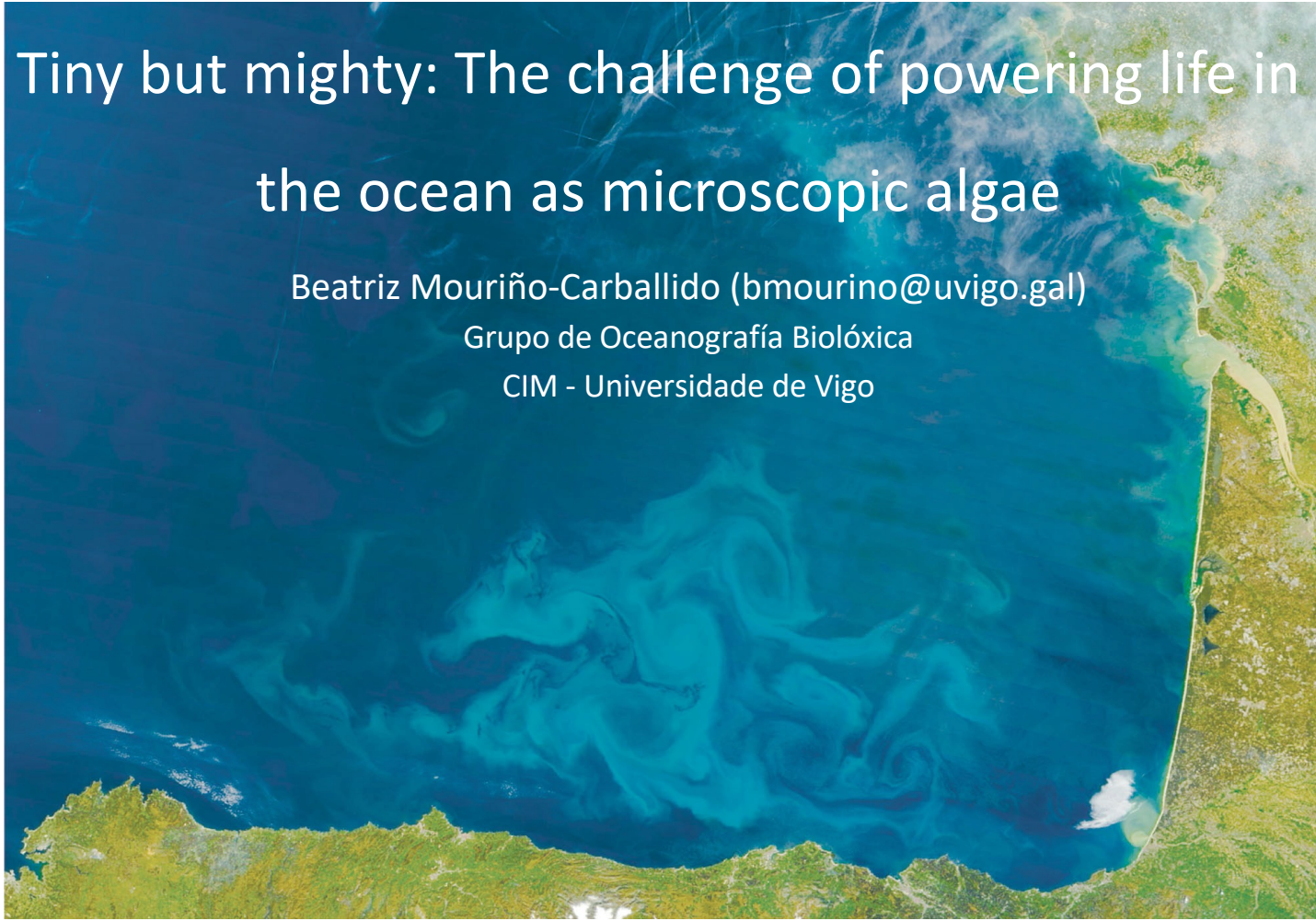




Tiny but mighty: The challenge of powering life in the ocean as microscopic algae

Beatriz Mouriño-Carballido (bmourino@uvigo.gal)

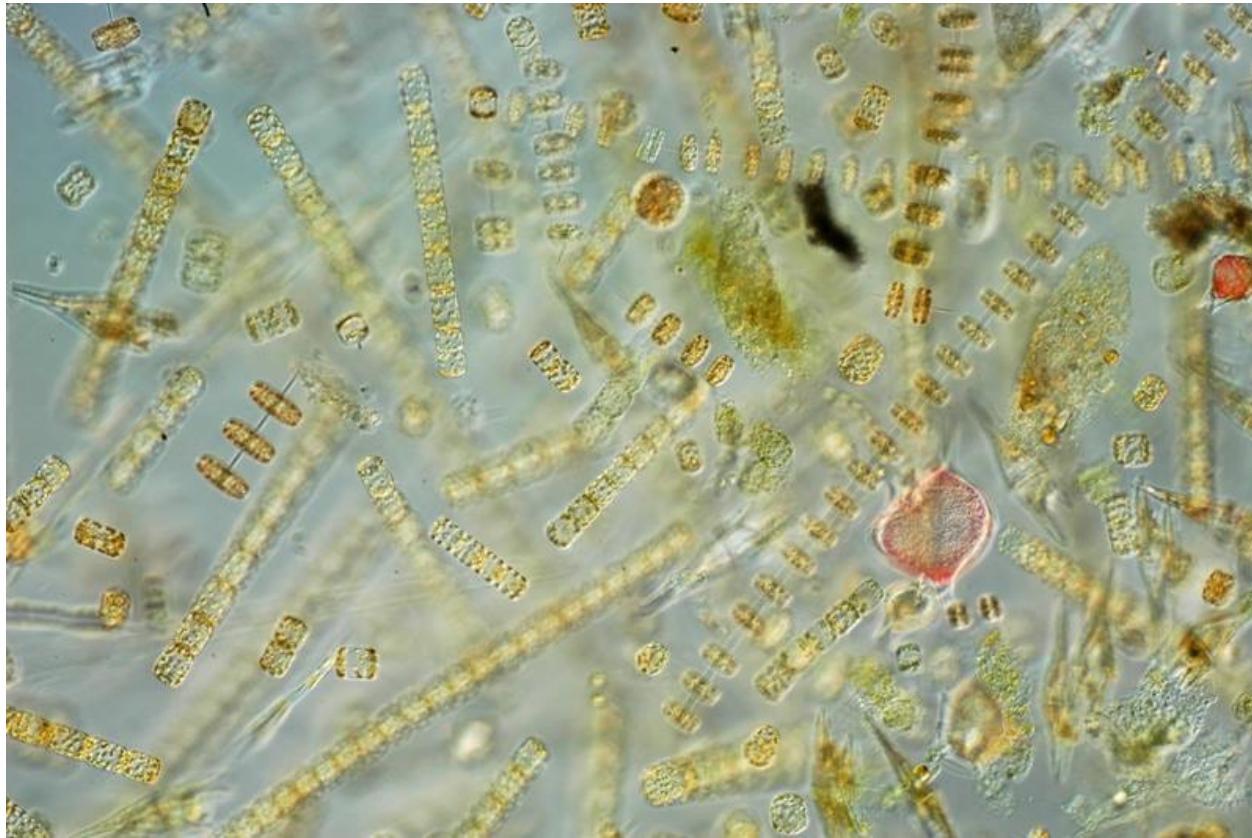
Grupo de Oceanografía Biológica

CIM - Universidade de Vigo

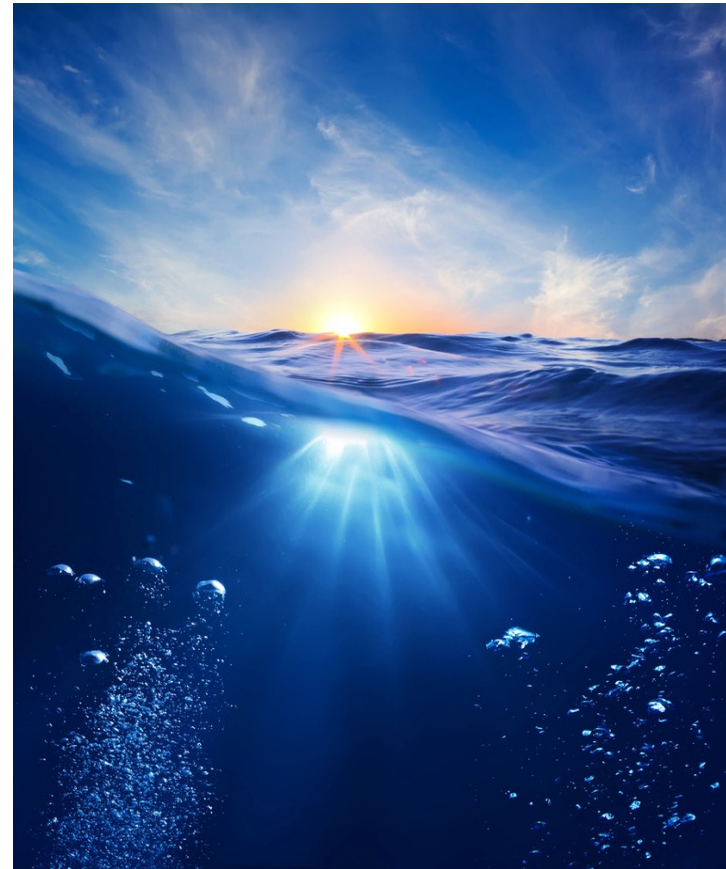
More than just a “hot” tourist destination



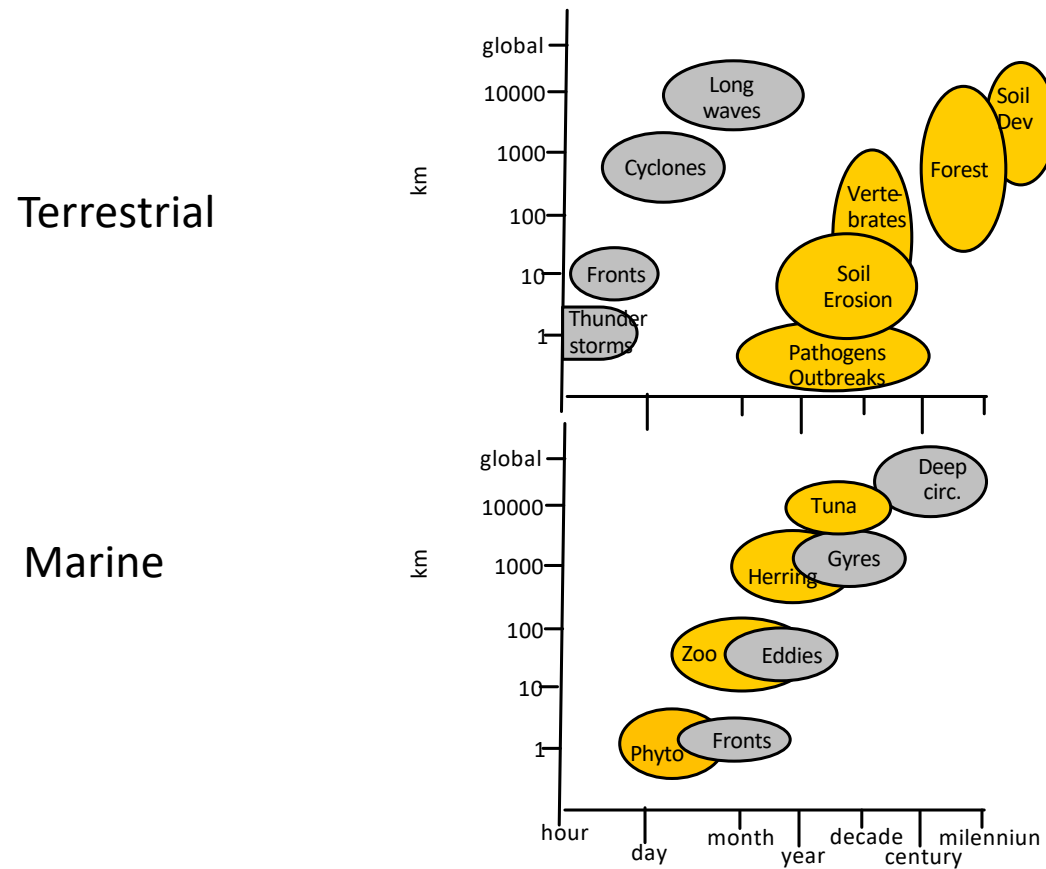
Tiny but mighty



How does your life compare to that of a tree?

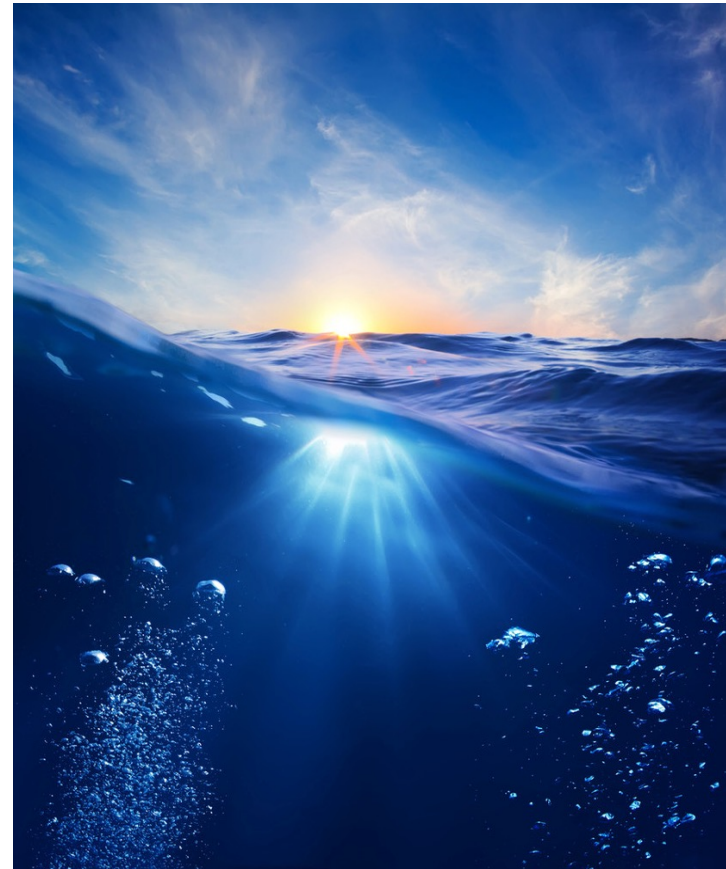


Living at different scales: marine vs. terrestrial ecosystems



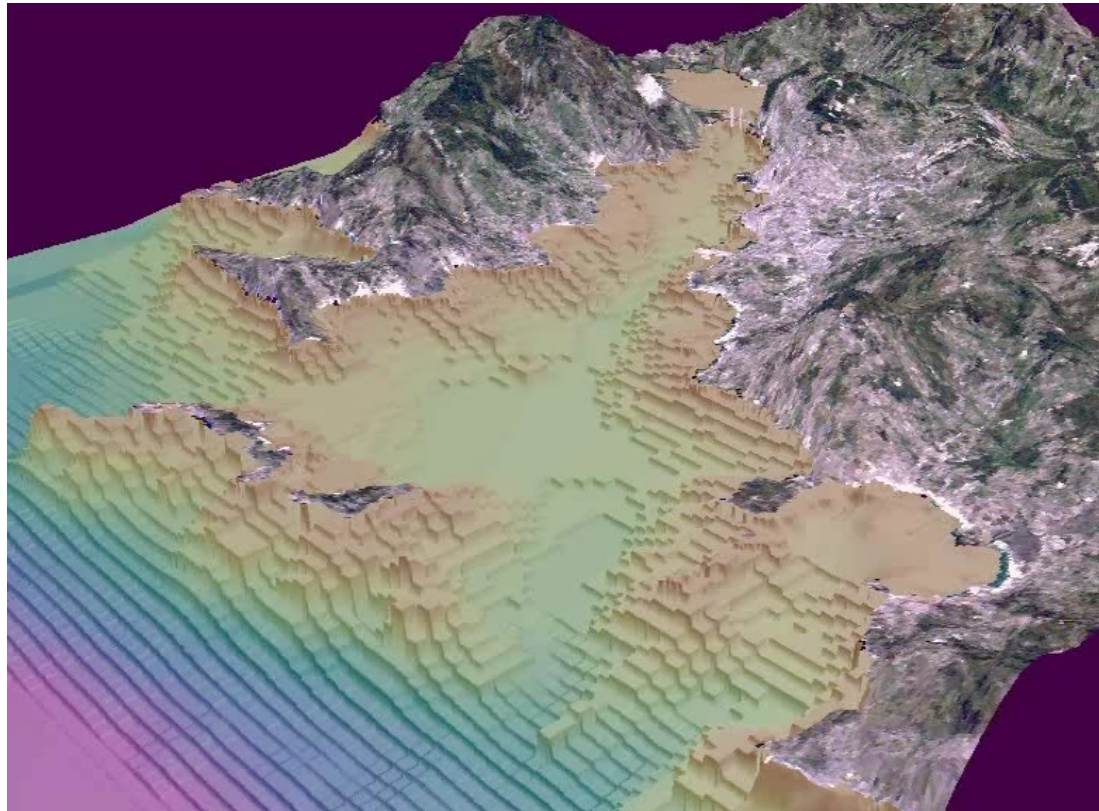
Marine ecologists need to care about oceanography, and
oceanographers need to fall a little in love with ecology

How does your life compare to that of a tree?

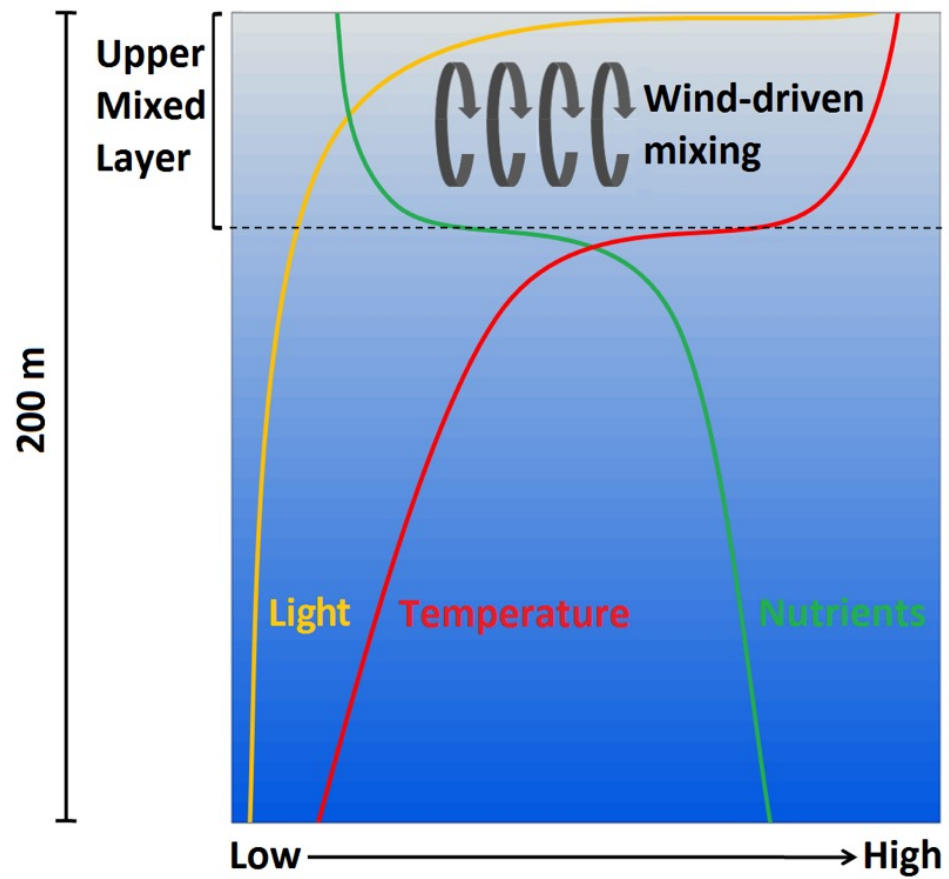


A 3D world in motion

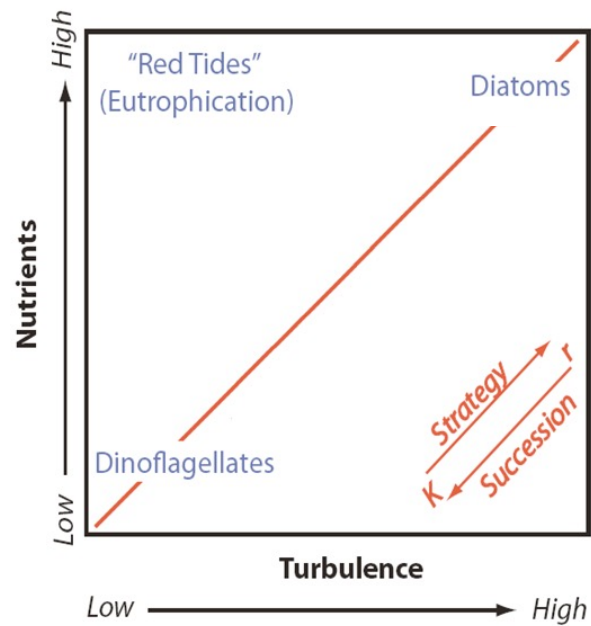
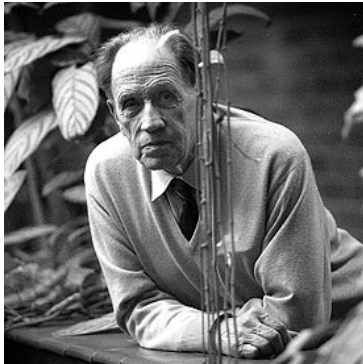
Numerical simulation of drifting buoys by Carlos Souto Torres (UVIGO)



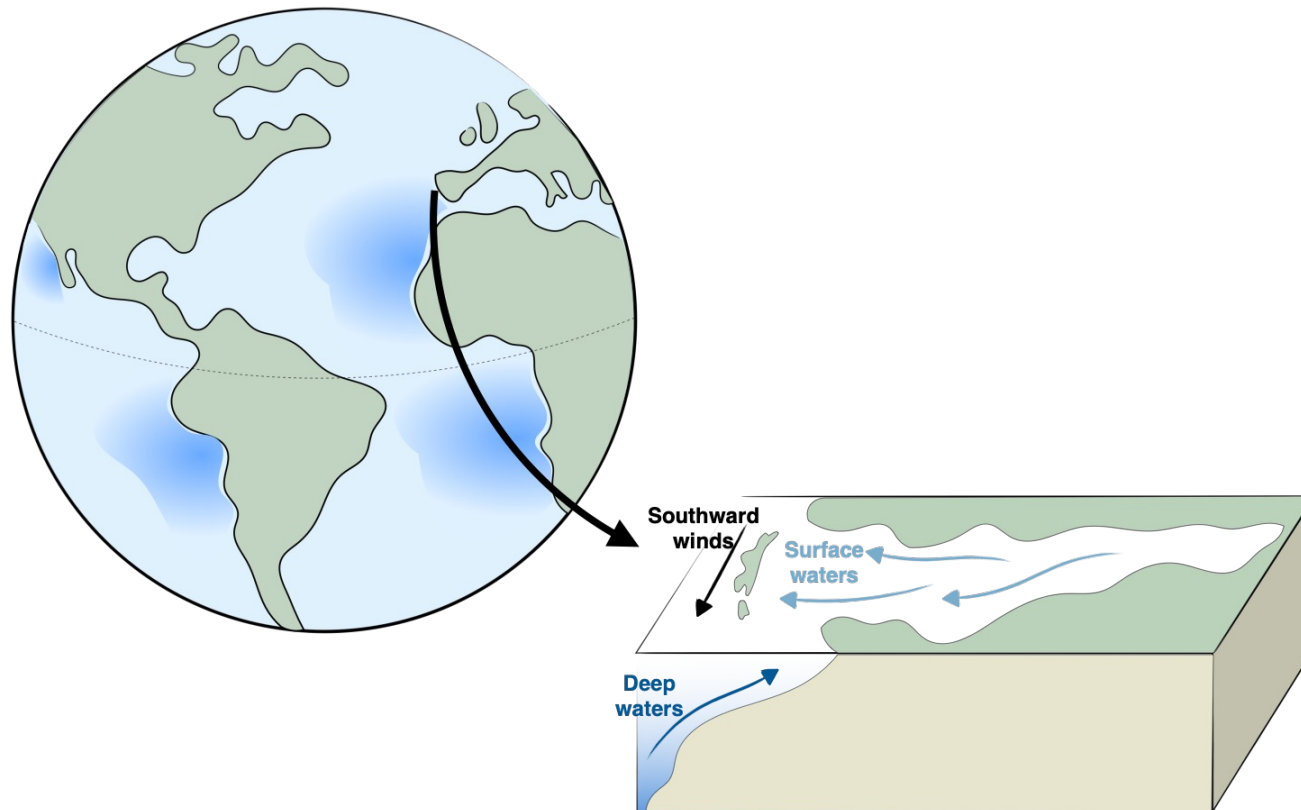
The vertical challenge



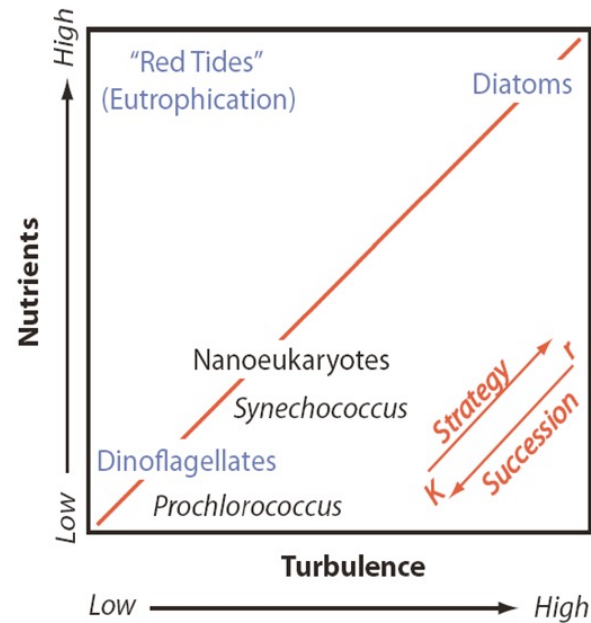
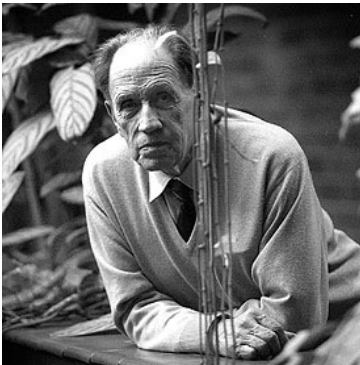
The mandala of Margalef (1978)



Natural laboratories of productivity

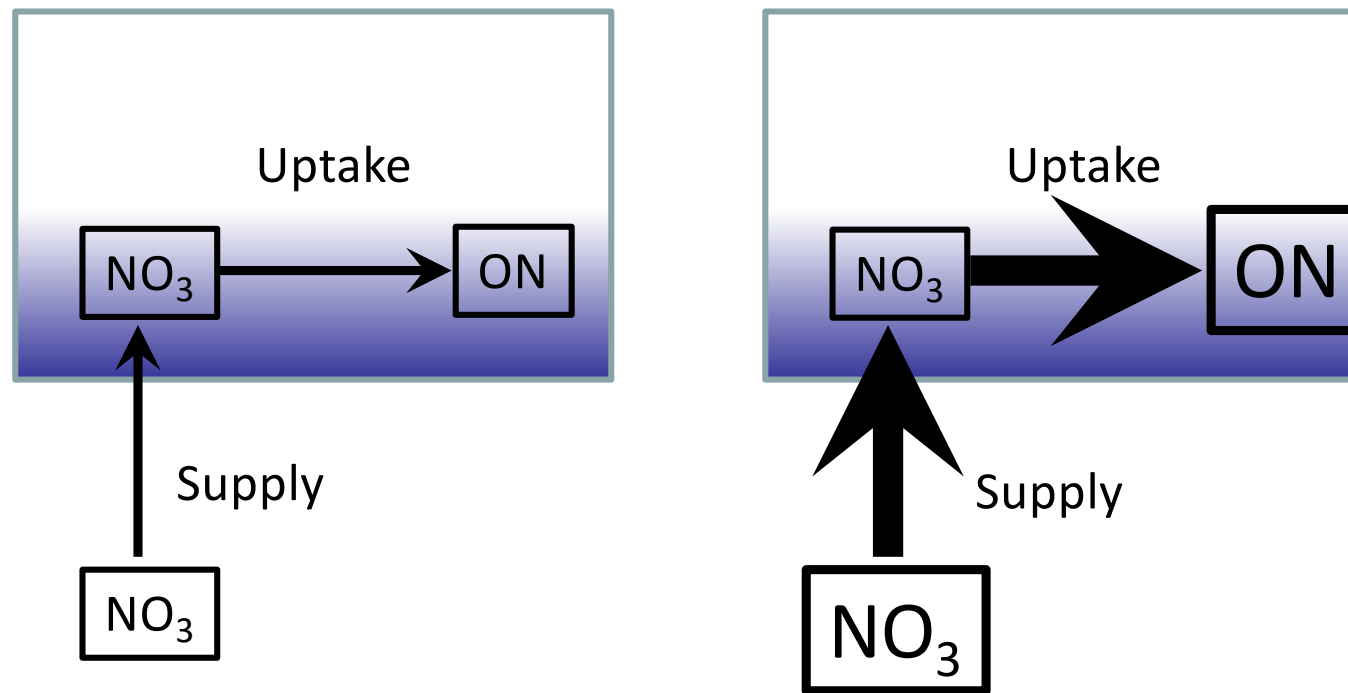


Limitations of the mandala



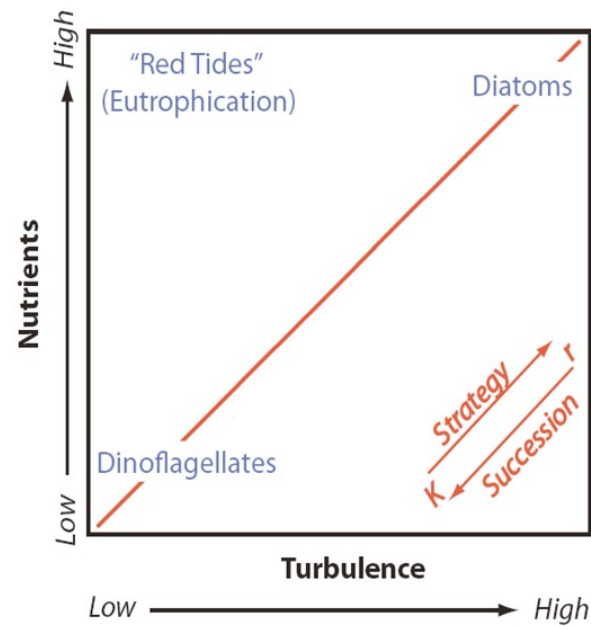
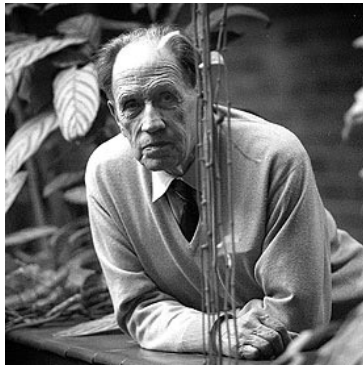
The smaller picophytoplankton ($\sim < 2 \mu\text{m}$) groups were not included in the original diagram

Nutrients in the ocean: concentration $\neq$ supply



Nutrient concentrations don't tell us how much is being delivered

Limitations of the mandala



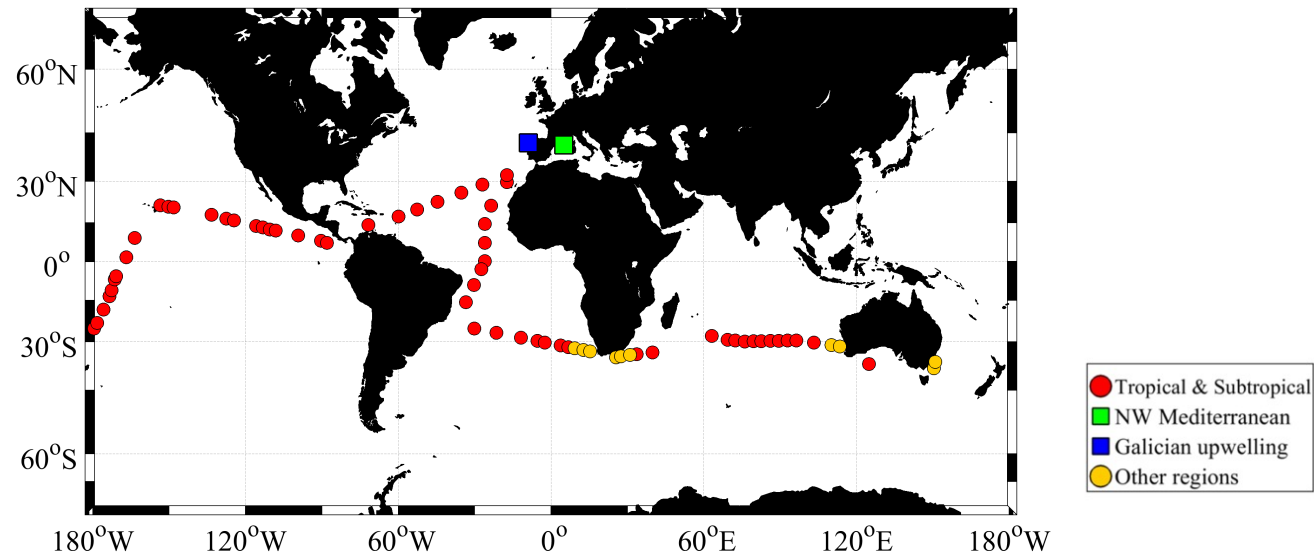
It's hard to measure how well the ocean mixes

Revisiting classic models with new tools



Drawn by Miquel Alcaraz (CSIC-Barcelona)

Testing the mandala for the whole phytoplankton community



- 102 stations
- Microturbulence
- Nitrate concentration
- HPLC pigments

Biomass (% chl-a)

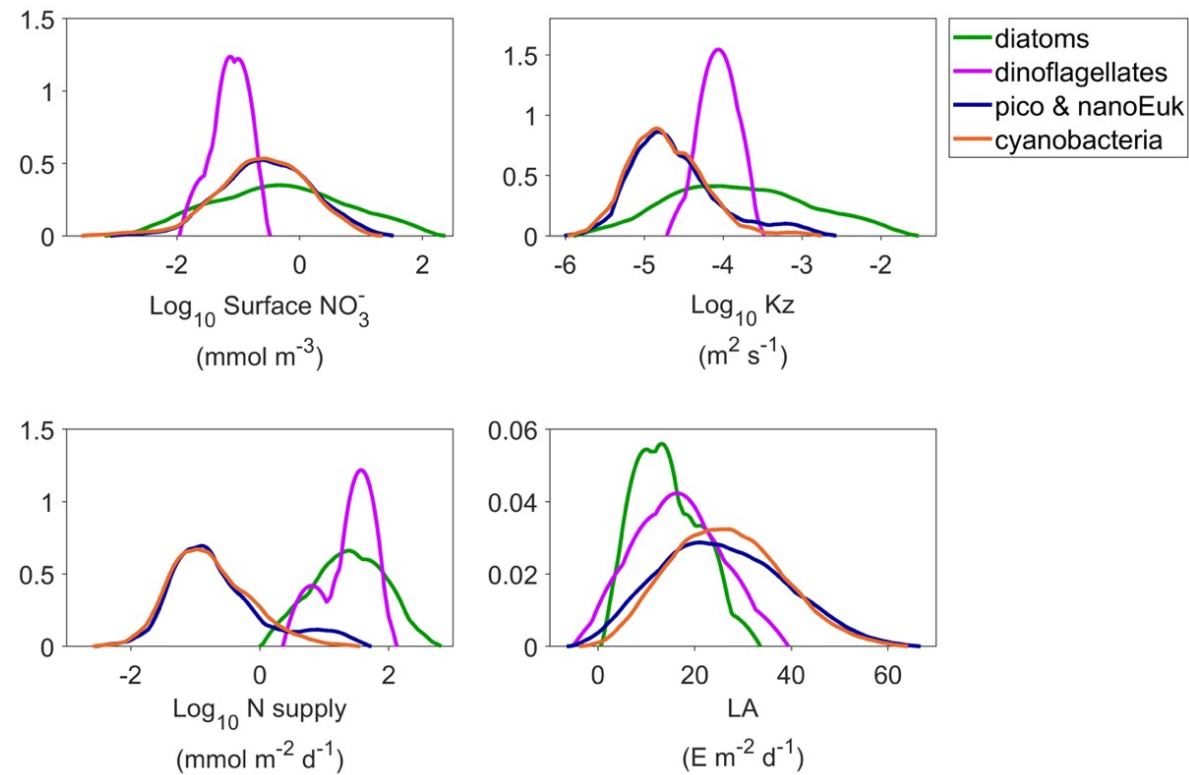
Diatoms
Dinoflagellates
Pico- & nanoeuk
Cyanobacteria

Opening the black box: measuring what phytoplankton really experience



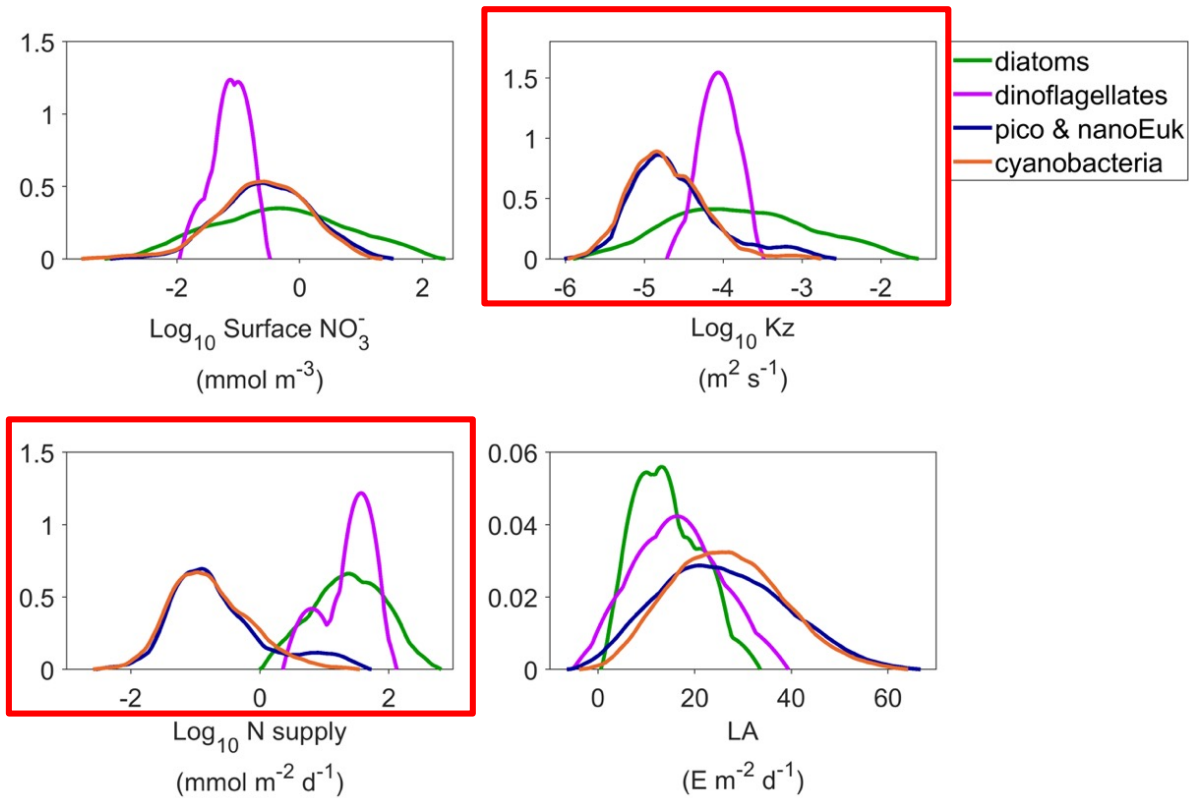
What did we find?

Mapping niche occupation

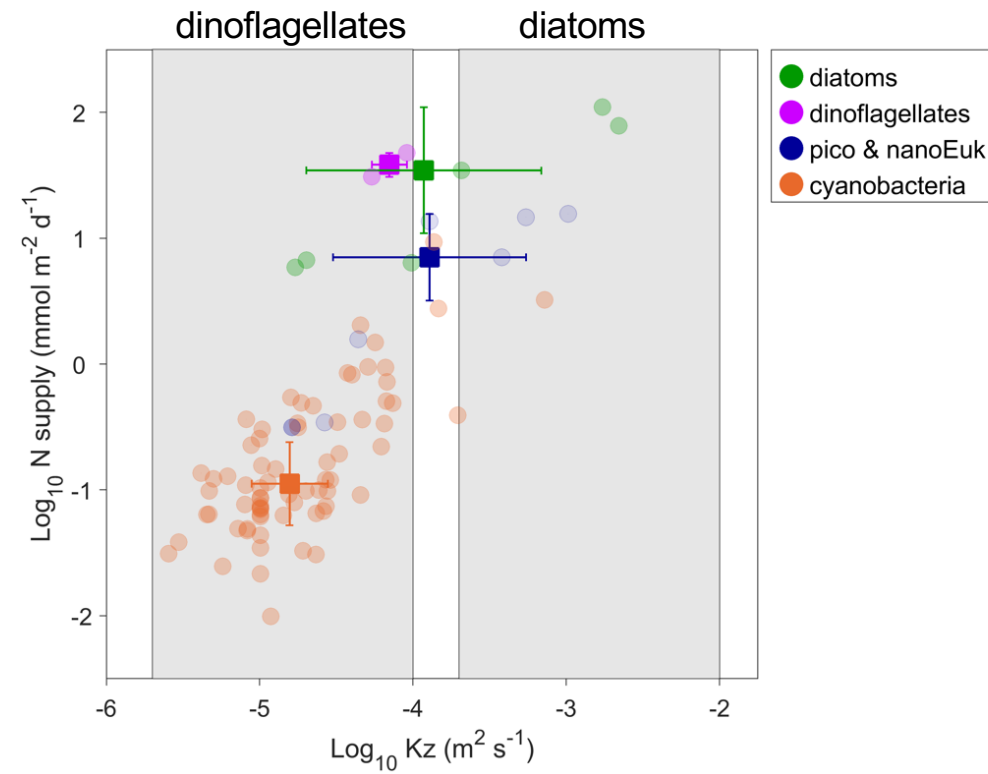


Villamaña V., Cermeño P., Estrada M., Fernández-Castro B., Figueiras F.G., Latasa M., Otero-Ferrera J.L., Reguera B., Marañón E., Mouriño-Carballido B. (2019). The role of mixing in controlling resource availability and phytoplankton community composition. *Progress in Oceanography*, 178, <https://doi.org/10.1016/j.pocean.2019.102181>

Mapping niche occupation

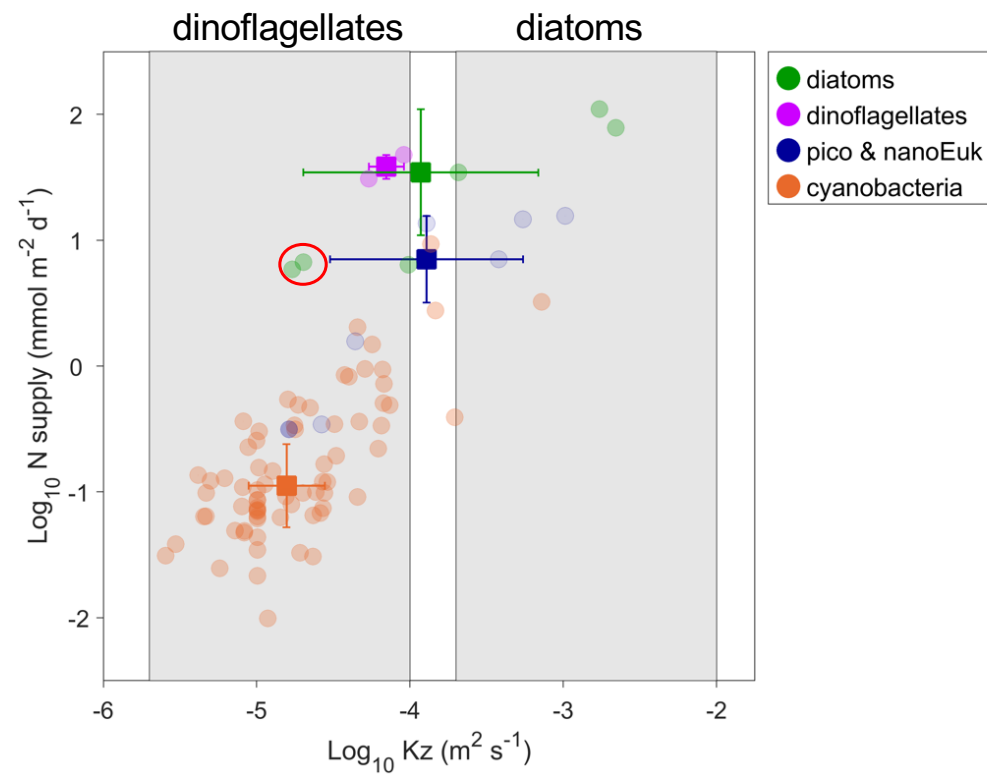


Revisiting the mandala of Margalef



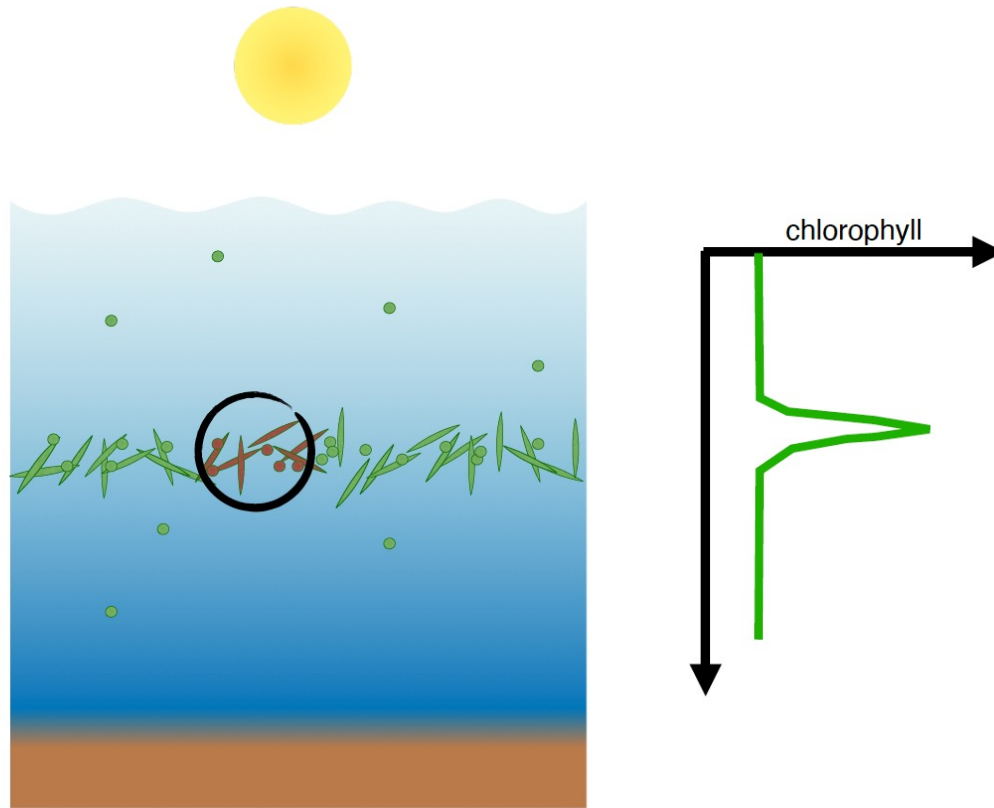
Villamaña V., Cermeño P., Estrada M., Fernández-Castro B., Figueiras F.G., Latasa M., Otero-Ferrera J.L., Reguera B., Marañón E., Mouriño-Carballido B. (2019). The role of mixing in controlling resource availability and phytoplankton community composition. *Progress in Oceanography*, 178, <https://doi.org/10.1016/j.pocean.2019.102181>

Revisiting the mandala of Margalef

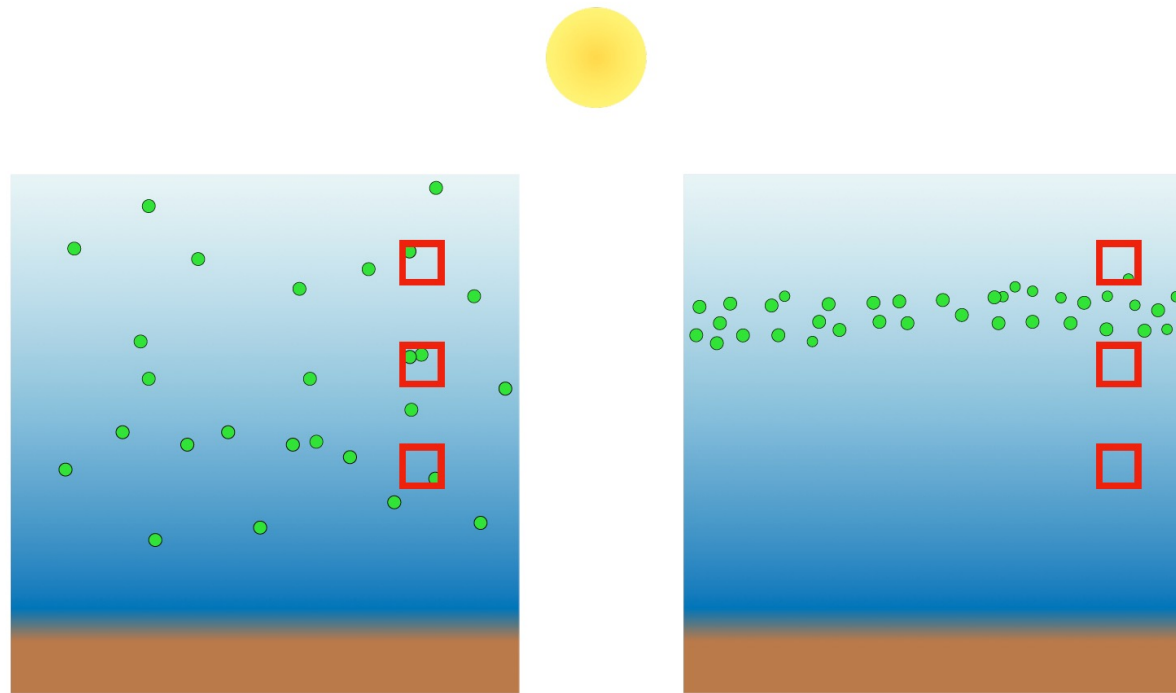


Villamaña V., Cermeño P., Estrada M., Fernández-Castro B., Figueiras F.G., Latasa M., Otero-Ferrera J.L., Reguera B., Marañón E., Mouriño-Carballido B. (2019). The role of mixing in controlling resource availability and phytoplankton community composition. *Progress in Oceanography*, 178, <https://doi.org/10.1016/j.pocean.2019.102181>

Thin layers big impact



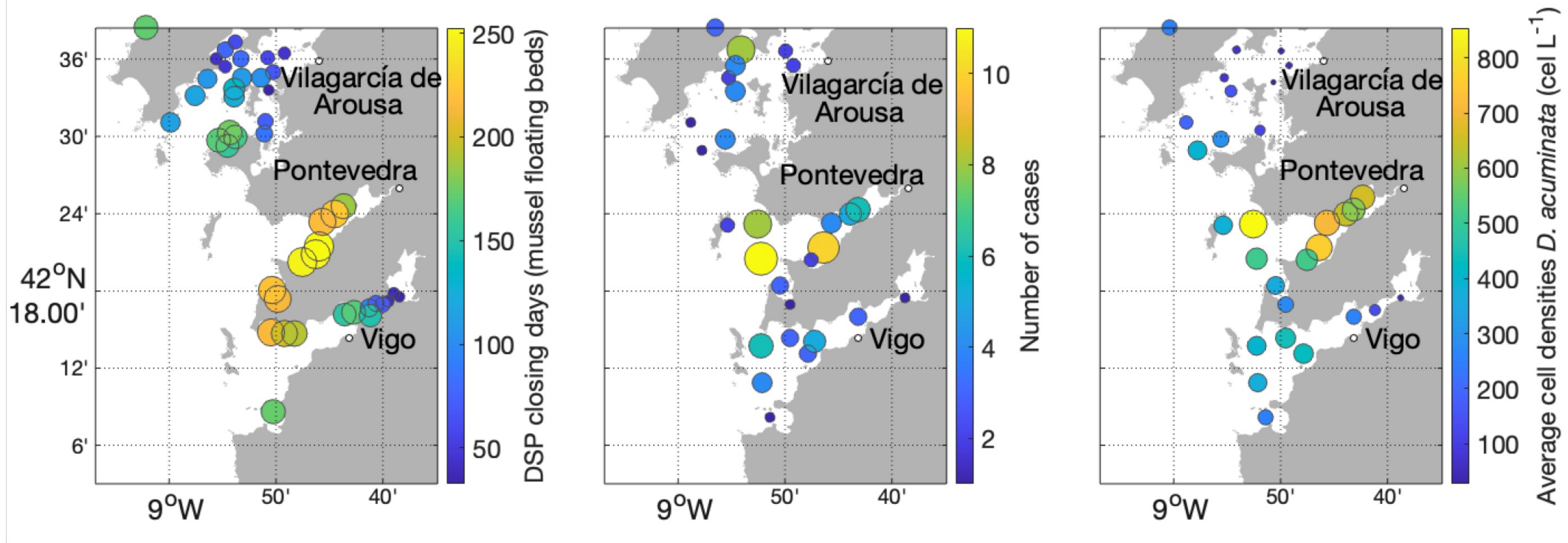
Thin layers big impact



Escalera et al., 2012 (*Marine Pollution Bulletin*)

Ría de Pontevedra: a hotspot for HABs and Thin Layers

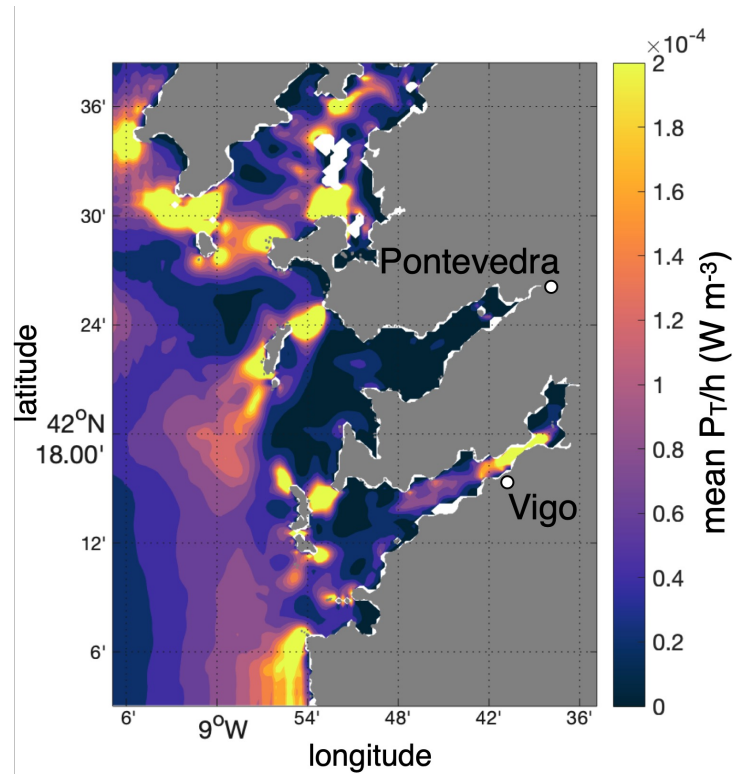
Harvesting closure days, TLP, and cell densities (INTECMAR 2012-2015)



Broullón E., López-Mozosa M., Reguera B., Chouciño P., Dolores Doval M., Fernández-Castro B., Gilcoto M., Nogueira E., Souto C., Mouriño-Carballido B. (2020). Thin layers of phytoplankton and harmful algae events in a coastal upwelling system. *Progress in Oceanography*, 189, doi.org/10.1016/j.pocean.2020.102449.

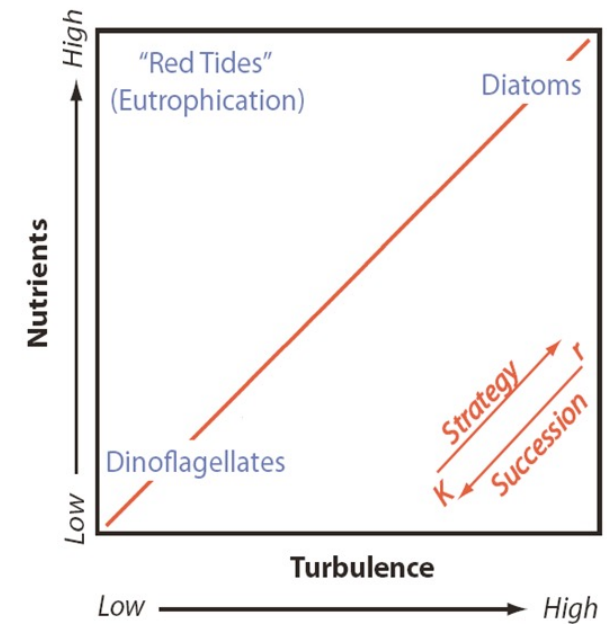
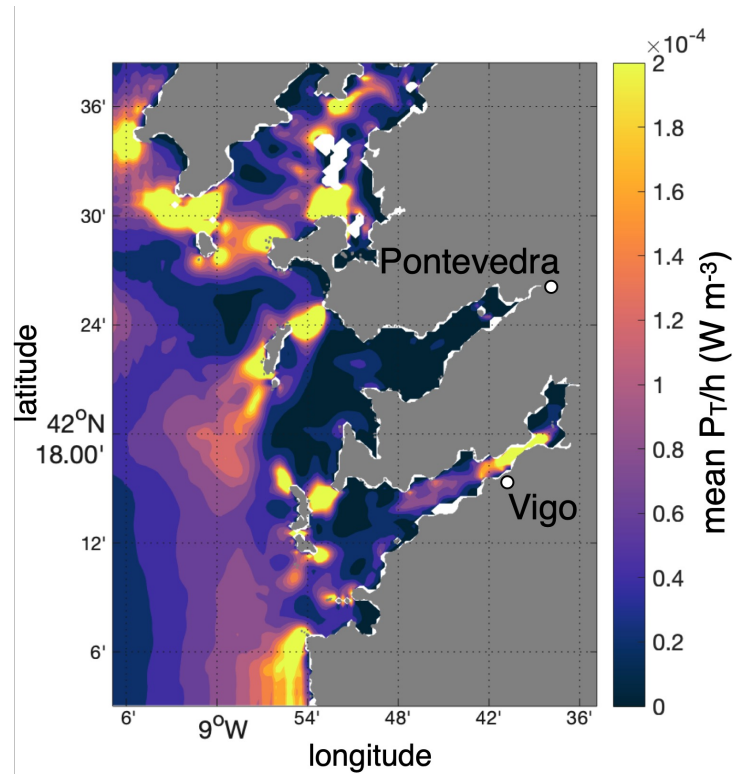
Why is the Ría de Pontevedra different?

Turbulent Energy Production from CROCO model



Why is the Ría de Pontevedra different?

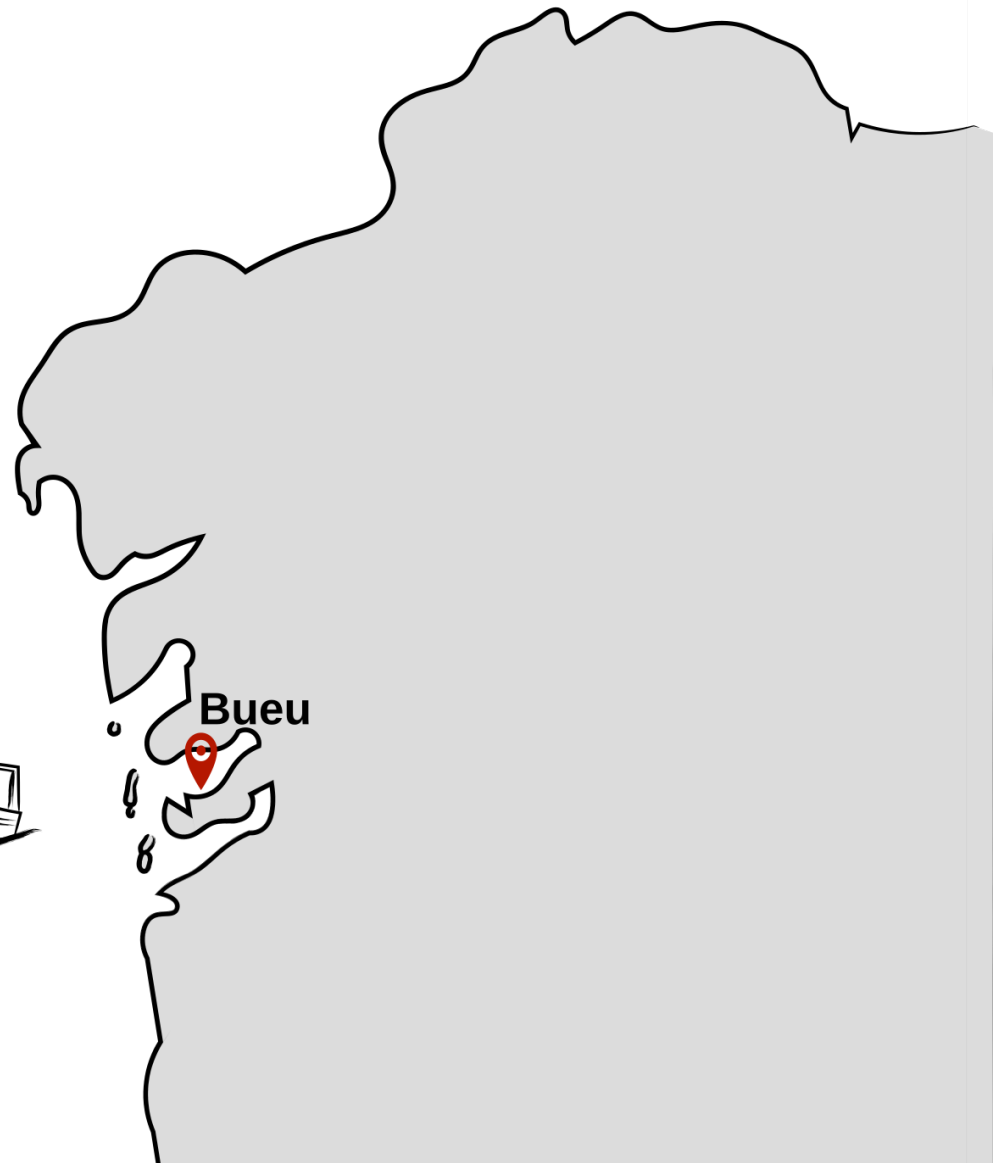
Turbulent Energy Production from CROCO model

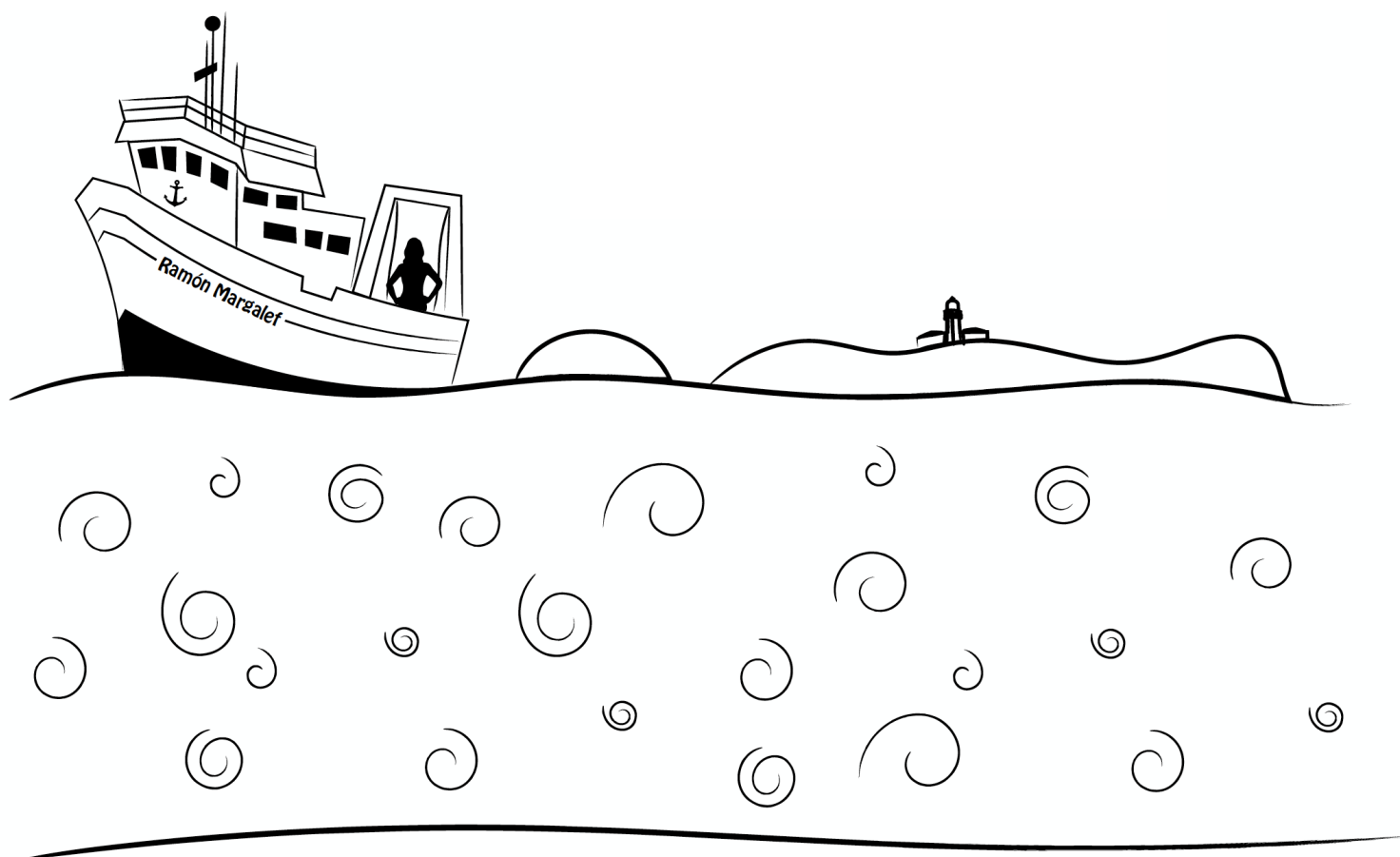


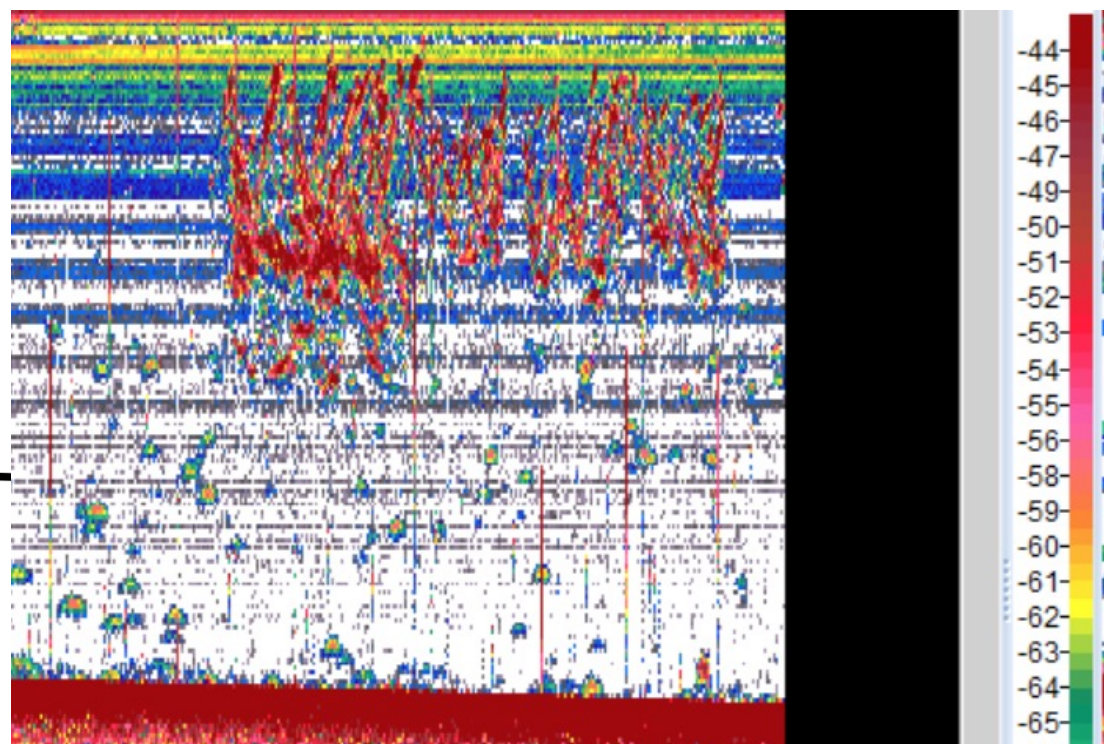
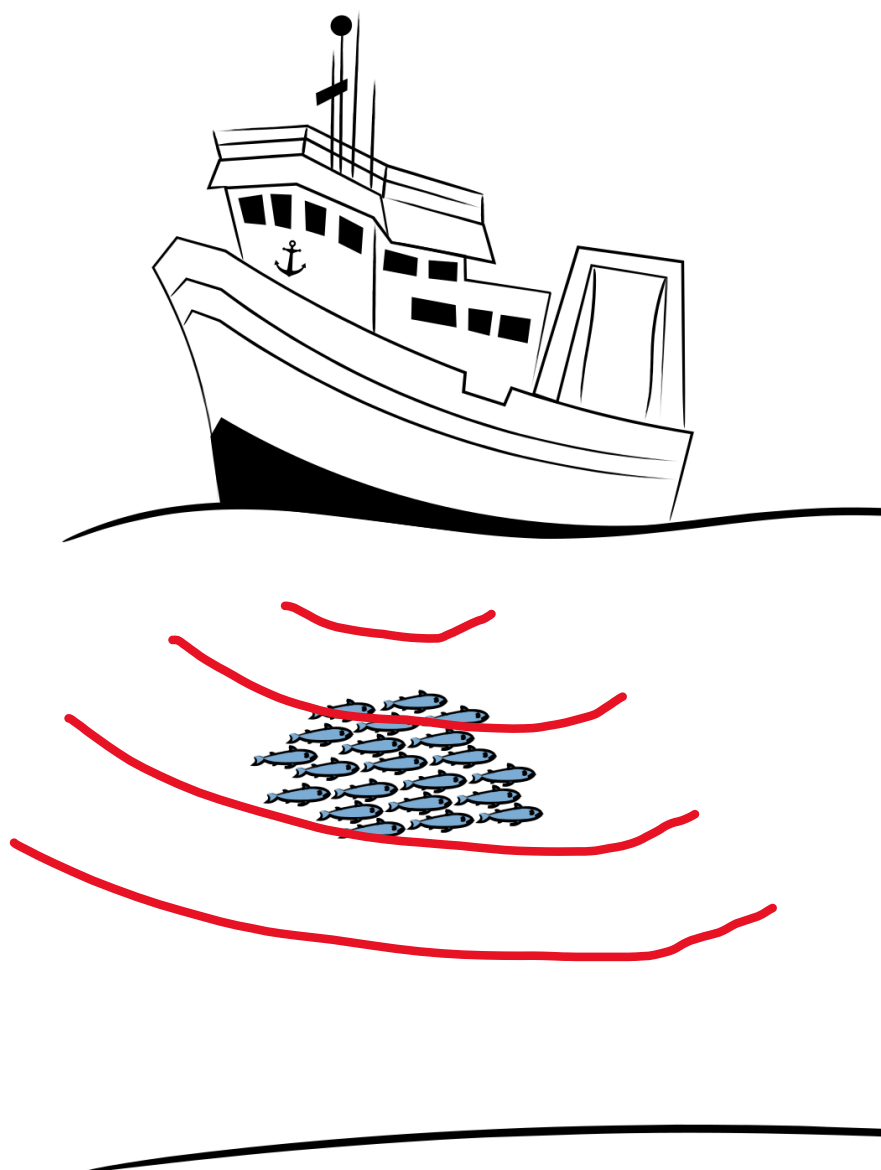
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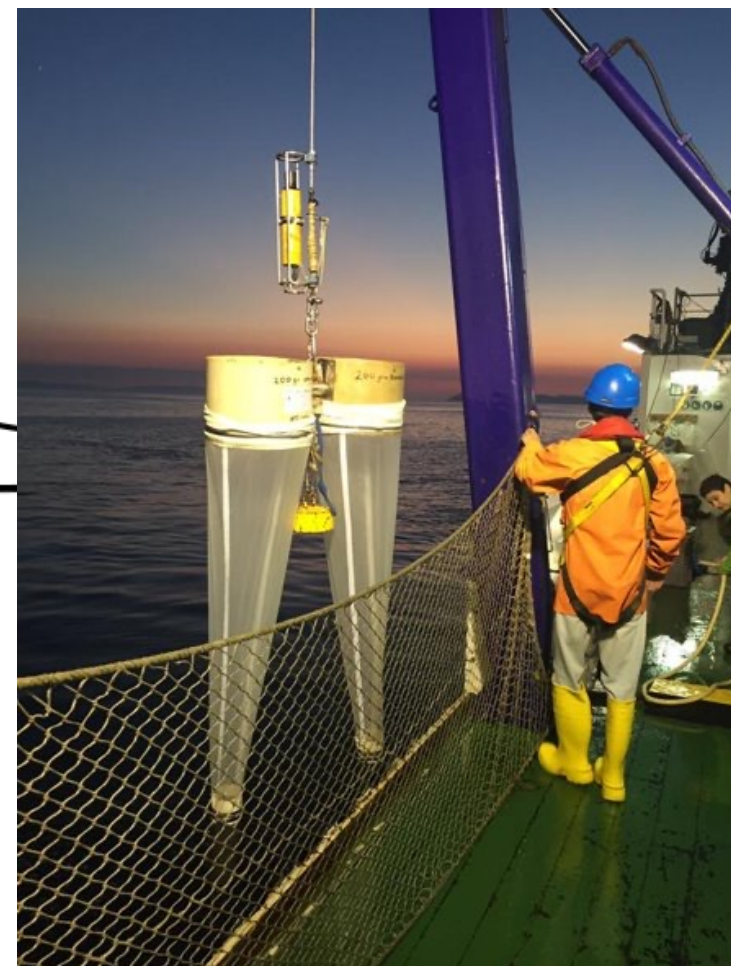
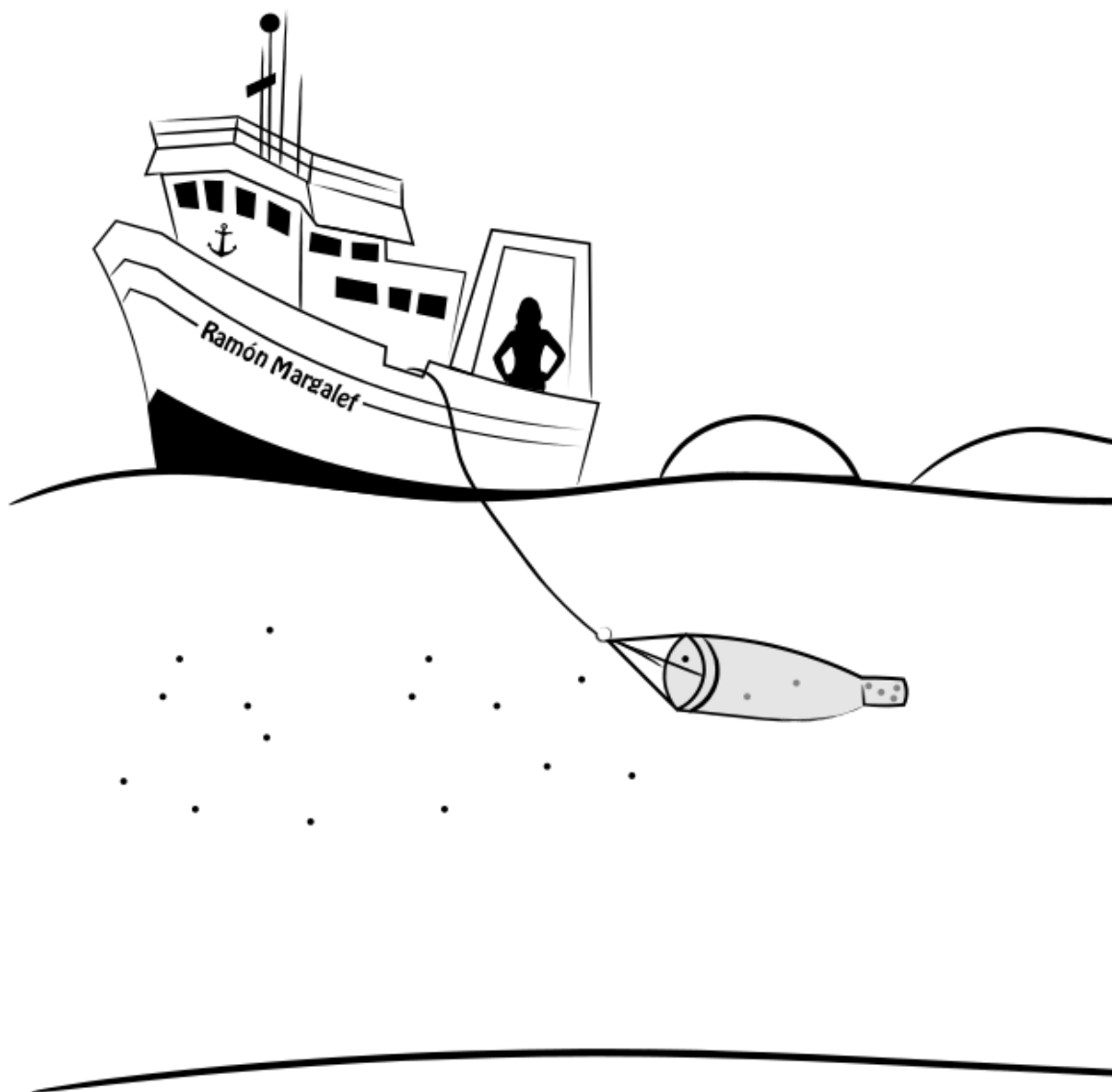


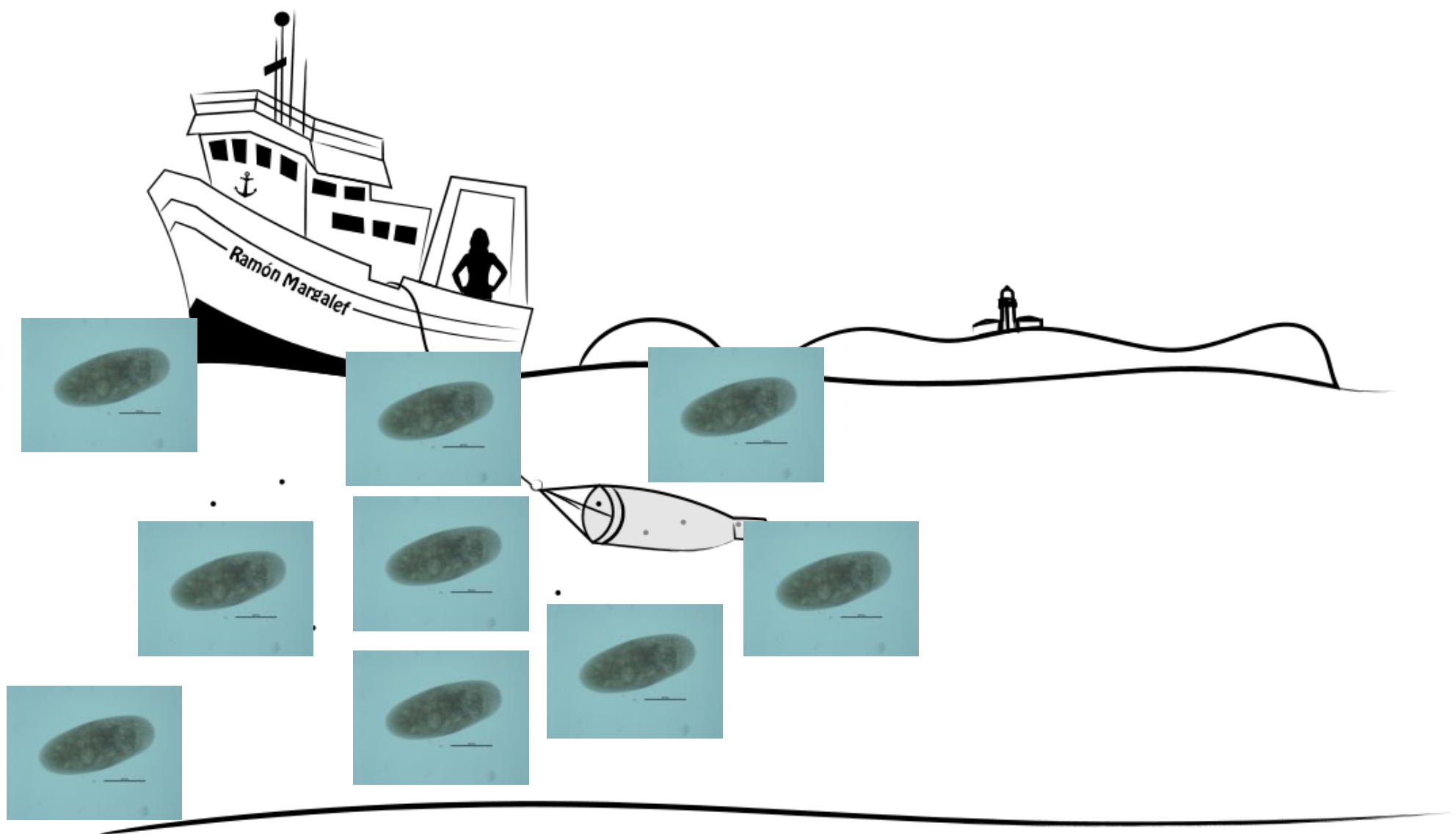
My favourite research story...

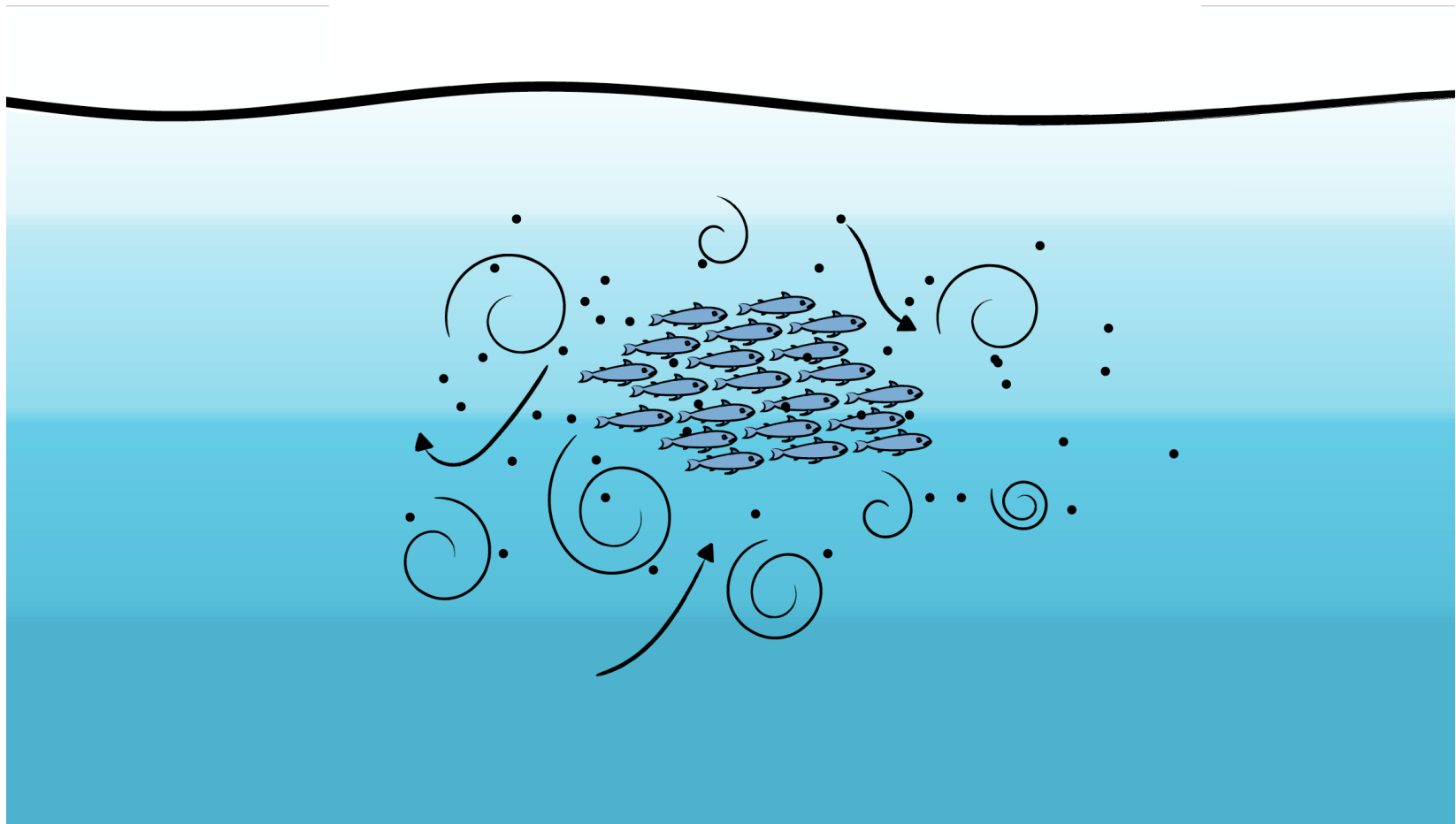


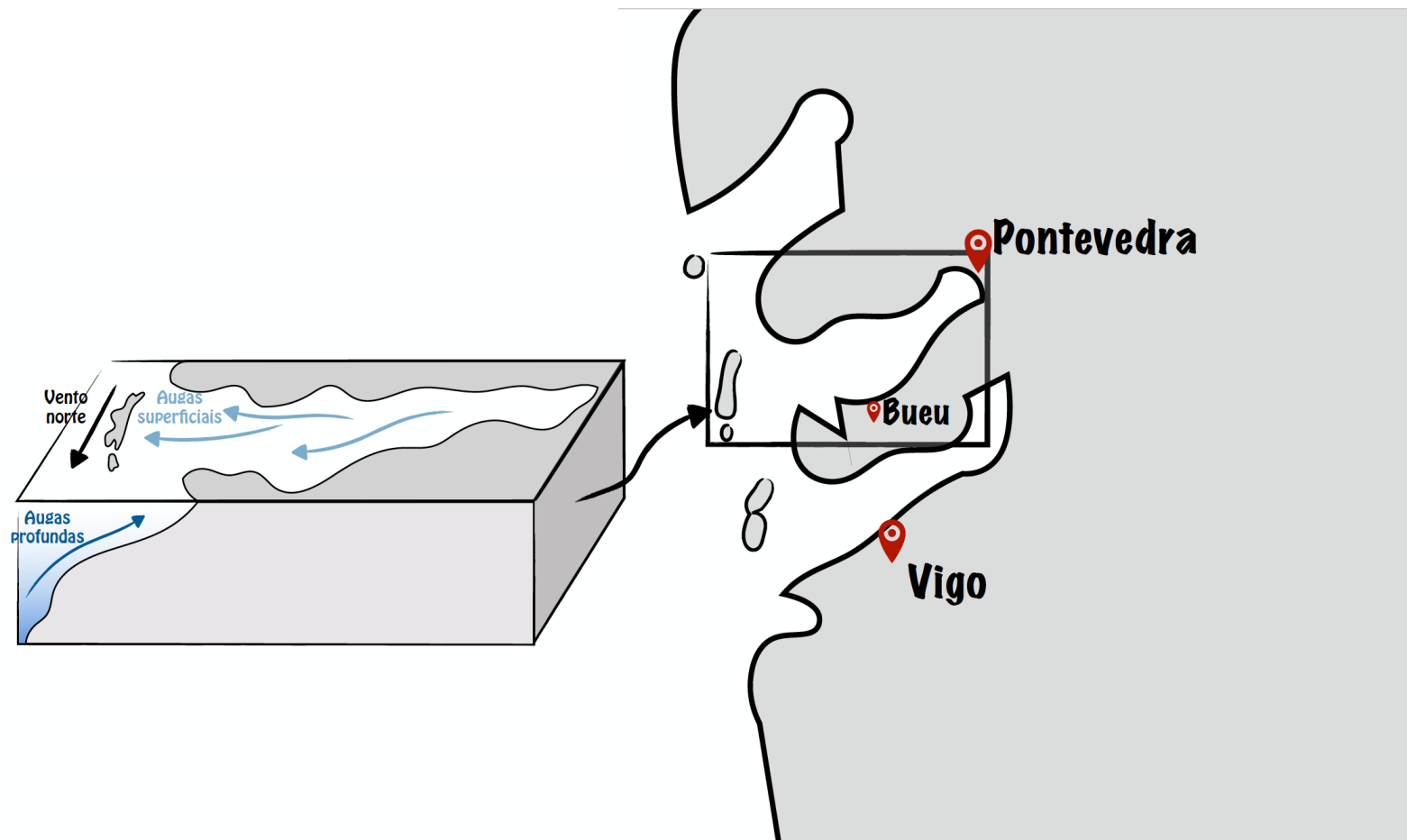


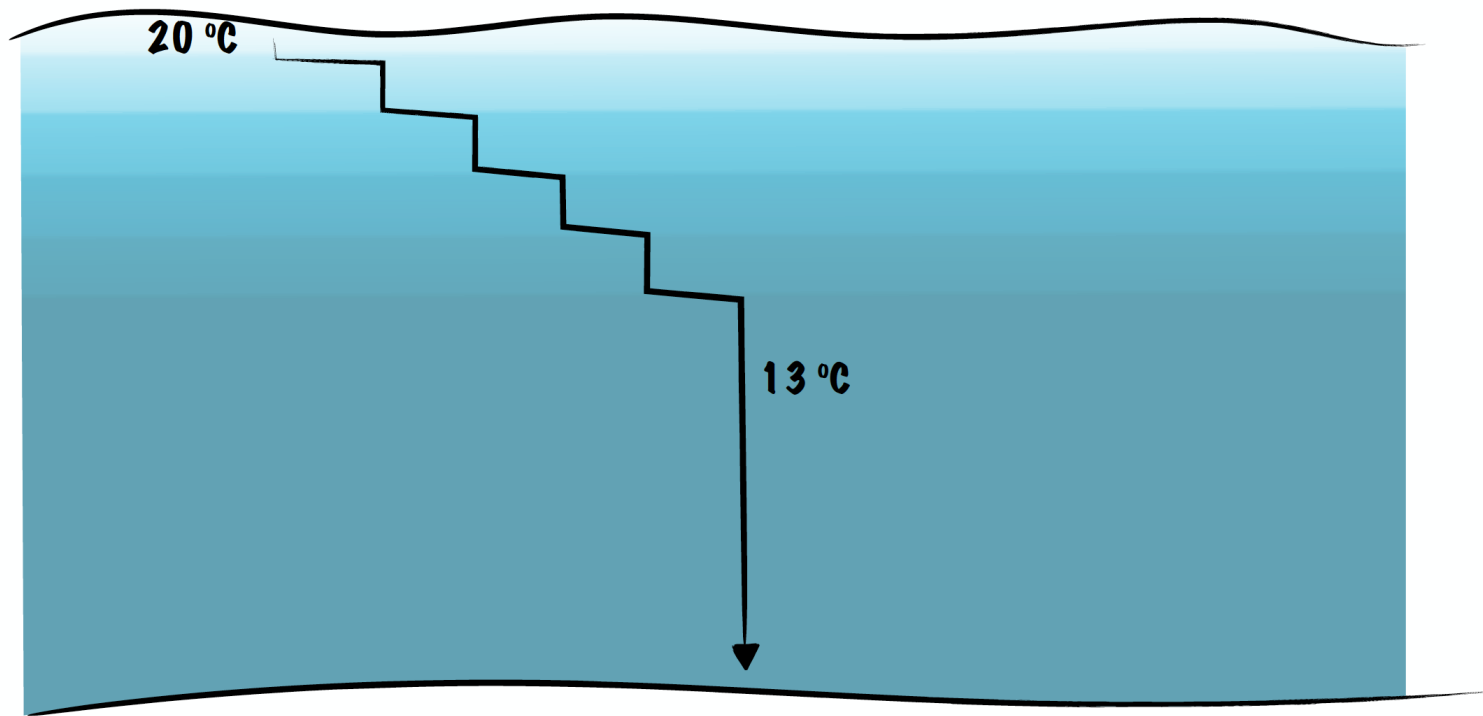




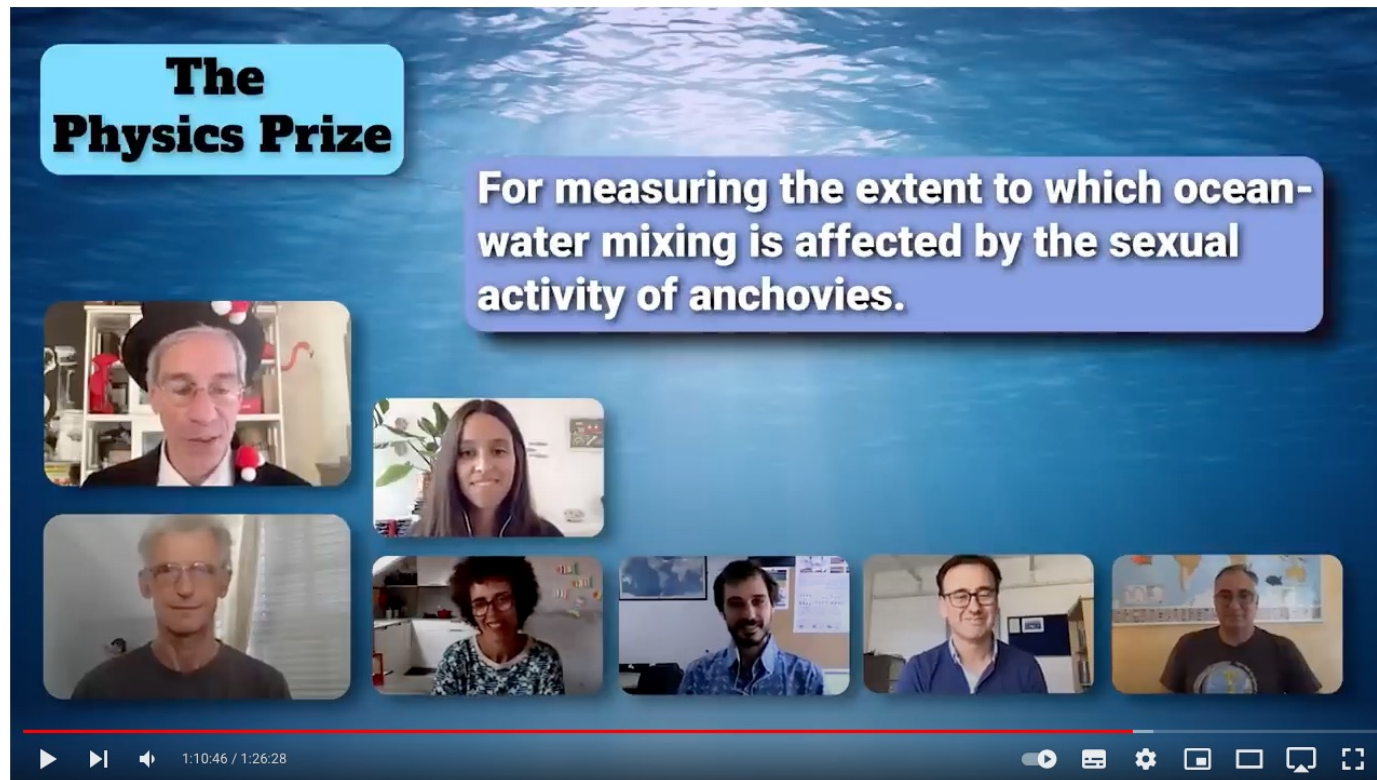








An IgNobel prize: first LAUGH then THINK



Fernández-Castro B., Peña M., Nogueira E., Gilcoto M., Broullón E., Comesaña A., Bouffard D., Naveira Garabato A., Mouriño-Carballido B. Efficient biological ocean mixing in fish spawning aggregations (2022). *Nature Geoscience* 15, 287–292, <https://doi.org/10.1038/s41561-022-00916-3>.

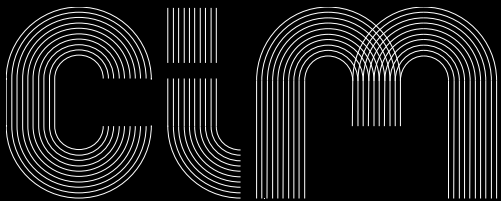
Concluding remarks

- Phytoplankton live in a 3D turbulent ocean
- Physical-biological processes closely linked
- Thinking across time and space scales
- Phytoplankton a great place to start

Thursday 13:30 (Seminar 3 TSF.4-O-4)

Unravelling the **temporal variability** **diazotrophy** in dynamic upwelling bays

D., **Fernández-Román**, M. Fontela, E. Broullón, M. M. Varela, H. Farnelid, A. Fernández-Carrera, B. Fernández-Castro, S. Martínez, T. Rodríguez-Ramos, E. Nogueira, E. Velasco, B. Mouriño-Carballido



CIM
Centro de Investigación Mariña
Universidade de Vigo



Marina Villamaña (PhD 2020)



José Luis Otero (PhD 2020)



Esperanza Broullón (PhD 2024)



Antonio Comesaña (PhD 2024)

Thanks to...

- Control of the structure of marine phytoplankton communities by turbulence and nutrient supply dynamics (CHAOS) CTM2012-30680 to B. Mouriño-Carballido
- Role of Mixing on phytoplankton bloom initiation, maintenance and Dissipation in the galician rías (REMEDIOS) CTM2016-75451-779 C2-1-R to B. Mouriño-Carballido
- Modelling and Analysis of phytoplankton Growth in the rías: understanding productivity and harmful algae Changes (MAGIC). **Proyectos de Generación de Conocimiento 2024. Fingers Crossed!**
- AI-based Solution for Marine Environmental Remediation (Blue-AI). **Proyectos de investigación en el ámbito de la inteligencia artificial 2025. Fingers Crossed!**

An aerial photograph of a coastal region, likely in Mexico, showing a large bay with several islands. The water is a deep blue, and the islands are covered in dense vegetation. In the foreground, two prominent, rugged islands with rocky shorelines and small sandy beaches are visible. The background shows a vast expanse of water and distant landmasses under a clear blue sky.

Graciñas!