Use of Argo observations at Mercator-Ocean

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Outline of the talk

Use of Argo observations at Mercator Ocean

- **Assimilation in real time of Argo T,S profiles** in the ocean and ice analysis and forecasting
- **Assimilation in the ocean and ice reanalysis of delayed time** Argo data
- **Impact studies** of present and future extension of the Argo network on the global ocean analysis and forecasts
- **Validation of biogeochemical simulations**
- **Perspectives**

Context

The ocean analysis and forecasts highly rely on the availability and quality of the assimilated observations.

The Argo observations represent one of the most important data set allowing to constrain the model 3D temperature and salinity and its variability, at large scale, with a global coverage.

- Availability in real time of observations, with a reliable QC, is required for use by operational systems,
- An “accurate” delayed time data basis is required for long term reanalysis production.

Copernicus Marine Service

The CMEMS provides regular and systematic core reference information on the state of the physical oceans and regional seas. The observations and forecasts produced by the service support all marine applications.

Thematic Assembly Center

In Situ TAC: CORIOLIS

-> provide in situ observations in real time and in delayed time (CORA)

Monitoring and Forecasting Centers

Mercator Ocean is operating the global ocean system. It is based on an ocean and ice models at 1/12° in real time and at ¼° for reanalysis.

- T and S profiles, along track SLA and SST are assimilated each week .

COPERNICUS
MARINE ENVIRONMENT MONITORING SERVICE

European Union Programme

Entrusted entity by mandate of the European Commission

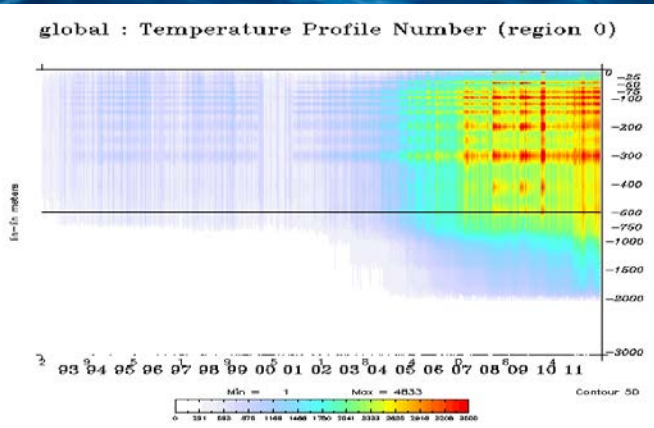
Ocean reanalysis

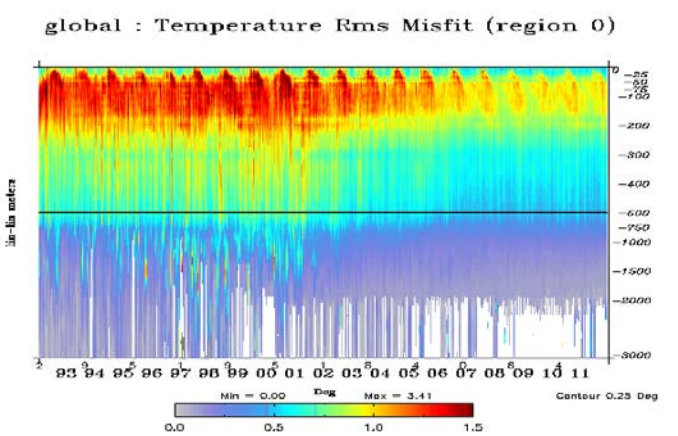
Observation minus model statistics for the Mercator Ocean Reanalysis

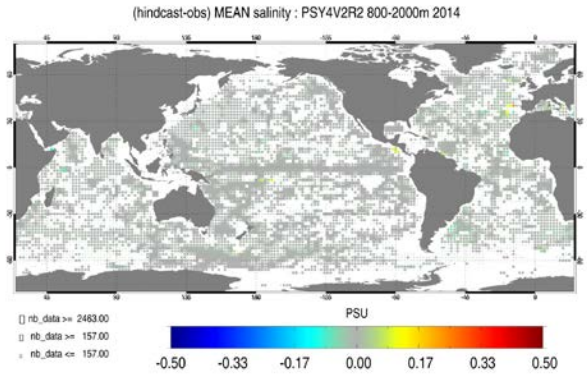
Temperature and salinity observation misfit statistics

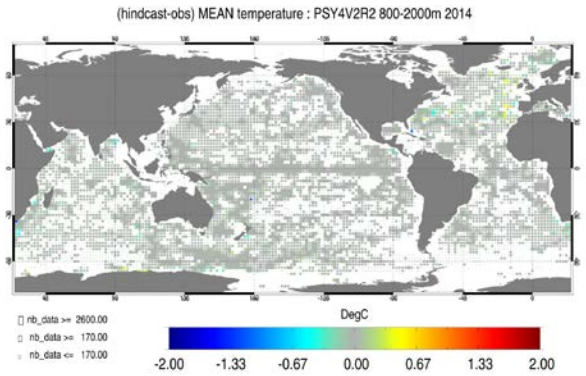
800m-2000m

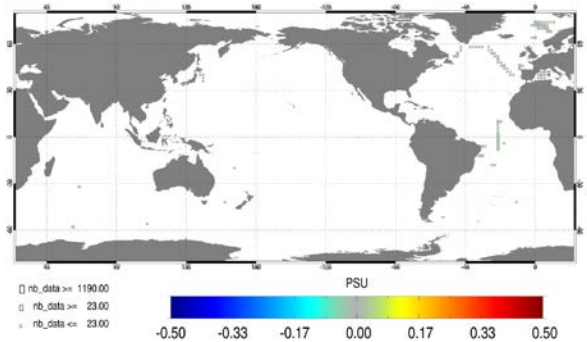
2000m-5000m

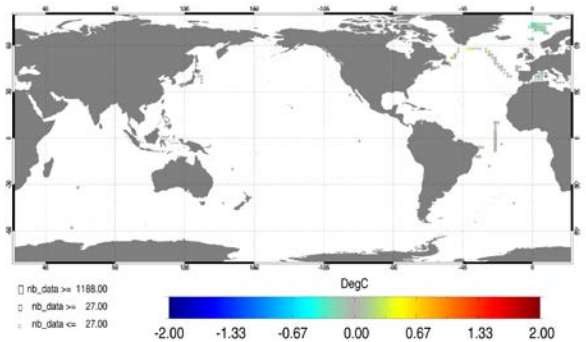




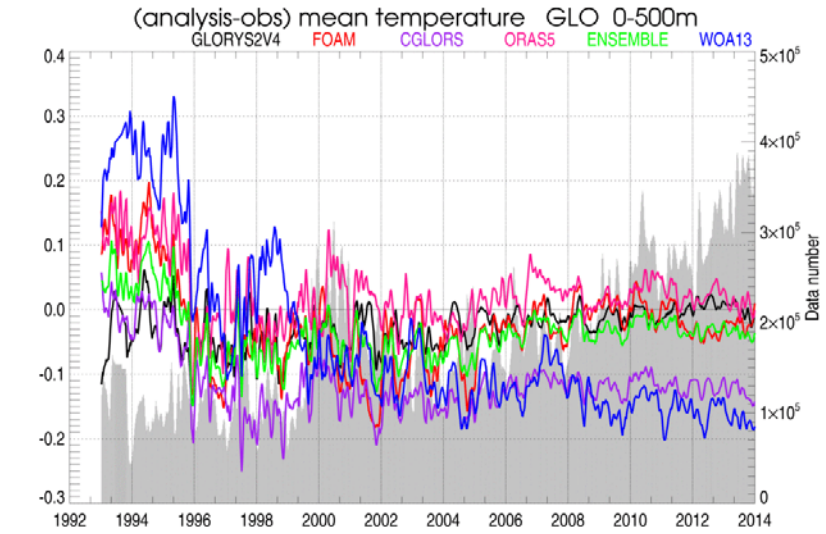


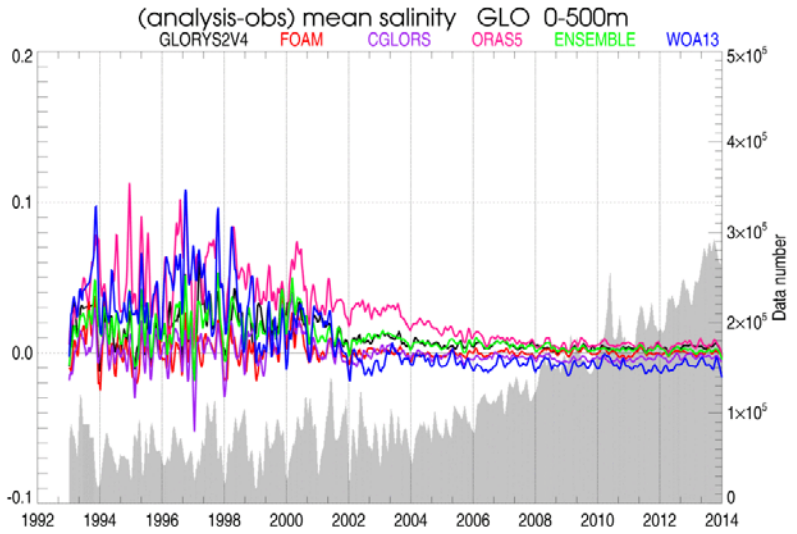


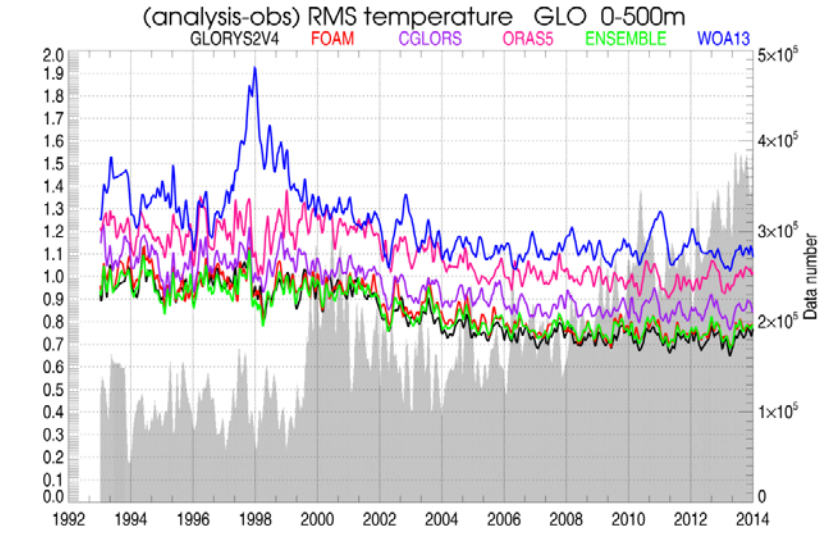


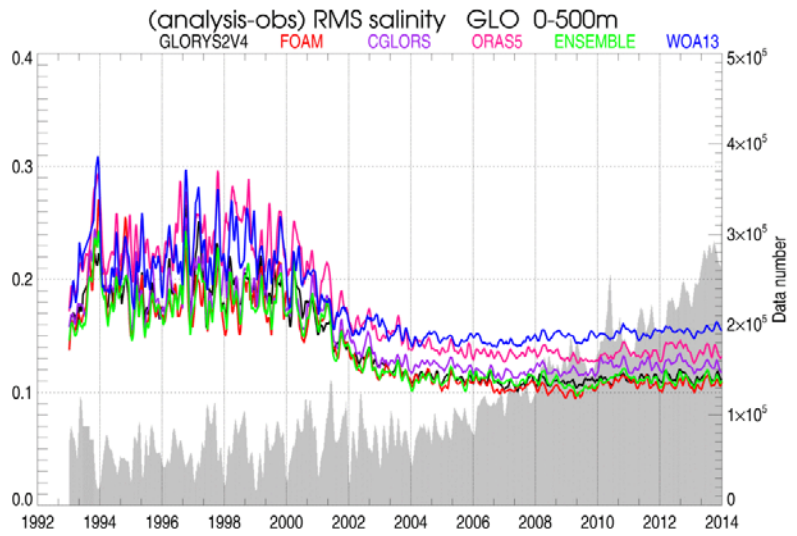


Ensemble of reanalysis in CMEMS (GREP)









QC based on model – data comparison

Additional QC is done on the in situ data using model forecast comparison

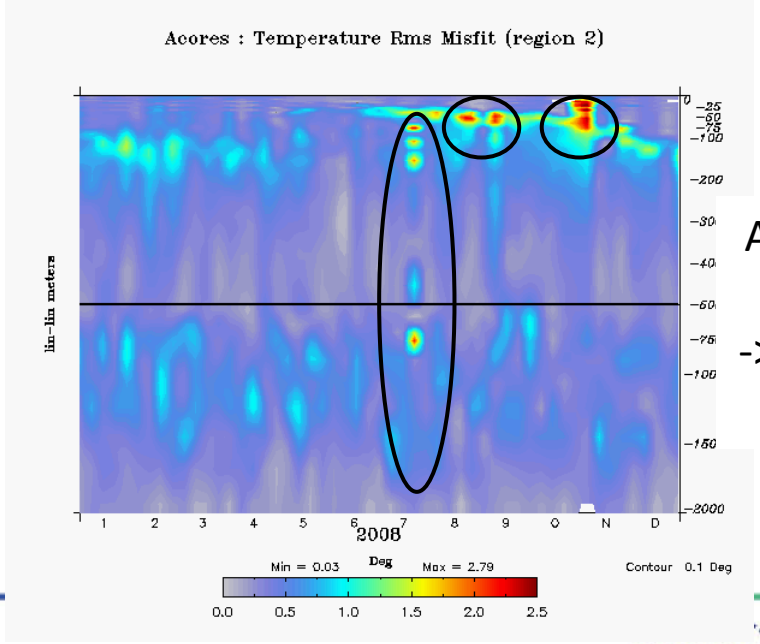
1st check: Based on **T & S innovation** (obs – forecast) statistics

→ detection of spikes, large biases

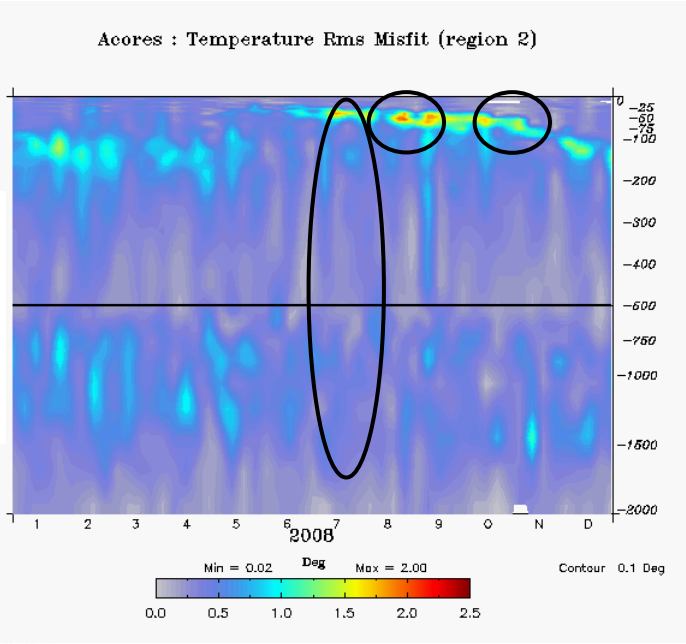
2nd check: Based on **dynamic height innovation** statistics

→ detection of small vertically constant biases

Vertical profile of Rms Misfit (Data-model) in Temperature (Açores region)

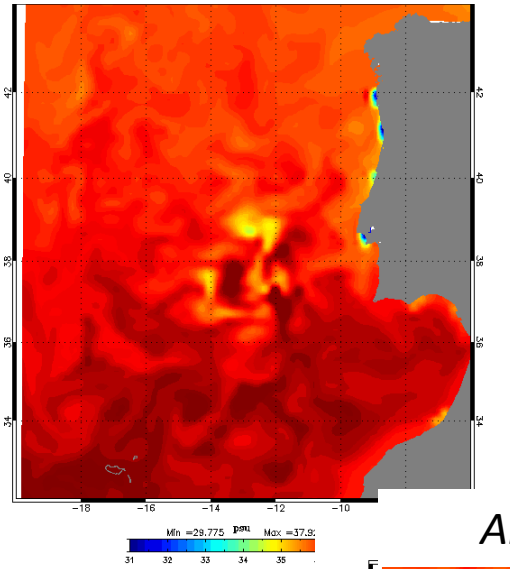


After the additional background check -> "bad" profiles are black listed

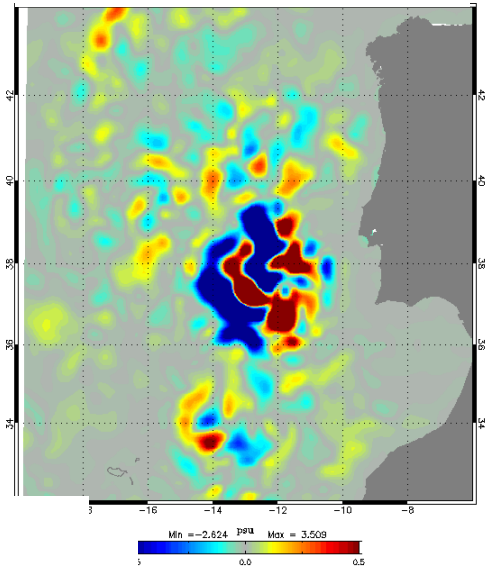


Effect of a « bad » profil

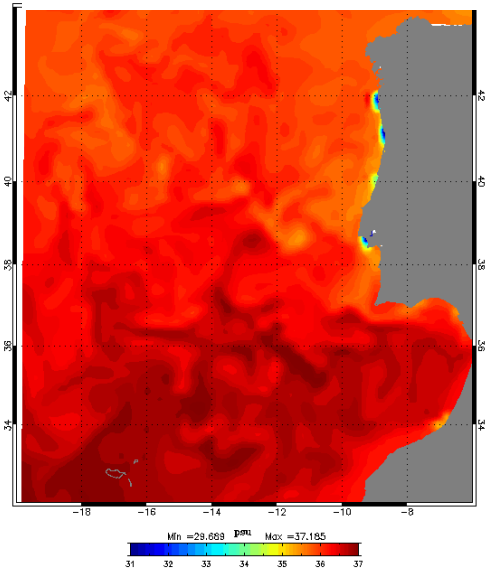
Analysed SSS



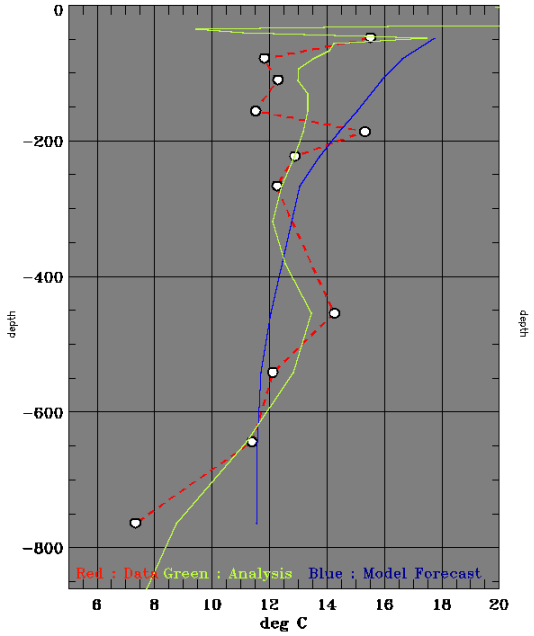
SSS increment



Analysed SSS



After background check



Impact studies

The impact of the assimilation of Argo T and S profiles in real time ocean forecasting systems is assessed within different projects.

As the Argo network, satellite observations and the model configuration are evolving (resolution, physical processes), the role of Argo in constraining the ocean analysis and forecast need to be revisited.

The use of multiple systems helps to get more robust conclusions.

- GODAE
- E-AIMS (Euro-Argo Improvements for the GMES Marine Service)
- AtlantOS H2020

-> better understanding of the data « content » and their errors,

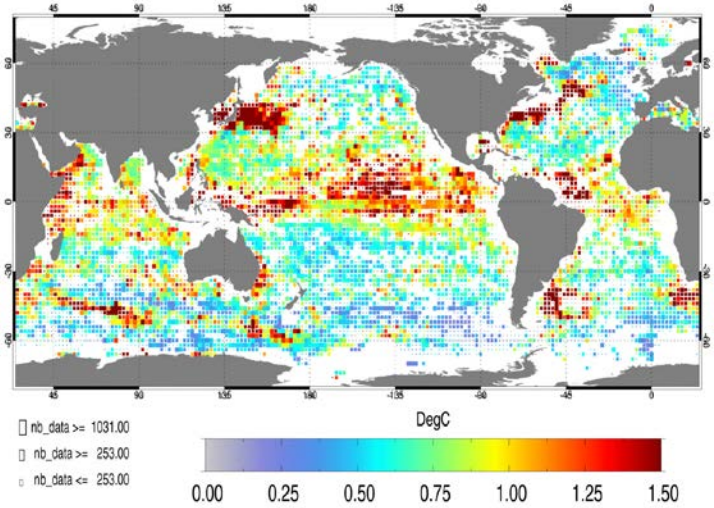
-> end-to-end check: from the sea to data assimilation in real time

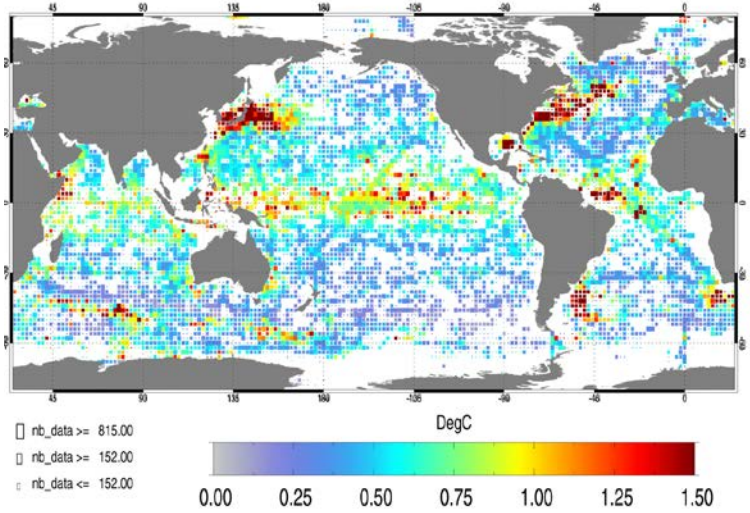
-> better use of the observations by the system (improvement of the observation operator and the observation error specified in the DA).

E-AIMS results

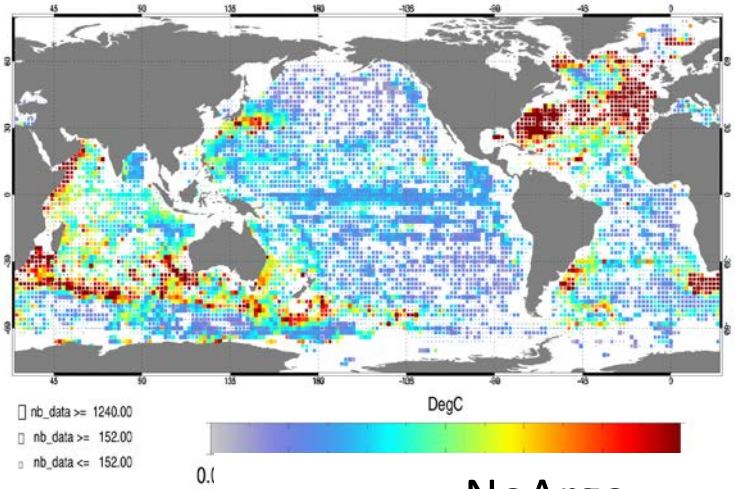
Global RMS misfit between the in situ temperature observations without / with Argo data assimilated (statistics on the last 6 months of the OSEs with the ¼°

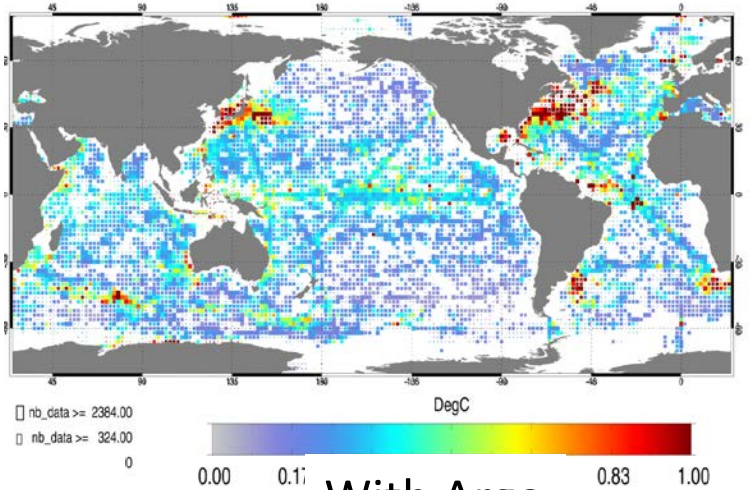
0-300m





700-2000m



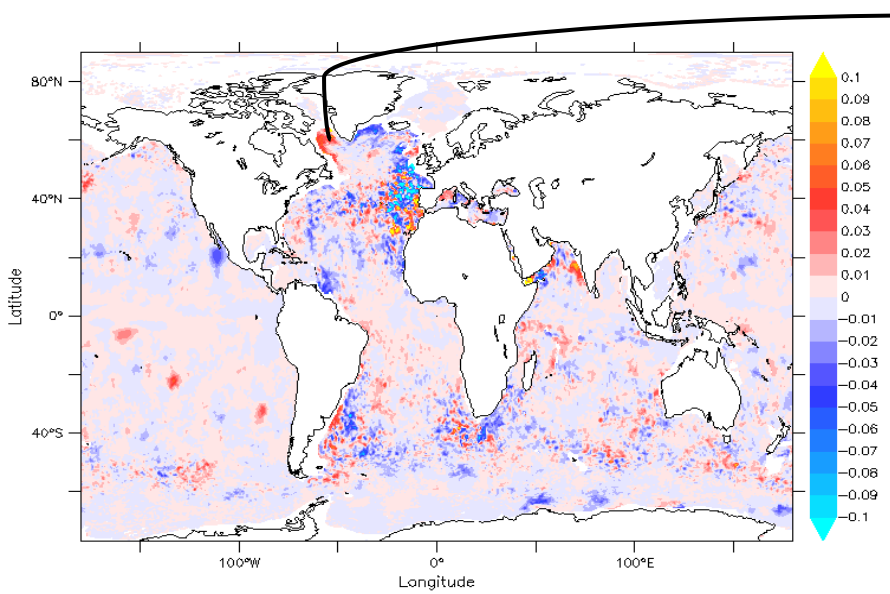


NoArgo

With Argo

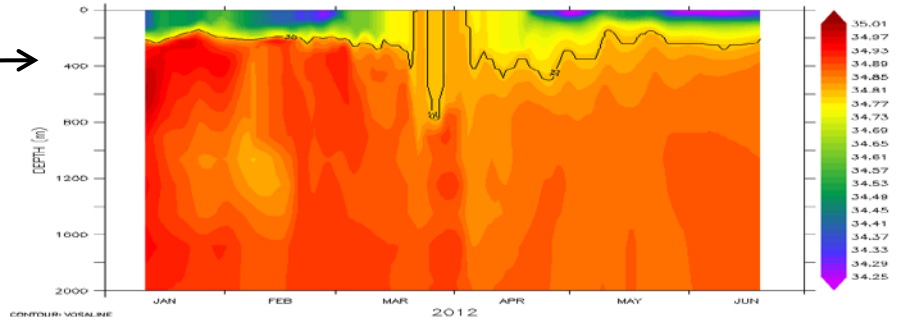
E-AIMS results

Water mass representation

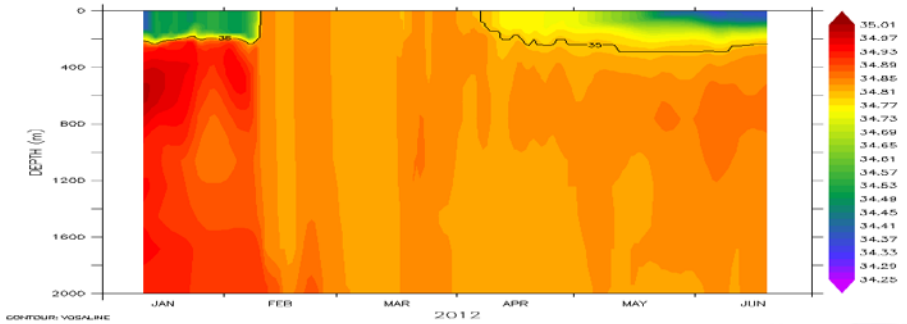


Differences in 1000-2000 m salt content for June 2012 between the simulation with all ARGO and no ARGO floats assimilated (in PSU).

All ARGO floats



No ARGO floats



Time evolution of the salinity profile in the Labrador Sea at 56 °E-60 °N

Impact of Argo observations

Conclusion of E-AIMS OSE experiments **for ocean analysis**:

- significant impact of Argo assimilation, maximum at subsurface (MLD), highly region dependent:

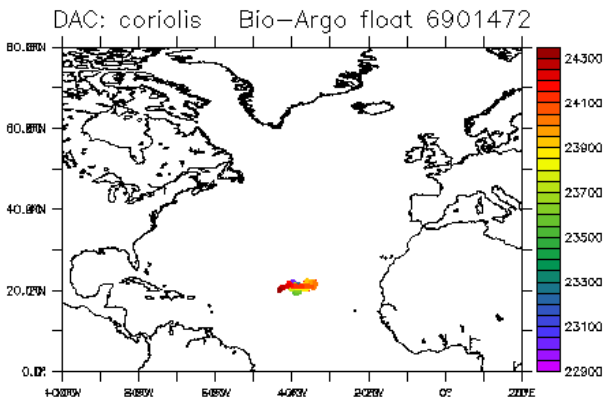
- in the surface layers, the largest impact is found in the tropical band and energetic ocean regions (WBC,…),

- at depth, water masses from outflow or deep convection are better represented,

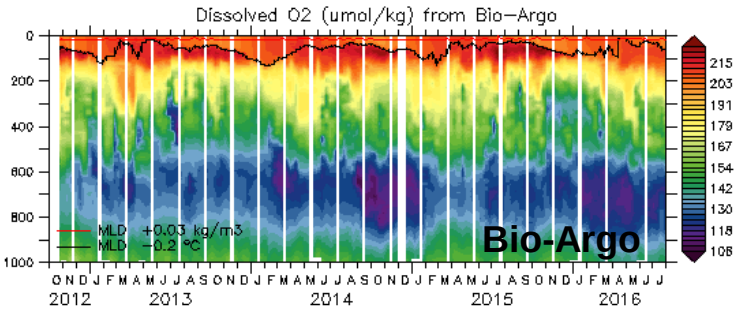
- no redundancy of each float information AT THE ANALYSIS SCALE,
- need of deep Argo profiles (coarse resolution),
- necessary to complement satellite observations (SST, SLA) in order to constrain the full 3D ocean state analysis,

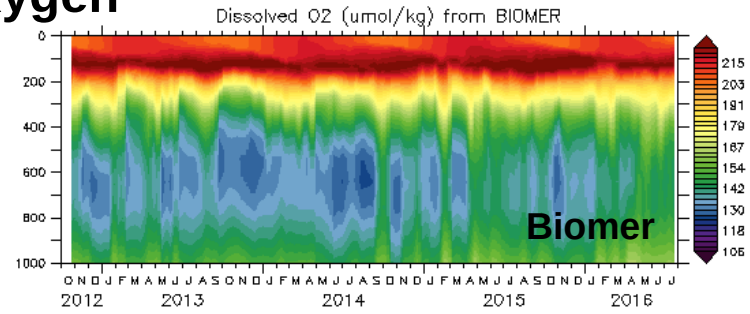
BGC observations

Comparaison Argo vs BIOMER

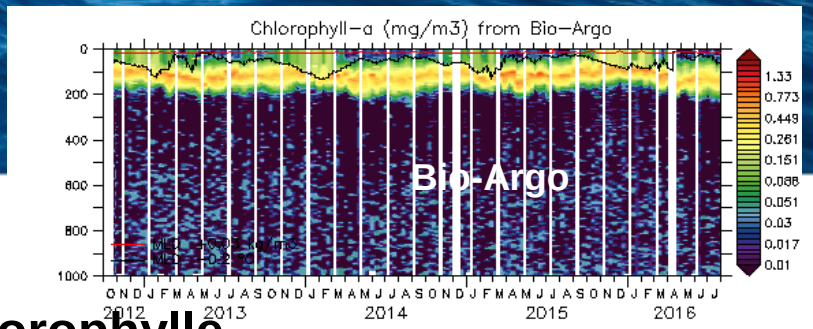


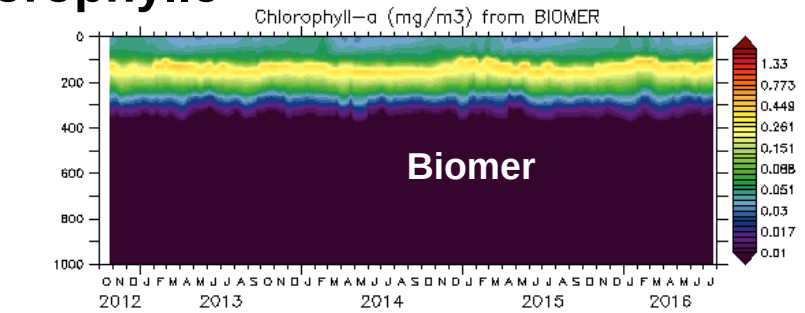
Oxygen



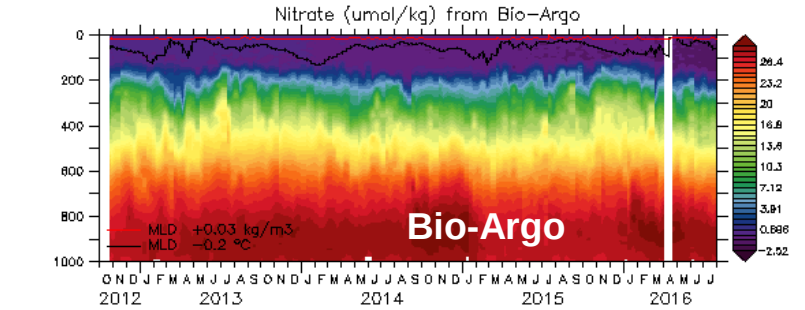


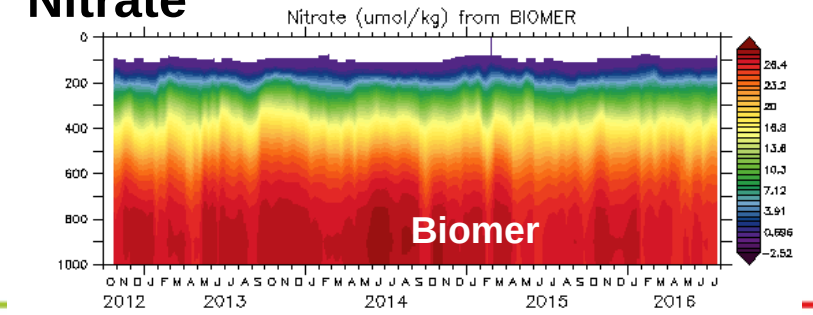
Chlorophylle





Nitrate





Biogeochemical measurements

Use of BGC observations for validation of model (PISCES) simulations:

- The model is more oxygenated than the observations
- The seasonal cycle of the chlorophyll is not in phase

The assimilation of BGC variables is an ongoing work:

- Assimilation of satellite chlorophyll (2018)
- Profiles of nutrients and oxygen (within 2 to 3 years)

Chlorophyll is deduced from optical measurement: its assimilation is not straightforward.

Conclusions

Present Argo network

- Constrain the ocean interior at large scale up to 2000 m depth,
- Complement the altimetry observations
- Decrease the spread of ensemble of reanalysis.

To be assessed: impact of the 0-5m measurements (daily cycle)

Future network evolution

- Deep argo observations – clearly needed: E-AIMS, AtlantOS OSSE
- Increased number of Argo in WBC and tropics: AtlantOS OSSE
- More Arctic profiles…

Assimilation of BGC observations in preparation

-> How to keep an « equilibrium » with satellite high resolution intermittent surface observations with sparser interior ocean observations and models that resolve more and more HR/HF processes within a data assimilative system?