



Satellite Radar Altimetry for Polar Monitoring

A. Guillot, S. Fleury, F. Garnier, J.-C. Poisson, J. Aublanc, P. Prandi et al.

pprandi@groupcls.com



Context

- CNES supports radar altimetry for cryosphere activities,
- Started with AltiKa, as part of a coastal, hydrology and ice effort
- Now a dedicated thematic
- Address three themes:
 - Ice sheets,
 - Sea ice,
 - Ice covered ocean



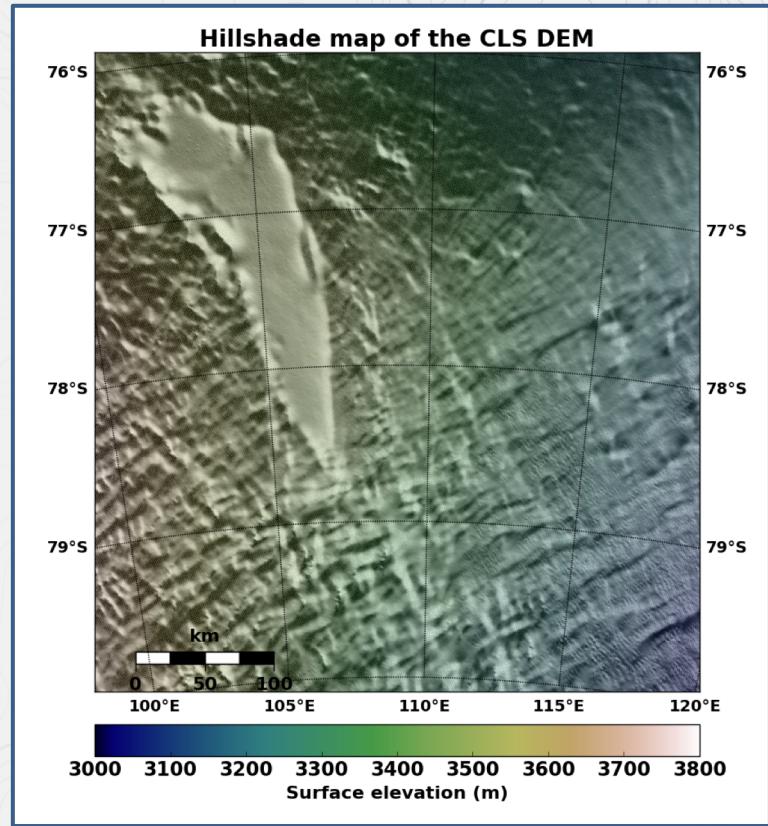
In a nutshell

- Process high resolution measurements,
- LRM (SARAL/AltiKa), and SAR (CryoSat-2 and Sentinel-3A/B)
- Covering two years from Jan 2016 to Dec 2018,
- For the Arctic Ocean sea level and freeboard, and Antarctic ice sheet
- We promote open/ice-covered ocean processing continuity

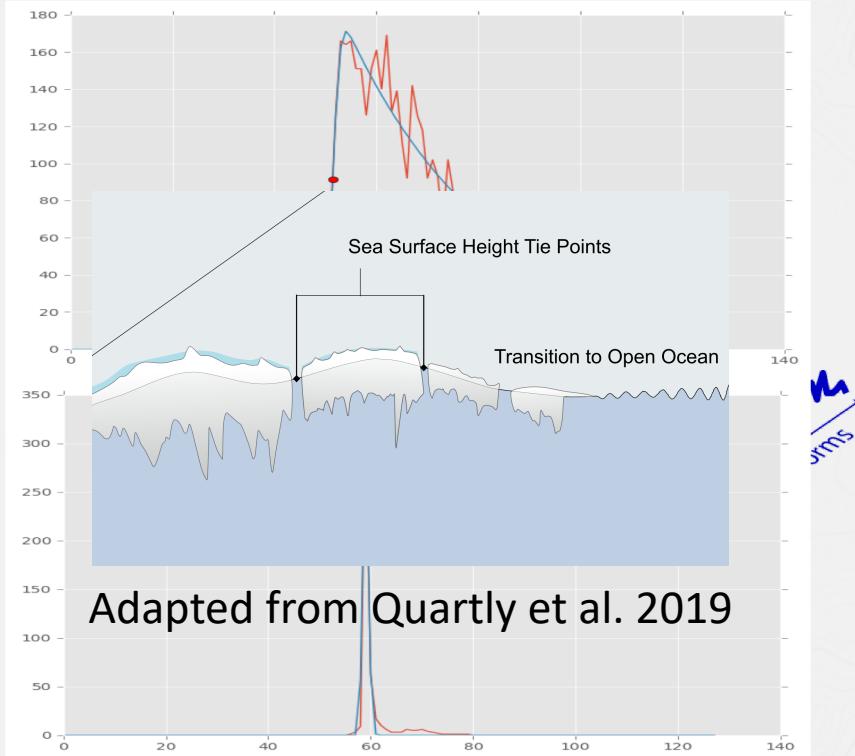


Objectives

- Sea level
 - Extend previous SARAL/AltiKa timeseries,
 - Add SAR mode data,
 - Prototype a multi-mission analysis
- Sea ice
 - Understand CLS/LEGOS differences,
 - Validate the retracking strategy,
 - Perform a sensitivity analysis,
- Ice sheets
 - Generate an Antarctica DEM using 4 altimeters,
 - Use CryoSat-2 SARIn in marginal areas



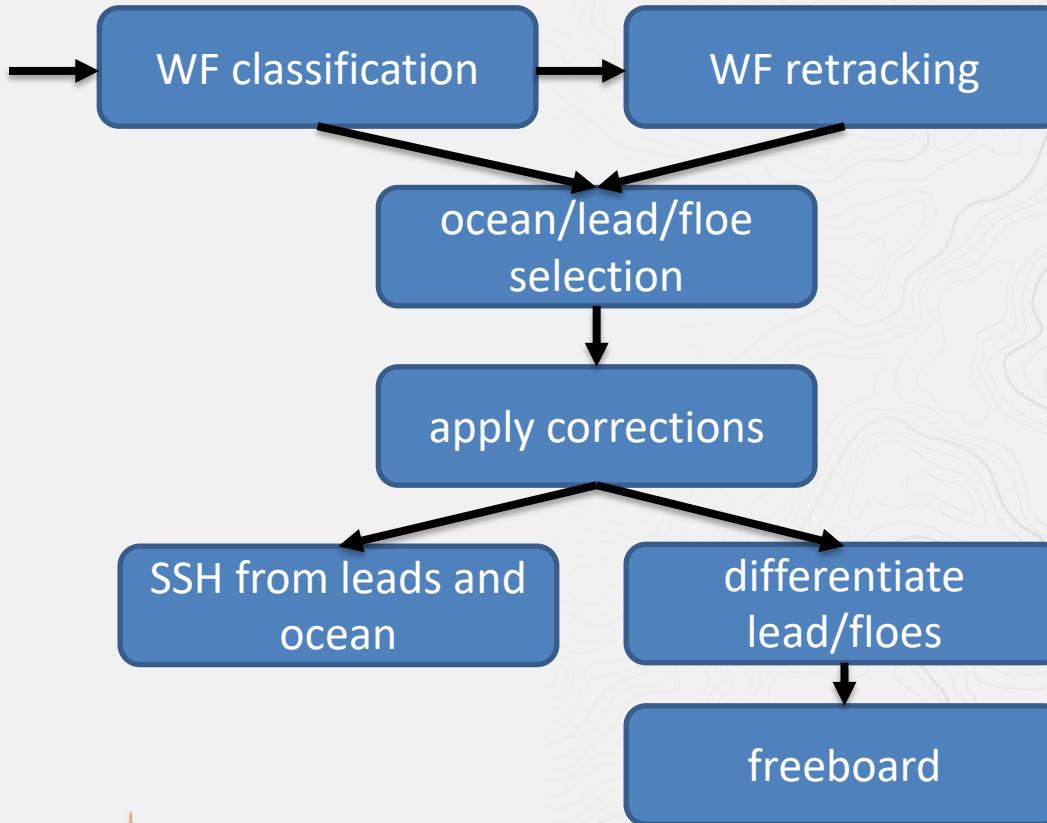
Radar Altimetry primer

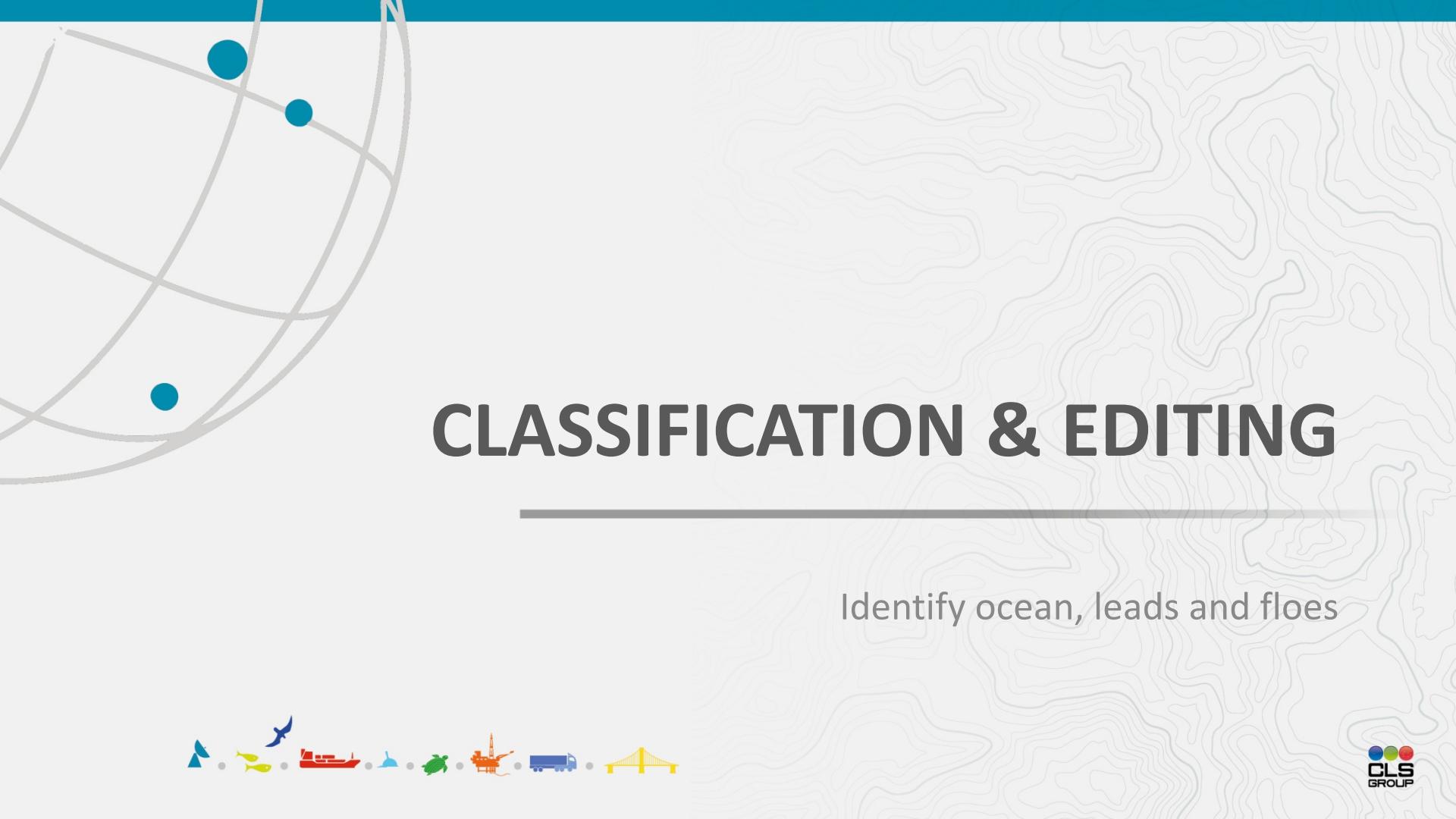


- Acquiring waveforms,
- Retracked to extract geophysical parameters
- Large variability of echo shapes over sea ice
- Identify and accurately track different returns



Processing workflow





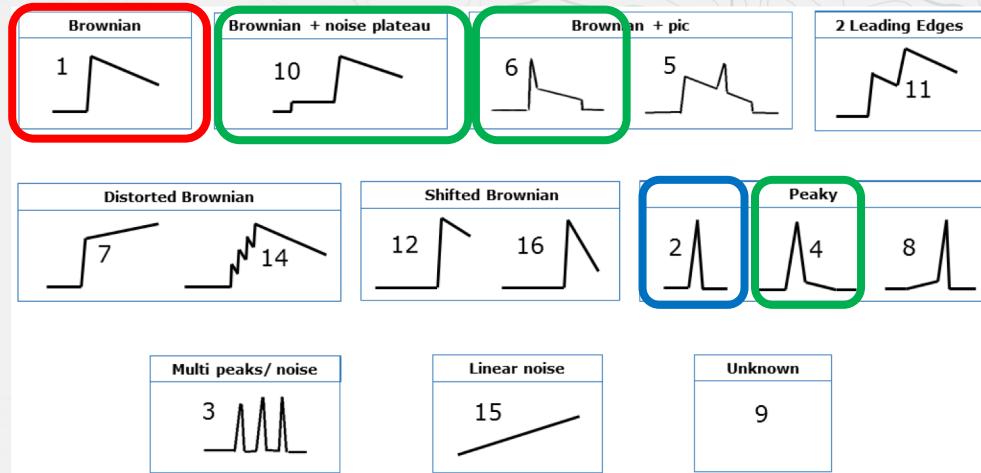
CLASSIFICATION & EDITING

Identify ocean, leads and floes



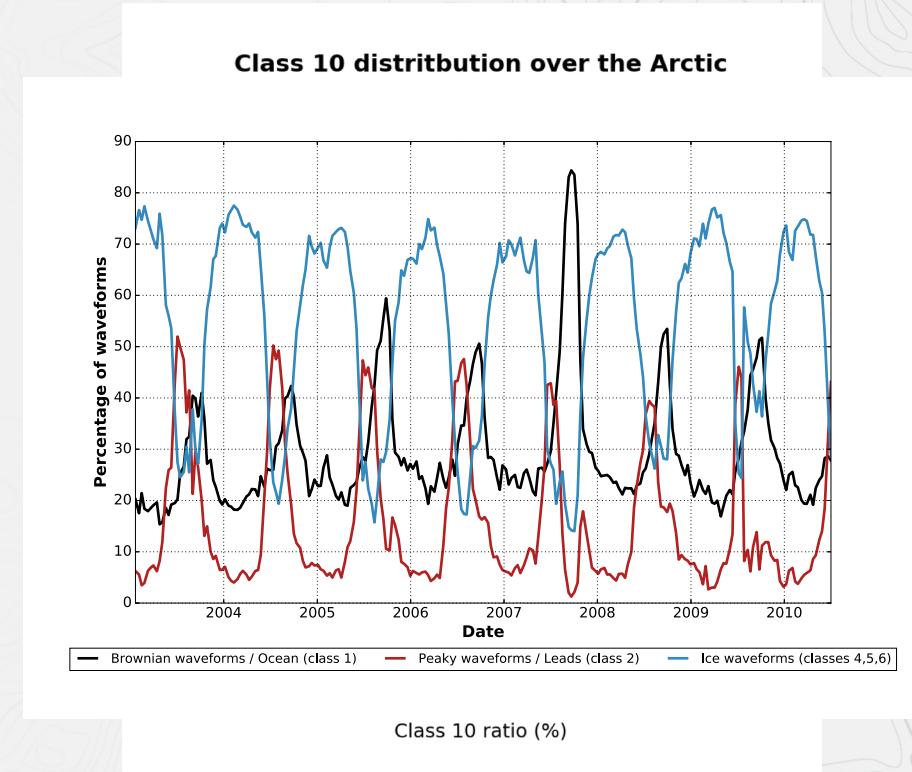
Waveform classification

- Neural net based,
- Classes are affected to
 - Open ocean,
 - Leads,
 - Floes
- With a little help from backscatter and SIC
- Alternative to pulse peakiness approaches



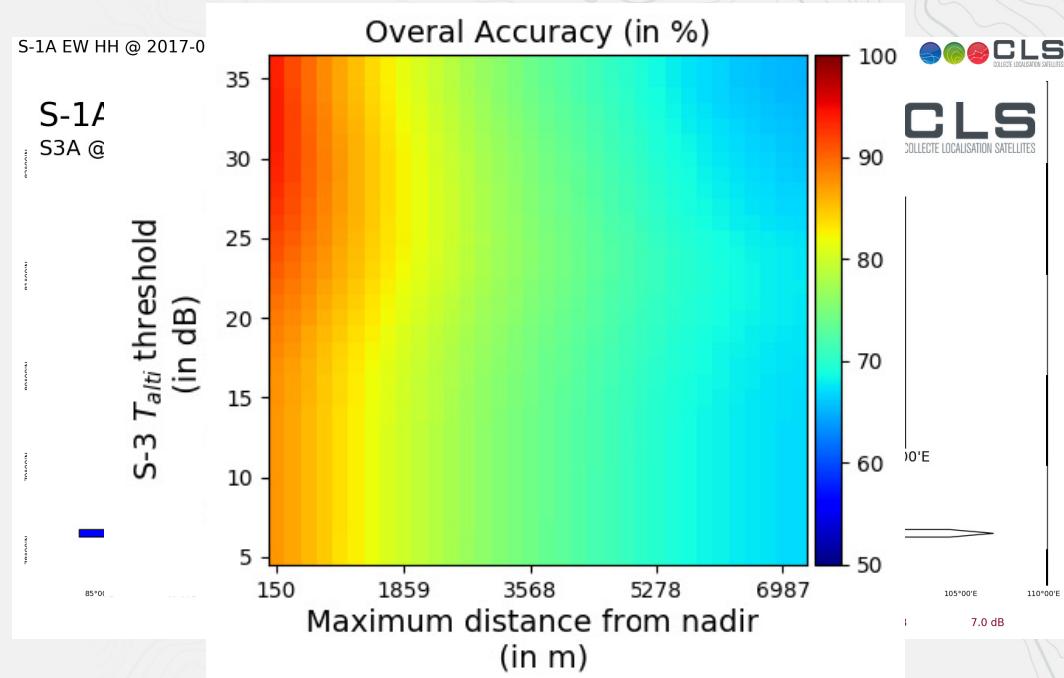
Classification validation

- We have no ground truth,
- Qualitative agreement with expected distribution,
 - In space
 - And time



Validation versus SAR images

- Lead detector on collocated S1 images,
- Compare with classification output,
- Overall accuracy is excellent,



From Longépé et al., 2019



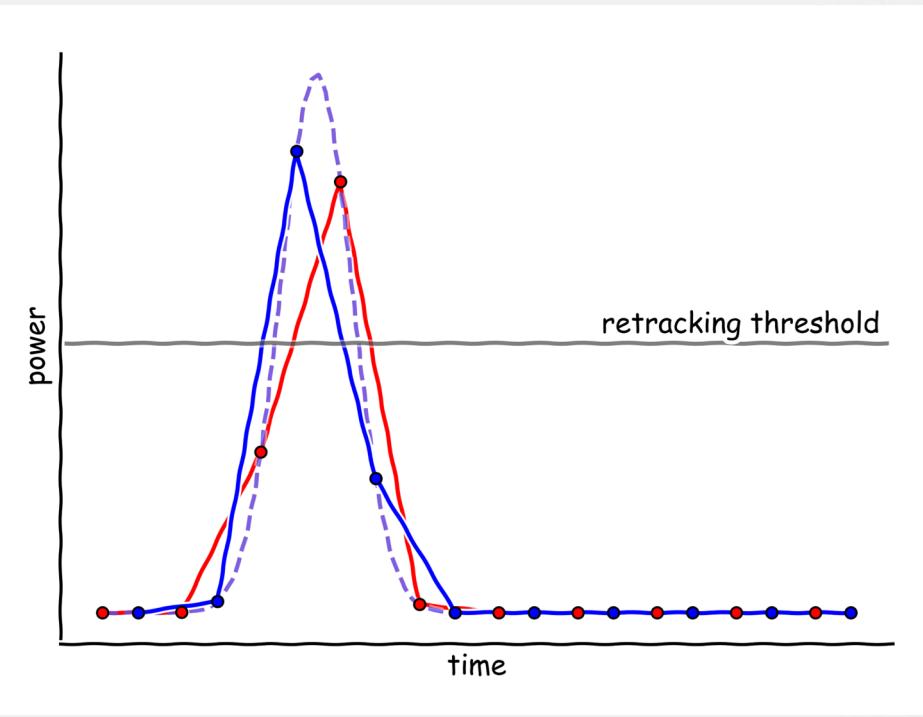


RETRACKING

Empirical vs physical retrackers



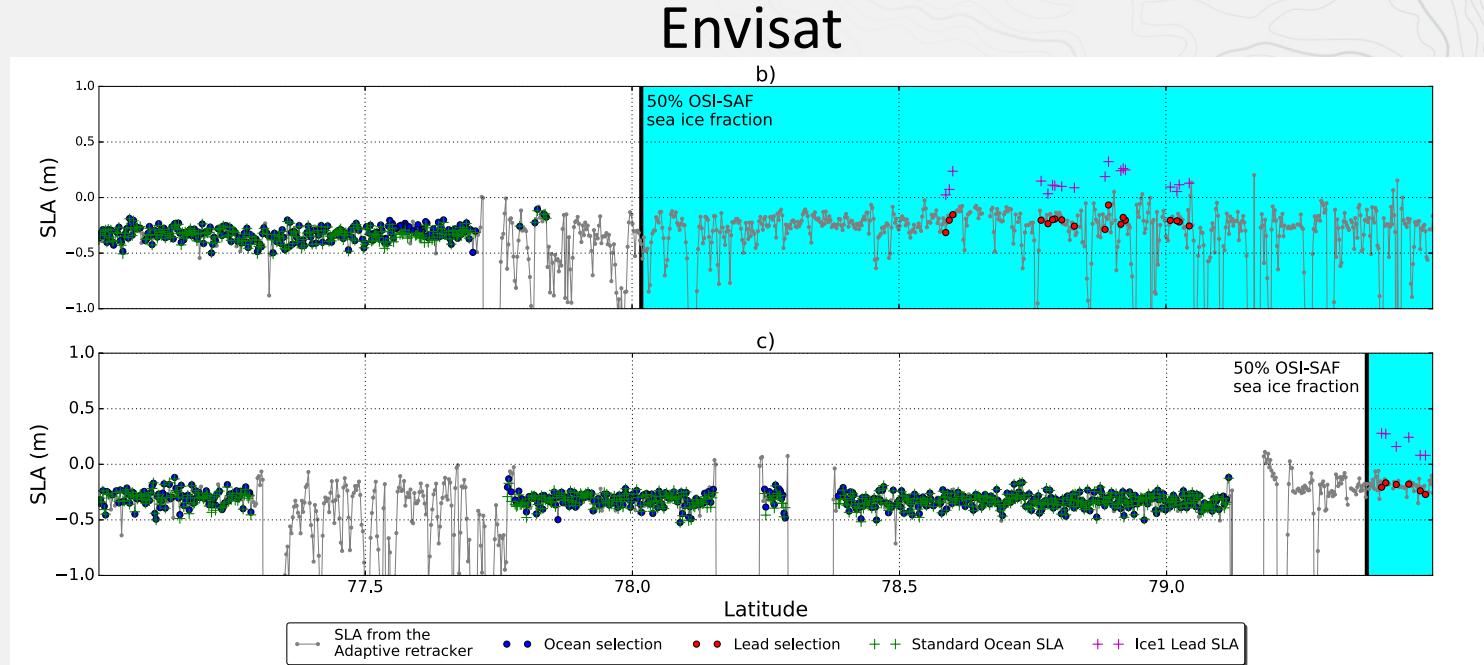
Physical vs empirical retracking



- Threshold retracking sensitive,
- Need to link it to open ocean,
- Adaptive retracker (Poisson et al. 2018)
 - Fits physical model,
 - Solves for surface roughness,



Why is a unique retracker important ?

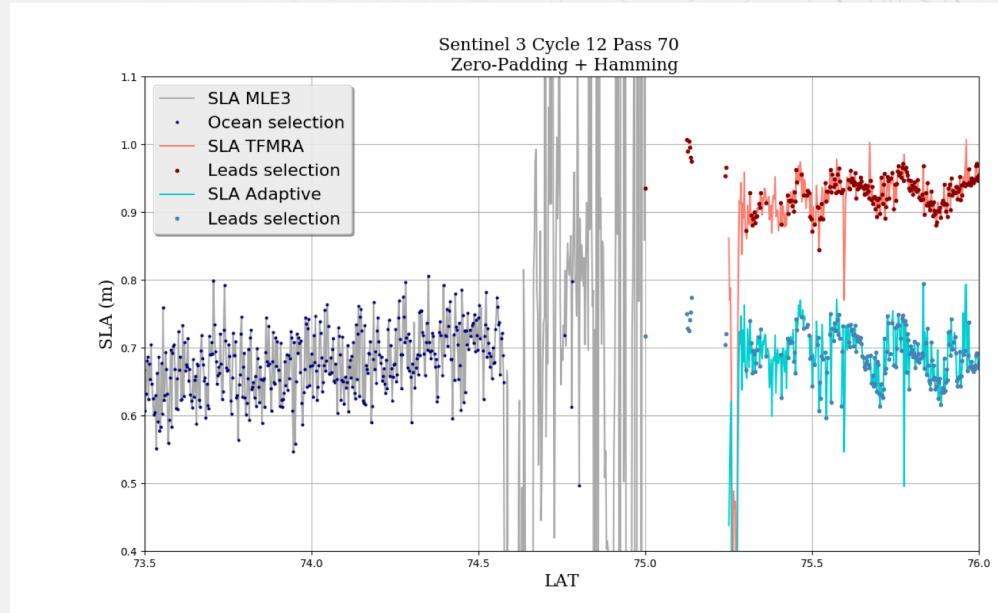


From Poisson *et al.*, 2018



Why is a unique retracker important ?

- Not yet possible at the regional scale,
- Fallback to an empirical retraker



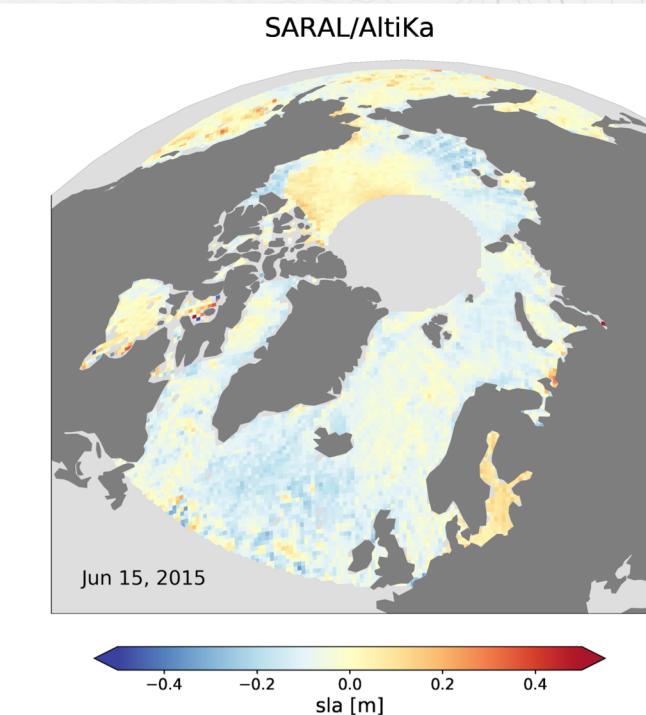


SEA LEVEL

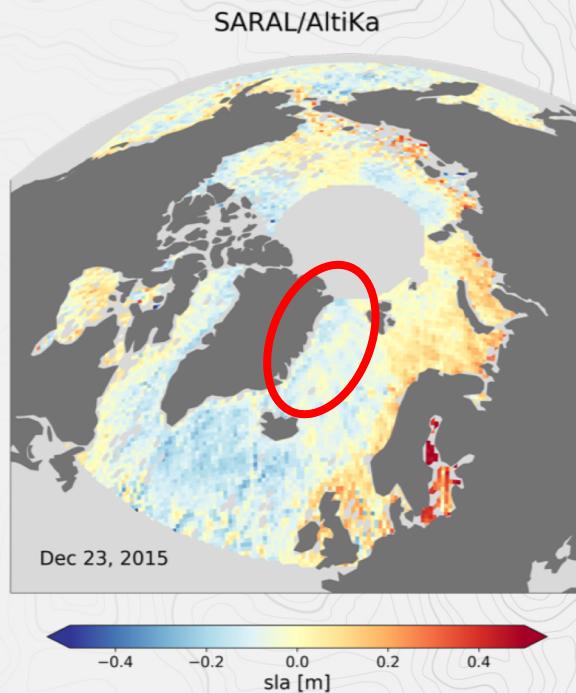
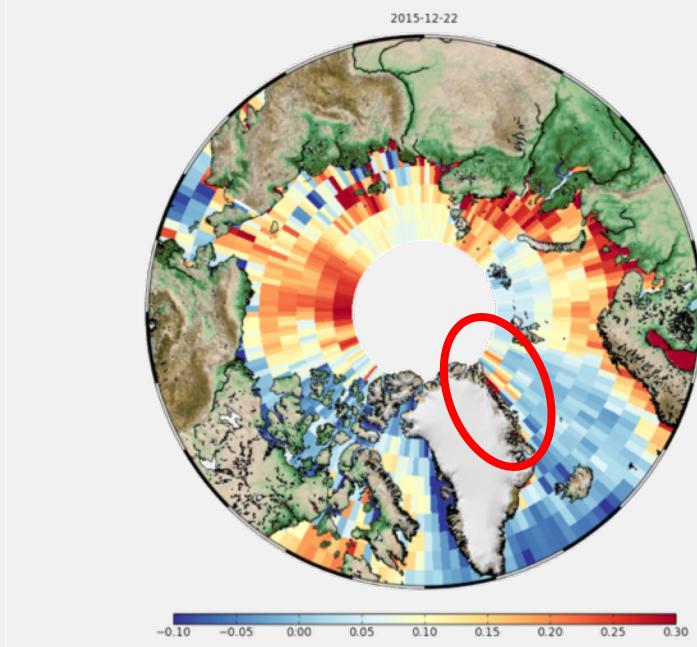


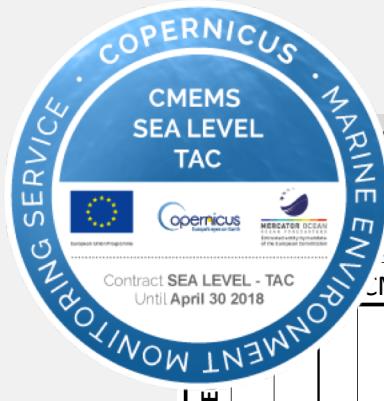
First sea level extractions

- Currently only SARAL/AltiKa
- Mono-mission,
- EASE2 grid,
- Monthly resolution,
- C2 and S3A are on the way
- Multi-mission will be next
 - M. Auger's talk



First results on SARAL/AltiKa





CMEMS Roadmap

DRAFT

version au 02/05/2019

JACS-HR & Transition Ops – Planning

Timeline Legend:

- L2EHR upgrades**: Orange triangle
- Demo Samples**: Green triangle
- Transfert to Ops**: Blue triangle
- Ops**: Blue triangle with a vertical line

Region	Month	Task
CMEMS/SL	June 2019	Upgrades L2EHR OceanV2
	September 2019	Sample L3 Natl V2
	December 2019	Dev L2p NRT/DT V1 (J3/S3A/S3B/H2B?)
	January 2020	Dev NRT/DT 5Hz V1 (J3/S3A/S3B/H2B?)
	February 2020	Upgrades L2EHR OceanV3
L3 5Hz E	March 2020	EIS L2p NRT
	September 2020	Sample L3 Natl V3
	October 2020	EIS EUR L3 5Hz NRT
	April 2021	EIS EUR L3 5Hz DT
	May 2021	EIS EUR L3 5Hz DT
L4 Arctic/Leads	July 2019	Upgrades L2EHR LeadsArcV1
	September 2019	Sample L4 monomiss Leads V1
	December 2019	Ext LeadsArcV1
	January 2020	Upgrades L2EHR LeadsArcV2
	February 2020	Sample L4 multimiss Leads V1
L4 Antartique (These M Augier)	March 2020	Dev L4 DT V1 (S3A/S3B/C2/H2B?)
	September 2020	Sample L4 Leads V2
	October 2020	EIS L4 V1 DT
	April 2021	L2EHR upgrades
	May 2021	Demo Samples
ESA R&D => CMEMS/\$L	July 2019	Upgrades L2EHR LeadsAntarcV1
	September 2019	Ext LeadsAntarcV1
	December 2019	Sample L4 Antarc Leads V1
	January 2020	Upgrades L2EHR OceanV3_BS
	February 2020	Delivery L3 HR Black Sea C2 + S3A
L3 5Hz Black SEA	March 2020	?? dev Black Sea ??
	September 2020	?? dev Black Sea ??

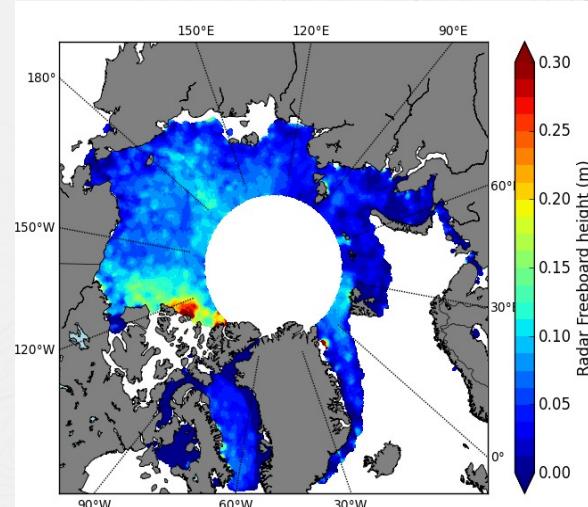
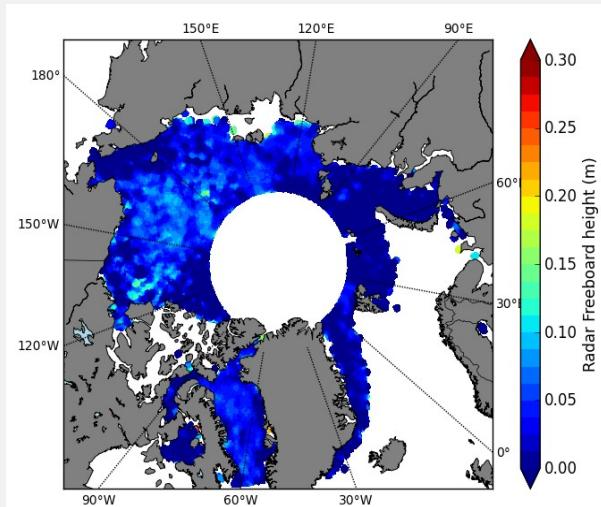


SEA ICE FREEBOARD



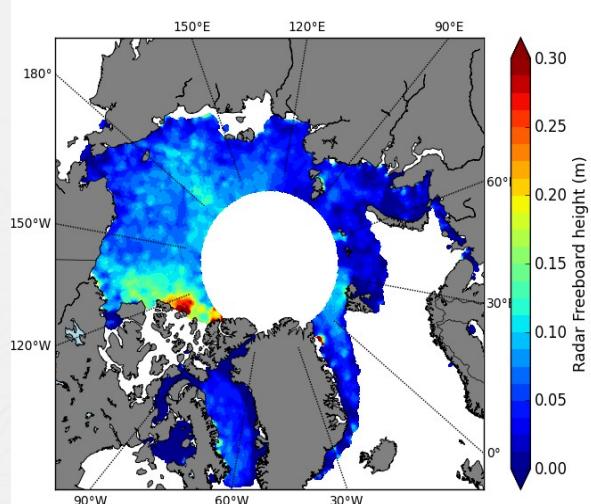
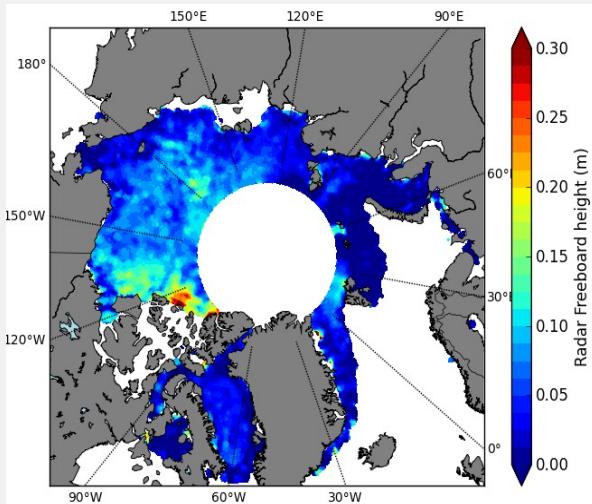
Comparing two solutions

- Underestimation problem on CLS side,
- Comprehensive sensitivity analysis performed by LEGOS



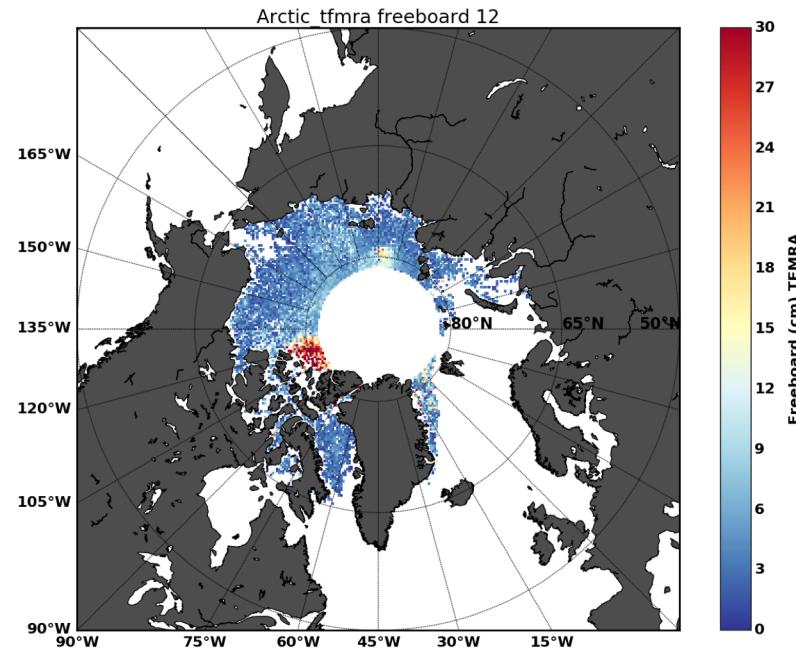
Sensitivity analysis

- Differences mainly are explained by
 - Floe classification,
 - Interpolation scheme,



Freeboard estimates

- SARAL/AltiKa is routinely processed
- On going C2 PDGS and S3-A data,
- Can we merge sea ice info from different altimeters ?



Conclusions

- CNES supports the use of radar altimeter for polar monitoring,
- We are data rich: 4 altimeters are currently flying up to 81.5°
 - Fine inter-calibration opportunity,
 - Refine the time/space resolution of products,
 - Ka-band measurements for preparation of future missions
- Processing consistency is mandatory, as is an uncertainty analysis,
- Arctic sea level will go into CMEMS operations in 2020,
 - Now is the time express needs

