→ SAR ALTIMETRY TRAINING COURSE

SAR Altimetry over the Polar Ocean

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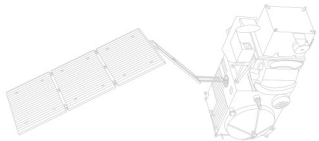
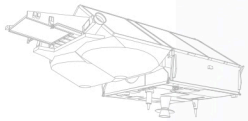
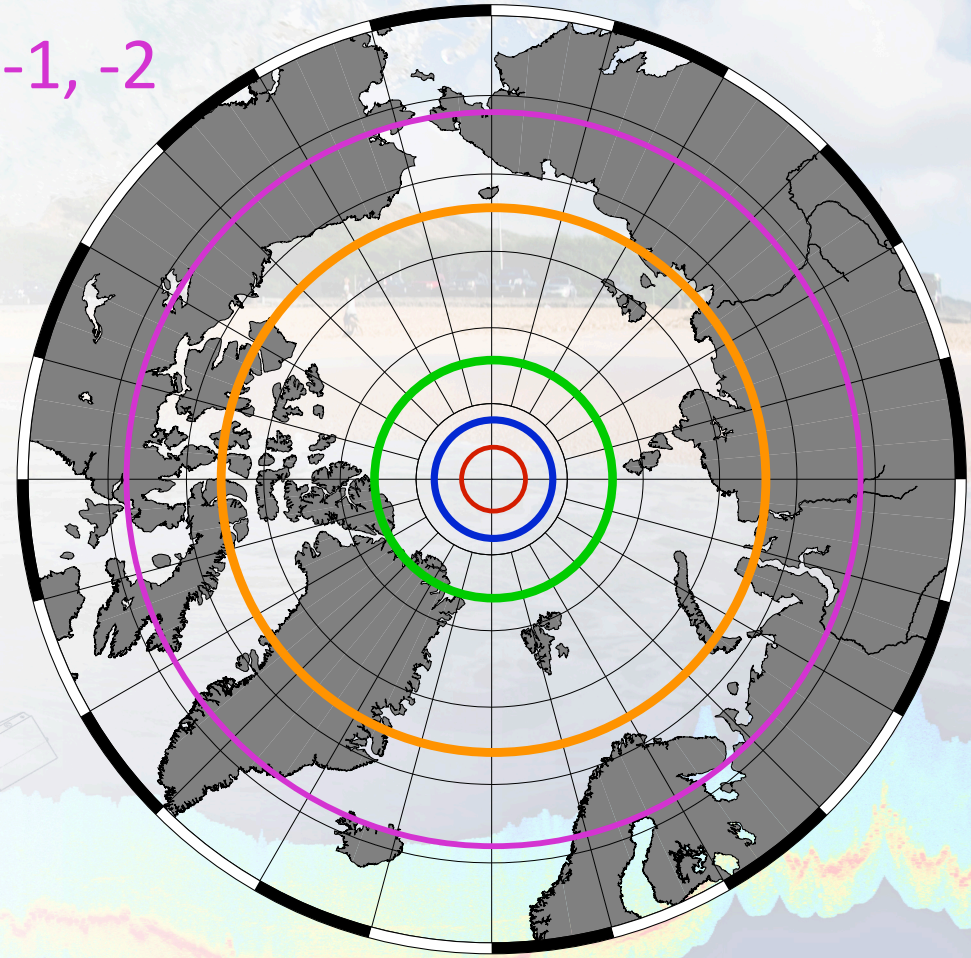




Altimetry at worlds end

- TOPEX/Poseidon, Jason-1, -2
- Geosat, GFO
- ERS-1, -2, ENVISAT
- IceSat
- CryoSat-2



The Arctic Ocean

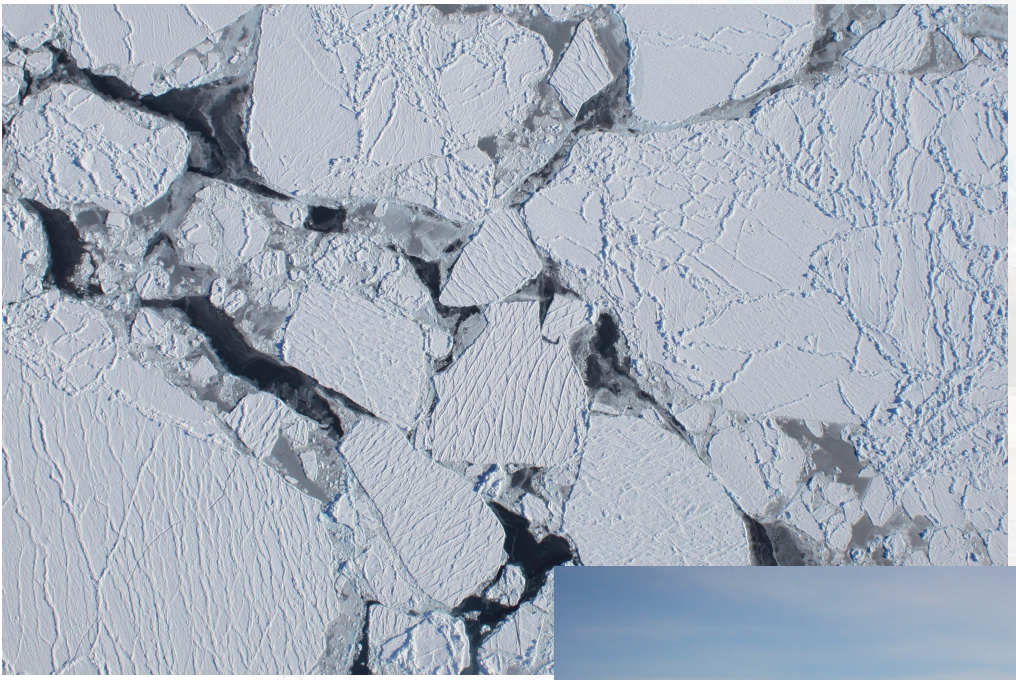
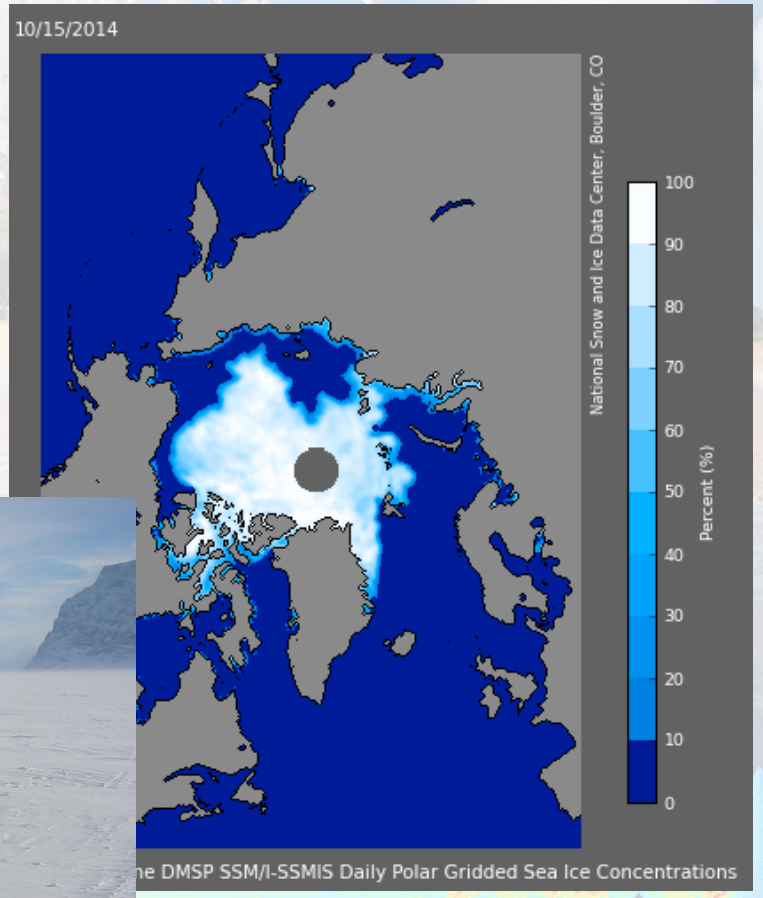


Photo: NASA

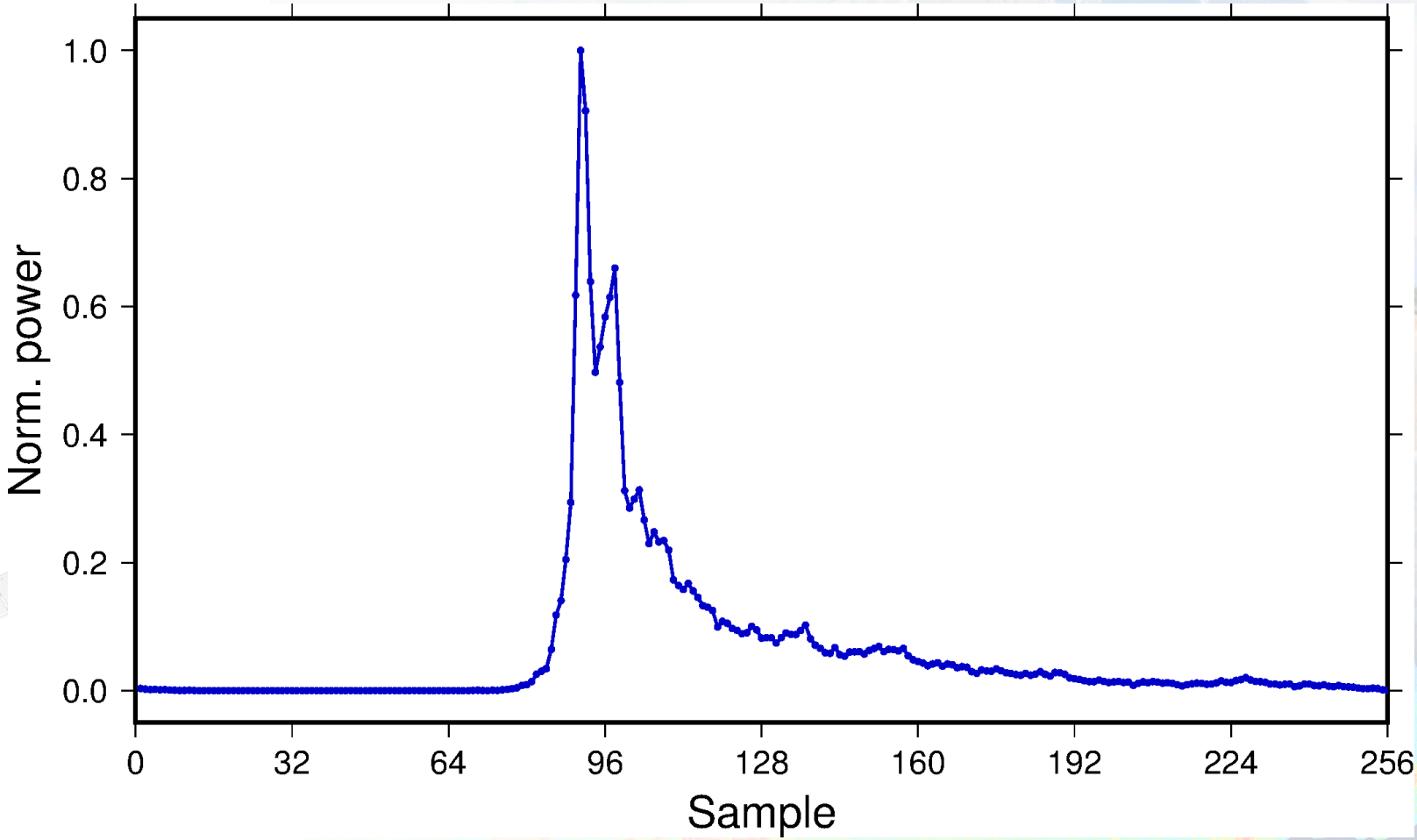
Photo: DTU Space

Sea ice concentration last week



National Snow and Ice Data Center
Maslanik and Stroeve 1999

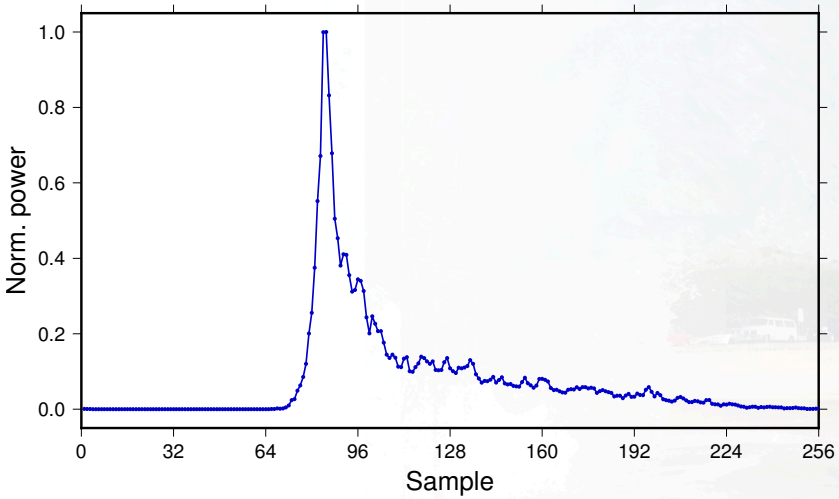
Waveforms in the Arctic

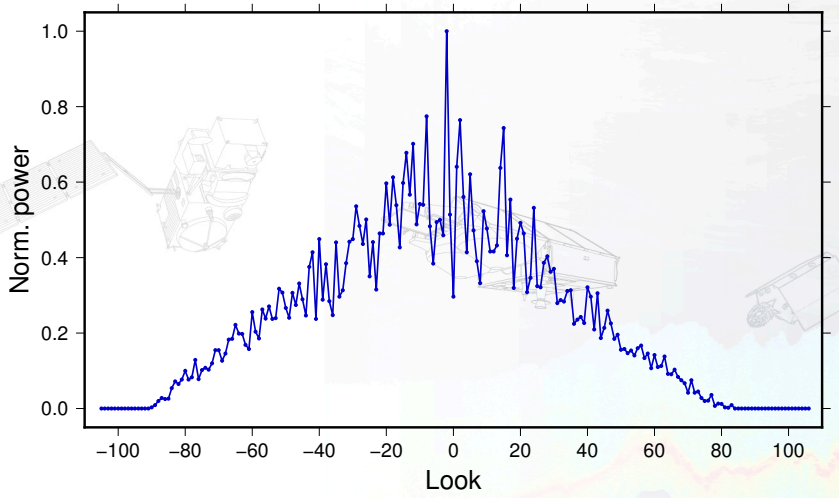


Data provided by CLS/CNES

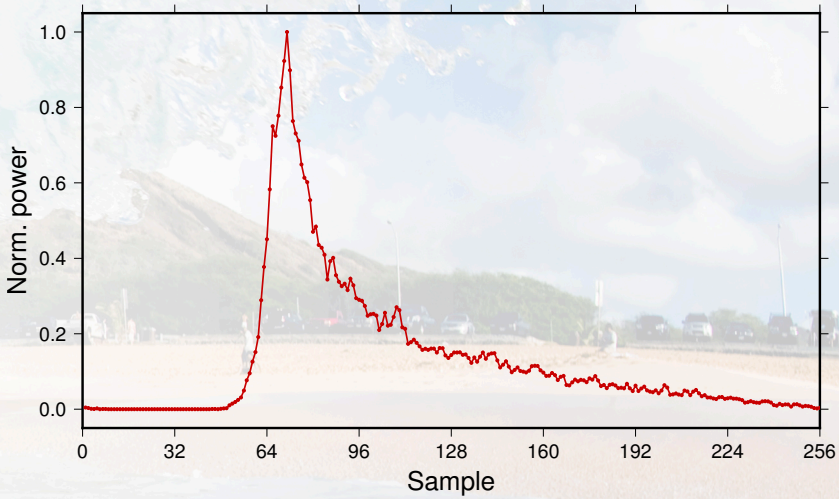
Waveforms in the Arctic

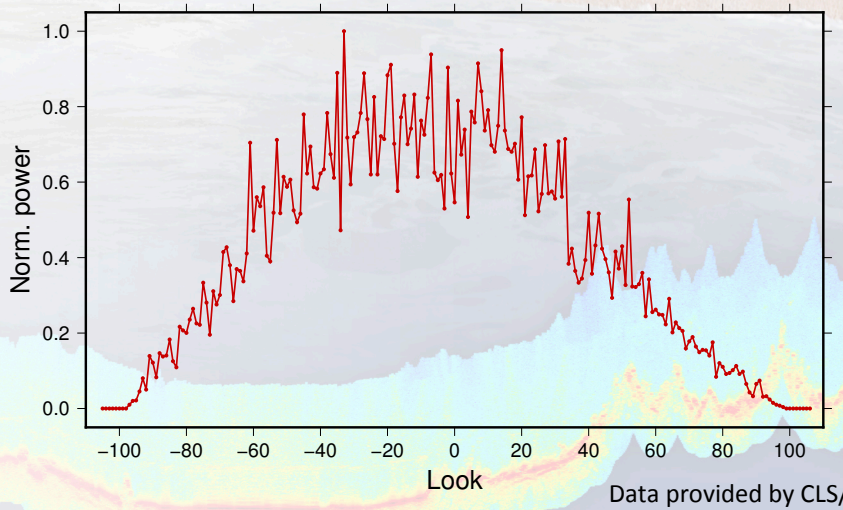
Arctic waveform





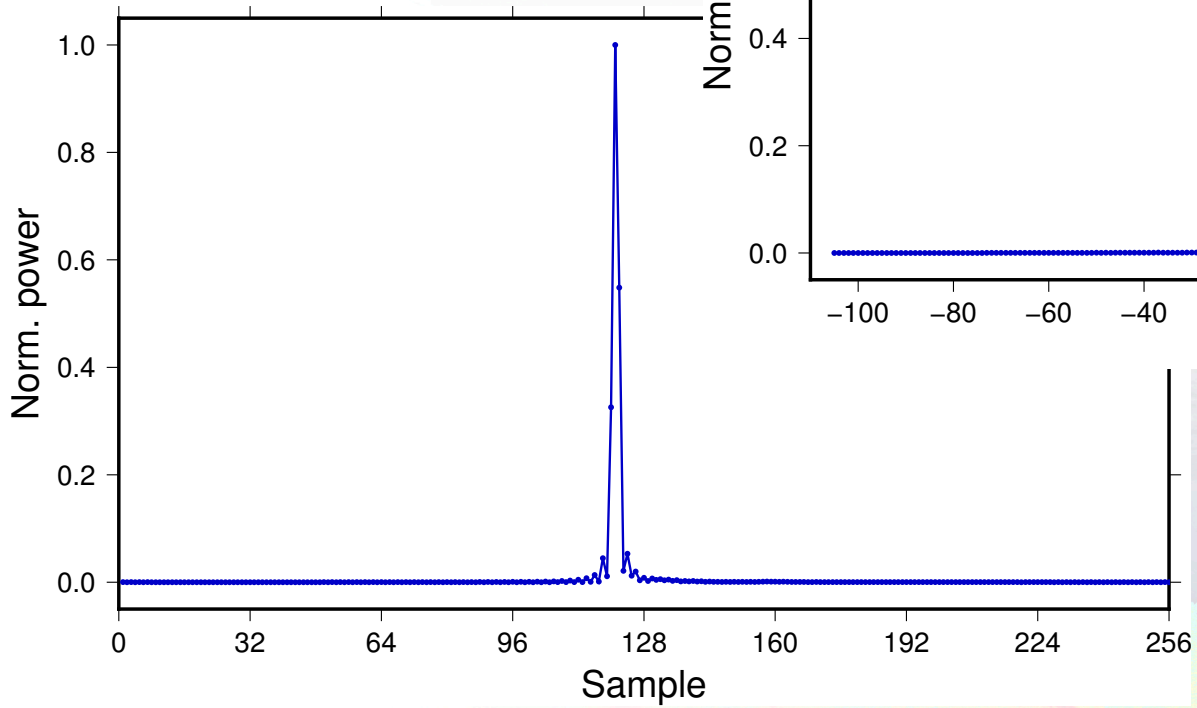
Ocean waveform

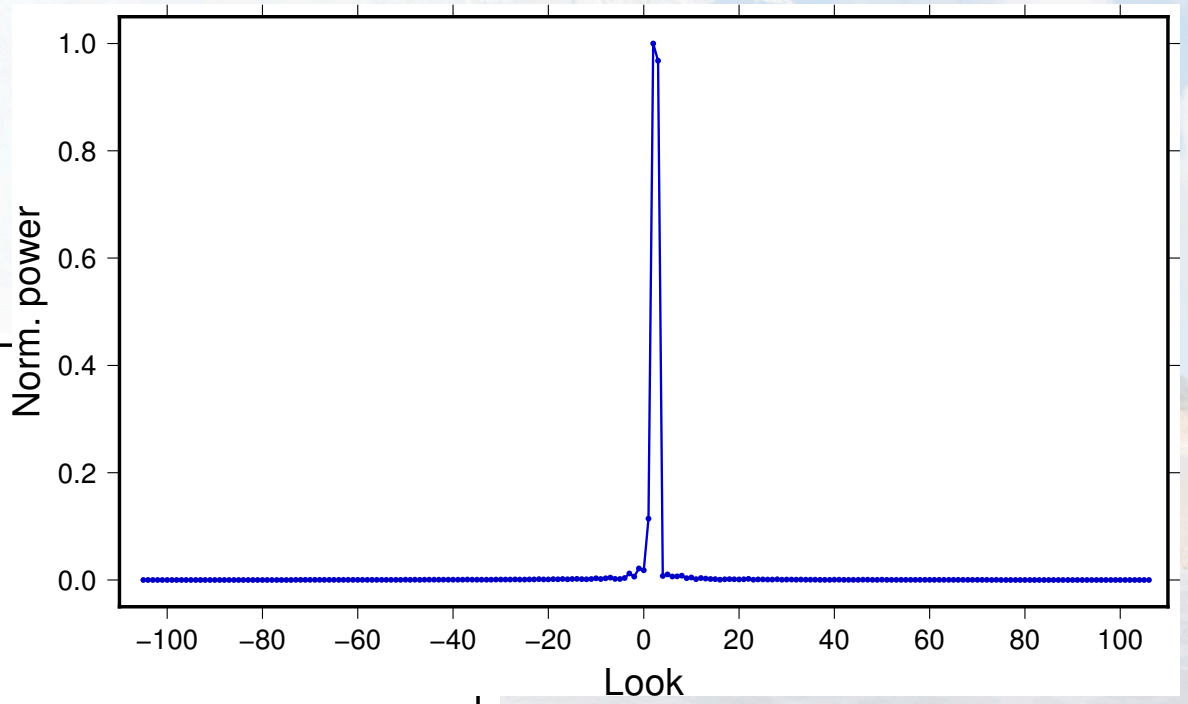




Data provided by CLS/CNES

Waveforms in the Arctic



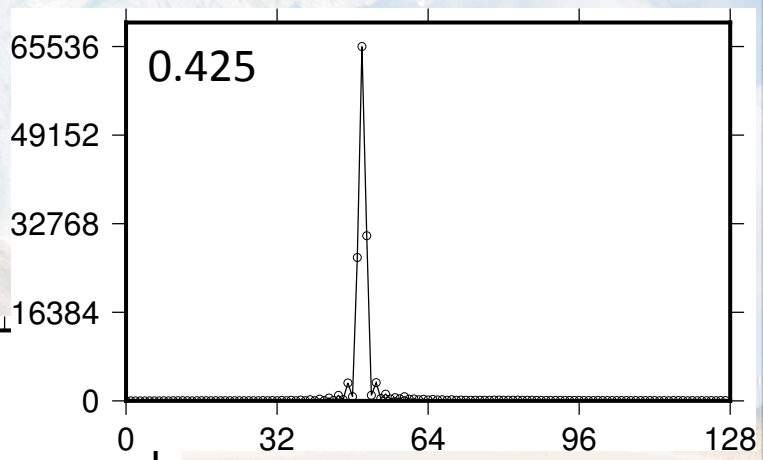


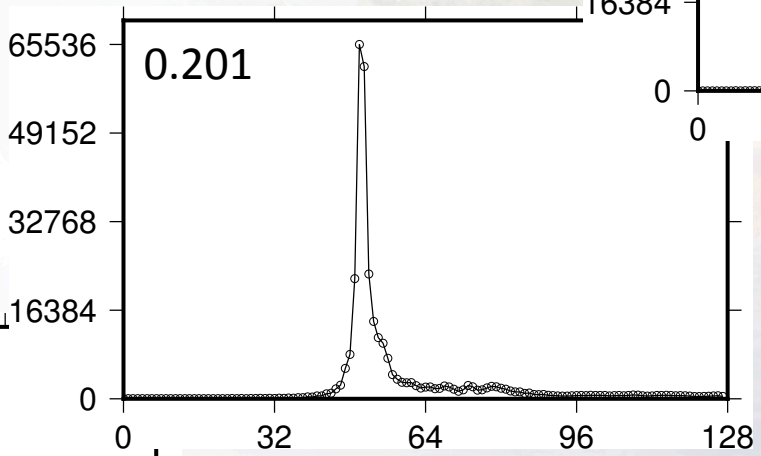
Data provided by CLS/CNES

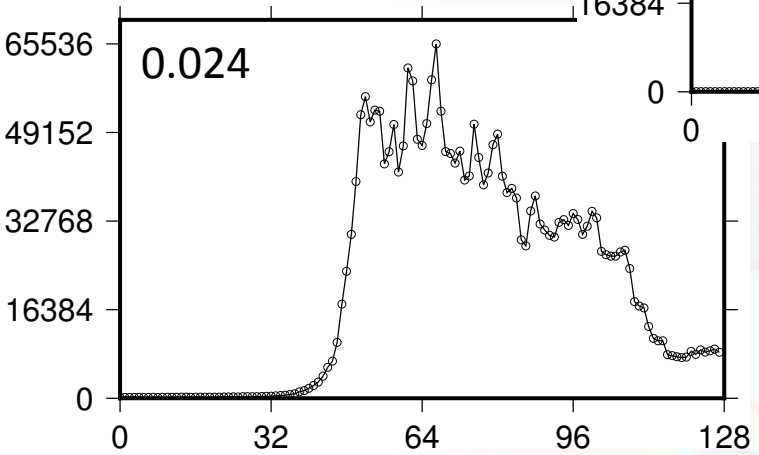
Classification

Pulse Peakiness (PP)

$$PP = \frac{65535}{\sum_{i=0}^{127} p_i}$$



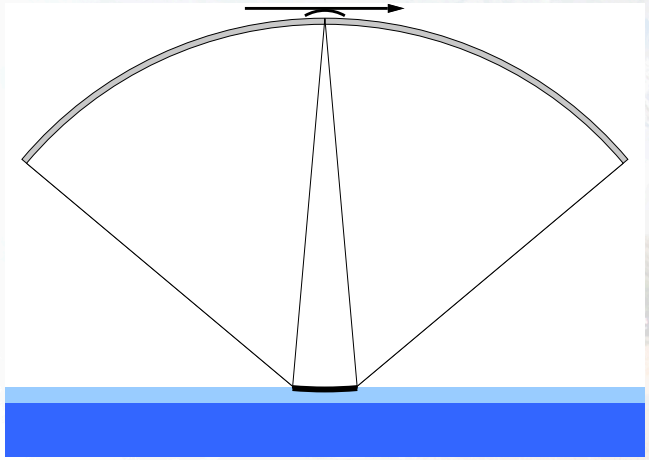




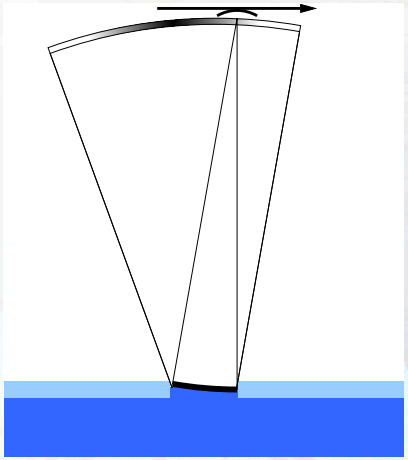
Francis (1991), Laxon (1994), and Stenseng (2014a)

Classification

Sea ice

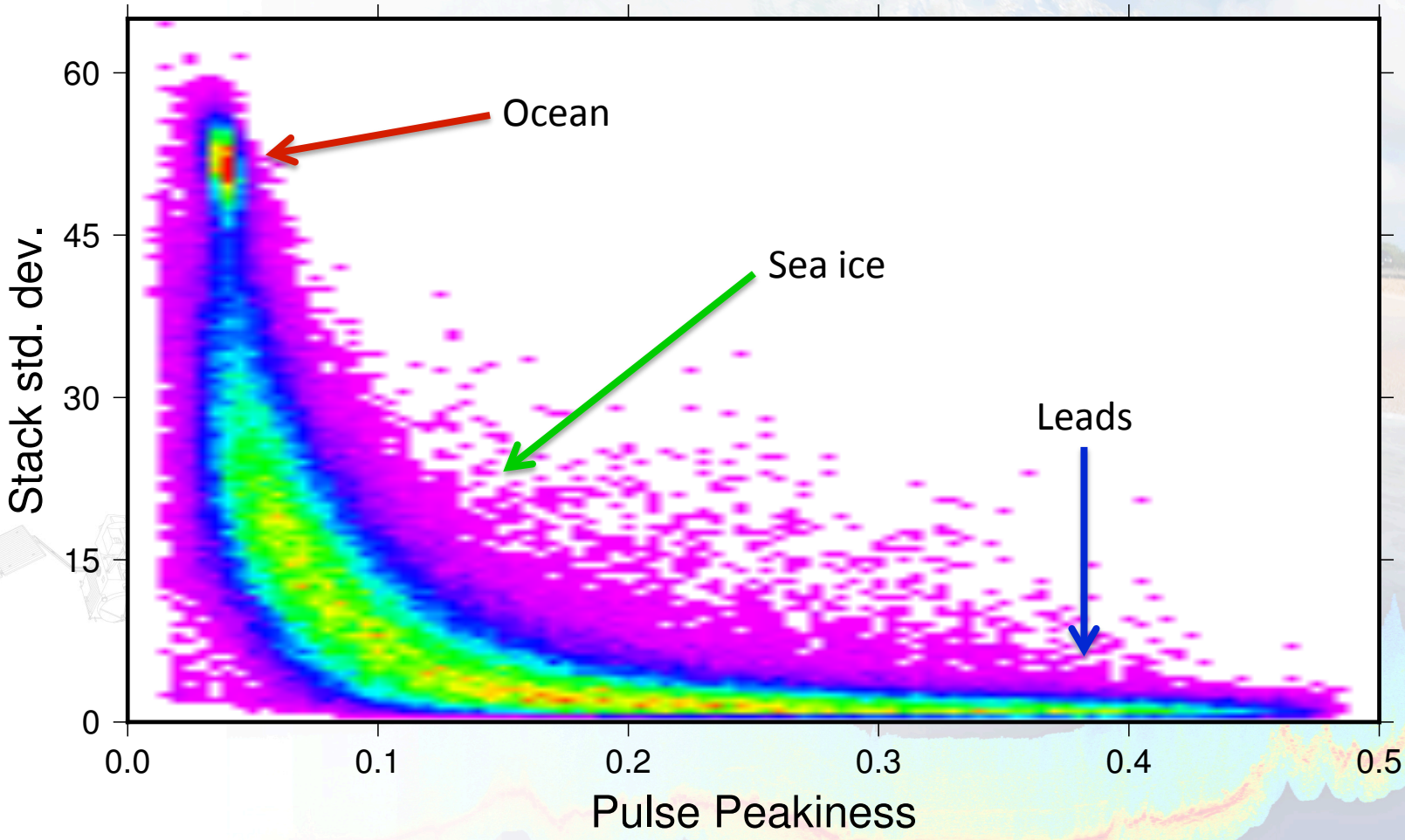


Lead in sea ice

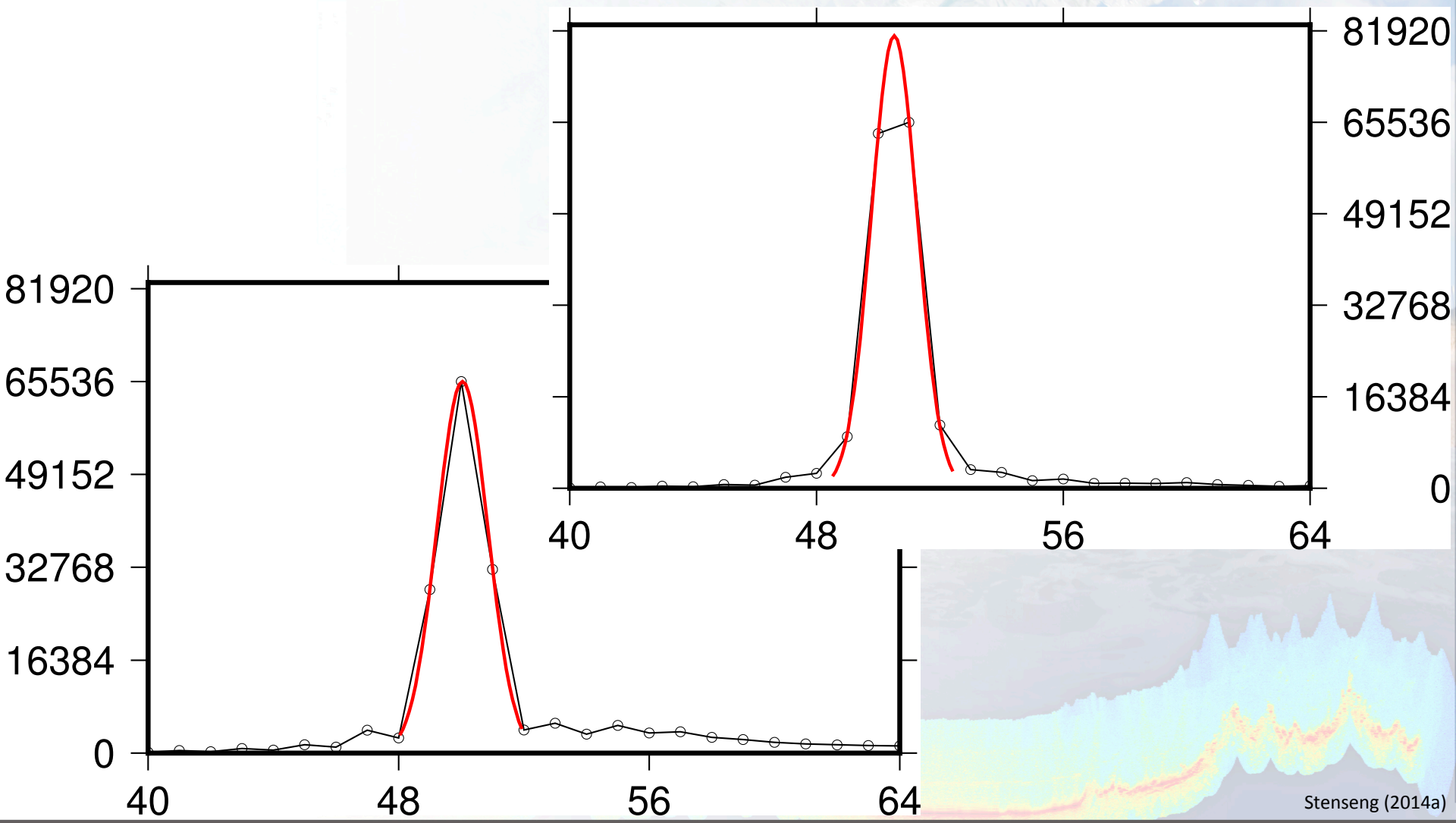


Stenseng (2014a)

Classification



Sampling and peak power

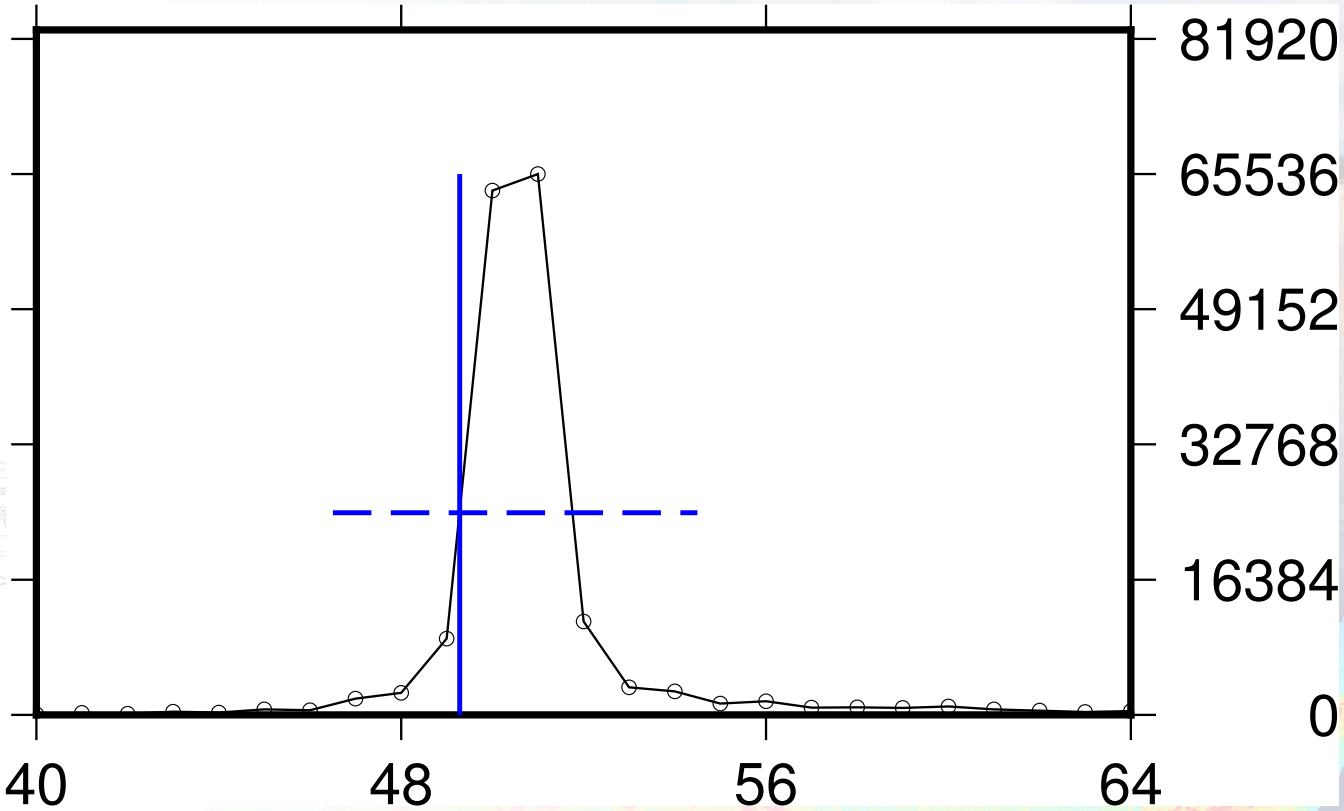


Stenseng (2014a)

Threshold Retracking

$$P_b = \frac{1}{5} \sum_{i=m-2}^{m+2} p_i$$

$$E = \frac{F_T \cdot P_b - p_{j-1}}{p_j - p_{j-1}} + j - 1$$



Davis (1997) and Stenseng (2011/2014a)

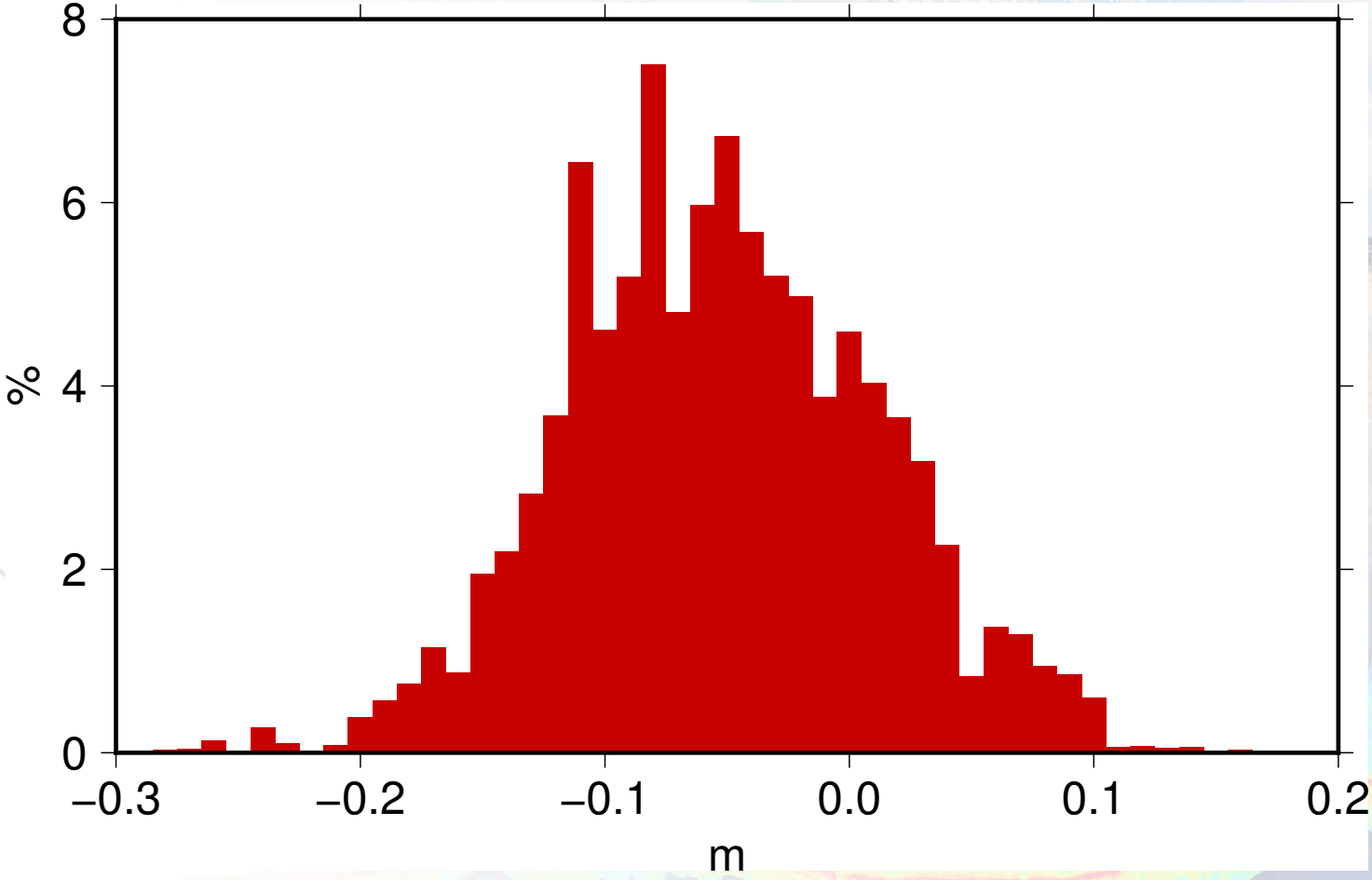
Validation

- Validation: DTU13 Mean Sea Surface
  - <20% of the observations is useful
  - Std. dev. calculated per track, not 1 Hz std. dev.

- Validation: IceBridge mission
  - ~15 dedicated CryoSat-2 under flights (3 used)
  - Georeferenced aerial photo for lead detection
  - Laser altimeter for sea surface height

Validation: DTU13MSS

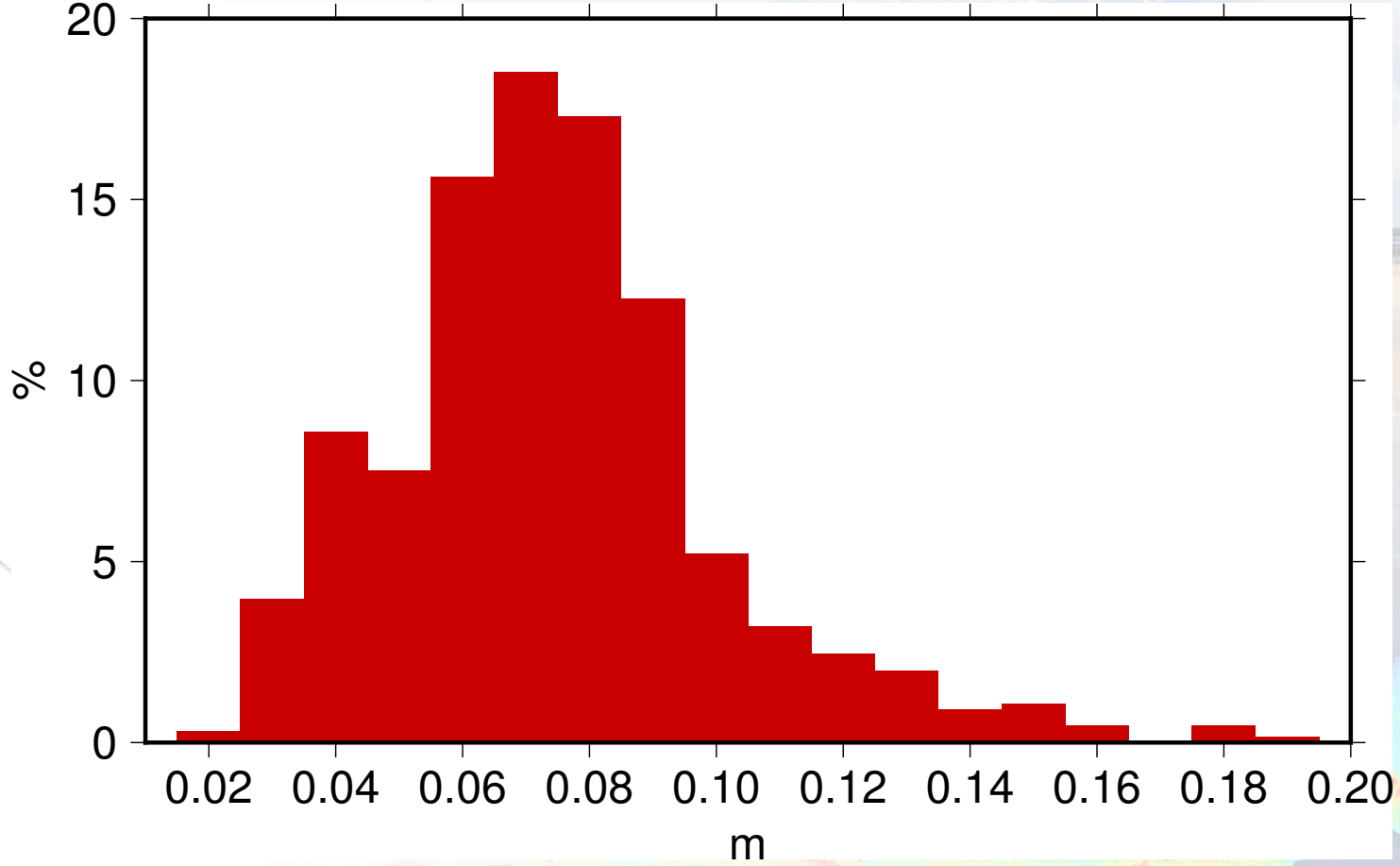
Mean track difference: -5.2 cm



Stenseng (2014b)

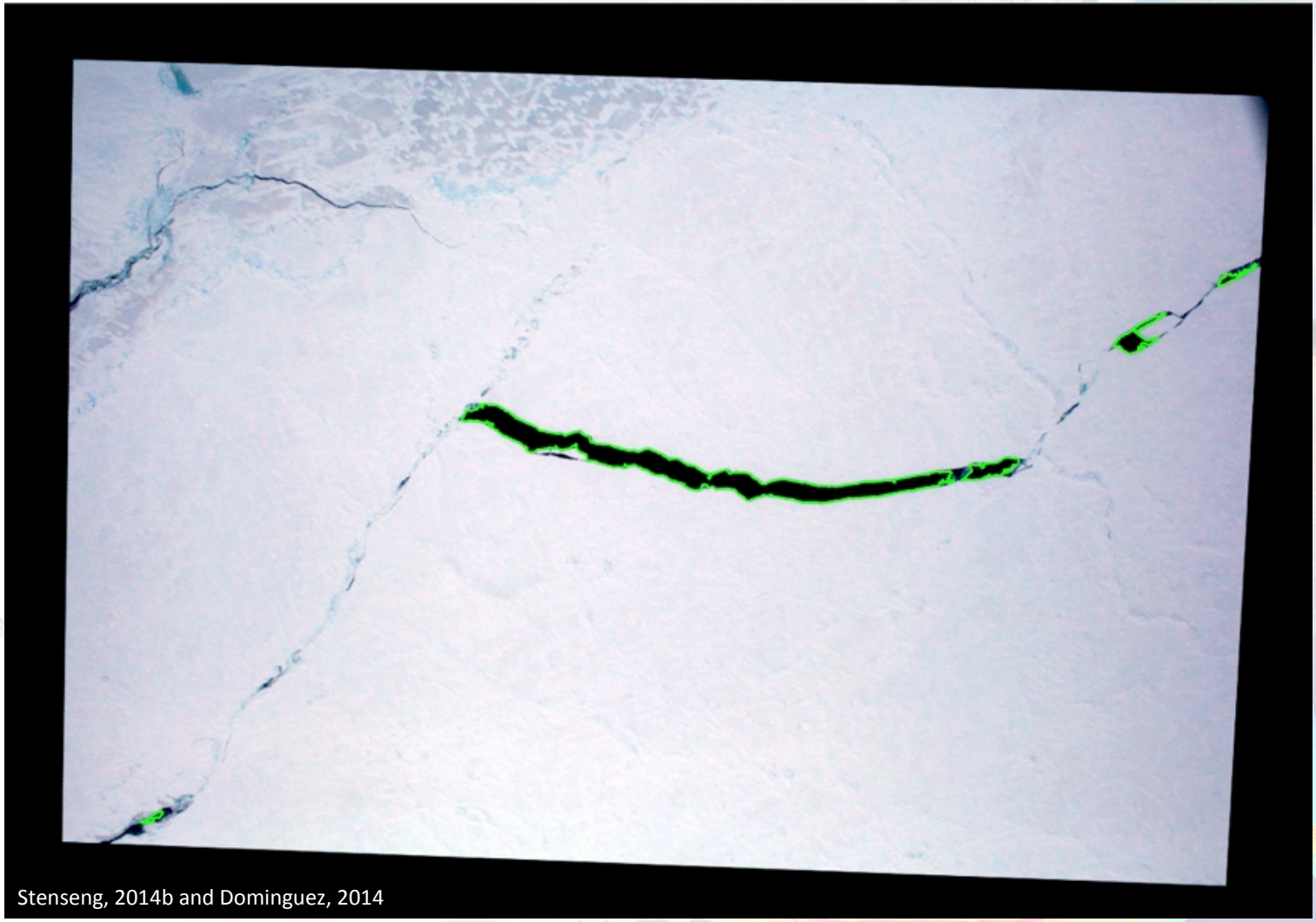
Validation: DTU13MSS

Track standard deviation: 7.4 cm



Stenseng (2014b)

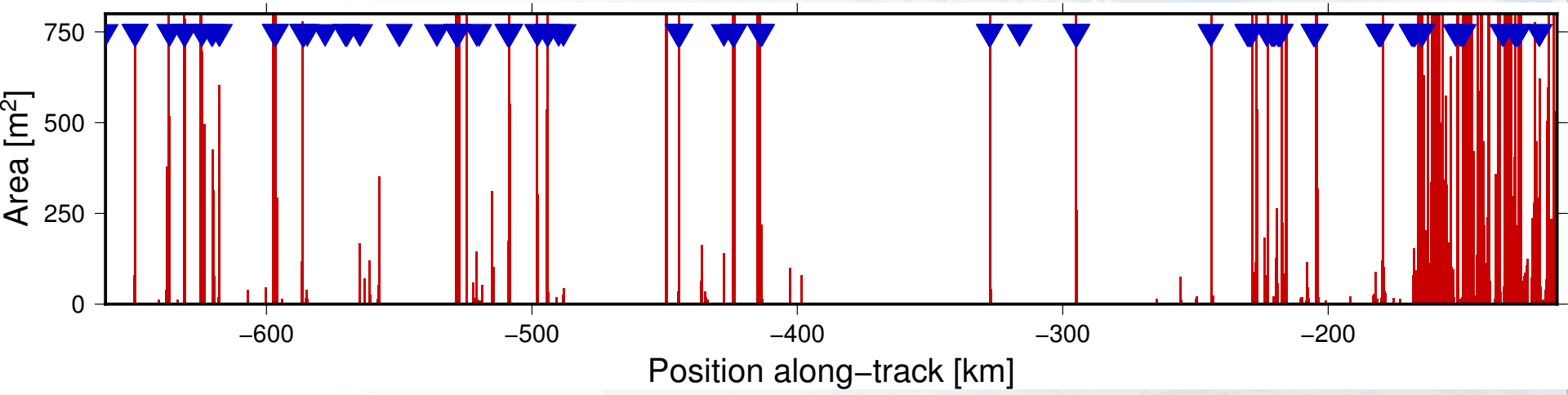
Validation: IceBridge



Stenseng, 2014b and Dominguez, 2014

Validation: IceBridge

Leads in aerial photos and CryoSat-2 data

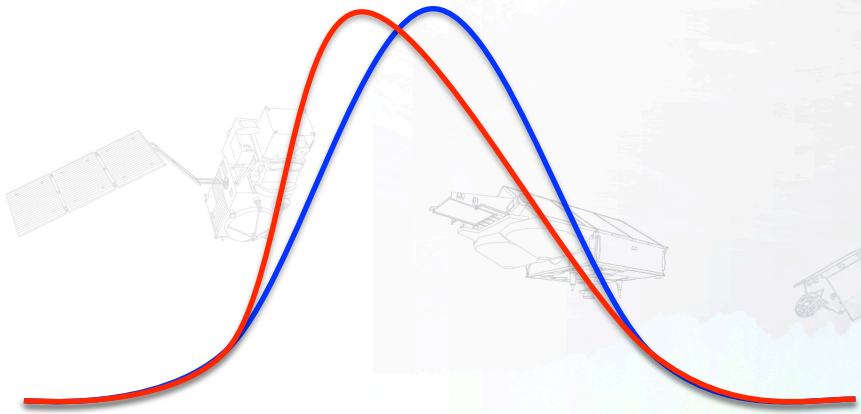


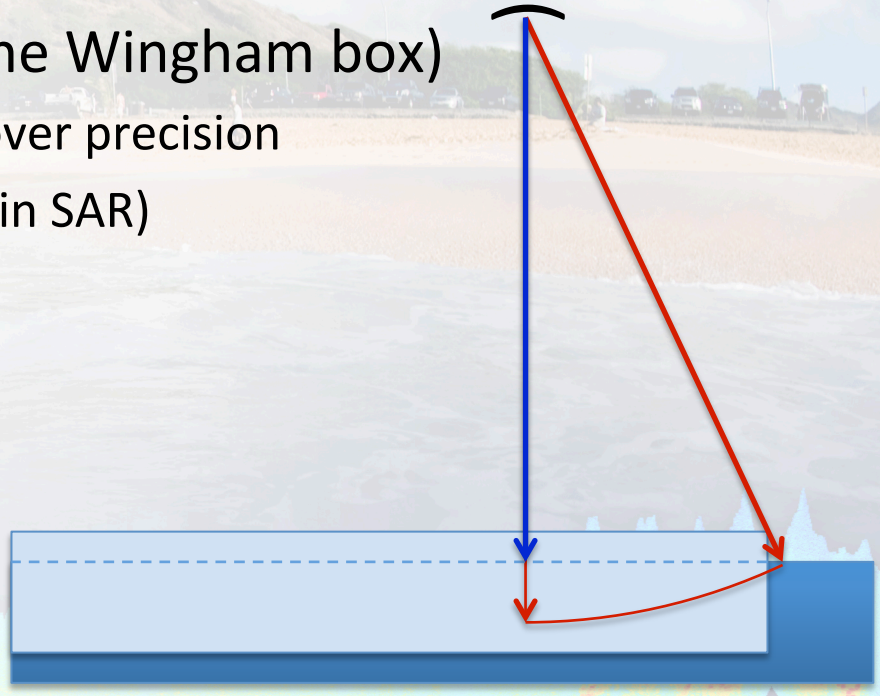
- Detected ~80% of leads >500 m^2
- LiDAR observations ~4 cm std. dev.
- Mean difference 0 cm Only 34 collocated observations

Stenseng (2014b)

“Snagging”

- Bright off nadir targets dominates
- Range to target longer ➔surface lower
- Cross-track angle from SARin (the Wingham box)
  - CryoSat-2 SARin mode: accuracy over precision
  - Only 1 burst per radar cycle (vs. 4 in SAR)

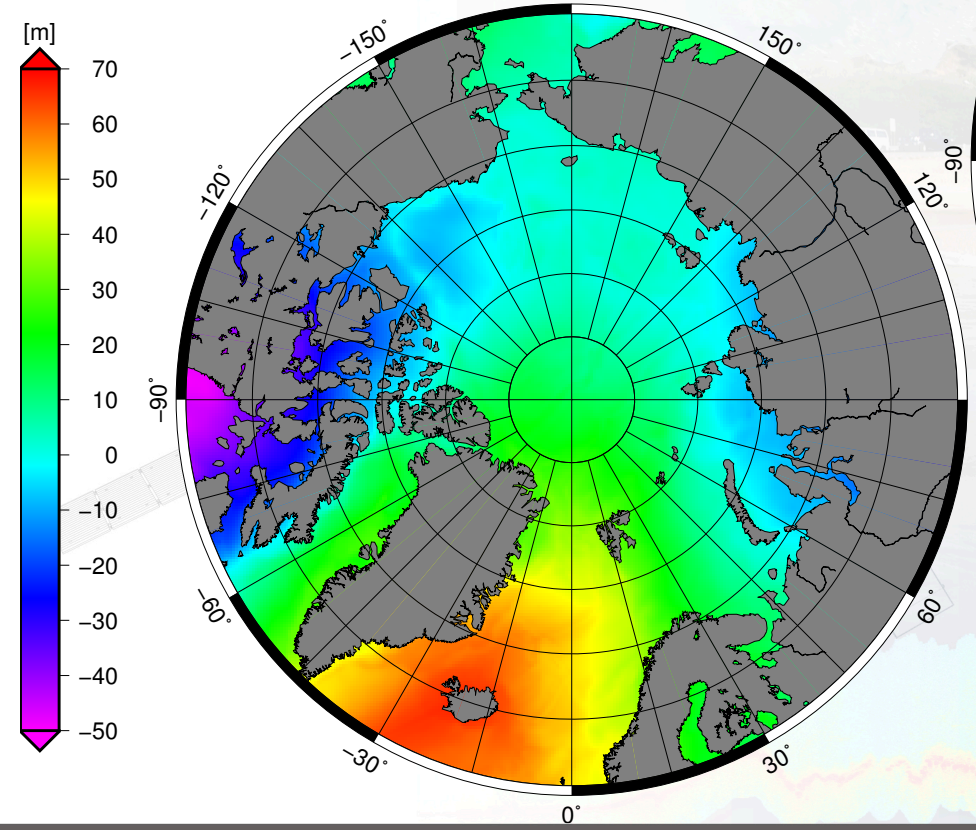


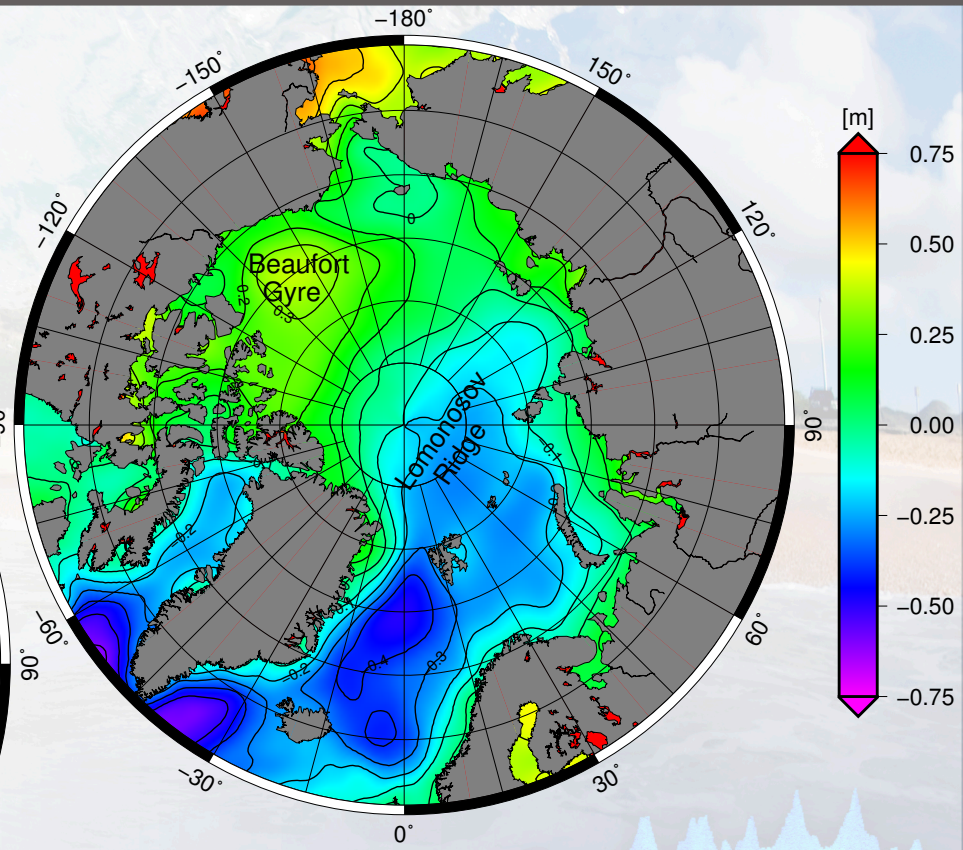


Stenseng (2014b), Armitage and Davidson (2014)

Putting it all together

DTU13 Mean Sea Surface





DTU13 Mean Dynamic Topography

ftp://ftp.space.dtu.dk/pub/DTU13

Stenseng et al. (2013/2014)

Questions?
If you are still awake!

Bibliography

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