U-GEOHAZ

CTTC Centre Tecnològic de Telecomunicacions de Catalunya

Satellite DInSAR monitoring of Landslides in mountainous areas

Anna Barra[a], Oriol Monserrat, Daniele Giordan, Lorenzo Solari, Martina Cignetti, Michele Crosetto, Silvia Bianchini, Filippo Catani, Davide Bertolo.

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UCPM-2017-PP-AG – 783169 U-Geohaz

Project Co-financed by the EU-Union Civil Protection Mechanism

EGU 2019, Vienna, 9 April 2019

AENOR ER Gestión I+D+i UNE 166002 IDI-0024/2011

Photography encouraged

HR EXCELLENCE IN RESEARCH

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U-GEOHAZ
Geohazard impact assessment for urban areas

https://u-geohaz.cttc.cat/

01/01/2018 – 31/12/2019

MAIN TARGET

Providing maps, based on **Sentinel-1 6-days ground deformations monitoring**, to assess continuously the **potential impact of geohazard** activity to urban areas and critical infrastructures and to be used as key inputs to **support early warning**.

NH6.3 | PICO

Remote sensing for geohazards investigations

Co-organized as GI3.9

Convener: Matteo Del Soldato | Co-conveners: Federico Raspini, Roberto Tomás Jover, Gerardo Herrera, Zhenhong Li

PICOs | Wed, 10 Apr, 10:45–12:30 PICO spot 1

11:15–11:17 | PICO1.12 | EGU2019-13569

The U-Geohaz project: Sentinel-1 to support geohazards early warning systems and impact assessment

Oriol Monserrat, **Anna Barra**, Gerardo Herrera, Lorenzo Solari, Elena González-Alonso, Marta Béjar-Pizarro, Silvia Bianchini, Roberto Sarro, Anselmo Fernández García, Paola Reichenbach, Filippo Catani, and Michele Crosetto

DInSAR processing in Valle d'Aosta

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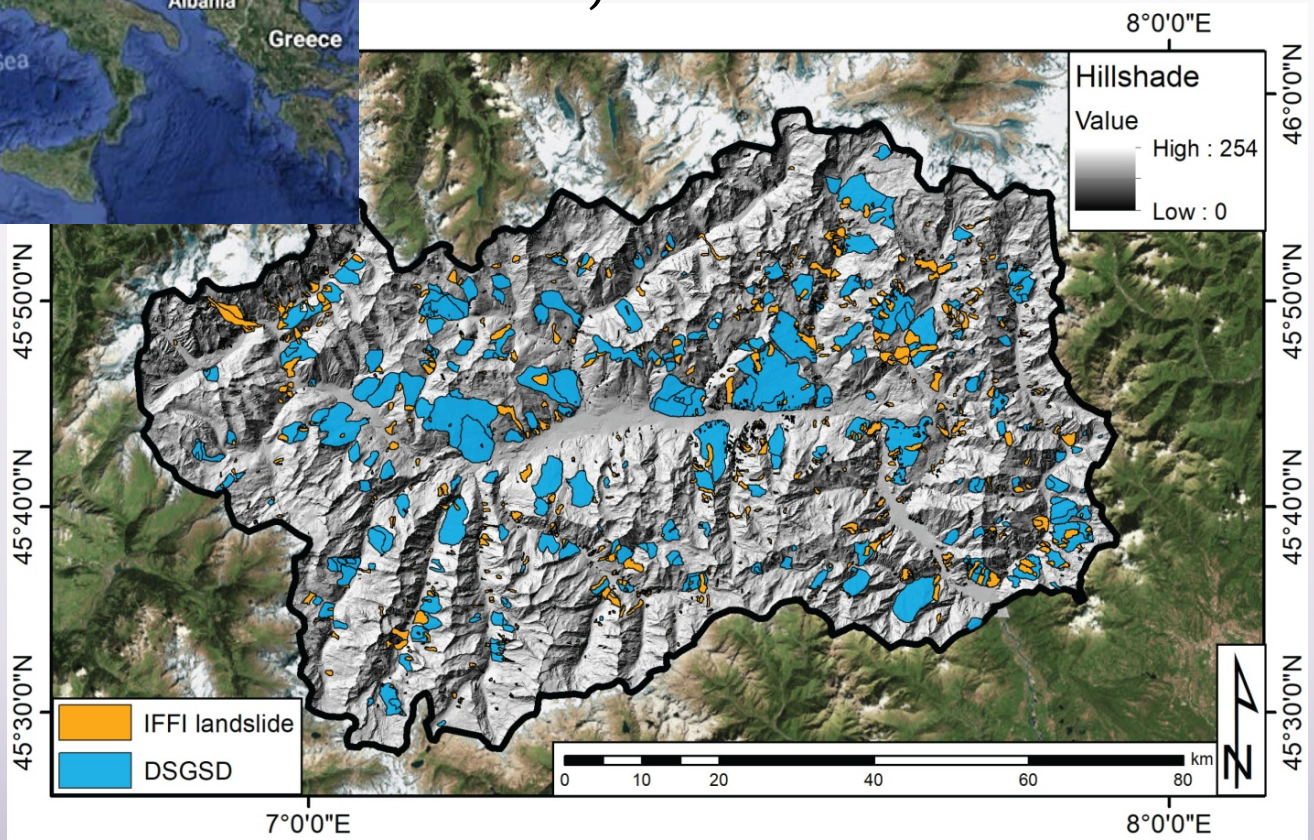


4400 landslides

134 landslides/100 sqkm

520 sqkm affected by landslides (16% of the total)

Deep-Seated Gravitational Slope Deformations (DSGSDs) are the most representative in terms of area coverage

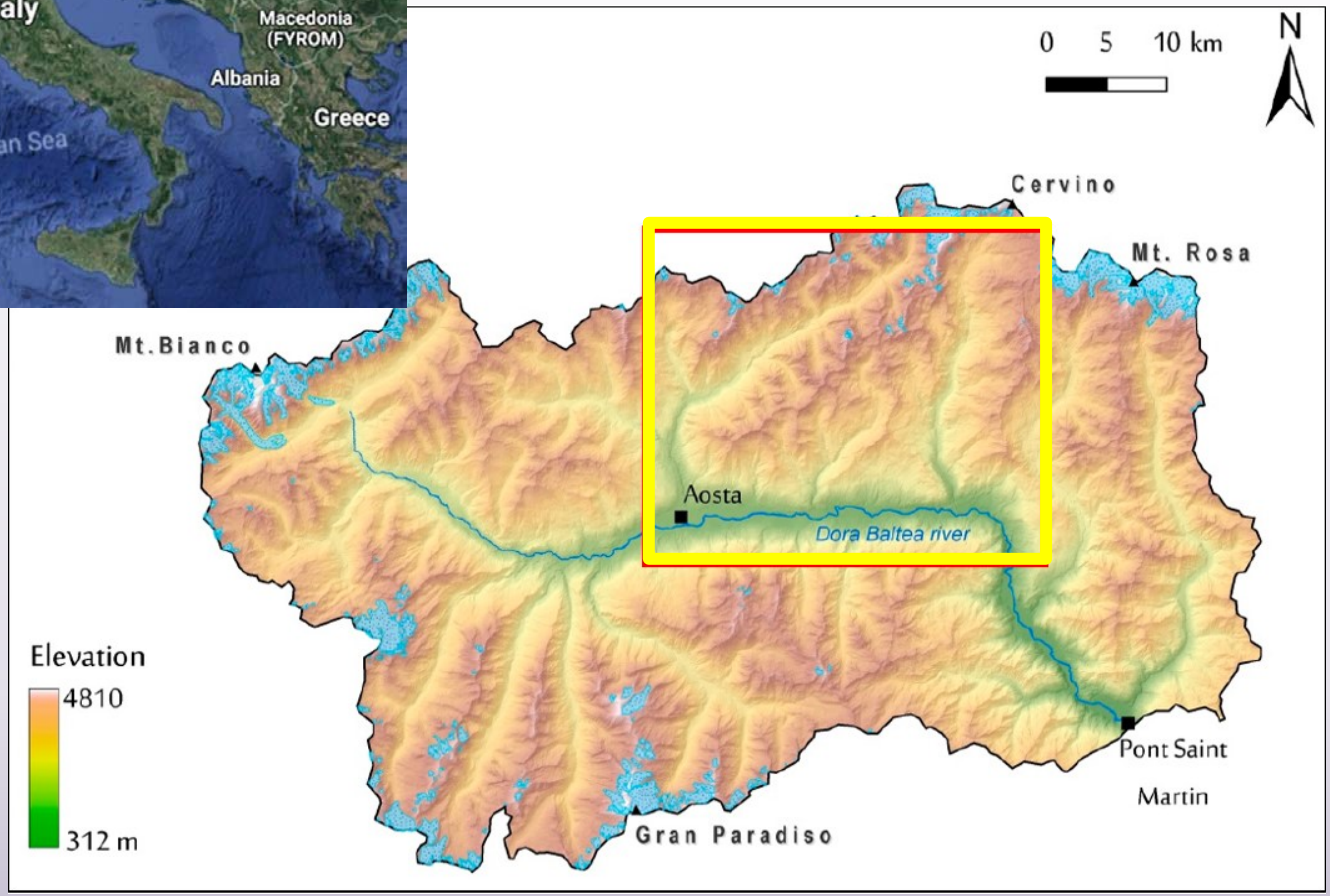


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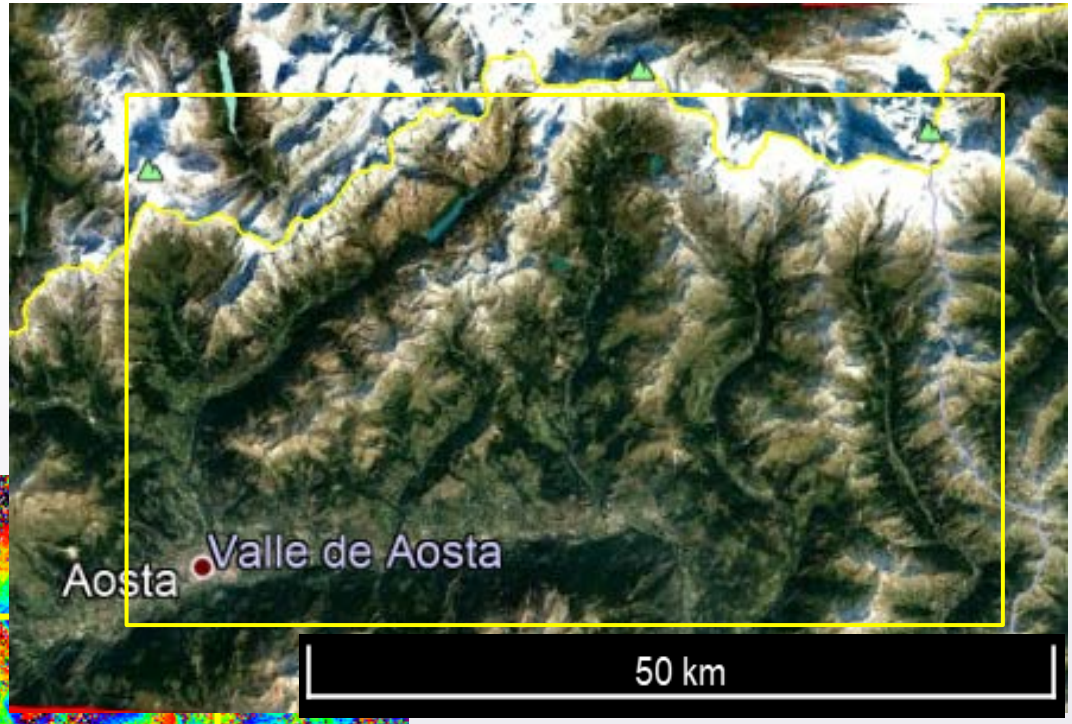


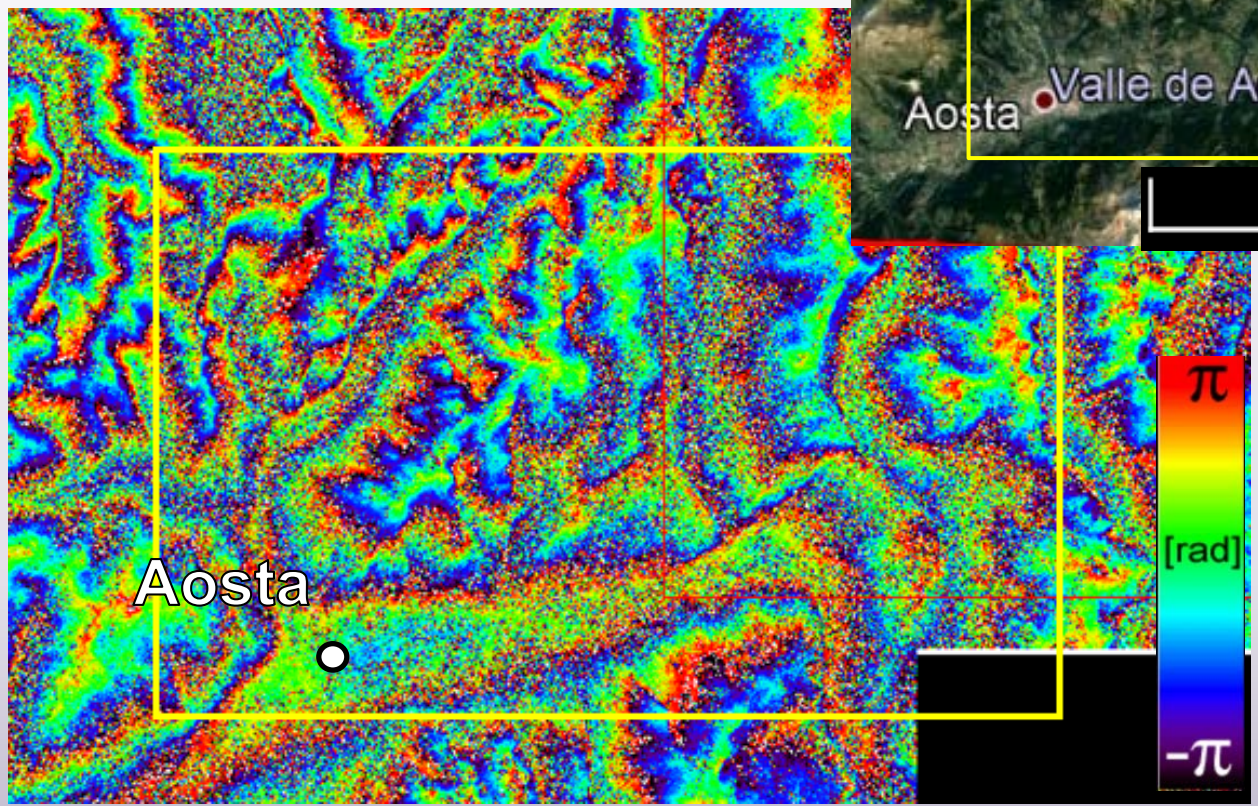
Highly variable topographic relief: ranging from 300 m a.s.l. to peaks higher than 4000 m a.s.l. with steep slopes.



Strong topography-related atmosphere component

2017/06/20 – 2017/06/26

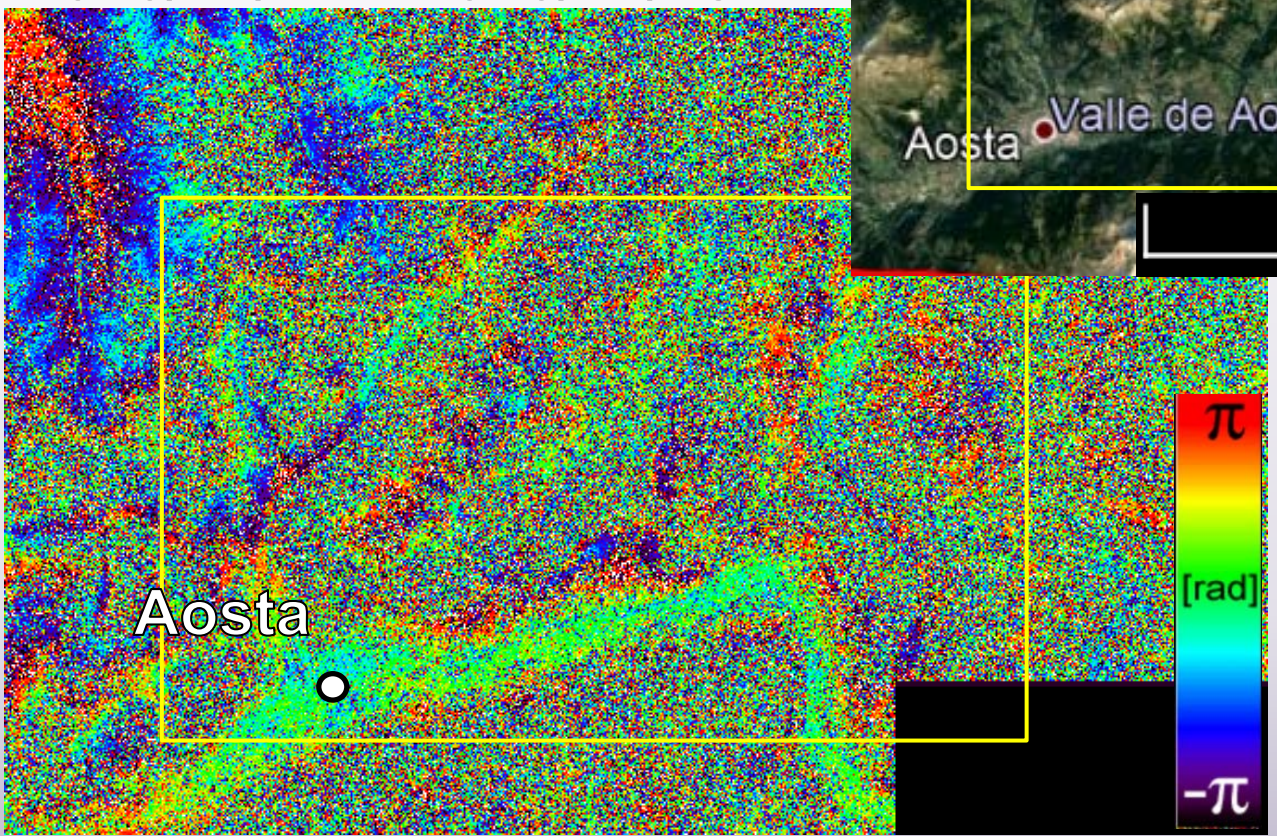


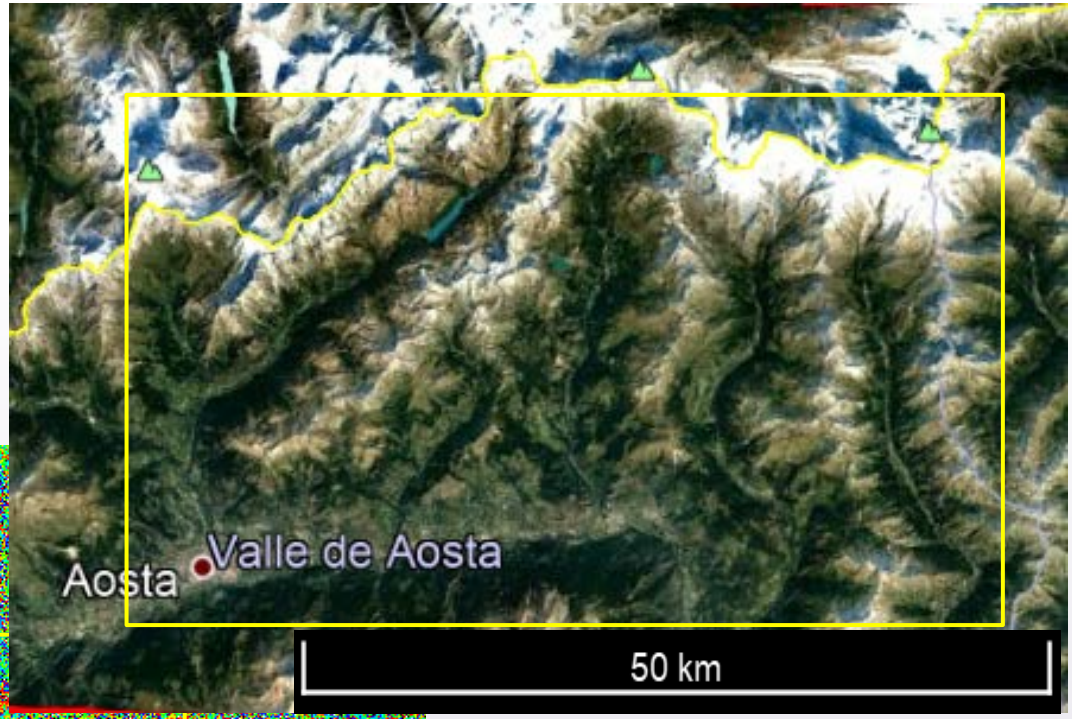


Strong "topography-related" coherence behaviour

Coherence changes in space and time

2016/12/22 – 2016/12/28





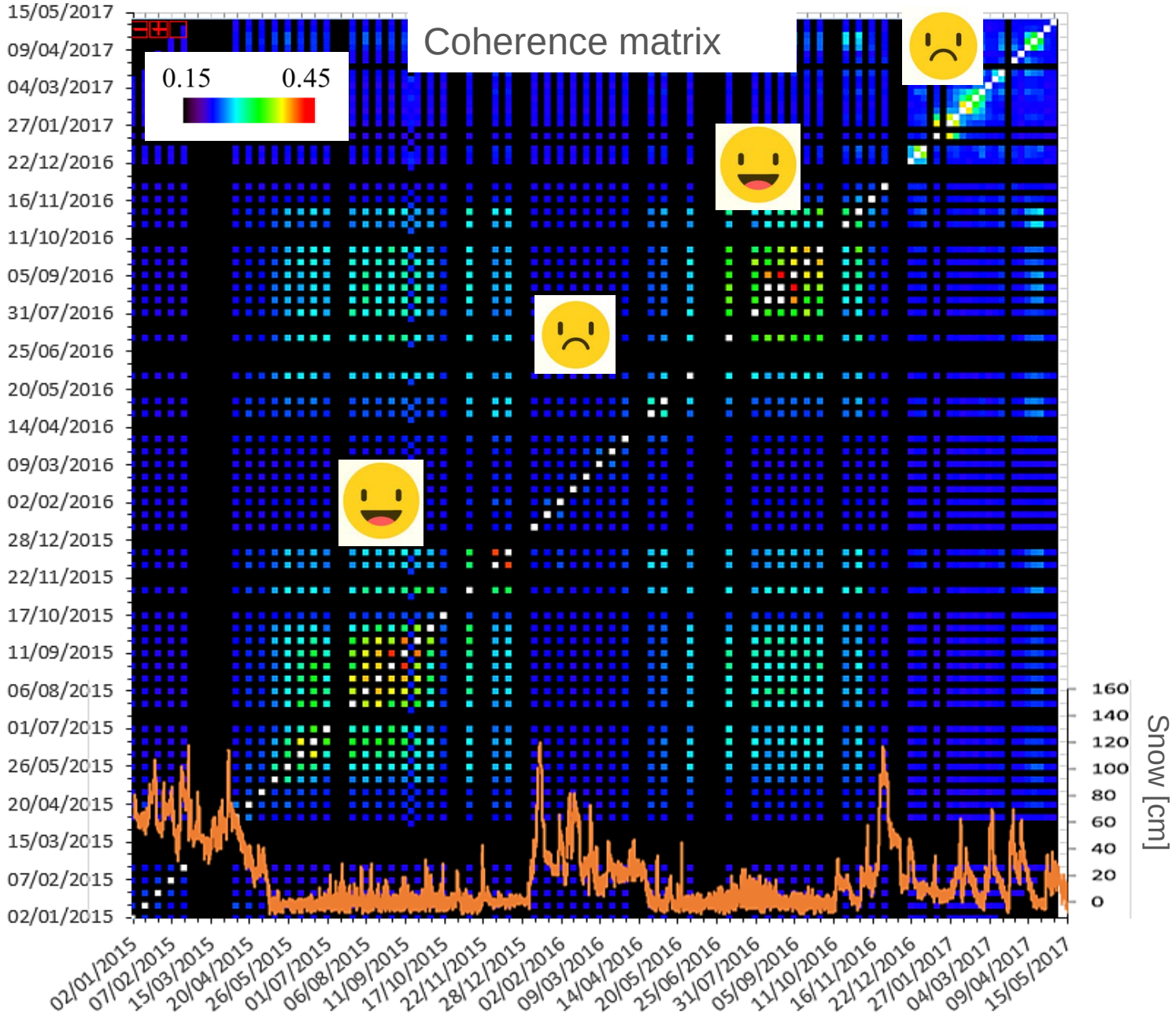
Snow time!!



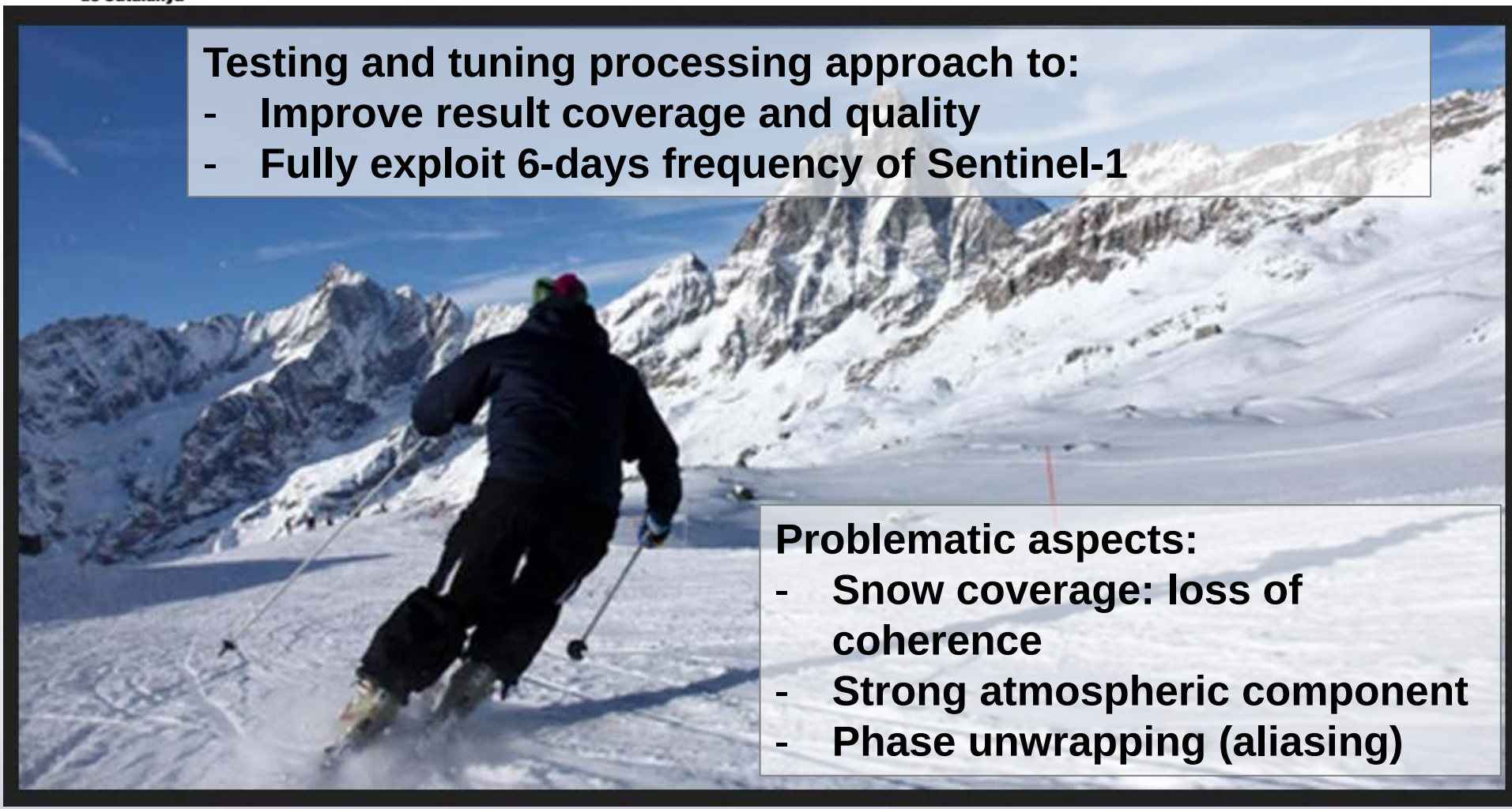
Problematic aspects:

- **Snow coverage: loss of coherence**
- **Strong atmospheric component**
- **Phase unwrapping (aliasing)**

Coherence-Snow correlation



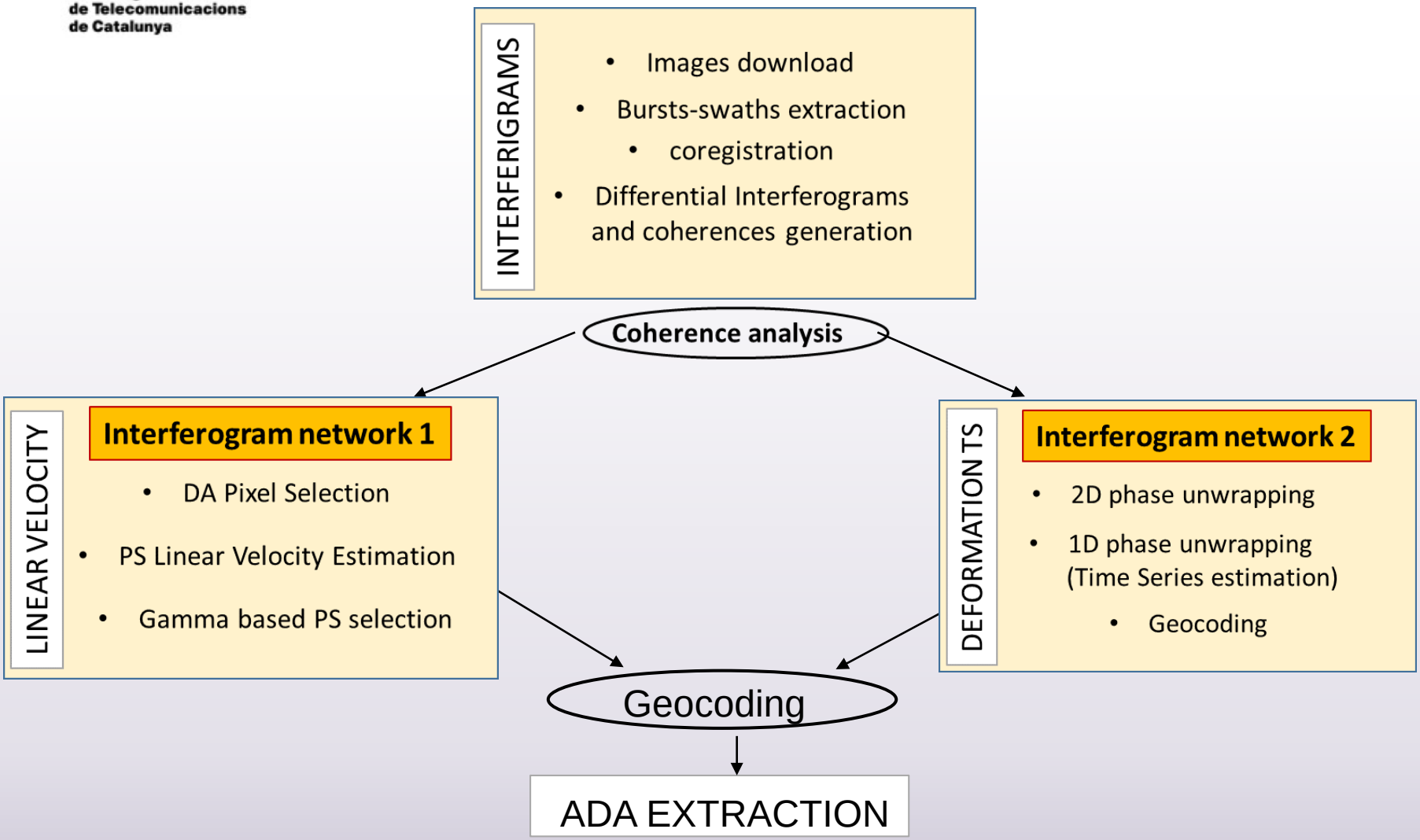
Snow time.. aspect to be solved!



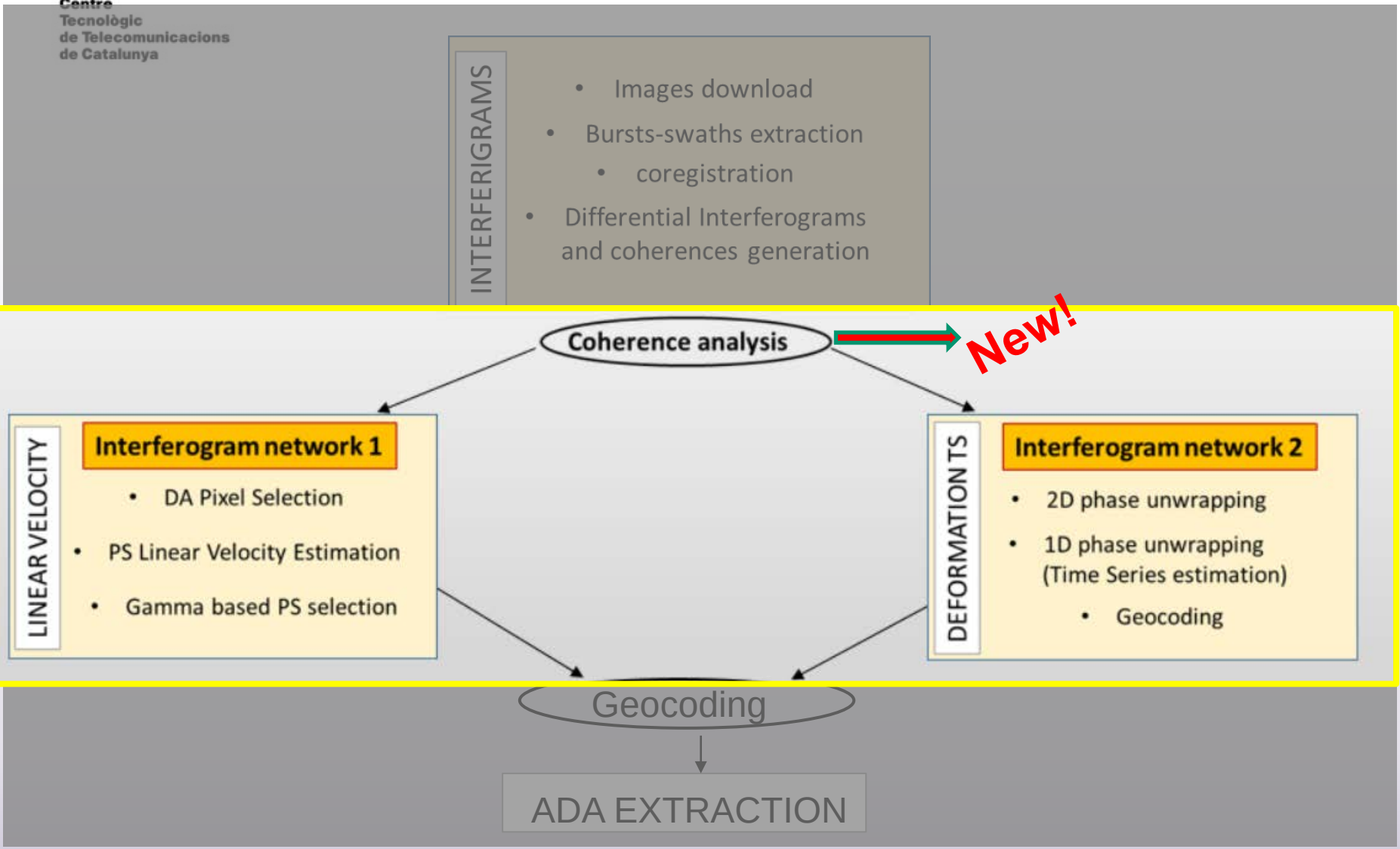
Testing and tuning processing approach to:
- **Improve result coverage and quality**
- **Fully exploit 6-days frequency of Sentinel-1**

Problematic aspects:
- **Snow coverage: loss of coherence**
- **Strong atmospheric component**
- **Phase unwrapping (aliasing)**

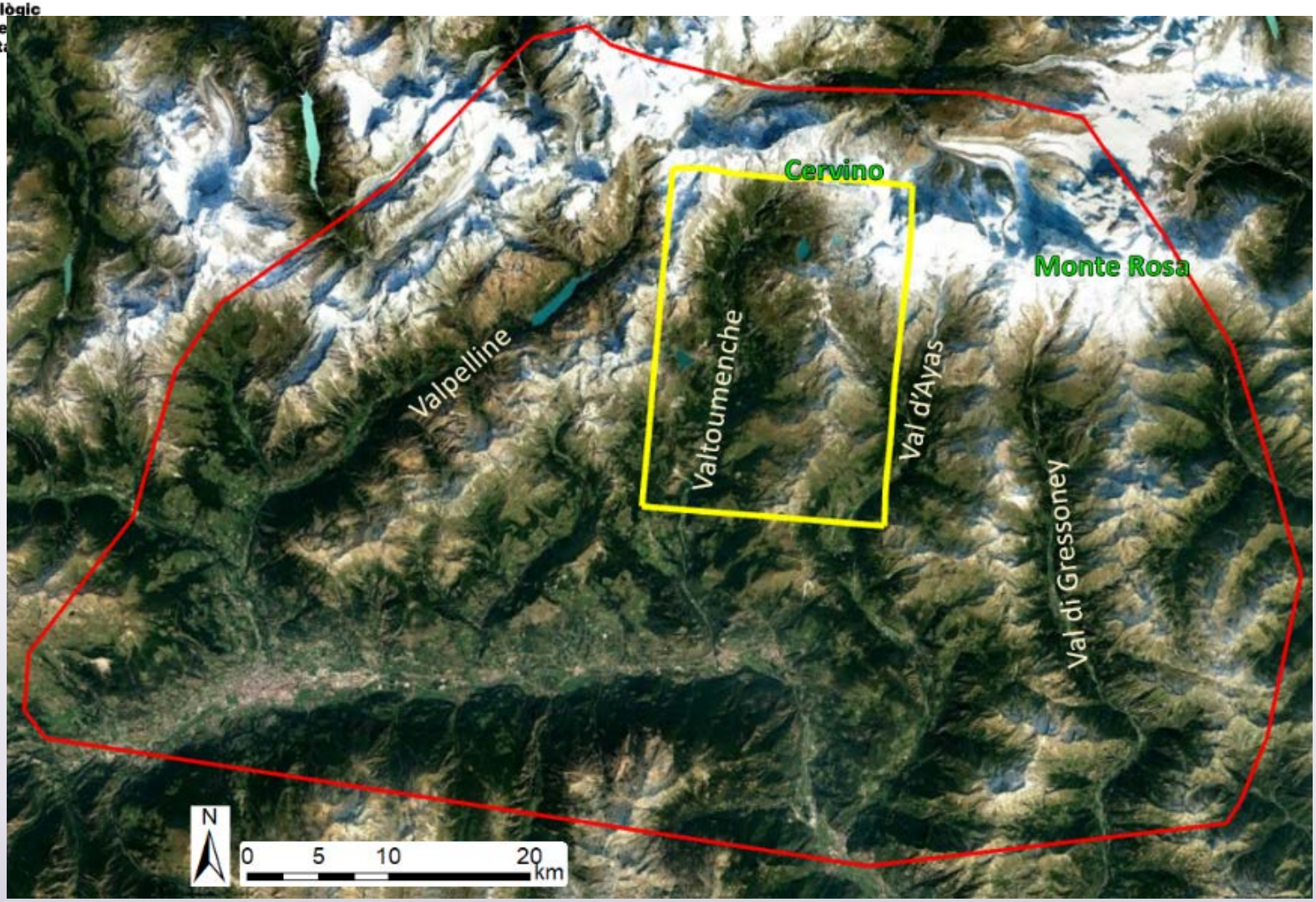
Processing steps



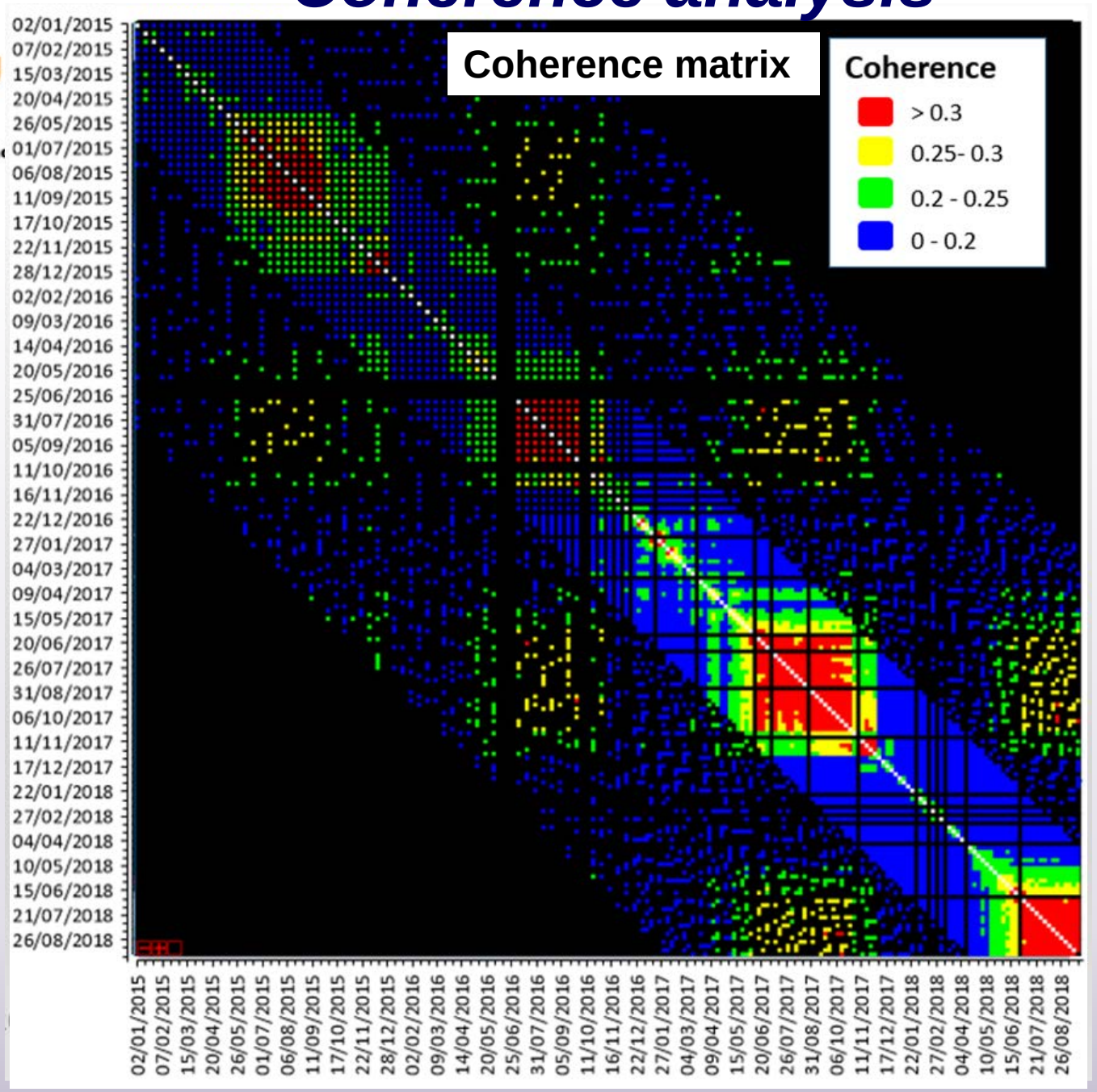
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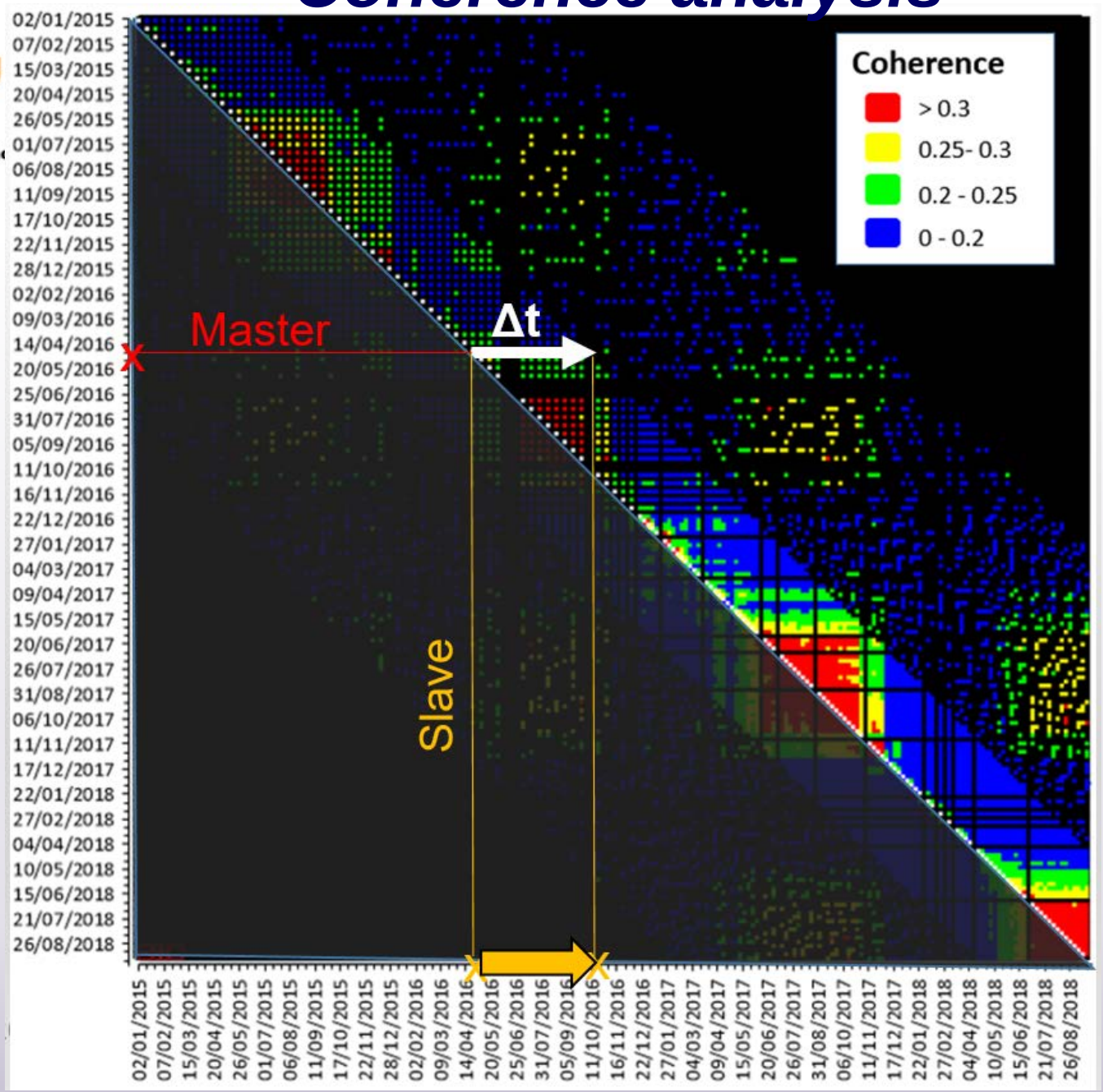
Area of mean coherence calculation



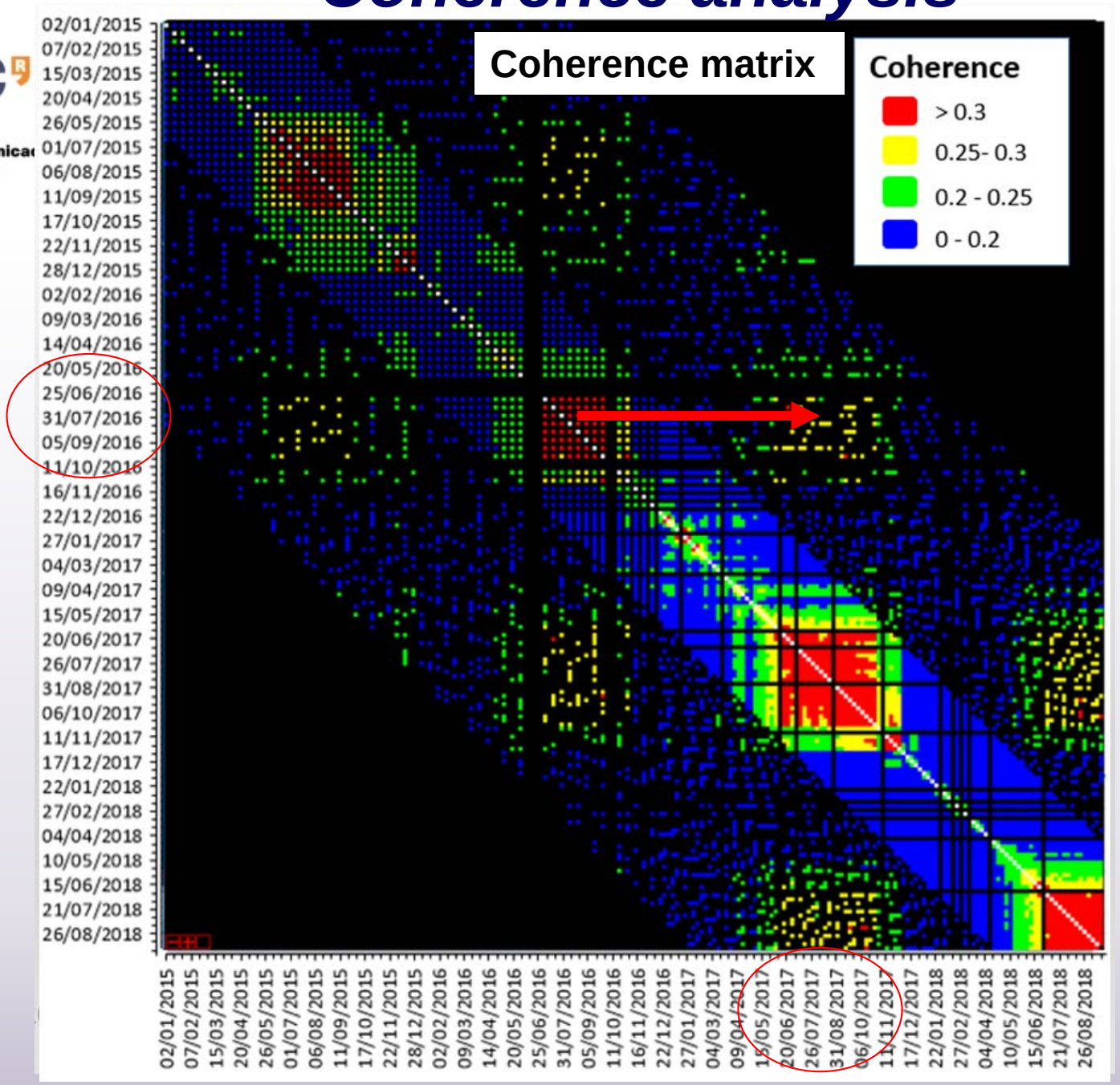
Coherence analysis



Coherence analysis



Coherence analysis



Annual linear velocity estimation

Centre Tecnològic de Telecomunicacions de Catalunya

LINEAR VELOCITY

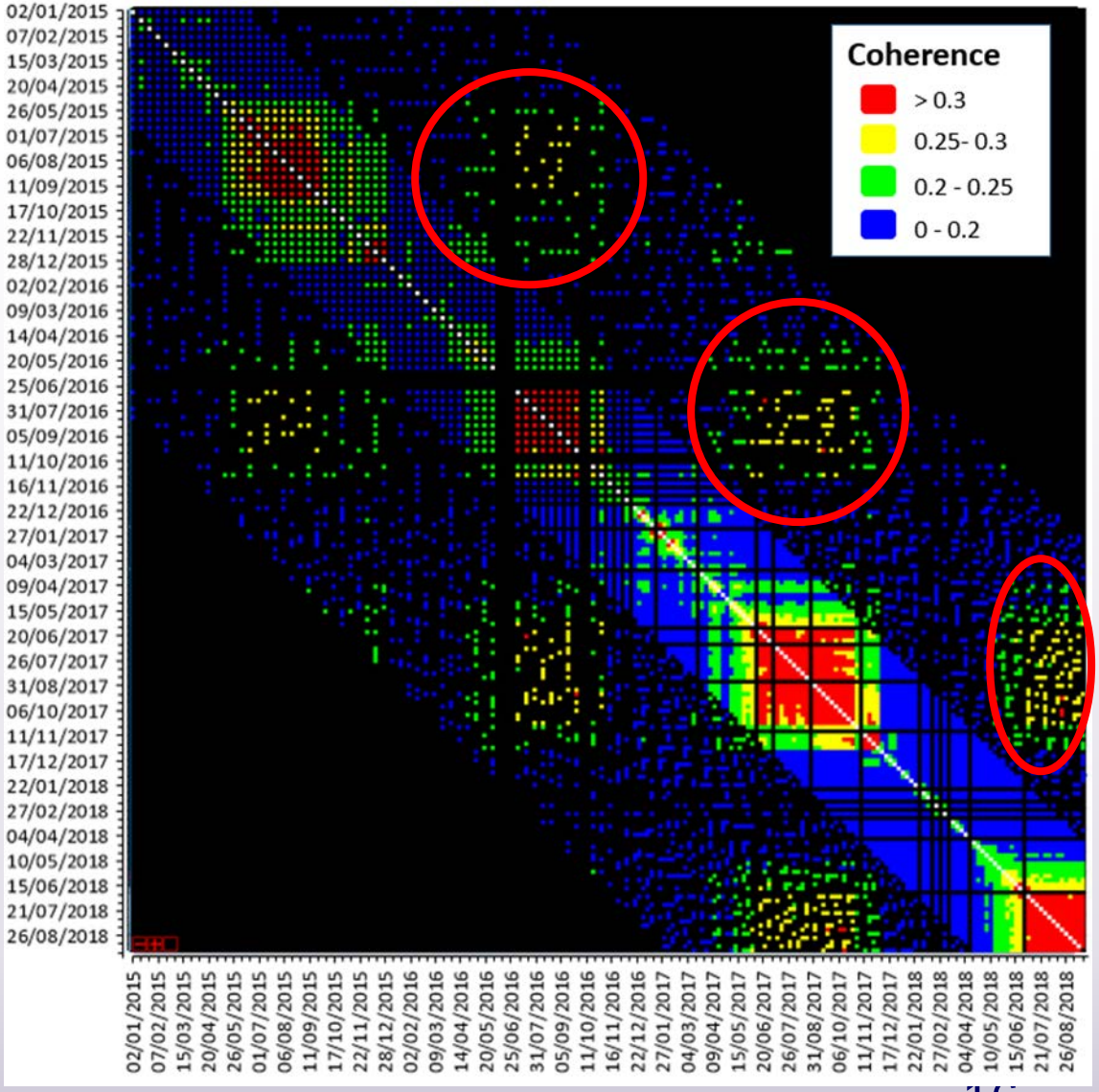
Interferogram network 1

- DA Pixel Selection
- PS Linear Velocity Estimation
- Gamma based PS selection

Interferograms selection:

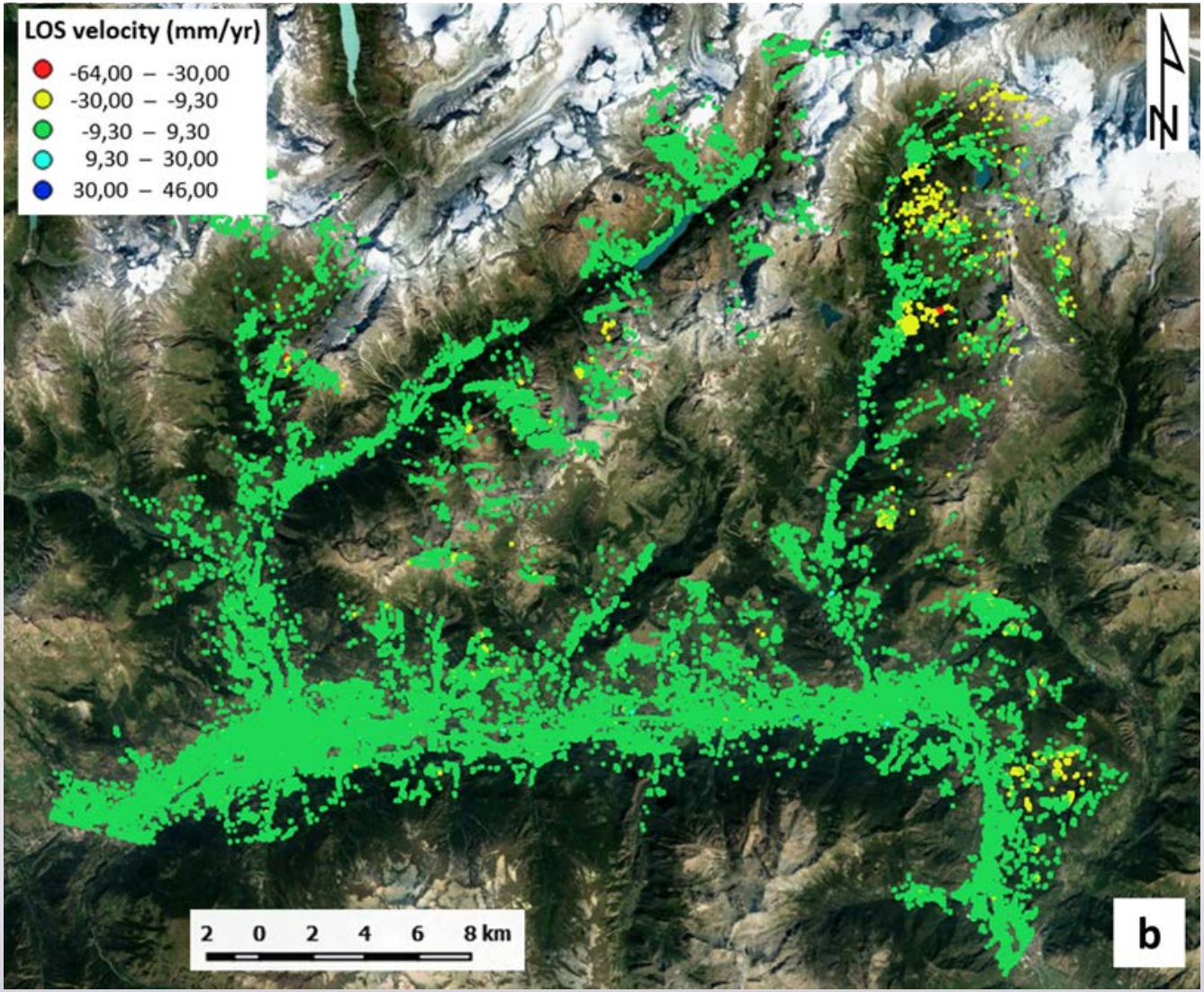
- Long temporal baseline observations
- NEW: coherence-based selection

Δt > 150
Coherence > 0.2
N of interferograms 423
DA < 0.4
Gamma > 0.84



Annual linear velocity estimation

Result 1: without coherence analysis



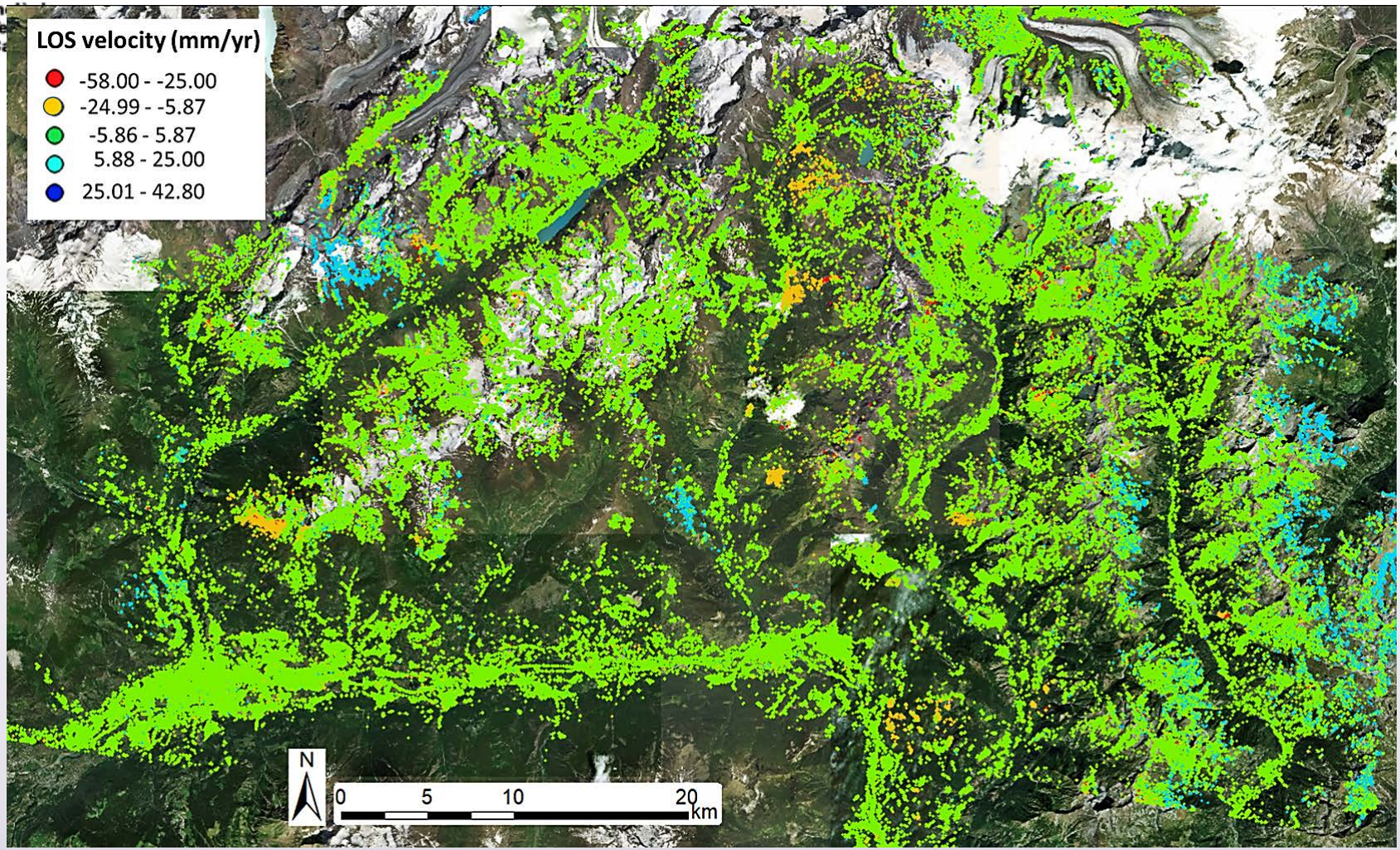
Interferogram selection:
- Long temporal baseline observations

St. Dev. = 3.1

Annual linear velocity estimation

Result 2: with coherence analysis

St. Dev. = 3.5



Deformation Time Series (TS) estimation

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DEFORMATION TS

Interferogram network 2

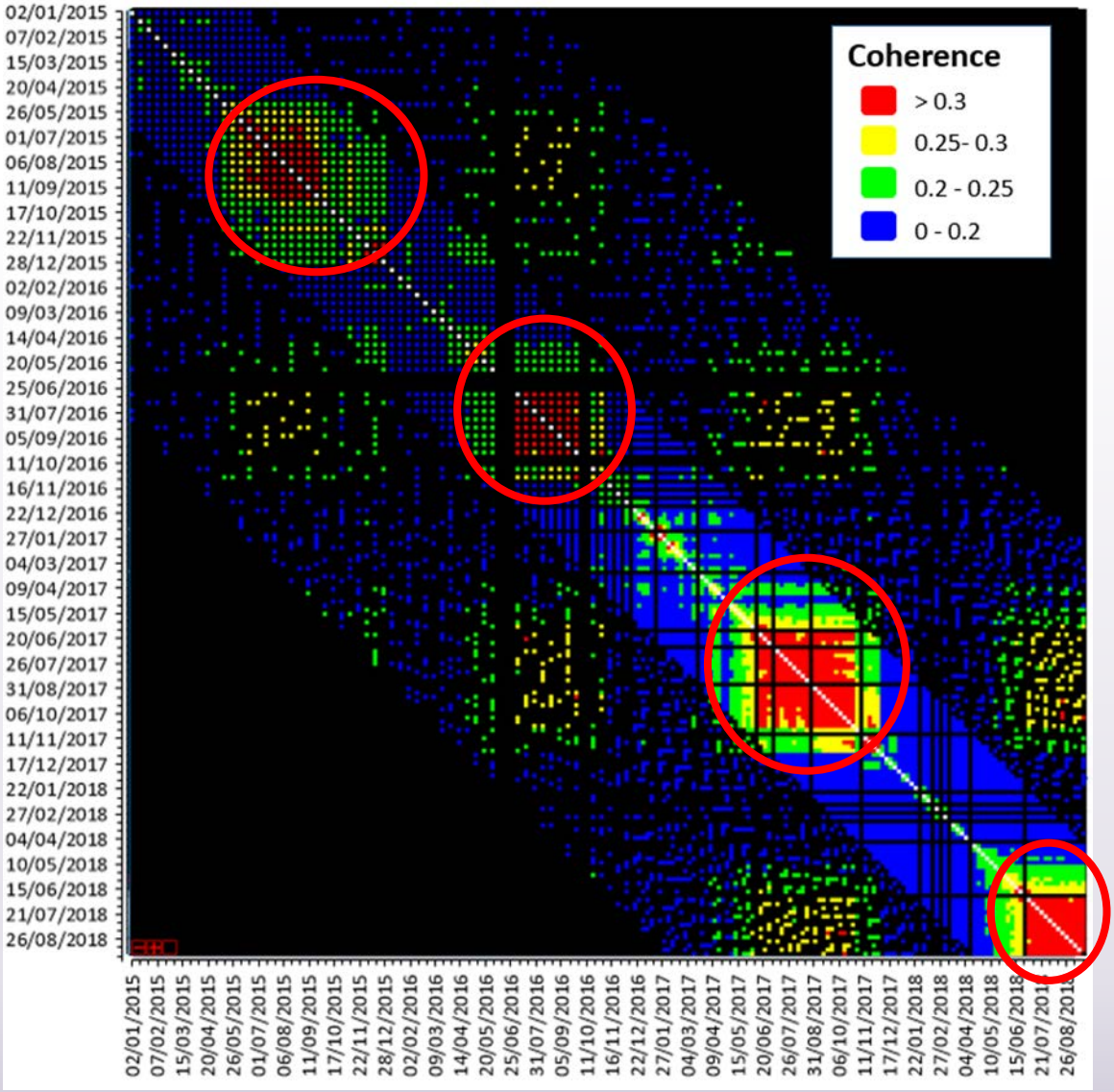
- 2D phase unwrapping
- 1D phase unwrapping (Time Series estimation)
- Geocoding

Interferograms selection:

- Short Δt observations
- NEW: coherence-based selection

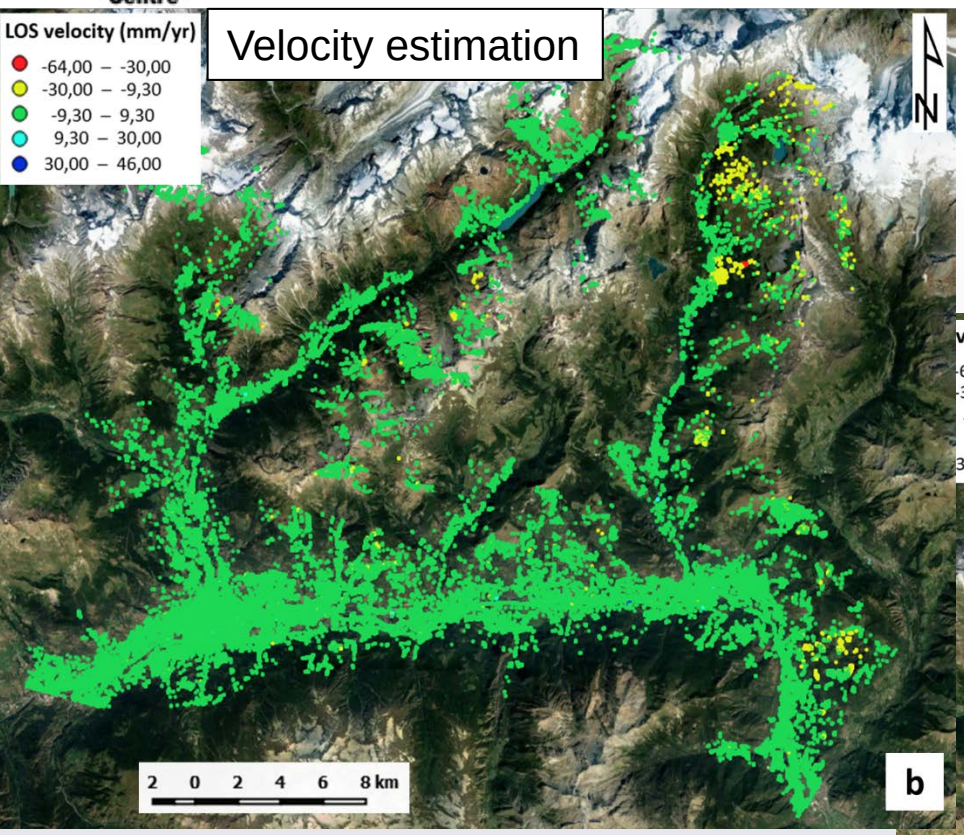
processed images: 106 over 153

Δt variable
Coherence > 0.2
N of interferograms 1325

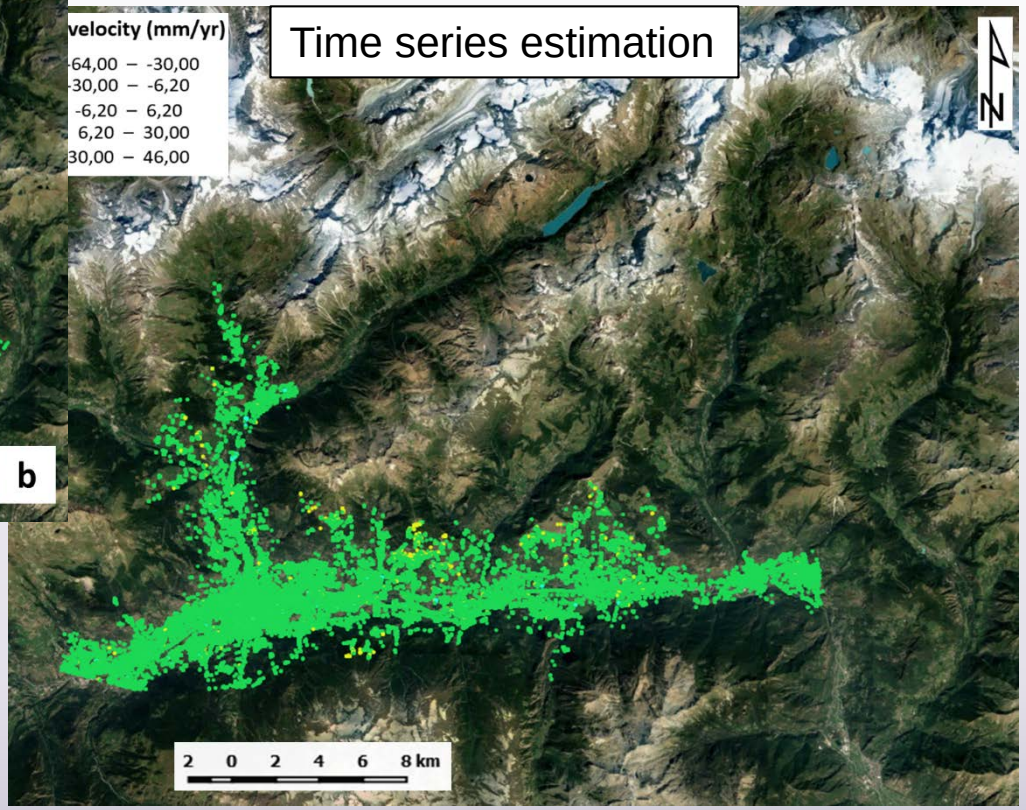


Deformation Time Series (TS) estimation

Result 1: without coherence analysis



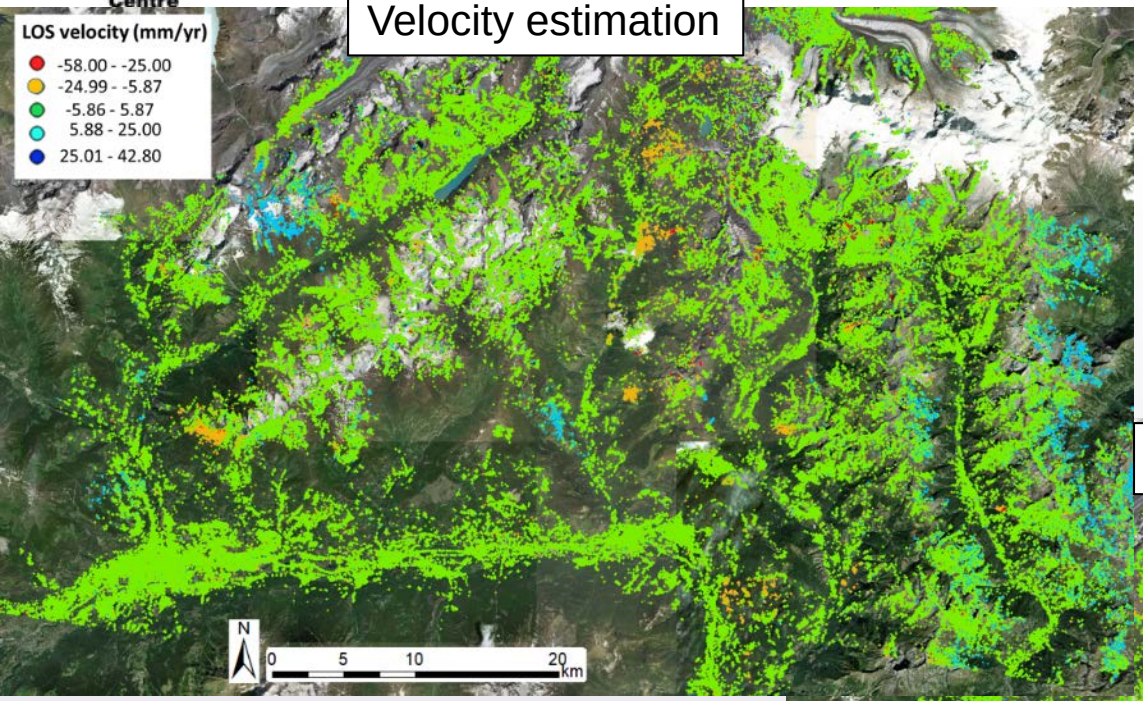
TS estimation over 65% of points



Deformation Time Series (TS) estimation

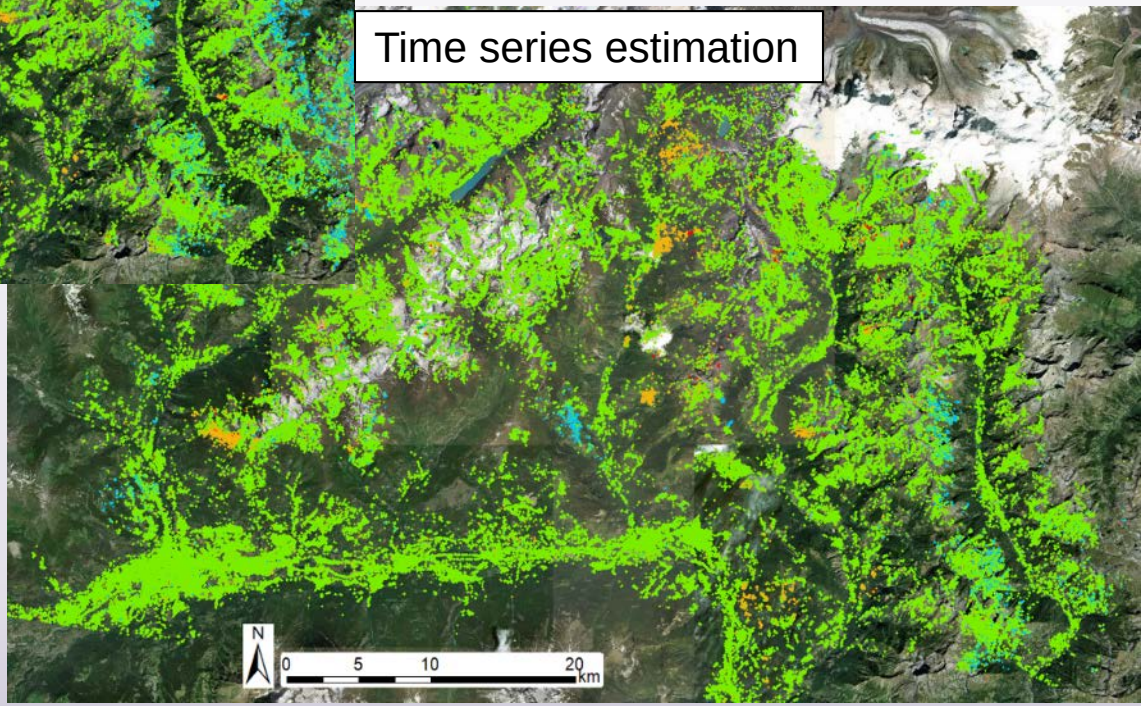
Result 2: with coherence analysis

Velocity estimation



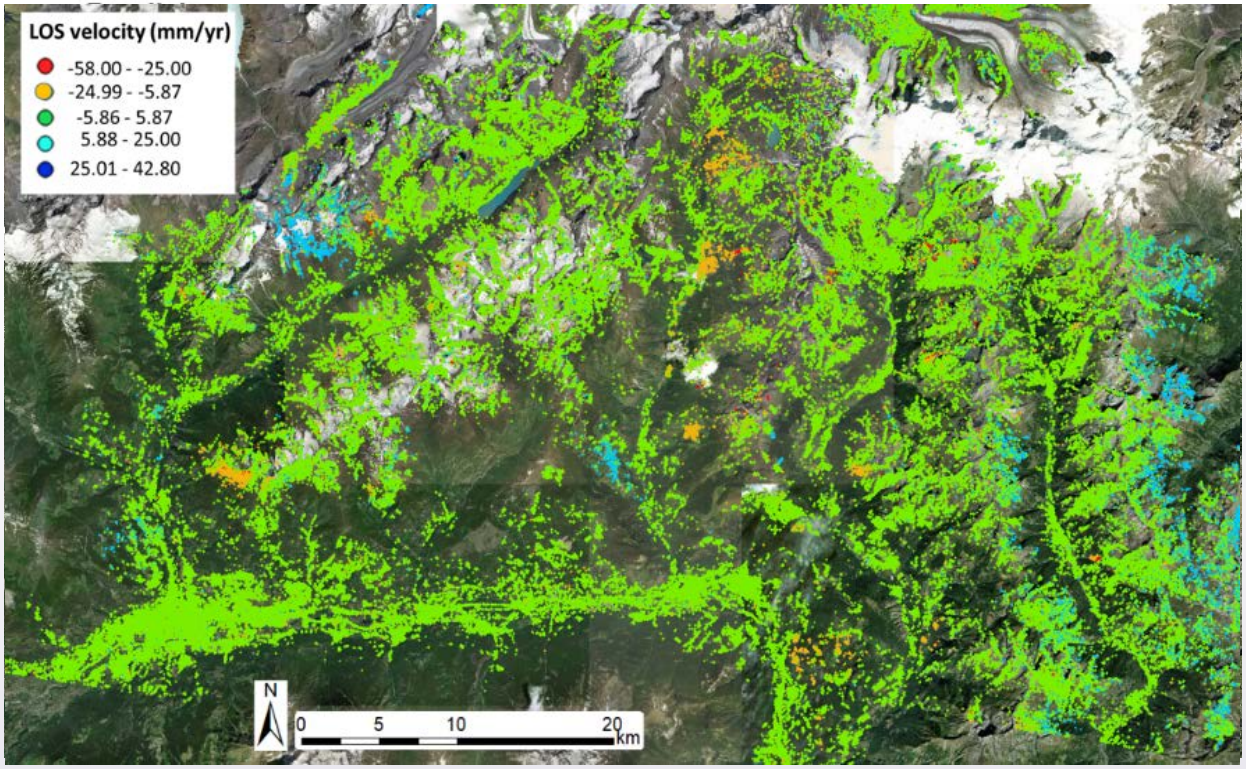
TS estimation
over 85% of points

Time series estimation



U-Geohaz Results

ADAFinder: automatic Active Deformation Areas extraction



InSAR processing: derived map

ADA RESUMED INFORMATION:

LOCALIZATION
ACCUMULATED DEFORMATION
MEAN VELOCITY
MAXIMUM VELOCITY
MINIMUM VELOCITY
MEAN DEFORMATION
VELOCITY CLASS
QUALITY INDEX

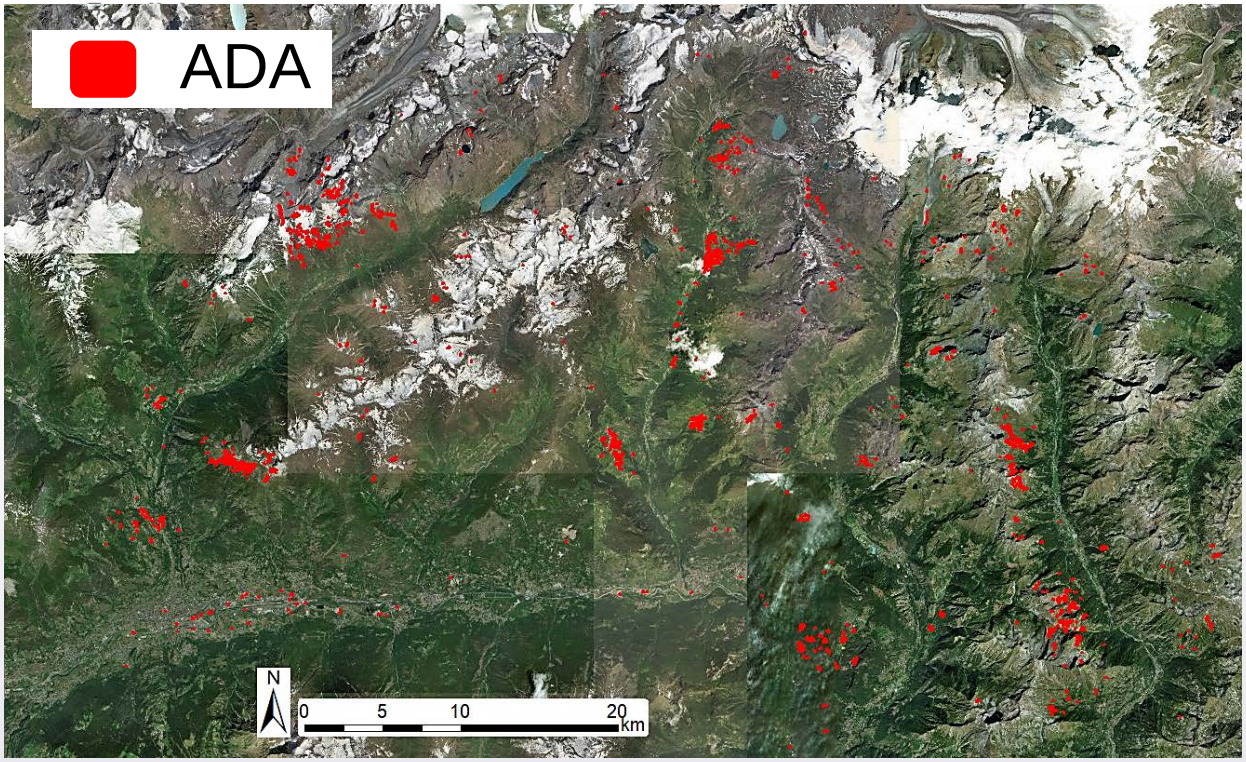
Barra A, Solari L, Béjar-Pizarro M, Monserrat O, ., ... & Moretti S. (2018). A Methodology to Detect and Update Active Deformation Areas Based on Sentinel-1 SAR Images. Remote Sens. 9:1002.

For not expert users involved in risk management:

- Simplify the readability of PSI results
- Avoid misunderstanding interpretations
- Fast focusing over the most interesting active areas

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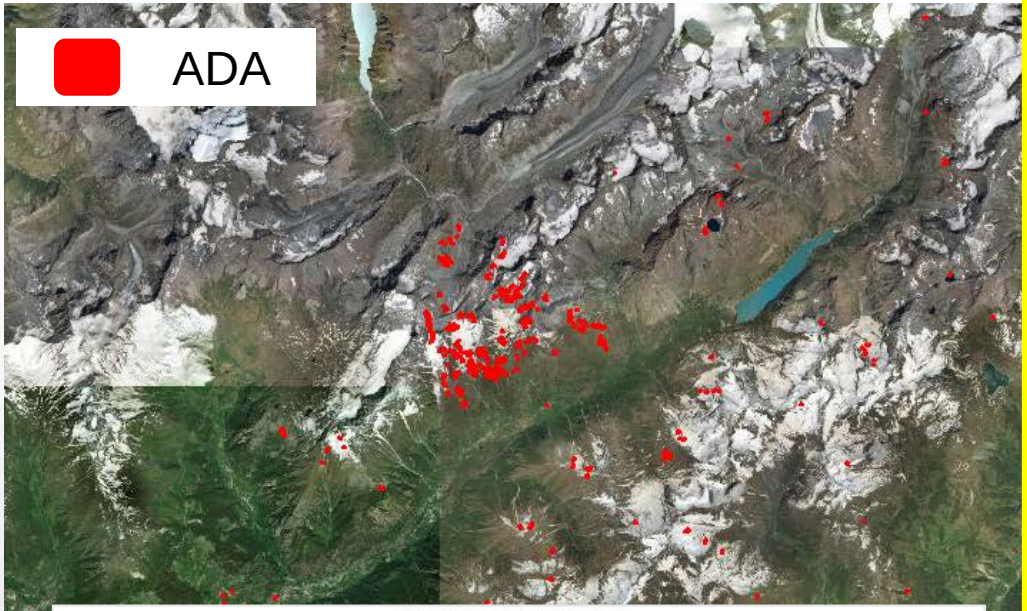
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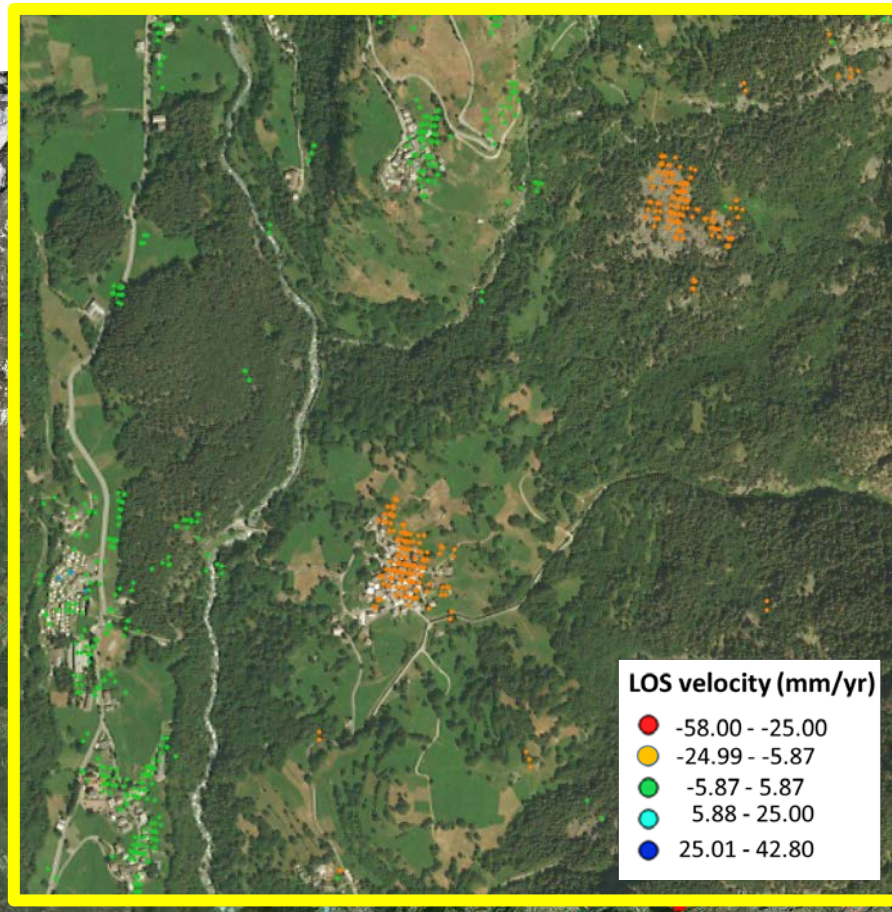
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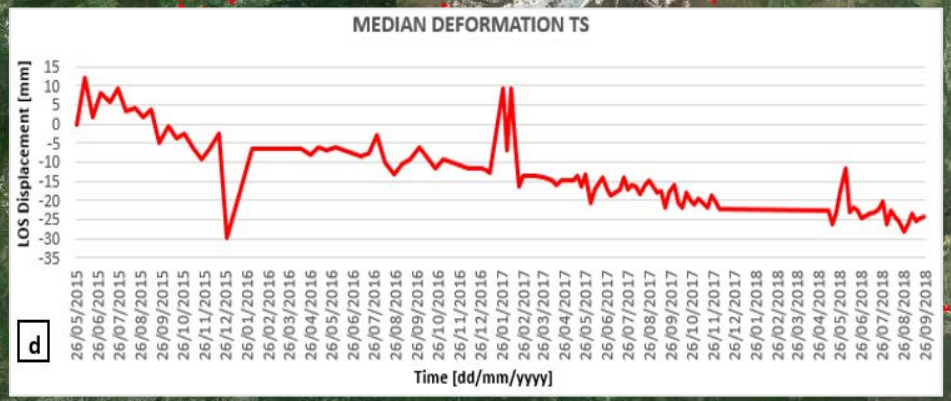
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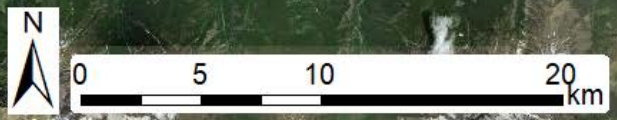
U-Geohaz Results

Median Time Series of Active Deformation Areas





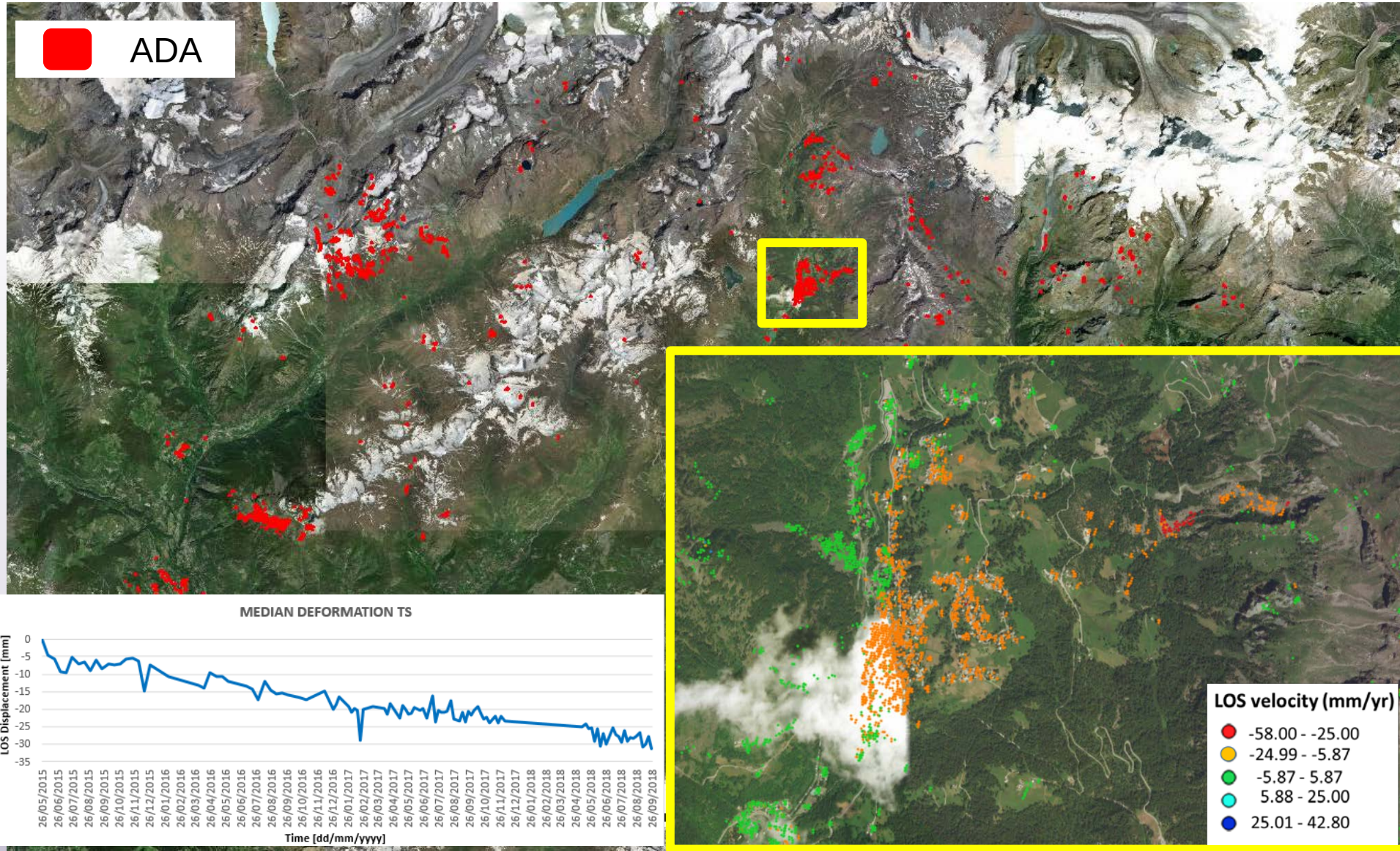




U-Geohaz Results

Median Time Series of Active Deformation Areas

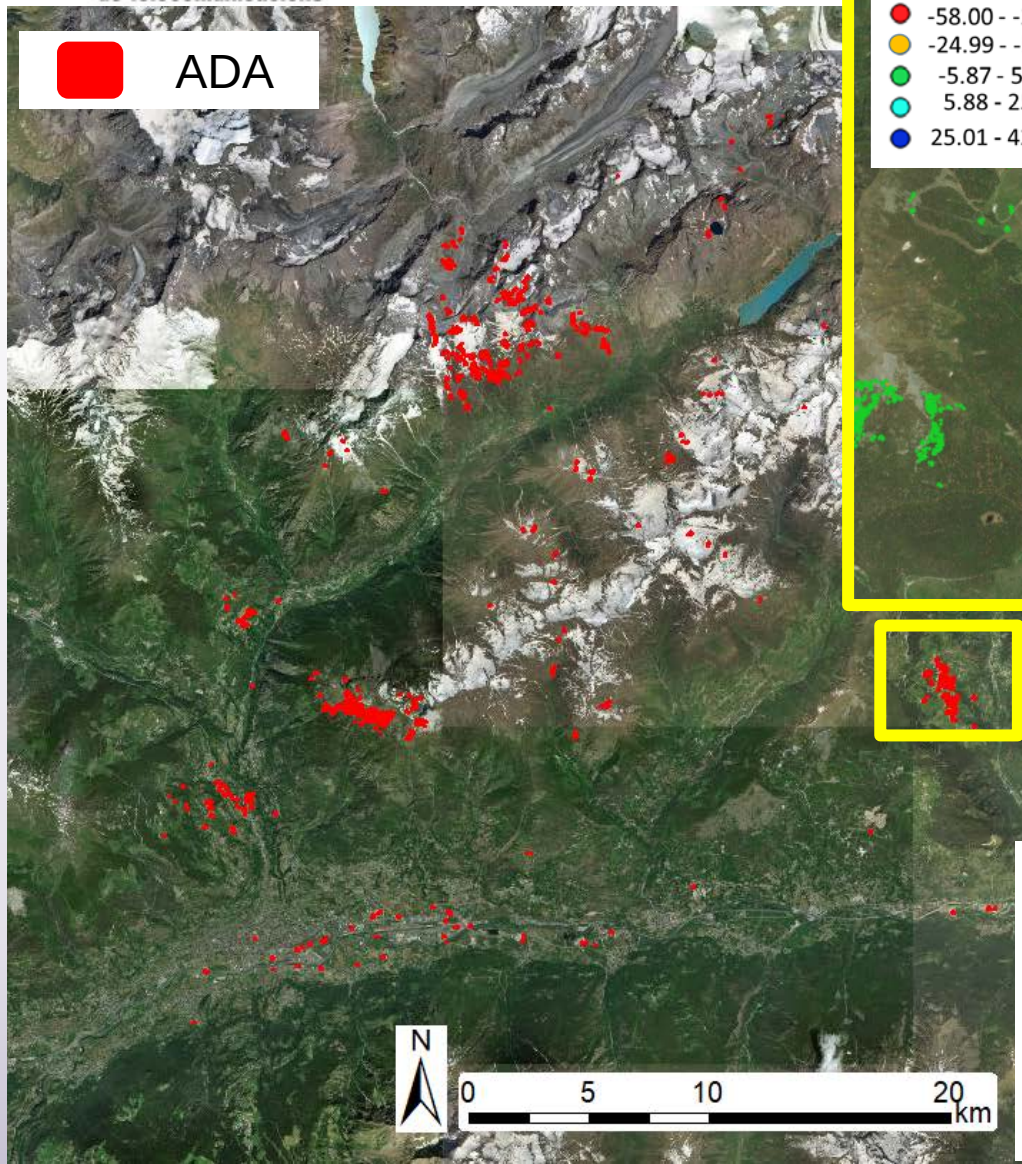
CTTC
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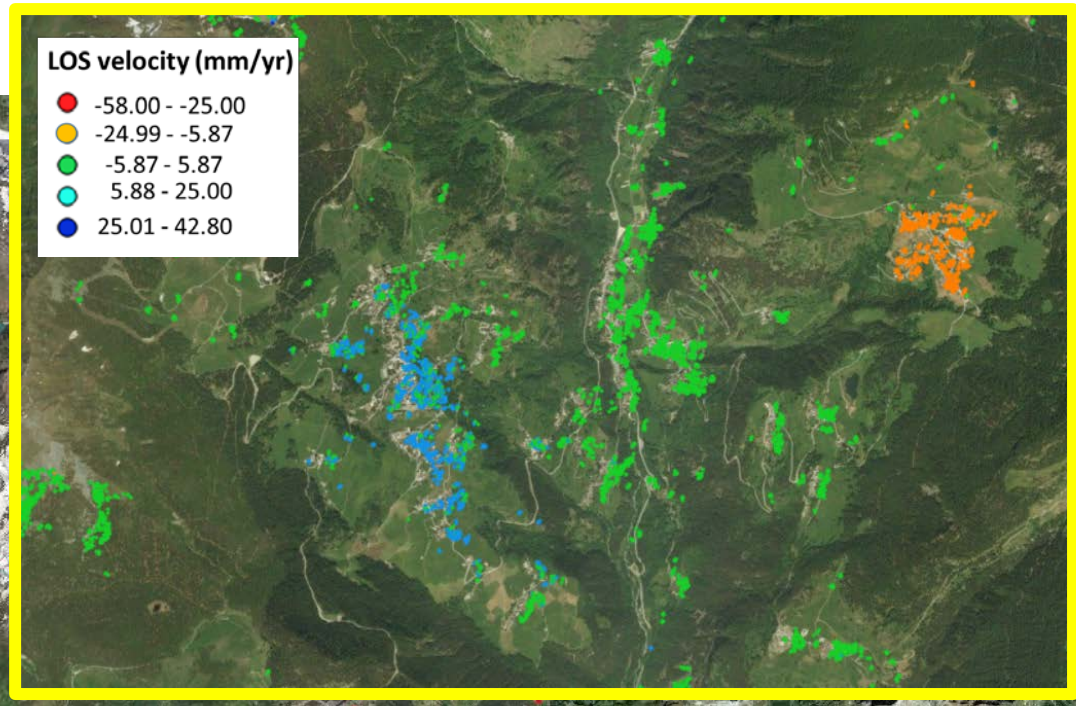


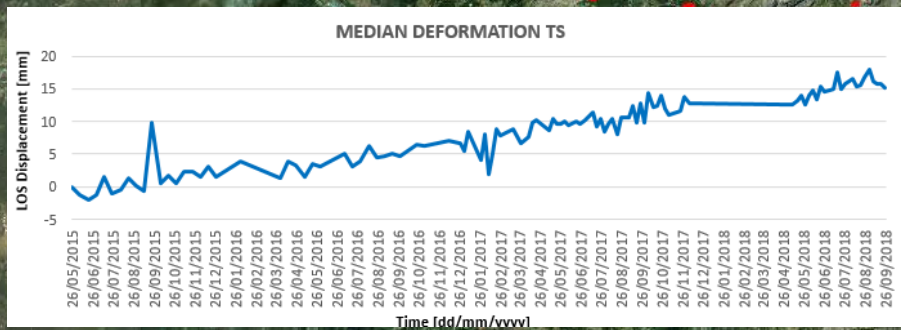
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Median Time Series of Active Deformation Areas

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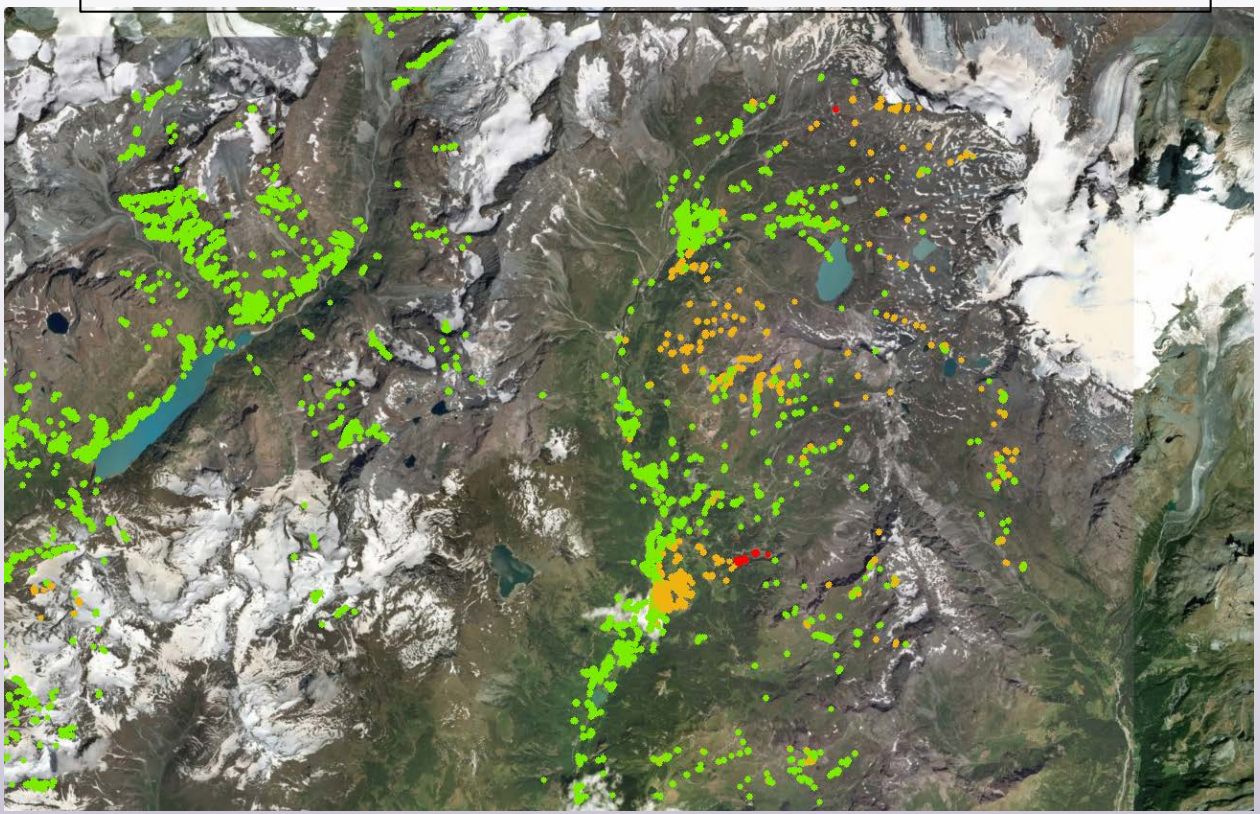




Conclusions

The Valle d'Aosta area presents some **challenging aspects** for what concerns the **processing approach** to be used in order to increase both the **quality and the coverage of the results**, mostly in the **mountainous areas**

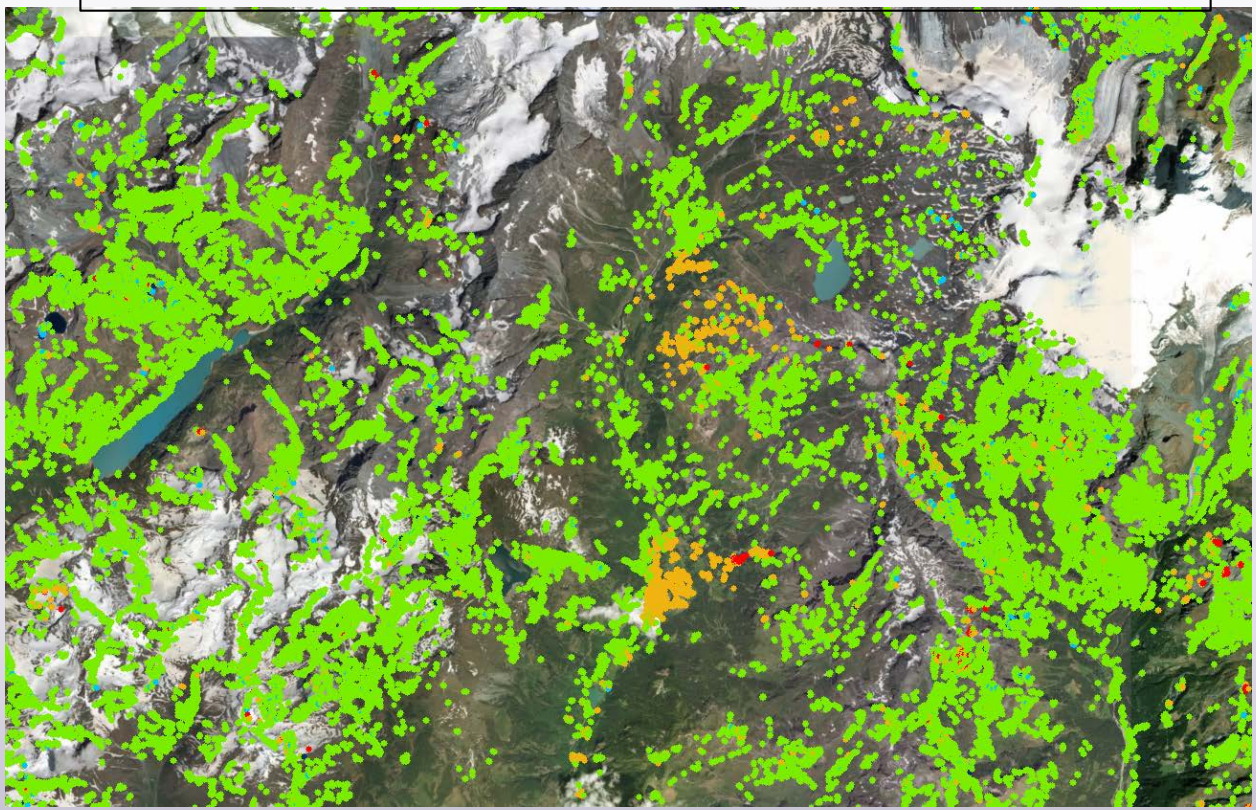
Improved coverage and TS estimation



Conclusions

The Valle d'Aosta area presents some **challenging aspects** for what concerns the **processing approach** to be used in order to increase both the **quality and the coverage of the results**, mostly in the **mountainous areas**

Improved coverage and TS estimation



New processing approach is being implemented

- **1st processing approach**: only based on temporal baseline
- **2nd processing approach**: temporal baseline + coherence threshold
- **3rd processing approach:** direct integration **for the exploitation of 6-days interferograms**→ ongoing

Thank you for your attention!!!

https://u-geohaz.cttc.cat/

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