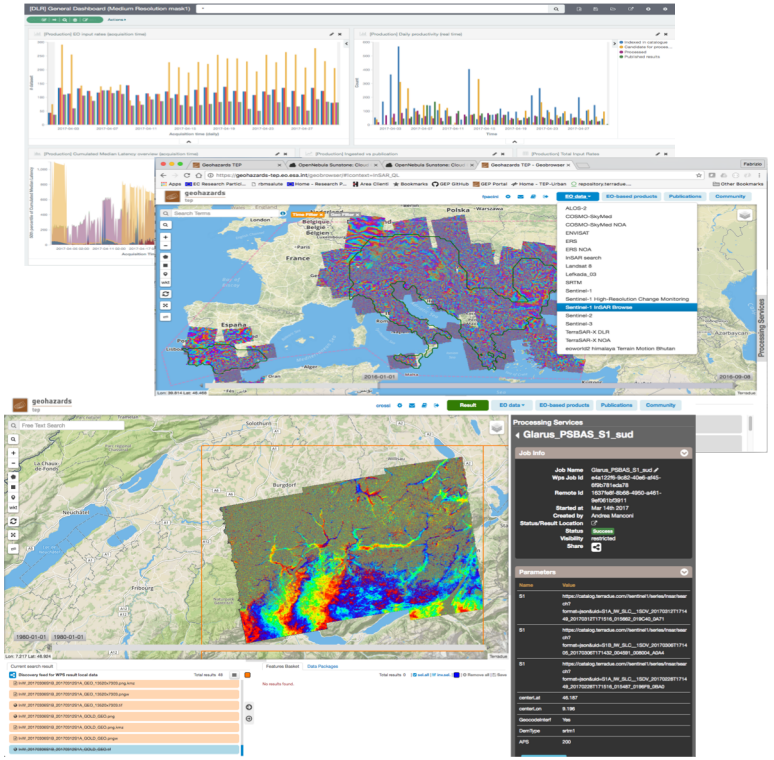
Geohazards Lab - Satellite EO exploitation and processing services to support geohazards community

MDIS 2019

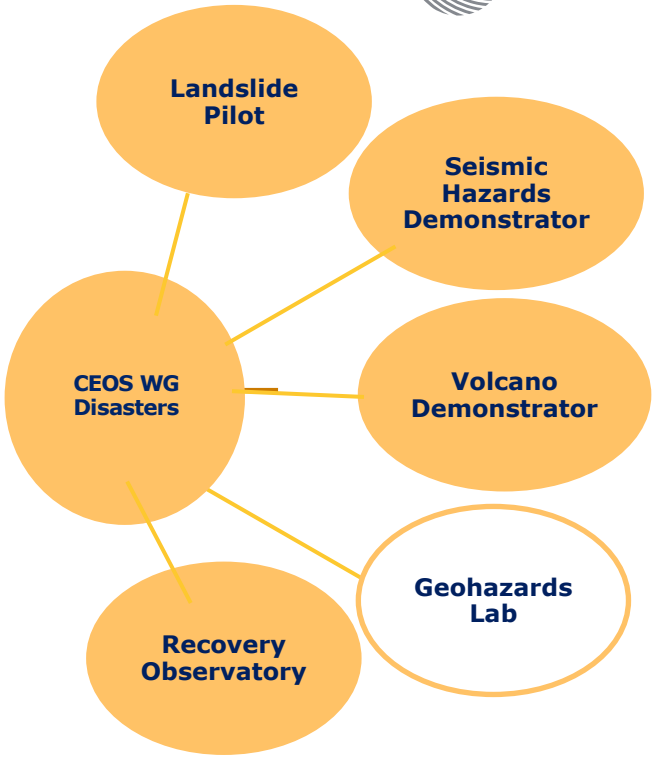
Theodora Papadopoulou, ARGANS Ltd. c/o ESA
Michael Foumelis, BRGM
Philippe Bally, ESA
Fabrizio Pacini, Terradue s.r.l.
Catherine Proy, CNES
Floriane Provost, ESA
Jolanda Patruno, RHEA Group c/o ESA



GeoHazards Lab Initiative

A platform with federated resources to **provide data access and an online processing and e-collaboration environment to exploit EO data to assess geohazards and their impact**

- ✓ Supports and complements the CEOS WG Disasters activities (on-going pilots, follow-on activities and the RO), GSNL, GEODARMA and users from the broader geohazards community.
- ✓ Maximize use of EO techniques and cloud processing by the EO expert community
- ✓ Achieve acceptance of EO products by the non-EO scientific community and decision makers



GeoHazards Lab | Contributions

- Access to the Geohazards Exploitation Platform including: data storage, processing software (InSAR and stereo-optical processing chains), e-collaboration environment;
- Man-power (staff & support under consultancy contract): scientific animation and promotion of information and results; support to coordination/governance.

- Access to the PEPS platform & products;
- Makes available CEOS and GSNL Pléiades collections through the GEP
- Man-power (staff & support contract): to support the scientific animation and promotion of EO products and results

- Shall make available CEOS and GSNL Cosmo-SkyMed collections through the GEP (already done for the Nepal event supersite). Further details TBD.

- Higher level science products derived from Sentinel-1 and TerraSAR-X data
- Access to the automated Sentinel-1 interferometric chain

Geohazards Community

Geoscience centers with EO expertise actively involved:

- BRGM [FR] provides in-kind contribution (labor) and leads the Geohazards Office
- CNR-IREA [IT] (via platform federation activities about InSAR data processing)
- CNRS EOST DSM processing and optical image correlation [FR]
- COMET [UK]
- IGME [ES]
- INGV [IT] (via the responsible of the Geohazards Supersites and Natural Laboratories initiatives)
- ISTerre / Institut de Recherche pour le Développement (IRD) [FR]
- NOA [GR]

Geoscience centres following closely the GLab activities:

- BGR [DE] (via SNGMS)
- NGU [NO]

PEPS | French Access to Copernicus Sentinels

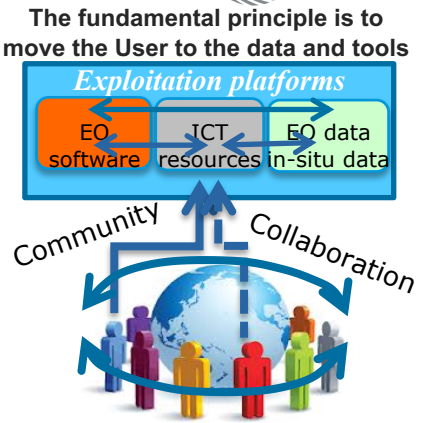
What is PEPS?

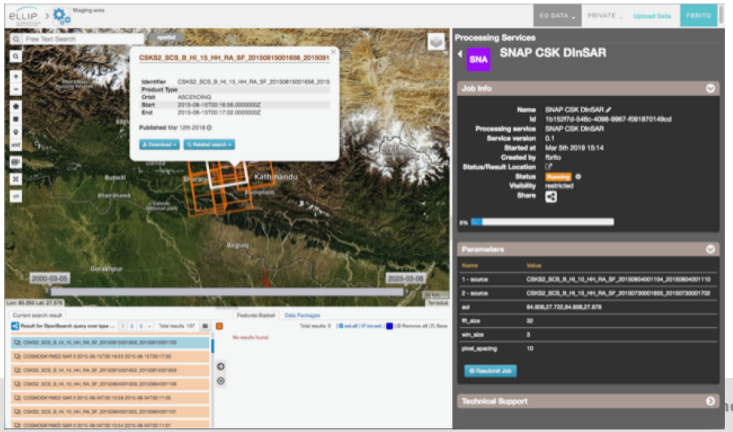
- PEPS – Satellite data distribution platform for COPERNICUS Sentinel-1, Sentinel-2 et Sentinel-3 missions.
  - Full temporal and geographical coverage (all the globe since the beginning of mission)
- Data volume : 12 Po (17 millions of products)
- Data download via dedicated interface or automated scripts
- PEPS online processing (e.g. S-2 atmospheric correction , S-1 rectification on S-2)
- PEPS also offers a capacity to host processing chains on a high performance 'cluster'

https://peps.cnes.fr

Geohazards Exploitation Platform | GEP

- One of ESA's Thematic Exploitation Platforms
- Develop a Platform based on virtualization & federation of satellite EO data and methods
- Provide **innovative responses to the geohazards community needs** (services & support)
- On-demand processing services to address AOI-specific analysis
- Systematic processing services to address needs for "common information layers"
- Massive Cloud Compute power, managing multi-tenant resources
- Access to open EO data repositories
- Access to EO data archives and specific data collections from EO missions, provided under special arrangements in the framework of the CEOS WG Disaster and the GSNL





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 on InSAR and Optical processing with Sentinel-1 and Sentinel-2

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

GEP | Other EO Resources

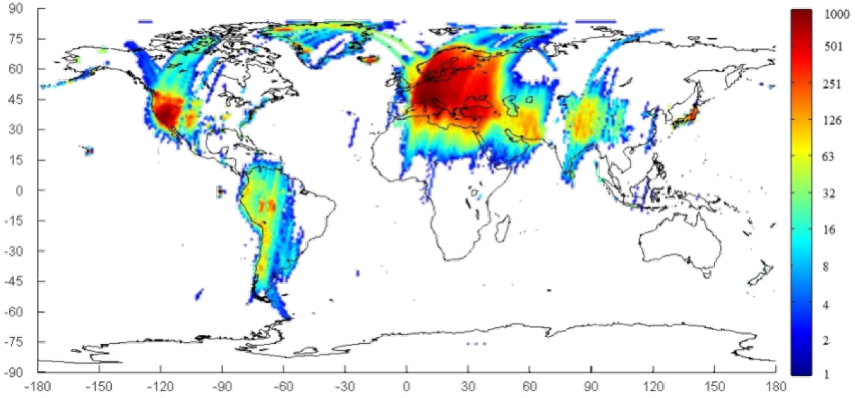
GEP has taken commitments about data access as per some recommendations associated to Fringe

- 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**
- **Pleiades** (only processing)
- **RADARSAT-2**

Spatial density of ERS & ENVISAT Level-0 data available as of December 2018



GEP| Users

Over 100 Early Adopters worldwide (primarily users from Europe, but also in Asia, Africa and the Americas) from the public (mainly) and private sector.

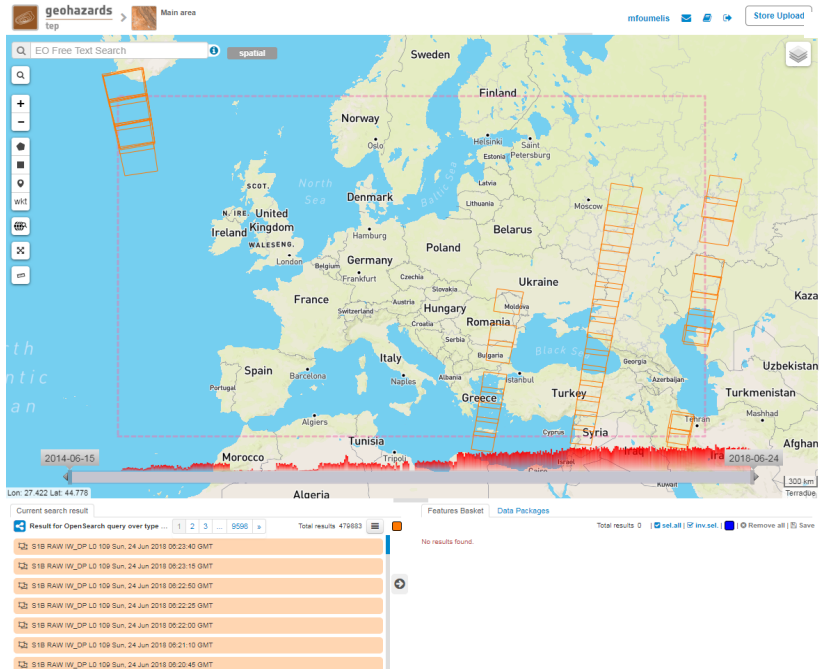
Typically geoscience centres in particular geohazard experts with skills in satellite EO that process, analyze, validate, integrate data to generate products for DRM purposes to be used by decision-makers (End Users).

End Users aren't intended to be direct users of the Geohazards Lab.

Users come ***from several groups:***

- users of thematic activities of the CEOS WG Disasters i.e. seismic, volcano, landslides and the R.O.
- the GSNL users
- other users of the geohazards community (the Geohazards Lab intends to support other users of the geohazards community that are not in CEOS WG Disaster activities)

GEP | Hosted Processing Services

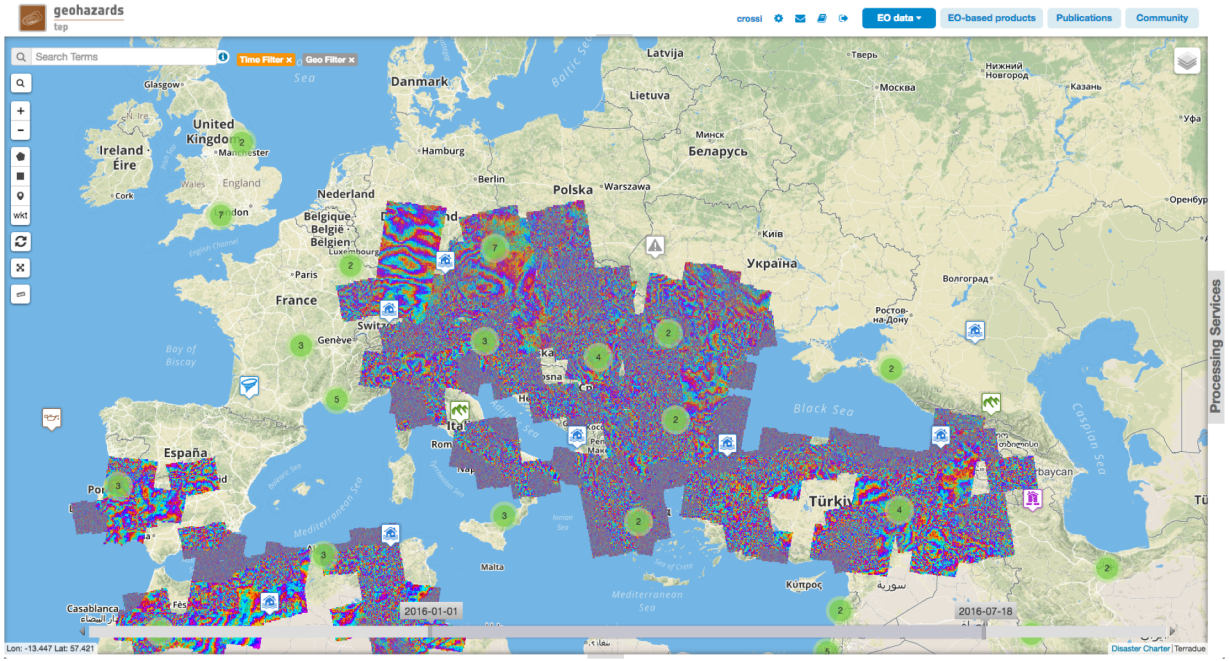


On-demand processing services **FASTVEL**, **P-SBAS**, **MPIC-OPT**, **DIAPASON**, **SNAP InSAR**, **GMTSAR**, **COIN**, **SNAC**, **RASTER** etc.

Automatic processing services **Sentinel-1 InSAR Browse** (DLR), **VEGAN** (NOVELTIS & INGV), **STEMP** (INGV)

GEP | Systematic service - Data Driven Scheduled Processing

Supported by BELNET-BEGRID (Belgium)



https://geohazards-tep.eu

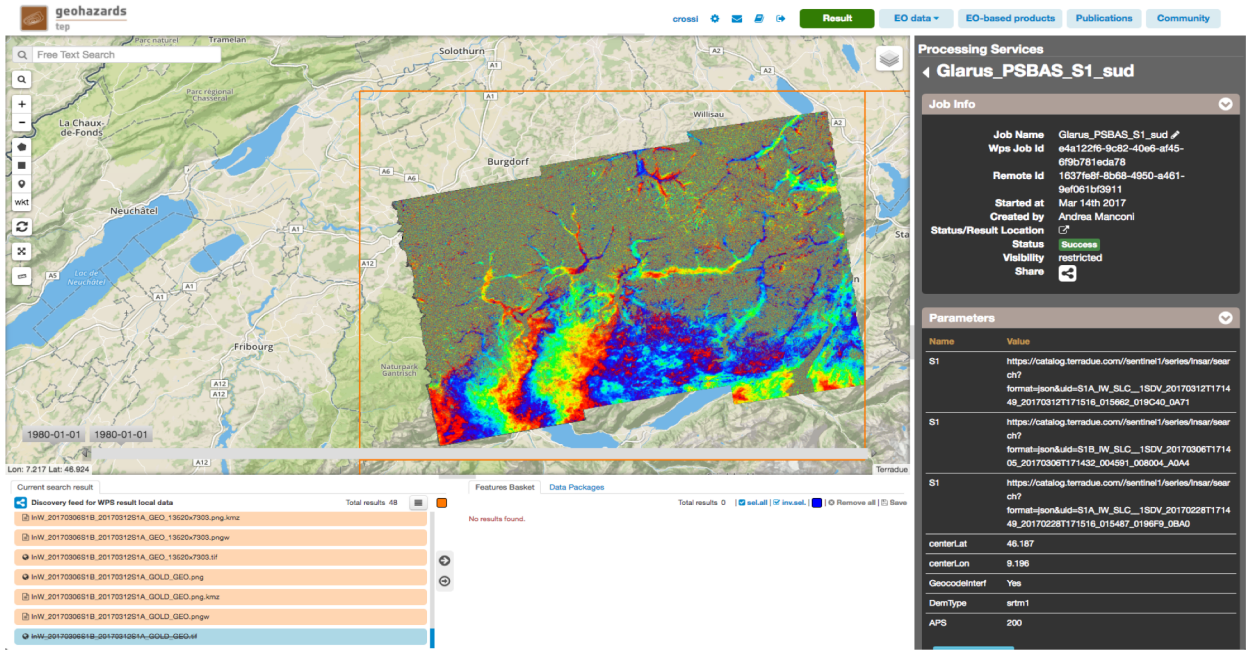
DLR InSAR Browse Medium Resolution Service

It's a data driven systematic processing. The service has followed a ramp-up process starting from Dec 2016 until Aug 2017:

- EU Tectonic area
- World tectonic area (25%)
- World tectonic area (40%)

It currently processes 150+ Sentinel-1 SLC pairs per day.

GEP | On-Demand service - User Driven Processing



https://geohazards-tep.eu

Will be supported by EGI
BELNET-BEGRID (Belgium)

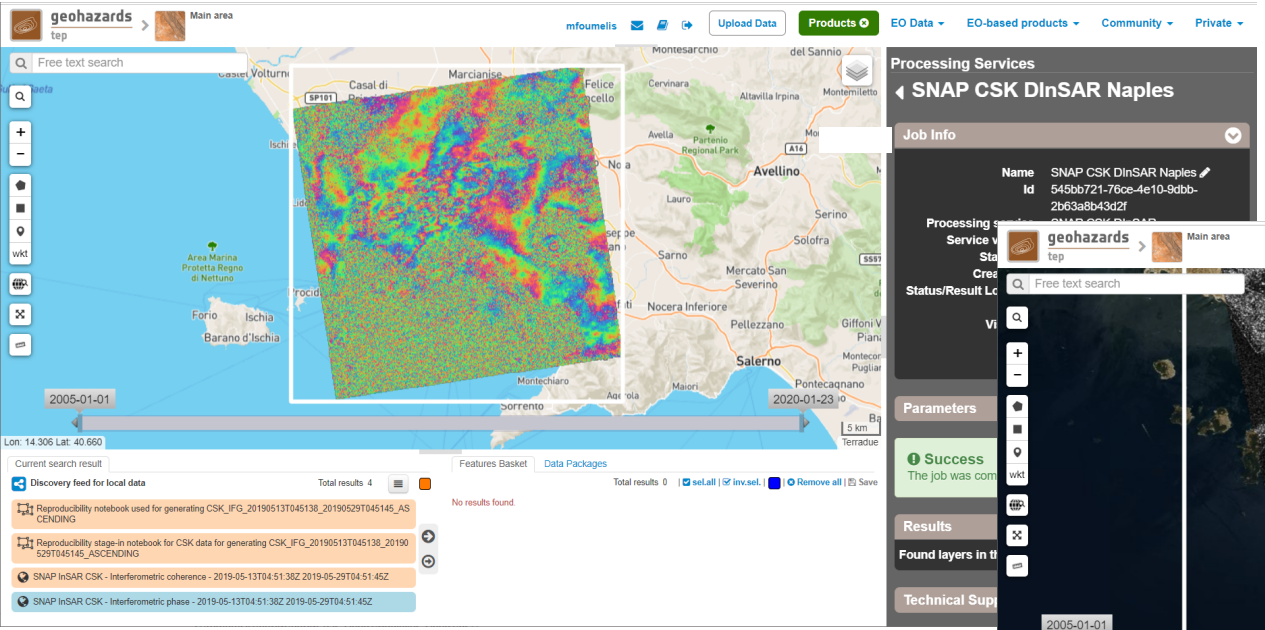
ONDA

CNR-IREA P-SBAS Sentinel-1 processing on-demand

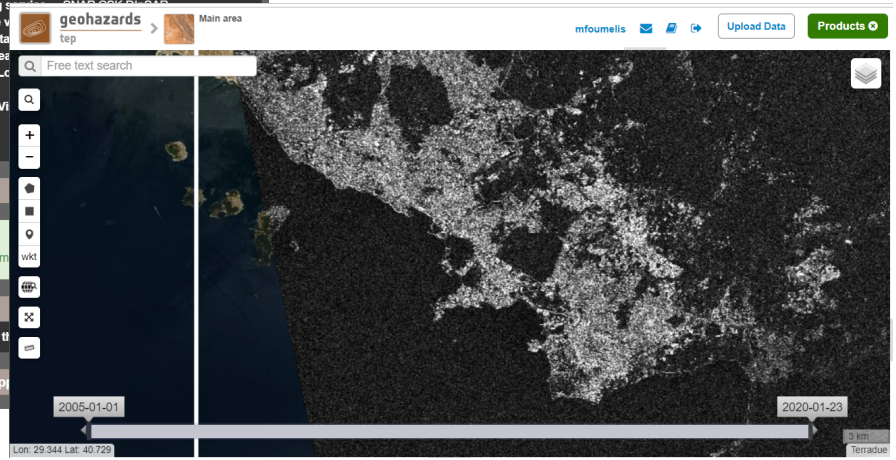
P-SBAS stands for Parallel Small BAseline Subset and it is a DInSAR processing chain for the generation of Earth deformation time series and mean velocity maps. Input: SLC (Level-1) Sentinel-1 data.

GEP | SNAP CSK DInSAR service
Products generated on GEP based on GSNL data

CSK 20190513-20190529 (16 days)
Name: SNAP CSK DInSAR Naples
Id: 545bb721-76ce-4e10-9dbb-2b63a8b43d2f



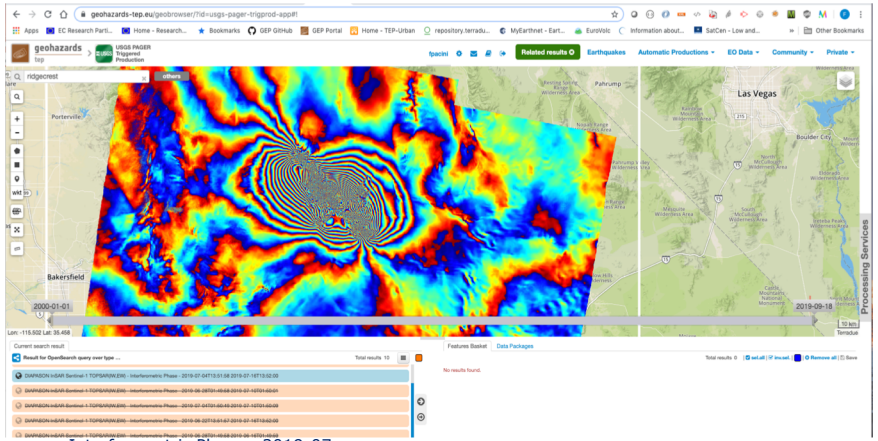
CSK ~7 months coherence
Name: SNAP CSK DInSAR Istanbul 20171023-20180503
Id: 10f67b55-7f4a-4708-a909-f54f1112fe16



GEP | Automatic Alerting System – USGS Pager

- **In operations** since July 2019
  - **Automatic trigger** based on USGS pager alerts
  - Productions with Sentinel-1 based DLR InSAR Browse and DIAPASON TOPSAR services are **triggered for each earthquake with a magnitude > 5 generating pre-, co- and post-seismic interferograms**
  - Production with Sentinel-2 based CNRS EOST MPIC-OPT service will start in October for Strike-Slip Fault Earthquakes
- **Available to GEP Early Adopters** in a dedicated thematic app
  - https://geohazards-tep.eu/geobrowser/?id=usgs-pager-trigprod-app#!&context=Earthquakes

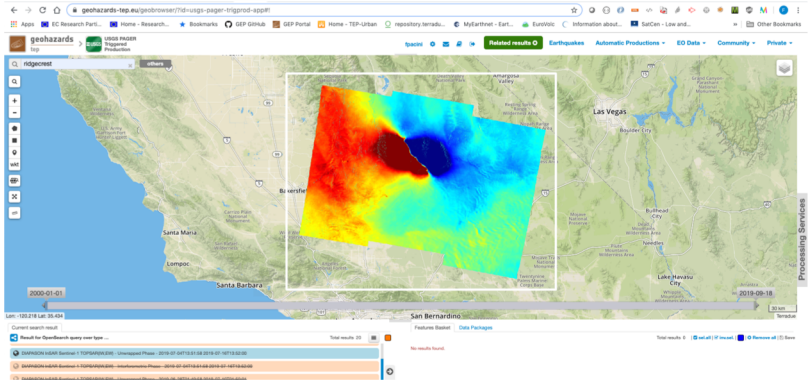
- Example: The July 6th, 2019, 03:19 UTC Mw 7.1 earthquake in eastern California, southwest of Searles Valley



Interferometric Phase - 2019-07-04T13:51:58 2019-07-16T13:52:00

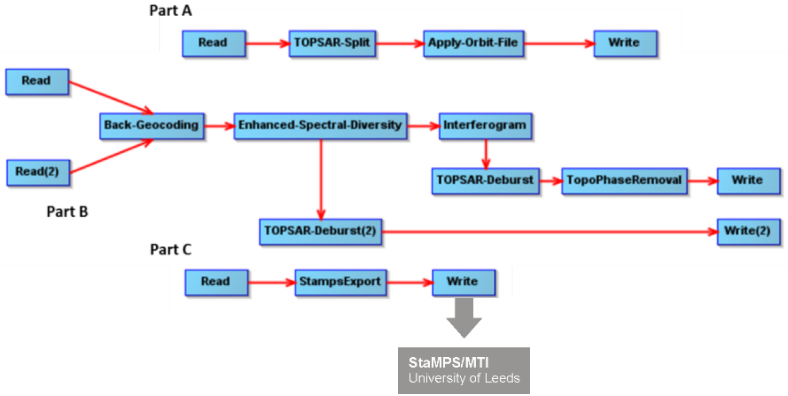
DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW)

Unwrapped Phase - 2019-06-28T01:49:58 2019-07-10T01:50:01

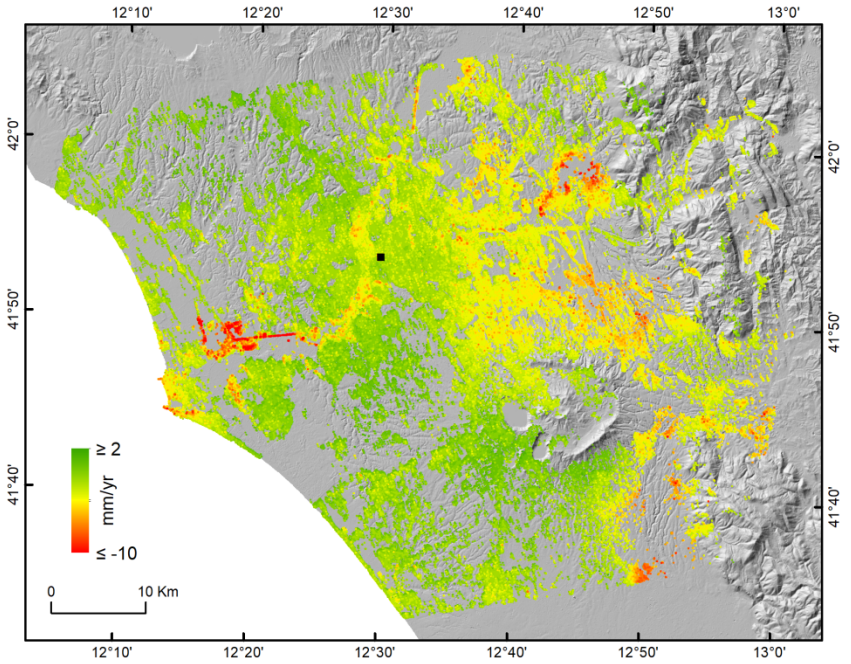


GEP | SNAP-StaMPS Sentinel-1 PSI service
(final steps of implementation)

ESA SeNtinel Application Platform SNAP
Graph Builder Processing Chains



Sentinel-1 vertical displacement rates



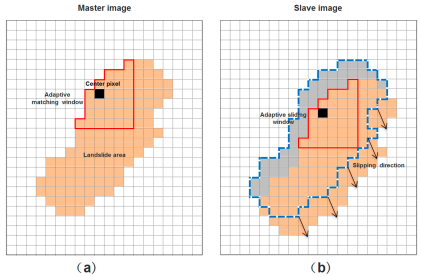
GEP | Landslide app'

École et observatoire des sciences de la Terre – Université de Strasbourg

3 main services developed by CNRS-EOST Strasbourg
Developed for landslide monitoring **but** can be applied to other objects (eg. Earthquake, volcano, glacier, etc.)

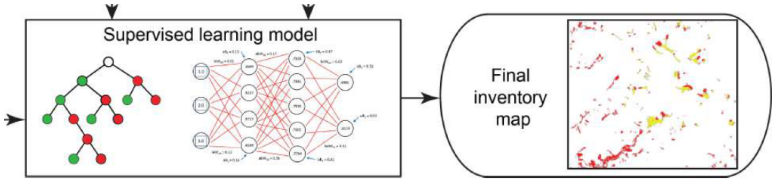
MPIC | ALADIM | DSM-OPT

Pixel-offset tracking



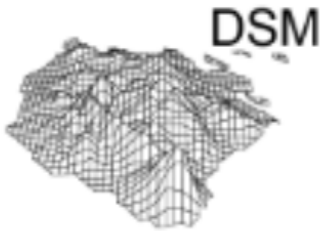
Measurement: Ground displacement
Application: local to regional scale
Satellites: Sentinel-2, Pléiades and VHR satellites (coming)

Automatic landslide detection based on Machine Learning (Random Forest)



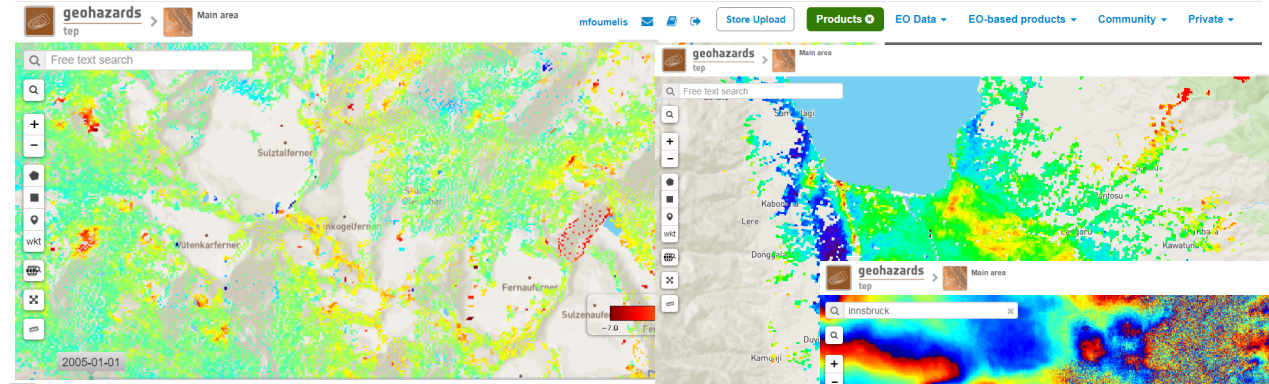
Measurement: landslide areas (polygon)
Application: regional scale
Satellites: Sentinel-2, Pléiades and VHR satellites (coming)

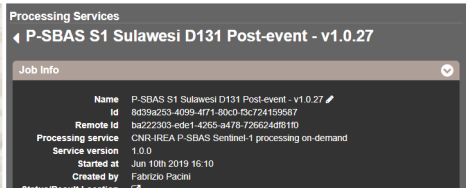
Digital surface Model

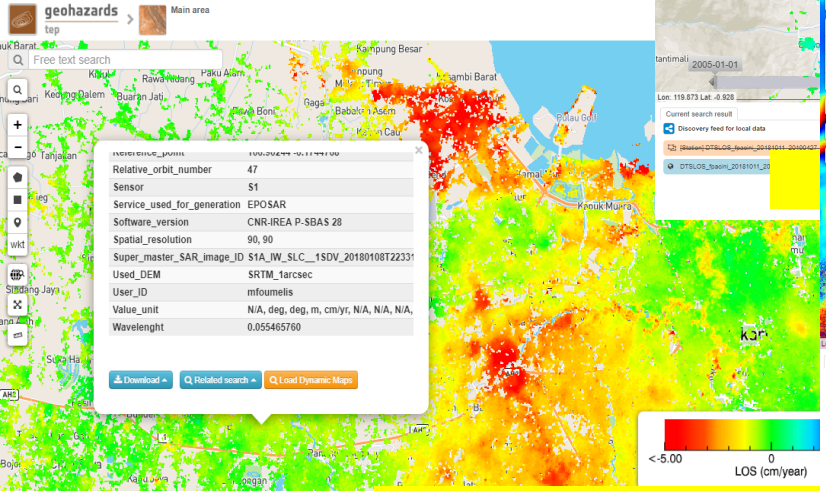


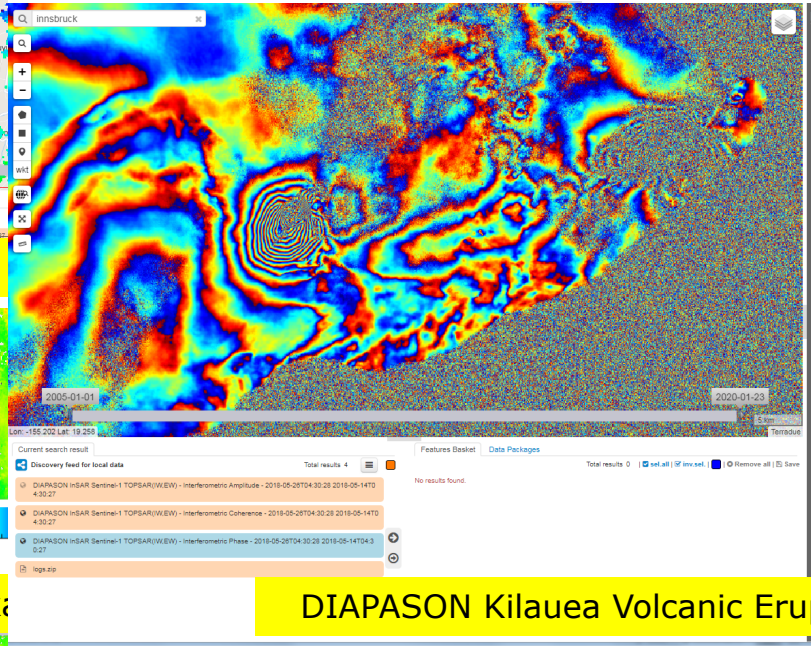
Measurement: surface elevation
Application: local to regional scale
Satellites: Pléiades and other tri-stereo VHR satellites (coming)

GEP Examples









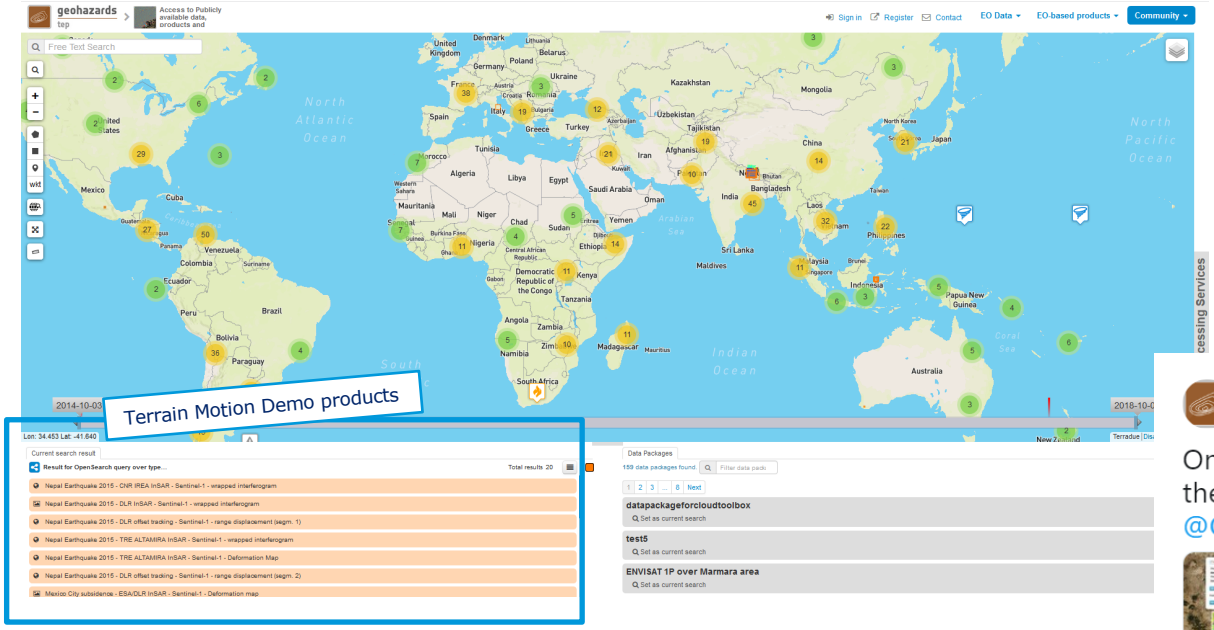
P-SBAS Subsidence in Jaka

DIAPASON Kilauea Volcanic Eruption

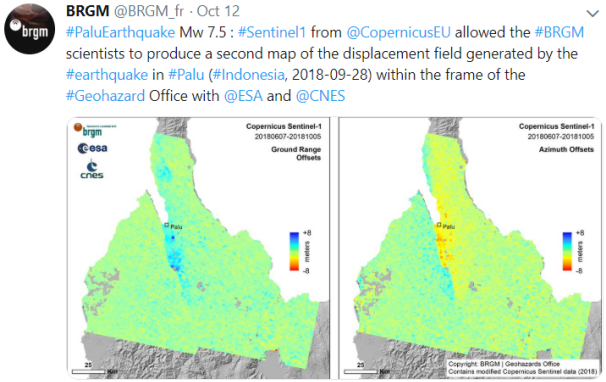
GEP | Terrain Motion Demo

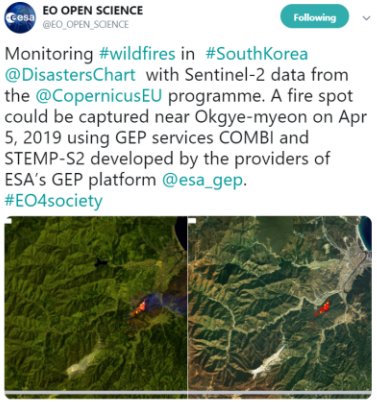
Promote use of EO for Geohazard applications

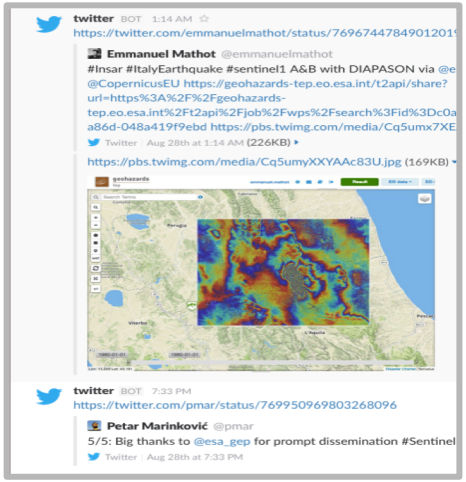
Demonstration of Ground Motion Services' products on different sites based on different terrain motion techniques using Optical and Radar data and publication on GEP.

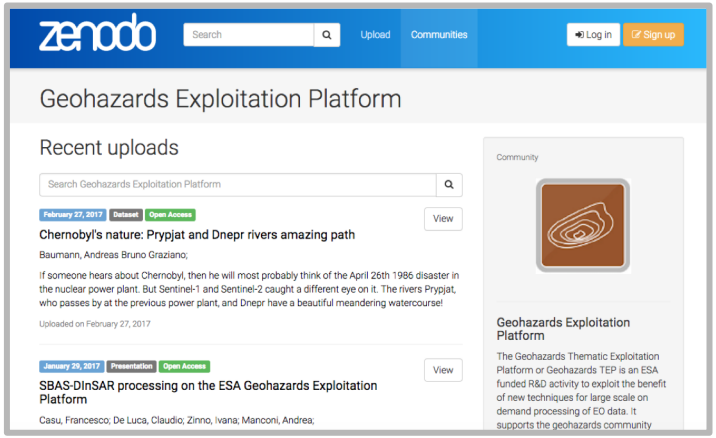


Animate & Communicate Scientific Results







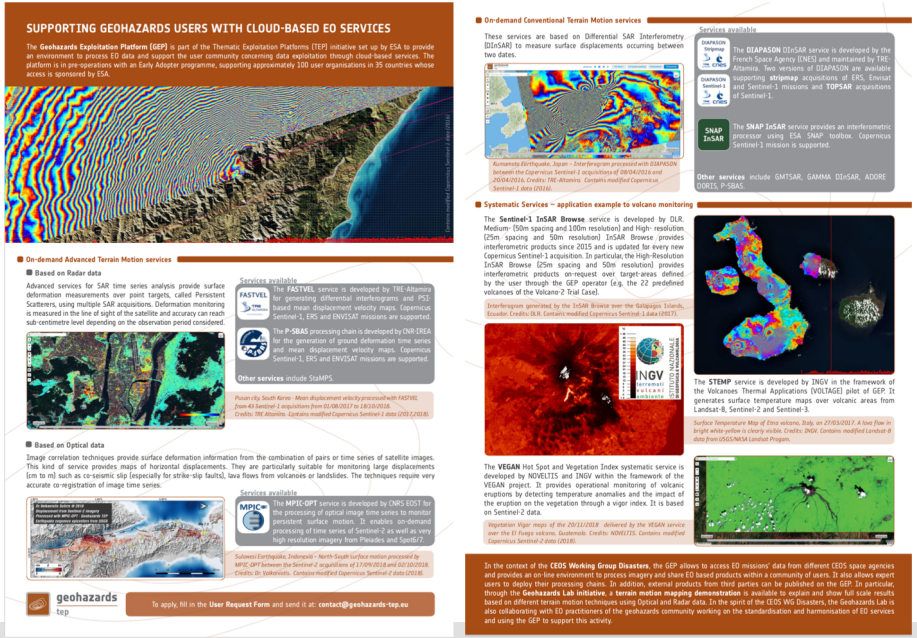


Geohazards Lab – EPOS collaboration

Proposition of collaboration between GLab and EPOS sent to EPOS TCS Satellite data:

- Inviting the EPOS community to discover and use EO processing services available on-line through the GEP platform. A Terrain Motion Demo and a brochure describing the GEP services is available (see image) to help users familiarize with cloud-based processing services.

- Sharing with the EPOS TCS Satellite Data, guidelines about the standards associated to EO based terrain motion measurements and take on board their views.



This proposition aims to foster:

- federation of EO cloud-based processing resources
- broader use of EO hosted processing services based on common standards
- interoperability of results obtained by different services and data providers

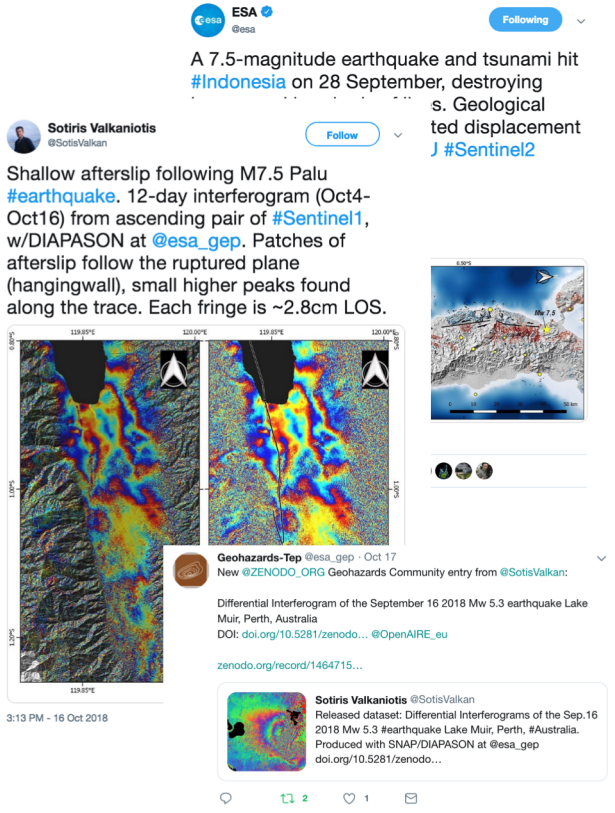
Geohazards Lab - Take-home Messages

Benefit from **fast access** to EO data, **storage** capacity and **processing** resources offered by platform-based solutions

A hosted processing platform is a **partnership** that needs the support of scientist/developer to offer operational services providing value added information to the community

Platform **e-collaboration** and **reproducible knowledge** promote innovation and response capacity

Communities remain owners of their created assets, and decide how to share these on the platforms



Thank you

Theodora Papadopoulou
tpapadopoulou@argans.co.uk

Philippe Bally
Philippe.bally@esa.int

Michael Foumelis
m.foumelis@brgm.gr