MERCATOR OCEAN INTERNATIONAL

Assessment of the (very) next CMEMS Global biogeochemical forecasting operational system, with assimilation of OC data

and collaborators

Outline

- The CMEMS Global BGC forecast/analysis system
- Validation elements
- Impact of Ocean Color Data Assimilation
- Conclusions / Future plans

Structure of the future operational CMEMS Global BGC forecasting/analysis system

Data Assimilation System

- Multivariate SEEK (log)analysis:
  - **2D Surface analysis** for **(N,D)CHL, NO3 + vertical projection along MLD**
  - Large-scale model error covariances: **correct only the large BGC structures (>500 km)** of the model (model is free to develop is own small-scale dynamics)
  - Model error covariances: from an ensemble of FREE model anomalies
- 2D-Localized correction
- 7-days IAU (incremental correction)

Observations

Surface satellite [Chla] CMEMS products

- **1 Daily L4 / per cycle (no gap)**
- Operational QC to remove statistically unrepresentative values (e.g. spurious spikes)
- Space-filtering to remove short-scales structures in the L4 observations ➔ only keep and **assimilate large-scale structures (>500 km)** into the model

Model

- NEMO-PISCES **3.6**
- GLOBAL 1/4°
- Physical forcing: **CMEMS global assimilated physical system (PSY4)** + coarsening 1/12° ➔ 1/4°
- **Climatological damping for some BGC variables (NO3, PO4,O2,DIC,ALK,Si,DOC,Iron)**

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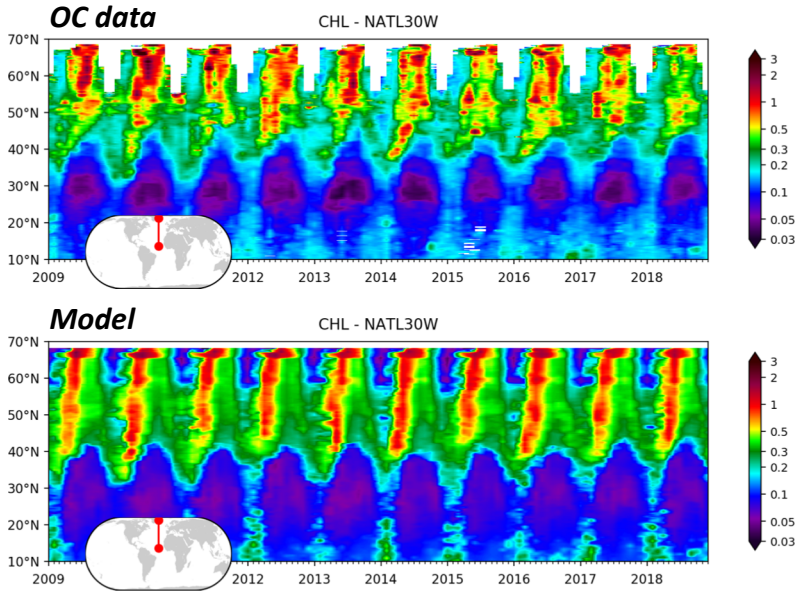
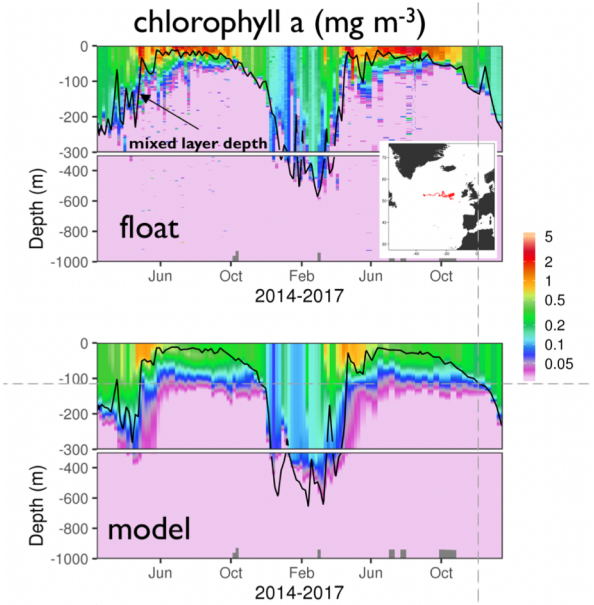
Seasonal variability and vertical structure

Bloom in North ATL – Surface CHL section





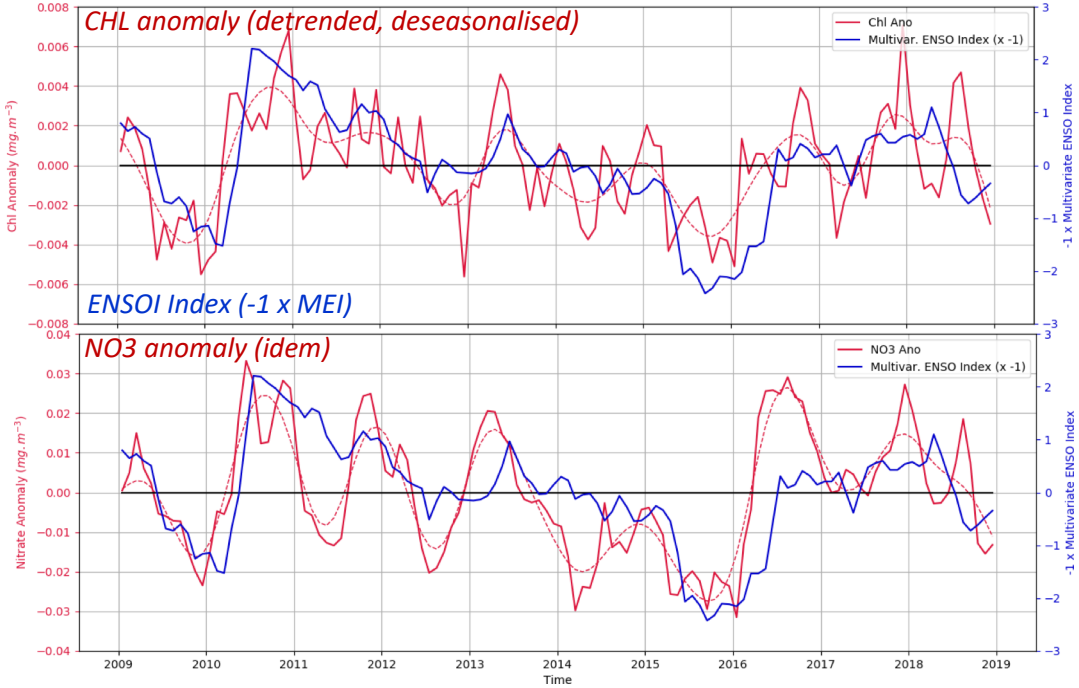
- ➔ Satisfying triggering/persistence of the bloom
- ➔ Good representation of the NATL olig. gyre extension/position/amplitude

- ➔ Correct representation of the bloom variability & vertical structure of CHL concentration. Intensity a bit weak

- ➔ Satisfying agreement with obs. datasets
- ➔ Satisfying modelled seasonal variability

Interannual variability: ENSO

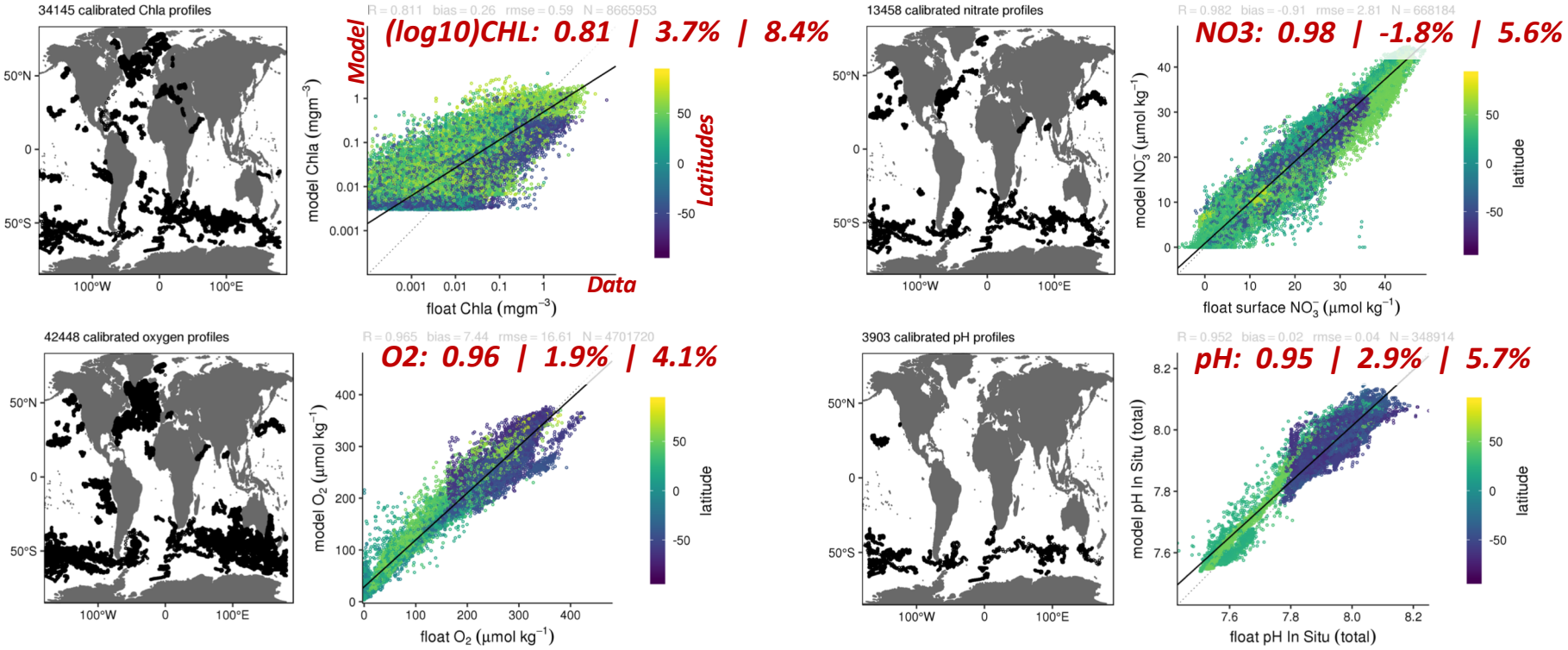
CHL & NO3 anomalies vs Multivariate ENSO Index
Equatorial Pacific (40°S – 40°N)



- ➔ **Significant correlation between signals: 0.8 for filt. CHL ; 0.6 for filt. NO3**
- ➔ **Negative (resp. positive) production anomalies during El Nino (resp. La Nina) events**
- ➔ **Model is able to reproduce the interannual variabilities ➔ climatological damping not too compelling**

Validation of the system

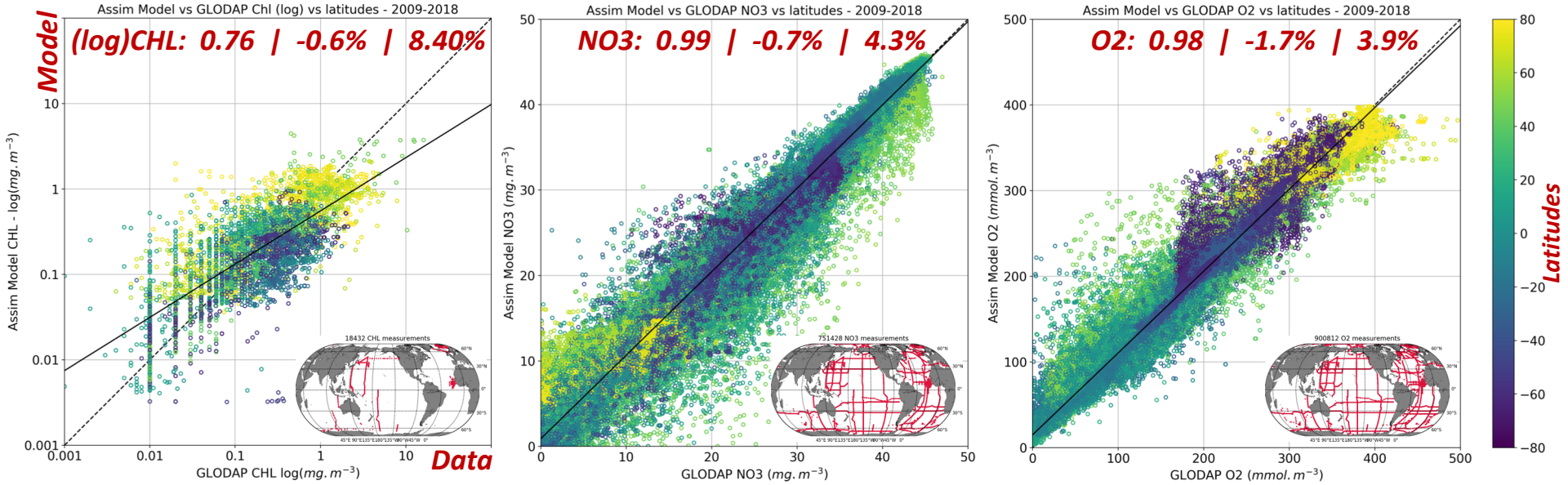
Space-time integrated metrics - comparison to full depth BGC-Argo dataset (2008-2017)



➔ **Solid comparison, satisfying scores at global scale (regional discrepancies exist, though)**

%=100 x Y / range(Y)

Space-time integrated metrics - comparison to full-depth GLODAP* dataset (2009-2017)



➔ **Very encouraging scores**

*GLODAP 2019.v2

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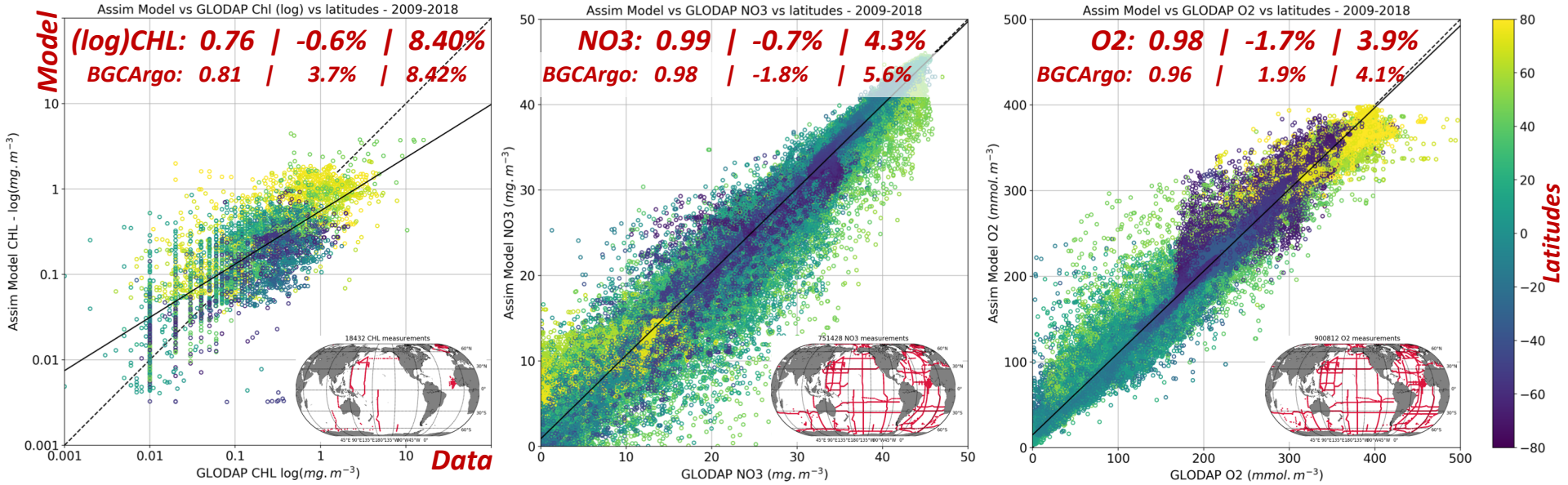
Space-time integrated metrics - comparison to full-depth GLODAP* dataset (2009-2017)



- ➔ Very encouraging scores
- ➔ Significant consistency with BGC-Argo scores

*GLODAP 2019.v2

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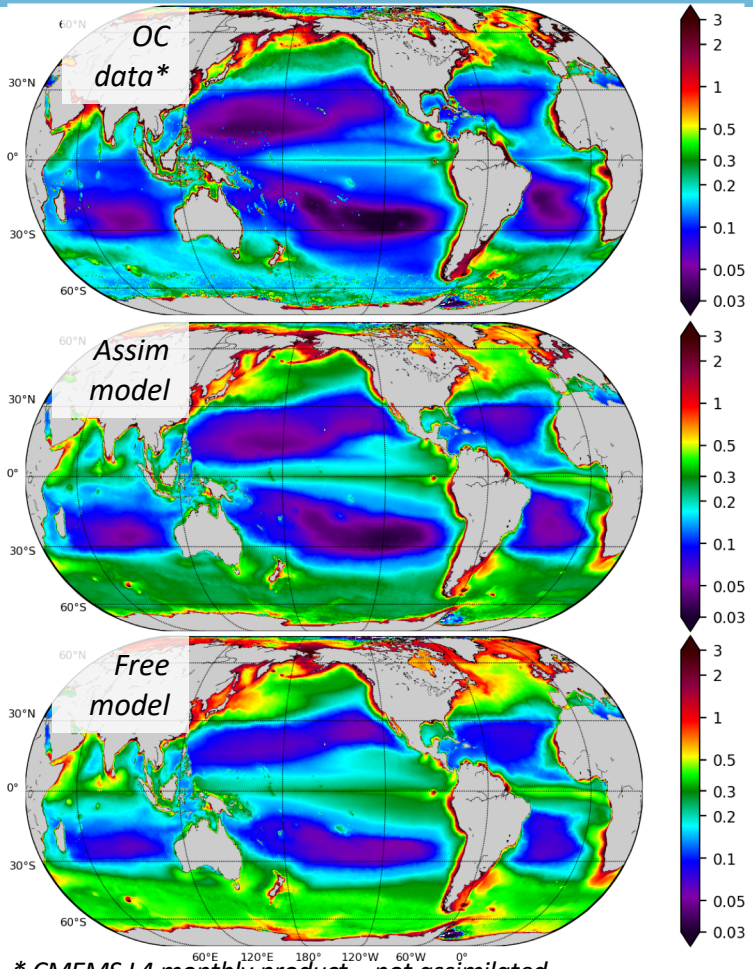
Impact of OC data assimilation - comp. vs OC

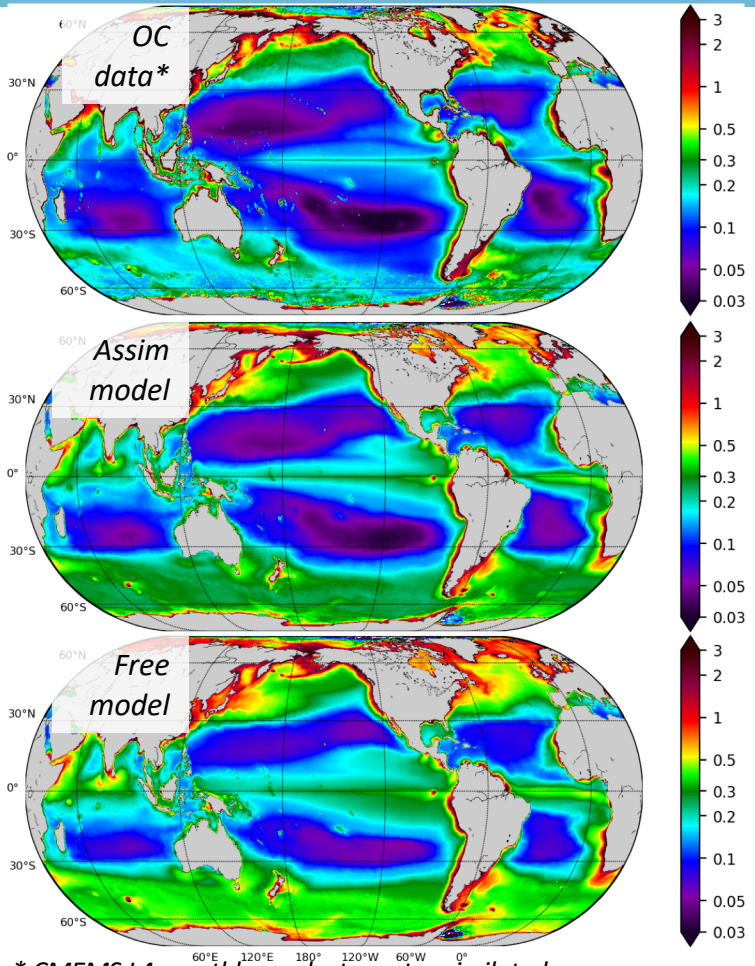


Global surface CHL 2009-2018 mean

- ➔ Significant impact at large scale
- ➔ Better extension/amplitude of oligotrophic gyres
- ➔ Still too productive in Southern Ocean (wrt OC data…)

** CMEMS L4 monthly product – not assimilated*

Impact of OC data assimilation - comp. vs OC



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Global surface CHL 2009-2018 mean

- ➔ Significant impact at large scale
- ➔ Better extension/amplitude of oligotrophic gyres
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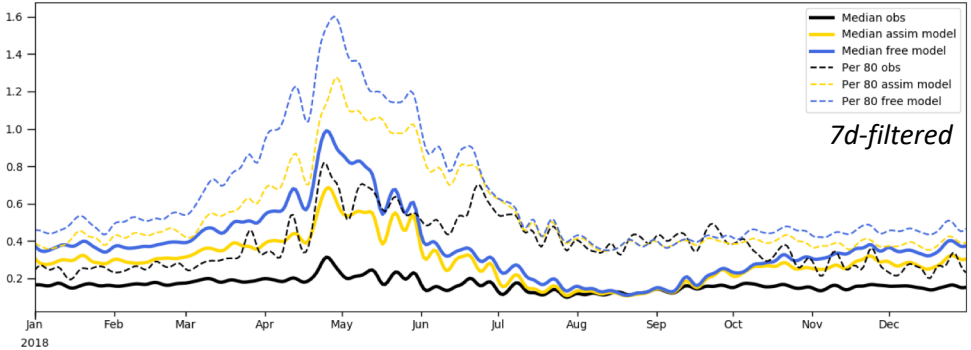
North ATL CHL median/percentile 80

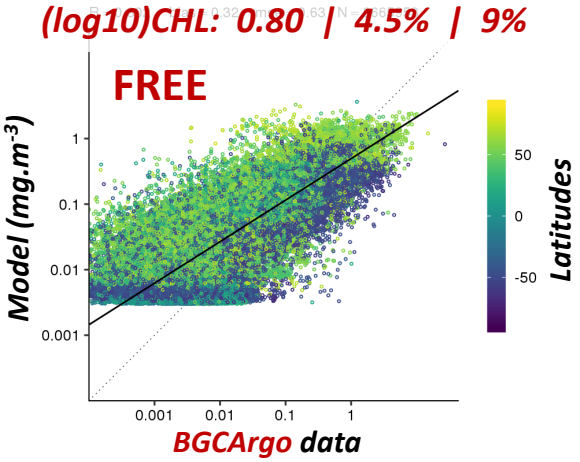
(CMEMS L3 daily product – not assimilated)

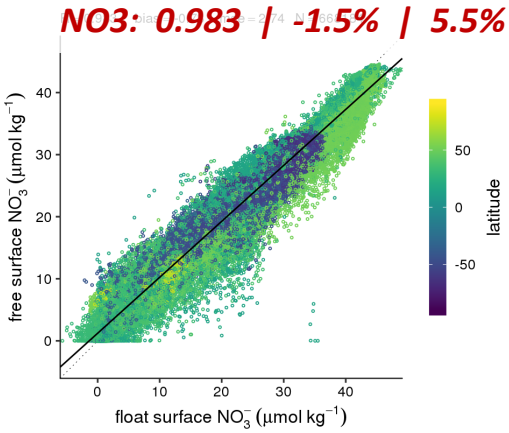


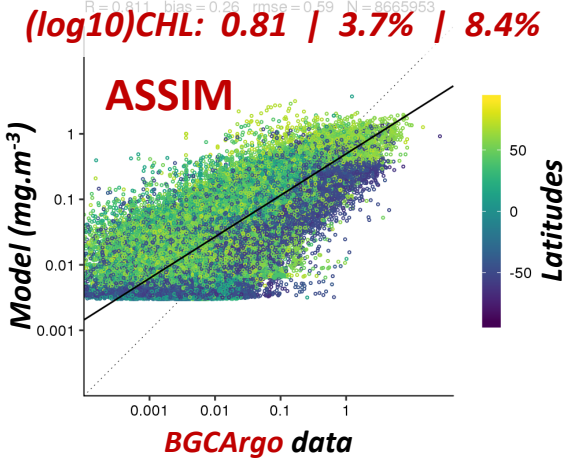
- ➔ Median&Perc80 reduced from 30-50%

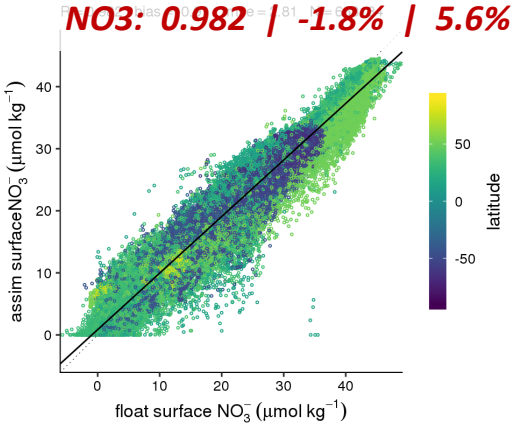
- ➔ Overall positive impact of OC data assimilation on CHL, <u>when compared to OC data</u>

Impact of OC data assimilation - comp. vs BGC-Argo





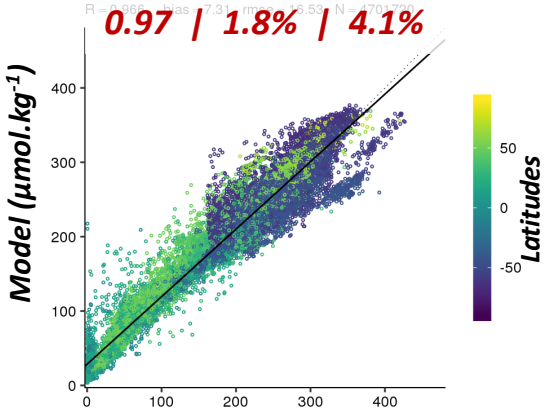


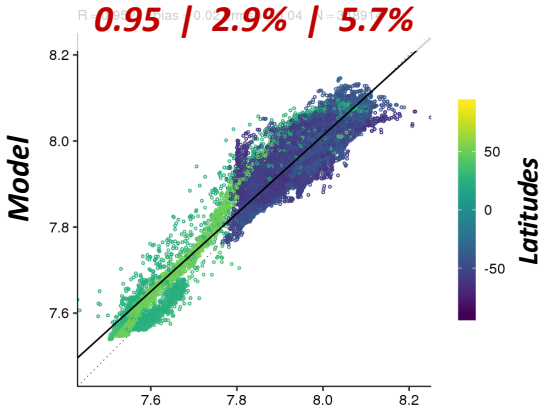


Impact of OC data assimilation - comp. vs BGC-Argo

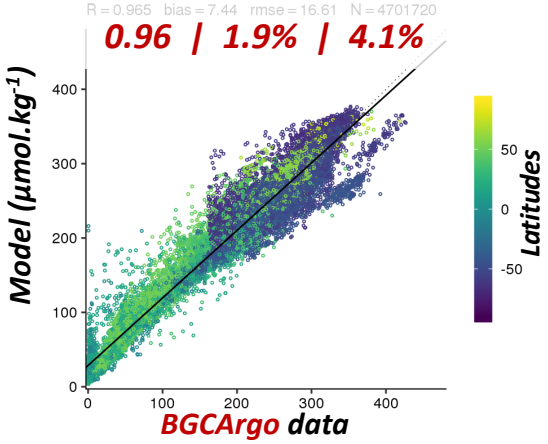
O_2 | pH

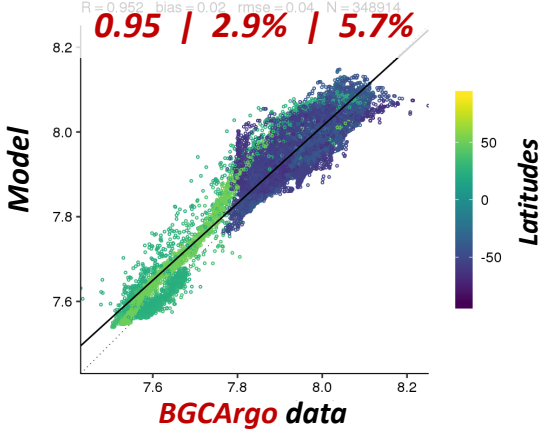
FREE





ASSIM





➔ No significant modifications of O2 and pH fields

Conclusions

Next CMEMS biogeochemical forecasting operational system

- Constrained by Global **assimilated physical dynamics** (forcings), **surface Ocean Colour** (data assimilation) and **nutrients/chemical climatologies** (damping)
- 2008-2018 ➔ NRT
- Validation against **satellite** and **in-situ datasets** (satellite, BGC-Argo, GLODAP)
  - Satisfying agreement between model and OC dataset **at large scale**
  - **solid consistency with BGC-ARGO and GLODAP**: Bias < 4%, RMSDiff <9%, and satisfying seasonnal and interranual variability, both in surface and at depth
  - ➔ **« Dynamical climatology »**

➔ **Deployment** of the GLO NRT BGC analysis and forecasting system, with OC DA ➔ **June, 2019**

Thanks for your attention !

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Any questions ?

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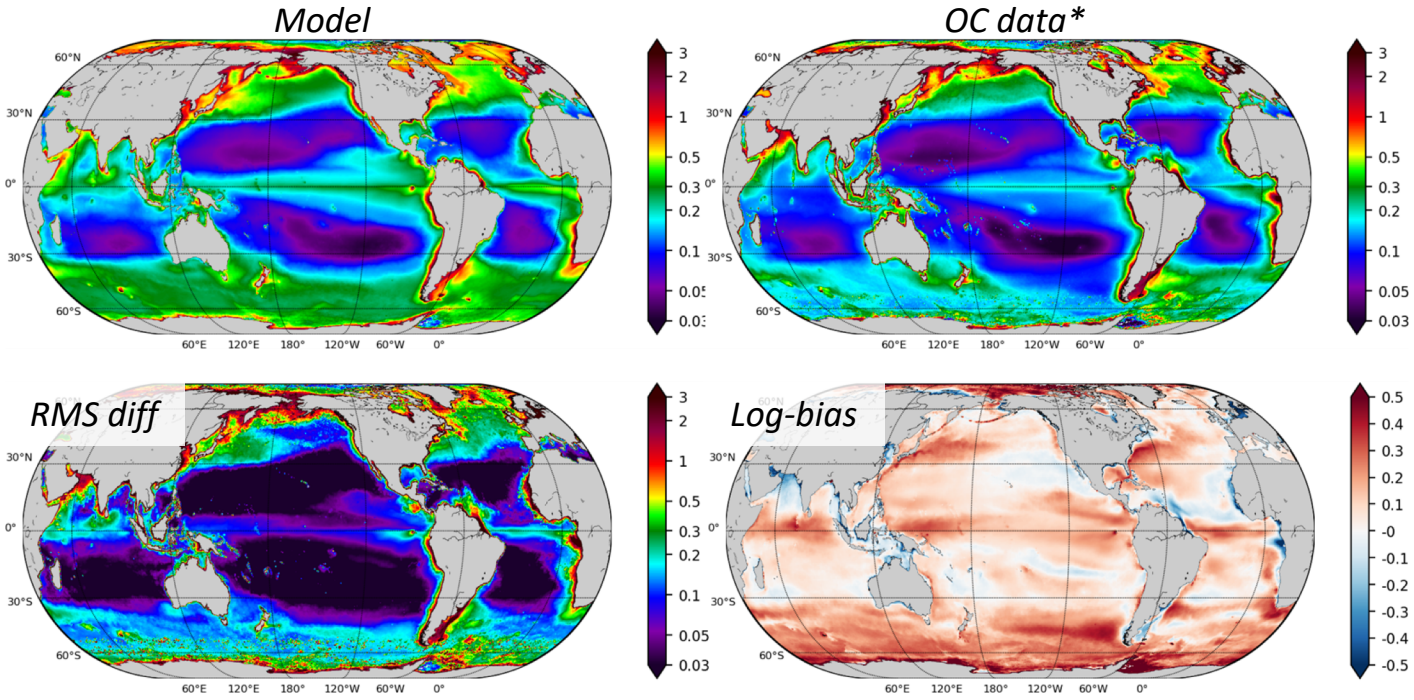
Surface CHL 2009-2018 mean



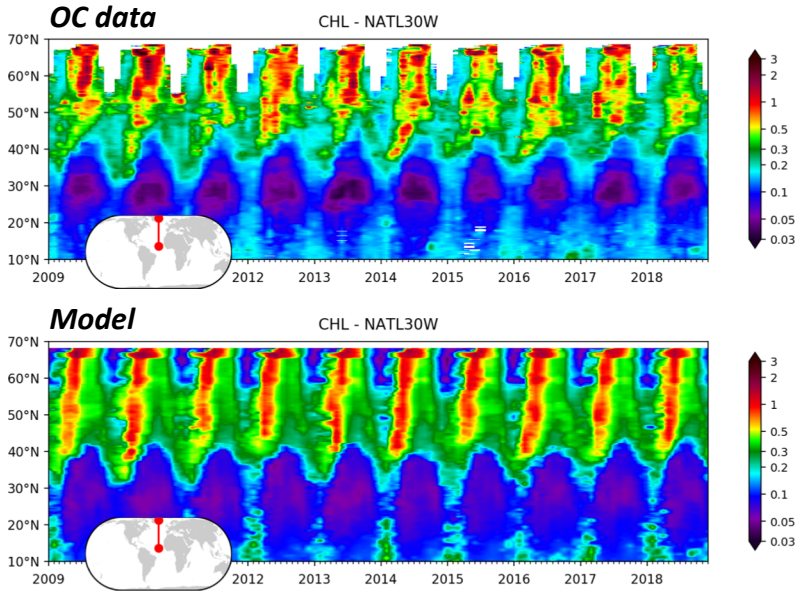
➔ **Satisfying agreement between model and OC dataset at large scale**

- **Oligotrophic gyres extension/amplitude**
- **Production 'Hot spots'**

** CMEMS L4 monthly product (not the assimilated data, but still only partially independant…)*

Seasonal variability and vertical structure

Bloom in North ATL – Surface CHL section



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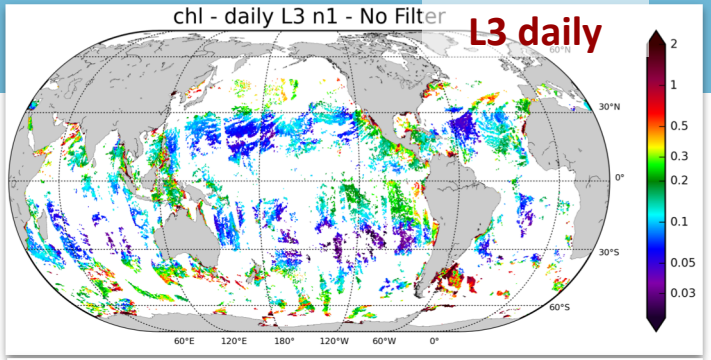
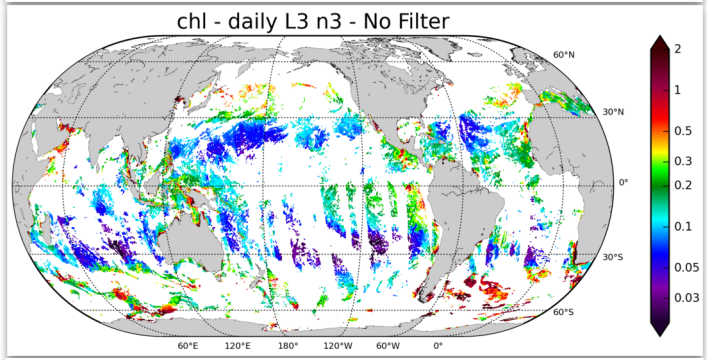

chl - daily L3 n1 - No Filter
L3 daily
60°N
30°N
0°
30°S
60°S
60°E
120°E
180°
120°W
60°W
0°
2
1
0.5
0.3
0.2
0.1
0.05
0.03


chl - daily L3 n3 - No Filter
60°N
30°N
0°
30°S
60°S
60°E
120°E
180°
120°W
60°W
0°
2
1
0.5
0.3
0.2
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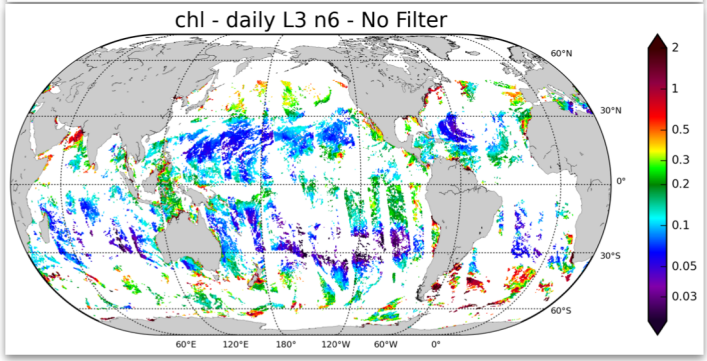
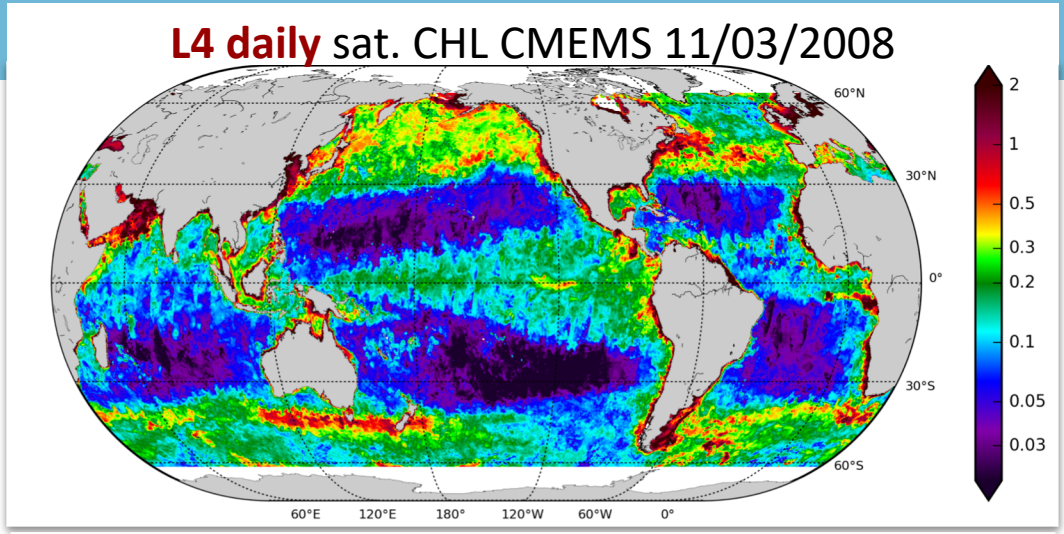
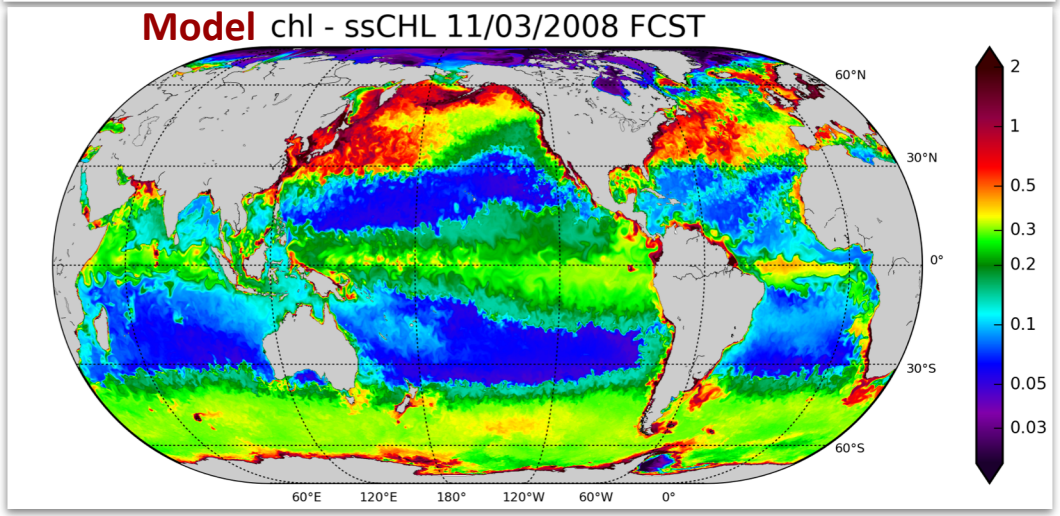
0.05
0.03

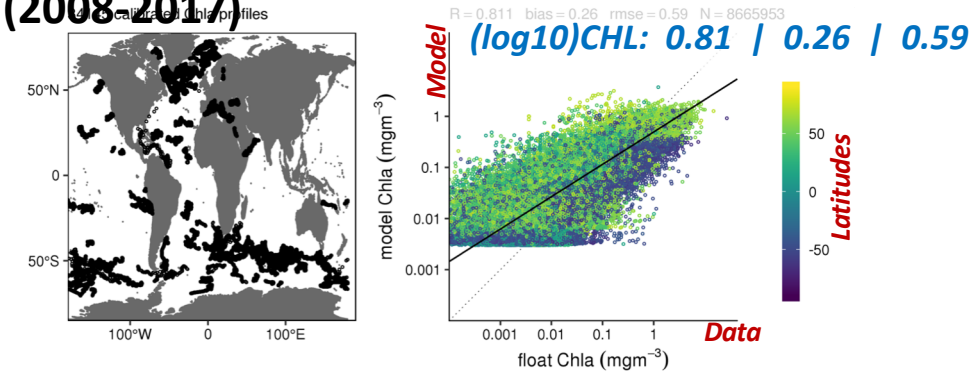

chl - daily L3 n6 - No Filter
60°N
30°N
0°
30°S
60°S
60°E
120°E
180°
120°W
60°W
0°
2
1
0.5
0.3
0.2
0.1
0.05
0.03

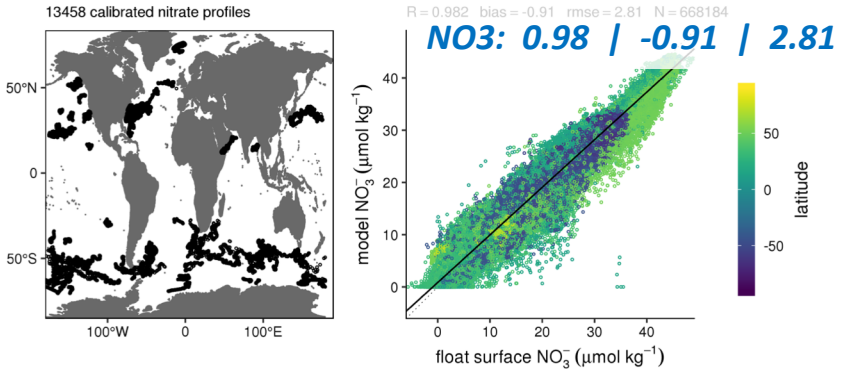

L4 daily sat. CHL CMEMS 11/03/2008
60°N
30°N
0°
30°S
60°S
60°E
120°E
180°
120°W
60°W
0°
2
1
0.5
0.3
0.2
0.1
0.05
0.03

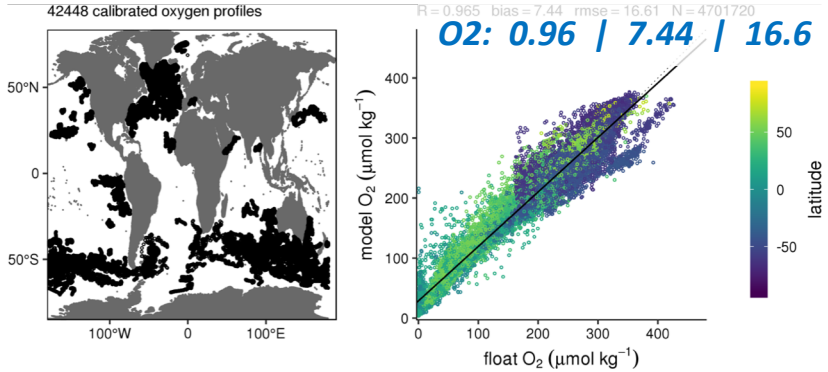

Model chl - ssCHL 11/03/2008 FCST
60°N
30°N
0°
30°S
60°S
60°E
120°E
180°
120°W
60°W
0°
2
1
0.5
0.3
0.2
0.1
0.05
0.03

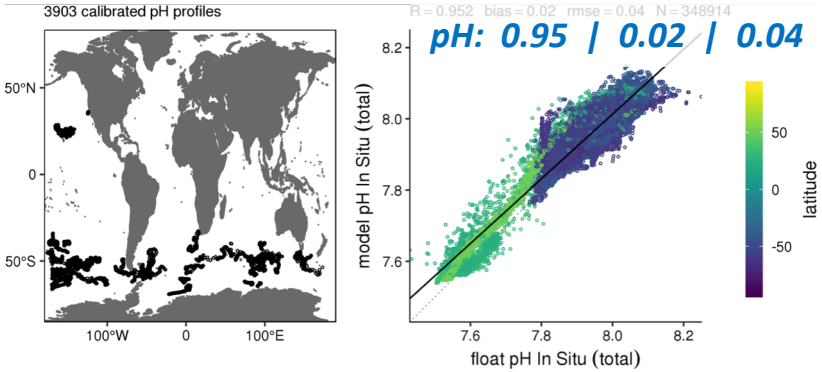
Validation of the system

Space-time integrated metrics - comparison to full depth BGC-Argo dataset (2008-2017)



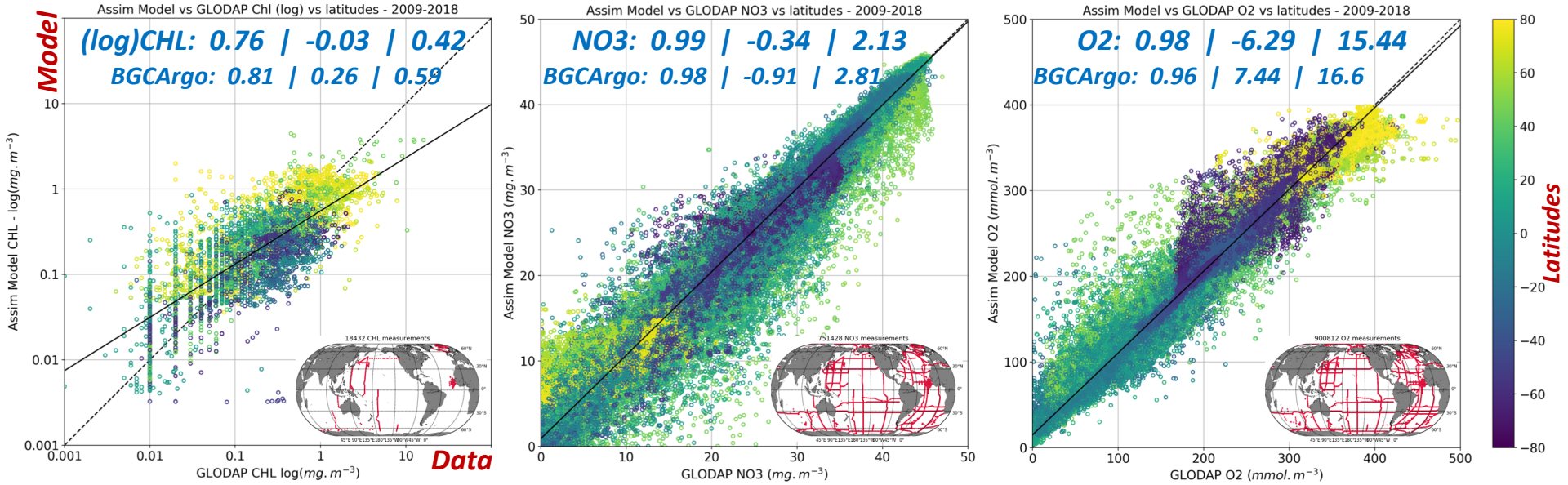






➔ Solid comparison, satisfying scores at global scale (regional discrepancies exist, though – not shown here)

Space-time integrated metrics - comparison to GLODAP* dataset



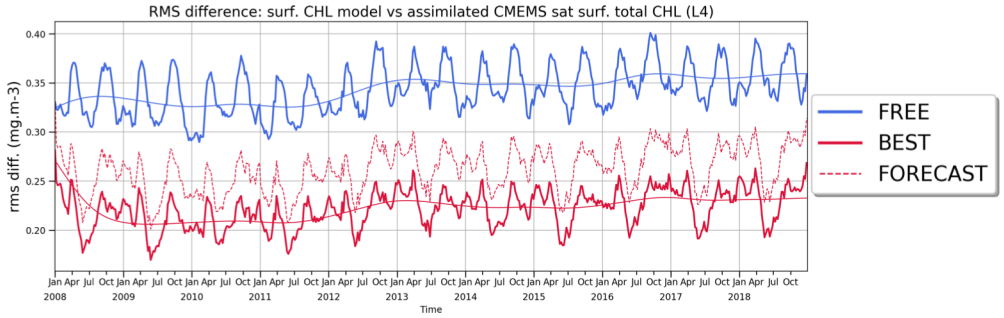
- ➔ Very encouraging scores
- ➔ Significant consistency with BGC-Argo scores

*GLODAP 2019.v2

Impact of OC data assimilation

Global

CHL RMSD model *.vs.* assimilated obs

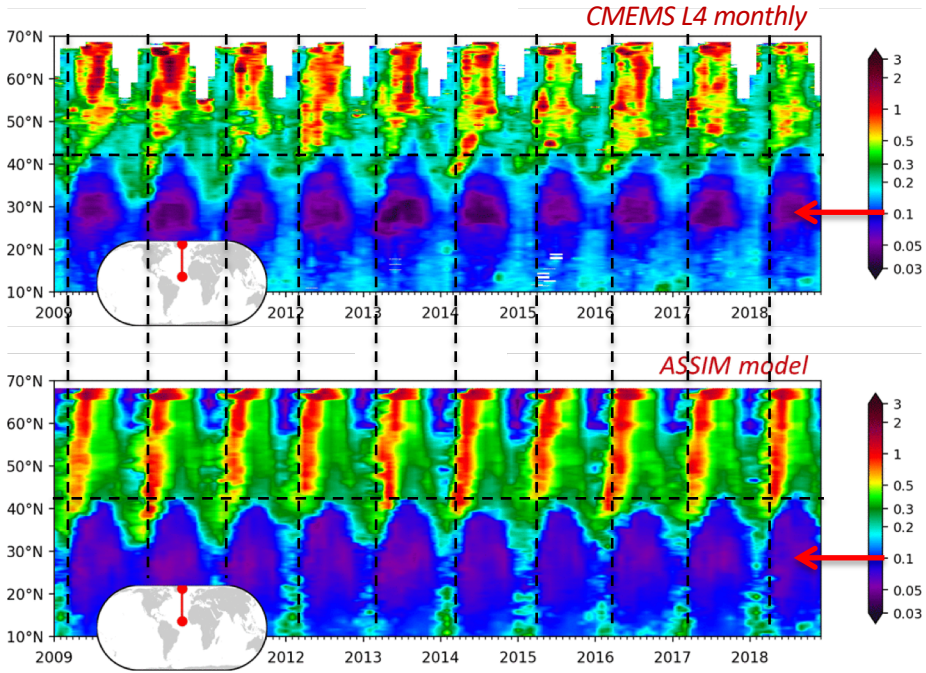


➔ **Satisfying control of the model (stability, correction strength)**

Impact of OC data assimilation

North ATL

Bloom in North ATL – Surface CHL section



➔ Better triggering/persistence of the bloom

➔ Better representation of the NATL olig. gyre extension/position/amplitude