Landslide Demonstrator 2021-2024

CE◉S

"EO-based Landslide services: Paving the Way for Landslide Hazard Management Products"

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with the contributions of:
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CNrS · NASA · BGC · Terranum · AFRICA museum

Propose landslide tailored tools, services, products and geo-information to support landslide hazard and risk assessment for several end user communities

- **Application 1**: Engage with stakeholders for promoting the use of satellite data for landslide disaster assessment and mitigation along **transportation and pipeline corridors**, with goal of establishing **local monitoring systems**

- **Application 2:** Engage with stakeholders for establishing **landslide hazard and risk forecasts,** using **satellite data** and **models**

- **Application 3:** Coordinate and expand the availability of landslide inventories and supporting data to advance **landslide science** at global scale, with the **systematic documentation of large landslide disasters triggered by extreme forcing events**
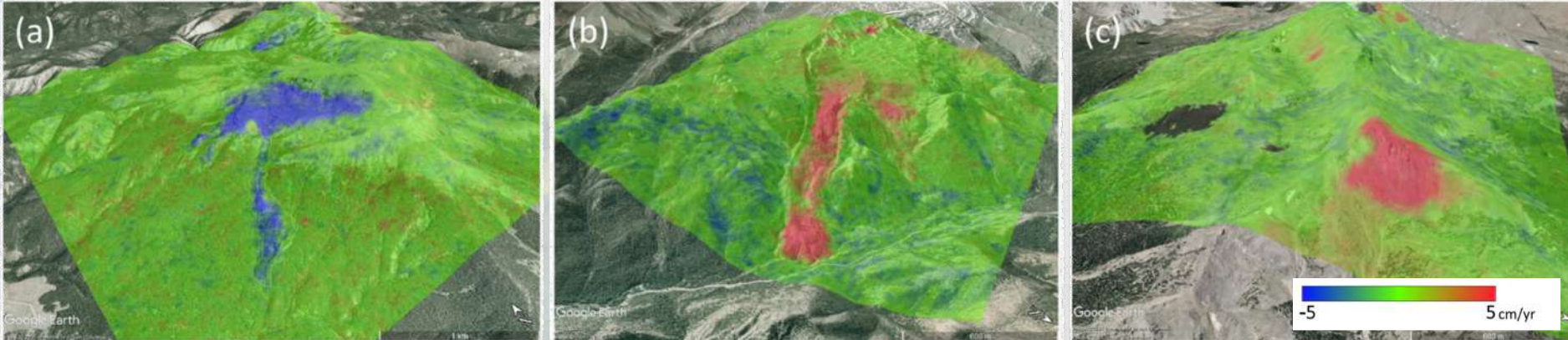
First science and operational application of RCM time series for landslides

RCM SBAS InSAR – 2020/06/26 - 2020/09/06
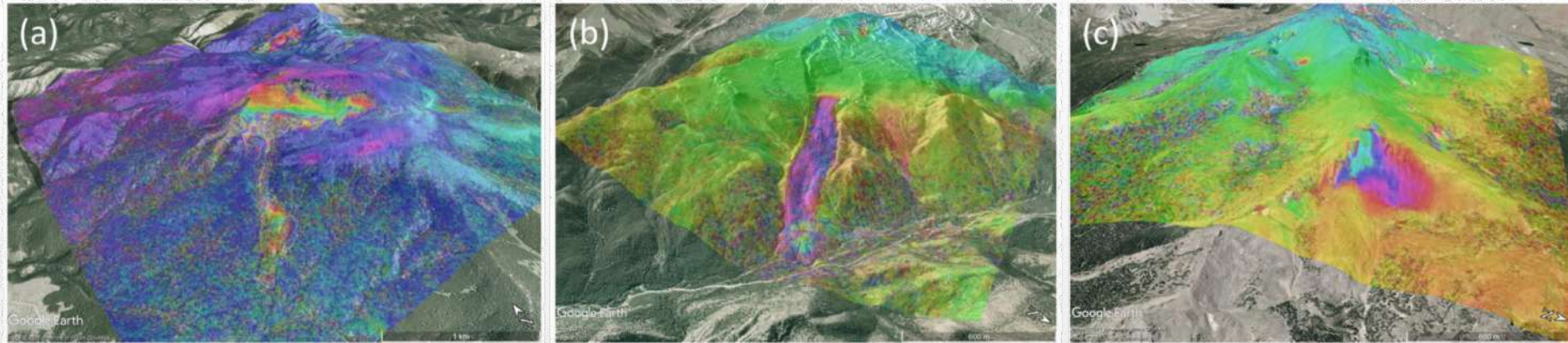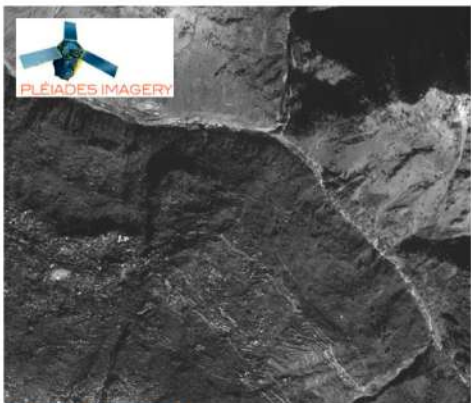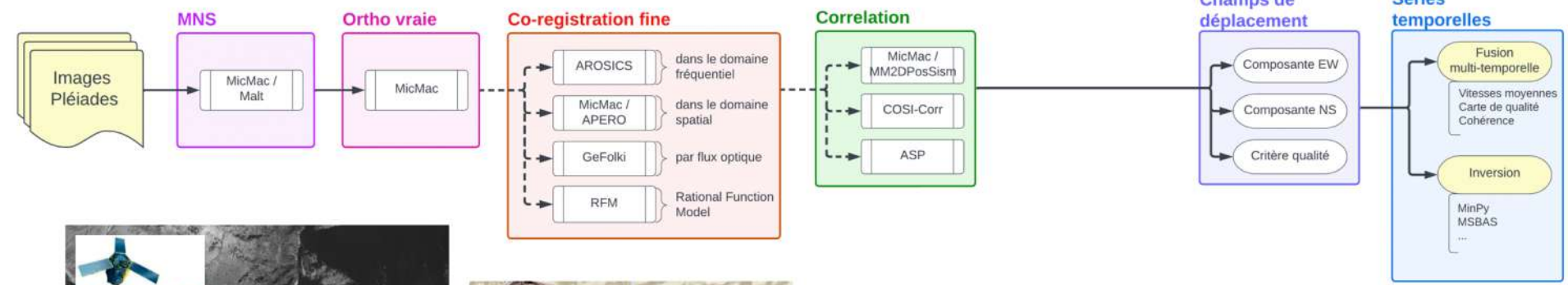

S1 SBAS InSAR – 2017/10/08 – 2021/06/13

Comparisons RCM InSAR vs. S1 InSAR on several unstable slopes in Eastern Canada (with CSG)
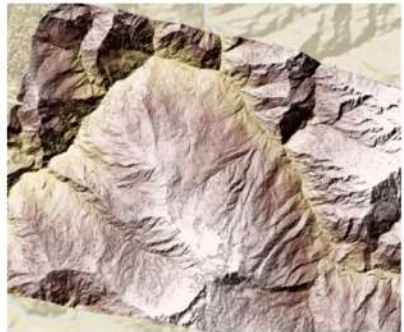
Engaging with private engineering bureaux to propose EO-based landslide services

Développer une chaine Très Haute Résolution (< 1 m)

ortho-image vraie

MNS

OTELO

Outils de TELédétection opérationelle des mOuvements de terrain

SAGE srl. (Grenoble)

New activity of the company: propose a portfolio of EO services for their clients

A 2-steps strategy:

1) Develop new services, mostly using optical VHR data (Pléiades, PNEO)
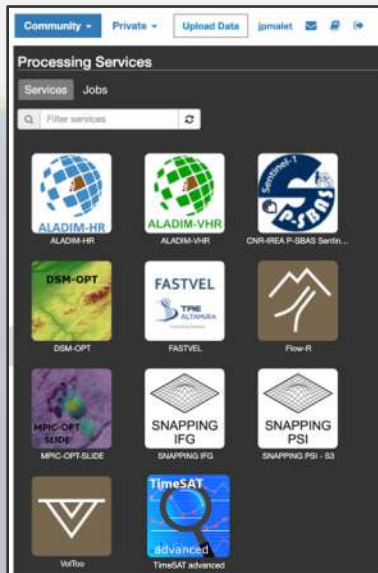
2) Later: develop InSAR based services

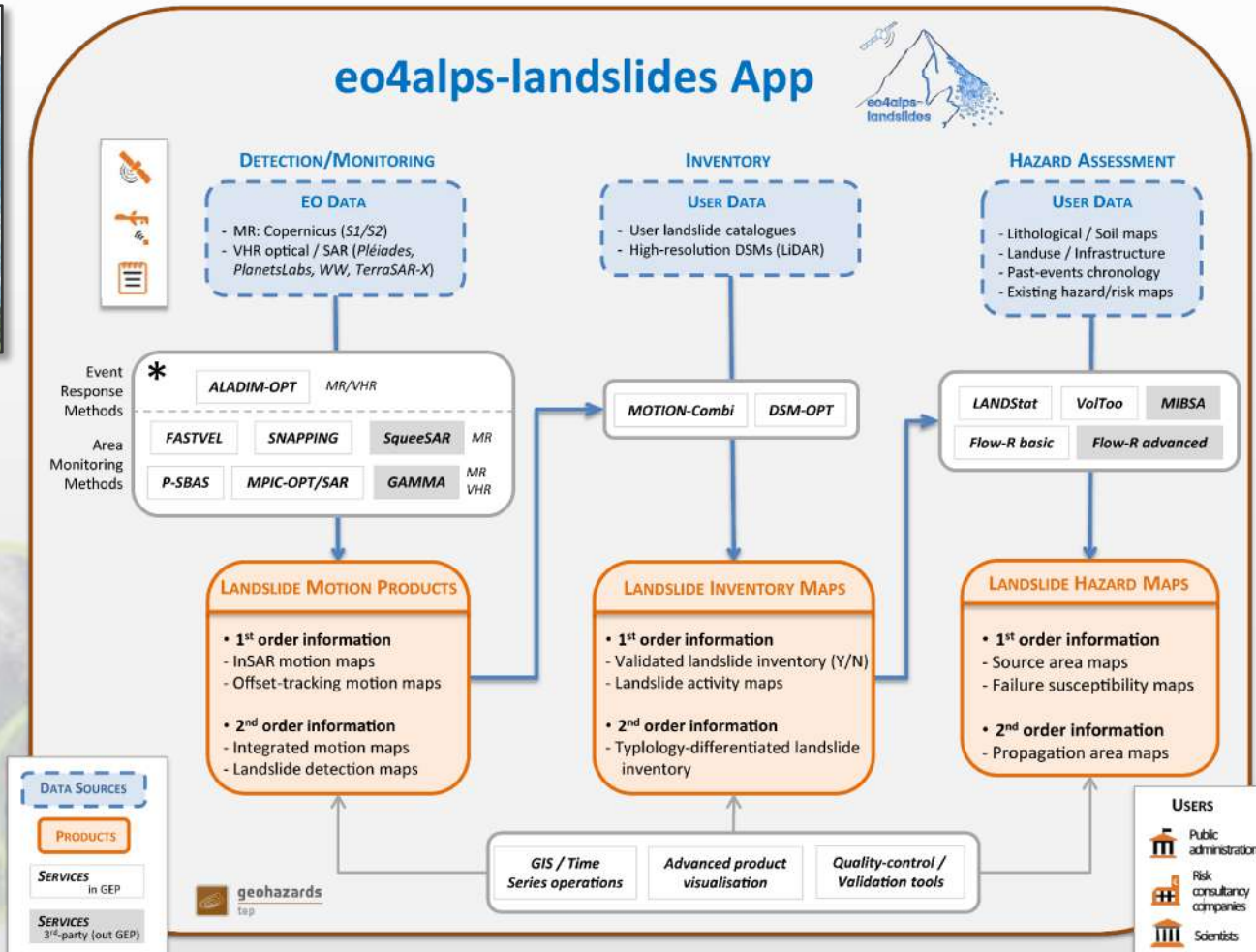**Towards a sustainability plan for the eo4alps-landslides cloud-based application**
…. from a project (ESA) to a sustainable ecosystem of services (Terradue and service providers)

geohazards-tep.eu/#!pages/eo4alps

National structuring programmes to transfer EO services to operations

In France: C2ROP (sponsored by MTE)

In Swiss: extending the Wallis experience to the Swiss territory (OFEV)

C2ROP - Edition 2

Mise en commun du savoir-faire pour optimiser la gestion du risque rocheux

▲ Télédetection spatiale pour la surveillance pour phénomènes de grande ampleur

Verrous scientifiques et techniques :

- Etat de l'art sur les données spatiales et méthodes de traitement des données
- Méthodes et configurations pour une utilisation opérationnelle

Actions :

- Rédaction d'un état de l'art
- Collecte des données
- Mise en oeuvre de méthodes de traitements pour une utilisation opérationnelle
- Guide des bonnes pratiques
- Ajouts dans le guide surveillance des risques rocheux

▼ Détection d'évènements par edge computing, tous phénomènes gravitaires

Sécurisation

▼ Alerte, alarme et sécurisation des enjeux mobiles

Surveillance spécifique

▼ Surveillance des ouvrages de protection

▼ Solutions agiles de surveillance des risques naturels gravitaires

Suivi des Déformations par Satellite

L'interférométrie SAR InSAR est une technique d'imagerie satellitaire radar très efficace pour mesurer la déformation de la croûte terrestre et les déplacements de terrain de l'ordre du millimètre. Dans le cadre de la surveillance des terrains instables, le Canton du Valais (Service des forêts, des cours d'eau et du paysage) a commandé à l'entreprise GAMMA Remote Sensing AG un historique des mesures de déplacement PS-InSAR (Sentinel-1 et RADARSAT-2) pour l'ensemble du

Sentinel 1 orbite descendant 66 (T066D) de 2015 à 2019
Incidence   Azimut nord
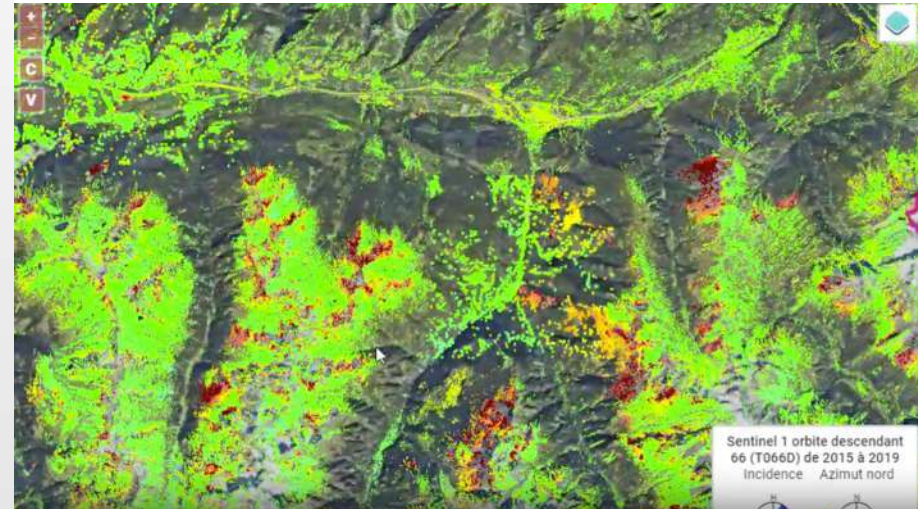
Wallis InSAR web-platform

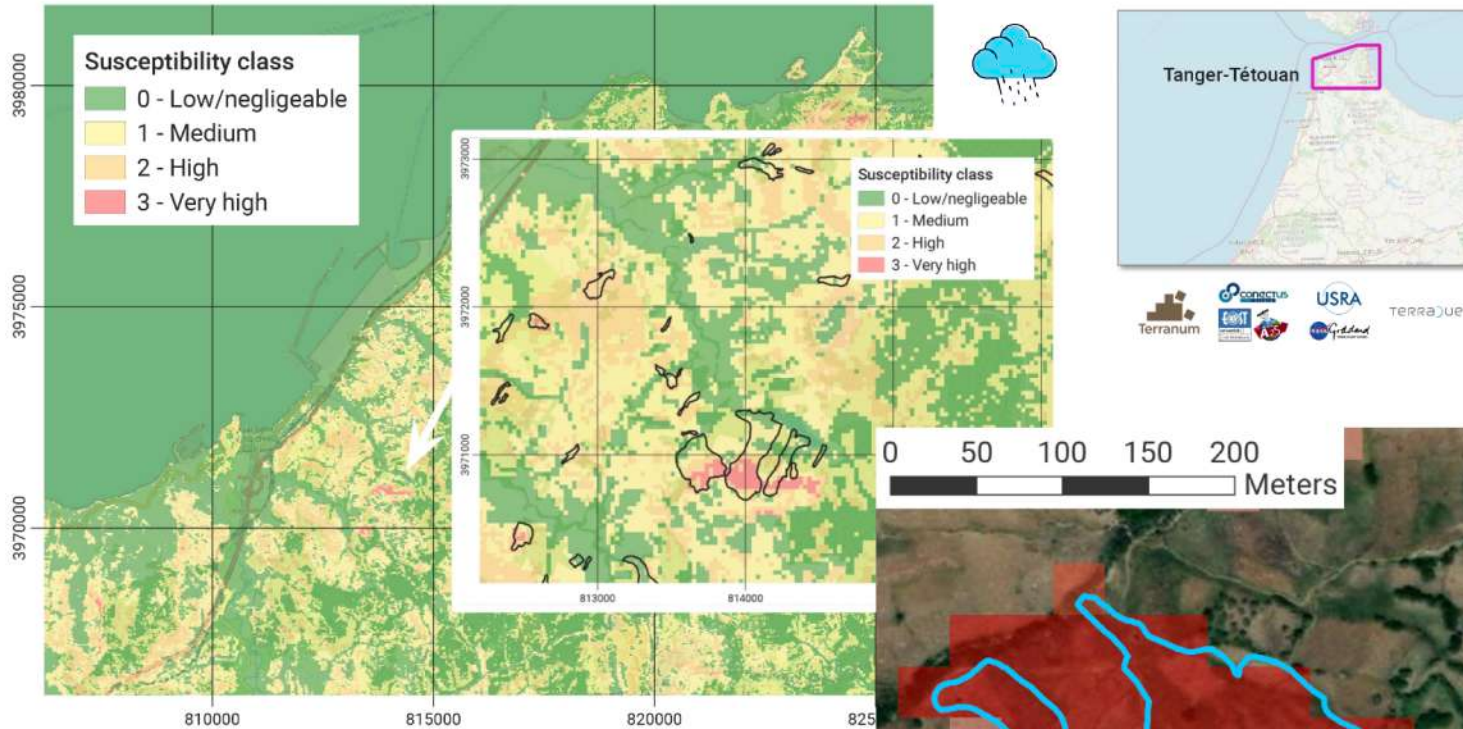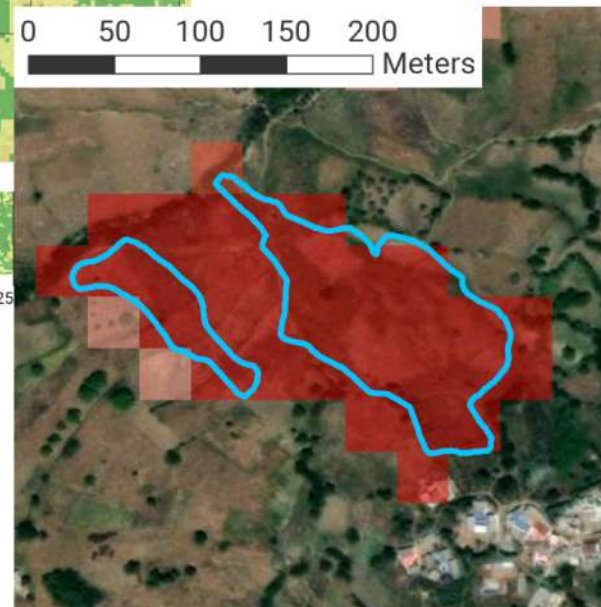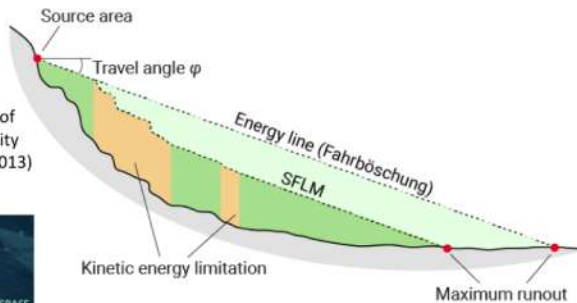**Can we propose models to forecast landslide disasters?** (World Bank / LHIS-P)

Illustration of the reach angle principle (or Fahrböschung) and of the effect of the maximum velocity parameter (after Horton et al., 2013)

MoU with Global AXA parametrics (subsidiary of AXA)
PhD project: to be funded in Fall 2023 to develop parametric insurance products for landslides
Target areas: all the Tropics +25°N to +25°S
Topic: Develop a consistent modelling scheme for landslide observations and risk modeling

Parametric insurance is based on an independent parameter or index that is correlated to client's losses

e.g. temperature, wave height, wind speed, etc.

Once a threshold is reached payment is triggered automatically
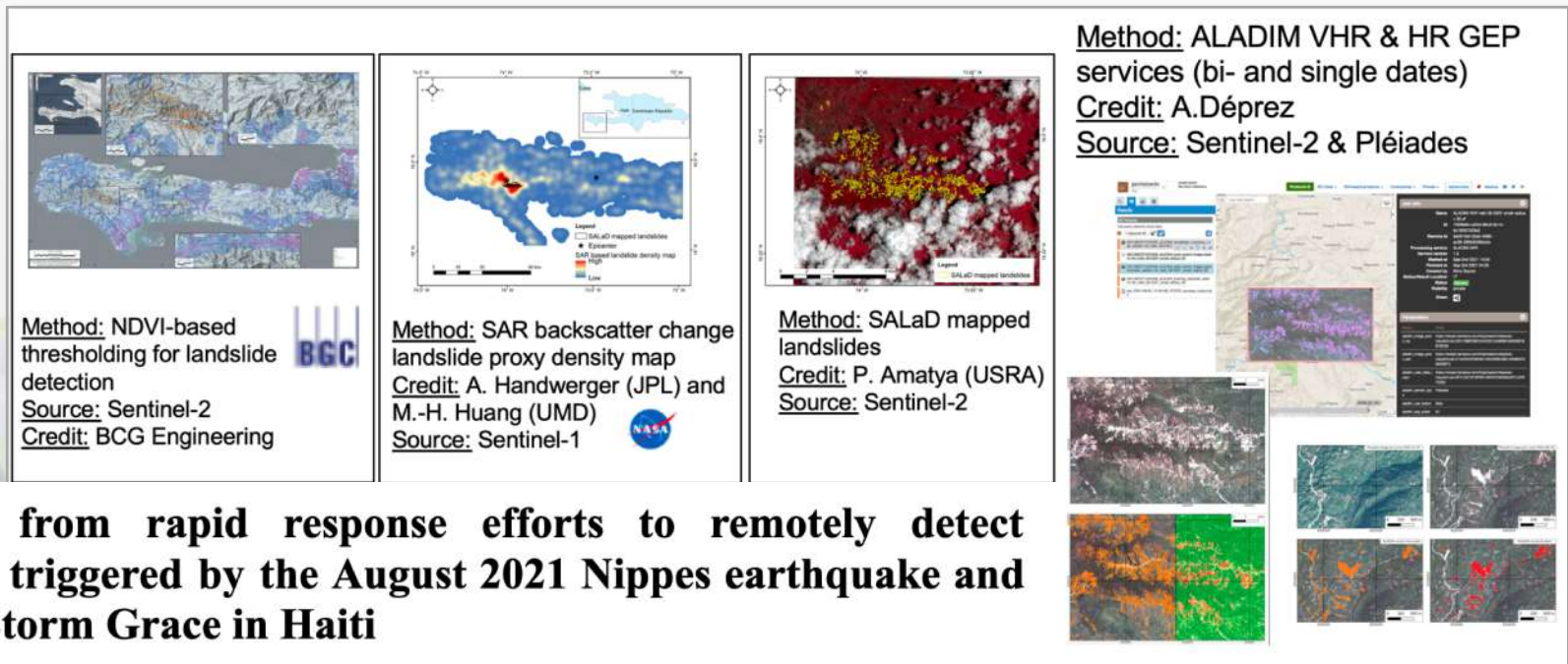
e.g. wind speed 10% below 5-year average

This product offers a seamless customer experience with an optimized insurance process and amplifies the scope of the insurable

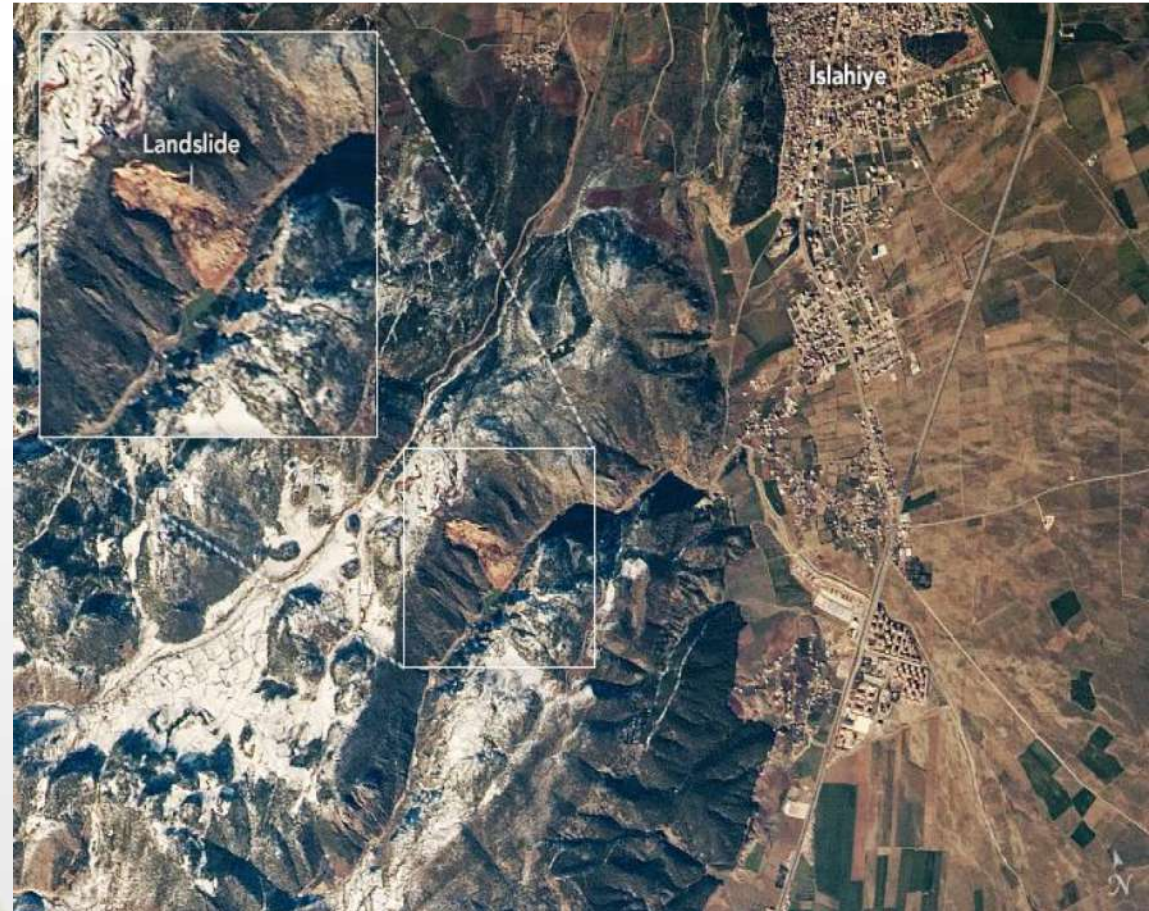## Advancing EO-based landslide inventories for extreme forcing events

o Science standards for creating and sharing EO-based landslide inventories
o Advance automatic methods to detect and monitor landslides
o Benchmarks of datasets and products and On-line repositories to share global landslide data

Method: NDVI-based thresholding for landslide detection
Source: Sentinel-2
Credit: BCG Engineering

Method: SAR backscatter change landslide proxy density map
Credit: A. Handwerger (JPL) and M.-H. Huang (UMD)
Source: Sentinel-1

Method: SALaD mapped landslides
Credit: P. Amatya (USRA)
Source: Sentinel-2

Method: ALADIM VHR & HR GEP services (bi- and single dates)
Credit: A. Déprez
Source: Sentinel-2 & Pléiades

Learning from rapid response efforts to remotely detect landslides triggered by the August 2021 Nippes earthquake and Tropical Storm Grace in Haiti

Pukar Amatya[1,2,*], Corey Scheip[3], Aline Déprez[4], Jean-Philippe Malet[4,5], Stephen L. Slaughter[6], Alexander L. Handwerger[7,8], Robert Emberson[1,2], Dalia Kirschbaum[9], Julien Jean-Baptiste[4], Mong-Han Huang[10], Marin Clark[11], Dimitrios Zekkos[12], Jhih-Rou Huang[12], Fabrizio Pacini[13], Enguerran Boissier[13]

One part of the team based at NASA's Goddard Space Flight Center identified more than 100 landslides, including several in the valley near Sarıseki, using high-resolution data from Planet Labs. The landslide data were included in maps provided to World Central Kitchen to help the aid group deliver food and water to earthquake victims. As new information becomes available, the team is posting maps and data products related to the earthquake on its open access mapping portal.

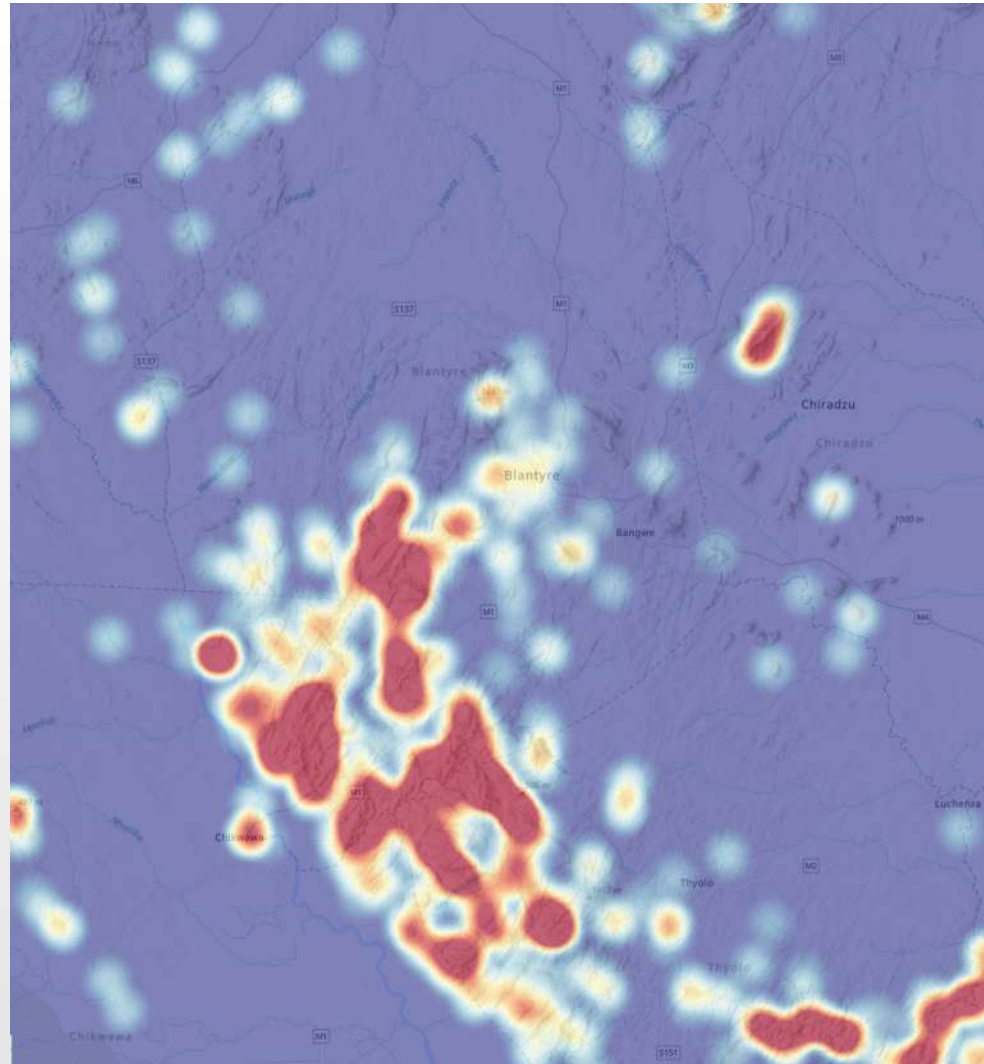Data: https://maps.disasters.nasa.gov/arcgis/home/item.html?id=03cdf5765e5b4ce58b69c69ceee98310

Credits: P. Amatya (UMBC/NASA) and R. Soobitsky (SSAI/NASA)

NASA used a Sentinel-1 SAR backscatter change approach developed in GEE (Handwerger et al., 2022) to detect areas with high landslide density. This approach detects potential landslides by calculating the change in the backscatter coefficient before and after the triggering event using the log ratio approach. False positives such as backscatter change due to flooding, agriculture, and more, are removed by using threshold-based masks made from the topographic slope from the 1 arcsec (~30 m) resolution NASADEM (NASA JPL, 2020). Using stacks of SAR data reduces noise, and furthermore, the pre-event stack provides backscatter data that is more representative of the pre-event ground surface properties. Finally, to detect landslide areas, the backscatter change raster was thresholded using the 99th percentile to highlight strong signals, and the heatmap was calculated.
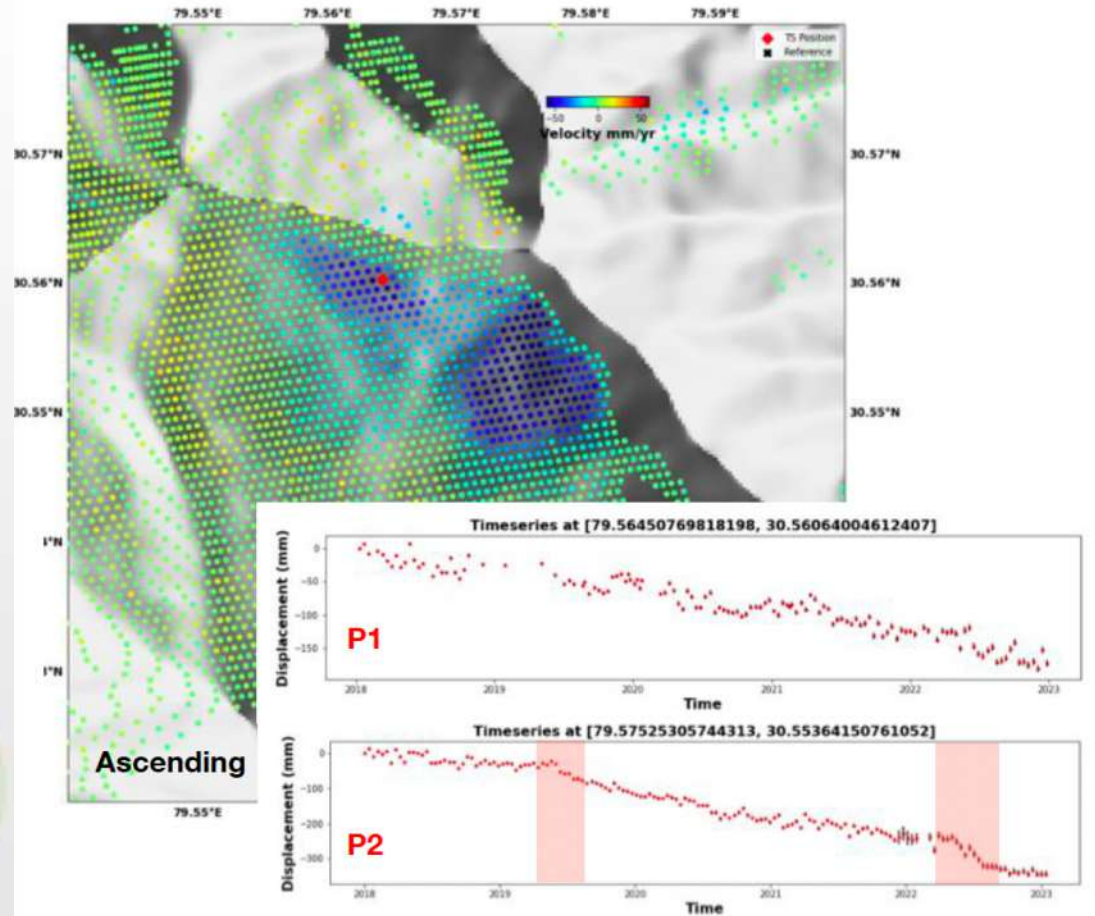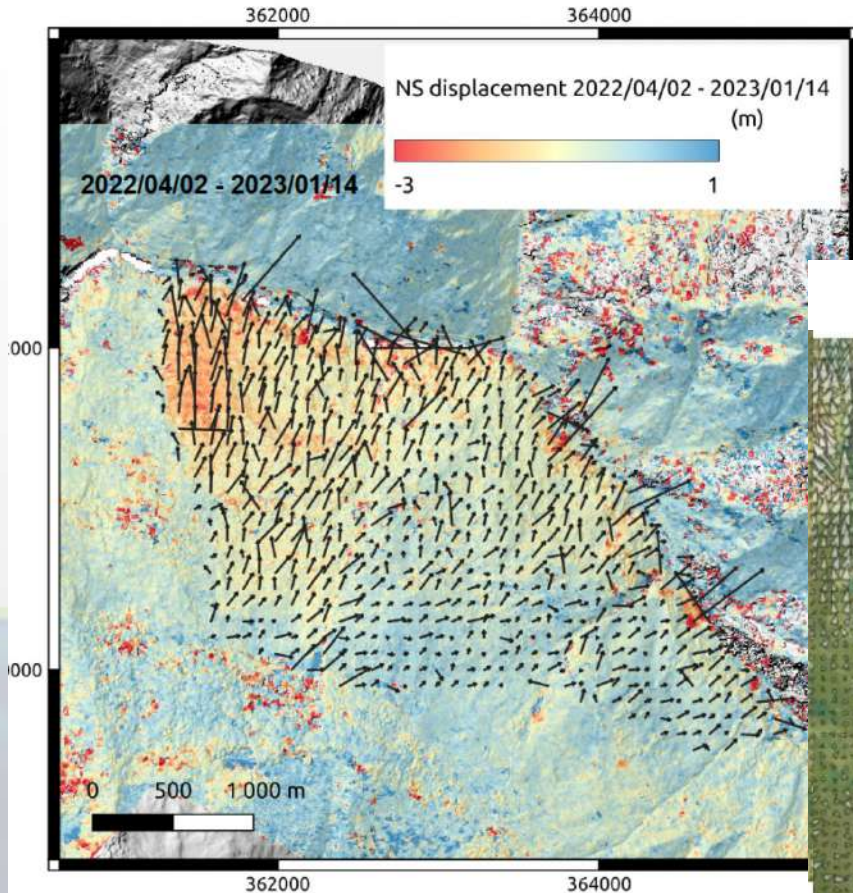
Data:
https://maps.disasters.nasa.gov/arcgis/home/item.html?id=66f1623a7c214e3b9006b6eb5180cc44

Credits: Pukar Amatya (UMBC/NASA)

S1 – NSBAS time series (ForM@Ter)

Credits: B. Raimbault, R. Jolivet (ENS)

NS displacement 2022/04/02 - 2023/01/14 (m)

2022/04/02 - 2023/01/14   -3   1

Pléiades – image correlation
(Credit: P. Lacroix, ISTerre)

PlanetsLabs – image correlation
(Credit: B. Wirtz – EOST)

20170920-20220813

20170920-20230106

Displacement (px)
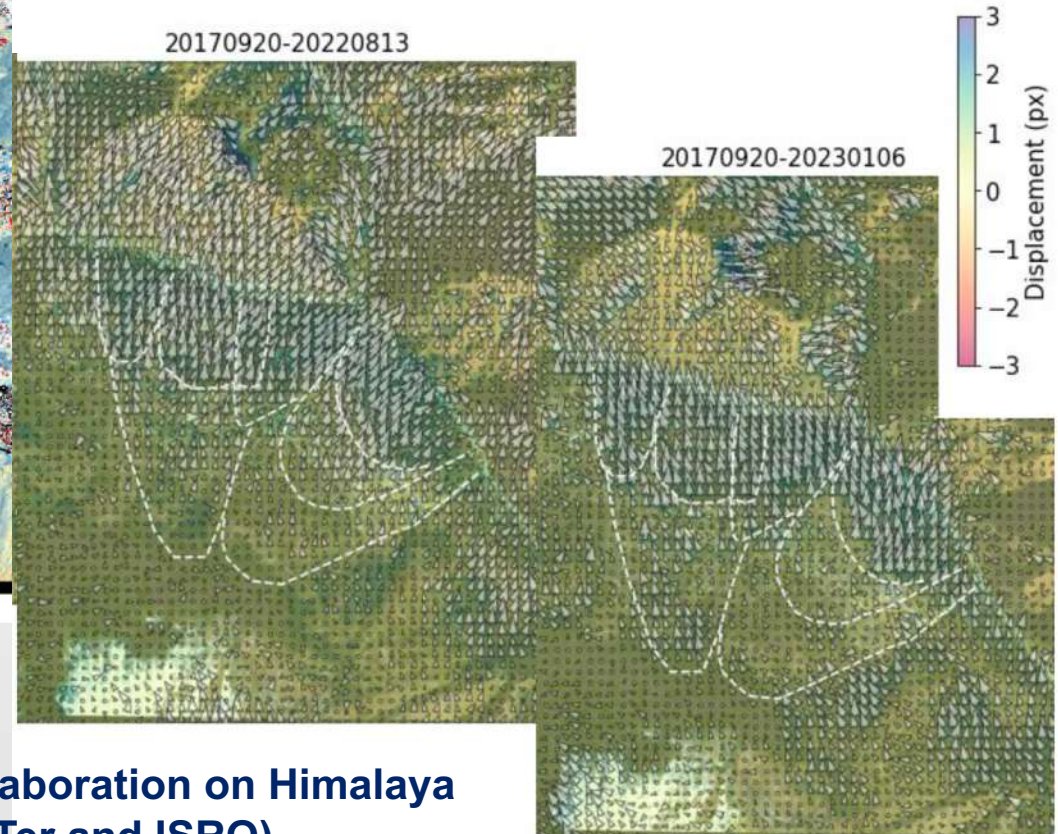
→ Setup of a MoU for long-term collaboration on Himalaya landslide monitoring (CNES/ForM@Ter and ISRO)

See you all in the US in September 2023!