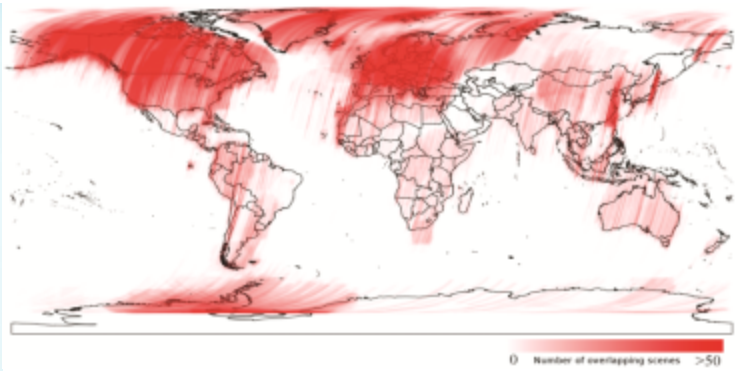
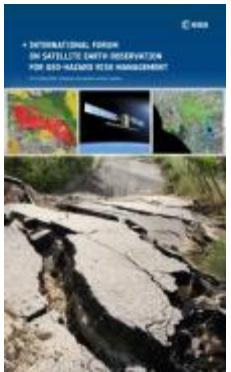
ESA's Thematic Exploitation Platform initiative and the GEP for terrain motion measurements

ESA, October 2017

Philippe Bally (ESA), Theodora Papadopoulou (Argans Ltd c/ ESA), Fabrizio Pacini (Terradue)

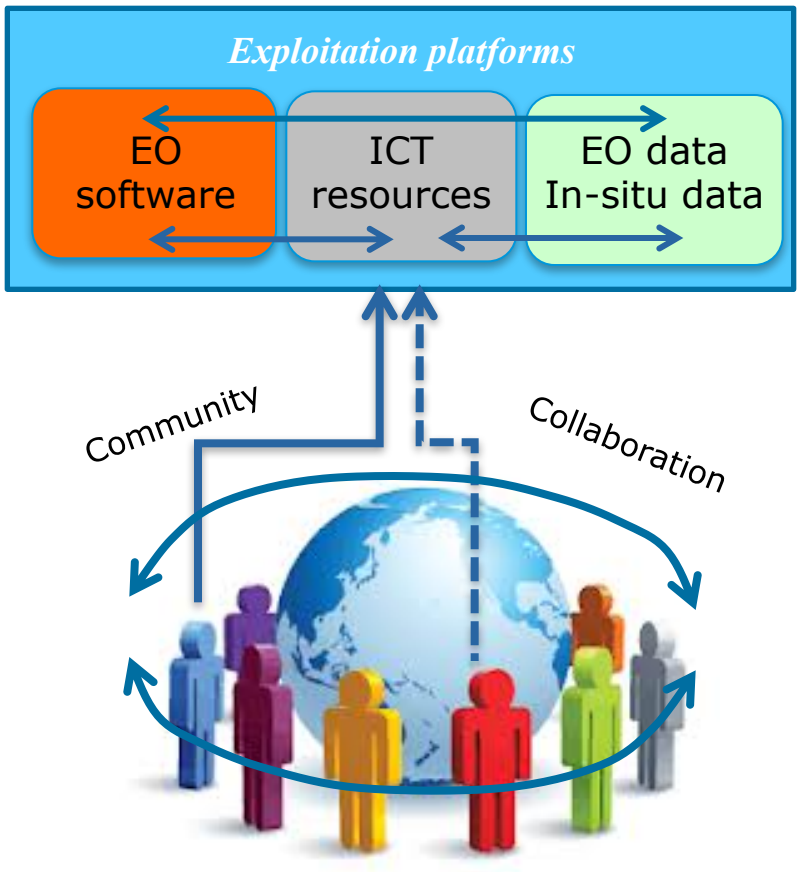




ESA’s Thematic Exploitation Platforms

Exploitation Platforms

"Move User activities to the Data"



A complementary operations concept: users access a work environment containing the data and resources required, as opposed to downloading and replicating the data 'at home'.

→ An R&D scenario for data intensive exploration gradually complementing the traditional operations concept for the ground segment

Exploitation platform (or community platform)
=
Virtual open and collaborative environment

bringing together:
- data centre (EO and non-EO data)
- computing resources and hosted processing
- collaborative tools (processing tools, data mining tools, user tools, …)
- development tools and test bench functions
- application shops and market place functionalities
- communication tools (social network) and documentation
- accounting tools to manage resource utilisation

ESA Thematic Exploitation Platforms

Pre-ops '16-17

Post-'17 under discussion

esa

hydrology tep

isardSAT

EOMAP

ALTAMIRA INFORMATION

TU Delft
Delft University of Technology

terradue 2.0

deimos ENGENHARIA

SMHI

forestry tep

VTT

CGI

arbonaut

Science & Technology Facilities Council
Rutherford Appleton Laboratory

SPACEBEL

coastal tep

ACRI ST

ThalesAlenia Space

cnes

DLR

Catalysts
software is our passion

planetek italia

TERRASIGNA

UCC
Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

food security tep

Vista

vito
vision on technology

CGI

Hatfield CONSULTANTS

polar tep

Polar View

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

s[&]t

AWST
science software technology

dmi

c-core

DTU Space
National Space Institute

FMI

Canadian Ice Service
Service canadien des glaces

INTERNATIONAL ICE PATROL

CEMS
Climate, Environment & Monitoring from Space

HICKLING ARTHURS LOW
INNOVATION POLICY ECONOMICS

geohazards tep

terradue 2.0

INGV

ALTAMIRA INFORMATION

UNIVERSITÉ DE STRASBOURG

ENS

DLR

urban tep

DLR

BROCKMANN CONSULT

IT4I

gisat

terradue 2.0

ESA’s Geohazards TEP: GEP

GEP overview

OVERVIEW from the user community viewpoint:

- A processing platform initiative feeding into EO Innovation Europe and implemented in the context of CEOS & GEO, in particular with CEOS WG Disasters pilots
- Mission statement: **better understanding geohazards using satellite EO**
- A clear focus on **scientific & operational users from public organisations** (DRM users and Academia) starting from the CEOS WG Disasters framework
- A **large number of users** contacted GEP to become Early Adopter (54 user organisations from 23 countries) active in either running GEP services or integrating services in GEP
- A portfolio of **40 services** with 20 services integrated & running (InSAR: 17, Optical: 3) and 20 under integration

Longer term:

- First attempts to obtain **non-ESA financing** for instance: EINFRA_12 (DG Connect), EO-2-20174 EO Big Data Shift (DG Research), MSCA-ITN-20177 (DG Research).
- Potential for broader activities about the **whole DRM cycle** (c.f. other DRM themes than geohazards e.g. the International Charter, Disaster Risk Transfer/Insurance, etc.)
- The capability demonstrated is also relevant to **industry customers** (but this is not the scope of GEP); interest manifested from commercial VA companies (e.g. PSI suppliers) and industry users (e.g. California Geological Survey)
- Now **federating** with other space agencies with the Geohazards Lab (ASI, CNES & DLR) in the CEOS WG Disasters context

Objectives of the geohazards community:

A. Support the generation of **globally self-consistent strain rate estimates** and the mapping of **active faults** at the global scale by providing EO InSAR and optical data and processing capacities to existing initiatives, such as the iGSRM

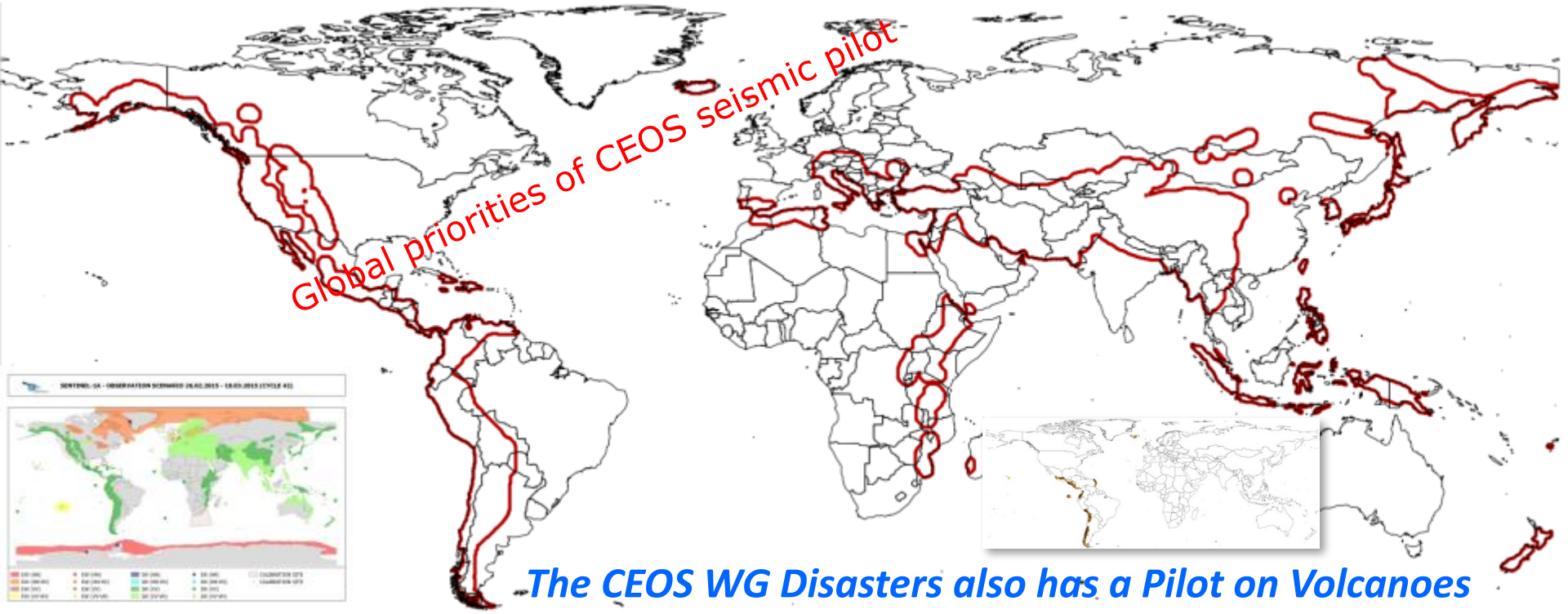
[role of EO: wide extent satellite observations]

B. Support and continue the Geohazards Supersites (GSNL) for seismic hazards and volcanoes

[role of EO: multiple observations focused on supersites]

C. Develop and demonstrate advanced science products for **rapid earthquake response**.

[role of EO: observation of earthquakes with M>5.8]



The CEOS WG Disasters also has a Pilot on Volcanoes

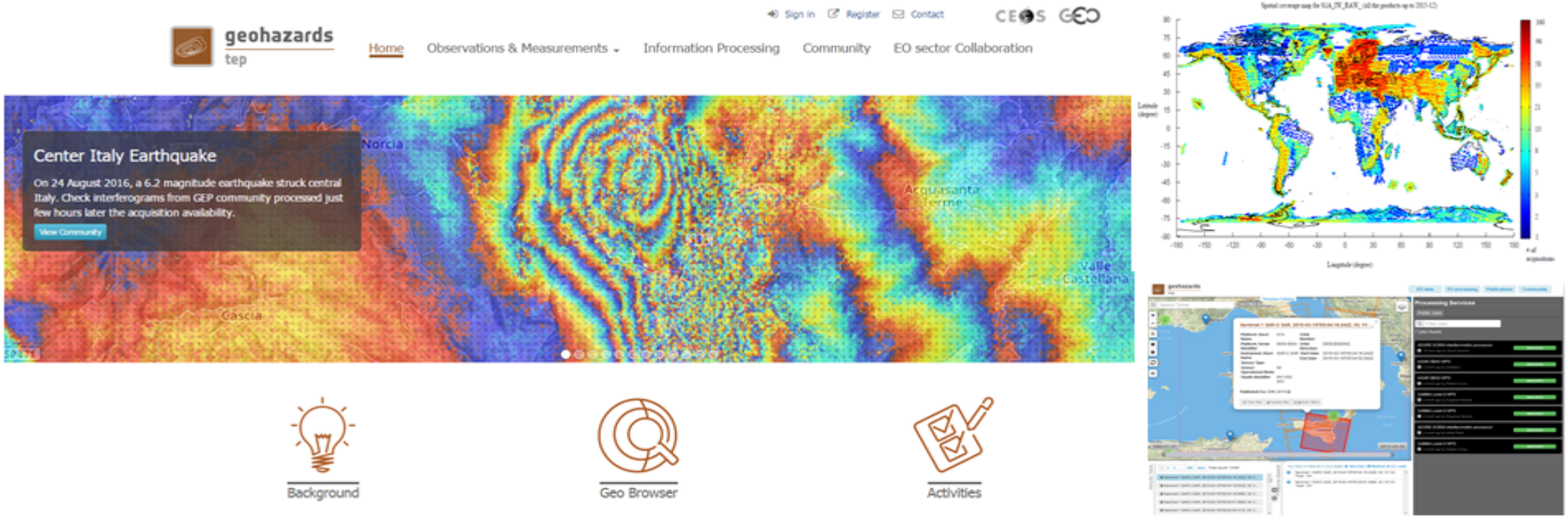
The Geohazards TEP (GEP):

An ESA originated **R&D activity on the EO ground segment** to demonstrate the benefit of new technologies for large scale processing of EO data.

Designed in the context of the Geohazards Supersite initiative (GSNL) and the CEOS Disasters Working Group which adress a Task of the **Disaster Societal Benefit Area of the intergovernmental Group on Earth Observations (GEO).**

A model for partnership and community building that is user driven. Started from the **International Forum on Satellite EO and Geohazards** organised by ESA and GEO in Santorini in 2012 (140+ participants from 20 countries, 70+ organisations incl. international organisations, public institutes, space agencies, universities & private sector).

GEP: an innovative response



An Exploitation Platform sourced with **data and processing** relevant to the GeoHazards theme:

- EO data **storage** concerning wide extent tectonic analysis for which large data stacks are needed (typically 1000+ and 5000+ scenes and larger)
- Access to **advanced processing tools** (e.g. InSAR and Optical based)
- A **collaborative** work environment and scientific animation
- October 2017: **61 users**
- One of the 6 Thematic Exploitation Platforms originated by ESA
- Follows the GPOD, SSEP and TEP-Qwin precursors

EO DATA AVAILABLE

Supported EO missions

Copernicus Sentinel-1, Sentinel-2, Sentinel-3 and US Landsat-8 data available globally:

Via the GEP Data Agency Catalogue, the Platform currently makes available for processing the **global coverage** of the following data collections:

- **Sentinel-1A/B:** (RAW, SLC, GRD and OCN) synchronized* with the Copernicus Open Access Hub
- **Sentinel-2:** (MSI L1C) synchronized* with the Copernicus Open Access Hub
- **Sentinel-3:** (OLCI, SLSTR) synchronized* with the Copernicus Pre-Operations Data Hub
- **Landsat-8:** (OLI and TIRS) synchronized* with the USGS EarthExplorer

GEP is primarily focusing in InSAR and Optical processing with Sentinel-1 and Sentinel-2.

*:
- *about metadata*: complete catalogues published in NRT.
- *about data*: different solutions according to use case incl. co-located data & processing, on-demand data fetching, caching, etc.

Other EO resources

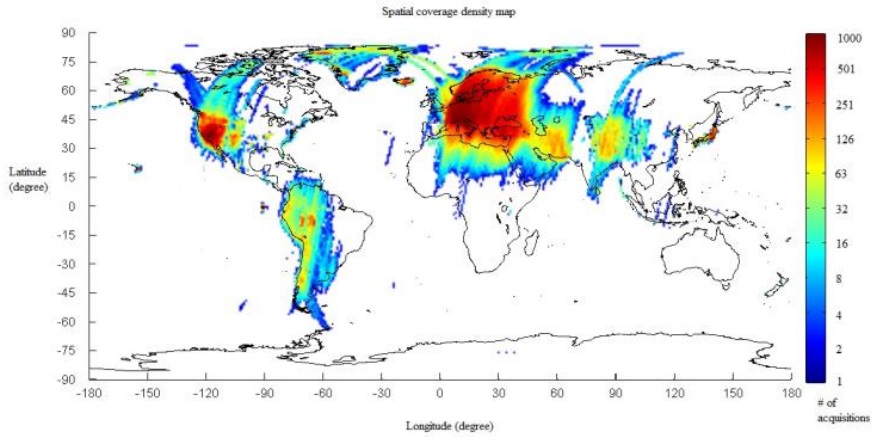
GEP has taken commitments about data access as per some recommendations associated to Fringe

- The GEP provides on line access to ESA heritage EO missions data:
  - **ERS (SAR IM Level-0)**
  - **ENVISAT (ASAR IM Level-0)**

  global coverage synchronized with the ESA VA4 (70+ terabytes)

Through agreements with CEOS partners and project partners (CEOS Pilots and Geohazards Supersites), limited private collections of the following missions are made available for processing & download:

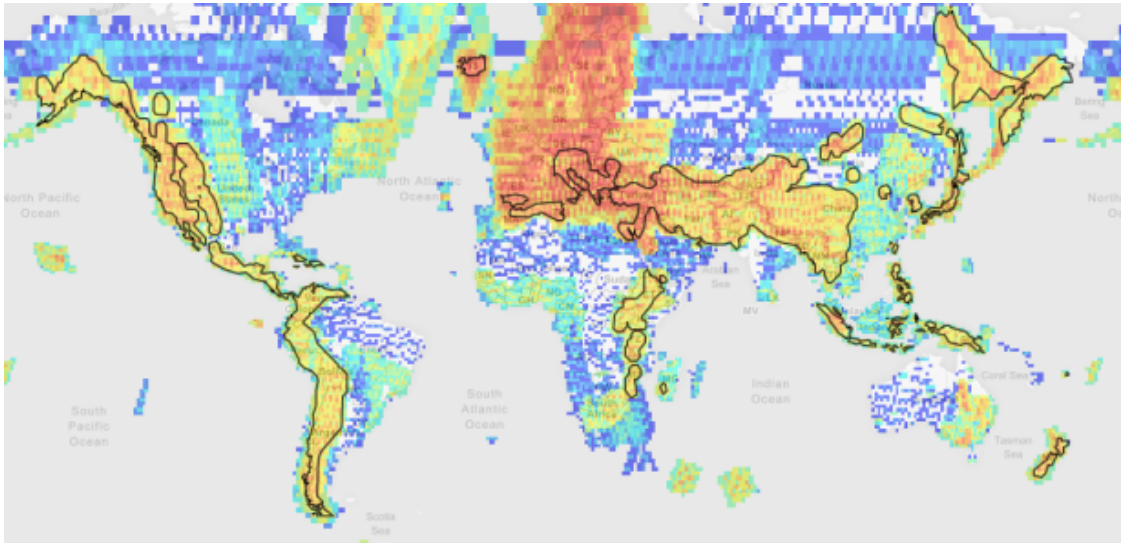
- **ALOS-2**
- **TerraSAR-X**
- **COSMO SkyMed**
- **RADARSAT-2**



ERS & ENVISAT Level-0 data available as of February 2016

Improving access to data collections relevant to geohazards community:

- **The geohazard community defined geographic priorities** with users (black contour below) that were fully taken on board for Sentinel-1 operations (the image below shows the density of S-1 acquisitions); GEP is fetching S-1 using multi-sourcing (ASF, PEPS, etc.).



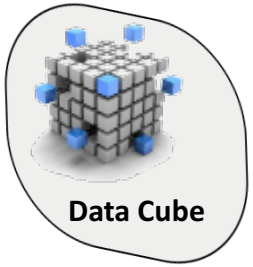
- Provide **a cache of last 30-days of Sentinel-1 SLC** data of about **48TB** over the World Tectonic Mask in support of systematic processing services performing InSAR production at global scale
- Provide **a dynamic fast access cache** (LRU - 1TB) of latest, most requested input datasets in support of on-demand processing
- GEP **federates external data centres** (e.g. IPT-PL, EGI, PSNC) & **computing centres** (e.g. CNR IREA) for supporting "local (to the data) processing"

Underlying technology supporting Data Access & Processing

EO Exploitation Platform – Components

*Exploitation Platforms typically feature **a set of components**. Some examples:*

Data Analytics



Data Cube

Toolboxes

EO data tools

Interoperability

Standardisation

common enabling elements

Data Storage

High Processing Computing

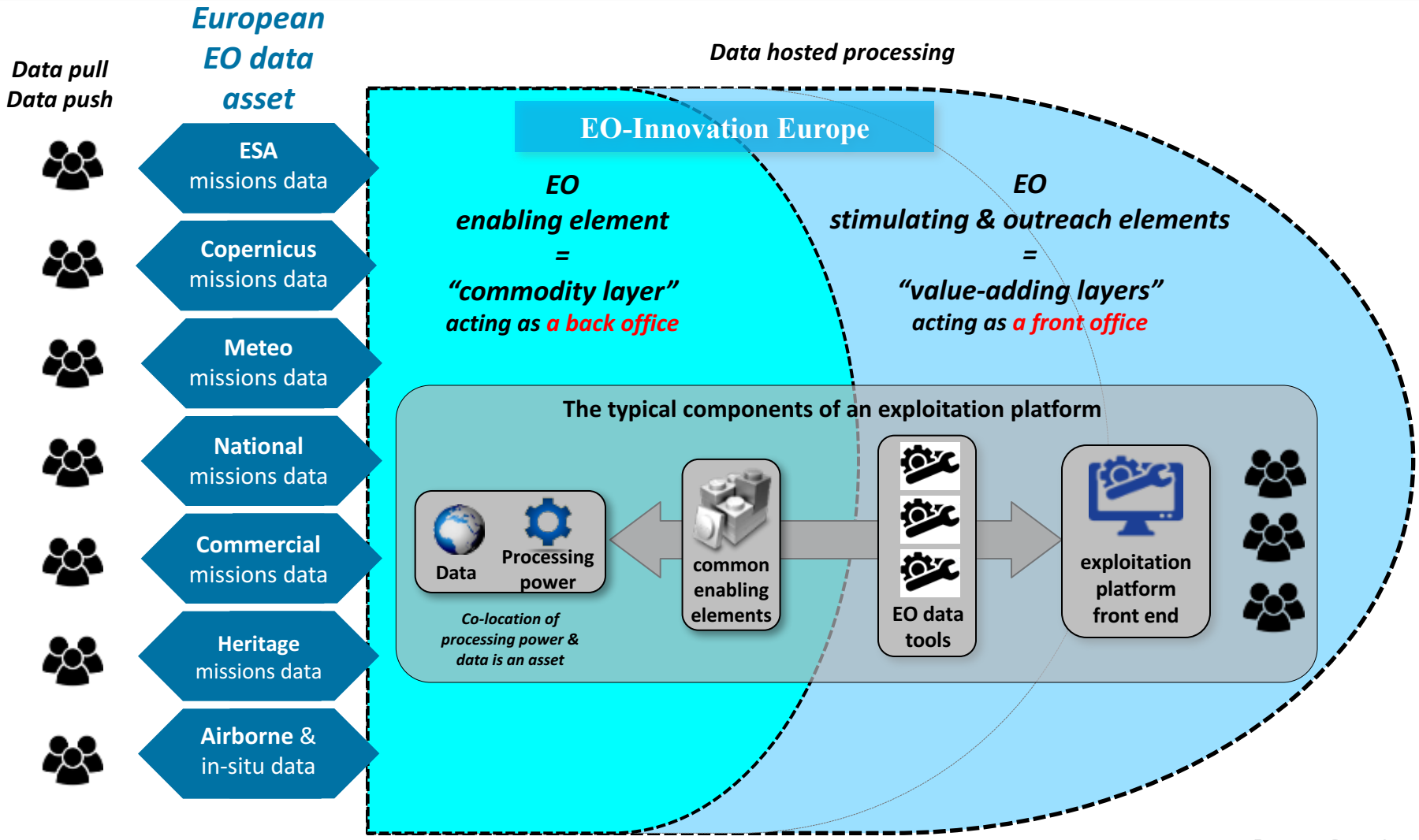
High Bandwidth Network

Data

Processing power

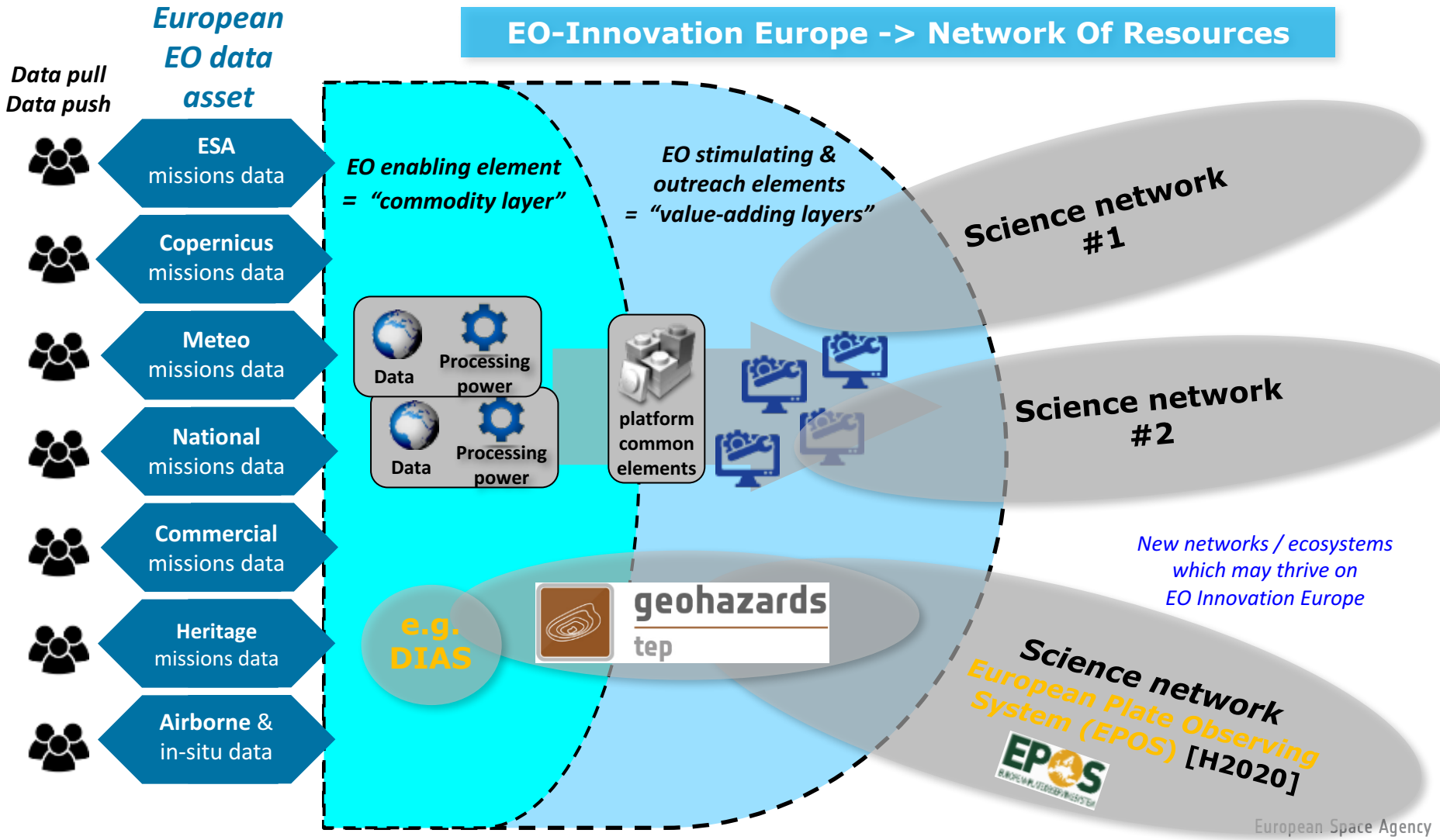
EO Innovation Europe

→ *the components of an exploitation platform*



Network of Resources

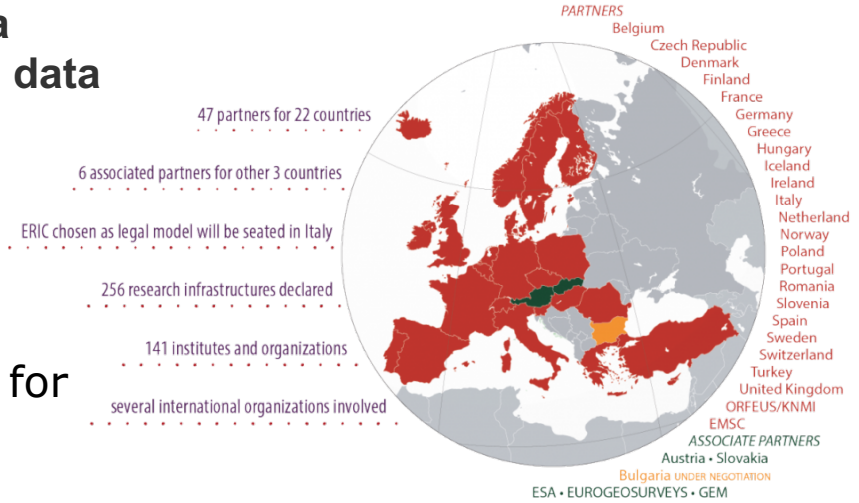
→ *link with large science networks and ecosystems*



Contribution from ESA to EPOS:

EPOS, the European Plate Observing System, is a long-term plan to facilitate integrated use of data, data products, and facilities from distributed research infrastructures for solid Earth science in Europe.

ESA is an associated partner *of EPOS IP,* contributing in-kind with EO data processing expertise and the **GEP platform**, in exchange for access to the EPOS in-situ data network.



- EPOS Implementation: **the GEP will be available to EPOS IP users** and provide the **interface for the Satellite Data Thematic Core Services** towards the EPOS central hub.

- EPOS Operations: in return, during EPOS operations (from January 2020), **GEP users will have access to any other data available within EPOS IP** and **EPOS ERIC will purchase GEP services from the GEP owner for EPOS users** (estimated initial budget allocation, 100k/year). *ESA intends to be an* ***associated partner*** *(in preparation)* within the Satellite Data TCS governance scheme.

SERVICES AVAILABLE

Supply chains integrated

Deployment of processing services to GEP Early Adopters (1/3)

2015

Conventional InSAR

Advanced InSAR

Optical

- **S-1 DIAPASON Interferogram (TRE-Altamira)**
- **S-1 InSAR Browse 200m (DLR)**
- **S-1 SBAS on GPOD (CNR IREA)** *not on GEP*

Deployment of processing services to GEP Early Adopters (2/3)

2016

Conventional InSAR

- S-1 DIAPASON Deformations (CNES, TRE-Altamira)
- S-1 SNAP Deformations (RSS)
- S-1 Change Monitoring 50m (DLR)
- S-1 InSAR Browse 200m (DLR)

Advanced InSAR

- S-1 SBAS on-demand service (CNR) IREA)
- S-1 SBAS Surveillance (CNR IREA)

Optical

- L-8/S-2/SPOT/Pléiades Landslide Deformations (UNISTRA)
- S-2/SPOT/Pléiades DSM Generation (CNRS-EOST)
- S-2 BoA Reflectance Correction (Telespazio VEGA)
- L-8 Surface Temperature Map (INGV)
- S-2 High Temperatures Detection Map (NOVELTIS)
- S-2 Vigor Map (NOVELTIS)

Deployment of processing services to GEP Early Adopters (3/3)

(list not exhaustive)

2017

Conventional InSAR

- S-1 DIAPASON Deformations (CNES, TRE-Altamira)
- S-1 SNAP Deformations (RSS)
- **S-1 InSAR Browse 100m, 50m spacing (DLR)**
- **Idem 50m, 25m spacing (DLR)**

Advanced InSAR

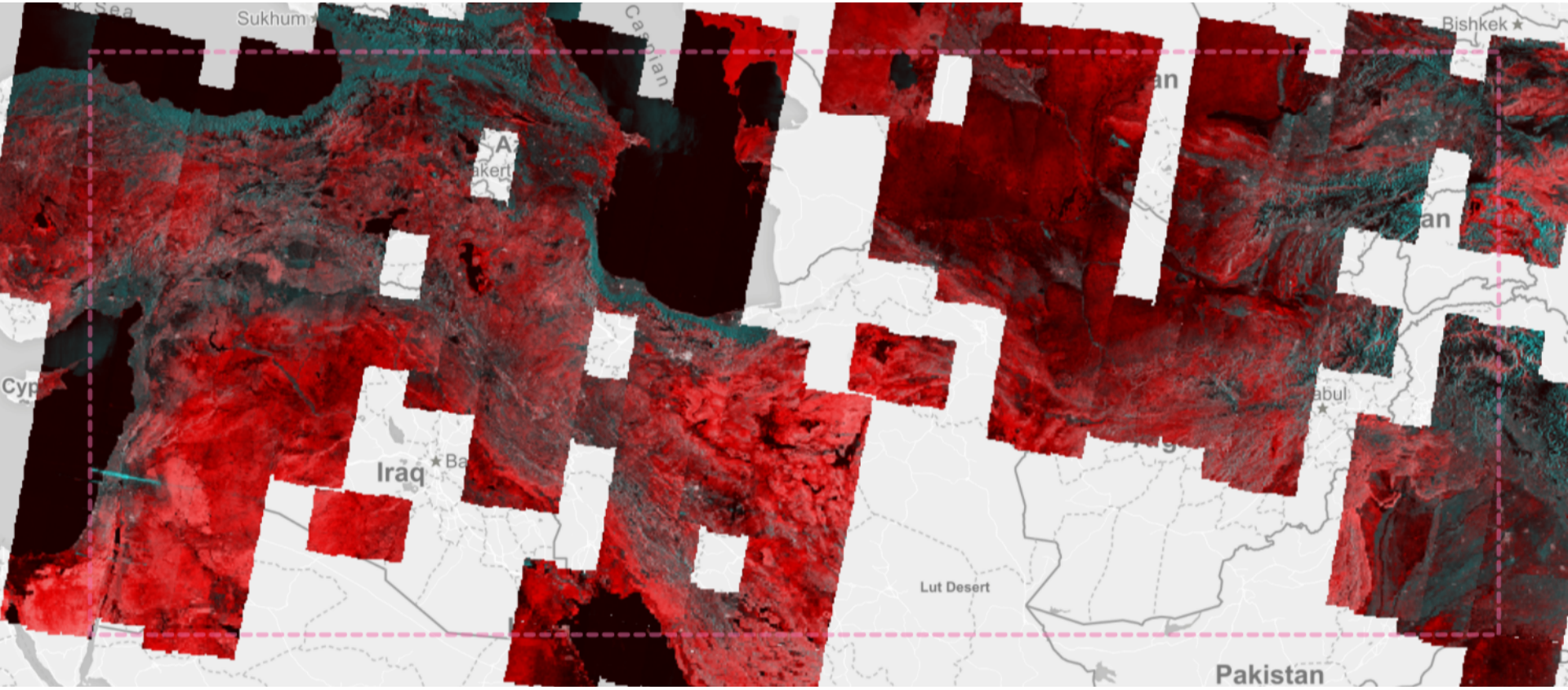
- **S-1 FASTVEL Terrain motion velocity map (TRE-Altamira)**
- **S-1 SBAS on-demand service (CNR IREA)**
- **Up & East-West terrain motion (CNR IREA)**
- **S-1 SBAS Analytical Source Model (CNR IREA)**
- **S-1 SBAS Surveillance (CNR IREA)**

Optical

- **L-8/S-2/SPOT/Pléiades Landslide** Deformations & **Inventories (CNRS-EOST)**
- S-2/SPOT/Pléiades DSM Generation (UNISTRA)
- **Landslide risk maps (CNR IRPI)**
- S-2 BoA Reflectance Correction (Telespazio VEGA)
- **Time-Series Displacement TOI (UGA)**
- S-2 High Temperature Detection Map (NOVELTIS)
- S-2 VIGOR Map (NOVELTIS)
- **L-8/S-2 Landslide Deformation (CNRS-EOST)**
- **L-8/S-3/S-2 Surface Temperature Map (INGV)**

Examples of SAR processing results:

Systematic production of S-1 InSAR pairs



Systematic processing using the InSAR Browse of DLR. Each tile has the extent of an S-1 footprint.

Providing **amplitude** (cyan) and **coherence** (red) of all consecutive S-1 pairs over the world tectonic mask.

A service developed by DLR

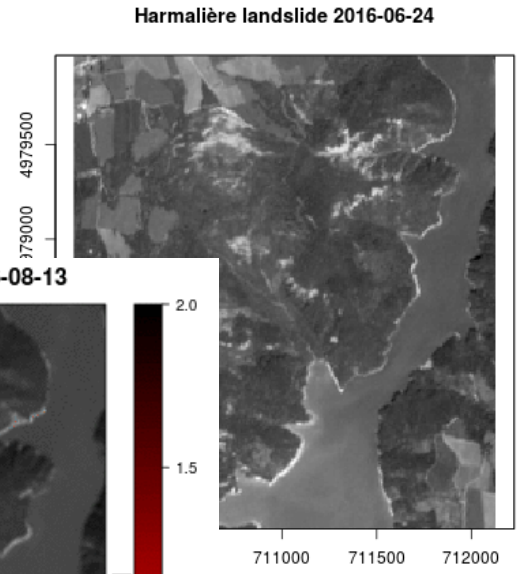
Current production rate: **150 pairs per day**. Available **freely to any user**.

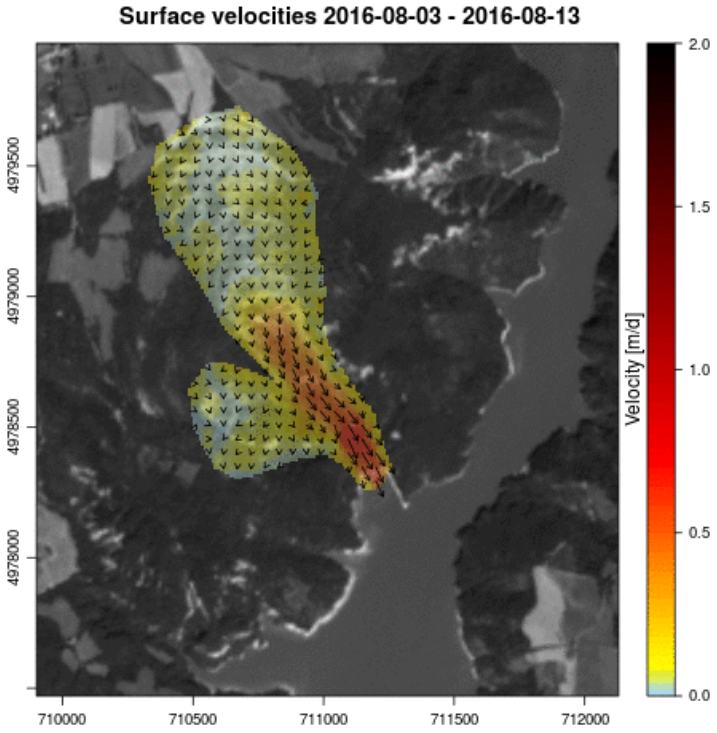
Examples of Optical processing results:

MPIC-OPT: Multiple-pairwise image correlation for the monitoring of surface deformation from optical image time-series.

The processing technique used image correlation techniques to generate stacks of partially redundant horizontal displacement fields and to compute multi-temporal indicators for a robust quantification of surface displacement.

S-2 image tile of Harmalière landslide (French Alps)



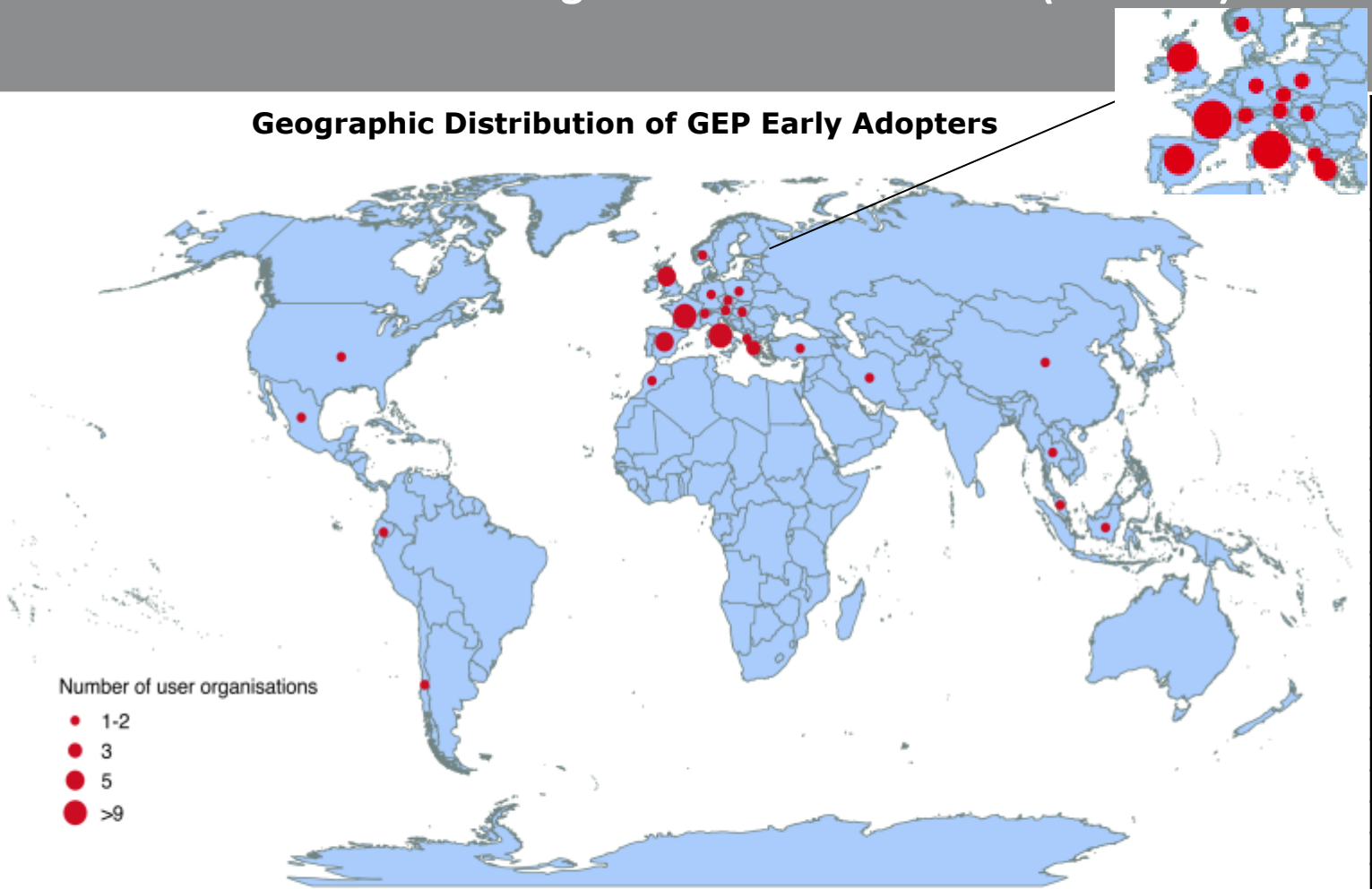


Results: surface velocities

A service developed by CNRS / EOST (Strasbourg)

The User Base

October 2017: 54 user organisations on-boarded (61 users):



Country	Number of User organisations
FR	11
IT	9
ES	5
UK	5
GR	3
DE	2
TR	2
AT	1
CH	1
CL	1
CN	1
CZ	1
EC	1
HU	1
ID	1
IR	1
MA	1
ML	1
MX	1
NO	1
PL	1
TH	1
US	1
Total	**54**

That is 21 users from the GEP Consortium + 40 users from the community via the **early adopters programme** in **23 countries**

Mainly **European users,** but also **12 users from the rest of the world: Asia** (Turkey, Thailand, Indonesia, China, Malaysia & Iran), **Africa** (Morocco), **South America** (Ecuador, Mexico and Chile) and **North America** (USA).

Examples of *Early Adopters and study areas*

User organisation	Areas
Ecole Normale Supérieure de Paris (France)	Etna, Italy and Corinth Rift, Greece
DLR IMF (Germany)	European tectonic mask
Altamira Information (Spain)	Test sites on landslides and earthquakes
ISTerre / Institut de Physique du Globe de Paris (France)	Subduction zones of Latin America, the NAFZ and Tibet.
INGV Roma (Italy)	Alto Tiberina Fault and Fogo Cape Verde
INGV Roma (Italy)	Marmara, East sector of NAFS
INGV Roma (Italy)	Haiti and West Java
ETH (Switzerland)	Large surface deformations caused by landslides in Bhutan Himalaya
NOA (Greece)	Geohazard sites in Greece incl. Corinth Rift
SATIM (Poland)	Silesia & Warsaw (Poland)
Obs. Physique du Globe de Clermont-Ferrand (France)	Piton de la Fournaise in La Réunion, Cordon del Azufre / Lastarria in Chile–Argentina
INGV Catania (Italy)	Etna & Campi Flegrei / Vesuvius
British Geological Survey (UK)	Urban areas of Great Britain
University of Leeds (UK)	Active deformation in the Alpine-Himalayan belt
ESA	Over calibration sites: Rain forest, Germany (DLR targets), Australia Milan, Chicago, Sao Paulo
ESA (Progressive Systems SLR)	Greater Cairo, South Rayan dune field, Middle Egypt province and Aswan province
CNR IREA (Italy)	Tests on Italian volcanoes and Hawaiian and Japanese volcanic and seismic areas
Universita De L' Aquila (Italy)	Abruzzo region: L' Aquila and Teramo for post-seismic ground displacements
University College of London (UK)	UK landslides
University of Rabat(Morocco)	Morocco seismic activity

Volcanoes
Earthquakes
Landslides
Subsidence

Examples of *Early Adopters and study areas* (2)

User organisation	Areas
CNR ISSIA (Italy)	Indonesia
IPGP (France)	Asia, N& S America, Indian Ocean
Universidad de Concepcion (Chile)	Southern Andean zone
Laboratoire de Dynamique Terrestre et Planétaire (France)	South America active volcanoes and tectonics
BRGM (France)	French coast subsidence
AIM CEA (France)	La Reunion
National Cartographic Center (Iran)	Iran
Instituto Geologico y Minero de Espana (Spain)	SouthEast Spain
USGS (USA)	Latin America volcanoes
CVGHM (Indonesia)	Indonesian and Mexican volcanoes
Yachay Tech (Ecuador)	
CNES (France)	Validation of tools for interferometric coherence over Syria and France
Istanbul Technical University (Turkey)	Deformation time series (volcanoes and faults)and mean velocity maps
Institute of Geodesy Cartography and Remote Sensing (Hungary)	Validated multi-technique of dynamics of anthropogenic ground deformations
Universitat Autònoma de Barcelona (Spain)	Identification of areas affected by wildfires, erosion and debris deposition/ ground motion due to debris deposition in Mallorca island
The Arctic University of Norway (Norway)	Analysis of deformation rates in complex landslides in Austra and Norway

Volcanoes
Earthquakes
Landslides
Subsidence

- **61 users** from **54 organisations** as of October 2017
- Mainly **public organisations**, but also **5 users from private sector**
- **5** of them being **CEOS pilot users** (4 Seismic pilot users and 1 Volcano pilot)
- In total **+130 requests received** from users

Promotion and outreach activities

Outreach Activities:

Since October 2015, GEP consortium partners have participated to several **major events/conferences in Europe and worldwide**

- EGU, AGU, BiDS, ESA EO Open Science, ESA Living Planet, Fringe, IGARSS etc.
- 25 oral presentations, 7 posters and 11 training sessions about the GEP.
- 4 papers have been published in scientific journals

The GEP consortium will be present at **Fringe 2017** with the following oral presentations, posters and a training course as follows:

- Poster: Casu et al. - The SBAS Sentinel-1 Surveillance service for systematic generation of Earth surface displacement within the GEP: characteristics and first results
- Training: Casu et al. - GEP: Geohazards Exploitation Platform
- Oral: Manunta et al. - The Geohazards Exploitation Platform
- Oral: Manunta et al. - The Thematic Core Service Satellite Data Of The EPOS Infrastructure
- Oral: Lanari et al. - Massive, systematic and automatic generation of Sentinel-1 deformation time series via the P-SBAS DInSAR processing chain
- Oral: Brcic et al. - DLRs Sentinel-1 InSAR Browse Service on the Geohazards Exploitation Platform
- Oral: Blanco et al. - FASTVEL: a PSI GEP service for terrain motion velocity map generation
- Poster: Roger et al. - Comparison and analysis of GEP-DIAPASON, SNAP and GAMMA Sentinel interferograms of Etna volcano

Capacity building:

- **Training courses for InSAR processing**
  - Training course: SBAS-DInSAR web tool for Earth surface deformation analysis (CNR-IREA), 2015 AGU Fall meeting http://www.irea.cnr.it/en/index.php?option=com_k2&view=item&id=575:training-course-on-the-sbas-dinsar-web-tool-for-earth-surface-deformation-analysis
  - 1-day workshop : Use of the SBAS-DInSAR on the GEP: 50 participants from different earth science groups and Swiss universities and 128 web connections (CNR-IREA and ETH Zürich), 25 January 2017 at ETH Zürich http://www.video.ethz.ch/events/2017/esa.html
  - Short course: Satellite optical processing methods (EOST/University of Strasbourg and CNRS), EGU on 23-28 April 2017 http://meetingorganizer.copernicus.org/EGU2017/session/25733
  - "SAR for Geoscientists" pilot course proposal submitted: intended for Master students, dedicated to train students to exploit SAR imagery in different geoscience applications using the GEP (ETH Zürich)
  - Researcher from Bhutan to be hosted at ETHZ to learn the use of remote sensing for landslide hazard analysis: the idea is to train Bhutanese researchers by exploiting the G-TEP tools (ETH Zürich under ESA contract for an Alcantara initiative)
- **Tools developed** in the context of the CEOS Seismic Hazards pilot used during InSAR training courses with international participation
- Regular **dialogue between EO experts and geoscience centers aiming to provide consensus results to local decision makers** where there is limited capacity to interpret EO results (activity to continue in a follow-on activity).

Evolution of the GEP

The Geohazards Lab (1):

Based on **lessons learnt from the Seismic Hazards pilot** activity some challenges have been identified:

- ✓ many users aren't aware or cannot afford EO based solutions
- ✓ EO techniques need to be adopted by users (standards, norms)
- ✓ some new EO missions' data are large in volume
- ✓ some EO applications require complex or intensive processing
- ✓ some EO applications require to maintain, reprocess and compare EO based VA products
- ✓ the EO data and derived VA products are costly to generate for the objectives of the community (e.g. with regional/global coverage)

- ✓ As a contribution from ESA to the CEOS WG Disasters (seismic, volcano and landslides) the Geohazards Exploitation Platform has provided an EO processing and an e-collaboration environment. It has demonstrated benefits:
- ✓ support expert users from CEOS and the GSNL with hosted processing
- ✓ support users who aren't processing experts (black boxes)
- ✓ help users in regions with limited bandwidth (EO results versus large EO data files)
- ✓ optimise impact over time with the persistency of results (on-line publication of results)

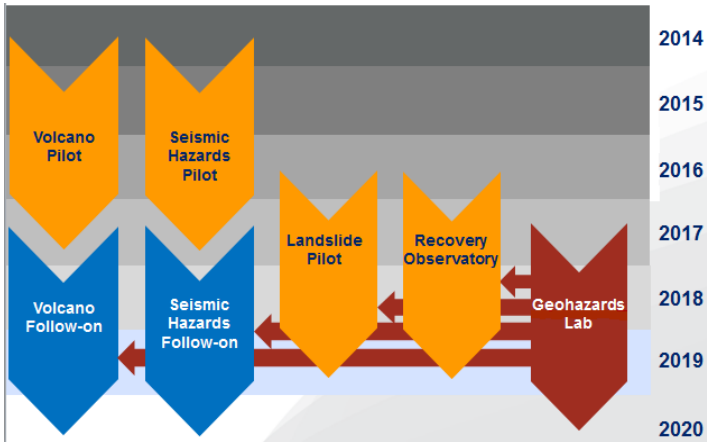
These concrete achievements from precursor platform activities are the basis for **a broader joint approach with several space agencies**.

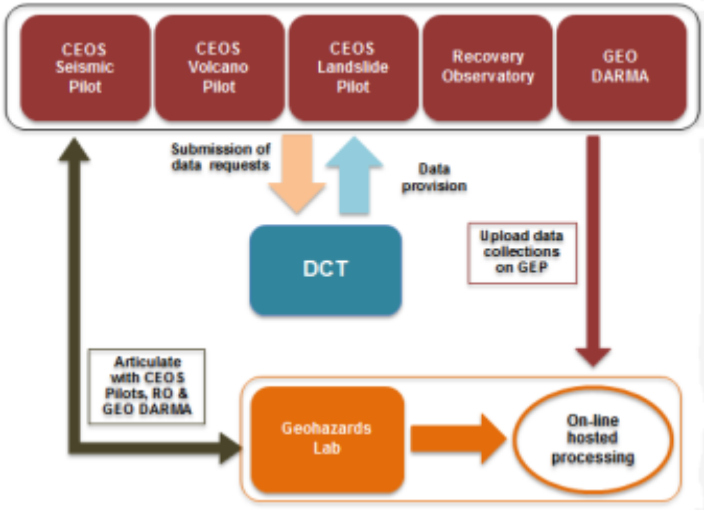
The **Geohazards Lab** is a new initiative to help the user community augment the impact of the CEOS WG Disaster activities. It is focused on geohazards (seismlic, volcano, landslides) and is intended to maximise how User needs are met with hosted processing and e-collaboration by:

- ✓ addressing the complexity and timeliness of massive volume processing
- ✓ finding more cost effective approaches to achieve greater geographic coverage
- ✓ raising awareness and share results with geoscience centers and end users
- ✓ supporting capacity development activities with on-line solutions
- ✓ work on standards and support consensus results generation

The Geohazards Lab (2):

- **A new initiative** under the CEOS WG Disasters
- ✓ Proposition **approved** at CEOS SIT in April 2017,
- ✓ Implementation Plan submitted to the **CEOS Plenary** (Oct'17).
- Aims to address priorities of the Sendai Framework for Disaster Risk Reduction 2015-2030 using satellite EO
- Main goal: *provide an EO processing & e-collaboration environment to exploit EO data to assess geohazards and their impact*
- Focus on platform functions (not thematic use). Has concrete goals:
  - achieve awareness/acceptance of EO with users
  - enable EO applications with massive volume and/or intensive processing,
  - increase access to users in regions where it is difficult to download large EO data products while the results of Cloud based processing generally are much smaller files
  - ensure the persistency of results & allow share/transform processing chains
  - reduce cost of EO exploitation via the mutualization of resources
- Support and complement **CEOS WG Disasters activities** (on-going pilots, follow-on activities and the RO), the GSNL and GEODARMA
- While CEOS activities focus on providing data to users, the Geohazards Lab will complement these activities **providing EO processing services**.
- **Contributions** and interest from CEOS agencies and partners:
  - Space agencies: **ESA, DLR, ASI and CNES**
  - Users: CNRS-EOST, IPGP, COMET, ISTerre/IRD, INGV, CNR-IREA





New thematic activities under the CEOS WG Disaster:

- **The CEOS Seismic Hazards Pilot has been a well-set** and **successful example** that helped the geohazards community to analyse the impact of the events and better support the decision making process.
- A new activity is proposed, the **Seismic Hazards Demonstrator.**
- The first analysis of a follow-on activity identifies objectives from the Santorini report http://esamultimedia.esa.int/docs/EarthObservation/Geohazards/esa-geo-hzrd-2012.pdf and has also new specific objectives :

Not on an emergency basis

1. **Pursue global strain rate mapping** (feasibility demonstrated during pilot) that is a long process
2. **Expand active fault mapping** from regional to global coverage primarily with **VHRO for fault reconnaissance mapping**
3. **Pursue support to GSNL**
4. **Develop a collaborative framework with geoscience centre**s to achieve adoption of technology by decision makers, **establish a consensus methodology** for product generation and reach decision makers

On an emergency basis

5. **Exploit EO data** to derive advanced tectonic products for **earthquake response**: expand to target of **at least 10-12 EQ per year**
6. **Articulate with EO disaster response capabilities** e.g. the Charter to make sure users are aware of and use it.

- Pilot leads have started gathering **contributions from space agencies** (already **ESA, ASI, DLR and CNES**) and other **partners**.
- The pilot intends to **use the Geohazards Lab** for data dissemination and as a processing and e-collaboration environment, especially on an emergency basis.

Same approach followed by **the Volcano and (later) Landslide thematic pilots (Pilot → Demonstrator)**.

The evolution of the GEP:

The GEP is ESA's contribution to the **Geohazard Lab**,

The GEP will be further used in the context of **thematic Demonstrators in the CEOS WG Disasters**,

Through the *GEP Early Adopter programme* ESA will augment the platform capability to enhance its **performance and fitness for purpose**,

ESA is willing to liaise with the Geohazard community and gather input about:

- The utility of hosted processing using SAR & Optical data
- What doesn't work and what is missing?
- New actions to be initiated to better support the community about satellite EO

Philosophy: the baseline is *not to finance users,* but **sponsor access to system for users of geohazard community** (i.e. extend the Early Adopter programme).

Main priorities: enhance **platform functions & platform services** (in principle the effort of a user to integrate a new chain in the GEP should be borne by the user and the GEP project allocates resources for integration on the platform operator's side)

Ideas for additional actions to be taken on board in Q4 2017:

- Organise scientific animation with thematic experts looking at **horizontal issues across platform services** (e.g. standards & norms about terrain motion mapping, define consensus methods about hazard mapping for earthquake response, etc.); ideas exchanged with INGV (GSNL Lead) and the BRGM with a new initiative: « **the Geohazards Office** ».

- Pursue support to the 60 users already on-board there is a risk of loosing users when the contract ends as Terradue won't able to support them even with the basic scenario 1. Extending the Early Adopter programme would help achieve more impact and gather more feedback. Accommodate current demand that exceeds the Early Adopter programme capacity: 116 user requests with a max capacity of 60 users. Pre-ops planned for 6 months. Needed to expand to 18 months.

➢ **SUPPORT USER ACCESS FOR MORE USERS (reach 100) & EXTEND PRE-OPS (Apr. 2019).**

- Integration of the GEP on Copernicus DIAS as Third Party Service for front-office operations and take advantage of GEP to have a Pilot about the performance of DIAS with a complete VA Layer.

➢ **SET UP A PILOT ABOUT THE PERFORMANCE OF DIAS BASED ON-LINE VA SERVICES.**

- Federation with DLR (e.g. exploiting TerraSAR-X based InSAR using CODE.DE) to support the expansion of GEP through the Geohazards Lab approved by CEOS. Develop innovative solutions with the InSAR services of DLR (correlation based earthquake response products, corrections for atmospheric & geo-dynamical effects etc.)

➢ **FEDERATE WITH DLR FOR TerraSAR BASED InSAR**

Other ideas:

- Support integration with tectonics community e.g. federating resources from **scientific networks** players e.g. FORMATER (FR), COMET (UK), the EPOS initiative and integrating dynamic in-situ databases (e.g. GPS). Support the expansion of GEP with CNES and Formater through the Geohazards Lab.

- Augment GEP capability to support Back Analysis (automated workflow for multi-event historical analysis using e.g. EPOSAR): set parameters & **organise processing according to data about the thematic context** e.g. GPS measurements

- GEP & DataCube: improve the collaborative approach of the GEP with the possibility to create **on-demand data cubes** to organize information processed on GEP

- Improve GEP capability to support **complex processing** (e.g. advanced InSAR) with user defined processing workflows providing intermediate checkpoints

- Expand Active Fault Mapping with Optical data (e.g. Pléiades/SPOT): go to regional/global scale with **on line processing of VHRO data** / data renting (processing without downloading)

ESA is willing to liaise with the Geohazard community and gather ideas about the GEP evolution.

…… your input is welcome
not later than 9 November 2017

- ESA:

Philippe Bally Philippe.bally@esa.int
Theodora Papadopoulou TPapadopoulou@argans.co.uk

- The GEP developer and operator:

Fabrizio Pacini fabrizio.pacini@terradue.com

Take home messages:

The system is NOT operational and has several limitations that ESA intends to address with the formal acceptance of GEP V2 in November 2017, however:

Positive signs:

- Requests received from **many public users** from academia and mandated geoscience centres looking at DRM
- **Research networks** like EPOS and Geohazards Lab are planning to use the platform
- some **private companies** (VACs) have shown interest in the GEP service provisioning model and in establishing partnership (based on revenue sharing) for integrating and deploying their service in the platform
- some **industry users** have requested to be granted access
- GEP proposed in two ITN (Innovative Training Network) proposals submitted by organizations of the geohazards community in the context of the MSCA-ITN-2017 call
- GEP considered for "SAR for Geoscientists" pilot course proposal: intended for Master students, dedicated to train students to exploit SAR imagery in different geoscience applications (ETH Zürich)
- GEP proposed as Reference Front Office in a proposal for the C-DIAS ITT

Main advantages illustrated so far:

- addressing the complexity of **massive volume processing**
- finding more **cost effective approaches** to achieve greater geographic coverage
- **Helped raise awareness** and promote & share results with geoscience centers and end users
- supporting **capacity development** activities with on-line solutions
- work on **standardisation** and support consensus results generation

Benefits:

- **supports expert users** (e.g. geoscience centres) with hosted processing
- supports **users who aren't processing experts** (black boxes)
- helps users in **regions with limited bandwidth** (EO results versus large EO data files)
- helps achieve greater impact over time with the **persistency of results** (on-line publication of results, DOIs, etc.)

Thank you

Your input is welcome!

- ESA:

Philippe Bally Philippe.bally@esa.int
Theodora Papadopoulou TPapadopoulou@argans.co.uk

- The GEP developer and operator:

Fabrizio Pacini fabrizio.pacini@terradue.com