SEA LEVEL CONTINUITY BETWEEN OPEN OCEAN AND SEA ICE REGIONS IN THE ARCTIC: LRM PROCESSING SOLUTIONS

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SARAL/AltiKa processing has been developed in the frame of the **PEACHI** project

ENVISAT/RA-2 processing has been developed in the frame of the **sea level CCI** project

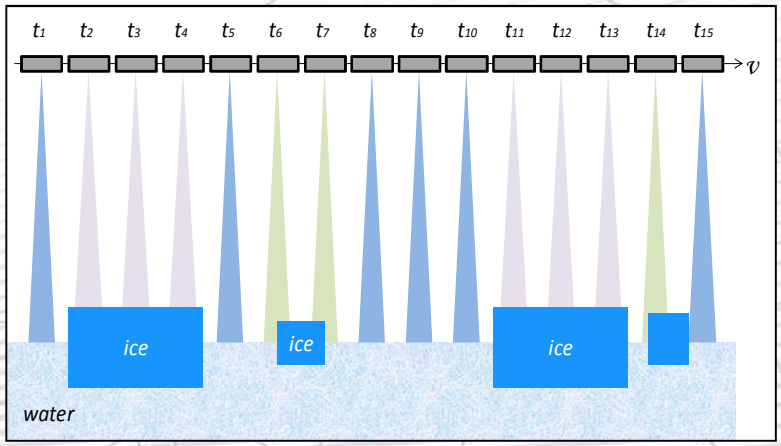
Context, existing and new processing solution

- The Arctic Ocean is an important component of the climate system whose exact influence on the global ocean circulation is still poorly understood today.

- Sea Ice regions are very complex for radar altimeter because different types of surfaces (water, sea ice, etc ..) are mixed in the altimeter footprint and the observed surface evolves rapidly with time.

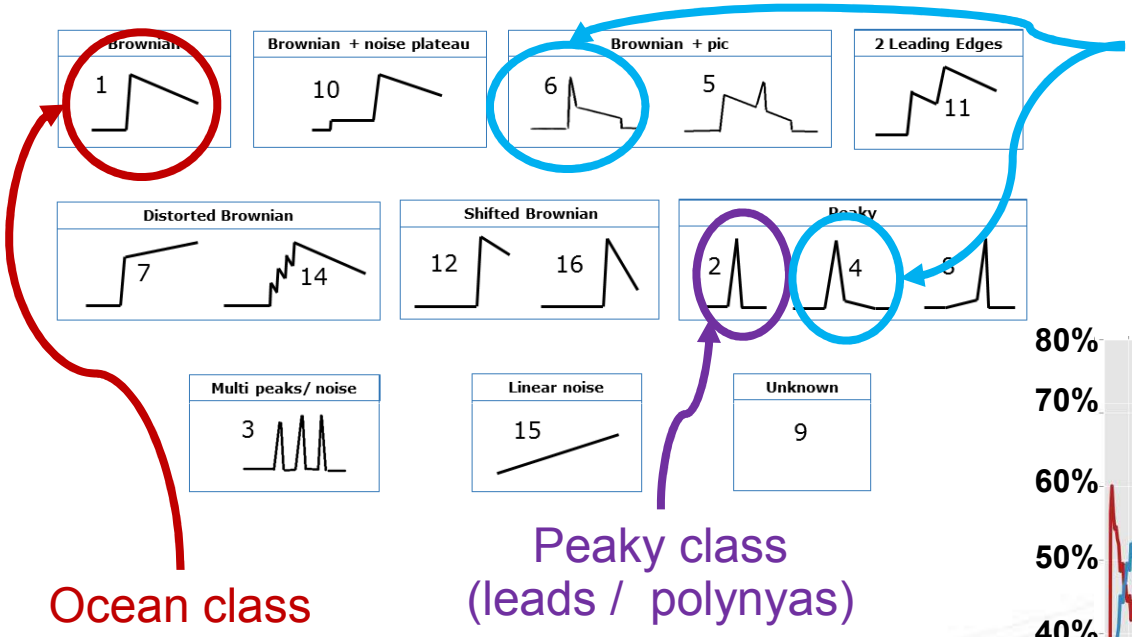
➢ The principle used here consists in identifying cracks in the sea ice (leads/polynyas) where the sea level can be estimated through the exploitation of the returned altimeter echo.

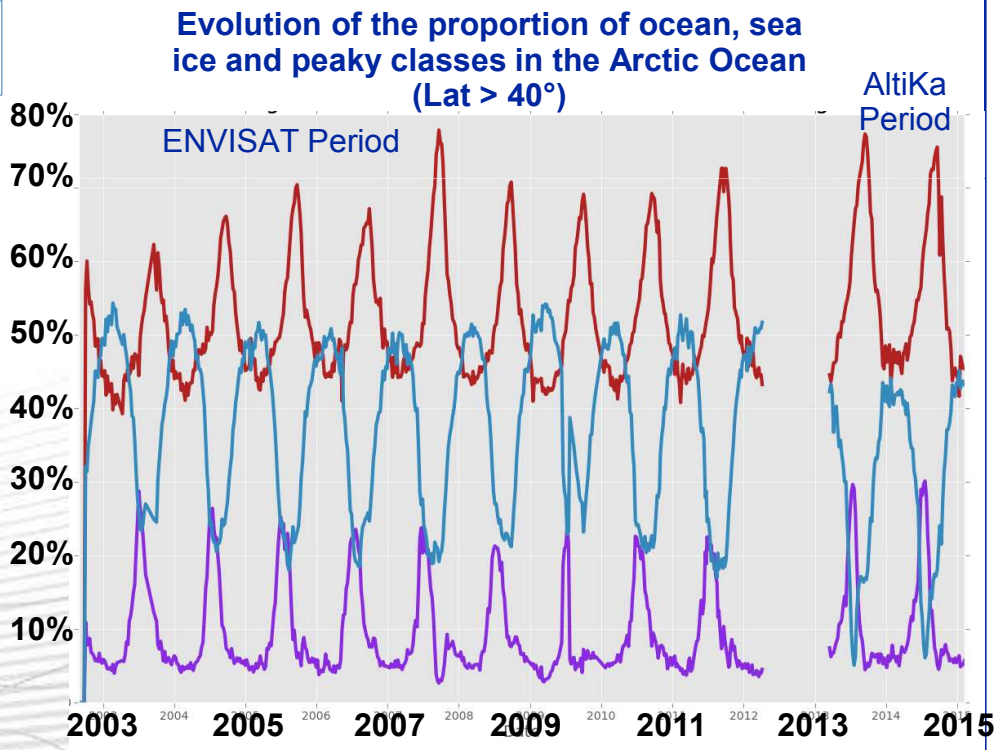
➢ We propose a new classification method and a new retracker to ensure performance and continuity of sea level estimates with the ocean.



Measurement selection

- We have developed a **waveform classification** based on a **neural network approach** in order to classify every single waveform from **AltiKa** and **RA-2 independently** of the **mission** and the **radar frequency**.



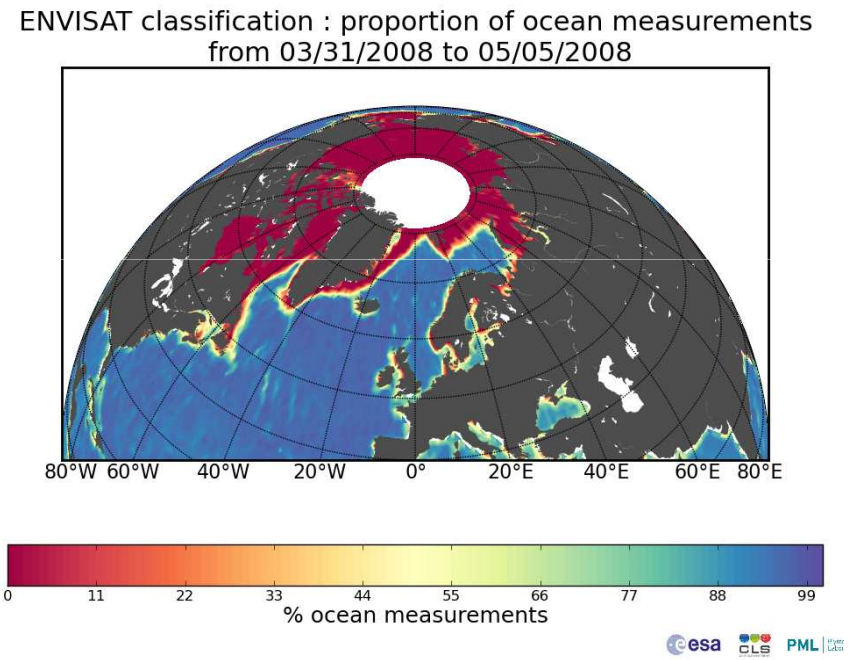


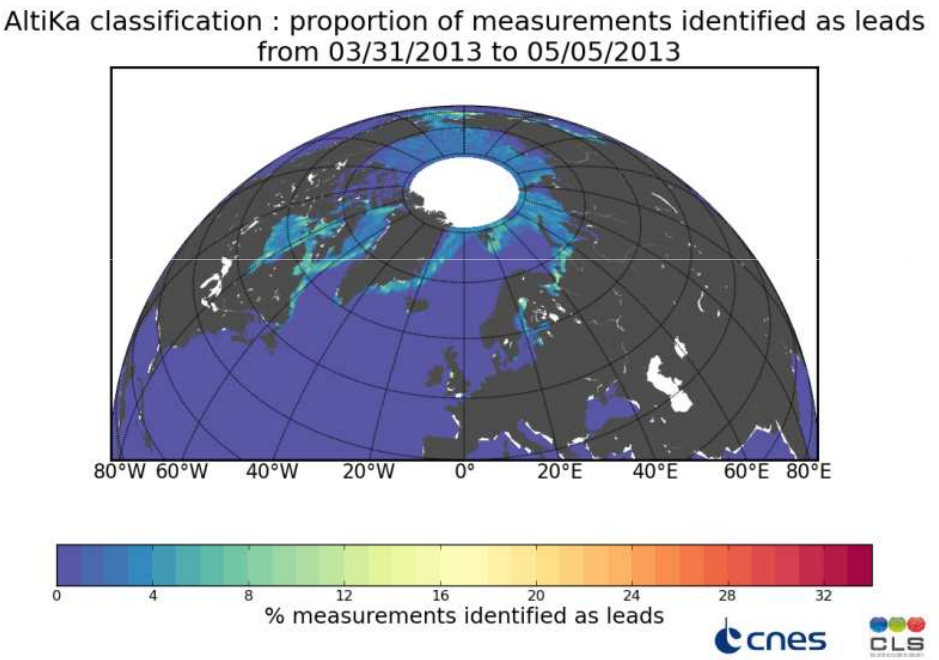
- The evolution over time of the proportion of these classes shows :
  - Consistent sea ice coverage
  - Strong increase of the lead number during the melting period

Measurement selection

- In the **RA-2 processing**, **PML** has worked on a classifier combining **criteria on several parameters** such as the pulse peakiness, σ_0, the leading edge slope, etc …

  ➔ RA-2 measurements are selected **through the combination of both classifiers**.

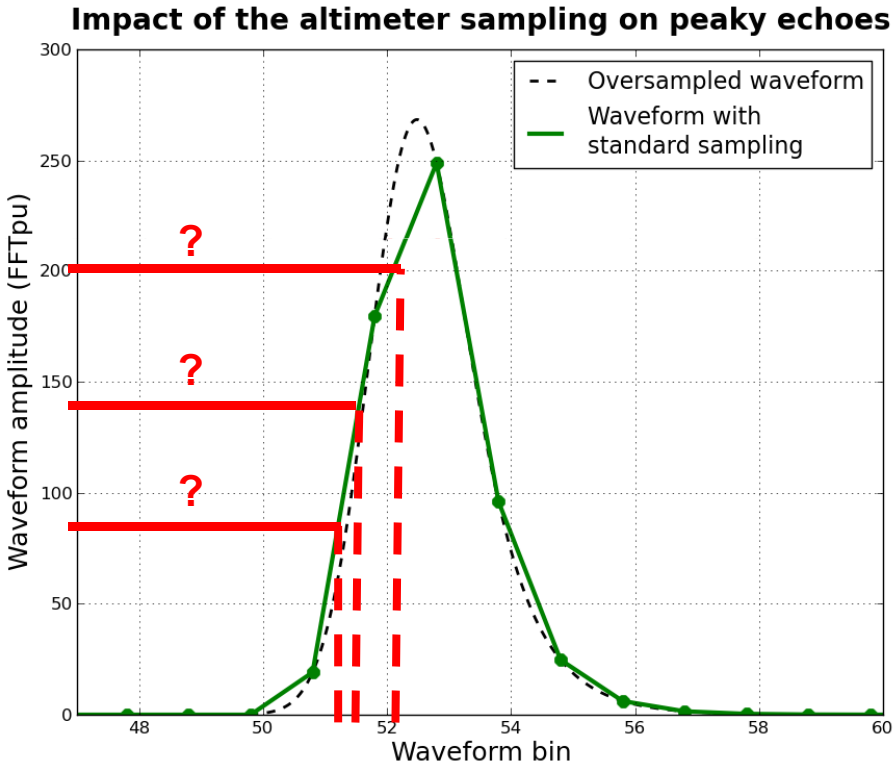




Retracking lead waveforms

- A big issue in **lead waveform processing** is the limitation of the WF sampling
  - 3.125 ns ~47 cm for ENVISAT/RA-2
  - 2.083 ns ~31 cm for SARAL/AltiKa

➢ **Poor sampling for peaky waveform processing !!**



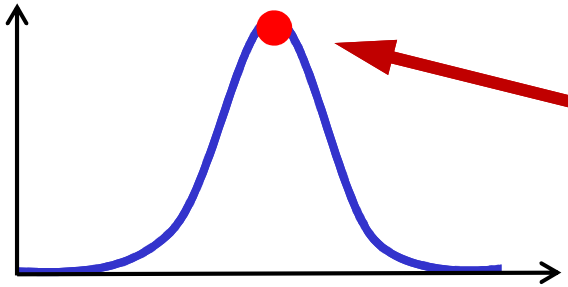
- **The waveform shape depends on the tracker positioning**
- **Threshold retrackers (Ice1, Sealce) are usually used on peaky waveforms…**

  … But are not adapted and relevant to process peaky waveforms
  (which threshold corresponds to the surface level ? Open ocean continuity ? Directly impact by the waveform shape…)

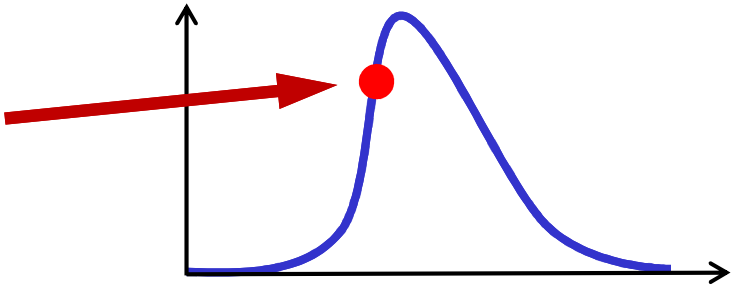
➢ **A model is needed**

Retracking lead waveforms

- Is a **Gaussian function** appropriate to describe a **lead waveform** ?



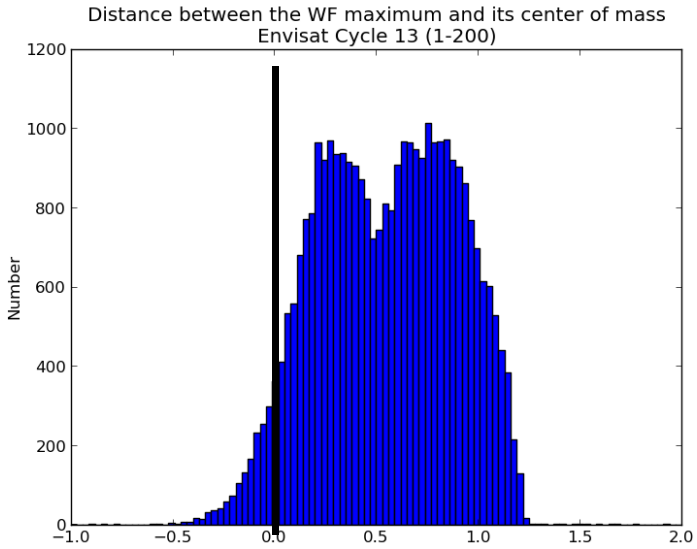
Surface level



Reflected waveform
from a specular surface

Reflected waveform
from a rough surface

- For peaky echoes identified as leads, the COG of the waveform is located after its maximum value
  - Lead waveforms have an asymmetrical shape
  - Leads have a rough surface
  - The Brown conditions are applicable but the model is not flexible enough to describe peaky waveforms



COG – Max(WF)

Retracking lead waveforms

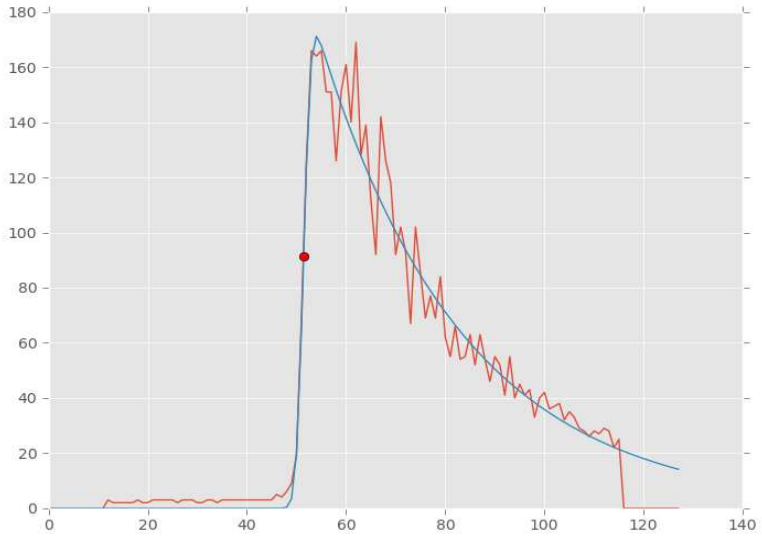
- The **Brown model** is defined by:

Model = FSSR * PTR * PDF with:

FSSR : Flat Sea Surface Response
PTR : Point Target Response
PDF : Probability Density Function of heights

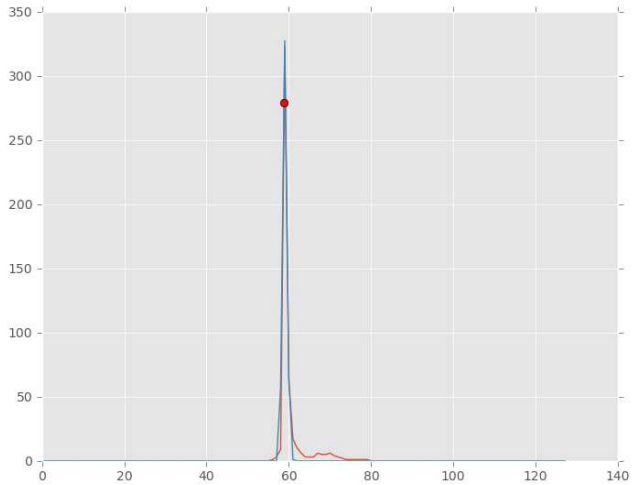
MSS: Mean Square Slope is injected in the FSSR through a parameter which modifies the correlation between the backscattering properties and the trailing edge slope ➔ **The IceNew model (L. Amarouche)**

➢ This model is **flexible enough** to fit **ocean echoes as well as peaky echoes** and allows to account for the instrument (**PTR**, **Antenna beamwidth**, etc …)



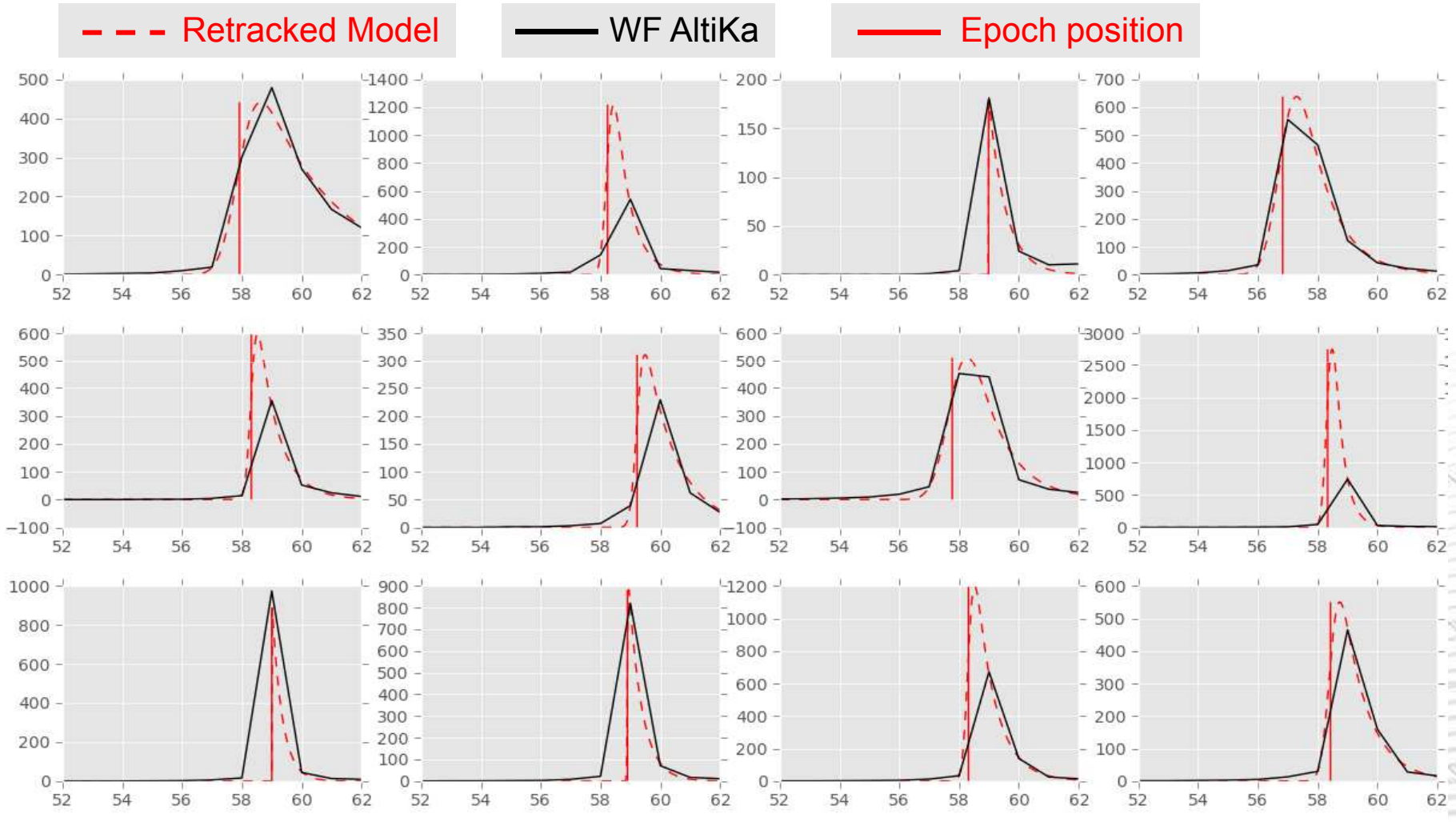
➢ A **new retracker** is then developed using the **WF classification** and a **robust convergence method** which estimates:

1. **Epoch**
2. **SigmaC**
3. **Amplitude**
4. **Γ parameter**



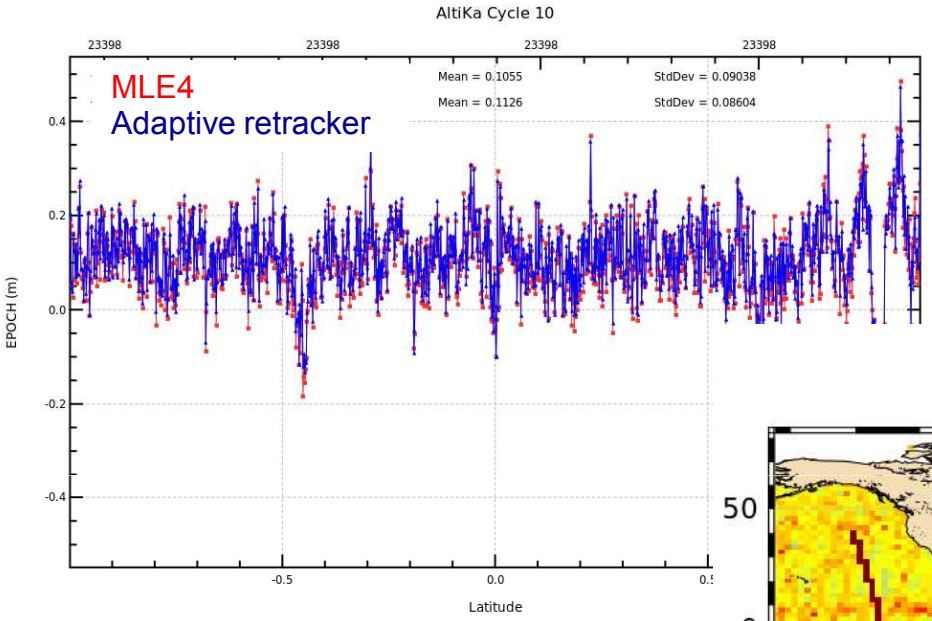
Retracking lead waveforms

- The adaptive retracker uses the **few available points to adjust the IceNew model on the lead waveform**.

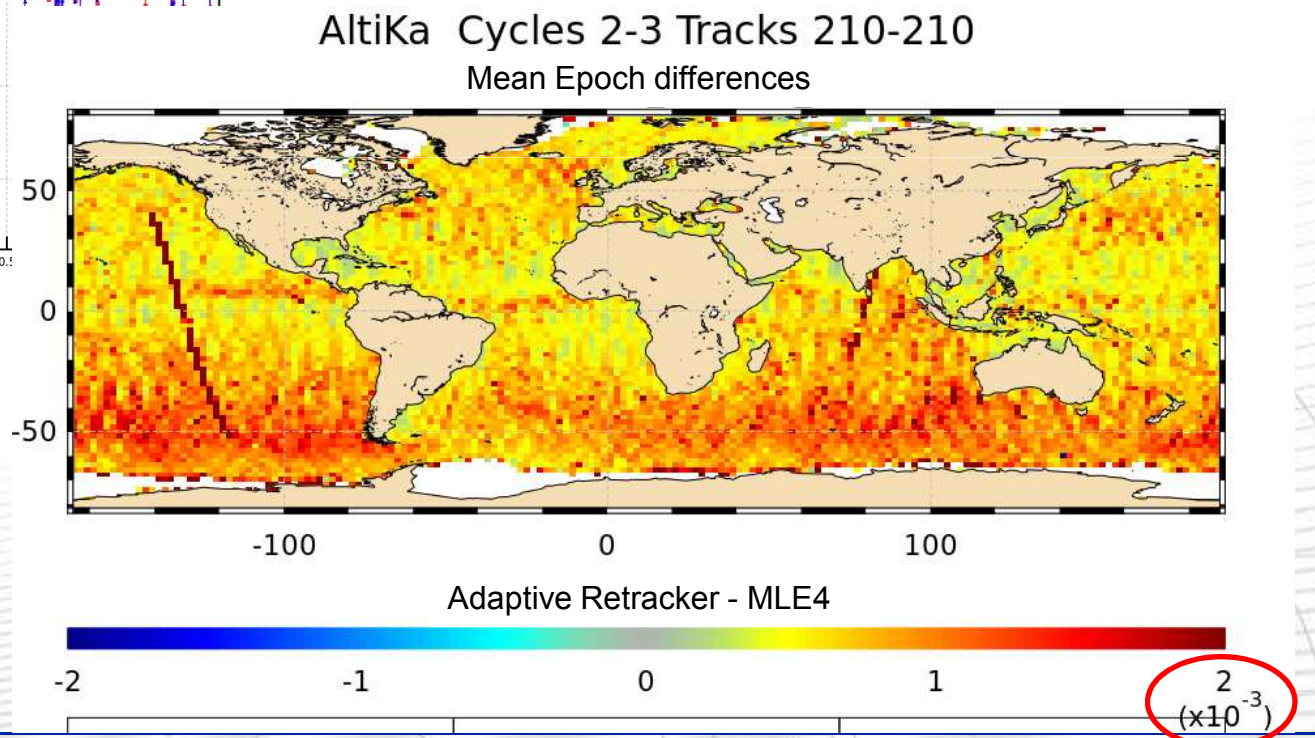


Continuity between open ocean and ice covered ocean

- **Performances over the ocean are similar to ones of a classical MLE-4**



The range estimate differences reach a maximum of **2 mm** between the MLE-4 and the new Adaptive retracker.

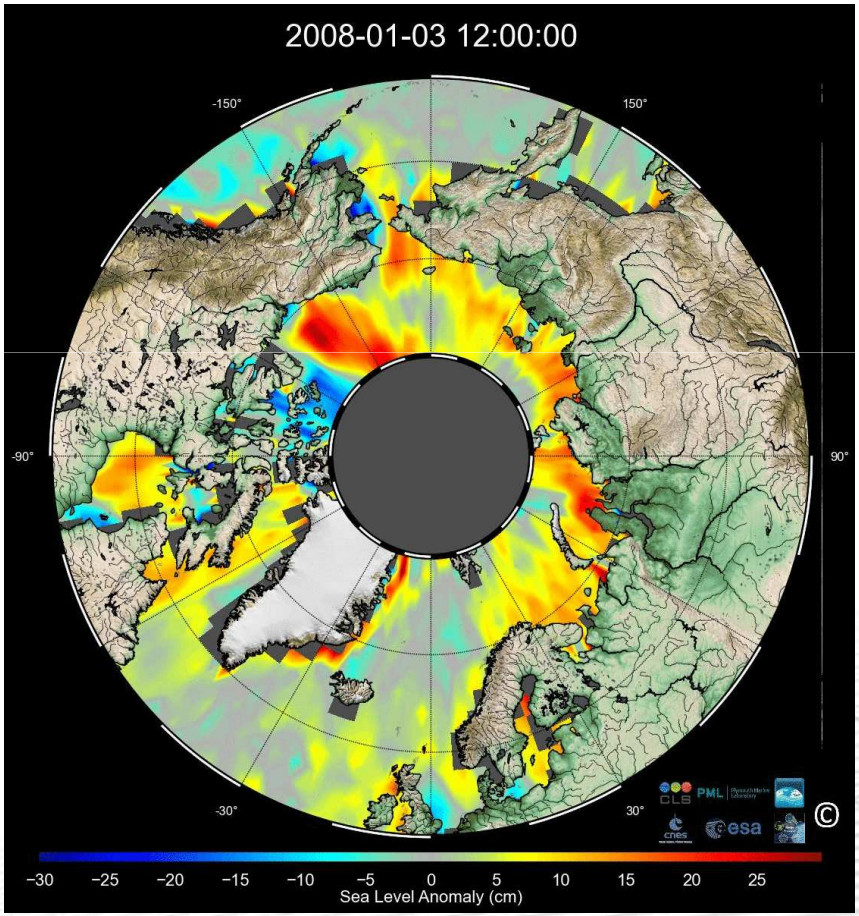


Track effects are due to SARAL maneuvers

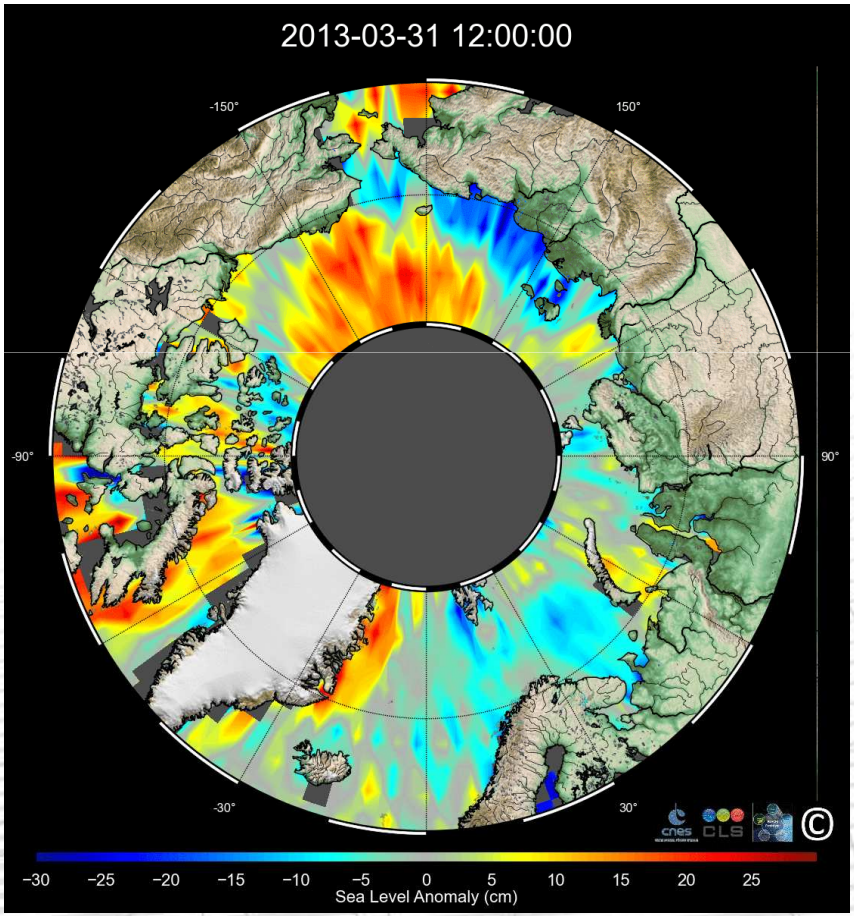
Continuity between open ocean and ice covered ocean

- SLA maps can be generated through this method (classification + retracking) after an adapted editing (see P. Prandi's poster)

ENVISAT SLA



ALTIKA SLA



Conclusions & Perspectives

- A classification of the **RA-2** and **AltiKa** has been developed and successfully performed **over the entire ENVISAT (CCI) and AltiKa (PEACHI) periods** in order to detect lead/polynya waveforms.

- A new **adaptive** retracker has been developed using **the IceNew model** (inherited from L. Amarouche) with an **adaptive and robust estimation process** in order to **retrack lead waveforms as well as ocean ones** (➔ guarantee of continuity).

- This new retracker **accounts for instrument characteristics ➔ Crucial for multi-mission processing.**

- **Arctic SLA maps** over the **whole ENVISAT and AltiKa periods** have been computed using this method (cf P. Prandi's poster).

- The same method (classification + retracking) **will be implemented on CryoSat-2 LRM/PLRM waveforms**.

- This method (classification + retracking) can be **very valuable for freeboard computation.**

Thank you for your attention