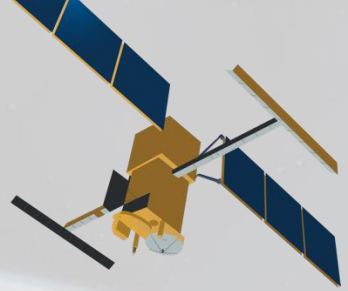
SWOT WEBINAR: OCEAN DATA PRODUCTS & SERVICES

November 15th, 2024

SWOT AVISO Team

CNES, Toulouse, France

Outline: SWOT Ocean Data Training Session



SWOT KaRIn Low Rate (LR, Oceanography) products – 15' (R. Chevrier)

- SWOT Products Overview
- SWOT Ocean Products Overview (Low Rate)
- Focus on the L3 LR SSH Product
- Focus on L4 (gridded) Multi-mission Product

Data Access and Services – 15' (C. Germineaud)

- Via AVISO & PODAAC
- SWOT Community GitHub platform
- On CNES HPC (Cloud-like hosting)

SWOT KaRIn LR Applications – 10' (C. Germineaud)

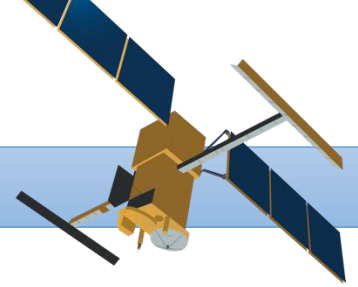
Ready-to-use tutorials (Jupyter notebooks) - 30' (A.S. Tonneau)

- Extract SWOT LR data, comparison Swot /vs CMEMS, Swot /vs SST
- Going further on CNES HPC

Perspectives – 5' (R. Chevrier)

Questions – 30-40'

SWOT Product Overview



Orbits

Cal/Val

1-day repeat
sparse coverage
28th March 2023 – 10th July 2023

Science

21-day repeat
global coverage
26th July 2023 – now

Instruments

1D Nadir Altimeter

Jason-class – Poseidon 3C

KaRIn 2D Interferometer

Timeliness levels

Near real time

3 hours to 3 days

Reprocessed data

More precise than NRT

KaRIn Resolutions

Low Resolution

- Ocean
- 250 m to 2 km

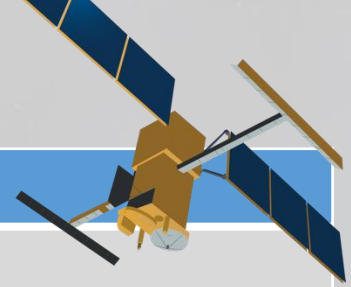
High Resolution

- Hydrology
- 10 to 60 m

Version released

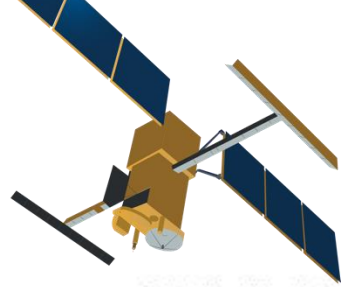
Baseline B	Nov 2023	Beta *prevalidated* release for early Cal/Val evaluation
Baseline C	March 2024	First « Science » release Declared as *validated* by the SWOT project (Aug 2024)
Baseline D	February 2025	

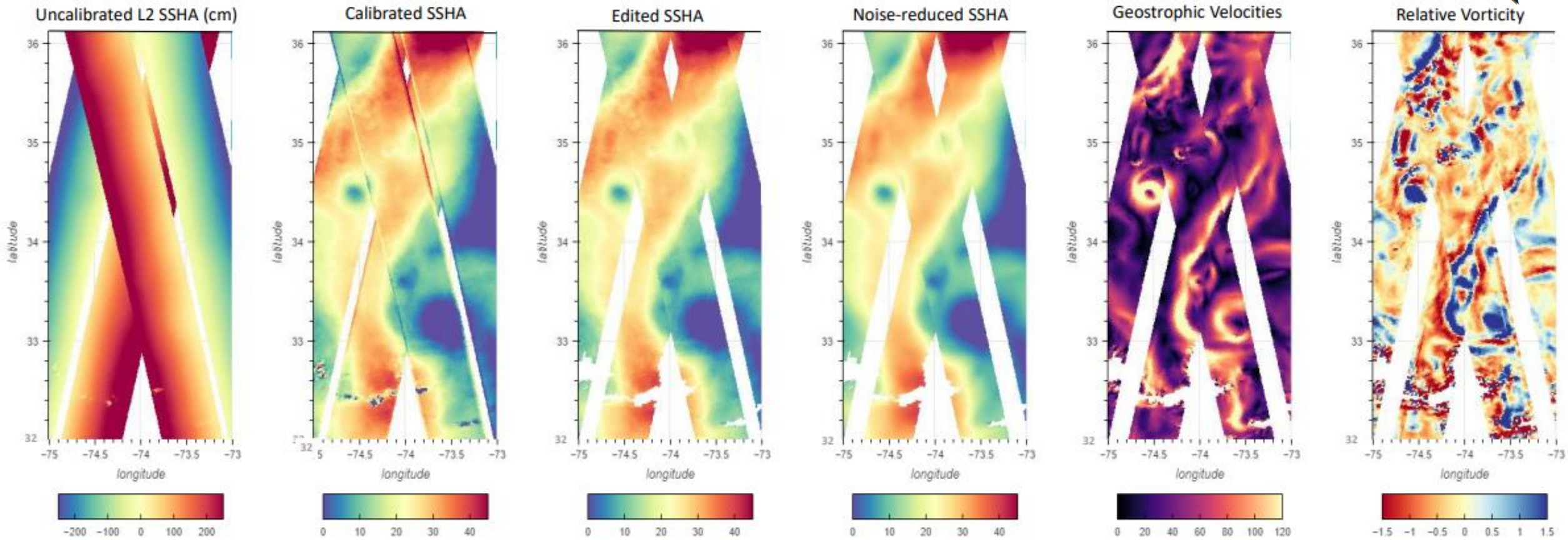
SWOT Ocean (Low Rate) Product Overview



Level	Dataset	Grid	Comment
Level-1B		~250 m Native grid	Interferogram Geo-location on a reference surface Surface height not computed High volumetry > 1 Tb per day
Level-2	Basic	2 km	Volumetry – 300 Mb to 1 Gb / per day WindWave and Basic: subset of the Expert dataset
	Expert		
	WindWave		
	Unsmoothed	250 m native grid	Technical No Sea surface anomaly yet High volumetry – 22 Gb per day
Level-3	Basic	2 km	New geophysical standards Multi-mission calibrated
	Expert		
	Unsmoothed	250 m	High volumetry – 15 Gb per day Sea surface anomaly
Level-4	Nadir	gridded (0.25°)	Available on CMEMS
	Nadir + KaRIn	Gridded (<0.125°)	Experimental datasets (available on AVISO only)

Level-3 KaRIn end-to-end example

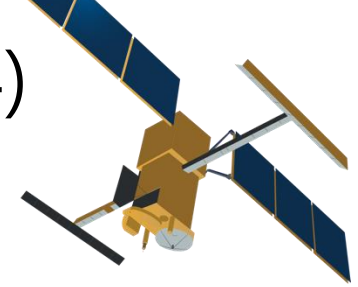


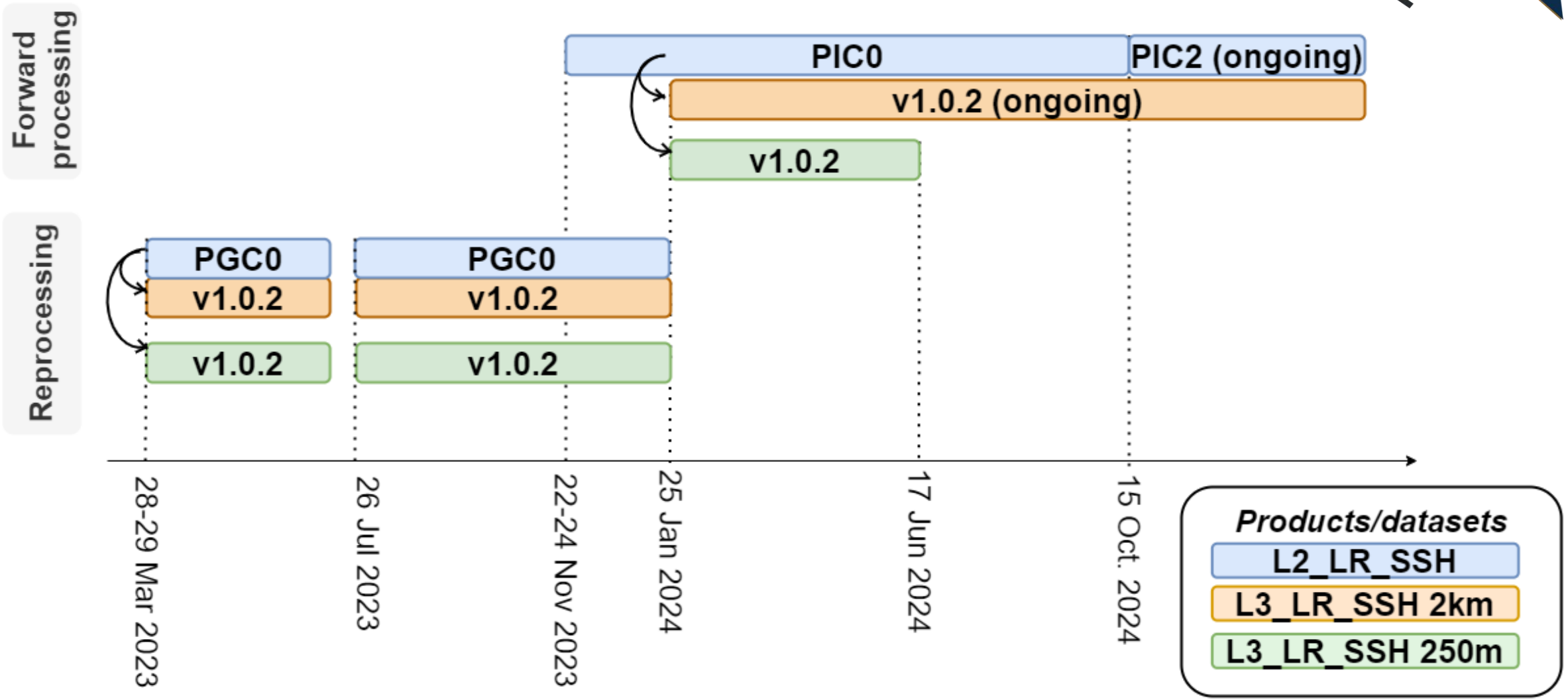


Credits: G. Dibarboure (CNES) & M.I. Pujol (CLS)

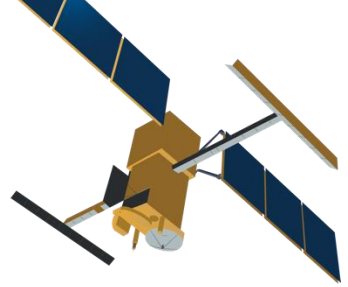
- Small mesoscales remain visible in Level-3 SSHA
- Denoising allows access to a first raw estimate of geostrophic currents & vorticity
- /!\ Denoising is likely to smooth out submesoscale physical features

Level-3 KaRIn products versions (2023-2024)





Focus on the L4 (Gridded) Multi-mission products



L4 CMEMS dataset with SWOT Nadir

- Available on CMEMS
- NRT since November 2023
- DT24 will use data from 2023
- Using SWOT Level-3 **Nadir data only** + CMEMS L3 along-track datasets
- Merging measurements from different altimeter missions available using objective analysis
  - ✓ Cannot process high volumetry
  - ✓ Will smooth out structures seen by SWOT
  - ✓ Switch to MIOST this year

SSALTO/DUACS Experimental datasets

- Available on AVISO
- DT from 2023
- Using SWOT Level-3 (**KaRIn & Nadir**) + CMEMS L3 along-track datasets
- Three Experimental datasets:
  - ✓ MIOST (global)
  - ✓ 4DVARNET (regional, N. Atl)
  - ✓ 4DVARQG (regional, N. Atl)

Reference
https://doi.org/10.5194/egusphere-2024-2345

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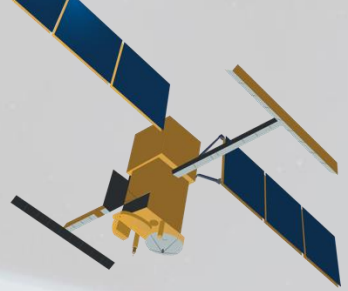

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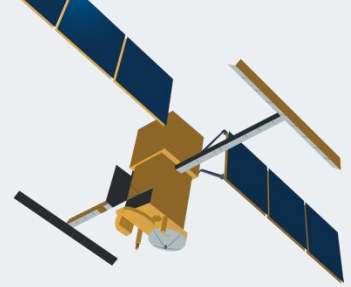
SWOT OCEAN DATA ACCESS & SERVICES

WHERE TO GET SWOT OCEAN PRODUCTS?



ODATIS/AVISO

L2, L3 & L4 Products

OPeNDAP / HTTPServer / (S)FTP / WMS / Viewers / ...

PODAAC

L1B, L2 Products

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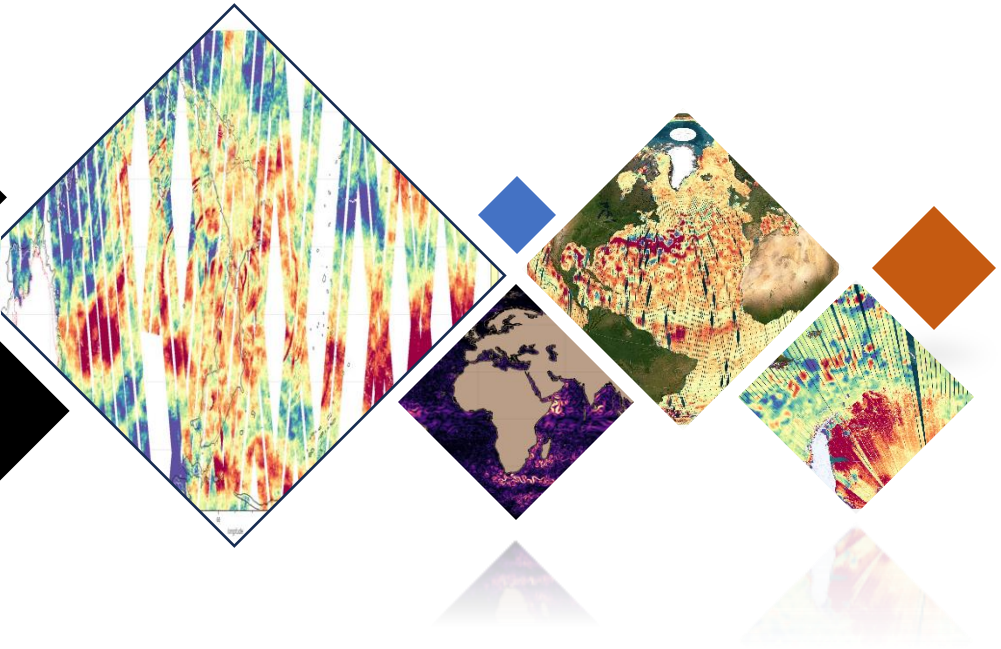
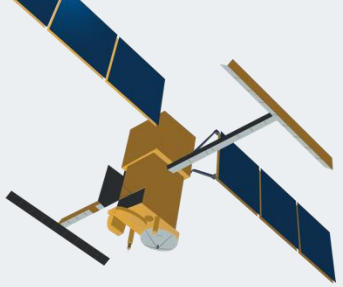




Data Access on ODATIS/AVISO

- AVISO CNES Data Center (archive catalog)
- THREDDS (OPeNDAP, WMS, and HTTP)
- FTP/SFTP,…

PRIOR REGISTRATION IS REQUIRED USING AVISO+ CREDENTIALS

CNES AVISO FTP/SFTP (with AVISO+ credentials):

•FTP access: ftp://ftp-access.aviso.altimetry.fr:21

•SFTP access: sftp://ftp-access.aviso.altimetry.fr:2221

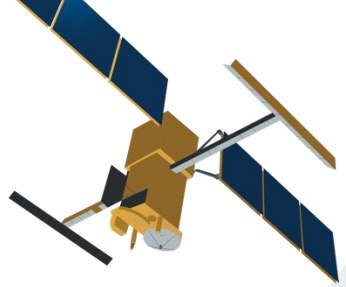
- /swot_products/l2_karin/l2_lr_ssh
- /swot_products/l3_karin_nadir/l3_lr_ssh

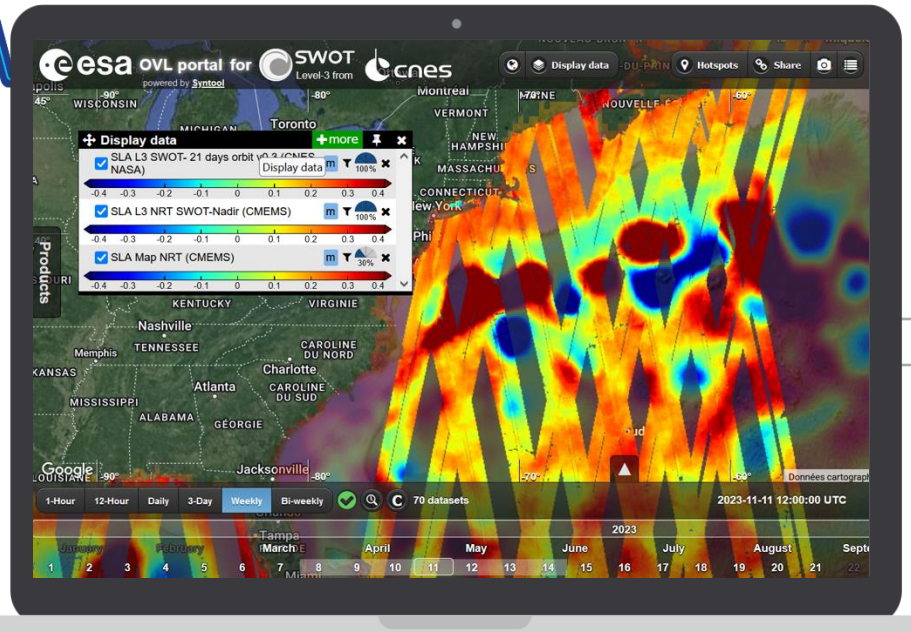
CNES AVISO TDS (with AVISO+ credentials):

•TDS access: https://tds.aviso.altimetry.fr

- https://tds.aviso.altimetry.fr/thredds/L2/L2-SWOT-DATA/L2-SWOT.html
- https://tds.aviso.altimetry.fr/thredds/L3/dataset-l3-swot-karin-nadir-validated.html

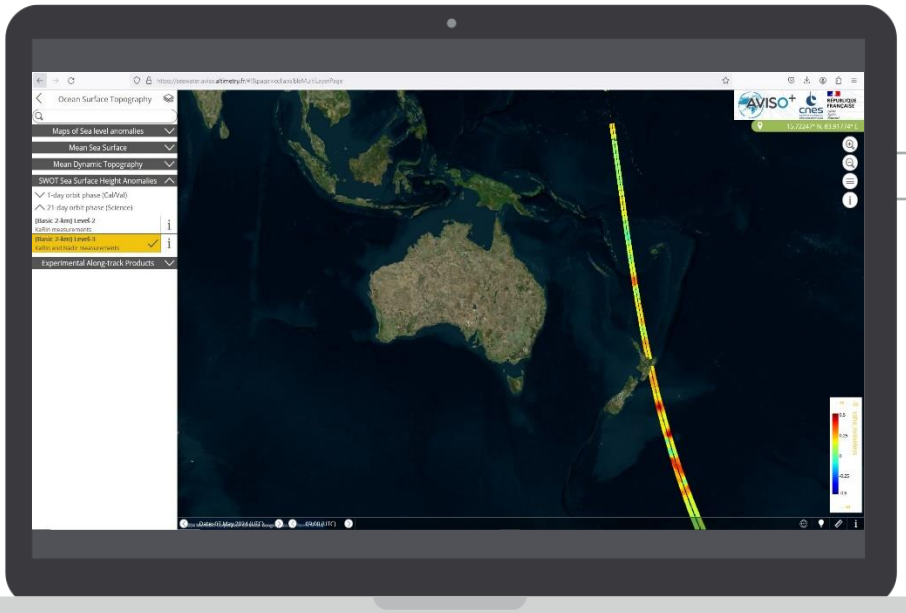
SWOT OCEAN
DATA ACCESS & SERVICES





OVL WEB PORTAL

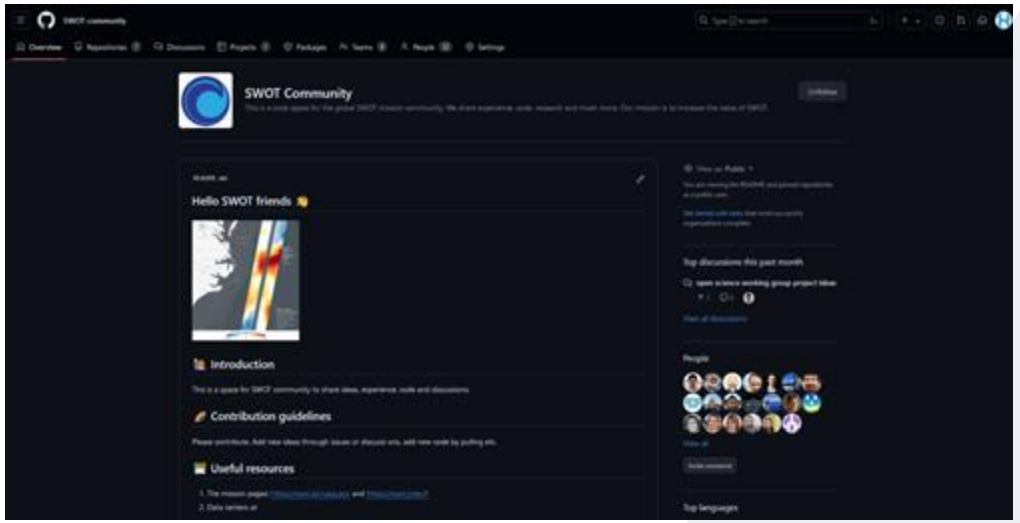
Exploration web portal for CNES Level-3 SWOT products (in collaboration with ESA and Ocean Data Lab)

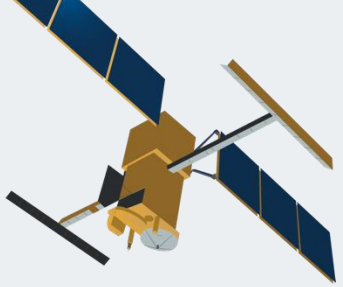


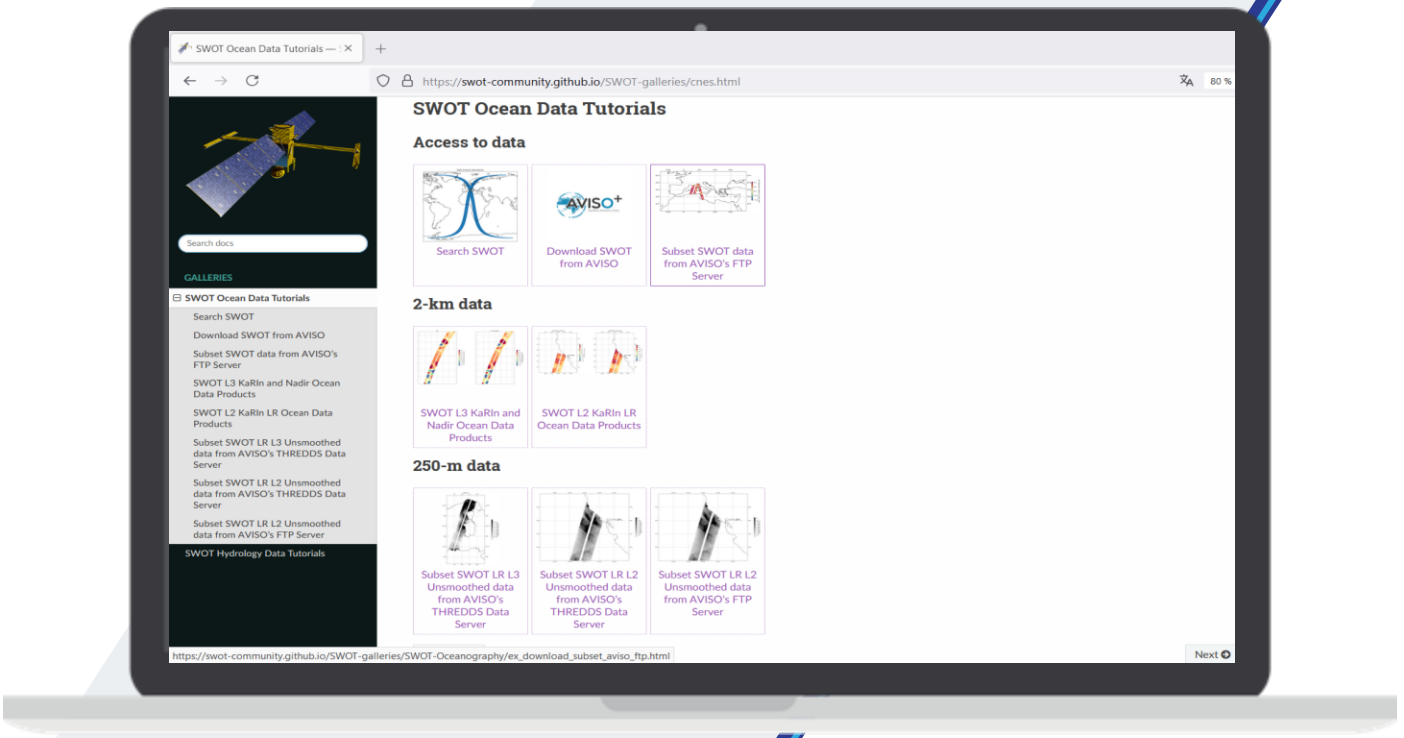
SEEWATER AVISO WEB PORTAL

Seewater provides an interactive web interface for exploring AVISO products (MSS, MDT, SLA,...)

Use, Contribute, Ask for new tutorials







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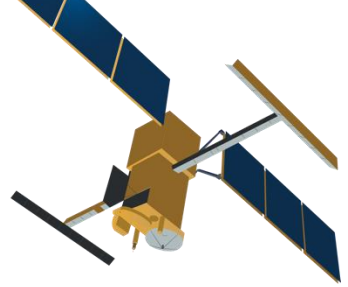
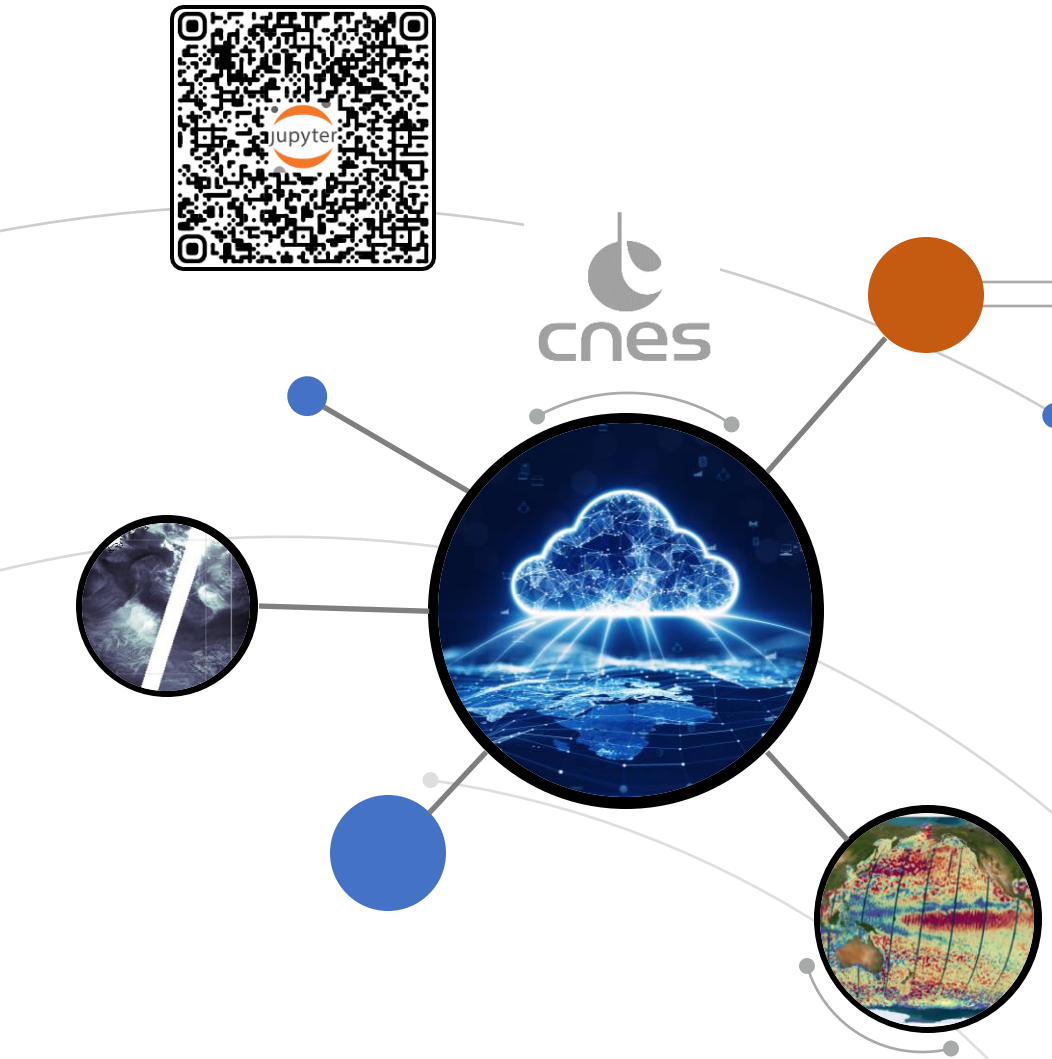


Free Hosting
of SWOT Projects on CNES HPC (cloud-like)



- FREE HOSTING ON CNES CLOUD/HPC INFRASTRUCTURE
- HIGH PROCESSING POWER (CPU & GPU)
- VERY FAST I/O FOR SWOT 250-M & 2-KM
  Cloud optimized format: Zcollection (Zarr)
- A SERIES OF SIMPLE EXAMPLES, POWERFUL TOOLS & EXTERNAL DATA
- PRIVACY FOR PROJECT MEMBERS (OR OPEN REPOSITORY IF YOU PREFER)
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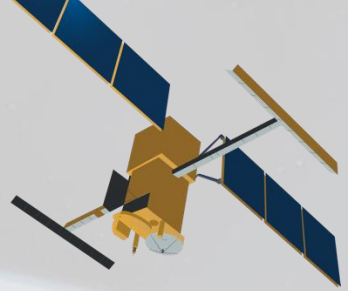

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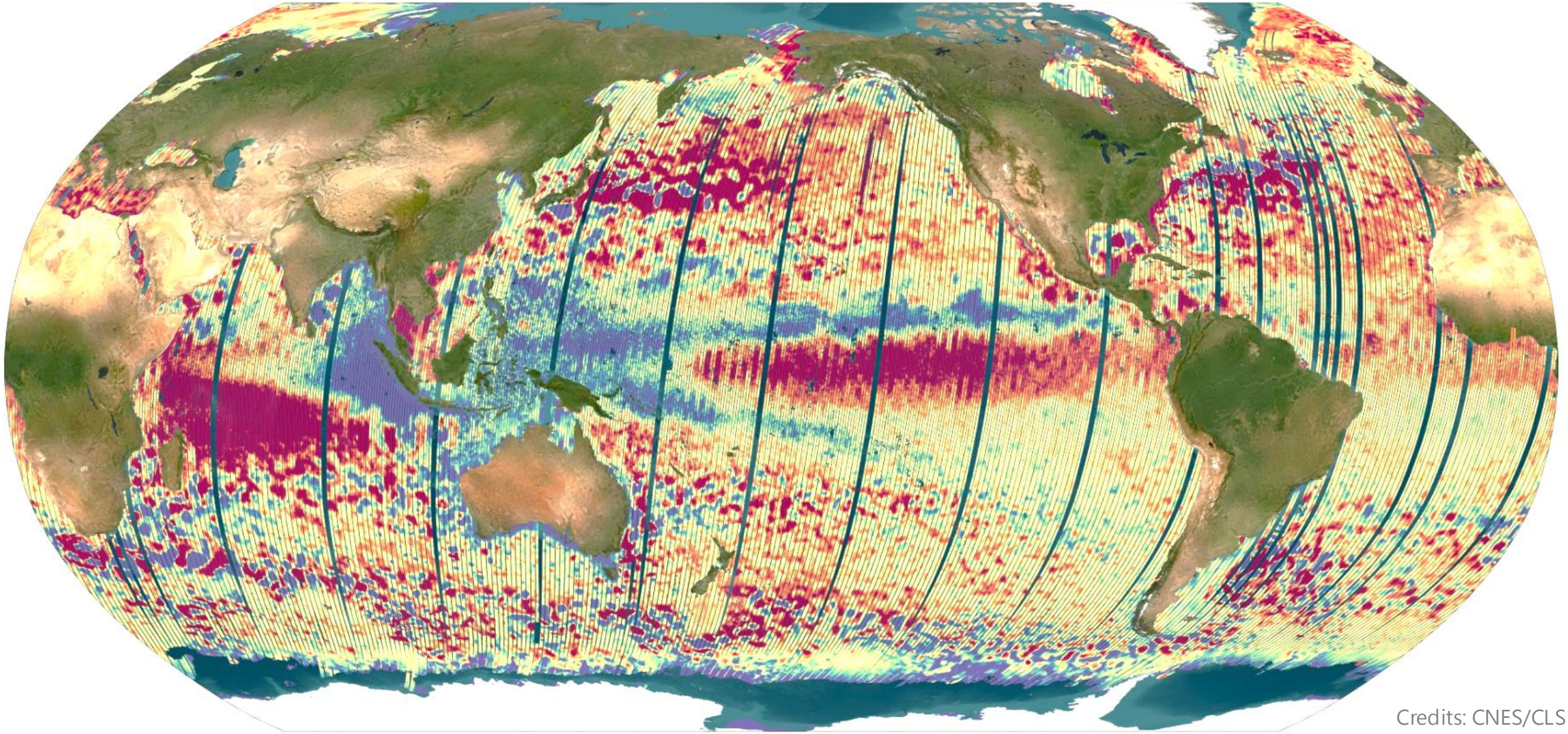
Ocean circulation: First results

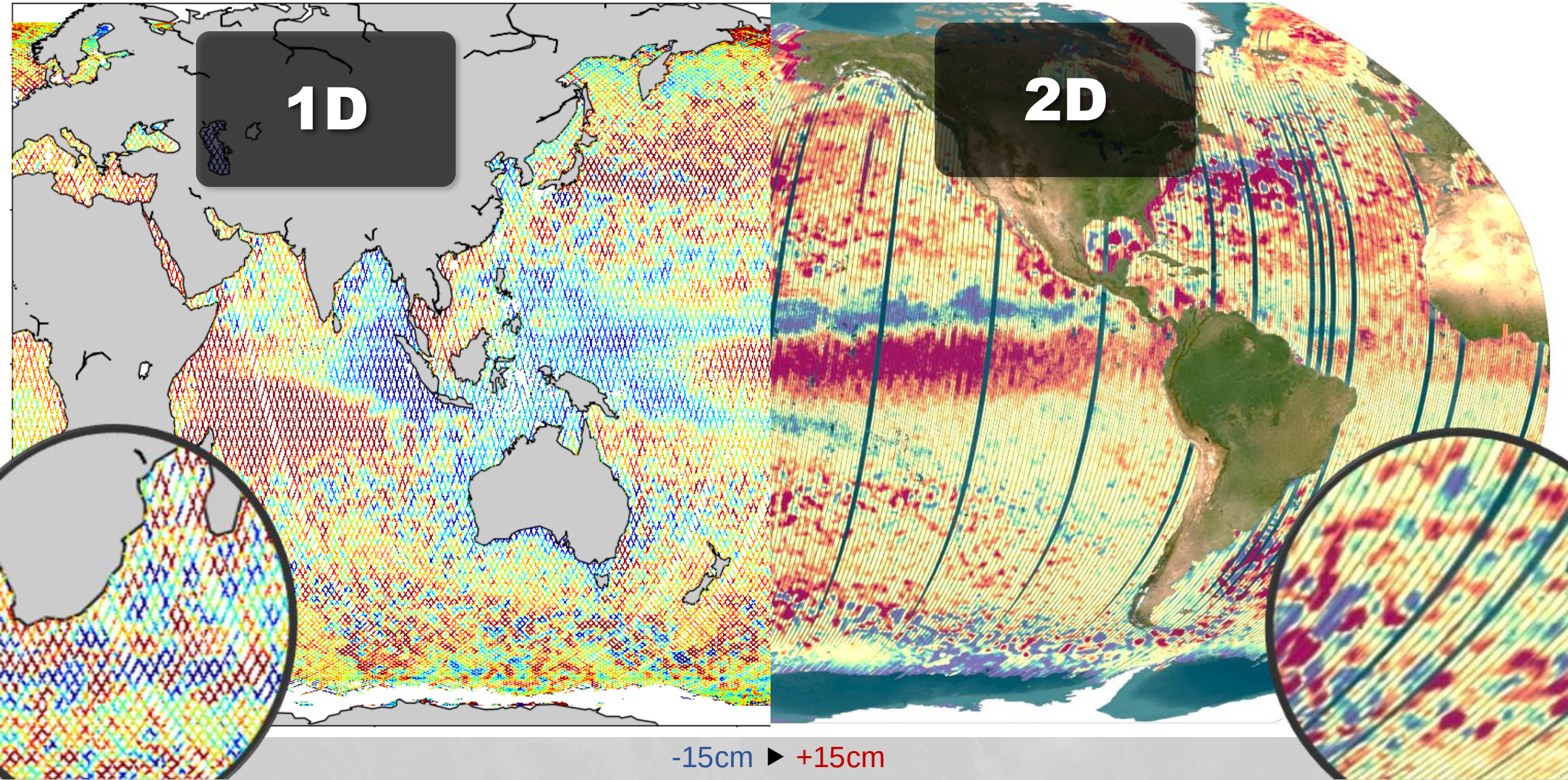
Ten days worth of SSHA in November 2023 from SWOT

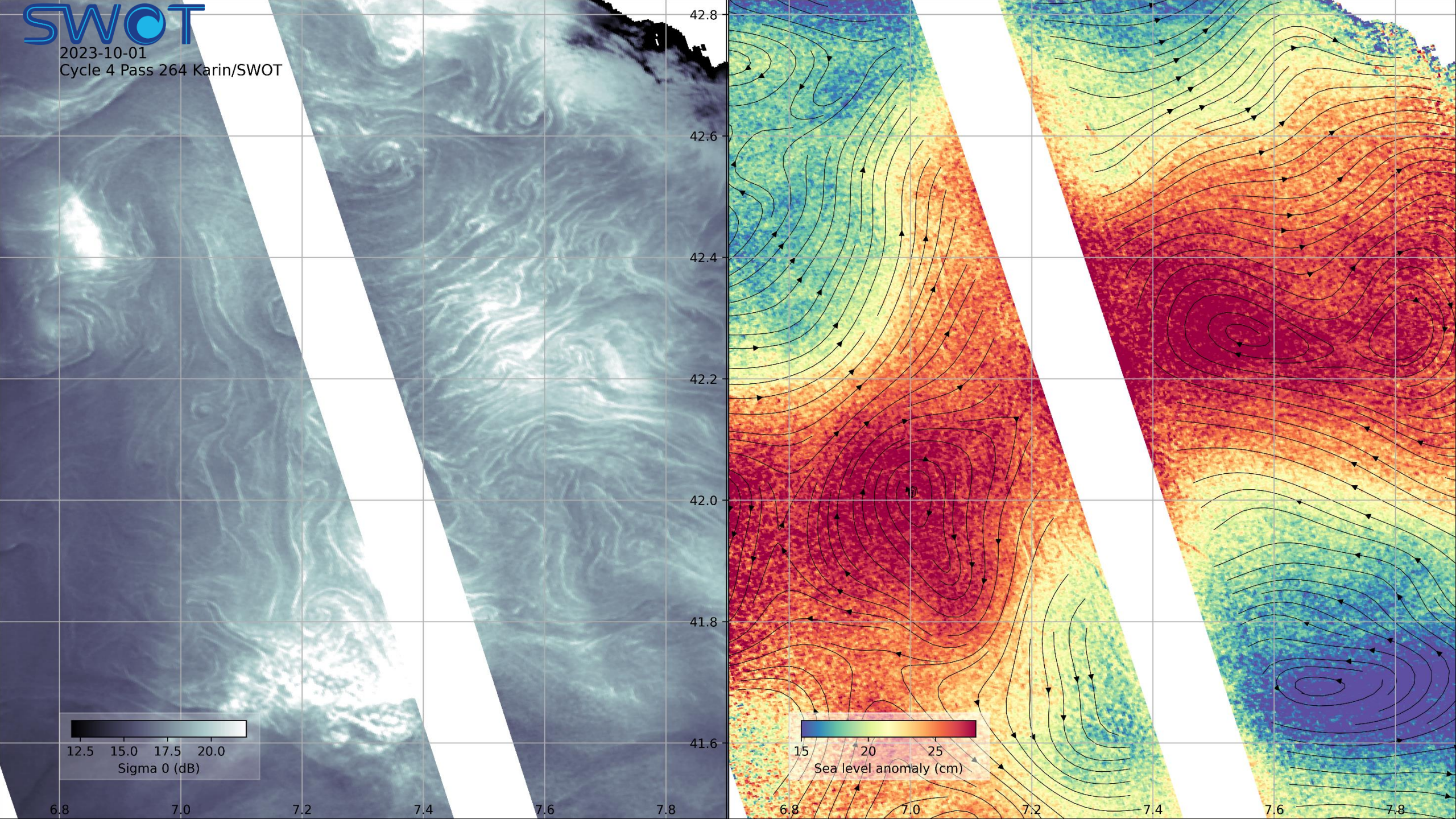


Credits: CNES/CLS

-15cm ▶ +15cm

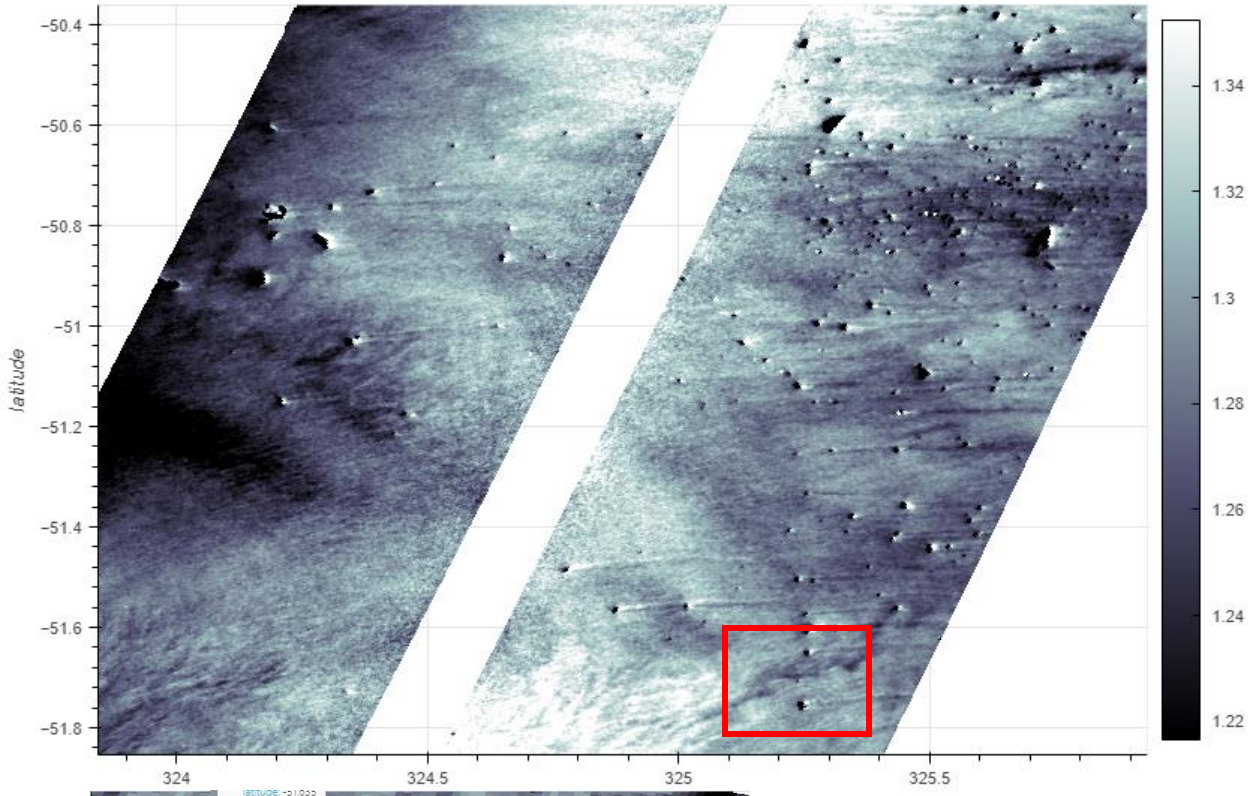
Ten days worth of SSHA in November 2023: Sentinel-6 & Jason-3 vs SWOT

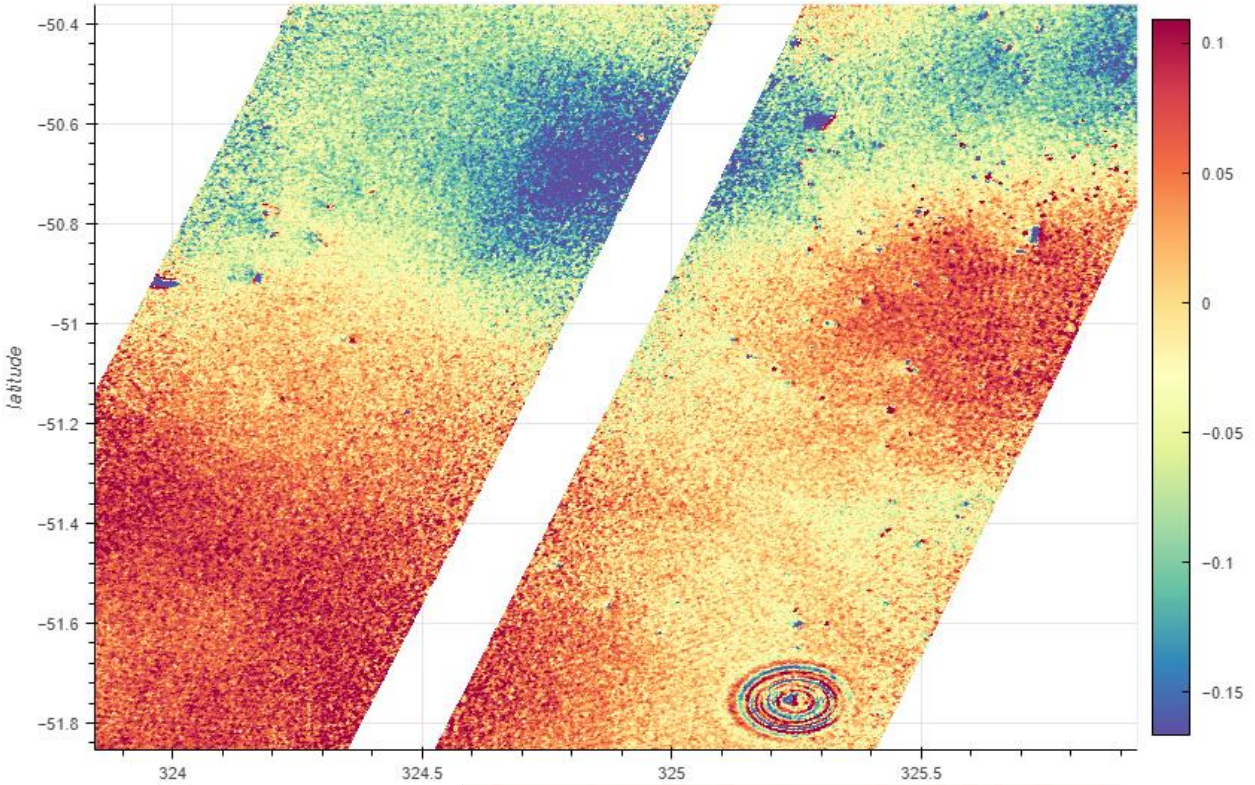


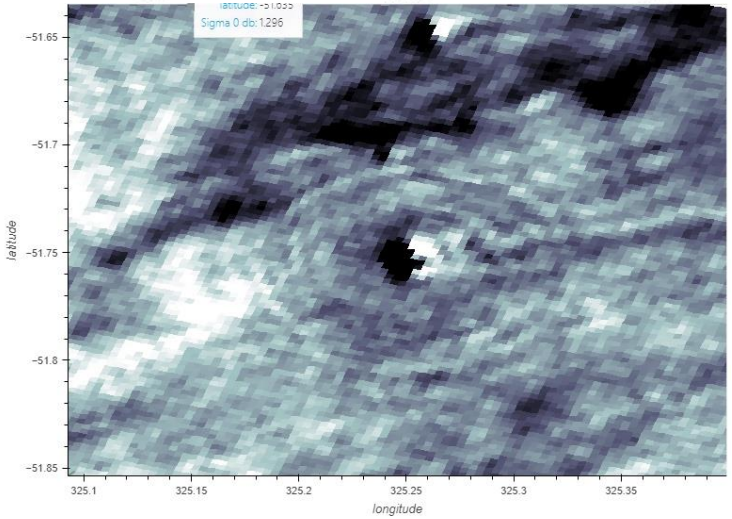

SWOT
2023-10-01
Cycle 4 Pass 264 Karin/SWOT
42.8
42.6
42.4
42.2
42.0
41.8
41.6
12.5 15.0 17.5 20.0
Sigma 0 (dB)
15 20 25
Sea level anomaly (cm)
6.8 7.0 7.2 7.4 7.6 7.8


SWOT
Unbalanced motions: tsunamis to internal waves

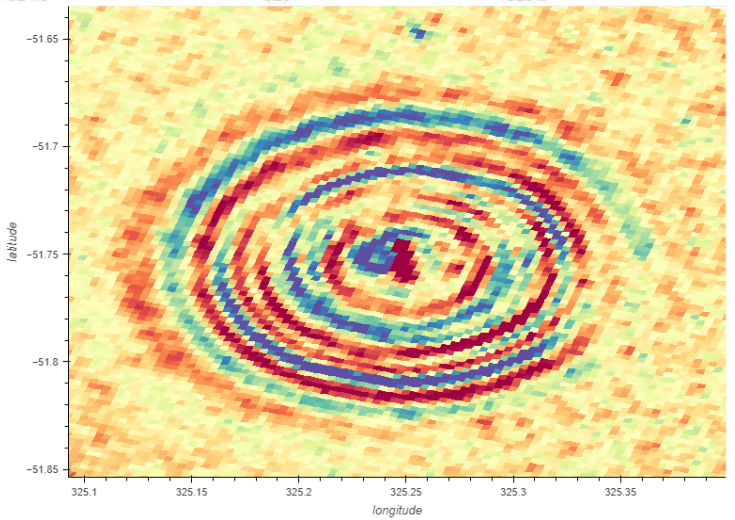
Occasional circular waves near icebergs





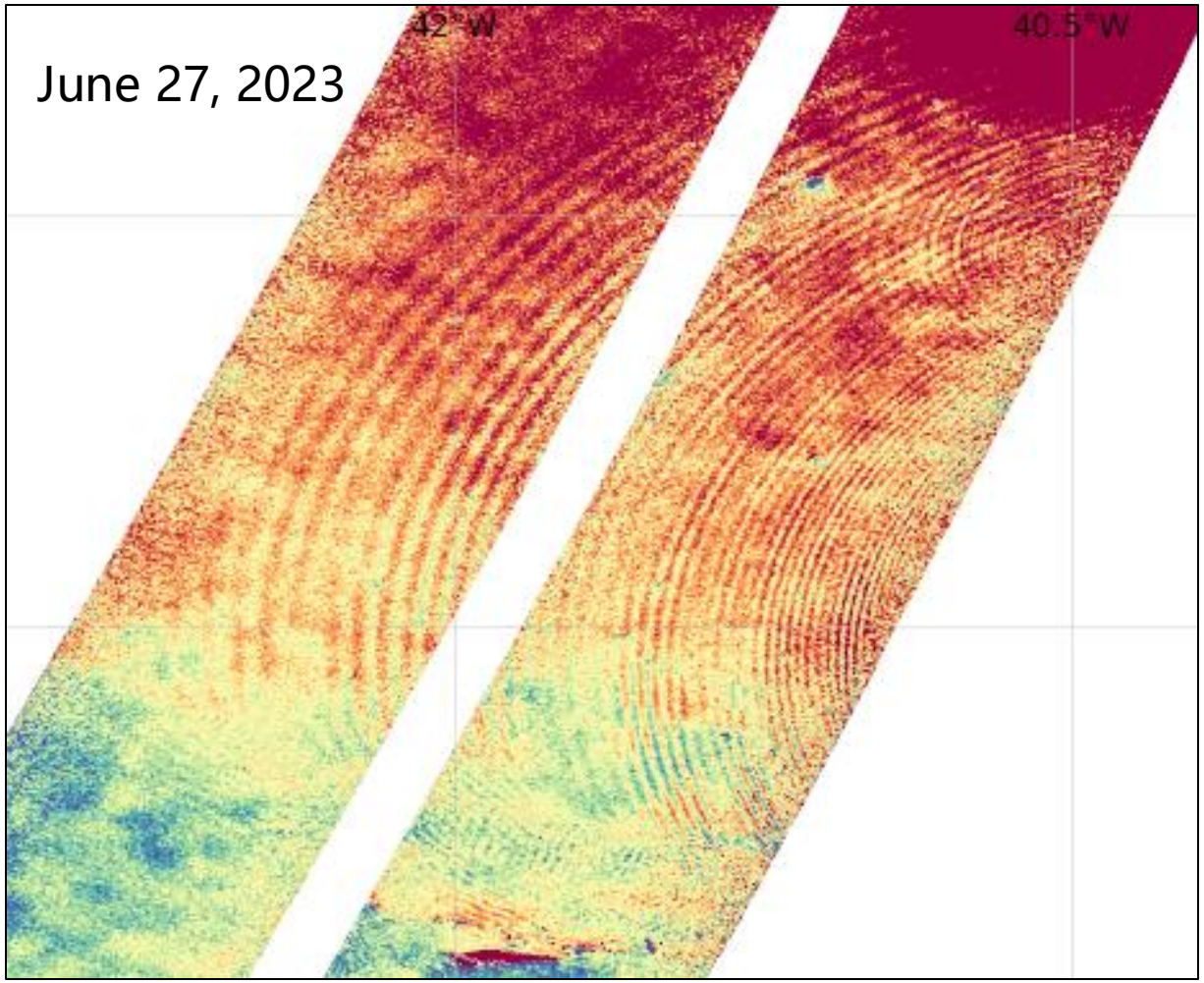


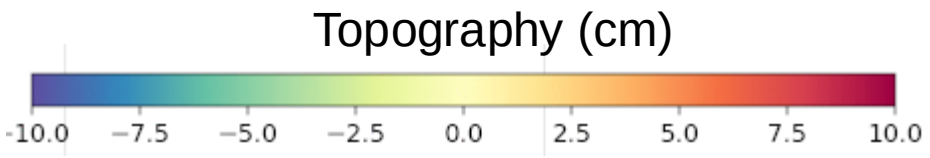
Mini-tsunamis occur as the iceberg capsizes (massive water displacement)



Credits: CNES/CLS

Some waves can be massive in extension and amplitude





Amplitude up to 10+ cm

Radius up to 200km

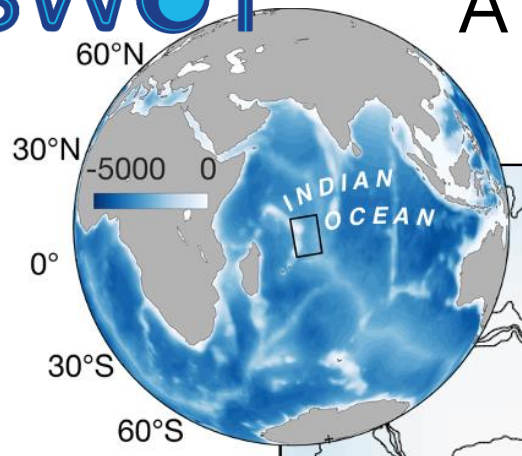
Widening of wave front from 250m to 10km

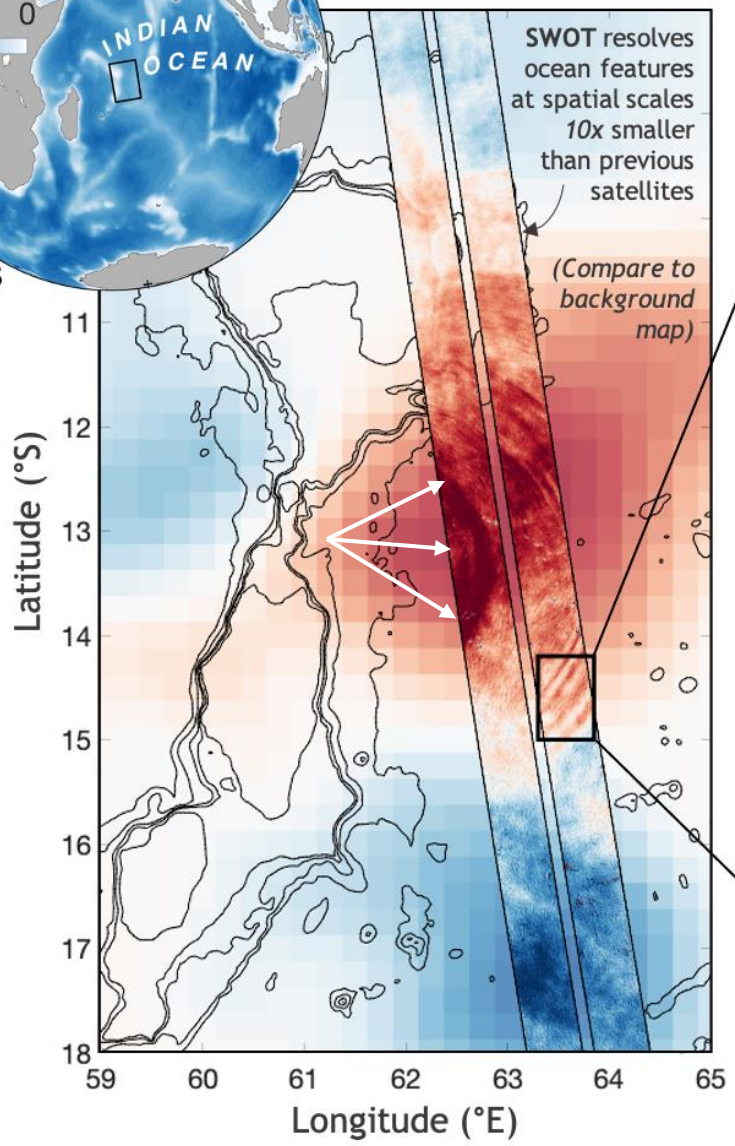
Credits: CNES/CLS

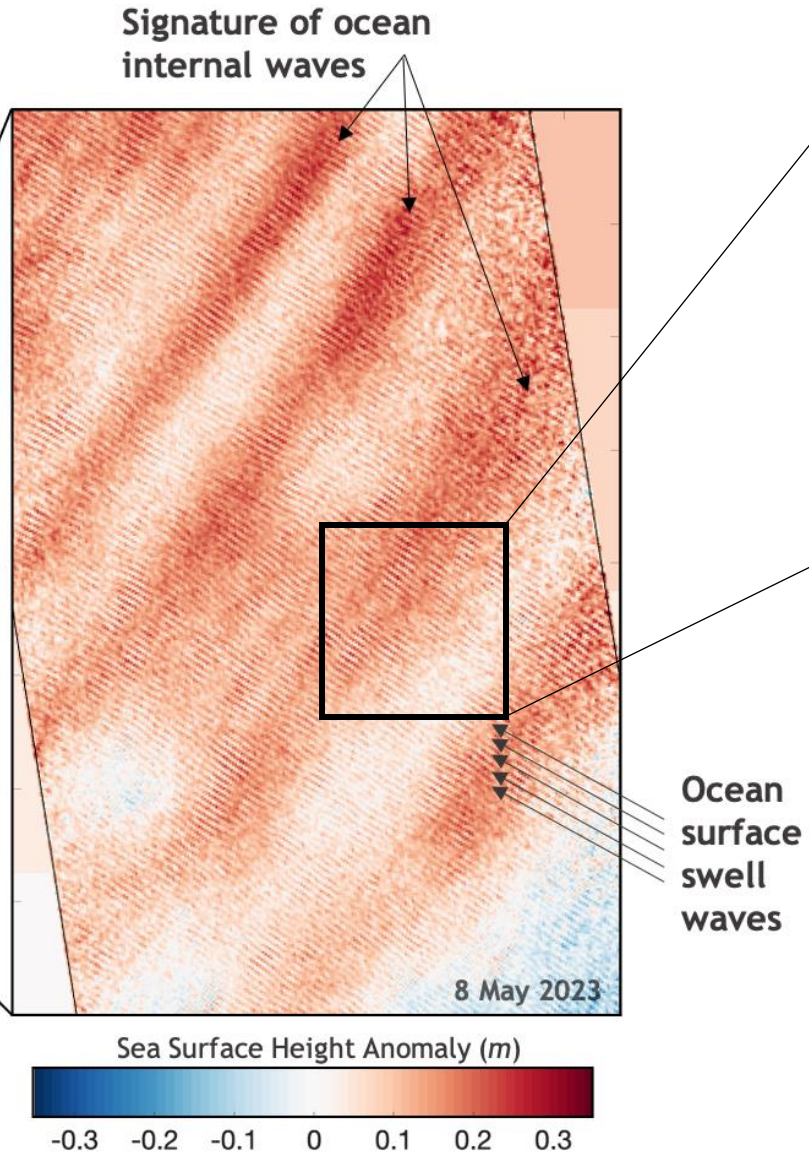
SWOT

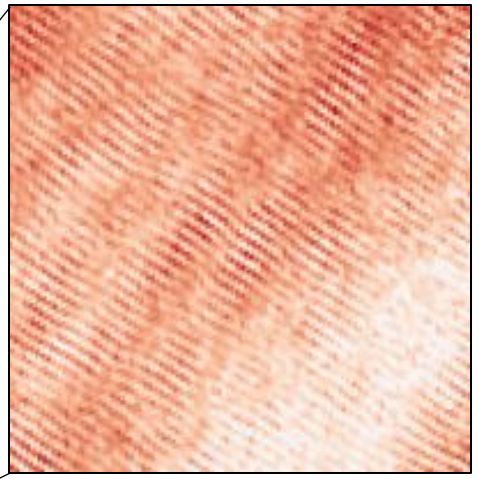
Resolved ocean swells

A Richness of resolved scales by SWOT (L2 KaRIn 250m)









Ocean Swell Wavelengths ~ 1 km

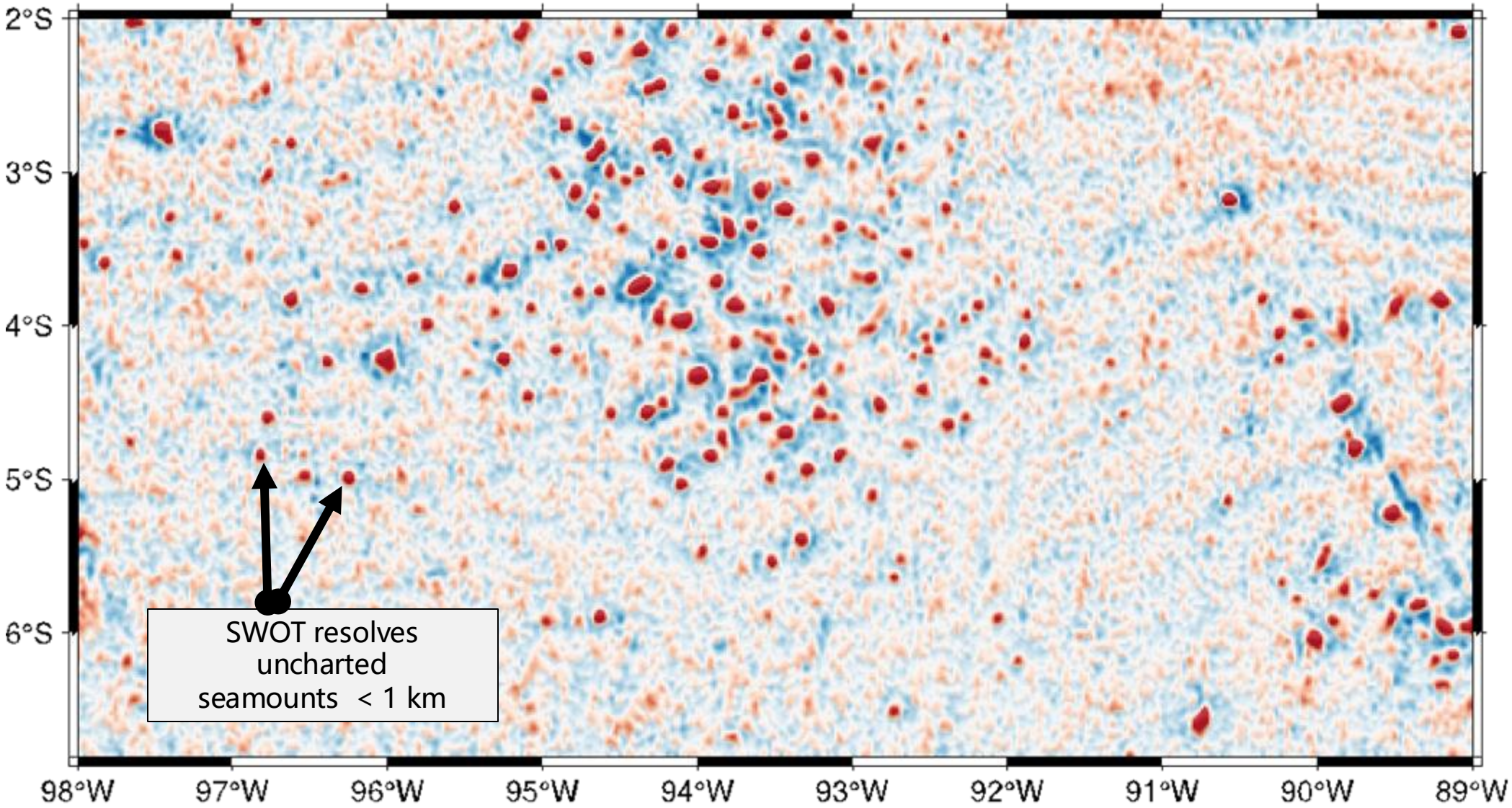
Ocean surface swell waves

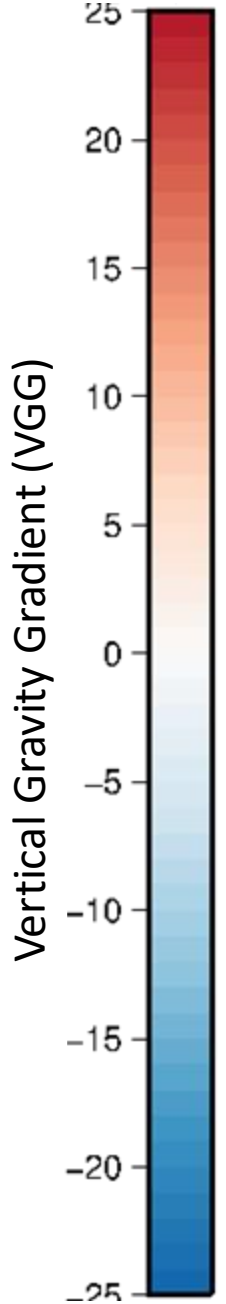
Courtesy of M.Archer, NASA/JPL

Marine Geodesy

Hundreds of seamounts charted by SWOT in < 1 year

(thousands of uncharted seamount to be discovered)





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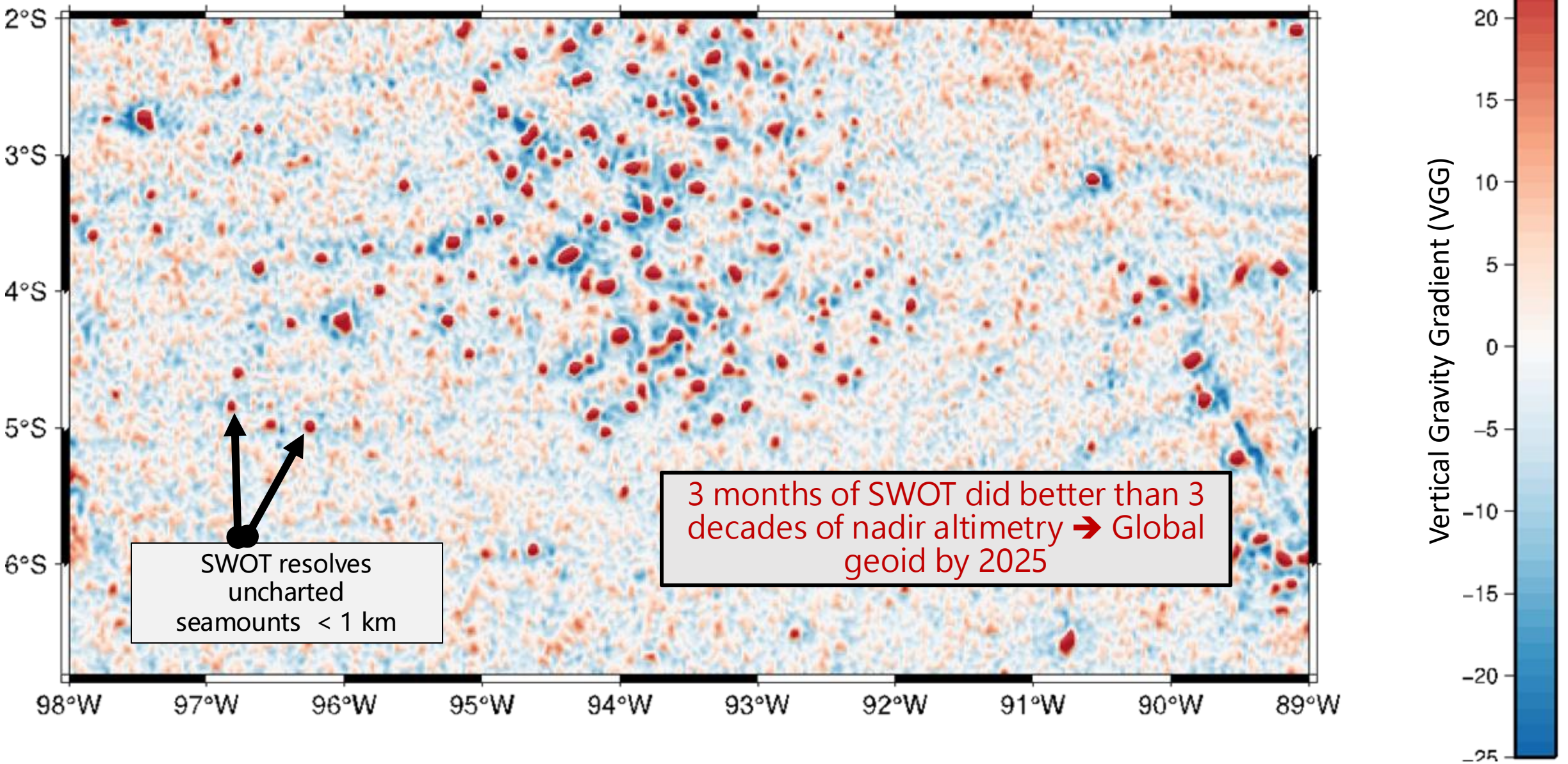
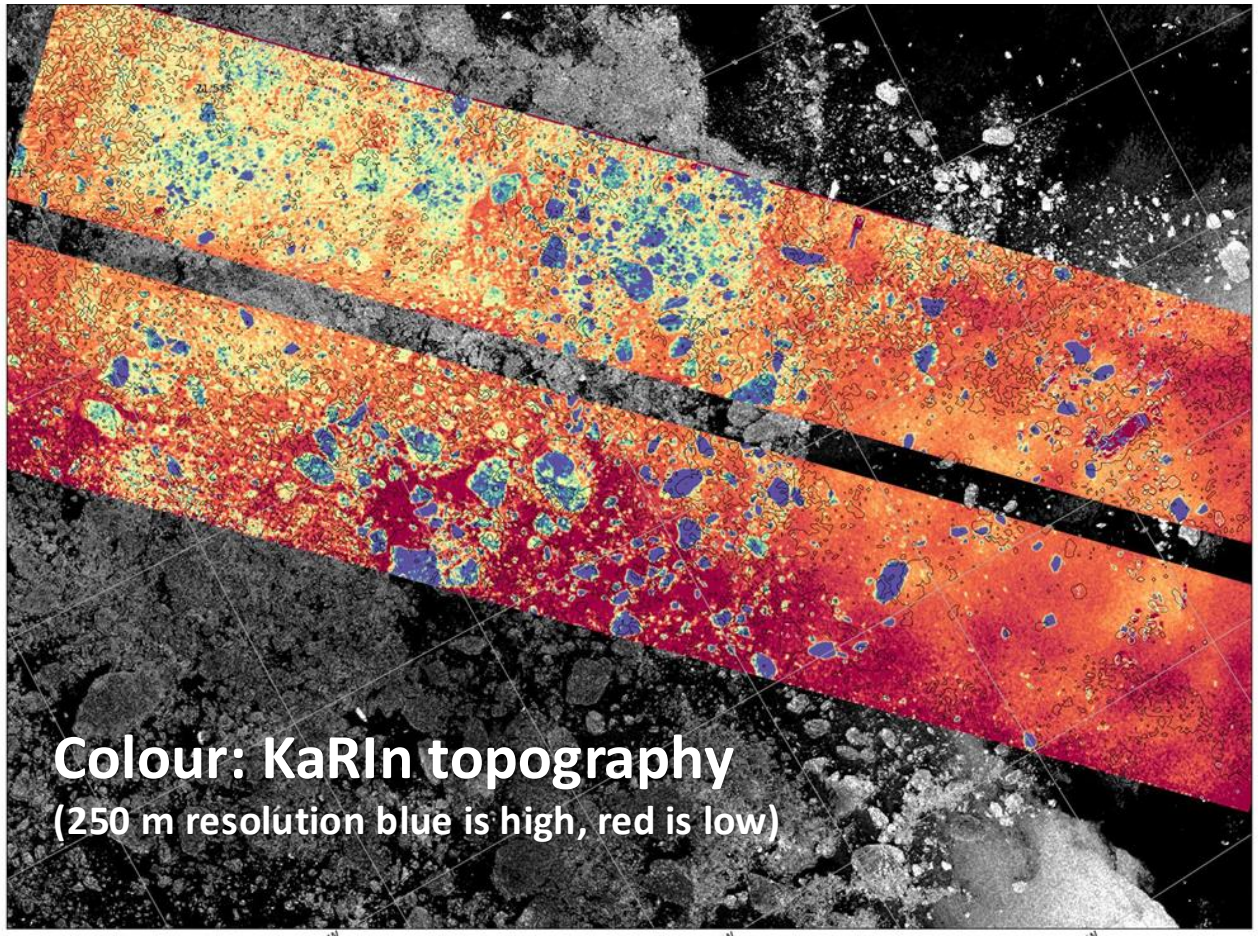
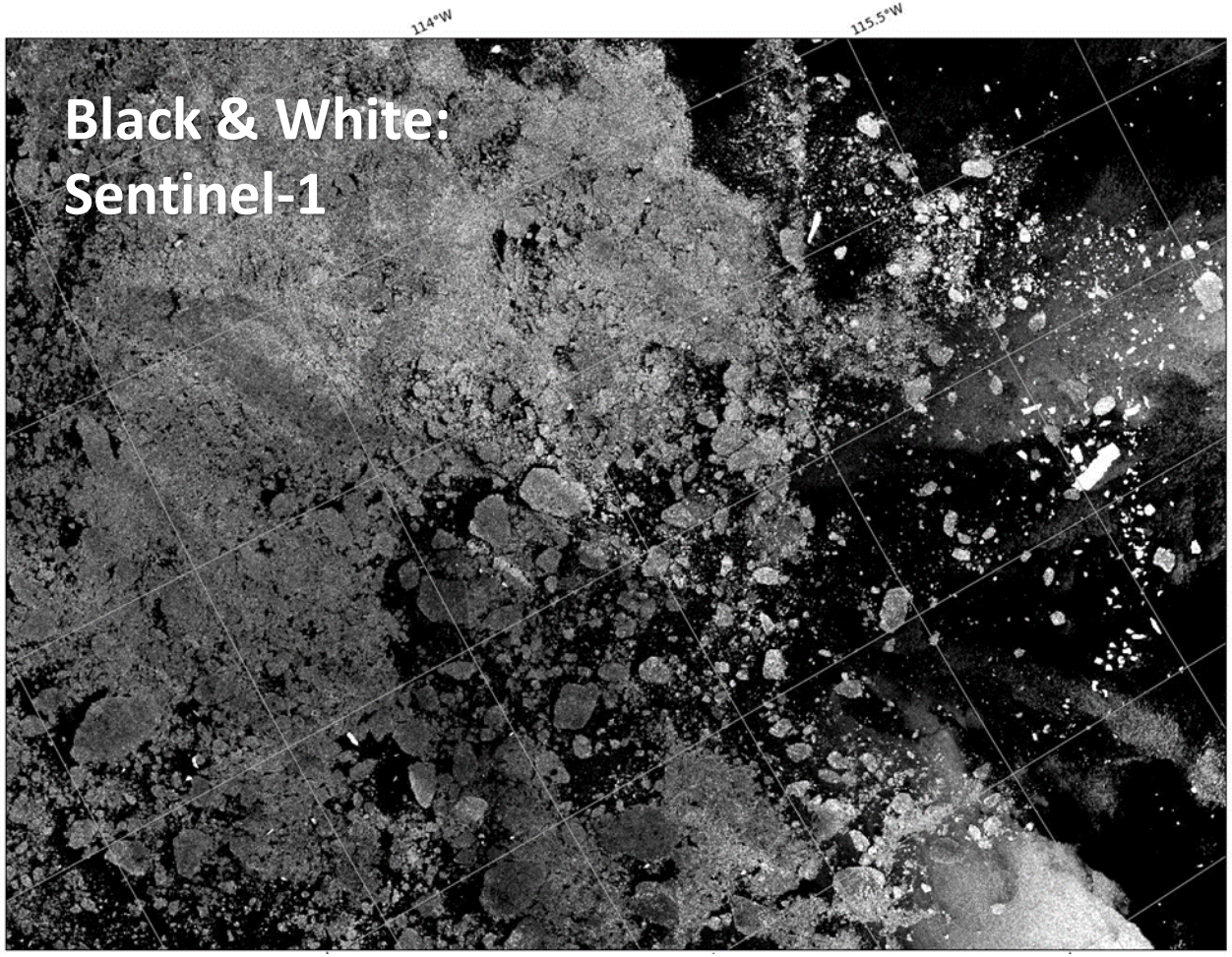


Polar Regions

Sea-ice: 250m freeboard and thickness in 2D





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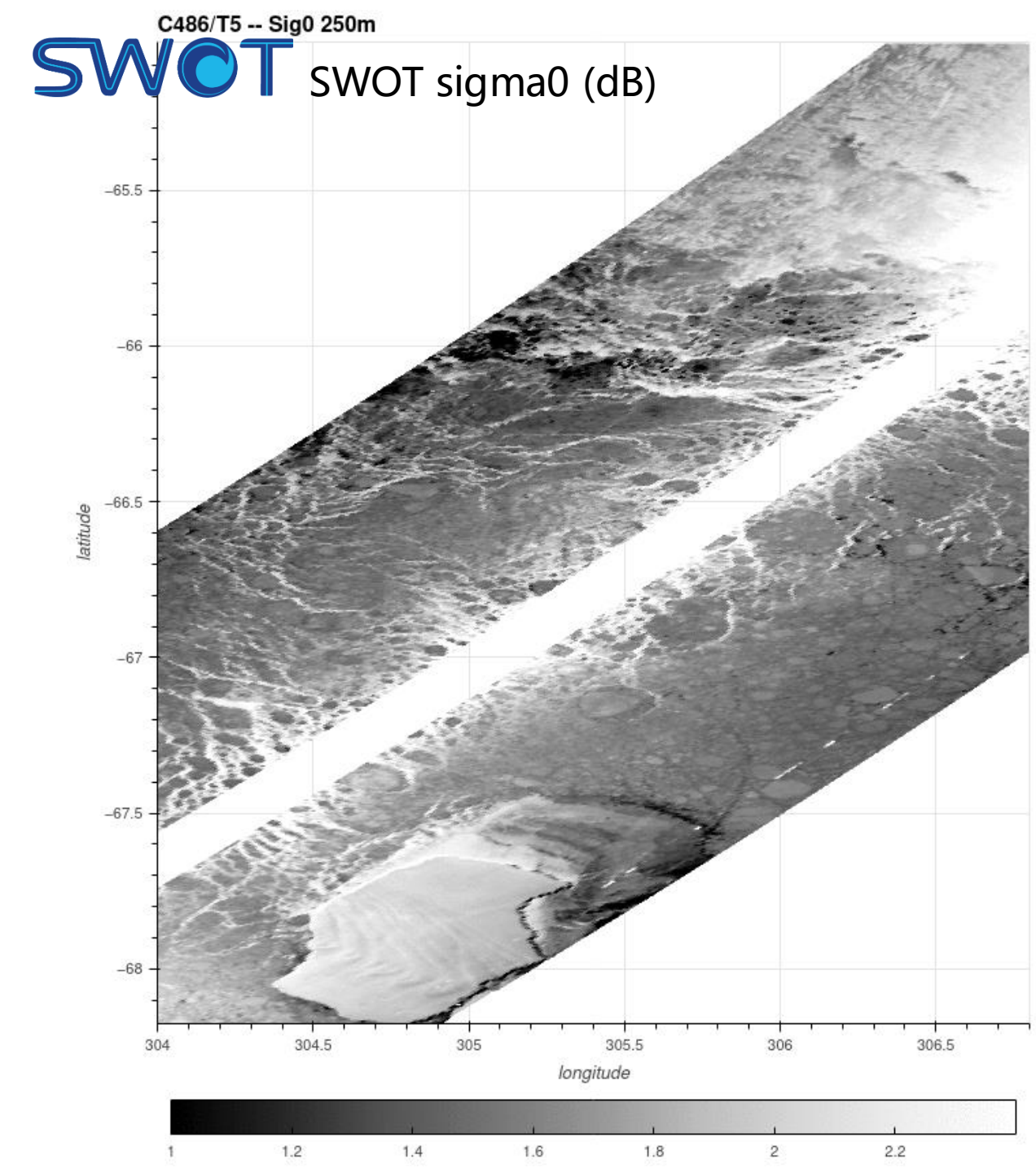

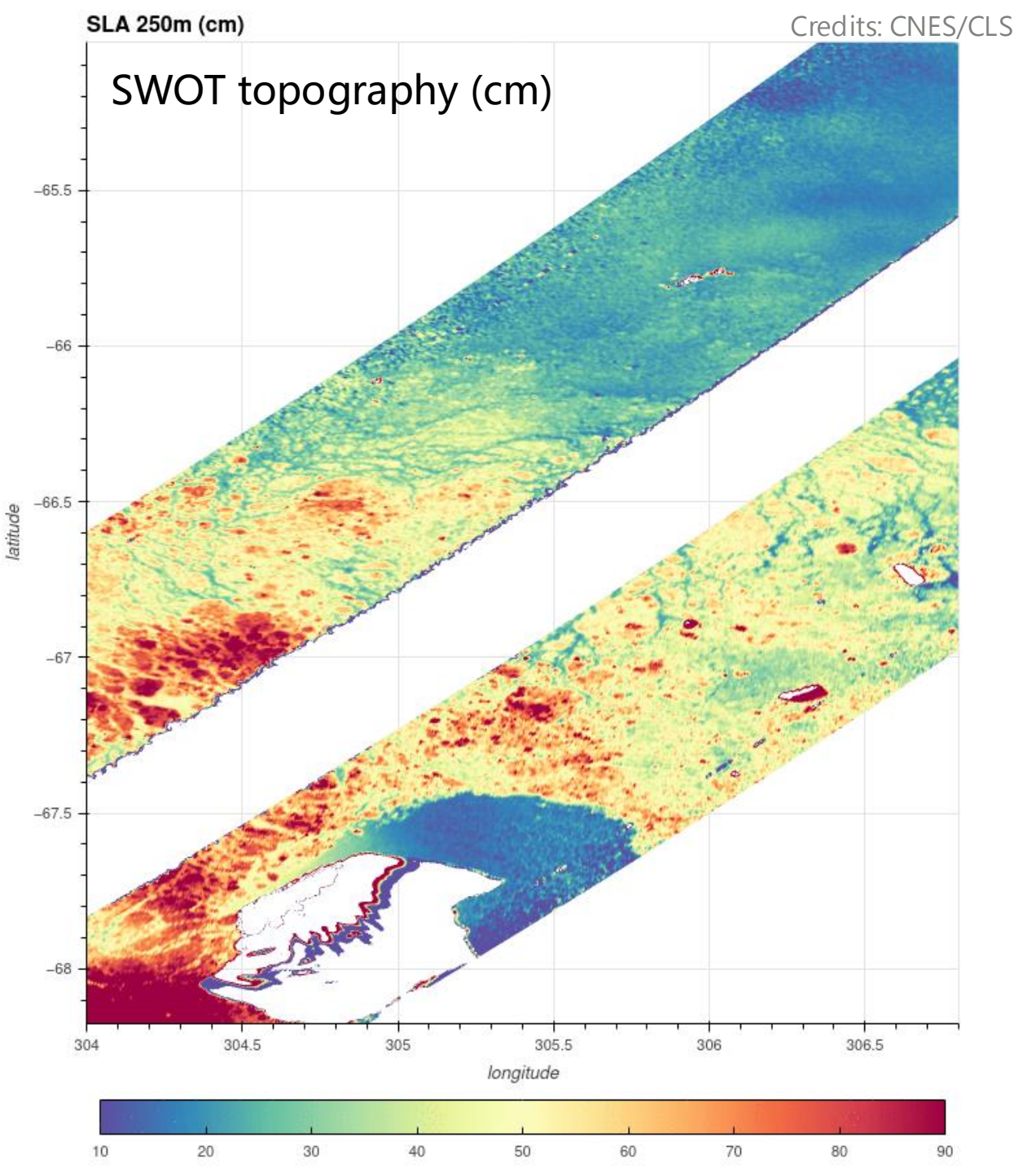

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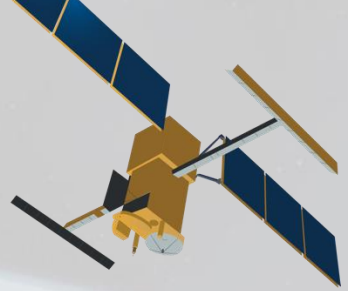

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Ready-to-use tutorials (Jupyter notebooks) - 30' (A.S. Tonneau)

- Extract SWOT LR data, comparison Swot /vs CMEMS, Swot /vs SST
- Going further on CNES HPC

Perspectives – 5' (R. Chevrier)

Questions – 30-40'

Tutorial 1 : SWOT data comparison with CMEMS L4 SLA and IFREMER SST data

Tutorial Objectives

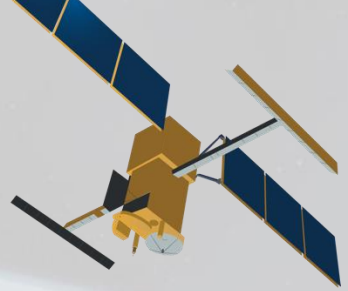
- Select SWOT data with cycle/pass numbers, and download via AVISO's FTP
- Select SWOT data that intersect a geographic area
- Download CMEMS (L4) maps of SLA and compare with SWOT KaRIn SLA
- Download SST map and plot it with SWOT SLA

Tutorial 2 : Going further on CNES HPC

Tutorial Objectives

- Access SWOT Unsmoothed L3 data hosted on CNES datalake via S3 protocol
- Apply geographic and temporal selections to SWOT data
- Visualise SWOT 250-m swath data
- Investigate missing or bad data by visualising quality flags

Outline: SWOT Ocean Data Training Session



SWOT KaRIn Low Rate (LR, Oceanography) products – 15' (R. Chevrier)

- SWOT Products Overview
- SWOT Ocean Products Overview (Low Rate)
- Focus on the L3 LR SSH Product
- Focus on L4 (gridded) Multi-mission Product

Data Access and Services – 15' (C. Germineaud)

- Via AVISO & PODAAC
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Planned evolutions & future releases

Disclaimer: Target release dates (to be confirmed in the coming months)

- L2_LR_SSH
  - New baseline: PID – February 2025
  - Associated reprocessing: PGD – end of the first semester 2025

- L3_LR_SSH
  - V2.0 - December 2024 (2km) and January 2025 (250m)
  - V3.0 blend of baselines C and D, to be defined based on L2 PGD reprocessing progress - late Spring 2025
  - V4.0 based on baseline D – Fall 2025
  - Complete time series for Unsmoothed dataset - 2025
  - Weekly update for Unsmoothed dataset - 2025

- L3 Wind & Waves with swells spectra
  - Follows the methodology of Ardhuin et al (2023).
  - Derived from the L2_LR_SSH and L3_LR_SSH Unsmoothed datasets
  - Beta version planned for December 2024

Perspectives – Helpdesk Support

- The hosting service on the CNES platform will continue, you can still apply via AVISO
- More thematic support: coastal zones, polar regions… Expert analyses are welcome so that we can share them
- New contributions will be added to the SWOT community GitHub platform (stay tuned to the examples gallery)


SWOT
THANK YOU
FOR YOUR ATTENTION
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AGENCY
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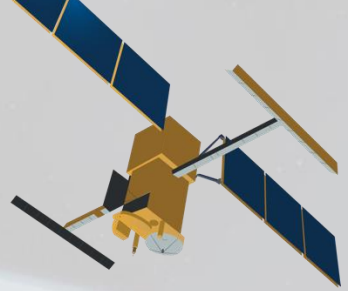
Outline: SWOT Ocean Data Training Session



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SWOT Ocean Products: an overview

SWOT Level-2 Ocean Products

- Nadir Altimeter and Radiometer (O/I)GDR products (similar to Jason-2/3)
- KaRIn L2_LR_SSH (2km & 250m)

KaRIn L2_LR_SSH	Grid	Volume /day - /year
Basic SSH ['Basic']	2km geographically fixed swath-aligned grid	< 1GB – 365 GB
Wind and Wave ['WindWave']	2km geographically fixed swath-aligned grid	< 1GB – 365 GB
Expert SSH with Wind and Wave ['Expert']	2km geographically fixed swath-aligned grid	1GB – 365 TB
Unsmoothed SSH ['Unsmoothed']	250m sampling grid	< 25 GB – 10 TB

SWOT KaRIn Level-2 Ocean L2_LR_SSH Products

Accuracy →
Latency →

Data sets	OGDR	IGDR	GDR
Reduced 1 Hz	OGDR-SSHA	IGDR-SSHA	GDR-SSHA
1 Hz + 20 Hz	OGDR	IGDR	GDR
1 Hz + 20 Hz + waveforms	Not generated	S-IGDR	S-GDR
Latency	3-5 hours	1-2 days	~90 days

Size and Complexity ↓

SWOT Nadir Altimeter Level-2 products

SWOT Level-3 Ocean Products (2km & 250m)

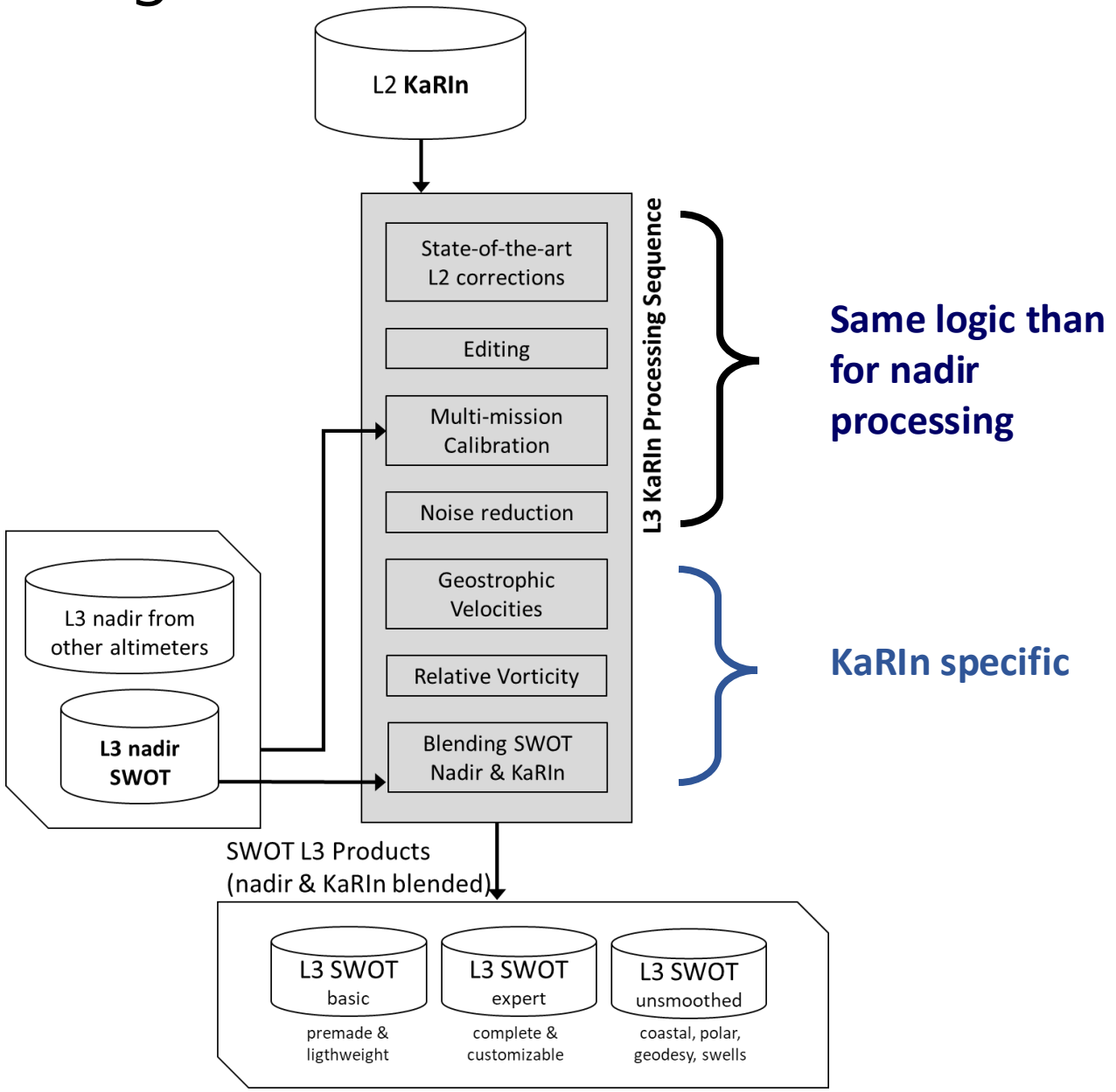
- Level-3 (KaRIn & Nadir) Basic 2km Product (SSHA and MDT only)
- Level-3 (KaRIn & Nadir) Expert 2km Product (unedited SSHA + all calibration/corrections and geostrophic velocity anomaly)
- Level-3 (KaRIn only) Unsmoothed 250m Product

Level-4 Ocean Multi-Mission Products

- Using SWOT Level-3 (KaRIn & Nadir) + CMEMS L3 along-track datasets

Level-3 KaRIn processing sequence

- Uses L3 from upstream nadir altimeters
- Follow nearly the same sequence than for nadir processing



Credits: G. Dibarboure (CNES) & M.I. Pujol (CLS)

Level-3 KarRIn: Standards & Corrections

	Level-3 SWOT KaRIn v0.3	Level-3 SWOT KaRIn v1.0
Product standard ref	PIA1 before 2023/09/06; PIB0 between 2023/09/06 and 2023/11/20; PIC0 after	PGC0 before 23/11/2023 PIC0 after
Orbit	MOE-F	POE-F until 30/04/2023 MOE-F after
Ionospheric	GIM model computed from vertical Total Electron Content maps (Chou et al. 2023) rescaled on the orbit altitude with IRI95 model (https://irimodel.org/)	
Wet troposphere	Model computed from ECMWF Gaussian grids	
Sea State Bias	Non-parametric SSB from AltiKa GDR-F (Tran 2019)	
Mean Profile/ Mean Sea Surface	Hybrid MSS (SIO22,CNES/CLS22,DTU21) (Schaeffer et al. 2023; Laloue et al., s. d.)	
Mean Dynamic Topography	MDT CNES_CLS_2022 (Jousset et Mulet 2020; Jousset et al. 2022) available on AVISO+ (https://doi.org/10.24400/527896/a01-2023.003)	
Dry troposphere	Model computed from ECMWF Gaussian grids (new S1 and S2 atmospheric tides are applied)	
DAC	DAC v4.0: TUGO forced with ECMWF pressure and wing fields (S1 and S2 were excluded) + inverse barometer computed from rectangular grids	
Ocean tide	FES2022: (Lyard et al. 2023; Loren Carrère et al. 2023)	
Internal tide	(Zaron 2019)(HRETv8.1 tidal frequencies: M2, K1, S2, O1)	
Pole tide	(Desai, Wahr, et Beckley 2015)& Mean Pole Location	
Solid earth tide	Elastic response to tidal potential (Cartwright et Edden 1973; Cartwright et Tayler 1971)	
Loading tide	FES2022: (Lyard et al. 2023; Loren Carrère et al. 2023)	

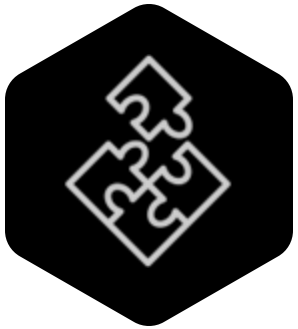
- Some standards are specific to the L3
- The quality of some corrections have a significant impact on KaRIn L3 product quality
- Some standards are susceptible to change from a L3 version to the other

Credits: G. Dibarboure (CNES) & M.I. Pujol (CLS)

Context : KaRIn Level-3 altimeter products

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 upstream
- Evolves quickly to use state-of-the art R&D

Serve a large community

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

Credits: G. Dibarboure (CNES) & M.I. Pujol (CLS)