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

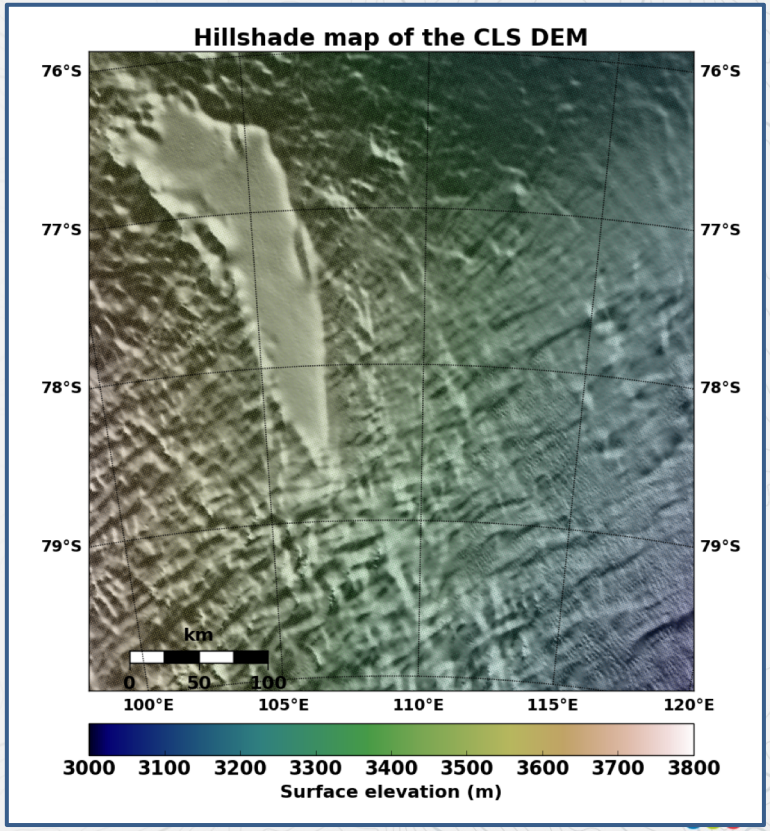
- Process high resolution measurements,
- LRM (SARAL/AltiKa), and SAR (CryoSat-2 and Sentinel-3A/B)
- Covering two years from Jan 2016 to Dec 2018,
- For the Arctic Ocean sea level and freeboard, and Antarctic ice sheet

- We promote open/ice-covered ocean processing continuity

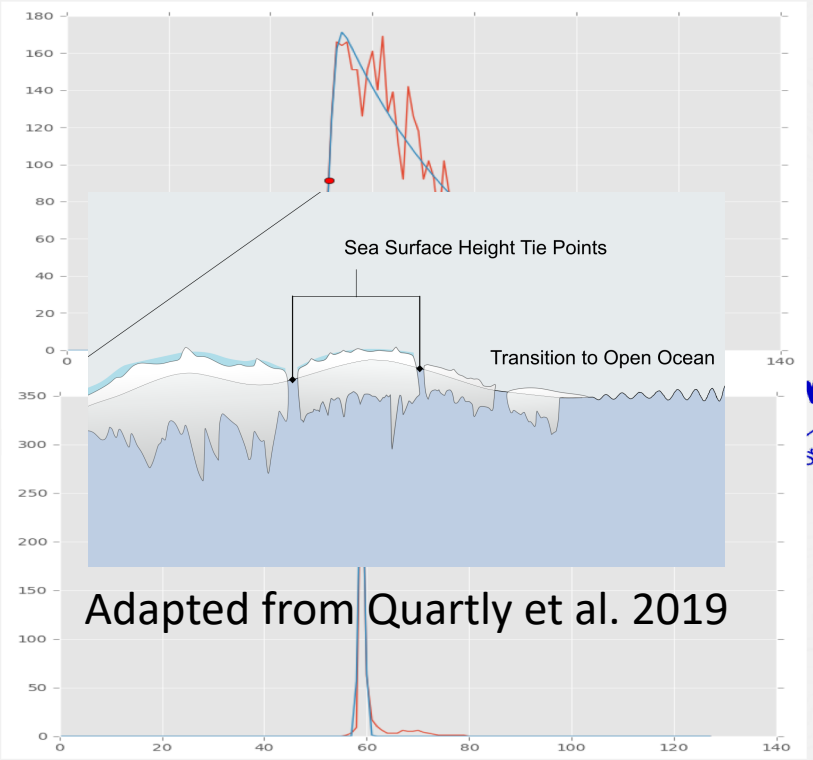
CLS GROUP

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

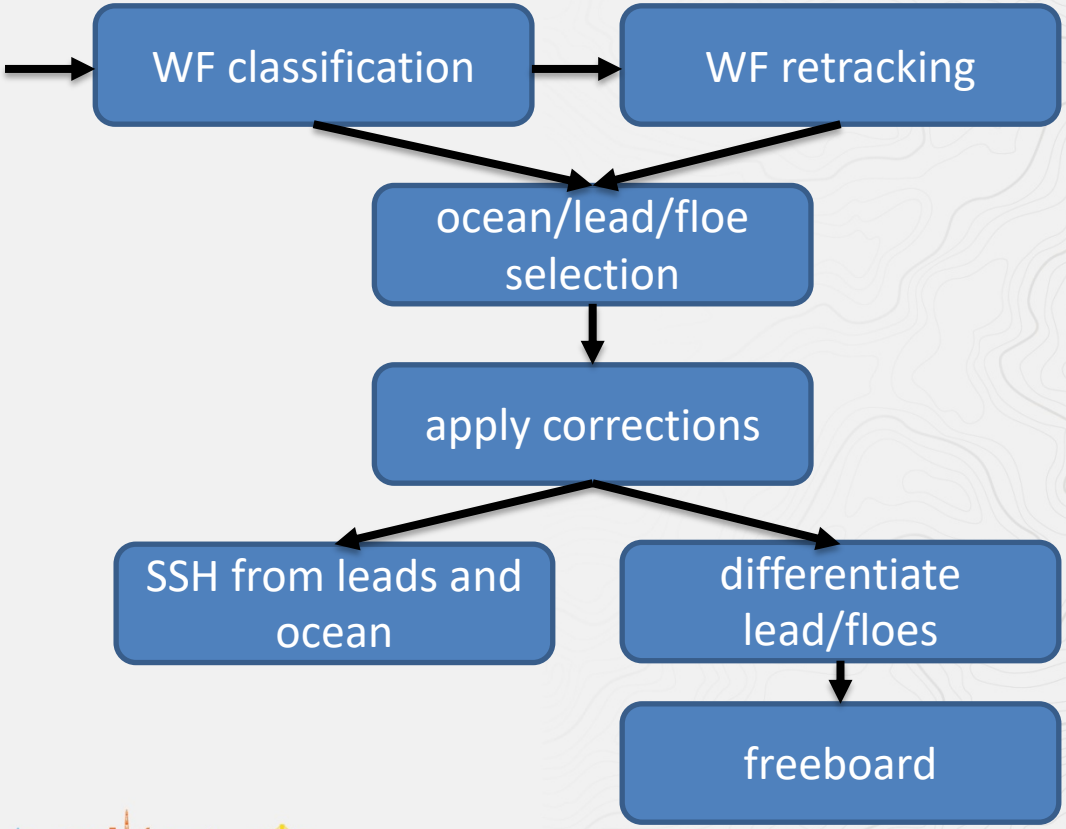


Radar Altimetry primer



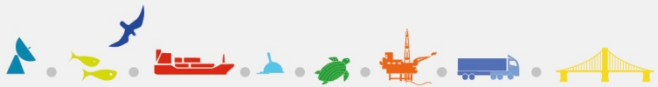
- Acquiring waveforms,
- Retracked to extract geophysical parameters
- Large variability of echo shapes over sea ice
- Identify and accurately track different returns

Processing workflow



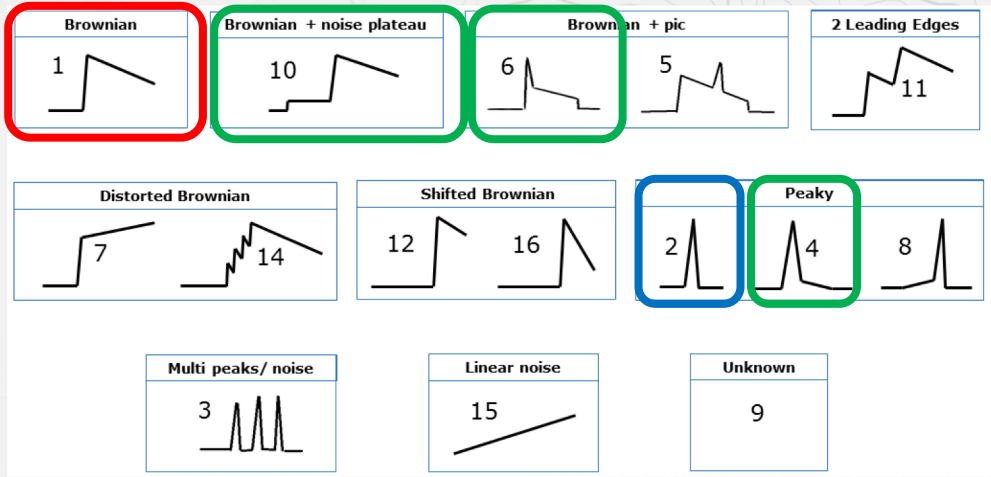
CLASSIFICATION & EDITING

Identify ocean, leads and floes



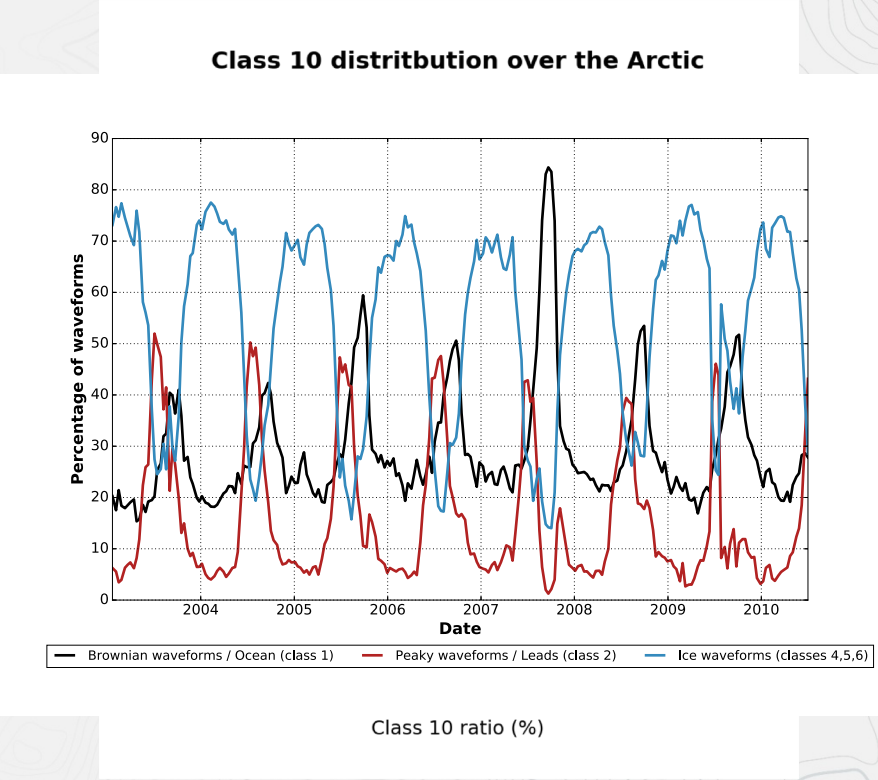
Waveform classification

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



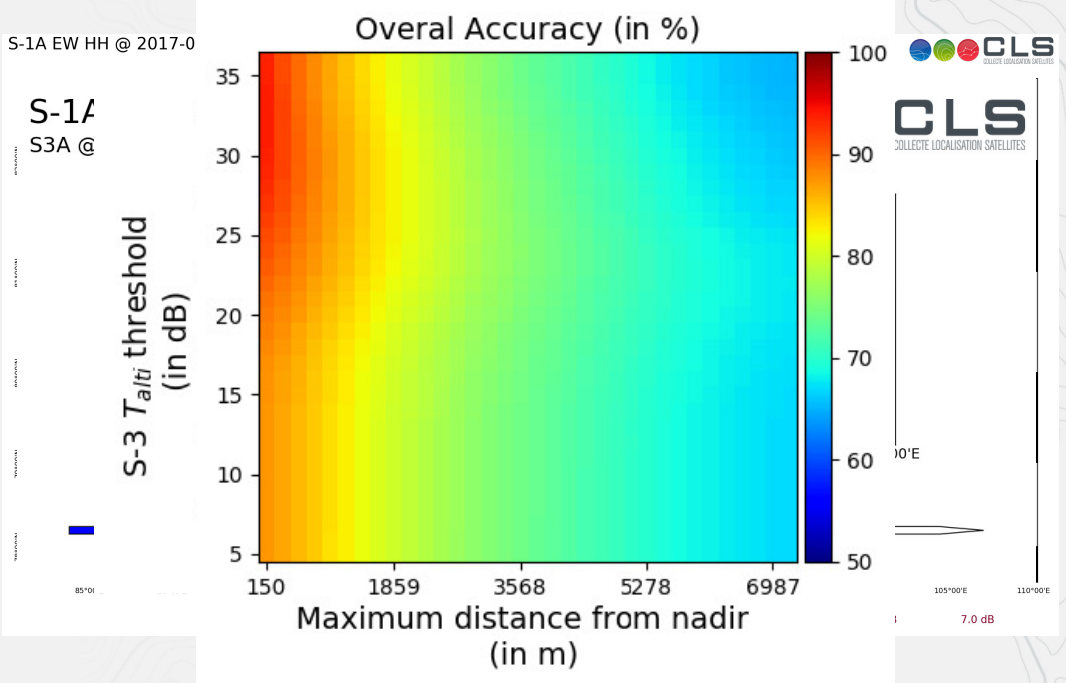
Classification validation

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



Validation versus SAR images

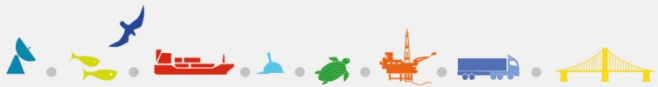
- Lead detector on collocated S1 images,
- Compare with classification output,
- Overall accuracy is excellent,



From Longépé et al., 2019

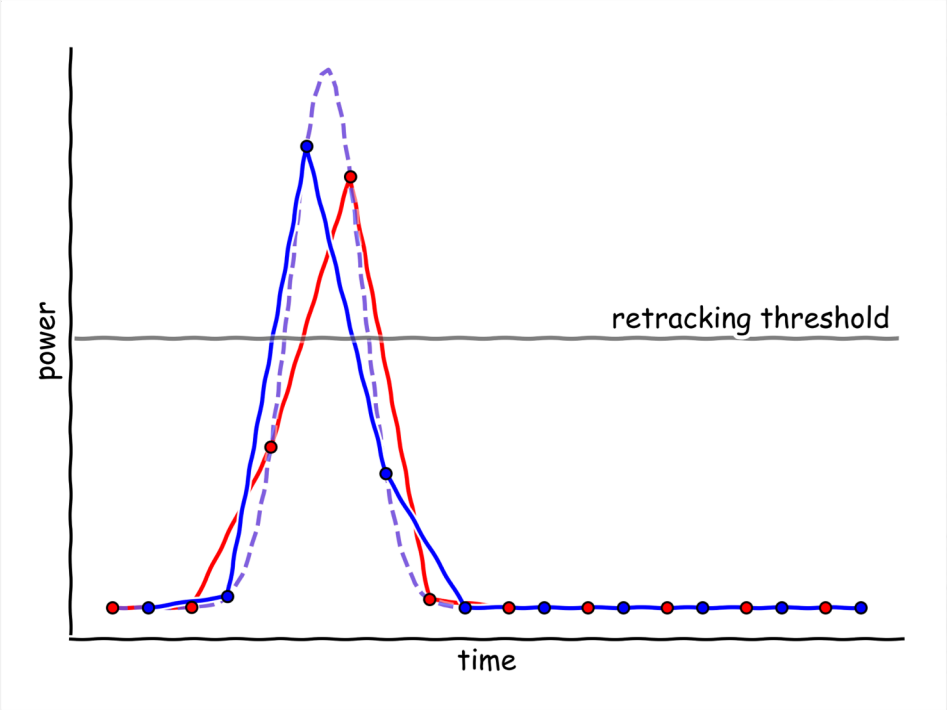
RETRACKING

Empirical vs physical retrackers



CLS GROUP

Physical vs empirical retracking

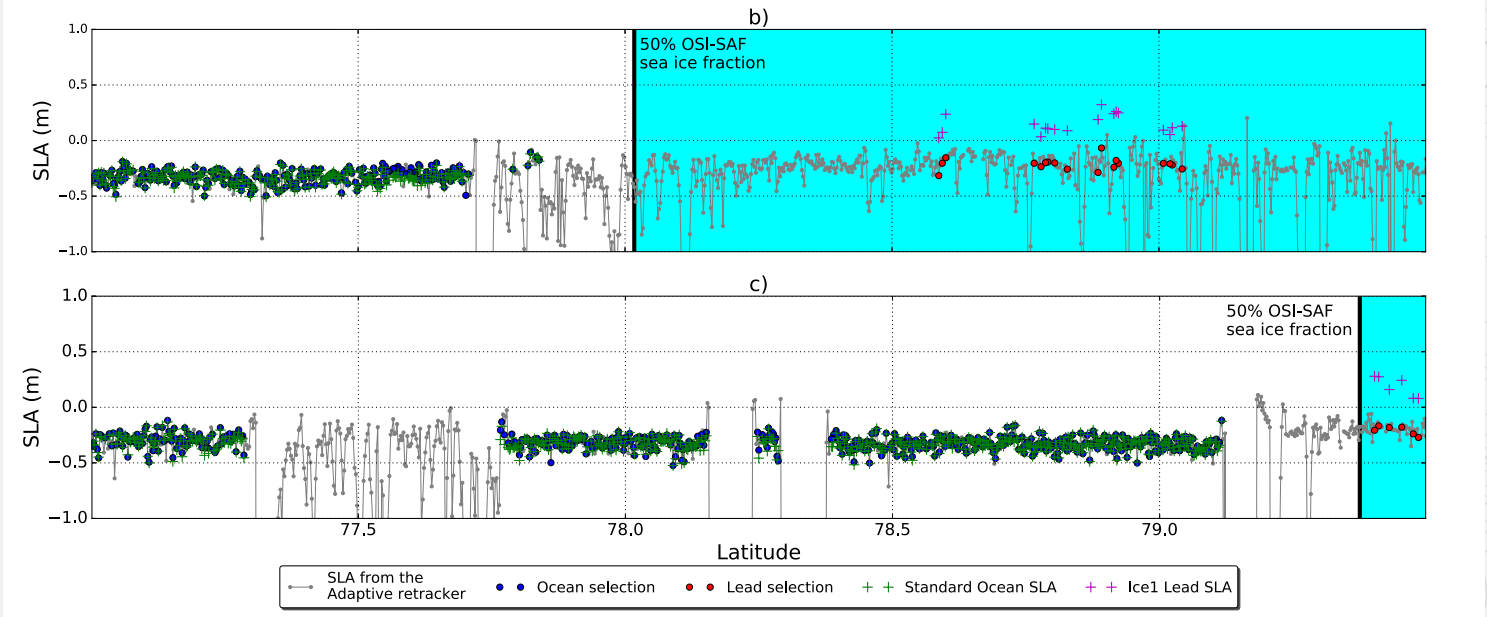


- Threshold retracking sensitive,
- Need to link it to open ocean,

- Adaptive retracker (Poisson et al. 2018)
  - Fits physical model,
  - Solves for surface roughness,

Why is a unique retracker important ?

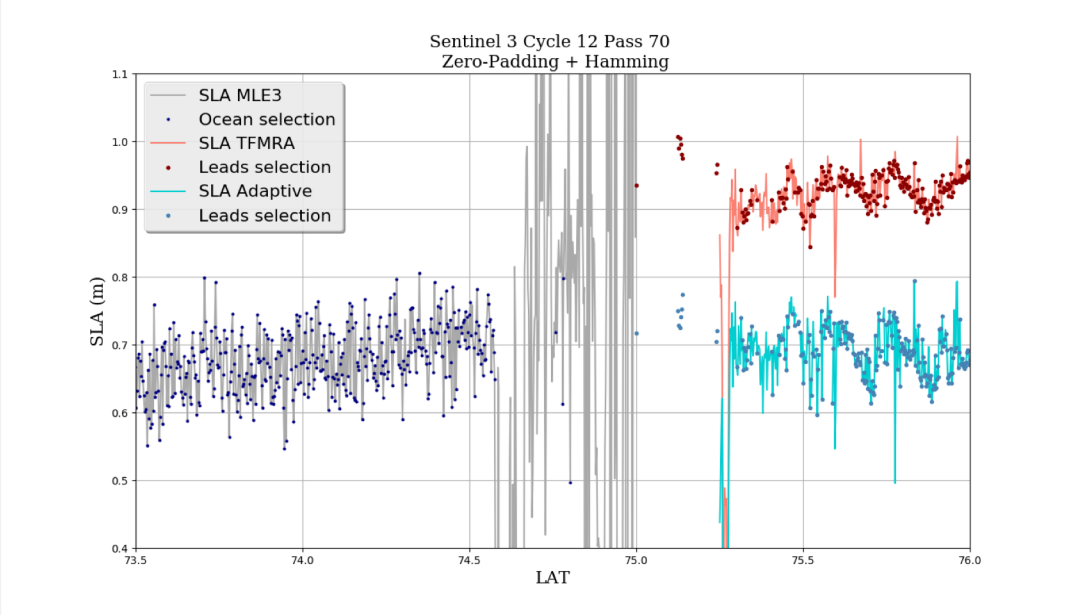
Envisat



From Poisson *et al.*, 2018

Why is a unique retracker important ?

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

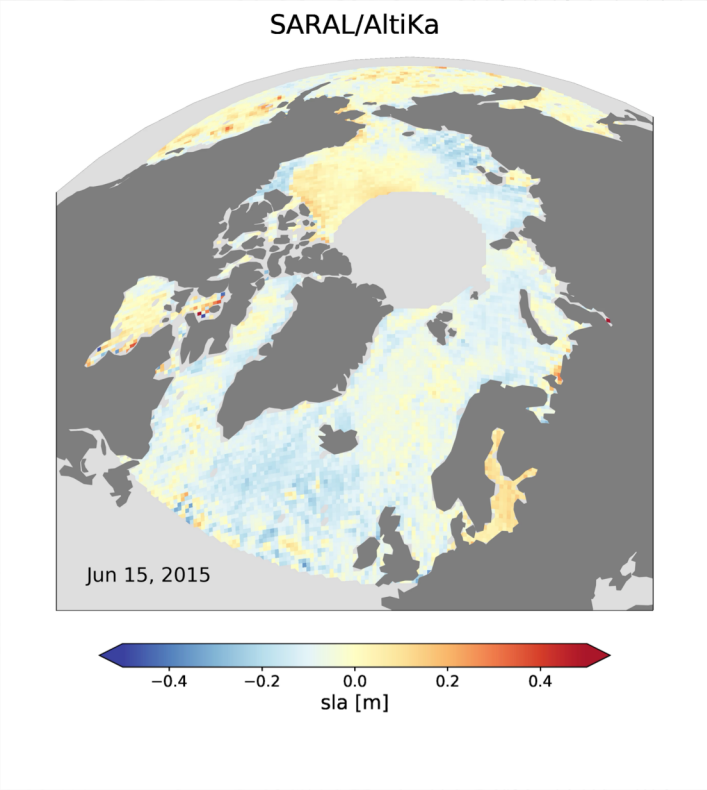


SEA LEVEL

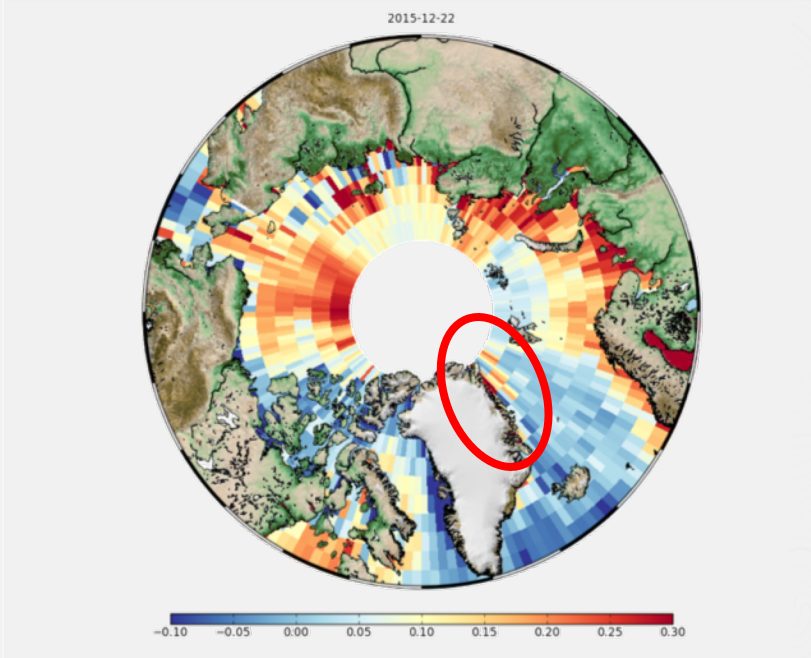
First sea level extractions

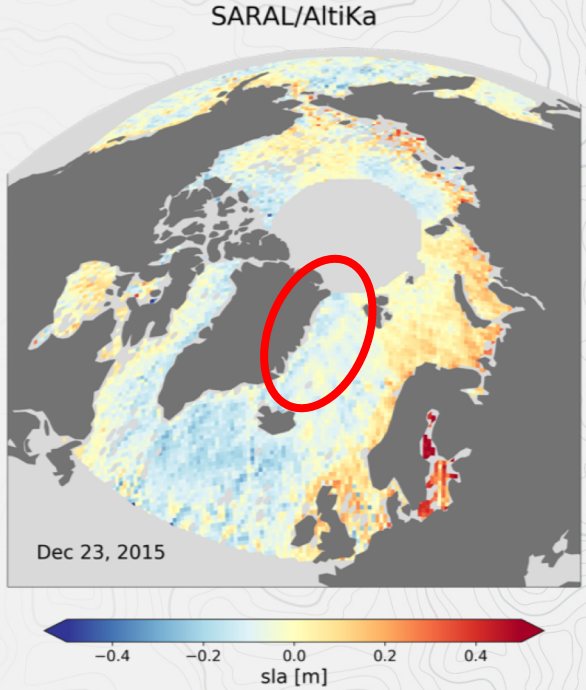
- Currently only SARAL/AltiKa
- Mono-mission,
- EASE2 grid,
- Monthly resolution,

- C2 and S3A are on the way
- Multi-mission will be next
  - M. Auger's talk

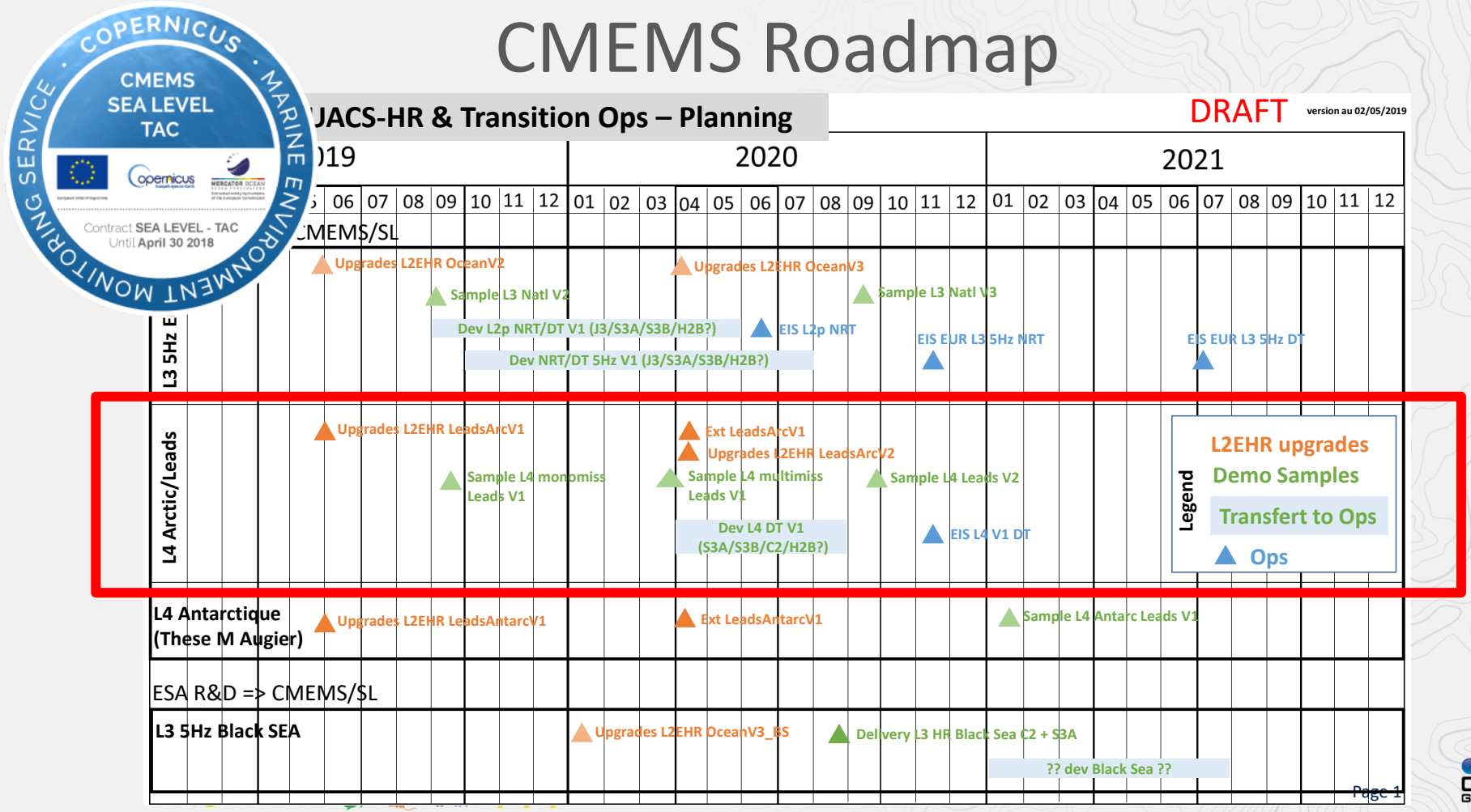


First results on SARAL/AltiKa





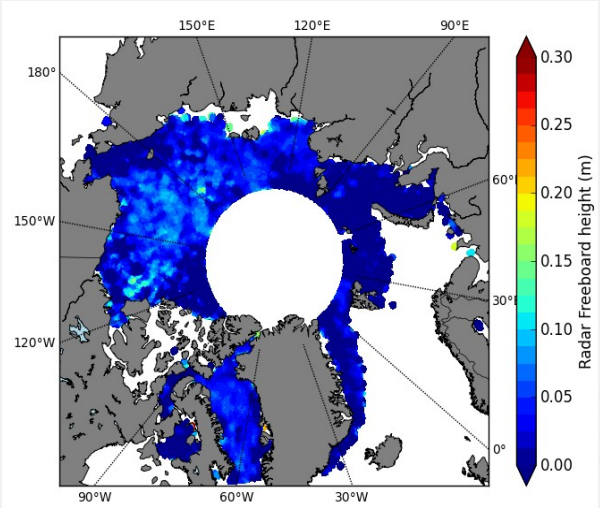
CMEMS Roadmap

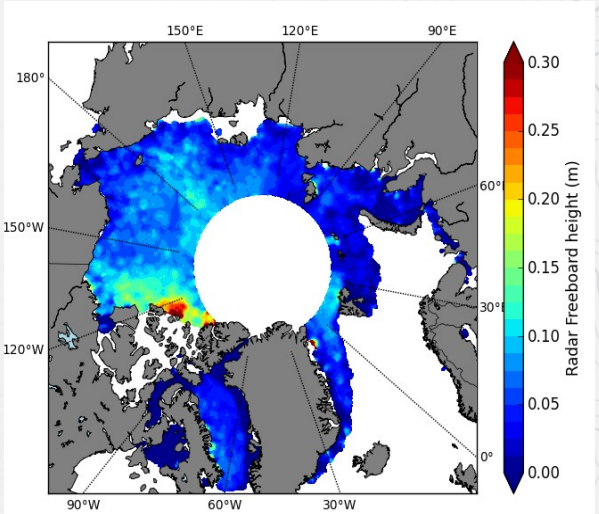


SEA ICE FREEBOARD

Comparing two solutions

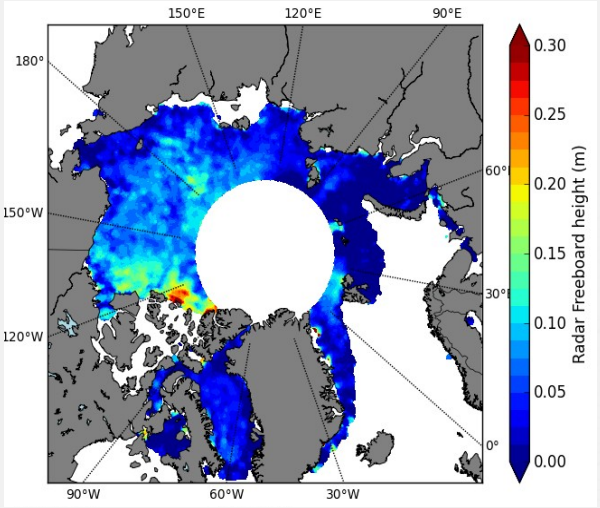
- Underestimation problem on CLS side,
- Comprehensive sensitivity analysis performed by LEGOS

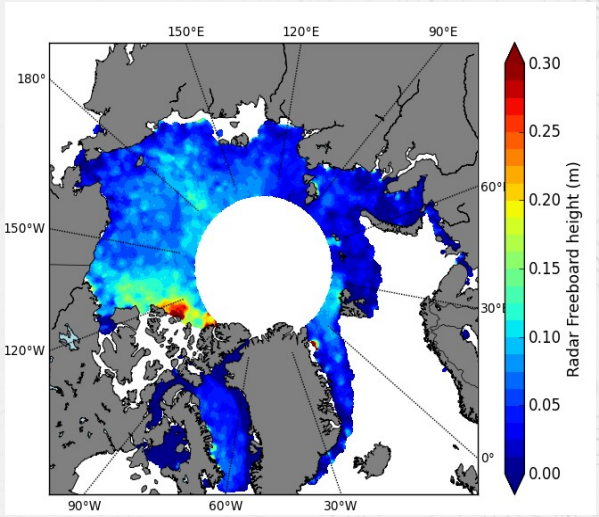




Sensitivity analysis

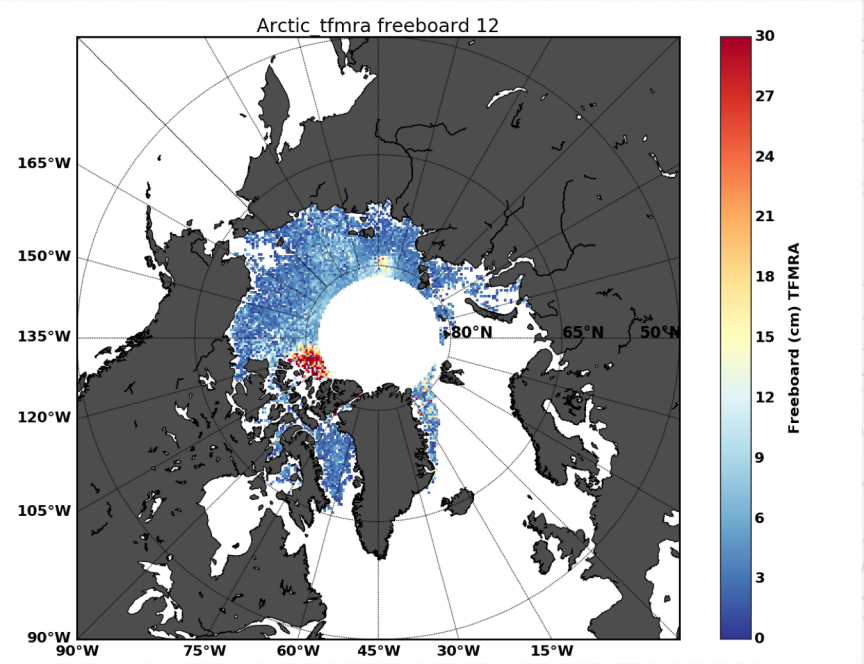
- Differences mainly are explained by
  - Floe classification,
  - Interpolation scheme,





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