

Baltic SEAL: assessment and perspectives of Ku and Ka band sea level retrieval with and without sea ice coverage

Marcello Passaro¹, Laura Rautiainen⁴, Felix L. Müller¹, Adili Abulaitijiang², Ole B. Andersen², Denise Dettmering¹, Jacob L. Høyer³, Kristine Skovgaard Madsen³, Julius Oelmann¹, Ida M. Ringgaard³, Jani Särkkä⁴, Rory Scarrott⁵, Christian Schwatke¹, Florian Seitz¹, Laura Tuomi⁴, Marco Restano^{6**}, Jérôme Benveniste⁶

¹ Deutsches Geodätisches Forschungsinstitut, Technische Universität München (DGFI-TUM), Germany

² SPACE National Space Institute, Technical University of Denmark, (DTU), Denmark

³ Danish Meteorological Institute (DMI), Denmark

⁴ Finnish Meteorological Institute (FMI), Finland

⁵ MaREI Centre, Environmental Research Institute, University College Cork (UCC), Ireland

^{6**} SERCO, c/o ESA-ESRIN, Italy

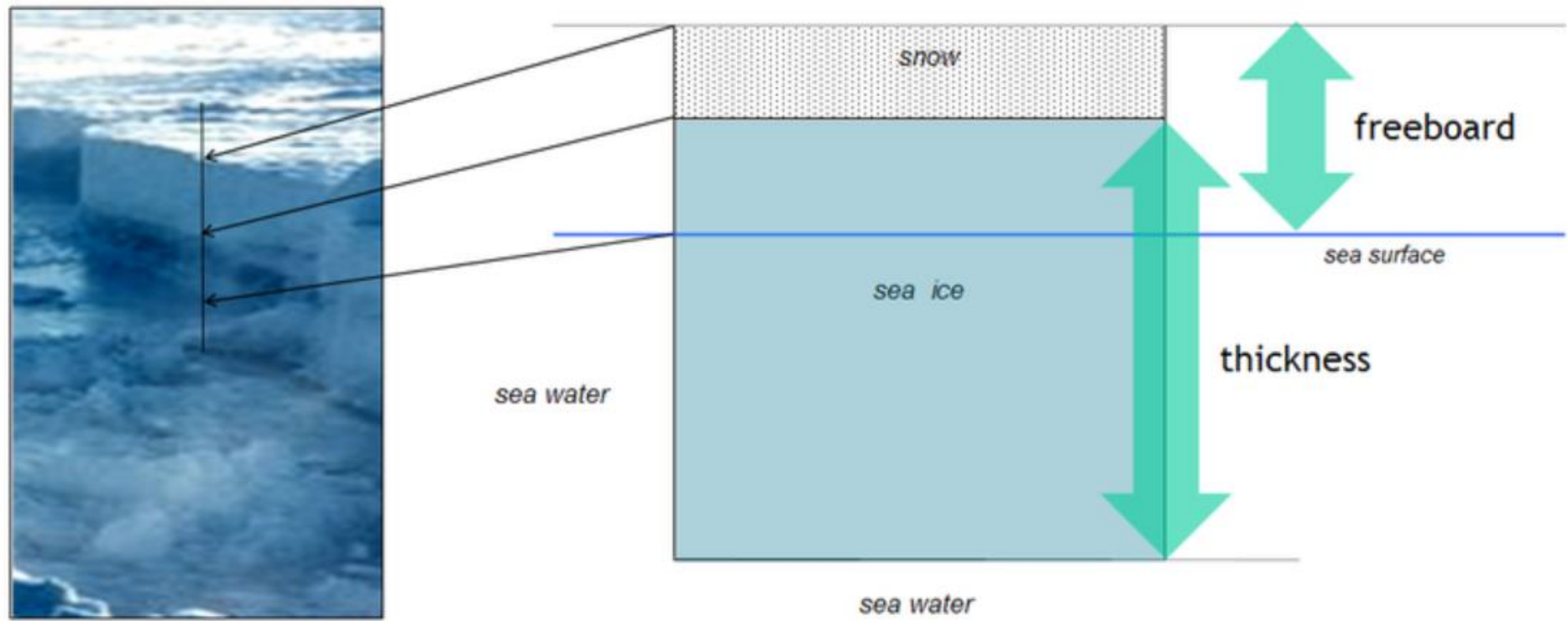
⁶ ESA-ESRIN, Italy



DUAL-CRYO ESA Workshop, 14.01.2021

Motivation

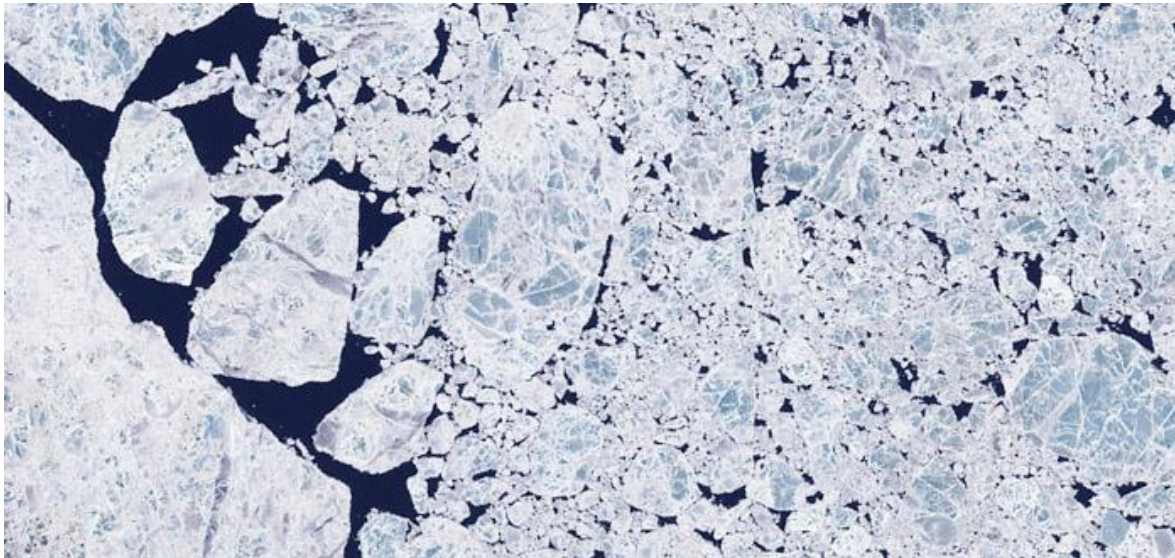
- To compute Sea Ice Freeboard, we need sea surface height



From: <https://bioage.typepad.com/.a/6a00d8341c4fbe53ef011571d6eff4970b-popup>

Motivation

- To compute sea surface height, we'd like to
- 1) Correctly classify radar returns coming from open water or sea ice
- 2) Avoid biases due to different algorithms used in different situations (sea ice vs open ocean, Ku vs Ka, coast vs open ocean)

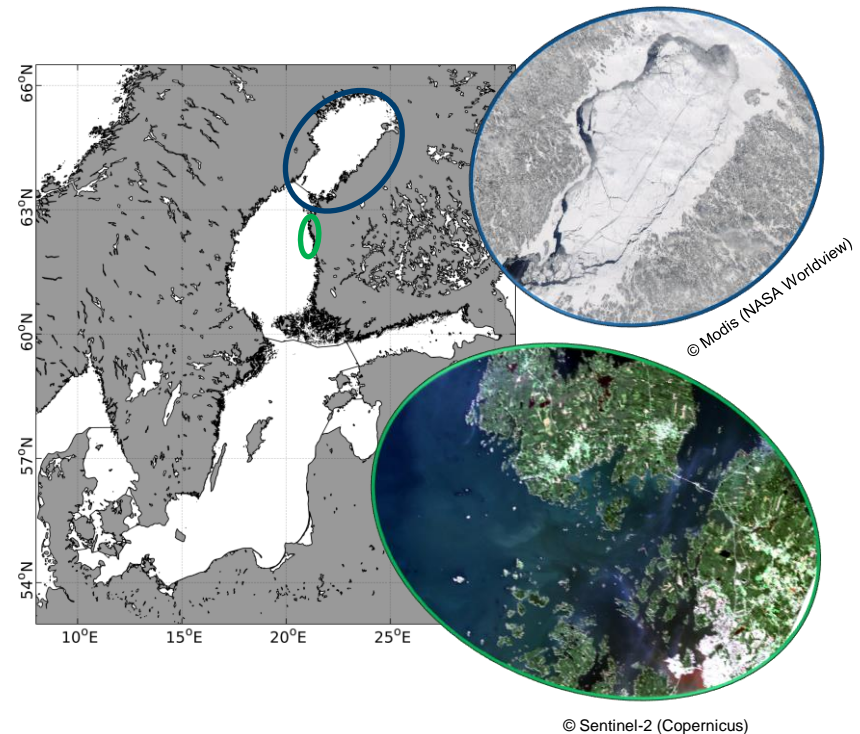


Landsat 7 Enhanced Thematic Mapper (ETM+) image
of sea ice in the Arctic Ocean. (NASA)

The Baltic+ Sea Level (BALTIC SEAL) – Motivation

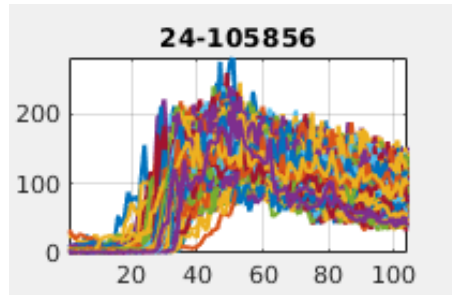
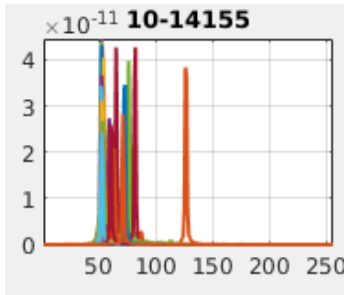
We have developed a HOMOGENOUS set of routines (classification, retracking and quality control) which are:

- Applicable to ALL altimetry missions (Ku, Ka, Low Resolution Mode Altimetry, SAR Altimetry, Fully Focused-SAR Altimetry)
- Applicable to all environments (sea-ice, open ocean, coast) with comparable performances



We have designed the Baltic Sea as a validation laboratory with ideal setting to test advanced processing strategies (e.g. plenty of tide gauges)

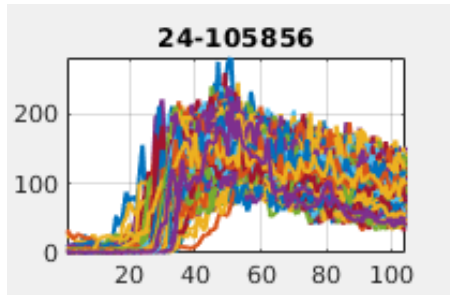
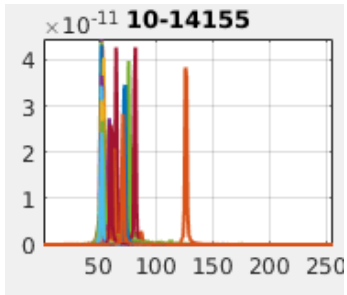
Baltic+ SEAL – Algorithm Development Challenges



UNSUPERVISED WAVEFORM
CLASSIFICATION

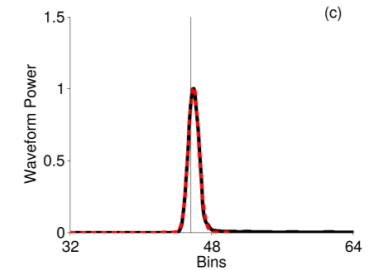
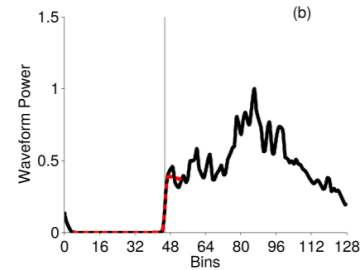


Baltic+ SEAL – Algorithm Development Challenges

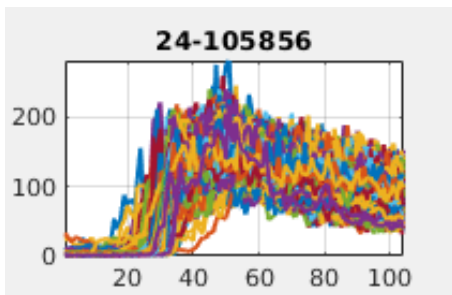
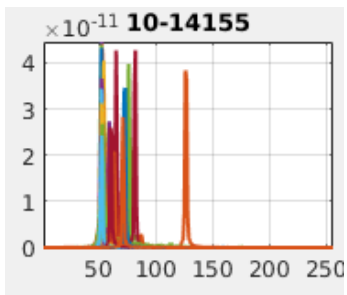


UNSUPERVISED WAVEFORM CLASSIFICATION

WAVEFORM RETRACKING
ALES+, ALES+ SAR

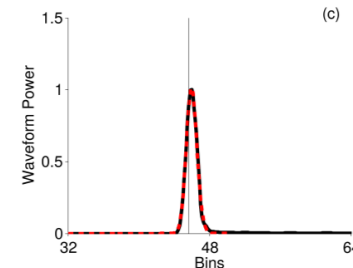
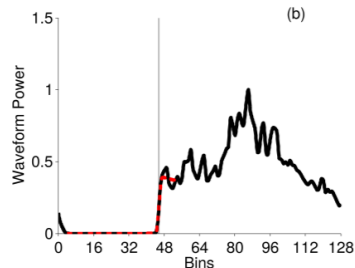


Baltic+ SEAL – Algorithm Development Challenges

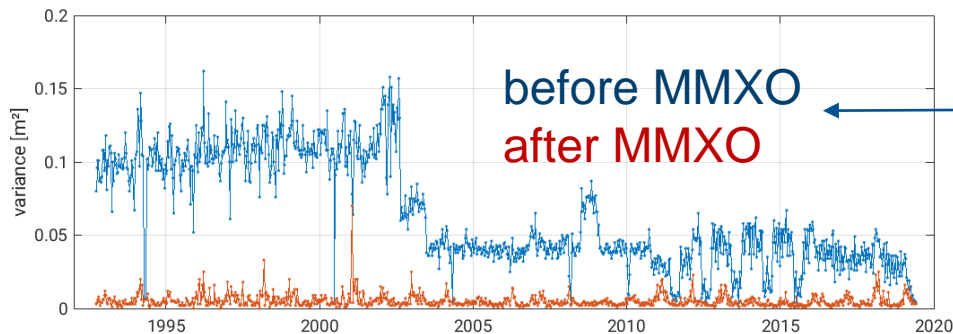


UNSUPERVISED WAVEFORM CLASSIFICATION

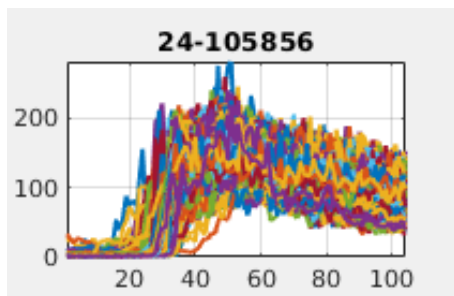
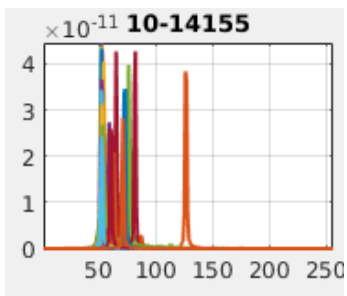
WAVEFORM RETRACKING
ALES+, ALES+ SAR



MULTIMISSION CROSSCALIBRATION

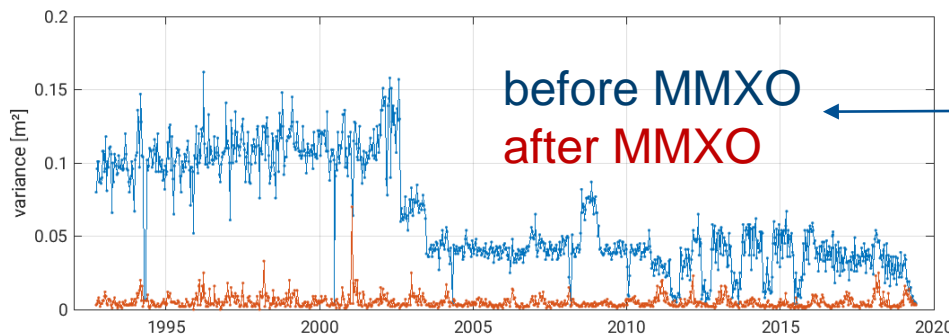
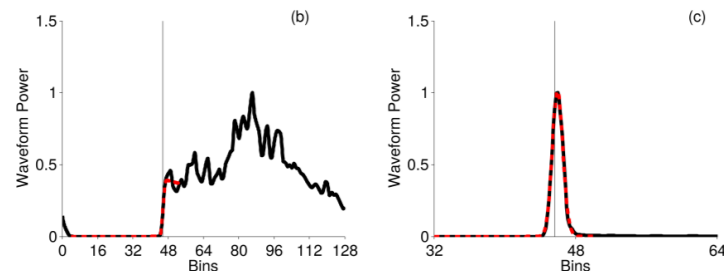


Baltic+ SEAL – Algorithm Development Challenges



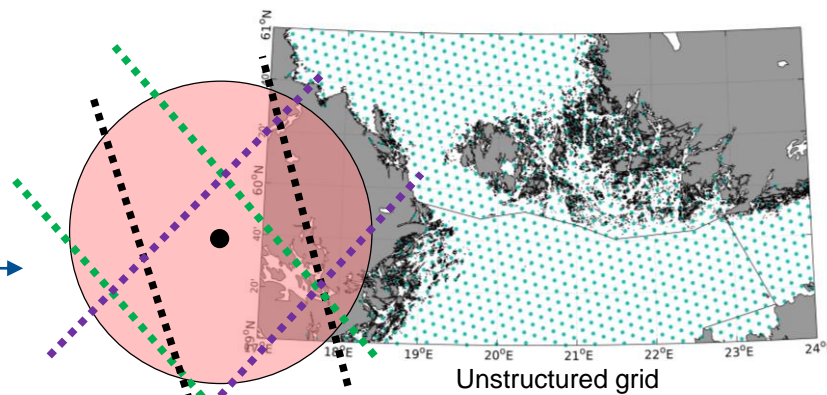
UNSUPERVISED WAVEFORM CLASSIFICATION

WAVEFORM RETRACKING
ALES+, ALES+ SAR

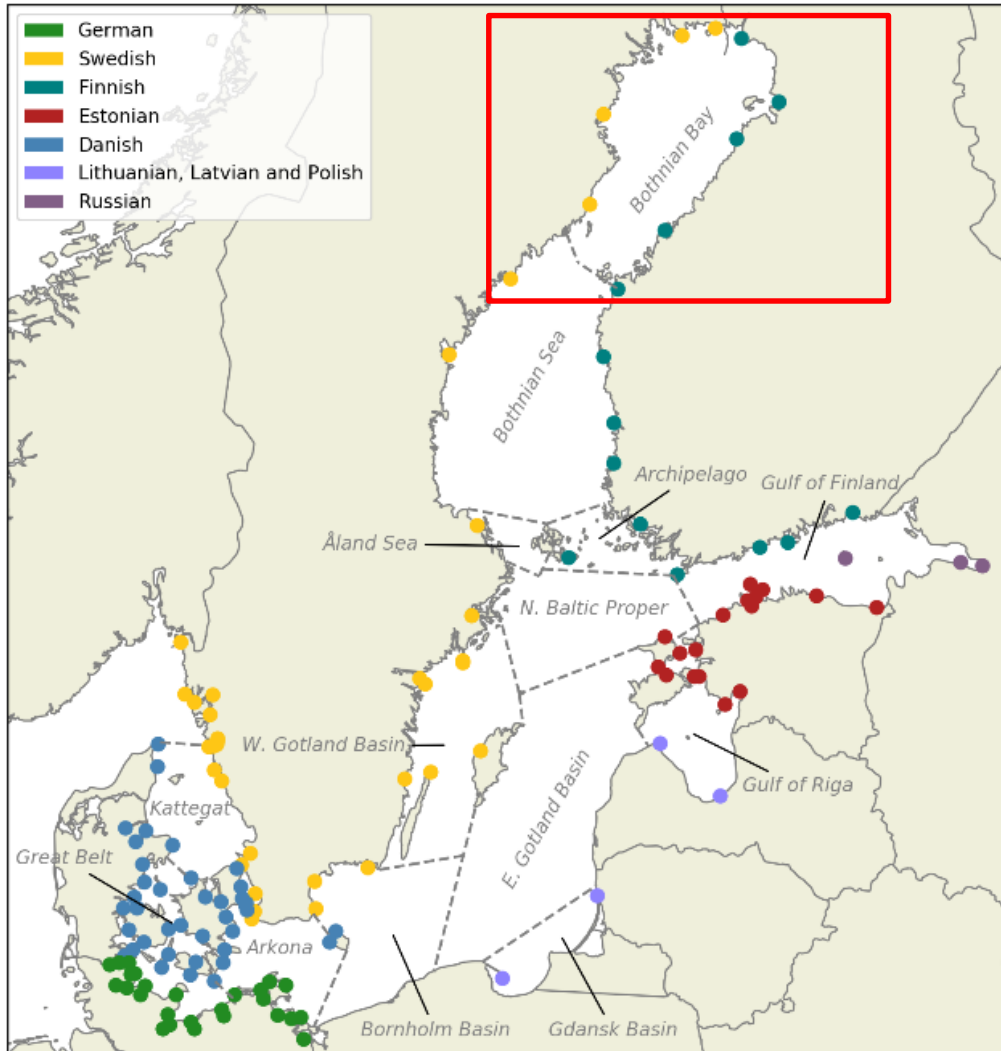


MULTIMISSION CROSSCALIBRATION

GRIDDING



Baltic+ SEAL – Validation steps

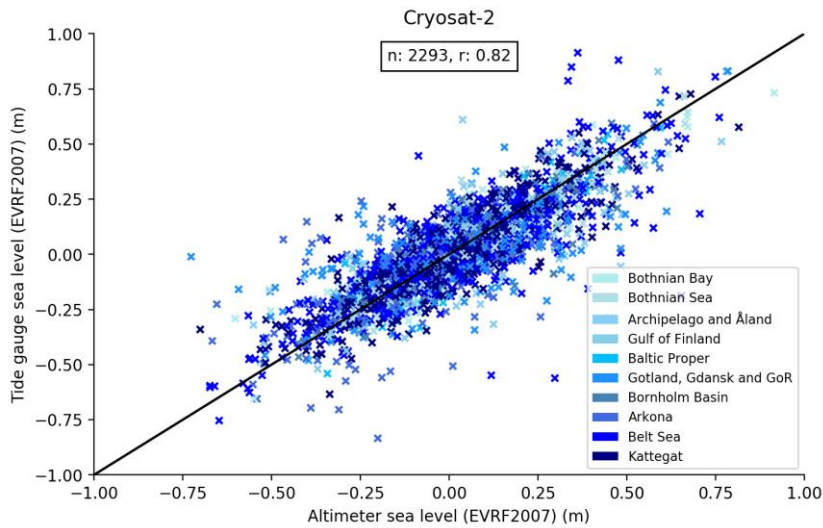


Validation of sea level products through tide gauges

Pearson's correlation 3-10 km away from coast and TG

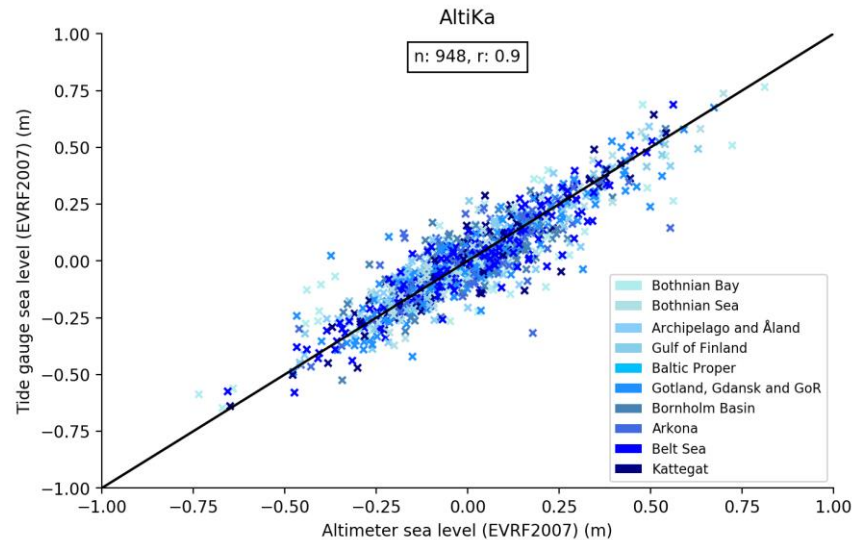
Focus on Bothnian Bay:
typical sea ice season
November to March (full coverage)

Basin-wide Validation results

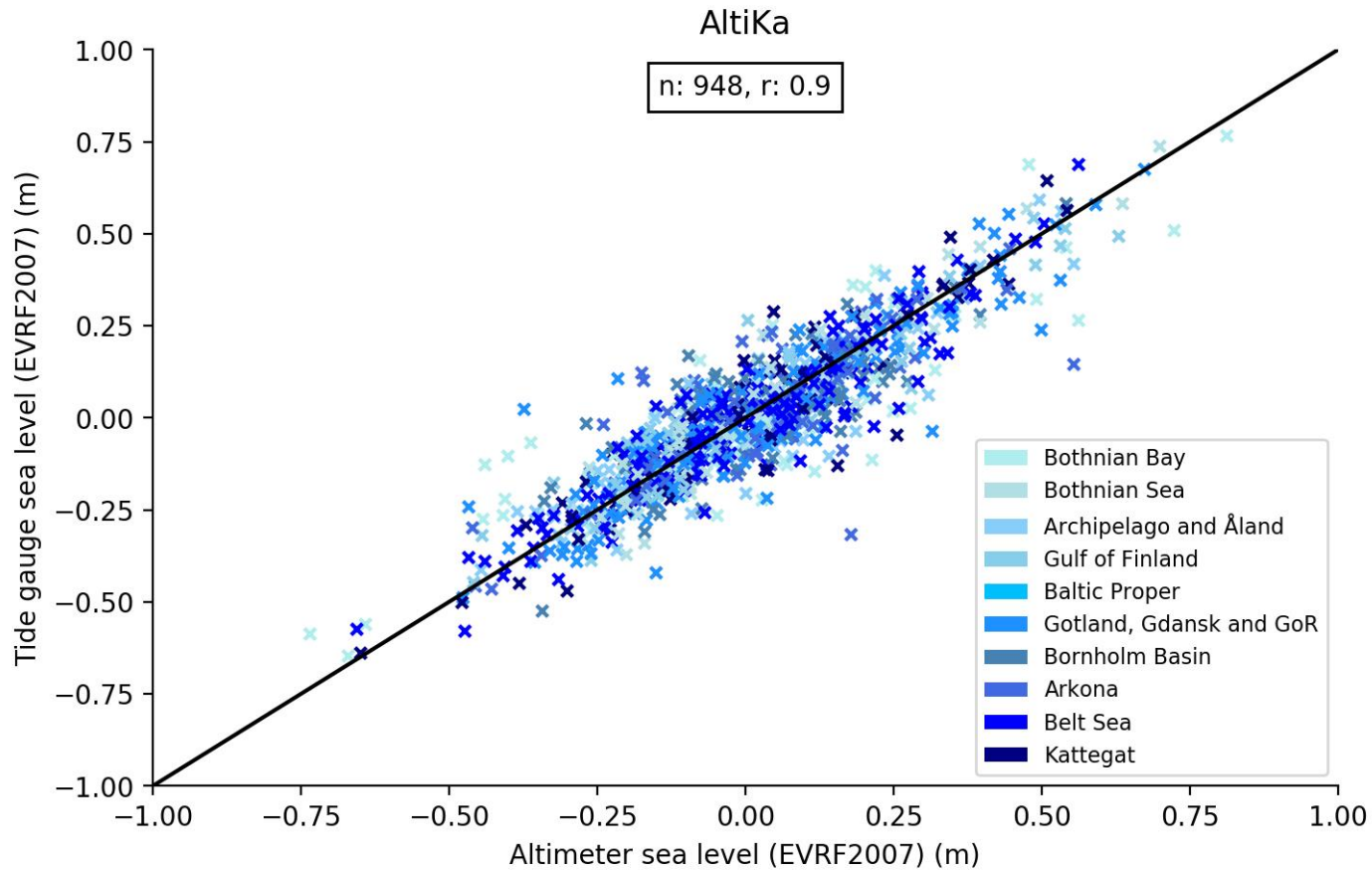


Cryosat-2 (Ku – SAR): $r=0.82$

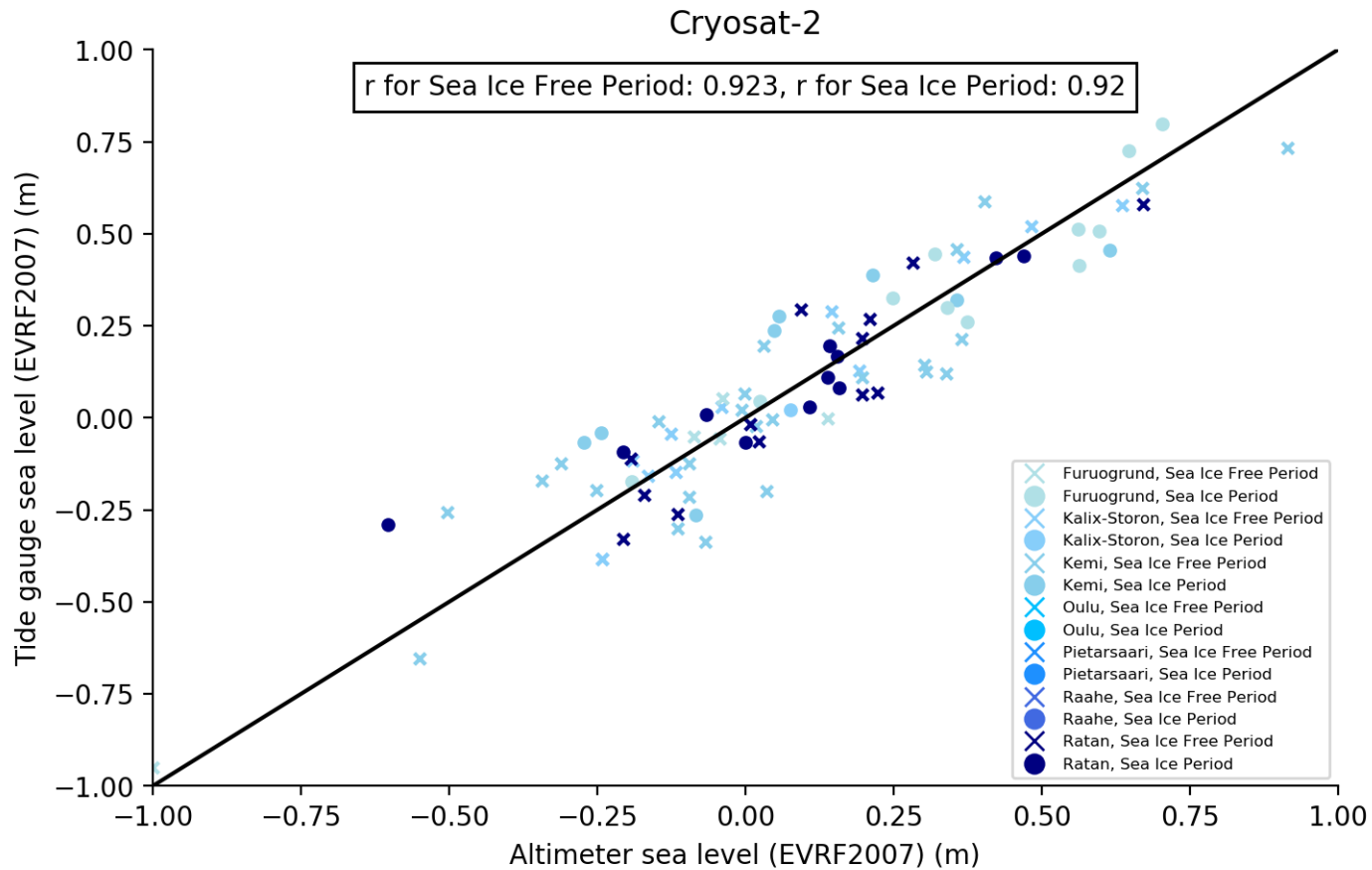
AltiKa (Ka – LRM): $r=0.9$



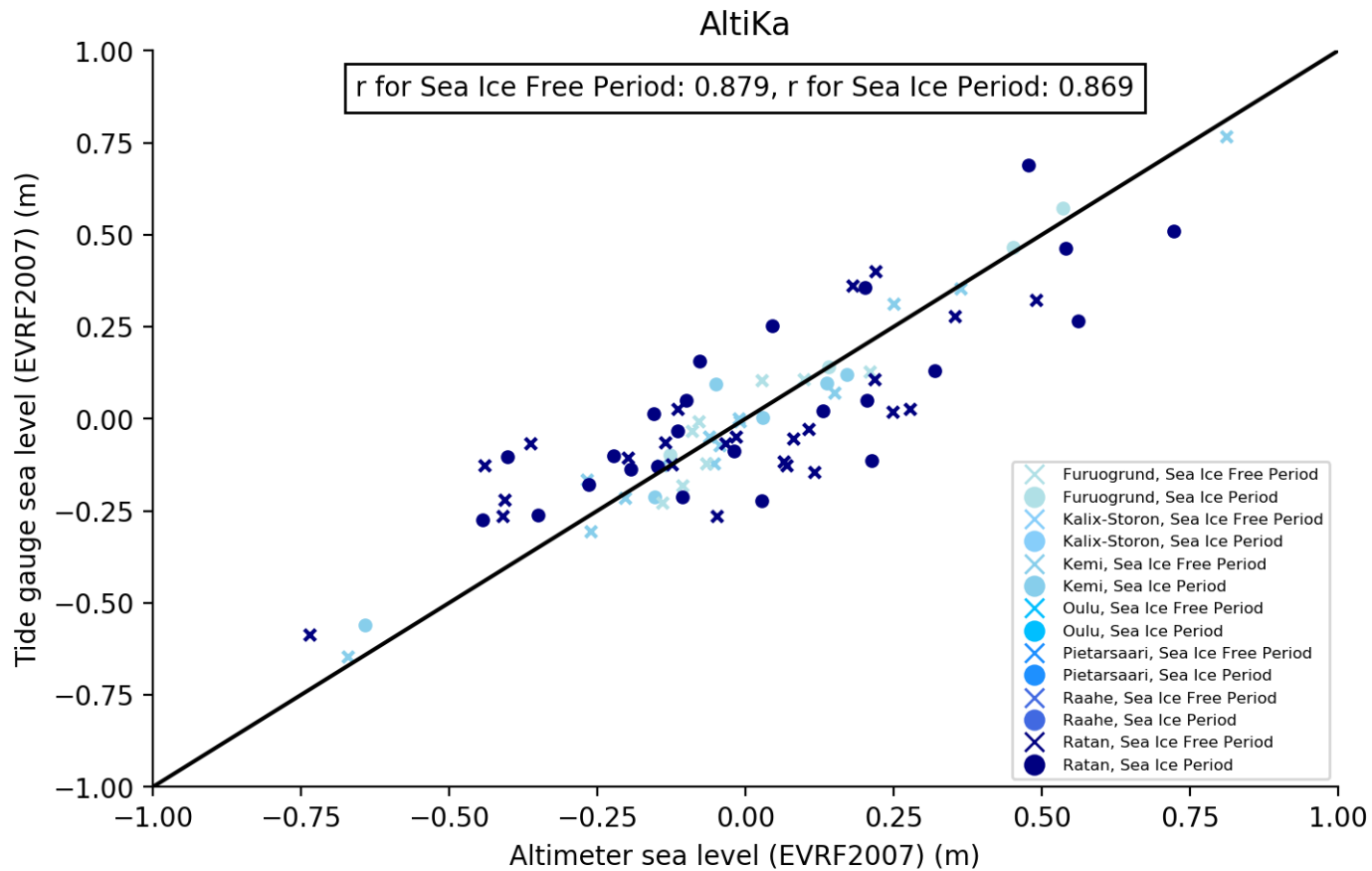
Basin-wide Validation results: AltiKa (Ka – LRM)



Bothnian Bay: Cryosat-2 (Ku – SAR)



Bothnian Bay: AltiKa (Ka – LRM)



The way forward

- Our dataset classifies and flags sea ice returns...but we have not used those yet
- We know that our waveform fitting works on sea ice returns as well -> we want to exploit this
- ALES+ SAR retracking data can be already processed through ESA GPOD for Cryosat and the Sentinels.
- We have already tested ALES+ FF-SAR on Sentinel-3 -> we want to exploit this

VISIT <http://balticseal.eu/> for documentation and (in the next couple of weeks) data access

TWIT to [@Baltic_SEAL](https://twitter.com/Baltic_SEAL)

