

The DTU10 Global Gravity field and mean sea surface – improvements in the Arctic

Ole B. Andersen

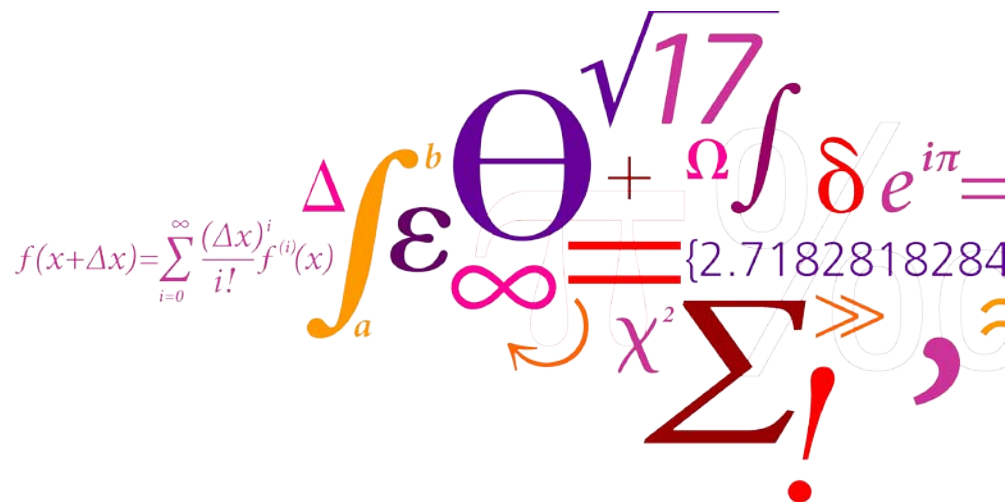
Acknowledge

NGA (Kenyon et al.)

De Montford (P. A. M Berry)

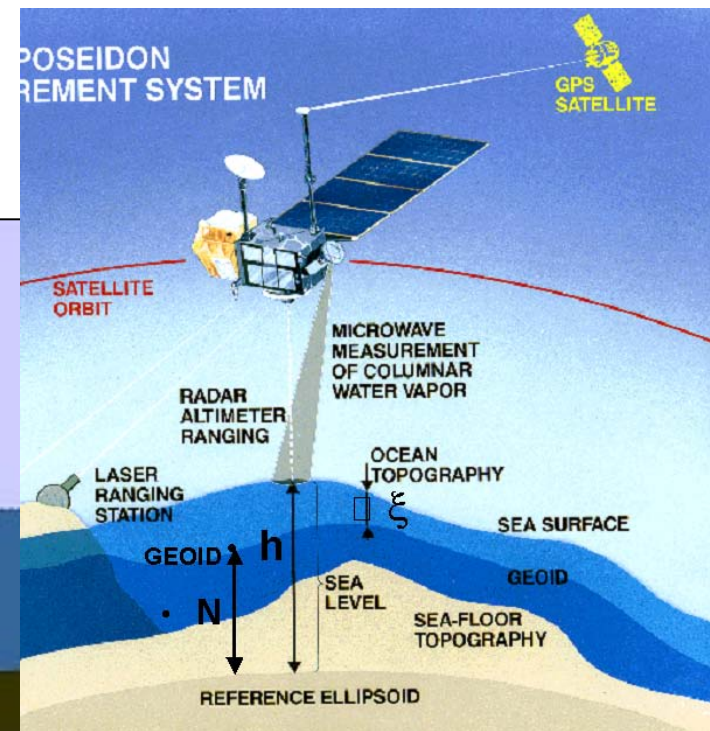
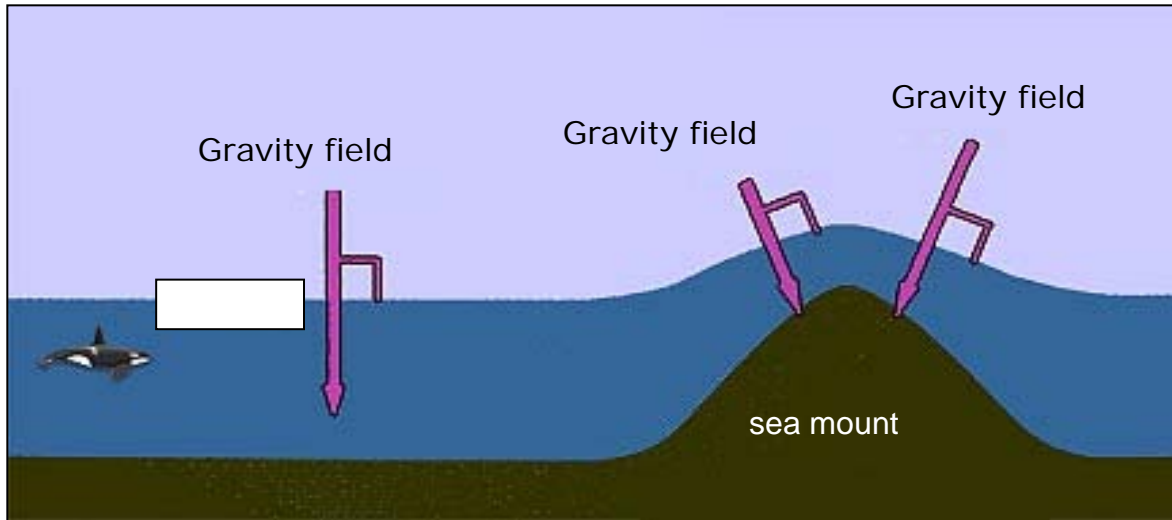
DTU Space

National Space Institute



From DNSC 08 -> DTU 10

- **Intro – setting the scene outline the problems**
- **Retracking**
- **Data Editing (ERS-1 and ENVISAT) Existing ERM data**
- **Ice-retreat**
- **Corrections (which to apply – difference)**
- **Accuracy**



The Sea surface height mimicks the geoid
MSS = Geoid + Mean Dynamic Topography (MDT)

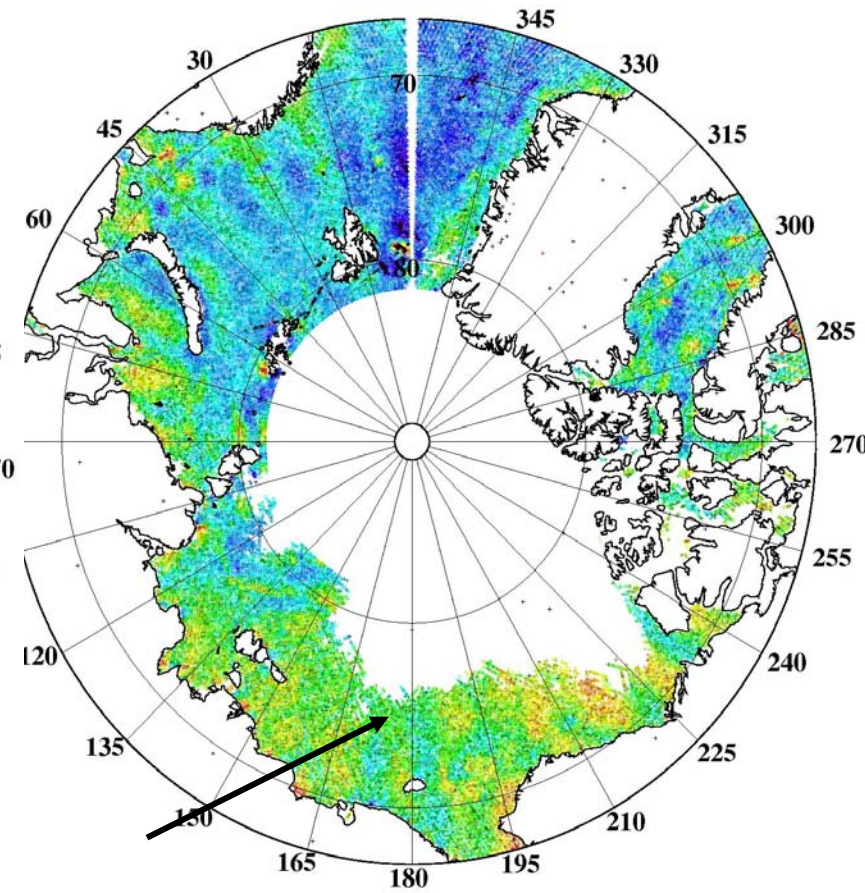
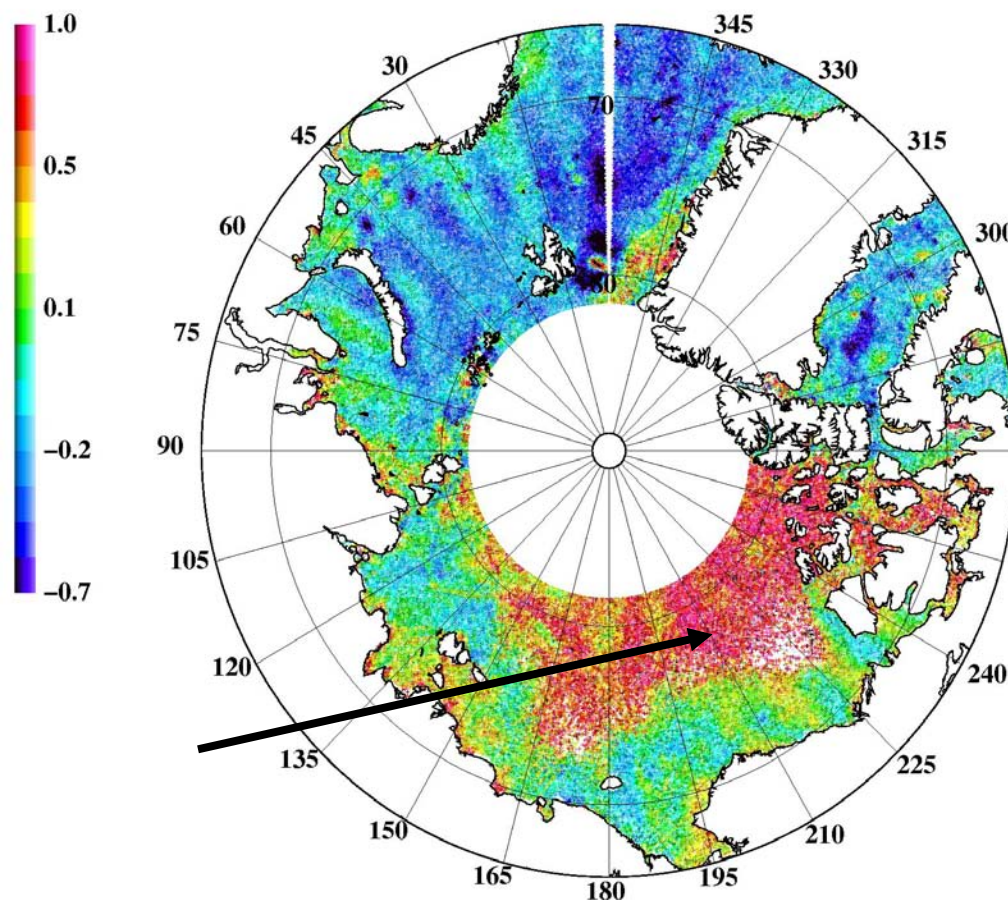
Gravity from MDT corrected MSS (=Geoid)

$$\Delta g = L_{\Delta g}(T) = -\frac{\partial T}{\partial r} - 2\frac{T}{r} \approx -\frac{1}{\gamma}\left(\frac{\partial N}{\partial r} + 2\frac{N}{r}\right)$$

Invert and map of the distribution of mass within the earth:
 density changes and bathymetry -> Bathymetry prediction.

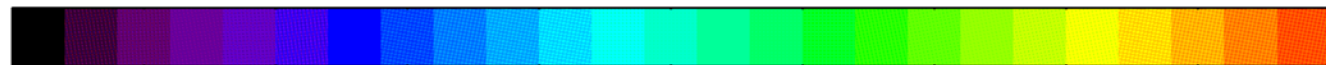
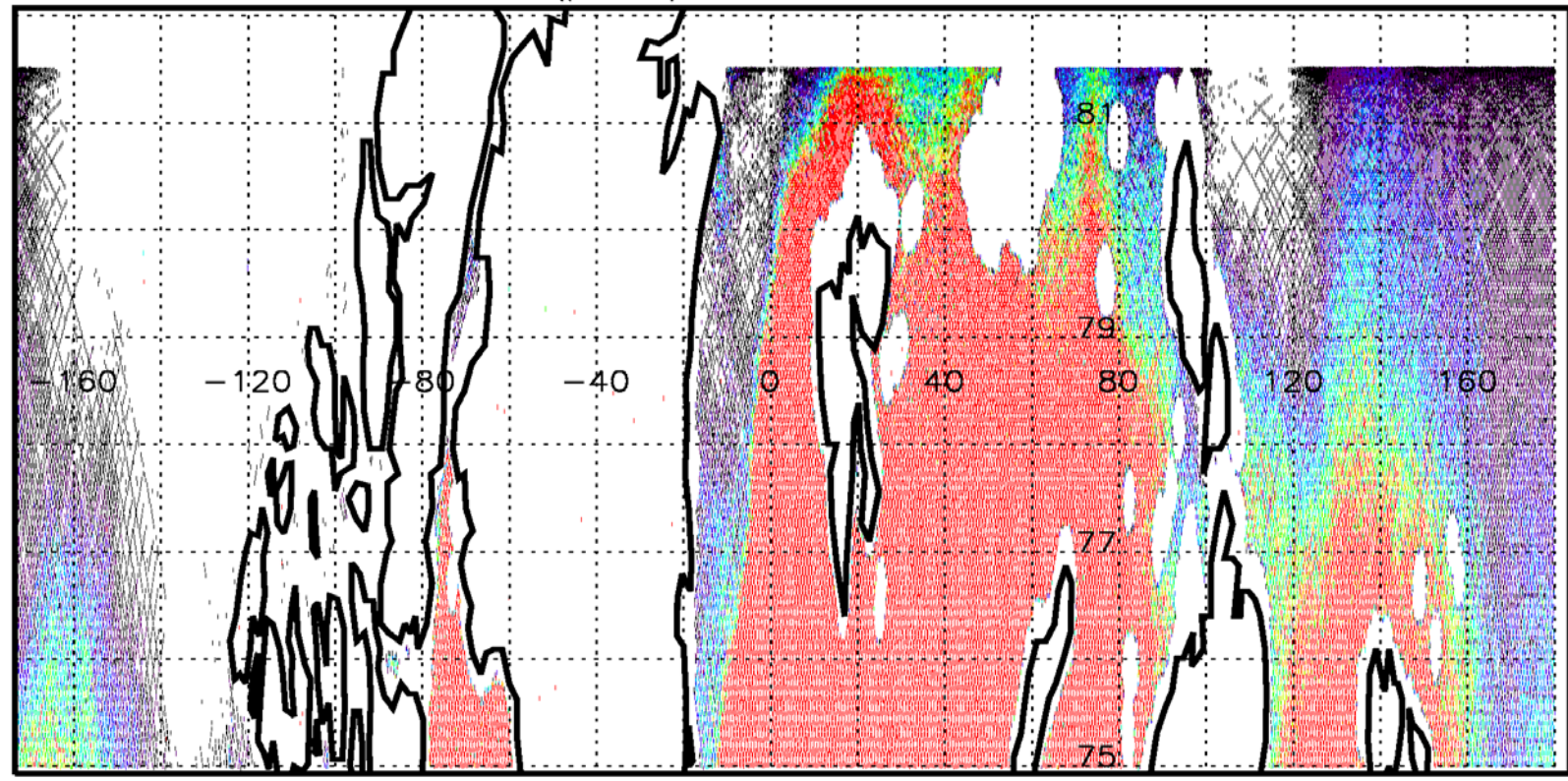
Height rel to PGM04 : ERS-2 (ALL)

ENVISAT (ALL)



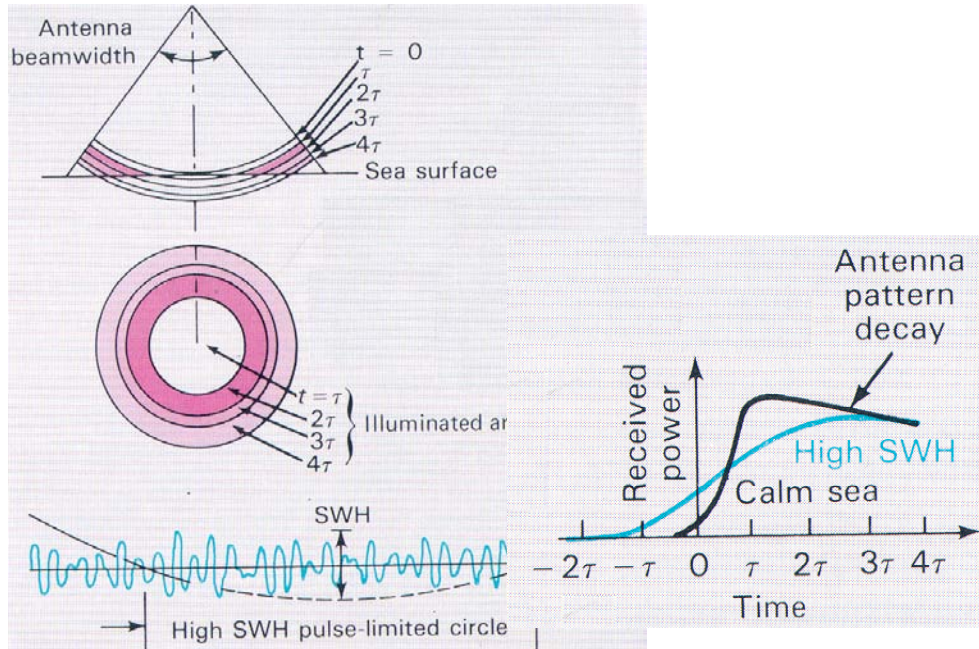
Number of Envisat points (out of 90 repeats)

of points - ENVISAT

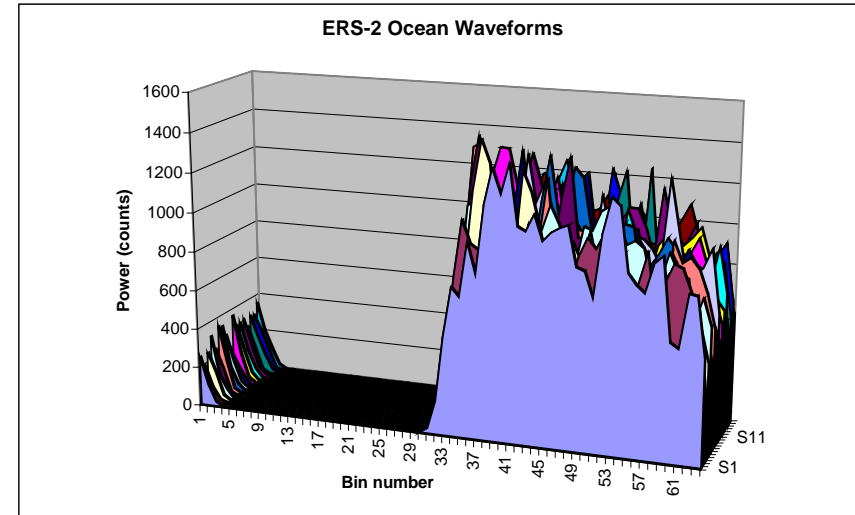


1.0 1.9 2.8 3.7 4.6 5.5 6.4 7.3 8.2 9.1 10.0

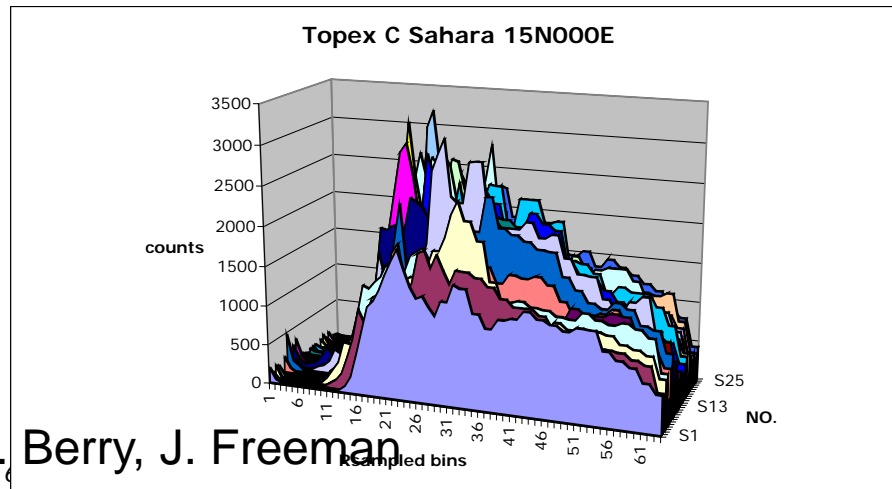
Retracking Needed



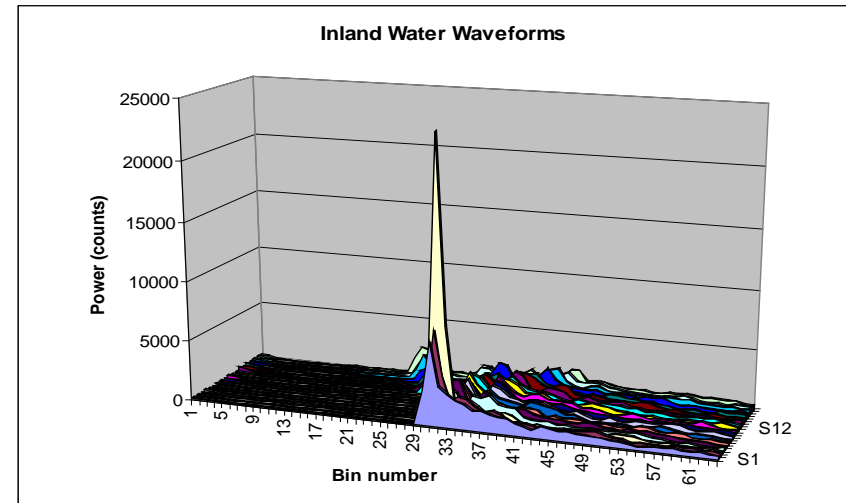
Ocean Echoes



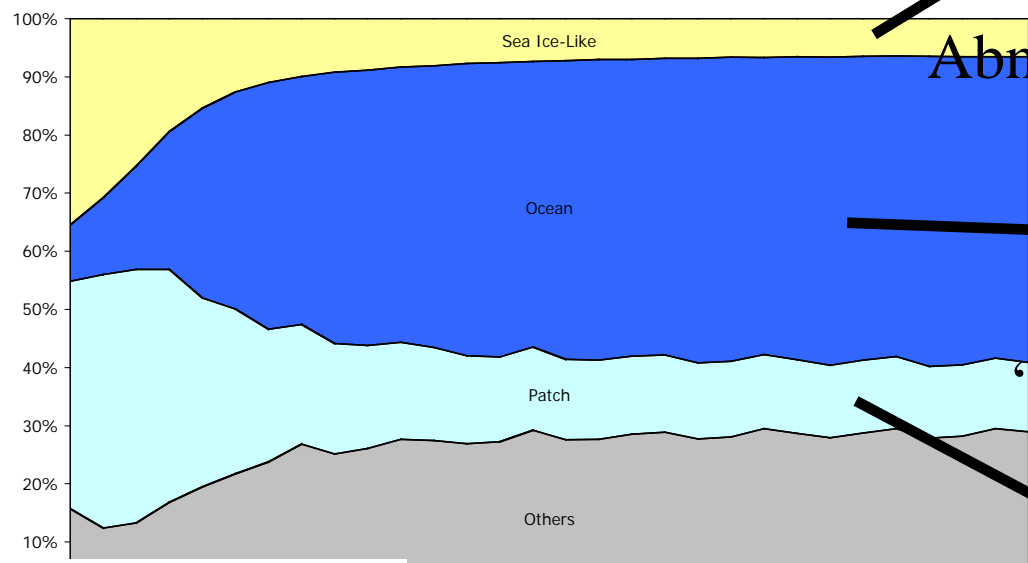
Desert – Australia



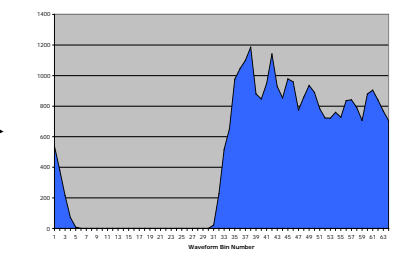
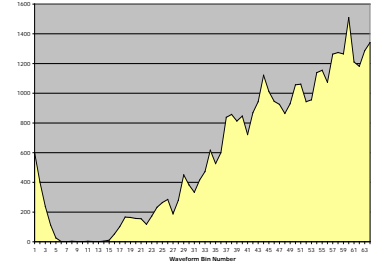
Inland Water (River – lake - ice)



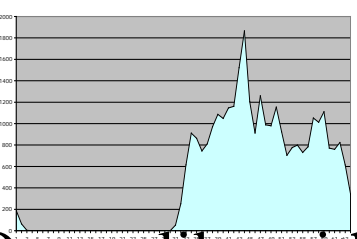
Waveform distribution Polar regions



Abnormally wide leading edge



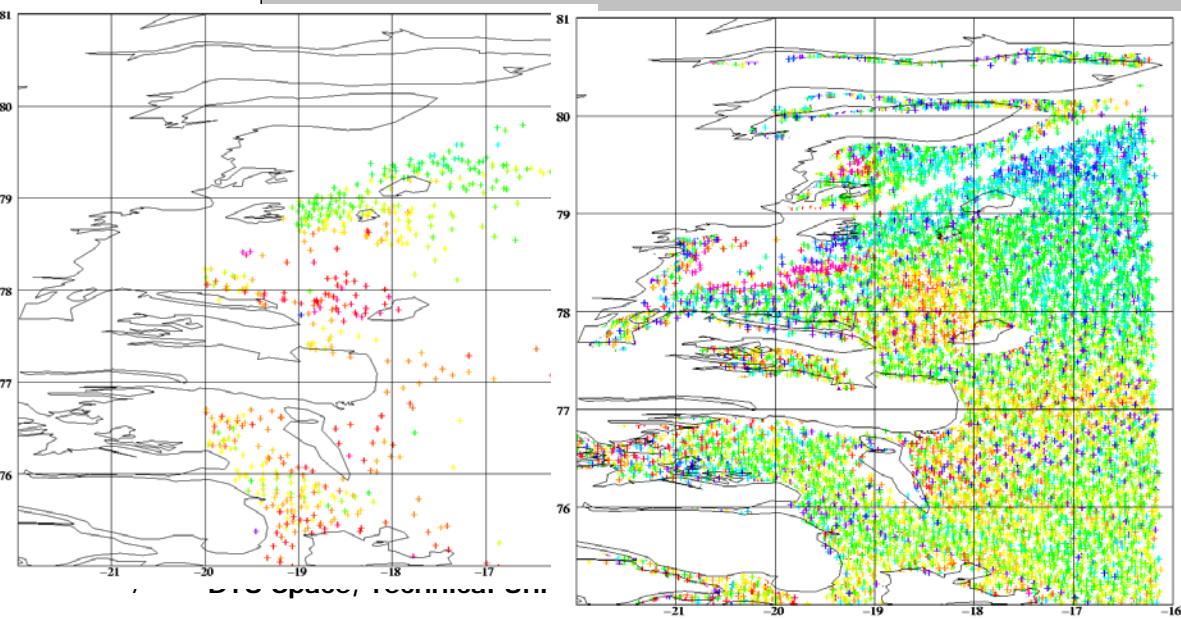
'Real' ocean waveforms



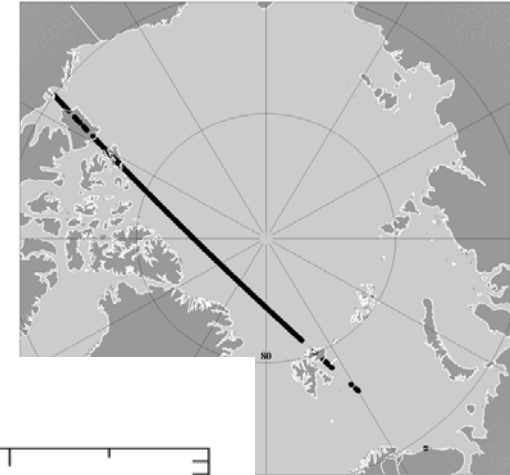
Ocean-like with quasi-specular component

**14 Different waveforms
Analysed using EAPRS**

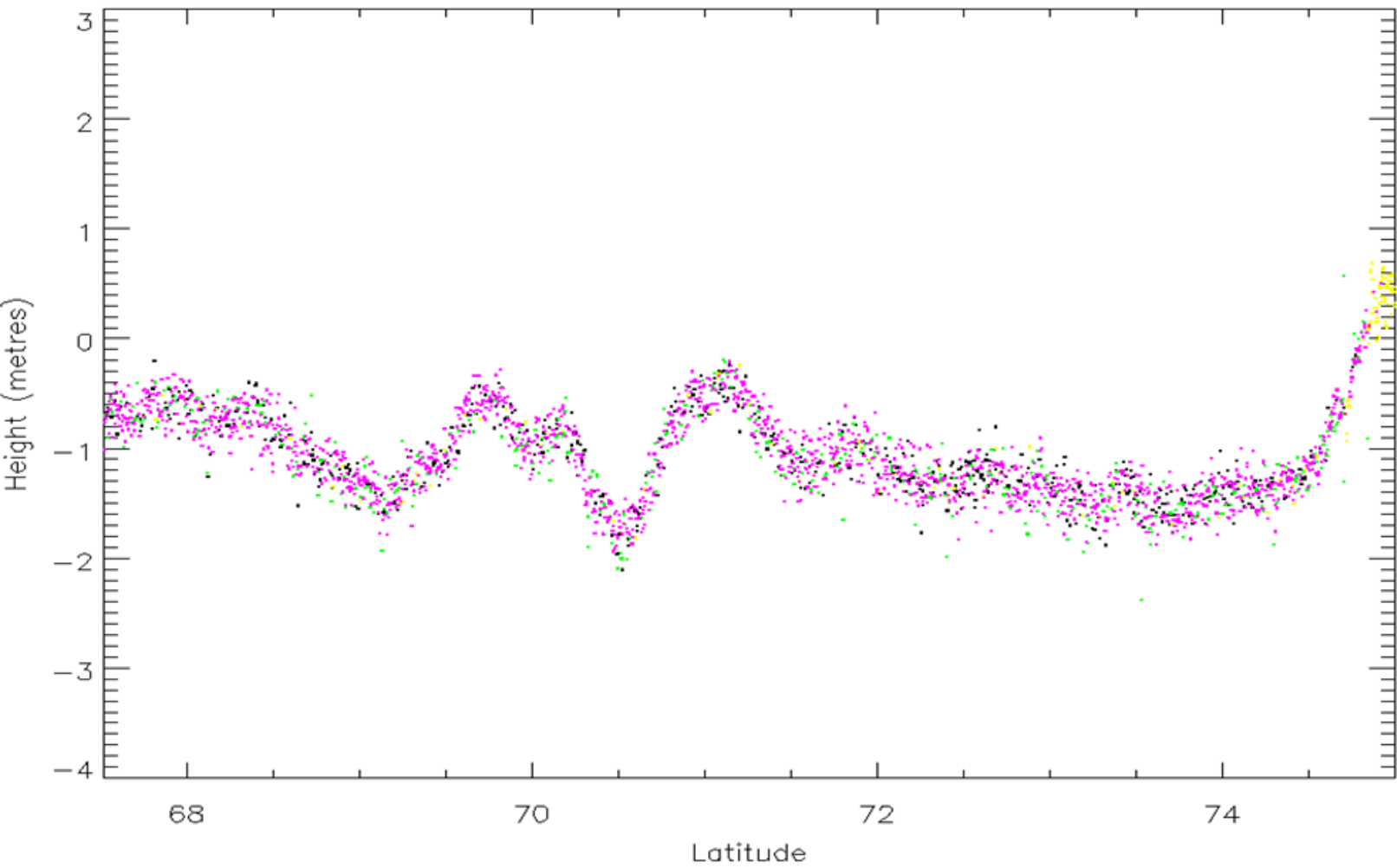
"Famous" GM example



Retracking ERS-2 Melting Ice example - First test



ERS-2 orbit12608.025.2.RAR



TRACK EX
NOT THIS
TRK USED

MSS + Gravity Improvement:

Successfully retracked the ERS-1 GM mission.

The ERS-2 GM + ENVISAT GM is ongoing (MSS + Climate + Sea level Change)
DTU12MSS, DTU12GRAV

Until then:

DTU10MSS, DTU10GRAV

Improved editing

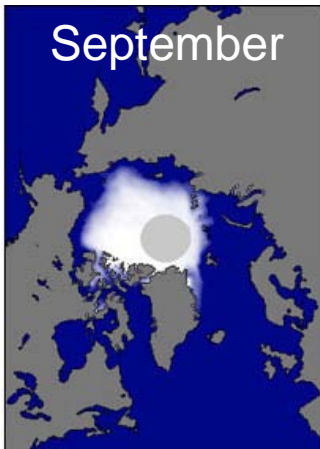
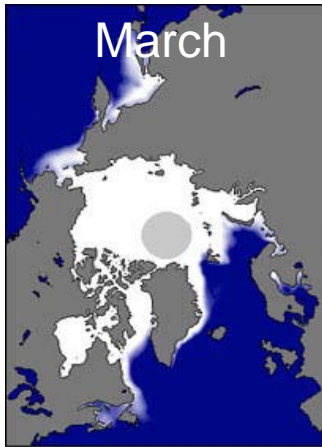
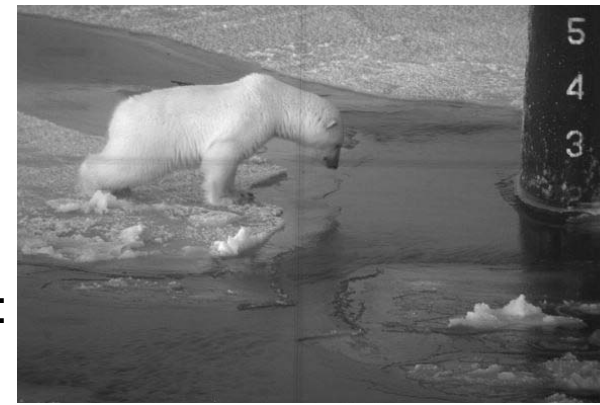
Take advantage of Climate Change (Ice-retreat)

Improving:

Range and geophysical Corrections (ocean tide etc)

Implementing Annual correction for better mean (seasonal data)

Total sea ice retreat

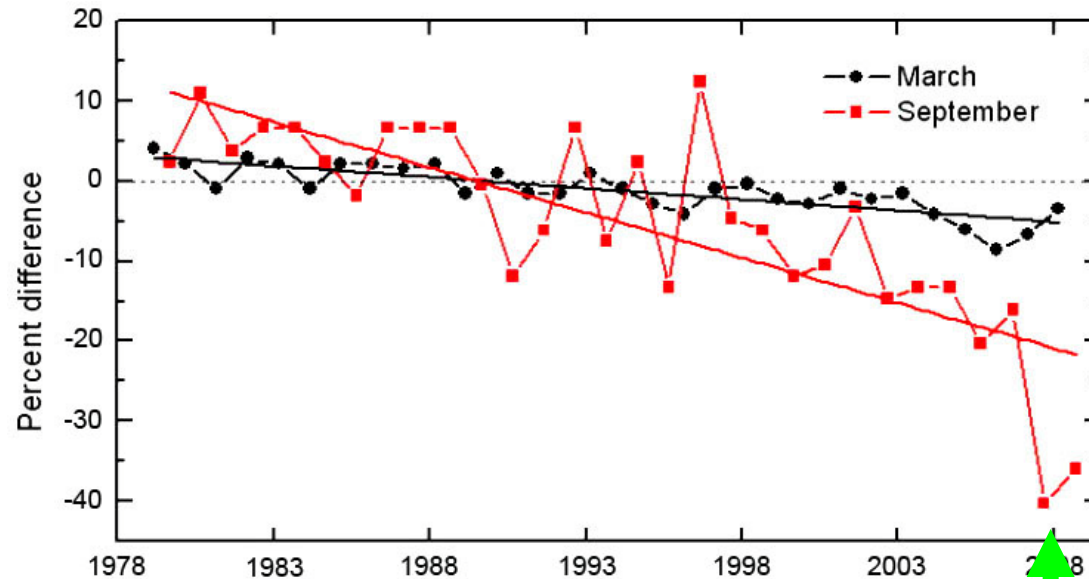


Decrease in total sea ice extent:

September: 11.1 % per decade

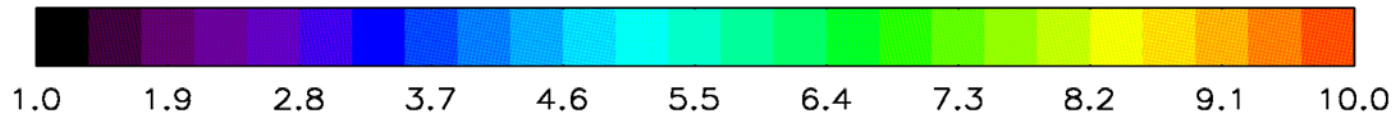
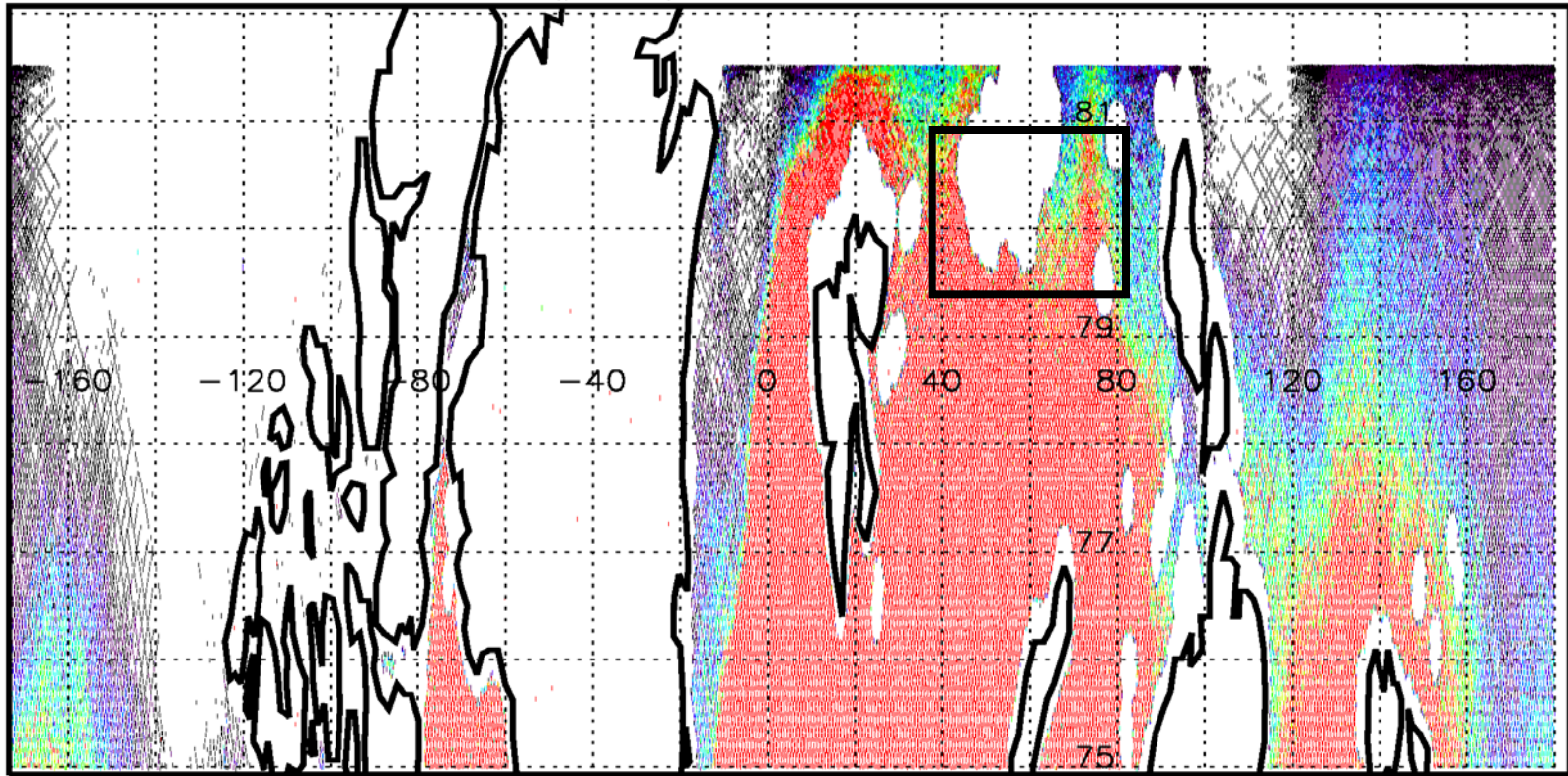
March: 2.8 % per decade

Richter-Menge et al, 2008

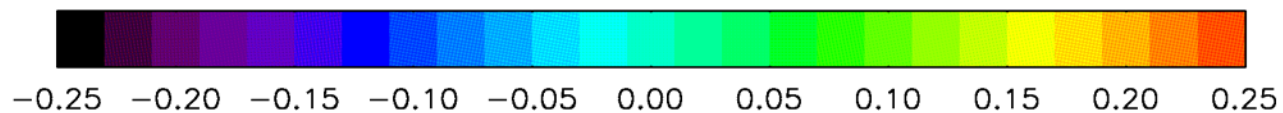
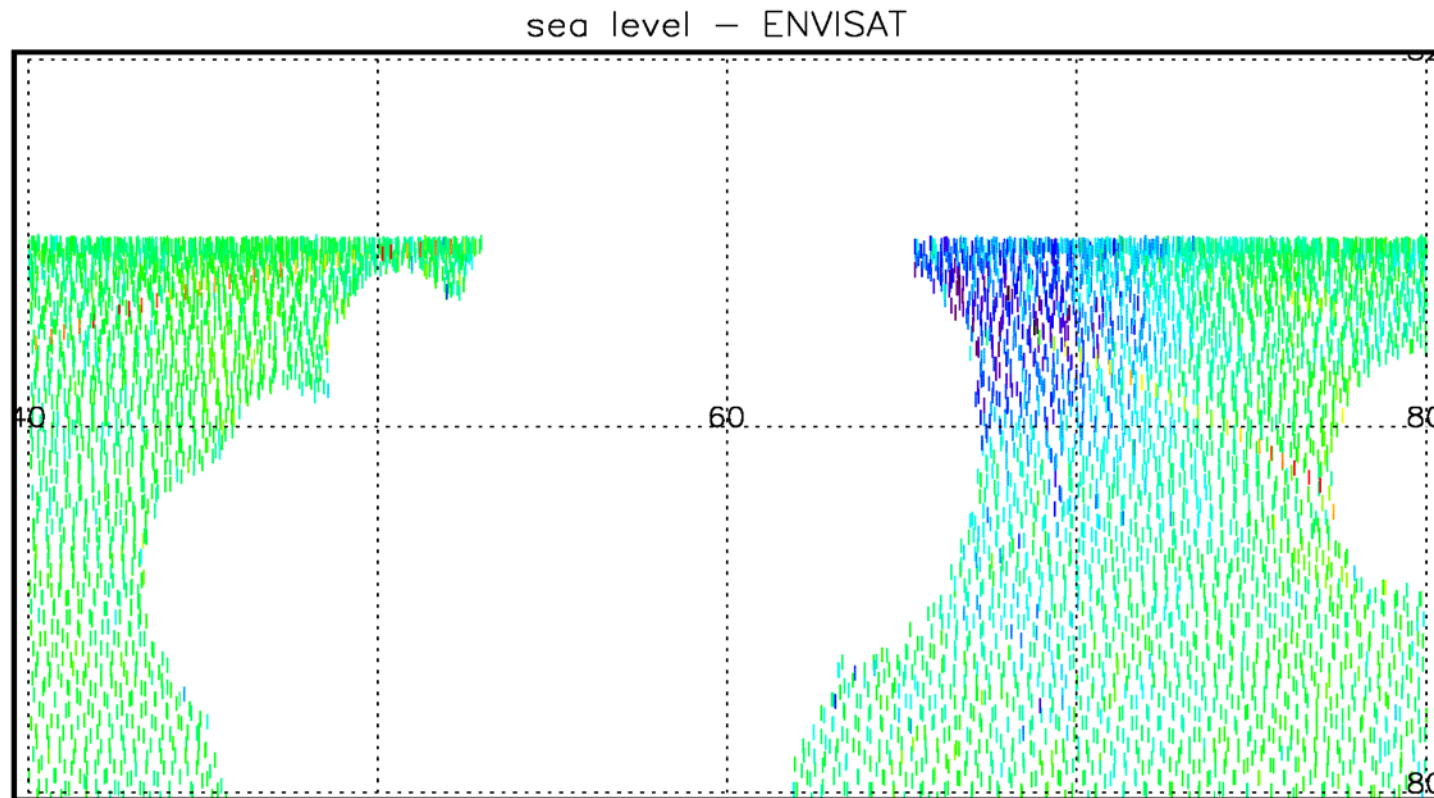


Fortunately ENVISAT survived 2007. Will investigate

of points – ENVISAT



Editing problems??

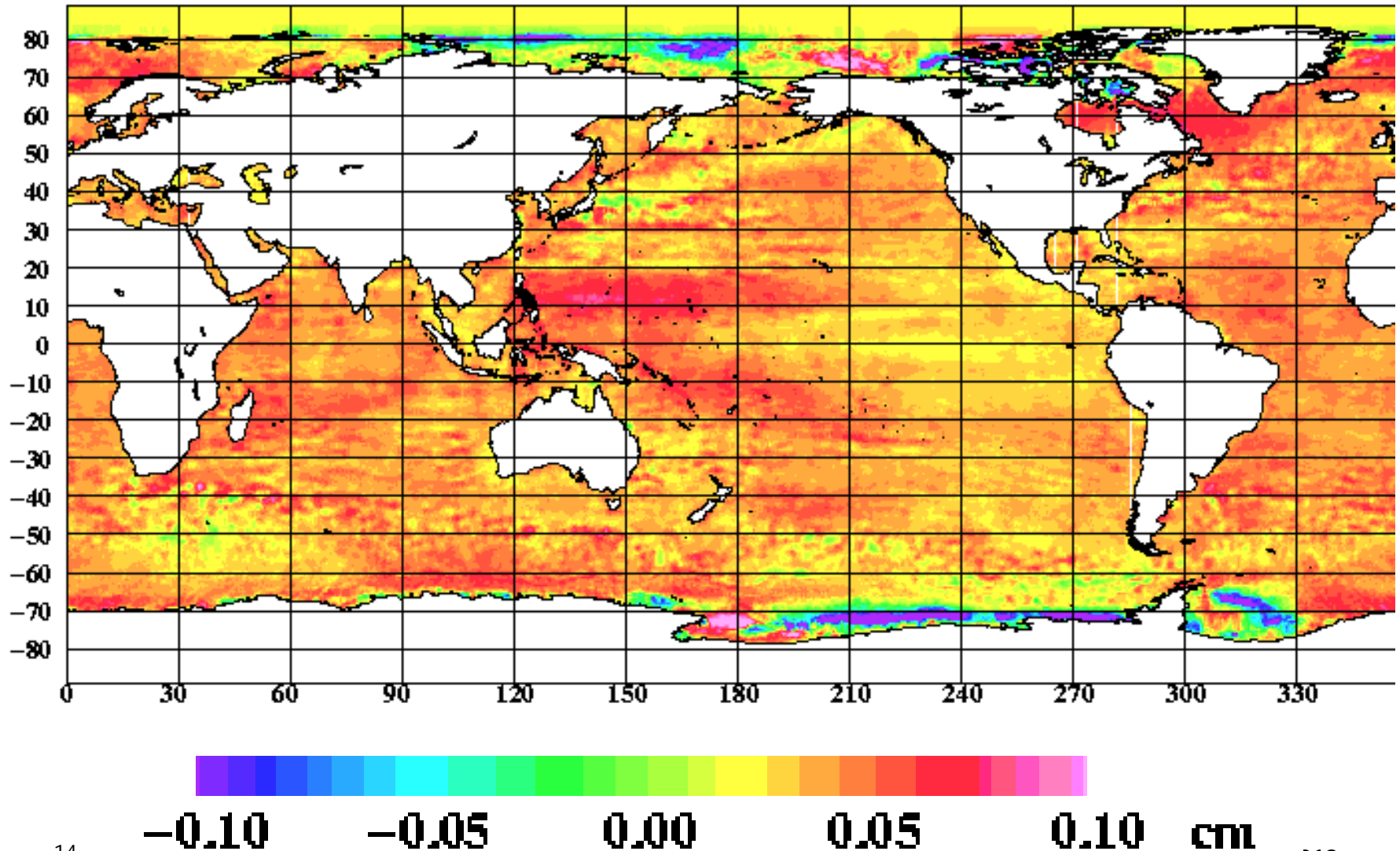


Range + Geophys Corrections

Standards	CLS01	DNOSC08MSS	DTU 10
Reference period	1993-1999	1993-2004	1993-2009
Orbit	ORB_POE_N	GGM02/ITRF2000	EIGEN-GL04C
Dry troposphere	ECMWF	ECMWF	ECMWF
Wet troposphere	Radiometer	ECMWF	Radiometer
Ionosphere	Altimeter	Altimeter	Altimeter
Dynamic Atmosphere	IB (1011 mbar)	IB (1013 mbar)	MOG-2D_IB
Ocean tides	GOT 99	GOT 00.2	GOT4.7
Sea State Bias	BM4	BM4	Non-PARAM

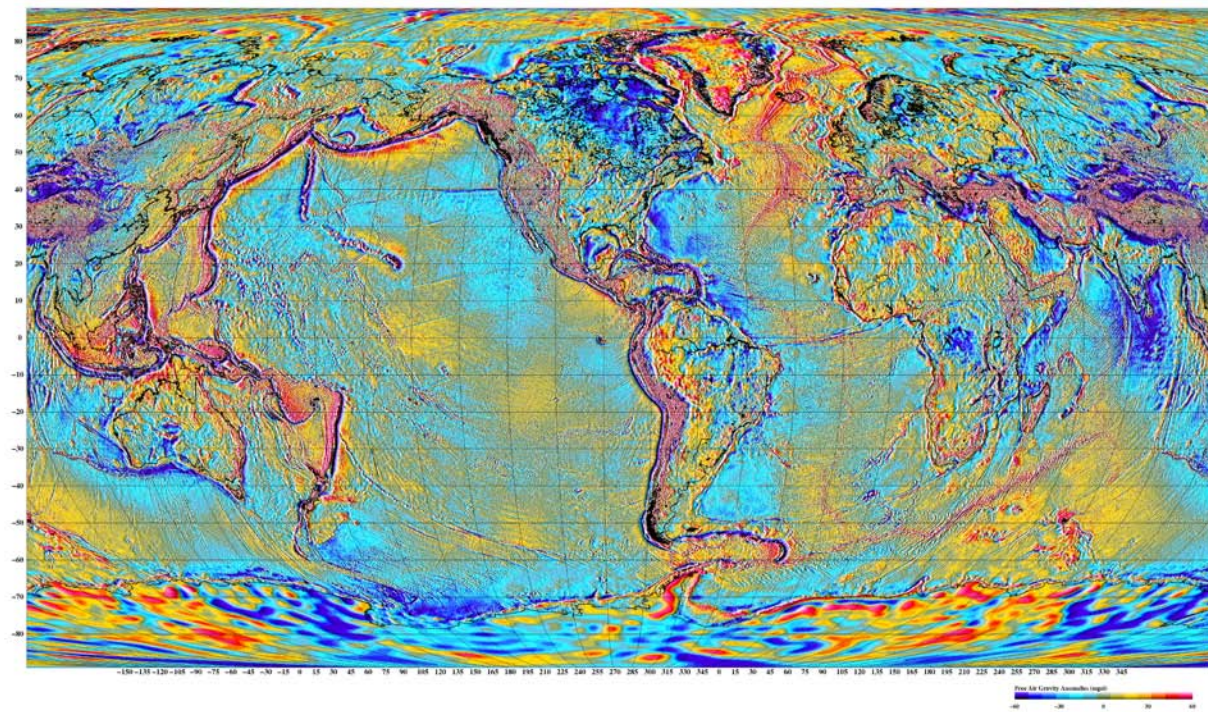
These will affect the MSS determination, but not so much Gravity.

DTU10MSS – DNSC08MSS (3 cm average difference)

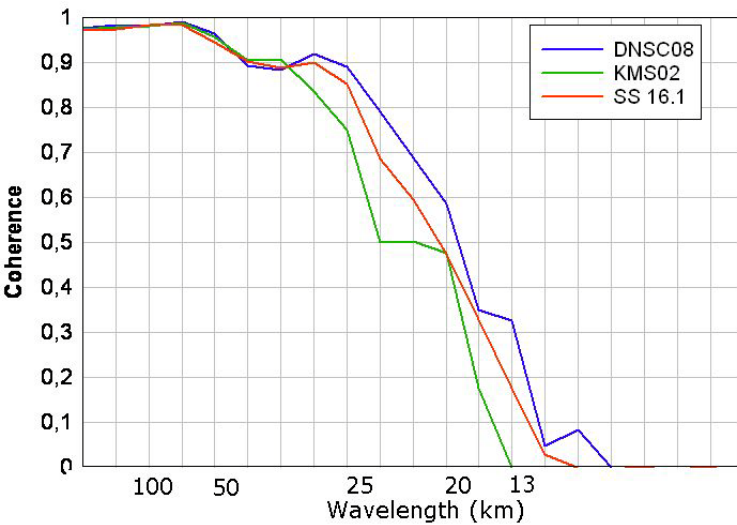


Gravity – DTU10

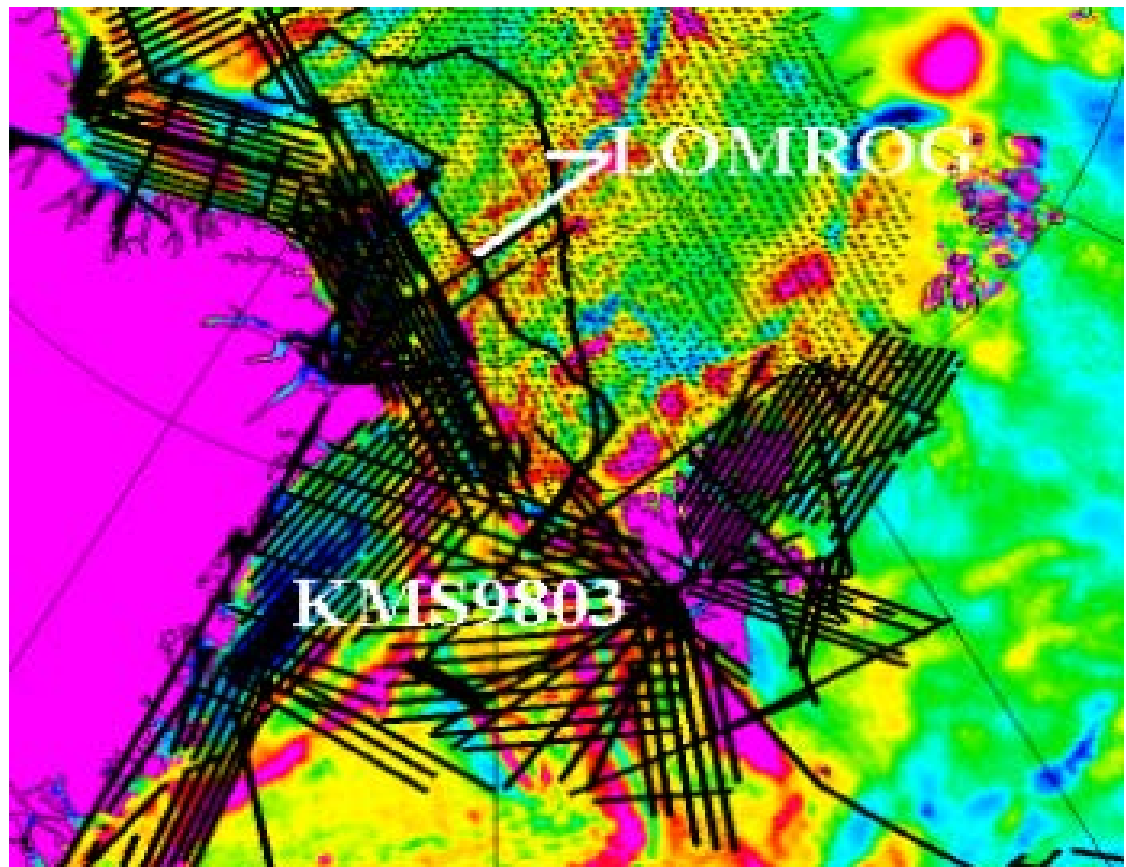
Refining Filtering (lower)



321.400 obs	Mean	Std Dev.	Max Dev	Note
KMS02	0.44	5.15	49.38	
DNOSC08	0.39	3.91	36.91	Double Retracked
DTU10	0.39	3.82	36.89	
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 V18.1	0.41	3.96	36.99	



**Correlation length remains
The same.**



900 points	Std (mGal)	Max (mGal)
KMS02	9.4	51.2
Laxon and McAdoo (97)	7.2	46.2
ArcGP (01-06)	5.8	34.4
SS 16.1 / 18.1	8.2 / 5.9	44.9 / 37.4
DSNC08	4.1	24.0
DTU10	4.0	24.0

DTU10MSS + DTU10GRAV is an improvement over DNSC08.

Currently improving:

Retracking the entire ERS-2 + ENVISAT

Exact Repeat Mission (17 years)

CRYOSAT-2 First results are

VERY INTERESTING.....

New 2011/2012 fields in preparation

**DTU10 removed striation caused
By HarmSynth and visible in EGM08
1 minute field.**