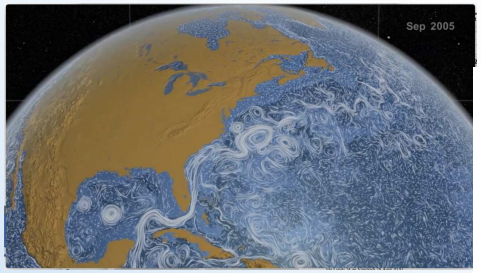
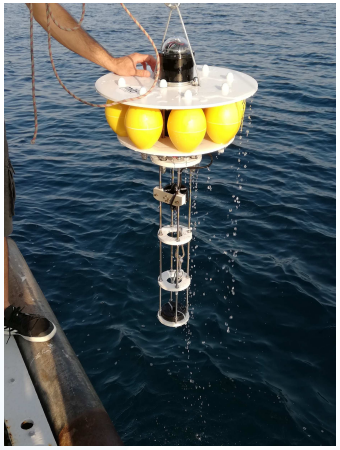
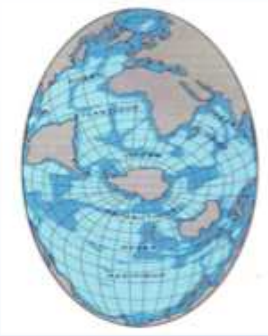
In situ measurement of Oceanic Vertical Velocities

Utrecht Visit, MIO, 05/09/2022

Stéphanie Barrillon, Anne Petrenko, Jean-Luc Fuda, Caroline Comby, Andrea Doglioli, Roxane Tzortzis (MIO, OPLC)

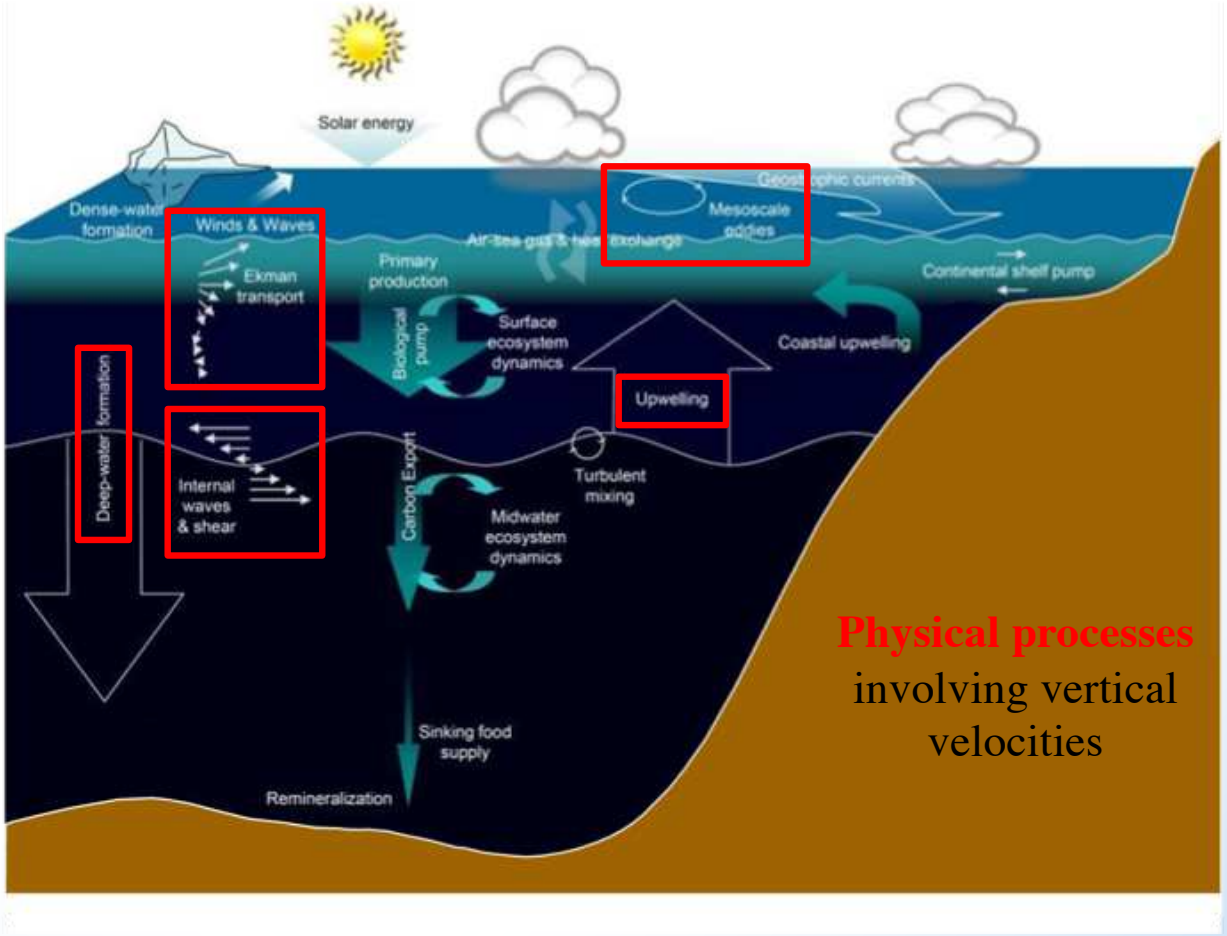






Oceanic Vertical Velocities

- Why ?
  - Many oceanic processes: **physical** and **biogeochemical**
  - **Key** for fine understanding of
    - **ocean dynamics** (meso and submeso scales)
    - **vertical exchanges** (carbon sequestration, nutrients to surface)
  - In situ measurement lacking : **challenge**
    - very low intensities
    - ephemeral nature



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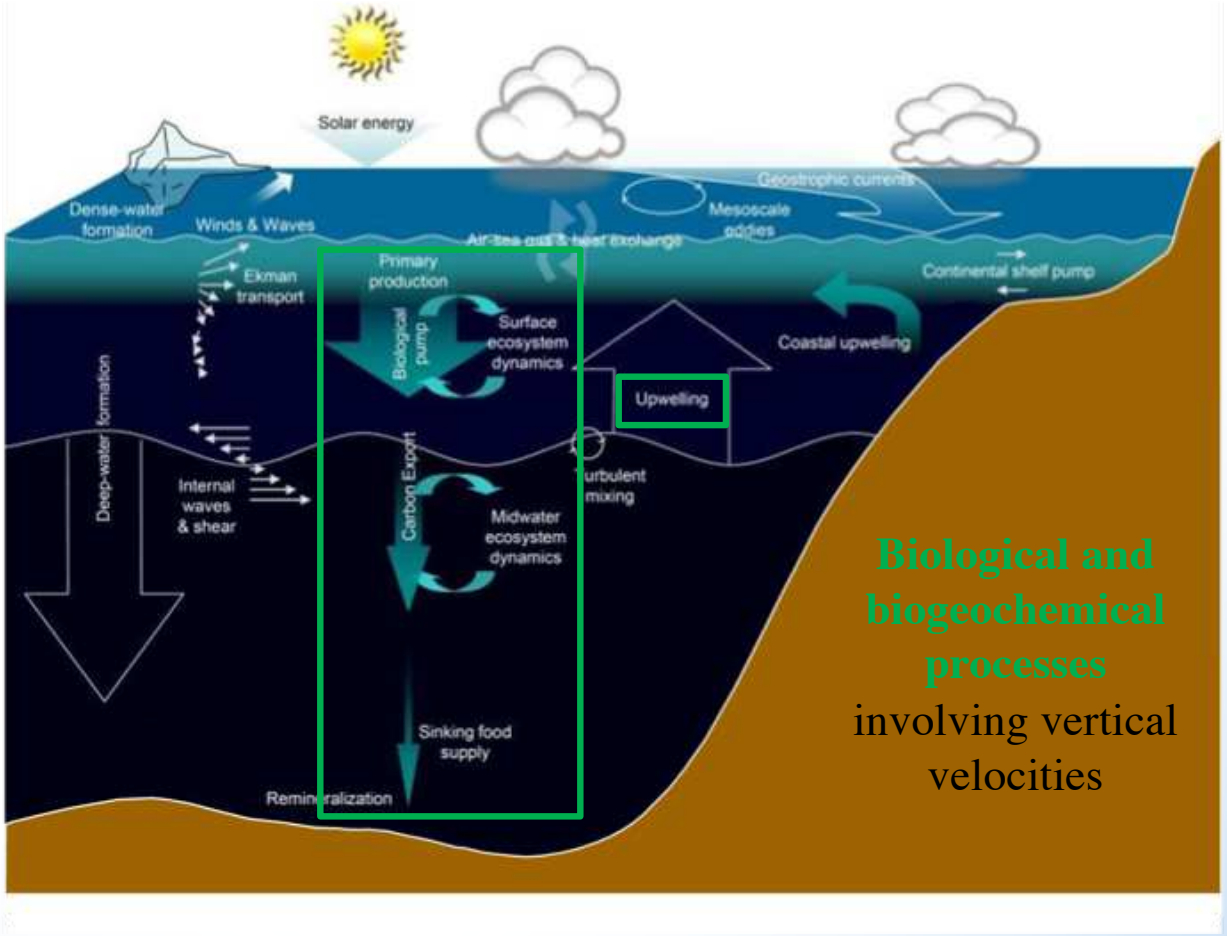
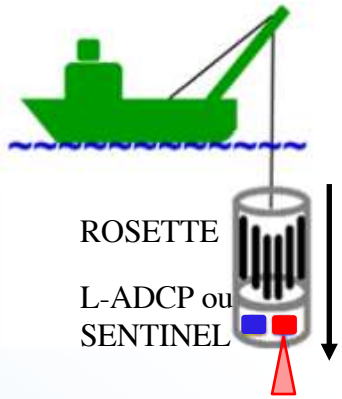


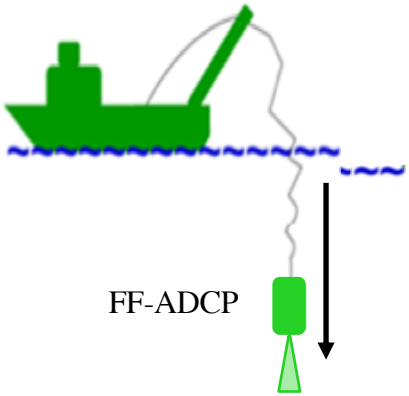
Vertical Velocities measurement

Direct *in situ* (ADCP)

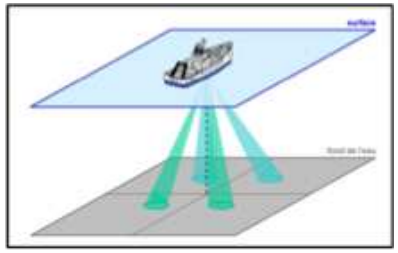
CTD package



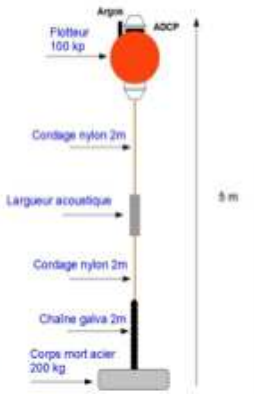
Free-Fall



Vessel-mounted



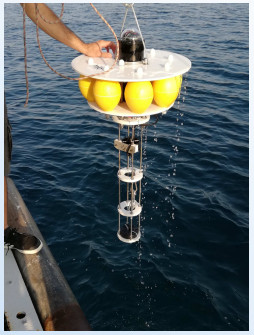
Mooring



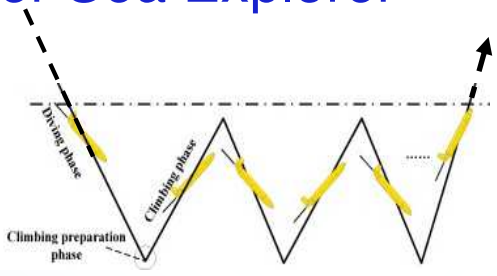
Direct *in situ* with flight model

VVP

(*Vertical Velocity Profiler*)



Glider Sea Explorer



Indirect :

ω equation

- + *in situ* density/ currents
- + satellite

+ Modelisation (hydrostatic)

Vertical Velocities measurement

Direct *in situ* (ADCP)

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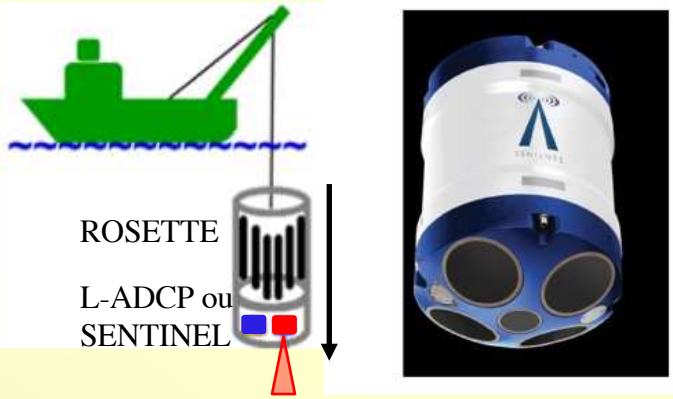

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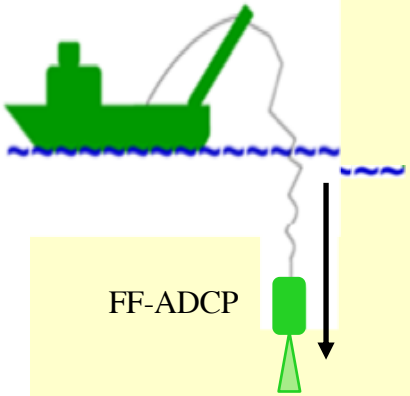

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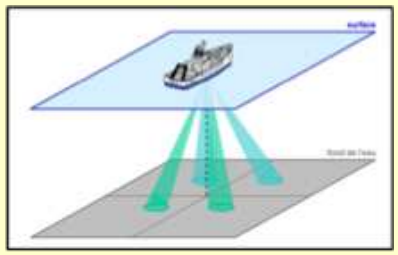
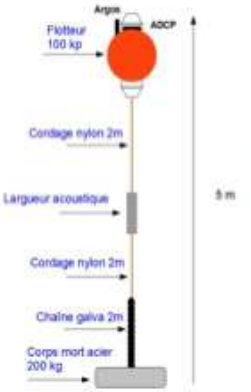


Mooring



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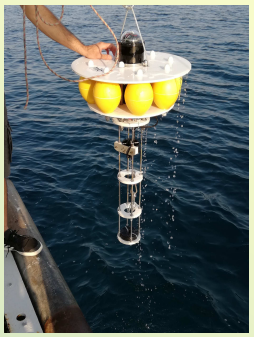

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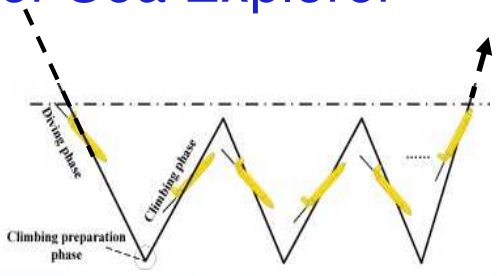

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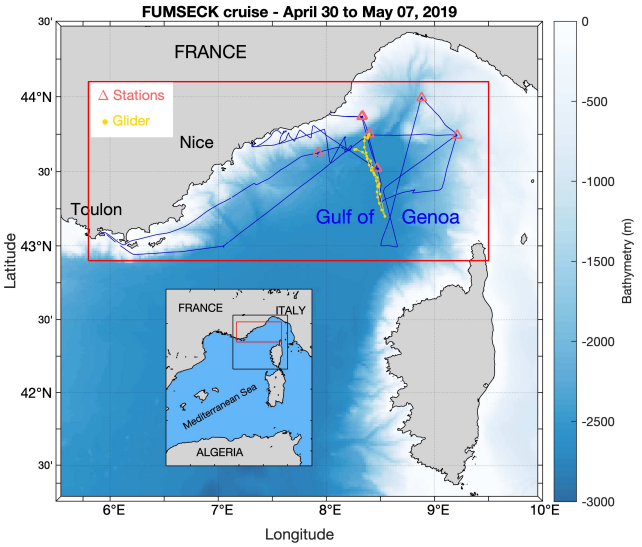
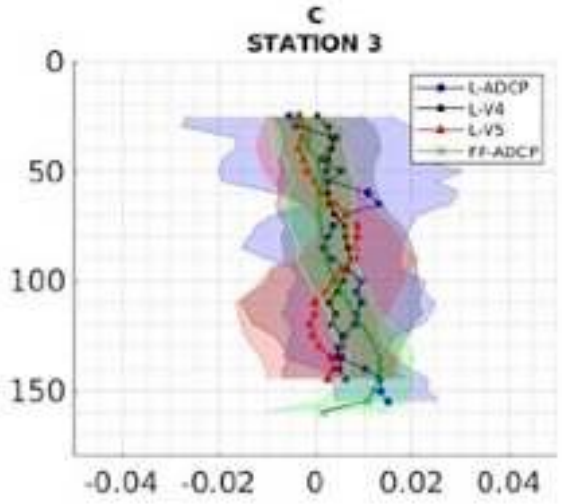
Vertical velocities ADCP



Comby *et al.* (2022)

- FUMSECK cruise, Med
- 6 stations
- 4 methods
  - Lowered-ADCP
  - Lowered-Sentinel
    4 beams + 5th vert.
  - FreeFall-ADCP



Results

Downcasts data 0 – 150 m

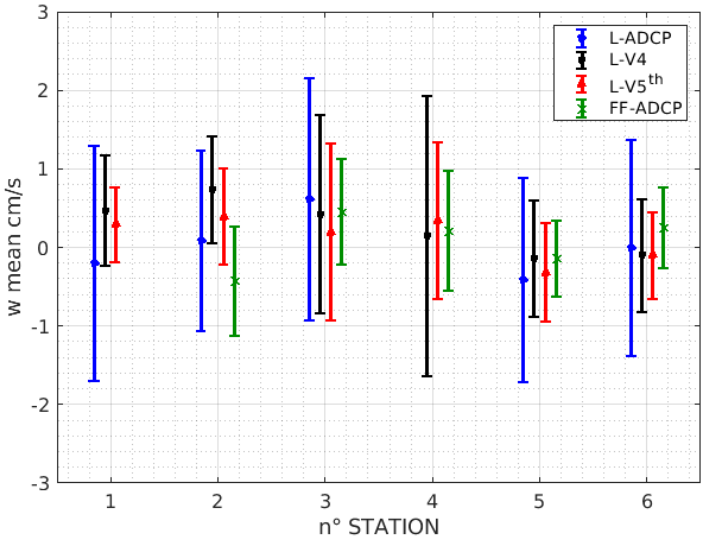
μ ~ mm/s

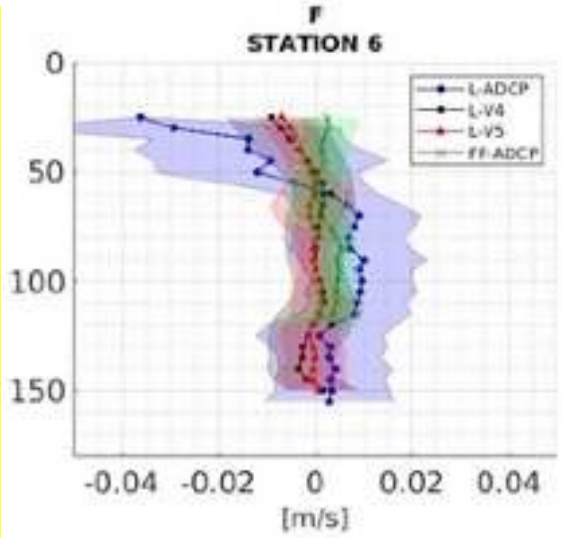
0.02 0.26 0.14 0.6 cm/s

σ ~ cm/s

1.3 1.0 0.7 0.6 cm/s

L-ADCP > L-V4 > L-V5 > FF-ADCP

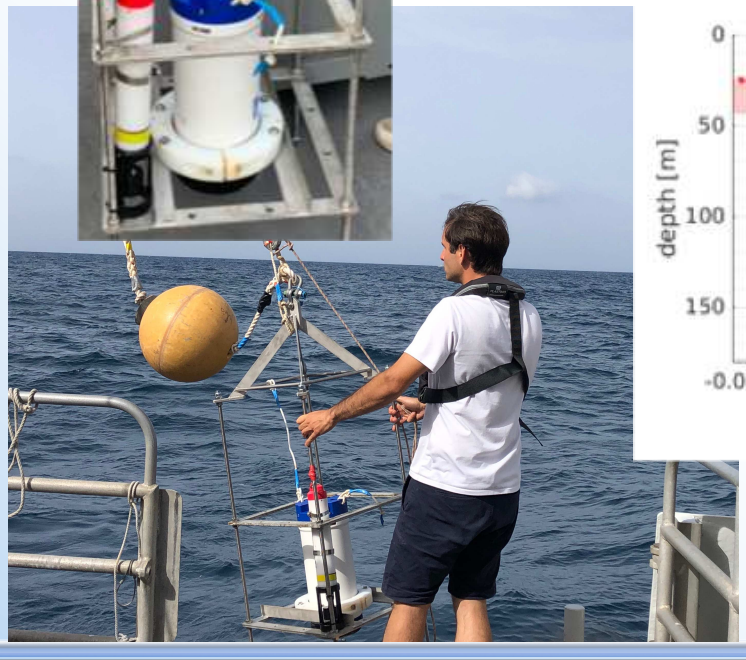


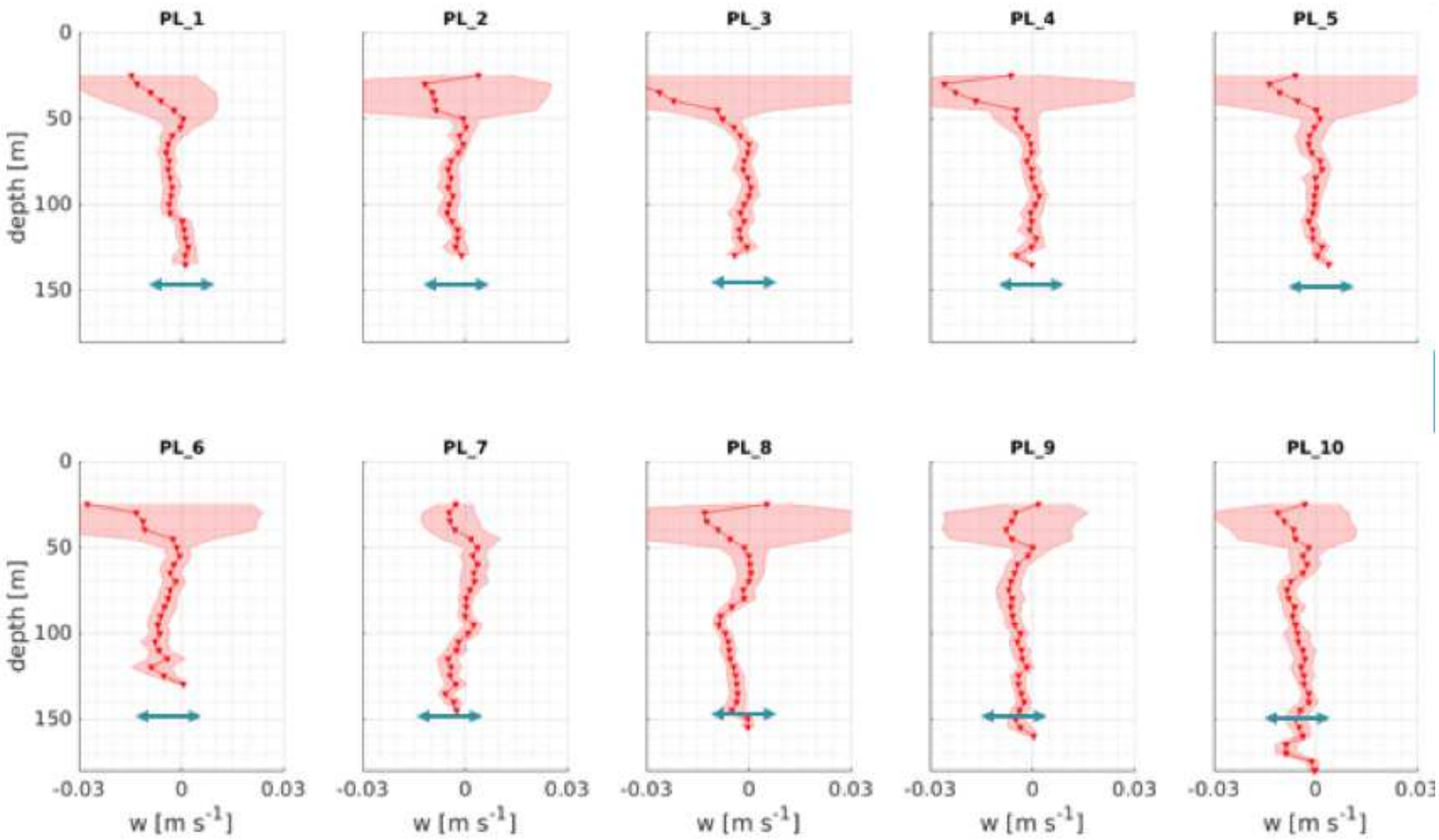


➔ best FF-Sentinel

FF-ADCP with Sentinel

VVPTest 2022 (Med)



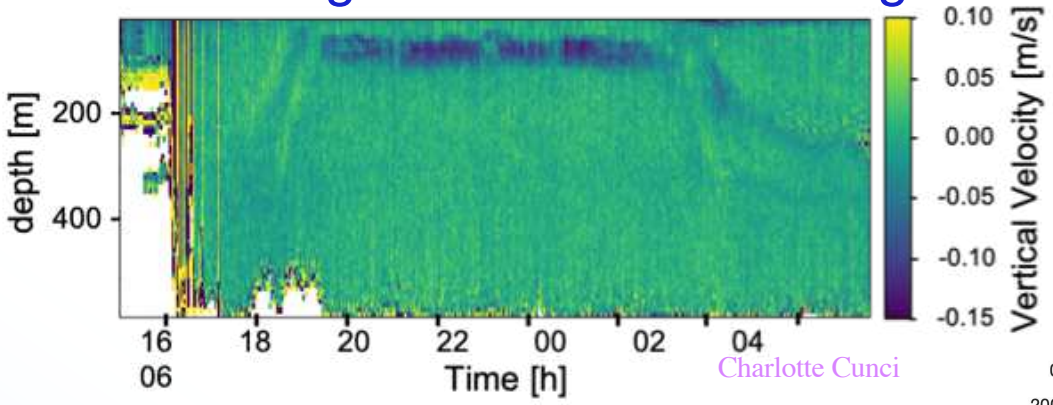


Caroline Comby

σ ≈ 3 mm/s

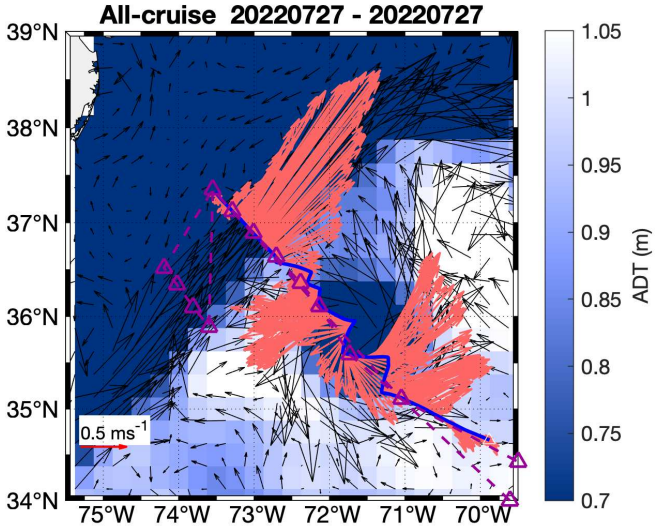
Vessel-Mounted ADCP

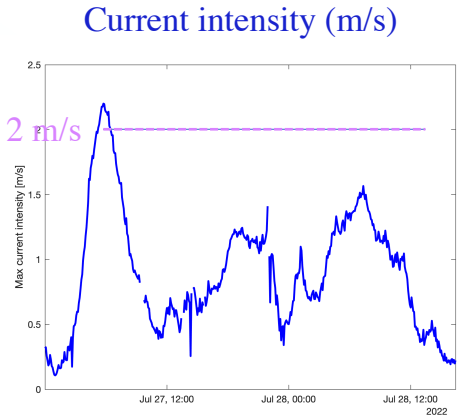
- Simple removal of ship vertical movement
  - FUMSECK: negative anomalies at night → krill nictemeral migration

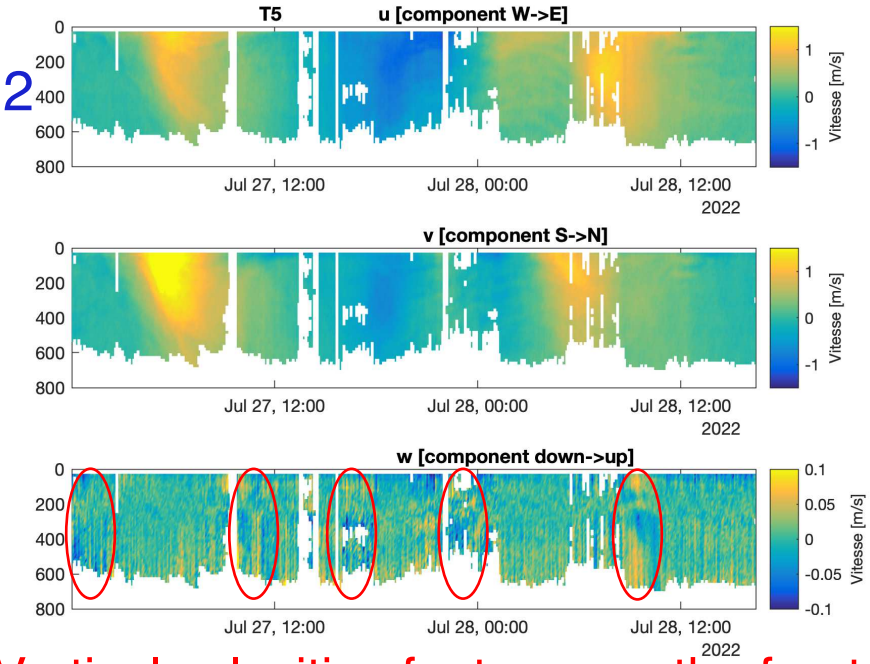


Charlotte Cunci

  - FIGURE (M. Benavides) Gulf Stream 2022







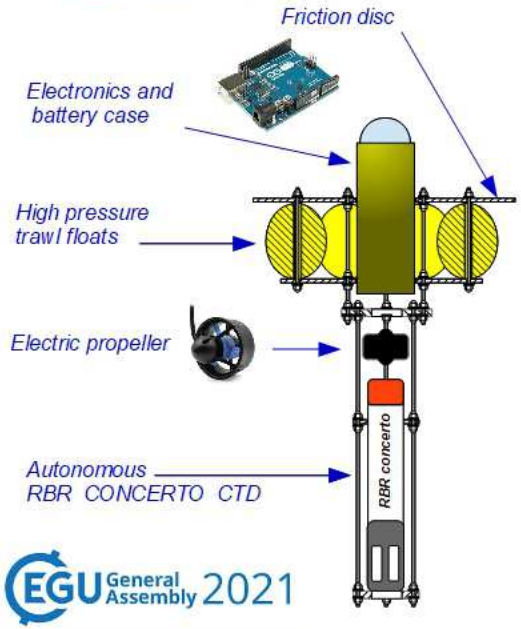
Vertical velocities features on the fronts

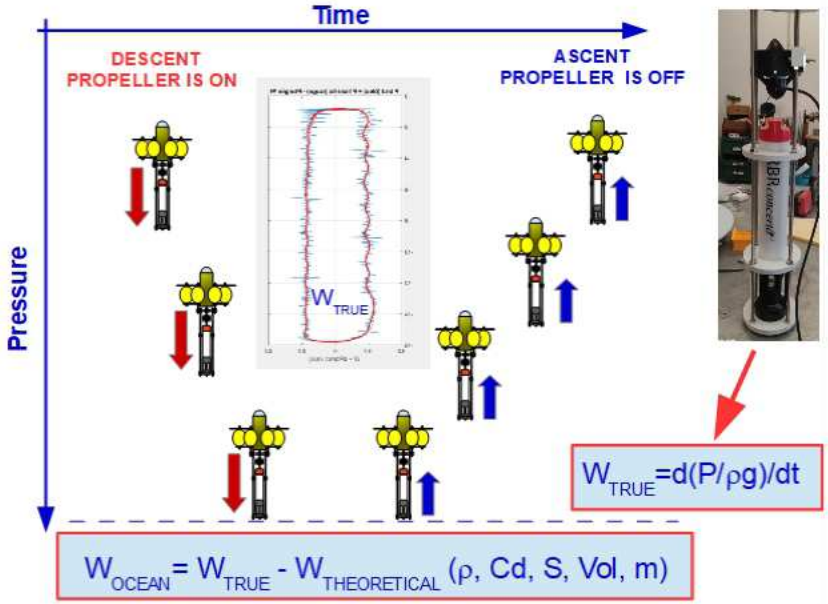
Vertical Velocity Profiler (VVP)

- VVP (Fuda *et al.*, EGU 2021): autonomous profiler, MIO development

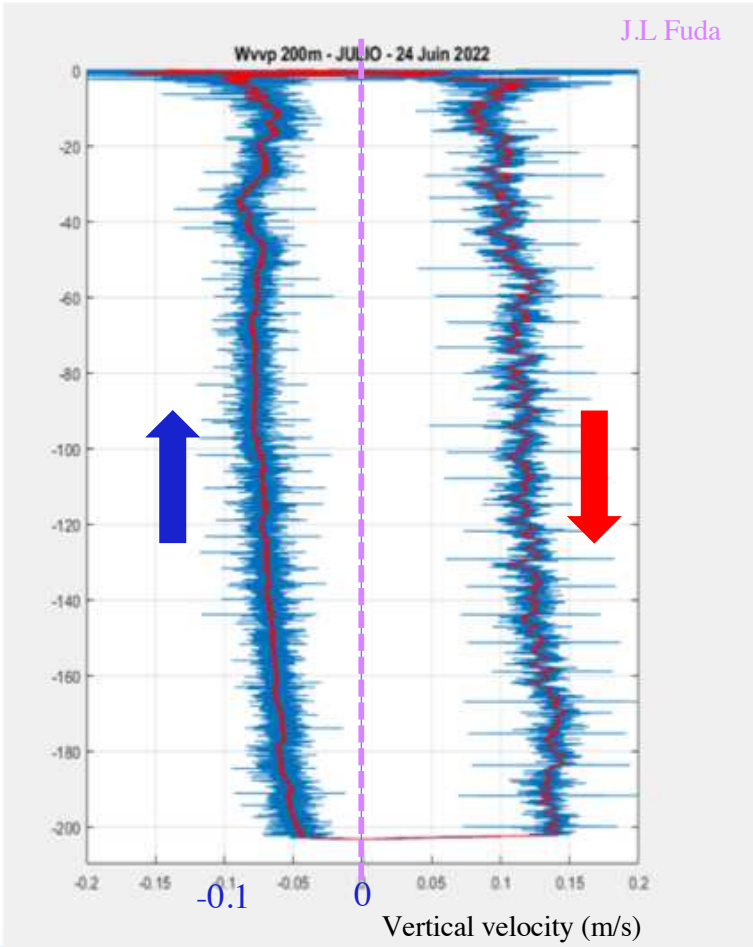
A new approach for measuring ocean vertical velocities

Fuda, J.-L[1]., Barrillon, S.[1], Doglioli, A[2]., Petrenko, A.[2], Gregori, G.[1], Tzortzis, R.[2], Comby, C.[2], Thyssen, M.[1], Lafont, M.[2], Bhairy, N.[1], Malengros, D.[1], Guillemain, D.[1], and Grenz, C.[1]*



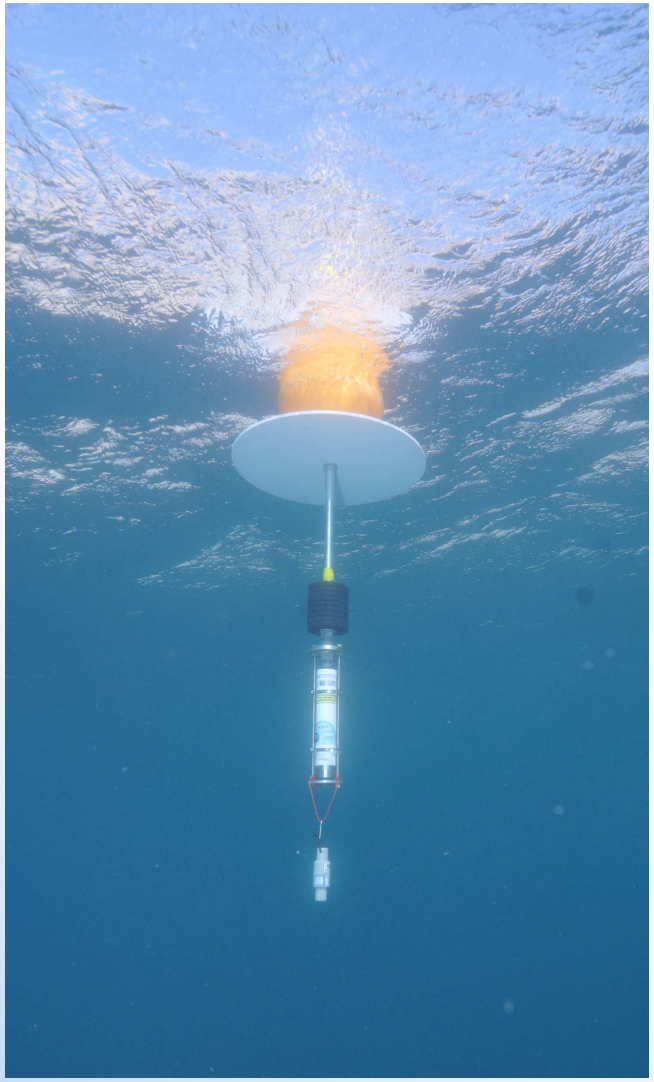


First 200 m profile (2022)

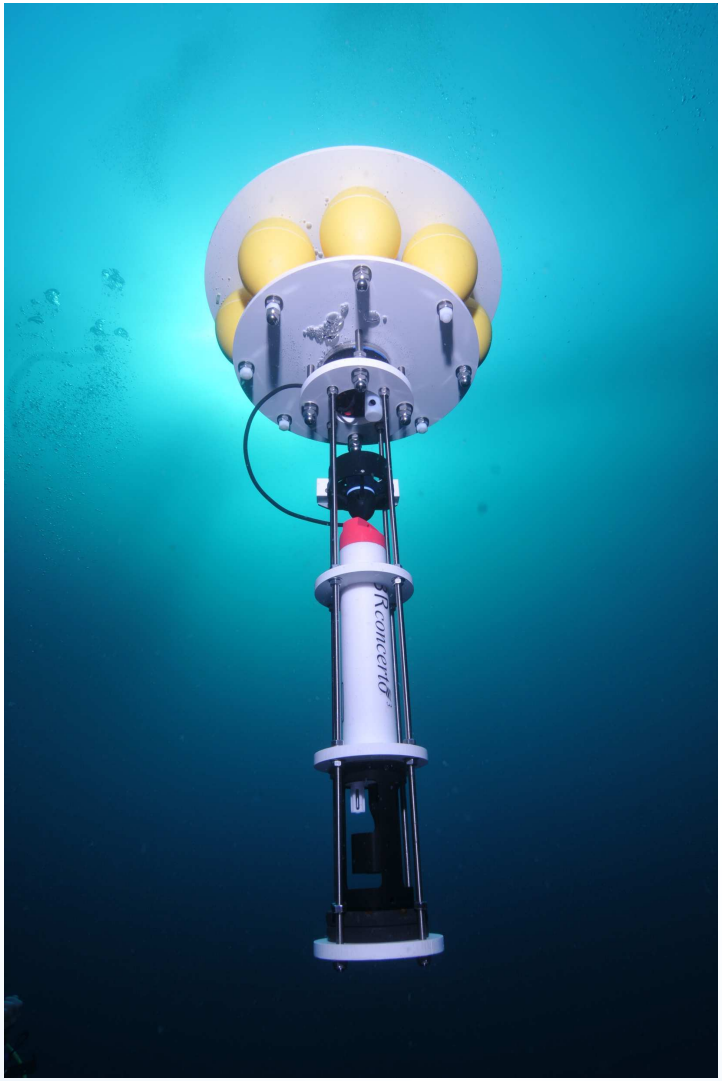


Vertical Velocity Profiler (VVP)

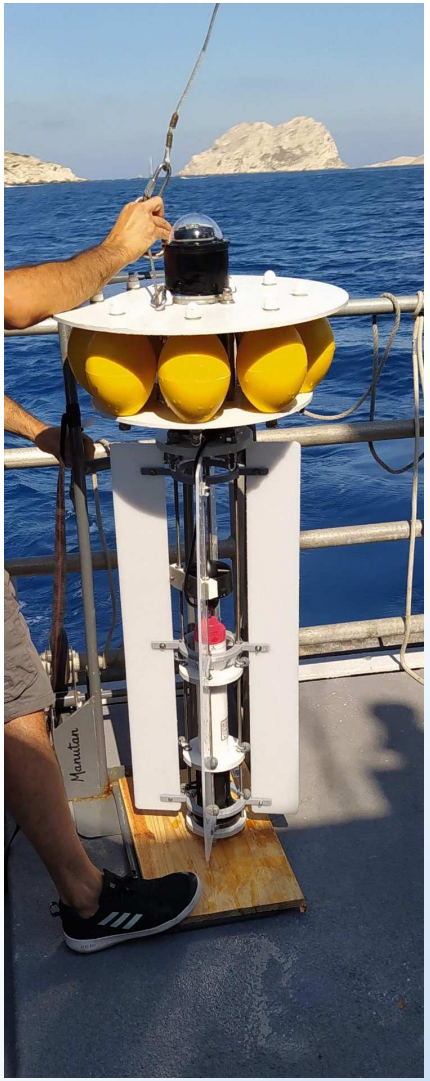
2019



2021

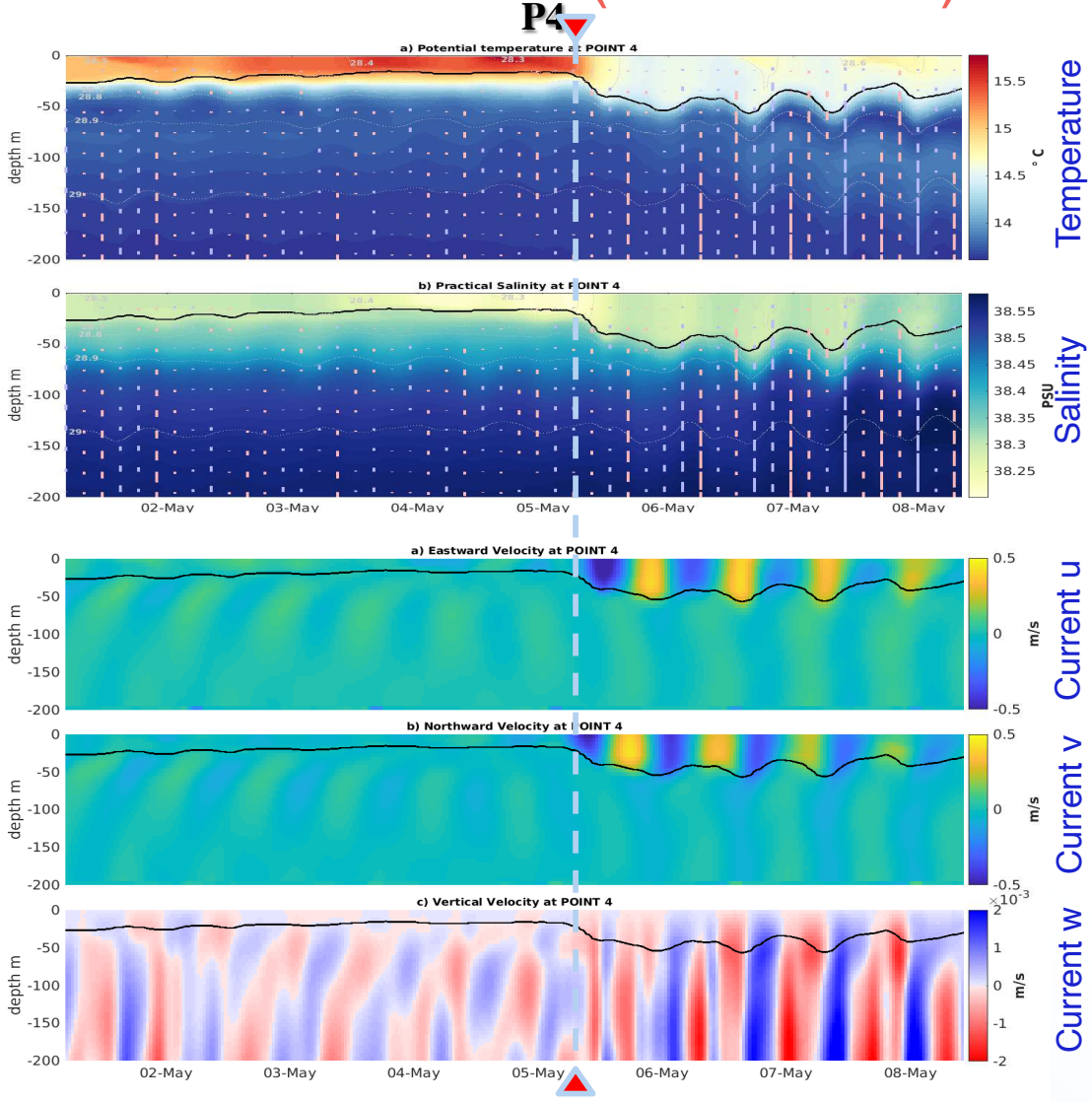


2022

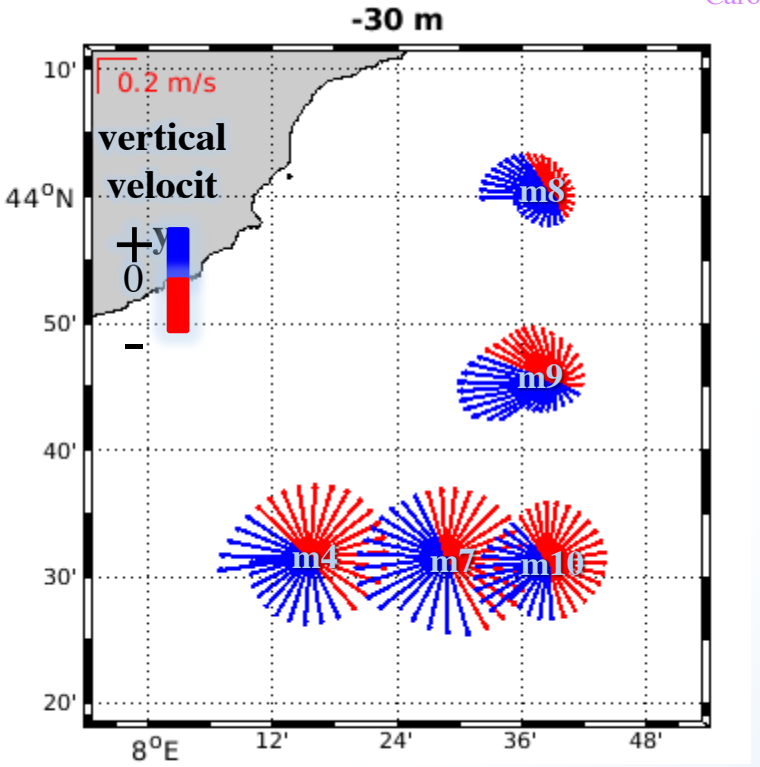


Symphonie Modelisation

Storm influence (FUMSECK)



Caroline Comby



- Deeper mixing layer
- Current intensification (horizontal and vertical)
- Inertial oscillations

Conclusion Vertical Velocities

- Important for understanding the ocean and its evolution towards global change
- Challenging in situ measurement
- New methodologies and instruments developed