INTERREG IVA 2 Mers Seas Zeeën Crossborder Cooperation Programme 2007-2013
Part-financed by the European Regional Development Fund (**ERDF**)

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

Lefebvre Alain [1], Nzigou Aimé-Roger[1,2], Artigas Felipe [3,4]

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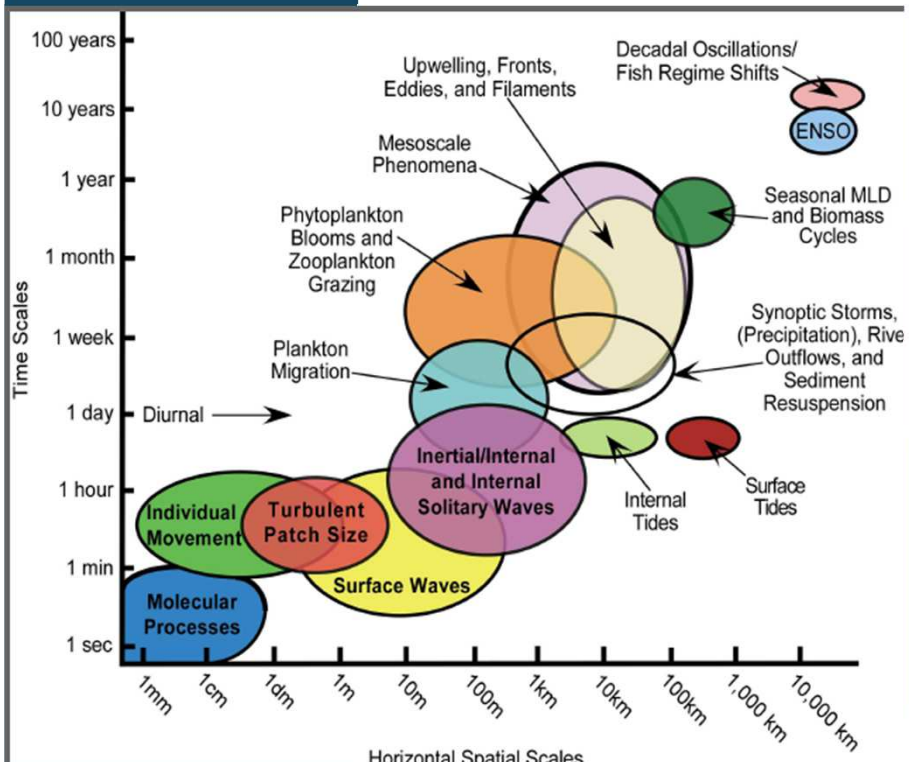
2 - Université des Sciences et Technologies de Masuku, Faculté des Sciences, Département de Biologie, BP 943, Franceville, Gabon

3 - Université du Littoral Côte d'Opale, Laboratoire d'Océanologie et Géosciences, Maison de la Recherche en Environnement Naturel, 32 Av. Foch, 62930 Wimereux, France

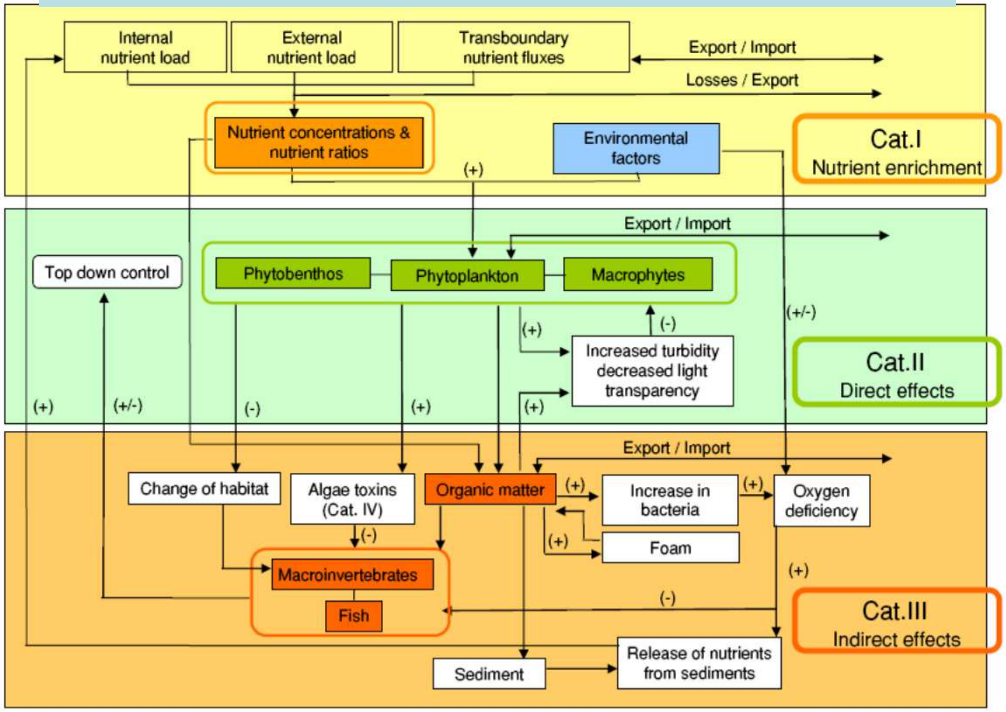
4 - CNRS UMR 8187 LOG, 28 Avenue Foch, 62930 Wimereux, France

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

Spatial and temporal scales of process involved in phytoplankton blooms



Complex relationships within pelagic and benthic compartments
Example : Interactions between elements involved in the Eutrophication process



(Source : Dickey, 1991 modifié par Grace et Dickey)

… and to do what ?

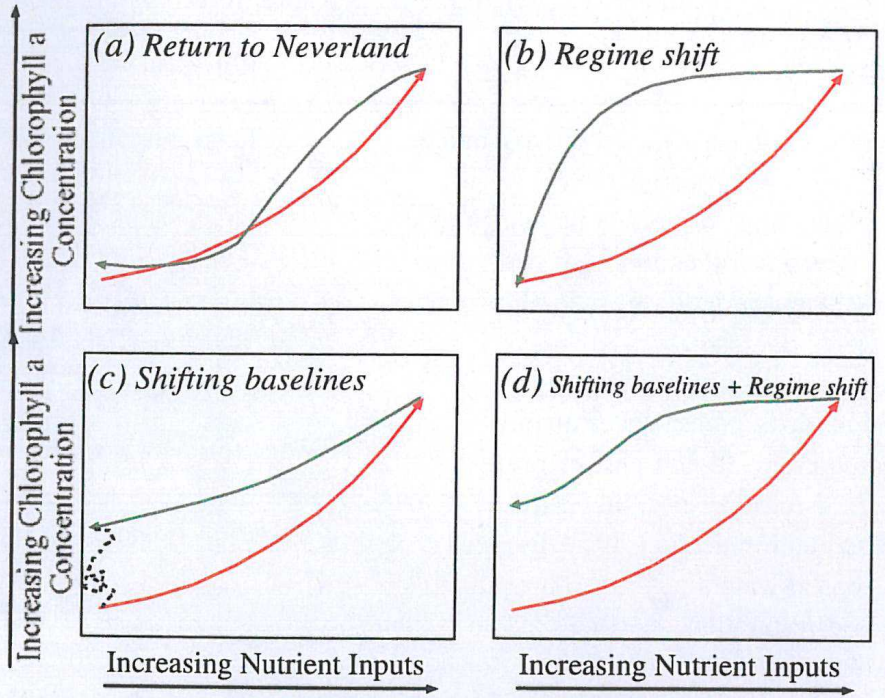


Fig. 1 Idealized trajectories of chlorophyll a concentrations, as an indicator of ecosystem status, and nutrient inputs to coastal ecosystems under increasing (*red line*) and decreasing (*green line*) nutrient inputs under different response scenarios: **a** "Return to Neverland" scenario implying a 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

OSPAR
Regional Sea Convention

WFD
Water Framework Directive

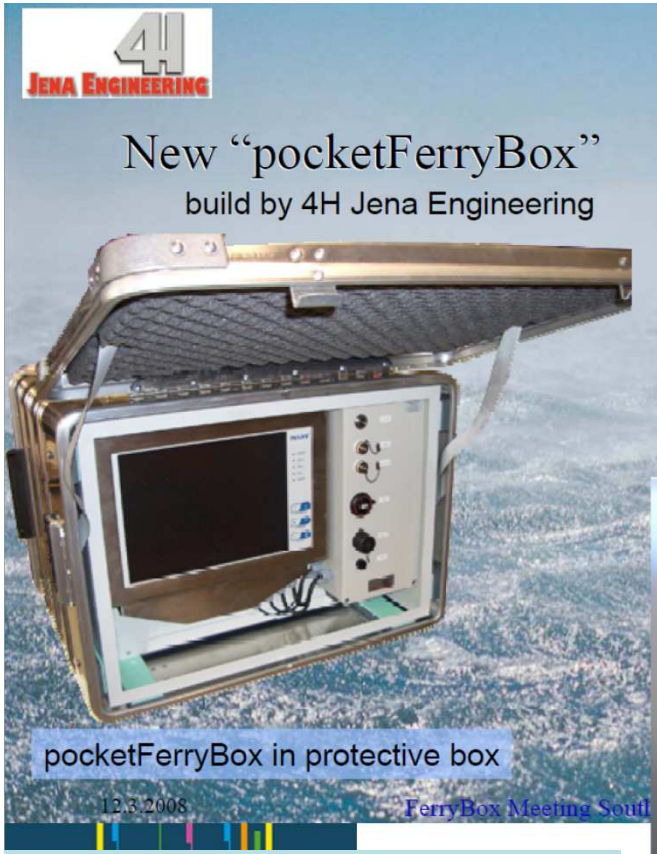
MSFD
Marine Strategy Framework Directive

MPA
Marine Protected Area

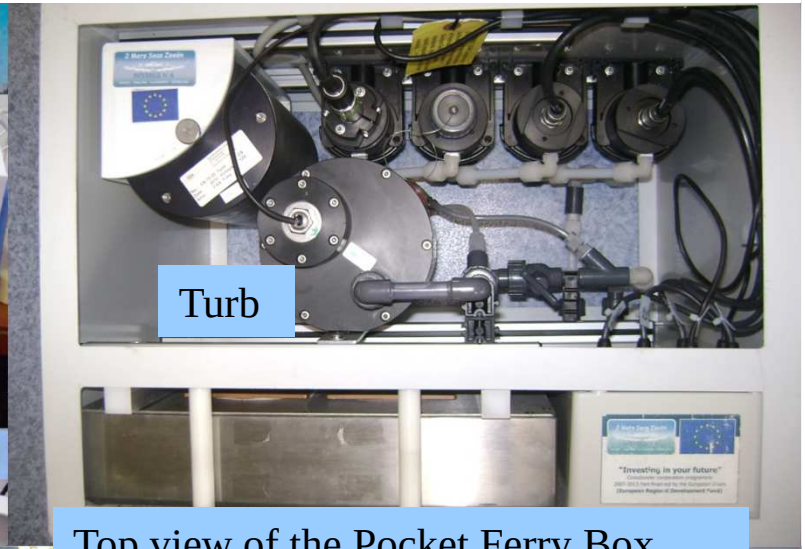
…

High resolution monitoring of water quality in the eastern English Channel

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

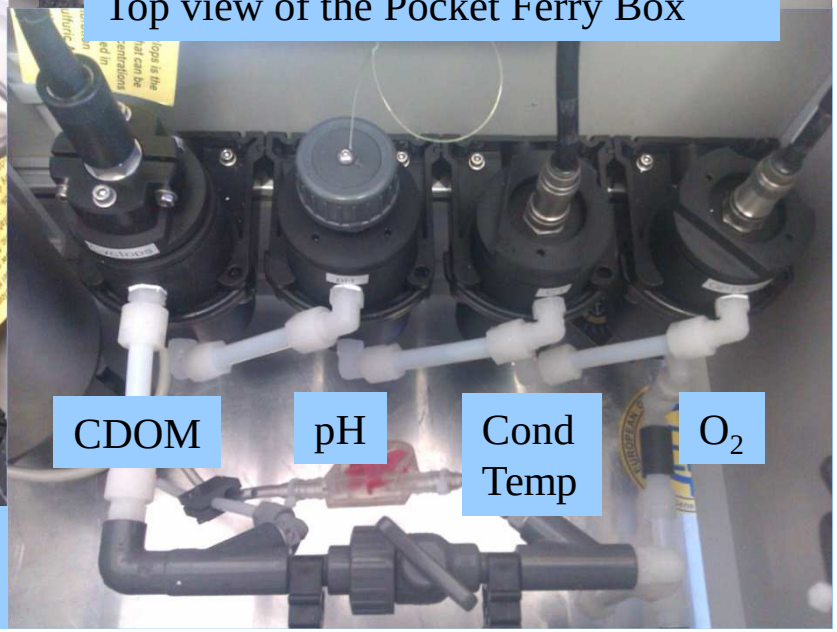


inner part of pocketFerryBox



Top view of the Pocket Ferry Box

Algae Online Analyzer (AOA, bbe©)

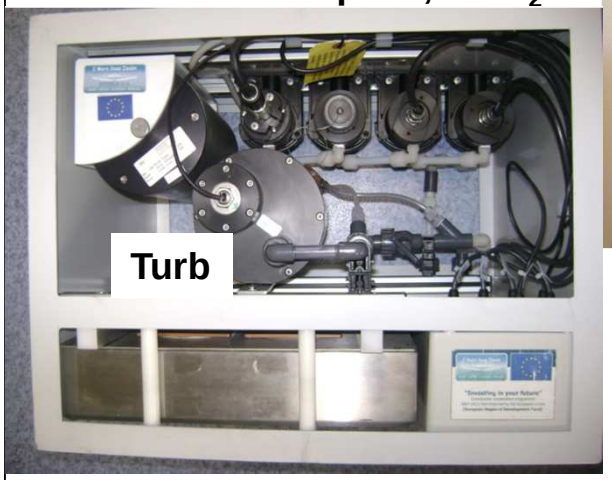


Portable device (<27 kg)
Easy power supply
Continuous measurements
Total time constant < 2 min
GPS

The Pocket Ferry Box and the Algae Online Analyser

Pocket FerryBox
(top view)

AOA CDOM pH T, S O_2



Pocket FerryBox
(Front view)

Battery

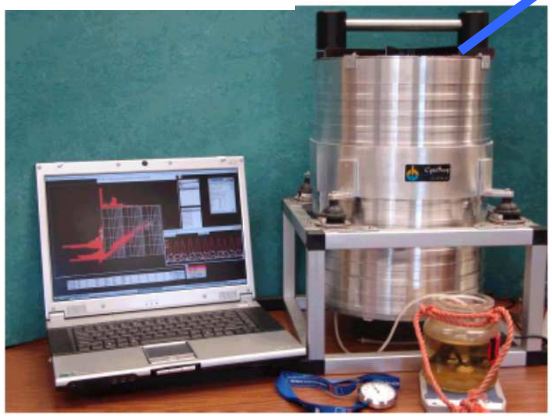
Pump

Input

Output

Ysi 6600 V2 data sonde
(+ Flow Cell)

Flow cytometer



RV Côtes de la Manche

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

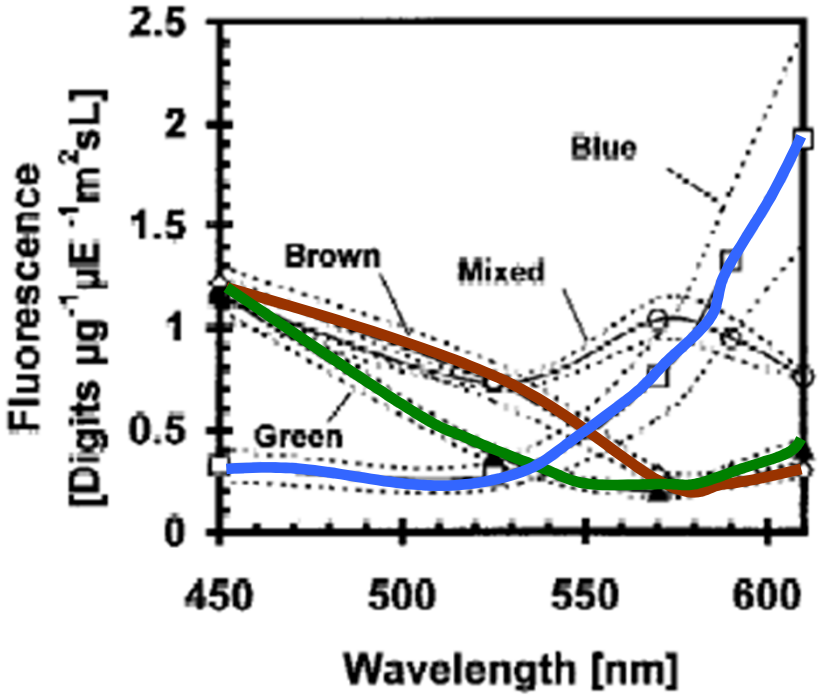
Main principle

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) (Source : Beutler et al., 2002)

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The Algae Online Analyzer (AOA - bbe) and its fingerprints

Parameters of fit (2011-03-24)

Offsets LEDs — filtrated water — distilled water

Hold for Refit | Cancel

	1	2	3	4	5	UV
F	11.093	3.3564	3.4712	3.3331	9.3363	16.953
F0						—
FM						—

global corr. factor: 1

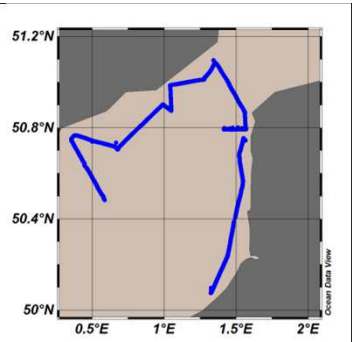
Algae classes

fit	type	name	factor LEDs 1	2	3	4	5	UV	standard deviation of LEDs 1	2	3	4	5	UV
☑	A	Green Algae	1.313	0.249	0.417	0.308	2.417	2.793	0.1	0.1	0.1	0.1	0.1	0.1
☑	A	Bluegreen	0.955	1.041	2.217	1.431	0.237	1.259	0.1	0.1	0.1	0.1	0.1	0.1
☑	A	Diatoms	7.149	0.794	0.746	0.633	6.972	6.647	0.1	0.1	0.1	0.1	0.1	0.1
☑	A	Cryptophyta	4.115	1.578	1.056	1.202	3.129	3.149	0.1	0.1	0.1	0.1	0.1	0.1
☐	A	Phaeocystis	1	1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1
☐	A	Pseudonitzschia	4.49748	0.50878	0.48567	0.45056	4.50818	1.87941	0.1	0.1	0.1	0.1	0.1	0.1
☐	Y	#6	1	1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1
☑	Y	Yellow substances	3.165	0.298	0.13	0.201	4.574	15.185	0.1	0.1	0.1	0.1	0.1	0.1

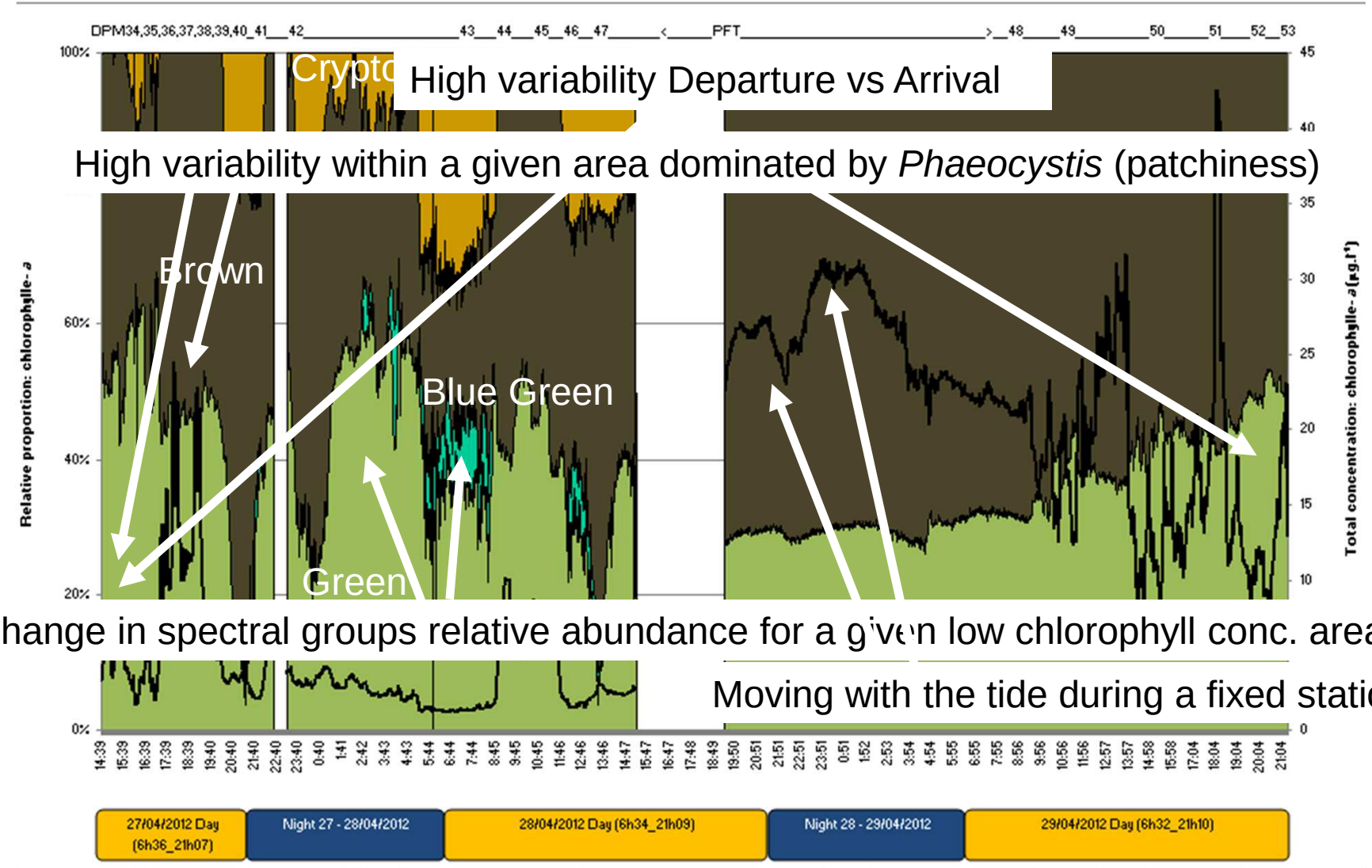
Original Fingerprints

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

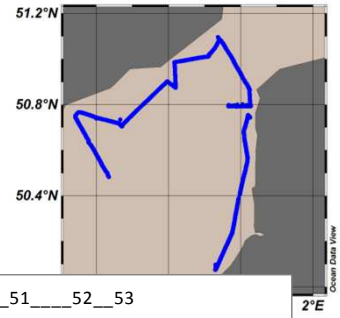
High variability within a given area dominated by *Phaeocystis* (patchiness)

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*



DP M34,35,36,37,38,39,40_41___42_____43___44___45__46__47_____<_____PFT_____>__48_____49_____50_____51____52__53

Phaeocystis

Crypto

Blue Green

Phaeocystis

Areas under freshwater influence

Brown

Relative proportion: chlorophyllea

Total concentration: chlorophyllea (µg.l^{-1})

100% 80% 60% 40% 20% 0%

45 40 35 30 25 20 15 10 5 0

14:39 15:39 16:39 17:39 18:39 19:40 20:40 21:40 22:40 23:40 0:40 1:41 2:42 3:43 4:43 5:44 6:44 7:44 8:45 9:45 10:45 11:46 12:46 13:46 14:47 15:47 16:47 17:48 18:49 19:50 20:51 21:51 22:51 23:51 0:51 1:52 2:53 3:54 4:54 5:55 6:55 7:55 8:56 9:56 10:56 11:56 12:57 13:57 14:58 15:58 17:04 18:04 19:04 20:04 21:04

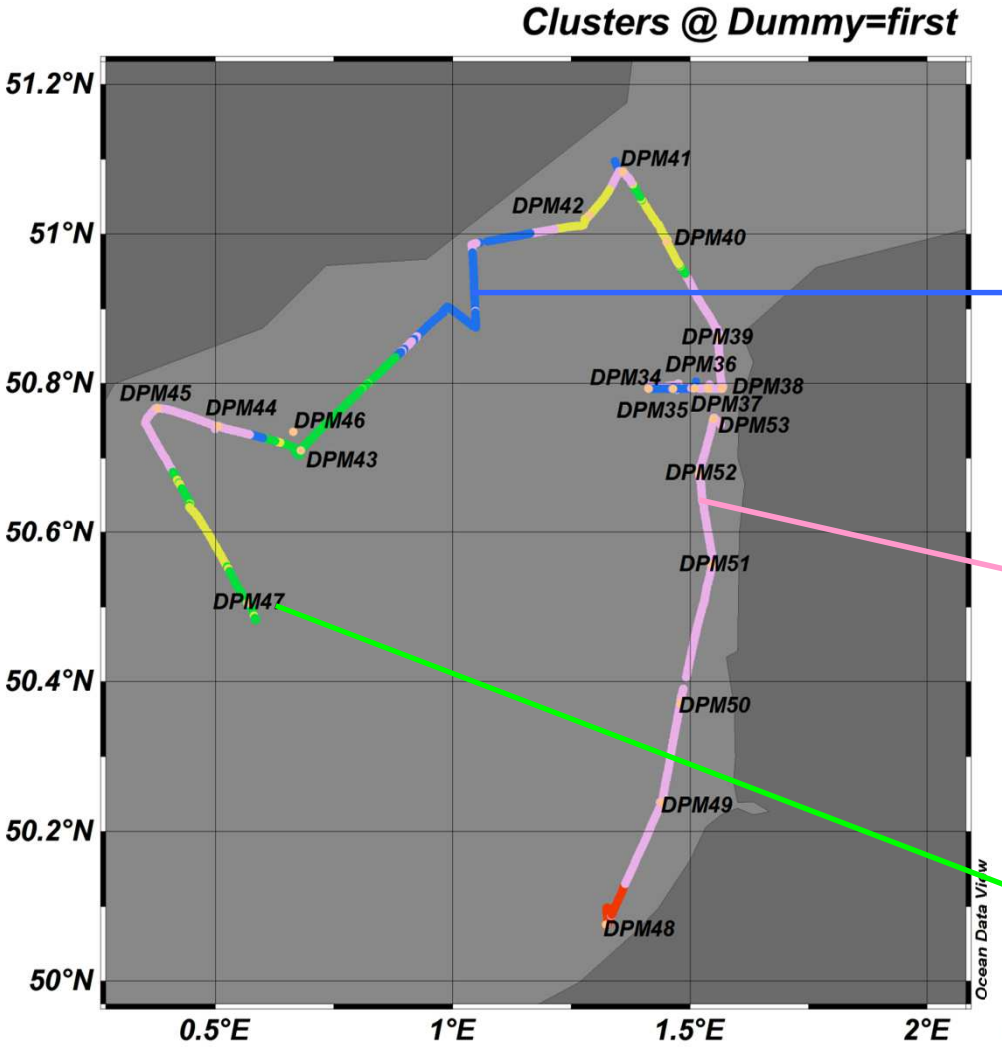
27/04/2012 Day (6h36_21h07) | Night 27 - 28/04/2012 | 28/04/2012 Day (6h34_21h09) | Night 28 - 29/04/2012 | 29/04/2012 Day (6h32_21h10)

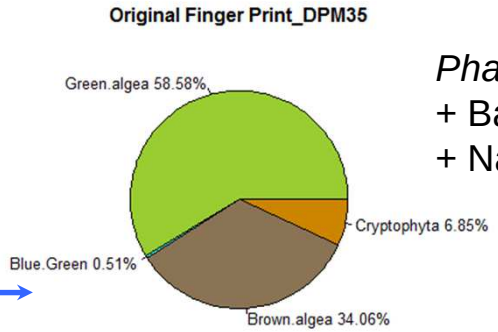
LEG 2 – April, 27-29, 2012

Hierarchical classification & associated spectral groups

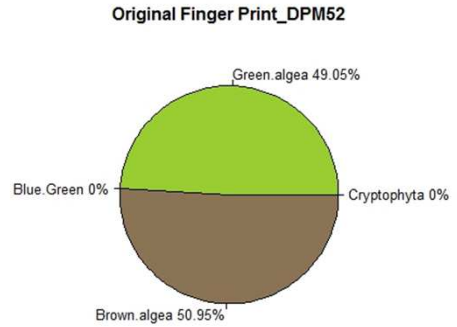
↳Real time Preliminary taxonomic approach

AOA Original Fingerprints **Inverted Microscopy**

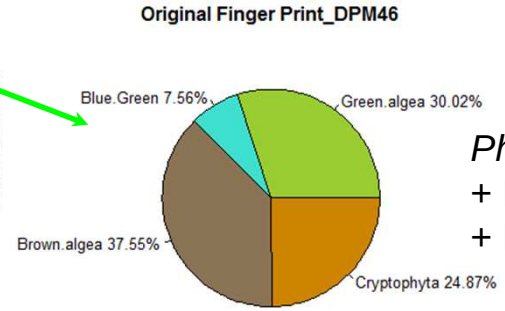




Phaeocystis
+ Bacillariophyceae
+ Nano~Picoplankton ?



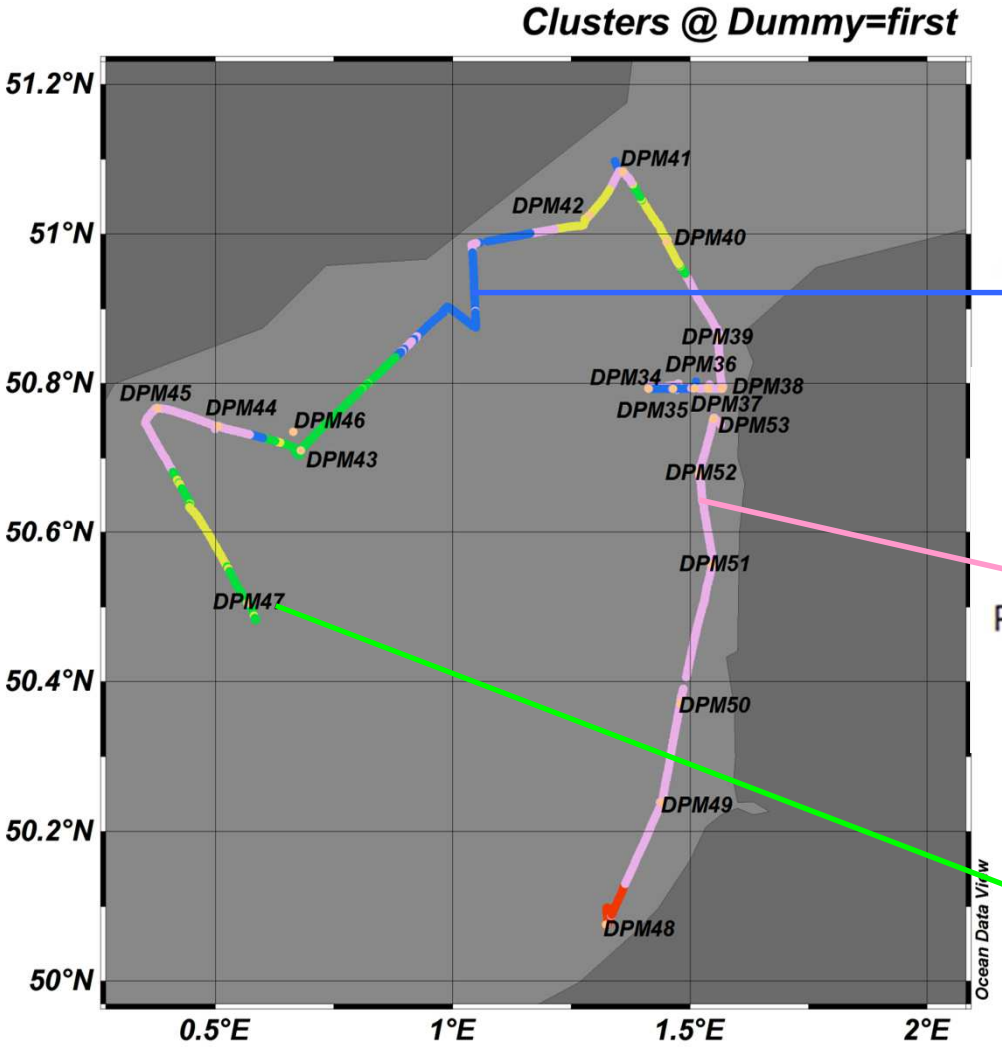
95 % *Phaeocystis*
(> 4 to 10.10^6 cell.l^{-1})

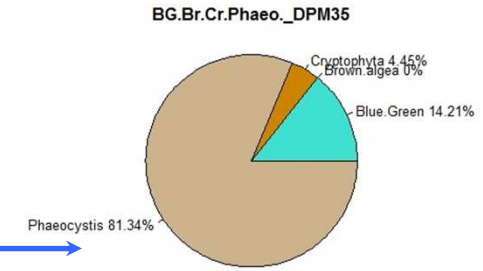


Phaeocystis
+ Bacillariophyceae
+ Nano~Picoplankton ?

LEG 2 – April, 27-29, 2012
Hierarchical classification & associated spectral groups
↳ Tracking *Phaeocystis* and direct/indirect effects

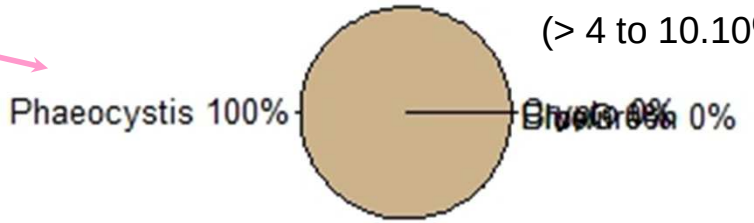
AOA Specific Fingerprints **Inverted Microscopy**



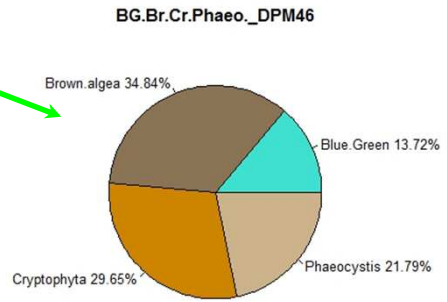


Phaeocystis
+ Bacillariophyceae
+ Nano~Picoplankton ?

BG.Br.Cr.Phaeo._DPM52



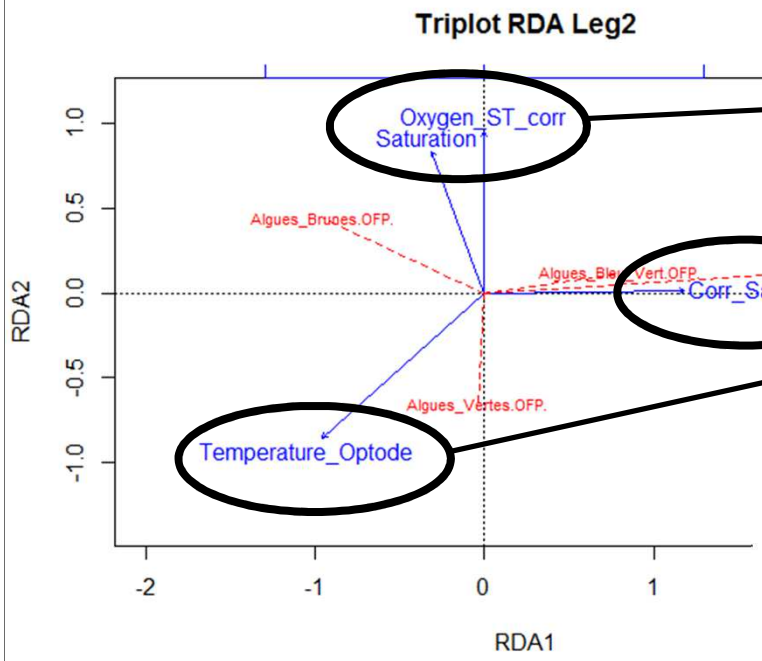
95 % *Phaeocystis*
(> 4 to 10.10^6 cell.l^{-1})



Phaeocystis
+ Bacillariophyceae
+ Nano~Picoplankton ?

LEG 2 – April, 27-29, 2012

Redundancy Analysis (Bio. x Envt. Matrix)



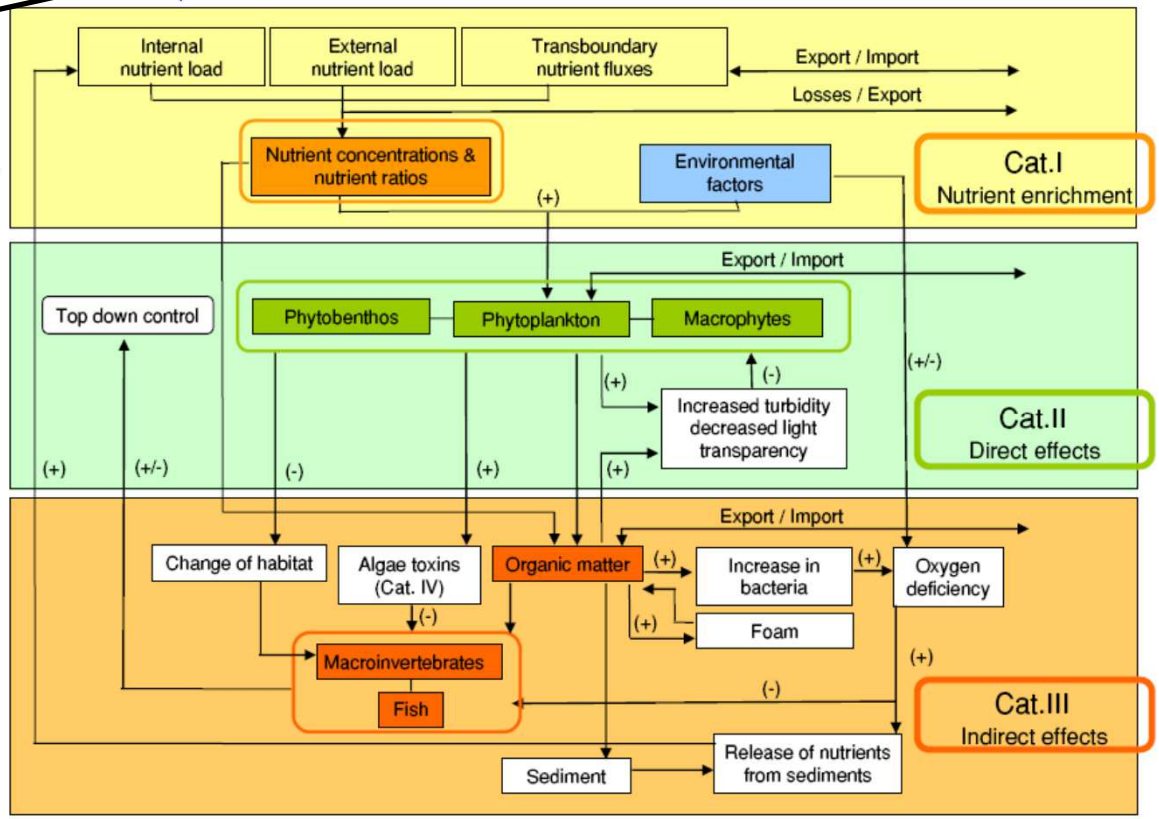
Effect / Response

"Pressure"

Water Quality Assessment

DPSIR approach

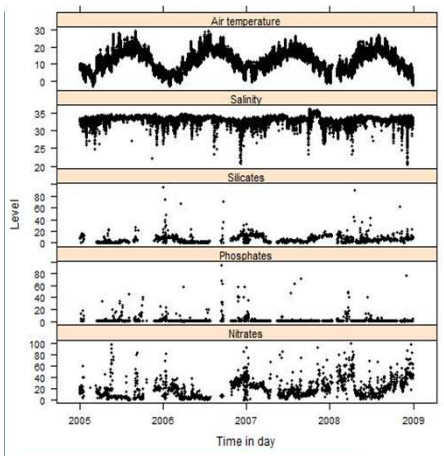
⇒Needs for further parameters (Ex. nutrients)



Monitoring system of phytoplankton blooms by using an Unsupervised Classifier and Time Modelling

See Poster:

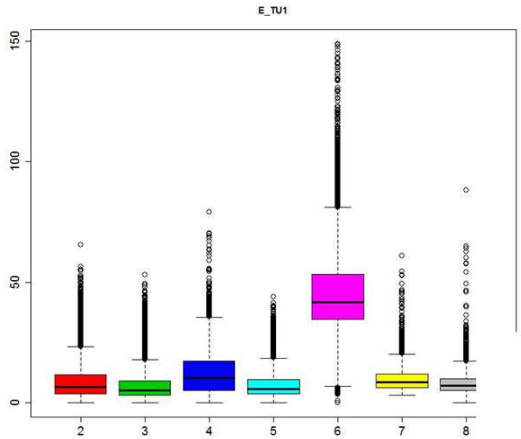
Detection and estimation of environmental states by unsupervised dynamics modelling. Application to FerryBox data. Rousseeuw K., Lefebvre A., Poisson Caillault E., Aimé-Roger Nzigou



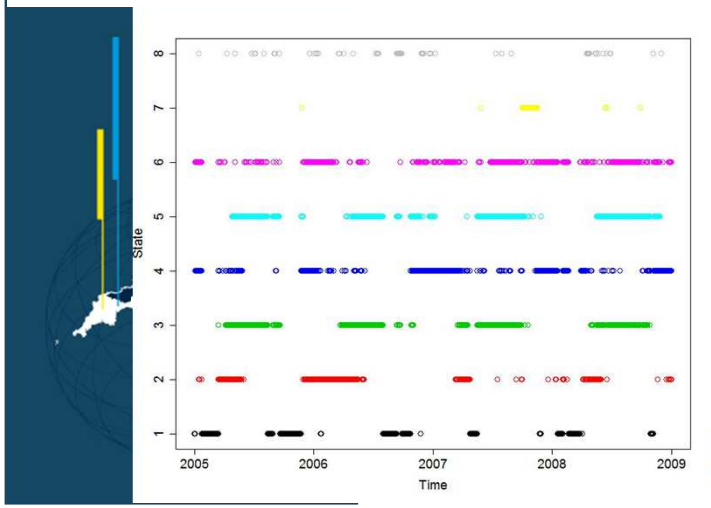
Data Set (X parameters)

Spectral Classification

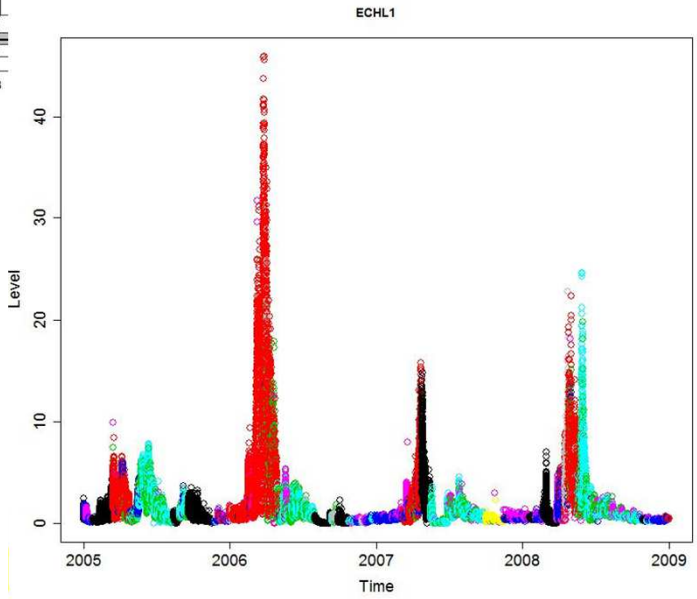
: States : Missing data



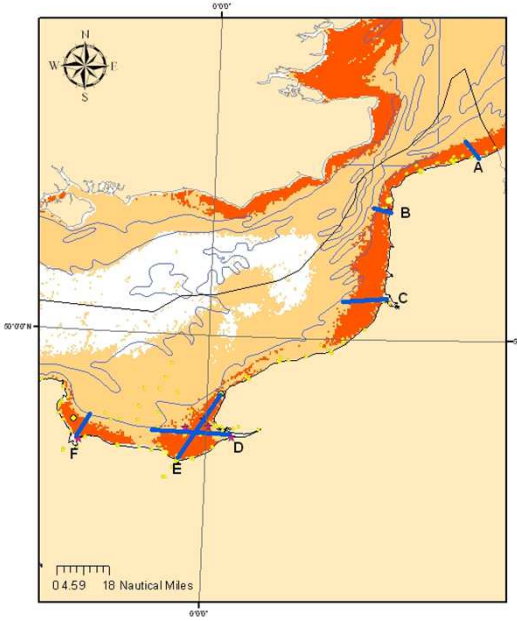
Y Clusters
(combination of X parameters)



Temporal dynamics
for the Clusters and
For a given parameter



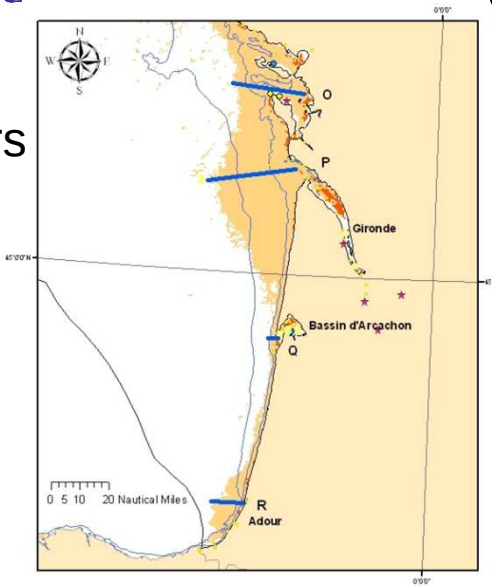
Marine Strategy Framework Directive (2008/56/EC) Proposal for the Monitoring Programme

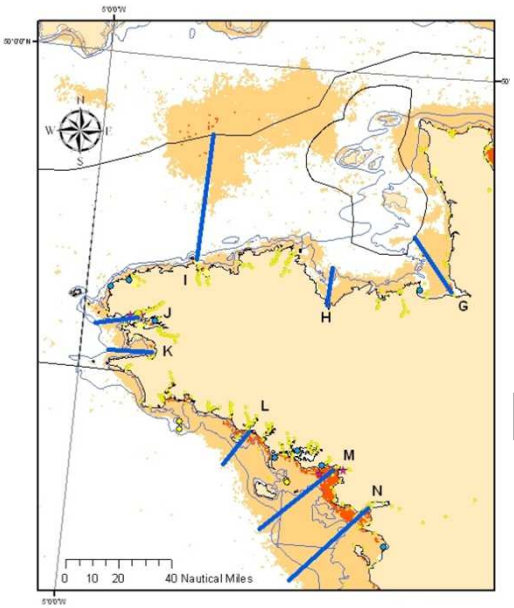


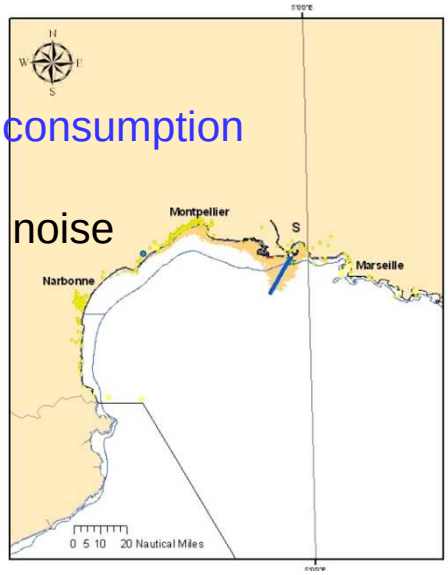
NEW: Ecosytem approach, offshore waters

Qualitative descriptors for determining GES

D 1: Biological diversity
D 2: Non-indigenous species
D 3: Population of commercial fish / shell fish
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

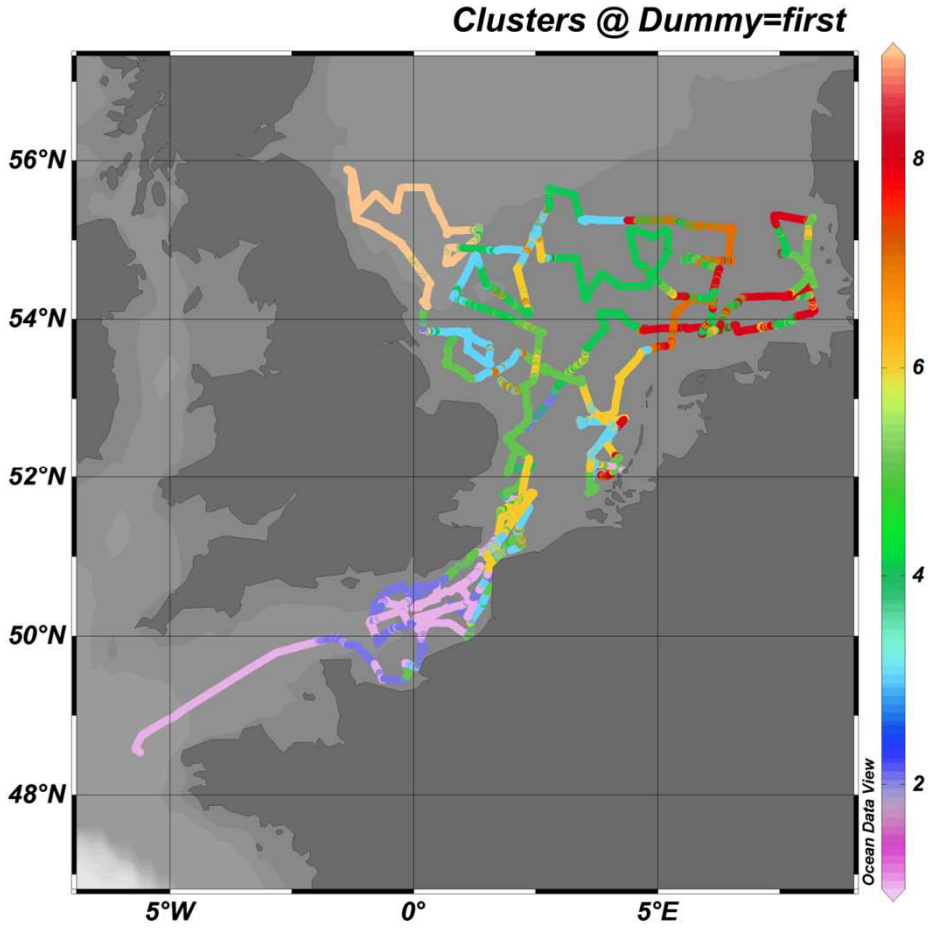
↳ Rare data on winter plankton communities in eastern English Channel and south of the North Sea.

↳ 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



INTERREG IVA 2 Mers Seas Zeeën Crossborder Cooperation Programme 2007-2013
Part-financed by the European Regional Development Fund (**ERDF**)

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

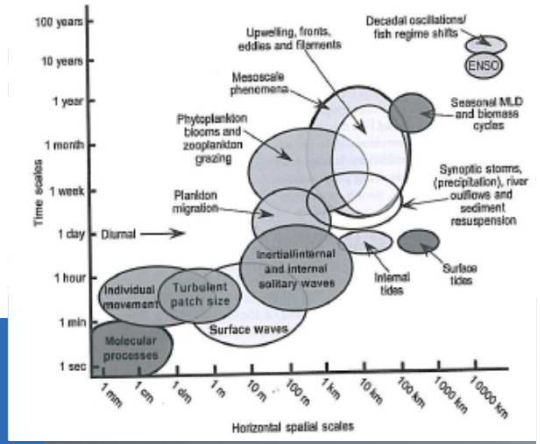
- Hydrology : main parameters measured and possibility to have more

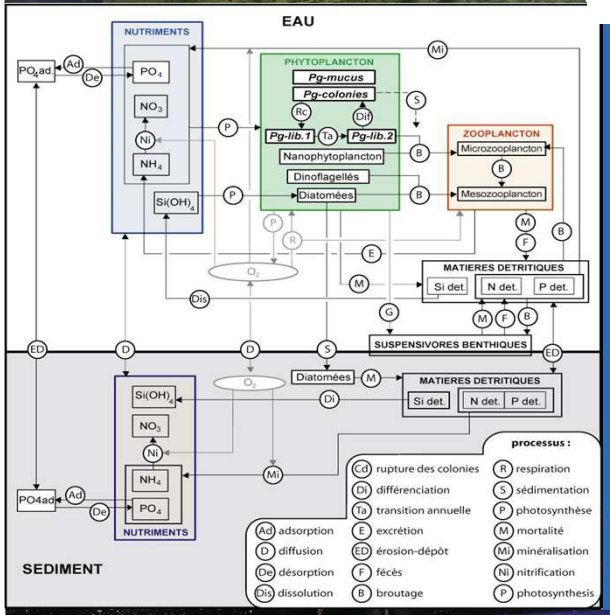
- *Phaeocystis* : further knowledge on bloom determinism and dynamics, HAB early warning system

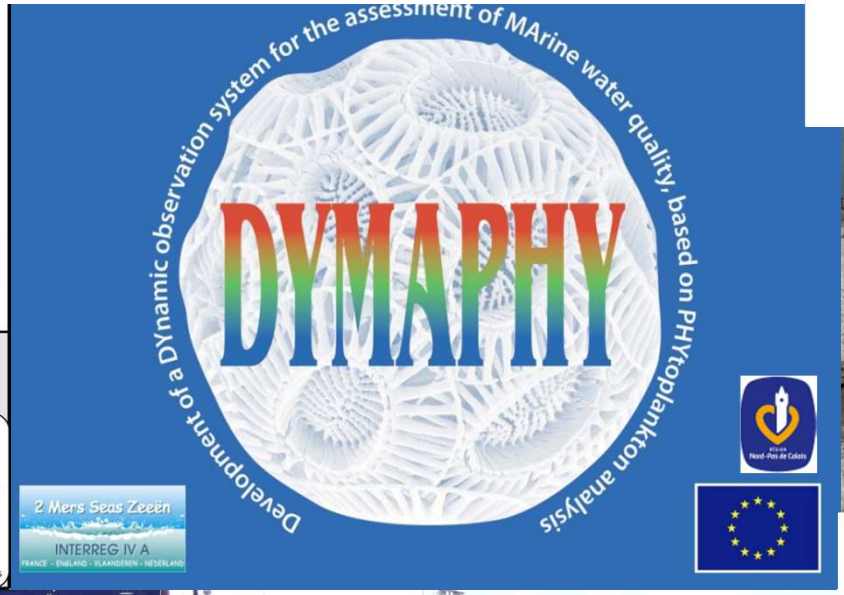
⇒ Implementation of a new monitoring program across the Channel ?
(to be confirmed in a few weeks)

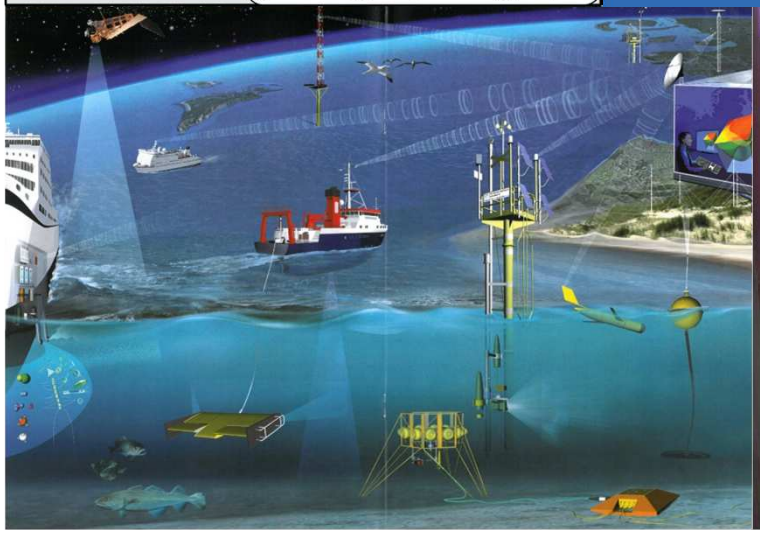
⇒ Increasing demand for implementation on board fisheries research vessels

Thanks for your attention









http://www.dymaphy.eu

Demonstration of the reliability of the HF coupled systems in the 2 Seas Regions

DONE

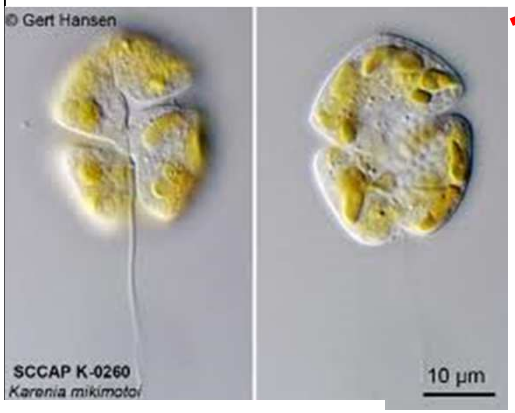
Phaeocystis globosa

Harmful Algal Bloom – High Biomass

Other applications ?

Scallops

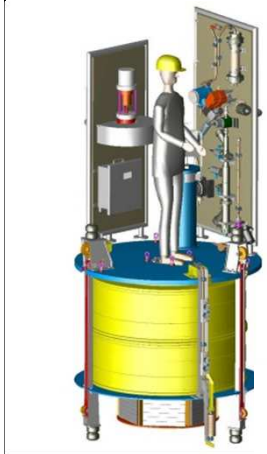
Most productive area in the Eastern English Channel



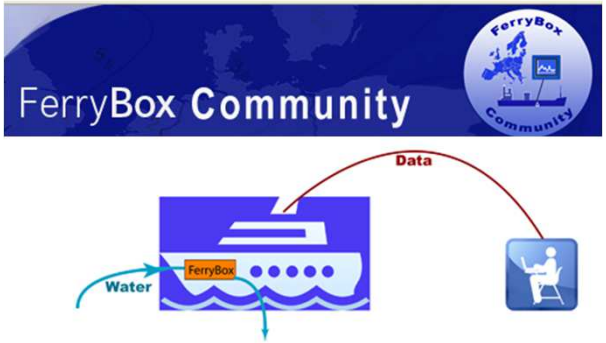
Karenia mikimotoï

HAB - ichtyotoxic

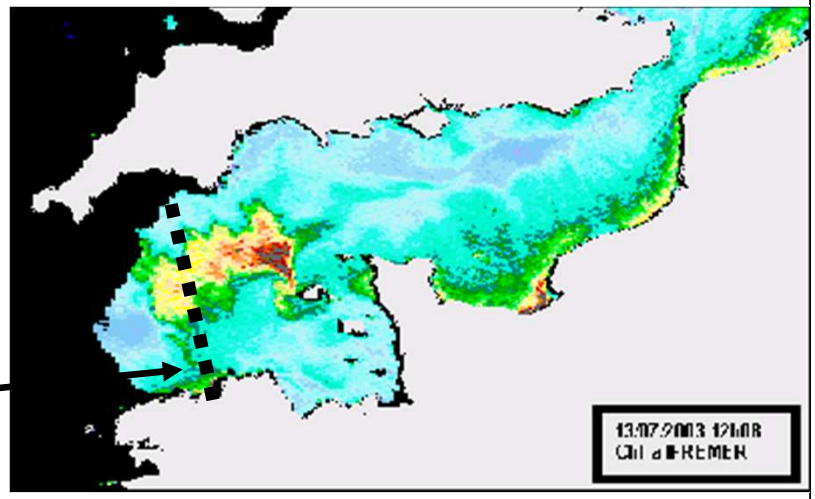
Other example of application - *K. mikimotoï* blooms



HF Instrumented Stations or Buoys

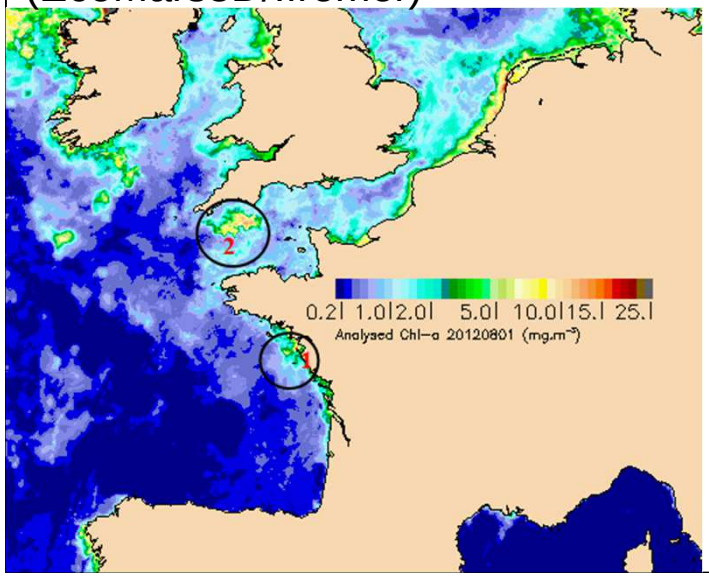


Ships of opportunity

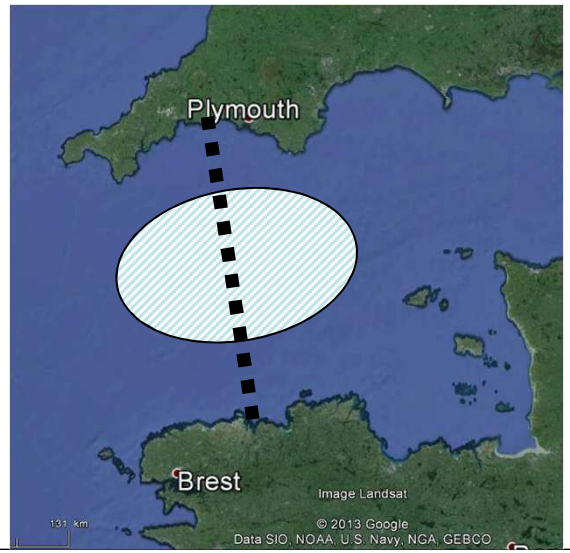


Satellite-derived products (SeaWifs/OC5)

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