A new Arctic 25-year Altimetric Sea-level Record (1992-2016) and Initial look at Arctic Sea Level Budget Closure

Ole B. Andersen, S. K. Rose

M. Passaro (TUM),
J. Benveniste (ESA)

Contribution to ESA SL_CCI+SLBC projects

DTU Space
National Space Institute

Outline

- Arctic Ocean

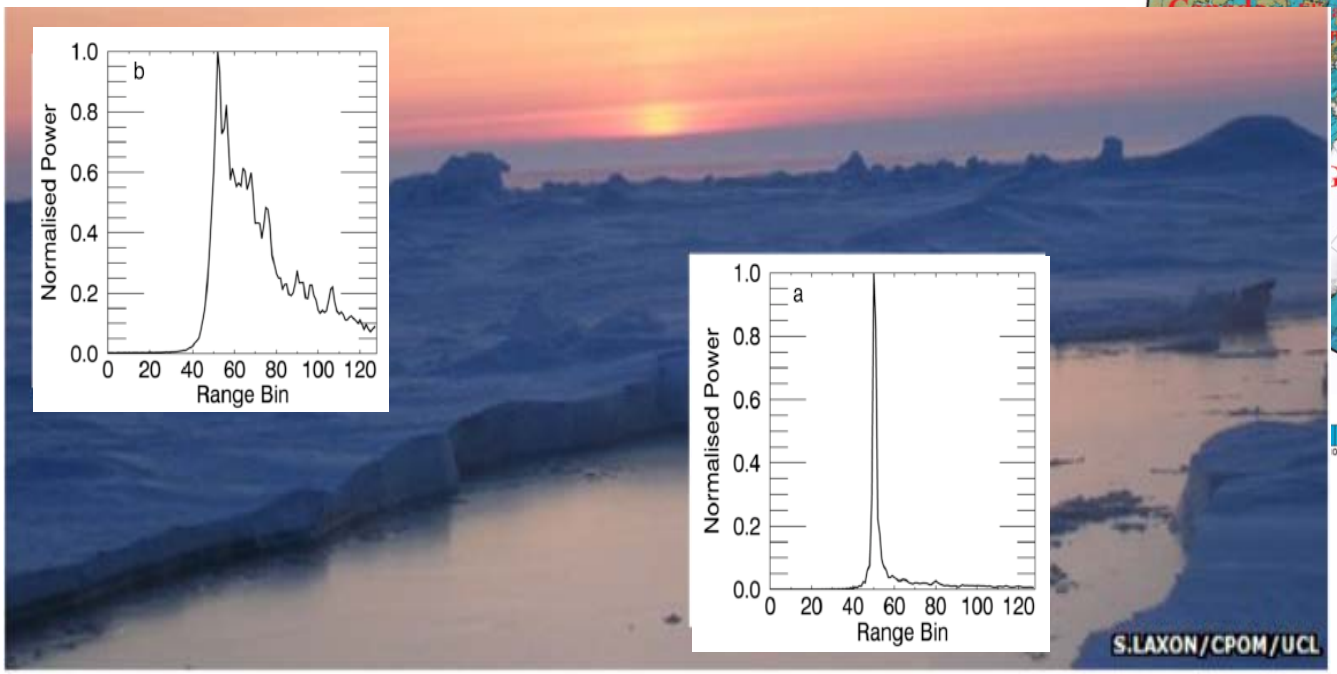
- 25 years Arctic Sea Level Products
  - DTU (reprocessed but largely un-retracked)
  - DTU/TUM (ALES+ retracked, REAPER and in house processed)

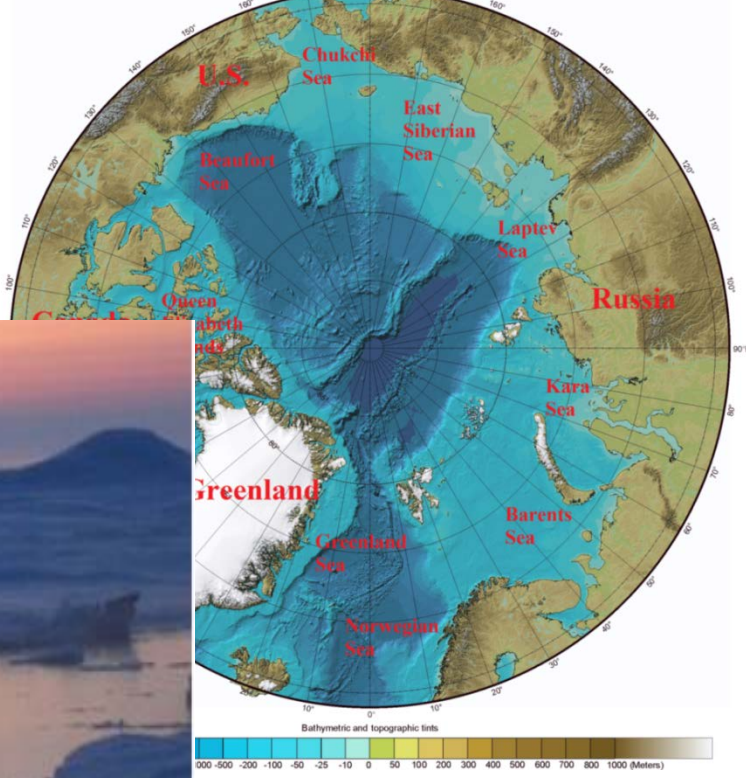
  Linear Arctic Sea level change.

  Preliminar Arctic sea level budget closure

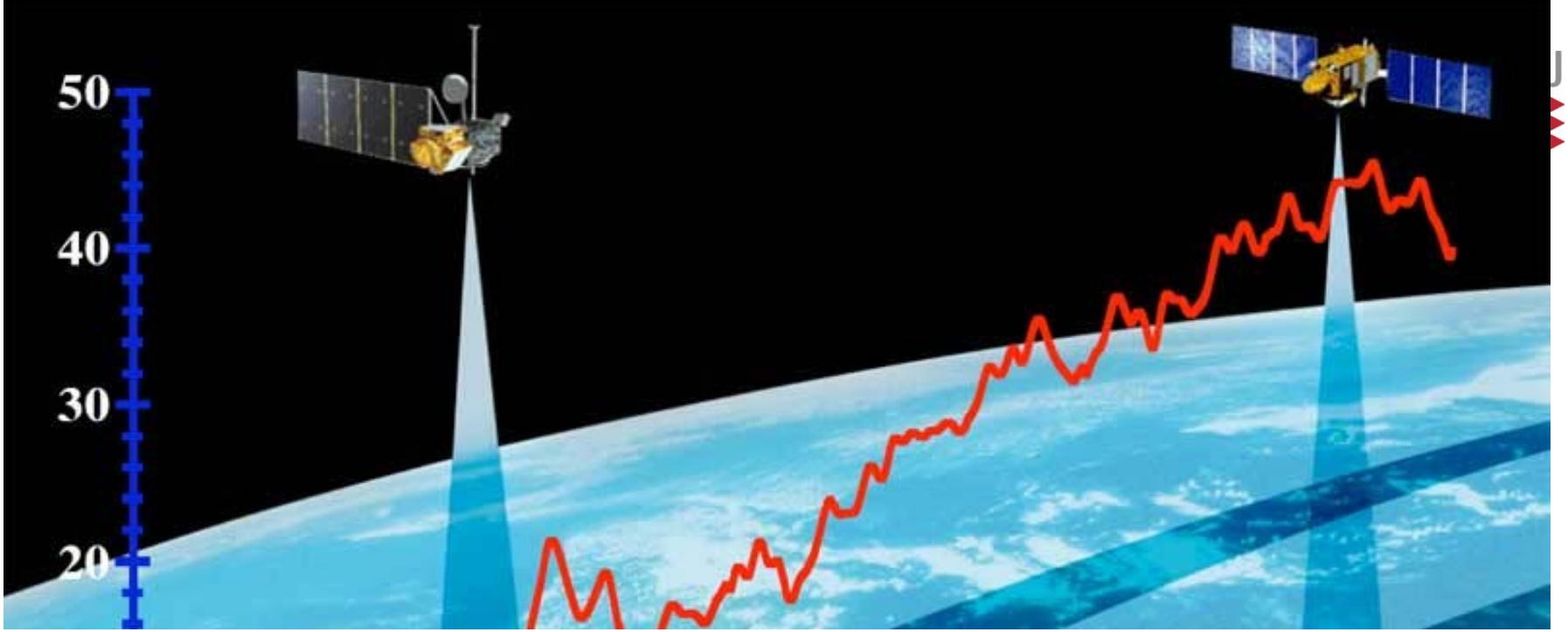
  Conclusion

Arctic Ocean –

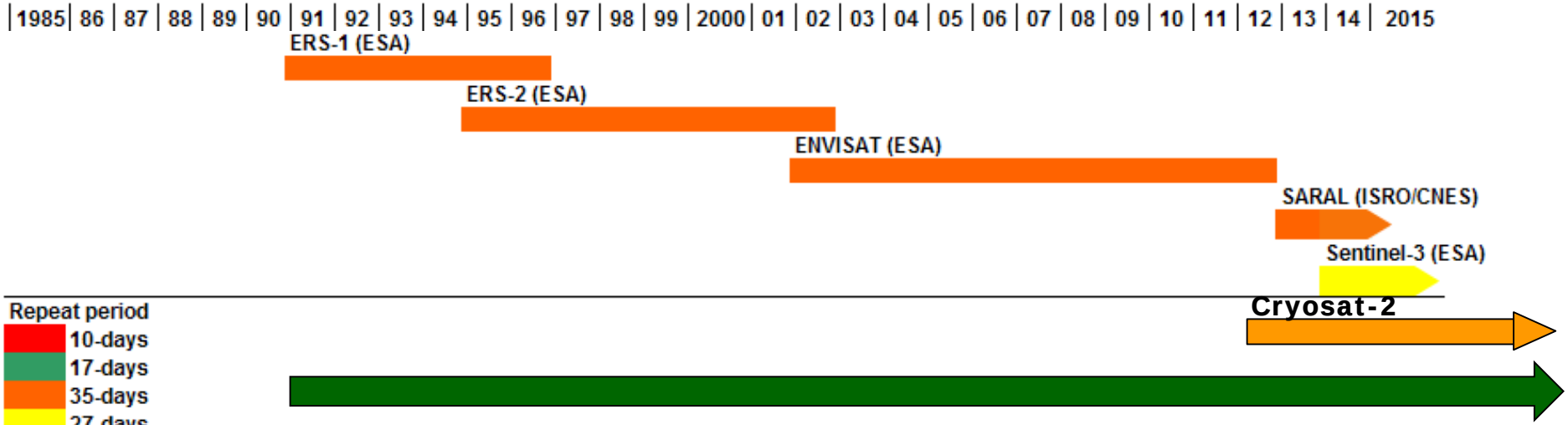




Arctic Ocean challenges:
Seasonal to permanent ice cover
Radiometer+altimeter observations are affected by ice
Ocean tide models less accurate (sun-syncronous ERS/ENVISAT/C2/S3)
Retracking is challenging
Residual orbit errors



General Timeline for Satellite Radar Altimeters with Short Repeat Periods



Two Arctic Sea level products

DTU sea level product

Covers Arctic Ocean (68N-82N -> 1991-2016)

Gridded: Spatial res: 0.5 degree, Temporal: 3 Days/1 month.

NO RETRACKING of ERS/ENVISAT(Brown/Haines retracked).

In stead: Tailored Arctic reprocessing of RADS data.

Retracking of Cryosat-2 Baseline B/C SAR data (DTU-LARS).

Data available from ftp.space.dtu.dk/pub/ARCTIC_SEALEVEL

Pros: consistent data, Cons: Not adequate data.

DTU/TUM product

ALES+ RETRACKING of ERS-2 and ENVISAT.

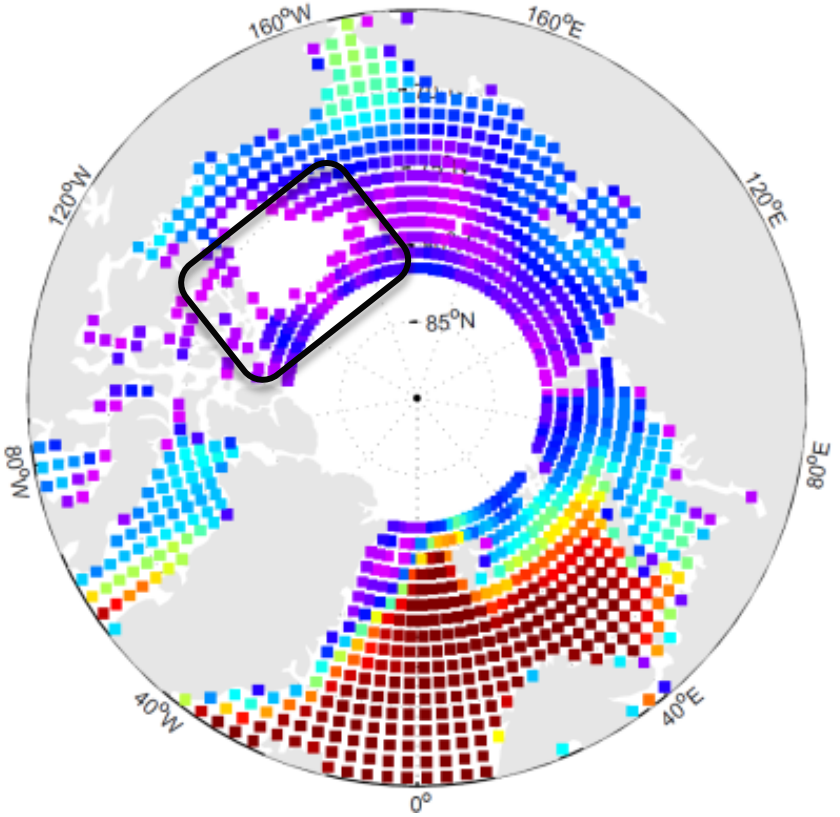
Retracking of Cryosat-2 Baseline B/C SAR data (DTU-LARS).

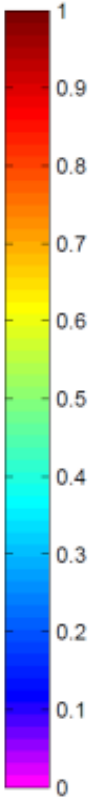
REAPER retracking of ERS-1.

Gridded: Spatial res: 0.5 degree, Temporal: 3 Days/1 month.

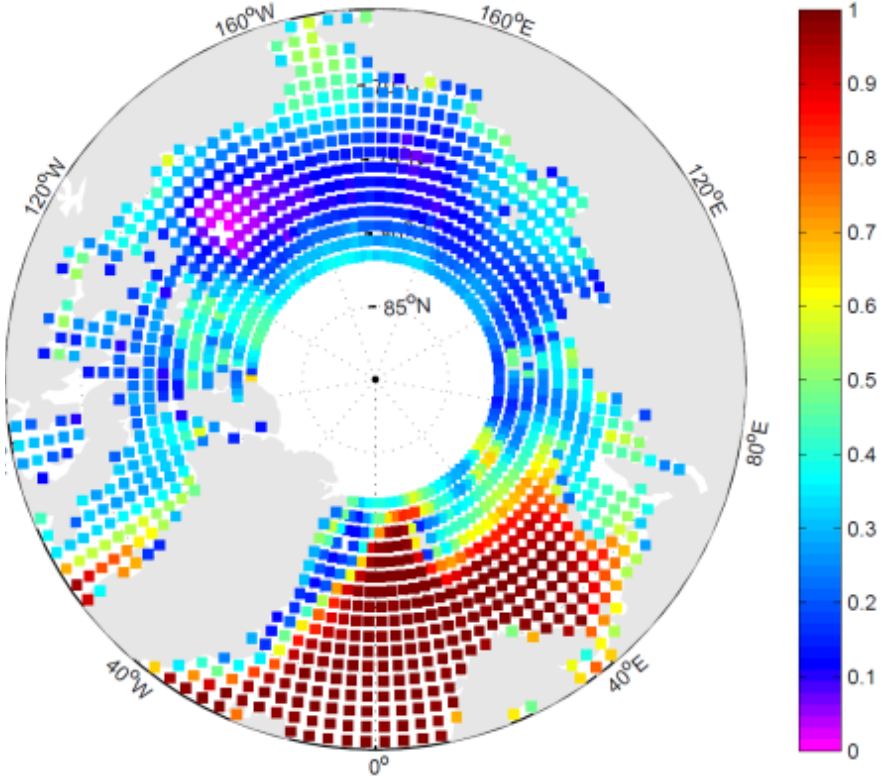
Pros: More data & inverse barometer signal (comp to tidegauge)

DTU Sea Level Product – reprocessed (ESA-SLcci_ECV V2)





RADS available default data
Relative to DTU13 MSS



DTU - Reprocessed data allowing for low SWH+few 20Hz obs and using model corrections (wet) relative to DTU13 MSS

Western Arctic/Beaufort: average data increases of **383 %**.
(74N-80.5N, 130W-180W) on average data increase of 130 %

DTU / TUM Sea level product:

ALES+ : ALES extension to peaky waveforms

ALES (non-peaky waveforms):

1. Leading Edge Detection

2. First retracking (leading edge only)

3. Subwaveform extension

4. Second retracking of the extended subwaveform

ALES (peaky waveforms):

1. Leading Edge Detection

1a: External estimation of trailing edge slope*

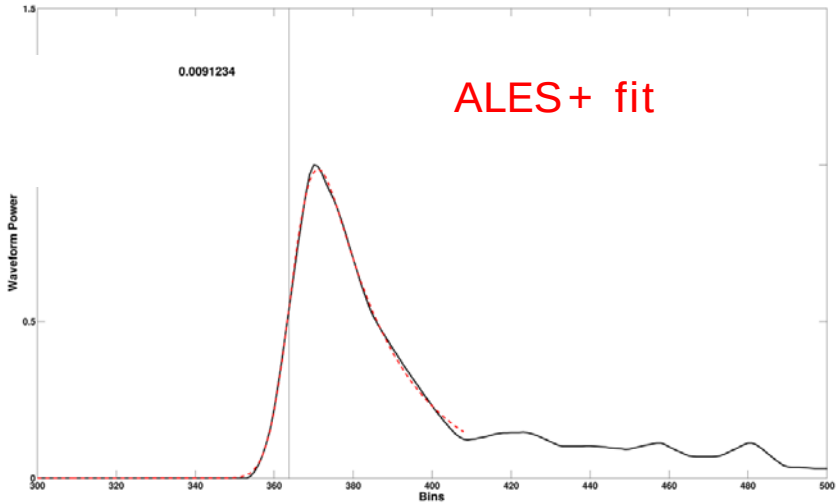
2. First retracking (leading edge only)

3. Subwaveform extension

4. Second retracking of the extended subwaveform

*1a: Brown-Hayne simplified model with trailing edge slope as 4th unknown

Retracking ENVISAT + ERS2 Considerably increases number of retrieved SLA valuable to complete time series.



Zoom on an 8x oversampled peaky waveform

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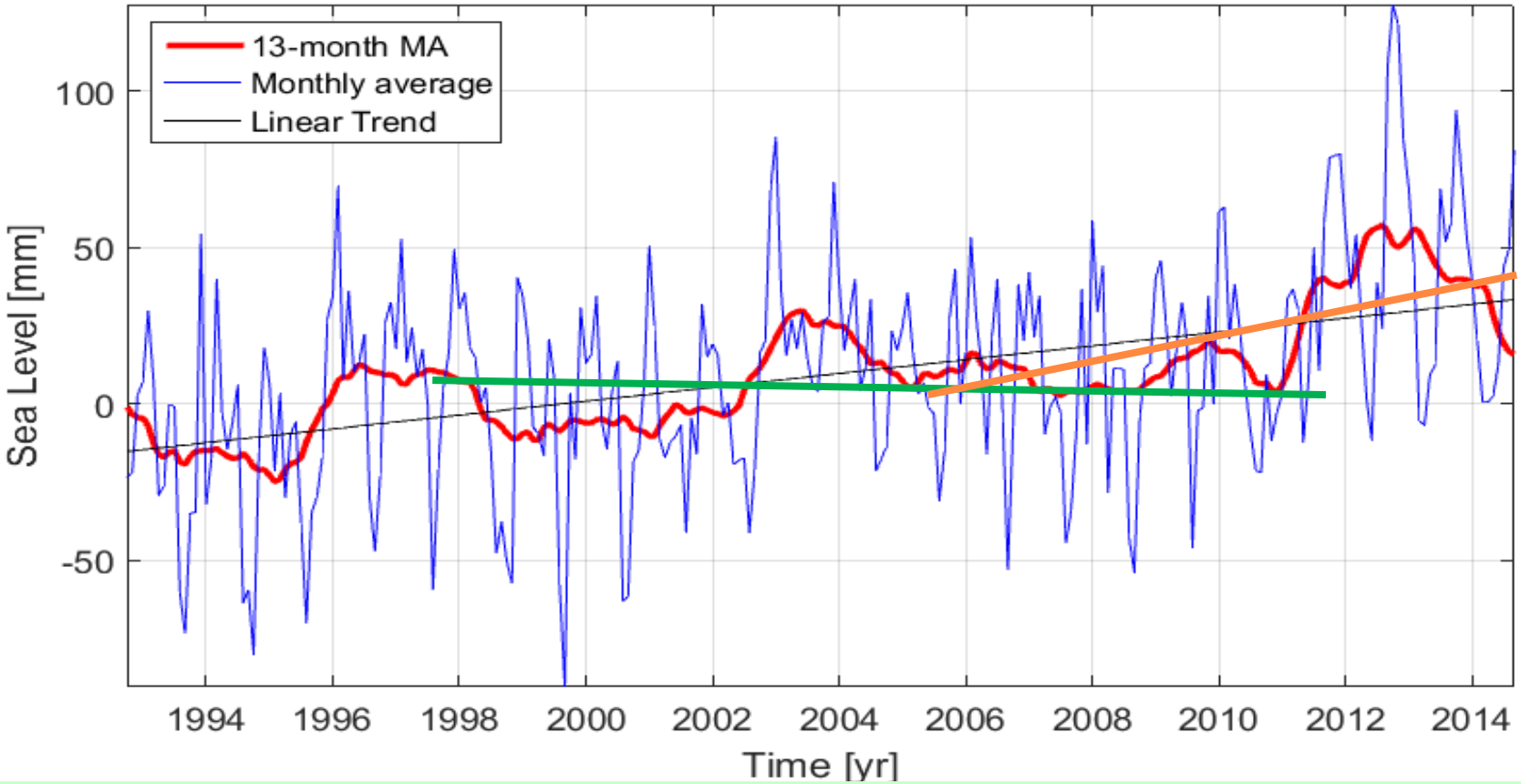
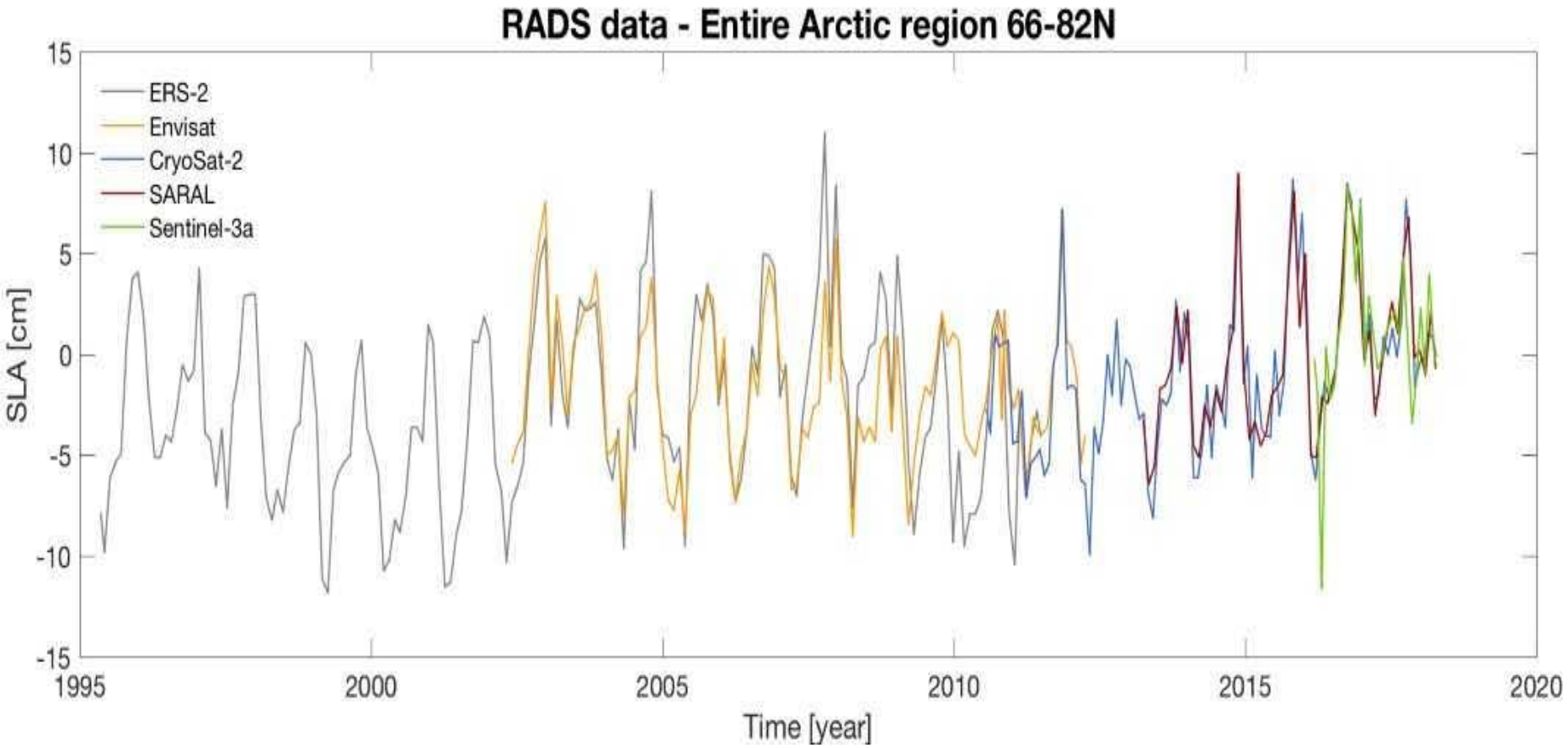
23 year Arctic Sea Level trend (68° N – 82° N)



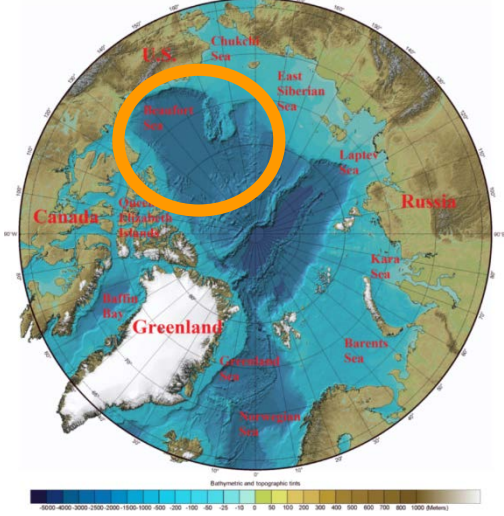
Average linear trend 2.2 mm/year. Large inter-annual variations (AO driven)

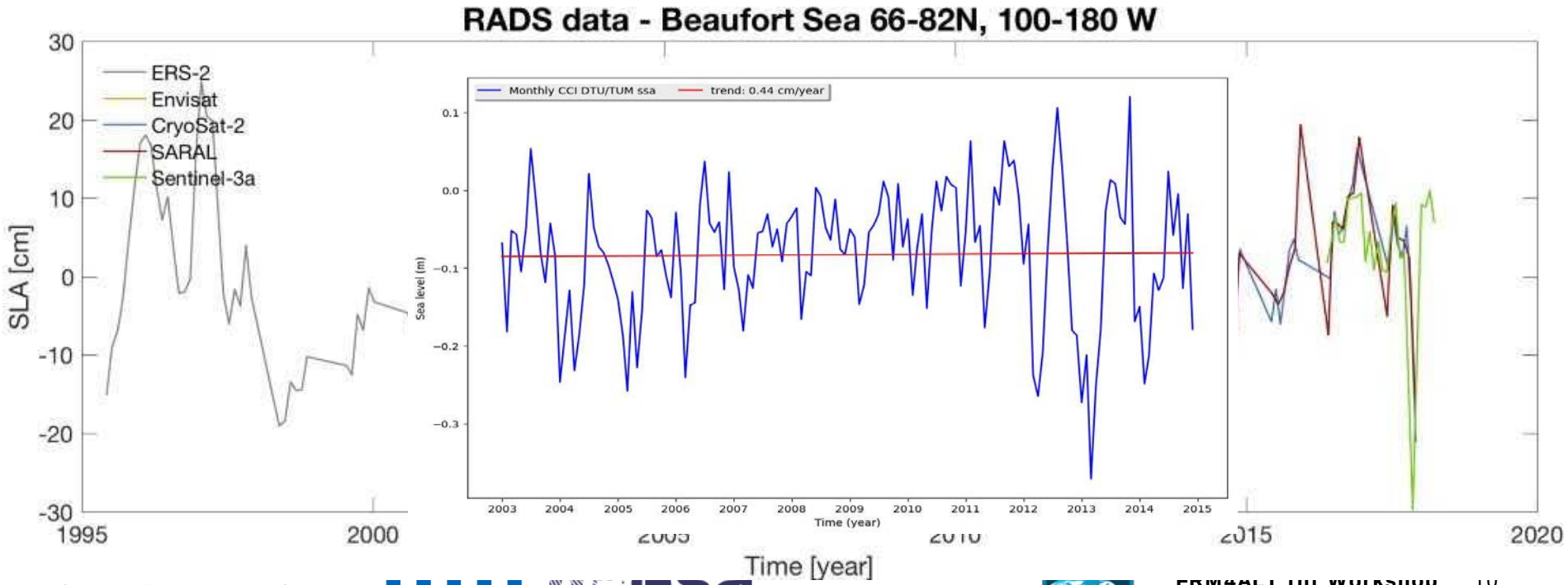
Updating the time series to 2018 incl S-3 and SARAL



Beaufort Gyre

- Average 0.8 cm sea level increase over the 25 years.
- Recently





Initial Arctic regional sealevel budget.

The sea level budget may be expressed as height changes using the main components of sea level change:

$$\Delta SSH = \Delta SH + \Delta OM$$

SSH = sea surface height, SH = steric height,
OM = ocean mass from GRACE (JPL-MASCONS)

Steric signal from NOAA model -> 2005-2015 period.

No ARGO data available

Closing the Arctic Sea Level budget (2005-2015 -> “first attempt”)

Components	Linear trend (2005 – 2015) [mm/y]
Sea level (Altimetry)	4.34 ± 2.44
Mass (GRACE)	3.85 ± 0.87
Total steric (NOAA)	0.09 ± 0.36
Thermosteric	0.33 ± 0.32
Halosteric	-0.24 ± 0.14
GRACE + steric	3.94 ± 0.94

Sea level budget closure within 0.5 mm/year (68N-82N)

During 2005-2010 large halosteric component found (0.9 mm/year).

Summary and availability.

- The DTU and DTU/TUM sea level product available (ftp.space.dtu.dk/pub/ARCTIC_SEALEVEL)
- The Annual signal is heavily influenced by atmospheric pressure
- The linear sea level trend has large inter-annual variations (AO driven).
- First attempt to close Arctic Sea level budget closes at < 0.5 mm/year