

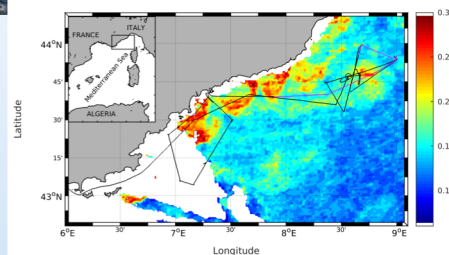
# *Fine scale studies in the Mediterranean Sea: Results and methodological perspectives*

*Mallorca, 07/06/2019*

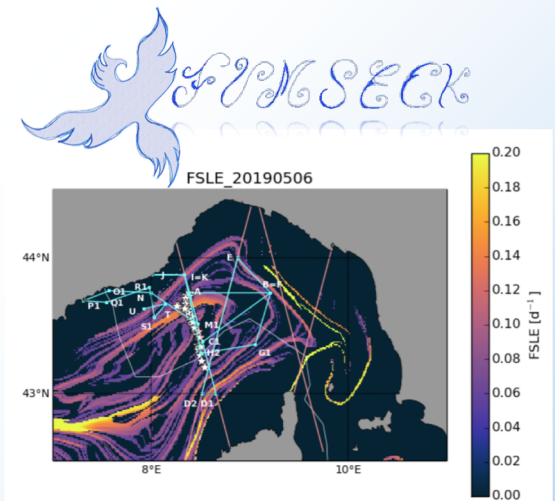
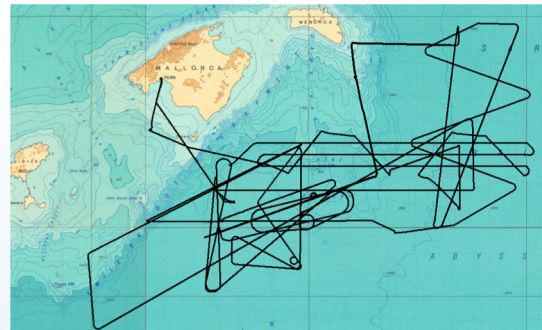
Stéphanie Barrillon (MIO), Andrea Doglioli, Jean-Luc Fuda, Gérald Grégori,  
Francesco d'Ovidio, Anne Petrenko, M. Thyssen,  
and the BIOSWOT collaboration



*OSCAHR*



*PROTEVS-SWOT*



# Outline

## ⚓ CALYPSO points in relation with MIO work

- 💬 Meso-submesoscale studies
- 💬 Lagrangian evaluations
- 💬 3D dynamics and vertical motions

## ⚓ SWOT preparation

- 💬 Instrumental and methodological prospects



<https://www.mio.osupytheas.fr/en>  
<https://www.mio.osupytheas.fr/en/research-teams/physical-littoral-and-coastal-oceanography-team-oplc>



## ⚓ MIO Mediterranean cruises

- 💬 **OSCAHR:** November 2015. Ligurian Sea
- 💬 **PROTEVS–SWOT:**  
May 2018. South of Balears
- 💬 **FUMSECK:** May 2019. Ligurian Sea

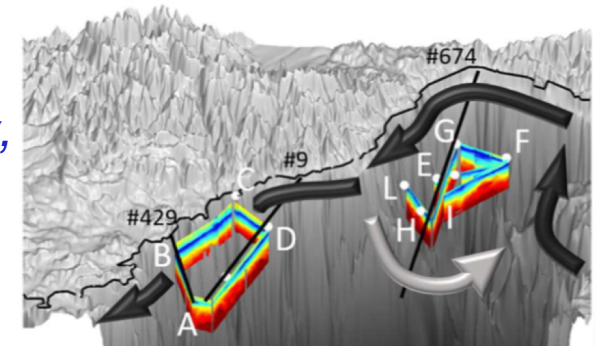


# OSCAHR



OSCAHR, Oct 29 - Nov 6 2015, Ligurian Sea. R/V Téthys II (A. Doglioli and G. Grégori)

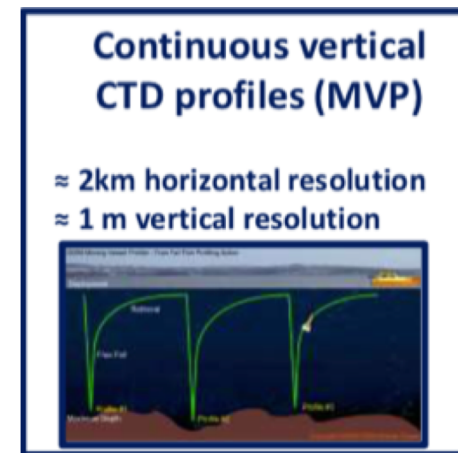
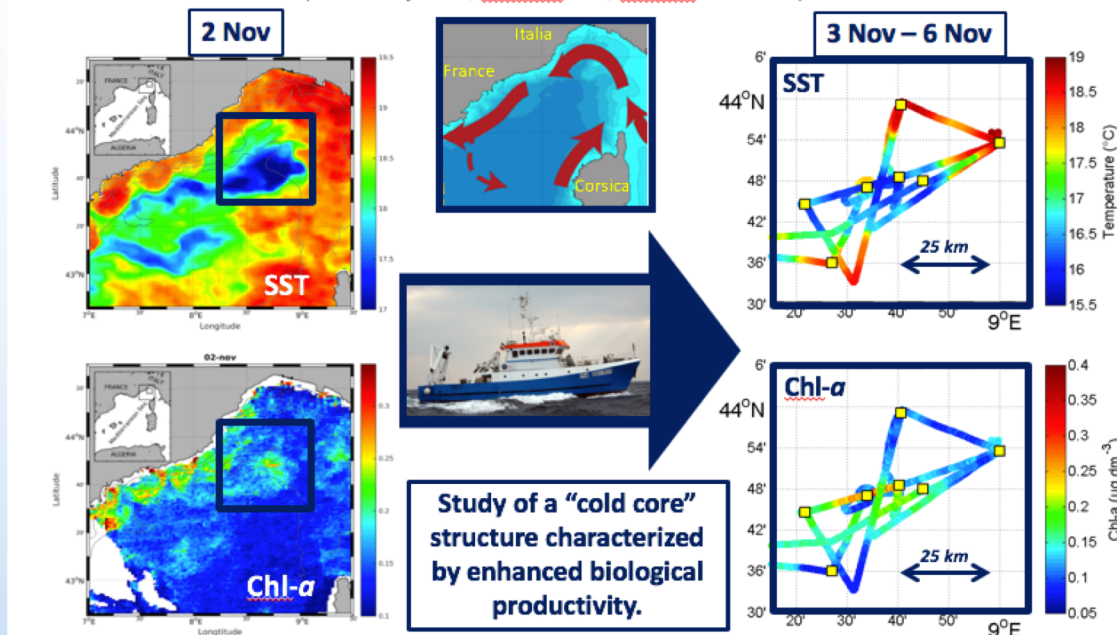
- **Fine scales. Physics – biogeochemistry coupling**
- Instruments: *Thermosalinometer, Automated flow cytometry, High resolution pumping system, Hull-mounted ADCP, MVP*
- Lagrangian strategy to spot a cyclonic structure



Meloni, *et al.*

Adaptative Lagrangian sampling strategy : near-real time analysis of satellite and numerical modeling data

(SPASSO software, d'Ovidio 2010, Nencioli *et al.* 2011)



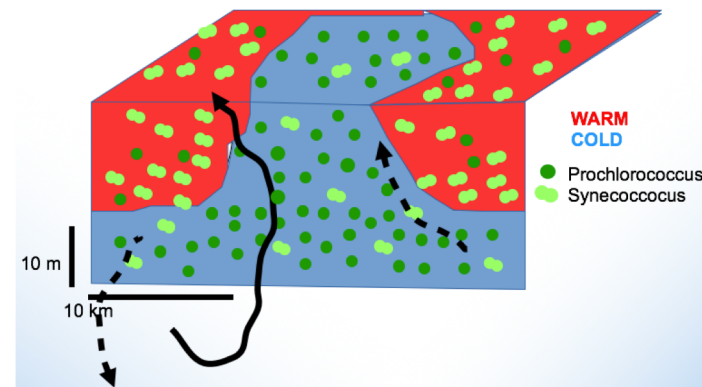
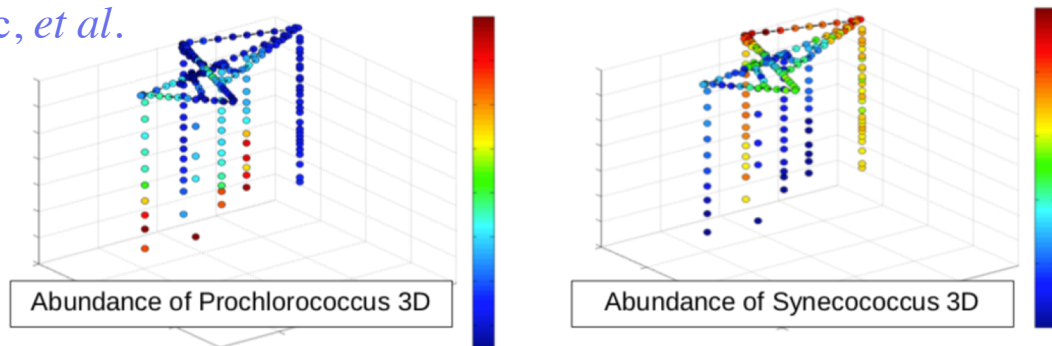
MVP



# OSCAHR Results

## Physics-biology coupling

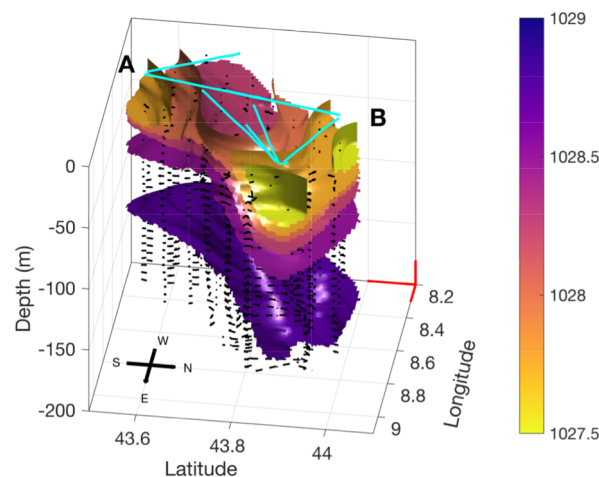
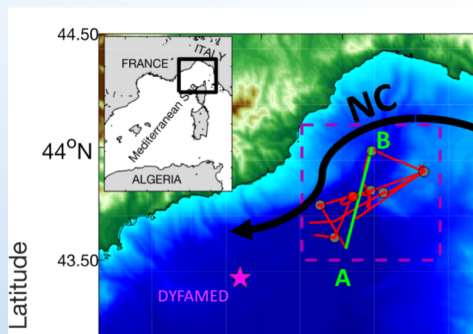
Marrec, *et al.*



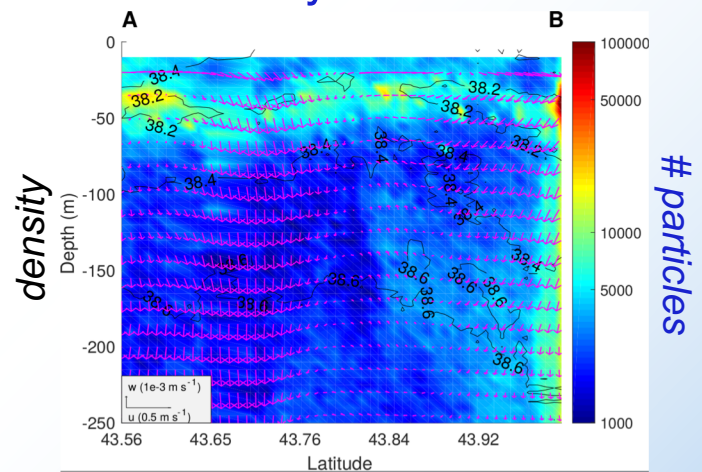
Fine scale structure of the physical field → spatial organization of the plankton functional groups

## Vertical velocities with MVP and ADCP data Reconstruction of 3-D fields : density and velocity (horizontal components)

Rousselet, *et al.*



→ *w-equation* Vertical component of the velocity field



Compatible with number of particles (LOPC)

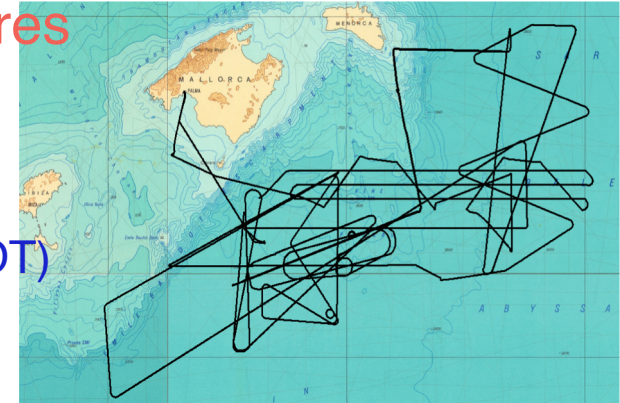


# PROTEVS-SWOT

⚓ **PROTEVS-SWOT, Apr 27 – May 14 2018, South Baleares**

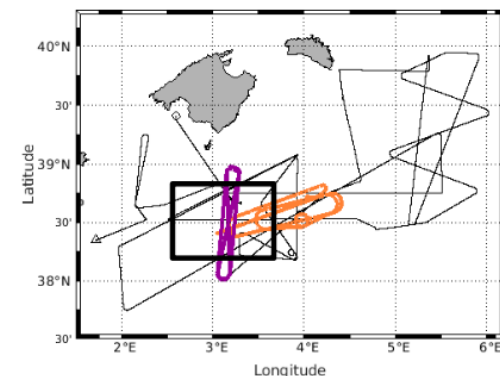
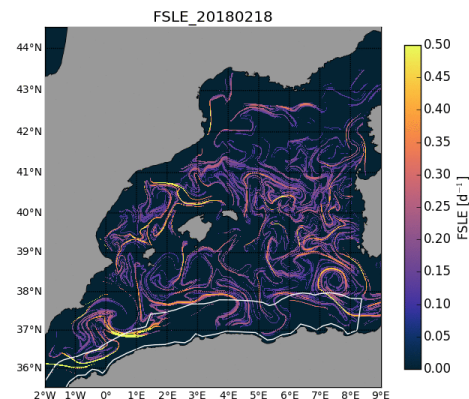
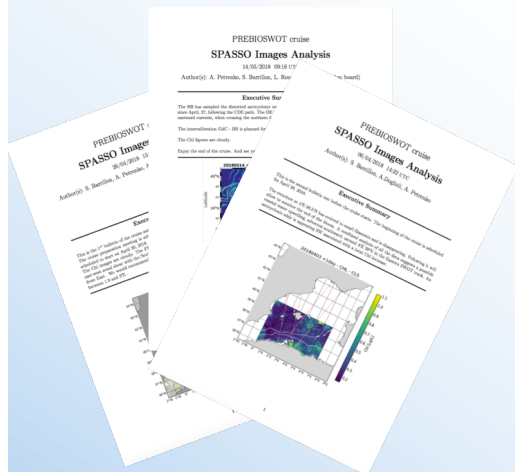
💬 **SWOT preparation**

💬 Synergy BBP (*Seasor, Cytometry, ADCP*) (F. Dumas & P. Garreau), Garcia del Cid (*CTD grid*) (A. Pascual, PRESWOT)  
*Drifting buoys + 2 gliders*



⚓ **Look for 2 distinct water masses fronts using SPASSO**

- 💬 From altimetry, SST and Chl-a observations, FSLE calculations
- 💬 Daily bulletin during the cruise → Lagrangian strategy on part of the cruise

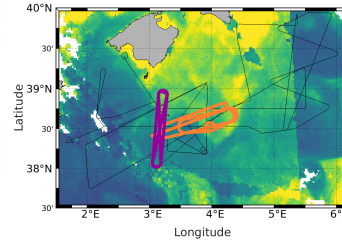
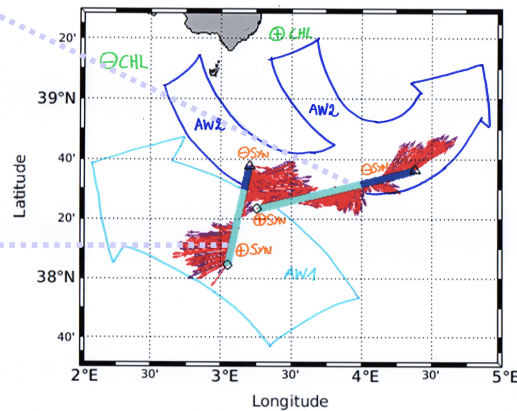
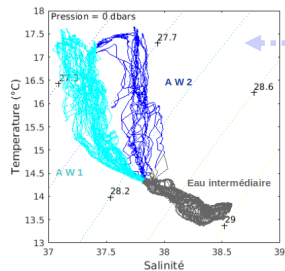
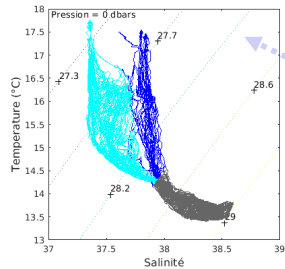


# PROTEVS-SWOT Results



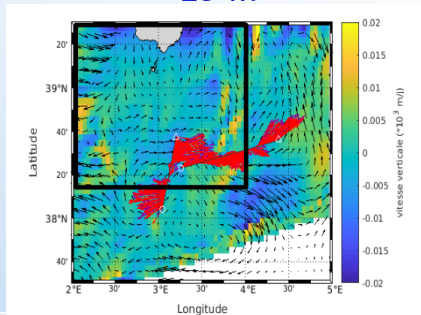
Physics-driven  
R. Tzortzis

Study of the water masses (ADCP  
Seasor, TSG)

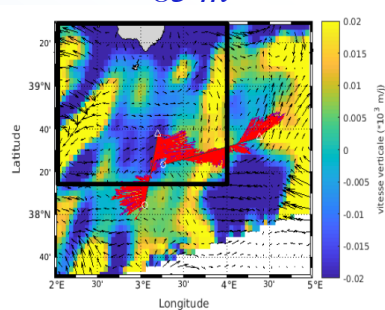


Vertical velocities with  $\omega$ -equation

25 m

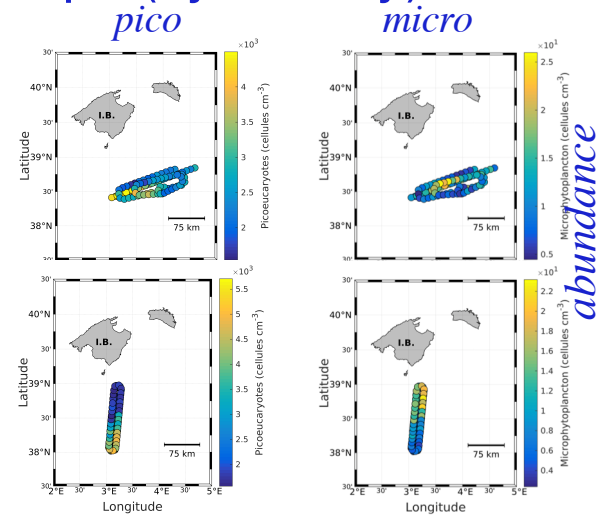


85 m

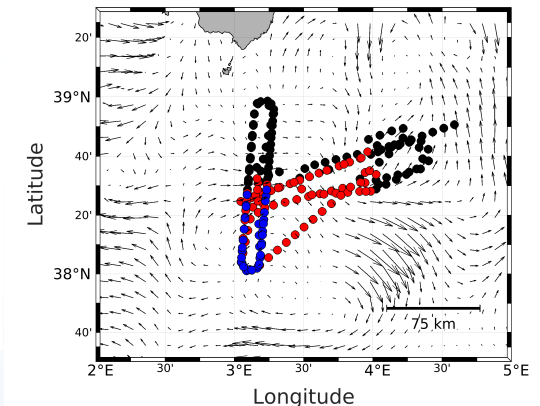
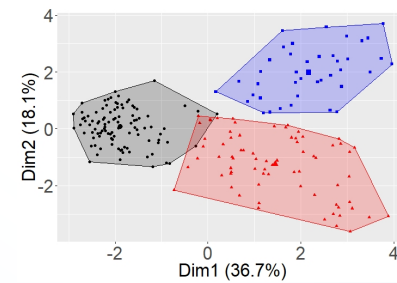


Biogeochemistry-driven  
L. Izard

Study of the phytoplankton  
groups (cytometry)



Statistical separation  
of samples

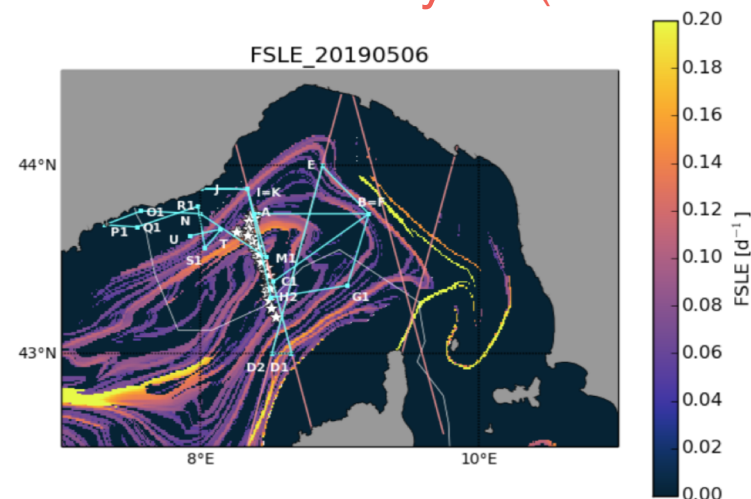
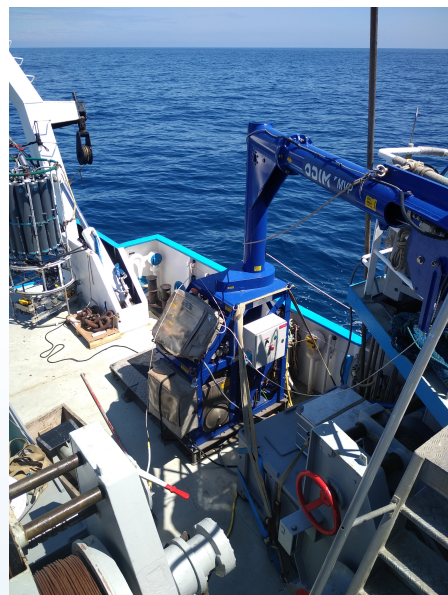
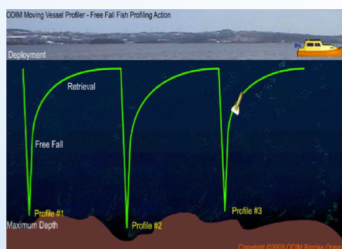






**FUMSECK** (*Facilities for Updating the Mediterranean Submesoscale - Ecosystem Coupling Knowledge*), Apr 30 - May 07 2019, Ligurian Sea. R/V Téthys II (S. Barrillon)

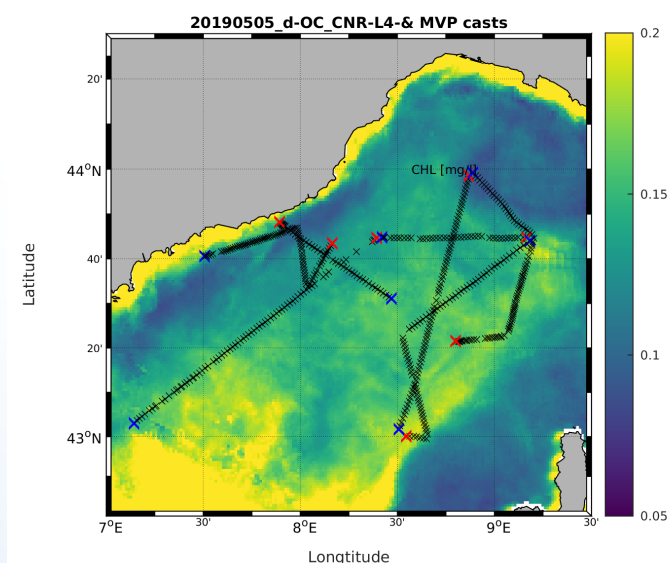
- Technological cruise
- Tests on **MVP**, vertical velocities measurement, **biodegradable micro particles tracers**



- OSCAHR zone. Lagrangian strategy

## MVP tests

 7 transects of mean 8h30 duration. Few minutes to deploy and retrieve

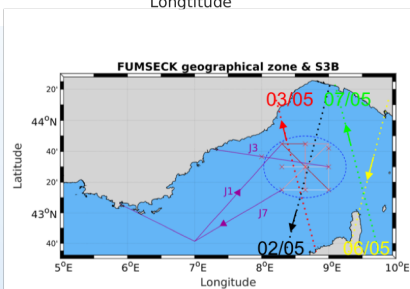
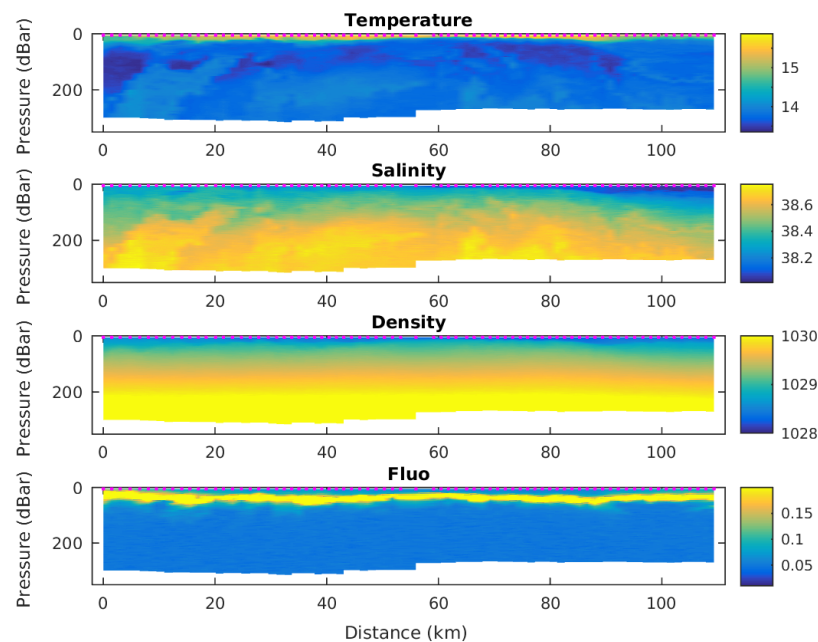
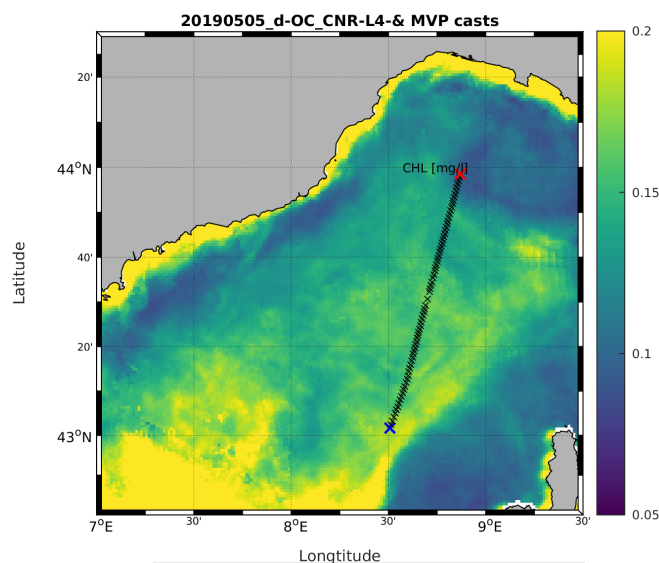


| N° de plongée | Dates                   | Immersion max | Distance | Temps de plongée |
|---------------|-------------------------|---------------|----------|------------------|
| 142/12/1      | 30/04/2019 - 01/05/2019 | 307 m         | 139 km   | 10:21:00         |
| 143/13/2      | 01/05/2019 - 01/05/2019 | 278 m         | 64.6 km  | 04:50:00         |
| 144/14/3      | 01/05/2019 - 02/05/2019 | 282 m         | 124 km   | 10:06:00         |
| 145/15/4      | 02/05/2019 - 02/05/2019 | 297 m         | 111 km   | 08:46:00         |
| 146/16/5      | 02/05/2019 - 03/05/2019 | 308 m         | 101 km   | 10:15:00         |
| 147/17/6      | 04/05/2019 - 04/05/2019 | 271 m         | 55.6 km  | 04:23:00         |
| 148/18/7      | 05/05/2019 - 06/05/2019 | 303 m         | 85.2 km  | 09:44:00         |



## MVP tests

 7 transects of mean 8h30 duration. Few minutes to deploy and retrieve



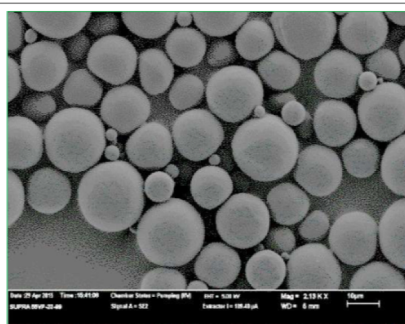
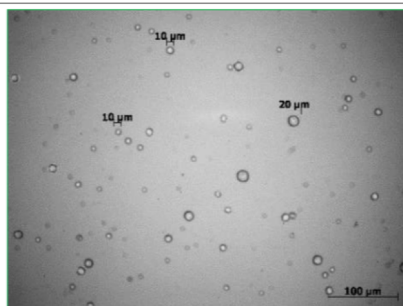
2019-05-02 09:58:07 (UTC)  
8.6845 43.5230  
on the middle of S3B satellite track !



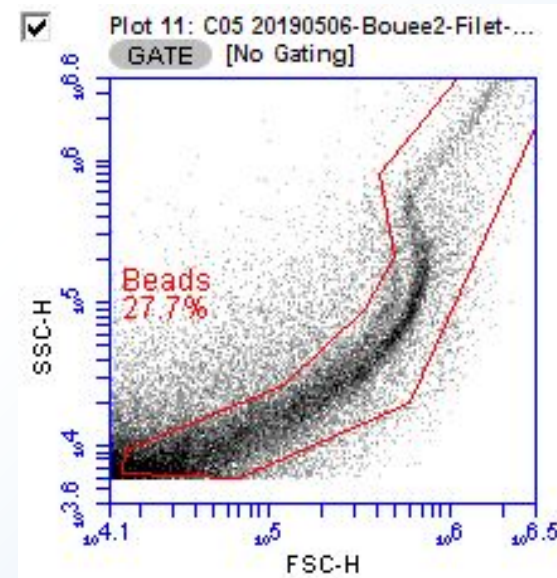
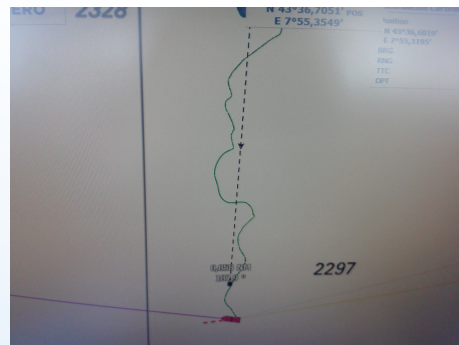
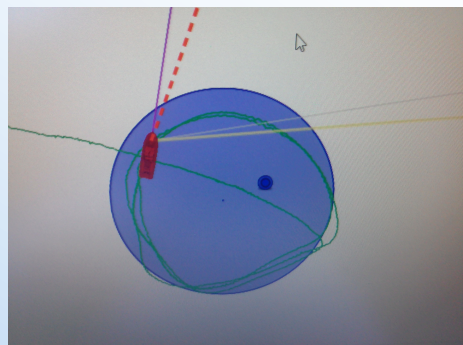
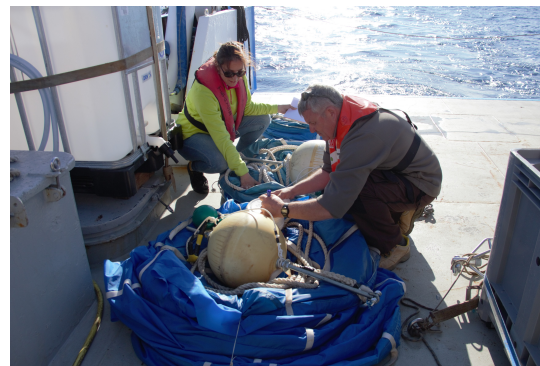
## Biodegradable microparticles as tracers for plankton dynamics



Experience release and detection of a small sample (1kg)



**Figure 3.** Images of the micro-particles taken by Optical (left) and Scanning Electron (right) Microscopy.



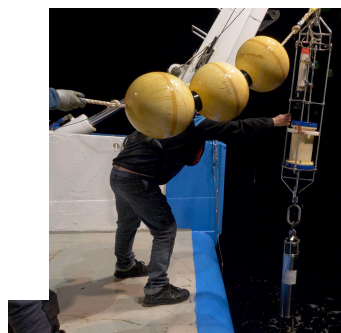
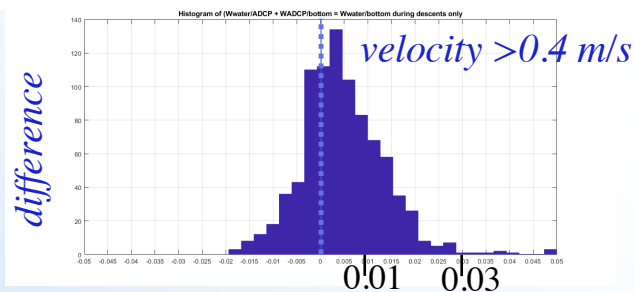
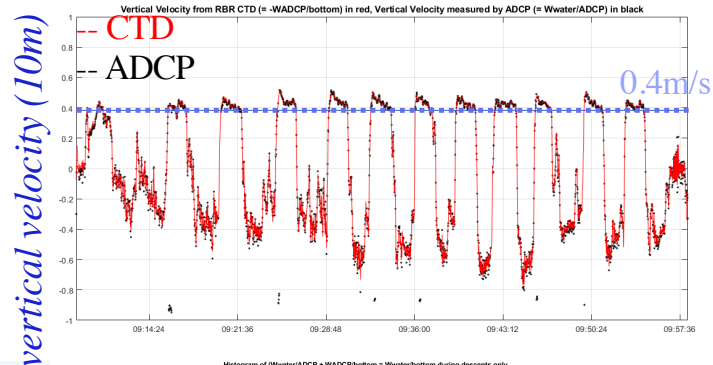


## Vertical velocities

Preliminary

J.L. Fuda

ADCPS (Hull-Mounted, L-ADCP and fixed depth and yoyo, Free-Fall ADCP)

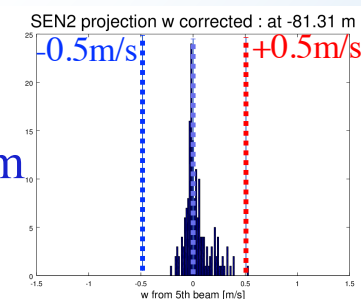
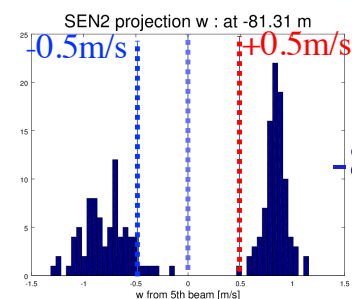
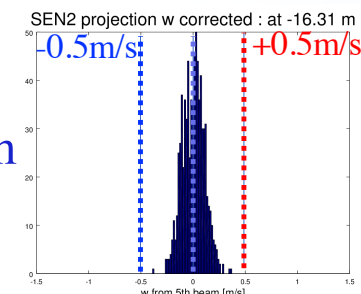
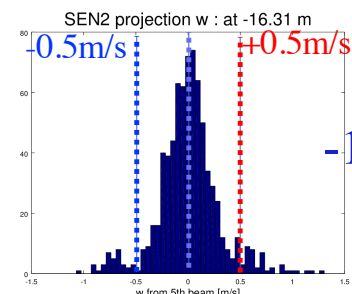
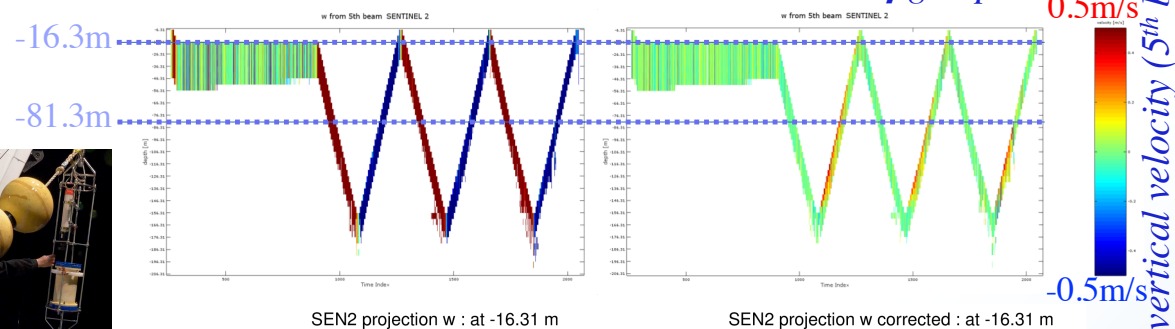


## Sentinel 5 beams

C. Comby

no correction

cor with Sentinel 1/ $\rho g \cdot dp/dt$



- «Vertical Velocity Profiler»
- Glider
- Comparison with MVP and  $\omega$ -equation

# Conclusions & Perspectives



## OSCAHR - PROTEVS-SWOT - FUMSECK

- Innovative **adaptive strategy** with **multidisciplinary** approach
- → **fine-scale physical structures** drive the **biogeochemical variability** and spatial **distribution of the phytoplankton functional groups**
- MIO Med cruises:
  - Gained **experience**
  - **Promising** results
  - → **deeper understanding** of the physical and biogeochemical processes at the fine scales



## CALYPSO, SWOT 2022 and the future cruises

- 2D → 3D (increase horizontal and vertical resolution, access vertical velocities) → 4D (temporal evolution) for fine scales understanding
- ...



# References

- ⚓ **Meloni, M.**, Bouffard, J., Doglioli, A.M., Petrenko, A.A., Valladeau, G. (2019). *Toward science-oriented validations of coastal altimetry: application to the Ligurian Sea*. Remote Sens.Envir., 224, 275-288, doi:[10.1016/j.rse.2019.01.028](https://doi.org/10.1016/j.rse.2019.01.028). *see preprint HAL*
- ⚓ **Rousselet L.**, Doglioli, A.M., de Verneil, A., Pietri, A., Della Penna, A., Berline, L., Marrec, P., Gregori, G., Thyssen, M., Carlotti, F., Barrillon, S., Simon-Bot, F., Bonal, M., d'Ovidio, F. and Petrenko, A.A. (2019). *Vertical motions and their effects on a biogeochemical tracer in a cyclonic structure finely observed in the Ligurian Sea*. J.Geophys.Res., 124, doi:[10.1029/2018JC014392](https://doi.org/10.1029/2018JC014392).
- ⚓ **Marrec, P.**, Grégori, G., Doglioli, A.M., Dugenne, M., Della Penna, A., Bhairy, N., Cariou, T., Hélias Nunige, S., Lahbib, S., Rougier, G., Wagener, T., Thyssen M. (2018). *Coupling physics and biogeochemistry thanks to high resolution observations of the phytoplankton community structure in the North-Western Mediterranean Sea*. Biogeosciences, 15, 1579-1606, doi:[10.5194/bg-15-1579-2018](https://doi.org/10.5194/bg-15-1579-2018). Popularization paper in French [HTML](#) [PDF](#)

# *Backup*