



CNES EARTH OBSERVATION PROGRAM



International Cooperation, a key driver



PACIFICEO WORKSHOP NEW-CALEDONIA, NOUMEA

APRIL 15, 2024

Dr. SELMA
CHERHALI
Head of Earth Observation
Programmes,
Strategy Directorate

OUR PLANET UNDER PRESSURE



+2°C

**PROJECTED GLOBAL WARMING
BY 2050**

- ◆ Impact on Water and Carbon Cycles
- ◆ Extreme events : droughts, floods, storms, fires



Adaptation and mitigation issues
Require Research and Management
To understand and manage processes

=> A need for available reliable metrics

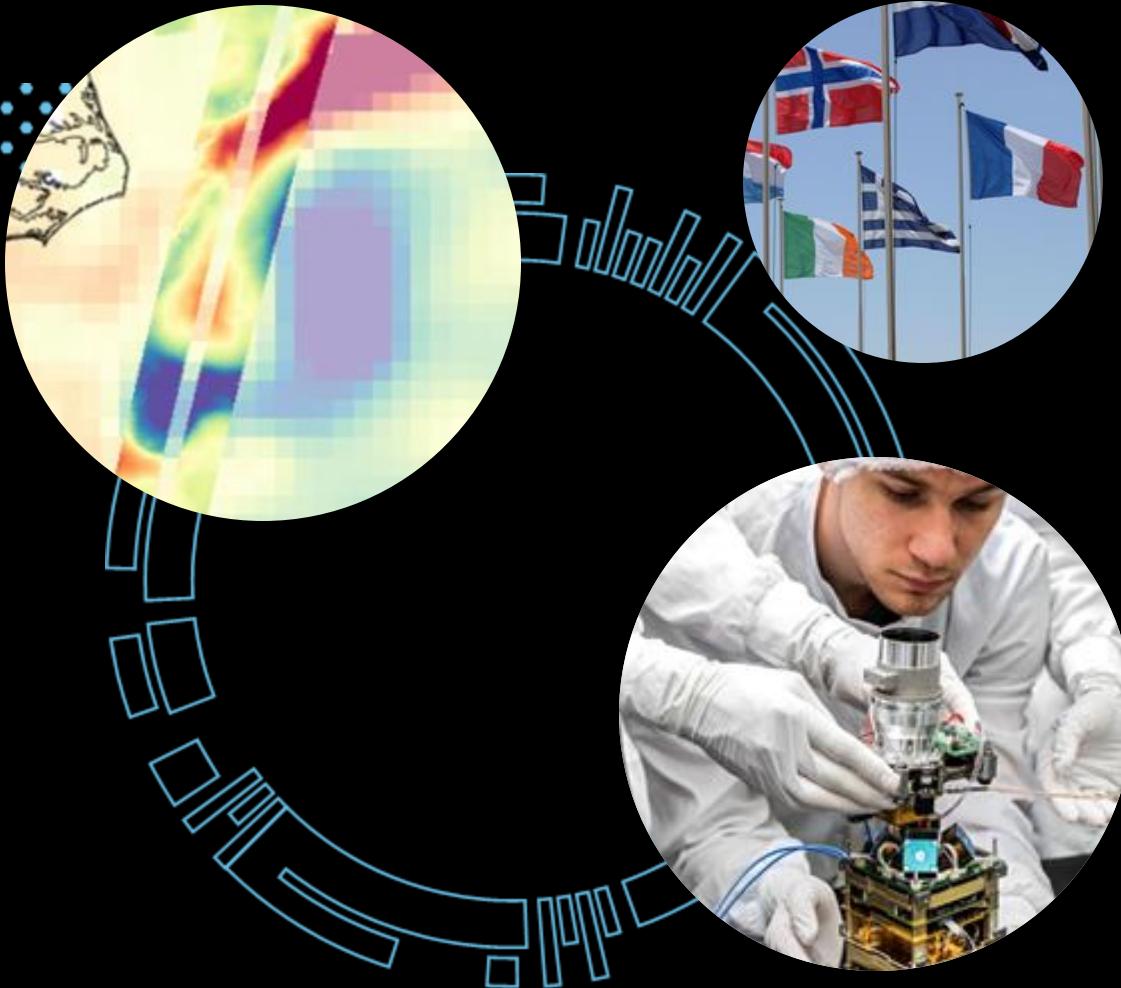
- ◆ Pressure on biodiversity and human population
- ◆ Flooded rivers and wet plains, coastal strip impacted by sea level rise
- ◆ Impacts by dams on basins connectivity,
- ◆ Impacts of pollution on human health

+2 Billion

**PROJECTED POPULATION GROWTH
BY 2050**

- ◆ Increased pressure on energy and food supply
- ◆ Increased pressure on transboundary reservoirs
- ◆ Higher population density in coastal areas and near major rivers

A CHANGING SPACE CONTEXT



► A new international context

New actors

Renewed ambitions for space exploration

► Environmental transition

Climate Change

Support to public policies

► Digital transition

High-value data

Complexity of information

► Fast innovation

Nanosatellites and constellations

NewSpace

SCIENCE AND SOCIETY

Scientific and societal challenges are strongly linked to global change and environmental issues

Study and understand the Earth system

Understand the Earth system and the processes that control it

Predict the evolution of our planet

Understand human impact



Live better

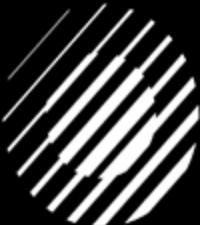
Predict our environment in the coming days/weeks

Predict and manage extreme events

Understand and manage our needs for water and food

A universal need : to study and understand processes on large spatio-temporal scales, in all compartments of the Earth system.

AN INTEGRATED APPROACH OF THE EARTH'S SYSTEM



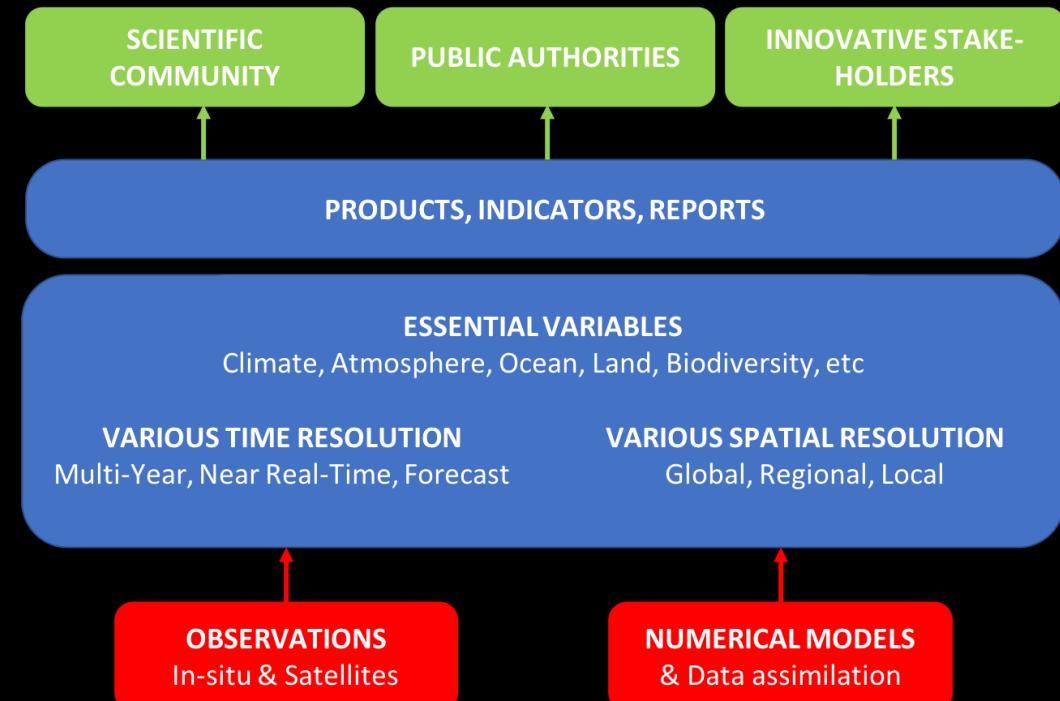
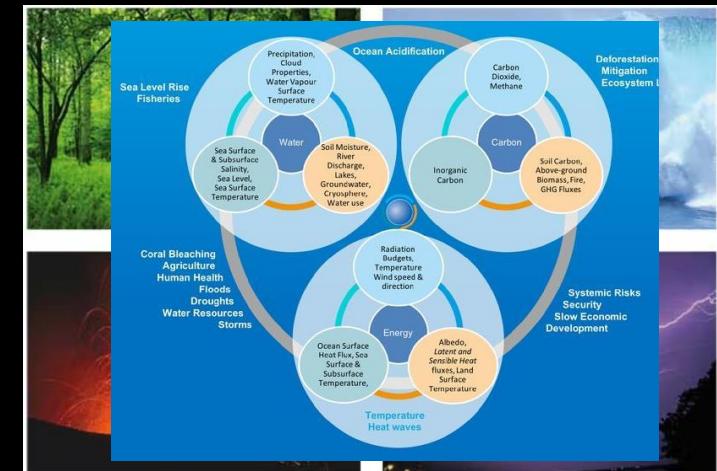
DATA
TERRA

Studying the Earth System requires:

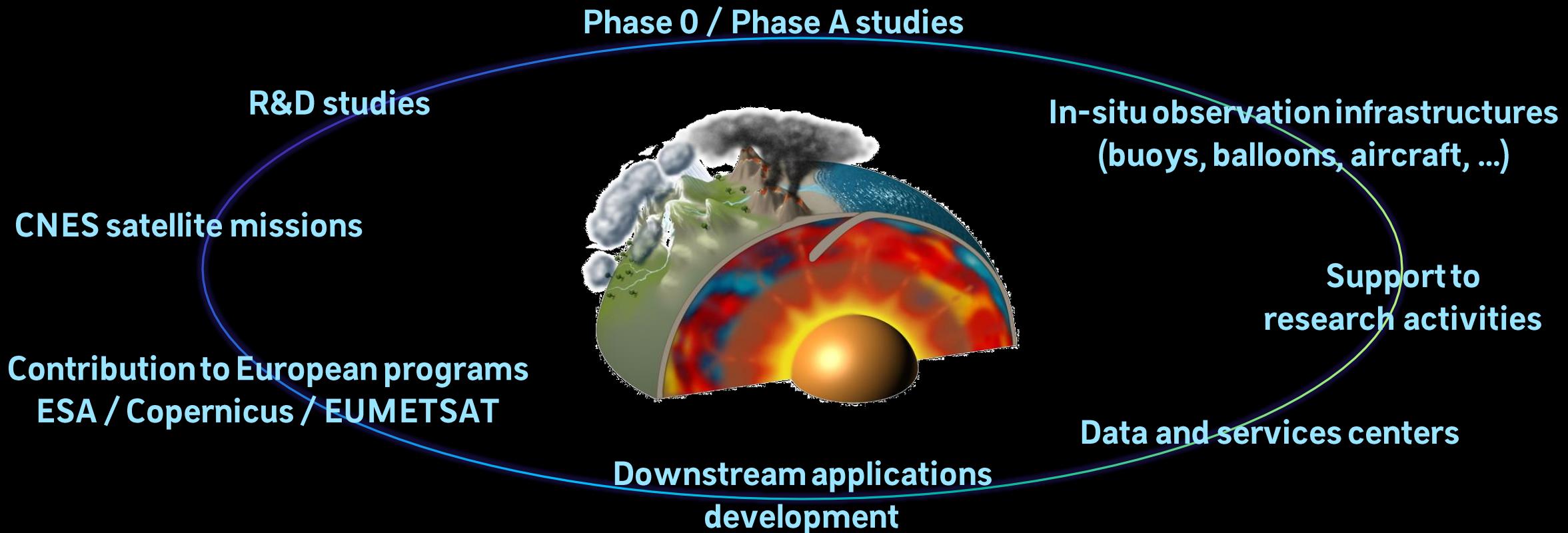
- Integrated, interdisciplinary research to better understand the processes associated with the Earth System and global change
- Multi-source, multi-sensor data for use at different spatial, spectral and temporal scales
- A combination of satellite, in-situ and numerical modeling data
- An interdisciplinary approach

An integrated approach makes it possible to:

- Serve scientific communities, public authorities and innovation players
- Forge European and international partnerships, fundamental to a global approach



CNES EARTH OBSERVATION PROGRAM

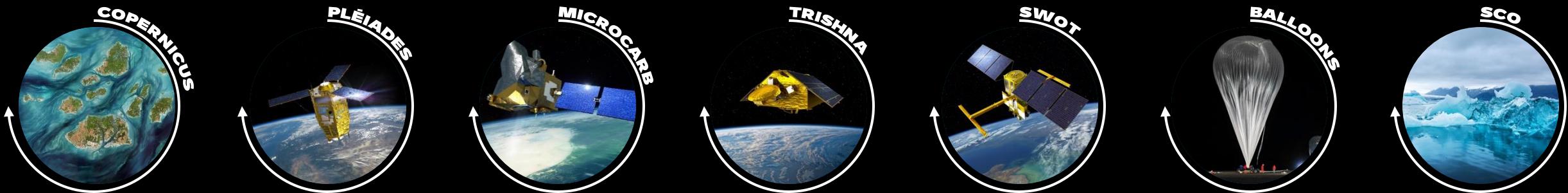
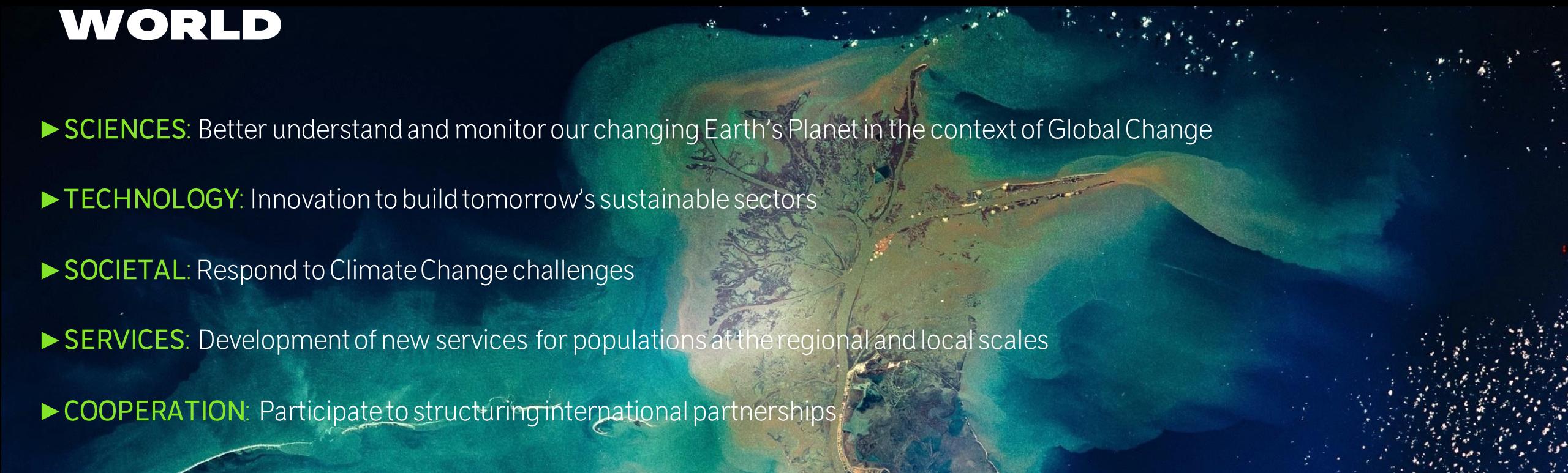


- ◆ A coherent set of actions covering all Earth System compartments
- ◆ Combining satellite + in-situ data + digital modeling
- ◆ Guidance and strategy developed with scientific committees (CPS / TOSCA)

- ◆ Cooperation and international partnerships
- ◆ Upstream (R&D) to downstream (applications) approach
- ◆ France2030: Accelerating the development of the space ecosystem for new services

COMMIT TO A MORE SUSTAINABLE WORLD

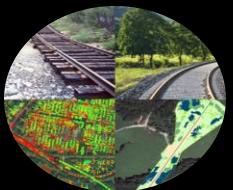
- ▶ **SCIENCES:** Better understand and monitor our changing Earth's Planet in the context of Global Change
- ▶ **TECHNOLOGY:** Innovation to build tomorrow's sustainable sectors
- ▶ **SOCIETAL:** Respond to Climate Change challenges
- ▶ **SERVICES:** Development of new services for populations at the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



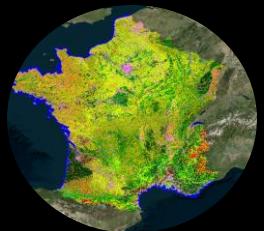


DATA & SERVICES CENTERS

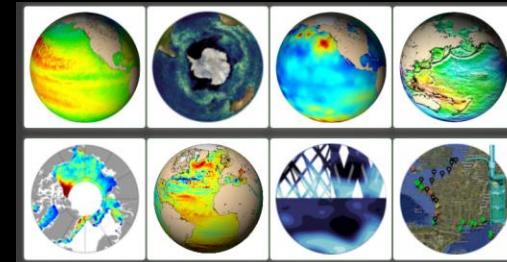
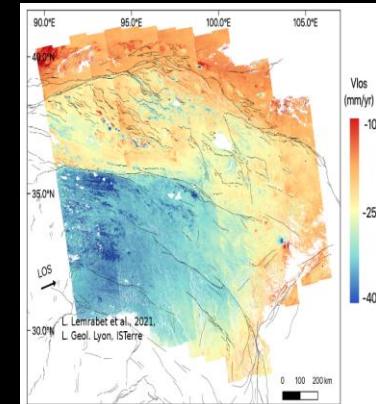
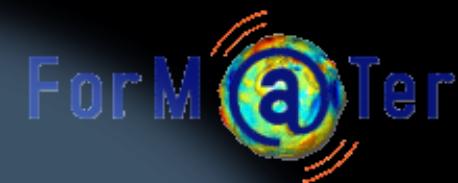
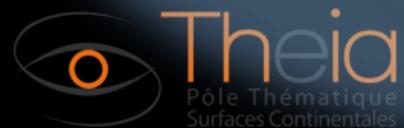
Increased role of data centers in the frame of future missions development
(e.g. Microcarb, C3IEL, Trishna...)



Railway monitoring
(SNCF-CNES)

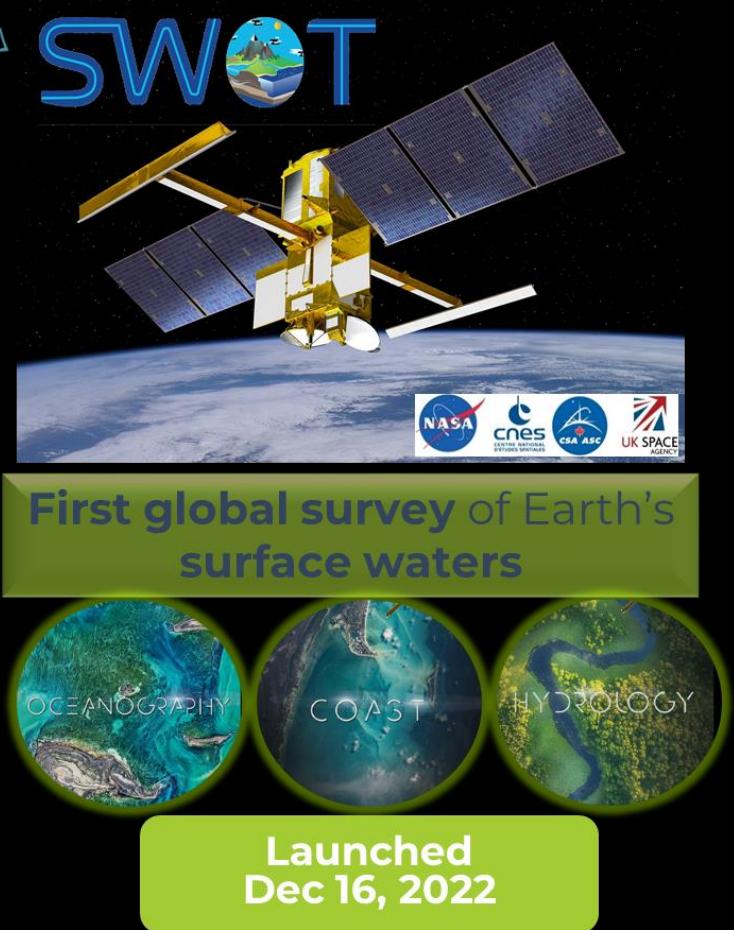
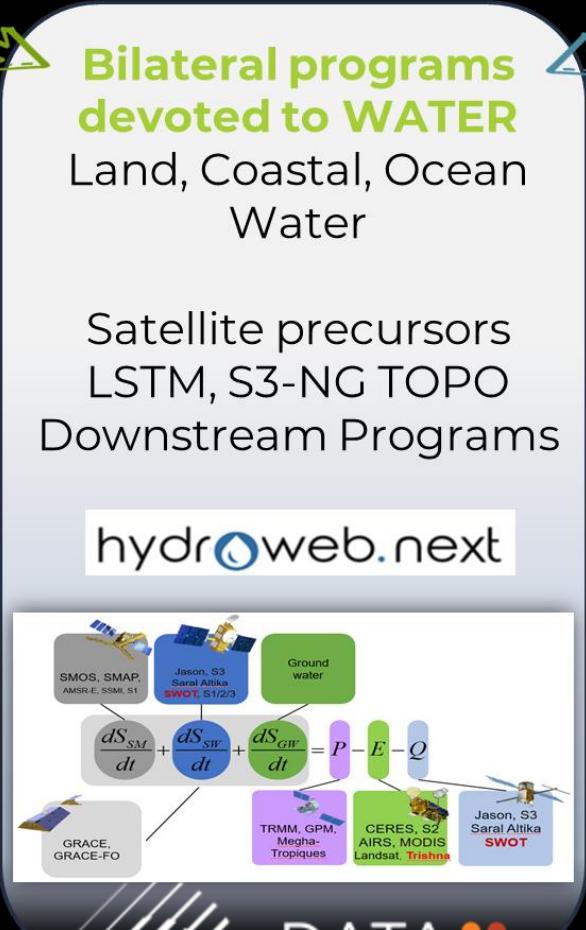
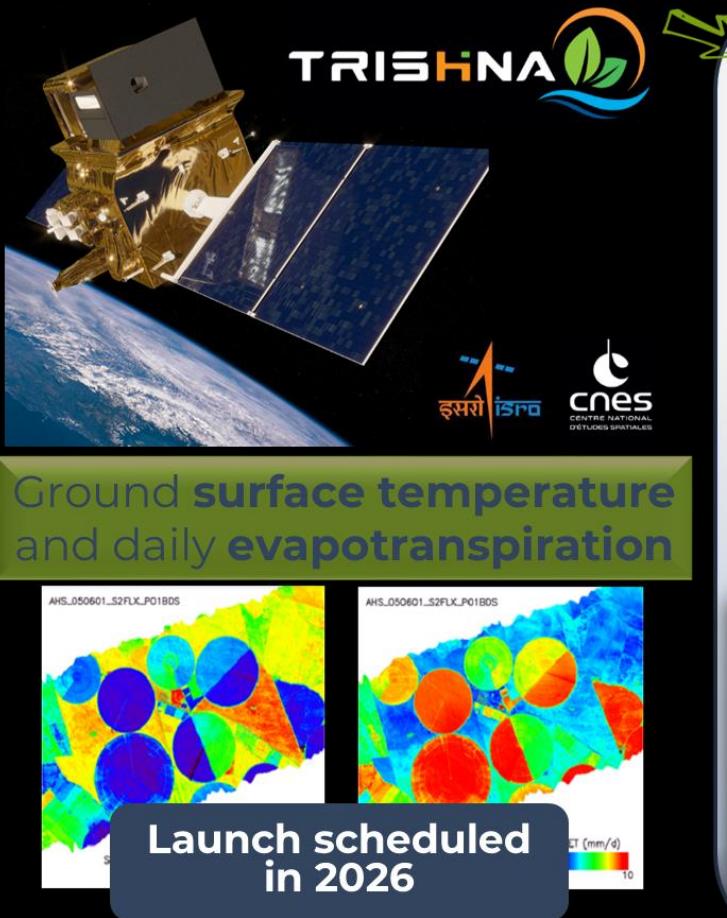


Theia land cover map



Beyond thematic data centers, **DataTerra services** facilitate access to space data with increased storage capability and processing solutions. These services are key to foster the users community **towards scientific excellence**

BILATERAL PROGRAMS AND INNOVATION



A REVOLUTION IN SPACE FOR HYDROLOGY

Increase in accuracy (more specific spectral bands)

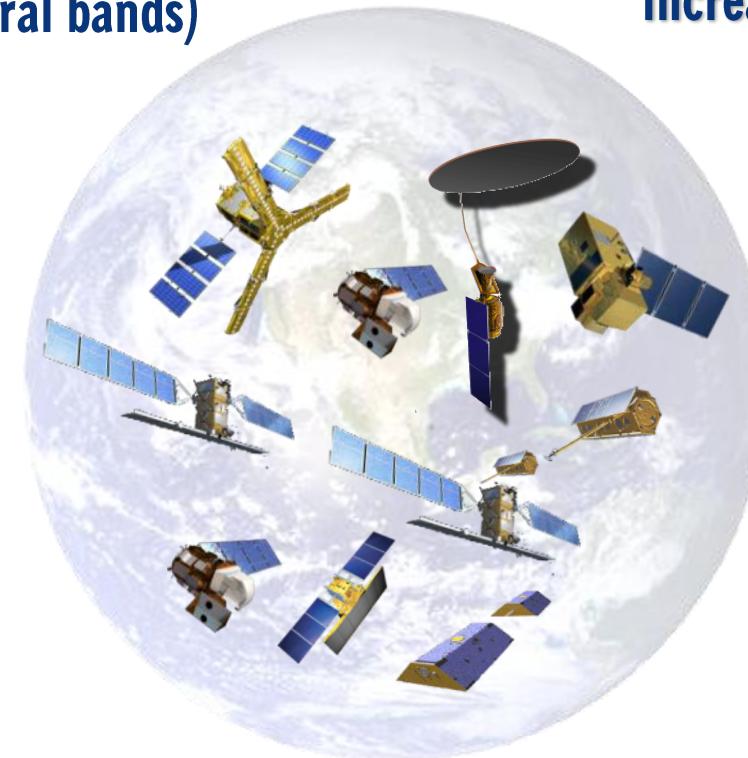
Example of soil moisture:

from AMSR-E (C-Band) *to* SMOS (L-Band)

Increase in spatial resolution

Example of altimetry:

from Jason (kilometric) *to* SWOT (100m)
Trishna, LSTM (~50m)



Increase in temporal resolution

Example of visible:

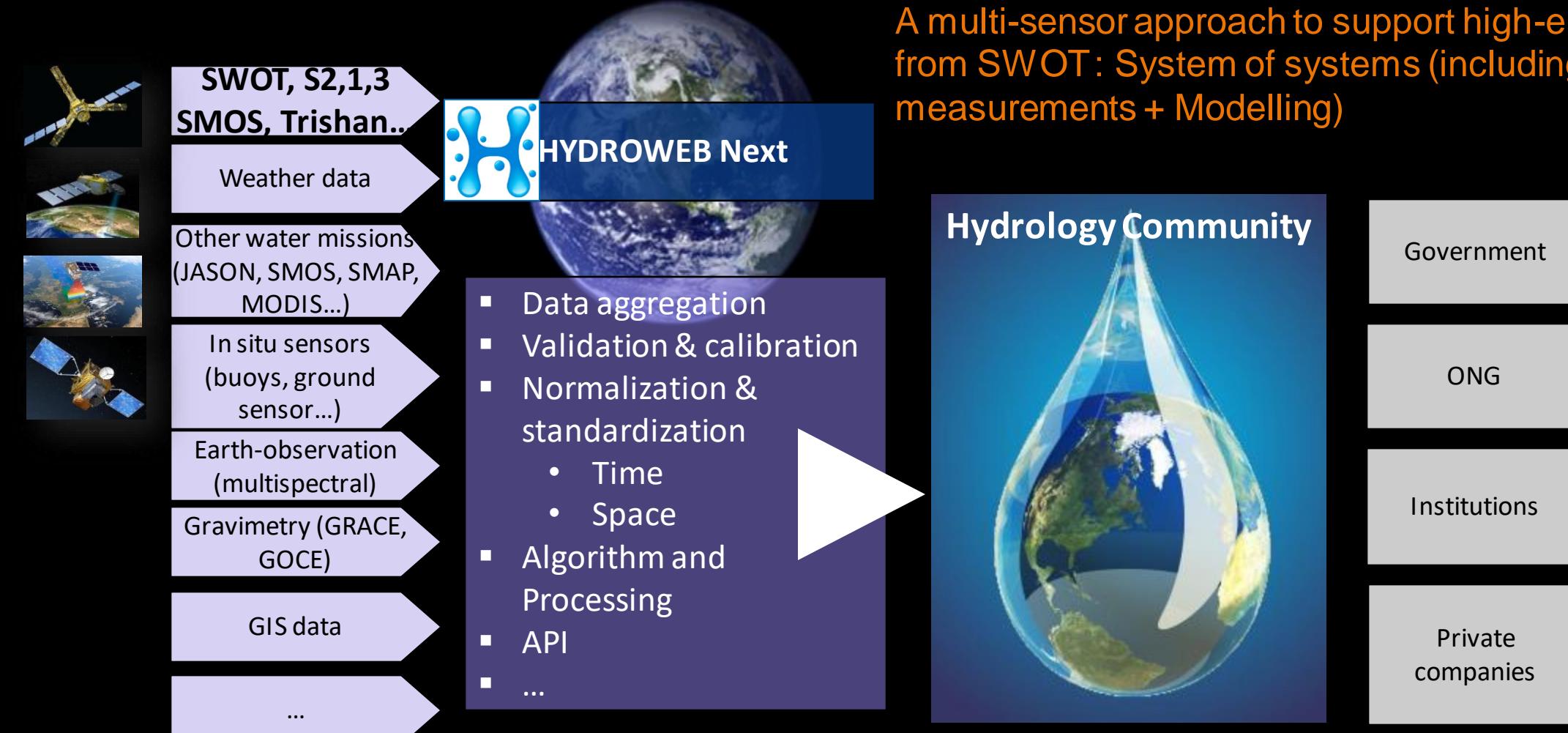
from SPOT5-6 (local) *to* Sentinel 1, 2 (5/6days)
Trishna (3 days), LSTM, SBG

Increase in accessibility of data

Vast majority (S1,2,3, SMOS, SMAP, Landsat)
are *freely accessible*

A long term sustainability with the Copernicus Program: Sentinel Expansion, Next Generation

HYDROWEB –NEXT : A multisensor- variable- modelling approach



- ✓ Operational scientific algorithms that generates products being automatically distributed
- ✓ A unique and simple access for EO-data relevant to hydrology
- ✓ A multi-sensors approach
- ✓ Global scale production and visualisation
- ✓ Free access to the product and its download
- ✓ Interoperability and standardization

Water surfaces

Water quality, temperature

Snow surfaces

Rainfall

Water height and discharge

Land cover

Soil moisture and humidity

Gravimetry

DEM

Numerical models and assimilation schemes

- ❖ Hydrology and hydrodynamics (assimilation of altimetry data, rainfall, ...)

Estimation of data quality and calibration (observations, models)

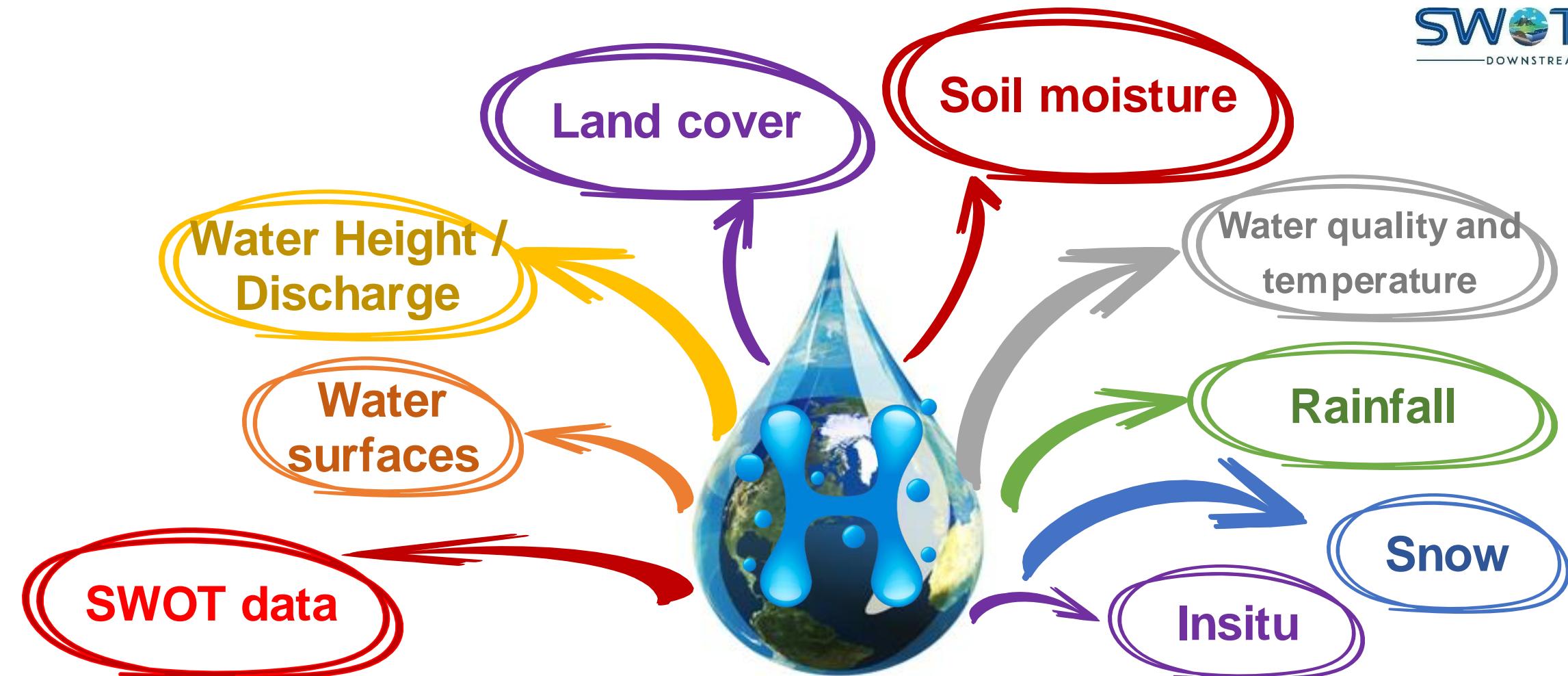
- ❖ Provides confidence in the use of the data and allows for a better perimeter use: knowledge of the distributed data

❖ Expanding spatio and temporal horizons products generation

❖ Homogeneous comparisons/overlay (x, y, t)

❖ Integration with in-situ data (OZCAR database)

Hydroweb-NG : an integrated platform



- ✓ Single access point for hydrology products from EO
- ✓ Multi-sensors approach
- ✓ Global scale targeted when possible

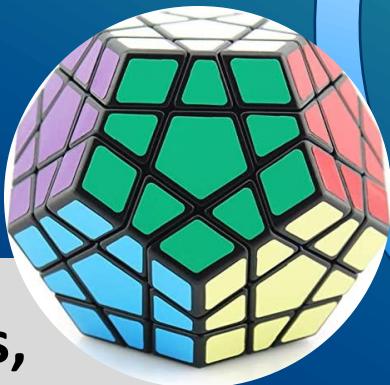
- ✓ Appropriate spatial and temporal resolutions
- ✓ Free access to data for all users
- ✓ Standardization of data, interoperability

Hydroweb-Next : much more than just a WebSIG !

Unique portal
for SWOT HR
data distribution



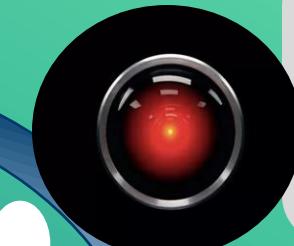
Easy access,
visualization and
combination
of heterogeneous data
: multi-sensors &
multi-variables



Virtual Research
Environment
'Sandbox'



AI
System
Hypervision



Global Scale
production
from innovative
algorithms

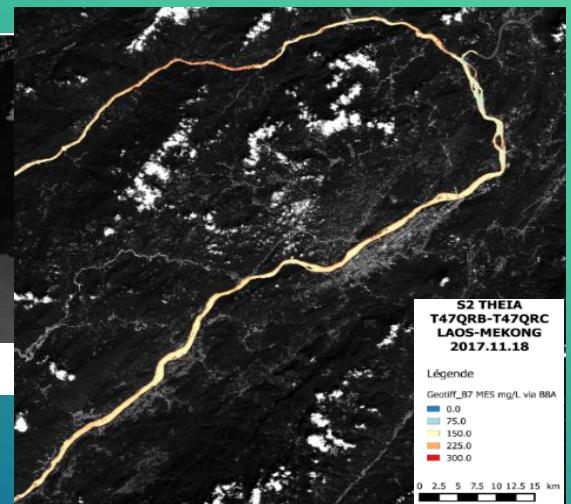
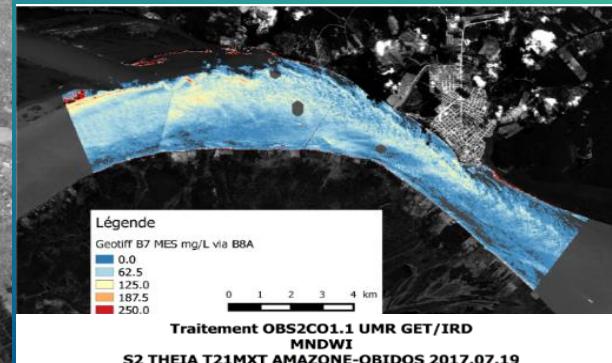
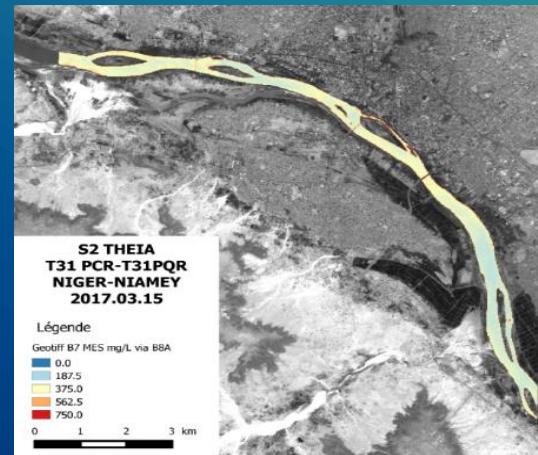


Monitoring of water quality and temperature

Water quality products @20m with Sentinel 2 :

- Suspended matter
- Turbidity
- CDOM - Colored dissolved organic matter
- Chlorophyll-a
- Harmful Algal bloom
- Perspective on sediment loading with SWOT

!! Specific atmospheric corrections on water surfaces with the Glint-removal for Sentinel-2 images –GRS algorithm (T. Harmel et al., 2019)



•Available on THEIA website :
<https://theia.cnes.fr>



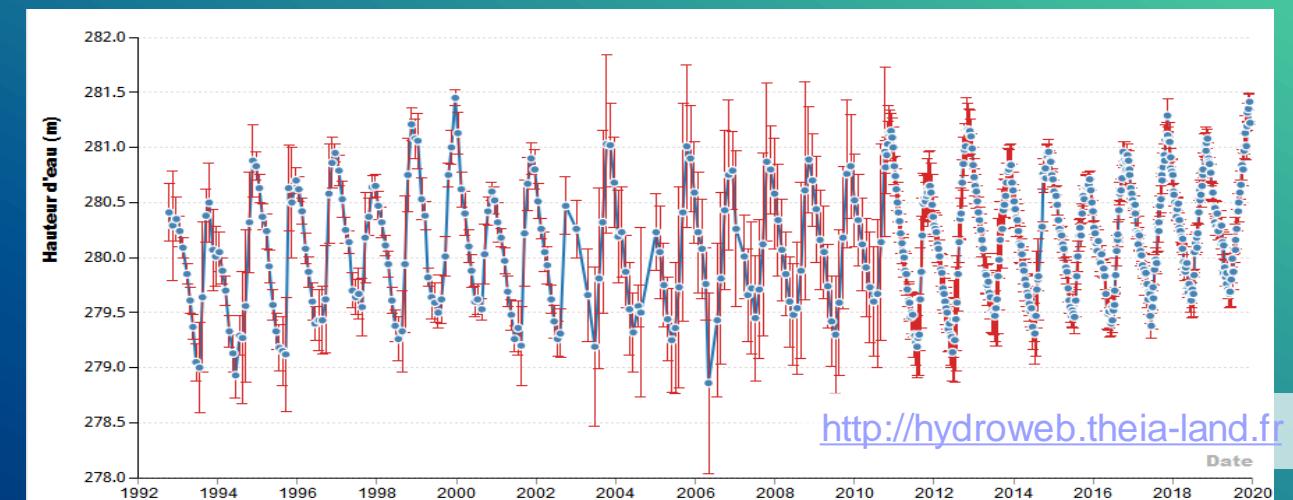
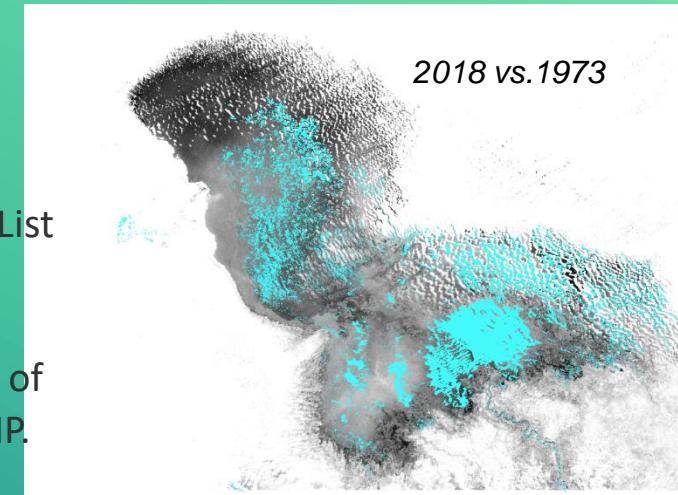
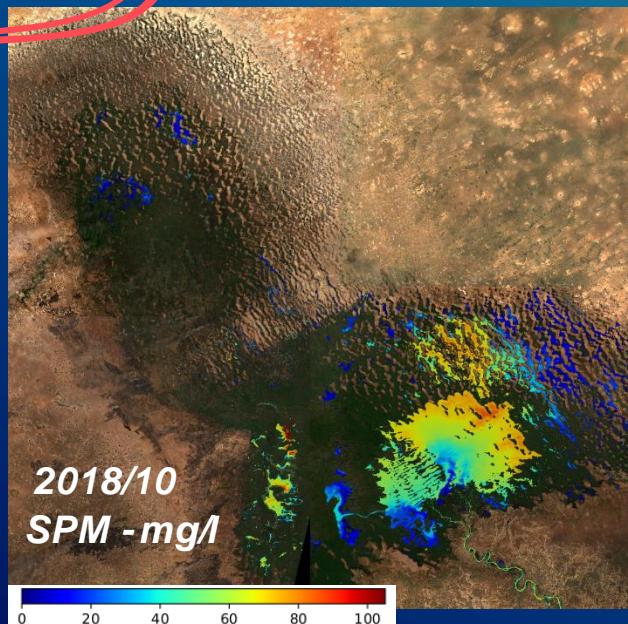
Monitoring of water quality and temperature

Water quality monitoring form space of the Lake Chad basin for peace and sustainable development

- support the restoration of degraded water resources and ecosystems for livelihoods and peace in the region.
- prepare the Lake Chad nomination to the World Heritage List
- identify certain sites that could be established as UNESCO Biosphere reserves.
- Data available on the UNESCO World Water Quality Portal of the International Initiative on Water Quality of UNESCO IHP.



Water Quality



<http://hydroweb.theia-land.fr>



Key indicators derived from satellite data:

- Water quality parameters (5 days - 20m)**
 - Suspended Particulate Matter
 - Colored Dissolved Organic Matter
 - Chlorophyll-a
 - Turbidity
 - Bloom index
- Water surface temperature (16 days - 100m) from Landsat**
- Water surface extent**
- Water level from nadir satellites**
- Institution Locale : Commission du Lac Tchad**



Le rôle des institutions

Le portail fournit aux décideurs des indicateurs clés sur les ressources en eau.

- Participation aux sessions de formation techniques
- Campagnes de mesures terrain pour calibrer et valider les algorithmes
- Transfert progressif des opérations du portail aux acteurs locaux



Workshop on *in situ* radiometric measurements during a training session for local experts



Lake Chad water quality field measurements by Lake Chad Basin Commission experts

SPACE CLIMATE OBSERVATORY



An international alliance developing Earth Observation-based services for local decision makers / end users to adapt to climate change

SCO International Objectives:

- Provide operational tools (SCO projects) and studies to help decision-makers to adapt to climate change.
- Foster cooperation around these applications to favour their reuse and communicate on them
- Build a network for space agencies and public and private entities involved in the use of EO data for operational climate action

45 SIGNATORIES

including 25 Member States and 3 United Nations organizations



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SPACE CLIMATE OBSERVATORY

SOME PROJECTS IN NEW CALEDONIA/AUSTRALIA



Topics: agriculture, water management, coastal, urban & rural areas, extreme events & natural disasters response



Monitoring the Gold Coast

An investigation into patterns of post-storm beach recovery in the Gold Coast

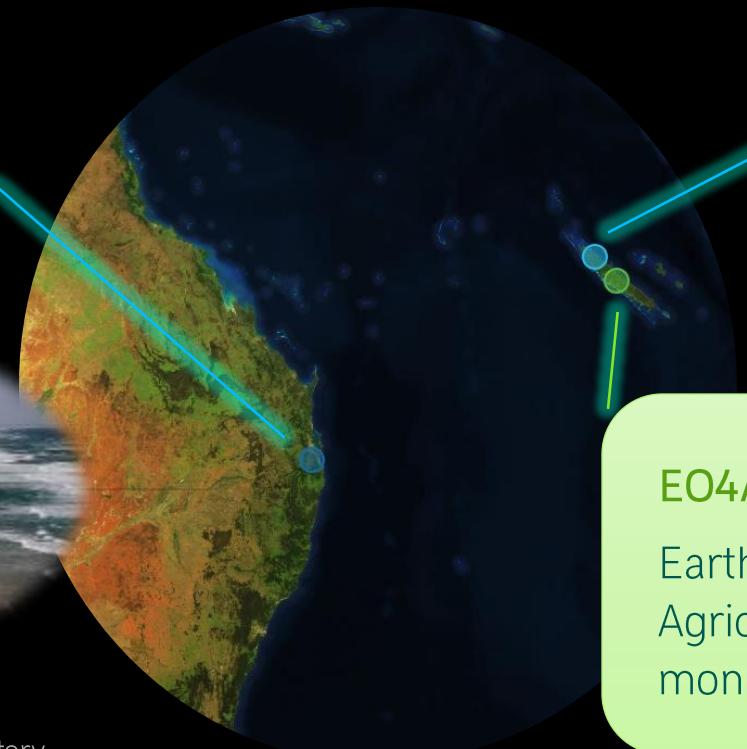


Links:

[Monitoring the Gold Coast | Space Climate Observatory](#)

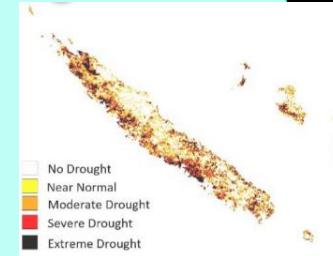
[EO4DroughtMonitoring | Space Climate Observatory](#)

[EO4AgriWater | Space Climate Observatory](#)



EO4DroughtMonitoring

A tool for characterizing, monitoring and forecasting drought on a territorial scale



EO4AgriWater

Earth Observation for Agricultural Water monitoring





ENERGIE



FORETS

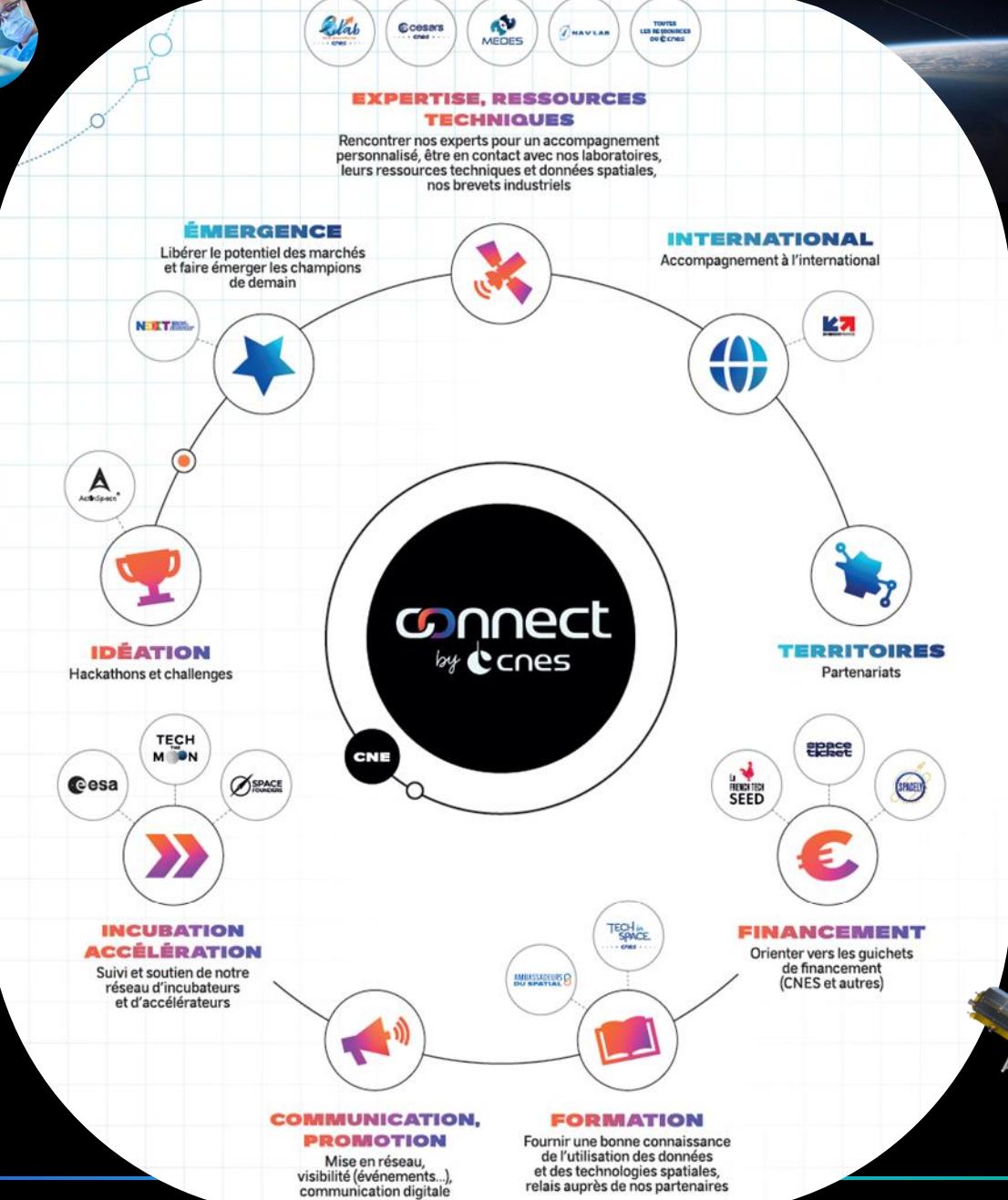


BOOSTER LE DEVELOPPEMENT
Économique, sociétal et environnemental
des acteurs français

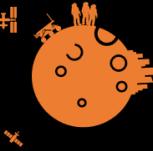
AGRICULTURE



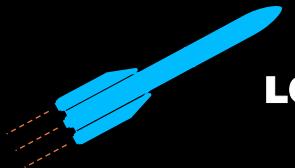
MARITIME



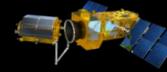
SERVICES EN ORBITE



ECONOMIE LUNAIRE



LOGISTIQUE SPATIALE



CONSTELLATION INFRASTRUCTURE

S'APPUYER SUR L'INNOVATION
Industrielle et Technique

CONVENTION NOUVELLE-CALEDONIE



Nouvelle-Calédonie : Convention signée le 4 décembre 2022 avec les axes :

- **Gouvernance :**

- o COS : Président (MdG Innovation) + CNES/DS/D CT : DINUM + CbC/Maritime&Outre-mer
- o 19/02/2024 : Signature plateforme labélisée Connect by CNES en Nouvelle-Calédonie (PF CBC NC) : K. Decludt
- o Participation à l'OGS :



- **Développement économique**



- SCO : Tahatai Néo
- Acteur AquaWatch – à définir



- Starship



- Prix IOM



- Forte implication infrastructure
- SCO avec MEOSS
- Acteur AquaWatch

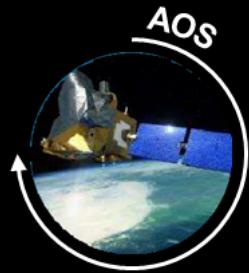
- **Expression et couverture des besoins institutionnels du territoire et de grands donneurs d'ordres**

- o Surveillance maritime avec France 2030 – travaux avec UnSeenLabs / Parc de la Mer de Corail : Magis-Ok
- o Connaissance et suivi Bande côtière :
 - o Prise en compte cartographies du littoral par France 2030, rédaction AO
 - o SCOast-DT
 - o Apport AquaWatch
 - o Jumeau numérique « Risques » : Echanges de « briques » avec la « DT Factory »

- **Augmentation des compétences (K. Decludt visite au CST – Juin 24)**

FUTURE MISSIONS & SERVICES

Four missions and services dedicated to the Climate and the Environment
= Top priorities from the French research community (Scientific Prospective Seminar 2019)



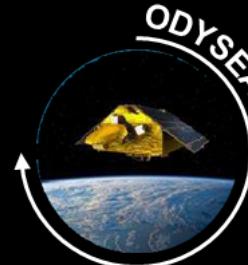
AOS
Atmospheric Observatory



C3IEL
Clouds and precipitations



SMASH
Land Water level with high revisit



ODYSEA
Oceanic currents and winds

CNES has adopted a global perspective in making cooperation a key element of its strategy.

CNES partnerships with all the Ecosystem are founded on a relationship of trust, built at the highest levels over many years

SCIENTIFIC FORESIGHT SEMINAR 2024

The CNES Scientific Foresight Seminar revolves around **several working groups** reflecting on :

- Universe sciences and exploration, coordinated by the Committee for the Evaluation of Space Research and Exploration (CERES),
- **Earth observation, led by the Earth, Oceans, Continental Surfaces, Atmosphere committee (TOSCA),**
- Human and material resources,
- International relations,
- Characterization of the strategy linked to our ambition,
- Science and NewSpace,
- The environmental footprint of space activities.



SÉMINAIRE DE
**PROSPECTIVE
SCIENTIFIQUE**

08 AU 10 | **20**
OCTOBRE | **24**
SAINT-MALO
www.sps2024.com

UN ÉCOSYSTÈME DU SPATIAL QUI S'ÉTOFFE ...

connect

SATELLITES

ThalesAlenia Space



hemeria

e-Space

AIRBUS

OneWeb Satellites

U SPACE

SOUS-SYSTEMES/EQUIPEMENT

SYNTONY GNSS

ANYWAVES

Syrlinks

Callisto

comat

EREMS

exotrail

hemeria

cailabs

ThrustMe

M ID

TERNWAVES

SEGMENT SOL

GS GROUP

KRATOS
READY FOR WHAT'S NEXT

magellum

connect

LANCEURS / BROKERS

VENTURE ORBITAL SYSTEMS



SPARKORBITAL

RIDE!
SATELLITE OPERATOR ACCESS



ASTREOS

malaspace

lean space



ORBITE / EXPLOR. / LUNE

exotrail



SPACE CARGO UNLIMITED

Xinétis



INFINITE ORBITS

The Exploration Company



SPACEABLE

Miratlas



ZEPHALTO

neofly



INTERSTELLAR

connect

STRUCTURES VERTICALES

PRIMÉTHÉE



kinéis

unseenlabs

DAWEX

KAYROS

geoflex

PRELIGENS

Reuniwatt

BLUE CHAM

AGREENCULTURE

QUANTCUBE TECHNOLOGY

Diginove

eodyn

i-Sea

CLS

SEA PROVEN

SINAY

Data Science Experts

MyEasy Farm

terraNIS

predict

KERMAP

namR

xsun

Pixstart

Space sense

Geo4i

la TELEScop

HyTECH Imaging

Weather FORCE

OpenForêt

DC

SGET

MURMURATION

TERCIEL Services immobiliers

A high-angle aerial photograph of a tropical island chain, likely the Maldives or a similar archipelago. The islands are densely forested and surrounded by clear turquoise waters. The perspective is from the upper left, looking down towards the lower right.

**Merci pour votre
attention**