

Journées Nationales Glider 2023

Opérations glider au Pérou: monitoring d'El Nino et des vagues de chaleur marines

Alice PIETRI

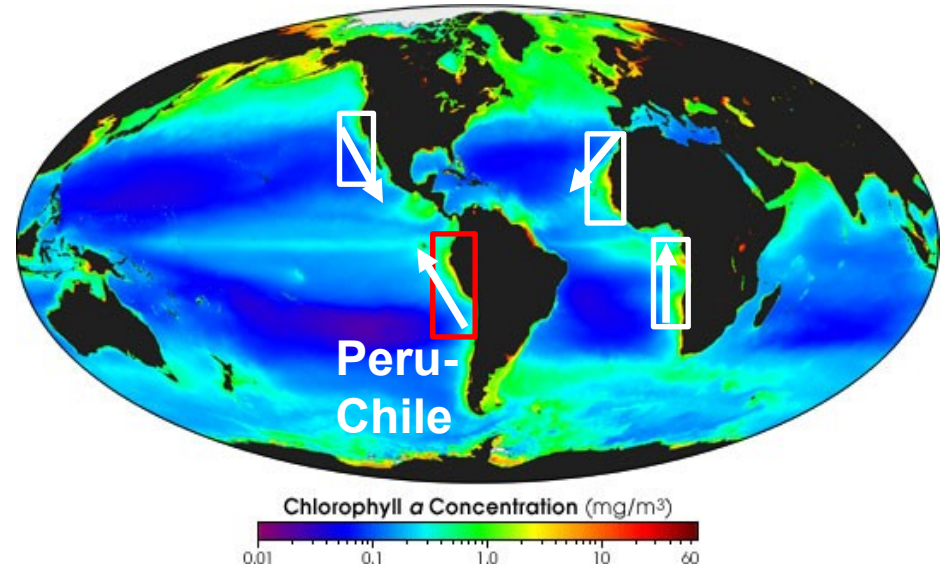
IRD, LOCEAN-IPSL

MIO – Marseille Luminy
07-08 December 2023

The Peru-Chile eastern boundary upwelling system

Four Eastern Boundary Upwelling Systems

- Very productive coastal ecosystems
- Peru is the most productive



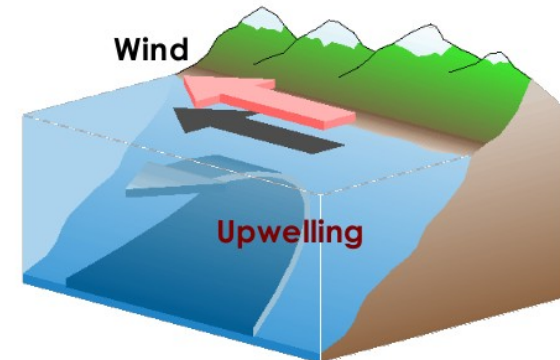
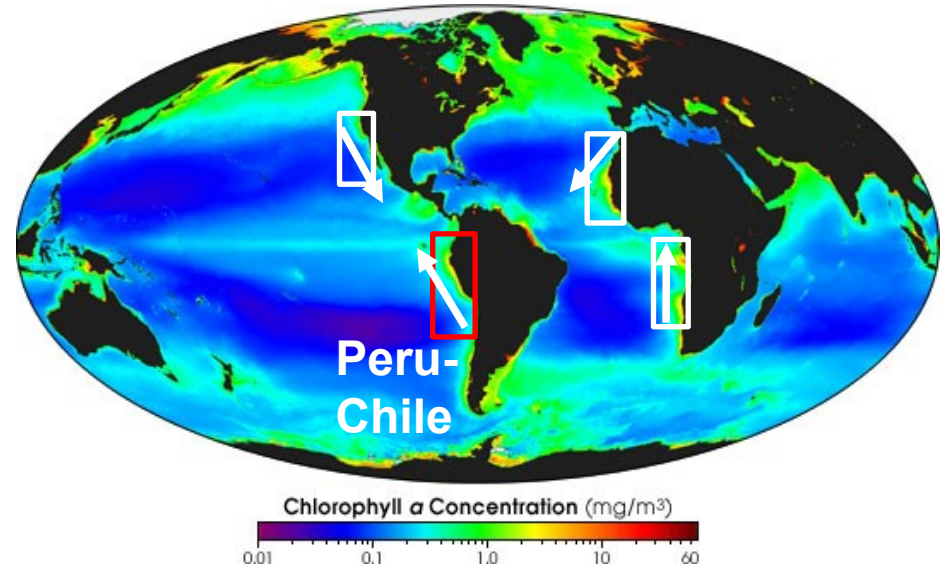
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Wind parallel to the coast

- Offshore surface transport
- coastal upwelling of cold and nutrients-rich water



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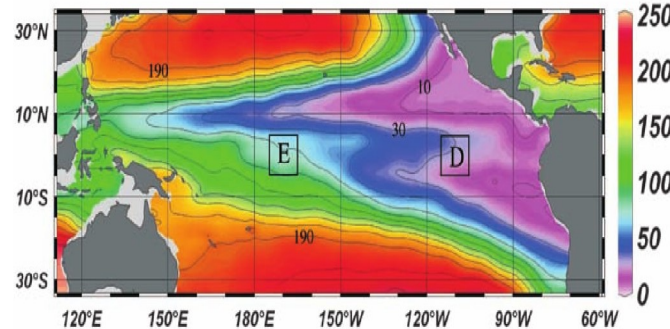
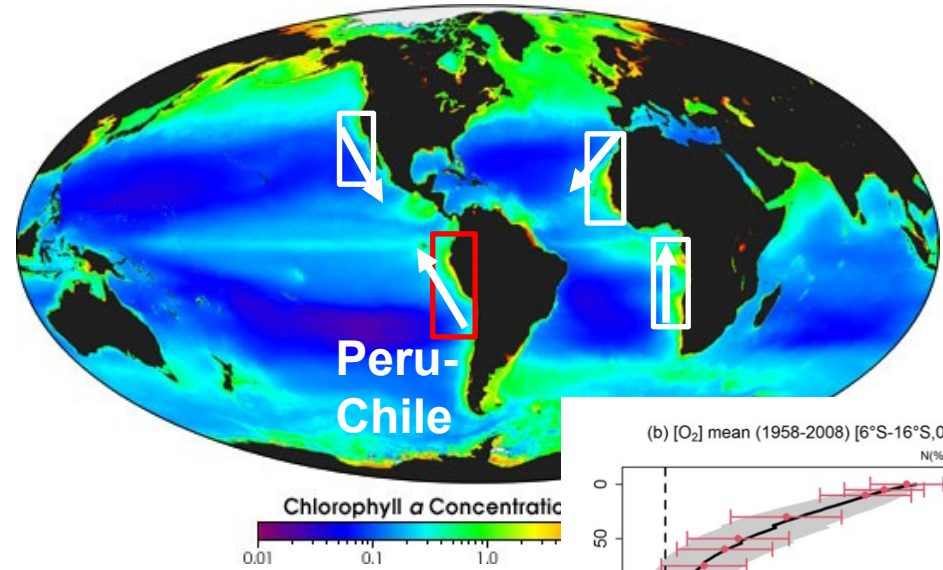
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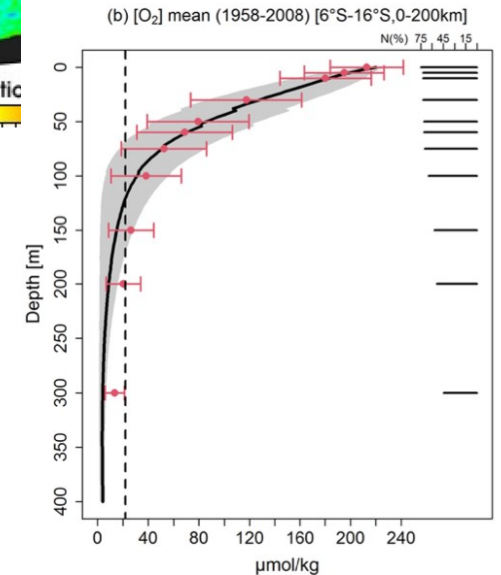
- Offshore surface transport
- coastal upwelling of cold and nutrients-rich water

Very intense oxygen minimum zone

- shallow oxycline



(Dissolved Oxygen – 400m depth;
Stramma et al. 2008)



(Ezpinoza et al. 2021, Scientific Reports)

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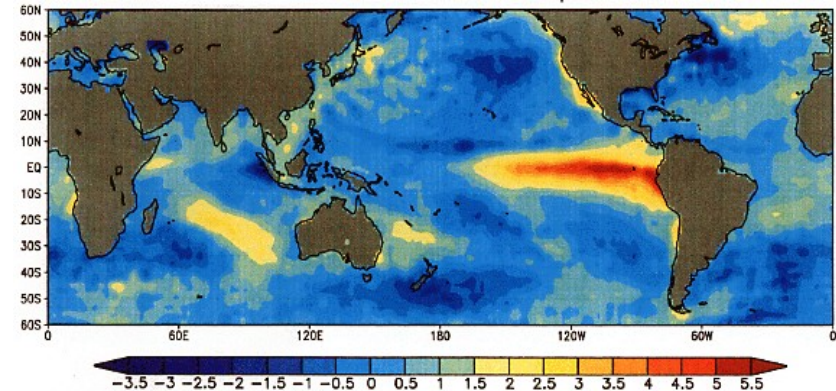
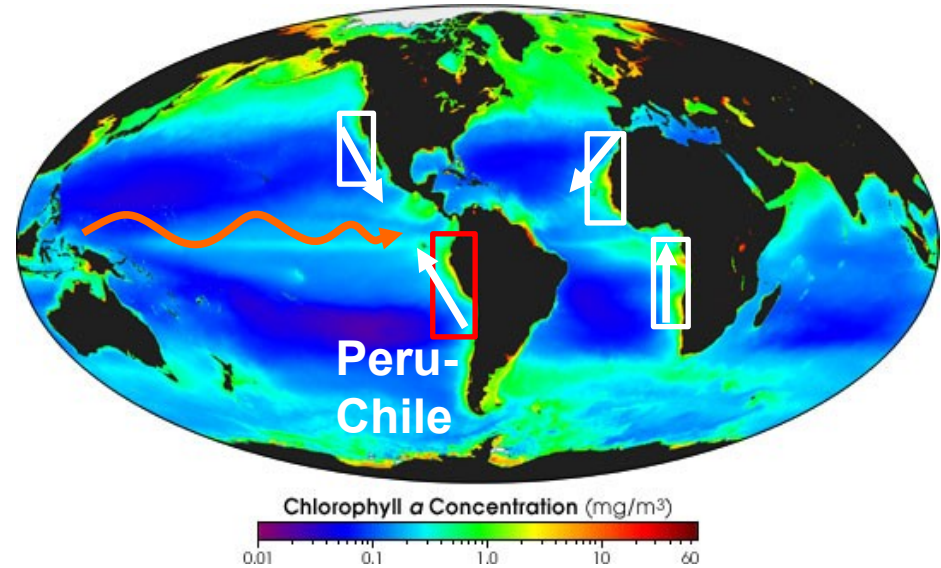
Very intense oxygen minimum zone

- shallow oxycline

Direct connection with equatorial Pacific

Waves and Currents

- strongly impacted by equatorial variability at interannual time scale (El Niño)



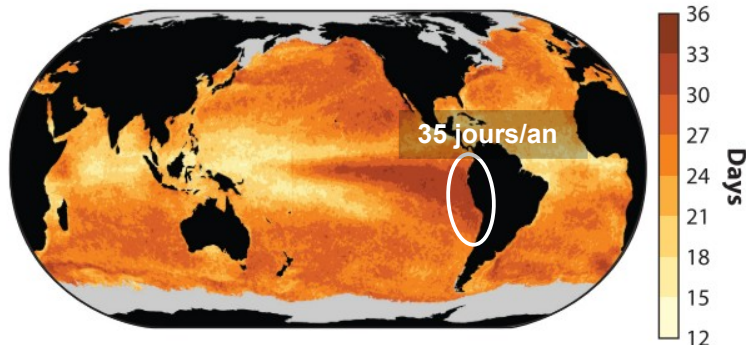
The Peru-Chile eastern boundary upwelling system

Une des régions les plus productive au monde

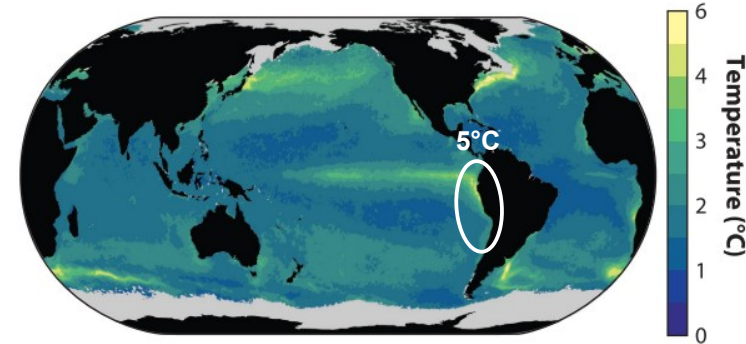
- 5 à 10% des captures mondiales
- Pérou, 2ème producteur halieutique au monde
- Sensible à la variabilité climatique en particulier aux événements El Niño
- Abrite la zone de minimum d'oxygène la plus intense et la moins profonde de l'océan mondial
- **Vagues de chaleur intenses et fréquentes**



Nombre de jours affectés par des vagues de chaleur chaque année



Anomalie de température moyenne pendant ces événements extrêmes



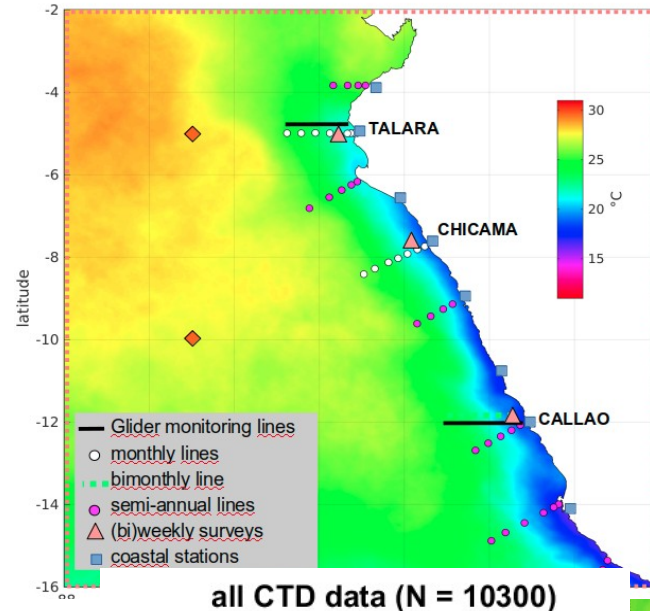
Peruvian marine observatory

- Regular monitoring of the coastal ocean by IMARPE ships and moorings

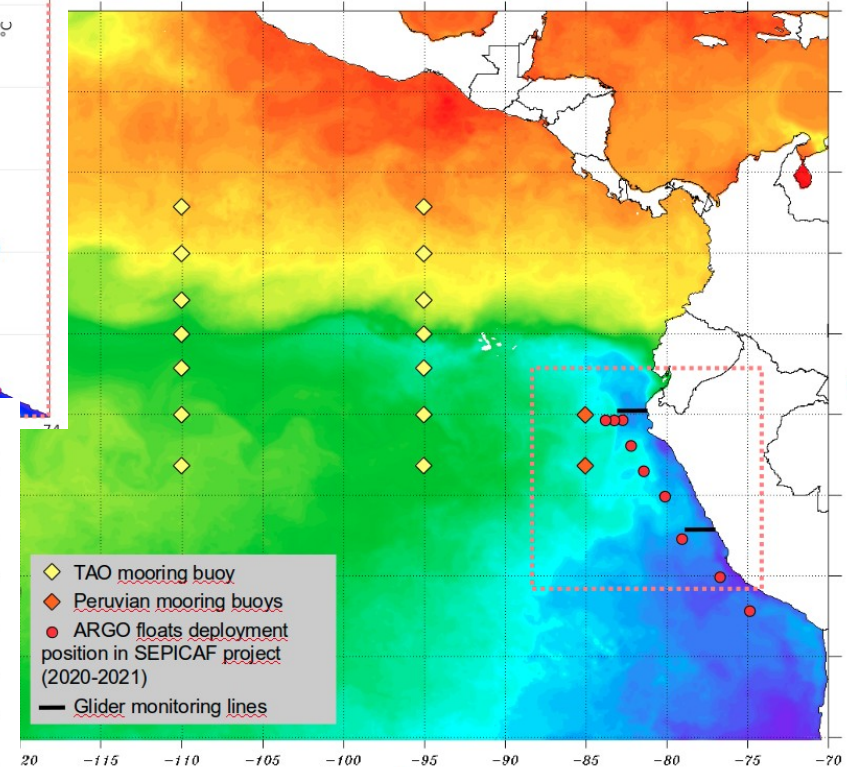
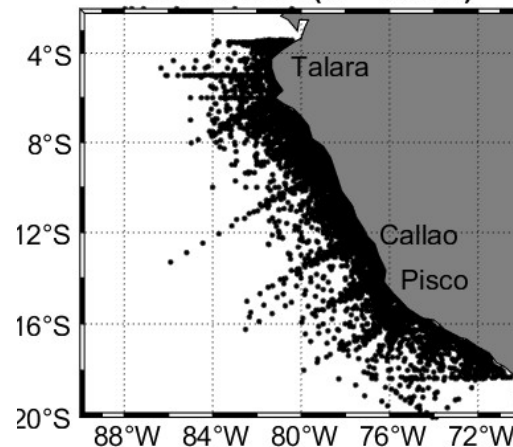
- One of the largest in situ database in a Southern Country

- >10 000 TS profiles

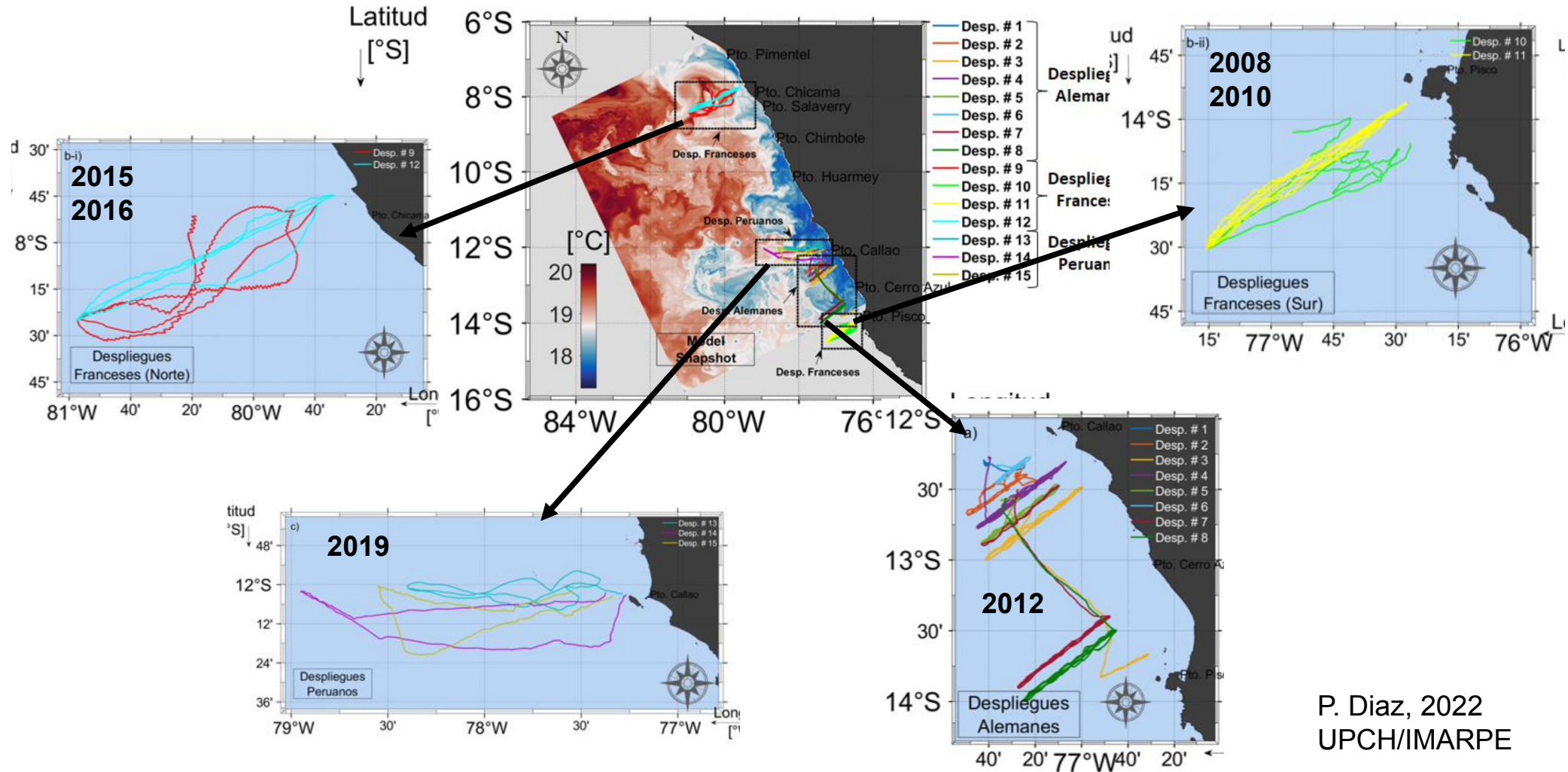
- >6500 O2 profiles



all CTD data (N = 10300)



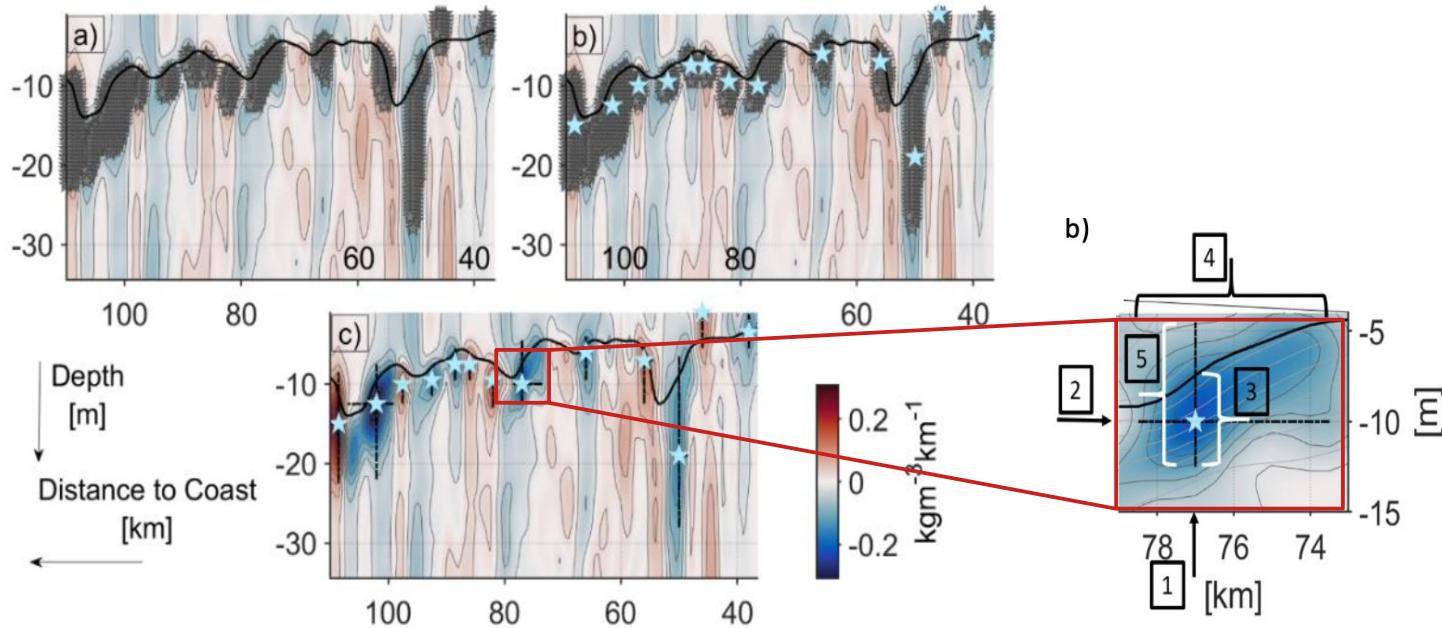
Peruvian marine observatory: glider deployments 2008-2019



Peruvian marine observatory: glider deployments 2008-2019

Thèse de master, Pedro Diaz (UPCH, 2022) :

Caractérisation des structures frontales de (sub)mesoachéle dans le Pacifique sud-est à partir de données « glider » et de simulations numériques

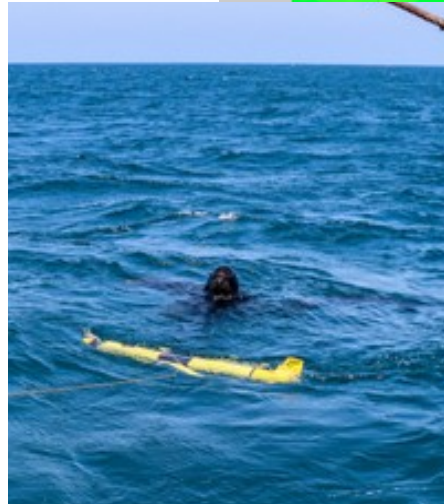
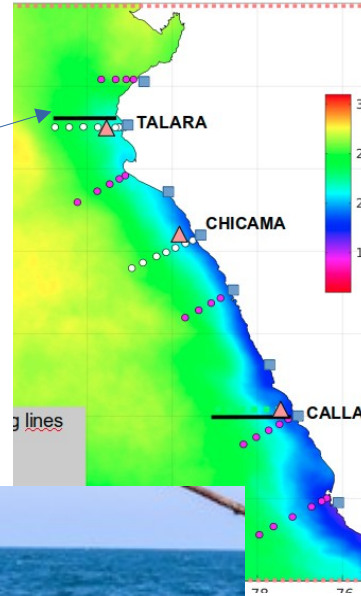


- 1-Posición del frente con respecto a la costa [km].
- 2-Profundidad del frente [m].
- 3-Distancia entre la profundidad máxima de la zona frontal con respecto a la profundidad de la capa de mezcla [m].
- 4-Longitud horizontal [km].
- 5-Longitud vertical [m].

Peruvian observatory: glider monitoring since 2020

Glider monitoring off Talara (4°S)

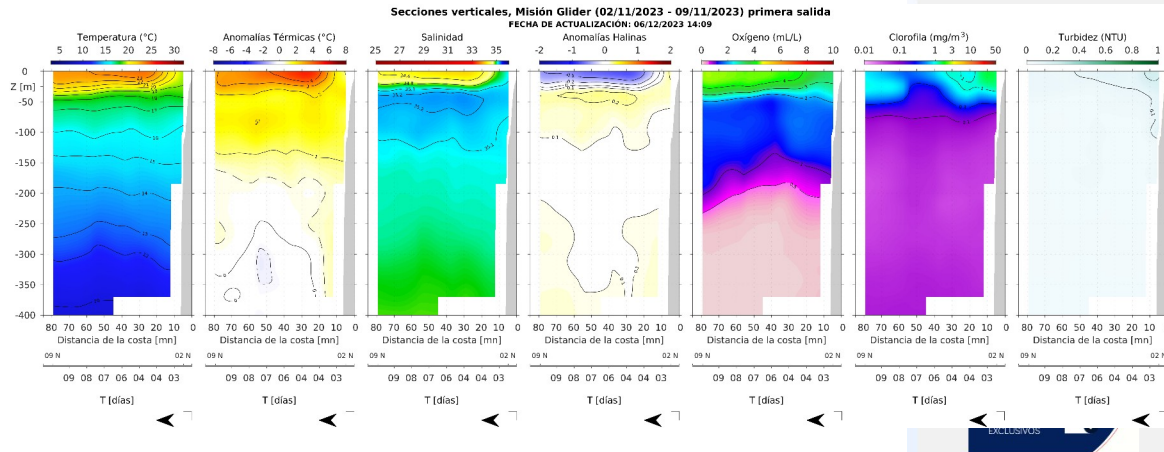
- **4 gliders** : Paracas, Nazca, Chimú et Mochica
- **1 active endurance line**
- Another in the future (12°S)
- Process oriented deployments



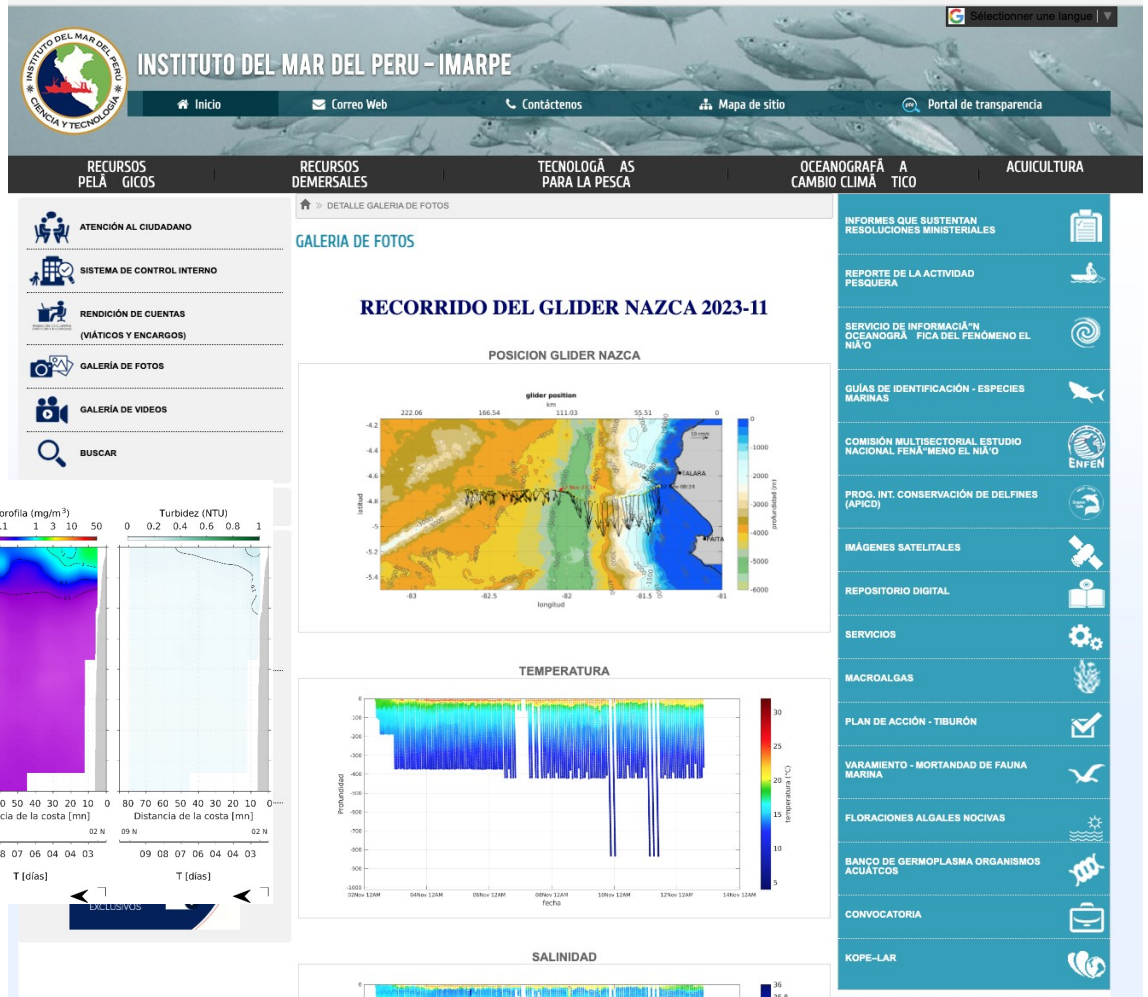
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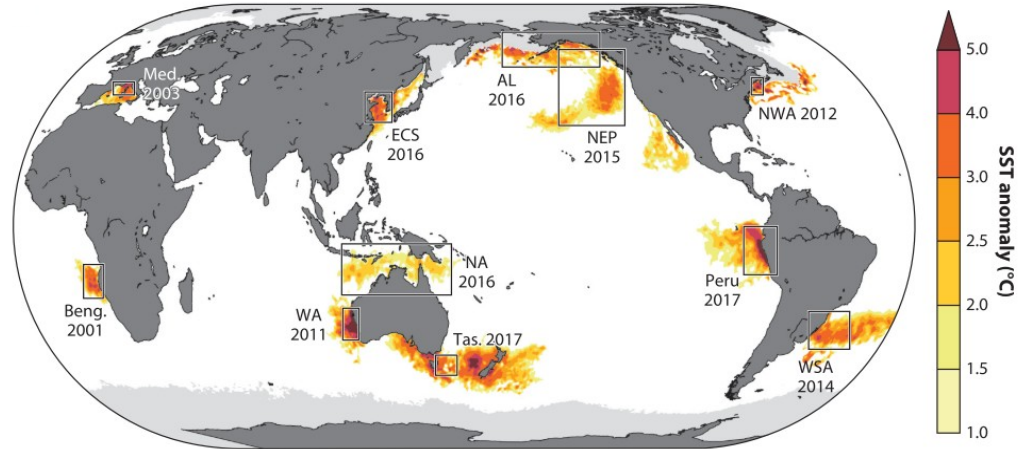


imarpe.gob.pe/imarpe/galeria.php?id_seccion=I01990000000000000000...



Extreme events: marine heatwaves

- Punctual events of anomalous extreme marine temperatures
- A few days to a few months
- Result from ocean processes and/ or atmospheric forcing
- Most prominent ones associated with favorable (warm) phase of climate modes of variability (ENSO, PDO, NAO, etc.)



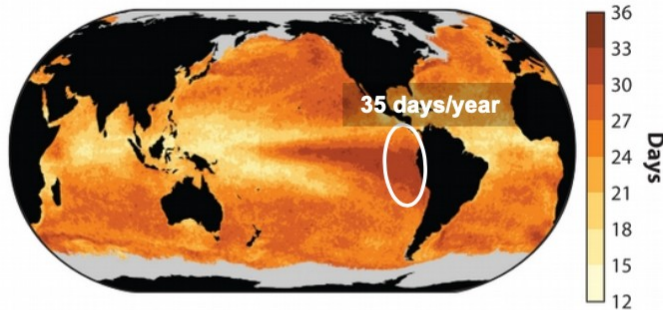
Oliver et al. (2021) Annu. Rev. Mar. Sci

TRENDS

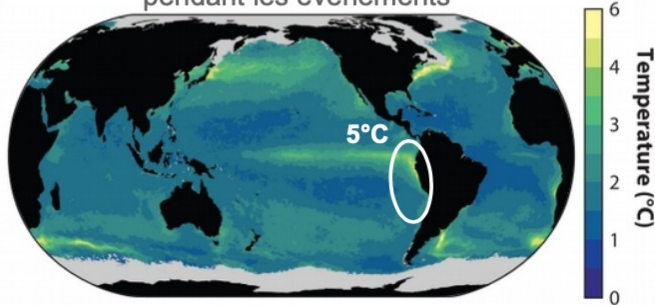
- **50% more heat wave days per year** during the period 1987-2016 compared to the period 1925-1954 (Smale et al. 2019).
- More frequent and prolonged, **record events have been observed in most ocean basins** over the past decades.
- **This trend is expected to increase further in the future** (Frölicher et al. 2018) due to warming oceans and increasing temperature variability.

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Nombre de jours par an affectés par des vagues de chaleur marines



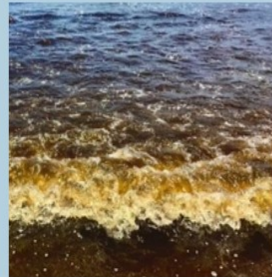
Anomalie de température moyenne pendant les événements



Oliver et al. (2021)

- ▶ Vagues de chaleur marines intenses et longues
- ▶ Région hautement productive
 - 5-10% des captures mondiales
 - Grande biodiversité
 - Pérou: Pêche 1,5-2,5 % PIB & 700 000 emplois

Événement de « Marée rouge » dans la baie de Sechura, le 12 Mars 2019



Source IMARPE

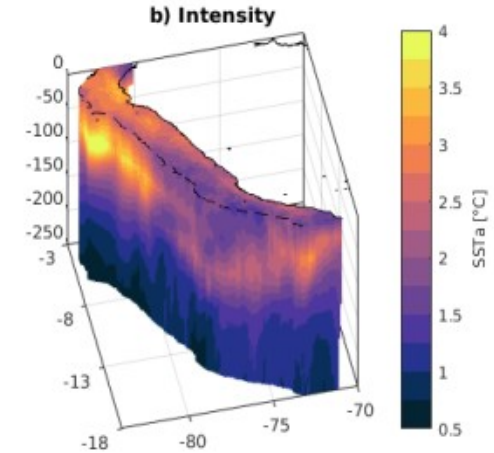
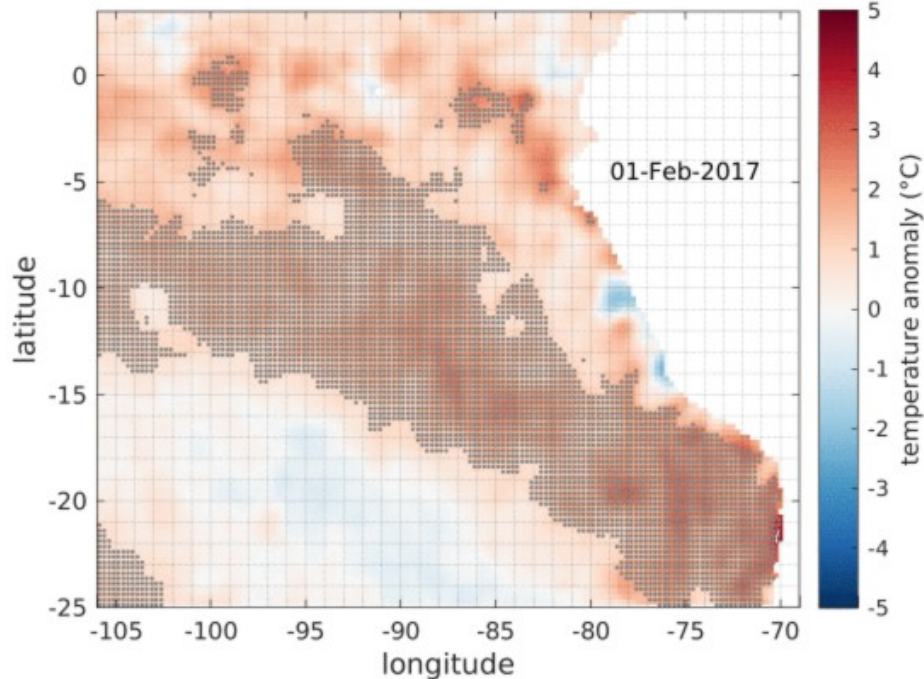


PÉROU

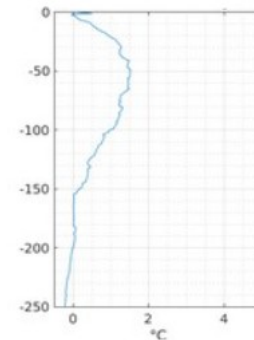
Extreme events: marine heatwaves

Vagues de chaleur en subsurface:

- ▶ Pas détectable par satellite
- ▶ Plus longues
- ▶ Impact plus grand sur les organismes benthiques peu mobiles et les zones côtières



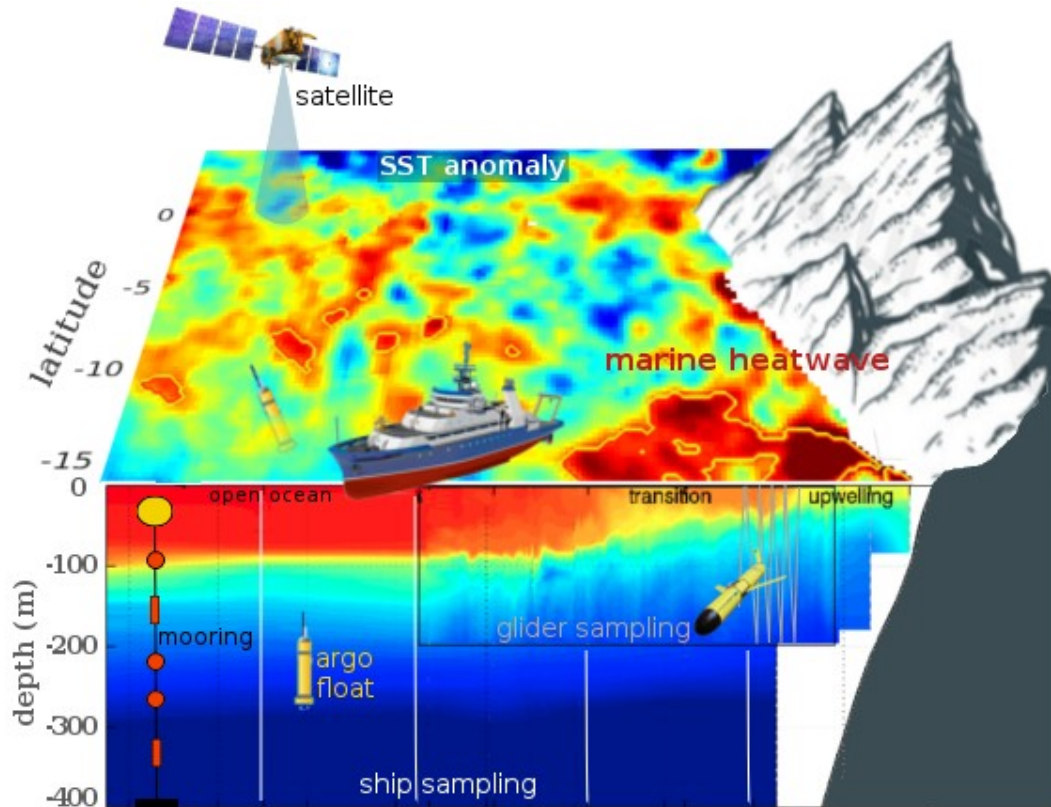
Modeled (CROCO) MHWs intensity in the PCUS (Mogollon, IMARPE)



Averaged temperature profile inside a MHW (ARGO)

Extreme events: marine heatwaves

Real time observation for early detection



Subsurface detection using gliders:

- tri dimensionnal threshold map from historical observations
- continuous 150 km cross section off 4°S (4 gliders)
- quasi real time temperature data to detect extreme values
- impact on the environment (oxygen, fluorescence and turbidity on all devices)

