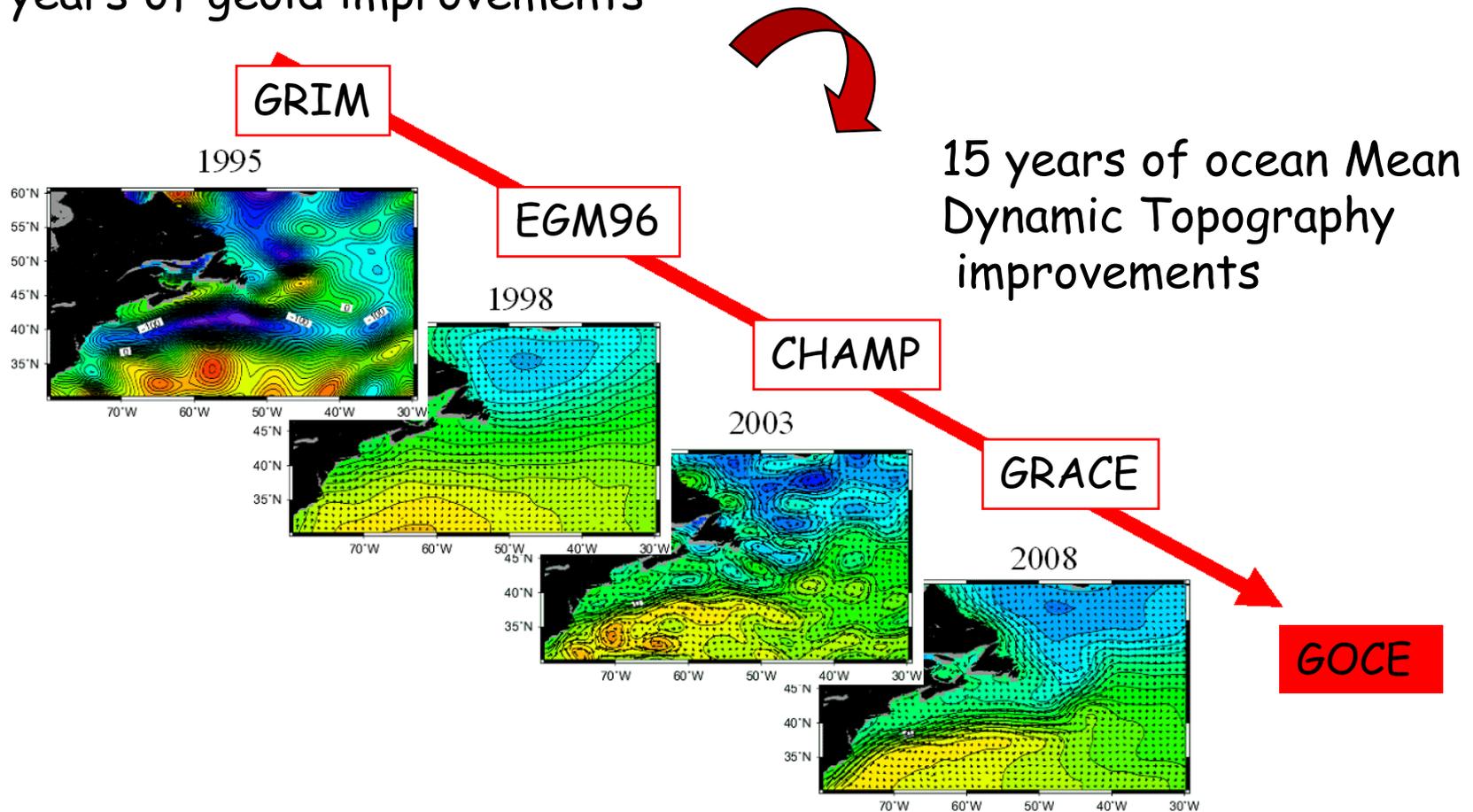


Use of oceanographic in-situ measurements and altimetry to assess the accuracy of the latest geoid models



M.-H. Rio, P. Schaeffer, M.F. Lequentrec-Lalancette

15 years of geoid improvements

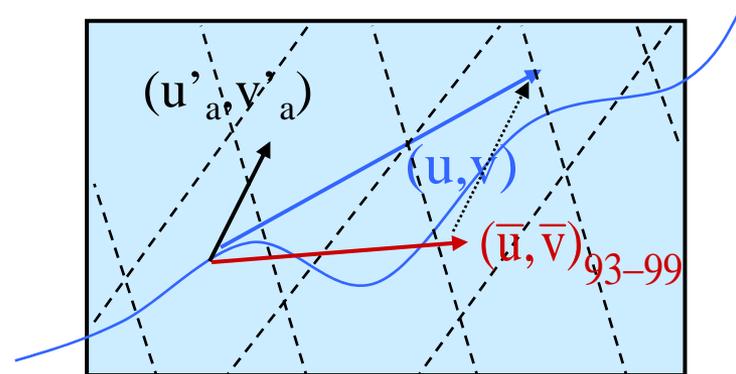
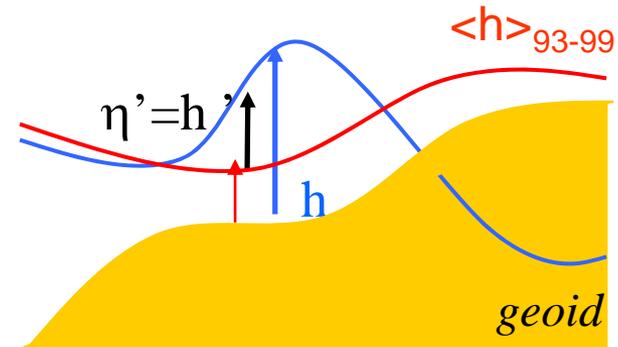
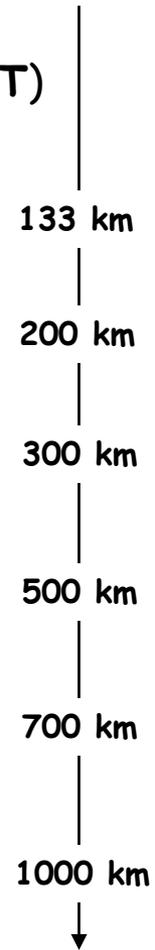
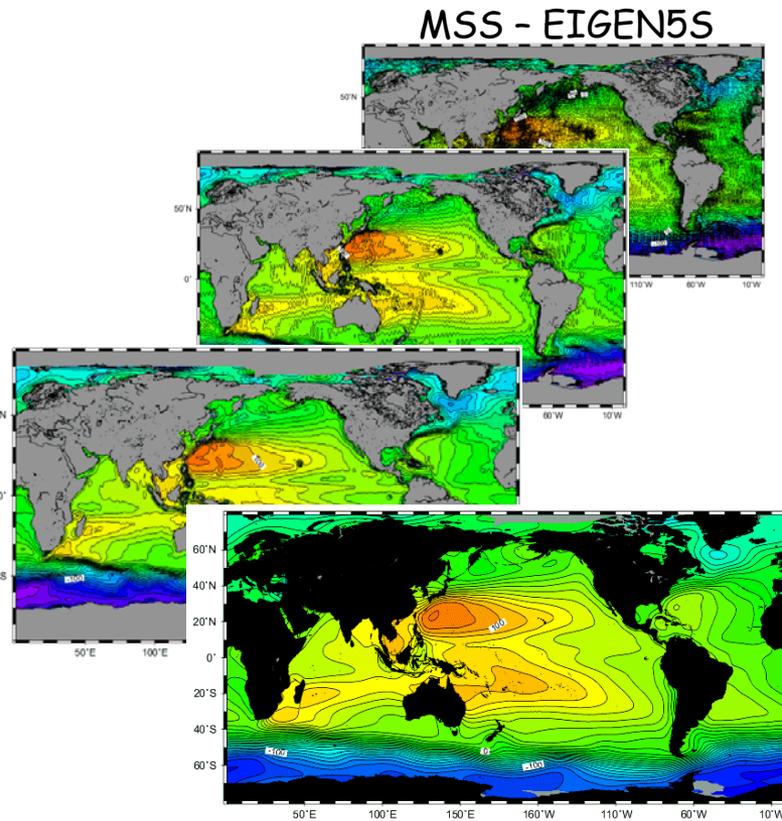


OSTST, November 2008, Nice

Method

Computation of the ocean Mean Dynamic Topography from filtered altimetric MSS - Geoid (direct MDT)

Use of in-situ oceanographic measurements and altimetry to compute **synthetic estimates of the MDT (and mean velocities)**



+ geostrophic mean surface currents

$$\text{RMS}^2_{\text{diff}} = \text{Err}^2_{\text{synth}} + \text{Err}^2_{\text{MSS}} + \text{Err}^2_{\text{Geoid/om}} + \text{Err}^2_{\text{Geoid/com}}$$

Data used

8 different geoid models

Model	Year	SH	Data
EGM96	1996	360	S/G/A
EGM08	2008	360	S/G/A
EIGEN3S	2005	150	GRACE (1 an)
EIGEN3C	2005	360	GRACE/G/A
GGM02S	2005	160	GRACE (1 an)
GGM02C	2005	200	GRACE (1 an)/G/A
EIGENGL05S	2008	150	5 ans GRACE + LAGEOS
EIGENGL05C	2008	360	GRACE/G/A

Altimetric data

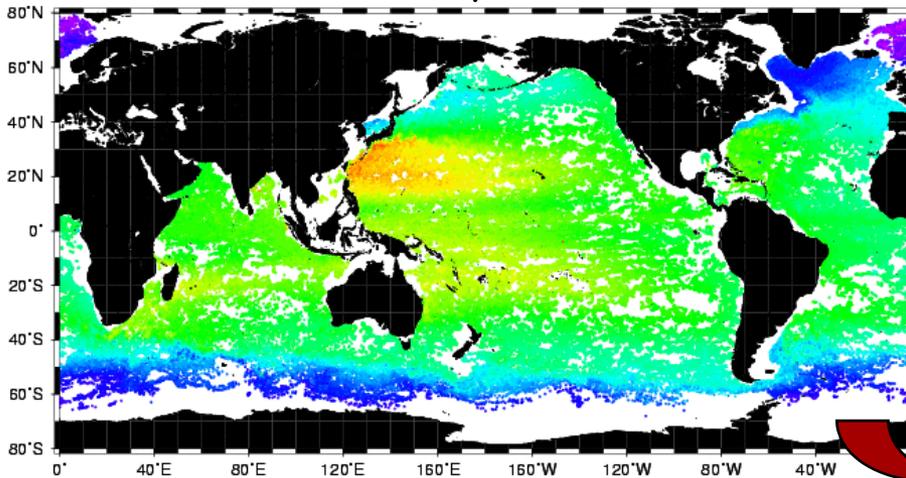
Altimetric Mean Sea Surface CLS01 (mean over 1993-1999)
Altimetric Sea Level Anomalies from Aviso for the 1993-2007 period

Data used

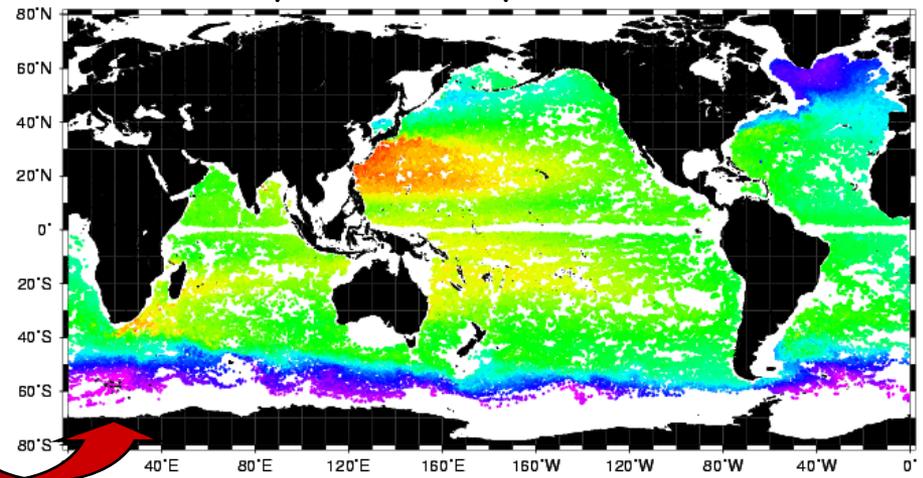
In-Situ oceanographic data

T/S profiles distributed via Coriolis for the 1993-2007 period
Used to compute dynamic heights relative to 1000m

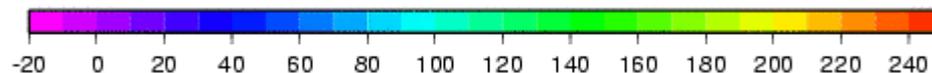
Hsynth



Hsynthtot=Hsynth+h1000

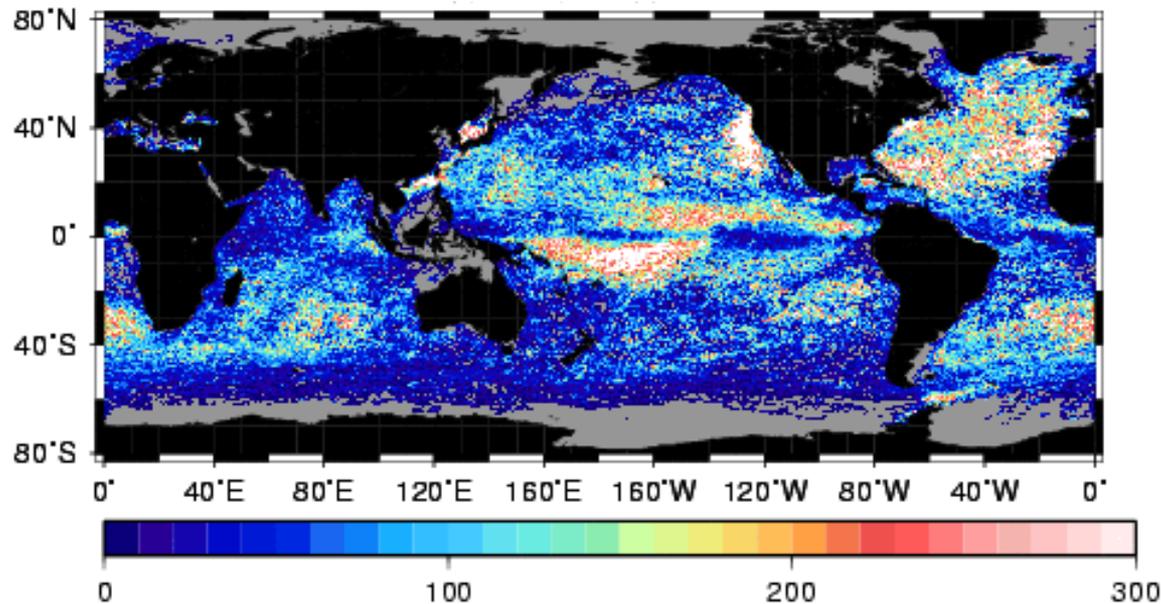


An estimate of the mean dynamic height at 1000m (Willis et al, 2006) is added to the dynamic heights relative to 1000m



Data used

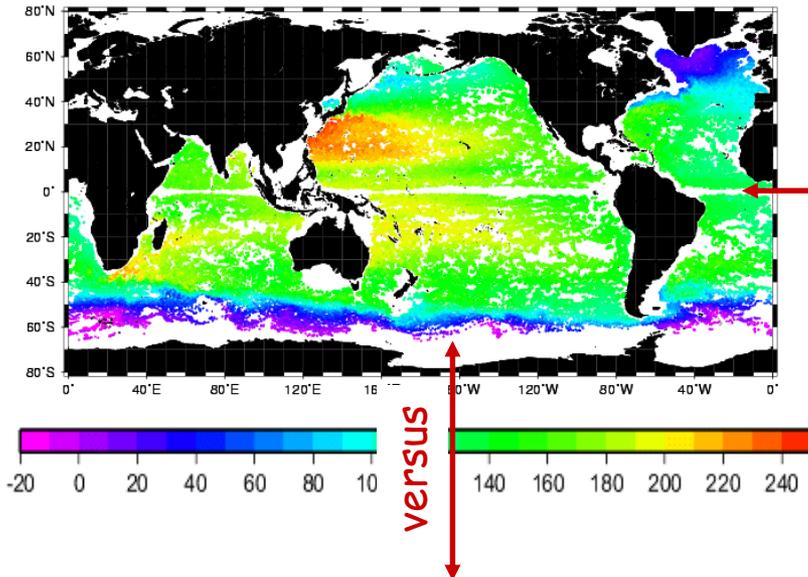
Surface current velocities measured by SVP type drifting buoys and distributed by AOML over the 1993-2007 period



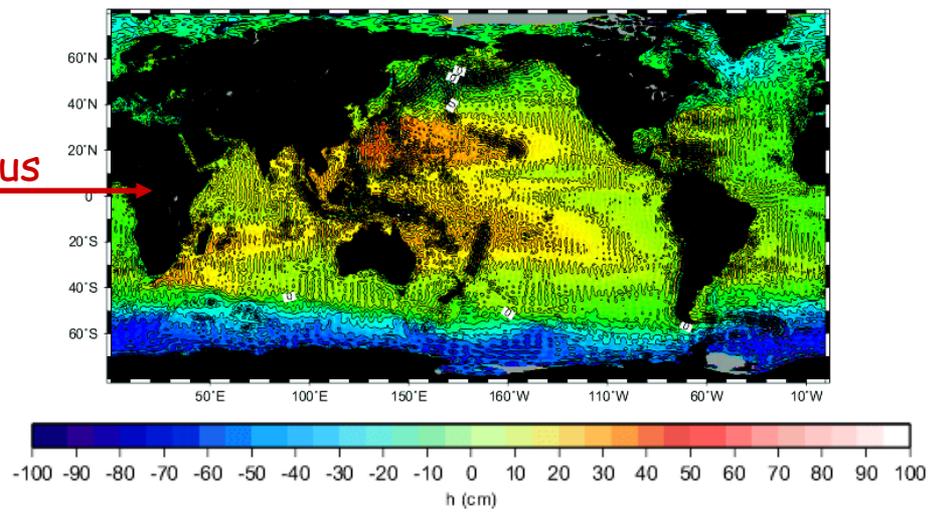
Drifter velocities are processed to extract the only-geostrophic component:
-Ekman currents are modeled (Rio et al, 2003) and subtracted
-A 3 days low pass filter is applied along the drifter trajectories

Results

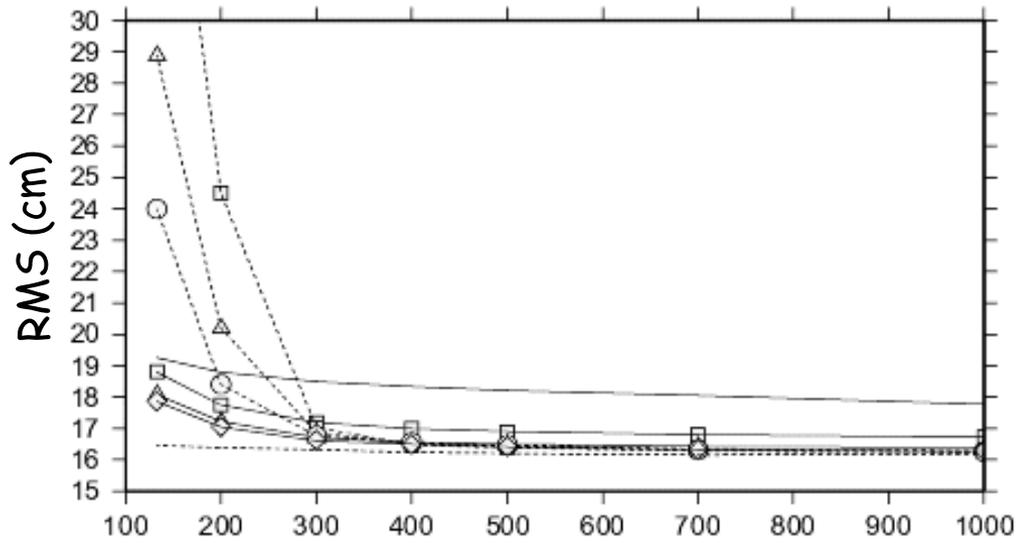
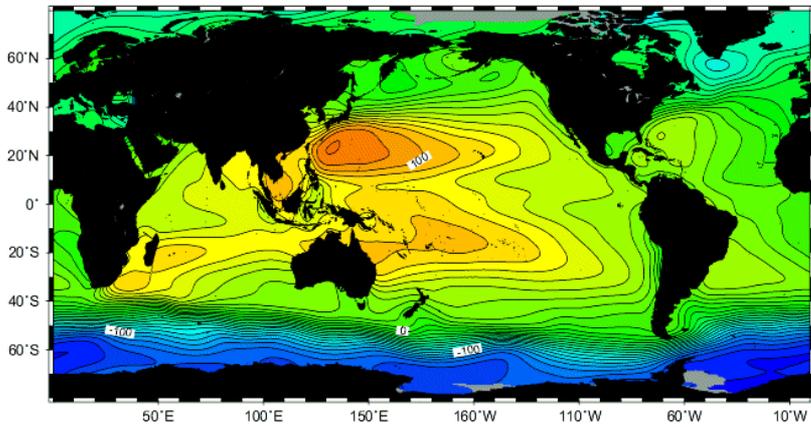
MDTsynth



MDT 133 km (MSS-EIGEN5S)



MDT 1000 km (MSS-EIGEN5S)

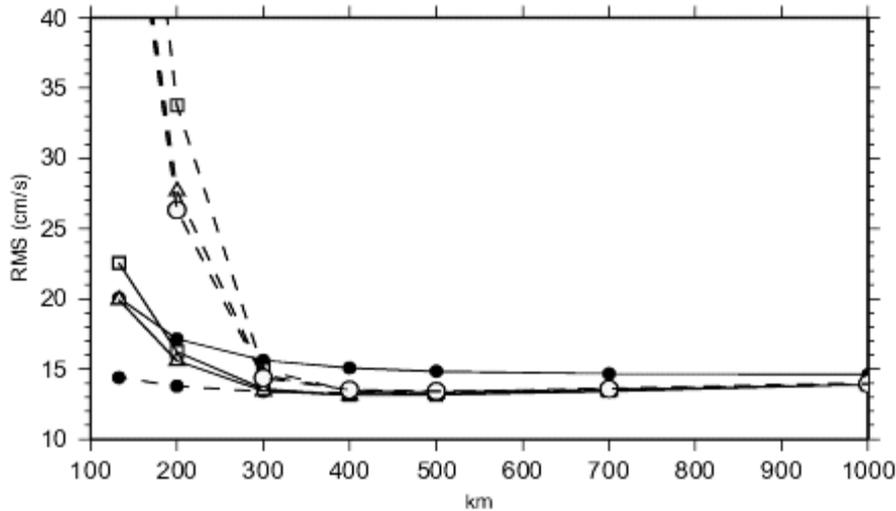


- EIGENGL05C
- △ EIGEN3C
- GGM02S
- EGM96
- GGM02C
- ⊙ EIGENGL05S
- △ EIGEN3S
- - - EGM08

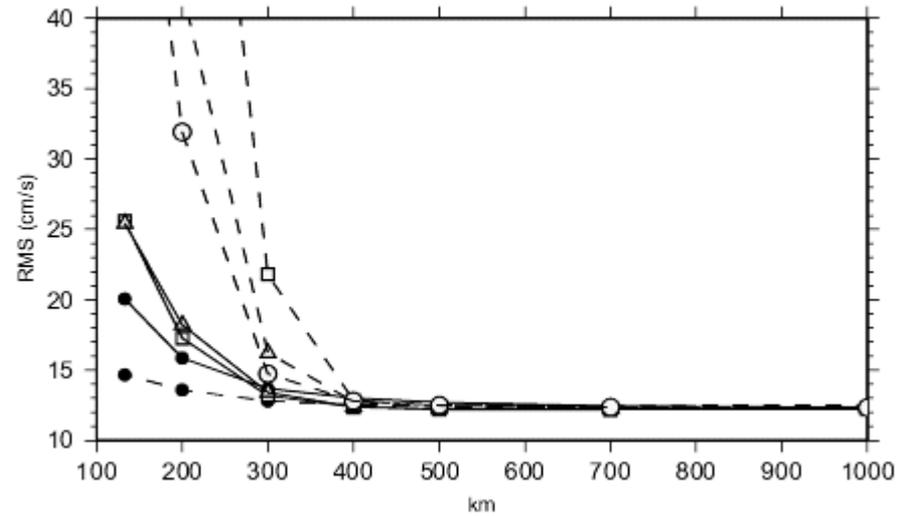
Results

Comparison to synthetic mean velocities

RMS U



RMS V

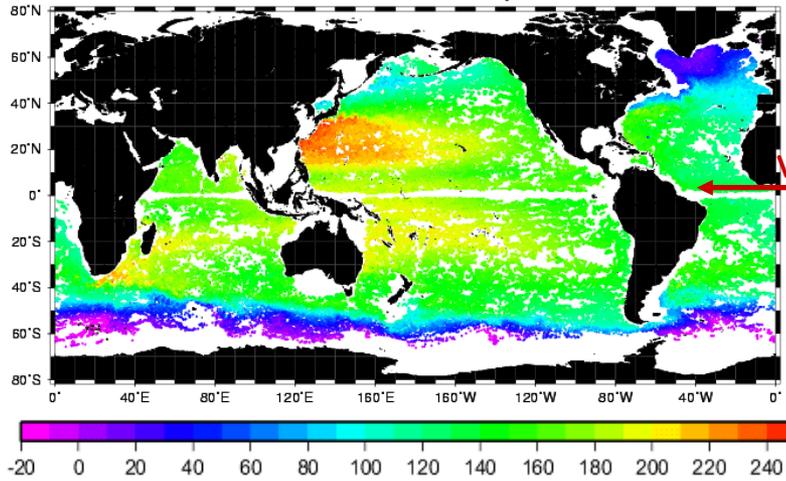


- | | | | | | | | |
|-----|------------|-------|------------|-------|---------|-------|-------|
| —○— | EIGENGL05C | —△— | EIGEN3C | --□-- | GGM02S | —●— | EGM96 |
| —□— | GGM02C | --○-- | EIGENGL05S | --△-- | EIGEN3S | --●-- | EGM08 |

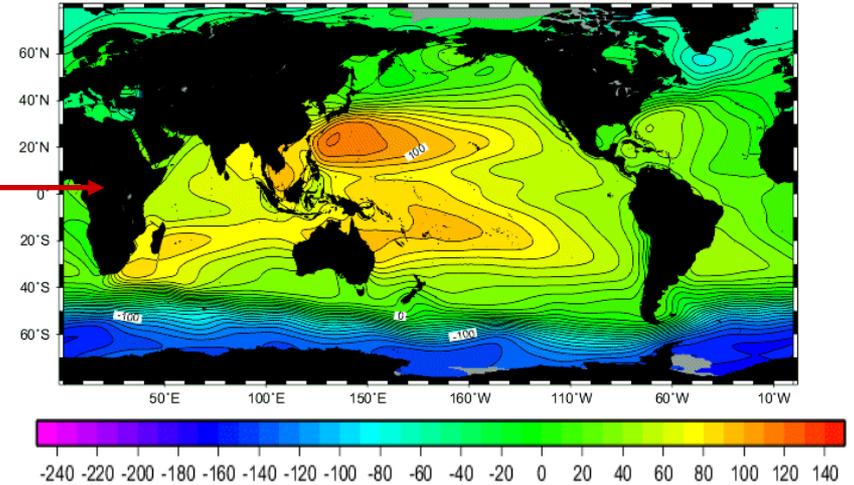
Results

$$RMS^2_{diff} = Err^2_{synth} + Err^2_{MSS} + Err^2_{Geoid/com} + Err^2_{Geoid/om}$$

MDT synth



MDT 1000 km (MSS-EIGEN5S)



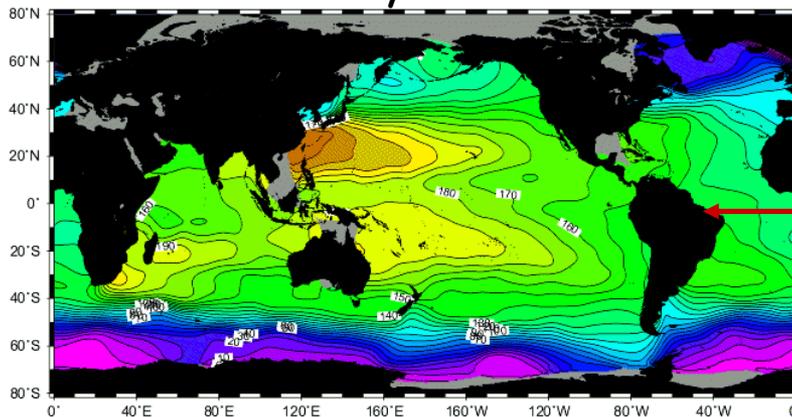
versus

If synthetic estimates are also filtered at the same resolution than the direct estimates

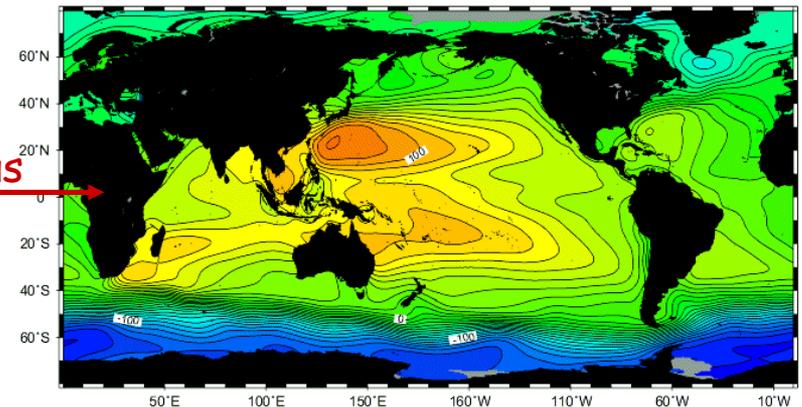
$$RMS_f^2_{diff} = Err^2_{synth} + Err^2_{MSS} + Err^2_{Geoid/com} + \cancel{Err^2_{Geoid/om}}$$

MDT synth 1000km

MDT 1000 km (MSS-EIGEN5S)

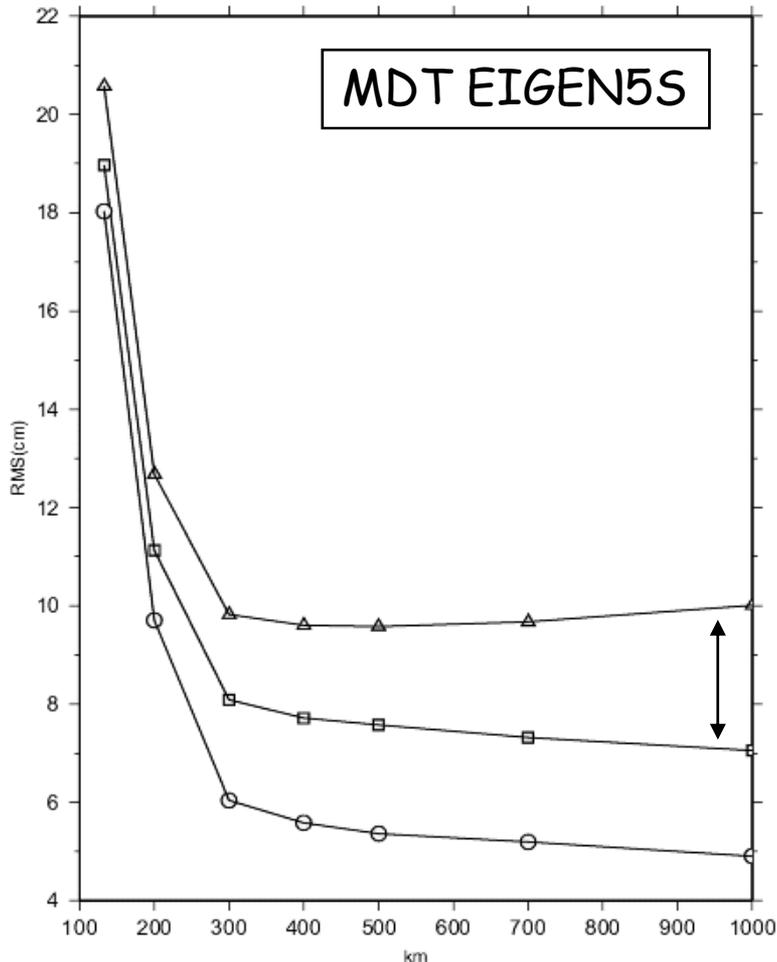


versus



Results

Comparison to filtered / unfiltered synthetic heights



- △ Comparison to unfiltered synthetic heights (relative to 1000m)
- Comparison to filtered synthetic heights (relative to 1000m)
- Comparison to filtered synthetic heights (total)

$$\approx \text{Err}^2_{\text{Geoid/om}}$$



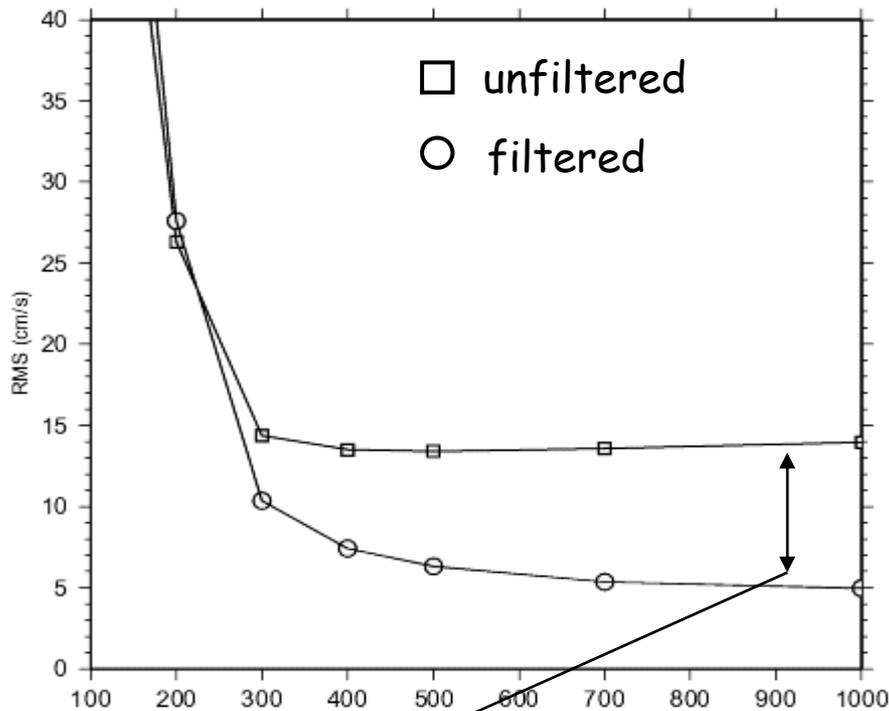
Short scales resolved by the synthetic estimates and not resolved by the filtered geoid-based MDTs

Results

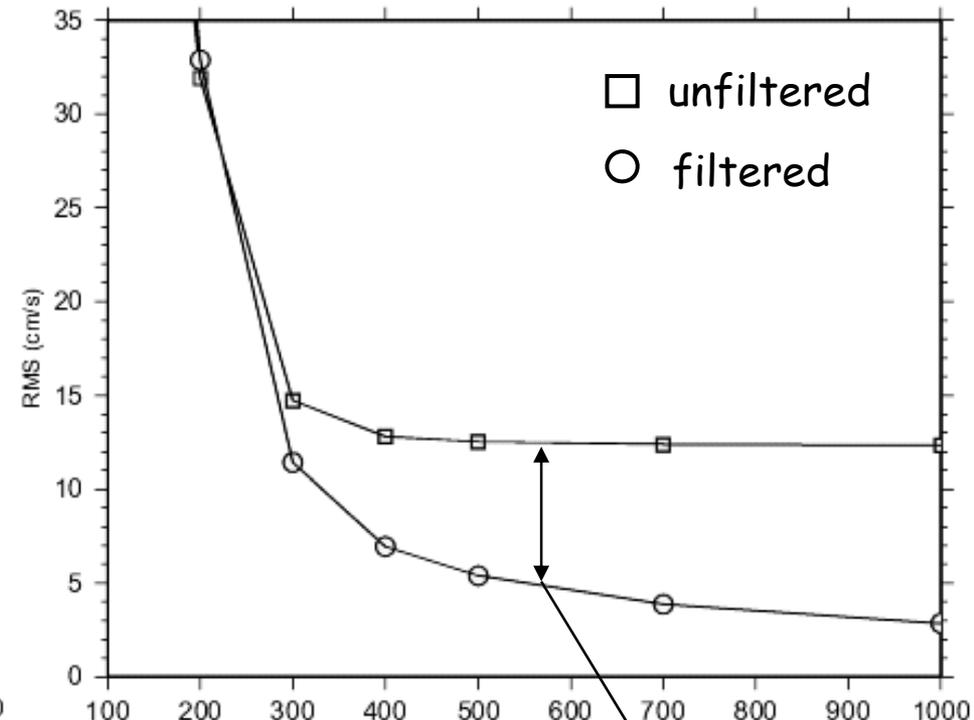
Comparison to filtered / unfiltered synthetic velocities

MDT EIGEN5S

RMS U



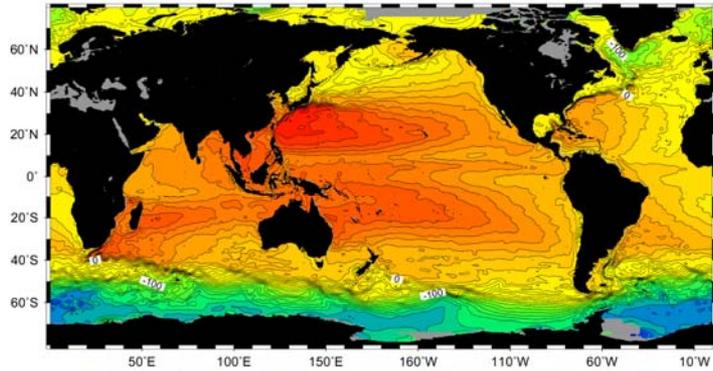
RMS V



Short scales resolved by the synthetic estimates and not resolved by the filtered geoid-based MDTs

Application of the synergy btw direct /synthetic estimates

CMDT RIO05

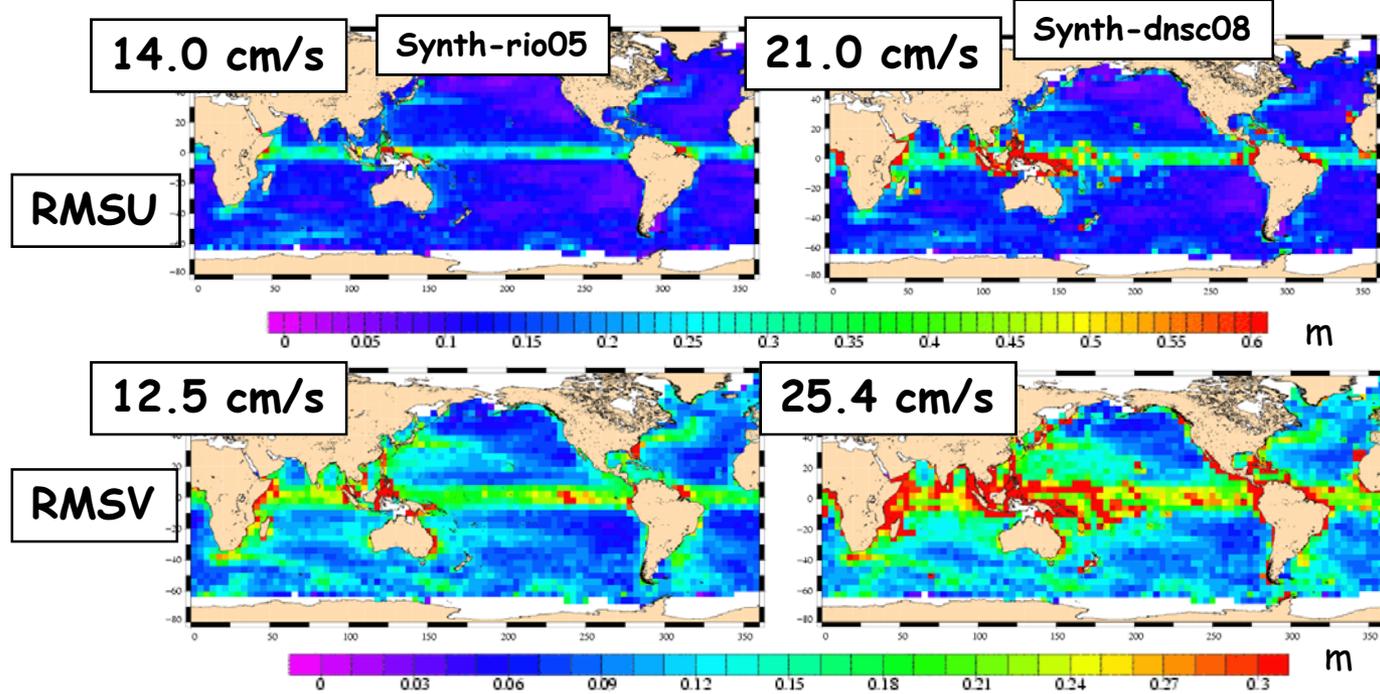


Combination of satellite only geoid-based MDT and synthetic height and velocity estimates to compute high resolution MDT (Rio et al, 2005 based on EIGEN3S MDT + in-situ-altimetric data from 1993 to 2003)

How does it compare to high resolution combined geoid-based MDTs?

MDT from MSS - EGM08 (O. Andersen, DNSC)

RMS differences with synthetic velocities based on altimetry and drifter velocities (2004-2008) NOT used in the CMDT RIO05 computation



Conclusions

- **Method routinely used to assess the accuracy of new geoid models**
Based on the comparison, at different space scales, between direct and synthetic estimates of the Mean Dynamic Topography
- **Satellite only geoids:** Significant improvement of EIGEN5S compared to previous models (EIGEN3S-GGM02S)
=> Same accuracy than combined models at scales larger than 300km
- **Combined geoids:** Very good performance of new EGM08
- Synthetic estimates contain much shorter scales than direct MDT based on Satellite-only solutions => **combination with synthetic estimates needed to compute high resolution MDT solutions** (Rio et al, 2004,2005,2007 + updated solution for 2009 - see poster SF.8 -127 about the SLOOP project)
- Such combined MDTs perform better than direct MDTs based on MSS minus combined geoid (e.g. EGM08)