CEOS

Committee on Earth Observation Satellites

WG Disasters Geohazards Lab

Michael Foumelis (AUTh)
Philippe Bally (ESA)
Jean-Philippe Malet (CNRS/EOST)
Fabrizio Pacini (Terradue)

WG Disasters 17 (virtual)
15, 16, and 17 March 2022

GeoHazards Lab Initiative

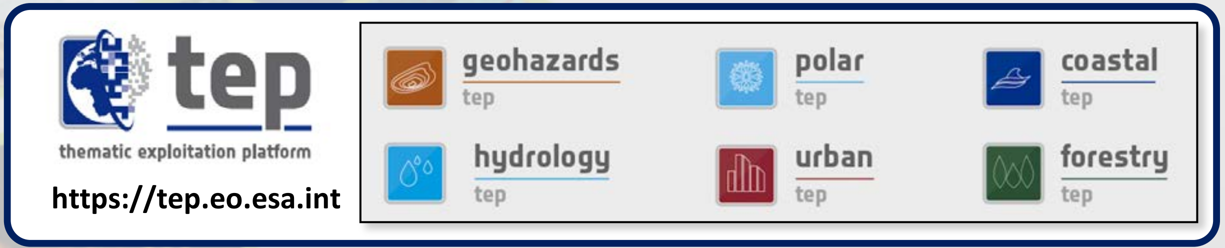
A platform with federated resources to provide **data access and an online processing and e-collaboration environment** to exploit EO data to assess geohazards and their impact

- ✓ Supports and complements the CEOS WG Disasters thematic activities, GSNL 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-expert EO scientific community, non-EO downstream users and decision makers

Geohazards Exploitation Platform - GEP

The GEP is a cloud-based environment providing a set of EO processing services that allow mapping hazard prone land surfaces and monitoring terrain motion.

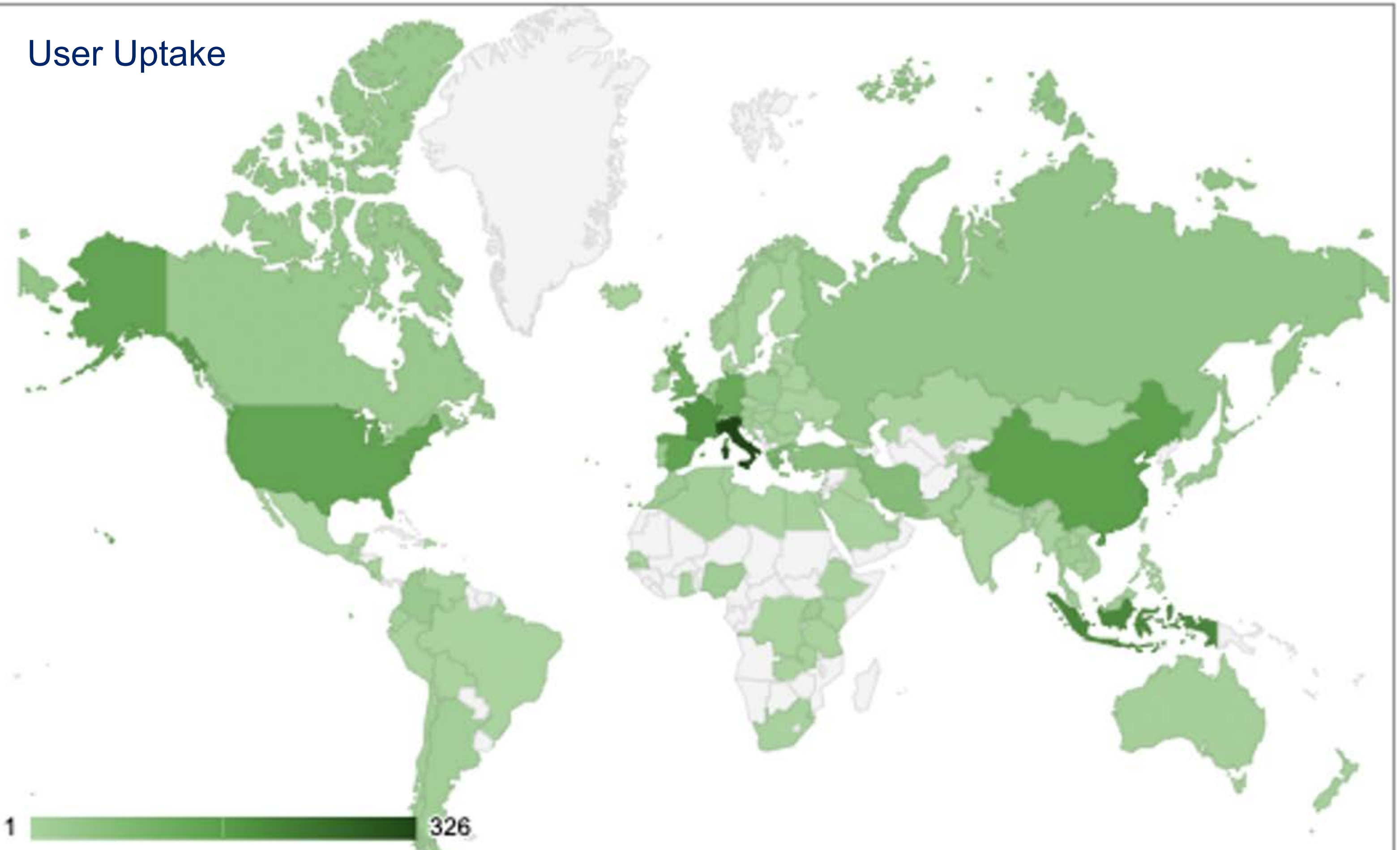
International Forum on Satellite EO and Geohazards organized by ESA and GEO in Santorini in 2012 (140+ participants)



GEP | Users Uptake

Pre-Operations Reporting Jan. 2022

User Uptake



#	Country	#users
1	Italy	326
2	Indonesia	203
3	France	
4	China	
5	United States	
6	Spain	
7	Germany	
8	United Kingdom	
9	India	
10	Greece	
11	Iran	
12	Switzerland	
13	Turkey	
14	Russia	
15	Canada	
16	Colombia	
17	Netherlands	
18	Portugal	
19	Japan	
20	Austria	
21	Poland	
22	Morocco	
23	Thailand	
24	Norway	
25	Belgium	
26	Uganda	
27	Philippines	
28	Nigeria	
29	Pakistan	
30	Mexico	
31	Argentina	
32	South Korea	
33	Romania	
34	Brazil	
35	Taiwan	
36	Chile	
37	Algeria	
38	United Arab Emira	
39	Malaysia	
40	Singapore	

#	Country	#users
41	Ireland	10
42	Australia	10
43	Tunisia	
44	Sweden	
45	Luxembourg	
46	Vietnam	
47	Hungary	
48	Finland	
49	Egypt	
50	Slovenia	
51	New Zealand	
52	Peru'	
53	Rwanda	
54	Nepal	
55	Hong Kong	
56	Ecuador	
57	Kazakhstan	
58	Estonia	
59	Czech Republic	
60	Cyprus	
61	Bangladesh	
62	Ukraine	
63	South Africa	
64	Slovakia	
65	Saudi Arabia	
66	Perú	
67	Lebanon	
68	Kenya	
69	Israel	
70	Ethiopia	
71	Denmark	
72	Bulgaria	
73	Belarus	
74	Venezuela	
75	Tanzania	
76	Tajikistan	
77	Sri Lanka	
78	México	
79	Lithuania	
80	Latvia	
81	Kurdistan	

#	Country	#users
82	India	2
83	Iceland	2
84	Dominican Republic	2
85	Dominica	2
86	Democratic Republic of the Con	2
87	Danemark	2
88	Czech Republik	2
89	Bolivia	2
90	Bhutan	2
91	Zambia	1
92	Trinidad & Tobago	1
93	Swaziland	1
94	Serbia	1
95	Senegal	1
96	Republic of Kosovo	1
97	Qatar	1
98	Philippine	1
99	Peru	1
100	Nicaragua	1
101	Myanmar	1
102	Mongolia	1
103	Malta	1
104	Lybia	1
105	Laos	1
106	Kenia	1
107	Guatemala	1
108	Guadalupe	1
109	Ghana	1
110	Georgia	1
111	El Salvador	1
112	Croatia	1
113	Costa Rica	1
114	Cambodia	1
115	Brasil	1
116	Birmania	1
117	Bielorussia	1
118	Azerbaijan	1
119	Armenia	1
120	Albania	1
	Grand Total	**2546**

GEP Portal | Users visits & Geo-Distribution
(Jan 2022)

Overview

Sample Dashboard for Apache logs

Simple dashboard for exploring & visualizing web traffic by analyzing Apache logs. This dashboard is included as a part of the Getting Started with ELK repo on Github.

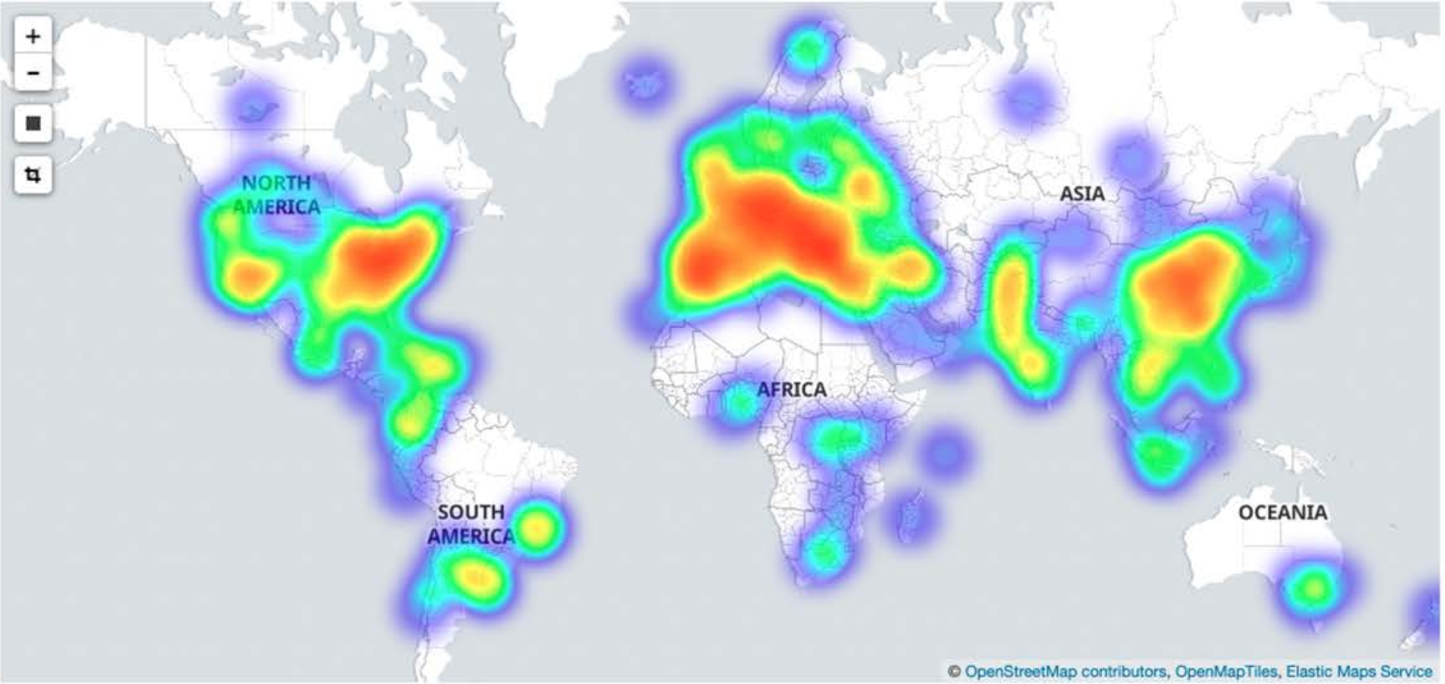
Dashboard includes:

- Number of unique visitors
- Map show # of hits by location
- Pie chart of traffic by device types
- Pie chart of traffic by operating systems

Feel free to explore & modify the dashboards to your hearts content. Ask questions, test hypothesis, diagnose issues!

Happy exploration!!!

Traffic vs. Location



Unique Visitors

Unique count of geoip.ip

2,823

Total Visitors

Count

216,881

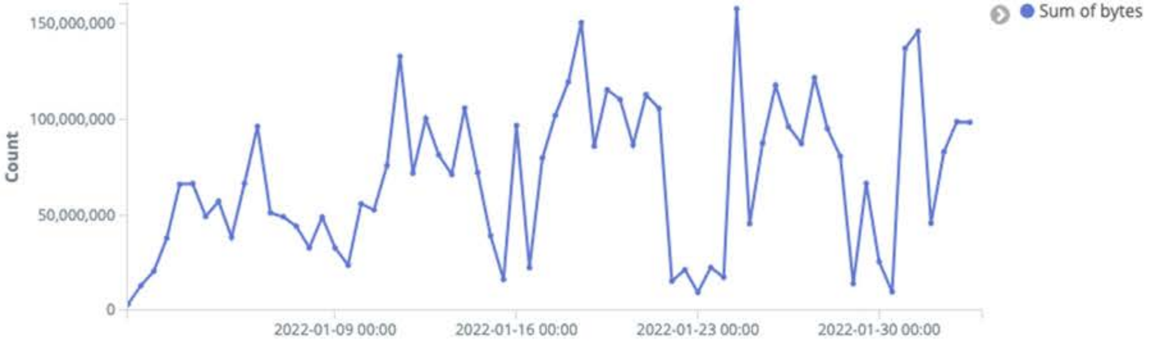
Unique Visits by City

geoip.city_name: Descending	Unique count of clientip
San Francisco	180
Hangzhou	160
Boardman	77
Falls Church	31
Strasbourg	31
Beijing	26

Total Hits by City

geoip.city_name: Descending	Count
Strasbourg	11,510
Rome	8,267
Toulouges	6,817
Chambly	5,376
Thermi	2,443
Madrid	2,320
Kukusan	2,306

Bytes vs. Time



GEP | Network of Resources (NoR)

Accepted Sponsorships 1/3

	NoR Sponsored Users		
#	Organization	Country	Project
1	CNR IRPI	Italy	Seismogenic faults investigation and monitoring
2	AUTh	Greece	InSAR hosted services for monitoring pipelines
3	Charles University	Czech Republic	Determination of long-term post-seismic ground movements in L'Aquila (Italy) after the earthquake of 2009
4	National Observatory of Athens (IAASARS)	Greece	GEP products for Corinth Rift Laboratory activities
5	Politecnico Milano	Italy	Data for master thesis in statistics
6	AUTh	Greece	Wide Area InSAR Processing
7	CNRS - EOST AUTh Université de Strasbourg	France, Greece	Science support for satellite EO and geohazard risk assessment
8	Instituto Geológico y Minero de España (IGME)	Spain	AGEO project- Platform for Atlantic Geohazard Risk Management
9	CONAE	Argentina	Detection and analysis of landslides in the Sierras Pampeanas of Argentina using advanced methods in SAR remote sensing
10	Istituto Nazionale di Geofisica e Vulcanologia	Italy	Community Data Hosting for Exploitation (500Gb Pleiades)
11	Istituto Superiore per la Protezione e Ricerca Ambientale (ISPRA)	Italy	Ground Motion in Como area
12	INRAE	France	Exploiting InSAR for Mekong Subsidence
13	NARSS, Egypt	Egypt	Monitoring coastal subsidence in Egypt
14	ESUT, Agbani, Enugu	Nigeria	Processing of Sentinel-1 Data using SBAS method and other related method

GEP | Network of Resources (NoR)
Accepted Sponsorships 2/3

#	Organization	Country	Project
15	IMPACT Initiatives	Ukraine	Displacement Analysis in Toretsk Coal Mining Area (Eastern Ukraine)
16	Universidad Politécnica de Madrid	Spain	Active tectonics in SE Spain and El Salvador
17	Istituto Nazionale di Geofisica e Vulcanologia (INGV)	Italy	Exploitation of the InSAR tools from the GEP Platform for ground deformation studies
18	ESA, CNR-IREA, University of Leeds, CalTech, Friedrich-Schiller-University Jena, Joanneum Research	Italy, UK, US, Germany	Sentinel-1 Extended Timing Annotation Processor - GEP hosting
19	Universidad Católica de Manizales	Colombia	DInSAR Analysis on Galeras and Chiles-Cerro Negro volcanoes (Sentinel-1 images)
20	European Space Agency	Italy	Sentinel-1 Extended Timing Annotation Processor
21	University of Lagos	Nigeria	Investigating and modelling land subsidence in parts of Nigeria
22	Instituto Geográfico Nacional (IGN)	Spain	GEP services to improve the Volcanic Monitoring System at Instituto Geográfico Nacional (Spain)
23	University of Huelva	Spain	Subsidence analysis of SW Spain
24	Center of Space Techniques (Algeria)	Algeria	Determination of land movement velocities at National scale (Algeria) by N-SBAS approach and Sentinel-1 data
25	University of Padova	Italy	Prevention of Potential Catastrophes Depending on Interferometric Radar Technique and Artificial Intelligence
26	National Research Council (CNR)	Italy	Monitoring land subsidence and its induced risk using advanced InSAR methods
27	University of Pisa	Italy	Crustal deformation monitoring
28	UNIZAR	Spain	Monitoring of sinkholes, large landslides and salt diapirs in the NE Spain

GEP | Network of Resources (NoR)
Accepted Sponsorships 3/3

#	Organization	Country	Project
29	Geological Survey of Austria	Austria	GEORIOS - Local scale landslide detection and monitoring based on Sentinel-data
30	NOA Geodynamic Institute	Greece	Rapid analysis & study of surface deformation by earthquake & geohazard events
31	University of Houston	USA	Subduction in the North to Northwest Houston, Texas Area, USA
32	University of Liege	Belgium	EO for the monitoring of proglacial lakes and related hazards in high-mountain conditions - Landslide and GLOFs detection and monitoring
33	University of Granada	Spain	Monitoring ground instability in Southern Spain
34	Alberta Geological Survey	Canada	Monitoring ground motion using Sentinel-1 data over landslide susceptible areas and abandoned coal mines in Alberta, Canada
35	Sapienza University of Rome	Italy	Applications of differential interferometryDInSAR for monitoring ground deformations and Civil infrastructures
36	Czech Geological Survey	Czech Republic	Detection of long-term subsidence across Czech Republic
37	Istituto Nazionale di Geofisica e Vulcanologia	Italy	Geodetic and seismological observations
38	Istituto Nazionale di Geofisica e Vulcanologia	Italy	Community Data Hosting for Exploitation (9TB CSK)
39	NORCE Norwegian Research Centre AS	Norway	AVAMAP - Automatic snow avalanche detection using Sentinel-1
40	European Space Agency	Italy	Sentinel-1 Extended Timing Annotation Processor
41	Istituto Nazionale di Geofisica e Vulcanologia	Italy	Monitoring of different hazards and environmental impact due to human activities and natural phenomena by means of remote sensing data
42	Carleton University / Environment and Climate Change	Canada	Sentinel-1 InSAR for peatland ecosystem mapping

Recent Developments

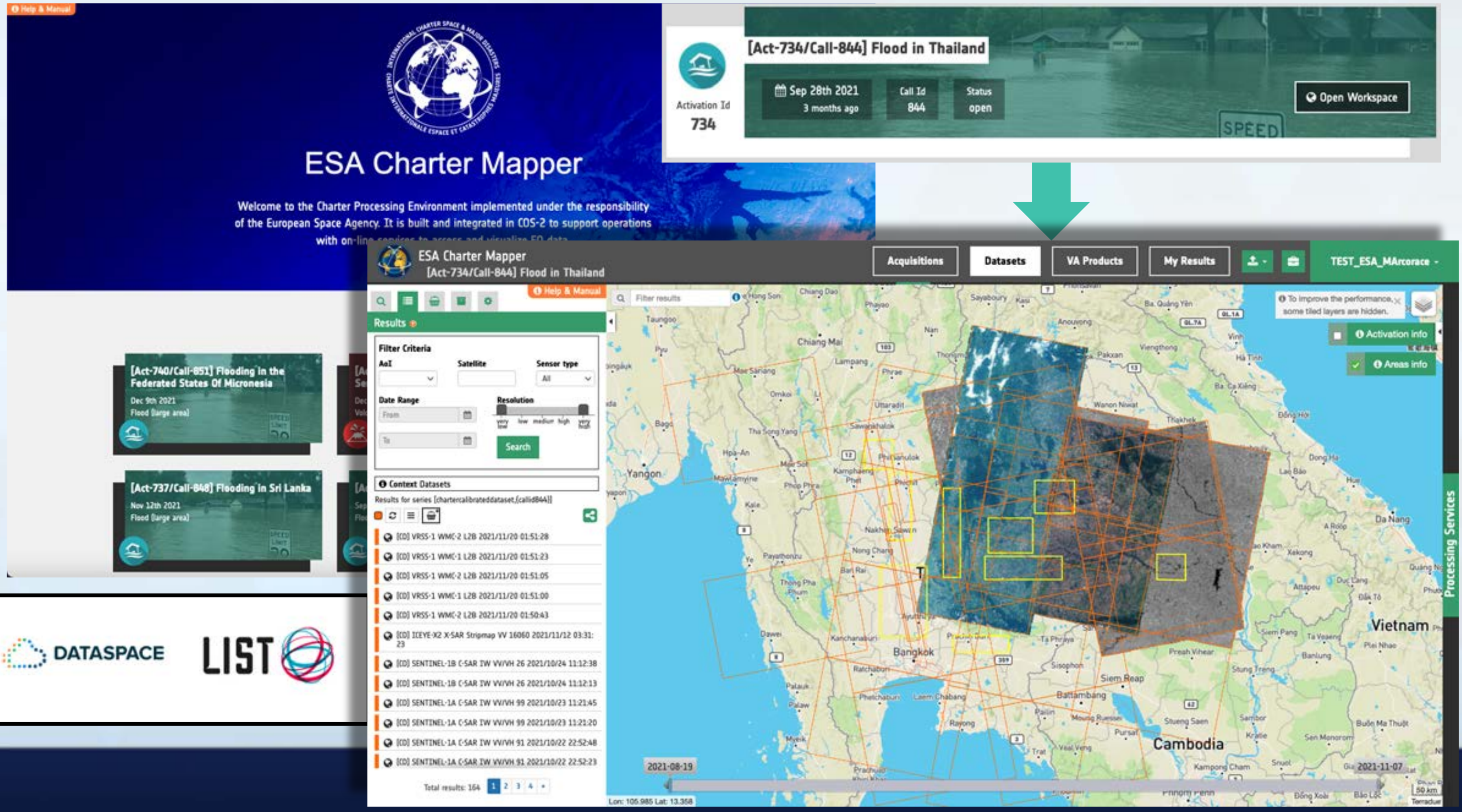
ESA Charter Mapper

- To support the Charter PM and the VA in the context of activations, the COS-2 system has been augmented with a processing environment to access EO data on-line and perform visual and GIS analysis and basic EO processing
- Access the Charter Mapper:

  https://cpe.disasterscharter.org
- The User Manual:

  https://docs.disasterscharter.org
- Same underlying platform as the GEP

  (chains and products can be shared)



EVERSIS AIRBUS TERRADUE TAITUS SOFTWARE DATASPACE LIST

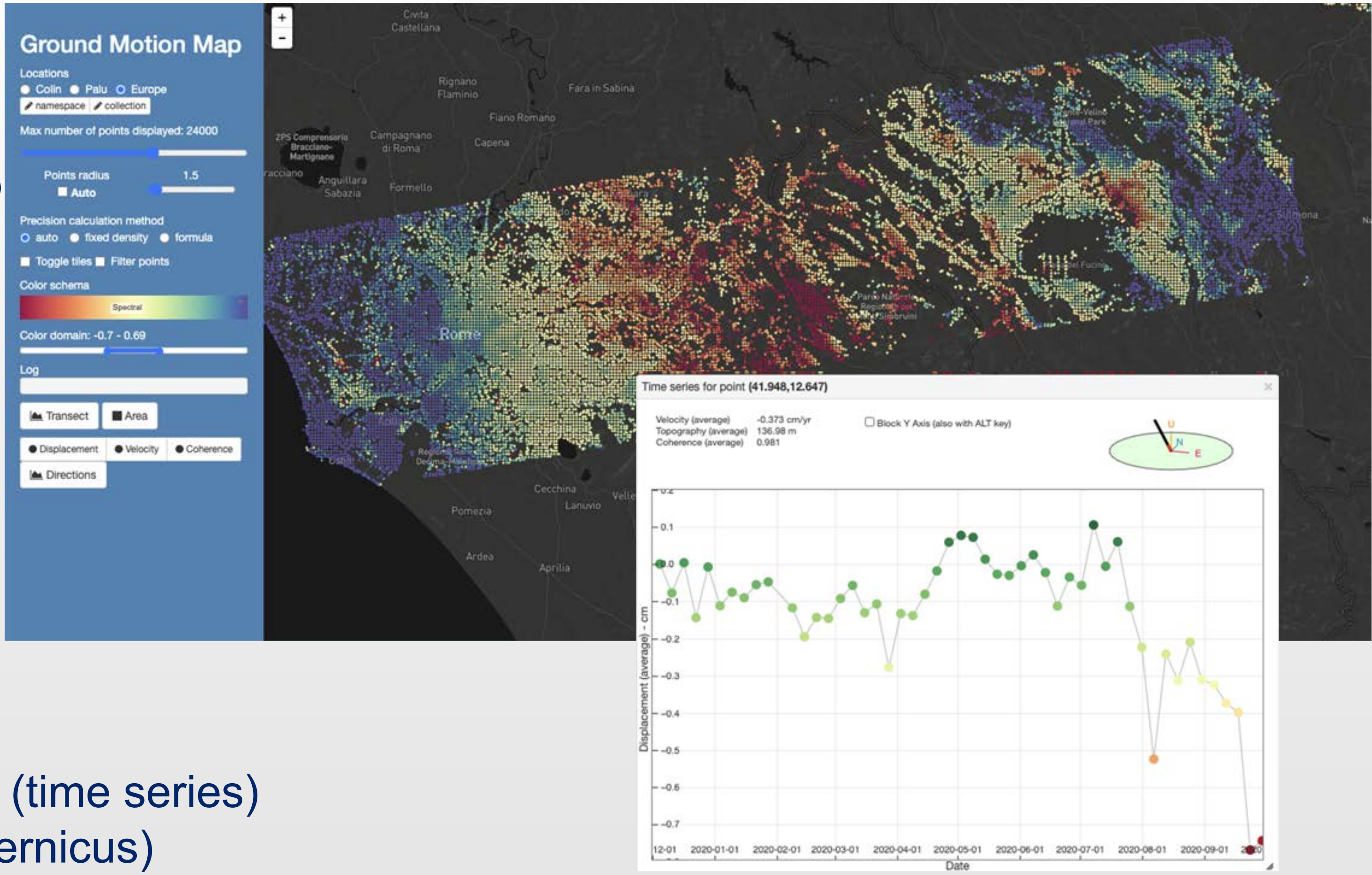
GEP | Improved Visualization of InSAR products

- New Plugin for querying & viewing terrain motion pixels in the geobrowser with integrated functions
  - Time Series (one or more pinpoints selection)
  - Profile Analysis (line selection)
  - AOI Statistics (polygon selection)

- Allows the user adjust rendering of data map
  - Data map layers selection
  - Color scale adjustment

- Many export formats supported
  - CSV, KML and shapefiles for a limited area
  - PDF for a given data selection

- Inputs supported
  - P-SBAS, SNAPPING PSI
  - MPIC-OPT-SLIDE, -ICE
  - EGMS Time Series



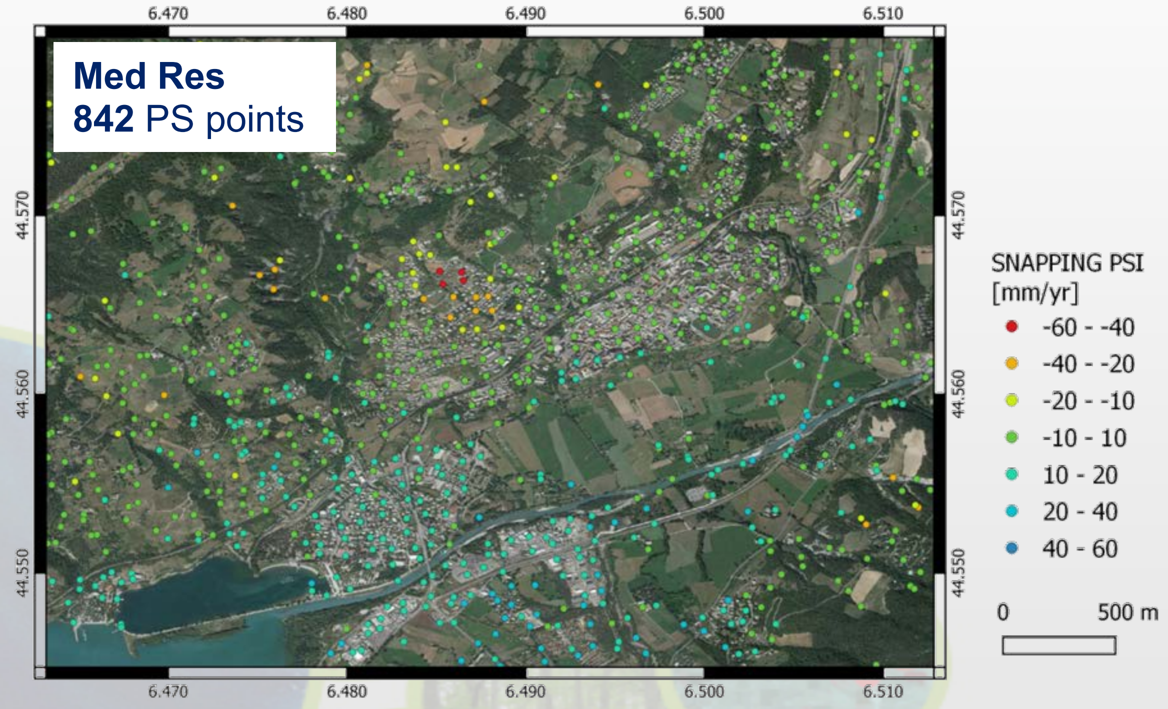
➢ Improves visualization of advanced products (time series) and including Third Party products (e.g. Copernicus)

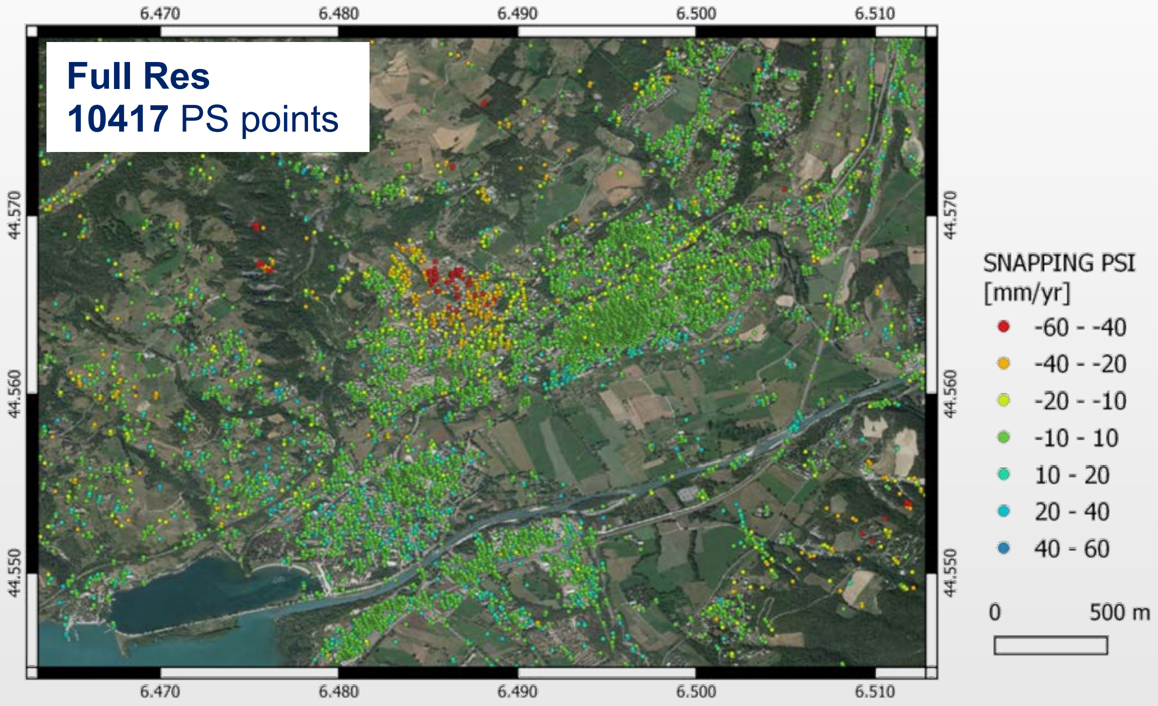
GEP SNAPPING PSI service @ Full Resolution

SNAPPING
SURFACE MOTION MAPPING

SNAPPING | Surface motioN mAPPING is a multi-temporal interferometric service for measuring terrain motion based on Persistent Scatterers Interferometry (PSI) technique using Copernicus Sentinel-1 mission data

SNAPPING Full Res version has been integrated and currently being internally tested (open to users Q2 2022)





geohazards tep
EO.Lab Earth Observation & Geospatial Applications Lab

GEP with Academic Research Centers and Universities

Ground motion services & other processing services of University of Strasbourg / HPC Production Centers are exposed through the GEP (for on-demand processing)

- Cost-effective data processing
- Pure HPC production center
- Easy maintenance and update of the code
- Better scalability of the resources

- Processing services
  - MPIC-OPT (ETQ, SLIDE, ICE)
  - ALADIM HR / VHR
  - DSM-OPT
  - FLOW-R / VolToo
  - LHIS

GEP | New modelling services to help understand/forecast hazards

eo4alps-landslides App: Modelling Landslide Propagation

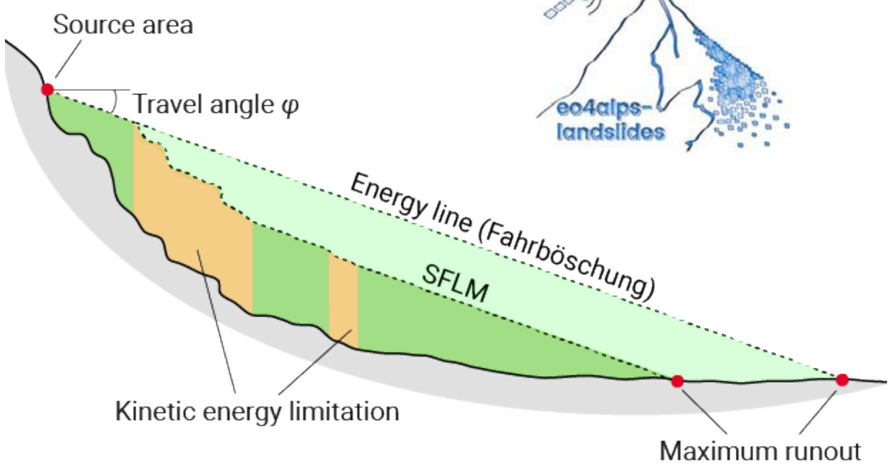


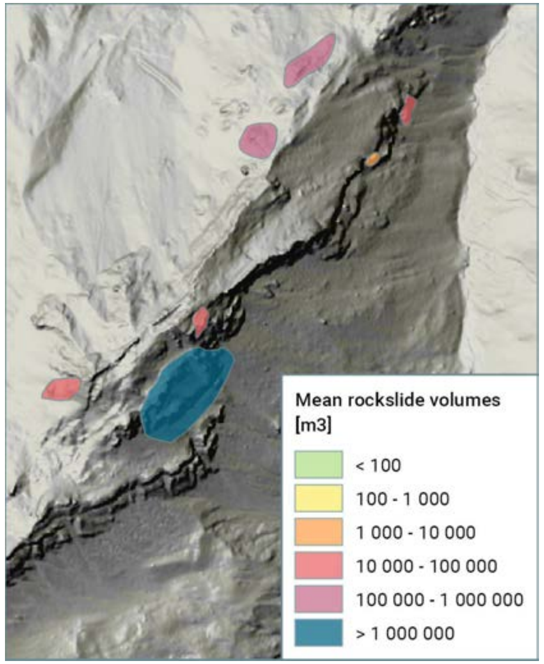
Illustration of the reach angle principle for modelling landslide propagation from geodatabases and high resolution relief

EO based services can contribute to the definition of landslide inventories & sources (e.g. MPIC, SNAPPING)

Terranum

EOST Université de Strasbourg

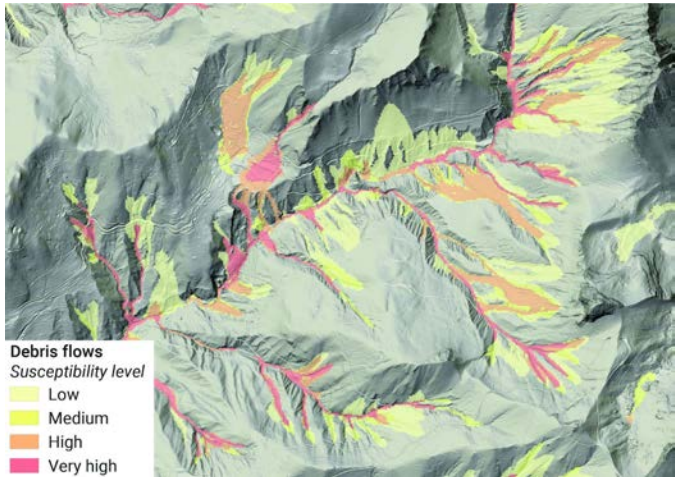
Assessement of mean volume of inventoried slope instabilities



Step 1:
VolToo for volume modelling

Step 2:
FLOW-R for propagation/hazard modelling

10m Copernicus DSM used to model landslide runouts



Extent of landslide runout areas

Activities' Overview

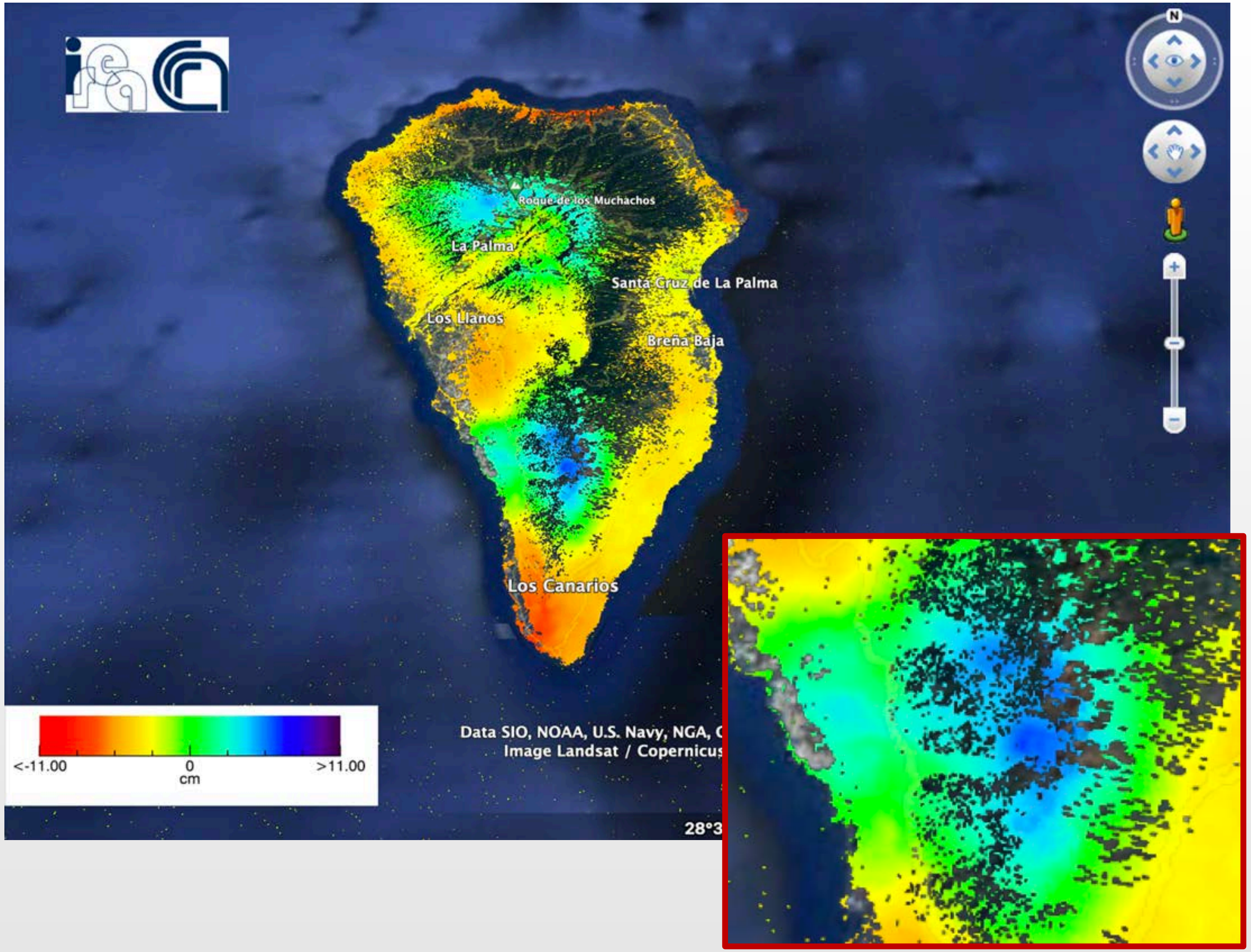
Overview of GLab activities

- GEP selected by EPOS for geospatial data cataloguing to support its user communities across Europe
- Demonstration of GEP services in International Development projects (EO-AID GDA, ADB, H2020)
- Nationally mandated geo-science centers from Europe have initiated subscription for GEP service
- Inter-verification of advanced GEP InSAR services (P-SBAS & SNAPPING)
- Standardization/Harmonization activity *put on hold* given in view of relevant activities
- Moving forward with GEP governance (policies & rules)

GEP P-SBAS I Cumbre Veija volcano

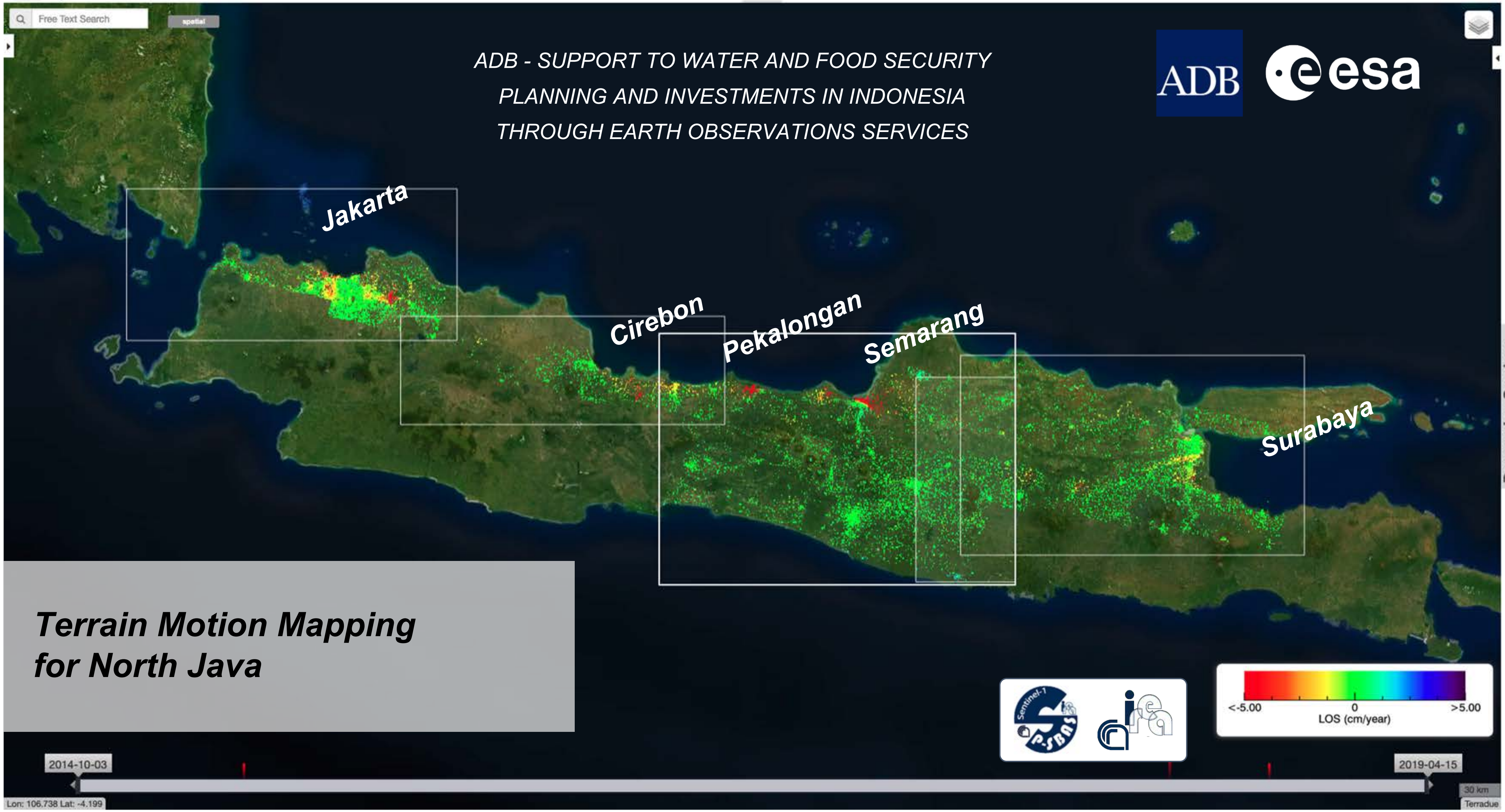
Protype product created by *Floriane Provost* of the ESA project SAT looking at geohazard applications based on the Geohazard Exploitation Platform GEP.
Terrain motion map based on the SBAS chain of CNR IREA (IT) and using Sentinel-1 SLC acquisitions.

Comment: A signal of 10 cm uplift over Cumbre Veija volcano area (insert) can be seen and it appears corrlated to the event while other signals appear accross the territory but their correlation isn't confirm and would require detailed assessment.



ADB - Support to Water & Food Security Planning & Investments in Indonesia through EO Services

North Java | GEP P-SBAS On-Demand InSAR Service



Contains modified Copernicus Sentinel-1 data (2015-2020)

Outreach & Capacity Building

Outreach and Capacity Building

Q2 2021 – Q1 2022

- Several communications to social media (mainly blog posts and twitter)
- Publishing in scientific journals and participation to international conference and workshops (Applied Science; Remote Sensing; LPS 2022; IGARSS 2022)
- Multiple training and capacity building activities for the adoption of platform-based solution in scientific investigations and operational frameworks.

Training & Capacity Building

List of Organized Activities:

- SFU / Canada
- RMCA / Belgium
- AIT / Indonesia (for ADB)
- Los Alamos National Laboratory / US
- University of Exeter / UK
- University of Padova / IT
- FSEC / Fonds de Solidarité Évènements Catastrophiques - Maroc
- L'Università di Pisa / IT
- AUTh / GR
- Sorbonne University Abu Dhabi (SUAD) / UAE
- National Authority For Remote Sensing & Space Sciences (NARSS) / Egypt
- AIT / Indonesia (for ADB)
- ESA-NASA Trans-Atlantic-Training (TAT) 2021
- SUAD Master Course
- Training Sessions with Multiple Users (DZ, FR, GR, ID, IT, UK, UAE etc.) organized by T2

List of Pending Activities:

- BGC / Vancouver / Canada
- UGA / ISTerre /France
- NIEP / Bucharest
- IGAR - UB - NMA - NIHWM - IGR - TUCEB / Bucharest
- IVAR / Azores / Portugal
- GNS / New Zealand
- IGOT / UL / Portugal
- CSIC / Spain

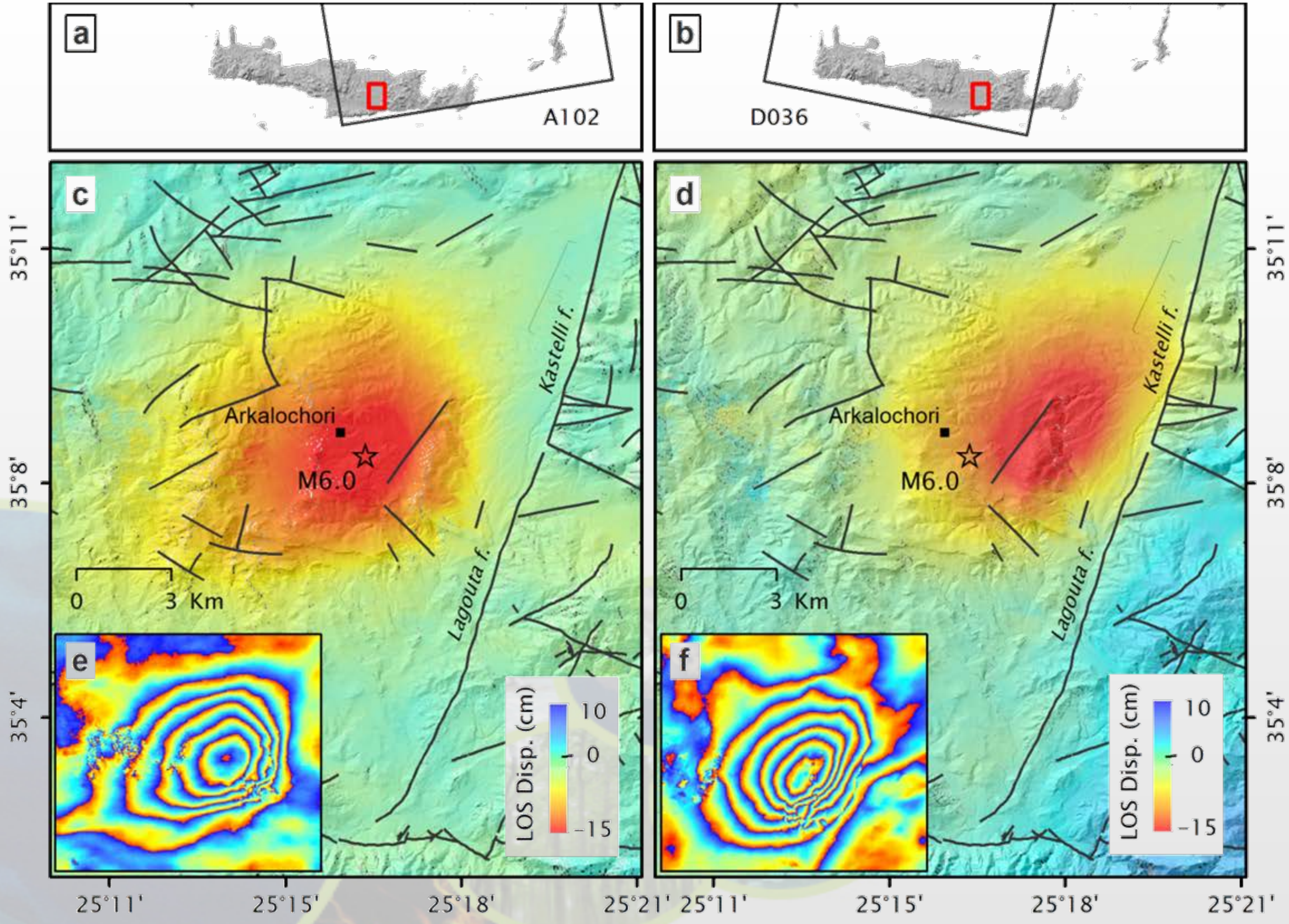
Scientific Publications around the GEP

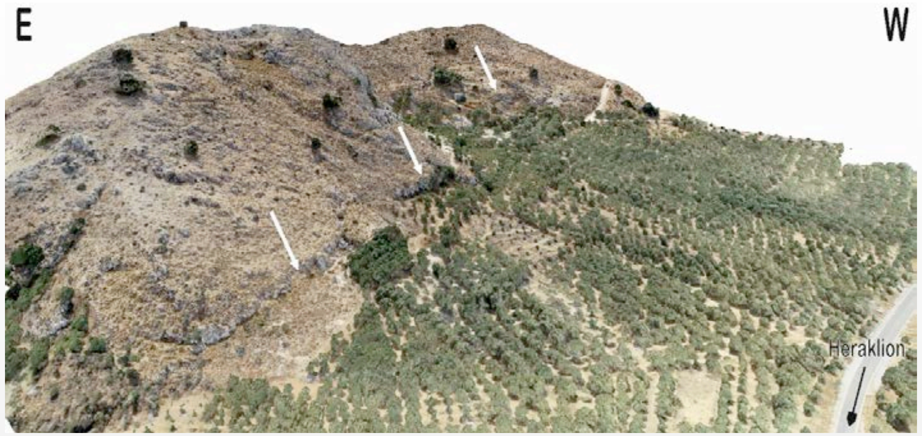
- ❖ Several publications in scientific journals
- ❖ Contributions to ESA Living Planet Symposium
  - Algerian Space Agency (ASAL), Algeria
  - Aristotle University of Thessaloniki (AUTh), Greece
  - Asian Institute of Technology (AIT), Indonesia
  - CNRS/EOST, France
  - CRL (ENS & NOA), France/Greece
  - Indra, Spain
  - National Authority for Remote Sensing and Space Sciences (NARSS), Egypt
  - Sorbonne University Abu Dhabi (SUAD), UAE

Crete (Greece) M6.0 Earthquake (Sept 2021)

GEP DIAPASON on-demand service

Contains modified Copernicus Sentinel-1 data (2021), processed by AUTh





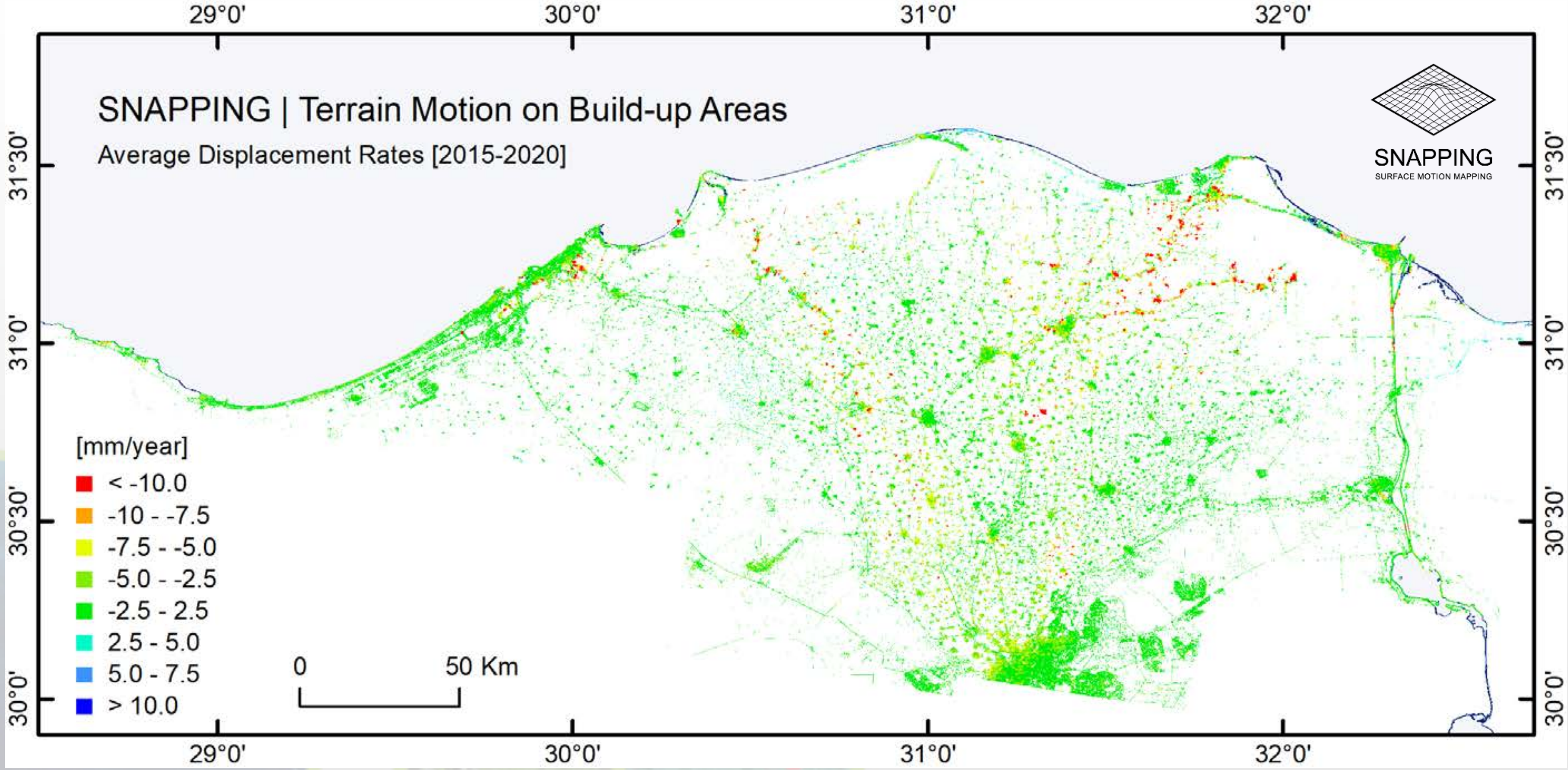
Photorealistic 3D model of a Kastelli fault segment, an active fault segment nearby the triggered tectonic structure. Morphological discontinuities (white arrows) along faults clearly indicate their activity during relatively recent geological era.

Vassilakis, E. et al. The 27 September 2021 Earthquake in Central Crete (Greece)—Detailed Analysis of the Earthquake Sequence and Indications for Contemporary Arc-Parallel Extension to the Hellenic Arc. *Appl. Sci.* **2022**, *12*, 2815. https://doi.org/10.3390/app12062815

Wide Area InSAR Processing I Nile Delta (Egypt)

Build-up area of the Nile Delta as outlined by the ESA WorldCover 2020 global product

Terrain motion over build-up areas of the Nile Delta



Contains modified Copernicus Sentinel-1 data (2015-2020), processed on GEP by NARSS/AUTh

Project supported by ESA NoR sponsorship involving the National Authority for Remote Sensing & Space Sciences (**NARSS**) of Egypt, the Aristotle University of Thessaloniki (**AUTh**) in Greece and the French Geological Survey (**BRGM**)

Sentinel-1 Tracks:
Descending 065 & 167

Observation Period:
2015-2020 (~6 years)

Nu of Sentinel-1 Scenes:
517

Nu of PS points:
~516k

EO.Lab Earth Observation & Geospatial Applications Lab

Géosciences pour une Terre durable brgm

The Way Forward

- Co-located data & processing still the best approach to ensure wider usage of EO data; yet it is challenging (e.g. improve multi-sourcing as storage cost affects data availability)
- Improve parallelization & scalability of EO services
- Build chains that utilize other EO missions (than Copernicus Sentinel)
- Connecting GEP to other processing environments, e.g. work started to federate GEP with WASDI to address hydro-met hazards
- Integrate EO services to address exposure & vulnerability
- Look beyond EO data to include non-EO information layers and in-situ measurements

Thank you

Geohazards Lab:

Fabrizio Pacini (Terradue) fabrizio.pacini@terradue.com
Michael Foumelis (AUTh) mfoumelis@geo.auth.gr
Jean-Philippe Malet (CNRS/EOST) jeanphilippe.malet@unistra.fr
Philippe Bally (ESA) philippe.bally@esa.int