EGU General Assembly 2020

Online | 4–8 May 2020

Session: OS4.5 Abstract: EGU2020-7356

Combining remote sensing and in situ observations to study the physical-biological coupling at fine scale: recent Mediterranean campaigns and outlook

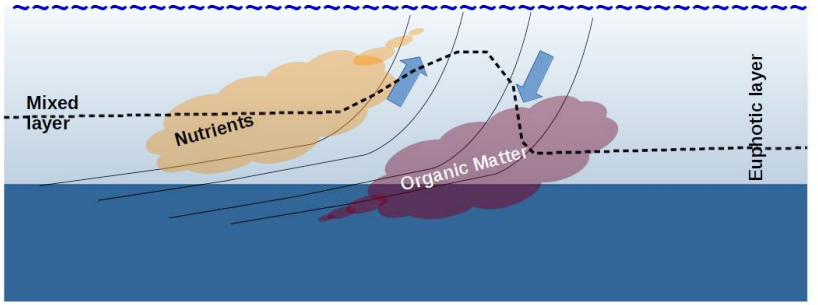
Doglioli A.M., Grégori G., d'Ovidio F., Petrenko A.A., Barrillon S., Comby C. Fuda J.-L., Thyssen M., Tzortzis R., Izard L., Dumas F., Garreau P., Pascual A., Marrec P., Rousselet L., Bhairy N., Cyr F., Tedetti M., Berline L., Carlotti F.

Fine scale biophysical processes

Fine scale circulation (~1-10km & ~1-10days) :

- impacts the carbon pump

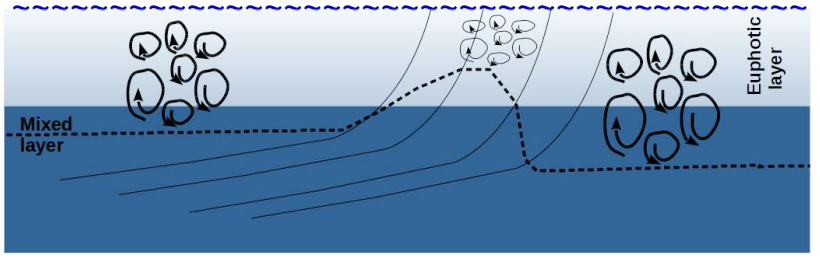
advecting nutrients upward and organic matter downward



[based on Lévy et al., 2012]

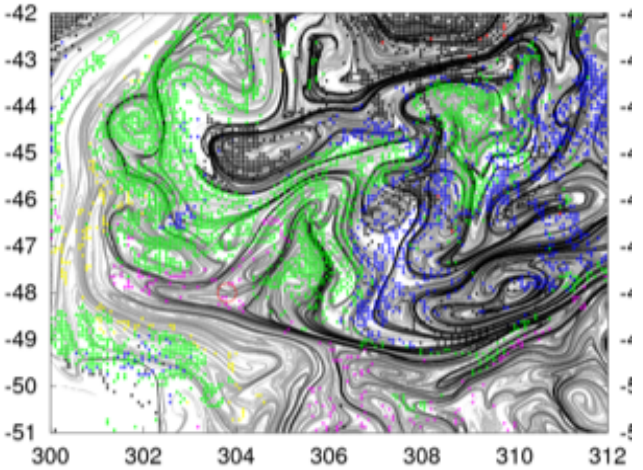
- controls the mixing

influencing primary production, grazing and predation



- drives the biodiversity

creating "fluid-dynamical niches"



Satellite data (FSLE & Physat)

[from d'Ovidio et al., 2010]

Fine scale biophysical processes

Fine scale circulation (~1-10km & ~1-10days) :

- impacts the carbon pump

advec
and o

- cont

influe
grazin

- drives the biodiversity

creating "fluid-dynamical niches"

Modellers generally highlight the need of in situ measurements at submesoscale :

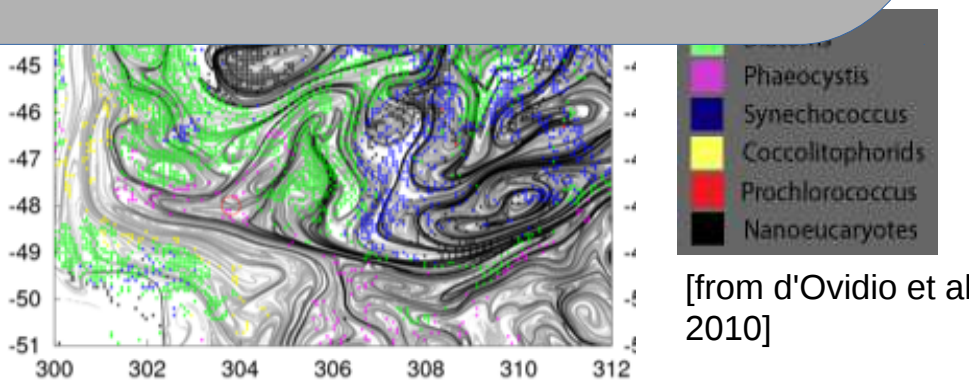
a big challenge due to the ephemeral character of these structures

A possible solution :

Adaptive sampling strategies & Innovative instrumentation & Lagrangian approach

more in 2012]

at)



[from d'Ovidio et al., 2010]

Adaptive sampling strategy

(Target the structures!)

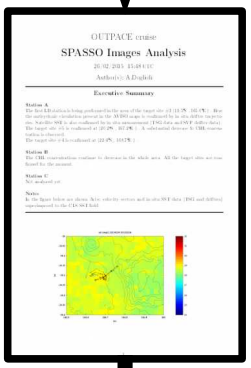
Remote sensed measurements

(& Numerical ModelingForecast)

Land Server (retrieval + processing)

Data and Figures

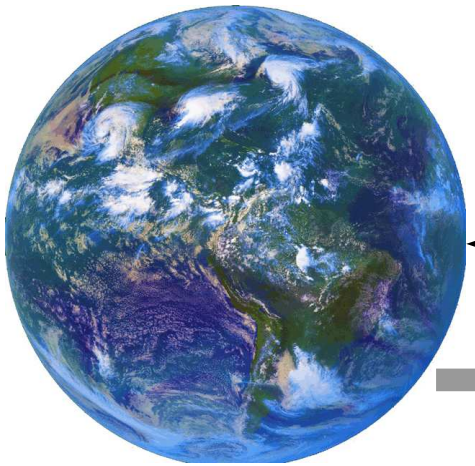
Daily Bulletin



SPASSO

***S**oftware **P**ackage for an **A**daptive **S**atellite-based **S**ampling for **O**cean campaigns*

https://spasso.mio.osupytheas.fr/

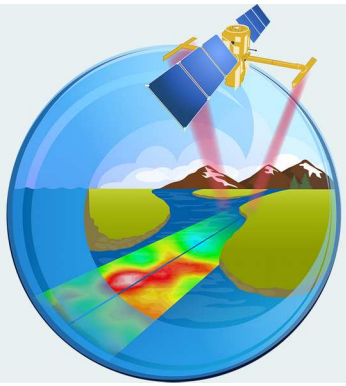


Sampling strategy

Preliminary results of in situ HF measurements

In-situ campaign

A new satellite mission



SWOT

SURFACE WATER & OCEAN TOPOGRAPHY

NASA • CNES • CSA • UKSA

Launch planned for 2022

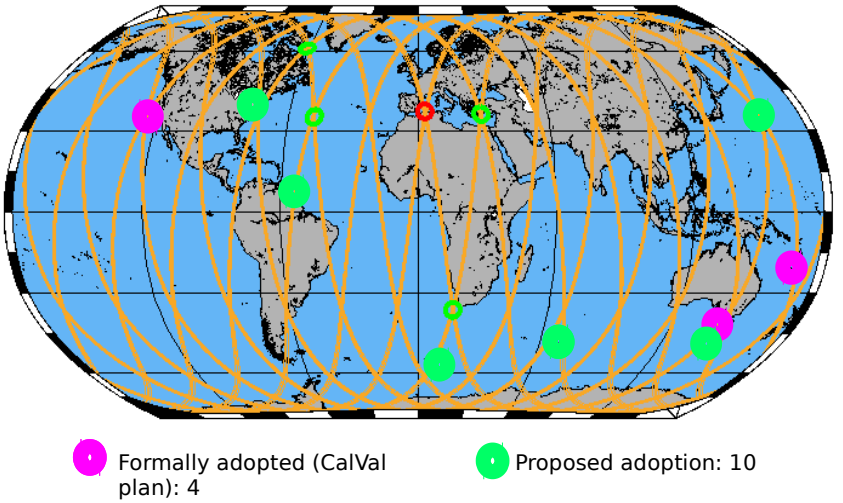
Altimetry-derived currents at a resolution approaching the one of SST & CHL

A great opportunity to study coupling at the fine scales !

The "Adopt a SWOT crossover" intiative

d'Ovidio et al [2019]

CLIVAR endorsement obtained in 2019



A series of cruises in the Mediterranean Sea

OSCAHR (nov '15)
Doglioli A.M., R/V Téthys II,
https://doi.org/10.17600/15008800

PROTEVSMED_SWOT (apr/may '18)
Dumas F., R/V Beautemps-Beaupré,
https://doi.org/10.17183/PROTEVSMED_SWOT_2018_LEG2
in synergy with ***PRE-SWOT***
Pascual A., R/V García del Cid

FUMSECK (may '19)
Barrillon S., R/V Téthys II,
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These activites are supported by BIOSWOT,
a TOSCA/CNES program (PI F.d'Ovidio, Co-I A.Doglioli & G.Grégori)

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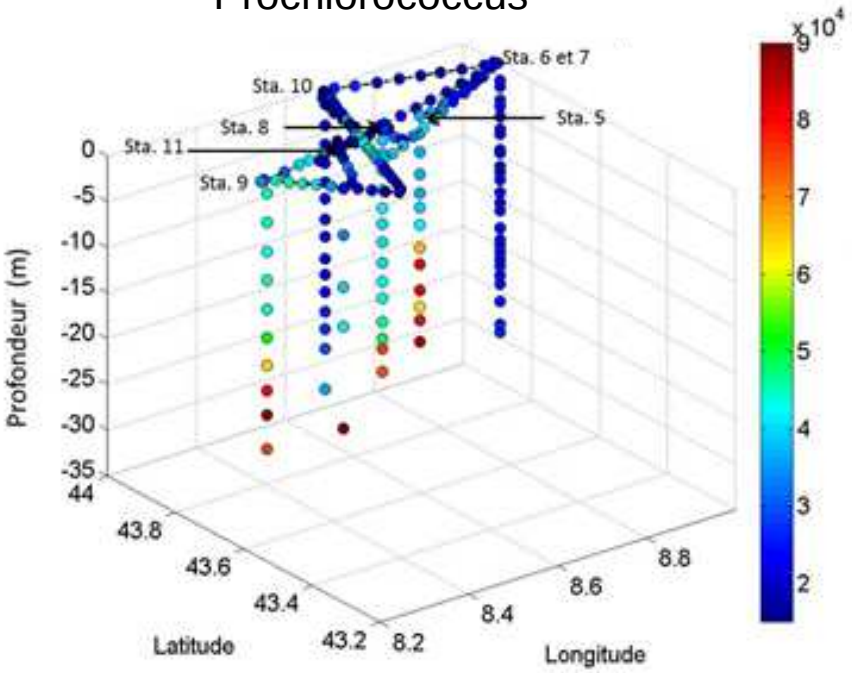
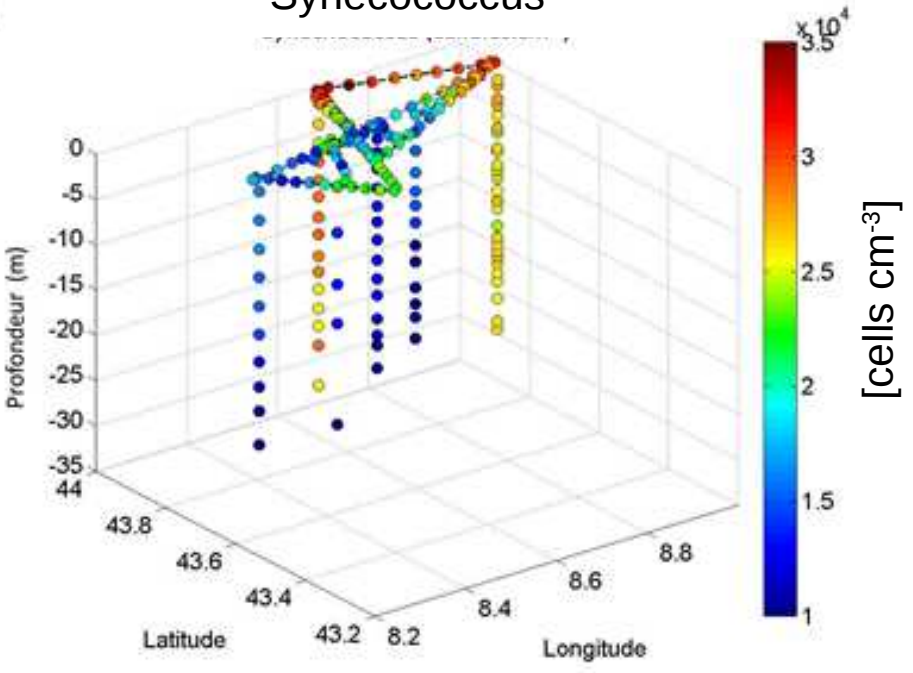
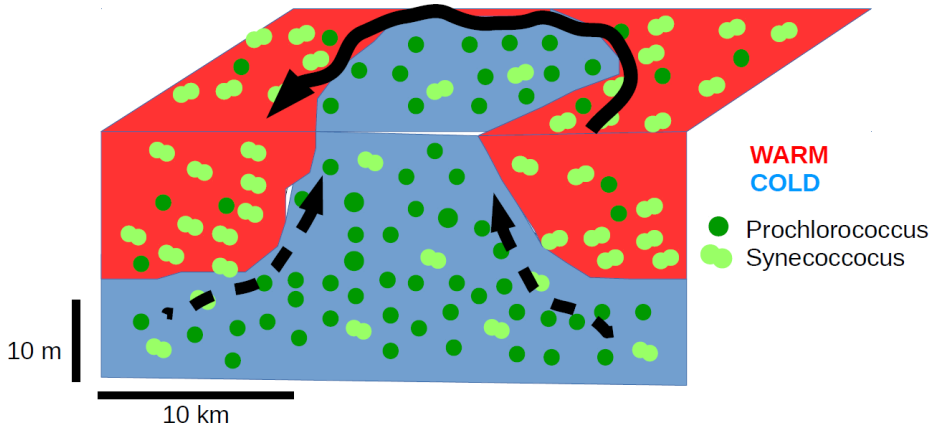
3D Phytoplankton assemblages from cytometry

Prochlorococcus



Synecococcus





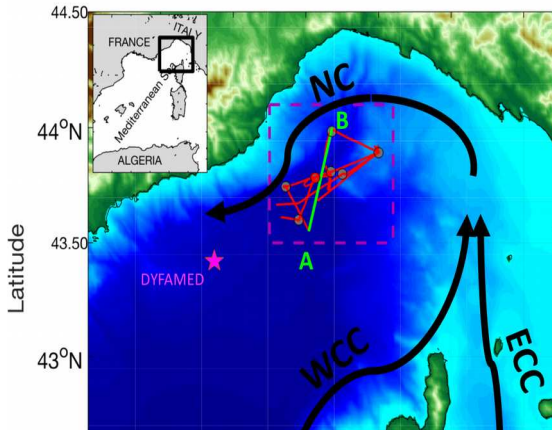
The fine-scale structure of the physical field as a driver for the spatial organisation of the planktonic communities

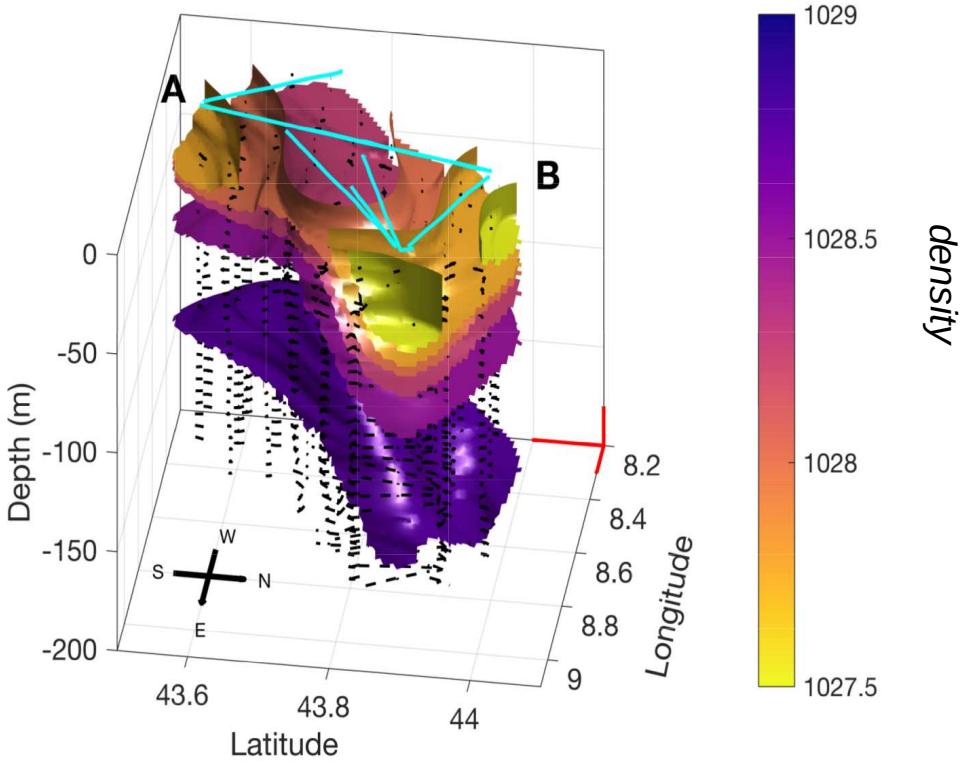
[Marrec et al., 2018]

Vertical Motions and effects on biology

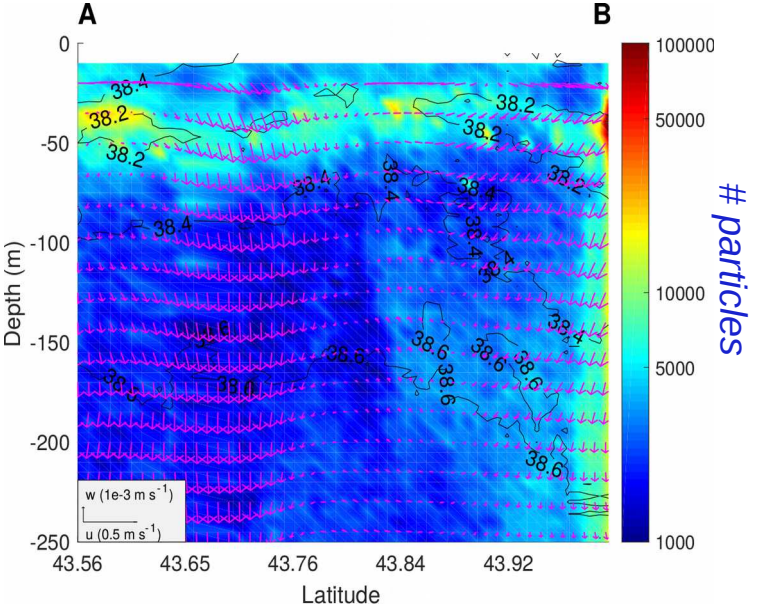
MVP and ADCP data :

reconstruction of 3-D fields of density
and horizontal and vertical velocities





Validation with independent
measurement of particles abundances
Measured with LOPC



[Rousselet et al., 2019]

Science-oriented validation of coastal altimetry

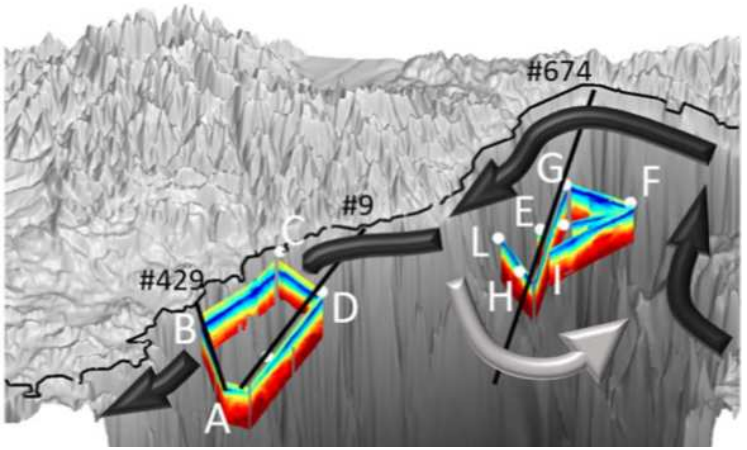
Along-track CTD casts with MVP (Moving Vessel Profiler)

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

Steric Height
(Gilson et al , JGR98)

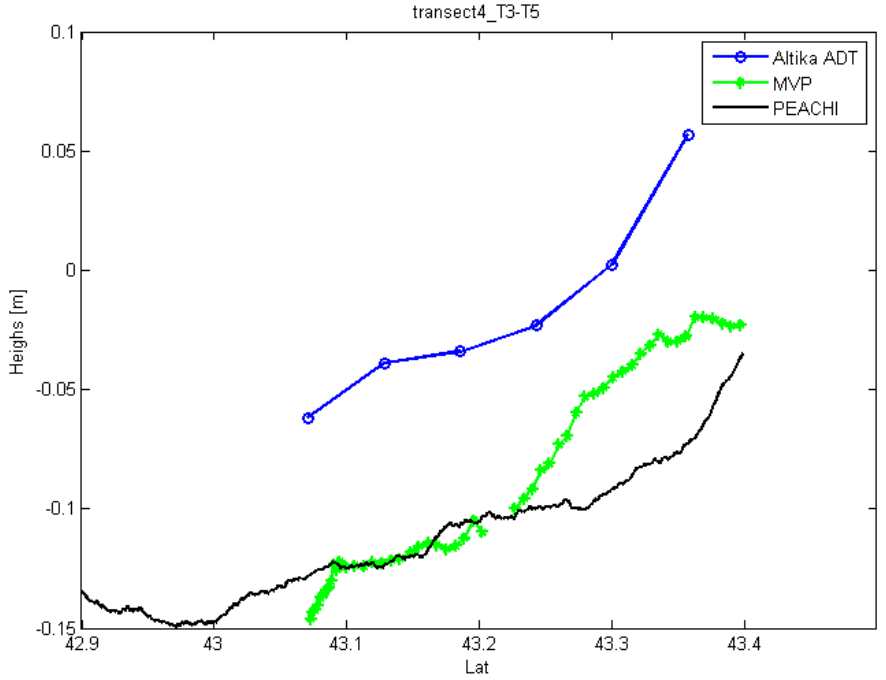
$$\Delta D = \int_{p1}^{0} \delta(S,T,p)dp = \int_{p1}^{0} \alpha(S,T,p)dp - \int_{p1}^{0} \alpha(35,0,p)dp$$

Combined with the ADCP measurements



Satellite SLA + RIO07 MDT
vs
PEACHI
vs
MVP (+ADCP)

Saral/AltiKa track #429



[Meloni et al., 2019]

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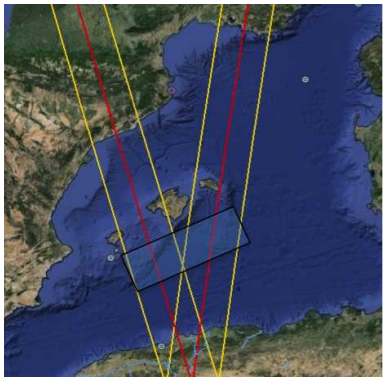
A synergy among three programs in the WS Mediterranean:

- PRE-SWOT (A. Pascual)
- PROTEVS_SWOT (F. Dumas, P. Garreau)
- BIOSWOT (F. d'Ovidio, A. Doglioli, G. Grégori, F. Cyr)



A multi-platform and multi-methods campaign :

BHO Beautemps-Beaupré
(SHOM, France)

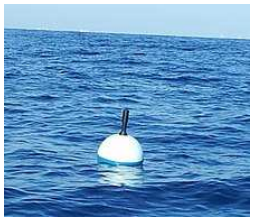
28 Avril-14 May 2018

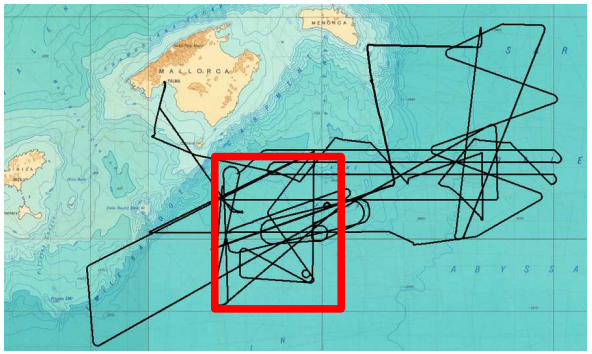
R/V García del Cid
(CSIC, Spain)

5-17 May 2018

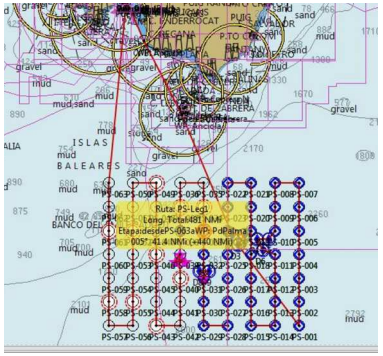
Gliders
(MIO & SOCIB)

Drifters
(CSIC, SOCIB, SHOM)

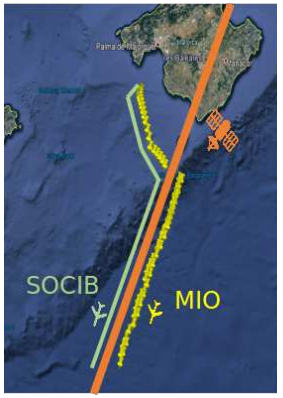




Lagrangian sampling area



Eulerian sampling area



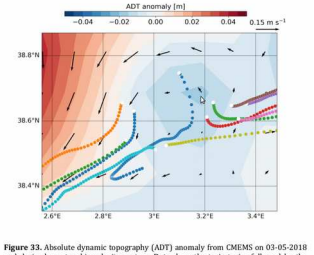


Figure 33. Absolute dynamic topography (ADT) anomaly from CMEMS on 03-05-2018 and derived geostrophic velocity vectors. Dots show the trajectories followed by the drifters released during the PRE-SWOT experiment for the period 5-13 May (white dots are the release positions).

From
Barceló-Llull et al.
[2018]

Onboard of the RV Beautemps-Beaupré

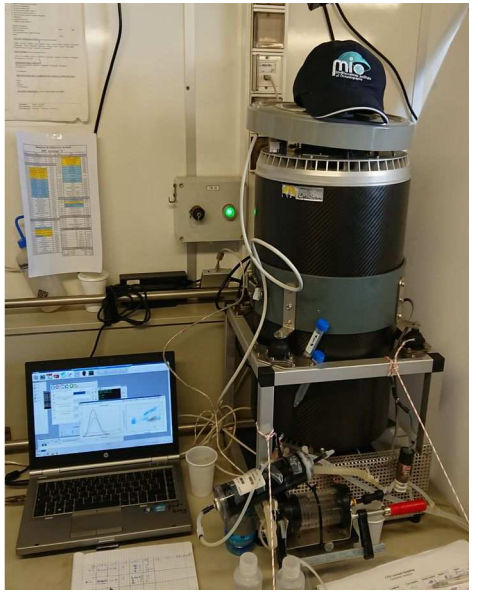
ADCP 150 & 38 kHz, TSG, SeaSoar (SHOM)
~3 km resolution & 300 m depth

Automated Flow Cytometer (MIO)

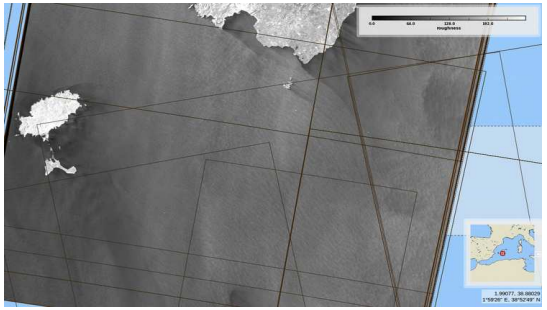
Identification of microbes from size, color, and shape.

One point every 20'

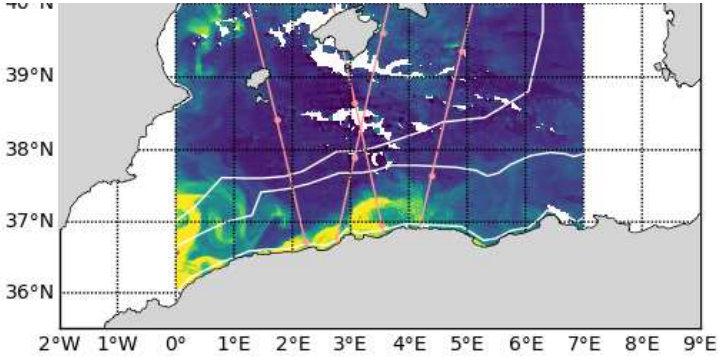
~= 5.5 km (@ 9 Knots)

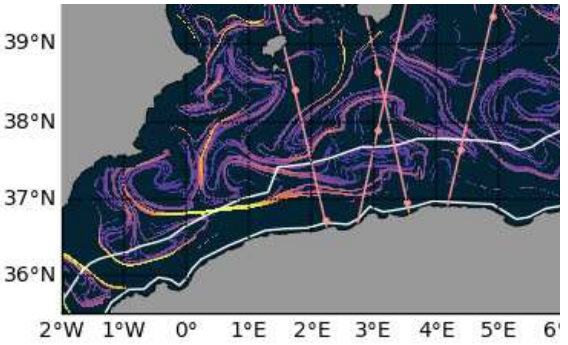


On land : multisatellite support



SAR

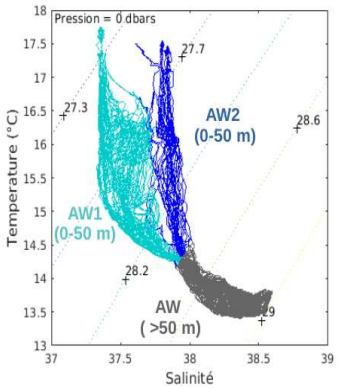


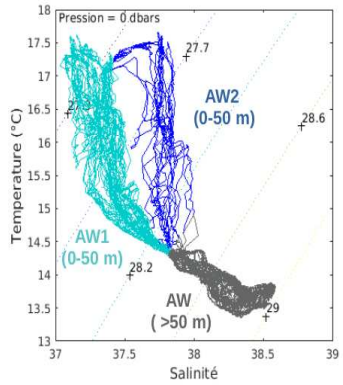


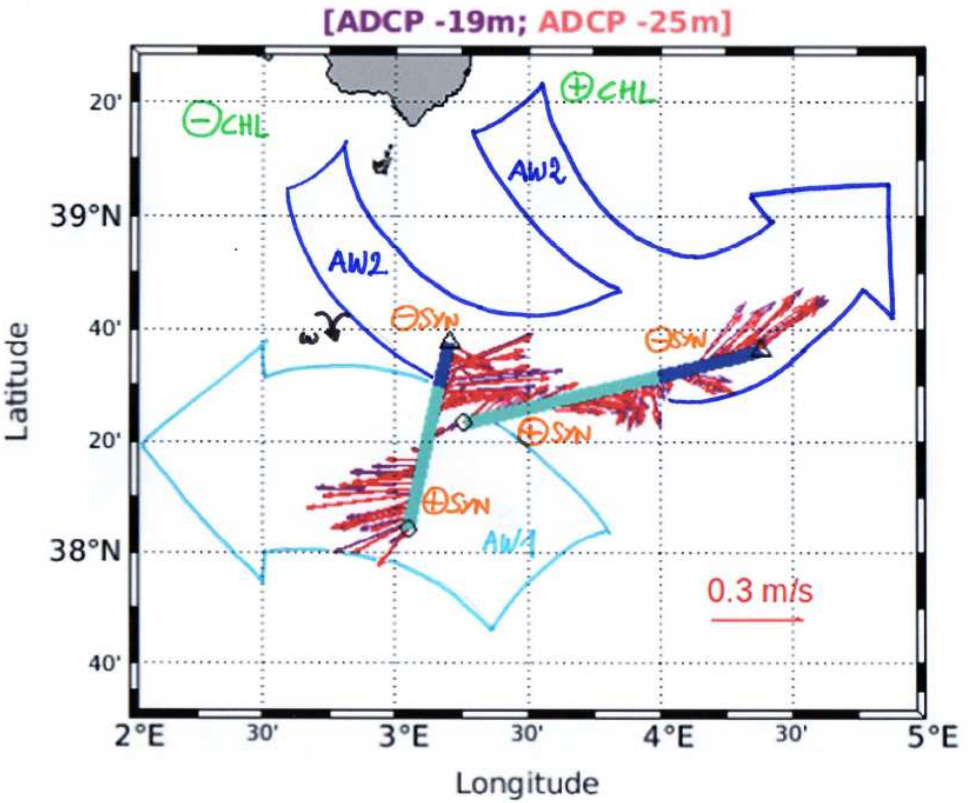
CLS data of SST and SCHL + Altimetry derived Lagrangian analyses by SPASSO http://spasso.mio.univ-amu.fr

Preliminary results

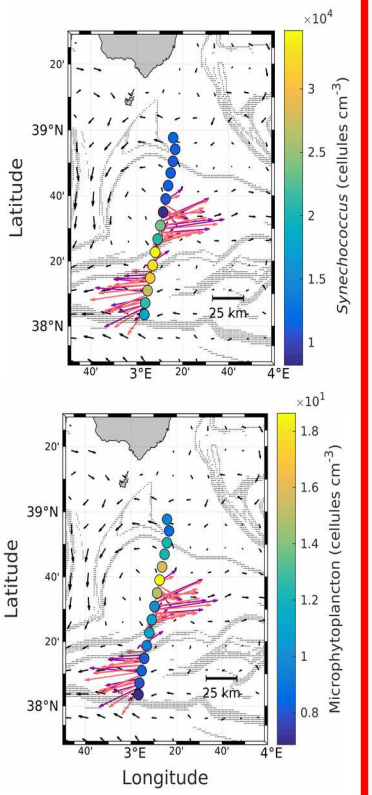
HR hydrology



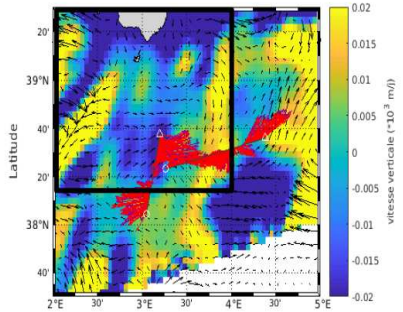




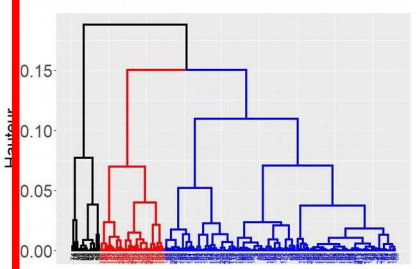
Phytoplankton Abundances

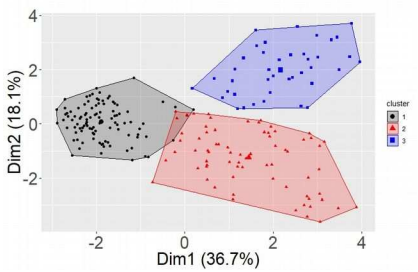


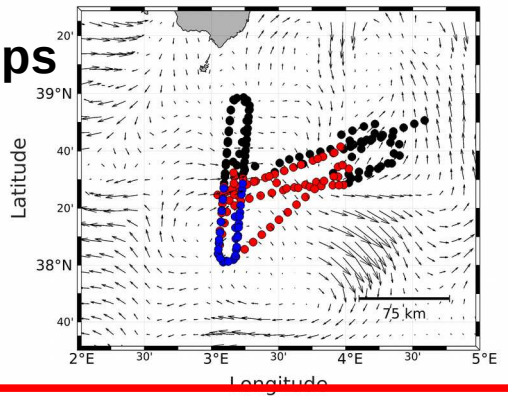
QG w estimation



Cluster analysis of phytoplankton groups

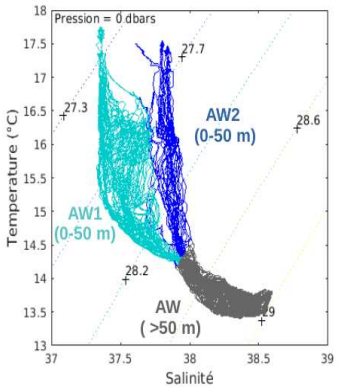


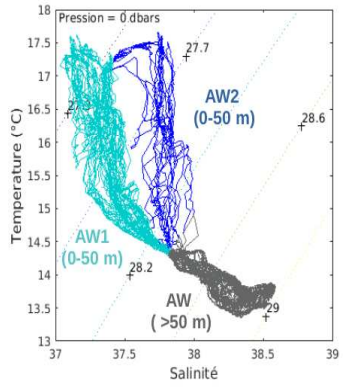




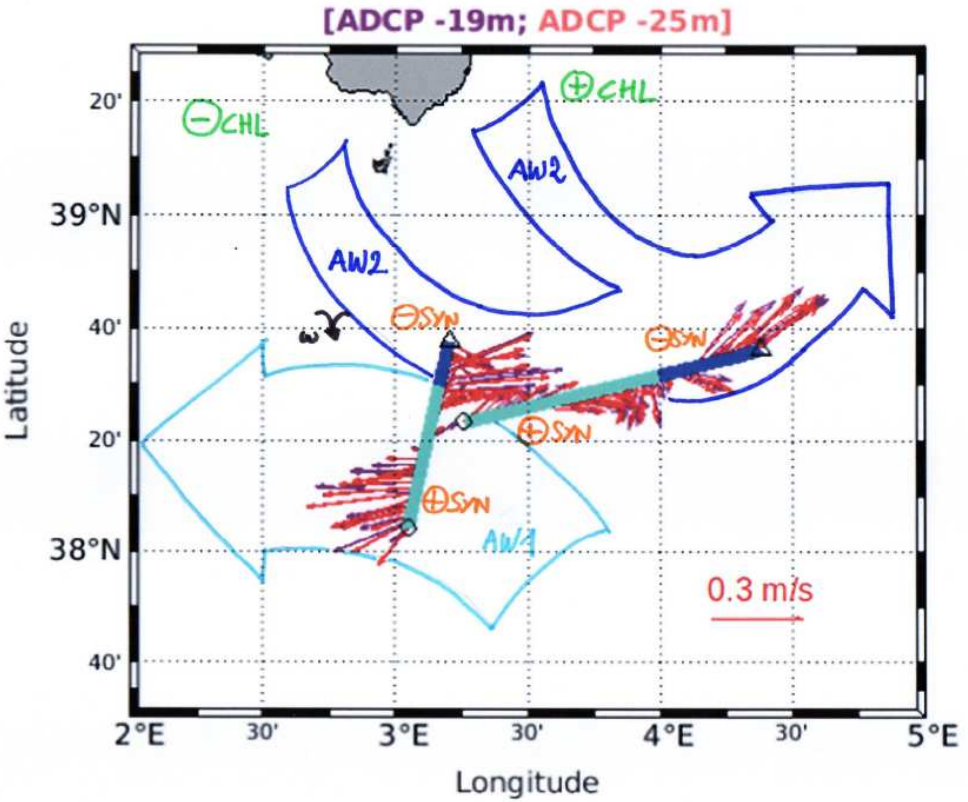
Preliminary results

HR hydrology





Tzortzis et al, in prep;
!!! see also the Abstract EGU2020-7357 !!!



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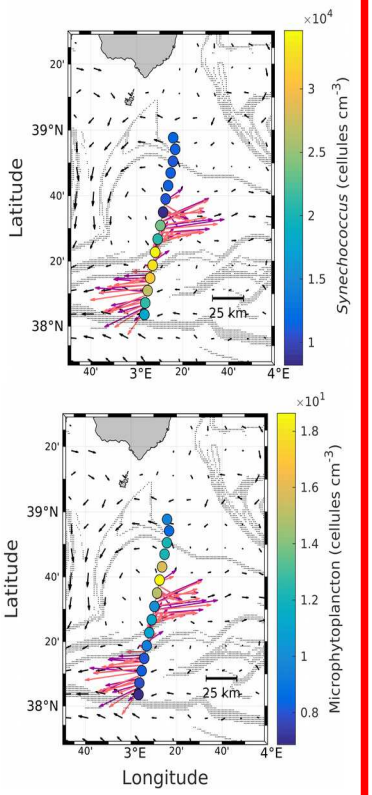

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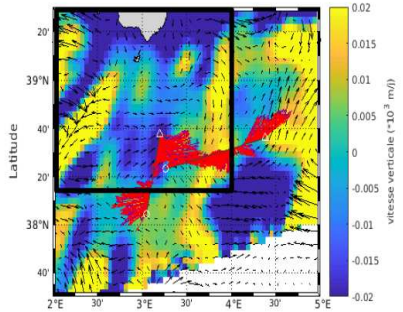

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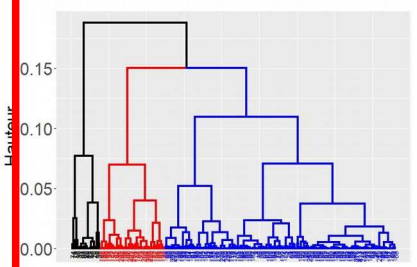
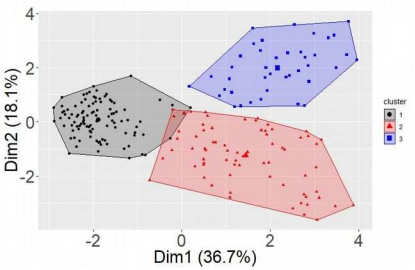
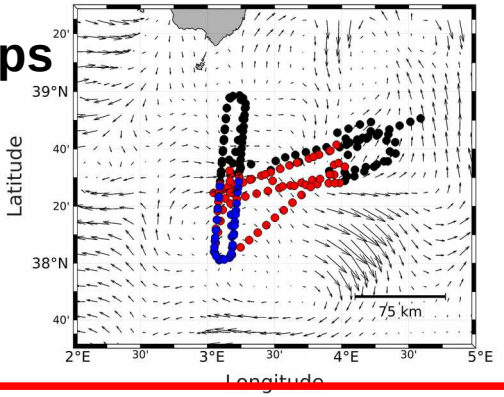
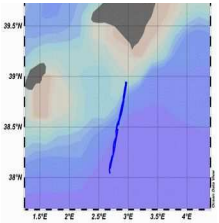




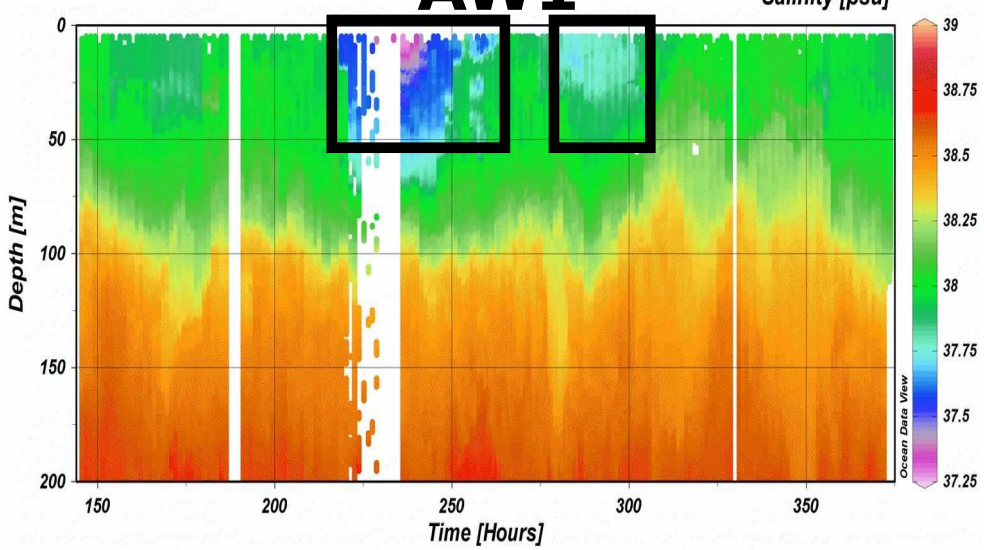


Preliminary results 2

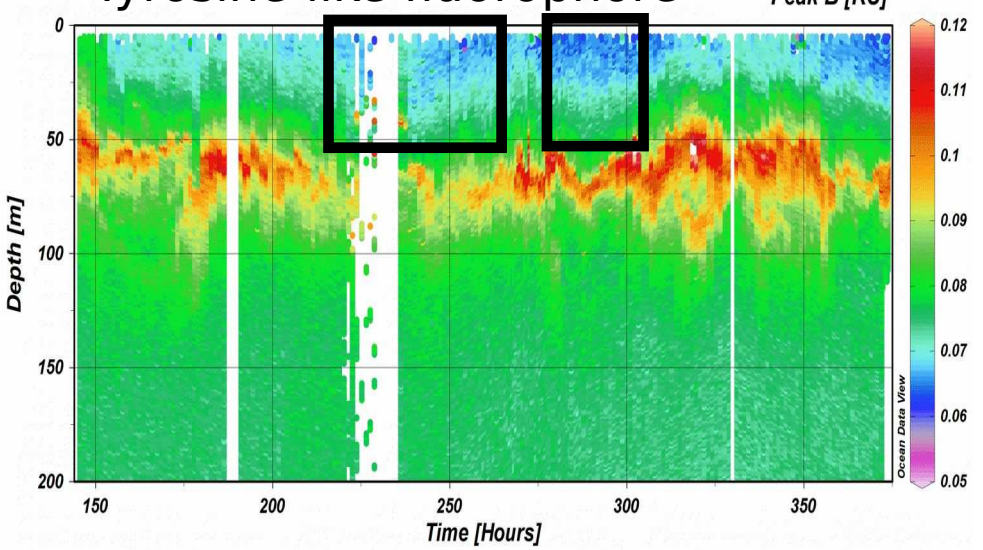


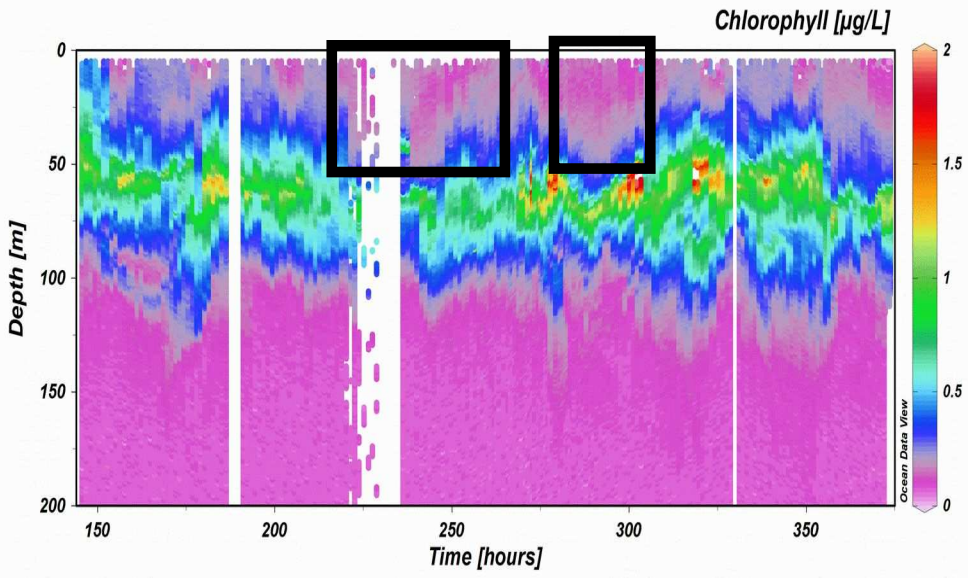
Glider data suggest a link between hydrology, phytoplankton biomass and dissolved organic matter content

AW1

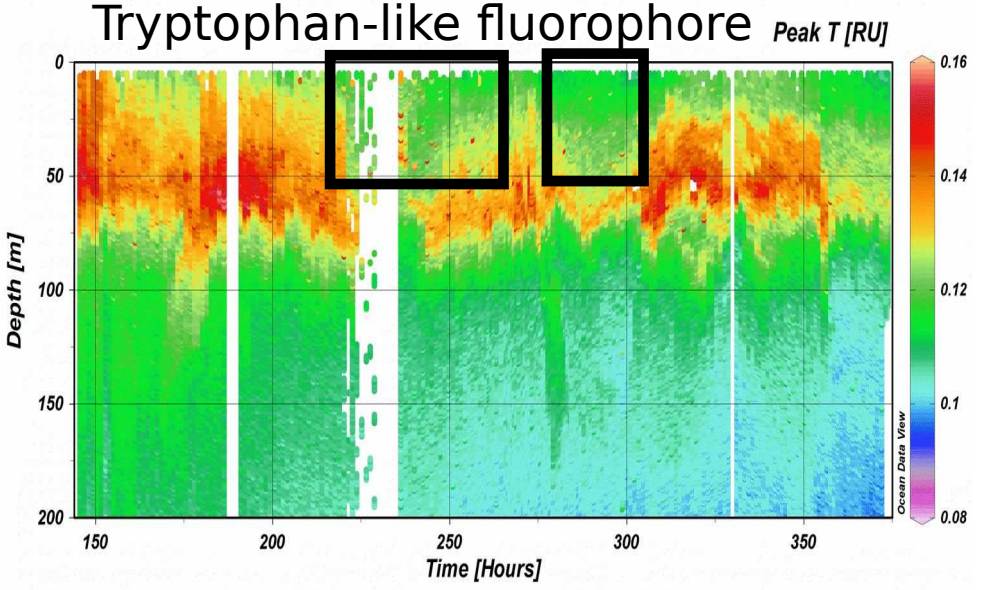


Tyrosine-like fluorophore





Tryptophan-like fluorophore



MIO Glider cruise duration

A series of cruises in the Mediterranean Sea

OSCAHR (nov '15)
Doglioli A.M., R/V Téthys II,
https://doi.org/10.17600/15008800

PROTEVSMED_SWOT (apr/may '18)
Dumas F., R/V Beautemps-Beaupré,
https://doi.org/10.17183/PROTEVSMED_SWOT_2018_LEG2
in synergy with ***PRE-SWOT***
Pascual A., R/V García del Cid

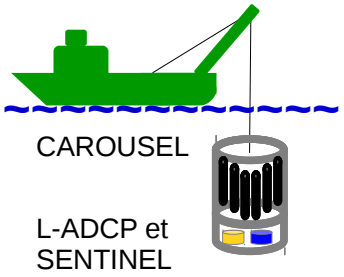
FUMSECK (may '19)
Barrillon S., R/V Téthys II,
https://doi.org/10.17600/18001155

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

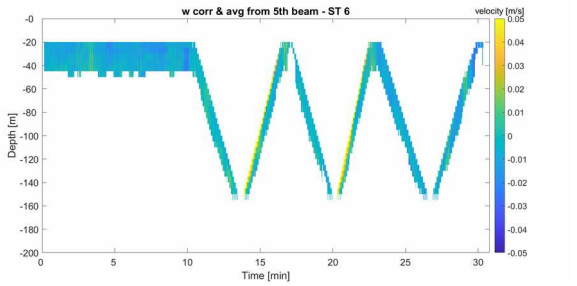
Session: OS4.5 **Abstract: EGU2020-7356**

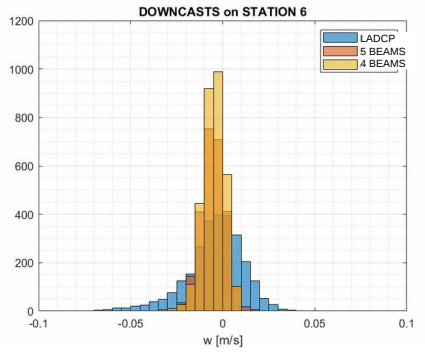
Tests of 3 methodologies to measure w in situ :

A 5-beams Sentinel ADCP and a L-ADCP deployed at fixed depth and yoyo

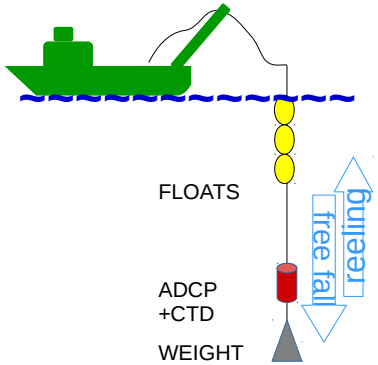


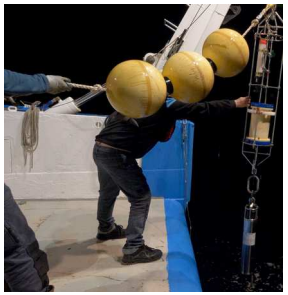
Correction with 1/ρg dp/dt



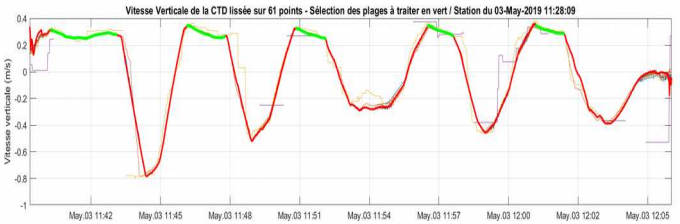


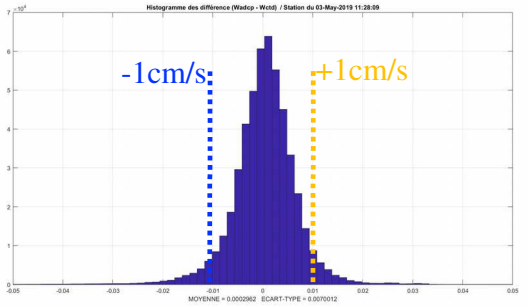
FF-ADCP (Free Fall ADCP)



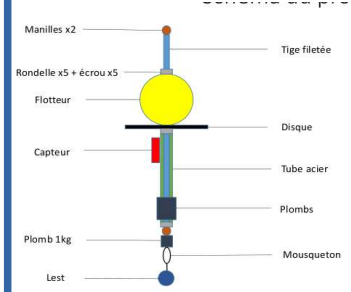


-- CTD --- ADCP





VVP (Vertical Velocity Profiler)



ANTENNA

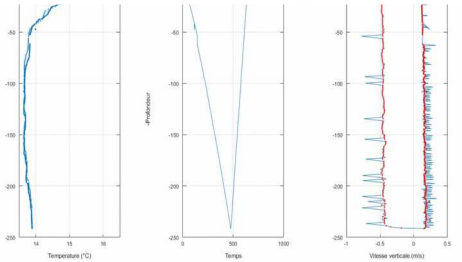
FLOAT

CTD
release
WEIGHT

Vertical acceleration =

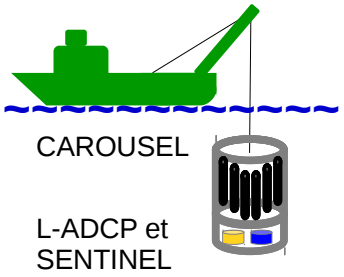
Buoyancy – Gravity + Friction

Temperature Depth Velocity

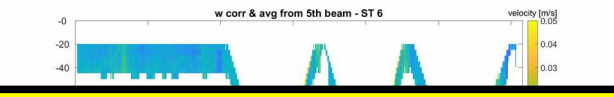


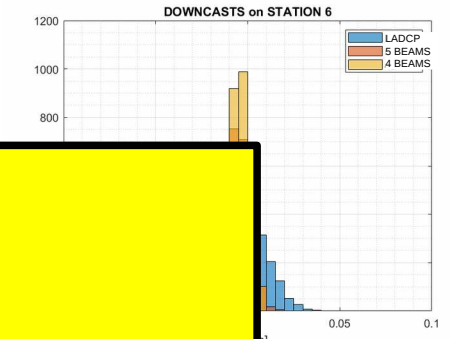
Tests of 3 methodologies to measure w in situ :

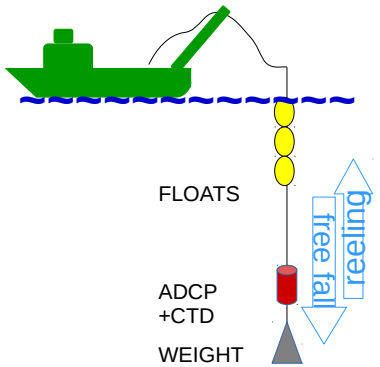
A 5-beams Sentinel ADCP and a L-ADCP deployed at fixed depth and yoyo

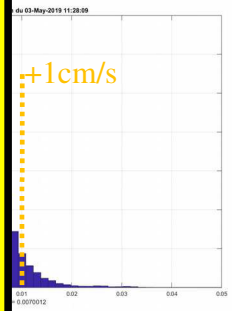


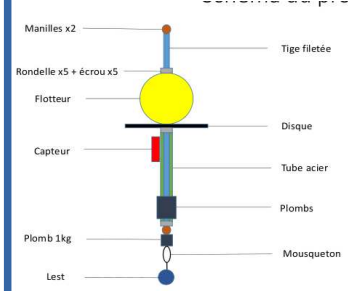
Correction with 1/ρg dp/dt











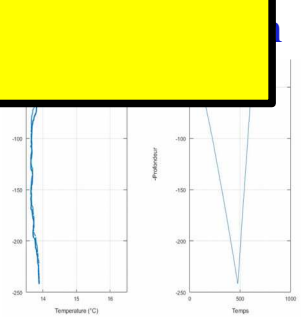
ANT

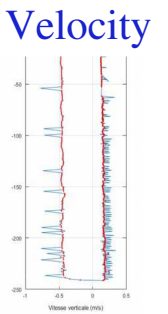
FLOAT

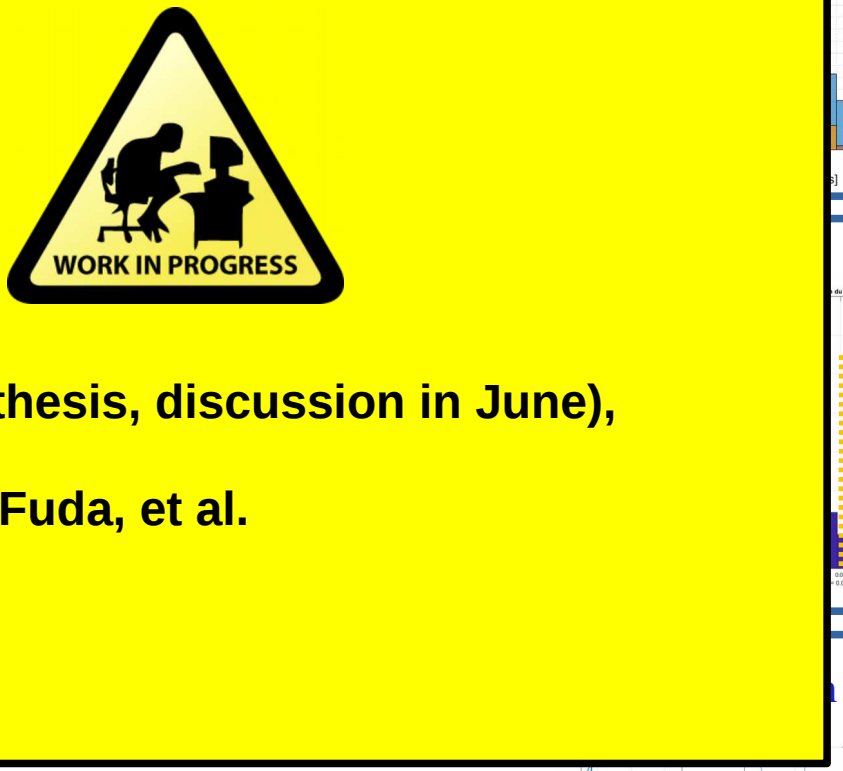
CTD
release
WEIGHT

Vertical acceleration =

Buoyancy – Gravity + Friction







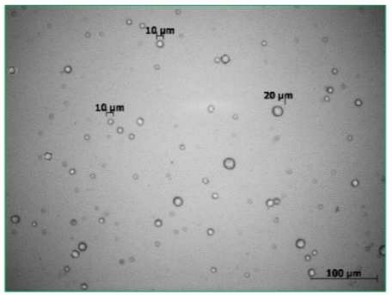
Comby (Master thesis, discussion in June),

Fuda, et al.

Biodegradable microparticles

as settling tracer for plankton distribution

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



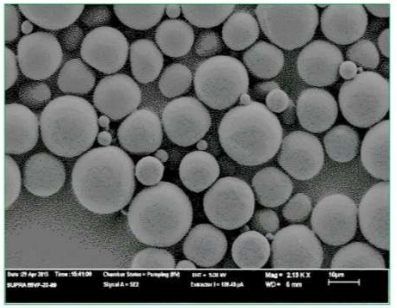
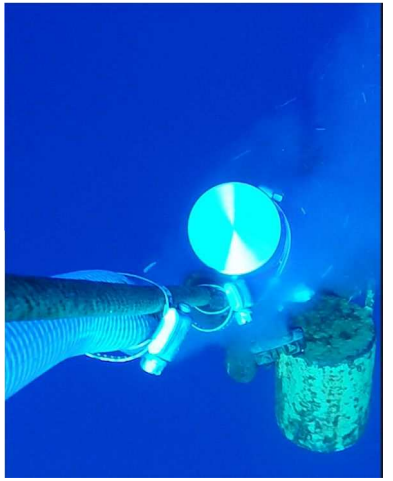
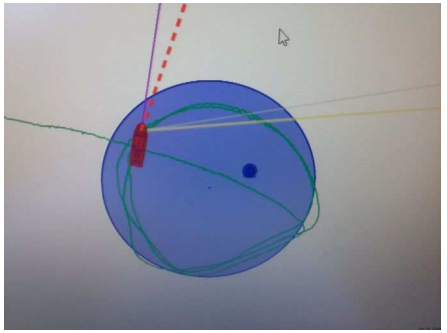


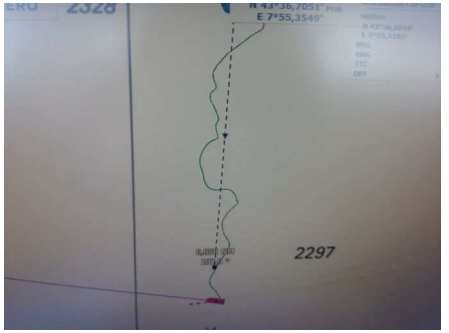
Figure 3. Images of the micro-particles taken by Optical (left) and Scanning Electron (right) Microscopy.



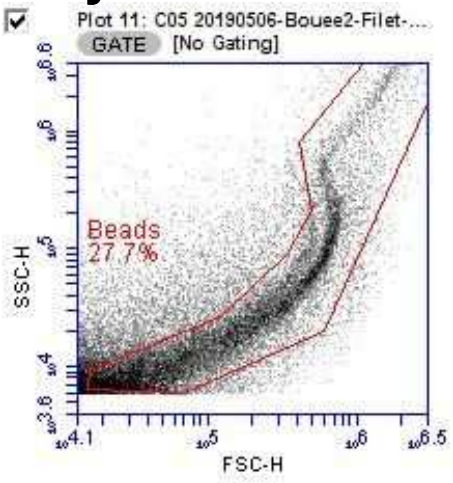
Area of ~$10^4 m^2$



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



Detected with the cytometer !



Summary

Satellite-based adaptive and Lagrangian strategies proved to be successful to target and follow fine scale structures in situ.

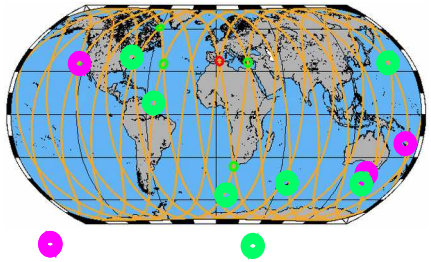
When paired with *in situ* high-frequency biological measurements, like automated cytometry, these strategies highlight the important role of the fine scales in structuring the phytoplankton community by acting as fluid dynamical barriers and biodiversity hot-spots.

Innovative methodologies are in development to directly measure in situ the vertical velocity and to increase the biological sampling.

Outlook

To extend these observations to other regions, we support an international coordinated experimental effort of the fine scale community at several sites all around the world to fully exploit the great opportunities offered by the launch of the satellite SWOT :

the BIOSWOT-AdAC « Adopt-A-Crossover » initiative



See : d'Ovidio, F., Pascual, A., Wang, J., Doglioli, A.M., Jing, Z., Moreau, S., Gregori, G., Swart, S., Speich, S., Cyr, F., Légresy, B., Chao, Y., Fu, L., Morrow, R. (2019). *Frontiers in fine scale in-situ studies: opportunities during the SWOT fast sampling phase*, Front.Mar.Sci. 6:168, doi:10.3389/fmars.2019.00168.

Thank you

for ~~listening~~ downloading !

Questions ?

I will be avalaible in the text chat

on Monday, 4 May 2020, 08:30–10:15

CITED LITERATURE

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Barceló-Llull, B., A. Pascual, L. Díaz Barroso, A. Sánchez-Román, B. Casas, C. Muñoz, M. Torner, E. Alou, E. Cutolo, B. Mourre, J. Allen, G. Aulicino, A. Cabornero, N. Calafat, E. Capó, Y. Cotroneo, F. Cyr, A. Doglioli, F. d'Ovidio, F. Dumas, J.-G. Fernández, L. Gómez- Navarro, G. Gregori, J. Hernández-Lasheras, A. Mahadevan, E. Mason, A. Miralles, D. Roque, M. Rubio, I. Ruiz, S. Ruiz, E. Ser-Giacomi and T. Toomey (2018). PRE-SWOT Cruise Report. Mesoscale and sub-mesoscale vertical exchanges from multi-platform experiments and supporting modeling simulations: anticipating SWOT launch (CTM2016-78607-P). 138 pp. doi: 10.20350/digitalCSIC/8584.

Tzortzis R., Doglioli A.M., Barrillon S., Petrenko A.A., d'Ovidio F., Izard L., Thyssen M., Pascual A., Cyr F., Dumas F., Grégori G., A Lagrangian strategy for in situ sampling the physical-biological coupling at fine scale : the PROTEVSMED-SWOT 2018 cruise.EGU General Assembly 2020, doi:10.5194/egusphere-egu2020-7357.