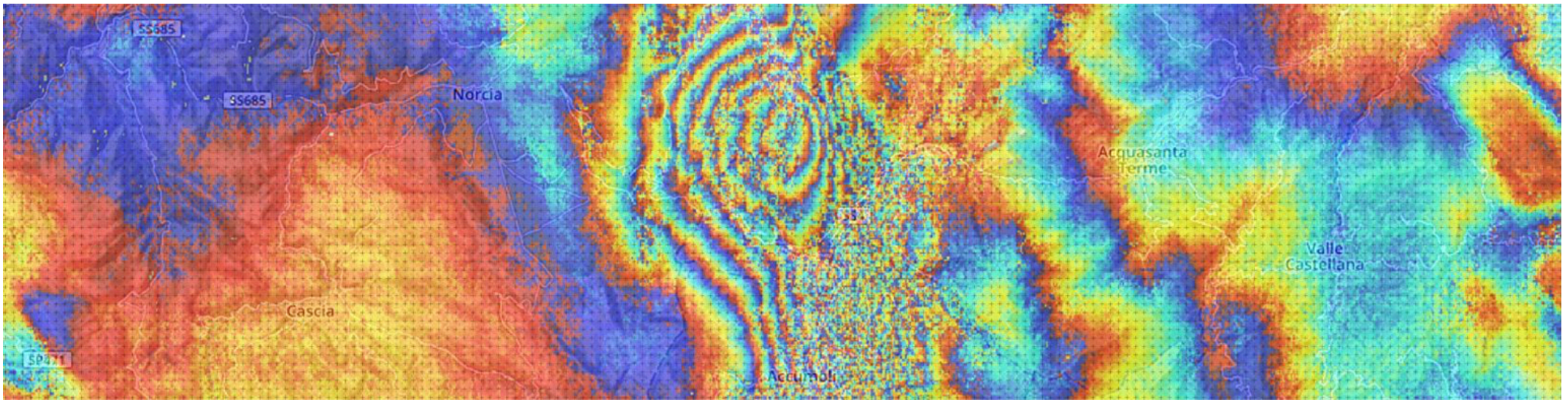
geohazards tep



The Geohazards Exploitation Platform v2:
moving Cloud Processing services into pre-operations phase

Hervé Caumont et al.
herve.caumont@terradue.com

MDIS Workshop
Besse-en-Chandesse, 19th October 2017

terradue 2.0 · TRE ALTAMIRA A CLS Group Company · ifa · DLR · UNIVERSITÉ DE STRASBOURG · ENS · INGV

Context: Thematic Exploitation Platforms

tep
thematic exploitation platform

- TEPs are 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
- TEPs are technology R&D, but still fully user driven

geohazards tep | hydrology tep | coastal tep | forestry tep

polar tep | urban tep | food security tep

- The **geohazards TEP** design started from the **International Forum on Satellite EO and Geohazards** organised by ESA and GEO in Santorini in 2012
- The **geohazards TEP** is an enhancement of the precursor platforms (G-POD, SSEP), and is designed to support the Geohazard Supersites (**GSNL**) and the Geohazards community via the **CEOS WG Disasters**

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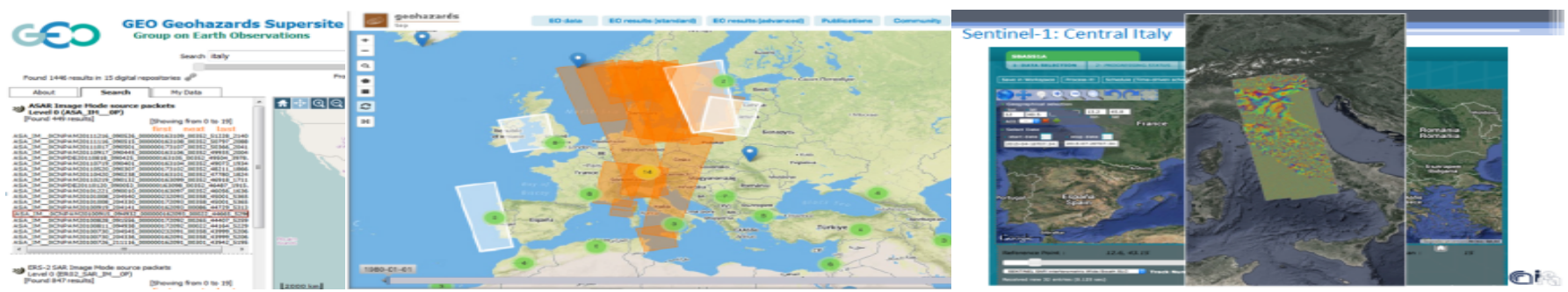
The Geohazards Exploitation Platform (GEP)

A 27+ months contract started on Nov 2015;
Consortium: **Terradue** (IT), **CNR IREA** (IT), **INGV** (IT), **DLR** (DE), **TRE ALTAMIRA** (ES), **EOST-CNRS** (F), **ENS-CNRS** (F)

- Develop an Exploitation Platform based upon **virtualization & federation of satellite EO data and methods**
- Provide innovative responses to the needs of the geohazards community

As a Platform, GEP:

➔ Provides **on-demand** processing services for specific user needs
➔ Runs **systematic** processing services to address "common information" community needs
➔ Connects to **massive compute** power on multi-tenant Cloud Computing resources, to address the challenges of monitoring tectonic areas, **globally**
➔ Connects to **full Copernicus Sentinels-1/2/3 repositories**
➔ Connects to 70+ TB of EO data (**ERS** and **ENVISAT** archive), and specific data collections from EO missions, such as JAXA's **ALOS-2**, ASI's **Cosmo-Skymed** and DLR's **TerraSAR-X**, provided under special arrangements in the framework of the CEOS WG Disaster and GSNL.



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Agenda

1. **GEP achievements so far**
   - Iterative development & Early Adopters Programme
   - GEP Usage Scenarios
2. **Next v2 evolutions: new features & impacted scenarios**
   - New data exploitation functions
   - New Cloud processing capacities
   - New community-contributed resources
3. **Pre-operations of the Platform v2**
   - Already running Services & Pilots: Provisioning Agreements (data and ICT)
   - Pilots evolutions: Operations Level Agreement, Terms & Conditions
   - Pilots users feedback
   - Integrated support for applications release: Transfer in production (& Production Center) process
4. **Sustainability**
   - Sustainable Operations concept note
   - Pre-operations 2018: six months baseline + six months extension
   - Reinforcing collaborations: EPOS, DIAS, Geohazards Lab, ...

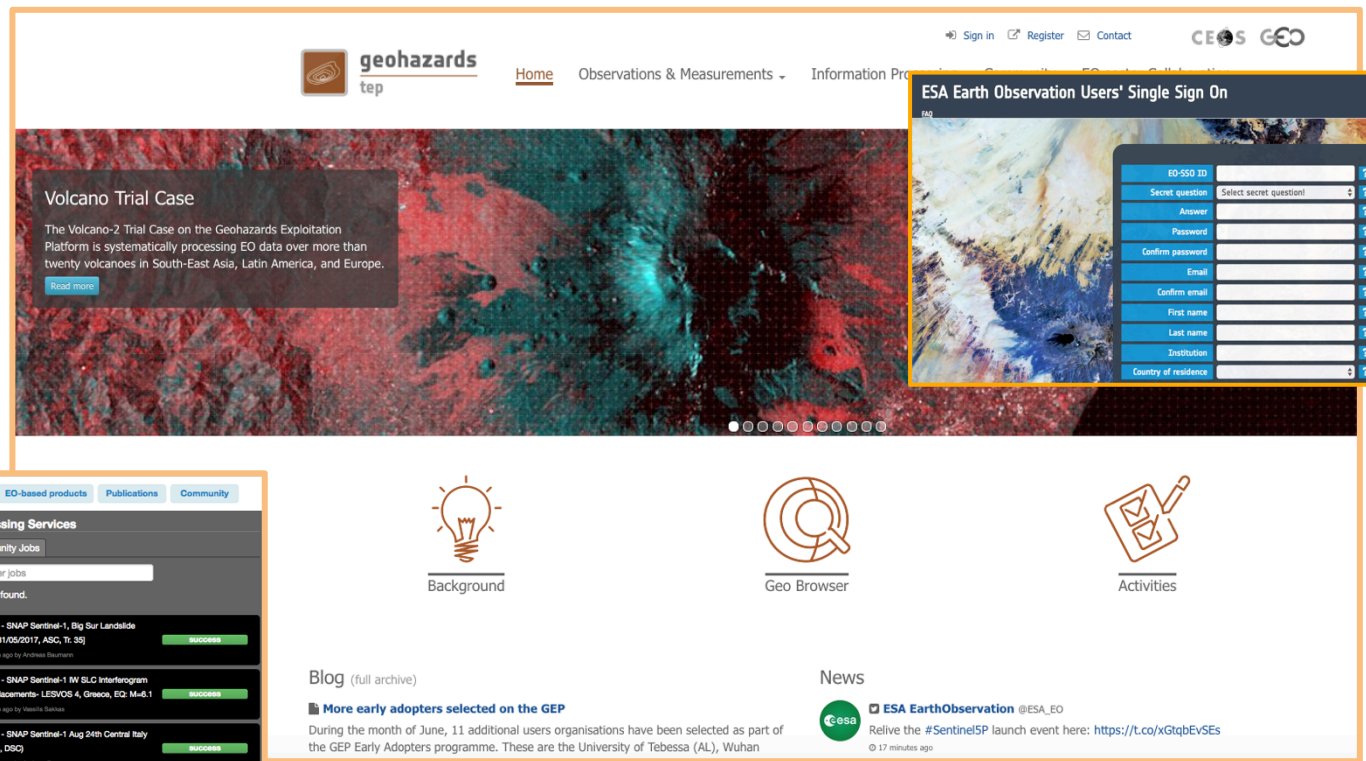
-1-
GEP achievements so far

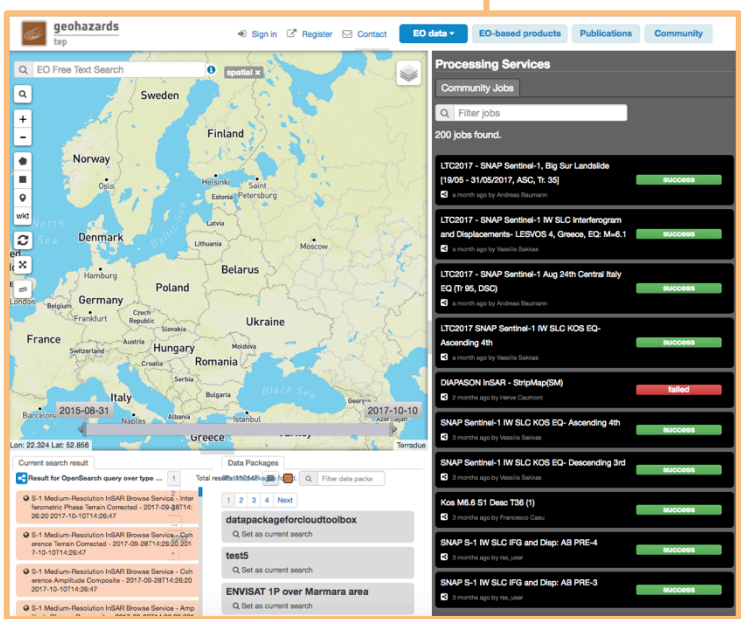
GEP in a Nutshell: Core & Partner services

Portal

ESA SSO

Geobrowser





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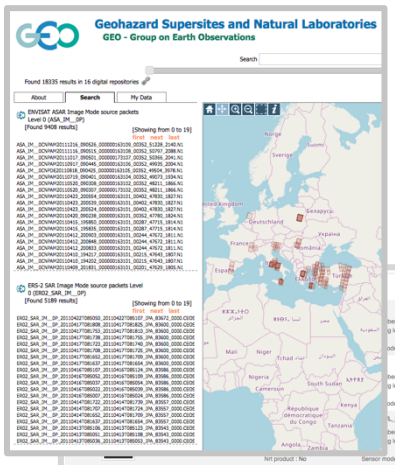
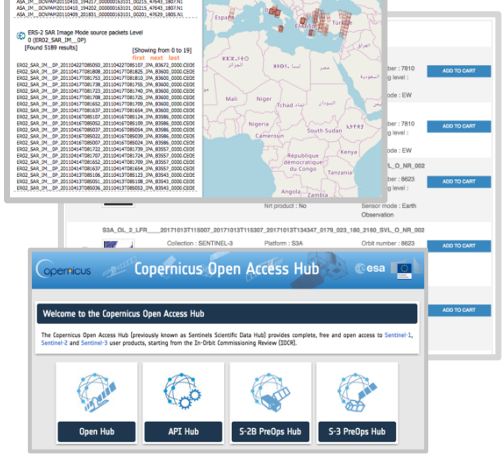
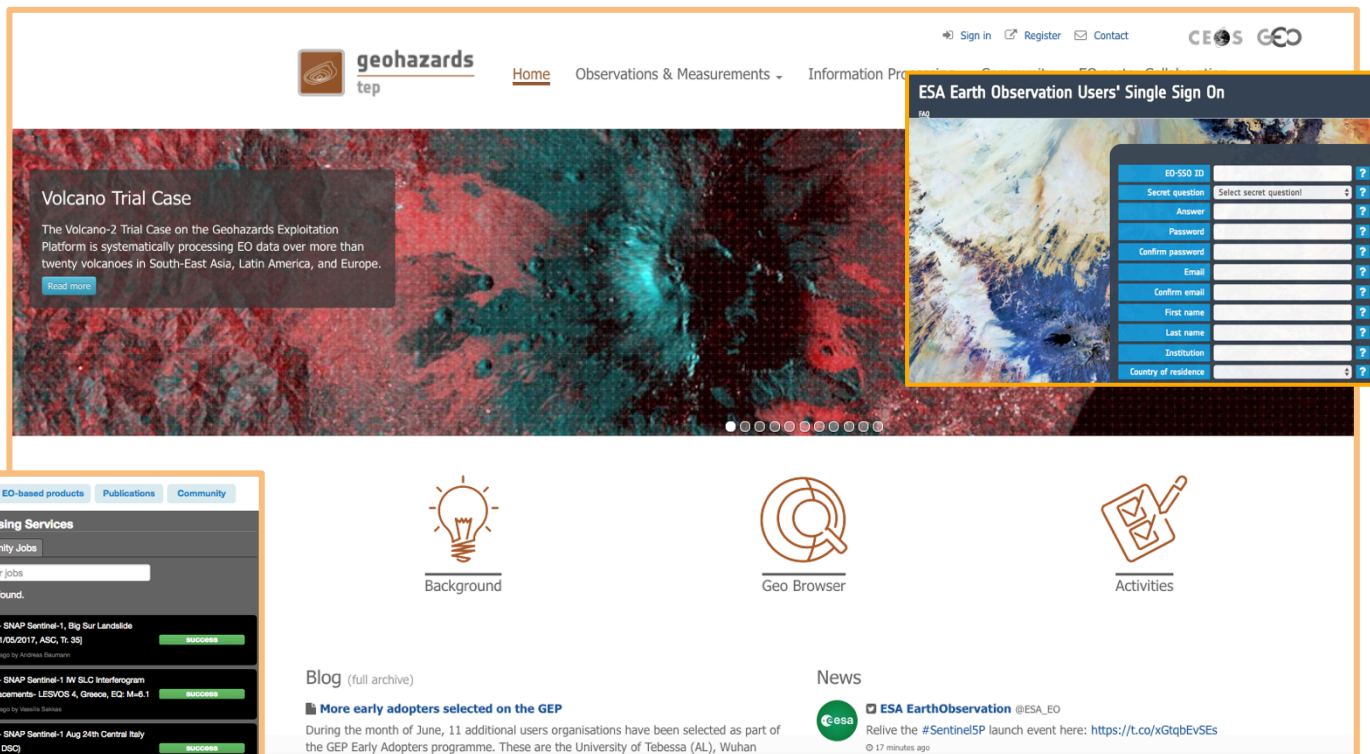
GEP in a Nutshell: Core & Partner services

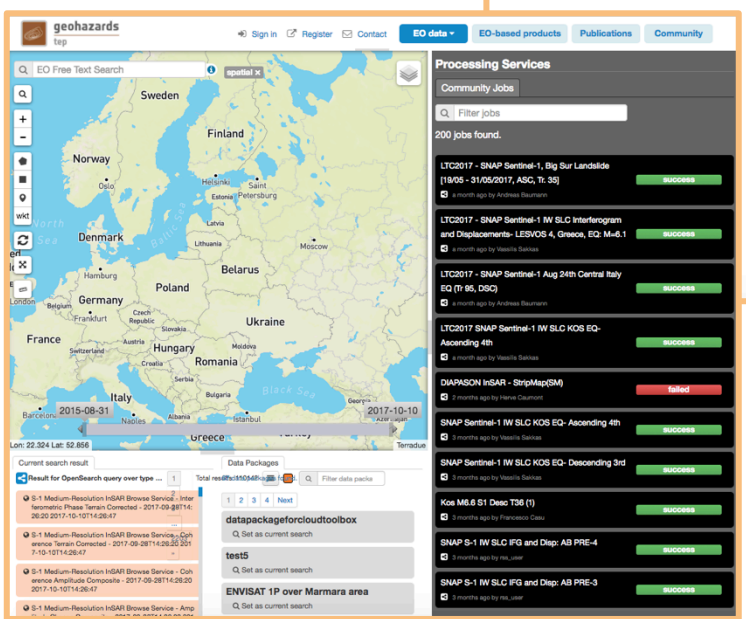
Data access integrations

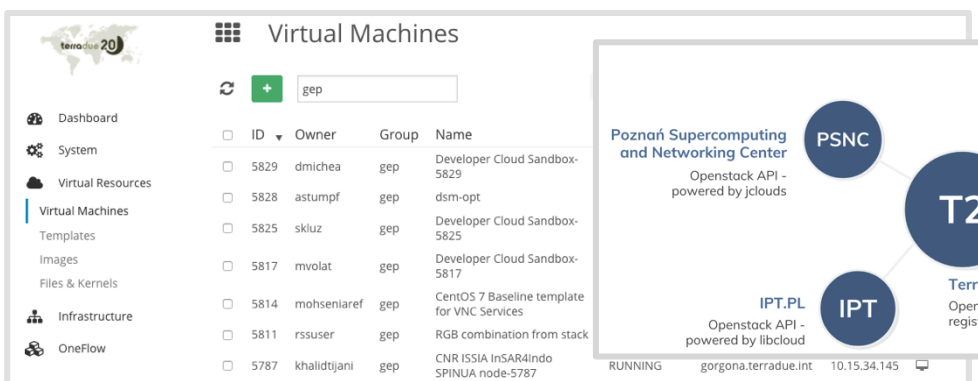
& Cloud services integrations



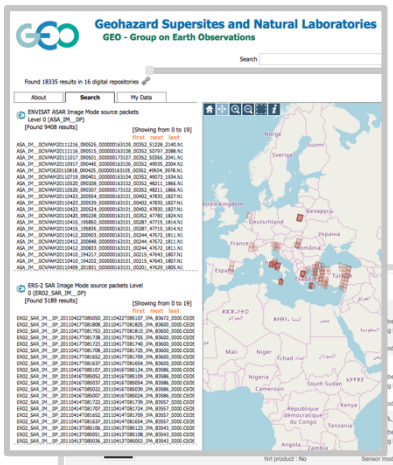


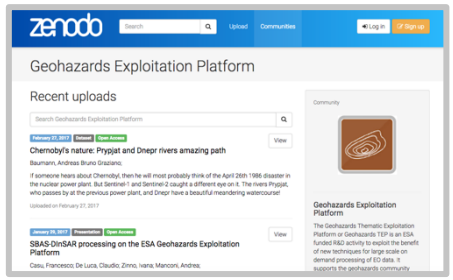


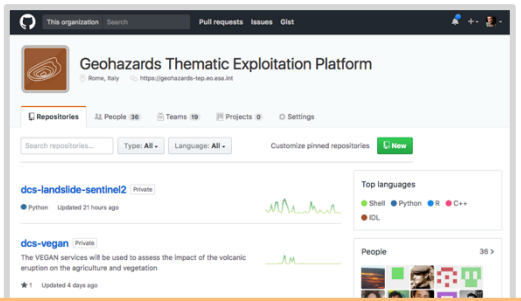


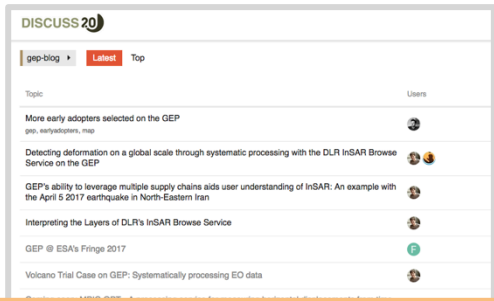


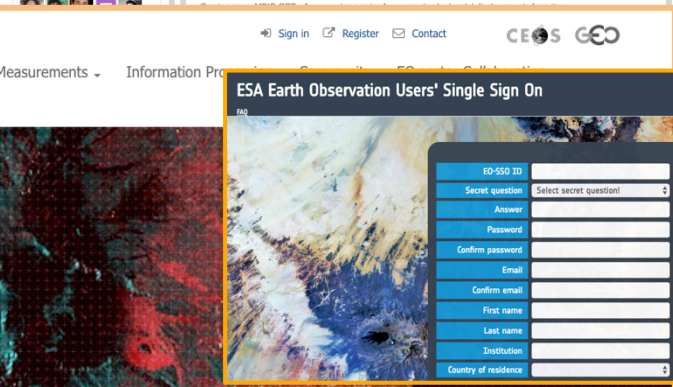
GEP in a Nutshell: Core & Partner services

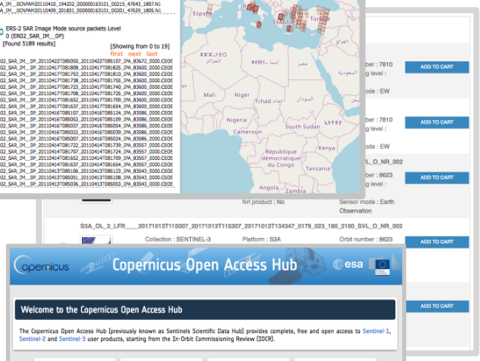


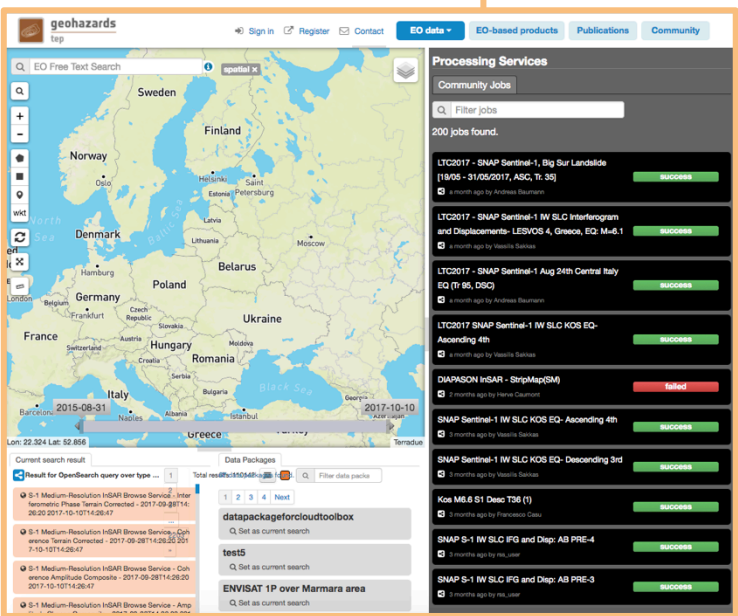













Background


Geo Browser


Activities

Blog (full archive)

More early adopters selected on the GEP

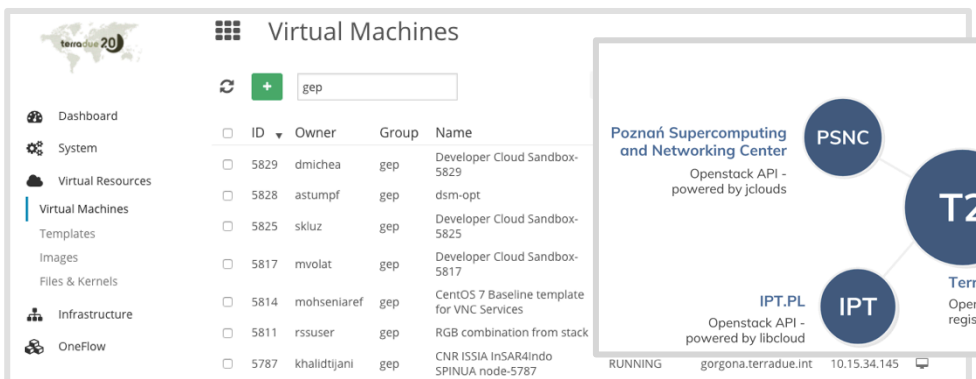
During the month of June, 11 additional users organisations have been selected as part of the GEP Early Adopters programme. These are the University of Tebessa (AL), Wuhan

News

ESA EarthObservation @ESA_EO

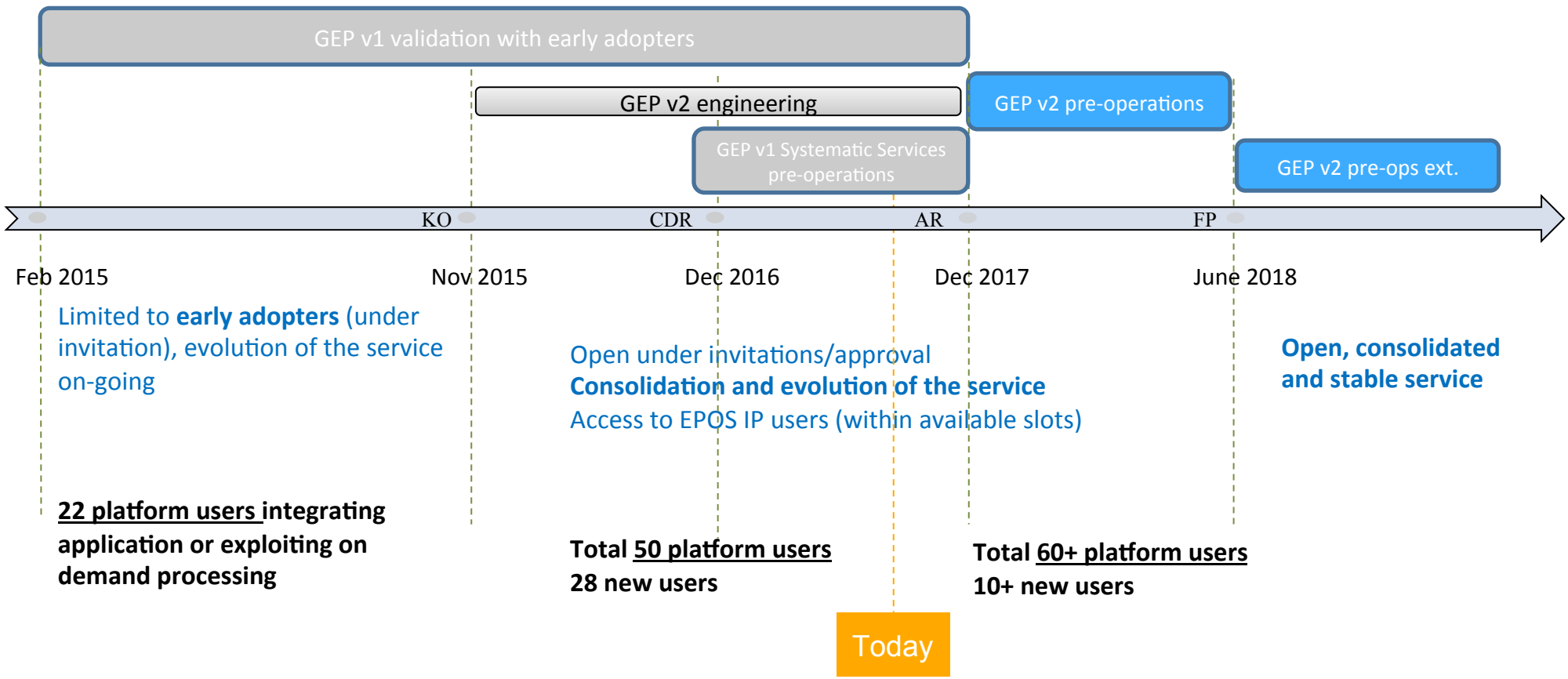
Relive the #Sentinel5P launch event here: https://t.co/xGtqbEvSEs

17 minutes ago



Roadmap

An iterative development, involving early adopters



GEP Early Adopters programme

Want to apply as early adopter of the GEP (limited slots)? geohazards-tep@esa.int

GEP Early Adopters Programme

➢ GEP user-driven activities based on User Registration Forms (= user projects)

- Create your account on the ESA SSO service
- Sign-in on GEP, and follow the guidance on your user profile page

➢ User on-boarding of:

- ESA designated users, based on the approved applications (URFs)
- GEP Pilot services users, based on the consortium partners' processing services integrated on the platform:

- **TRE Altamira** with an end-to-end InSAR service for terrain motion velocity mapping using SAR data (free and commercial products)
- **CNR-IREA** with SBAS based Sentinel-1 Surveillance service
- **DLR** with InSAR-Browse products generation
- **EOST-CNRS** with MICMAC based optical data processing for landslides
- **INGV** for optical data processing for volcanoes monitoring
- **ENS-CNRS/NOA** with the validation by experts of the platform services to serve the Corinth Rift Laboratory

- ESA Projects users, e.g. from the **Disaster Risk Reduction** GSP projects.

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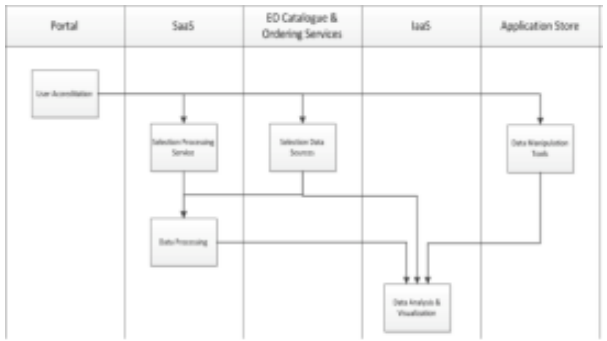
Supported Scenarios for Users

Scenario 1) **EO Data Exploitation** which allows a user to discover/select data and pre-existing processing service; **process data**; and visualize/analyse results, or select and apply data manipulation tools to the result; share his/her results

Scenario 2) **New EO Service Development** which allows a user to discover/select a data sample and software components; engineer (or upload) and validate an application (such as a processor); and **deploy an application on the platform** for use also by other users.

Scenario 3) **New EO Product Development** which allows a user to discover/select data, define data ingestion triggers on newly uploaded / deployed processor; setup and monitor the data processing tasks; and **publish results as new information layers**.



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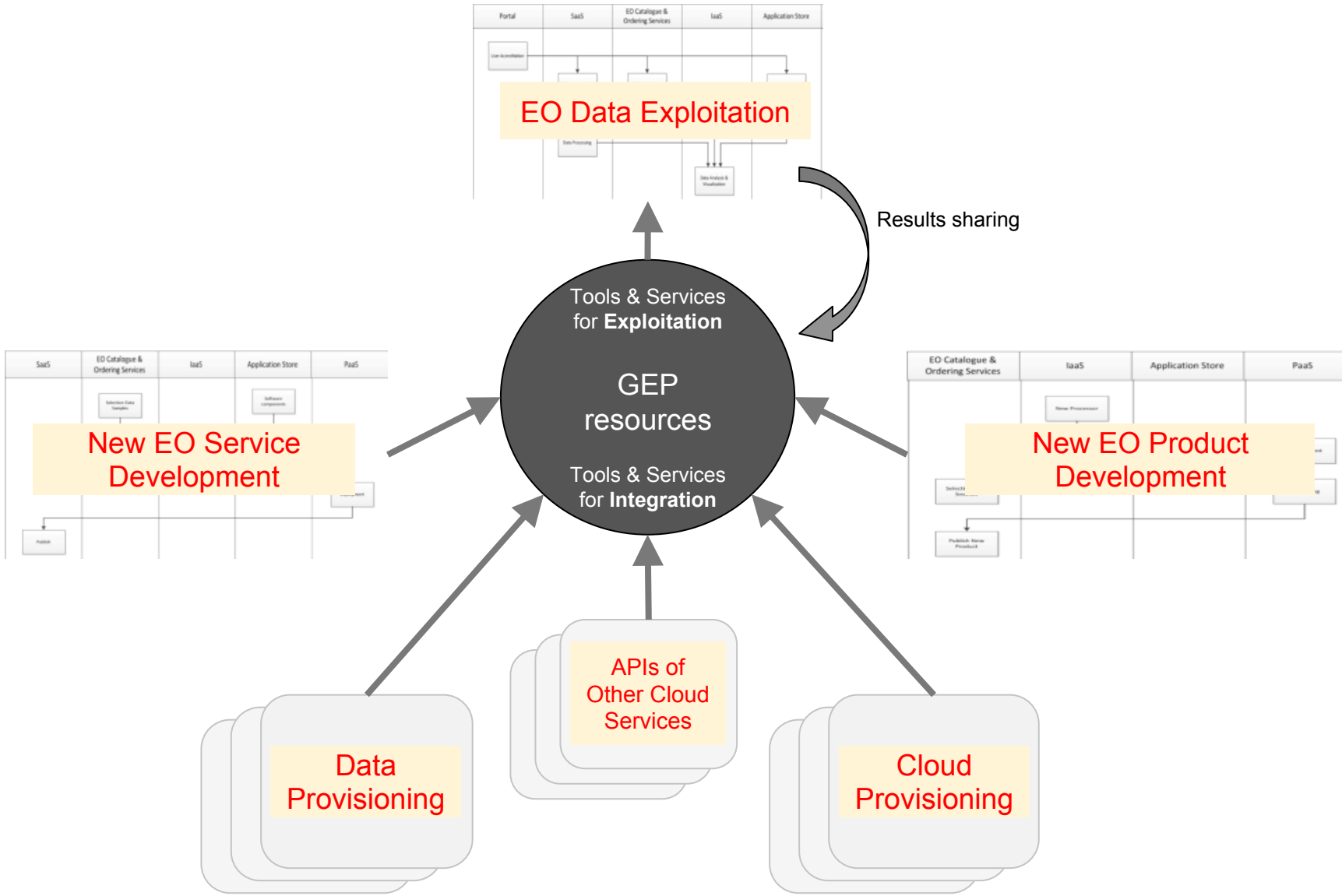
An ecosystem of GEP resources providers



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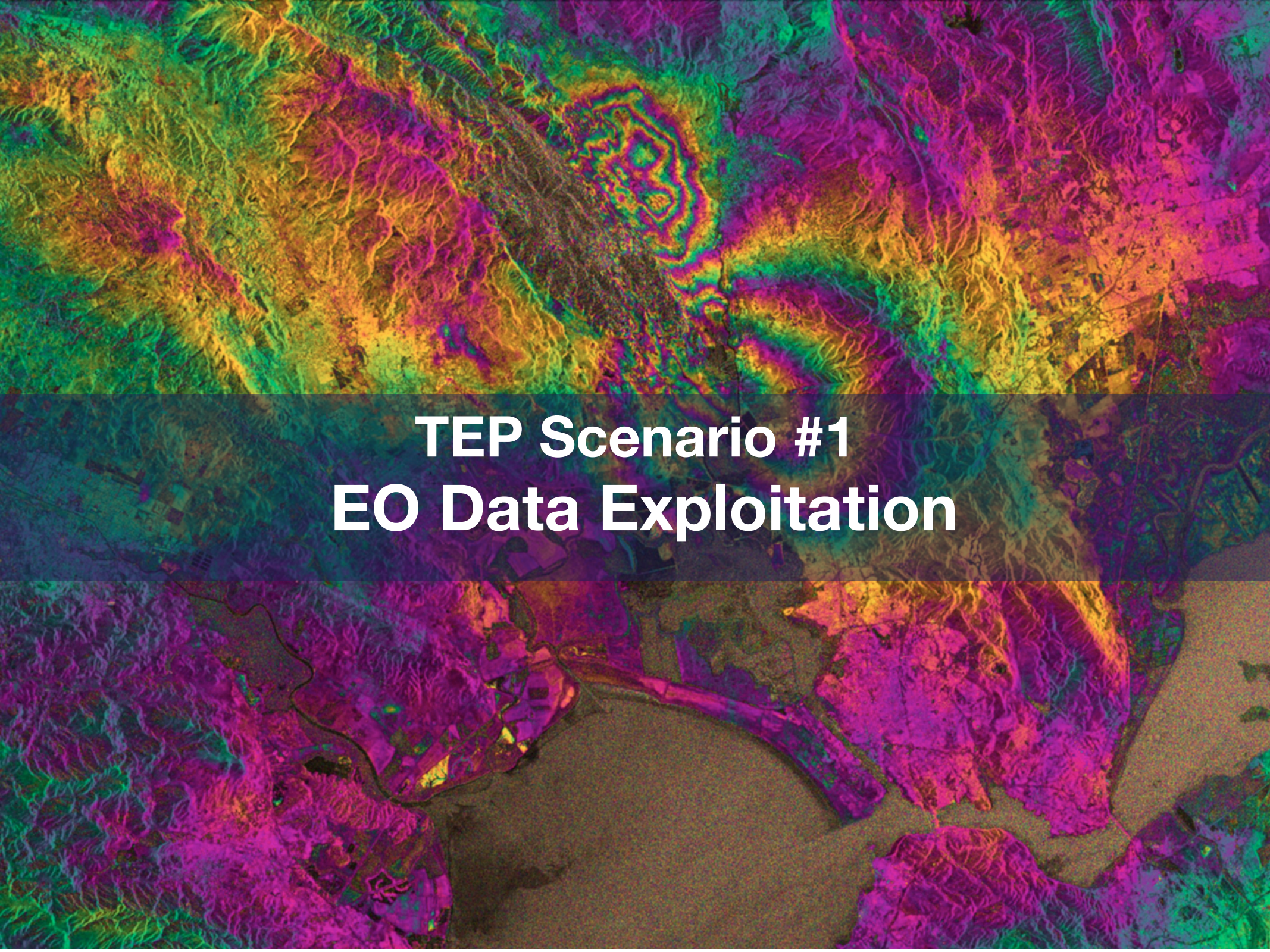
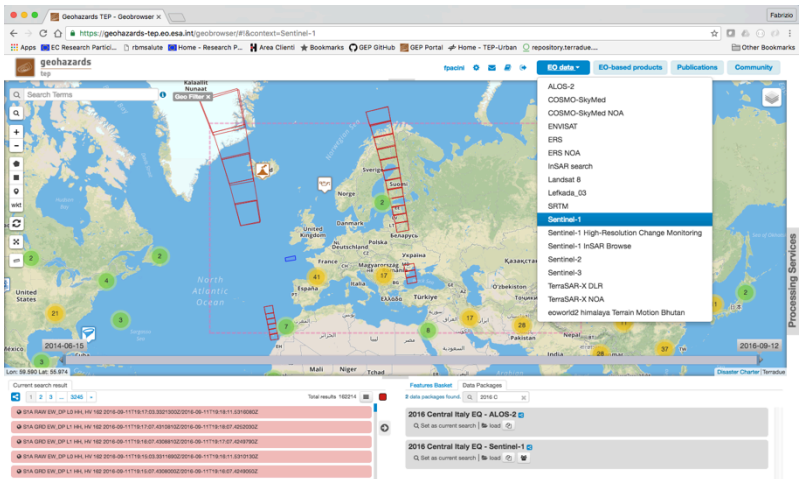
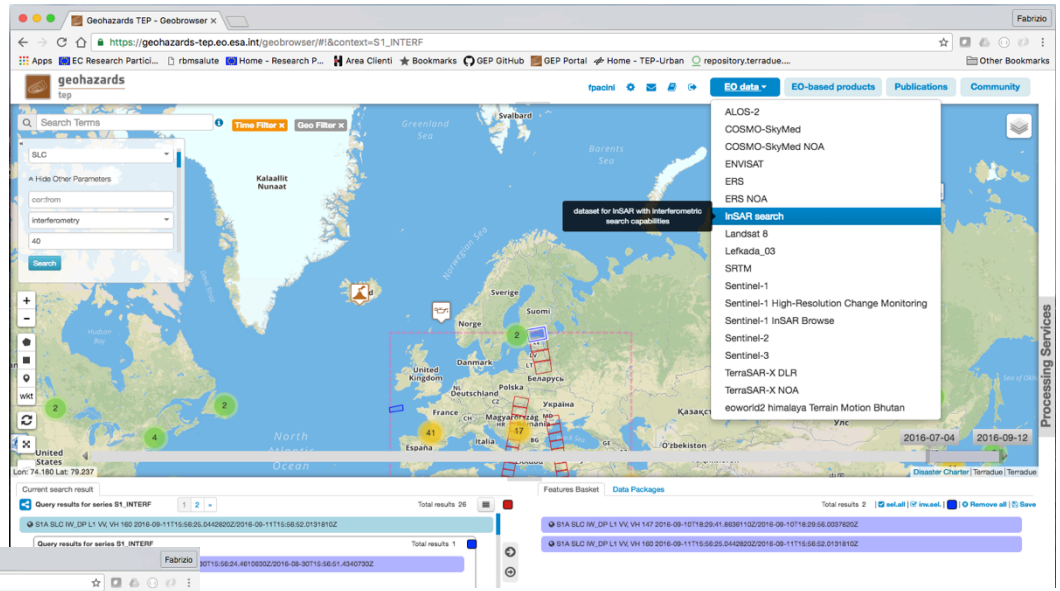


TEP Scenario #1
EO Data Exploitation

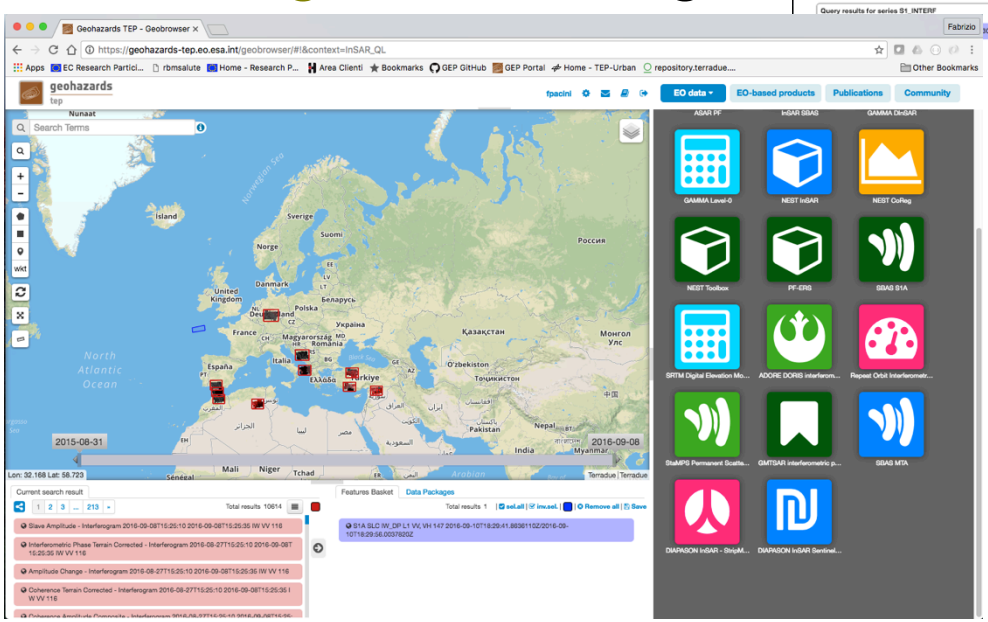
EO Data - discovery and selection



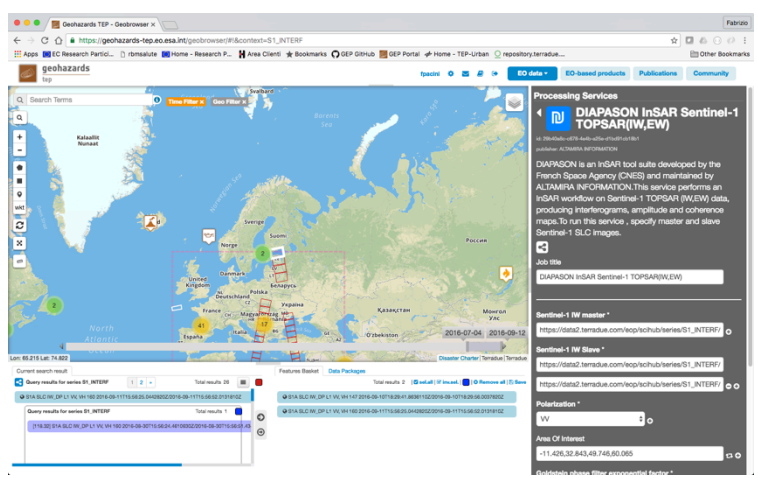
interferometric search



Processing tools - listing



inputs selection and job run



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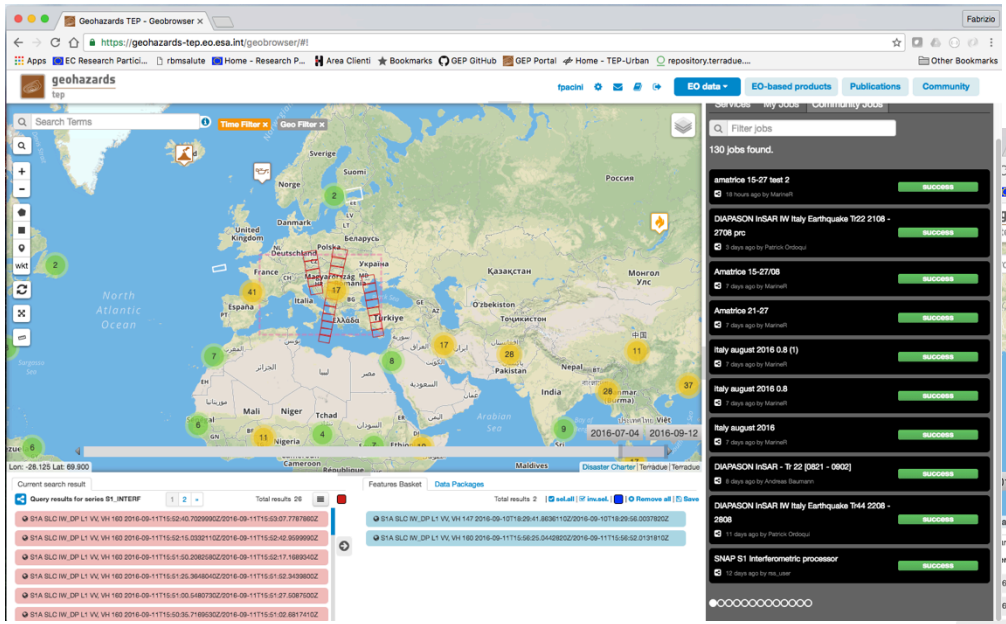
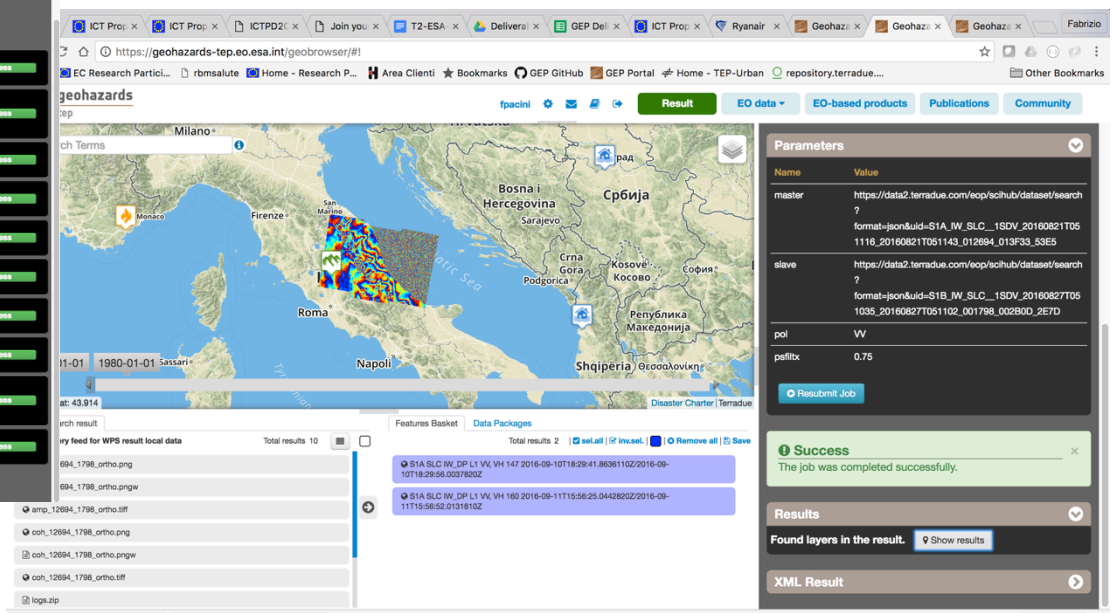
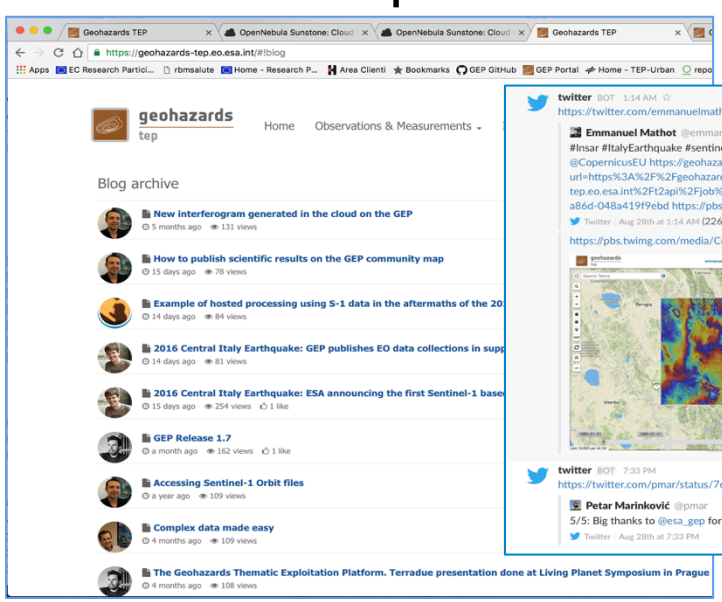
Processing tools – monitor progress

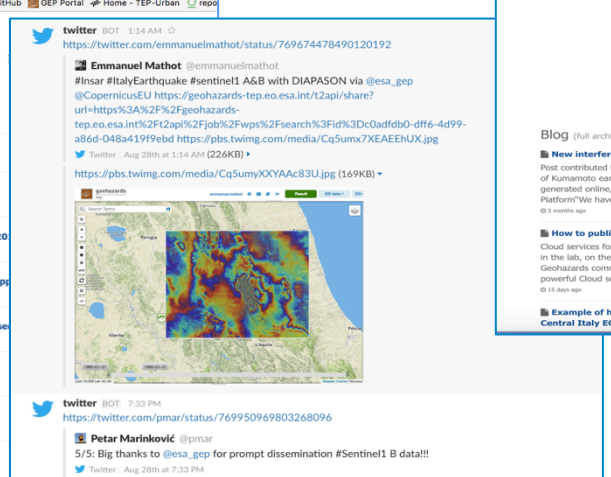


visualize results



Social Web - promote results





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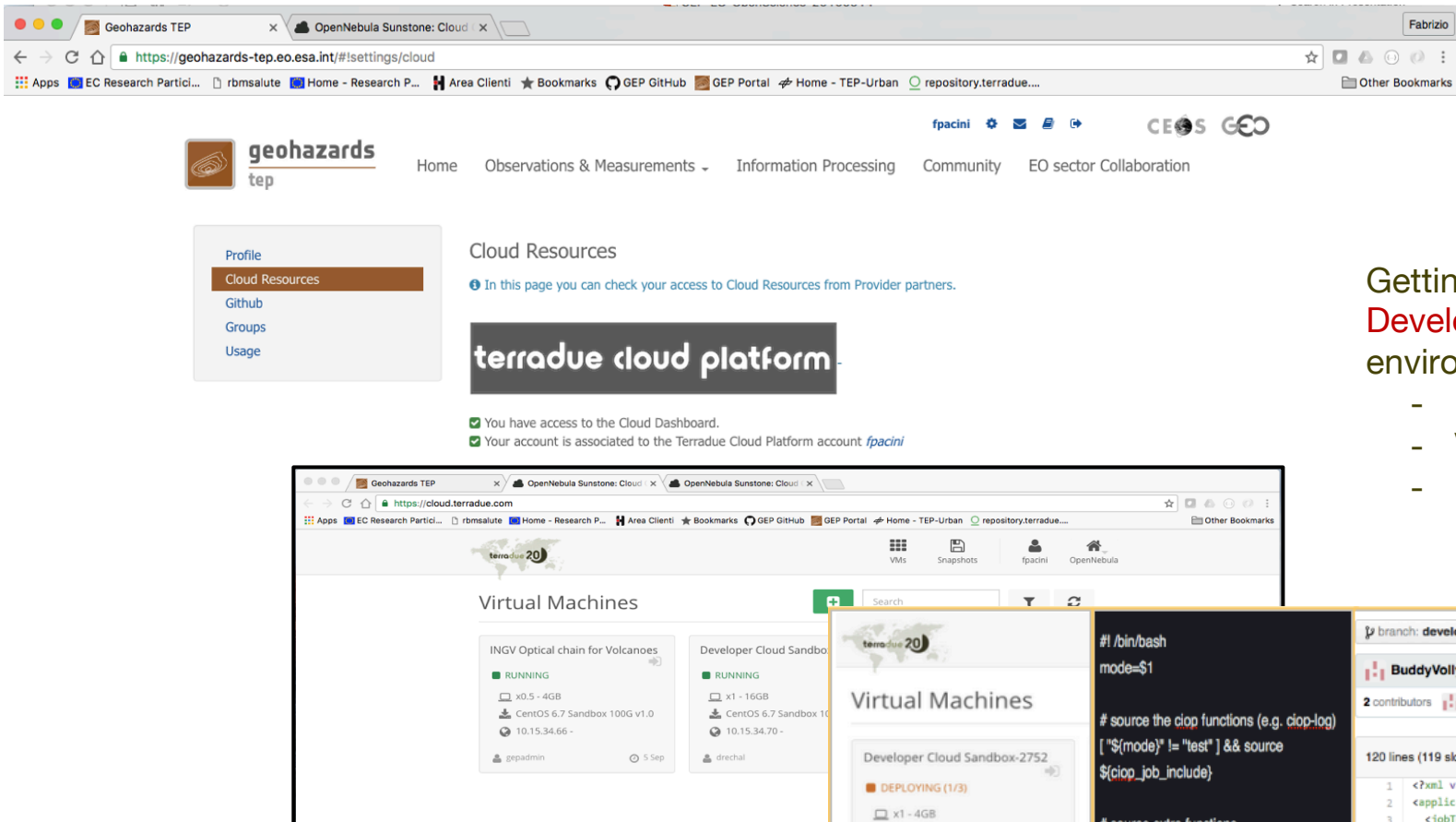
TEP Scenario #2
New EO Service Development

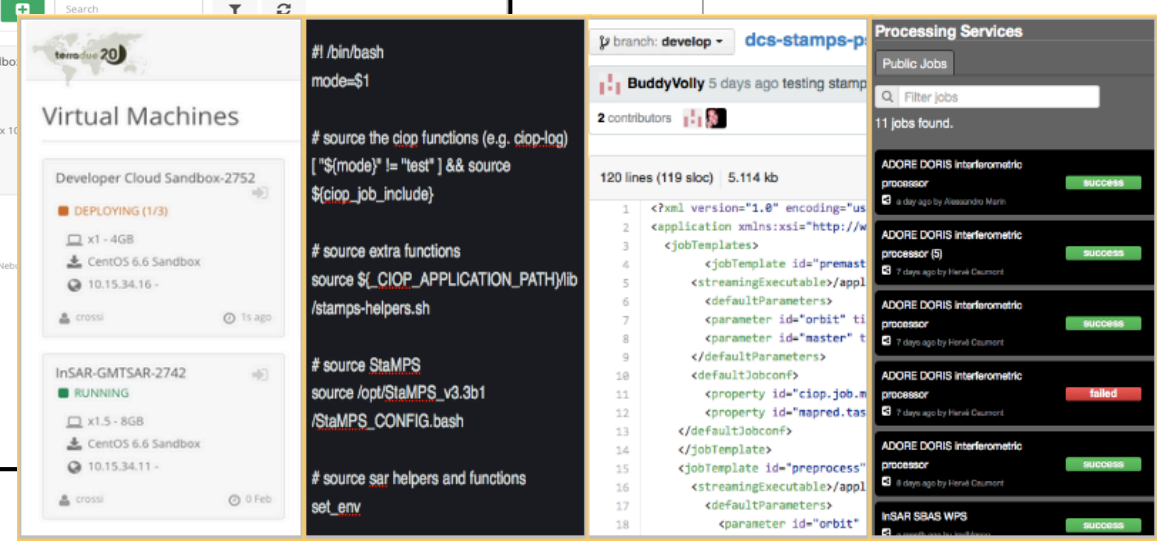
Integrate and deploy your own service

Connect processors to the GEP Catalogue and Geobrowser



Getting access to the Developer Cloud Sandbox environment for Apps:

- Integration
- Validation
- Release packaging



The Cloud dashboard allows to:

- ➢ Browse the Virtual Machines created on GEP
- ➢ Create a new Virtual Machine for processor integration

The Operations Support team is handling the deployment of validated applications on Production clusters

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Integrate and deploy your own service

Enrich the GEP Thematic Service Catalogue

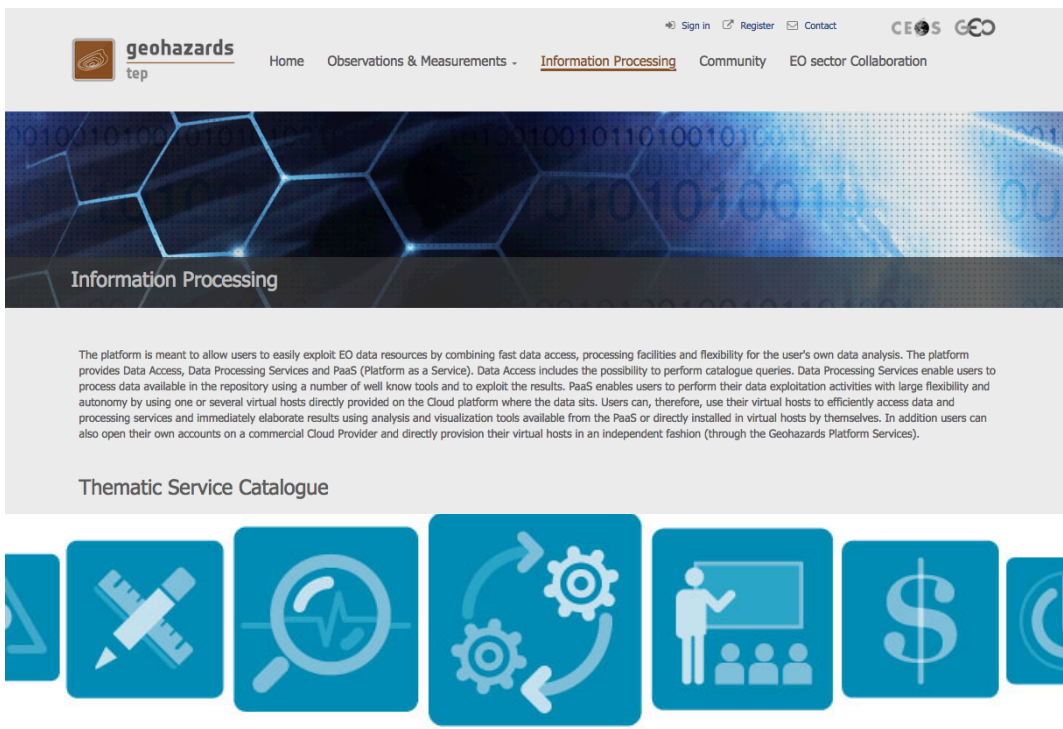
Processing chains published on the Platform's code repositories

+

Deployed on productions servers for on-demand (user driven) processing

+

Accessed by usersvia the GEP Geobrowser User Interface



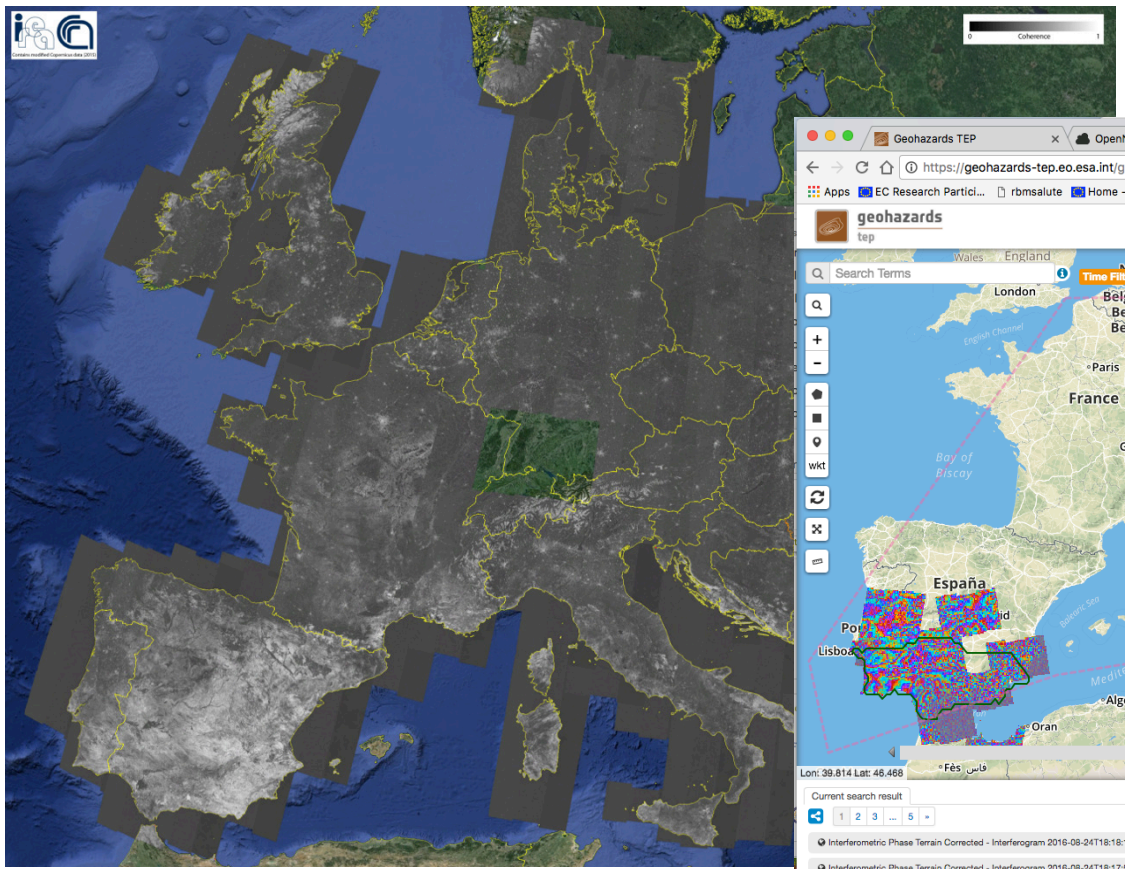
GEP Thematic Service Catalogue

On-demand processing services

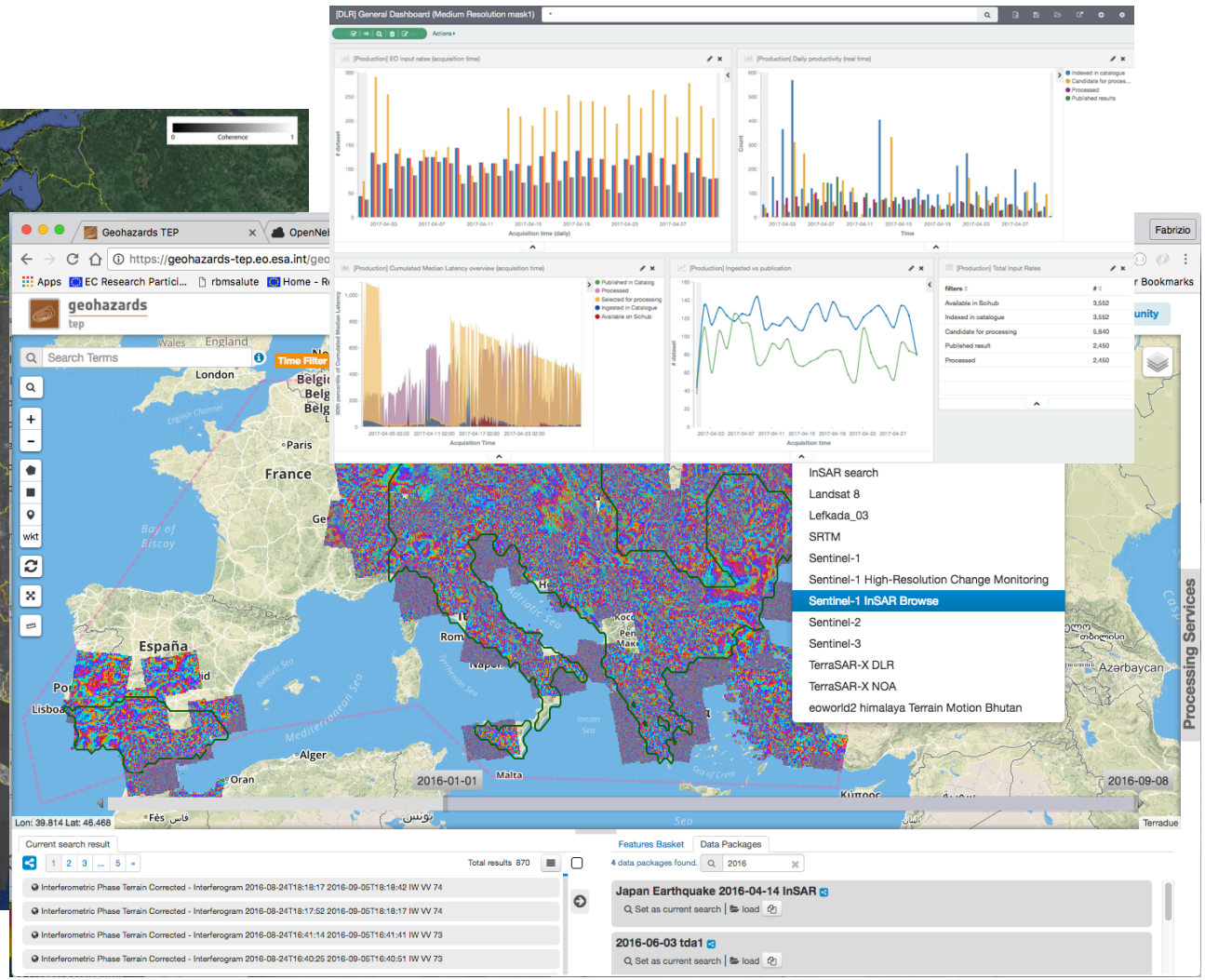
TEP Scenario #3
New EO Product Development

Publish new products as information layers

Monitor processing tasks



S-1A 12-day Coherence Map over Europe



DEM corrected interferograms

istituto per il rilevamento elettromagnetico dell'ambiente

DLR Earth Observation Center

esa

geohazards tep

Publish new products as information layers

Enrich the GEP Thematic Service Catalogue

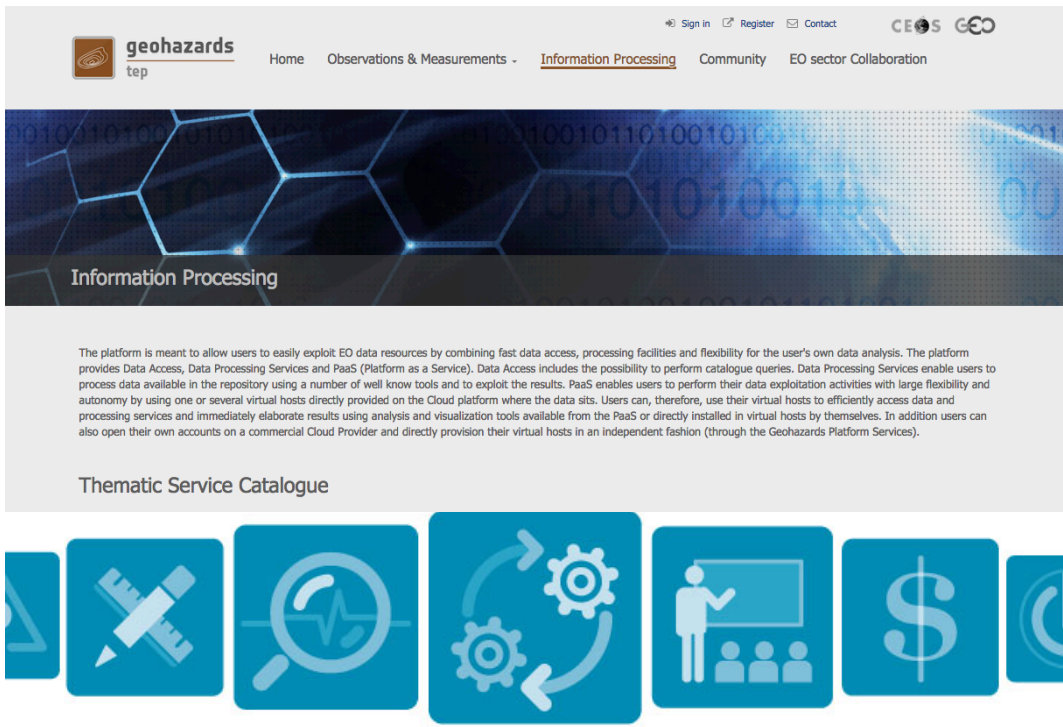
Processing chains published on the Platform's code repositories

+

Deployed on productions servers for "AOI driven" / "Time driven" processing

+

Generating outputs as GEP datasets, catalogued and stored on the Platform

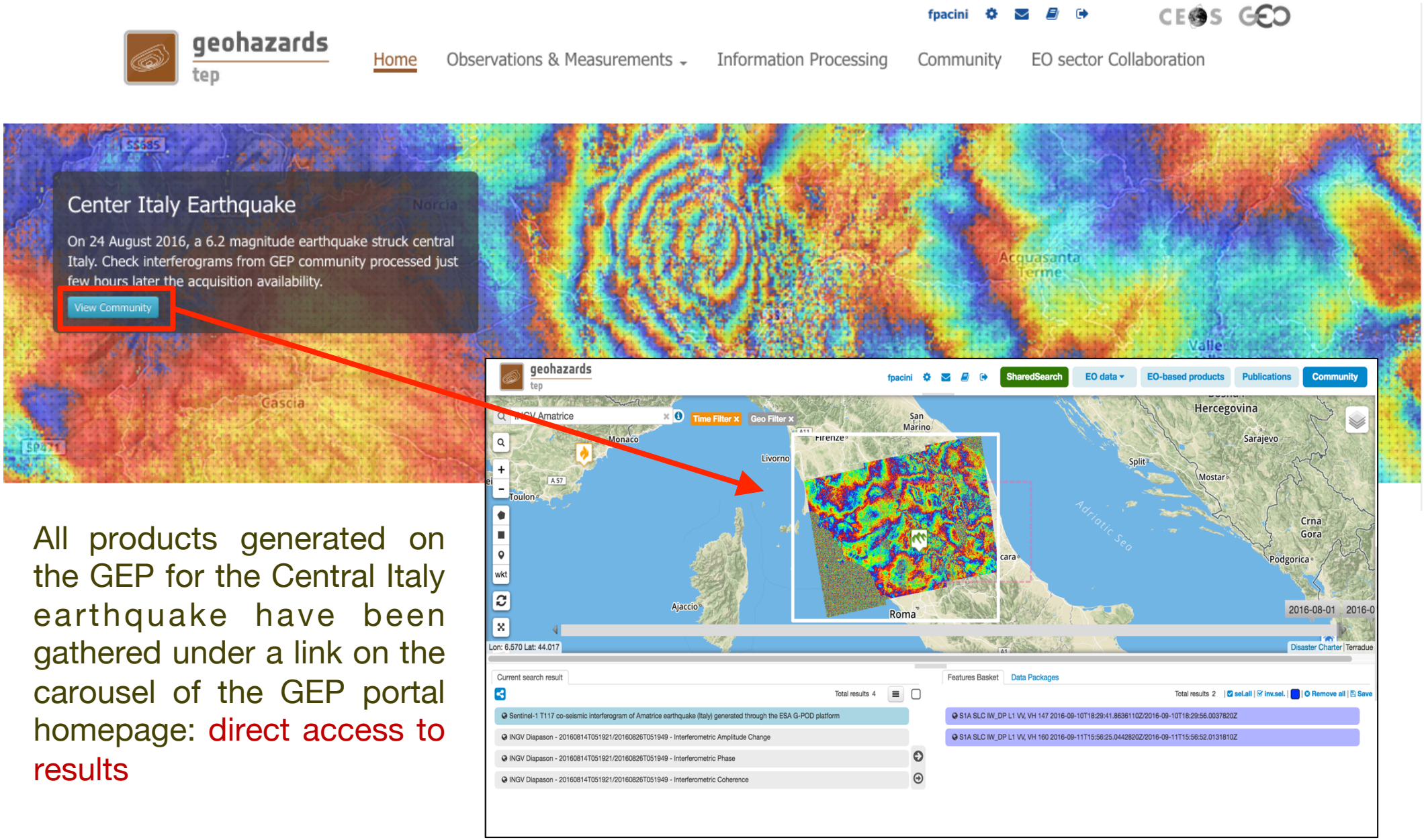


GEP Thematic Service Catalogue

Information feed layers

Examples of achievements so far

Results dissemination (1)



All products generated on the GEP for the Central Italy earthquake have been gathered under a link on the carousel of the GEP portal homepage: direct access to results

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Results dissemination (2)

https://geohazards-tep.eo.esa.int/#!blog

Apps | EC Research Partici... | rbmsalute | Home - Research P... | Area Clienti | Bookmarks | GEP GitHub | GEP Portal | Home - TEP

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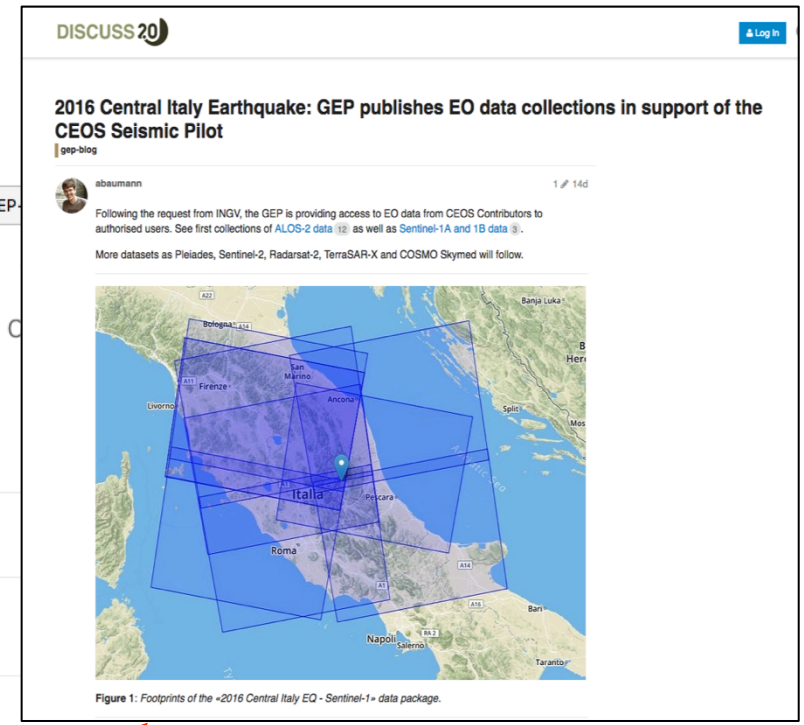
Home | Observations & Measurements | Information Processing

Blog archive

- **New interferogram generated in the cloud on the GEP** — 5 months ago — 131 views
- **How to publish scientific results on the GEP community map** — 15 days ago — 78 views
- **Example of hosted processing using S-1 data in the aftermaths of the 2016 Central Italy EQ** — 14 days ago — 84 views
- **2016 Central Italy Earthquake: GEP publishes EO data collections in support of the CEOS Seismic Pilot** — 14 days ago — 81 views
- **2016 Central Italy Earthquake: ESA announcing the first Sentinel-1 based measurements after the Earthquake** — 15 days ago — 254 views — 1 like
- **GEP Release 1.7** — a month ago — 162 views — 1 like
- **Accessing Sentinel-1 Orbit files** — a year ago — 109 views
- **Complex data made easy** — 4 months ago — 109 views
- **The Geohazards Thematic Exploitation Platform. Terradue presentation done at Living Planet Symposium in Prague** — 4 months ago — 108 views



DISCUSS 20 — Log In

2016 Central Italy Earthquake: GEP publishes EO data collections in support of the CEOS Seismic Pilot

gep-blog

abaumann — 1 — 14d

Following the request from INGV, the GEP is providing access to EO data from CEOS Contributors to authorised users. See first collections of ALOS-2 data [2] as well as Sentinel-1A and 1B data [3].

More datasets as Pleiades, Sentinel-2, Radarsat-2, TerraSAR-X and COSMO Skymed will follow.

Figure 1: *Footprints of the «2016 Central Italy EQ - Sentinel-1» data package.*

A number of posts have been published on the GEP blog regarding CEOS datasets, first products generated by the CEOS Seismic pilot team, etc.

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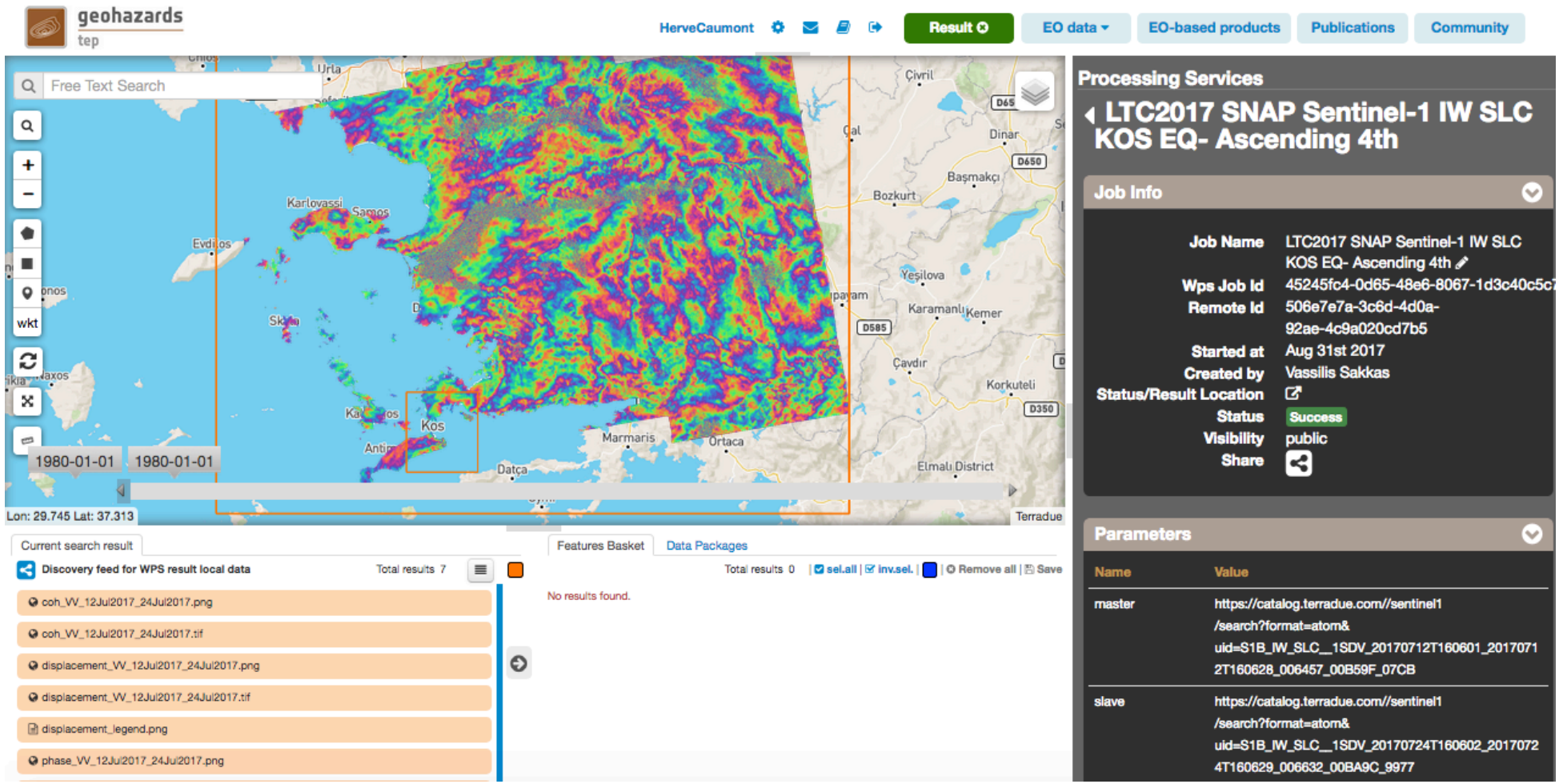
Kos island, M6.6 earthquake

20th July 2017

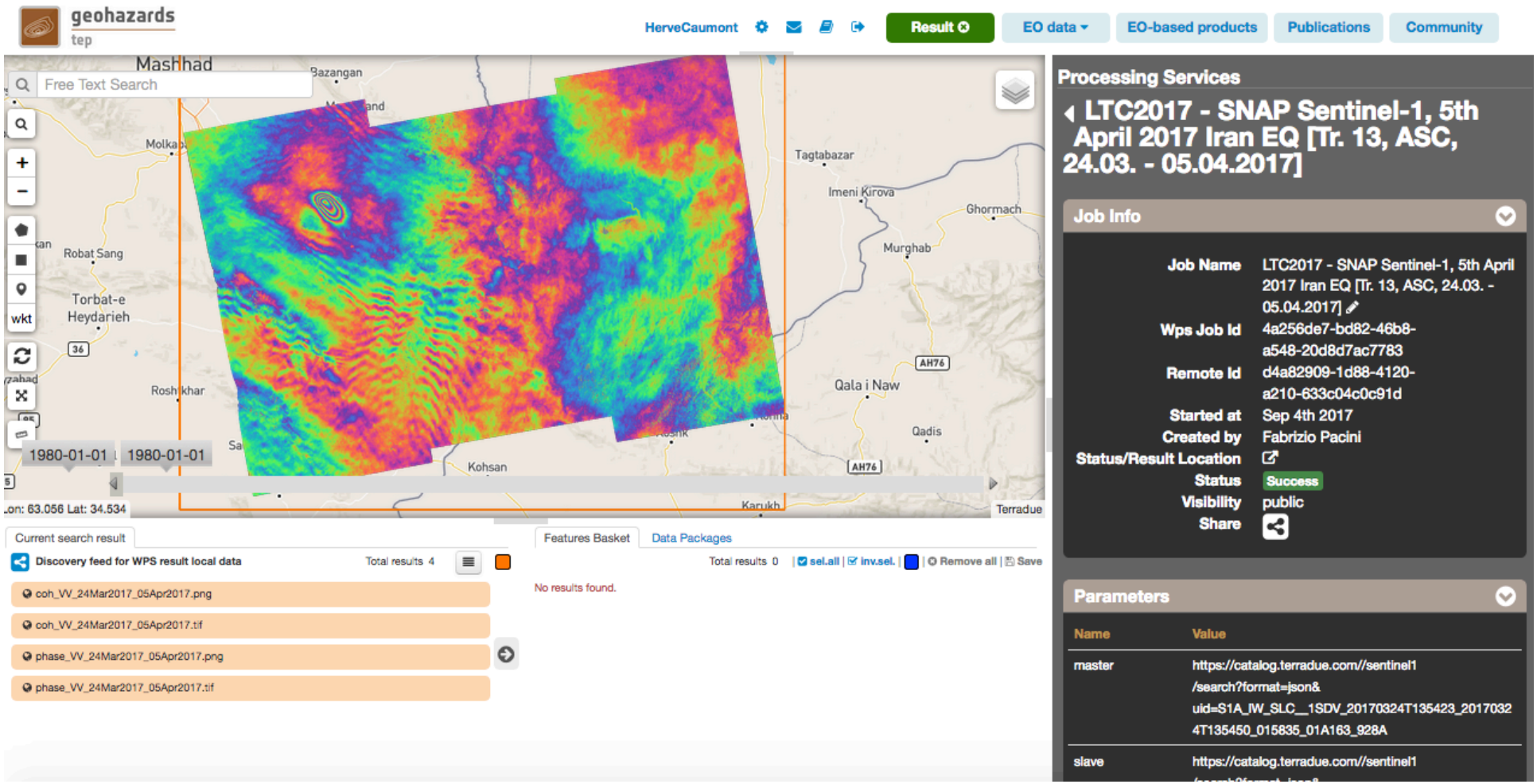


Differential SAR interferogram generated through a small baseline 12 days pair of SAR images acquired by the Sentinel1 constellation (pre-event image acquired on 12/07/2017 and post-event image acquired on 24/07/2017).
This result was generated using hosted processing on the Cloud based Geohazards Exploitation Platform (GEP).
The processing chain is the SNAP chain of ESA integrated on the GEP by ESA RSS.
Sentinel1 data are copyright of Copernicus (2015).

geohazards
tep

Northeastern Iran, M6.1 earthquake

5th April 2017



Differential SAR interferogram generated through a small baseline 12 days pair of SAR images acquired by the Sentinel1 constellation (pre-event image acquired on 24/03/2017 and post-event image acquired on 05/04/2017).
This result was generated using hosted processing on the Cloud based Geohazards Exploitation Platform (GEP).
The processing chain is the SNAP chain of ESA integrated on the GEP by ESA RSS.

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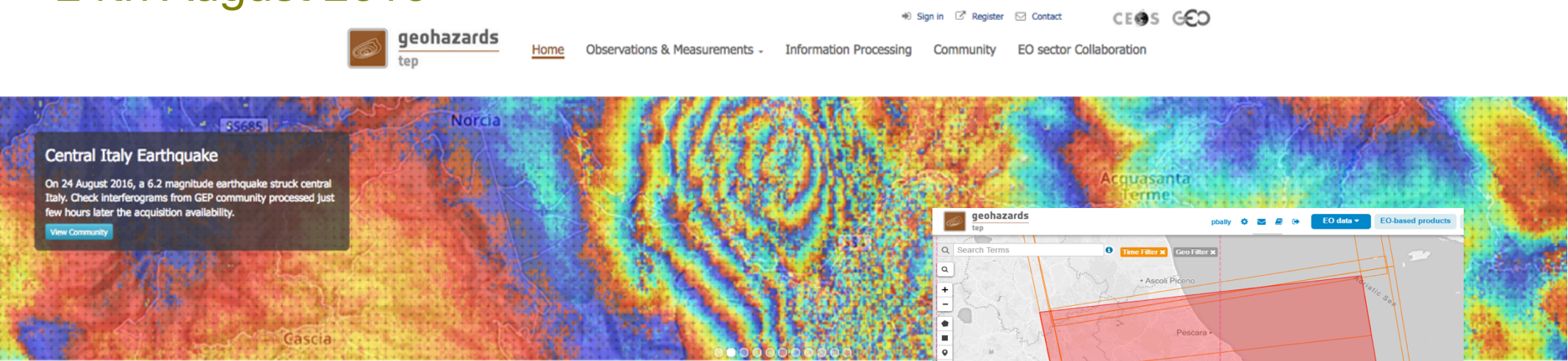
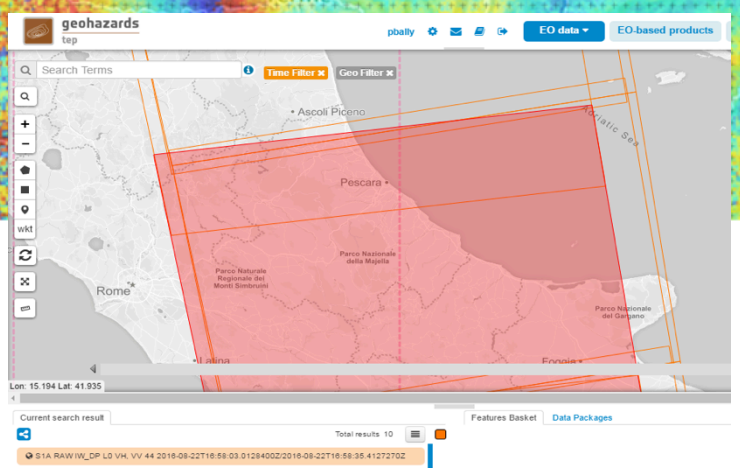
Central Italy earthquake
24th August 2016





GEP contributions

- The CEOS Seismic Pilot led by ESA and INGV was activated on 24th August to provide EO data and EO derived science products
  - CEOS Pilot Objective C: advanced products for operational seismology
- Several EO data collections accessed or planned to be accessed via CEOS were made available on the GEP
  - JAXA's ALOS-2 acquisition of 24 August
  - Sentinel-1 A (26 & 27 August)
  - Sentinel-1 B* (27 & 28 August)
  - Radarsat-2 planned, TerraSAR-X awaiting feedback
  - Pleiades data (incl. Tristereo) planned

- GEP as a repository to access / exploit / share data & results
- Hosted and published EO measurements from the community (e.g. InSAR results generated offline)
- Access to Cloud based hosted processing (e.g. on demand) and systematic processing (e.g. DLR's S-1 InSAR Browse service)
- Collaboration, exchange and sharing
- Scientific experiments to test new methods (e.g. S-1 based coherence signatures)

*: S-1B not yet in full operations, but data made available for this event

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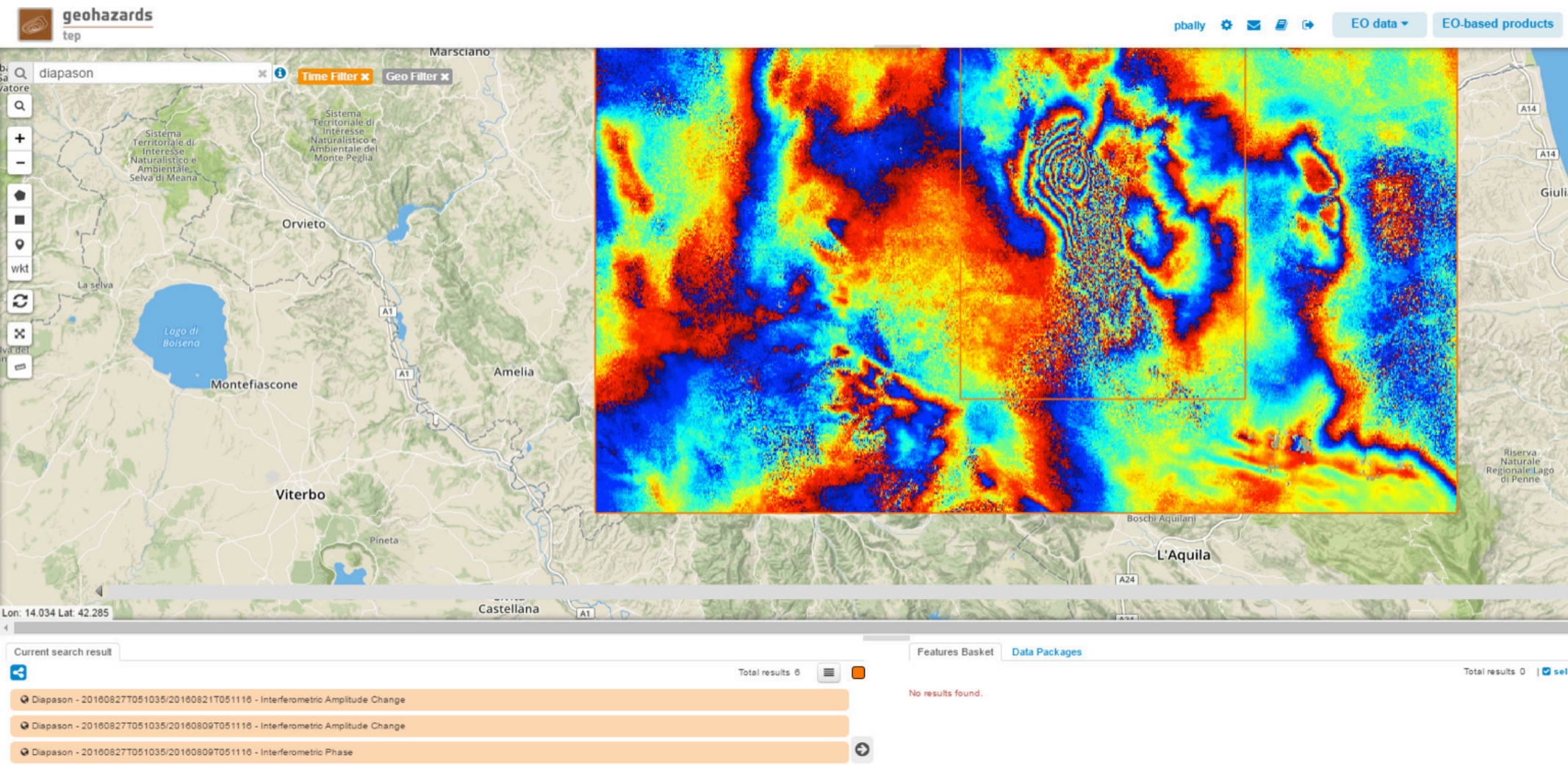
Central Italy earthquake

First results generated on GEP (1)



Differential SAR interferogram generated through a small baseline 18 days pair of SAR images acquired by the Sentinel1 constellation (pre-event image acquired on 09/08/2016 and post-event image acquired on 27/08/2016).
This result was generated by Terradue using hosted processing on the Cloud based Geohazards Exploitation Platform (GEP).
The processing chain is the DIAPASON chain of CNES integrated in the GEP by TRE ALTAMIRA.
Sentinel1 data are copyright of Copernicus (2015).

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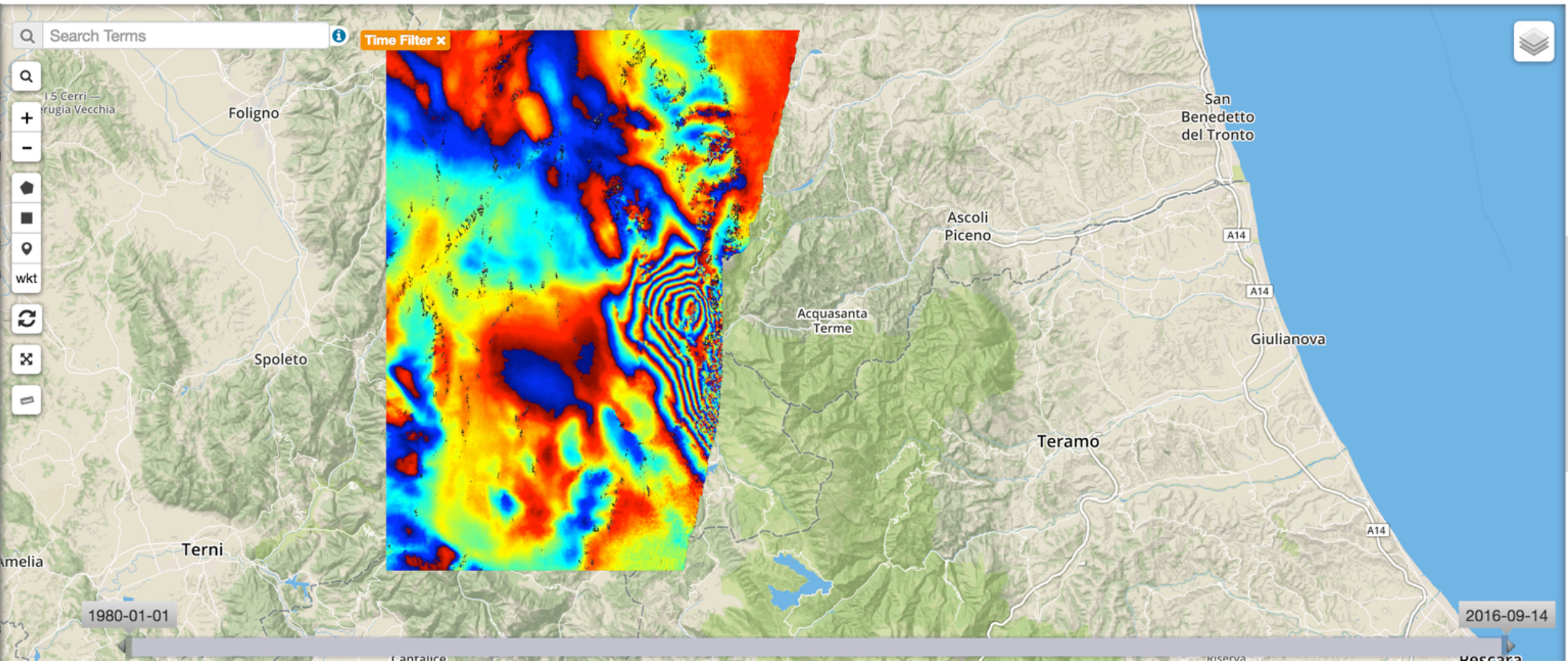
Central Italy earthquake

First results generated on GEP (2)



Interferogram based on the GEP-hosted processing chain DIAPASON of the French space agency CNES.
Sentinel-1 interferogram processed by INGV using acquisitions of 14th and 26th August 2016 covering the western part of the earthquake area.

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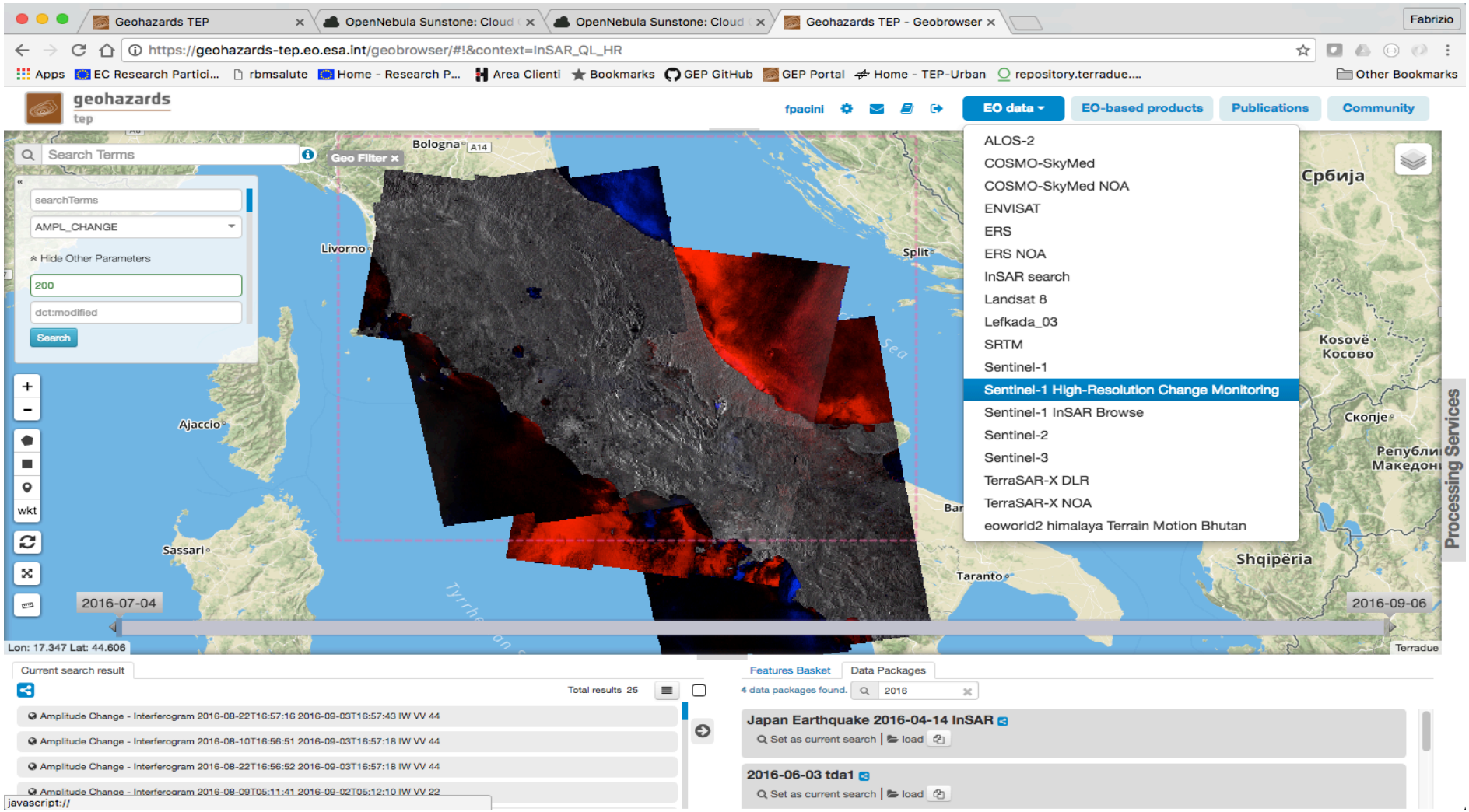
Central Italy earthquake

First results generated on GEP (3)



Started the Sentinel-1 High-Resolution Change Monitoring service of DLR for systematic processing over the earthquake area. Amplitude and coherence product at 50m resolution are generated processing Sentinel-1data acquisitions pre- and post-event starting from 9th August

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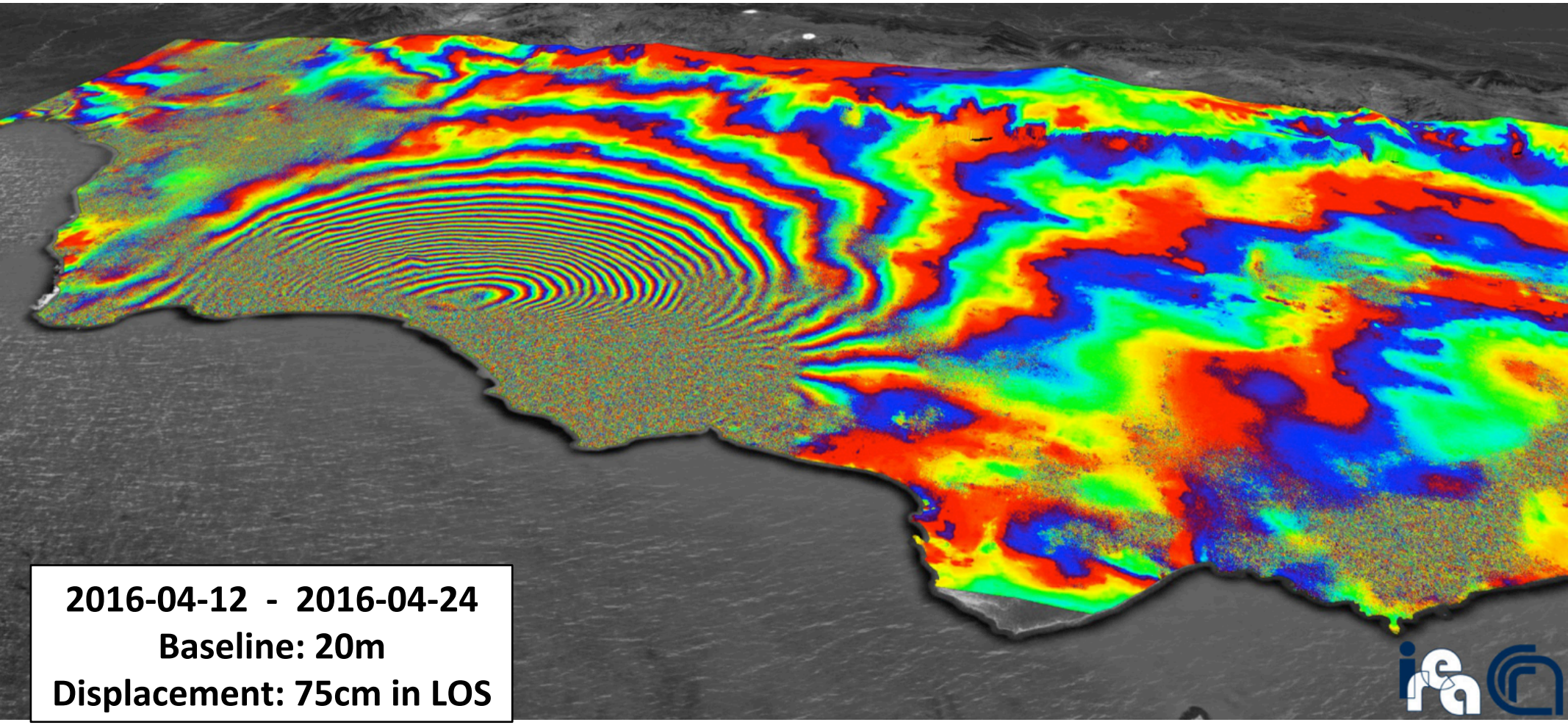
Cloud-based DInSAR services: Ecuador earthquake



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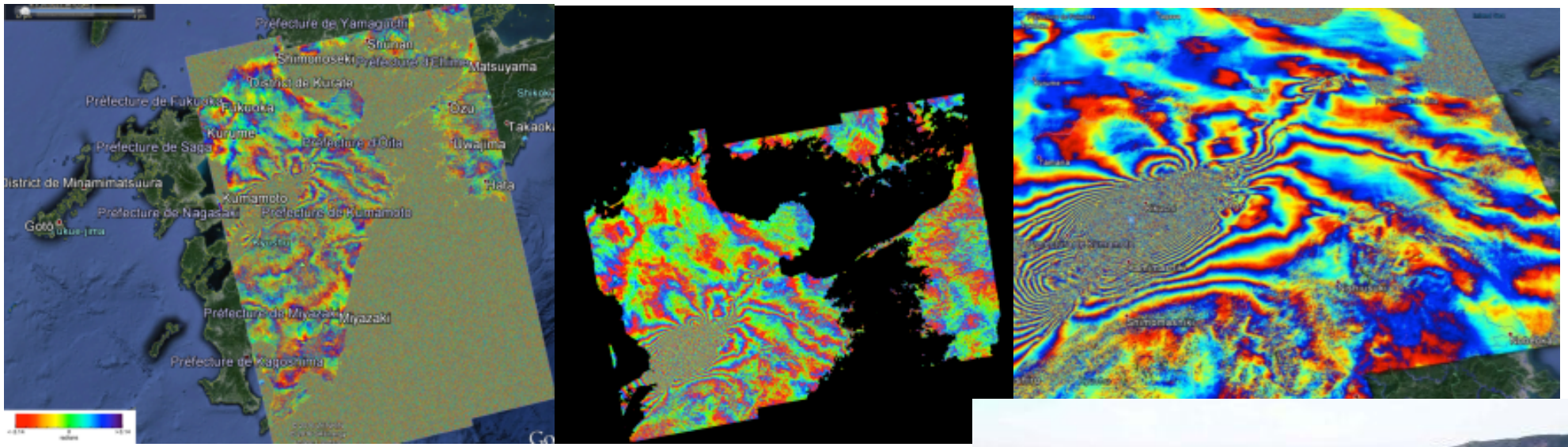
Cloud-based DInSAR: Kumamoto earthquake

Integrated SBAS, DIAPASON and the InSAR Browse to exploit Sentinel-1



- Sentinel-1 interferogram of Kumamoto earthquake, on the island of Kyushu in southwest Japan, in April 2016:
  - SBAS chain of CNR IREA (Left),
  - DLR InSAR Browse chain (Centre),
  - DIAPASON Processing Service of CNES/Altamira Information (Right).

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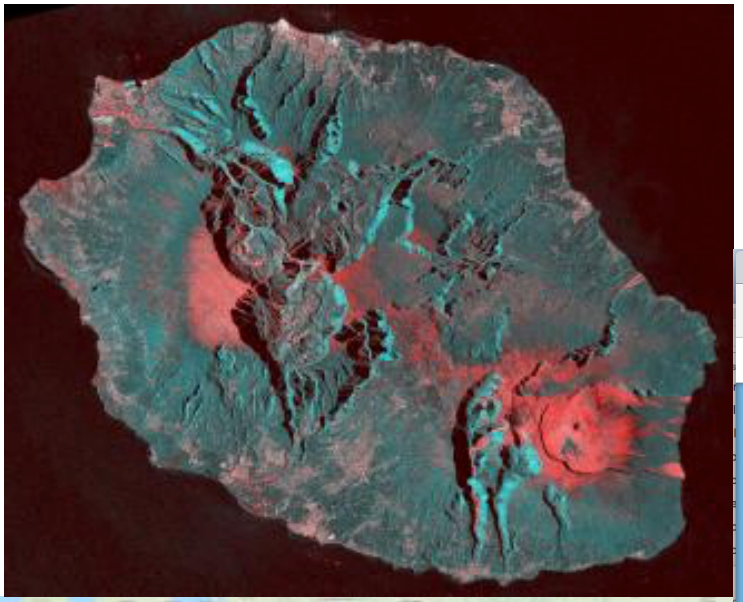
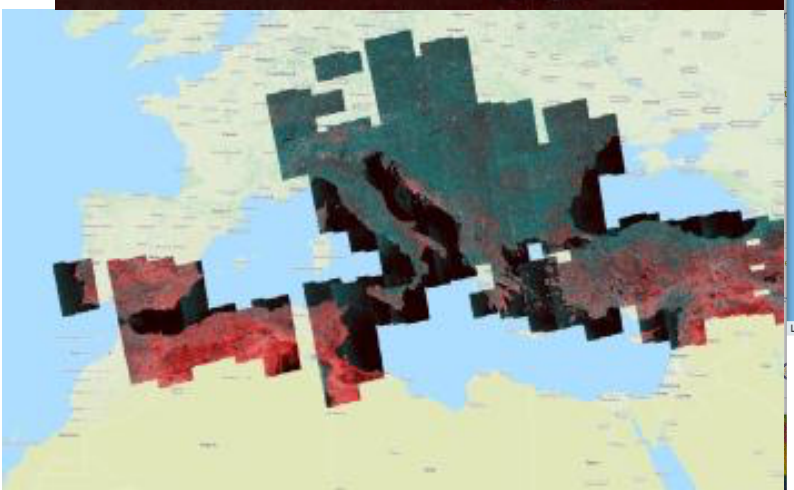
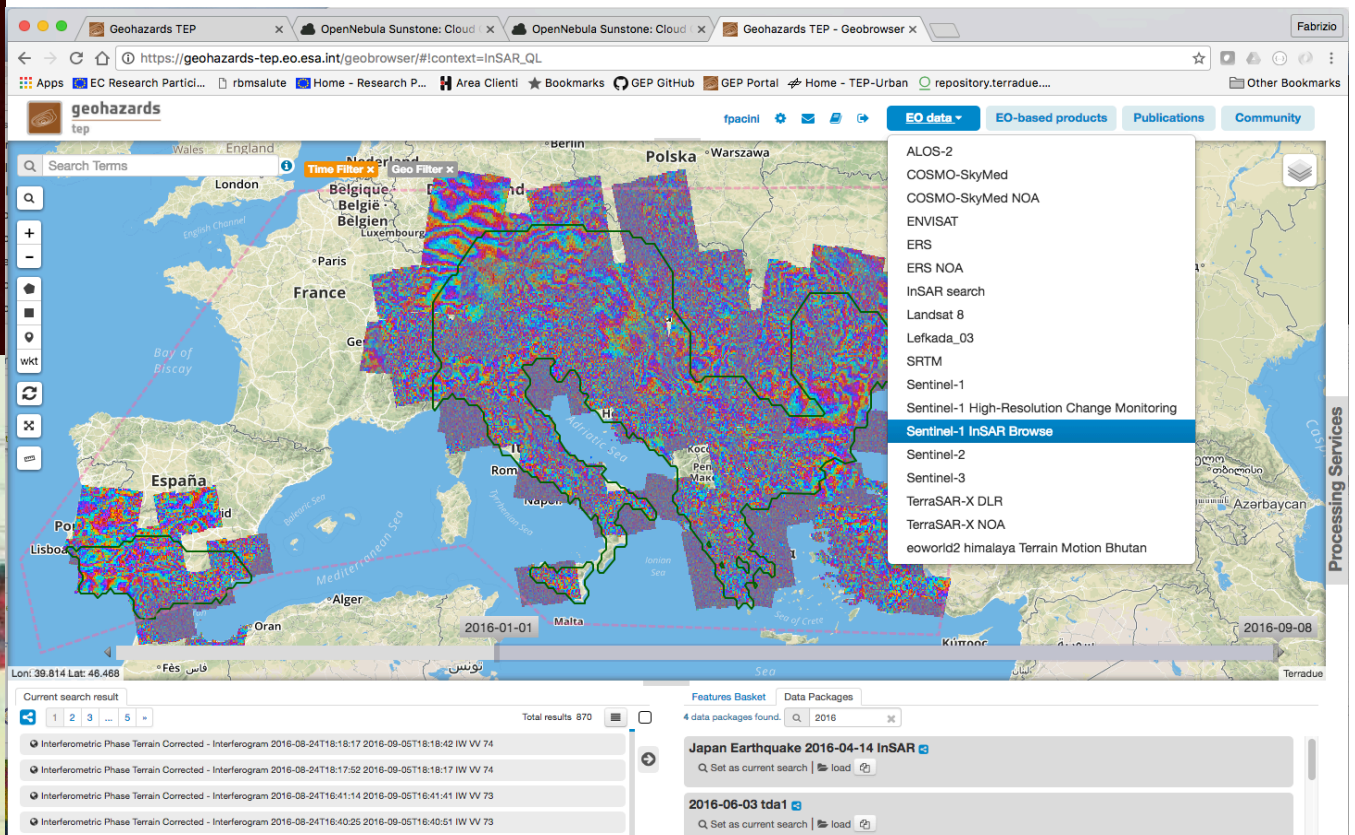
DLR's chain for systematic processing of Sentinel-1 InSAR pairs

Systematic *processing all S-1 pairs* over world tectonic areas: **amplitude, coherence & interferograms for all 6- and 12-day pairs.** About 150 / day. 23000+ pairs processed to date (as of Oct. 2017). *Free browse images at 100m resolution*.





Left: coherence (R) and amplitude (G, B) over la Réunion.
Bottom Left: collection of coherence & amplitude composites over Europe.
Bottom Right: Examples of DEM corrected inteferograms.
Credits DLR.



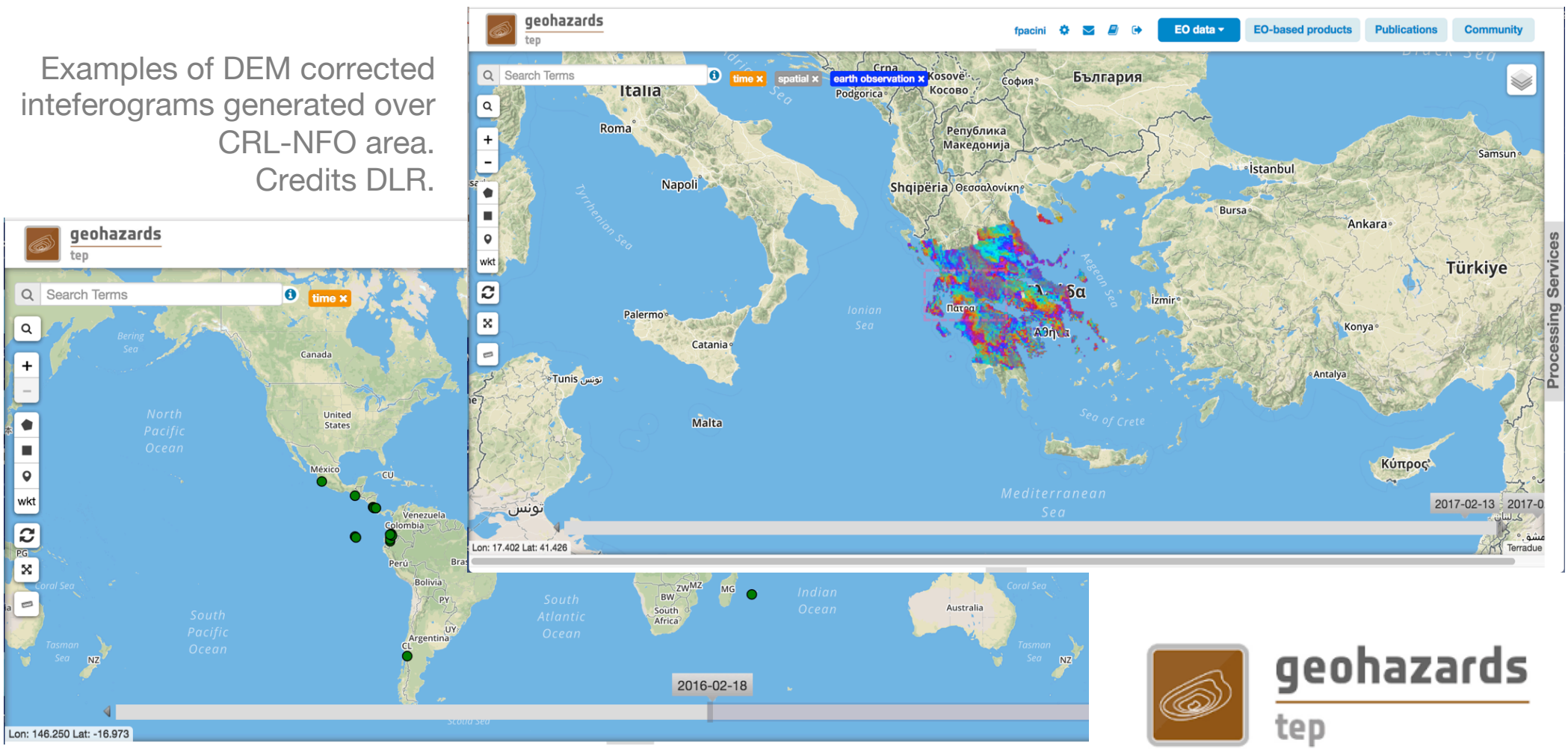
High-Resolution change monitoring

22 Volcanoes and Corinth Rift Laboratory

➢ Performing systematic processing with the DLR High-Resolution InSAR Browse service (50m resolution - 25m spacing) of all S-1 pairs over

- 22 active volcanoes worldwide
- The CRL-NFO area

Examples of DEM corrected inteferograms generated over CRL-NFO area. Credits DLR.



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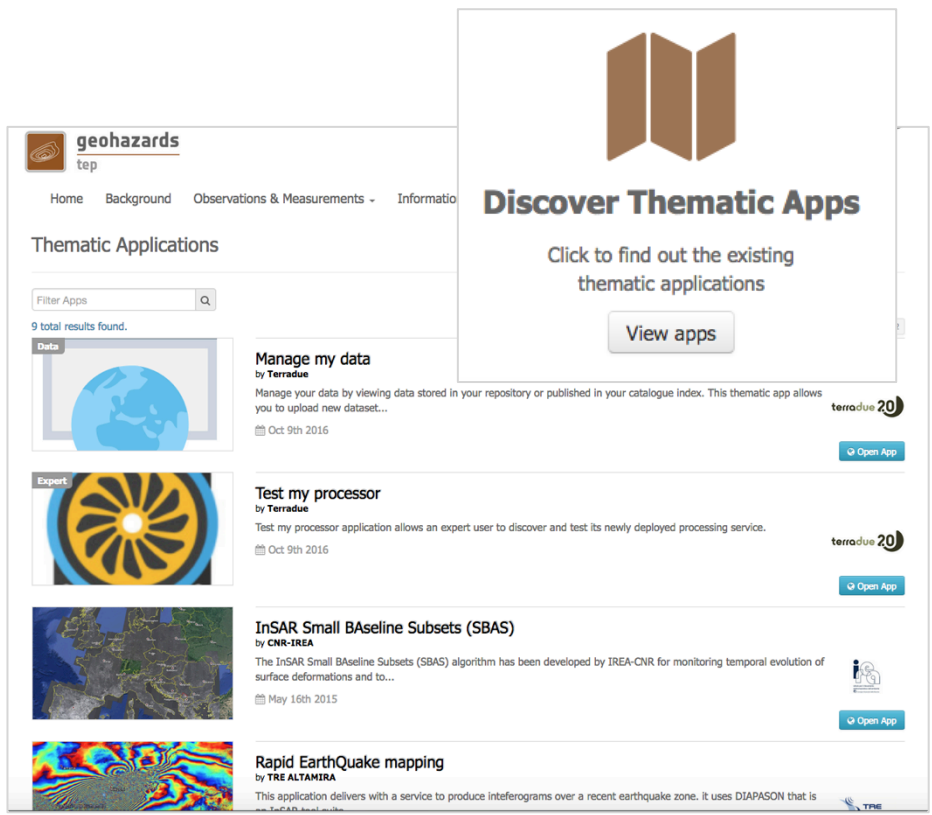
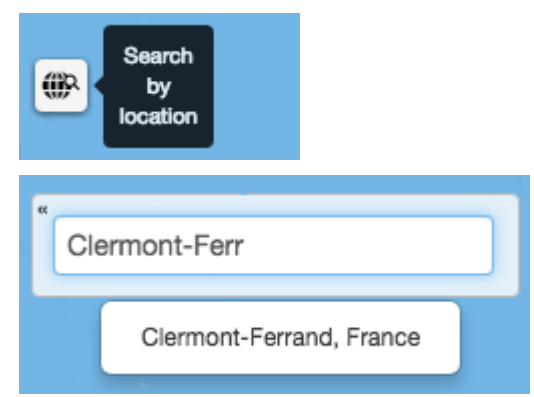
-2-
Next v2 evolutions
new features & impacted scenarios

New data exploitation functions

- **Quicklooks** systematic generation, for the Geobrowser views over data collections
- **Gazetteer search**
- **Thematic Apps**: rule-based bundling of data collections and processing services
  - Processing services accessed on the GEP Portal via “Discover Thematic Apps”
  - My data uploads App: for user uploads on Data Gateway, with automated cataloguing
- **Visualisation of processing outputs**: handling of additional results file types, for CSV time series, KML & SHP vector, full resolution rasters (including legends)
- **Results publication Web Service**, accessed / shared by all Virtual Machines





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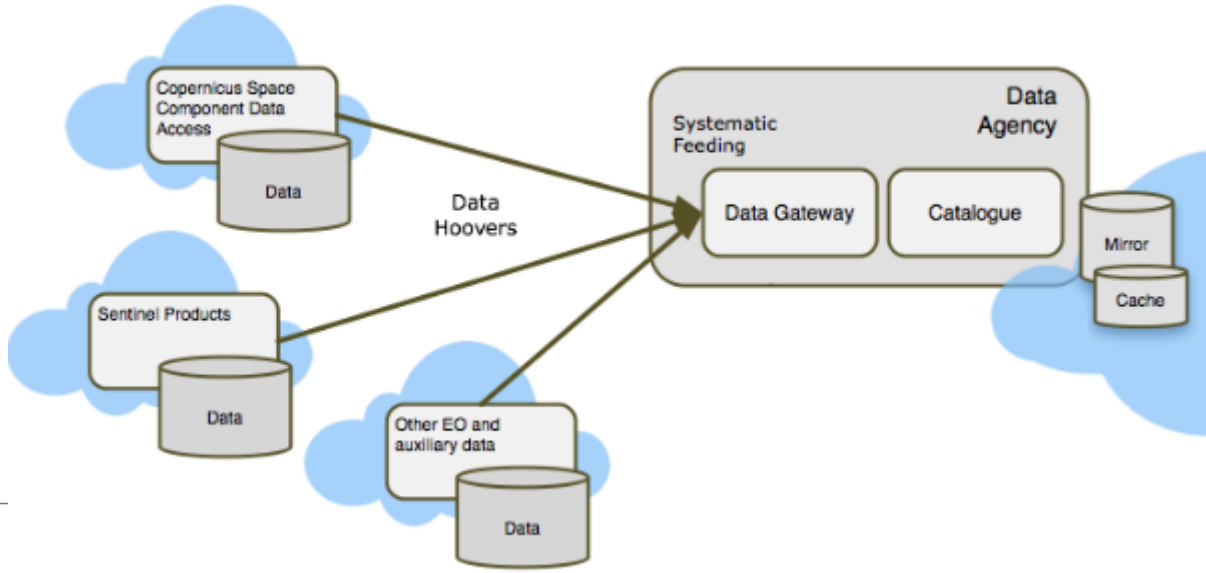
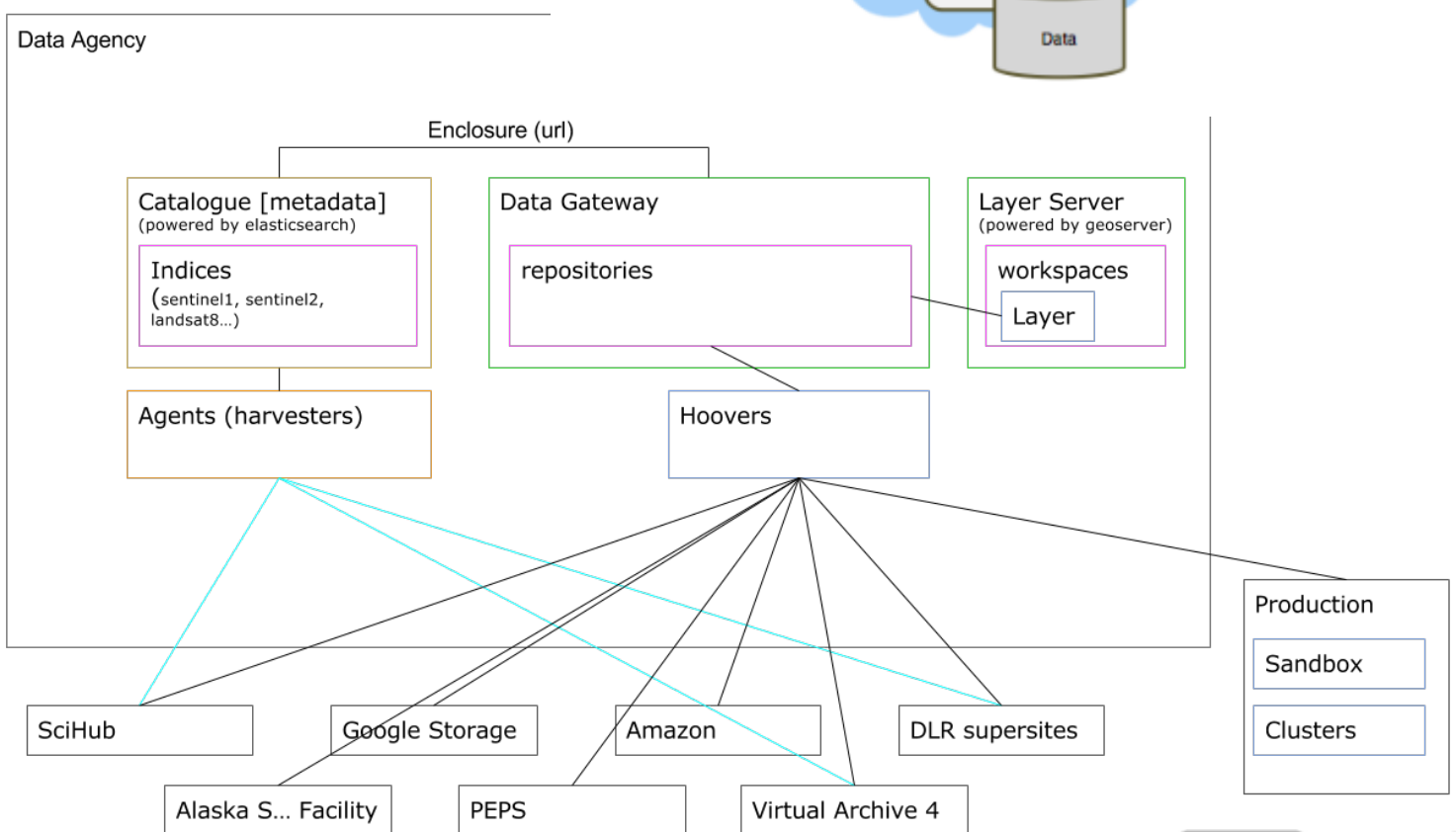
Data Gateway

- Automatic multi-sourcing
- Programmed cache
- Personal storage (repository)
- Production staging
- Data usage accounting





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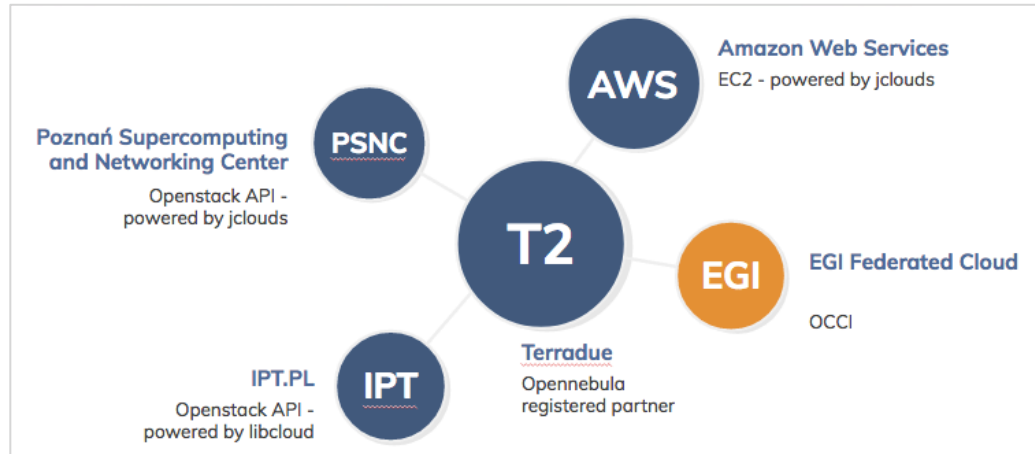
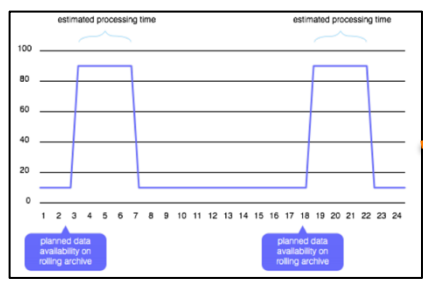
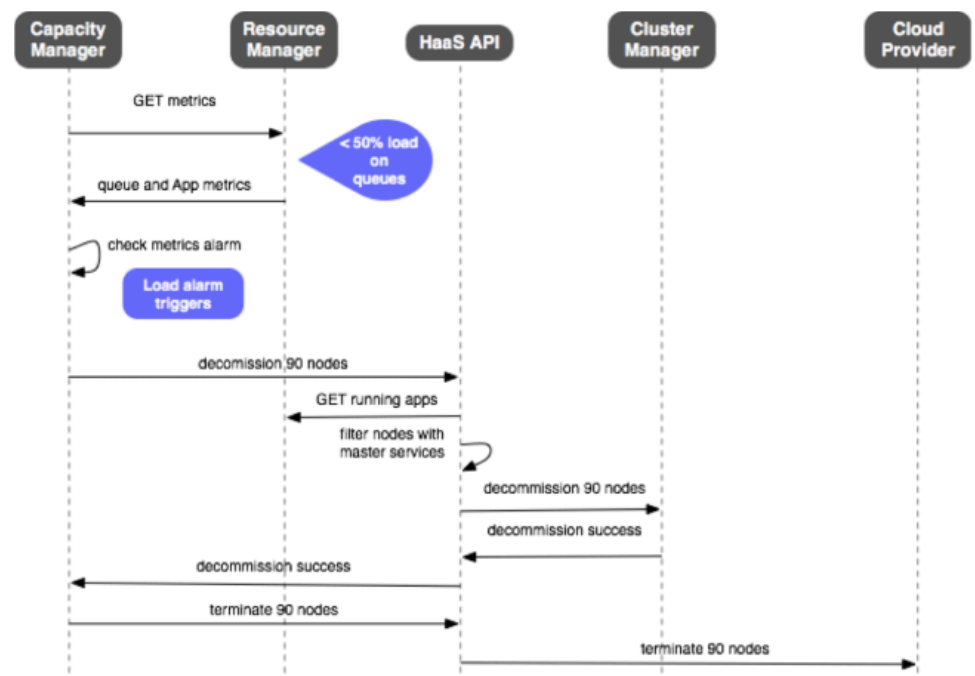
New Cloud processing capacities

- Federation of new Cloud providers:
  - IPT Poland
  - EGI.eu (BELNET, INFN RECAS BARI)
  - CNR IREA Private Cloud's GEP domain



Processing load over time





- Production Center instances (x2, funded for 12 months) running on:
  - either Hetzner / Terradue Cloud Platform (InSAR services)
  - and/or IPT Poland (Optical services, accessing Sentinel-2 mirror) based on ESA funding.
  - Future funding expected over 2019, with Terradue brokering.
- Accounting:
  - initial capability allowing the tracking of user credits for processing

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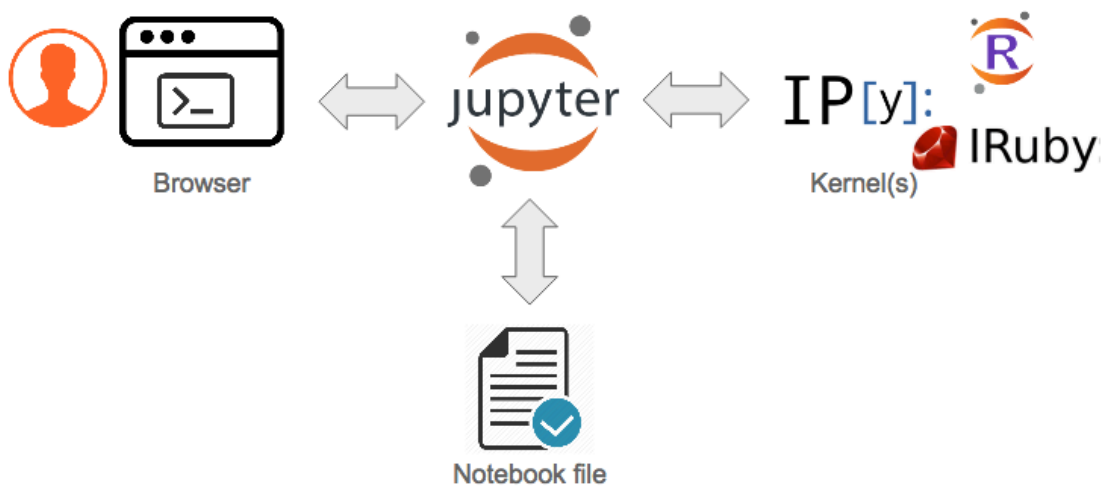
New community-contributed resources

- New toolboxes installers for DCS Application integrators:
  - Orfeo
  - SNAP extensions
  - StaMPS extensions
- New toolboxes installers for Virtual Desktops:
  - Monteverdi
- New processing services contributed by the users community:
  - ISTerre TIO
  - ISTerre NSBAS
  - SATIM MineSAR
  - ESA RSS SNAP Sentinel-1 COherence and INtensity (COIN)
- GEP results post-processing, using Jupyter notebooks: the MPIC case



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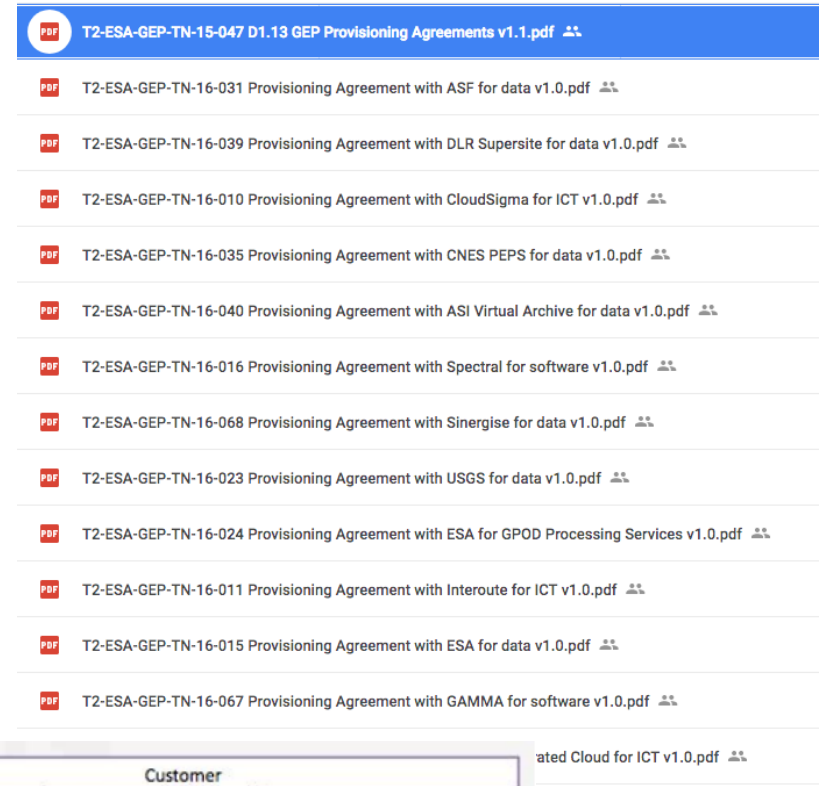
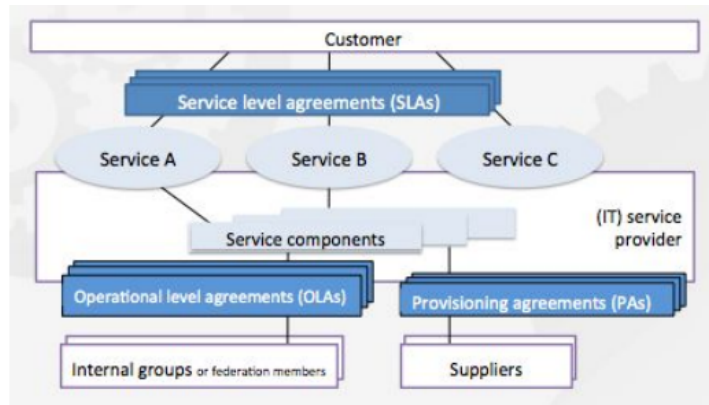
-3-
Pre-operations of the Platform v2

Provisioning Agreements (data and ICT)
for all running Services & Pilots

- Monitor & perform accounting on Cloud resources provisioned (CPU power, storage) as production servers for the GEP processing services
- Optimise the data provisioning processes for specific requirements (e.g. access to data quotas based on CEOS & GSNL Agreements)





Adapted from FitSM

Also, formalise the terms & conditions related to the reuse and adaptation of processing chains already contributed to GEP, that are managed under 'Open Source' license.

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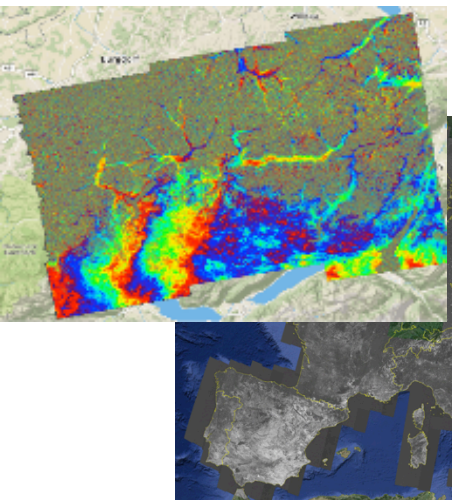
GEP Pilots (1/2)

Operations Level Agreement, Terms & Conditions, Users Feedback

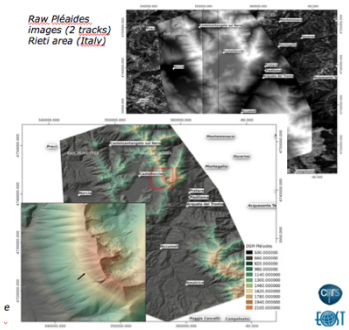
CNR IREA

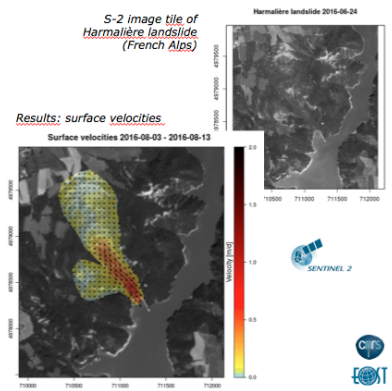
- Terrain motion surveillance
  - Data provisioning: S-1 SLC
  - Results visualisation: displacement time-series, mean velocity maps
- Engagement of designated users
  - EPOS Community & Italian Department of Civil Protection
- Validation goal
  - On-demand generation of Earth deformation time series and mean velocity maps
  - Automatic “Sentinel-1 Surveillance Service”over Mt Etna & Napoli Bay volcanic area



CNRS/EOST

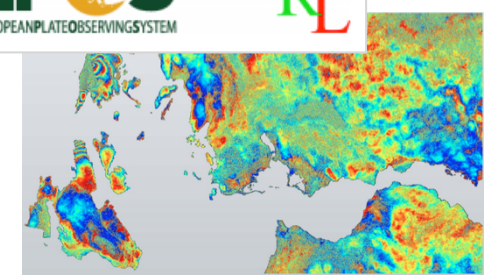
- Processing chains for optical images
  - Data provisioning: HR (S-2 & L7/8), VHR (Spot6/7, Pléiades)
  - Results visualisation: digital surface models,
- Engagement of designated users
  - CEOS Pilot on Seismic Hazards
- Validation goal
  - DSM-OPT: Automation of satellite-photogrammetry pipeline for rapid processing of multi-views images (Pléiades, Spot6/7)
  - MPIC-OPT: Monitoring of surface deformation from optical image time-series, based on Multiple-pairwise image correlation





CRL (ENS,NOA,HUA)

- Corinth Rift Laboratory
  - Data provisioning: S-1 SLC
  - Results visualisation: all possible interferograms from archive over CRL, e.g. ~5000 S1 asc. and ~5000 S1 desc. then all pairs after each new acquisition
- Engagement of designated users
  - Workshops & Summer Schools involving MSc, PhDs
- Validation goal
  - Deliver methods & data products as part of the Near fault observatory of EPOS



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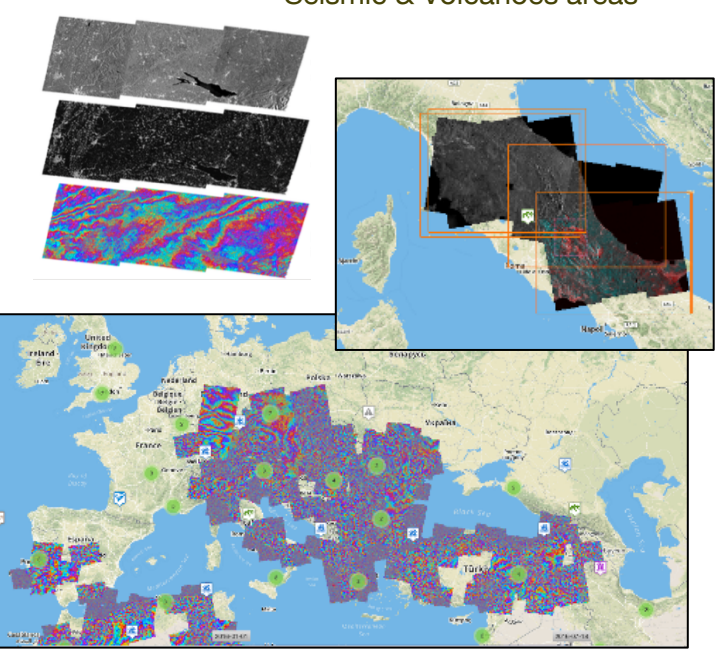
GEP Pilots (2/2)

Operations Level Agreement, Terms & Conditions, Users Feedback

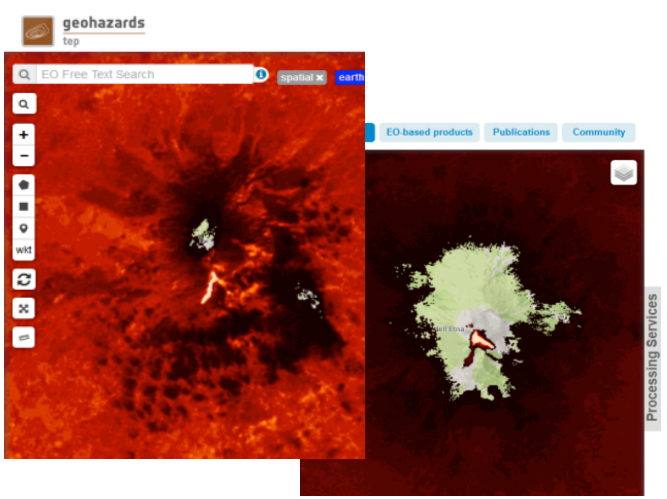
DLR

- Systematic InSAR QuickLook service
  - Data provisioning: S-1 SLC
  - Results visualisation: geocoded quicklooks of Amplitude, Coherence, Diff. interferograms
- Engagement of designated users
  - CEOS Pilot on Seismic Hazards
- Validation goal
  - Monitoring service of the CEOS Seismic & Volcanoes areas



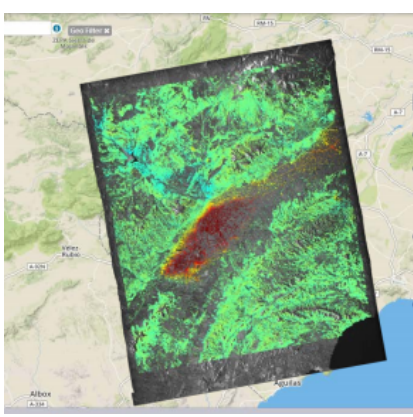
INGV

- Volcanic hazard monitoring
  - Data provisioning: L8 (L1B), S-2 (L1C), S-3 (SLSTR, L1B/L1C)
  - Results visualisation: Surface temperature maps/hotspot detection
- Engagement of designated users
  - Italian Civil Protection
- Validation goal
  - Generation of time series relevant for the CEOS Pilot on volcanoes, for Mount Etna and Phlegrean field



TRE-ALTAMIRA

- PSinSAR for precise terrain motion mapping
  - Data provisioning: S-1 SLC
  - Results visualisation: ground motion velocity map, corrected topography map
- Engagement of designated users
  - Commercial sector (pay-per-use via TRE-ALTAMIRA Sales Dept.)
- Validation goal
  - Define a SaaS business model for GEP hosted InSAR services



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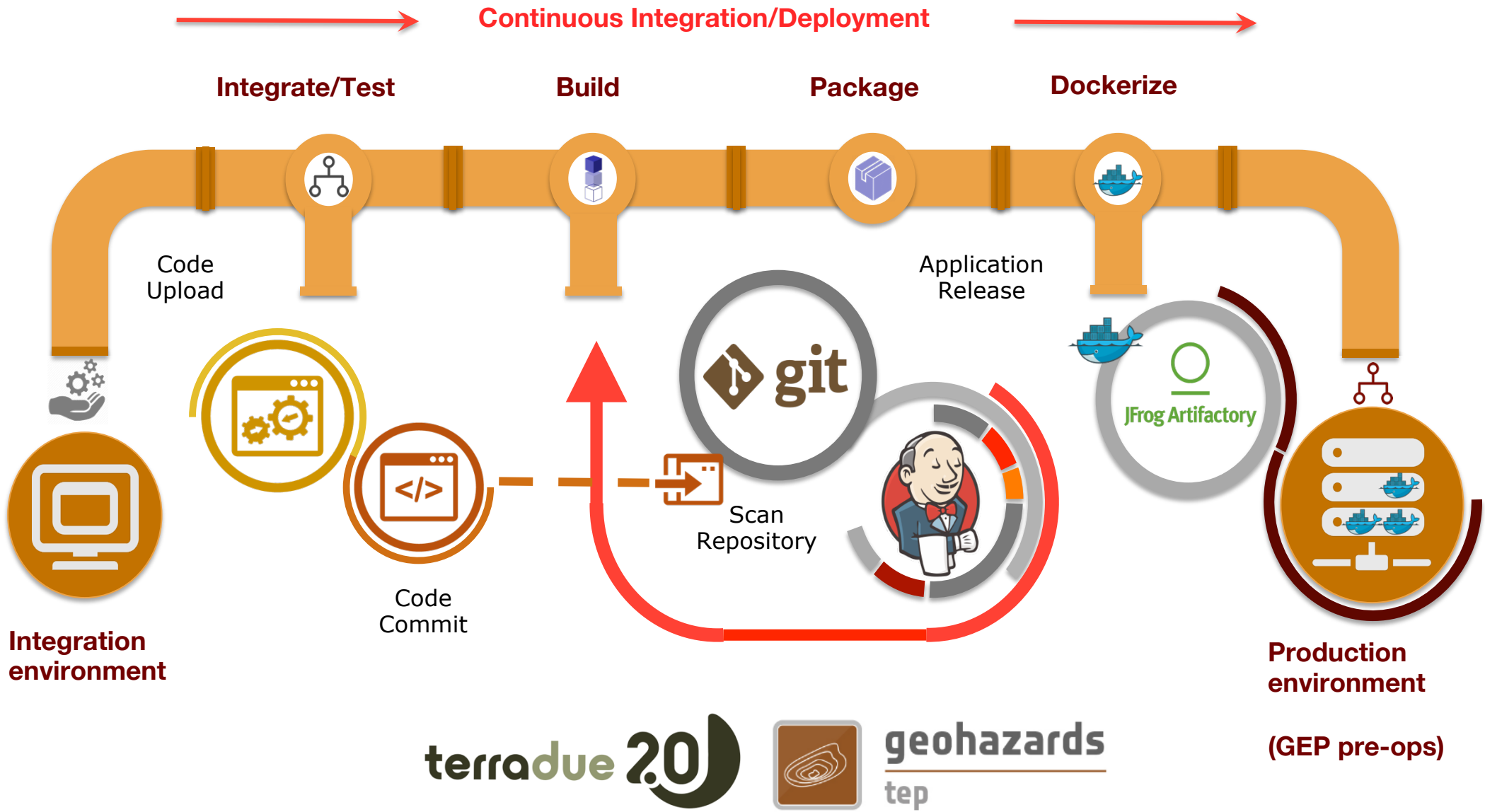
Cloud processing services integration & deployment

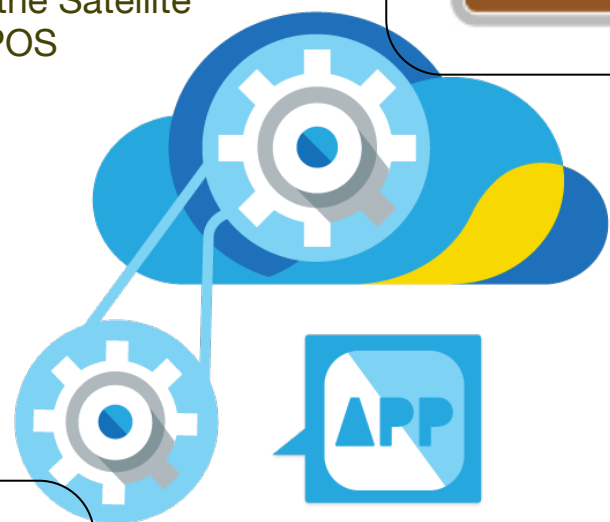
Continuous integration & better automation



-4-
Sustainability

GEP and EPOS

GEP selected as the gateway for the Satellite Data Thematic Core Service in EPOS



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

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Sustainability actions

- Positive dynamic:
  - Interest from **Private sector** companies (VACs) for the GEP service provisioning model, and for establishing partnership (based on revenue sharing) for their Service integration & deployment on the platform
  - Access requests received from some industry users
  - Research networks like **EPOS** and **Geohazards Lab** are both planning to use the platform

- Additional funding opportunities:
  - In the context of the **European Regional development funds**
    - GEP inclusion in proposal led by CNRS EOST to Interreg Alpine Space Call about Landslides mapping across the Alps
  - In the context of **EC Horizon 2020 calls** targeting the development and deployment of e-infrastructures, by fostering the innovation potential of research infrastructures:
    - EINFRA-22-2016 (DG Connect)
    - EINFRA_12 (DG Connect)
    - EO-2-2017 EO Big Data Shift (DG Research)
  - In the context of **ESA ITT** being issued starting from Q4 2017 under the "EO Exploitation Platforms" component of EOEP5 - Block4 programme of ESA

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Examples of Identified challenges/opportunities

- Extend the GEP Early Adopter programme
  - to allow achieving more impact and gather more feedback
  - to accommodate current demand that exceeds the planned 60 EA
  - to extend the pre-operations period (from 6 months to at least 12 months)

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

- Federation with DLR to support the expansion of GEP through the **Geohazards Lab**, approved by CEOS
  - Integrate innovative InSAR services of DLR
    - *e.g. TerraSAR-X based InSAR*
  - Federate with the DLR infrastructure
    - *e.g. using CODE.DE*

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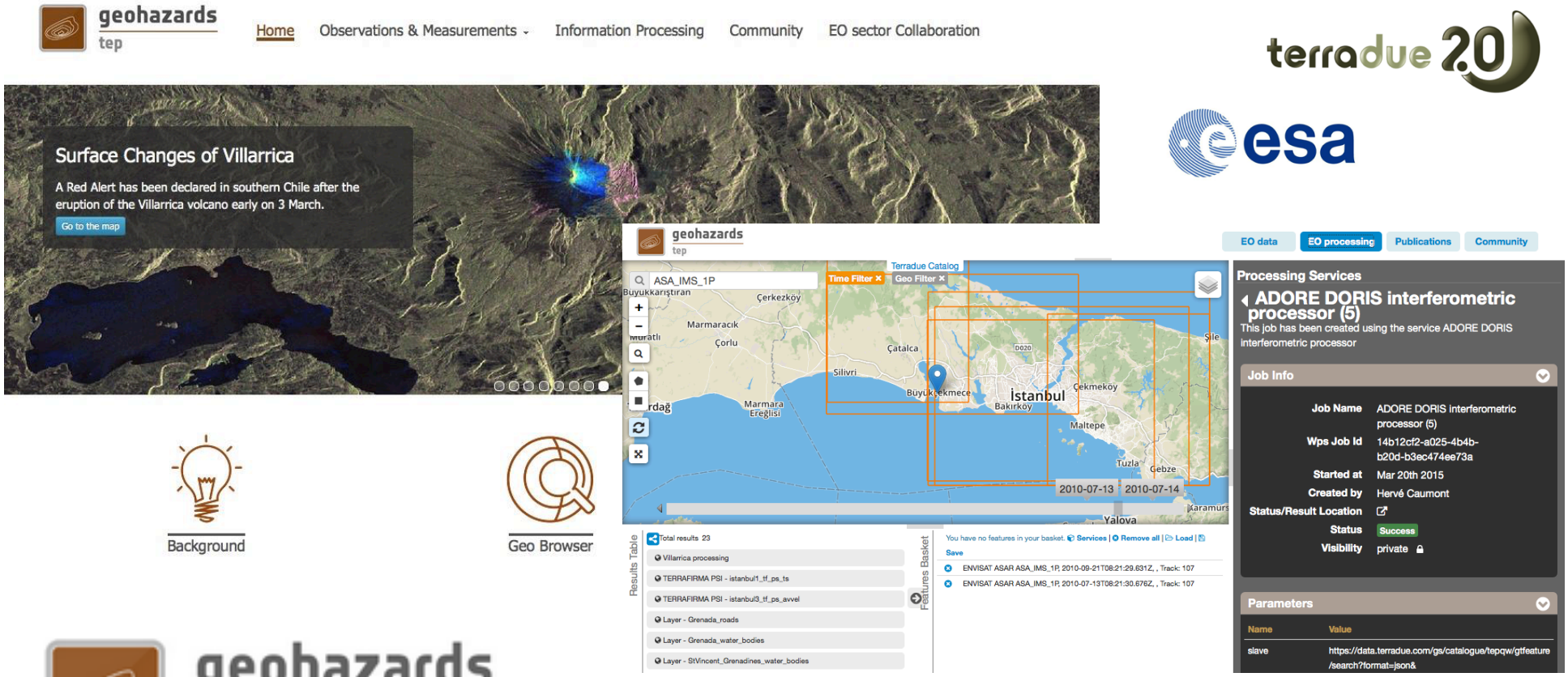

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https://geohazards-tep.eo.esa.int

WATCH THE SPACE !

Contact us: geohazards-tep@esa.int