D’où vient cette mousse ?

L’apport des données multi-sources pour l’observation des changements du continuum terre-mer.

Lefebvre A. et coll.

Atelier Thématique Interpôles, Lorient

9-10 avril 2024

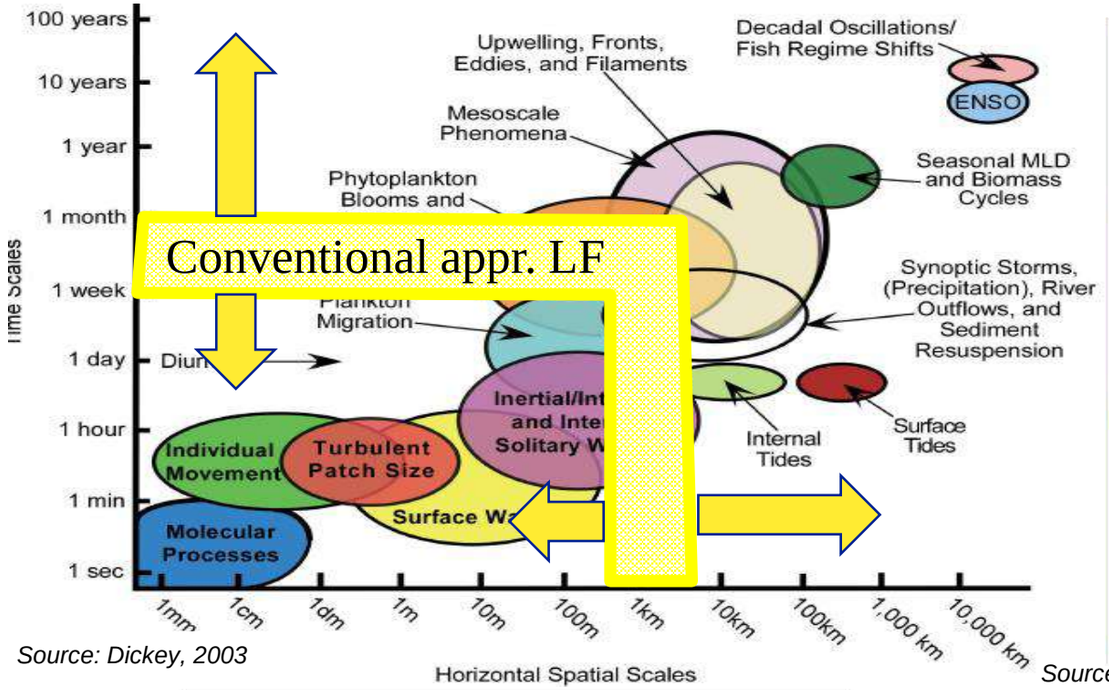
The Coastal ocean

An interface in the **land-coastal ocean-open ocean continuum**

Wide range of processes and scales (from small to large temporal and spatial scales)

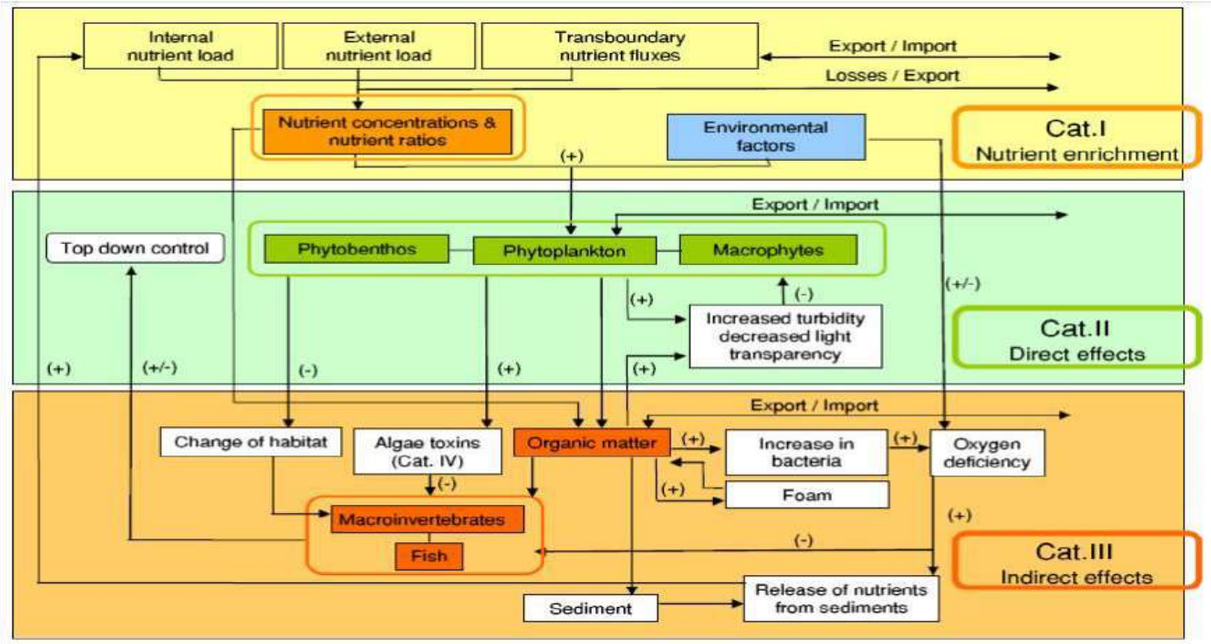
Long Term, High-Resolution and multi-parameter approach

Spatial and temporal scales involved during phytoplankton blooms

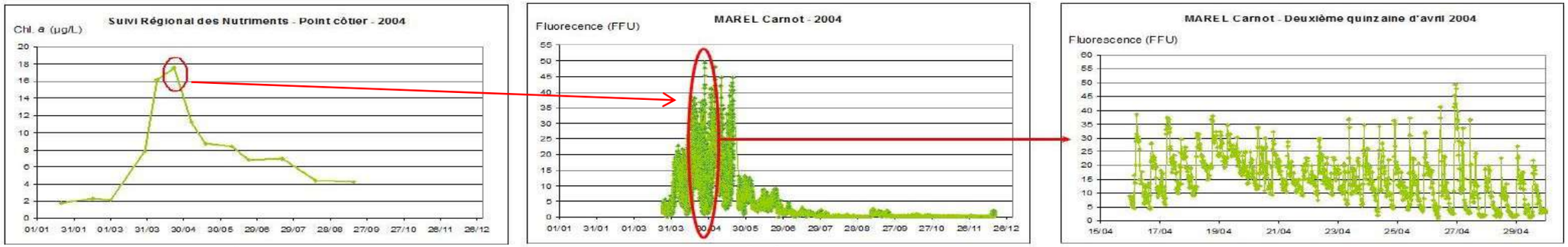


Source: Dickey, 2003

Interactions of the differents elements involved in the eutrophication process



Source: Claussen U. (stagesproject.eu)



Low frequency

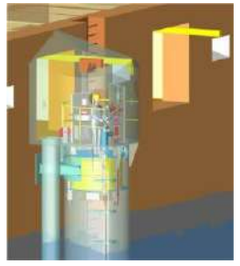
High frequency

Integrated Observation

Data flow from Low to High Resolution monitoring systems (Ferry Box, buoys,…)



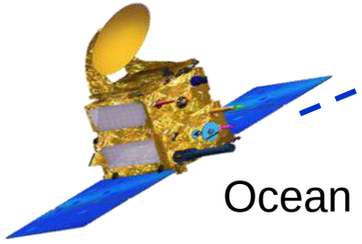





Data Base

Raw Data

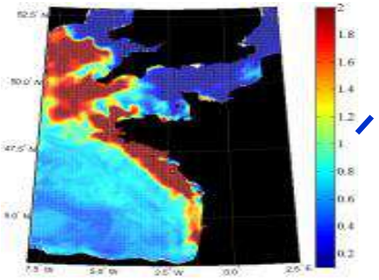
Processed Data (incl. QA/QC)



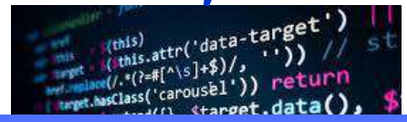
Ocean Color

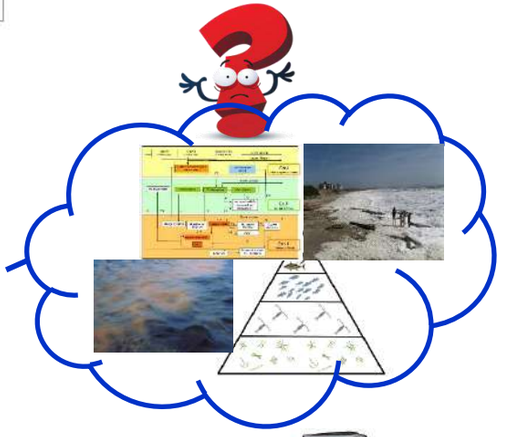
DATA TERRA

ODATIS



Modelling





Huge amount of data!
Data Quality?
Missing data? Completion?
Regularization of time series?
Optimal Information from HF data?
Modelling? Forecasting?

CONTEXT *Bloom of Phaeocystis globosa* in the English Channel

General context

• Geographical l

Channel / Strait
North Sea

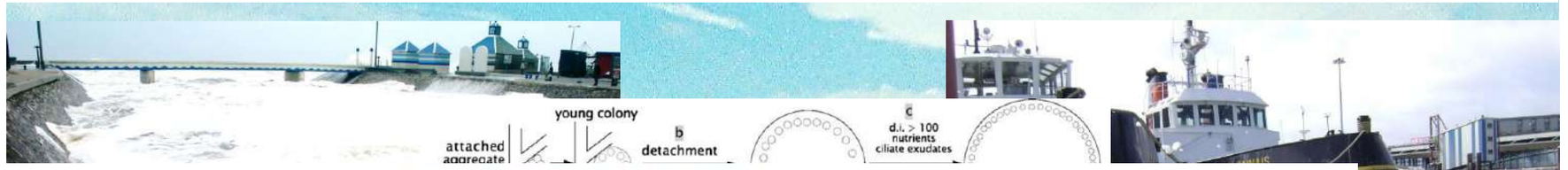
Cross-border asp
(Belgium, U.K.)

• Attendance, mu
activities, issues

•Pressures
Nutrient inputs

• Recurring bloo
Phaeocystis sp

CROSS-BORDER SITE STRONGLY IMPACTED BY ANTHROPIC ACTIVITIES

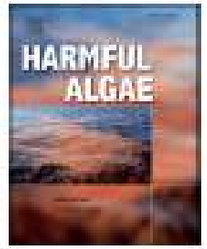


Harmful Algae 130 (2023) 102545

Contents lists available at ScienceDirect

Harmful Algae

journal homepage: www.elsevier.com/locate/hal



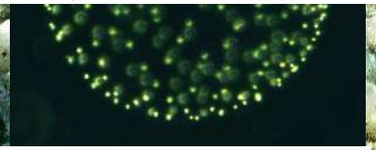
er Harbor

Human fatalities related to a *Phaeocystis* harmful algal bloom in the North Sea

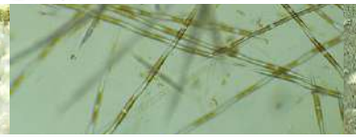
Louis Peperzak [a,*], René van Wezel [b]

[a] NIOZ Royal Institute for Sea Research, Department of Estuarine & Delta Systems, PO Box 59, NL-1790 AB, Texel, the Netherlands
[b] Rijkswaterstaat (RWS-CIV), Laboratory, Section Hydrobiology, Zuiderwagenplein 2, NL-8224 CE, Lelystad, the Netherlands

biomass
cotoxine
agic and
rtments
(biodiversity, food web…)
Human Health



Colony (Microscopy)



Pseudo-nitzschia (Harmful Algae)
Production of phycotoxine

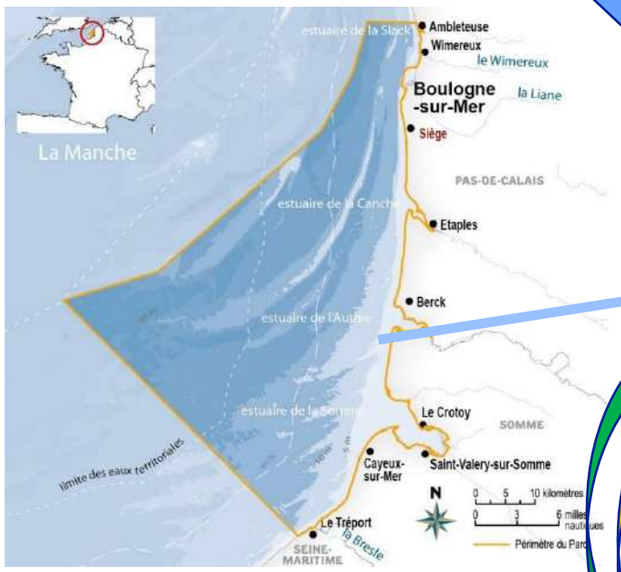
Main considered pressures in the eastern English Channel – North Sea Ecosystem

Global Change, Extreme Events

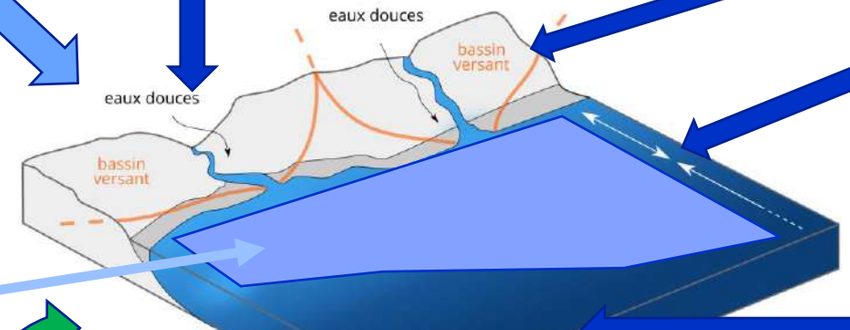
OM, nutrients inputs
Transboundary effects

Nuclear Power Plant
(Gravelines + Normandy)

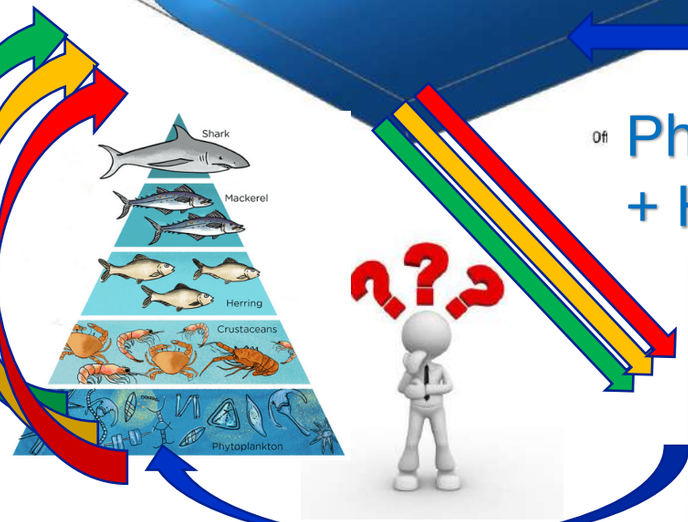
Aquaculture
Fish farming



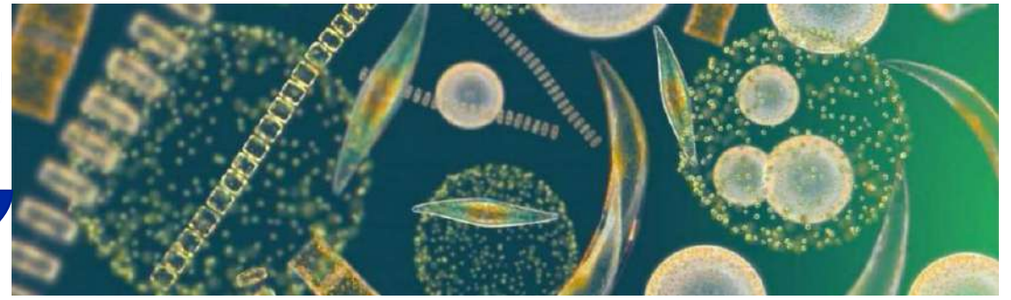
Parc Marin EPMO



Offshore windfarm



Phytoplankton Biodiversity, Dynamics (incl. HAB)
+ Hydrology + Interactions (biot., abiot., scales)



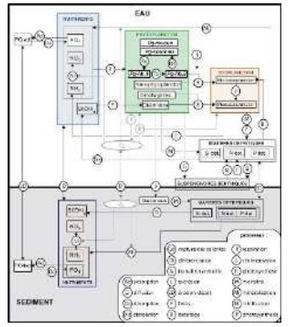
Web Alert System and Forecasting of HAB in the English Channel (and elsewhere)

Watershed data

In situ Data from **cruises** + **Ferry Box**

In situ Data from **buoys**

Satellite-retrieved Chl-a and turbidity



Modelling (phys / Biogeoch / Biol)

Pressures

"conventional" statistics

Machine Learning

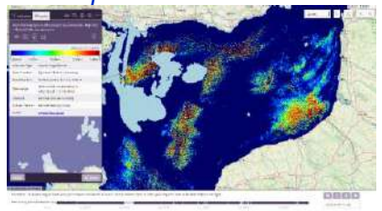
Machine Learning

(near) real time info

Delayed mode

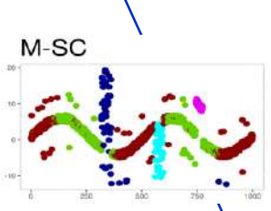
Phytoplankton Dynamics, Phenology, Niche and sub-niche For *Phae* and *Psnz*

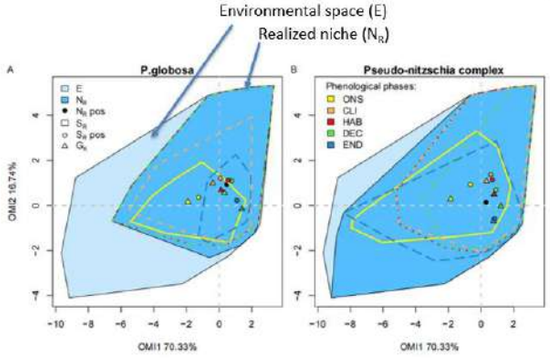
Clusters of Environmental States



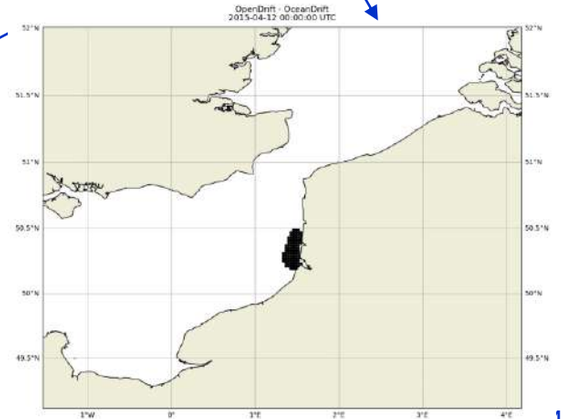
Web Alert System

LTS, Ref., "new" variables, Scenarios of trajectories





HAB controlling factors



Early Warning System & Forecasting

Coastal observation – Machine learning and early HAB detection

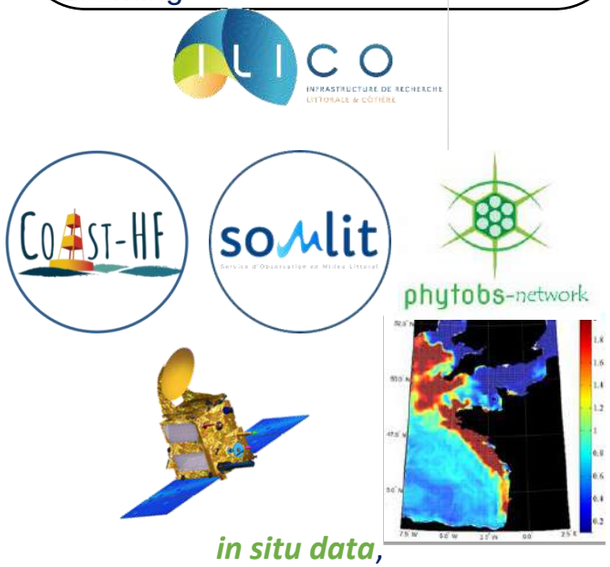
Definition of **Favourable Environmental Statuses for Blooms**
Development of an **Expert Forecasting, Warning and Decision-Making System**

❶

Data flow

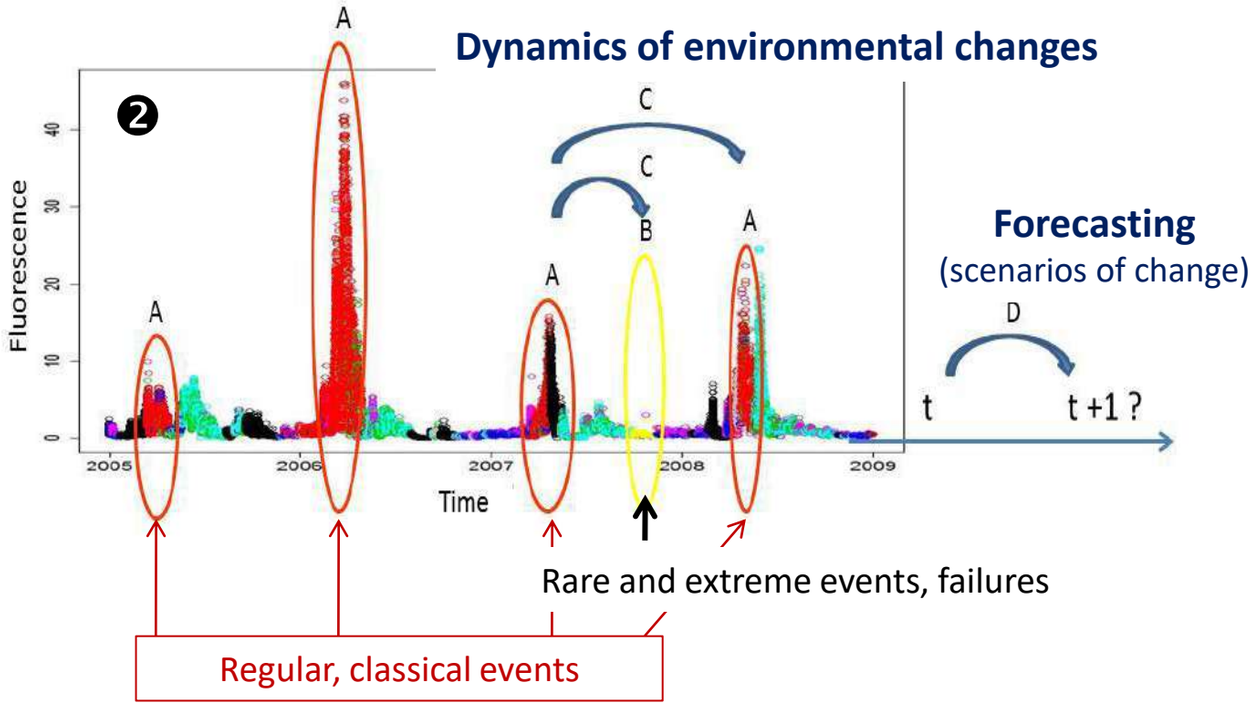
multi-scale, multi-source, multi-variable

Adaptation/optimisation of Numerical Methodologies based on Mach. Learning



in situ data,
Satellite and modelling products

❷ **Dynamics of environmental changes**



Forecasting
(scenarios of change)

❸ **Towards an early warning system**

Development of an expert system, facilitating the issuance of scientific and technical recommendations by human experts, in support of environmental managers and decision-makers for the Driver and Response components.

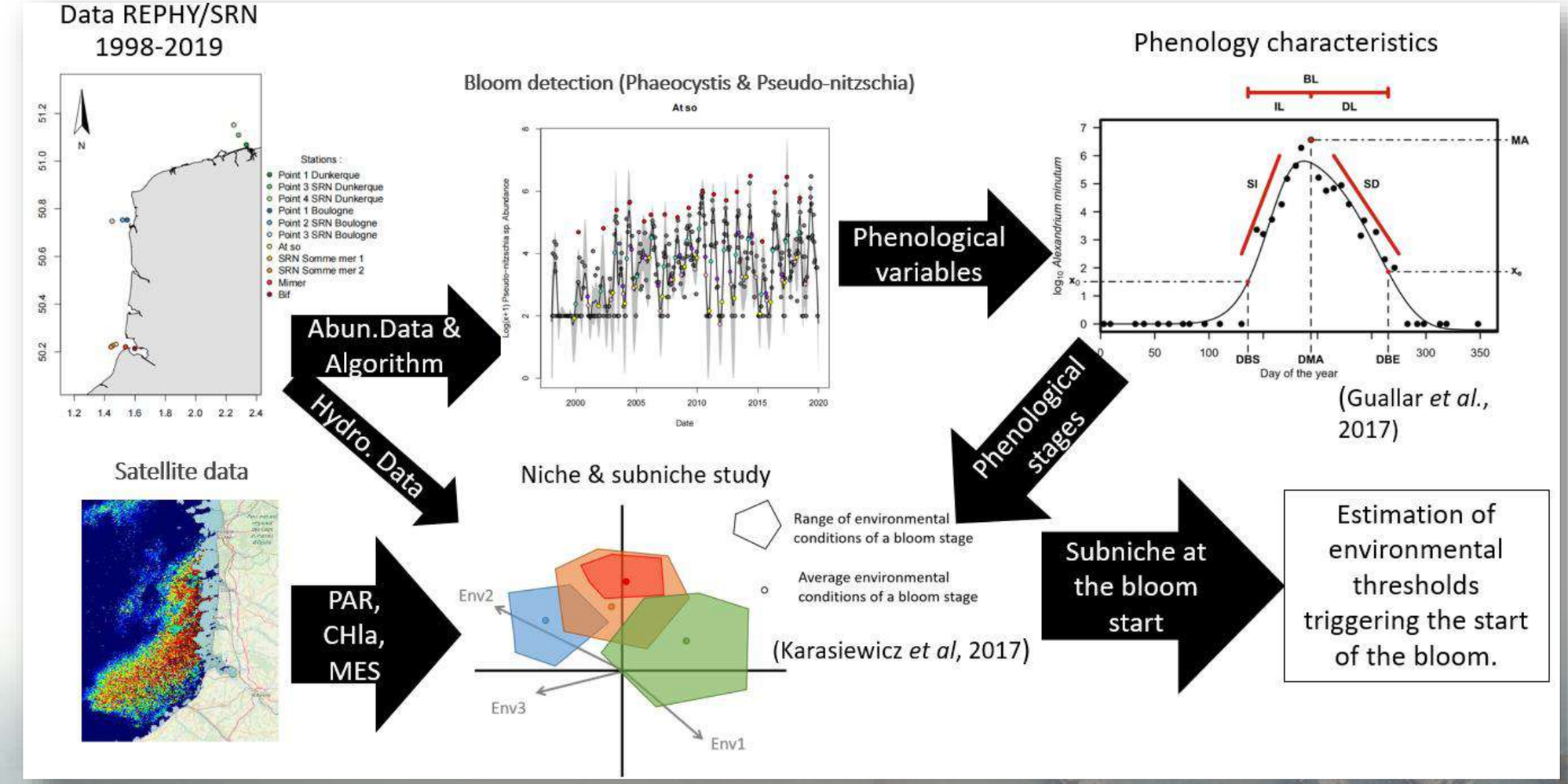
Harmful Algal Blooms – Observing, Understanding and Predicting

Citation: Karasiewicz, S.; Lefebvre, A. Environmental Impact on Harmful Species *Pseudo-nitzschia* spp. and *Phaeocystis globosa* Phenology and Niche. *J. Mar. Sci. Eng.* **2022**, *10*, 174. https://doi.org/10.3390/jmse10020174

Environmental Impact on Harmful Species *Pseudo-nitzschia* spp. and *Phaeocystis globosa* Phenology and Niche

Stéphane Karasiewicz * and Alain Lefebvre *

Coastal *in situ* observations



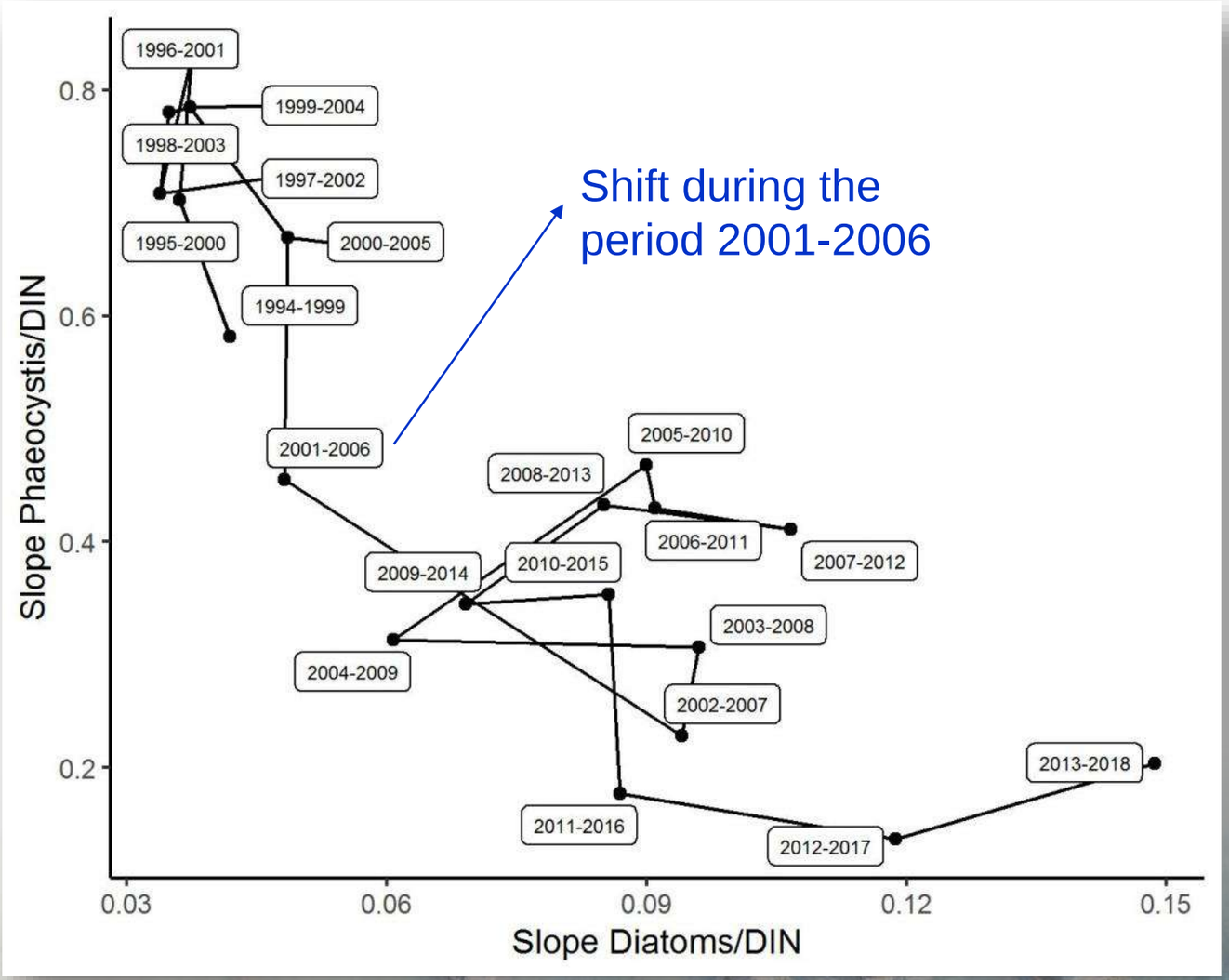
Harmful Algal Blooms – Observing, Understand and Predict

Bloom of Phaeocystis globosa in the English Channel

With <u>long-term</u> **coastal observations**:

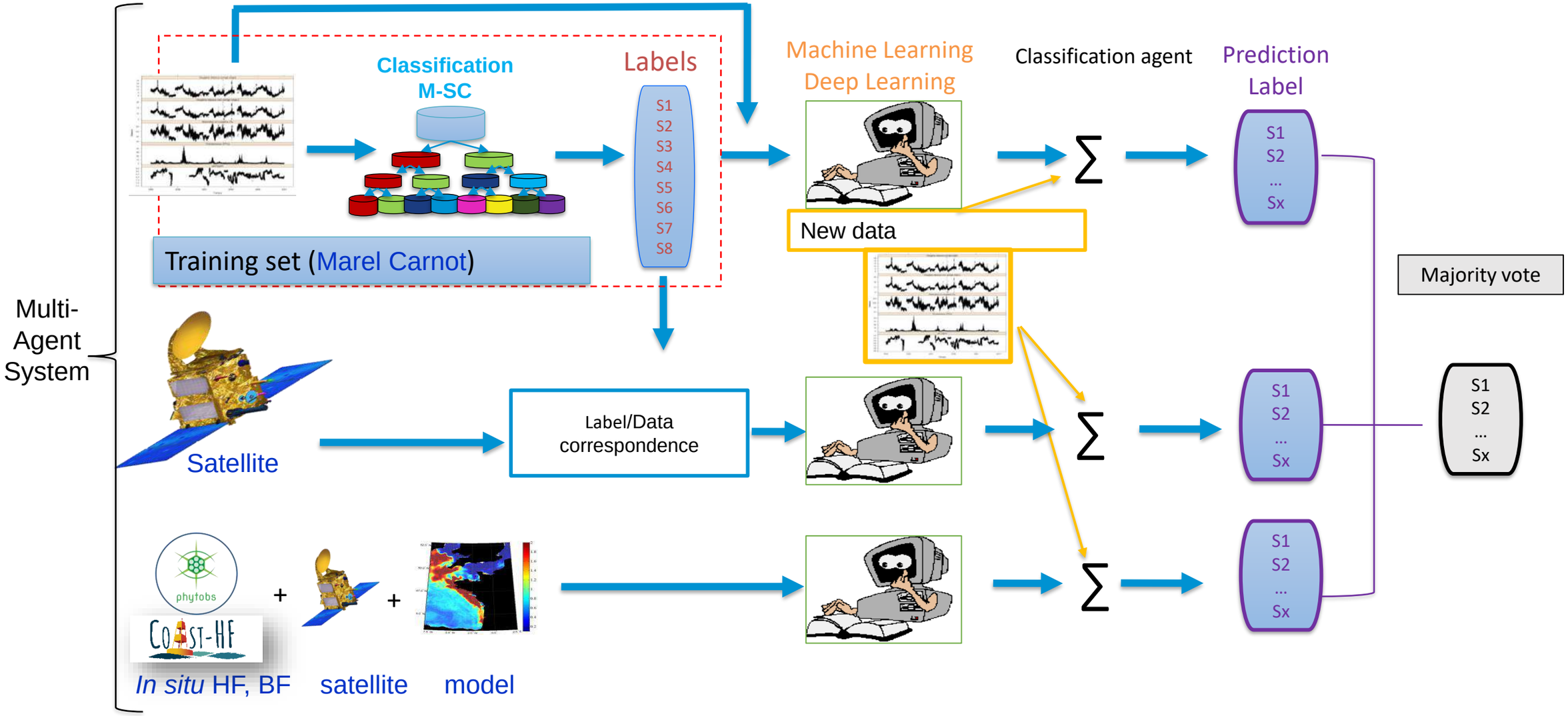
- Ability to **detect and prevent HABs**
- Ability to deconvolute **global and local changes**
- Including changes from low to high trophic levels

Changes in the balance of the *Phaeocystis* / Diatoms ratio



IA-based Expert System

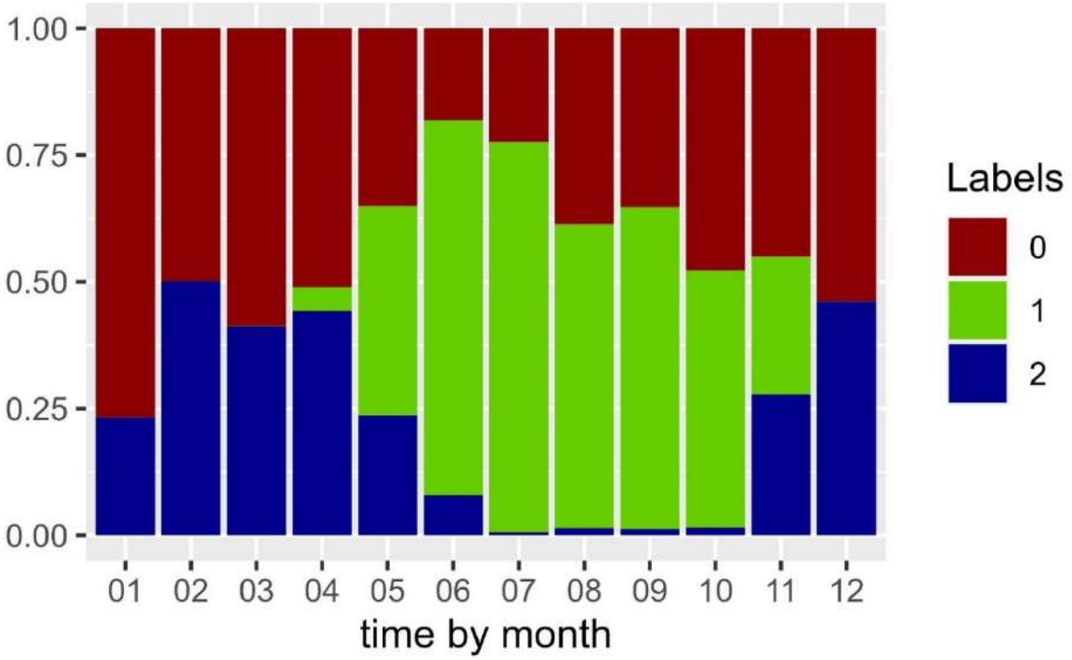
R. Halawi Ghosn (PhD 2021-2024)

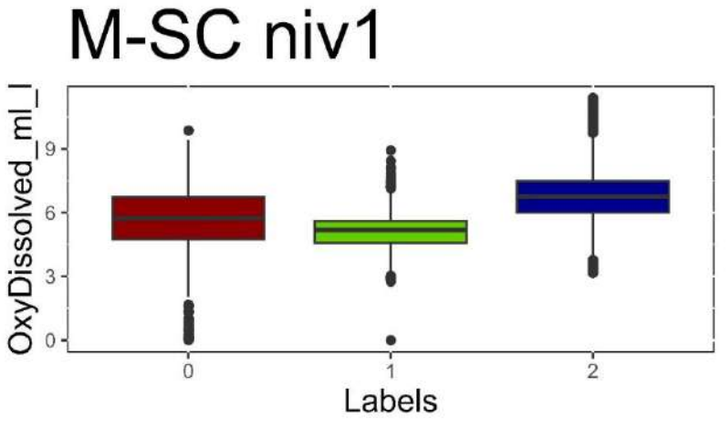


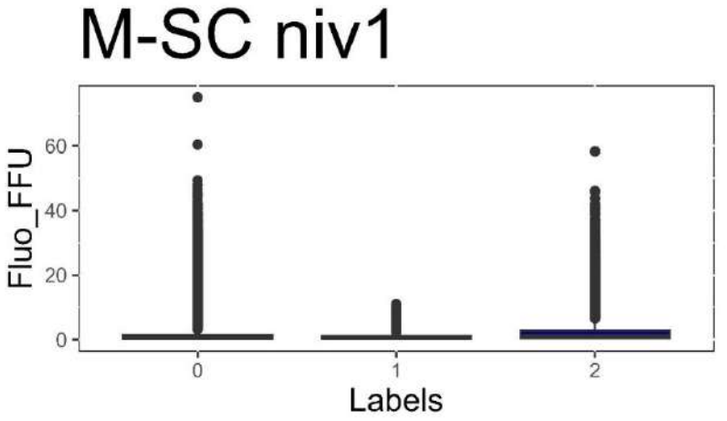
Multi-level Spectral Clustering

Characterization of phytoplankton biomass dynamics by defining multi-criteria environmental states

- MSC Level 1: Two periods were identified, one being more productive than the other







Journal of Marine Science and Engineering

MDPI

Article

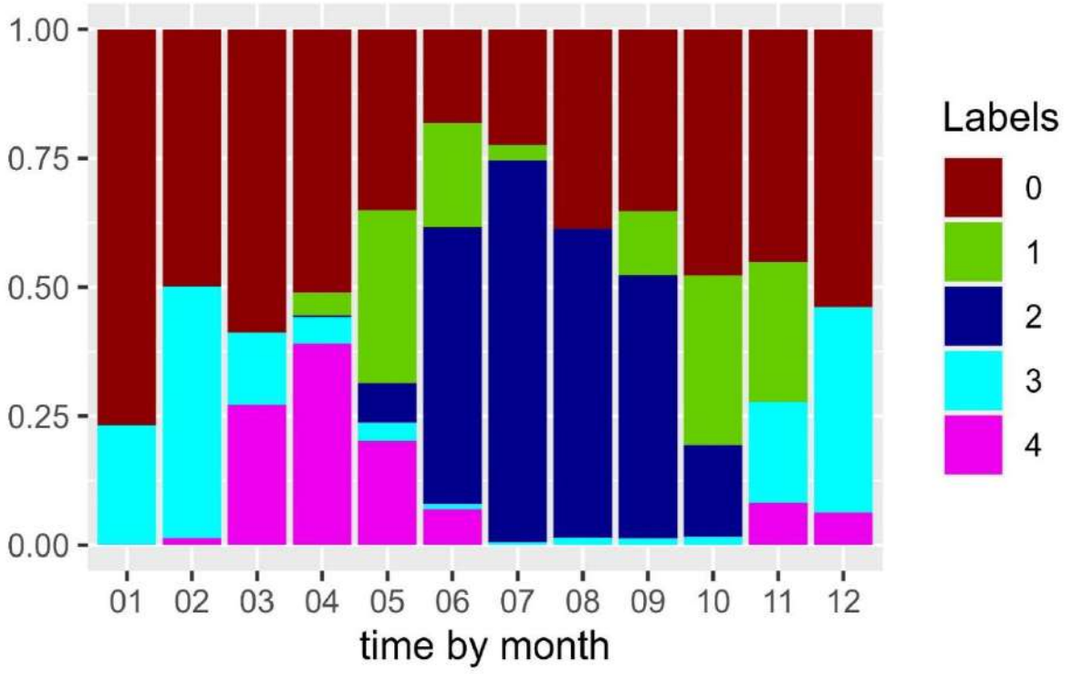
Comparative Study of Clustering Approaches Applied to Spatial or Temporal Pattern Discovery

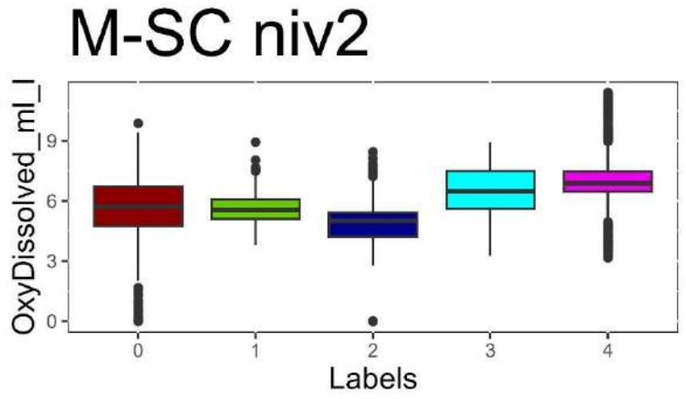
Kelly Grassi [1,2,3], Émilie Poisson-Caillault [2], André Bigand [2] and Alain Lefebvre [3,4]

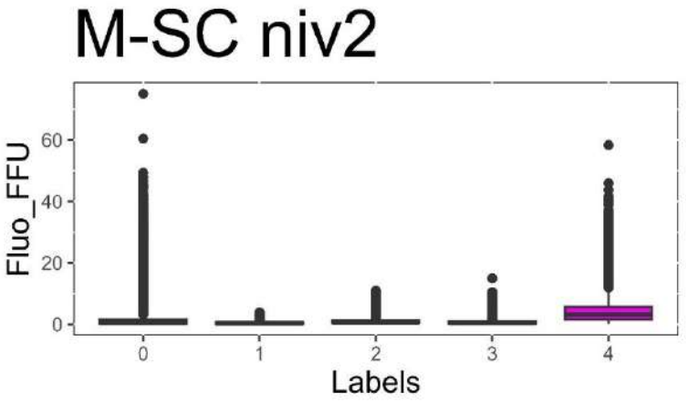
Multi-level Spectral Clustering

Characterization of phytoplankton biomass dynamics by defining multi-criteria environmental states

- MSC Level 2: Each of these two main periods (productive and non-productive) is divided into sub-periods corresponding to key environmental states: pre-bloom, bloom and post-bloom.



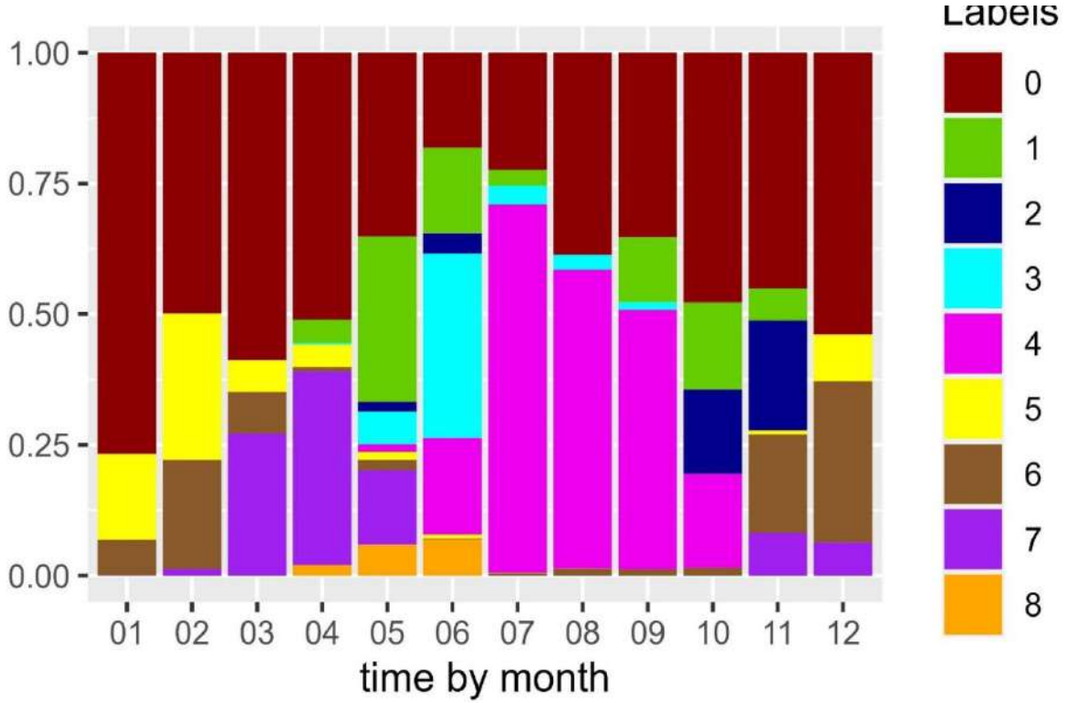


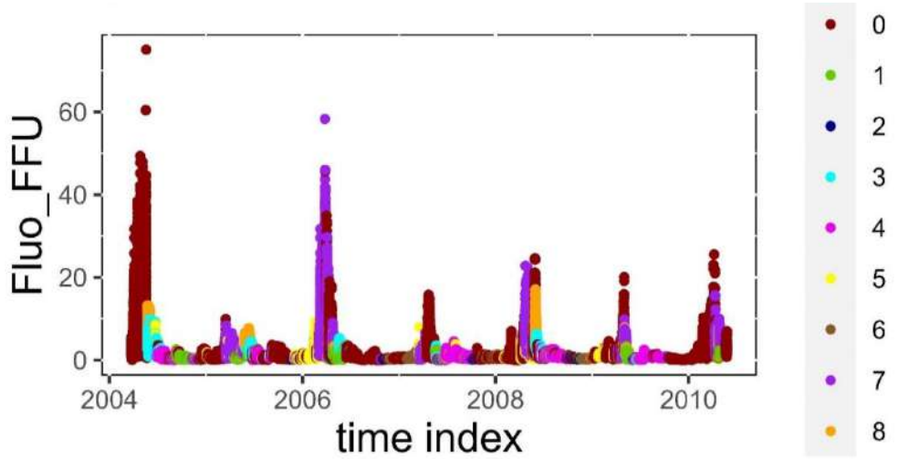


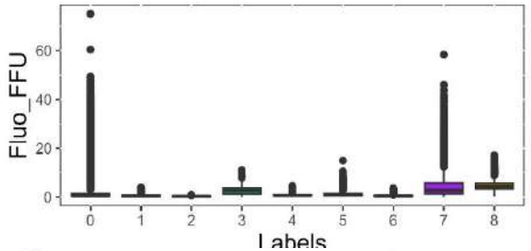
Multi-level Spectral Clustering

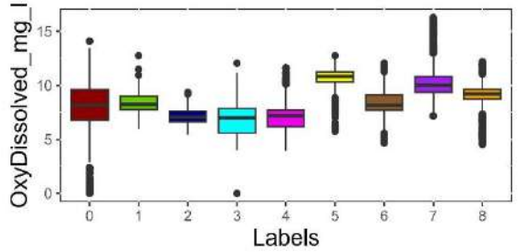
Characterization of phytoplankton biomass dynamics by defining multi-criteria environmental states

- MSC Level 3: 8 environmental states with different dynamics and characteristics in terms of controlling factors.
- Detect the start of a phytoplankton bloom when nutrients are added.





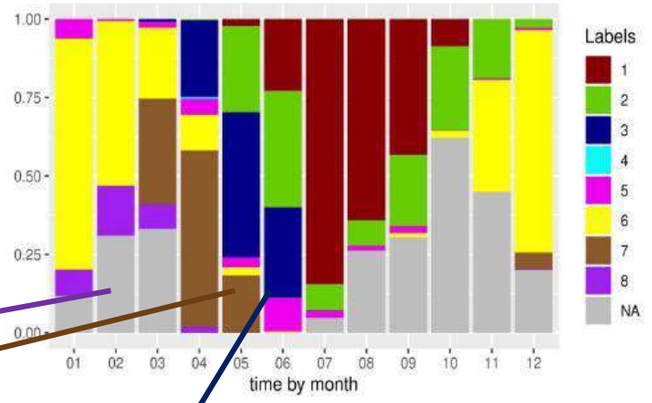




Multi-level Spectral Clustering

Bloom states: Classes 8, 7 and 3

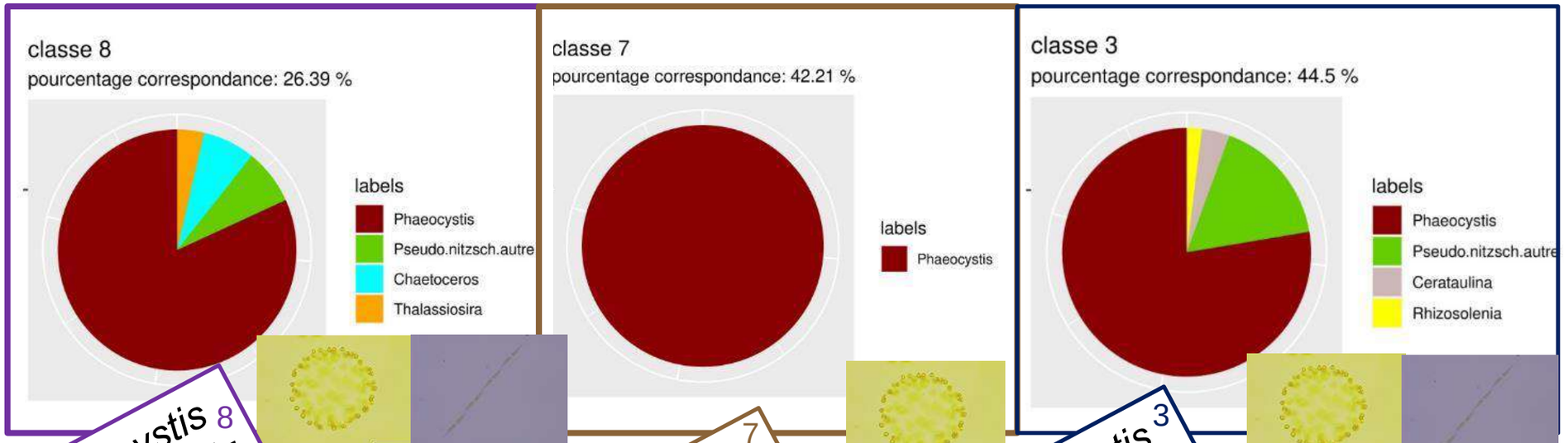
States correlated
with different phytoplankton community,
Including **Harmful Algae**



8 - Winter transition
towards bloom state

7- Bloom

3- End of bloom



Phaeocystis 8
+ Pseudo Nz
+ autres

Toxic sp.

Phaeocystis 7

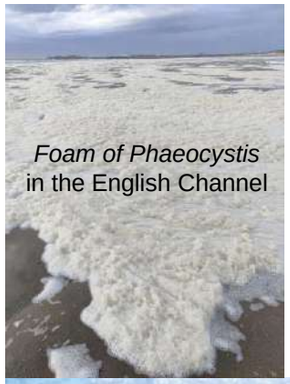
Harmful sp.

Phaeocystis 3
+ Pseudo Nz

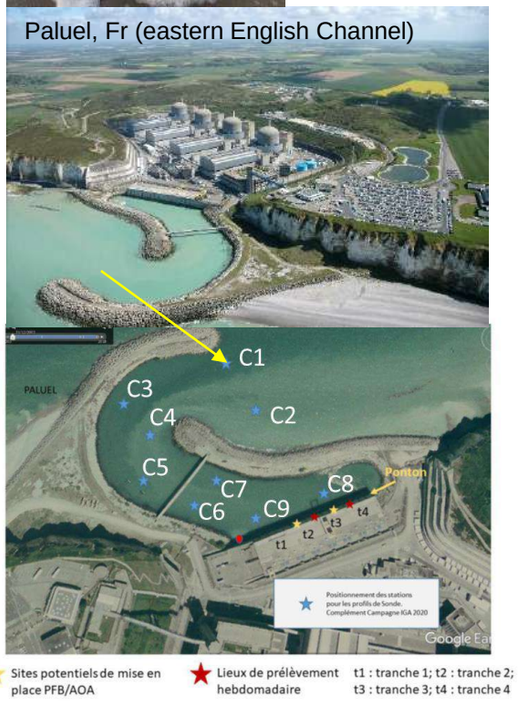
Toxic sp.

Application

Impact of Phaeocystis blooms on the Nuclear Power Plant of Paluel



Foam of Phaeocystis in the English Channel



Sites potentiels de mise en place PFB/AOA

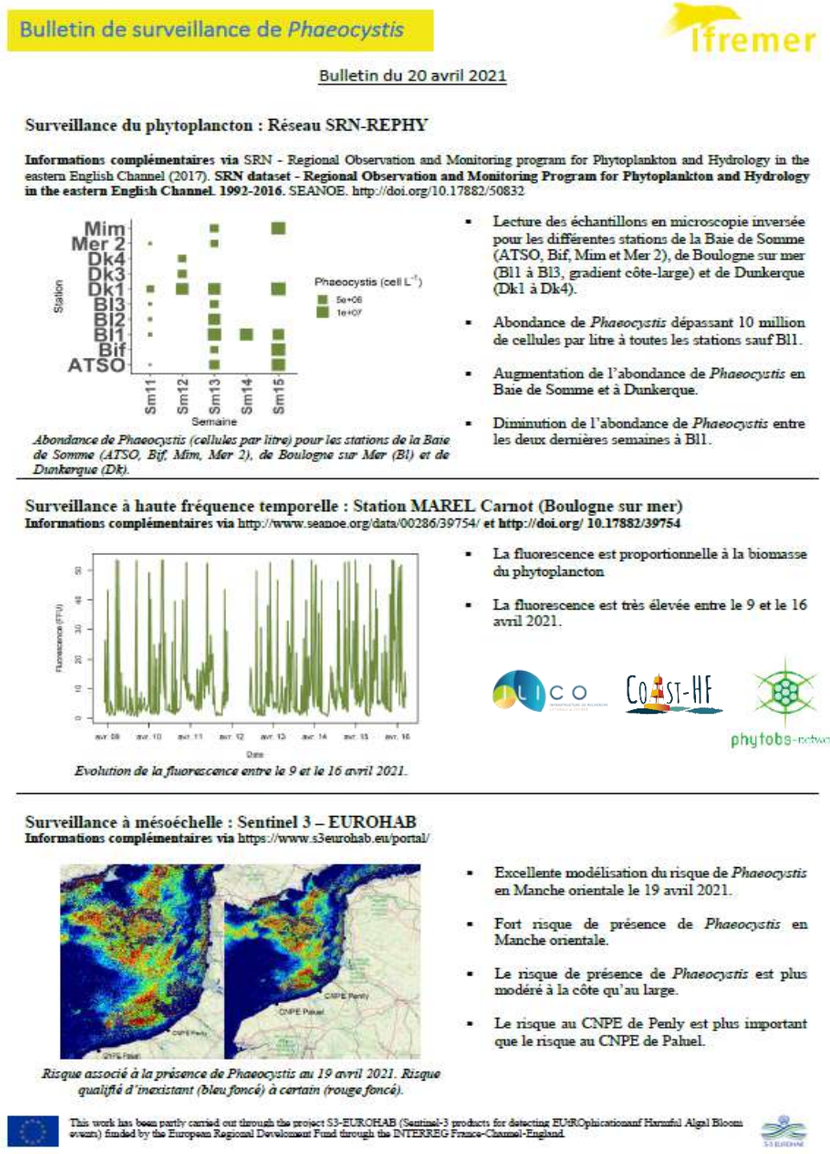
Lieux de prélèvement hebdomadaire

t1 : tranche 1; t2 : tranche 2; t3 : tranche 3; t4 : tranche 4

Weekly Newsletter

based on:
microscopic counts,
HF data,
S3 EuroHAB Web Alert System

anticipation of clogging problems



Bulletin de surveillance de *Phaeocystis*

Ifremer

Bulletin du 20 avril 2021

Surveillance du phytoplancton : Réseau SRN-REPHY

Informations complémentaires via SRN - Regional Observation and Monitoring program for Phytoplankton and Hydrology in the eastern English Channel (2017). **SRN dataset - Regional Observation and Monitoring Program for Phytoplankton and Hydrology in the eastern English Channel. 1992-2016.** SEANOE. http://doi.org/10.17882/50832

Mim
Mer 2
Dk4
Dk3
Dk1
Bl3
Bl2
Bl1
Bif
ATSO
Station
Sm11
Sm12
Sm13
Sm14
Sm15
Semaine
Phaeocystis (cell L⁻¹)
5e+06
1e+07

Abondance de Phaeocystis (cellules par litre) pour les stations de la Baie de Somme (ATSO, Bif, Mim, Mer 2), de Boulogne sur Mer (Bl) et de Dunkerque (Dk).

- Lecture des échantillons en microscopie inversée pour les différentes stations de la Baie de Somme (ATSO, Bif, Mim et Mer 2), de Boulogne sur mer (Bl1 à Bl3, gradient côte-large) et de Dunkerque (Dk1 à Dk4).
- Abondance de *Phaeocystis* dépassant 10 million de cellules par litre à toutes les stations sauf Bl1.
- Augmentation de l'abondance de *Phaeocystis* en Baie de Somme et à Dunkerque.
- Diminution de l'abondance de *Phaeocystis* entre les deux dernières semaines à Bl1.

Surveillance à haute fréquence temporelle : Station MAREL Carnot (Boulogne sur mer)

Informations complémentaires via http://www.seanoe.org/data/00286/39754/ **et http://doi.org/ 10.17882/39754**

Fluorescence (FFU)
Date

Evolution de la fluorescence entre le 9 et le 16 avril 2021.

- La fluorescence est proportionnelle à la biomasse du phytoplancton
- La fluorescence est très élevée entre le 9 et le 16 avril 2021.

LICO
Coast-HF
phytobs-network

Surveillance à mésoéchelle : Sentinel 3 – EUROHAB

Informations complémentaires via https://www.s3eurohab.eu/portal/

Risque associé à la présence de Phaeocystis au 19 avril 2021. Risque qualifié d'inexistant (bleu foncé) à certain (rouge foncé).

- Excellente modélisation du risque de *Phaeocystis* en Manche orientale le 19 avril 2021.
- Fort risque de présence de *Phaeocystis* en Manche orientale.
- Le risque de présence de *Phaeocystis* est plus modéré à la côte qu'au large.
- Le risque au CNPE de Penly est plus important que le risque au CNPE de Paluel.

This work has been partly carried out through the project S3-EUROHAB (Sentinel-3 products for detecting EUtROphicationand Harmful Algal Bloom events) funded by the European Regional Development Fund through the INTERREG France-Channel-England

Financial support:
eDF

Ifremer

Portail intégrateur

de l'Observation Littorale et Côtière

Approche spécifique Lien vers SNO

Approche Intégratrice Inter-SNO + DCIC

⇩

Analyses Exploratoires

Téléchargement des données liées au filtre sélectionné

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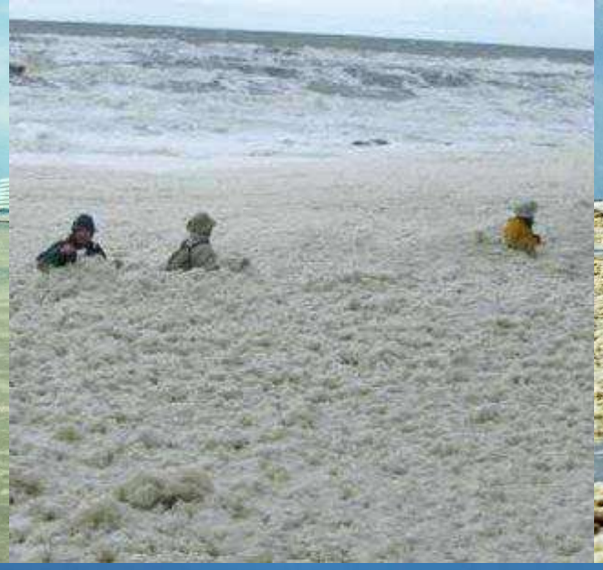
Analyses Approfondies

A développer : mode Découverte / mode Expert


MERCI POUR VOTRE ATTENTION

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