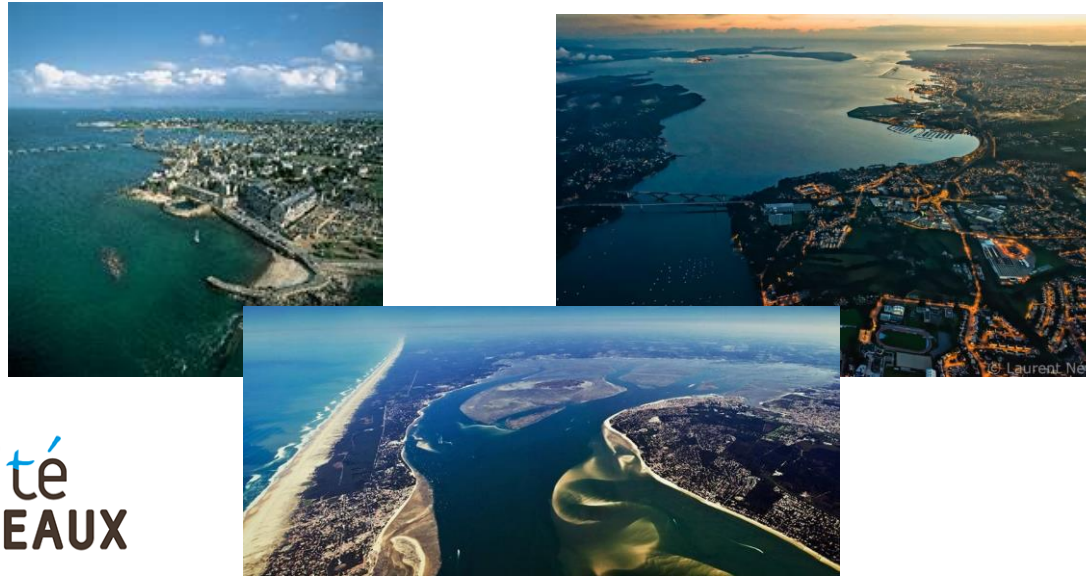


Evolution décennale du fonctionnement des écosystèmes côtiers : nutriments et biomasse chlorophyllienne

Stage de M2 SCIENCES de la MER
« Biologie et Ecologie Marines »
Samuel Rodriguez



université
de **BORDEAUX**



EPOC

Maîtres de Stage :

Nicolas Savoye, Yolanda Del Amo

en collaboration avec Stéphane L'Helguen et Pierre-Guy Sauriau (SOMLIT) et Valérie David



Evolution pluri-décennale du fonctionnement des écosystèmes côtiers : nutriments et biomasse chlorophyllienne

Decadal evolution of coastal system functioning: nutrients and chlorophyll biomass

S. Rodriguez¹, Y. Del Amo^{1*}, V. David¹, L. Bourasseau¹, Y. Bozec², T. Cariou³, M.-A. Cordier⁴, L. Costes⁵, S. Ferreira⁶, E. Grossteffan⁷, S. L. Helguen⁶, E. Macé⁶, F. Rigaud-Julabert⁷, P. Rimmelin-Maury³, P.-G. Sauriau⁷ and N. Savoye¹.

¹ UMR EPOC, Université de Bordeaux / CNRS, Arcachon/Pessac, France

² UMR AD2M, Université Pierre et Marie Curie / CNRS, Roscoff, France

³ FR Observatoire océanologique de Roscoff, Université Pierre et Marie Curie / CNRS, Roscoff, France

⁴ UMS OASU, Université de Bordeaux / CNRS, Pessac, France

⁵ UMS IUEM, Université de Bretagne Occidentale / CNRS, Plouzané, France

⁶ UMR LEMAR, Université de Bretagne Occidentale / CNRS, Plouzané, France

⁷ UMR LIENSs, Université de La Rochelle / CNRS, La Rochelle, France

* yolanda.del-amo@u-bordeaux.fr

Keywords: Coastal systems, nutrients, phytoplankton biomass, long-term trends, environmental forcing.

Abstract for oral presentation

Coastal systems play a key role in the transformation of biogenic elements and in marine productivity. The great diversity of these systems, as well as the spatial and temporal heterogeneity of the factors controlling the biogeochemical and biological processes governing those systems, contribute to their richness. Among these processes, phytoplankton primary production is directly impacted by nutrient inputs from watersheds. The nature and amount of these inputs directly affect the biological production rates and can account for ecological imbalances (nutritive, biomass and taxonomy). The aims of this study are 1) to characterize decadal changes in nutrient concentrations, 2) to identify the main drivers, and 3) to investigate consequences on chlorophyll biomass in order to better understand of evolution of coastal systems. This study focused on 3 contrasted systems of the Atlantic-English Channel façade over a 15-years period [2000-2015]. Results indicate system-specific evolutions. The littoral system of Roscoff is characterized by a decrease in benthic Si inputs that leads to a decrease in chlorophyll biomass. In the bay of Brest, the decrease in N, in line with similar decrease in river inputs, does not affect the chlorophyll biomass, suggesting that N is not the main limiting factor. At last, in Arcachon Bay, the increase of N concentrations, probably induced by the decline of eelgrass beds, leads to the increase in chlorophyll biomass. These results illustrate the diversity and complexity of the relationships between environmental drivers and abiotic and biotic compartments.

Rodriguez. S., et al , International COAST Meeting, 7 – 10 November 2017, Bordeaux, France.

EVOLECO

Évolution à long terme des écosystèmes côtiers
vers une mise en évidence des forçages et des processus
associés

Pessac, décembre 2017



Rodriguez. S., et al , EVOLECO Meeting, December 2017, Pessac, France.



INTERCOMPARAISON SOMLIT MARSEILLE 25 AU 29 SEPTEMBRE 2017

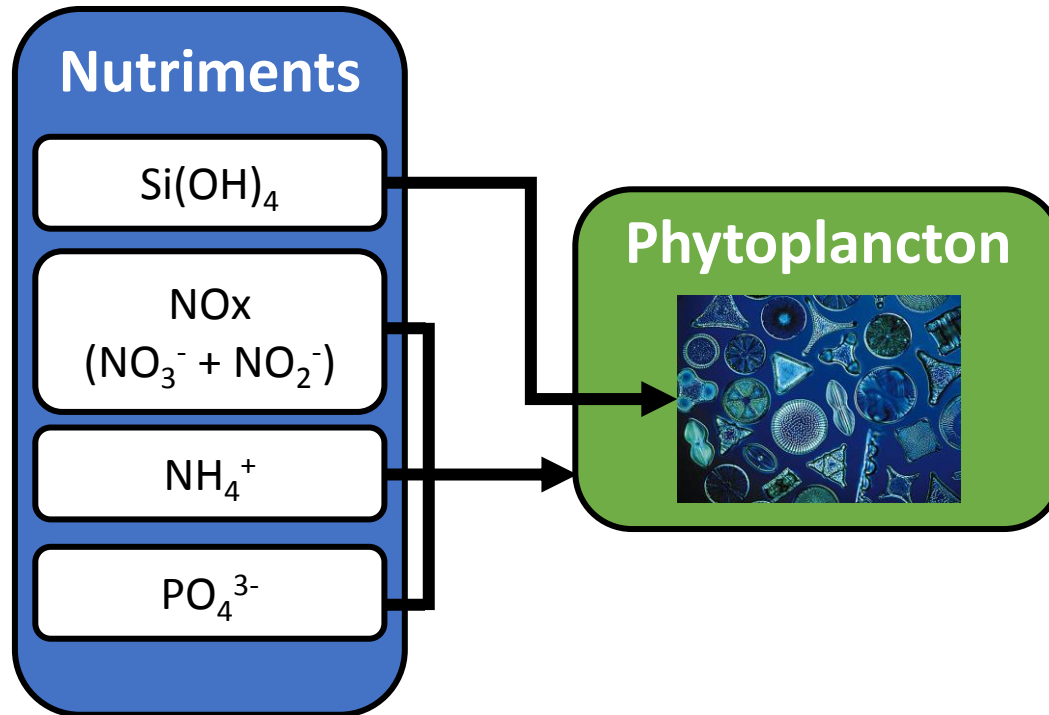
L'exercice
d'intercomparaison
annuel a lieu à
Marseille dans les
locaux
OCEANOMED du
M.I.O
(OSU Pythéas)

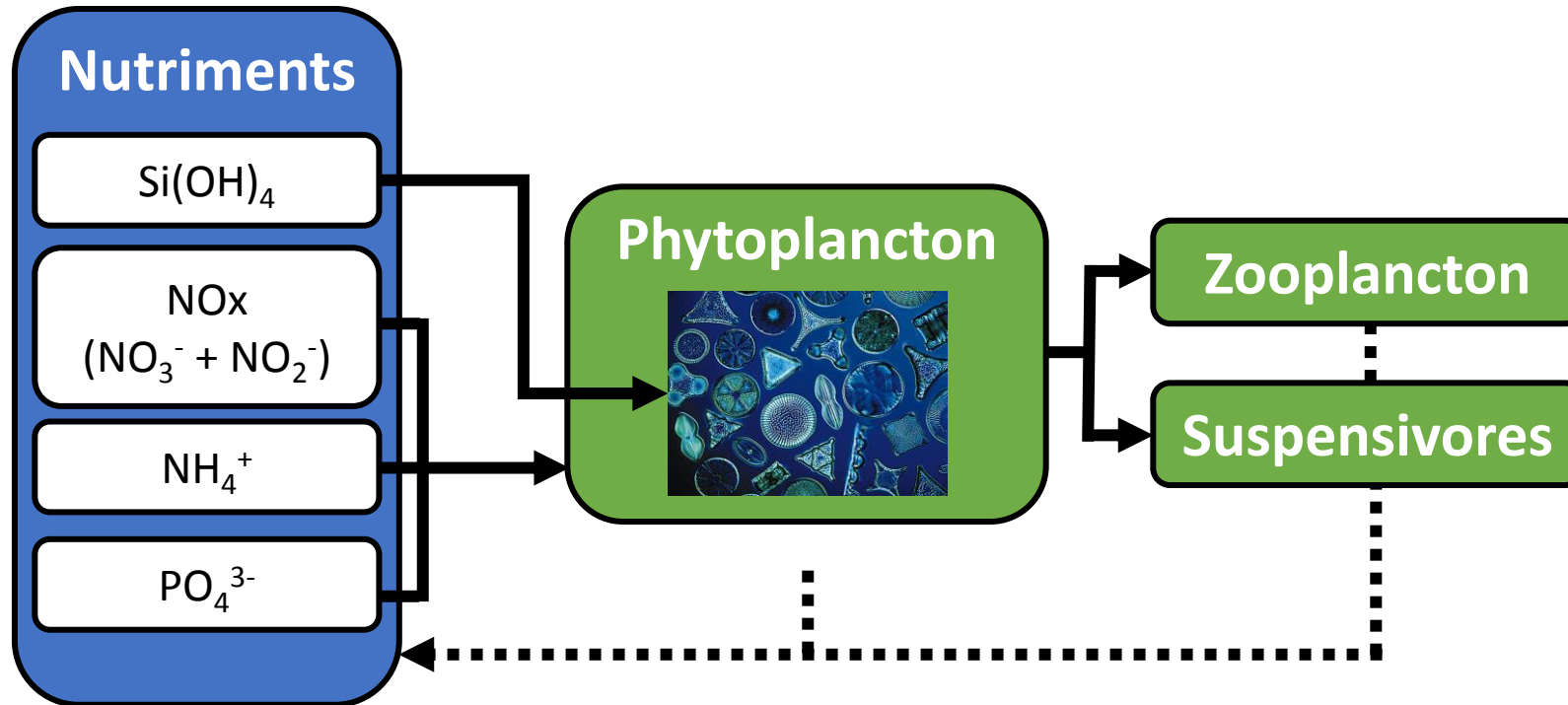
Il a pour but d'évaluer les pratiques
de chaque équipe dans le cadre de la
démarche Qualité, d'échanger sur
les besoins et évolutions techniques
dans le cadre de l'observation.

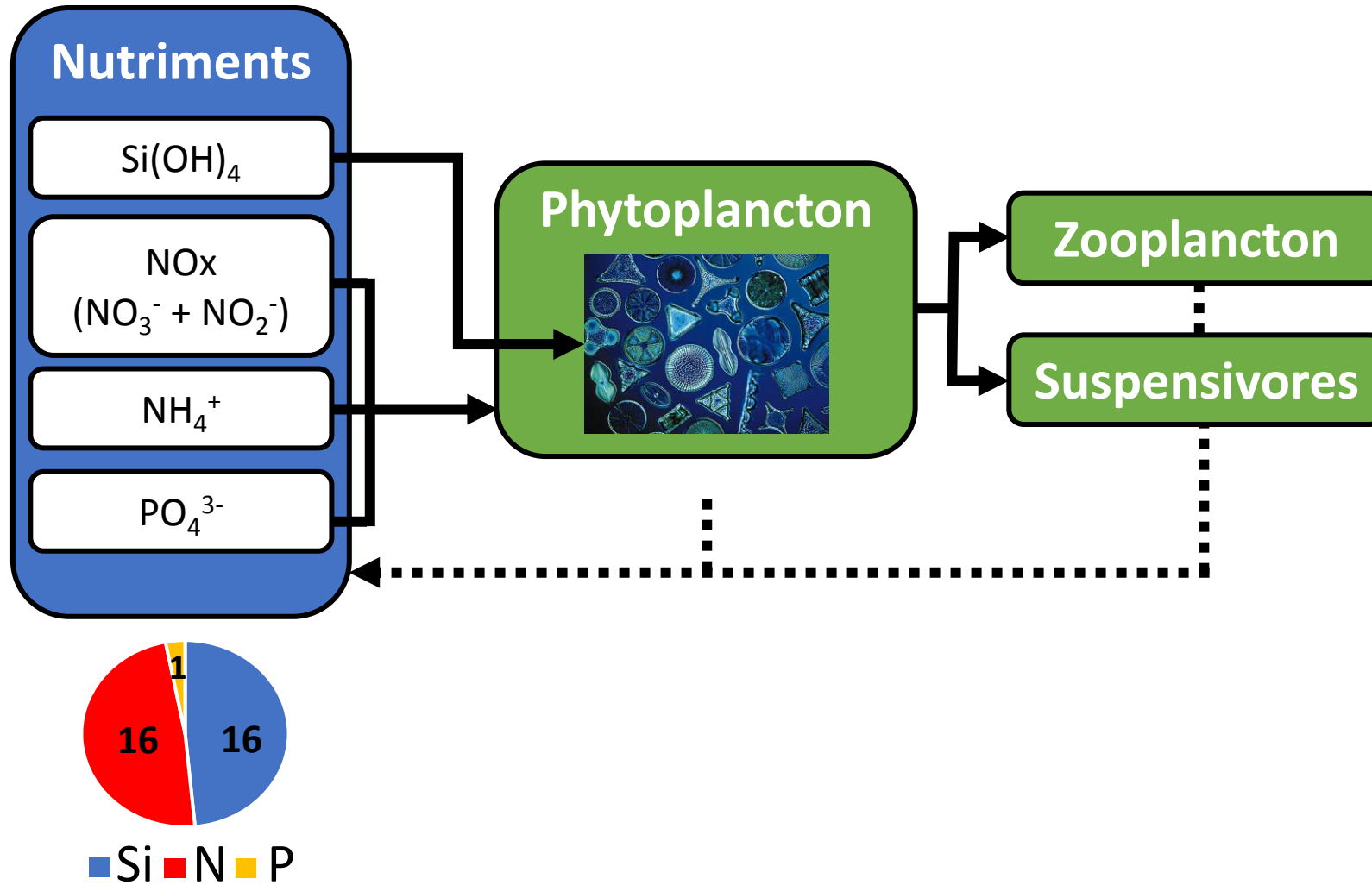
PROGRAMME		
	MATIN	APRÈS-MIDI
Lundi 25	Accueil des participants/Infos générales	
Mardi 26	Prélèvements pour paramètres dissous puis particulières	
Mercredi 27	Atelier : Prise en main de l'outil de visualisation de l'évolution décennale des données SOMLIT = MySOMLIT	Fin de l'atelier. Réunions générale et Qualité
Jeudi 28	Journée Scientifique : Après 20 ans, SOMLIT au cœur de l'observation côtière nationale. (Tout public)	
Vendredi 29	Départ des participants	

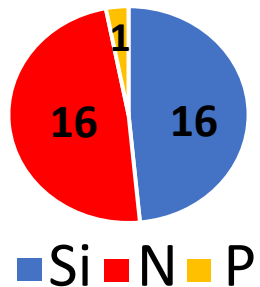
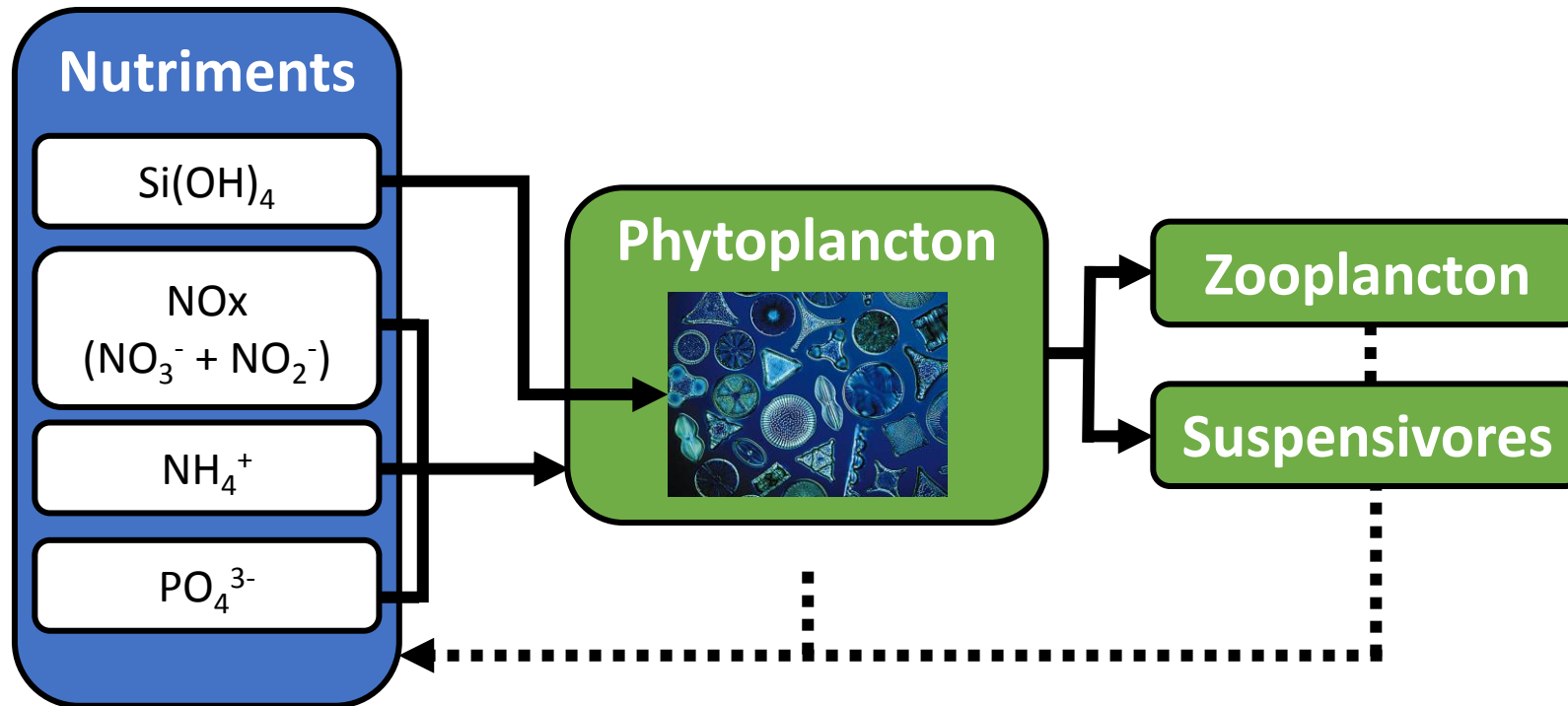
Rodriguez. S., et al , SOMLIT Meeting, 25 - 29 September 2017, Marseille, France.

Rôle des nutriments



Rôle des nutriments

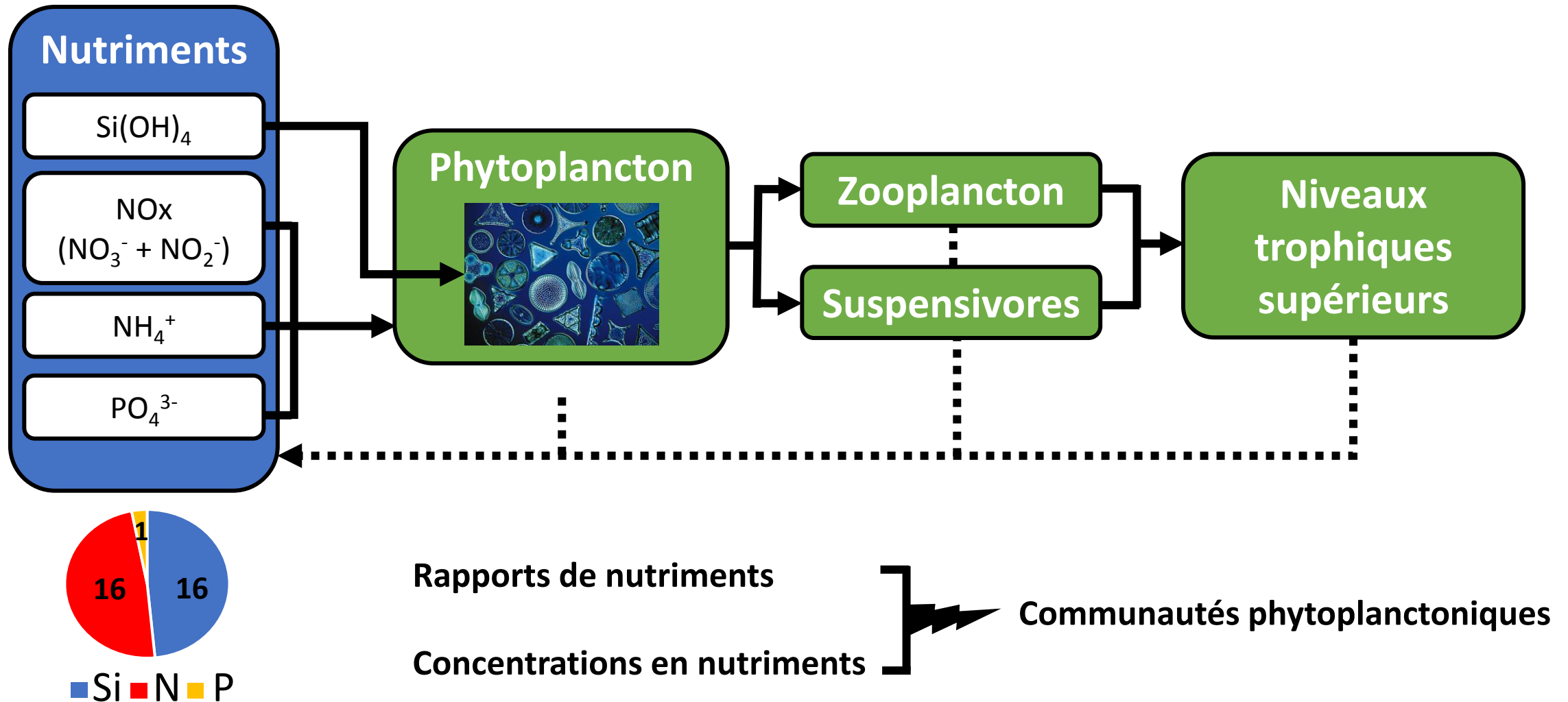
Rôle des nutriments

Rôle des nutriments

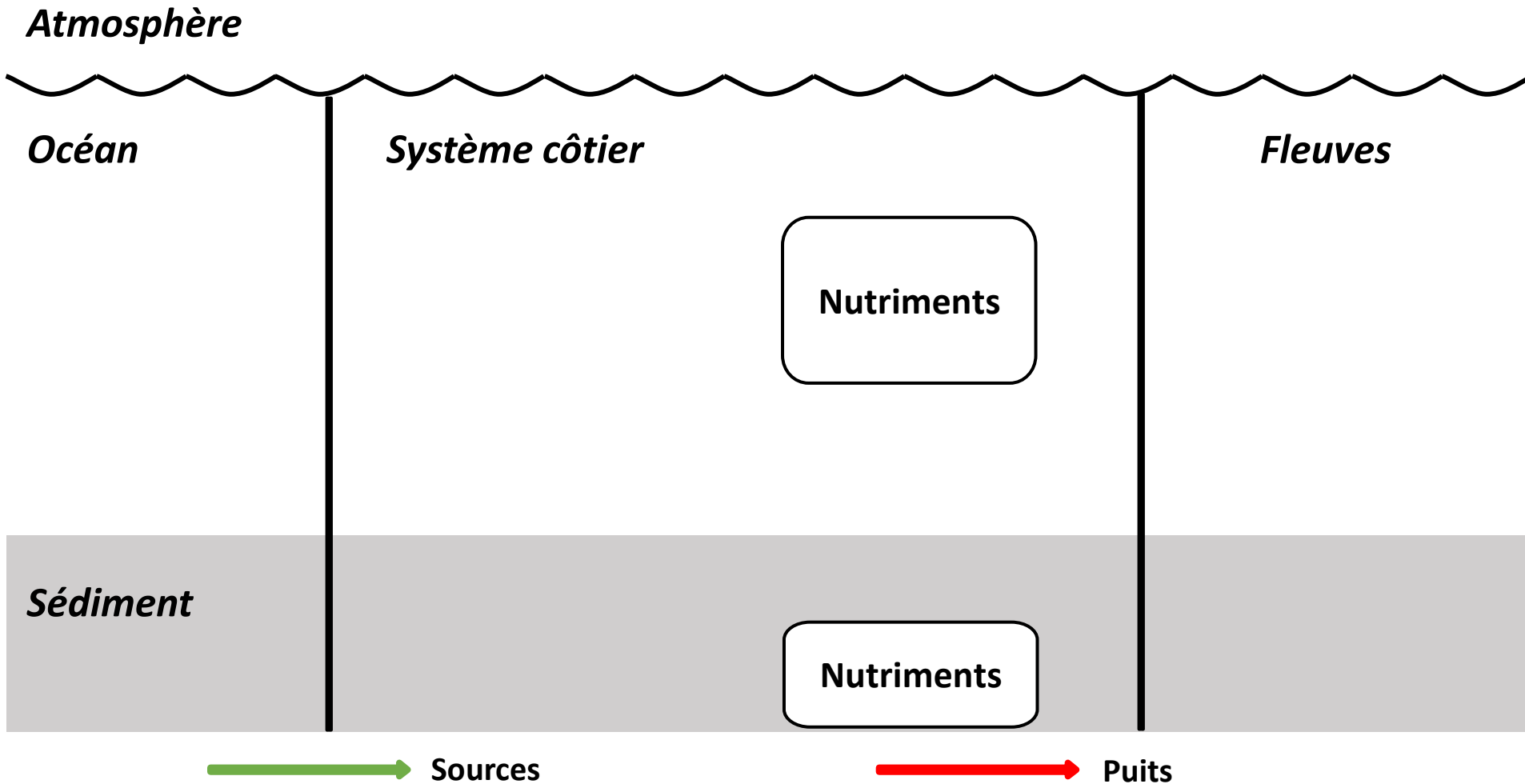
Rapports de nutriments

Concentrations en nutriments

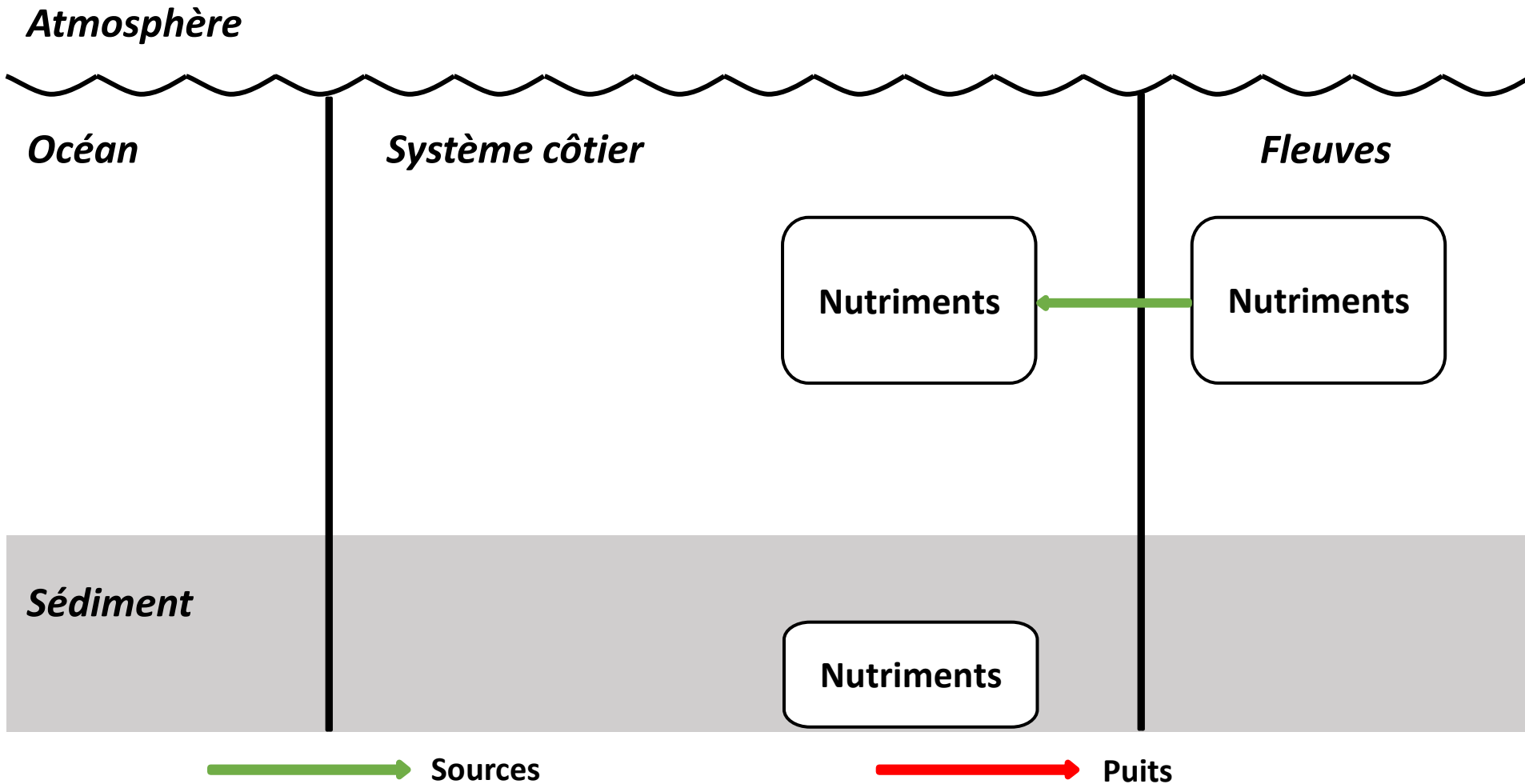
Communités phytoplanctoniques

Rôle des nutriments

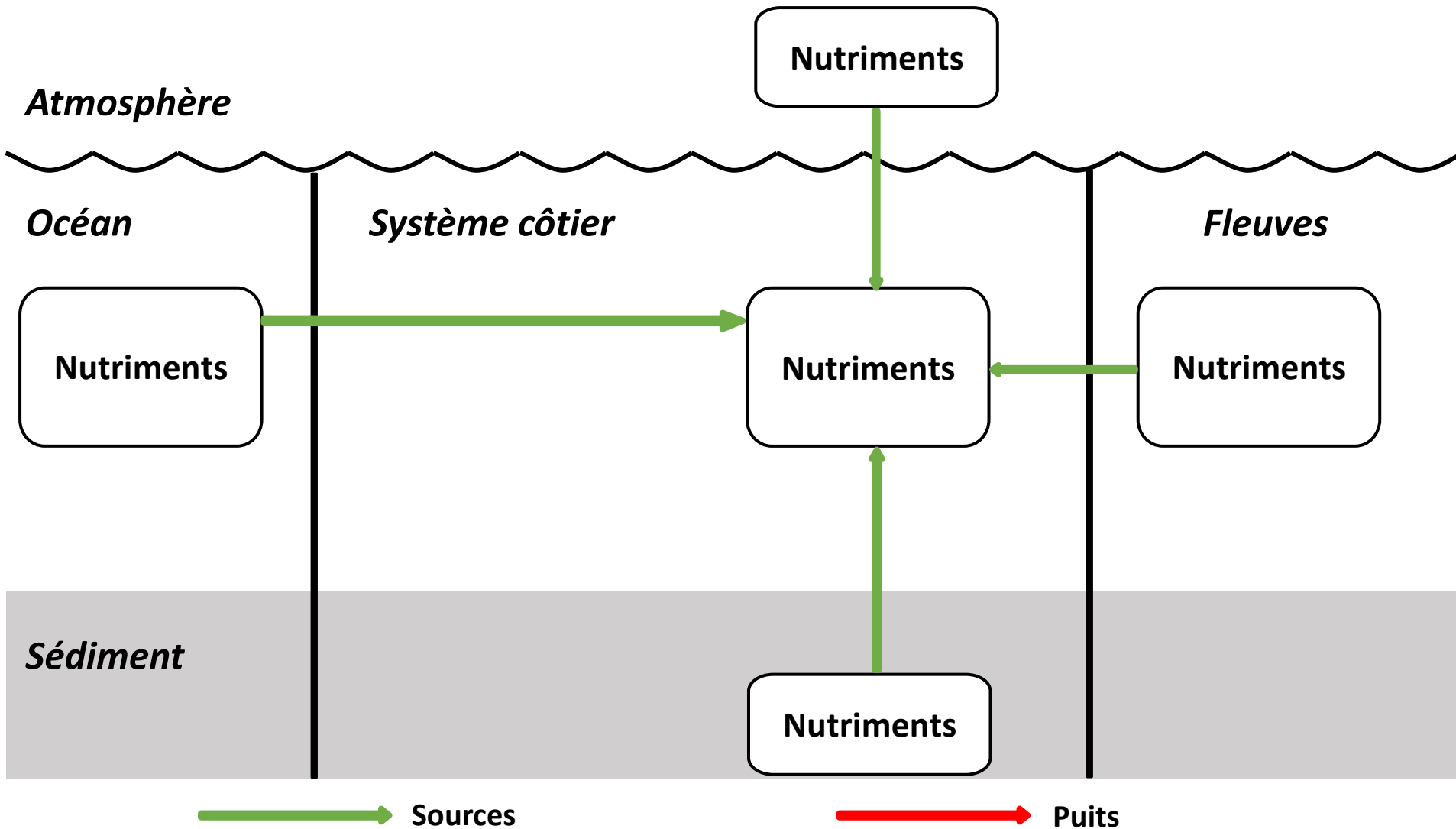
Les nutriments dans les systèmes côtiers



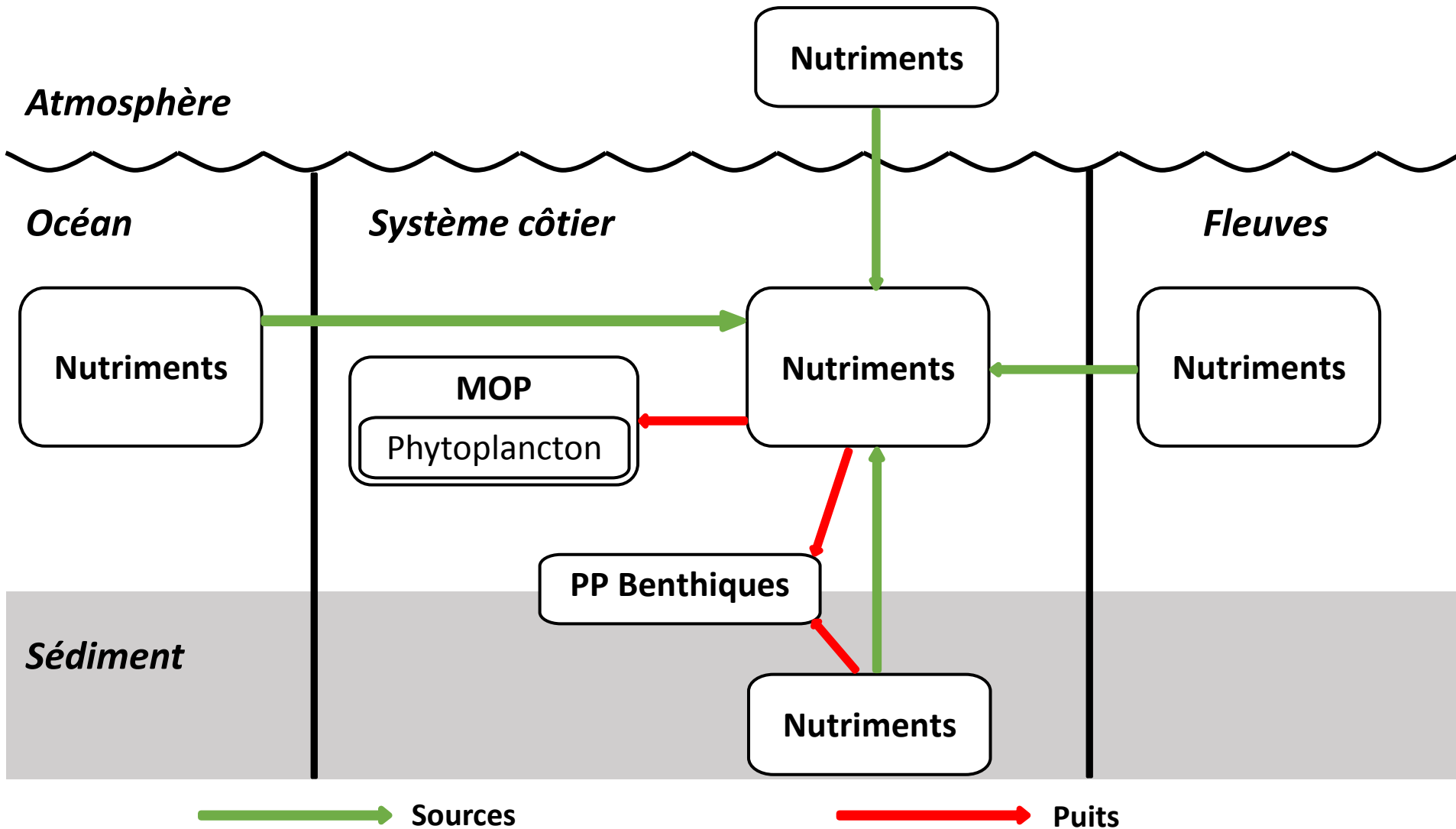
Les nutriments dans les systèmes côtiers



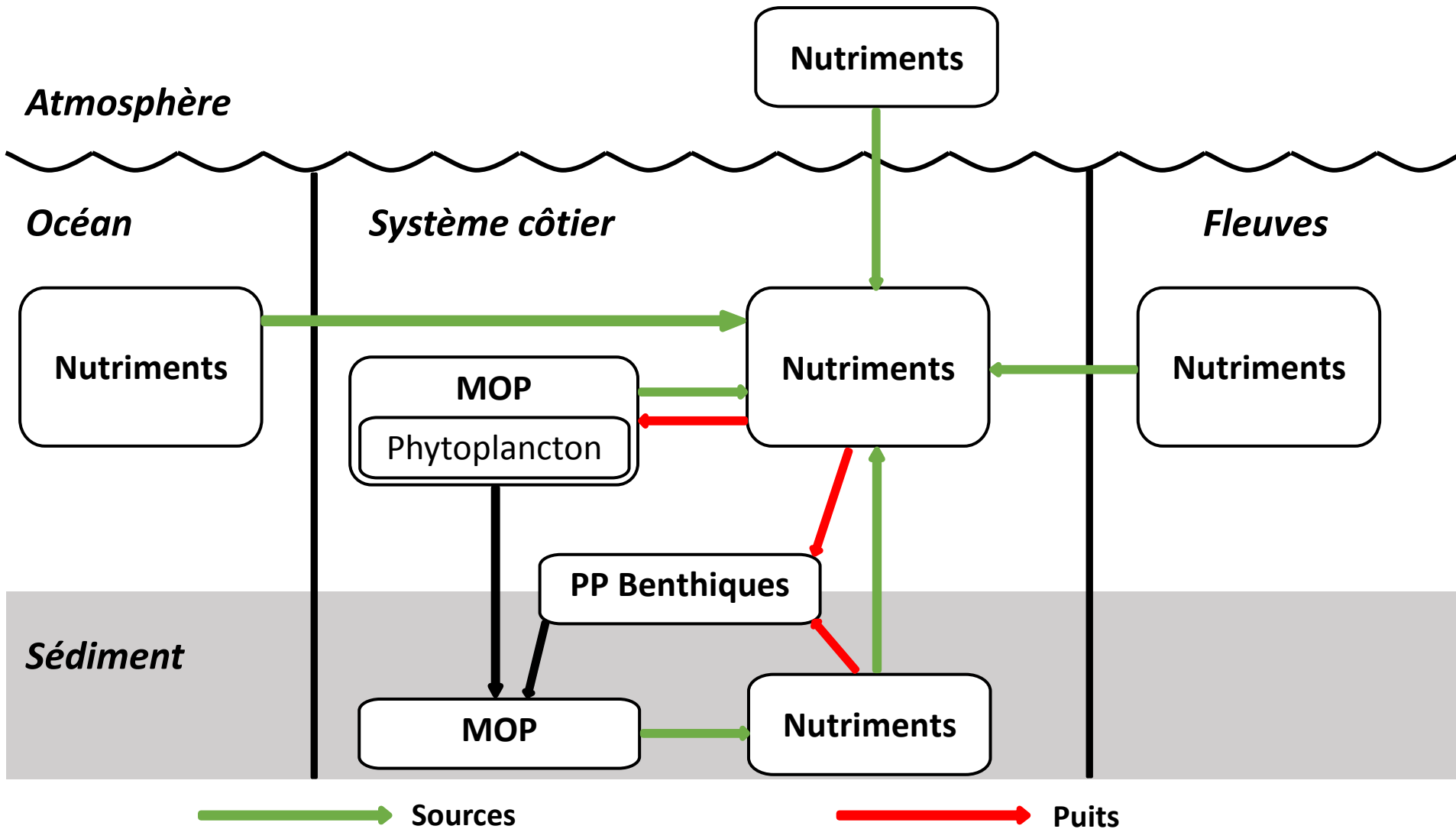
Les nutriments dans les systèmes côtiers



Les nutriments dans les systèmes côtiers

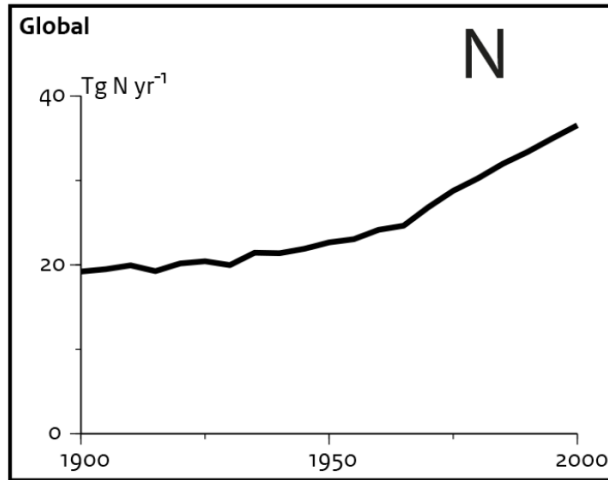


Les nutriments dans les systèmes côtiers



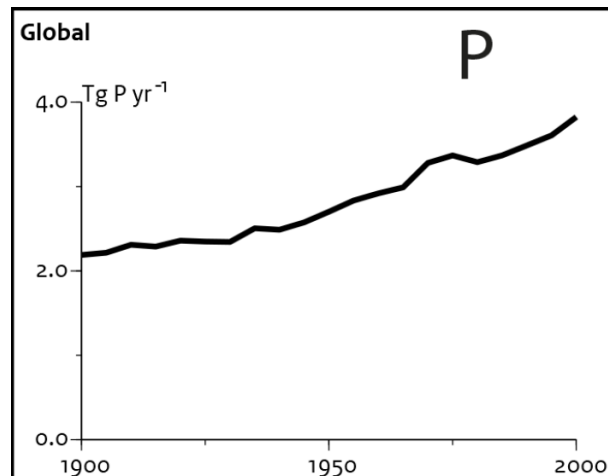
Apports de nutriments aux océans via les fleuves

Fleuves mondiaux



19 - 37 Tg.an⁻¹

→ + 90%

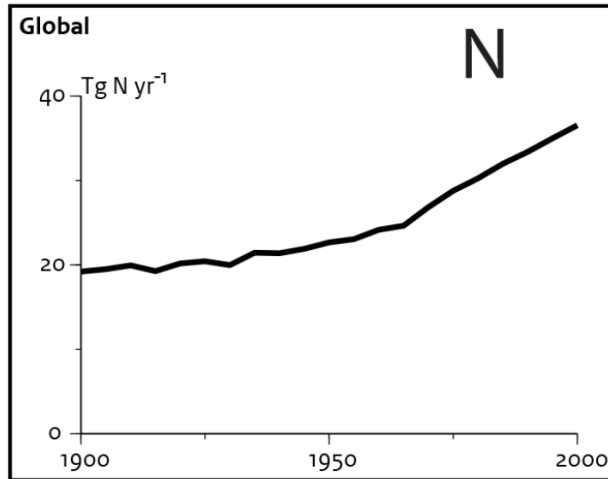


2 - 4 Tg.an⁻¹

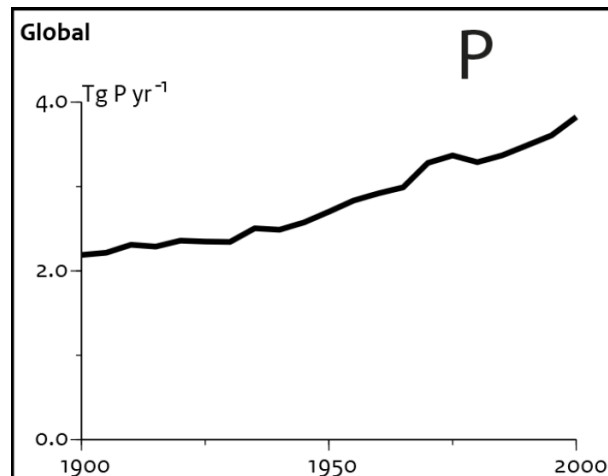
→ + 75%

Apports de nutriments aux océans via les fleuves

Fleuves mondiaux

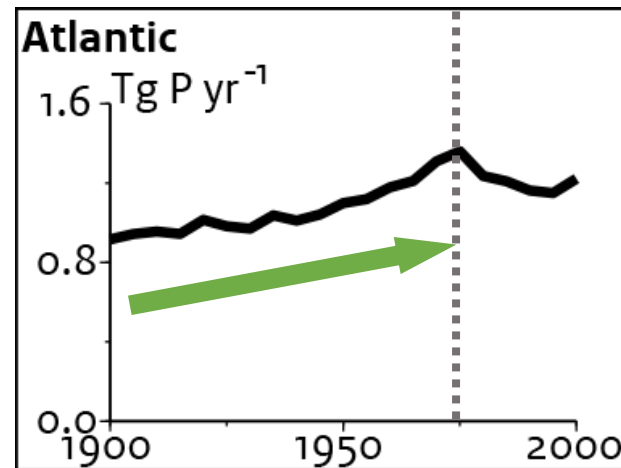
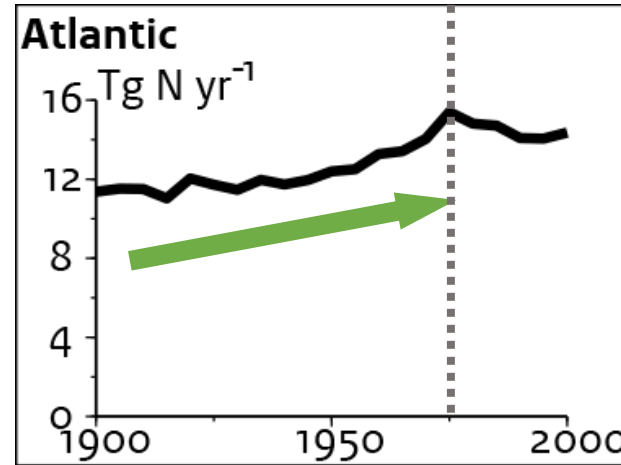


19 - 37 Tg.an⁻¹
→ + 90%



2 - 4 Tg.an⁻¹
→ + 75%

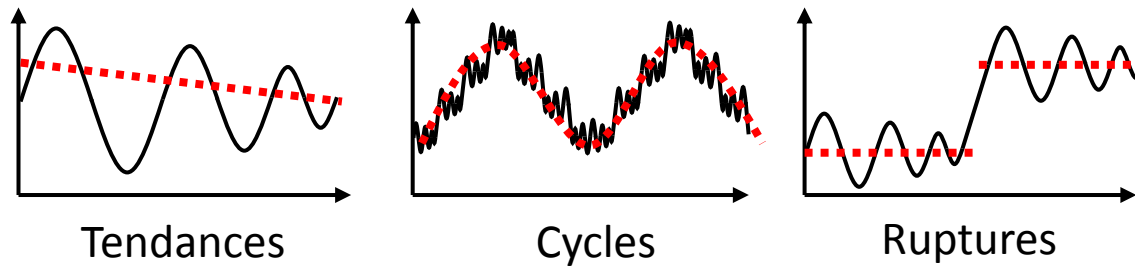
Océan Atlantique



Augmentation des nutriments
jusqu'aux années 1980 suivie
d'une diminution

Les objectifs de cette étude sont les suivants :

1. Caractériser l'évolution décennale des nutriments

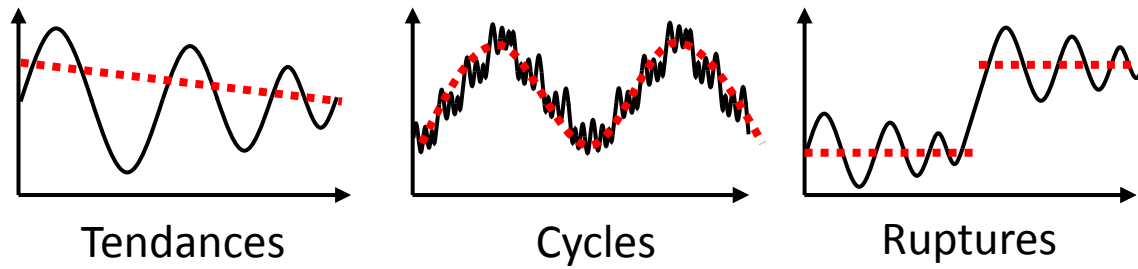


**Concentrations
&
Rapports**

Saisonnalité

Les objectifs de cette étude sont les suivants :

1. Caractériser l'évolution décennale des nutriments

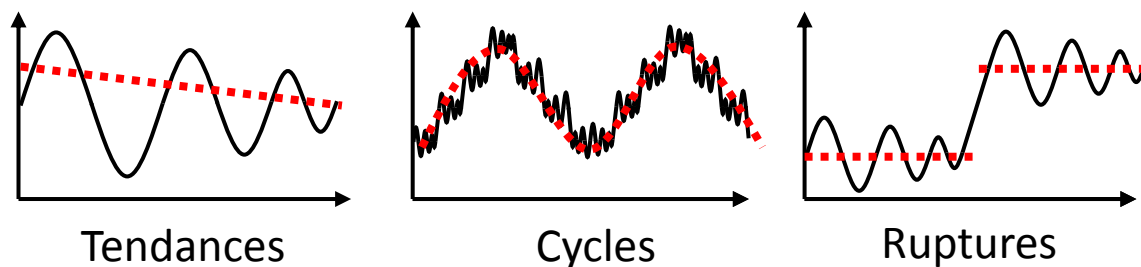


2. Identifier les facteurs de contrôle



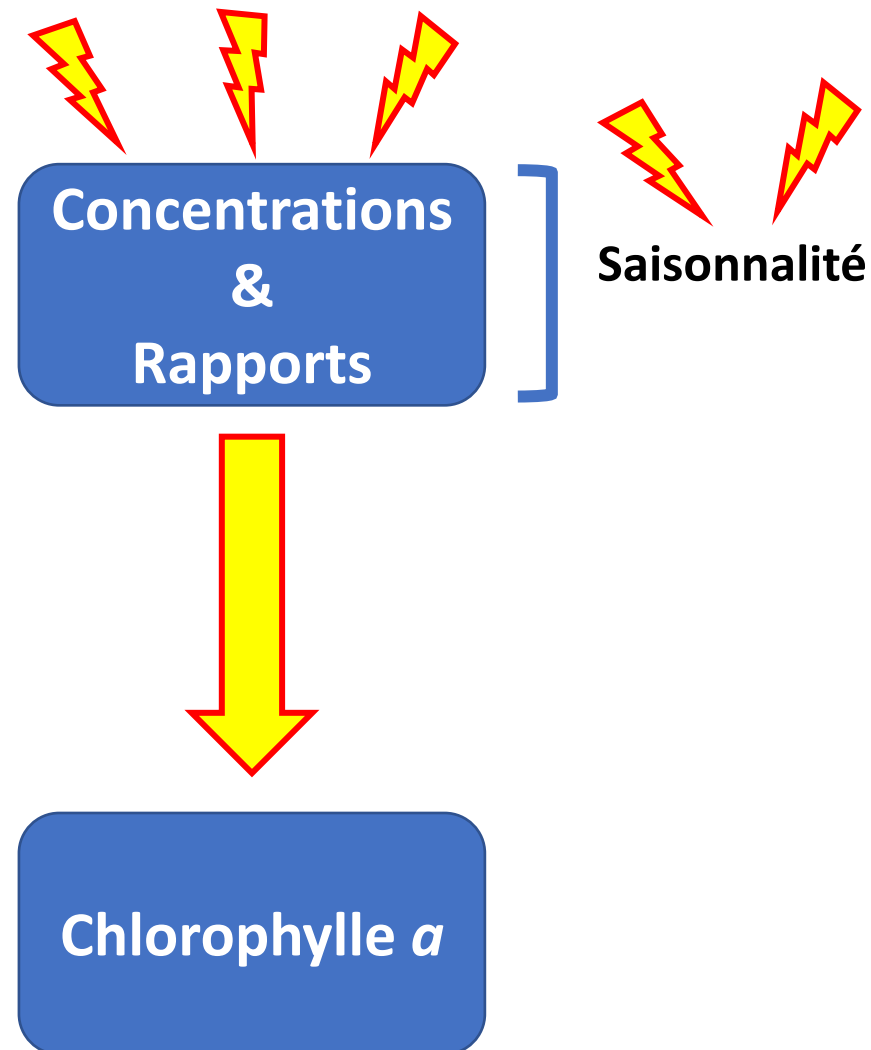
Les objectifs de cette étude sont les suivants :

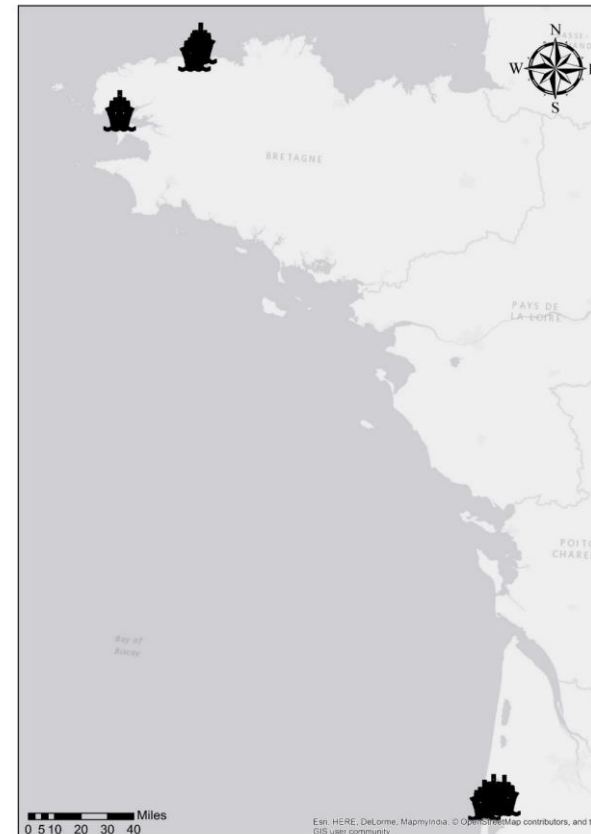
1. Caractériser l'évolution décennale des nutriments



2. Identifier les facteurs de contrôle

3. Investiguer les conséquences sur la biomasse chlorophyllienne





Stations	Astan	Estacade
Fleuves	Penzé, Guilhec	
Profondeur (m)	60	3
Salinité	35,2 ± 0,2	35,2 ± 0,2

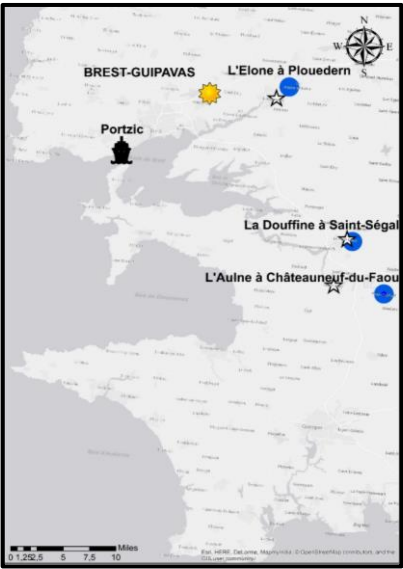


Roscoff

ECOFLUX

- Agence de l'eau
- BanqueHydro
- ☀ Météo-France
- ⚓ SOMLIT

Stations	Portzic
Fleuves	Aulne, Elorn
Profondeur (m)	10
Salinité	34,6 ± 0,6



Brest

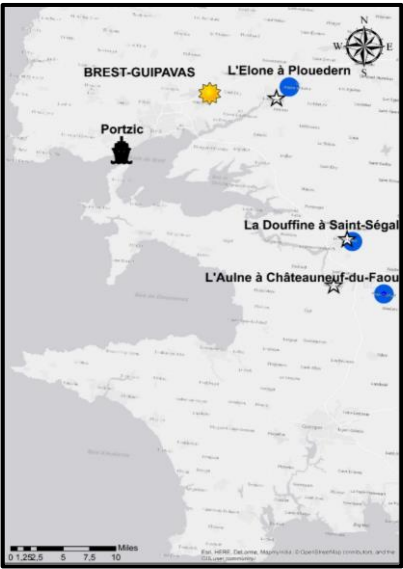
Stations	Astan	Estacade
Fleuves	Penzé, Guilhec	
Profondeur (m)	60	3
Salinité	35,2 ± 0,2	35,2 ± 0,2



Roscoff

- ECOFLUX
- Agence de l'eau
 - BanqueHydro
 - ☀ Météo-France
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Stations	Portzic
Fleuves	Aulne, Elorn
Profondeur (m)	10
Salinité	34,6 ± 0,6



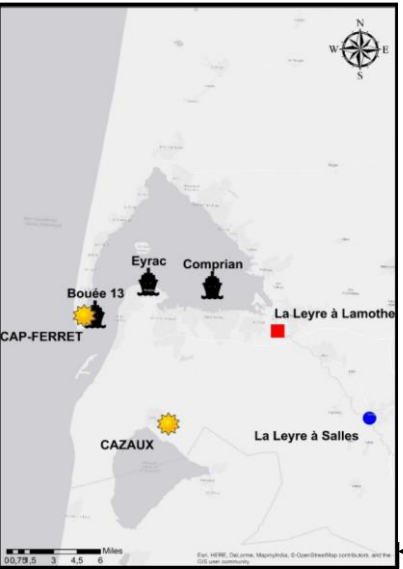
Brest

Stations	Astan	Estacade
Fleuves	Penzé, Guilhec	
Profondeur (m)	60	3
Salinité	35,2 ± 0,2	35,2 ± 0,2



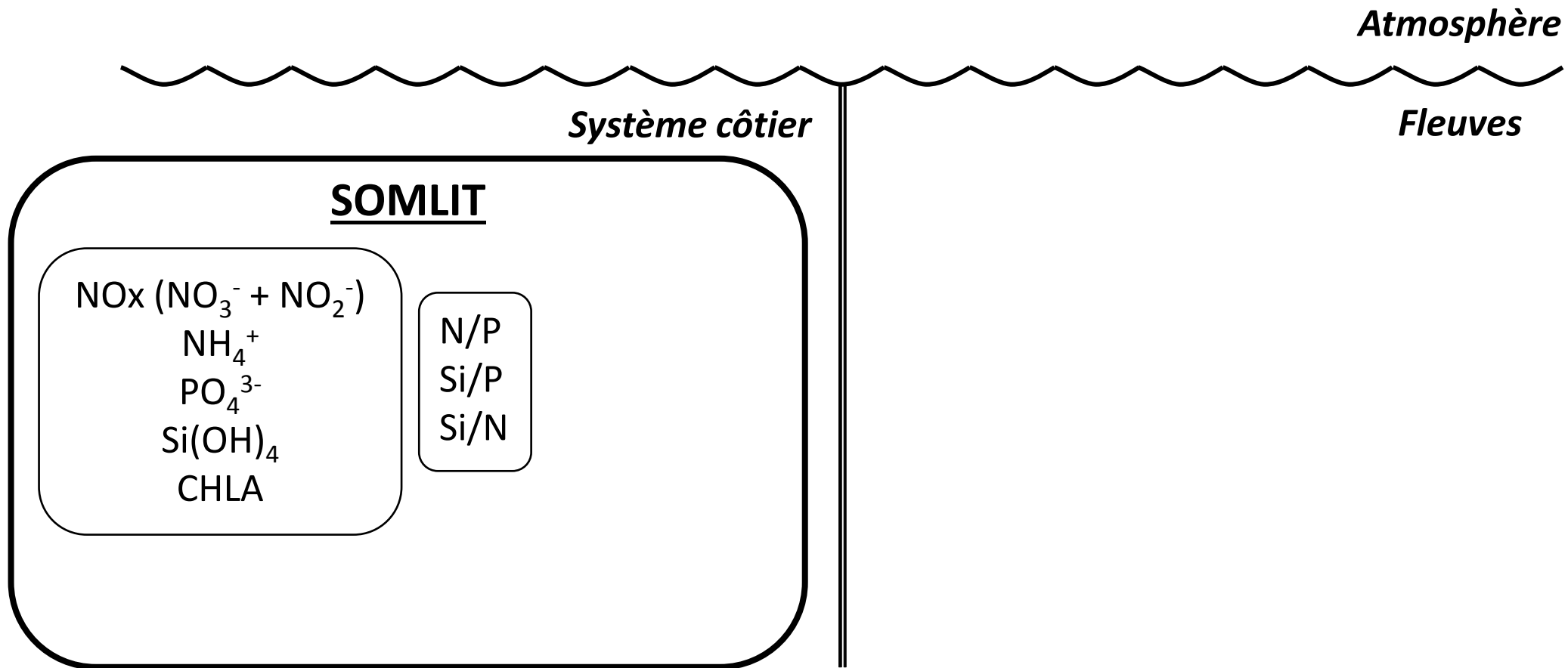
Roscoff

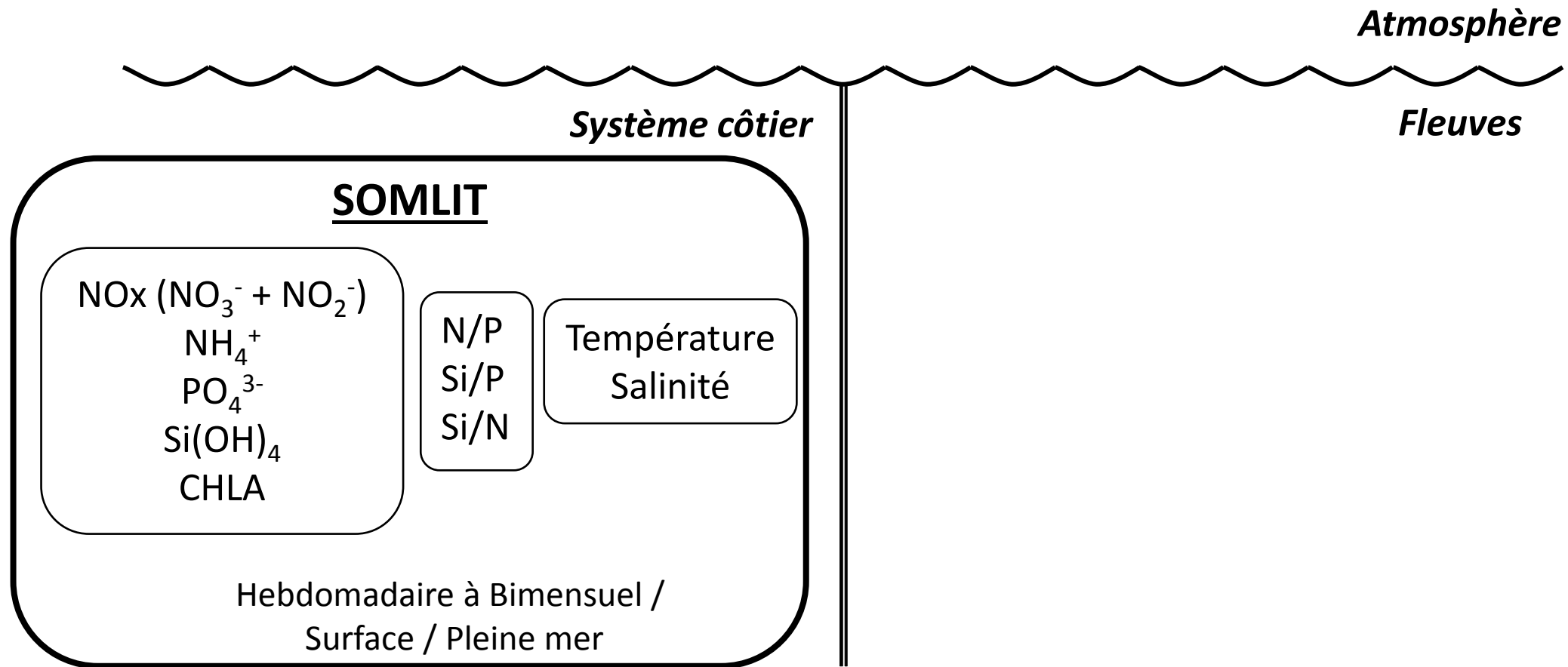
Stations	Bouée 13	Eyrac	Comprian
Fleuves	Leyre		
Profondeur (m)	25	8	6
Salinité	34,4 ± 0,8	32,6 ± 1,8	31,4 ± 2,6

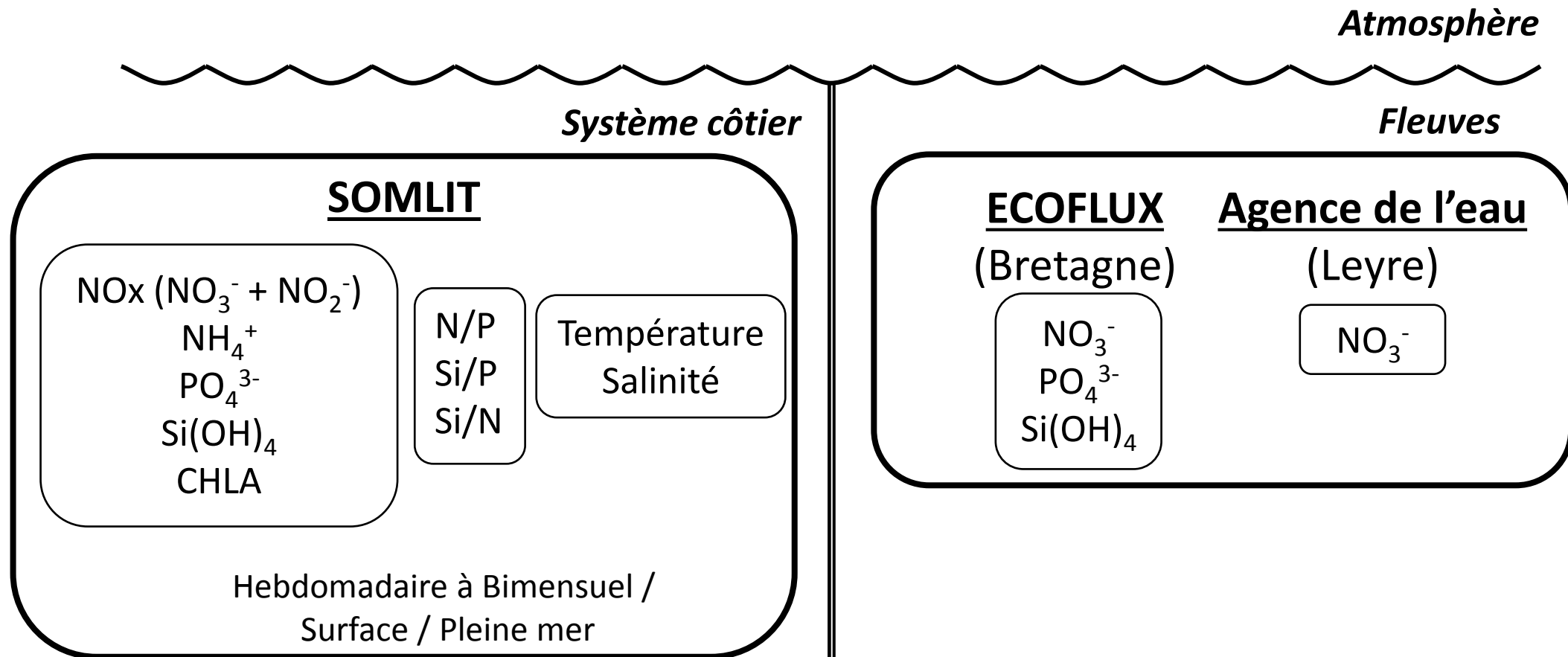


Arcachon

- ECOFLUX
- Agence de l'eau
 - BanqueHydro
 - Météo-France
 - SOMLIT







Météo-France

Précipitations



Rayonnement



Force du vent



Température

*Atmosphère**Système côtier**Fleuves***SOMLIT** $\text{NO}_x (\text{NO}_3^- + \text{NO}_2^-)$ NH_4^+ PO_4^{3-} $\text{Si}(\text{OH})_4$

CHLA

N/P

Si/P

Si/N

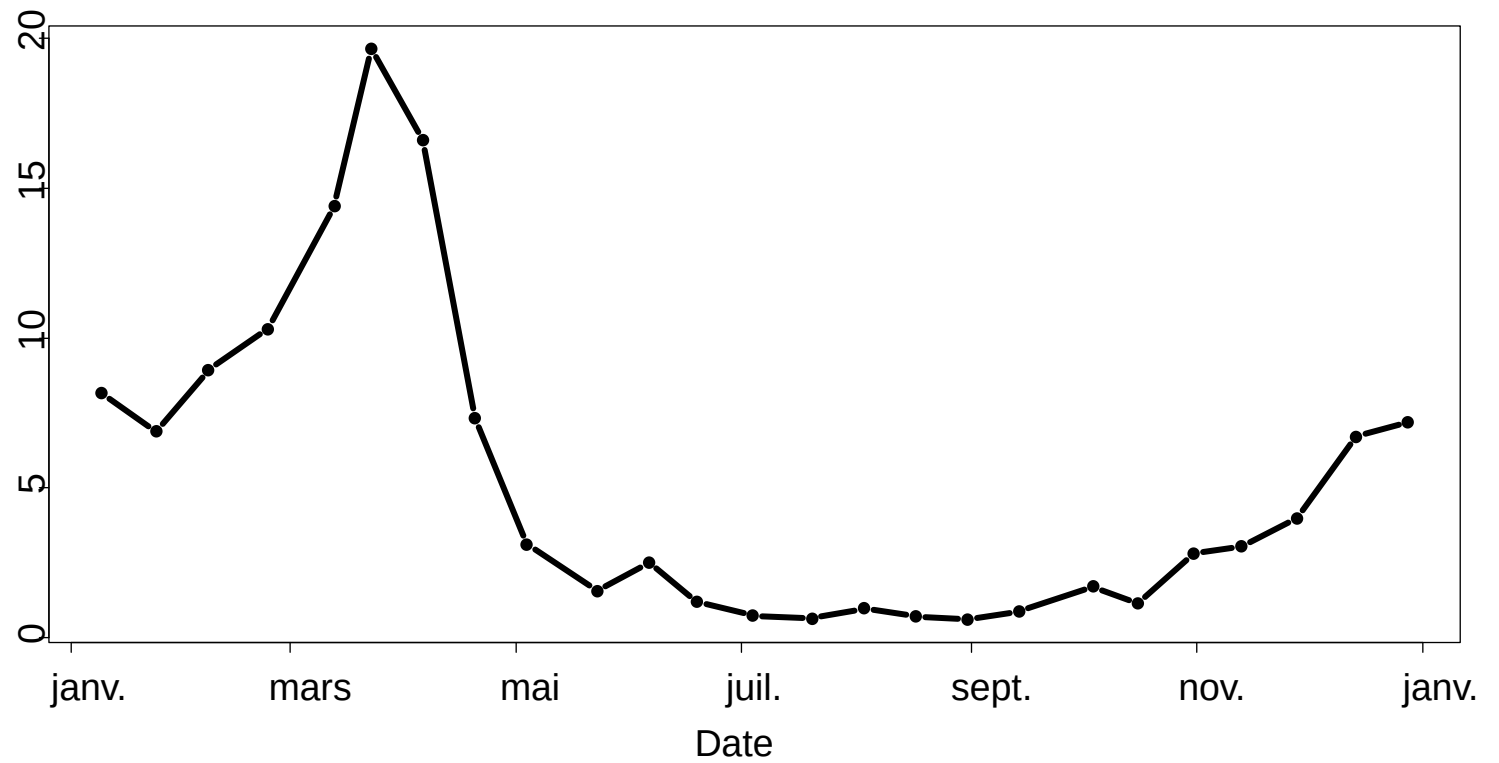
Température

Salinité

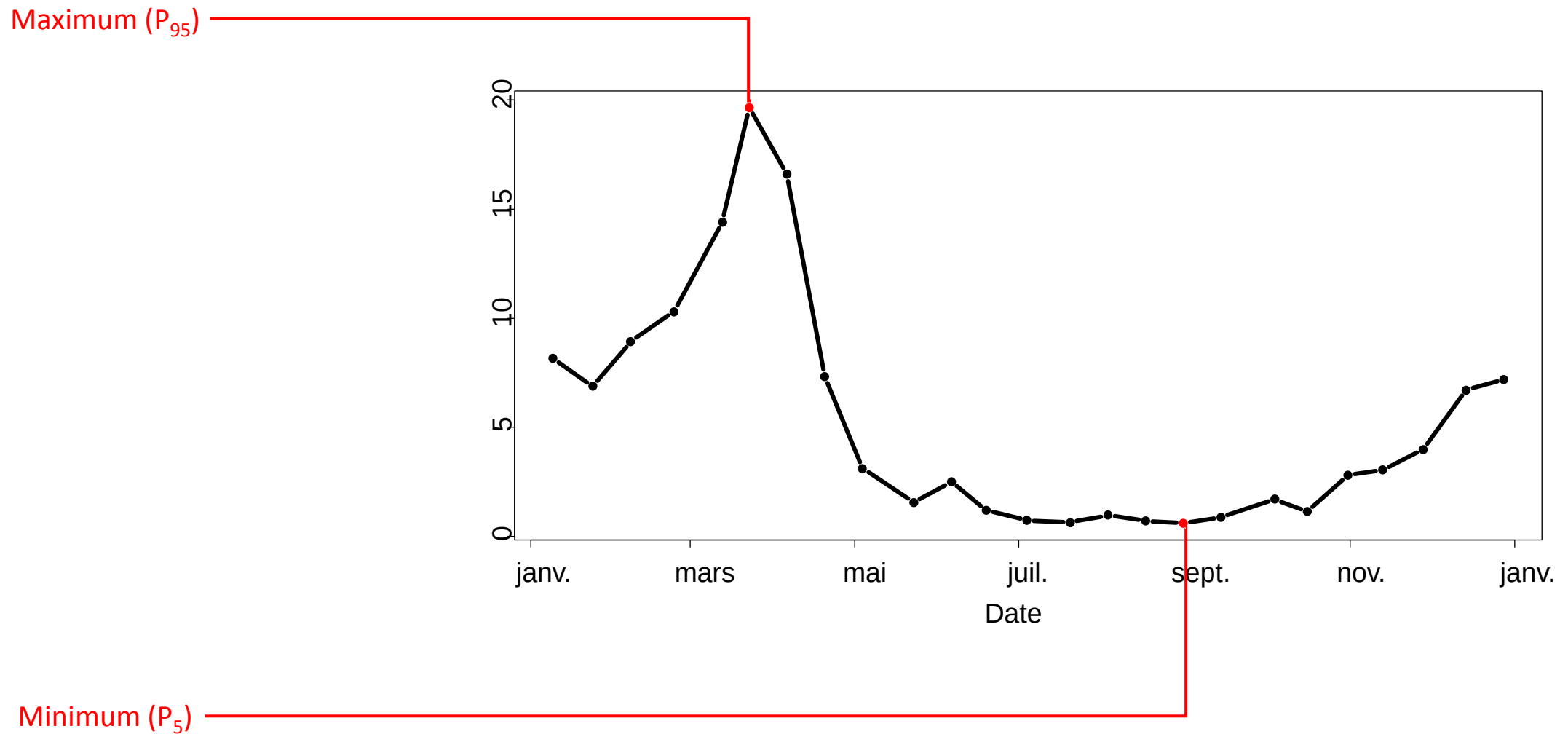
Hebdomadaire à Bimensuel /
Surface / Pleine mer**ECOFLUX**
(Bretagne) NO_3^-
 PO_4^{3-}
 $\text{Si}(\text{OH})_4$ **Agence de l'eau**
(Leyre) NO_3^-

2000 – 2015

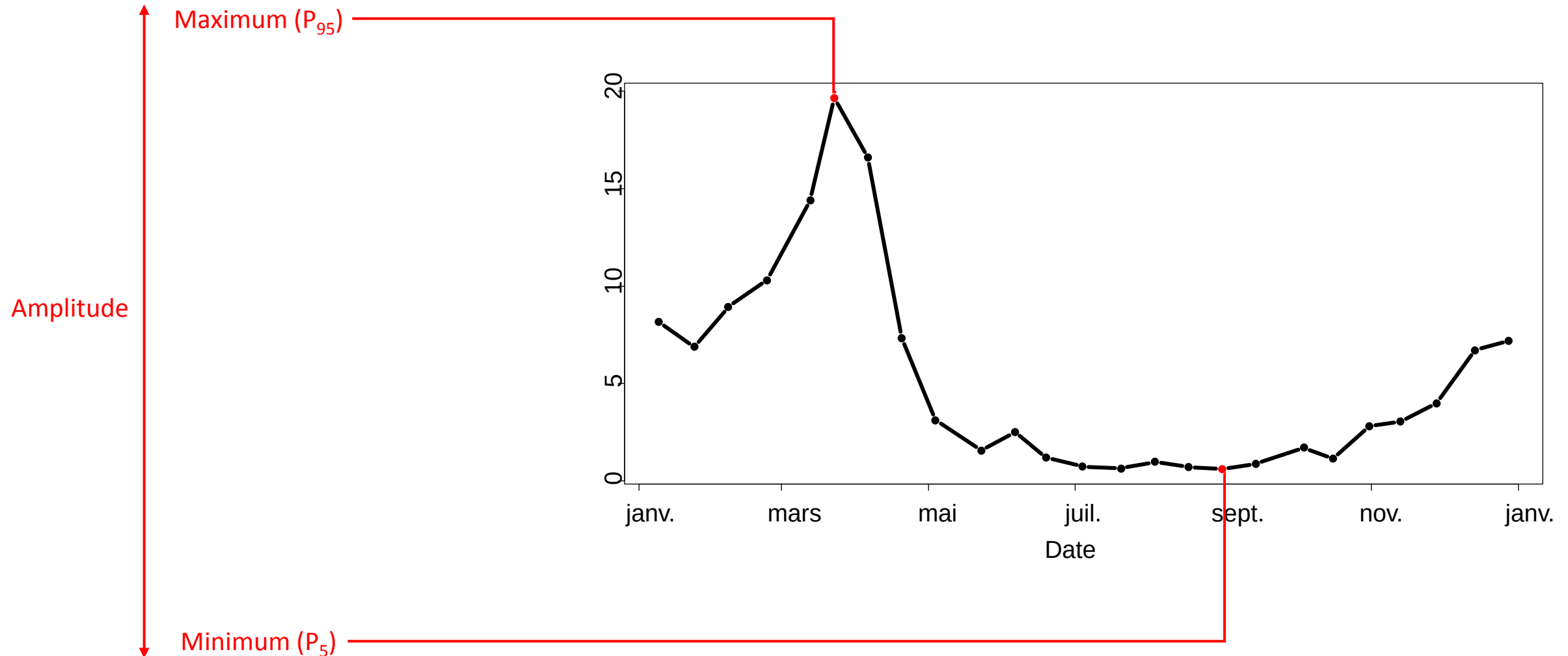
Saisonnalité des concentrations en nutriments



Saisonnalité des concentrations en nutriments



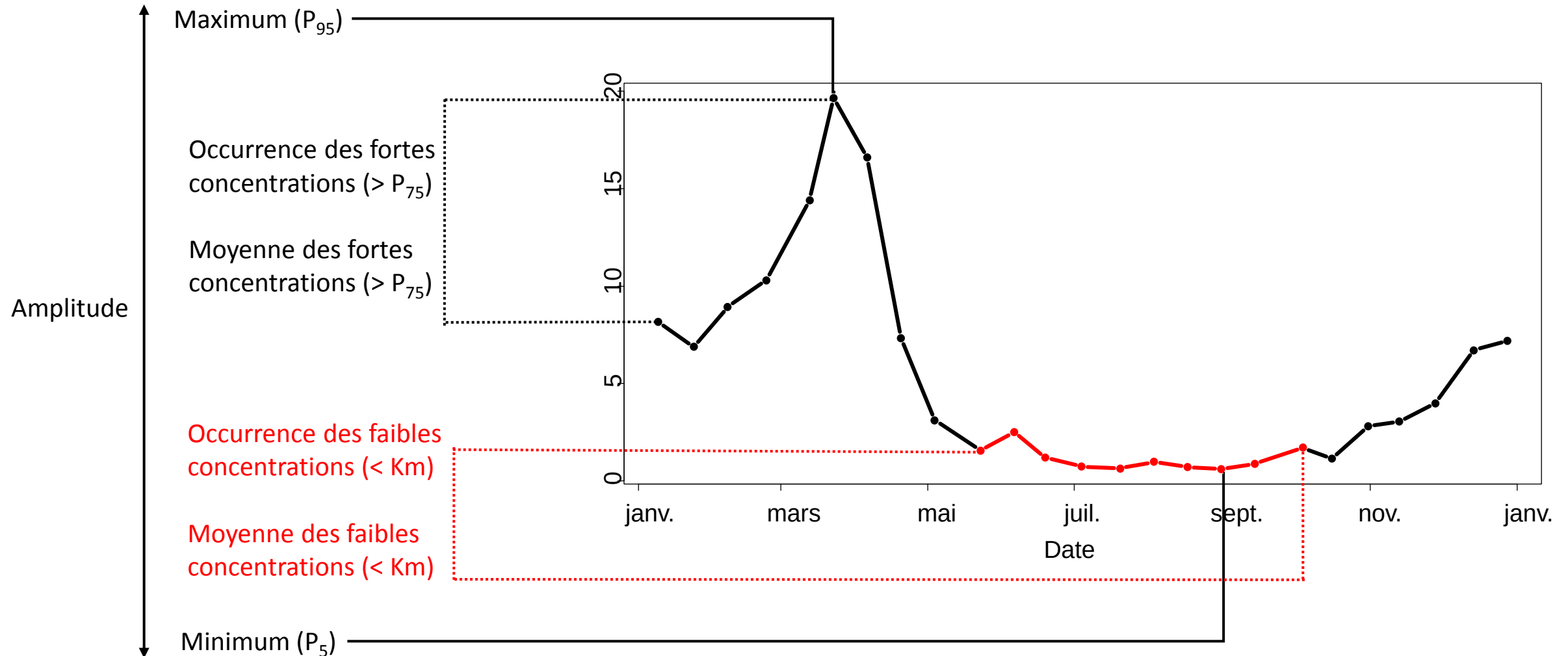
Saisonnalité des concentrations en nutriments



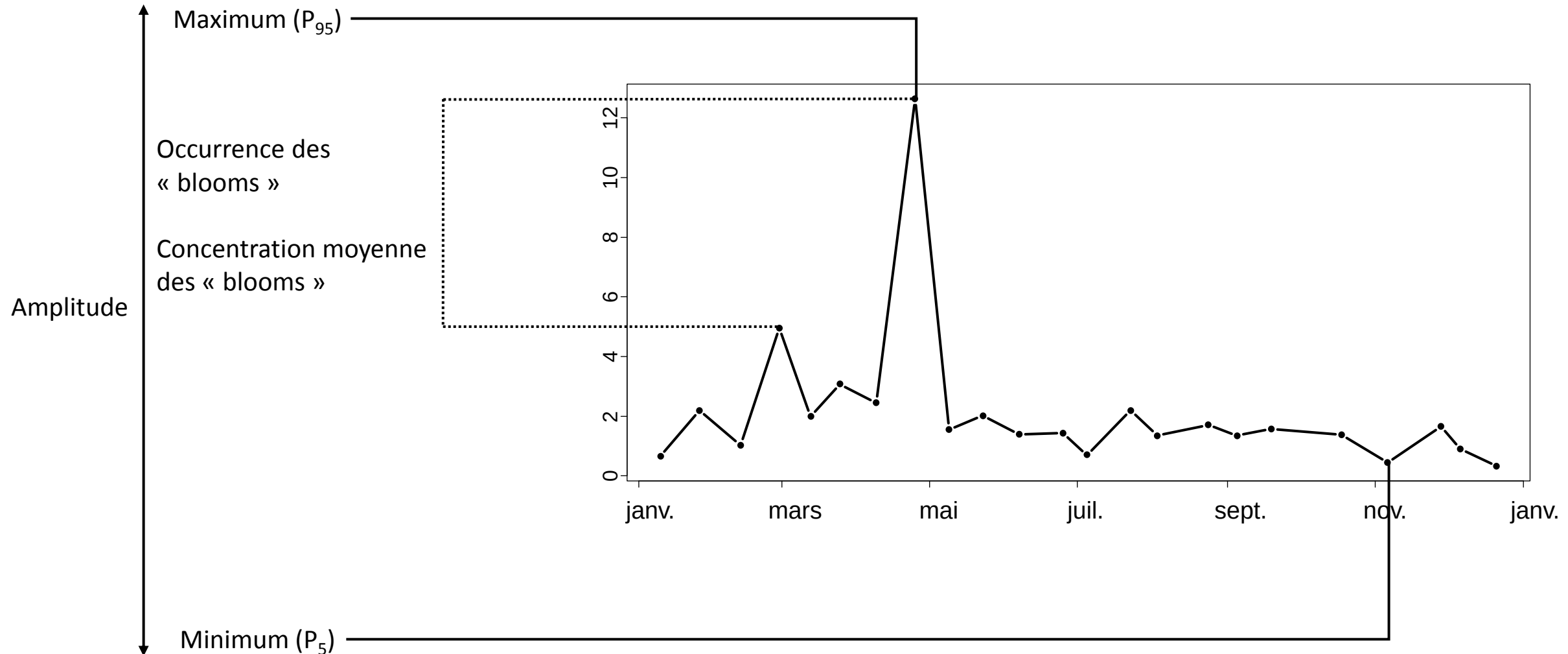
Saisonnalité des concentrations en nutriments



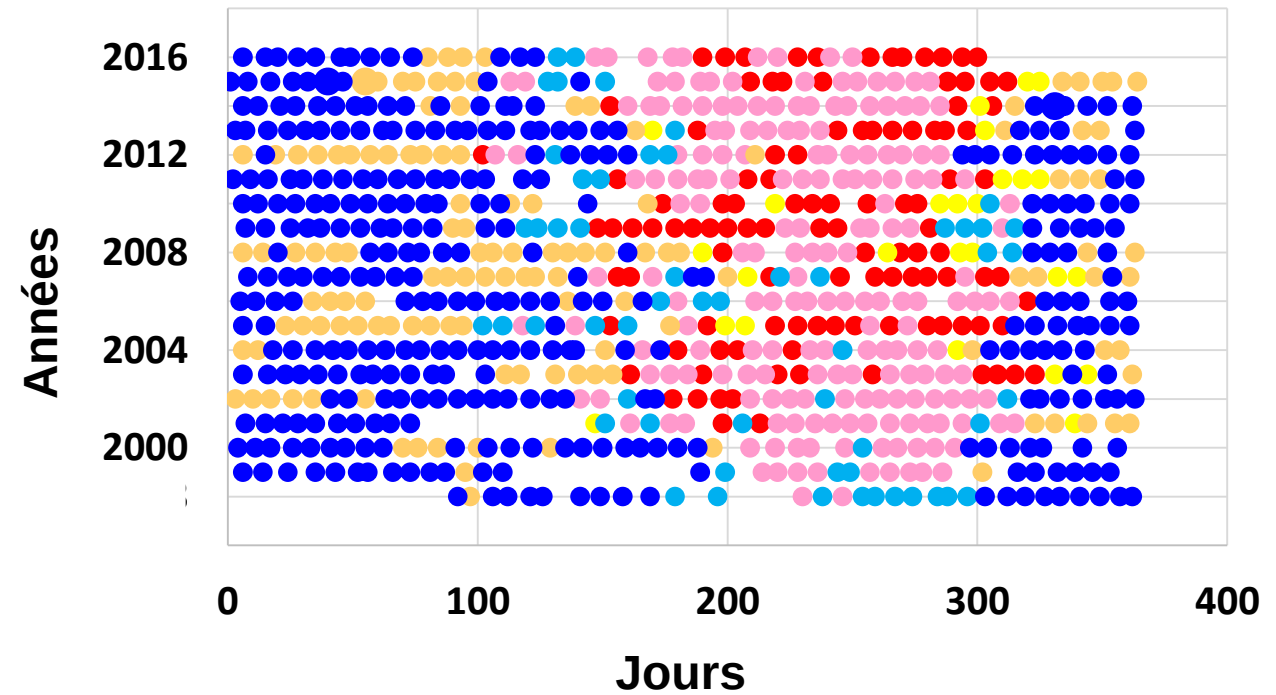
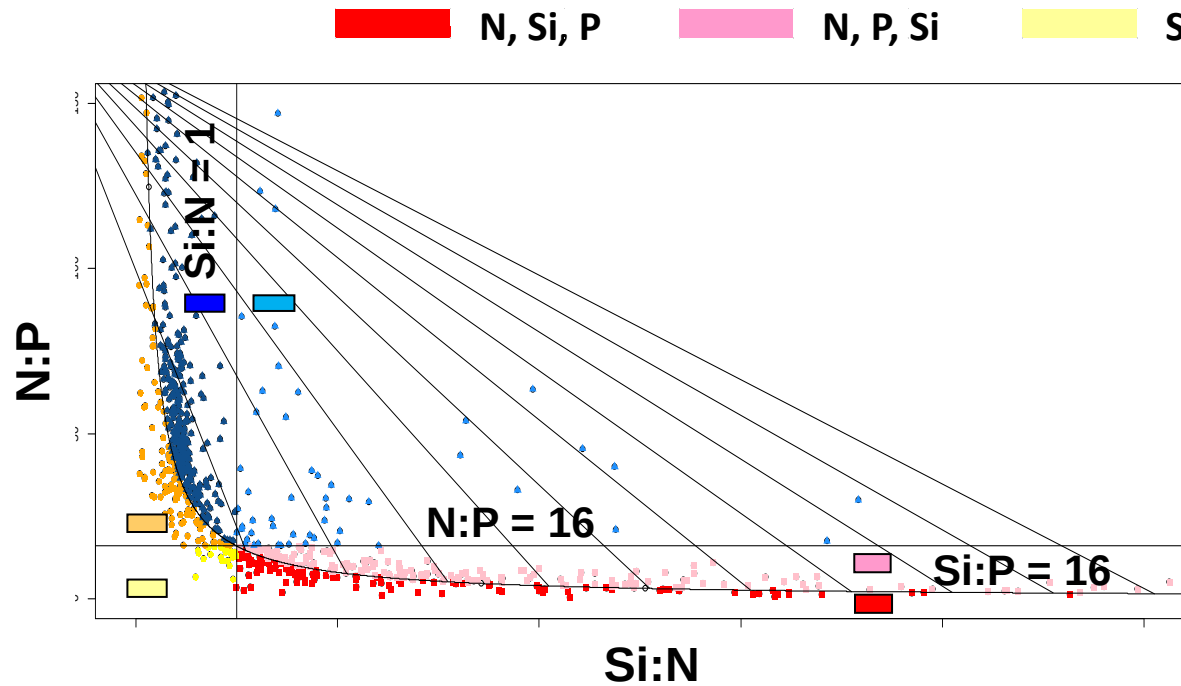
Saisonnalité des concentrations en nutriments



Saisonnalité de la chlorophylle *a*



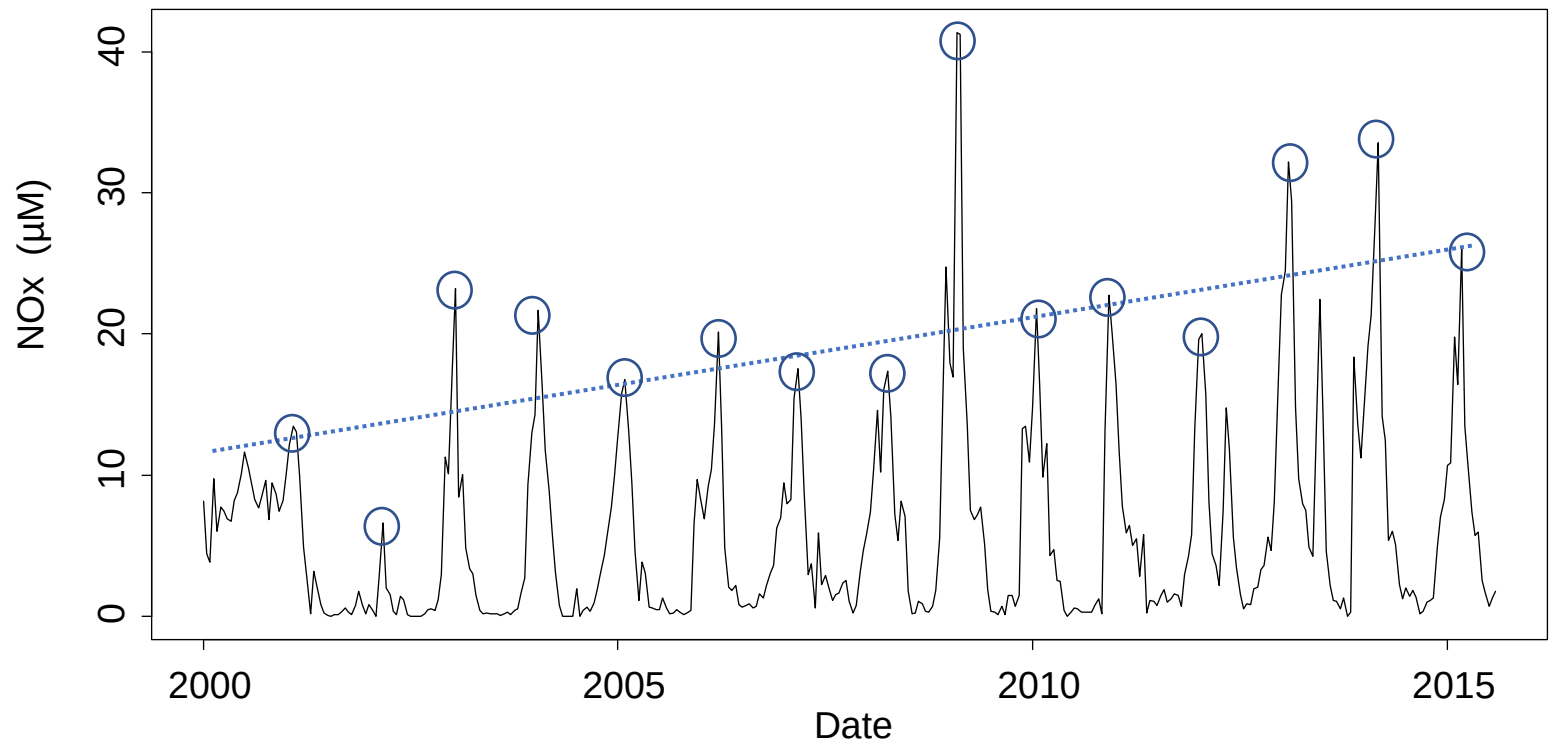
Saisonnalité des rapports en nutriments

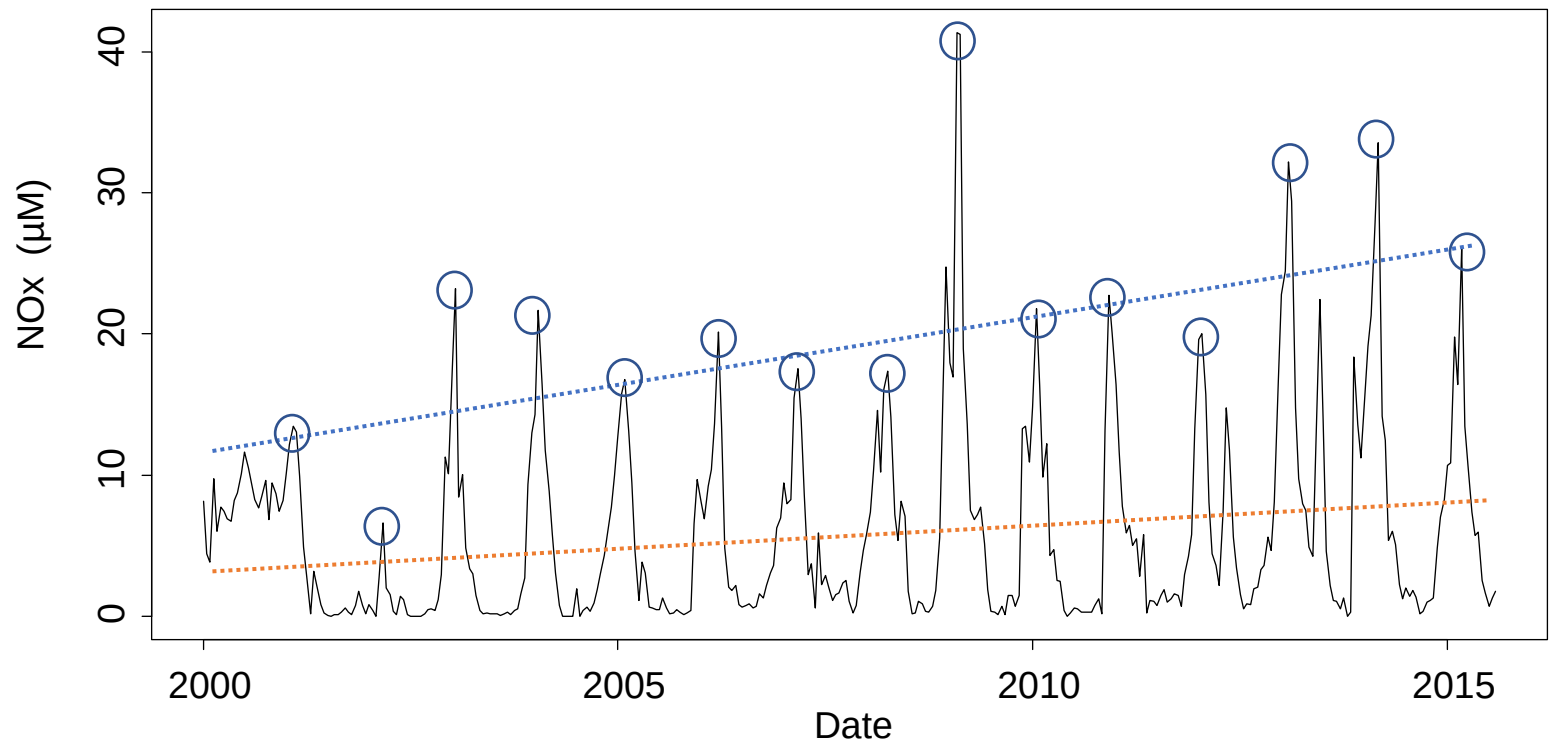
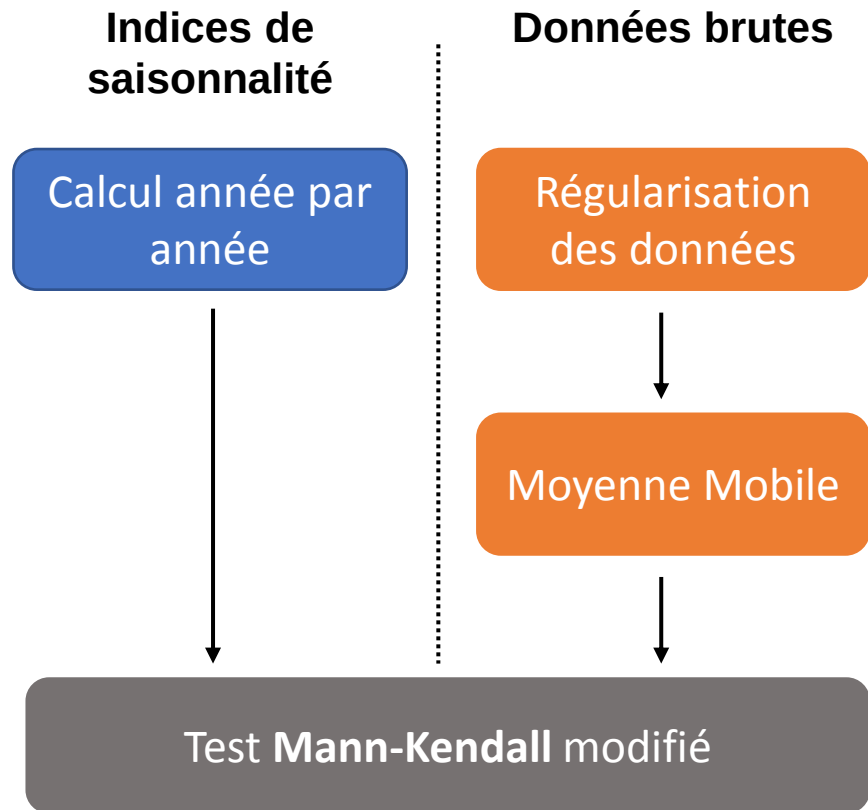


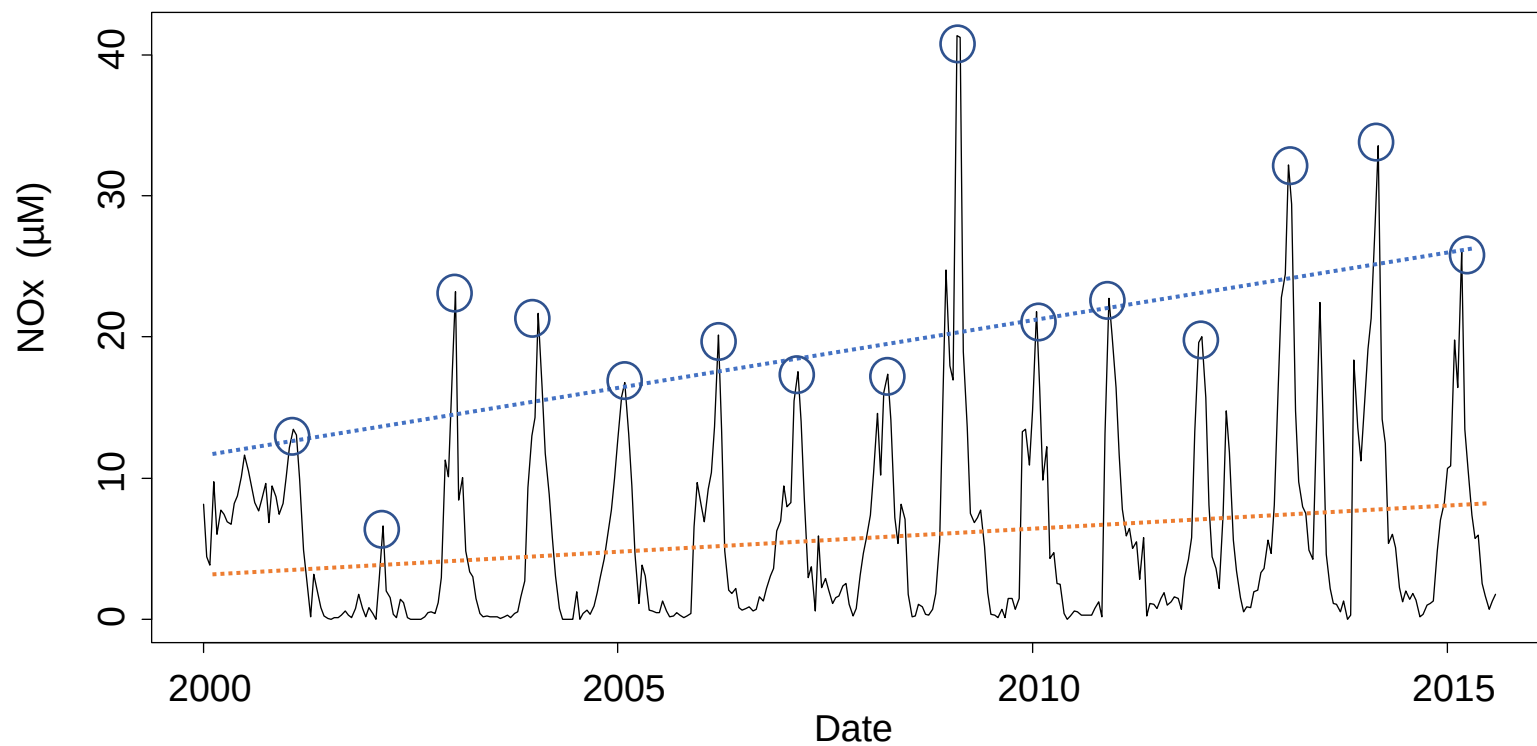
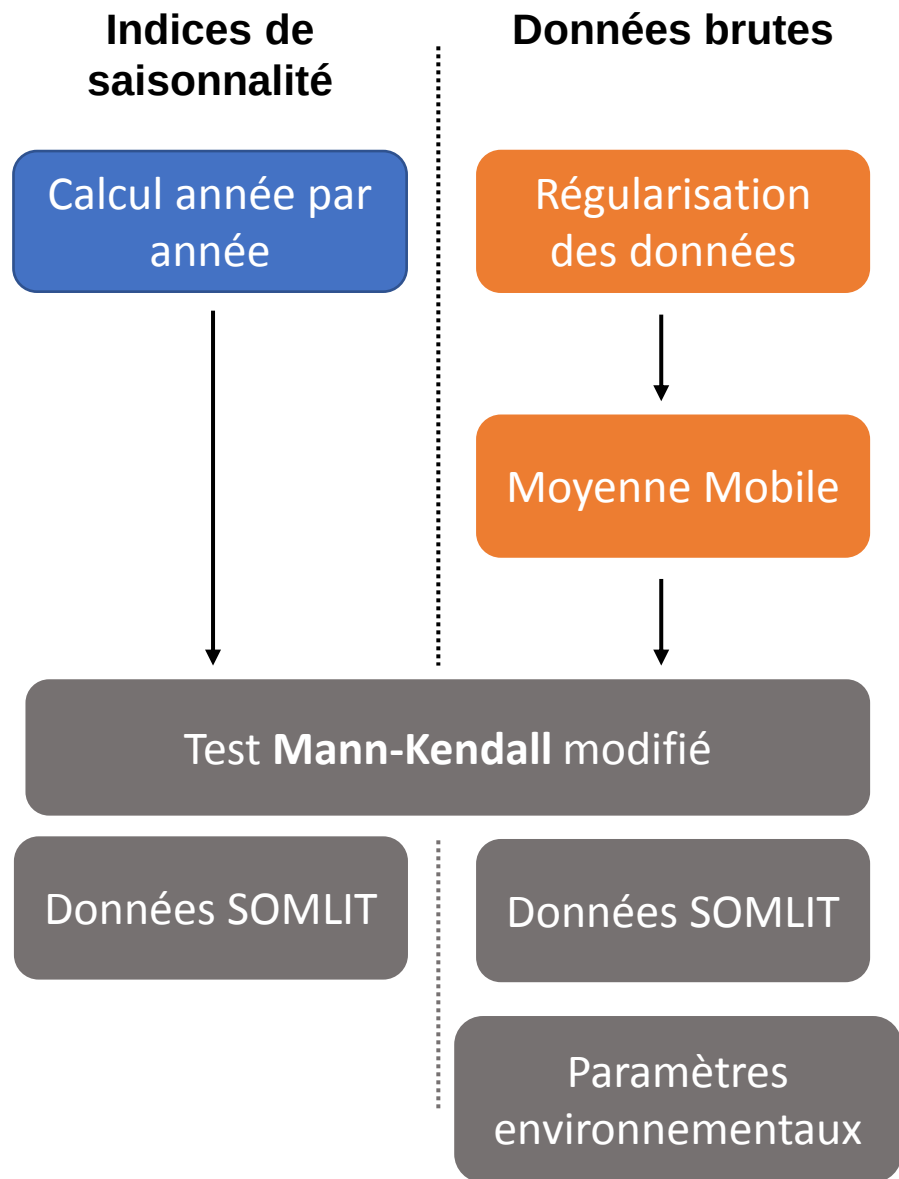
Indices de
saisonnalité

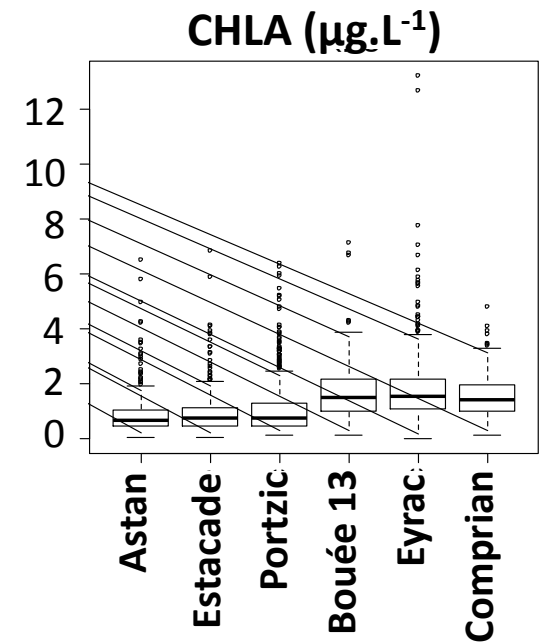
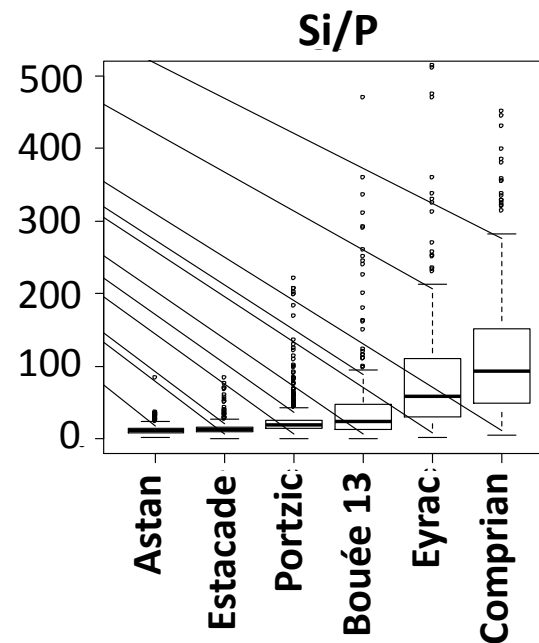
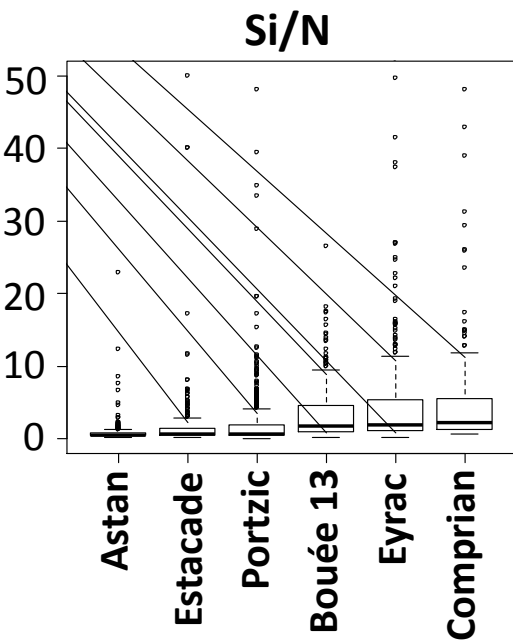
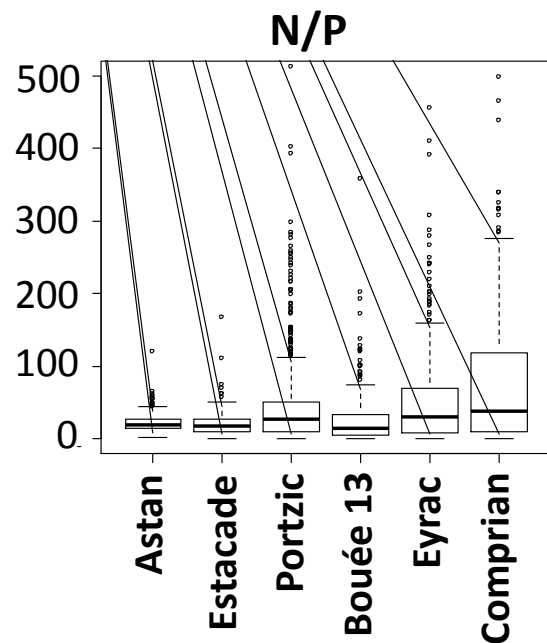
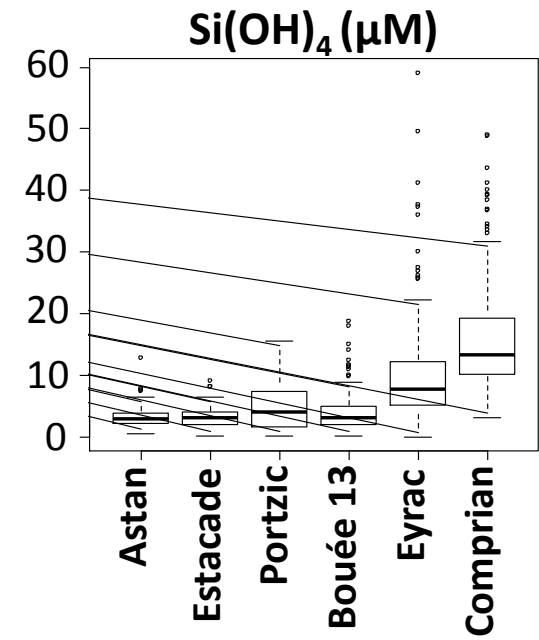
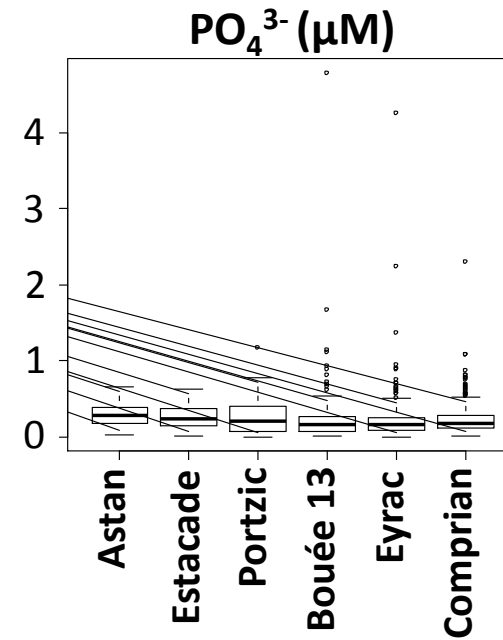
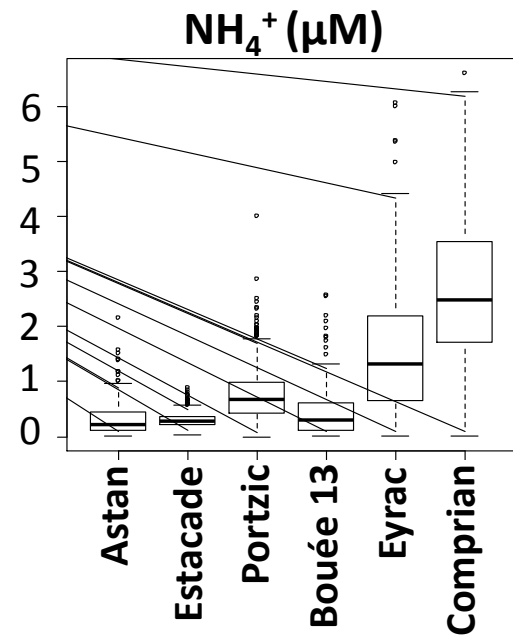
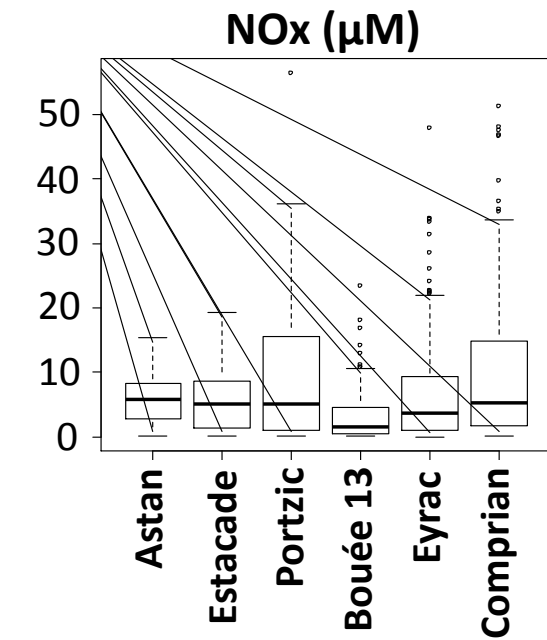
Calcul année par
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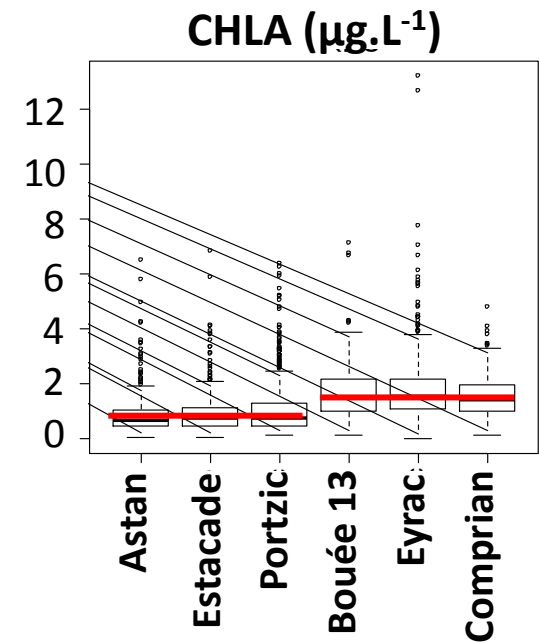
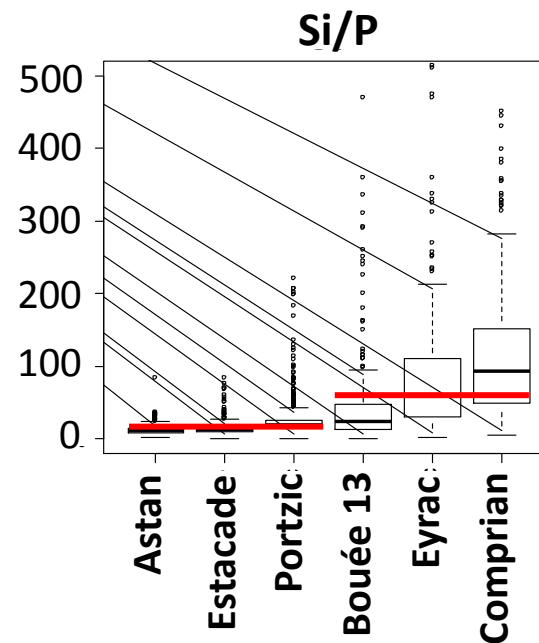
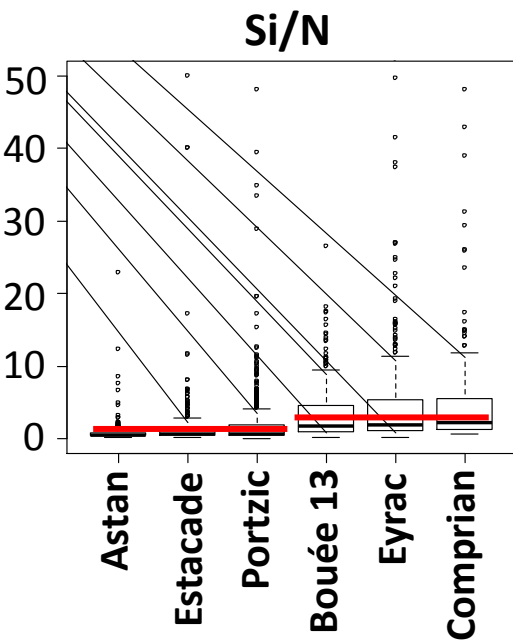
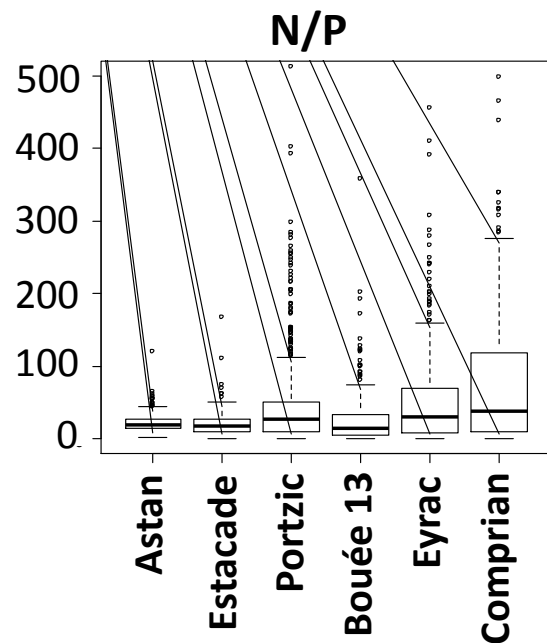
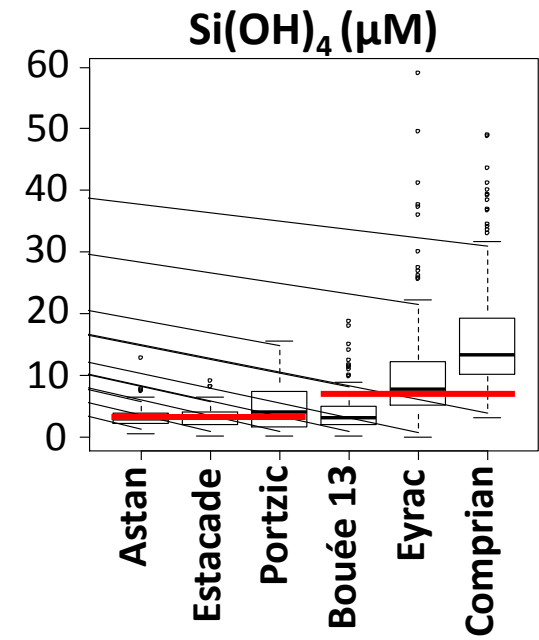
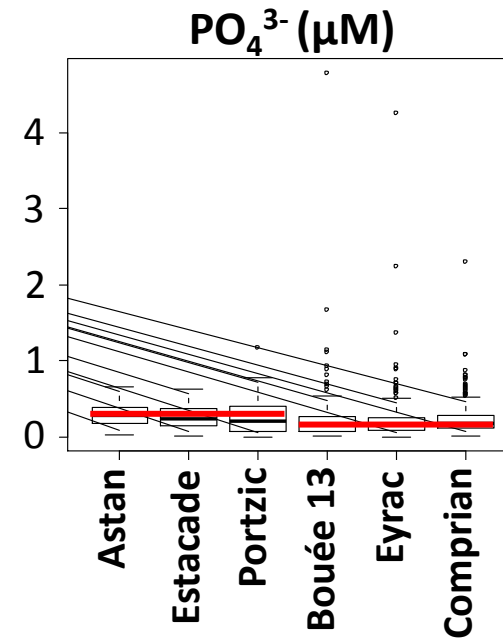
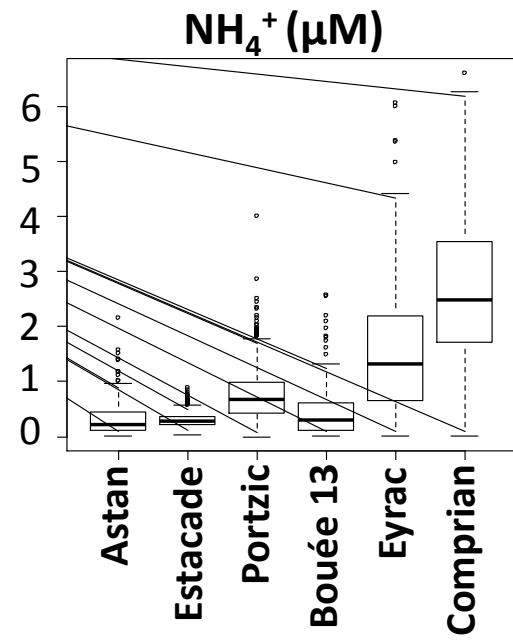
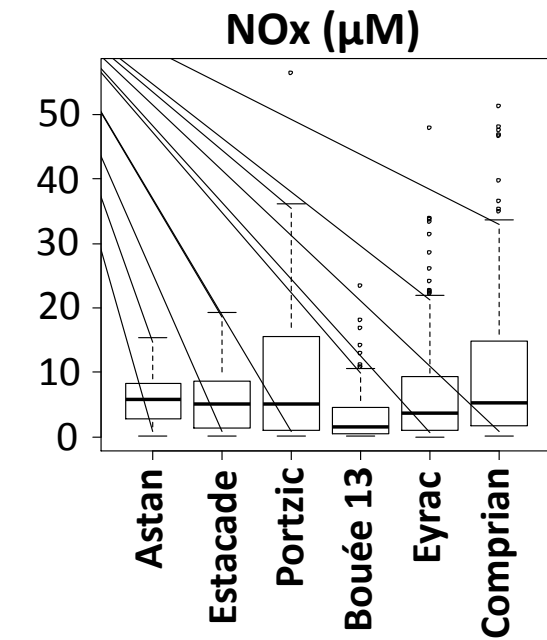
Test **Mann-Kendall** modifié

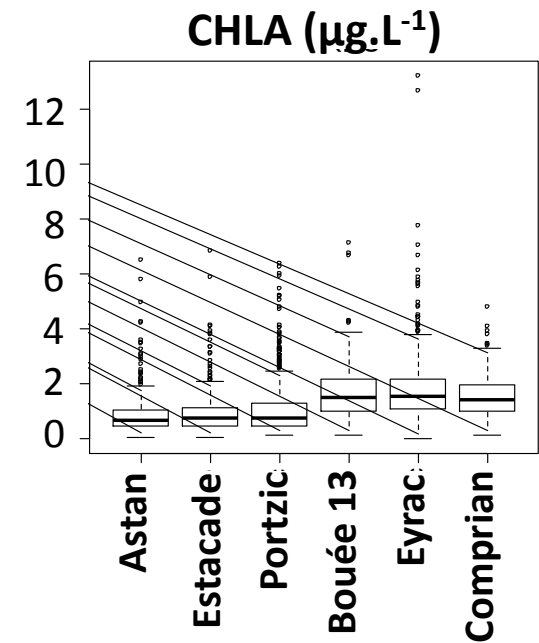
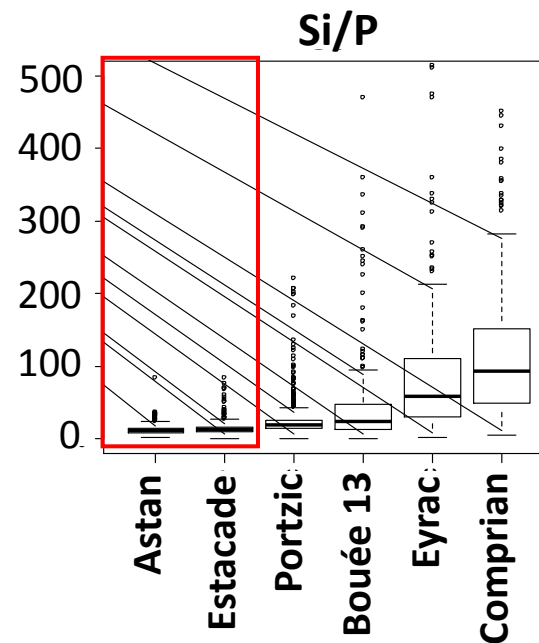
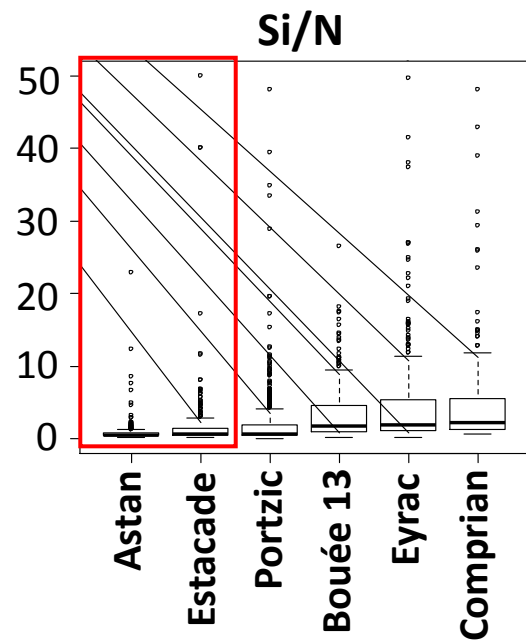
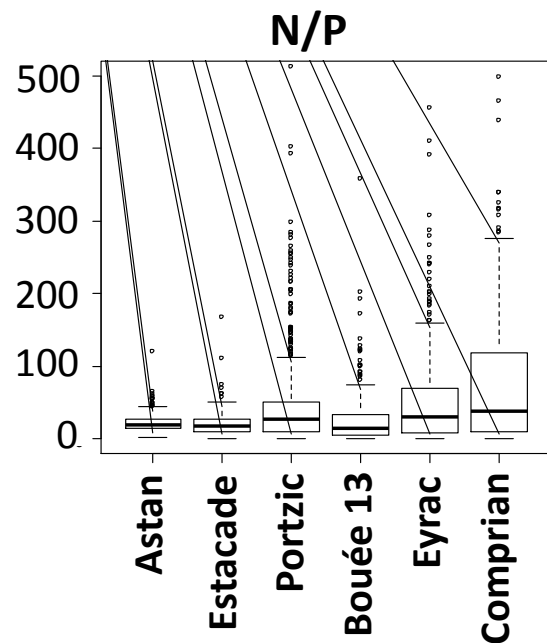
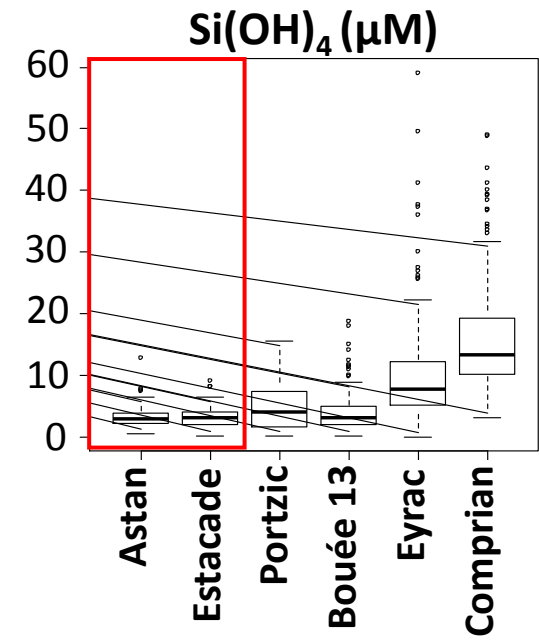
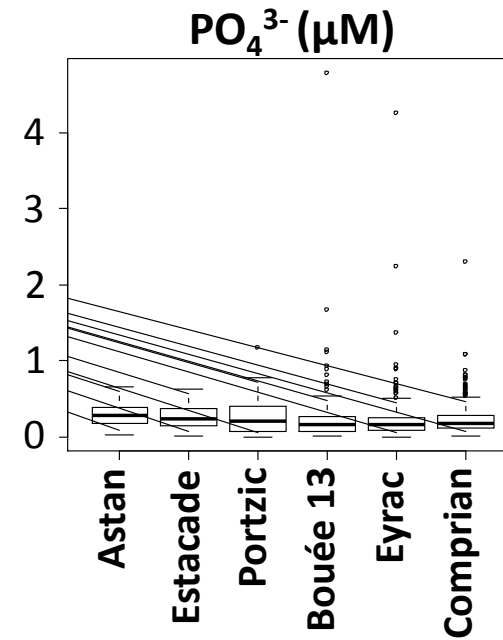
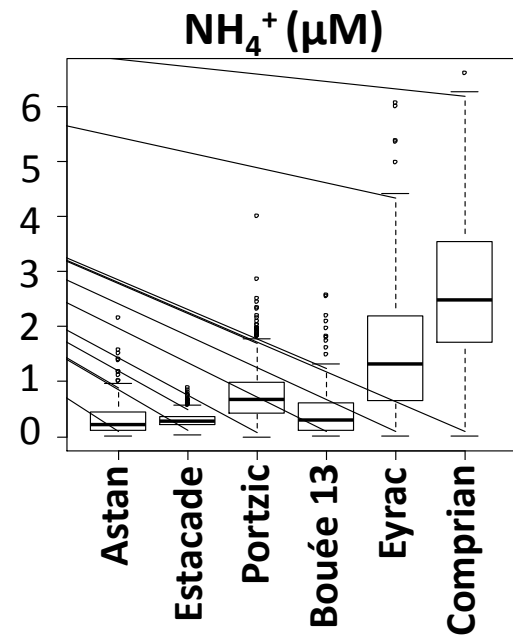
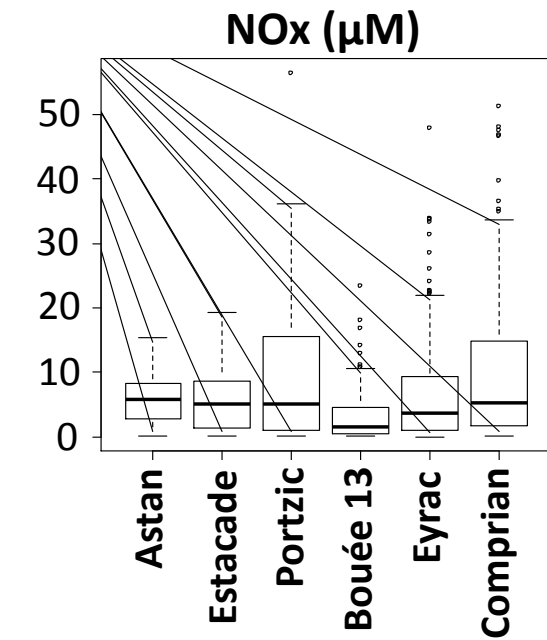


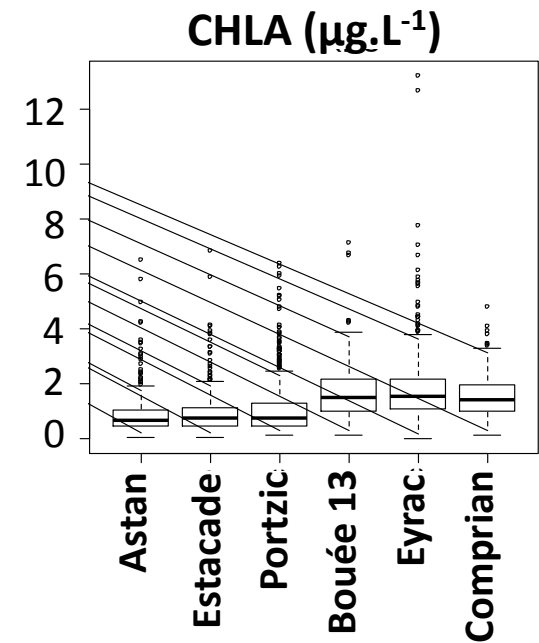
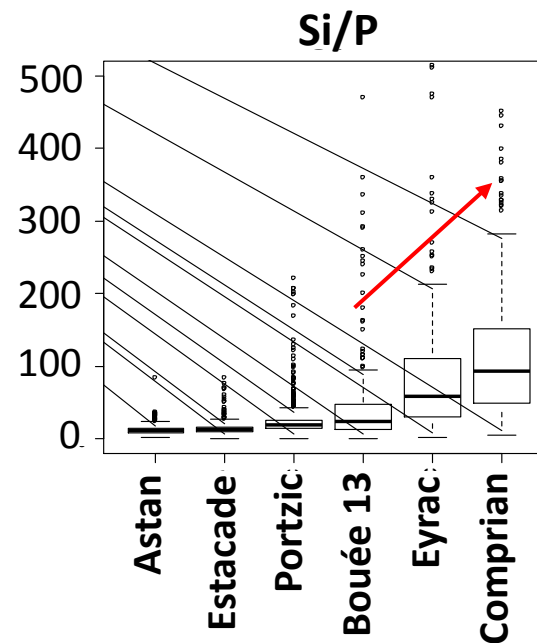
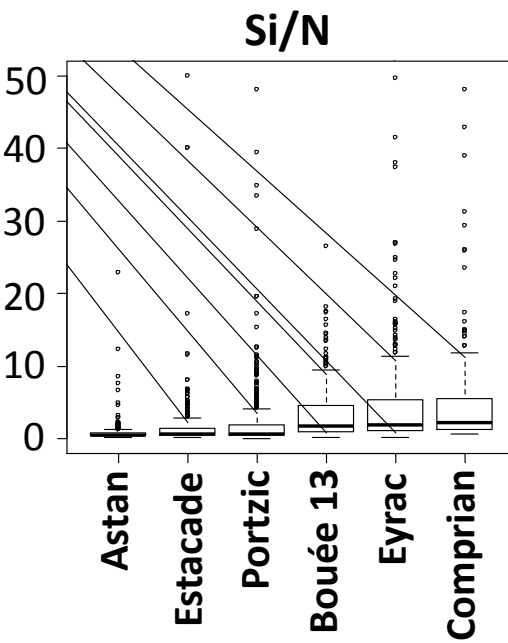
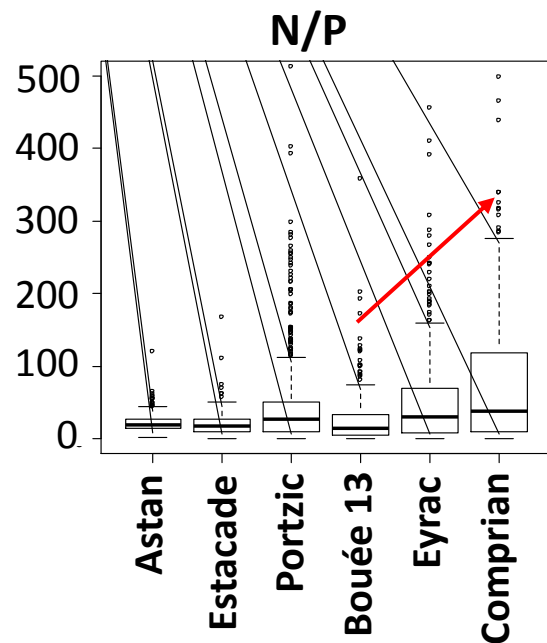
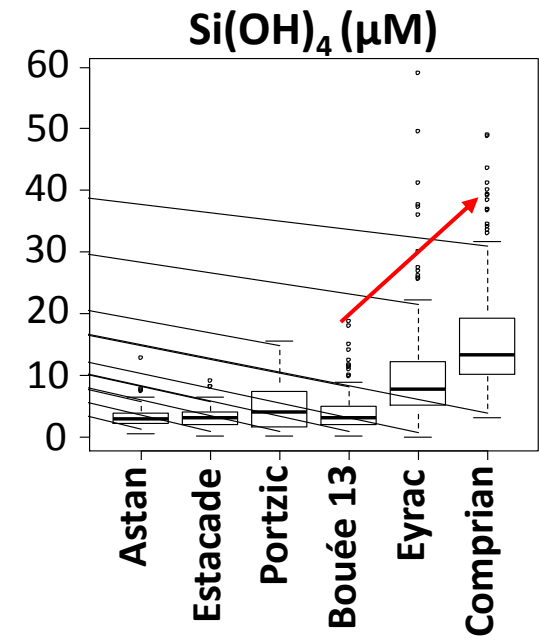
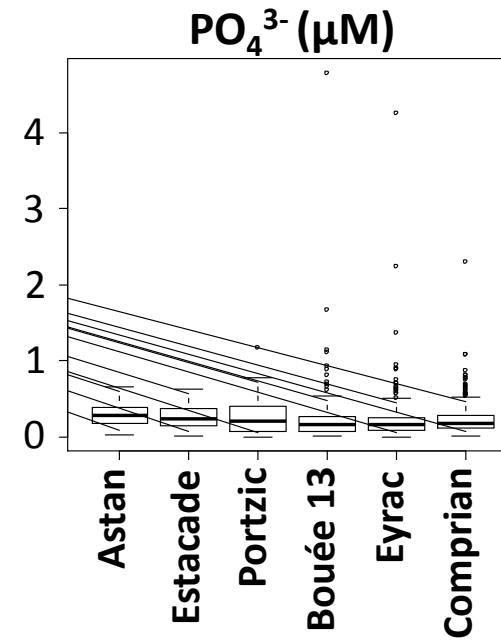
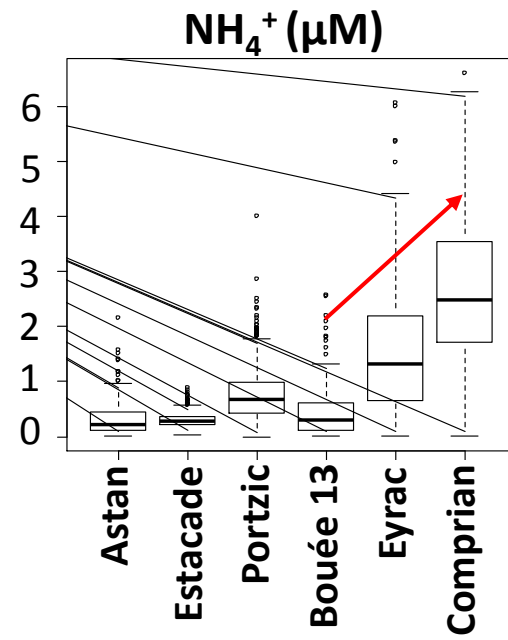
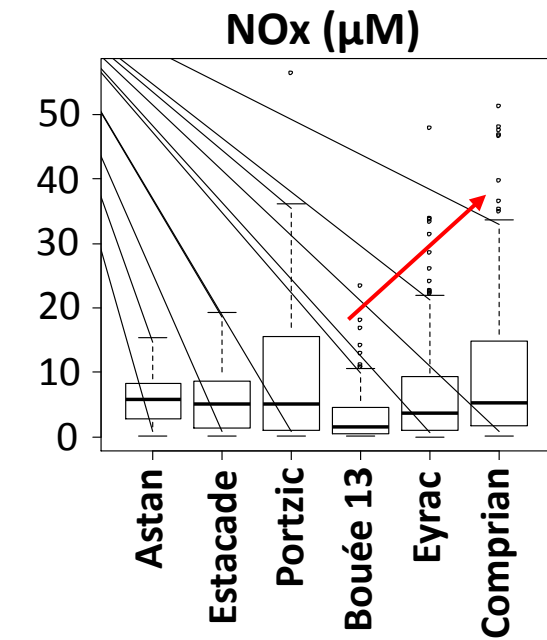


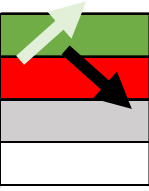












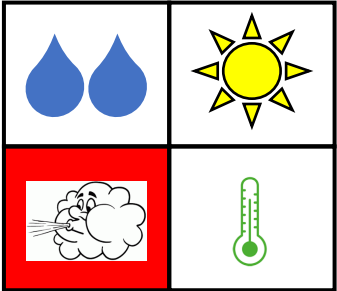
Tendance positive

Tendance négative

Données inutilisables

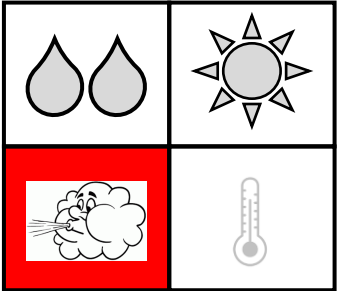
Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Astan										
Estacade										
Fleuves										



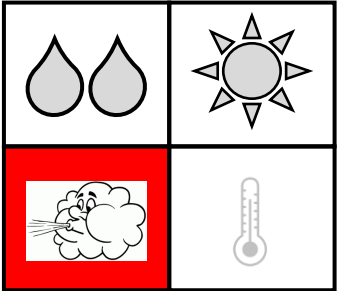
	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Astan										
Estacade										
Fleuves										



	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

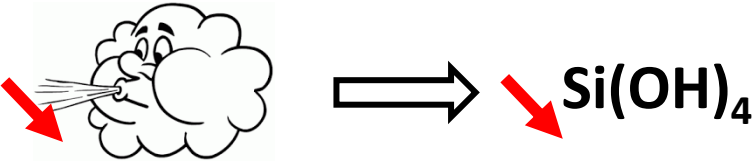
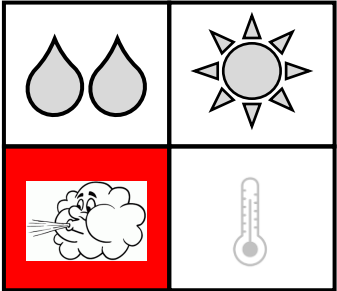
	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Astan										
Estacade										
Fleuves										



⇒  Si(OH)₄

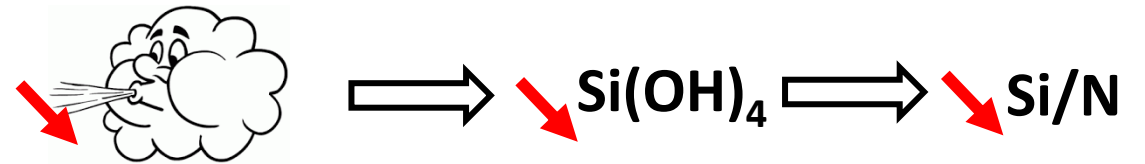
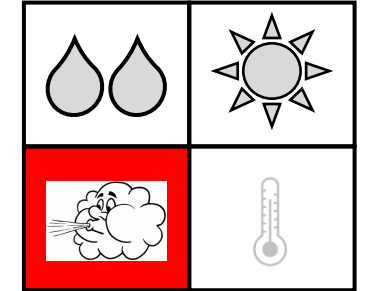
	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

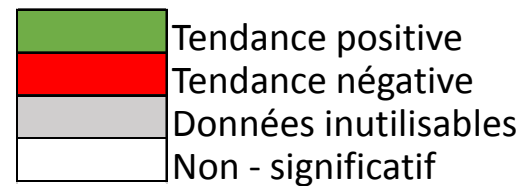
	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Astan										
Estacade										
Fleuves										



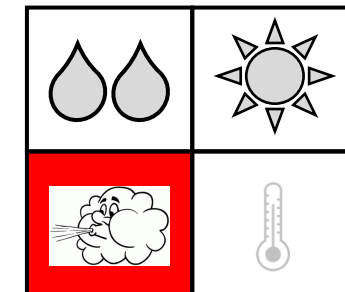
	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Astan										
Estacade										
Fleuves										

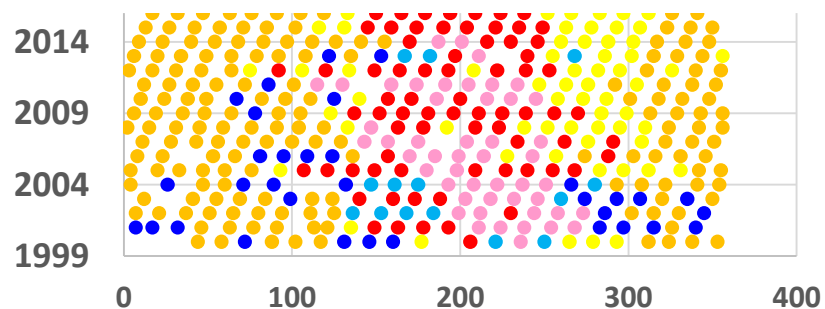




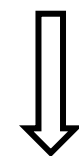
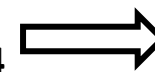
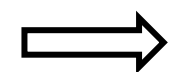
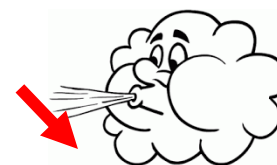
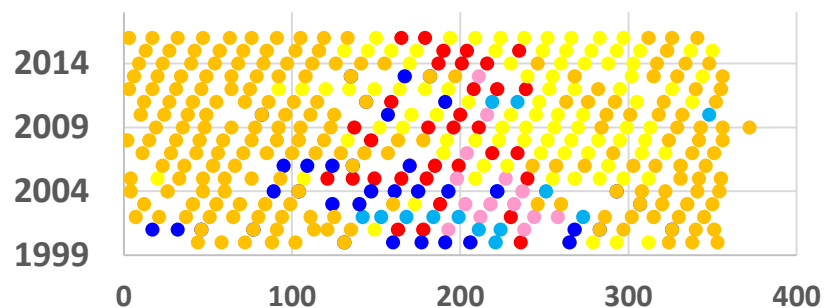
	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Astan										
Estacade										
Fleuves										



Estacade



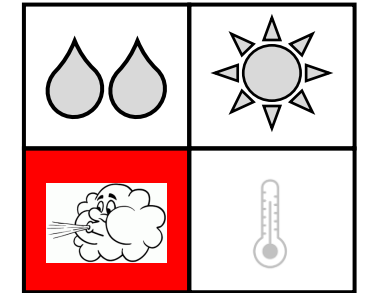
Astan



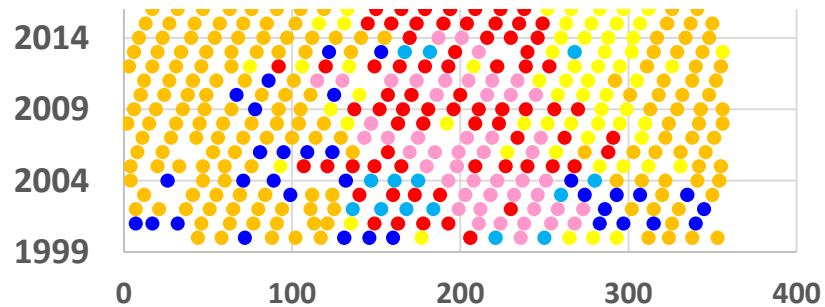
Si limitant

	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Astan										
Estacade										
Fleuves										

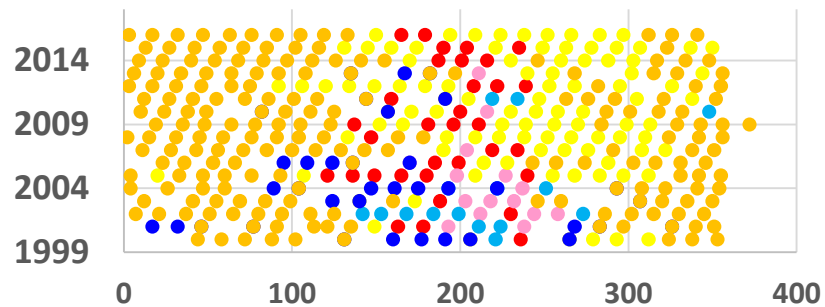


Estacade

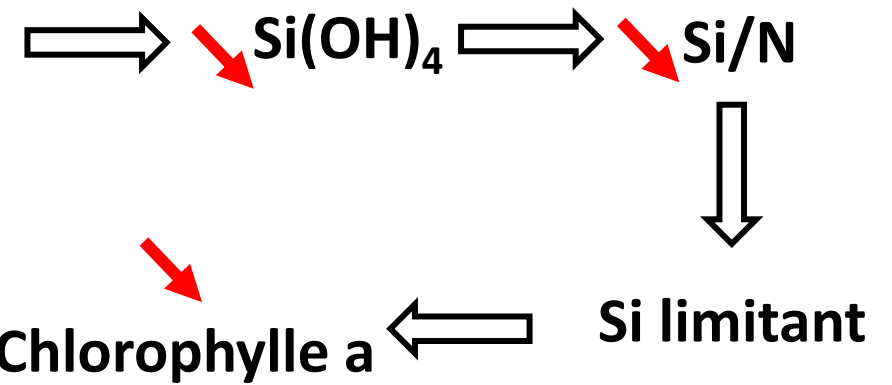
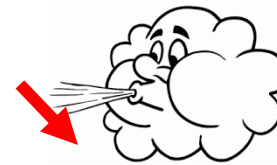


Astan

- N, Si, P
- N, P, Si
- Si, N, P
- Si, P, N
- P, N, Si
- P, Si, N

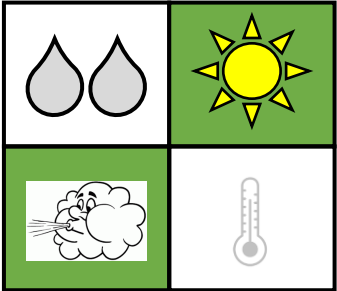


Jours



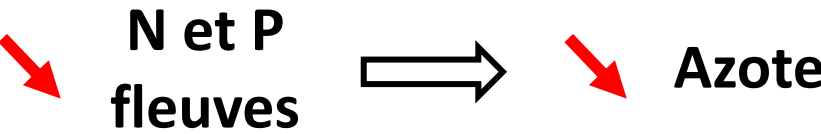
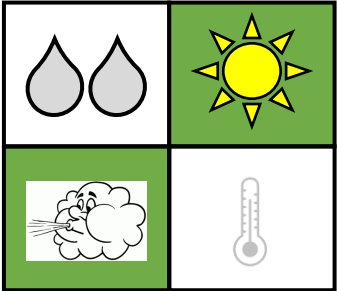
	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Portzic										
Fleuves										



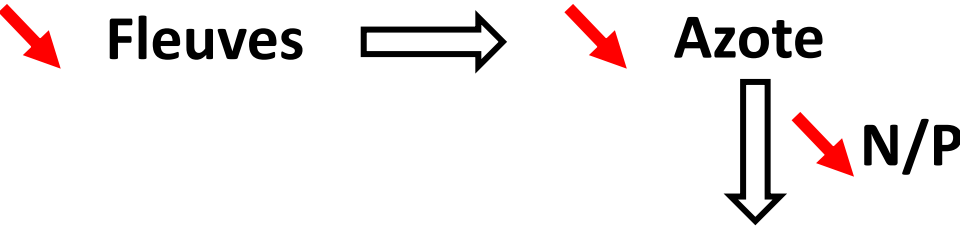
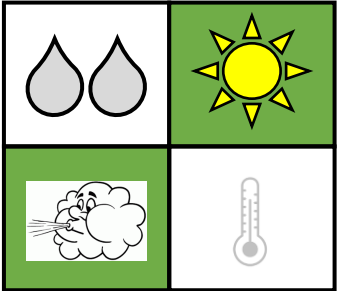
	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N
Portzic							
Fleuves							



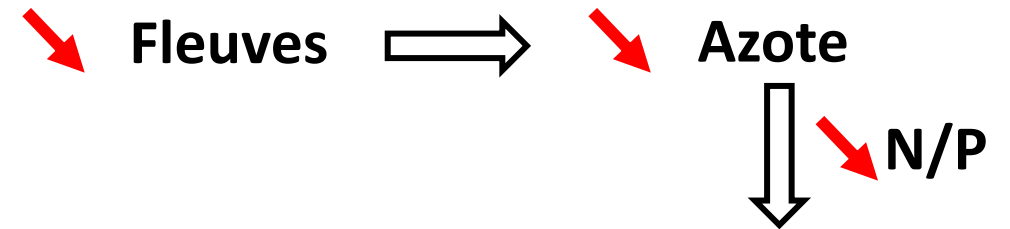
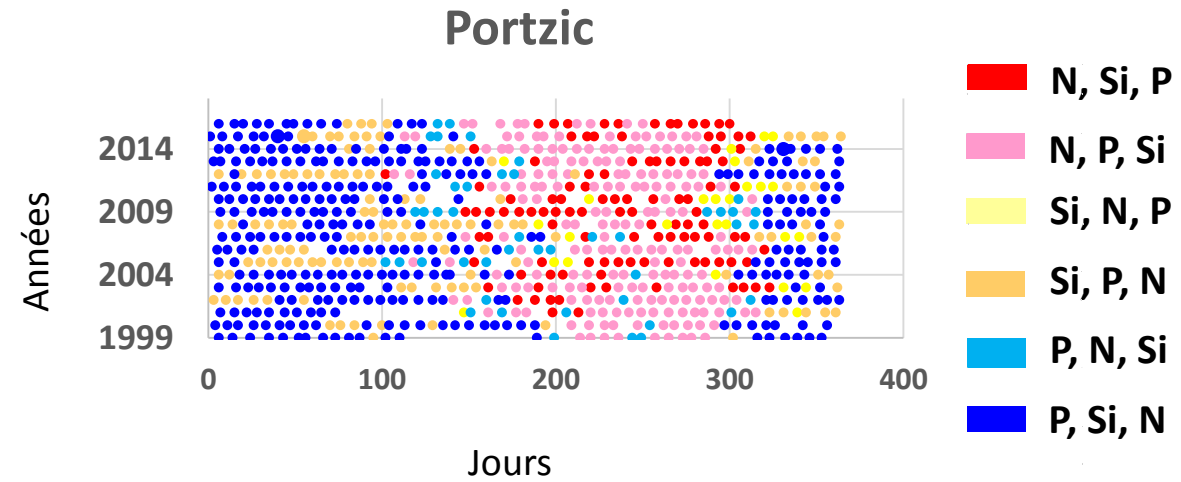
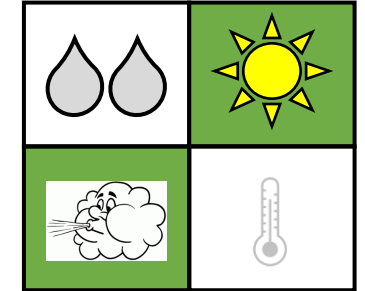
	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Portzic										
Fleuves										



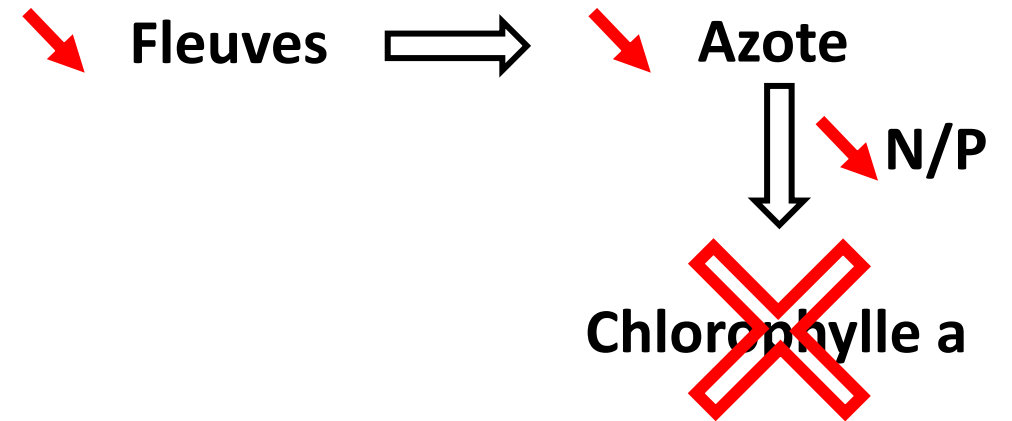
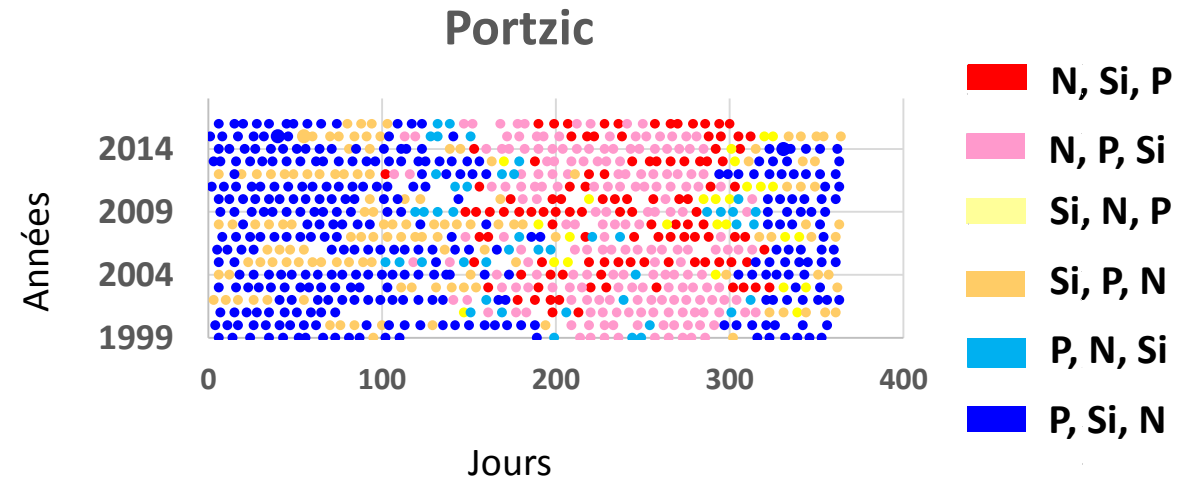
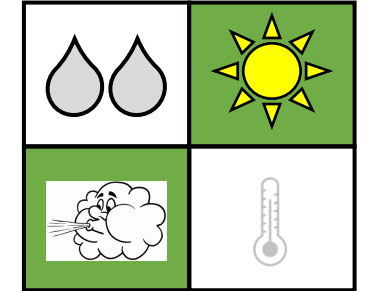
	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Portzic										
Fleuves										



	Tendance positive
	Tendance négative
	Données inutilisables
	Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Portzic										
Fleuves										



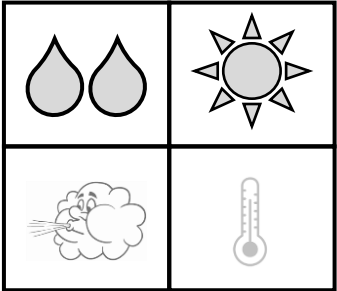
Tendance positive

Tendance négative

Données inutilisables

Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Bouee13										
Eyrac										
Comprian										
Fleuves										



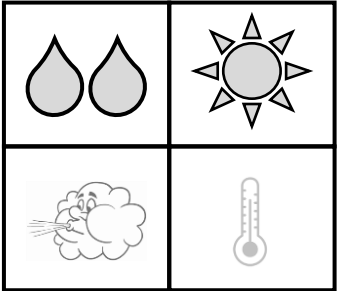
Tendance positive

Tendance négative

Données inutilisables

Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Bouee13										
Eyrac										
Comprian										
Fleuves										



↗ NOx
Si(OH)₄

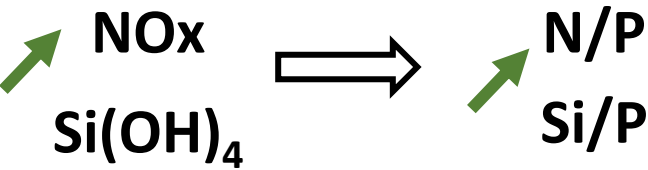
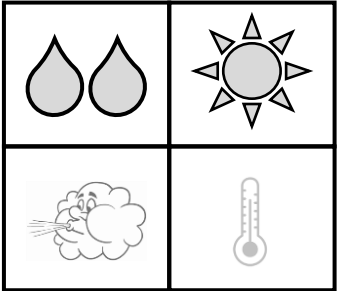
Tendance positive

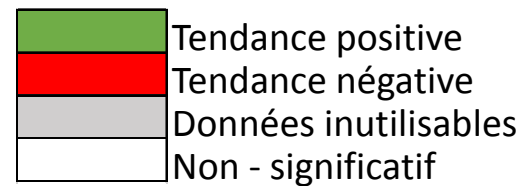
Tendance négative

Données inutilisables

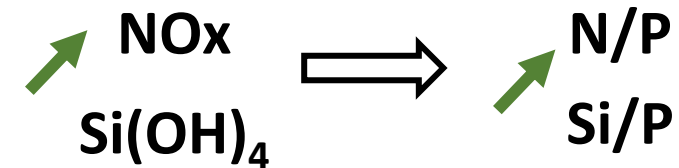
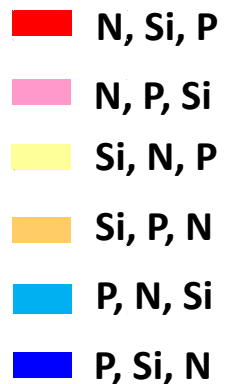
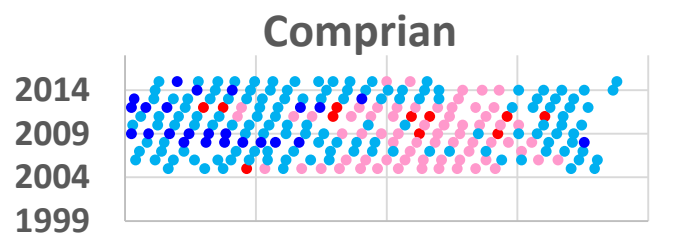
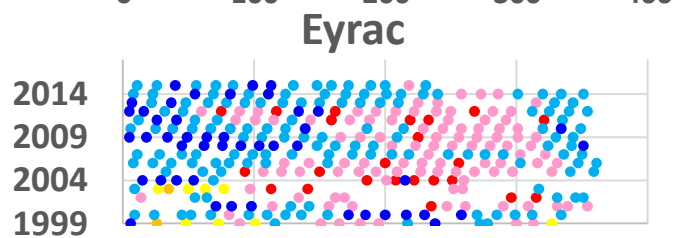
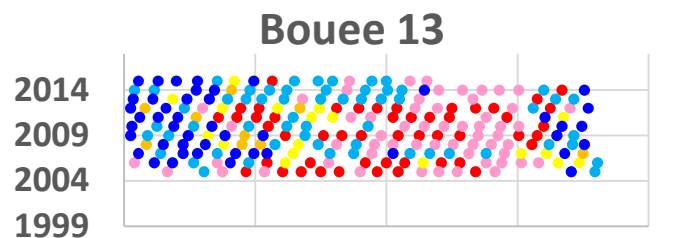
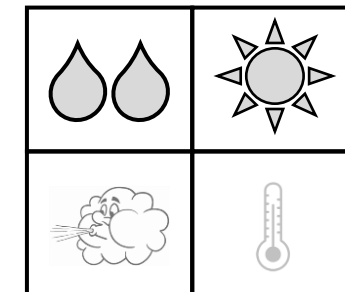
Non - significatif

	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Bouee13										
Eyrac										
Comprian										
Fleuves										



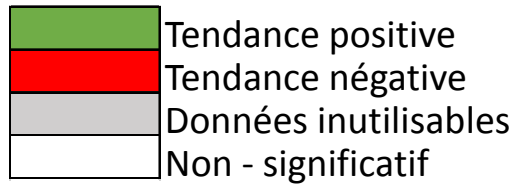


	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Bouee13										
Eyrac										
Comprian										
Fleuves										

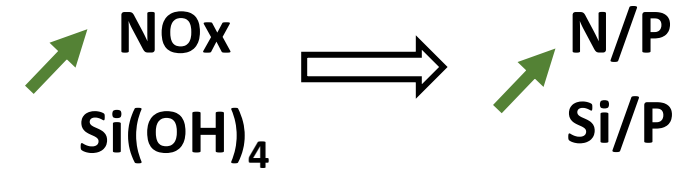
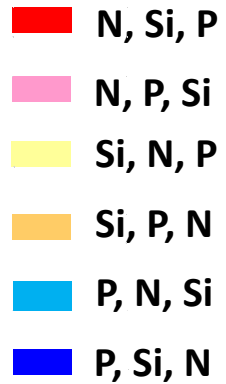
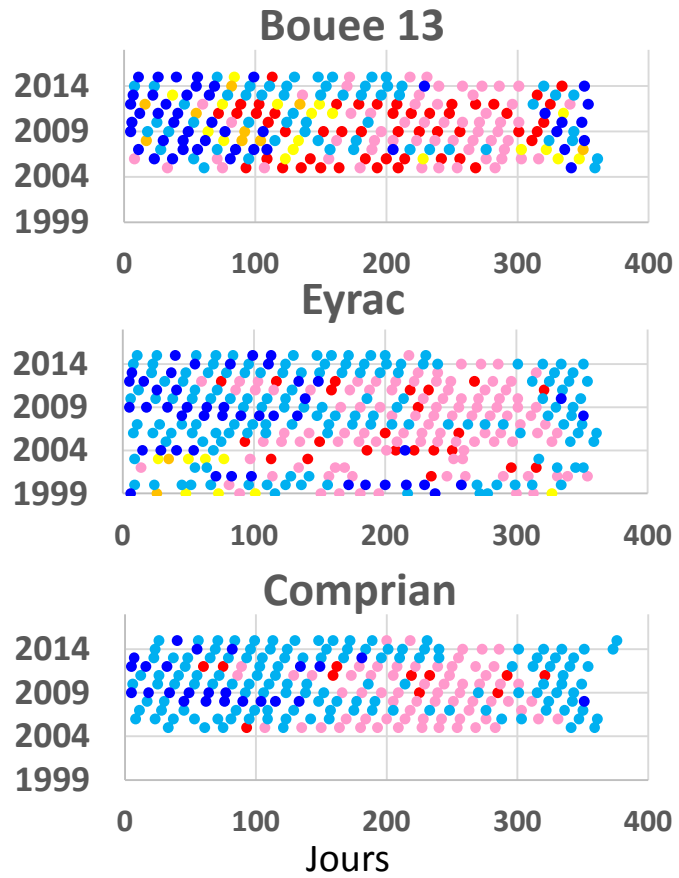
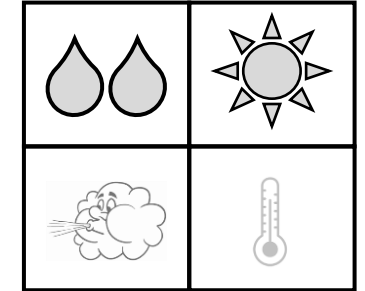


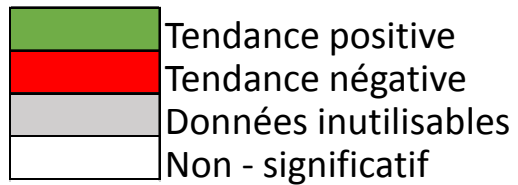
Années

Jours

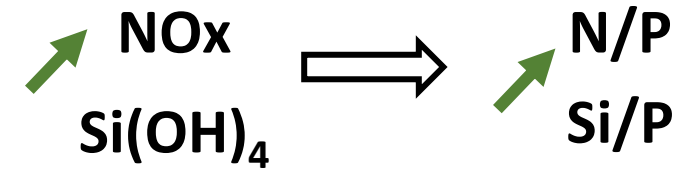
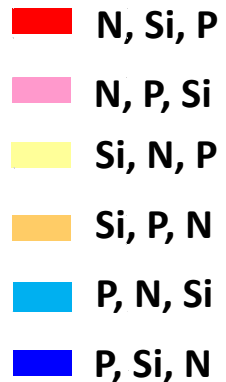
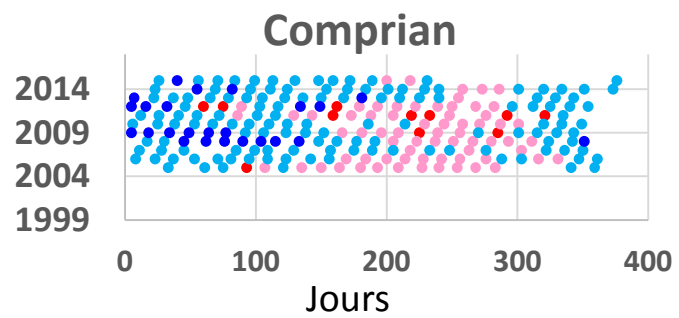
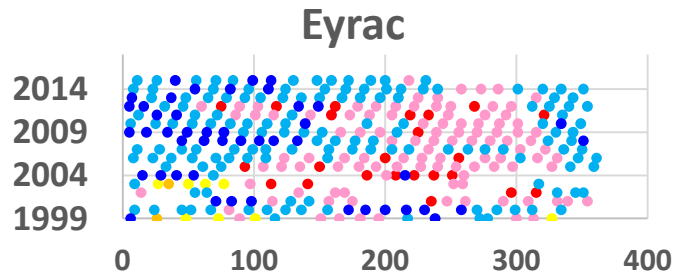
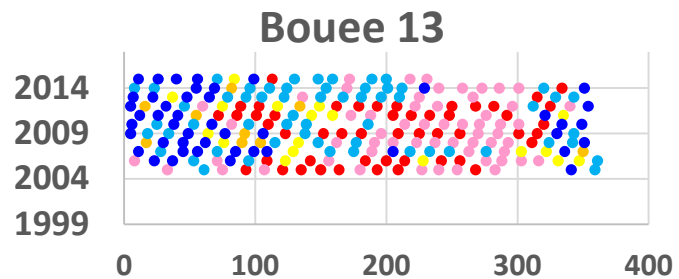
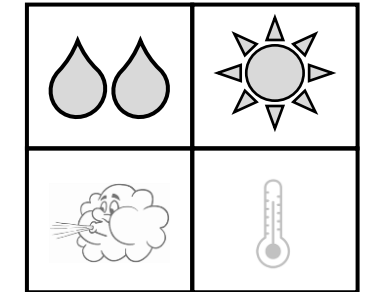


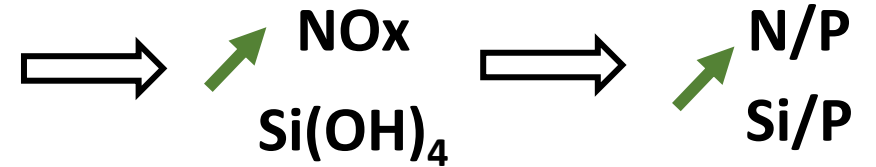
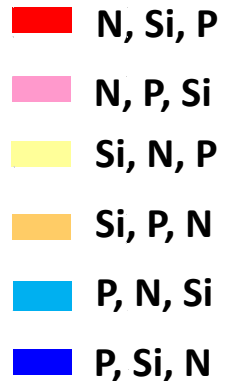
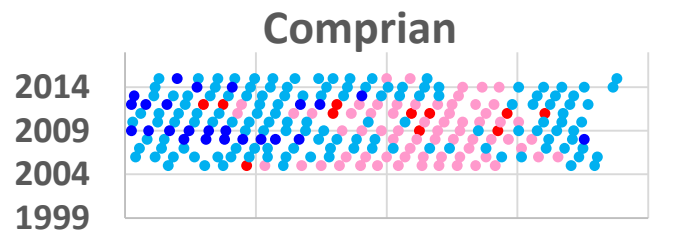
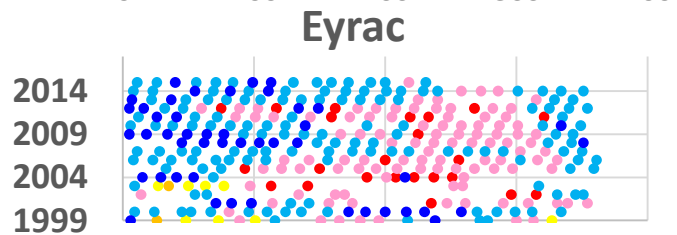
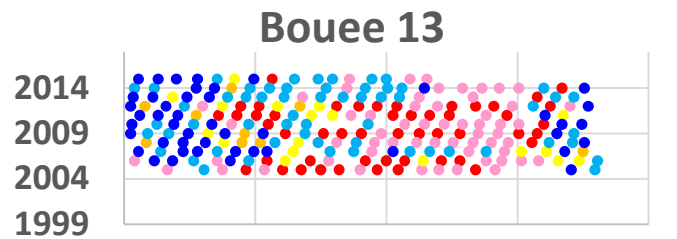
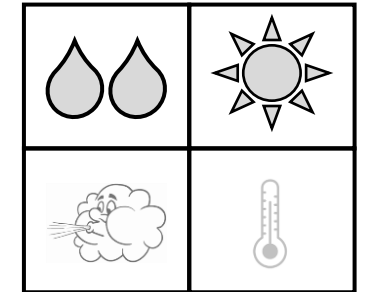
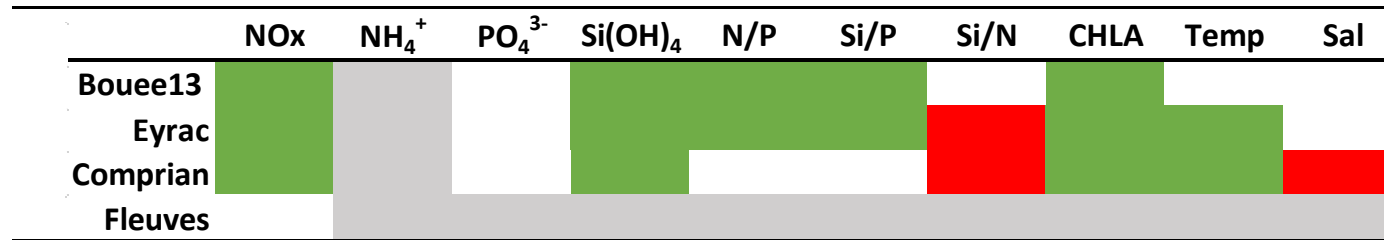
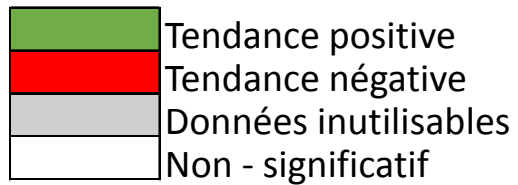
	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Bouee13										
Eyrac										
Comprian										
Fleuves										





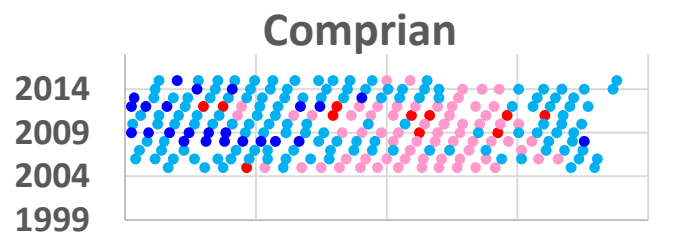
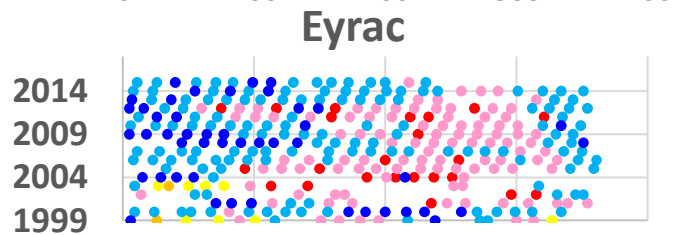
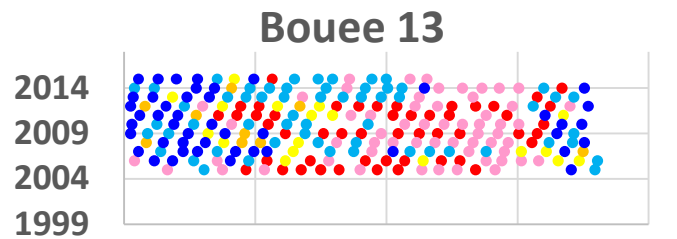
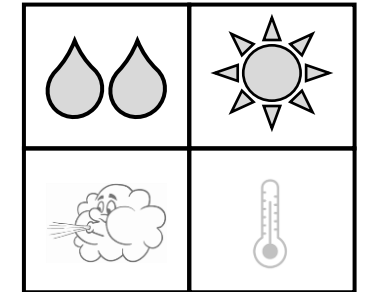
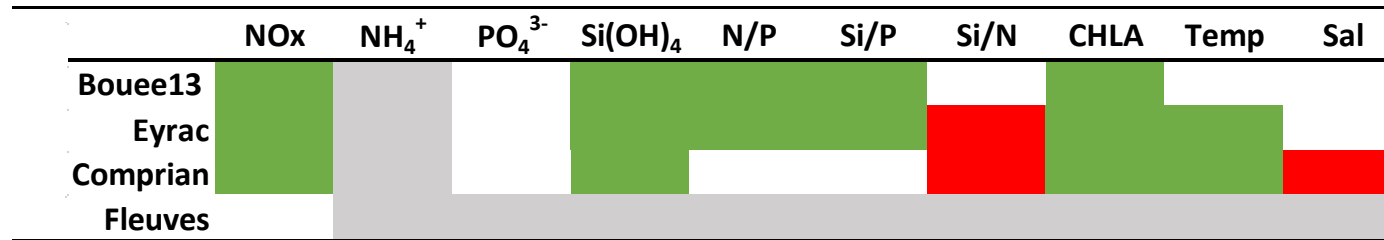
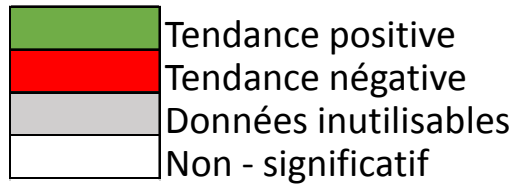
	NOx	NH ₄ ⁺	PO ₄ ³⁻	Si(OH) ₄	N/P	Si/P	Si/N	CHLA	Temp	Sal
Bouee13										
Eyrac										
Comprian										
Fleuves										



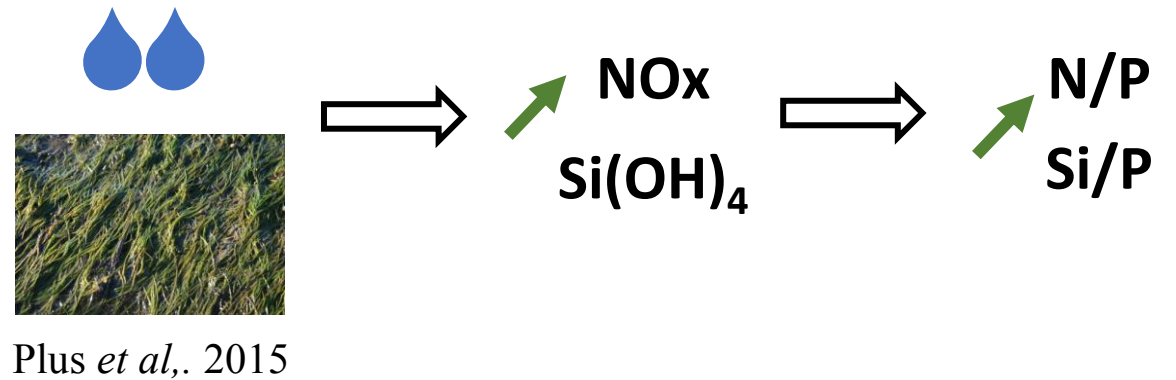
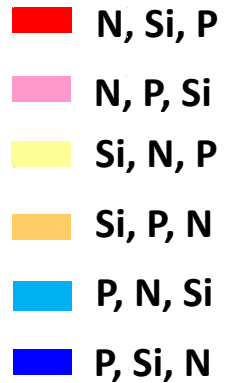


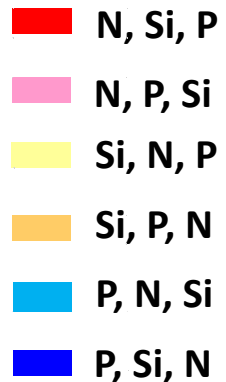
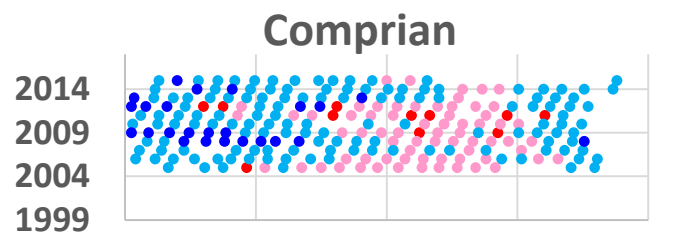
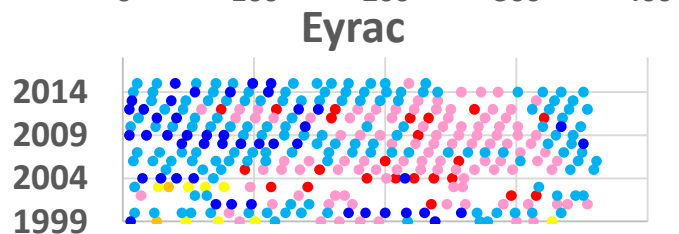
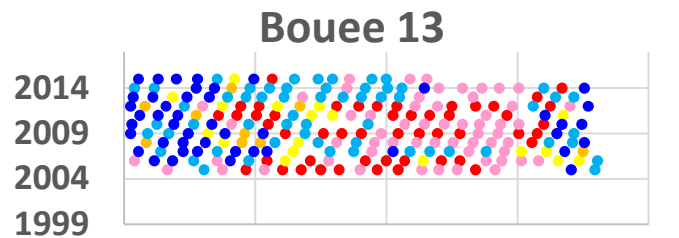
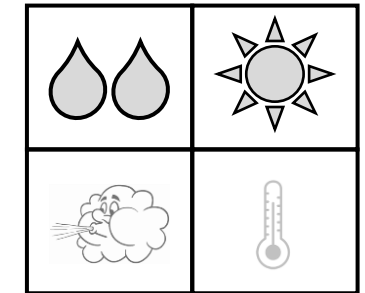
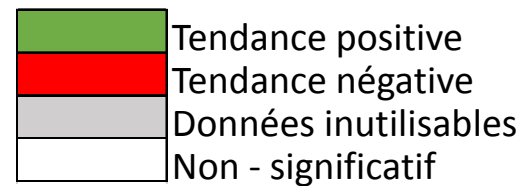
Années

Jours

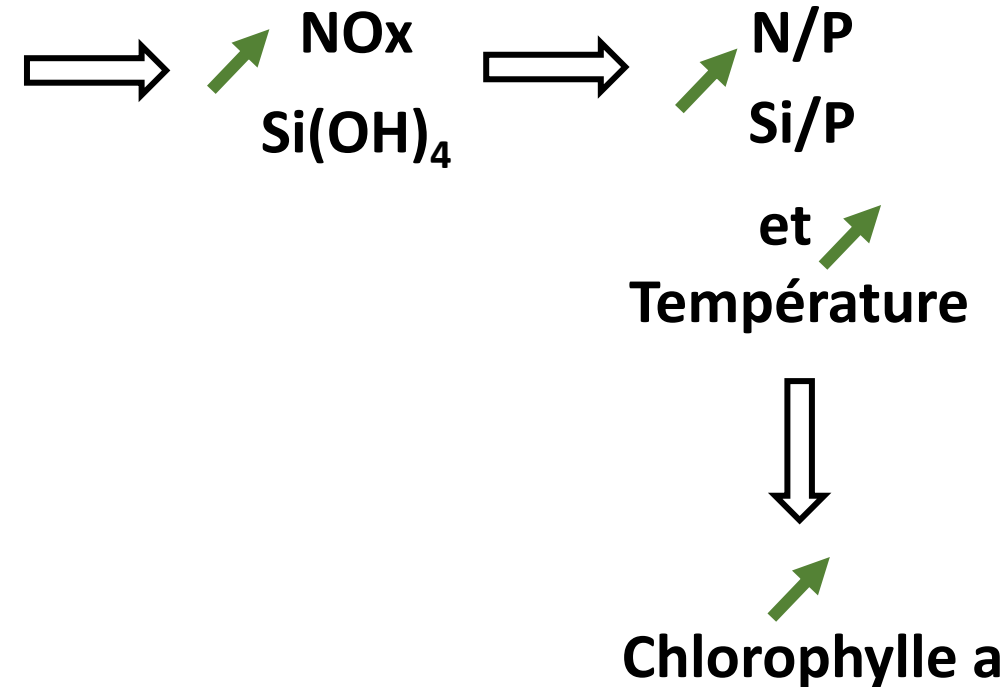


Jours



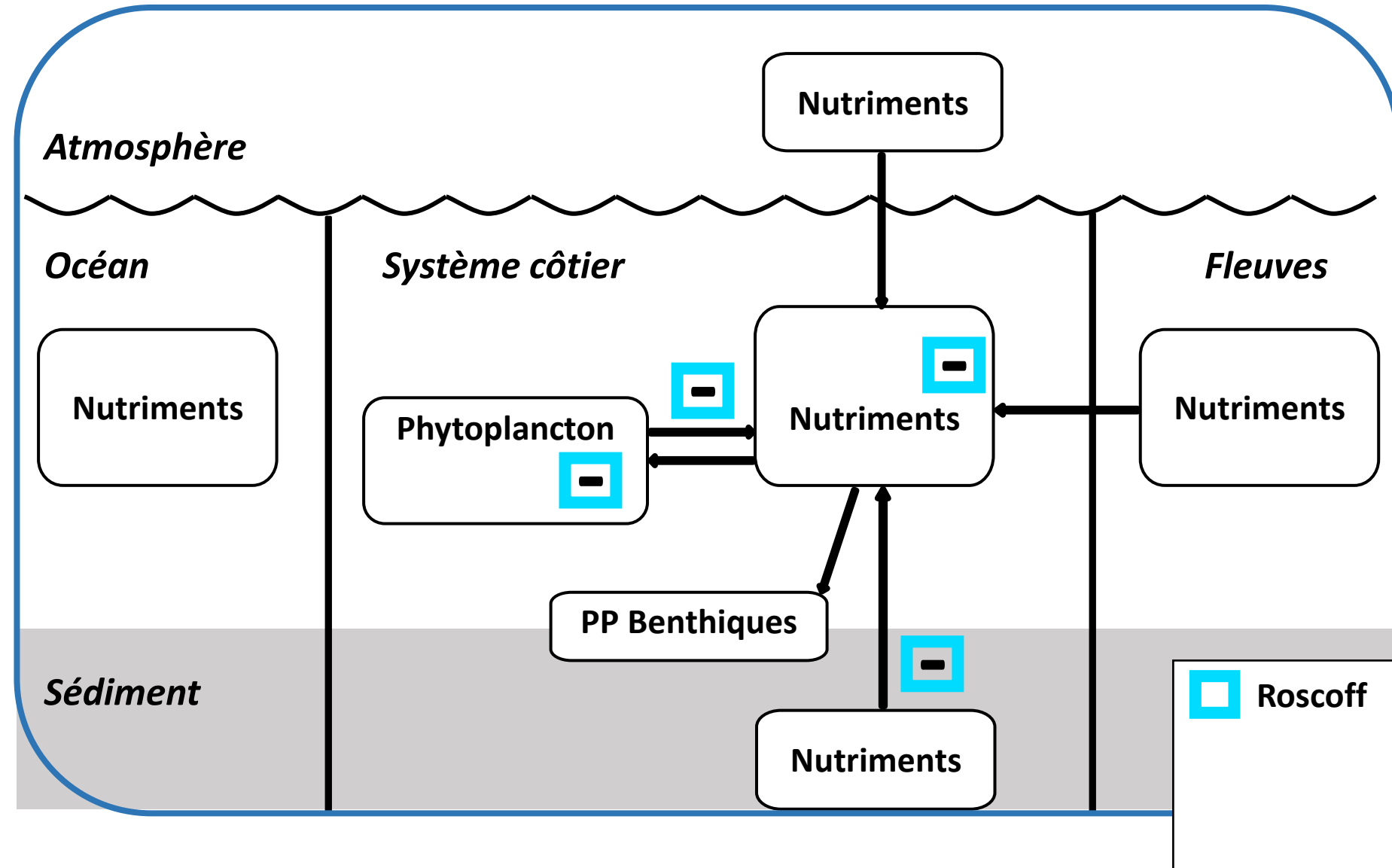


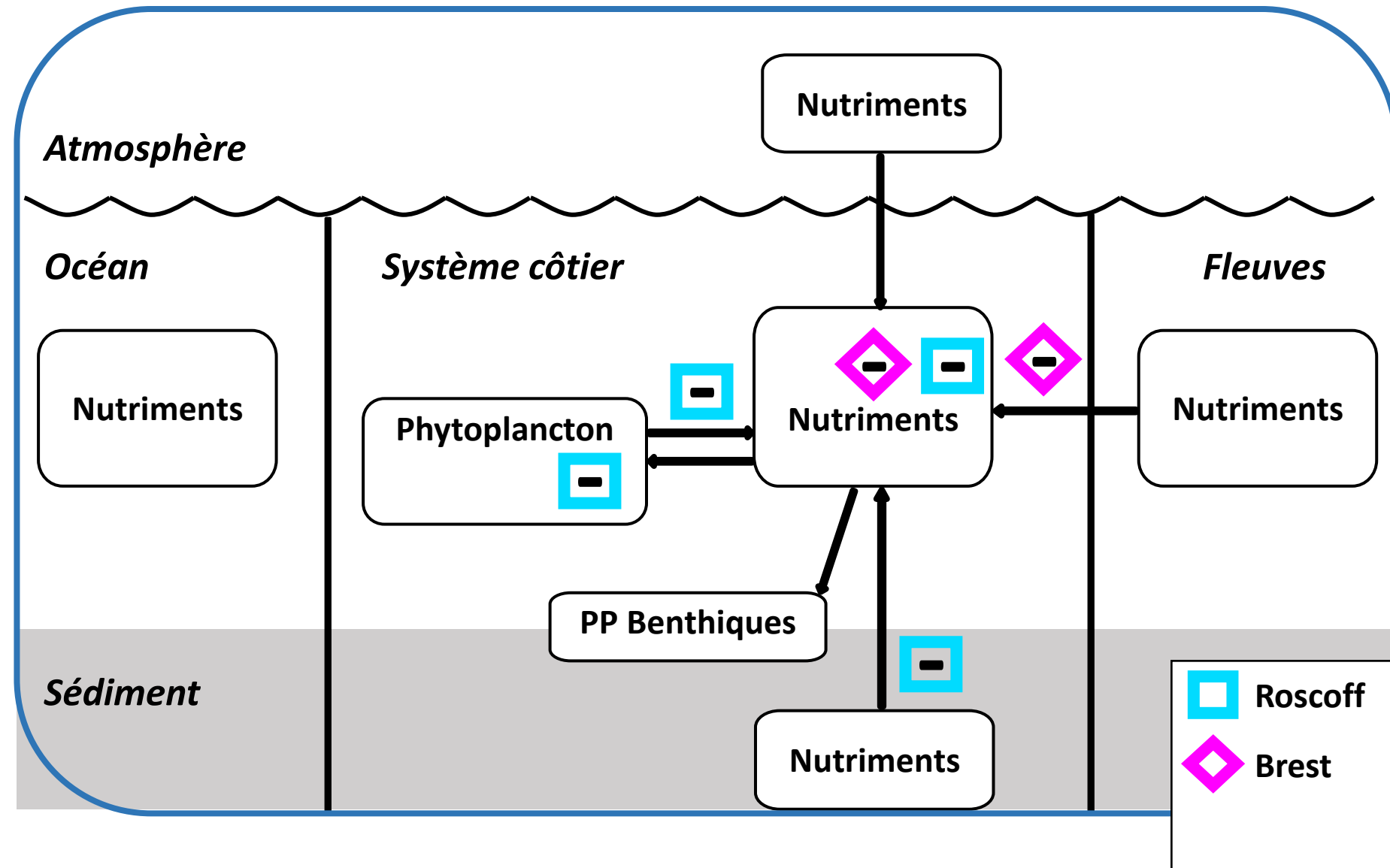
Plus *et al.*, 2015

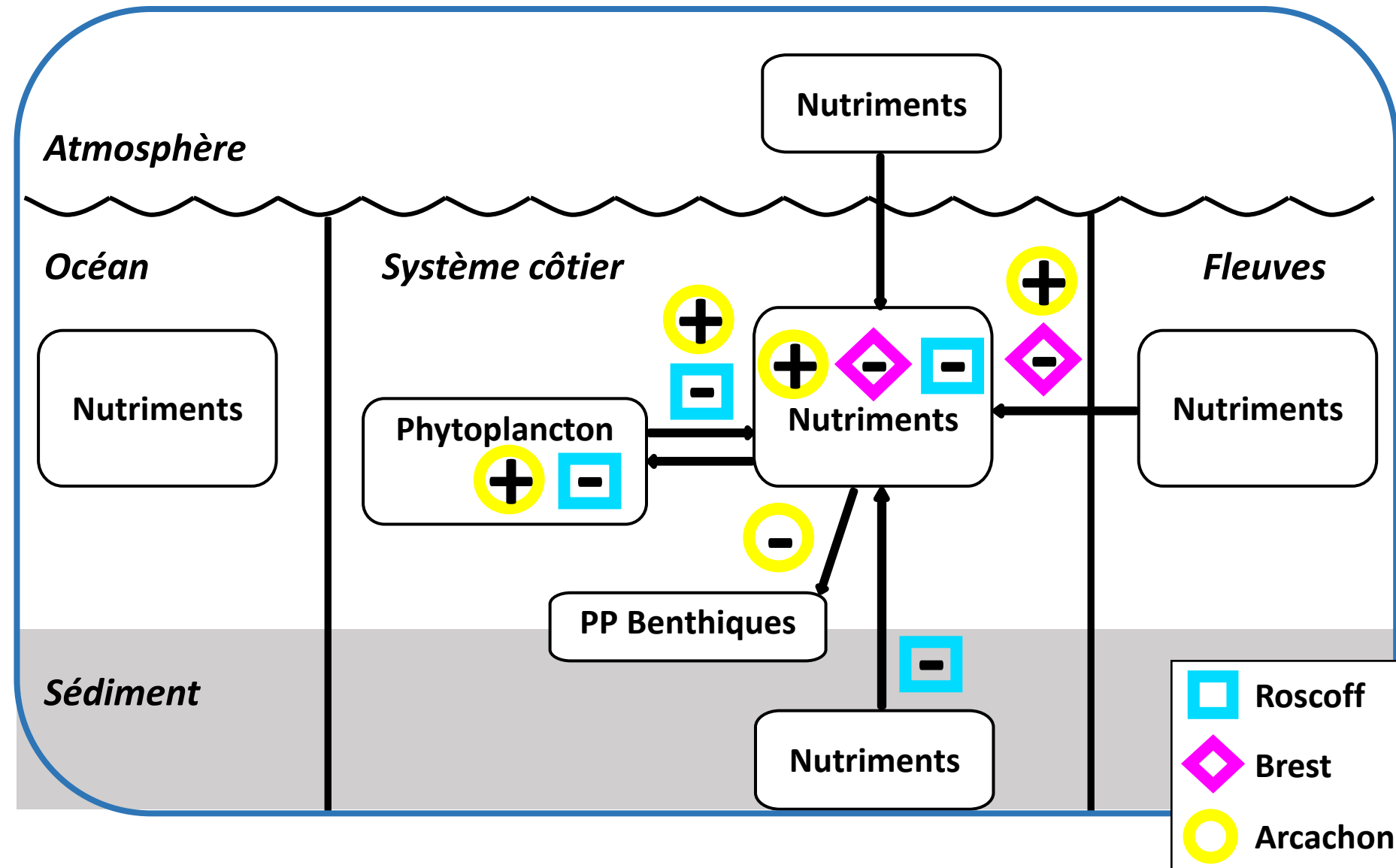


Années

Jours







Conclusions

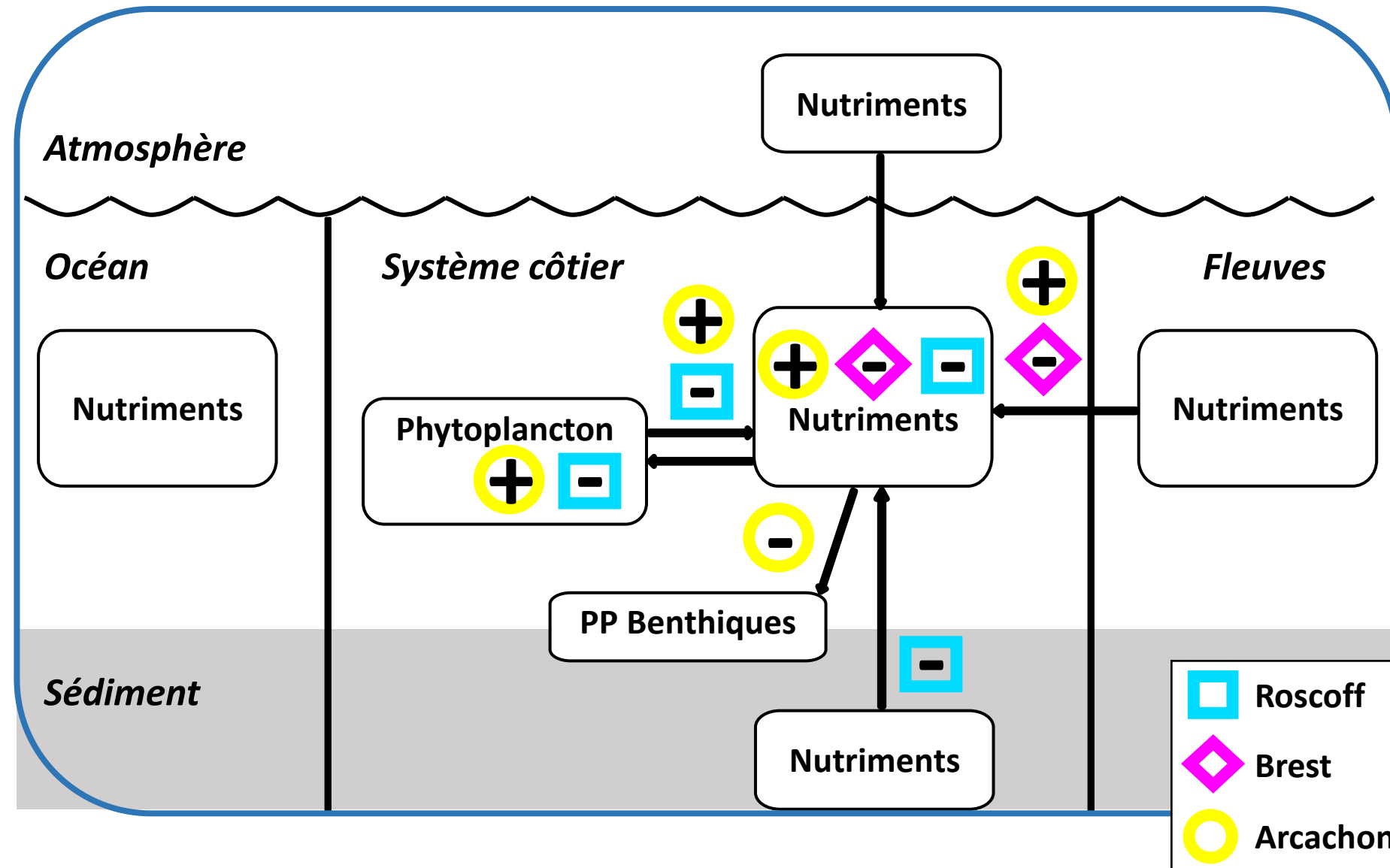
3 systèmes =
3 fonctionnements et
évolutions

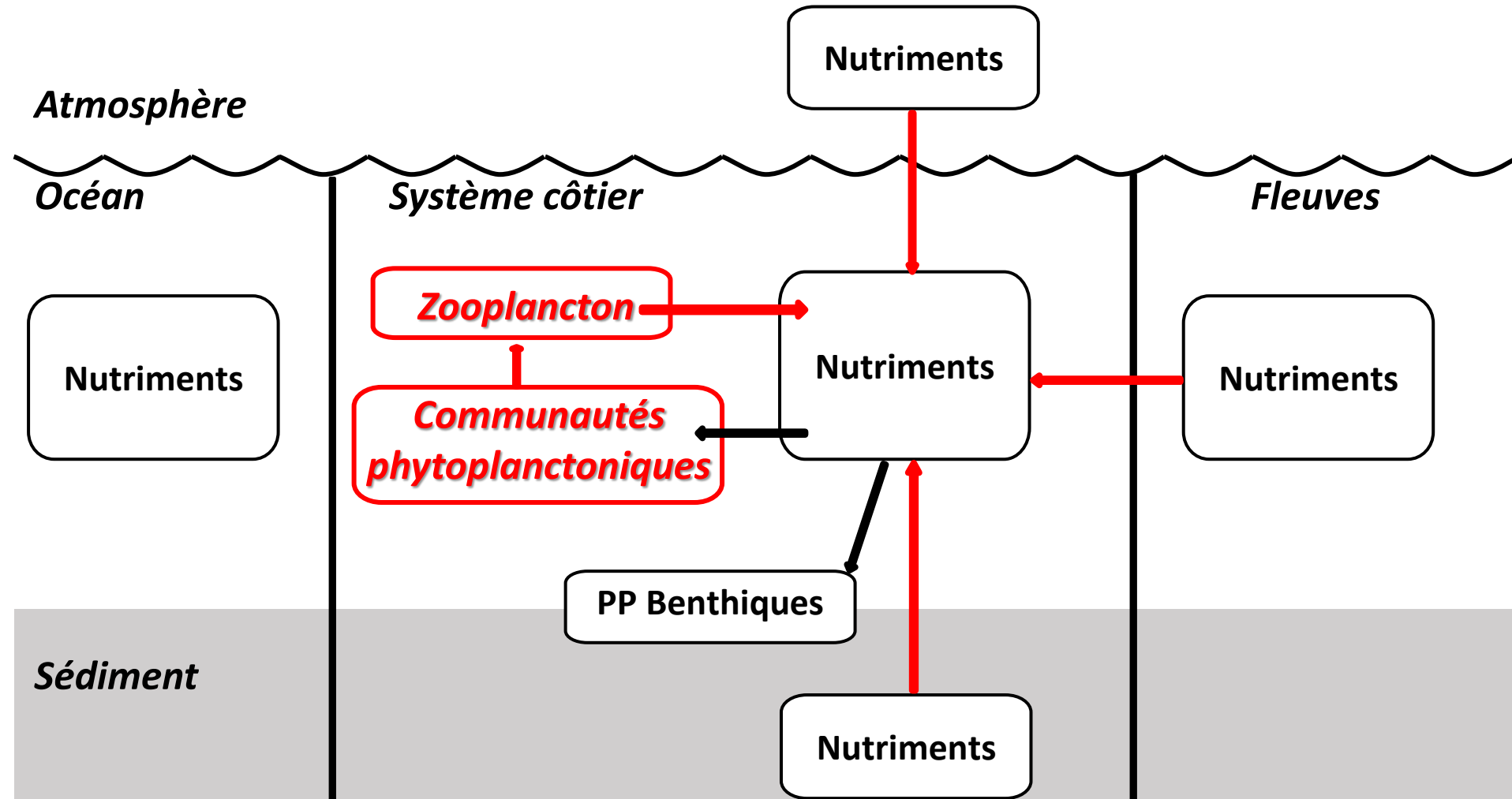
* *Impact des apports continentaux*

* *Couplage benthopélagique*



Complexité
des systèmes côtiers





Quelle suite ?

Pression de broutage, origine des nutriments, communautés phytoplanctoniques

Merci à tous !