



Centre d'études
biologiques de
Chizé



Cross contribution of satellite and seal's oceanographic observations for a better understanding of the Southern Ocean: from large to fine scale

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Coriolis
INTERDISCIPLINARY OCEANOGRAPHY



ANR

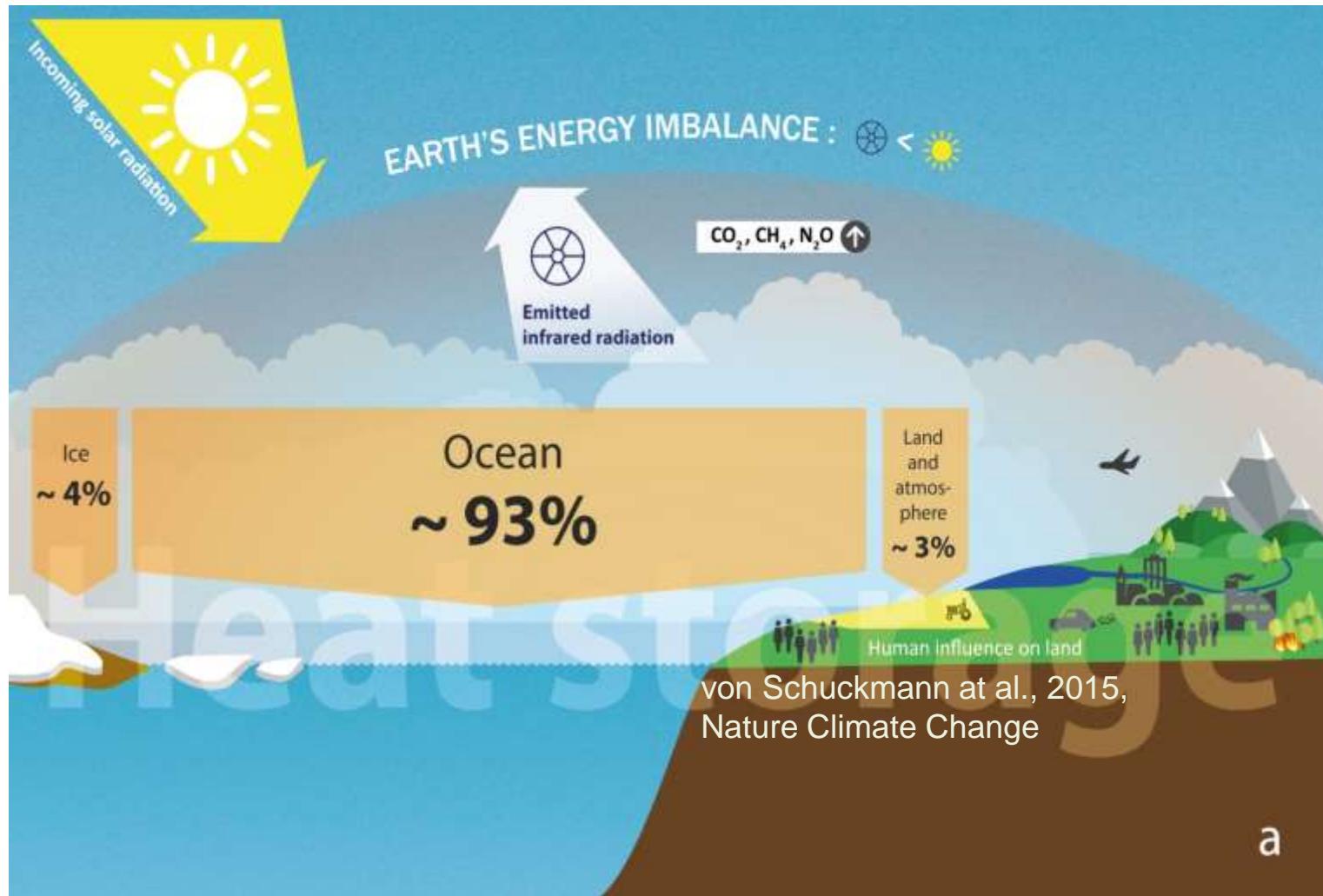
AGENCE
NATIONALE
DE LA
RECHERCHE

cnes

IPEV
INSTITUT
POLAIRE
Paul Emile Victor

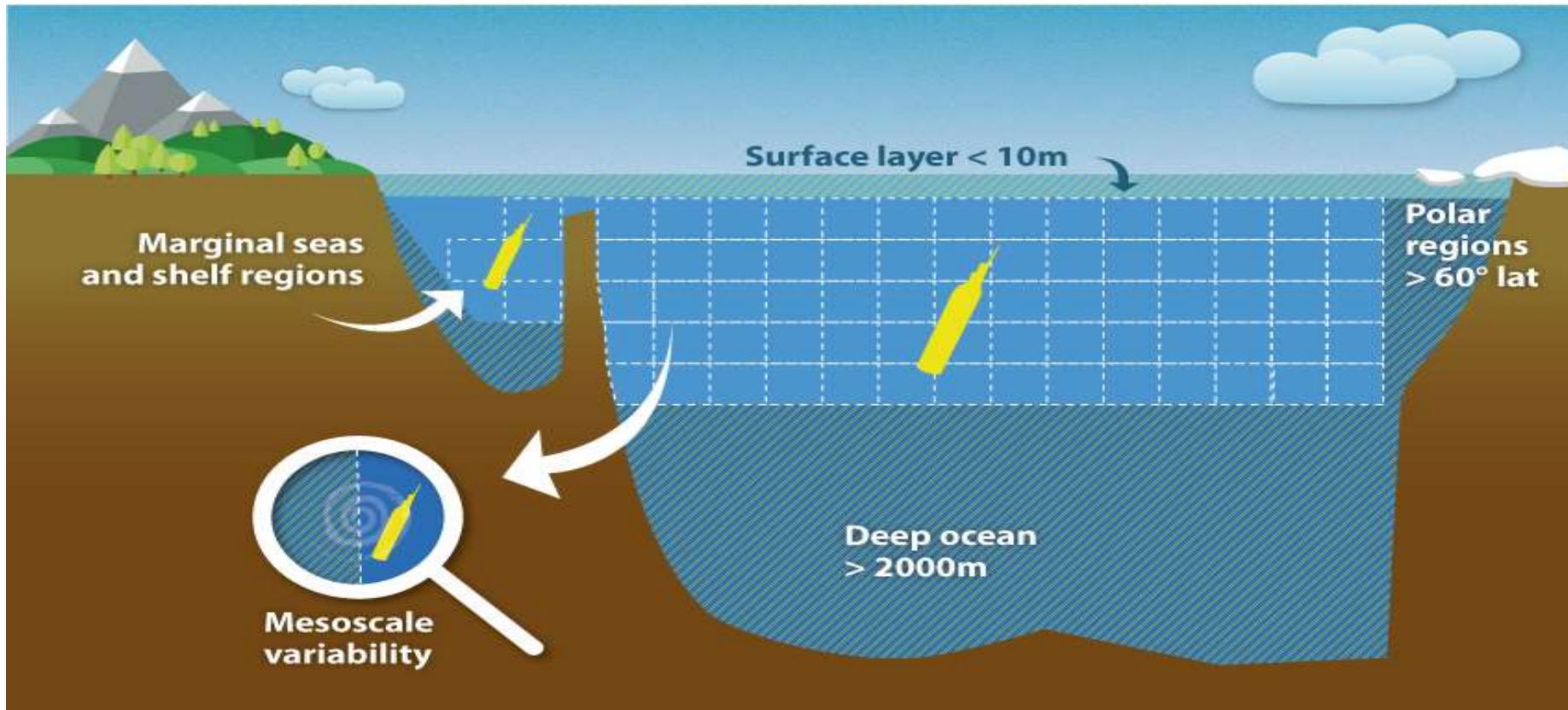
**FONDATION
TOTAL**

To observe the ocean is critical to understand the earth thermal unbalance ($0.5\text{-}1\text{W/m}^2$: IPCC, 2013): due to energy accumulation and storage

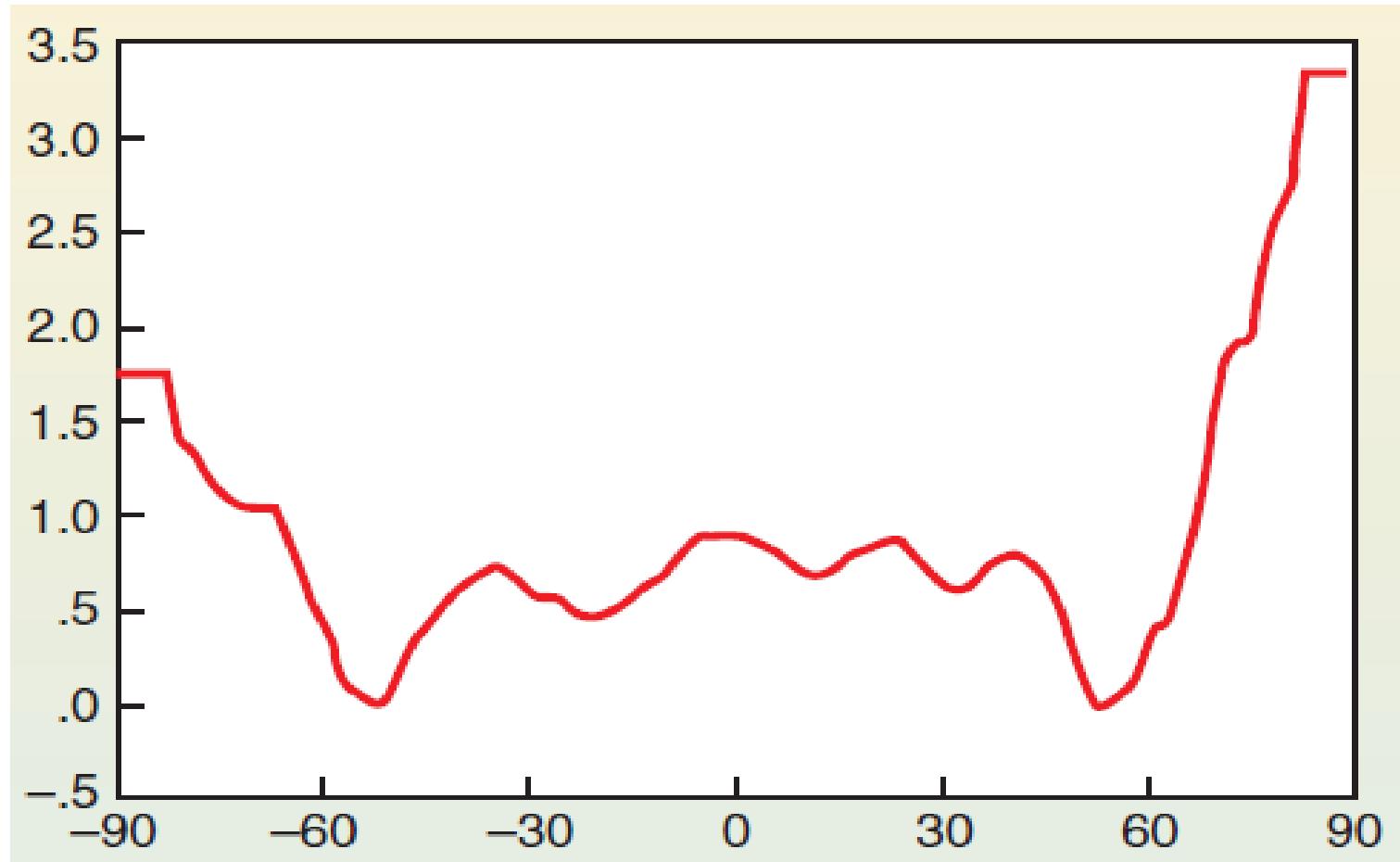


von Schuckmann et al., 2015,
Nature Climate Change

The Global Ocean : Oceanographic blind spots



von Schuckmann et al., 2015, Nature Climate Change



Anomalie de température de surface en 2010 relative à la moyenne établie sur la période 1951-1980 en fonction de la latitude

Since 2003 simultaneous study of the at sea ecology of southern elephant seals and acquisition of oceanographic data



Elephant seal : a seal of exception

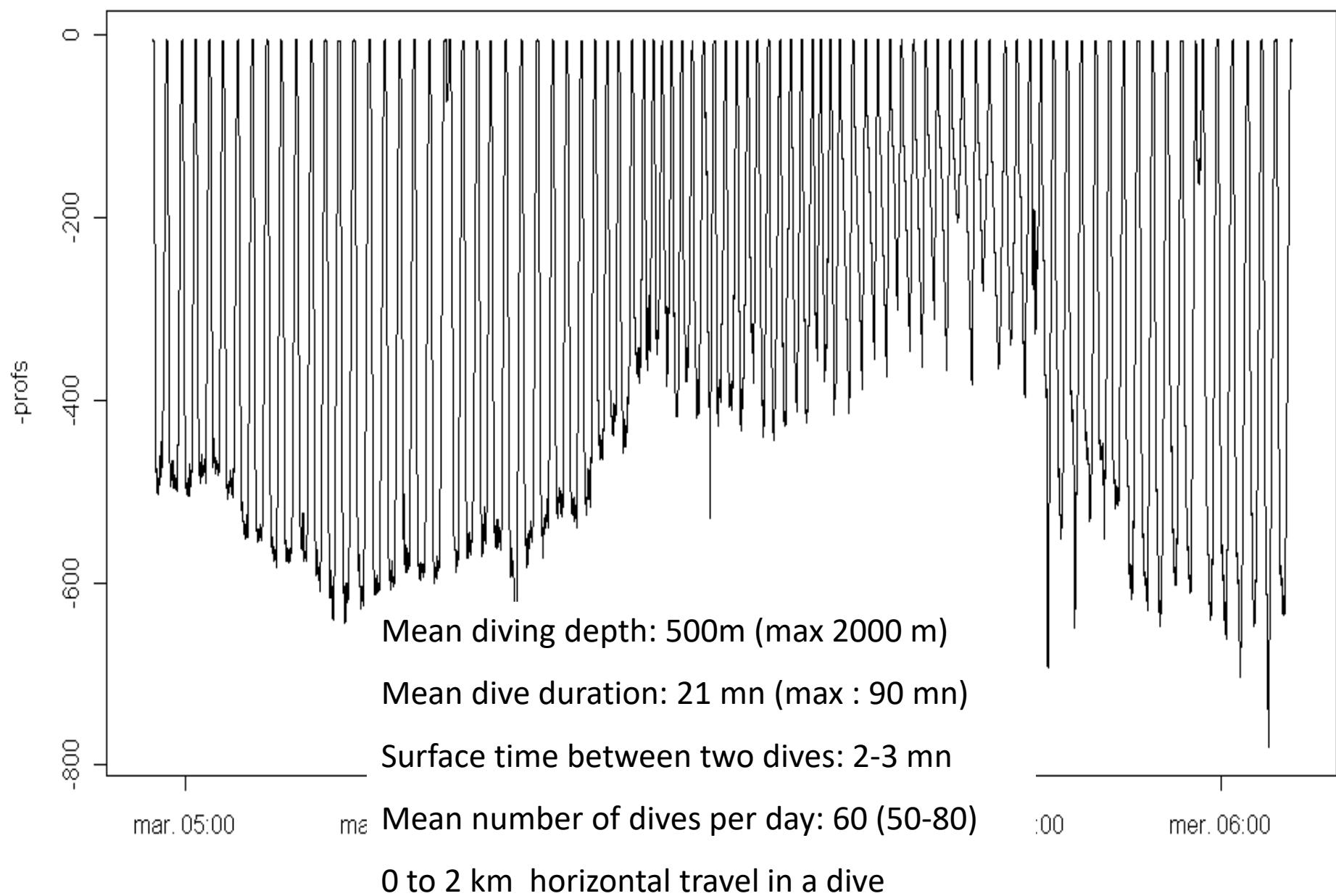




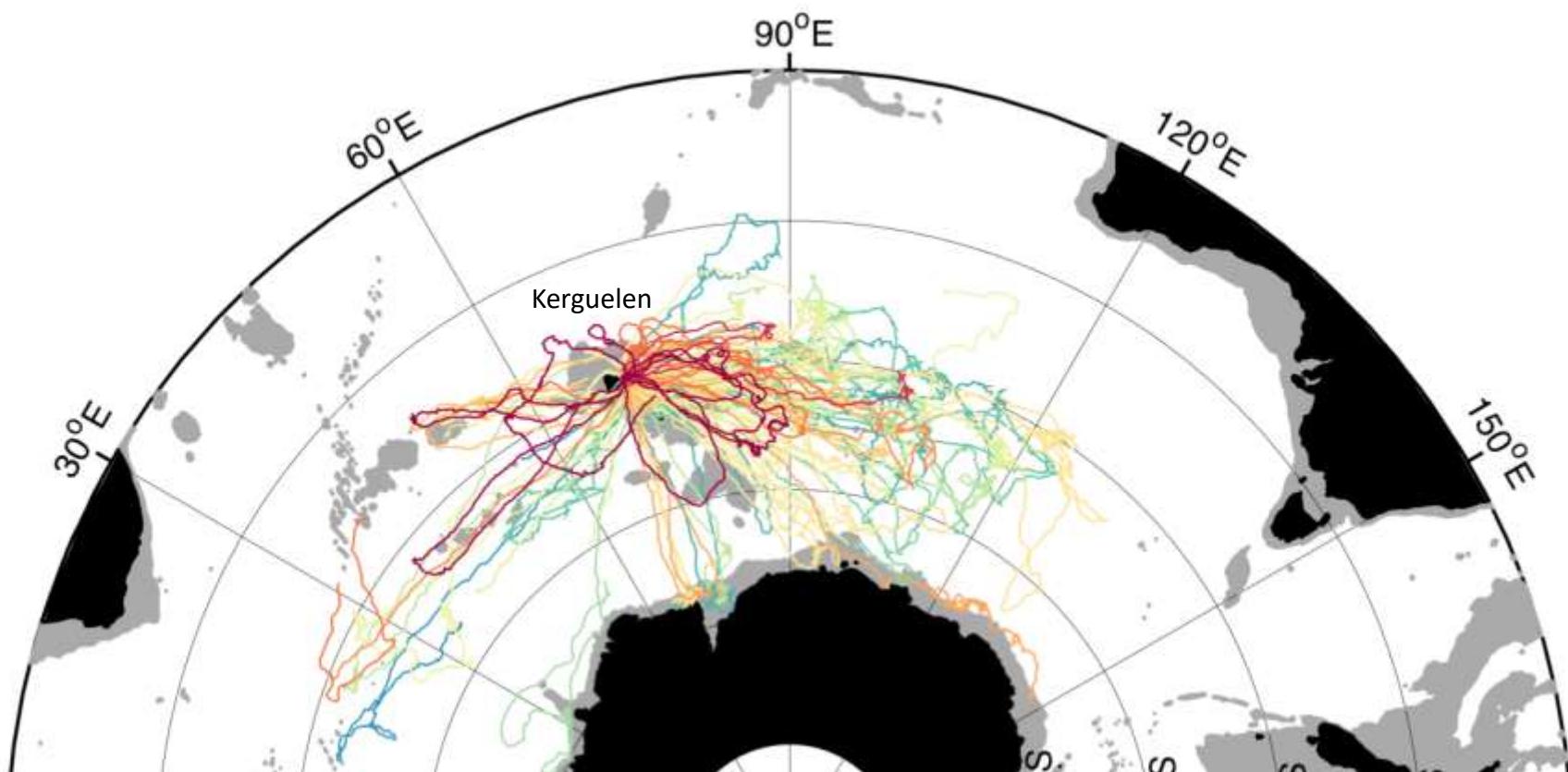


A continuous and a deep diver!

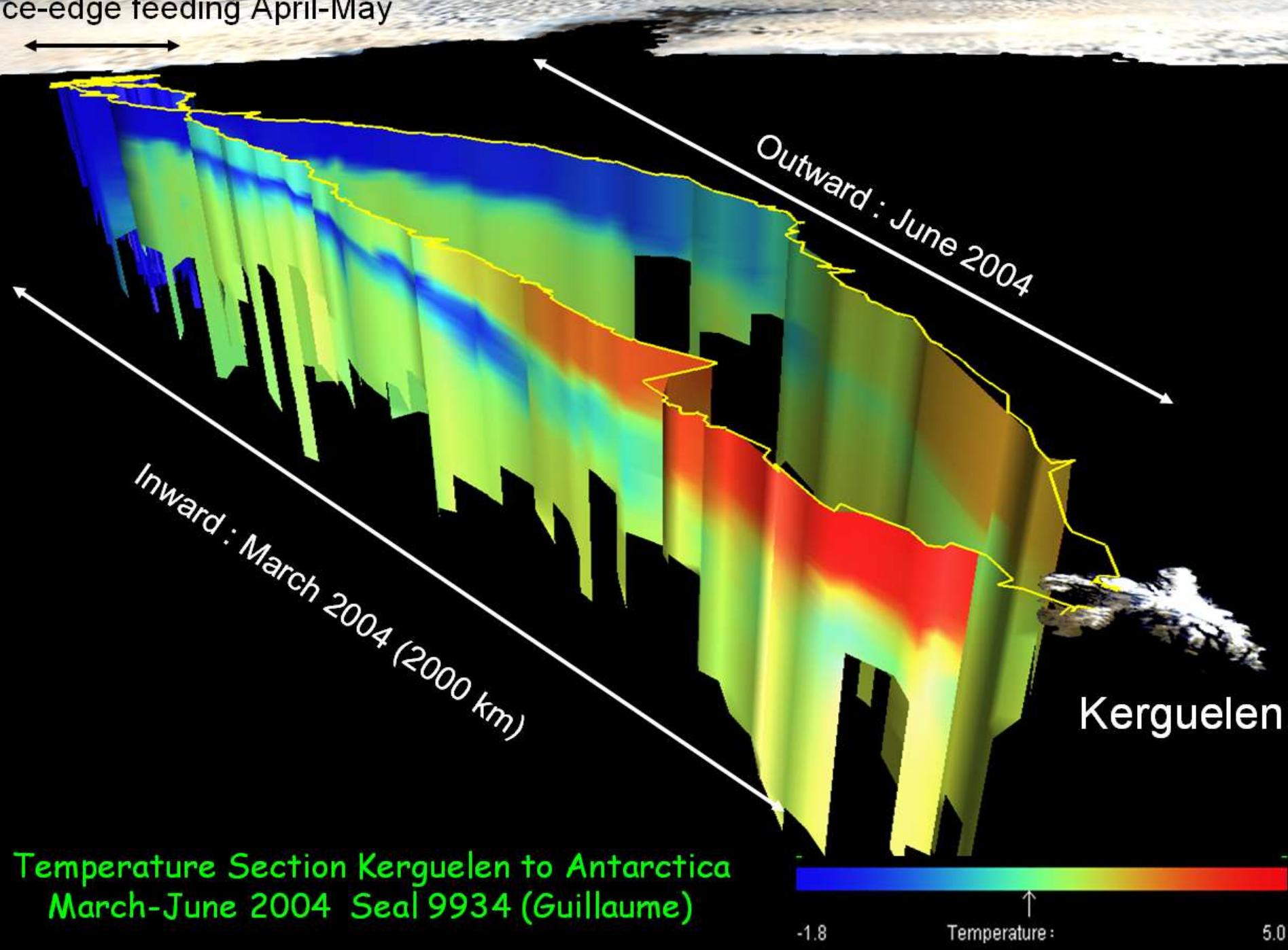
24h of an elephant seal life



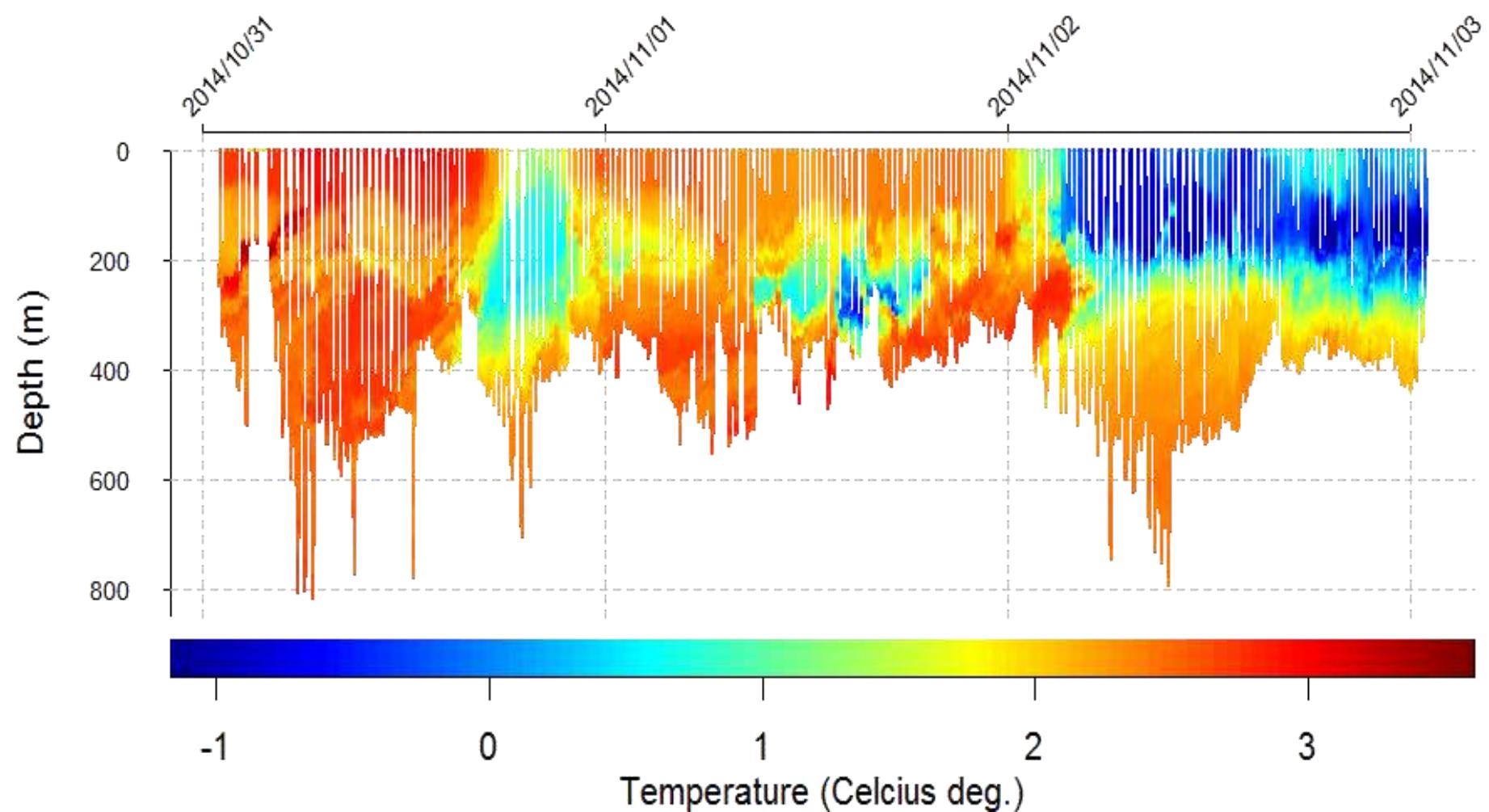
They cover thousands of kilometers within the Southern Ocean to forage



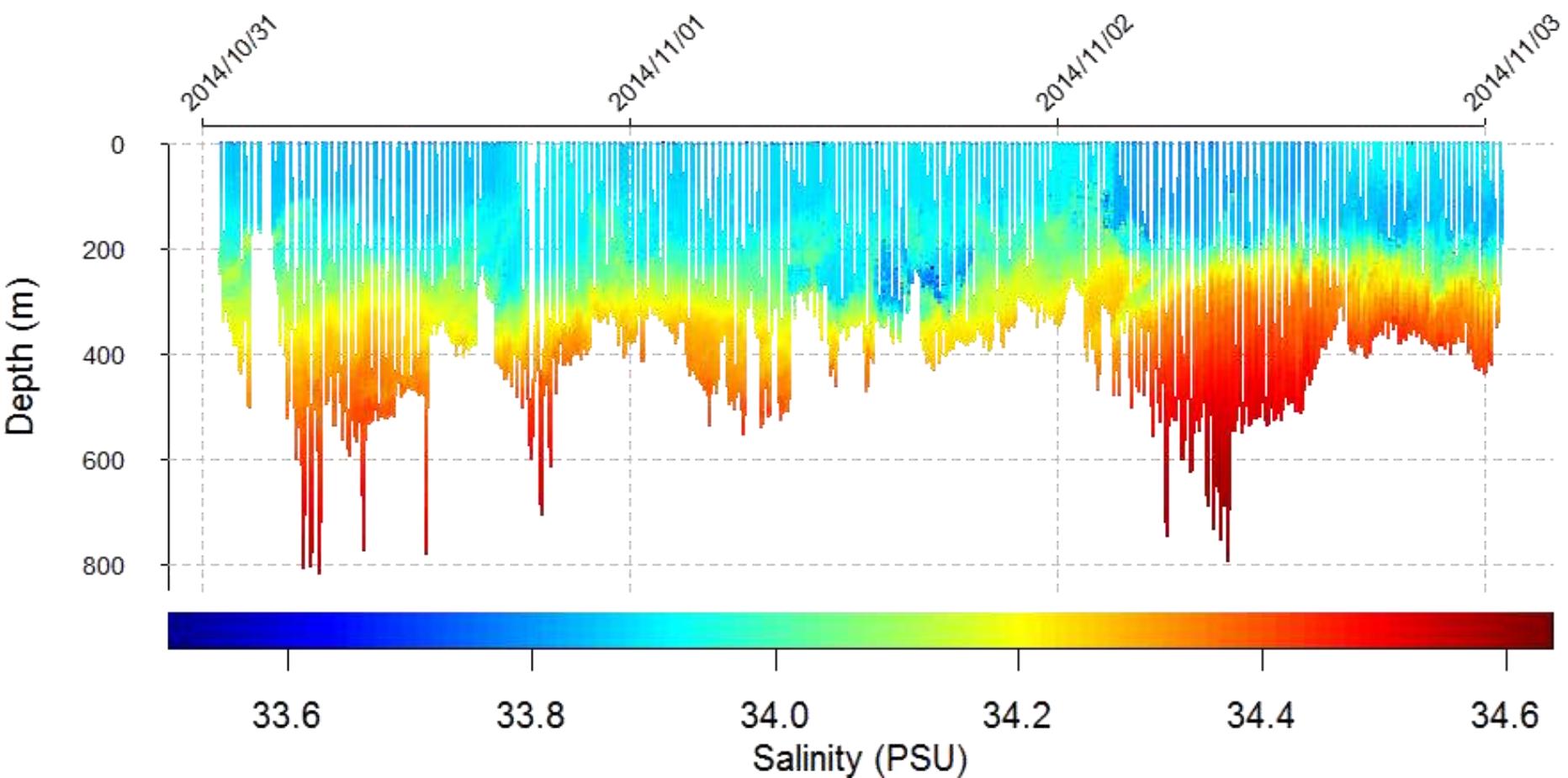
ce-edge feeding April-May

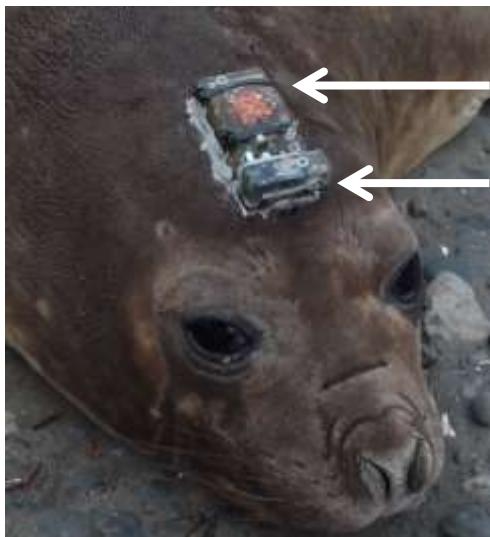


Currently the only operational system to collect high frequency oceanographic data within the Southern Ocean



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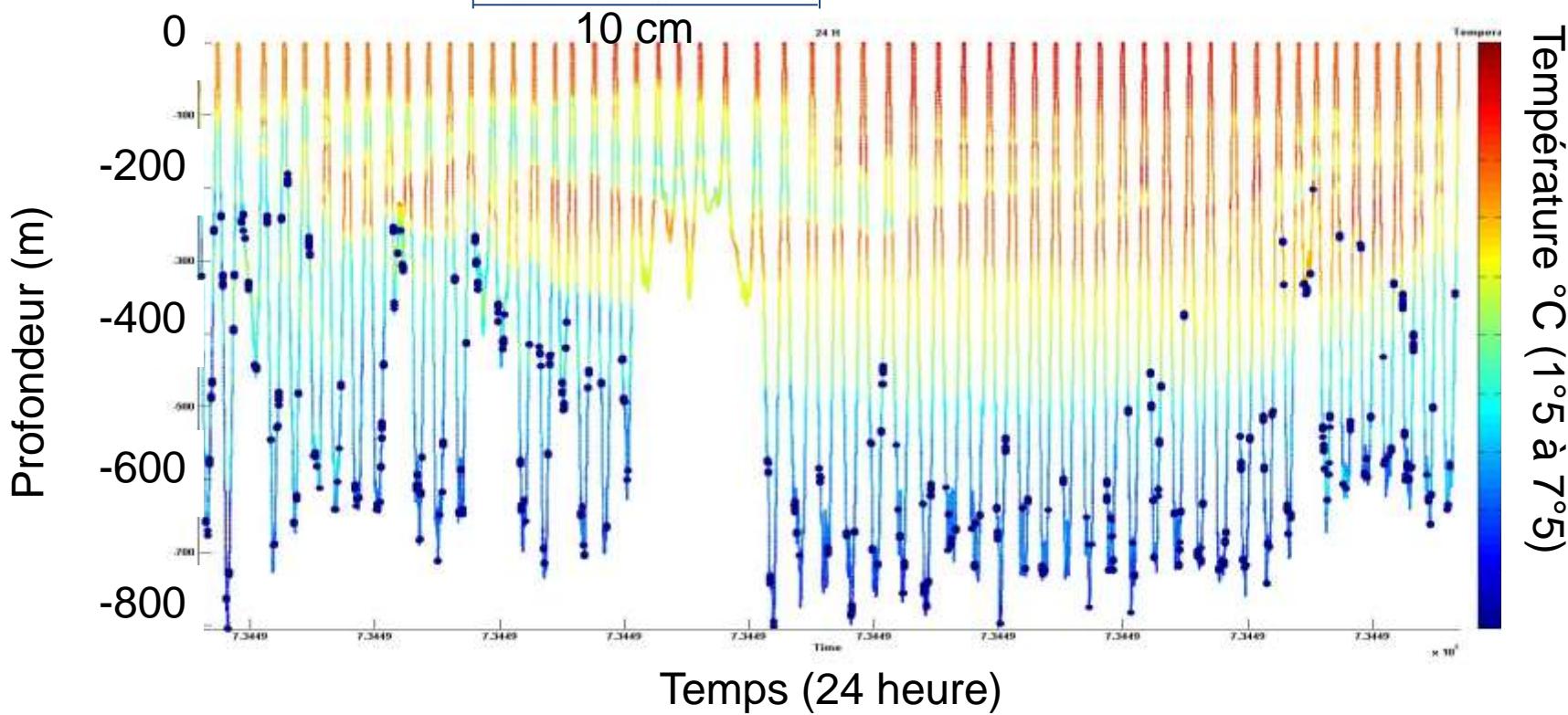
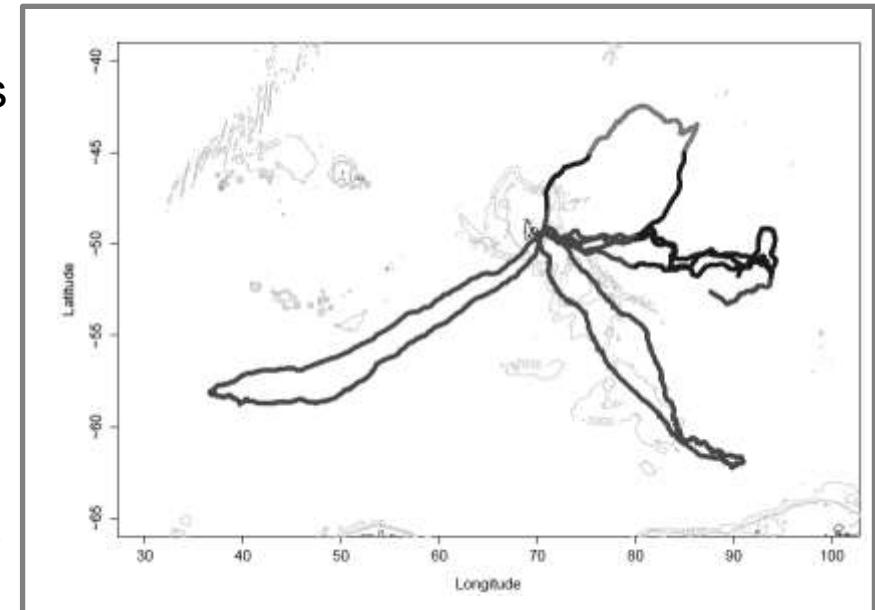
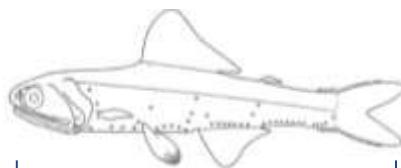


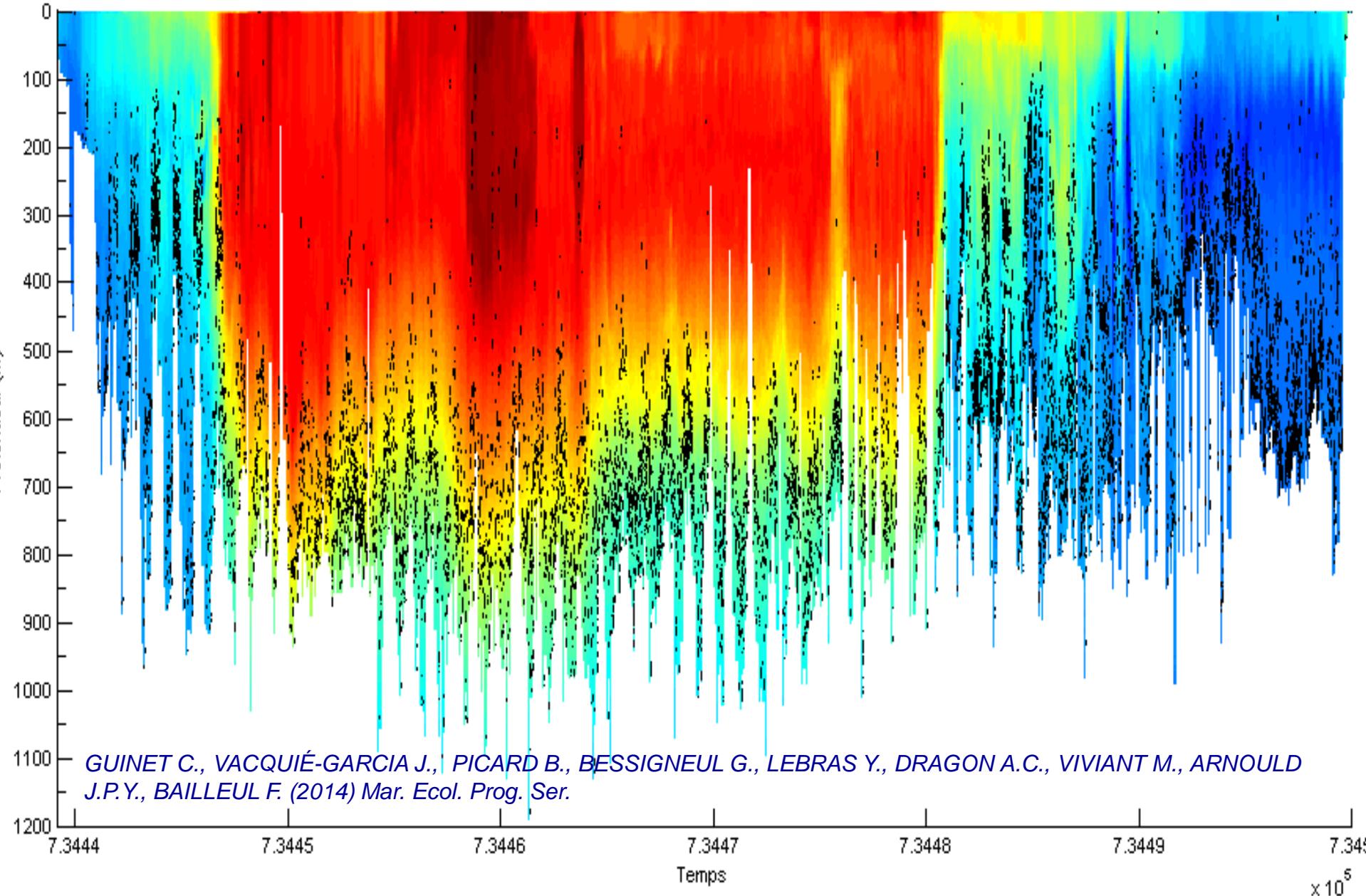
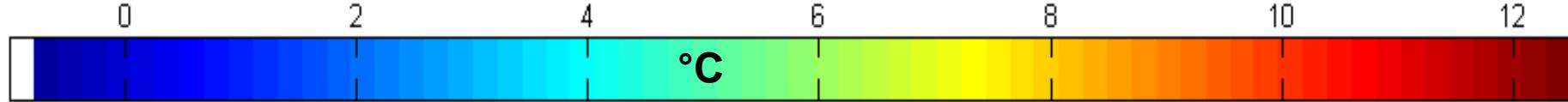


Argos/GPS beacons

Accélérometers

Elephants seals are predators of mesopelagic fishes





GUINET C., VACQUIÉ-GARCIA J., PICARD B., BESSIGNEUL G., LEBRAS Y., DRAGON A.C., VIVIANT M., ARNOULD
J.P.Y., BAILLEUL F. (2014) Mar. Ecol. Prog. Ser.

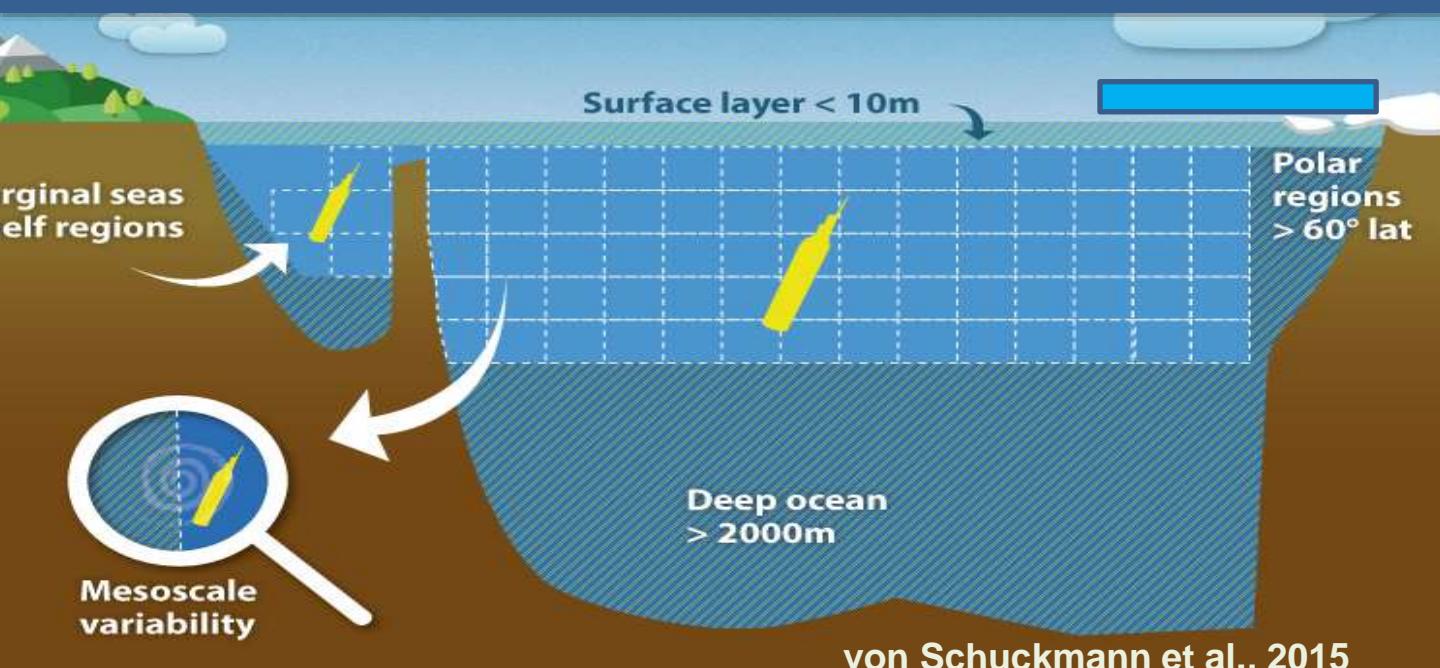
Temps

$\times 10^6$

Objectives:

1. Contribute to the observation of Polar Oceans
2. Validation of satellite measurements by in situ-ones
3. Prolonged surface observation from the space to the water column
4. Contribute to scientific programmes and research at the interface between ecology and oceanography

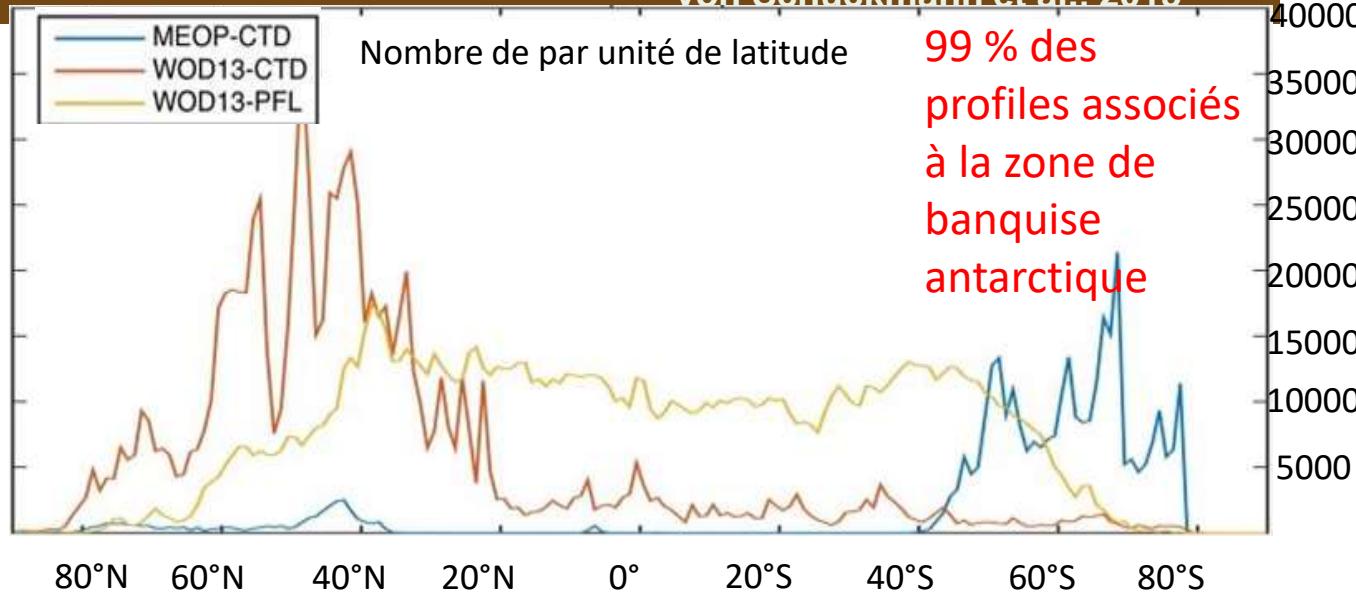
Des progrès considérables ont été accomplis en terme de quantité et de la qualité des données océanographiques collectées. Cependant il subsiste des manques importants pour évaluer correctement le contenu thermique de l'océan global



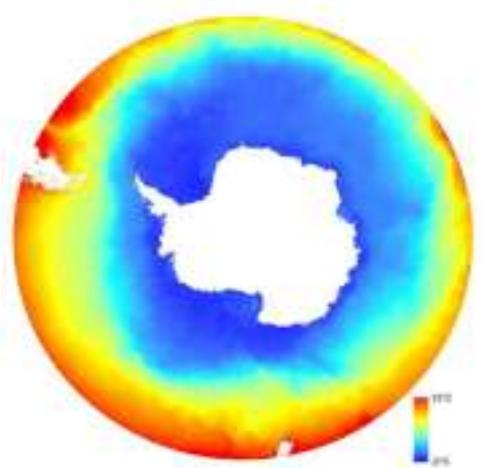
La couverture n'est pas totalement globale. Argo ne couvre pas:

- L'océan profond >
- Les zones côtières et les mers marginales
- La couche de surface proche
- au sud de 60°s

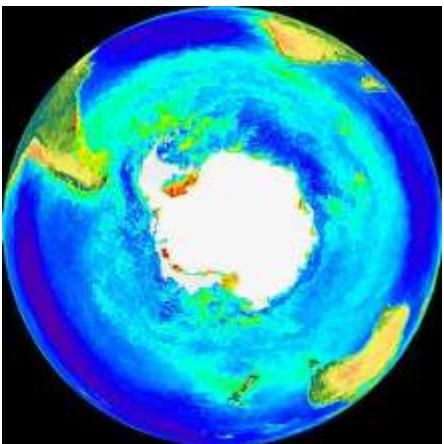
von Schuckmann et al., 2015



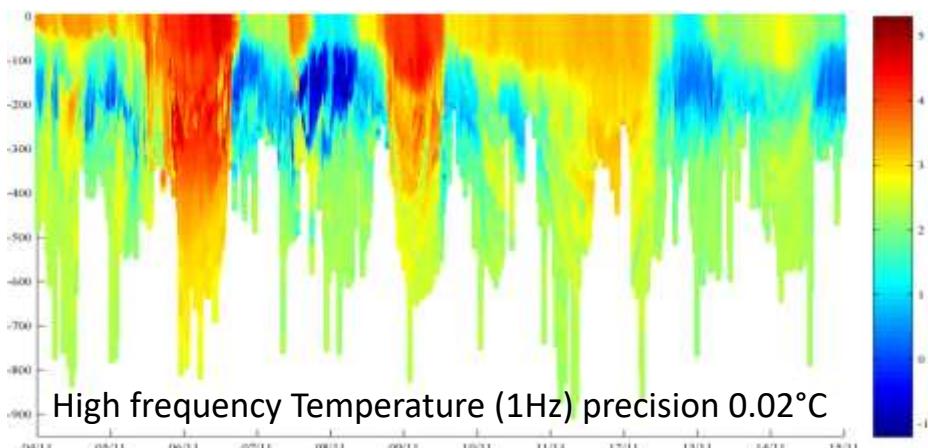
Temperature and ocean color (Sentinel-2, 3)



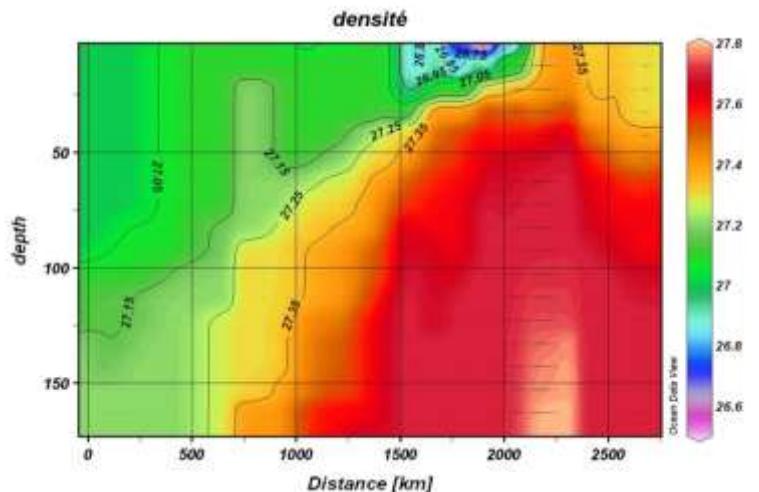
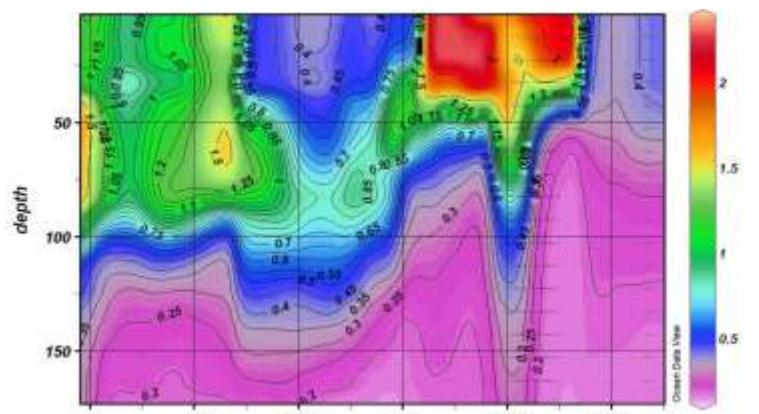
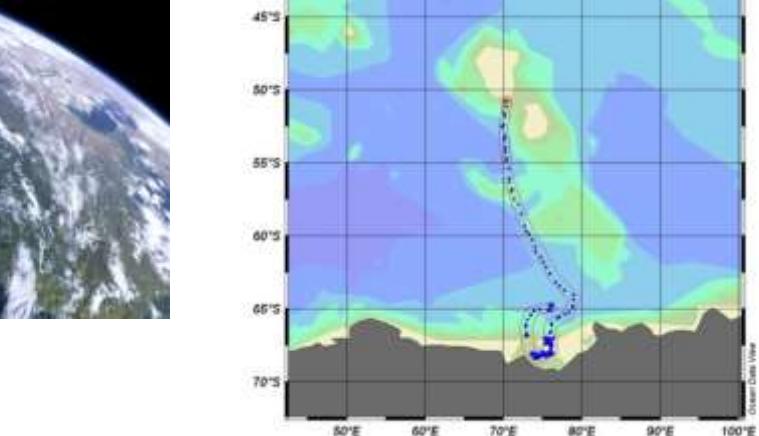
Sea Surface Temperature



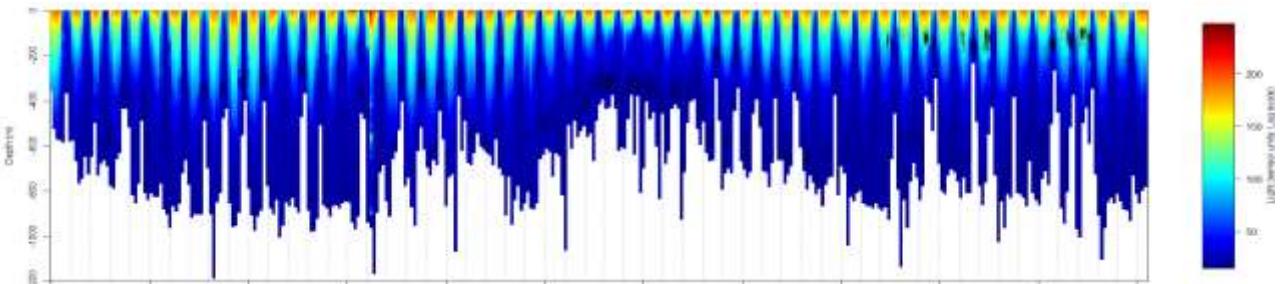
Ocean Color



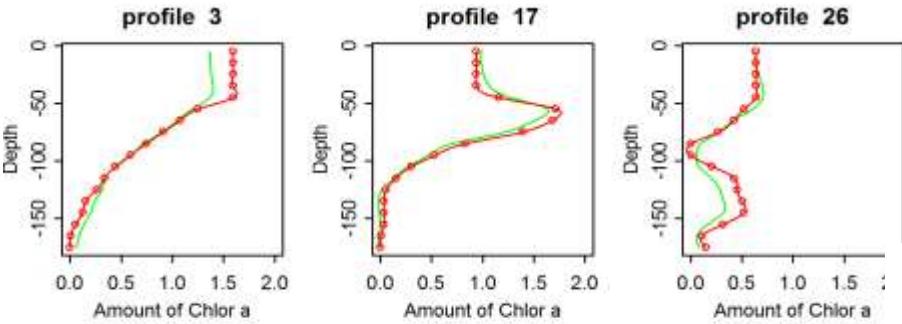
High frequency Temperature (1Hz) precision 0.02°C



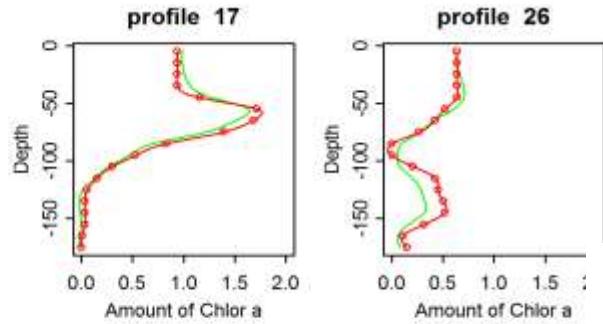
Highh resolution reconstruction of Chl-a field using light –fluorescence profiles



profile 3



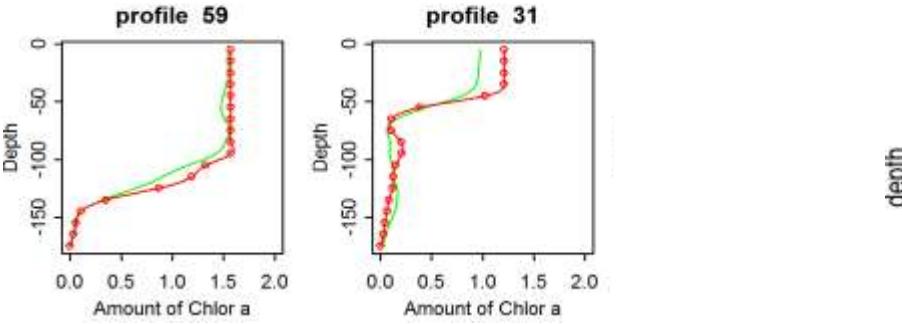
profile 17



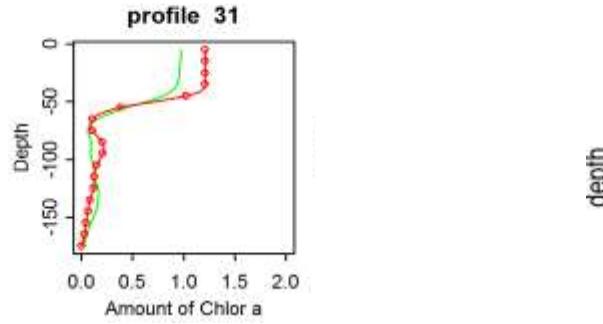
profile 26

— Chla- CTD-Fluo

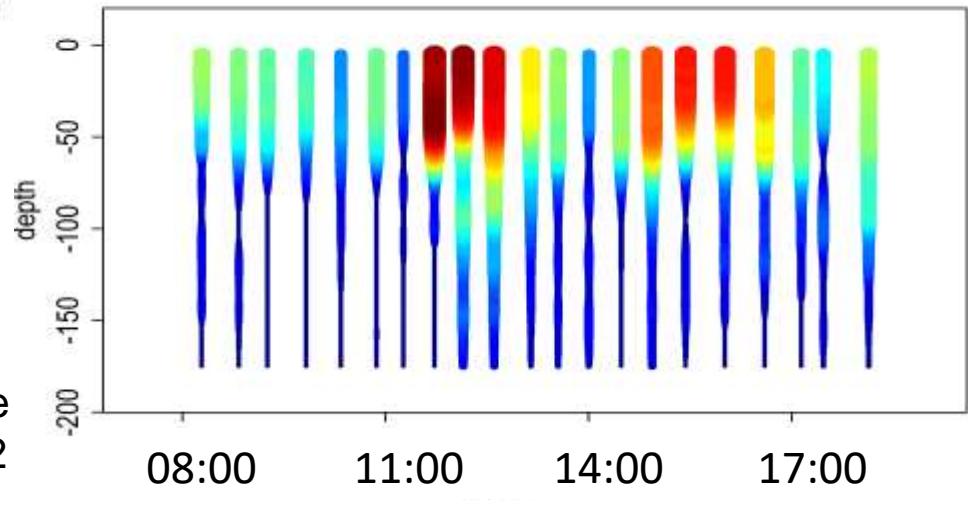
profile 59



profile 31



— Chla predicted from light attenuation



Light is easy and inexpensive to sample. One profile can be defined by 3 coefficient s and 2 values (transmission of more data through Argos)

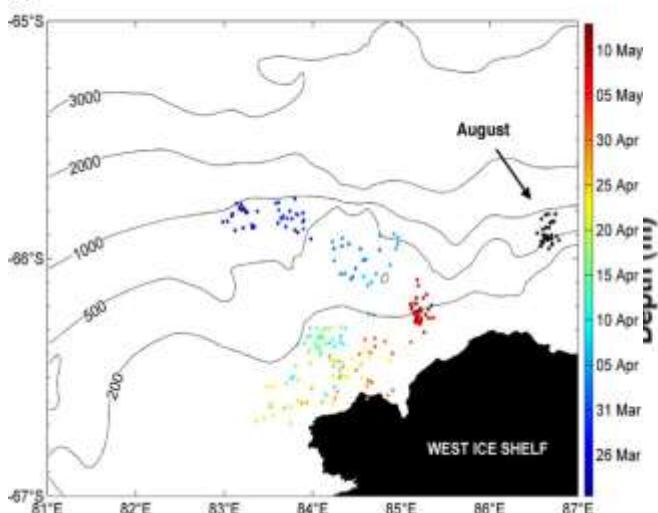
Bayle, et al. (2015) Moving toward finer scales in oceanography: predictive linear functional model of chlorophyll-a profile from light data Progress in Oceanography

Sea-Ice extent and thickness (CRYOSAT)

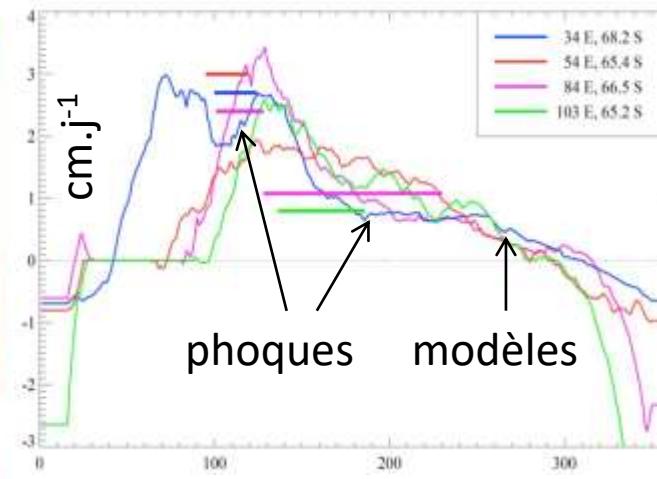
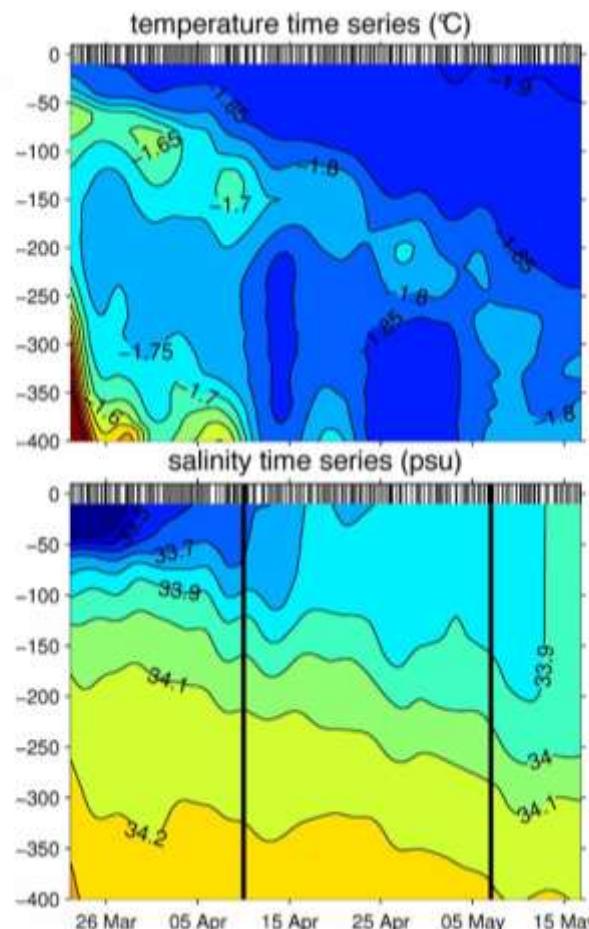


Estimation of the quantity of sea-ice produced:

A

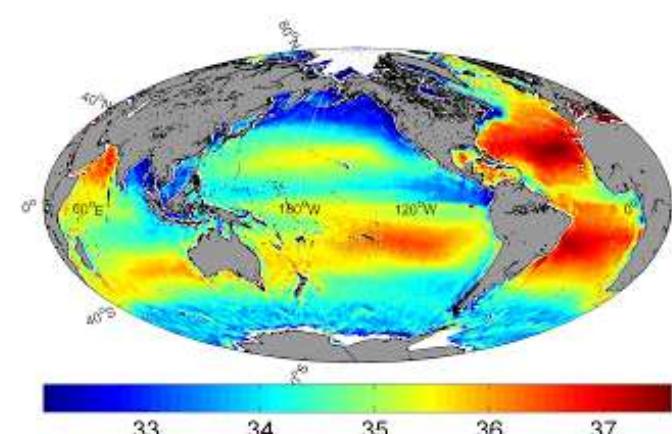


B

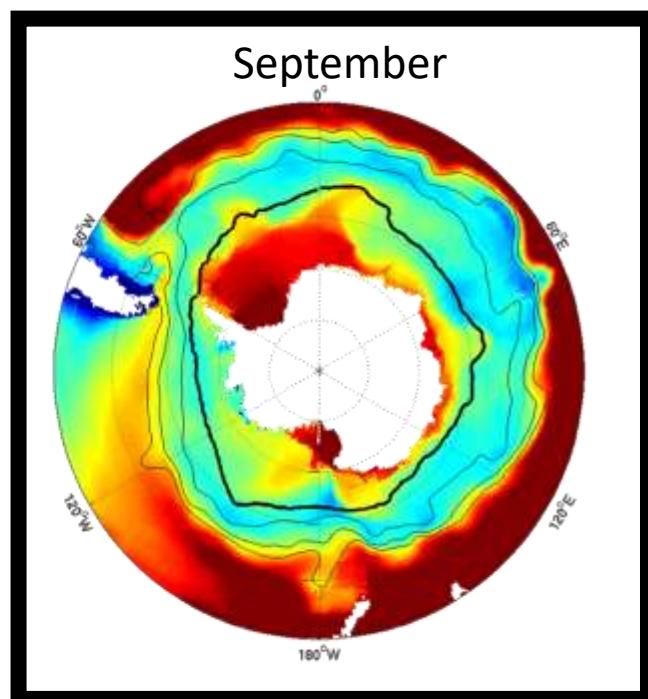
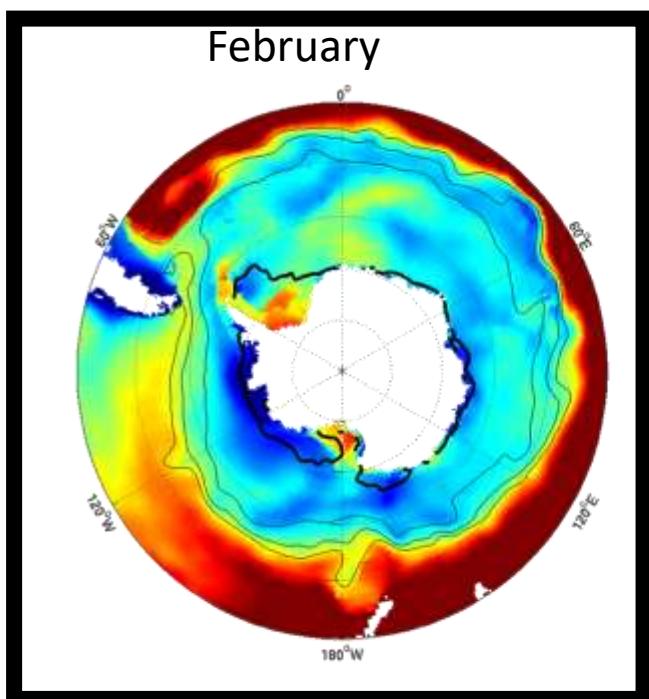


CHARRASSIN J.B., et al. (2008) Southern Ocean frontal structure and sea ice formation rates revealed by elephant seals. Proceedings of the National Academy of Sciences 105:11634-11639

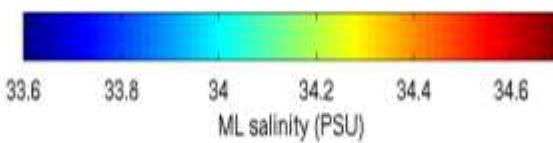
Ocean Salinity (SMOS)



Seasonal cycle of salinity of the mixed layer



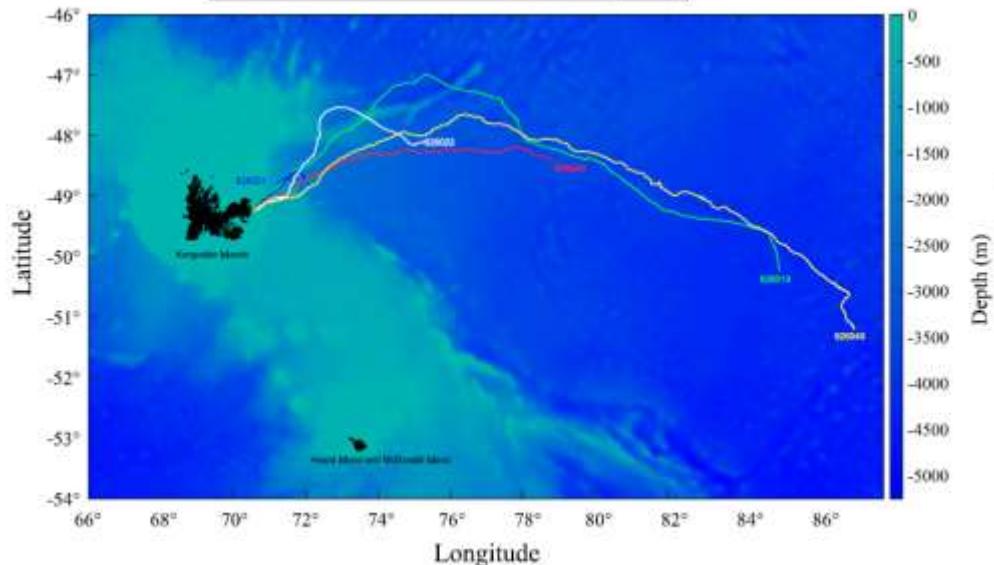
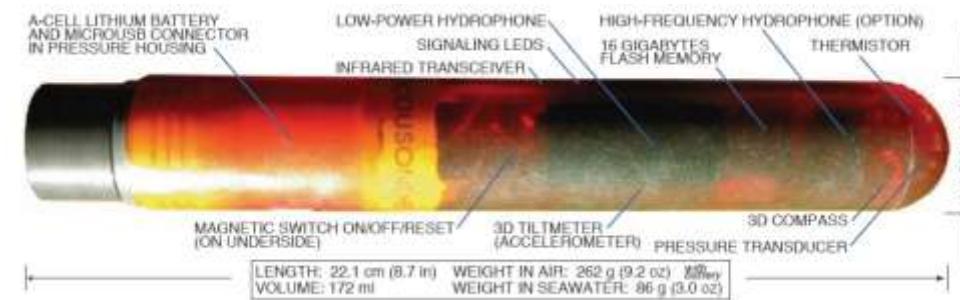
Pellichero, V., Sallée, J.B., Schmidtko, S., Roquet, F., Charrassin, J.B., 2016,
*The ocean mixed-layer under Southern Ocean sea-ice: seasonal cycle and
forcing, JGR*



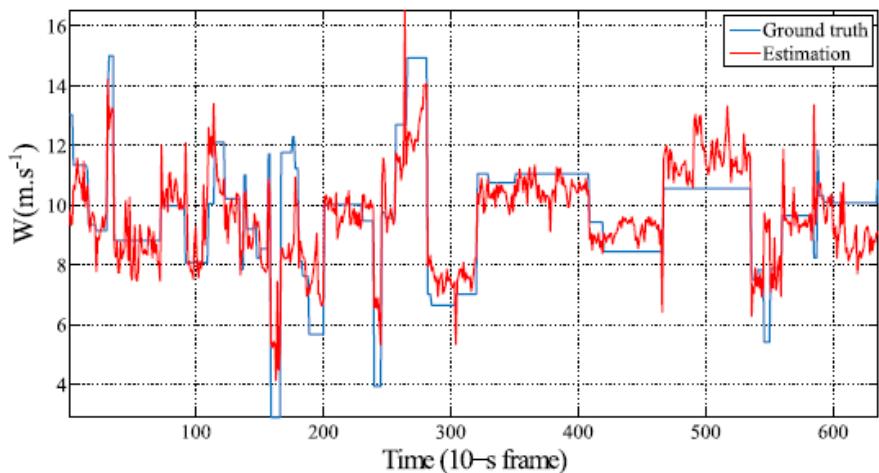
Sea-state (waves) and wind (CFOSAT-2018)



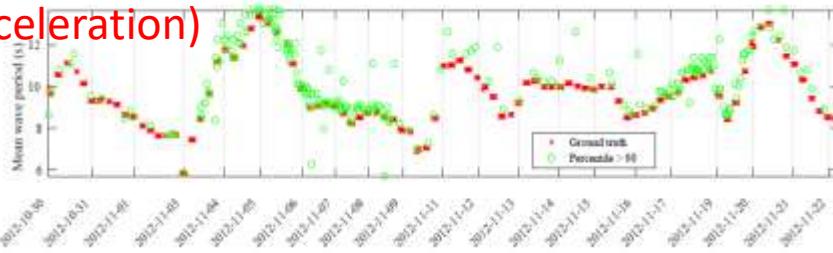
Acousonde



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



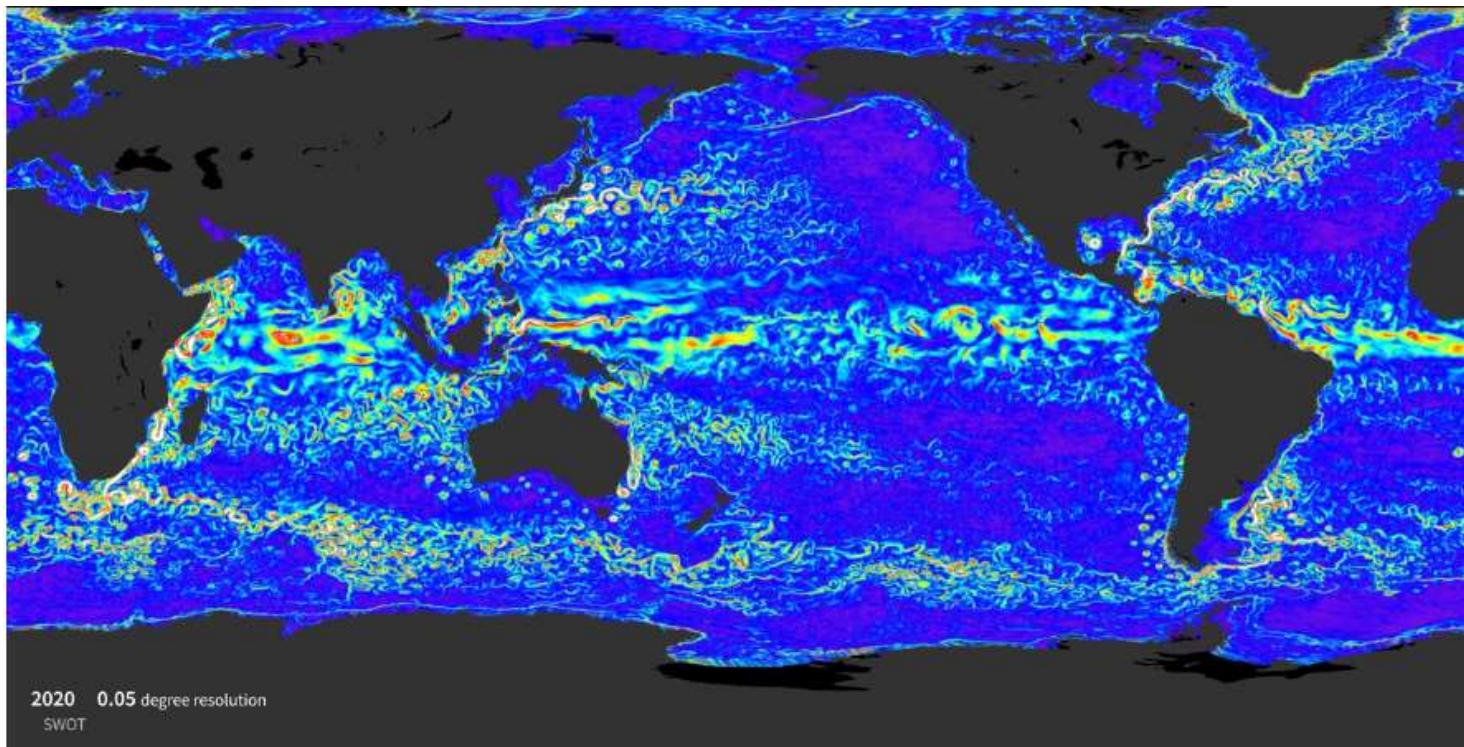
Waves frequency and amplitudes
(acceleration)



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 et al. in revision.

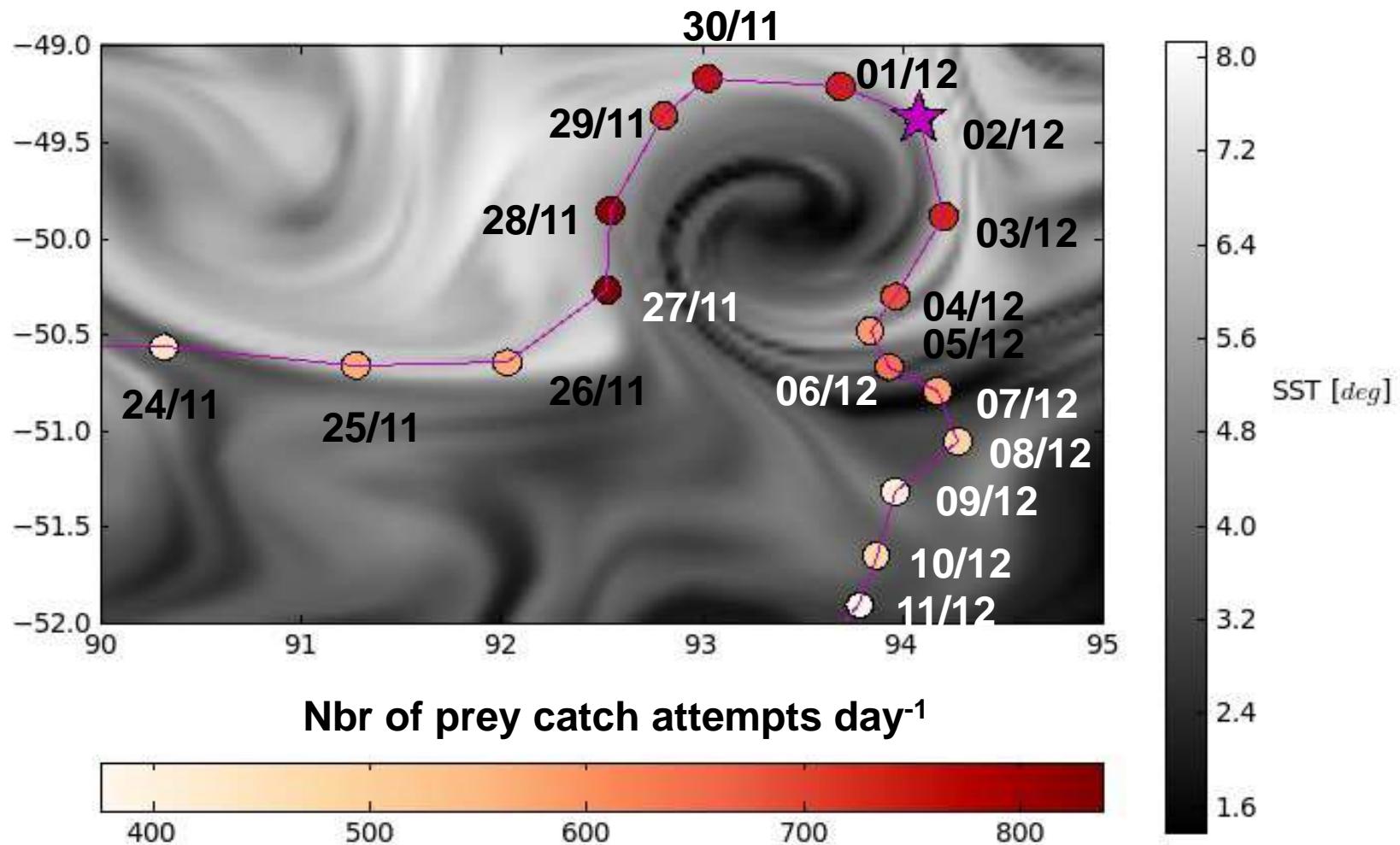
Measur the surface topography of
the ocean (sea height)
(JASON, SARAL, SWOT-2020)

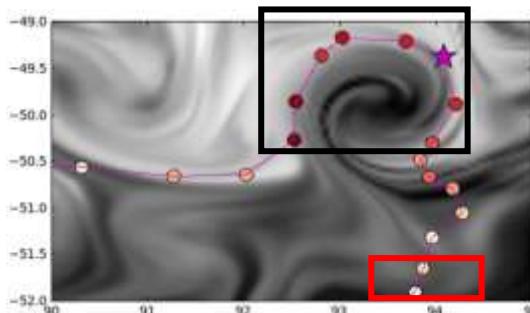


Mesocale Turbulence

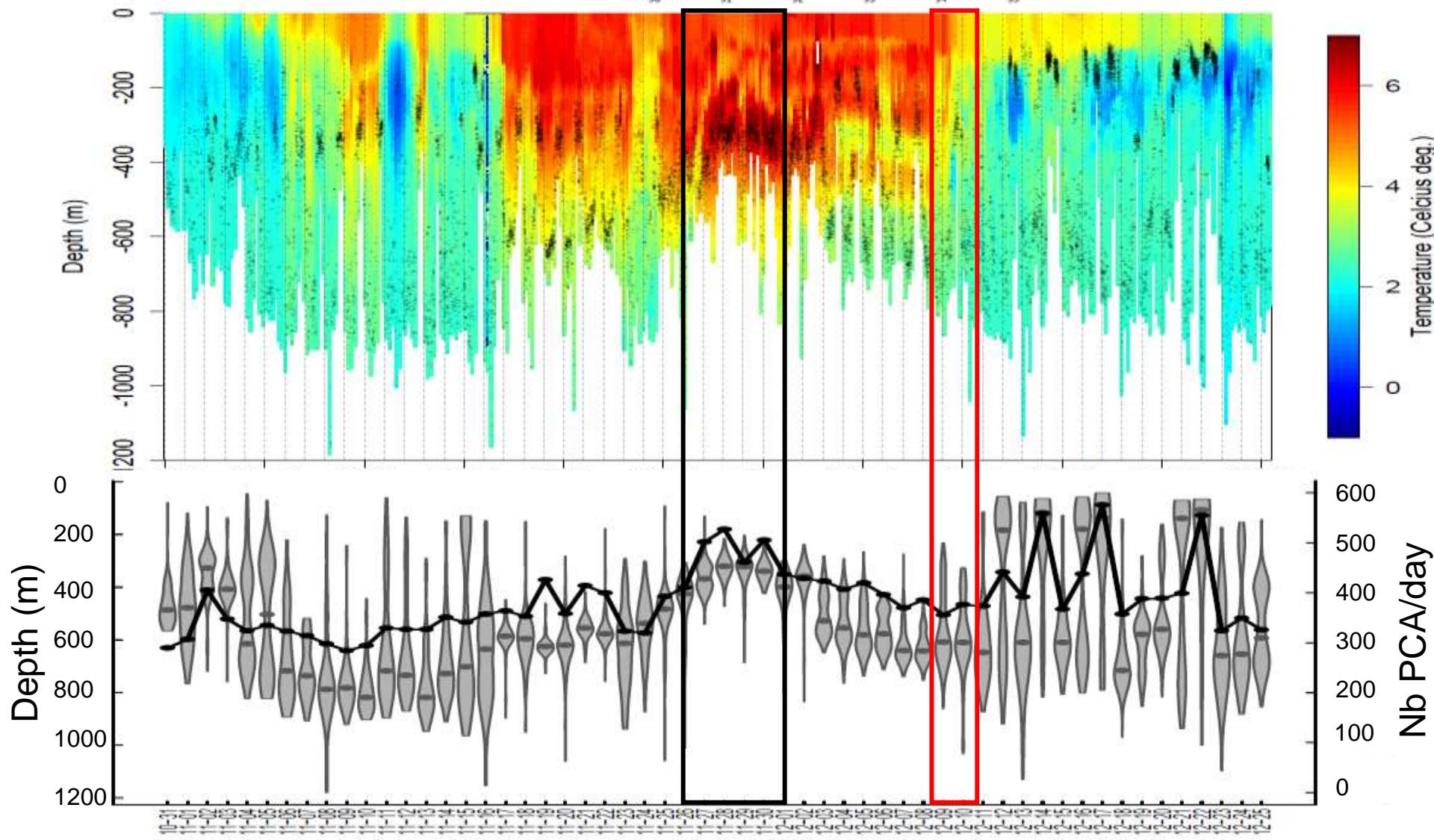
Develop new approaches and tools at the interface between physical oceanography and marine ecology

Structuring effect of oceanographic conditions on biological fields : from phytoplankton to mesopelagic resources





Yves LeBras, thèse

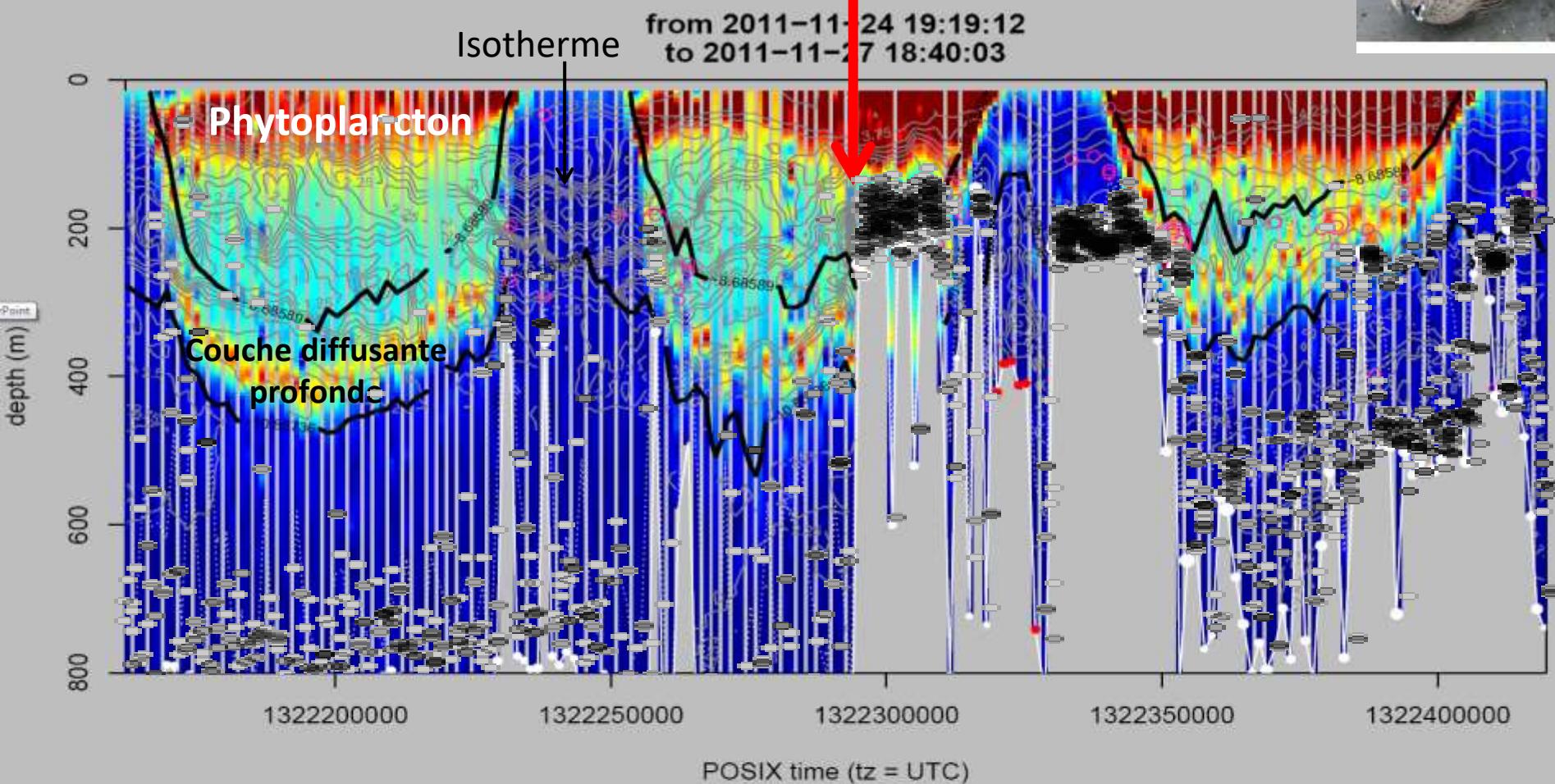


Processus physiques structurant les champs de ressources biologique à fine échelle



FRONT

Tentatives
captures de proies



Stratégie de chasse selon distribution des proies et variables physique/biotiques



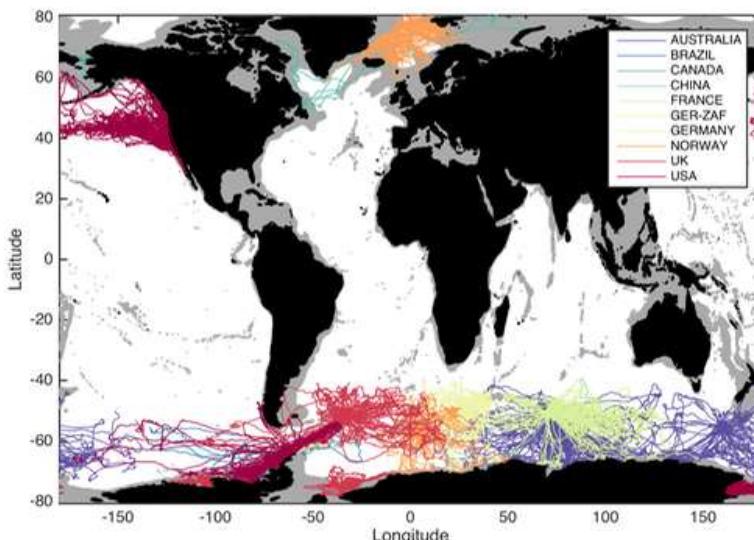
Marine Mammals Exploring the Oceans Pole to Pole

When diving animals help us to observe the oceans

Some marine mammals travel thousands of kilometres to find their food, continuously diving to great depths. By instrumenting them, it is possible to directly observe their foraging behaviour. Simultaneously, we collect unique oceanographic data in the remote Polar regions.

The [MEOP consortium](#) (MEOP stands for "Marine Mammals Exploring the Oceans Pole to Pole") brings together several national programmes to produce a comprehensive quality-controlled database of oceanographic data obtained in Polar Regions from instrumented marine mammals.

MEOP-CTD dataset : 329565 profiles, 104 deployments, 772 tags



*World map showing the distribution of CTD profiles (i.e. vertical profiles of temperature and salinity) currently available in the MEOP-CTD database.
More information on the [data distribution](#) can be found on this website.*

The MEOP data portal



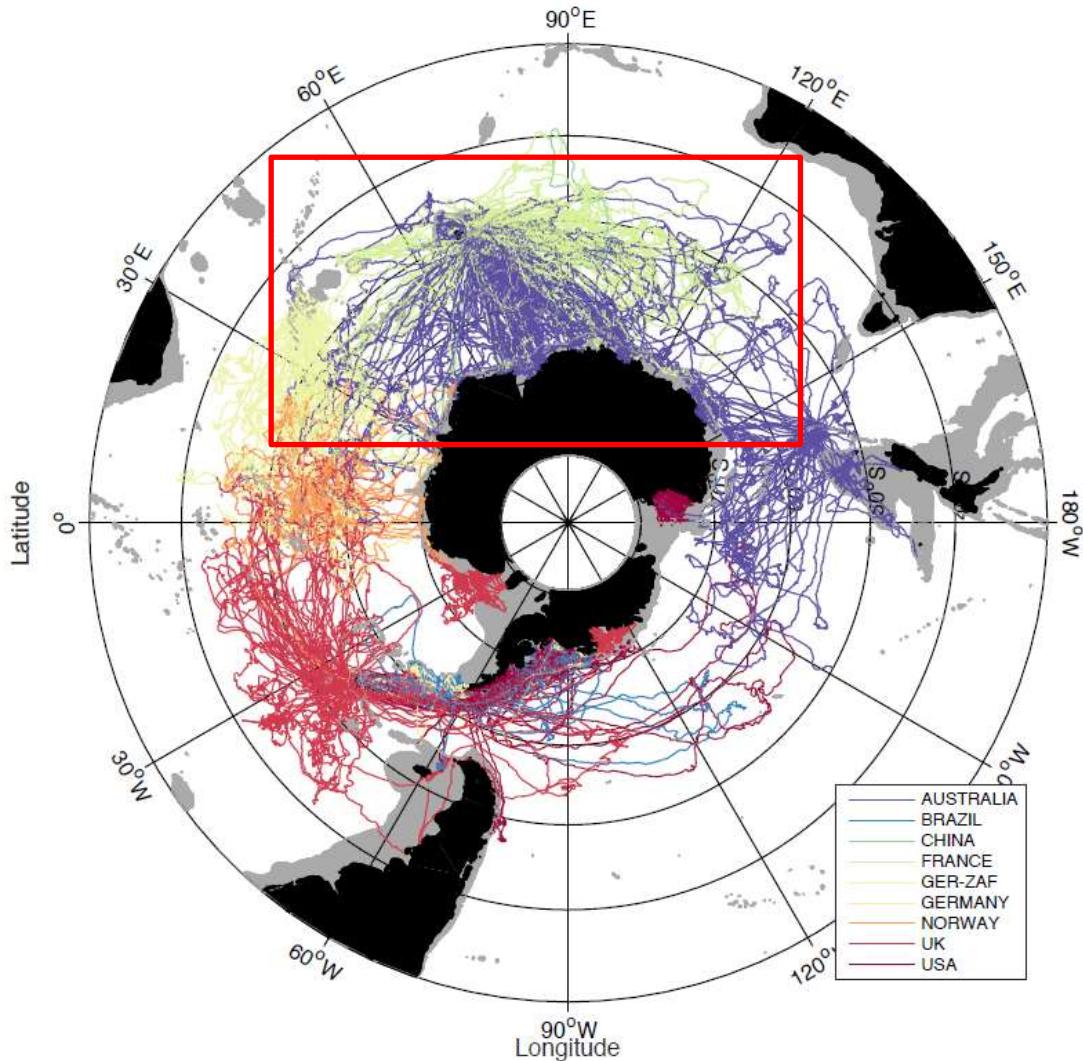
Over [300,000](#) vertical profiles of Temperature and Salinity have been collected since 2004 in the World Ocean by attaching tags on marine mammals, such as Southern elephant seals.

In this website, you will find information about the marine mammal tagging programs, and an access point to the publicly available [MEOP-CTD database](#).

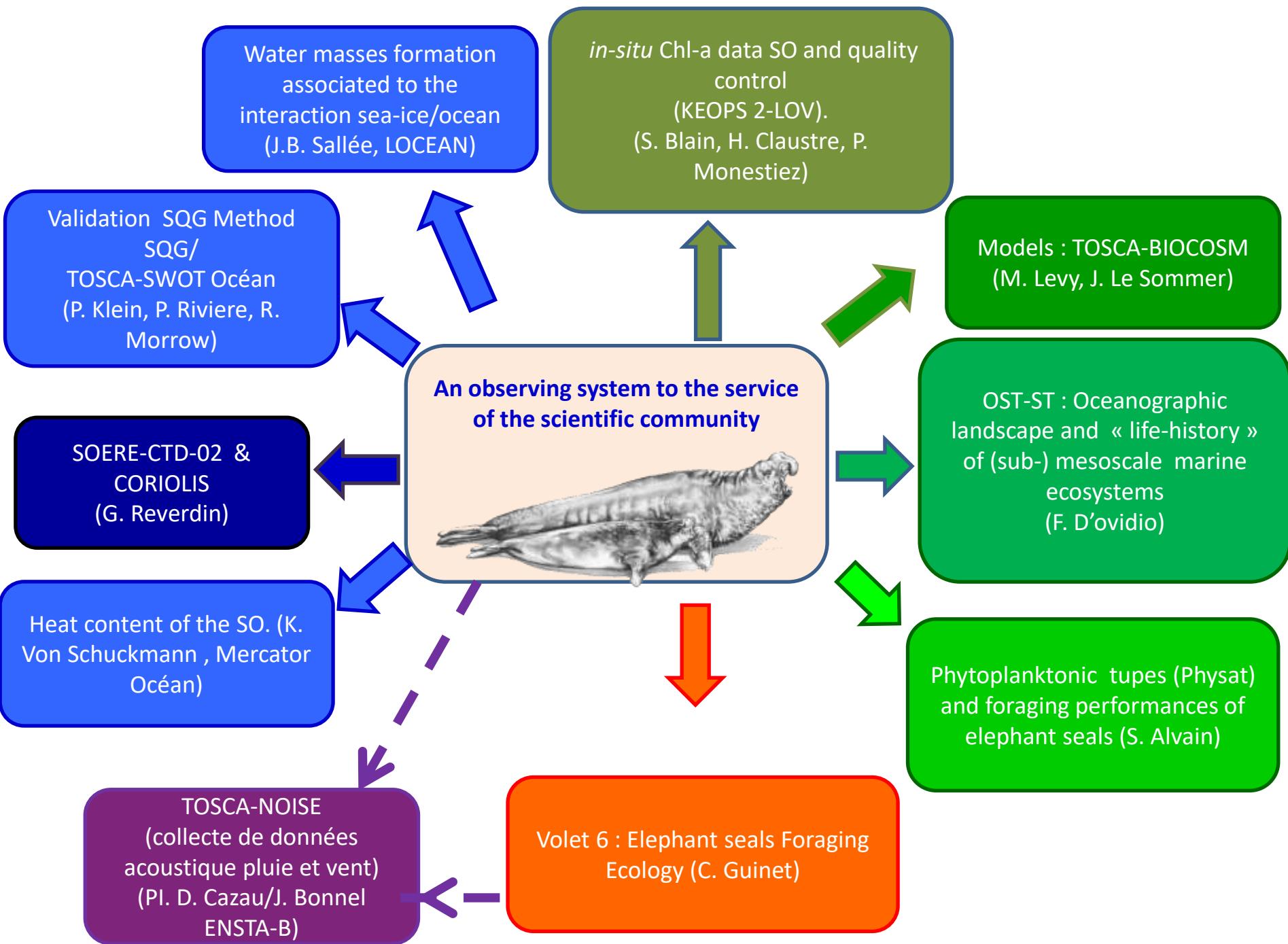
Please let us know if you are using our data. Send us your [contact information](#) if you want to subscribe to the newsletter. And don't hesitate to contact us (mail to info@meop.net) if you have any question !!

- Le MEOP gateway in numbers
- 10 Nations : South Africa, Australia, Brasil, Canada, China, Germany, Great Britain, France, Norway, United States.
- 19 Projects
- **517 429** profiles T/S (1197 tags) available to the scientific community

France-(Australia) : the only continuous time series available since 2004 for the Indian sector of the SO.



www.meop.net



Authier Matthieu (CEBC), Bailleul Frédéric (CEBC), Bataile Brian (MMRU-UBC), Bessineul Guillaume (CEBC), Blain Stéphane (LOB-UPMC), Bost Charles André (CEBC), 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), Jooma 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), Vivant Morgane (CEBC), Vacquié Garcia Jade (CEBC), Xing Xiaogang (LOV-UPMC), Weimerskirch Henri (CEBC).



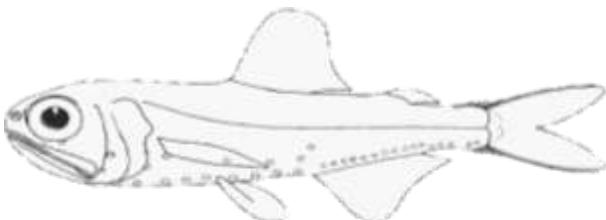
Questions?

<http://biology.st-andrews.ac.uk/seaos/>
<http://www.annee-polaire.fr/api/MEOP/>
<http://www.cebc.cnrs.fr/>

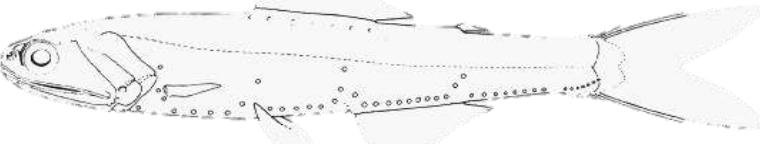
Les femelles éléphant de mer sont de gros prédateurs de ressources mésopélagiques (Poissons lanternes)



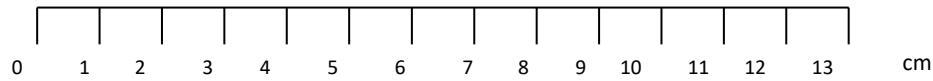
Electrona antarctica (74 mm)



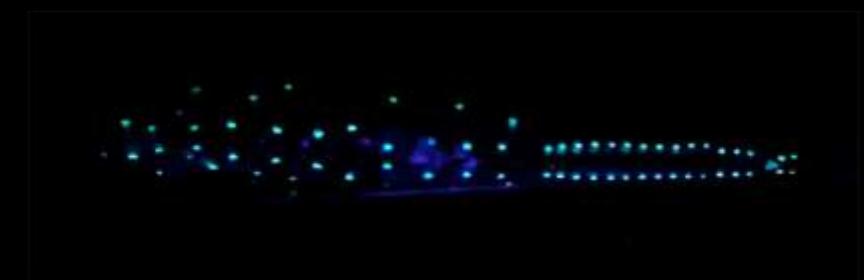
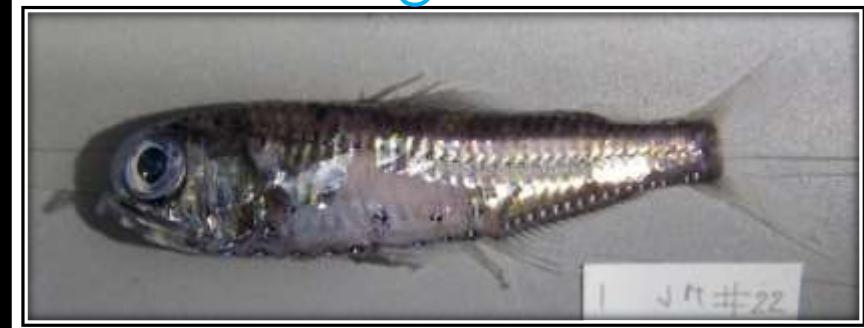
Electrona carlsbergi (95 mm)



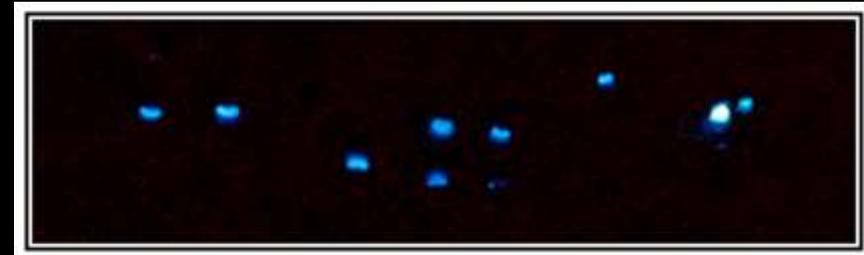
Gymnoscopelus nicholsi (125 mm)



Electrona carlsbergi



Fluorescence



Bioluminescence