High resolution overview of phytoplankton community (*via spectral groups*) and hydrology in spring in the eastern English Channel. First attempt before a new Ship-Opportunity line across the Channel?

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Why do we need high resolution and multi-parameters monitoring of water quality in the eastern English Channel (and everywhere)?

Complex relationships within pelagic and benthic compartments

Example: Interactions between elements involved in the Eutrophication process

(Source: Dickey, 1991 modifié par Grace et Dickey)
Fig. 1 Idealized trajectories of chlorophyll a concentrations, as an indicator of ecosystem status, and nutrient inputs to coastal ecosystems under increasing (red line) and decreasing (green line) nutrient inputs under different response scenarios: a “Return to Neverland” scenario implying a direct reversible relationship between chlorophyll a concentrations and nutrient inputs; b a trajectory resulting from a “Regime Shift” in ecosystem status in response to nutrient inputs. This trajectory results in an apparent time lag, or hysteresis effect, in the response to reducing nutrient inputs; c “Shifting Baselines” scenario, where changes in forcing factors other than nutrients (e.g., climate, food web structure) forces a trajectory for the ecosystem independent of that forced by nutrients, depicted by the dotted line, preventing the ecosystem to return to the “reference condition” after reducing nutrient inputs; and d a trajectory displaying “Regime Shift and Shifting Baselines” combined.
High resolution monitoring of water quality in the eastern English Channel

The Pocket Ferry Box (PFB) and the Algae Online Analyser (AOA)

Portable device (<27 kg)
Easy power supply
Continuous measurements
Total time constant < 2 min
GPS

Algae Online Analyzer (AOA, bbe©)

Top view of the Pocket Ferry Box

New “pocketFerryBox” build by 4H Jena Engineering

inner part of pocketFerryBox
The Pocket Ferry Box and the Algae Online Analyser

Pocket FerryBox
(top view)
AOA  CDOM  pH  T, S  O₂

Pocket FerryBox
(Front view)

Battery

Pump

Flow cytometer

Ysi 6600 V2 data sonde
(+ Flow Cell)

Input

Output

RV Côtes de la Manche

AOA  CDOM  pH  T, S  O₂

Sampling frequency: 1 min. continuous sampling mode / Spatial resolution approx. 0.1 nm
System coupled with a YSI 6600 water-quality probe connected with a flow-through system (for comparison / added parameters) and with a flow cytometer (sampling frequency: 10 min.)
The Algae Online Analyzer (AOA - bbe)

- Fixed-wavelength spectral fluorometer
- LED centered at 470, 525, 570, 590 and 610 nm (+ CDOM 370 nm)
- Emission measured at 680 nm.
- Original fingerprints described in AOA parlance as Green, BlueGreen, Diatoms, Cryptophyceae

**Main principle**

*Shape of the spectral fluo signature*

=> taxa discrimination

*Fluo intensity and the group-specific fluo/chl ratio*

=> total phytopl biomass (chla)

![Mean fluorescence-excitation probabilities for 4 spectral algal groups (norm spectra)](image)
(Source : Beutler et al., 2002)
The Algae Online Analyzer (AOA - bbe) and its fingerprints

Implementation of new fingerprints: *Pseudonitzschia, Phaeocystis, Isochrysis*
Common Cruise - LEG 2 – April, 27-29, 2012

AOA: Original Fingerprint  
(Blue Green + Green + Crypto + Brown)

High variability Departure vs Arrival

High variability within a given area dominated by *Phaeocystis* (patchiness)

Change in spectral groups relative abundance for a given low chlorophyll conc. area

Moving with the tide during a fixed station
Common Cruise - LEG 2 – April, 27-29, 2012
AOA: Blue Green + Crypto + Brown + Phaeocystis
LEG 2 – April, 27-29, 2012
Hierarchical classification & associated spectral groups

Real time Preliminary taxonomic approach

Phaeocystis
+ Bacillariophyceae
+ Nano~Picoplankton?

95 % Phaeocystis
(> 4 to 10\(^{10}\) cell.l\(^{-1}\))
LEG 2 – April, 27-29, 2012
Hierarchical classification & associated spectral groups

⇒ Tracking *Phaeocystis* and direct/indirect effects

**Clusters @ Dummy=first**

**AOA Specific Fingerprints**

**Inverted Microscopy**

*Phaeocystis*
- Bacillariophyceae
- Nano~Picoplankton ?

95% *Phaeocystis* (> 4 to 10.10^6 cell.l^-1)

*Phaeocystis*
- Bacillariophyceae
- Nano~Picoplankton ?
LEG 2 – April, 27-29, 2012

Redundancy Analysis (Bio. x Envt. Matrix)

Water Quality Assessment

DPSIR approach

⇒ Needs for further parameters (Ex. nutrients)
Monitoring system of phytoplankton blooms by using an Unsupervised Classifier and Time Modelling

See Poster:
Detection and estimation of environmental states by unsupervised dynamics modelling. Application to FerryBox data. Rousseeuw K., Lefebvre A., Poisson Caillault E., Aimé-Roger Nzigou

Spectral Classification

Y Clusters (combination of X parameters)

Data Set (X parameters)

Temporal dynamics for the Clusters and For a given parameter
Proposal for the Monitoring Programme

NEW: Ecosystem approach, offshore waters

Qualitative descriptors for determining GES

D 1: Biological diversity
D 2: Non-indigenous species
D 3: Population of commercial fish / shellfish
D 4: Elements of marine food webs
D 5: Eutrophication
D 6: Sea floor integrity
D 7: Alteration of hydrographical conditions
D 8: Contaminants
D 9: Contaminants in fish and seafood for human consumption
D 10: Marine litter
D 11: Introduction of energy, including underwater noise

Of interest for Dymaphy-like approaches
Other example of application at the Great North Sea scale towards ecosystem approach for fisheries …

International Bottom Trawl Survey – IBTS 2013, 2014,…

❖ Main Objective: Assessment of abundance and recruitment of main commercial fishes

❖ Rare data on winter plankton communities in eastern English Channel and south of the North Sea.

❖ How to explain changes in the intensity and start of the spring phytoplankton bloom ?

❖ Winter feeding conditions encountered during the early larval stages of Downs herring and consequences for their recruitment ?

New CAMANOC 2014 cruise in the Channel (mid-sept. to mid-oct. 2014)

EVHOE 2014 in the Bay of Biscay
Conclusions

- Reliability of the Pocket Ferry Box (in its now a day version)

- Added value of HF approach (general knowledge, sampling strategy,…)

- Easy implementation on (small to big) boats

- Phytoplankton : preliminary taxonomic approach

- Phytoplankton : Possibility to track a taxa using a specific fingerprint

- Hydrology : main parameters measured and possibility to have more

- *Phaeocystis* : further knowledge on bloom determinism and dynamics, HAB early warning system

⇒ Implementation of a new monitoring program across the Channel ?
(to be confirmed in a few weeks)

⇒ Increasing demand for implementation on board fisheries research vessels
Thanks for your attention

http://www.dymaphy.eu
**Demonstration of the reliability of the HF coupled systems in the 2 Seas Regions**

**DONE**

**Other applications?**

- **Phaeocystis globosa**
  - Harmful Algal Bloom – High Biomass

- **Scallops**
  - Most productive area in the Eastern English Channel

- **Karenia mikimotoi**
  - HAB - ichthyotoxic

- **Census of Pseudo-nitzschia blooms in 2012**

- **Dover Strait**

- **Bay of Seine**
Other example of application - *K. mikimotoï* blooms

HF Instrumented Stations or Buoys

Ships of opportunity

Satellite-derived products (SeaWifs/OC5)

Modeling-derived products (EcoMars3D/Ifremer)

Hybrid model: Unsupervised classification + Hidden Markov Model

**Deliveries:**
- Potential Problem Area
- Potential Problem Period
- Environmental status (HF + multi-parameters)
- Dynamics of the bloom
- Determinism
- Forecasting