

A HIGH RESOLUTION REANALYSIS FOR THE MEDITERRANEAN SEA



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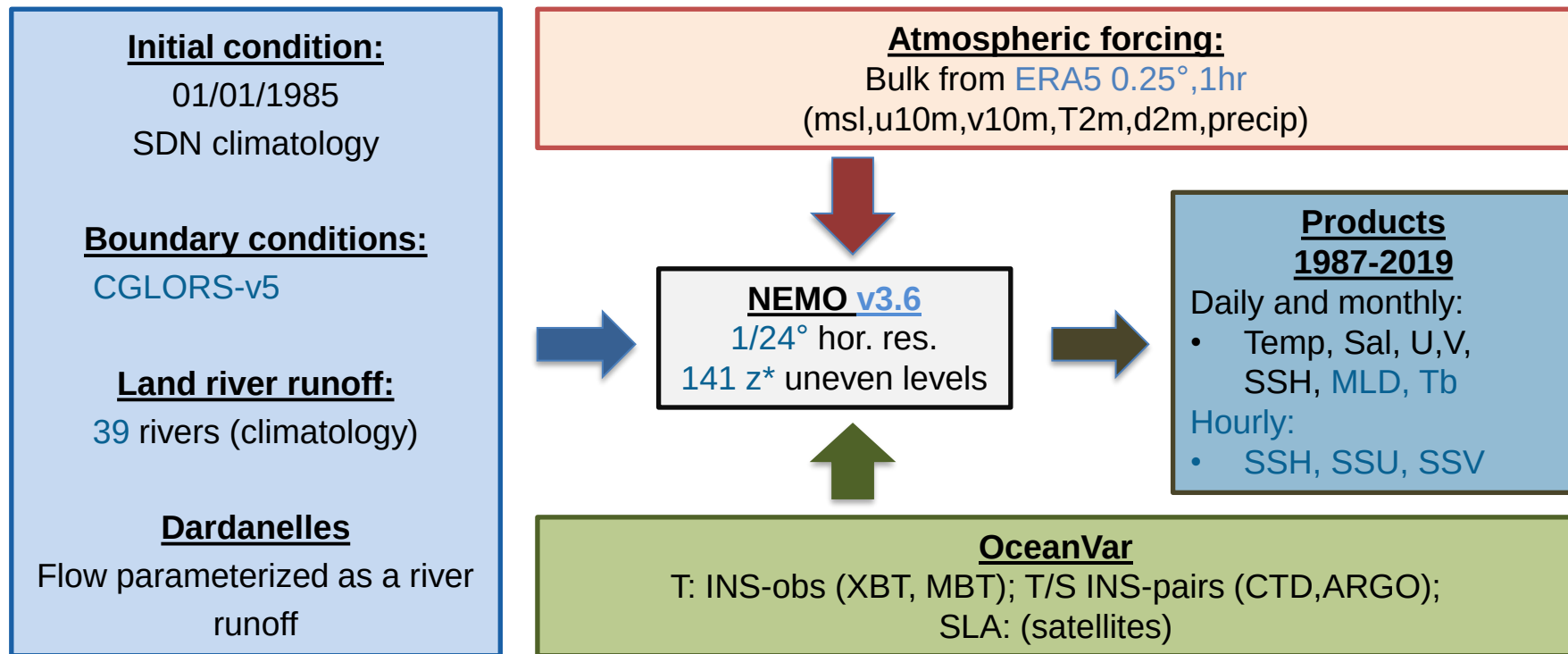
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Reanalysis system



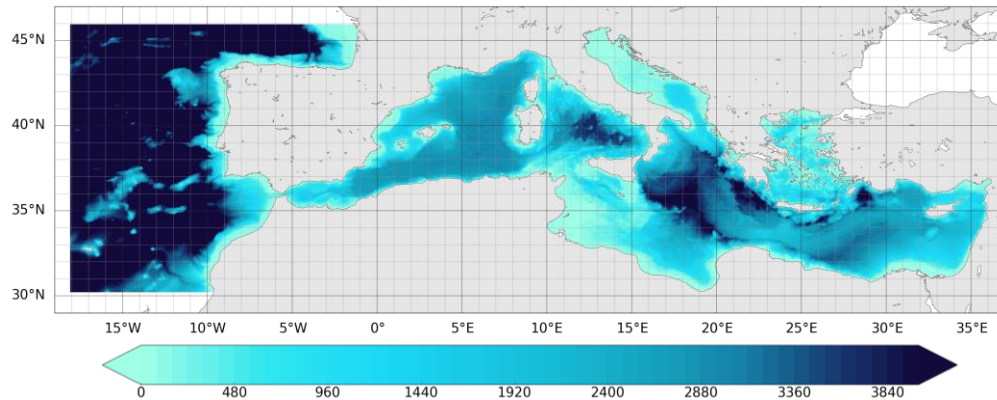
Comparison with the previous reanalysis

	MEDREA16	MEDREA24
Resolution	1/16 deg (~5.5km) horizontal; 72 vertical levels	1/24 deg (~4.5km) horizontal; 141 vertical levels
OGCM	NEMO v3.2 and v3.4 linear free-surface; Z coordinates	NEMO v3.6 non-linear free-surface; Z* coordinates
Initial Conditions	SDN Climatology T and S	
Bathymetry	Modified DBDB1 1min	Modified GEBCO 30 arc-sec
Atmospheric forcing	ERA interim (0.75 deg, 6hrs)	ERA5 (0.25 deg, 1hr)
Lateral Boundaries in the Atlantic box	Monthly climatological fields from GLO-MFC ¼ deg	Daily mean fields from CGLORS REA ¼ deg
River inputs	7 with Q>100m3/s (climatological)	39 with Q>50m3/s (climatological)
Data assimilation	Vertical profiles of Temperature and Salinity, Along track satellite sea level anomalies (OceanVar; Dobricic and Pinardi, 2008)	Vertical profiles of Temperature and Salinity, Along track satellite sea level anomalies (OceanVar; Storto et al, 2015)
SST nudging	-40W/m2/K constant during the day	Gaussian around 00:00 (max=-110W/m2/K)
Reanalysis period	1987-2018	1987-2019
Released variables	Daily and monthly 3D: T, S, UV and 2D: SSH	Daily and monthly 3D: T, S, UV and 2D: SSH, MLD, Tb Hourly 2D: SSH, SSUV

NEMO configuration

1307 x 380 x 141 → ~4.5 km resolution

- Res: 1/24 and 141 levels
- Vertical coord: z^* with partial steps
- Bathymetry: GEBCO HR + smoothing
- Nonlinear free surface
- Advection scheme for active tracers: mixed up-stream/MUSCL
- Biharmonic visc. & diff., Pacanowsky and Philander (1981) for vertical mixing
- Interactive air-sea fluxes with ERA5: MFS bulk formulae described in Pettenuzzo et al. (2010)
- Nested in daily global CMCC CGLORS-v5 reanalysis
- Night time correction of heat fluxes toward the satellite SST
- 39 river inputs + Dardanelles Strait (parameterized as a river)
- NEMO 3.6, MPI on 240 cores



OceanVar description

$\mathbf{B} = \mathbf{V}\mathbf{V}^T$ (Dobricic and Pinardi, 2008, Storto et al., 2011)

$\mathbf{V}$ is modeled as a sequence of linear operators:

$\mathbf{V} = \mathbf{V}_h \mathbf{V}_H \mathbf{V}_V^{ts}$

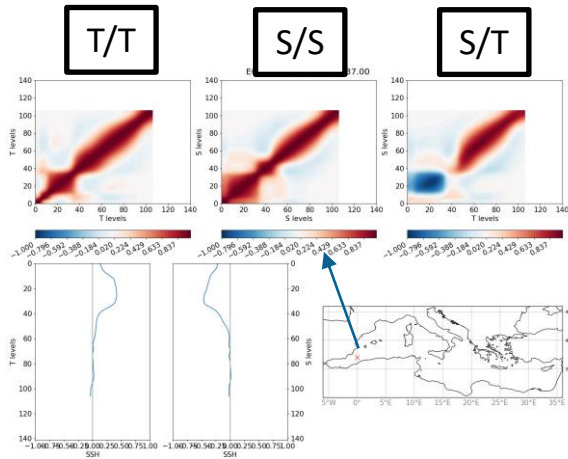
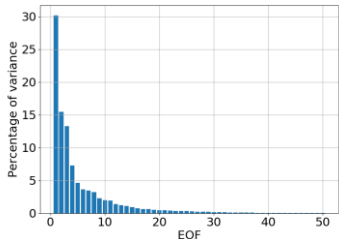
$\mathbf{V}_V^{ts}$ Vertical EOFs: monthly bi-variate T/S at each grid point.

$\mathbf{V}_H$ Dynamic height operator (1000 m level of no motion)

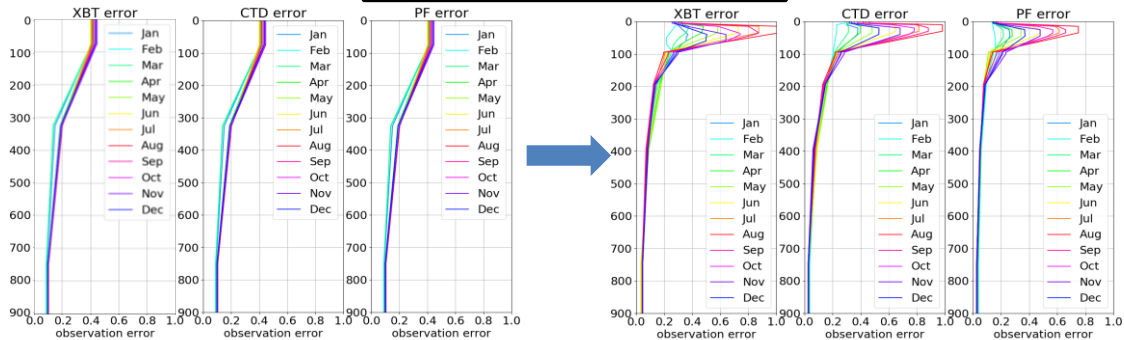
$\mathbf{V}_h$ Horizontal covariance (recursive filter)

The data matrix used is composed by T,S profiles from a previous 32 years reanalysis. A vertical localization is also applied to the EOFs.

50 eigenvalues are retained



T observation error profiles



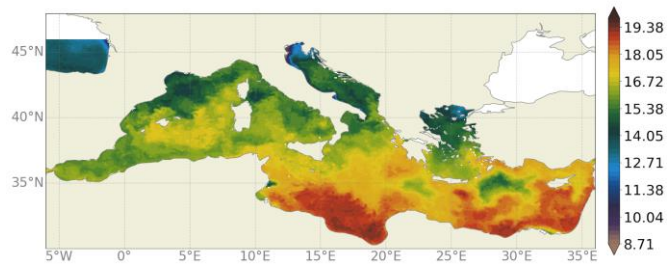
SLA Fixed for all satellites and is 3 cm.

In-situ Estimated using Desroziers iterative method. Monthly estimate. No spatial variability.

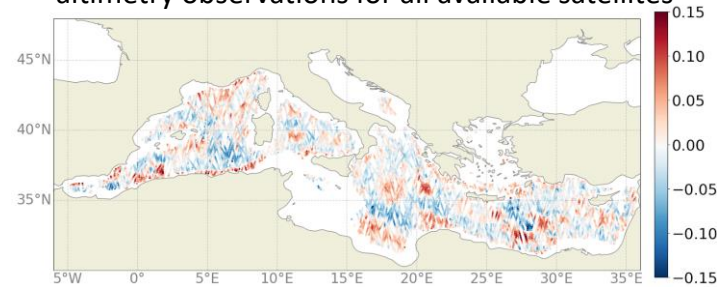


Observation datasets

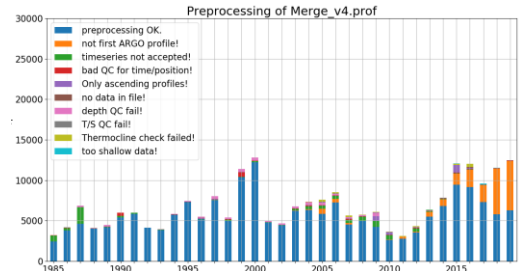
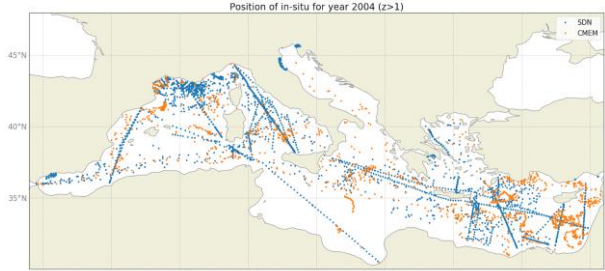
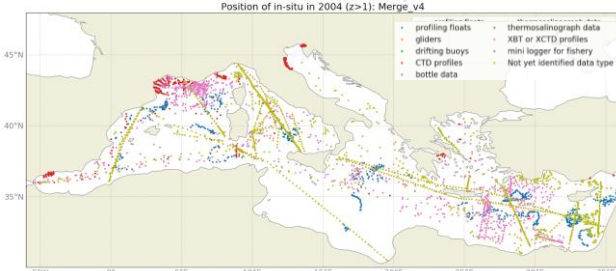
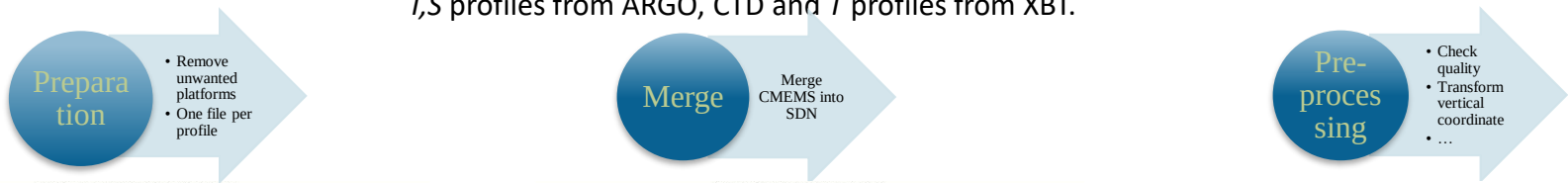
SST CMEMS MED product
L4 data are used for nudging and validation



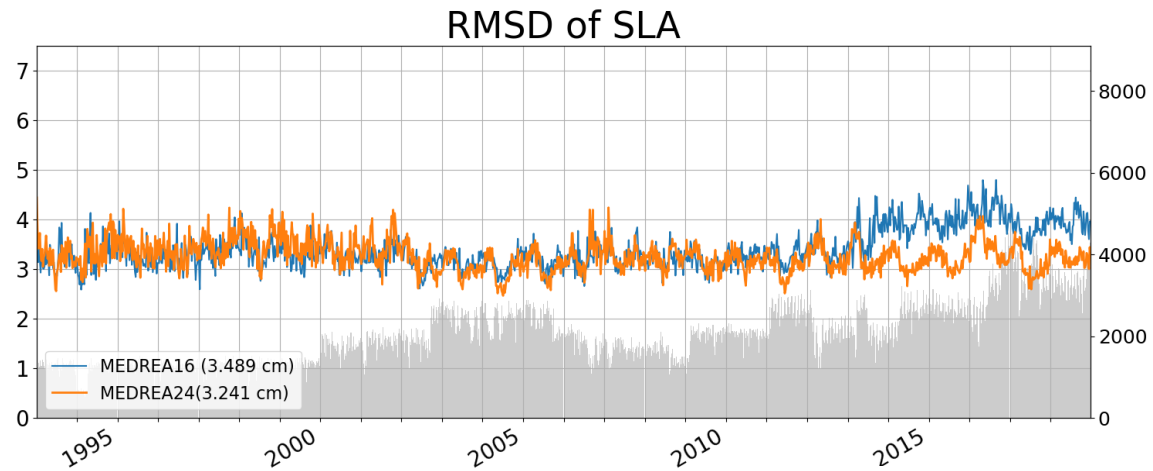
SLA along track DT L3 CMEMS EUR product
altimetry observations for all available satellites



INSITU CMEMS MED HISTORY Global repository + *SeaDataNet* (SDN) repository
T,S profiles from ARGO, CTD and *T* profiles from XBT.

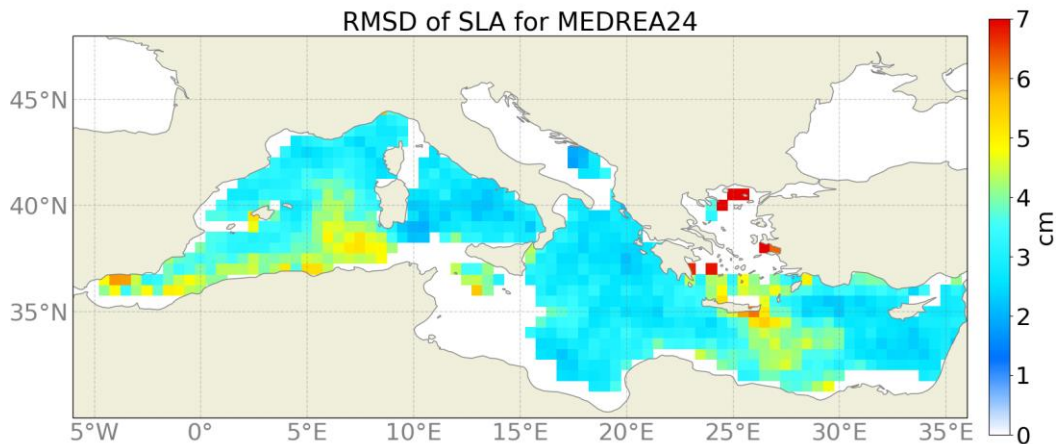


Sea level anomaly RMSD

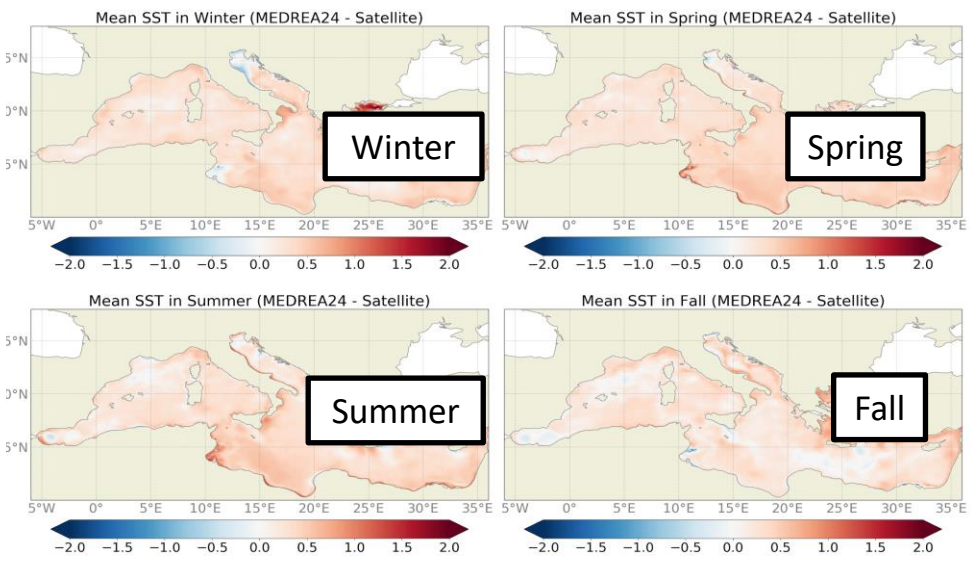
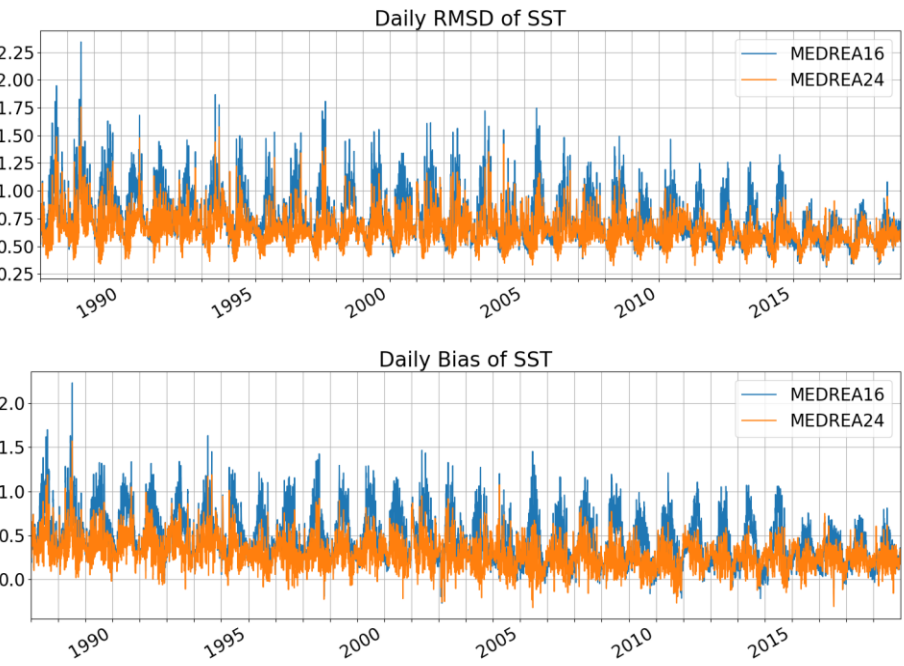


Decrease of SLA mean
RMSD
from 3.5 to 3.25 cm

Highest error in area of high
mesoscale variability



Sea surface temperature RMSD and Bias

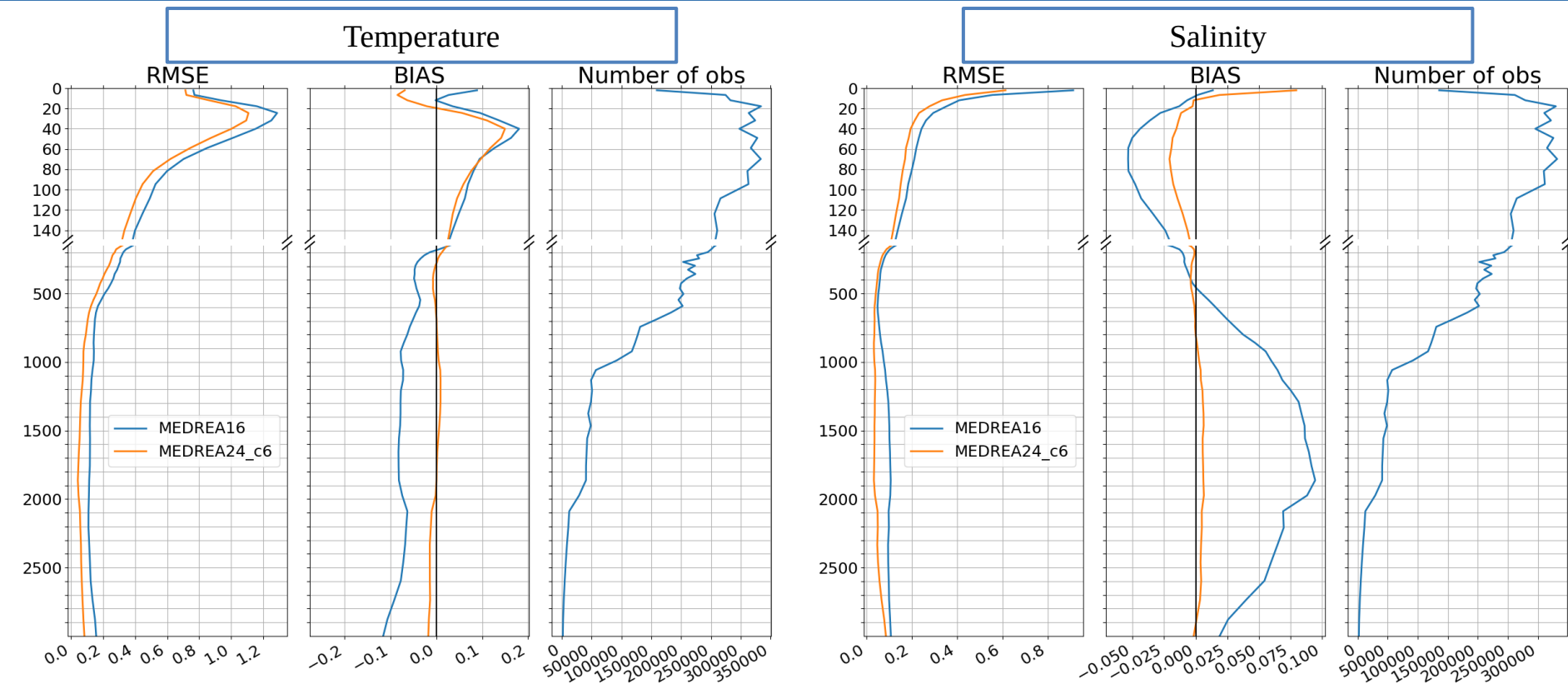


Bias is warm all over the basin

Average decrease in
SST RMSD: $\sim 0.1^{\circ}\text{C}$ (from 0.78°C to 0.66°C)
Warm Bias : $\sim 0.1^{\circ}\text{C}$ (from 0.40°C to 0.29°C)



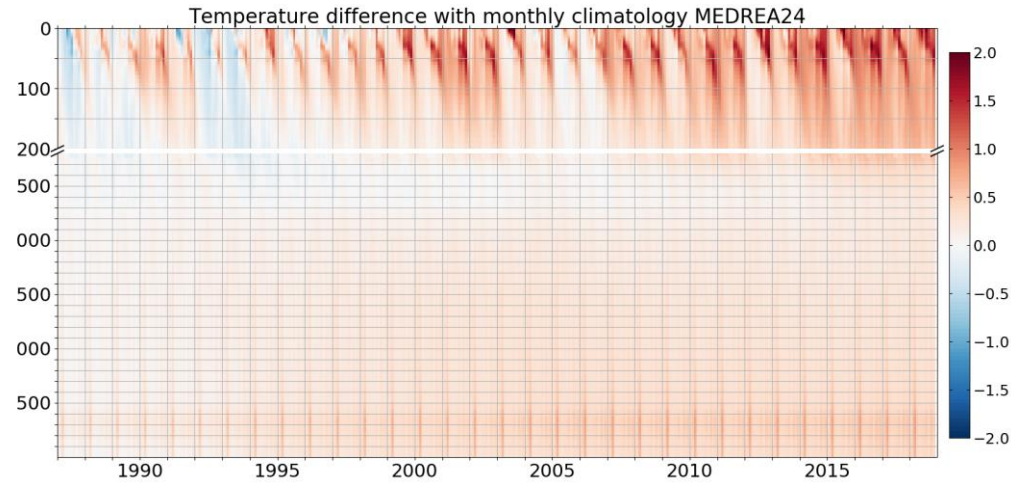
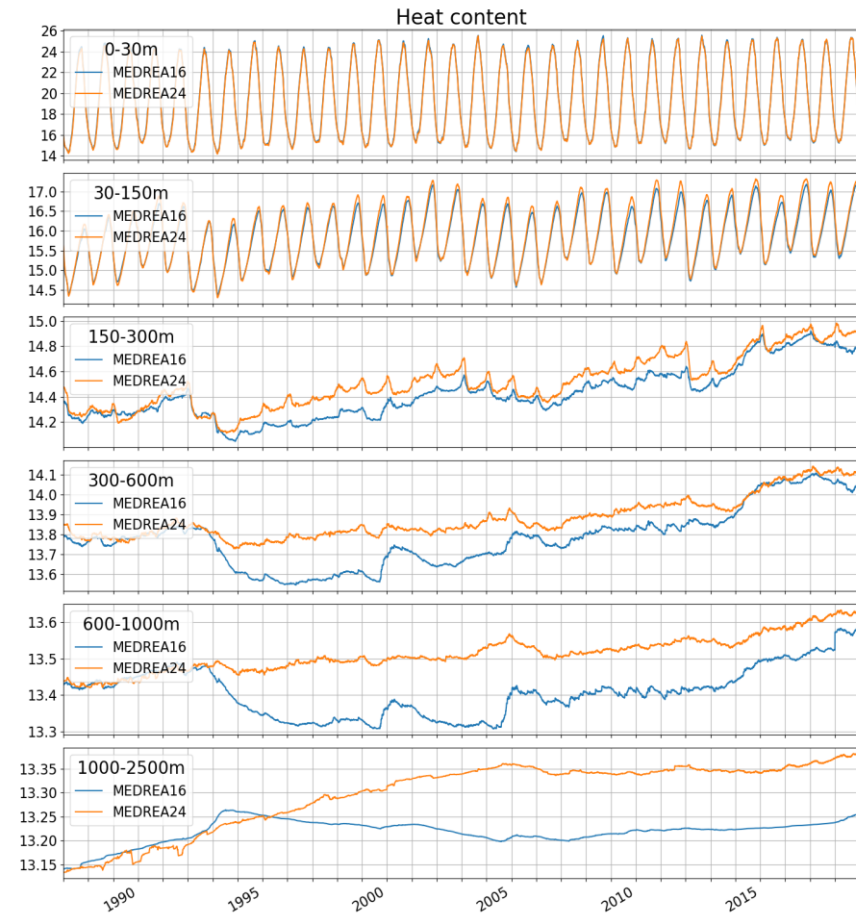
Temperature and salinity profiles



Increase of the skill of the reanalysis with respect to MEDREA16



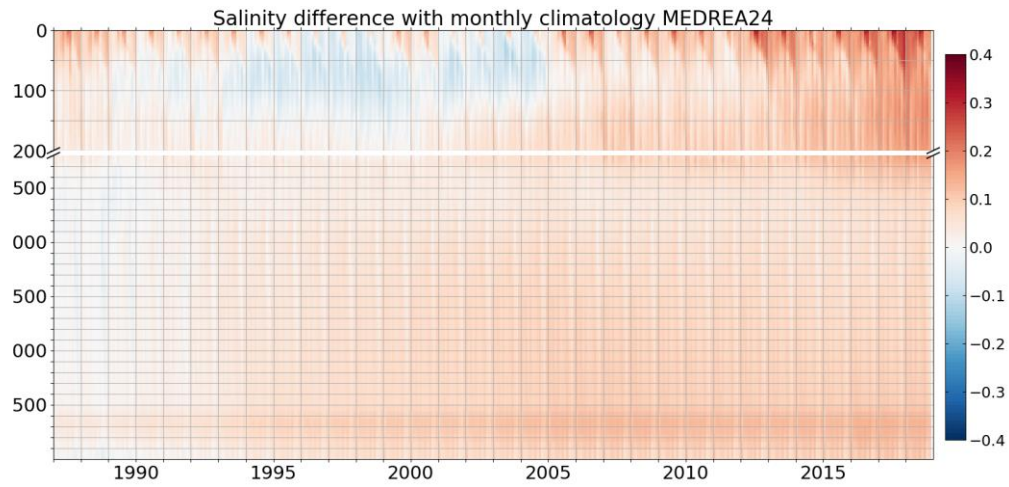
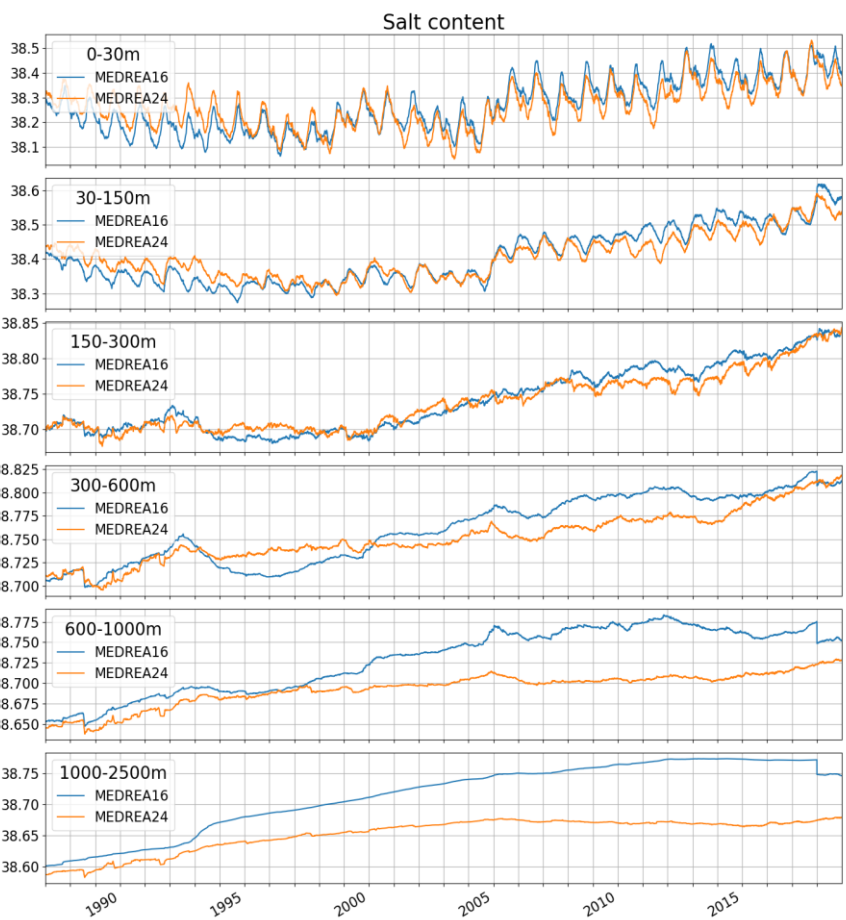
Heat content



Gradual increase of the heat content in the whole water column



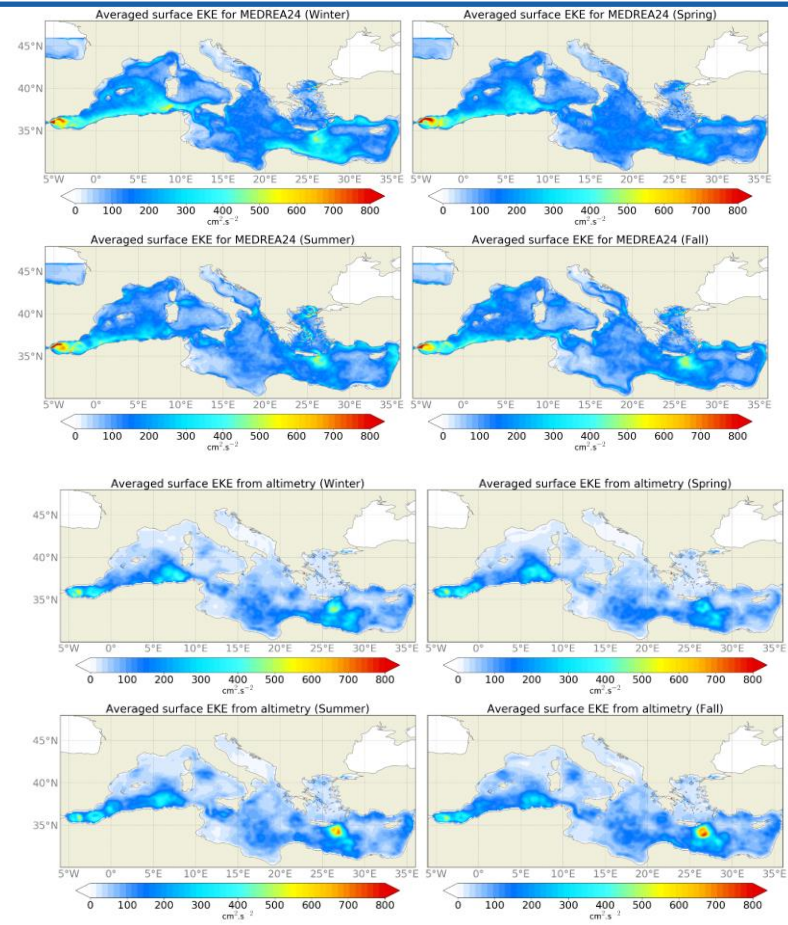
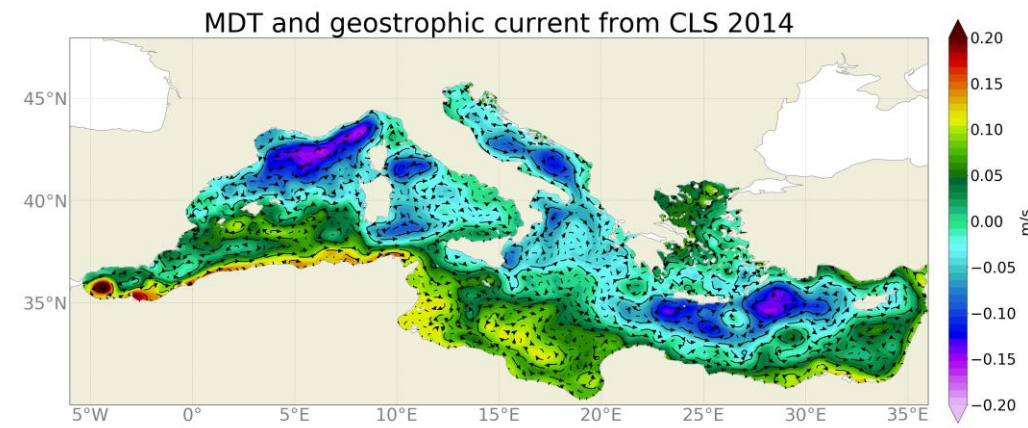
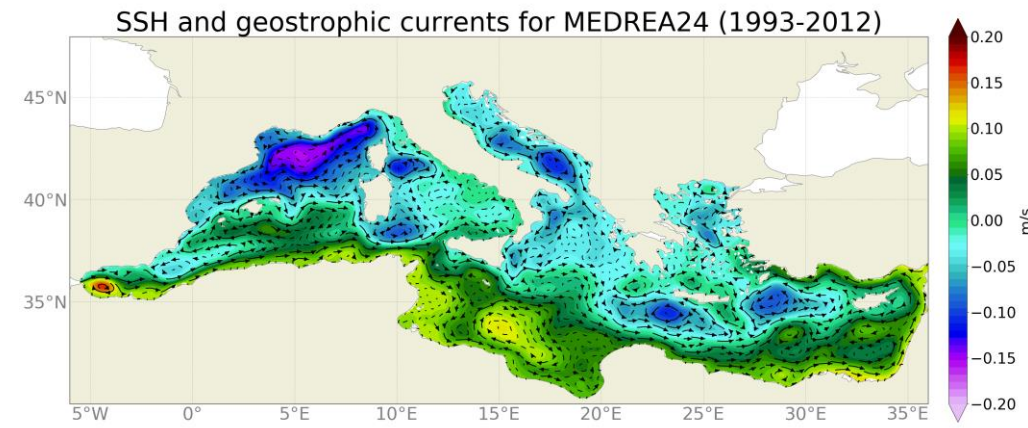
Salt content



Gradual increase of the salt content in the whole water column but less than previous reanalysis (too salty at depth)

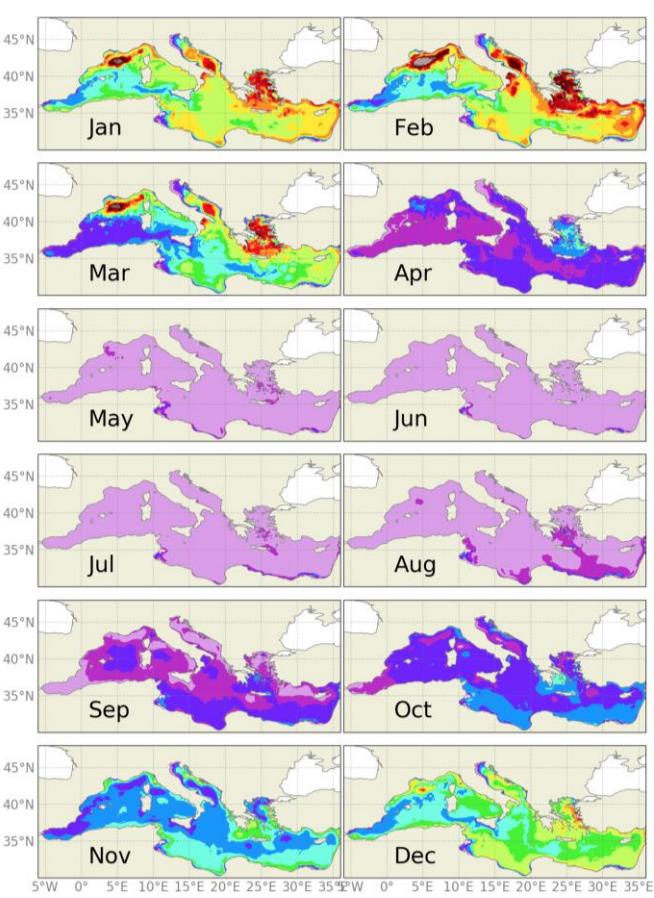
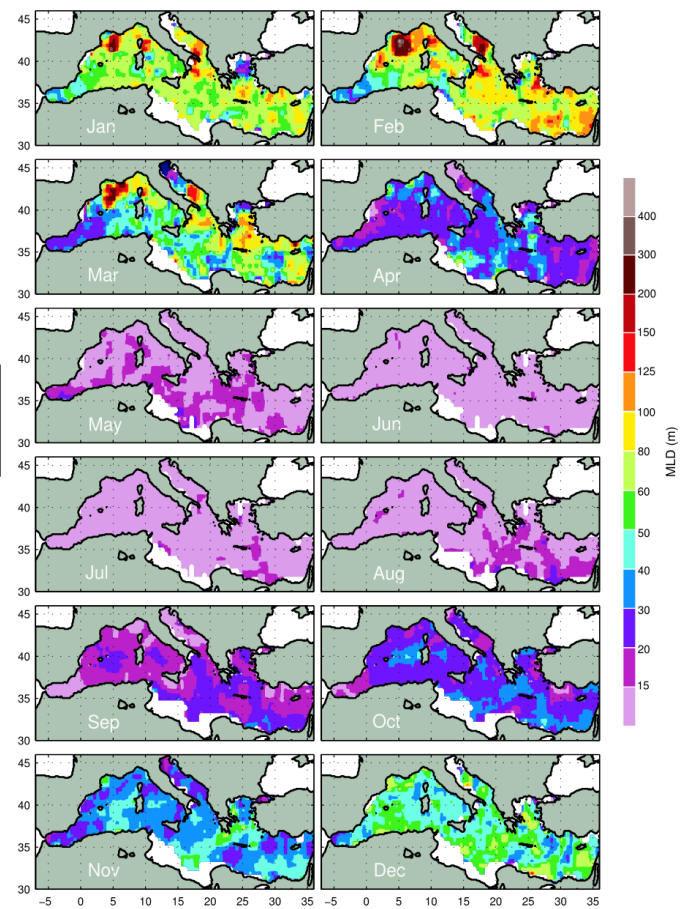


Surface currents and EKE



Mixed layer depth

Observations
(Houpert 2015)

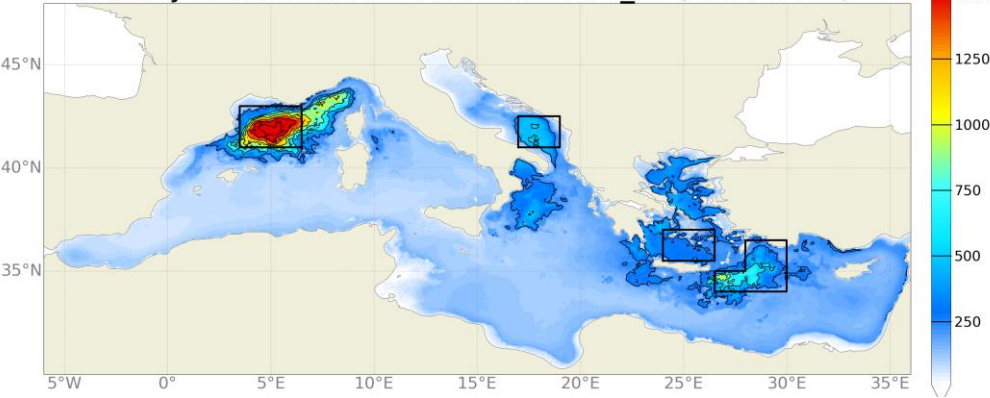


MEDREA24

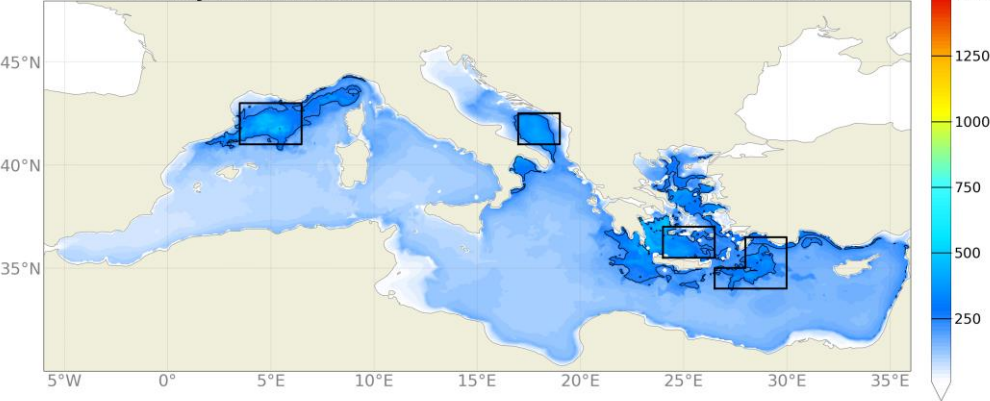


Deep convection

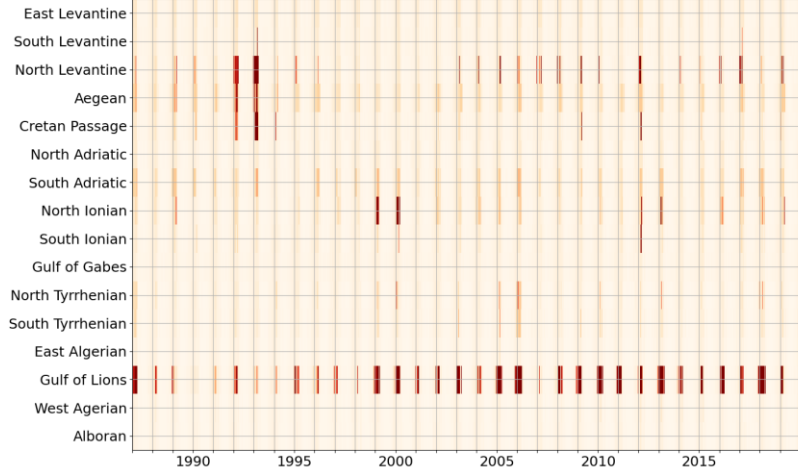
Yearly maximum MLD for MEDREA24_c6 (1987-2019)



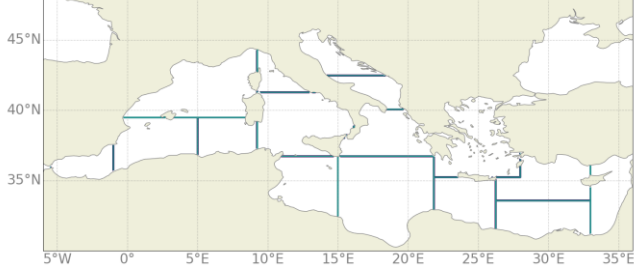
Yearly maximum MLD for MEDREA16 (1987-2018)



Max MLD for MEDREA24_c6



Mediterranean regions



Product on CMEMS

OBSERVATION/MODELS	numerical-model
PRODUCT TYPE	multi-year
PROCESSING LEVEL	L4
DATA ASSIMILATION	SST Sea Level In-Situ TS Pr
VARIABLES	sea_water_p sea_water_p sea_water_s sea_surface_ eastward_se northward_se ocean_mixed (model_level_ sea_floor_de cell_thickness
SPATIAL RESOLUTION	0.042degree
VERTICAL COVERAGE (NUMBER OF VERTICAL LEVEL)	from -5500 to
COORDINATE REFERENCE SYSTEM	WGS 84 (EP
FEATURE TYPE	Grid
TEMPORAL COVERAGE	from 1987-01
TEMPORAL RESOLUTION	daily-mean monthly-mean hourly-mean
UPDATE FREQUENCY	biannually (N/A)
PRODUCTION UNIT	MED-CMCC-
ORIGINAL FILE FORMAT	NetCDF-4

MEDITERRANEAN SEA PHYSICS REANALYSIS

Metadata provided by CMEMS
Credits: E.U. Copernicus Marine Service Information

Escudier, R., Clementi, E., Omar, M., Cipollone, A., Pistoia, J., Aydogdu, A., Drudi, M., Grandi, A., Lyubartsev, V., Lecci, R., Cretí, S., Masina, S., Coppini, G., & Pinardi, N. (2020). Mediterranean Sea Physical Reanalysis (CMEMS MED-Currents) (Version 1) [Data set]. Copernicus Monitoring Environment Marine Service (CMEMS).

https://doi.org/10.25423/CMCC/MEDSEA_MULTIYEAR_PHY_006_004_E3R1

MEDSEA_MULTIYEAR_PHY_006_004



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PRODUCT IDENTIFIER

MEDSEA_MULTIYEAR_PHY_006_004

OVERVIEW

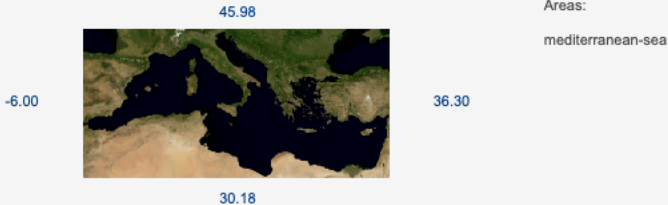
Short description:The Med MFC physical reanalysis product is generated by a numerical system composed of an hydrodynamic model, supplied by the Nucleus for European Modelling of the Ocean (NEMO) and a variational data assimilation scheme (OceanVAR) for temperature and salinity vertical profiles and satellite Sea Level Anomaly along track data. The model horizontal grid resolution is 1/24° (ca. 4-5 km) and the unevenly spaced vertical levels are 141.

Product Citation:Please refer to our Technical FAQ for citing products.<http://marine.copernicus.eu/faq/cite-cmems-products-cmems-credit/?idpage=169>
DOI (Product):https://doi.org/10.25423/CMCC/MEDSEA_MULTIYEAR_PHY_006_004_E3R1

REFERENCES

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GEOGRAPHICAL COVERAGE



Summary and conclusions

New reanalysis:

- **Increased resolution and improved model physics (z^* /free surface, rivers, forcings,...)**
- **Improved background and observation error matrices**
- **Better observation dataset**

Quality assessment show:

- **Better skill score for all variables**
- **Coherent circulation and deep convection processes**

