Atelier : Observations Low COAST en milieu côtier

Une nouvelle génération de biologger sur éléphants de mer dédiée à l'observation de biologie des océans

Christophe Guinet, CEBC, UMR 7372

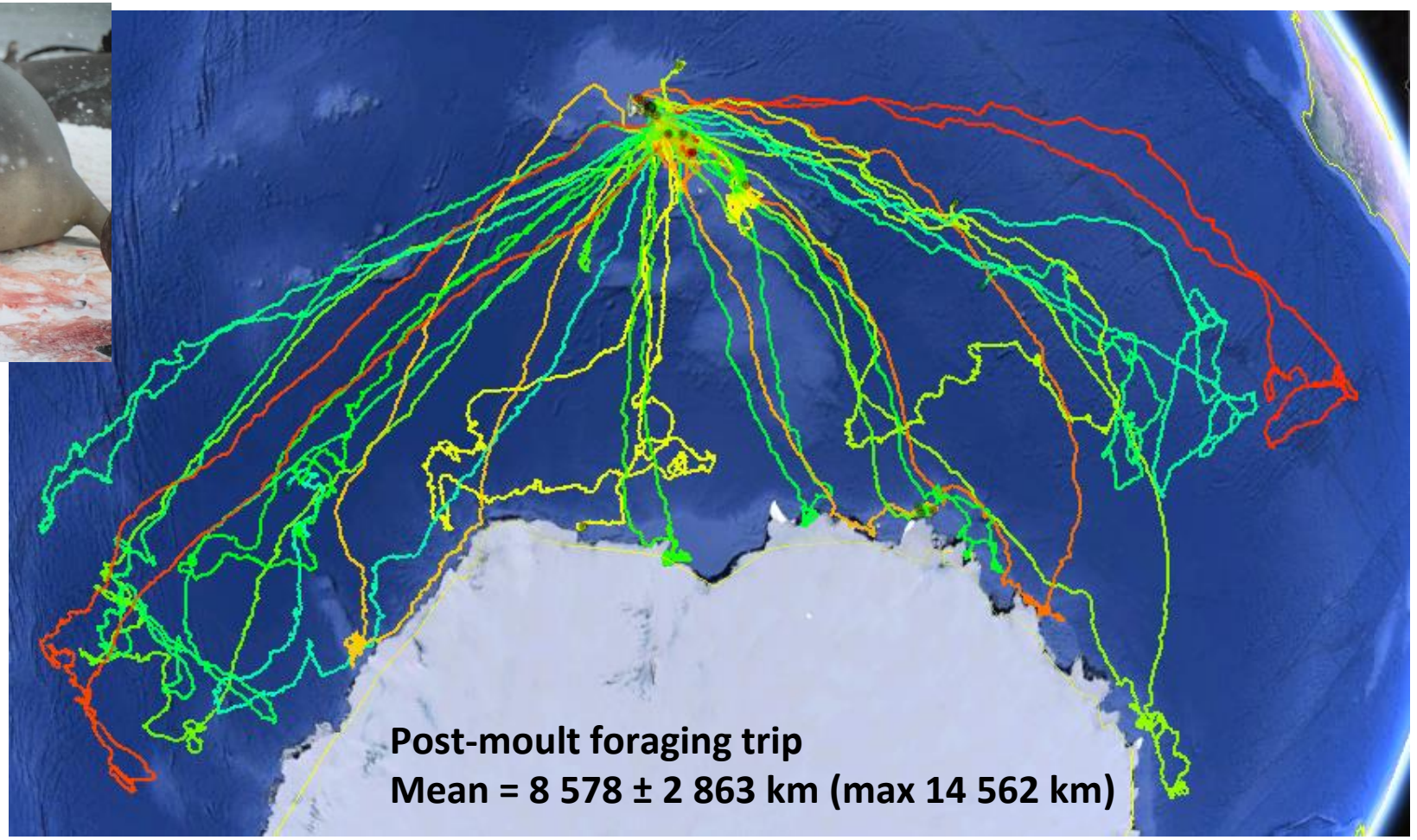
8 Septembre 2022

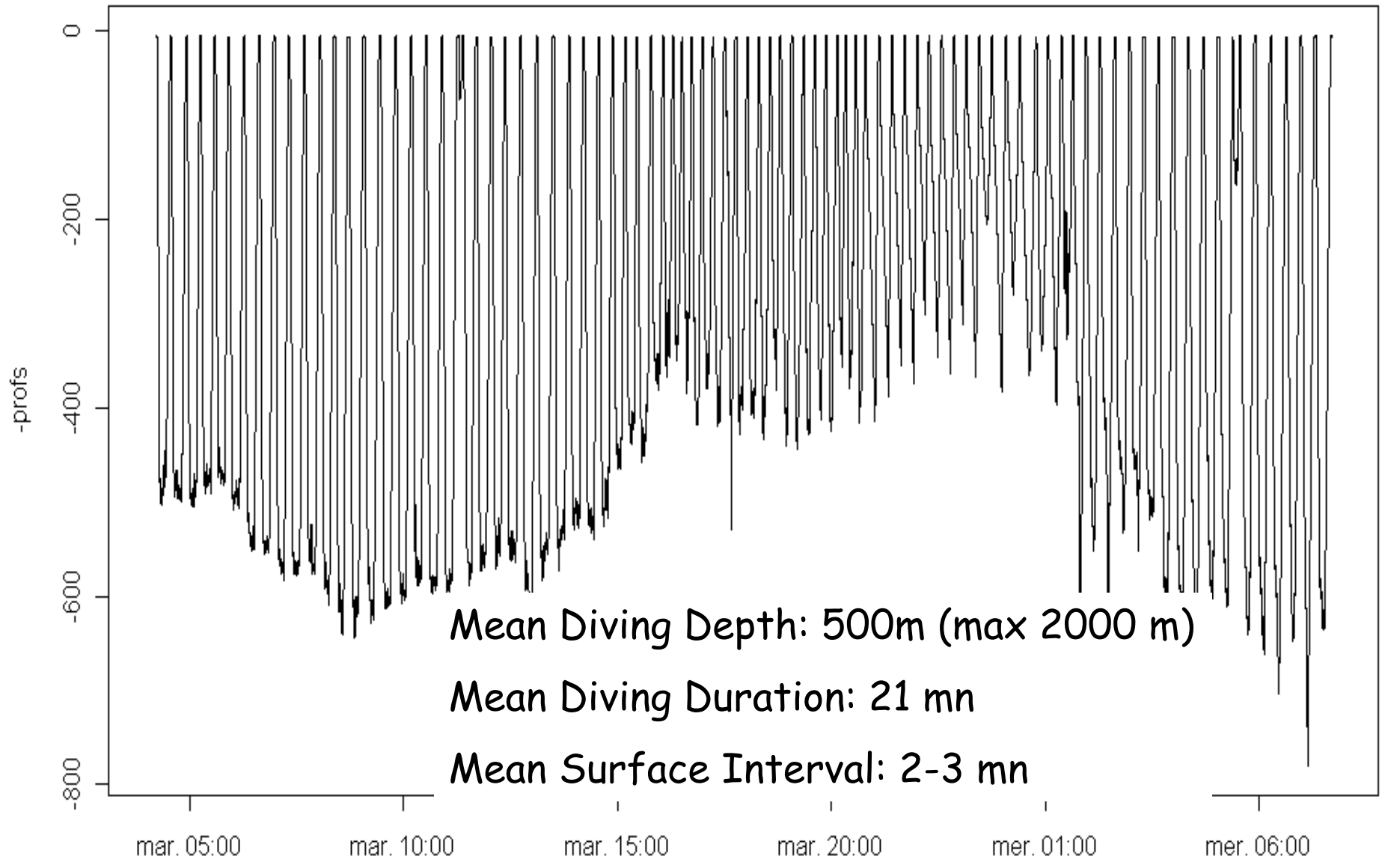
J	F	M	A	M	J	J	A	S	O	N	D

Moult **Reproduction**

- 10 months at sea

- 2 month on land to breed and moult




-profs
0
-200
-400
-600
-800
mar. 05:00
mar. 10:00
mar. 15:00
mar. 20:00
mer. 01:00
mer. 06:00
Mean Diving Depth: 500m (max 2000 m)
Mean Diving Duration: 21 mn
Mean Surface Interval: 2-3 mn

Constraints :

- Size
- Limited energy supplyCold environement
- Presure

Optimization of data acqusition, processing and transfert

Biotelemetry : Argos Transmitted (2-4 profiles/day), Real time

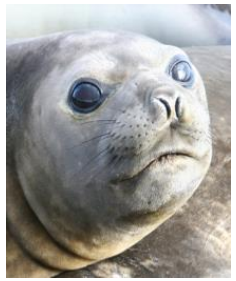
- Depth
- Temperature (0.02°C)
- Salinity (1HZ, 0.03 PSU)
- (Fluorescence)
- Dissolved oxygen

Biologging : Archived (the tag need to be recovered)

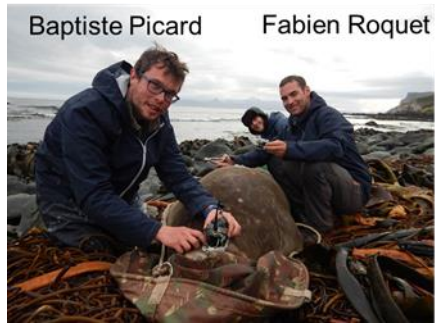
- Depth (1Hz)
- Temperature (1Hz, 0.02°C)
- Salinity (1Hz, 0.03 PSU)
- Fluorescence, (1Hz 4/profiles per day)
- Dissolved oxygen (1 Hz, 4 profiles per day)
- Light (1 Hz)
- Accelerometer (12Hz)

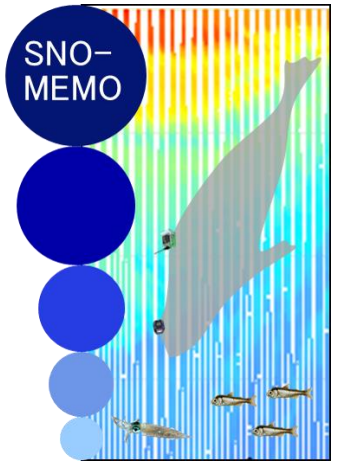
Time series : 2004-2022 (638 SES)

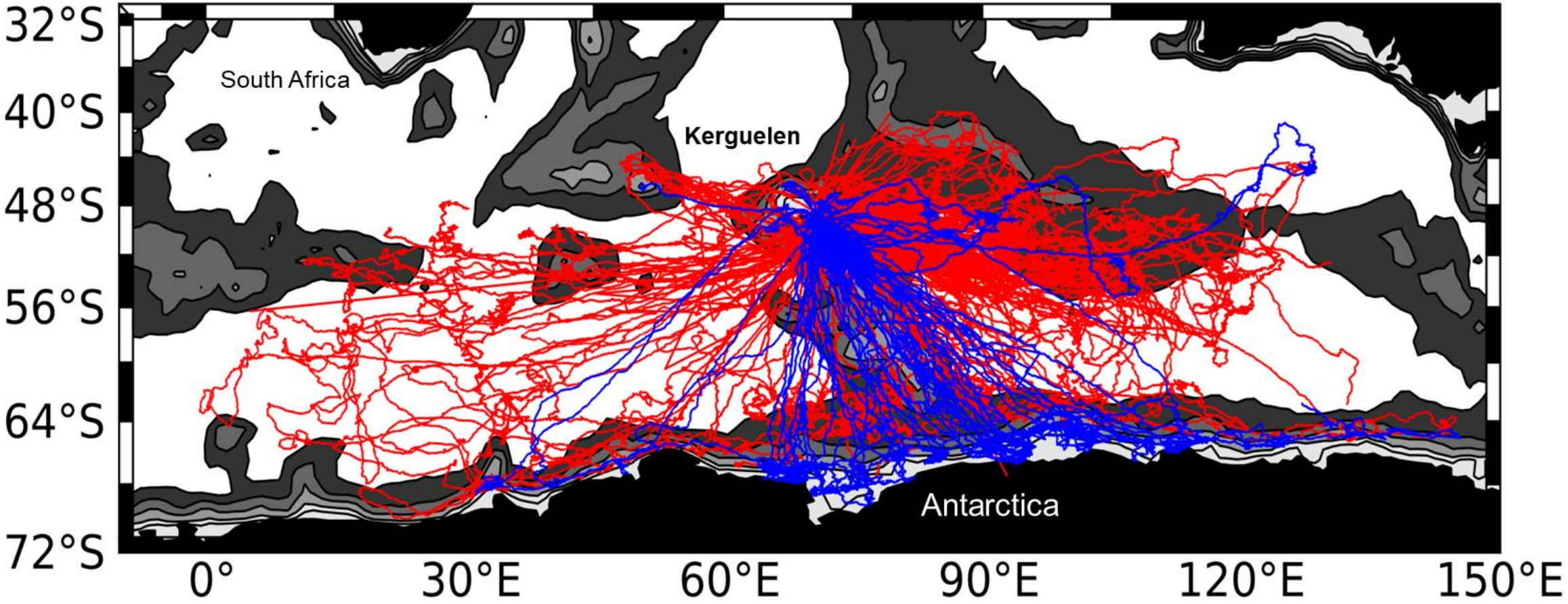
Males:
Benthic
Kerguelen &
Antarctic Shelf



Femelles:
Pelagic
Polar frontal Zone
Sea Ice Zone

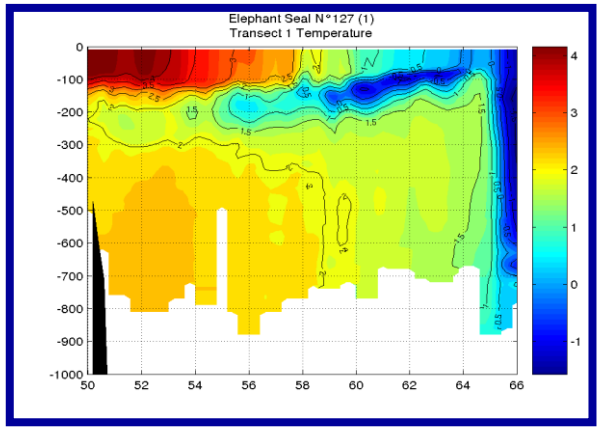


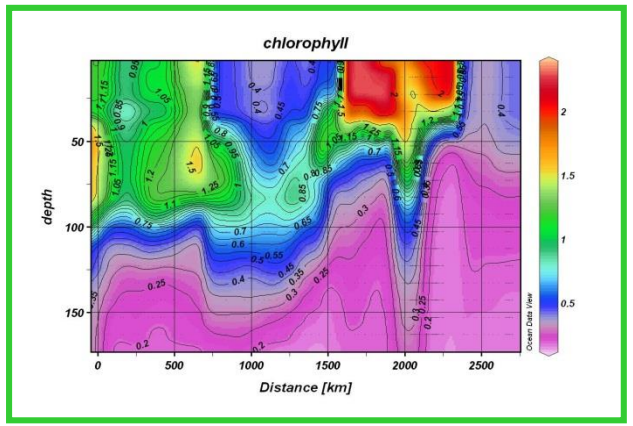


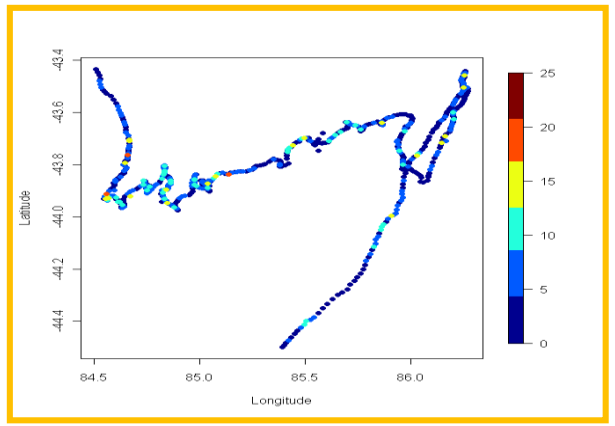


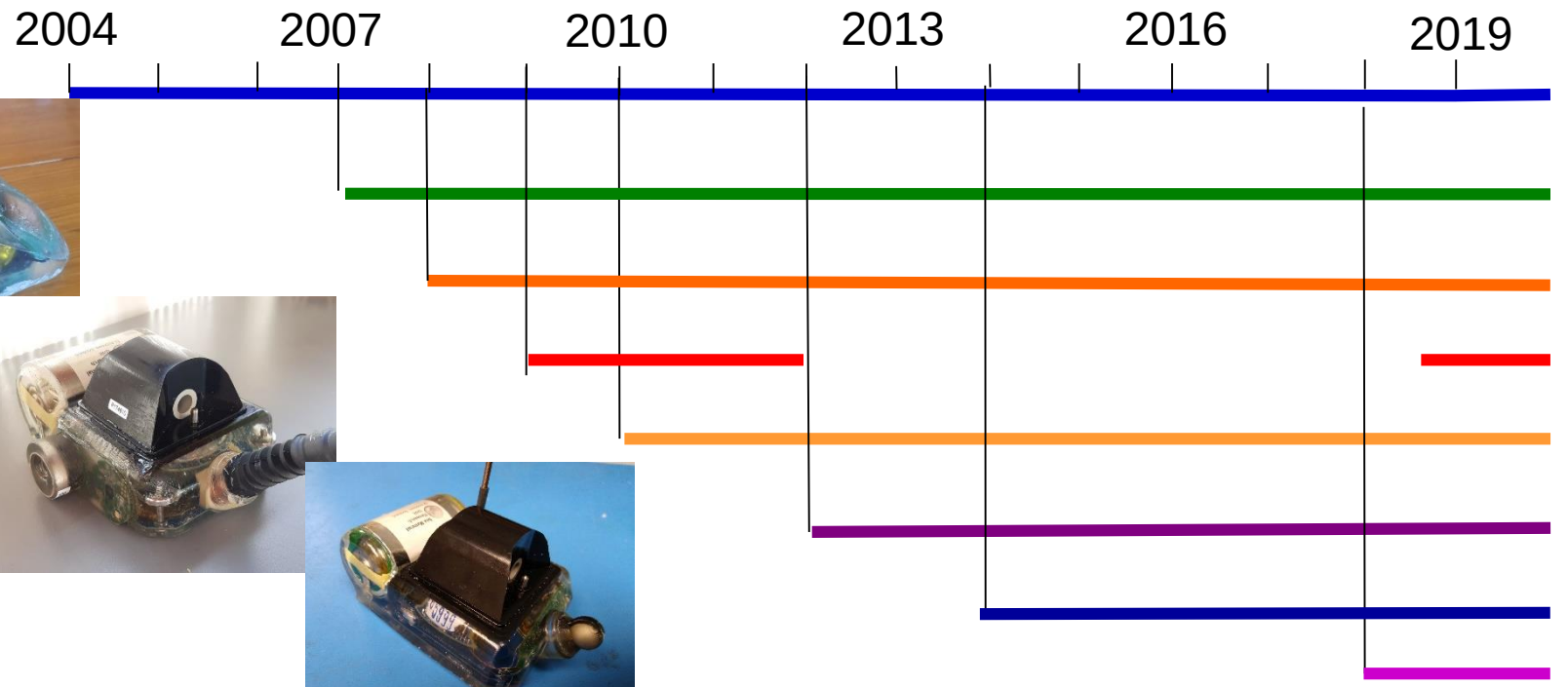
Kerguelen tags deployment chronology and sensor used

365 deployments (2004-2019)

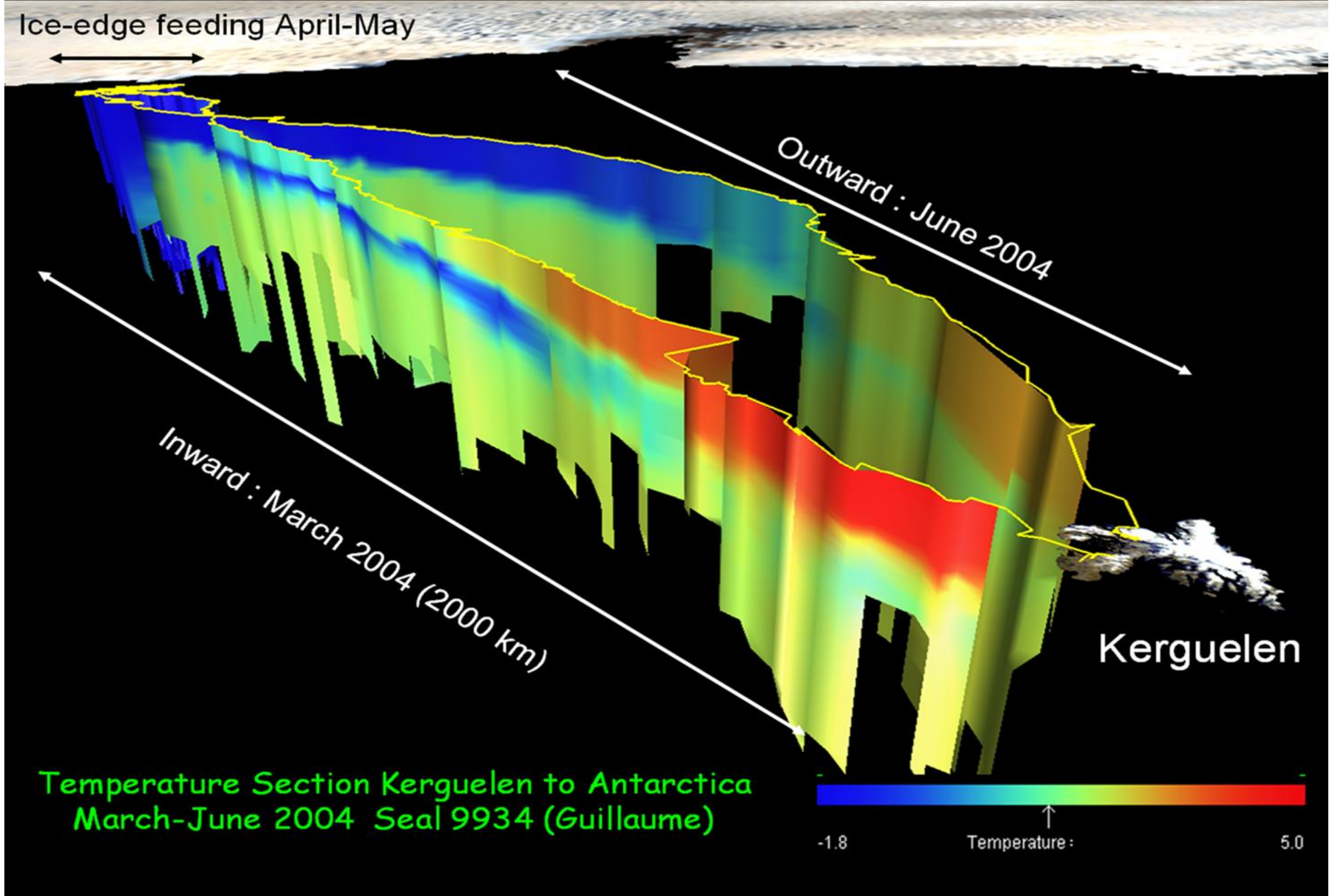


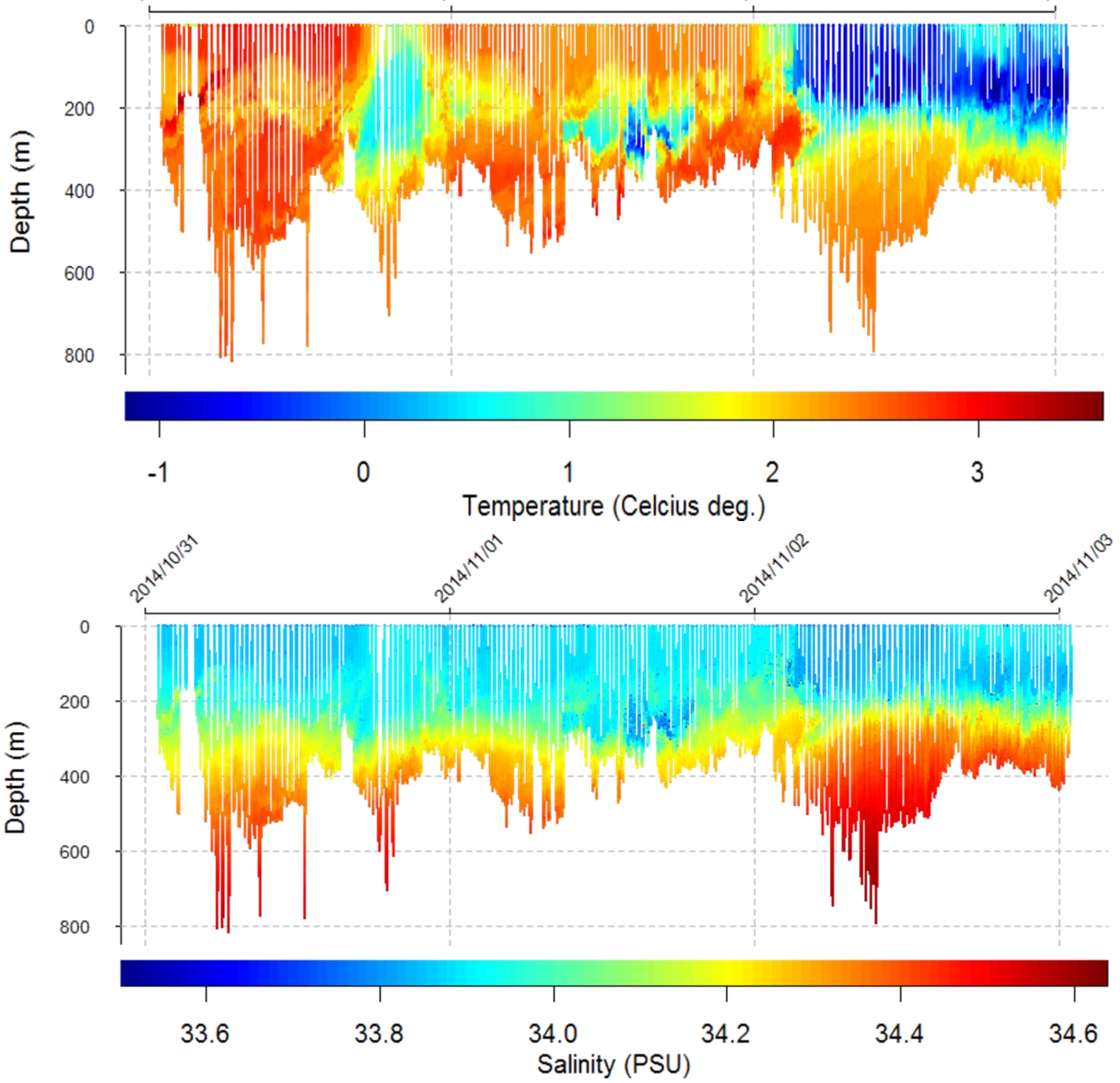




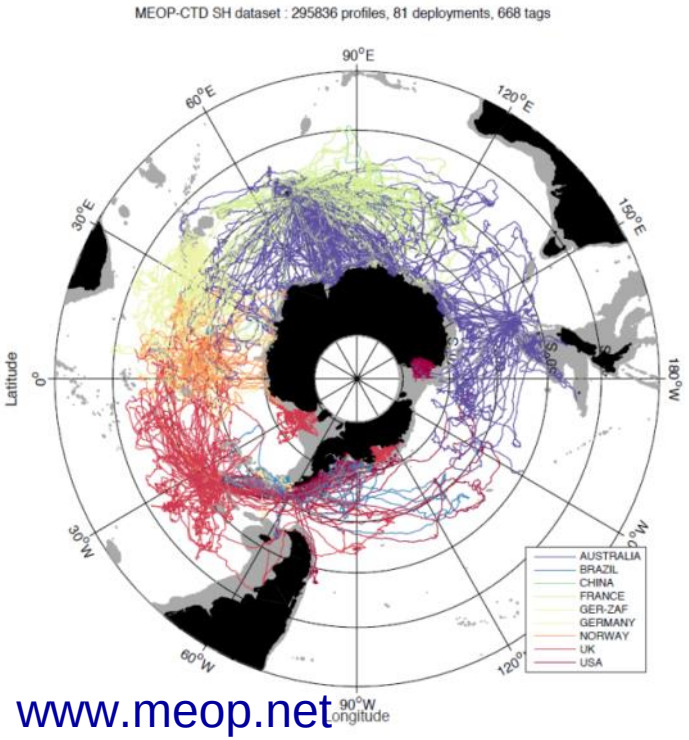


Continous technological developments.

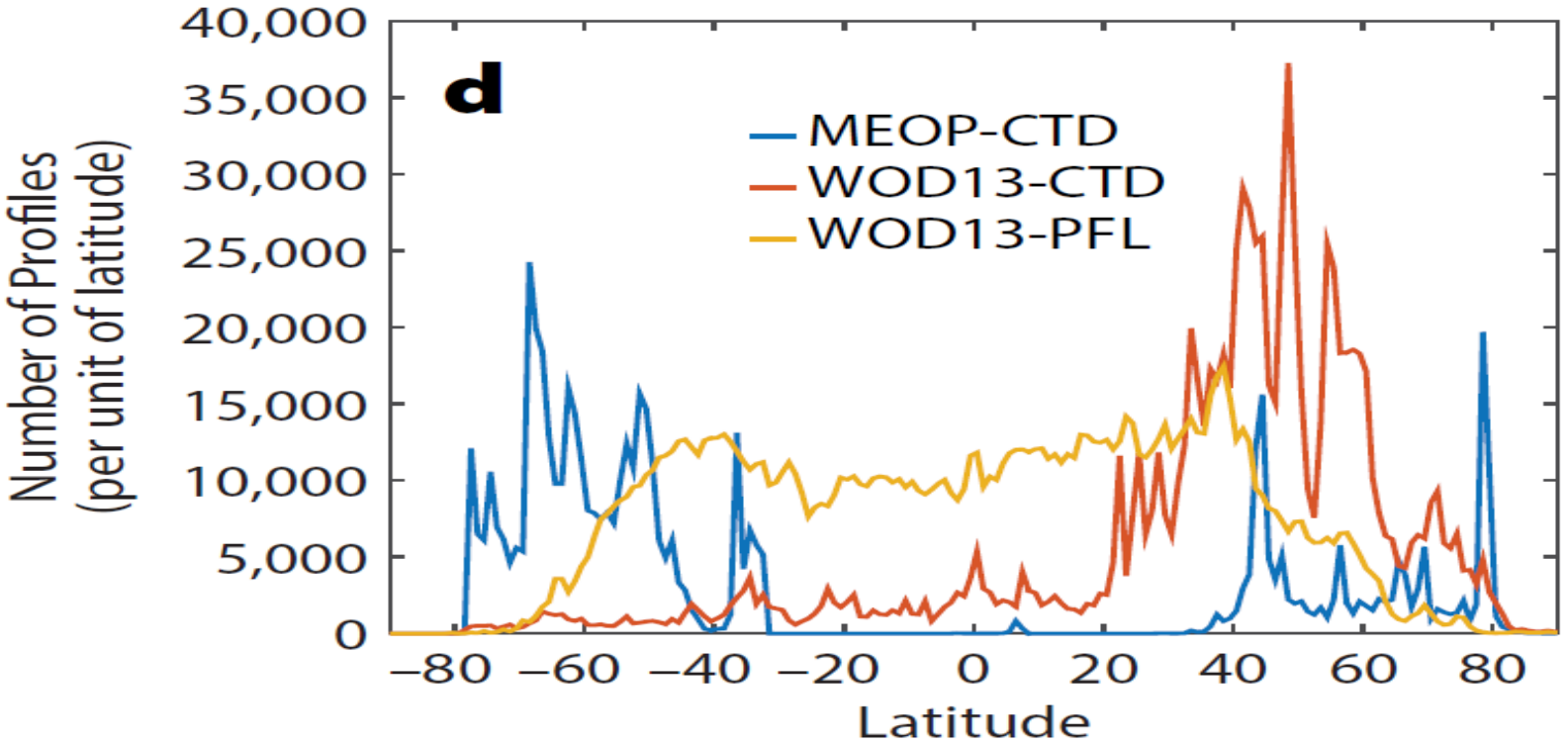

Ice-edge feeding April-May
Outward : June 2004
Inward : March 2004 (2000 km)
Kerguelen
Temperature Section Kerguelen to Antarctica
March-June 2004 Seal 9934 (Guillaume)
-1.8
Temperature :
5.0



0.5 – 1 Hz, up to 7 months



www.meop.net



80% of oceanographic profiles South of 60 °S

98 % of the profiles within antarctic sea-ice

ANIBOS

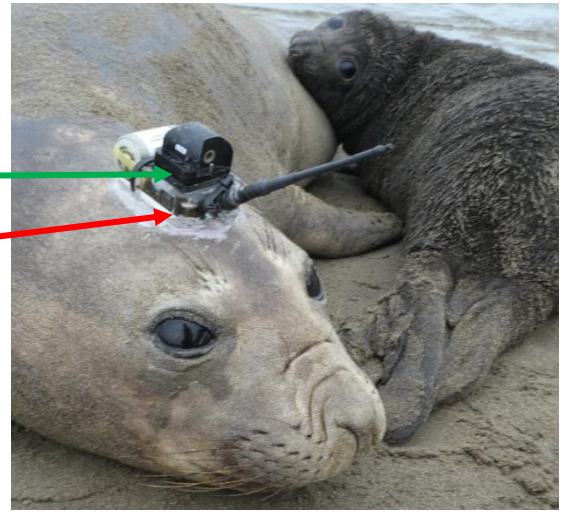
The Global Ocean Observing System

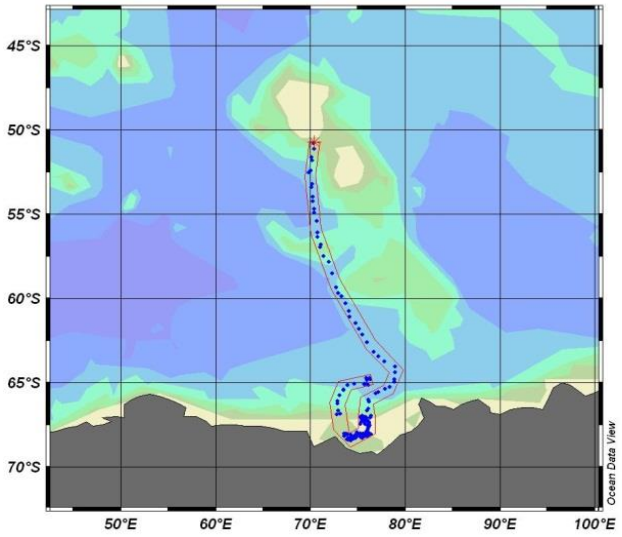
Measurement of biogeochemical variables

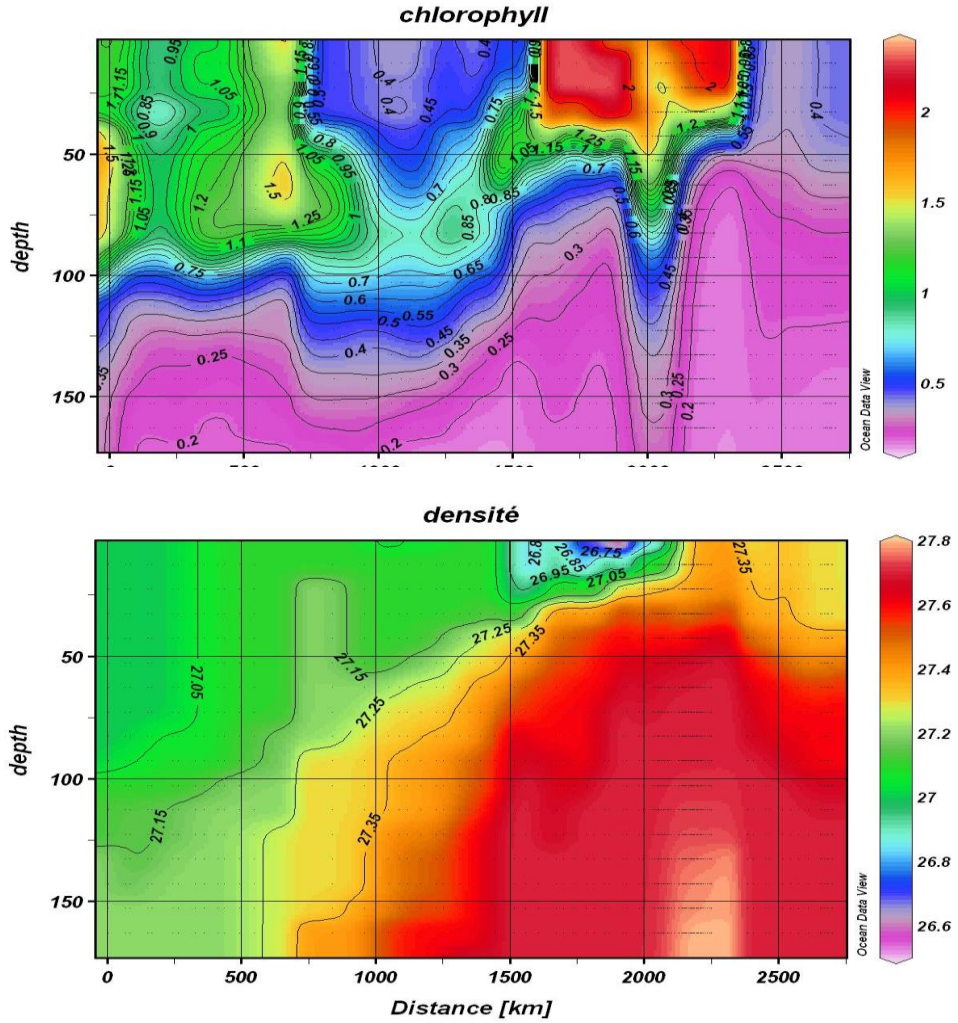
Chlorophylle a

Fluoremeter

Light Sensor

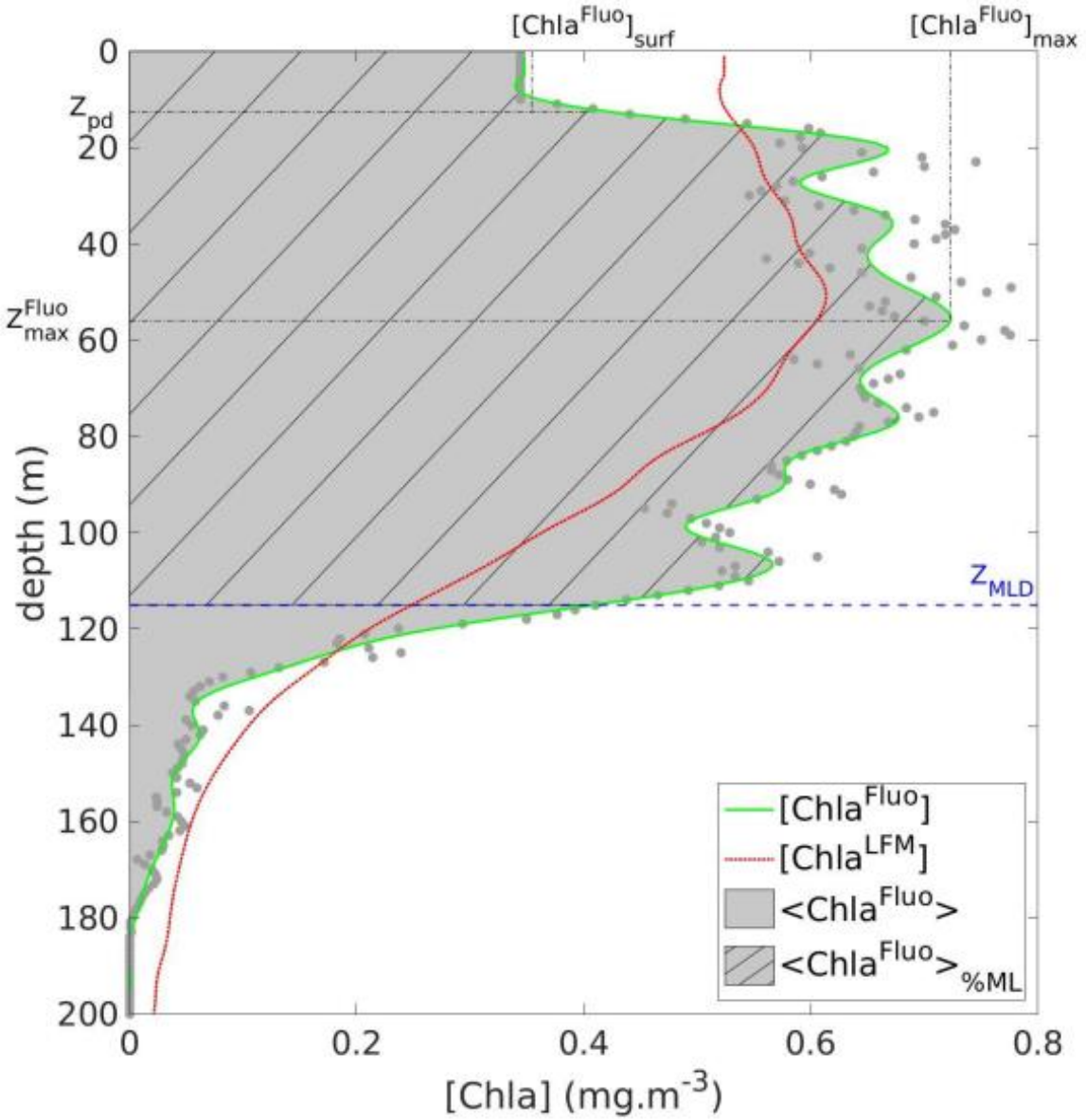






Guinet et al. (2012) Earth Syst. Sci. Data Discuss.;
Blain et al. (2013) Geoph. Res. Let.,

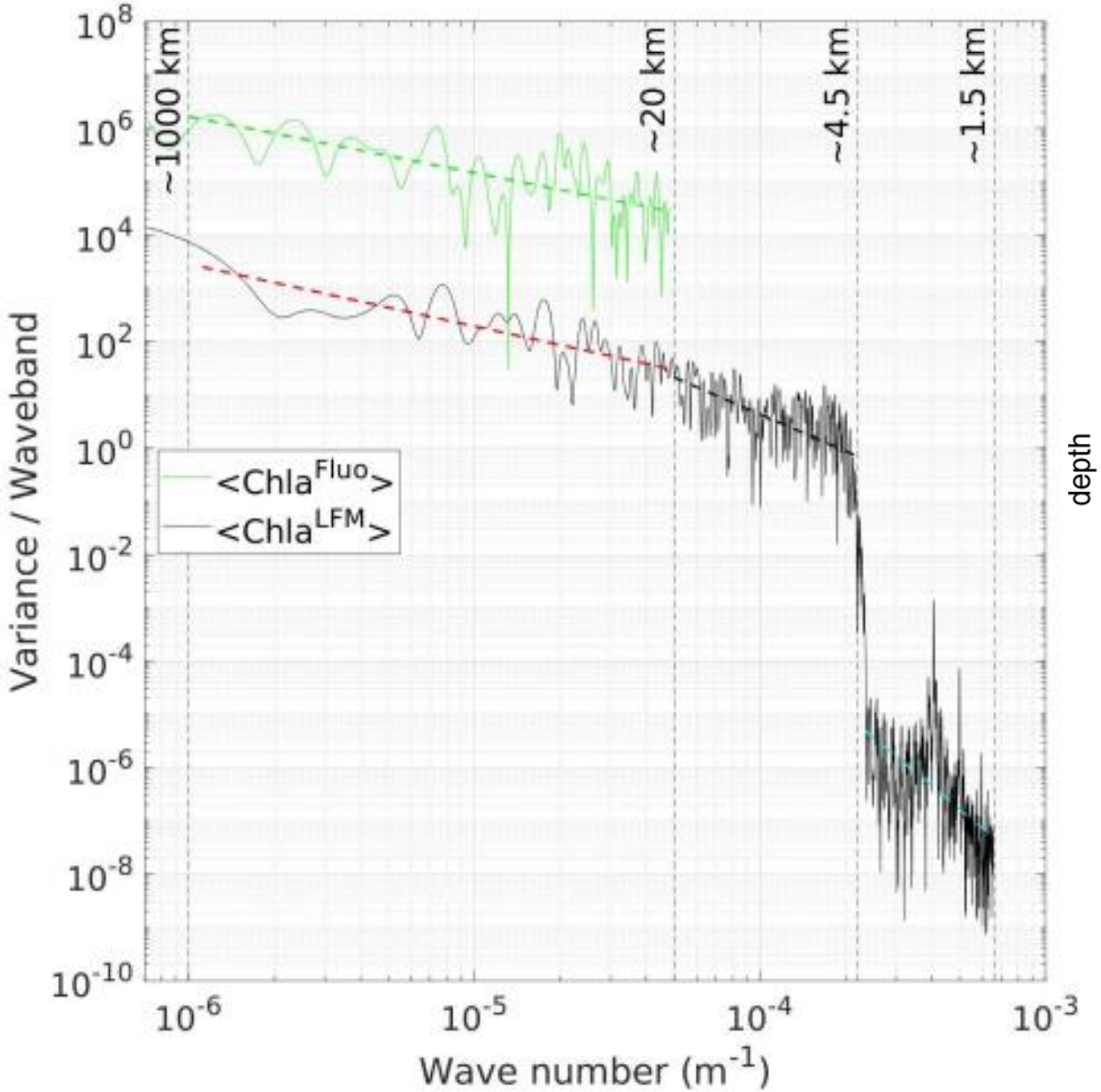
Light attenuation as an estimtor of Chla concentrations

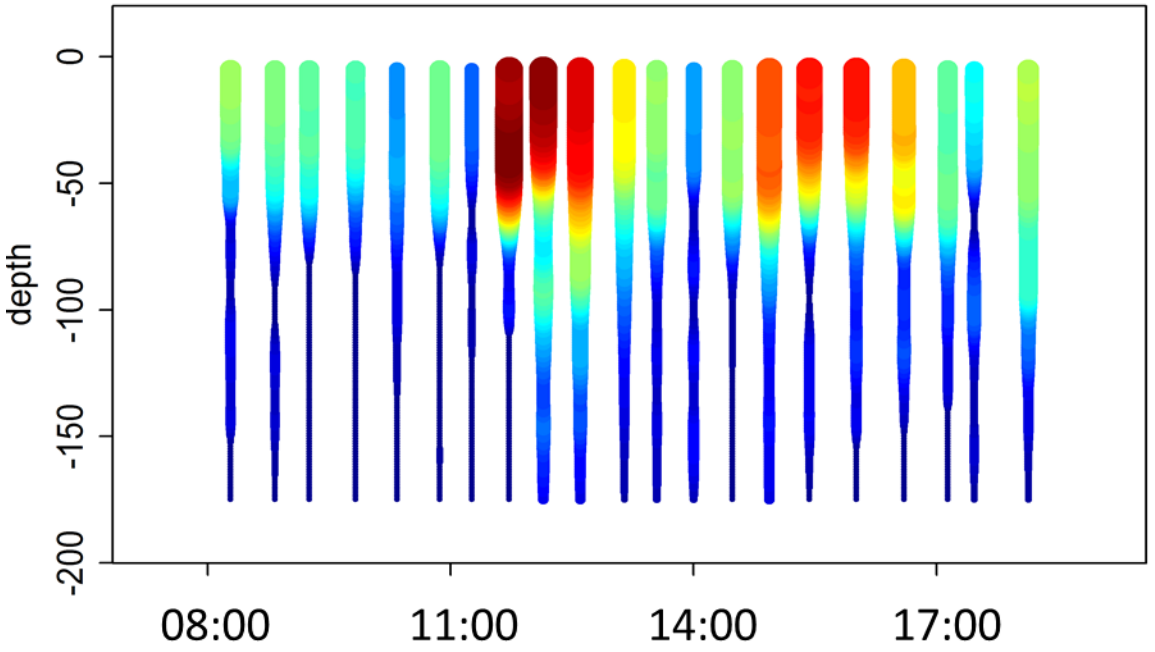


Light is inexpensive to measure

But only valid for oceanic waters, not costal waters!

Thèse Loic le Ster, Co-dirigée par H. Claustre LOV et C. Guinet.

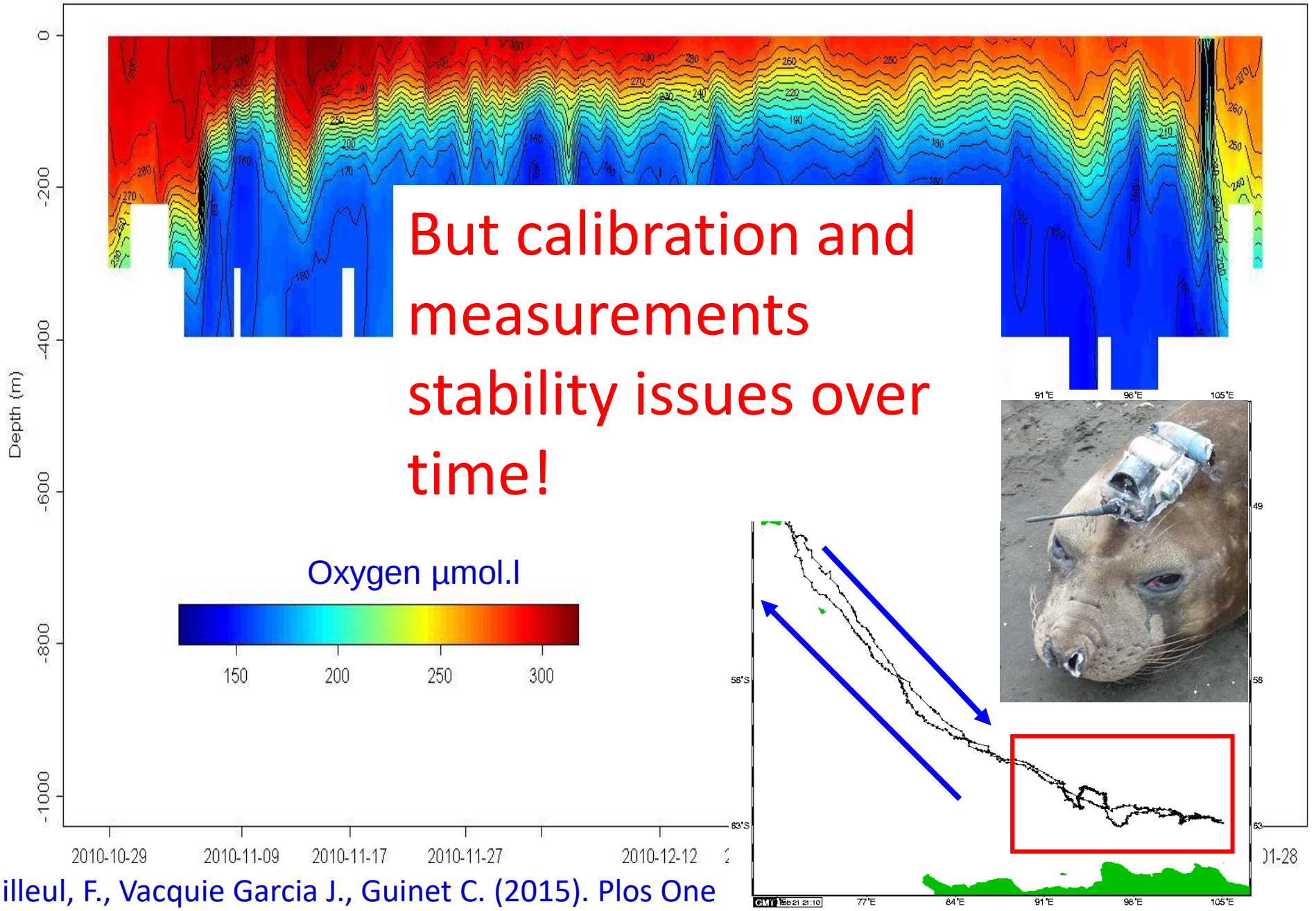




Bayle, et al. (2015) Moving toward finer scales in oceanography: predictive linear functional model of chlorophyll-a profile from light data Progress in Oceanography

Oxygen

25 Oct -17 Nov 2010 | 17 Nov 2010 -10 Jan 2011 | 10 - 28 Jan 2011



But calibration and measurements stability issues over time!

Jade Vacquié-Garcia
Projet post-doc Marie Curie, CEBC.

Optode Aanderaa
Oxygen Optode 4330F

Bailleul, F., Vacquie Garcia J., Guinet C. (2015). Plos One

Measurement of biogeochemical variables

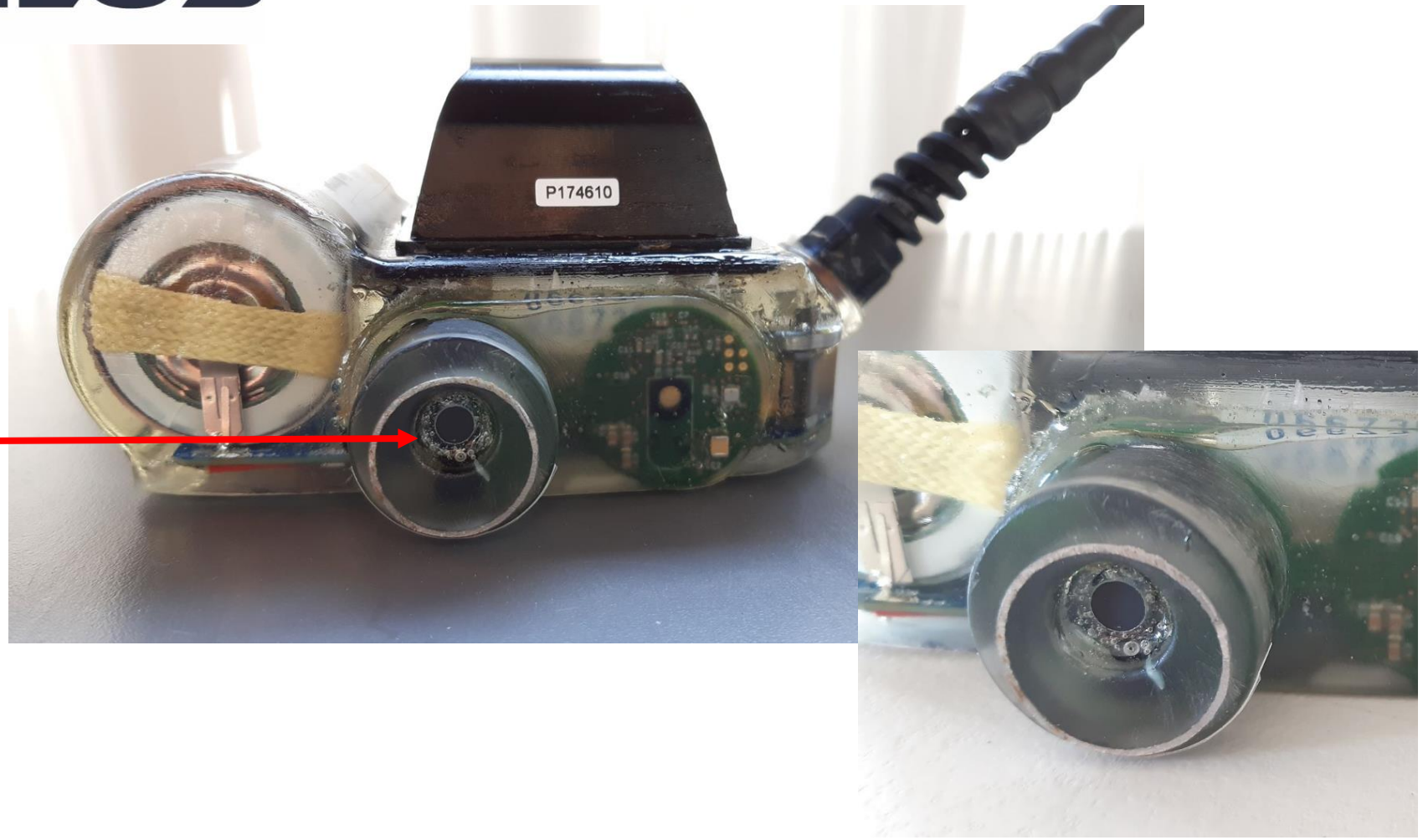
Dissoled Oxygen

NAUTILOS

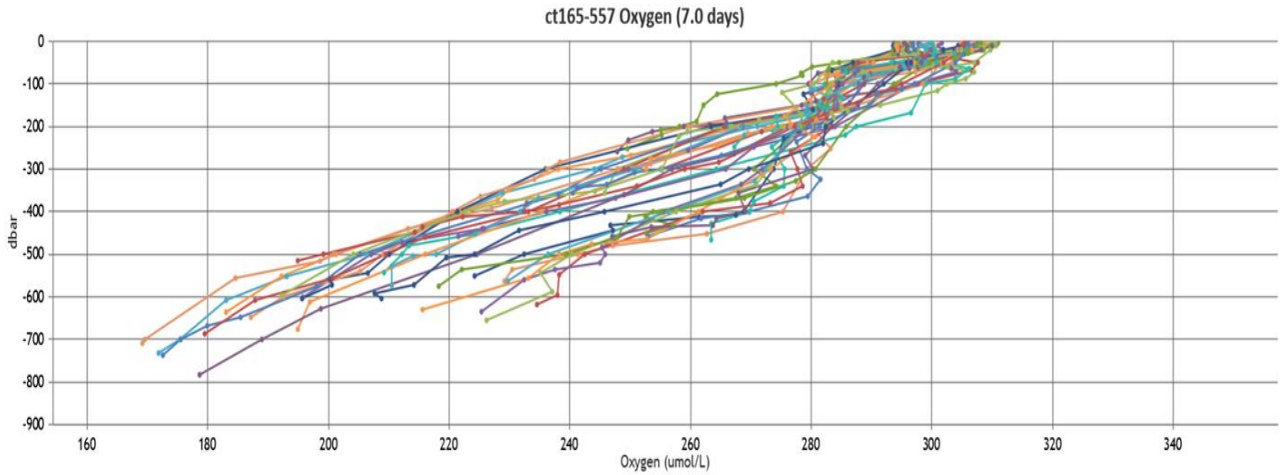
Centre d'études biologiques de Chizé

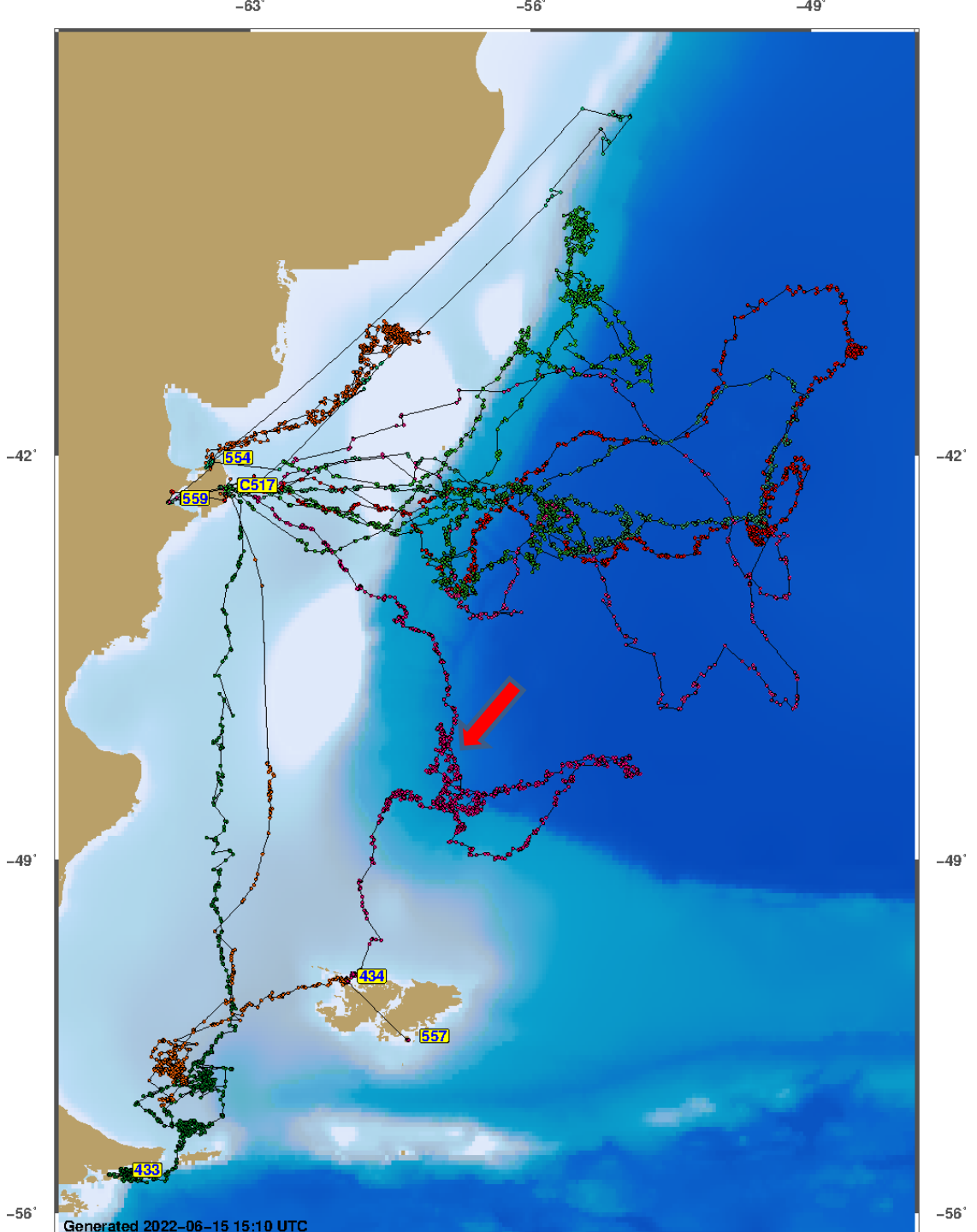
SMRU

Pyro FD-OEM-O2
Oxygen sensor

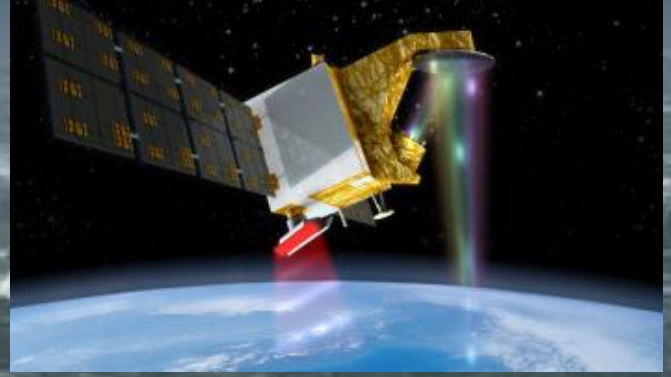


WCS


ct165-557 Oxygen (7.0 days)
dbar
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
160
180
200
220
240
260
280
300
320
340
Oxygen (umol/L)


-63°
-56°
-49°
-42°
-49°
-56°
554
C517
559
434
557
433
Generated 2022-06-15 15:10 UTC

Wind and sea-state



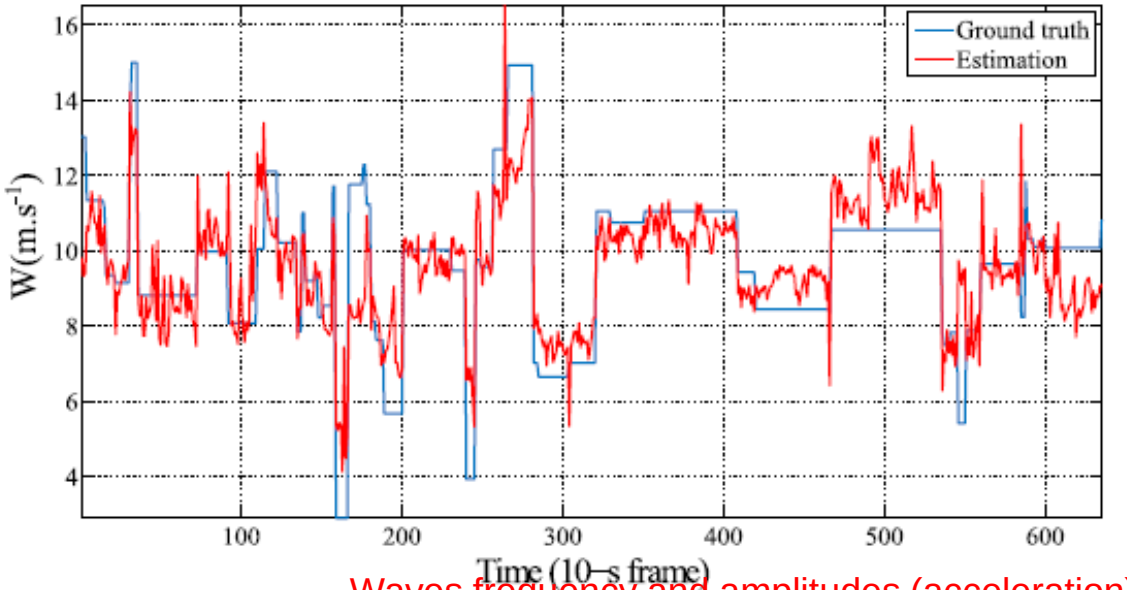
cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

(Chineese-French Ocean SAT-2018)

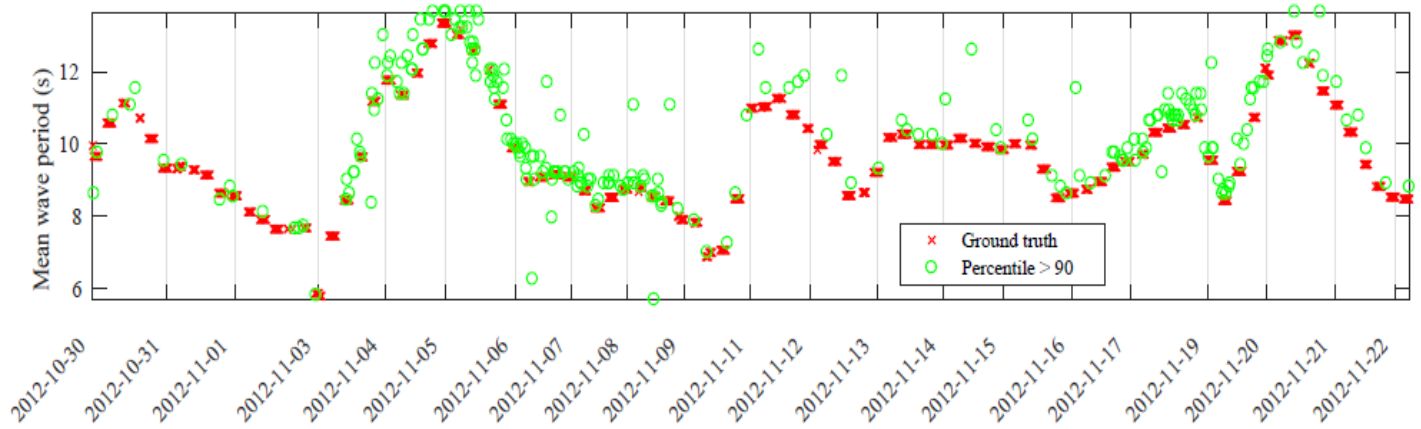
Hydrophone + accelerometer

Sea-state (waves) and wind (CFOSAT-2018)

In-situ estimations from the noise level recorded by SES when diving

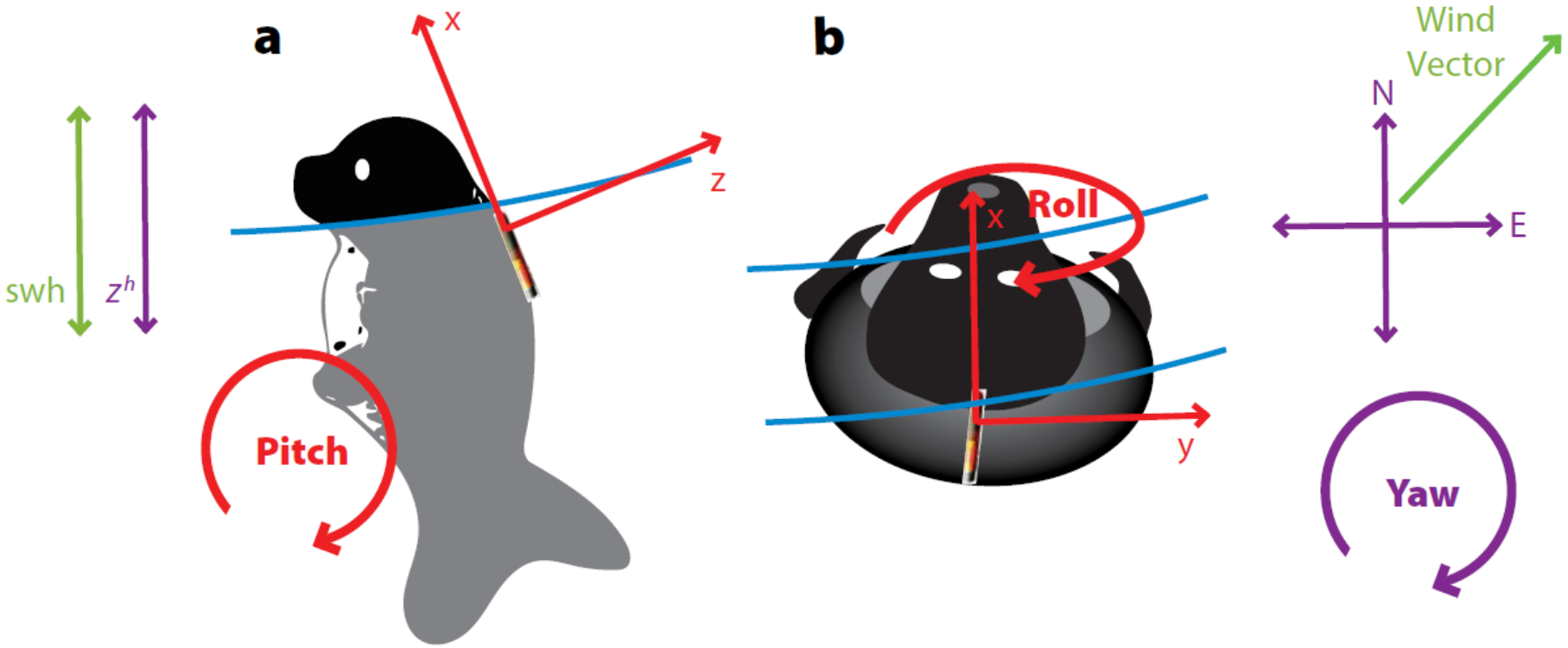


Waves frequency and amplitudes (acceleration)



CAZAU D., BONNEL J., JOUMA'A J., LE BRAS Y., GUINET C. (2017) Measuring the marine soundscape of the Indian Ocean with Southern Elephant Seals used as acoustic gliders of opportunity. Journal of Atmospheric and Oceanic Technology. DOI: 10.1175/JTECH-D-16-0124.1

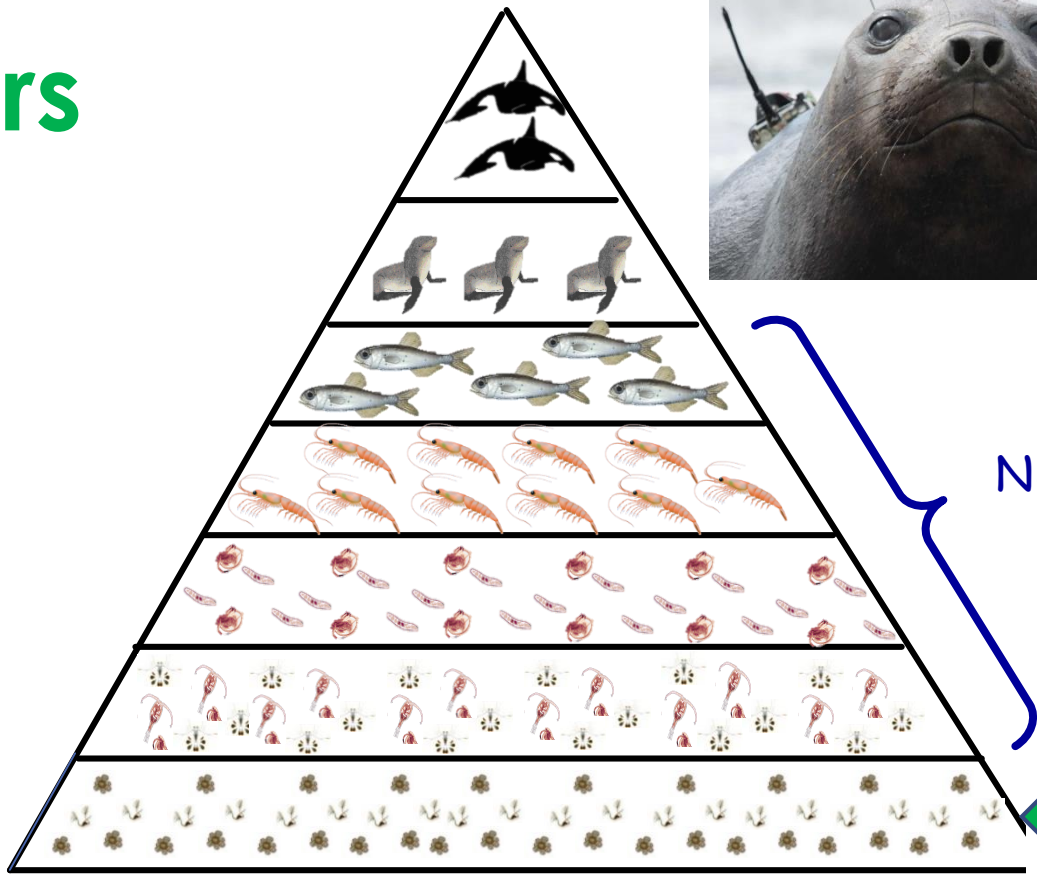
CAZAU, D., PRADALIER, C., BONNEL, J., GUINET, C., (2017) "Do Southern Elephant Seals Behave Like Weather Buoys?", Oceanography,



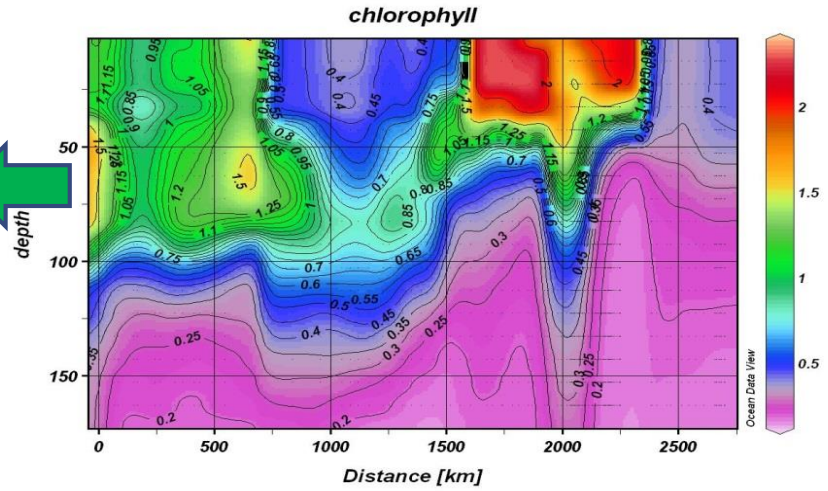
CAZAU D., PRADALIER C., BONNEL J., GUINET C., (2017).Do Southern Elephant Seals buoy like meteorological buoys ? Oceanography 30(2):140–149, https://doi.org/10.5670/oceanog.2017.236.

Thèse Anatole Gros-Martial.

Biology the new frontiers

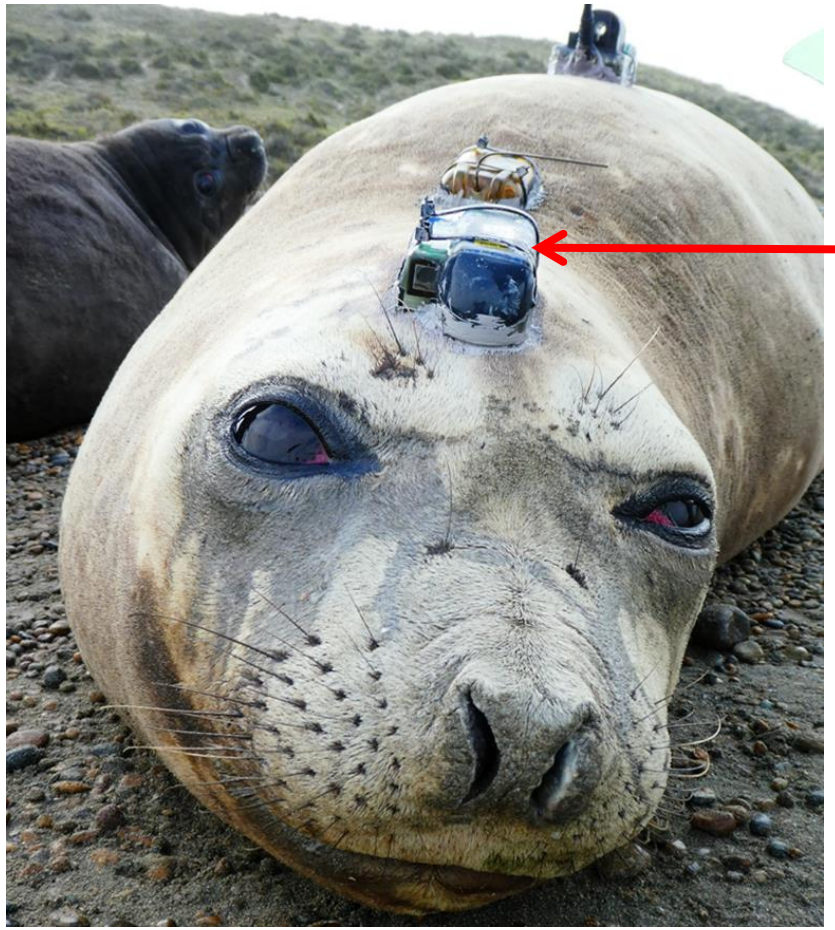


Niveaux intermédiaires?



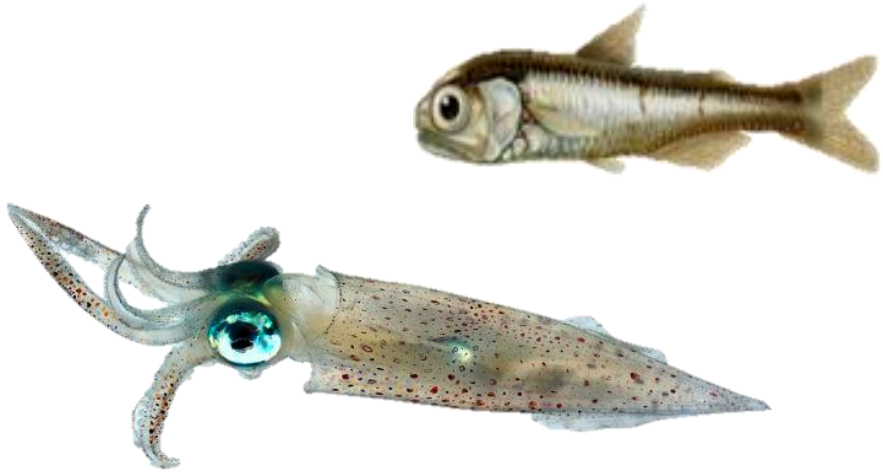
Developping new biollogging techniques to observe and investigate intermediate trophic levels

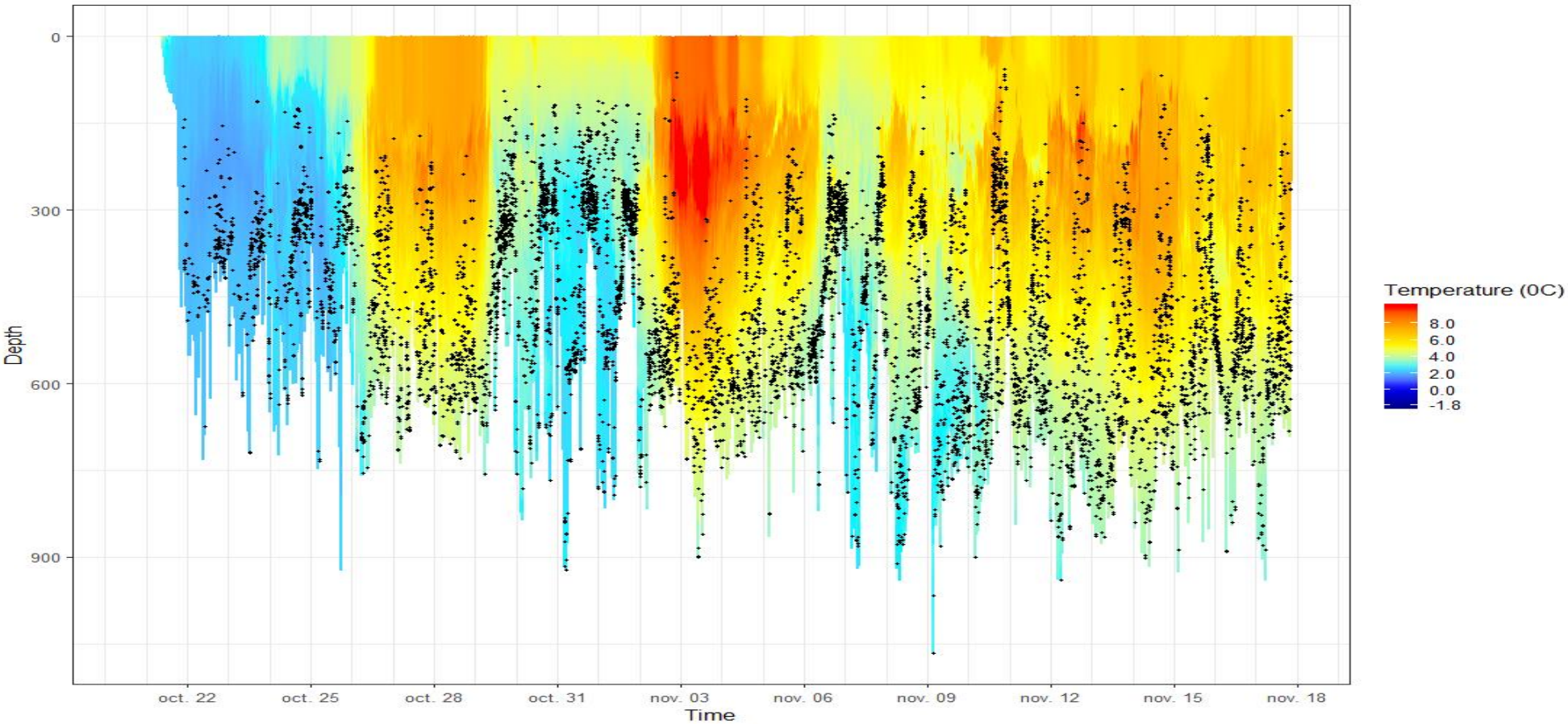
(Collaboration M. Johnson & P. Goulet Sea Mammal Research Unit):



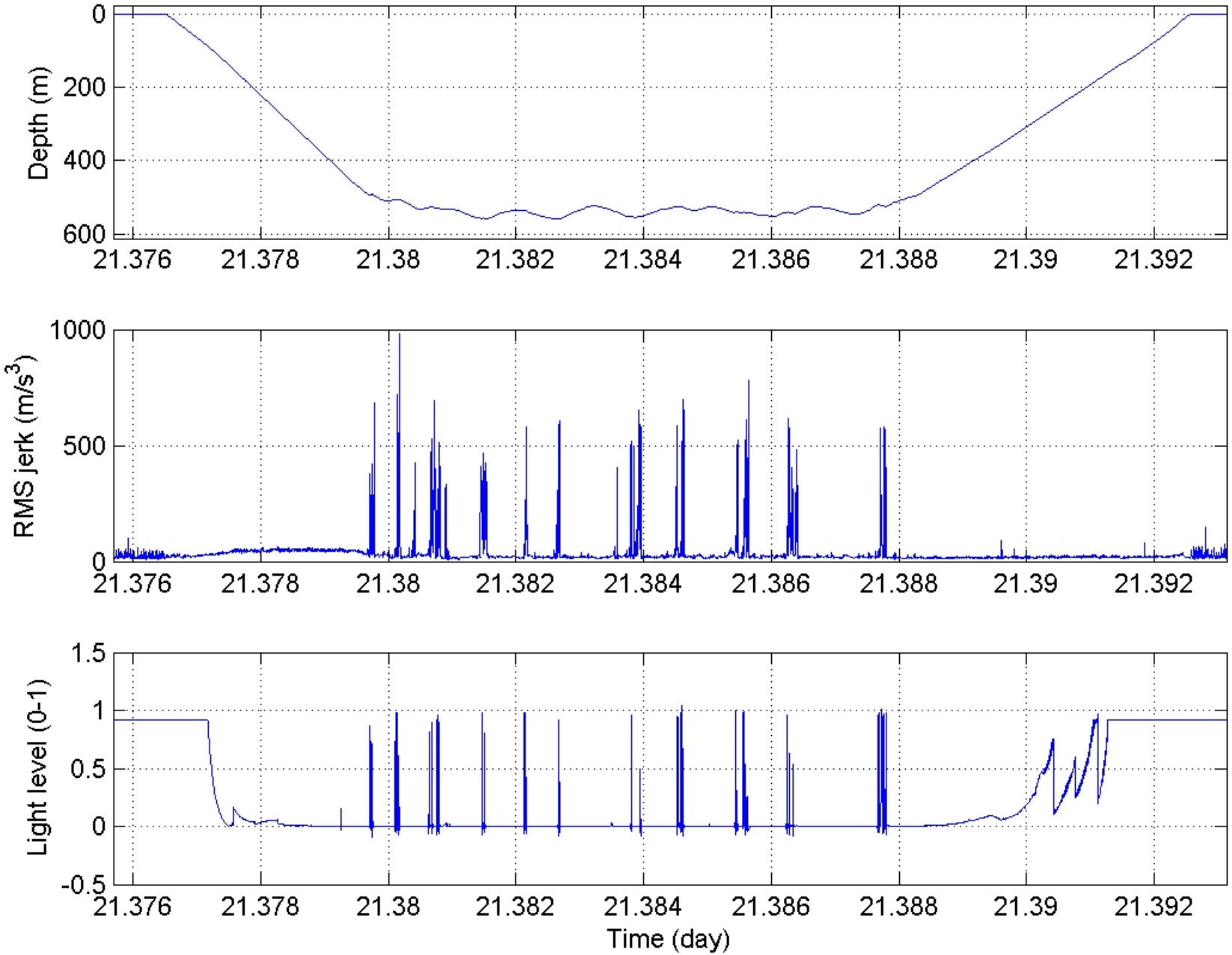
Hydrophone,
Accelerometer,
Magnetometer
GPS

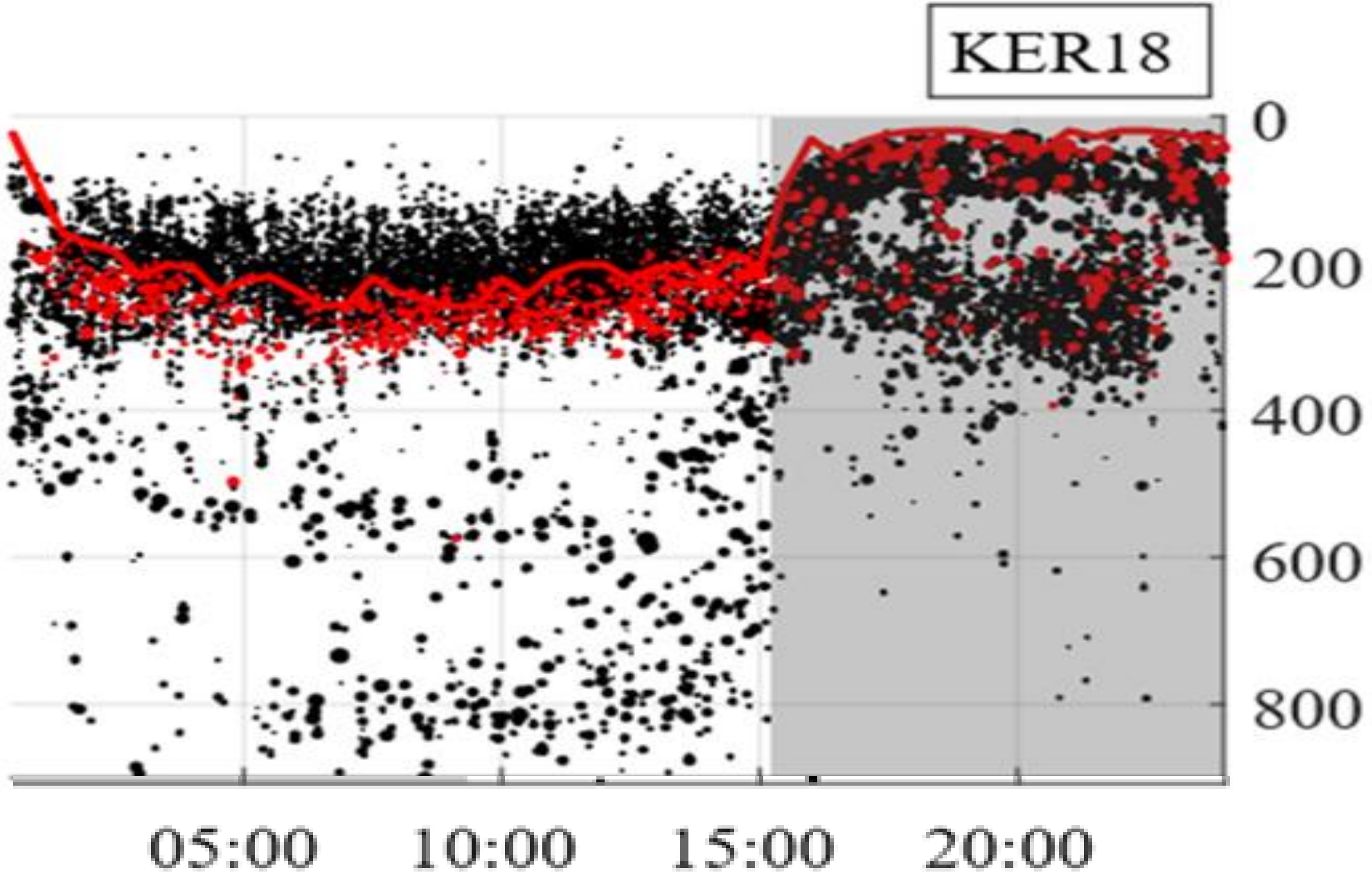
High sensitivity-High frequency 50 hZ sampling Light sensor



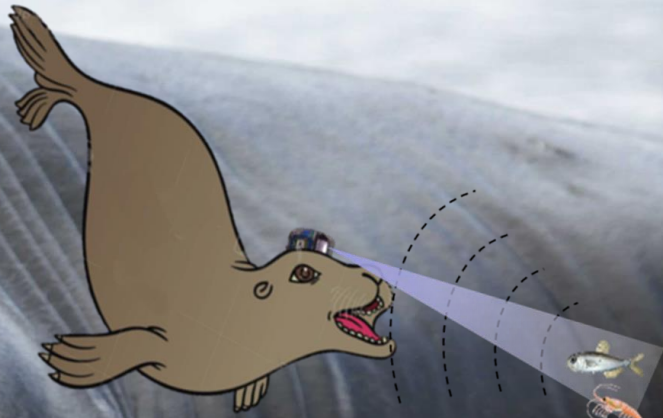


Capture de 400 à 800 proies par jours d'une dizaine de cm, et une trentaine de grammes


Depth (m)
0
200
400
600
RMS jerk (m/s3)
1000
500
0
Light level (0-1)
1.5
1
0.5
0
-0.5
21.376
21.378
21.38
21.382
21.384
21.386
21.388
21.39
21.392
Time (day)


KER18
0
200
400
600
800
05:00
10:00
15:00
20:00

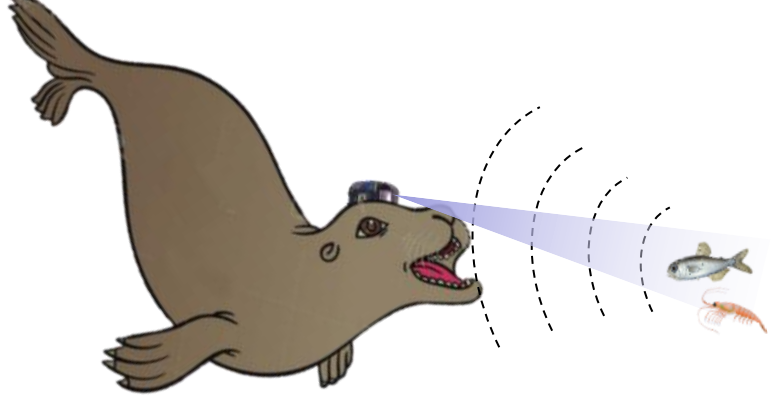
Active µ-sonar: collaboration with M. Johnson & P. Goulet, Sea Mammal Research Unit),
Tiphaine Jeanniard du Dot (CEBC)

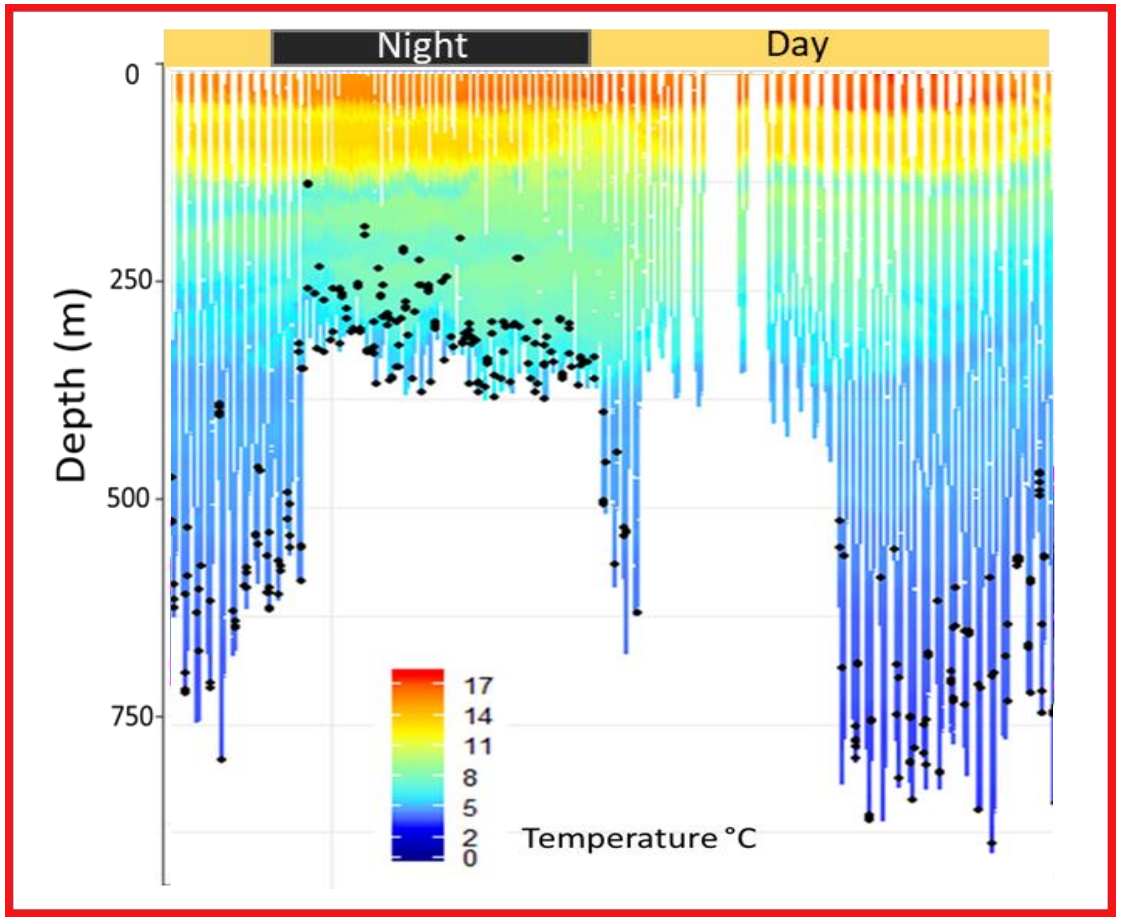


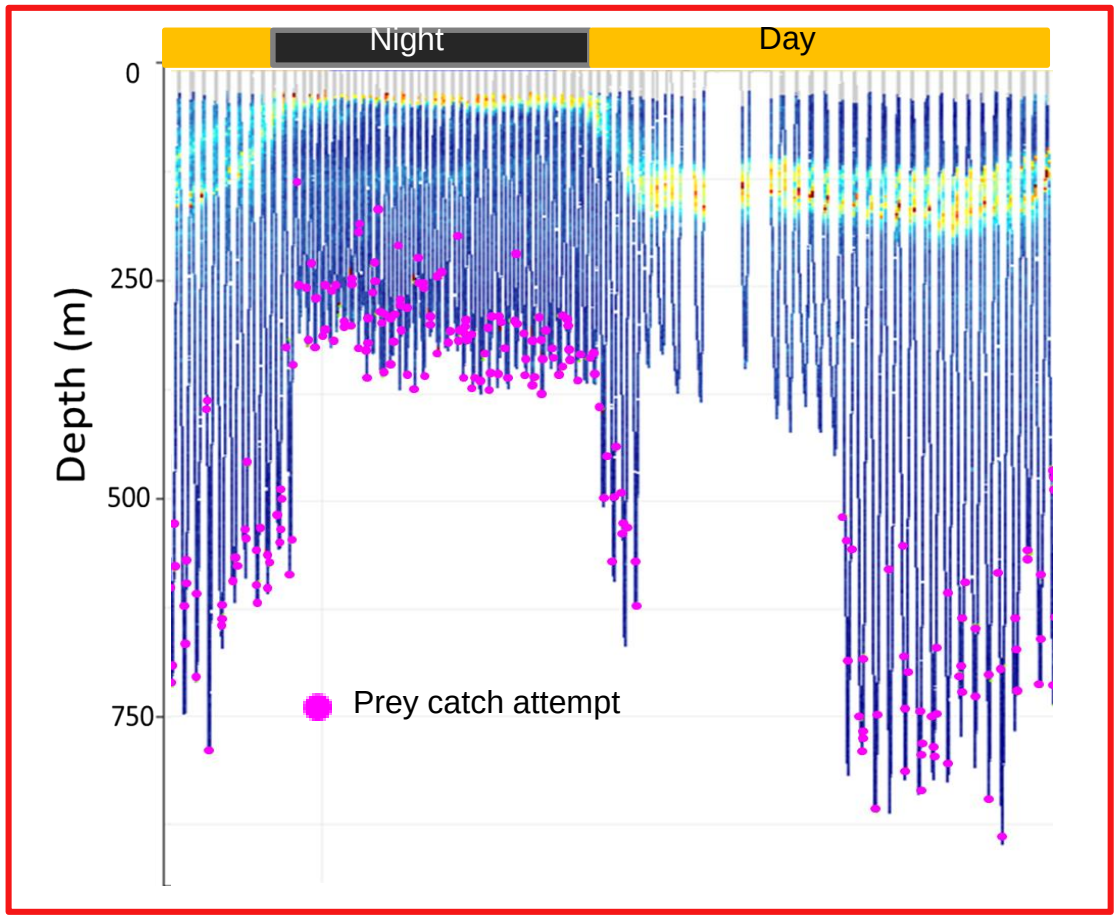
SenSe SENTINELS OF THE SEA ICE

FONDATION BNP PARIBAS
Sous l'égide de la Fondation de France

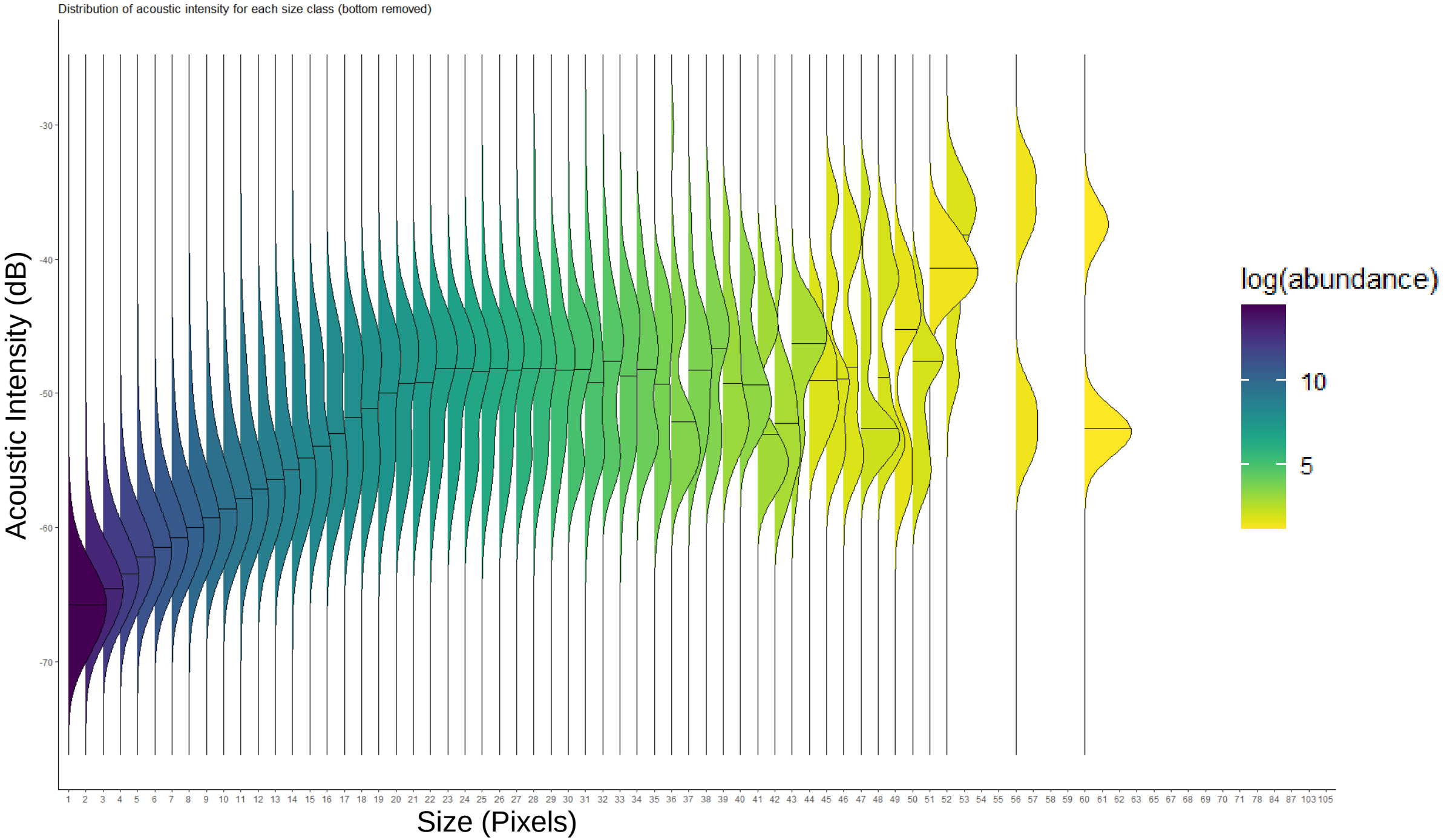
cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

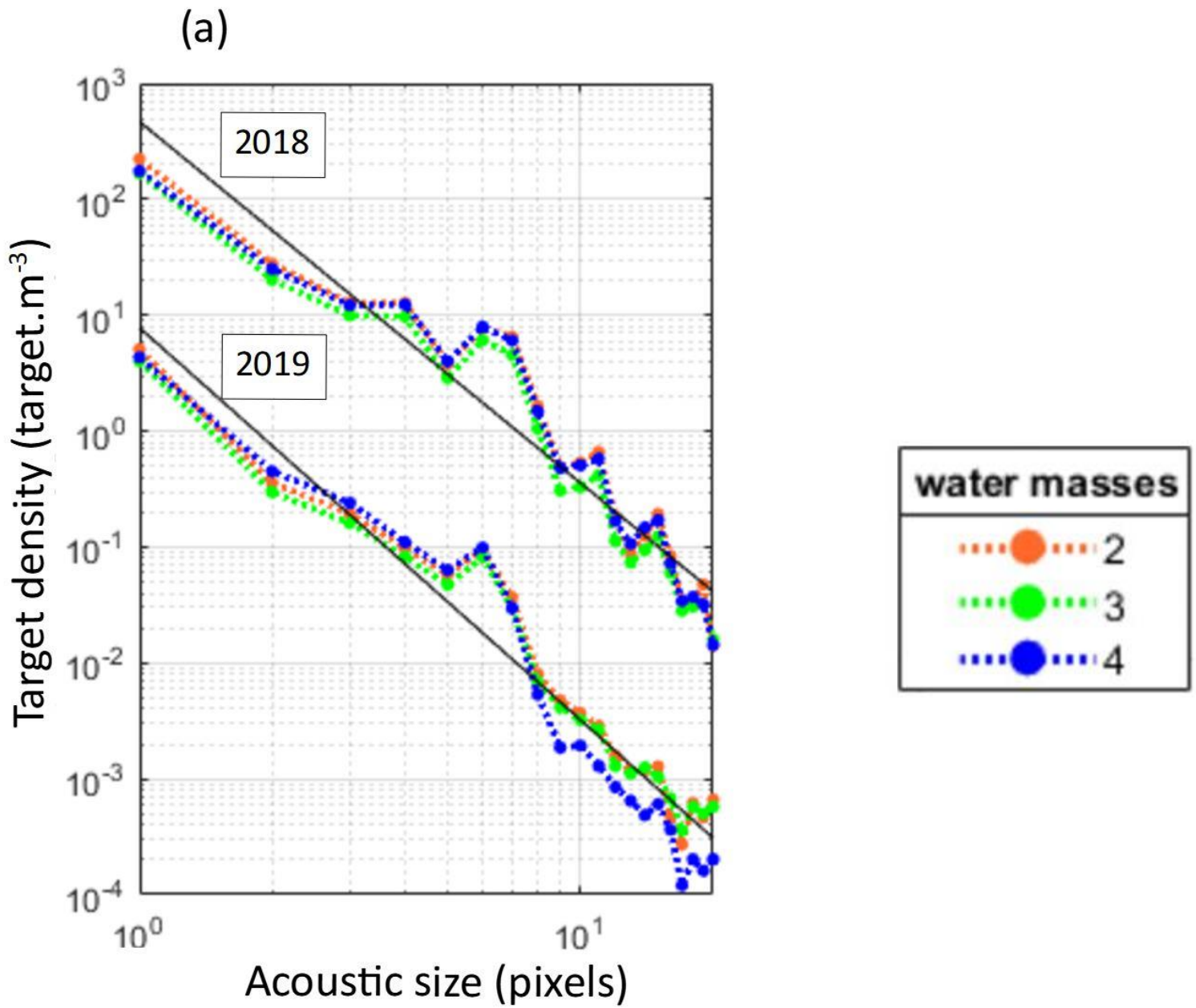






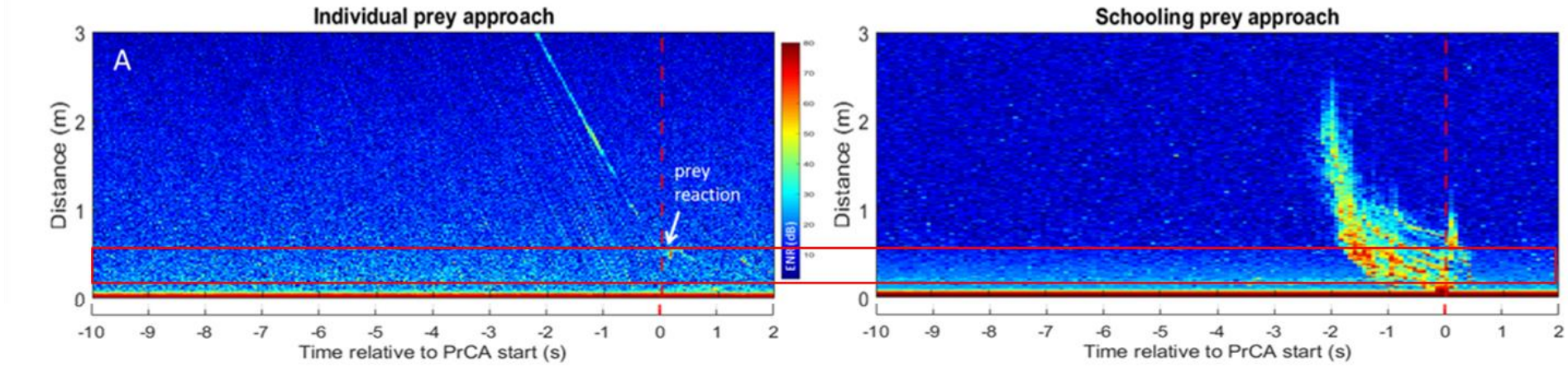
Tournier et al. 2021.


Distribution of acoustic intensity for each size class (bottom removed)
Acoustic Intensity (dB)
-30
-40
-50
-60
-70
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 65 67 68 69 70 71 78 84 87 103 105
Size (Pixels)
log(abundance)
10
5

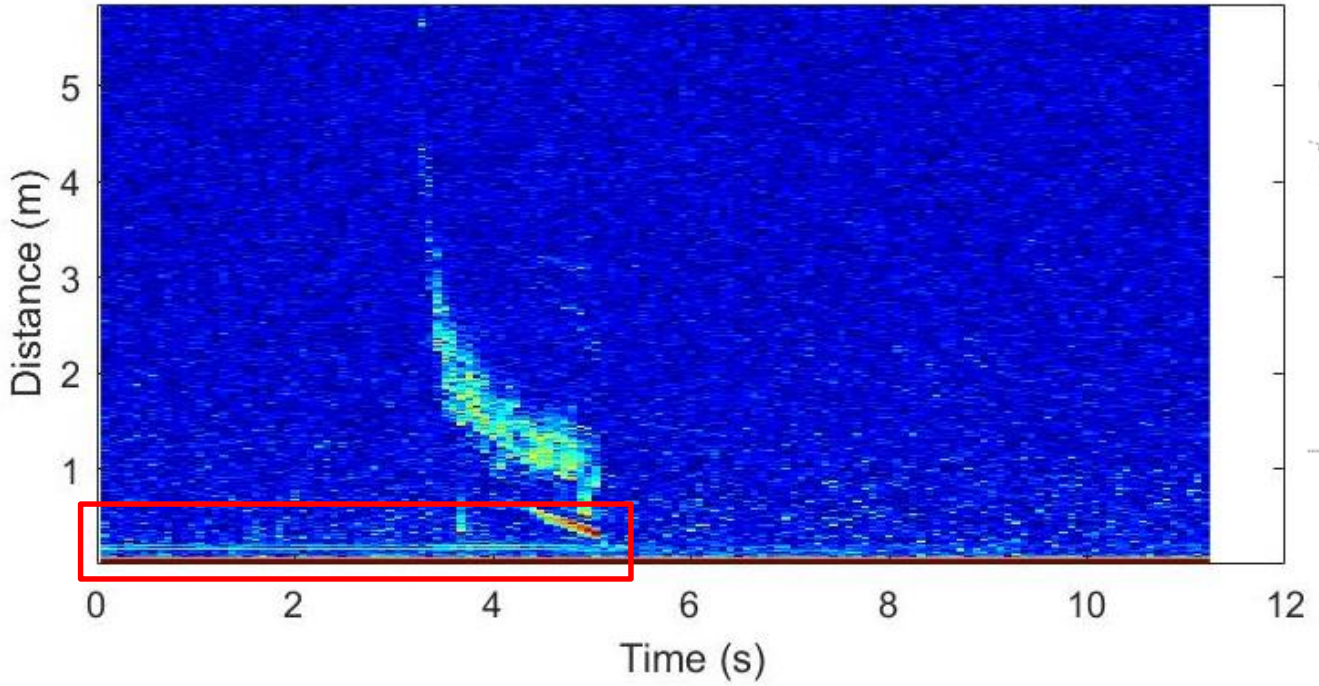

(a)
2018
2019
Target density (target.m-3)
Acoustic size (pixels)
water masses
2
3
4

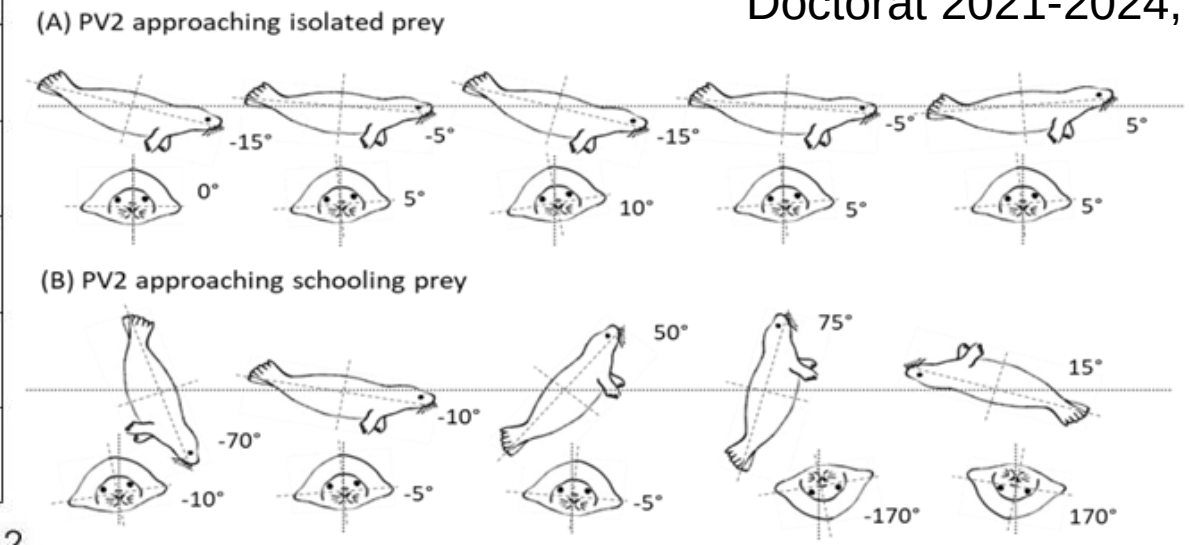
Proies Isolées

Proies en Banc



Mathilde Chevallay,
Doctorat 2021-2024,

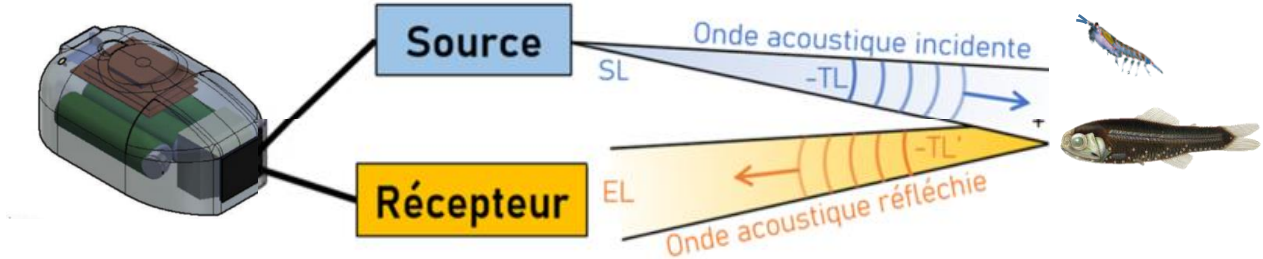




Investigating intermediate Trophic Levels (zooplankton and micronekton)

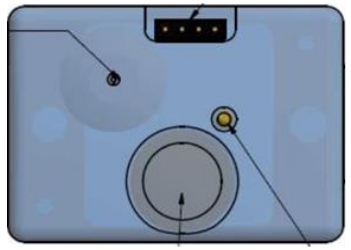
Combining a miniature echosondeur to trigger a miniature camera when target are detected at a given distance from the sensor (Funding CNRS Innovation (A2V-µcam).

CNRS-Innovation: projet de co-prématuration A2V-µCam



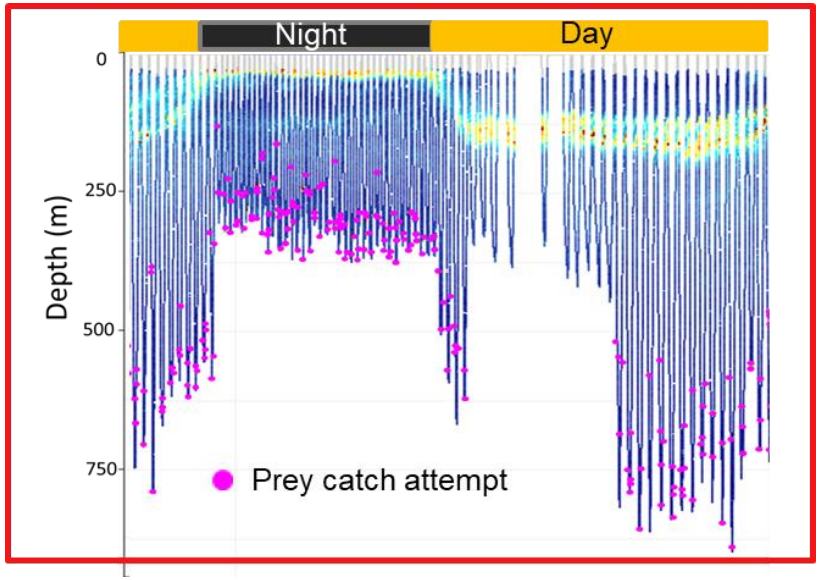
+

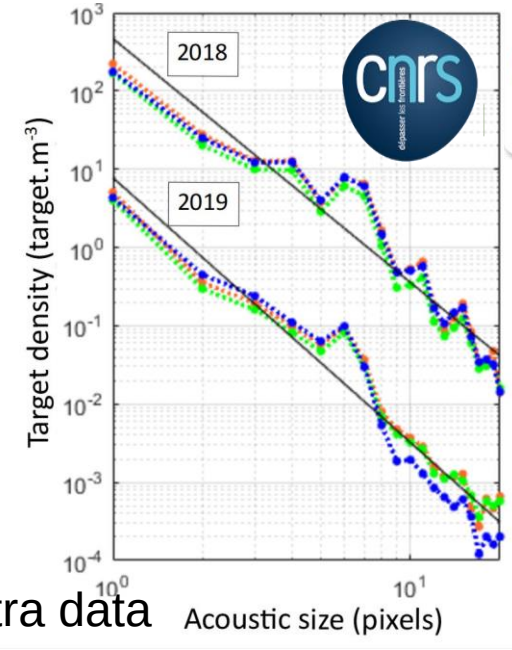
Led: flashes



Module photographique haute résolution

Capteur CMOS HD





Qualitative Data

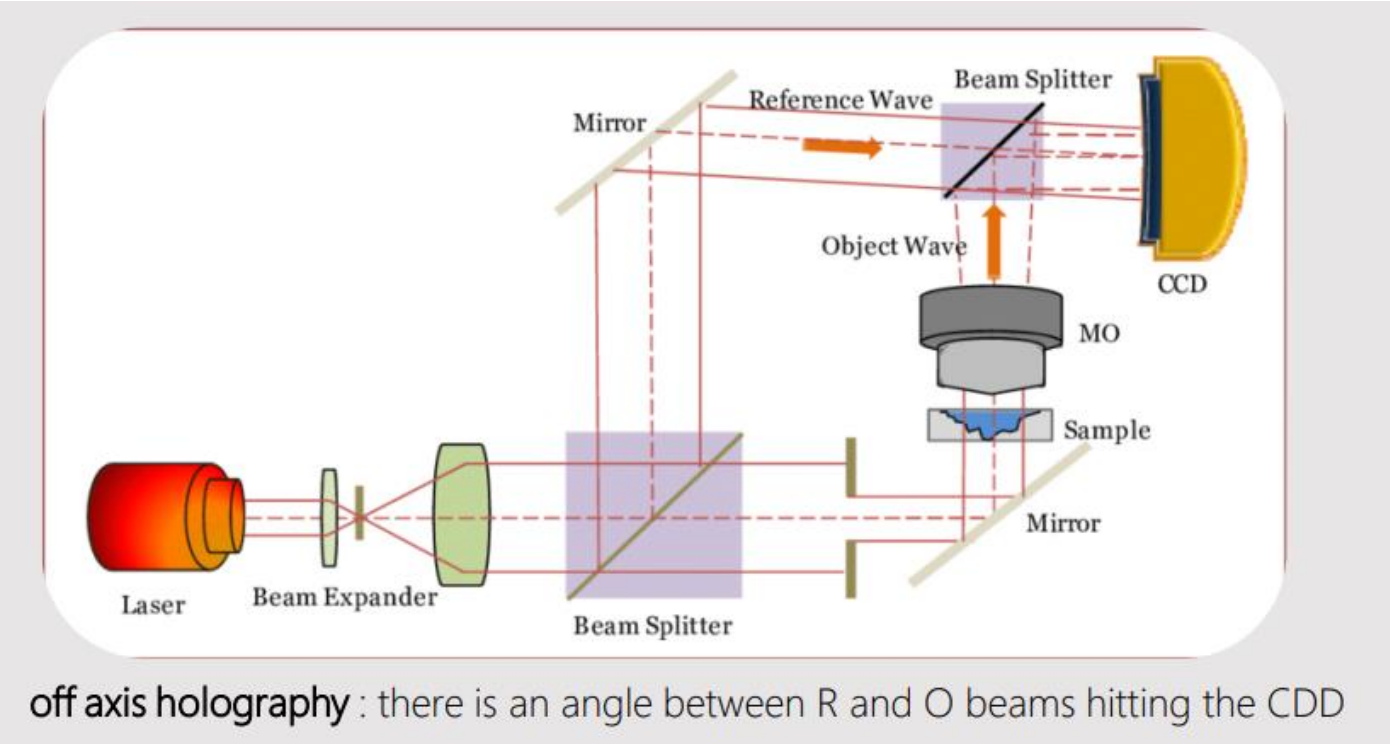
Behavioural & size abundance spectra data

GOULET P, GUINET C, SWIFT R, MADSEN P. JOHNSON M. (2019). A miniature biomimetic sonar and movement tag to study the biotic environment and predator-prey interactions in aquatic animals. Deep-Sea Research Part 1.

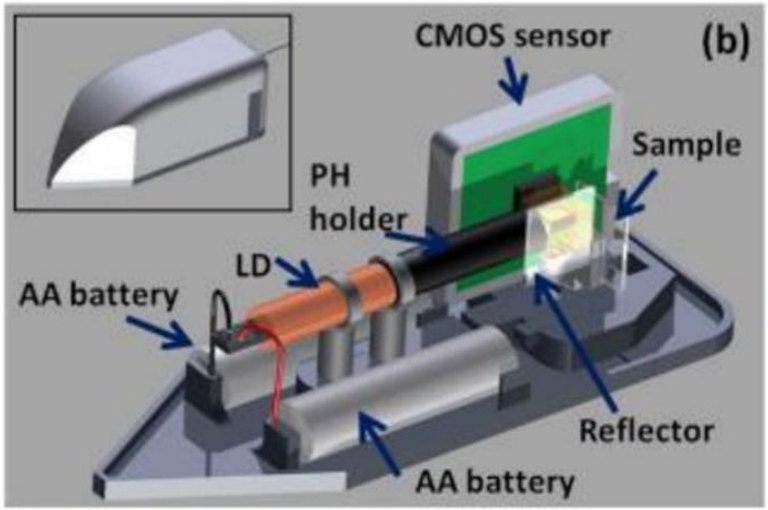
TOURNIER M, GOULET P, JOHNSON M, NERINI D, FONVIEILLE N, GUINET C (2021). A novel animal-borne miniature echosounder to observe the distribution and migration patterns of intermediate trophic levels in the Southern Ocean. Journal of Marine System, 223: 103608.

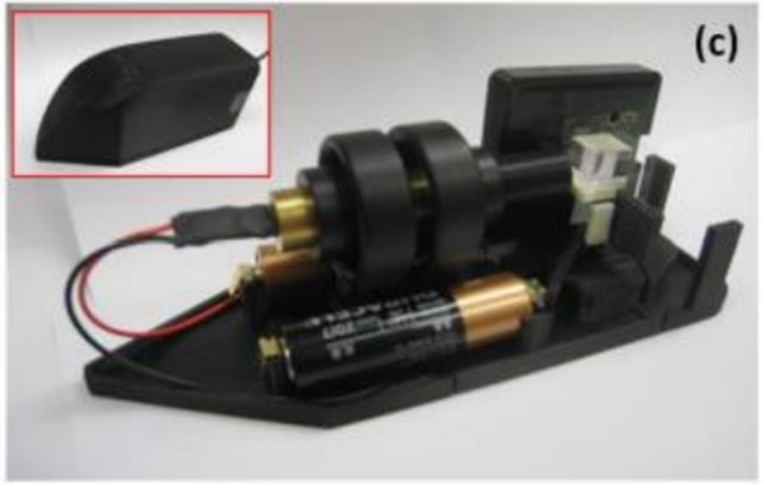
Imagerie Holographique: ou microscopie sans objectif

- Qualifier les types phytoplanctoniques



off axis holography : there is an angle between R and O beams hitting the CDD

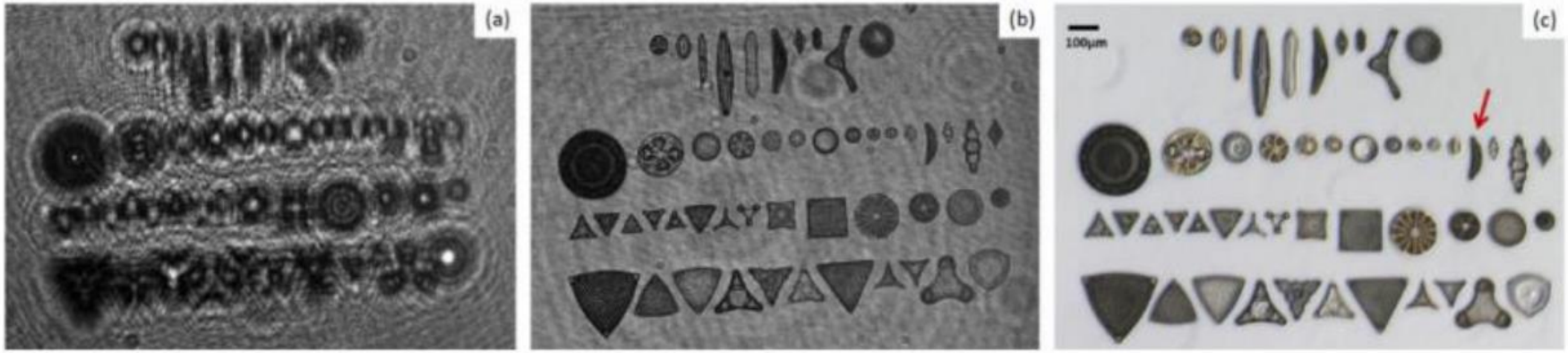




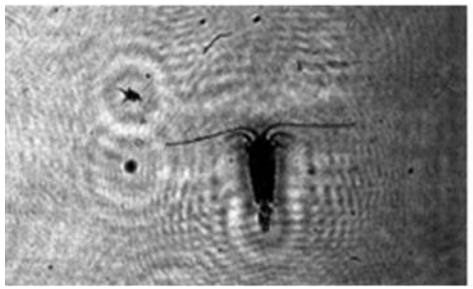
Thèse Asma Chaqroun

Teresa Cacace, Vittorio Bianco, Biagio Mandracchia, Vito Pagliarulo, Emilia Oleandro, Melania Paturzo, and Pietro Ferraro, "Compact off-axis holographic slide microscope: design guidelines," Biomed. Opt. Express 11, 2511-2532 (2020)

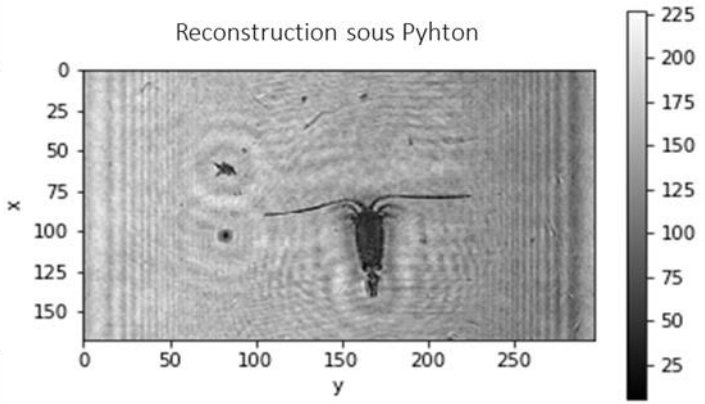
50 different diatom species, with diameter ranging from 50 µm to 200 µm



Reconstruction tiré de [2]



Reconstruction sous Pyhton



Collaboration avec Oberon Science, et Karine Leblanc MIO,; avec une grosse approche IA. Post-traitement des données,

Authier Matthieu (CEBC), Bailleul Frédéric (CEBC), Bataile Brian (MMRU-UBC), Bessigneul Guillaume (CEBC), Blain Stéphane (LOB-UPMC), Bost Charles André (CEBC), CazaU Dorian (ENSTA-B), Chaigne Adrien (CEBC), Charrassin Jean Benoit (MNHN-LOCEAN), Cherel Yves (CEBC), Claustre Hervé (LOV-UPMC), Cotté Cédric (CEB-LOCEAN-UPMC), Bataile Brian (UBC), Dubois Guillaume (CEBC), Dragon Anne Cécile (CEBC), El Skaby Nory (CEBC), Fedak Michael (SMRU), Genin Alexandre (CEBC), Halliwel Simon (SMRU), Hindell Mark (AWRU-UTAS), Jaud Thomas (CEBC), Joouma Joffrey (CEBC), Marchand Stéphane (MNHN-CEBC), Laurent Cécile (CEBC), Lebras Yves (CEBC), Levy Marina (LOCEAN-UPMC), Lovell Phillip (SMRU), Monestiez Pascal (INRA), d'Ortenzio Fabrizio (LOV-UPMC), d'Ovidio Francesco (LOCEAN-UPMC), Park Young Hyang (MNHN-LOCEAN), Picard Baptiste (CEBC), Pons Jean Baptiste (CEBC), Reverdin Gilles (LOCEAN-UPMC), Richard Gaetab (CEBC),Roquet Fabien (MNHN-LOCEAN-MIT), Royer François (CLS Argos), Trites Andrew (MMRU-UBC), Viviant Morgane (CEBC), Vacquié Garcia Jade (CEBC), Xing Xiaogang (LOV-UPMC), Weimerskirch Henri (CEBC)…