CEOS Disaster Risk Management

CEOS WG Disasters

The Geohazards Lab

CEOS WG Disasters 11th meeting

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Floriane Provost, ESA
Aims to address priorities of the Sendai Framework for Disaster Risk Reduction 2015-2030 using satellite EO (focus: better understanding hazards & risks).

Supports and complements the CEOS WG Disasters activities (on-going pilots, follow-on activities and the RO), GSNL, GEODARMA and other relevant initiatives.
• 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.

• **Processing services** developed by the French Solid Earth community within the forM@Ter data centre including systematic InSAR processing, DEM processing and optical image correlation;

• **Cosmo-SkyMed collections** for CEOS WG Disasters and GSNL are made available through the GEP;

• **Higher level science products** derived from Sentinel-1 and TerraSAR-X data

• Access to the **automated Sentinel-1 interferometric chain**
Thematic users are proposing to take part to the Geohazards Lab activity about platform specific issues.

GeoHazards Lab | Contributions from the 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** [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]
The idea of the Geohazards Lab

CEOS WG Disasters

- Seismic Demonstrator
- Volcano Demonstrator
- Landslide Pilot
- Recovery Observatory

GEO

- GEO-DARMA
- GSNL

Geohazards community users

- Upload data collections on GEP
- Integrate processing tools and services

Geohazards Lab

- Geohazards Office

Space agencies

- Integrate processing tools and services
- Access and links to federated resources
- Man-power support

Submission of data requests

Data provision

Access and visualize open data and dedicated data collections

Access online processing tools and services

Share results
Concrete objectives

Not on an emergency basis

Support the CEOS activities, the GSNL, GEO-DARMA and the broader geohazards community by (i) providing data delivery, access to tools and hosted processing for geohazards assessment and (ii) working on the standardization of EO products

On an emergency basis

Pursue and support the generation and distribution of advanced science products based on terrain motion mapping, landslide monitoring, thermal signatures of volcanic eruptions etc.
Consortium: Terradue [lead] (IT), TRE ALTAMIRA (ES), CNR IREA (IT), DLR (DE), EOST-CNRS (F), ENS-CNRS (F), INGV (IT)

• 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 Copernicus Sentinels-1/2/3 repositories
➔ Access to 70+ TB of EO data archives (ERS and ENVISAT), 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 the GSNL
GEP | Roadmap

As of May 2018:
860+ registered users

GEP v1 validation with early adopters
Limited to early adopters (under invitation), evolution of the service on-going
February 2015 to December 2016

GEP v2 engineering
Open under invitations/approval
Consolidation and evolution of the service
Access to EPOS IP users (within available slots)
November 2015 to January 2018

GEP v2 pre-operations

GEP v2 pre-ops ext.
Open, consolidated and stable service
December 2016 to December 2018

Today

22 platform early adopters
integrating application or exploiting on demand processing

50 platform early adopters
28 new users in the period

100 platform early adopters
40+ new users in the period

As of May 2018:
860+ registered users
That is 21 users from the GEP Consortium and 67 users from the community via the early adopters programme in 33 countries.

Mainly European users, but also users from the rest of the world: Asia (Turkey, Thailand, Indonesia, China, Malaysia, Japan, Iran & South Korea), Africa (Morocco, Algeria, Nigeria), Latin America (Ecuador, Mexico and Chile) and North America (Canada, USA).
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 life of the satellites)
- Data volume : +4 Po (5 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'
PEPS offers the possibility of experimenting with a service or a processing chain as close as possible to the storage archive using the CNES computing cluster:

- Quick and direct access to the entire archive of Sentinels 1, 2, 3
- Access to data as soon as they are made available by ESA
- Provision of high computing power: High Performance Computing Cluster (HPC), 8000 cores
- Treatment hosting infrastructure based on the WPS standard, open to the docker technology and offering an orchestrator to parallelize and distribute the treatments on the resources
- Supervision and technical support - thematic and computer
GeoHazards Office Goals:

- Full in line with the GeoHazards Lab Implementation Plan
- Liaise with the geohazards community to promote their results when using the GeoHazards Lab resources
- Develop collaboration with experts to harmonize and improve acceptance of platform based EO techniques
- Demonstrate and showcase hosted processing services for terrain motion mapping
Support CEOS activities, the GSNL and GEO-DARMA

- Agreement with CNES to bring Pleiades data on GEP for on-line processing.
  - First dataset under integration (by authorized user) ONLY for online processing
  - License signed by GEP operator. FTP under preparation by Airbus.

Pursue and support the generation and distribution of advanced science products

- Integration of SNAP-StaMPS on GEP started (BRGM, University of Leeds)
- SBAS Sentinel-1 Surveillance service for ground deformation monitoring (generates updated surface displacement time series via the P-SBAS-InSAR algorithm) fully integrated (CNR-IREA).
- Integration of Volcanic Plume Elevation Model (VPEM) on GEP to start shortly (BRGM)
- CSK DInSAR chain under integration (BRGM)
- MPIC-OPT (measuring horizontal displacement-series of optical satellite images) available on GEP by University of Strasburg/CNRS-EOST
- DSM-OPT available on GEP by University of Strasburg/CNRS-EOST
- Terrain Motion Demo is under preparation by ESA and BRGM
- Federation between GEP and CNRS EOST’s HPC to start shortly
Example of activity | SNAP-StaMPS integrated Sentinel-1 PSI processing
Example of activity:
SNAP COSMO-SkyMED DInSAR service

Develop & Harmonize

Expansion of SNAP services on GEP to support TPM interferometric processing (on-going)

CSK_Stack_CrossCor.Wrap_Lfg.xml
CSK_TopRem_ML_Flt_Sub.xml
CSK_TC.xml
Example of activity: Processing Pléiades on-line

DSM-OPT service on-line on GEP: creation of High-Resolution Digital Surface Models (HR-DSMs) and orthophotos from Pléiades stereo-images
Example of activity:
Processing Pléiades on-line

DSM-OPT service on-line on GEP: creation of High-Resolution Digital Surface Models (HR-DSMs) and orthophotos from Pléiades stereo-images

Hillshade of a HR-DSM (0.5m) over the city of Strasbourg / Pléiades stereo of Sept. 2016
Example of activity: Processing Pléiades on-line

DSM-OPT service on-line on GEP: creation of High-Resolution Digital Surface Models (HR-DSMs) and orthophotos from Pléiades stereo-images

Ortho-images of a HR-DSM (0.5m) over the city of Strasbourg / Pléiades stereo of Sept. 2016
Example of activity:
Processing Pléiades on-line

LICENCE TO USE PLEIADES PRODUCTS GRANTED
AT A PREFERENTIAL PRICE BY CNES TO CATEGORY 1 INSTITUTIONAL
USERS AND ASSIMILATED CATEGORY 1 INSTITUTIONAL USERS UNDER
THE ISIS - PLEIADES PROGRAMME

Please read the terms and conditions of this User Licence Agreement carefully before placing any
orders for Protected Products.

INTRODUCTION

In the framework of the public service delegation agreement concerning the operations of the Pléiades satellites
concluded between CNES and Airbus DS (subsequently referred to as the “DSP”), Airbus DS has committed itself to
distribute Pléiades products and services for the benefit of AUTHORISED INSTITUTIONAL USERS in order to
fulfill their responsibilities in the frame of their institutional mission for NON-COMMERCIAL SERVICES.

CNES and Airbus DS have opened the ISIS programme to Pléiades products allowing eligible users (European
scientific community) to obtain Pléiades images under special ISIS programme preferential pricing conditions, based
on DSP Category 1 pricing.

Accomplishing any of the following acts implies acceptance by the USER of the terms of the present Licence
Agreement (hereinafter “Licence”):

Management of the Pléiades license through GEP (for CEOS-related images)
Example of activity: 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.
  - Published on GEP

EO satellites
- Sentinel-1 & 2,
- Envisat, ERS-1&2,
- TSX, CSM,
- Pléiades...

Providers
- DLR, INGV, TRE-ALTAMIRA, CNR-IREA...

Ground Motion Processing
- Diapason, SNAP,
- MicMac, P-SBAS,
- MPIC-OPT,
- PSinSAR®,
- SqueeSAR®

Geohazard
- Earthquake,
- Volcano, Ground subsidence,
- landslide...

Example of activity:
Terrain Motion Demo
- Sentinel-1 & 2, Envisat, ERS-1&2, TSX, CSM, Pléiades...
- DLR, INGV, TRE-ALTAMIRA, CNR-IREA...
- Diapason, SNAP, MicMac, P-SBAS, MPIC-OPT, PSinSAR®, SqueeSAR®

Earthquake, Volcano, Ground subsidence, landslide...
Example of activity: Terrain Motion Demo

- Example for the Sulawesi Earthquake 2018:

  - Co-seismic
    Sentinel-2, MPIC (offset tracking)
    Sentinel-1, SNAP (offset tracking)
    Sentinel-1, Diapason (InSAR)

  - Pre-seismic
    Sentinel-1, FASTVEL (PSInSAR)
- Organization of advisory **WG meetings** collocated to other relevant events (CoV 2018, ESA EO Φ-week & Living Planet 2019)

- Revival of the **CIEST** «Cellule D'intervention et d'Expertise Scientifique et Technique» collaborative framework between research institutes → Rapid response to earthquake events by e-collaboration within hosted processing platforms (GEP & PEPS)

- Co-Organization with Univ. of Strasbourg (EOST) of next **MDIS** (Mesure de la Déformation par Imagerie Satellite) conference of the Form@Ter group (Oct 2019)

- Communicate **scientific results** obtained using hosted processing services
The GeoHazards Office is a GEO initiative and part of the GEO Harmonized GEO祝福 | 网站（尚未上线）

This GeoHazards initiative is an activity integrated in the GeoHazards Office initiative within the Committee on Earth Observation Satellites (CEOS). Working Group on Missions for GEO祝福 (WG-GeoNat) to enable a greater use of Earth Observation (EO) data and derived products to assess geo-hazard and their impact.

This GeoHazards initiative is a group effort, supported by GEO members, with the aim to develop a collaborative framework to support geo-hazard management and to coordinate efforts in the field of geo-hazard monitoring. The initiative involves various GEO members, including the European Space Agency (ESA), the French Space Agency (CNES), and the German Aerospace Research Center (DLR).

In this context, the GeoHazards Office is established and supported by GEO members, collaborating with CEOS WG-GeoNat to develop a collaborative framework to support geo-hazard management and to coordinate efforts in the field of geo-hazard monitoring. The initiative involves various GEO members, including the European Space Agency (ESA), the French Space Agency (CNES), and the German Aerospace Research Center (DLR).
Example of activity:
GeoHazards Office | Animate & Communicate Scientific Results

Sulawesi Earthquake (Indonesia)

The Copernicus Emergency Management Service is a key tool providing understanding of the situation on the ground, thus assisting the European Union’s Civil Protection Mechanism, activated following a request for assistance from the government of Indonesia. The Emergency Response Coordination Centre is working hard to deliver offers of assistance to the affected areas. One of the ways in which ESA is contributing to this area is through feeding a range of satellite data into the framework of the Committee on Earth Observation Satellites (CEOS) Working Group on Disasters.
“Cellule d’Intervention et d’Expertise Scientifique et Technique (CIEST)”

From satellite platforms to geophysical knowledge: rapid response to geohazards in seismotectonics

Collaborative framework between research institutes of ForM@Ter group

Community building at the French level:

CNES, BRGM, IPGP, CEA, CNRS (ENS Paris), EOST, Uni Grenoble, Uni Clermont Ferrand (other)

Community building at EU level (Mediterranean tectonics):

BRGM, INGV, NOA, KOERI, IGME

For generating geophysical knowledge using EO processing platforms (but not limited to, e.g. modelling & value added maps)
A scientific advisory Working Group (WG) is set up

Purpose: *Work on the definition and harmonization of EO products for geohazards applications (terrain motion mapping, landslide monitoring etc.)*

- 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
- Facilitate interpretation and improve understanding of EO products (and derived information) by end-users

- **Preparatory meeting held** on 5 September 2018, Naples, Italy: Introduction to the concept and roadmap of activities
- **1st meeting of the WG** held on 16 November 2018 at Frascati, Italy (during the Φ-Lab week)
Standardization of EO results & formats

- Requirements based on both the thematic domains and EU legislation for geospatial information

Independent activities cannot achieve wide acceptance

EPOS  
INSPIRE OGC  
GOffice  
CEOS WG Disasters GLab  
SNGMS  
Norwegian NGMS

Cartographic & IT requirements

http://inspire.ec.europa.eu
http://www.opengeospatial.org
GLab Working Group | Addressing Standardization Issues

Standardization of EO results & formats → Earthquakes & Landslides

- A family of techniques (Image Matching/Correlation or Offset Tracking) not yet properly addressed in terms of standardization.
Standardization of EO products

Completed:
- Investigate whether standards for SAR and InSAR products are being defined by OGC
- **Proposition of collaboration between GLab and EPOS** sent to EPOS TCS Satellite data (awaiting response from EPOS)
  - The WG agreed to propose to EPOS to allocate the output of their work under the EPOS framework (at least for Europe) to facilitate acceptance by EO practitioners and decision makers.
- Preparation and dissemination of a **brochure describing the GEP services** in view of use by the EPOS community

Foreseen for Q3 2019:
- Organize a **benchmarking activity for a landslide site** in the French Alps and address capabilities, drawbacks and complementarities of EO monitoring (ImCor, DInSAR, PSI, etc.)
- Gather inputs on EO products, formats and metadata used in their institutes
- Collect and analyse the variables delivered by different data providers for SAR, InSAR, PSI and ImCor techniques
- Prepare and circulate a **doc/survey summarizing existing products and formats**, incl. proposed generic standards addressing user needs
**SUPPORTING GEOHAZARDS USERS WITH CLOUD-BASED EO SERVICES**

The Geohazards Exploitation Platform (GEP) is part of the Thematic Exploitation Platforms (TEP) initiative set up by ESA to provide an environment to process EO data and support the user community concerning data exploitation through cloud-based services. The platform is in pre-operation with an Early Adopter programme, supporting approximately 100 user organisations in 35 countries whose access is sponsored by ESA.

**On-demand Advanced Terrain Motion services**

**Based on Radar data**

Advanced services for SAR time series analysis provide surface deformation measurements over point targets, called Persistent Scatterers, using multiple SAR acquisitions. Deformation monitoring is measured in the line of sight of the satellite and accuracy can reach sub-centimetre level depending on the observation period considered.

**Based on Optical data**

Image correlation techniques provide surface deformation information from the combination of pairs or time series of satellite images. This kind of service provides maps of horizontal displacements. They are particularly suitable for monitoring large displacements (cm to m) such as volcanic eruptions (especially for strike-slip faults), lava flows from volcanoes or landslides. The techniques require very accurate co-registration of image time series.

**Services available**

- **FASVEL**
  - The FASTVEL service is developed by TREC-Austria for generating differential interferograms and PSI-based mean displacement velocity maps. Copericus Sentinel-3, ERS and ENVISAT missions are supported.
  - The PSI processing chain is developed by DLR for the generation of ground deformation time series and mean displacement velocity maps. Copericus Sentinel-1, ERS and ENVISAT missions are supported.
  - Other services include StMPs

- **MPIC-DOP**
  - The MPIC-DOP service is developed by CNR-ESTR for the processing of optical image time series to monitor volcanic surface motion. It provides deformation monitoring at all time series of Sentinel-2 as well as very high-resolution imagery from Probes and Spire.

**Systematic Services – application example to volcano monitoring**

The Sentinel-1 InSAR Browse service is developed by DLR, Medium (70m spacing and 100m resolution) and High-resolution (25m spacing and 90m resolution) InSAR Browse provides interferometric products since 2015 and is updated for every new Copericus Sentinel-1 acquisition. In particular, the High-resolution InSAR Browse (25m spacing and 90m resolution) provides interferometric products on request over target areas defined by the user through the GEP operator (e.g. the 22 predefined volcanoes of the Volcanic Eruption Test Case).

**Other services** include GMSAR, Gamma D3 SAR, Adore et al., P-SAR.

**Promotional Brochure for EPOS users**

The DEPAISON D3SAR service is developed by the French Space Agency (CNES) and maintained by TREC-Austria. Two versions of DEPAISON are available: supporting stripmap acquisitions of ERS, Envisat and Sentinel-1 missions and TOPS acquisitions of Sentinel-1.

The SNAP ISAR service provides an interferometric processor using ESA SNAP toolbox. Copericus Sentinel-1 mission is supported.

The STERN system is developed by INFN in the framework of the Volcanic Eruption Applications (VOVATE) project of GEP. It generates surface temperature maps over volcanic areas from Landsat-8, Sentinel-2 and Sentinel-3.

The VEGAN Hot Spot and Vegetation Index systematic service is developed by NOVETEC and INGV within the framework of the VEGAN project. It provides operational monitoring of volcanic eruptions by detecting temperature anomalies and the impact of the eruption on the vegetation through a vigour index. It is based on Sentinel-2 data.

**To apply for the User Request Form and send it at: contact@geohazards-top.eu**

In the context of the EPOS Working Group Disasters, the GEP allows access EO missions’ data from different EPOS space agencies and provides an online environment to process imagery and share EO-based products within a community of users. It also allows support users to deploy their processing chains. In addition, external products from third parties can be published on the GEP. In particular, through the Geohazards Lab initiative, a terrain motion imaging demonstration is available to system and show full-scale results based on different terrain motion techniques using Optical and Radar data. In the spirit of the EPOS WG Disaster, the Geohazards Lab is also collaborating with EO practitioners of the geohazards community working on the standardisation and harmonisation of EO services and using the GEP to support this activity.
A new platform functionality is being implemented on the GEP in order to be able to **trigger services based on events polled from external systems**

- **Actuators** are event-based components able to start specific data discovery, ingestion, caching and processing workflows

- The following actuators will be implemented
  - **USGS pager** based on the ATOM Syndication (https://earthquake.usgs.gov/earthquakes/feed/)
  - **@INGVterremoti** twitter feed based on the earthquake magnitude
  - **Copernicus EMS** rapid mapping and risk & recovery feeds
  - **UNOSAT/GDACS** disaster feed
For each new feed/tweet informing about an earthquake with a magnitude > X (configurable threshold), the actuator starts an embedded workflow that:

- creates an **earthquake event** in a specific index in the GEP catalogue
- searches for specific **datasets** based on specific sources intersecting the lat/lon point of the event, in the pre- and post-event temporal period
- for each dataset/pair/stack found, caches and harvests the datasets and starts **automatic production of deformation maps** with different GEP processing services
- **publishes** the generated maps in a specific index in the GEP catalogue linked to the originating event
The following **GEP processing services** will be initially triggered by the actuators:

- CNRS-EOST MPIC-OPT (optical - Sentinel-2 / Pleiades)
- DLR InSAR Browse (InSAR – Sentinel-1)
- SAR Pixel Offset Tracking (InSAR – Sentinel-1)
- SNAP InSAR (InSAR – Sentinel-1 / COSMO SkyMed)
- DIAPASON TOPSAR (InSAR – Sentinel-1)
- CNR IREA P-SBAS (InSAR – Sentinel-1)

The actuators framework is designed to support triggering of any service integrated on the GEP for any type of event.
**Presentations and posters**

- **Oral presentation accepted**: Geohazards Lab - Satellite EO exploitation and processing services to support the geohazards community, LPS 2-019 13-17 May 2019, Milan, Italy
- **Poster accepted**: The geohazards Exploitation Platform – An innovative approach for online processing, LPS 2-019 13-17 May 2019, Milan, Italy
- **Abstract submitted**: The Geohazards Lab initiative in support of the geohazards community, EGU 2019, Vienna, Austria
- **Generating InSAR products with COSMO-SkyMed and TerraSAR-X imagery in the Geohazards Exploitation Platform (GEP) to support the CEOS Recovery Observatory in Haiti**, Φ-week, 12-16 November 2018, Frascati, Italy

**Papers**

- **Abstract submitted**: Monitoring geohazards using on-demand and systematic services on ESA’s Geohazards Exploitation Platform, IGARSS 2019

**Training**

- **Upcoming training**: Capacity building exercise for the Central Sulawesi Earthquake-Tsunami Reconstruction Plan, Jakarta, Indonesia
- **Hands-on InSAR (ESA software and on-line tools)**, 21-25 September 2018, Corinth, Greece

**Web articles and social media**

- [http://www.esa.int/spaceinimages/Images/2018/10/Indonesia_earthquake_displacement_map](http://www.esa.int/spaceinimages/Images/2018/10/Indonesia_earthquake_displacement_map)
### Status and milestones

<table>
<thead>
<tr>
<th>Milestones of the Implementation Phase</th>
<th>Status Q1 2018</th>
<th>Status Q3 2018</th>
<th>Status Q1 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expand integration of services and tools to better meet community needs</td>
<td>Started</td>
<td>On-going</td>
<td>On-going</td>
</tr>
<tr>
<td>Document procedures to access and use processing chains</td>
<td>Not started</td>
<td>Not started</td>
<td>Not started</td>
</tr>
<tr>
<td>Define protocol with CEOS agencies that contribute to the Geohazards Lab. As a baseline ESA will provide access to the GEP</td>
<td>Not started</td>
<td>Started</td>
<td>On-going</td>
</tr>
<tr>
<td>Enhance procedure to make data available in a timely fashion</td>
<td>Not started</td>
<td>Not started</td>
<td>Started</td>
</tr>
<tr>
<td>Develop a Website/Webpage</td>
<td>Not started</td>
<td>Started</td>
<td>On-going</td>
</tr>
<tr>
<td>Promote hosted processing and raise awareness (capacity building, training courses, workshops)</td>
<td>Started</td>
<td>On-going</td>
<td>On-going</td>
</tr>
<tr>
<td>Analyse geohazards community requirements</td>
<td>Not started</td>
<td>Started</td>
<td>On-going</td>
</tr>
<tr>
<td>Develop collaborative framework with geoscience centres and other initiatives to define common standards/methodologies</td>
<td>Not started</td>
<td>Not started</td>
<td>Started</td>
</tr>
<tr>
<td>Work on harmonization and improvement of EO results</td>
<td>Not started</td>
<td>Not started</td>
<td>Started</td>
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</table>
Glab initiative kick-off in Q3 2018
1st Geohazards Lab meeting held in November 2018
Geohazards WG intends to collaborate with EPOS TCS Satellite Data to allocate the work on standardization of EO products under the EPOS framework (proposition sent)
Pleiades data on GEP for online processing: license signed by platform operator, first dataset processed online
Tools and services: integration on-going, federation of HPC service on GEP to start shortly, Terrain Motion Demo under preparation
New service: USGS Pager (and INGV Twitter) triggering automatic production of deformation maps
Promotion and capacity building:
- presentations foreseen for EGU 2019 and LPS 2019
- paper abstract submitted for IGARSS 2019
- Brochure for EPOS community disseminated
- hands-on training course held in September 2018 in Greece
- upcoming training course in Indonesia
- Website under preparation
- CEOS webpage available (on http://ceos.org/)
Thank you

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