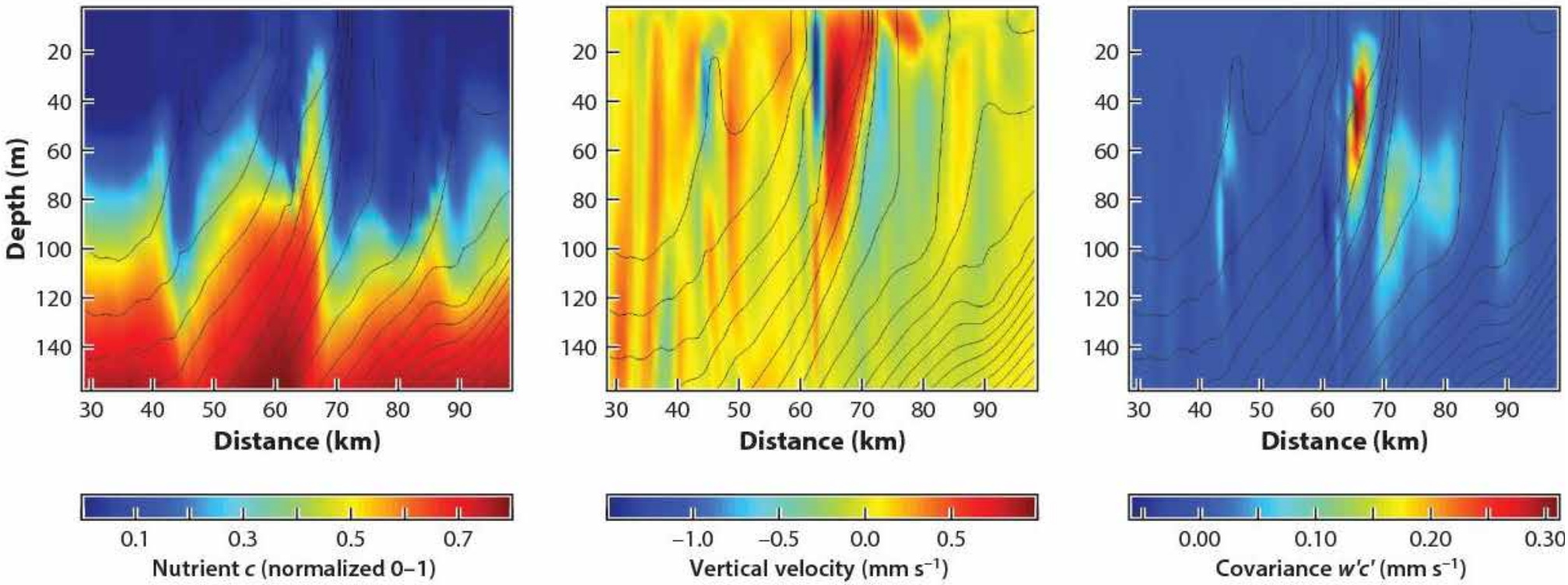
SWOT and fine scale biophysical processes

Motivation 1: Vertical velocities and the biological carbon pump

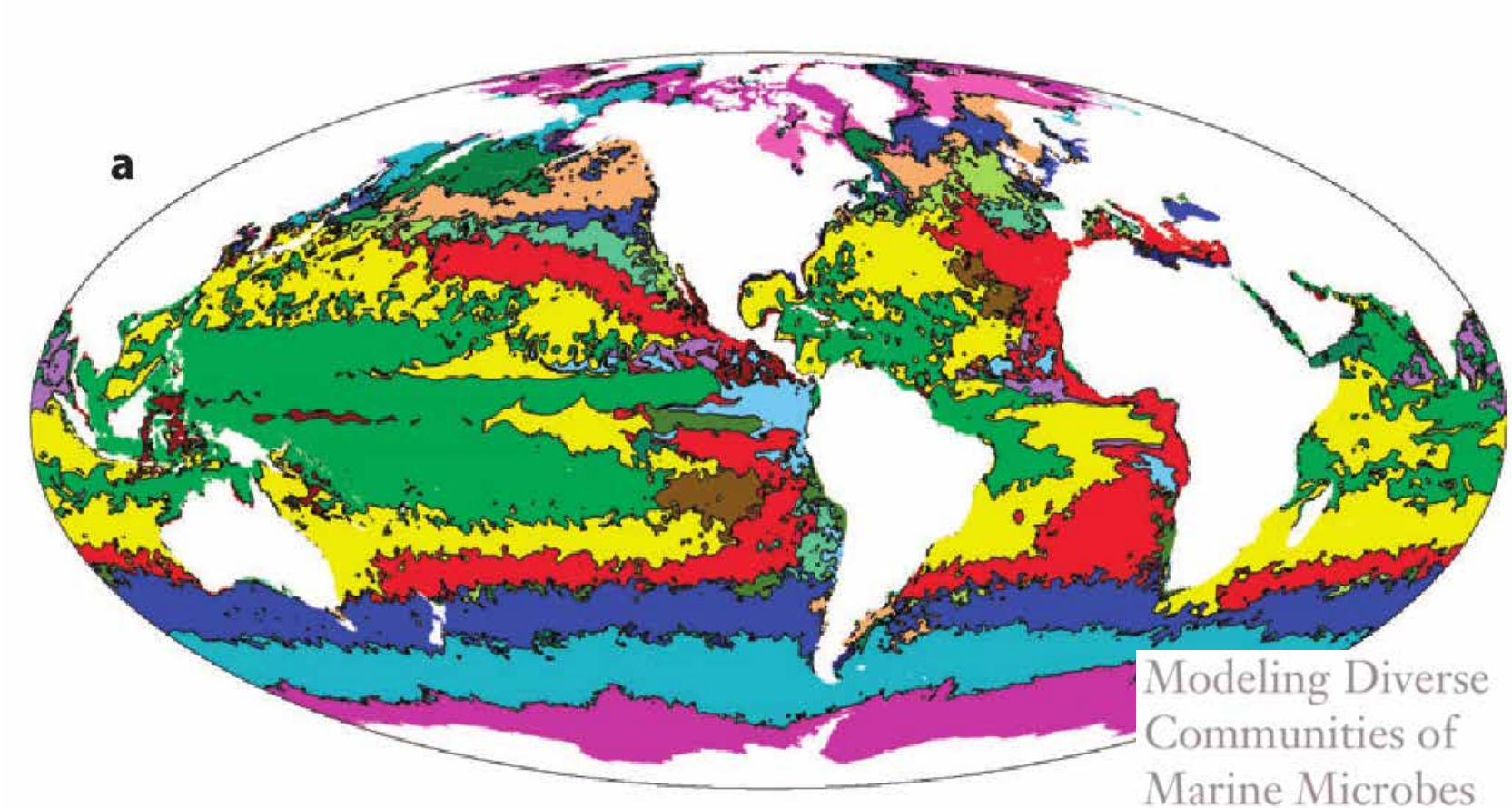


Mahadevan, Ann. Rev. of M. Science 2017

The key role of the fine scales in modulating the intensity of the biological carbon pump is now well established. SWOT will not measure vertical velocities, but should help in determining vertical velocities when paired with in situ observations.

SWOT and fine scale biophysical processes

Motivation 2: Biodiversity (phytoplankton)



A current challenge in climate modeling is to represent plankton diversity in the global biogeochemical cycles.

Ecological models exist, which provide an emergent planktonic biodiversity.

Modeling Diverse Communities of Marine Microbes

Michael J. Follows and Stephanie Dutkiewicz

Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology,

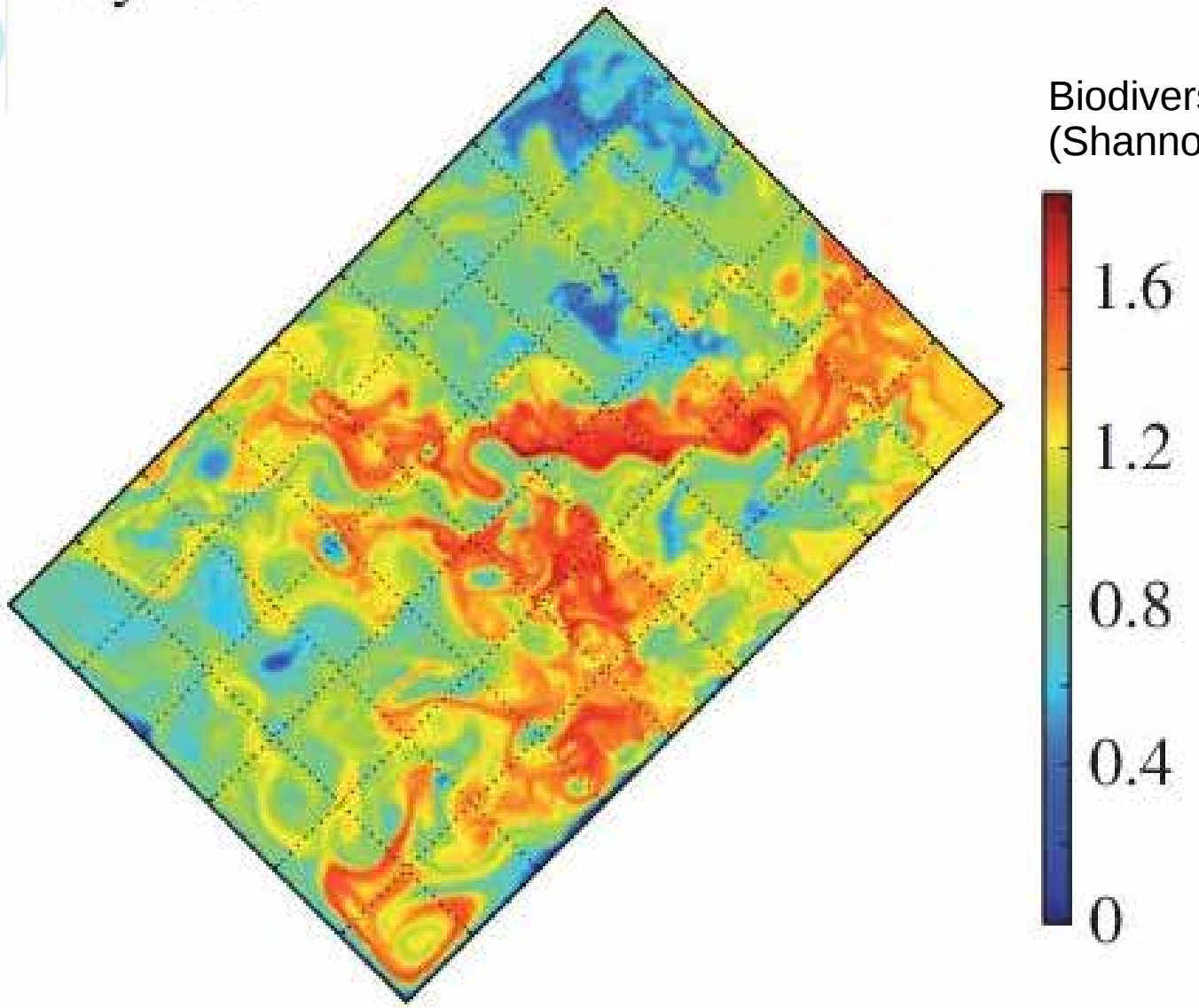
Annu. Rev. Mar. Sci. 2011. 3:427–51

Emergent Biogeography of Microbial Communities in a Model Ocean

Michael J. Follows,[1*] Stephanie Dutkiewicz,[1] Scott Grant,[1,2] Sallie W. Chisholm[3]

SCIENCE VOL 315 30 MARCH 2007

Fine scale model studies



An important part of biodiversity appears to be driven by the fine scales in model studies: fronts enhance biodiversity, retentive eddies suppress it.

Validation from observation and empirical details are lacking

d'Ovidio, et al., PNAS 2010

Lévy, et al., J. R. Soc. 2015

Mediterranean sea May 2018 cruise

A. Pascual, F. Dumas, A. Doglioli, G. Gregori, P. Garreau, F. d'Ovidio

A synergy among three programs:

1. PRE-SWOT (A. Pascual: SWOT-ST, CSIC, IMEDEA, SOCIB)

2. PROTEVS_SWOT (F. Dumas, P. Garreau SHOM)

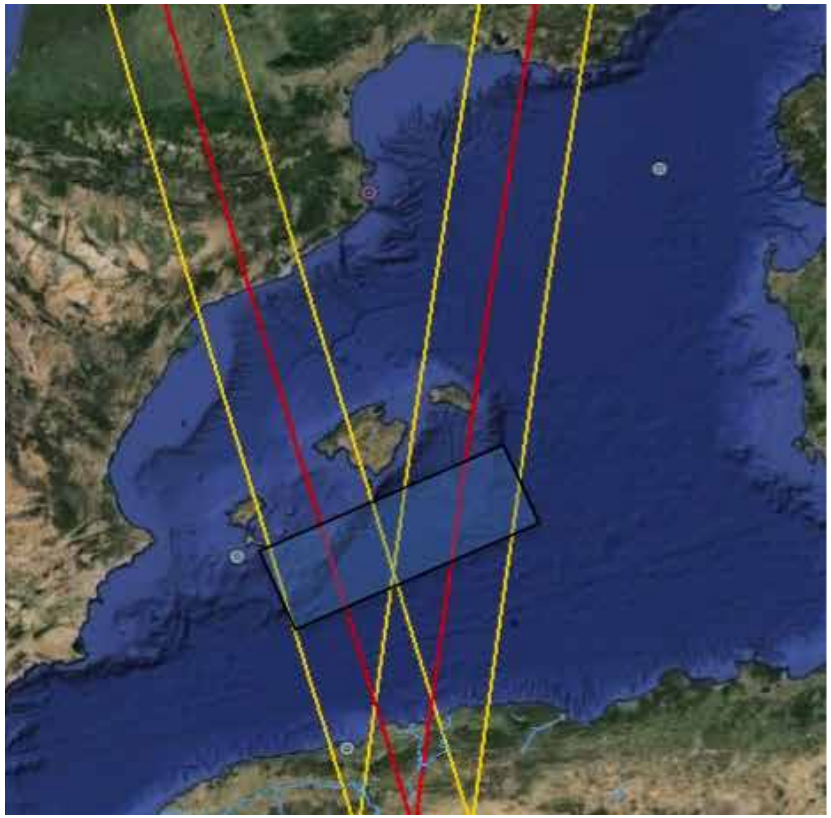
3. BIOSWOT (SWOT-ST; A. Doglioli, G. Gregori, F. d'Ovidio: MIO, LOCEAN-IPSL; L. Froideval, U. Caen; F. Cyr NAFC, St John's)

BIOSWOT

Objectives

One common objective..

Evaluate the interest of the west Med SWOT crossover



Provide feedback on a “multisatellite package”.

Gain experience in multi-platform, multi-lateral campaign coordination.

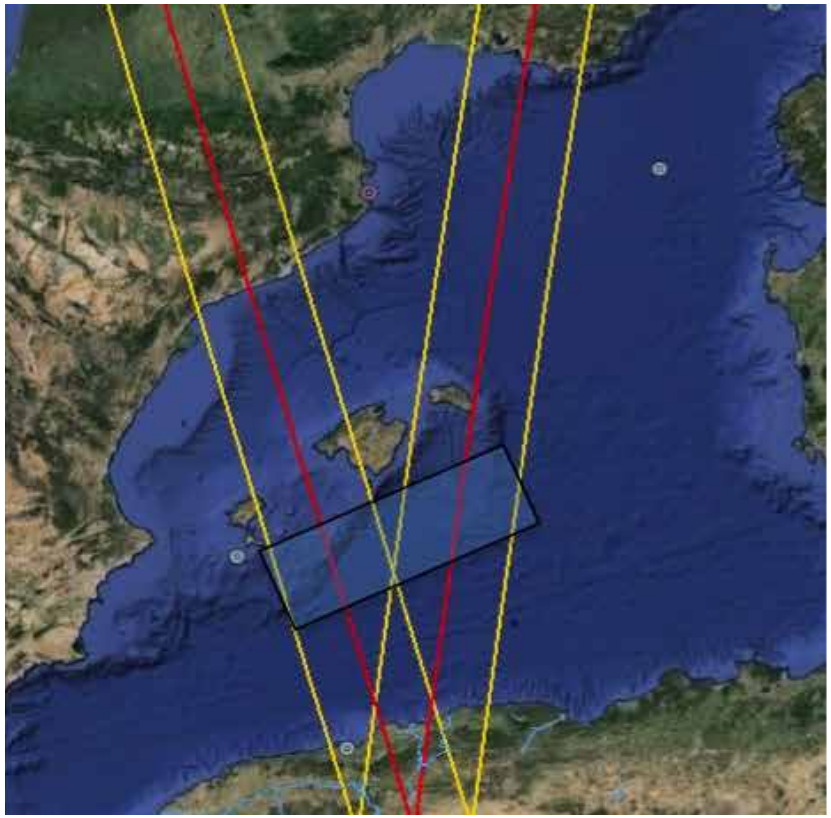
Explore the dynamics present in this region.

Test airborne lidar for SWOT CalVal.

Objectives

One common objective..

Evaluate the interest of the west Med SWOT crossover



Provide feedback on a “multisatellite package”.

Gain experience in multi-platform, multi-lateral campaign coordination.

Explore the dynamics present in this region.

Test airborne lidar for SWOT CalVal.

.. and three separate ones

SHOM: hydrography of mesoscale features in the Mediterranean

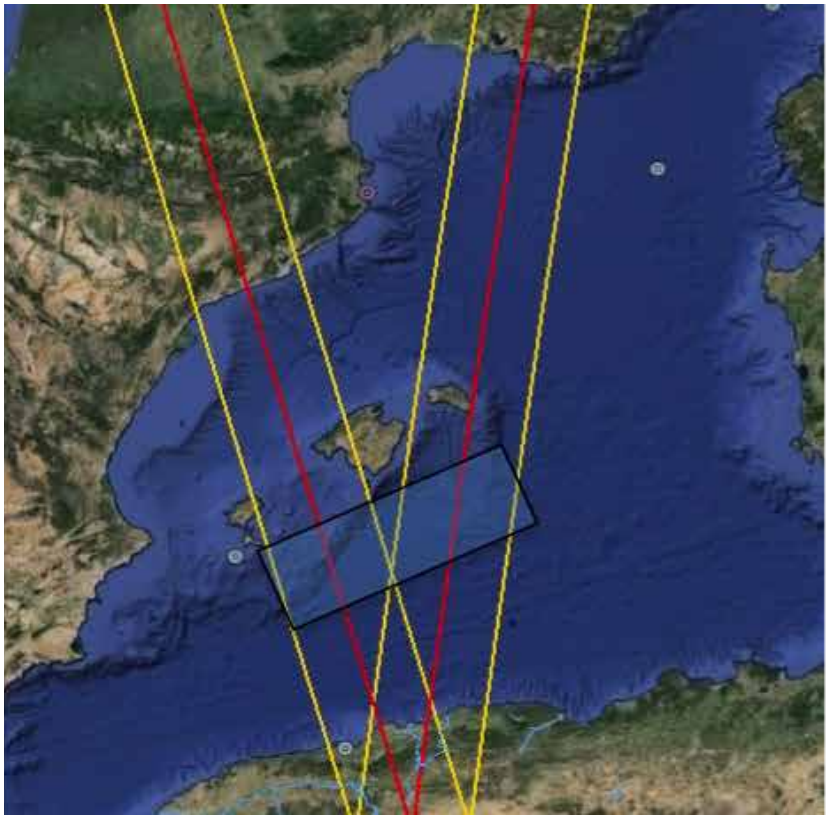
PRE-SWOT: vertical velocities (omega equation) and altimetry (nadir) CalVal

BIOSWOT: Plankton biodiversity at the fine scale

Platforms and instruments (1/2)

R/V García del Cid
(CSIC, Spain)

5-16 May 2018



BHO Beautemps-Beaupré
(SHOM France)

28 April – 14 May 2018

Airplane
LIDAR + Hiperspectral camera
(Univ. Caen)

Slocum glider
(SOCIB, Spain)

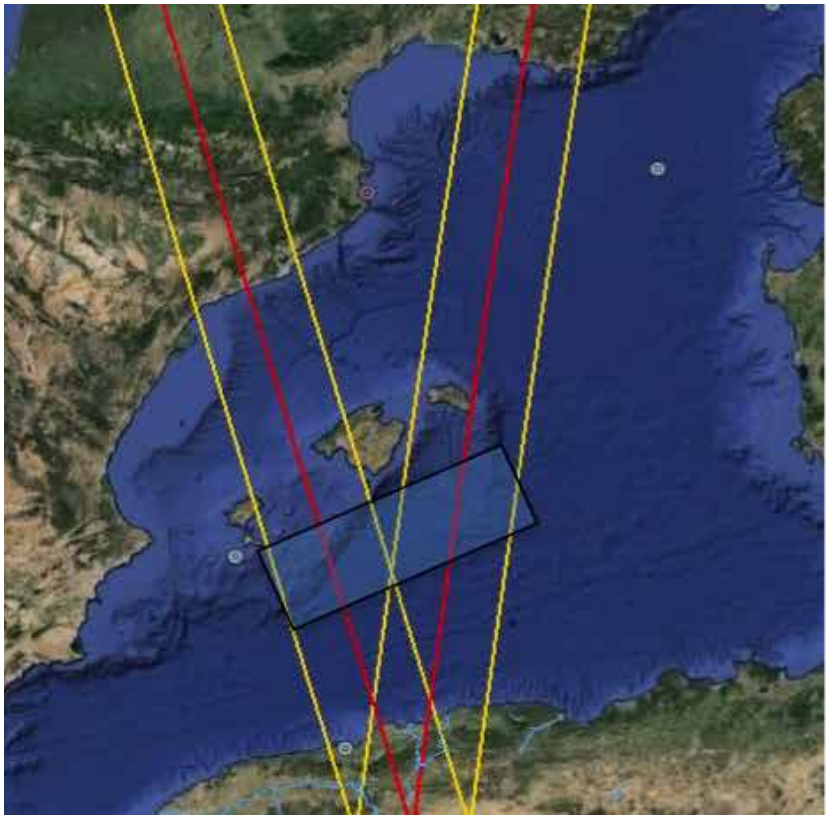
SeaExplorer glider
(MIO, France)

Drifters
(CSIC, SOCIB, SHOM)

Platforms and instruments (1/2)

R/V García del Cid
(CSIC, Spain)

5-16 May 2018



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Slocum glider
(SOCIB, Spain)

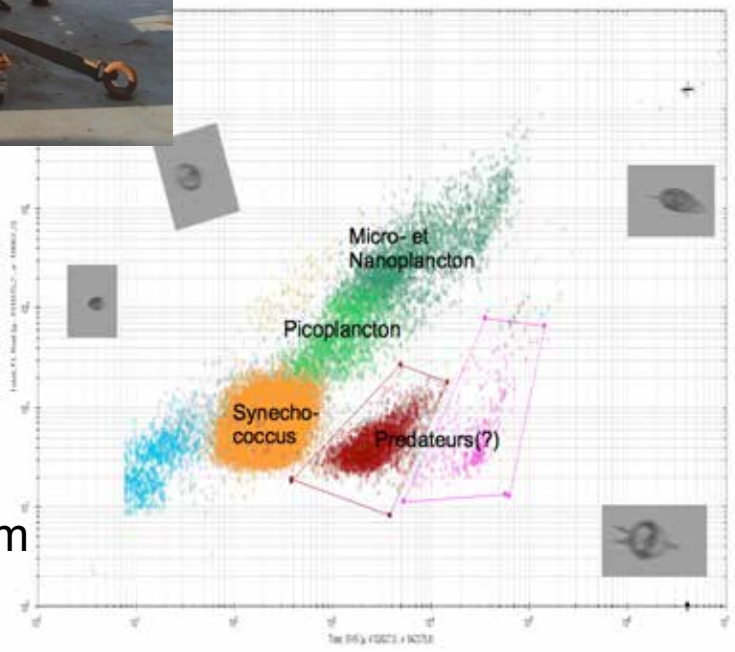
Drifters
(CSIC, SOCIB, SHOM)

SeaExplorer glider
(MIO, France)

Platforms and instruments (2/2)

SeaSoar (SHOM)

~3 km resolution
300 m depth

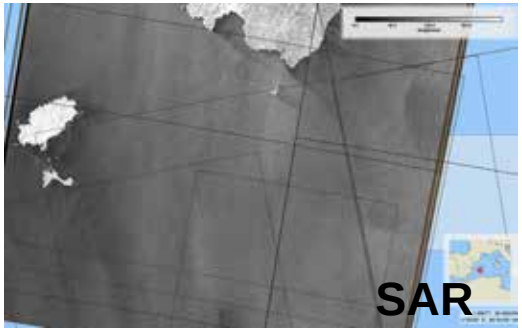


Flux cytometry (MIO)

Identification of microbes from size, color, and shape.

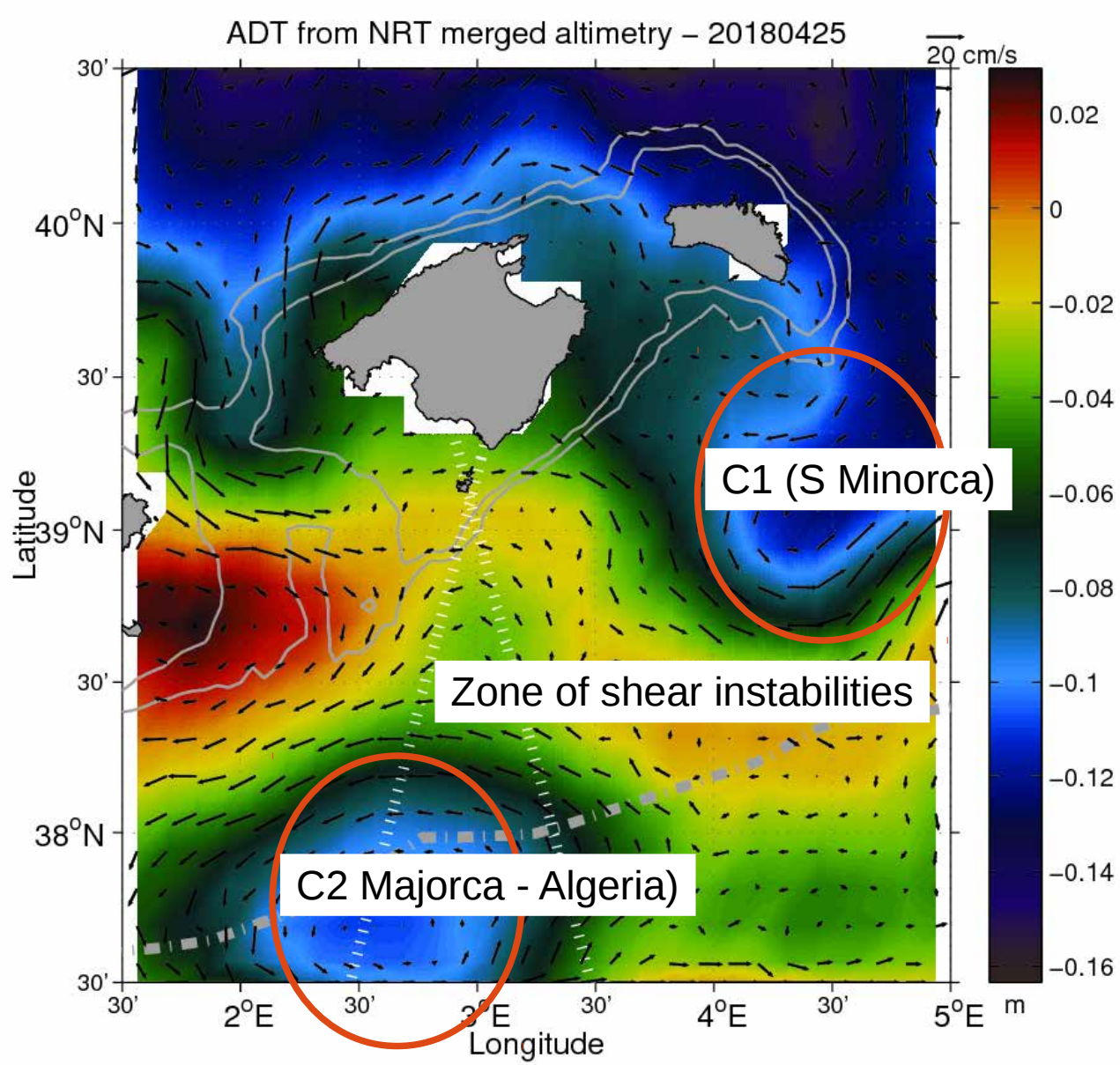
One point every 20 minutes @ 9
Knot = 5.5 km

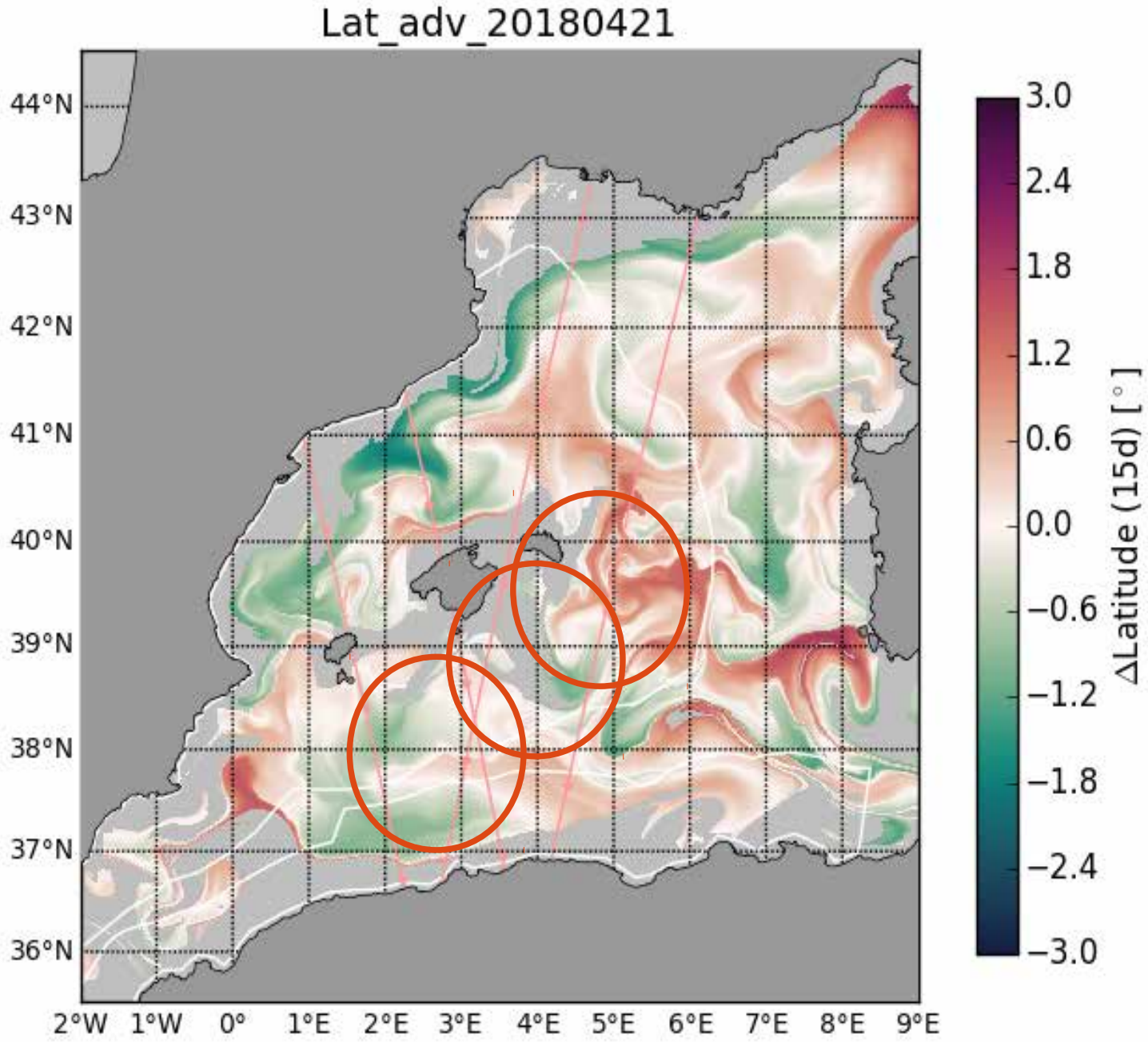
Multisatellite support



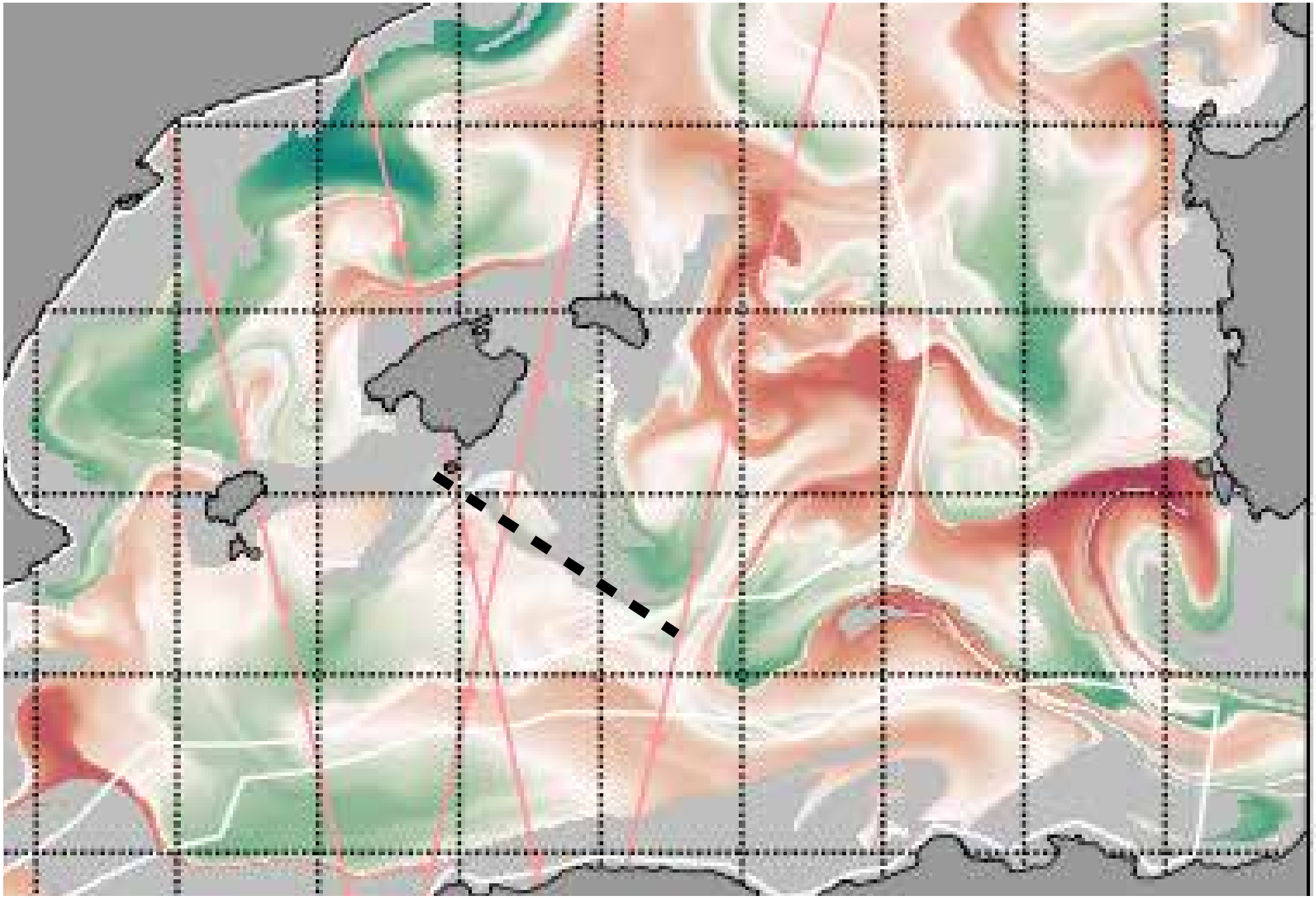
cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

Cruise plan
Altimeter maps

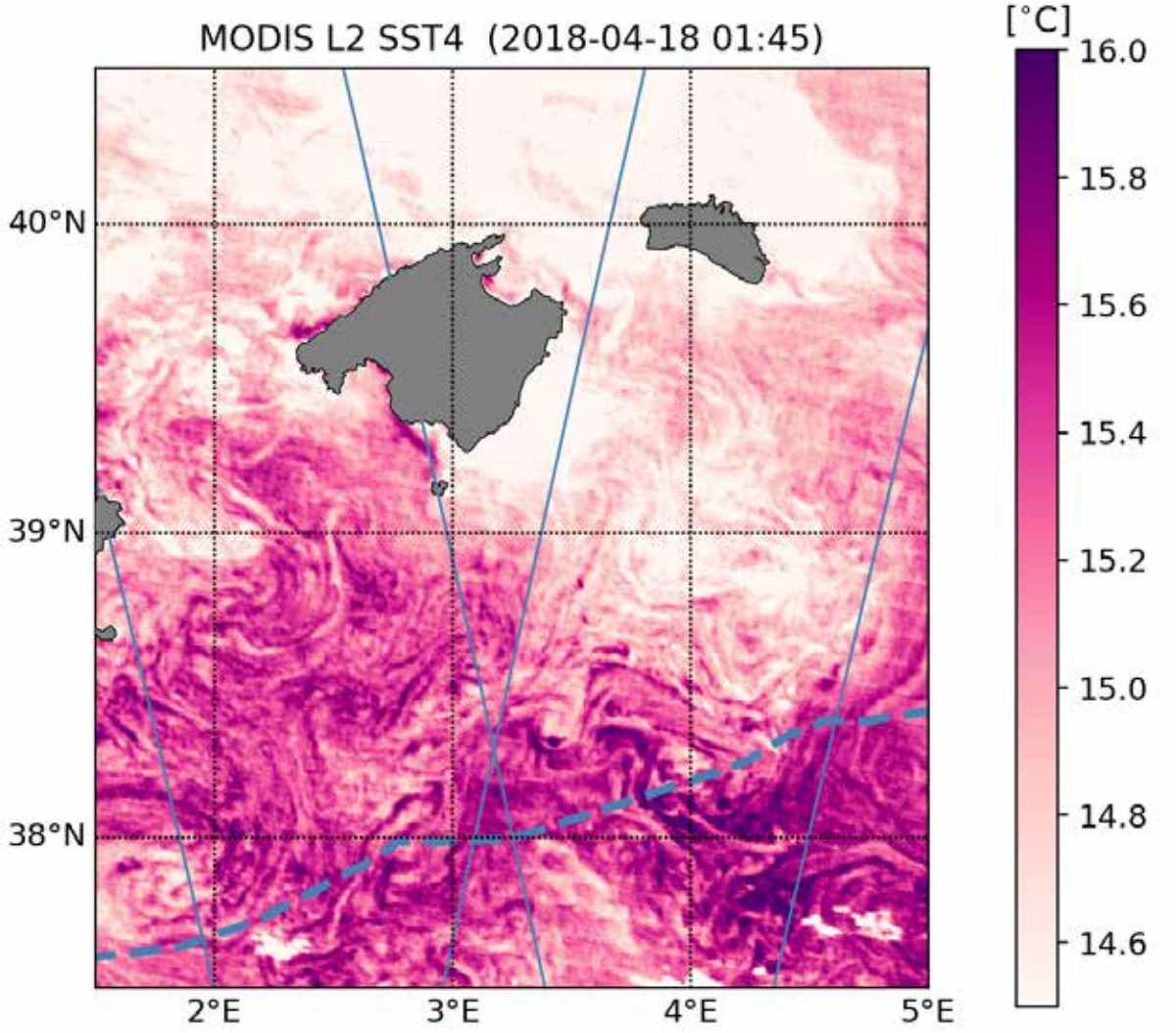




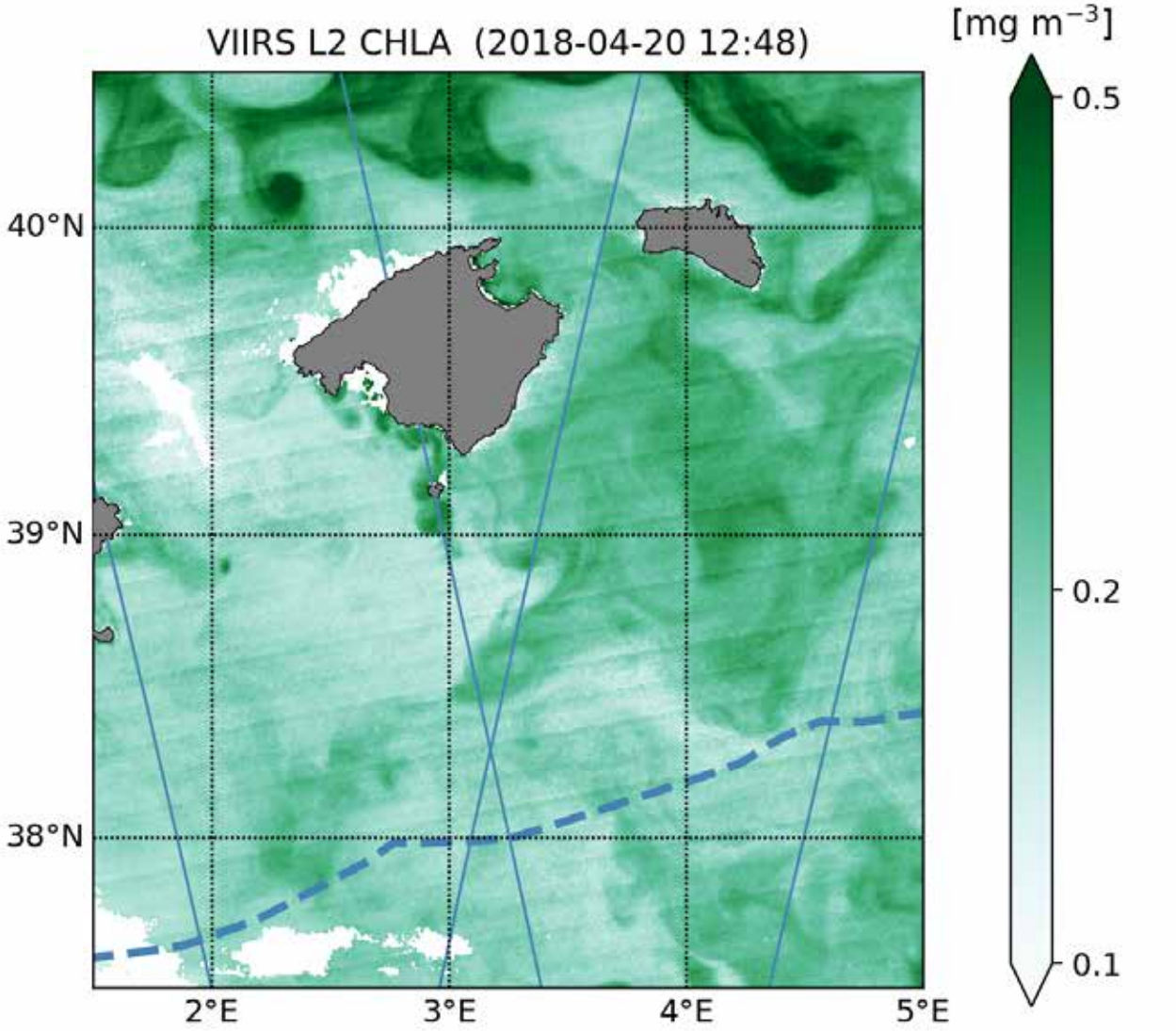
Effects on tracer dispersion



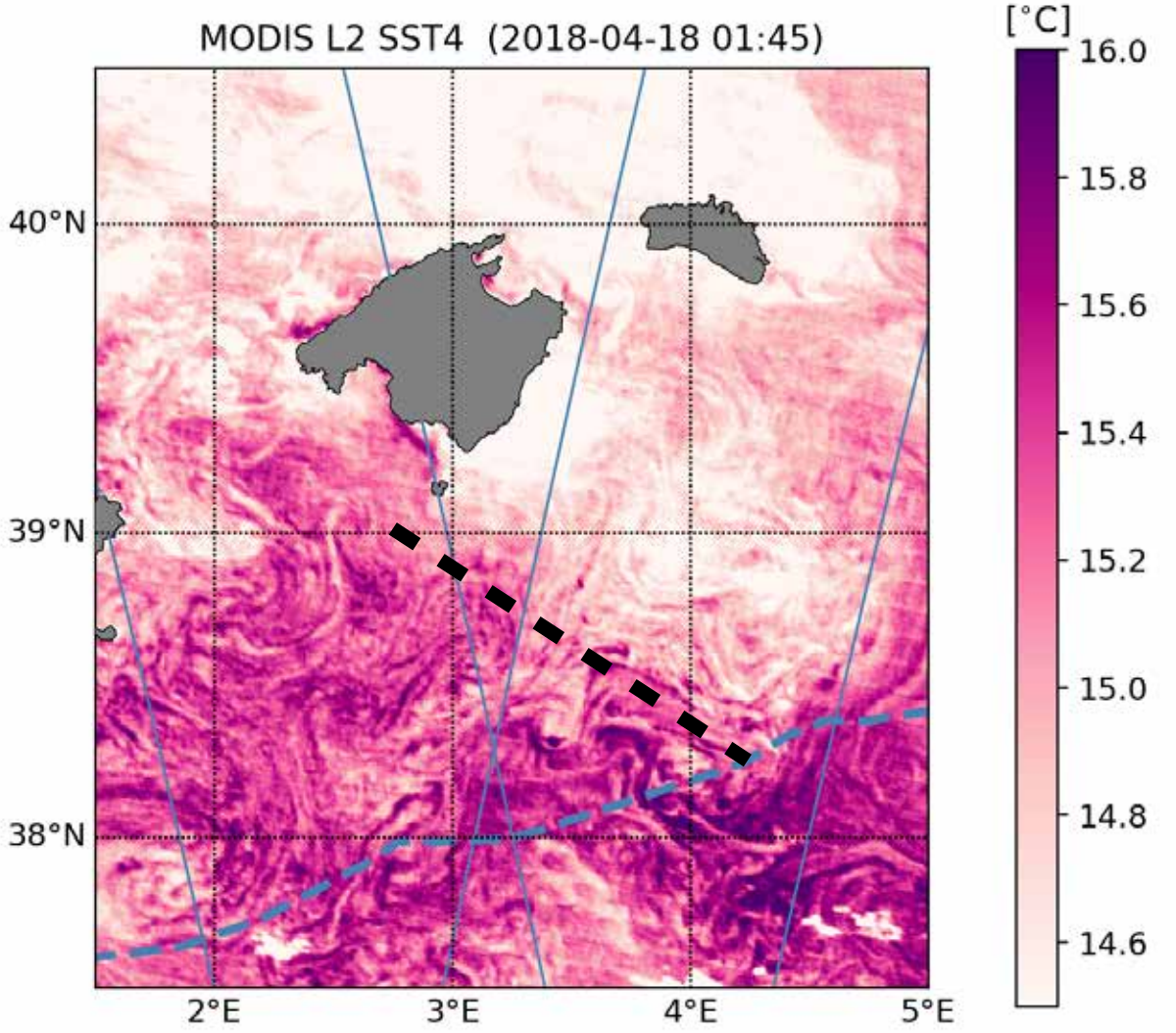
Cruise plan
SST Modis



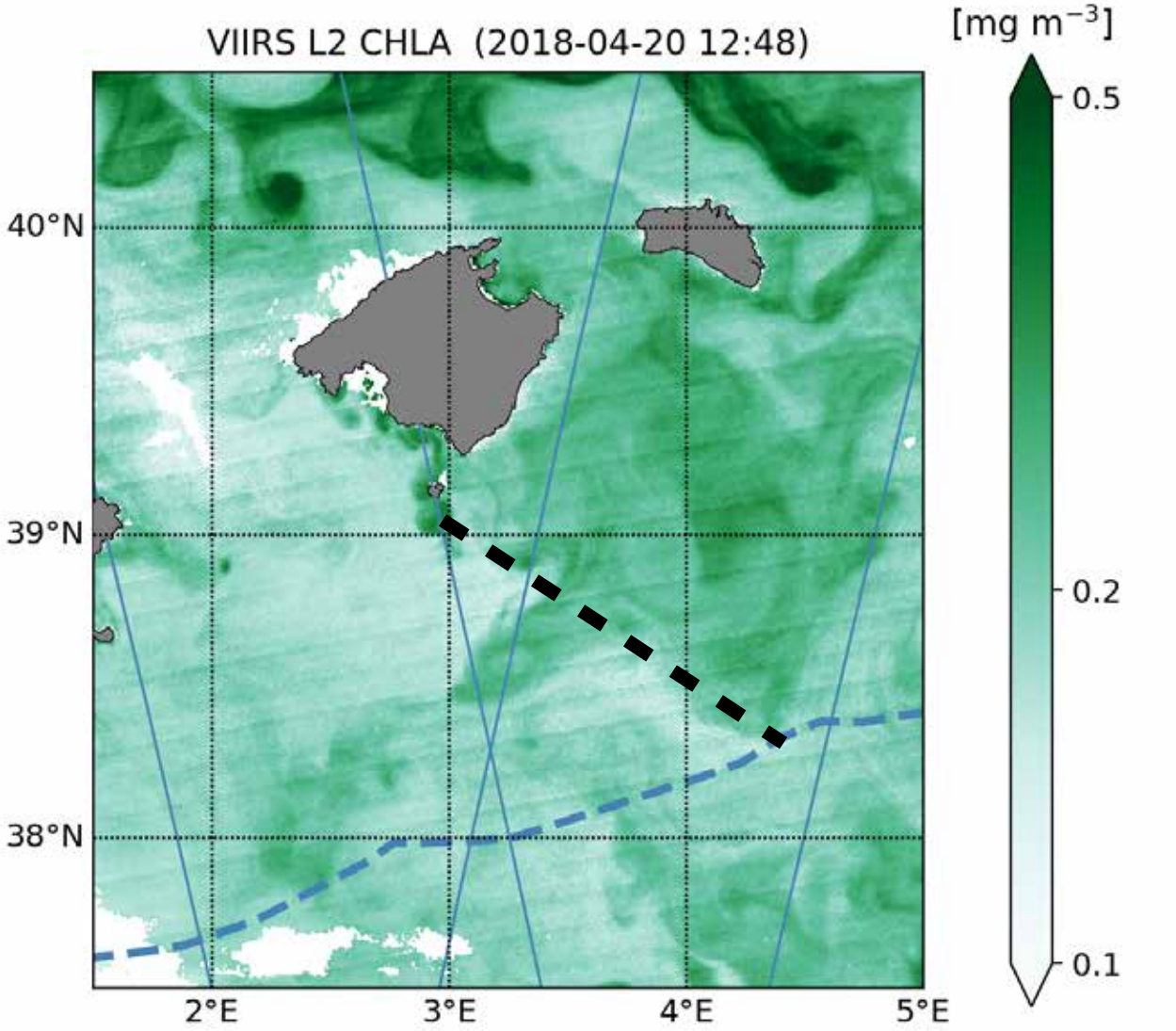
Cruise plan
Chl VIIRS



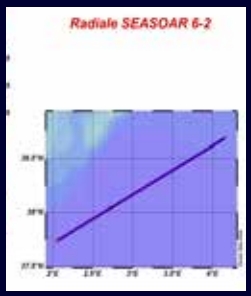
Cruise plan
SST Modis



Cruise plan
Chl VIIRS

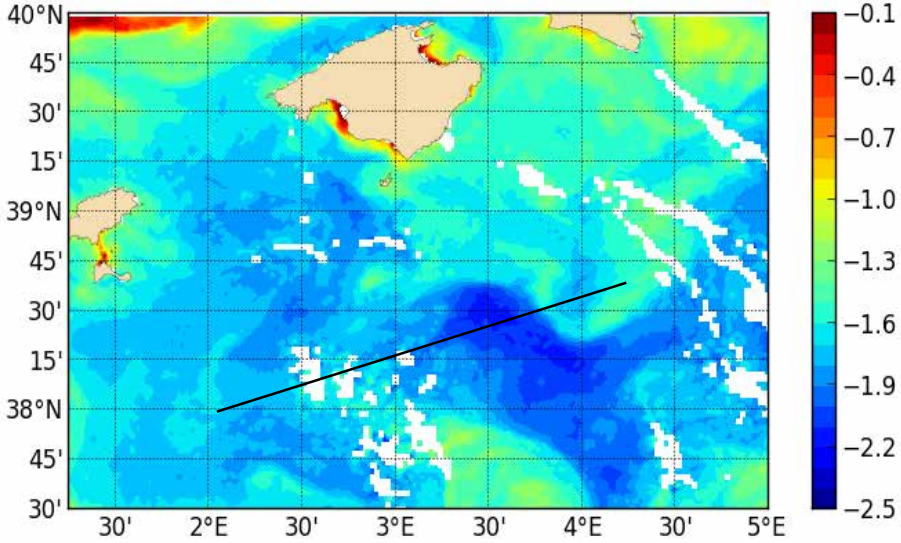


SHOM L'océan en référence

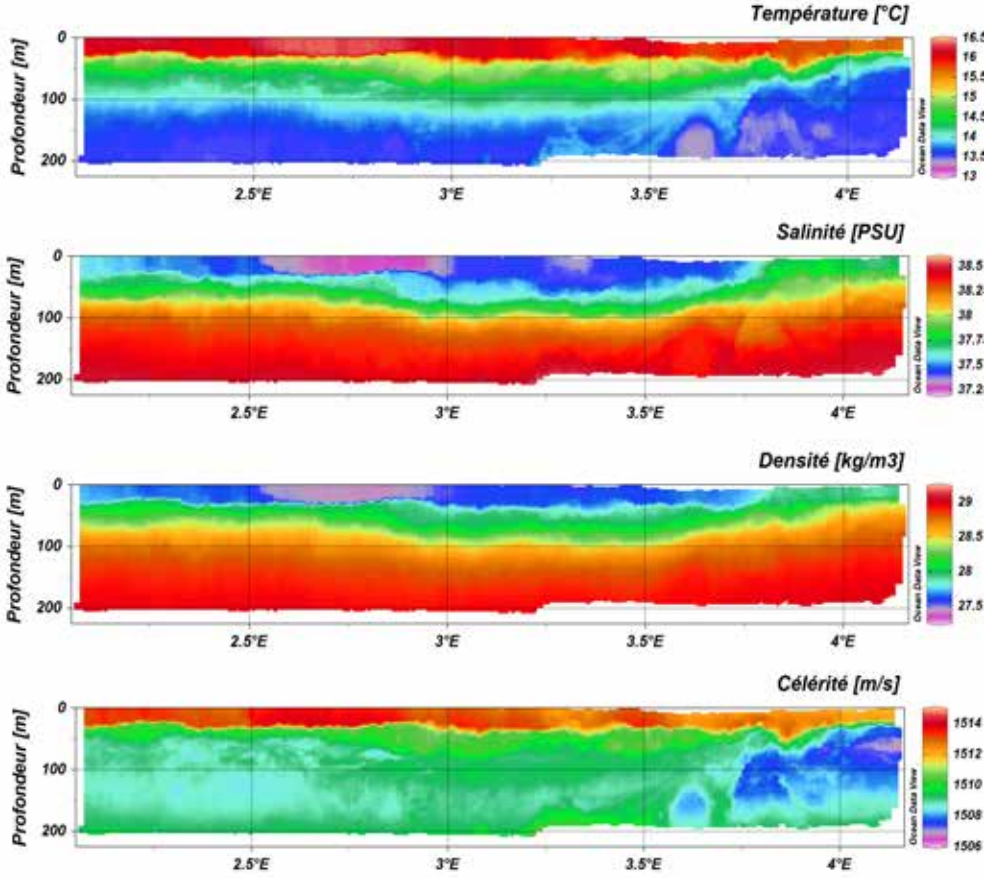


- In situ confirmations

Two water masses with physical and biological contrats



log(chl) 20180501

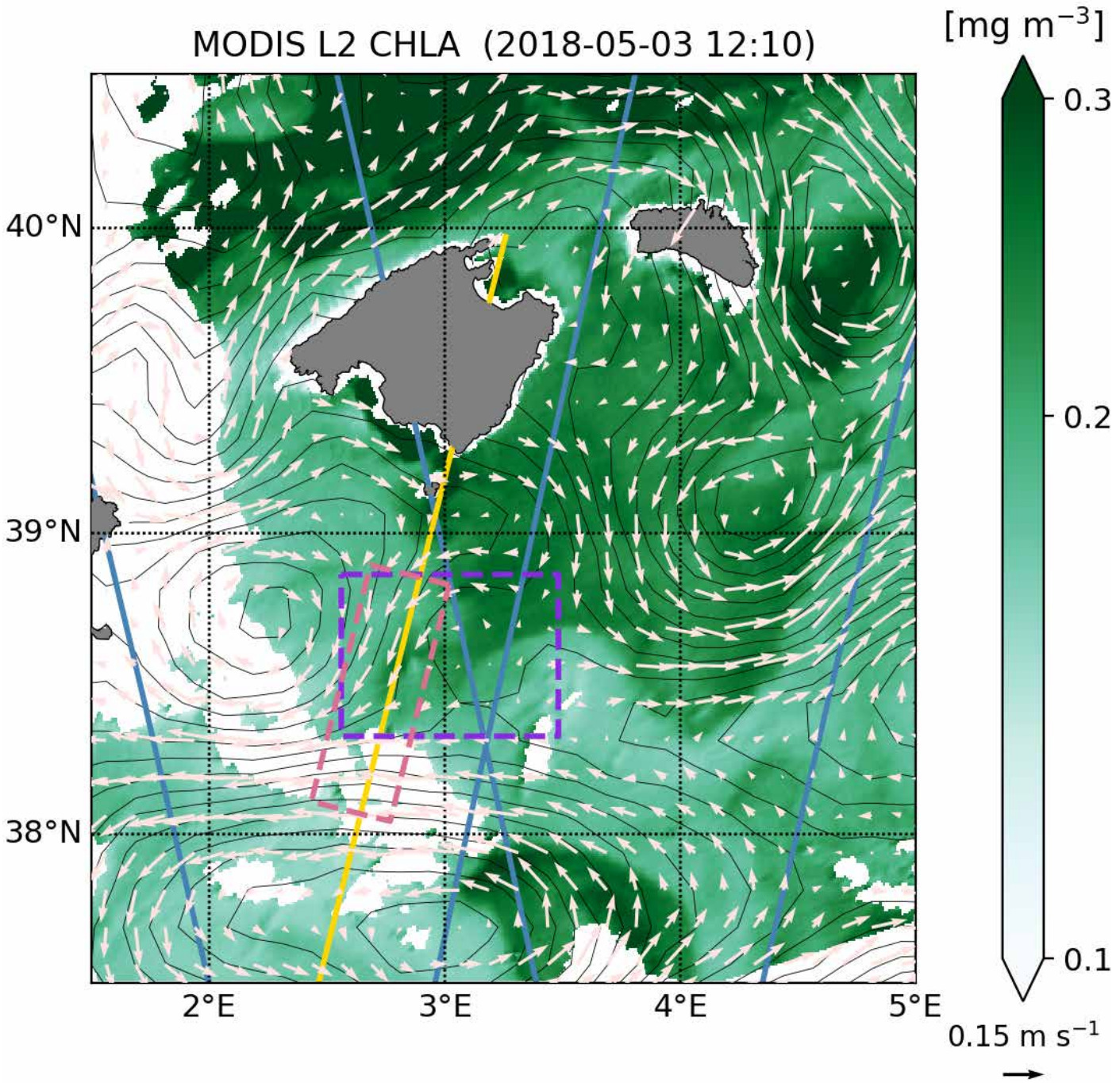


PRE-SWOT (A. Pascual)

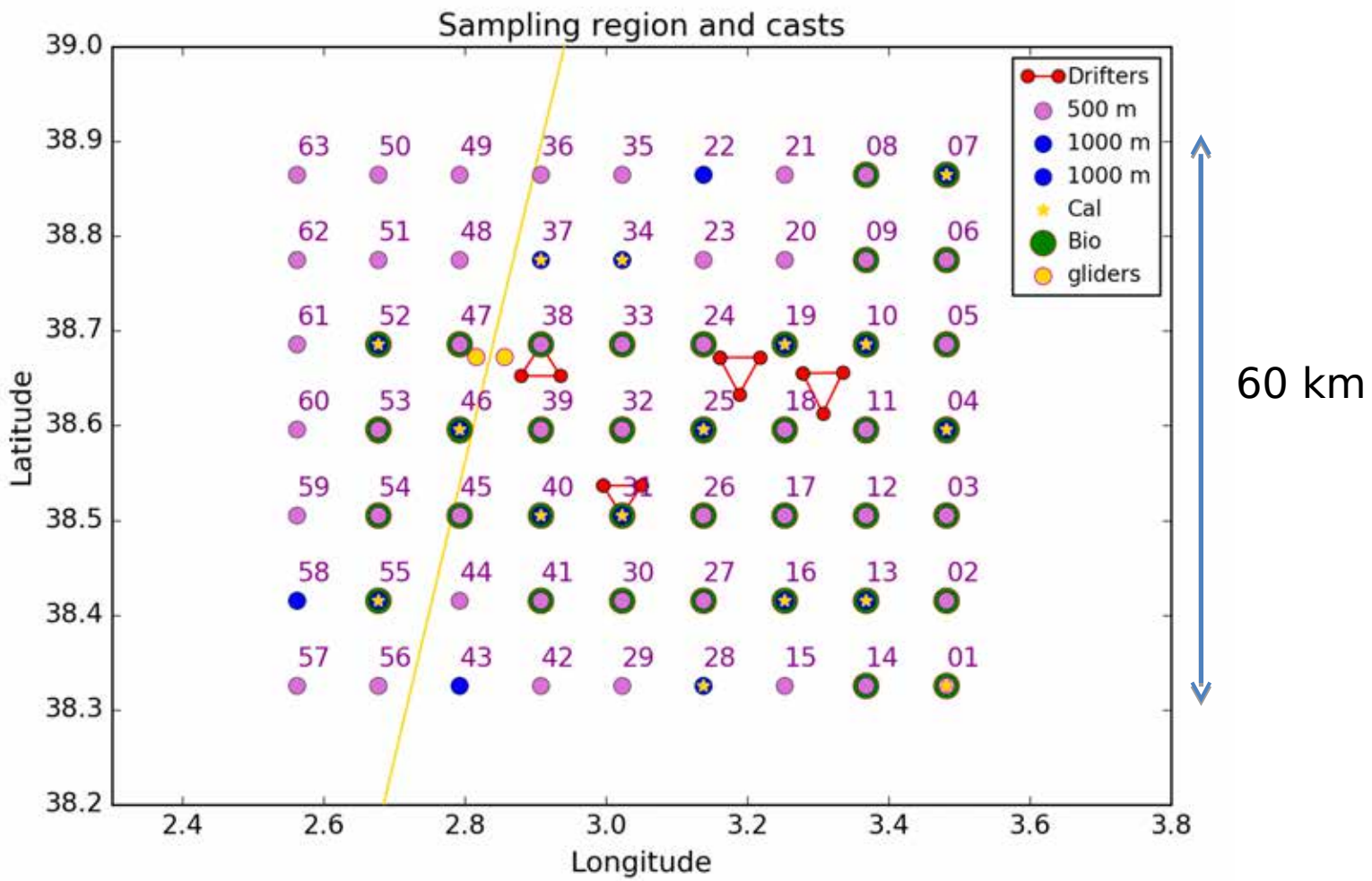
Chl +Altim

SWOT
and
Sentinel-3
Tracks

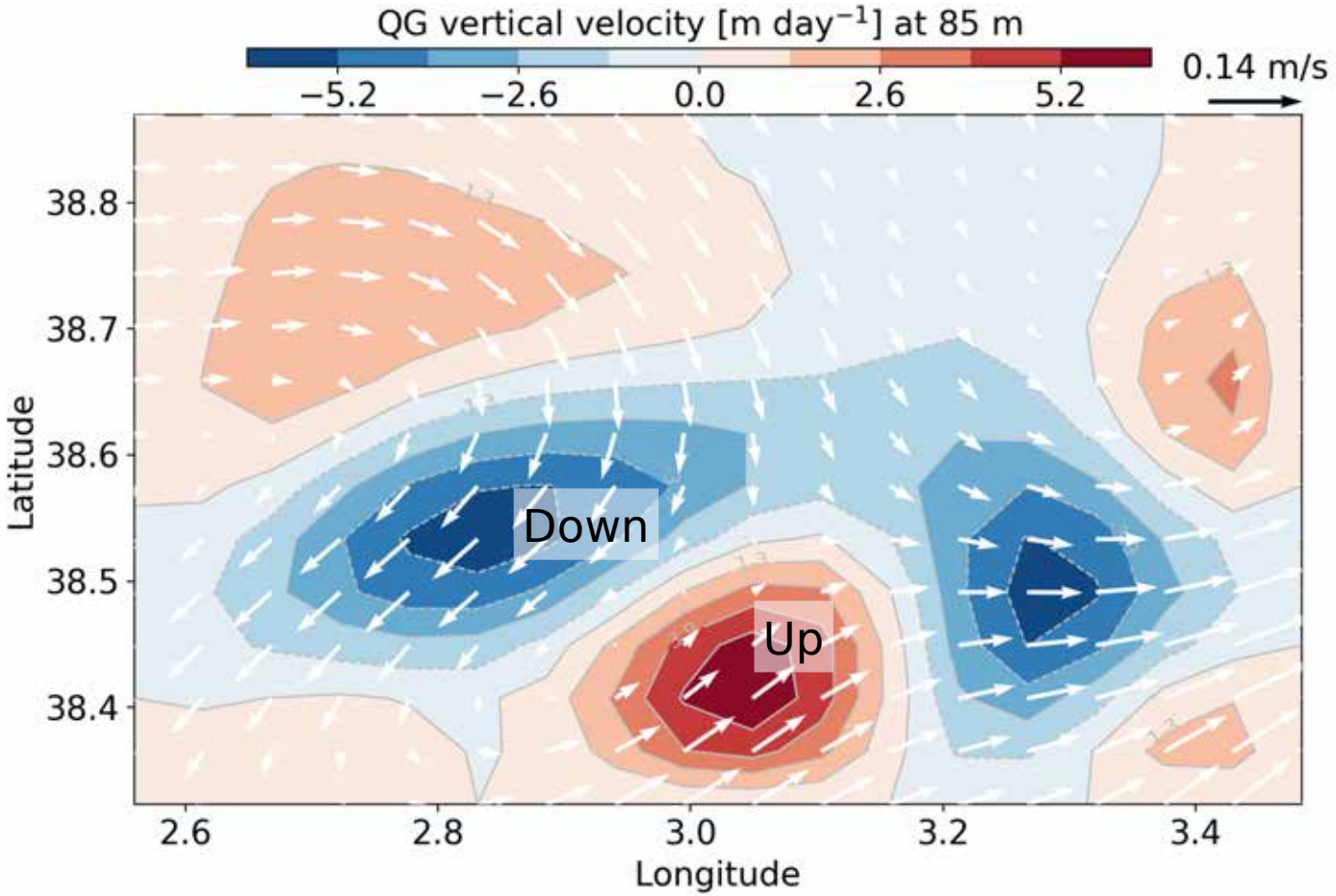
PRE-SWOT
Sampling
Leg-1
Leg-2



PRE-SWOT preliminary results (Leg 1)

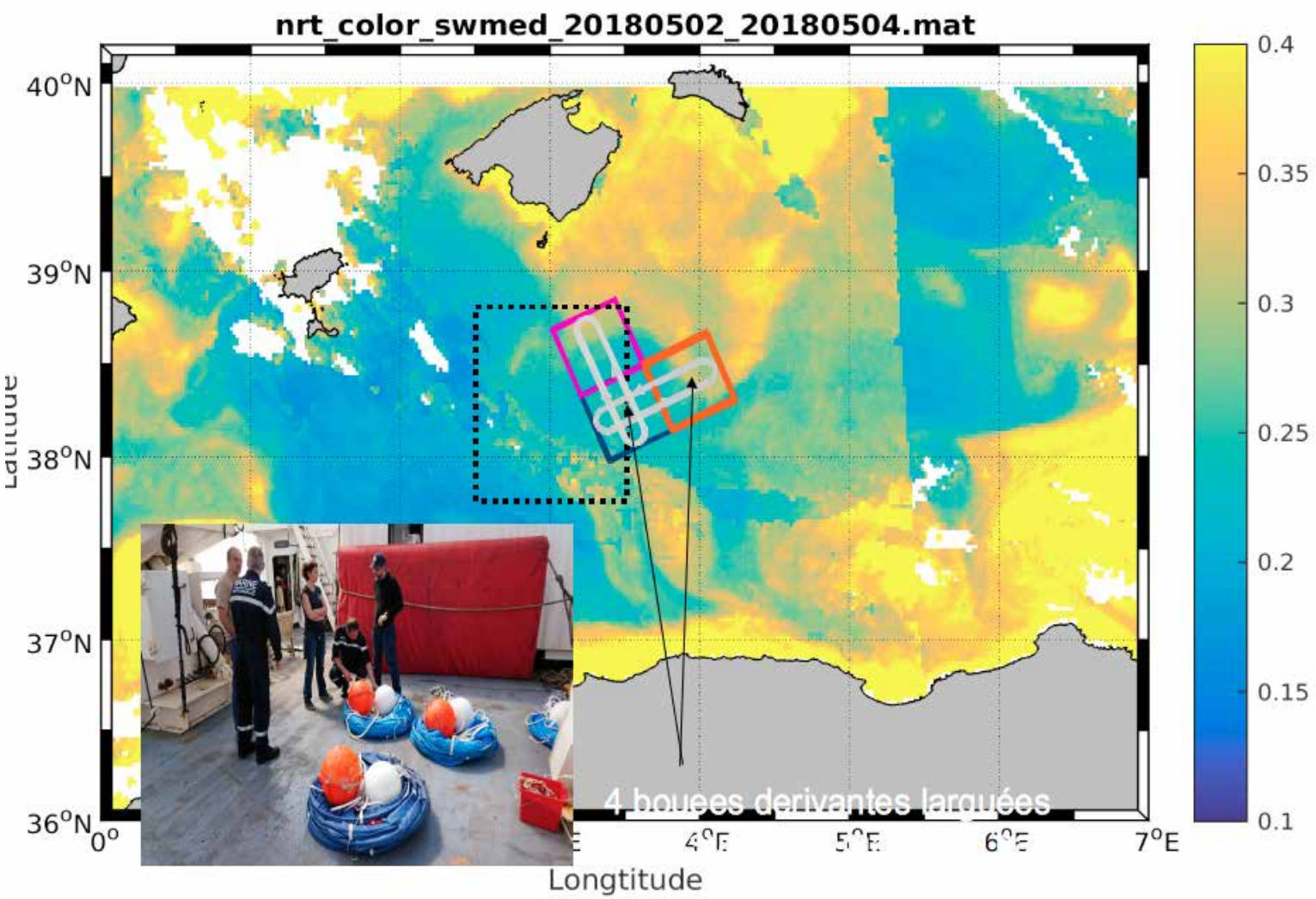


Quasi-geostrophic vertical velocity

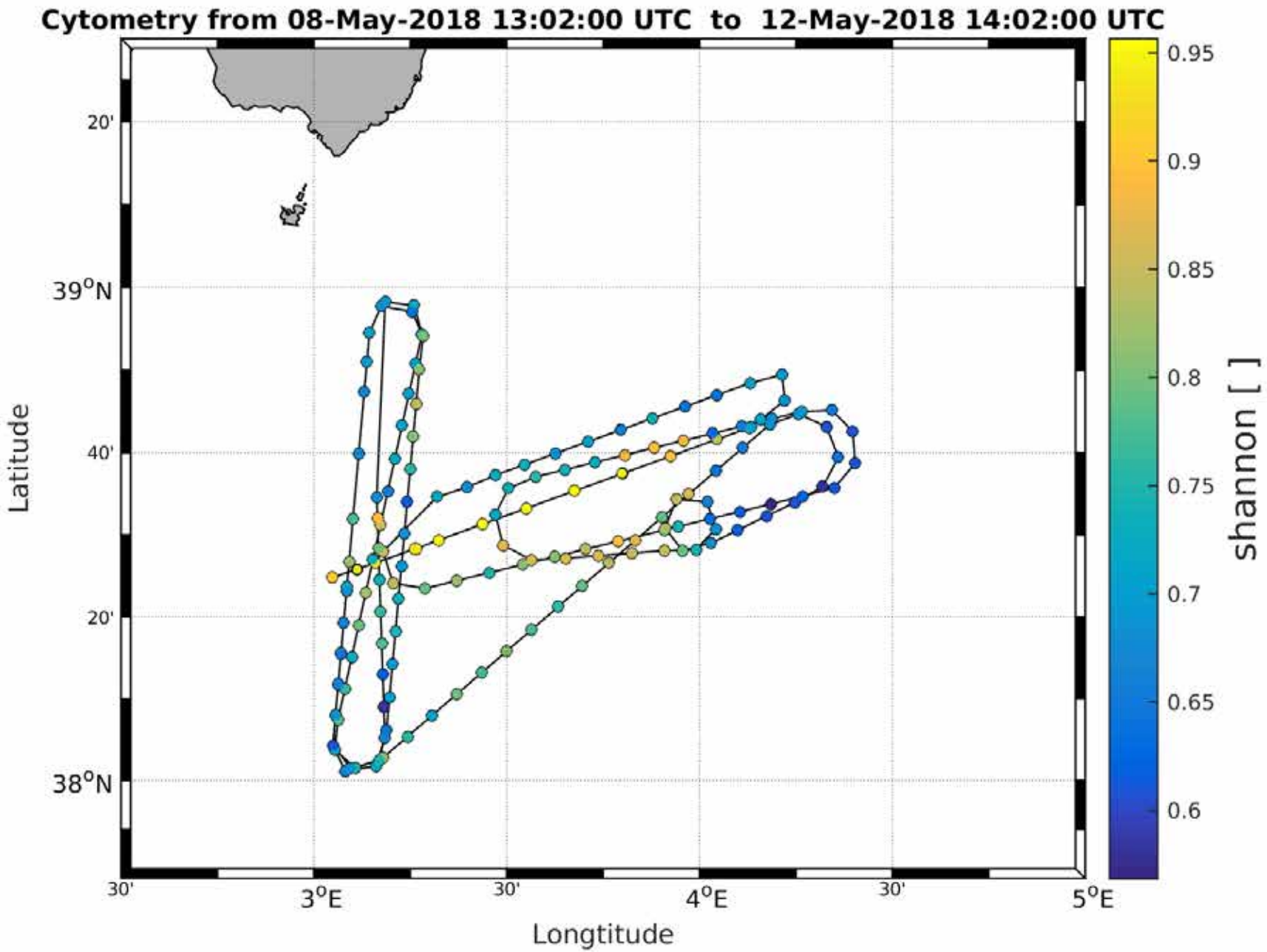


- Consistent with QG theory
- Maximum up & down upstream/downstream meander

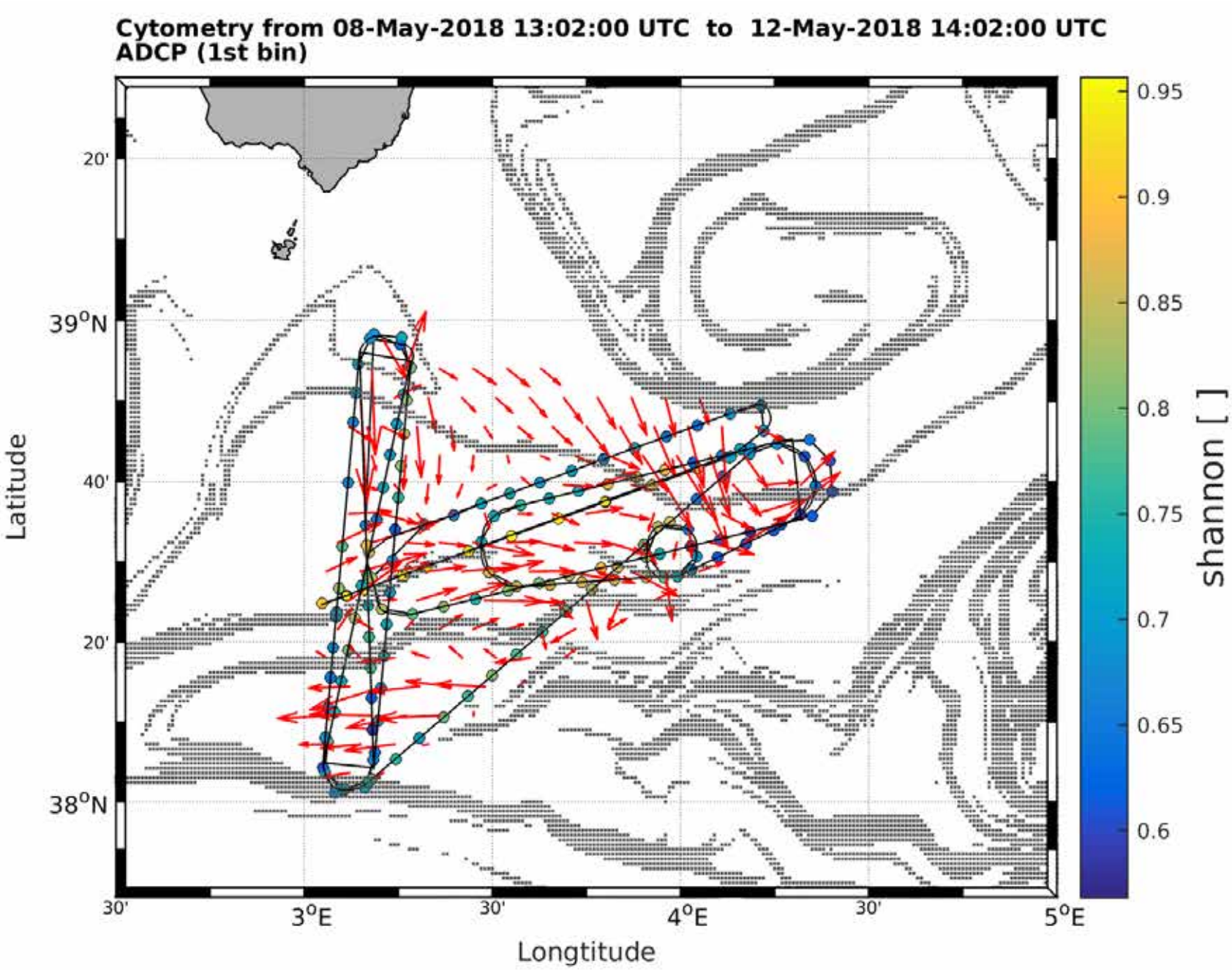
Poster B. Barceló-Llull


nrt_color_swmed_20180502_20180504.mat
40°N
39°N
38°N
37°N
36°N
0°
4°E
5°E
6°E
7°E
Longtitude
0.4
0.35
0.3
0.25
0.2
0.15
0.1
4 bouees derivantes larguées

Phytoplankton biodiversity



Preliminary results show a nice biodiversity contrast, with higher diversity along the front.



Preliminary results show a nice biodiversity contrast, with higher diversity along the front.

Lessons learned

(+) The west Med SWOT crossover presents contrasts of Mediterranean and Atlantic water giving rise to an interesting fine-scale activity for both physics and biology, even outside of the Algerian current.

(+) Proximity to major ports and airports, small Rossby radius and low internal wave activity, make of this region a very good candidate for testing SWOT detection of balanced motion at “sub-nadir” resolution with a flexible campaign.

(+) High resolution multisatellite package extremely useful, but all current technology is unpredictable. SAR is no exception.

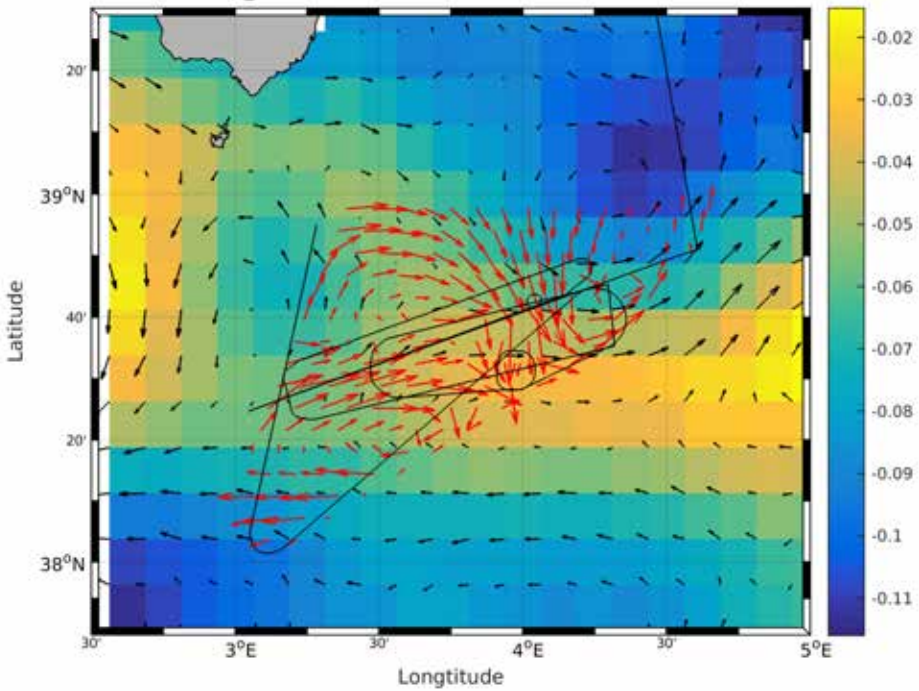
(W) Avoid international and Algerian waters, whose accessibility is unpredictable.

(W) If airplane operations are a priority, window of opportunity should be of several weeks (e.g., multi-leg campaign).


Thank you!

nrt_med_allsat_phy_l4_20180501_20180501.mat

ADCP (1st bin) _INTERP



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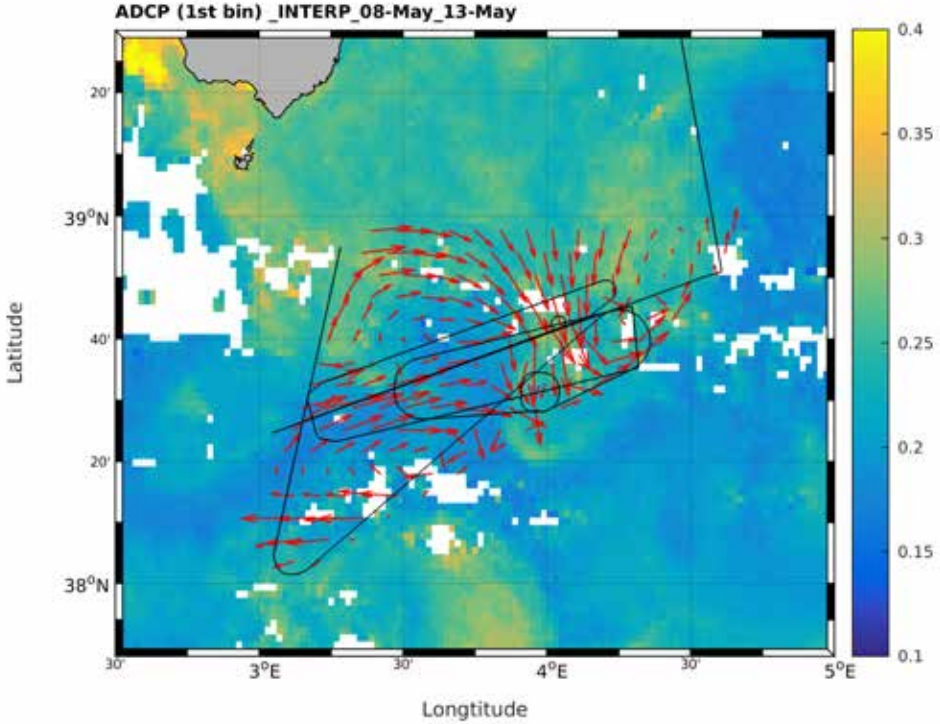
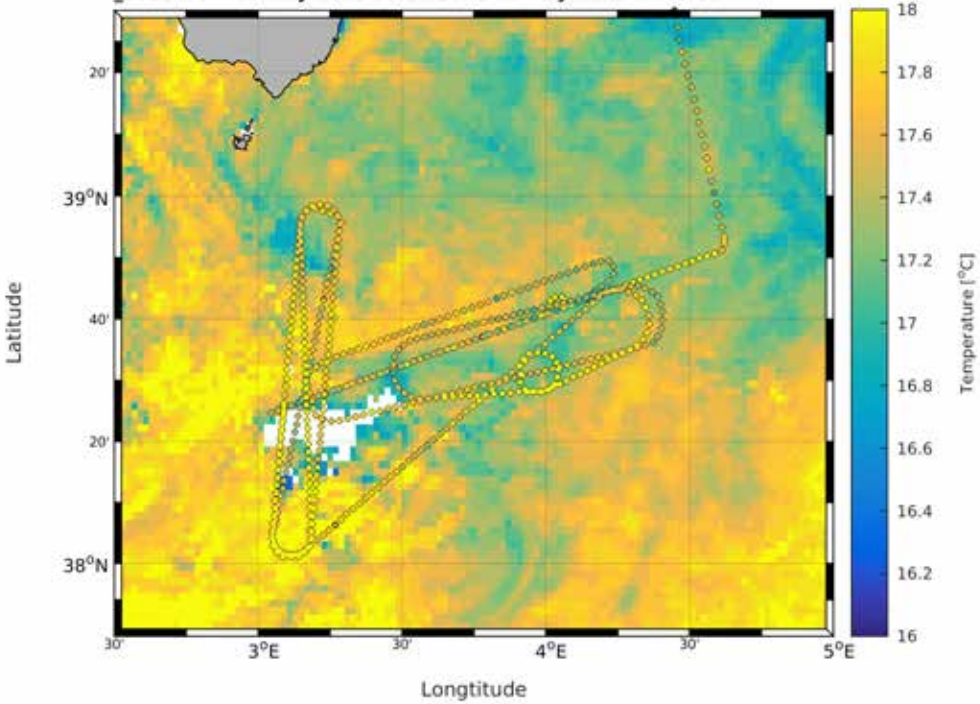
ADCP (1st bin) _INTERP_08-May_13-May

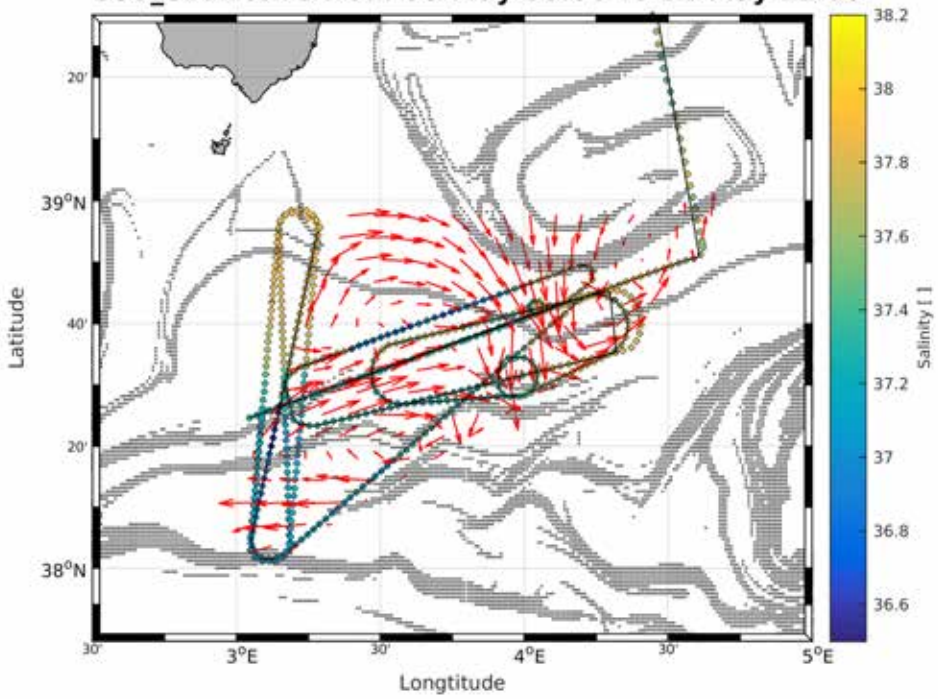


nrt_temperature_swmed_20180510_20180512.mat

_SB38 from 08-May-2018 00:00:30 to 12-May-2018 12:29:30



SSS_SB21cuve from 08-May 00:00 to 12-May 12:29

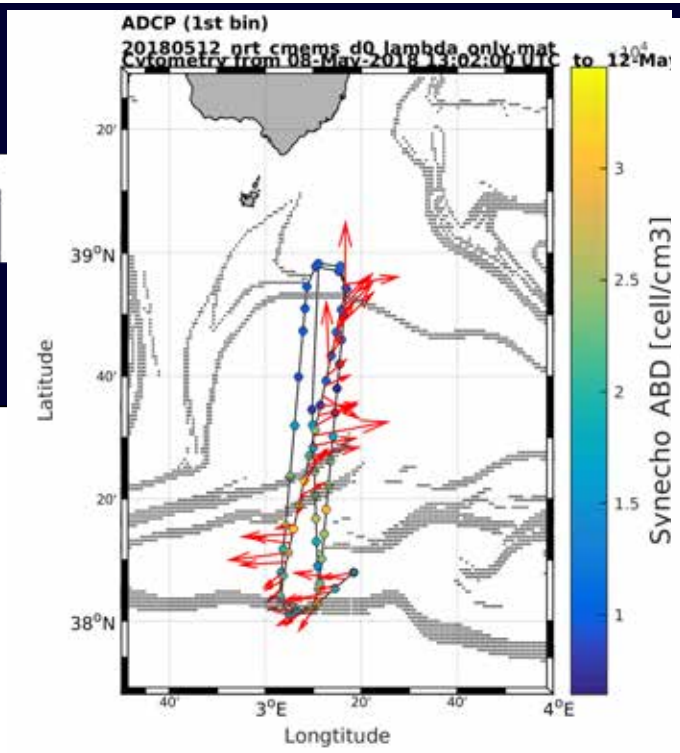


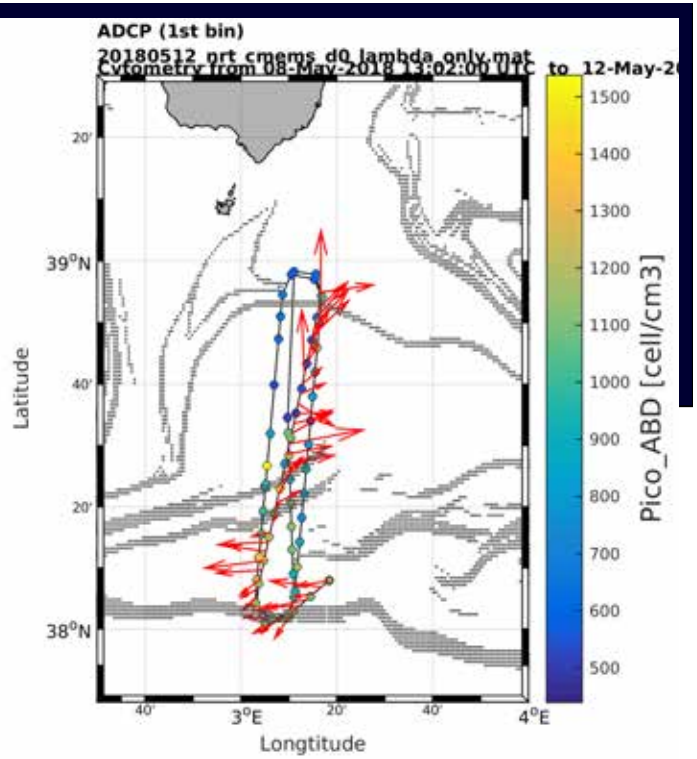
Suivi physique et biologique de masses d'eau contiguës et contrastées

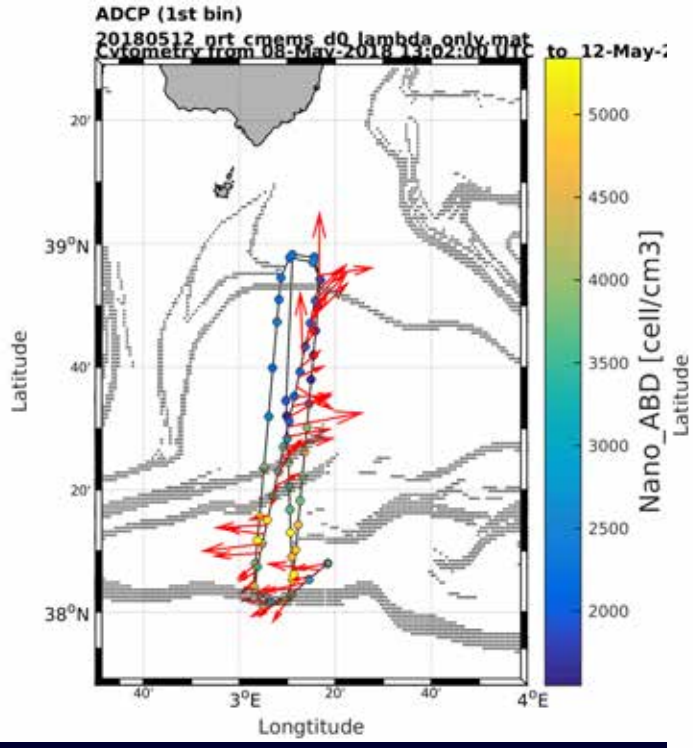
- rouge : courant mesureé (vmadcp)

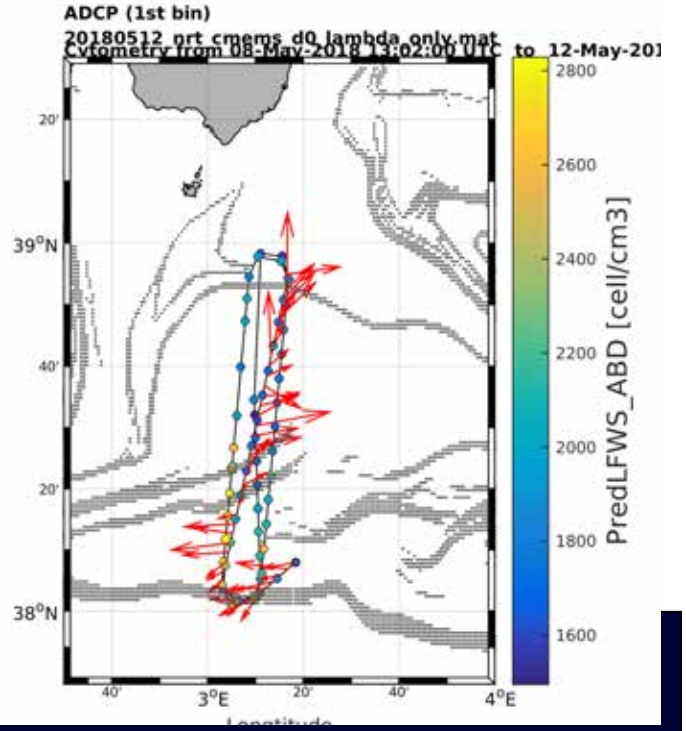
- noir : ligne de séparaion hydrodynamique issue de l'altimétrie

- couleur : abondance du groupe d'organisme





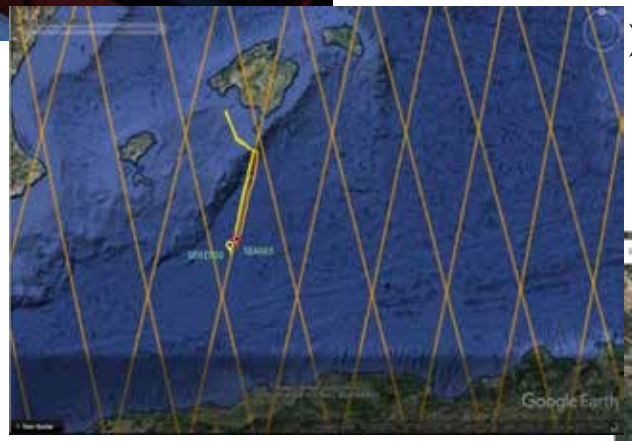




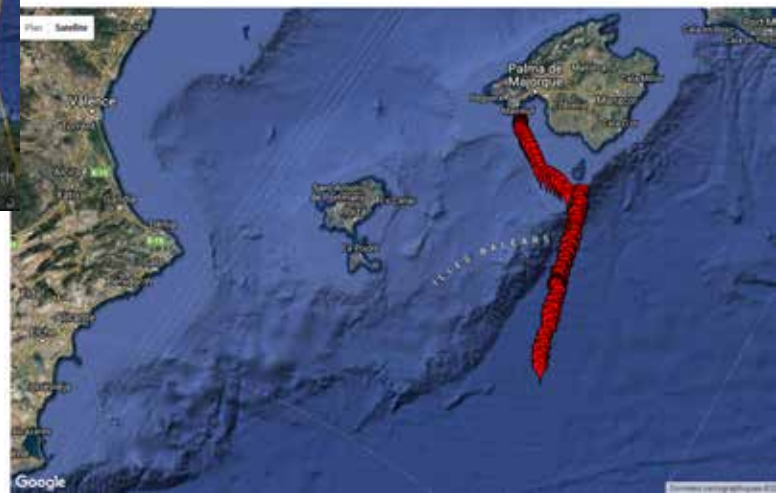
Pre-BIOSWOT: South-Baleares glider SeaExplorer (SEA003) mission

- Glider SeaExplorer (MIO , Marseille) equipped with 1 GPCTD, 1 Wetlabs triplet puck (Chla, CDOM, BB_{700},) & 2 two-optical pathways MiniFluos (MFL-UV1 & MFL-UV2).

- SEA003 (FR) & SDEEPP00 (Spain) gliders deployed in parallel.



- Gliders and Sentinnel 3 tracks

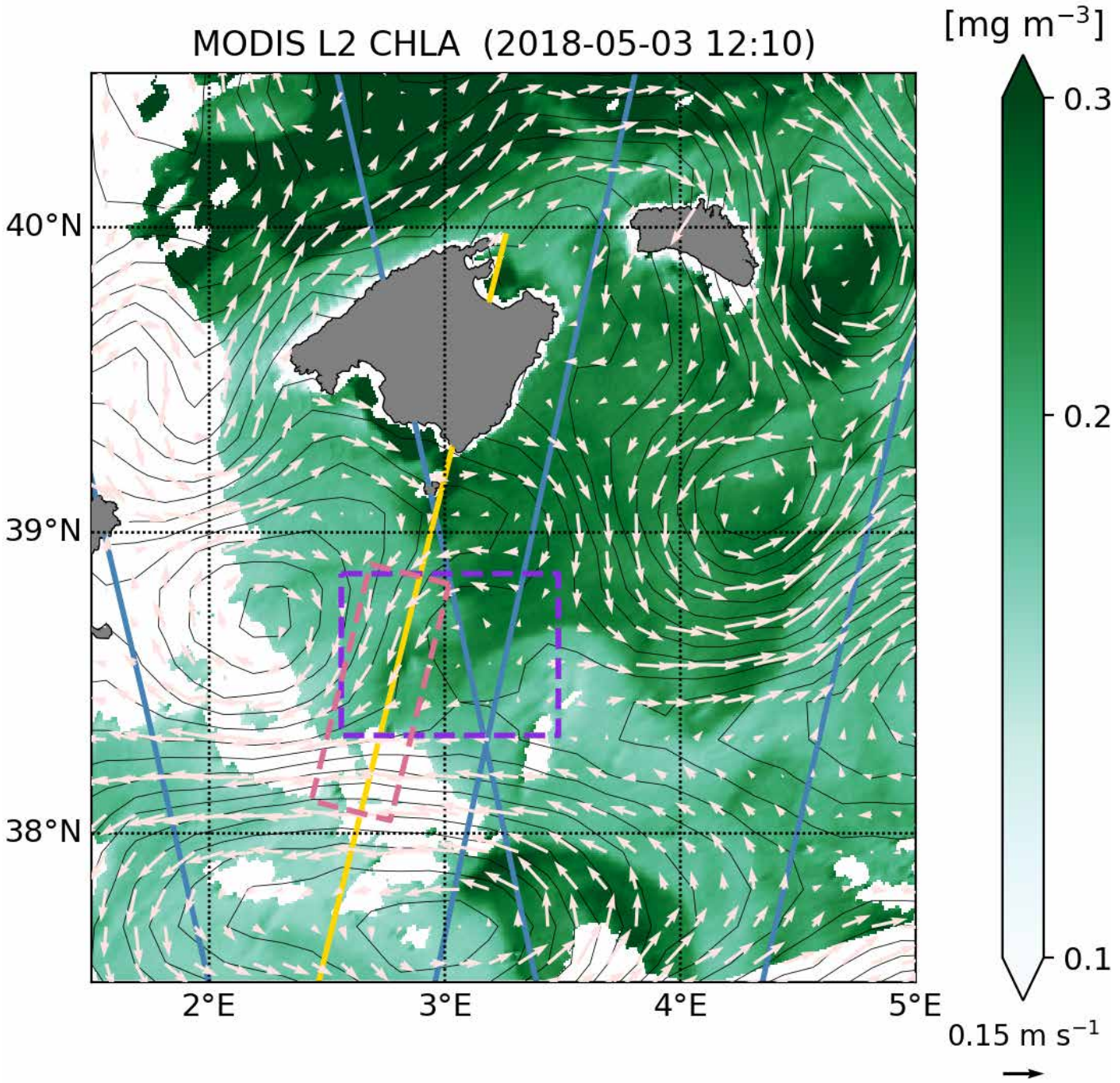


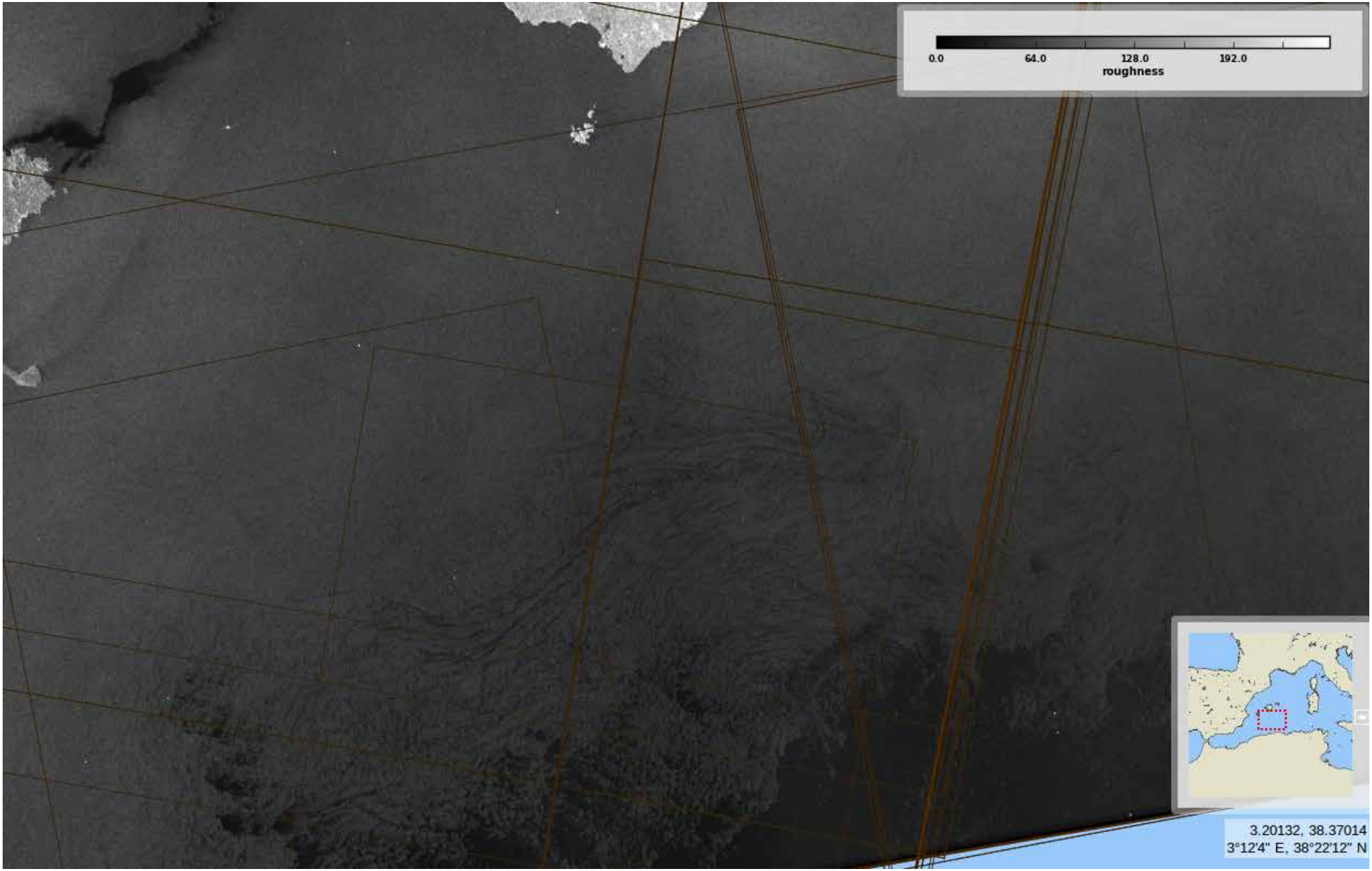
- Sea003 tracks : Transit – Transect 1 (N-S), Transect 2 (S-N), Transect 3 (½ transect N-S)

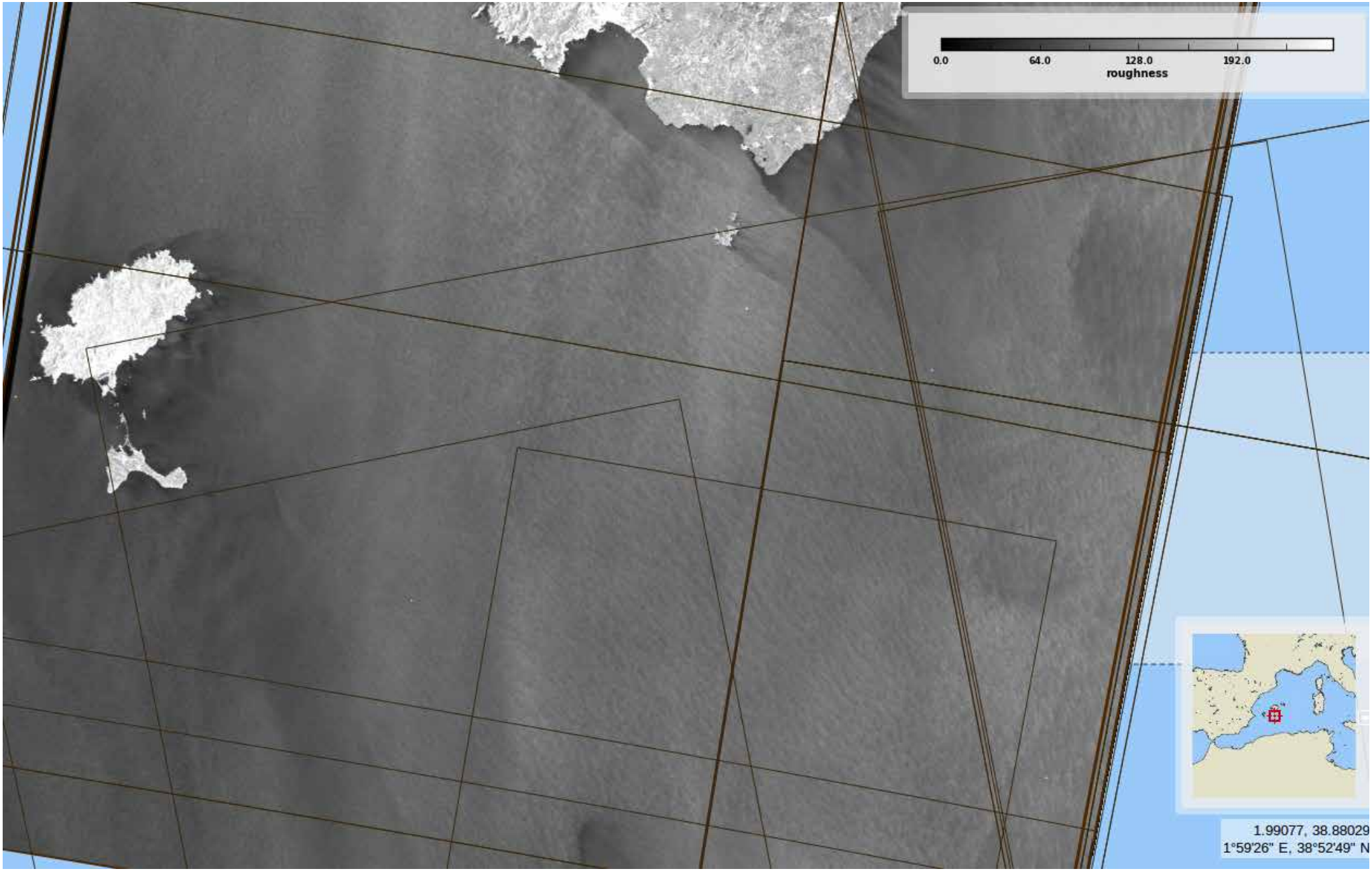
Chl + Altim

SWOT and Sentinel-3 Tracks

PRE-SWOT Sampling
Leg-1
Leg-2




0.0
64.0
128.0
192.0
roughness
3.20132, 38.37014
3°12'4" E, 38°22'12" N


0.0
64.0
128.0
192.0
roughness
1.99077, 38.88029
1°59'26" E, 38°52'49" N

Project: BIOSWOT

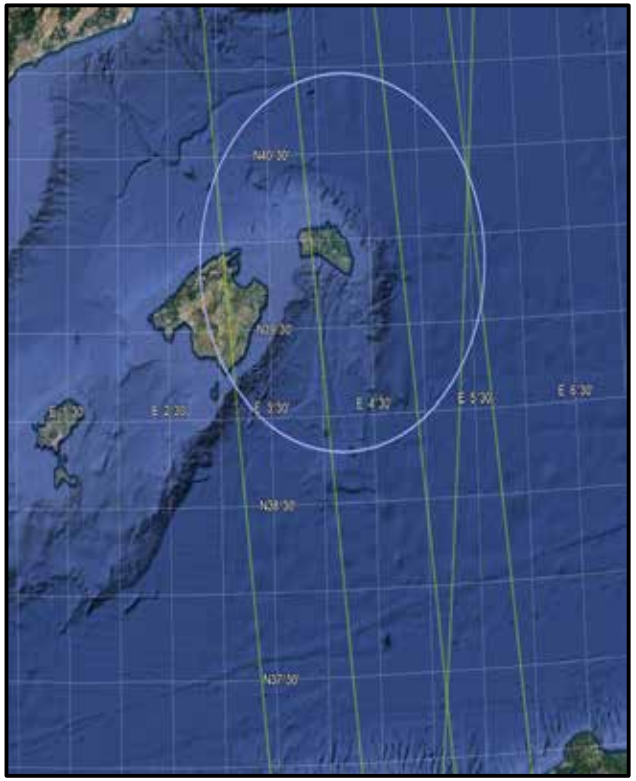
LiDAR / Hyperspectral flight over the Mediterranean

Flights

- 2 flights
  - scientific calval: hyperspectral measure coupled with LiDAR data over area of interest
    - Flight plan in a “comb” shape over the boat sampling area
  - technical calval: flight over altimeter track
    - Sentinel 3A, Jason 3 or Cryosat 2
    - Flight plan
      - 150 km straight line over altimeter track flown 4 times (2 round trips)
- Originally planned for beginning of May 2018, these flights were canceled due to weather forecast conditions (overcast) not compatible with LiDAR / Hyperspectral sensors

Team involves

Josias Lefèvre (Research Engineer, IETR), Kacem Chedhi (Professor, IETR), Christophe Conessa (Engineer, CNRS), Laurent Benoit (Assistant Engineer, CNRS), Pixair Survey (2 pilots), Laurent Froideval (Research Engineer, CNRS)



Examples of groundtracks selection
In green: possible altimeter tracks for Cryosat 2 in the airport range (Port Mahon, Minorca)
Blue circle: Possible range for the local transit depending on the total flight time

Calval LiDAR

Project: BIOSWOT

Top Left
Piper Navajo used for the LiDAR/Hyperspectral test flight on April 24, 2018

Top Right
LiDAR + Hyperspectral camera

Bottom Right
Sensors installed on the plane

LiDAR / Hyperspectral flight over the Mediterranean

Objectives

- SSH: evaluate the capacity of in-situ LiDAR data to measure SSH
- Improve 3D current modeling through in-situ sea surface topography
- Hyperspectral measure of the phytoplankton

Flight

- Sensors:
  LiDAR (Leica ALS60) coupled with a Hyperspectral camera
  Collaboration with the Hyperspectral team SHINE-TSI2M of IETR laboratory
  - Sensor: SPECIM AISA Eagle 1K / VNIR (400-970 nm, 3.3 nm spectral res.)
  - First test flight of this coupled system in April 24, 2018
    - flight was successful
    - fine processing of the coupled data still in progress