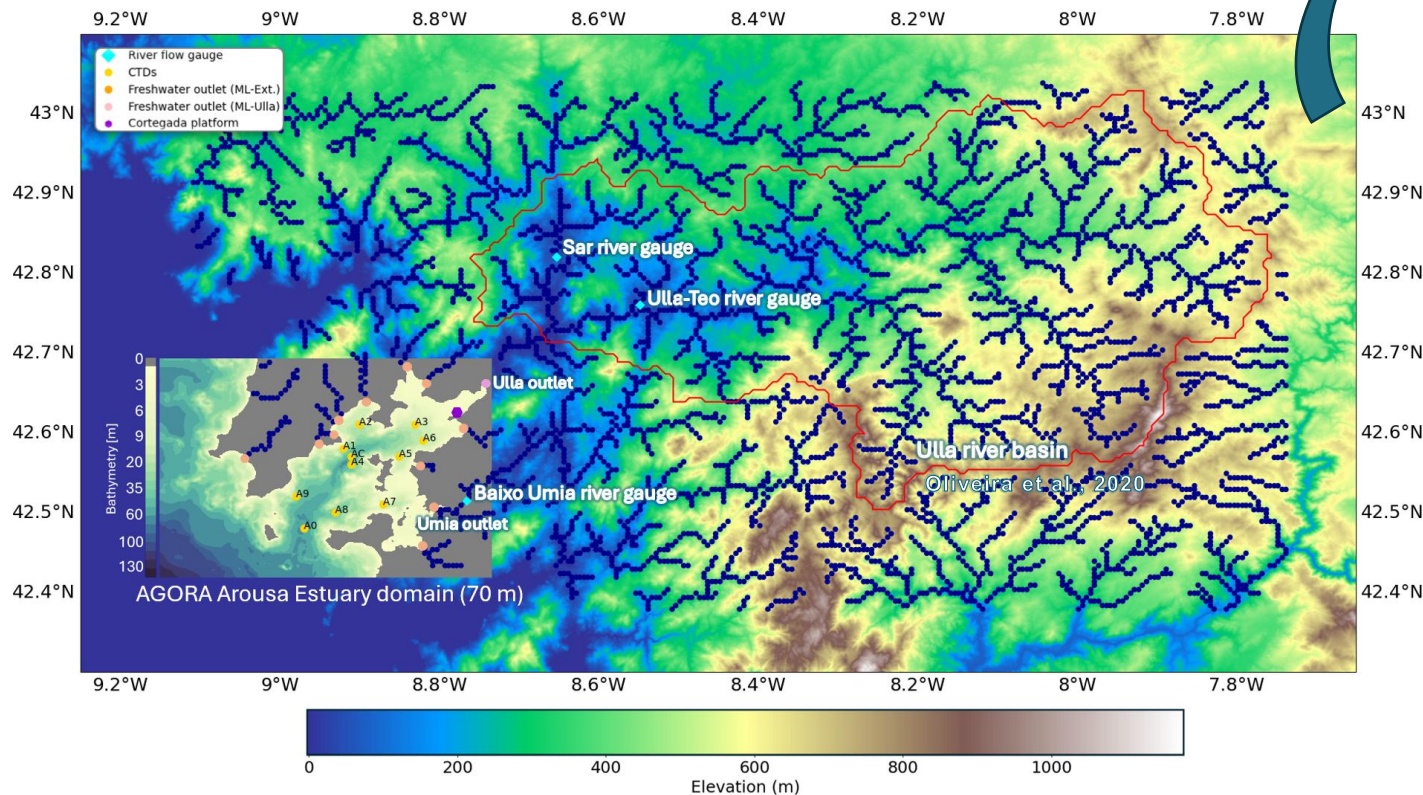


Coastal freshwater runoff

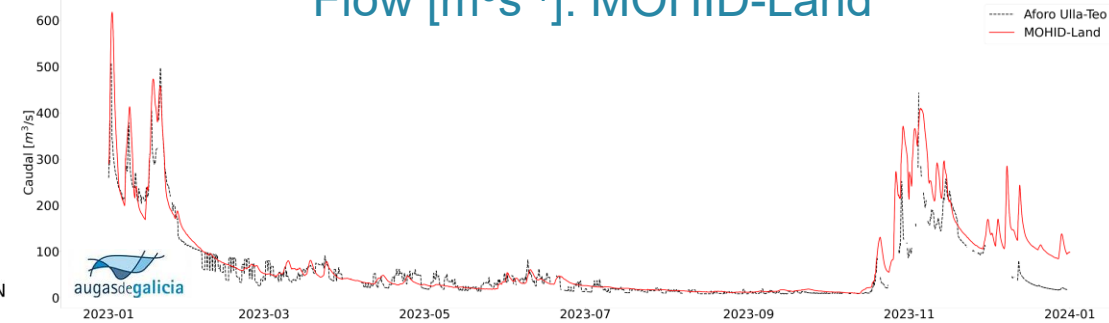


Wave-current coupling (COAWST – Warner et al., 2010 –)

Freshwater coastal runoff forcing



Flow [m^3s^{-1}]: MOHID-Land

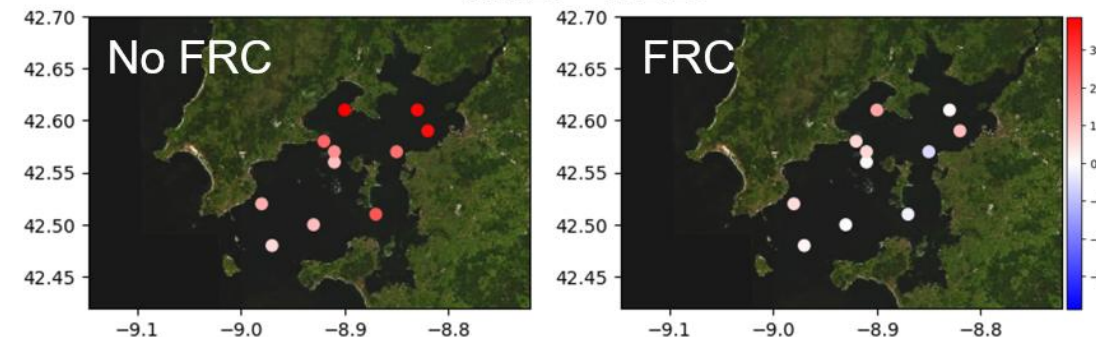


Forcing water properties:

- Temperature [$^{\circ}\text{C}$]: Nearest CTD surface value
- Salinity : 0.5 PSU



Salinity bias at 3m [PSU]
10/2023 – 12/2023



Impact on AGORA salinity solution →



Wave-Current interactions



Wave induced processes significantly **impact forecasting accuracy**, specially during **extreme events**

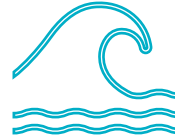
- Wave-induced Stokes drift (Polton et al. 2005; Röhrs et al. 2012).
- Modulation of transfer from atmosphere to ocean (Komen et al. 1994, Wu et al. 2019)



Intense tidal currents affects propagation terms (Ardhuin et al. 2012, 2017).

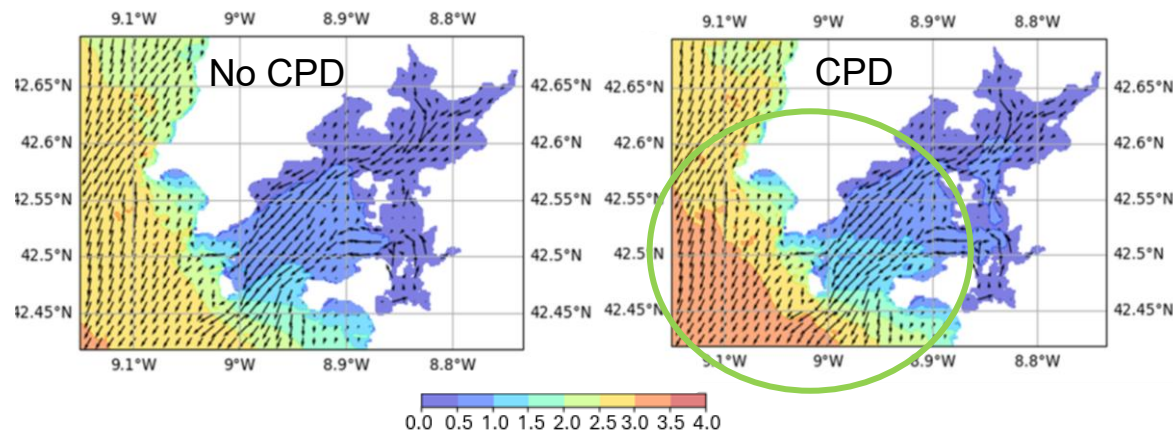
- Current-induced refraction
- Frequency shifting of sea swell
- Wave breaking

AGORA Wave-Current coupling

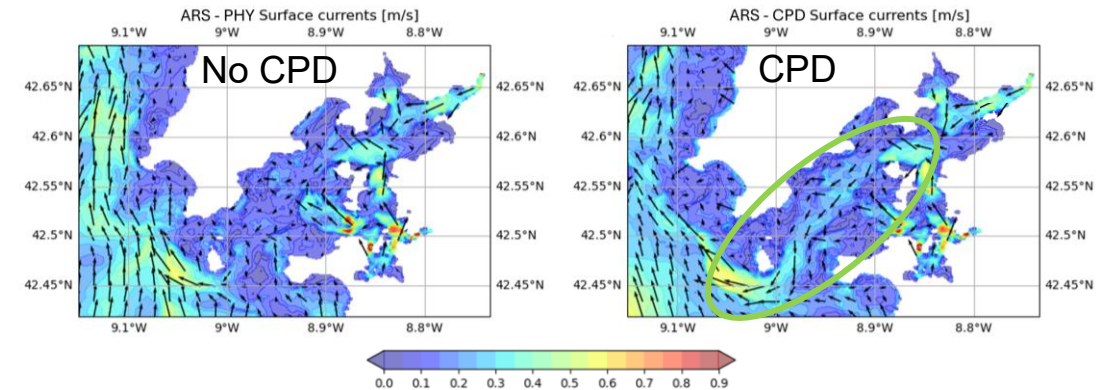


- **Stokes drift** calculated from full spectrum OBC (Spectrum reconstruction Kumar et al., 2017)
- Influence of **waves** in bottom friction and, hence, **bottom stress**. (Styles and Glenn 2000)
- **Vortex force** formalism (Kumar et al., 2012). Realistic representation in shoaling regions.
- **Lin&Sheng** (Lin and Sheng 2020) implementation. **Sea surface roughness correlates more strongly with wave age** than with wave steepness.

Significant wave height [m]



Sea surface currents [m/s]



Next step: Lagrangian transport model sensitivity to coupling effects



How does the inclusion of waves impact the particle solution?



What is the relative impact of Stokes drift and wave-driven Eulerian currents?

$$\begin{array}{l} \text{Particle velocity} = \underbrace{\text{Eulerian current velocity}}_{\text{ROMS}} + \text{Stokes drift in the direction of wave propagation} + \text{Non-linear and wave-current interacting processes} \\ \underbrace{\hspace{10em}}_{\text{ROMS + SWAN (standalone)}} \\ \underbrace{\hspace{15em}}_{\text{COAWST}} \end{array}$$

Next step: Lagrangian transport model sensitivity to coupling effects

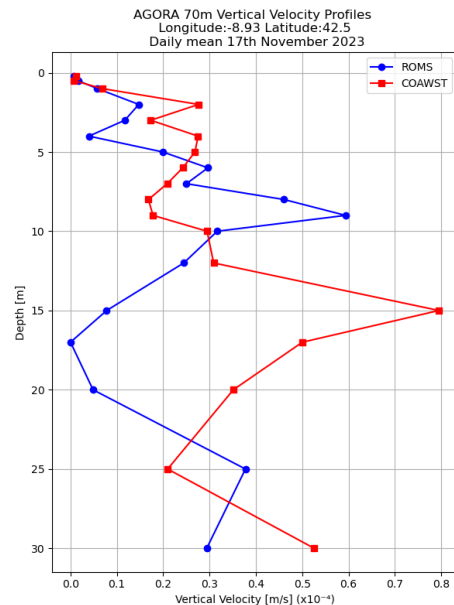


How does the inclusion of waves impact the particle solution?



What is the relative impact of Stokes drift and wave-driven Eulerian currents?

Particle velocity = Eulerian current velocity + Stokes drift in the direction of wave propagation + Non-linear and wave-current interacting processes



ROMS

ROMS + SWAN (standalone)

COAWST

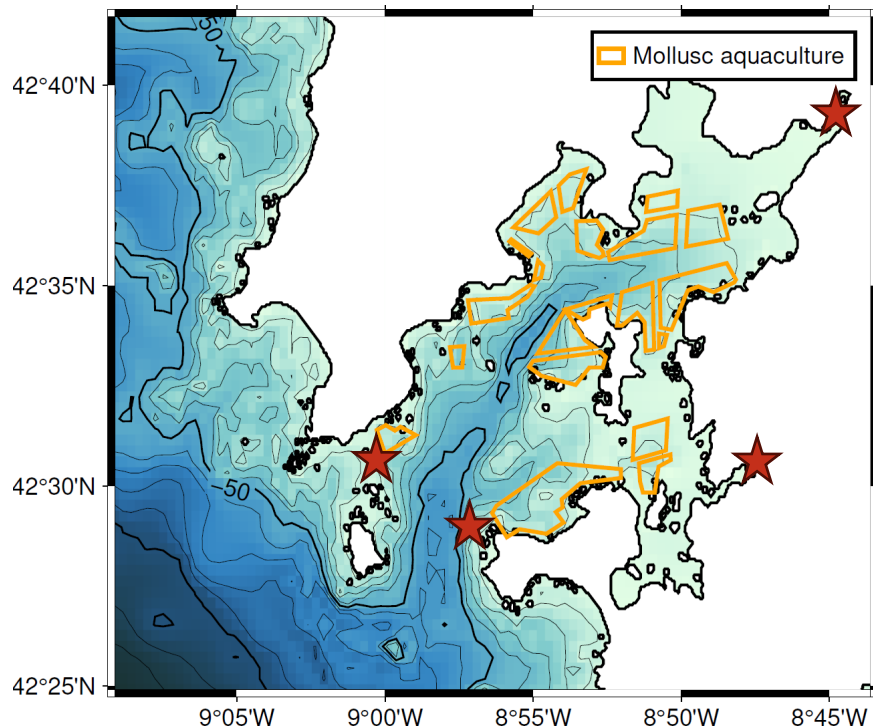
Next step: Lagrangian transport model sensitivity to coupling effects



How does the representation of waves impact the particle solution?

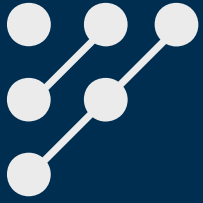


What is the relative impact of Stokes drift and wave-driven Eulerian currents?



Special focus on resuspension

- Two types of particles (less and more density than water)
- Four particle source's locations ★
- Simulation period: Last quarter 2023
 - Succession of severe storms, with westerly swells.
 - Spring tides.
 - Heavy coastal runoff.



Thank you!

