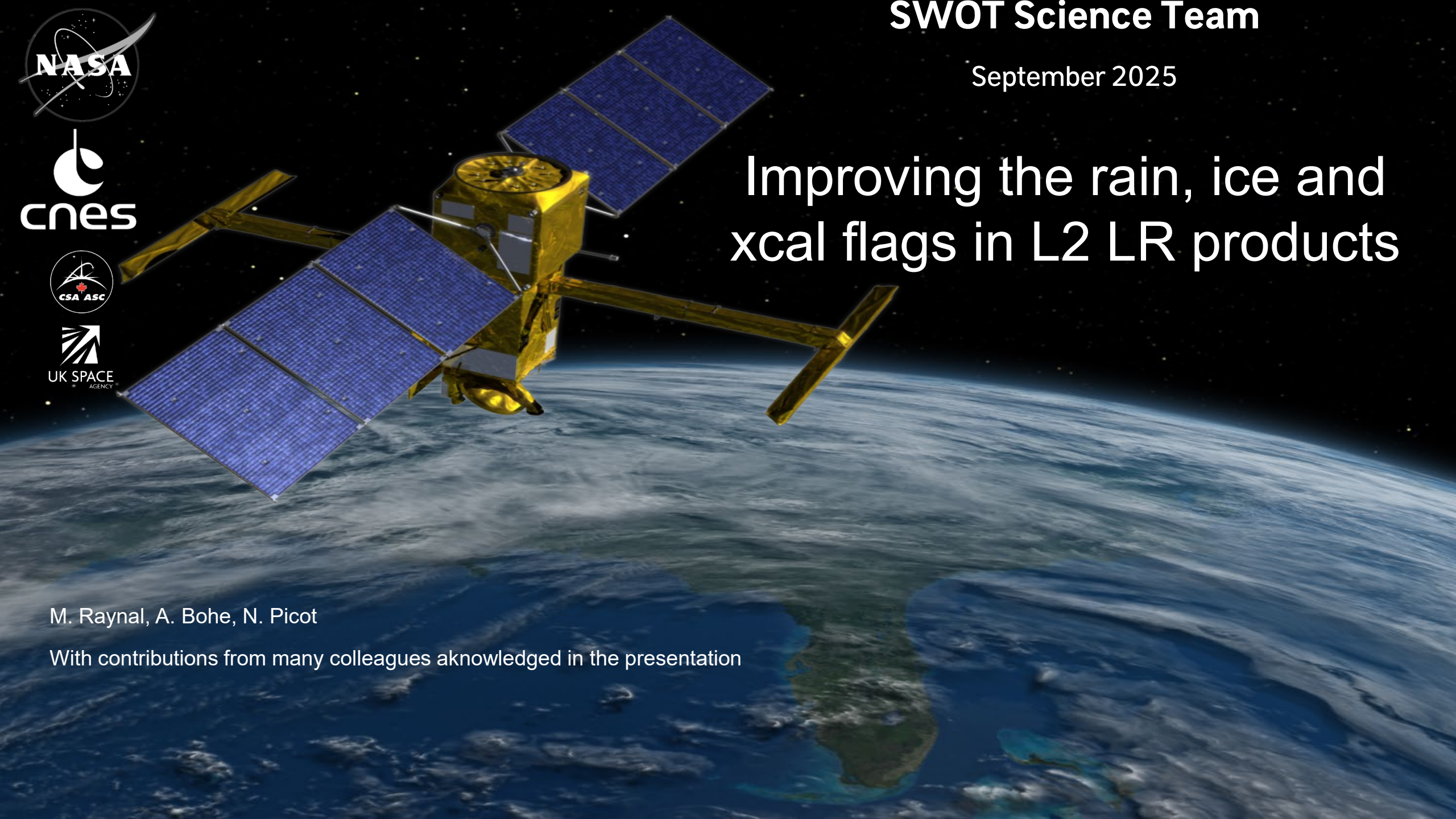

SWOT Science Team

September 2025

Improving the rain, ice and xcal flags in L2 LR products

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With contributions from many colleagues aknowledged in the presentation

Objectives / Context

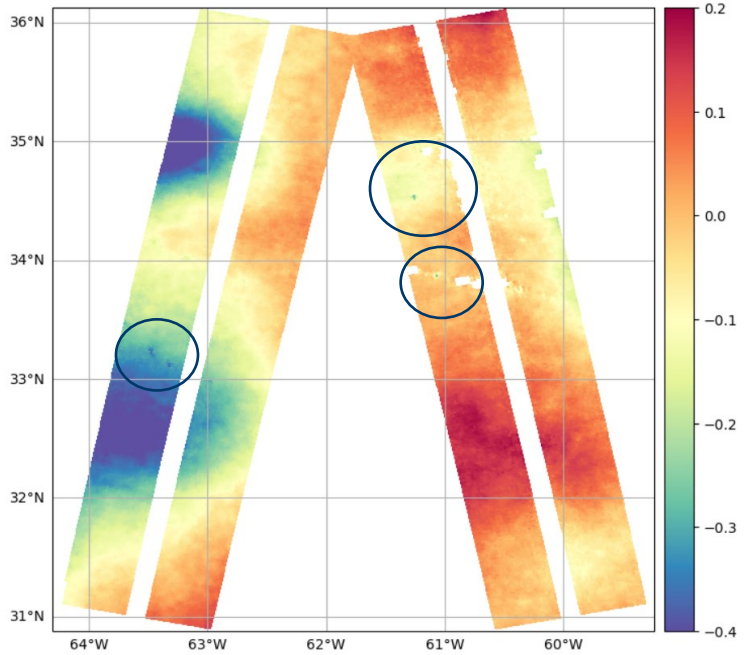
- Inform SWOT user community about work in progress to enhance the L2 LR products
  - Focus on the rain and ice flag information (and associated physical variables : ice concentration, rain attenuation)
  - Focus on the Xover Calibration quality flag / Uncertainty

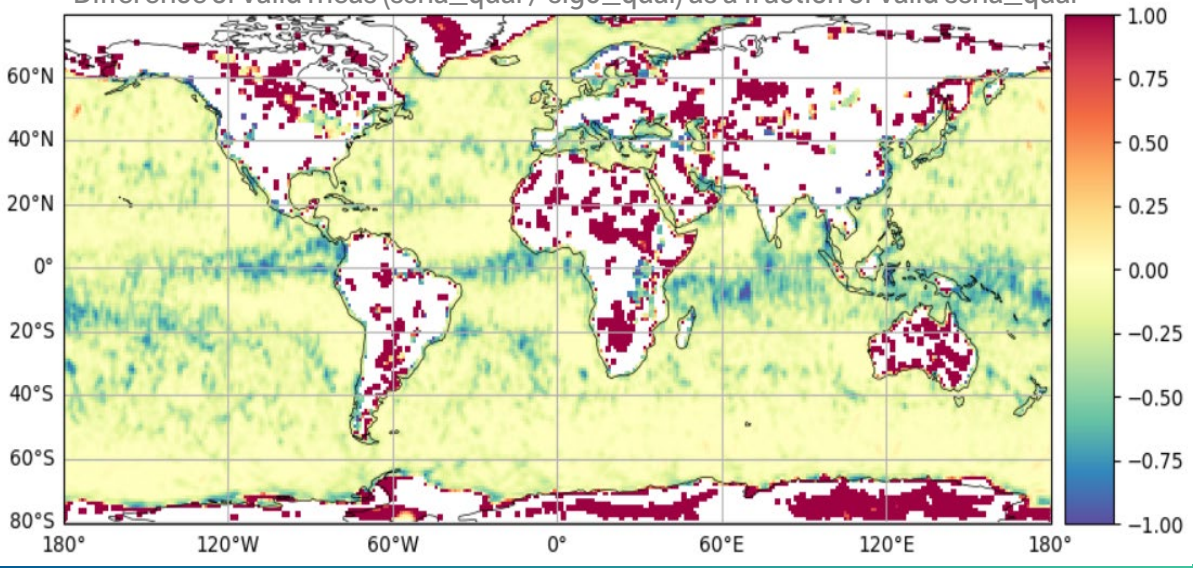
- These indicators are intended to provide additional information on the conditions affecting the KaRIn measures.

- They are useful for the development of several applications and studies (SWH, freeboard, Ka band attenuation caracterisation, …)

Rain Flag: current limitations

- Ka-band is particularly sensitive to rain events
  - Sensitivity to rain (atm att) varies for the different KaRIn retrievals (sig0,volumetric correlation, topography).
  - Quality flags available in the products have all their own limitations, depending on the application.
    - Ssha_karin(_2)_qual not restrictive enough
    - Sig0_karin(_2)_qual too restrictive for topography applications and miss part of rain events affecting the volumetric correlation.
    - Do not allow for the identification of rain events in particular.

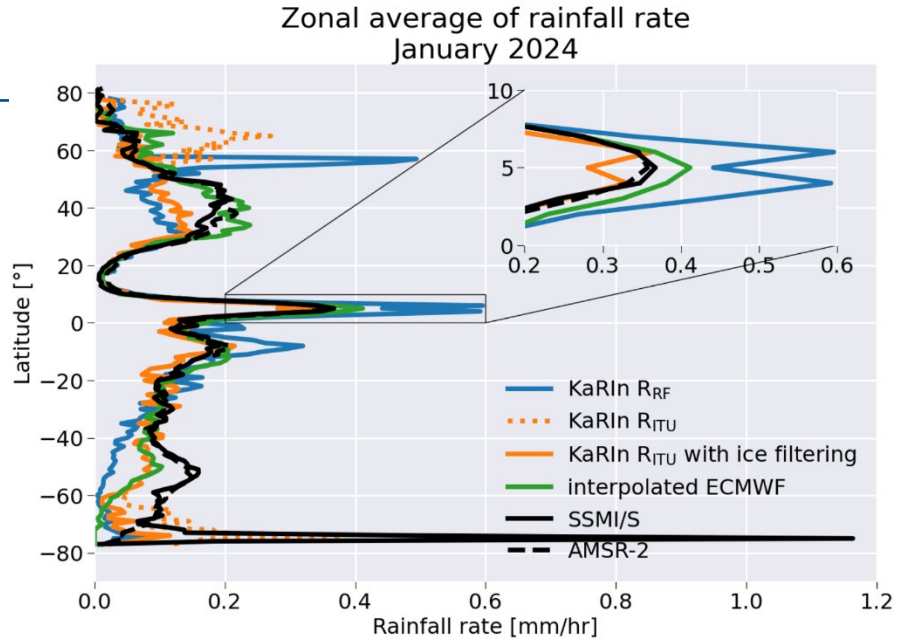




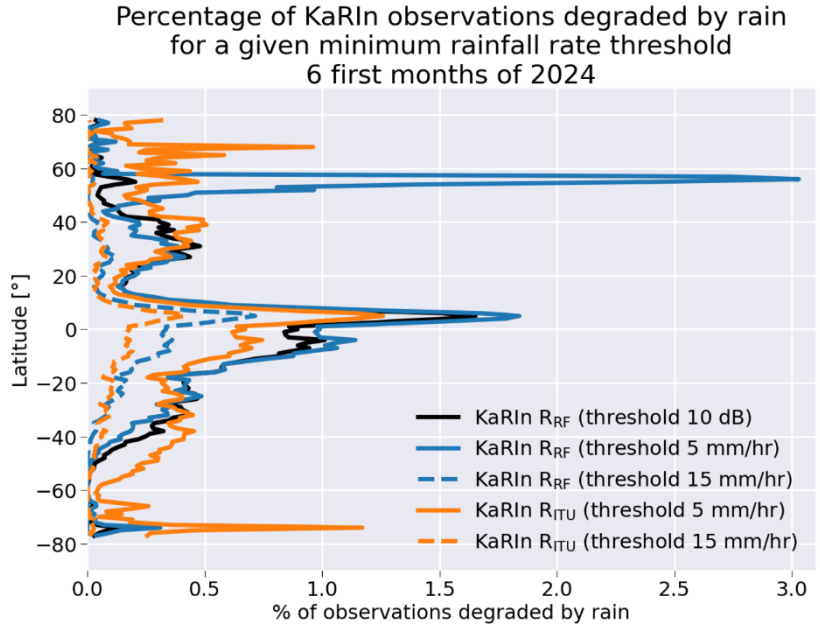
Rain Flag: New methods studied

- Two different approaches were developed to estimate the rain rate from KaRIn measurements
  - Supervised random Forest classifier with NEXRAD radar data [A. Colin, CLS]
  - Adaptation of ITU-R model to estimated KaRIn sig0 attenuation and corresponding rainfall rate [B. Picard, Fluctus]

➔ See B. Picard poster and B. Picard et al, 2025 (submitted) for more details.



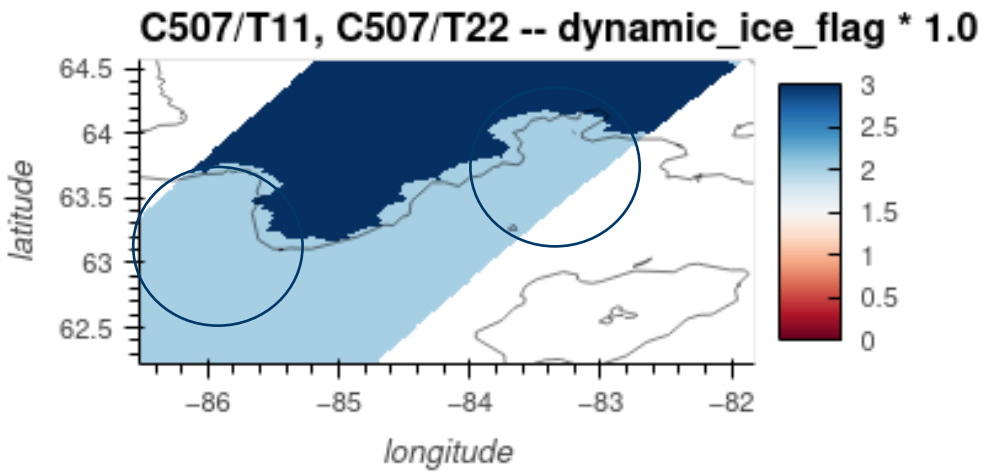
- Toward an improved characterization of Ka-band attenuation and its impacts on geophysical parameters retrieved (topography, wind, SWH estimates).
- Relevant rain fall estimates to define various flagging strategy depending on use cases
- Useful to prepare future Ka-band missions:
  - Operational flagging and quality monitoring for Sentinel-9 (/CRISTAL) and Sentinel-3NG
  - Error modeling adapted to ODYSEA.

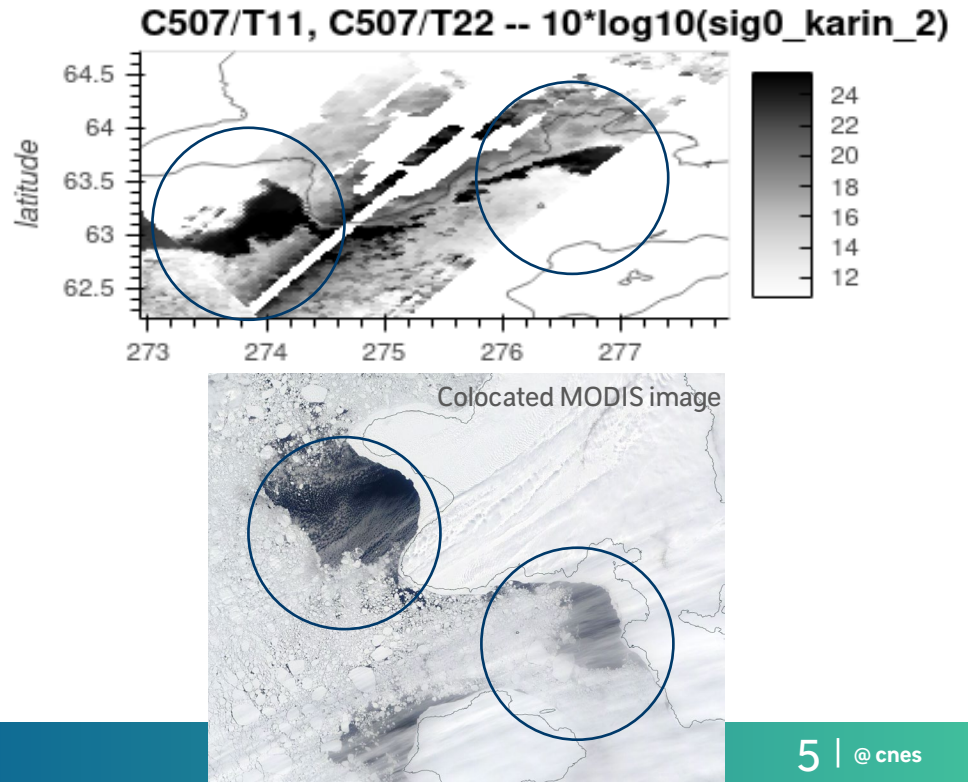


Ice Flag: limitations

- Ice flag used to discriminate Ocean/sea ice surfaces and necessary for :
  - L2 quality monitoring over Ocean: filtering/editing
  - KaRIn Wind, SWH computation
  - Polar Ocean science
  - Freeboard and ice thickness estimations

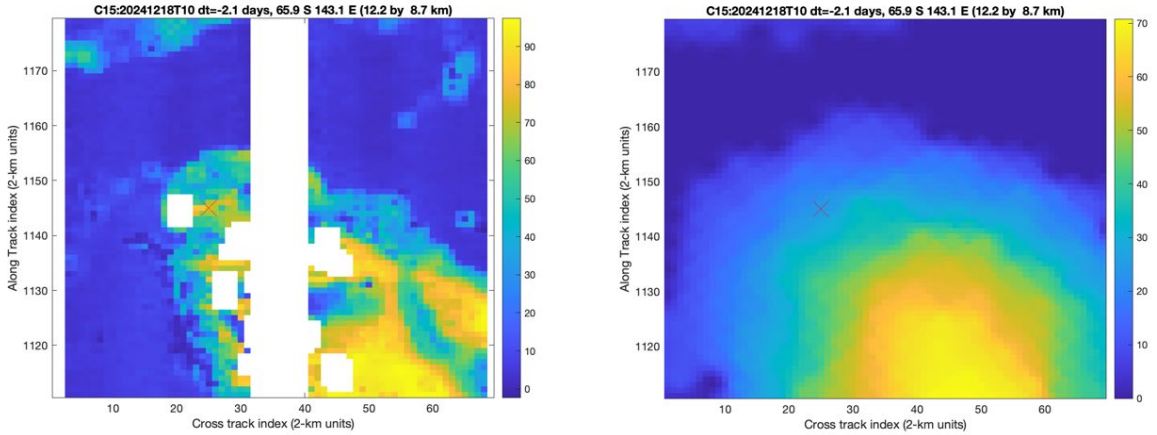
- Current ice flag retrieved from OSISAF ice concentration (AMSRE-2) model presents some limitations related with its temporal/spatial resolutions.

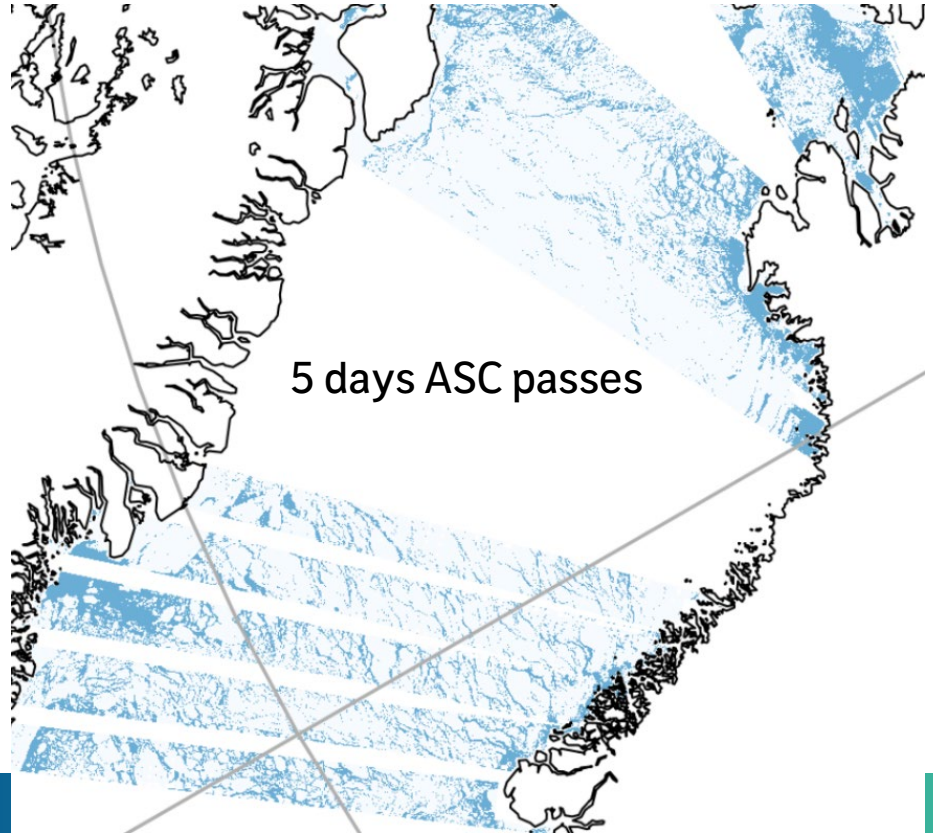




Ice Flag: methods & perspectives

- Different approaches studied to improve ocean / ice detection
  - JPL [B. Styles] approach based on 2 km consist in training a neural network to benefit from the KaRIn parameters sensitive to the presence of ice (sigma0, volumetric correlation …)
  - Legos [S. Fleury, G. Jestin] approach based on Kmeans method applied to KaRIn sig0 and SSHA from Unsmoothed products
- Possibility to refine ice concentration estimation from LR Unsmoothed classification.
- Sea ice classification is the first crucial step toward better characterisation and observation of the polar oceans



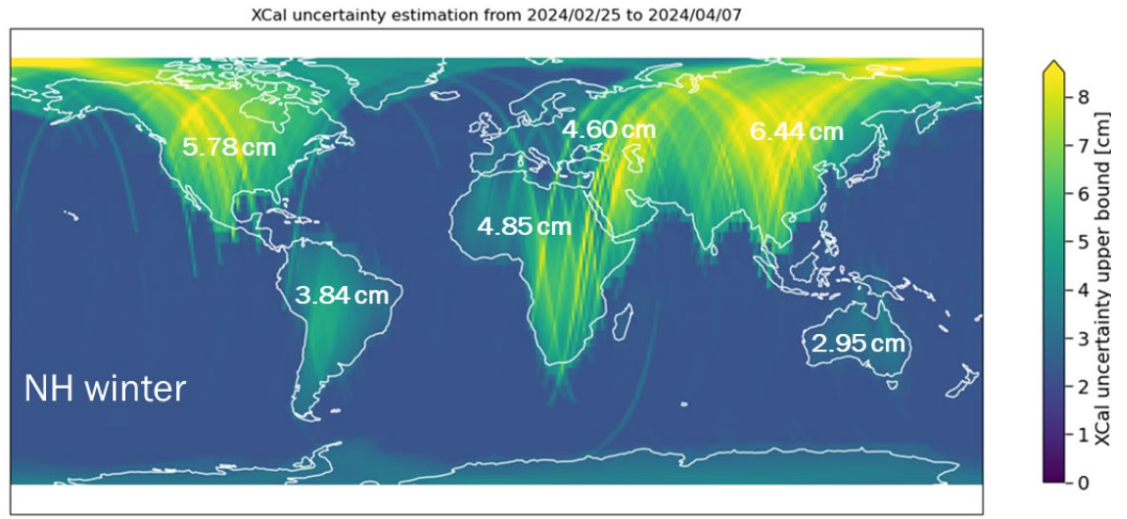


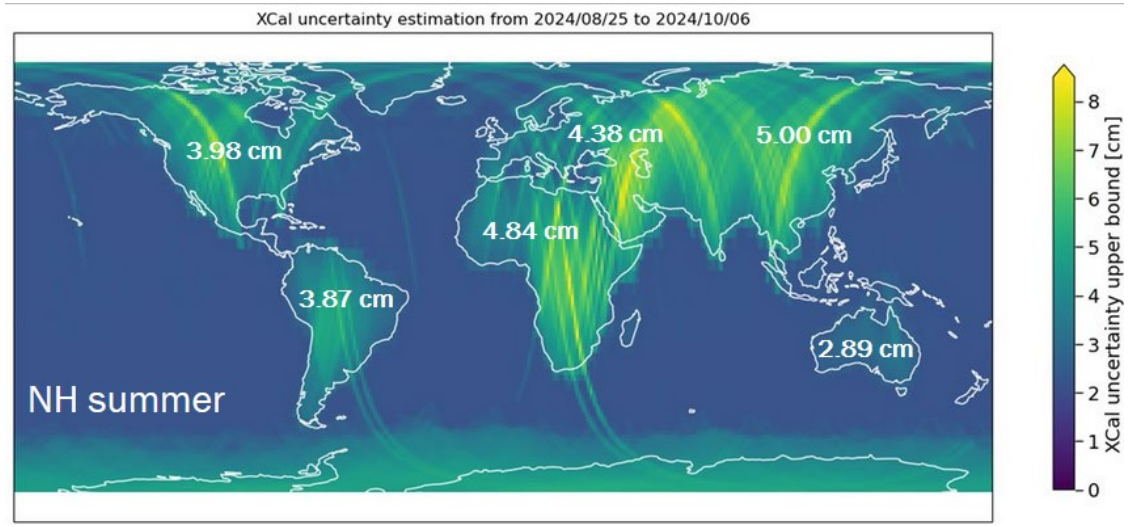
XCAL

- Current XCAL flag based on distance wrt nearest crossovers used for computation (deployed in version D).
- XCAL uncertainty estimation based on virtual continent has been refined

  ➔ See E. Jussiau talk

  - Will be available in XCAL products with next version deployment .
  - Propagation into HR/LR products to be confirmed and discussed.
- For users this should ease the data filtering/editing to discard degraded conditions.





Conclusions

- KaRIn measurements can be used to refine geophysical information (rain and sea ice geophysical variables and flags) and limit inaccuracies from global models.
- Better precision and resolution obtained can be useful for data filtering/editing but are also an opportunity for new studies.
- These new variables will be available in L3 products for demonstration
  - From V2.0 Unsmoothed products for sea ice classification
  - In next version for the rain flag
- Implementation in the SWOT mission center is not straightforward and depends on the algorithm complexity and computation time.