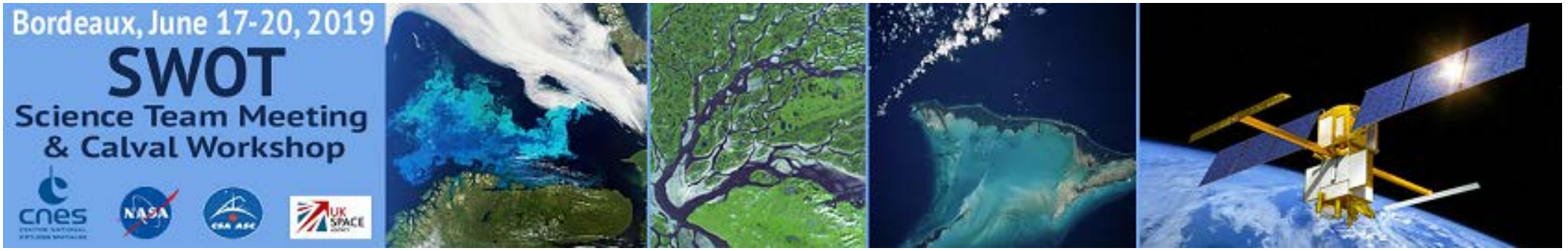


W Mediterranean CalVal updates

A.M.Doglioli (MIO, Marseille, France)

F.d'Ovidio, X.Capet et A.Pietri (LOCEAN, France),
G.Grégori, L.Rousselet, S.Barrillon, A.Petrenko,, M.Thyssen,
M.Goutx, N.Bahiry, J.-L.Fuda (MIO, France)
F.Dumas (SHOM, France), P.Garreau (IFREMER, France),
A.Pascual (IMEDEA, Spain), F.Cyr (DFO, Canada)

Mediterranean Institute of Oceanography

LOCEAN

SHOM L'océan en référence

Ifremer

IMEDEA

CSIC

Universitat de les Illes Balears

MED ACTIVITIES TIMELINE

Test Cruise OSCAHR (nov ‘15)
methodological development, instrument tests

FineMed colloquium (jun ‘17)
mediterranean consortium bulding & 2018 cruise implementation

PROTEVS-SWOT campaing (apr/may ‘18)
New in-situ multiplatform measurements

VVPTest cruise (mar ‘19) & FUMSECK cruise (may ‘19)
New methods developments and instrument tests

Next steps :
Gibraltar Strait cruise (sept ‘19)
New tests on direct w measurements

BIOSWOT_MED (in prep. for 2022)
SW Med Cruise with biophysical measurements

**All these activites are supported by BIOSWOT,
a TOSCA/CNES program (PI F.d’Ovidio, Co-I A.Doglioli & G.Grégori)**

OSCAHR

OSCAHR

PIs : A.M.Doglioli et G.Grégori

Collaborators :

P.Marrec, L.Rousselet, A.DellaPenna, A.deVerneil,O.Ross
M.Thyssen, T.Wagener, A.Petrenko, L.Berline, C.Pinazo, B.Zakardjian,
G.Rougier and N.Bahiry (MIO), C.Yohia (OSU Pytheas),
F.Nencioli (PML), F.d'Ovidio (LOCEAN),
M.Meloni and J.Bouffard (ESA), I.Pujol (CLS)

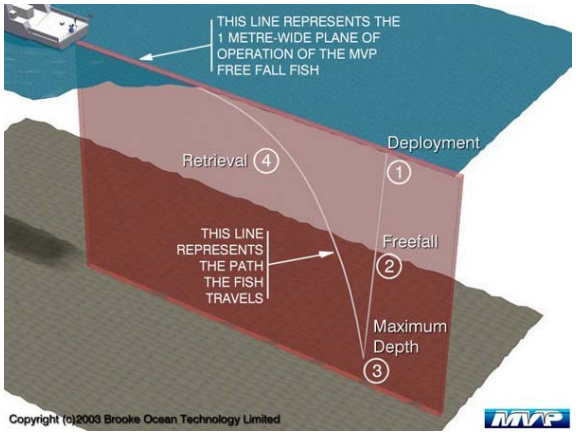
Cruise citation :

DOGLIOLI Andrea (2015) OSCAHR cruise, RV Téthys II, http://dx.doi.org/10.17600/15008800

www.mio.univ-amu.fr/OSCAHR/

OSCAHR

Altimetry



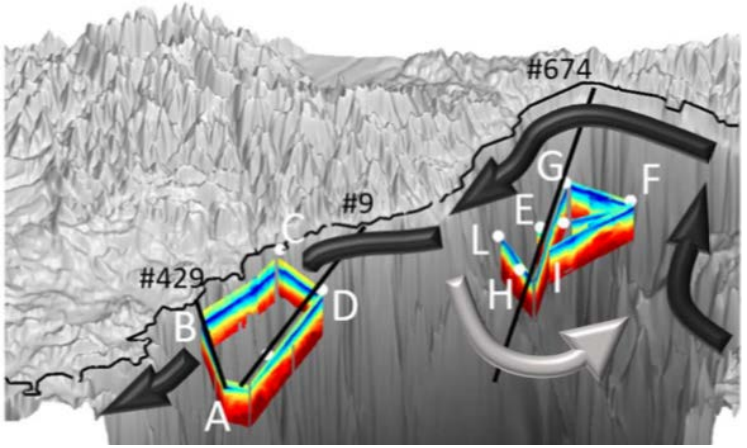
Along-track CTD casts with MVP (Moving Vessel Profiler)

Spatial resolution : ~1.5 km Route precision : < 2km

Steric Height
(Gilson et al , JGR98)

$$\Delta D = \int_{p1}^{0} \delta(S,T,p)dp = \int_{p1}^{0} \alpha(S,T,p)dp - \int_{p1}^{0} \alpha(35,0,p)dp$$

Combined with the ADCP measurements



Satellite SLA + RIO07 MDT

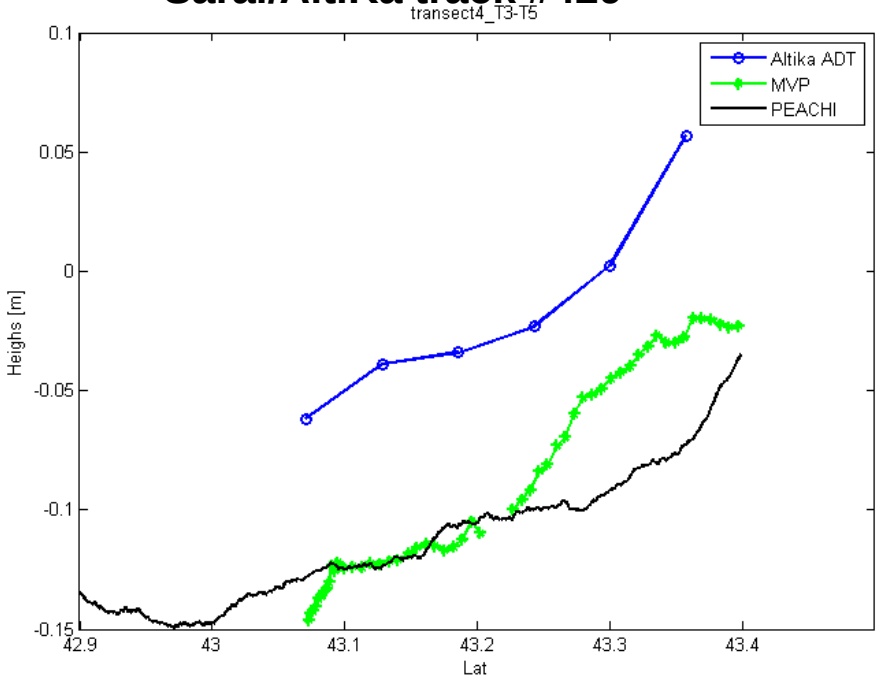
vs

PEACHI

vs

MVP (+ADCP)

Saral/AltiKa track #429



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.

OSCAHR

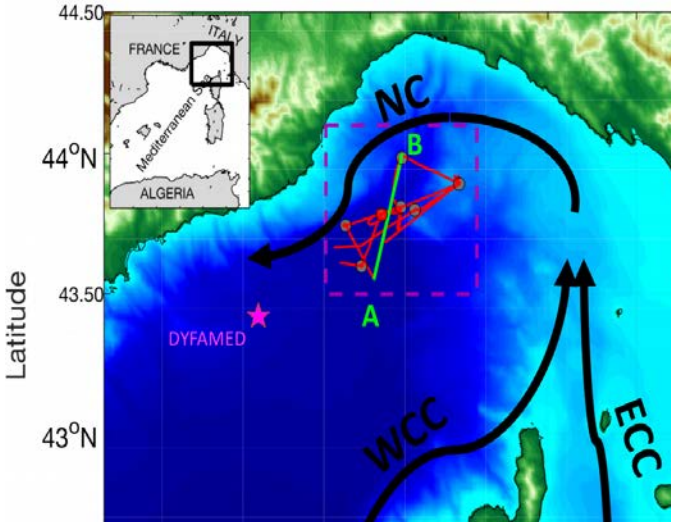
Vertical Motions and effects on biology

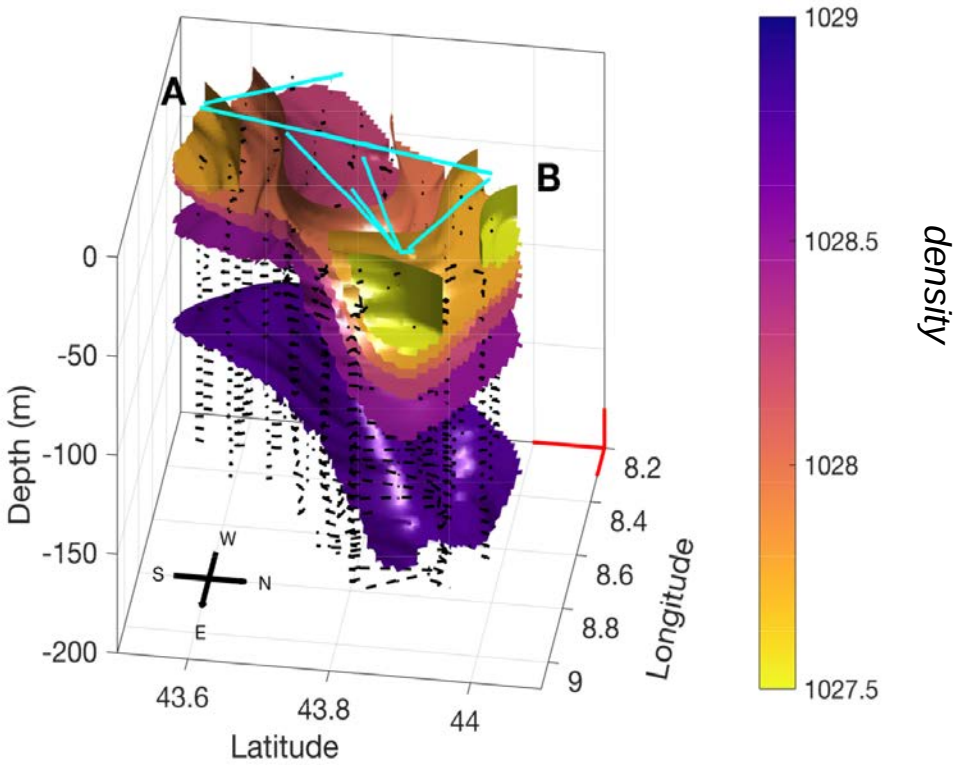
MVP and ADCP data

reconstruction of 3-D fields : density and velocity
(horizontal components)

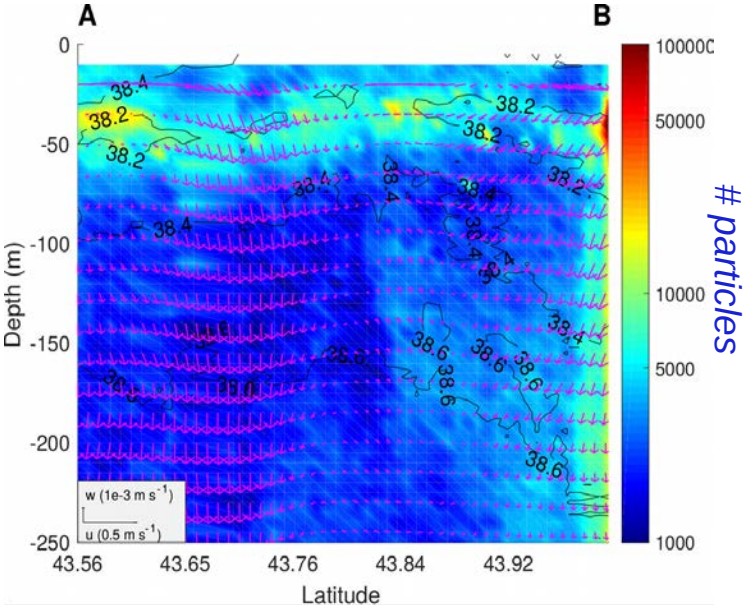
ω-equation

Vertical component of the velocity field





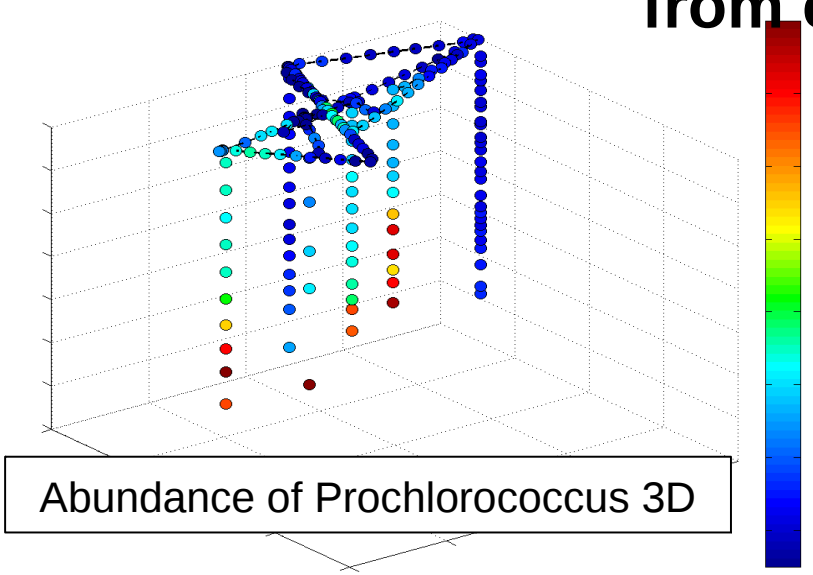
Validation with independent measurement of number of particles (LOPC)



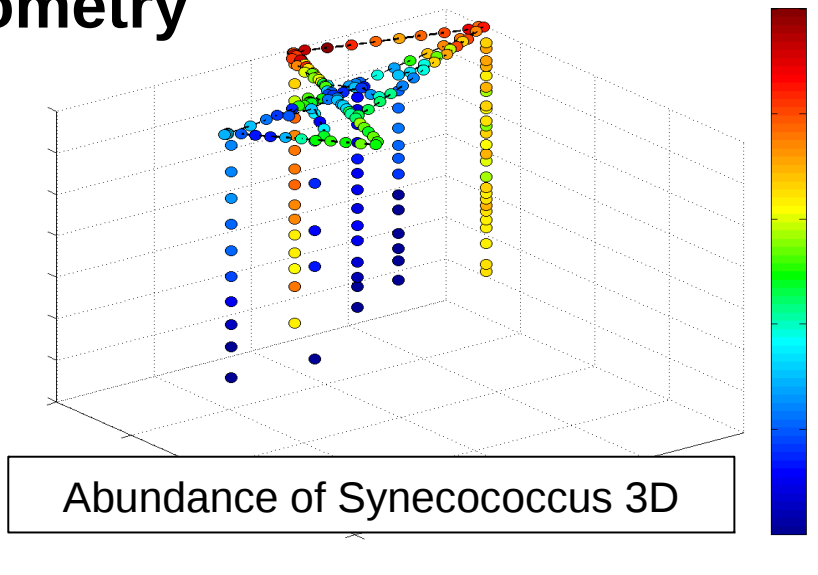
Rousselet et al. (2019), Vertical motions in a fine-scale cyclonic structure observed in the Ligurian Sea and their effects on a biogeochemical tracer. J.Geophys.Res.

OSCAHR

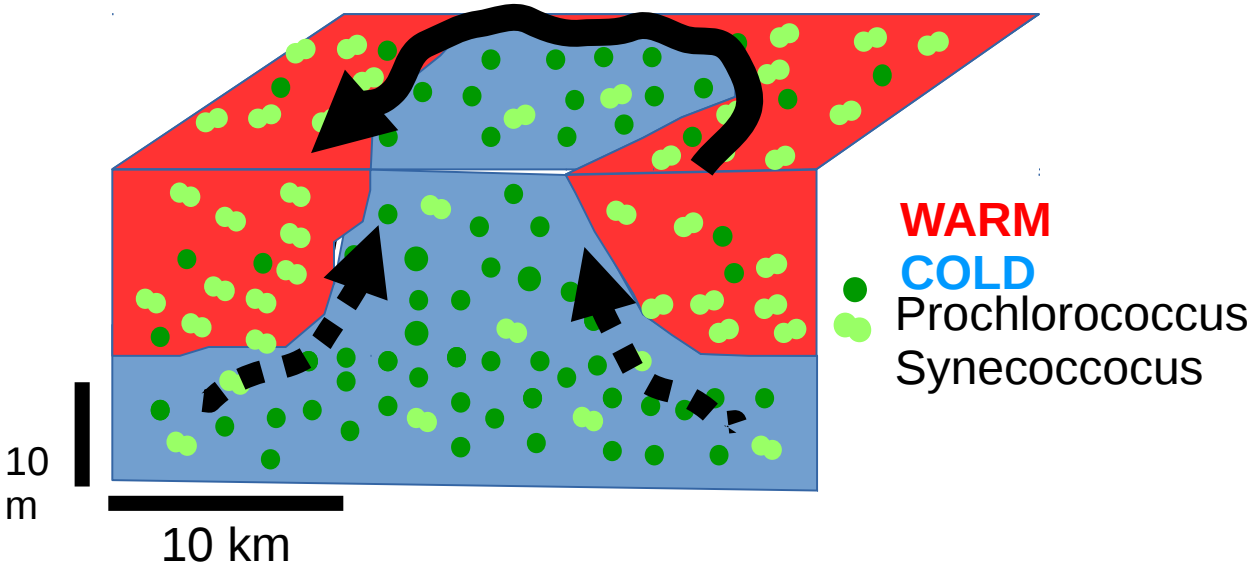
3D Phytoplankton assemblages from cytometry



Abundance of Prochlorococcus 3D



Abundance of Synecococcus 3D



the fine-scale structure of the physical field as a driver for the spatial organisation of the planktonic communities

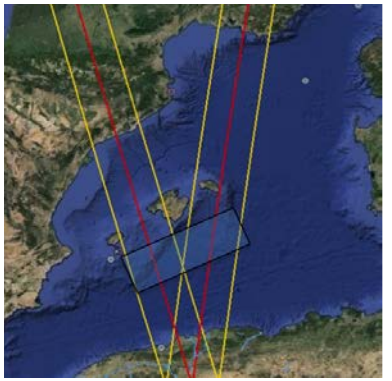
Marrec, P., Grégori, G., Doglioli, A.M., Dugenne, M., Della Penna, A., Bhairy, N., Cariou, T., Hélias Nunige, S., Lahbib, S., Rougier, G., Wagener, T., Thyssen M. (2018). *Coupling physics and biogeochemistry thanks to high resolution observations of the phytoplankton community structure in the North-Western Mediterranean Sea*. Biogeosciences, 15, 1579-1606, doi:10.5194/bg-15-1579-2018.

SW Mediterranean 2018: the PROTEVS-BIOSWOT campaign

A.M.Doglioli (MIO, Marseille, France)

F.d'Ovidio (LOCEAN),
G.Grégori, R.Tzortzis, L.Izard, S.Barrillon, A.Petrenko, M.Thyssen, M.Goutx, N.Bahiry (MIO)
F.Dumas (SHOM), P.Garreau (IFREMER), A.Pascual (IMEDEA, Spain), F.Cyr (DFO, Canada)

May 2018



A synergy among three programs:
1. PRE-SWOT (A. Pascual: SWOT-ST, CSIC, IMEDEA, SOCIB)
2. PROTEVS_SWOT (F. Dumas, P. Garreau : SHOM)
3. BIOSWOT (SWOT-ST; F. d'Ovidio: LOCEAN-IPSL;
A. Doglioli & G. Grégori : MIO, F. Cyr NAFC)

BHO Beautemps-Beaupré
(SHOM, France)

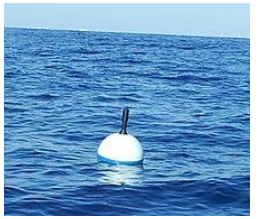
28 Avril-14 May 2018

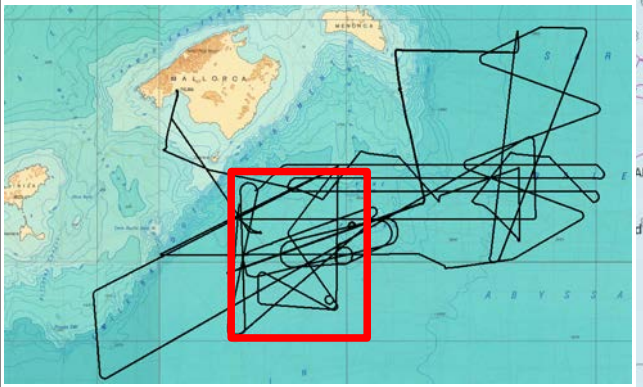
R/V García del Cid
(CSIC, Spain)

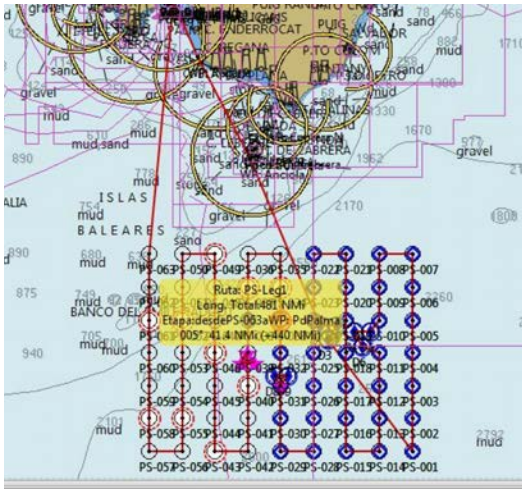
5-17 May 2018

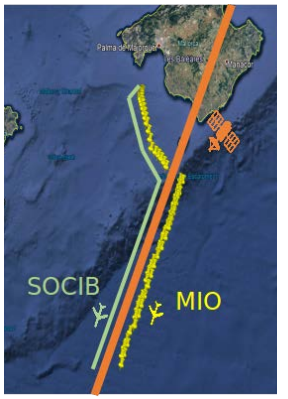
Gliders
(MIO & SOCIB)

Drifters
(CSIC, SOCIB, SHOM)









Lagrangian sampling area

Onboard of the BHO Beautemps-Beaupré

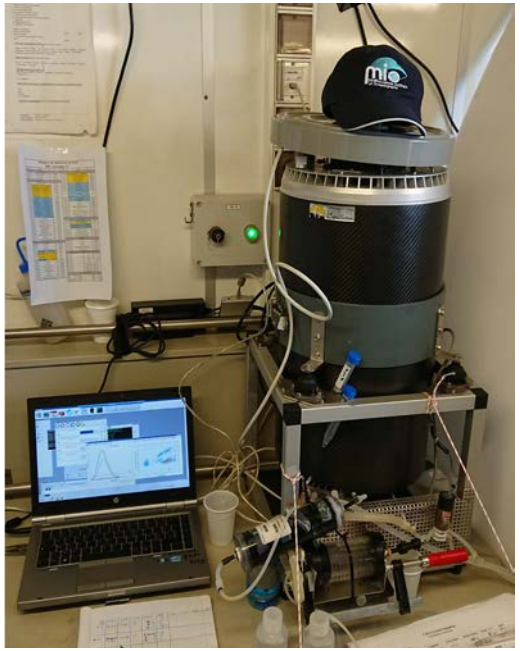
ADCP 150 & 38 kHz, TSG, SeaSoar (SHOM)
~3 km resolution & 300 m depth

Flow Cytometer (MIO)

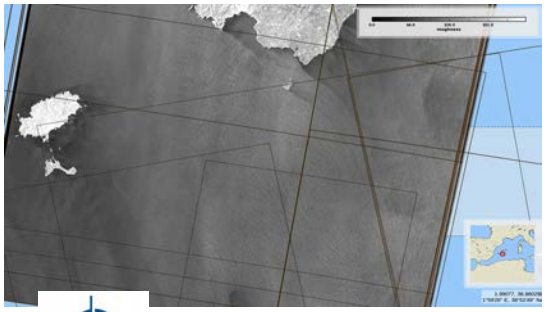
Identification of microbes from size, color, and shape.

One point every 20’

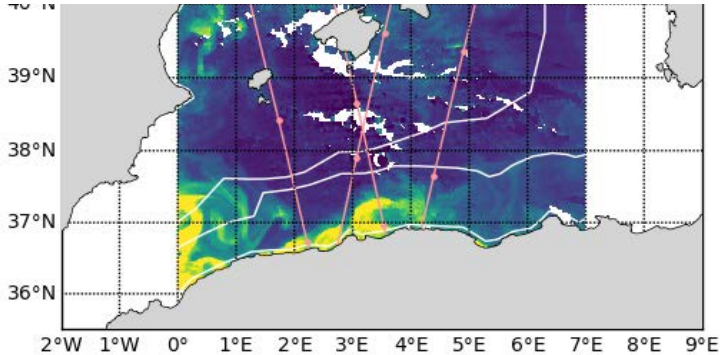
@ 9 Knot ~= 5.5 km

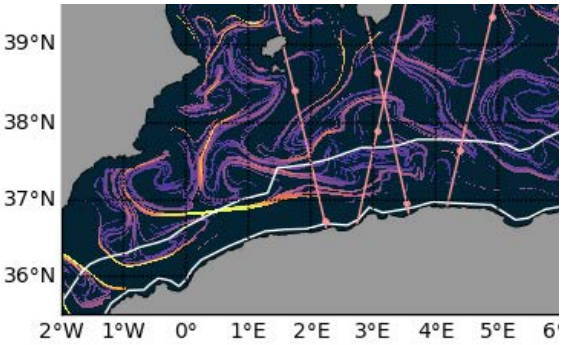


On land : multisatellite support



SAR

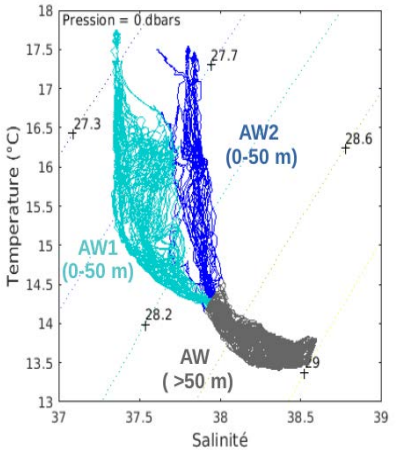


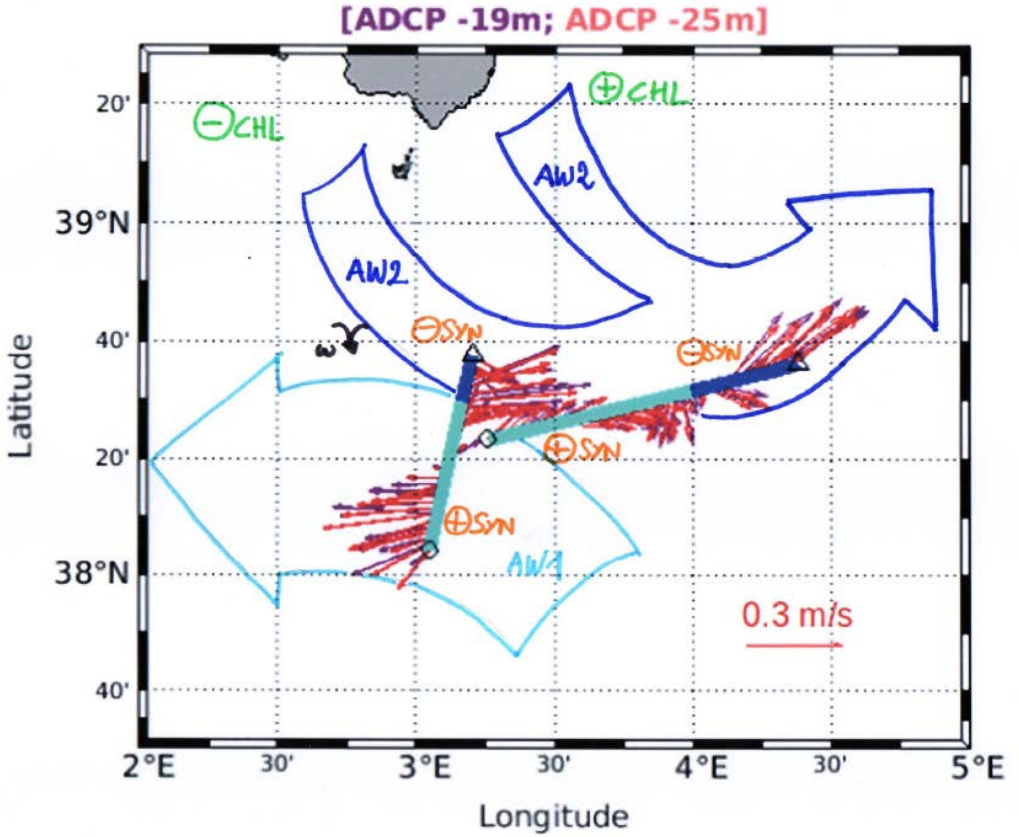


CLS data of SST and SCHL + Lagrangian analyses by SPASSO http://spasso.mio.univ-amu.fr

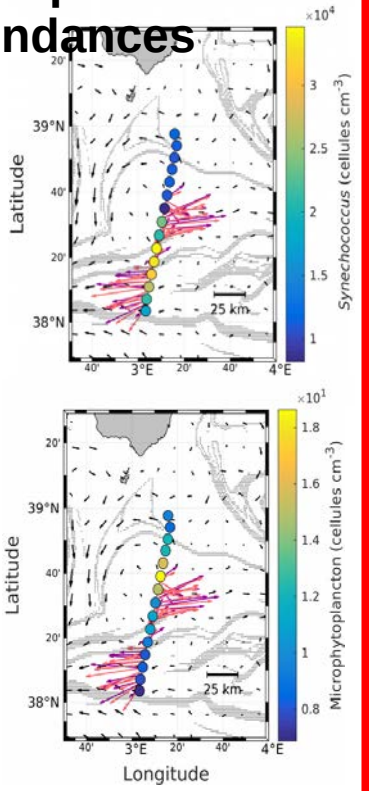
Preliminary results

HR hydrology

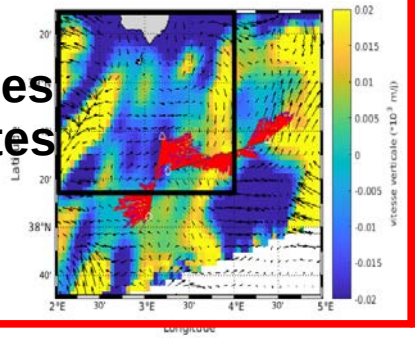




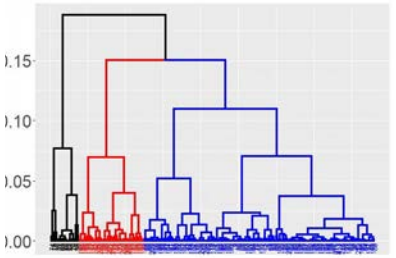
Phytoplankton abundances

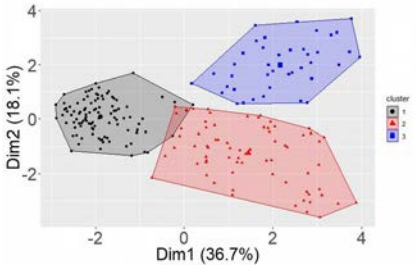


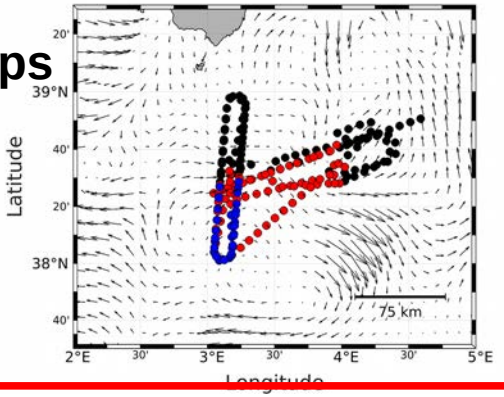
QG vertical velocities estimates



Cluster analysis of phytoplankton groups

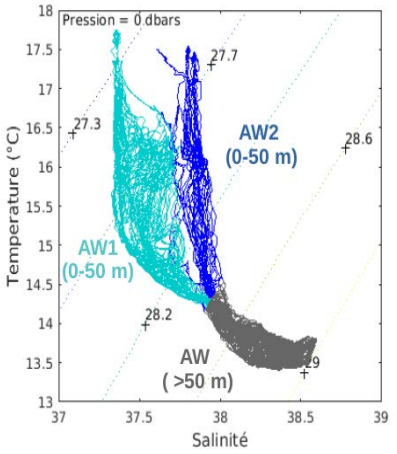


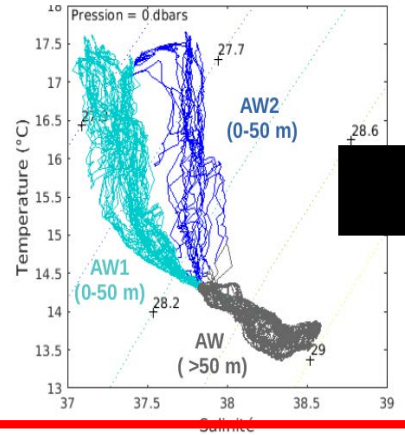


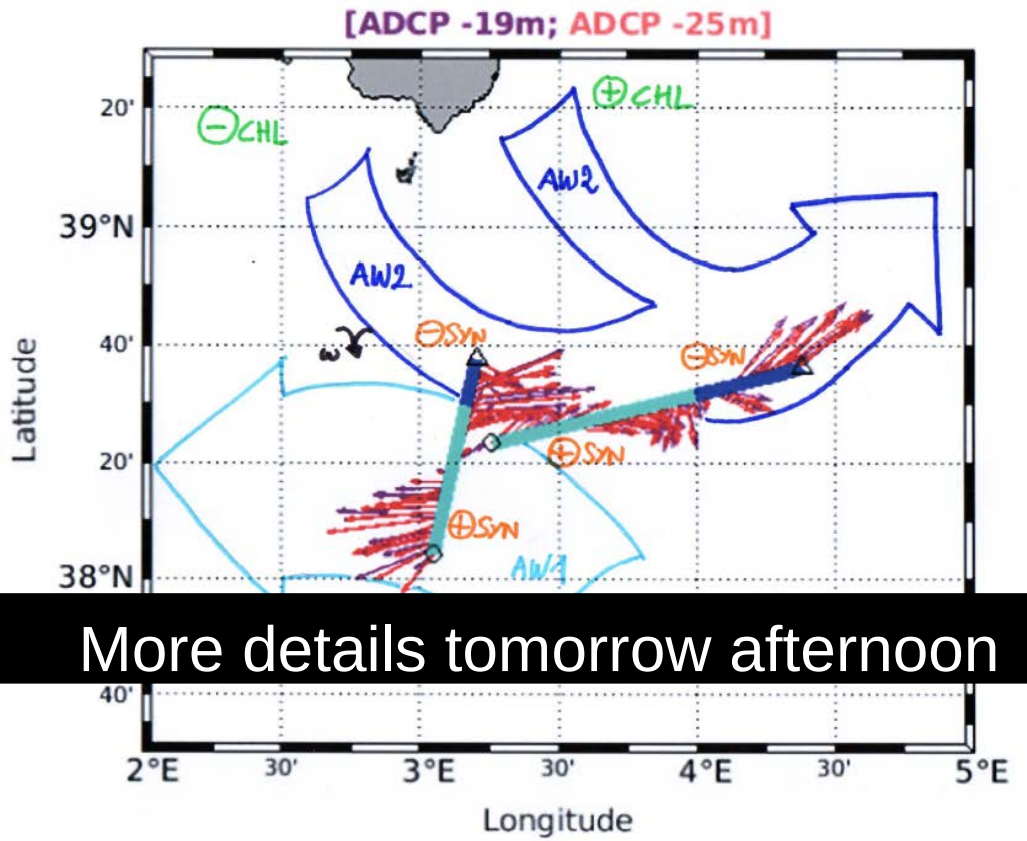


Preliminary results

HR hydrology

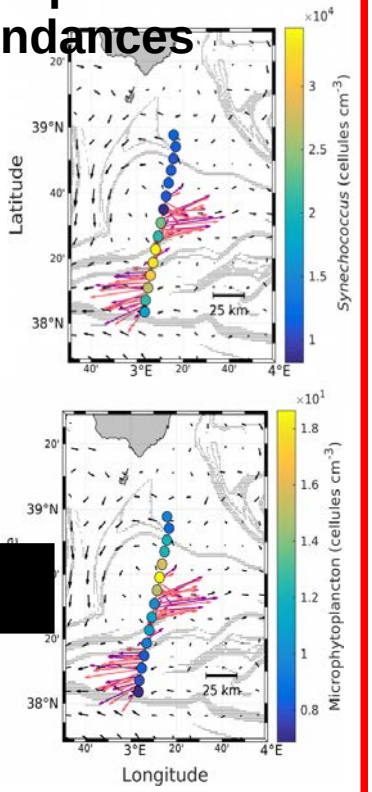




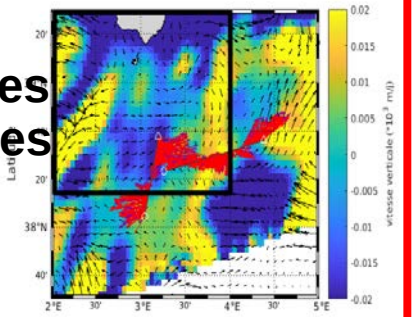


More details tomorrow afternoon

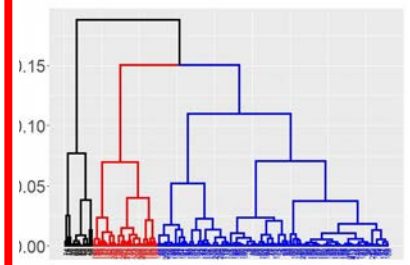
Phytoplankton abundances

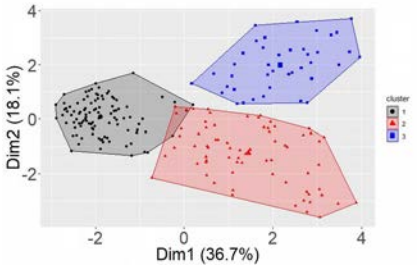


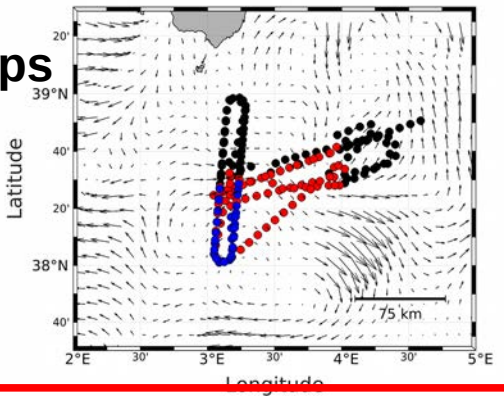
QG vertical velocities estimates



Cluster analysis of phytoplankton groups







FUMSECK 2019

Facilities for Updating the Mediterrenean Submesocale - Ecosystem Coupling Knowledge

S.Barrillon, A.Dolioli,G.Grégori, A.Petrenko, M.Thyssen, J.-L. Fuda, C.Comby (MIO)

F.d'Ovidio (LOCEAN), A.Dove (Univ.Birmingham) and the MVP team (GENAVIR)

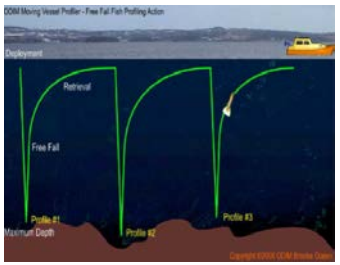
FUMSECK

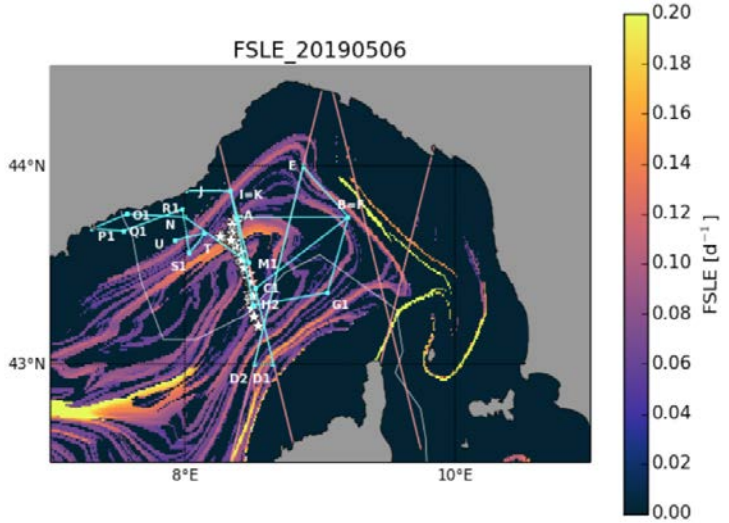
Apr 30 - May 07 2019, Ligurian Sea. R/V Téthys II (Chief Scientist : S. Barrillon)

OSCAHR zone. Lagrangian strategy

Technological cruise, tests on

- **MVP**,
- **vertical velocities direct measurements,**
- **biodegradable microparticles tracer**

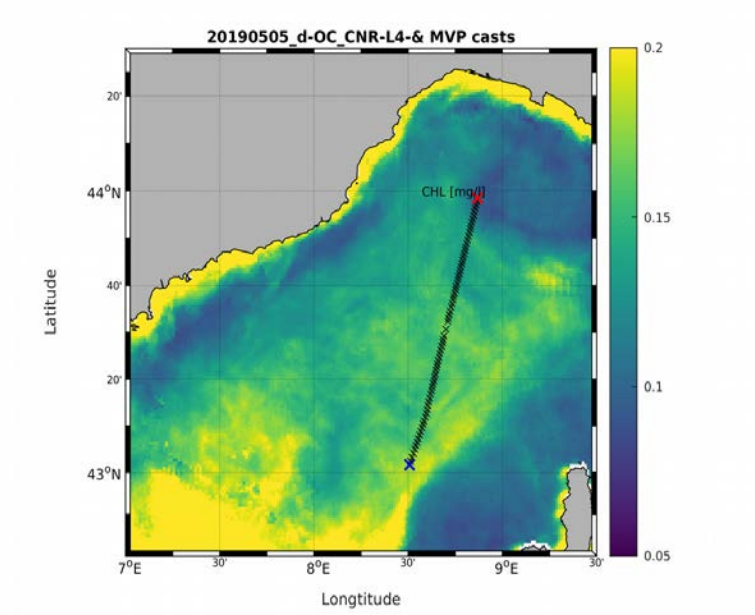


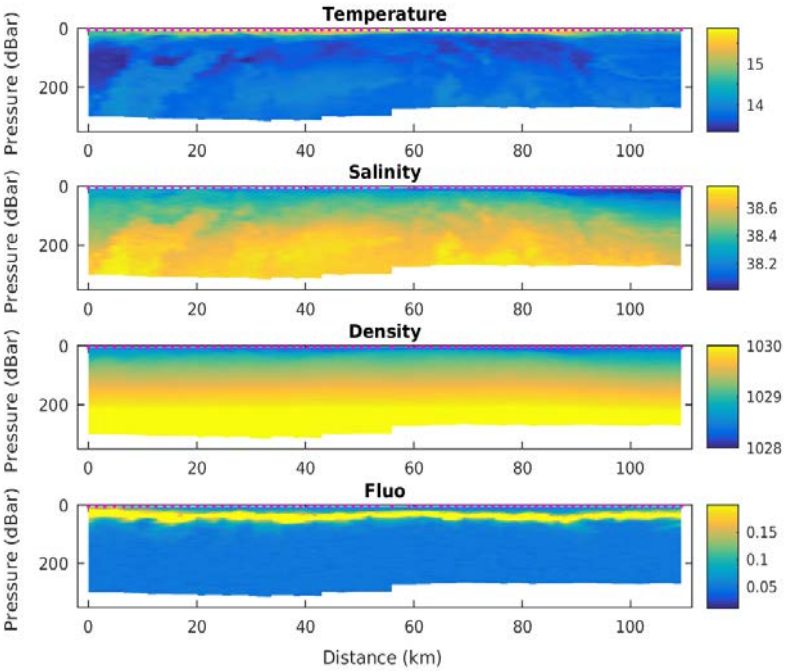


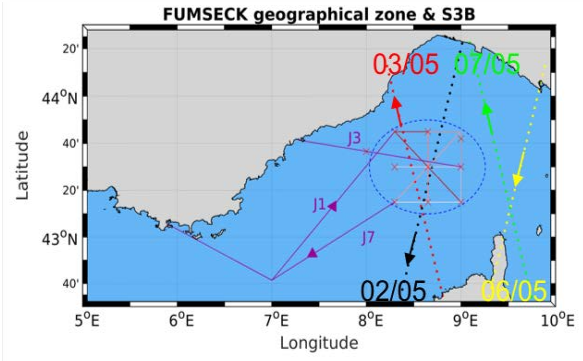
FUMSECK

MVP tests

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





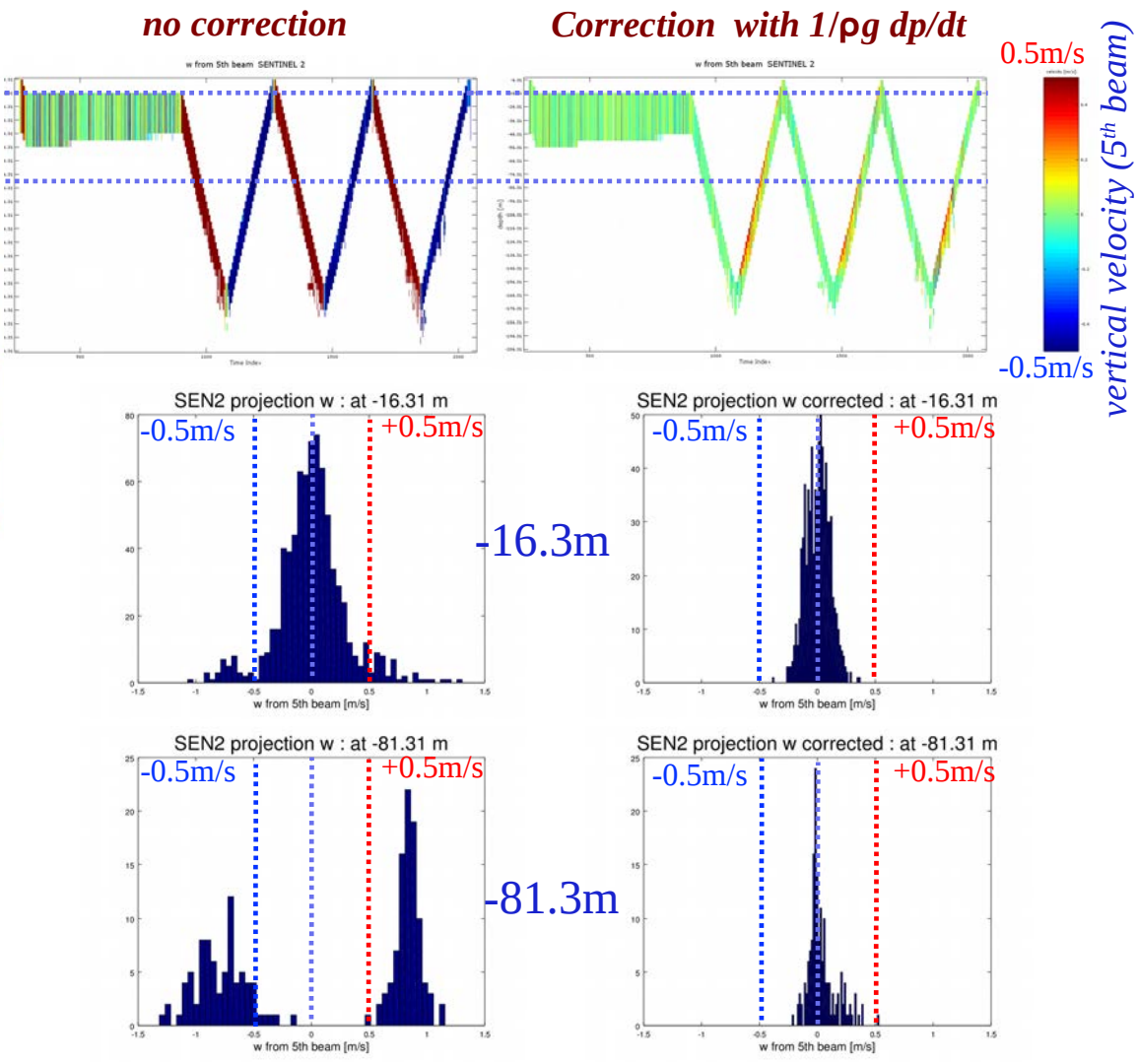


2019-05-02 09:58:07 (UTC)
8.6845 43.5230
on the middle of S3B satellite track !

FUMSECK

Test of direct measurements of vertical velocities

L-ADCP (A.Thurnherr's method) and a **5-beams Sentinel**, both mounted on the carousel, at fixed depth and then on yoyo



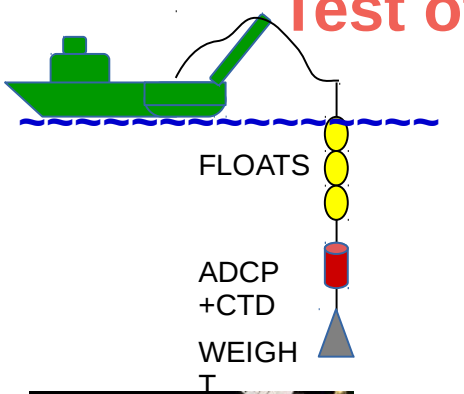
!!! Very preliminary !!!

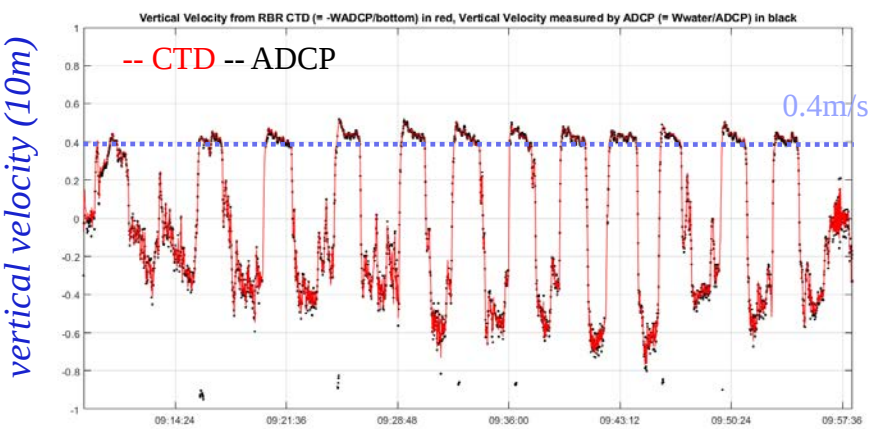
FUMSECK

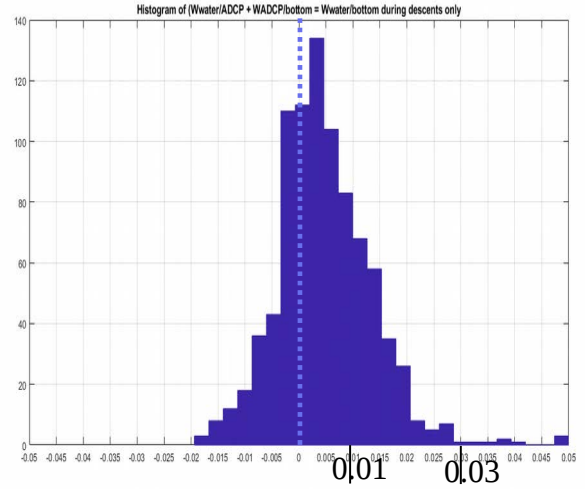
Test of direct measurements of vertical velocities

Free-Fall ADCP

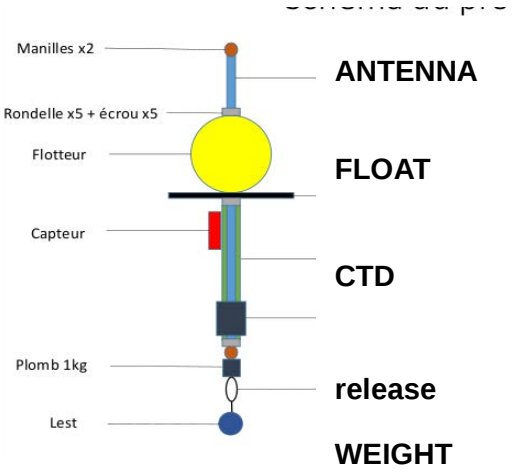
!!! Very preliminary !!!







VVP-Vertical Velocity Profiler



Vertical acceleration =

Buoyancy – Gravity + Friction

!!! WORK IN PROGRESS !!!
DATA TO BE ANALYZED

FUMSECK

Biodegradable microparticles as settling tracer for plankton dynamics

Test of release of a small sample (1kg in 500 l of seawater) at 15-m depth and then detect the dispersed particles

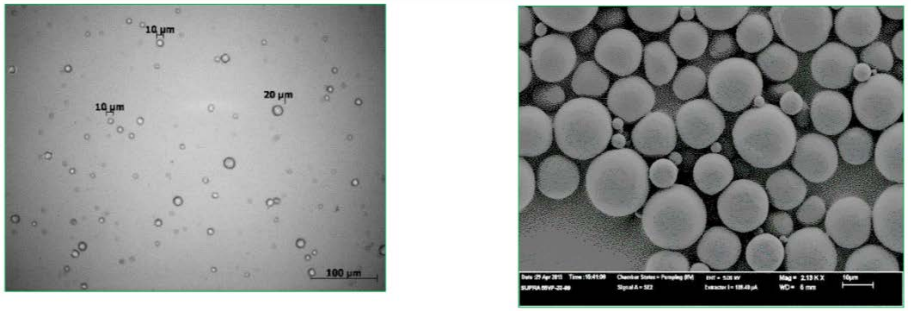
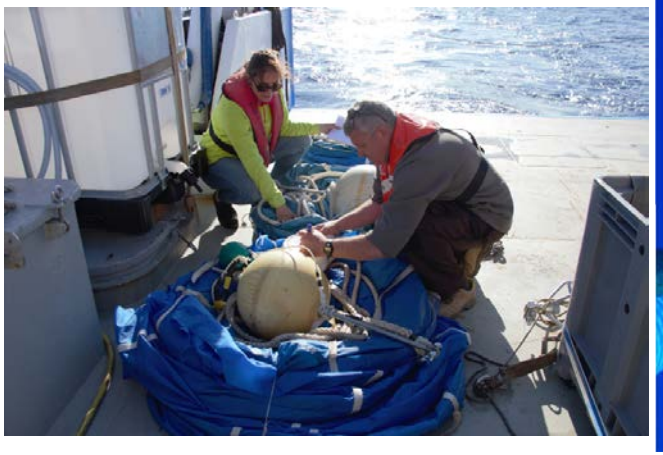
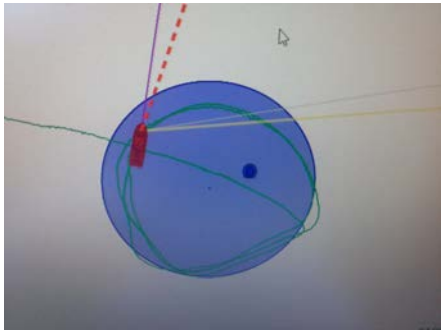


Figure 3. Images of the micro-particles taken by Optical (left) and Scanning Electron (right) Microscopy.

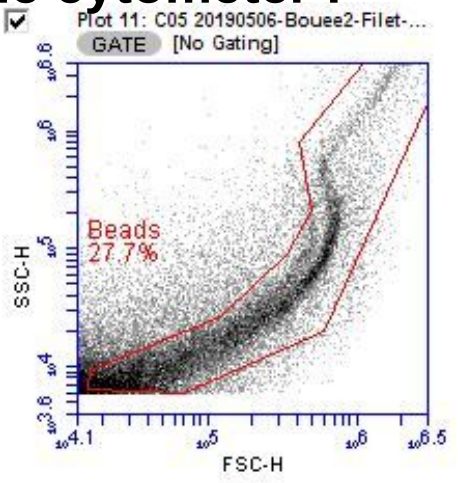


Area of ~$10^4 m^2$



wind : ~14 knots
current : ~0.2 m/s

Detected with the cytometer !



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**

Med cruises:

- Gained **experience** & **promising** results from new methods

- for a **deeper understanding** of the physical and biogeochemical processes at the fine scales

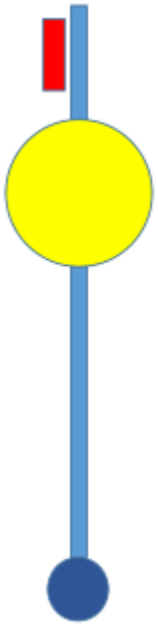
- NOM : Sentinel V Self-Contained / Real-Time
- FRÉQUENCE : 500 kHz
- CELL SIZE : 5 m
- MAX RANGE : 50 m
- Nb BEAM : 5 beams

Rappel manipulation :

10 min d'immersion à profondeur fixe (environ 10 m)

10 min de yoyo entre 2 m et 150 m (3 plongées/remontées)

Utilisation du sentinel sur 6 stations.



Équation de la chute d'un corps avec frottement :

Force = Buoyancy – Weight + Drag

$$(Mb + Ml) * \frac{dw}{dt} = \rho_e * (Vb + Vl)g - (Mb + Ml) * g + \frac{1}{2} * \rho_e * S * Cd * w^2$$

Hypothèse : seul le flotteur frotte et Cd est une constante

Vitesse en prenant en compte l'accélération :

$$\rho_e * (Vb + Vl) * g - (Mb + Ml) * g + \frac{1}{2} * \rho_e * S * Cd * wnew^2 = (Mb + Ml) * \frac{wnew - wold}{\Delta t}$$

$$\frac{frot}{(Mb + Ml)} * \Delta t * wnew^2 - wnew + g * \Delta t * \left(\frac{\rho_e * (Vb + Vl)}{(Mb + Ml)} - 1\right) + wold = 0$$

$$a = \frac{frot}{(Mb + Ml)} * \Delta t \qquad b = -1 \qquad c = g * \Delta t * \left(\frac{\rho_e * (Vb + Vl)}{(Mb + Vl)} - 1\right) + wold$$

$$wnew = \frac{-b - \sqrt{delta}}{2a} = \frac{1 - \sqrt{1 - 4 * \frac{frot}{(Mb + Ml)} * \Delta t * (g * \Delta t * \left(\frac{\rho_e * (Vb + Vl)}{(Mb + Ml)} - 1\right) + wold)}}{2 * \frac{frot}{(Mb + Ml)} * \Delta t}$$

FUMSECK

Facilities for Updating the Mediterrenean Submesocale - Ecosystem Coupling Knowledge

Test of direct measurements of vertical velocities

Preliminary

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

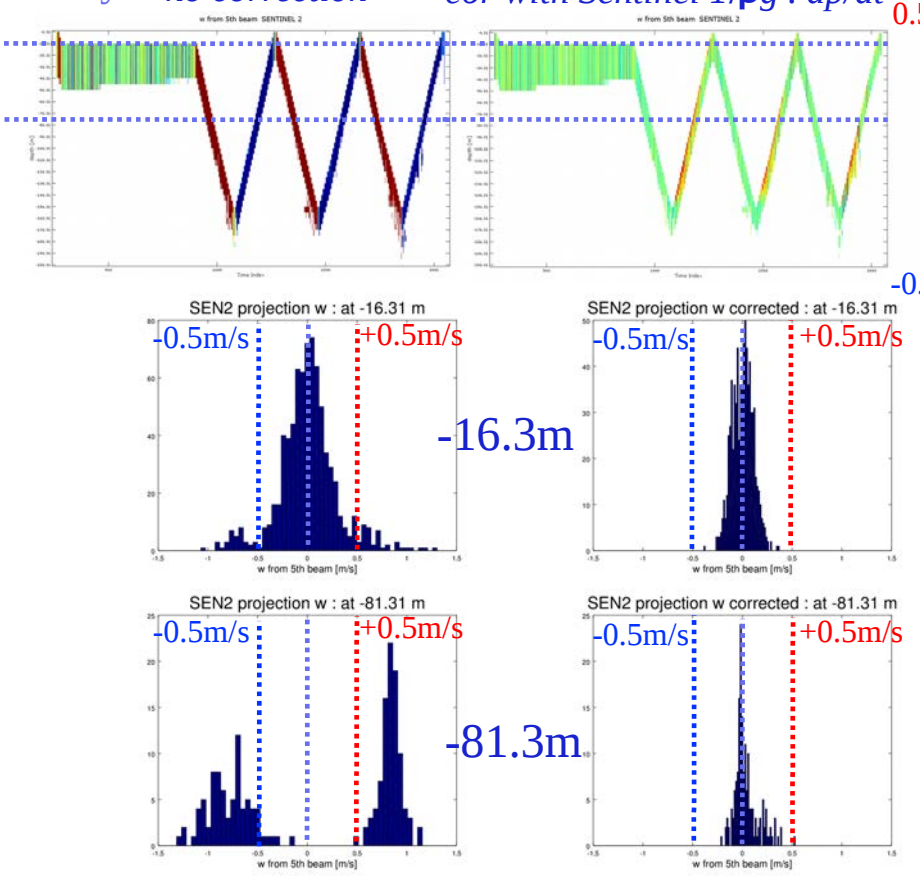
«Vertical Velocity Profiler»

Glider

Comparison with MVP and $\boldsymbol{\omega}$-equation

Sentinel 5 beams

C. Comby



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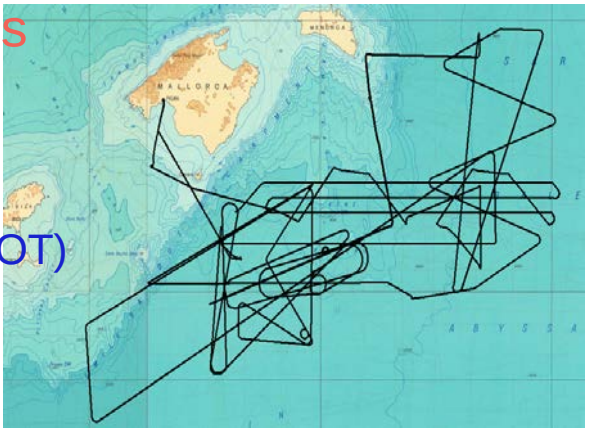
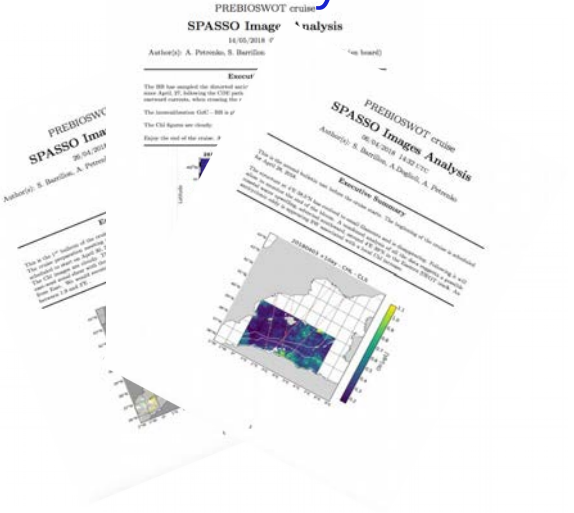
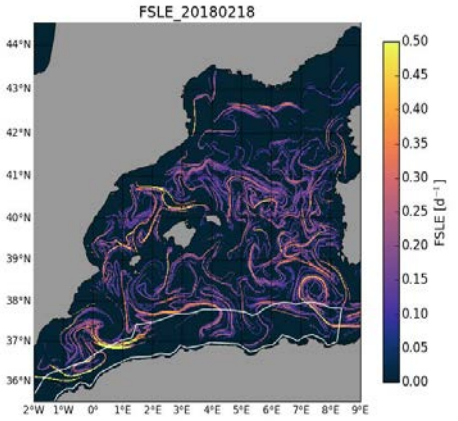
PROTEVS-SWOT

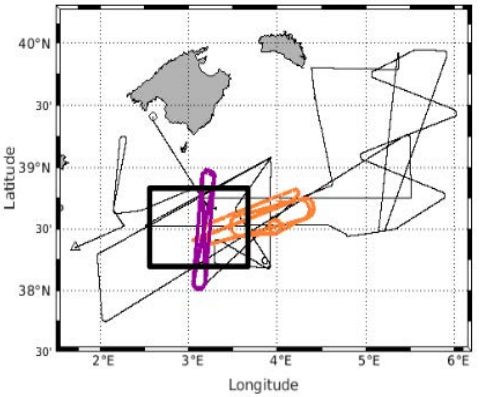
- PROTEVS-SWOT, *Apr 27 – May 14 2018,* South Baleares
  - **SWOT preparation**
  - Synergy BBP (*Seasor, Cytometry, ADCP*) (F. Dumas & P. Garreau), Garcia del Cid (*CTD grid*) (A. Pascual, PRESWOT)
    Drifting buoys + 2 gliders



- 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





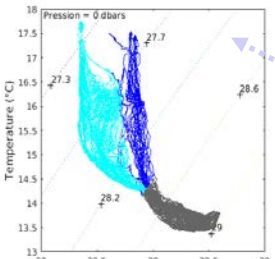


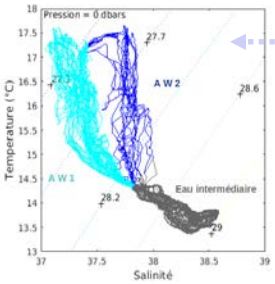
PROTEVS-SWOT Results

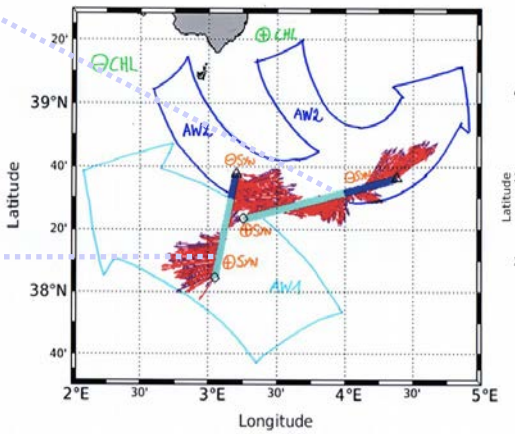
Physics-driven

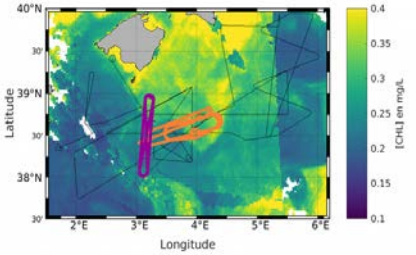
R. Tzortzis

- Study of the water masses (ADCP Seasor, TSG)



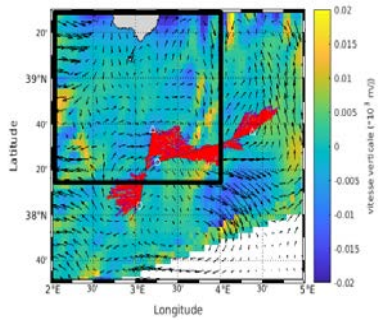




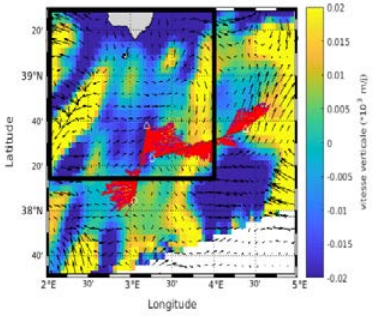


- Vertical velocities with ω-equation

25 m



85 m

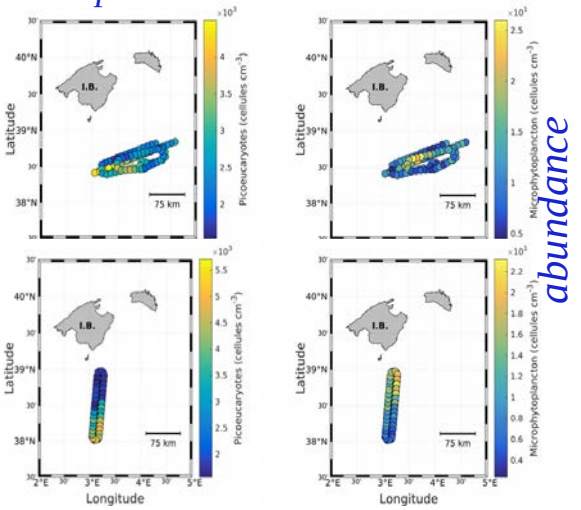


Biogeochemistry-driven

L. Izard

- Study of the phytoplankton groups (cytometry)

pico *micro*



abundance

Statistical separation of samples