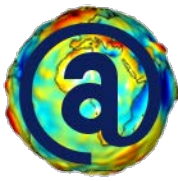
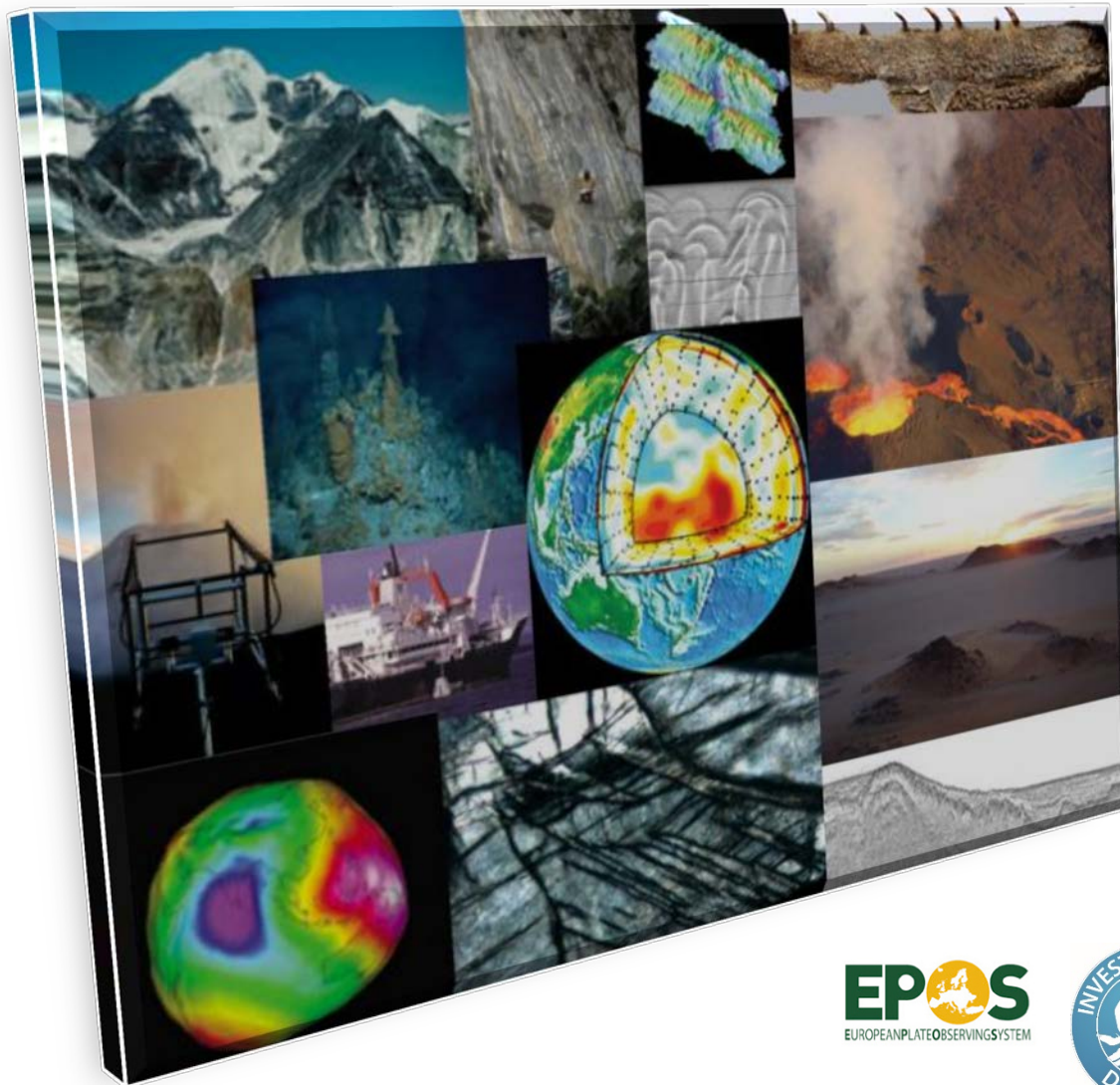


ForM@Ter



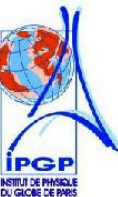
Forme et Mouvements de la Terre



MDIS – ForM@Ter 2017

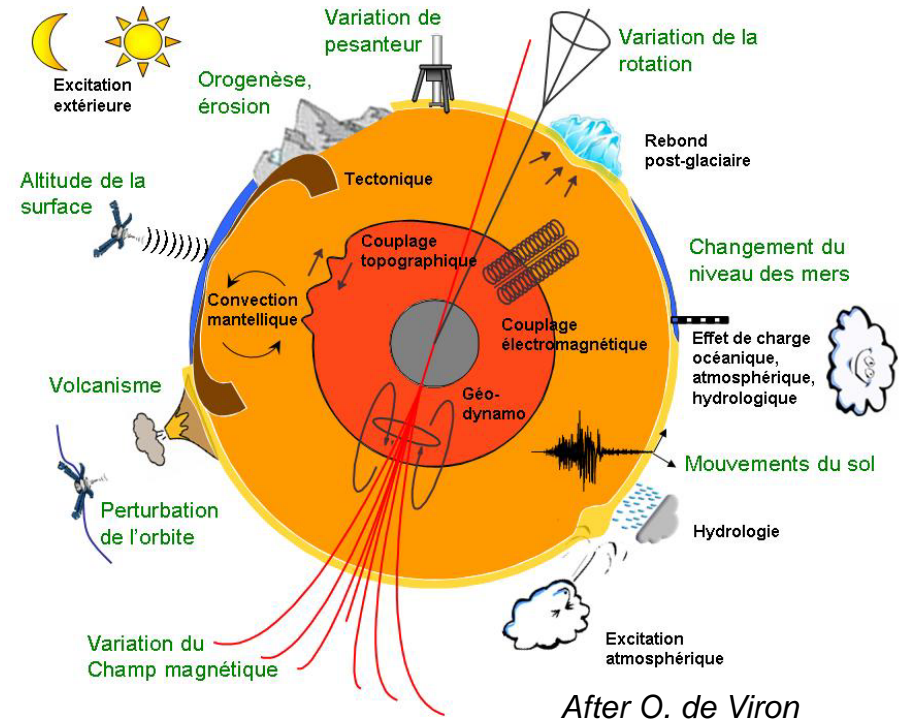
The data and services centre for Solid Earth ForM@Ter within the national research infrastructure

Michel Diament (IPGP), Emilie Deschamps-Ostanciaux (IPGP), Olivier Jamet (IGN) & Mioara Mandaia (CNES)



The Earth : a fascinating but complex system...

Earth is a fascinating but complex system subjects to numerous geophysical and geodynamic processes with variable spatial and temporal scales, that interact each other, within and between its various compartments: inner Earth, land surfaces, ocean, atmosphere (not forgetting interactions with Universe and of course with anthroposphere ...).



The understanding of these geophysical and geodynamic processes can be only achieved through the analysis of numerous and very large datasets (satellite, in situ, campaigns, **long term observations** but also experimentation results, model outputs...).

Scientists and decision makers need to have an easy access to all these data and associated products!



Beginning of story (First act)

CNES and CNRS-INSU mandated a working group (in January 2012)

Provide recommendations on « thematic data poles for the Earth Observation » in France within the European context.

RAPPORT DU
GROUPE DE REFLEXION
« POLES THEMATIQUES EN OBSERVATION DE LA TERRE »

AVRIL 2014

Ce rapport a été rédigé par le groupe de réflexion « Pôles thématiques en observation de la Terre », mis en place par le Centre National d'Etudes Spatiales et l'Institut National des Sciences de l'Univers du Centre National de la Recherche Scientifique, et composé de :

- Gilles Bergametti (LISA et président du groupe TOSCA du CNES)
- Philippe Bertrand (INSU)
- Michel Diament (INSU)
- Jean-Pierre Gleyzes (CNES)
- Steven Hosford (CNES)
- Nicole Papineau (IPSL)
- Alain Podaire (CNES), animateur du groupe
- Marc Pontaud (Météo-France)
- Didier Roumiguières (CNES)
- François Vial (INSU)
- Jean-Pierre Wigneron (INRA)

Françoise Genova (INSU) a été associée aux travaux du groupe au moment de l'élaboration des propositions.

As a result : four « poles » (data centres) existing or currently under implementation, one for each compartment of the physical Earth System.

Atmosphere (Aeris)

Ocean (Odatis)

Land Surfaces (Theia)

Solid Earth (ForM@Ter)

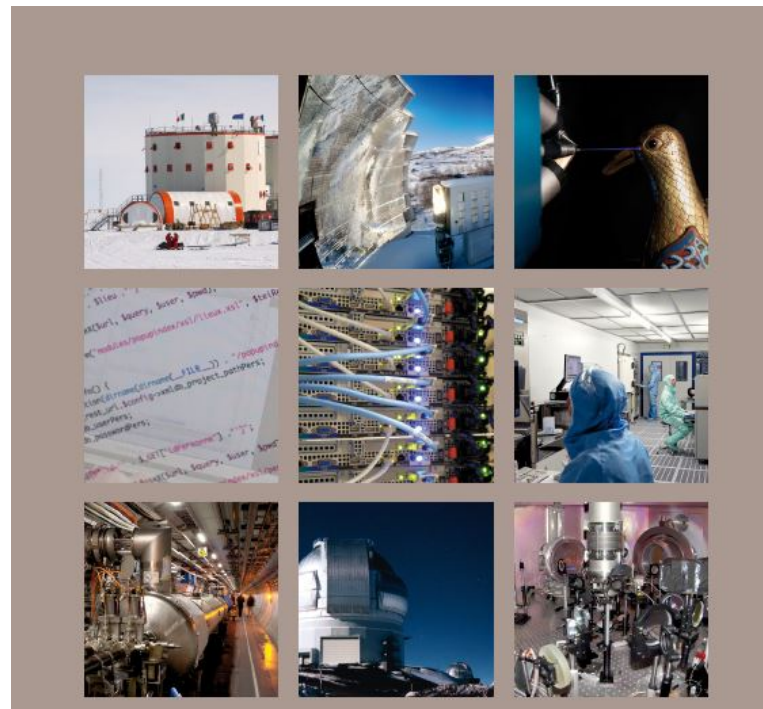
Why four poles and not a single one?

One system Earth means also coordination and common working groups (DOI's, interoperability...)

Second act

The four poles should be federated in an **unique Research Infrastructure** in order to ease the use of satellite and in situ data for investigations about the **Earth System**.

This RI is selected as « in project » on the French RI road map published in 2016 and is being implemented.



PÔLE DE DONNEES

Pôle de données et services pour le Système Terre



Type de l'infrastructure : Projet

Localisation : Paris (coordination)

Localisation des autres sites : IR Virtuelle

Responsables de l'infrastructure : Nicole Papineau (AERIS), Michel Diamant (Form@Terre), Nicolas Baghdadi (THEIA), Fabienne Gaillard (OCEAN)

Création :	Exploitation :
2016	2017

Titelles / Partenaires : CNES, CNRS, Ifremer, IRD, IRSTEA, Météo France, SHOM, BRGM, CEA, CEREMA, CIRAD, IGN, INERIS, INRA, INPG, ONERA, OCA, Observatoire de Paris, Ecole Polytechnique, Réseau des Universités marines, Univ. Lille 1, Univ. Toulouse, Univ. Pierre et Marie Curie/ Région Nord-Pas-de-Calais

Contact en France : nicole.papineau@ipsl.jussieu.fr, diamant@ippg.fr, nicolas.baghdadi@teledection.fr, fabienne.gaillard@ifremer.fr

Pour compléter le dispositif des infrastructures de recherche (IR) d'observation du Système Terre et organiser de manière intégrée l'accès aux données, l'infrastructure de recherche se propose de mettre à disposition les données, les produits et des services relatifs à l'observation de ce système, via les pôles de données et de services existants : AERIS (atmosphère), Form@Terre (Terre Profonde), THEIA (surfaces continentales) et OCEAN (Océans et Littoral). Elle donnera accès aux données produites par les IR d'observation, les infrastructures dites « logistiques » (bâtimeaux, avions, ballons...), ainsi que les données des satellites.

Destinés en priorité à la communauté scientifique française, ces produits ont aussi une portée internationale (missions satellites, réseaux d'observation globaux, partenariats pour le développement). Afin de garantir le respect des standards scientifiques et techniques en vigueur, les produits de l'IR sont définis et élaborés sous la responsabilité d'experts. Les séries de données et produits issus des réseaux d'observation, des campagnes et chantiers nationaux, des missions satellites, seront qualifiés, documentés et interopérables. À partir de ces données, l'IR élaborera ses propres produits.

Pour faciliter l'exploitation des informations l'IR mettra à disposition des outils d'exploration, de visualisation, d'extraction et d'analyse ainsi que les moyens de calculs appropriés.

L'IR hébergera des plateformes collaboratives pour le partage d'information et de données pratiques et participera à la formation scientifique et technique des communautés concernées.

IMPLICATIONS SOCIO-ÉCONOMIQUES

Les données fournies par l'IR aident à la mise en œuvre des politiques publiques car les travaux utilisant ces données ont un impact socio-économique dans les domaines des risques naturels, du changement climatique, des ressources minérales et en eau.

Au côté des centres de données implantés en région se développent des pépinières de PME spécialisées dans le traitement et l'utilisation des données.

DONNÉES

Estimation du flux de données : Jusqu'à plusieurs Po/an

Stockage : Centres de données de l'IR

Accessibilité : Web, FTP

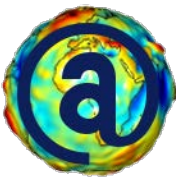
Présence dans des réseaux de données : RESIF/EPOS, EURO-ARGO, EMSO, ICOS, IAGOS, ACTRIS, EUMAR, EmodNet, Copernicus et plusieurs réseaux mondiaux contributeurs à GEOS

STRATÉGIE NATIONALE DES INFRASTRUCTURES DE RECHERCHE ÉDITION 2016

www.enseignementsup-recherche.gouv.fr



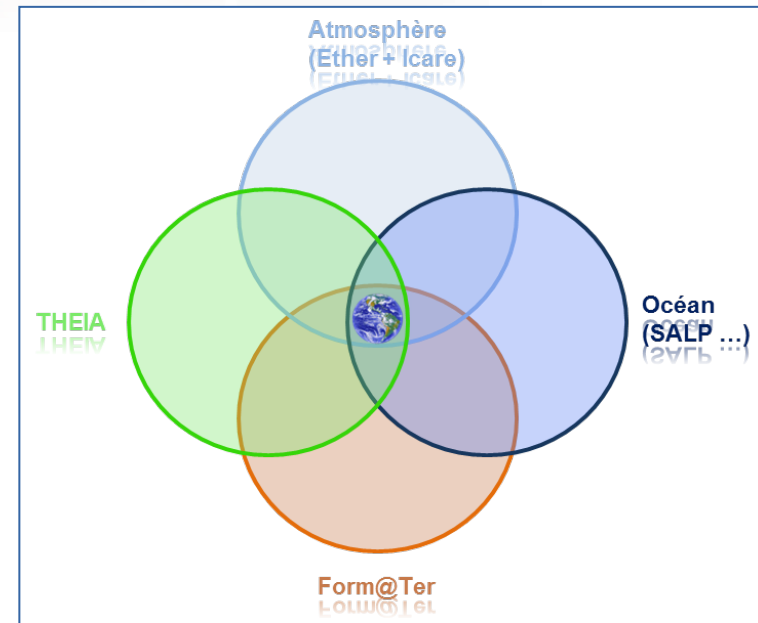
MINISTÈRE DE L'ÉDUCATION NATIONALE DE L'ENSEIGNEMENT SUPÉRIEUR ET DE LA RECHERCHE



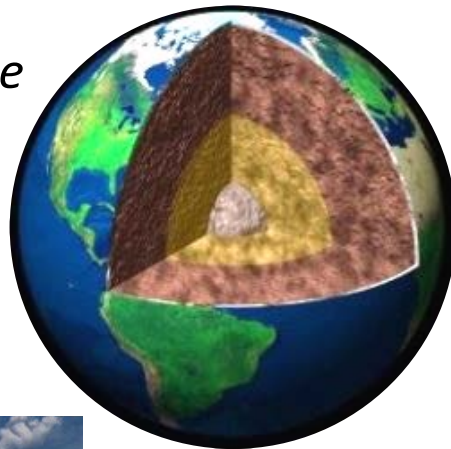
Four data centres for the physical Earth system in one infrastructure

Atmosphere, Ocean, Land surfaces, **Solid Earth**

The solid Earth, numerous scientific and societal issues ...



The Earth structure

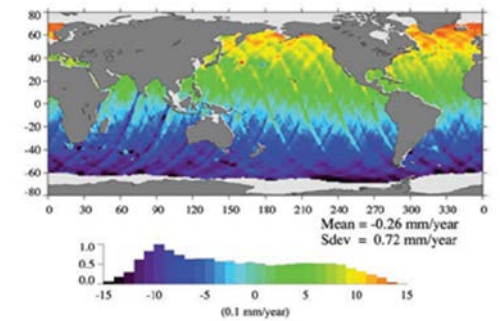


Resources

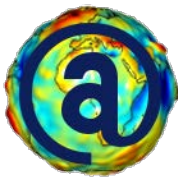
Telluric risks



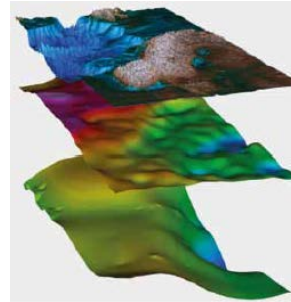
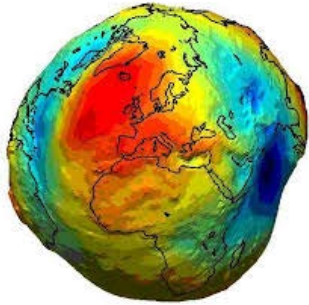
... and interdisciplinary



Example: sea level

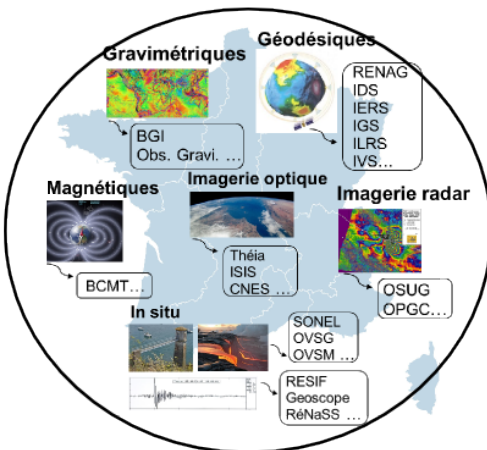


First target: **Shape, movements and deformation of the Earth**



Objectives

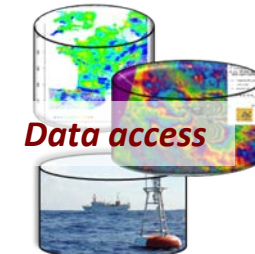
Federate existing data and expertise centres



To be embedded within the european e-infrastructures landscape



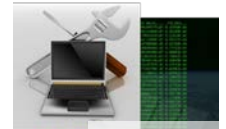
Provide services for the community and non-specialists



Data access



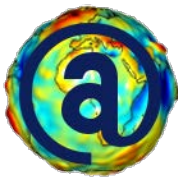
Outreach



Tools and software

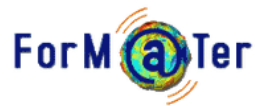


Collaborative working environment



A website: www.poleterresolide.fr

Currently under work! The new website will be set up in November



[FORM@TER EN](#)

[NEWS](#)

[AGENDA](#)

Recherche...

[LE PÔLE FORM@TER](#) ▾

[ACCÈS AUX DONNÉES](#) ▾

[PROJETS](#) ▾

[FORUMS](#) ▾

FORM@TER

Données et services pour la Terre Solide

Bienvenue

Le pôle Terre solide ambitionne de faciliter l'accès aux données et contribuer à la création de nouveaux produits et services en apportant de la valeur ajoutée aux données spatiales et « in-situ » disponibles. Il veut s'inscrire dans les paysages national et européen en articulation étroite avec les infrastructures en place et en construction.

Pour cela, le pôle Terre solide, a pour mission de fédérer les centres existants au service de la communauté Terre Solide.

Il se propose de mettre en place un portail donnant accès aux données spatiales, in-situ et d'expérimentations du domaine. Il ambitionne d'apporter de la plus-value, notamment pour les

Prochains évènements

[Colloque MDIS-ForM@Ter](#)

2017

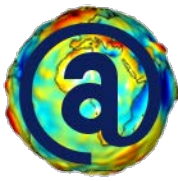
18 octobre - 20 octobre

[Voir tous les Évènements](#)

News

Données Sentinel 1 aériennes du 18/01/2017

ForM@Ter - Projects



Current projects: Ground movements from radar data

- *MUSCATE/ForM@Ter*



(see presentation P. Durand «Interférométrie à large échelle spatiale et temporelle dans la chaîne MUSCATE/Form@ter. Point sur les traitements PEPS »)

Systematic production of interferograms from Sentinel-1 data over large areas via the MUSCATE calculation platform (MULTi Satellite, multi-CApteurs, pour des données multi-TEmporelles) developed by CNES.

Products will be available via the ForM@Ter website.

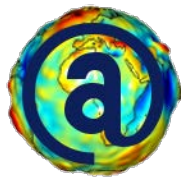
In the end the aim will be to produce **time series of interferograms**.

Scientific objectives :

- Ensure the temporal monitoring of critical zones (faults, volcanoes, landslides, urban subsidence, etc.);
- Measure intracontinental deformations on a large scale;
In a first step: **stacks of co-registered interferograms**, corrected for errors of MNT and atmospheric delays.

In a second step: **time series of displacements**.





Current projects: **Ground movements from radar data**

- **GDM - SAR**

Ground Deformation Monitoring service

Developed by ForM@Ter in the framework of EPOS research infrastructure.

A service to facilitate access and exploitation of **radar and optical imagery** for **quantifying ground displacements**.

For a wide panel of scientific fields: earthquake cycle studies, tectonics, volcanism, erosion dynamics, or anthropogenic deformations.

GDM will proposed two processing services.

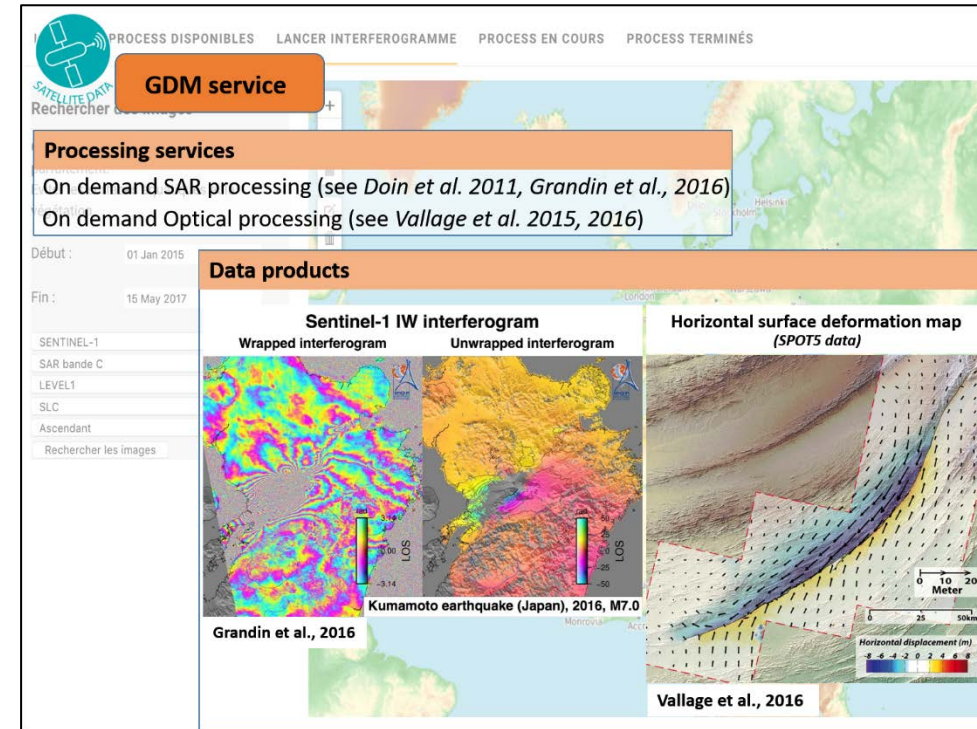
The first available service will be focused on SAR data

GDM-SAR is based on the New Small temporal and spatial BASelines (*NSBAS*, M.-P. Marie-Pierre Doin, F.Lodge, S. Guillaso, R. Jolivet, C. Lasserre, G. Ducret, and R. Grandin (2011)).

➔ **on-demand computation service** on Copernicus Sentinel-1 data to **provide stacks of co-registered interferograms**.

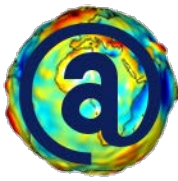
Products will be available on GEP, the ESA's Geohazards Thematic Exploitation Platform

Ground Deformation Monitoring service: processing services and example of data products.



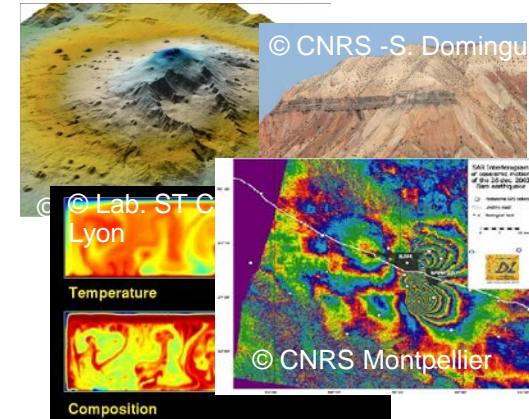
<https://www.epos-ip.org/tcs/satellite-data/data-services/gdm>

ForM@Ter - Projects



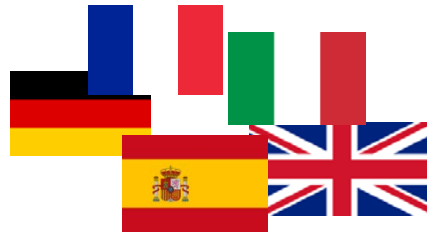
GDM is developed in the framework of the **TCS Satellite data**.

Main goal of the TCS: contribute with mature services that have already well demonstrated their effectiveness and relevance in investigating the physical processes controlling earthquakes, volcanic eruptions and unrest episodes as well as those driving tectonics and Earth surface dynamics.



Leader du WP: **CNR (Italie)**

CNRS (France) INGV (Italie)
GFZ (Allemagne) UoL (Roy. Uni)
CSIC (Espagne)

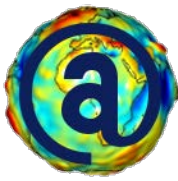


TCS partners provide products and services

Input satellite data that come from National and International space agencies.



One of the TCS objectives is to **broaden the base of national space agencies that actively contribute to the TCS**.



Services and products:

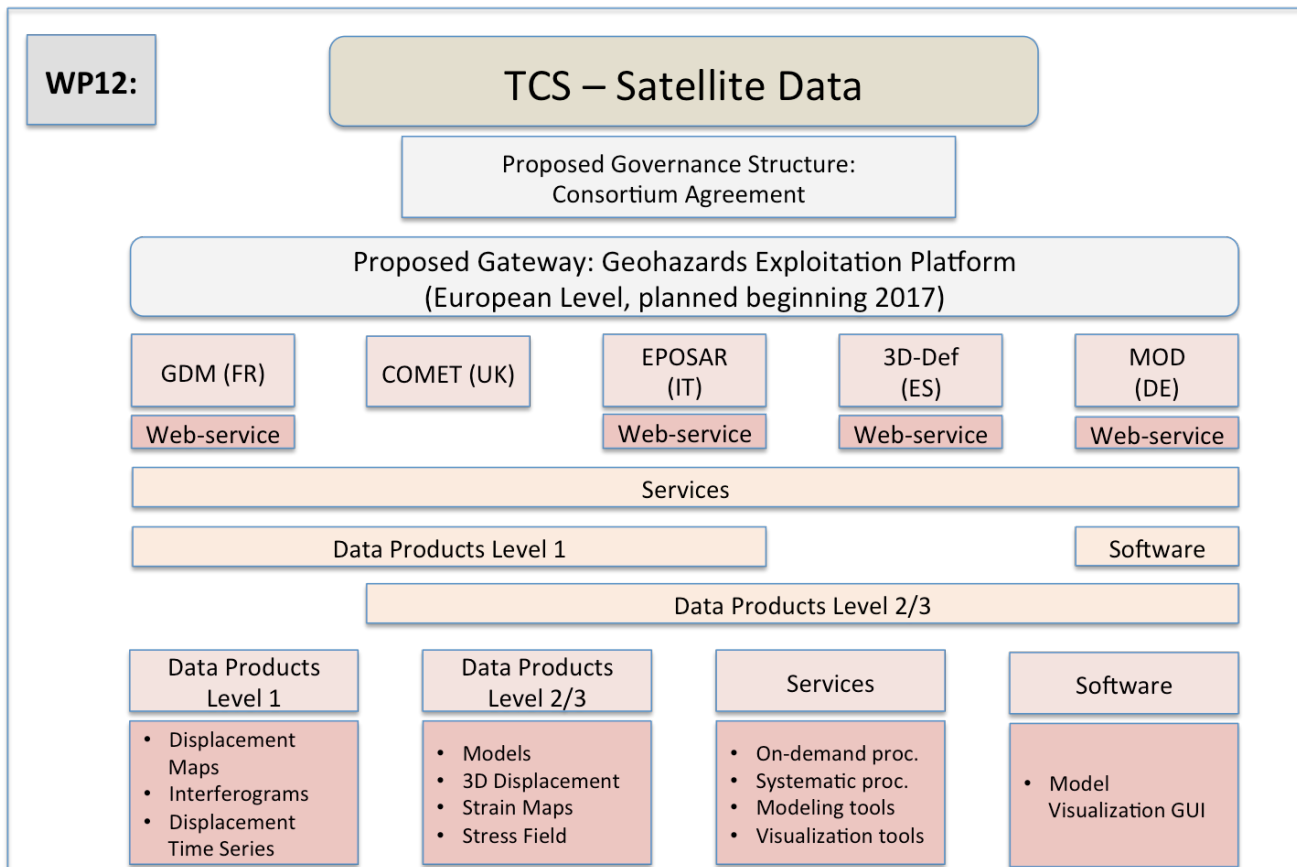
dedicated to the **determination of the Earth surface displacements** through Satellite Radar and Optical data

2 specific functioning modes:

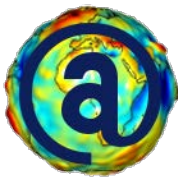
- **Continuous**, systematic and periodic generation of products (*ex. the systematic production of updated time series of surface deformation over a given defined area*)
- **On demand**, users run the tools and process the chosen satellite dataset (*ex. ad hoc generation of a deformation measurements using diachronic satellite observations during a telluric crisis, e.g. a co-seismic terrain motion map*).

2 levels:

- **“Standard”** (level 1) satellite products/tools: *interferograms, displacements maps, deformation time series.*
- **Value-added** (level 2/3) satellite products/tools: *3D displacement maps, source mechanisms, fault models...*

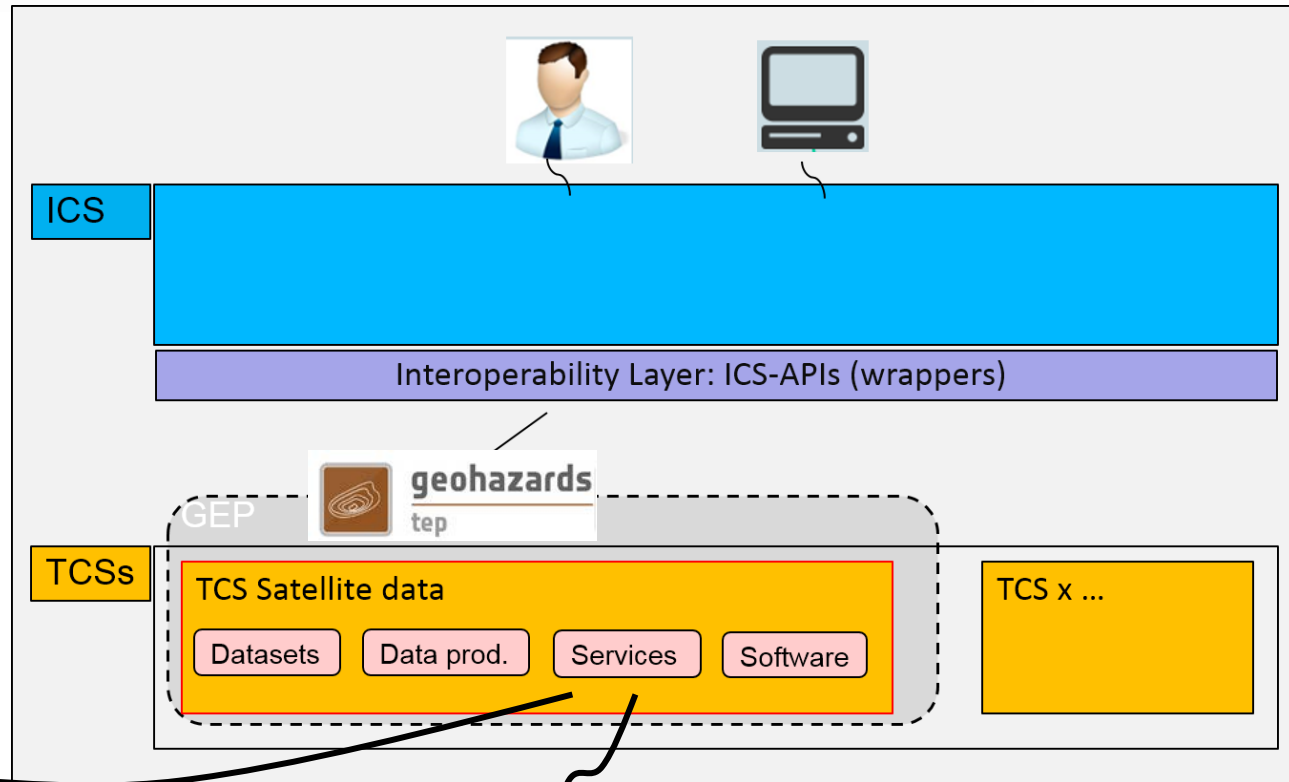


ForM@Ter - Projects



A common interface to access the TCS products and services.

ESA is contributing to the TCS with **GEP**: is using **Cloud processing facilities** to enable both systematic and on-demand services.



L1 on demand:

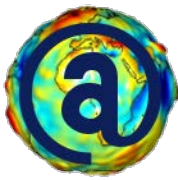
- GDM-SAR processing
- GDM-SAR visualization
- GDM-optical processing
- Sentinel-1 SBAS Processing
- ERS-ENVISAT SBAS Processing

L1 Surveillance:

- Syst. Sentinel-1 SBAS Processing
- Syst. Generation of Interferog. and Displ. Time Series

L2 et L3:

- Displ. Analytical Modelling – Displ. Maps
- Displ. Analytical Modelling – Displ. Time Series
- Modelling toolbox with User Interface
- Data fusion (InSAR , GNSS,...) to obtain 3D displ. maps
- Joint Displacement and Gravity data Modeling



Satellite Data TCS leads the HG-03 Harmonization Group.

The partner in charge of the harmonization is **CNR**.

There is **no widely agreed international format** for data products derived from Satellite Data.

Discussions “internally” among the TCS partners to **find out common formats for the data products representation**.

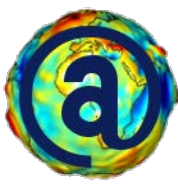
➔ A set of **formats in accordance** to the delivered data products.

The **metadata format has also been selected** and it corresponds to the **ISO 19115** as defined by the OGC consortium.

After the “internal” harmonization, discussions with other EPOS partners contributing to the HG-03 on the TCS work status and try to **investigate possible interaction and conflicts among the different TCSs**.

TCS	SEISMOLOGY	WP8
TCS	NEAR FAULT OBSERVATORIES	WP9
TCS	GNSS DATA AND PRODUCTS	WP10
TCS	VOLCANO OBSERVATIONS	WP11
TCS	SATELLITE DATA	WP12
TCS	GEOMAGNETIC OBSERVATIONS	WP13
TCS	ANTHROPOGENIC HAZARDS	WP14
TCS	GEOLOGICAL INFORMATION AND MODELING	WP15
TCS	MULTI-SCALE LABORATORIES	WP16
TCS	GEO ENERGY TEST BEDS FOR LOW CARBON ENERGY	WP17

ForM@Ter - Projects



Current projects: **Ground movements from radar data**

- *Etalab*



Issues:

- Inevitable evolution towards the establishment of a **limited number of data centres**

Increase of data volume and computation needs no longer allow each research team to meet its own needs.

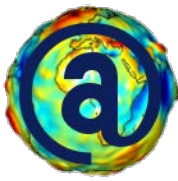
- But: the **extreme diversity of data** in observing Earth System calls too specific expertise to adopt a purely centralized management mode.
- In this context need of **capacity of adaptation** from scientific teams

Pb: insufficient IT support, working habits, pressure for immediate scientific performance, etc.



Project objectives:

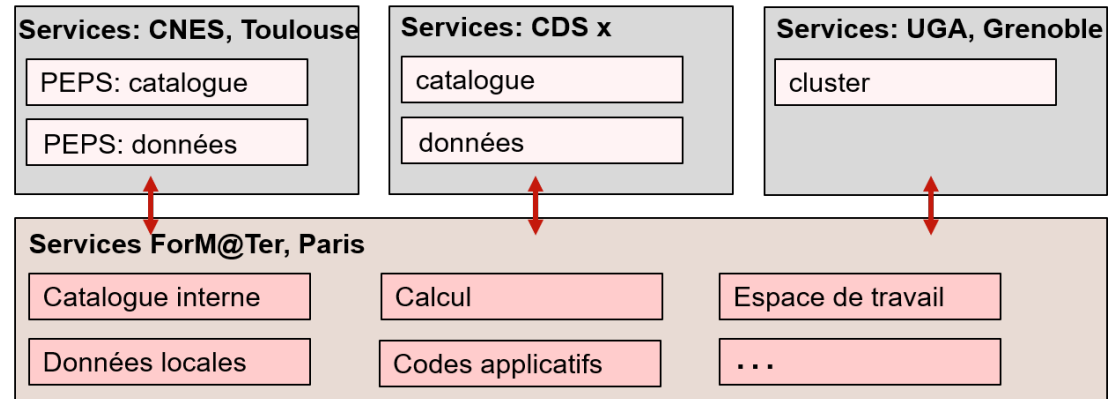
- Test open source technologies in the context of research.
- Constructing tools allowing functioning of a distributed infrastructure.
- Assess **the acceptability** of these new environments by researchers, particularly by researchers which develop algorithms..
- Provide **further insight** concerning solutions envisaged for the interoperability of the services provided by the data poles.



First demonstration centered on SAR imaging (computation of interferograms and time series of interferograms)

• Services are limited to :

- implementation of the interface and search functions;
- processing built on a single software chain developed by the French community

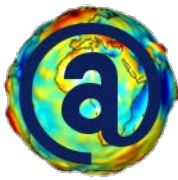


➔ **NSBAS** (New Small temporal and spatial BASelines, see *M.-P. Marie-Pierre Doin, F.Lodge, S. Guillaso, R. Jolivet, C. Lasserre, G. Ducret, and R. Grandin (2011)*)

• Data centers limited to 2:

- CNES (Toulouse): Copernicus data Sentinel 1 (PEPS)
- CASOAR database (OPGC) (around 1200 pictures)





Short-term objectives for the Etalab project

- Search and download data from different platforms
- Processing on a cluster
 - On-demand processing (press button) of interferograms with NSBAS
 - « **Expert** » on-demand processing of interferograms with NSBAS
- Sharing expertise on data and processings

Proof of concept

Target: the national community within the framework of the four data and services centers

Available for:

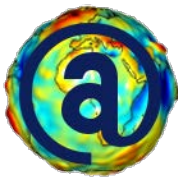
May/june 2018

Next ...

- Internal catalog of data and services
- Authentication server
- Processing development / development workspace
- Launch processing closest to the data
- HPC calculation ?
- ...

Evolutions towards an operational platform

Target: the national community

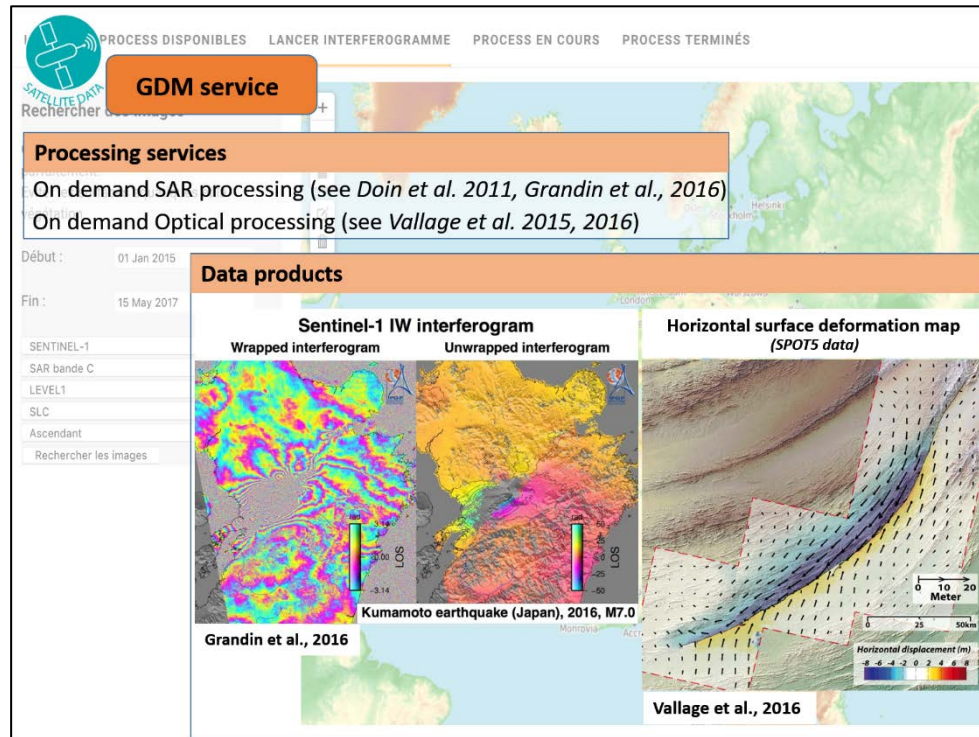


Projects to be soon implemented

Ground movements from optical data

GDM - optic

Ground Deformation Monitoring service: processing services and example of data products.

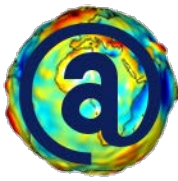


<https://www.epos-ip.org/tcs/satellite-data/data-services/gdm>

In a next stage the second GDM service will be focused on optical data:

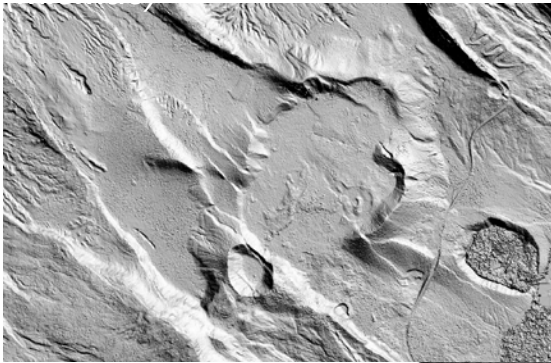
GDM-optic intend to process Copernicus Sentinel-2 data to provide horizontal surface deformation maps.

Vallage A., Klinger Y., Grandin R., Bhat H.S., Pierrot-Deseilligny M., Inelastic surface deformation during the 2013 Mw7.7 Balochistan, Pakistan, earthquake. (2015); Vallage A., Klinger Y., Lacassin R., Delorme A., Pierrot-Deseilligny M., Geological structures control on earthquake ruptures : the Mw7.7, 2013 Balochistan earthquake, Pakistan. (2016).

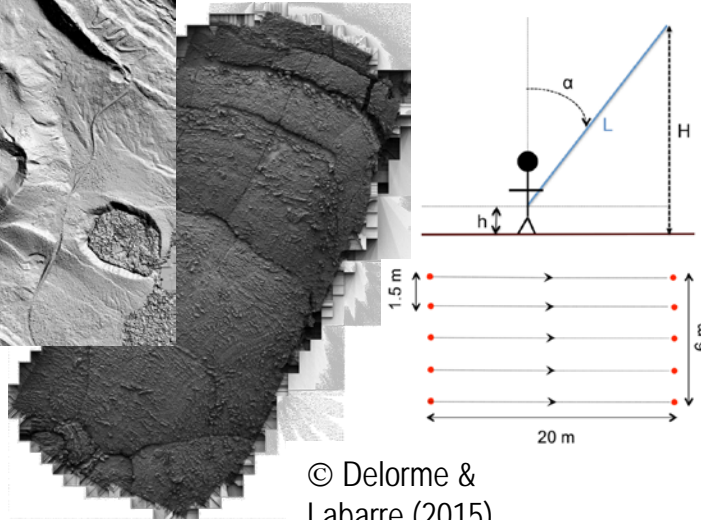


DEM production

Satellite data (Péiades 1-B):
reconstruction of metric DEM



Field data: reconstruction of
millimetric DEM (MicMac)



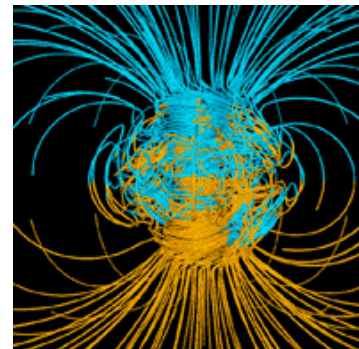
© Delorme &
Labarre (2015)

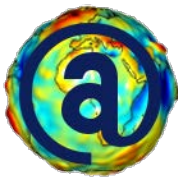
Construction of a service
dedicated to **DEM production**
(including ground-ocean).

A service built by ForM@Ter
**To be used by the f 4 data
and services centres**

Magnetic data and related services

Access to magnetic data (in
collaboration with BCMT) and
construction of related services.





Conclusion

ForM@Ter: a Solid Earth data and services centre under implementation in France in the framework of national research infrastructure built to provide data and services on the Earth system. This RI federates four data and services centres: AERIS (atmosphere), ForM@Ter (solid Earth), ODATIS (ocean) and THEIA (land surfaces).

First target: surface deformation from radar and optical data. Ground Deformation Monitoring service in the framework of TCS Satellite data in the EPOS IP. A service for scientific and private users to facilitate exploitation of radar and optical data for ground motion monitoring applications.

Future: access to other data (gravimetry, magnetism, global geodesy ..) and associated services.

153 years after the publication of Verne's « Journey to the Center of the Earth » the challenging exploration and understanding of our inner globe should greatly benefit from the joint analysis of the massive and diverse datasets nowadays available.

