



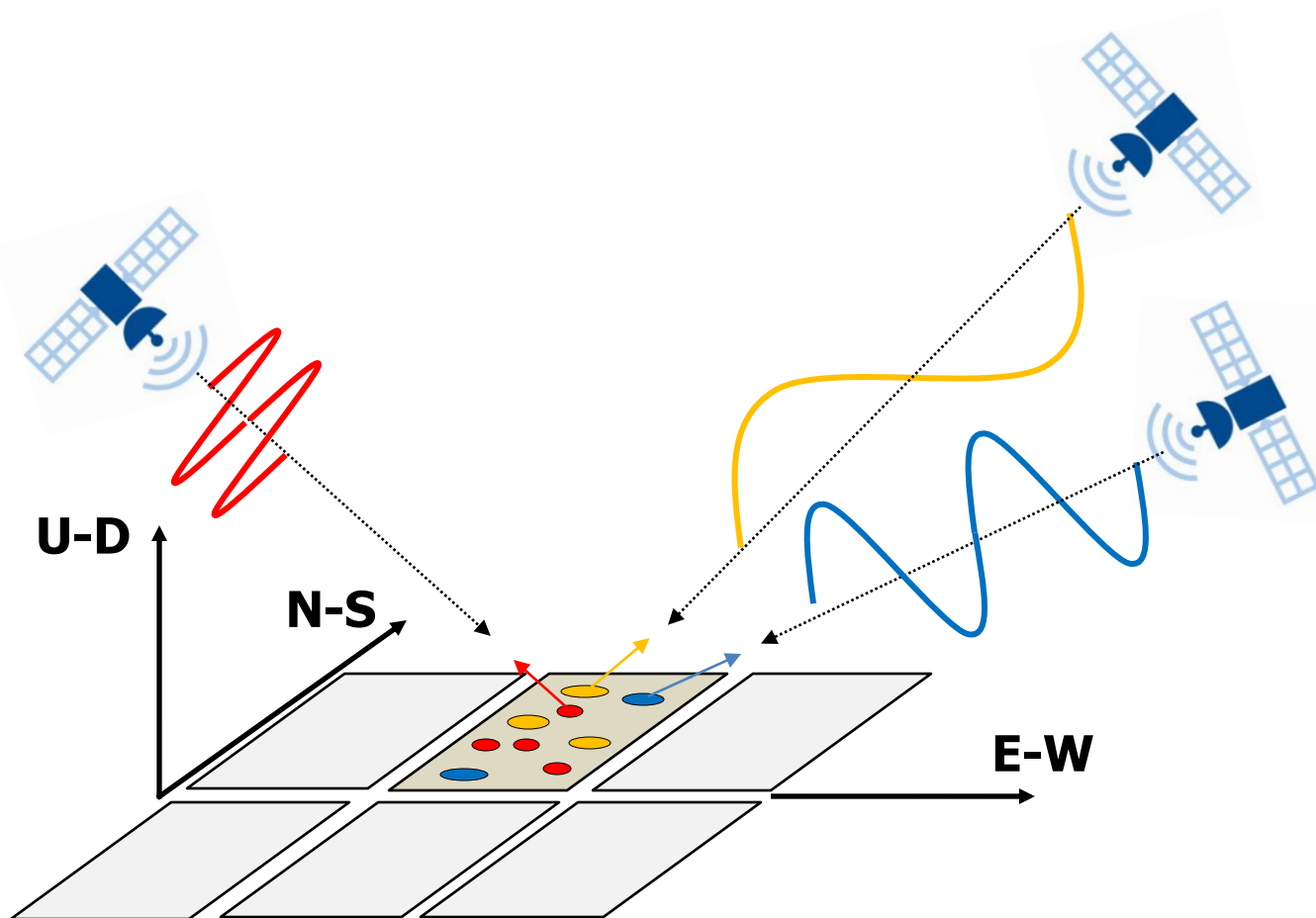
TRE
ALTAMIRA
A CLS Group Company

Opportunities in merging multi-Mission InSAR measurements

Alessandro Parizzi, Anton Filatov, Roberto Montalti, Alfio Fumagalli, Alessio Rucci

ESA FRINGE Workshop
Krakow, 15th June 2026

General Purpose of multi-mission merging



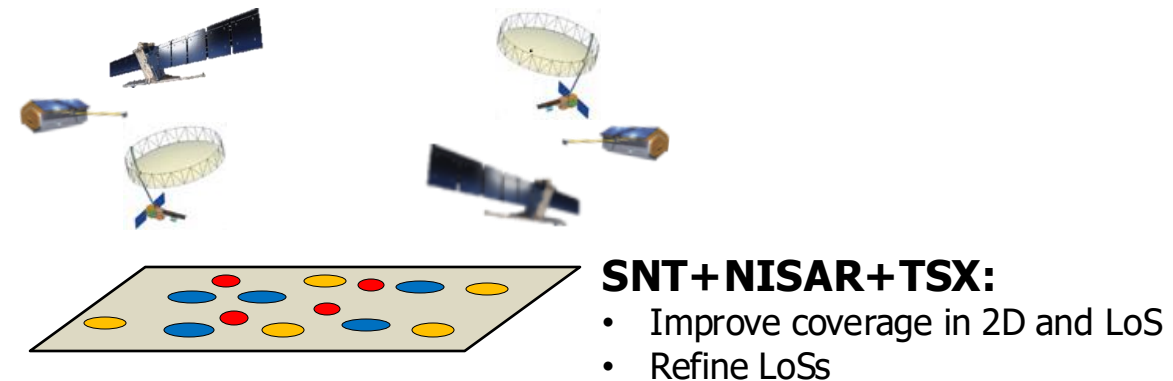
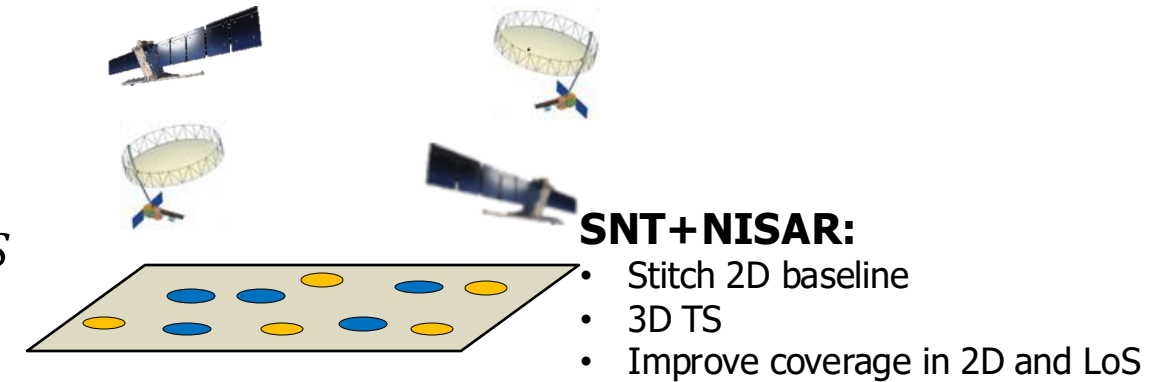
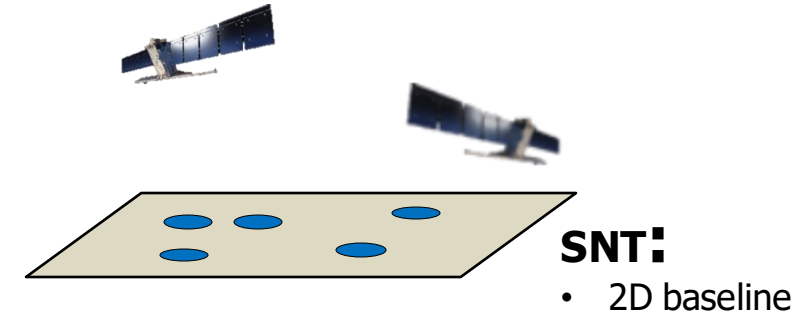
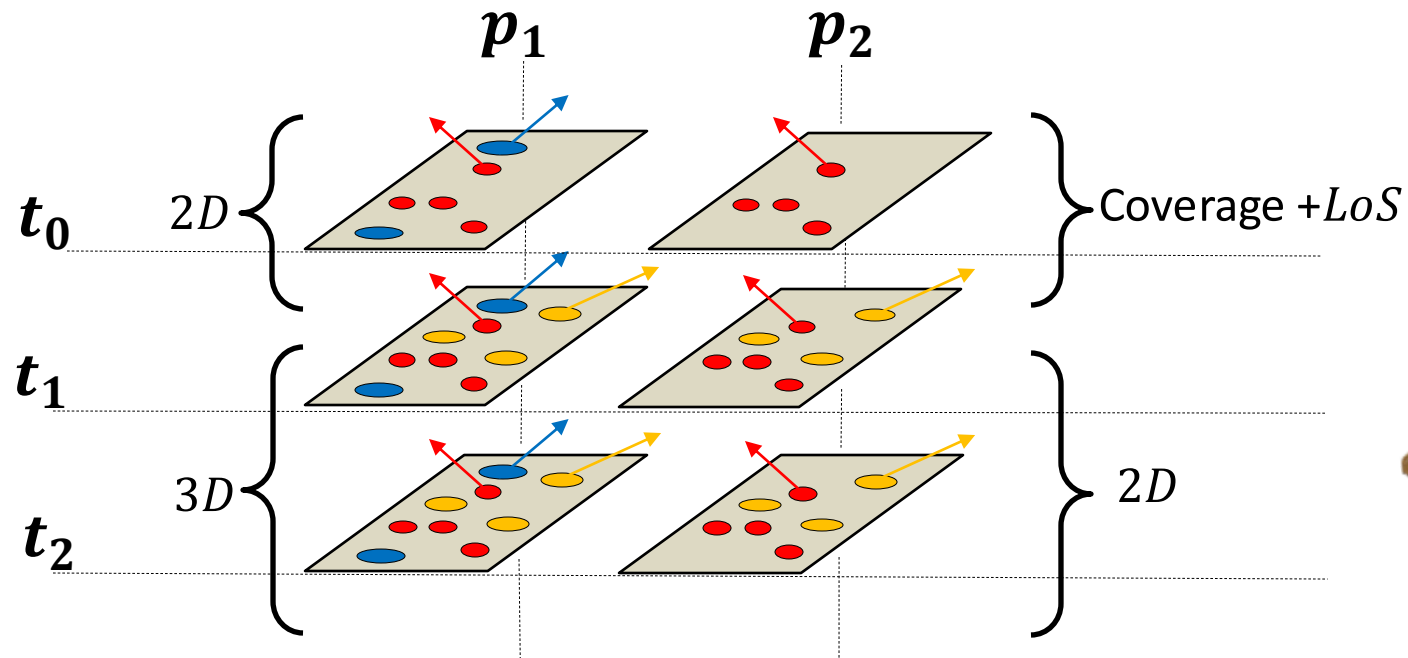
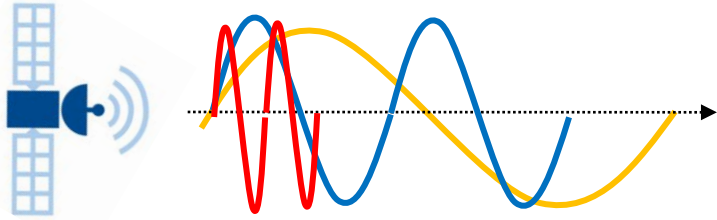
ABSTRACT: combine the InSAR measurements coming from different missions/sensors having diverse:

- wavelengths
- resolutions (MP density)
- geometry (A/D pass, look direction)
- revisit pass

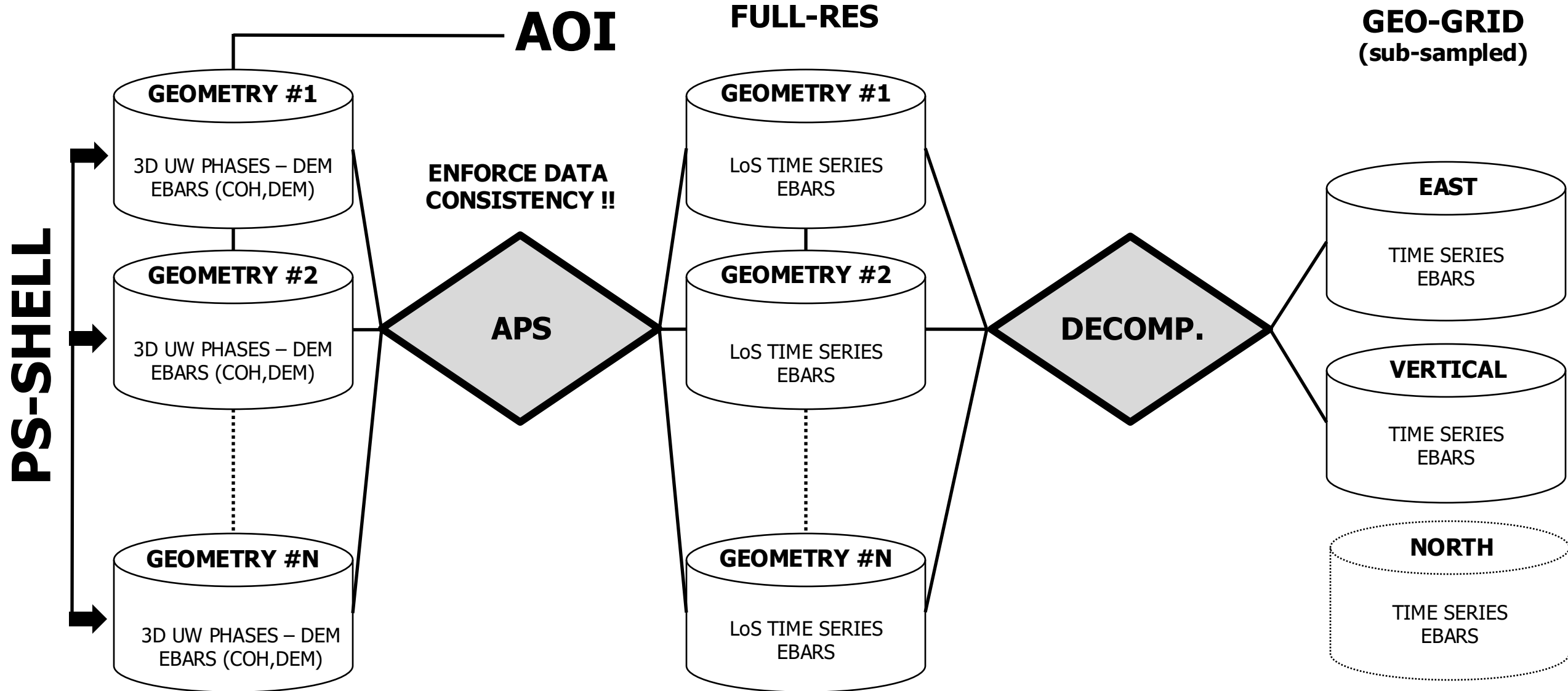
to obtain an optimal merged deformation product no longer related to mission design parameters including as much information as possible.

Relevant for the free data policy missions that can be used as baseline and eventually enhanced with other data.

Information Merging: enhancing coverage

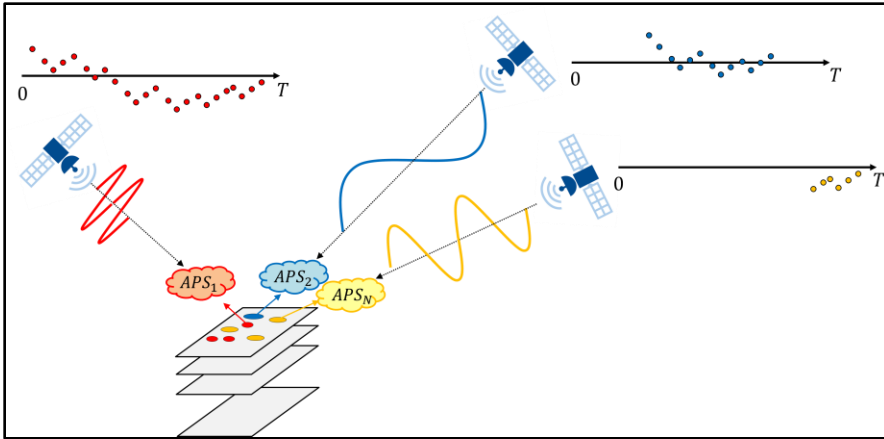


Information Merging: improve APS filtering

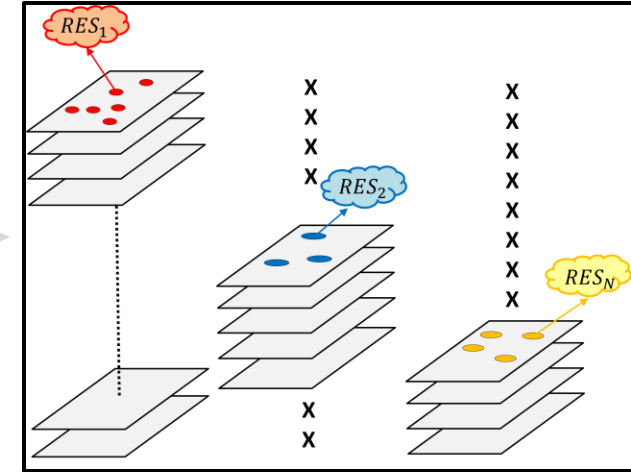


We measure ground and structural movement from space

Information Merging: improve APS filtering



2/3D MODEL



☐ More robust model estimation

- Quantity/quality of data
- Length of the temporal support

☐ APS filtered Phases of the different geometries are no longer uncorrelated

SPATIAL FILTER

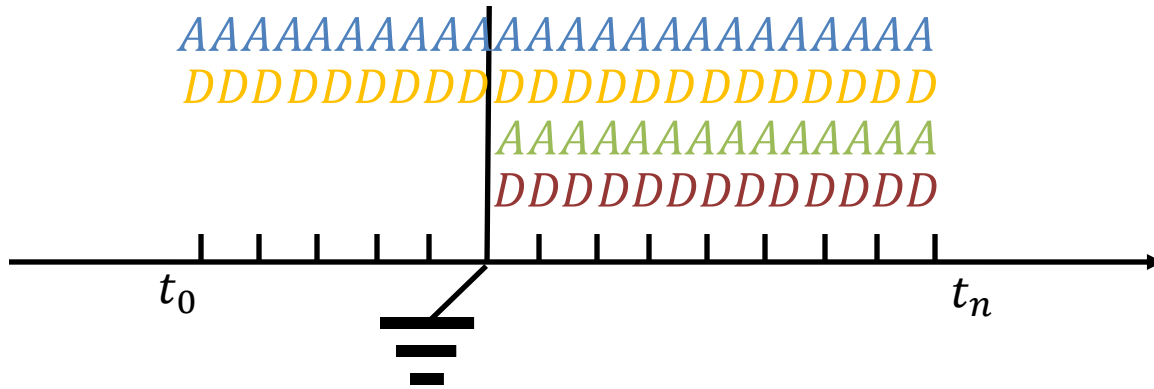
FEASIBILITY STUDY

WHAT DO WE EXPECT FROM THE JOINT APS FILTERING?

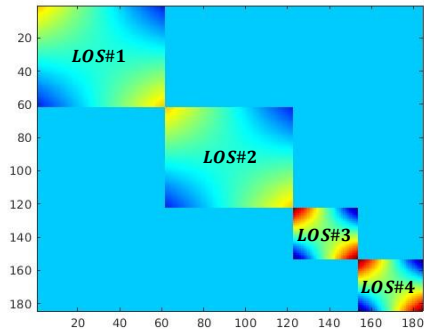
- Clear impact for large areas
- Limited impact for small areas

7

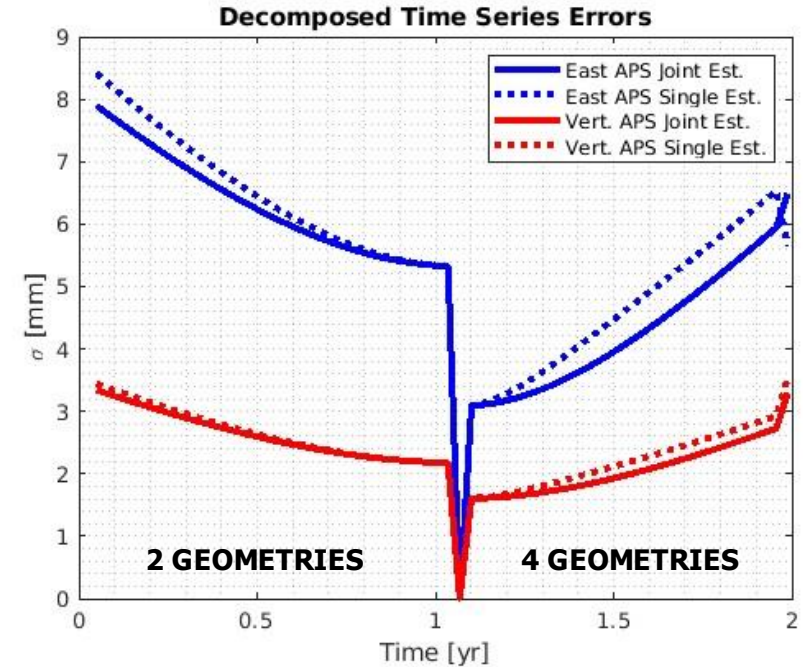
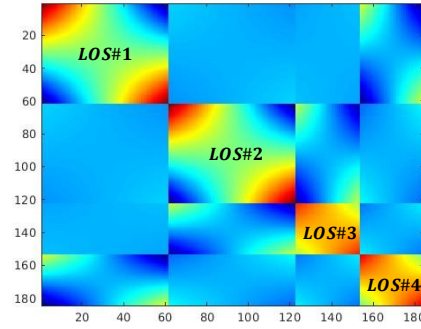
2D Decomposition Accuracy: temporal overlap 50 %



**INDEPENDENT APS EST.
UNCORRELATED LoSs**



**JOINT APS EST.
CORRELATED LoSs**

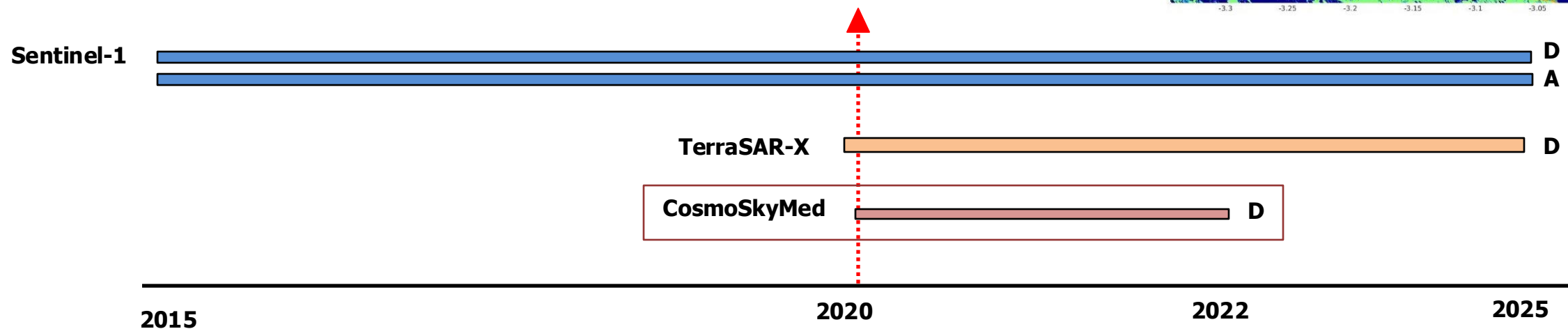
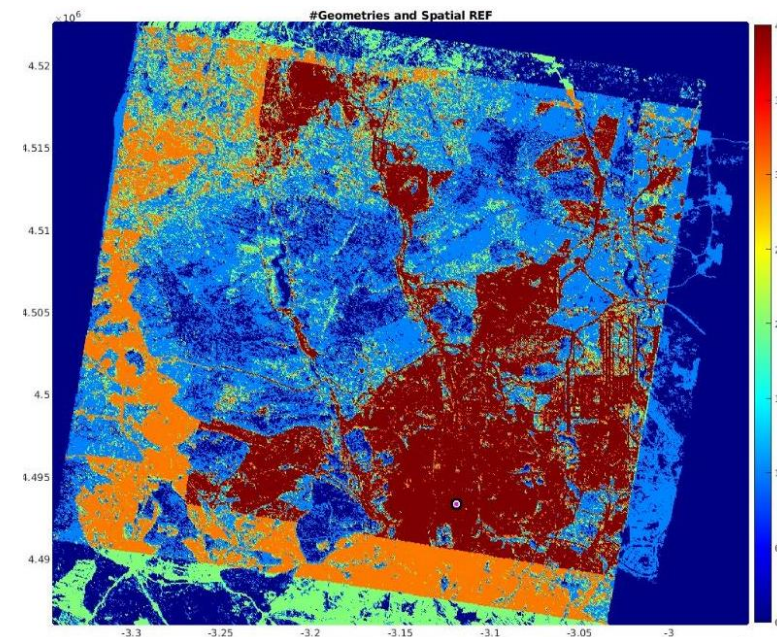


- Clear impact of geometries combination
- Limited impact of joint APS estimation

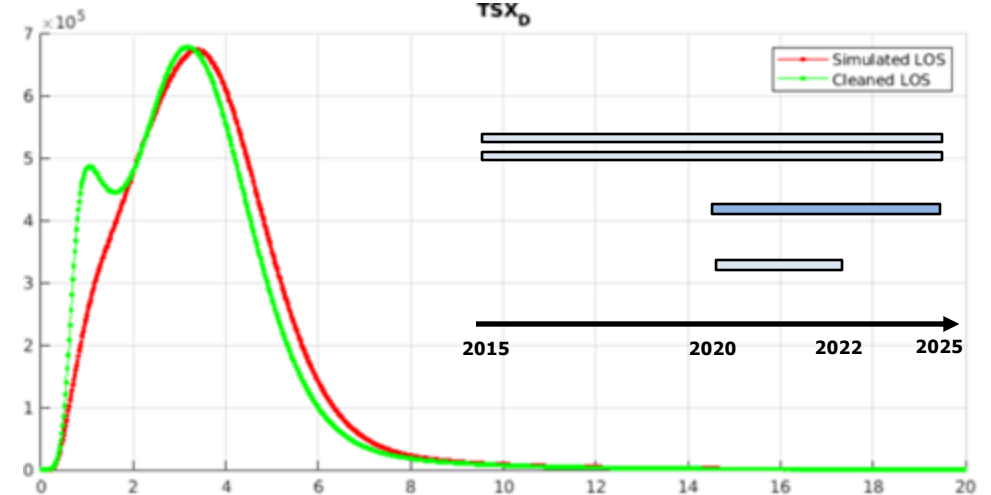
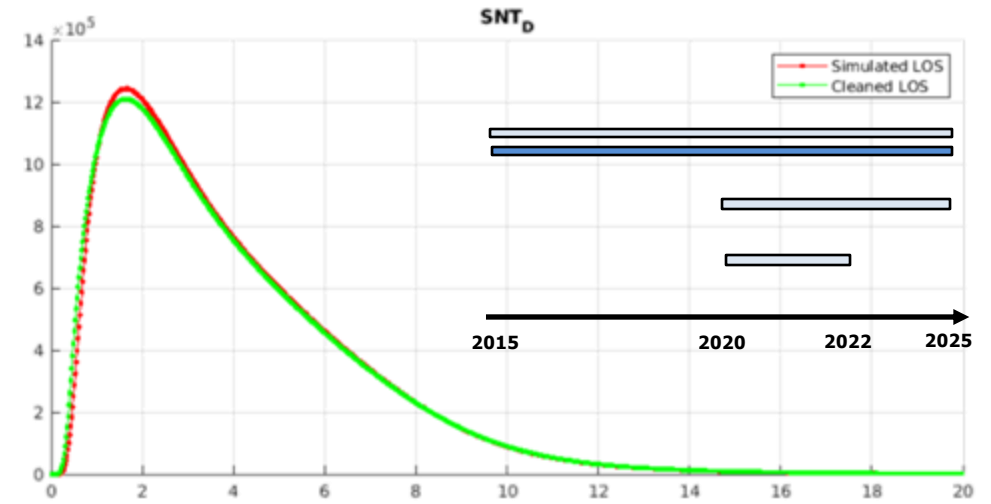
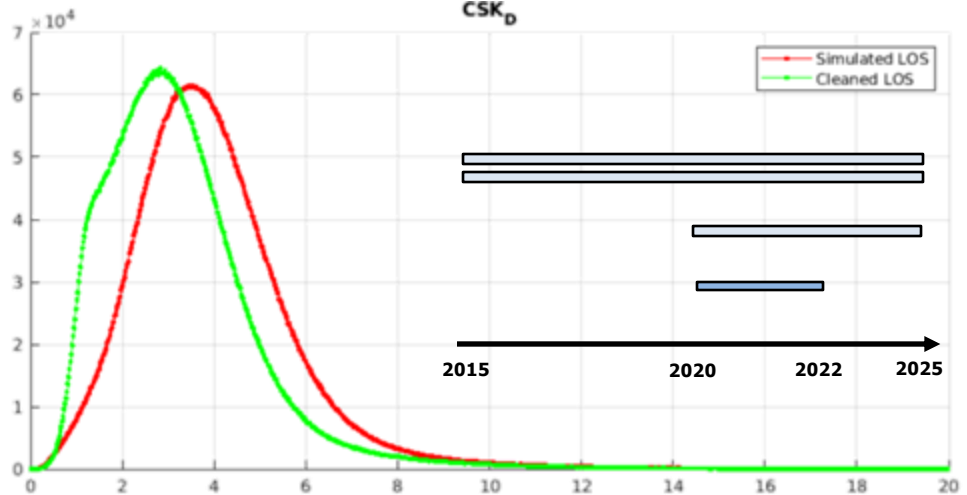
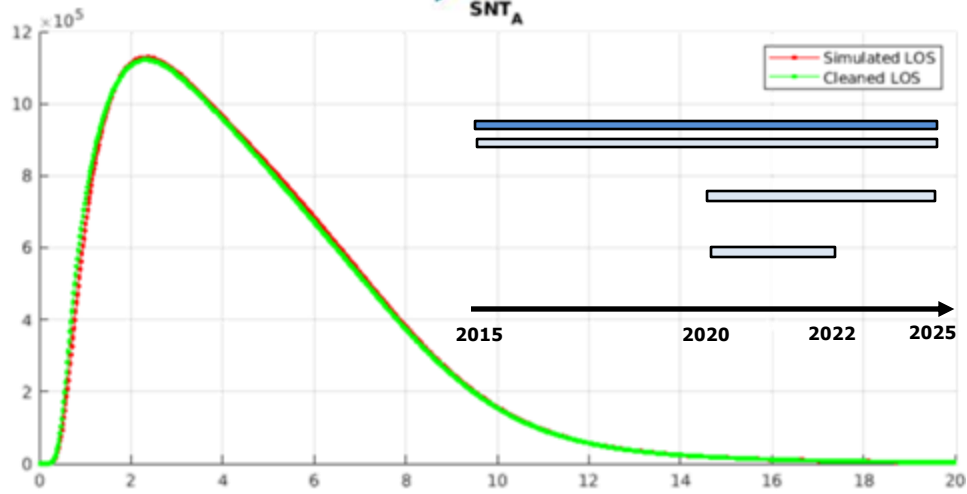
WORKFLOW VERIFICATION

Datasets: Spatio-Temporal Coverage

SENSOR	PASS	θ_{inc}	δ_{head}	N_{imag}	START	END
Sentinel-1	ASCE	39	9.6	464	02/02/2015	16/05/2025
Sentinel-1	DESCE	42	-10.2	488	08/02/2015	12/11/2025
TerraSAR-X	DESCE	42	-9.9	121	10/03/2020	13/05/2025
Cosmo-SkyMed	DESCE	32	-11	28	19/10/2020	21/07/2022

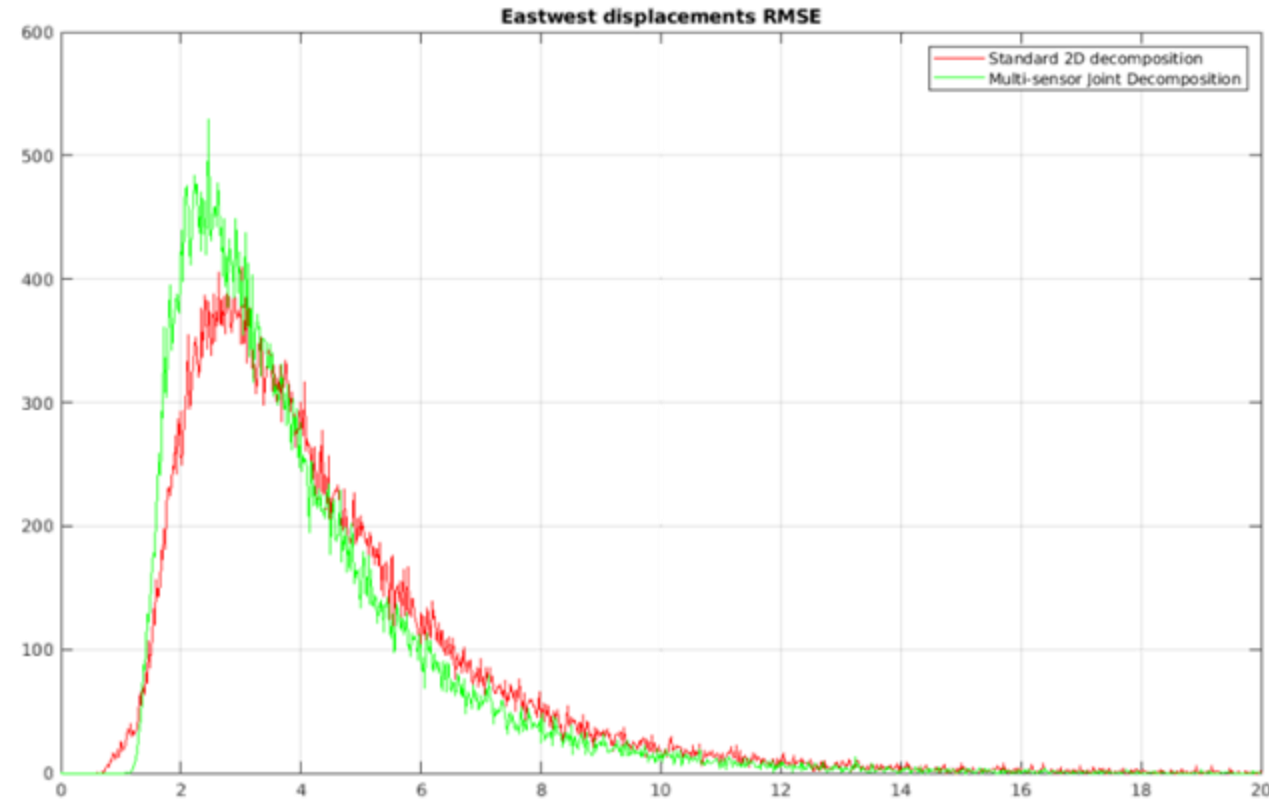
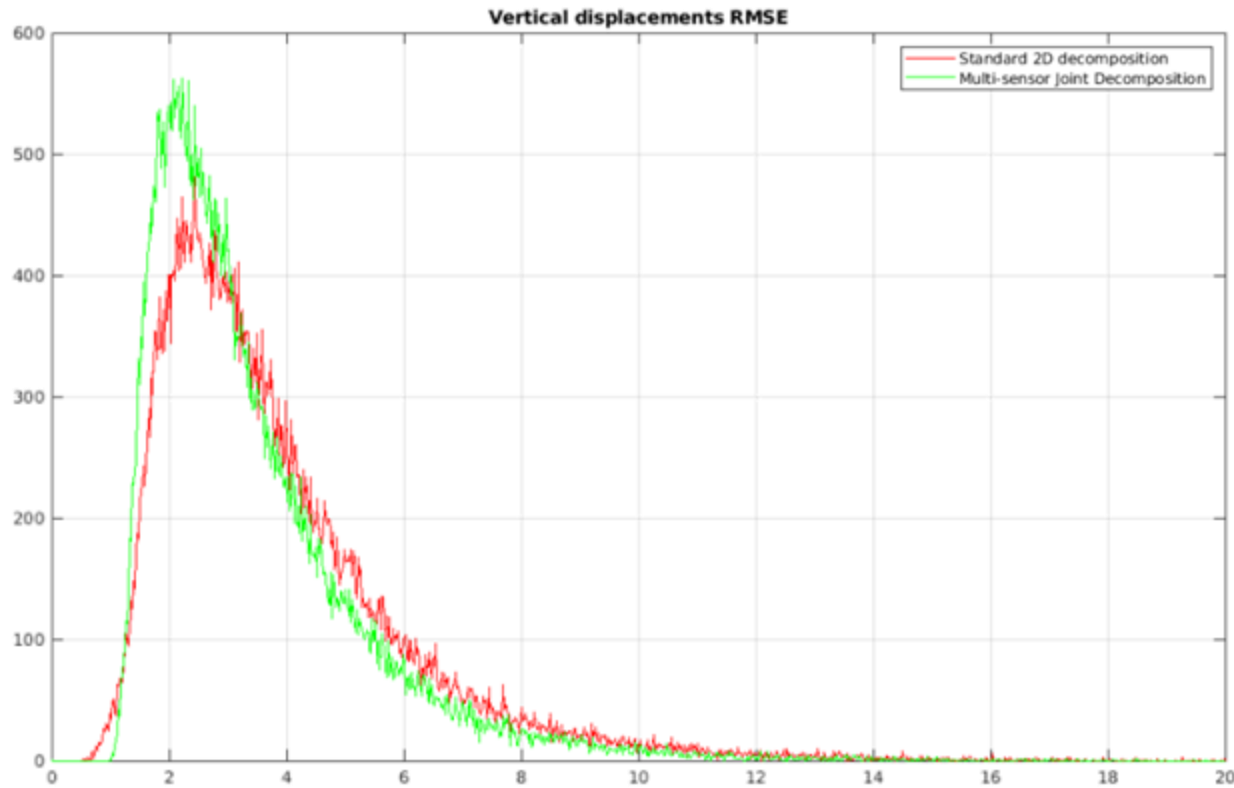


Multi-Sensor combination - Joint Aps Estimation



Comparison of RMSE estimated for every point between the initial simulated noise and processed with the Joint APS estimation block of CBI. CSD_D and TSX_D histograms show significant improvement with respect to single LOS APS compensation.

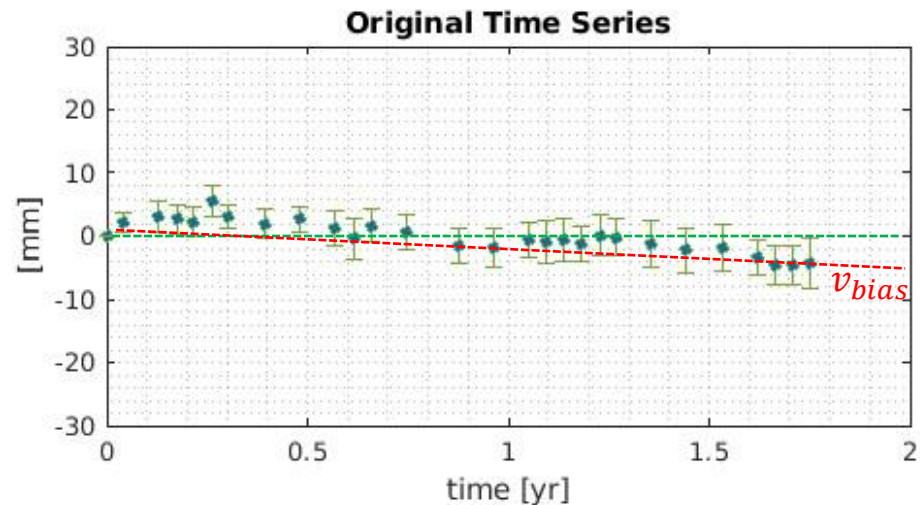
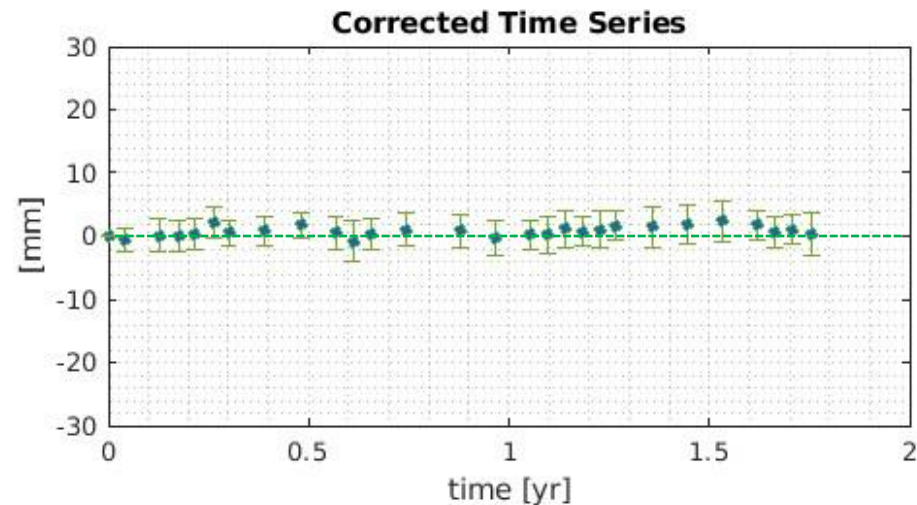
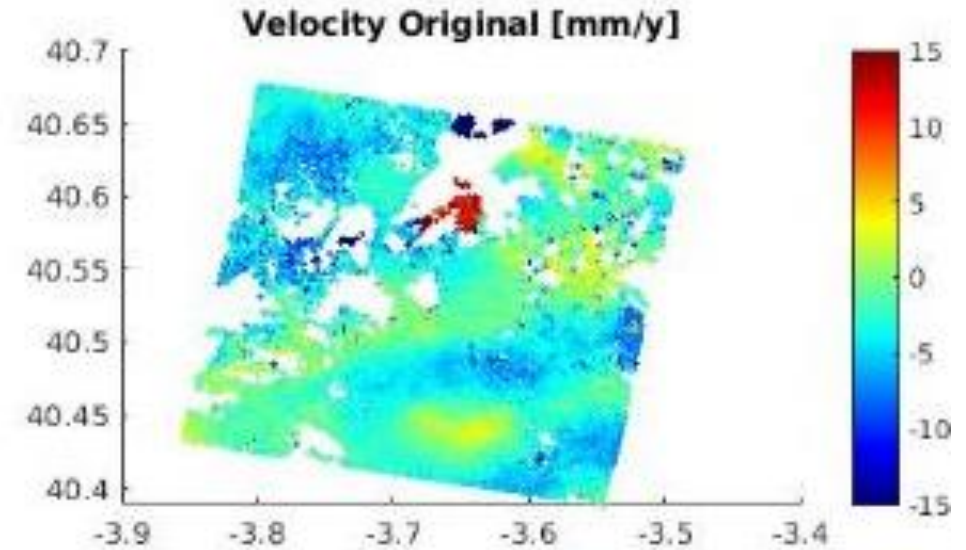
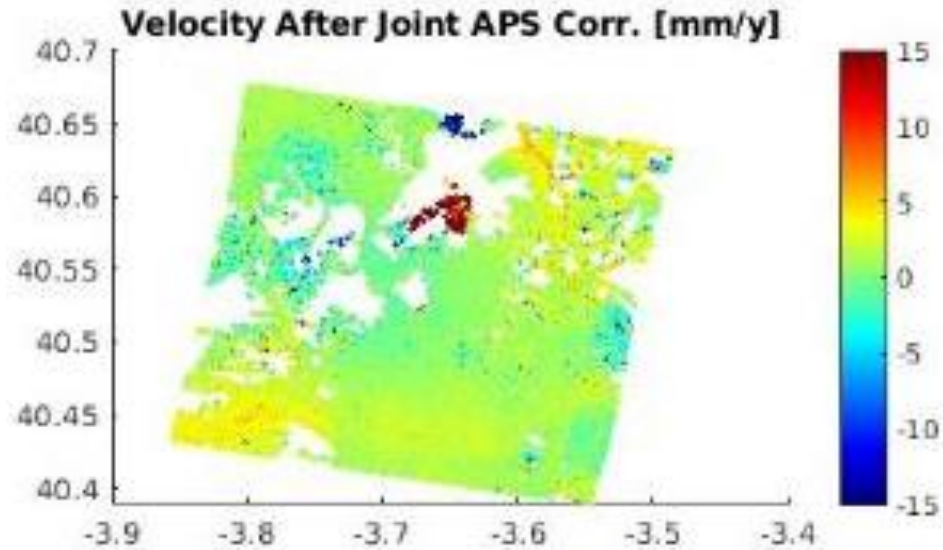
Multi-Sensor combination - Joint Decomposition Estimation



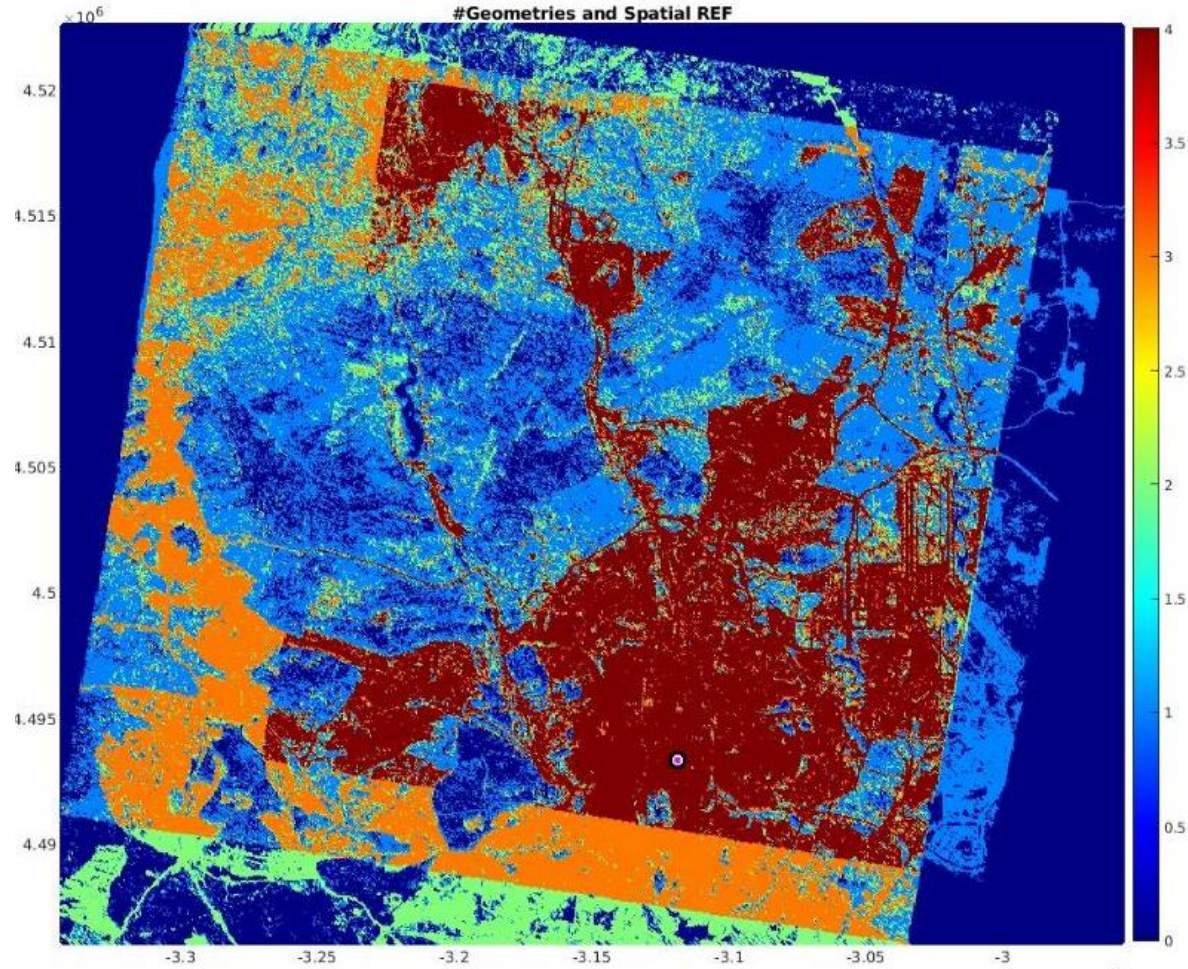
Comparison of RMSE estimated for every point between the standard 2D decomposition (red line) and the multi-sensor joint decomposition of CBI (green line).

REAL DATA RESULTS

Improvements of the systematic error in velocity field



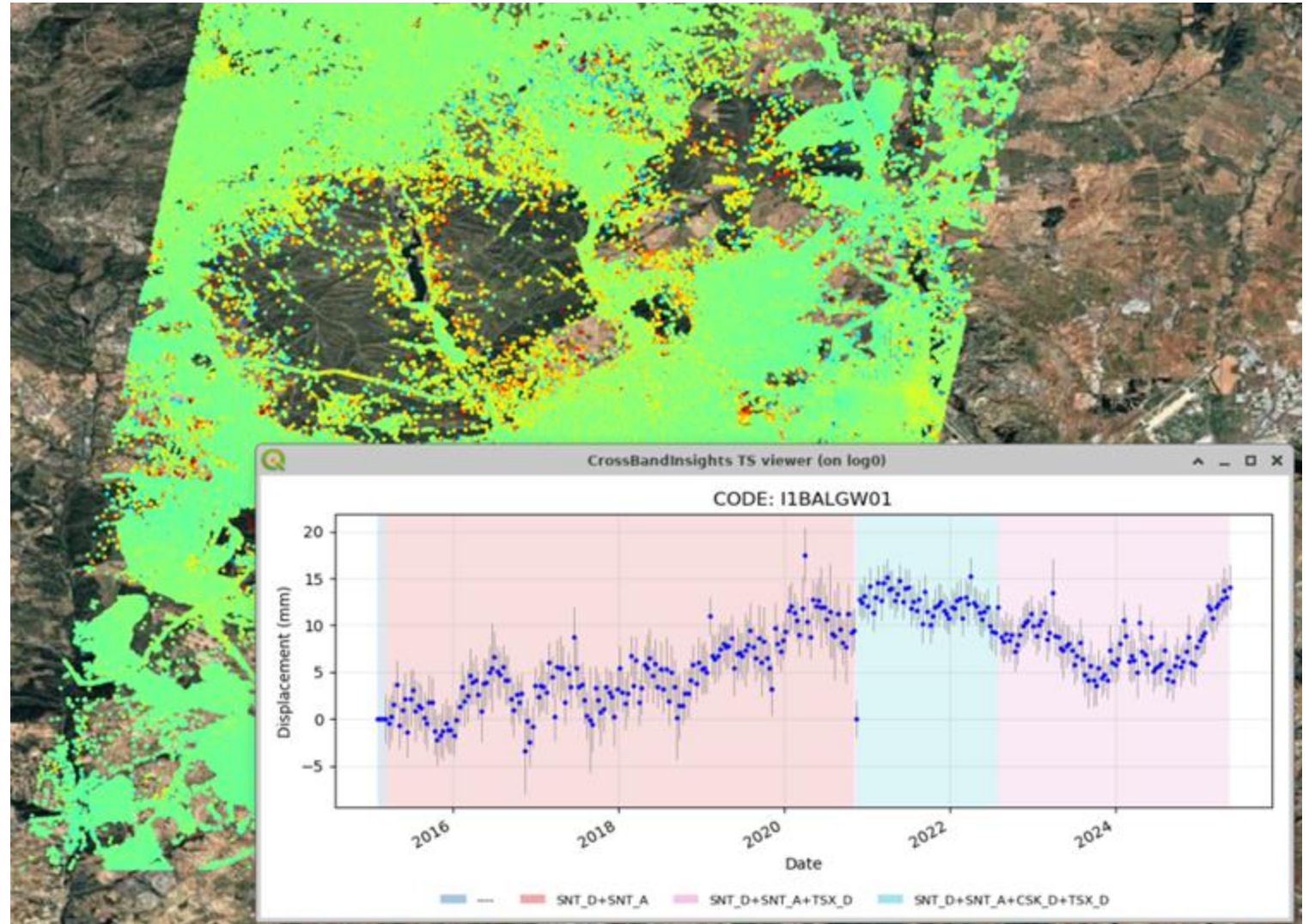
Spatio-Temporal Coverage maximization



We measure ground and structural movement from space

Multi Mission 2D Decomposition: tracking sensors

Cross Band Insights decomposition product allows to track satellite type for every point and date depending on the temporal coverage of the observation period by input LOS data.



Conclusions

- ❑ It is possible to implement a conjunct post-processing approach for the InSAR time series that allows to:
 - enhance the spatial temporal coverage of the TS
 - can be handled by the users independently from the data used

- ❑ The performance improvement related to the joint APS estimation in post-processing
 - Improves the single LoS performance:
 - Large areas and MPs distant from the REF → relevant improvement
 - Small areas and MPs close to the REF → limited improvement

 - Marginal improvements on the 2D combination

- ❑ Joint Phase Unwrapping (or unwrapping mutual correction) shall be investigated

MILAN

Ripa di Porta Ticinese, 79
20143 Milano - ITALY
Tel: +39 02 4343 121

BARCELONA

Carrer de Còrsega, 381-387
08037 Barcelona - SPAIN
Tel: +34 93 183 57 50

VANCOUVER

Suite 410, 475 West Georgia Street
Vancouver, BC V6B 4M9 - CANADA
Tel: +1 604 331 2512

Contact us: sales@tre-altamira.com



Regional
offices

FRANCE

Parc Technologique du Canal
11, Rue Hermès
F-31520 Ramonville St Agne
Tel: +33 561 39 47 19

AUSTRALIA

U4 7 Toorak Rd, South Yarra
VIC 3141, Australia
Tel: +61 455 154552

BRAZIL

Av. Rio Branco, 311 sala
1205
Centro, Rio de Janeiro,
RJ, 20.040-009
Tel. +55 21 2532-5666

CHILE

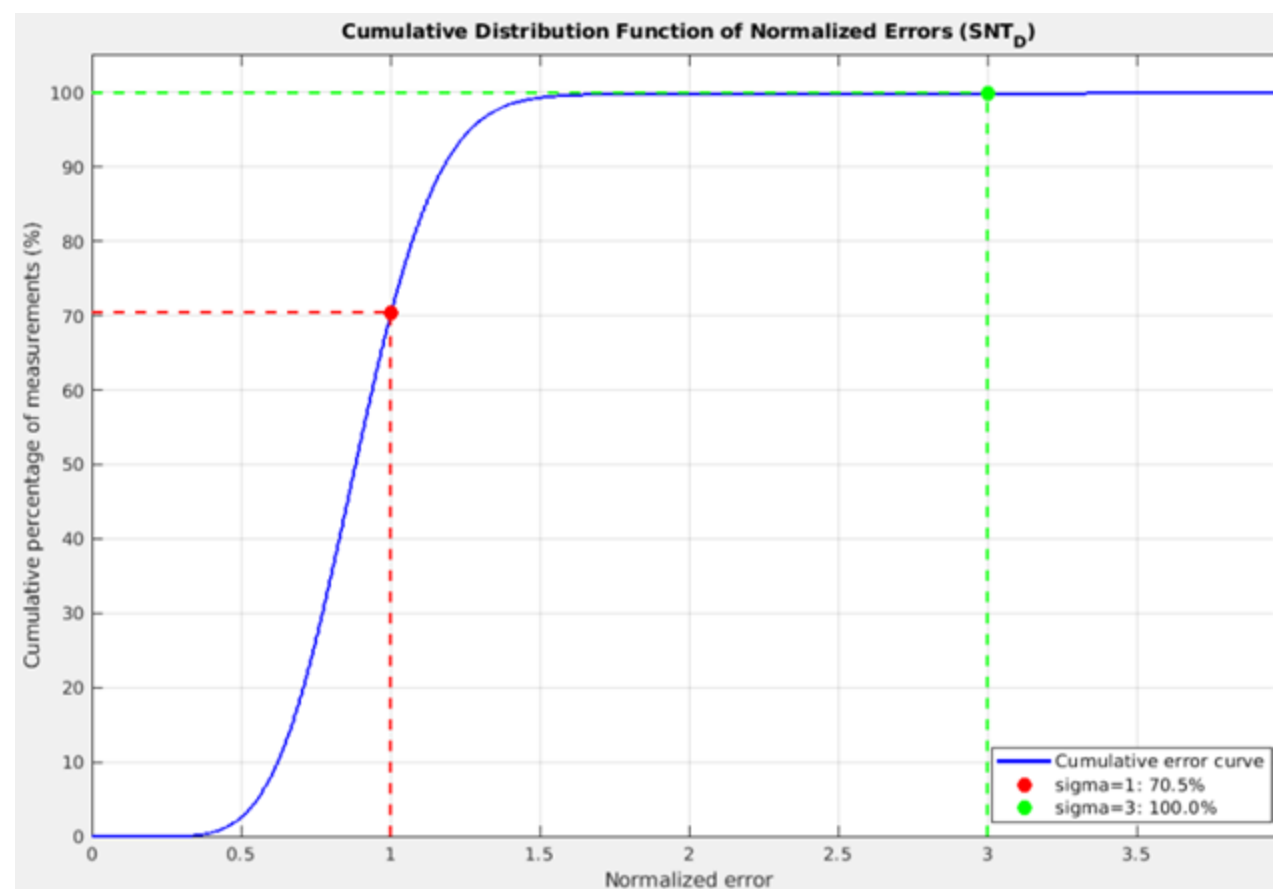
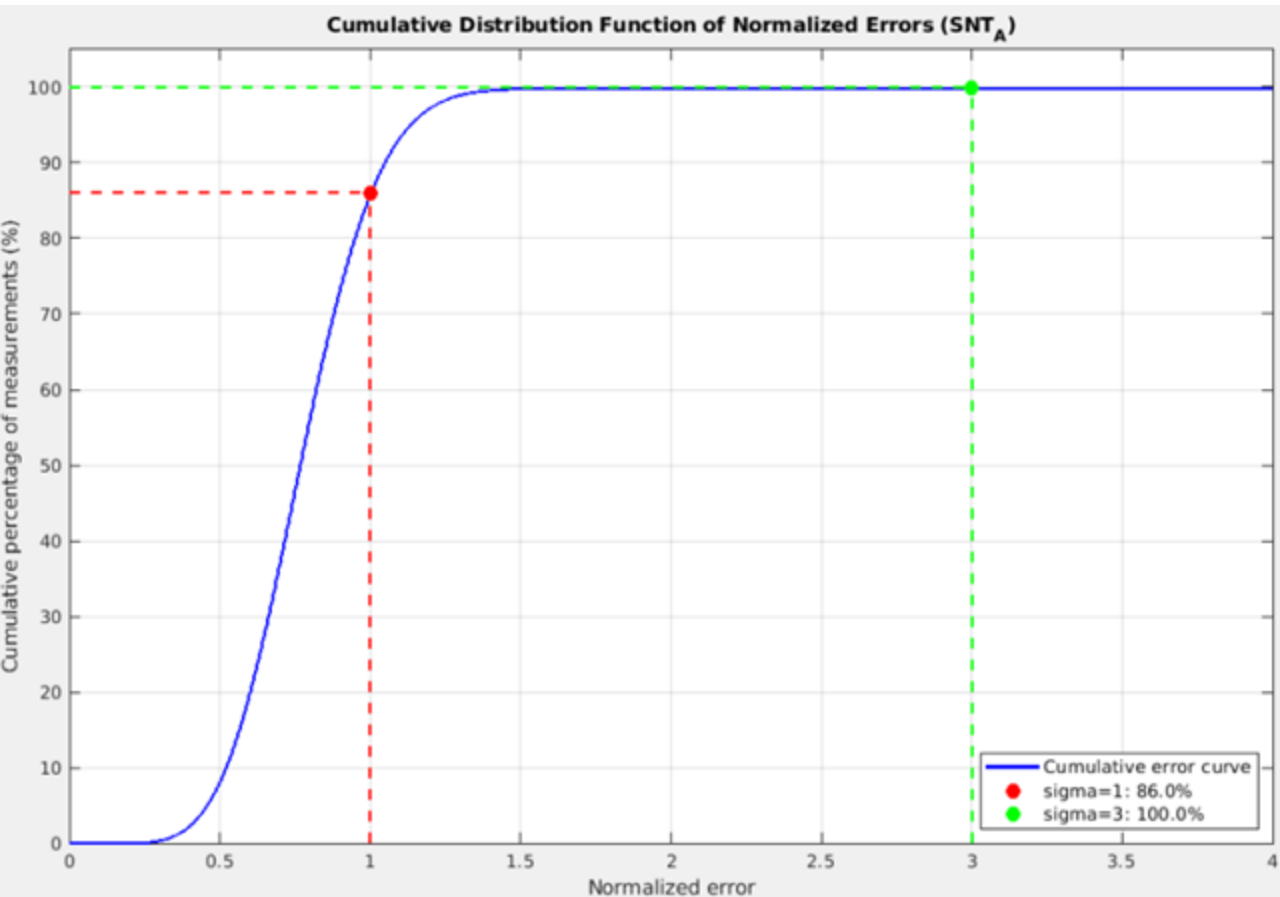
Almirante Señoret
70, Oficina 74
Valparaíso
Tel +56 32 2252843

PERU

Av. Angamos Oeste 537
Miraflores, Lima
Tel: +51 1 4402717

SOUTH AFRICA

B3 Millside Park, Morningside Road
Ndabeni, 7405, Cape Town
Tel: +27 21 705-0819



Error-bars are estimated for all refined LOS results and describe the uncertainty of measurements. Histograms show the percentage of measurements depending on normalized deviation from modeled LOS displacements performed using joint APS estimation. Sentinel LOS layers.