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Geesthacht
Centre for Materials and Coastal Research

Observing System Evaluation (OSE) for the Black Sea: Focus on ARGO floats and altimetry during 2005-2012

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General Concept of Data Assimilation
Fitting a Linear Reconstruction Operator

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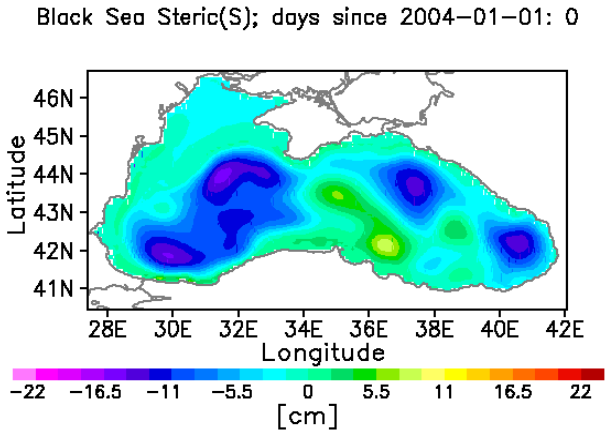
Simulated
Global State (*x,'GL'*)



$$X = \begin{pmatrix} x_1(t_1) & \cdots & x_1(t_q) \\ \vdots & & \vdots \\ x_m(t_1) & \cdots & x_m(t_q) \end{pmatrix}$$

Linear Reconstruction
of Simulated State

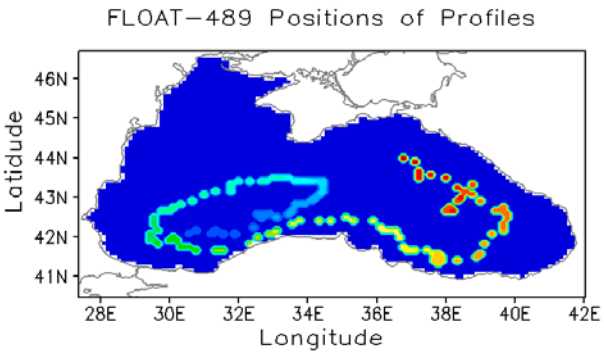
$$x = A\,y$$

Linear Reconstruction Operator

$$A = XY^T(YY^T)^{-1}$$

Least Squares Method

Synthetic/Simulated
Local Observations (*y,'O'*)



$$Y = \begin{pmatrix} y_1(t_1) & \cdots & y_1(t_q) \\ \vdots & & \vdots \\ y_n(t_1) & \cdots & y_n(t_q) \end{pmatrix}$$

A Priori Knowledge from Numerical Model (Free Run)

Estimate of Error Propagation in Linear Reconstruction (OSE/OSSE)

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Adjusted Linear Reconstruction Operator

$$K = P\,H^T(H\,P\,H^T + R)^{-1}$$

***K*: Kalman Gain Matrix** (Linear-Reconstruction-Operator)

P*: Covariance Matrix of *X; $P=1/q\ XX^{-1}$ (Contains the large scale covariance patterns of *X*)

***H*: Measurement Operator**; $y=H\,x$ (Mirrors the position of the observations)

Estimate of Observation Error Propagation in Linear Reconstruction

$$\Gamma_{t_i} = \sqrt{\mathrm{DIAG}\left[P - K(t_i)\ H(t_i)\ P\right]}$$

Feasibility of reconstructing the variance of global state realisations (***X***) based on erroneous observations at position (***H(t$_i$)***)

Model Description / Validation
General Setup

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Nucleus of European Modeling of the Ocean (NEMO)

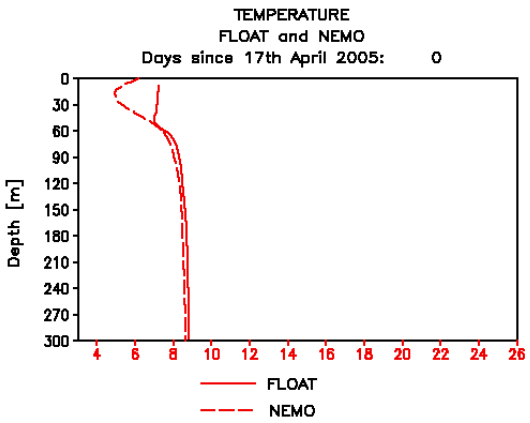
Grid-Type: Arakawa C-grid
Resolution: horiz. ~10km
vertic. 31 z-Levels

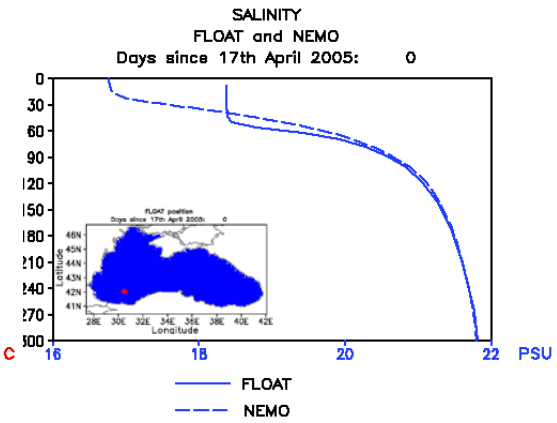
Forcing: European Center of Medium-Range Weather Forecast (ECMWF) atmospheric data; semi-climatic river runoff; estimated inflow of salty water at 75m depth from the Bosporus straits; the Kerch straits is closed

In Assimilation Mode:

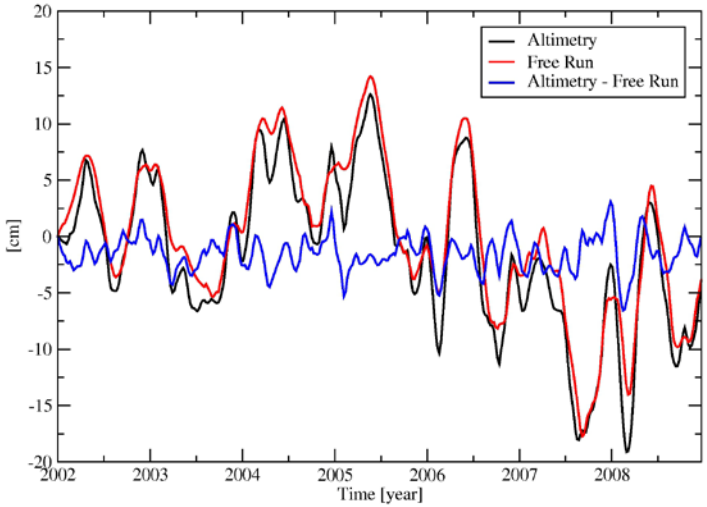
Altimetry; Aviso Altimetry; Resolution: 1/3 °, weekly

SST Analysis: Reynolds 'Daily High-Resolution Blended Analysis for Sea Surface Temperature';
Resolution: 1/4 °, daily

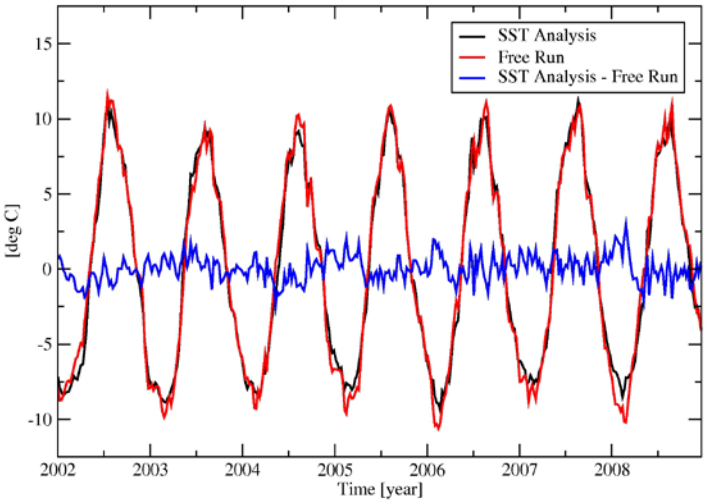




Basin Mean SLA - Simulated Steric Signal



Basin Mean SSTA



Model Description / Validation
Representation of Altimeter Observation | DEOF 1

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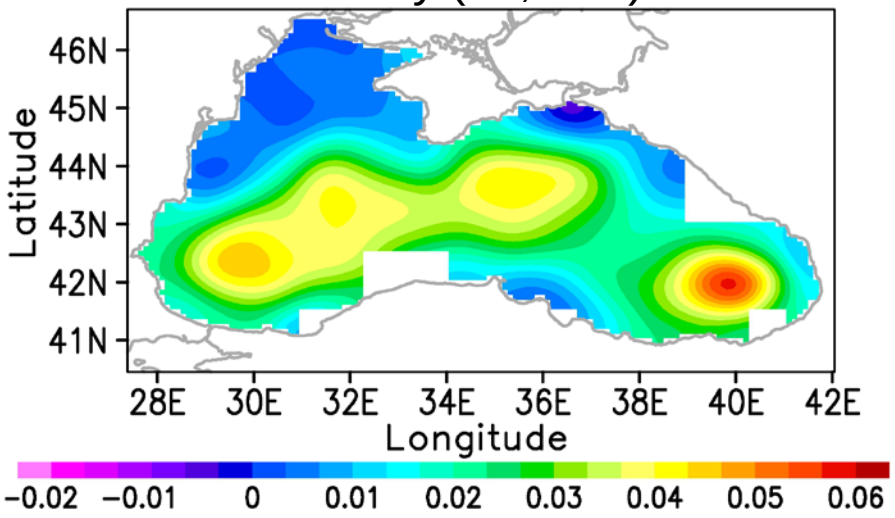
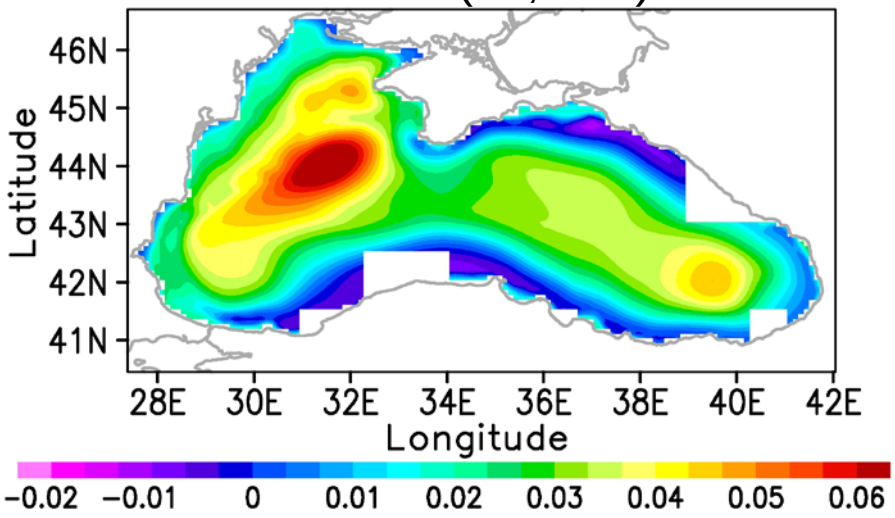
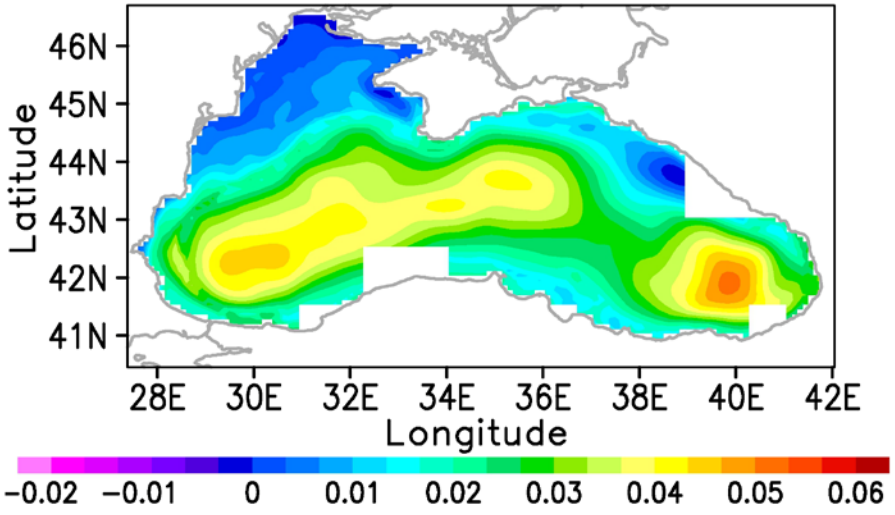
Altimetry (46,57%)



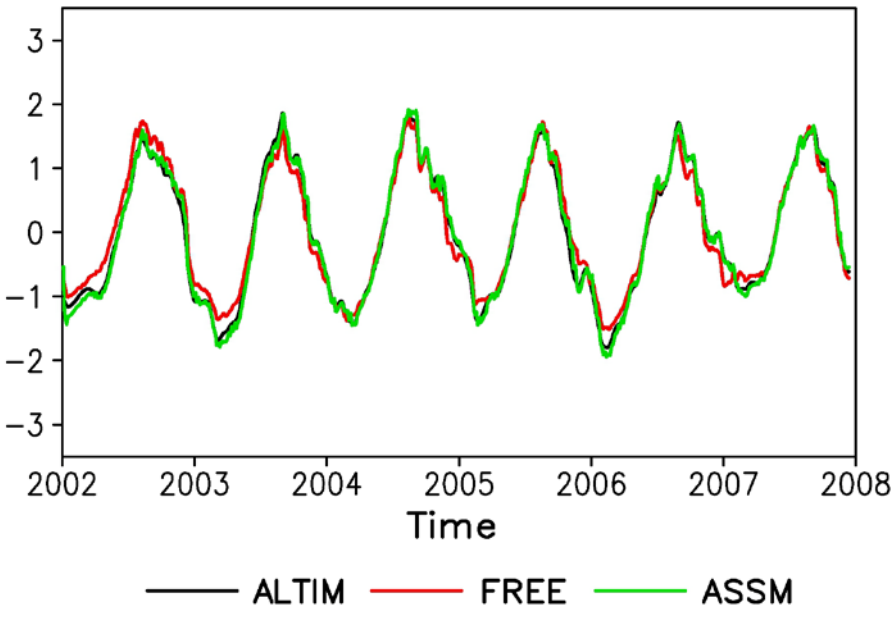
Free Run (34,46%)



Assimilation Run (43,16%)



PCs



Preliminary Error Propagation Estimates (OSSE)
Temperature and Salinity | Idealized Floats

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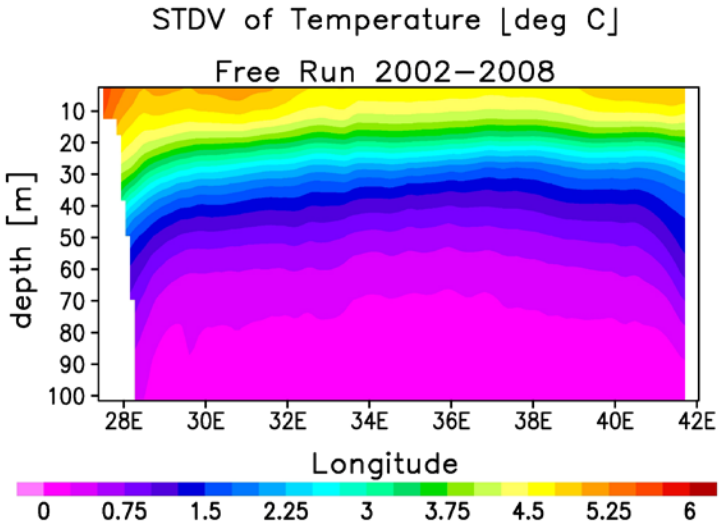

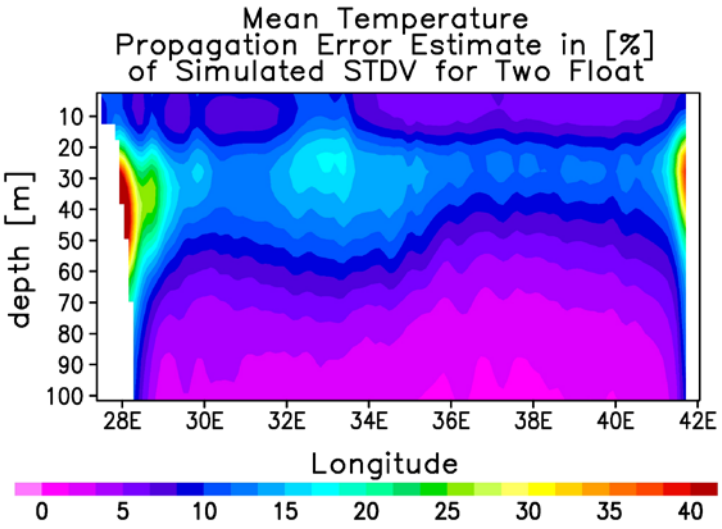

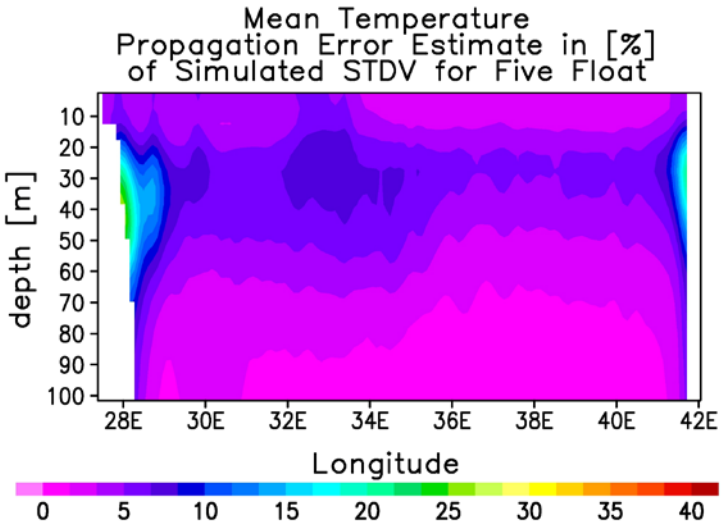

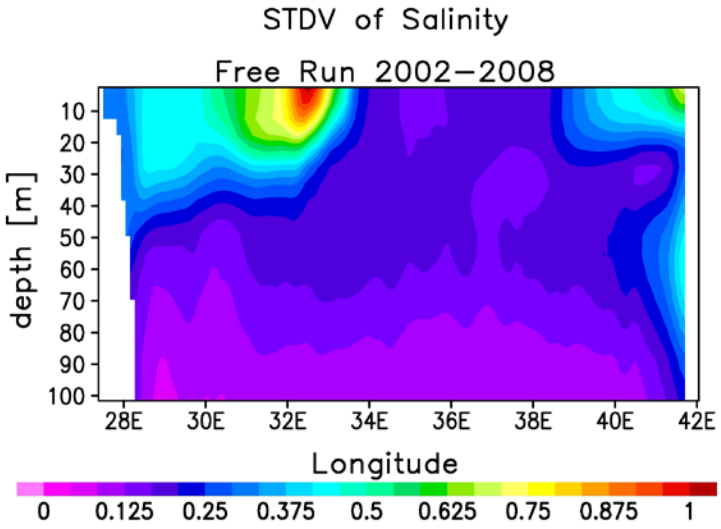

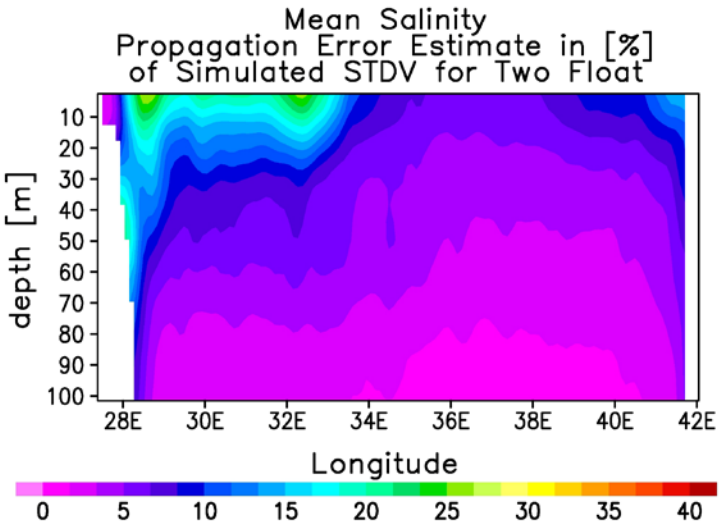

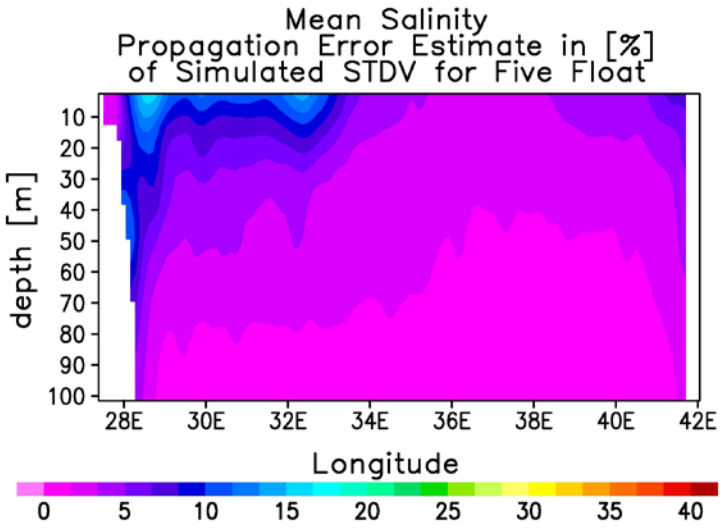

Error Propagation Estimates
Setup

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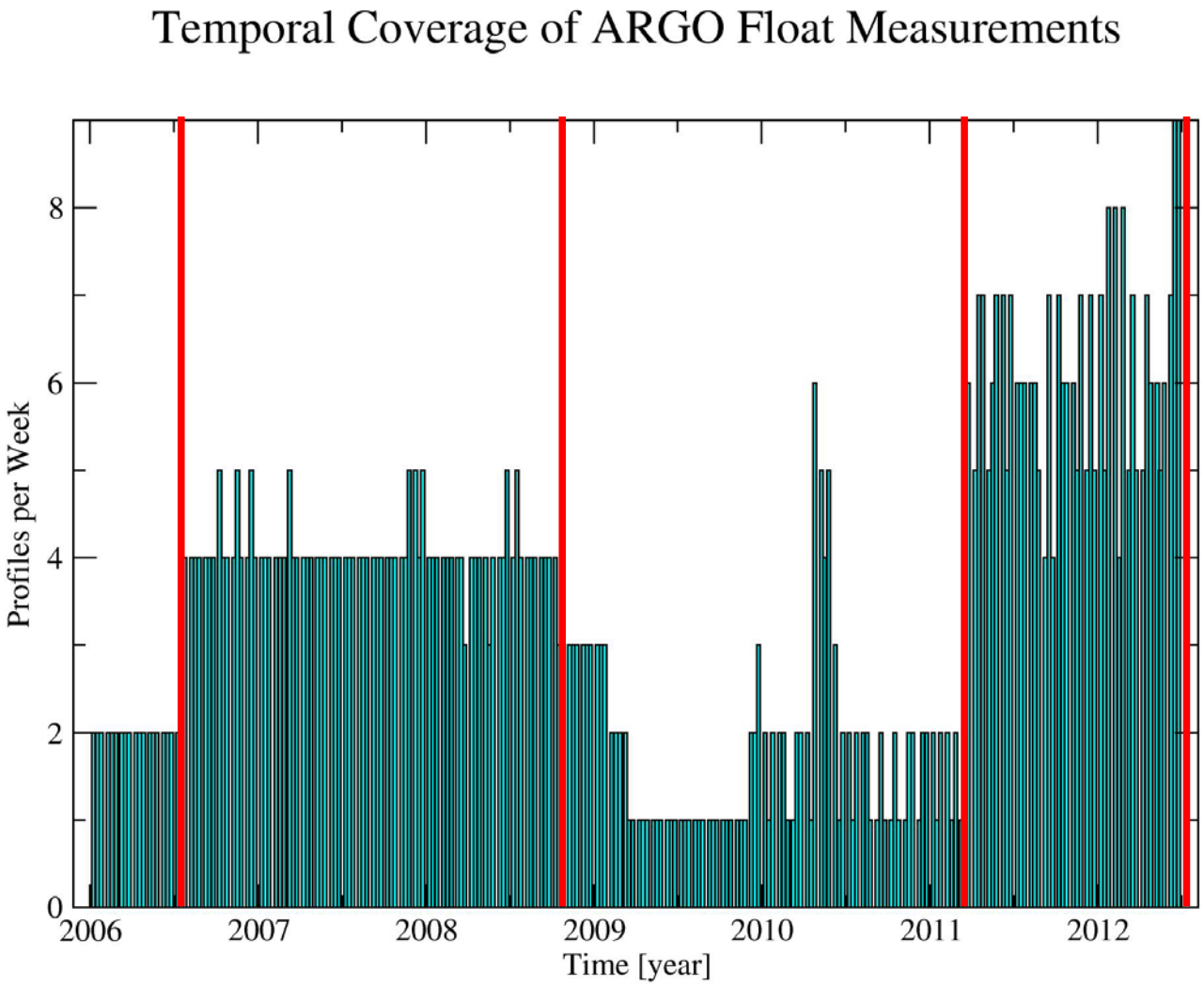

- climatic monthly covariance information in ***P*** are derived from numerical simulations
- error estimate is performed for each individual week during the two periods in 2007-2008 and 2011-2012.
- availability and positions of altimeter and ARGO float measurements mimics reality
- observation error for altimeter measurements is 4.5cm
- error assumptions for ARGO floats are spatial dependent and based on simulation results because the accuracy of individual measurements is assumed to be dominated by systematic errors (e.g. accuracy of estimates for MDT and depth of measurements)

Error Propagation Estimates 01.06.2011-31.05.2012
Temperature | Seasonal Mean

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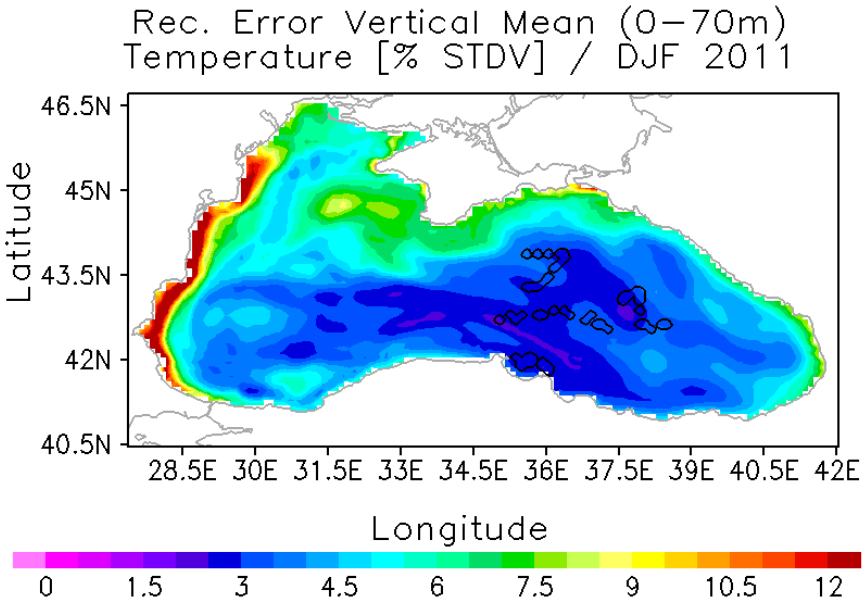

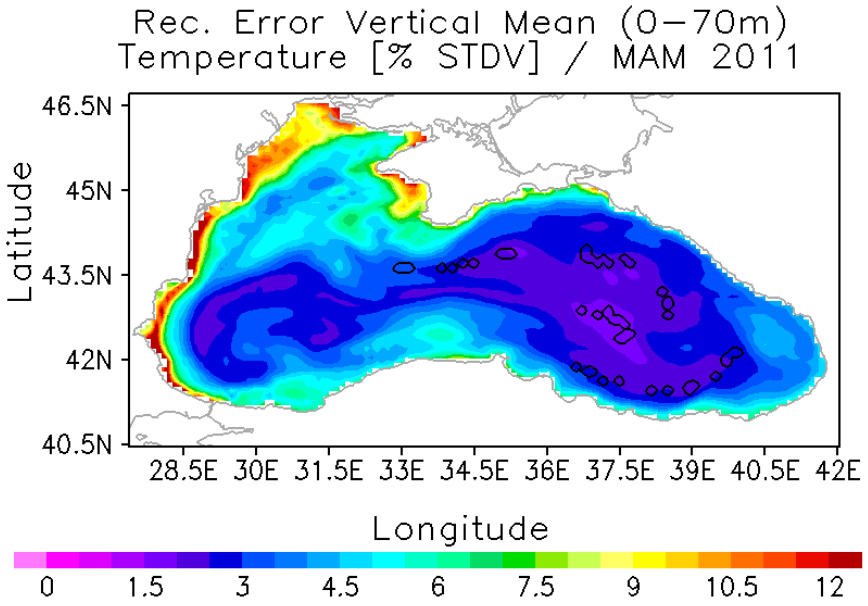

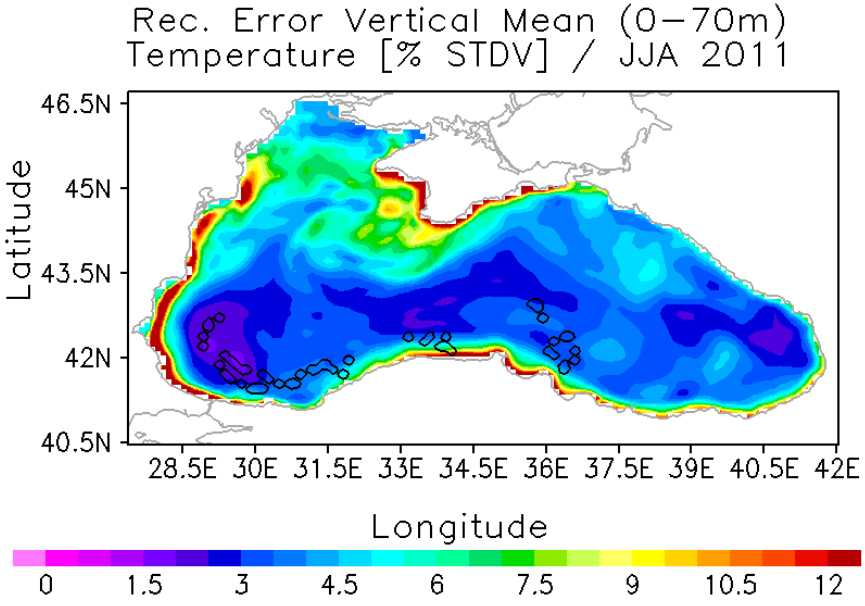

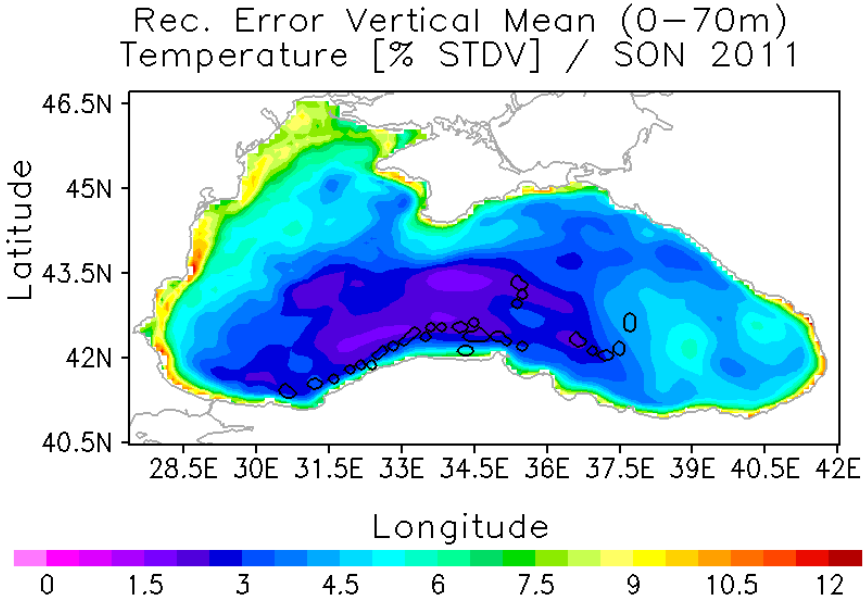

Comparison of Error Propagation Estimates
Temperature | Annual Mean

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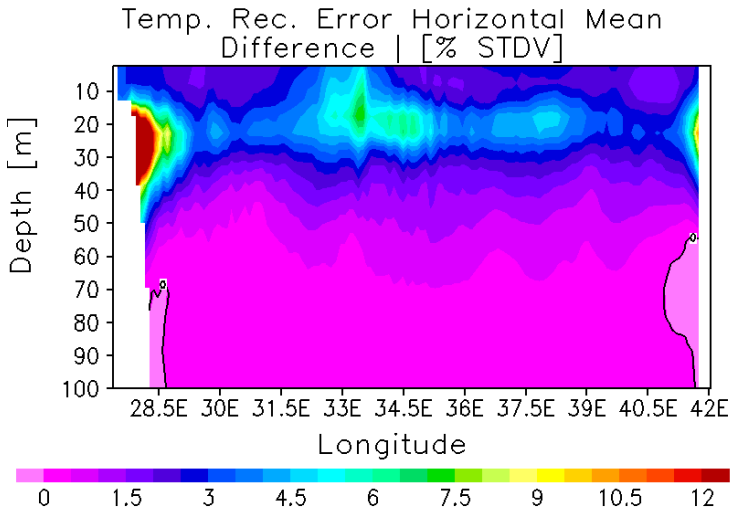

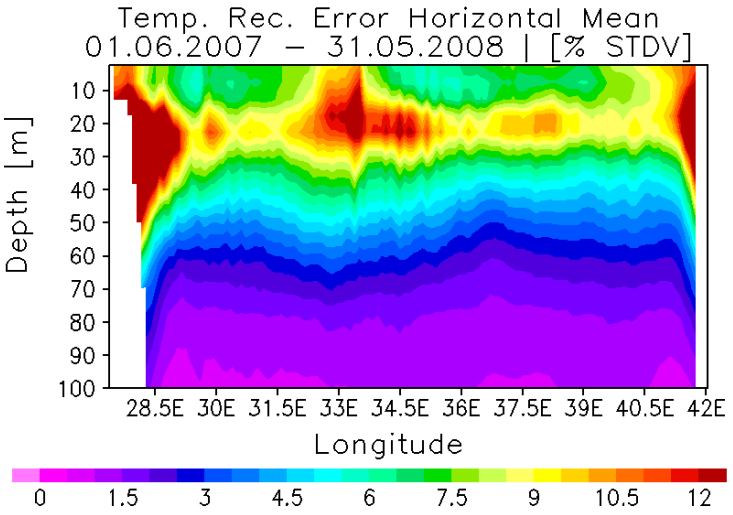

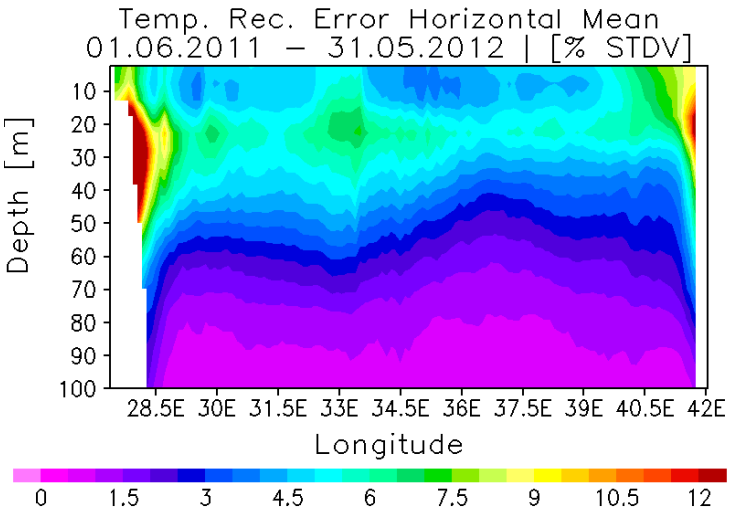

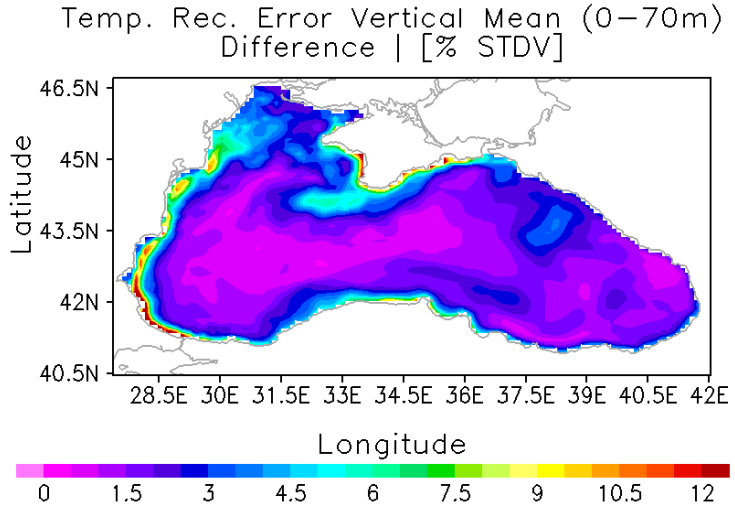

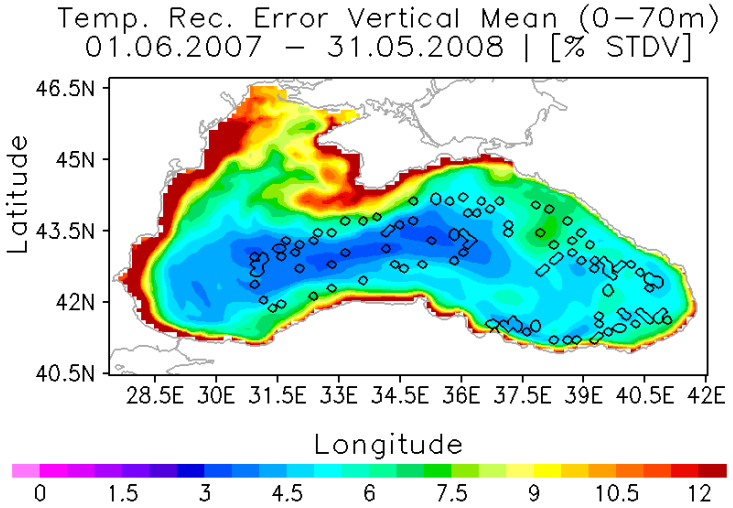

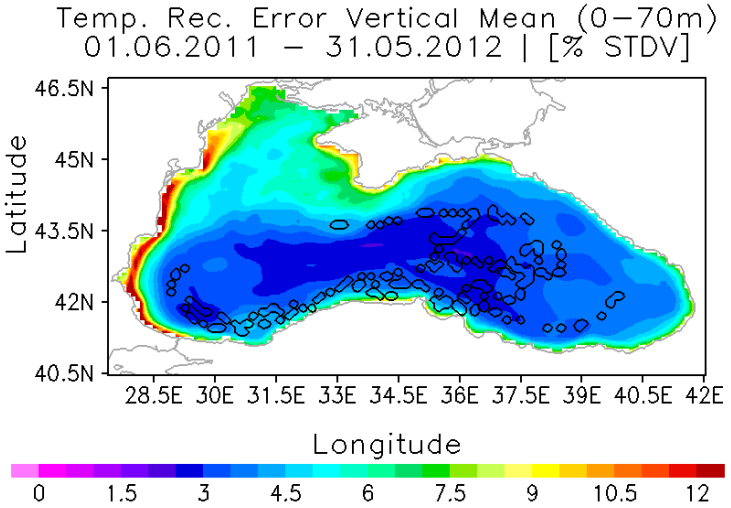

Comparison of Error Propagation Estimates
Salinity | Annual Mean

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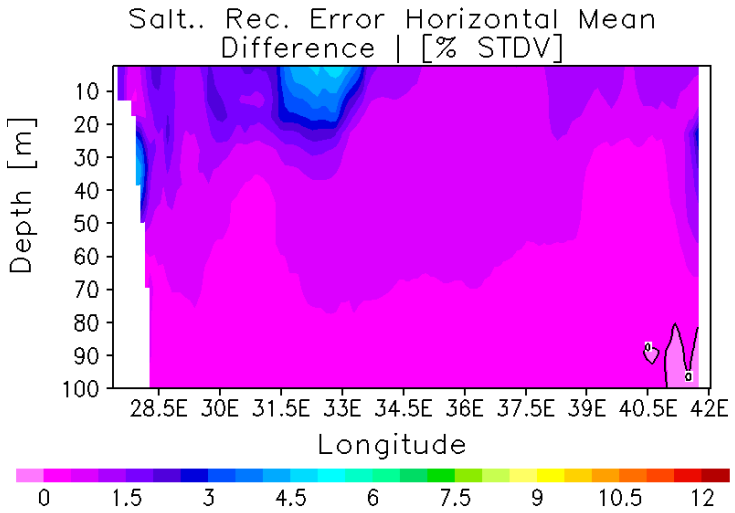

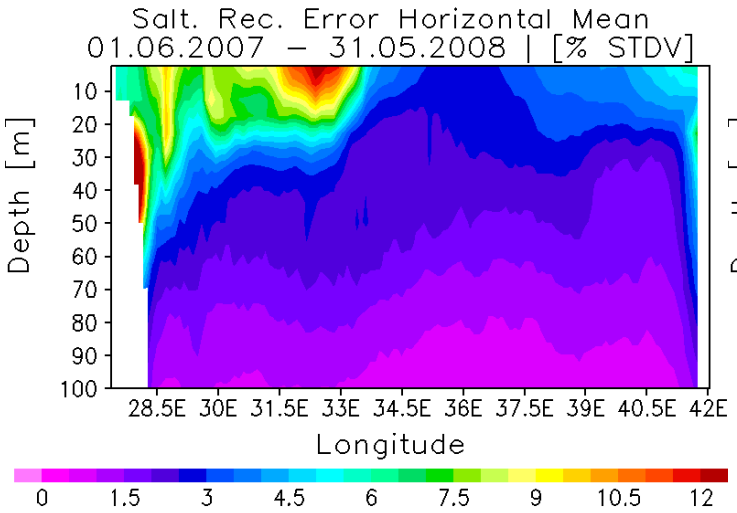

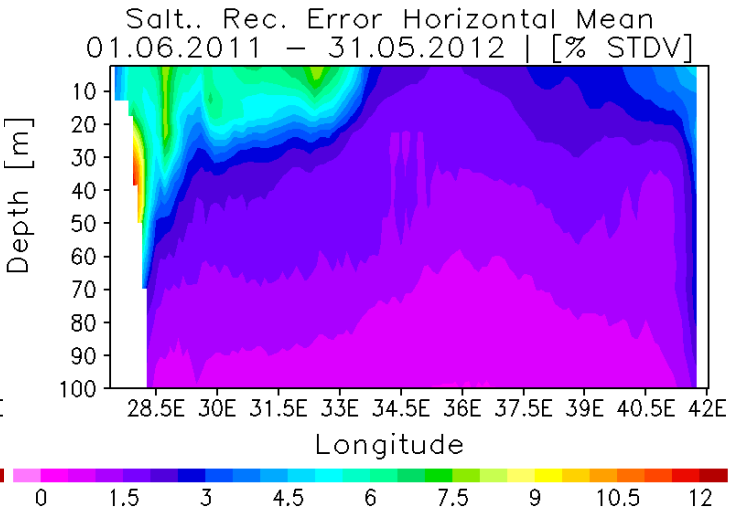

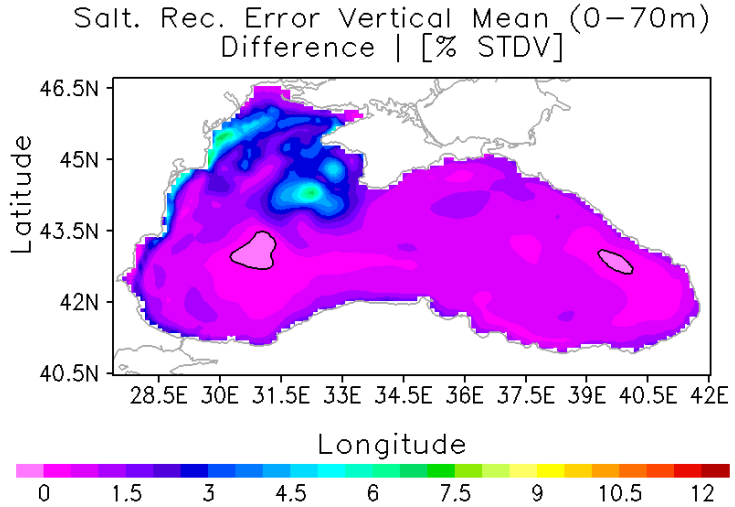

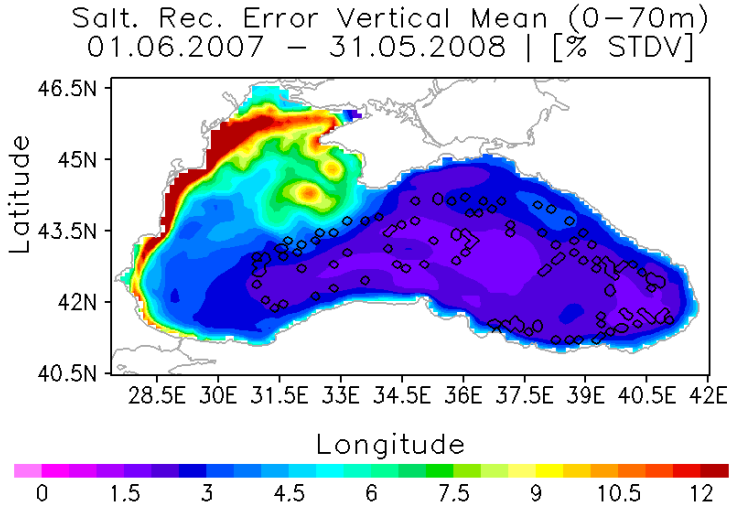

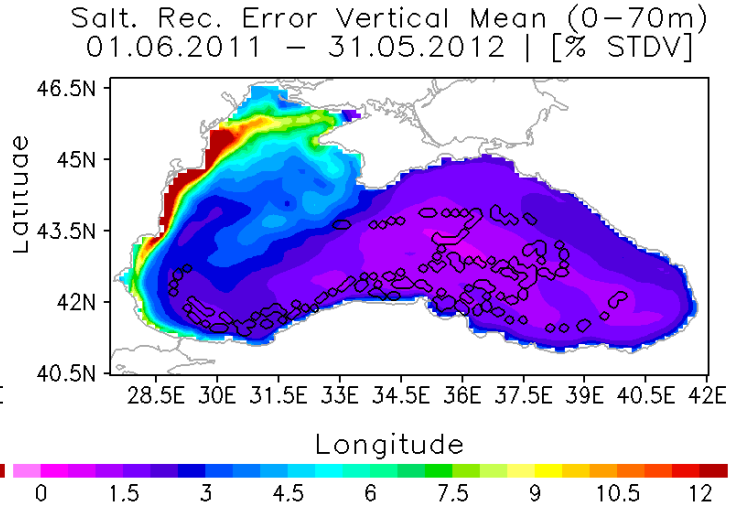

Conclusions

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- performance of salinity field reconstruction for the deeper part of the basin shows a reasonable error range during both investigated periods

- there is a significant increase of reconstruction performance for temperature fields in the period with higher density of ARGO float measurements

- the performance of salinity field reconstruction does not show a significant reaction to the amount but to the position of ARGO float measurements

- with the actually given amount of ARGO float measurements an assimilation seems to be reasonable

Headline

Sub-Headline

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