

DYNAMIC OCEAN TOPOGRAPHY (DOT)

—

FIRST ESTIMATES WITH GOCE GRAVITY FIELDS

Wolfgang Bosch and Roman Savcenko
Deutsches Geodätisches Forschungsinstitut (DGFI), München
E-mail: bosch@dgfi.badw.de

The geodetic way

Equation

$$DOT = h - N$$

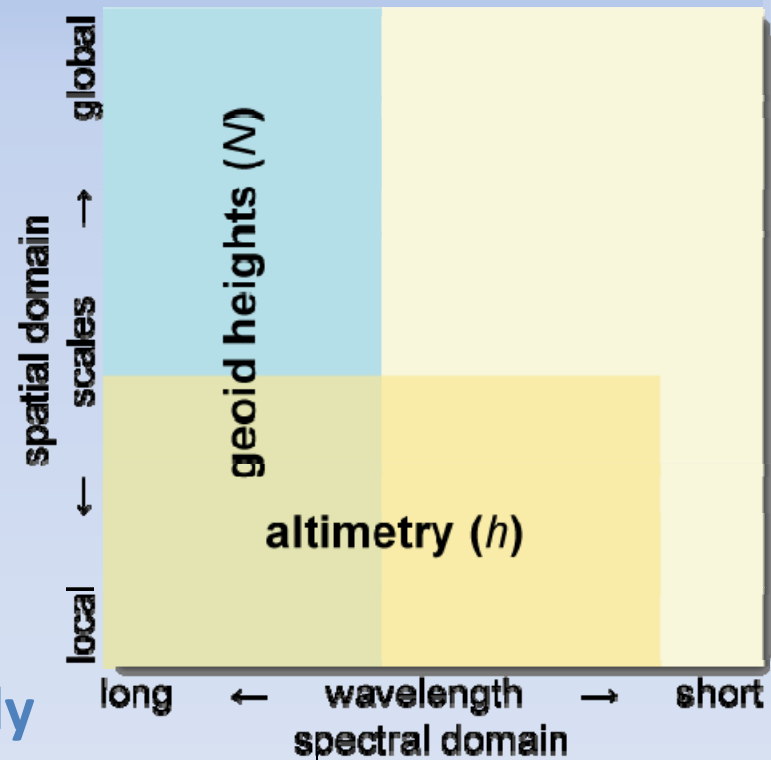
not as simple as it seems!

Geoid heights N

- are defined everywhere
- Relative smooth
(from spherical harmonics)

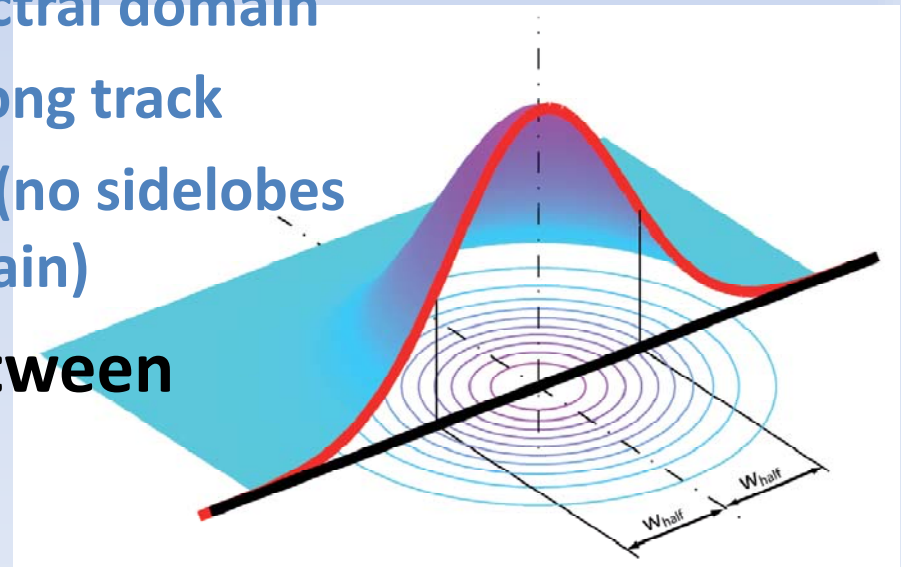
Sea surface heights h

- observed on ocean profiles only
- High along-track resolution (e.g. 7km sampling)



The „profile approach“ - rationale

- **Perform differences $h - N$ on individual altimeter profiles**
 - Avoids initial gridding of h with undesirable smoothing
 - No artificial extension of h on land
- **Consistent low-pass filtering to both, h and N**
 - N can be filtered in the spectral domain
 - h must be filtered in 1-D along track
 - Gauss-type filter preferred (no sidelobes in spectral and spatial domain)
- **Systematic differences between 1-D and 2-D filtering**

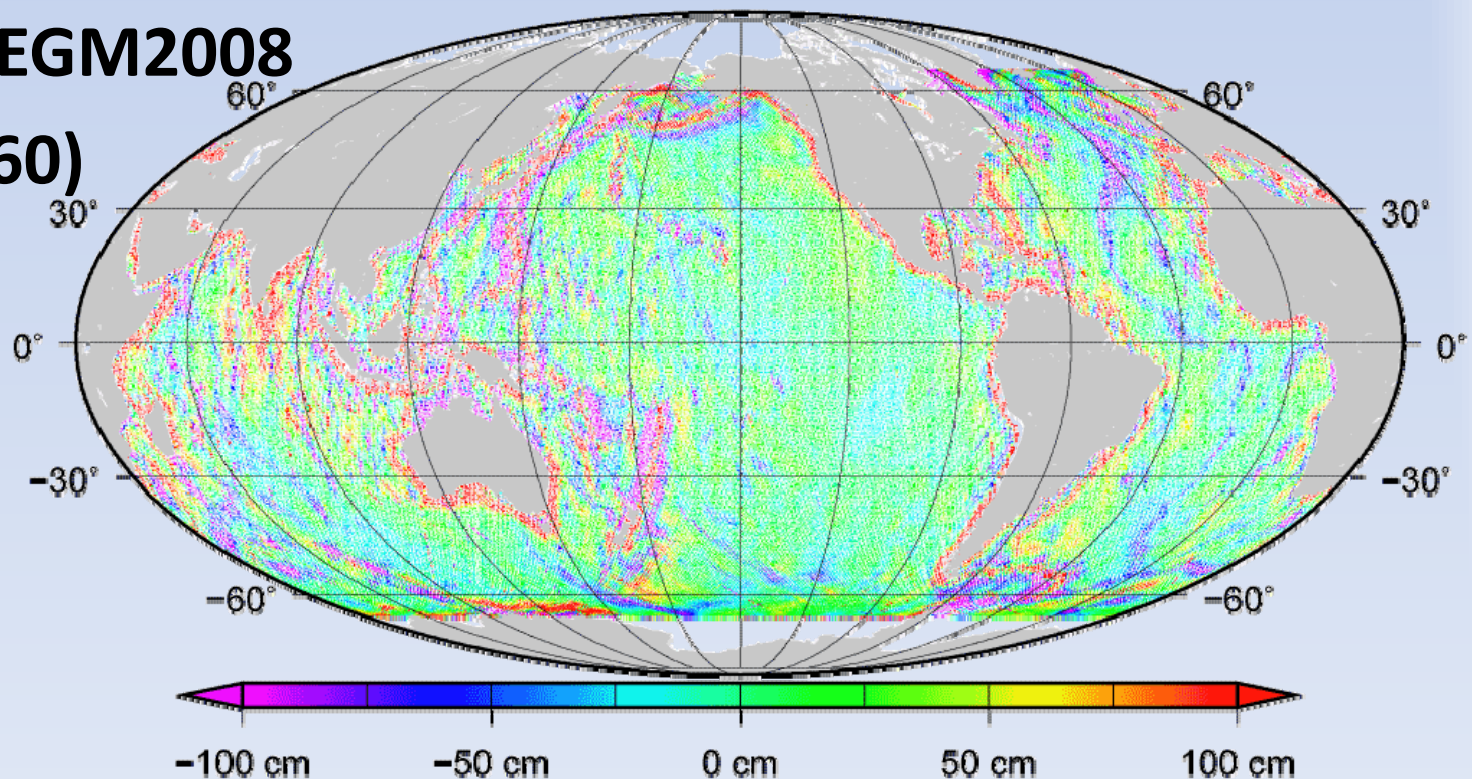


Filter Correction

accounting for systematic differences between 1-D and 2-D filtering

- $2D[h] = 1D[h] + (2D[h] - 1D[h])$
 $\approx 1D[h] + (2D[N_{\text{high-res}}] - 1D[N_{\text{high-res}}])$
Filter correction

$N_{\text{high-res}}$ of EGM2008
($L_{\text{max}}=2160$)



DOT computation on individual profiles

$$\begin{aligned}\text{DOT} &= 2D[h - N] \\ &= 2D[h] - 2D[N] \\ &= 1D[h] + (2D[N_{\text{high-res}}] - 1D[N_{\text{high-res}}]) - 2D[N]\end{aligned}$$

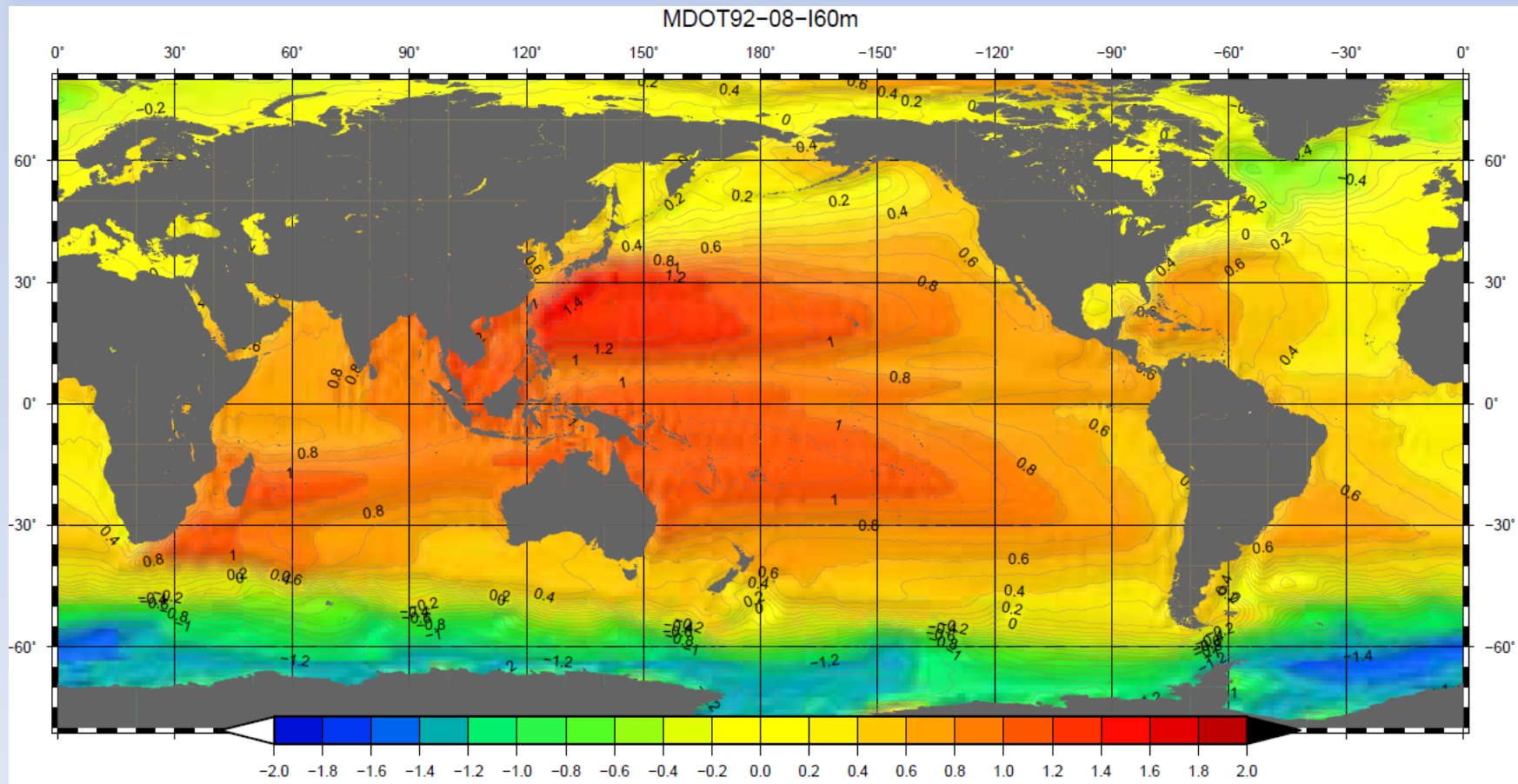
It's even more favourable to re-order:

$$\begin{aligned}\text{DOT} &= 1D[h] - 1D[N_{\text{high-res}}] + 2D[N_{\text{high-res}}] - 2D[N] \\ &= 1D[h - N_{\text{high-res}}] + 2D[N_{\text{high-res}} - N]\end{aligned}$$

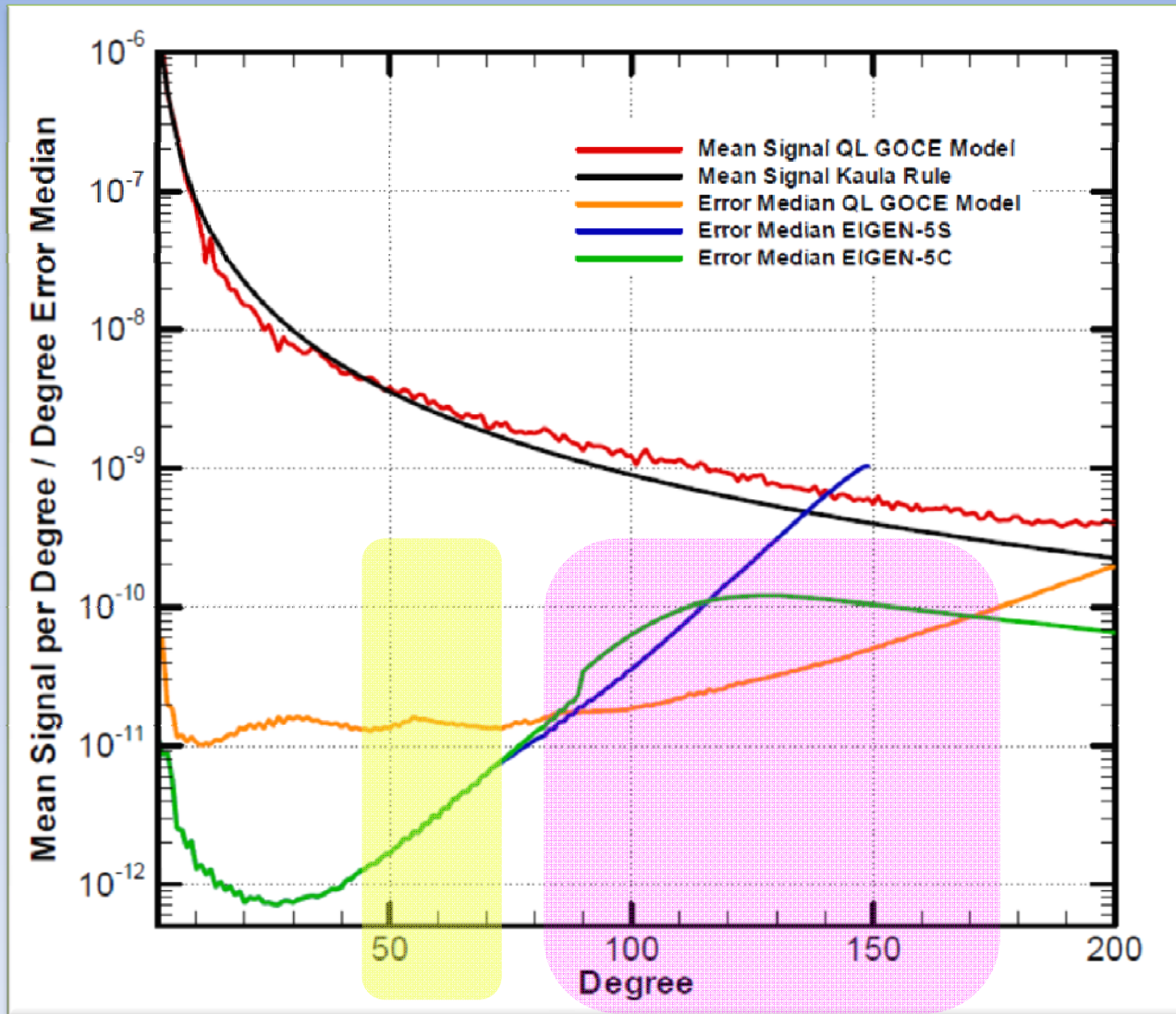
„Pre-Geoid Correction“

Pre-GOCE results

Using ITG03S & multi-mission altimetry for 1992-2008
with Gauss Filter Width $D = 241\text{km}$ ($L=60$)



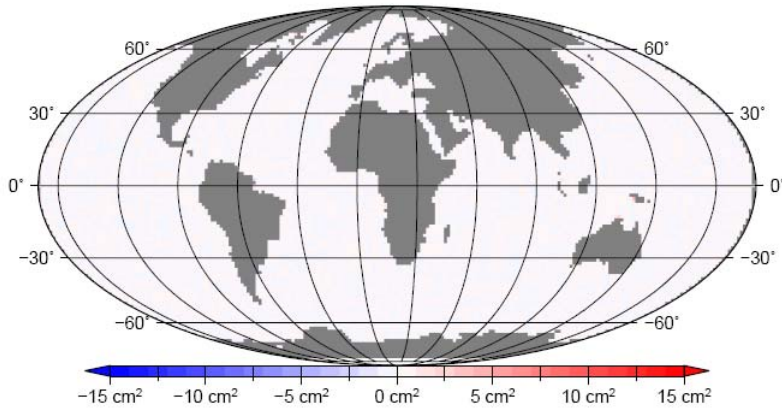
Rationale for higher resolution: QL-GOCE



Increase in signal variance [cm²]

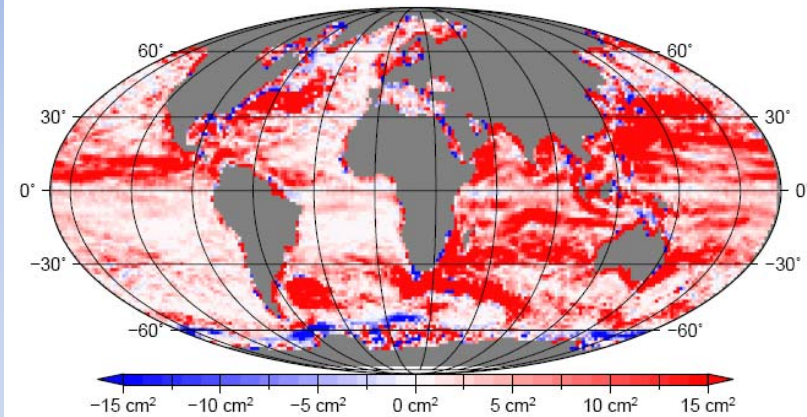
GRACE versus GOCE; Filter D=241km/L=60

ITG-Grace03s - GOCO JW241.6667km



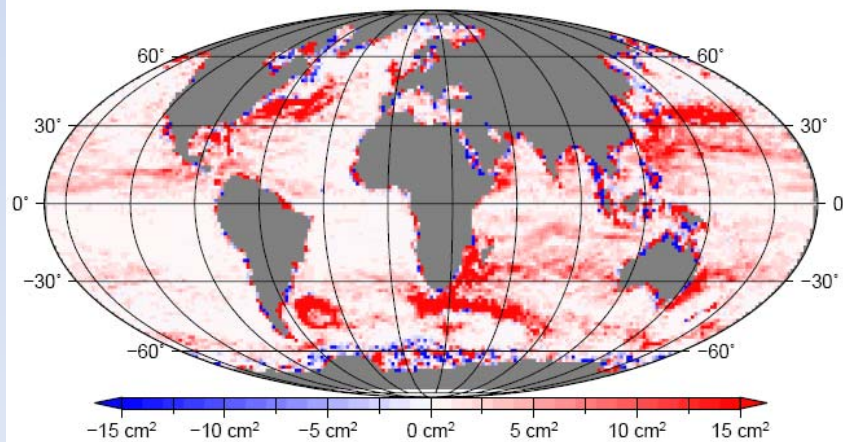
GOCE: ΔFilter D=121km/L=120 – D=241km/L=60

GOCO (JW 241.6667km - 120.8333km)



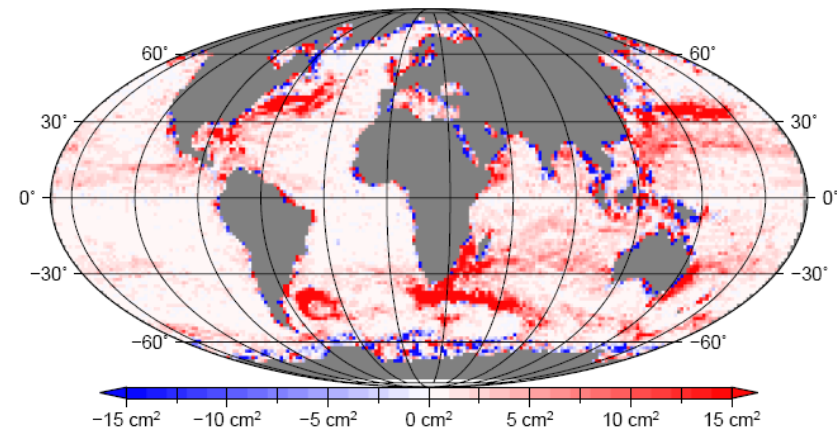
GOCE: ΔFilter D=97km/L=150 – D=121km/L=120

GOCO (JW 120.8333km - 96.6667km)

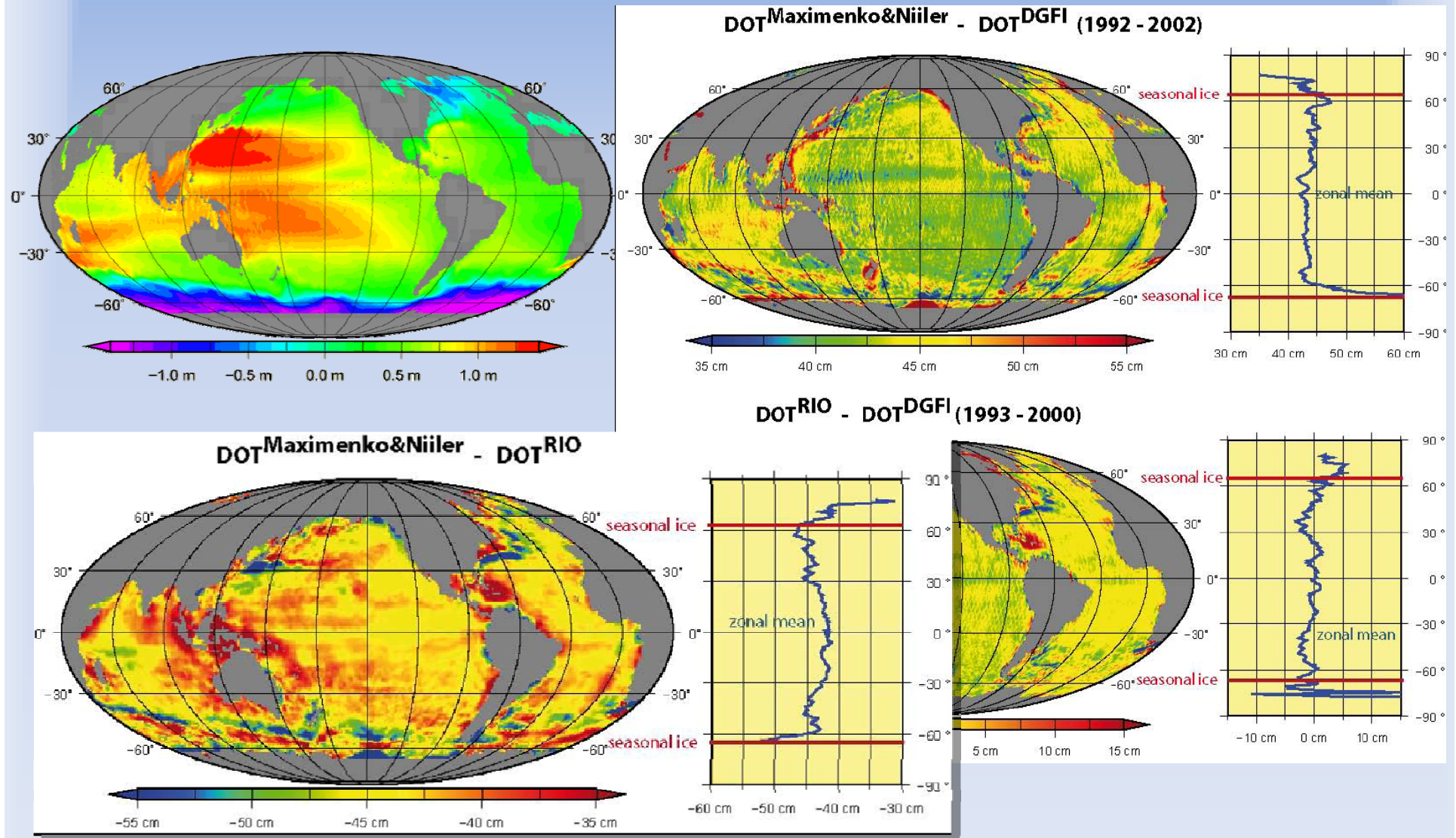


GOCE: ΔFilter D=80km/L=180 – D=97km/L=150

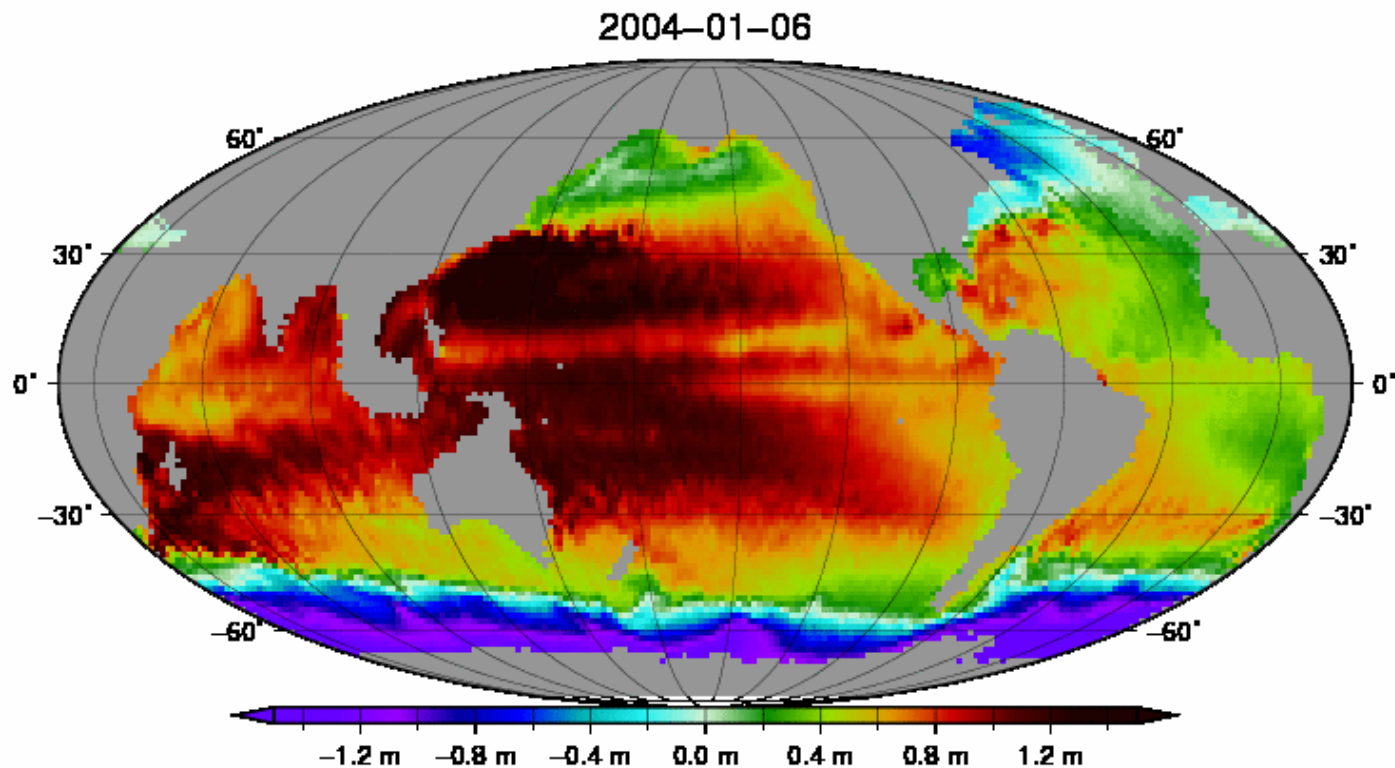
GOCO (JW 96.6667km - 80.5556km)



Mean GOCE DOTs (D=121km/L=120) compared with external estimates



DOT variations in 2004 (GOCO1S geoid; Filter width $D=121\text{km}/L=120$)



Conclusions

- The geodetic „profile approach“ performs spectrally consistent differences $h - N$
- DOT profiles show reasonable pattern with no artifacts in coastal area
- Compared to GRACE, the first GOCE gravity field allows at least to double the DOT resolution (D=121km/L=120)
- The profile approach is applied to individual altimeter profiles and thus provides „instantaneous“ DOT-profiles

**Thanks
for your attention !**

DOT computation on individual profiles

$$\begin{aligned}\text{DOT} &= 2D[h - N] \\ &= 2D[h] - 2D[N] \\ &= 1D[h] + (2D[N_{\text{high-res}}] - 1D[N_{\text{high-res}}]) - 2D[N]\end{aligned}$$

Re-ordering is even more favourable

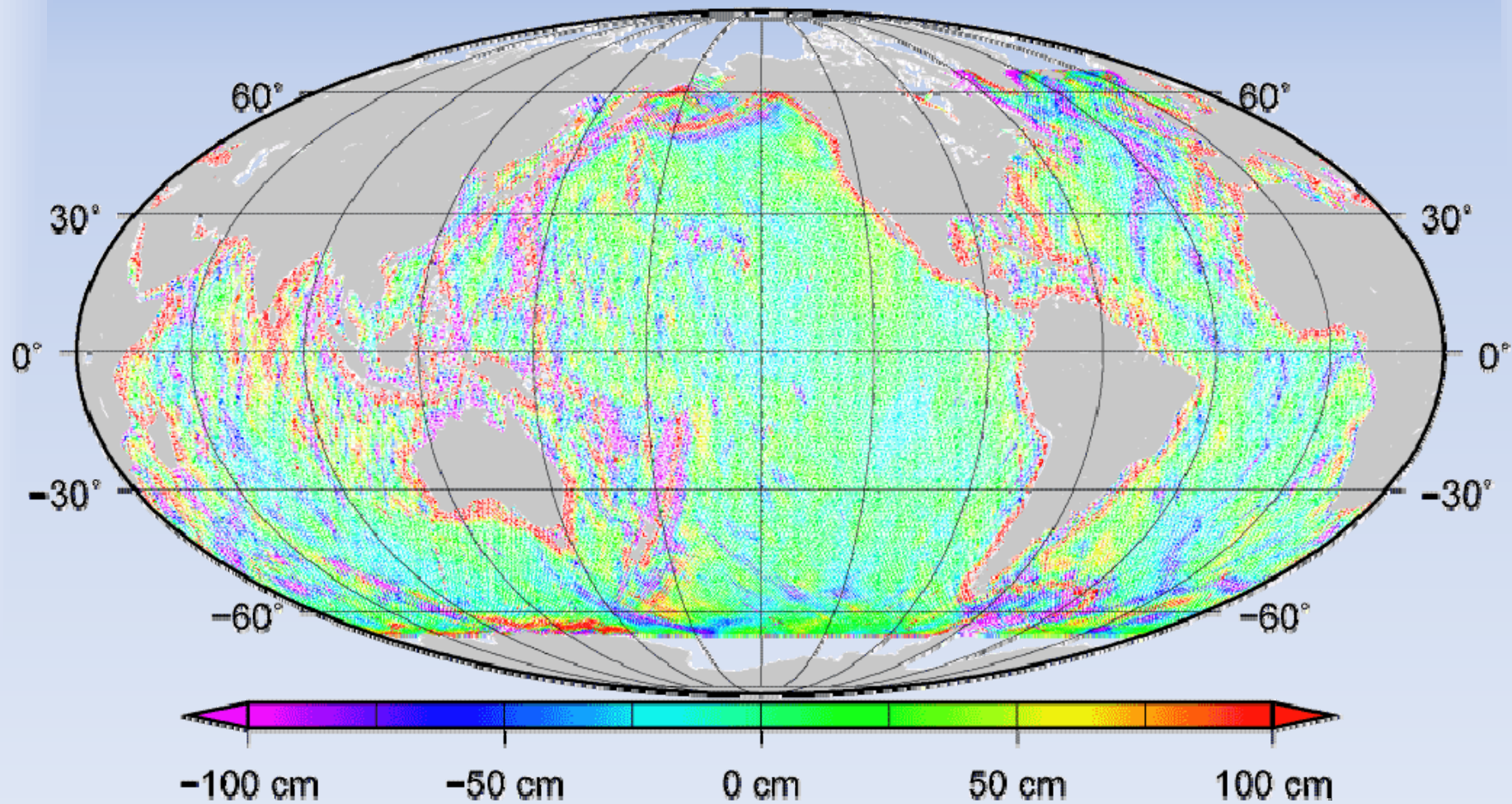
$$\begin{aligned}\text{DOT} &= 1D[h] - 1D[N_{\text{high-res}}] + 2D[N_{\text{high-res}}] - 2D[N] \\ &= 1D[h - N_{\text{high-res}}] + 2D[N_{\text{high-res}} - N]\end{aligned}$$

„Pre-Geoid Correction (PGC)“

PGC can be computed once in advance !

Filter Correction for a common Topex-EM/Jason-1 Cycle

$$(2D[N_{\text{EGM2008}}] - 1D[N_{\text{EGM2008}}])$$



Pre-geoid Correction for GRACE and GOCE

$$2D[N_{\text{EGM2008}} - N]$$

N from GOCO1S:

N from ITG03S:

Small, but systematic pattern (tbi)

