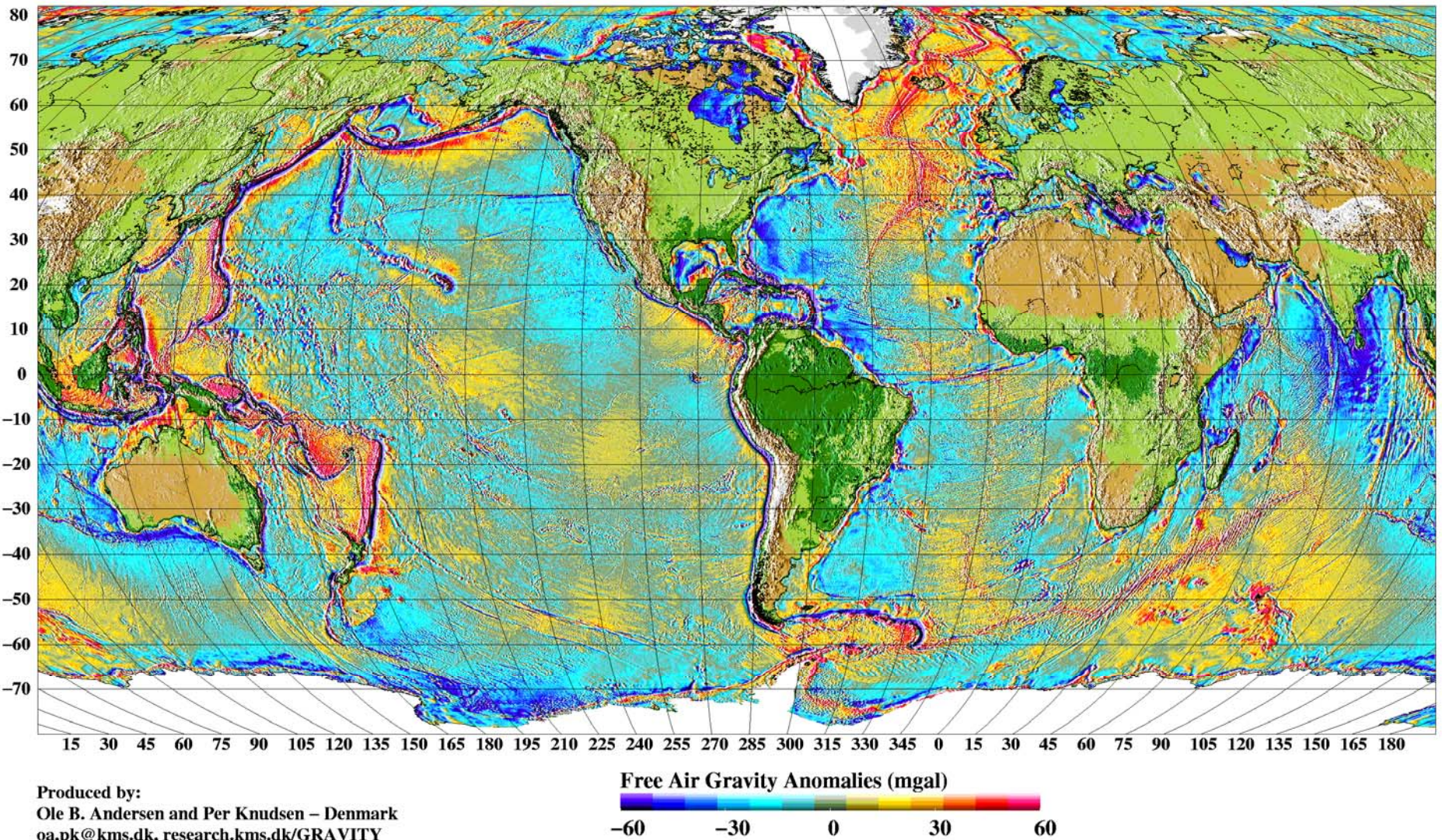


The DNSC08 ocean-wide altimetry derived gravity anomaly field

Ole B. Andersen, P. Knudsen (DTU-SPACE),
P. Berry (EAPRS lab., De Montford, UK)
S. Kenyon (NGA)



Free Air Gravity Anomalies from Satellite Altimetry



- Global Altimetric gravity from sea surface height.
- EAPRS Double retracking – improvement in coastal+polar regions.
- ICESAT - Improvement in high-latitude ice-covered Polar regions.
- Using PGM2007B - improvement of high frequency gravity signal
- Adding Mean Dynamic Topography. – improvement in current regions

DNESC08 is an update of DNESC07 using EGM2008 as reference. This also means that EGM2008 augments the marine gravity field on land.

Examples of Improvements

- The Gulf Stream
- Florida Keys

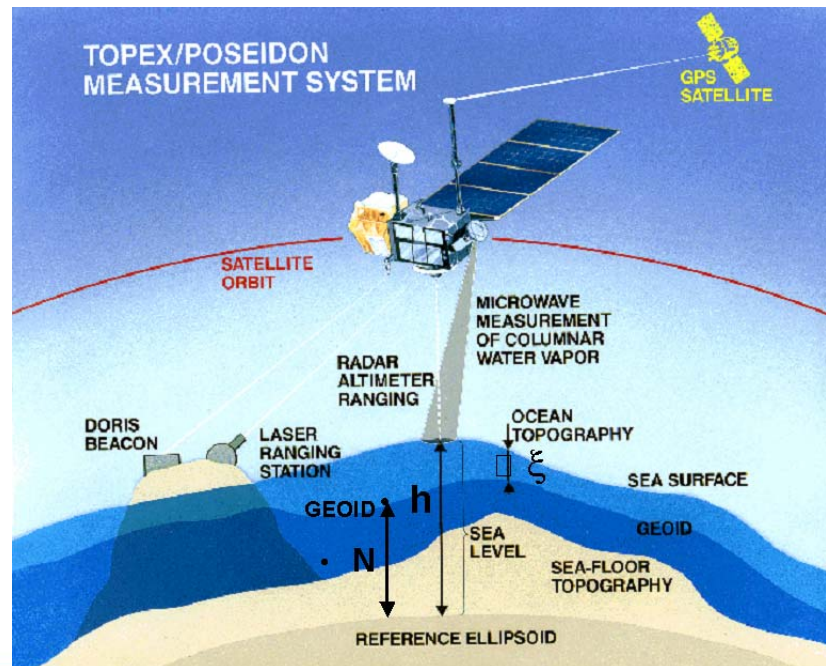
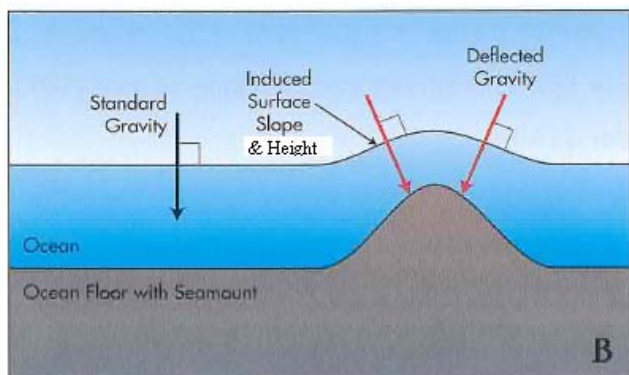
DNOSC08 Features

- Truly global marine gravity field (90°S-90°N)
- 1-2 km resolution grid (1 minute = 1/60 °)
- Based on Satellite altimetry: Retracked (ERS-1 GM + GEOSAT GM), ICESAT, Topex/Poseidon, JASON-1, ERS-2, GFO ERM

$$h = N_{REF} + \Delta N + MDT + n$$

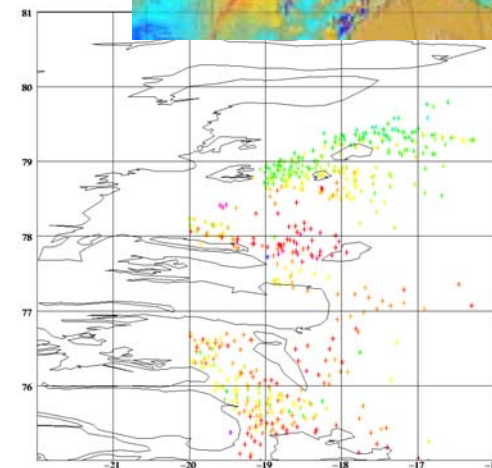
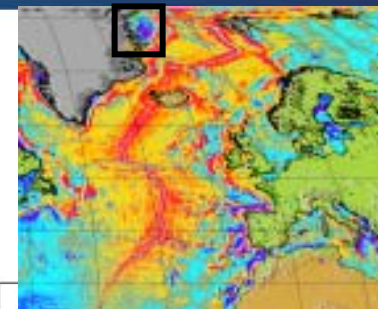


$$\Delta g = -\gamma \frac{\partial N}{\partial r} - 2\gamma \frac{N}{r}$$

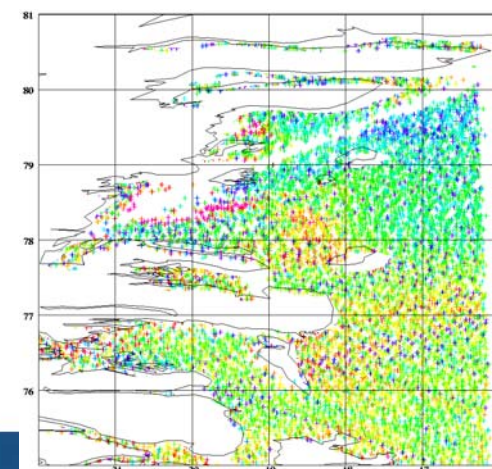


Double Waveform retracking (ERS-1 GM)

First Retracking: Gain more data and better spatial coverage
 Second Retracking: Enhancing SSH estimation (ocean WF)



ESA
RADS



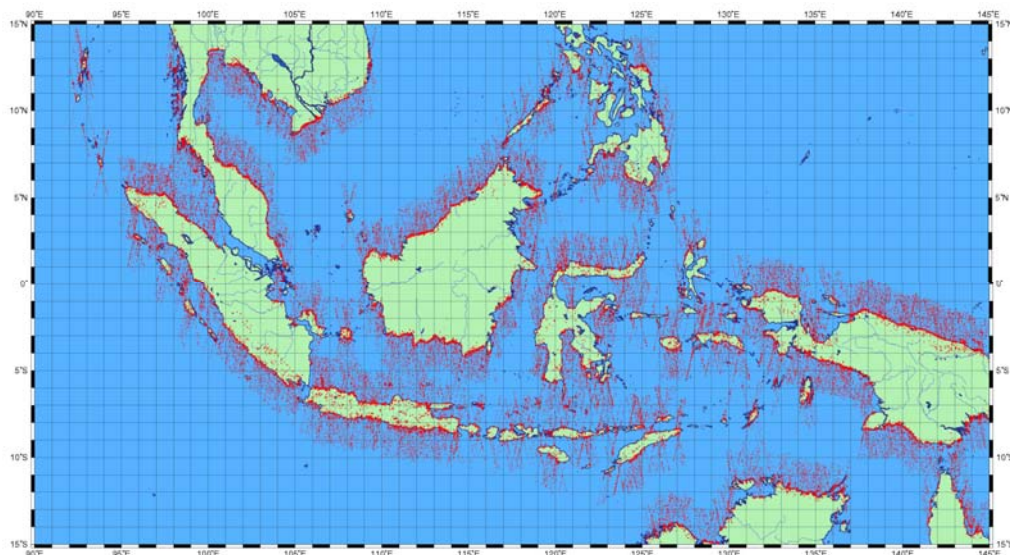
EAPRS

First Retracking:

Using EAPRS rule-based Expert System:

Identify 12 different waveform type (ocean, ice, patch, specular..)

Retrack using specially designed retrackers.



Globally: 9% gain but focused on **Polar and Near Shore** regions.



Second-retracking (All Ocean WF data)

Second EAPRS Retracking

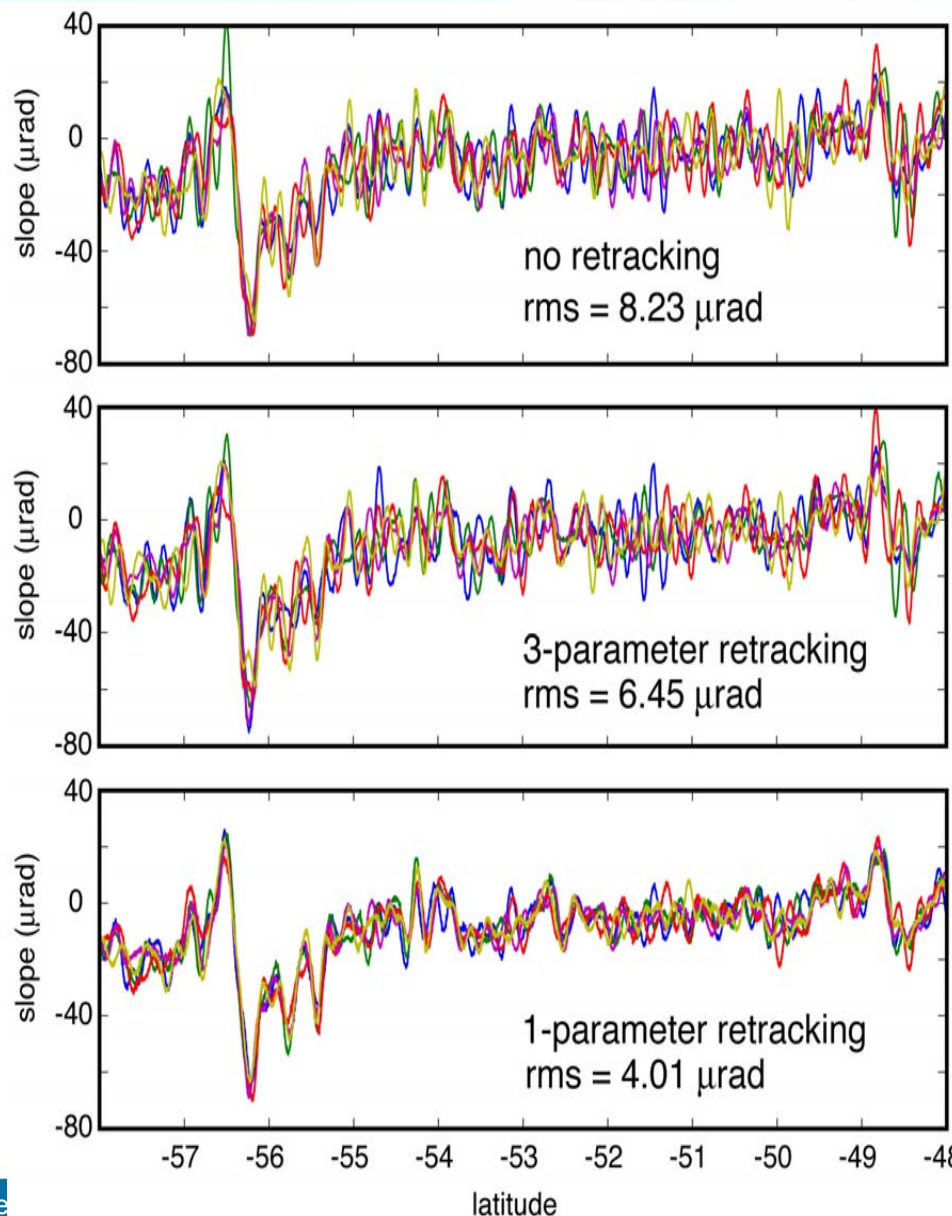
Decoupling SSH and SWH estimation:



- 1) Retrack using 3 par. Brown model
- 2) Smoothing SWH along track
- 3) Retrack using 1 par. (fixed SWH)

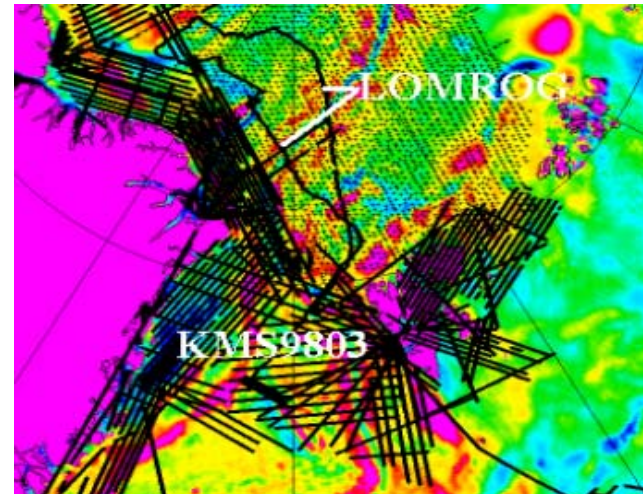
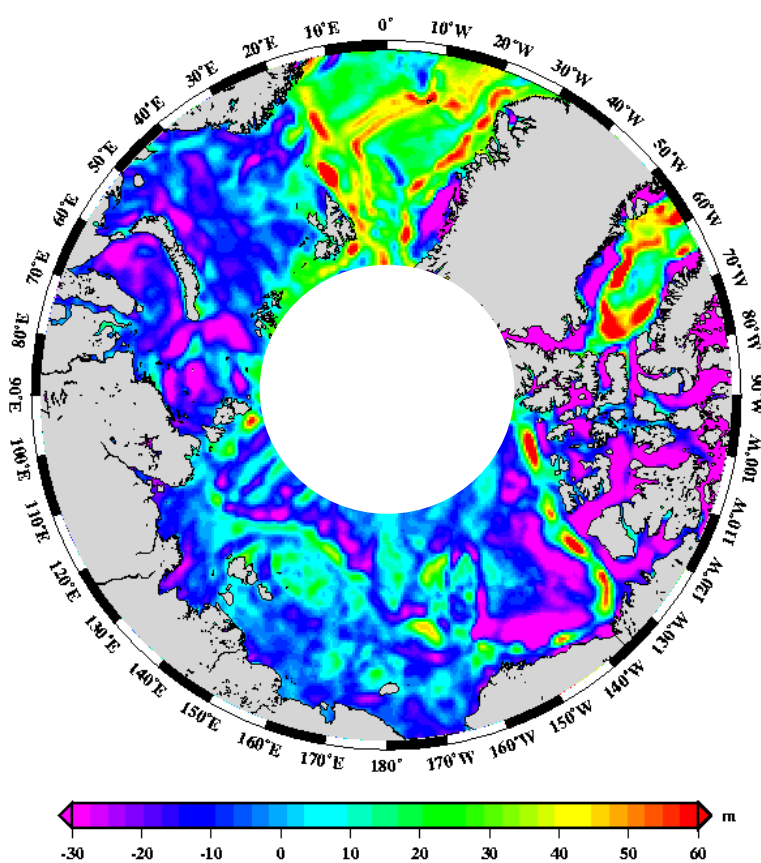
All Geosat GM retracked and provided by Lillibridge, Sandwell and Smith.

Example by D. Sandwell





ICESAT laser data introduced between 80 °N and 86°N
ArcGP patched in between 86 °N and 90°N



Comp with KMS9803 airborne survey
Region Mostly Icecovered

900 points	Std (mGal)	Max (mGal)
KMS02	9.4	51.2
ArcGP (01-06)	5.8	34.4
DSNC07	4.1	24.0

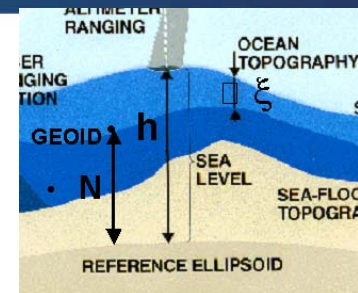
ArcGP gravity not to scale

Effect of Mean Dynamic Topography

Account for MDT in $h - N_{PGM07} = \Delta N + MDT + n$

$$\Delta g_{ALT} = -\frac{1}{\gamma} \frac{\partial h}{\partial r} = -\frac{1}{\gamma} \left(\frac{\partial N}{\partial r} + \frac{\partial MDT}{\partial r} \right)$$

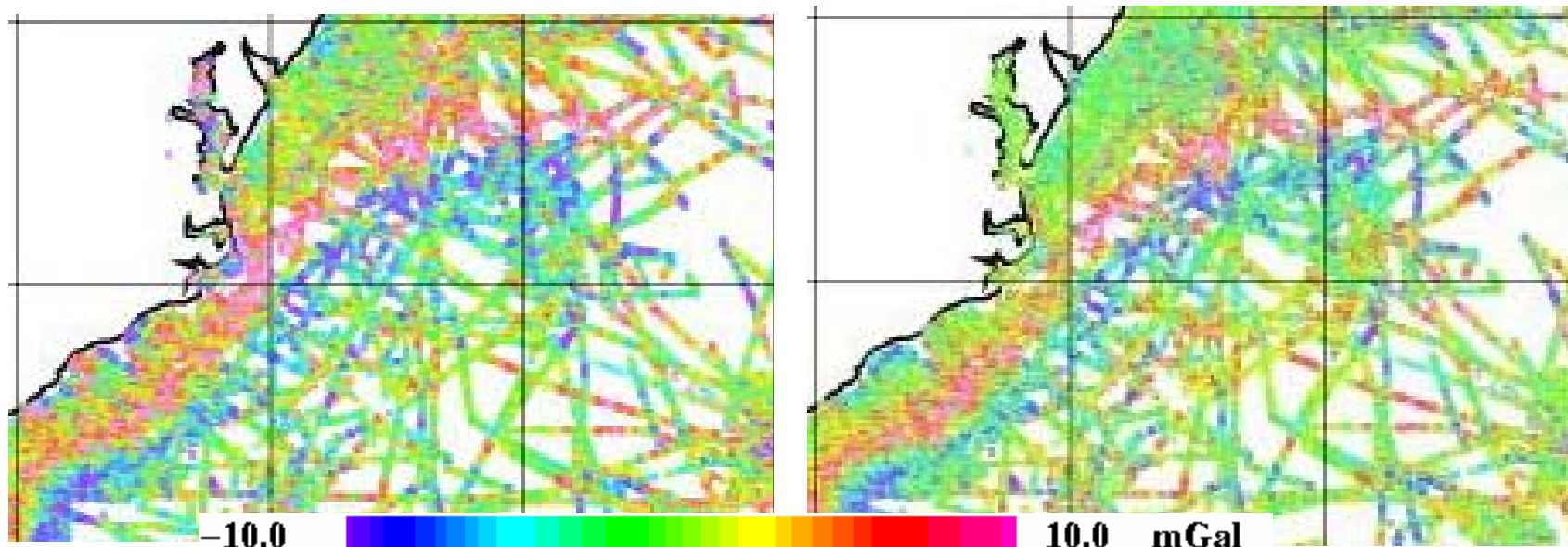
+/- 300 mGal +/- 3 mGal.



DNOSC08GRA Derived using consistent developed Mean Dynamic Topography DOT07A

KMS02 – Marine Gravity (no MDT)

DNOSC08 – Marine Gravity





PGM 2007B

Derived from GRACE, MSS, surface gravity+other sources.

Complete to degree and order 2190 (4 times higher than EGM96)

Tscherning Rapp – Variance/Covariance Function.

$$\sigma_i^{TT} = \begin{cases} \kappa_i & i = 2, \dots, 360 \\ \frac{A}{(i-1)(i-2)(i+4)} \left(\frac{R_B^2}{R^2} \right)^{i+1} & i = 361, \dots \end{cases}$$

EGM96: Remaining signal: 20-30 cm and 30-40 km correlation length

PGM07B: Remaining signal: 4-5 cm and 7-10 km correlation length

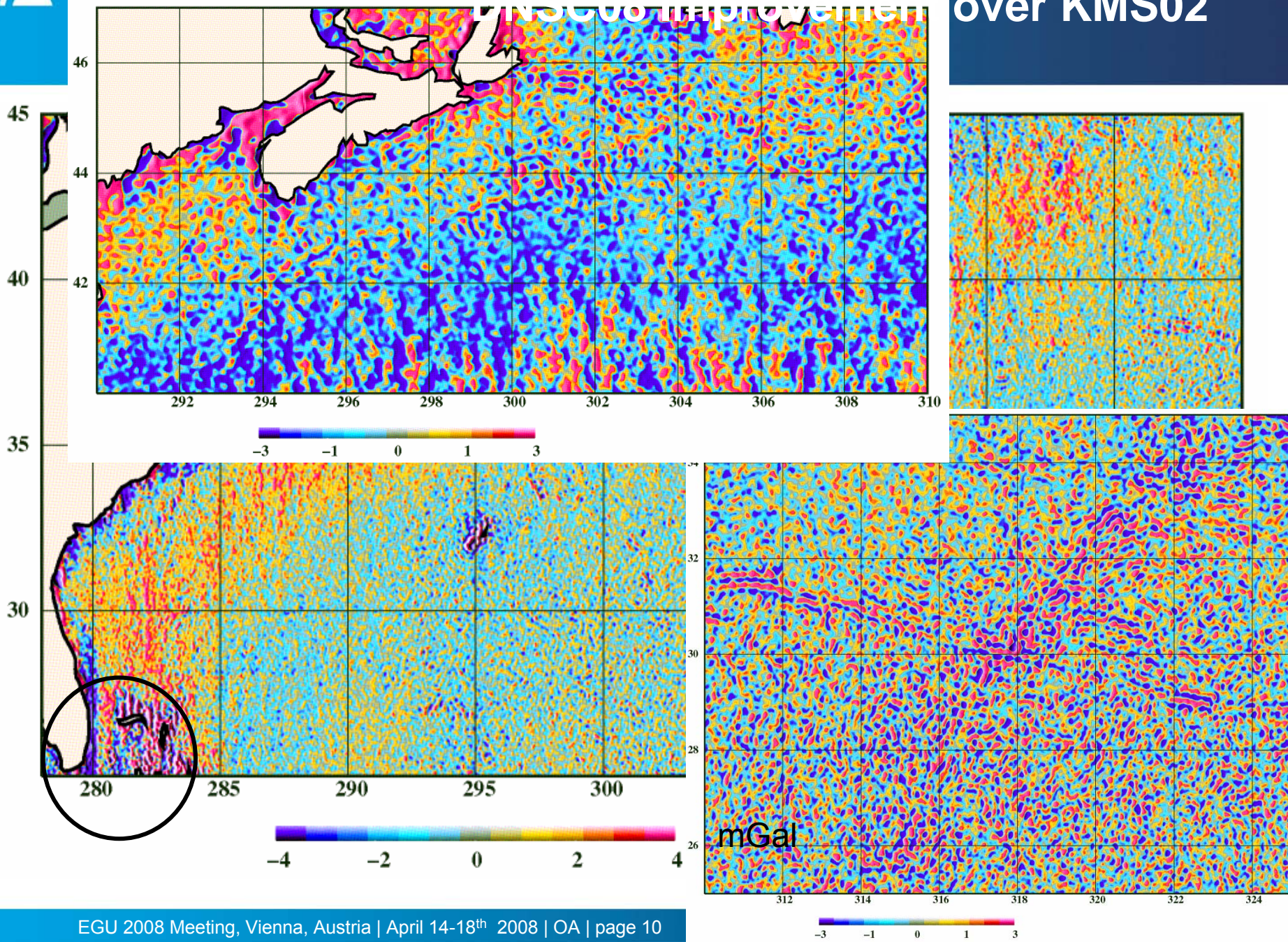
Signal variance and correlation length locally fine-tuned for DNSC08.

Correlation length for interpolation: 18 km (KMS02) -> 7-9 km (DNSC08):

$$c(r) = C_0 \left(1 + \frac{r}{\alpha}\right) e^{(-r/\alpha)} + D_0 \left(1 + \frac{r}{\beta}\right) e^{(-r/\beta)}$$

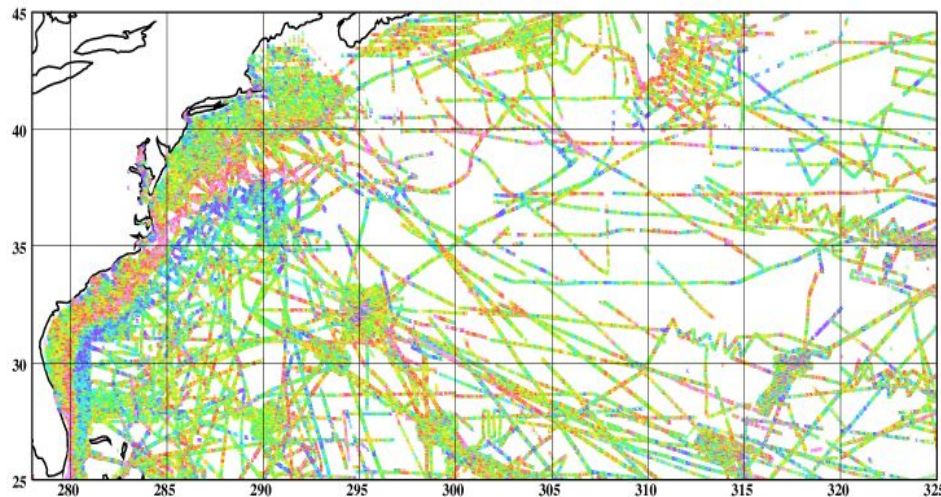
-> Significantly improvement of short wavelengths

DNSC08 Improvement over KMS02





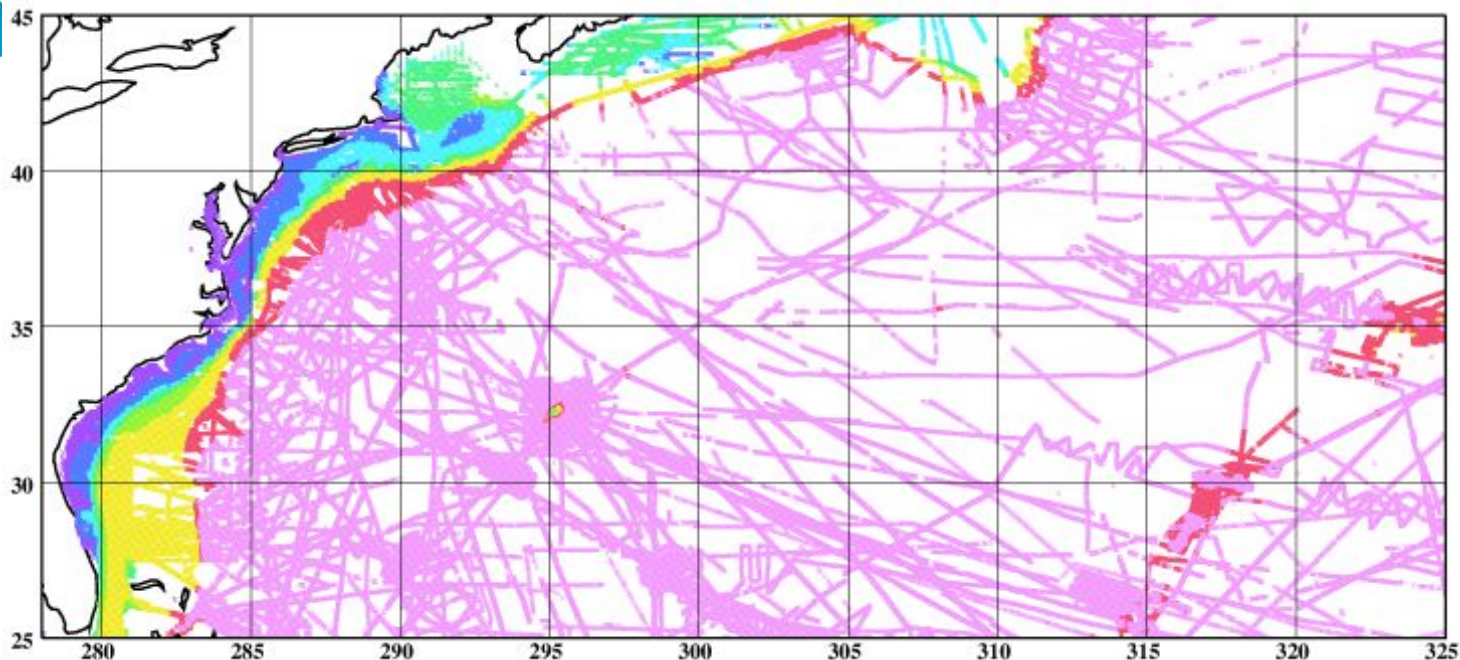
History of Improvememet



321.400 obs	Mean	Std Dev.	Max Dev	Note
KMS99	0.60	5.69	73.74	
KMS02	0.44	5.15	49.38	
DNSC05	0.48	4.79	46.88	Retrack ERS-1, PGM04
DNSC08	0.39	4.36	36.91	Double Retrack ERS1+ PGM+ Retracked GSAT
SS V12.1	0.62	5.79	82.20	
GSFC 00.1	0.68	6.14	89.91	
NTU01	0.79	6.10	92.10	
SS V16.1	0.59	4.88	45.29	Retracked ERS1+GSA
SS V 17??				PGM 07B



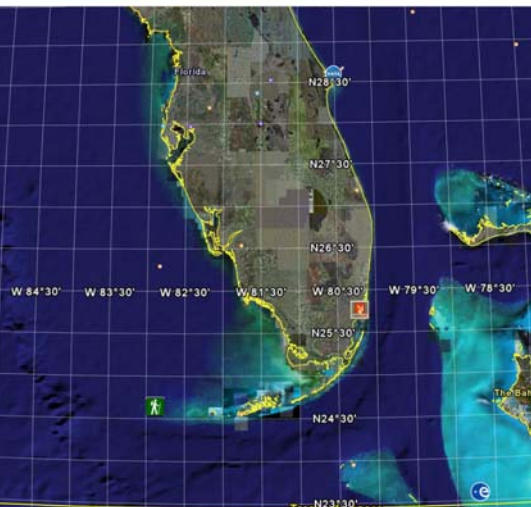
Coastal regions heavily improved



All > 10.000 obs	Std(KMS02)	Std(DNSC08)	Percentage Imp
Purple (0-20 m DEPTH)	6.54	3.46	48
Dark Blue (20-50 m)	4.16	3.34	20
Light Blue (50-200 m)	4.06	3.83	6
Green (200-500 m)	5.74	4.89	15
Yellow (500-1000 m)	5.36	4.38	22
Red + Pink (1000-5000 m)	5.60	4.89	13

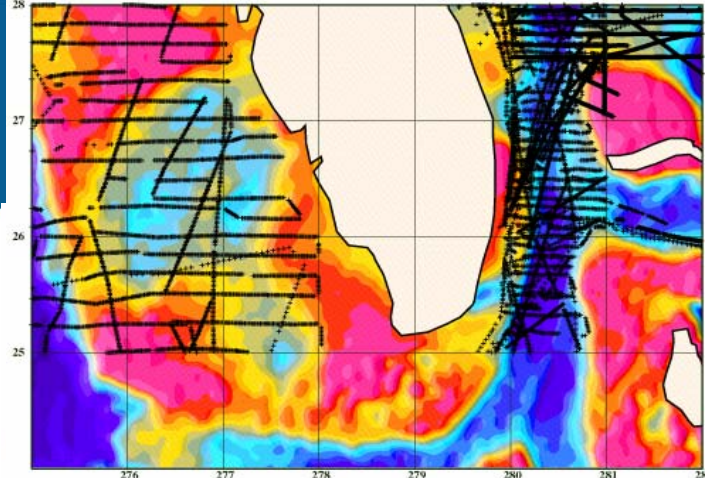


Florida Keys



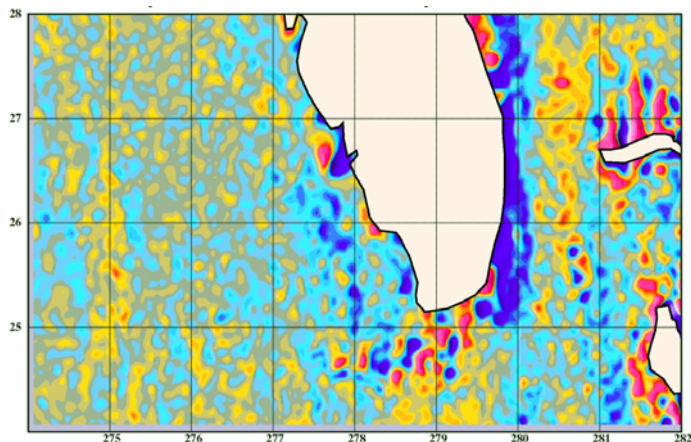
Large differences between
KMS02, DNSC08, SS16.1
Lots of marine Gravity

Strong currents
Steep Bathymetry

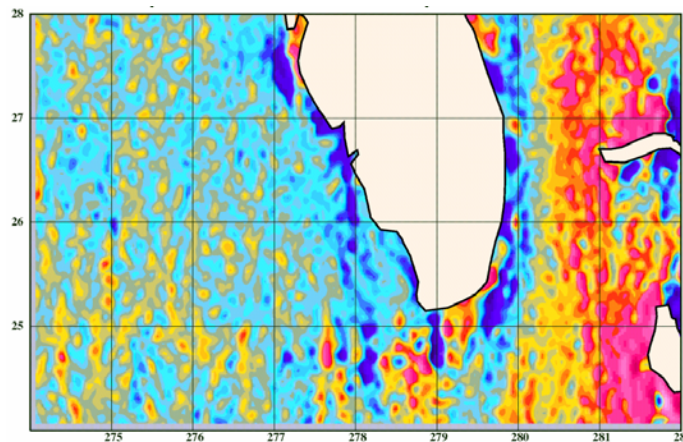


10100 marine Obs	Std Dev (mGal)
KMS02	4.99
SS 16.1	5.89
DNSC08	2.78

KMS02-DNSC08



SS16.1 – DNSC08



-10.0  10.0 mGal



Summary

- **DNOSC08**
 - Resolution: 1 minute by 1 minute (2 km by 2 km)
 - True global marine gravity field (90°S to 90°N)
- Significant improvement at short scales, in polar and coastal regions
- **DNOSC08GRA:** <ftp://spacecenter.dk/pub/GRAVITY>
- **DNOSC08 All files** <ftp://spacecenter.dk/pub/DNOSC08> (all files)
- **DVD:** Contact oa@space.dtu.dk
- **Consistent Products available:**
 - Altimetric (geometrical) MSS **DNOSC08-MSS**
 - Altimetric derived Bathymetry **DNOSC08-BAT**
 - Mean Dynamic Topography **DNOSC08-MDT**
 - Altimetric Marine Gravity field **DNOSC08-GRA**
 - Products also available in Google Earth

