SWOT Level-3 Overview

algorithms and examples

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Context

Level-3 products are formally part of the Science Team Project DESMOS

Convergence point: Project CalVal, ST research and Operational Oceanography

Added-value

State of the art research-grade upgrades (incl. very recent & submitted papers)

Multi-mission calibration (SWOT is consistent with other altimeters)

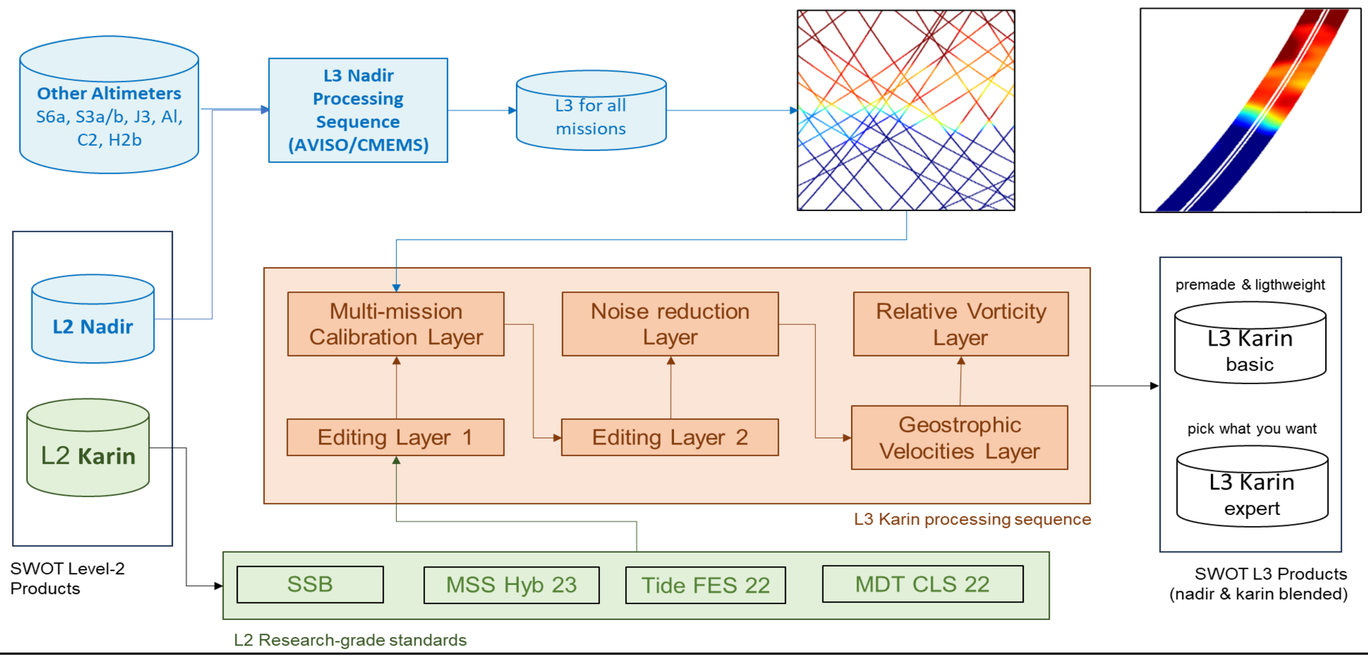
Noise-mitigation for SSHA derivatives (experimental, AI-based)

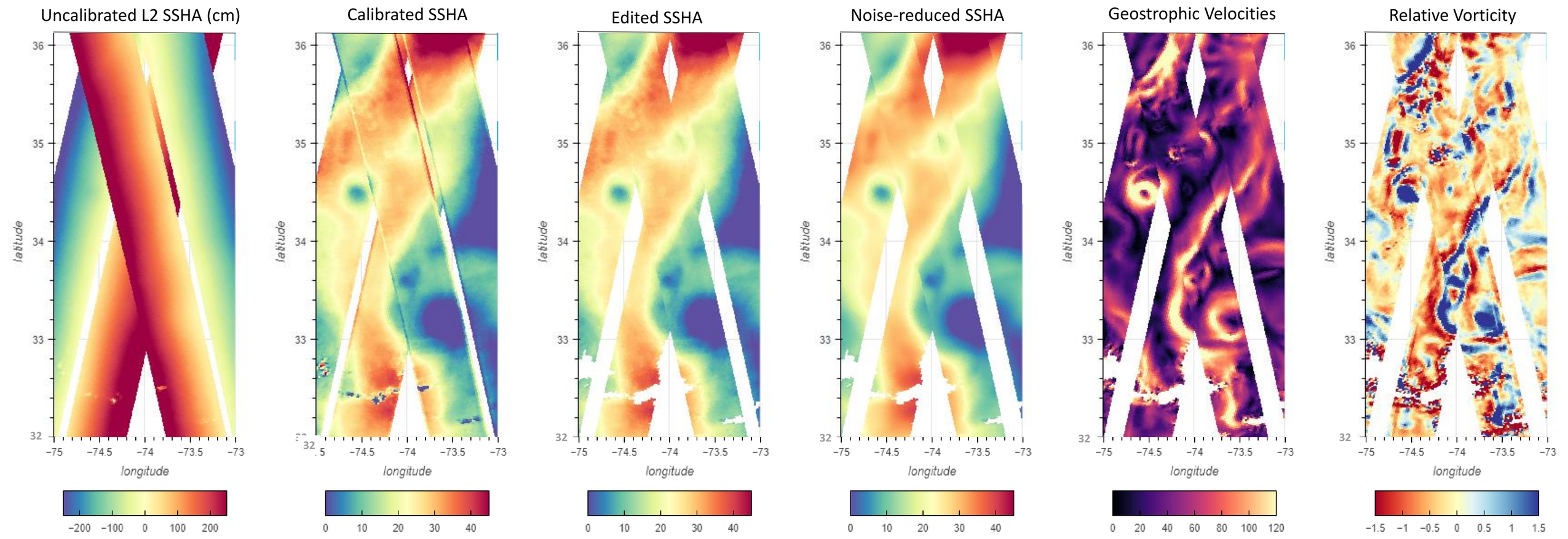
Pre-made sophisticated editing procedure

KaRIN and nadir instruments blended into a single image

L3 has new layers (optional) that can blend with L2 fields

SWOT Level-3 algorithm sequence





L2 Research-grade standards

The CLS/SIO/DTU hybrid 2023$_{\beta 1}$ as a Mean Sea Surface

Blends the strengths of 3 modern MSS models

- CLS22 for large scale and coastal variability
- SIO22 for smaller geoid features
- DTU21 for polar regions

MSS model	Error (cm²)	Error (% of SSHA variance)
CNES&CLS v2015	0,40	34
DTU v2021	0,34	29
CNES&CLS v2022	0,23	20
SIO v2022	0,21	18
HYBRID v2023 (SIO, CNES/CLS, DTU)	0,20	17

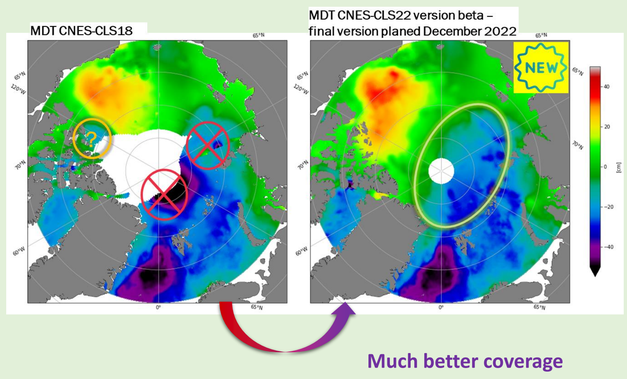
50% improvement at small scales

*SSHA "noise free" variance is estimated to 1,16cm²

See Pujol et al & Schaeffer et al. pres & poster

The CNES/CLS22 as a Mean Dynamic Topography

- Regional improvements with v2022 model
- Known 2018 artifacts fixed
- Velocities are 10% more consistent with drifters on average (locally much more)

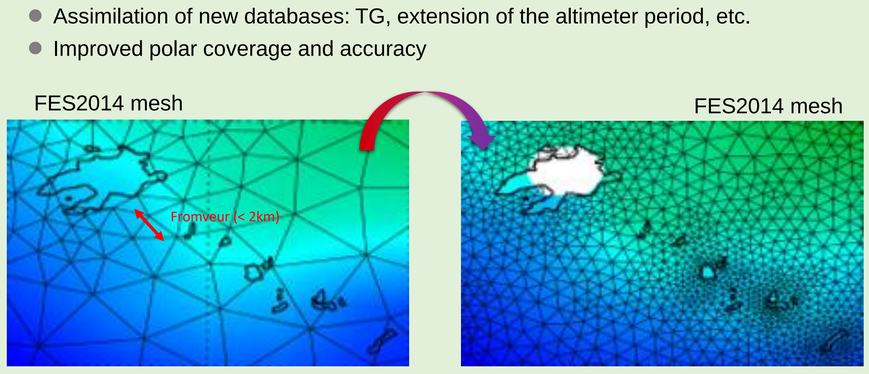


Jousset et al (in prep)

The FES 2022 a s tide model

Lyard et al (in prep)

- Improved bathymetry partly through the use of regional bathymetry
- New high resolution mesh: 8 times more elements than on the FES14B grid
- Assimilation of new databases: TG, extension of the altimeter period, etc.
- Improved polar coverage and accuracy

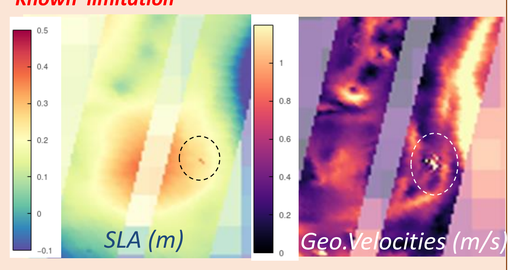


L3 Karin processing sequence : the V0.1 version

Editing Layers (V0.1)

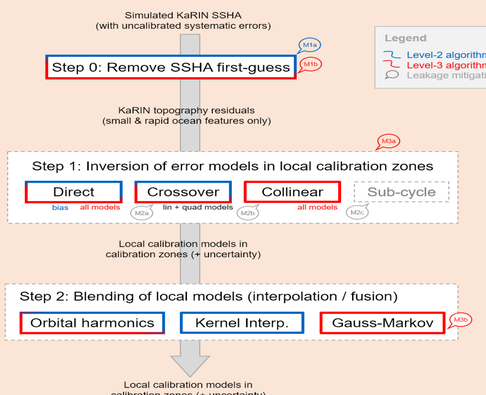
1. **Mask non-ocean data**: use of *ancillary_surface_classification_flag*
2. **Mask data with ice concentration above 30 %** : use of *ice_conc (OSI SAF)*
3. **Mask data with products quality information**
   - **combination of quality flags from** 19 bits in *ssha_karin_2_qual*
   - **threshold in KaRIn uncertainty from** *ssh_karin_uncert*

Known limitation



L3 data-driven calibration

- Step 0 & M1b: external data from all nadir altimeters (SWOT + S6 + S3)
- Step 1: use Direct and Crossover retrieval algorithms for the 21-day orbit, and Direct + Collinear for the 1-day orbit
- Step 1: Can resolve intra-crossover variability (not just a scalar/xover)
- Step 2: use Gauss-Markov interpolator for broadband error (not a simple kernel interpolator)
- M3a & M3b: use covariance/spectra instead of least squares (measured in simulation, determined in CalVal for flight data)



Dibarboure & al 2022

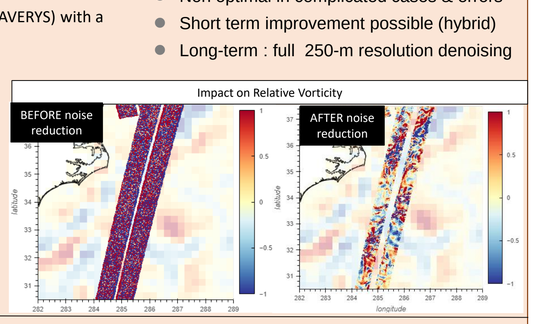
AI-based Noise-mitigation algorithm

Treboutte & al 2023

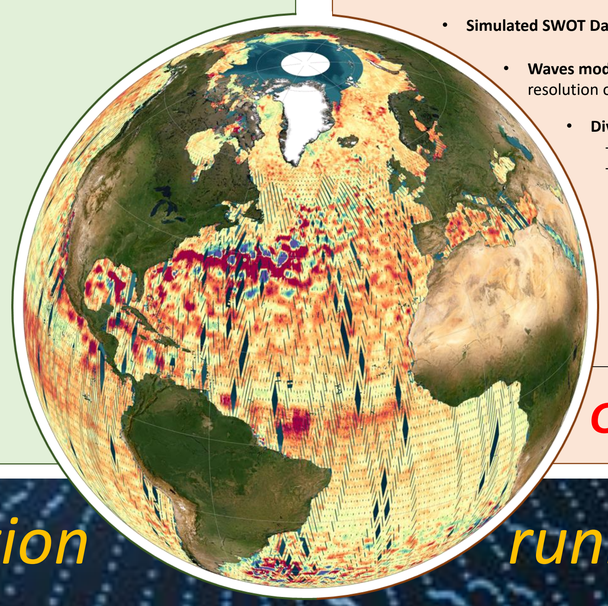
- **Simulated SWOT Data (eNATL60 model)** : Noisy SSH = true SSH + Karin noise modulated by the waves
- **Waves model** : global ocean reanalysis wave system of Météo-France (WAVERYS) with a resolution of 1/5° degree
- **Division of the dataset** :
  - Year 2009 : training dataset (train : 75 %, validating : 25 %)
  - Year 2010 : dataset for the calculation of scores
- **Data preprocessing :**
  - used of anomalies of SSH
  - used of data normalization
  - used of data augmentation : Vertical and/or Horizontal Flip
- **Division of the swaths :** 512 km along-track

Known limitation

- Non optimal in complicated cases & errors
- Short term improvement possible (hybrid)
- Long-term : full 250-m resolution denoising



Community feedback & suggestions welcome



Near real time production *running since last Spring*