DTU Space
National Space Institute

A preliminary mean dynamic topography model – DTU16MDT.

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DTU Space
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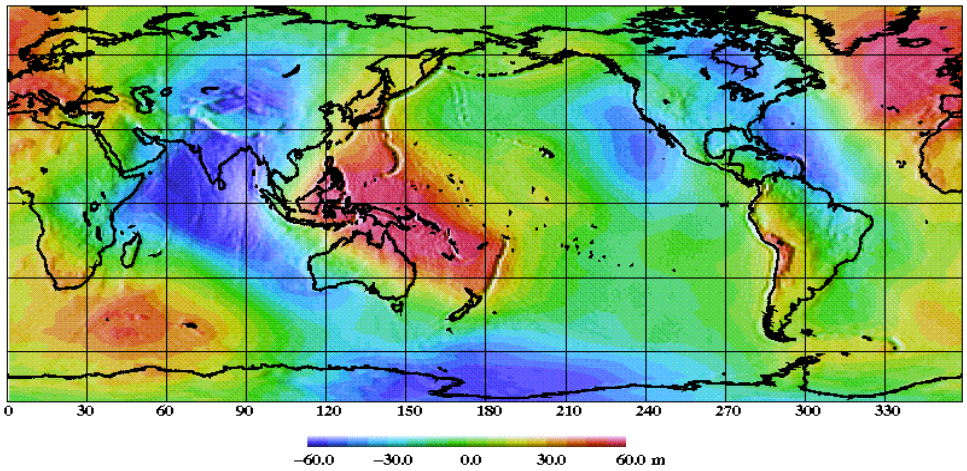
The Gravity field and steady-state Ocean Circulation Explorer (GOCE)

Its objectives are to improve understanding of:

- global ocean circulation and transfer of heat
- physics of the Earth's interior (lithosphere & mantle)
- topographic processes, ice sheets and sea level change



GOCE

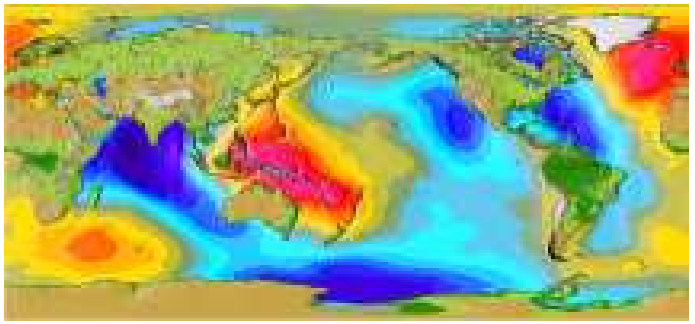
Computation of a MDT

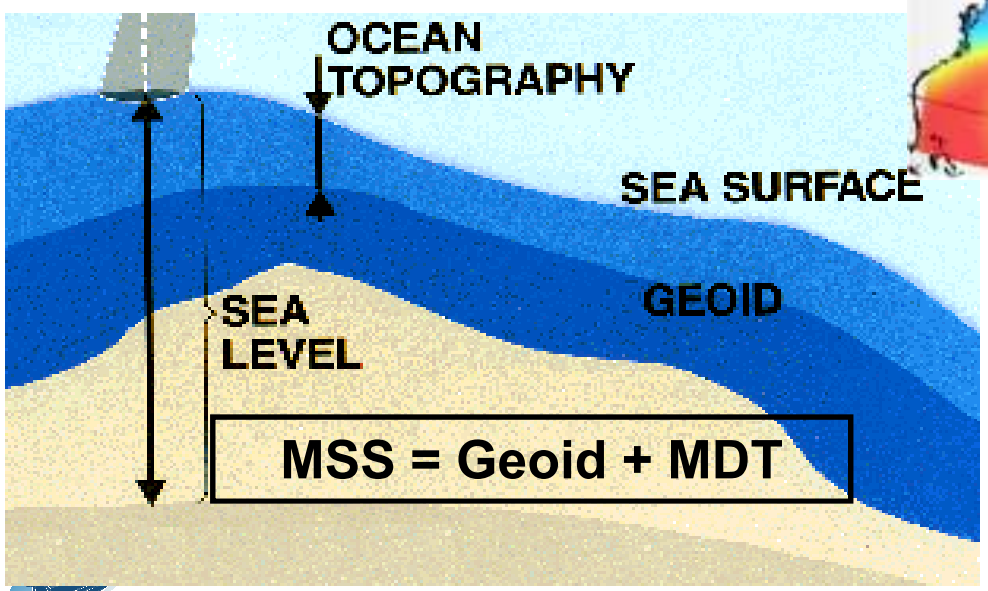
Basically, the Mean Dynamic Topography is obtained through:

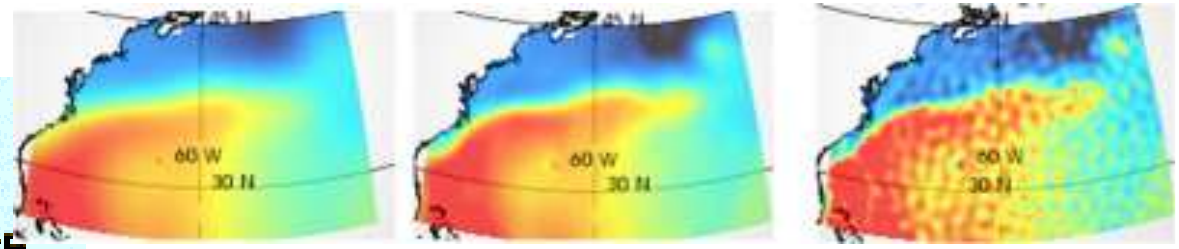
1. Subtracting a MSS and a GOCE geoid

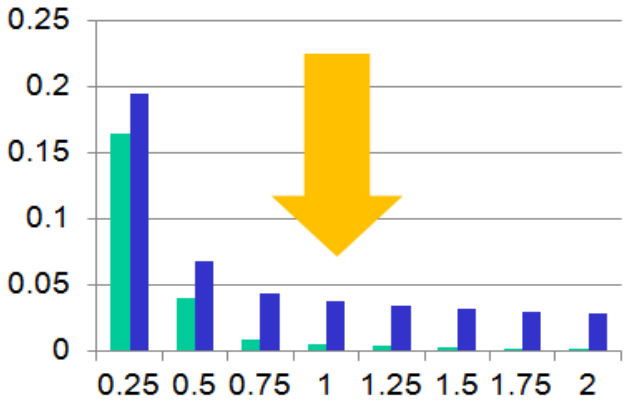
MDT = MSS – Geoid

2. Filtering to remove unmodeled parts of the geoid

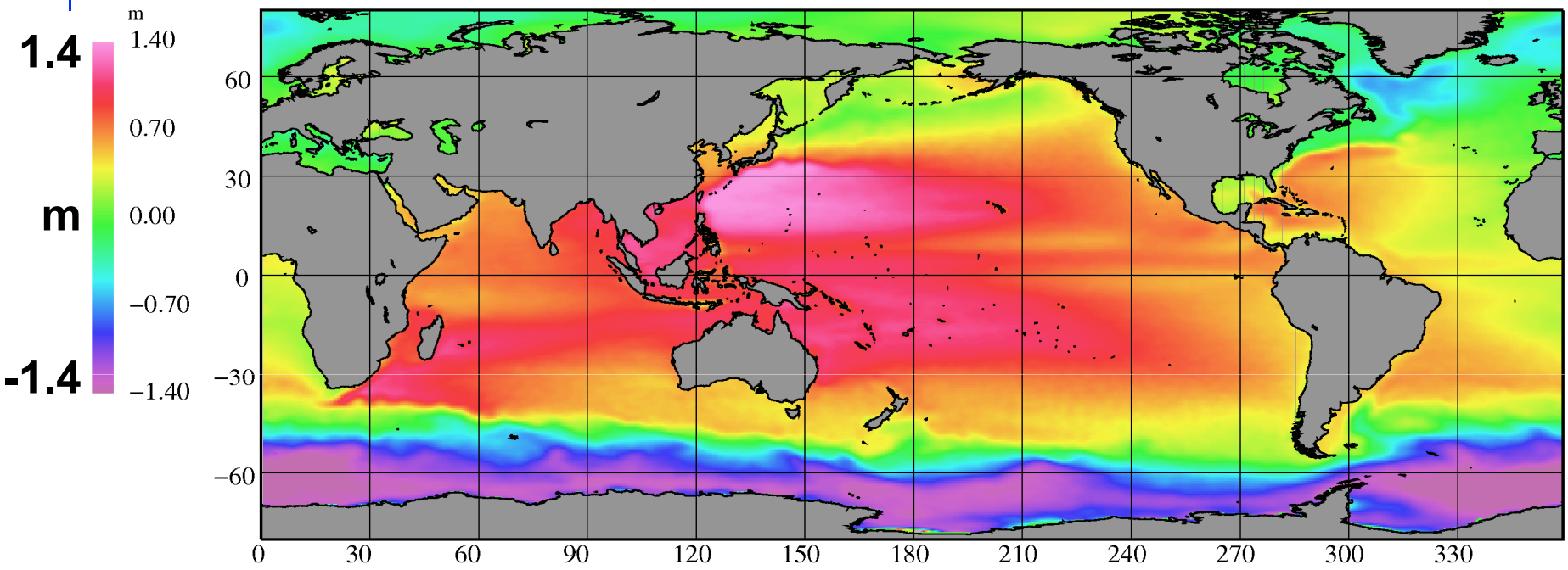








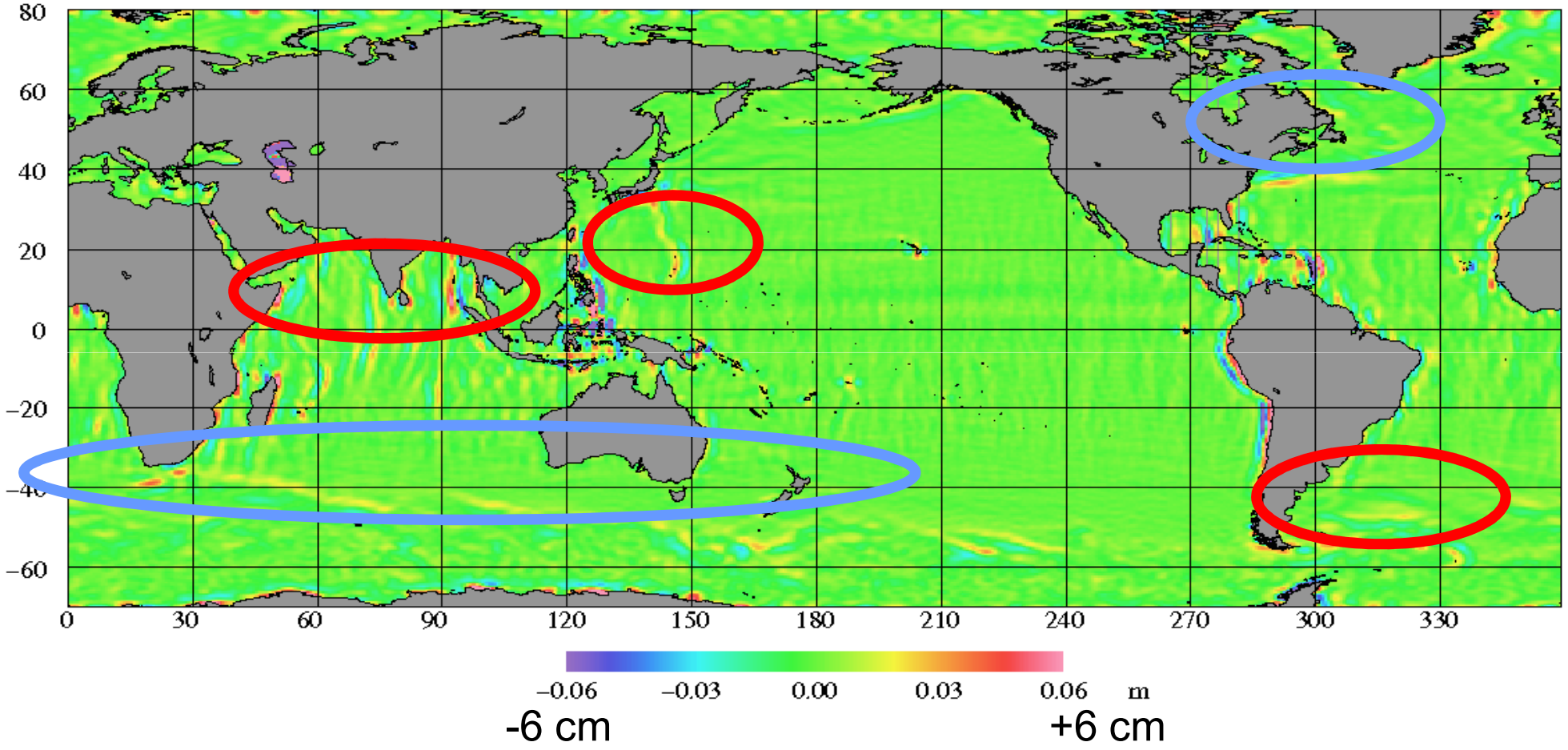
Results - MDT:



The GOCE MDT (r.1 DIR) display the well-known features with enhanced resolution and sharpened boundaries.

Ref.: Knudsen, P., R. Bingham, O. Andersen, M.-H. Rio, Enhanced Mean Dynamic Topography and Ocean Circulation Estimation using GOCE Preliminary Models, J. of Geodesy, 2011, DOI 10.1007/s00190-011-0485-8.

More on filtering:



-6 cm +6 cm

Towards DTU16MDT:

DTU16MDT, as the 13 and 15 models, is (still to be) a purely geodetic MDT.

Update models – all GOCE data – DTU15MSS.

Assessment of geoid models over the oceans:

- Quantify the quality of various models,
- Extract inhomogeneous/anisotropic features,
- Resolve resolution capacities wrt geostrophic currents.

Improvement of filtering:

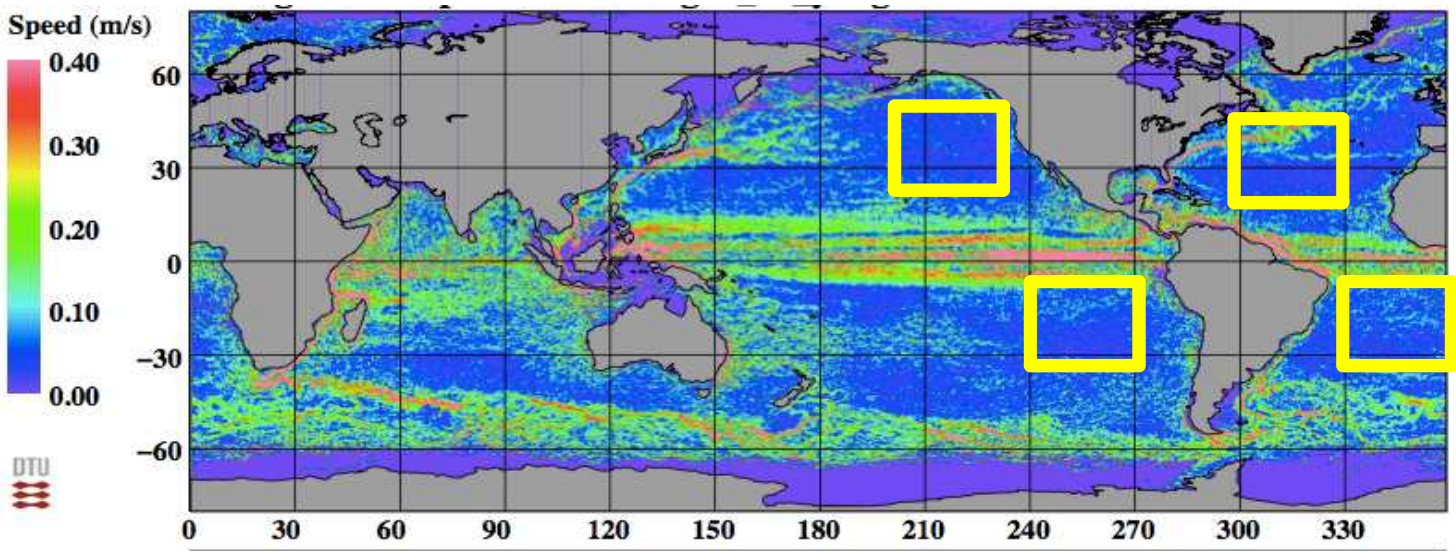
- Fine tune ½-width and anisotropy.

Assessment of geoid models using MSS

The assessment of the models is carried out using Fourier spectra of differences with the DTU15MSS model in

- 30x30 deg areas (frequency spacing: 0.033 cy/deg ~ d/o 12),
- 1/4x1/4 deg grids (Nyquist frequency: 2.0 cy/deg ~ d/o 720),
- up to Nmax,
- no filtering.

4 areas:



Assessment of geoid models using MSS

Residuals (SE Pacific):

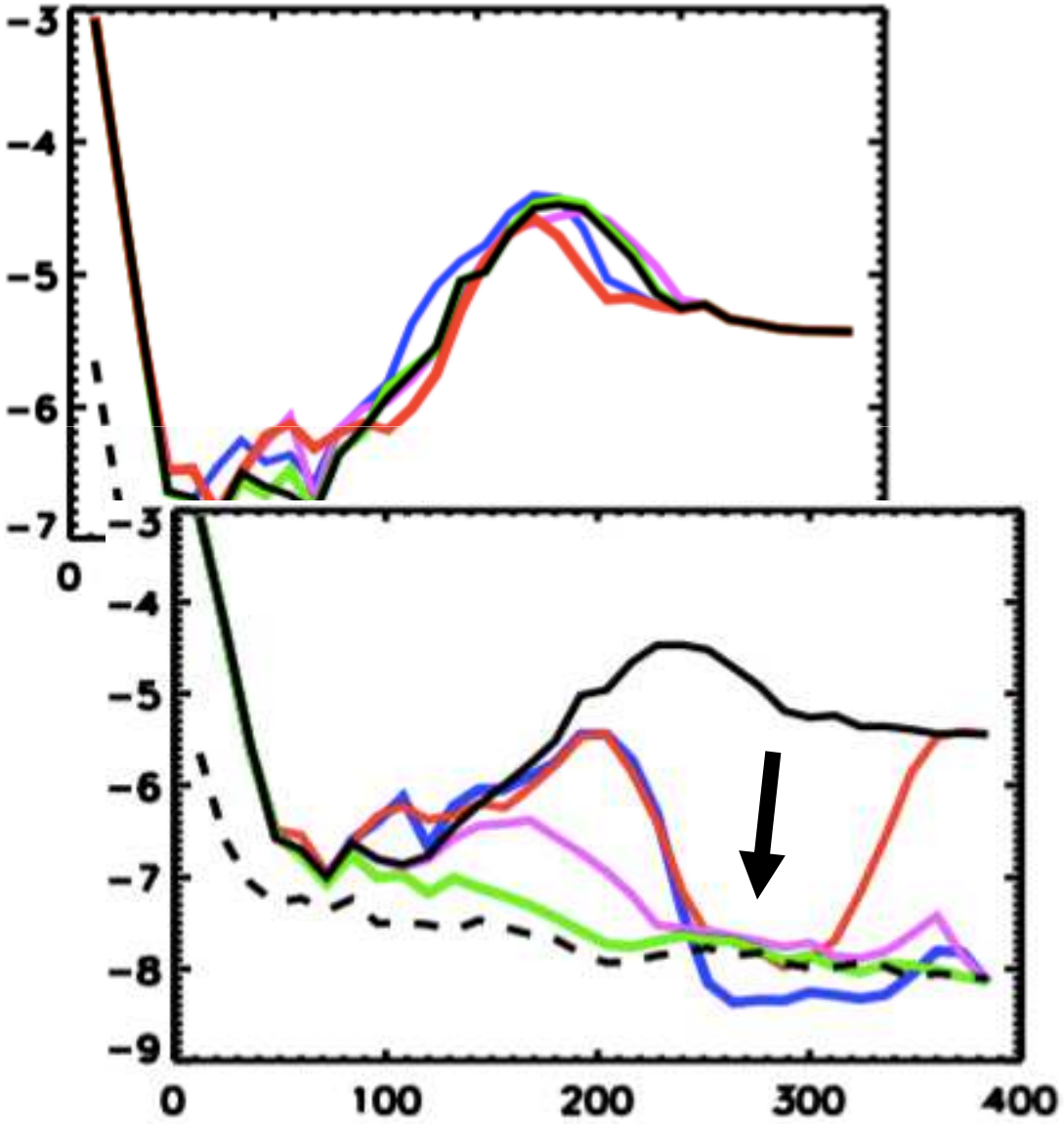
Sat-only:

- eigen6s2
- **dir_r5**
- tim_r5
- Goco05s
- GGM05g

Combination:

- Eigen6c4
- GGM05c
- GECO
- Goco05c

Effect of combining
With surface gravity



Assessment of geoid models using MSS

Correlations (SE Pacific):

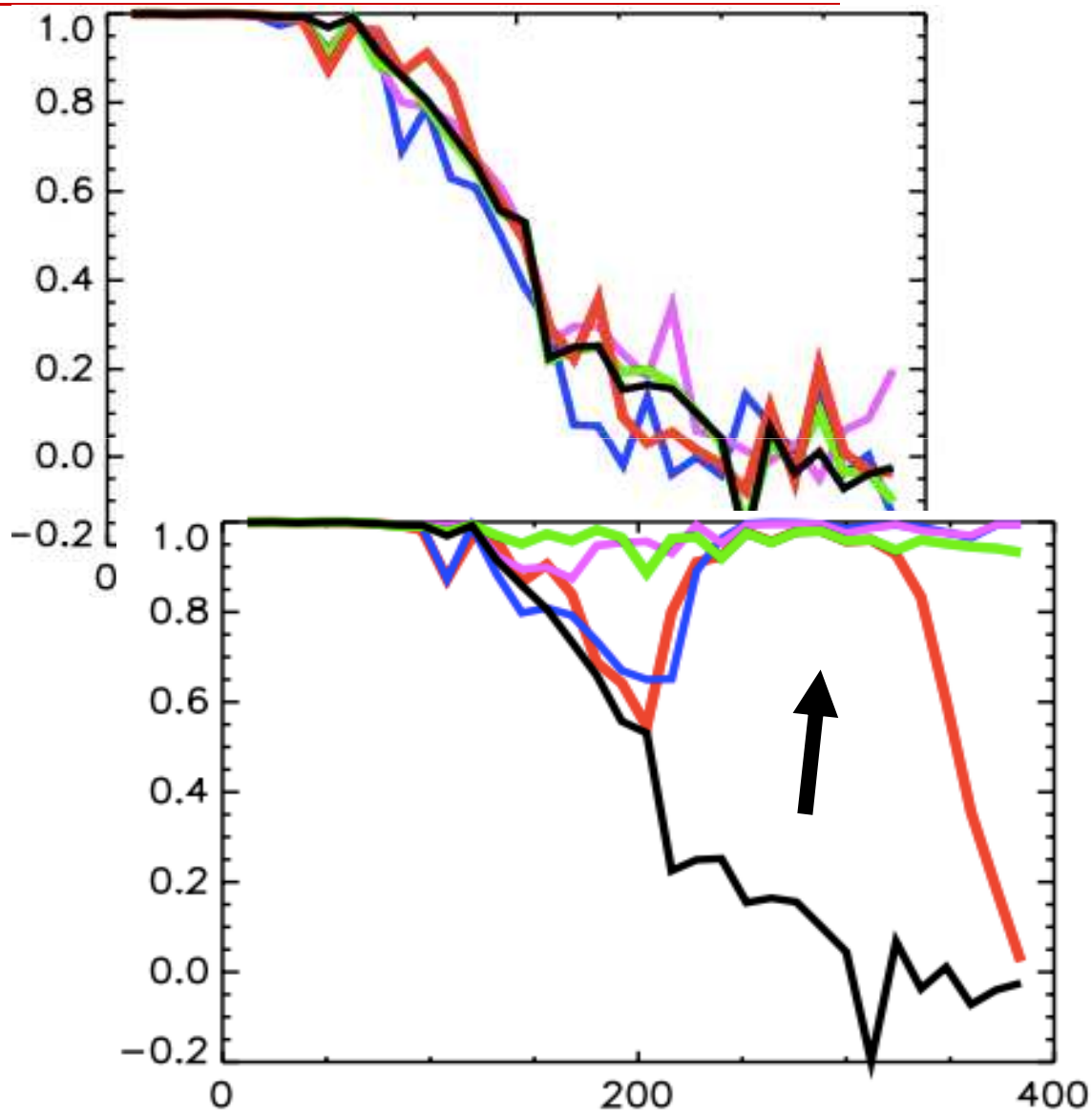
Sat-only:

- eigen6s2
- **dir_r5**
- tim_r5
- Goco05s
- GGM05g

Combination:

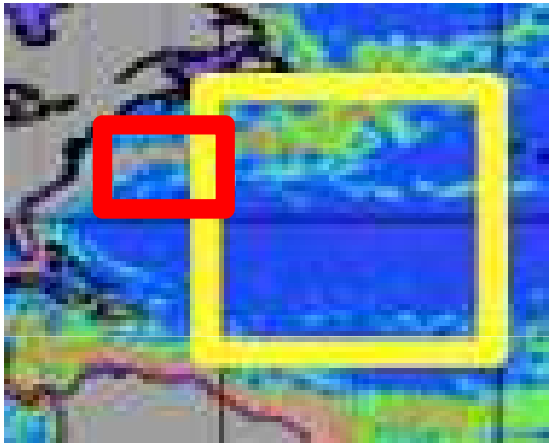
- Eigen6c4
- GGM05c
- GECO
- Goco05c

Effect of combining
With surface gravity



Assessment using MSS and drifter velocities

New area (NW Atlantic):



Sat-only:

- tim_r5

Combination:

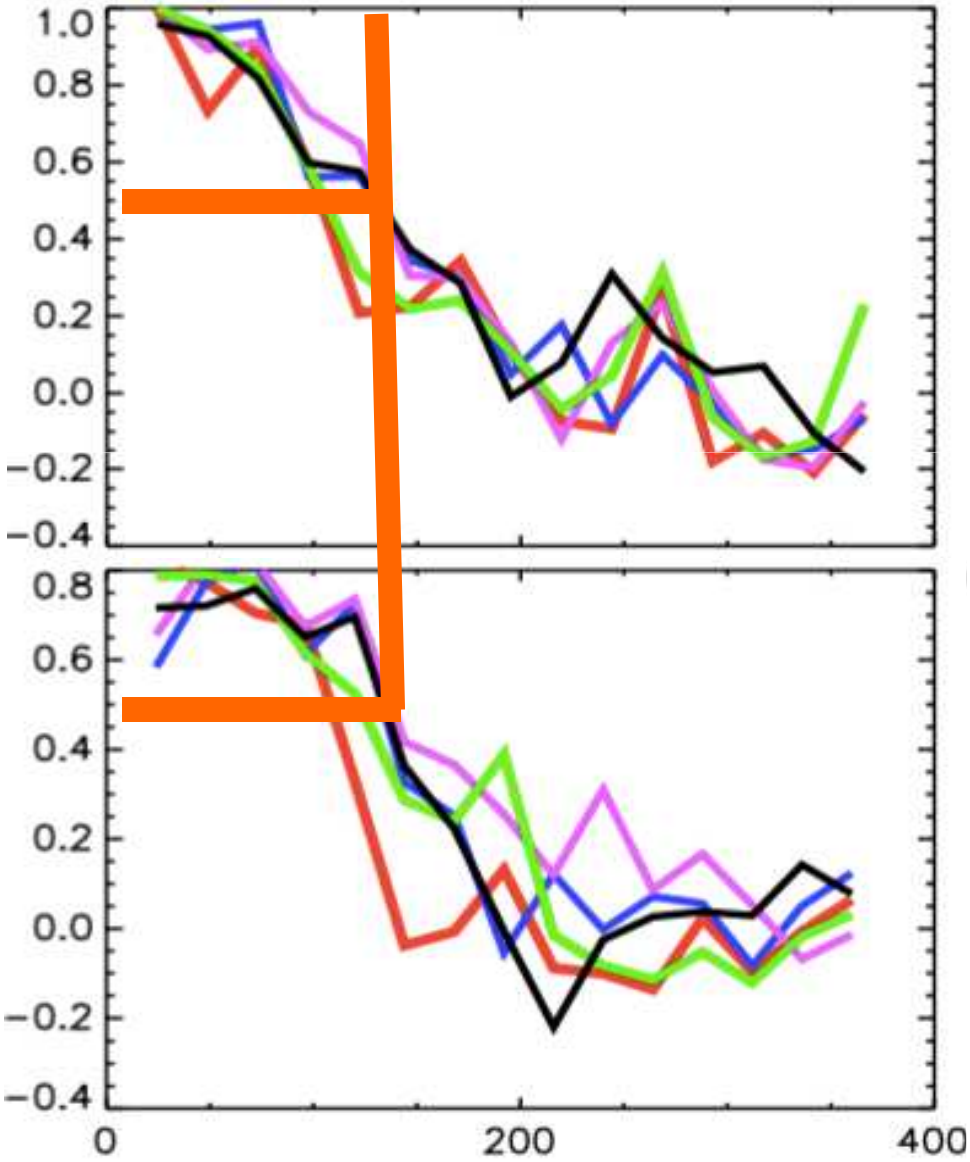
- Eigen6c4
- GGM05c
- GECO
- Goco05c

d/o ~140

(285 km)

vx:

vy:



Assessment of geoid models using MSS

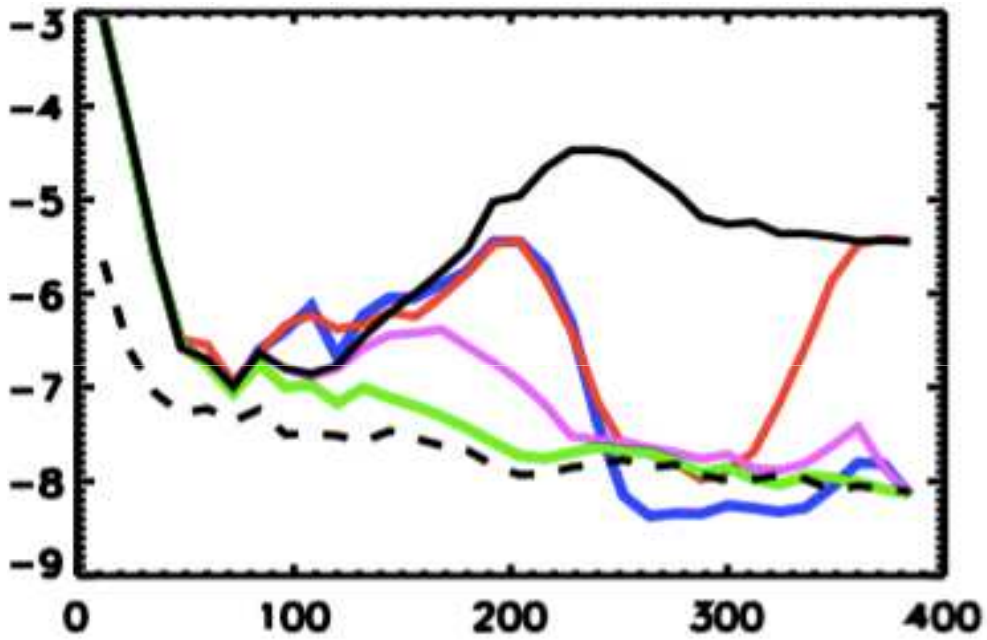
Residuals (SE Pacific):

Sat-only:

- tim_r5

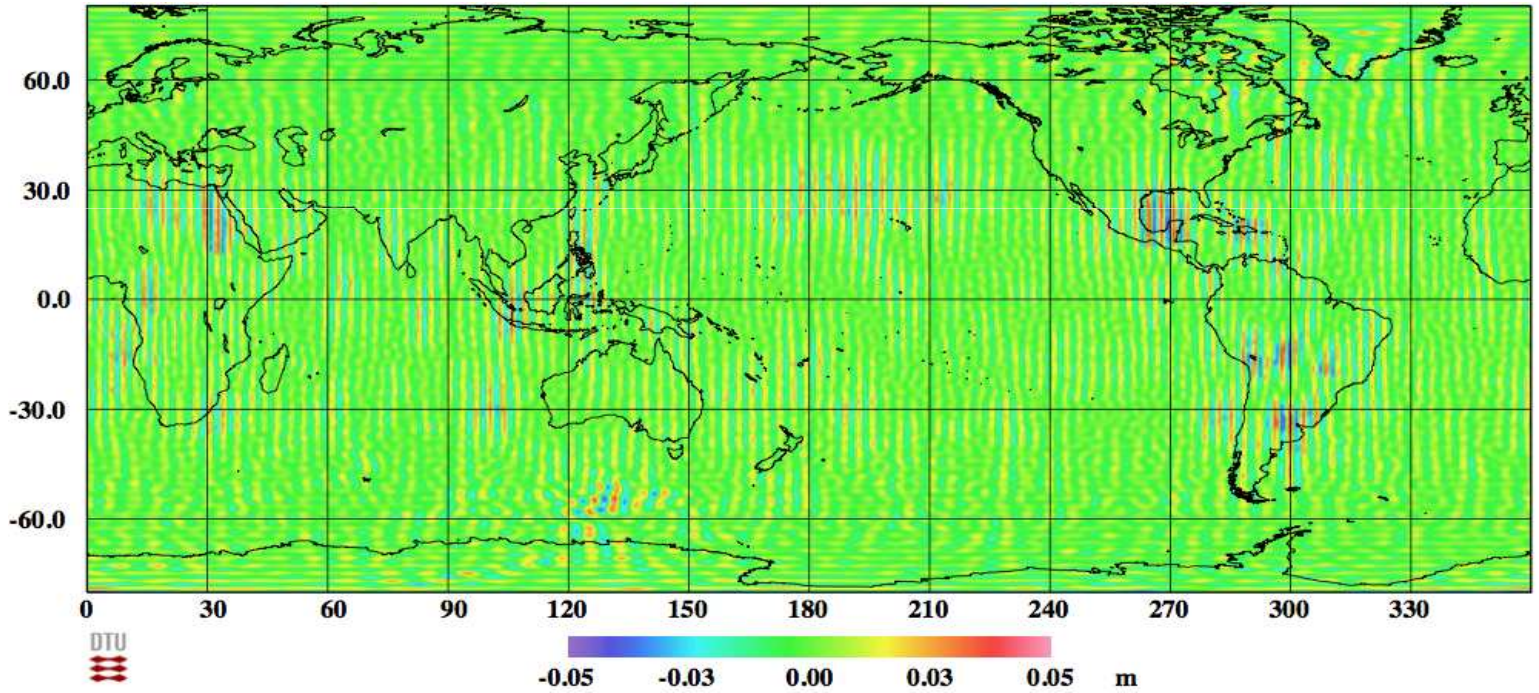
Combination:

- Eigen6c4
- GGM05c
- GECO
- Goco05c



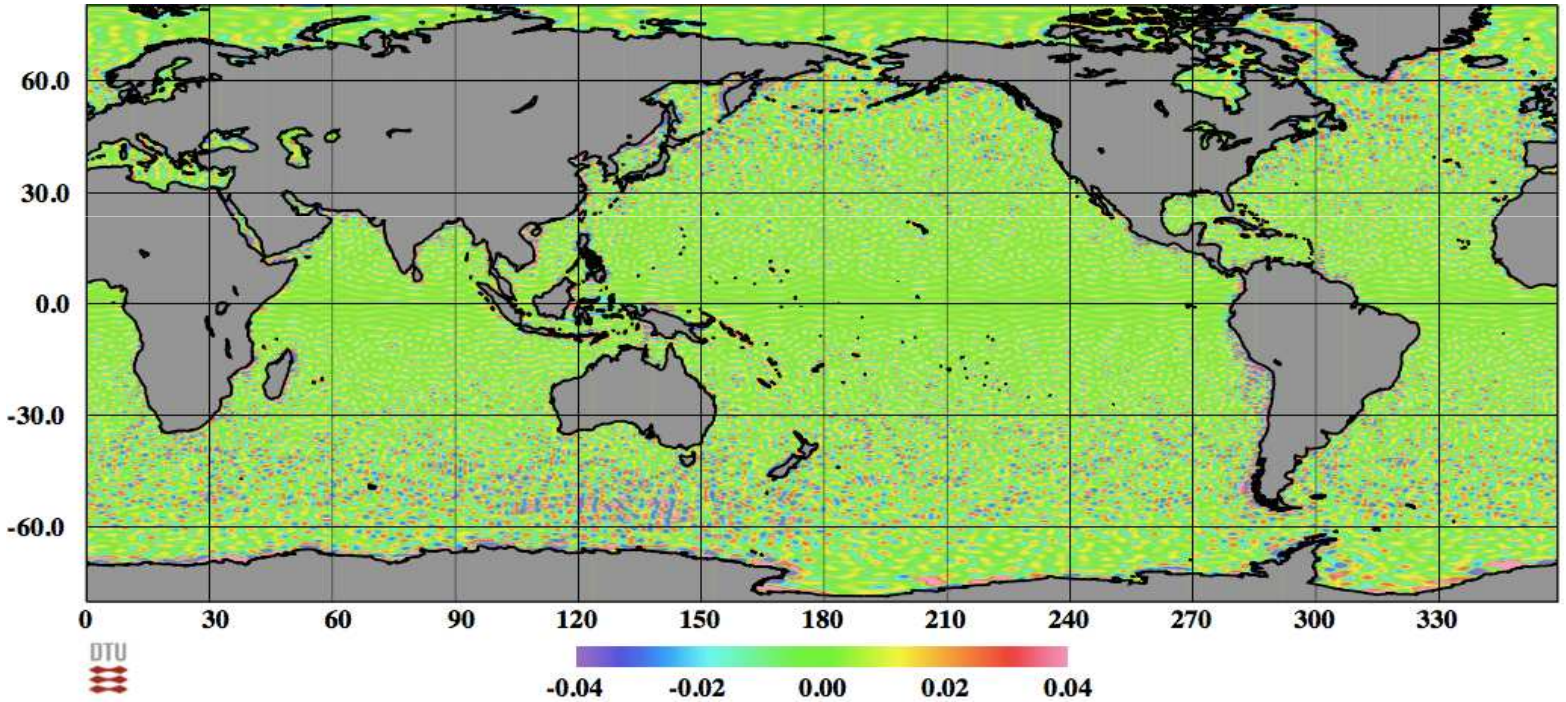
Geoid model differences

Differences Eigen6c4 - GOCO05s up to d/o 175 (with a linear cut from 125) to display stripes at d&o 100-120.



Geoid model differences

Differences Eigen6c4 - GOCO05c d/o 150 – 250.



DTU16MDT – Step 1:

Update models:

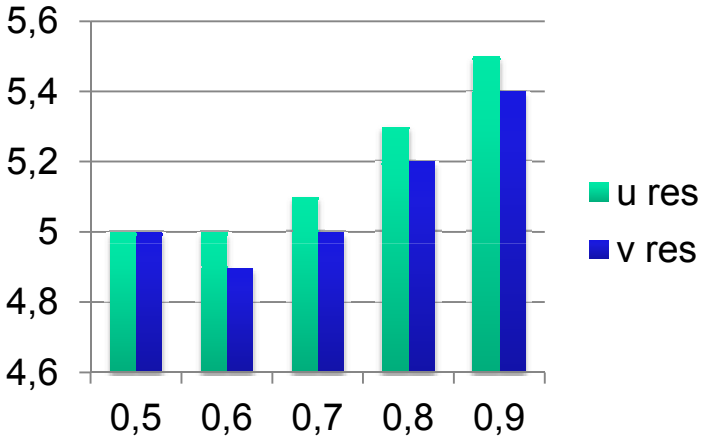
	Mean Sea Surface	Geoid
DTU13MDT	DTU13MSS	EIGEN-6C3stat
DTU15MDT	DTU15MSS	GOCO05S-EIGEN-6C4 hybrid
DTU16MDT	DTU15MSS	GOCO05C-EIGEN-6C4 hybrid

- New Mean Sea Surface DTU15MSS (mainly Cryosat-2 in Polar regions)
- Geoid models complete to d/o 2160.

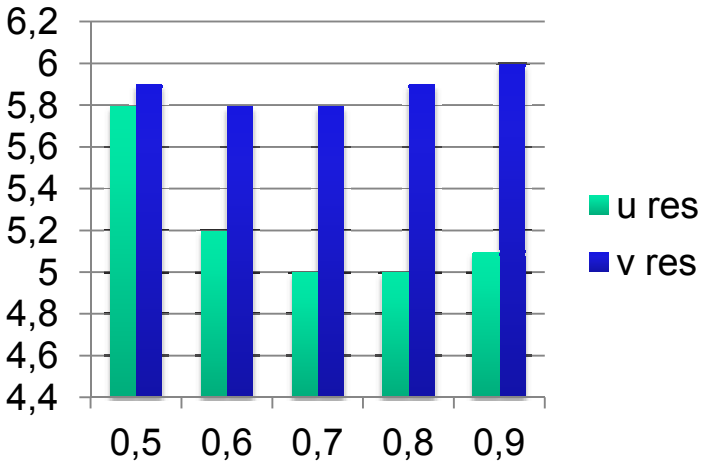
Improving the filtering

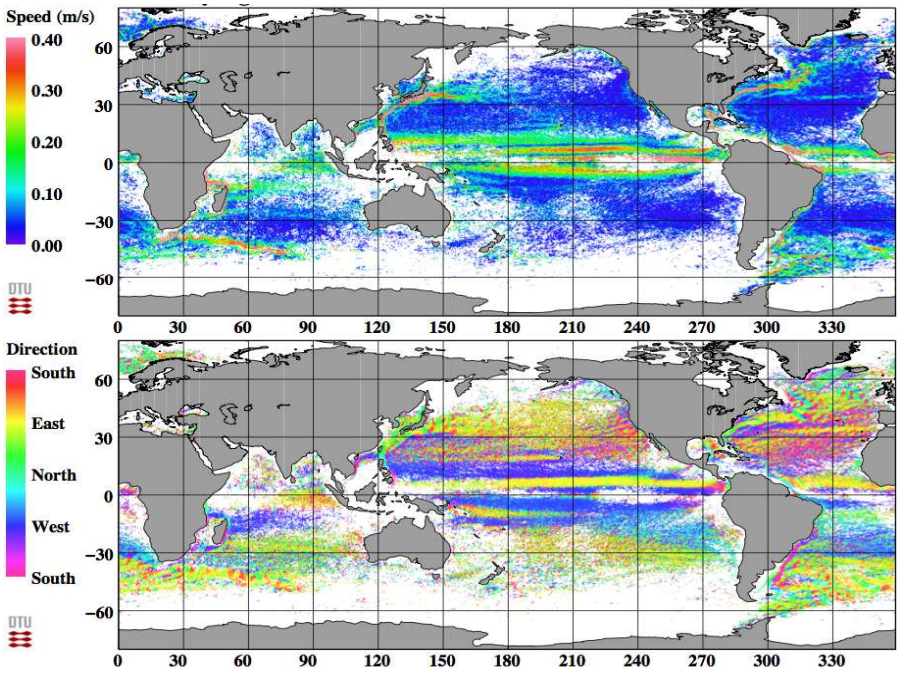
The spatial filtering (using a Gaussian function) is optimized by comparing the models with drifter mean velocities.

Lat. 30-50



Lat. 10-30





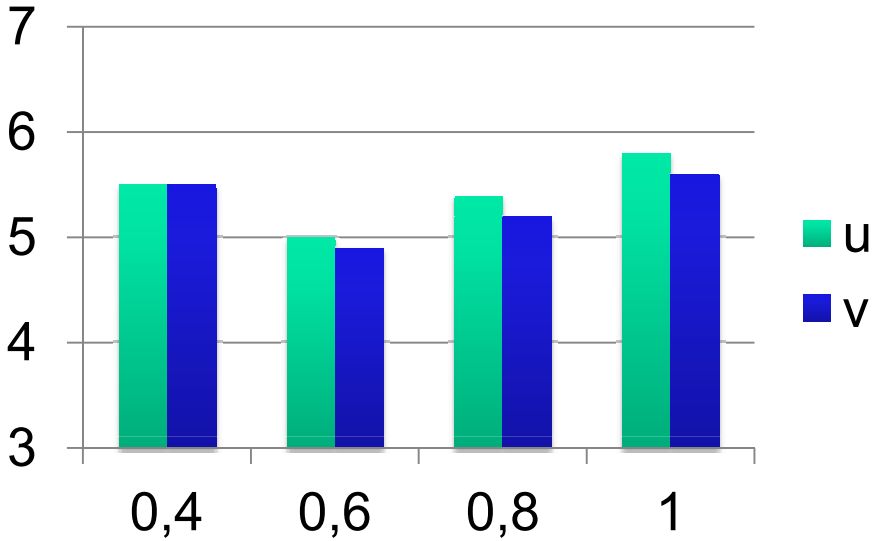
The optimal half-width vary:

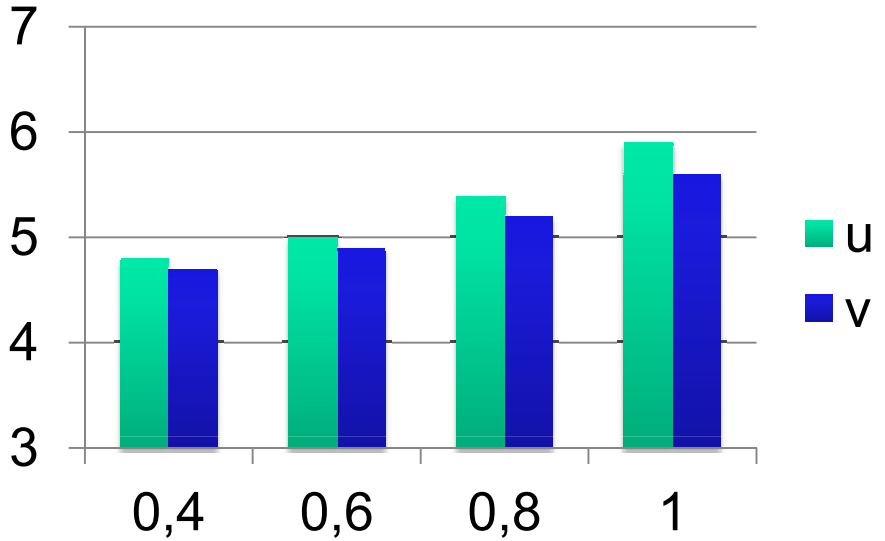
Lat. 30-50: around 0.6 deg.

Lat. 10-30: around 0.7 deg.

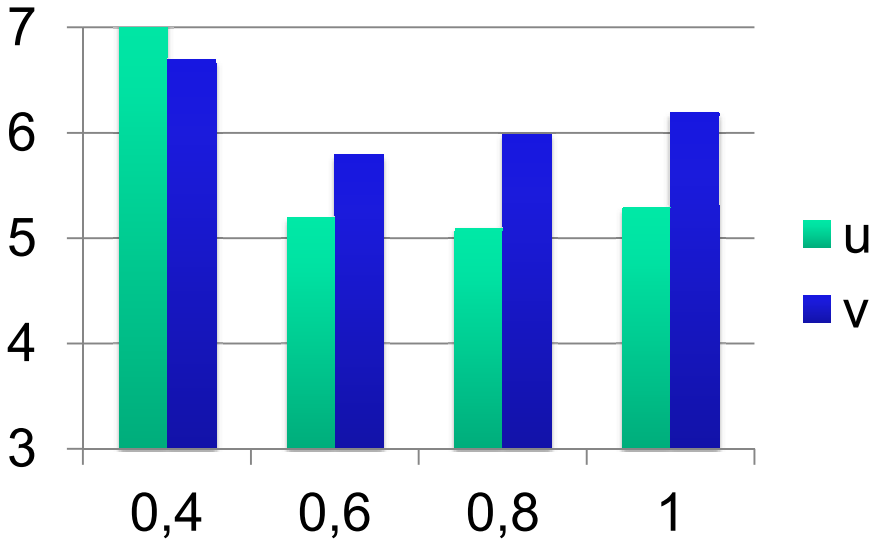
Comparisons – DTU15MDT vs DTU16MDT

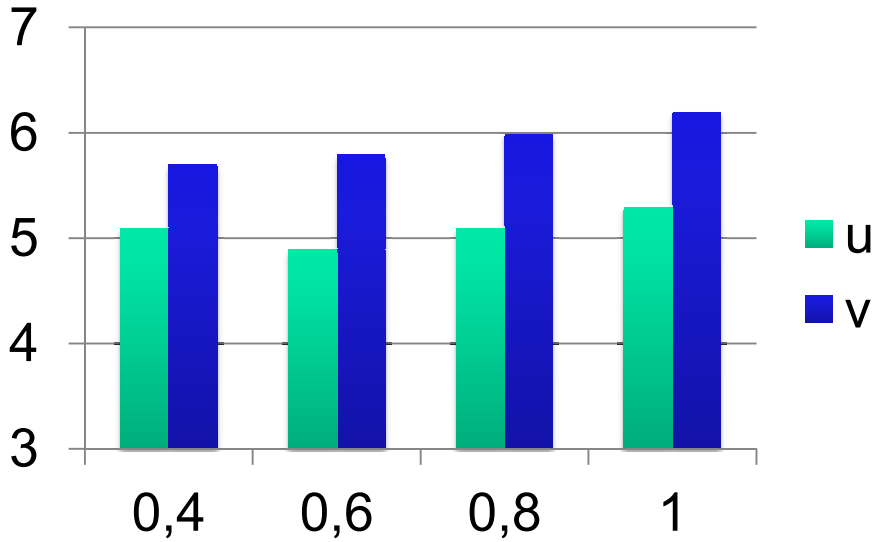
Lat. 30-50





Lat. 10-30

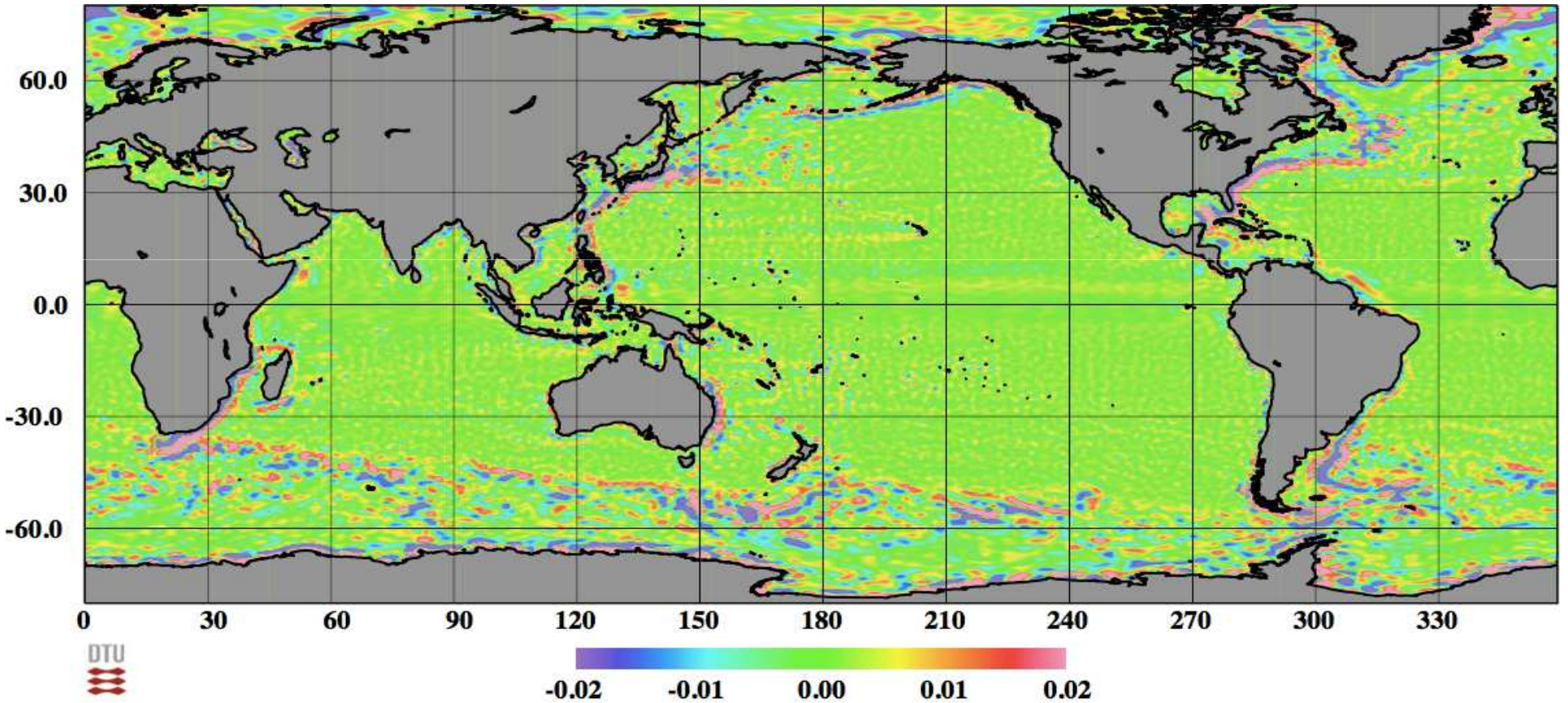




GOCE

Improving the filtering

MDT differences using ½-widths of 0.4 vs 0.6 deg

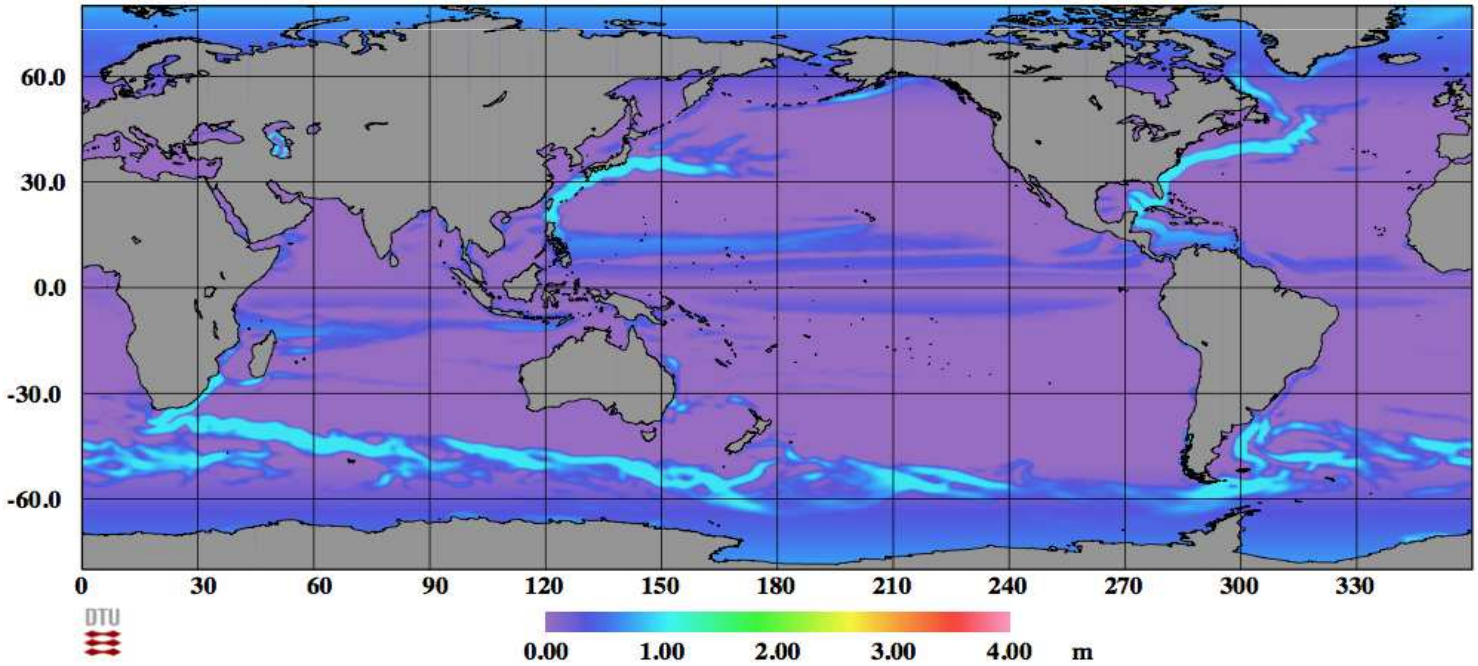


-2 cm +2 cm

GOCE

DTU15MDT – Step 2:

- The filtering by using geographically varying ½-width and anisotropy,
  - More smoothing towards the poles,
  - More anisotropy towards the Equator,
  - More details in energetic areas.



DTU16MDT

- Stats: [cm/s]

	lat 10-30		lat 30-50	
	u	v	u	v
DTU15MDT	5	5.9	5	4.9
DTU16MDT	4.9	5.6	4.7	4.7

Summary

GOCE ability to recover gravity and subsequent ocean circulation has been assessed and quantified.

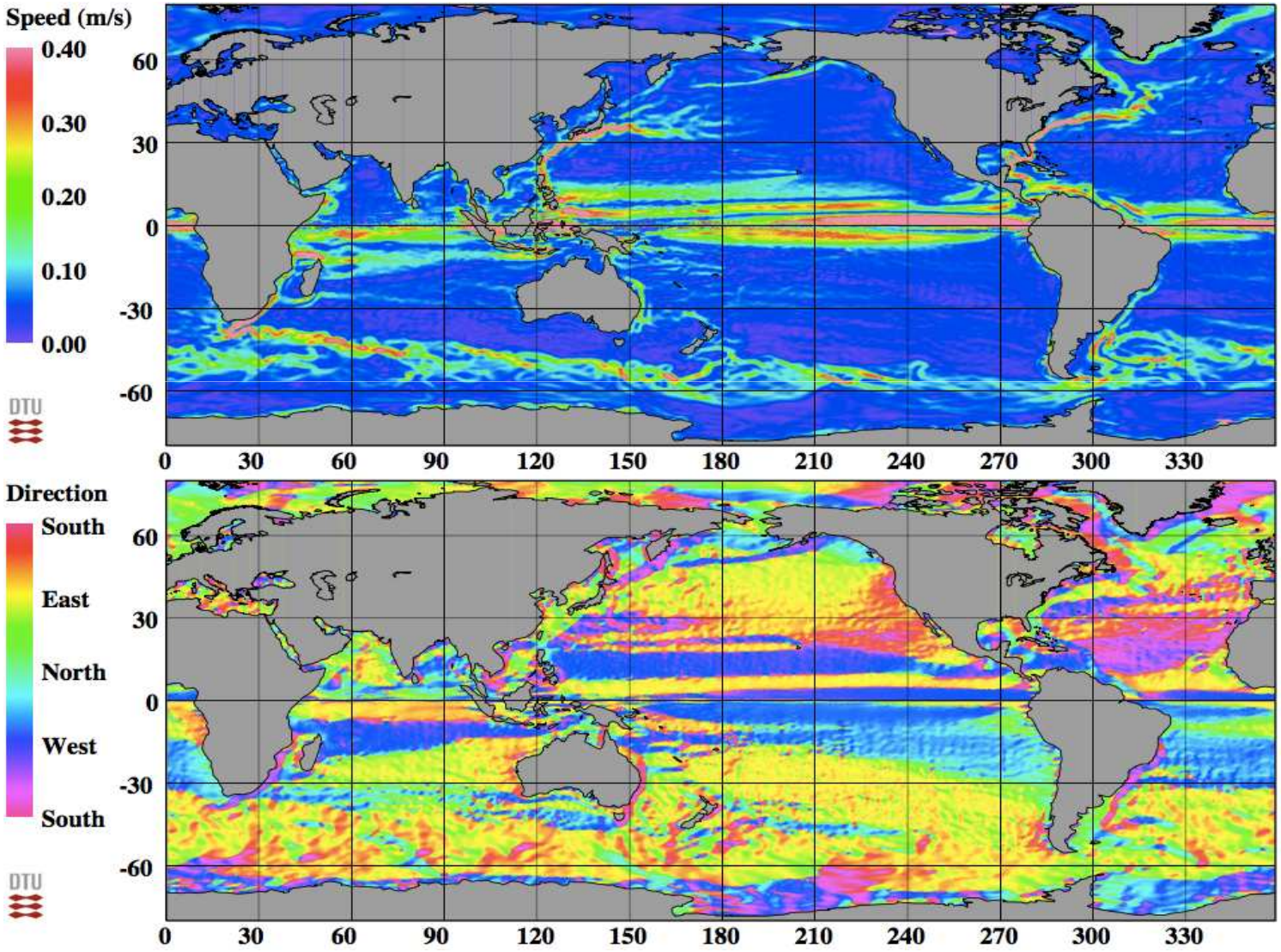
DTU16MDT has been obtained using:

1. DTU15MSS
2. Hybrid Goco05c-Eigen6c4 geoid
3. Improved filtering

Will integrate drifter velocities in early 2017.

(Contribution to ESA project GOCE-OGMOC
and ESA project on GOCE User Toolbox)

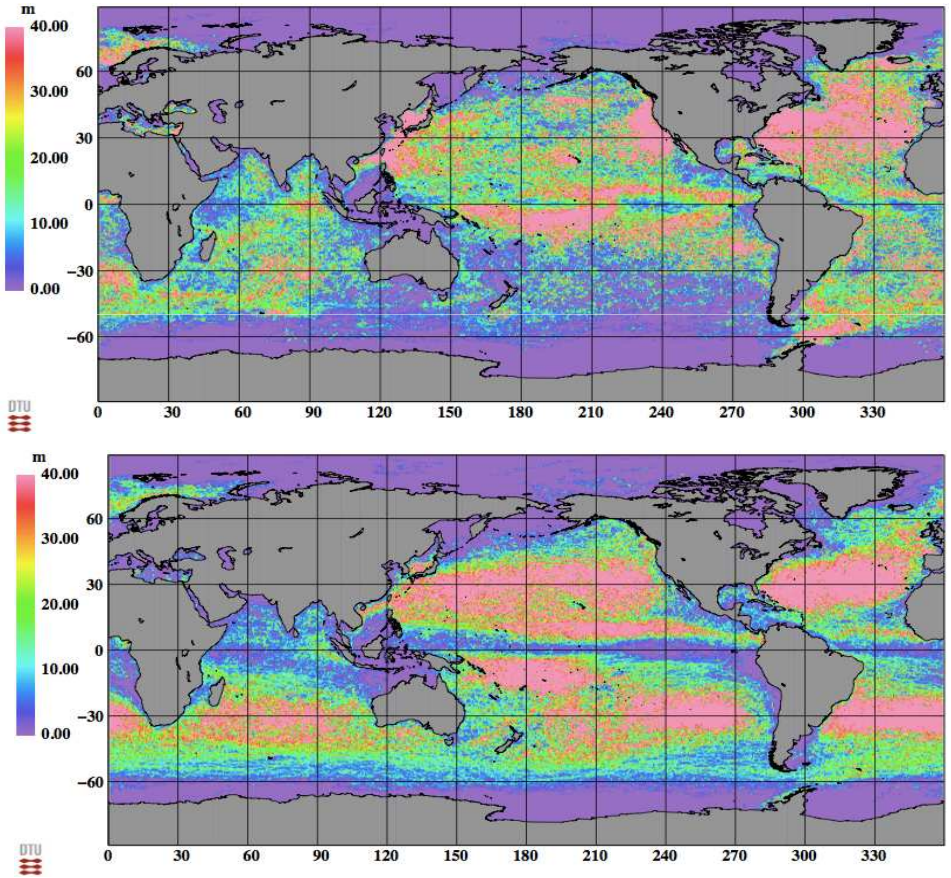
DTU16MDT geostrophic surface currents



GOCE

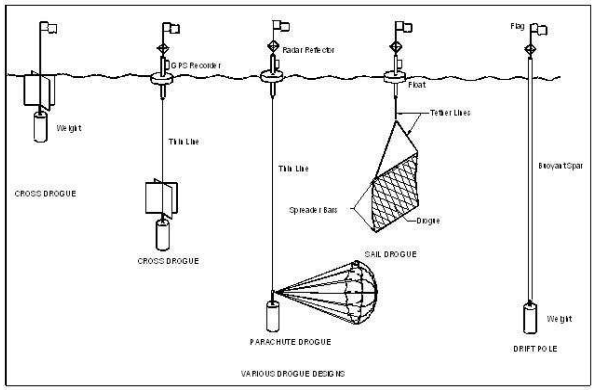
Revision of drifter data

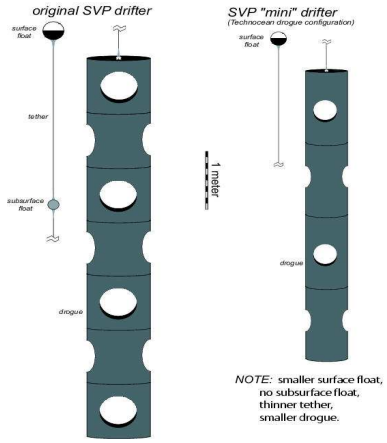
40 per 1/4x1/4 cell



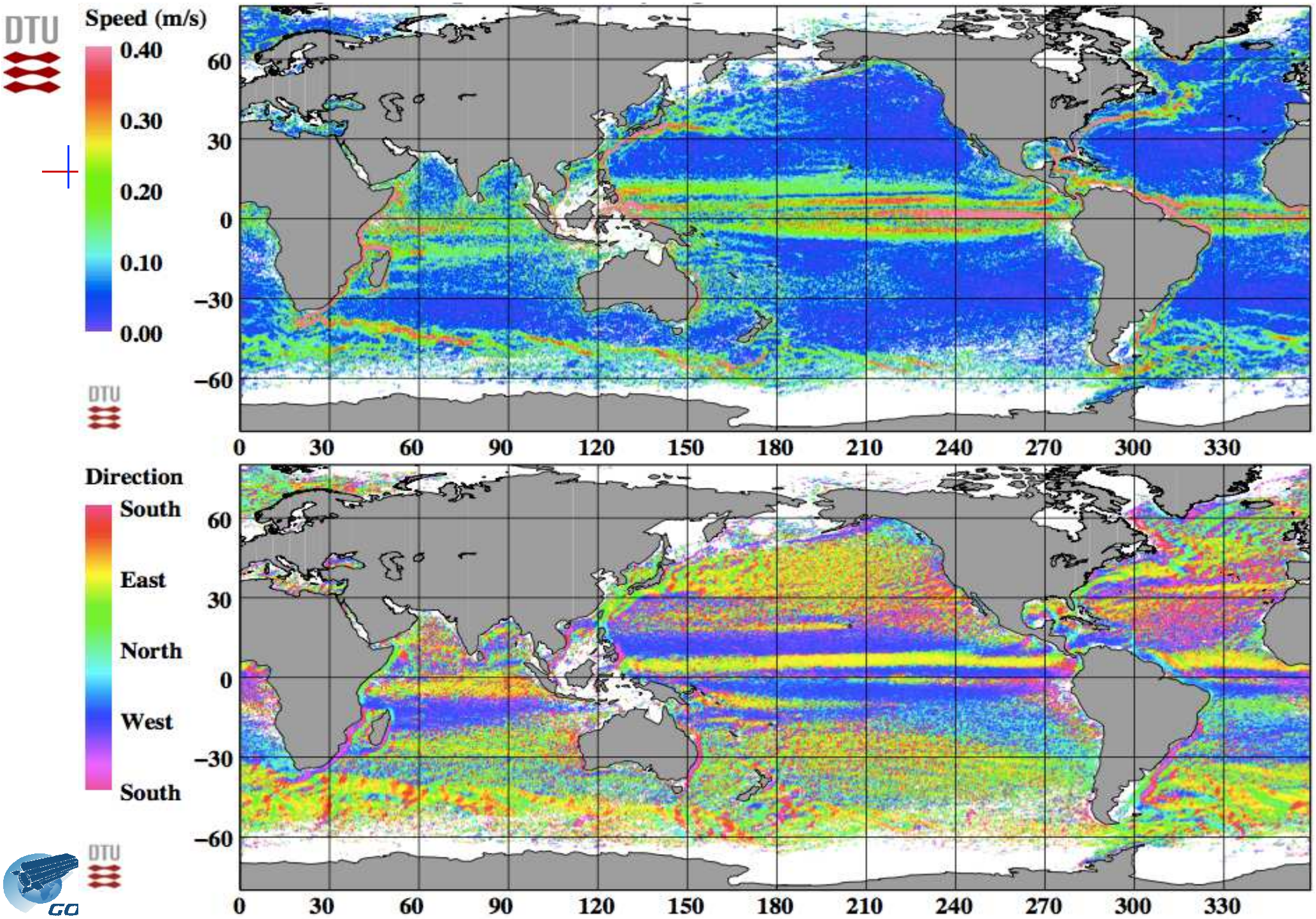
Revising drifter data wrt

- Drogued and undrogued buoys
- Wind driven currents
- Meso-scale corrections (new 20y reference period – AVISO currents)





GOCE


DTU
Speed (m/s)
0.40
0.30
0.20
0.10
0.00
DTU
60
30
0
−30
−60
0
30
60
90
120
150
180
210
240
270
300
330
Direction
South
East
North
West
South
DTU
60
30
0
−30
−60
0
30
60
90
120
150
180
210
240
270
300
330
GO

DTU13MDT:

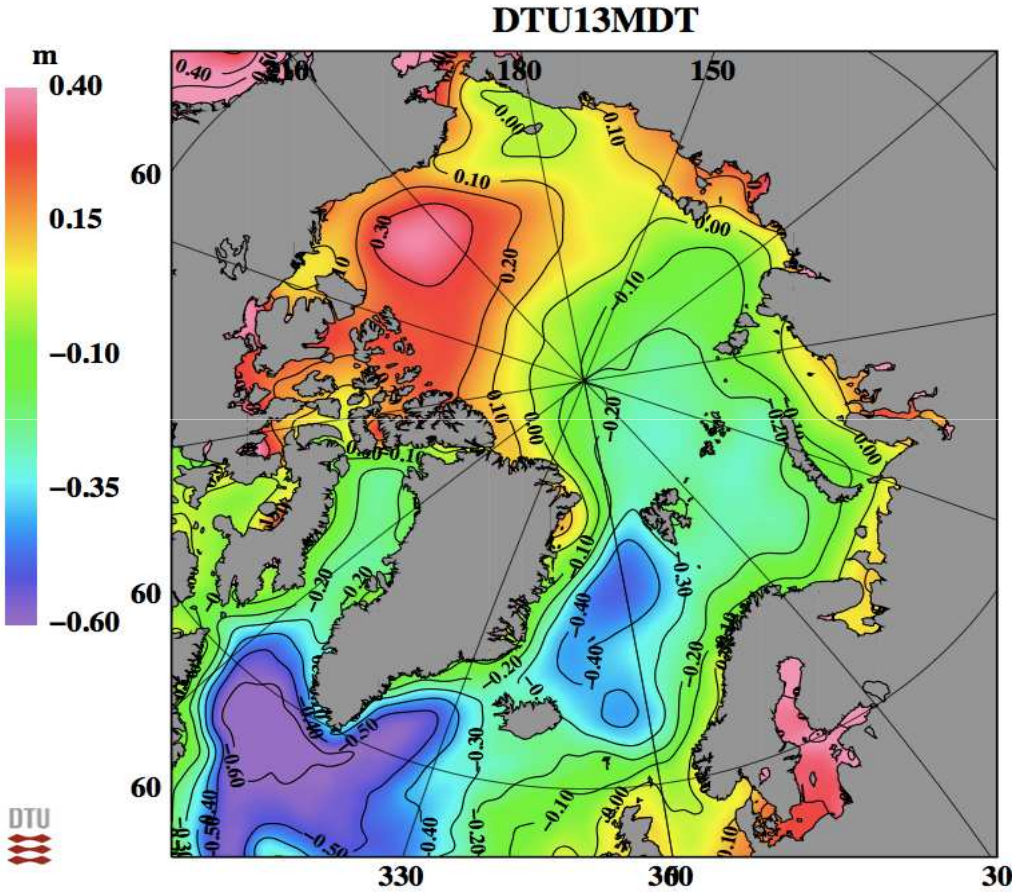
Similar to previous DTU MDTs updated with

- DTU13MSS
- Eigen-6C3

Improved mainly in the Arctic and in the equatorial region..

20 year reference period

Consistent with the new AVISO altimetry reference period.



DTU15MDT geostrophic surface currents