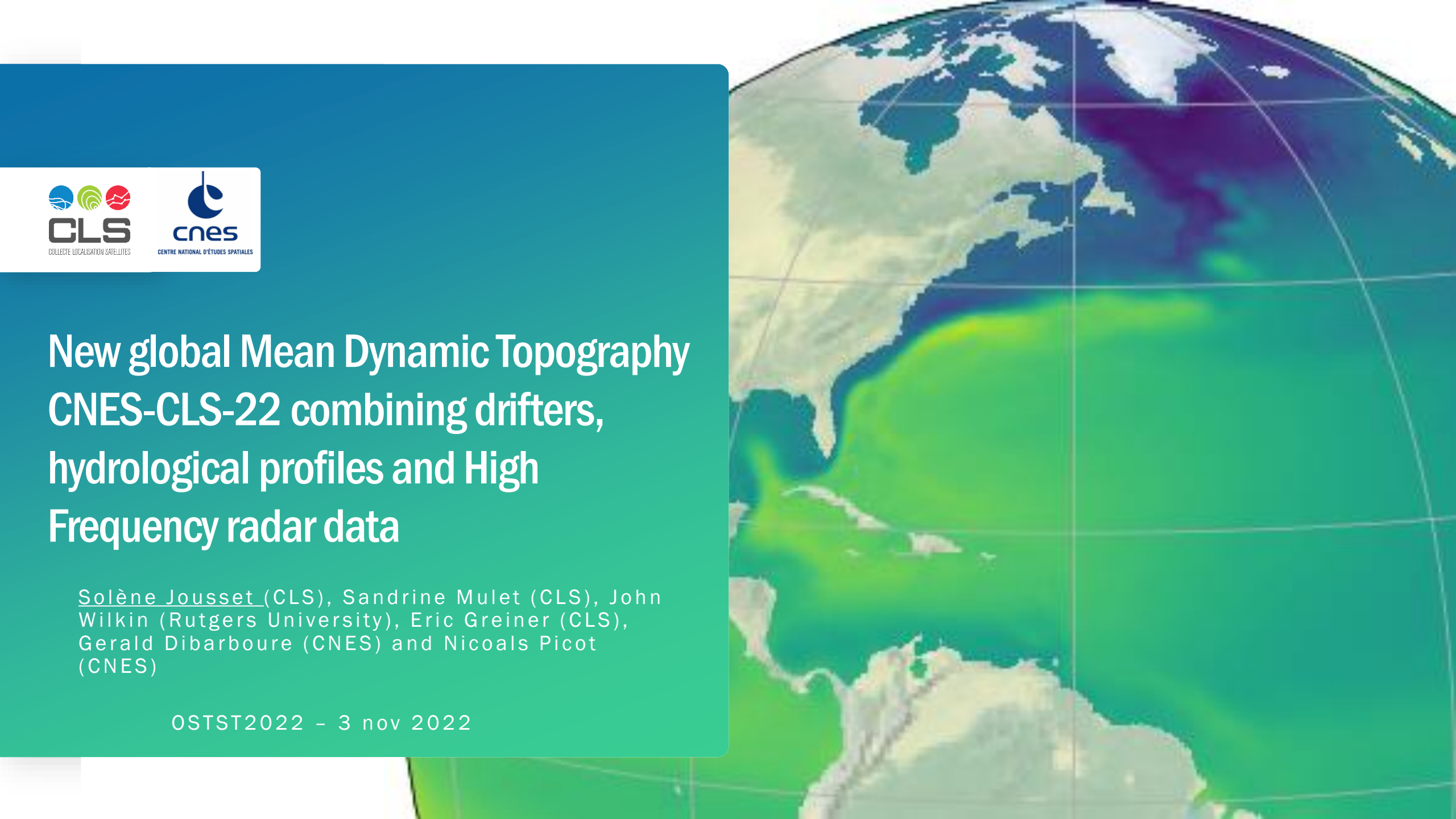
New global Mean Dynamic Topography CNES-CLS-22 combining drifters, hydrological profiles and High Frequency radar data

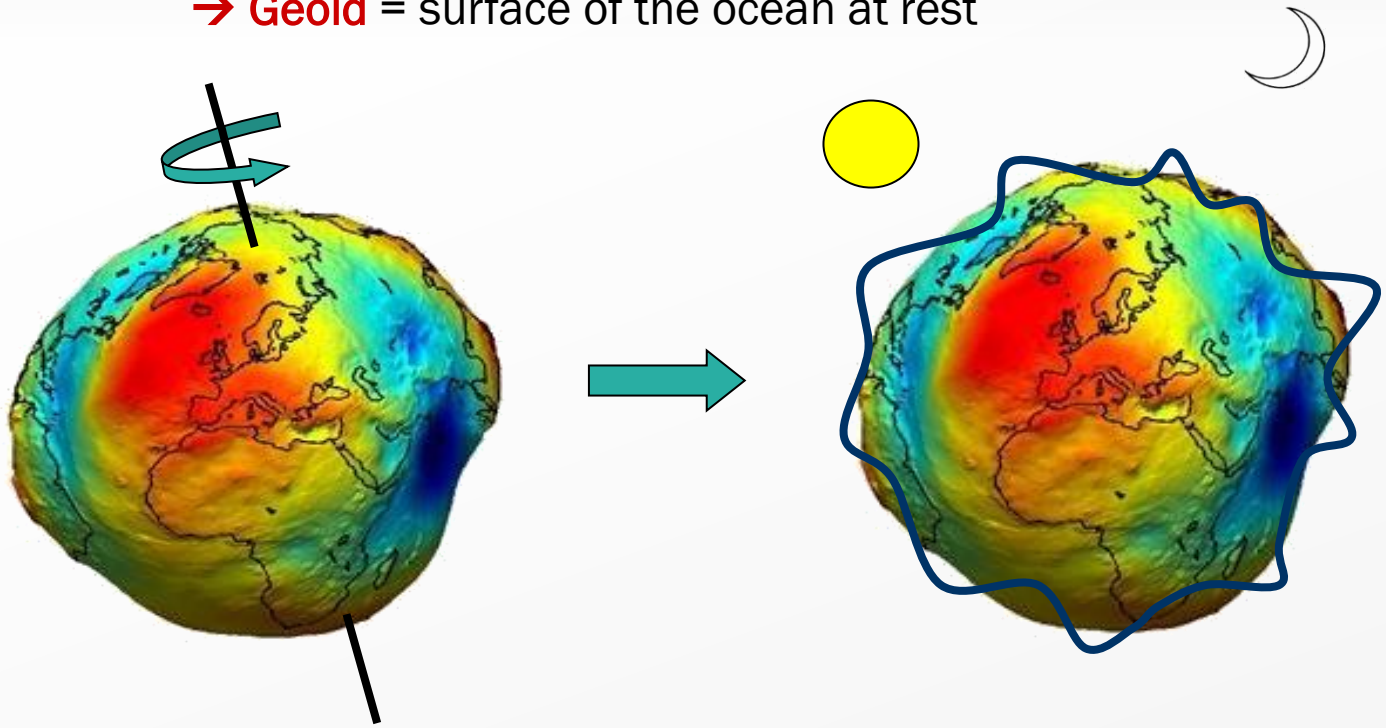
Solène Jousset (CLS), Sandrine Mulet (CLS), John Wilkin (Rutgers University), Eric Greiner (CLS), Gerald Dibarboure (CNES) and Nicoals Picot (CNES)

OSTST2022 – 3 nov 2022



Height referenced to which surface ?

→ **Geoid** = surface of the ocean at rest



Ocean at rest, submitted only to the Earth's gravity field

Dynamic of the ocean → Absolute Dynamic Topography (ADT)

Need to be estimated !

Altimetric product

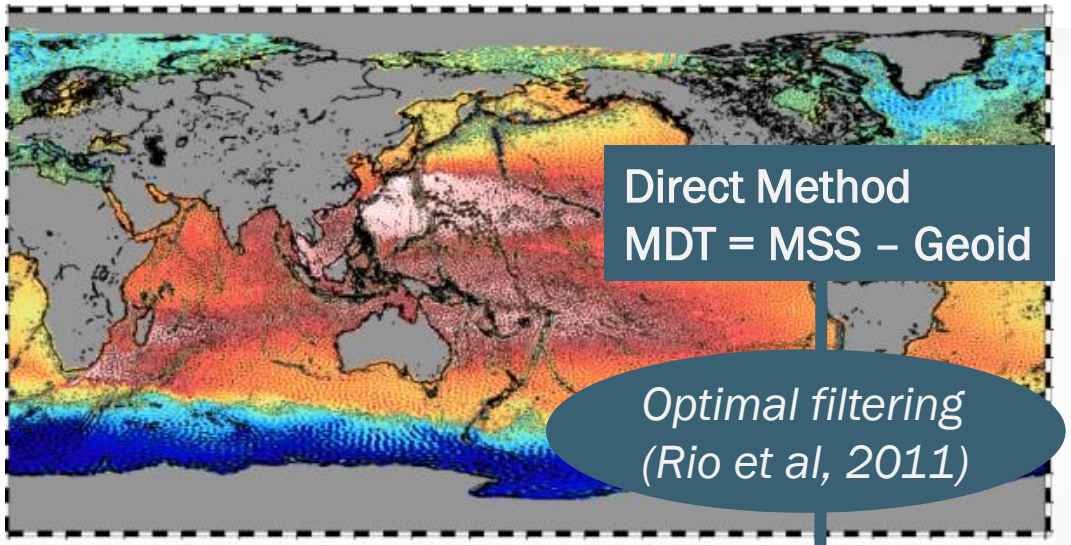
ADT = SLA + MDT

Absolute Dynamic Topography

Sea Level Anomaly

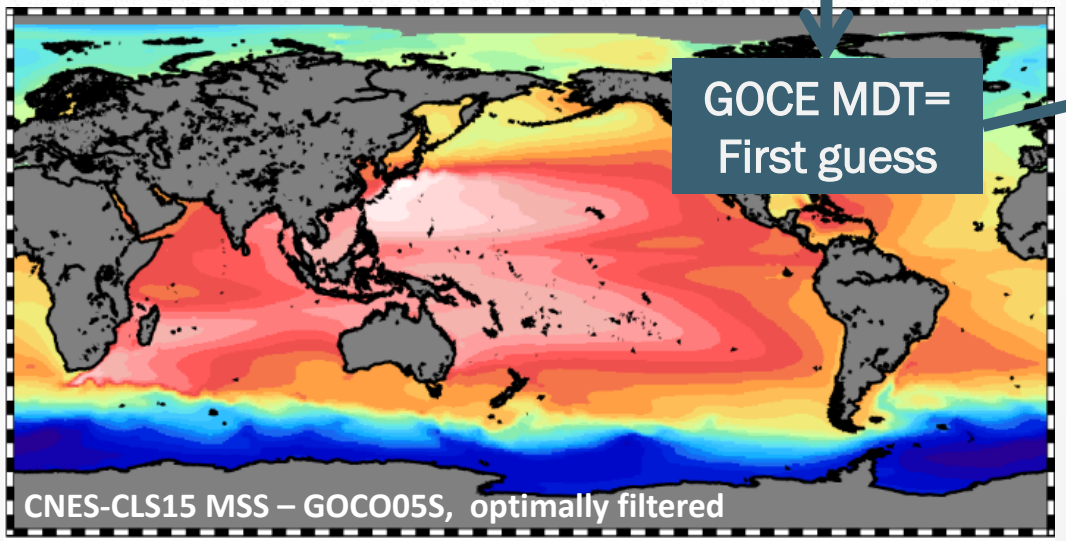
Mean Dynamic Topography

MDT estimation method

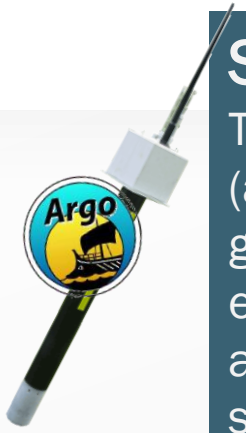


Direct Method
MDT = MSS – Geoid

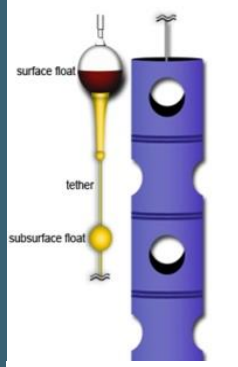
Optimal filtering (Rio et al, 2011)



GOCE MDT=
First guess

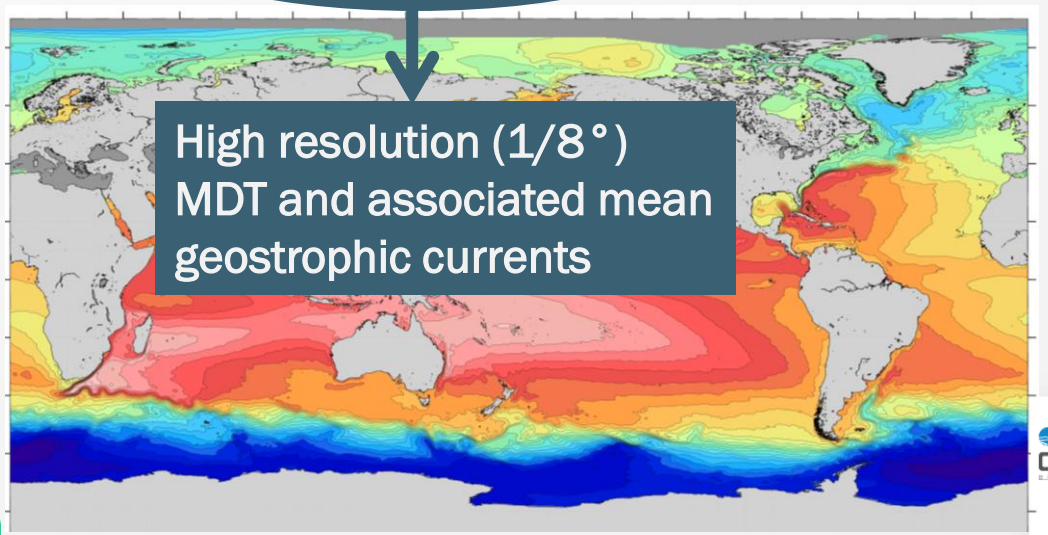


Synthetic Method:
The short scales of the MDT (and corresponding geostrophic currents) are estimated by combining altimetric anomalies and in-situ data (Argo floats, drifting buoys)



Multivariate Objective Analysis

Rio and Hernandez, 2004
Rio et al, 2005, 2011, 2014



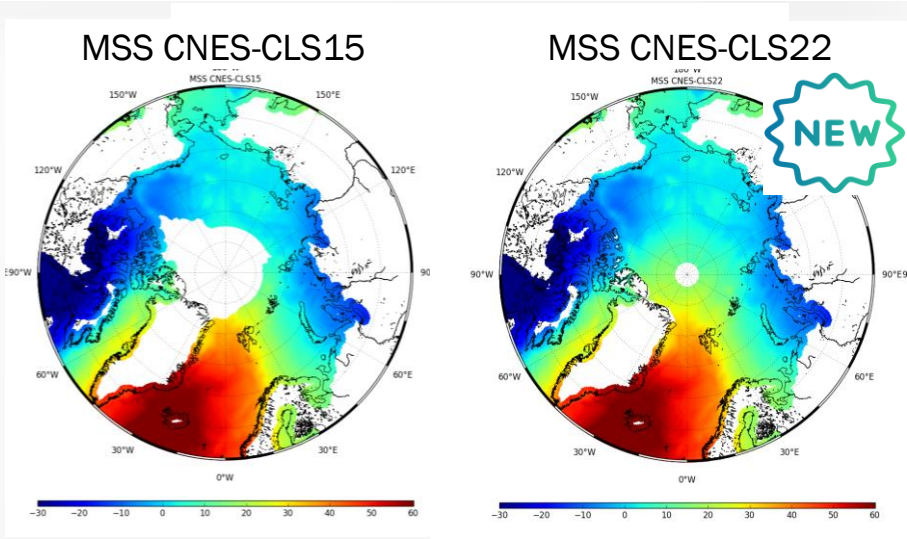
High resolution (1/8°)
MDT and associated mean geostrophic currents

MDT CNES-CLS18

New global MDT : MDT CNES-CLS22

What is new ?

	MDT CNES-CLS18	MDT CNES-CLS22
MSS	**MSS CNES-CLS15** (Pujol et al, 2018)	**MSS CNES-CLS22**
Geoid	**GOCO05S** (Mayer-Gürr,et al. 2015)	**GOCO06S (GOCE data fully reprocessed)**
First Guess filtering	Optimal filter (Rio et al, 2011)	Optimal filter (Rio et al, 2011) + **lagrangian filter along the coast to avoid streamline going into land**
In-situ data (T/S profiles and drifters)	1993-2016	**1993-07/2021 + update of the processing**



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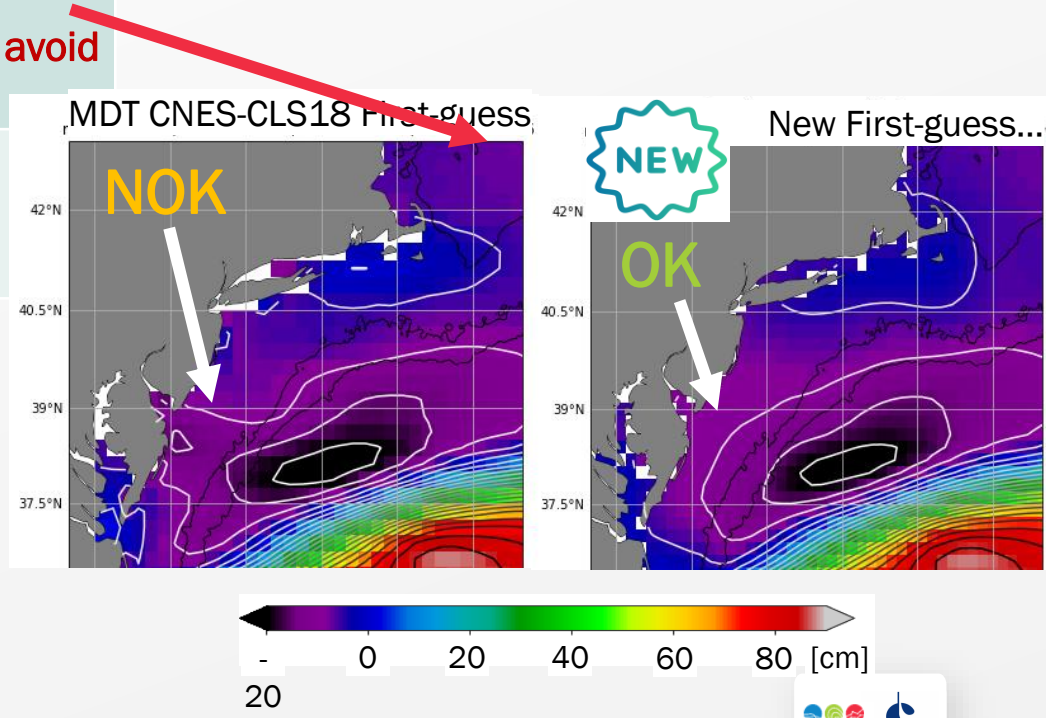

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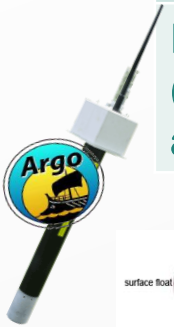
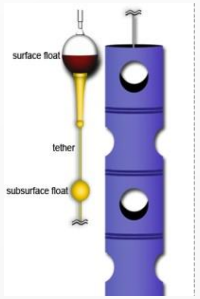
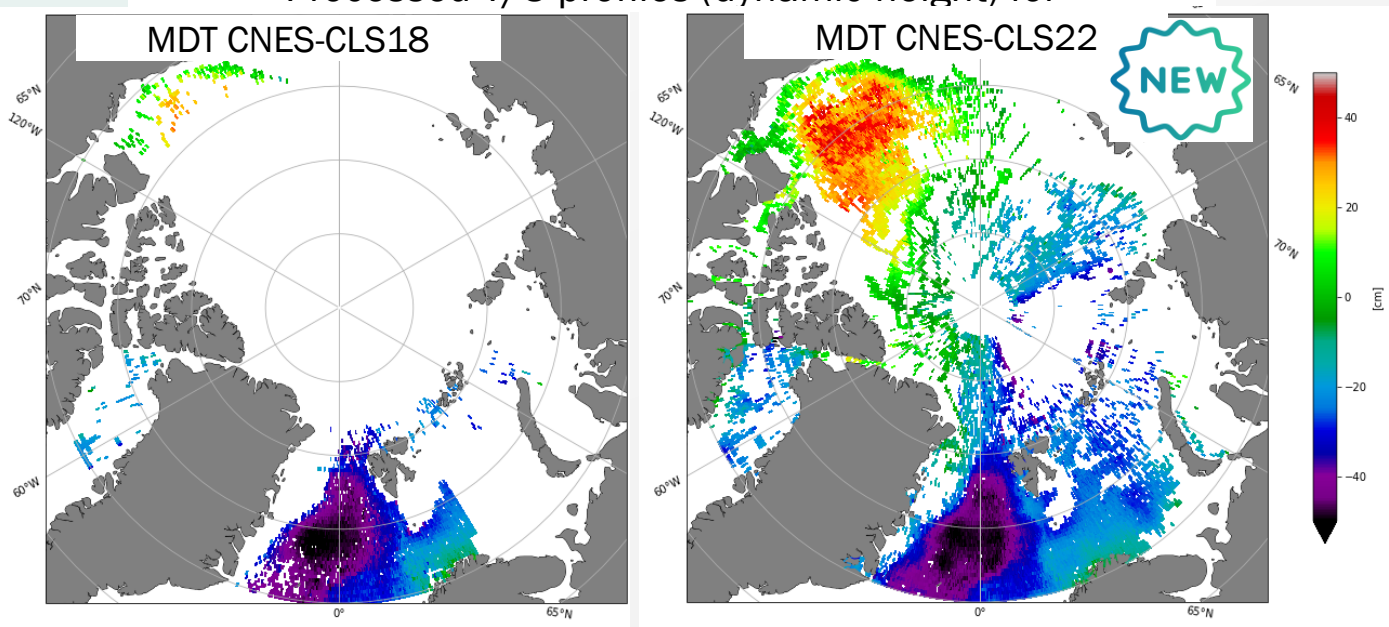




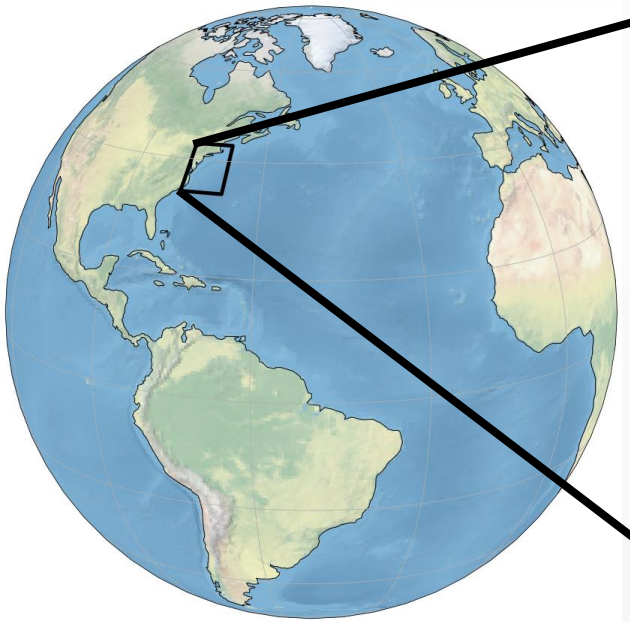
- In-situ data are processed to be consistent in terms of physical content with altimetry

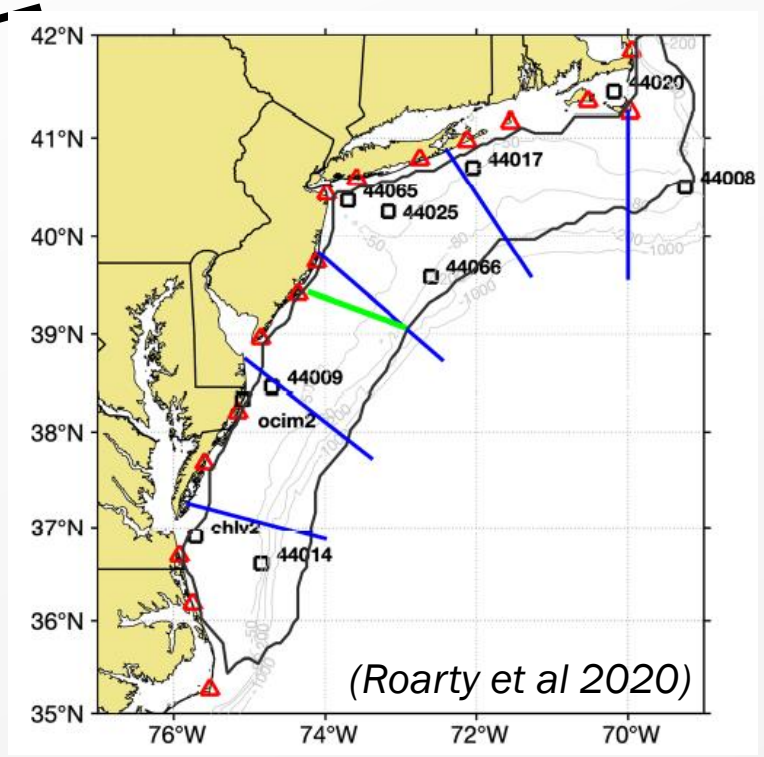
Processed T/S profiles (dynamic height) for



Additional data in Mid Atlantic Bight : HF radar data

- Objective: to improve the MDT in the coastal zone
- How to do it? Add coastal data: test the contribution of current data estimated by High Frequency (HF) radar in the Mid Atlantic Bight (area well observed by U.S. HF radars)





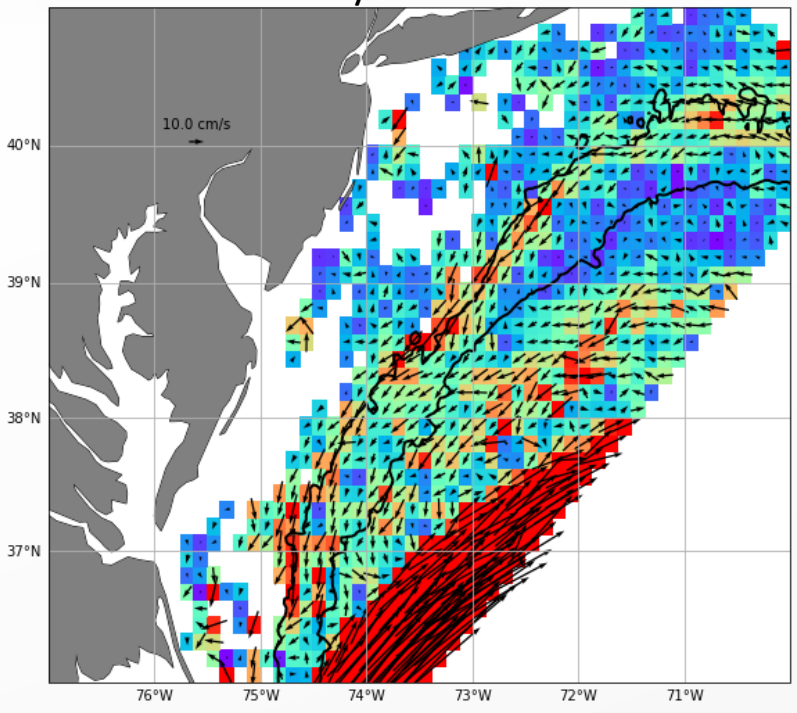
- **2006-2016 Mean** HF radar currents processed by **Rutgers University** *Roarty et al 2020*
- Remove Ekman mean currents
- Re-reference radar data mean on the period 1993-2012

△ 16 5-MHz-SeaSondes (CODAR) from **2007 to 2016**

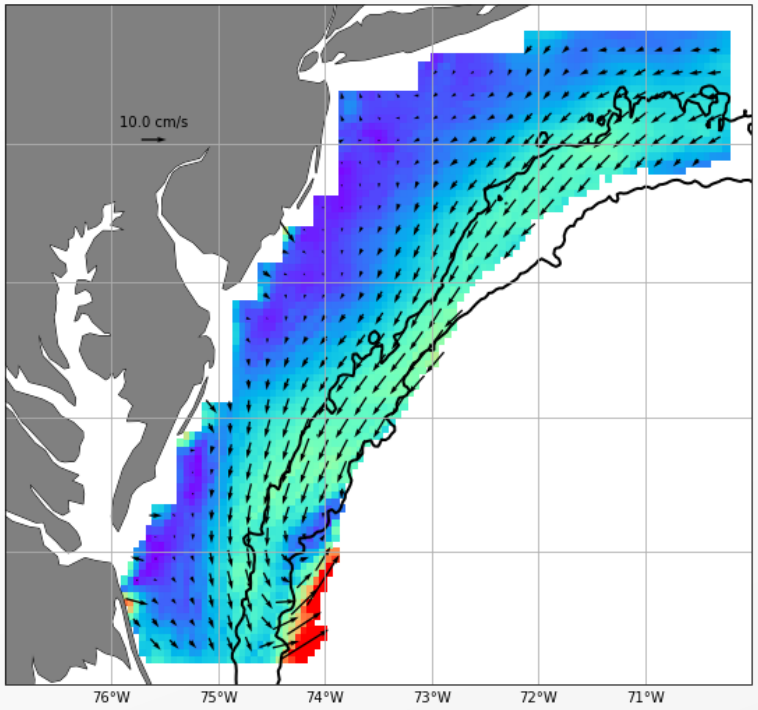
http://tds.marine.rutgers.edu/thredds/cool/codar/cat_totals.html

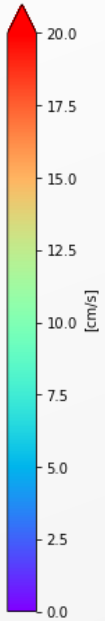
Comparison of radar/drifters currents

Drifters 1/8° 1993-2012



Radar-Ekman 1993-2012





- Current along the shelf-break seen by drifters more intense and narrower than in the HF radar current

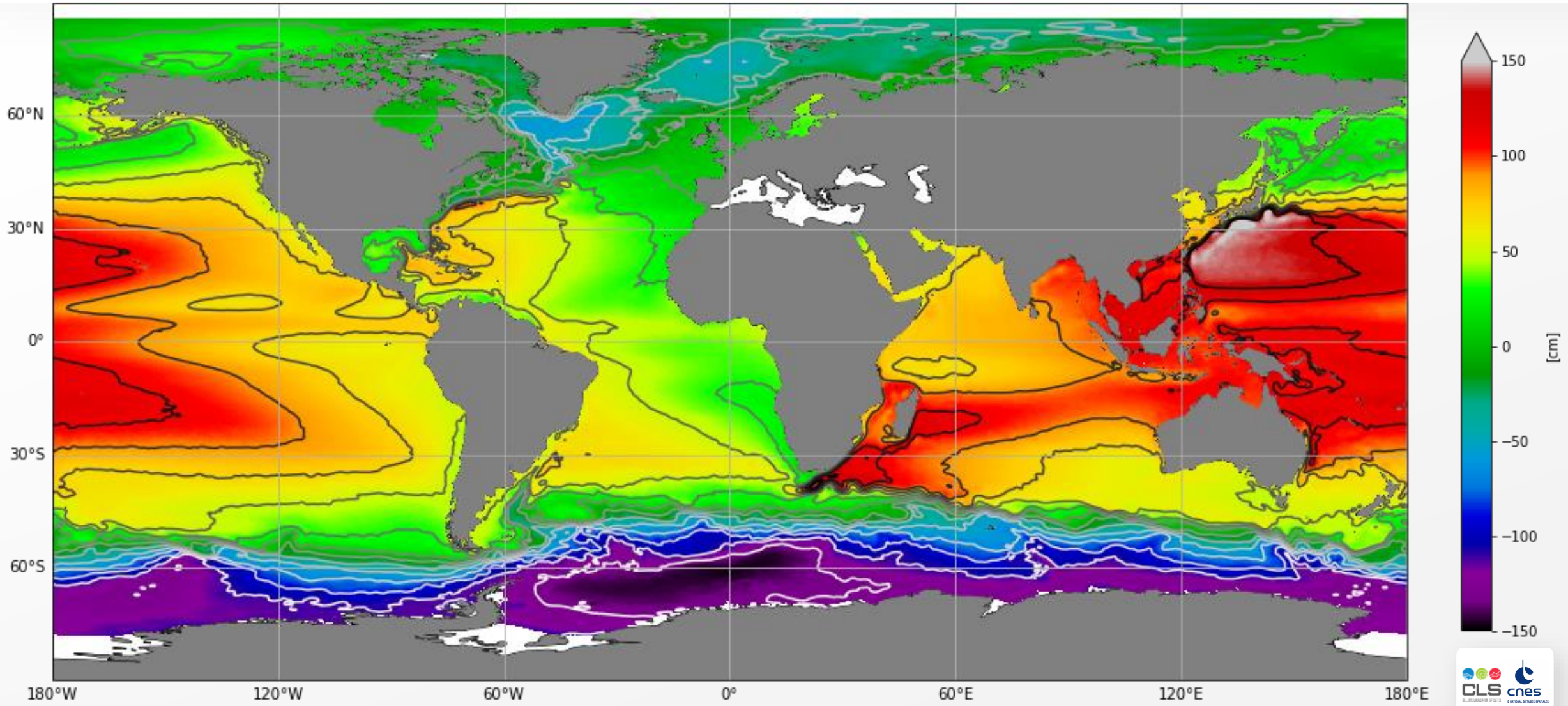
➢ Which data should we trust the most?

➢ We have chosen to rely more on HF radars because there is much more data

How to explain the differences between the two data sets ?

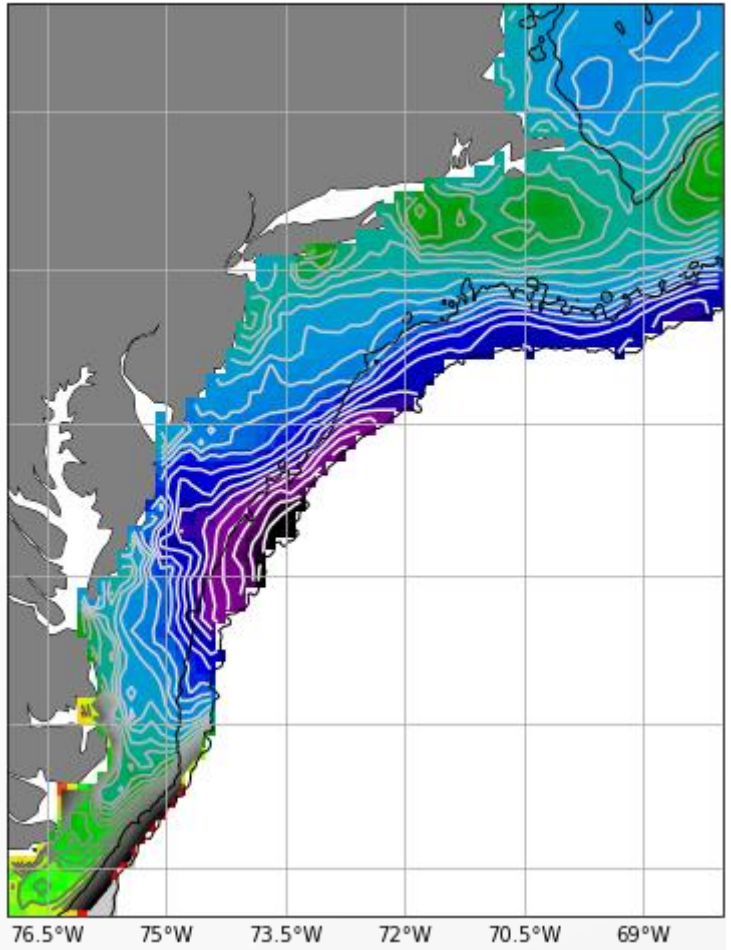
- Sampling:
  - Poor seasonal sampling for near-shore drifters (only summer and fall observations) and on the shelf-break (only spring observations)
  - For radars on the shelf-break: only winter observations
- Drifters have a tendency to accumulate in this front because of convergence and subduction, so there may be a sampling bias toward a narrow jet. [J. Wilkin].

New global MDT : MDT CNES-CLS22 beta version

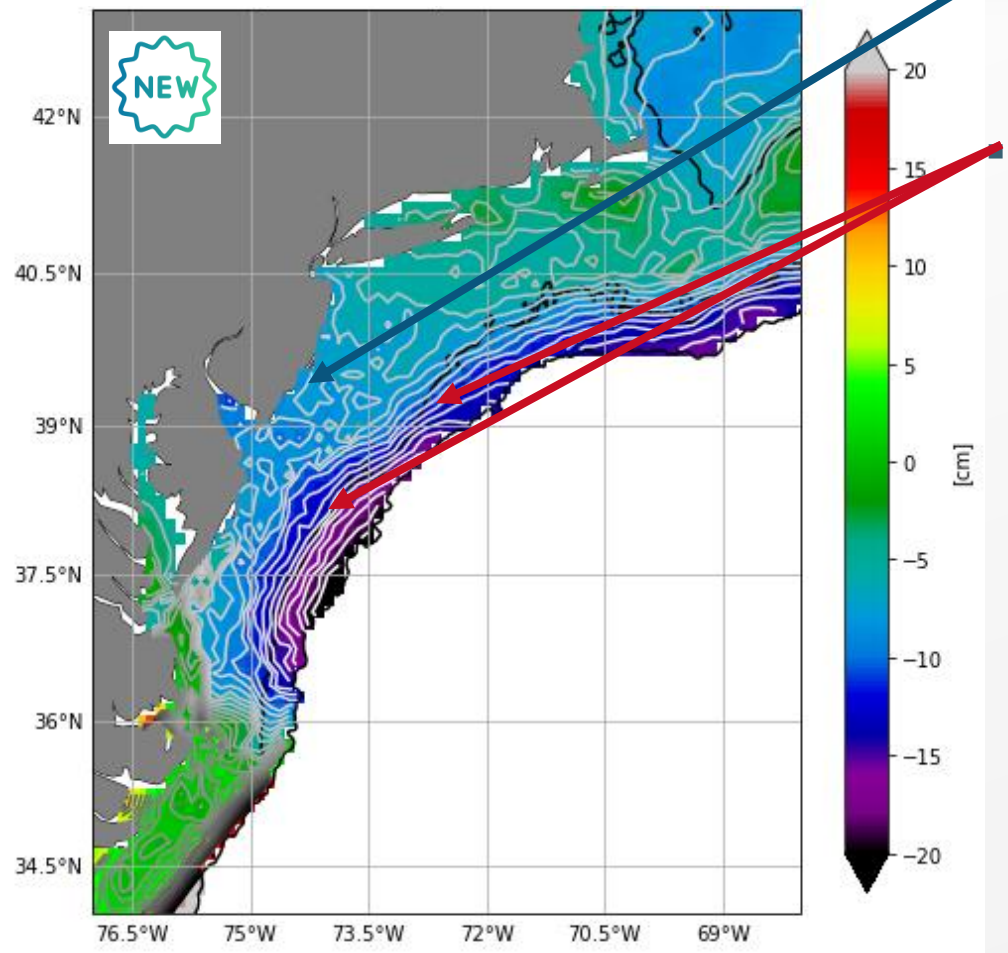


MDT CNES-CLS22 - zoom in Mid Atlantic Bight (HF radar data added)

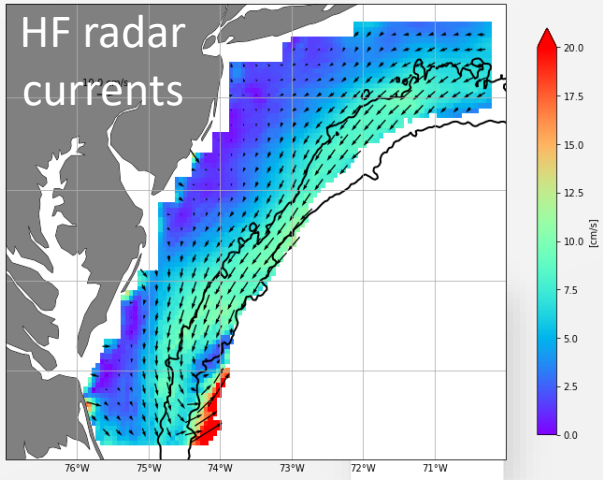
CNES-CLS18



CNES-CLS 2022β



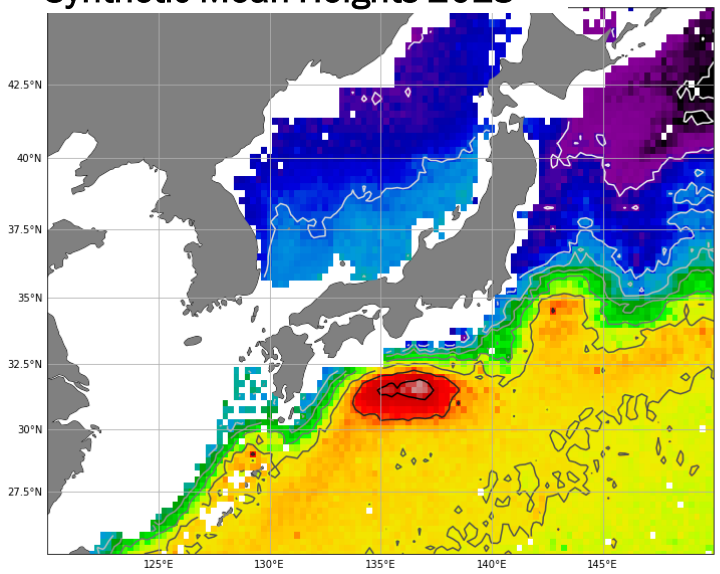
- No appreciable across-shelf gradient near the coast but very weak currents > **very influenced by the first-guess**
- A more organized across-shelf gradient following the shelf-break, suggestive of a more continuous mean flow along this region from 70W to 74W, **which is an improvement over the MDT CNES-CLS18** thanks to HF radar currents.



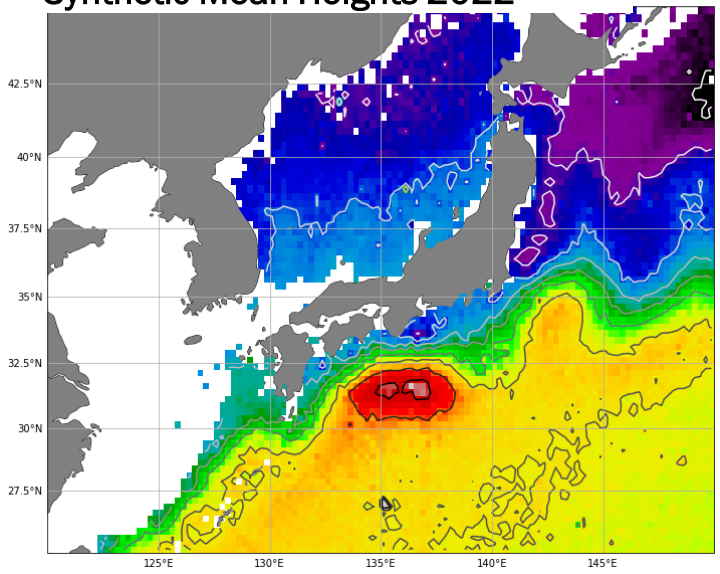
The contours are drawn every 1cm

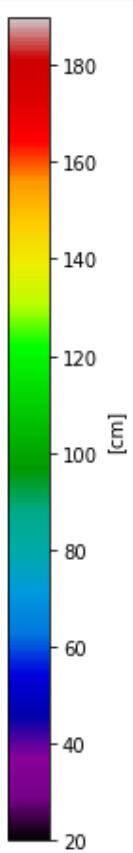
MDT CNES-CLS22 - zoom in Kuroshio

Synthetic Mean Heights 2018

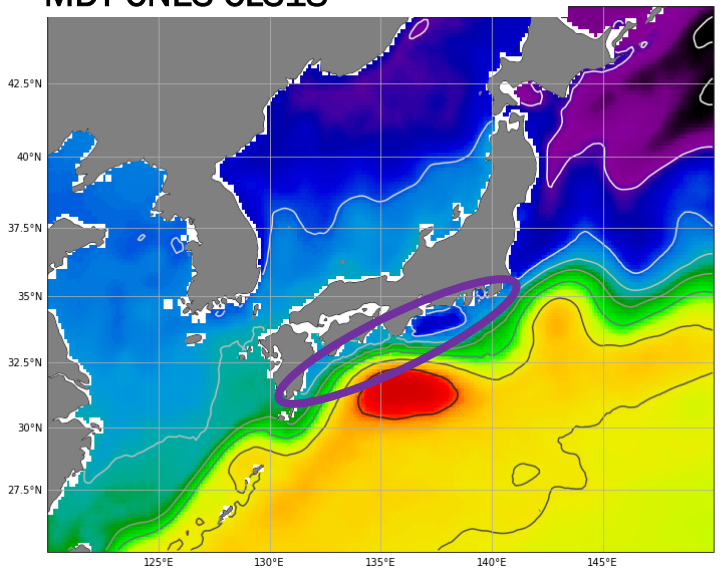


Synthetic Mean Heights 2022

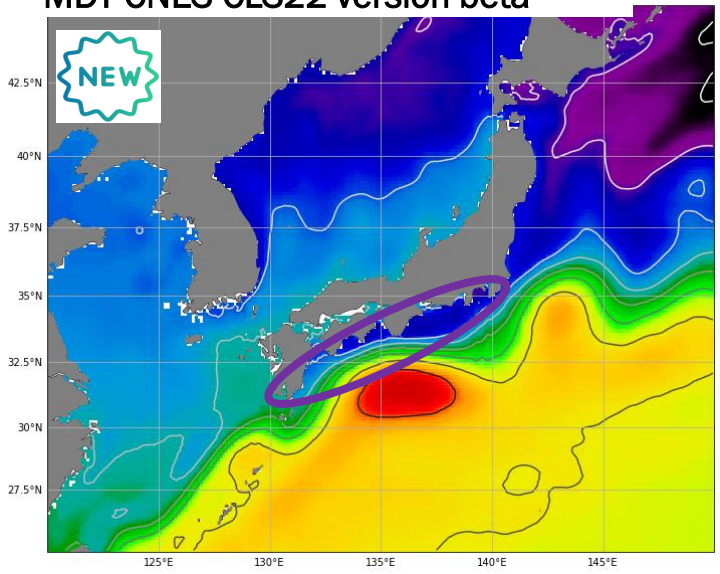




MDT CNES-CLS18

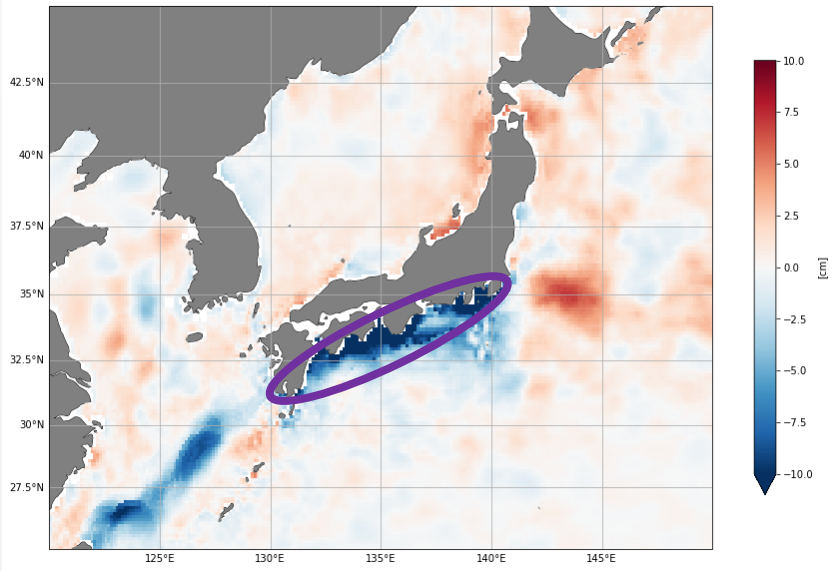


MDT CNES-CLS22 version beta



- Intensification/Widening of the Kuroshio because the MDT is deeper at the southern coast of Japan (we have more data in this area)

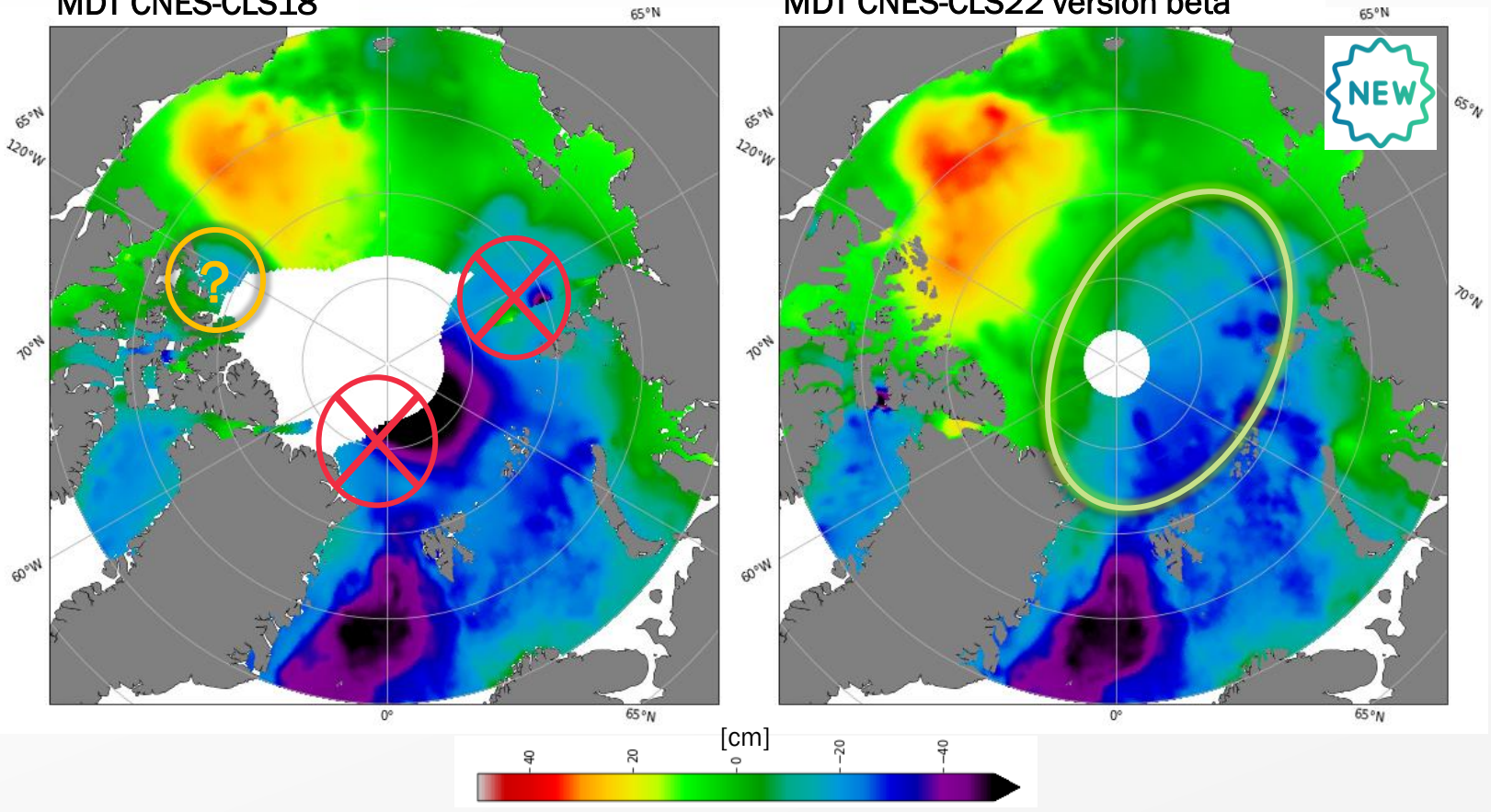
MDT CNES_CLS22 – MDT CNES_CLS18



MDT CNES-CLS22 - zoom in the Arctic

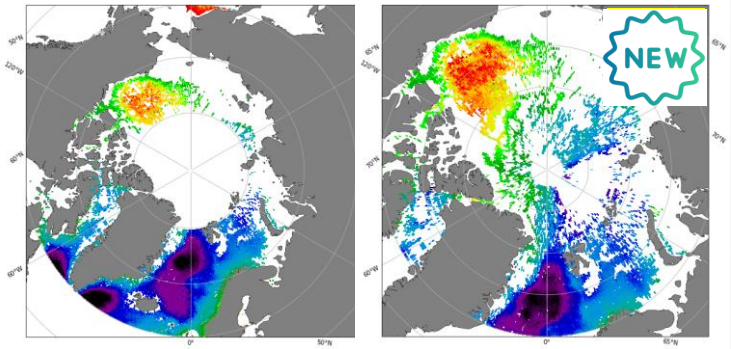
MDT CNES-CLS18

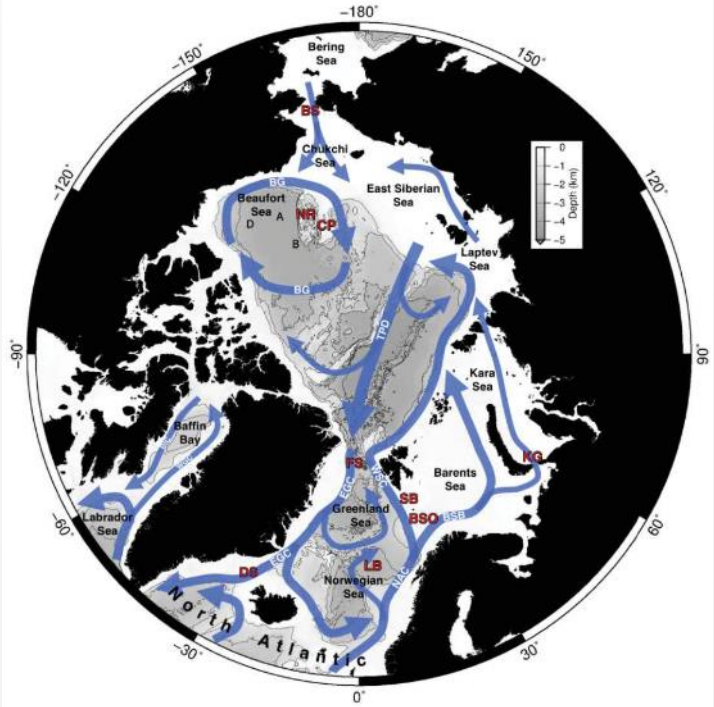
MDT CNES-CLS22 version beta



Processed T/S profiles (dynamic height) for

MDT CNES-CLS18 MDT CNES-CLS22



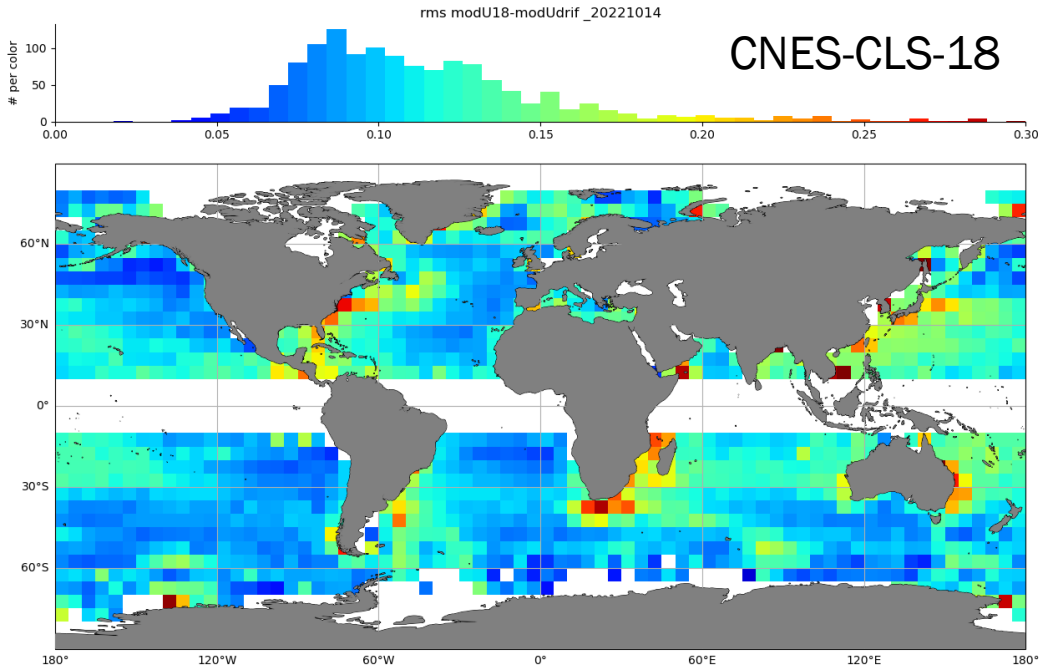


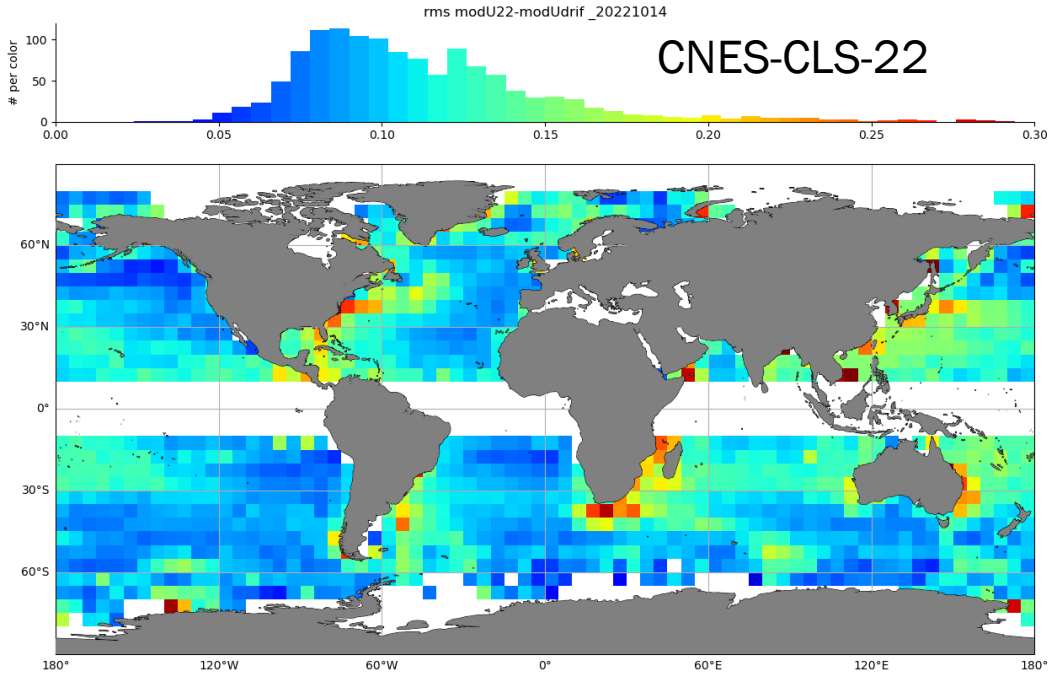
[Armitage et al., 2017]

➢ Improvement on the coverage and representation of large structures in Arctic

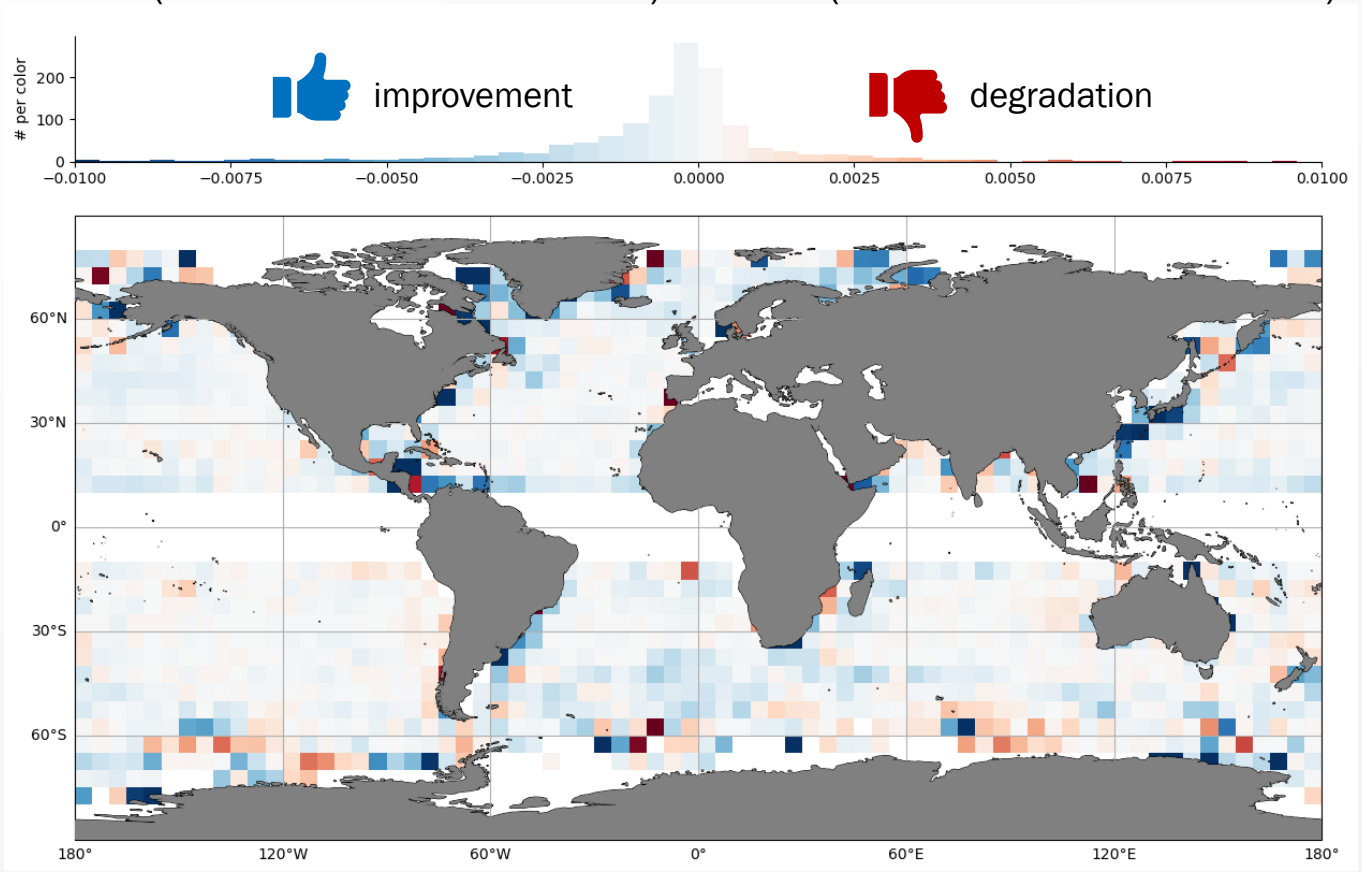
Validation with independent drifters – **current modulus**

RMS differences with drifters



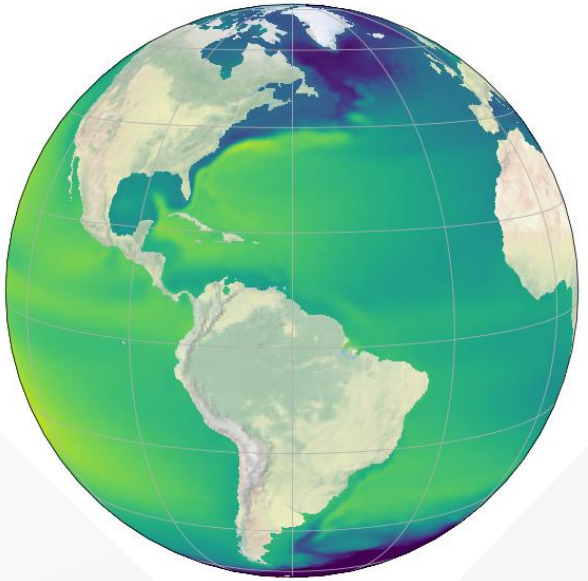


RMSD(CNES-CLS-22 vs drifters) - RMSD(CNES-CLS-18 vs drifters)



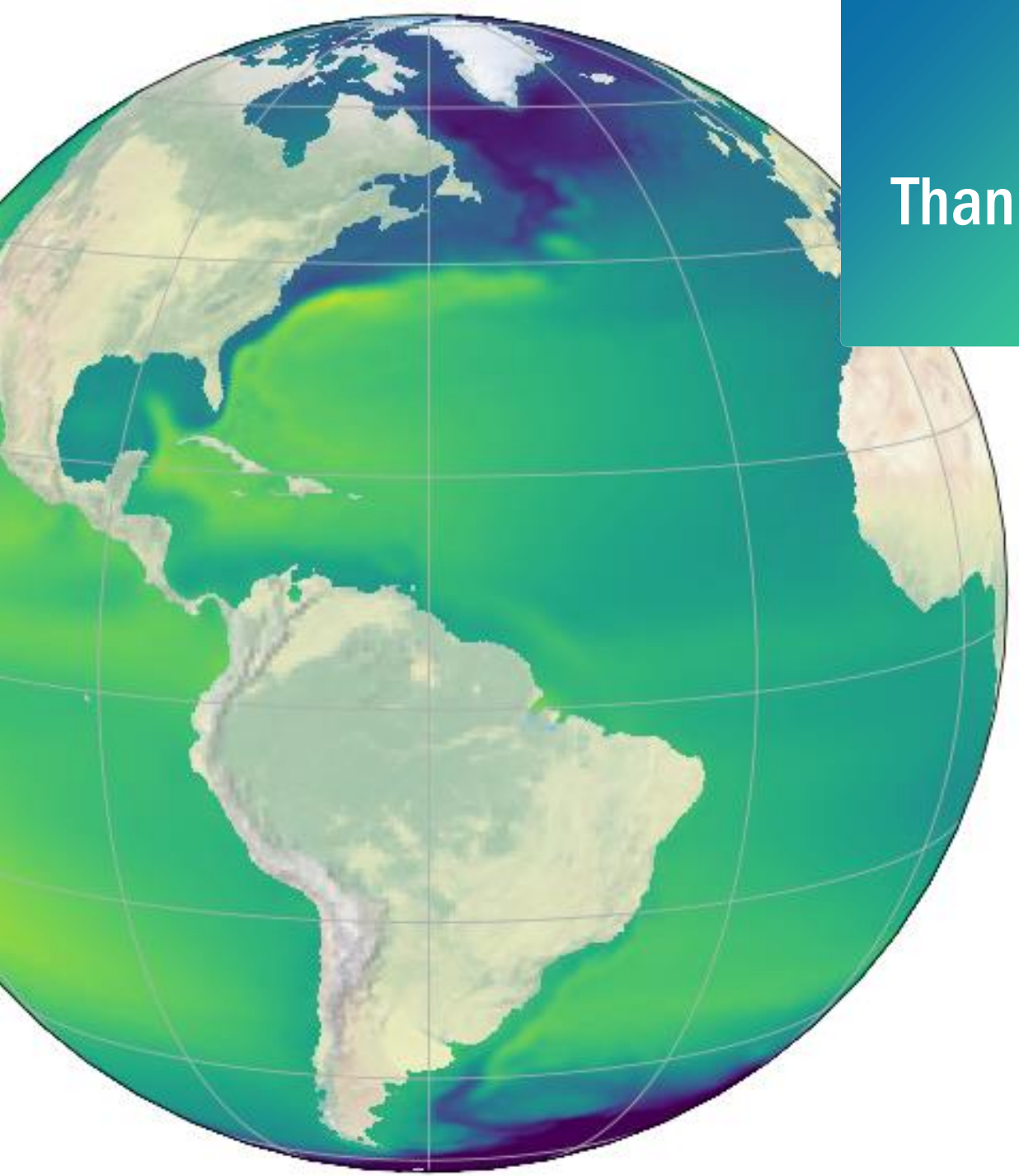
Global improvement even if deterioration in some boxes

Conclusions/Futur work



- HF radar data
  - need **substantial pre-processing** (here favourable case because data already detided, filtered and averaged)
  - allow a **better representation of the shelf-break current**
- Calculation of the new first-guess with the **new MSS** and the **new geoid** allowed
  - a **better coverage** and
  - a **better representation of the structures** in the **Arctic**
- Slight improvement compared to CNESCLS18 for drifters

- **End of 2022**: Finalize the new CNES-CLS2022 MDT
- Beta version distributed for beta users
  - happy to receive your feedbacks/validation soon
  - **If you are interested to be beta tester**, let me know sjousset@groupcls.com



Thank you

sjousset@groupcls.com