Comparison of SAR sensors in emergency applications: La Palma volcanic eruption - 2021

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IABG

Copernicus
Europe's eyes on Earth

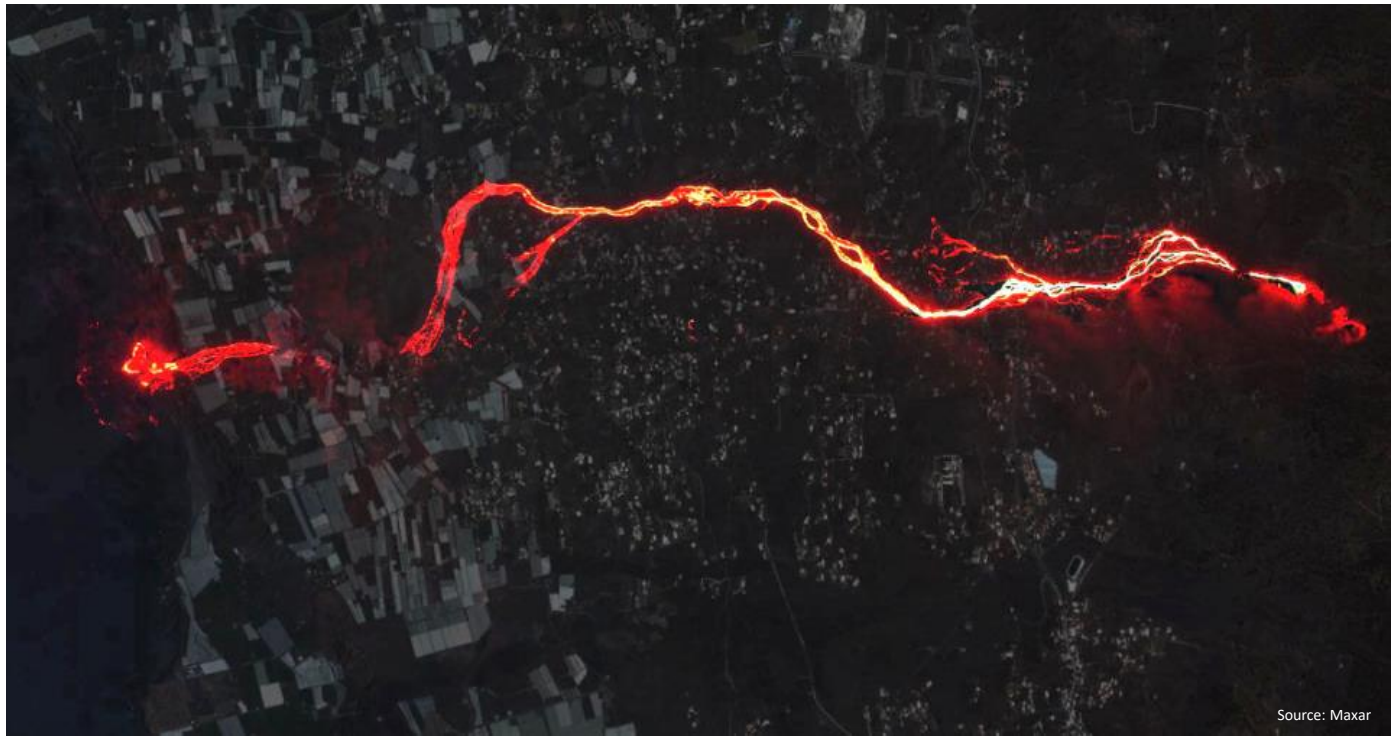
Emergency Management

Outline

- Overview
- DEM Acquisition plan
- T1 – TDX
- T2 – TSX/PAZ
- Outputs
- Conclusions

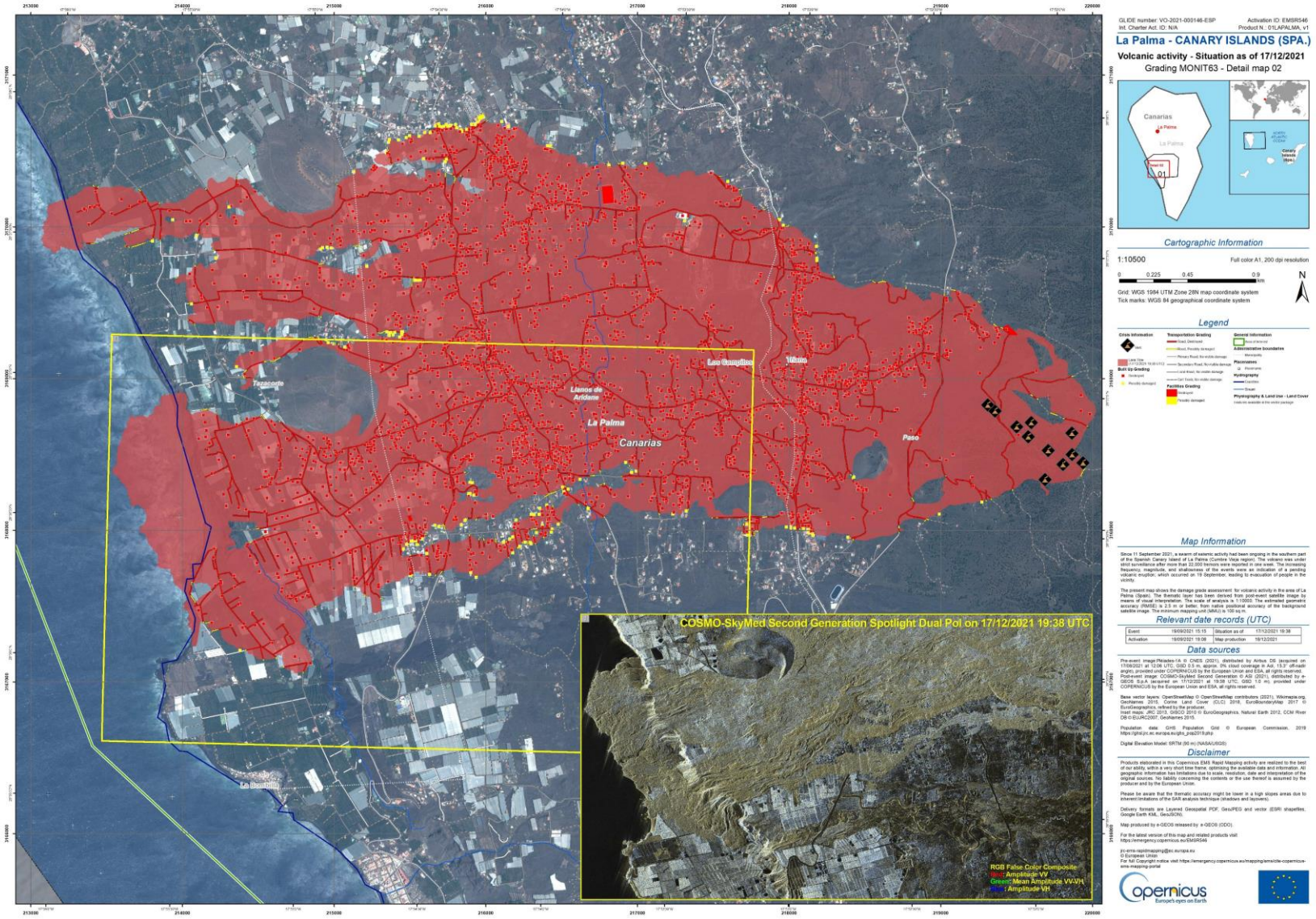
Overview

- Volcanic eruption started on September 19th, 2021
- 85 days duration, officially ended on December 25th, 2021
- Longest known eruption on La Palma and the first on the island since the eruption of Teneguía in 1971.



Overview

- 7000 people evacuated
- 3.5 km at widest point x 6.2 km long
- 1200 ha affected
- Two new peninsulas
- 3000 buildings and 70 km on transportation affected

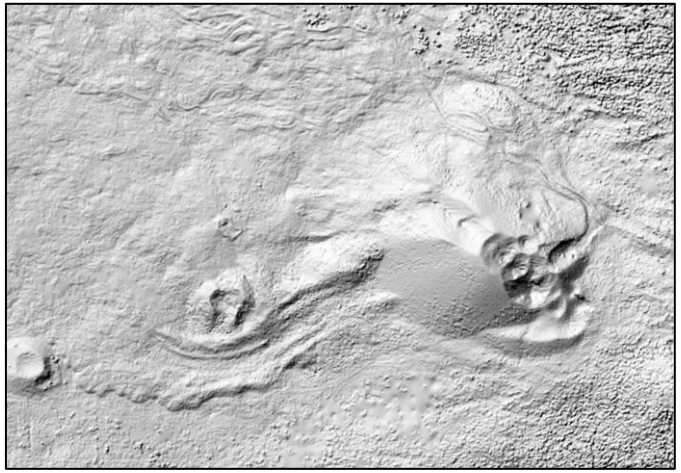


Source: Copernicus Emergency Management Service (© 2022 European Union), [EMSR112] Ground deformation in La Palma Island, Spain

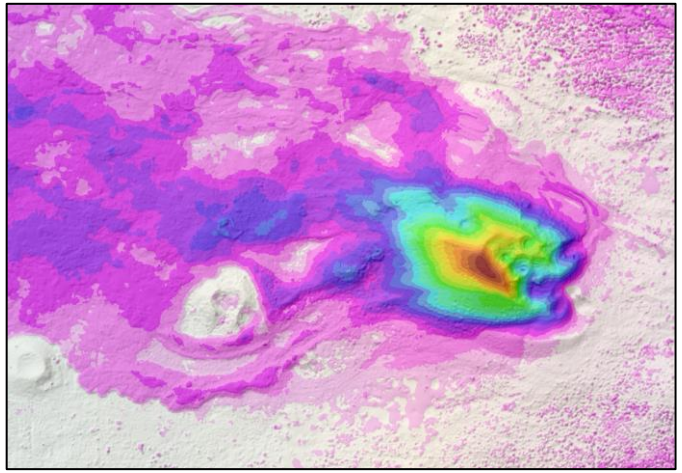
Overview

- Eruption monitored by several activations from the Copernicus Emergency Management Service, on which IABG takes part
- EMSN119: Digital Elevation Models of the Cumbre Vieja Volcano in La Palma, Spain
- User: Geological Survey of Spain (IGME)

OUTPUTS



DEM



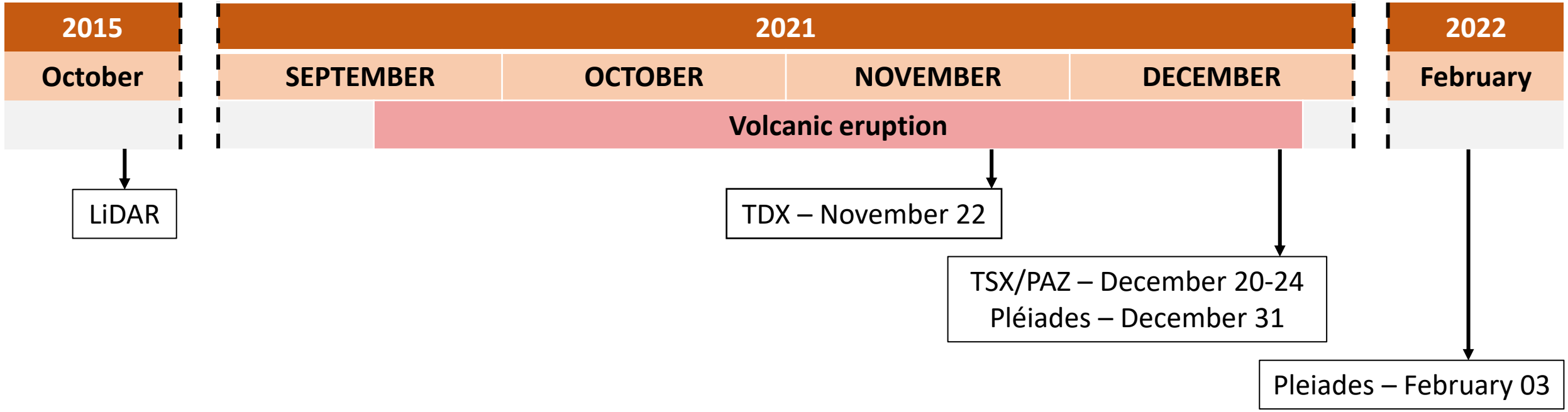
Elevation change

Volume
&
TADR

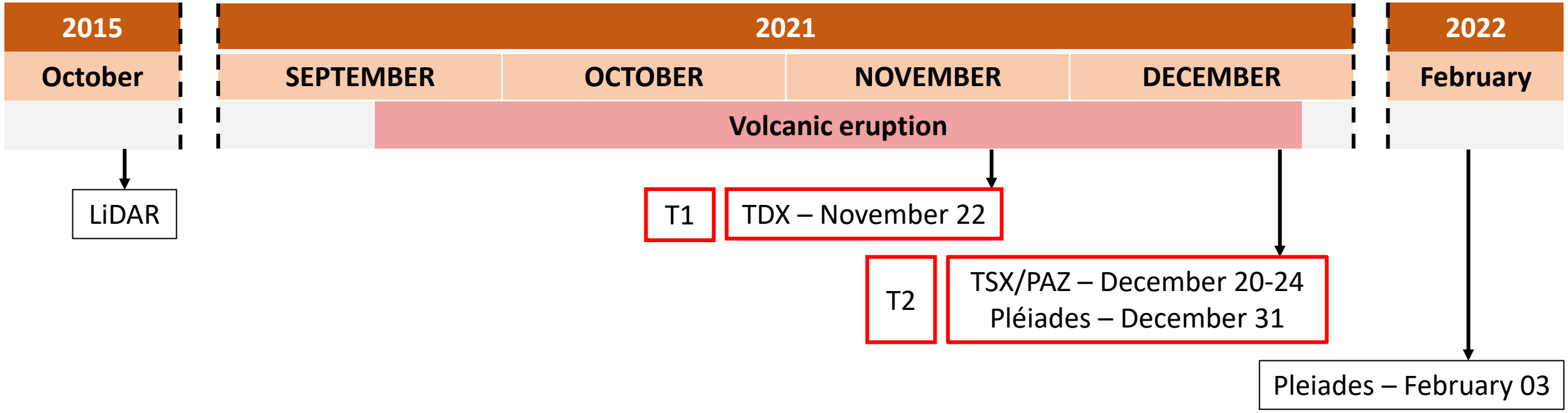
Statistics

Source: Copernicus Emergency Management Service (© 2022 European Union), [EMSR119] Digital Elevation Models of the Cumbre Vieja Volcano in La Palma, Spain

DEM Acquisition plan



DEM Acquisition plan



SAR Acquisition plan

ID	Image Pair	Satellite	Btemp	Bperp	Mst angle	Orbit	H. Ambiguity
1	19.10 - 26.10	TSX / PAZ	7	418	42	ASC	17
2	26.10 - 30.10	TSX / PAZ	4	192	42	ASC	37
3	21.11 - 28.11	PAZ / TSX	7	195	42	ASC	36
4	22.11	TDX	0	424	33	DESC	24
5	28.11 - 02.12	TSX / PAZ	4	9	42	ASC	832
6	09.12 - 13.12	TSX / PAZ	4	180	42	ASC	39
7	20.12 - 24.12	TSX / PAZ	4	112	42	ASC	63

SAR Acquisition plan

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T1 DEM - TDX

- High demand over La Palma, with both TSX and TDX observing the volcano
- Alternating bistatic (consistent parameters with elder DEM acquisitions) with monostatic mode
- Low chances to task satellite in desire orbit.

+

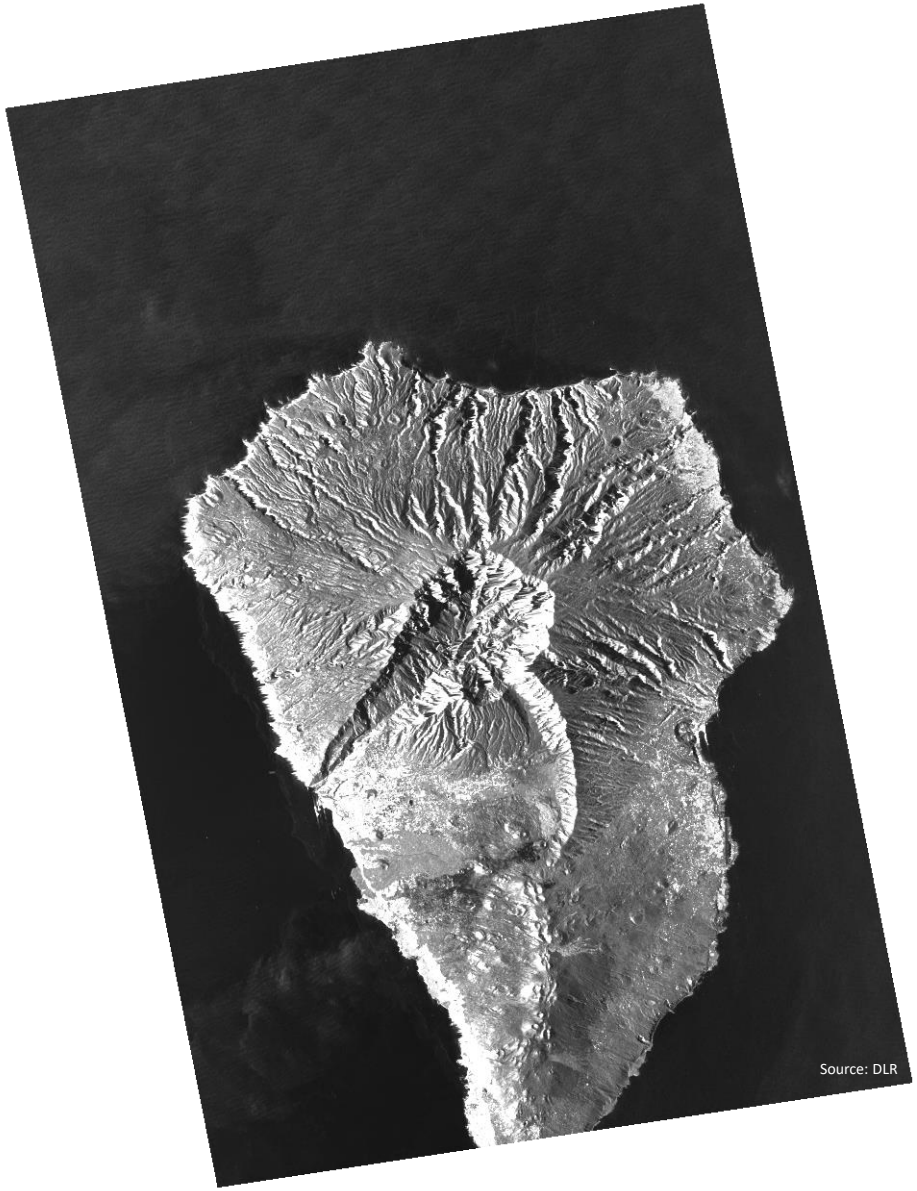
- TDX failure on Q4 2021. Close formation dissolved for safety reasons by December

3 options from archive:

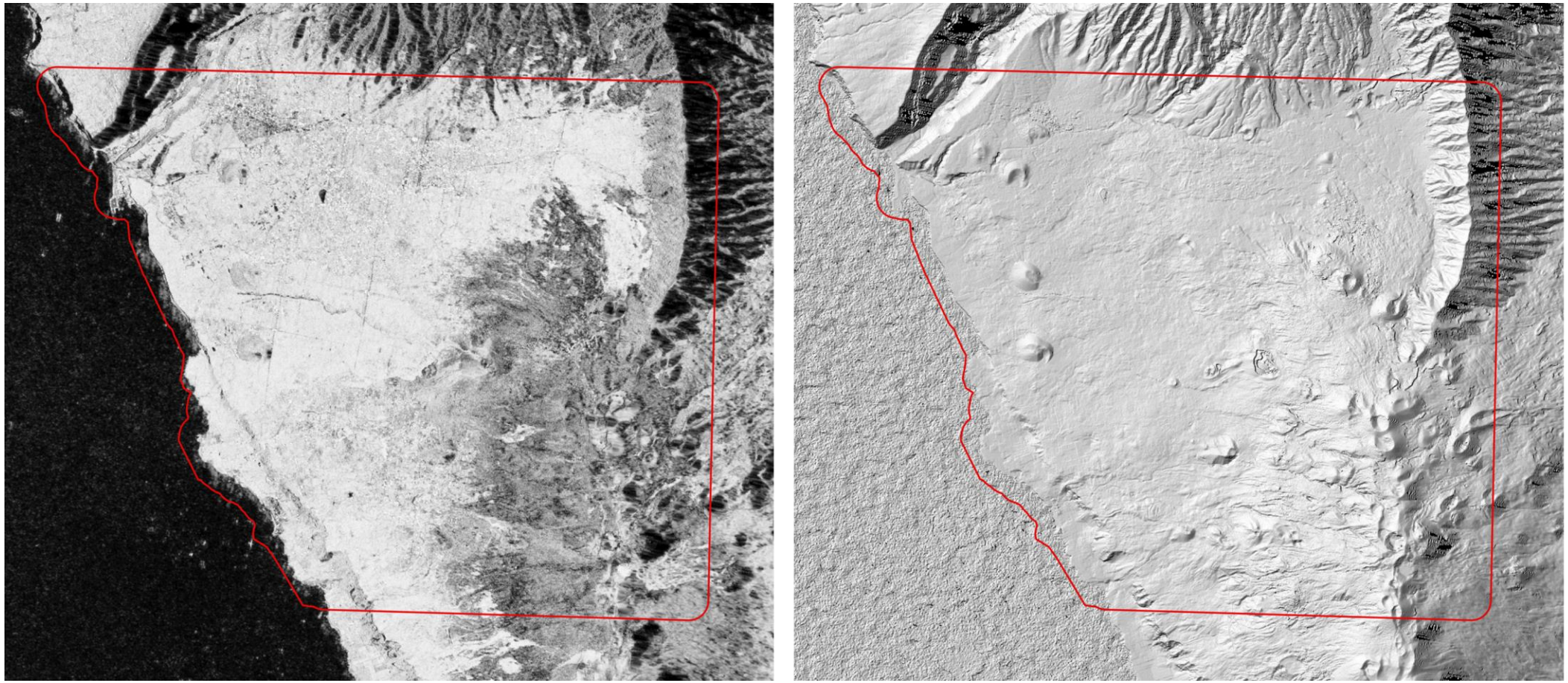
2021-10-15 (tanDEM_a1_060, orbit 11 ascending)

2021-11-17 (tanDEM_a1_060, orbit 11 ascending)

2021-11-22 (tanDEM_a1_020, orbit 79 descending)



T1 DEM - TDX



T1 coherence (left) and hillshade (right) of the TDX CoSSC derived DEM

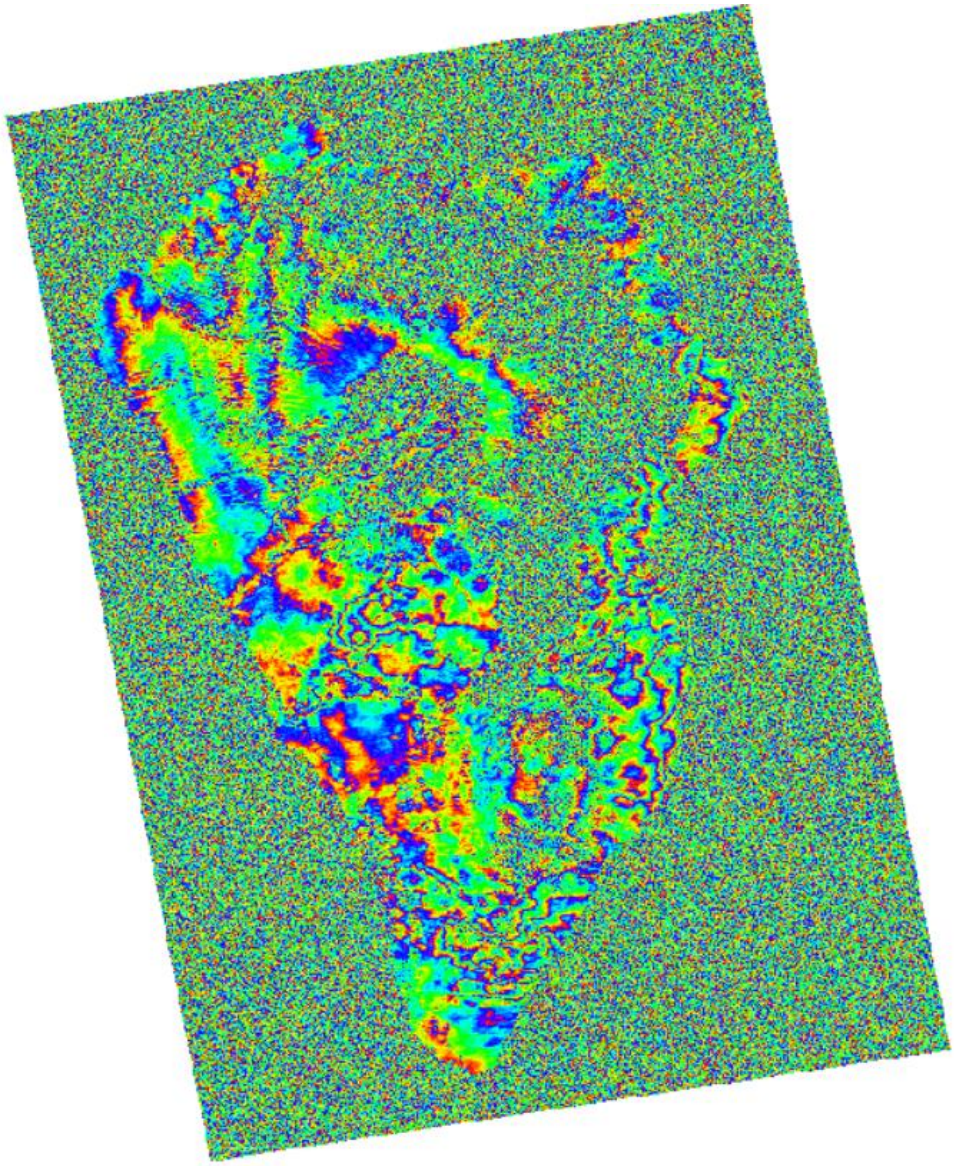
Source: Copernicus Emergency Management Service (© 2022 European Union), [EMSR119] Digital Elevation Models of the Cumbre Vieja Volcano in La Palma, Spain

T2 DEM – TSX/PAZ

- Low perpendicular baseline (113)
- Temporal decorrelation due to 4 days difference in acquisition time
- Unwrapping errors (phase noise, discontinuity, etc.)
- Path delay due to atmospheric conditions

Compromise was needed as no other SAR data was available for this project.

To reduce atmospheric noise, the archive of TSX/PAZ products acquired for the EMSN112 activation was considered. Due to low number of products (7) and heterogeneity in perpendicular baseline, this approach was discarded.



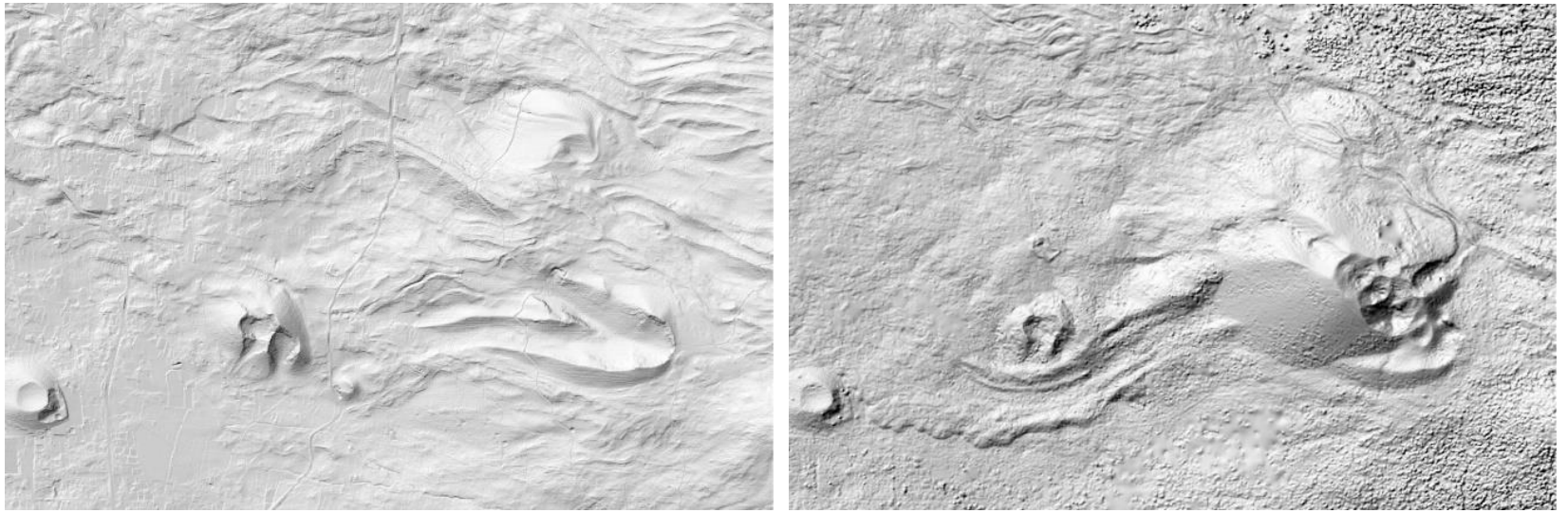
Source: Copernicus Emergency Management Service (© 2022 European Union), [EMSR112] Ground deformation in La Palma Island, Spain

Outputs

- A total of 0.2159 km³ of lava erupted from the volcano from September 19th until December 25th 2021
- Time Average Discharge Rate (TADR):

  2.096.542 m³ / day

  24.3 m³ / s
- Maximum elevation change of 187 m was observed in the proximity of the cone area

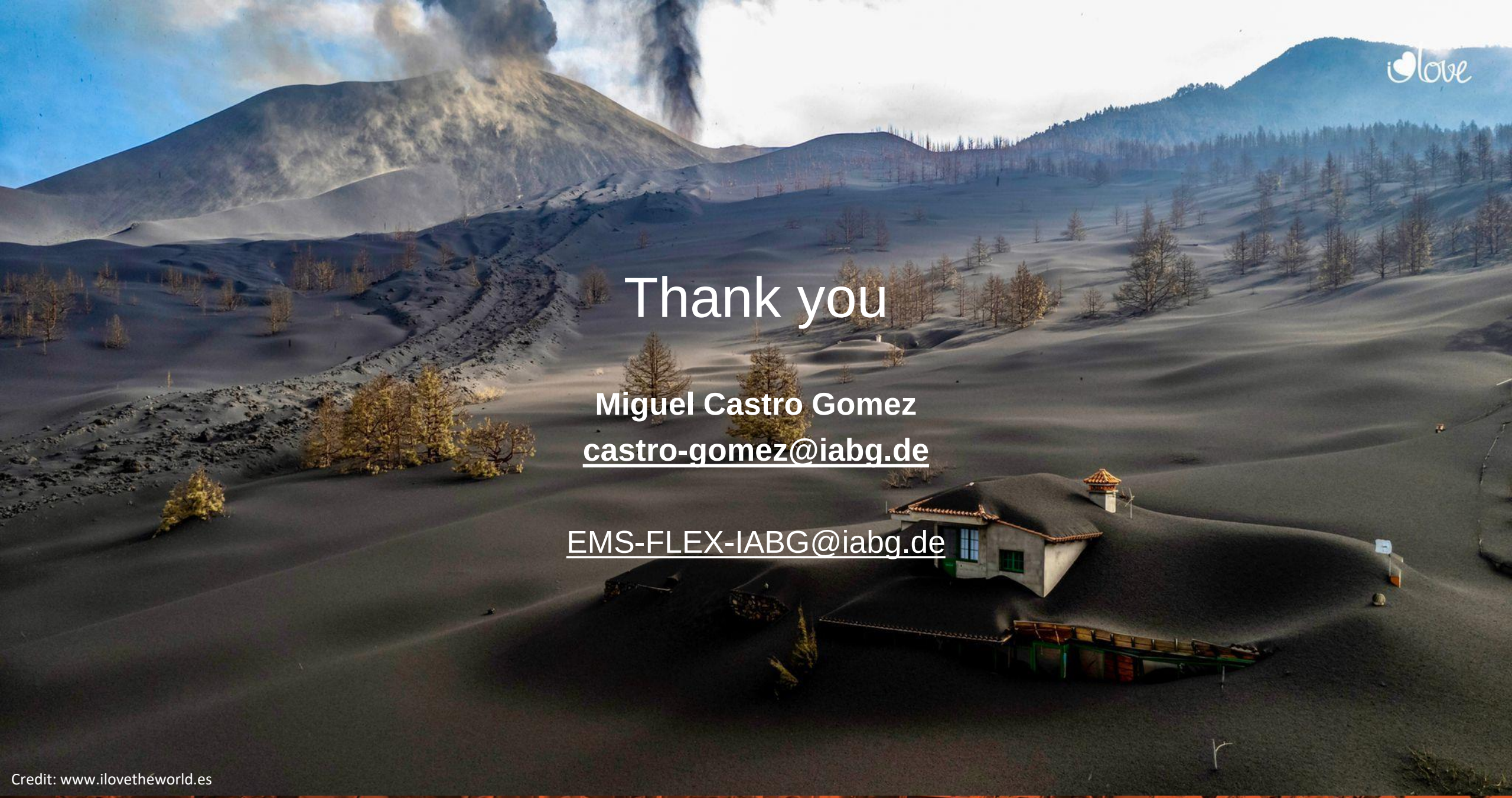


DEM comparing the cone area in pre-event (left) and post-event conditions

Source: Copernicus Emergency Management Service (© 2022 European Union), [EMSR119] Digital Elevation Models of the Cumbre Vieja Volcano in La Palma, Spain

Conclusions

- DEM generation with SAR is a demonstrated technique which priority becomes more relevant in poor weather conditions
- Influence of acquisition parameters (Bperp, Btemp, incidence angle, etc.) dictates achievable quality
- Repeat-pass interferometry more common that single-pass, leading to decorrelation and lower quality. Low availability of bistatic acquisitions
- InSAR subsidence vs. topography retrieval conflict. Non-common archives
- Access to ICEYE InSAR data was granted from ESA and promising results were obtained.
- Full report available in: https://emergency.copernicus.eu/mapping/list-of-components/EMSN119



Thank you

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Credit: www.ilovetheworld.es