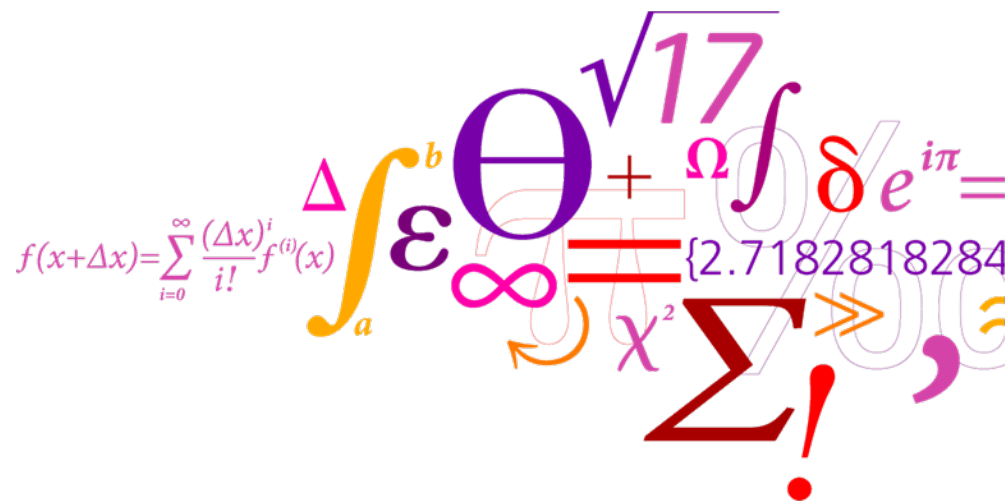


# Large scale sea level variation in the Arctic Ocean from Cryosat-2 SAR altimetry (and ERS1/ERS2/ENVISAT).

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 Yongcun Cheng



# Outline

## 1. Introduction

- Arctic problems for Altimetry
- HOW DO WE GET A GOOD TIME SERIES - REPROCESSING.

## 2. Mean and Sea level trend in the Arctic Ocean (66N-82N)

- New Re-processed 21Y ERS1/ERS2/ENVISAT/C2 altimetric time series
- Sea level trends, mass changes.

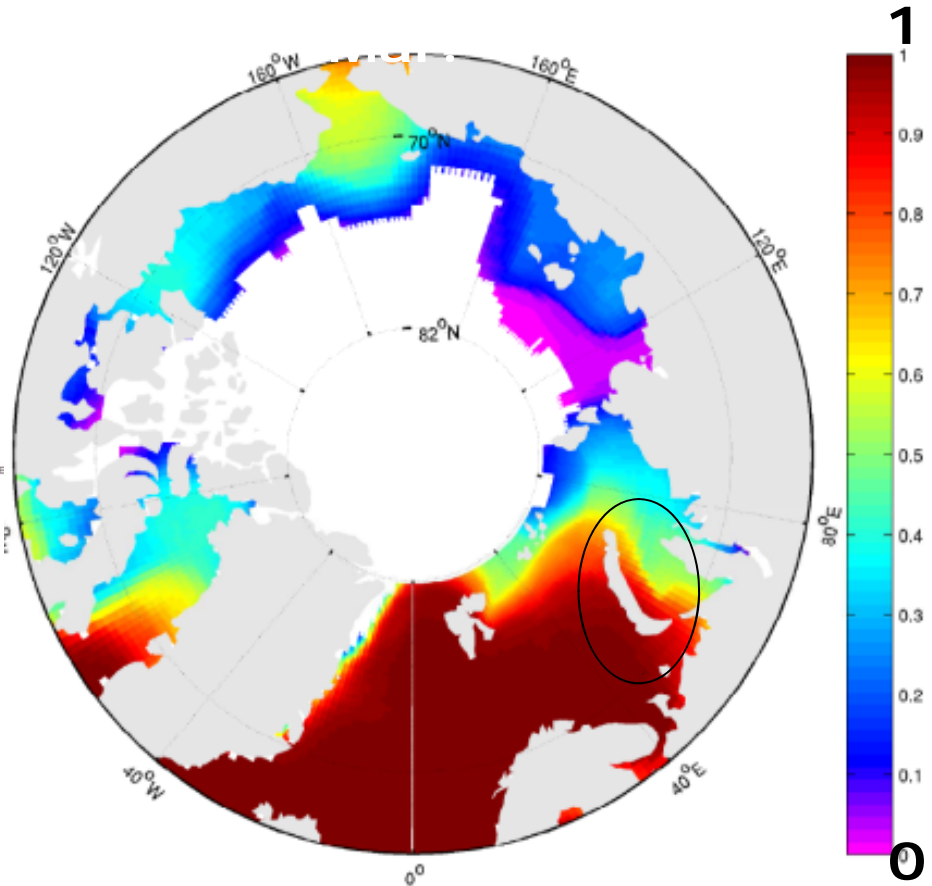
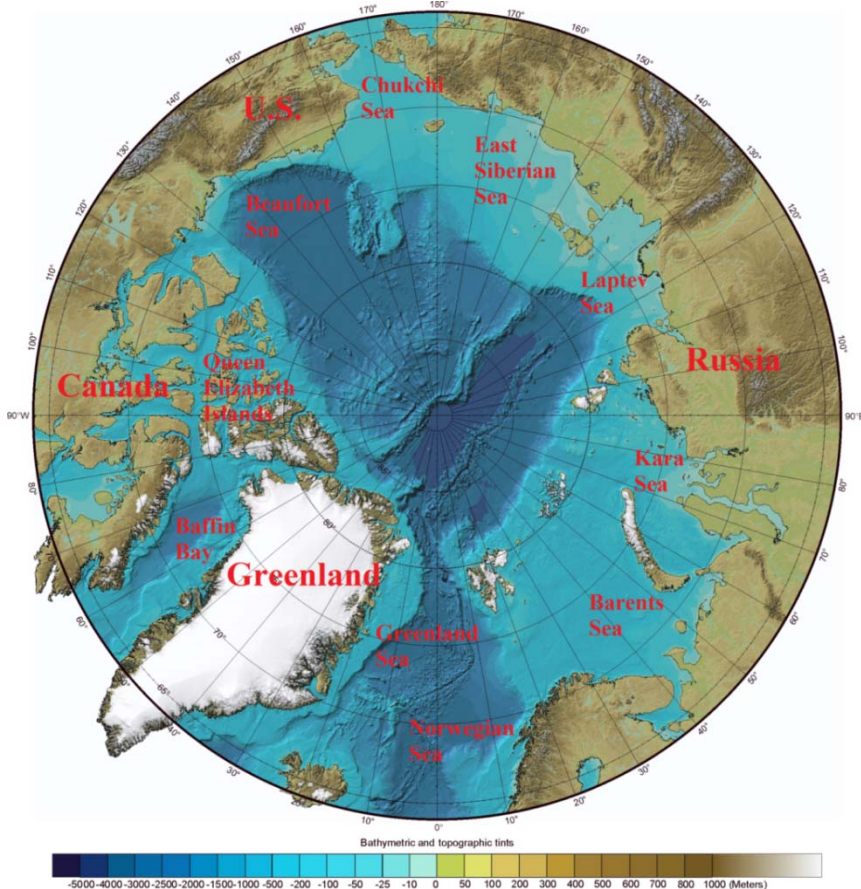
## 3. Mean Dynamic Topography **MDT = MSS – Geoid**

- Cryosat-2, DTU13MSS/MDT

## 4. Geostrophic ocean circulation (though small)

## 5. Conclusions

# Study Area and problems



**Data availability in DUACS  
standard sea level products**

<http://geology.com/world/arctic-ocean-bathymetry-map.shtml>

**Only ERS-1/ERS-2/ENVISAT/ICESAT/CryoSat-2 available**

# Deriving a long term altimetric mean sea level. Reprocessed 20 years ERS-1/2/ENVISAT data

**Tailoring** the default global editing criterias to Arctic Conditions

- ❖ Radiometer editing
- ❖ SWH editing (Allow for  $SWH < 0$ )
- ❖ Allow for the number of valid 20Hz data is less than 17
- ❖ DTU10 mean sea surface editing

## **Re-Editings**

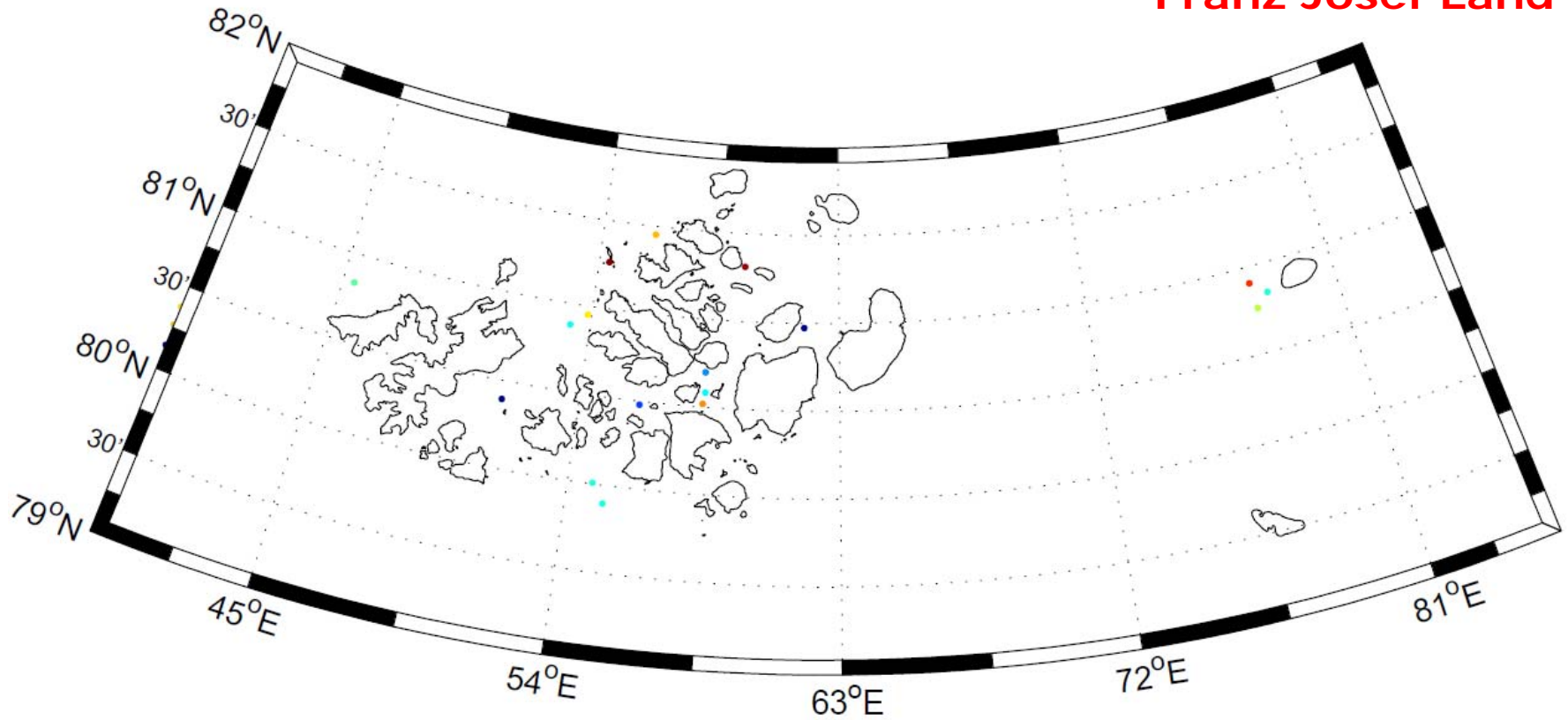
- ❖ SLA relative to MSS  $< 0.7m$
- ❖ SLA  $< 3$  times of Sea level variance
- ❖ SLA relative to MSS  $< 0.4m$  (winter)
- **Renewed Orbit error adjustment**
- ❖ Perform Long wavelength correction (TOPEX/Jason-1/2) ala LeTraon include annual signal(DTU10ANN).

**Create along-track data and 3 days gridded data sets**

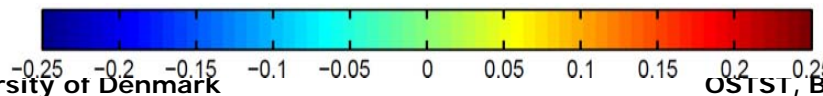
# Importance of tailoring editing.

(SLA: Envisat, cycle 72, 09/09/2008-13/10/2008)

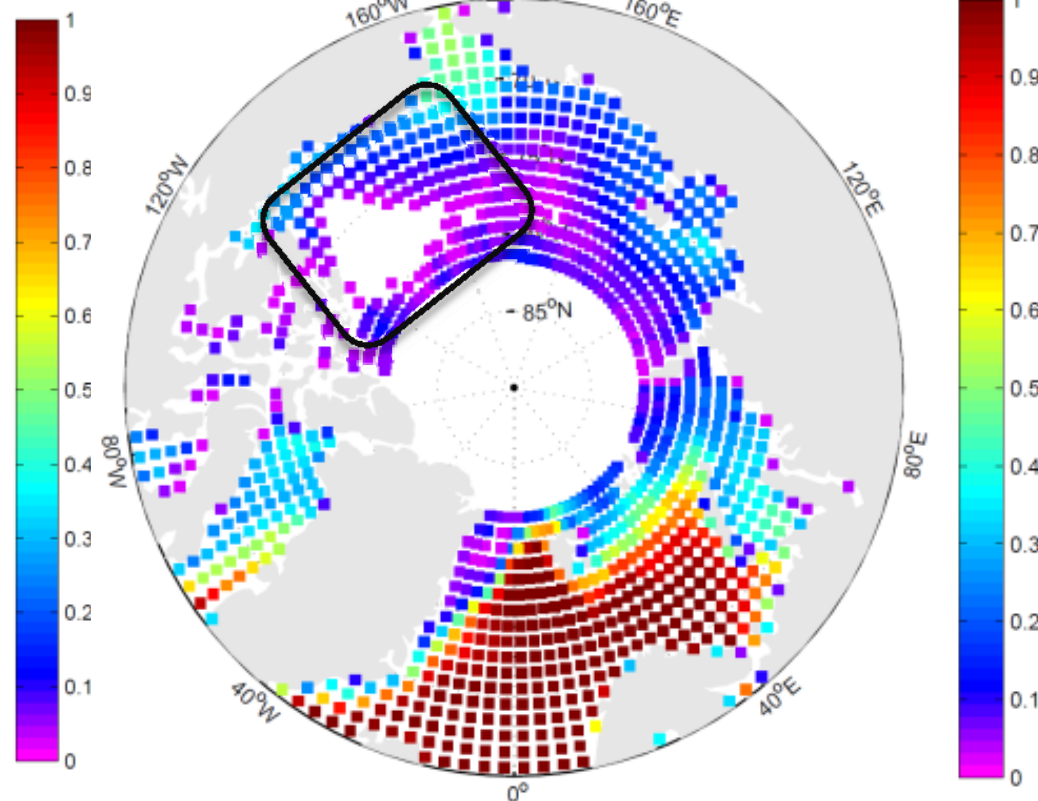
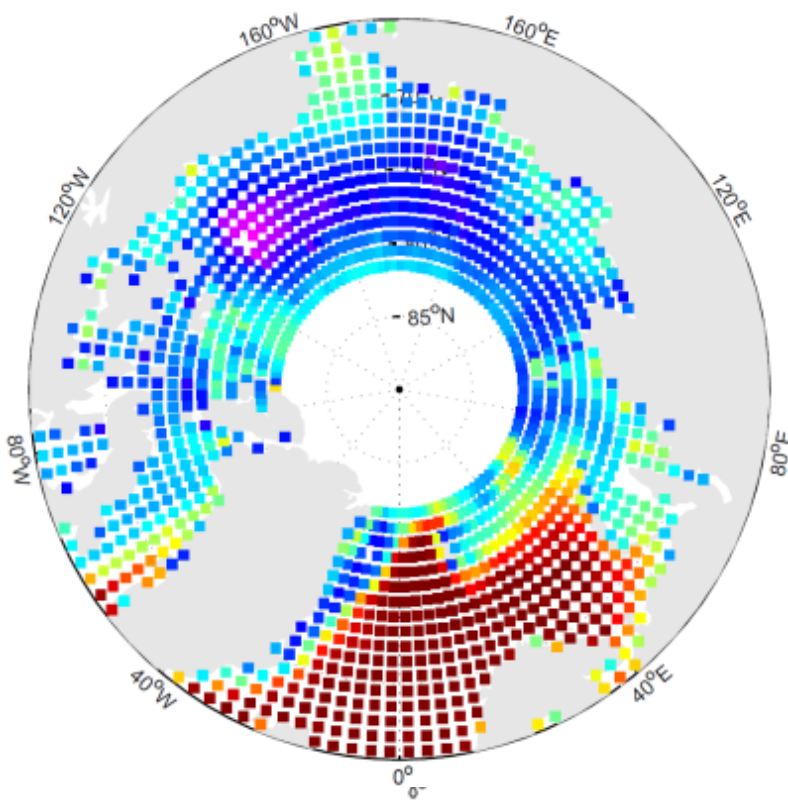
Franz Josef Land



Allow for the Tailored Radiometer flags 17 (20 points more)



# Importance of tailoring editing (using availability) DTU10 MSS.



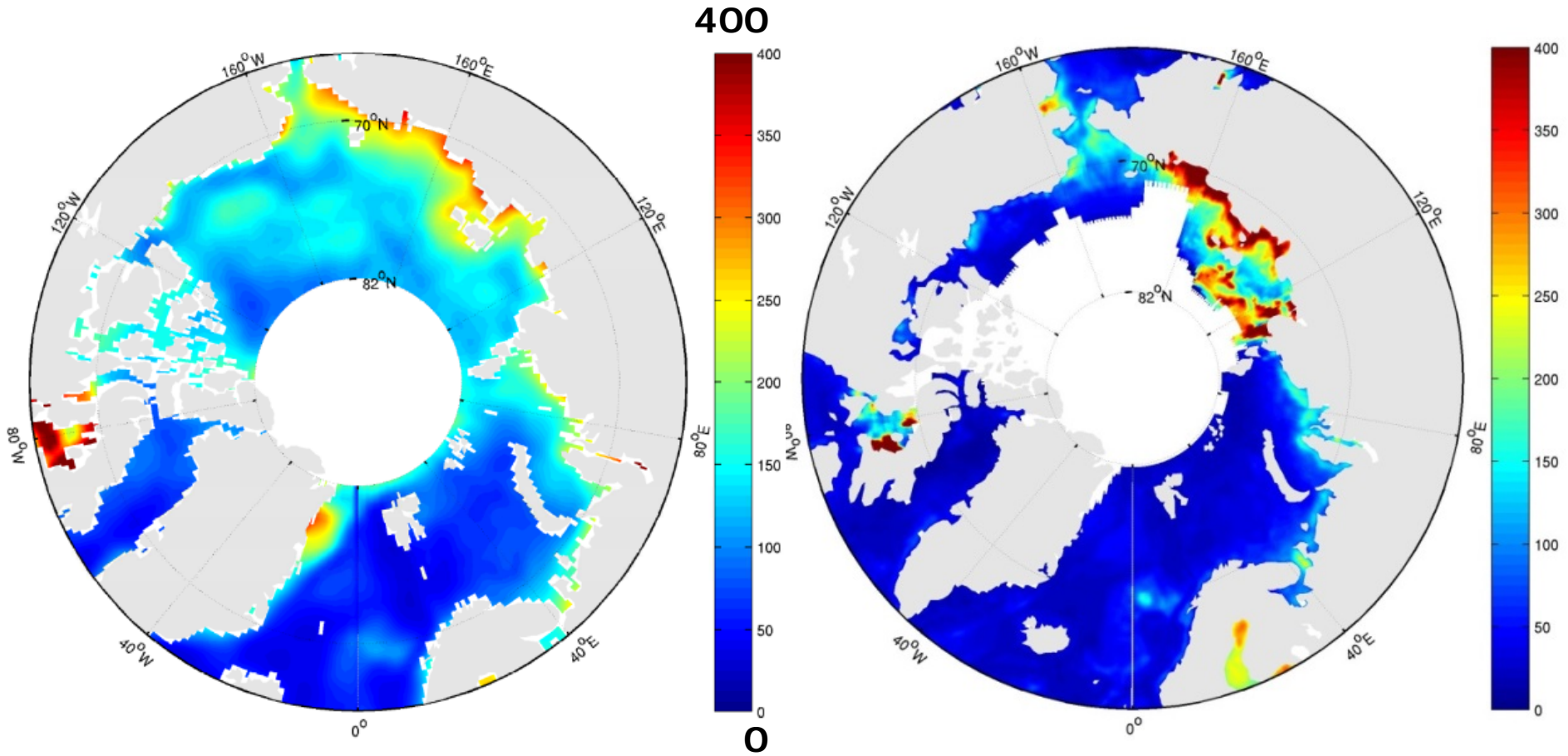
**Data availability:**  
 Data availability:  
 DUACS standard products  
 Re-processed along track products  
 relative to CLS09 MSS  
 relative to DTU10 MSS

**Data availability:**  
 RADS standard along-track products  
 relative to DTU10 MSS

**Western Arctic:** the number of available data increases of **163%**.  
 (70N-81.5N, 130W-180W)

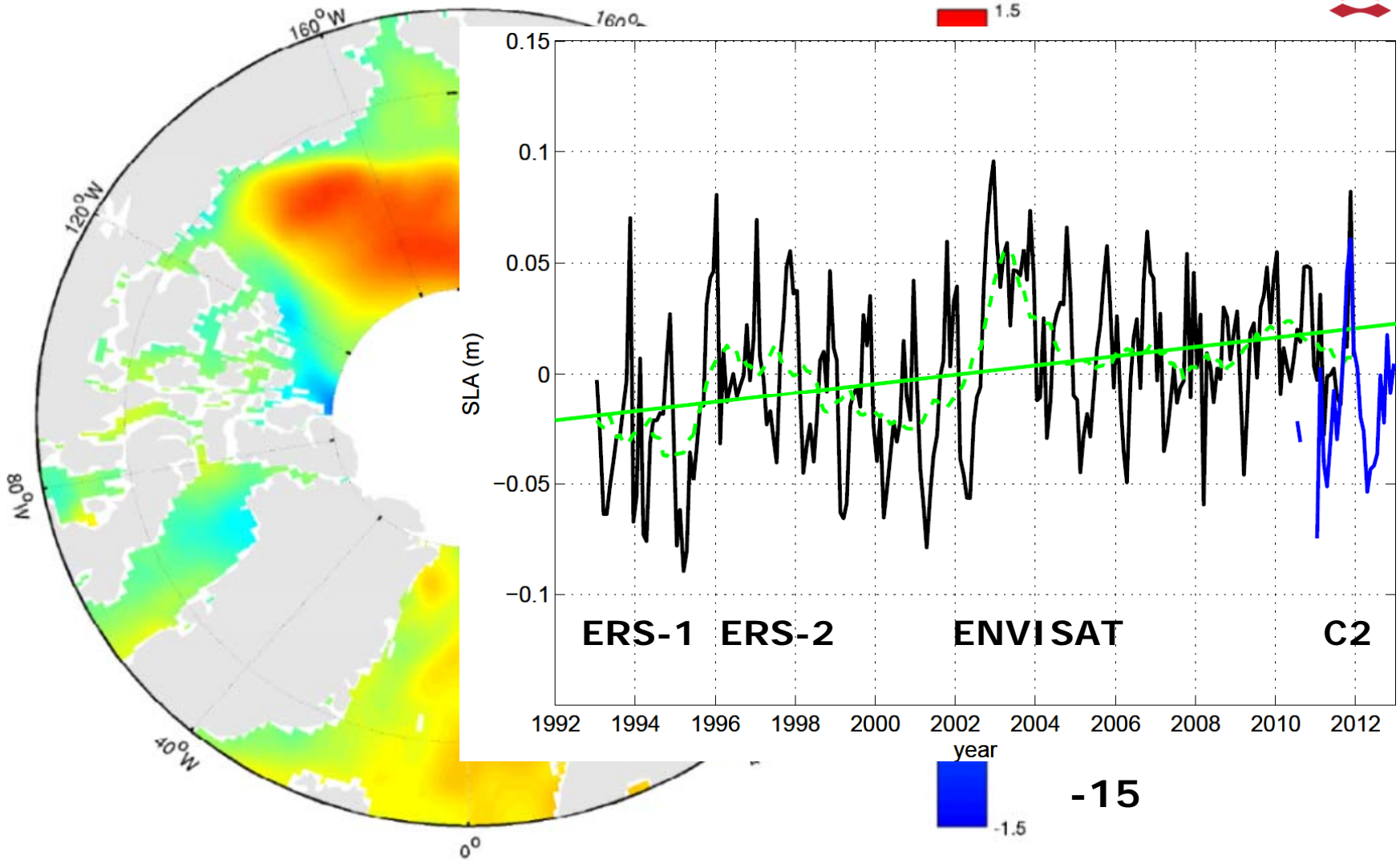


# Checking SLA Variance



Mainly subscribed to the fact that we dont do along track filtering

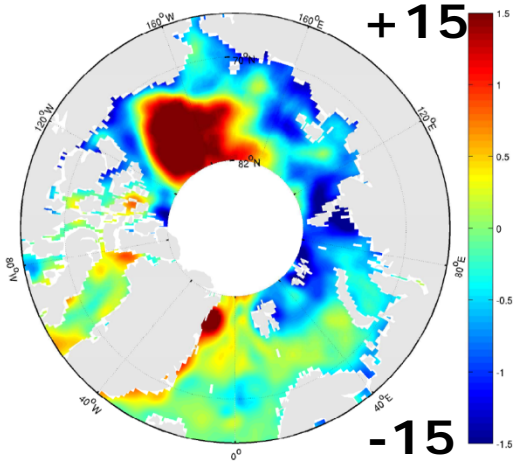
# Sea Level Trend (1993-2013, 66N-82N)



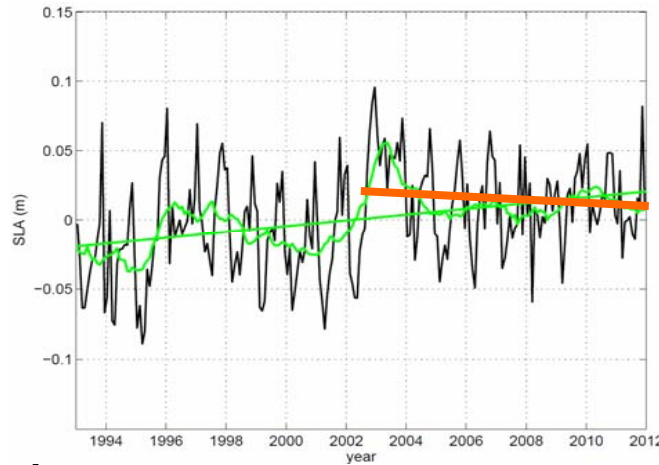
Re-processed 3-days gridded data. Mean: **2.0 mm/year**



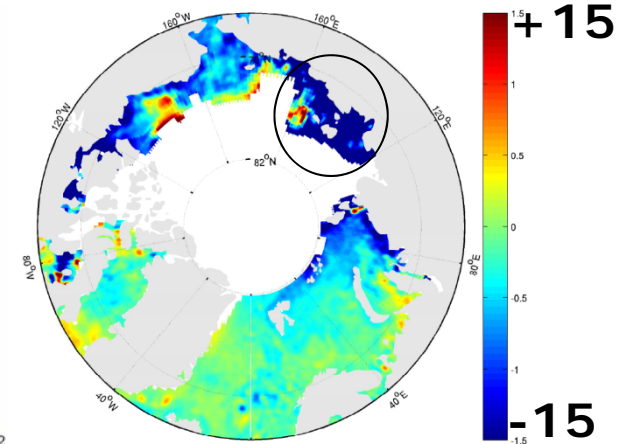
# Sea Level Trend (Envisat, 2003-2012, 66N-82N)



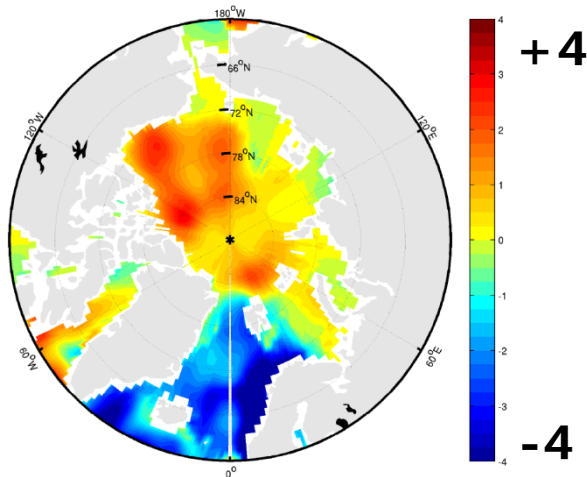
Reprocessed Sea level trend  
Mean: **-1.6 mm/year**



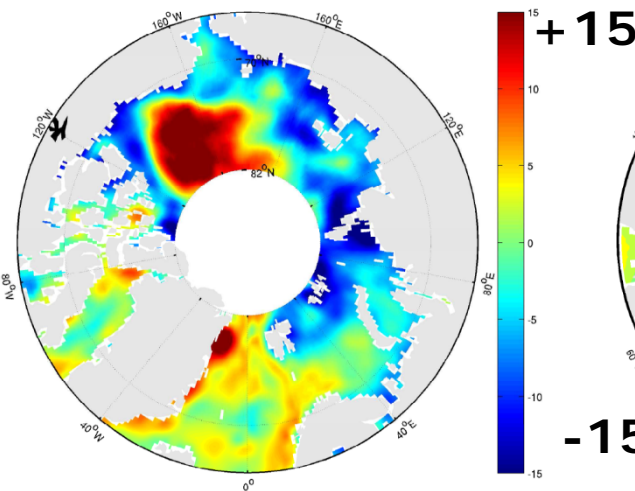
Sea level time series



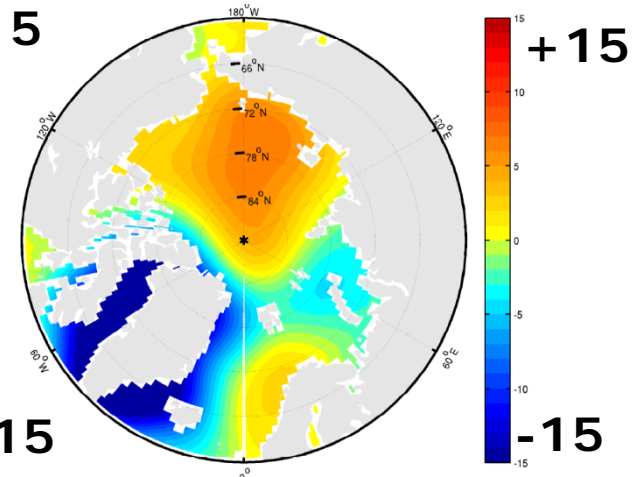
DUACS "partial" SL  
Mean: **-5.4 mm/year**



Steric sea level trend  
Mean: **-0.3 mm/year**



Residual trend  
Mean: **-1.3 mm/year**



GRACE (Water Thickness Trend) Mean: **-0.9 mm/year**

# Updating the MSS and MDT using Cryosat-2

Arctic under SAR+SAR-in Mask.

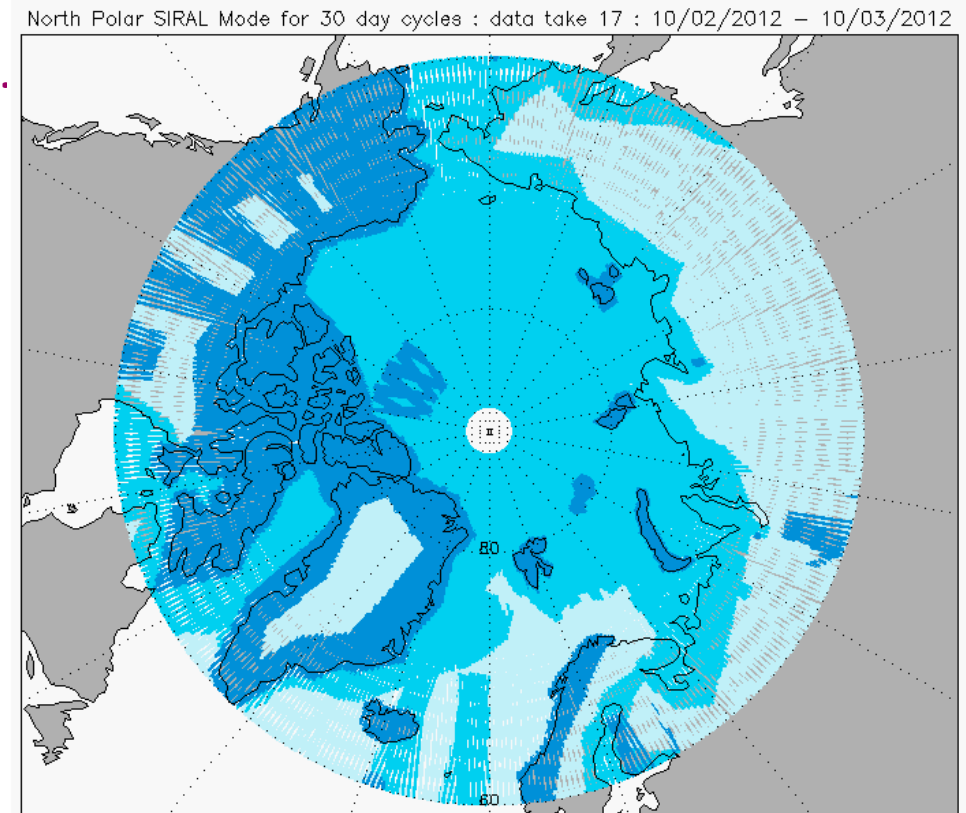
ESA L1 GDR 2.4 data.

2012:  
ESA L1 Processor upgraded:

Currently "in limbo " because  
delay in back-processing

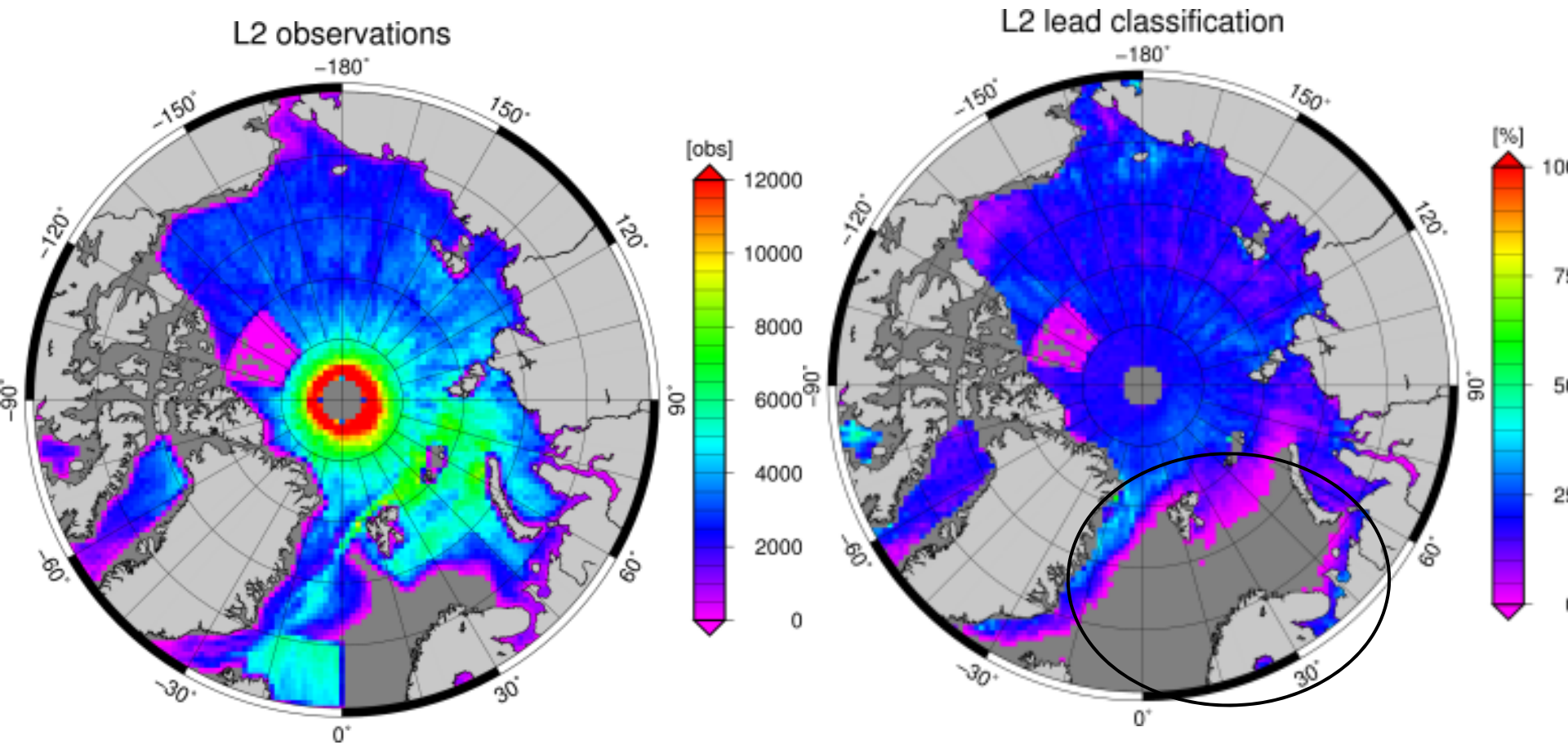
1.6 Year C2 data retracked

(2012,2013,  
Few month in 2011, 2010)



**CRYOSAT-1 GIVES US MSS + MDT UP TO 88°N**

# Cryosat-2 SAR DATA Using 20 Hz L1B (2012+2013)



Processed all C-2 Lead data retracked using a Gaussian peak retracker.

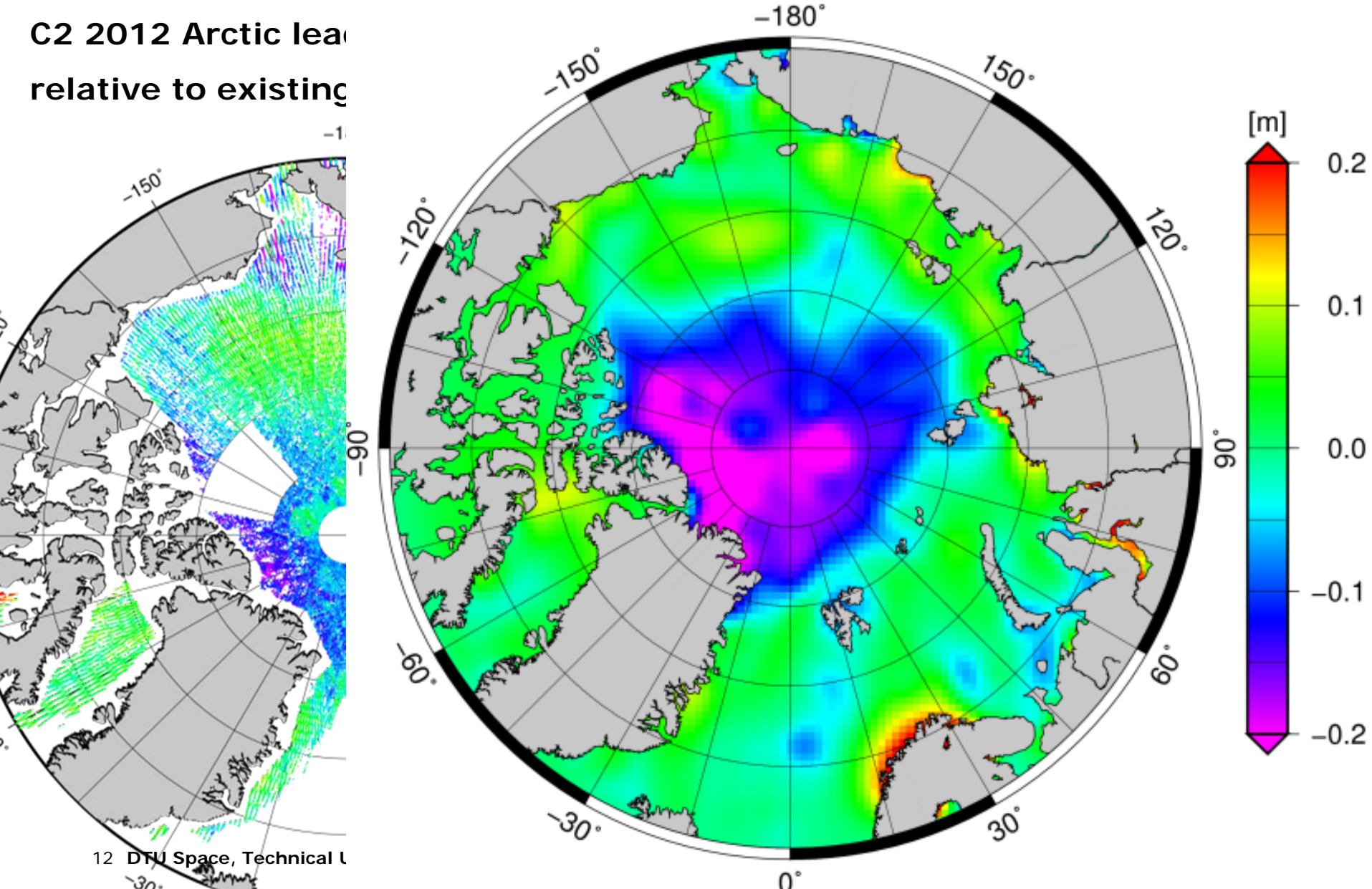


# DTU13MSS

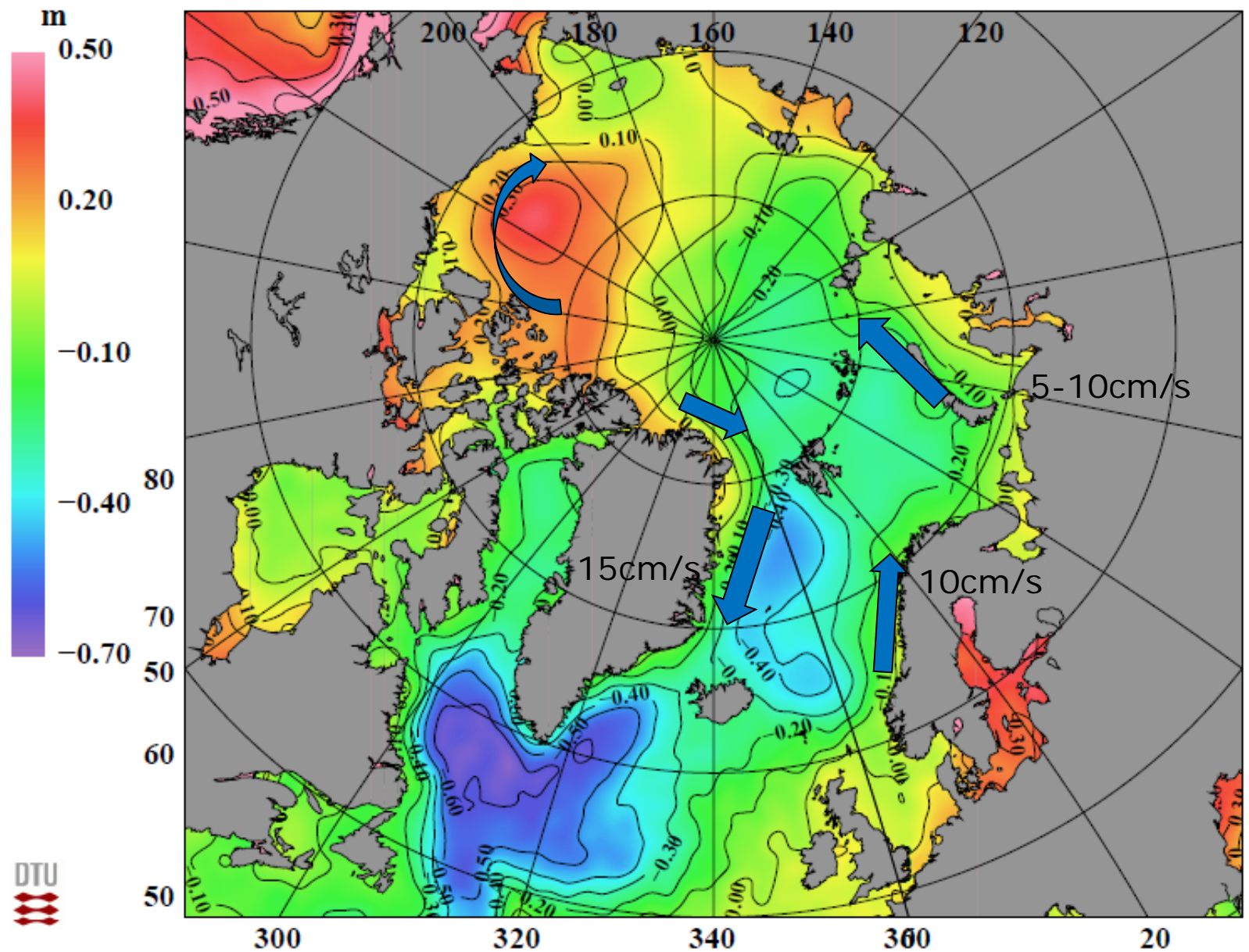


Gridded smoothed selected mean

C2 2012 Arctic lead  
relative to existing



# DTU13MDT = DTU13MSS-Eigen6C1

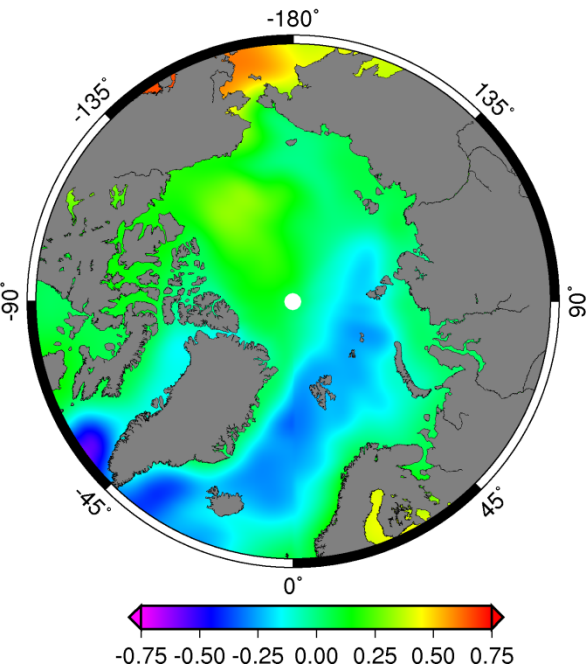




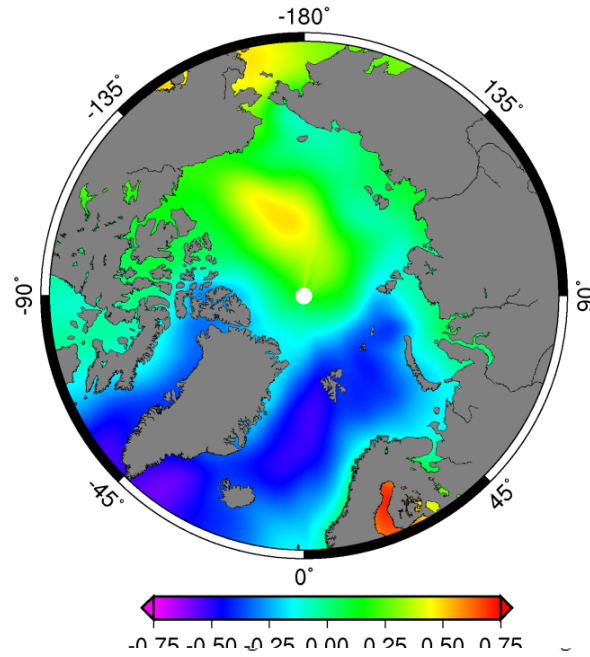
# Satellite MDT vs hydrodynamic MDT



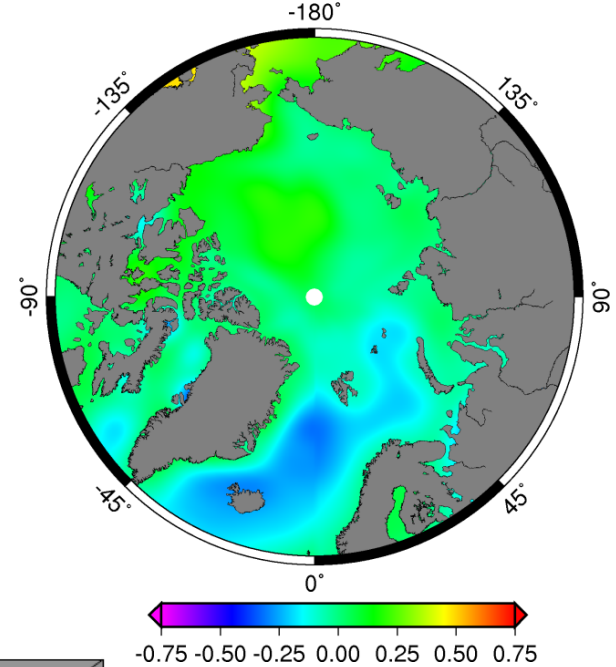
## GECCO MDT



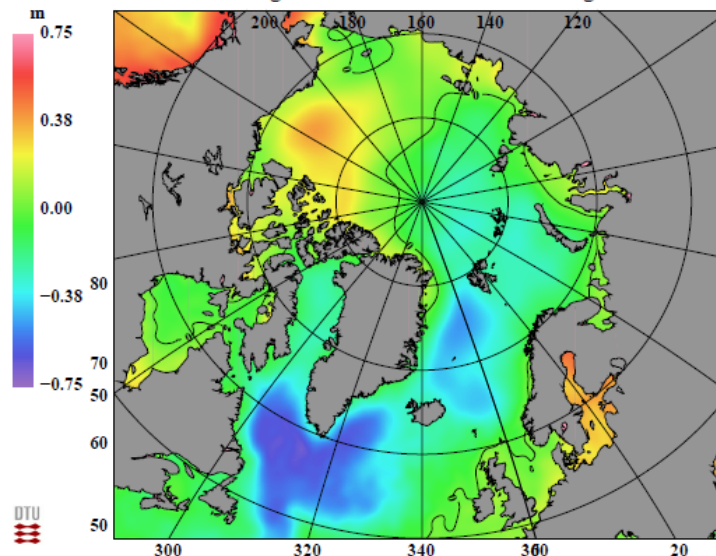
## MICOM MDT



## UW/PIO MDT



## DTU13MDT



Models shown on same scale (offsets removed)



# Summary

Describe the sea level changes in the Arctic Ocean using increased spatial and temporal timeseries from reprocessed satellite altimetry.

Trend in (1993-2013, 66N-82N)

sea level: 2.0 mm/year

steric sea level: 0.0 mm/year

Cryosat-2 SAR still problematic to consolidate with old LRM:

## NEW DTU13MSS and DTU13MDT

### DTU 3-days along-track/gridded SLA data

Spatial coverage:  $>50^{\circ}\text{N}$

Temporal coverage: 1992.09.18-2012.04.16 available from

<ftp.space.dtu.dk/pub/Altimetry/ARCTIC/>