Monitoring the global ocean hydrographic variability from Argo, SST and altimeter observations

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A.-L. Dhomps
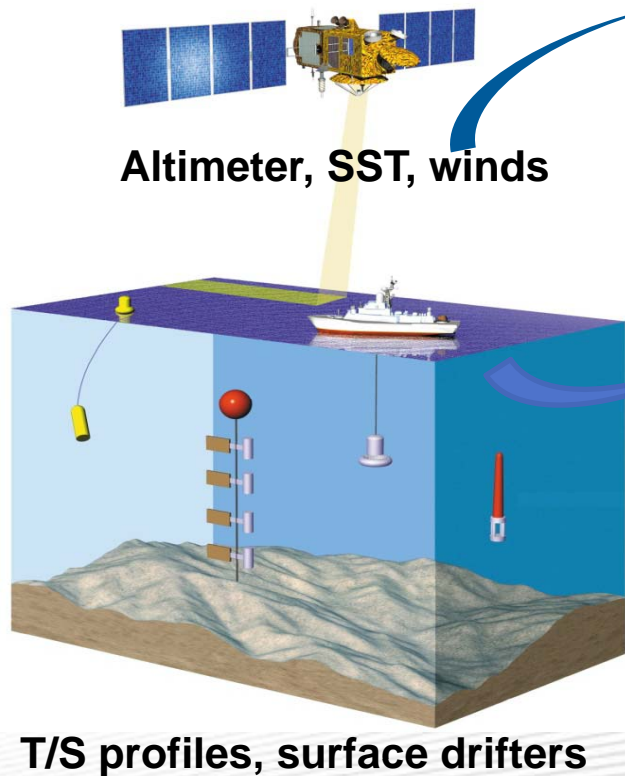**G. Larnicol**
P.-Y. Le Traon

Introduction - Outline

❑ Our approach :

– Consists of estimating 3D-thermohaline and current fields using ONLY observations and statistical methods

– Represents an alternative to the one developed by forecasting centers – based on model/assimilation techniques

– Monitoring component of the Global MyOcean Monitoring and Forecasting Center lead by Mercator-Océan

❑ Previous studies have shown the capability of such approaches :

– In producing reliable ocean state estimates (Guinehut et al., 2004; Larnicol et al., 2006)

– In analyzing the contribution and complementarities of the different observing systems (in-situ vs. remote-sensing) (2nd GODAE OSE Workshop, 2009)

❑ 3D- thermohaline fields

– Method, 1993-2008 reanalysis

– Validation with independent data sets

– Analysis of the ocean thermohaline variability for the 1993-2008 period / Glorys
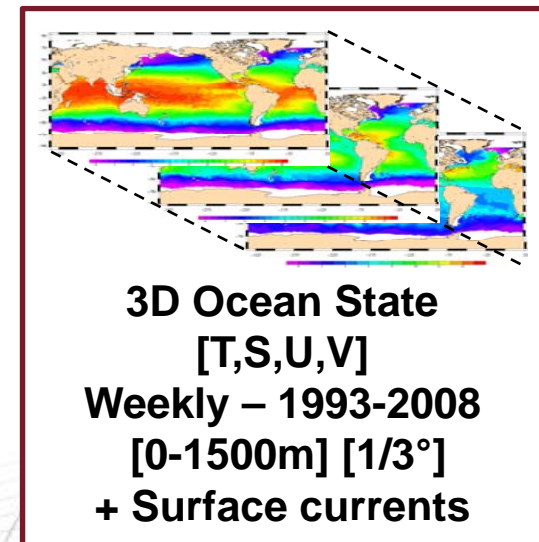
The principle

The observations

Altimeter, SST, winds

T/S profiles, surface drifters

+ MDT estimate

The method

Guinehut et al., 2004
Guinehut et al., 2006
Larnicol et al., 2006
Rio et al., 2010

The products

3D Ocean State
[T,S,U,V]
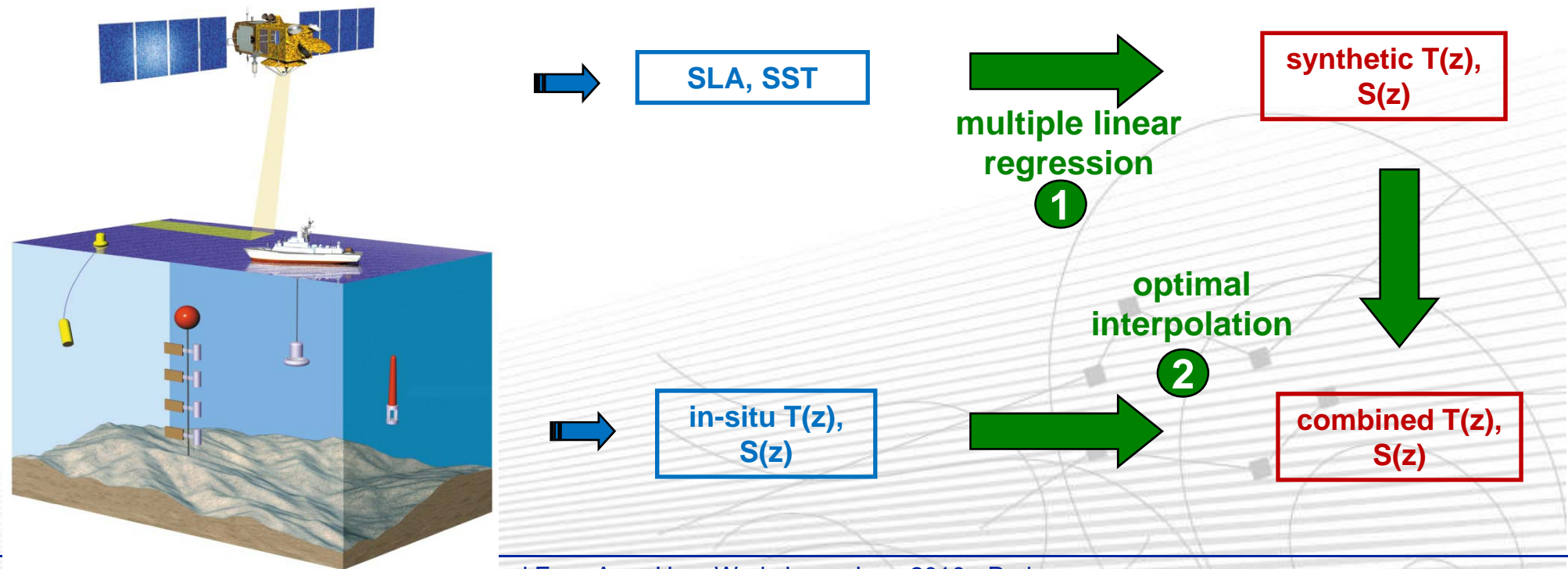Weekly – 1993-2008
[0-1500m] [1/3°]
+ Surface currents

Intercomparison with independent data sets and model simulations
Analysis of the ocean variability
Observing System Evaluation

3D T/S fields - Method

1 **vertical projection** of satellite data (**SLA**, **SST**)

$$T(x,y,z,t) = \alpha(x,y,z,t).SLA_{steric} + \beta(x,y,z,t).SST' + T_{clim}(x,y,z,t)$$
$$S(x,y,z,t) = \alpha'(x,y,z,t).SLA_{steric} \qquad\qquad\qquad + S_{clim}(x,y,z,t)$$

2 **combination** of synthetic and in-situ profiles

SLA, SST → **multiple linear regression** **1** → synthetic T(z), S(z)

in-situ T(z), S(z) → **optimal interpolation** **2** → combined T(z), S(z)

1993-2008 reanalysis

SSALTO-DUACS MSLA 1/3° weekly DT - 04/07/2007
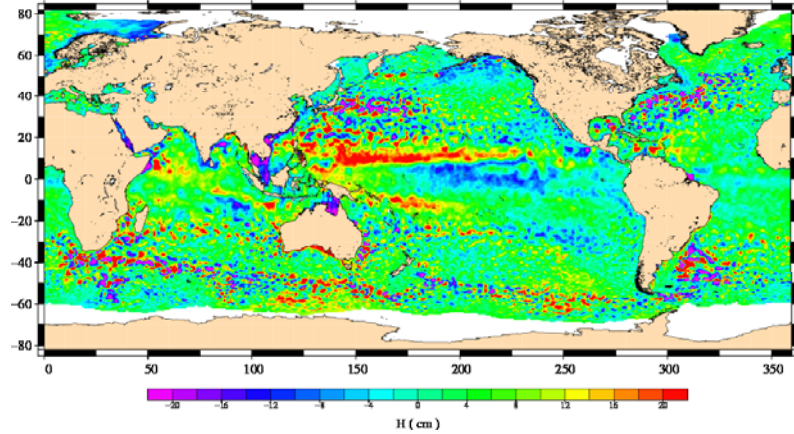
NCEP Reynolds OI-SST 1/4° daily - 04/07/2007
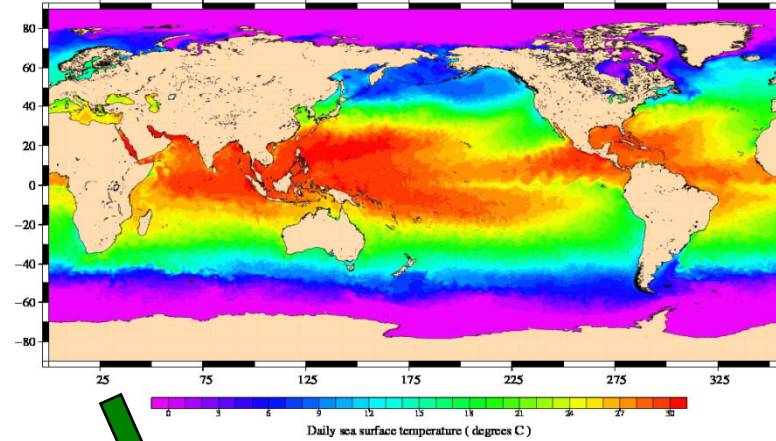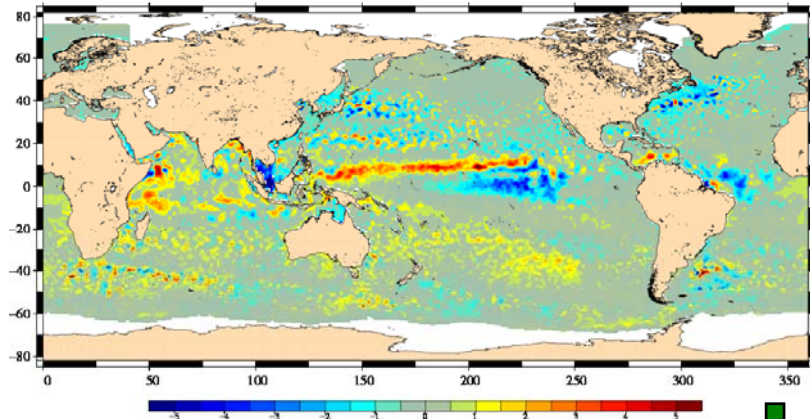
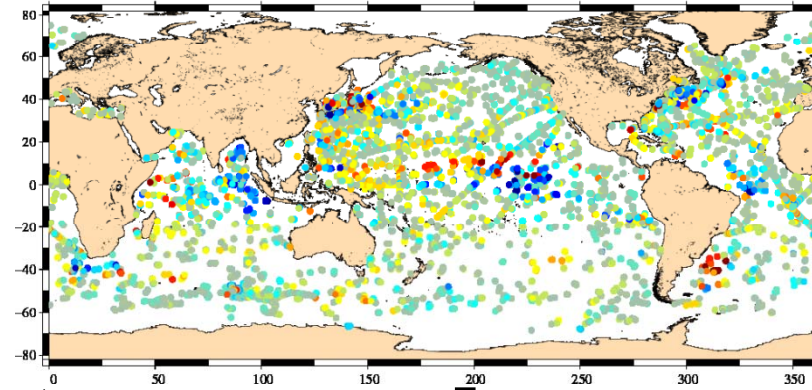**ARIVO climatology – July – T at 100 m**
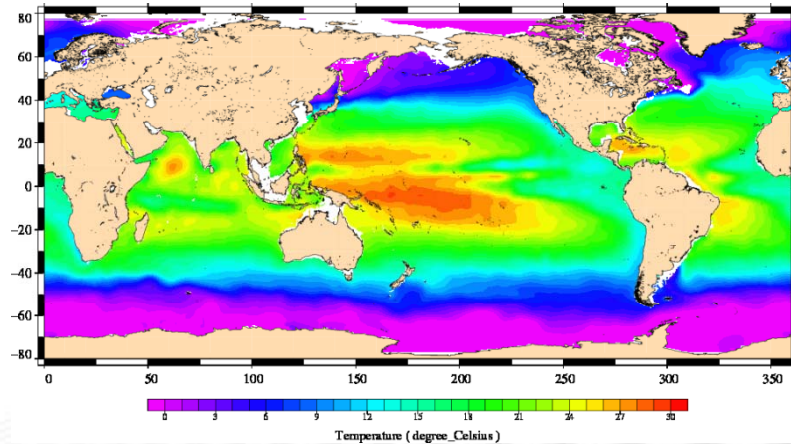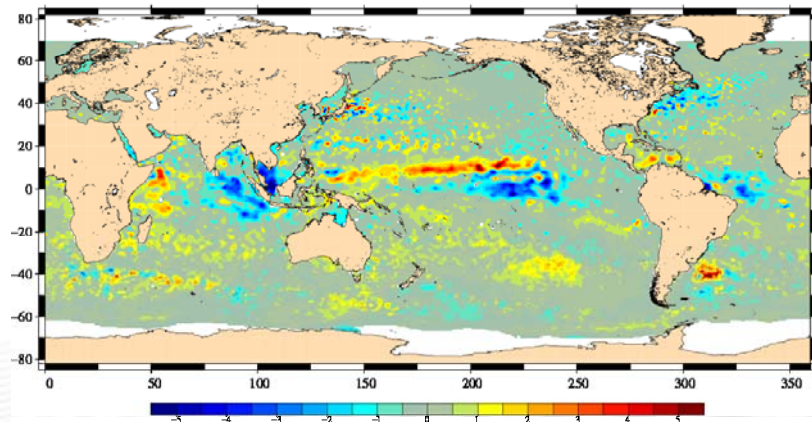
Synthetic T' – at 100m
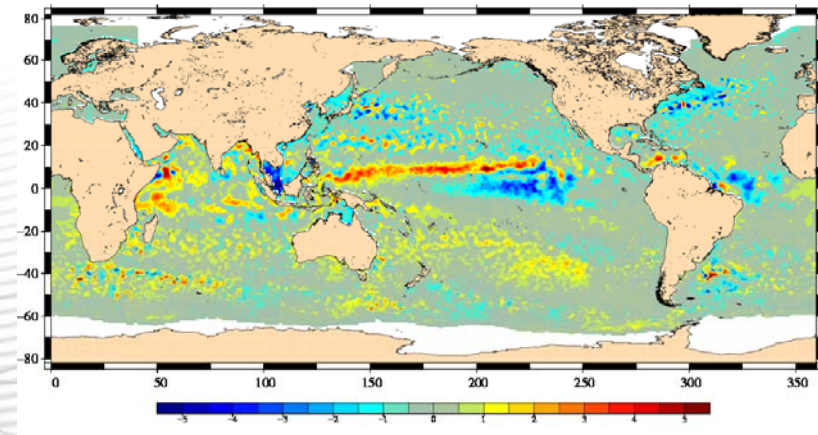
1993-2008 reanalysis

Synthetic T' – at 100m
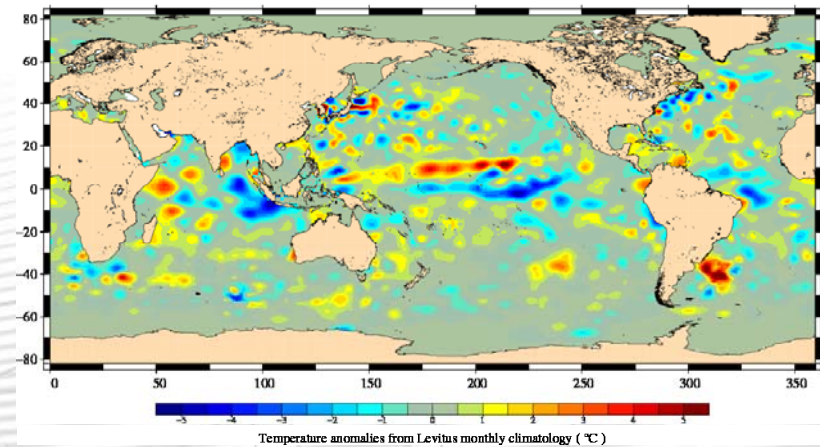
In-situ observations – Coriolis data center – CORA2.1

Combined T'

Argo T

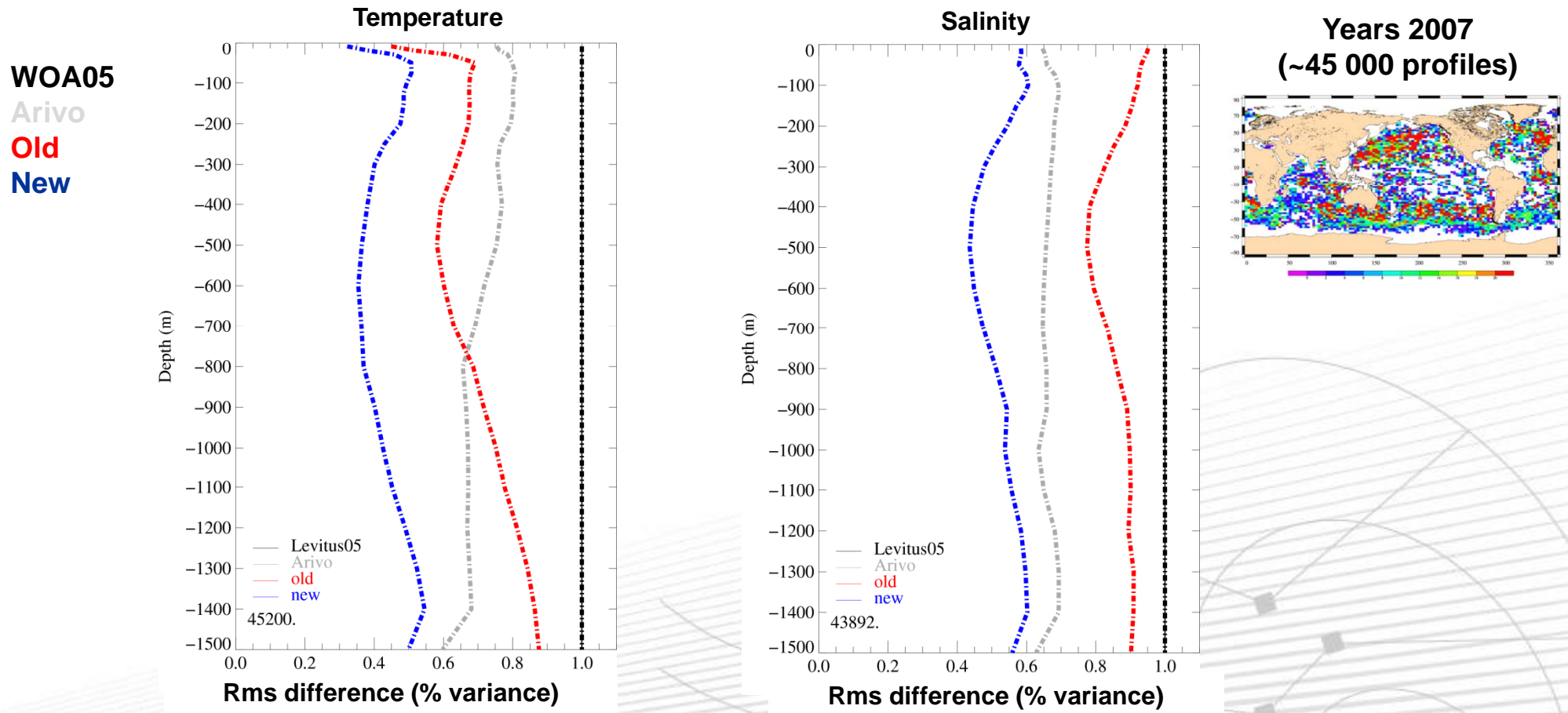Temperature anomalies from Levitus monthly climatology (°C)

Validation with in-situ T/S profiles

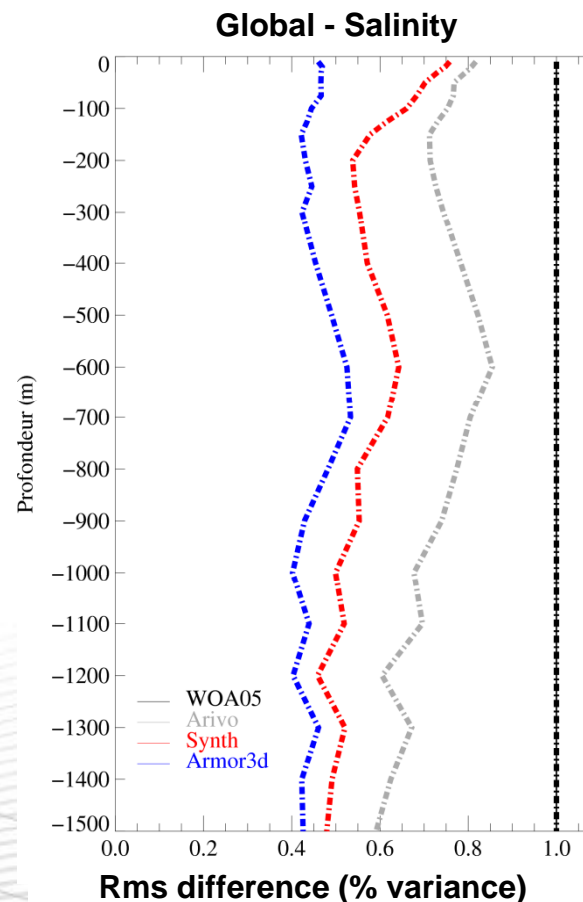❑ Validation of step 1 over the year 2007 – using independent T/S profiles
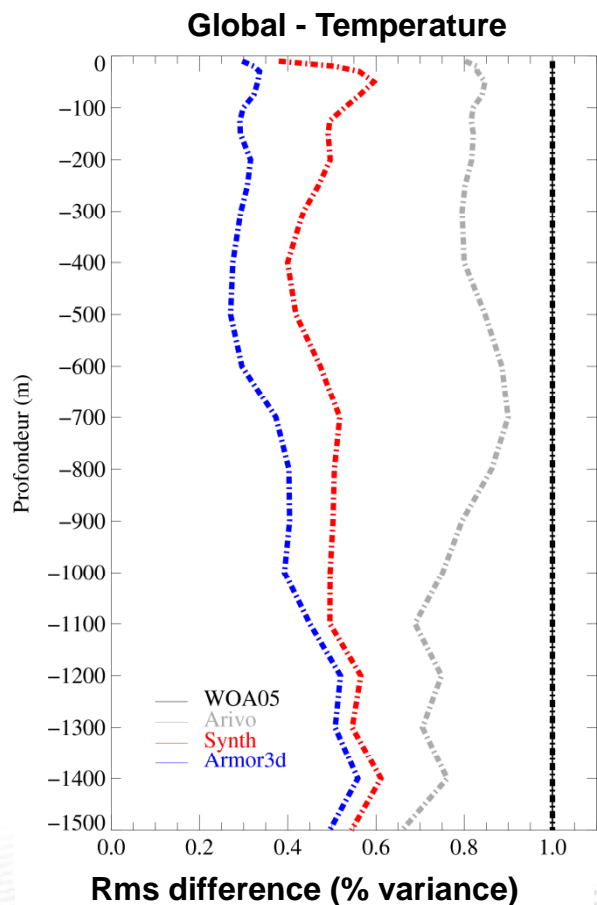

➔ **Large improvements compared to previous estimate, Arivo climatology + new covariances**
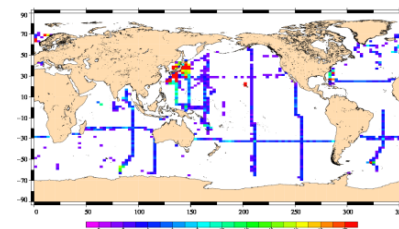
Validation with in-situ T/S profiles

❑ Validation of step 2 over the years 2002-2008 – using independent T/S profiles

WOA05
Arivo
Synth
Combined

Global - Temperature

Global - Salinity

**Years 2002-2008
(~3400 profiles)**

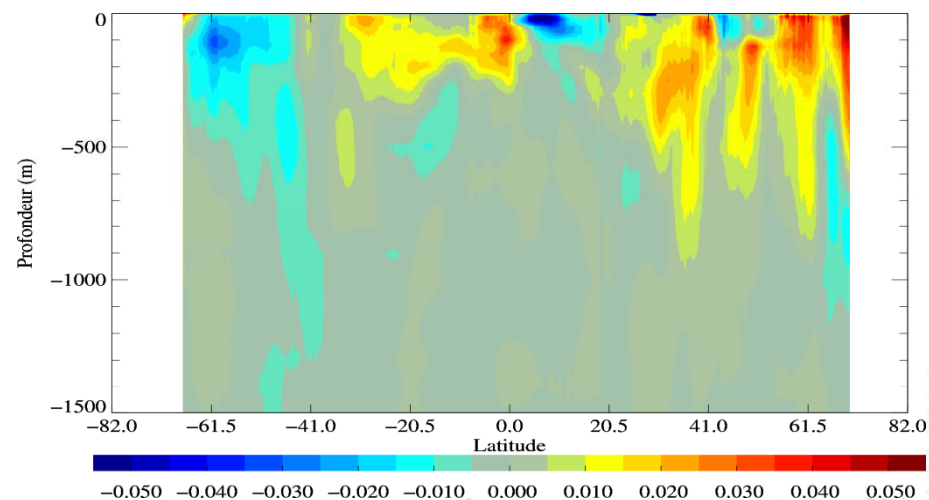➔ **Contribution of the Argo observing system visible at all depth, 10 to 20 % of the signal variance**

Hydrographic variability patterns

❑ Global zonal averaged of the differences between (2003-2008) combined fields and WOA05:
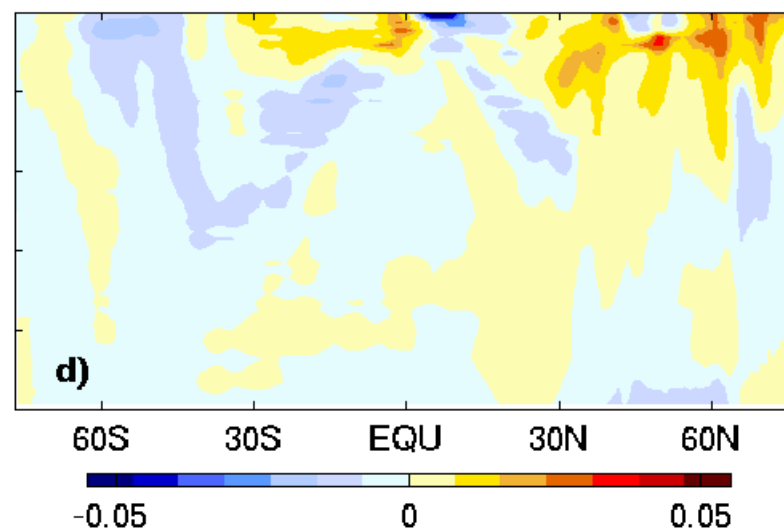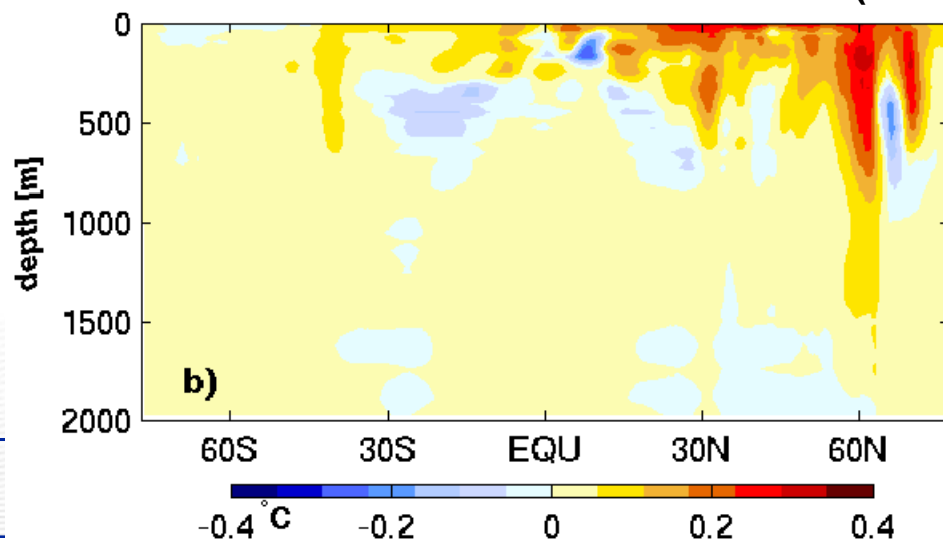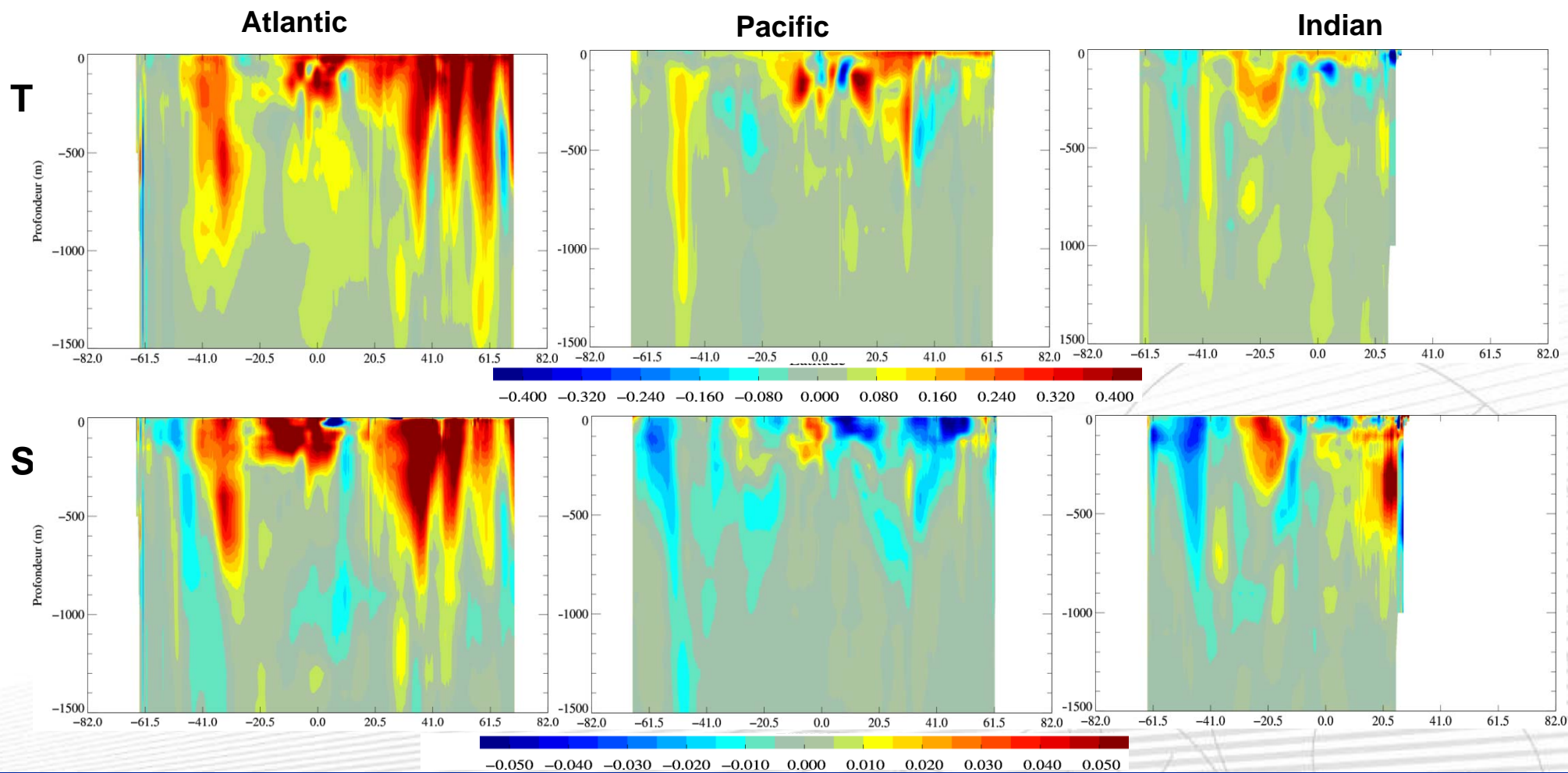
Temperature
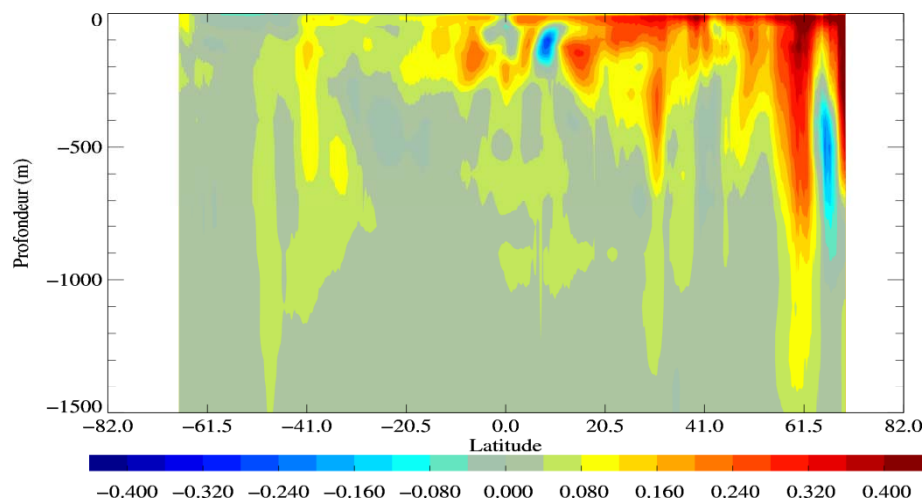
Salinity

**ARIVO (2003-2008) - WOA05**   **(von Schuckmann et al., JGR, 2009)**

Hydrographic variability patterns

❑ Zonal averaged of the differences between (2003-2008) combined fields and WOA05:
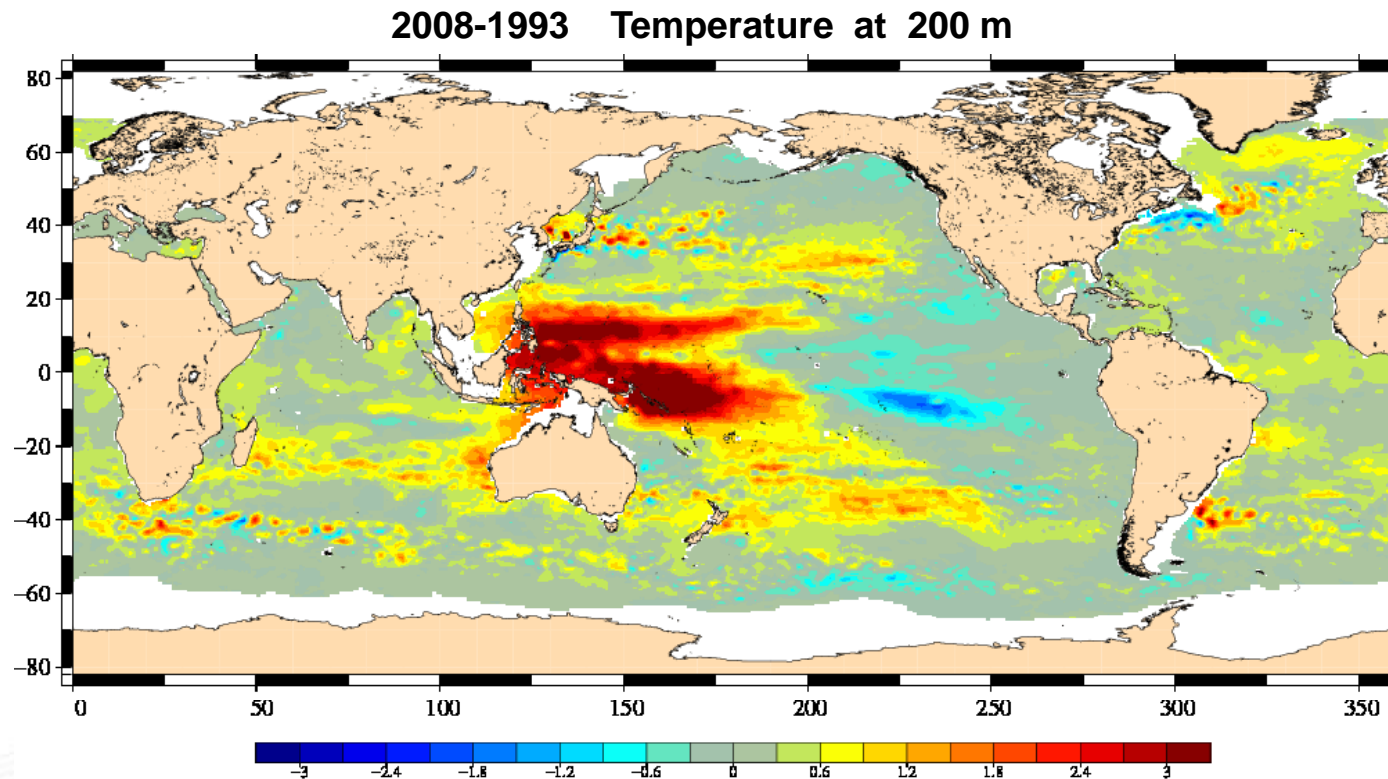
Hydrographic variability patterns

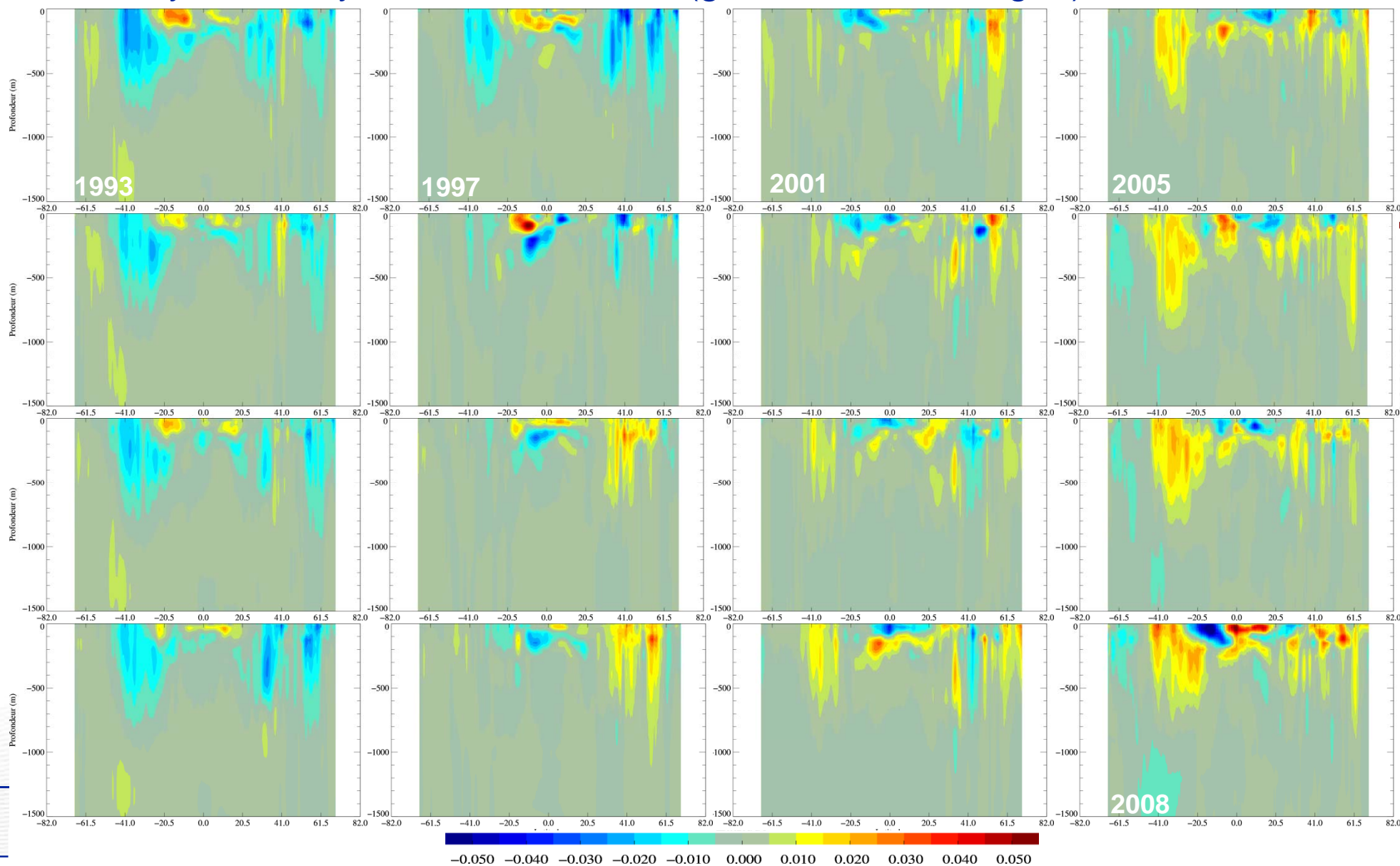❑ Temperature variability from 1993 to 2008 (global zonal averaged) :

Hydrographic variability patterns

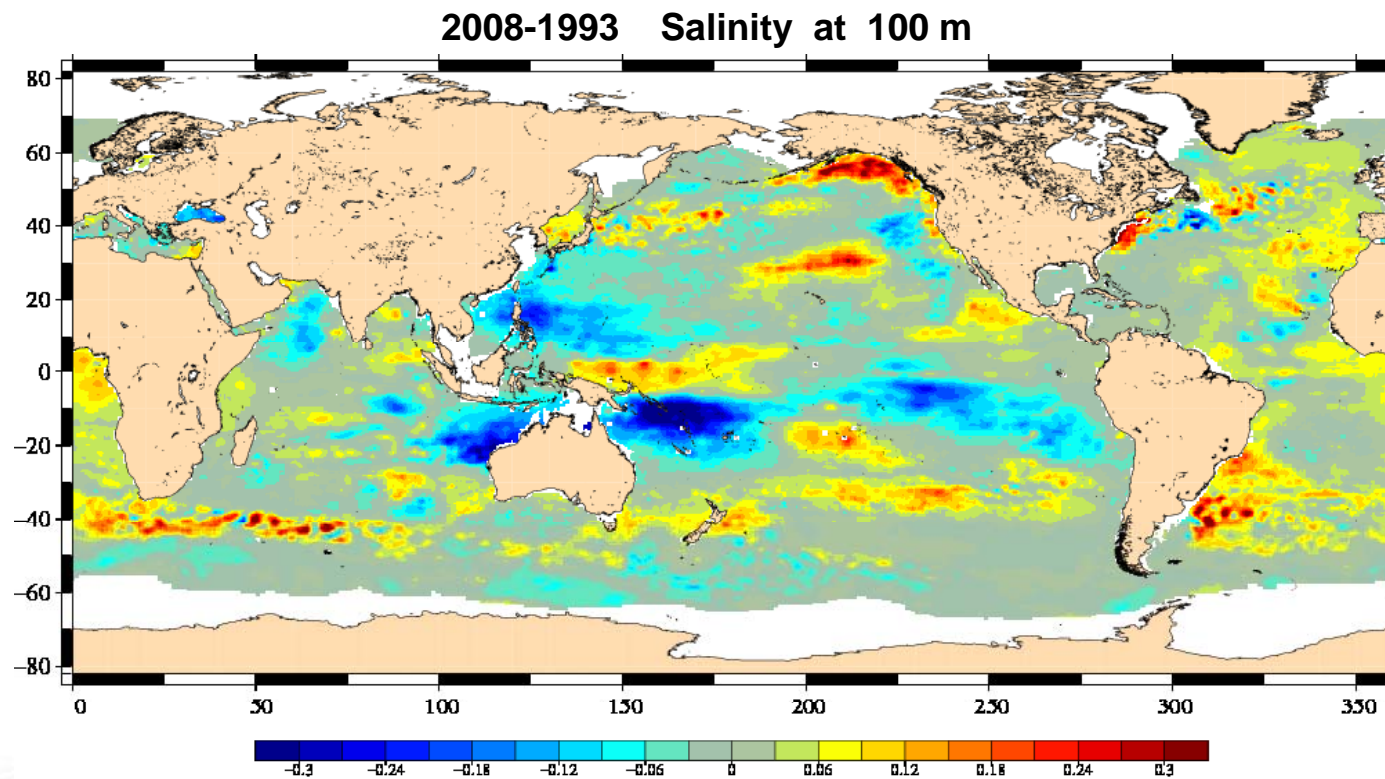❑ Temperature variability from 1993 to 2008 :

2008-1993   Temperature at 200 m
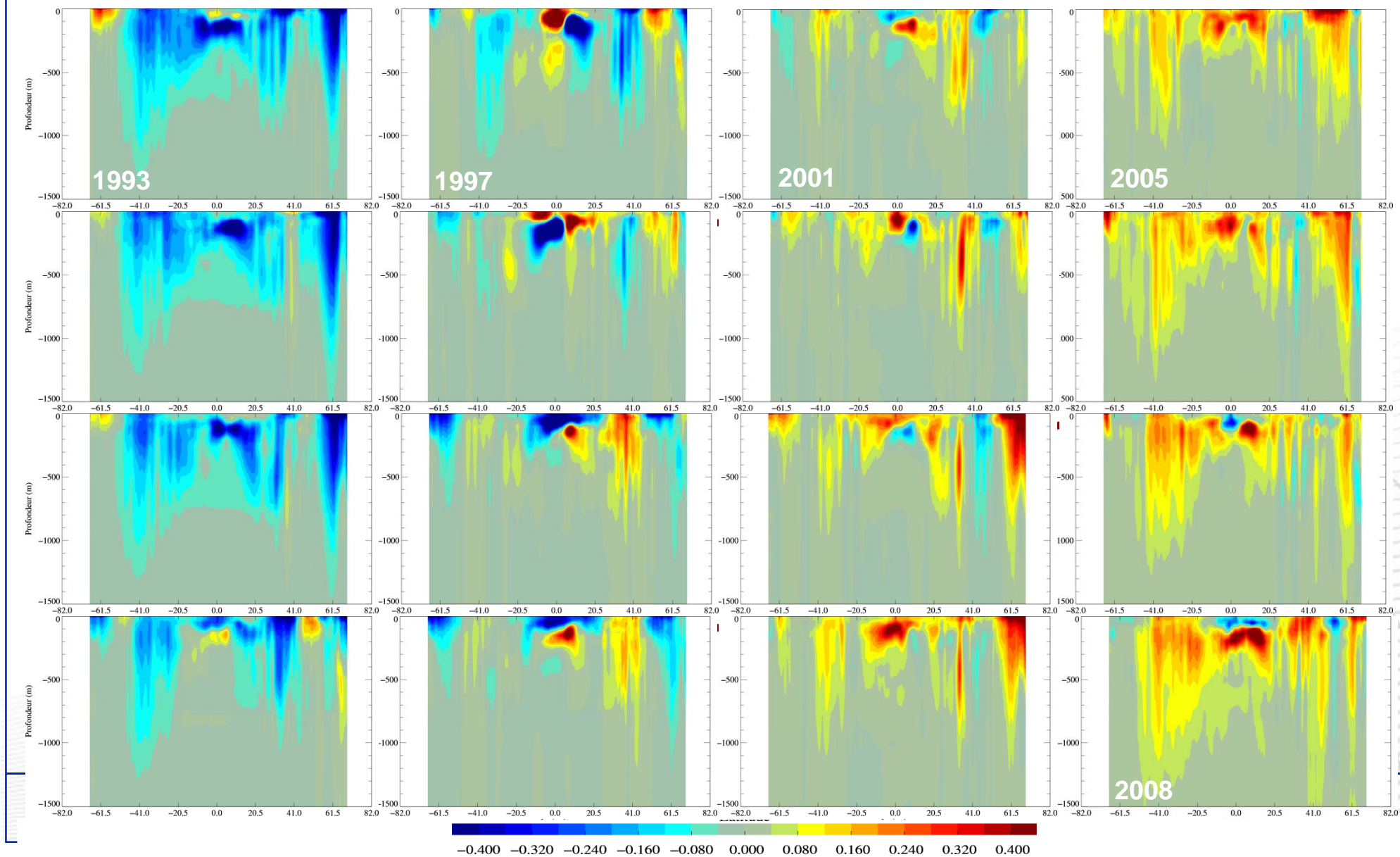
Hydrographic variability patterns

☐ Salinity variability from 1993 to 2008 (global zonal averaged) :

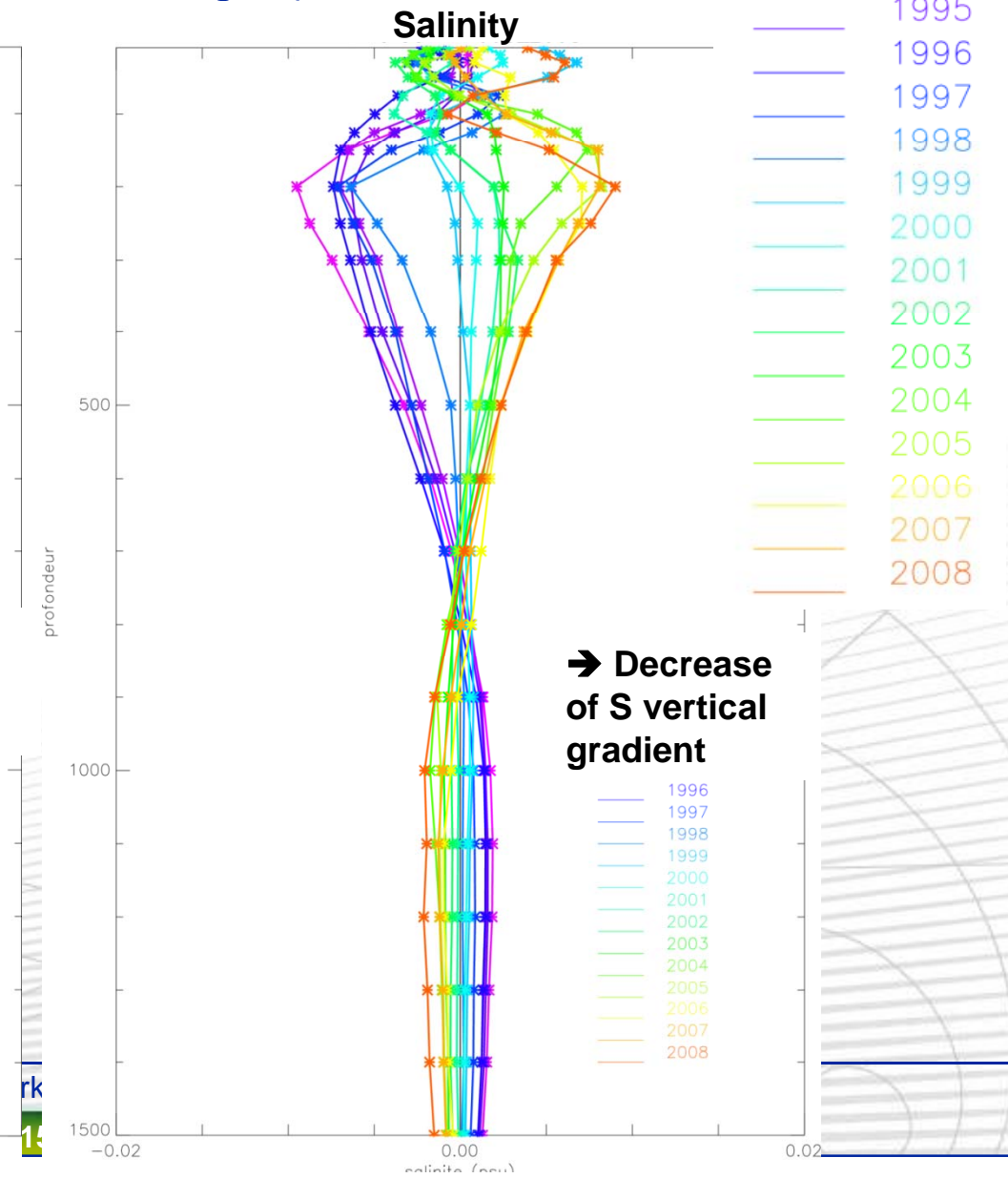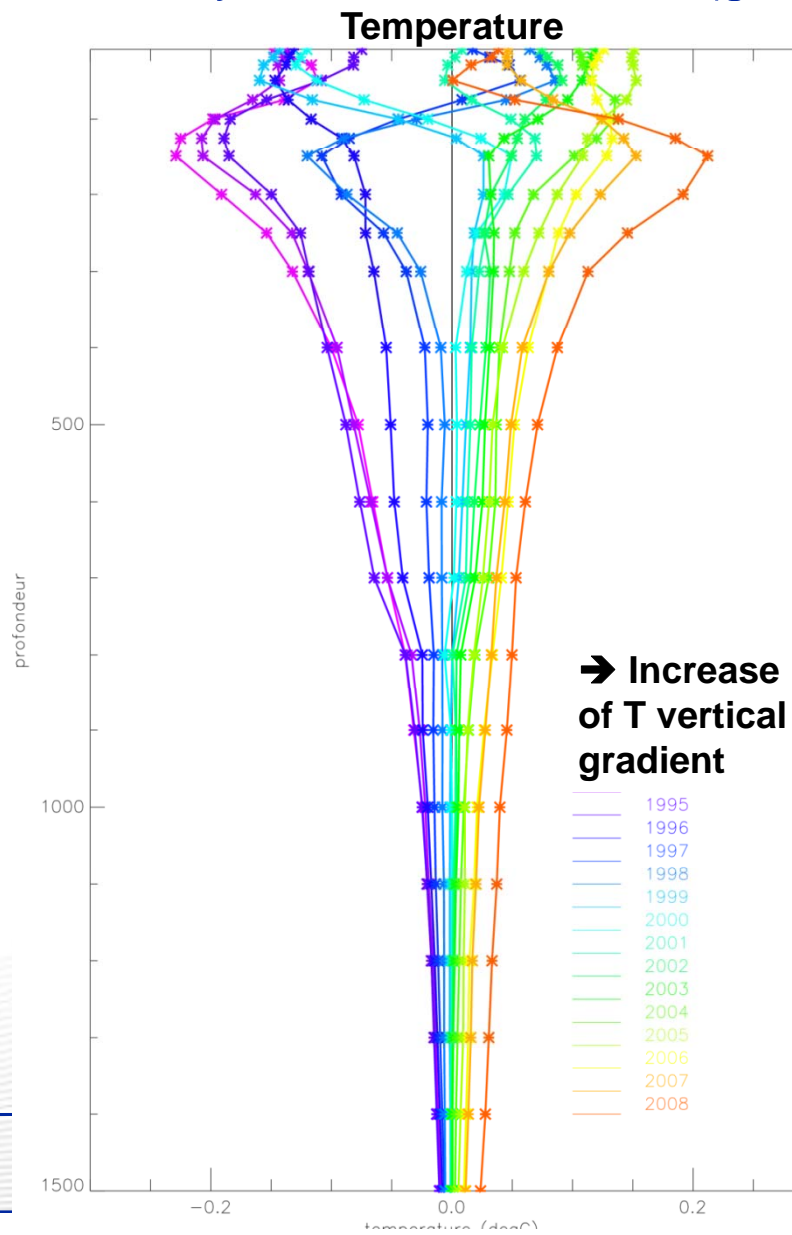# Hydrographic variability patterns

❑ Temperature variability from 1993 to 2008 :

2008-1993   Salinity at 100 m
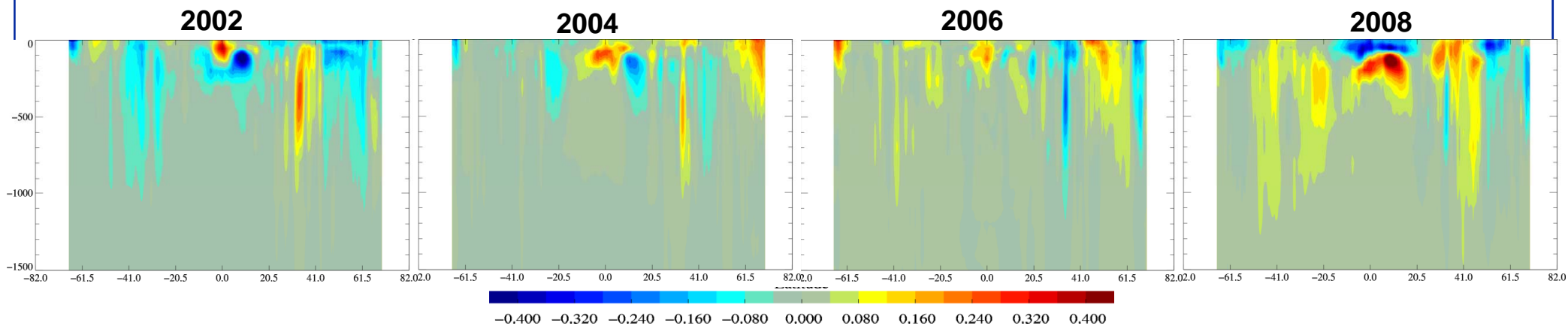
Hydrographic variability patterns

☐ T/S variability from 1993 to 2008 (global averaged) :

Temperature

Salinity

➔ **Increase of T vertical gradient**

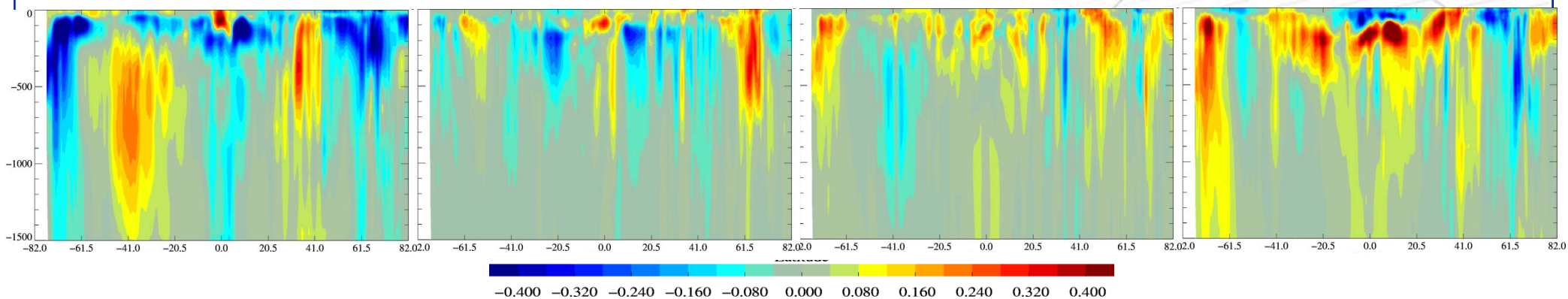➔ **Decrease of S vertical gradient**

Hydrographic variability patterns

❑ Temperature variability from 2002 to 2008 (global zonal averaged) :
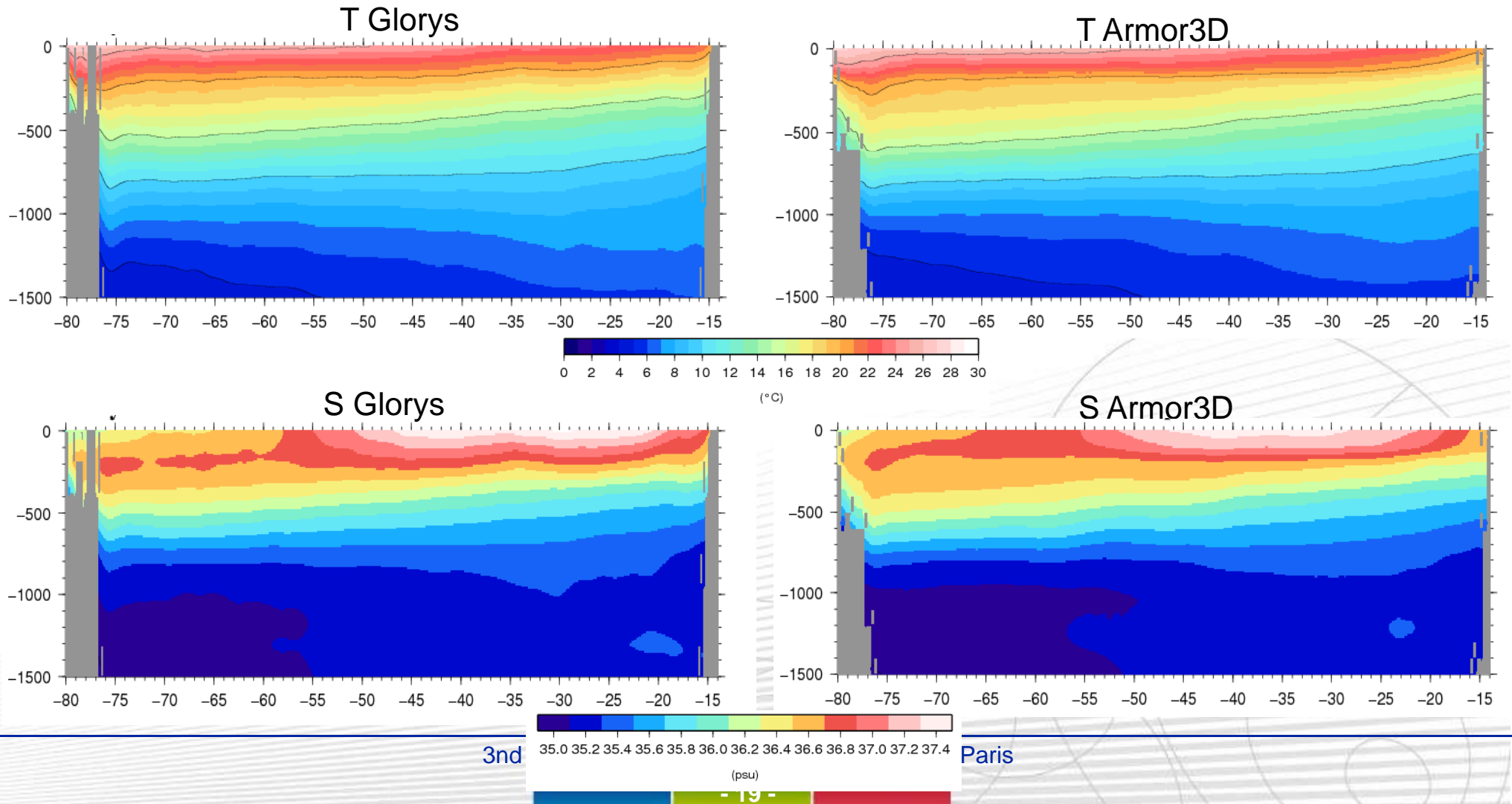
ARMOR-3D

GLORYS

Conclusions / Perspectives

✖ Using simple statistical techniques, T and S fields can be deduced from SLA(+SST)+T/S profiles

✖ Armor3D tool useful to evaluate the impact and complementarities of the different observing systems

✖ Work is in progress to study the hydrographic interannual variability patterns from the Armor3D fields – comparison with the Glorys/MyOcean reanalysis outputs just started

✖ Intercomparison studies carried on with other MyOcean reanalysis and other products

■ ■ ■

✖ …

Comparison with model outputs

❑ Qualitative comparison with the Mercator Glorys reanalysis: Atlantic 26°N T/S section in 2003

ARIVO (2003-2008) -WOA05

von Schuckmann et al., JGR, 2009