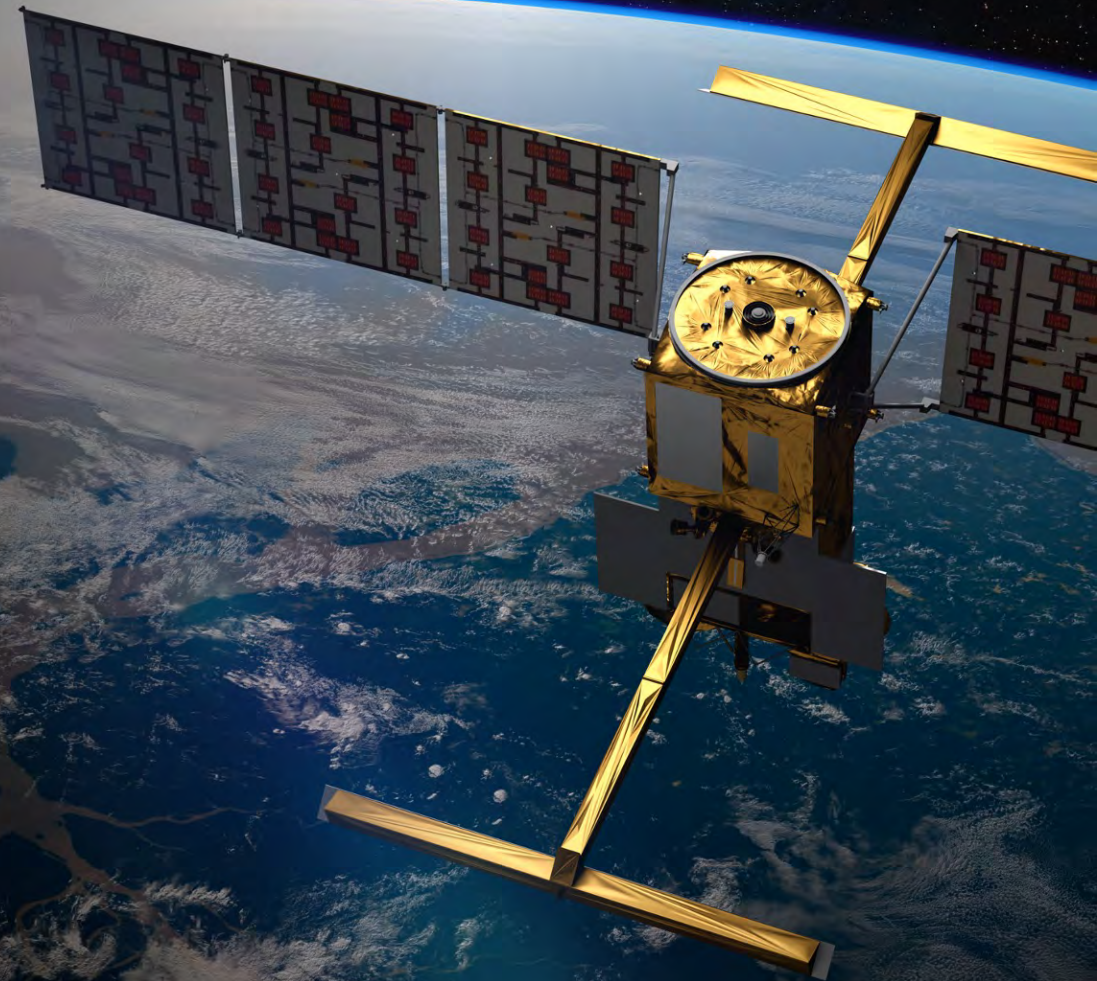


NASA OSTST update

Dr. Nadya Vinogradova Shiffer

NASA HQ

November 7 — 11, 2023 · San Juan, Puerto Rico



NASA Ocean Physics & Altimetry Highlights 2023



SWOT
Launch!
(next slide)



S6 MF
Annual SLR
ENSO tracking
OHC/EEI WG



CRISTAL
KDP A/B



COWVR
Surface winds &
convection from space



S-MODE
Remote sensing of
dynamics &
turbulence



SASSIE
Open Science
Polar salinity
CIMR



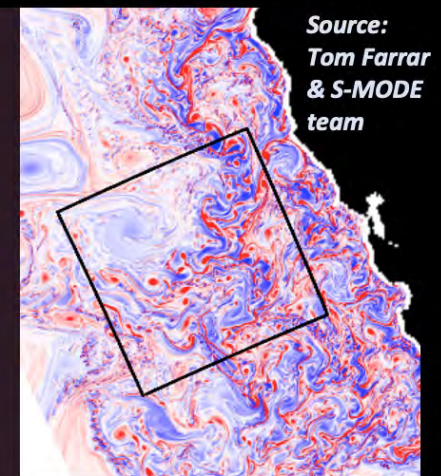
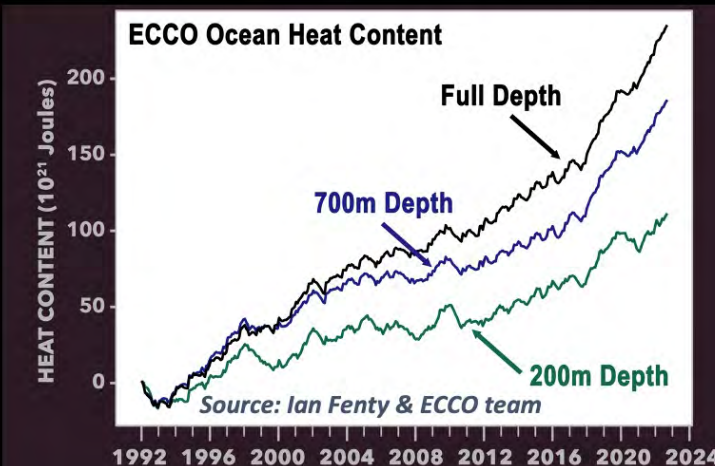
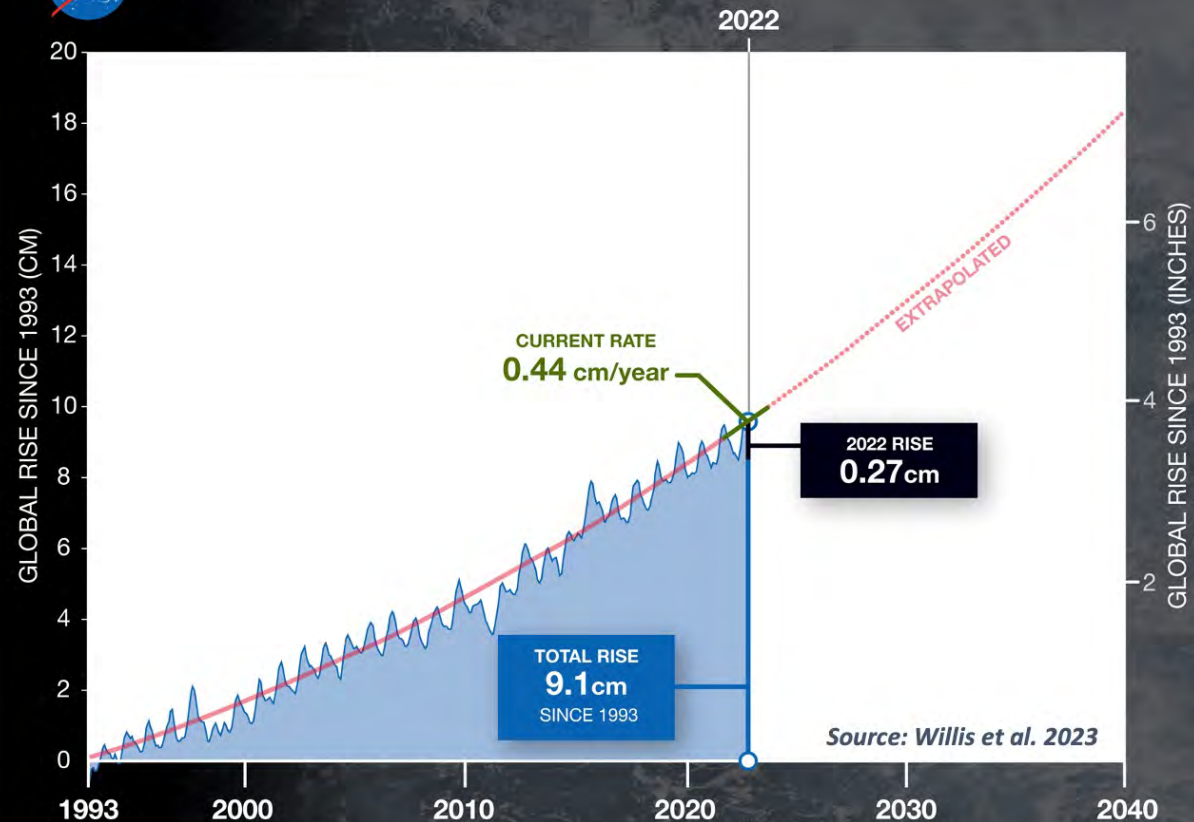
SEA LEVEL TEAM
Science to Action
New Team 2024

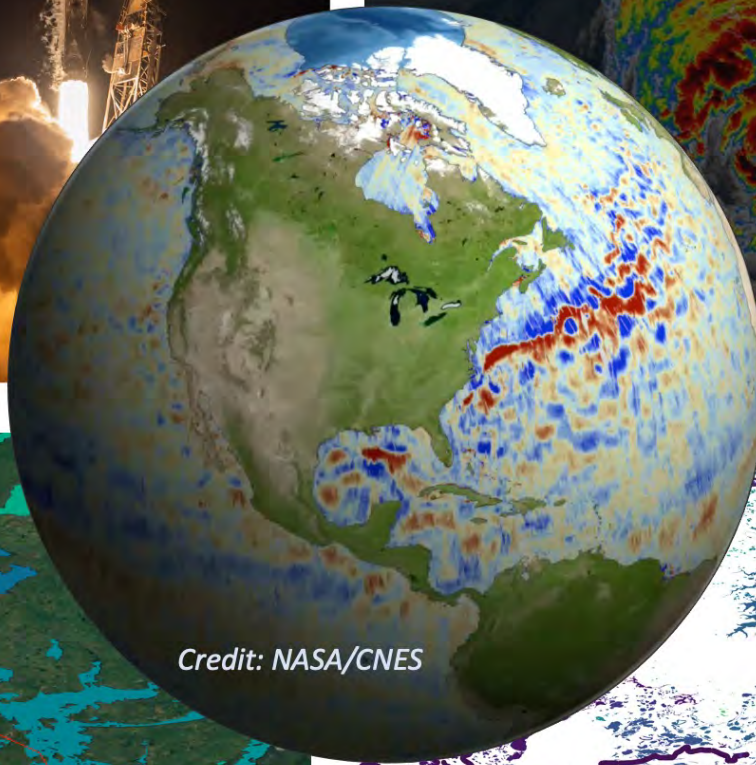


ECCO
Ocean heat & transport
Sea ice
Carbon & biology

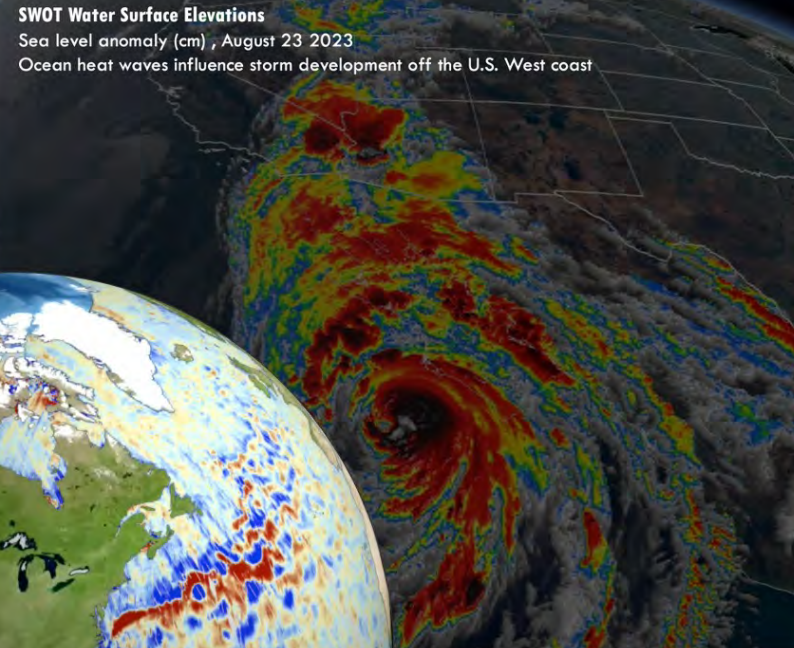


Satellite Record of Sea Level Rise

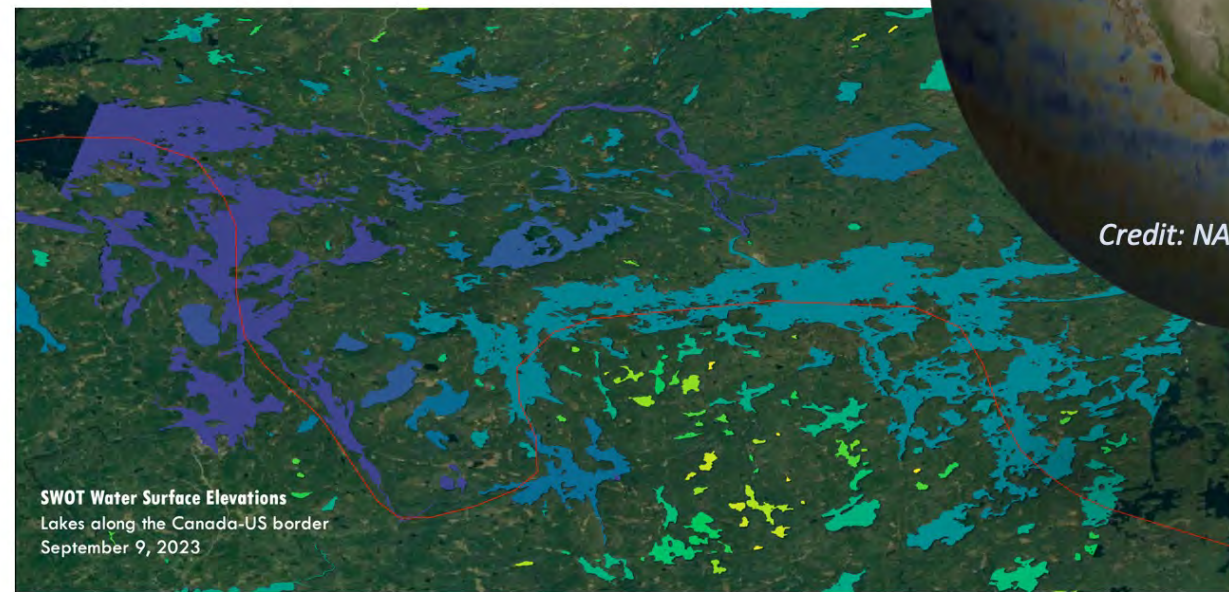
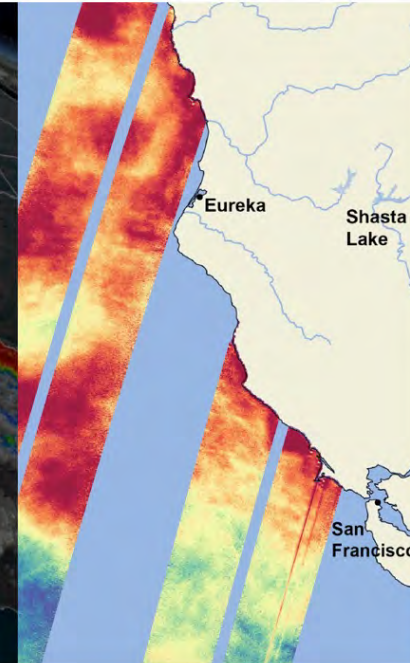




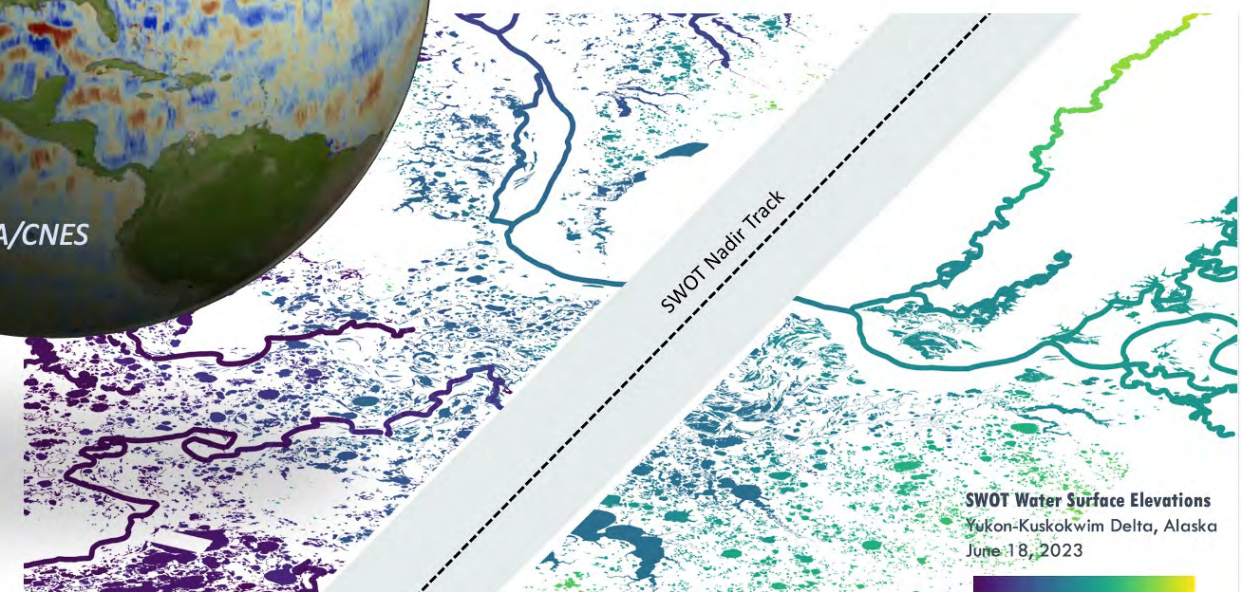
Credit: NASA/CNES



SWOT Water Surface Elevations
Sea level anomaly (cm), August 23 2023
Ocean heat waves influence storm development off the U.S. West coast



SWOT Water Surface Elevations
Lakes along the Canada-US border
September 9, 2023



SWOT Water Surface Elevations
Yukon-Kuskokwim Delta, Alaska
June 18, 2023

A satellite in orbit over Earth, with solar panels and instruments visible. The sun is visible in the upper left corner, creating a lens flare effect. The Earth's surface shows a network of rivers and lakes.

Join SWOT Science Team

Funding opportunity via NASA ROSES and CNES TOSCA —

Demonstrate how SWOT's global, high-resolution mapping enables new discoveries in Earth science

Topic 1: Measurement physics, data challenges and products

Topic 2: Novel Earth science and research applications with SWOT



October 2, 2023: Notices of Intent due
November 13, 2023: Proposals due



November 9, 2023: Notices of Intent due
December 15, 2023: Proposals due (first anniversary)



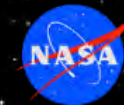
OSTST - Ocean Program Status

Annick Sylvestre-Baron, CNES ocean program manager

November 7 – 11, 2023 · San Juan, Puerto Rico

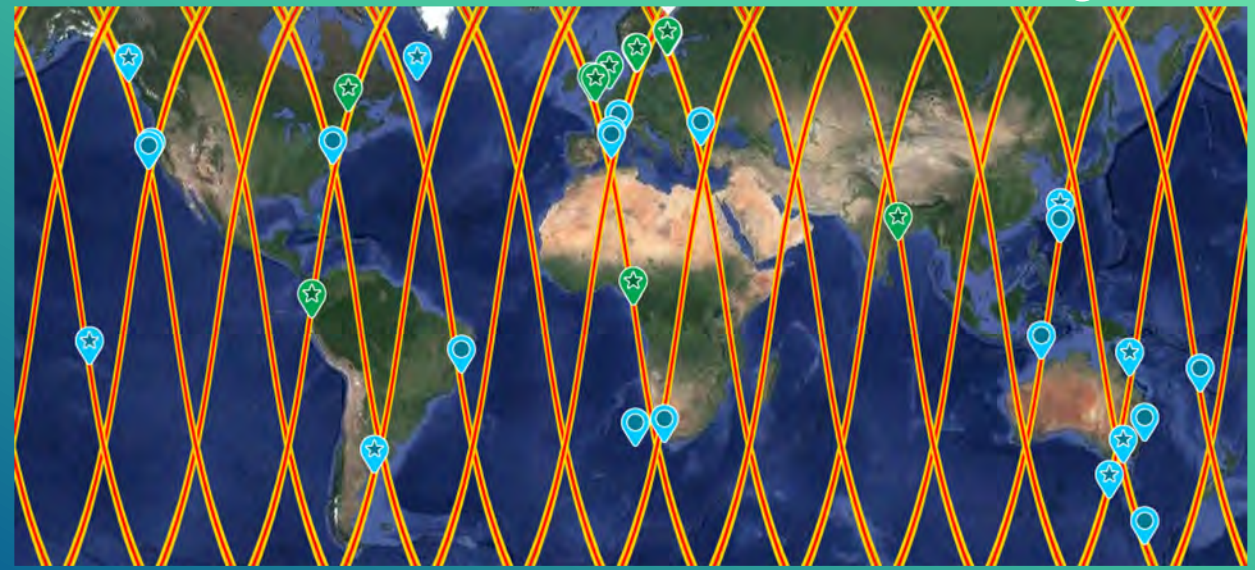


SWOT

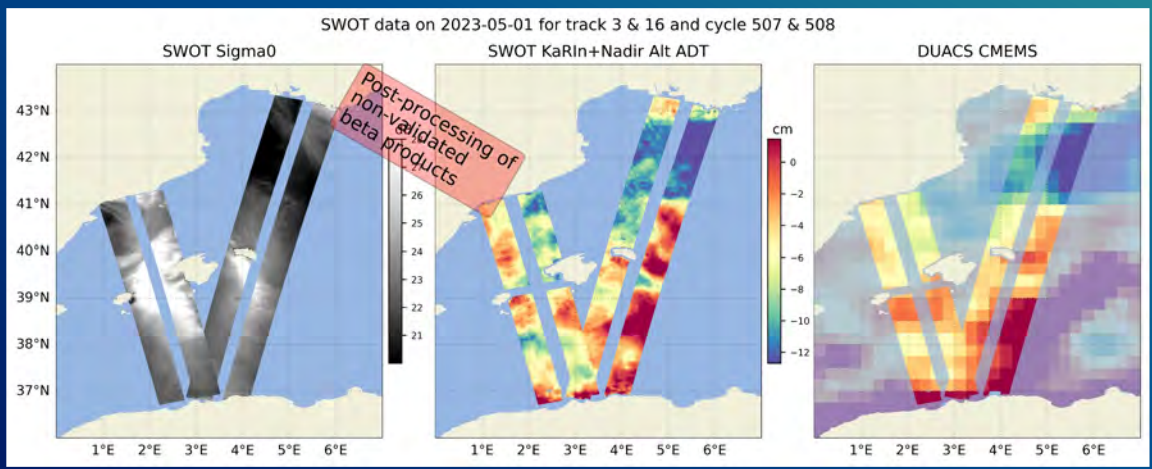


- International Science Team meeting in Toulouse on September 19-22, 2023
 - 9 months after launch,
 - 250+ participants
 - Press conference dedicated to impressive first results





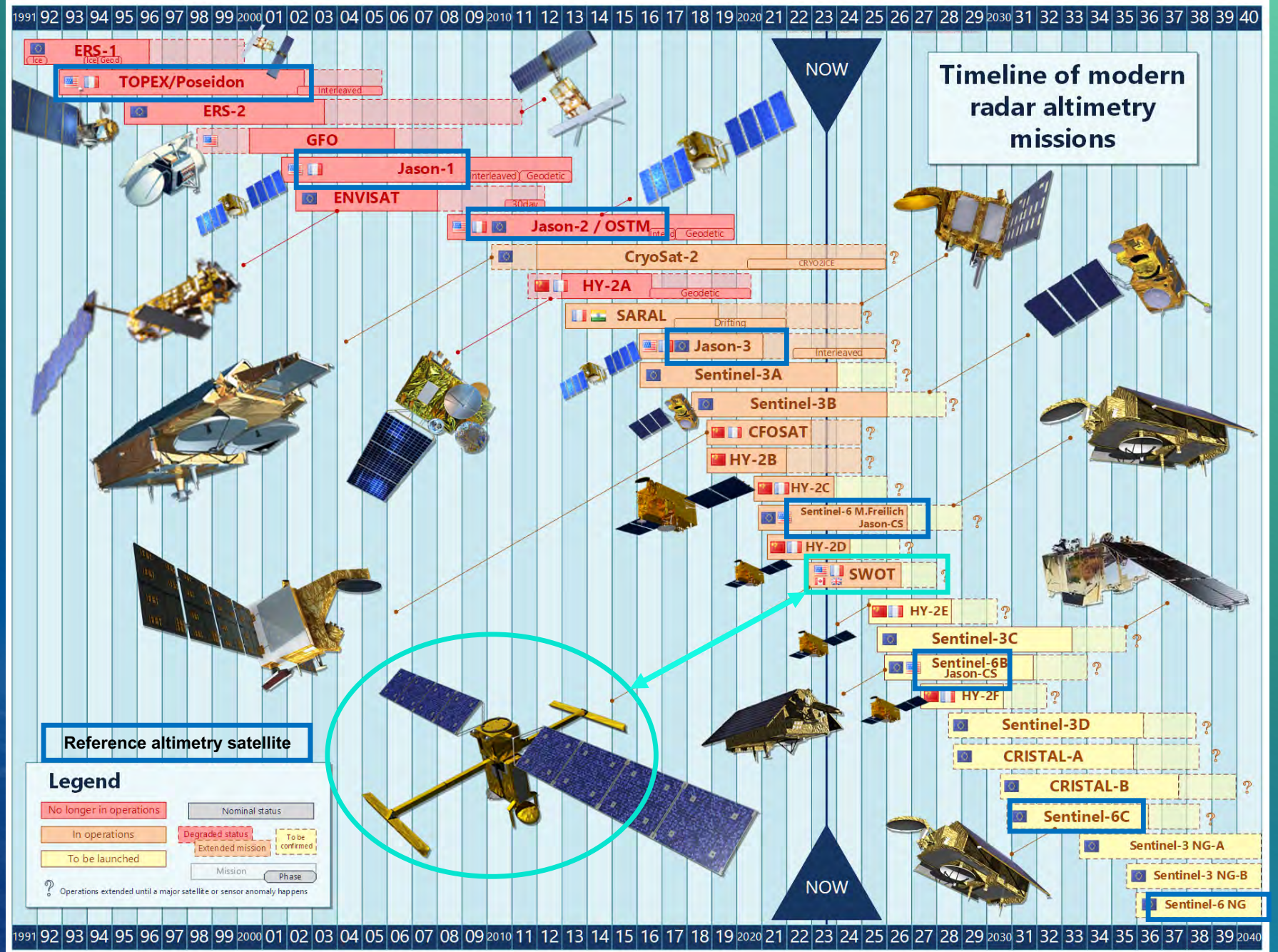
14 offshore (ship) 7 offshore (infrastructure) 9 coastal/estuary



**SWOT Ocean campaigns
a new approach**

SWOT

First wide-swath altimeter in flight





Ka-band Altimetry - a «world premiere»



Satellite with ARgos and ALtika



Launch on Feb. 25, 2013
Fourth mission extension for one year → until End of 2024
allowing a very good overlap with SWOT for at least two years



SARAL/AltiKa decade of in-orbit operations provided high-quality observations and substantial contributions in oceanography!

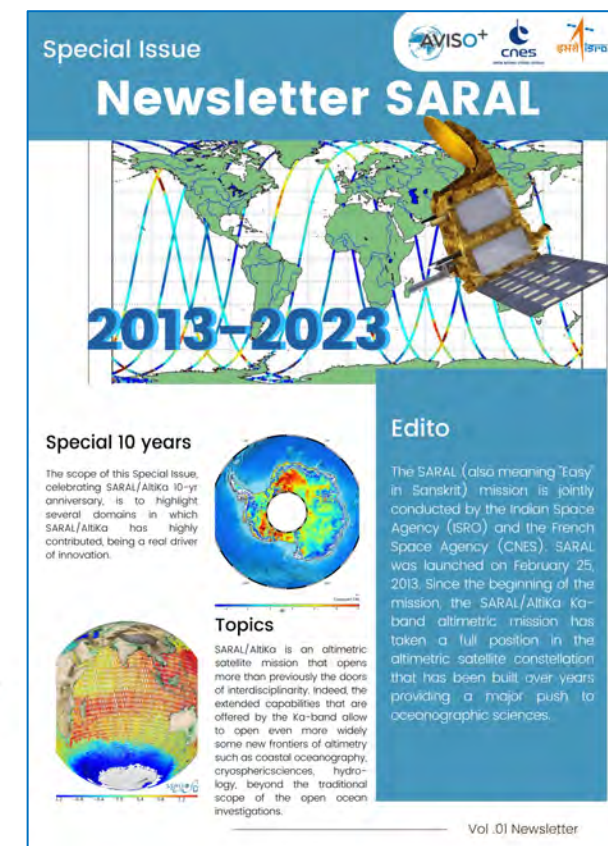
→ also in glaciology, hydrology and geodesy applications



To celebrate SARAL/AltiKa 10-yrs anniversary:

AVISO Newsletter special Issue will highlight major contributions from CNES/ISRO Science Teams

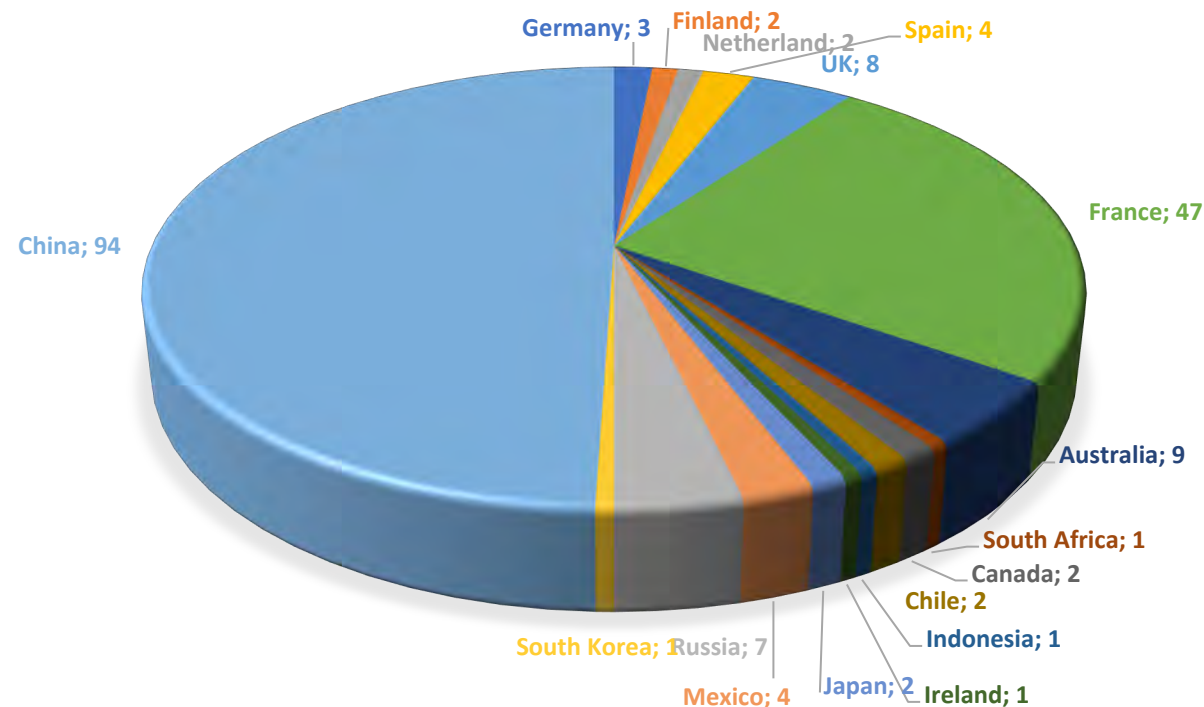
Stay tuned!





Launch on Oct. 29, 2018
 First mission extension for 2 years planned until end of 2024

Science Team members worldwide repartition



Wave spectra: a «world premiere»

- CFOSAT SWIM-NRT data distribution via WMO GTS network before End of 2023
- CFOSAT Science Team renewed since January 2023:
 - 22 projects selected by CNES call (6 France, 7 Europa, 9 international except China)
 - 22 projects from China,
 - Science Team : 190 scientists from 17 countries
- CFOSAT ST meeting in China on Nov. 28-30, 2023

- **CNES Science prospective in preparation for the next five years**
 - Final conclusions presented during CNES Seminar in November 2024



- **CNES/EUMETSAT OSTST call for the renewal of the OSTST (2025-2028) for international scientists (except US ones selected by NASA via a ROSES call)**

- **CNES/EUMETSAT OSTST call - Provisional timetable:**

- ✓ **Release: April 2024 at the latest**
- ✓ **Notice Of Intent: End of June 2024**
- ✓ **Proposals: Fall 2024**
- ✓ **Selection: End of 2024**
- ✓ **KO: January 1, 2025**





Ocean Program Status and Outlook

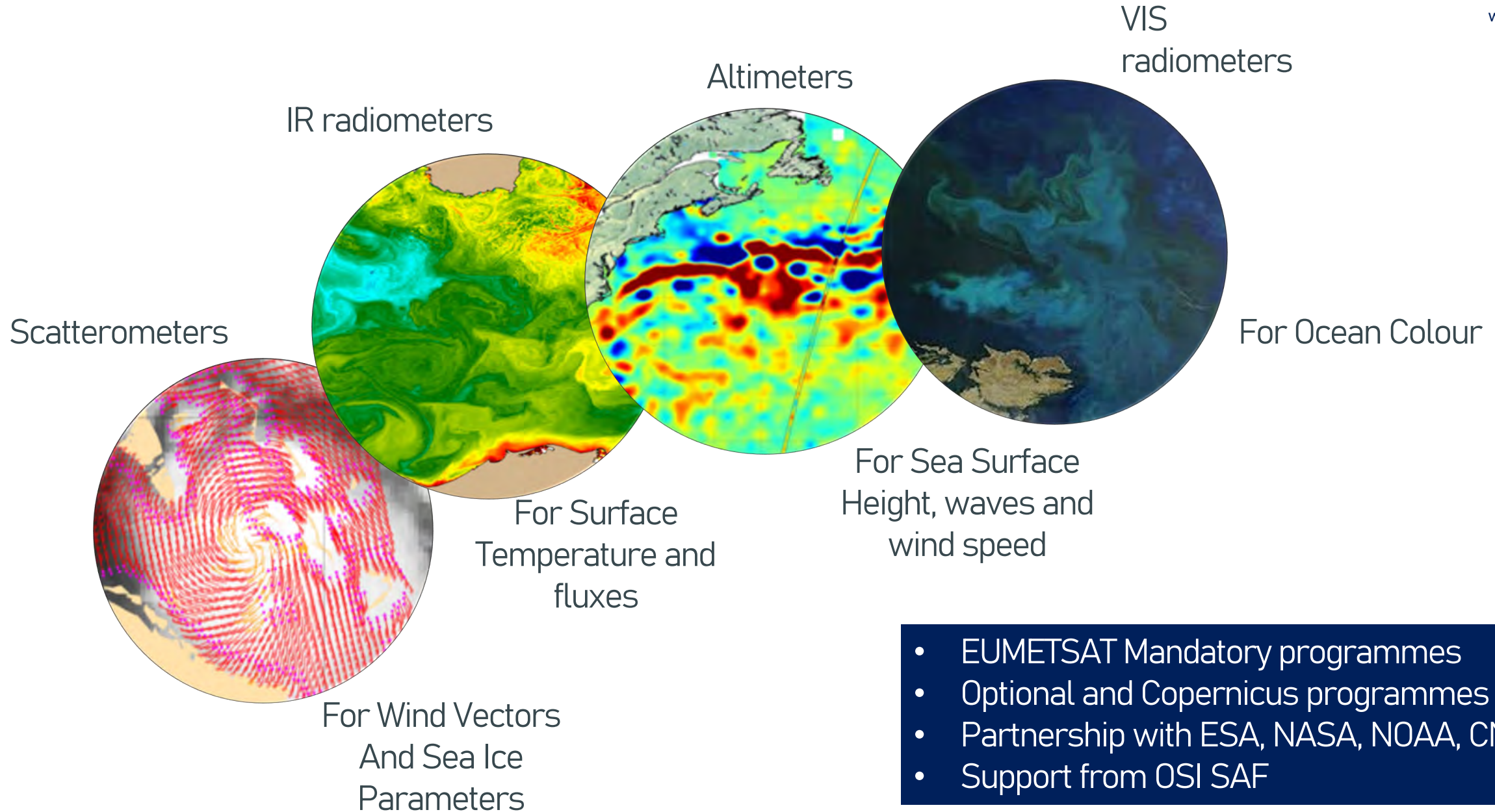
Estelle Obligis

OSTST, 7 November 2023





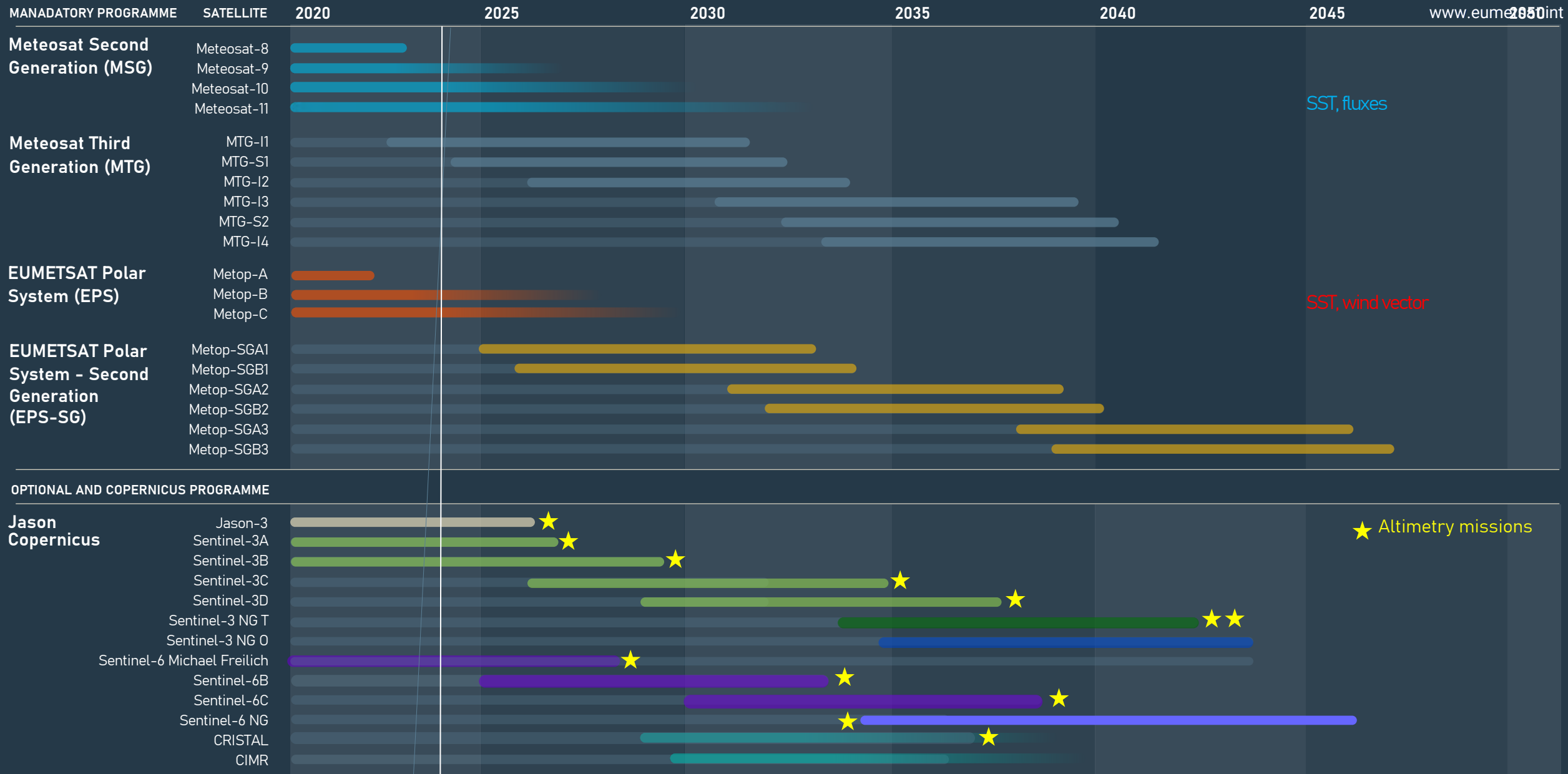
A growing integrated stream of marine products



- EUMETSAT Mandatory programmes
- Optional and Copernicus programmes
- Partnership with ESA, NASA, NOAA, CNES
- Support from OSI SAF



EUMETSAT mission planning



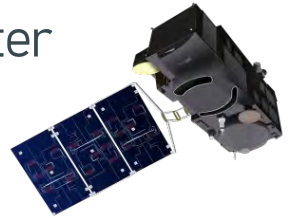
SENTINEL-6: operated by EUMETSAT for Copernicus in partnership with ESA, NASA and NOAA and the support from CNES

- ✓ High precision reference missions, monitoring long term global mean sea level at mm scale and providing an 'anchor' for the assimilation of other altimetry data
- ✓ Continuation with S6 B, C
- Preparation of S6NG



SENTINEL-3: operated by EUMETSAT for Copernicus in partnership with ESA and the support from CNES

- ✓ In polar orbit, helping understand the ocean variability in the mesoscale, as well as inland-water monitoring
- ✓ Continuation with S3 C, D
- Preparation of S3NG-T considering the successful in-flight demonstration of wide swath altimetry concept (NASA-CNES SWOT scientific mission)



CRISTAL: operated by ESA for Copernicus in partnership with EUMETSAT

- ✓ monitoring the cryosphere but providing also additional cover over the ocean



The Copernicus Altimetry Constellation and its next generation ensure continuity of altimetry observations until 2050.



- The success of satellite altimetry is one of [international cooperation](#), addressing technical and scientific challenges as a community and building up a solid heritage.
- Altimetry helps us better understand our [Earth System](#) and has made its way to operational use in meteorological, oceanographic and climate models, with a clear contribution to science and people's lives.
- Increased interest of EUMETSAT Member States for satellite derived [operational hydrological products](#) (precipitation, soil moisture, snow, as well as flood monitoring, etc.) → organization of a hydrological applications from satellite observations workshop in 2024.
- We will continue the development and operations of altimetry missions for Copernicus by exploiting [synergies](#) in operations, scientific and technical heritage.
- EUMETSAT is preparing a [Mandatory Altimetry Programme](#) (target date for approval by Council 2026).

OST-VC White Paper Update

VC co-lead:
E. Obligis (EUMETSAT)
A. Sylvestre-Baron (CNES)

OST-VC white paper status



Action from 2019 SIT meeting to update the “Next 15 years of altimetry – OST Constellation User Requirement Document”, 2009

- Integration of new user needs

A Coordinated International Satellite Altimetry Virtual Constellation: Toward 2050

Current status : draft version being consolidated by the editorial core team (integration, standardisation, formatting, editing...)

THANK YOU ALL (book captains and contributors) for your invaluable inputs

Next steps:

- Full version of the document will be circulated to and reviewed by the book captains by the end of the year
- New version sent to OST-VC members for final review in early 2024
- Final delivery to CEOS management by Q2 2024

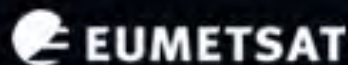
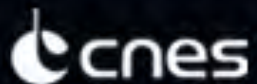


Program Status (NOAA)

Chris Sisko (Program Manager)
Eric Leuliette (Program Scientist)

Ocean Surface Topography Science Team Meeting (OSTST)

7–11 November 2023
San Juan, Puerto Rico

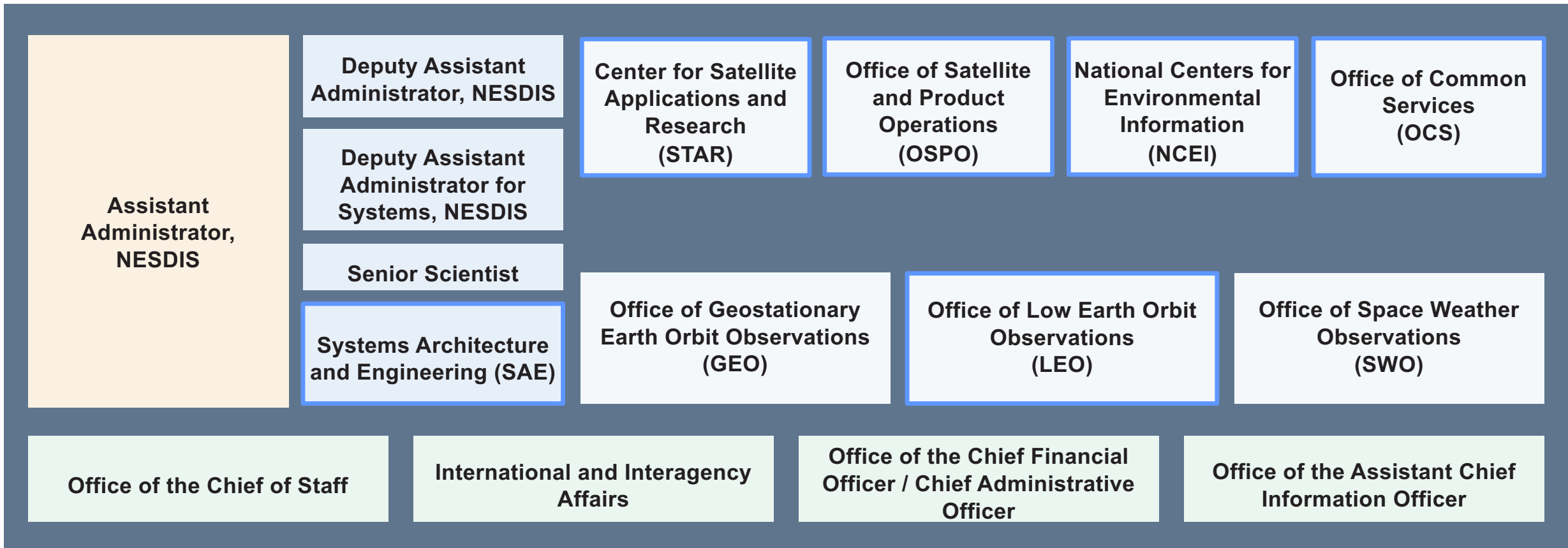


NESDIS Reorganization

The National Environmental Satellite, Data, and Information Service (NESDIS) reorganized its offices in August 2023

Adjusted the overall mission development process to use a portfolio approach

The Laboratory for Satellite Altimetry is now in the STAR Ocean Topography and Cryosphere Branch

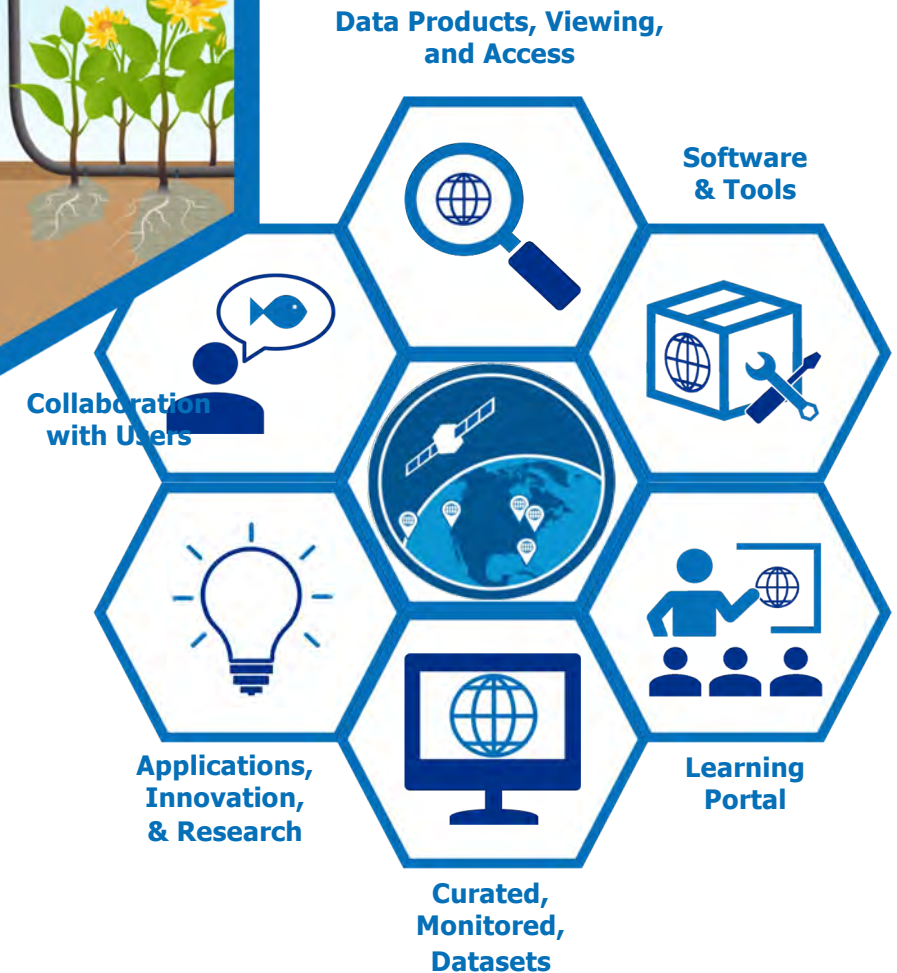
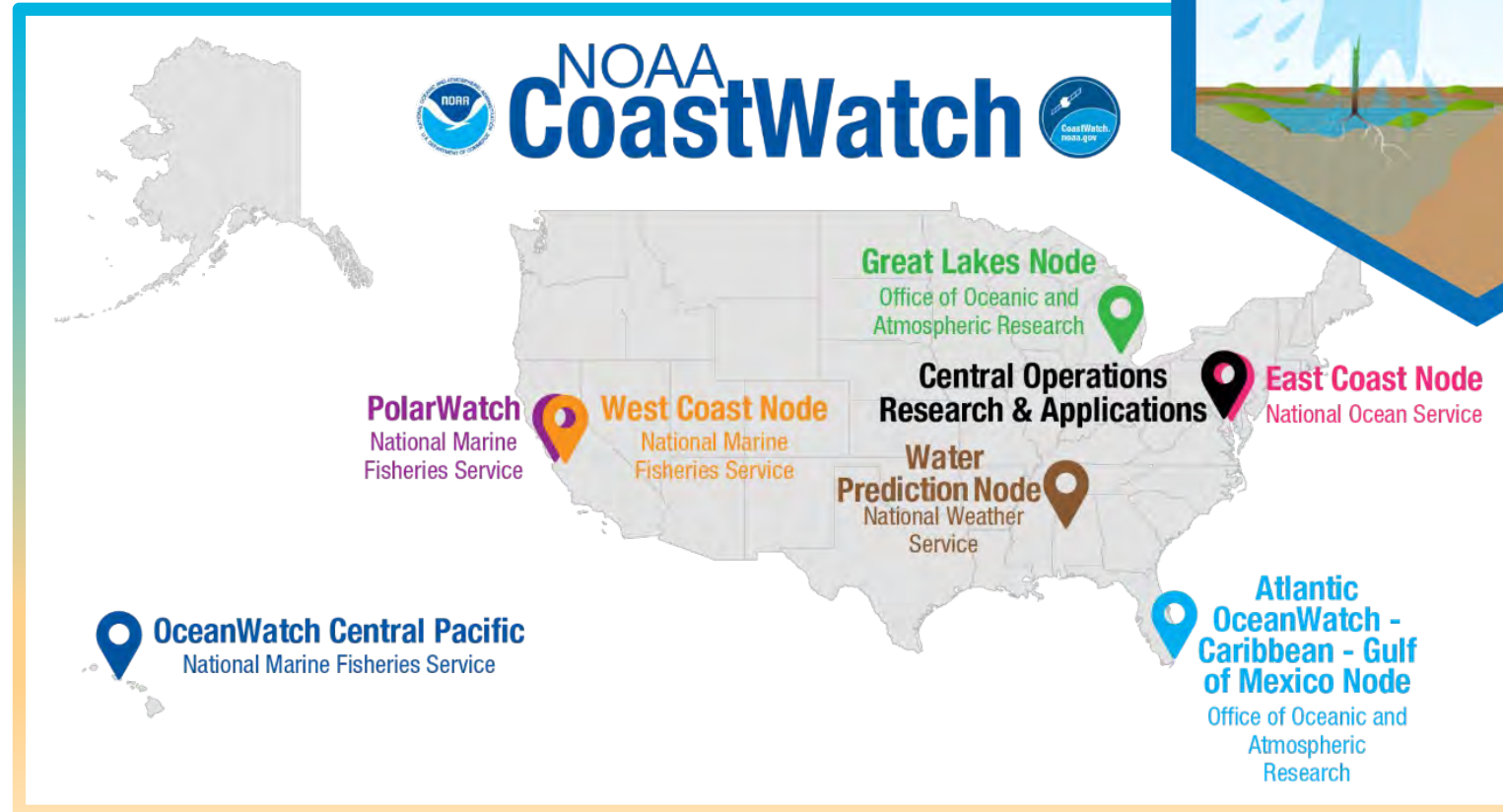
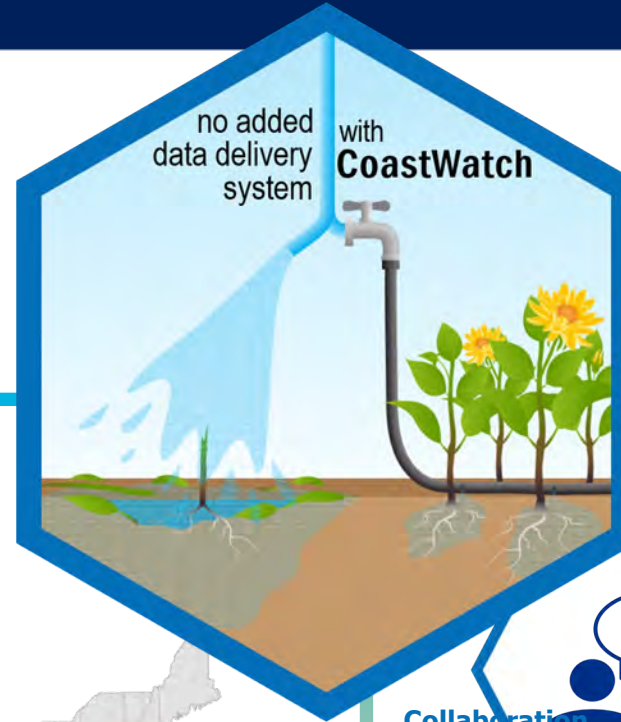


NOAA CoastWatch: Purpose

Satellite
Data Streams

coastwatch.noaa.gov

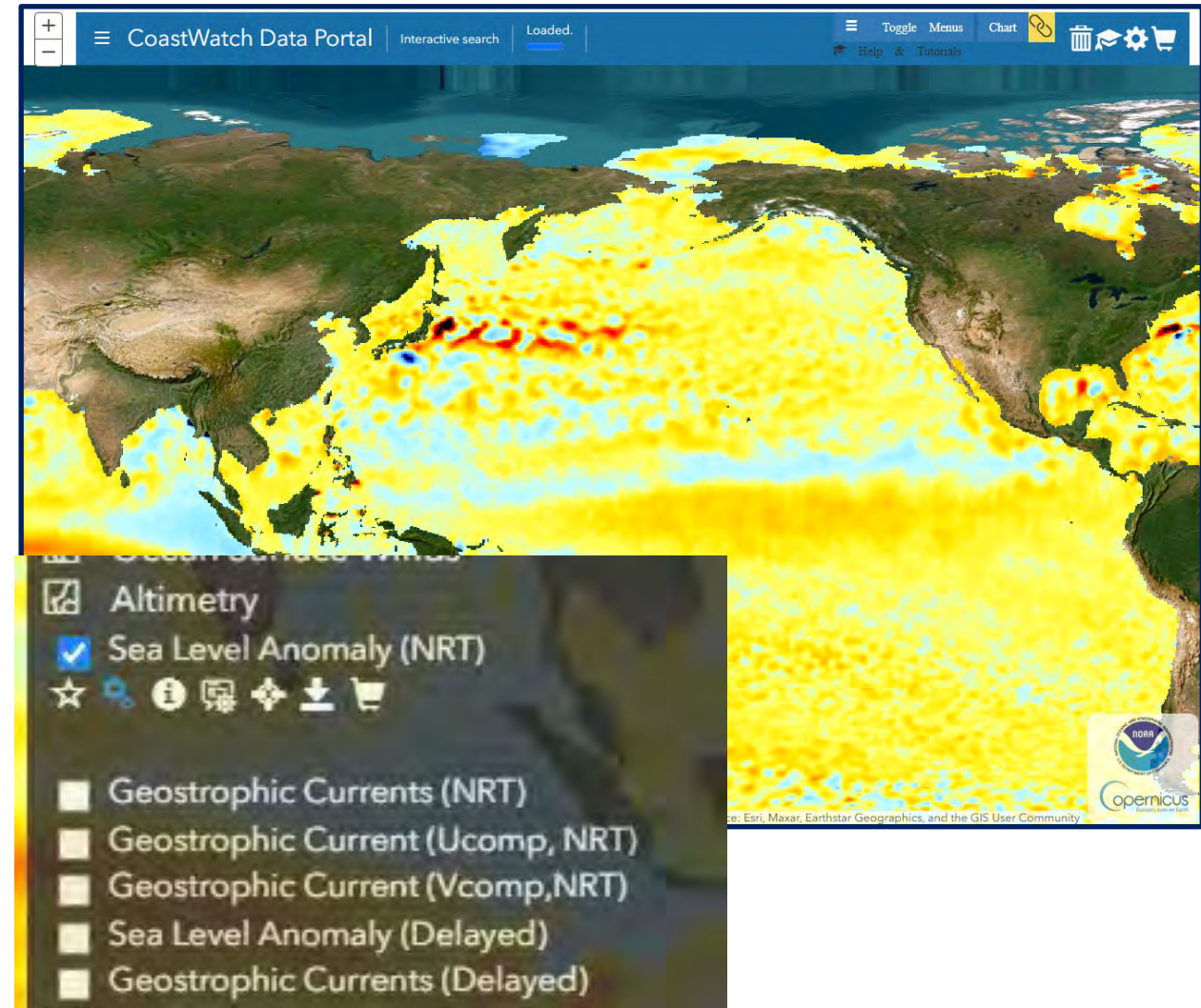
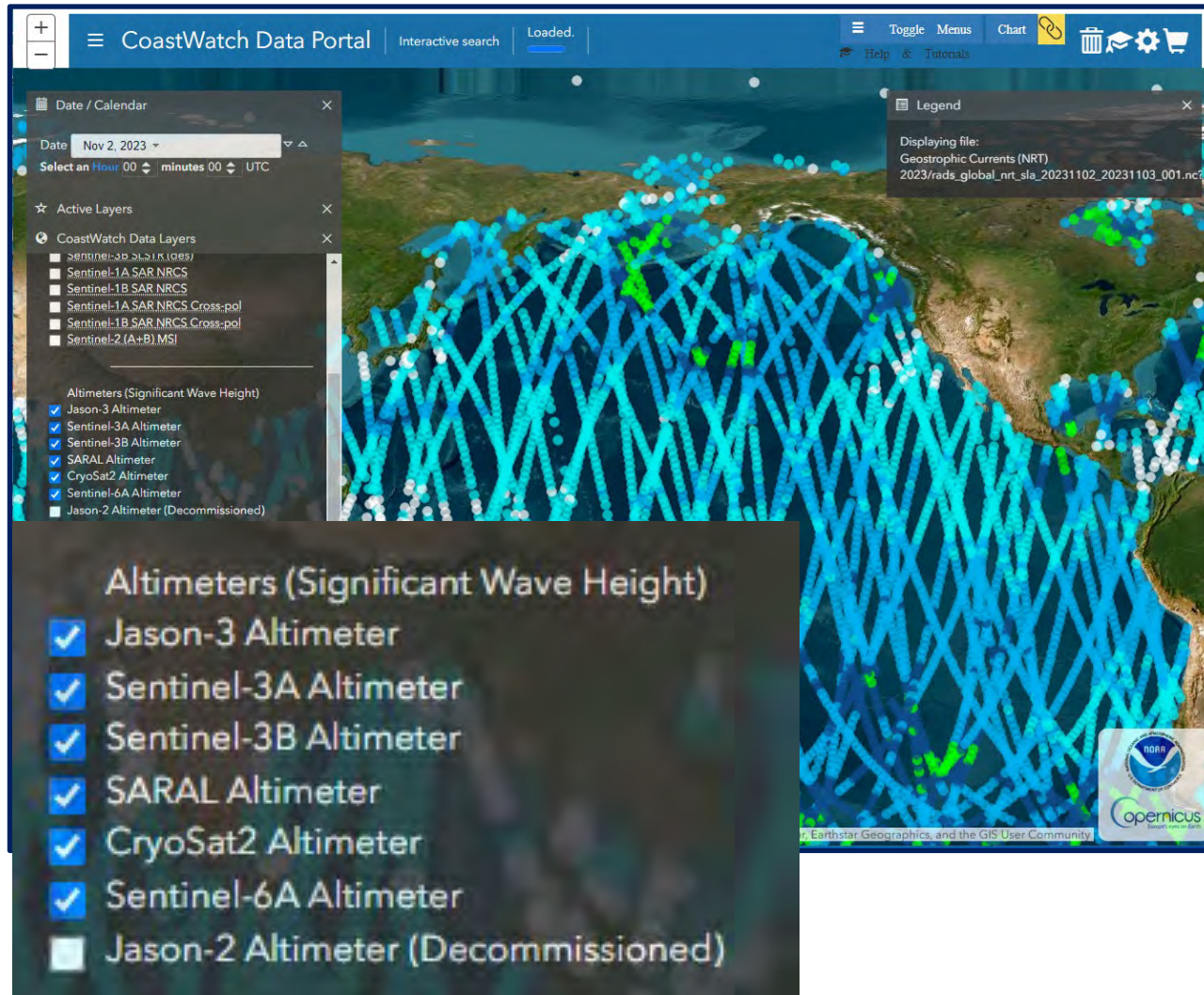
NOAA CoastWatch exists to help **people** find, choose, access, and use satellite data in applications and decision-making for ocean, coastal, and fresh waters.



2 November 2023

Significant Wave Heights

Sea Level Anomaly



Operational Satellite Oceanography Symposia

Third International Operational Satellite Oceanography Symposium (June 2023)

Organized by EUMETSAT and NOAA and hosted by the Korea Hydrographic and Oceanographic Agency (KHOA)

A final summary report is in preparation



Free online OSOS-3 Training Sessions, November 2023

Overview of satellite products from the partners as well as guidance and tutorials on using available tools and software packages to facilitate data analysis, automated data access and processing and product validation. The workshop will be split into three sessions:

- Session 1: Monday 27 November, NOAA CoastWatch (15:00 - 21:00 UTC)
- Session 2: Tuesday 28 November, EUMETSAT (10:00 - 18:00 UTC)
- Session 3: Wednesday 29 November, KIOST/KHOA (12:00 - 15:00 UTC)

<https://training.eumetsat.int/course/view.php?id=492>

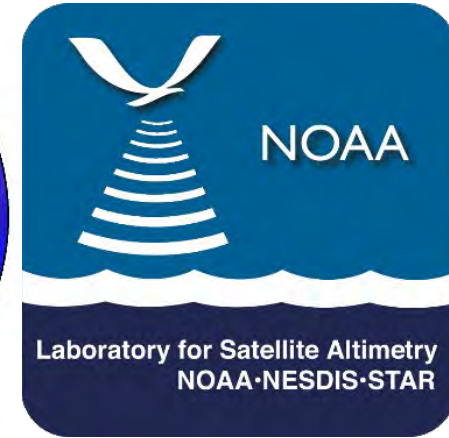
OSOS-4 planned for 2025

NOAA Jason/Sentinel-6 Program

NOAA Support of the OSTST

Four PIs funded for the 2021-2024 Team

Planning for 2025-2028 Team with joint NOAA/NASA ROSES solicitation coordinated with CNES/EUMETSAT TOSCA



Investigator	Institution	Title
James Carton	University of Maryland	Improving Tropical Cyclone Intensity Forecasts by Assimilating Ocean Surface Drifter paths with altimeter sea level
Christopher Buchhaupt	Global Science & Technology, Inc.	Reconciliation of High- and Low-Resolution Ocean Altimeter Measurements Under Changing Surface Wave Structure Conditions
Sinead Farrell	University of Maryland	High-Latitude Multi-Altimeter Observations of the Arctic Ocean and its Sea Ice Cover
John Wilkin	Rutgers University	Mesoscale to submesoscale ocean state estimation by 2-way nested 4-dimensional variational data assimilation

<https://www.star.nesdis.noaa.gov/socd/lisa/OSTST.php>

NOAA @ OSTST	
Instrument Processing	Usage of SAR Stack Data over Sea-Ice – A First Overview (Buchhaupt et al.)
Cal/Val	Tide gauge comparisons for Jason-3, Sentinel-3, and Sentinel-6MF (Leuliette and Plagge)
S6VT	Discrepancies in Sentinel-6MF Sea Surface Parameters Estimated from Low- and High-Resolution Data (Buchhaupt et al.) Stability Monitoring of the AMR-C on Sentinel-6 (B. Zhang and Leuliette)
Synergies between Argo, GRACE and Altimetry	Can Deep Argo Close the Sea Level Budget in the Southwest Pacific Basin? (Lavin et al.)
Science	Atlantic meridional overturning circulation modulates flood risk along the United States southeast coast (Volkov et al.) Implementation of the Optical Flow to Estimate the Propagation of Eddies in the South Atlantic Ocean (Volkov and Negahdaripour)
Applications	Assessing Tropical Cyclone Intensity Forecasts Using the NOAA Next-Generation Enterprise Ocean Heat Content Algorithm (Byrne et al.) Multiparameter Mesoscale Eddy Tracking Products for Operational Use (Roman-Stork et al.) NOAA’s Jason-3 Products (Richardson) Jason-3 Near-Real Time Products Latency from October 2022 to October 2023 (Richardson)
Coastal	Satellite Altimetry Sea Level Height and Related In Situ DART® and Tide Gauge Products Stewardship and Comparison Study in NOAA/NCEI (Y. Zhang et al.)
Geoid, MSS, and MDT	Development of Puerto Rico and US Virgin Islands sea surface topography for vertical datum transformation using retracked altimetry and tide gauges (Jeong and White)



ESA PROGRAM STATUS

(S3, S6MF, S3NG-T and CRISTAL in other talks this morning)

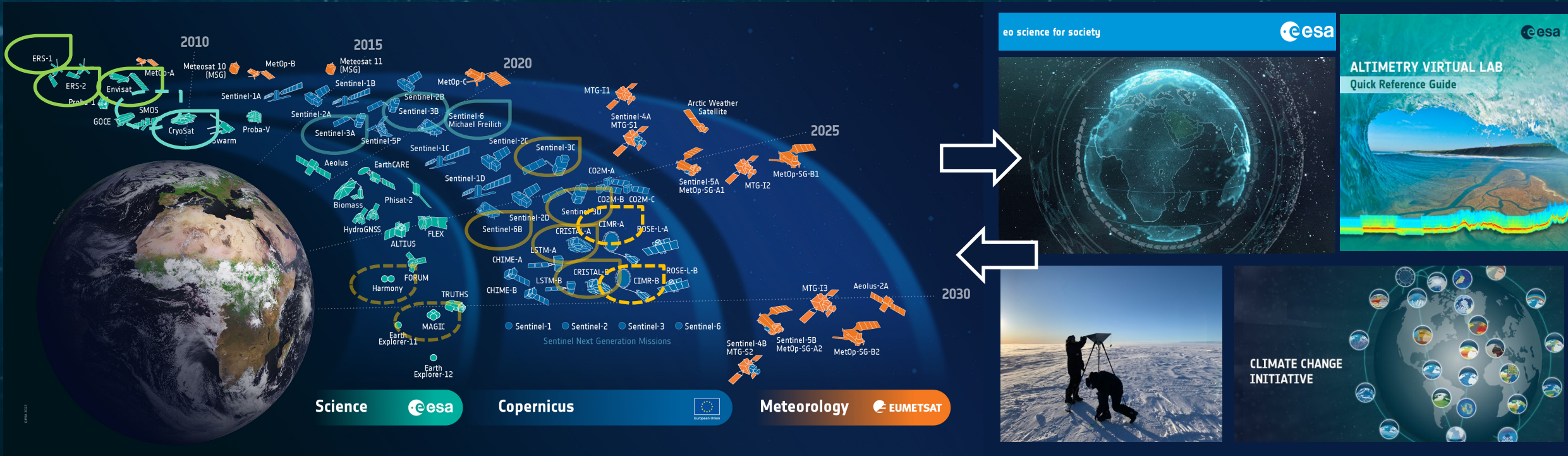


Jérôme Bouffard*, Jérôme Benveniste & many ESA colleagues

*ESA - Sentinel-3 and CRISTAL Missions Manager

OSTST 2023 | November 7-11, 2023 | | San Juan, Puerto Rico

FROM PREPARATION TO EXPLOITATION



- Prepare, develop and/or operate **world class EO systems**, in cooperation with European and Global partners to support Climate, Science and Operational Services.
- **3 families of EO missions** (Science – Copernicus - Meteorology) including **altimetry** and complementary sensors.
- Key importance of **R&D** and **Cal/Val** to improve data quality from **past**, **current** missions and prepare **future** concepts.



FULL MISSION REPROCESSING (FDR4ALT)

- Based on **state-of-the-art** algorithms & corrections (ENV new retracker, ERS pulse blurring)
- Generated innovative Earth system data records: 2 **FDR**'s and 6 **TDP**'s
- **Synergies** with past, current & future ESA projects (EMIR, FIDUCEO, REAPER, ENVISAT V3.0, SS_CCI, SI_CCI, LI_CCI, Lakes_CCI, S3 LAND STM branches, CRYO-TEMPO...)

<https://www.fdr4alt.org>



Fundamental Data Records

L1B products containing all ancillary and instrumental data used for calibrations



Thematic Data Products

Level-2P, easy to use, validated products with uncertainties included serving different communities involved in long term data exploitation



Ocean & Coastal Topography

Inland waters

Land-Ice Greenland Antarctica

SeaIce

Atmosphere

Ocean Waves

First time series of homogeneous sea-ice estimates between 1991 & 2012

High resolution wave analysis for climate, coastal and wave current interactions applications

Inland Water data to increase temporal coverage

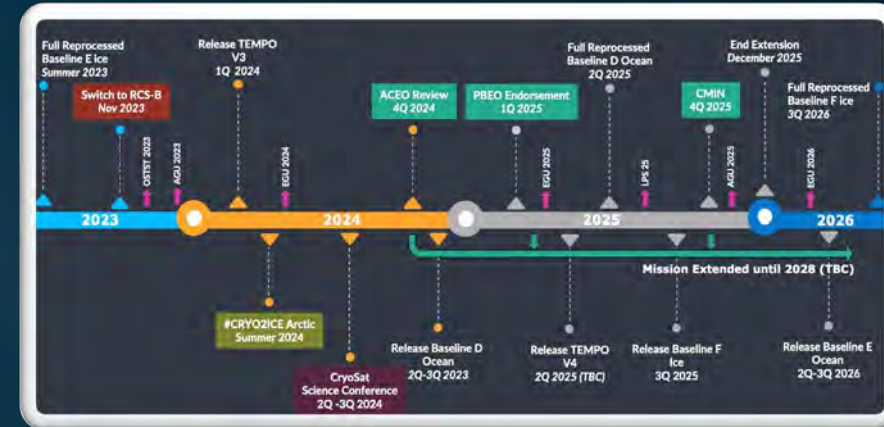
Data release (~4TB) by end 2023

See talk on 9 Nov in Grande Beach Room (#208) @ 11:15

STATUS & HIGHLIGHTS

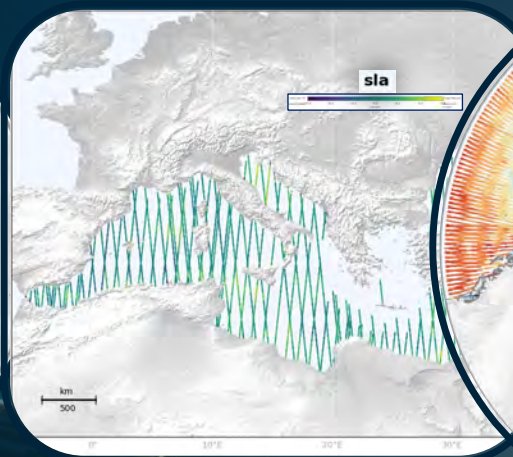
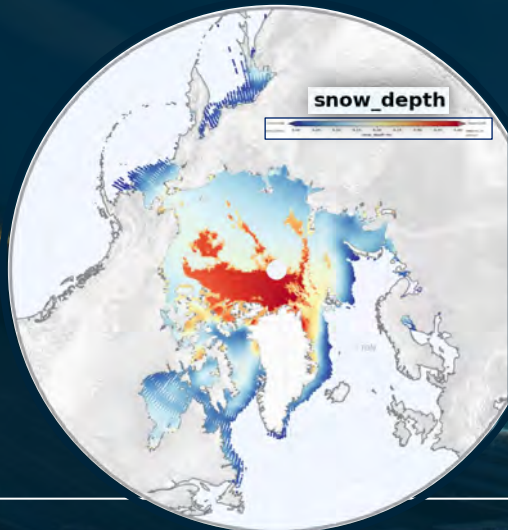
- Overall performance of the mission **excellent**. One of **longest** climate records measured by one single instrument. Operations extended until **2025**
- 21st Nov, switchover to the backup propulsion branch (**RCS-B**) to stop leakage
- **Enhanced data** portfolio (core L1/L2 + thematic products) & **Multi-mission synergies** (CRYO2ICE, S-3 TDP, SMOS ...)

CryoSat Timeline 2023 - 2026



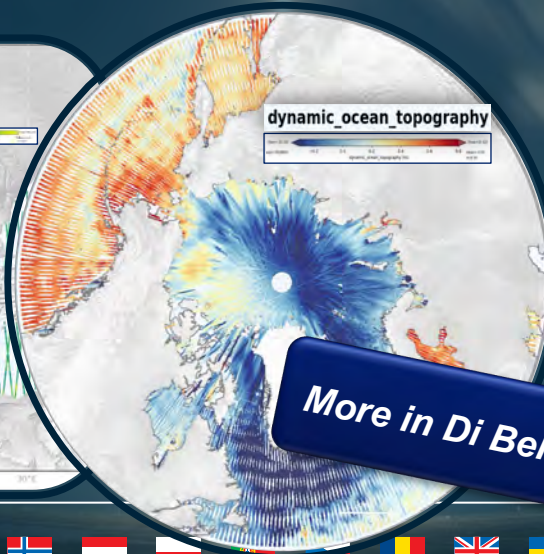
New CRYOTEMPO Products

<http://www.cpom.ucl.ac.uk/cryotempo/>



New COP Baseline D

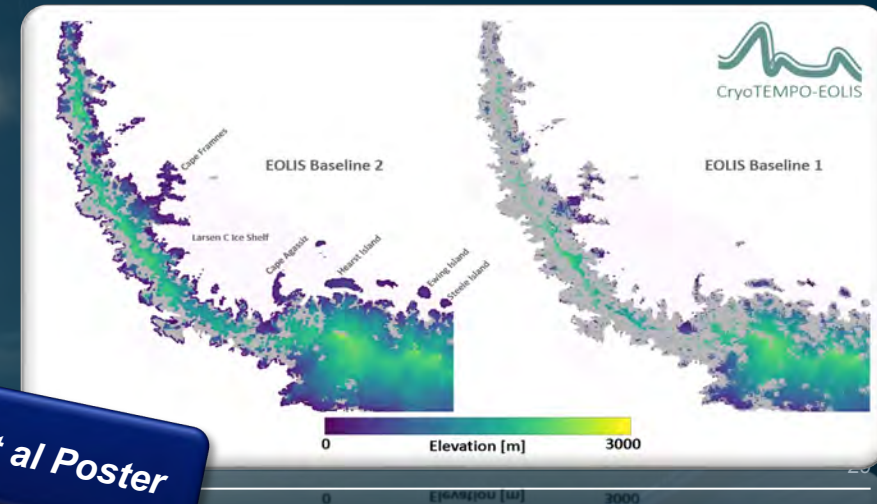
postponed to Q2-24 and FMR for 2025



More in Di Bella et al Poster

New Monthly EOLIS DEM

Based on SWATH processing. New algorithm offers improved spatial coverage



STATUS & HIGHLIGHTS

- Platform and payload in **excellent** condition. Operation extended until **2025**. Preparation for a mission **extension** will start next year
- Synergies between altimetry & L-band radiometry to retrieve SIT. Observes thin SIT (0-1m) with high sensitivity, **complementing** CryoSat and S3.
- Also promising in preparation of **CRISTAL** and **CIMR**

New CS2/SMOS L4 Arctic SIT



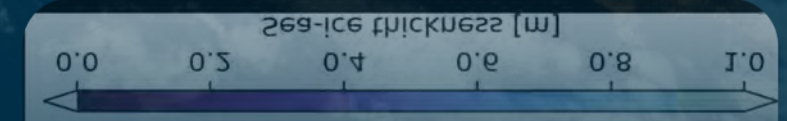
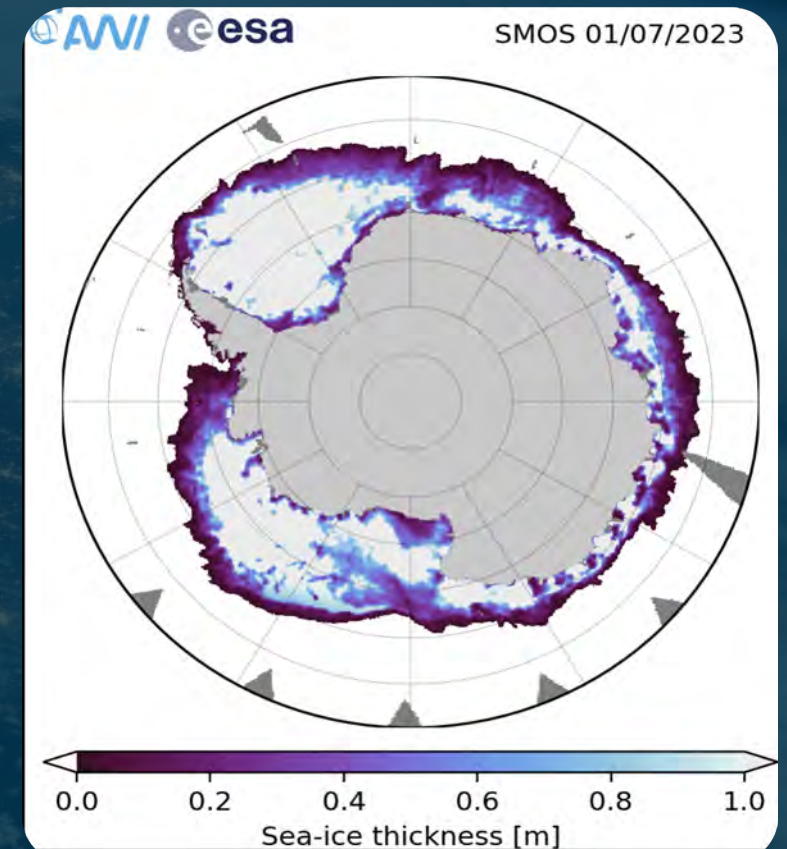
CS2/SMOS SIT new Level-4 processor version v205 since January 2023

Full Reprocessing using SMOS SIT from L1C v724

Testing feasibility of CS2SMOS Antarctic product

Testing feasibility of including Sentinel-3 SIT

SMOS Antarctic SIT (Q4 2023)



<https://spaces.awi.de/display/CS2SMOS>
<https://smos-diss.eo.esa.int/>



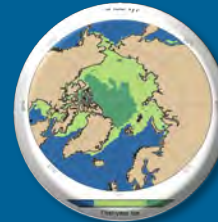
STATUS & HIGHLIGHTS

- Mission payload: Conically scanning imaging **radiometer**
- Primary objectives: Measure **SIC**, **SIE** and **SST** with **sub-daily** coverage of the Polar Regions
- Status: System CDR in second half of 2025



Synergies of CIMR with altimeters

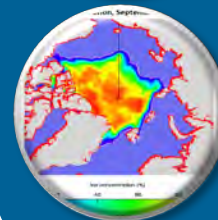
CIMR can provide **auxiliary inputs** to improve geophysical retrievals



Sea Ice Type



Sea Ice Edge



Sea Ice Concentration

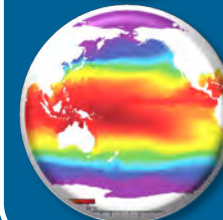
Can be **jointly exploited** to improve quality of geophysical retrievals & **cross cal/val**



Snow depth



Sea Ice Thickness

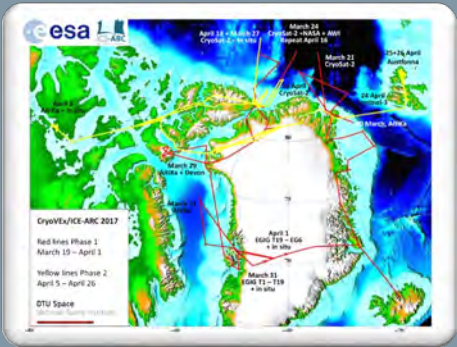


Global Surface Currents

CALVAL ACTIVITIES

FIDUCIAL REFERENCE MEASUREMENTS

- Develop protocols/procedures based on **metrology**, ensure the operational provision of FRM and derive traceable uncertainty parameters for altimetry
- Special emphasis over **Inland Waters** and **Cryosphere** (e.g. St3ART), i.e. domains where ESA is responsible of Ground Segment and core data products for Sentinel missions



POLAR CAMPAIGNS

- From 2002 to 2022, **20** Campaigns (15 Arctic, 5 Antarctic) within international **collaborations**
- Since 2022, focus on **CRYO2ICE** and multi-band (Ka-Ku-La) approach to retrieve snow and sea ice thickness (see also CEMSIE for polar CEM)

INTERCOMPARISONS EXERCICES

- **International & multi-agency** collaborations to develop joint protocols for the intercomparison of Altimetry + other EO products over the cryosphere.
- 3 activities to reconcile estimates of mass balance for glaciers (GLAMBIE), ice sheets (IMBIE) and of SIT (SIN'XS) → Key for **CCI / IPCC**



ESA CCI PROJECTS

All Data: <https://climate.esa.int/en/odp/#/dashboard>

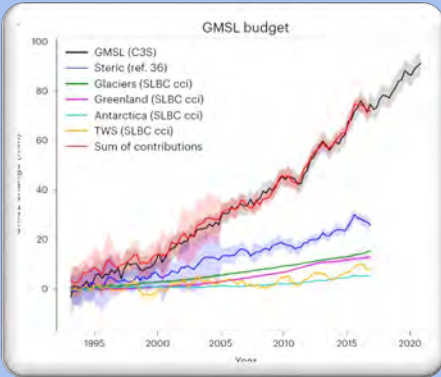
OCEAN



Sea Level Budget Closure

Sea Level V2.2 includes network of virtual **altimetry** stations for coasts

GMSL budget
Meysignac et al 2023



Ocean Colour New version (V6) as of Aug 2023, Global chlorophyll-a 4km, 1997-2022.

Sea State V3 (2003-2021, monthly). Phase 2 launching in Nov 2023.

Ocean Carbon Phase 1 invitation to tender launching 2024.

Salinity V3.2 (2010-2020, weekly, monthly). Phase 2 working on V4.

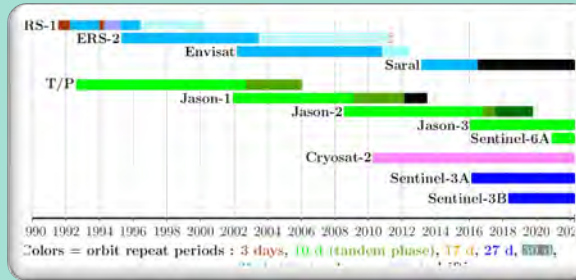
Sea Surface Temperature : V3 available soon: 1980-2021. Phase 4 launching early 2024.

HYDROLOGY



River Discharge Precursor

Derive long term climate data records for some selected river using EO (**altimetry** and multispectral images) and ancillary data

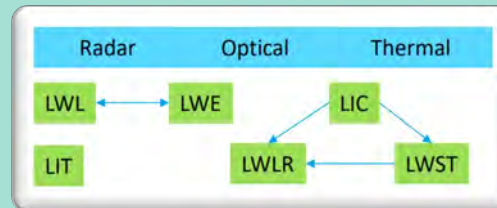


<https://climate.esa.int/en/projects/river-discharge/about-the-river-discharge-project/>

Lake Projects

Lake Water Extent & Water Level (coupled), Lake Ice Thickness... New CDR (>2000 Lakes, 1992-2020) including S1, S2, S-3 & S-6

<https://climate.esa.int/en/projects/lakes/>



CRYOSPHERE

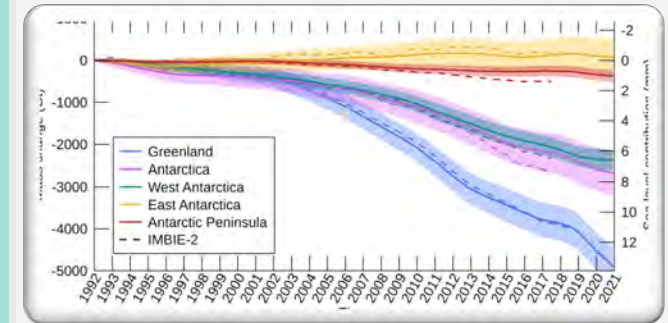


Sea Ice

Advance the retrieval capability for two main variables of the ECV: SIC & SIT.

Antarctic & Greenland Ice Sheets

Release of new ice sheet mass balance data (1992-2020) for IPCC AR6.



Cumulative mass change from IMBIE Team.

Otosaka et al 2023

Glaciers

Contribute to the efforts of creating a detailed glacier inventory as requested by GCOS..

+Snow, Permafrost

OCEAN SCIENCE CLUSTERS

<https://eo4society.esa.int/projects/>

12 ALTIMETRY-BASED PROJECTS



BOOMS
DTE_p - MHW

MAXSS
CYMS **BiCOME**

Ocean Health - Acidification **MITHO**

MedE OS *ocean health* **Sargassum**

WQ-FC **SOON** **Eu-MON**

Coastal Erosion **POSEIDON**

Sentinel Coastal Charting

Hydrocoastal *Baltic+Salinity*

FFSAR-Coastal *Baltic+SEAL*

E OatS E E **4DME D**

Space4SafeSea **World Ocean Circulation**

Ocean Health - Marine Heatwaves

S-6 JTEX **SwellStats** **SARWAVE** **Clean Arctic**

ARI - DUST

ARI-OHC

SCOPE

BICEP

Aeolus+COLOR

Aeolus+AOC **ARI-PRIMUS**

S5P+OC *OceanFlux-GHG*

AMT4OceanSatFlux

Baltic+SeaLaBio

PYROPLANKTON

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ESA POLAR SCIENCE CLUSTER

EO SCIENCE FOR SOCIETY



GATHERING THE ALTIMETRY COMMUNITY



Thank you for your attention

European Space Agency

30 YEARS OF PROGRESS

IN RADAR ALTIMETRY

SYMPOSIUM

2-6 September 2024
Montpellier, France

