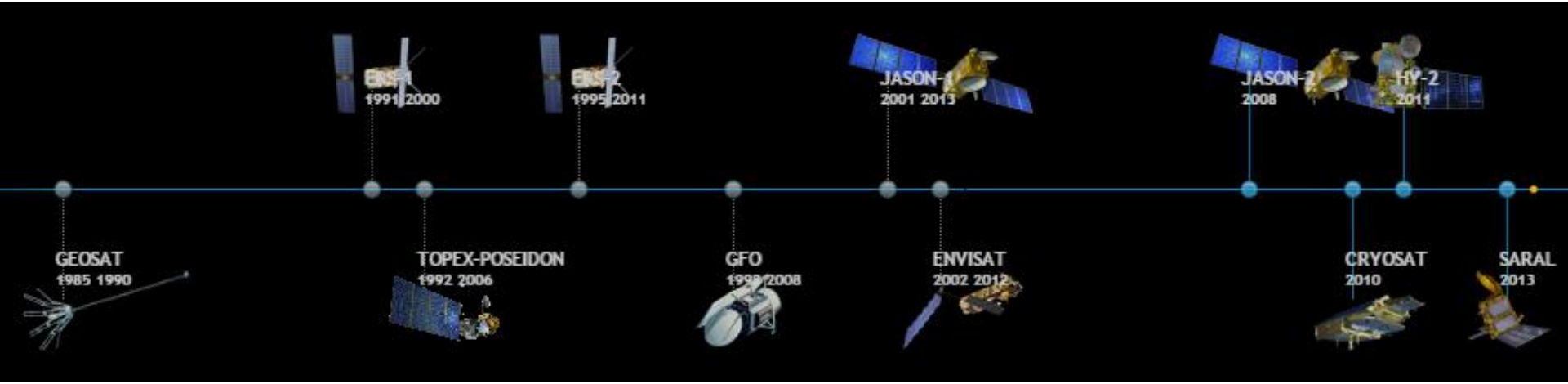
Zoom on reference surfaces



From SSH to Sea Level Anomalies

Altimeter SSH =Geoid + oceanic Dynamic Topography

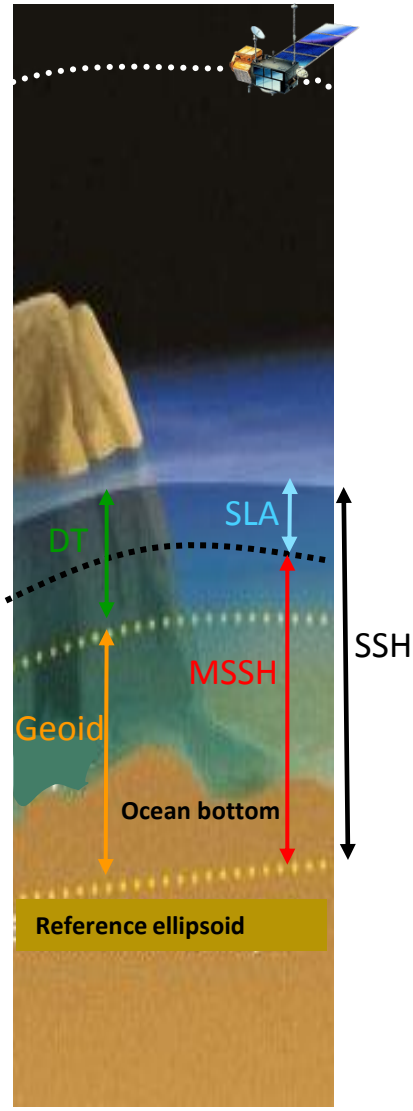
Due to large geoid errors at small scales, one can not remove it from SSH to access the ocean variability.

► **removal of an accurate along-track temporal mean MSSH**

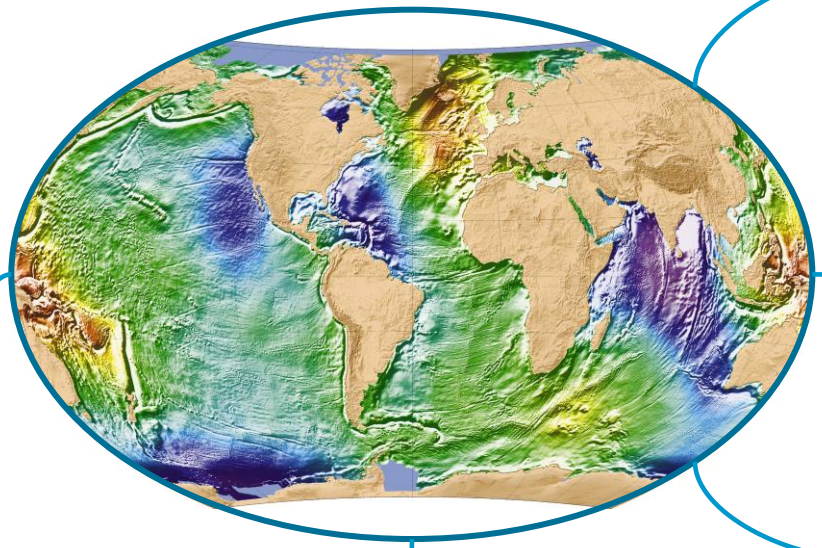
SLA = SSH – MSSH

MSSH (mean along-track profiles) are computed over a defined time period.
In AVISO/CMEMS L3 products, it is now 1993-2012.

2 gridded fields (OI of MSSH) are made available by DTU and CNES-CLS. There will be new releases this year.



MSS is a reference surface for altimetry,
it is also important for the determination of other reference fields !



Mean Dynamic Topography
MDT = MSS - geoid

Geoid model
Contribue to the short wavelengths

Altimetric processing:
Correction of geoid gradient

Bathymetry = f(geoid, gravity anomaly)

Calculation of SLA
(new mission, or non-repetitive orbit)

All these fields are used in operational oceanography.

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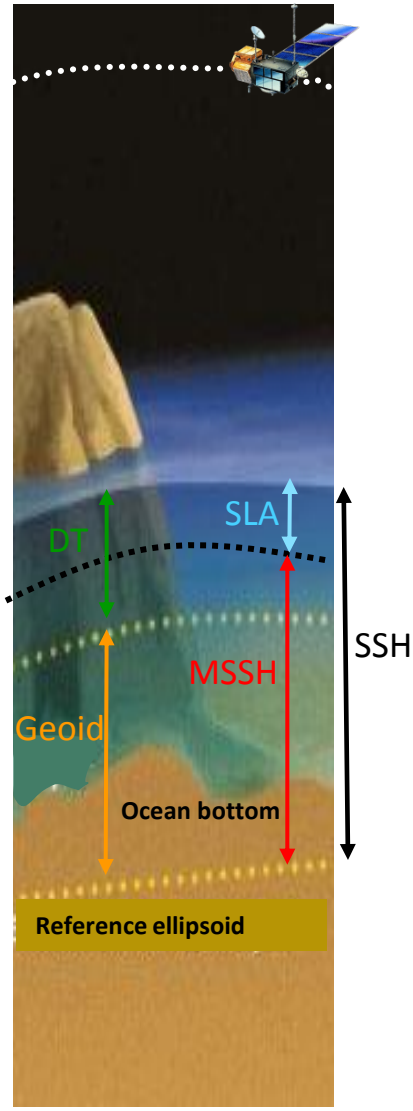
☝ Modeled SSH = DT



From SSH to Sea Level Anomalies

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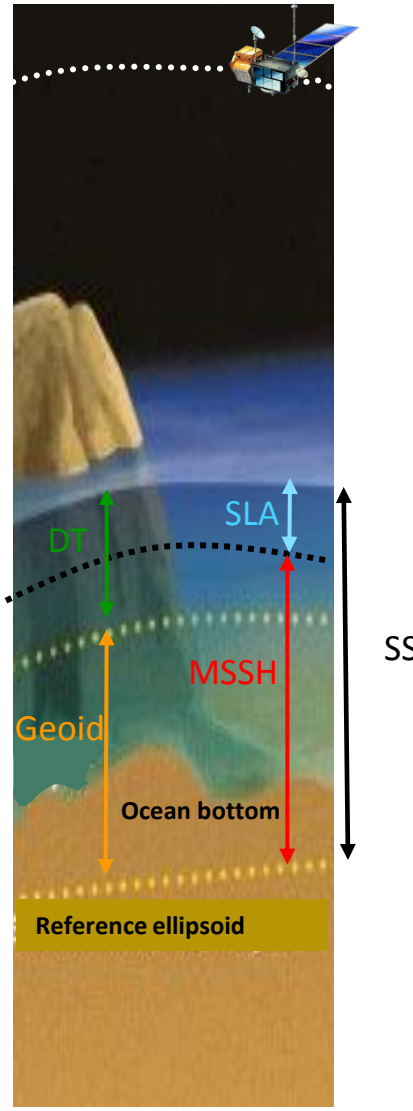


From Sea Level Anomalies to DT

DT = SLA + Mean Dynamic Topography

The Mean Dynamic Topography

- **For assimilating SLA** into ocean forecasting systems or **validate your model with altimetry**, you need to

  - add a MDT to SLA
  - or remove the mean from your model SSH over a given period and remove the mean from your SLA over the same period

- In Open Ocean, **prescribing a realistic MDT** into a model leads to modeling system improvements (GOCINA project)
  - in the mean current position
  - in the mesoscale eddy field
  - at the surface but also at depth
  - both on analysis and forecasts
  - on transport computation (closer to observations)

The Mean Dynamic Topography

- It can be computed
  - from Ocean model means
  - inverse modelling
  - climatological fields
  - combining altimetric MSS and geoid model information
  - using ocean in-situ measurements…

- The MDT CNES CLS 13 provided with the AVISO products is computed from a combination of altimeter data, geoid model and ocean in-situ measurements (drifting buoys and T/S profiles)

- Regional MDT can be computed with model mean state and using local/regional in-situ dataset (drifters, HF radar, etc)

CNES CLS MDT Methodology

Direct Method

MDT=MSS-Geoid

filtering

Large scale MDT=First Guess

Synthetic Method

Computation of the **MDT shortest scales** (heights and geostrophic velocities) combining altimetric anomalies and in-situ data

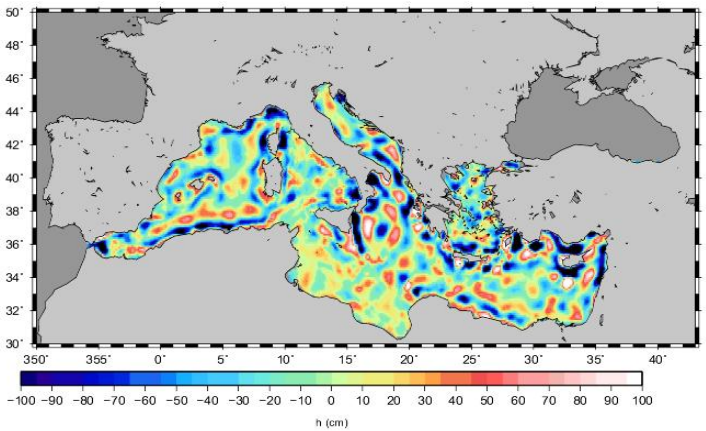
Multivariate Objective Analysis

High Resolution Mean Dynamic Topography

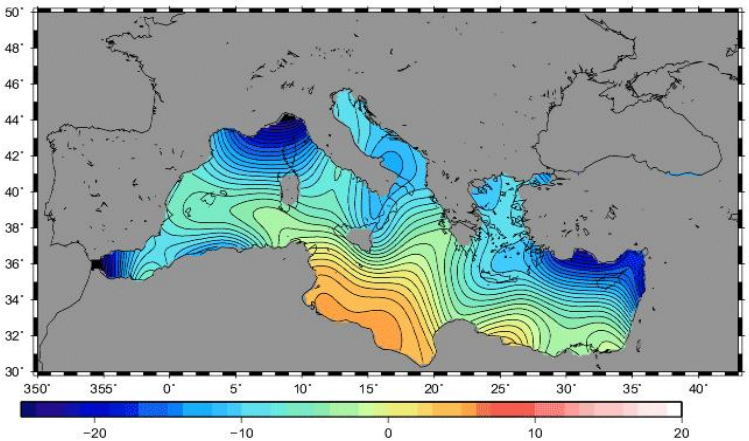
Rio and Hernandez, 2004 – Rio et al, 2005 – Rio et al, 2014

First guess choice for a regional MDT

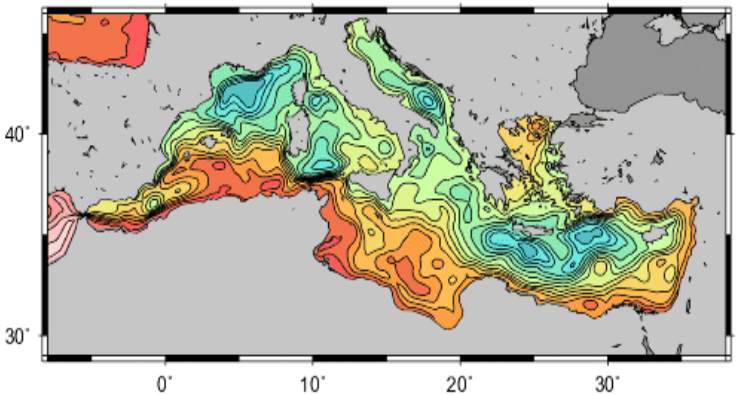
Raw MDT computed as CNESCLS11 MSS - EGM-DIR V3 geoid model.



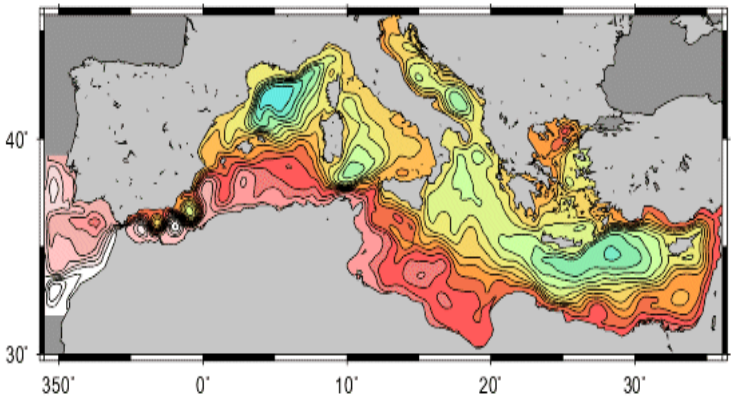
raw MDT + 200 km resolution Gaussian filter

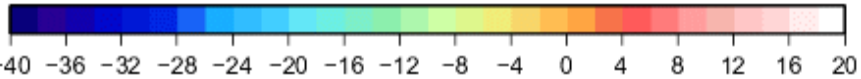


averaged MFS model outputs over 1993-1999



averaged NEMO12 model outputs over 1993-1999



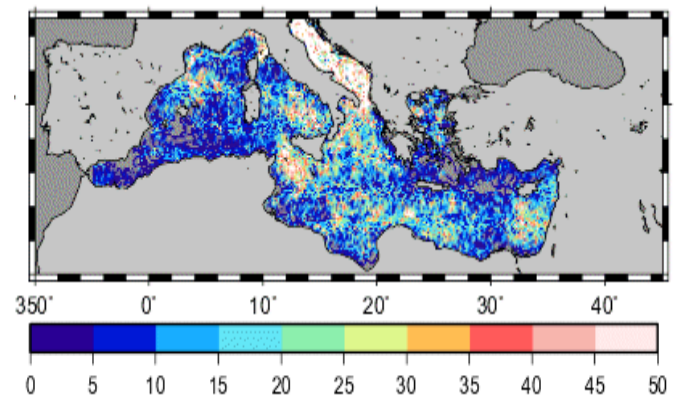


Synthetic mean velocities:

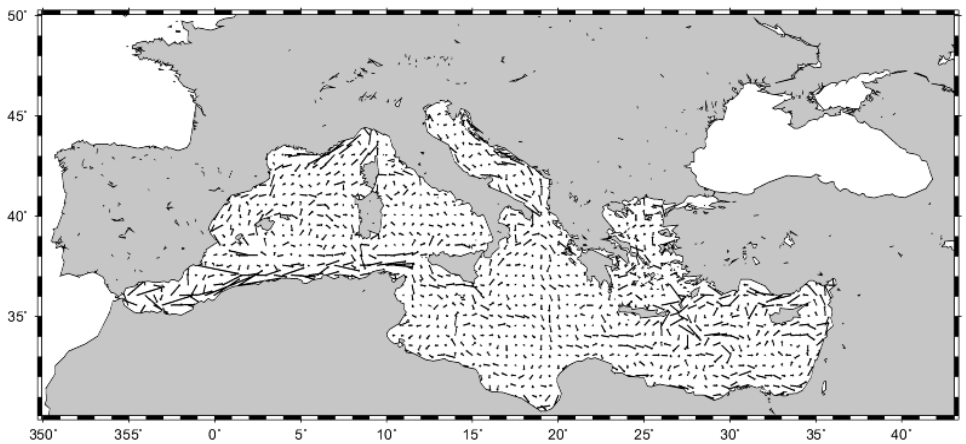
$$u_{synth}=u-u'_{alti}$$

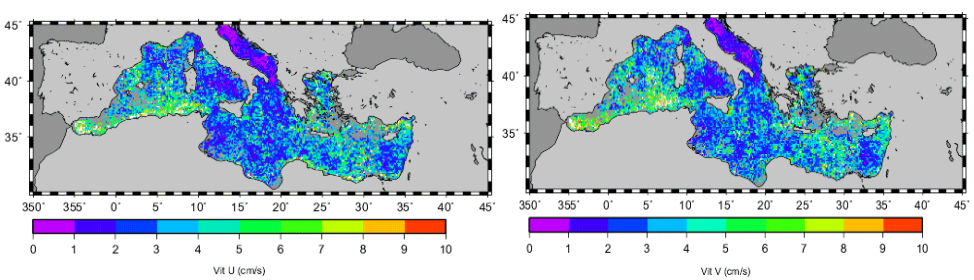
Using the **geostrophic drifter velocities** calculated for the Mediterranean Sea for the period 1993-2011 by (Poulain et al, 2012).

Number of drifter velocities in 1/8° by 1/8° boxes



Synthetic mean velocities averaged into 1/8° by 1/8° boxes.





Error on the mean zonal (left) and meridional (right) mean synthetic velocity

For each 1/8° by 1/8° box mean velocity, an error is associated that is the maximum between:

- ❑the individual velocity error estimates
- ❑the variance in the box where synthetic mean velocities are computed.

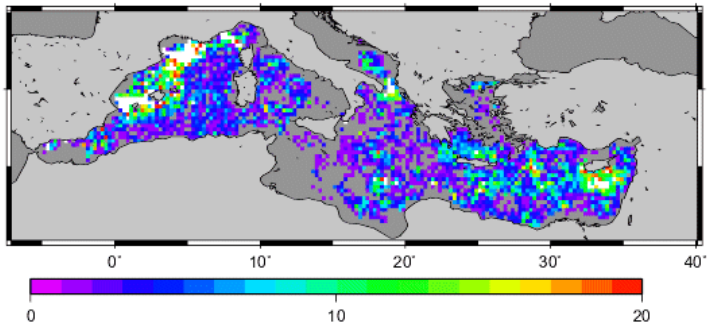
Synthetic mean heights:

$h_{synth}=h-h'_{alti}$

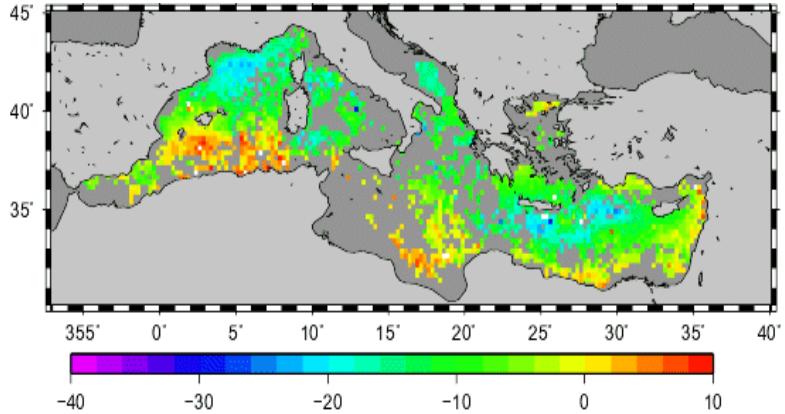
•Using **CTD hydrological profiles** (IBAMar database covering the period 1993-2010)
•Using **gliders** (Socib-Imedea database for 2011)
•Using **different other instruments**, including ARGO floats from the EN3 database for the period ranging from 1993-2012.

► dynamic heights relative to 350m ($hdyn_{350}$).

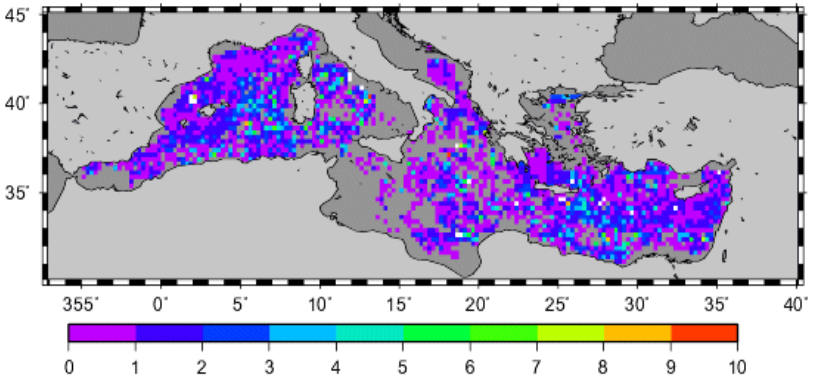
Number of hydrogolgical profiles (0-350m) i
0.25° by 0.25° boxes



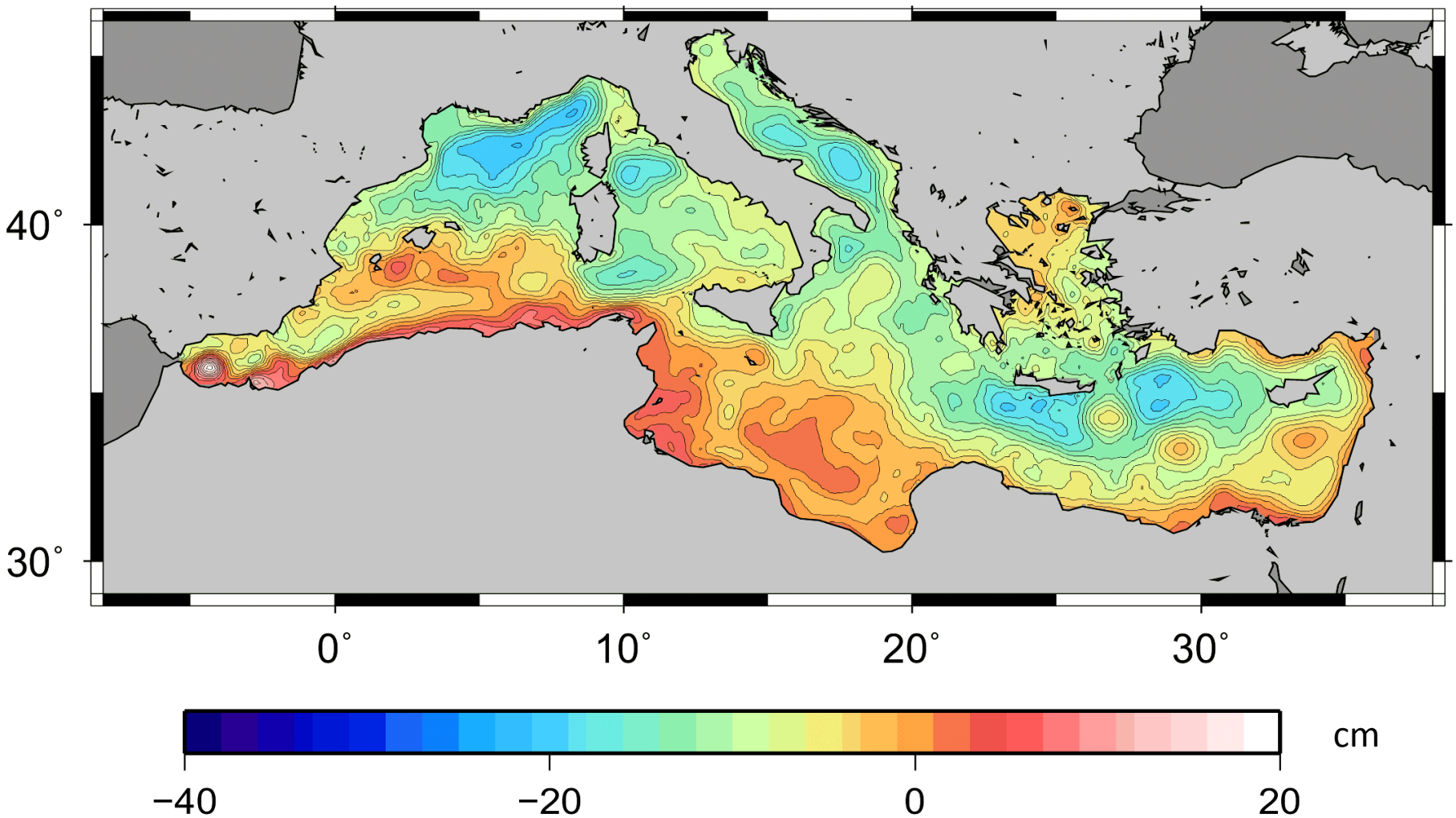
Synthetic mean heights



Error on Synthetic mean heights



The regional SOCIB-CLS MDT



Discussion

- ❑ If you currently use SSH (L2 products) with your models, how do you compute the SLA?
  - ❑ using a MSS field (DTU or CNES-CLS) ?
  - ❑ computing your own along-track MSSH? Over which time period?
  - ❑ How to you compute the ocean Dynamic Topography?

- ❑If you currently use SLA (L3 or L4 products) with your models, how do you get the Ocean Dynamic Topography?

  - ❑ model long-term mean. How long?
  - ❑ model short-term mean / SLA short-term mean removal
  - ❑ AVISO MDT
  - ❑ other?

- ❑ in case of assimilation, do you take into account an associated error with MDT field?