LAECOS
Lagrangian altimetry for open ocean environmental applications

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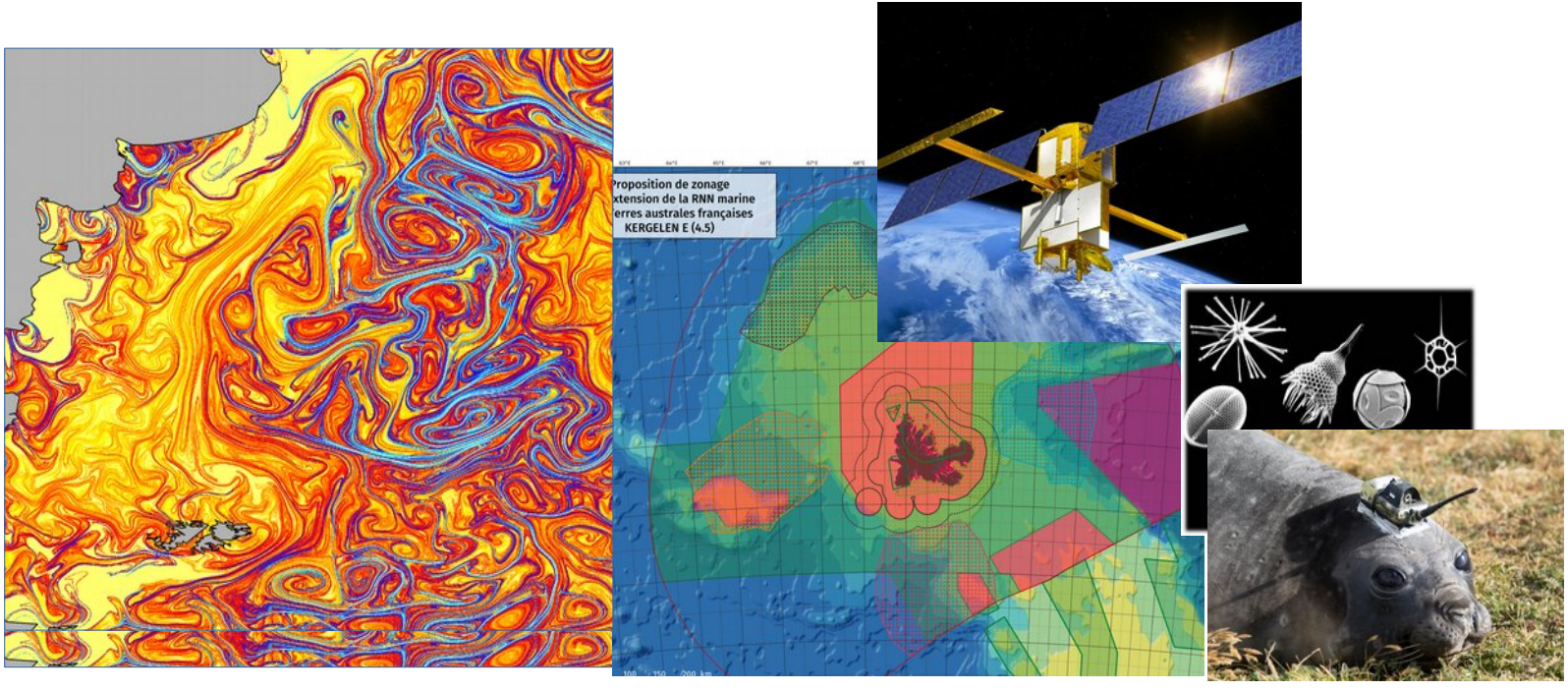


OSTST 2020
Virtual Meeting

Lagrangian dynamics and satellite altimetry

Lagrangian tools compute statistics along particle trajectories. They:

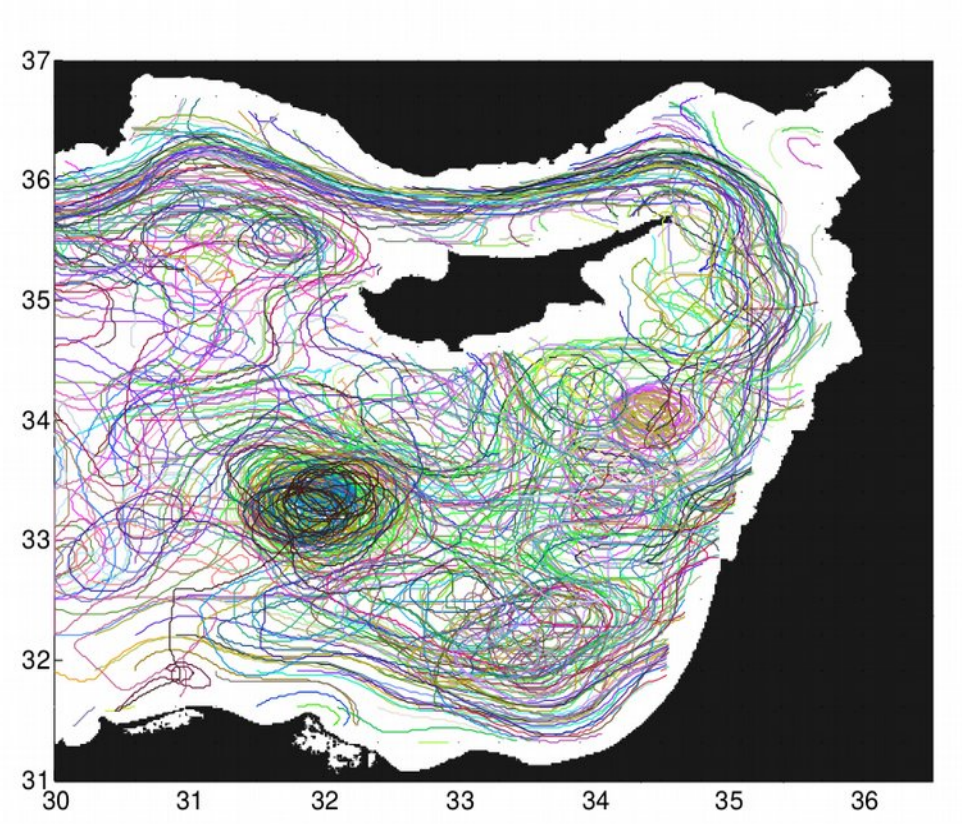
- summarize transport properties (regions with strong mixing vs. retention)
- link the velocity field to tracer fields (e.g., chlorophyll, contaminants, drifters..)

Interest for:

- Use of tracer information for CalVal
- Impact of physics on biogeochemistry and ecology
- Applications for contaminant dispersion: **see OSTST presentation by G. Fifani**

From trajectories to Lagrangian diagnostics

Just computing trajectories from altimetry is easy, but results in the so-called “spaghetti diagram”. Lagrangian diagnostics synthesize this information in more meaningful pictures.



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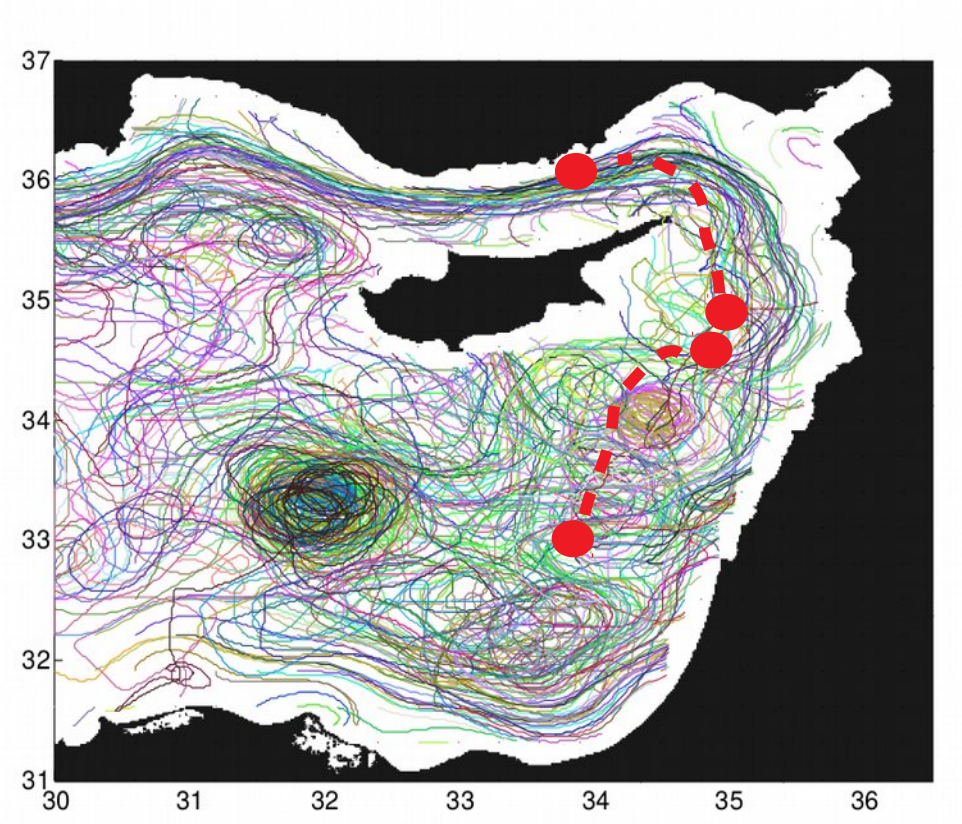
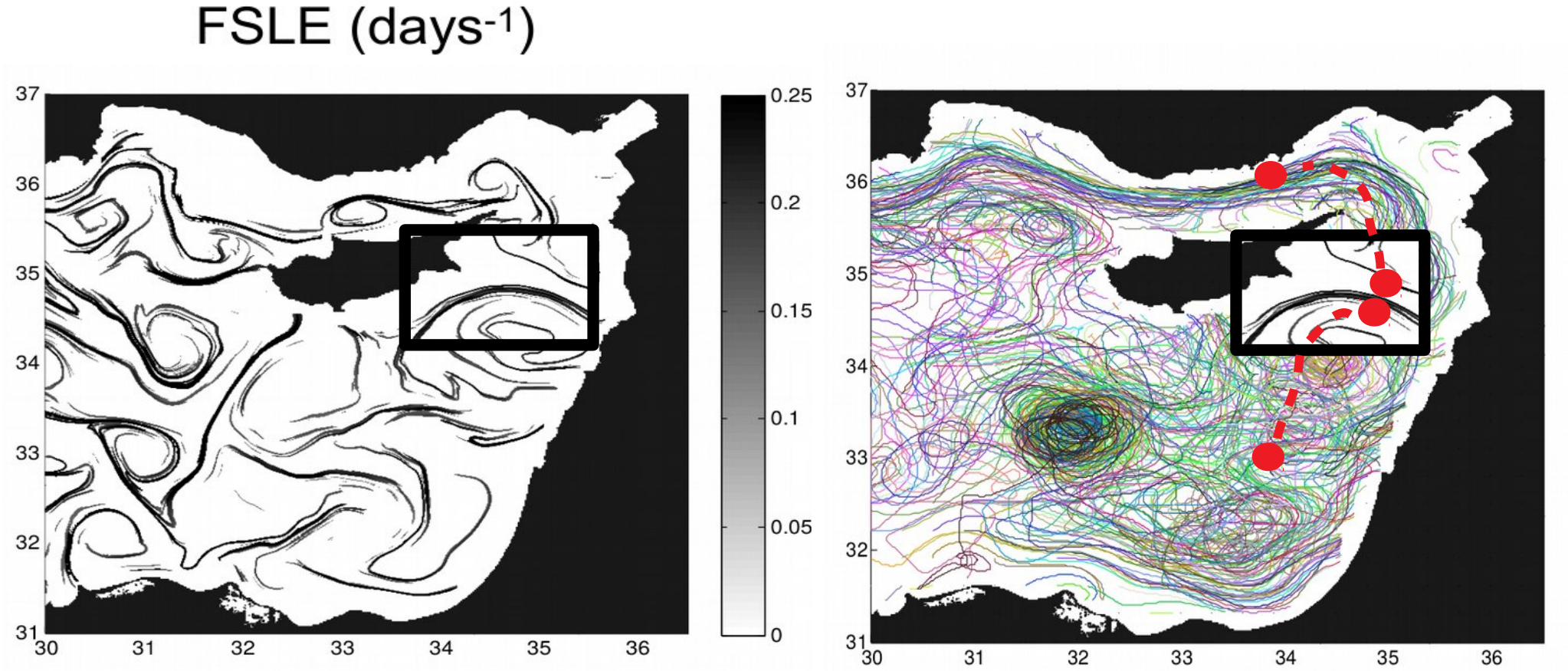
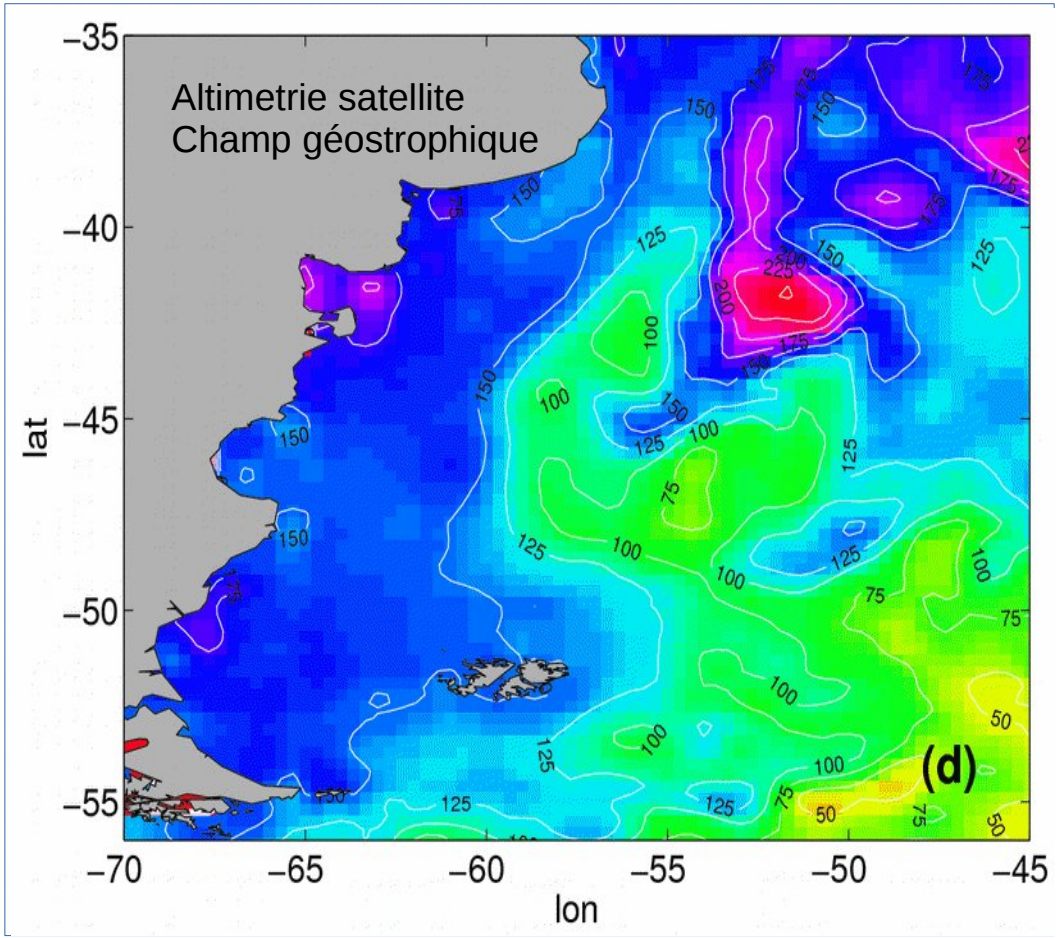
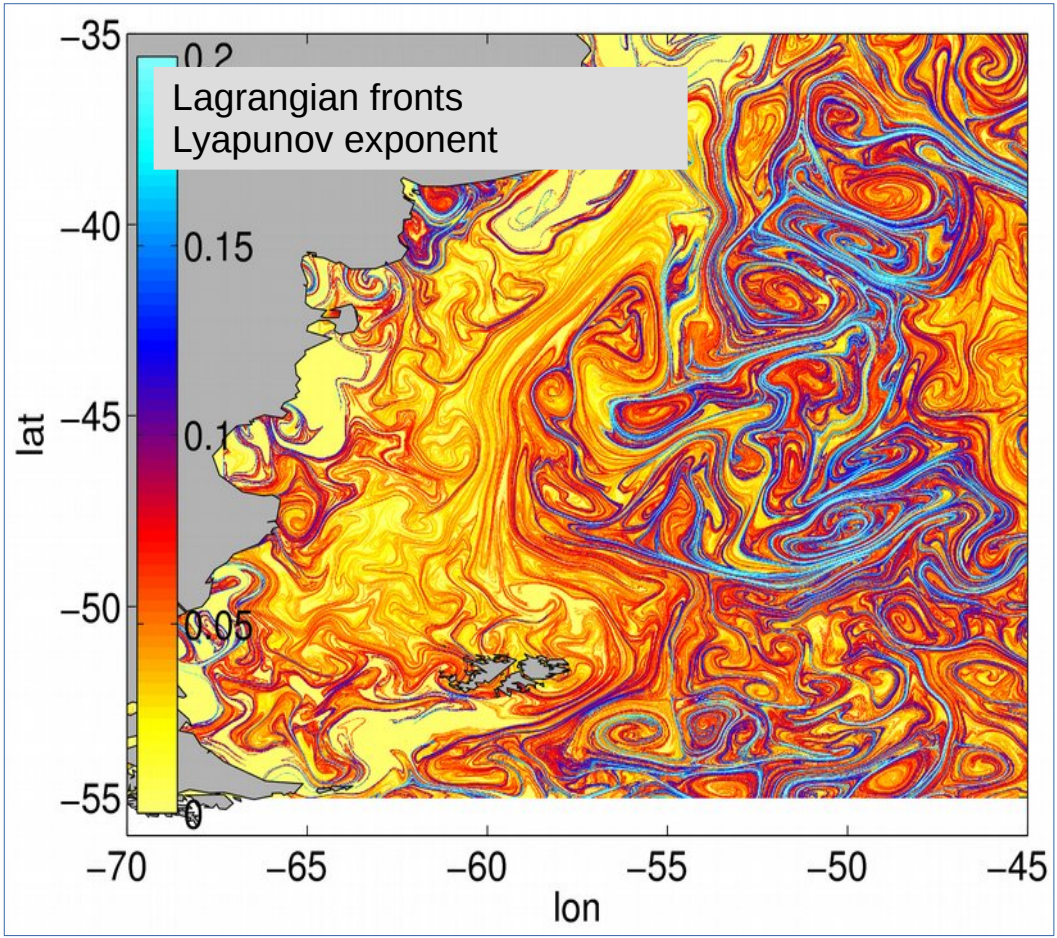


Finite-size Lyapunov Exponent



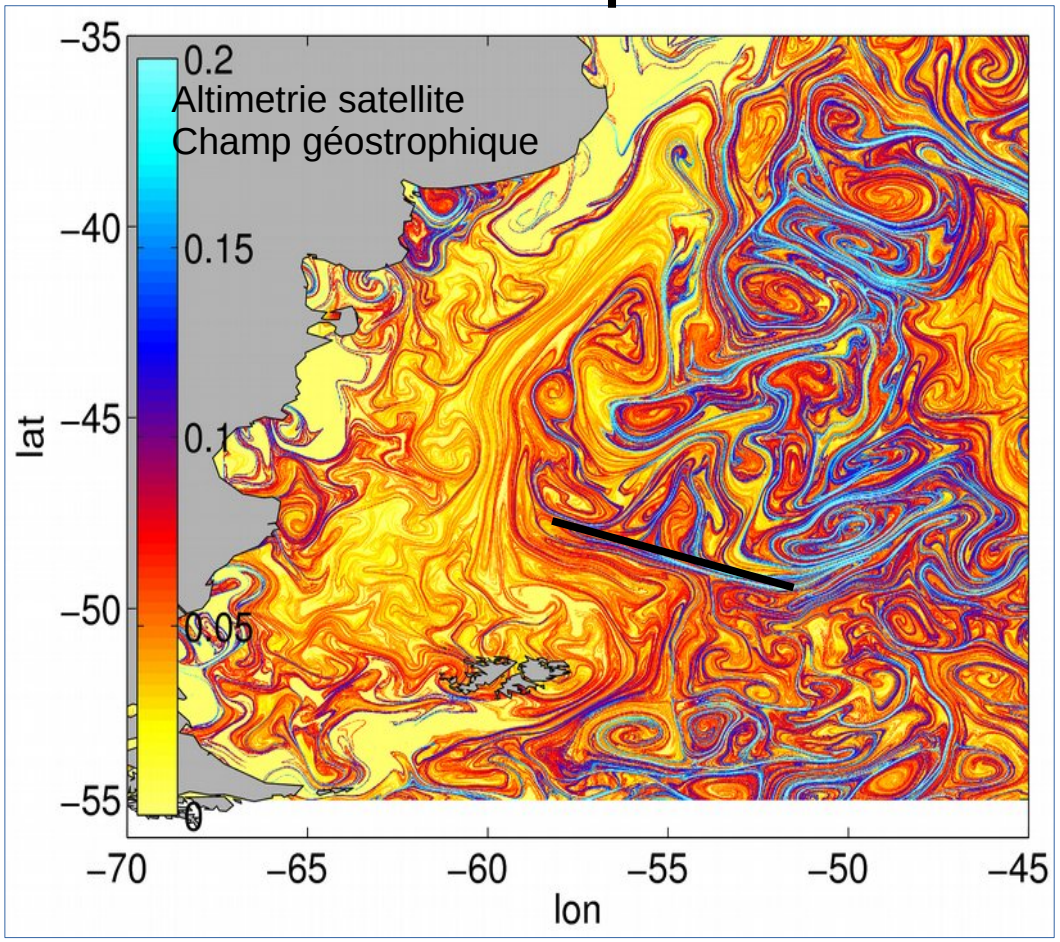
Example: Lyapunov exponents

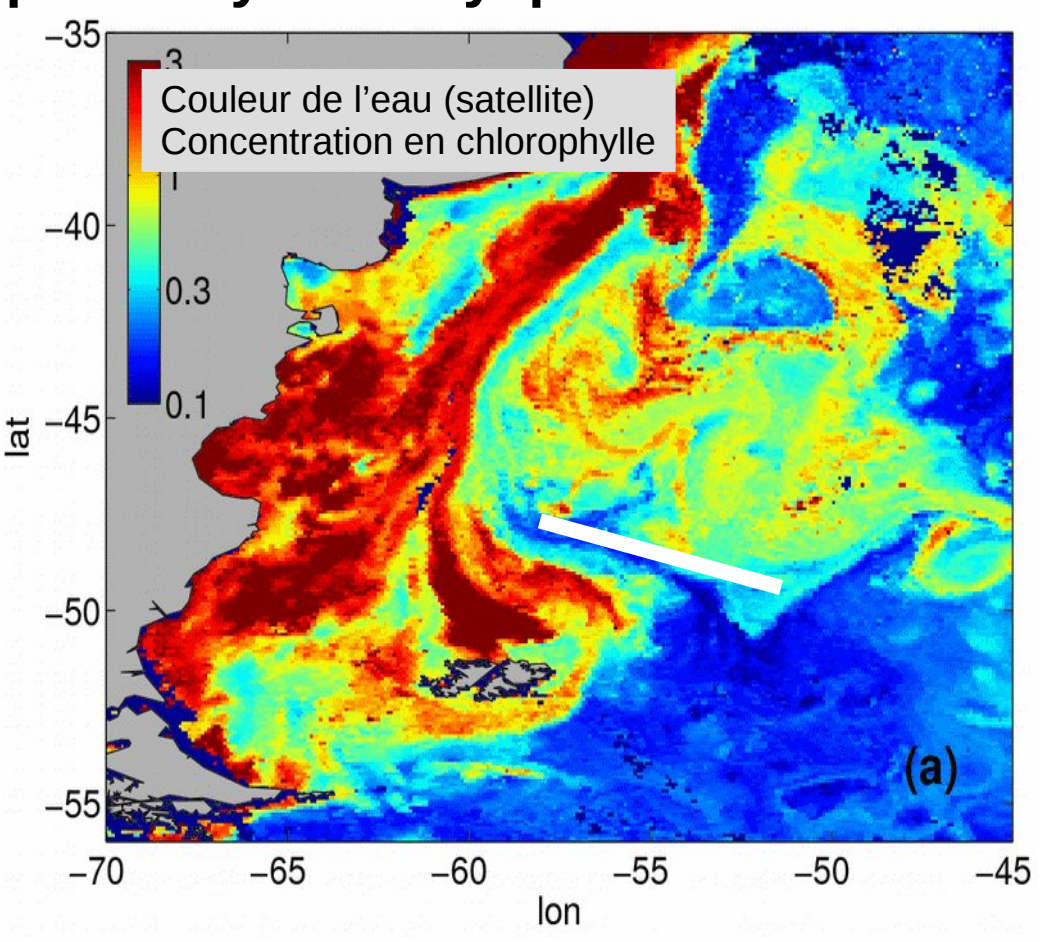




Altimetry-derived Lyapunov exponents provide fronts which separate water masses with different physical and biological characteristics. Their resolution is higher than altimetry maps.

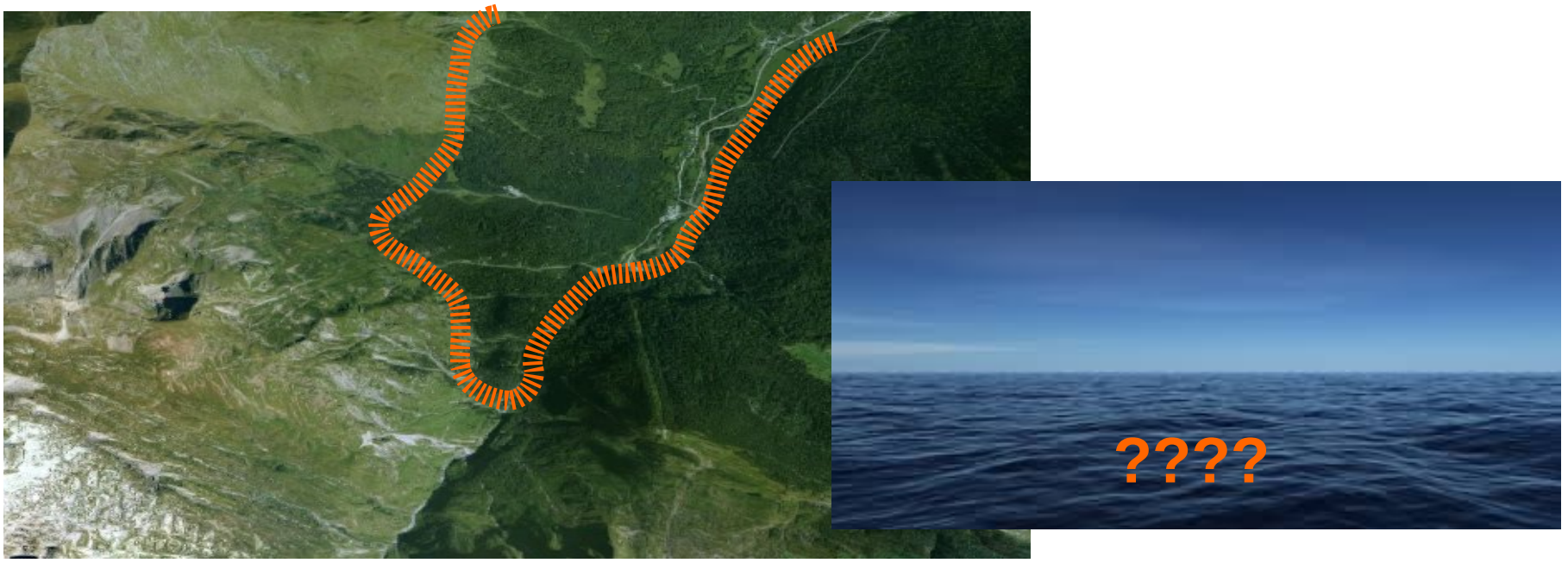
Exemple: Fine echelle par analyse de Lyapunov



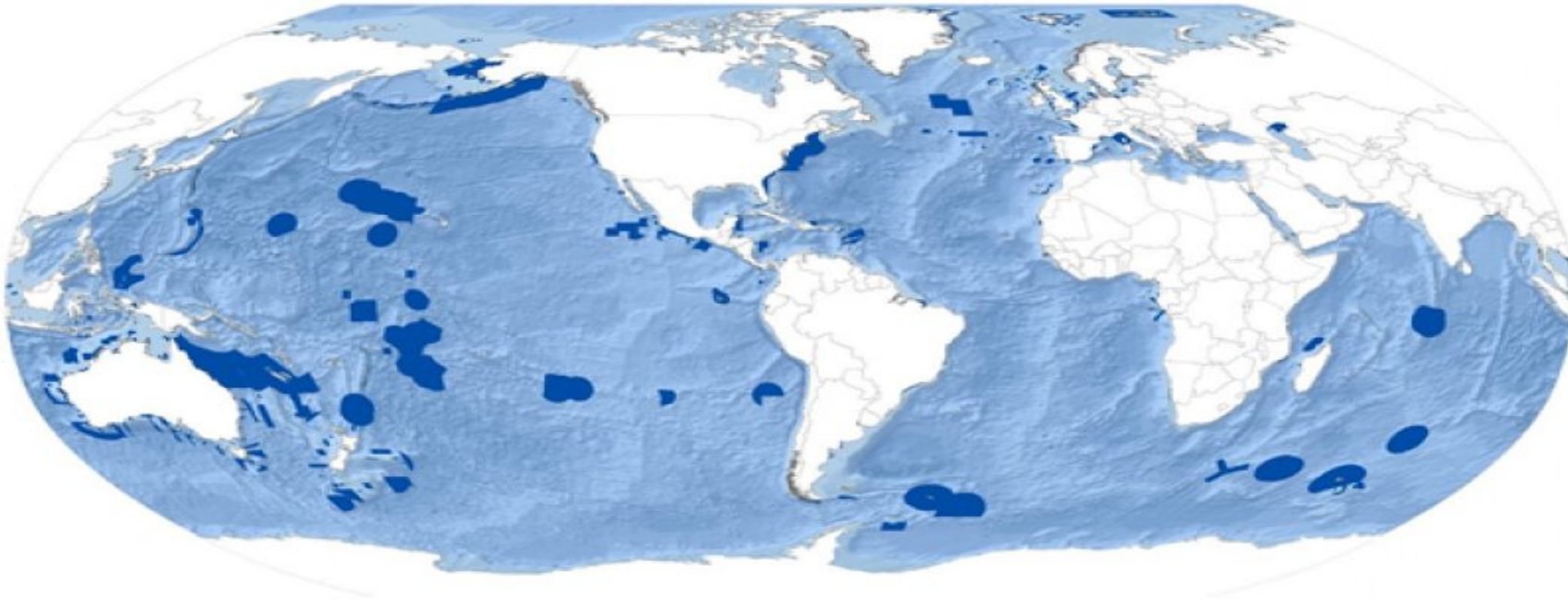


Fronts derived by Lagrangian altimetry are useful to interpret biophysical mechanisms, like in this case chlorophyll pattern formation.

Lagrangian diagnostics like the Lyapunov exponents can be seen as the analogous of physical boundaries on land



Lagrangian altimetry and open ocean Marine Protected Areas

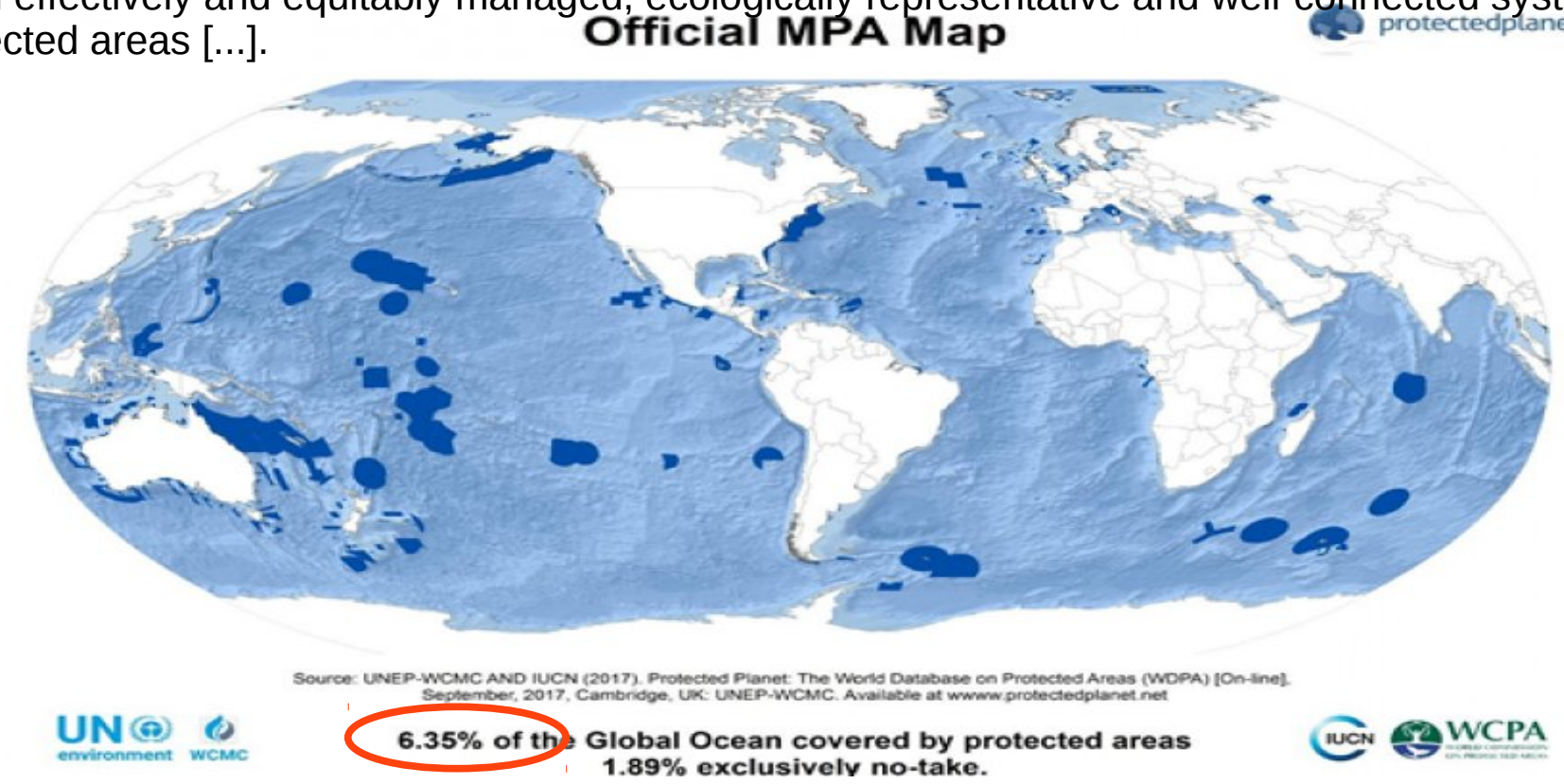


One interest in identifying boundaries in the ocean is for biogeographical studies, in support to the growing conservation actions around the world ocean.

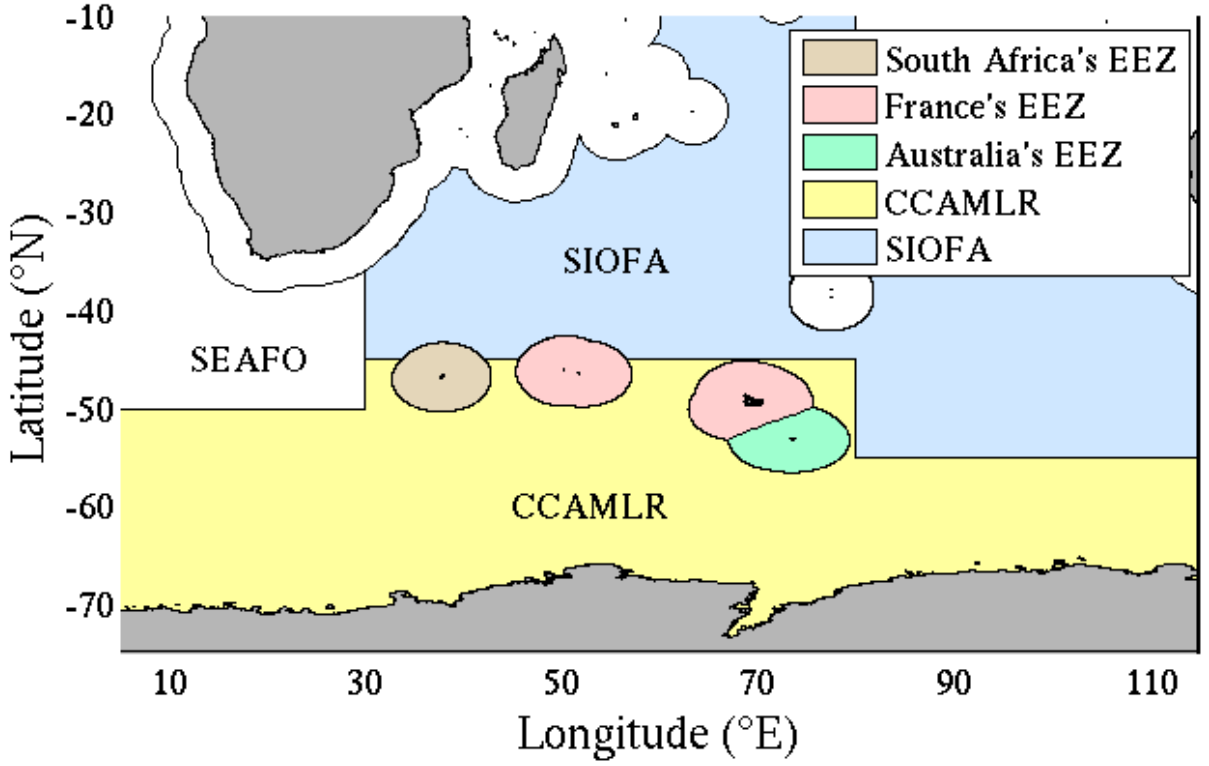
Political framework

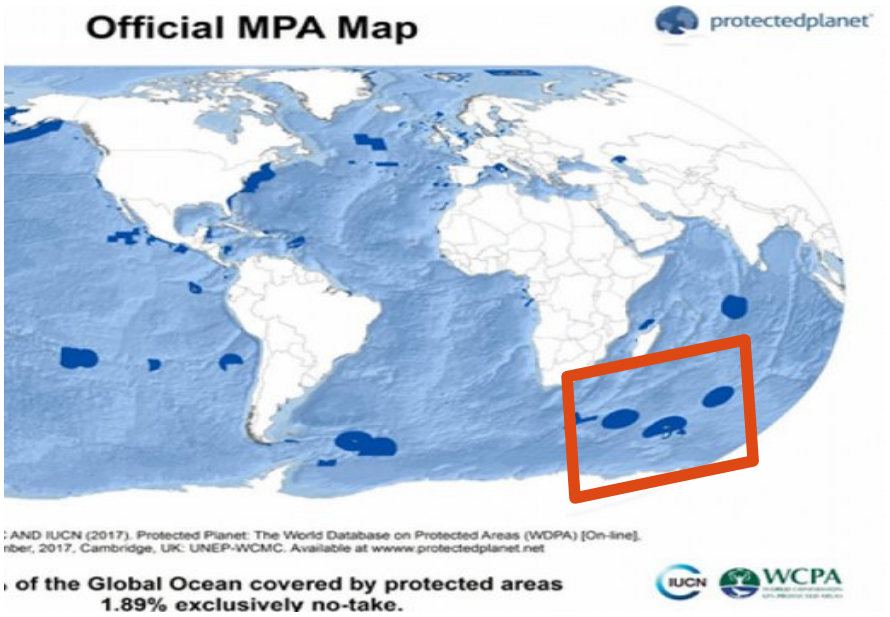
1992 Convention on Biological Diversity (Rio “Earth Summit”)

Aichi Target 11: By 2020, at least [...] **10 per cent** of coastal and marine areas [...] are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas [...].

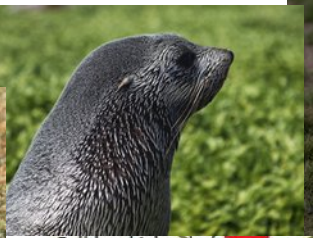


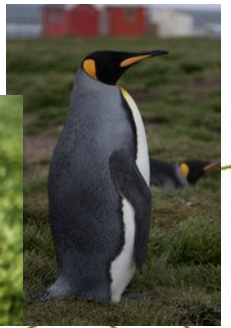
Our study region

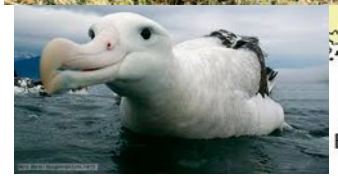




Images: © E. Pauthenet







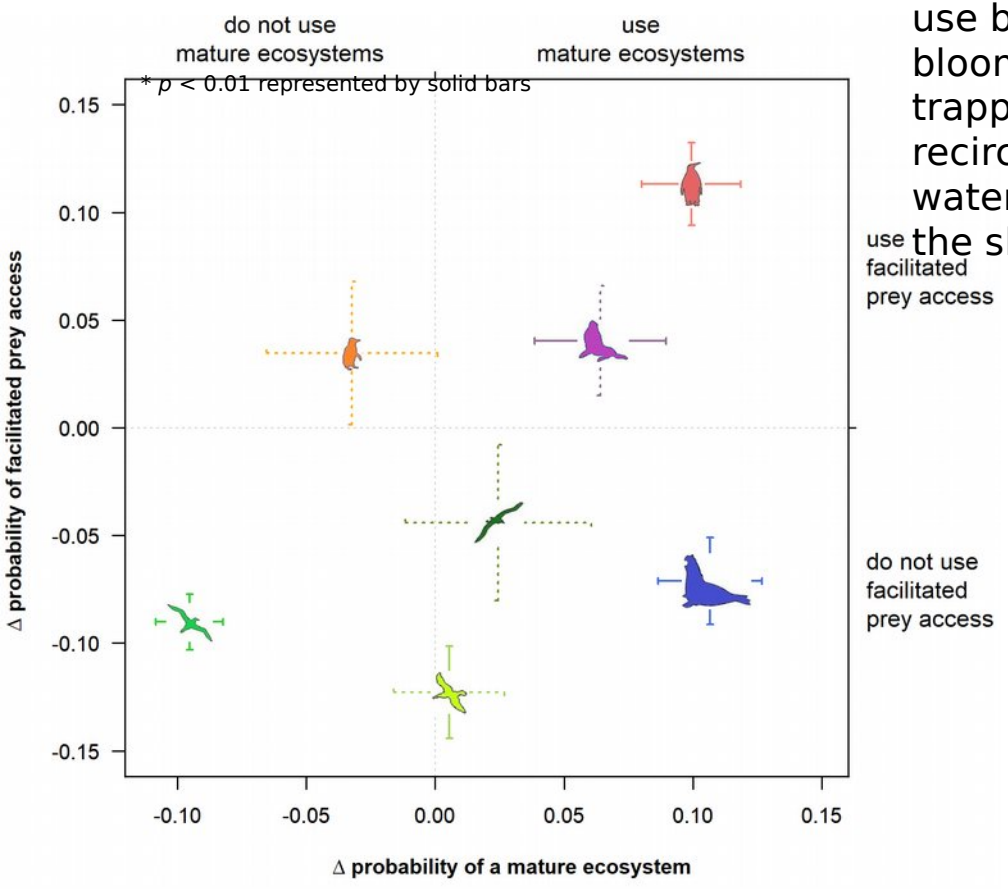
The Southern Ocean presents a special interest for conservation, due to the co-existence of large population of endangered species, profitable fisheries, and a legal framework for decision making.

Anticipate commercial mesopelagic fish exploitation

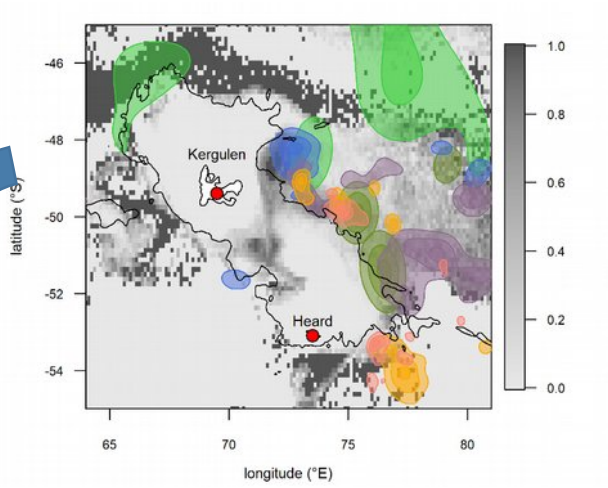
Future ?

One question that we addressed has been the identification of foraging grounds for species feeding on *Myctophidae sp.*, very abundant fish of few cm long which constitutes an immense and yet untapped reserve of proteins and lipids in the open ocean. This fish is the diet of many endangered species and one day may become a commercial fishery.

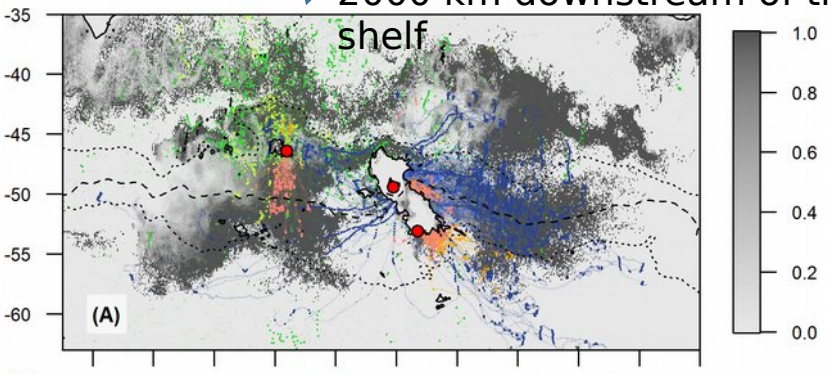
We have crossed altimetry-derived Lagrangian structures with the trajectories of many different species and with patterns of phytoplankton blooms



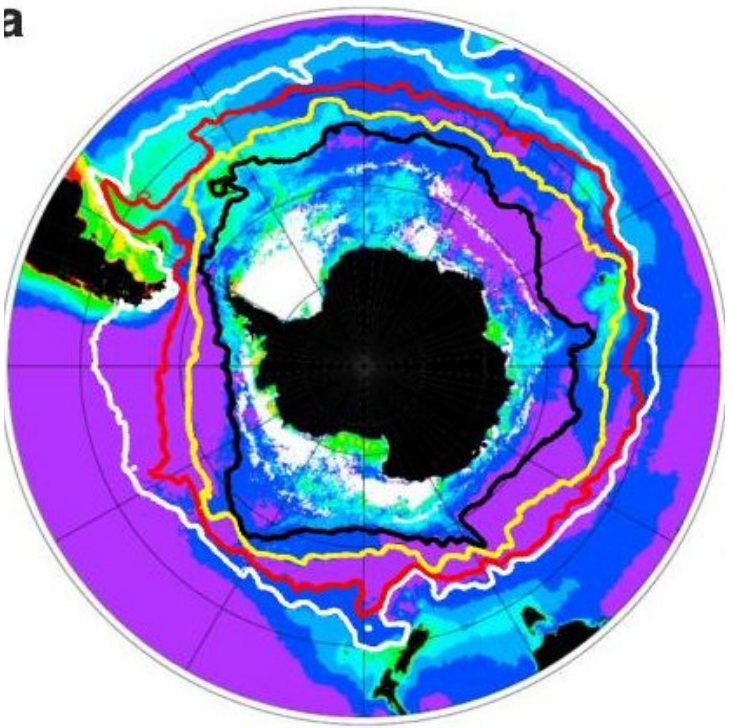
elephant seals use both post-bloom waters trapped in recirculated waters close to the shelf..

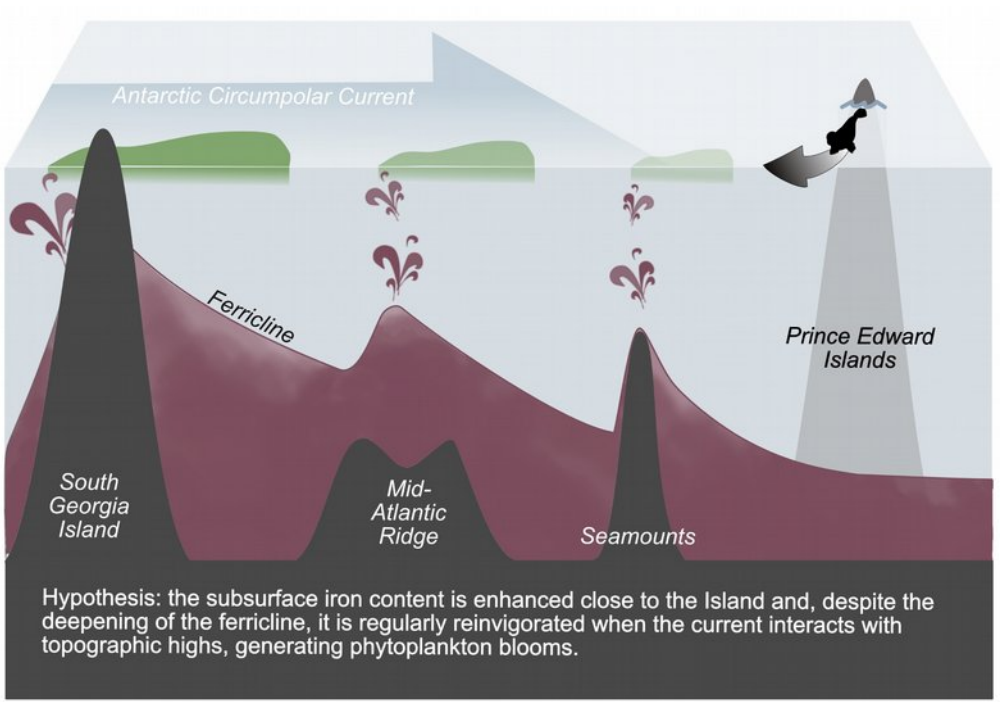


... and post-bloom waters 2000 km downstream of the shelf



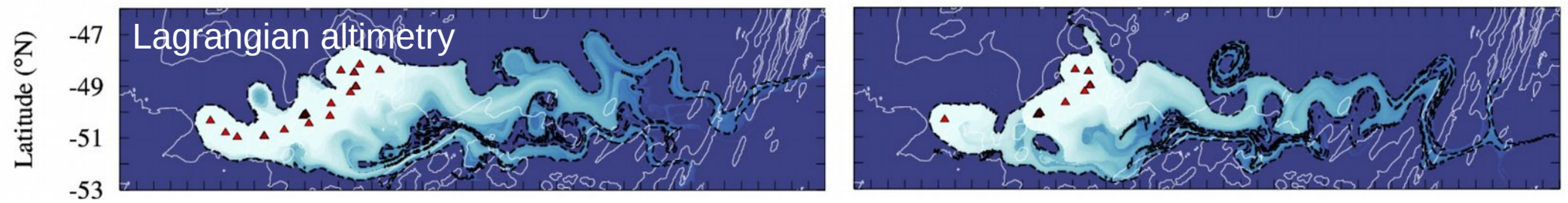
Some results for 2020: the biogeochemical role of seamounts on plankton blooms along the Antarctic Circumpolar Current.





Sergi et al. (2020) Frontiers in Marine Sciences.

Prediction of open ocean planktonic blooms initiated by seamounts



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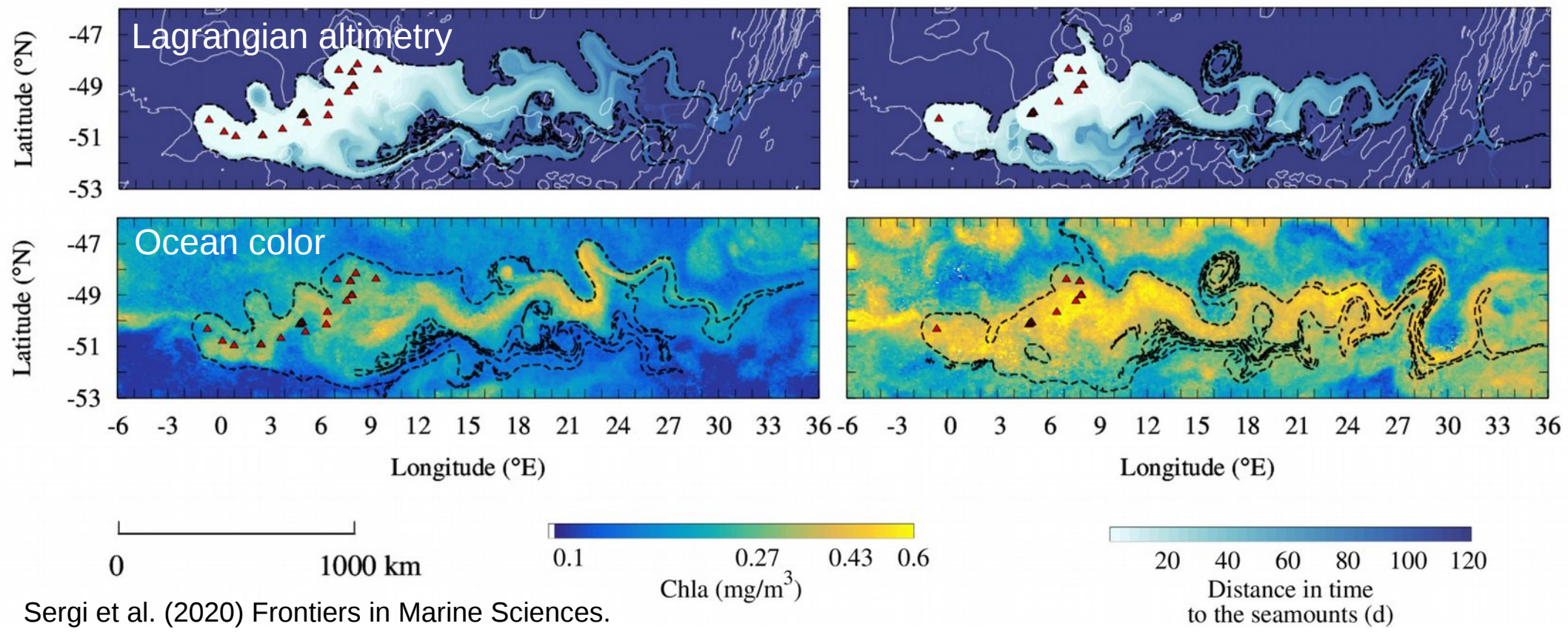


Sergi et al. (2020) Frontiers in Marine Sciences.

We have identified a similar mechanism for hydrothermal vents.

nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-019-09973-6 OPEN

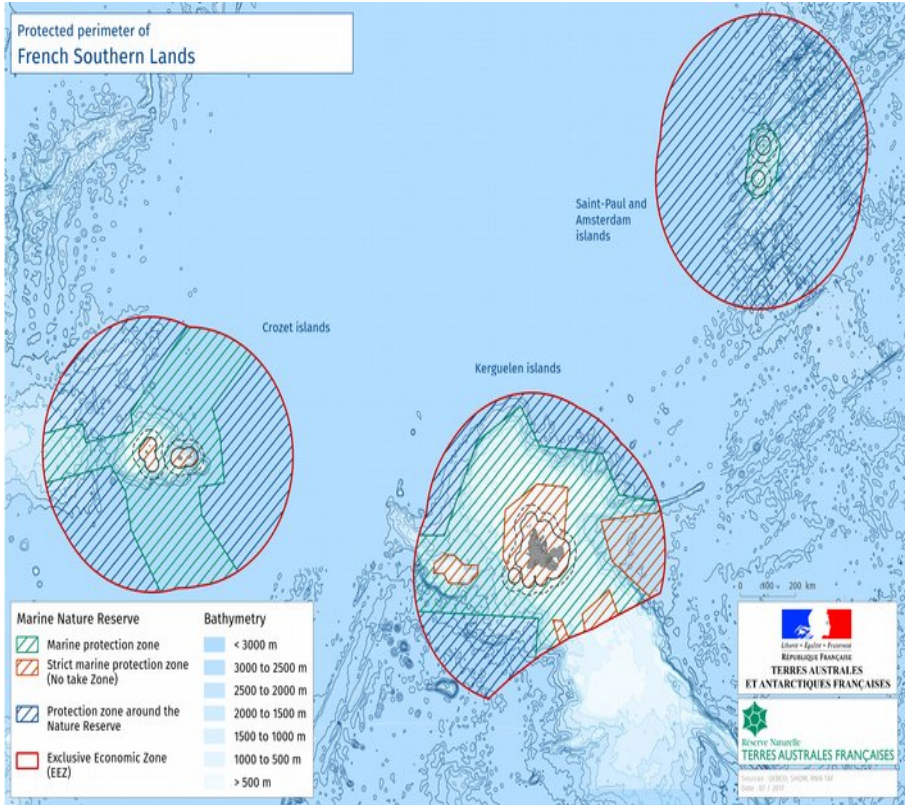
Hydrothermal vents trigger massive phytoplankton blooms in the Southern Ocean

Mathieu Ardyna[1,2], Léo Lacour[1,3], Sara Sergi[4], Francesco d'Ovidio[4], Jean-Baptiste Sallée[4], Mathieu Rembauville[1], Stéphane Blain[5], Alessandro Tagliabue[6], Reiner Schlitzer[7], Catherine Jeandel[8], Kevin Robert Arrigo[2] & Hervé Claustre[1]

Our project:

- Extension of Kerguelen natural reserve (2017)
- Inclusion of Kerguelen and Crozet lands and seas to UNESCO World Heritage List (2018)
- Contributions to Commission for the Conservation of Antarctic Marine Living Resources

Workshop : « Conservation in the high seas : challenges in marine and political sciences » (Museum of Natural History, Paris, juin 2019)



Thank you!