Ministry of Science and Higher Education
Republic of Poland

JAGIELLONIAN UNIVERSITY IN KRAKÓW

EUROPEAN SPACE AGENCY

15 - 19 June 2026 | Auditorium Maximum of the Jagiellonian University, Kraków, Poland

FRINGE 2026

L-BAND SAOCOM-1 MULTI-TEMPORAL DINSAR ANALYSES IN VEGETATED AND LANDSLIDE-PRONE AREAS OF THE ITALIAN TERRITORY: A NEW ASSESSMENT OF THE P-SBAS RESULTS

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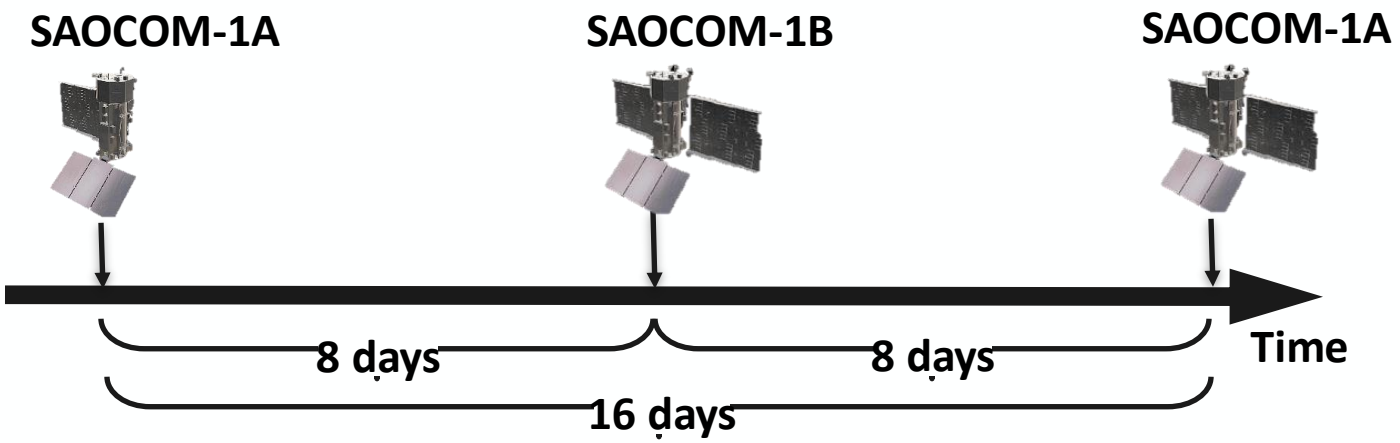
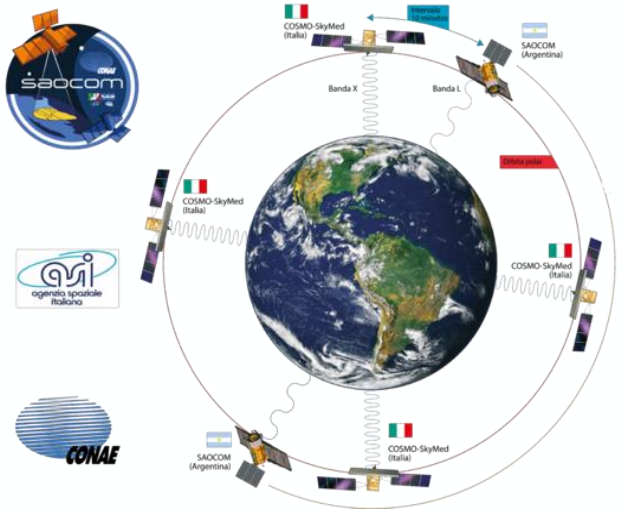
Francesco Poggi, Matteo Del Soldato, Federico Raspini (2)

1. Institute for Electromagnetic Sensing of the Environment, IREA-CNR, Napoli, Italy
2. Earth Sciences Department, University of Florence, Firenze, Italy

SAOCOM-1 constellation

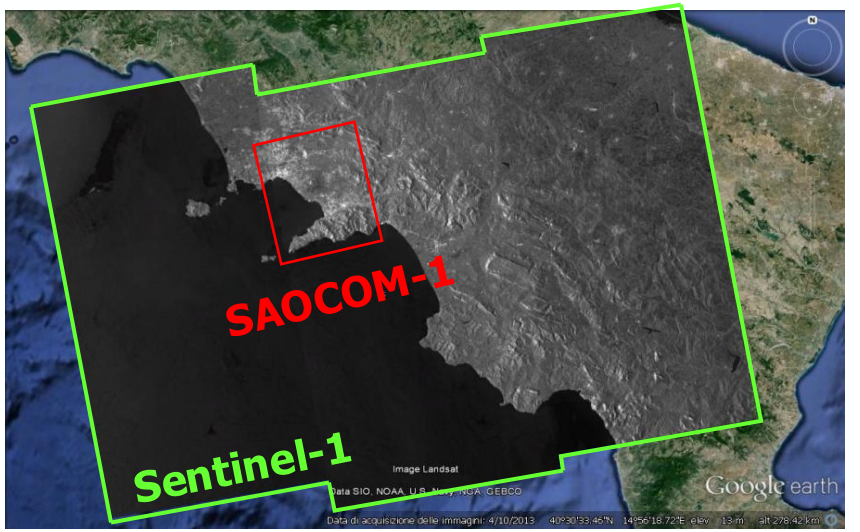


SIASGE system

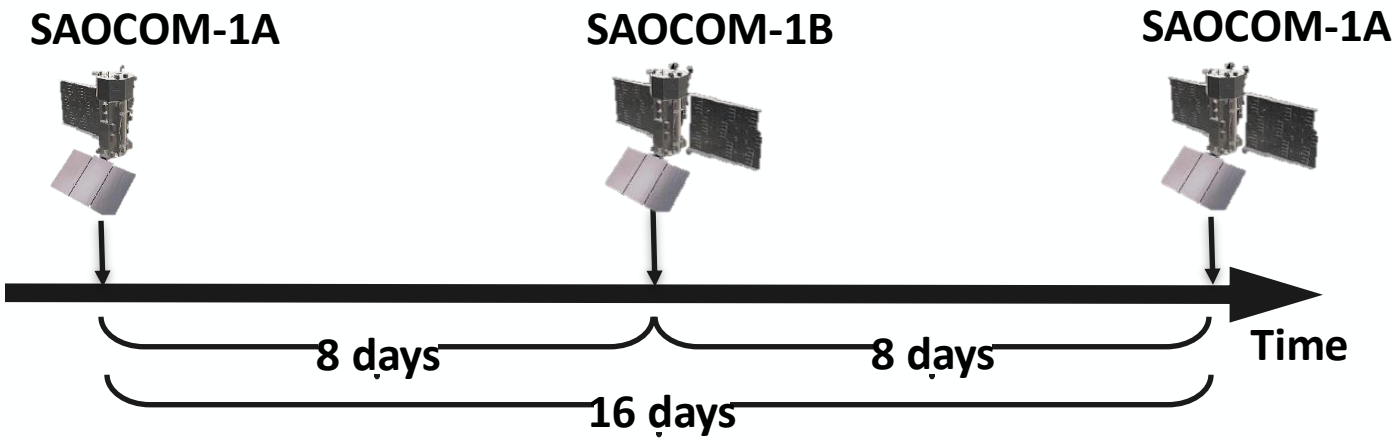


The Argentinian L-band SAOCOM-1 and the Italian X-band COSMO-SkyMed constellations share the same orbits, forming the SIASGE system.

- **Spatial resolution (Stripmap mode)**: 5 m x 10 m (Single & Dual Pol), 5m x 6m (Quad Pol)
- **Footprint extent**: 40-60 km (Single & Dual Pol), 20-30 Km (Quad Pol)
- **Frequency**: L-band ($\lambda \cong 23.5$ cm)



SAOCOM-1 constellation



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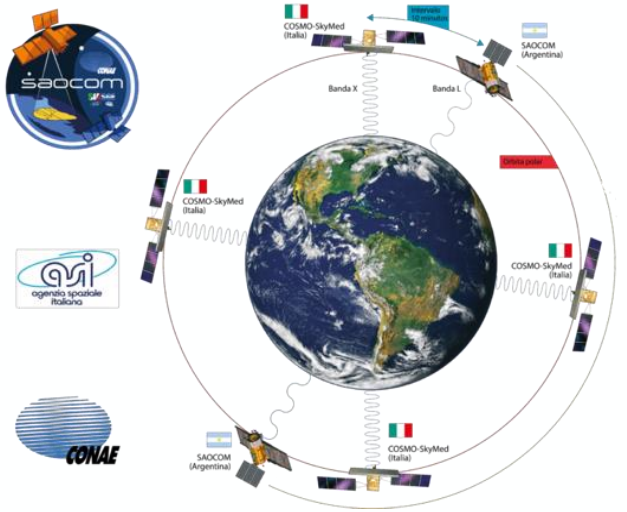

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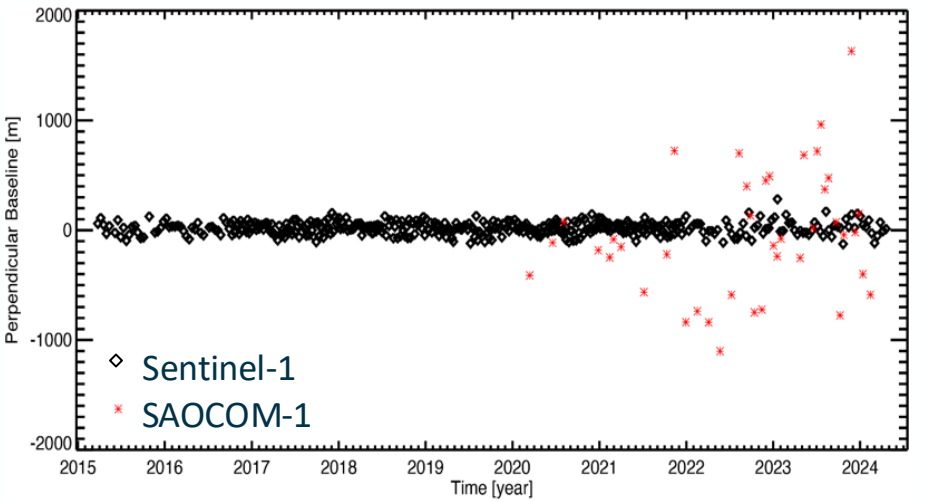

ASI Zone of Exclusivity (ZoE)

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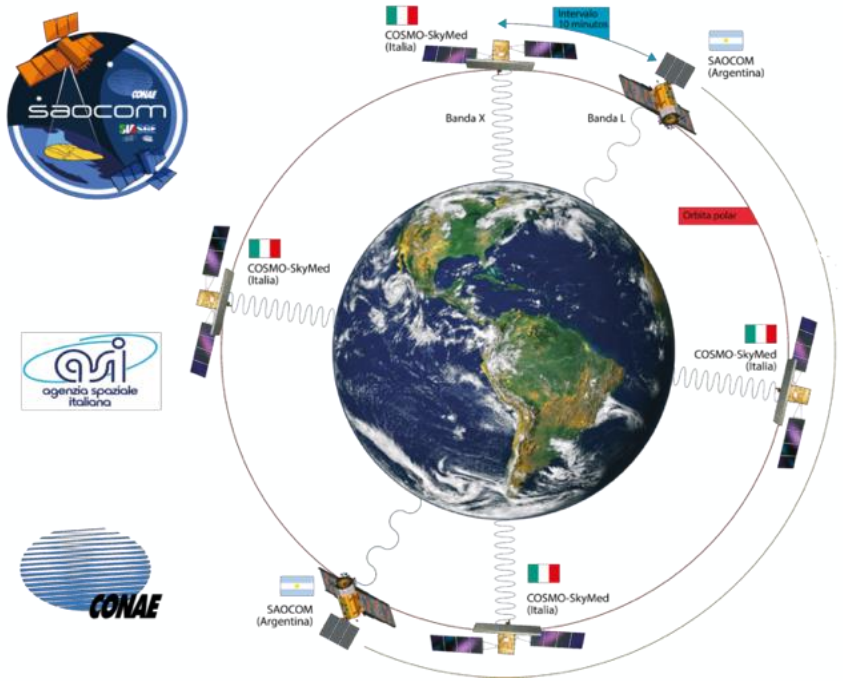
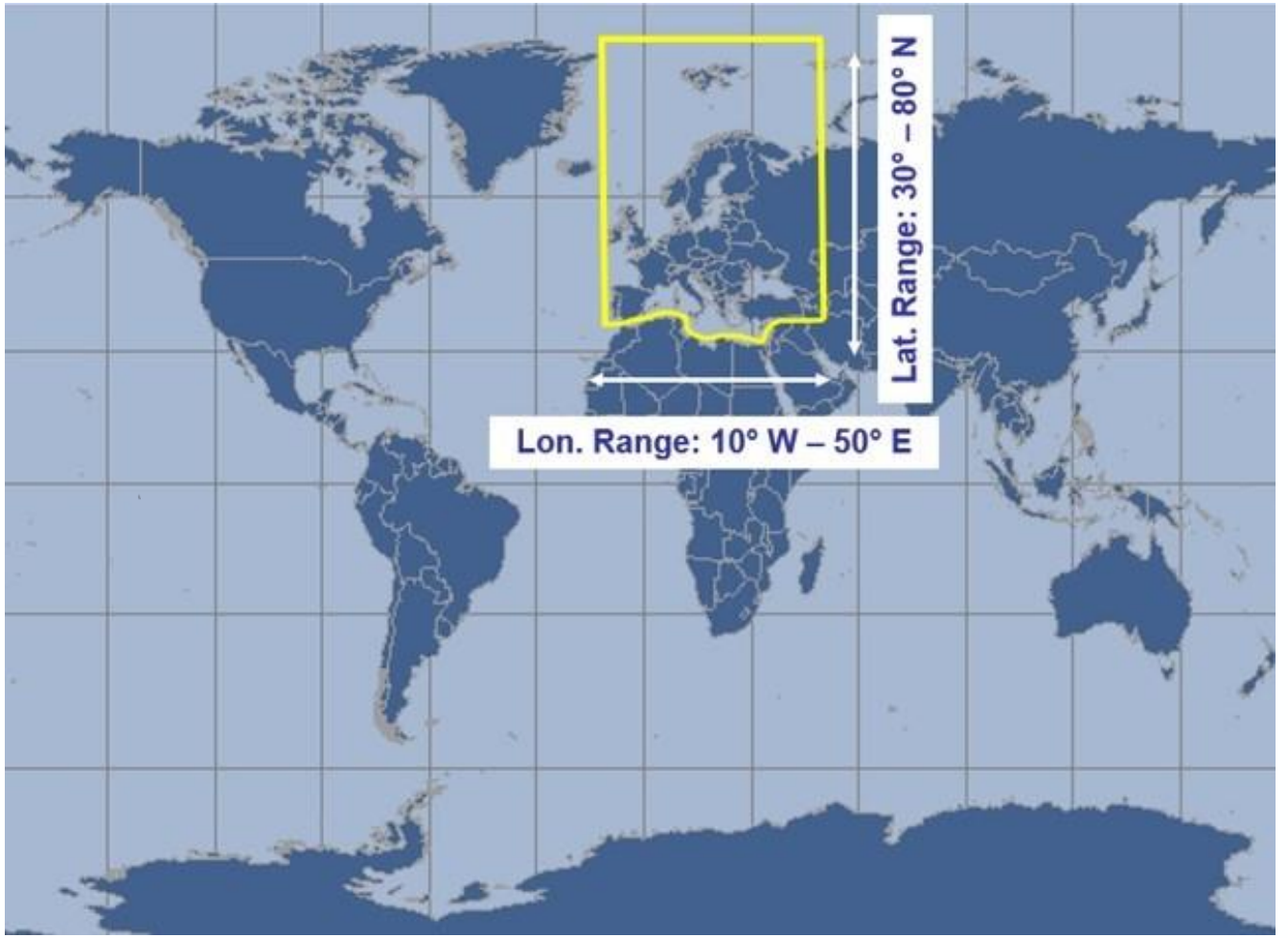
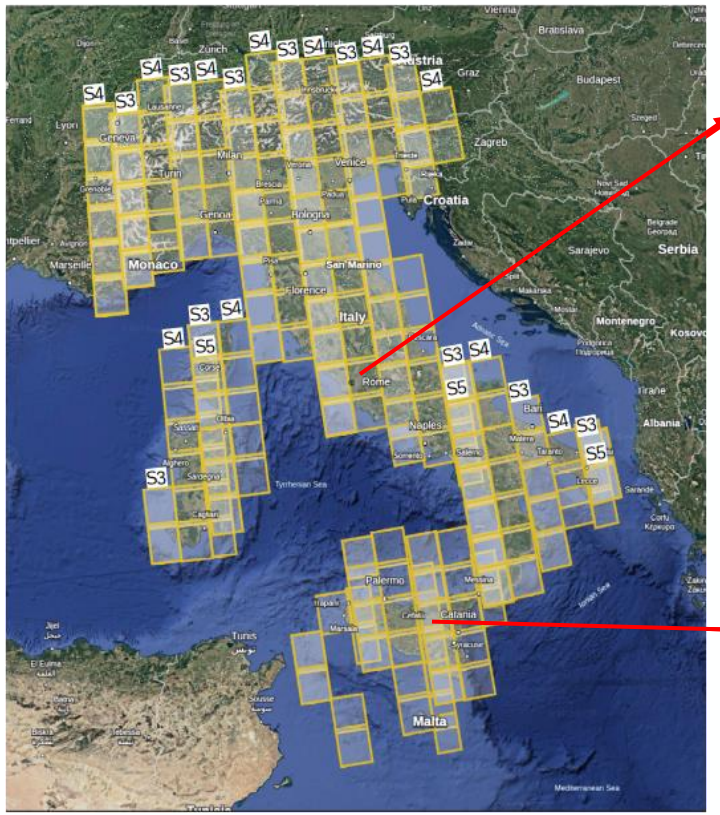
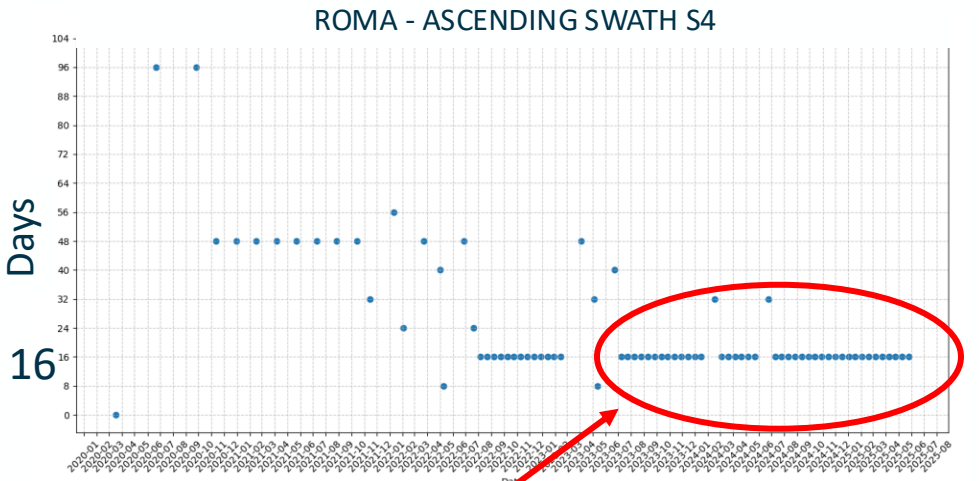
SIASGE system

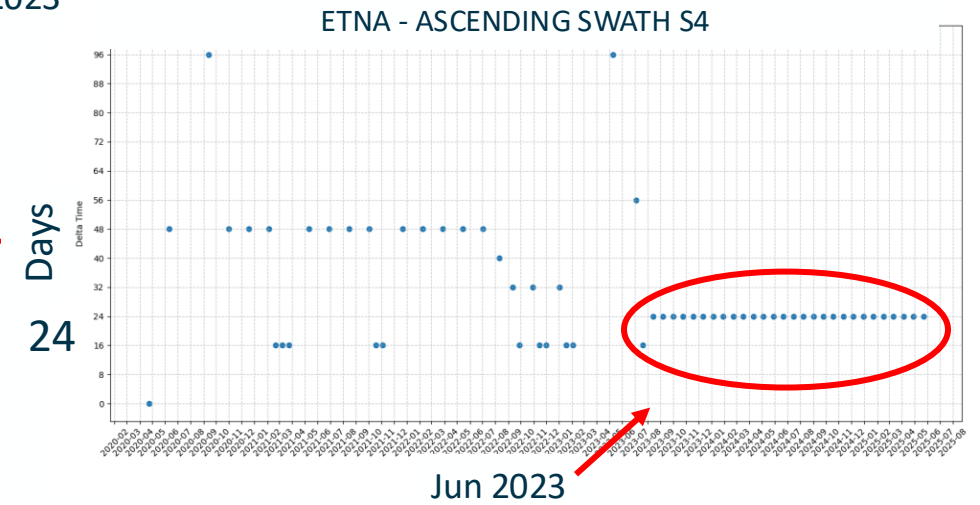




SAOCOM-1 Stripmap Italy coverage

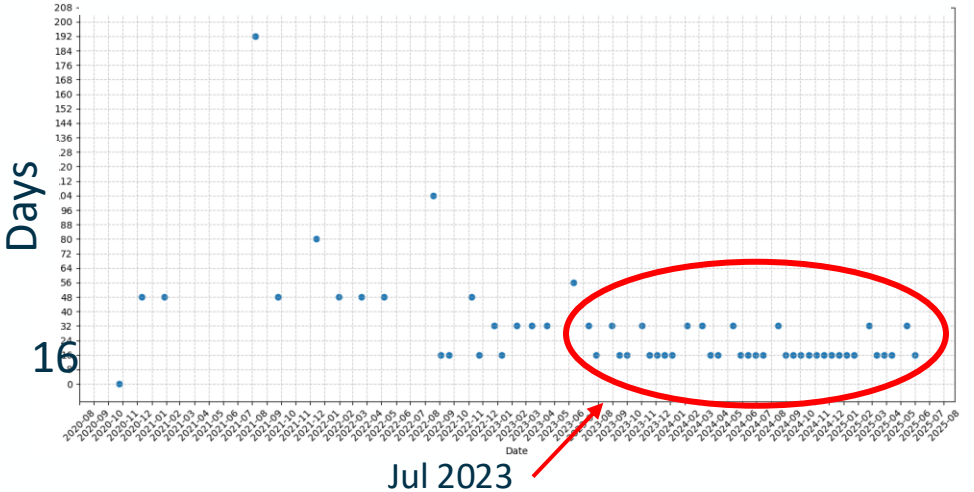






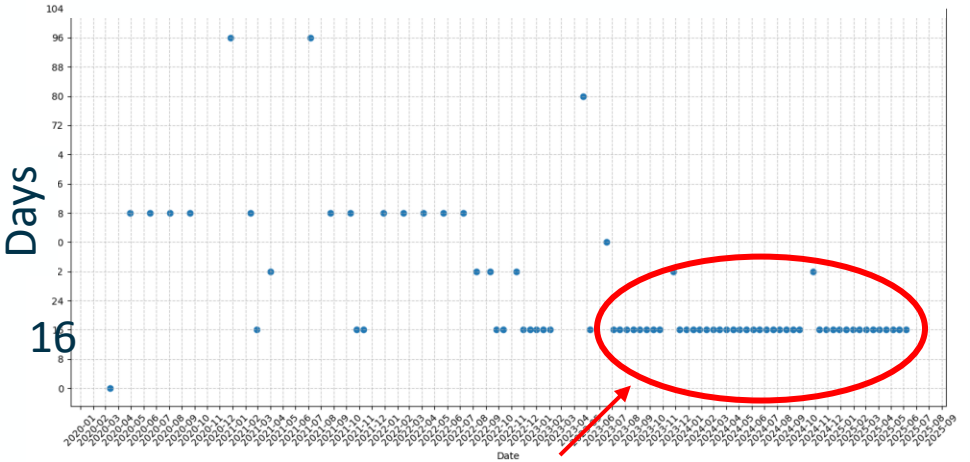
SAOCOM-1 Stripmap Italy coverage

BOLOGNA - DESCENDING SWATH S3



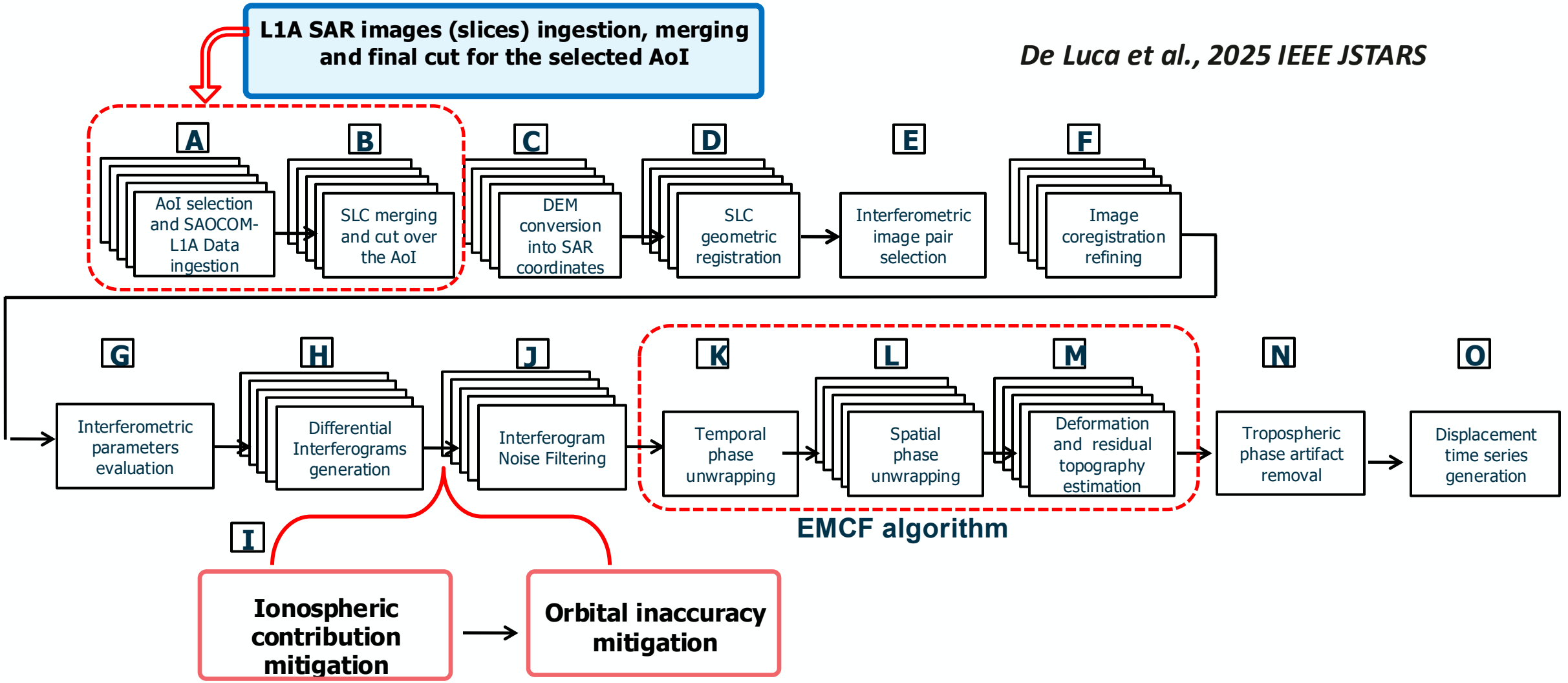
Jul 2023

NAPOLI CF - DESCENDING SWATH S4



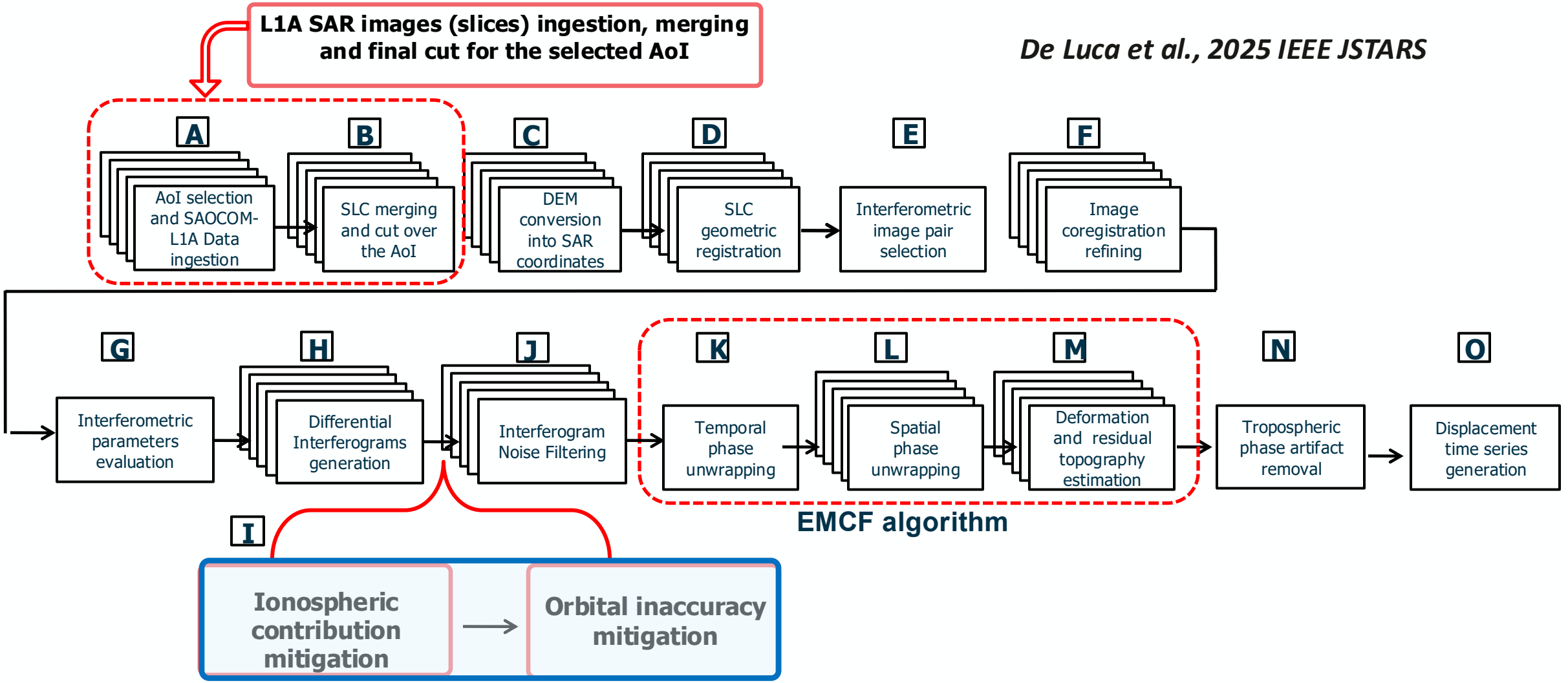
Jun 2023

SAOCOM-1 Stripmap P-SBAS processing chain



De Luca et al., 2025 IEEE JSTARS

SAOCOM-1 Stripmap P-SBAS processing chain



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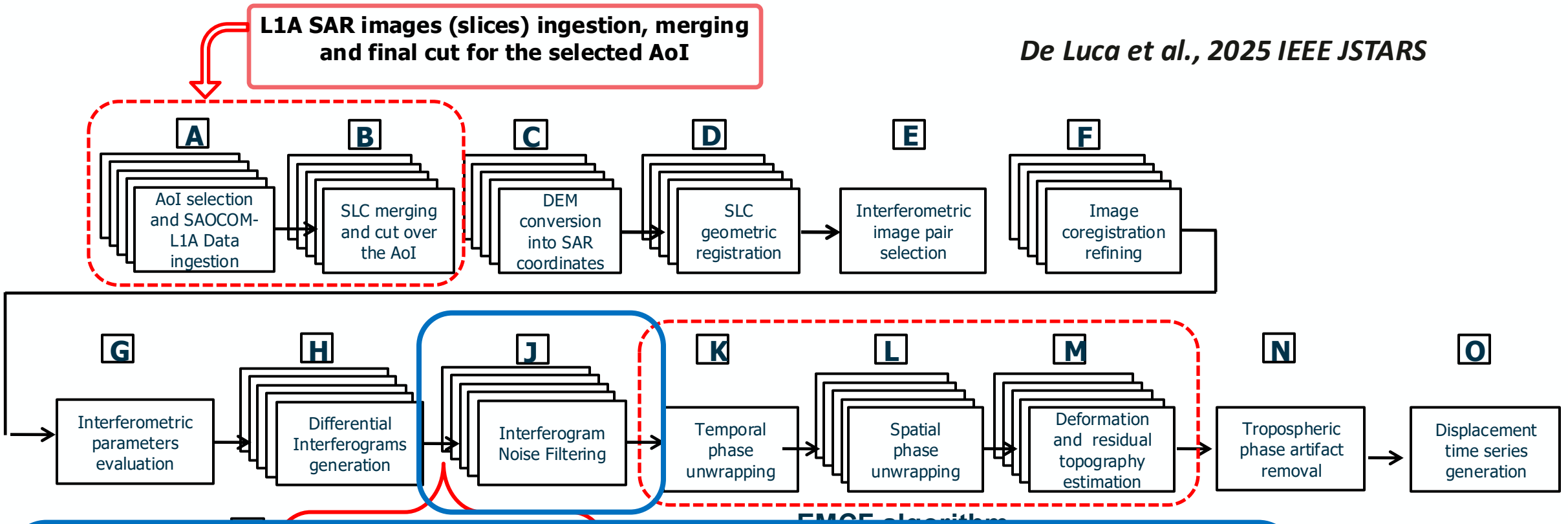


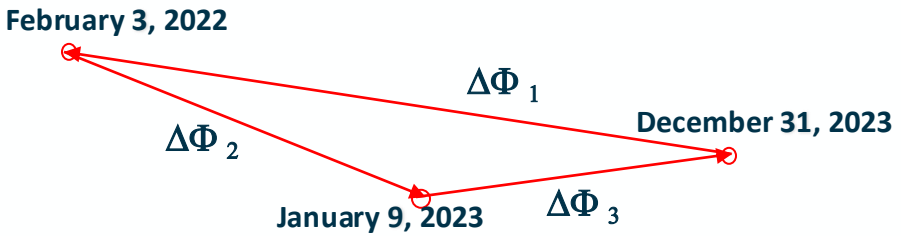
De Luca et al., 2025 IEEE JSTARS

Interferograms noise filtering → Interferograms consistency retrieval

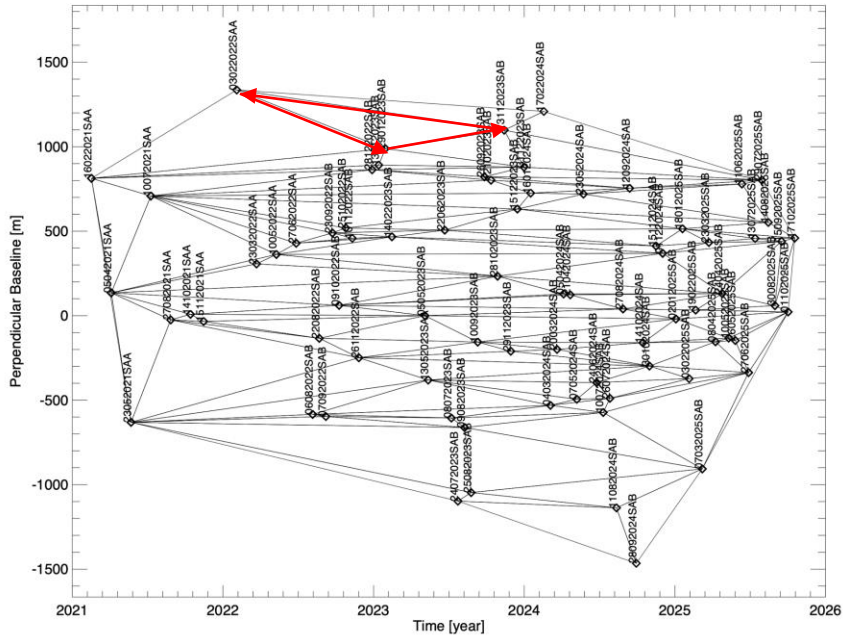
Pepe et al. 2015. Improved EMCF-SBAS Processing Chain Based on Advanced Techniques for the Noise-Filtering and Selection of Small Baseline Multi-Look DInSAR Interferograms. *IEEE TGRS*

SAOCOM-1 Stripmap P-SBAS analysis: non-closure phase issue

$$< \Delta\phi_{res}^{tr} >_{\square\pi\ ,\pi} = < \Delta\Phi_1 + \Delta\Phi_2 + \Delta\Phi_3 >_{-\pi\ ,\pi} \neq 0$$



B_{temp}=1000 [days] - B_{perp} = 1500 [m]



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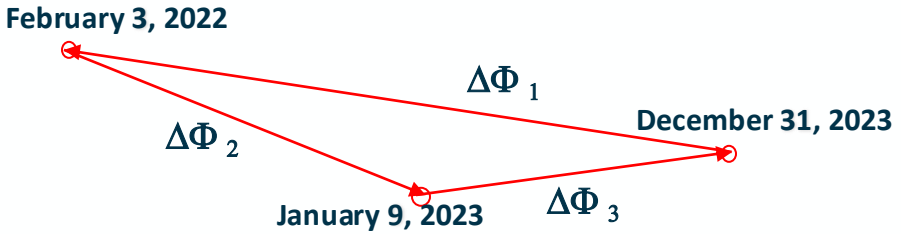

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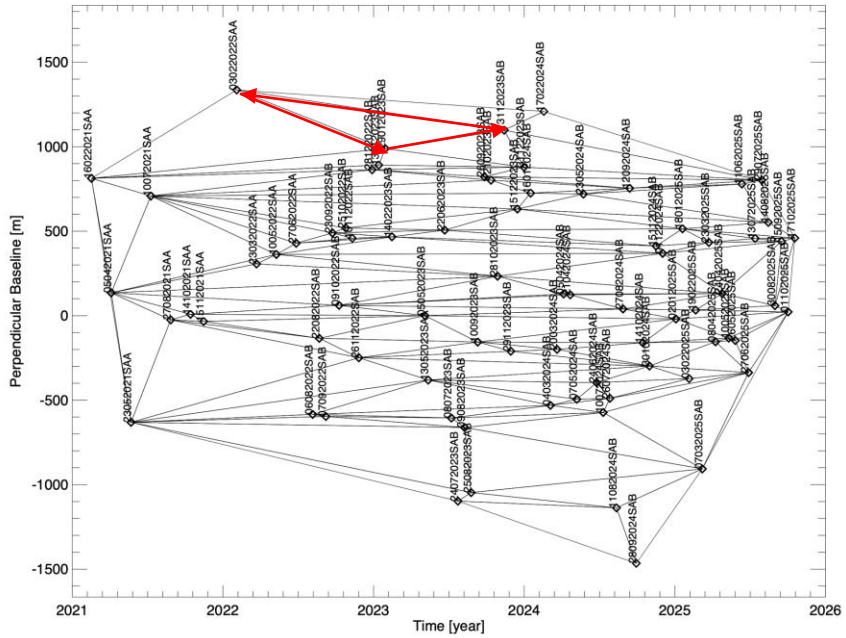
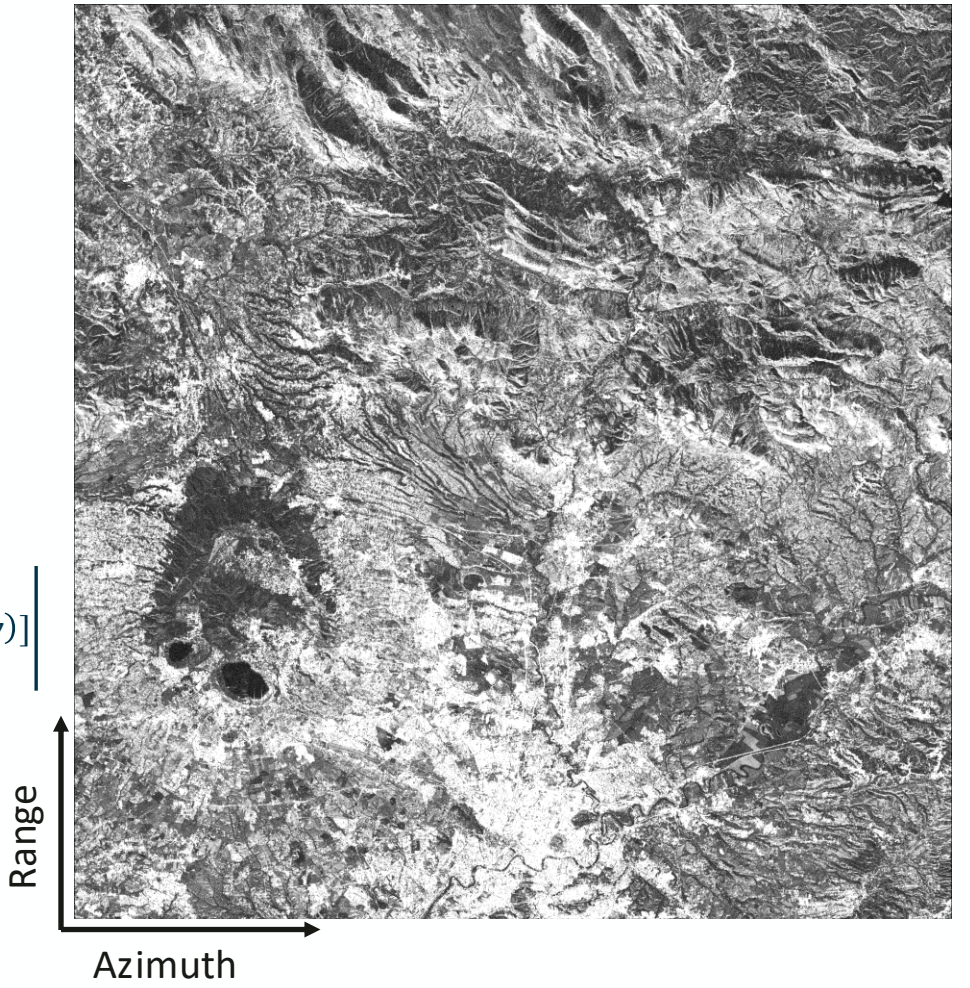


Triangular coherence

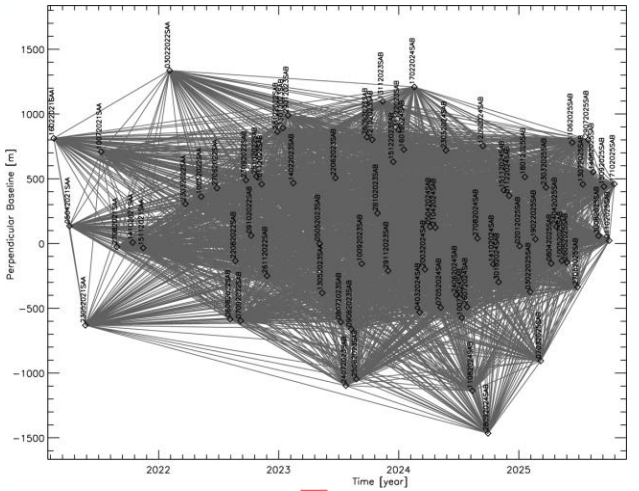
$$\gamma_{tr}(x,y) = \frac{1}{N_{tr}} \left| \sum_{k=1}^{N_{tr}} \exp[j\ \Delta\phi_{res_k}^{tr}(x,y)] \right|$$



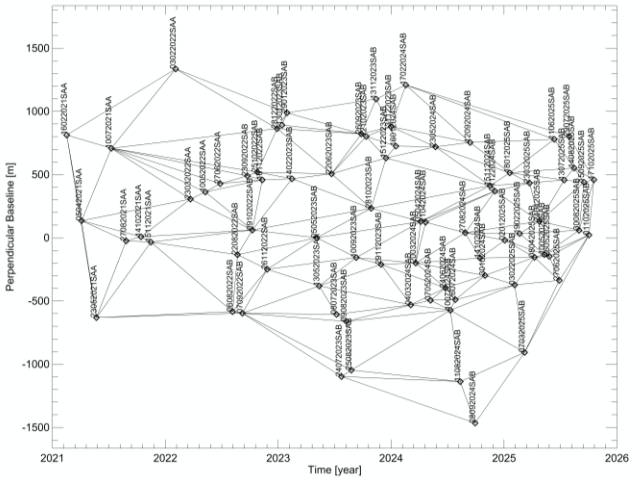
Manunta et al., 2019 IEEE TGRS

SAOCOM-1 Stripmap P-SBAS analysis: non-closure phase issue

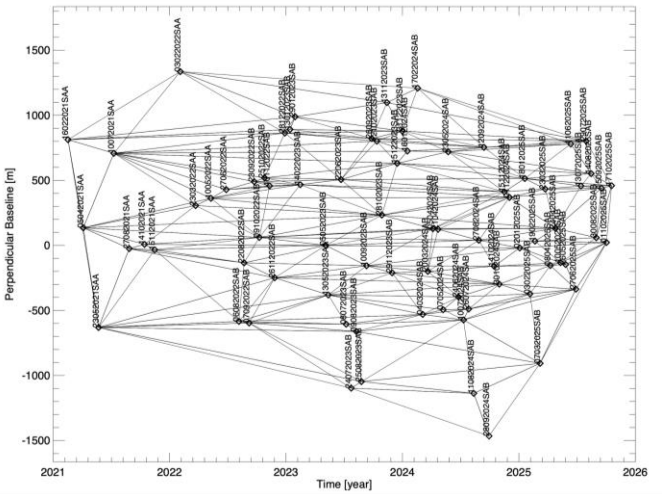
Full connection distribution



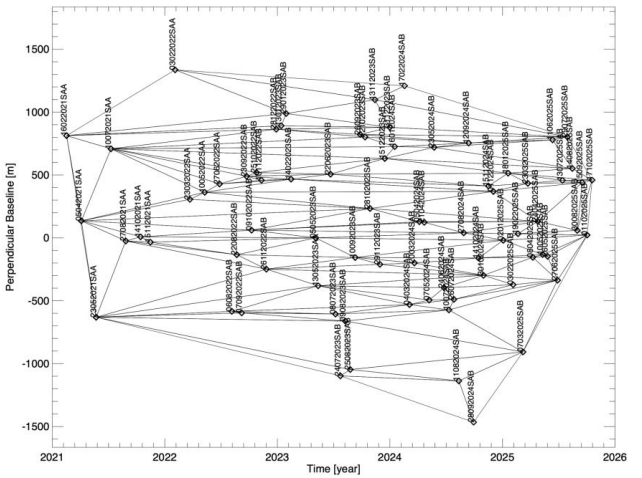
Short term → **B_{temp} = 600 [days]**



B_{temp1} = 600 - B_{temp2}=1000 [days] - B_{perp} = 1500 [m]



Medium term → **B_{temp}=1000 [days]**



Manuela Bonano (bonano.m@irea.cnr.it)

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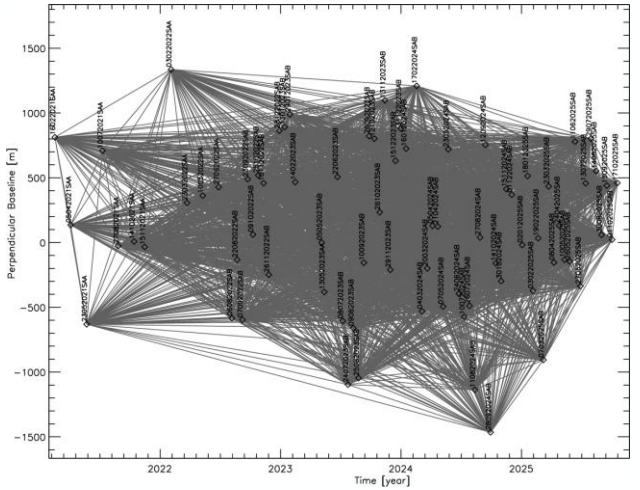

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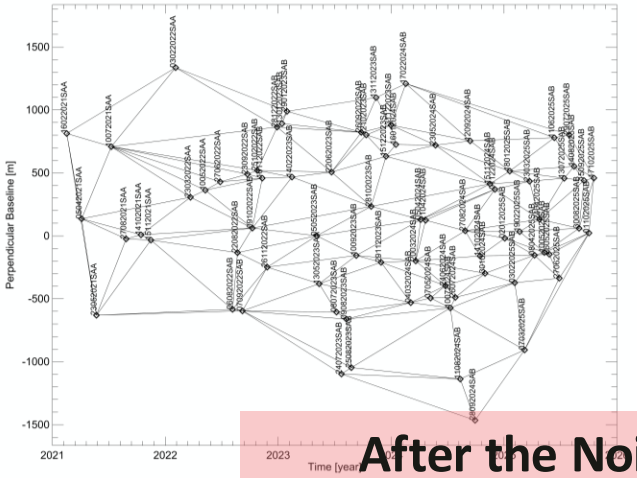

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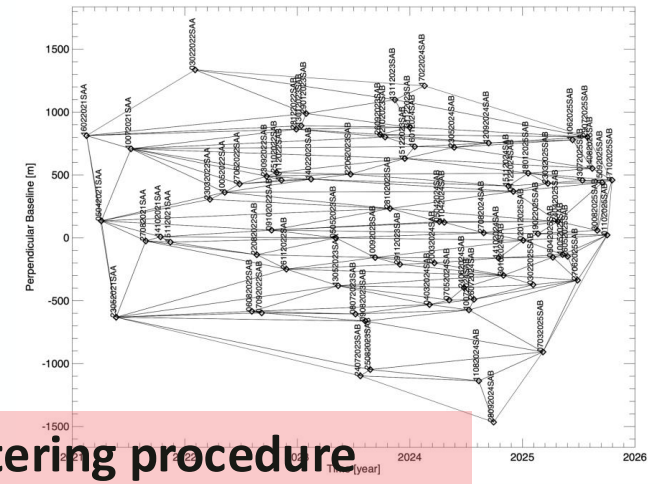
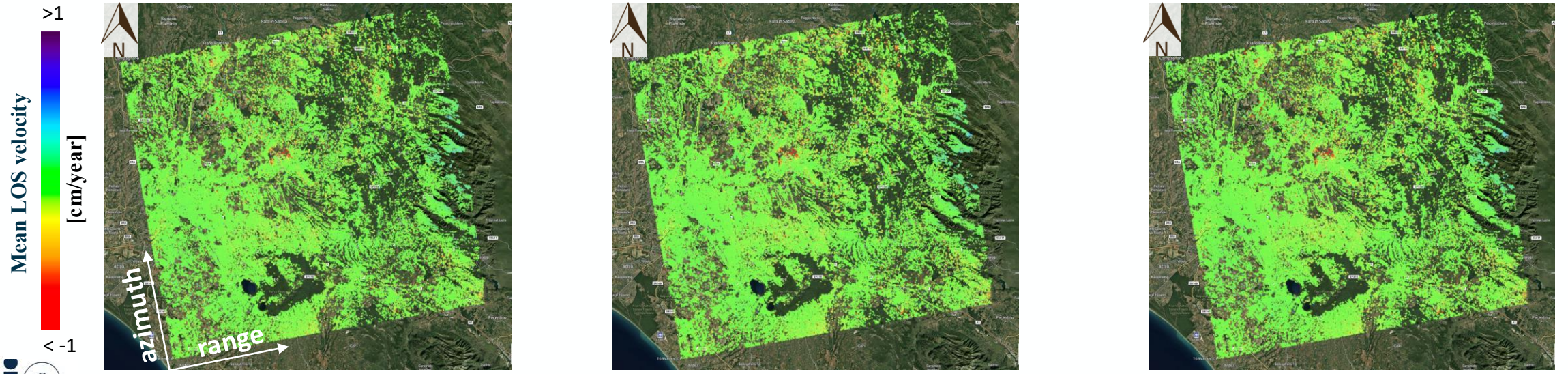


After the Noise Filtering procedure



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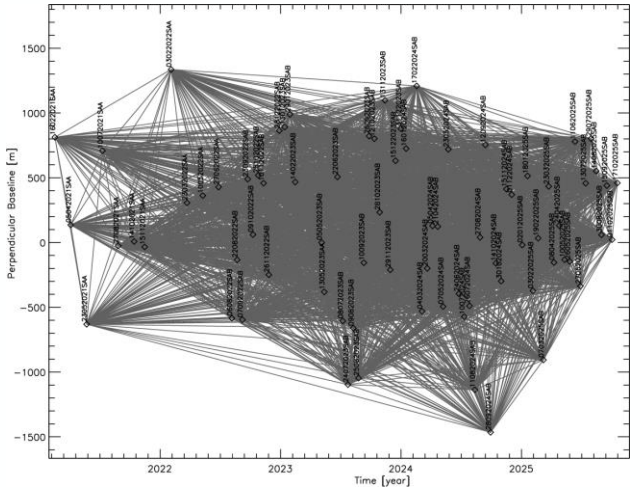

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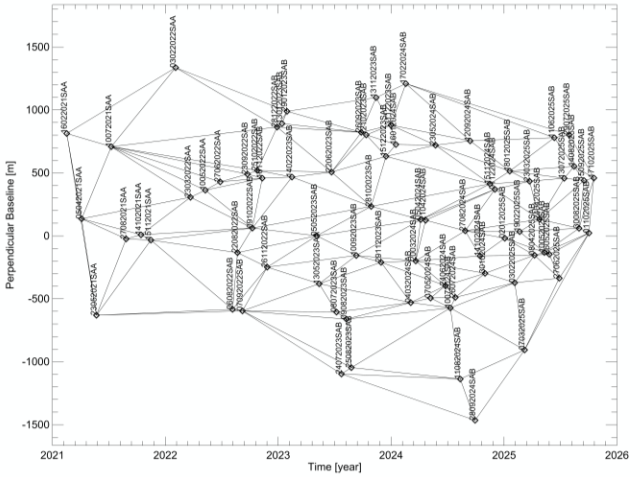

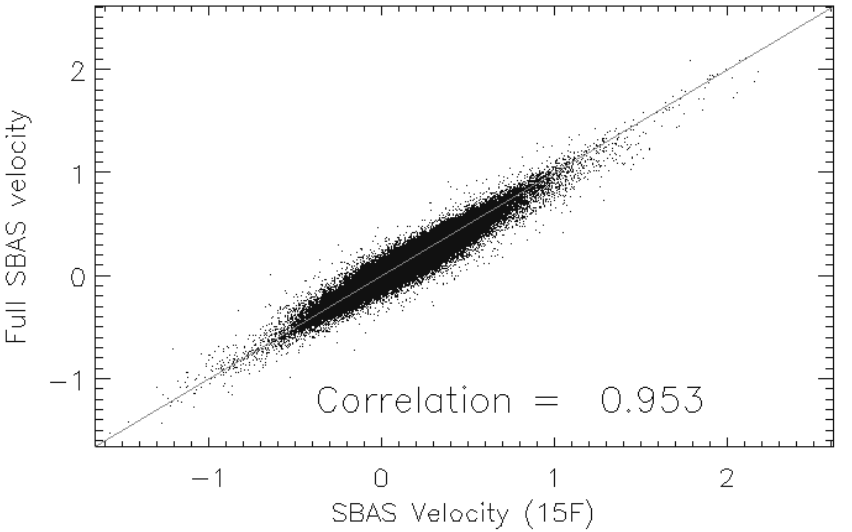

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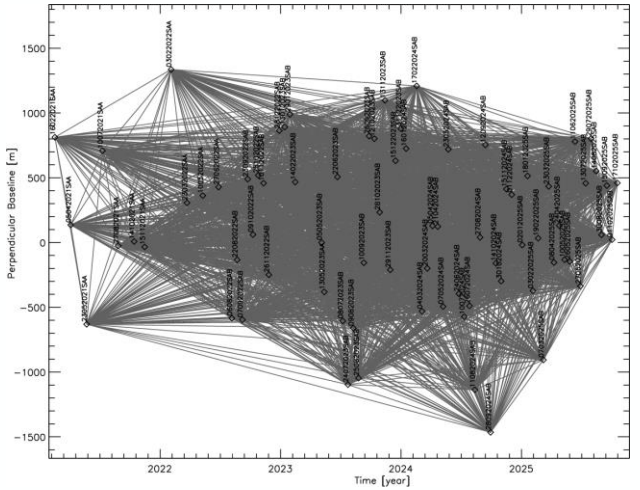

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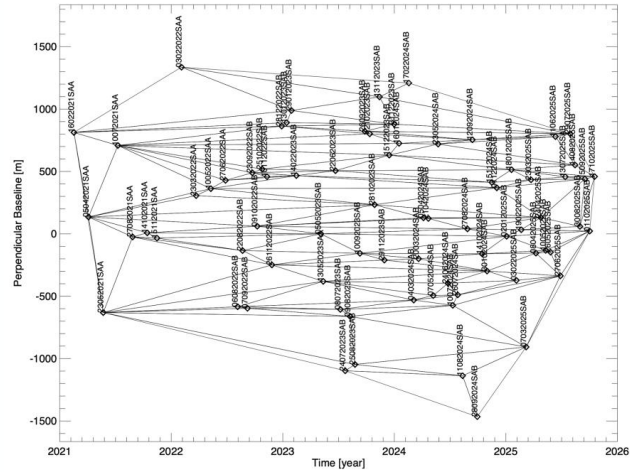
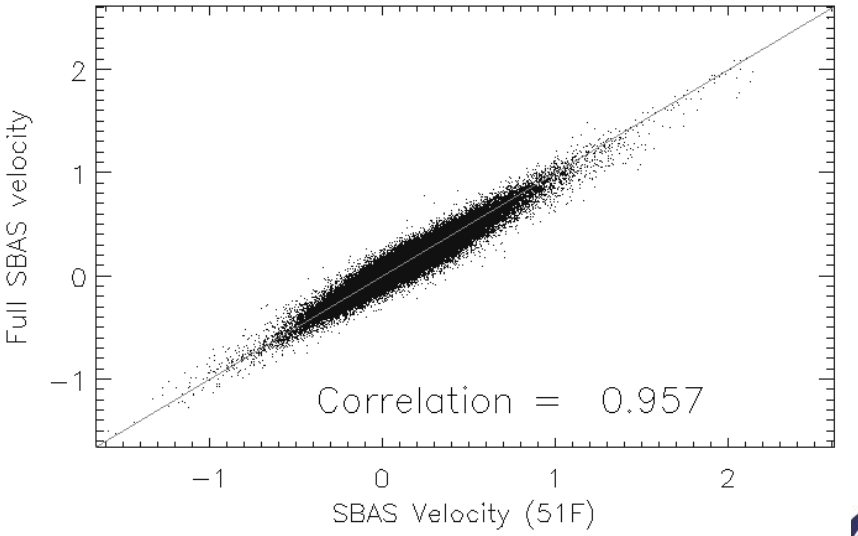
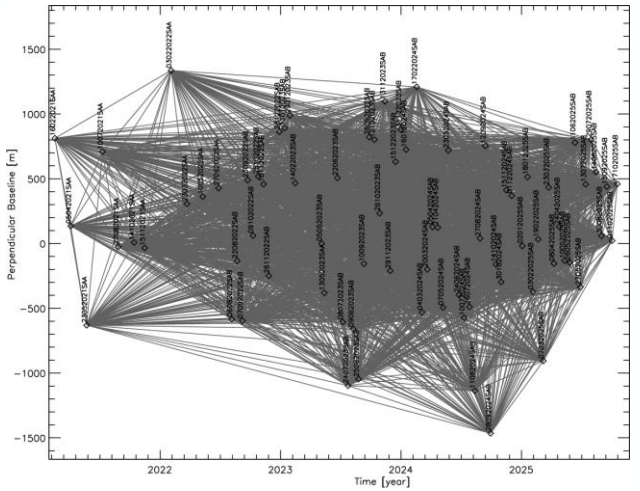




Manuela Bonano (bonano.m@irea.cnr.it)

SAOCOM-1 Stripmap P-SBAS analysis: non-closure phase issue

Full connection distribution



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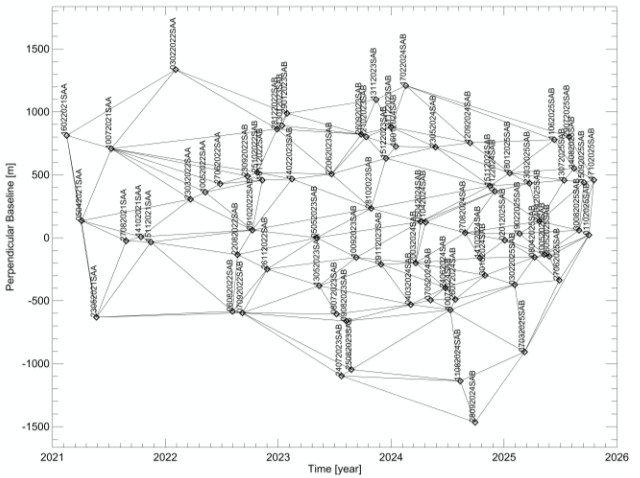

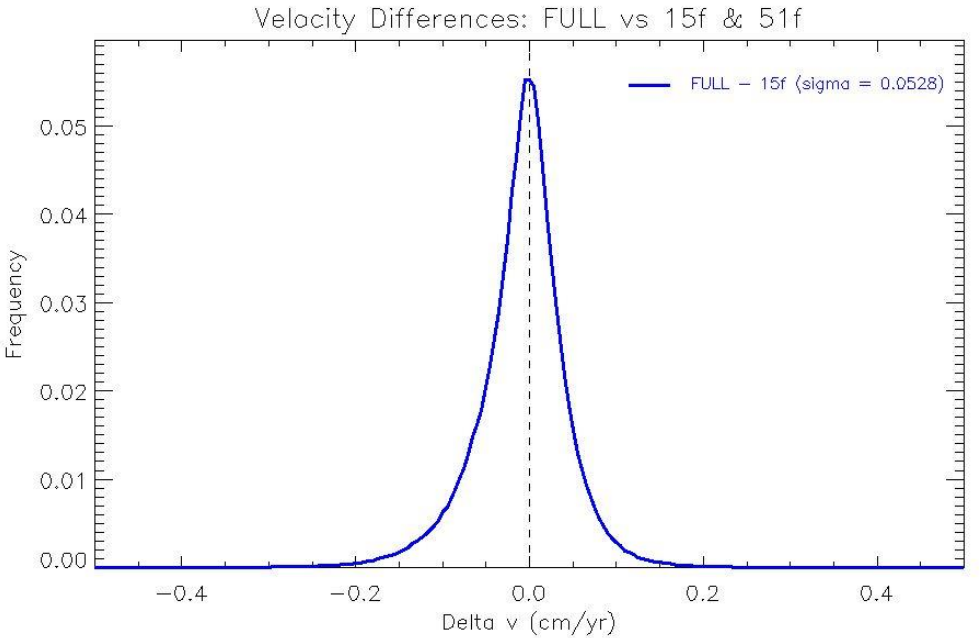

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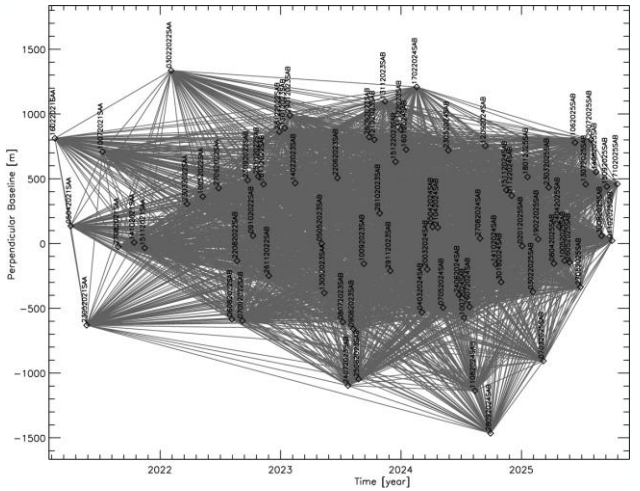

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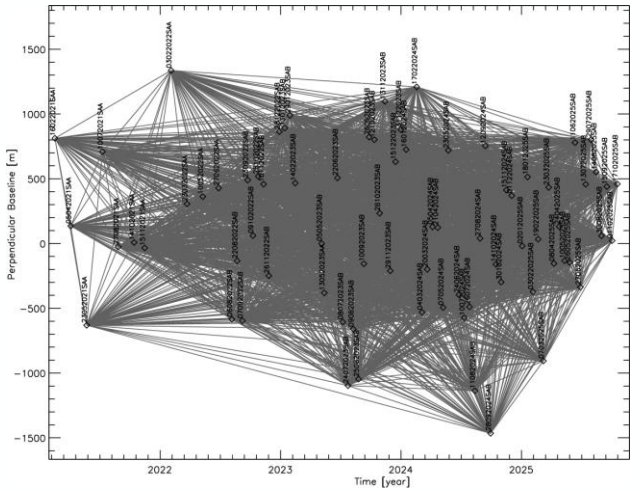

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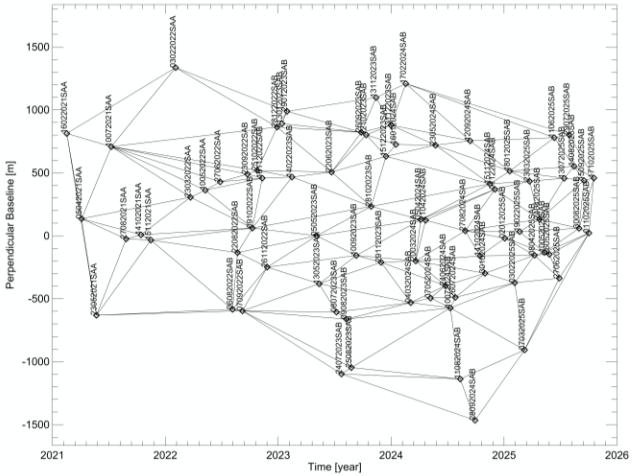
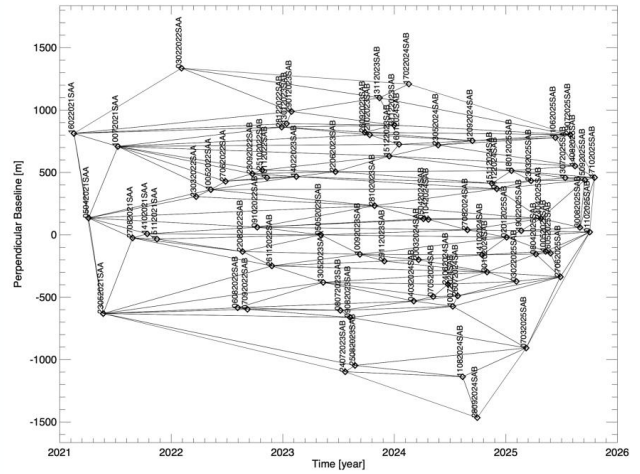
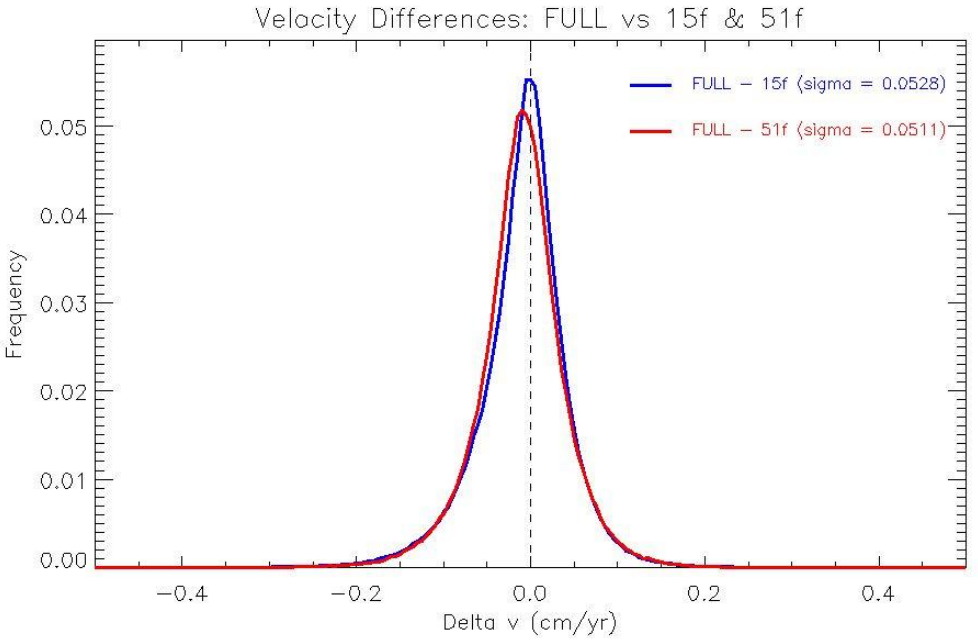


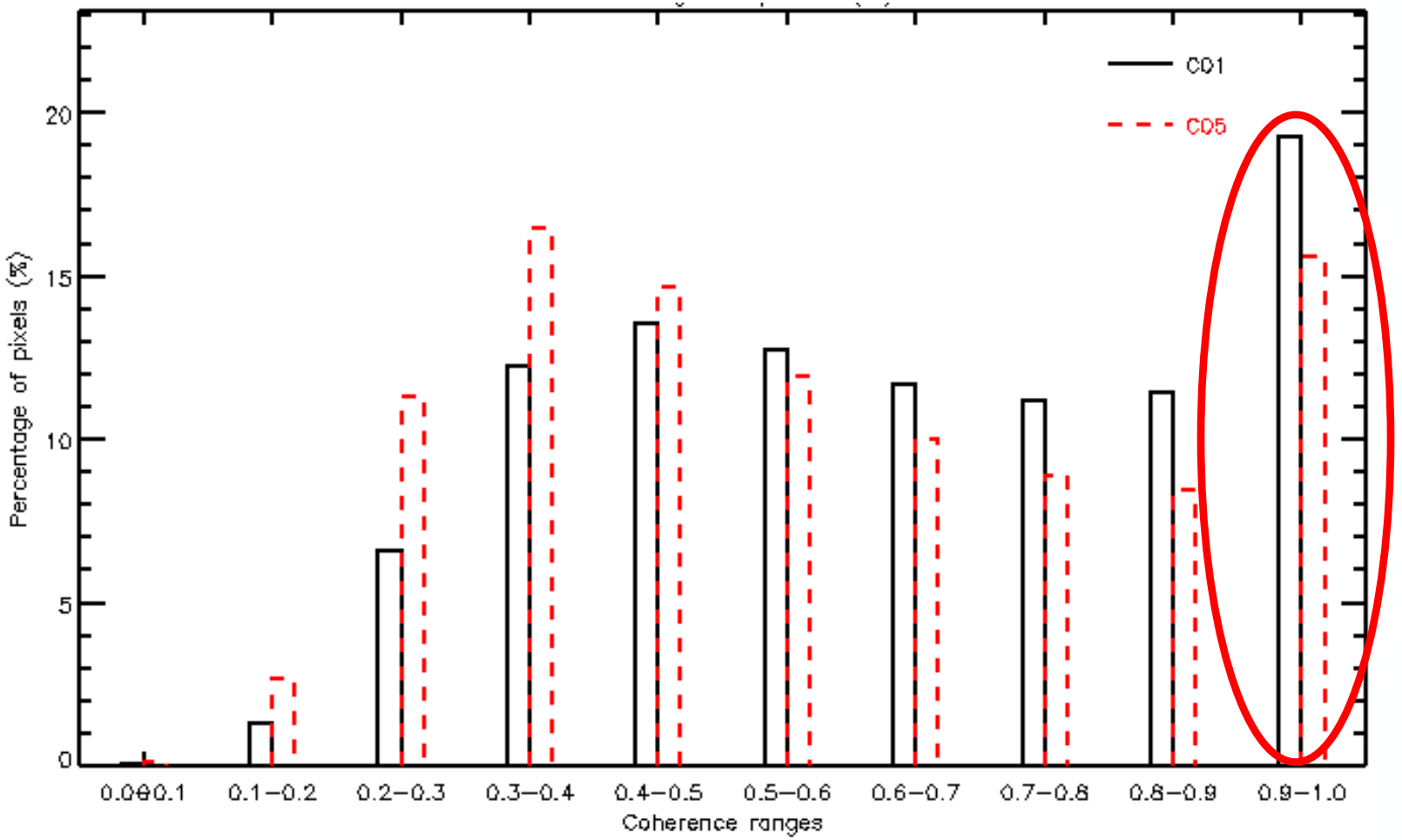
Medium term → B_{temp}=1000 [days]





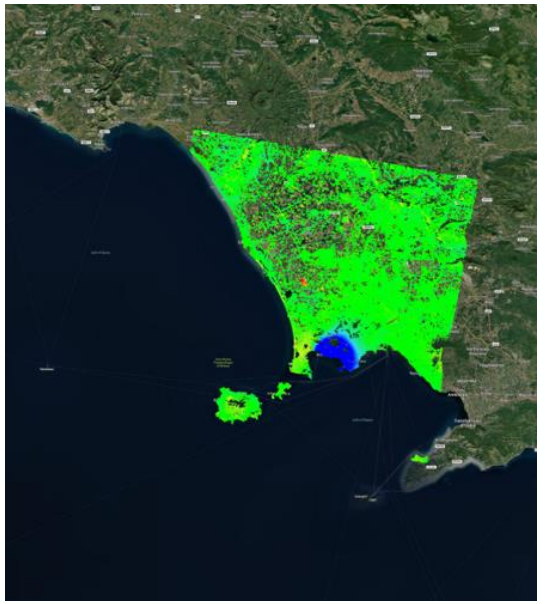
The P-SBAS results achieved through the triangulation-based strategy do not show any significant bias effect

SAOCOM-1 Stripmap P-SBAS analysis: non-closure phase issue

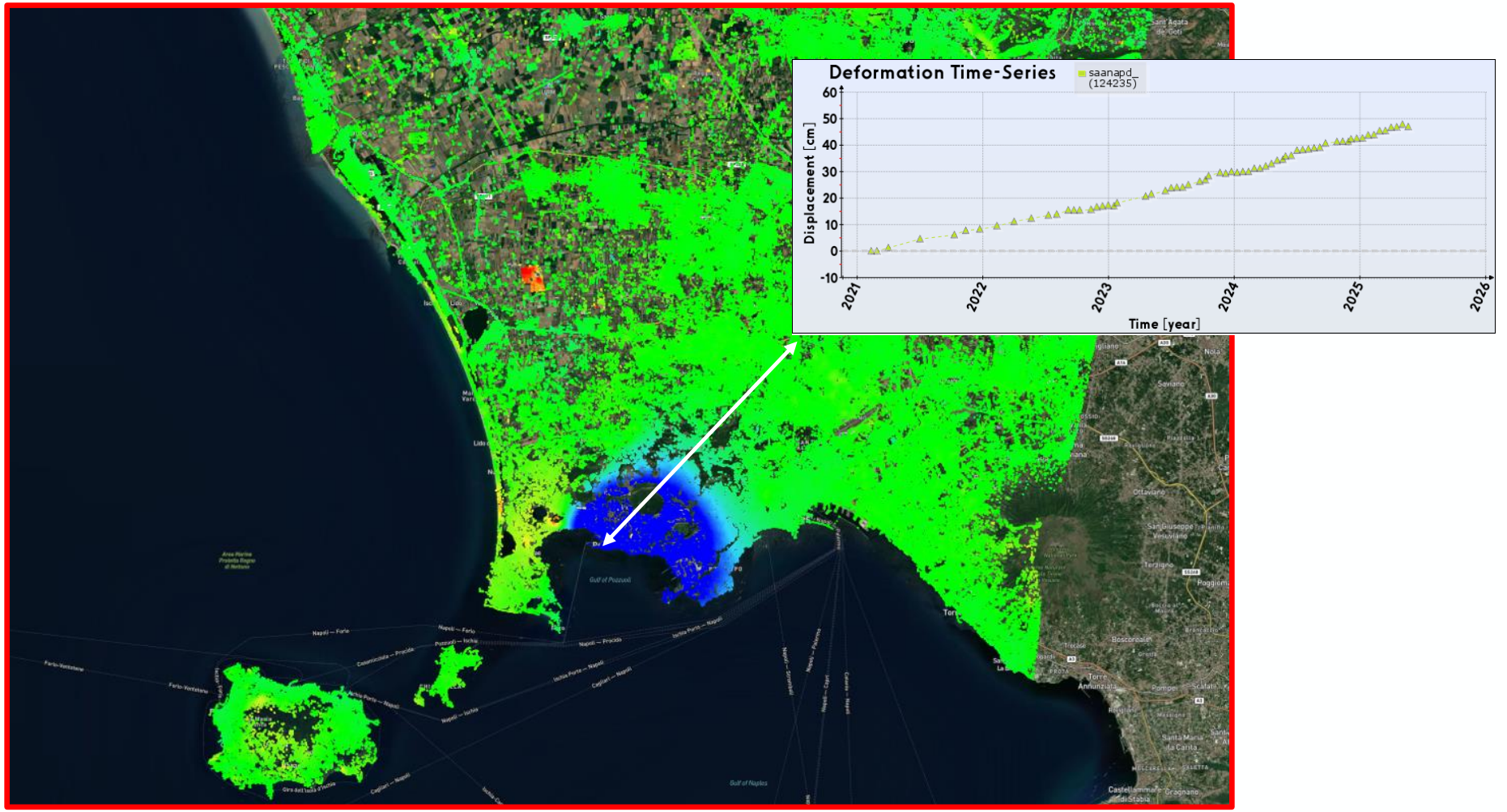


Manuela Bonano (bonano.m@irea.cnr.it)

SAOCOM-1 P-SBAS results: a quantitative assessment



SAOCOM-1 P-SBAS results over the Napoli area (Swath S4, DESC)

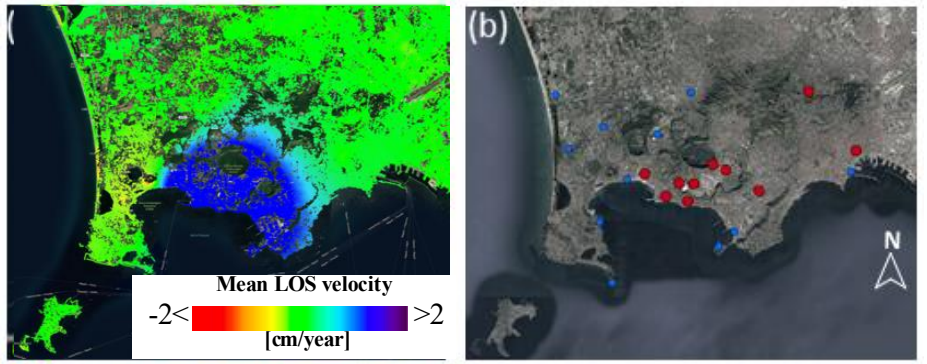


Zoom over the Campi Flegrei caldera

Manuela Bonano (bonano.m@irea.cnr.it)

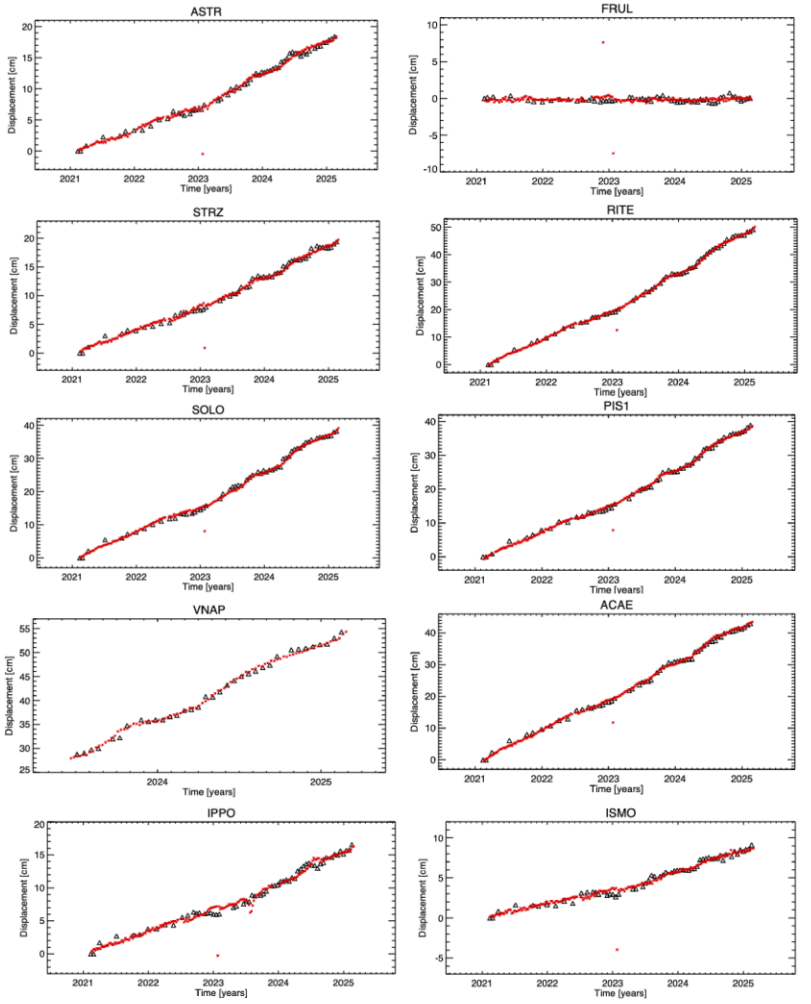
SAOCOM-1 P-SBAS results: comparison with GNSS

Campi Flegrei caldera



Results of the comparison between the P-SBAS and the LOS-projected GNSS deformation time series relevant to the Neapolitan volcanic area (Campi Flegrei caldera)

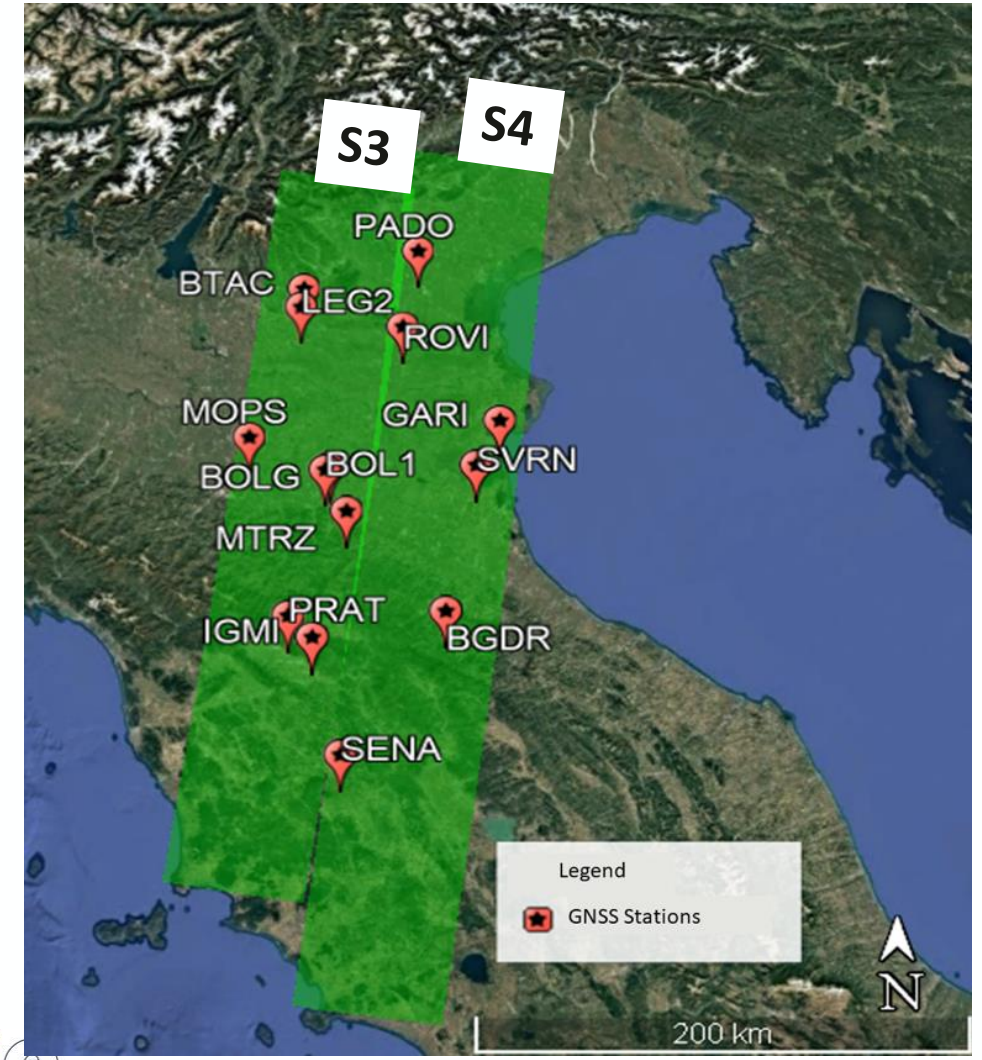
GNSS Station	Standard deviation [cm]		GNSS Station	Standard deviation [cm]
ACAE	0.57		LICO	0.63
AGR1	0.55		VNAP	0.53
ARFE	0.38		MORU	0.39
ASTR	0.50		NAMM	0.29
BAGN	0.42		NISI	0.57
BAIA	0.50		PIS1	0.52
CMIS	0.40		QUAR	0.30
CUMA	0.43		RITE	0.41
FRUL	0.50		SOLO	0.61
IPPO	0.52		STRZ	0.41
ISMO	0.35		VICA	0.53
Average standard deviation value for L-band: 0.41 cm				



Δ: DInSAR
*: GNSS (INGV-OV)

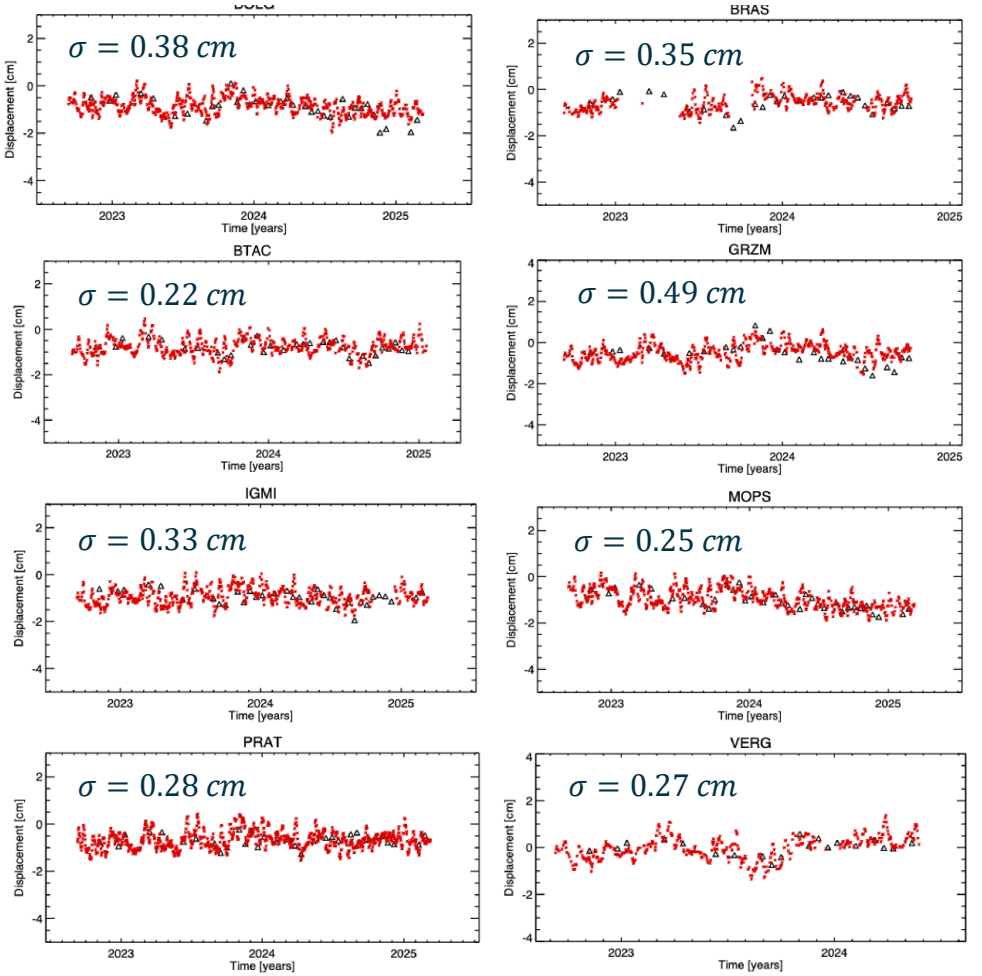
SAOCOM-1 P-SBAS results: comparison with GNSS

Northern Apennines



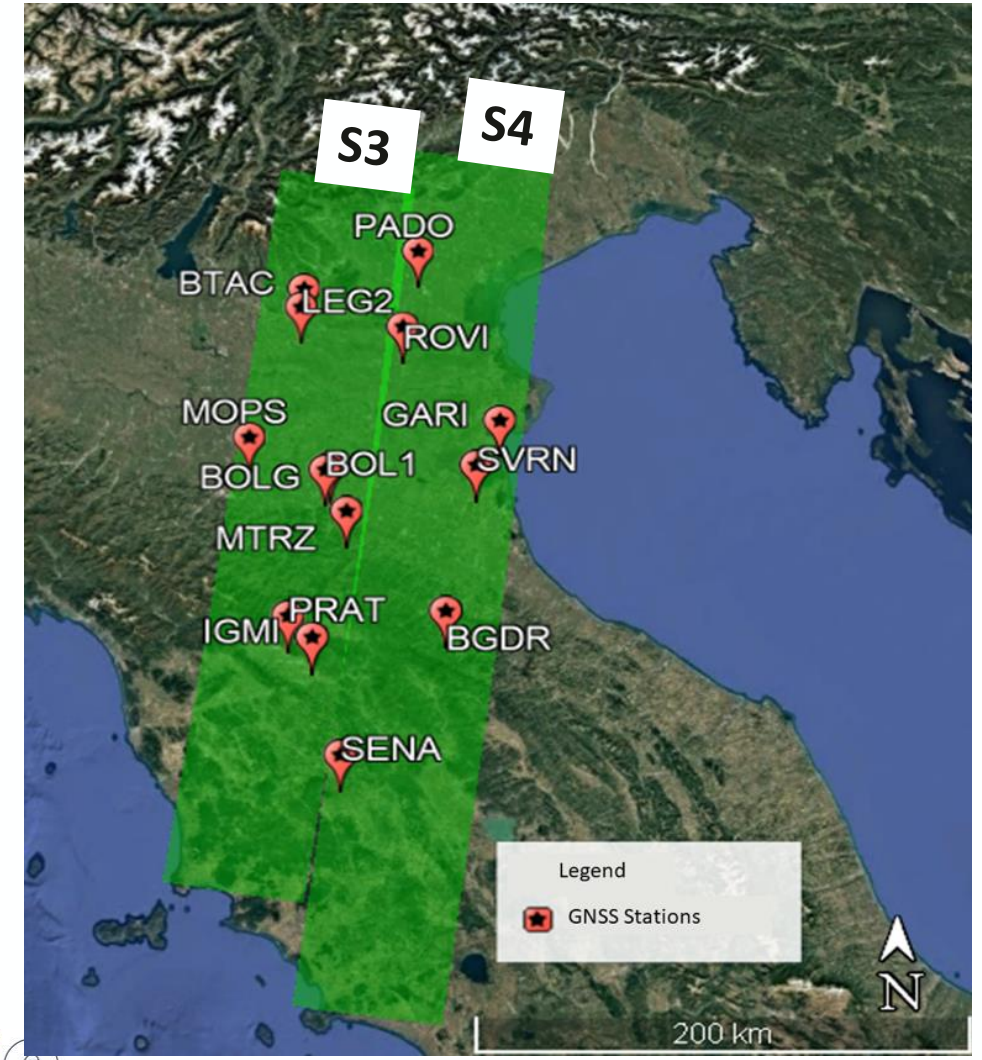
Δ: DInSAR
*: GNSS (UNIBO)

Swath S3

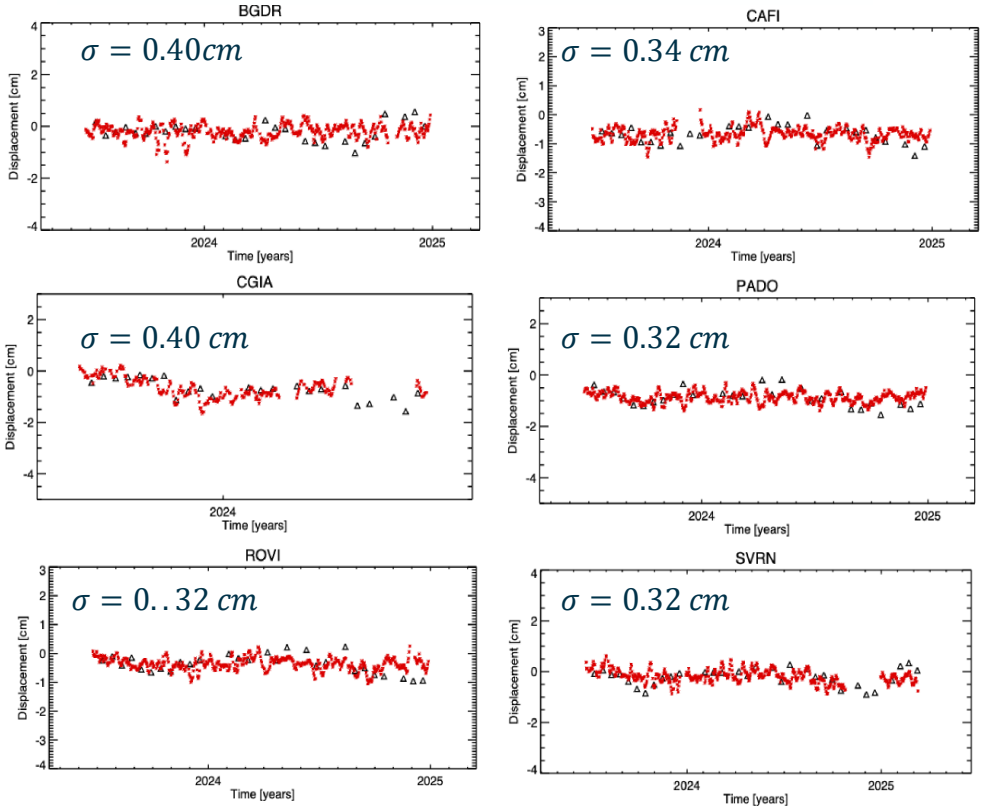


SAOCOM-1 P-SBAS results: comparison with GNSS

Northern Apennines



Swath S4



Δ: DInSAR
*: GNSS (UNIBO)

SAOCOM-1 P-SBAS results: ground coverage improvement

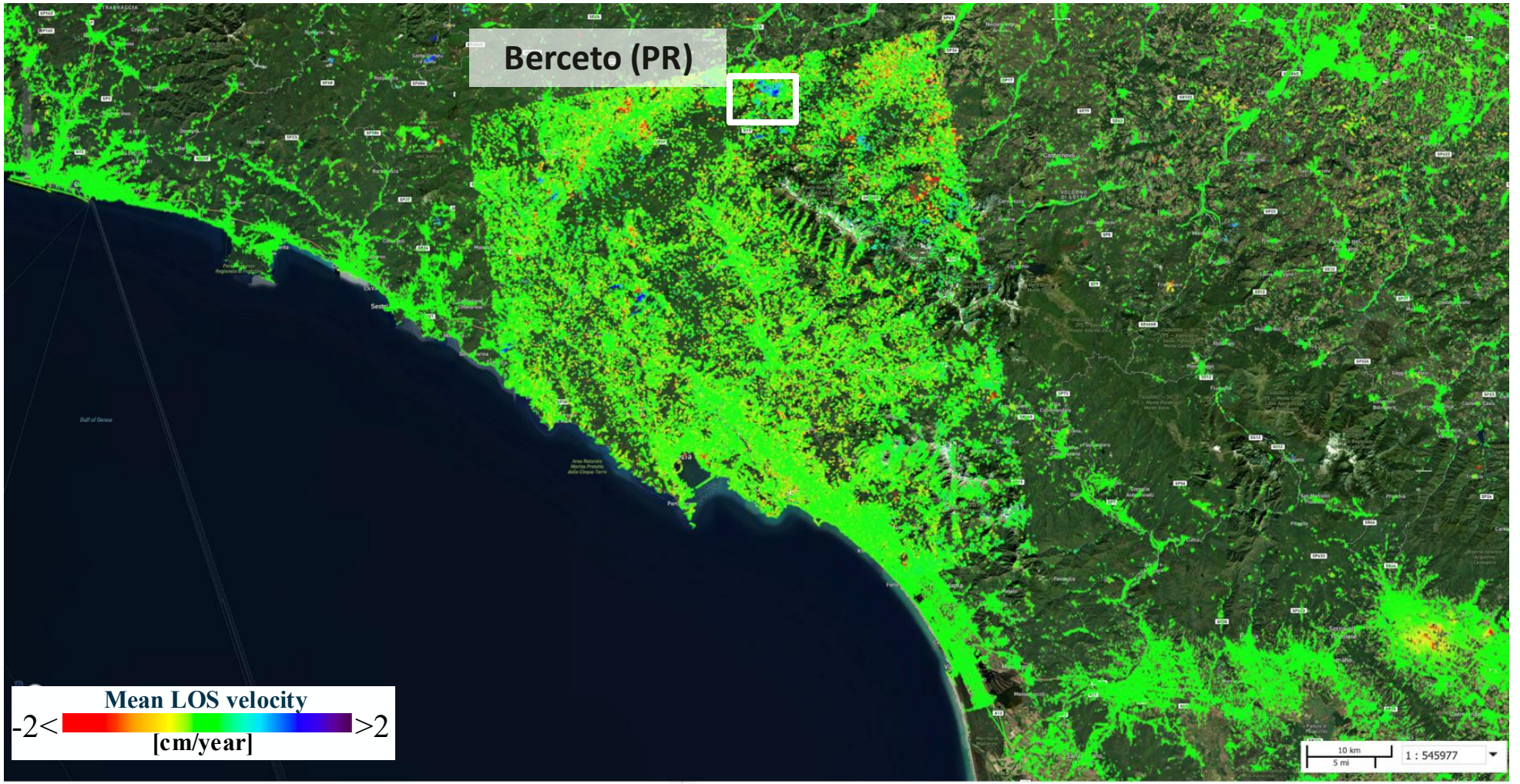
Comparison with Sentinel-1: the Berceto (Northern Italy) landslide

SAOCOM-1 P-SBAS results: ground coverage improvement

Comparison with Sentinel-1: the Berceto (Northern Italy) landslide

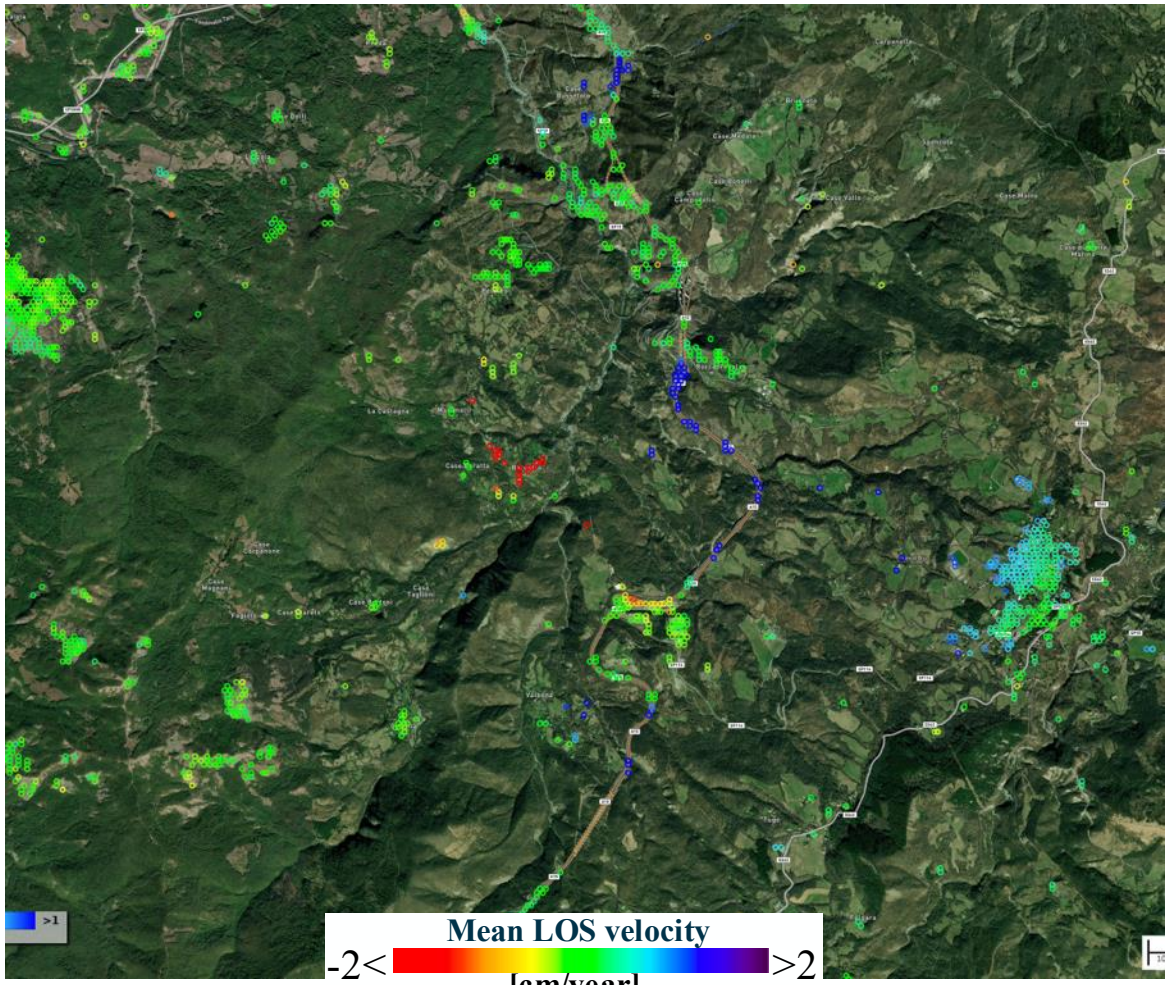
SAOCOM-1 P-SBAS results: ground coverage improvement

Comparison with Sentinel-1: the Berceto (Northern Italy) landslide

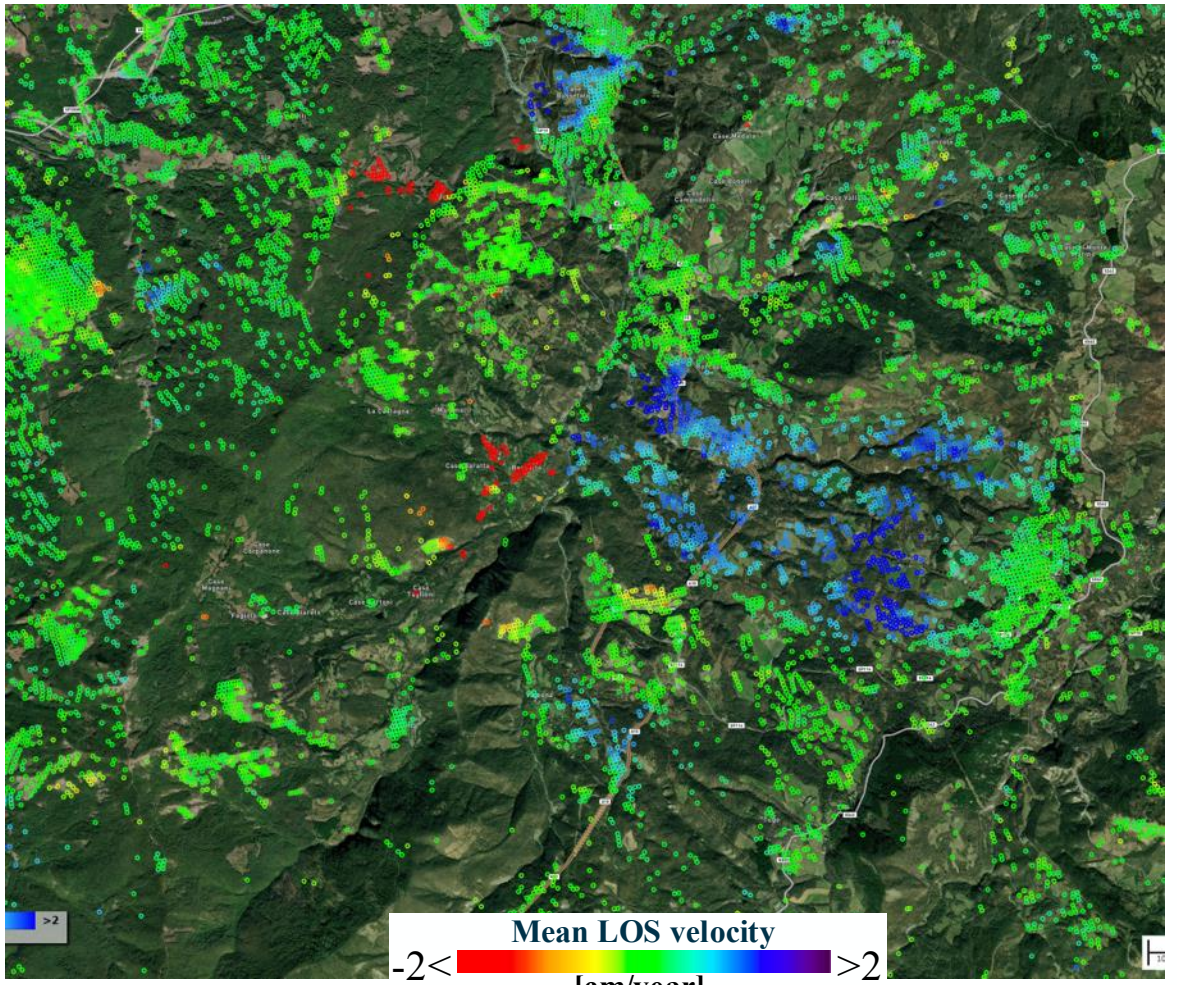


SAOCOM-1 P-SBAS results: ground coverage improvement

Sentinel-1 P-SBAS analysis

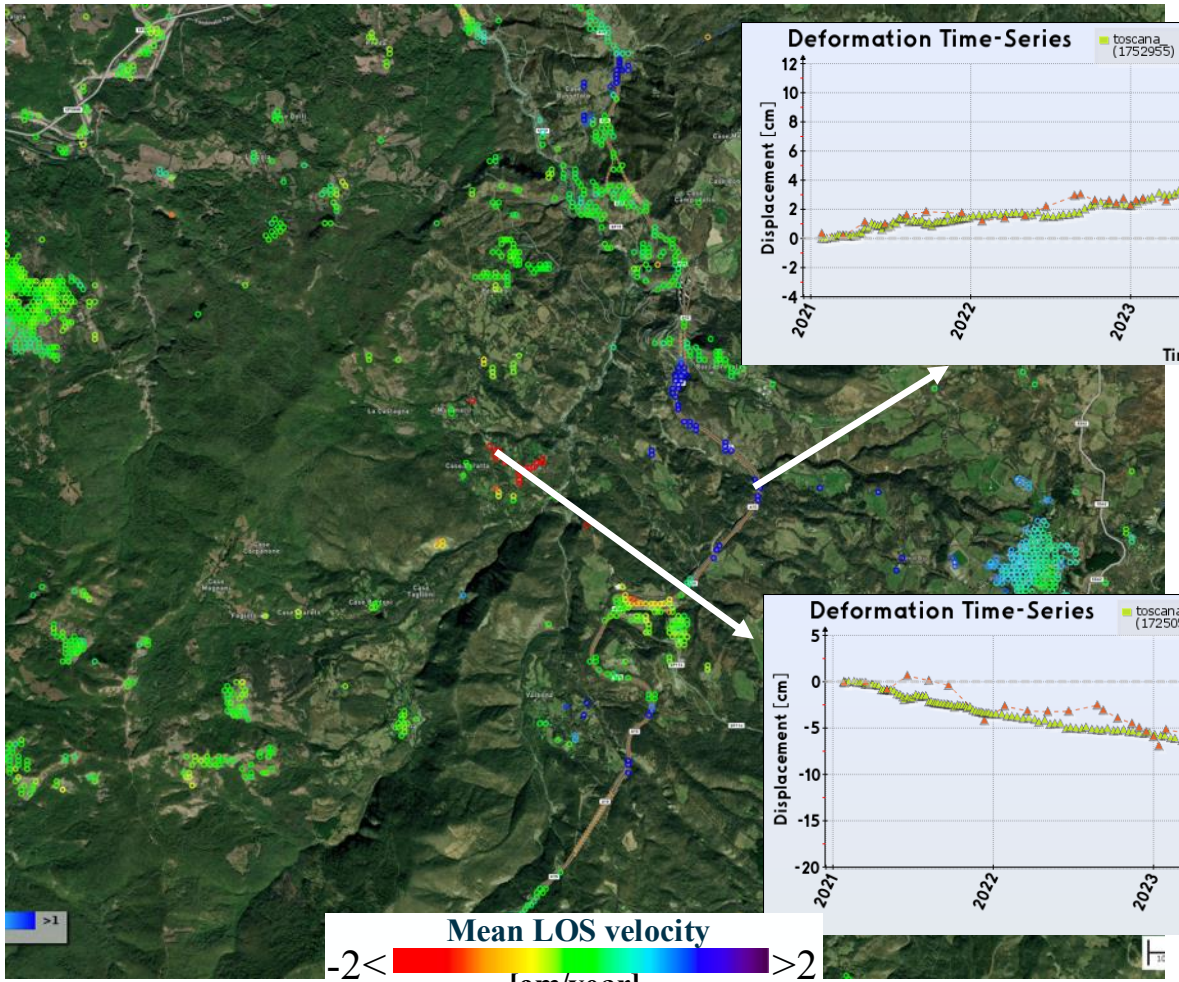


SAOCOM-1 P-SBAS analysis

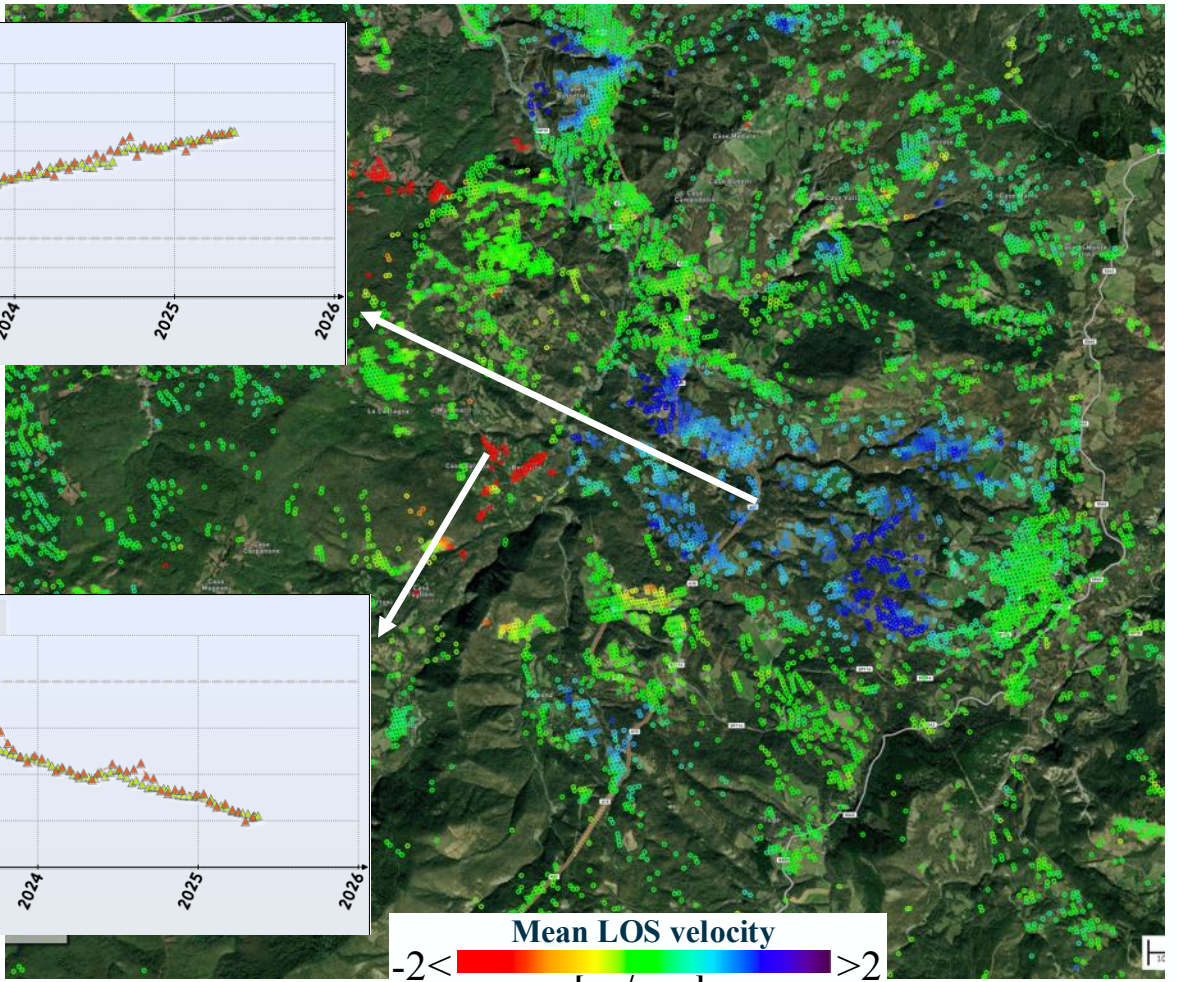


SAOCOM-1 P-SBAS results: ground coverage improvement

Sentinel-1 P-SBAS analysis



SAOCOM-1 P-SBAS analysis



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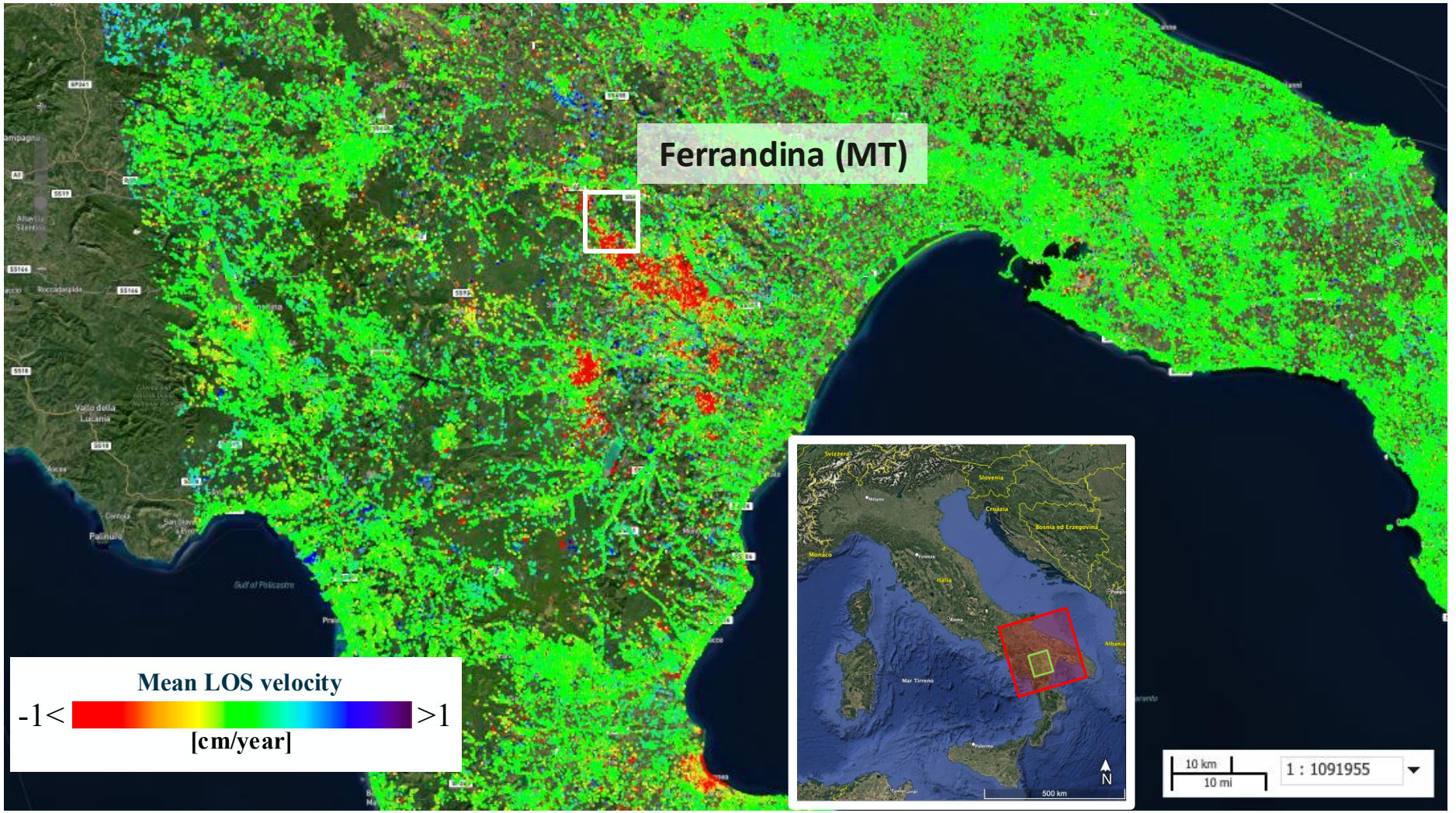
SAOCOM-1 P-SBAS results: ground coverage improvement

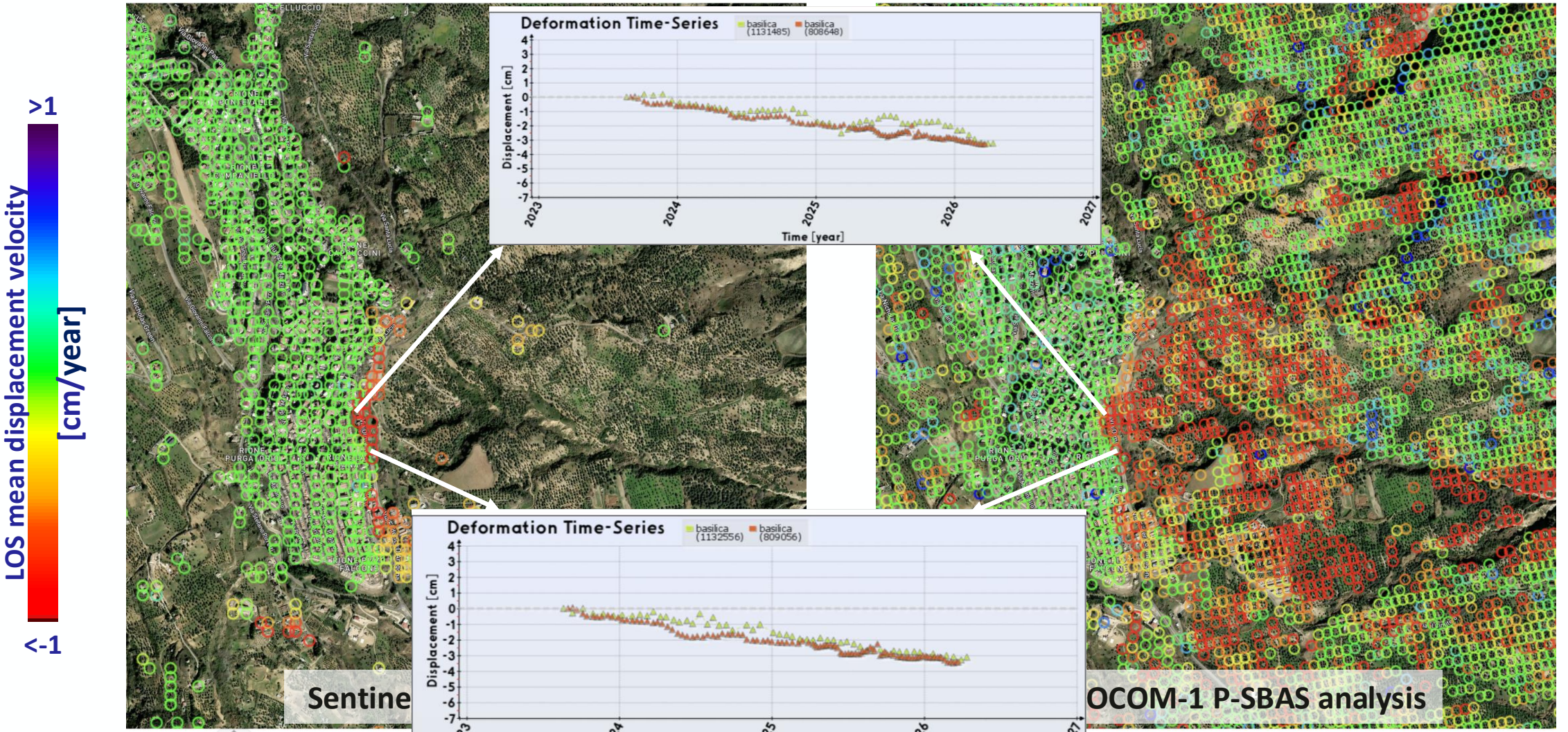
Comparison with Sentinel-1: the Ferrandina (Southern Italy) landslide



SAOCOM-1 P-SBAS results: ground coverage improvement

Sentinel-1 P-SBAS analysis

SAOCOM-1 P-SBAS analysis



Conclusions and further developments

- The implemented ***multi-temporal noise filtering solution*** allows achieving the consistency of the generated Small Baseline multilook interferograms, without bias effects in the retrieved SAOCOM-1 P-SBAS results, by exploiting a triangulation distribution of the data pairs.

- The performance analysis shows **high accuracy of the SAOCOM-1 P-SBAS time series** across various hazard scenarios, thereby demonstrating the suitability of L-band systems for operational DInSAR monitoring.

- The rather long wavelength of the L-band SAR data ensures **significantly enhanced temporal coherence over challenging scenarios**, such as vegetated areas and landslide-prone areas, **and remarkable mitigation of PhU errors,** which highly **increase the ground coverage.**


Thank you