



# SWOT-KaRIn Level-3 Algorithms and Products Overview

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## For ocean applications

- L3 along-track/swath: calibrated with other missions
- L4 gridded: merging measurements from different missions



## Complementary to the L2 products

- L2 LR product (2km & 250m) used as upstream
- Evolves quickly to use state-of-the art R&D



## Serve a large community

- Flexible to adjust to need of the different communities (SWOT-ST; OSTST, others)
- Consistent with other nadir products (DUACS)
- Available in DT & NRT

# V3.0 changes in a nutshell

## Content update on 2km products only

### Geophysical standards

- **MSS change:** new CNES\_CLS\_2025 solution using KaRIn measurements will replace the Hybrid\_2023 solution
- Ocean tide FES\_2022 solution extended in some coastal areas

### New sub-product (separate files)

- **Addition of a "technical" product** with additional variables : alternative geophysical corrections & geostrophic currents estimation; complementary information for some corrections (ocean tide, calibration)

## L3 algorithms

- Coastline improved
- Data selection quality flag granularity improved for rain cells
- **Optimization of the cross-calibration**
- **Optimization of the denoising** with correction of geographically bias artefacts
- **Improved geostrophic current estimation** : the 2D-spline fit methodology proposed by Tranchant (2025) will replace the stencil derivative

# V3 Evolutions: MSS

- The L3 v3 uses the first beta release of the CNES/CLS 2025 model
- MSS errors reduced by more than 80% compared to H23 MSS available in L3 v2

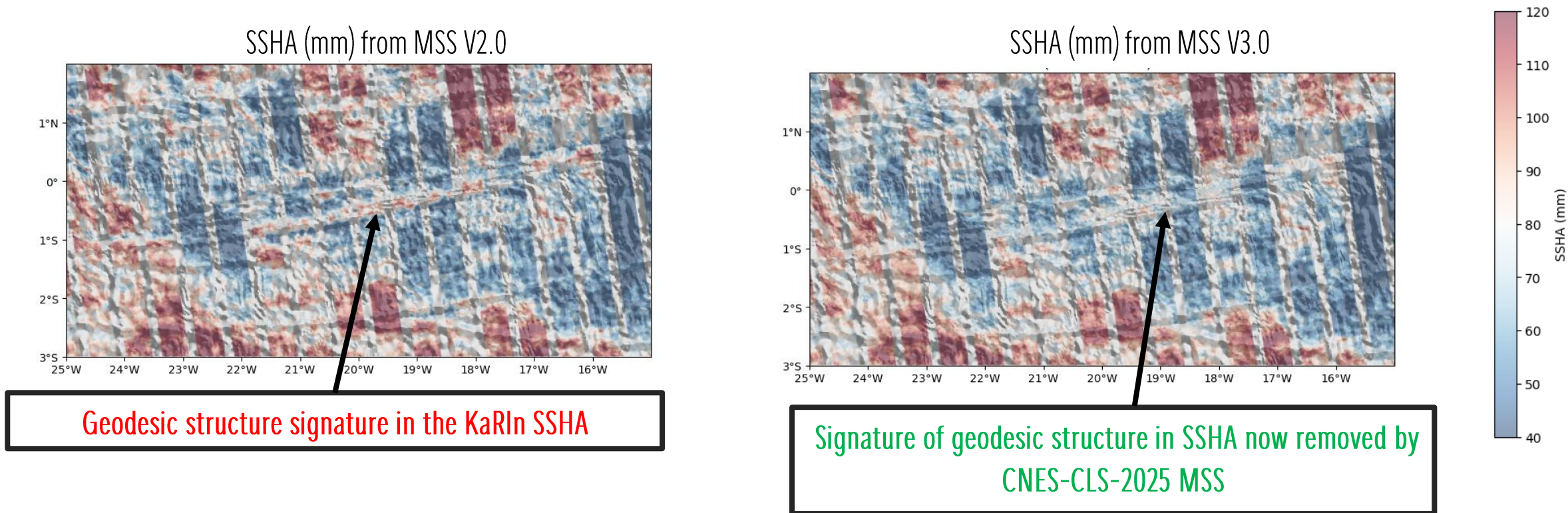


Figure: KaRIn ssha superimposed with bathymetric gradients

See the MSS CNES\_CLS\_25 Presentation on Friday 11:10 in MSS session

# V3 Evolutions: L3 Calibration

- Improved calibration algorithm with a better estimation of low frequency correction
- Reduction of uncorrected KaRIn systematic errors with calibration v3.0, especially in polar ocean and near land areas
- Addition of a low frequency calibration in the technical product which absorbs less geophysical error residues
- Important improvement for hydrology (1-day phase calibration is based on L3 algorithm)

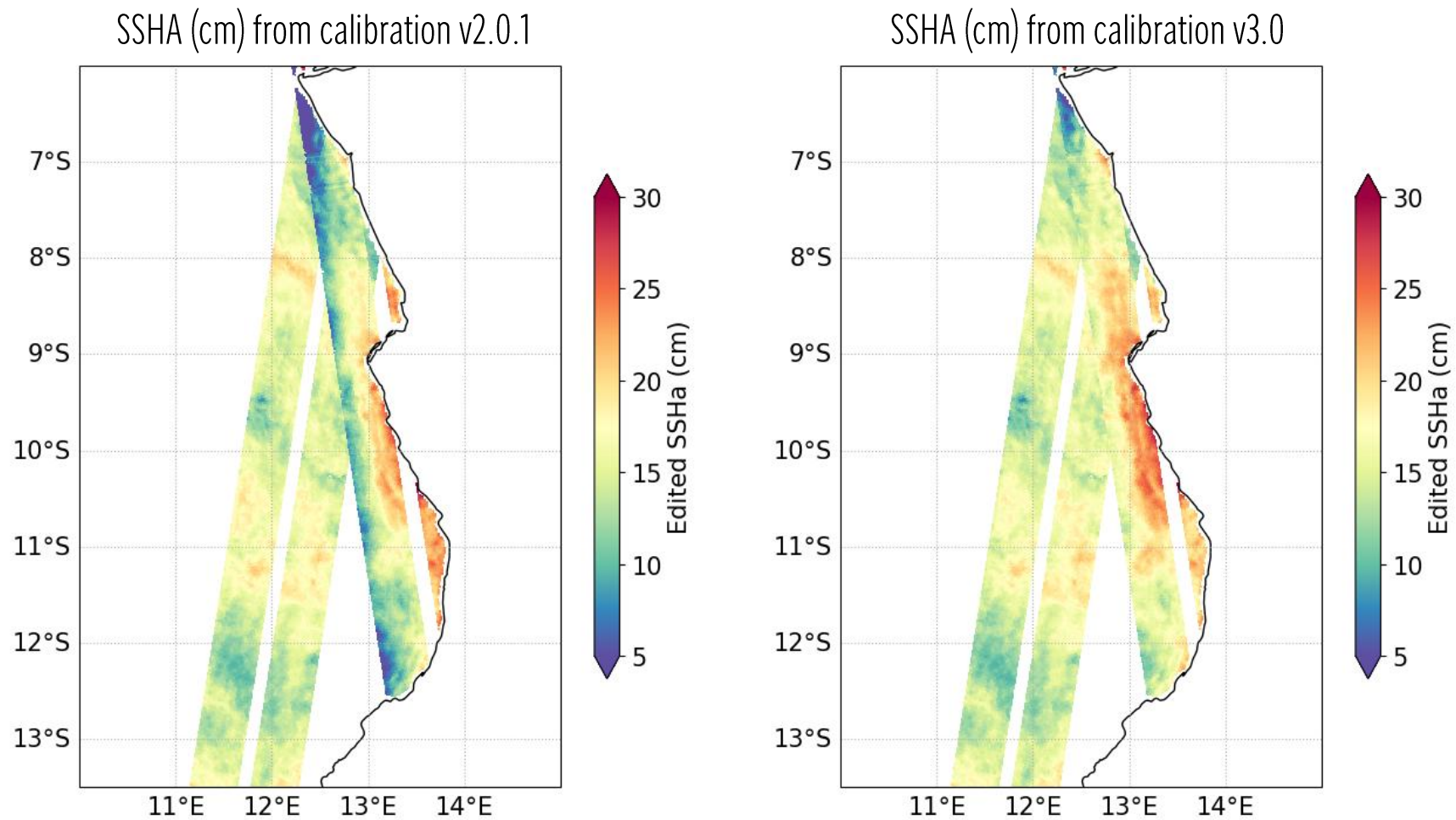
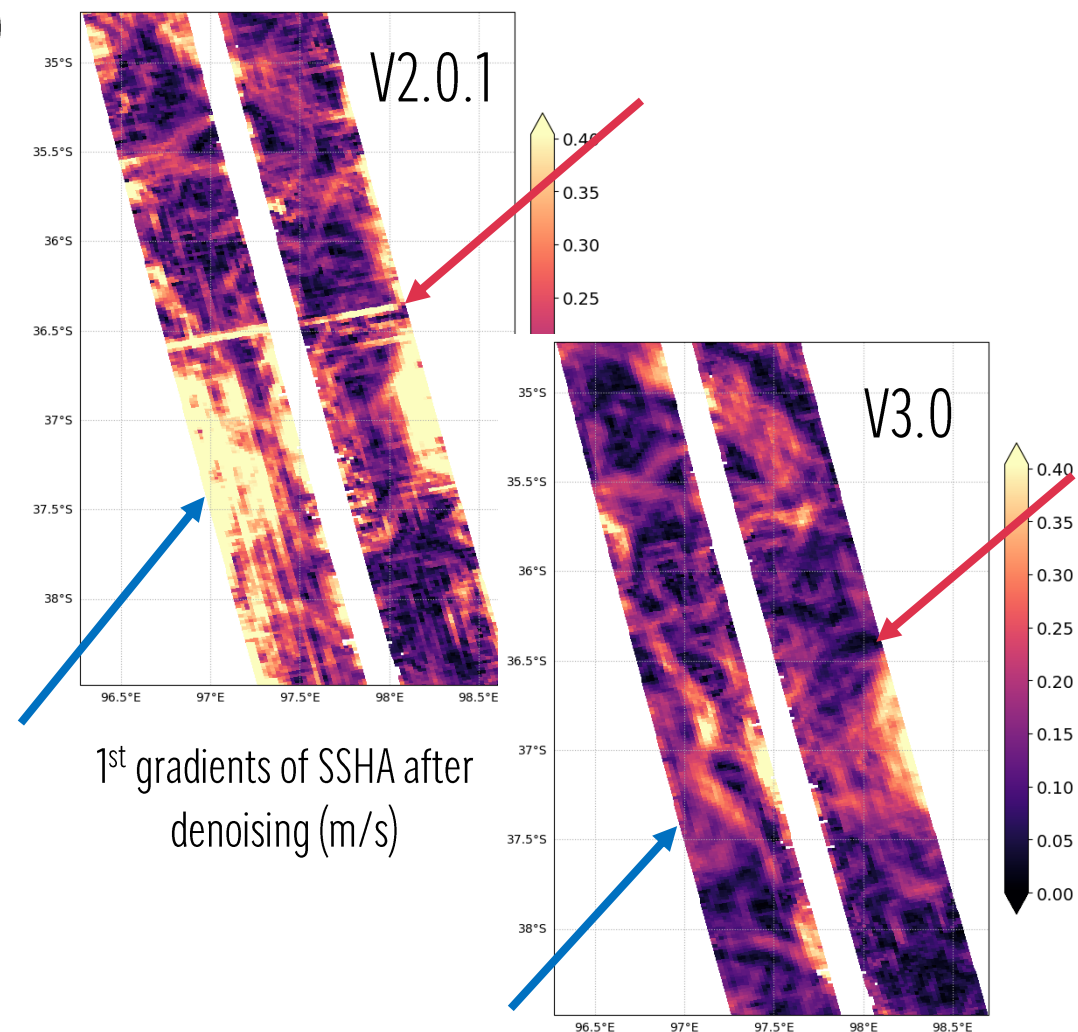
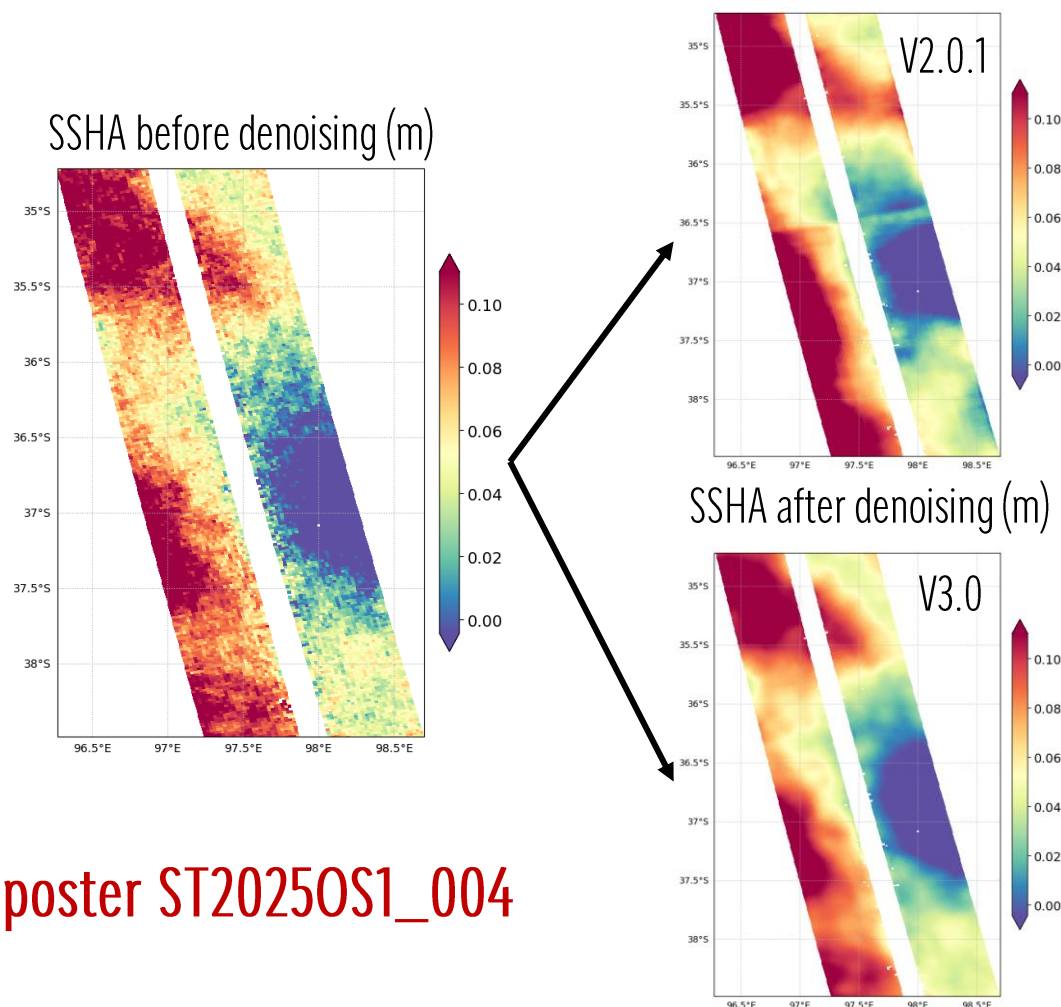


Figure: Signature of uncorrected satellite roll angle in SSHA now removed by calibration v3.0

See the poster [ST2025OS1\\_018](#)

# V3 Evolutions: Denoising

- Improved UNet performance with slower learning process and real L3 editing applied on simulated ENATL60 swaths, no more style-transfer
- Reduce regional biases and other artifacts that can be observed in V2.0.1 (e.g. **sea-wave correlated biases**, **local discontinuities**)
- Reduce possible absorption of some physical signal (e.g. short wavelength tides)



See the poster [ST2025OS1\\_004](#)

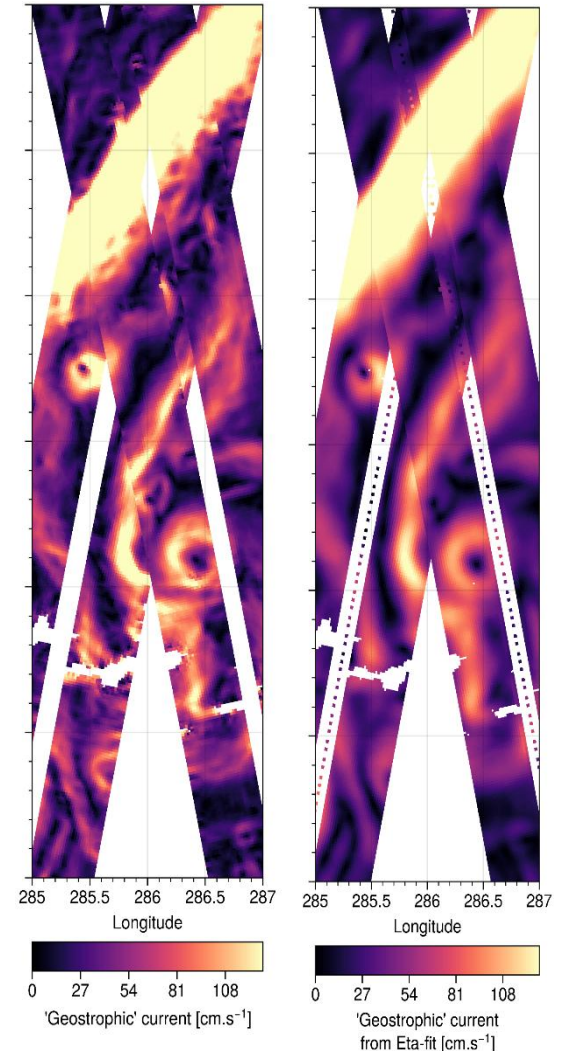
# V3 Evolutions: Geostrophic currents

## Optimized geostrophic current estimation for v3

- Use 2D spline fitting methodology proposed by Tranchant et al. [1]: allow to filter part of the short wavelength signal that may include part of unbalanced motion not compatible with geostrophic approximation
- Better consistency of the KaRIn geostrophic currents estimated with independent drifter measurements : overall, the L3 fitting method reduces RMSD by 10 to 20%
- Geostrophic current from stencil methodology (v2) still available in new technical product

L3 STENCIL  
(v2.0)

L3 FITTING  
(v3.0)



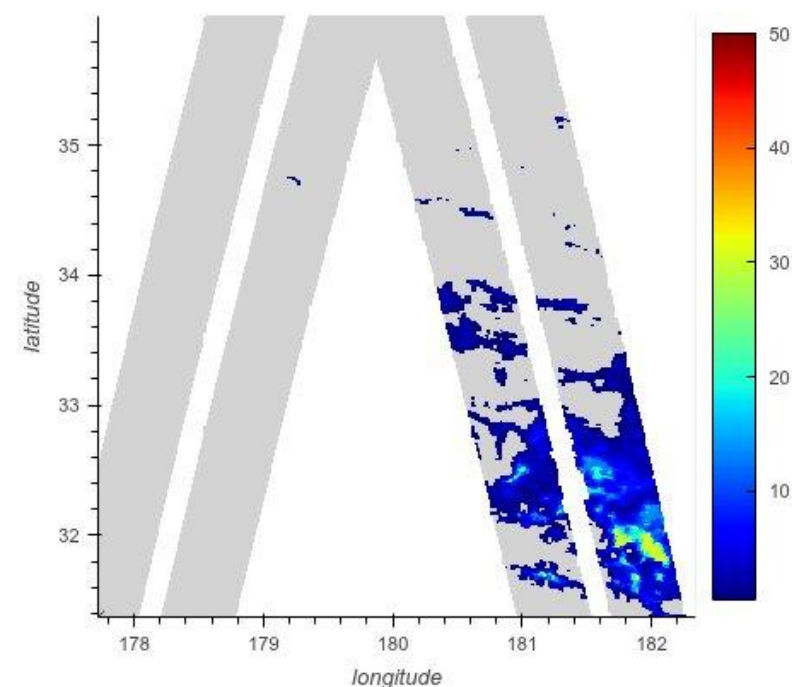
[1]: Tranchant et al. SWOT reveals fine-scale balanced motions and dispersion properties in the Antarctic Circumpolar Current. ESS Open Archive . January 11, 2025, DOI: 10.22541/essoar.173655552.25945463/v1

# KaRIn L3 2km technical product content

Gives access to additional parameters and geophysical fields of interest : useful for some specific studies/applications; alternative solution to the one proposed in the core L3 product not yet available in L2

## New variables :

- Loading tide component from FES 2022 model
- Ocean tide and loading tide from GOT5.6 model [1]
- Internal tide from Zhao [2] and from MIOST-IT24 [3]
- Precipitation rate and rain flag based on an atmospheric attenuation model [4]
- Precipitation rate from a random forest model [4]
- Low frequency component of the calibration
- MSS compression corrected for 2km product
- Geostrophic velocities anomalies derived from denoised ssha using a stencil derivation method



Example of Precipitation rate from a random forest model (mm/h)

[1] Ray, 2025; [https://science.gsfc.nasa.gov/sed/content/uploadFiles/publication\\_files/GOT5-TechMemo.pdf](https://science.gsfc.nasa.gov/sed/content/uploadFiles/publication_files/GOT5-TechMemo.pdf)

[2] Zhao, 2025; <https://doi.org/10.5194/essd-2024-611>

[3] Tchilibou et al, 2025; <https://doi.org/10.5194/egusphere-2024-3947>

[4] Picard et al, 2025; <https://doi.org/10.31223/X5WF0Z>

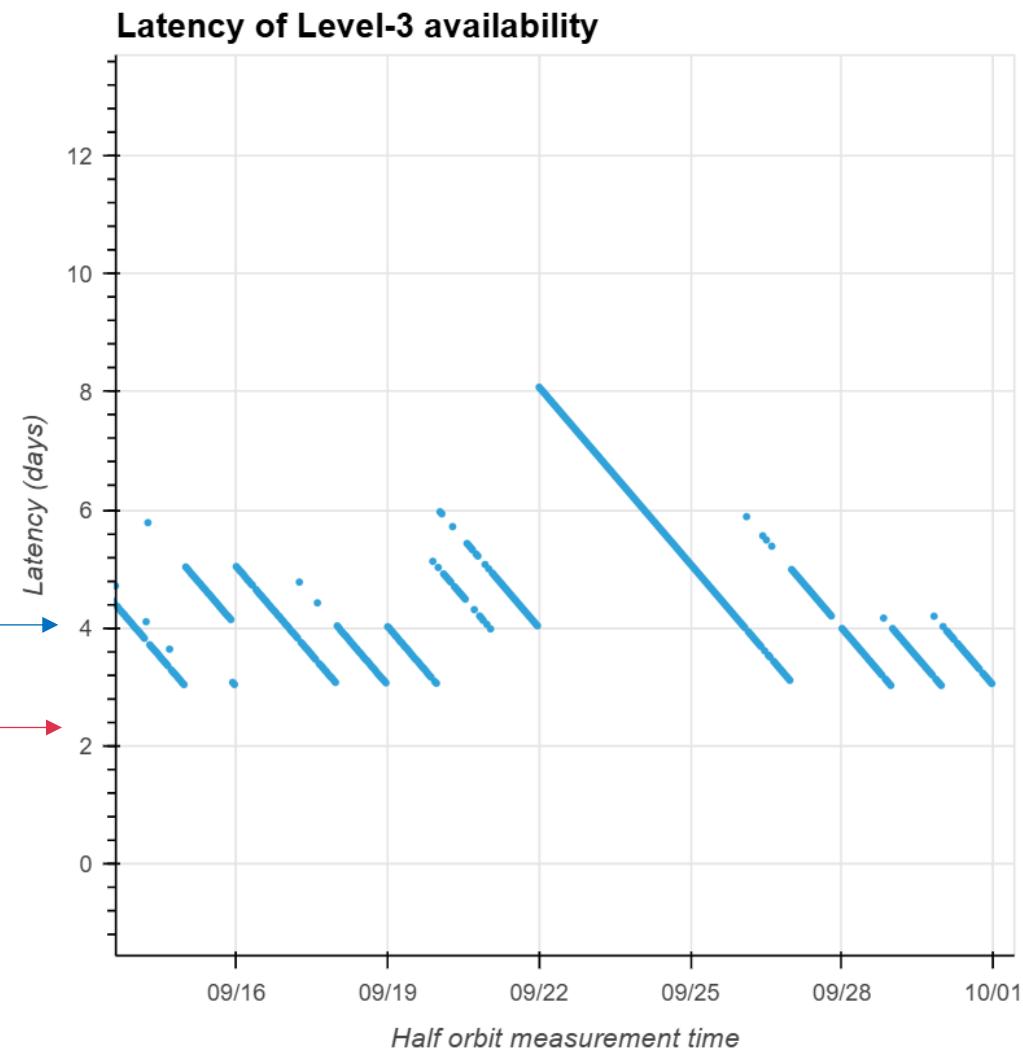
# Timeliness reduced for NRT production

## Reduction of the delay of availability for the L3 expert (2km) product by end 2025

- Possible thanks to the access to L2 precal product & optimization of the L3 processing
- Tentative to reduce for 2,5 days latency instead of 4,5 days currently
- Will be set up with L3 v3 reprocessing dissemination : possibly mid-November

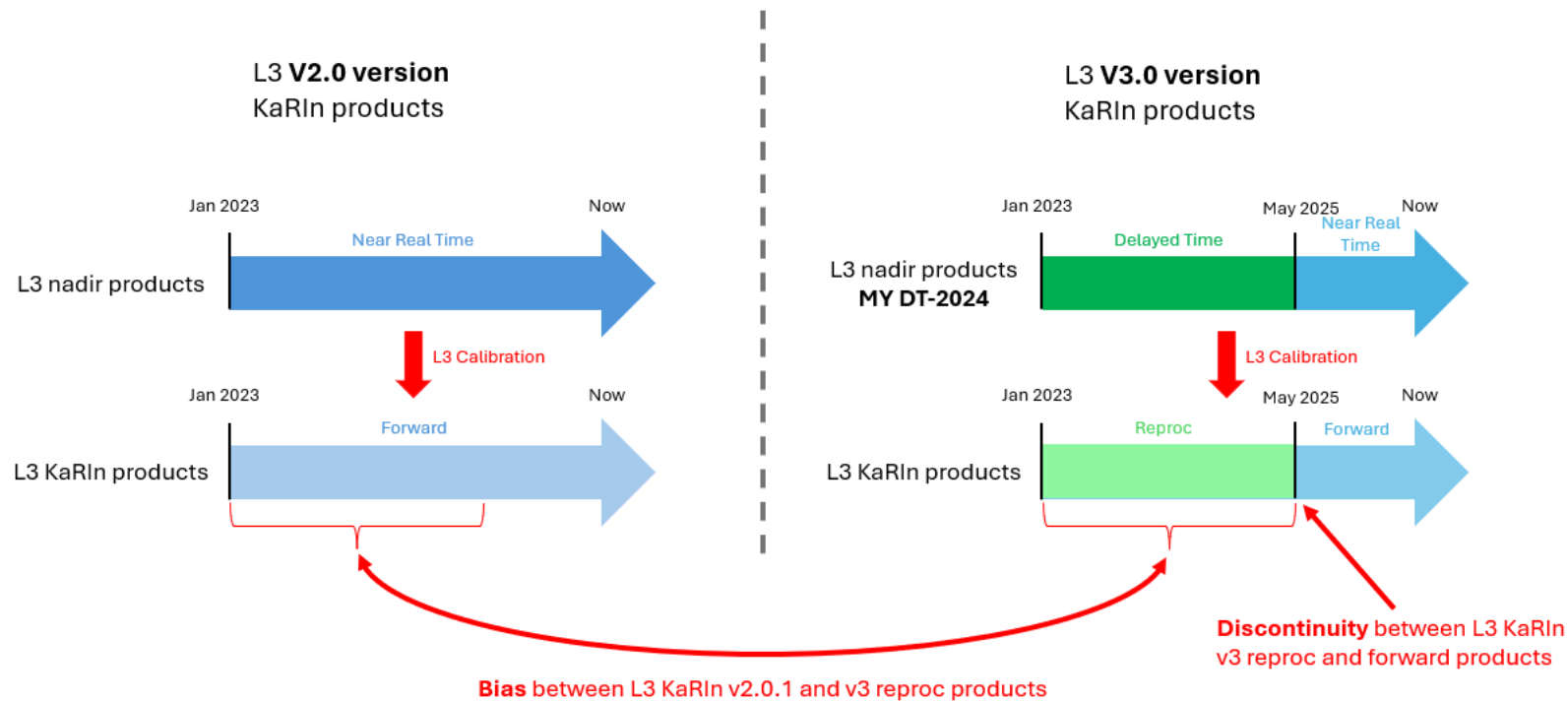
4 to 4,5 days current nominal latency

2 to 2,5 days expected latency

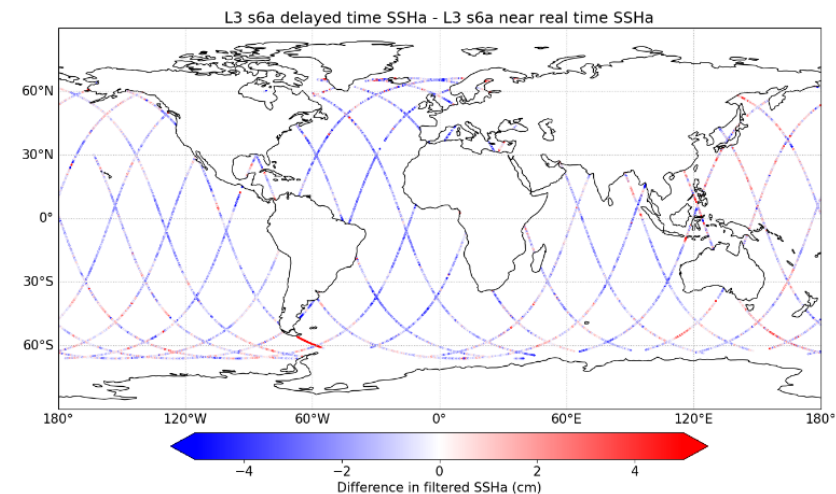


# Impacts of L3 nadir products on the L3 KaRIn calibrated products

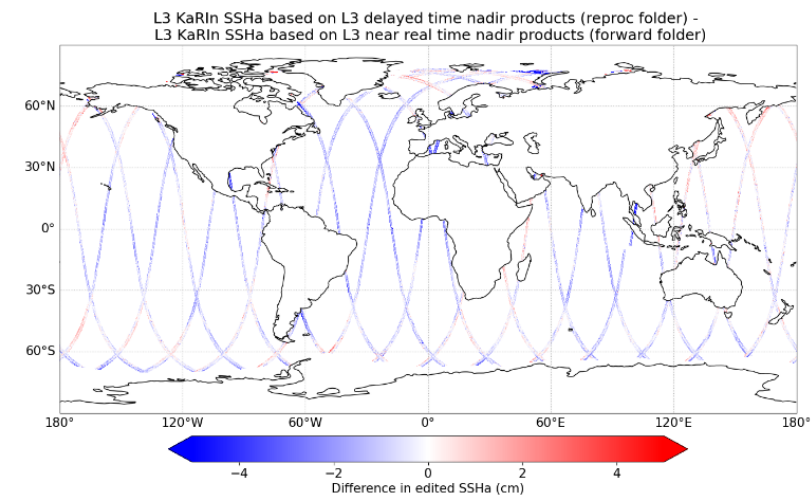
- L3 v3 KaRIn products are distributed in two separate directories:
  - reproc: L3 KaRIn products based on L3 Delayed Time nadir inputs
  - forward: L3 KaRIn products based on L3 Near Real Time nadir inputs



Impact diagram of L3 nadir inputs on L3 KaRIn products



Difference between L3 s6a delayed time and near real time SSHA (cm)



Impacts of L3 DT and NRT inputs on L3 KaRIn reproc and forward SSHA (cm)

# Conclusions

- Reprocessing of L3 KaRIn v3 Basic and Expert products will be published in November
- NRT will be updated to v3 algorithms after the release of the reprocessing
- The handbook with updates related to version 3.0 of the products is available online
  - Please do not hesitate to provide feedback on the handbook if information is incomplete or missing

→ L3 KaRIn product is a Science Team collaborative product:

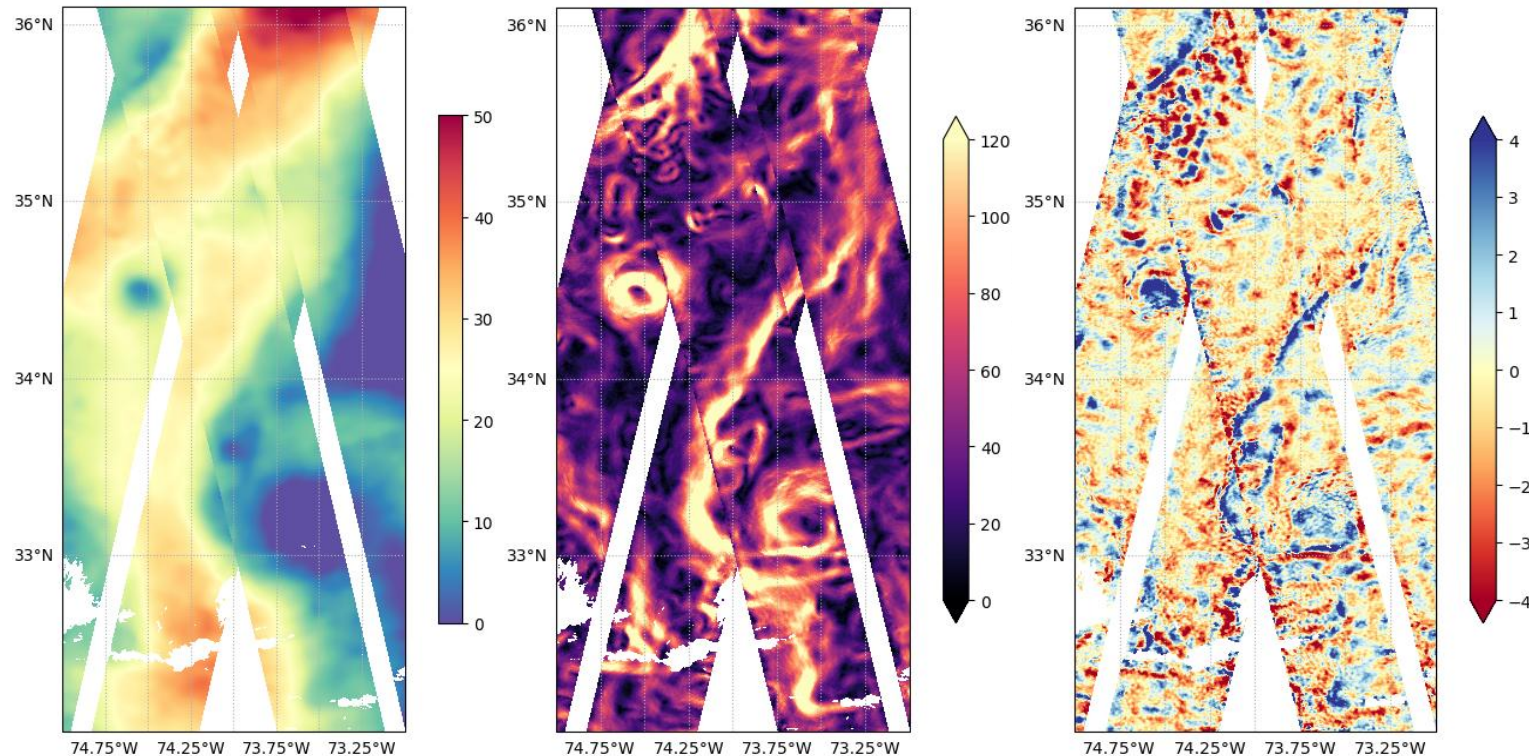
- Your remarks are needed to make it better;
- L3 product can integrate your research algorithm.



Access to the handbook

For future L3 product (V4) expected in 2026 :

- Take into account the **PGD reprocessing**
- Improvement of the **calibration** (use of beta angle dependance and better estimation of bias term)
- Improvement of the **denoising** for the unsmoothed product (new architecture and training process for cleaner results)
- Improvement of the **editing** for the unsmoothed product (new sea-ice classification and new coastal editing)



Potential future denoising in 250m products in V4.0, SSHA, 1<sup>st</sup>, 2<sup>nd</sup> gradients

*Thank you for your attention !*

## L3 paper

[https://doi.org/10.5194/  
os-21-283-2025](https://doi.org/10.5194/os-21-283-2025)

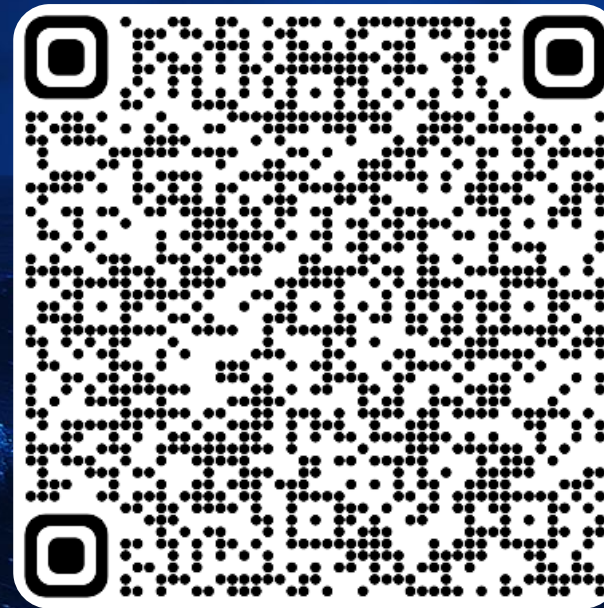


## L3 product access

[https://doi.org/10.24400/  
527896/A01-2023.018](https://doi.org/10.24400/527896/A01-2023.018)

## L4 paper

[https://doi.org/10.5194/  
os-21-63-2025](https://doi.org/10.5194/os-21-63-2025)



## L4 product access

[https://doi.org/10.24400/  
527896/A01-2024.007](https://doi.org/10.24400/527896/A01-2024.007)