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

Conventional appr. LF

Interactions of the different elements involved in the eutrophication process

Source: Dickey, 2003

Source: Claussen U. (stagesproject.eu)

Low frequency

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

Integrated Observation

Data Base

Raw Data

Processed Data (incl. QA/QC)

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

- Geographical location: Channel / Strait of Dover / North Sea
- Cross-border aspects: (Belgium, U.K.)
- Attendance, multiple activities, issues
- Pressures: Nutrient inputs
- Recurring bloom of Phaeocystis sp

**CONTEXT**

**Bloom of Phaeocystis globosa in the English Channel**

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

Louis Peperzak, René van Wezel

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Contents lists available at ScienceDirect

Harmful Algae

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

Colony (Microscopy)

Pseudo-nitzschia (Harmful Algae)
Production of phycotoxine

(Biodiversity, food web...)

Human Health

CROSS-BORDER SITE STRONGLY IMPACTED BY ANTHROPC ACTIVITIES
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
- Offshore windfarm
- Parc Marin EPMO
- Phytoplankton Biodiversity, Dynamics (incl. HAB) + Hydrology + Interactions (biot., abiot., scales)
Web Alert System and Forecasting of HAB in the English Channel (and elsewhere)

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

**Satellite**-retrieved Chl-a and turbidity

In situ Data from **buoys**

**Modelling** (phys / Biogeoch / Biol)

Watershed data

“conventional” statistics

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

**Clusters of Environmental States**

**Machine Learning**

**Clusters of Environmental States**

**Machine Learning**

Web Alert System

**Web Alert System** & Forecasting

**LTS, Ref., “new” variables, Scenarios of trajectories**

Delayed mode

HAB controlling factors

Early Warning System & Forecasting
Definition of **Favourable Environmental Statuses for Blooms**

**Development of an Expert Forecasting, Warning and Decision-Making System**

1. **Data flow**
   - multi-scale, multi-source, multi-variable
   
   Adaptation/optimisation of Numerical Methodologies based on Mach. Learning

2. **Dynamics of environmental changes**
   
   Regular, classical events
   
   Rare and extreme events, failures

3. **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.
Environmental Impact on Harmful Species *Pseudo-nitzschia* spp. and *Phaeocystis globosa* Phenology and Niche

Stéphane Karasiewicz * and Alain Lefebvre *


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**Data REPHY/SRN 1998-2019**

**Bloom detection (Phaeocystis & Pseudo-nitzschia)**

**Phenology characteristics**

(Guallar et al., 2017)

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**Coastal in situ observations**

**Abun.Data & Algorithm**

**Hydro. Data**

**Satellite data**

**PAR, Chla, MES**

**Niche & subniche study**

**Range of environmental conditions of a bloom stage**

Average environmental conditions of a bloom stage

(Karasiewicz et al, 2017)

**Phenological stages**

**Estimation of environmental thresholds triggering the start of the bloom.**
Bloom of *Phaeocystis globosa* in the English Channel

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

Shift during the period 2001-2006

With long-term coastal observations:
- Ability to detect and prevent HABs
- Ability to deconvolute global and local changes
- Including changes from low to high trophic levels
IA-based Expert System

Multi-Agent System

Satellite

Training set (Marel Carnot)

Classification M-SC

Labels

Machine Learning
Deep Learning

Prediction Label

New data

Label/Data correspondence

Labels S1, S2, S3, S4, S5, S6, S7, S8

Sum

Sum

Sum

Majority vote

In situ HF, BF

satellite

model

R. Halawi Ghosn (PhD 2021-2024)

Satellite model

Prediction Label

S1, S2, ..., Sx

In situ HF, BF
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.
**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.
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

Multi-level Spectral Clustering
Application

Impact of Phaeocystis blooms on the Nuclear Power Plant of Paluel

Weekly Newsletter

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

anticipation of clogging problems
Portail intégrateur
de l’Observation Littorale et Côtière

Approche spécifique
Lien vers SNO

Approche Intégratrice
Inter-SNO + DCIC

Téléchargement des données liées au filtre sélectionné

Analyses Exploratoires

A développer : mode Découverte / mode Expert
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