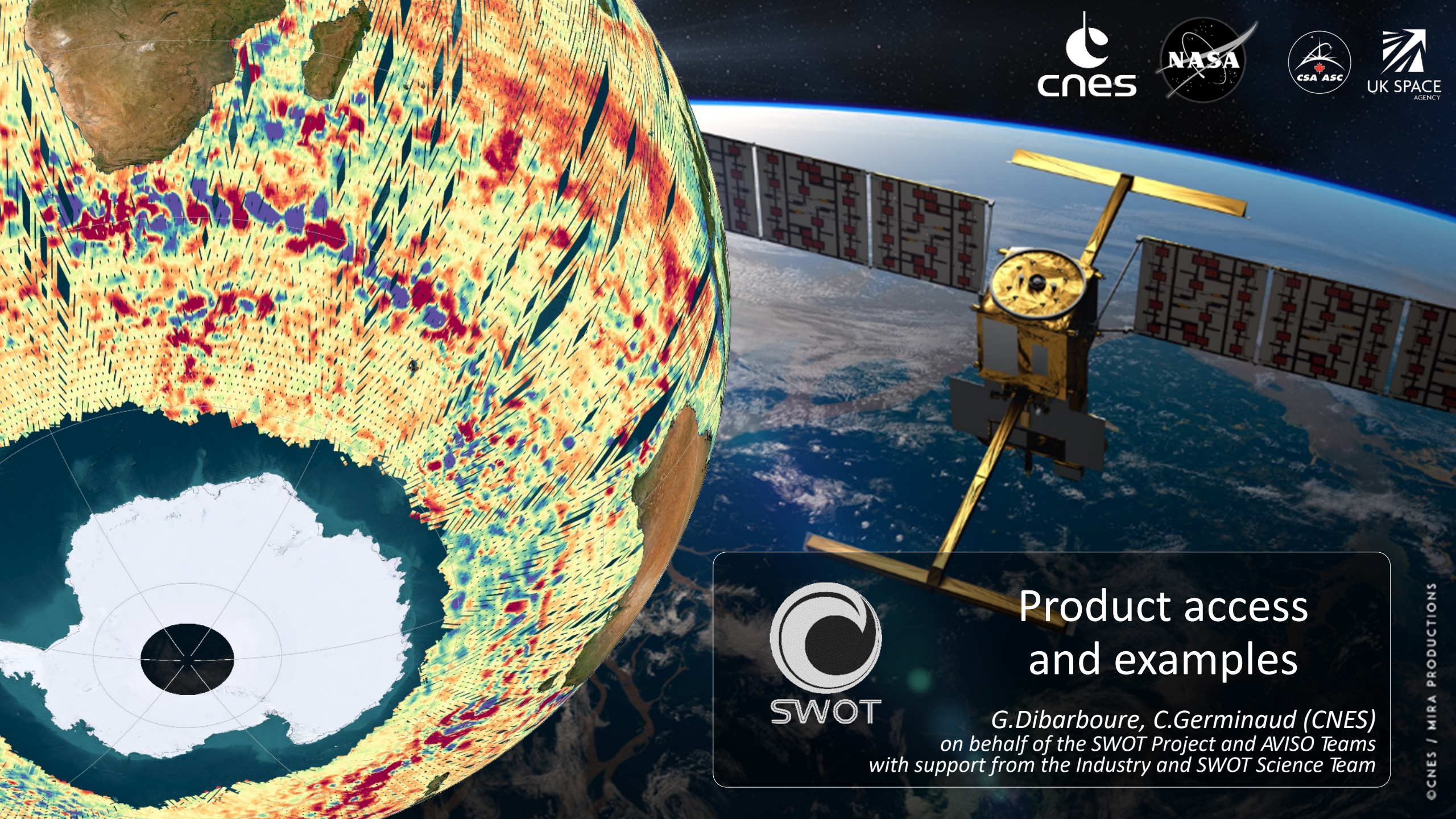


Product access and examples

G.Dibarboure, C.Germinaud (CNES)
on behalf of the SWOT Project and AVISO Teams
with support from the Industry and SWOT Science Team

Product Cheat Sheet

Two orbits

- Cal/Val : 1-day repeat, sparse coverage, Spring 2023
- Science : 21-day repeat, global coverage, since Aug 2023

Two instruments

- Old-school 1D nadir altimeter (Jason-class)
- KaRIn 2D interferometer

Two timeliness levels

- Near Real Time (3 hours to 3 days)
- Reprocessed Data (more precise than NRT)

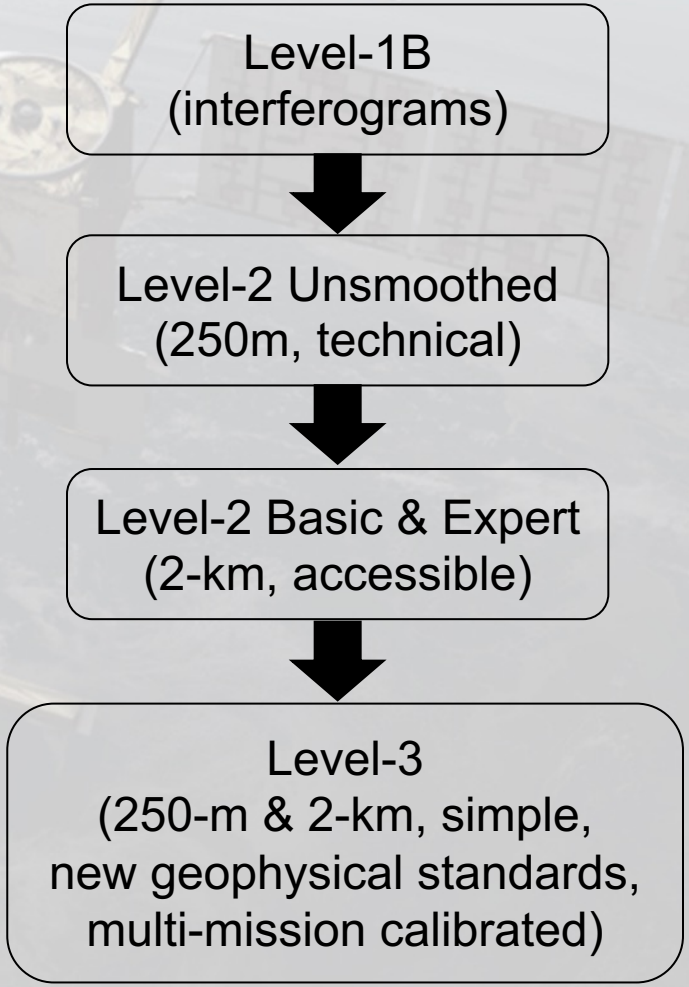
Two resolutions

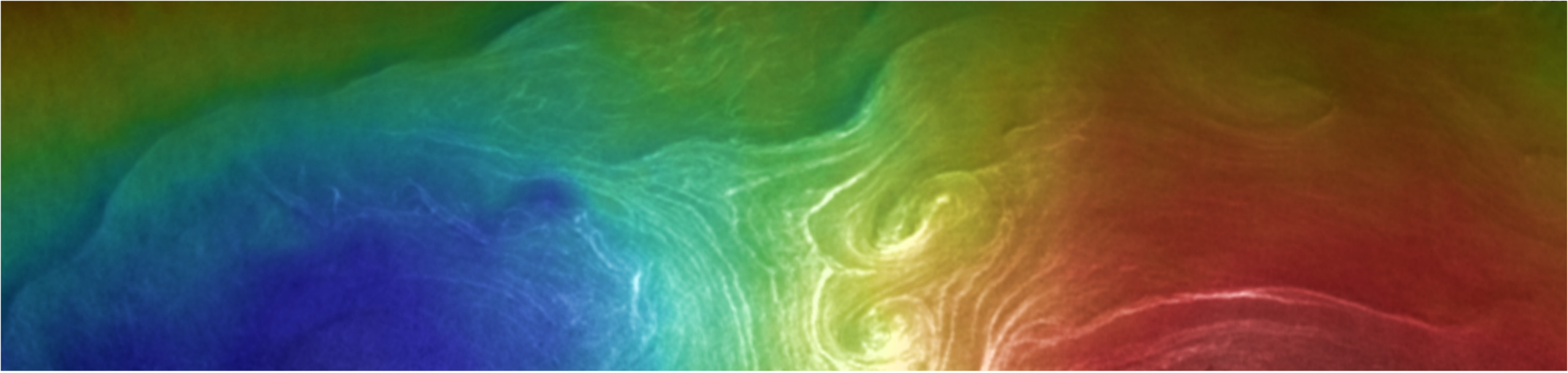
- Ocean @ 250-m to 2-km: Low Resolution
- Hydrology @ 10 to 60 m: High Resolution

Two versions released

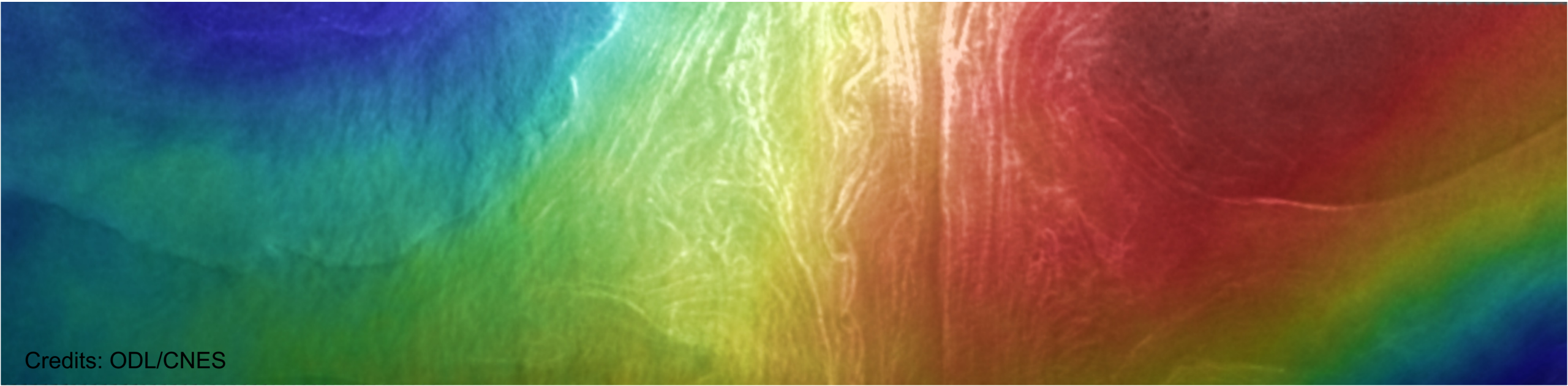
- Version B (Nov 23) : beta release for early CalVal evaluation
- Version C (March 24) : first “science” release

LR Product Levels



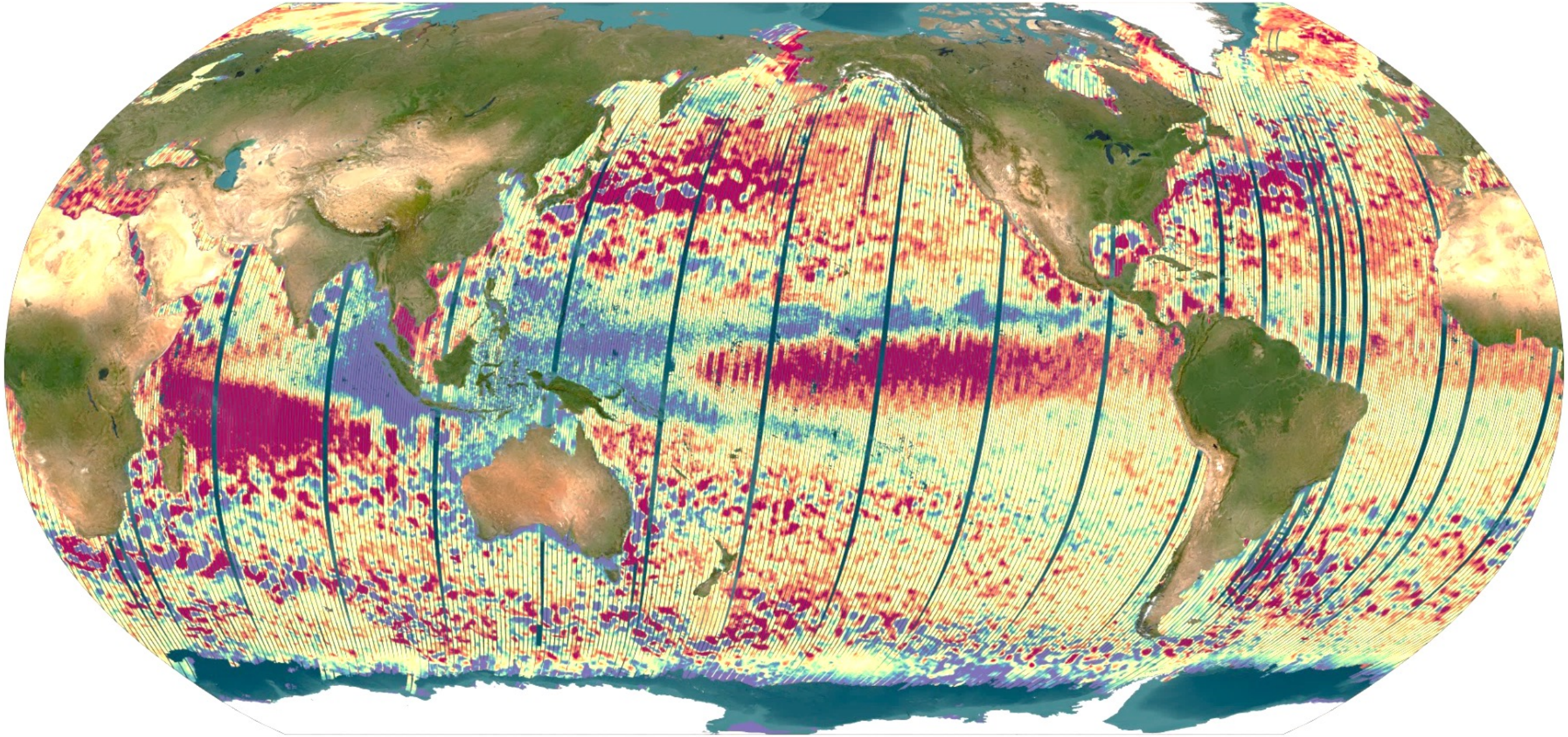


Composite of SWOT topography (color) and sigma0 (brightness)
Mesoscale to submesoscale



Credits: ODL/CNES

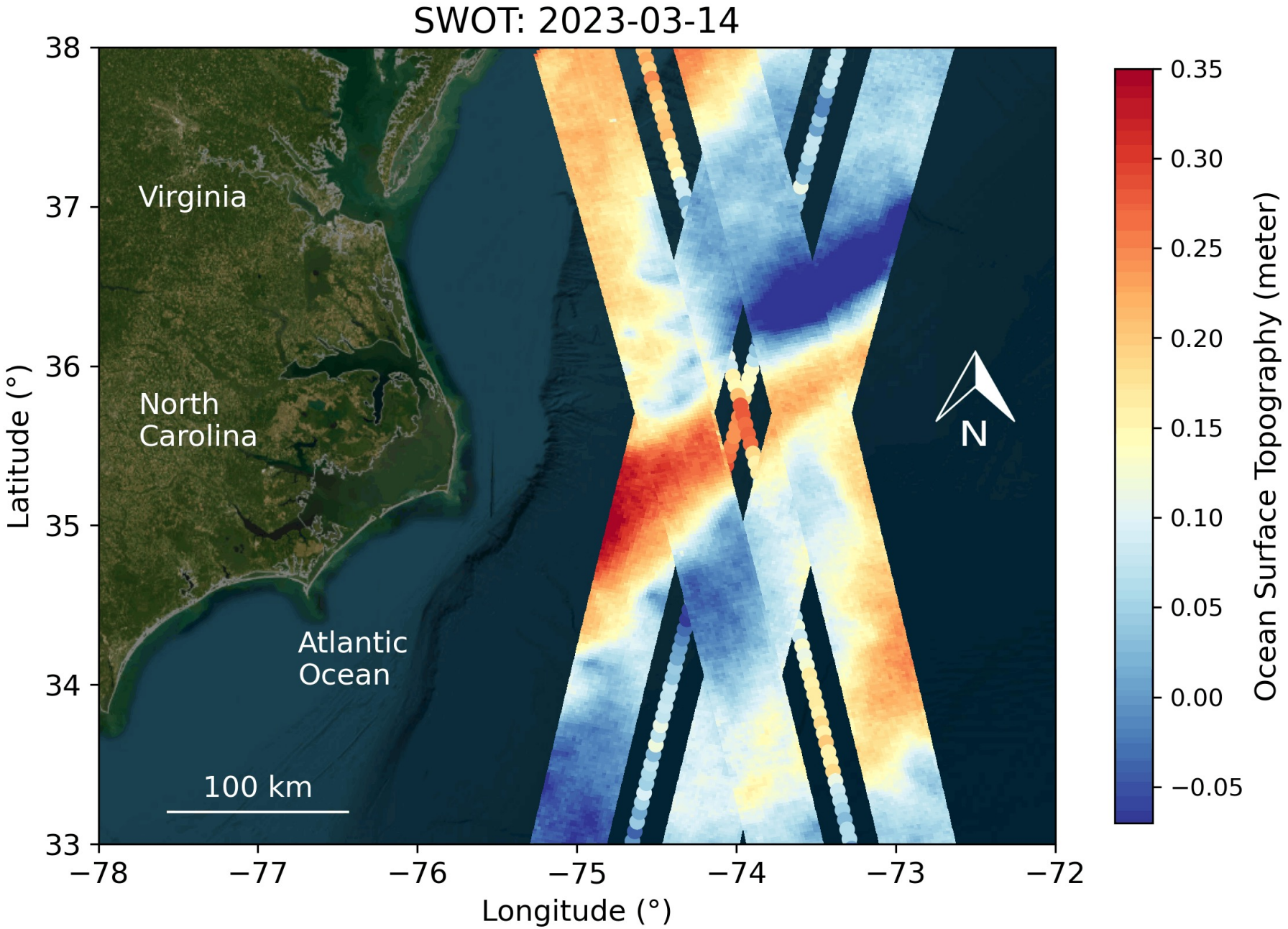
Ten days worth of Level-3 SWOT SSHA in November 2023



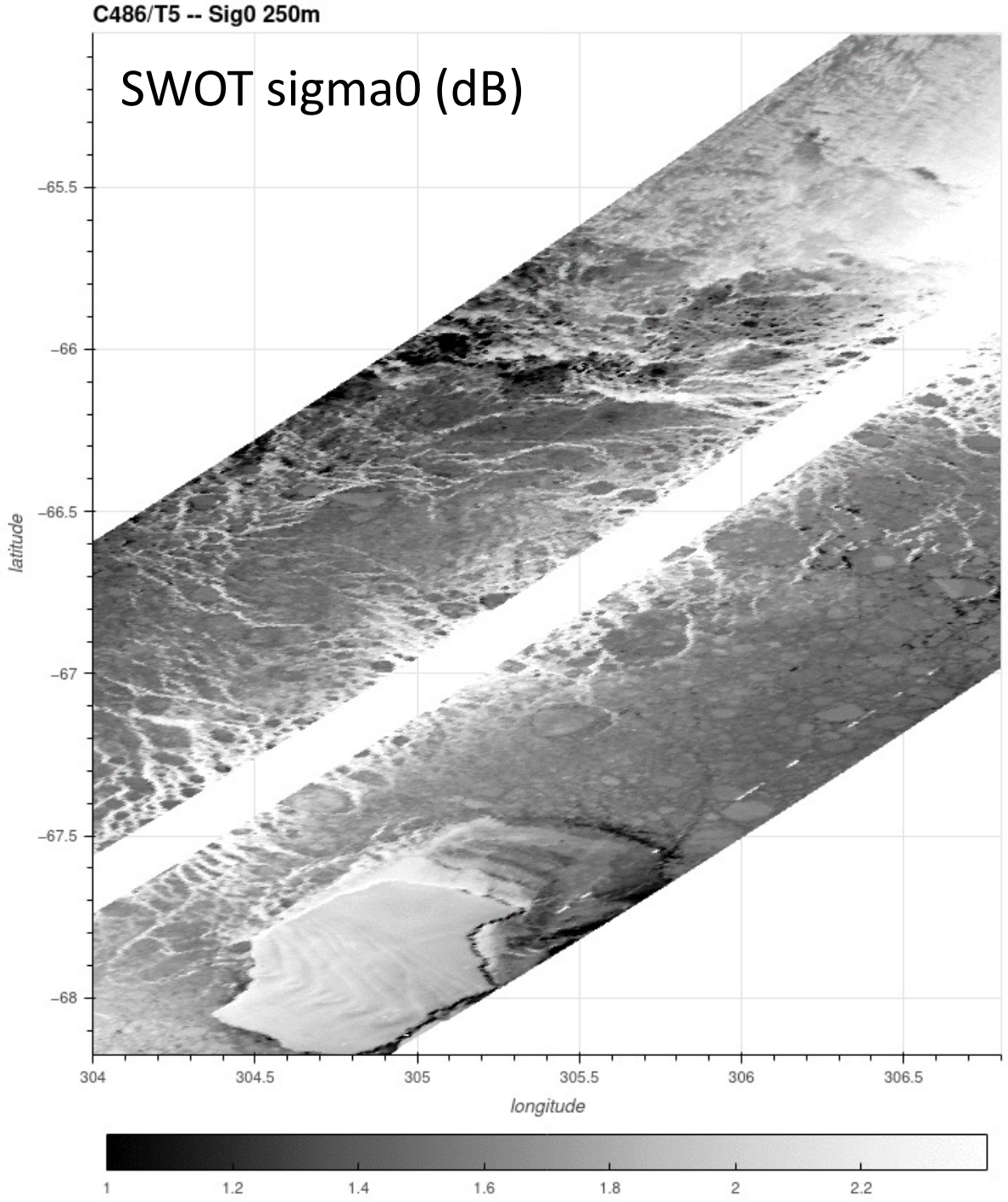
Credits: CLS/CNES

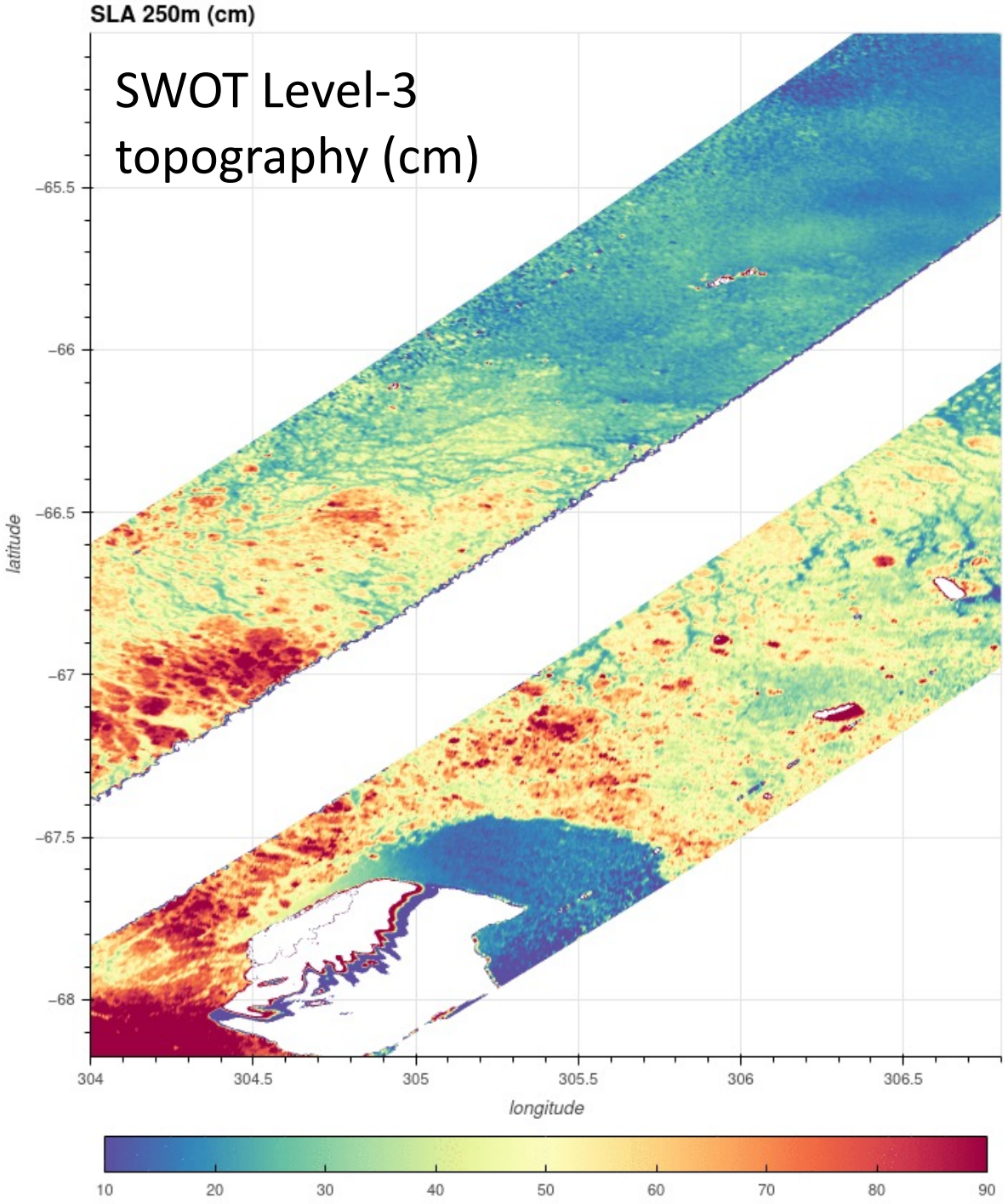
-15cm ▶ +15cm

SWOT Level-3 during the 1-day phase



Credits: CNES





Credits: CLS/CNES

Where to get SWOT ocean products?

OpenDAP
Thredds
FTP
sFTP
WMS
Viewer
…

L2

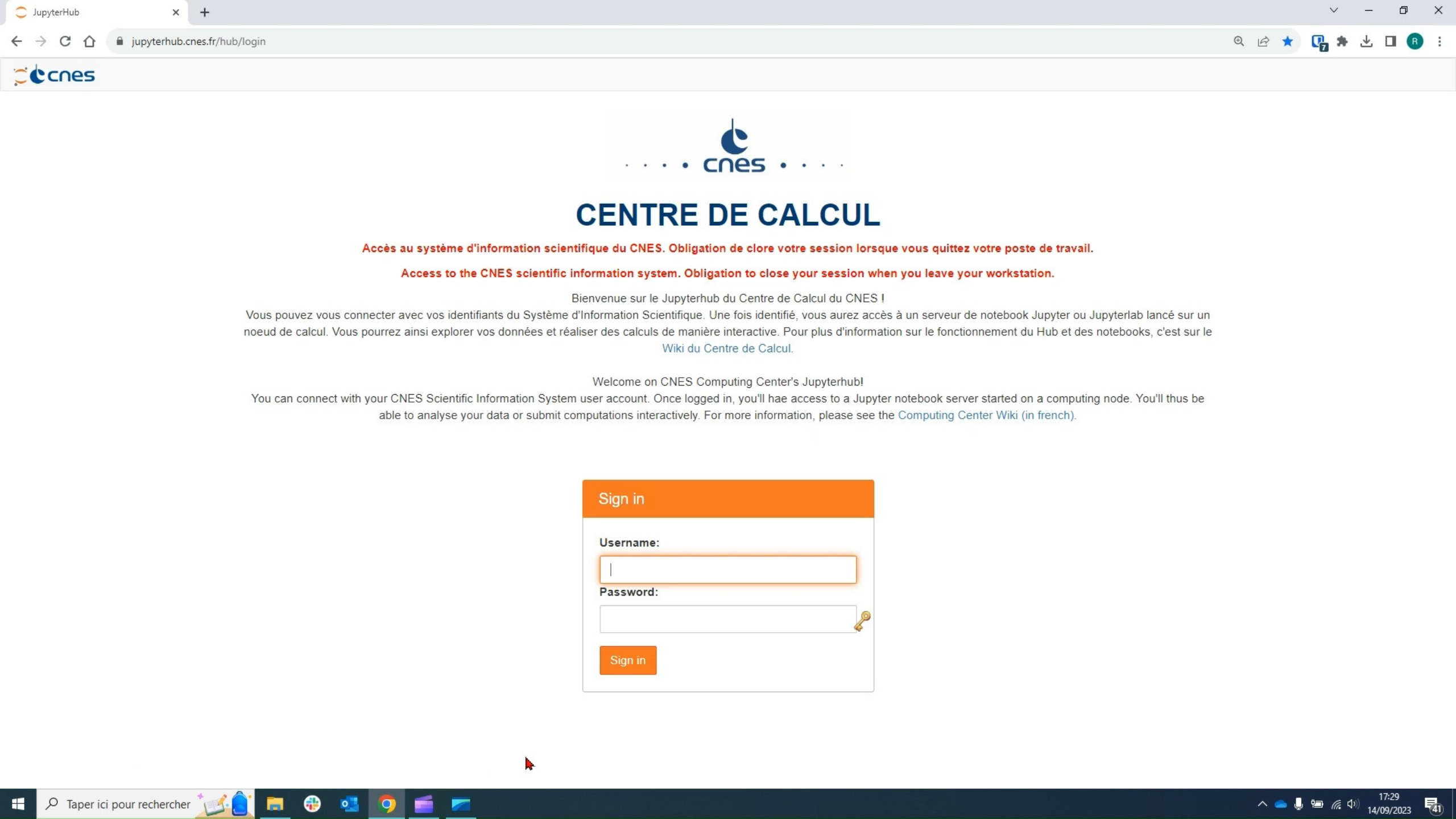
L3

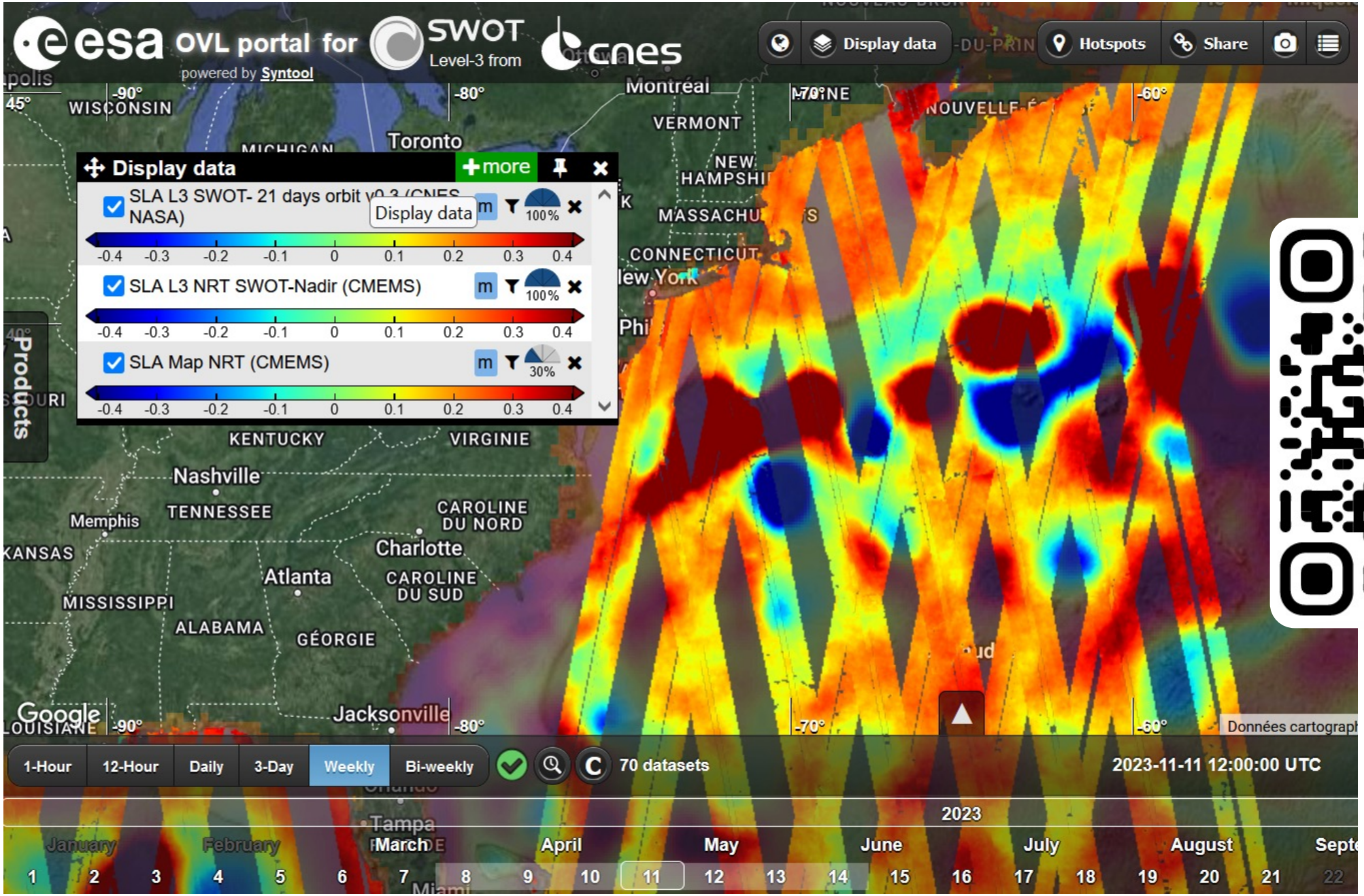
L1B

Free Hosting of SWOT Projects on CNES Cloud

- Free hosting on CNES Cloud & HPC infrastructure
- High processing power (CPU & GPU)
- Very fast I/O for SWOT 250-m & 2-km
- A series of simple examples, powerful tools & external data
- Privacy for Project Members (or open repository if you prefer)
- Helpdesk & technical support for smooth sailing

aviso-swot@altimetry.fr


JupyterHub
jupyterhub.cnes.fr/hub/login
cnes
CENTRE DE CALCUL
Accès au système d'information scientifique du CNES. Obligation de clore votre session lorsque vous quittez votre poste de travail.
Access to the CNES scientific information system. Obligation to close your session when you leave your workstation.
Bienvenue sur le Jupyterhub du Centre de Calcul du CNES !
Vous pouvez vous connecter avec vos identifiants du Système d'Information Scientifique. Une fois identifié, vous aurez accès à un serveur de notebook Jupyter ou Jupyterlab lancé sur un noeud de calcul. Vous pourrez ainsi explorer vos données et réaliser des calculs de manière interactive. Pour plus d'information sur le fonctionnement du Hub et des notebooks, c'est sur le Wiki du Centre de Calcul.
Welcome on CNES Computing Center's Jupyterhub!
You can connect with your CNES Scientific Information System user account. Once logged in, you'll hae access to a Jupyter notebook server started on a computing node. You'll thus be able to analyse your data or submit computations interactively. For more information, please see the Computing Center Wiki (in french).
Sign in
Username:
Password:
Sign in
Taper ici pour rechercher
17:29
14/09/2023



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

SWOT variant of the Ocean Virtual Laboratory

Tens of different datasets and parameters from different providers (ESA, EUMETSAT, ECMWF…)

Scan for SWOT data access

aviso-swot@altimetry.fr

Product access and examples

G.Dibarboure, C.Germinaud (CNES)
on behalf of the SWOT Project and AVISO Teams
with support from the Industry and SWOT Science Team

Documentation and links

Entry points

- AVISO: https://www.aviso.altimetry.fr/en/missions/future-missions/swot.html
- PODAAC : https://podaac.jpl.nasa.gov/SWOT?tab=mission-objectives&sections=about
- Links and reference HUB: https://www.aviso.altimetry.fr/en/missions/future-missions/swot/links-and-references-on-swot.html

Documentation

- Product Description documents (PDD) for Level-1 and Level-2 ocean products
  https://podaac.jpl.nasa.gov/SWOT?tab=datasets&discipline=ocean&sections=about%2Bresources
- Algorithm and Theoretical Basis Documents (ATBD) for onboard, L1B and L2 processors

  L1B/L2 processor: ongoing work from Project, first draft reviewed by ADT members

  Onboard processor : https://swot.jpl.nasa.gov/system/documents/files/4216_D-79130_KaRIn_OBP_ATBD_RevA_20171103_URS_Approved_Signed.pdf
- SWOT Mission Performance and Error Budget

  https://swot.jpl.nasa.gov/system/documents/files/2178_2178_SWOT_D-79084_v10Y_FINAL_REVA__06082017.pdf

SWOT ocean data products on AVISO

SWOT Level 2

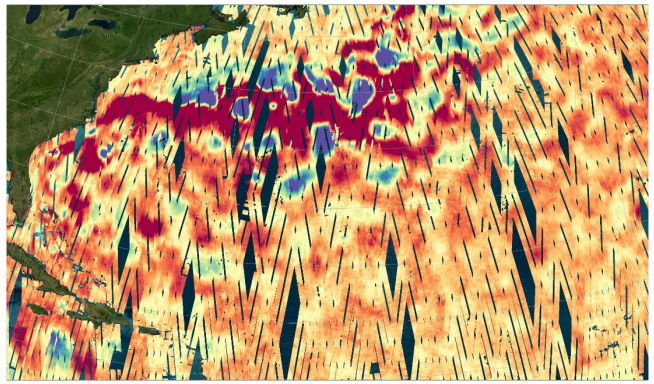
- ✓ Nadir Altimeter and Radiometer (O/I)GDR products (similar to Jason-2/3)
- ✓ KaRIn LR SSH 'ocean' beta pre-validated product only

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 ↓

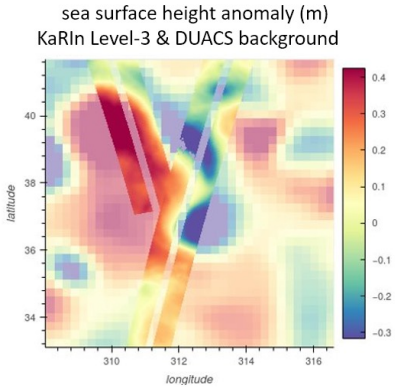
SWOT Nadir Altimeter Level 2 products

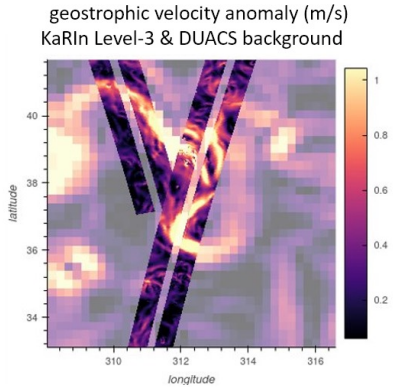


SWOT KaRIn Level 2 SLA – Gulf Stream (2023-08-2023)

KaRIn L2_LR_SSH	Grid	Volume /day - /year
Basic SSH ['Basic']	2 km geographically fixed swath-aligned grid	1GB - 365 GB
Wind and Wave ['WindWave']	2 km geographically fixed swath-aligned grid	1GB - 365 GB
Expert SSH with Wind and Wave ['Expert']	2 km geographically fixed swath-aligned grid	3GB - 1 TB
Unsmoothed SSH ['Unsmoothed']	250 m sampling grid	40 GB - 15 TB

KaRIN L2 Low Rate 'ocean' products

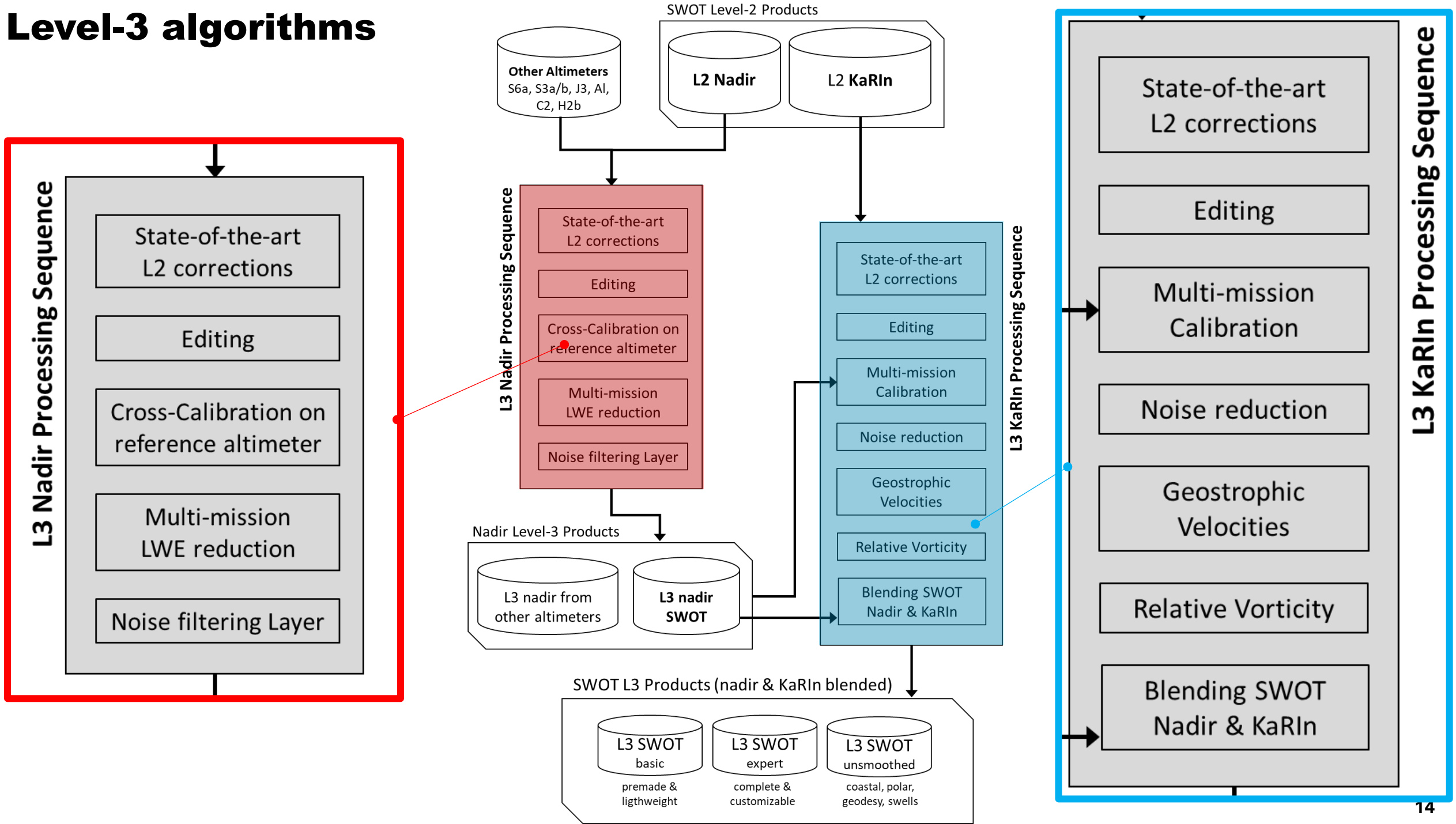


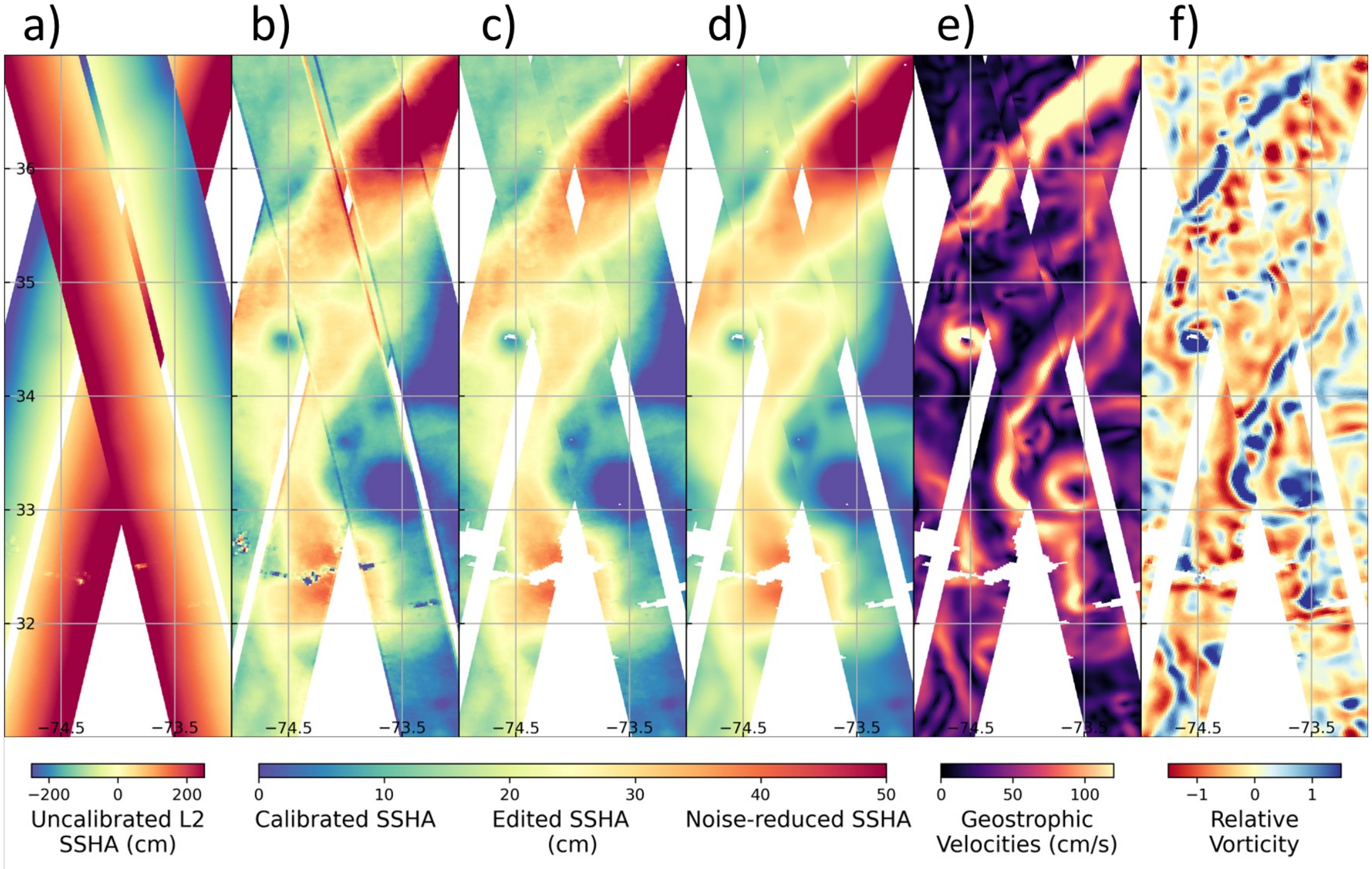


SWOT Level 3 ocean data 2-km products

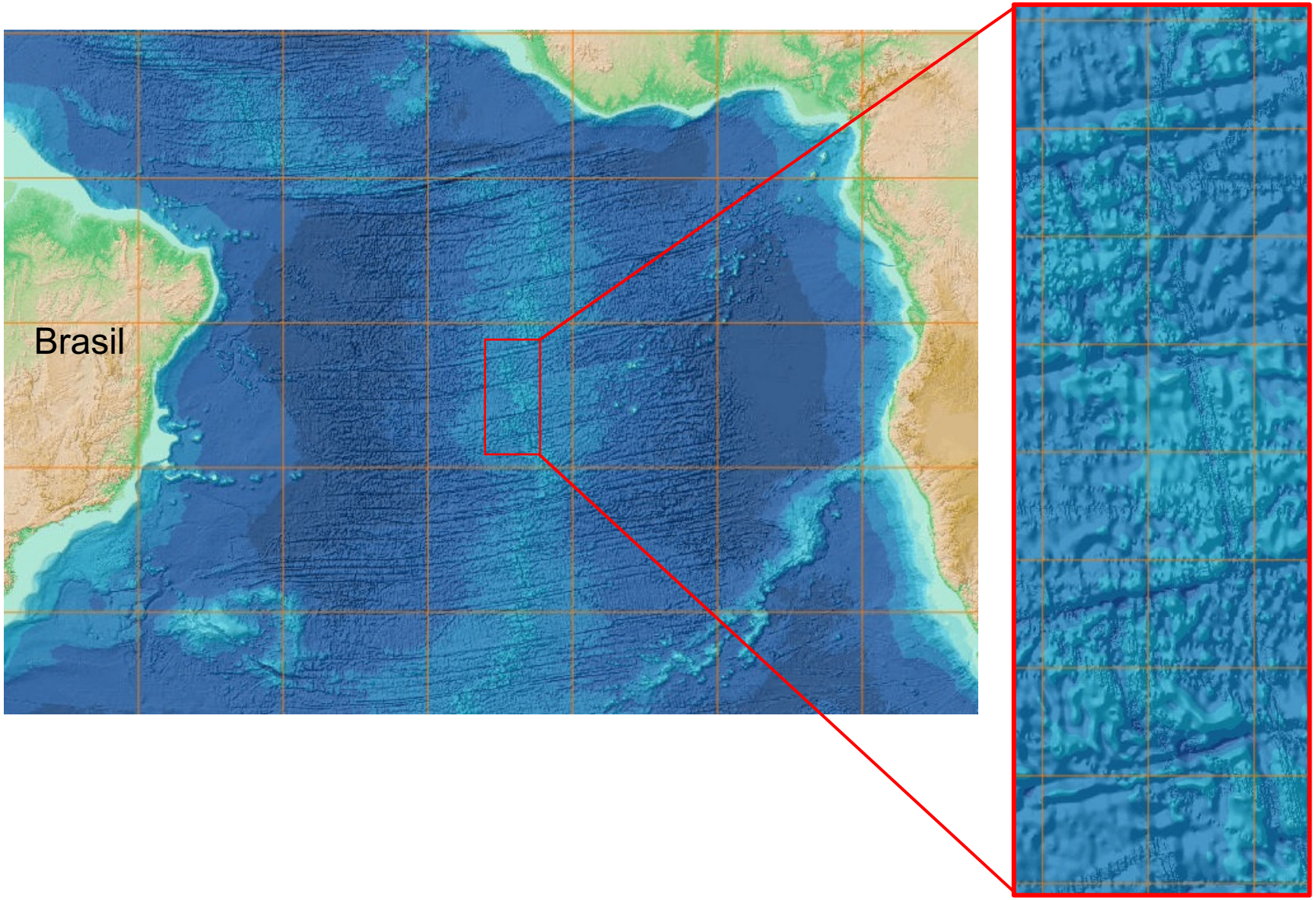
- ✓ Level 3 (KaRIn + Nadir) 'basic' or lightweight (SSHA and MDT only)
- ✓ Level 3 (KaRIn + Nadir) 'expert' or extended (unedited SSHA + all calibration/corrections and geostrophic velocity anomaly)

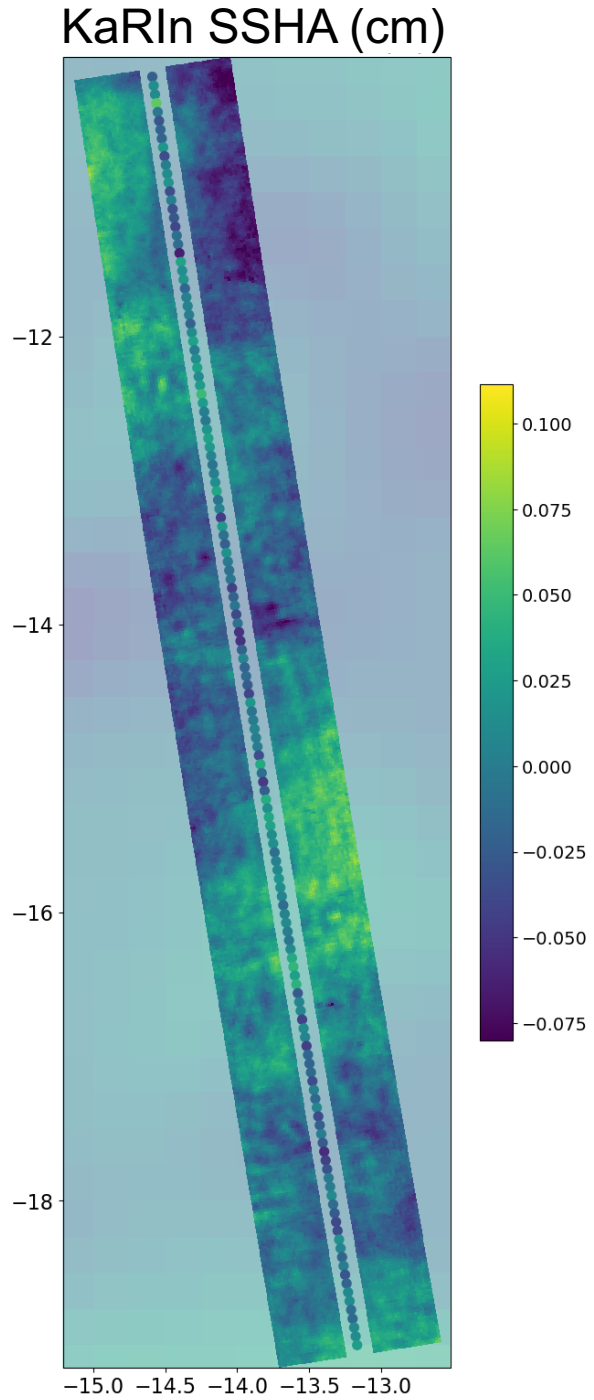
Level-3 algorithms




a)
b)
c)
d)
e)
f)
36
35
34
33
32
−74.5
−73.5
−200
0
200
Uncalibrated L2 SSHA (cm)
0
10
20
30
40
50
Calibrated SSHA
Edited SSHA (cm)
Noise-reduced SSHA
0
50
100
Geostrophic Velocities (cm/s)
−1
0
1
Relative Vorticity

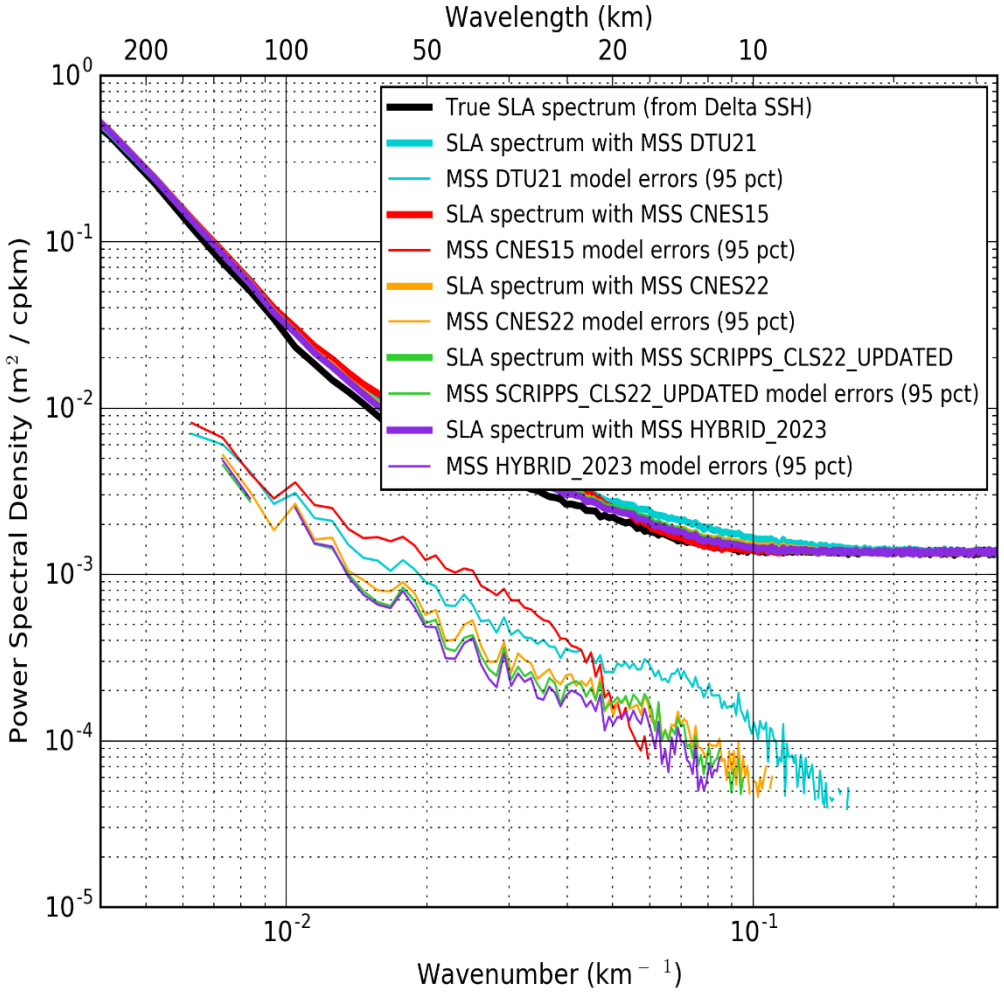
Mid-Atlantic rift shows up as MSS error (South)





Why CLS/SIO/DTU hybrid $2023_{\beta 1}$ as a MSS model?

Sentinel-3A LRRMC used for validation



MSS errors from 15 to 100 km wavelengths

MSS model	Error (cm^2)	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%

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

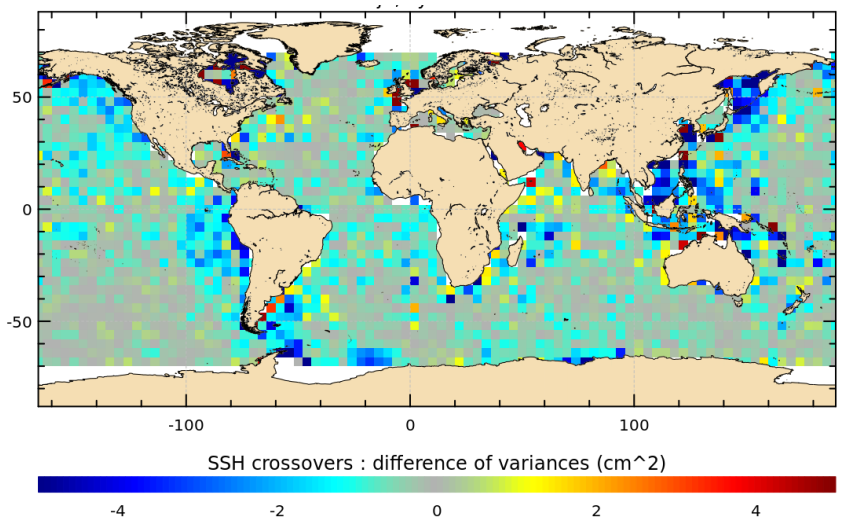
Blends the strengths of 3 modern MSS models

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

See Pujol et al & Schaeffer et al. presentation & poster in MSS splinter

Why FES22 as a tide model?

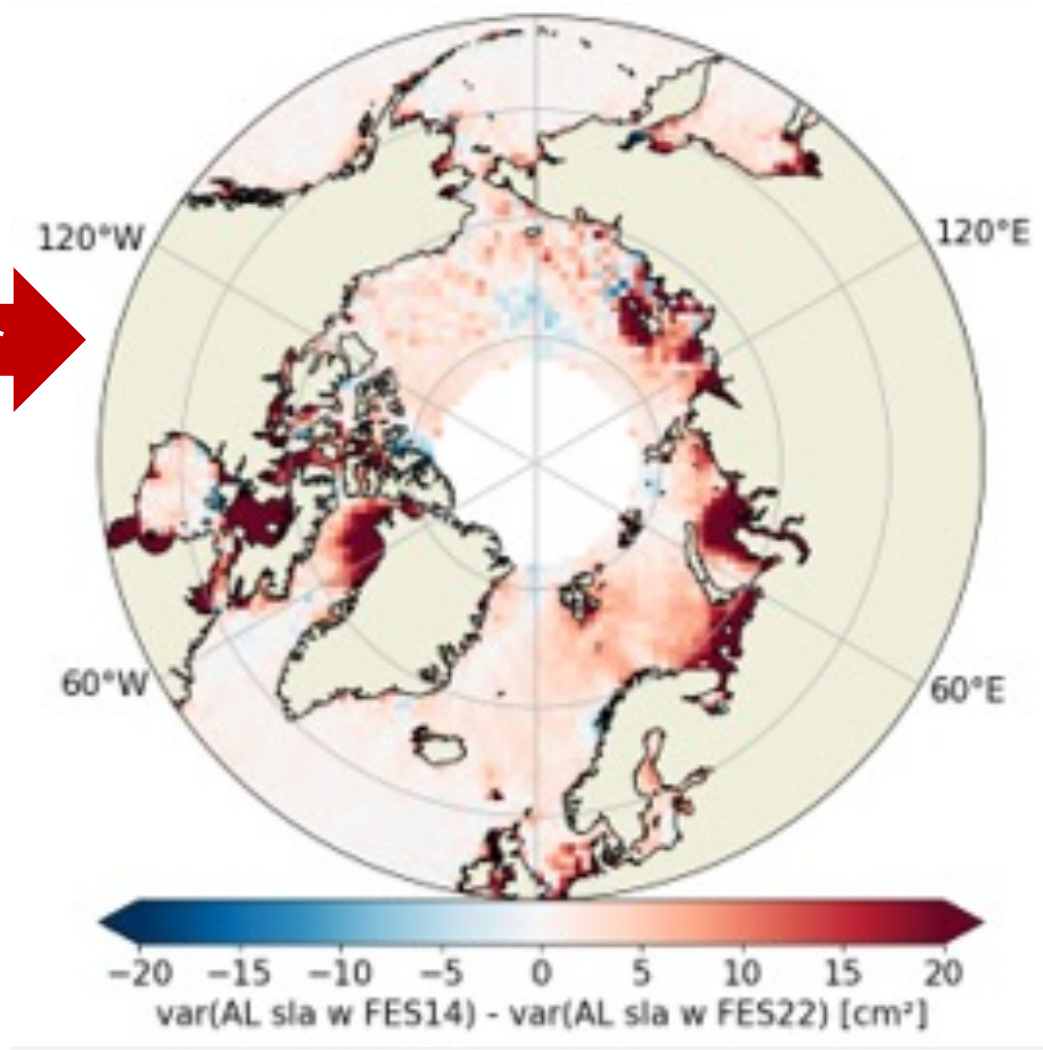
SSHA xover variance reduced from FES14B to FES 23a (measured with Sentinel-3A which is independent)

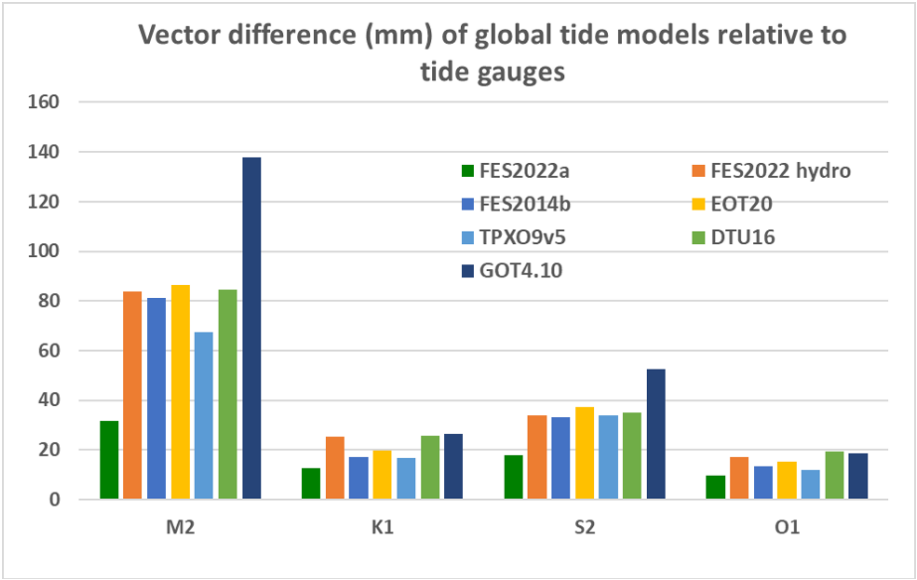


BLUE is better

RED is better

SSHA variance reduction from FES23 to FES 14a (measured with SARAL)





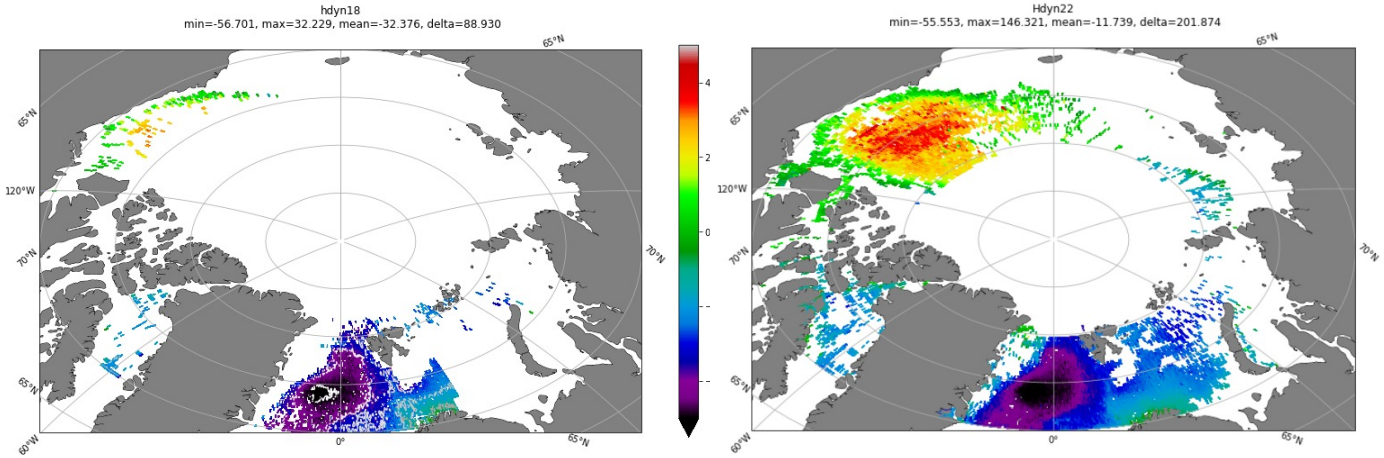
See Carrere et al (OSTST22) and Lyard et al paper (in prep)

Why CLS22 as a Mean Dynamic Topography?

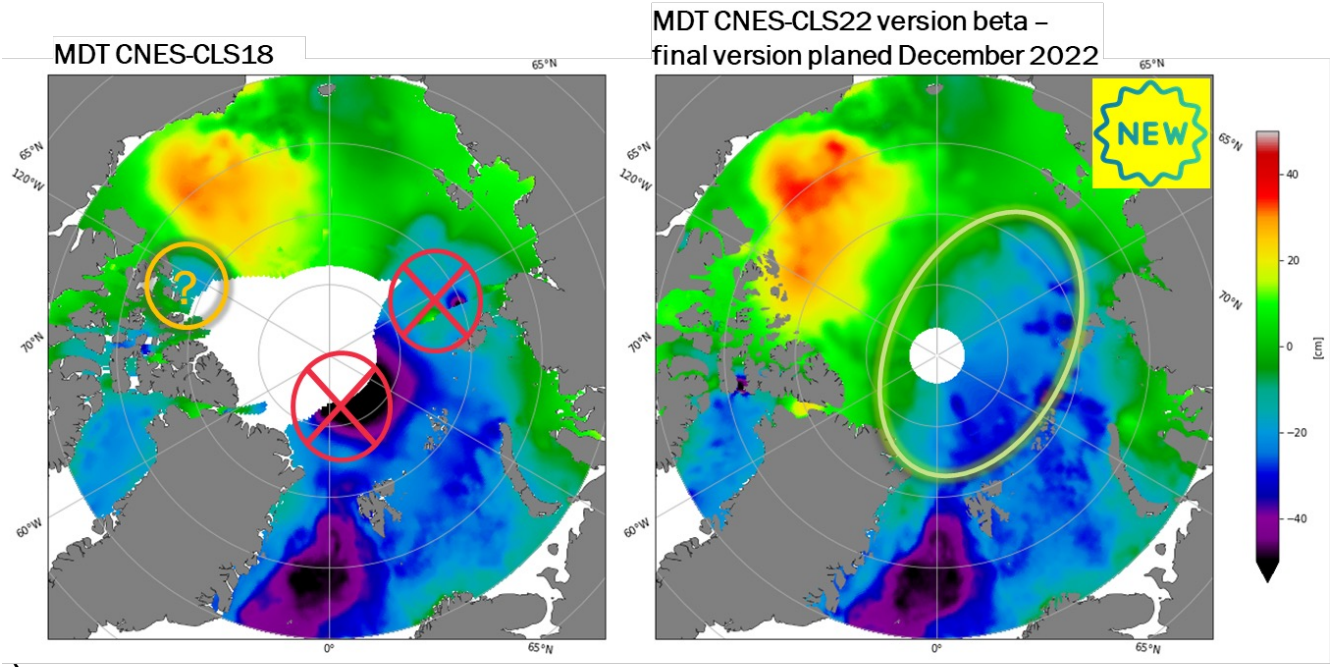
2018

2022

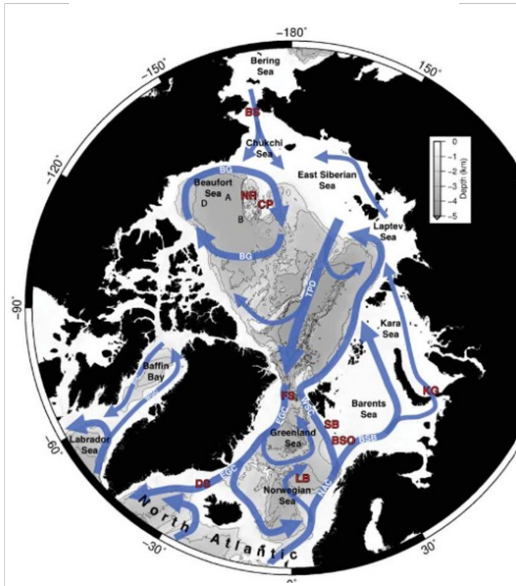
In-situ HDYN



MDT model



Arctic circulation from Armitage et al. (2017)



Regional improvements with v2022 model

- Much better coverage
- Known 2018 artifacts fixed
- Velocities are 10% more consistent with drifters on average (locally much more)

See Jousset et al (OSTST 2022, paper in prep)

SWOT Level-2 KaRIn LR (Ocean) Data Products Roadmap

November 2023 (v1.0 or version B)

- Beta pre-validated L2_LR_SSH (summer 2023 reprocessing release)
- Available only for the 1-day CalVal orbit phase (March 29 to July 10, 2023), and the 21-day Science orbit phase (September 7 to November 21, 2023)

Release for CalVal studies only and community feedbacks

March 2024 (v2.0 or version C)

- Production and distribution of the pre-validated L2_LR_SSH:
  - PIC0 for forward-processed version C products (effective November 23, 2023)
  - PGC0 for reprocessed version C products (from March 30 to January 25, 2024)

First public release of KaRIn products (no usage restrictions)

Reprocessed LR data should be used when available

SWOT Level-3 KaRIn LR (Ocean) Data Products Roadmap

v0.2 (first external release)

- September 2023: L3 reprocessing (from L2 beta pre-validated)
- Available only for the 1-day CalVal orbit phase (March 29 to July 10, 2023), and the 21-day Science orbit phase (September 7 to November 21, 2023)

Release of L3 products has the same usage restrictions as L2

v0.3 (December 2023)

- FES22 ocean tide model based on native and high resolution unstructured grid
- Improved flagging/editing strategy to better remove spurious pixels
- Revised noise mitigation algorithms…

Community feedback (good or bad) is crucial to drive future work

v1.0 and beyond

- April 2024: v1 released for NRT upgrade & reprocessing derived from the pre-validated L2_LR-SSH (version C)
- Quarterly updates until quality is deemed stable
- Unsmoothed (250 m) version to be released shortly (before summer 2024)

Community product: we can integrate your algorithms and variants

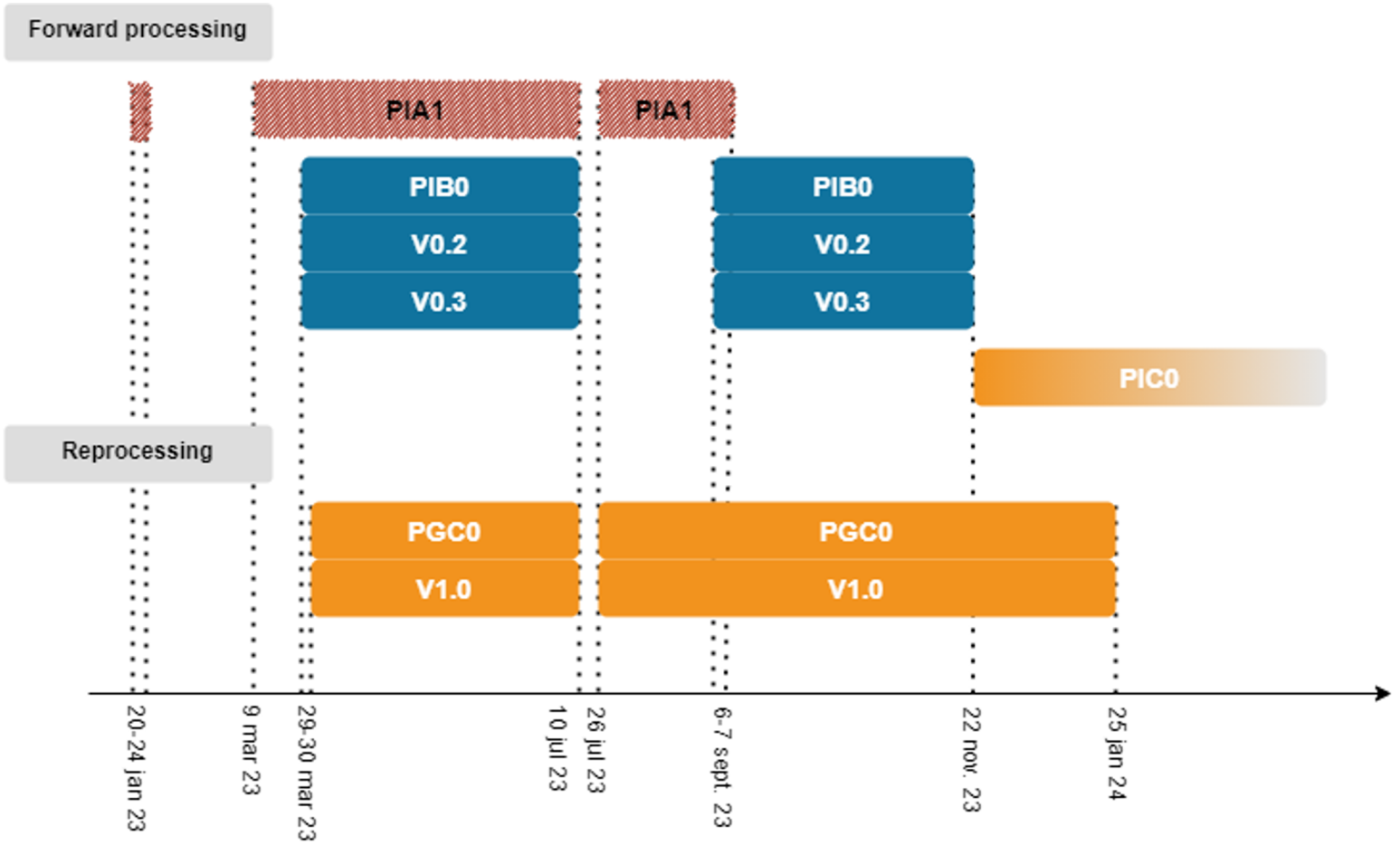
Surface Water Ocean Topography (SWOT) mission:

Table: SWOT Orbit and Mission Phase Timeline

Date	Orbit and Mission Phase
Dec 16, 2022	Launch
Dec 16 - 24, 2023	Launch and Early Operations Phase (LEOP)
Dec 16 - Jan 14, 2023	Orbit Maneuvers and Drift
Jan 14, 2023	Start of 1-day Repeat Orbit
Jan 3 - Mar 30, 2023	Commissioning Phase
Mar 30 - Jul 10, 2023	Calibration Phase
Jul 11 - Jul 20, 2023	Orbit Maneuvers and Drift
Jul 21, 2023	Start of 21-day Repeat Orbit
Jul 21, 2023	Science Phase Begins (no useful KaRIn data until July 26)

SWOT KaRIn LR (Ocean) Data Products Roadmap: Current Status

Diagram: SWOT KaRIn Science Data Products Release Timeline



1. PIA1 is not an official dataset. PIB0 for Calval phase can be considered as a 'reprocessing' of PIA1, even if we use forward data