

CNES EARTH OBSERVATION PROGRAM

Co-authors :

S. Cherchali, D. Leroux, A. Carbonnière, A. Deschamps, Y. Faugere, P. Maisongrande



International Cooperation, a key to success



SOPHIE
LE GAC

CNES Earth Observation
Department,
Strategy Directorate

CNES

THE FRENCH SPACE AGENCY

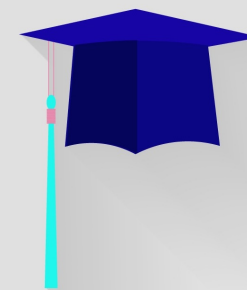
≈ 70,000

People in the French space ecosystem

≈ 2350
employees



at 4 centres



130
doctoral

and post-doctoral
research grants awarded
every year to French
and foreign students.

44

Nations

we are working
with around the
world.

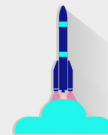


€38

Mean yearly
per-capita amount
that France devotes
to space, the world's
2nd largest space
budget.

+100 space projects

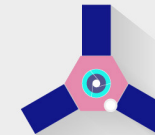
Currently led by
CNES in 5 key
domains.



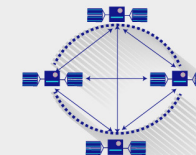
Space transportation



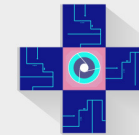
Science



Defence



Telecommunications



Earth observation

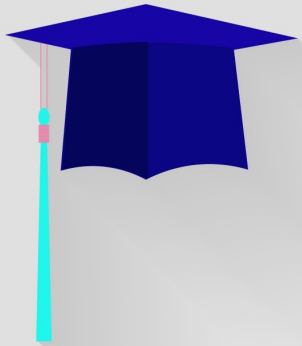


2,598
million euros

Budget for 2023,
including France's
contribution
to ESA of €1,079m.

CNES

OUR ECR PROGRAM



130
doctoral

and post-doctoral
research grants awarded
every year to French
and foreign students.

60
laboratories



25

Funding partners
(industry,
research institutes,
public institutions)



*Yearly ECRs event at La Cité de l'Espace
in Toulouse*

7,5

millions €

Yearly program cost

- **Train** young scientists in the fields of space science
- Provide a scientific environment of **excellence** and maintain **innovation** capacity
- **Foster** space research
- **Strengthen** links between ECRs, academia, CNES and industry



Call for PhD & post-doc applications each year in February-March



OUR 4 STRATEGIC PRIORITIES

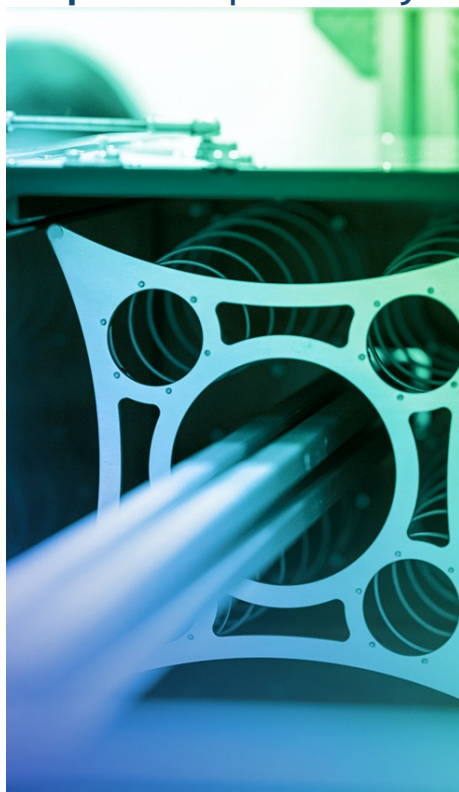
Strengthen

our **strategic** independence



Sustain

a **competitive** space ecosystem



Work

towards a **sustainable** world



Extend

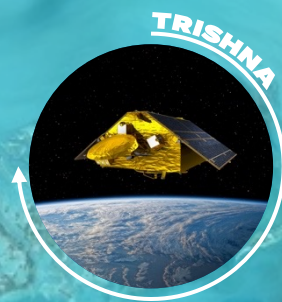
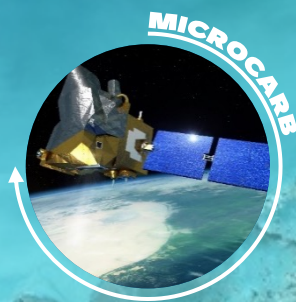
our **scientific** excellence



CNES EARTH OBSERVATION PROGRAM

Commit to a more sustainable world

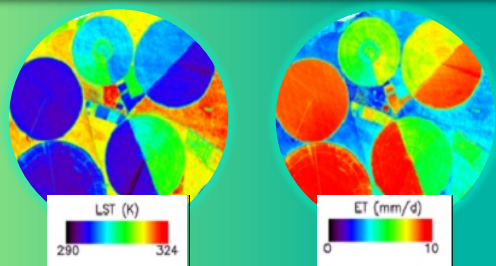
- ▶ **SCIENCES** Better understand and monitor our changing Earth's Planet in the context of Global Change
- ▶ **TECHNOLOGY** Innovation to build tomorrow's sustainable sectors
- ▶ **SOCIETY** Respond to Climate Change challenges
- ▶ **SERVICES** Development of new services for populations at the regional and local scales
- ▶ **COOPERATION** Participate to structuring international partnerships



BILATERAL PROGRAMS AND INNOVATION



Ground surface temperature
and daily evapotranspiration



Launch scheduled in 2026

Bilateral programs devoted to water

Land, Coastal, Ocean
Water

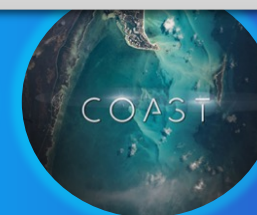
Satellite precursors
LSTM, S3-NG TOPO
Downstream Programs



DATA
TERRA



First global survey of Earth's
surface waters



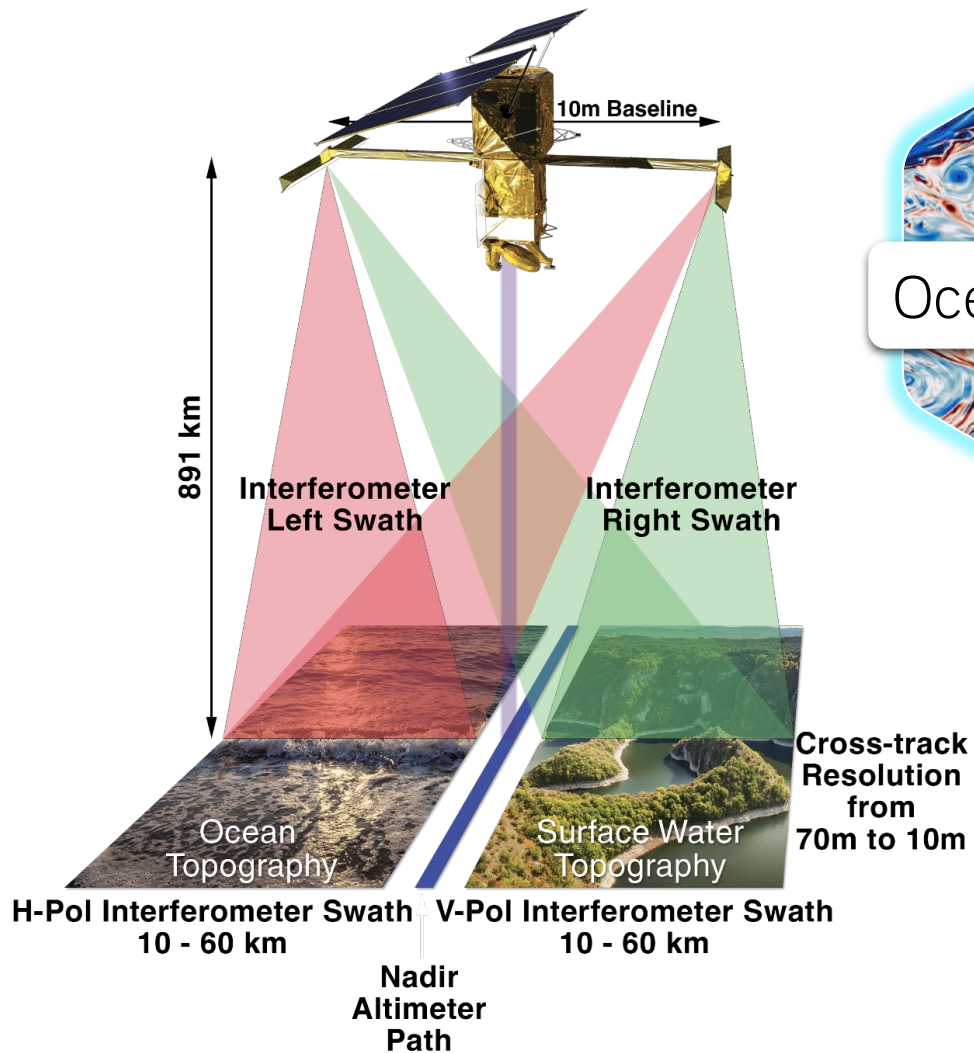
Launched Dec 16, 2022

A satellite with large solar panels and a long boom is shown in orbit above the Earth's surface. The satellite is gold-colored with dark blue solar panels. The Earth below shows a mix of blue oceans, white clouds, and brown landmasses.

SWOT

SURFACE WATER AND OCEAN TOPOGRAPHY

SWOT MISSION OVERVIEW



Ocean circulation

Lakes and rivers

Beyond the primary science objectives

marine geodesy – coastal altimetry – swell and tsunamis – winds and cyclones - surfaces DEM - polar regions - ship detection

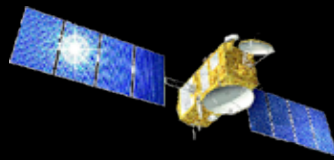
HISTORICAL PARTNERSHIP



NOAA



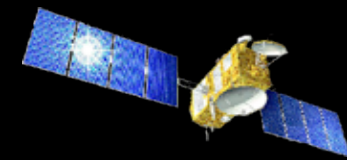
TOPEX/POSEIDON



JASON 1



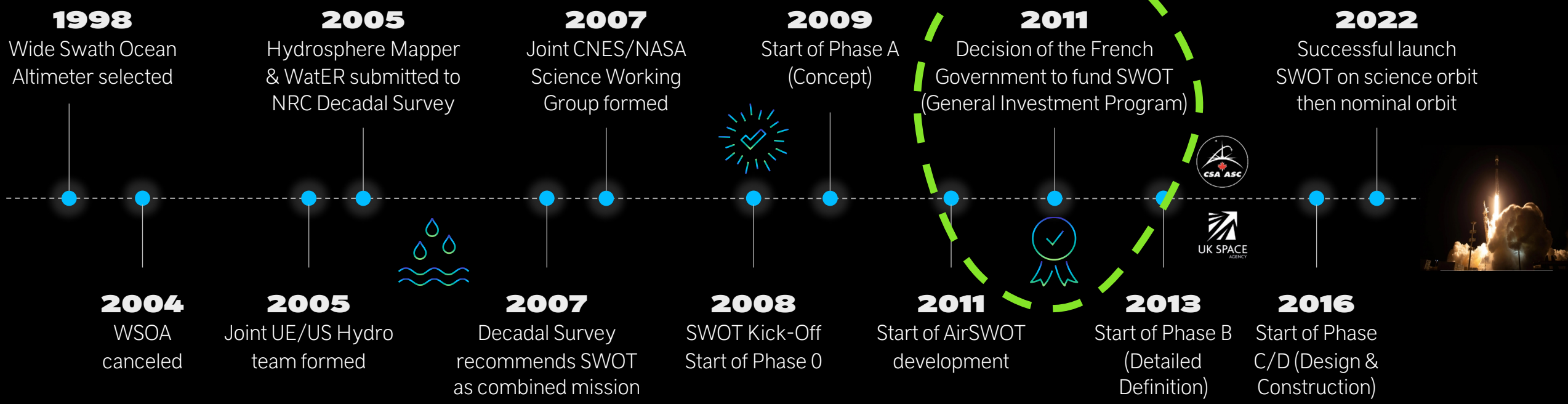
JASON 2



JASON 3

Innovation in science, technology,
physics, potential for applications

SWOT key milestones



SUCCESS KEY – PREPARING FOR NEW DATA



- Major effort on the **preparation of the downstream program**: supporting science while preparing for the development of new services
- Strong relation with **NASA Early Adopter Program**

SUPPORT EXPERTS AND RESEARCHERS

- Support for hydrological and oceanographic research

OUTREACH

- Target market analysis
- Information and targeted communication

SIMULATION & IN SITU

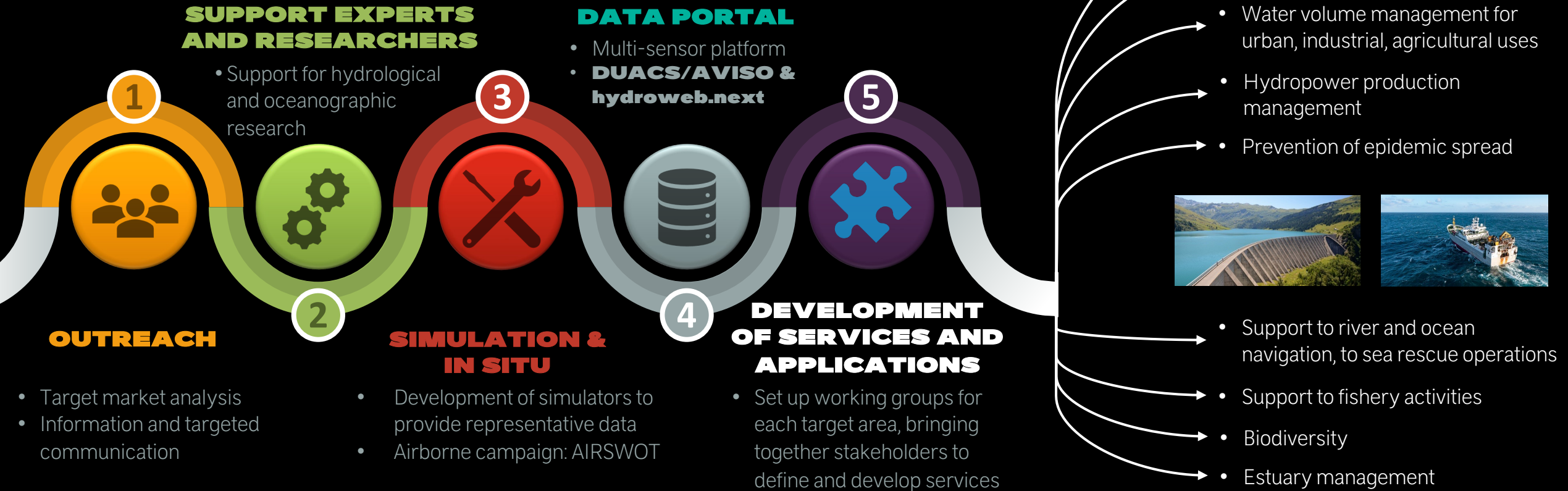
- Development of simulators to provide representative data
- Airborne campaign: AIRSWOT



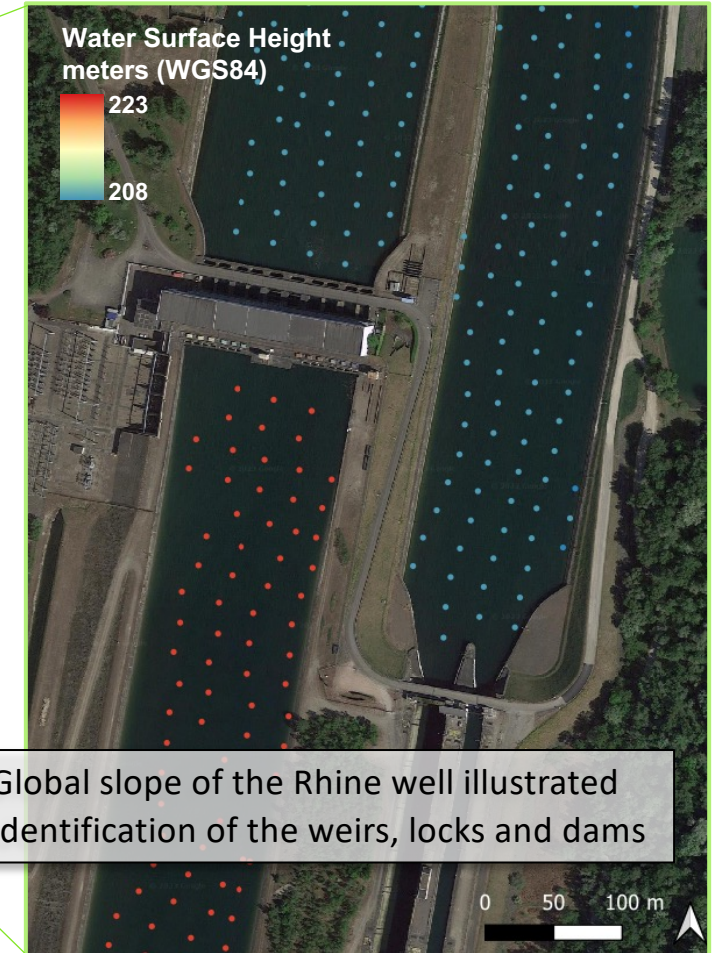
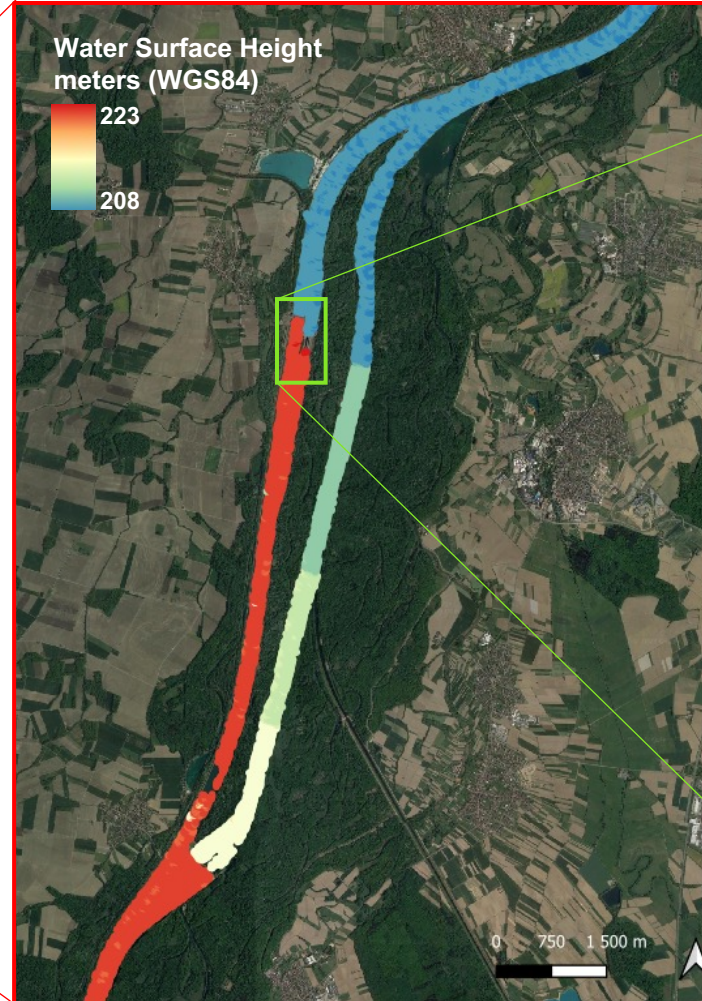
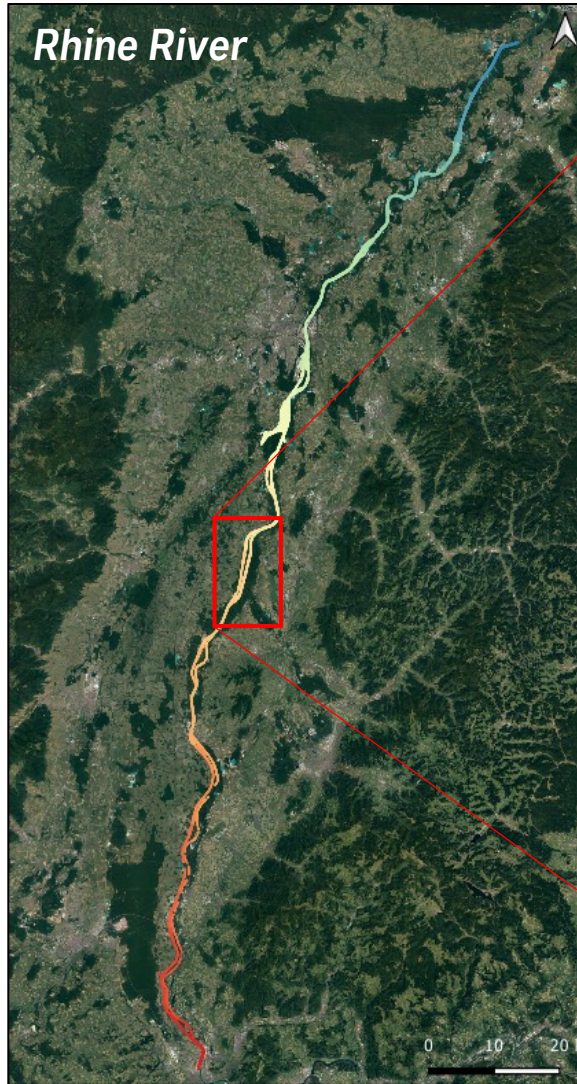
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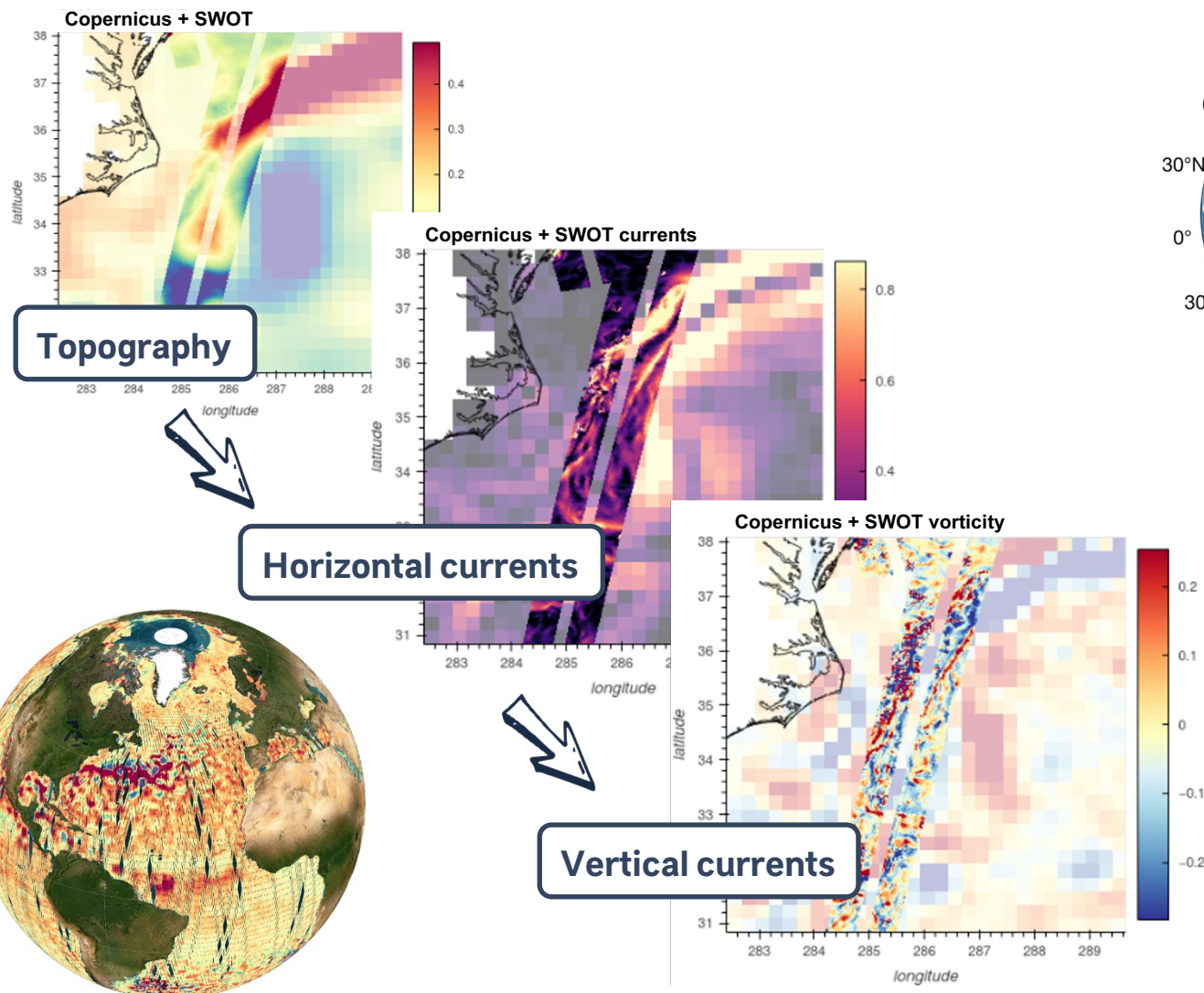
SWOT RESULTS - HYDROLOGY



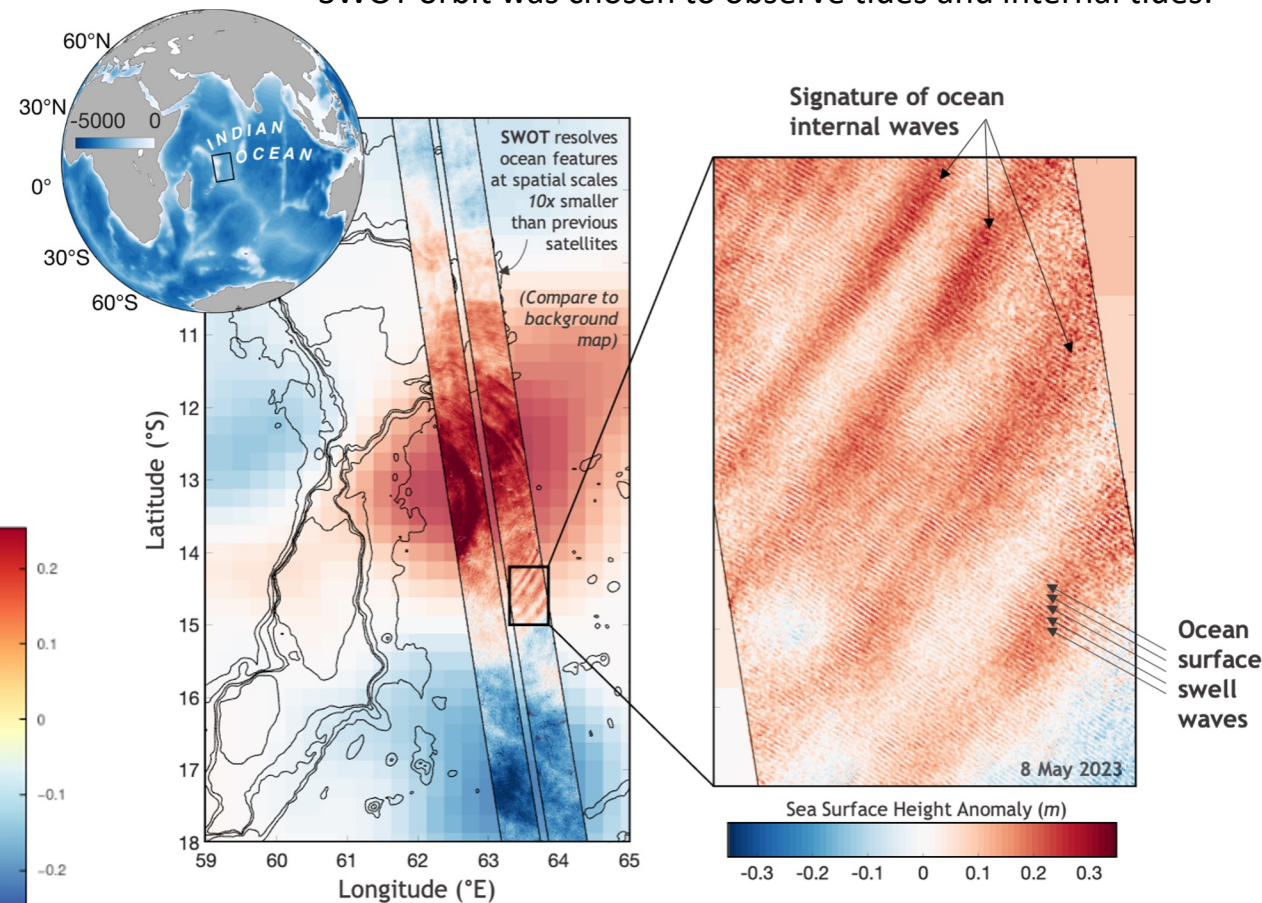
- ✓ Global slope of the Rhine well illustrated
- ✓ Identification of the weirs, locks and dams

SWOT PIXC L2 HR PGC0 - Class 4 - Cycle 540

SWOT RESULTS - OCEANOGRAPHY



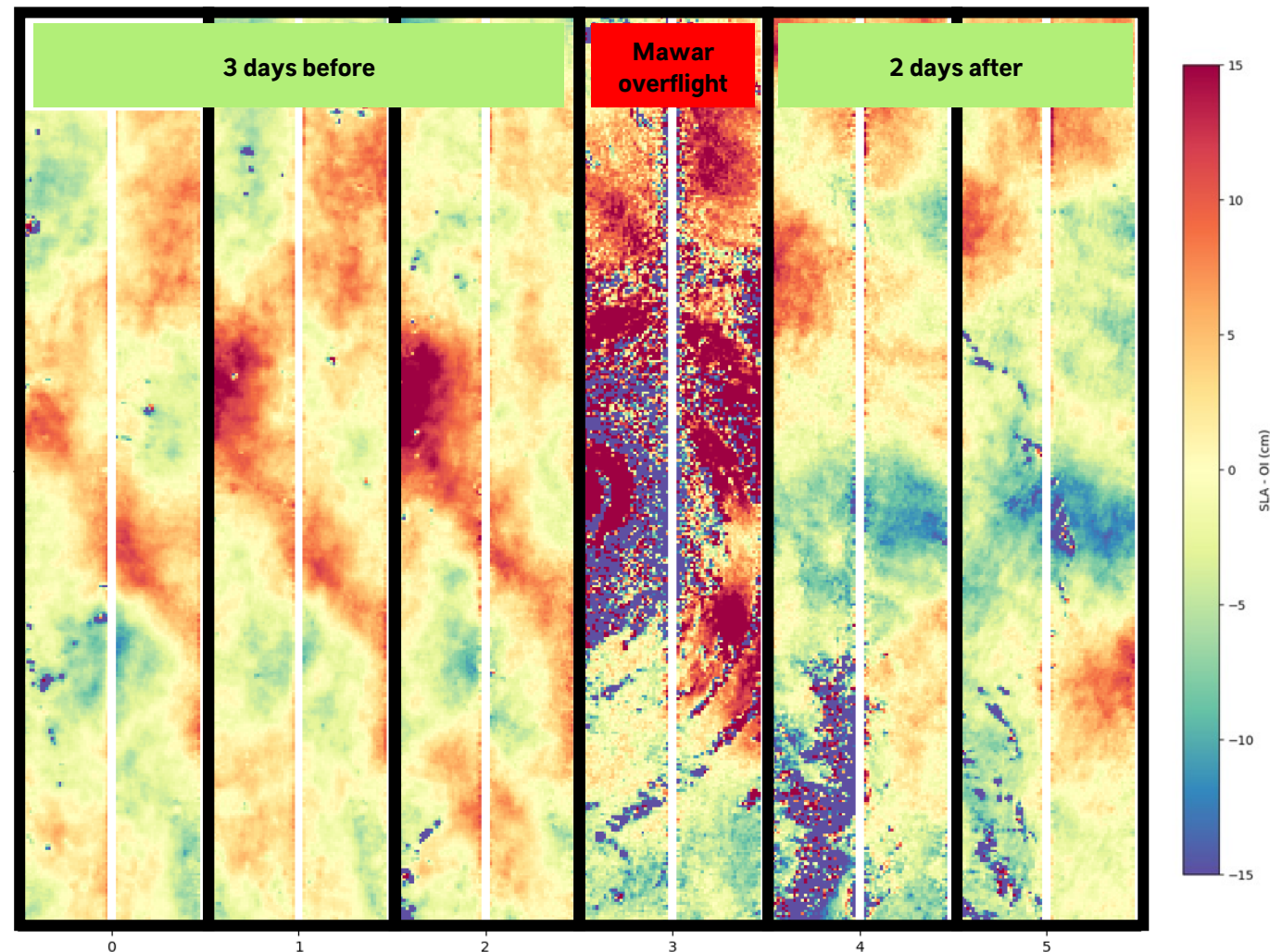
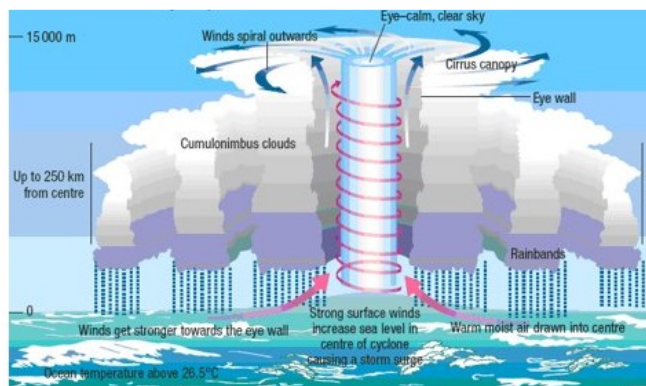
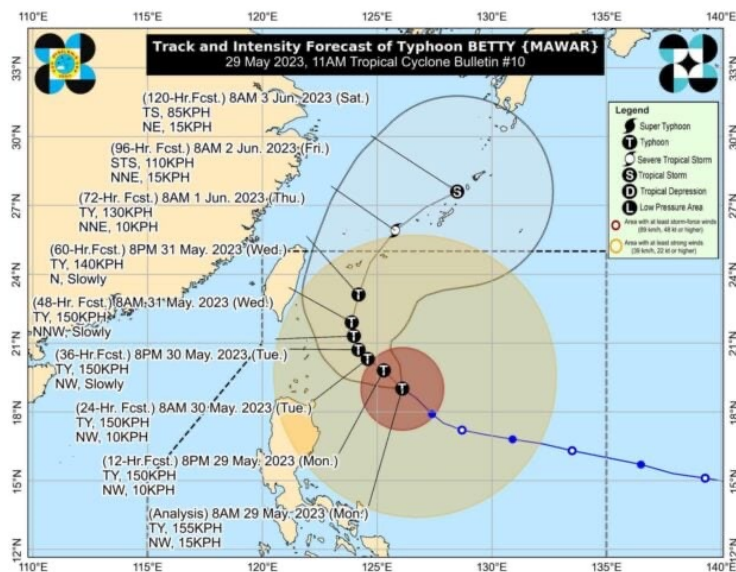
SWOT orbit was chosen to observe tides and internal tides:



M Archer, JPL/NASA

SWOT RESULTS LOOKING AT TYPHOON MAWAR

May 29, 2023



SUCCESS KEY – INTEGRATED DATA PORTAL

- **Integrated approach of the Earth System** with DataTerra to serve the **science** community and answer **society** issues
 - Multi-source, multi-sensor data for use at different spatial, spectral and temporal scales
 - Combination of satellite, in-situ and numerical modeling data
 - Support European and International partnerships, fundamental to a global approach
- **Free hosting on CNES Cloud** and HPC infrastructure



DATATERRA
DINAMIS



Theia
Pôle Thématique
Surfaces Continentales

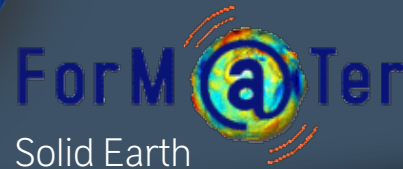
Land Surfaces
& Hydrology



Atmosphere



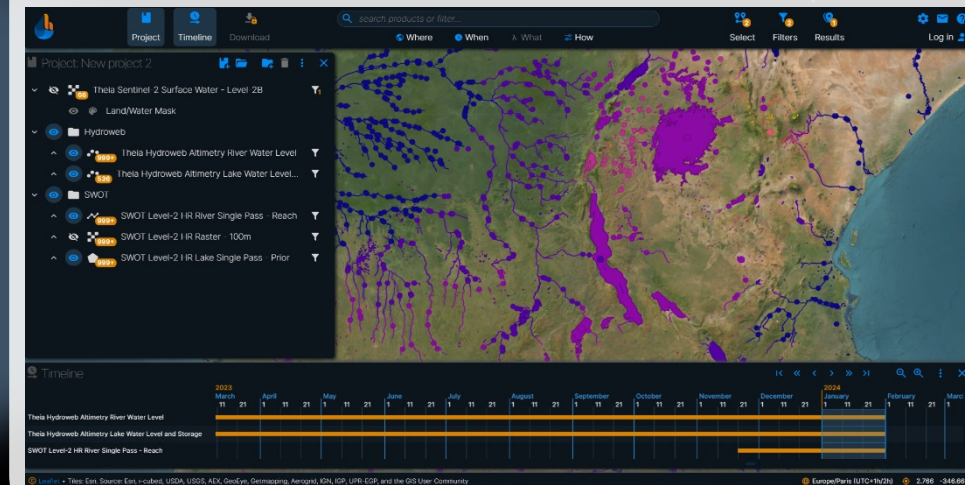
Ocean



Solid Earth

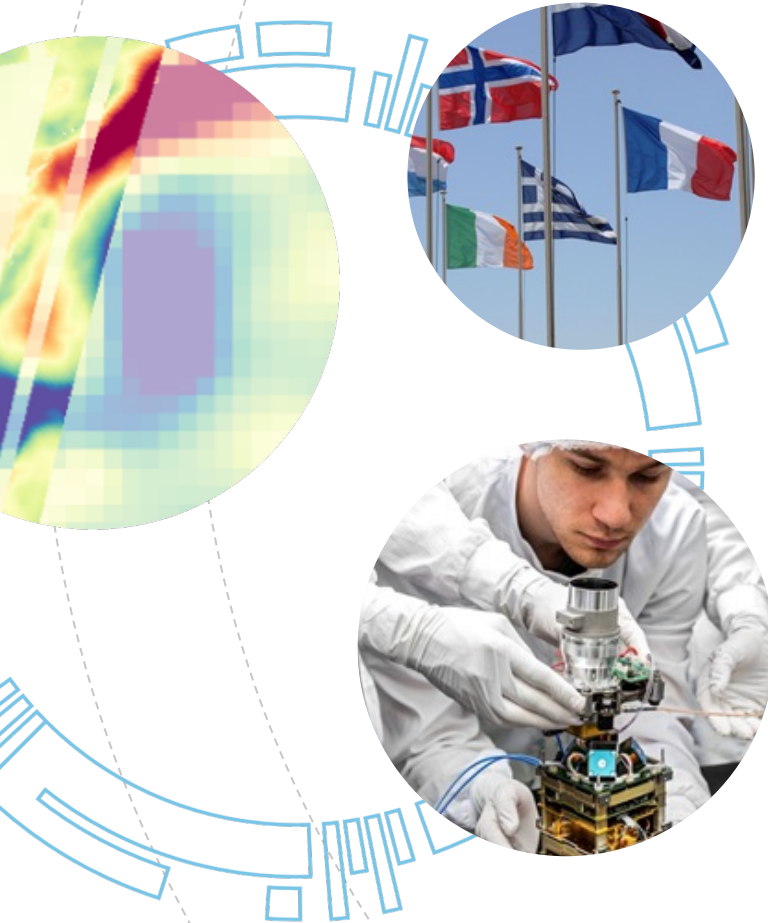


A multi-sensors/multi-variables integrated
approach for hydrology



OUR FUTURE MISSIONS

PROGRAMMATIC APPROACH



- **A committee of scientists** is advising CNES Executive on scientific challenges and lays priorities every 5 years.
- **R&D and technology innovation studies** are carried out with our scientific and industrial partners, to support future missions development and new concepts
- Identify programmatic frameworks and funding to engage projects
- Crucial **preparation** with integrated project team, scientists (joint science Team) & downstream ecosystems
e.g. SWOT
- **Build strong partnerships with a collaborative spirit:** additive skills, building trust, valuing diversity, common vision & ambition



OUR FUTURE MISSIONS IN THE NEXT DECADE



Missions addressing **GEWEX** scientific challenges:

"to observe, understand, and model the hydrological cycle and energy fluxes in the Earth's atmosphere at and below its surface"



2025

MICROCARB

TRISHNA

IASI-NG

C3IEL

**High-revisit
Hydrology**

GENESIS

ODYSEA

2030

AOS

NGGM

**S-3-NG
Topo**

2035

CARIOQA

Other CNES missions addressing various EO scientific challenges: Carbon cycle, numerical weather prediction, geodesy, quantum gravity...

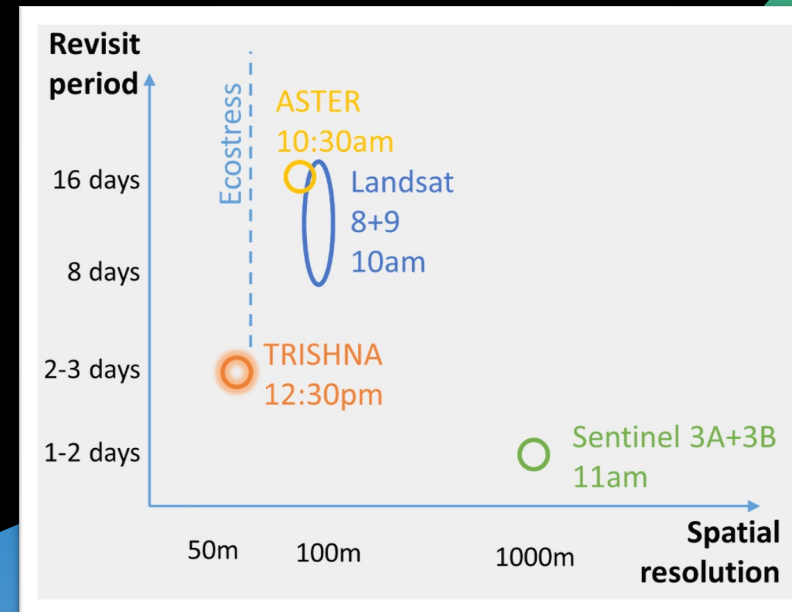
OUR FUTURE MISSIONS

TRISHNA



Thermal infraRed Imaging Satellite
for High-resolution Natural resource Assessment

- ISRO/CNES cooperation, **launch scheduled in 2026**, 5-year lifetime
- For Science and Applications
- Design drivers: **ecosystem stress & water use**; **coastal & continental hydrology**
- Global coverage land + coastal
- 3-day revisit, 60m, VNIR-SWIR (7 bands) – LWIR (4 bands)



TRISHNA

2025

OUR FUTURE MISSIONS

Cluster for **C**loud evolution, **C**limate and **L**ighting

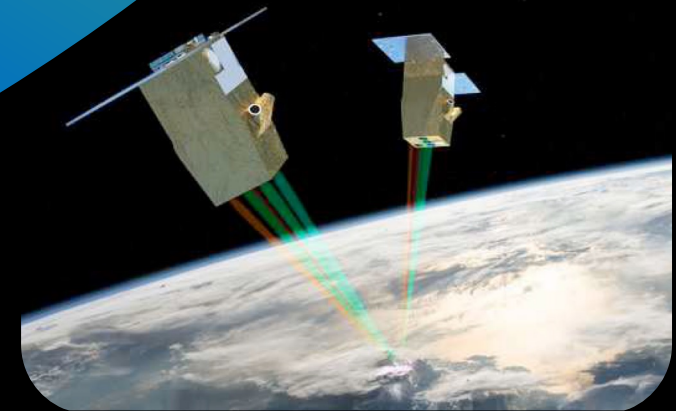
- CNES/ISA cooperation, launch scheduled in Q4 2026
- Train of **2 nanosatellites** in sun-synchronous orbit
- Observation of cloud scenes, **simultaneous multi-angle views**
- Better understanding of **physical processes** linked to convective clouds, to improve their modelization and parameterization in Large Eddy Simulation and numerical weather prediction models
- Synergy with NASA INCUS mission (2027)



2035

C3IEL

2025



OUR FUTURE MISSIONS

High-revisit Altimetry mission for Hydrology

- Based on the SMASH (SMall Altimetry Satellites for Hydrology) mission concept (*Blumstein et al., 2019, Biancamaria et al. EGU 2024*)
- **High priority mission** since 2019 for science and industry
- Ka-band nadir altimetry mission to measure global, **daily water levels**
- **Complementary to SWOT high spatial resolution**
- A constellation of altimeters, unique in the world, built on French expertise in altimetry

**High-revisit
Hydrology**

2030

2035

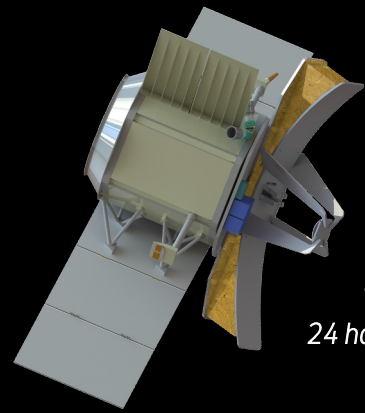


OUR FUTURE MISSIONS

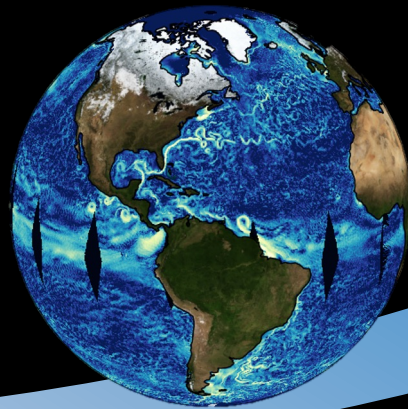


Ocean **Dy**namics and **S**urface **E**xchange with the **A**tmosphere

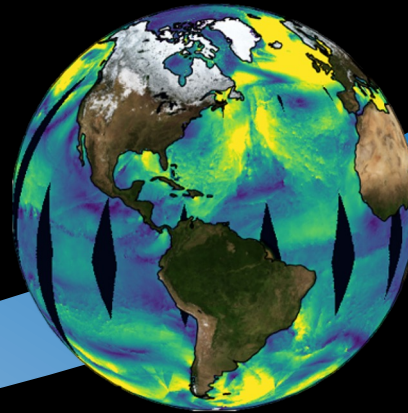
- **Selected** in May 2024 – NASA Call « Earth System Explorer » (4 missions)
- Partnership NASA JPL / CNES
- Ka-band Doppler Scatterometer
- Provides the **first-ever global measure of total surface currents**, including simultaneous **ocean vector winds with improved resolution** for coupled air-sea science and applications **closer than ever to the coast**



1 satellite,
24 hours coverage:



Currents



Winds

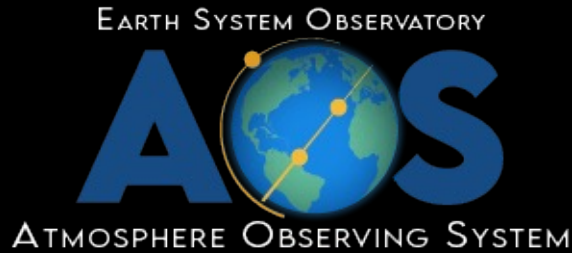
ODYSEA

2030

2035



OUR FUTURE MISSIONS

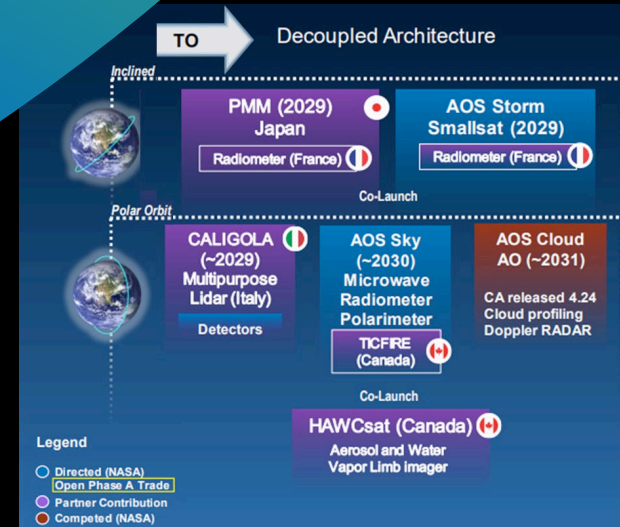


- The AOS programme focuses on three themes : climate, convection, aerosols
- French contribution to AOS :
 - The **C2OMODO** (Convective Core Observations through Microwave Derivatives in the trOpics) mission, a tandem of microwave radiometers onboard NASA and JAXA platforms
 - Level-2 and Level-3 **processing algorithms for clouds and aerosols** retrieval
- Launch in 2029 (AOS-Storm and PMM)

AOS

2030

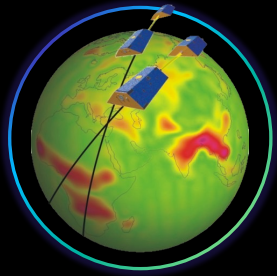
2035



2025



OUR FUTURE MISSIONS

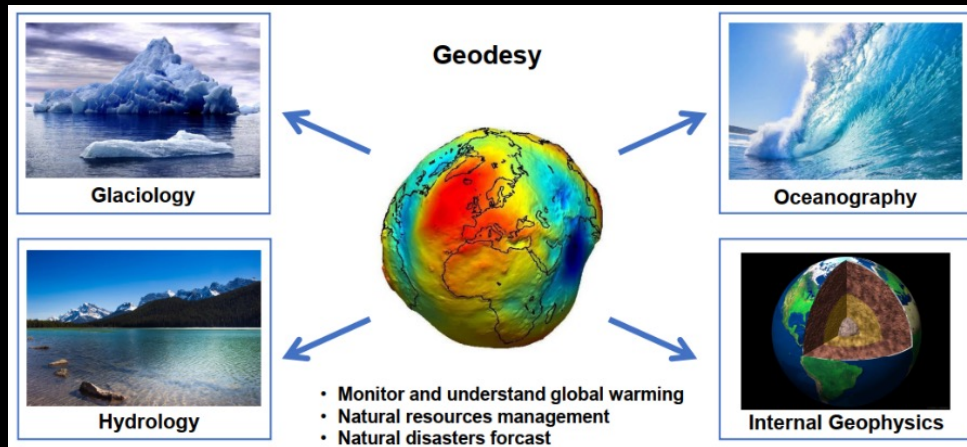


NGGM/MAGIC

MAss change and **Ge**oscience **I**nternational **C**onstellation



- A mission to study variations in the strength of **Earth's gravity field**, mass distribution and transport, water storage and fluctuations



NGGM

2035

2030

2025

OUR FUTURE MISSIONS



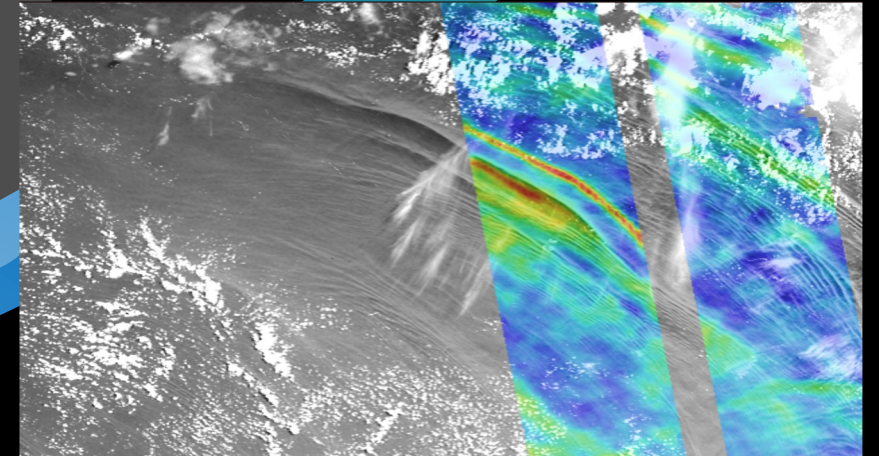
Sentinel-3 Next Generation Topography

Improved continuity of the altimetric component of Sentinel-3 mission, launch expected in 2032-2033

- 2 main objectives: over **ocean** and over **hydrology**
- Constellation of **2 satellites**, both carrying a **Ka-band swath interferometer** and a Ku-band nadir altimeter
- **Strong heritage from SWOT mission**

**S-3-NG
Topo**

2035



2025

OUR FUTURE MISSIONS

hydrology water
precipitation aerosols ocean
clouds gravimetry currents
rivers convection lakes
climate wind

TRISHNA

C3IEL

High-revisit
Hydrology

ODYSEA

AOS

NGGM

S-3-NG
Topo

2035

2030

2025

Conclusion

- CNES strategy for **integrated observations** of Earth's Water, Carbon and Energy Cycles
- **International partnership** is a key to success
 - CNES contributes to innovative missions such as **SWOT**, **TRISHNA** and the European Copernicus Sentinel missions
- A lot of missions addressing **GEWEX challenges** in the next decade +
- Ambitious **downstream programme** for science and applications, to optimize mission data use
 - **SWOT** sets an example for future missions
- Opportunities for **Early Career Researchers** in France

