Committee on Earth Observation Satellites

WGDisasters Geohazards Lab

Philippe Bally | ESA
Michael Foumelis | BRGM
Theodora Papadopoulou | ARGANS Ltd. c/ ESA

WGDisasters-15 Meeting
Virtual Meeting
9 – 11 March 2021

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 (on-going pilots, follow-on activities and the RO), 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

Overview of GLab activities

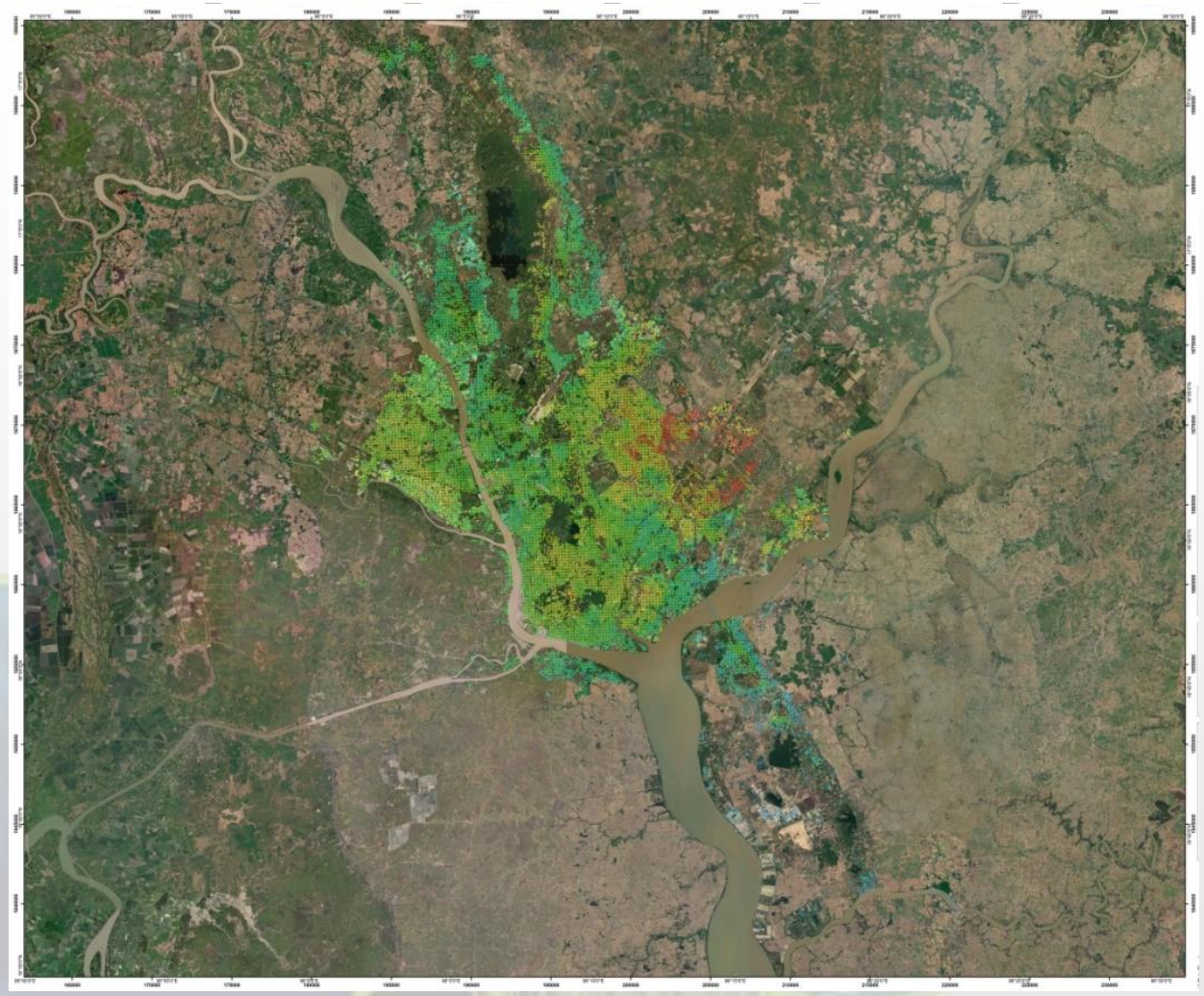
- Interview of GEP users (IGME, INGV, ASI) concerning experience and utilization comments
- Demo processing of 9 cities using **P-SBAS** service for WB CRP project
- Demo processing of Dakar (Senegal) (entire Sentinel-1 archive); Contribution to the WACA report
- Completion of the integration and bug fixing of **SNAPPING service** (based on SNAP-StaMPS chain); Check performance both in terms of scientific results and processing time; Improve parallelization of the service; Run demo jobs
- SNAPPING processing over Suez (Egypt) for University of Suez; Palu (Indonesia) for AIT (Asian Institute of Technology)
- GEP processing (several jobs using different services) as early response to geohazards events (e.g. Samos earthquake)
- Release of new services from CNRS EOST (**MPIC-OPT-EQ, MPIC-OPT-ICE, MPIC-OPT-SLIDE, DSM-OPT** and **ALADIM-HR**)

Outreach and Capacity building

Q3 2020 – Q1 2021

- Capacity Building activity with AIT on 19 & 21 Jan 2021
- Demo for the World Bank concerning Flood Mapping using GEP services
- Presentation of GLab/GEP in the WB UR 2020 workshop and FORTH institute (GR)
- Demo of GEP services to the World Bank for the Cities Resilience Program, under which 10 cities in Africa and Asia have been processed on GEP
- Demo & training on GEP services to support the CRL 2020 Workshop (organized by NOA) in September 2020.
- Contributions to IGARSS 2021
- Several Web Stories and blog posts (e.g. SNAPPING service, Samos Oct. 2020 earthquake)
- Press release of AUTh for announcing SNAPPING service on GEP to Greek scientific community and public authorities and several interview to media channels

Demo to WB City Resilience Program



Contains modified Copernicus Sentinel-1 data (2015-2020), processed by BRGM via GEP

Banjul (The Gambia)

Beira (Mozambique)

Cap-Haitien (Haiti)

Paramaribo (Suriname)

Vinh Long (Vietnam)

Yangon (Myanmar)

disaster risk reduction
eo4sd

Cost effective platform services delivering of medium resolution / wide area products

Subsequent involvement of commercial providers offering tailored analysis

Advanced Interferometric Processing (InSAR) using CNR-IREA P-SBAS | **9 selected cities**

A total number of **582** Sentinel-1 scenes

Total number of measurements **81147 points**

Total area covered **~8680 sq. km**

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GEP results featured in World Bank report

West Africa State of the Coast Report 2020

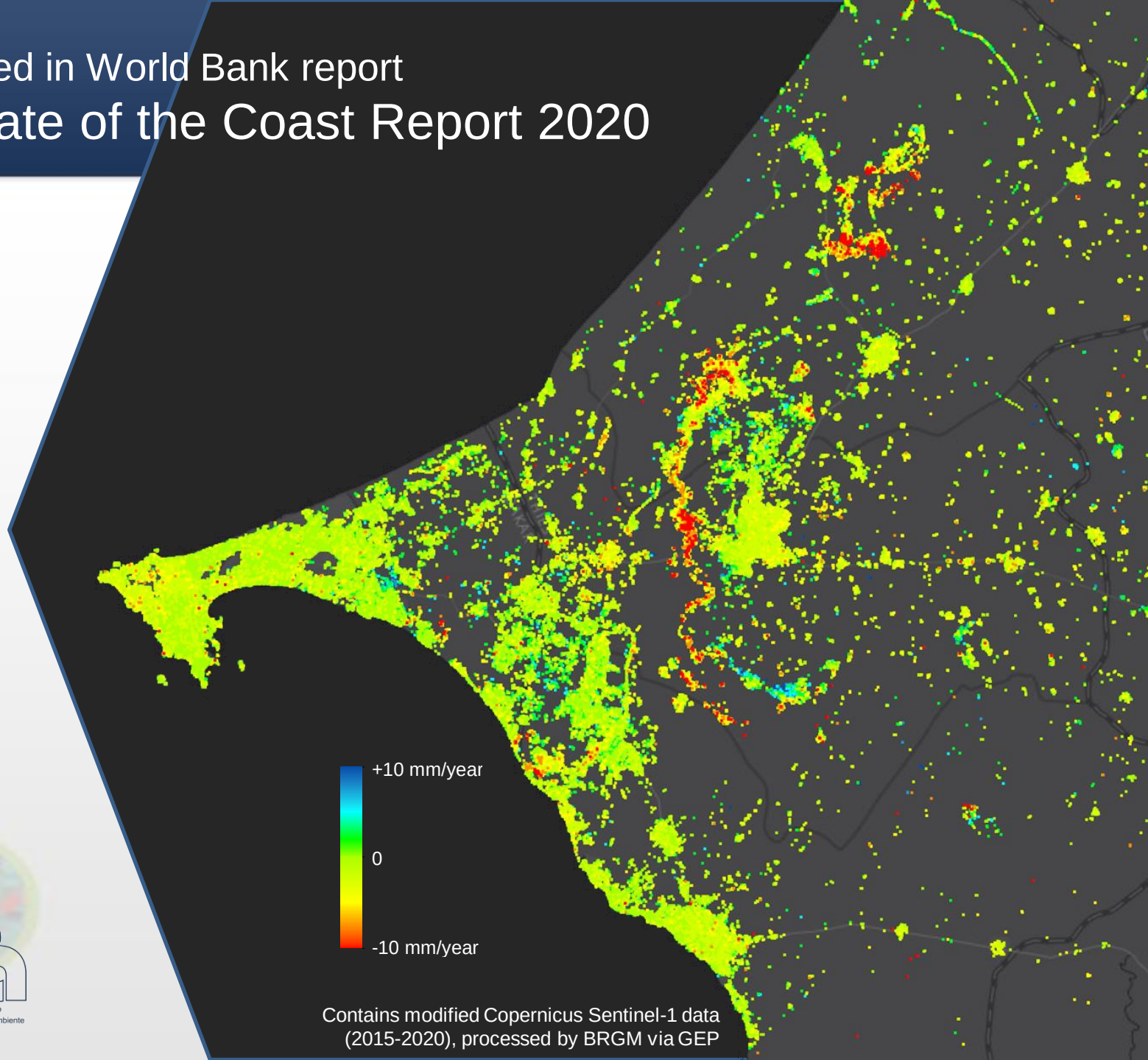
Terrain deformation of broader Dakar area (Senegal) using the P-SBAS service of CNR IREA on the GEP.

Demonstration of robust and cost effective solution for processing big data volumes.

Raise awareness to wide user community concerning benefits of space technology.

More than **90.000** measurement points using **352** Sentinel-1 acquisitions over the period **04/2015 – 08/2020** (~5yr)

Production completed in **~30hrs**



Contains modified Copernicus Sentinel-1 data (2015-2020), processed by BRGM via GEP

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Geoscience for a sustainable Earth brgm

istituto per il rilevamento elettromagnetico dell'ambiente

SNAPPING PSI service on GEP

SNAPPING
SURFACE MOTION MAPPING

SNAPPING | Surface motioN mAPPING is a multi-temporal interferometric service developed by AUTh (GR), MJaen (ES), with the support of Terradue (IT), that produces measurements of surface displacements based on open source ESA SNAP and StaMPS software packages.

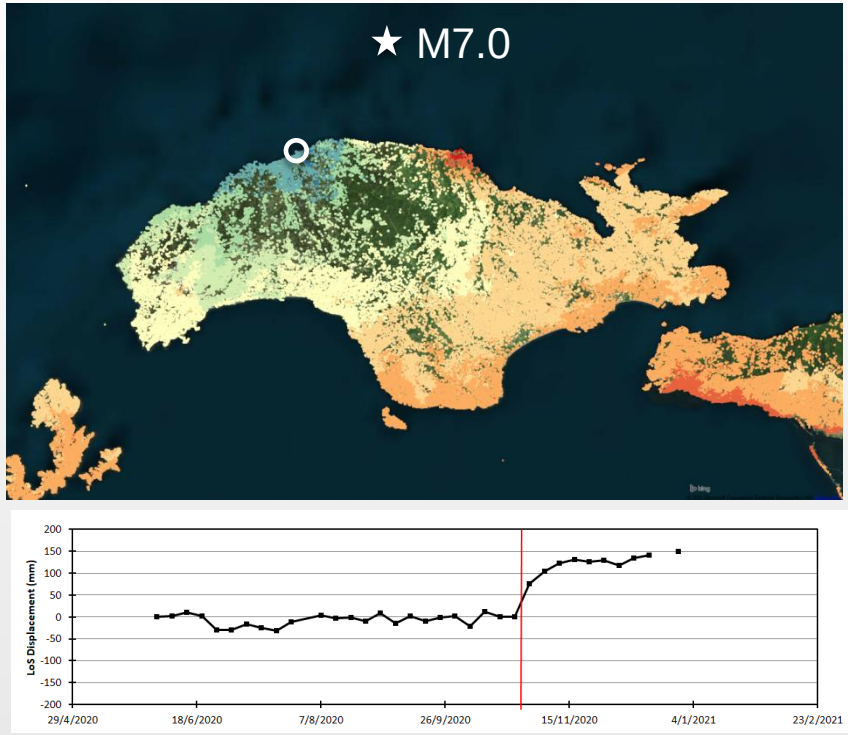
SNAPPING IFG

First step consists in setting-up **SNAPPING IFG** processing pipeline to generate the interferogram stack.

SNAPPING PSI

Second step the interferogram stack is channeled to the **SNAPPING PSI** pipeline for time series analysis0

Samos (Greece) **M**7.0 2020 Earthquake
S1 20200602-20210104 (76 acquisitions, ~7 months)



While S-1 data are available in openly and freely, gathering a multiyear data-stack is a known challenge.

SNAPPING has been implemented to be resilient to data access issues i.e. is able to process large data collections in a seamless fashion

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EO.Lab Earth Observation & Geospatial Applications Lab

Universidad de Jaén

TERRADUE Advancing Earth Science

Optical imagery: domain / application "tailored" services on GEP

Federation of resources has allowed the release of "domain" tailored services for S2 image correlation

MPIC-OPT-ETQ

Earthquake post-seismic ground motion

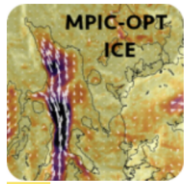
MPIC-OPT-SLIDE

Landslide motion analysis from image time series

MPIC-OPT-ICE

Ice glacier/shelf analysis from mage time series

MPIC-OPT-ICE: Multiple Pairwise optical Image Correlation of OPTic images for ICE/glacier analysis

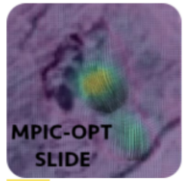


MPIC-OPT-ICE

MPIC-OPT-ICE is a service
MicMac image matching lib
8 images) and MPIC (Mutipl
quantification of Earth surfa

MPIC-OPT-ICE is an on-de
number of input images. Nu
knowlegde in the theory of i
measuring sub-pixel displac
filtering of residuals and (c)

MPIC-OPT-SLIDE: Multiple Pairwise optical Image Correlation of OPTic images for landSLIDE analysis



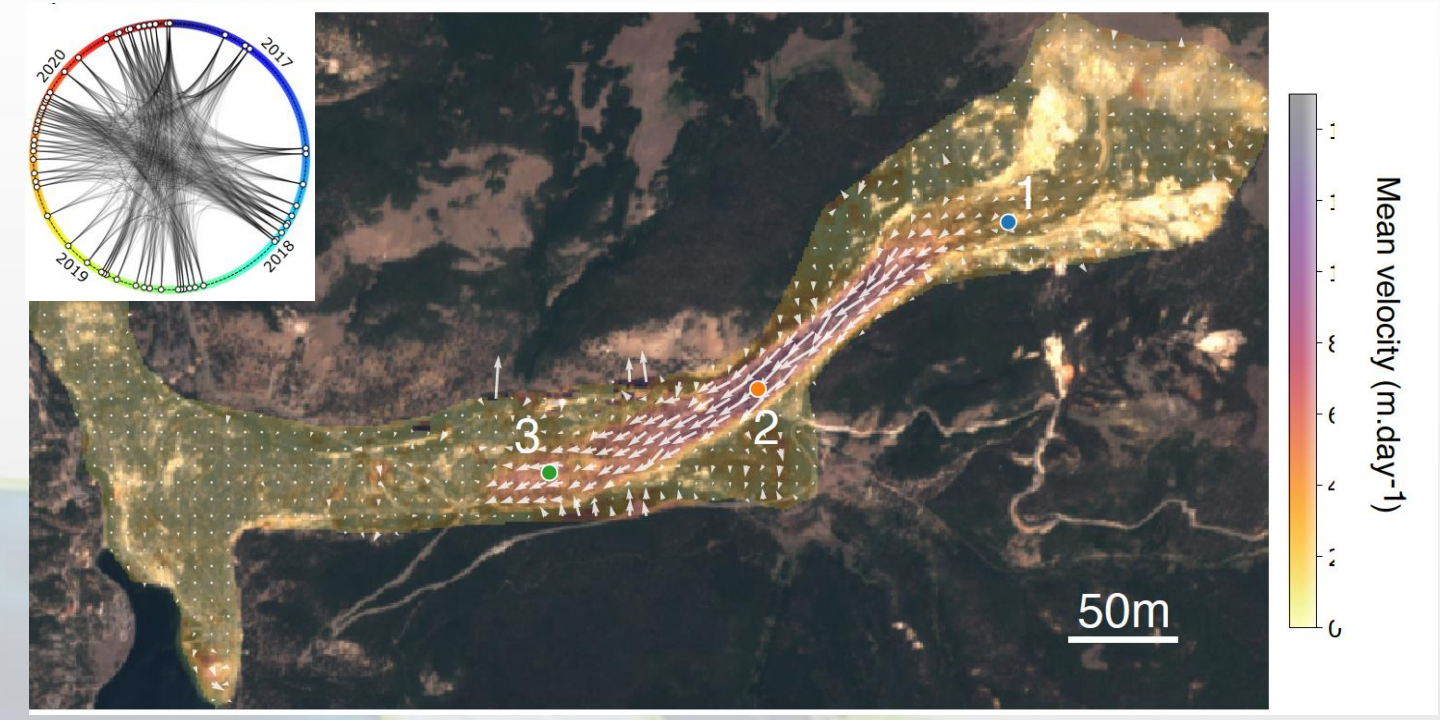
MPIC-OPT-SLIDE

MPIC-OPT-SLIDE is a service based on the **CO-REGIS/MPIC** library developed by CNRS EOST (Strasbourg, France) [1], [2] and the MicMac image matching library developed by IGN (Marne-la-Vallée, France) [3]. CO-REGIS (CO-REGIStration of Sentinel 2 and Landsat 8 images) and MPIC (Mutiple Pairwise Image Correlation of image time series) enable the processing of image time series for the quantification of Earth surface motion.

MPIC-OPT-SLIDE is an on-demand service tailored for quantifying ice velocity and ice surface displacement time series from a large number of input images. Numerous parameters are accessible to the user for fine tunning of the processing which requires a certain knowlegde in the theory of image matching and time serie inversion. It comprises three components with (a) an analysis module for measuring sub-pixel displacement from optical image pairs, (b) a correction module for the systematic geometric correction and filtering of residuals and (c) an inversion of the displacement time serie.

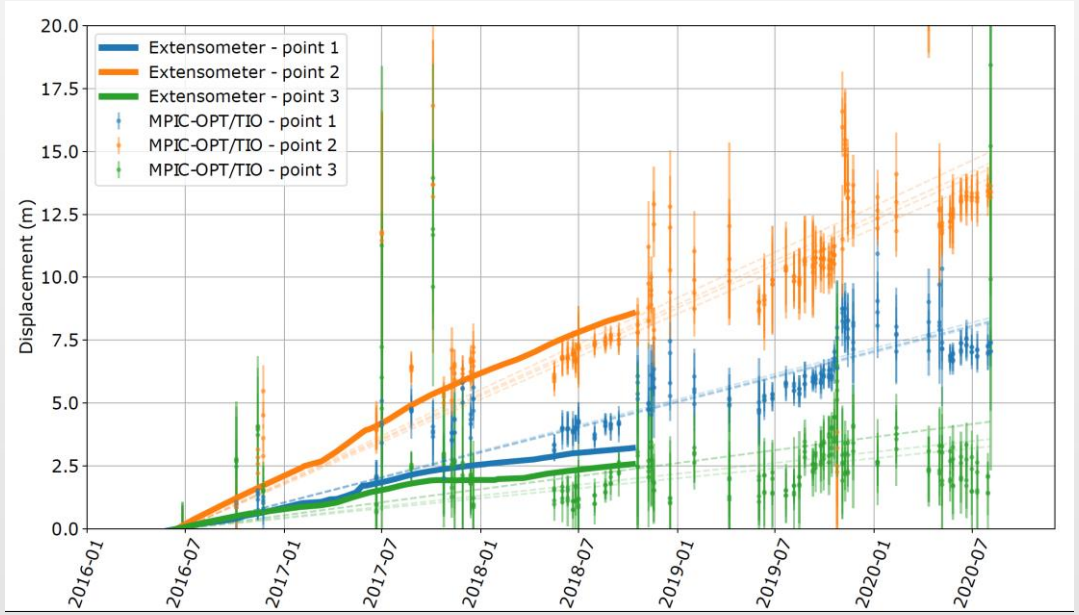
Optical imagery: domain / application "tailored" services on GEP

MPIC-OPT-SLIDE: understanding the dynamics of Slumgullion landslide



Slumgullion mean velocity : 2017-2020

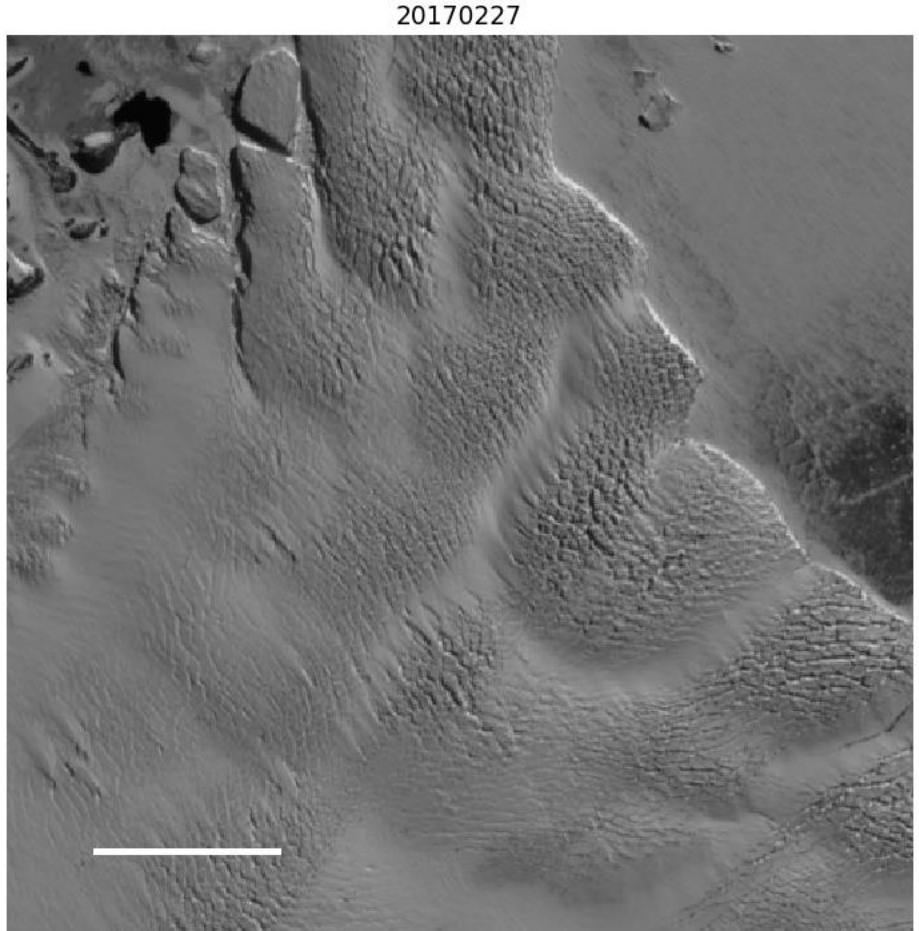
Comparison MPIC-S2 vs. in-situ observations (extensometers)



Optical imagery: domain / application "tailored" services on GEP

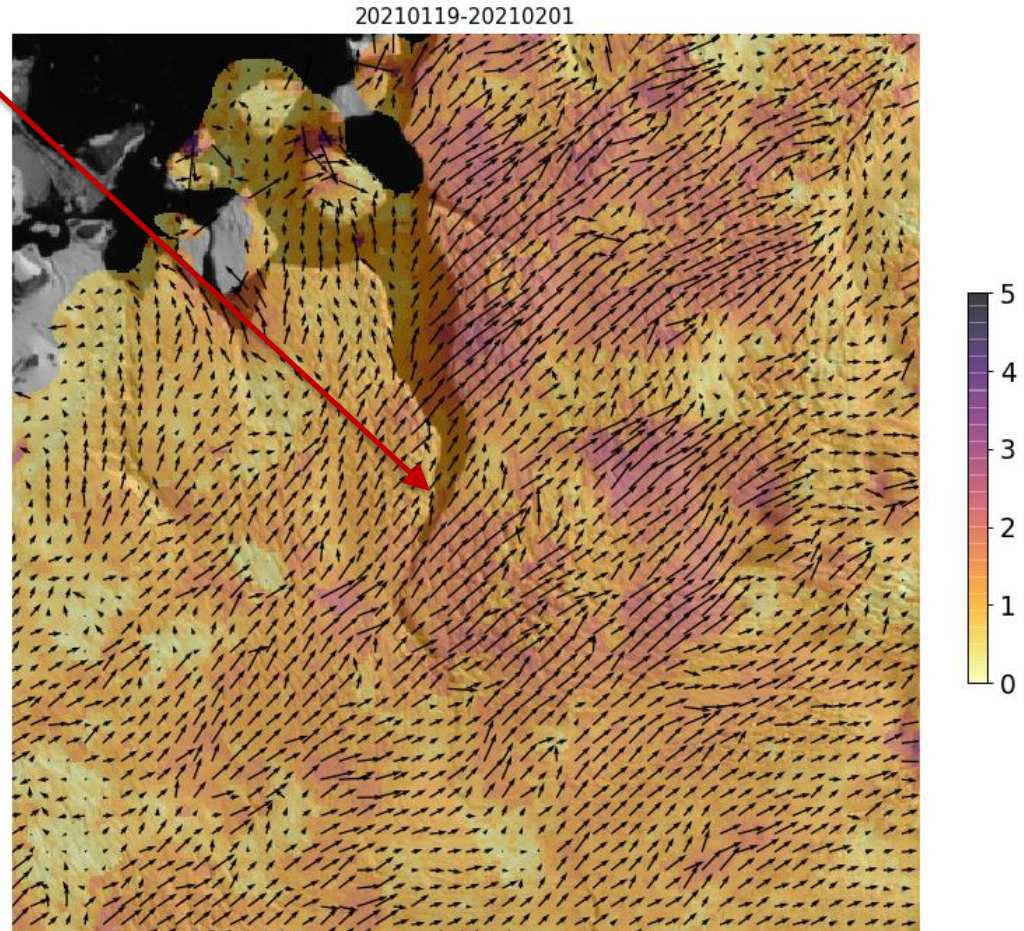
MPIC-OPT-ICE: understanding the calving of the Astrolabe ice glacier (Antarctica)

S2 images: 2017-2021



fracture propagation

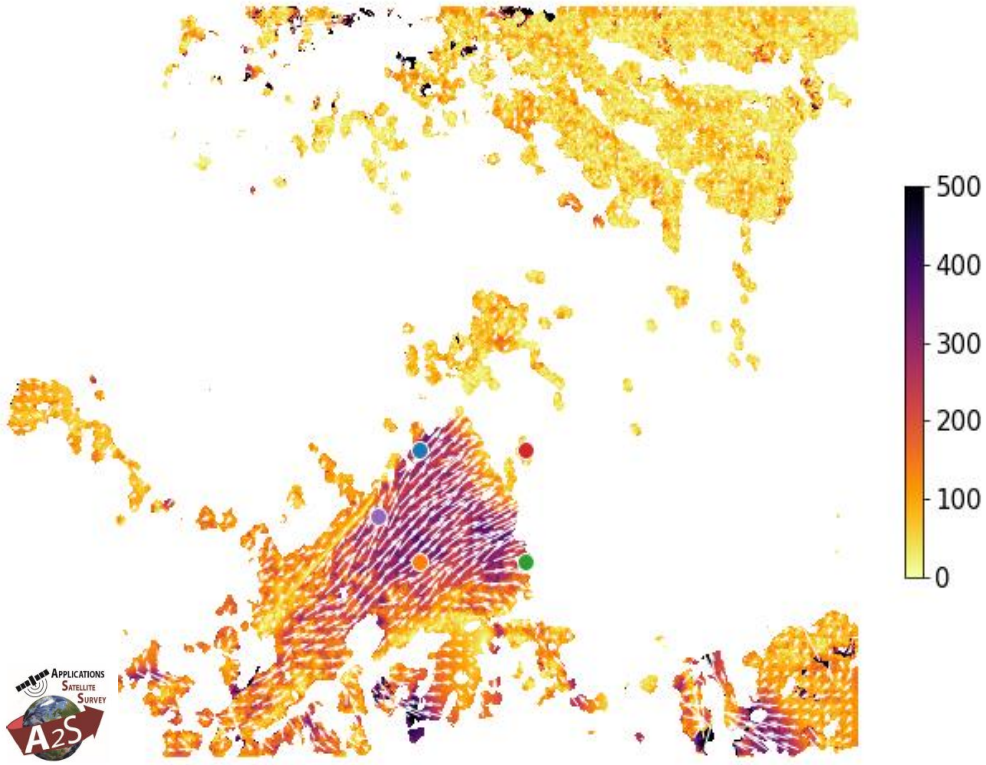
Differential velocity: 2021/01 – 2021/02



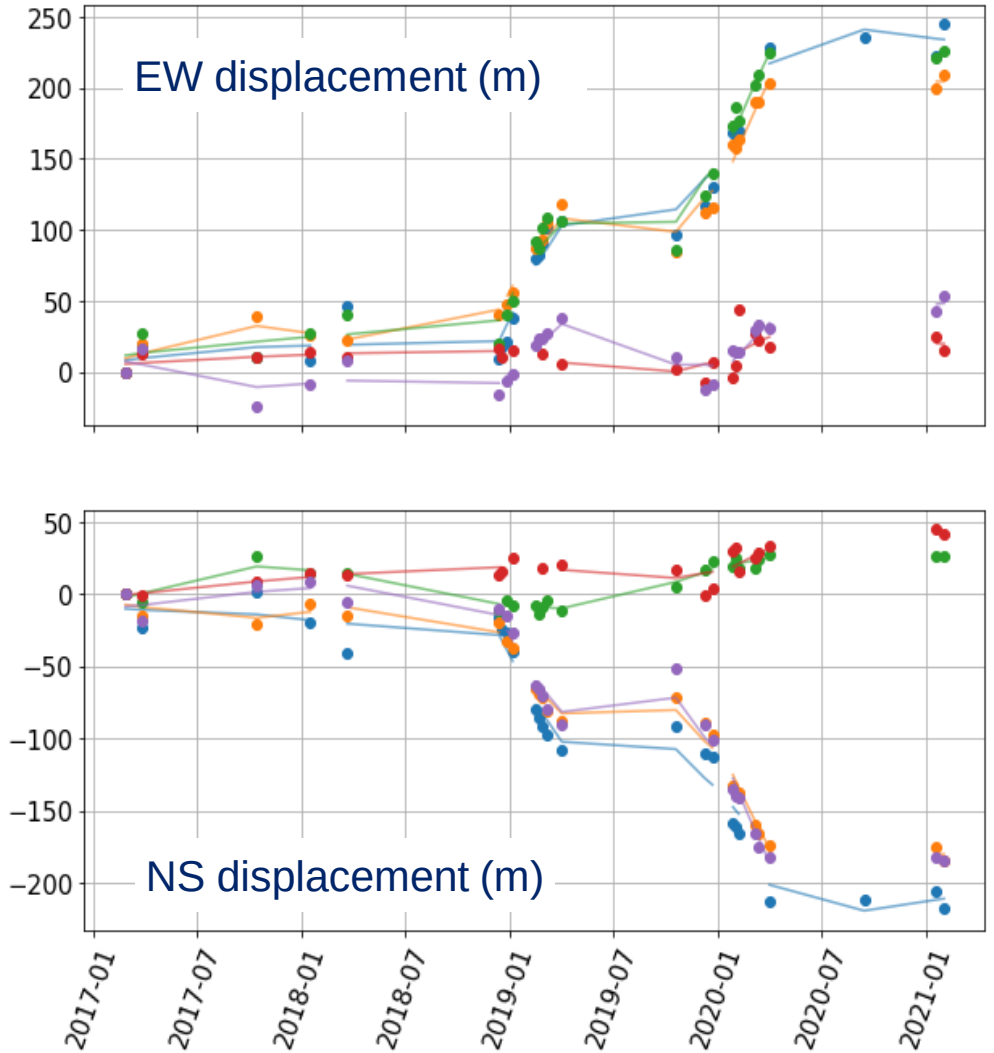
Optical imagery: domain / application “tailored” services on GEP

New service on GEP: Physical modelling of time series: generation of long motion time series

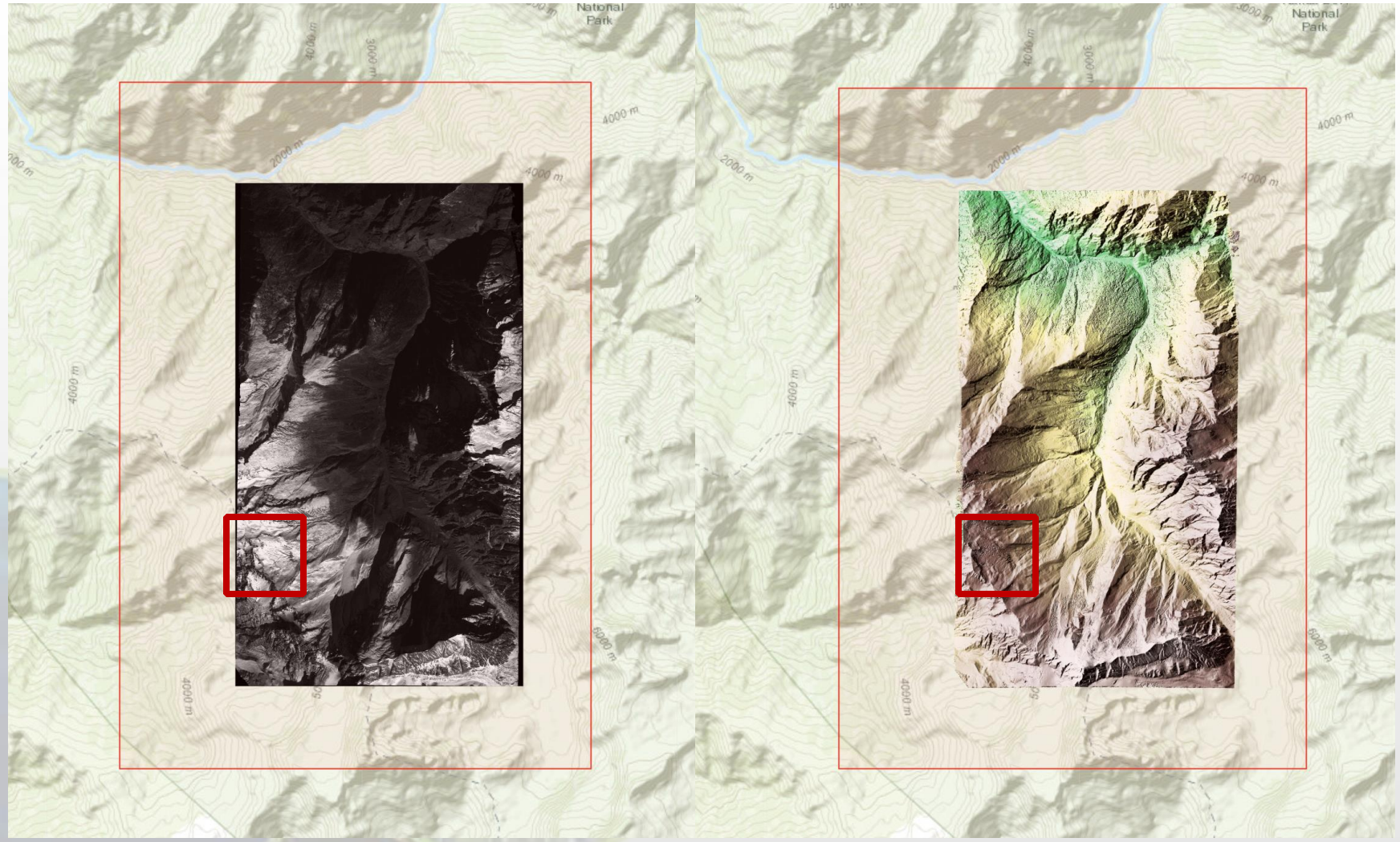
Astrolabe: cumulative displacement (m)



Acceleration/bloking of the ice per season



Pléiades DSM with DSM-OPT
Analysis of Uttarakhand landslide



Pléiades stereo
of 2021/02/10

→ Towards automated methods for DSM differencing on GEP

Pléiades generated DSM vs. Copernicus GLO30

Scientific Publications

ELSEVIER

Remote Sensing of Environment

Volume 254, 1 March 2021, 112254

Satellite InSAR survey of structurally-controlled land subsidence due to groundwater exploitation in the Aguascalientes Valley, Mexico

Francesca Cigna, Deodato Tapete

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https://doi.org/10.1016/j.rse.2020.11225

ELSEVIER

Remote Sensing of Environment

Volume 253, February 2021, 112161

Present-day land subsidence rates, surface faulting hazard and risk in Mexico City with 2014–2020 Sentinel-1 IW InSAR

Francesca Cigna, Deodato Tapete

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https://doi.org/10.1016/j.rse.2020.112161

remote sensing

Open Access Feature Paper Article

Sentinel-1 Big Data Processing with P-SBAS InSAR in the Geohazards Exploitation Platform: An Experiment on Coastal Land Subsidence and Landslides in Italy

by Francesca Cigna * and Deodato Tapete

Italian Space Agency (ASI), Via del Politecnico snc, 00133 Rome, Italy

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ly Koch and Lorenzo Solari

5), 885; https://doi.org/10.3390/rs13050885

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ıe Special Issue Big Data in Earth Observation: A New Computing Paradigm for Remote Data

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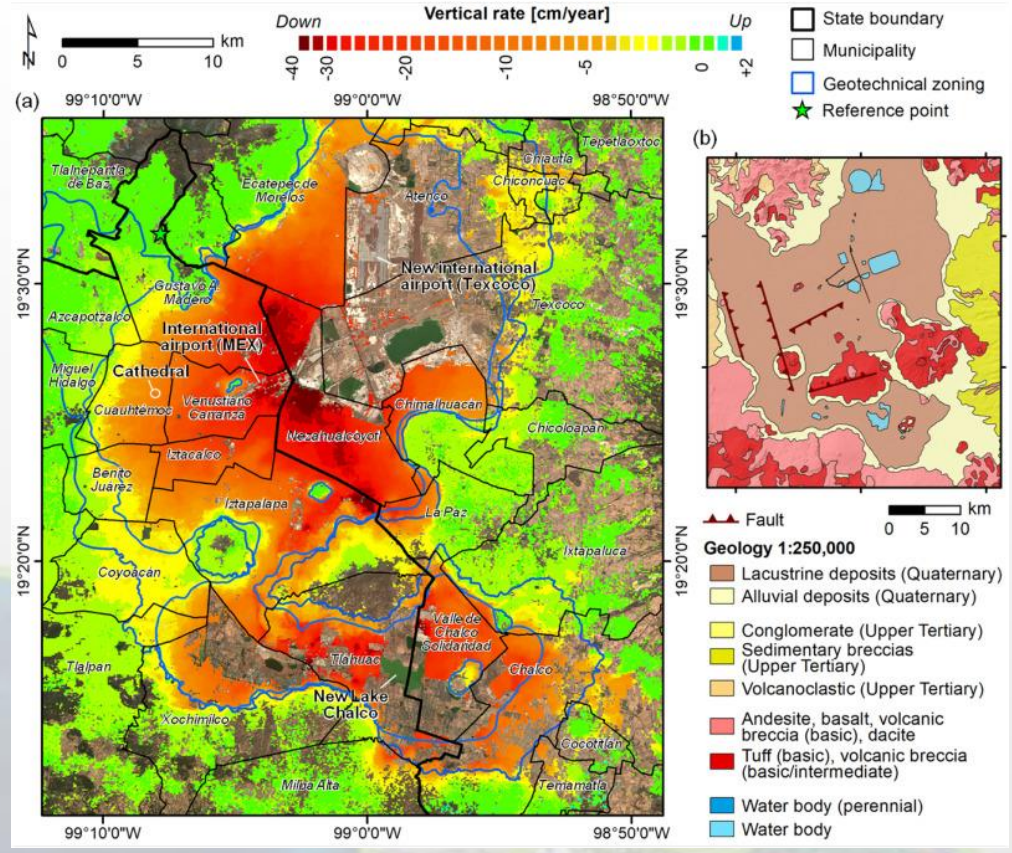
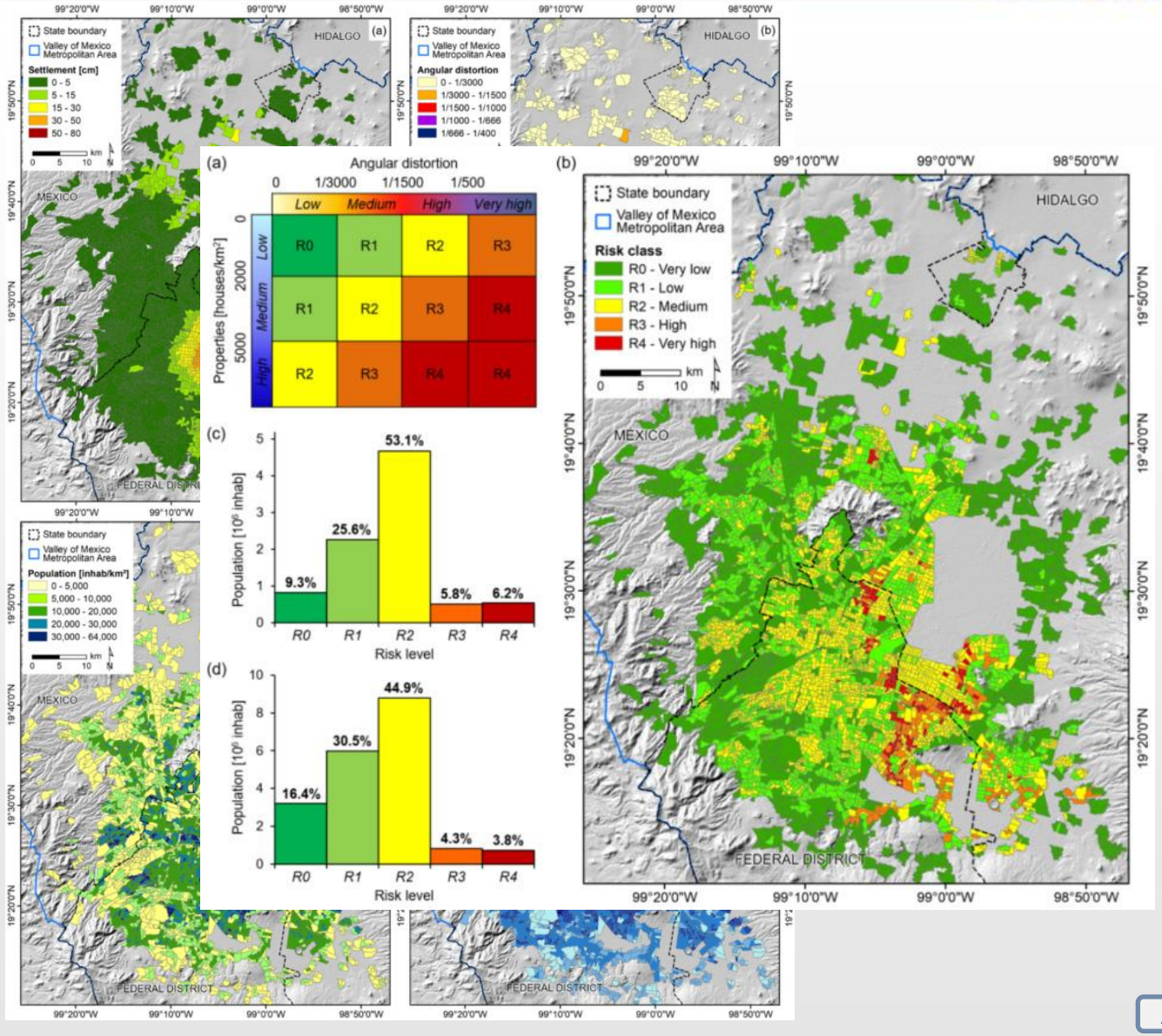
EO4SD DISASTER RISK REDUCTION TERRAIN MOTION PRODUCTS IN SUPPORT OF THE CITY RESILIENCE PROGRAM

Michael Foumelis[1,2], Alberto Lorenzo-Alonso[3], Ross Eisenberg[4], Ángel Utanda González[3], Christoph Aubrecht[5], Philippe Bally[5], Jan Kolomaznik[6], Vincenzo Massimi[7], Steven Rubinyi[4], Francisco Cano Gonzalez[3], María Encina Aulló-Maestro[3], Francesco Casu[8], Fabrizio Pacini[9]

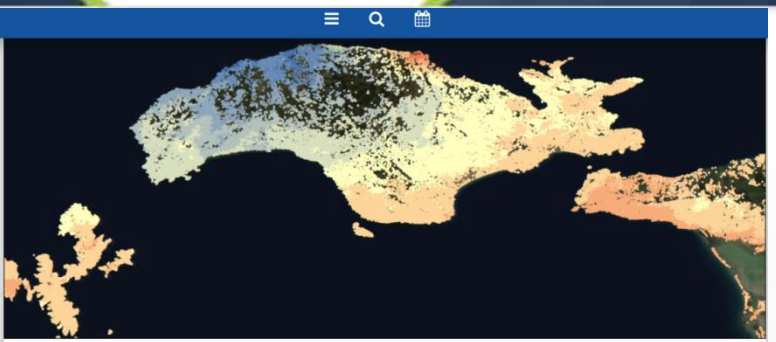
Present-day land subsidence rates, surface faulting hazard and risk in Mexico City with 2014–2020 Sentinel-1 IW InSAR





Francesca Cigna, Deodato Tapete, Present-day land subsidence rates, surface faulting hazard and risk in Mexico City with 2014–2020 Sentinel-1 IW InSAR, Remote Sensing of Environment, Volume 253, 2021, 112161,https://doi.org/10.1016/j.rse.2020.112161.

Animate & Communicate Scientific Results

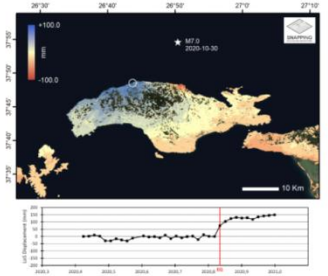


New PSI service SNAPPING operational on the GEP

Platform Services, Toolboxes February 4, 2021

A new advanced InSAR processing service called SNAPPING (Surface motioN mAPPING) has just been deployed in the Geohazard Exploitation Platform (GEP).

The potential of the service is illustrated in the context of the Samos (Greece) M7.0 seismic event of 30 October 2020.



Co-seismic ground displacements of the Samos M7.0 earthquake of 30 October 2020 as extracted by time series analysis of Copernicus Sentinel-1 data using SNAPPING service on GEP. In the case of Samos earthquake, it was possible to run a data stack of 35 acquisition dates and detect earthquake induced deformation, apart from the long-term terrain motion common for PSI approaches. The effect of both co- and post-seismic deformation is clearly visible in the displacement history plot. Contains modified Copernicus Sentinel data (2020), processed by AUTh.

Based on the open source SNAP toolbox and StaMPS software, the SNAPPING service has been implemented and integrated on-line by European experts from the Aristotle University of Thessaloniki (AUTh, GR) and University of Jaen (UJaen, ES), with the support of Terradue (IT).

It is using radar data from the Copernicus Sentinel-1 mission and it is based on the Persistent Scatters Interferometry (PSI) technique that combines large data collections to retrieve precise terrain motion measurements. Following successful testing and performance optimization it is now in operations in view of making it available to GEP users.

DISCUSS

The MPIC-OPT services presented at the AGU Fall meeting 2020

gep-blog

fprovost 1 Dec '20

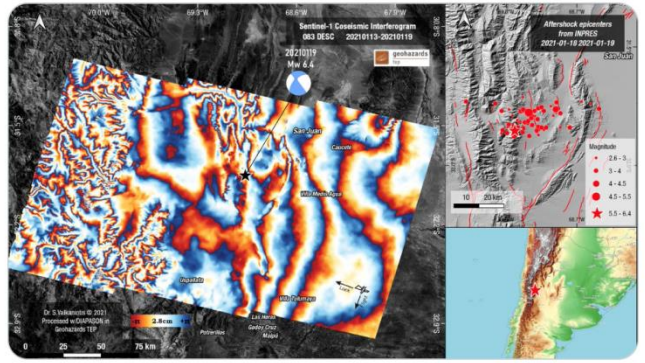
The MPIC-OPT services are currently presented at the AGU 2020 Fall Meeting in the form of a digital poster visible to conference participants. The service chain provides ground displacement/velocity from Copernicus Sentinel-2 time series by applying image matching techniques. The service has been derived into three services and target three specific applications: co-seismic deformation mapping (MPIC-OPT-ETQ), glacier monitoring (MPIC-ICE) and landslide motion monitoring (MPIC-SLIDE).

Figure 1. Screenshot of the iposter.

Ο χρήστης Geohazards Exploitation Platform έκανε Retweet

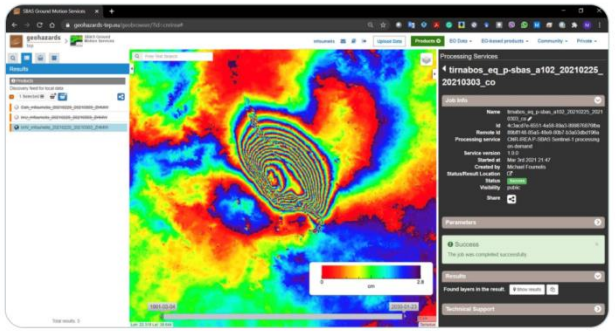
Sotiris Valkaniotis @SotisValkan · 19 Ιαν

#Sentinel1 interferogram reveals no surface deformation from the M6.4 San Juan, Argentina #earthquake. Lack of surface deformation pattern confirms current depth estimate (~20km). Strong tropospheric noise also present. Processed w/DIAPASON at @esa_gep, epicenters from INPRES.



Michael Foumelis @mfoumelis · 2 ώ

Please note that nice interferograms were generated and shared publicly on @esa_gep using SNAP, DIAPASON & P-SBAS services.



CEOS Pleiades users agreement - Data order/delivery Procedure

1. *A CEOS user submits a Pleiades data request form to isis-pleiades@cnes.fr , provided the request is approved by the thematic CEOS Demonstrator/Pilot lead**
2. *CNES checks that the entity/public institution to which belongs the « User » has signed the SCA*
3. *If 2 is OK, CNES asks Airbus to acquire/produce the image*
4. *Airbus informs the user and the platform operator for the delivery of the images by FTP*
5. *The dataset is made available on the platform by the platform operator*
6. *The platform operator grants access to all CEOS-Pleiades users and the Pleiades lisence is signed (electronically if possible) before each download*
7. *The dataset is shown on the catalogue for all platform users; no processing/download is permitted but any user can see the (metadata) catalogue of imagery.*

Agreement in place

***Leads responsible for Pleiades data requests**
Landslides: Jean-Philippe Malet
Seismic: Theodora Papadopoulou, Stefano Salvi
Volcano: Michael Poland
RO: Hélène Deboissezon

Charter Processing Environment based on GEP

Pleiades on the Charter PE for Alex storm

Pleiades scene of 10 Oct 2019

Pleiades scene of 5 Oct 2020 (36hrs after the storm impact)

Credits: CNES, ESA

- Data supplied by CNES as example of crisis imagery for on-line visualization
- *The Charter has decided to have a processing environment. Procedure (including testing, verification and operational readiness) started for the system to* ***become operational****.*

Santorini Report – Review Process

The Memorandum of the "International Forum on Satellite EO for Geohazard Risk Management"

- manifesto of the Disaster Risk Reduction community looking at geohazards
- produced in 2012
- open review process with users and practitioners
- 5-10 year objectives and requirements concerning **how satellite EO can contribute to hazard and risk mapping**
- focusing on members of the geohazards community that use satellite EO.

In the framework of the CEOS Working Group Disasters, the GLab **proposed to review these objectives and requirements and capture major milestones achieved over the last years** against these objectives.

- Feedback is needed by WGDisasters and the broader geohazards community working with EO (feedback received only for volcanic hazards and landslides)

Discussions started and are on going with thematic leads to identify changes in achievements or in community objectives wrt to the 2012 Santorini report

The Way Forward

- Collocating data and processing is still challenging (incl. archiving cost)
- Make services resilient to data access issues
- Build chains that utilize other missions (apart from Copernicus Sentinel)
- Well-defined platform governance (incl. service providers)

Thank you

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Theodora Papadopoulou, ARGANS Ltd. c/ ESA tpapadopoulou@argans.co.uk