mercator-ocean.eu

marine.copernicus.eu

Les configurations couplées physique – biogéochimie à Mercator Océan:

Simulations interannuelles et temps réel

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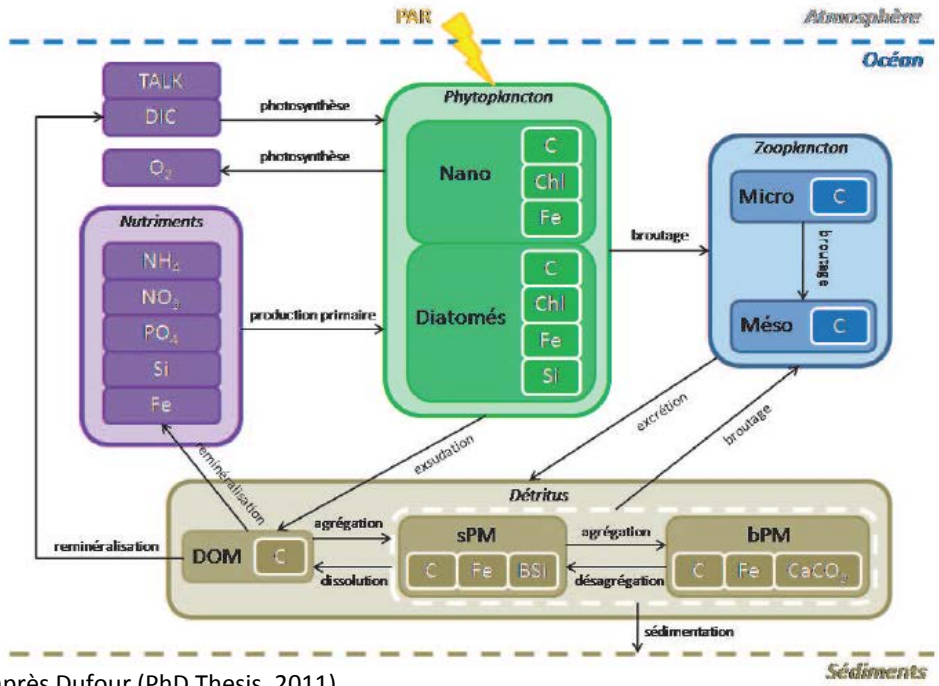
[1] Mercator Océan, France

[2] Marine Institute, Irelande

[3] Puertos de Estado, Espagne

Le modèle PISCES

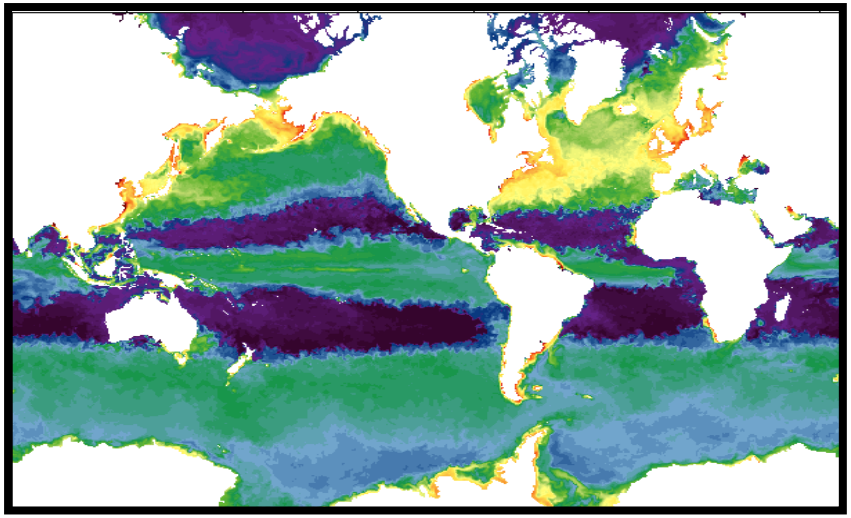


D'après Dufour (PhD Thesis, 2011)

- 24 variables prognostiques, 5 nutriments limitants, 2 espèces de phytoplancton et de zooplancton, 3 compartiments de matière détritique
- Modèle Redfieldien
- Rapport C / Chl, C/Fe, C/Si variable
- Cycle du carbone et de l'oxygène
- Pas de rétroaction sur la physique
- Modèle de type Monod (Monod, 1942): Pas de cycle diurne
- Pas de modèle sédimentaire: équilibre entre apports externes et ce qui est piégé dans les sédiments
- Apports externes: rivières, poussières (Fer, Si et P), Fer sédimentaire (friction)

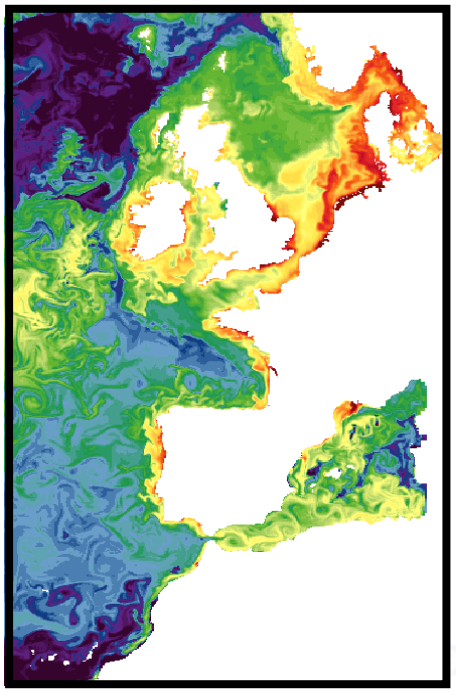
Les systèmes couplés à Mercator Océan:

Mercator-Vert/Green Grog



GLOBAL
¼°

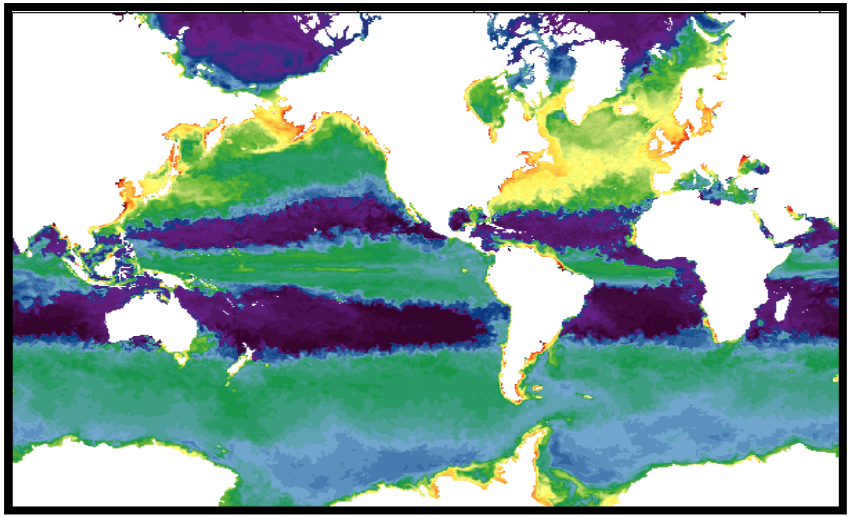
AMICO-BIO



IBI
1/12° et 1/36°

Les systèmes couplés à Mercator Océan:

Mercator-Vert/Green Grog



GLOBAL
¼°

AMICO-BIO

IBI
1/12° et 1/36°

GLOBAL ¼°:

TEMPS REEL

- NEMO3.2
- Résolution spatiale: ¼°
- 50 niveaux verticaux
- Conditions initiales: WOA et GLODAP
- 2007 – temps réel
- Couplage offline
- Forçage océanique: PSY3 journalier (avec assimilation de données SST, SLA et in situ T et S)
- Forçage atmosphérique: analyses oper ECMWF bulk CORE
- Carbone anthropique (Masarie and Tans, 1995)

TEMPS DIFFERE

- NEMO3.5
- Résolution spatiale: ¼°
- 75 niveaux verticaux
- Conditions initiales: WOA et GLODAP
- 1992 – 2014 (distribué à partir de 1998)
- Couplage offline
- Forçage océanique: GLORYS2V3 libre journalier (pas d'assimilation)
- Forçage atmosphérique: ERA-INTERIM bulk CORE
- Carbone anthropique (Masarie and Tans, 1995)

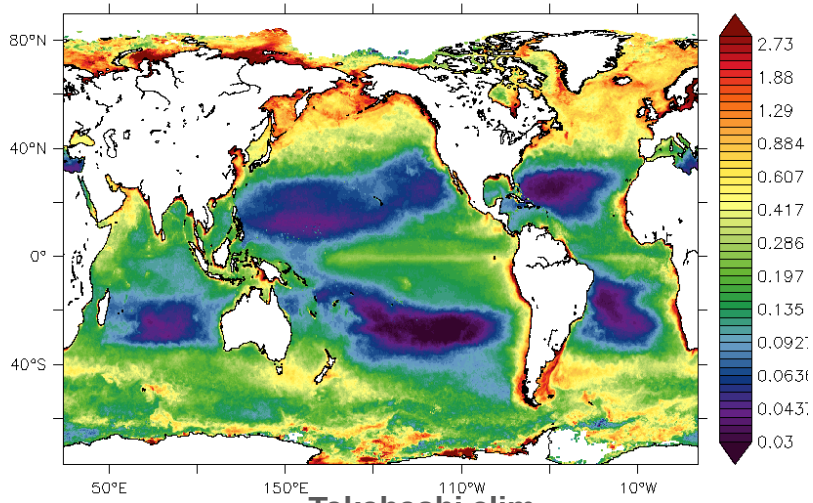
Dès lors, on se focalise sur le TEMPS DIFFERE

GLOBAL ¼°: *Simulation interannuelle*

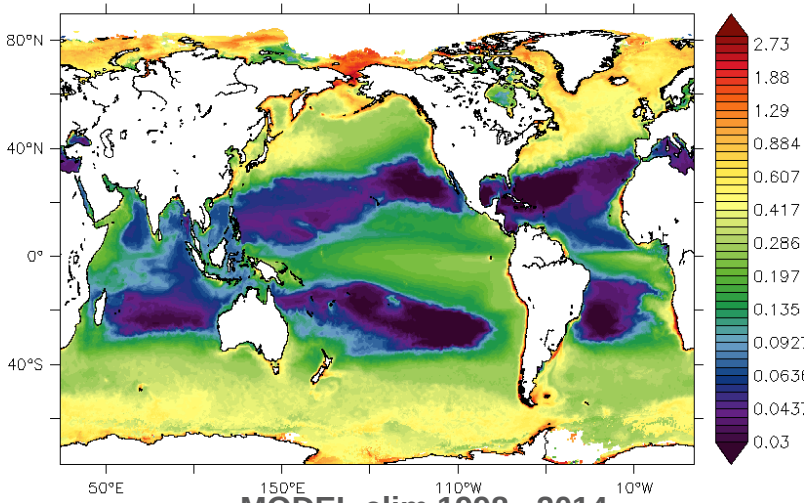
Le modèle reproduit bien les structures grandes échelles

CHL

Globcolour DATA 2014

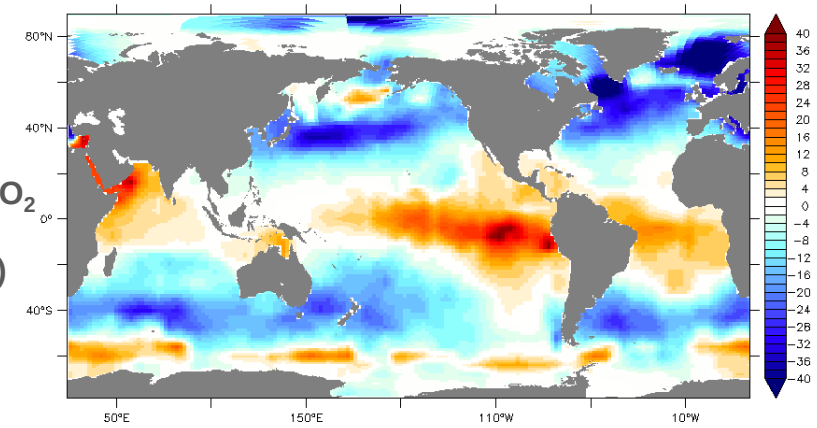


MODEL 2014

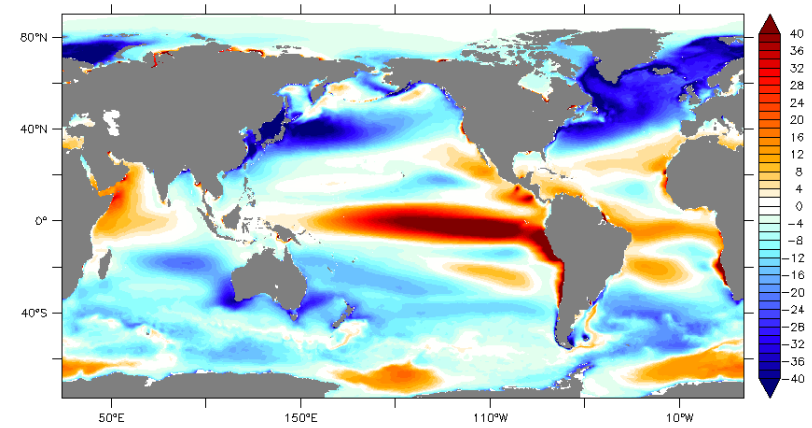


Air-Sea CO_2 flux ($gC/m^2/yr$)

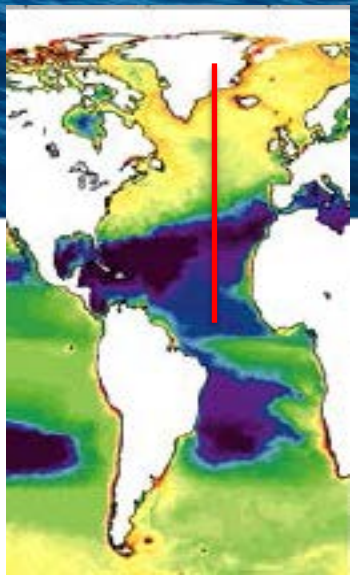
Takahashi clim



MODEL clim 1998 - 2014



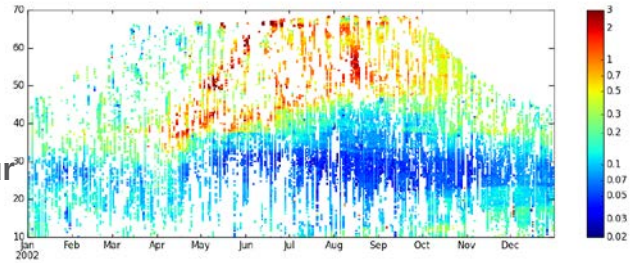
GLOBAL ¼°: *Simulation interannuelle*



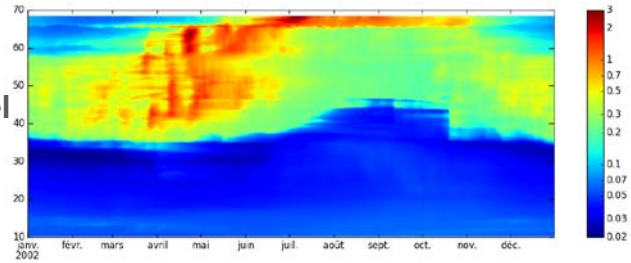
Cycle saisonnier en Atlantique Nord

2002

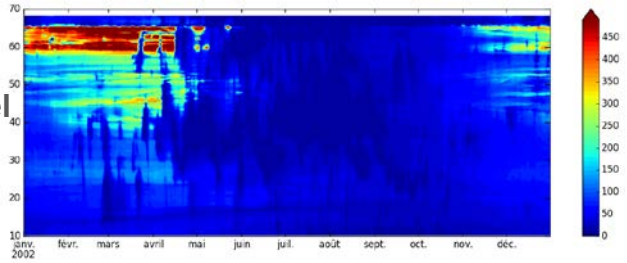
CHL Globcolour Daily



CHL Model Daily

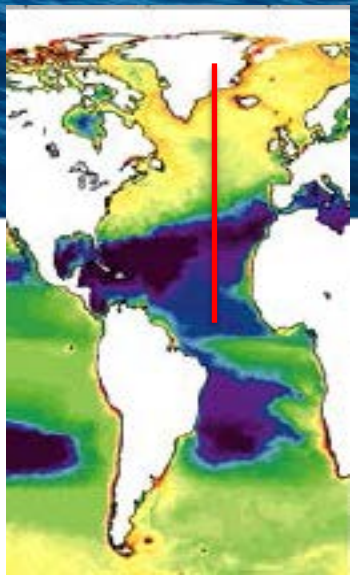


MLD Model Daily



- Cycle saisonnier correctement reproduit
  - 1er bloom (secondaire) en automne au moment de l'approfondissement de la couche de mélange (limitation par les nutriments)
  - Bloom principal au printemps au moment de la restratification de la couche mélangée (limitation par la lumière)
  - En été, couche mélangée peu profonde et très peu de production primaire

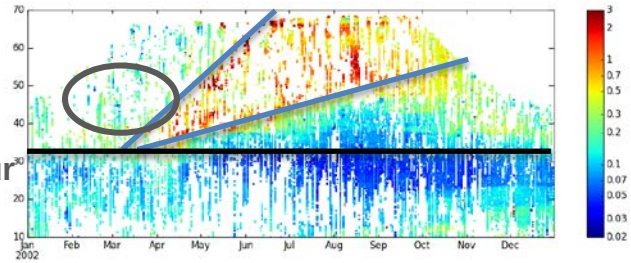
GLOBAL ¼°: *Simulation interannuelle*



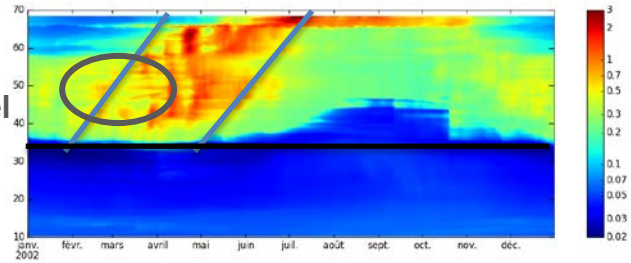
Cycle saisonnier en Atlantique Nord

2002

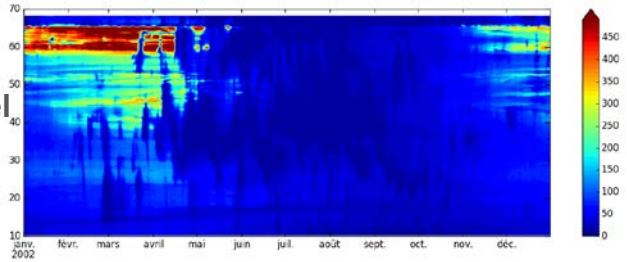
CHL Globcolour Daily



CHL Model Daily

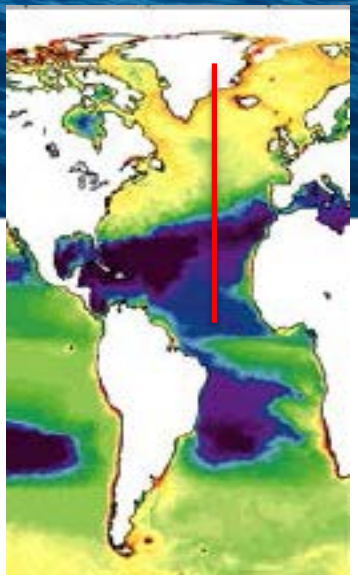


MLD Model Daily



- Chlorophylle quasi-inexistante dans les gyres oligotrophes contrairement aux données
- Démarrage trop précoce du bloom (un mois d'avance)
- Le bloom se propage trop vite vers le Nord
- Le bloom ne se maintient pas suffisamment longtemps en été

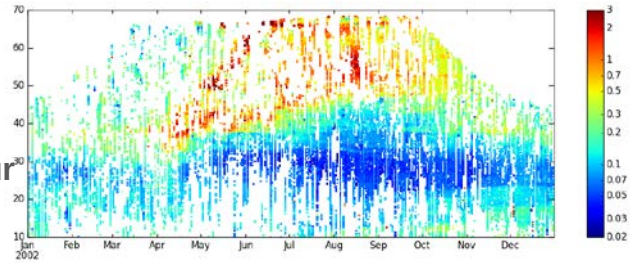
GLOBAL ¼°: *Simulation interannuelle*



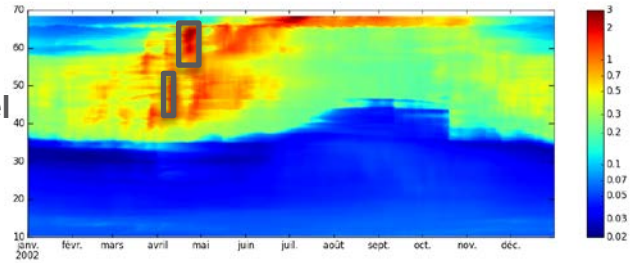
Cycle saisonnier en Atlantique Nord

2002

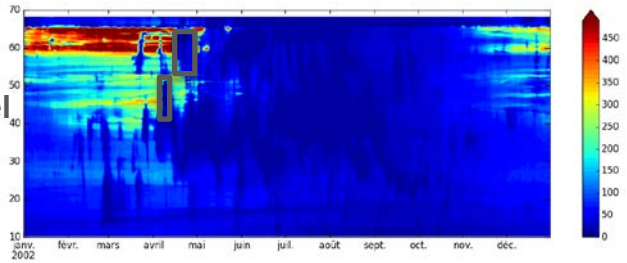
CHL Globcolour Daily



CHL Model Daily



MLD Model Daily



- Chlorophylle quasi-inexistente dans les gyres oligotrophes contrairement aux données
- Amplitude du max du bloom est bonne

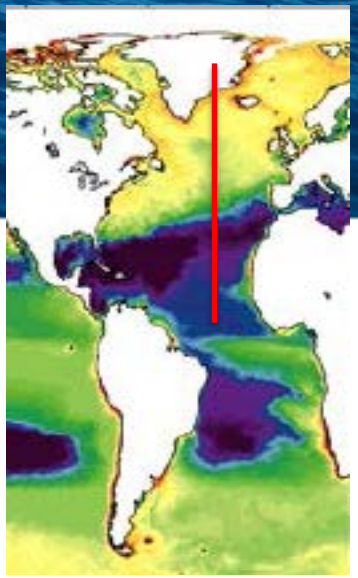
- Démarrage trop précoce du bloom (un mois d'avance)

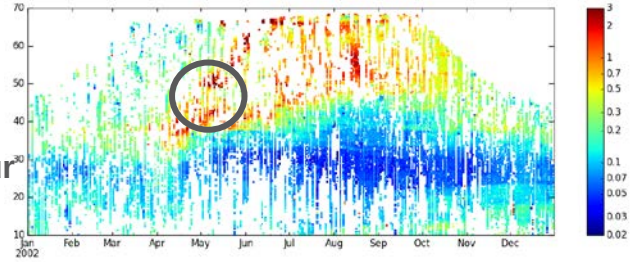
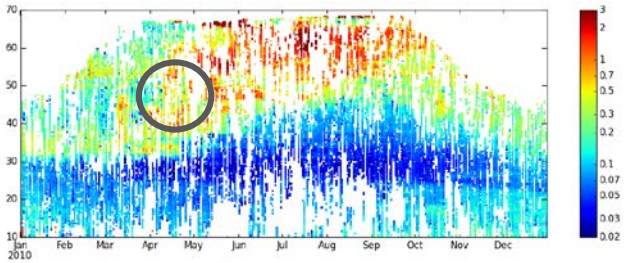
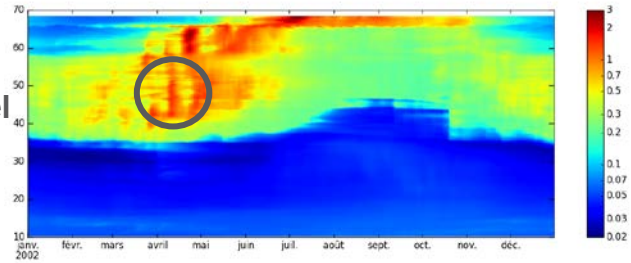
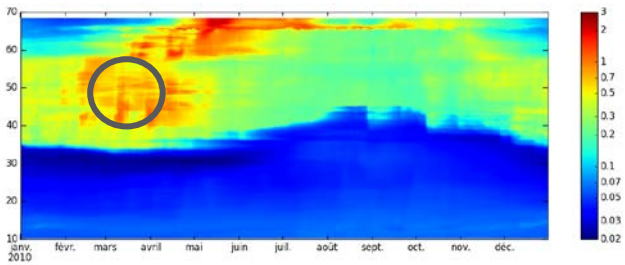
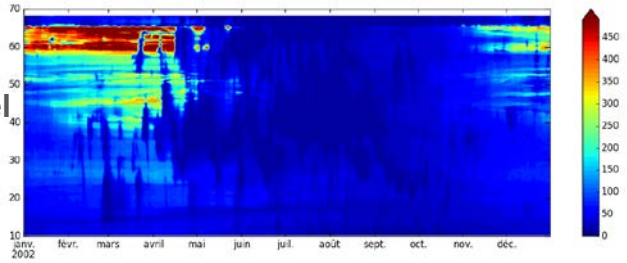
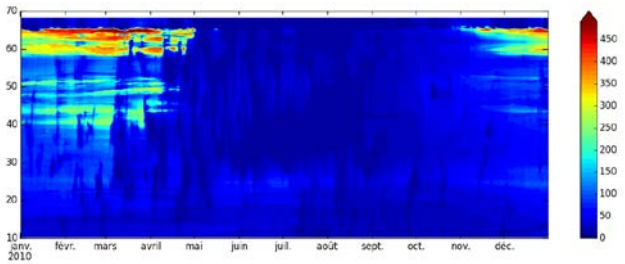
- Le bloom se propage trop vite vers le Nord
- Le bloom ne se maintient pas suffisamment longtemps en été

- Phénomène de restratification: pas un processus continu, petits épisodes successifs entrecoupés de réapprofondissements, le phytoplancton réagit instantanément

GLOBAL ¼°: *Simulation interannuelle*

Cycle saisonnier en Atlantique Nord

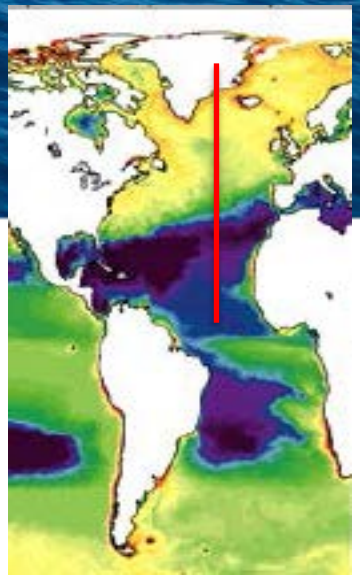


	2002	2010
CHL Globcolour Daily		
CHL Model Daily		
MLD Model Daily		

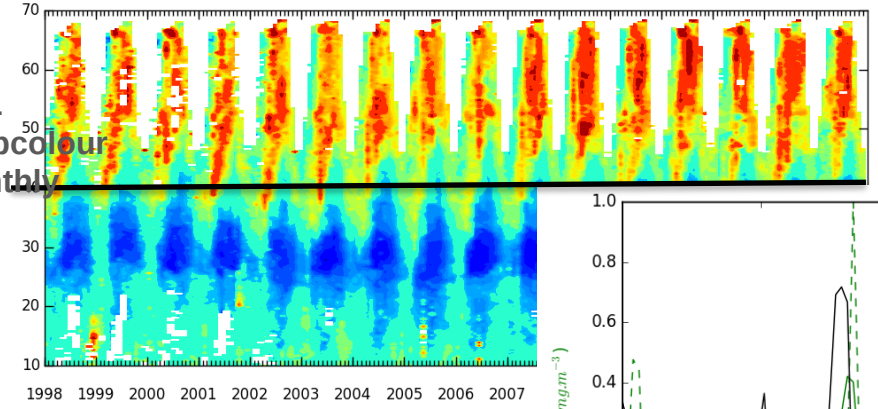
- Grande variabilité interannuelle du timing du bloom
- Bloom plus précoce en 2010
- Bloom plus intense en 2002
- Bien reproduit par le modèle

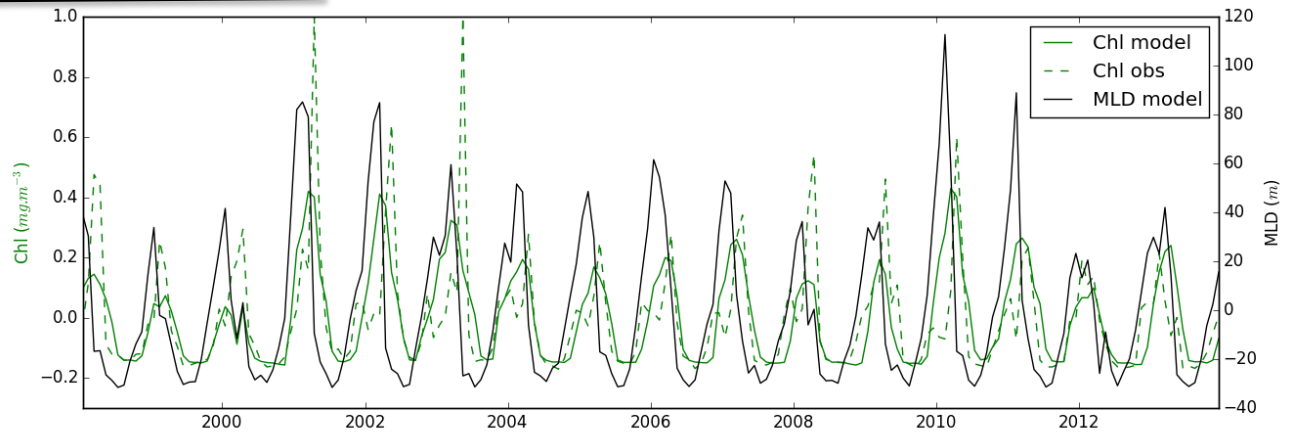
GLOBAL ¼°: *Simulation interannuelle*

Variabilité interannuelle du bloom en Atl. Nord

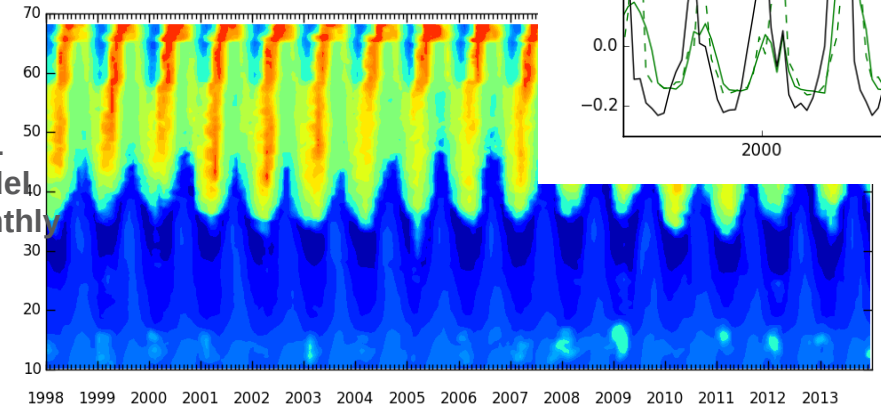


CHL Globcolour Monthly





CHL Model Monthly



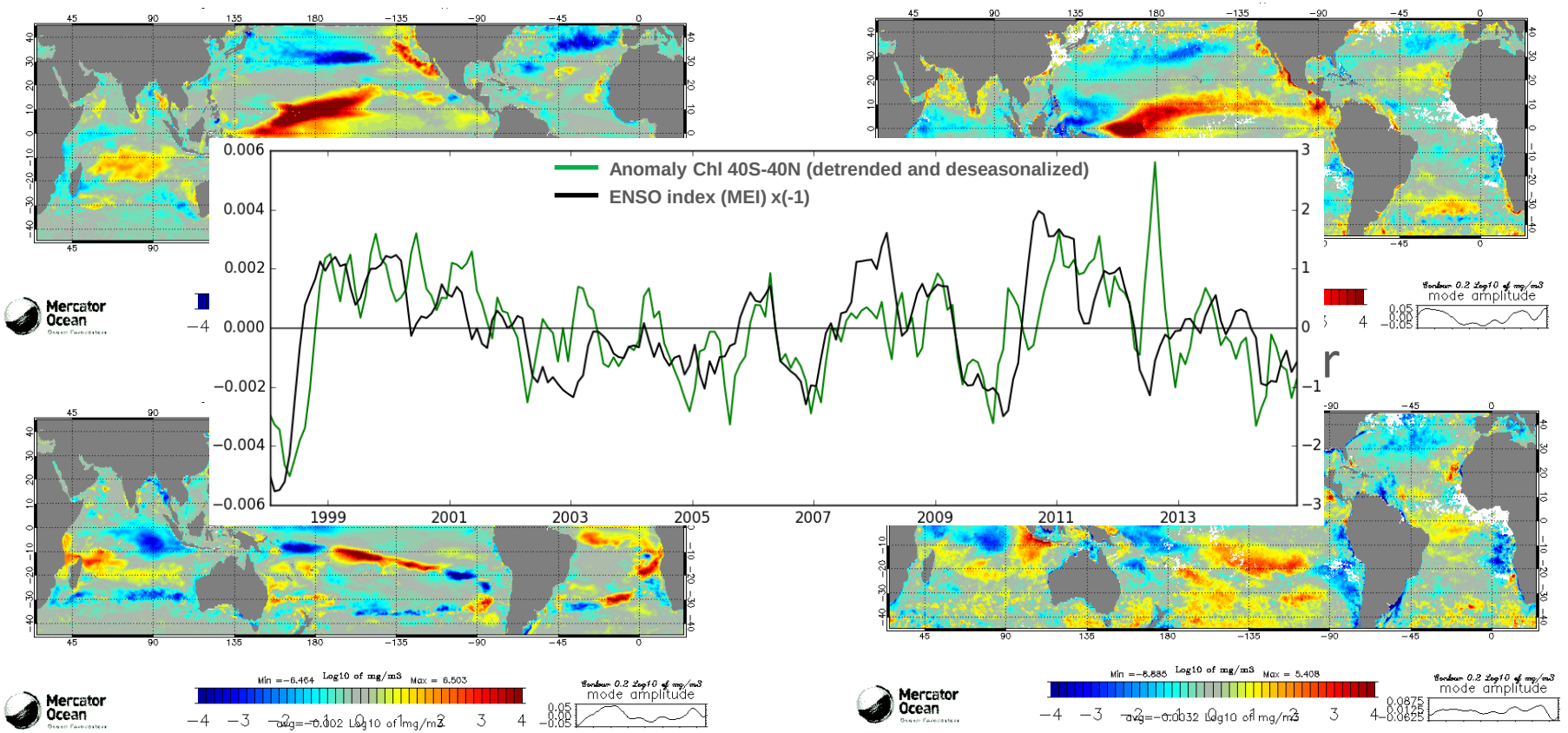
Variabilité spatiale nord-sud du démarrage du bloom saisonnier bien reproduite par le modèle
⇨processus local: dû à la variabilité de la profondeur de la MLD en hiver

GLOBAL ¼°: *Simulation interannuelle*

Variabilité interannuelle
Décomposition en EOF de la chlorophylle

Mode #1

Mode #2



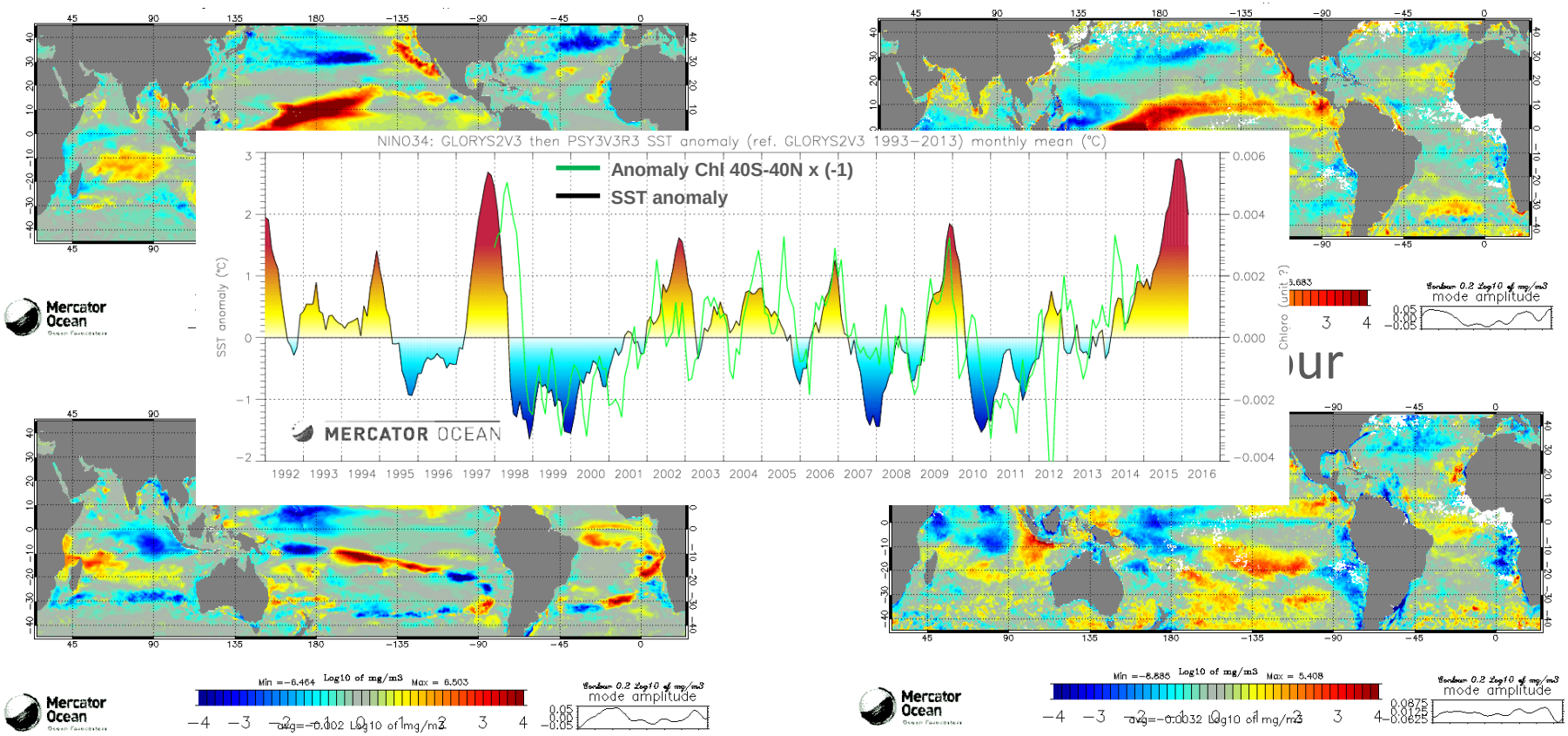
→ bonne représentation des deux 1er modes de variabilité (spatiale et temporelle)

→ Bonne corrélation avec ENSO index (Thomas et al., 2012)

GLOBAL ¼°: *Simulation interannuelle*

Variabilité interannuelle
Décomposition en EOF

Mode #1



Mode #2

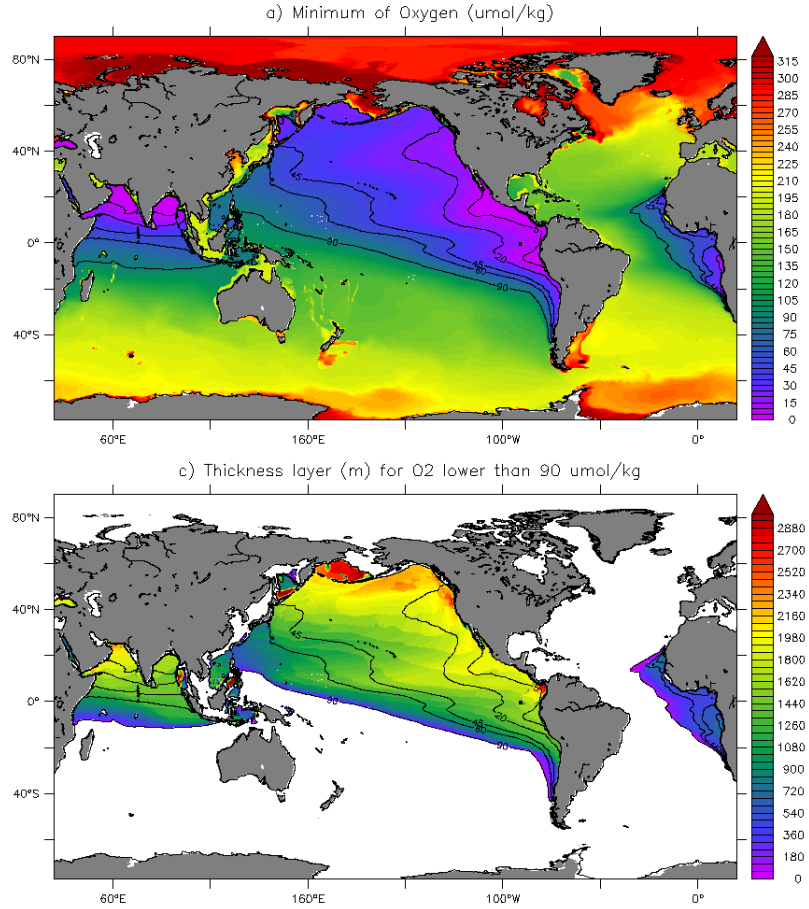
→ bonne représentation des deux 1er modes de variabilité

→ Bonne corrélation avec ENSO index (Thomas et al., 2012)

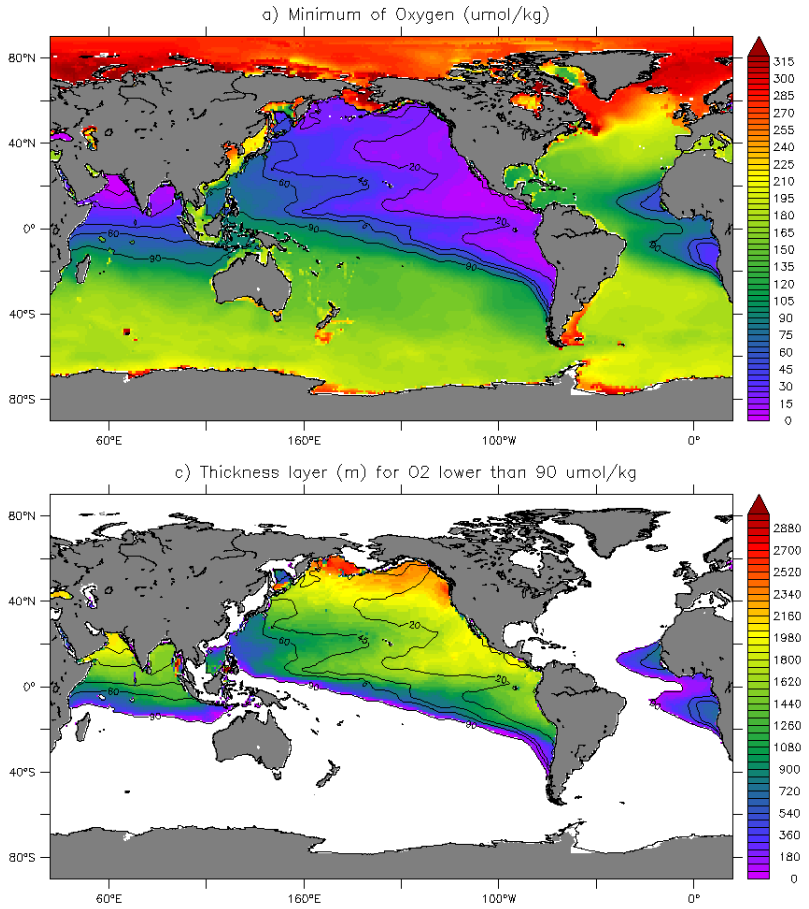
GLOBAL ¼°: *Simulation interannuelle*

Distribution des OMZ (Oxygen Minimum Zone)

MODEL clim 1998 - 2014



CLIM WOA 2013



GLOBAL ¼°: *Prochains systèmes*

- **Septembre 2016: dans CMEMS, nouveau système opérationnel forcé par le GLOBAL 1/12° (coarsening offline vers du ¼°) = PSY4**

- **Future simulation NEMO3.6: démarrage à partir d'une simulation du XXème siècle réalisée dans le cadre d'ERACLIM2 (NEMO3.6, 1°, 130 ans de spin-up, cf poster 89 A. Albert)**

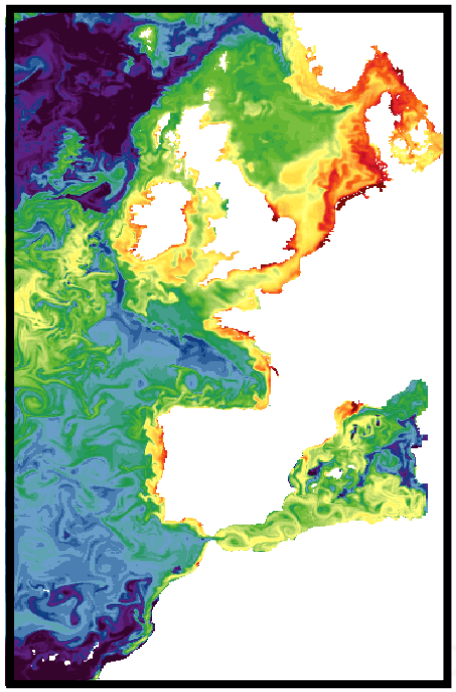
- **Assimilation des données de couleur de l'eau**

Les systèmes couplés à Mercator Océan:

Mercator-Vert/Green Grog

GLOBAL
¼°

AMICO-BIO



IBI
1/12° et 1/36°

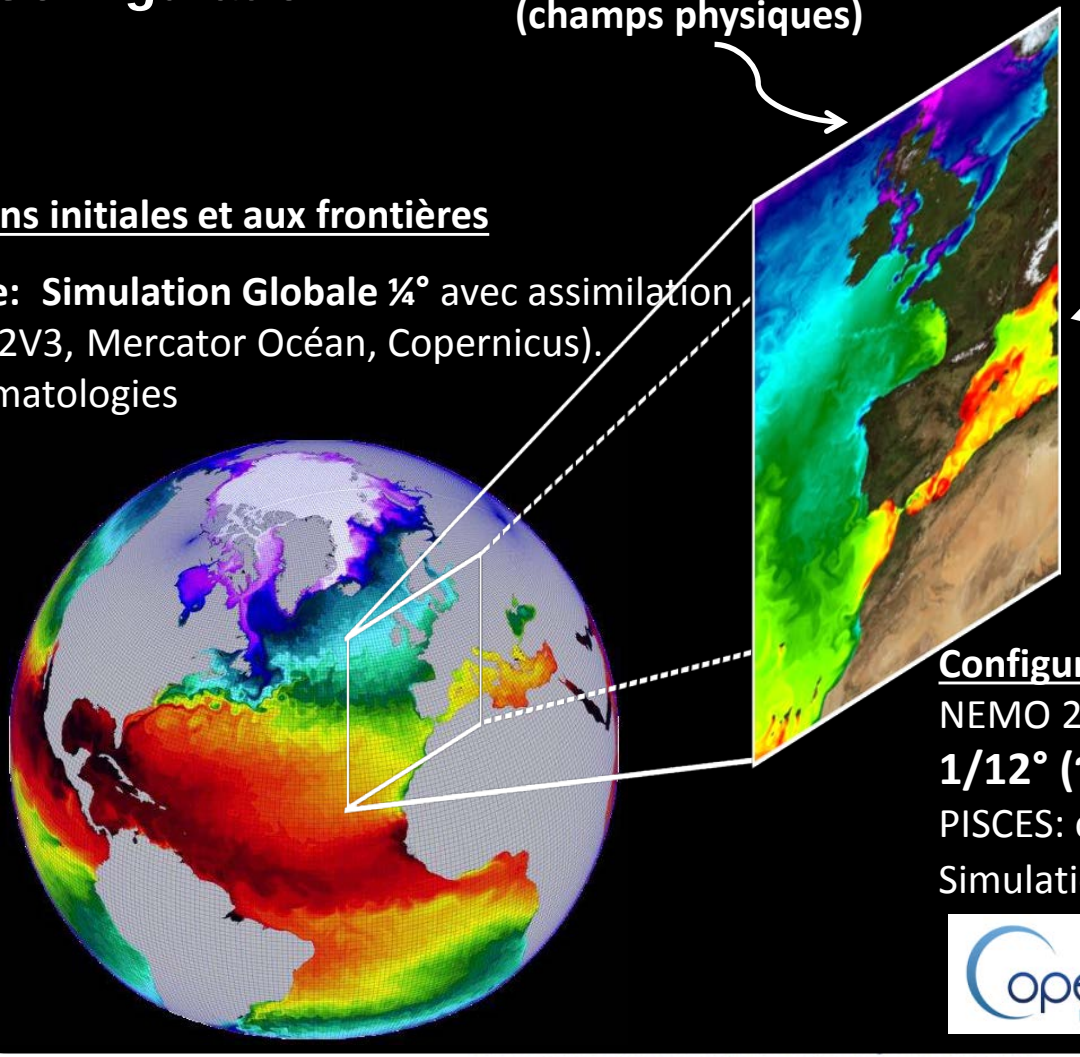
Côtes Européennes
IBIRYS: Simulation interannuelle au 1/12°

La Configuration

SAM
Système d'Assimilation Mercator
(champs physiques)

Conditions initiales et aux frontières

Physique: Simulation Globale ¼° avec assimilation (GLORYS2V3, Mercator Océan, Copernicus).
BGC: Climatologies



Forçages atmosphériques

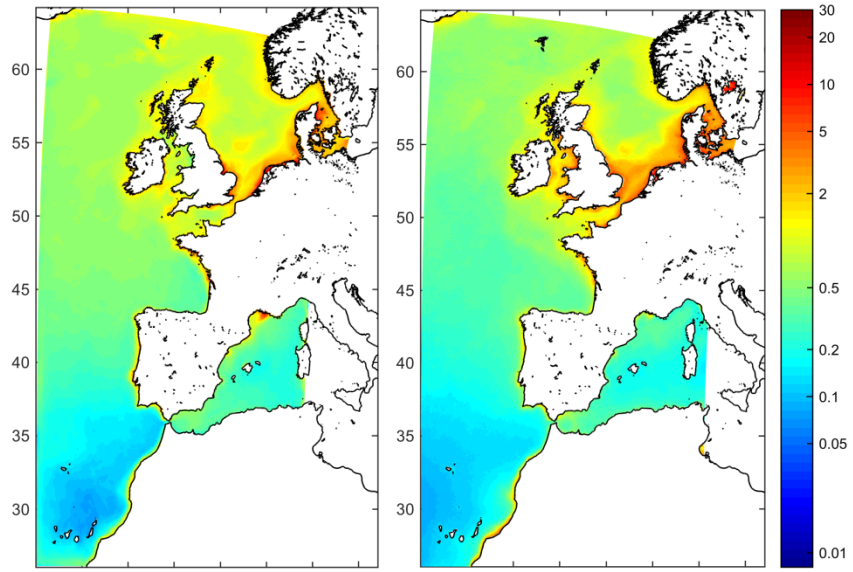
ECMWF
ERA-Interim 3-h

Configuration régionale
NEMO 2.3 – PISCES 3.2
1/12° (~6km), 75 niveaux verticaux
PISCES: couplé **«online»** avec la physique
Simulation : **02/2002-12/2014**

Côtes Européennes
IBIRYS: Simulation interannuelle au 1/12°

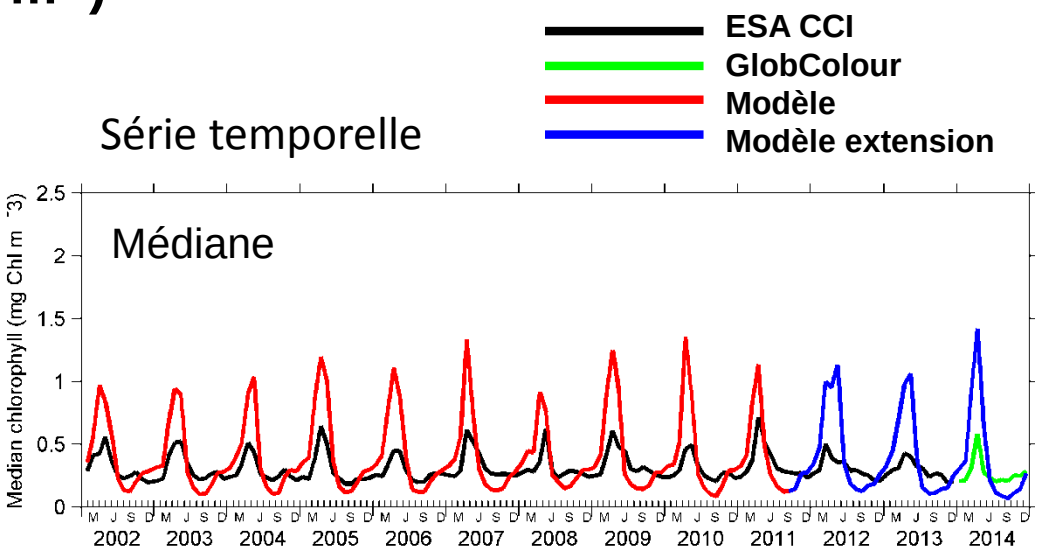
Chlorophylle-a (mg Chl m^{-3})

moyenne sur 2003-2013



Modèle **ESA CCI**

Série temporelle



Good agreement with satellite data
Temporal variation: seasonal cycle (spring bloom) reproduced, good timing , but amplitude too strong

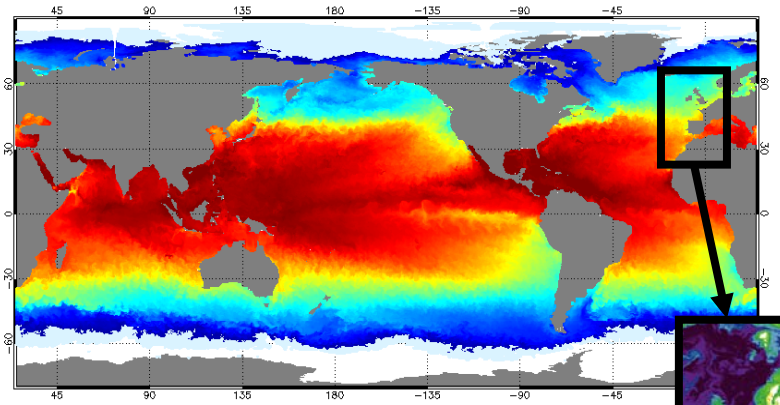
Extrait du Quality Information Document (QUID):
http://marine.copernicus.eu/documents/QUID/CMEMS-IBI-QUID-005-003.pdf

Pour la V3 de CMEMS en Avril 2017:
Nouvelle réanalyse : 1/12° NEMO-PISCES 3.6 période : 2002-2015

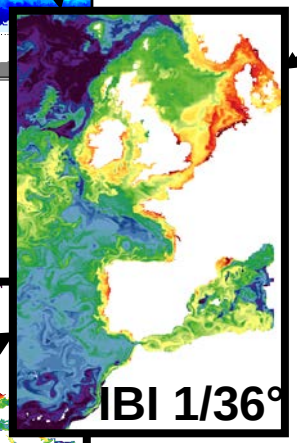
Côtes Européennes
Temps réel au 1/36°

La Configuration

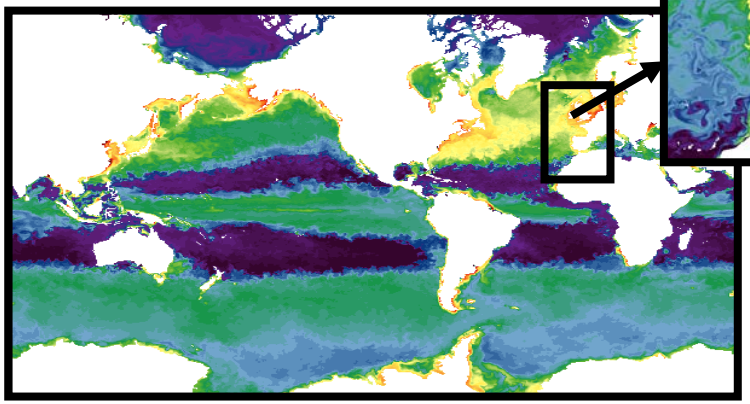
Physique



Système opérationnel global 1/12°
(PSY4, Mercator océan, Copernicus)

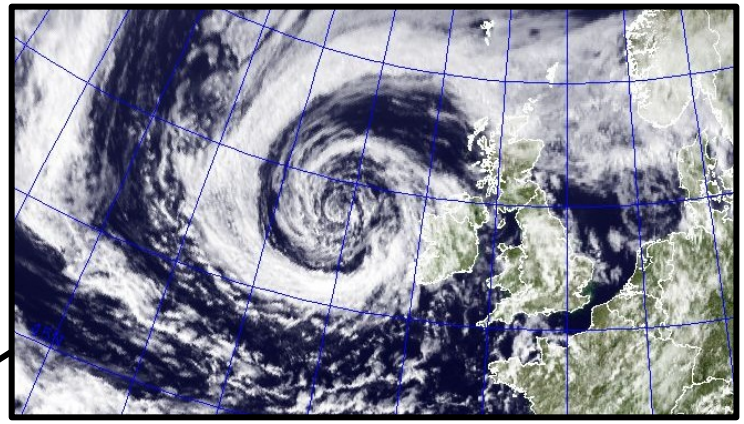


Biogéochimie



Système opérationnel global 1/4° (BIOMER, Mercator Océan, Copernicus)

Forçages Atmosphériques



ECMWF (3h)

Système opérationnel:

NEMO-PISCES 3.6

1/36°, 50 niveaux verticaux

PISCES: couplé **«online»** avec la physique

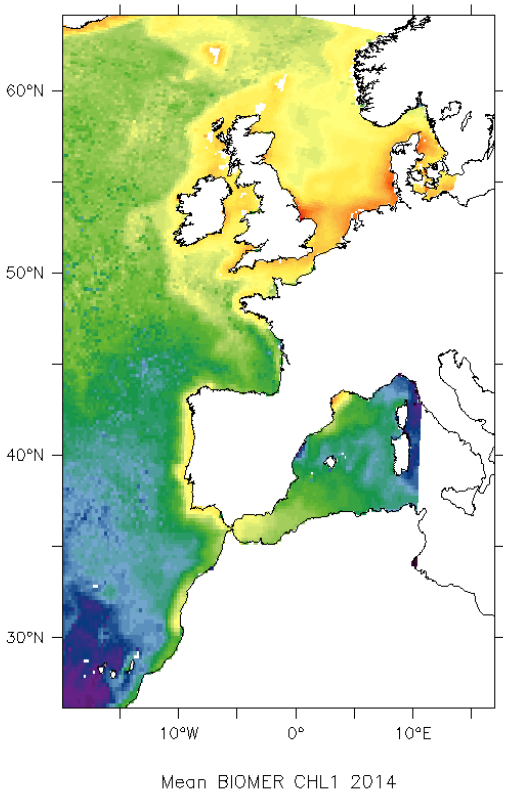
Rattrapage Temps Réel en cours

→ Mise en opérationnel en interne (non diffusée)

Côtes Européennes
Temps réel au 1/36°

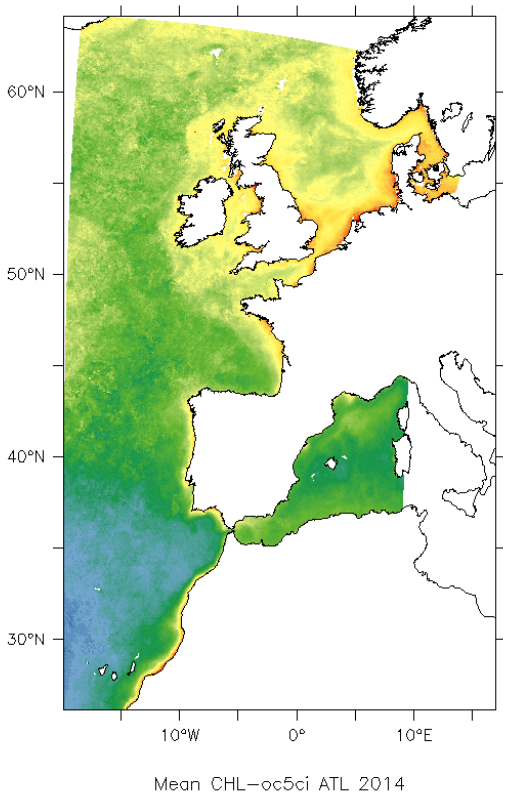
Sea surface chlorophyll (mg Chl m^{-3}): Annual mean - 2014

Modèle Global



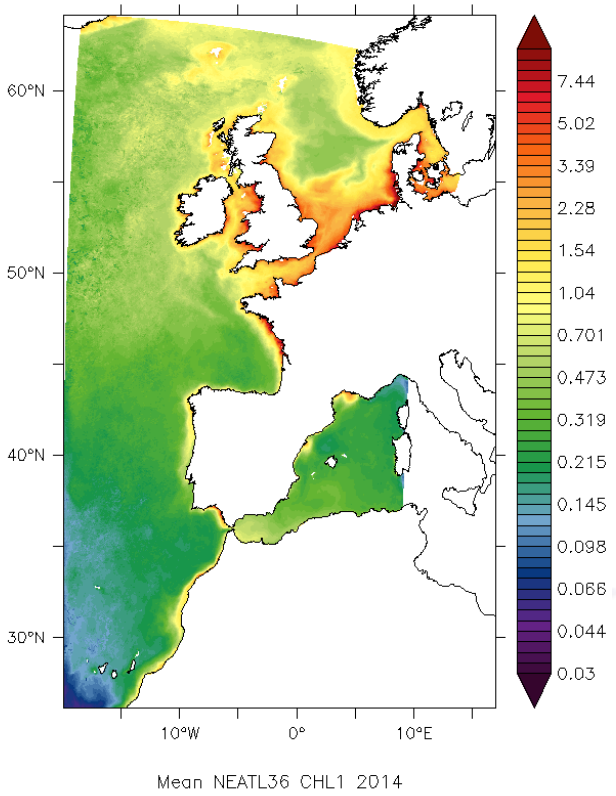
Mean BIOMER CHL1 2014

ESA-CCI OC5CI



Mean CHL-oc5ci ATL 2014

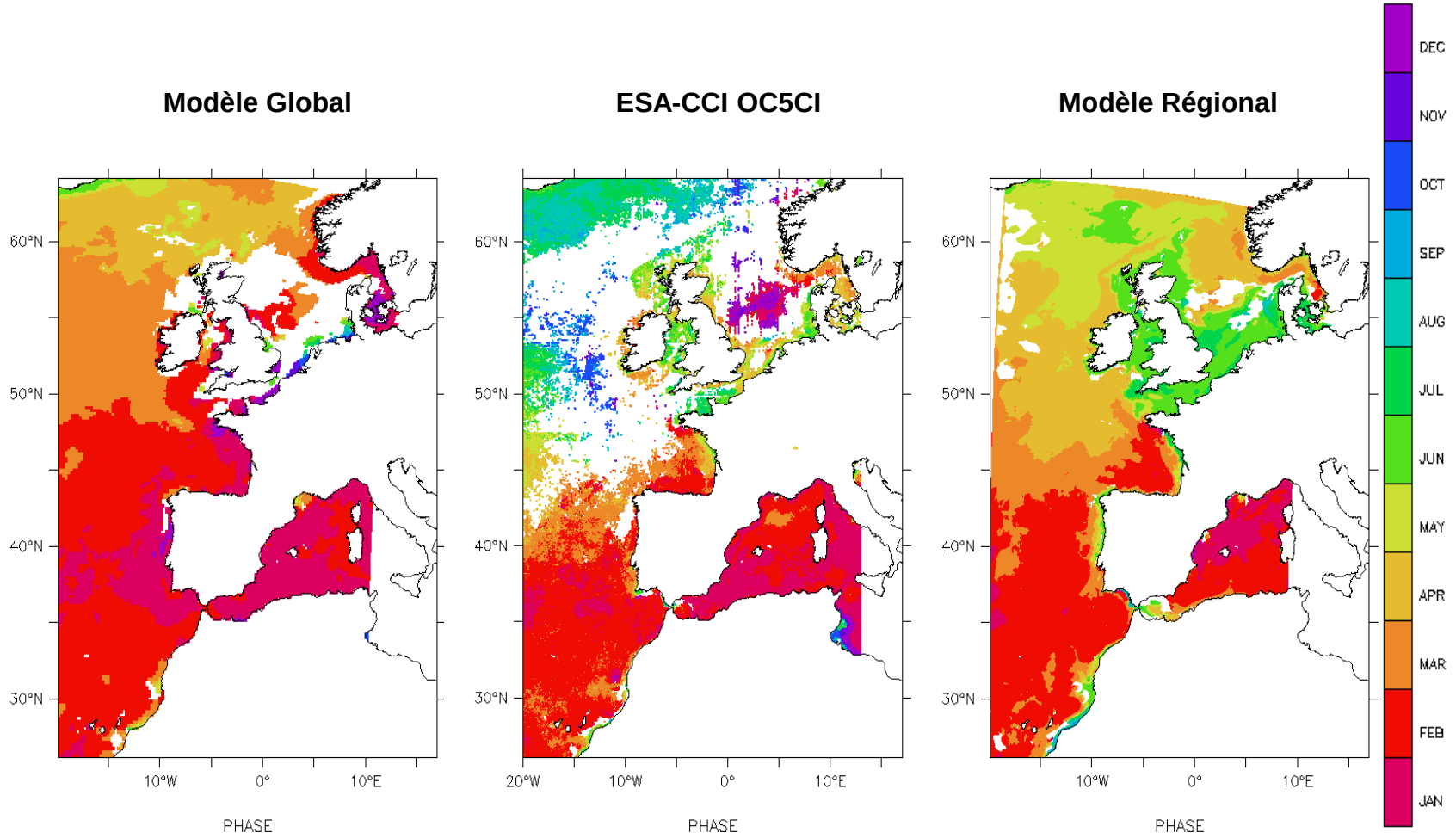
Modèle Régional



Mean NEATL36 CHL1 2014

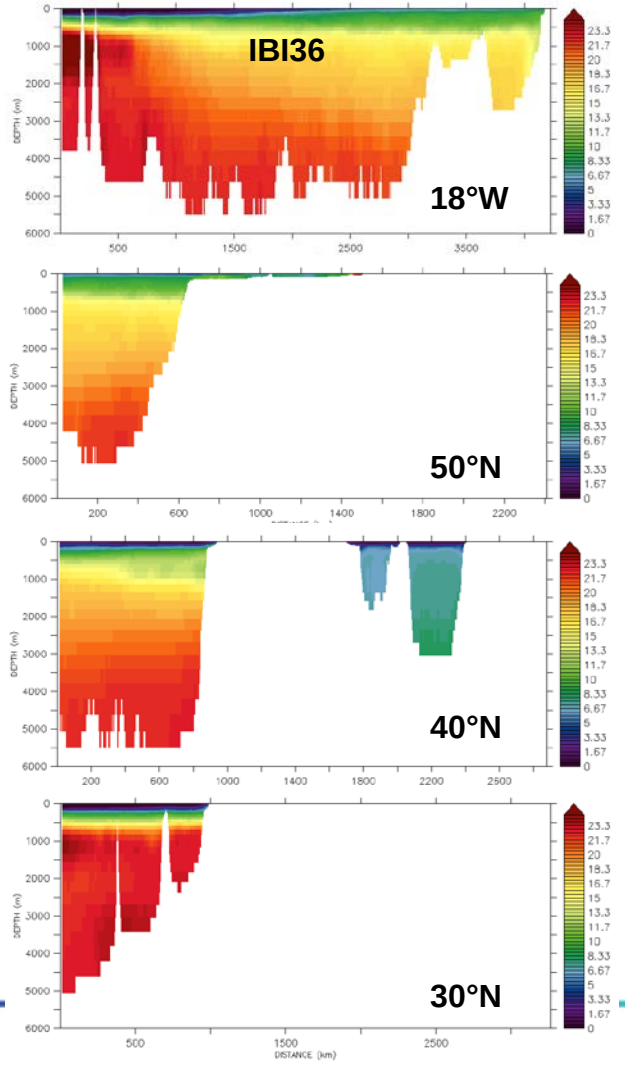
Côtes Européennes
Temps réel au 1/36°

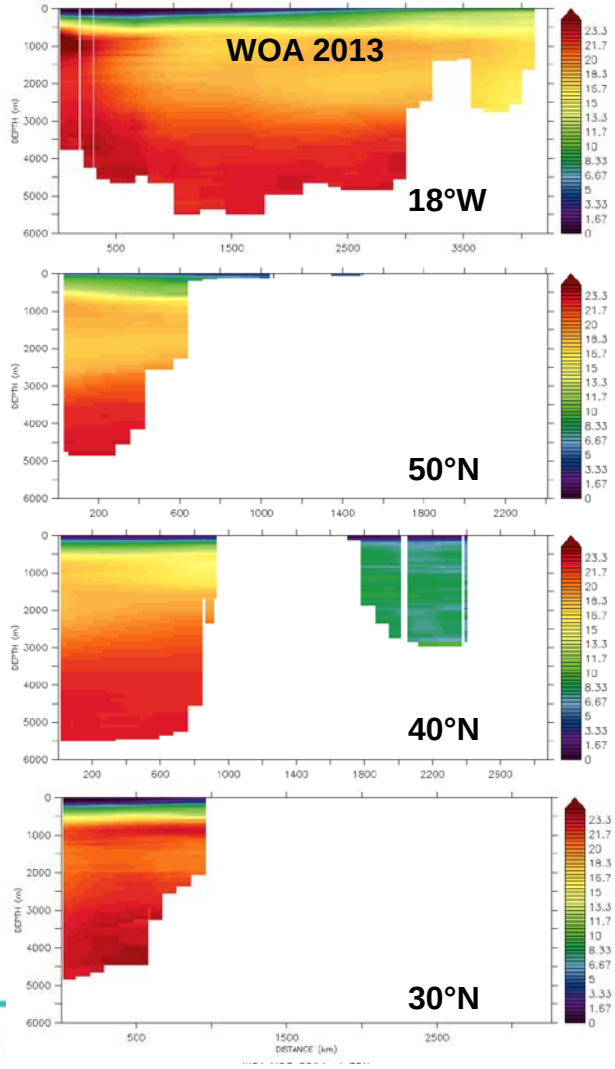
Sea surface chlorophyll (mg Chl m^{-3}): Month of Chloro Maximum - 2014



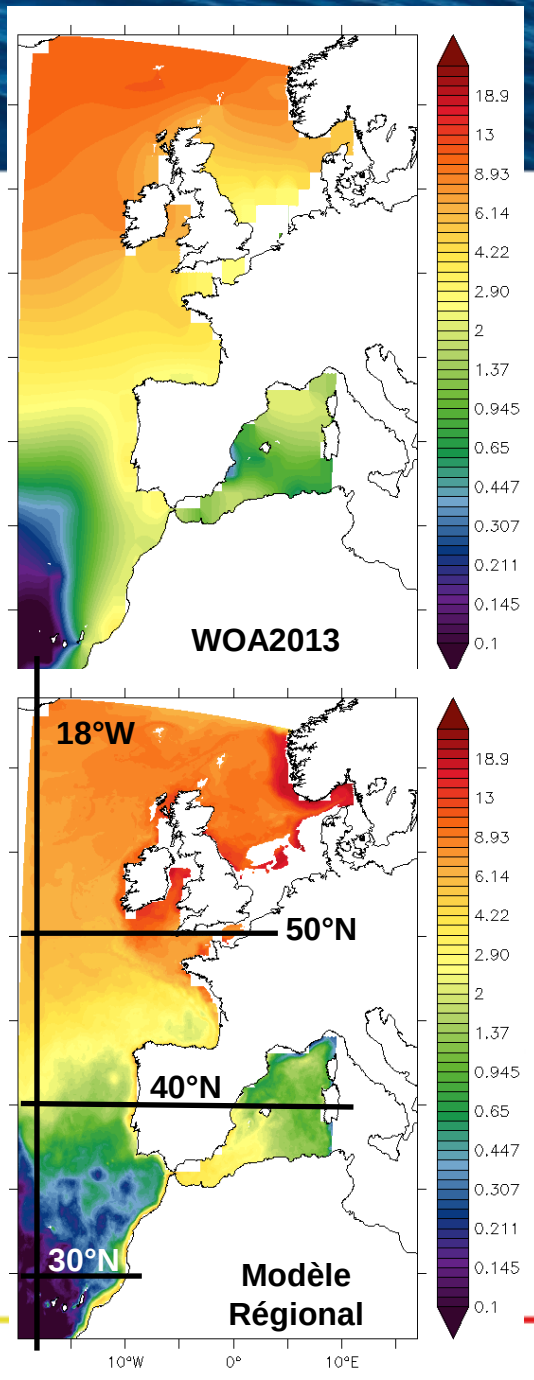
Côtes Européennes
Temps réel au 1/36°

annual mean - 2014 Nitrates (µmol N l^{-1})

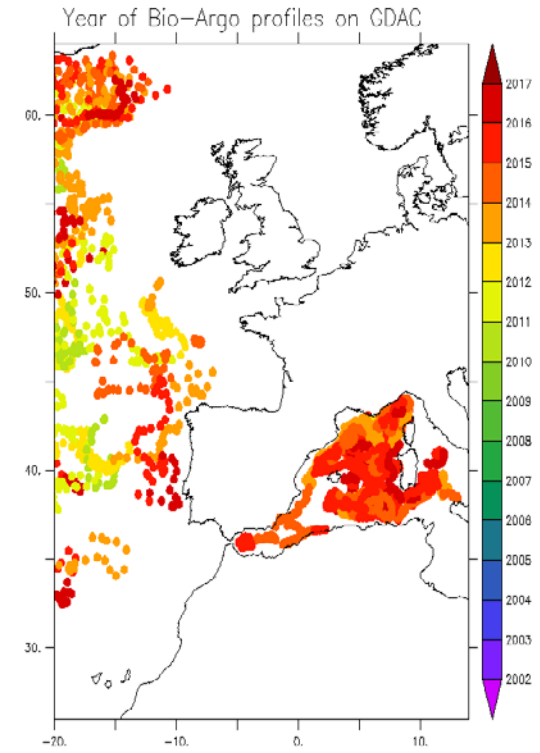




annual mean - 50m depth



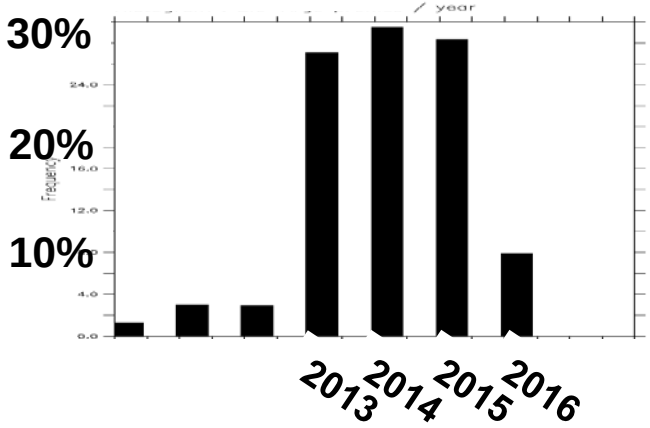
Côtes Européennes
Temps réel au 1/36°

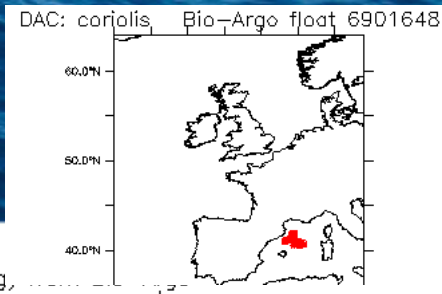


Bio-ARGO

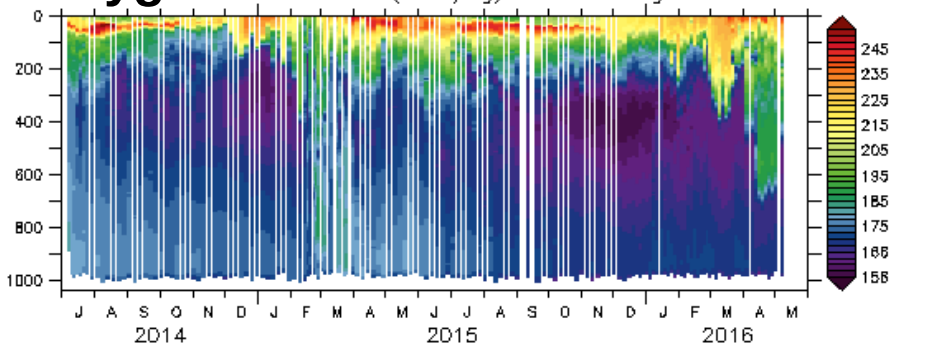
dans la zone IBI:

- → **4693 profils**
- → **52 flotteurs**
- → **90% ≥ 2013**

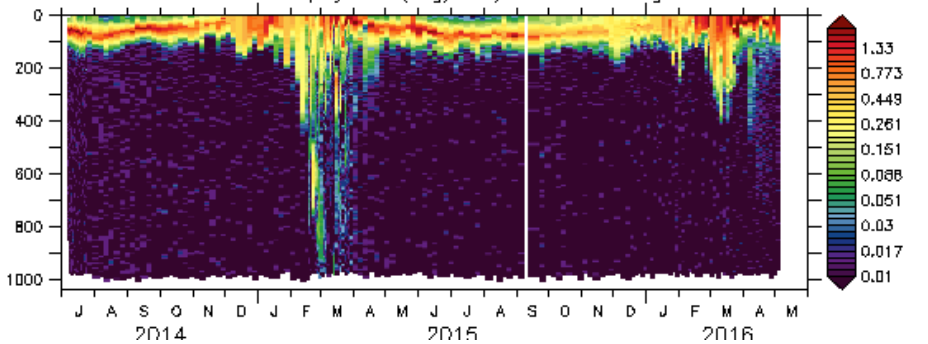




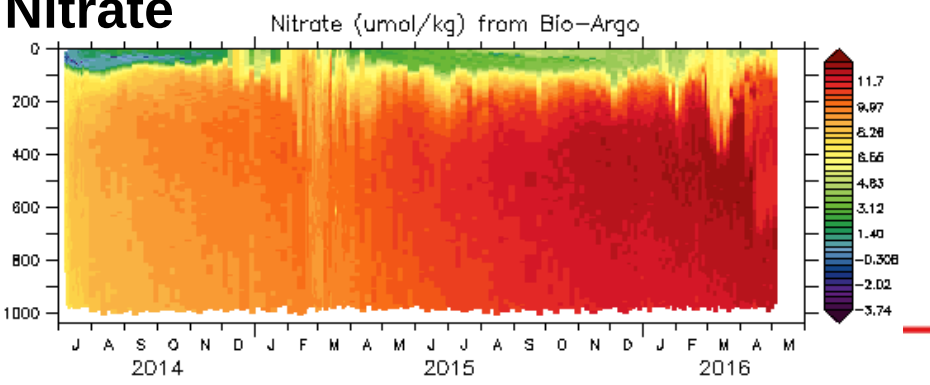
Oxygen



Chloro

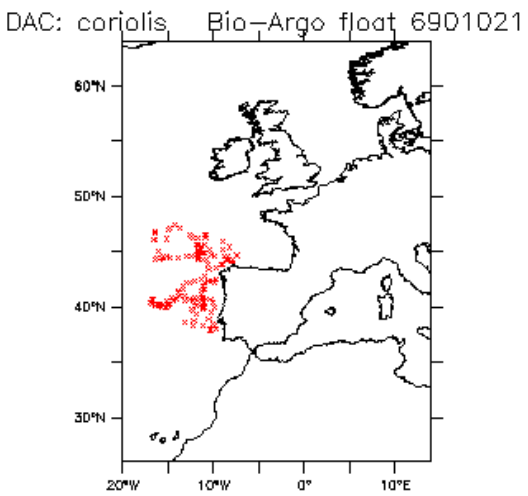


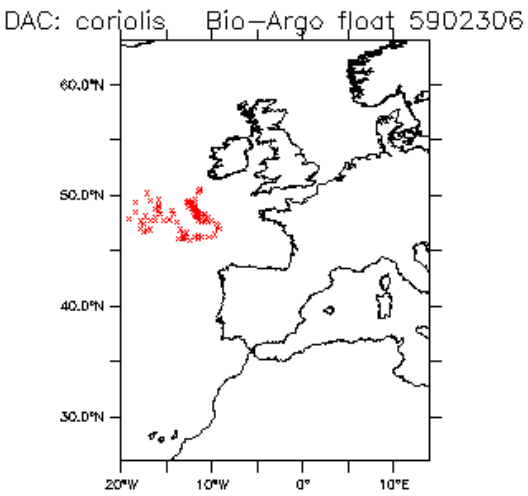
Nitrate



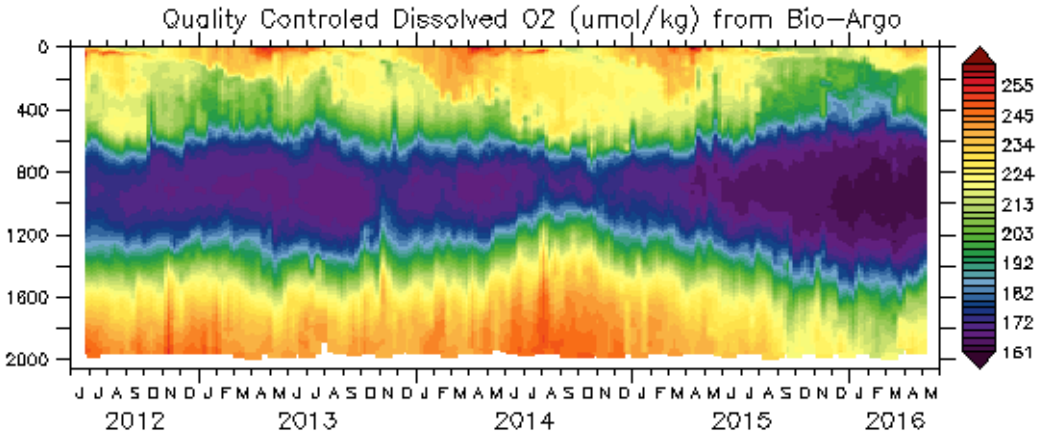
Côtes Européennes
Temps réel au 1/36°

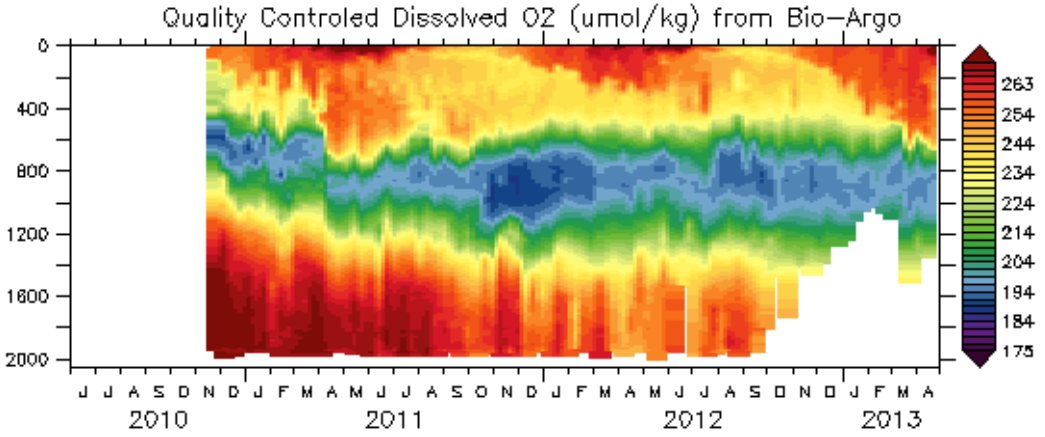
Bio-ARGO





Quality Controled Oxygen





Côtes Européennes

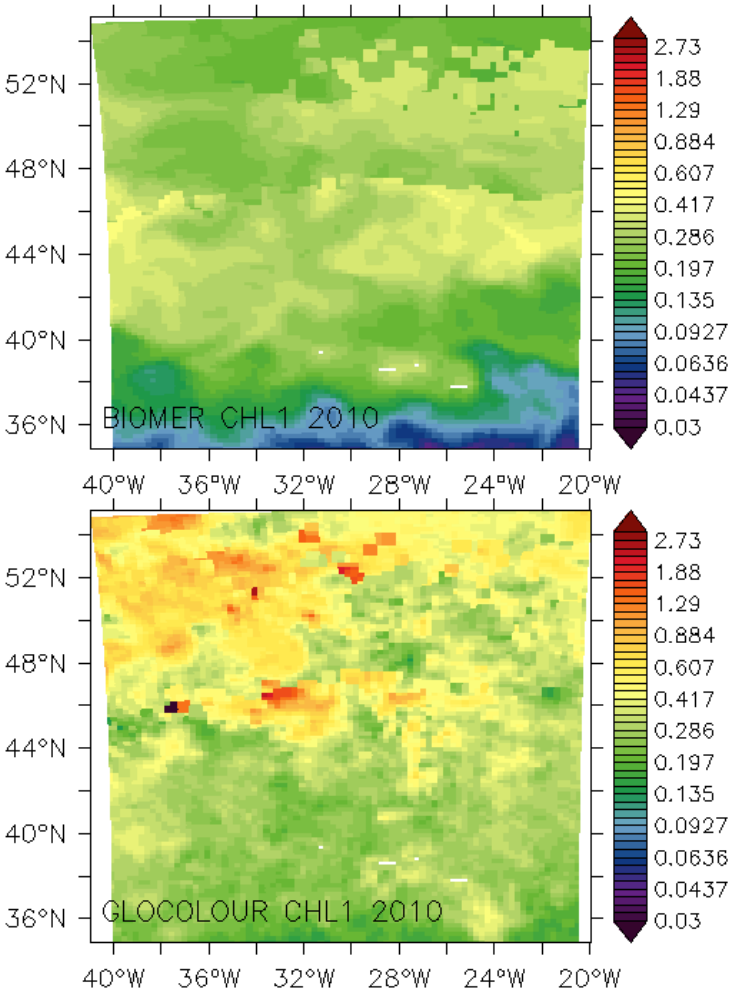
Pour la V3 de CMEMS en Avril 2017:

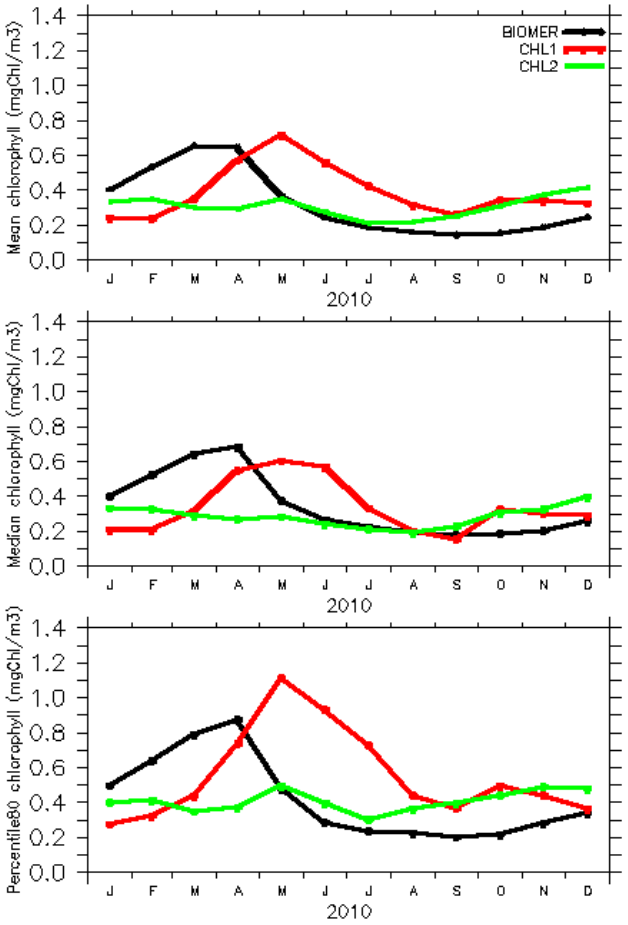
1/ IBIRYS: Simulation interannuelle au 1/12°

Nouvelle réanalyse : 1/12°
NEMO3.6
2002-2015

2/ Temps Réel au 1/36°

Mise en opérationnel
Physique + BGC + vagues
7 jours de prévisions


52°N
48°N
44°N
40°N
36°N
BIOMER CHL1 2010
40°W
36°W
32°W
28°W
24°W
20°W
2.73
1.88
1.29
0.884
0.607
0.417
0.286
0.197
0.135
0.0927
0.0636
0.0437
0.03
GLOCOLOUR CHL1 2010

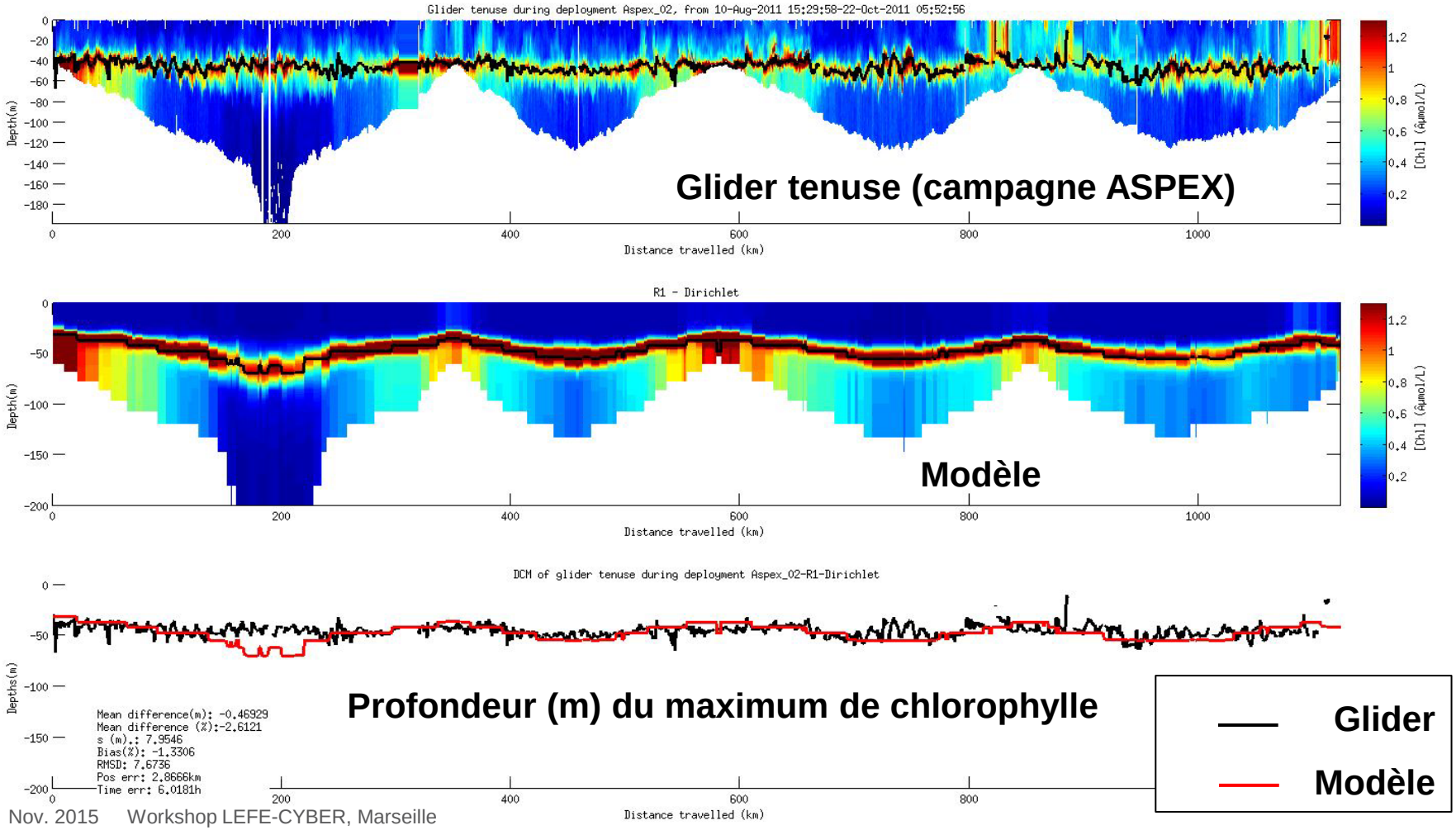

BIOMER
CHL1
CHL2
Mean chlorophyll (mgChl/m3)
Median chlorophyll (mgChl/m3)
Percentile80 chlorophyll (mgChl/m3)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
J F M A M J J A S O N D
2010

Côtes Européennes
Simulation interannuelle au 1/12°

Projet AMICO-BIO

Simulation libre:
Pas d'assimilation des champs physiques

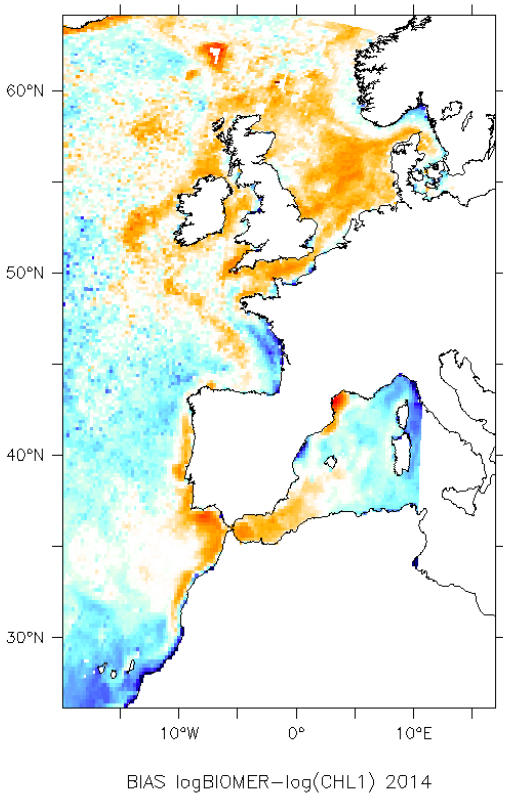
Chlorophylle-a (mg Chl m^{-3}): Distribution verticale.



Côtes Européennes
Temps réel au 1/36°

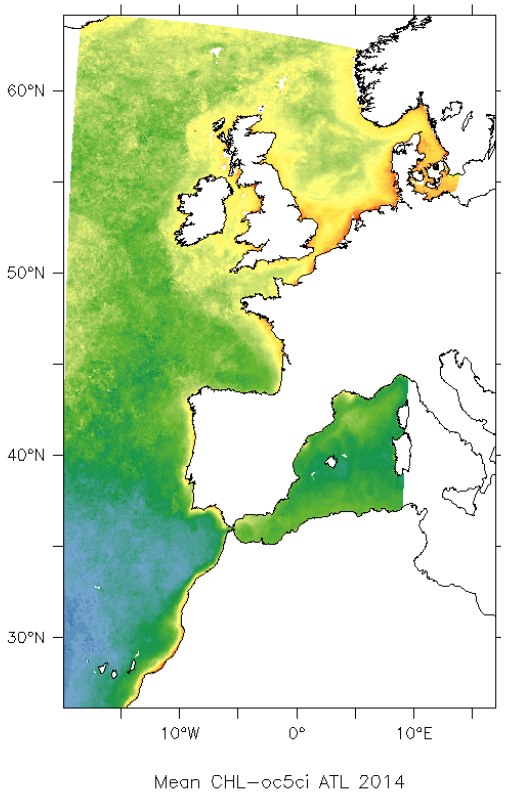
Sea surface chlorophyll (mg Chl m^{-3}): Annual mean bias of log transformed Chloro - 2014

Modèle Global



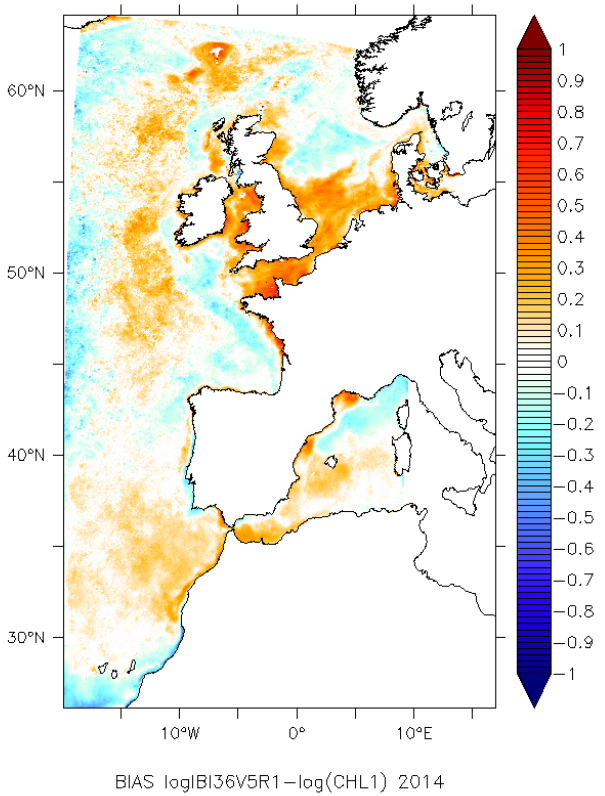
BIAS logBIOMER−log(CHL1) 2014

ESA-CCI OC5CI



Mean CHL−oc5ci ATL 2014

Modèle Régional

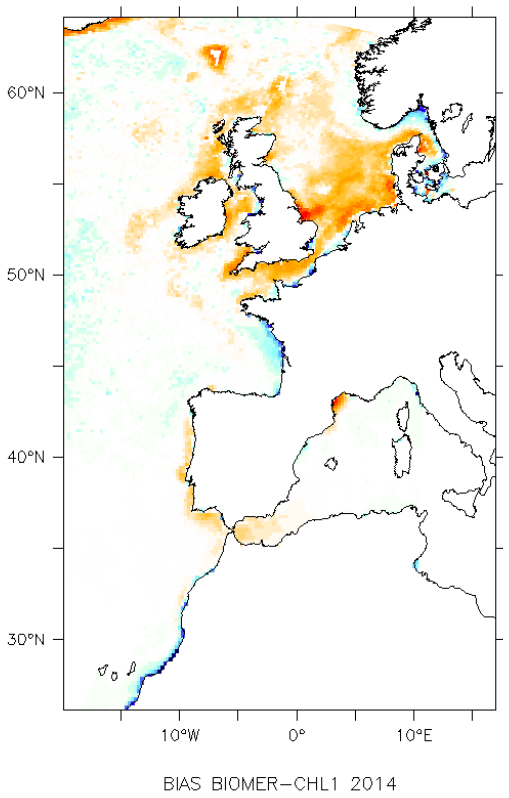


BIAS logBI36V5R1−log(CHL1) 2014

Côtes Européennes
Temps réel au 1/36°

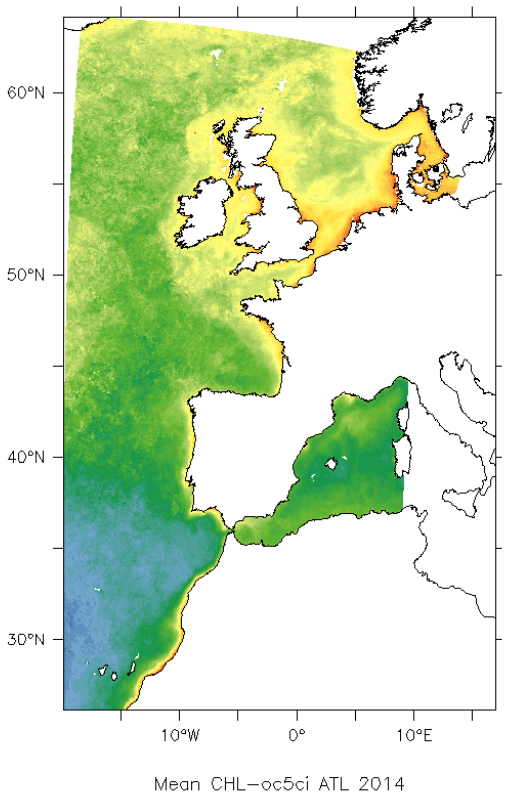
Sea surface chlorophyll (mg Chl m^{-3}): Annual mean bias - 2014

Modèle Global



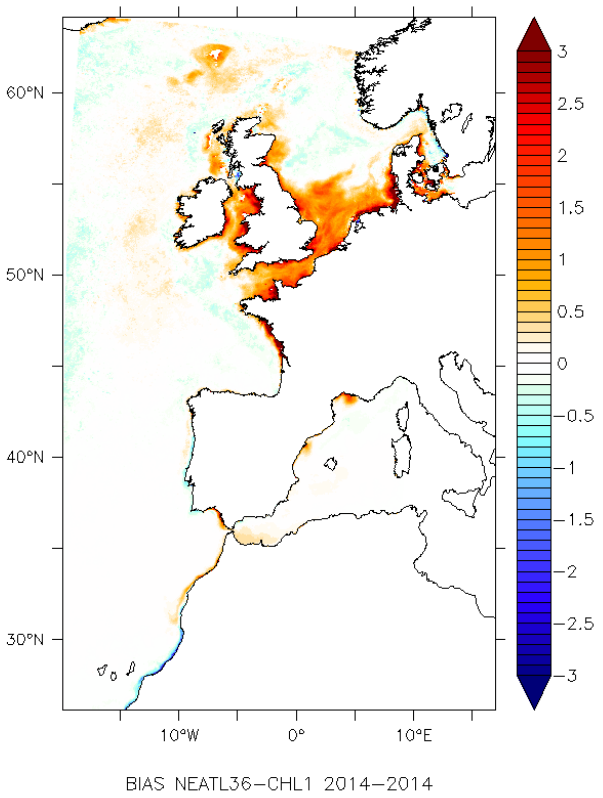
BIAS BIOMER-CHL1 2014

ESA-CCI OC5CI



Mean CHL-oc5ci ATL 2014

Modèle Régional

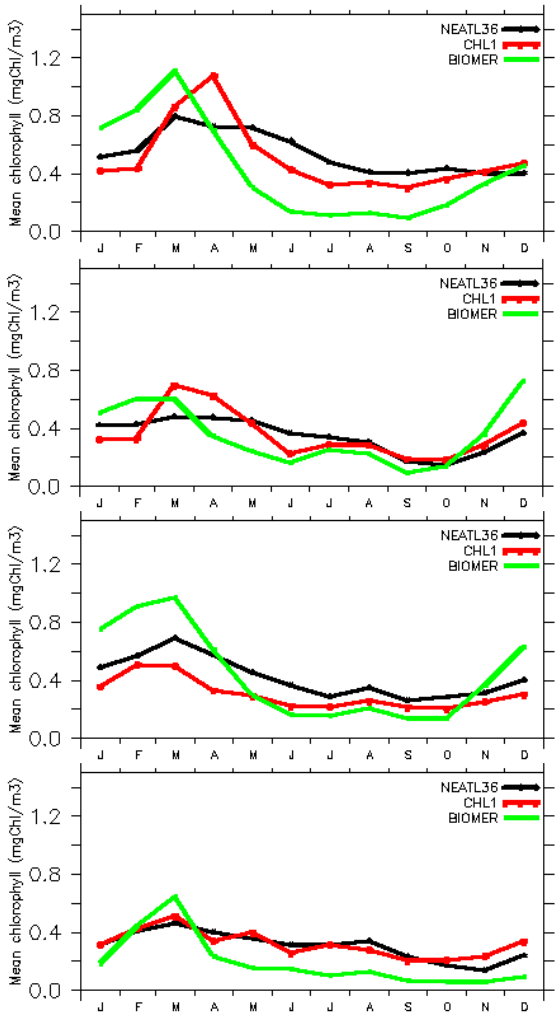


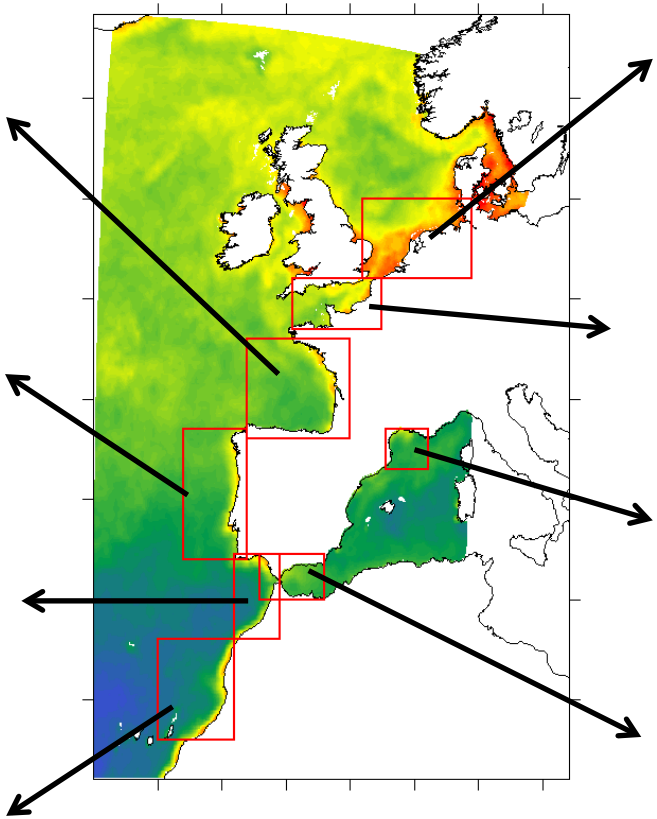
BIAS NEATL36-CHL1 2014-2014

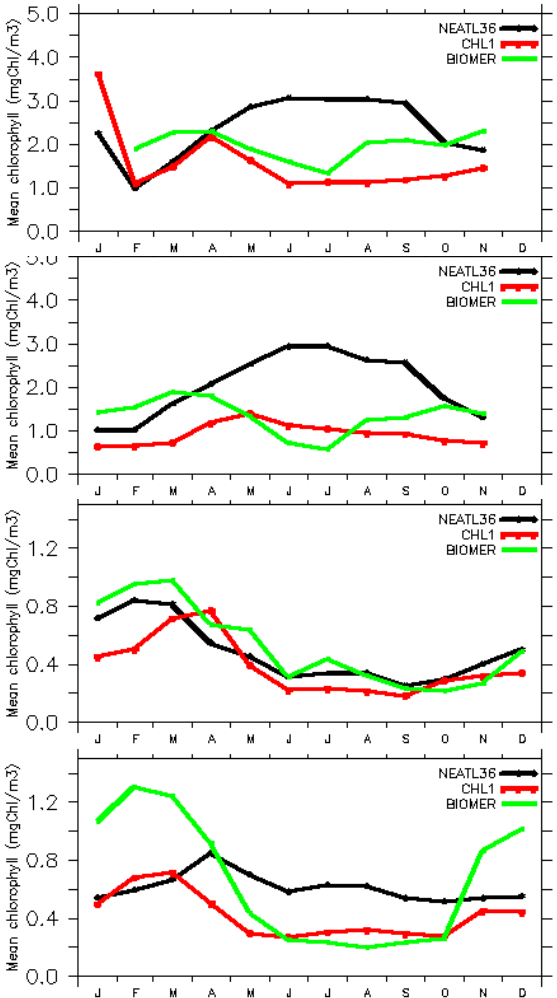
Côtes Européennes
Temps réel au 1/36°

Sea surface chlorophyll (mg Chl m^{-3}): Seasonal cycle - 2014

Modèle Régional
ESA CCI
Modèle Global



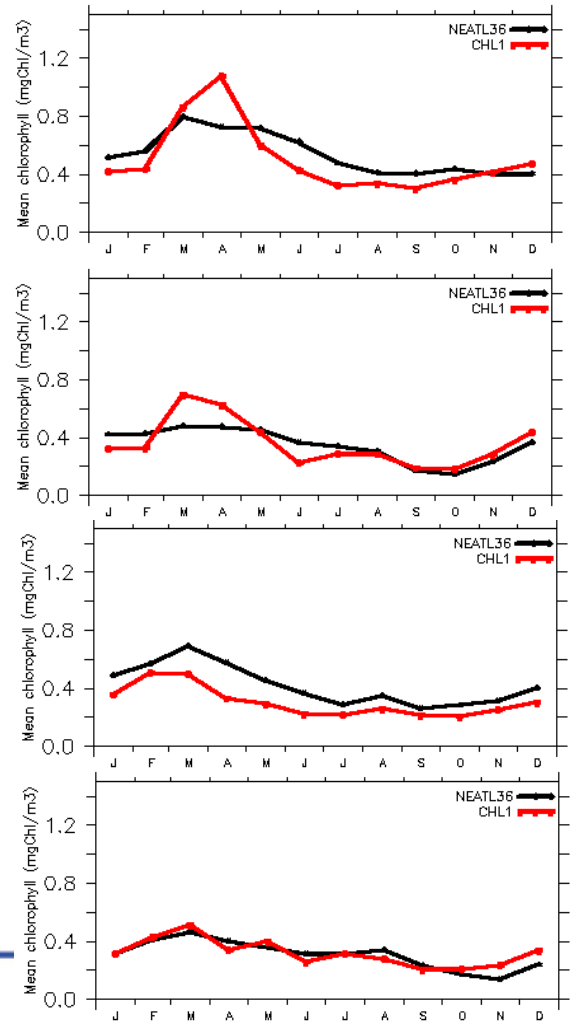


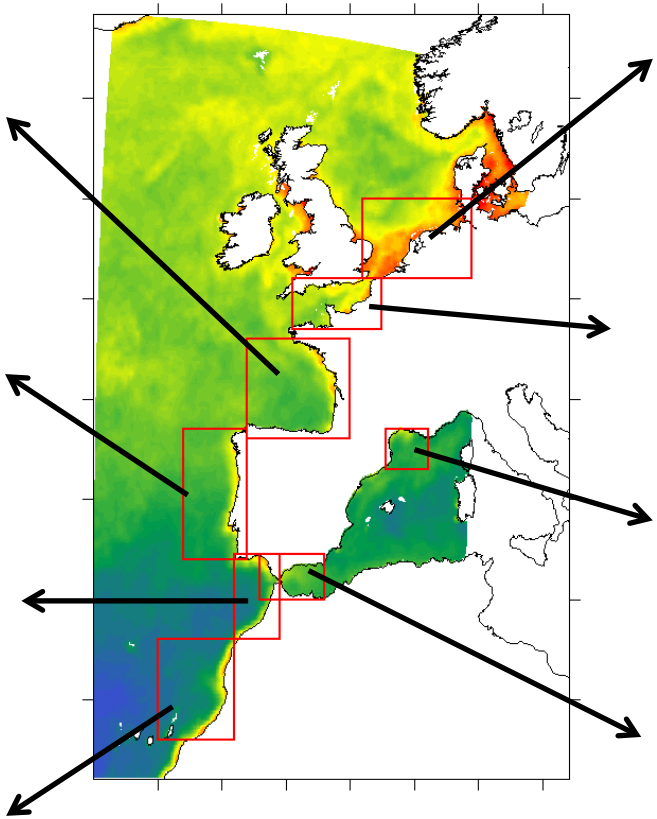


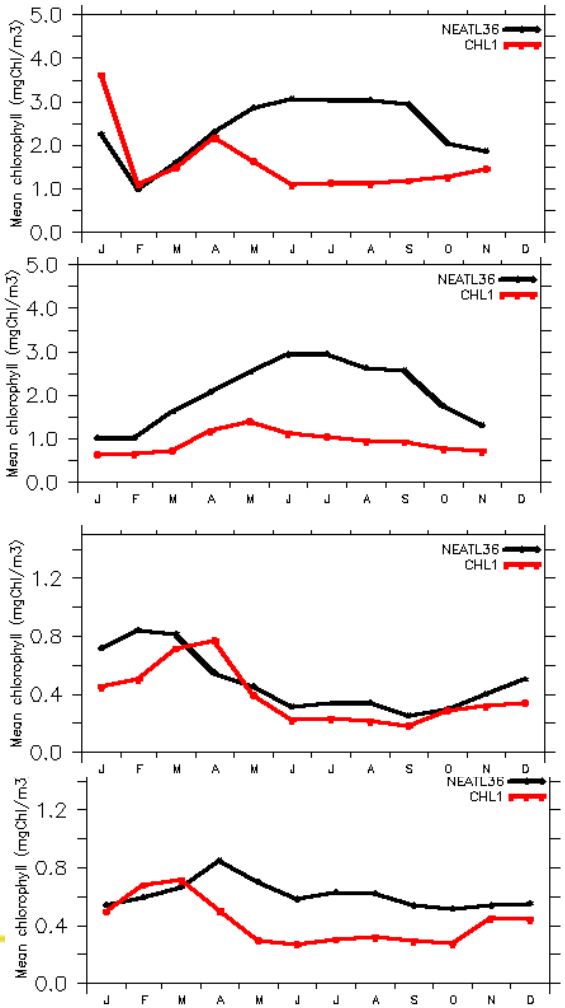
Côtes Européennes
Temps réel au 1/36°

Sea surface chlorophyll (mg Chl m^{-3}): Seasonal cycle - 2014

Modèle
ESA CCI



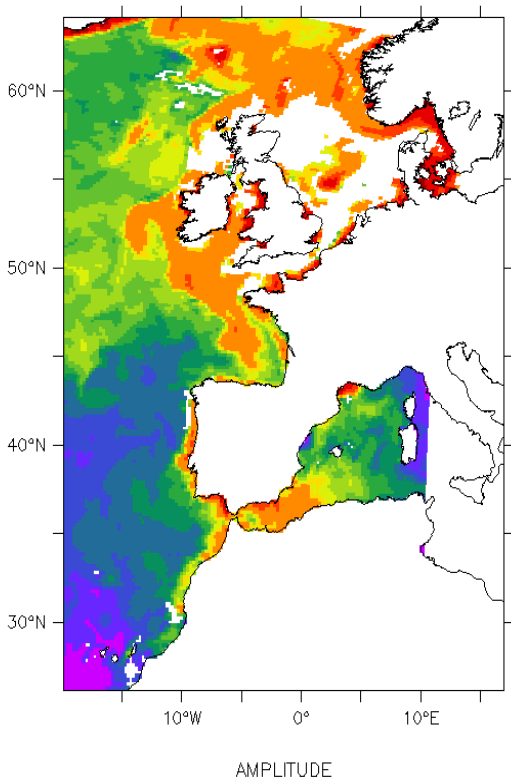




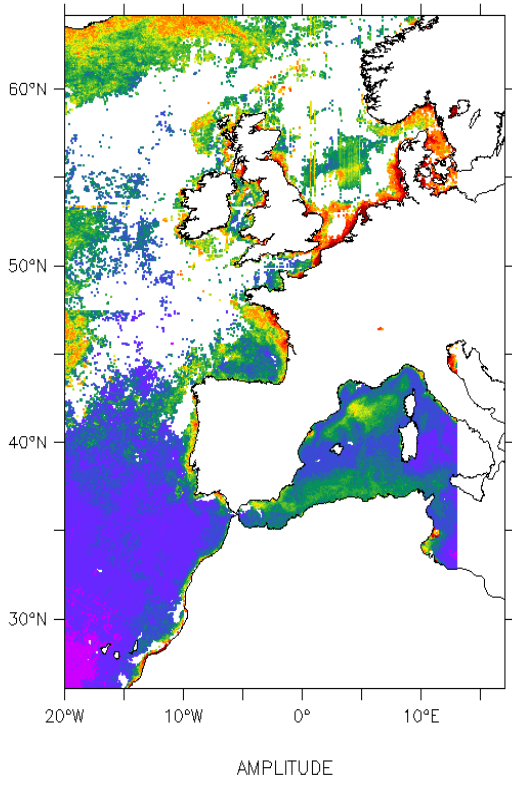
Côtes Européennes
Temps réel au 1/36°

Sea surface chlorophyll (mg Chl m^{-3}): Seasonal amplitude - 2014

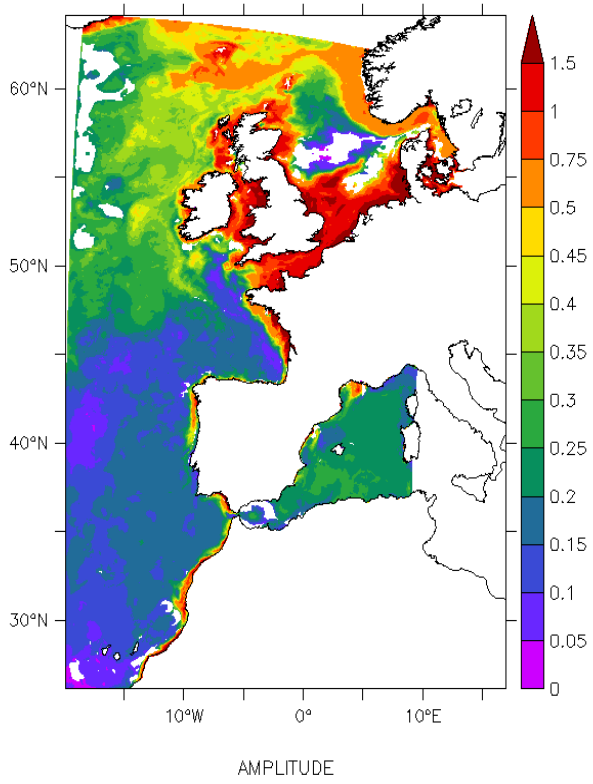
Modèle Global



ESA-CCI OC5CI



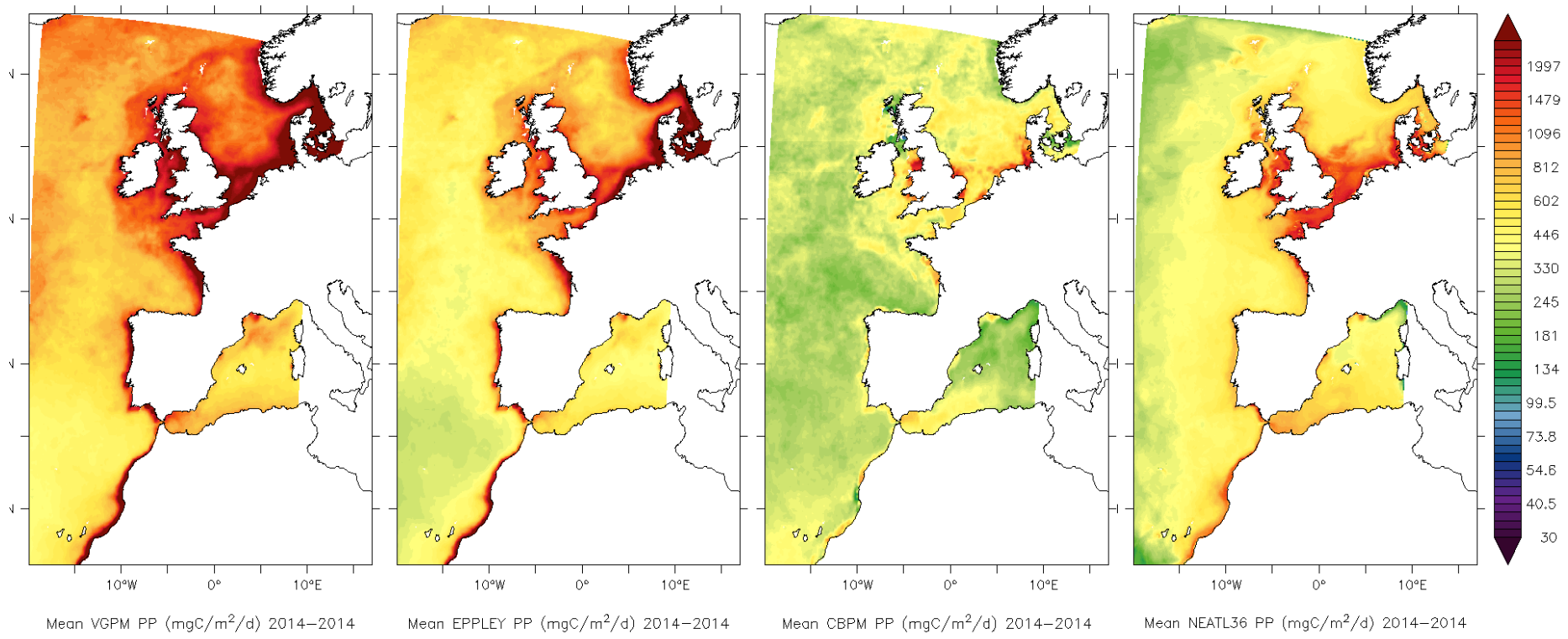
Modèle Régional



Côtes Européennes
Temps réel au 1/36°

Net Primary Production (mg C m^{-2} d^{-1}): Annual mean – 2014

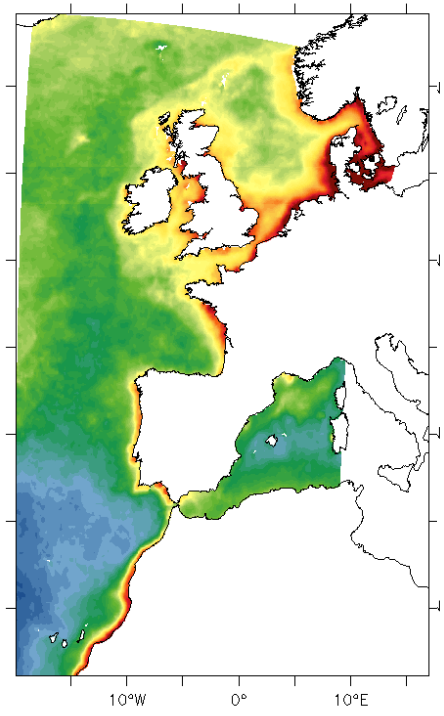
VGPM (standard) | **Eppley-VGPM** | **CbPM** | **Modèle Régional**



Côtes Européennes
Temps réel au 1/36°

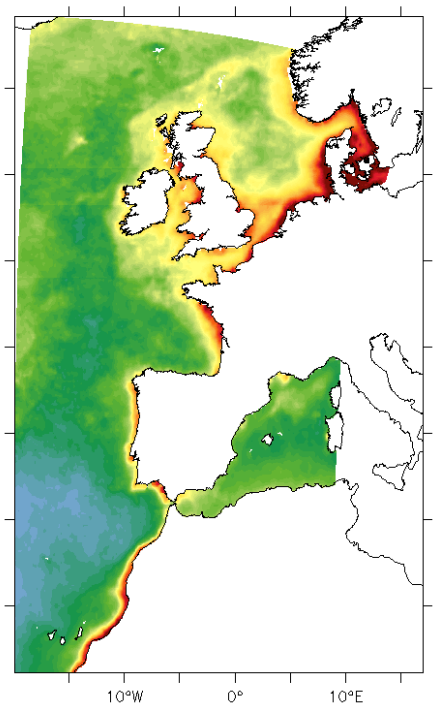
Net Primary Production (mg C m^{-2} d^{-1}): Normalized annual mean – 2014

VGPM (standard)



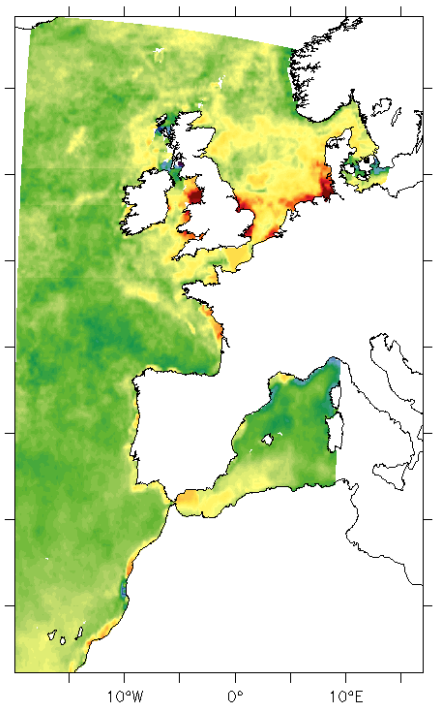
Normalized VGPM PP (mgC/m^2/d) 2014–2014

Eppley-VGPM



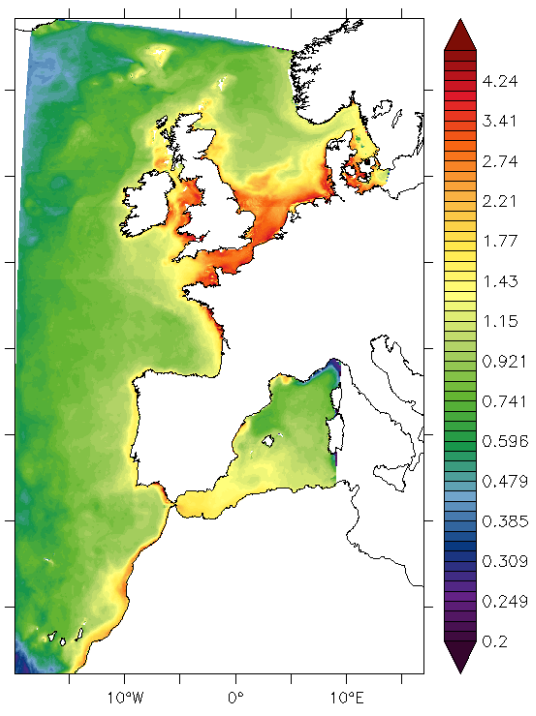
Normalized EPPLEY PP (mgC/m^2/d) 2014–2014

CbPM



Normalized CBPM PP (mgC/m^2/d) 2014–2014

Model Régional



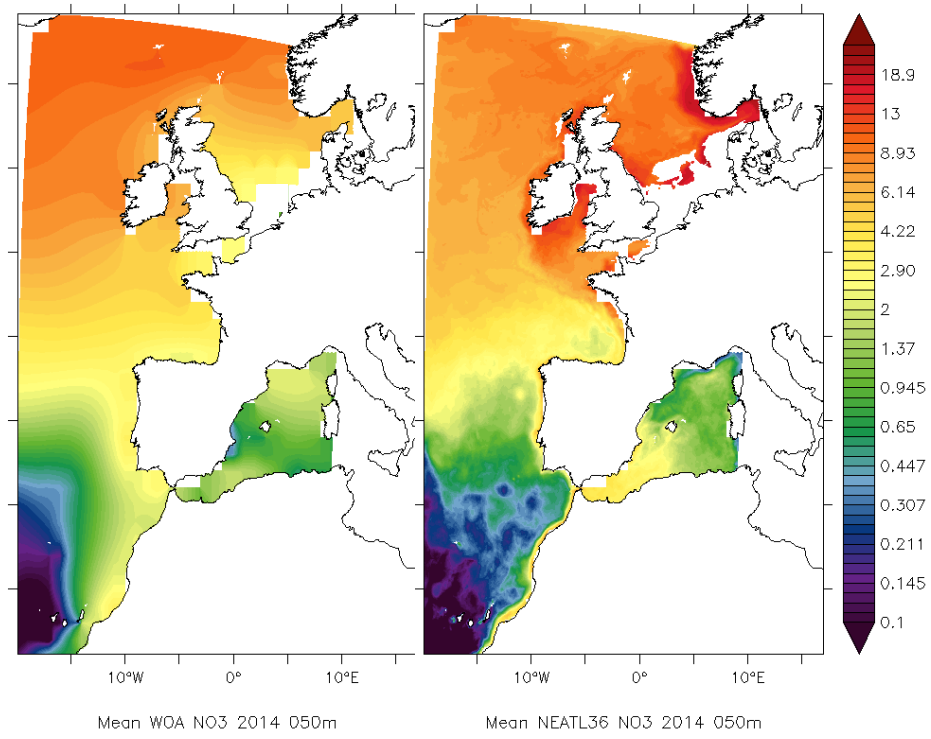
Normalized NEATL36 PP (mgC/m^2/d) 2014–2014

Côtes Européennes
Temps réel au 1/36°

annual mean at 50m depth - 2014

Nitrates (µmol N l^{-1})

WOA2013



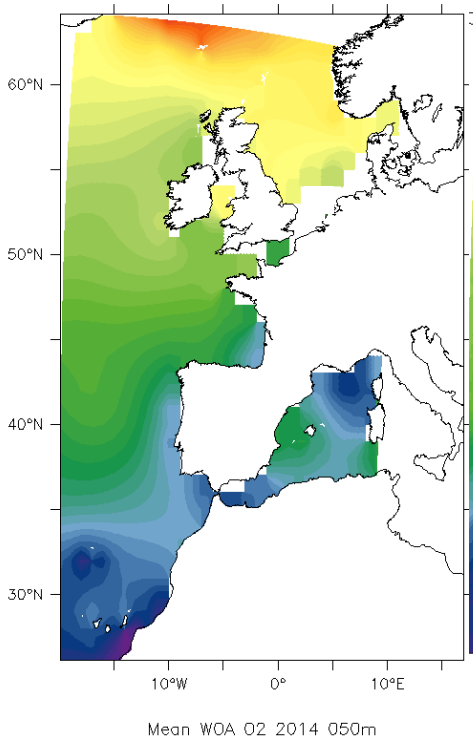
Mean WOA NO3 2014 050m

Modèle Régional

Mean NEATL36 NO3 2014 050m

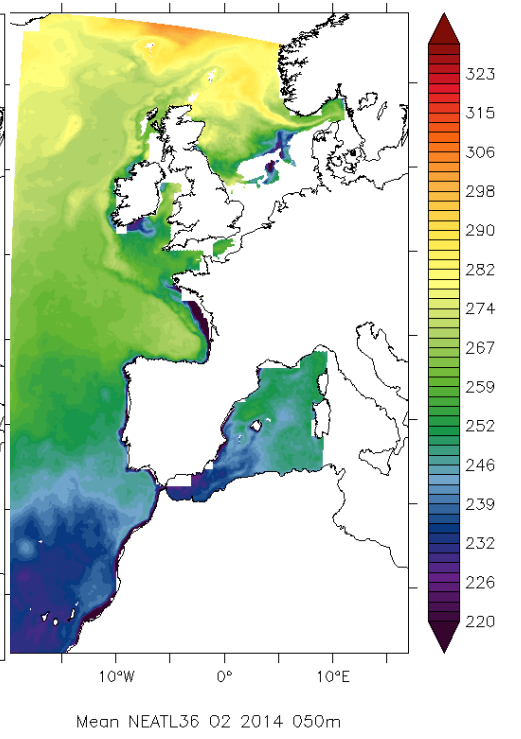
Oxygen (µmol O_2 l^{-1})

WOA2013



Mean WOA O2 2014 050m

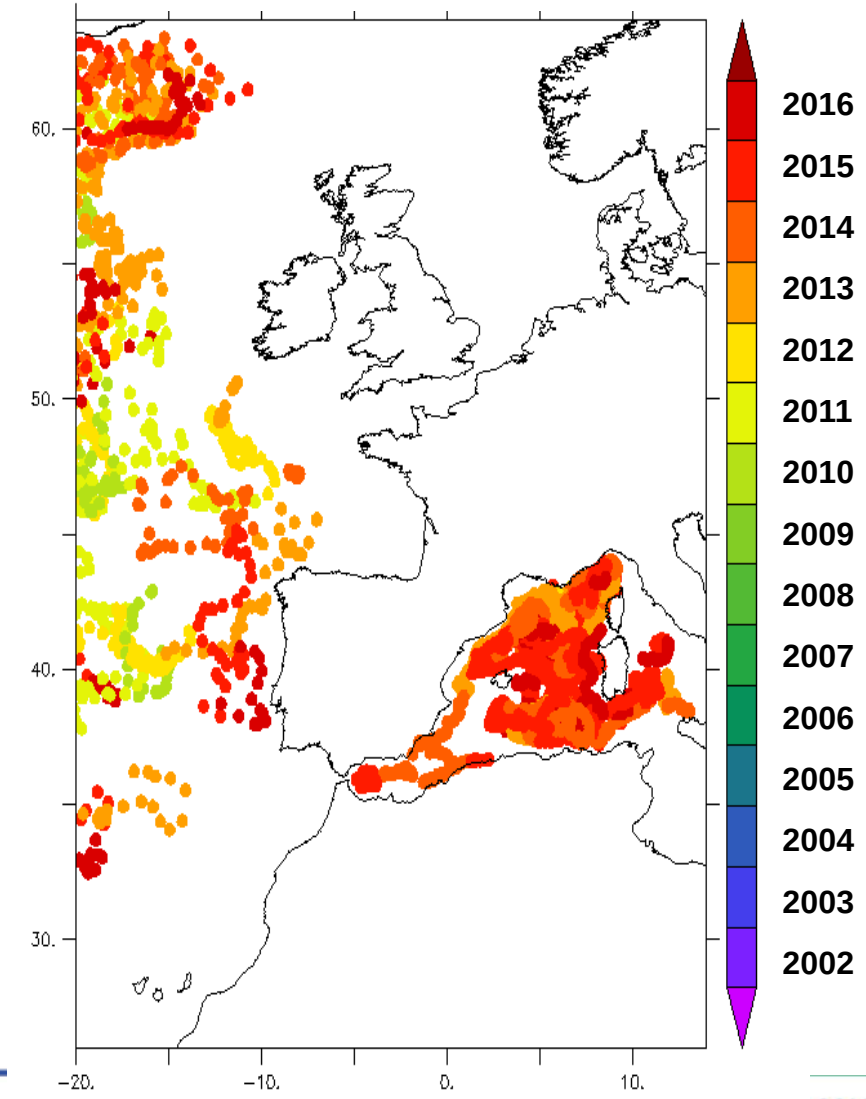
Modèle Régional



Mean NEATL36 O2 2014 050m

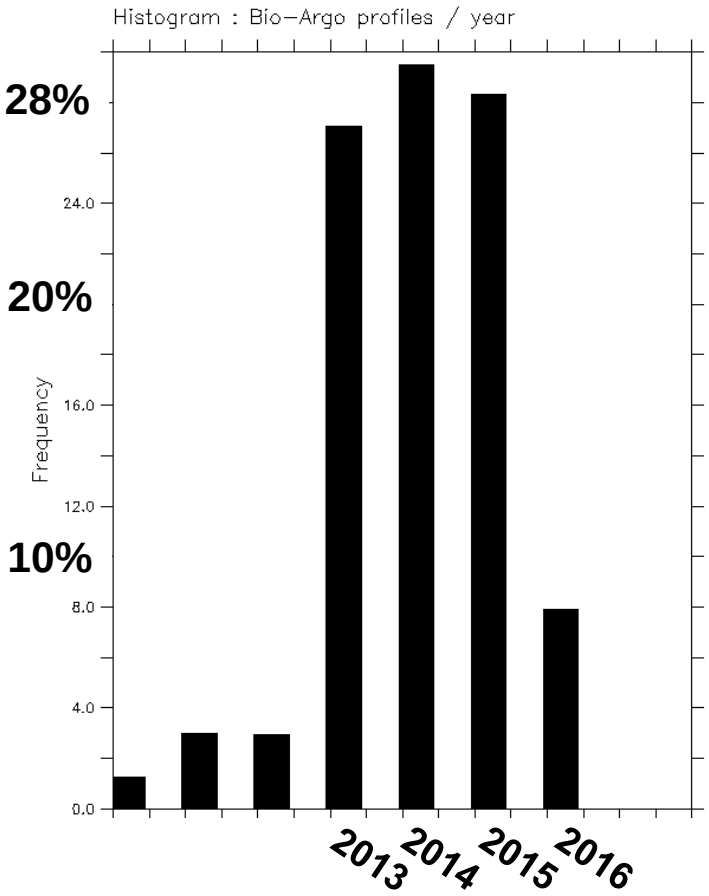
Côtes Européennes
Temps réel au 1/36°

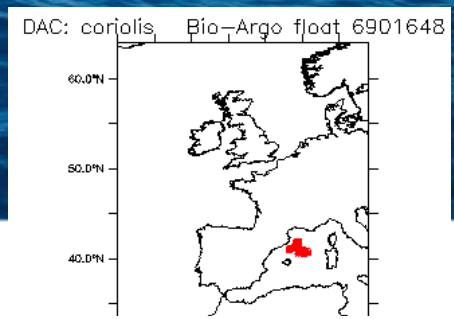
Années des profiles



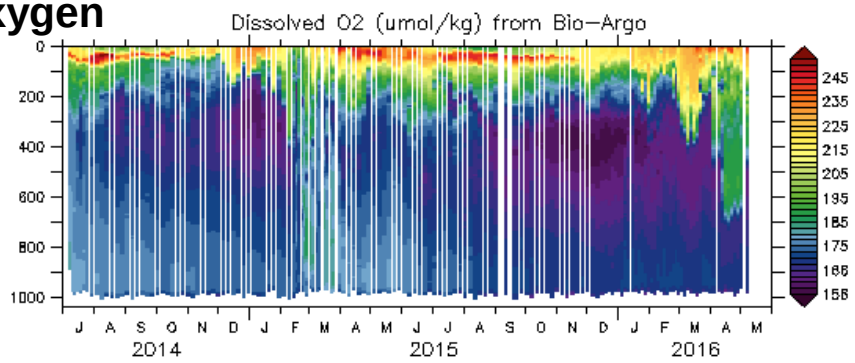
Bio-ARGO dans la zone IBI

→ 4693 profils
→ 52 flotteurs

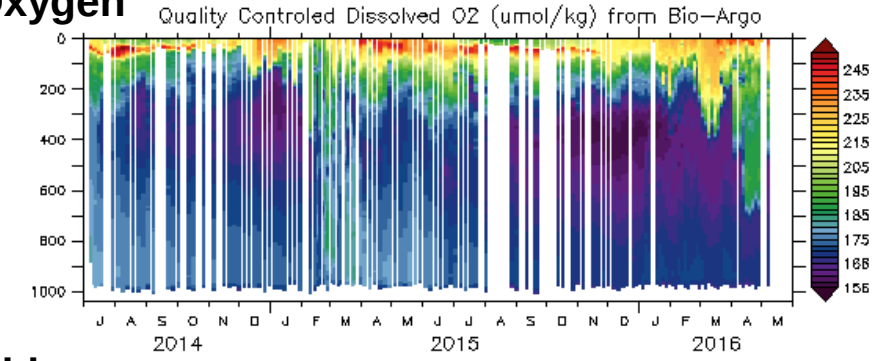




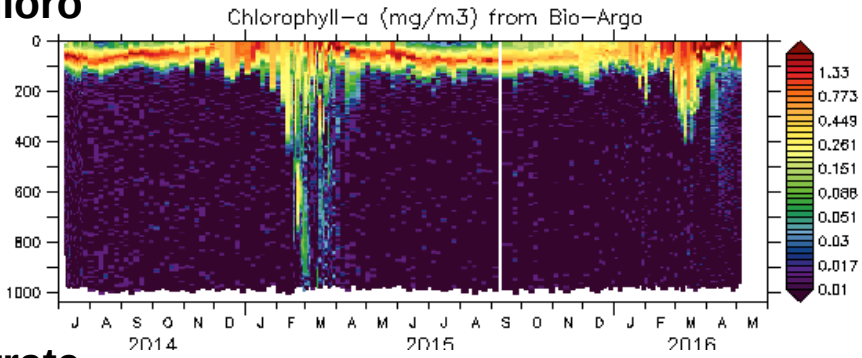
Oxygen



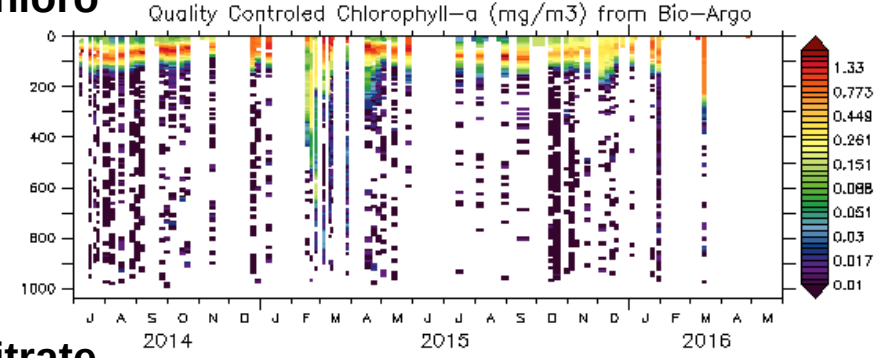
Oxygen



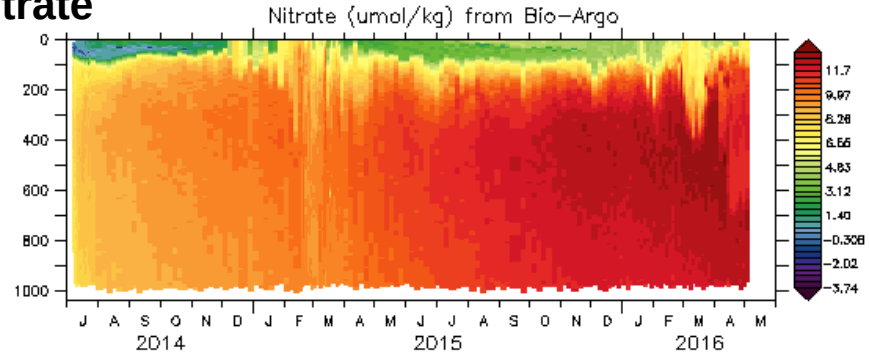
Chloro



Chloro



Nitrate



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