# EUROGEO WORKSHOP 2023

## National GEO activities
## DATA TERRA E-Research Infrastructure
## data (spatial, in-situ) and knowledge for earth system and environment integrated observation

*Frédéric HUYNH*
*DATA TERRA Director*

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*Liberté Égalité Fraternité*

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Cerema · cirad · INERIS · ONERA · Observatoire de la Côte d'Azur · École Polytechnique · Université de Lille
Université Fédérale Toulouse Midi-Pyrénées · AgroParisTech · UGA Université Grenoble Alpes · Université de Strasbourg · UCA Université Clermont Auvergne

**BOLZANO 2-4 OCTOBER 2023**

eurac research · Institute of Atmospheric Pollution Research, National Research Council of Italy · European Commission


# SOMMAIRE

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DATA TERRA

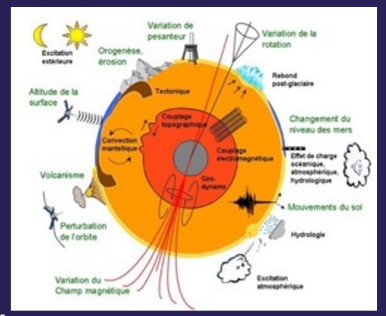
# 01 DATA TERRA

## *Earth System E-Research Infrastructure*

DATA TERRA

# The Earth, a complex dynamic system

- Numerous geophysical and environmental processes,
- With different spatial and temporal scales,
- permanent interactions between the solid Earth, continental surfaces, ocean,
- atmosphere compartments as with the anthroposphere.





## EVOLUTION OF THE NEEDS

- More integrated approaches to complexity
- Multi-source data, multi-sensor allowing multi-scale (*spatial, spectral & temporal*)
- Coupling of in-situ & space data
- Need of long-term data series and services
- Integrated Artificial intelligence and big data services
- Interdisciplinarity

Understanding these processes requires access to and analysis of numerous, complex and voluminous data sources (**satellites**, in situ, campaigns, **long-term observations** as well as experimental results, models etc...)

Scientists and decision makers need to have an integrated easy access and on-demand treatments to all these data and associated products and services

DATA TERRA

## AMBITION AND GOALS

Develop a global organization to access to data, products and treatments/services to observe, understand and predict in an integrated way functioning and evolution of the Earth system subject to global changes

Data Terra allows, through interconnected portals, access to all of these standardized and interoperable FAIR data, thematic products and services for visualization and cross-referencing to address scientific issues and interdisciplinary societal challenges.

**Integrated platform : Earth system sciences data, services and products.**

- ➔ 26 Research Organizations and Universities
- ➔ 30 Observing Data and Services Centers (CDS)
- ➔ 32 Consortium of Scientific Expertise (CES)
- ➔ 450 scientists, engineers and technicians

**€42m/year**

**1000** products & services

**15,000** regular users

**> 100 PB** (2022/2023)

### DATA & SERVICES HUBS

- AERIS — Atmosphere
- ODATIS — Ocean, coastal
- Theia — Land Surfaces
- ForM@Ter — Solid Earth
- PNDB — Biodiversity
- CLIMERI — Climat models, data simulation

### CROSS-CUTTING SERVICES

- DATA TERRA DINAMIS — HR Spatial Imagery
- DATA TERRA INTER-PÔLES — FAIR Data and Services Networking Communities


### WORKING GROUP :

SCIENCE, TECH, TRAINING, PUBLIC-PRIVATE partnership,
EUROPE & INTERNATIONAL,
COMMUNICATION/MEDIATION,
COOPERATION South Countries

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ForM@Ter AERIS ODATIS Theia

cnes cnrs Ifremer IGN INRAE IRD METEO FRANCE

AgroParisTech brgm cea Cerema cirad ONERA Sorbonne Université Université de Lille Université Toulouse III Paul Sabatier

# European and international positioning


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# Data Terra: unified access to access Earth system observation data and services d'observation du système Terre

DATA TERRA

- Atmosphere — AERIS
- Solid earth — ForM@Ter
- Ocean — ODATIS
- Land Surfaces — Theia
- Very High Resolution satelite data — DATATERRA DINAMIS

Catalog of data and services for each earth system compartments and for some transversal/commun services


aeris-data.fr


poleterresolide.fr


odatis-ocean.fr


theia-land.fr


dinamis.data-terra.org

Liens avec les producteurs de la donnée

1 **Accès aux données** — Accéder à des services dédiés

2 **Production régulère de données** — Améliorer la qualité des méta données

3 **Analyse et traitement à la demande** — Faciliter le croisement des observations

4 **Services d'aide aux utilisateurs** — Partage logiciels, Plateforme d'analyse, Évaluation modèle

Centre référence établissement recherche.data.gouv.fr

eosc

EuroGEO

DestinE

# ATMOSPHERE DYNAMICS

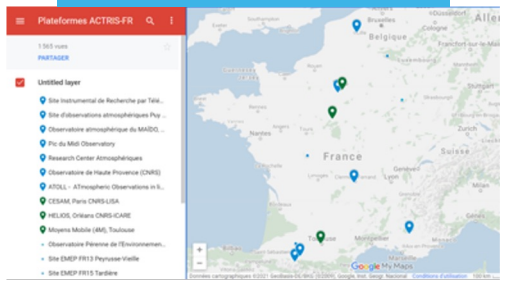
## atmospheric physics and chemistry, climate change, air quality, etc.

The AERIS Atmospheric Data and Services hub brings together **data management activities** and **scientific expertise** in the atmosphere at the national level.

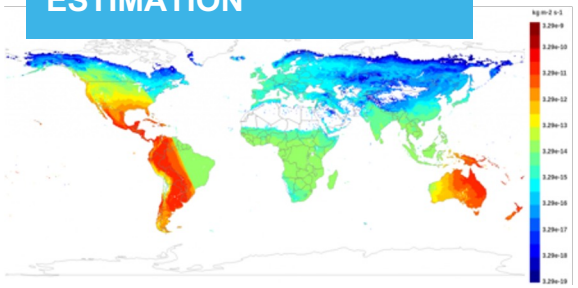
The **data** comes from **platforms, observation networks, instruments on board satellites, balloons, planes, laboratory measurements, inventories, models, data from scientific campaigns.**

## STUDY CASE : AIR QUALITY

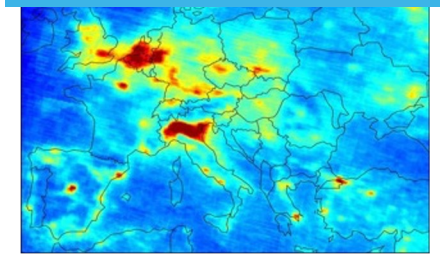
### AIR QUALITY MONITORING



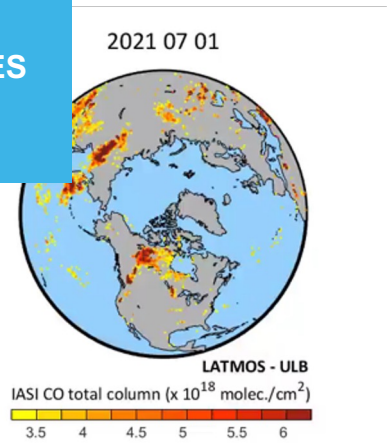

### CARBON & EMISSIONS ESTIMATION



### EUROPEAN AIR QUALITY NETWORK INVOLVED



### EFFECTS OF FOREST FIRES ON AIR QUALITY




www.aeris-data.fr/

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ForM@Ter

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# SOLID EARTH

## Knowledge about the structure and composition of the Earth, telluric risks and resources

The solid earth data and services center Form@ter brings together **data management activities** and **scientific expertise** in solid earth at the national level.

The data comes from **satellite missions, in situ instruments and the results of experiments, modeling and simulations**.
**Calculation services** are also available.

## STUDY CASE

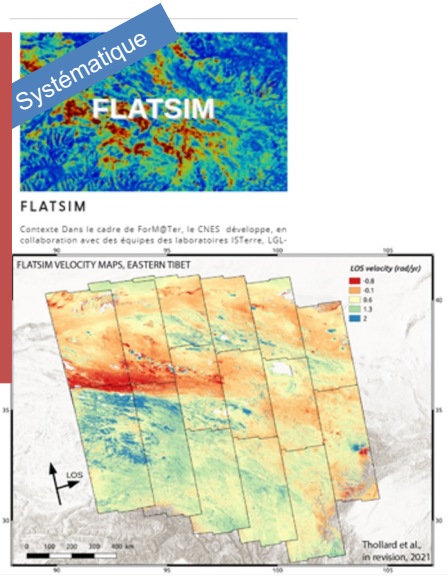
**GROUND DEFORMATION CALCULATION BY SPATIAL IMAGERY**

A la demande


**SPATIAL TEMPORAL MONITORING OF CRITICAL REGIONS**


**APPLICATIONS**

**Large active fault zones and magmatic systems, landslides and lithospheric deformation on the scale of large massifs.**




www.poleterresolide.fr

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# OCEANS DYNAMICS

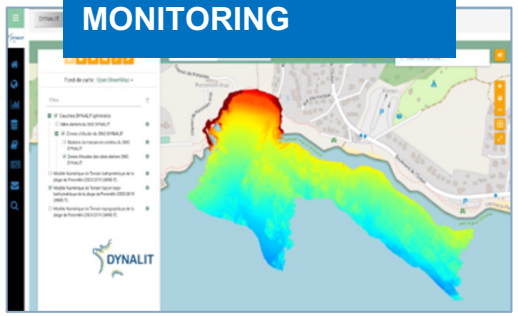
## Observing and understanding the dynamics of the oceans

The Odatis ocean data and services center brings together **data management activities** and **scientific expertise** for the oceans at the national level.

The data comes from **satellite missions, in situ instruments (fixed platforms, floats, gliders, radars, sea campaigns, laboratory measurements, …)**

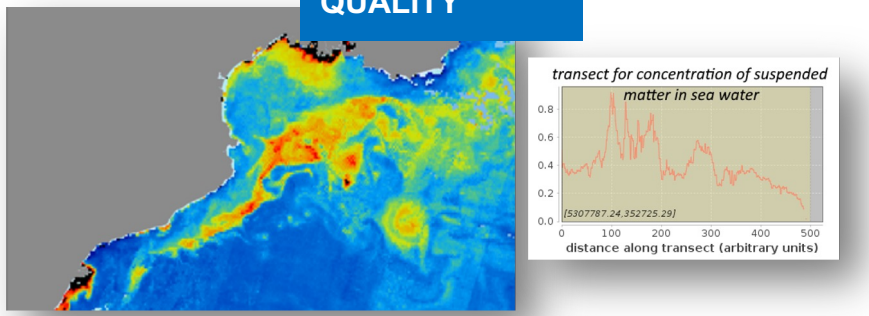
## STUDY CASE

**COASTLINE MONITORING**

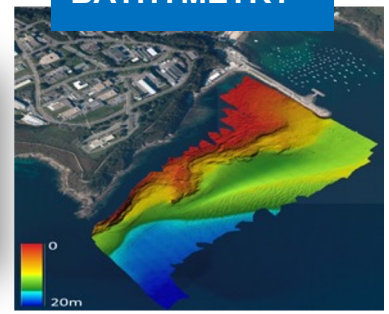



**WATER OXYGENATION**


**WATER QUALITY**




**LASER / LIDAR BATHYMETRY**




www.odatis-ocean.fr

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# LAND SURFACES
## Observe the dynamics of land surfaces and natural resources

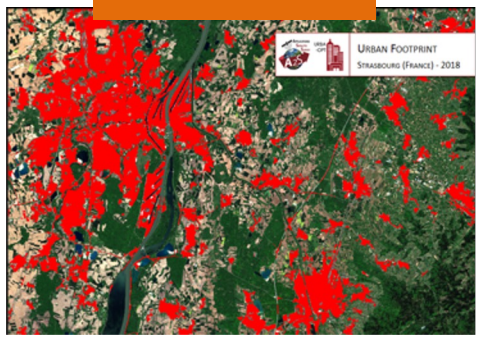
The Theia land surfaces data and services hub federates **ecosystem** and **environmental resource monitoring activities** at the national level.

The data comes from **satellite missions and in situ instruments**. They support the development of value-added **products, models and software in ten themes:** agriculture, biodiversity, climate, water, forest, coast, snow & ice, natural risks, health, urban.

## STUDY CASE

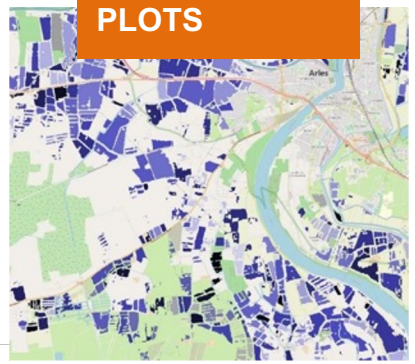
**SOILS OCCUPATION**

**URBAN PLOTS**

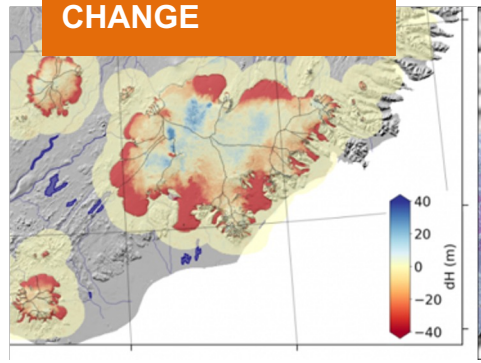



**BIOMASS PRODUCTION**

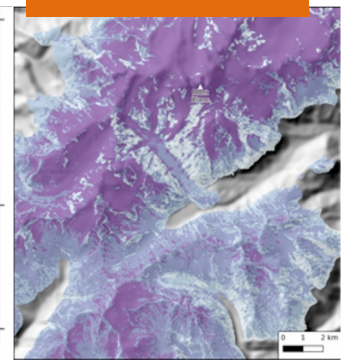
**HUMIDITY PLOTS**



**GLACIER ALTITUDE CHANGE**




**SNOW COVER**



www.theia-land.fr

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DATATERRA DINAMIS

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# DINAMIS SERVICES

## Access to and use of very high spatial resolution satellite images

### An institutional offer

Pleiades specific coverage
metropolitan and French Guiana sandy coastlines, DOM TOM...

Vintage covers SPOT 6-7 Metropolitan France
Ad-hoc acquisitions Pléiades and SPOT 6-7 Worldwide - Expressed by UIAs, regardless of their place of employment.

High resolution complementary images
Relay to the CNES Spot World Heritage program (Spot 1-5), CNES PEPS platform (Sentinel 2), Geosud, CNES Kalideos program: RapidEye, CosmoSkyMed, TerraSar, -X, Aster...

Littoral Sénégal. Pléiades
Copyright CNES, ADS

*Montpellier. Pléiades © CNES 2020, distribution Airbus DS*

Couverture métropolitaine *2020*. Copyright
ADS - IRD, INRAE, IGN

**FOR 3 USERS SEGMENT**

**French Authorized Institutional Users**
For scientific research, higher education and territorial actors

**European and international Scientific Authorized Institutional Users**

**Private users**
For R&D project leaders and public order providers

**dinamis.data-terra.org**

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# 02 The GAIA DATA platform : integrated data, distributed and transversal services

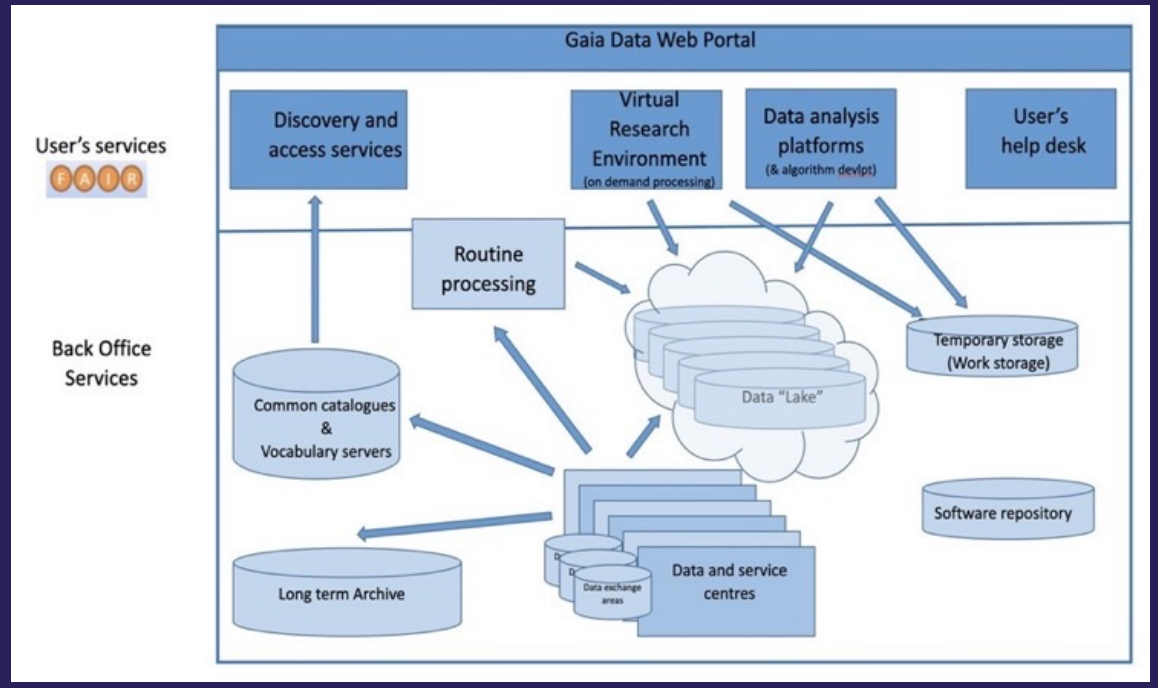
# Gaia Data Project

**G**lob**A**l **I**ntegr**A**ted **Data** and services Research platform for Earth system, biodiversity and environment understanding

## Implement an **integrated platform for distributed data and services**

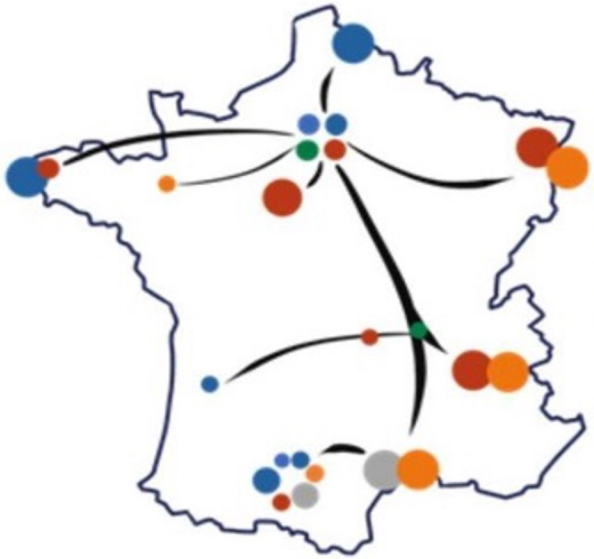
**Proposed by 3 research e-Infrastructures gathering 21 partners:**

- **Data Terra**
  - organizes integrated access to observation data, products and services covering the various compartments of the Earth system (**Ocean**, **Atmosphere, Land surface** & **Solid Earth**) and their interactions
- **CLIMERI-France**
  - The French **climate modeling e-**infrastructure, its mission is to produce international numerical simulations for the WRCP and to make their results available to various users in France and abroad.
- **PNDB**
  - The french **biodiversity** data center, aims to federate existing data approaches within research infrastructures on "Living Earth"

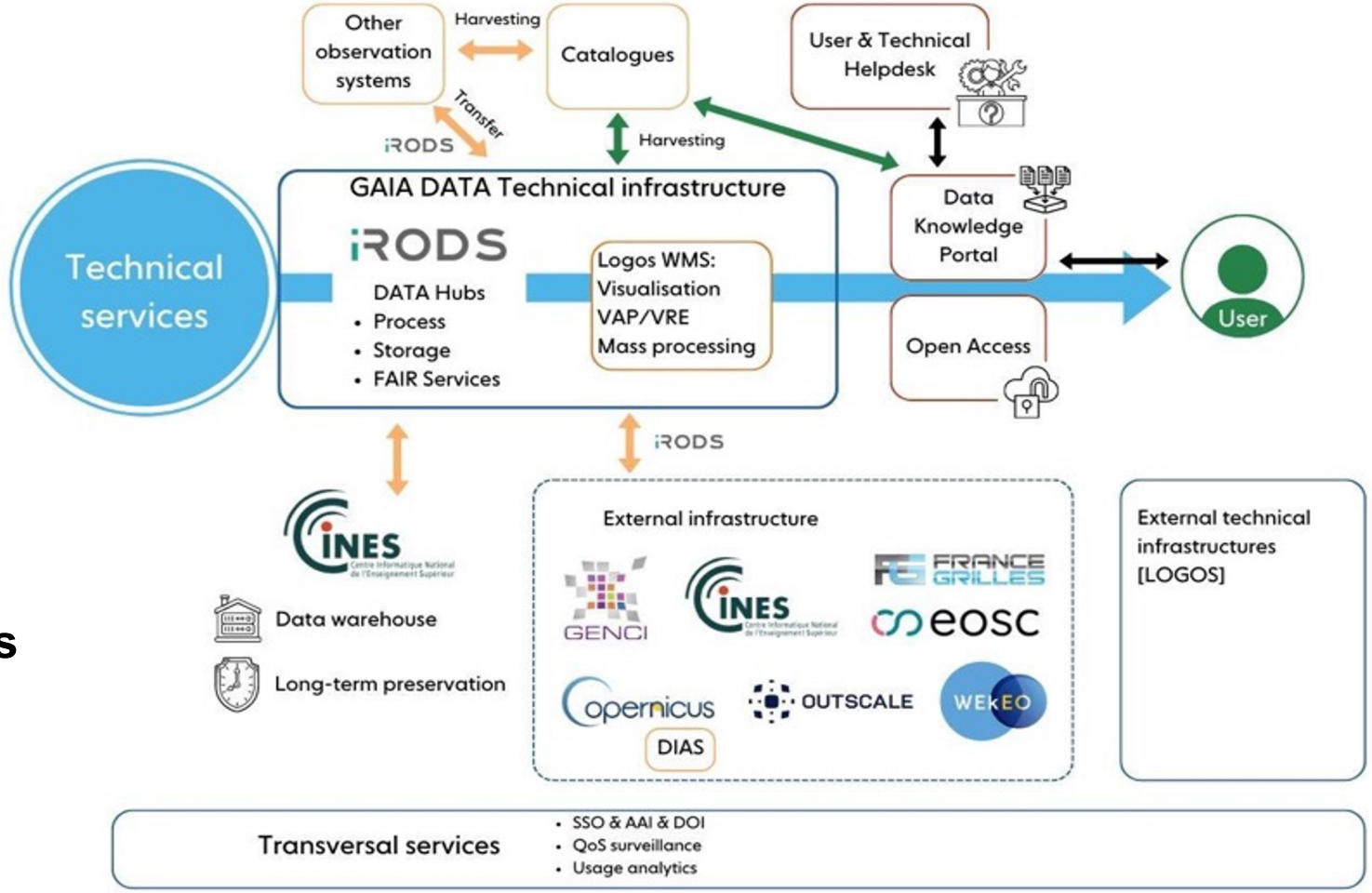



EQUIPEX+ project funded by the (French) **P**rogram of **I**nvestments for the **F**uture - France 2030 – ANR (2021-2028)
*Rated A+, granted 16,2 M€, global budget : 65 M€, 2021-2029*

# A DISTRIBUTED DATA AND SERVICES INFRASTRUCTURE



**8 principal sites**
30 existing sites



# GAIA DATA INTEGRATED PLATFORM

## 8 main networked data and services centers

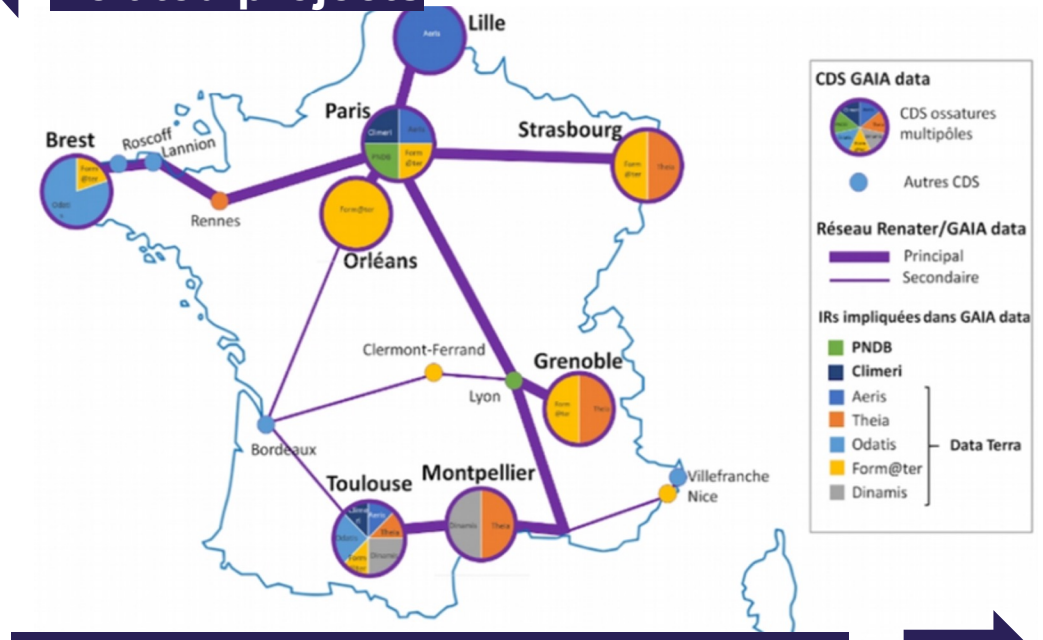
**Equipex+ or PIA4 infra**
- FITS
- MesoNet
- Clusster

**Equipex+ or PEPR thematics**
- Obs4Clim
- TerraForma
- Marmor
- OneWater

**H2020 Projects – Horizon Europe**
- IS-ENES
- EOSC-Pillar
- FAIR EASE
- FAIR IMPACT
- ENVRI-HUB

**Projets CPER en région**

**Related projects**




**international / European integration**

**DESTINATION EARTH**

GAIA-X

- Creation of a dedicated high-speed and secure network (10 to 100 Gbit/s) already operational between certain sites
- Deployment data grid (iRODS AC system) / S3 remote access to data and rapid automatic transfer of large data sets from different centers
- Interoperability of processing between the thematic centers, HPC and with commercial clouds services (GAIA-X - DIAS)

# SERVICES

## Research, Access and Data Management Services

**Research** (navigating through thousands of datasets)

**Catalog** (metadata, vocabularies, ontologies)

**Consultation and access** to data via integrated platforms

**Advanced dataviz**

Supporting **FAIR** scientific communities

## Transversal services facilitate transdisciplinary research work

**Data grid, cloud, knowledge management system, SSO, metrics, user support & training – community animation**

Supporting campaigns

Analysis Ready Data Datacubes, ...

## Earth Analytics Lab Data exploration

**Virtual Analysis Platform - VAP : Notebook/PANGEO/ STAC ecosystem**

**Datacubes**

**Ability to connect directly to On-demand Processing centers (WPS)**

**NoCode/Low Code: Galaxy-E, FG/VIP, ~Matlab/Simulink**

## Regular production services

**Optimization** of processing (orchestration tools) and data formats (Zarr, CoG, Dask, ...)

Supporting on a **continuum of shared infrastructures**

# DATA TERRA services

## User Services

F Findable A Accessible I Interoperable R Reusable

- Discovery, Knowledge & Services
- Earth Analytics Lab
- FAIR practices training and outreach
- Distributed data access, interoperability and processing
- National reference centre for Earth System & environment
- Earth system & environment communities stewardship

## Back Office

- Thesaurus
- Federated and harmonized catalogues & API
- Harvesting Transformation
- Software repository
- Identity & Access management
- Secu-rity
- Hypervision metrics
- Machine Actionable DMP

## Distributed Datalakes

- *PNDB*
- *DATA TERRA*
- *CLIMERI-France*

- Catalogues, thesaurus and APIs
- Local helpdesks

*Distributed Object Architecture and Fair Services*

- Data Lakes Multi-sources and distributed data repositories
- Federated Dat a & Processing services
- Long-term data archives & stewardship

*Distributed processing*

## Hardware

- **NETWORK AND COMMUNICATION** (Geant/RENATER)
- **GRID / CLOUD** (EGI/EUDAT/FranceGrille)
- **HPC** (EuroHPC, Prace/GENCI)

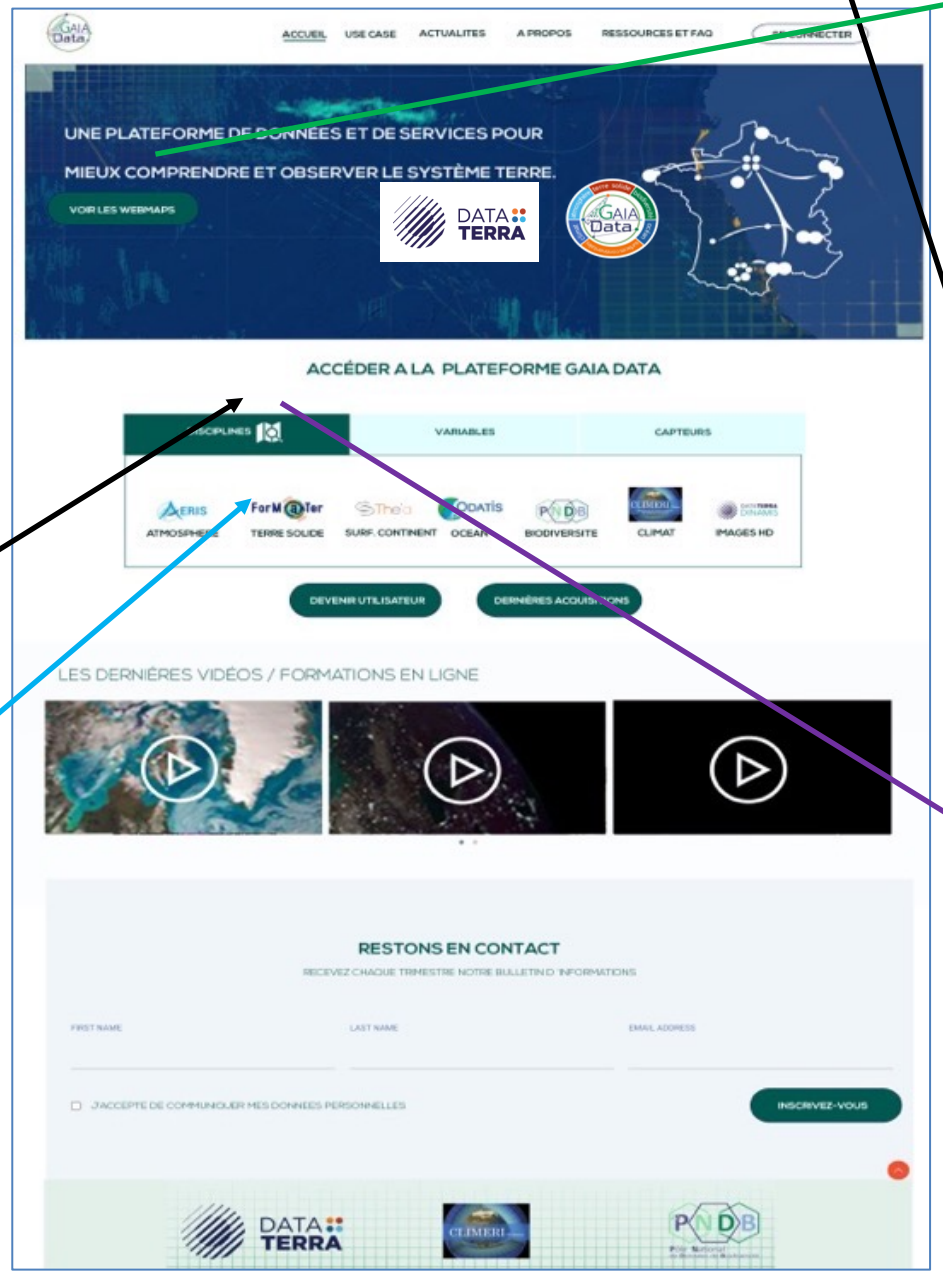
# Discovery Portal

**single point of access**

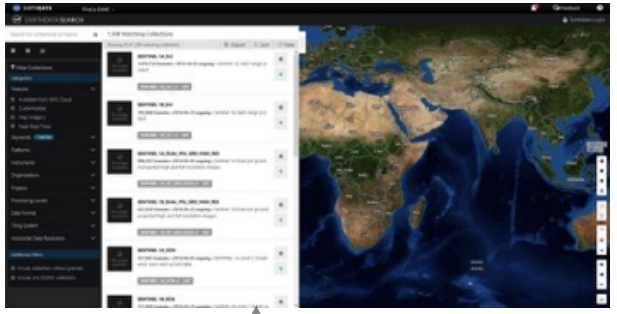
**Multiple entries**

vocabularies and ontologies to select datasets

Thematic portals, hubs, areas or projects




Visualization (WebMap)
Access / explore all available data



« User WebMap"
View a user-defined and configured set of datasets

Entry by domain (ex: Ocean): Pointer to "Ocean" theme page
=> Information on space missions and related data
WebMap presenting only data relating to the Ocean
Set of ocean-related services





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# 03 APPLICATIONS

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# ERUPTION TONGA

**14 jan. 2022** the volcanic eruption caused waves that hit **Australia, New Zealand, Japan** and the **west coasts** of North and **South America** for several days.

All the information collected by scientists thus facilitates emergency response and helps to better understand and anticipate this type of natural disaster in the future.

*The Tonga Islands are made up of approximately 170 islands*

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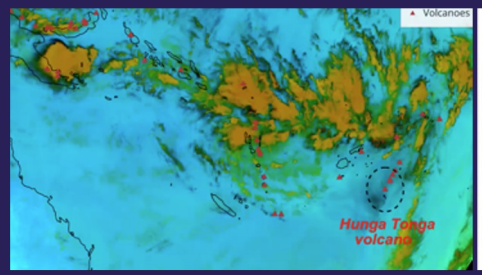
**AERIS** — **Atmosphere**

**FORM@TER** — **Solid Earth**

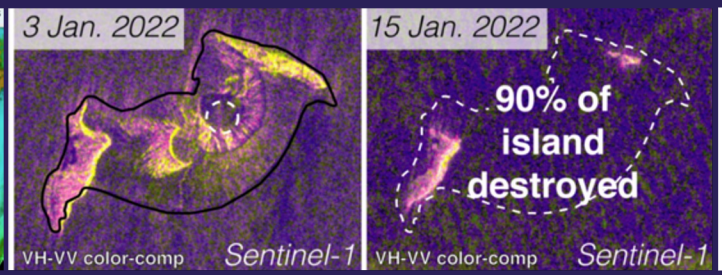
**ODATIS** — **Oceans**

**THEIA** — **Land surface**

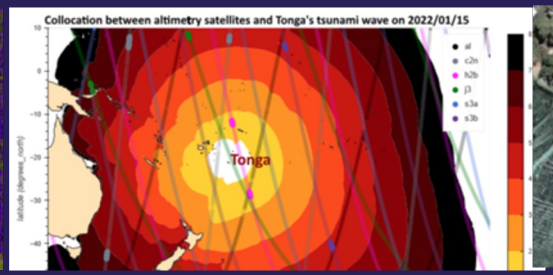
**DINAMIS** — **HD satellite imagery**



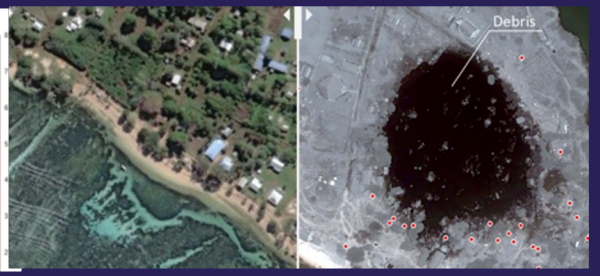

Eruption seen by Geostationnary Satellites




Evolution of the Volcanic Island before and after the eruption




Measurement of the tsunami wave front by altimetry satellites and of the coastal surge by in-situ tide gauges.




Mapping the Damage to guide rescue

# ERUPTION TONGA

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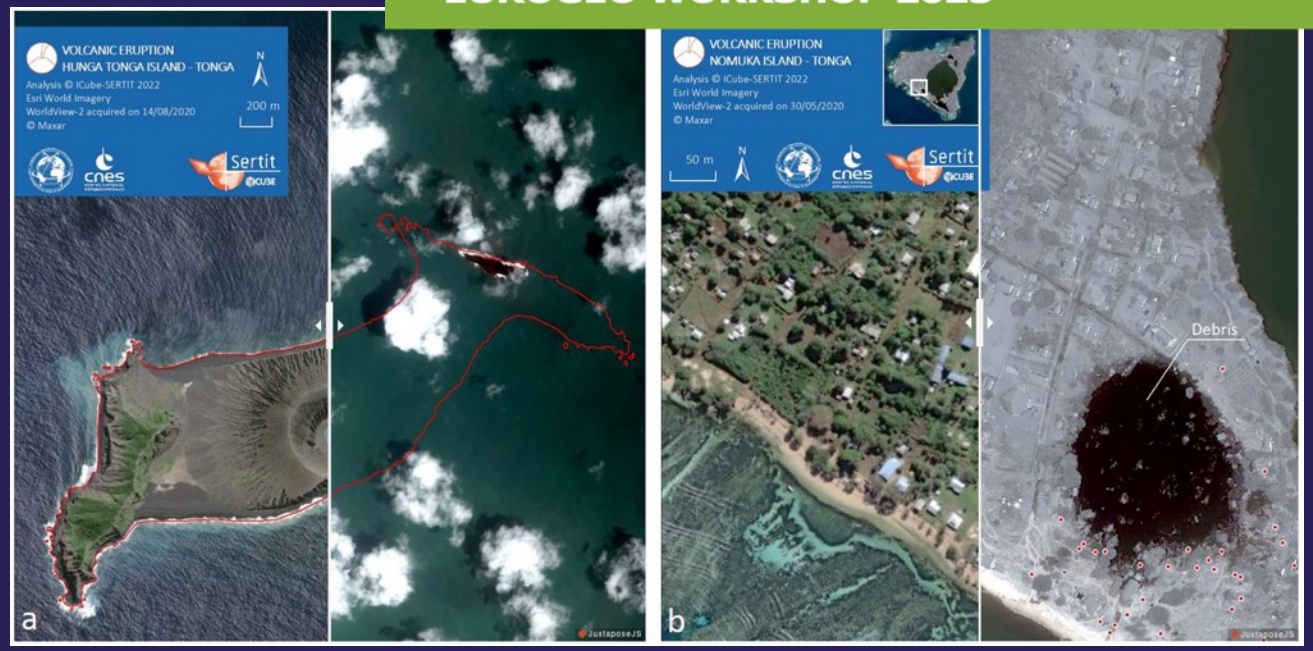
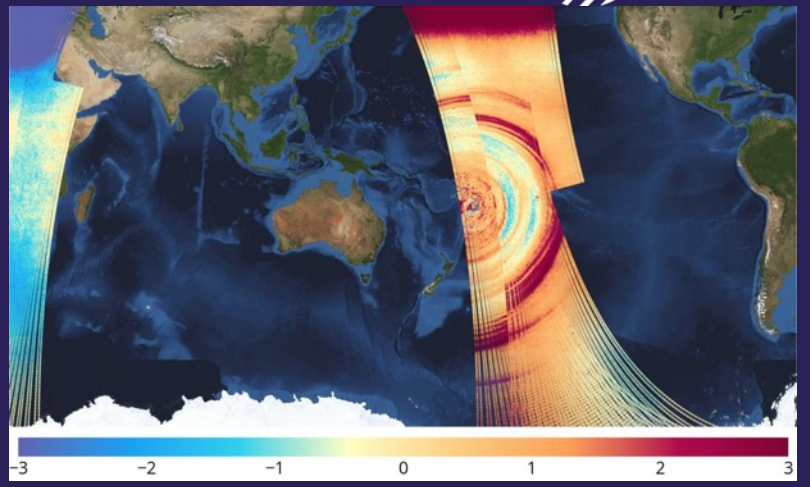
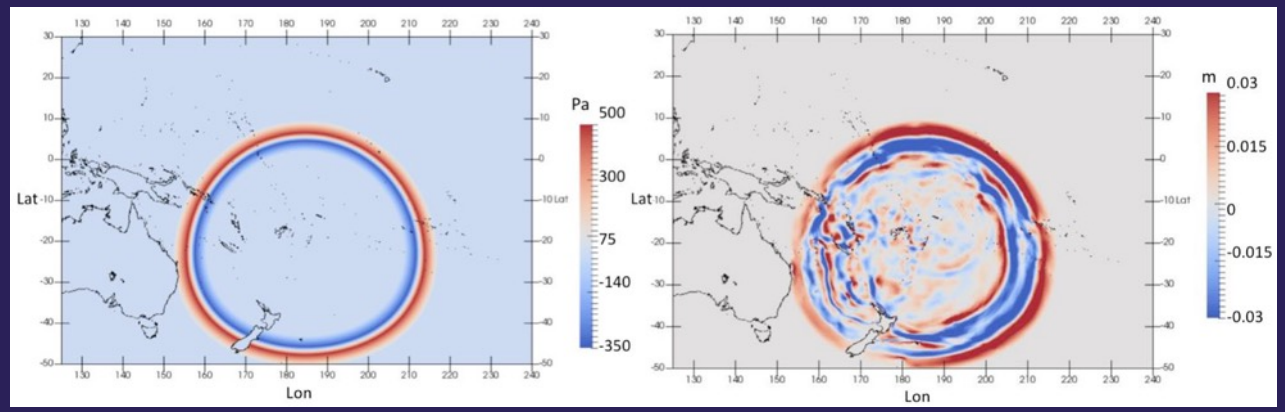


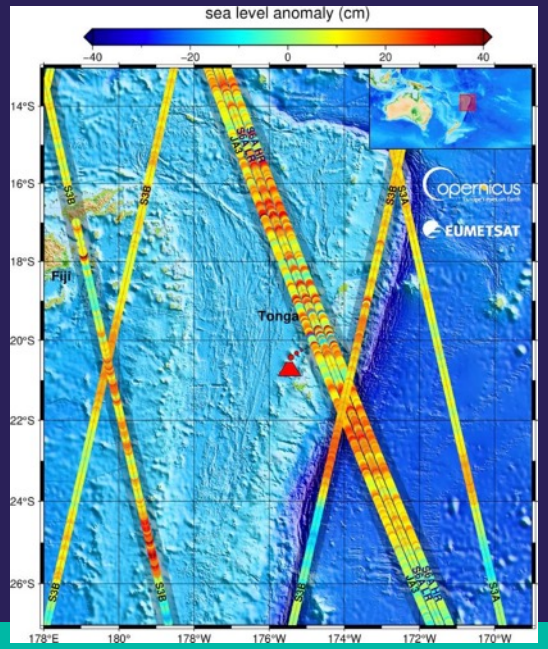

Images Pléiades-HR post-événement (à droite) et des images WorldView pré-événement (à gauche) sur les îles




Perturbations du champ de température dues aux ondes de gravité se propageant dans la stratosphère mesurées par le sondeur IASI




Propagation de l'onde de Lamb et propagation du tsunami associé, 3 heures après l'explosion. A gauche : champ de pression en surface (en Pa) modélisé par une onde sinusoïdale se propageant à la vitesse du son. A droite : élévation de la surface de l'eau (en m) générée par l'onde de Lamb et simulée




Anomalies du niveau de la mer (hauteur du niveau de la mer par rapport à une moyenne à long terme) mesurées par Sentinel-3A et -B, Sentinel-6 et Jason-3, les 14 et 15 Janvier à 04:15 UTC6

Theia Land Data Centre

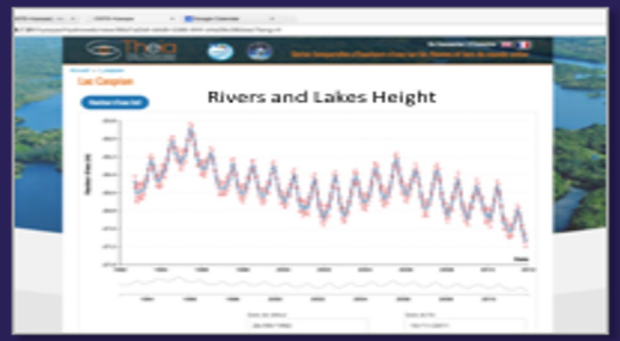
DATA TERRA

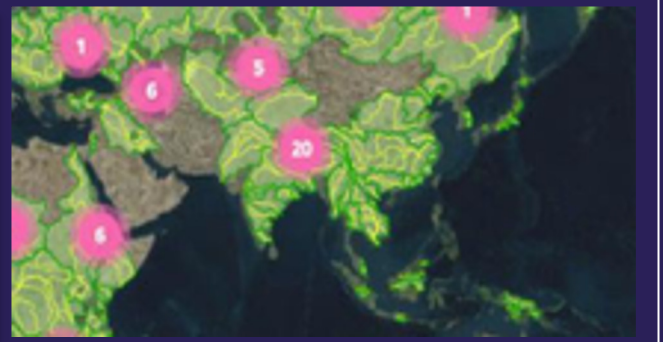
# HYDROWEB : WATER LEVELS OF RIVERS AND LAKES

Continuous, long-duration time-series of the levels of **64 lakes** and **248 virtual stations on rivers** (500 virtual stations at the end of 2018)

**Satellite altimetry is used to measure the water level**

currently Jason-3, Sentinel-3A and in the future Sentinel-3B, Jason-CS and SWOT



# SOIL MOISTURE MAP VERY HR RESOLUTION

**Source data**

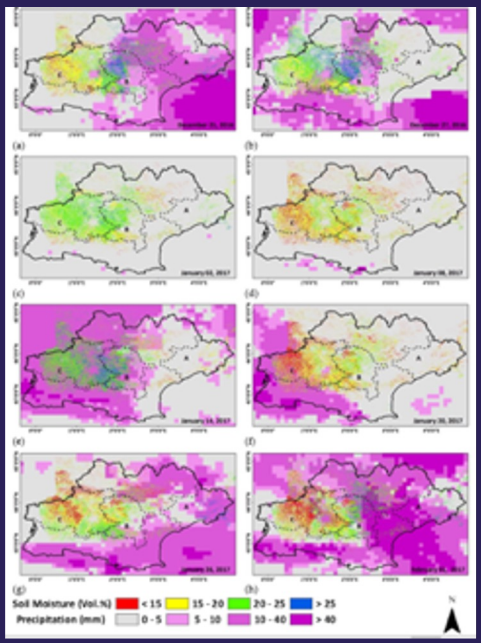
**Sentinel 1** : main source for radar signal inversion with neural networks

**Sentinel 2** : for contribution of vegetation to the total radar signal

**Theia Land Cover map** : to extract agricultural parcels

**Scale :** sub-parcel scale

**Production by Theia** : 6 days update over some regions



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