# The challenge of GOCE and multi-mission altimetry: instantaneous dynamic ocean topography profiles with meso-scale resolution

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# OUTLINE

- Motivation
- Geodetic way of DOT computation
- Profile approach
- Application
- Conclusions





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# MOTIVATION

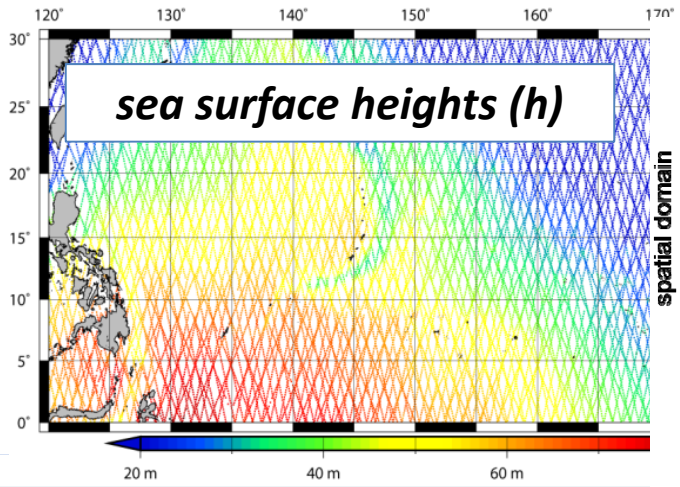
- Mean dynamic ocean topography is the main altimetric product today, but
  - Mean DOT is an artificial static surface
  - Mean DOT doesn't reflect any real state of the ocean
- Instantaneous dynamic ocean topography (iDOT) is
  - Processed along-track measurement values
  - With exactly known time

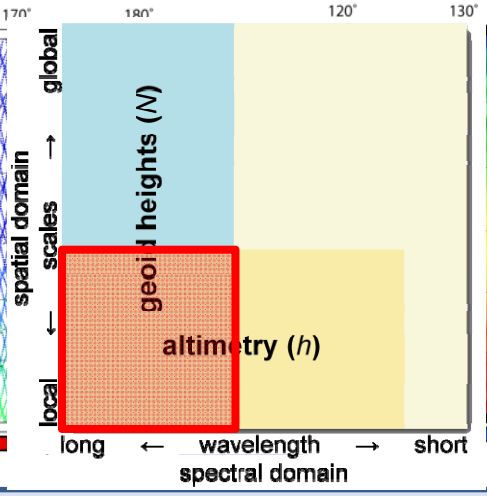
# GEODETIC WAY OF DOT COMPUTATION

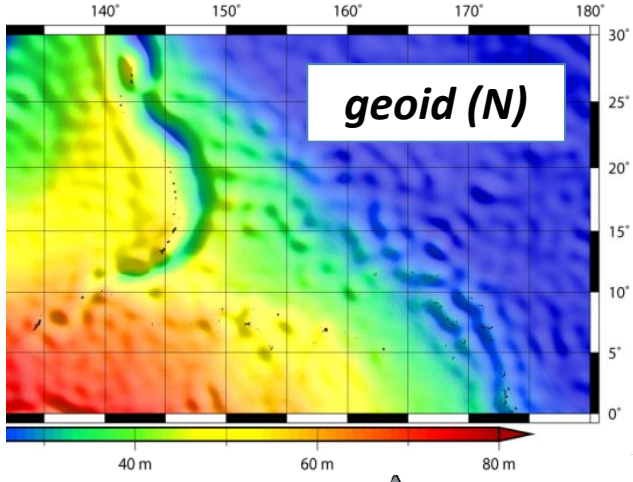
- Simple formula

  $DOT = h - N$

- **but (!!!)**
  - Sea surface heights ($h$): high resolution along track, low resolution cross track
  - Geoid heights ($N$): limited resolution in frequency domain, artificial effects (e.g. striping)



# DOT COMPUTATION ON INDIVIDUAL PROFILES (IDOT)

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

for details: Bosch & Savcenko (2010), Springer IAG Symposia, Vol. 135, p263

Re-ordering (more convenient):

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

„Pre-geoid correction“





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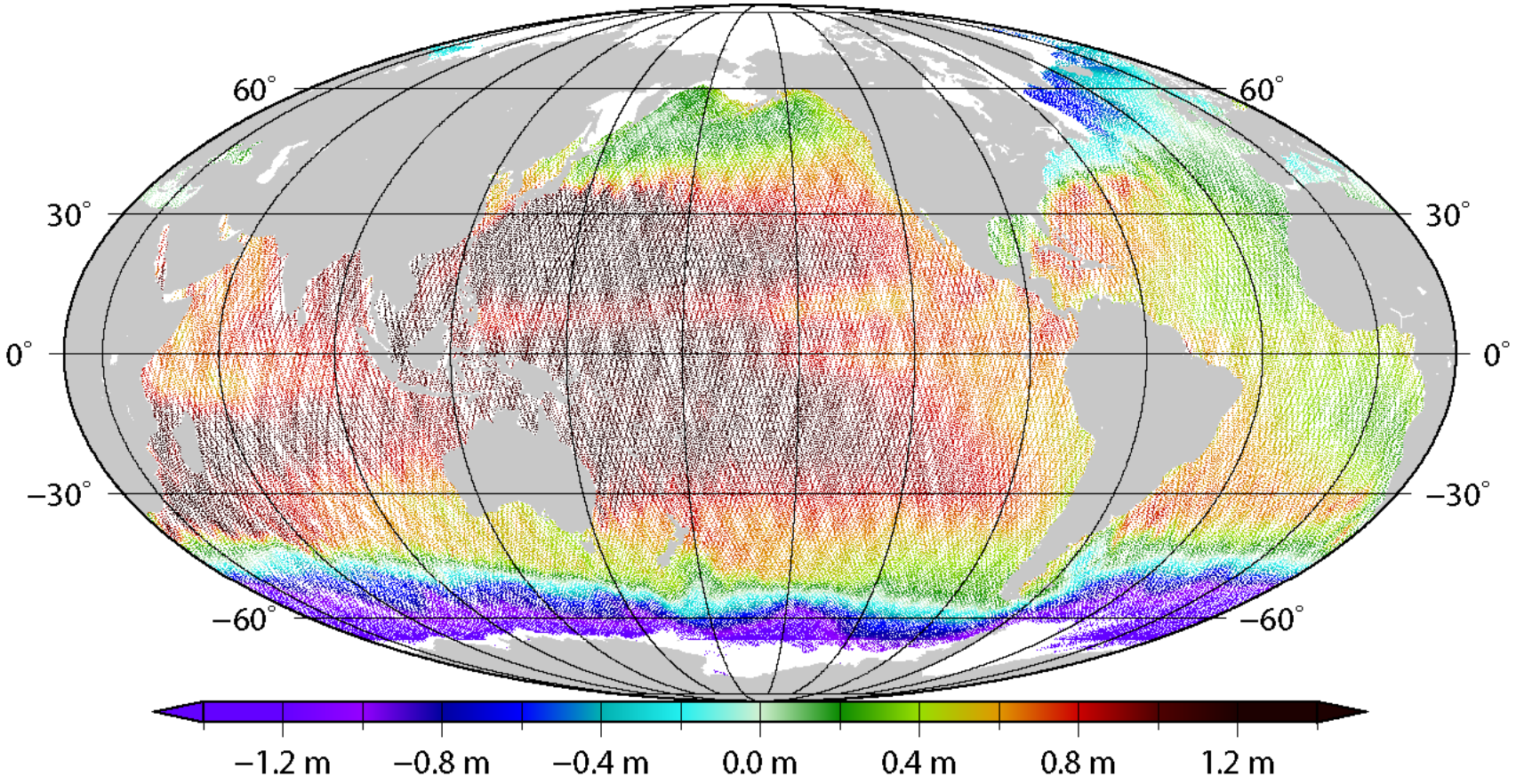
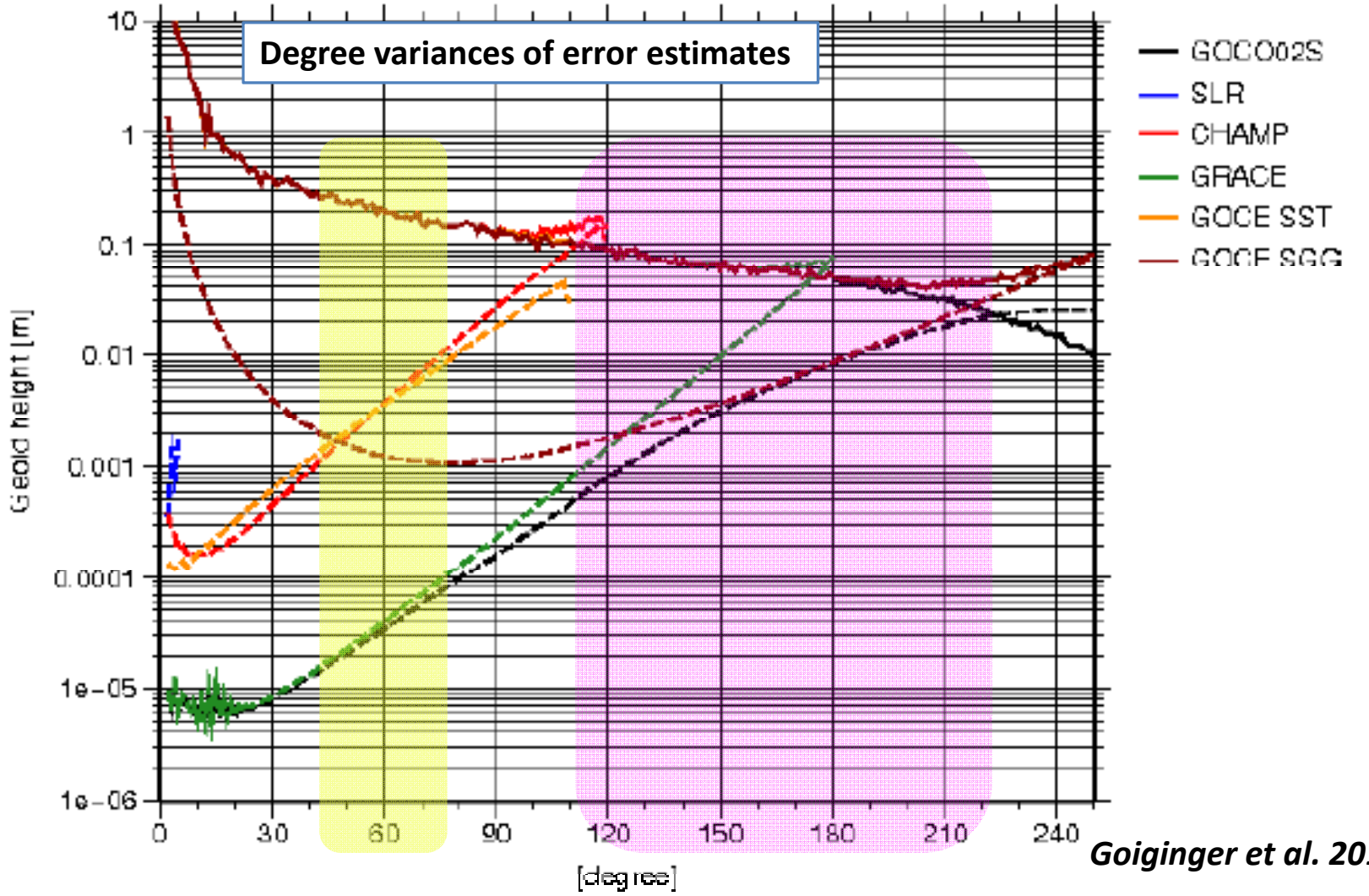
# SNAPSHOT OF IDOT




Ten-day snapshot of DOT from Jason1, TOPEX, ENVISAT, and GFO

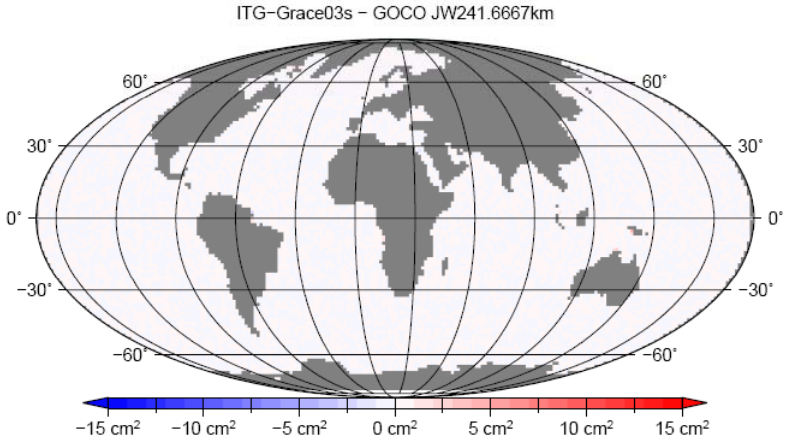
# INCREASE OF RESOLUTION OF IDOT BY GOCE



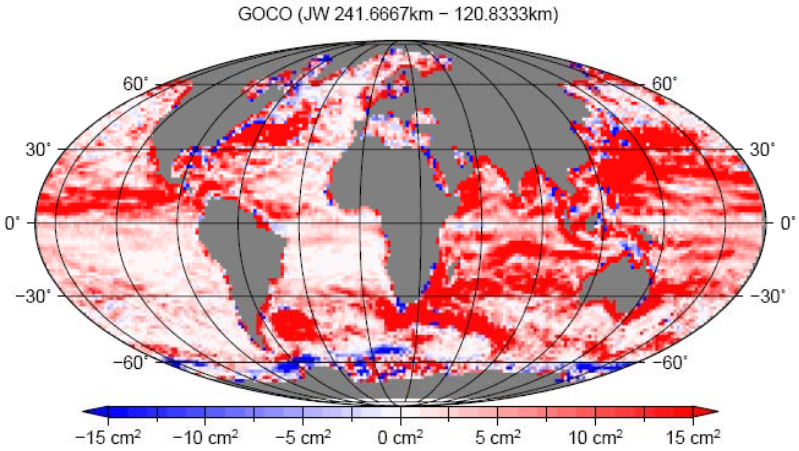

*Goiginger et al. 2011*

# INCREASE IN SIGNAL VARIANCE [CM$^2$]

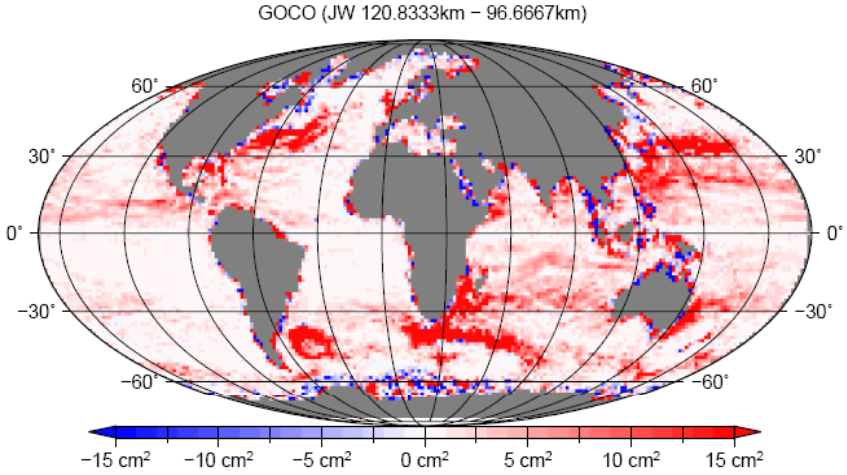
**GRACE versus GOCE; Filter D=241km/L=60**



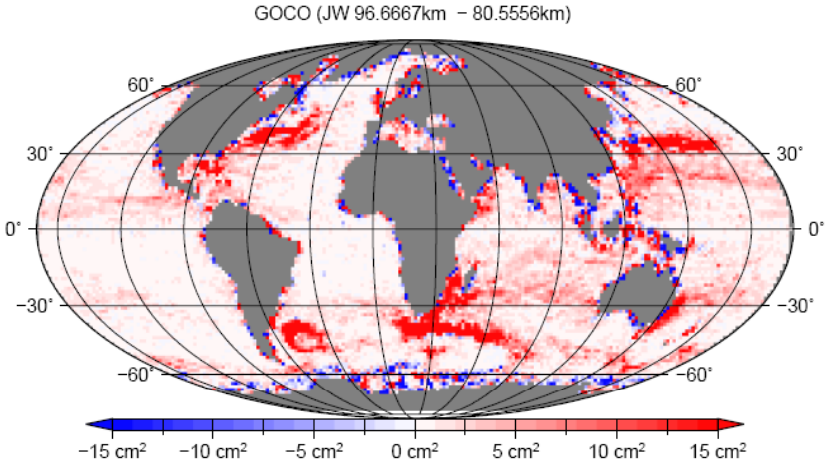

**GOCE: ΔFilter D=121km/L=120 – D=241km/L=60**




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



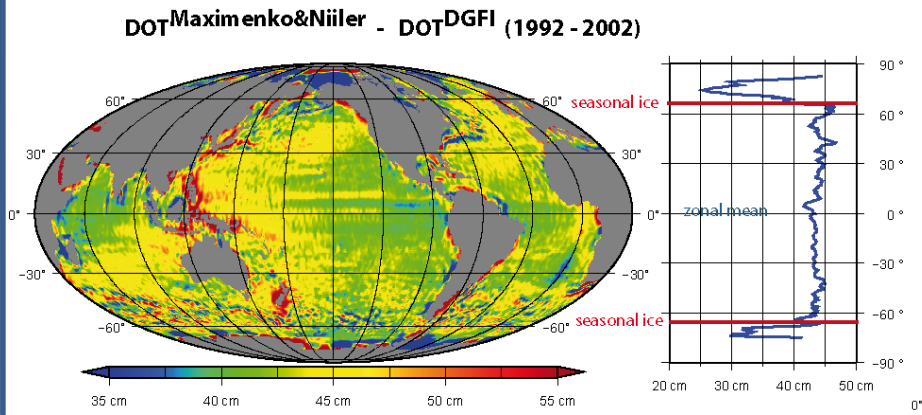

**GOCE: ΔFilter D=80km/L=180 – D=97km/L=150**

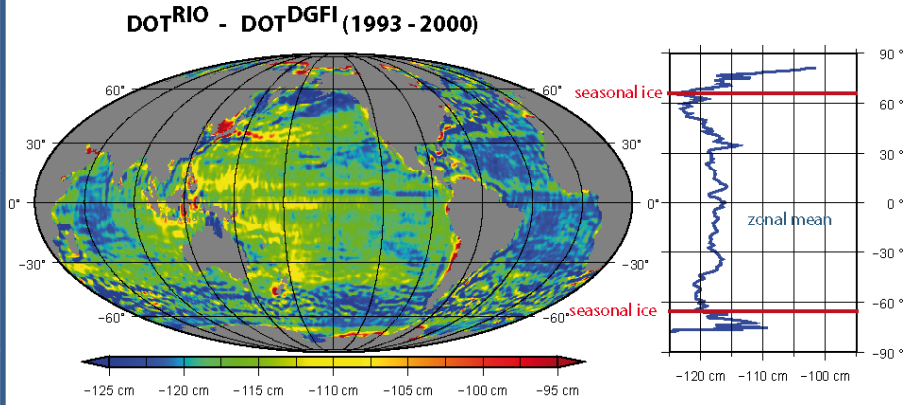


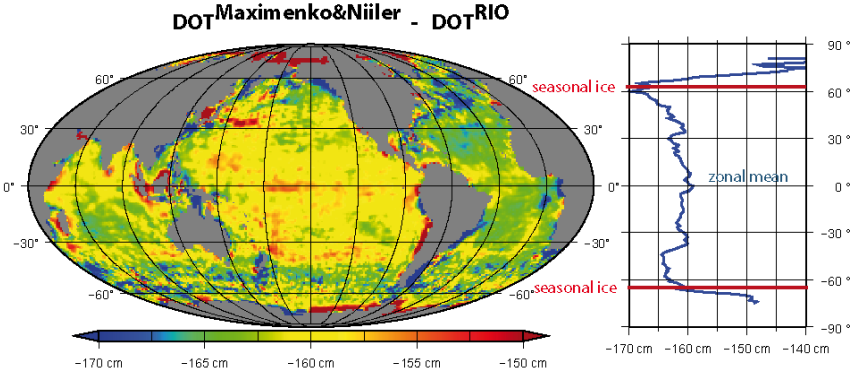
# STRENGTHS OF DOT FROM PROFILE APPROACH

- Gridding of iDOT is uncritical
  - Small amplitude (± 1 – 2 m)
  - Smooth, compared to sea surface heights
  - No artifacts (Gibbs effects) at the coast
- iDOT represents the temporal DOT evolution
- Any mean of iDOT can be performed (weekly, 10 days, monthly, annual, long term)
- iDOT carries meso-scale signal (due to GOCE)

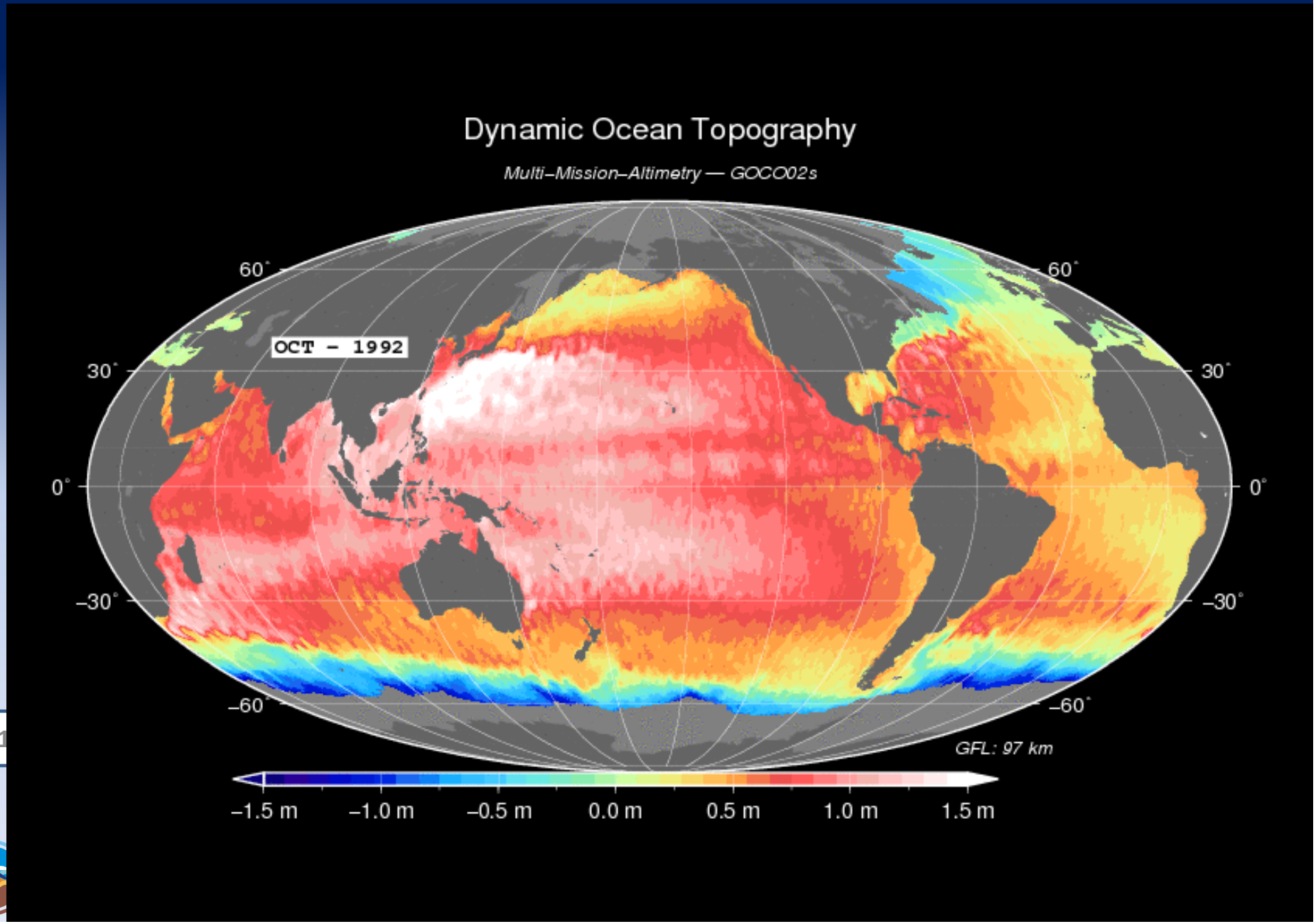
# APPLICATIONS: LONG TERM MEAN DOT



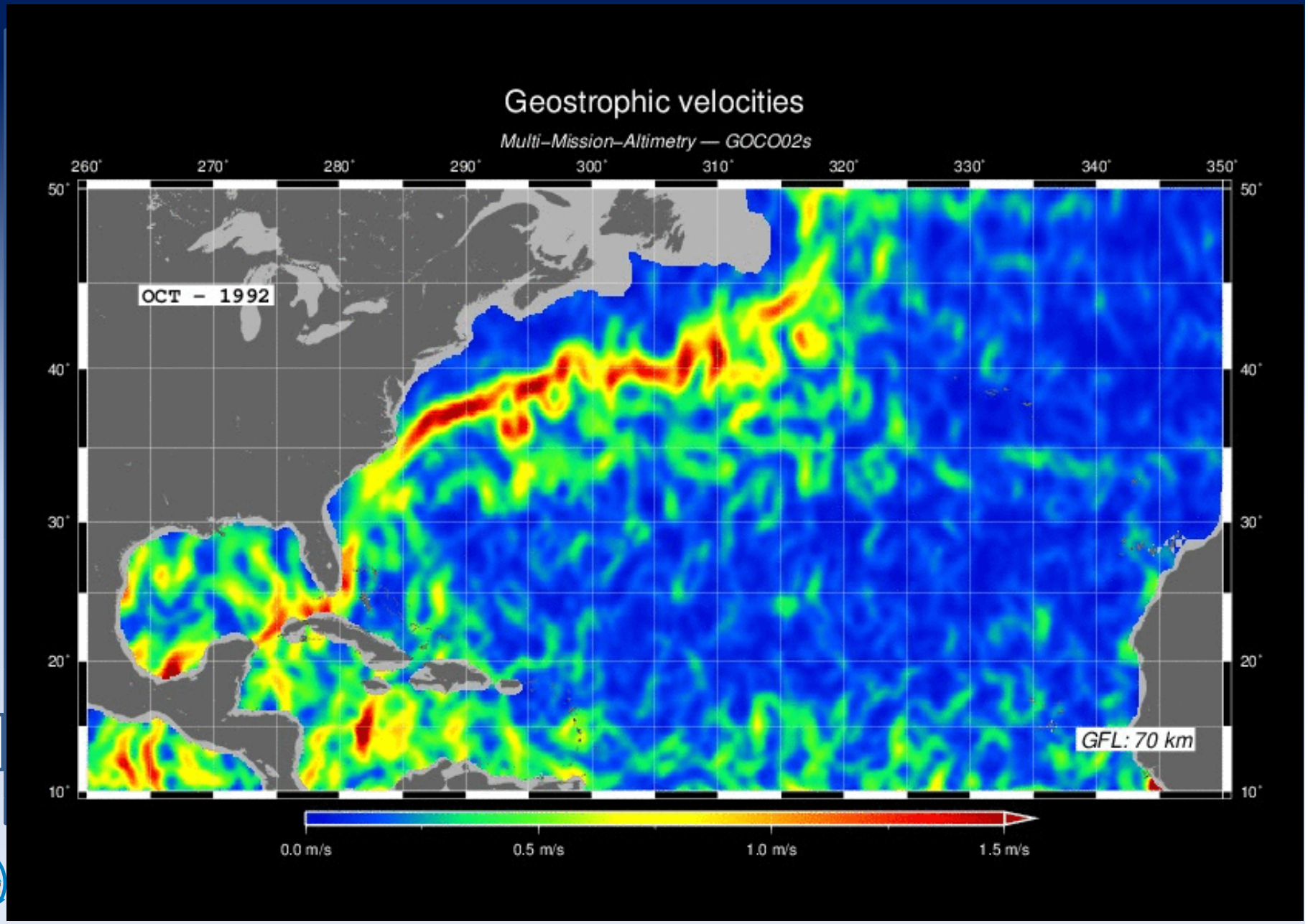



# APPLICATIONS: TIME-DEPENDEND DOT



# APPLICATIONS: GEOSTROPHIC VELOCITIES



# CONCLUSIONS

- Since the geoid improvements of GOCE iDOT profiles can resolve meso-scale structures
- iDOT carries the quasi-stationary DOT pattern as well as temporal variations (long-term, seasonal, down to Eddies)
- Multi-mission iDOT profiles allow to generate DOT-snapshots (ten days) or mean DOTs
- Generation of iDOT profiles is nearly operational

The first iDOT profiles
for TOPEX/Poseidon
are available at:

ftp://ftp.dgfi.badw.de/iDOT/gaussFilter.69km/

iDOT profiles for other missions
will follow soon

# INSTANTANEOUS DOT FROM PROFILE APPROACH

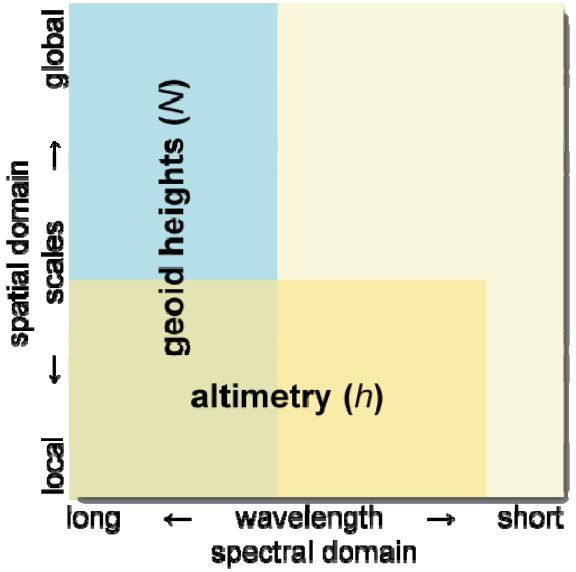
- Filtering
  - purpose
    - treatment of omission errors
    - minimizing of commission errors
  - suggested filtering for altimetric *h*
    - one-dimensional: 1D[*h*]
  - suggested filtering of geoid *N*
    - two-dimensional (spectral): 2D[*h*]
  - problem

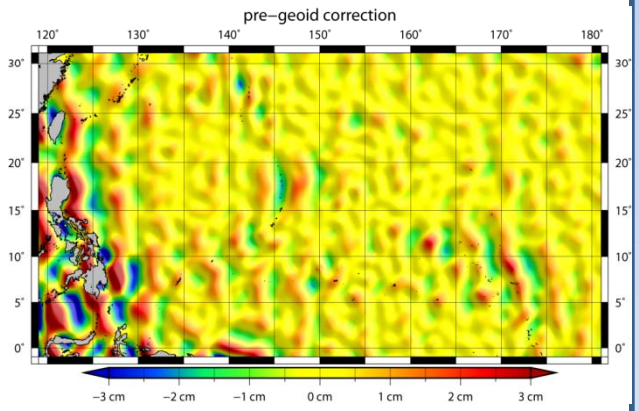
    1D[*x*] ≠2D[x]
- Profile approach:

  filtering of high frequency geoid and sea surface heights along track and correction of geoid errors

  DOT=1D[*h*] - 1D[$N^{hf}$]+Δ2D[*N*]

  where Δ2D[*N*]=2D[$N^{hf}$]- 2D[$N^{sat}$] is pre-geoid correction



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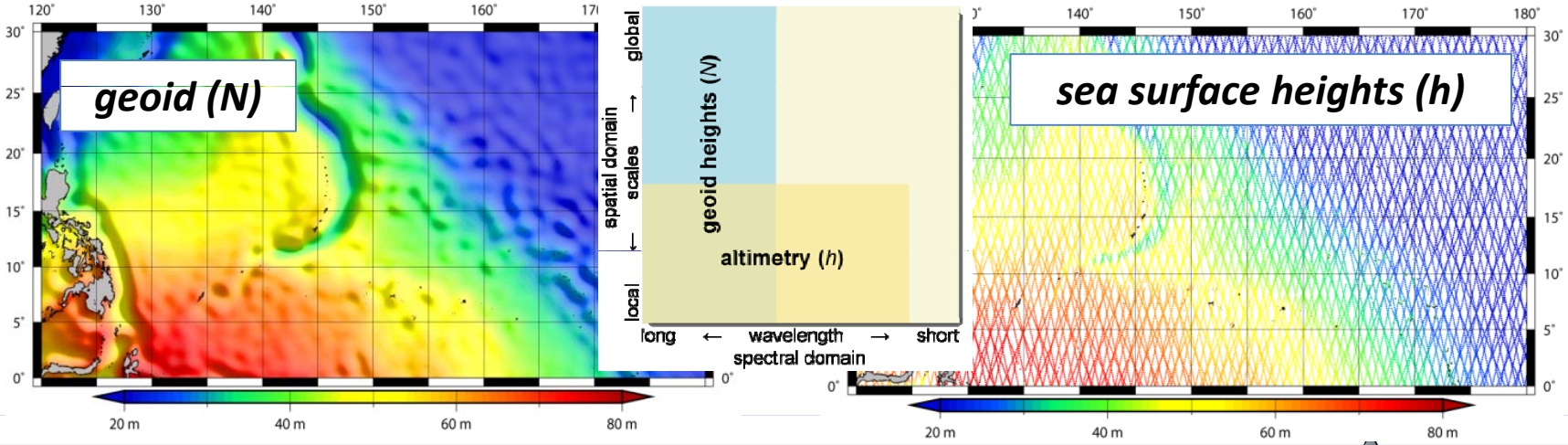

# SNAPSHOT OF IDOT