PALSAR-2 - PALSAR-3 cross-interferometry

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Gamma Remote Sensing

- Swiss company founded in 1995
- Focus on microwave remote sensing
- Main activities:
  - Research projects
  - Gamma SAR/InSAR/PSI processing software
  - Microwave instruments
  - Services and consulting
- Significant experience with L-band SAR

Contents

- Reading and concatenating PALSAR-3 Stripmap SLC
- PALSAR-3 Stripmap – PALSAR-2 Stripmap DInSAR
- PALSAR-3 Stripmap – PALSAR-2 ScanSAR DInSAR
- PALSAR-3 ScanSAR – PALSAR-2 Stripmap DInSAR
- PALSAR-3 ScanSAR – PALSAR-2 ScanSAR DInSAR
- PALSAR-2/3 Persistent Scatterer Interferometry
- Remarks and recommendations

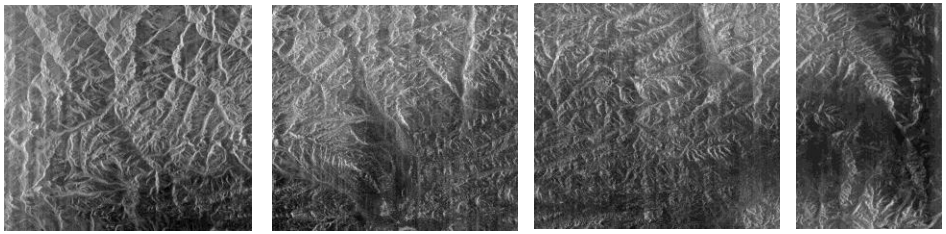
PALSAR-3 stripmap SLC

(with 28MHz bandwidth)

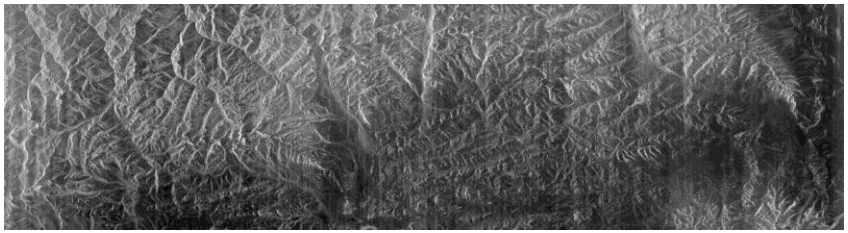
- SLC data is provided in multiple sub-beam sections
  - A consistent grid is used for the sub-beams
  - Data of the sub-beams slightly overlap in range direction

  → We read and concatenate the data to get one SLC

4 sub-beam SLCs



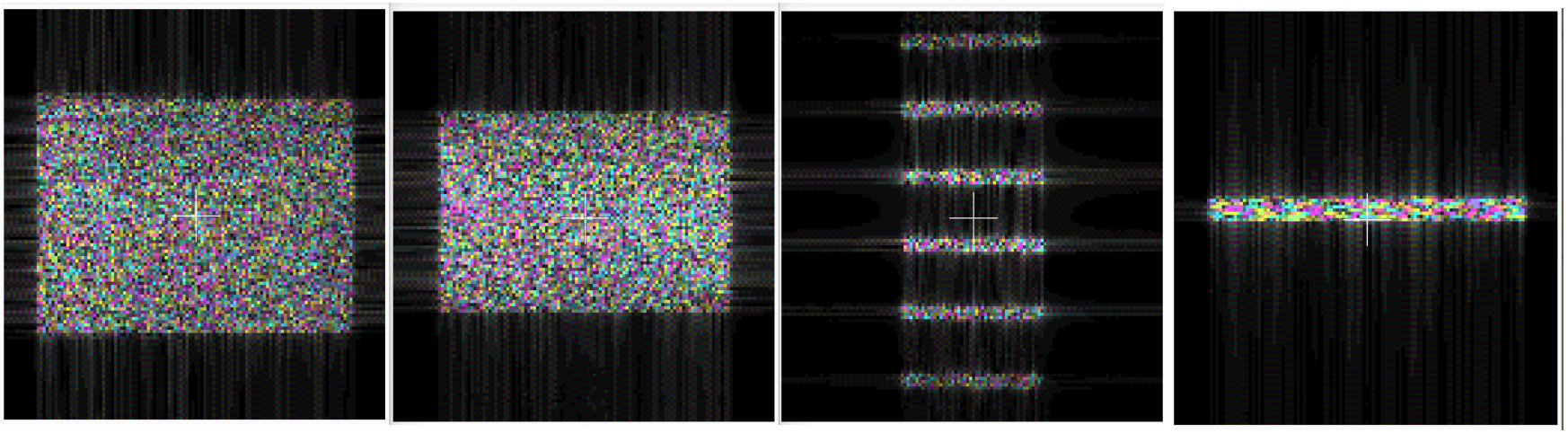
mosaic SLC



Cross-mode / cross-sensor DInSAR processing steps

1) Determine common range bandwidth and related center frequency
2) Center frequency shifting and bandpass filtering (as necessary)
3) Co-registration (considering different sampling grids, avoiding aliasing)
4) DInSAR

Stripmap – ScanSAR DInSAR



P3 Stripmap | P2 Stripmap | P2 ScanSAR | P3 ScanSAR

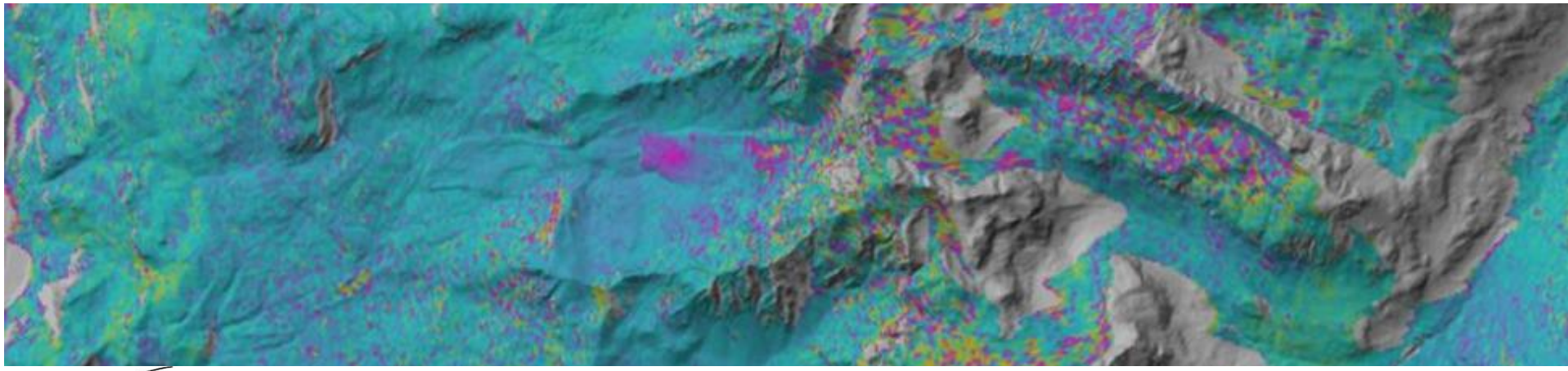
spatially variable

If ScanSAR data (P2 or P3) are involved the common band filtering needs to be done spatially adaptively.

PALSAR-2/3 DInSAR D095 over the Alps

Scene 1	Scene 2	dt	$B_\perp$
$P2_{ScanSAR}$ 20250626	$P3_{stripmap}$ 20250704	8 days	577m
$P2_{ScanSAR}$ 20250626	$P2_{stripmap}$ 20250710	14 days	451m
$P2_{ScanSAR}$ 20250626	$P2_{stripmap}$ 20250724	28 days	88m
$P3_{stripmap}$ 20250704	$P2_{stripmap}$ 20250710	6 days	-126 m
$P3_{stripmap}$ 20250704	$P2_{stripmap}$ 20250724	20 days	-188m
$P2_{stripmap}$ 20250710	$P2_{stripmap}$ 20250724	14 days	-63m

Short intervals → suited to study fast displacements



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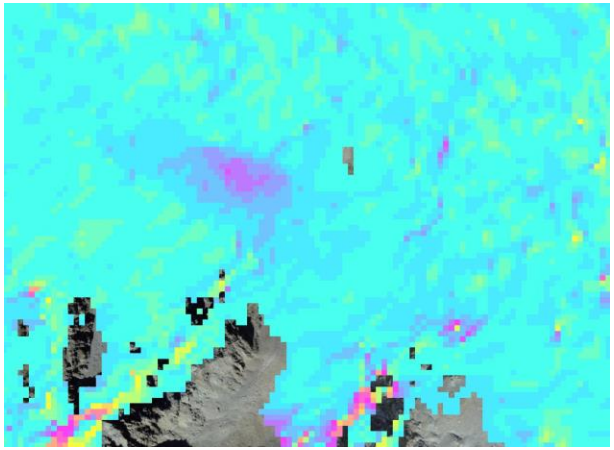
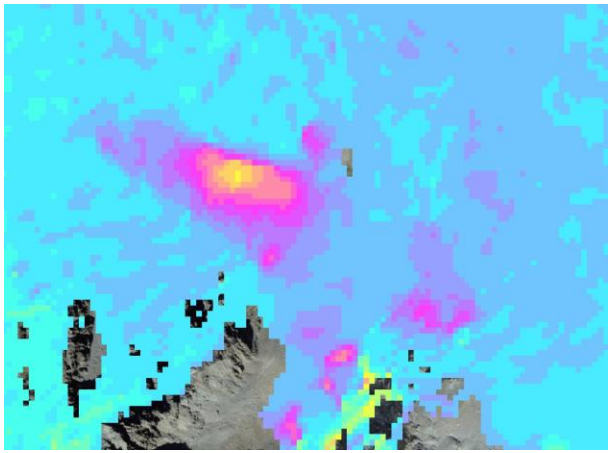
P3 - P2, 6 days, -126 m

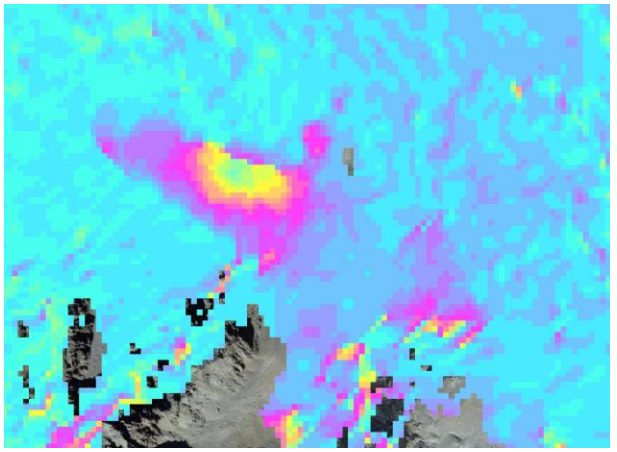
Muragl rock glacier: PALSAR-2/3 DInSAR



P3/P2 4.7.-10.7. 6d -126m

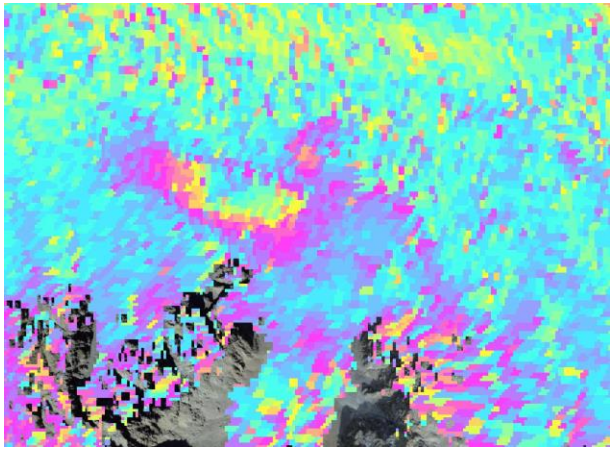


P2/P2 10.7.-24.7. 14d -63m

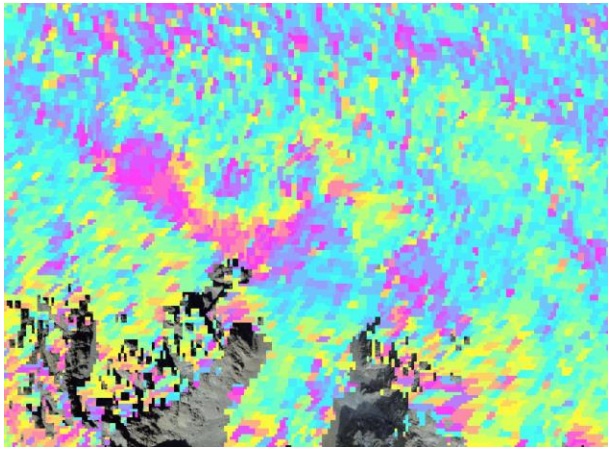


P3/P2 4.7.-24.7. 20d -126m

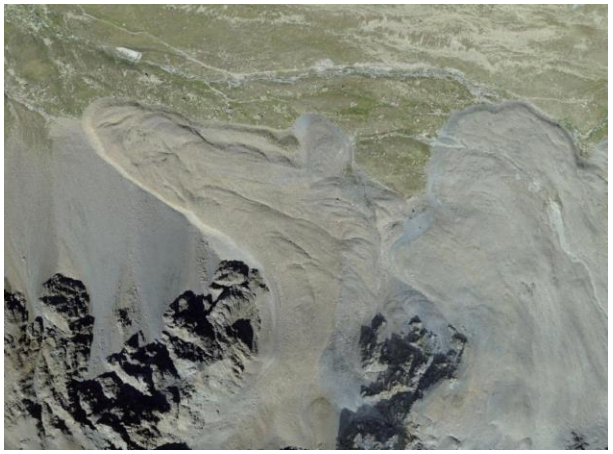
Muragl rock glacier: Sentinel-1 DInSAR



S1 9.7.-15.7. 6days



S1 15.7.-21.7. 6days



aerial photograph

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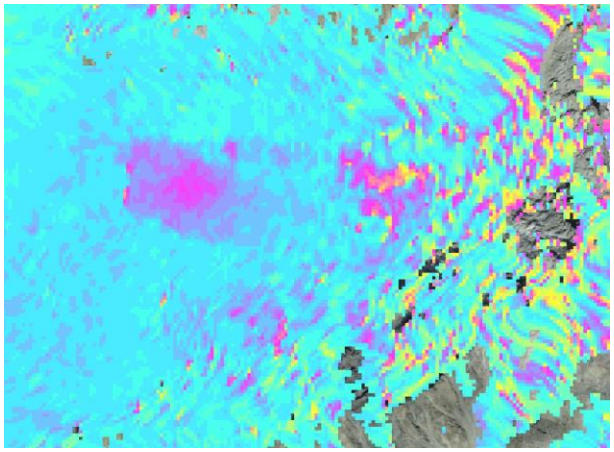
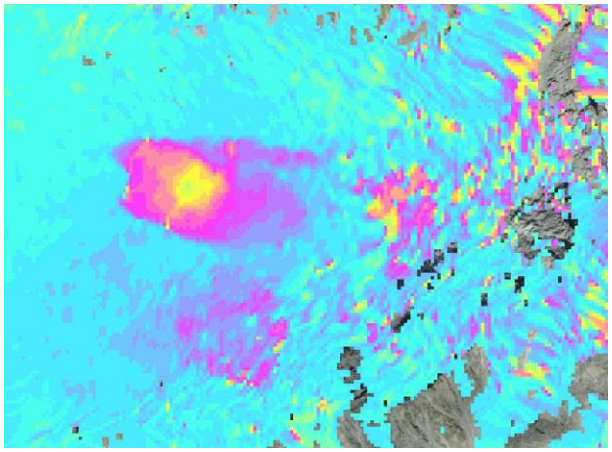
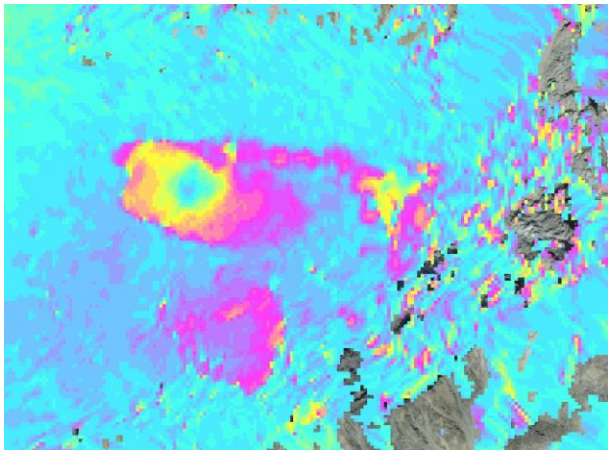
Tellers-Davains rock glacier: PALSAR-2/3 DInSAR



P3/P2 4.7.-10.7. 6d -126m

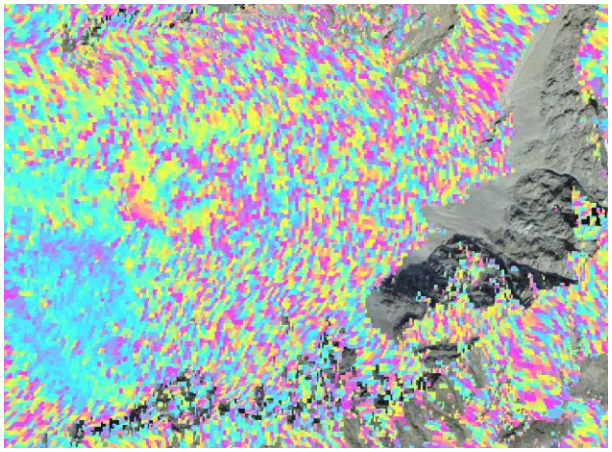


P2/P2 10.7.-24.7. 14d -63m

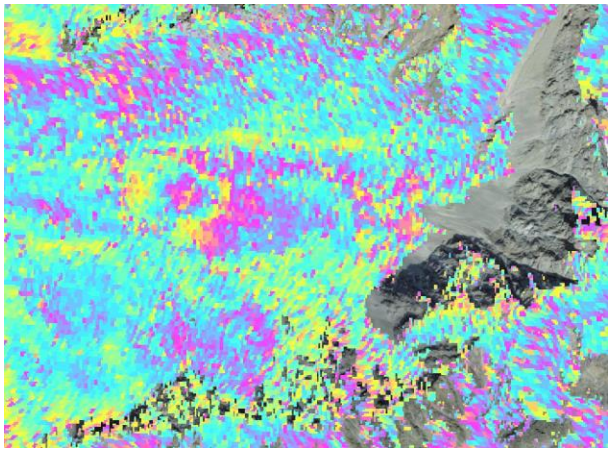


P3/P2 4.7.-24.7. 20d -126m

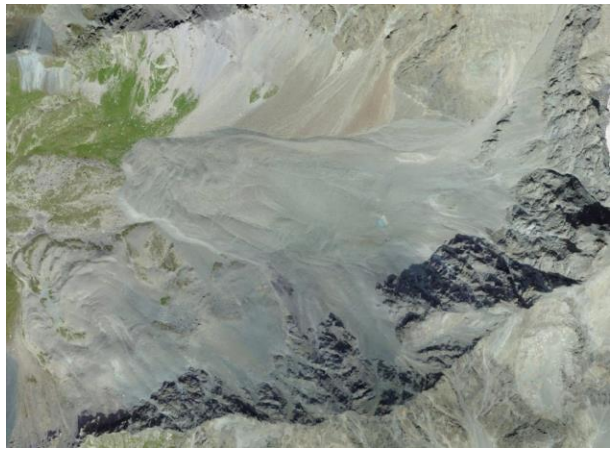
Tellers-Davains rock glacier: Sentinel-1 DInSAR



S1 9.7.-15.7. 6days



S1 15.7.-21.7. 6days



aerial photograph

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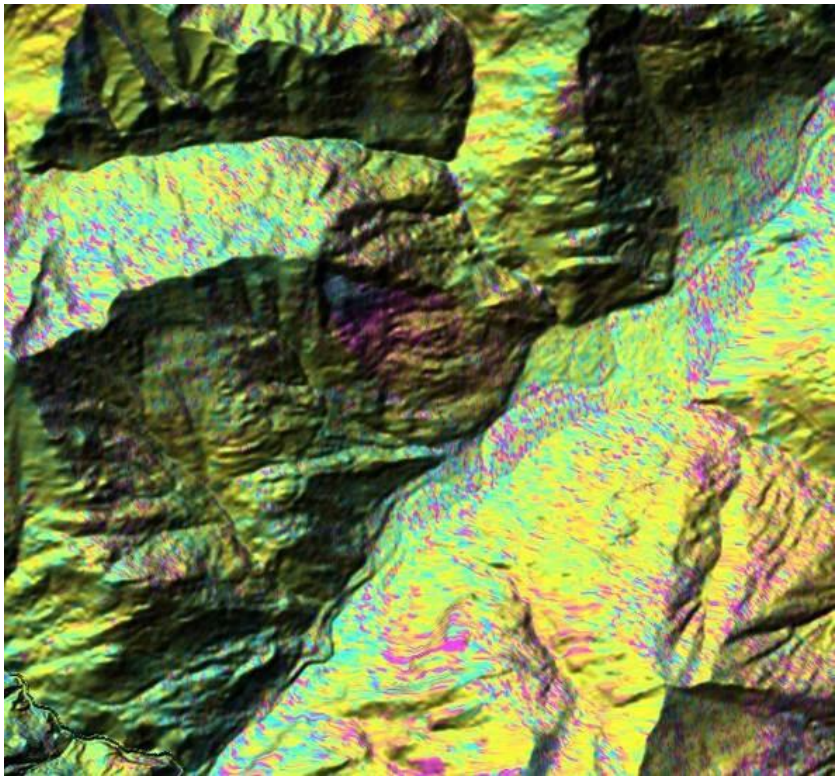
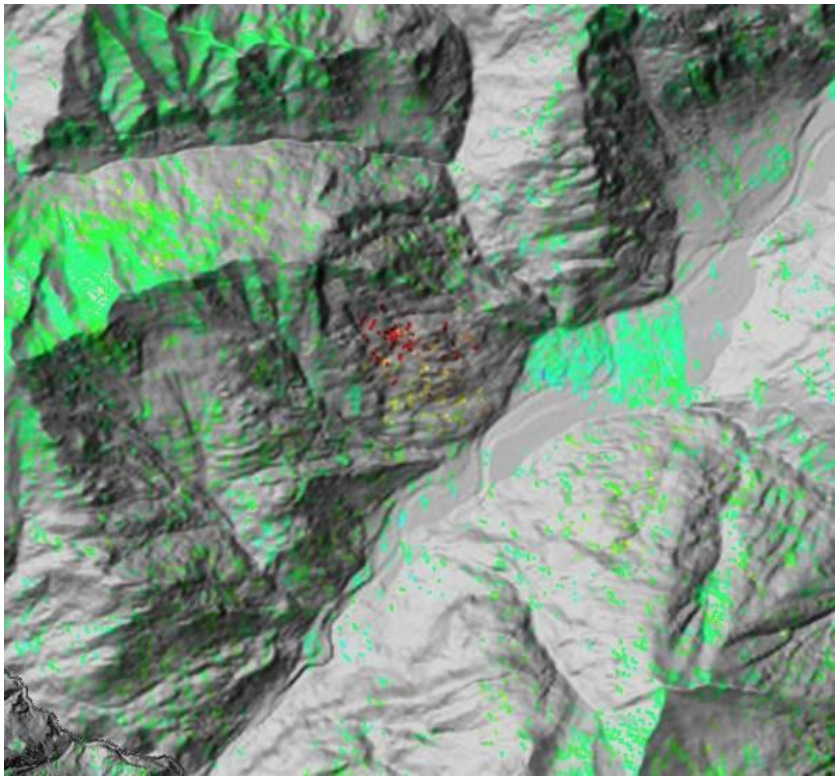
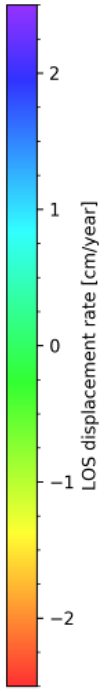
PALSAR-2/3 DInSAR A198 over the Alps

PALSAR-$3_{ScanSAR}$ 20250506 – PALSAR-$2_{stripmap}$ 20241014







20250506 - 20241014

PALSAR-2 PSI 2015-2024

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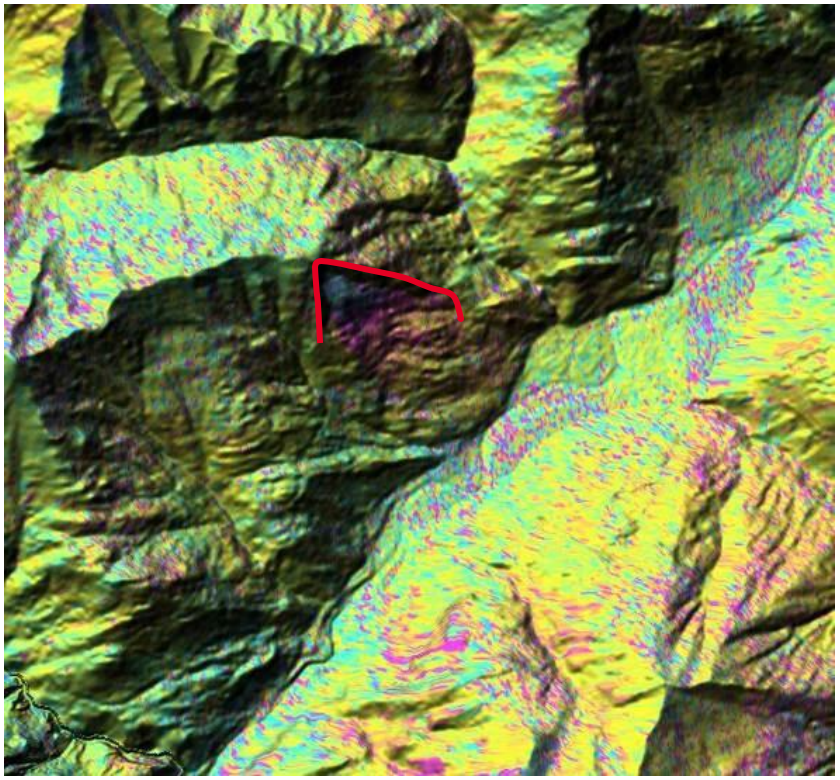
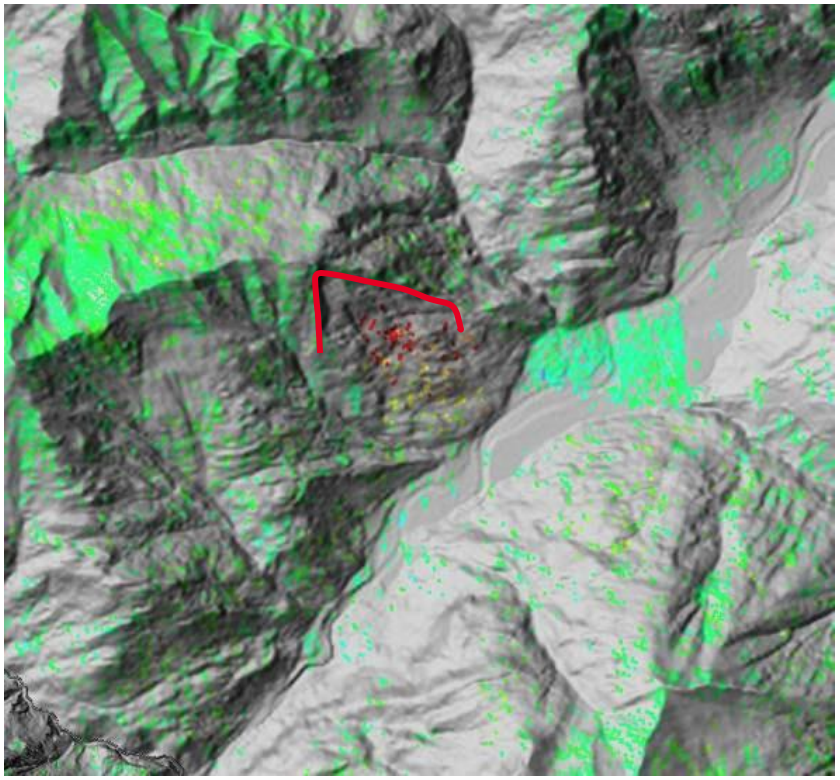
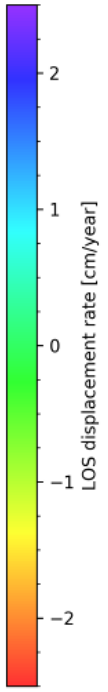
PALSAR-2/3 DInSAR A198 over the Alps

PALSAR-$3_{ScanSAR}$ 20250506 – PALSAR-$2_{stripmap}$ 20241014







20250506 - 20241014

PALSAR-2 PSI 2015-2024

→ short-interval L-band DInSAR well suited for fast movements

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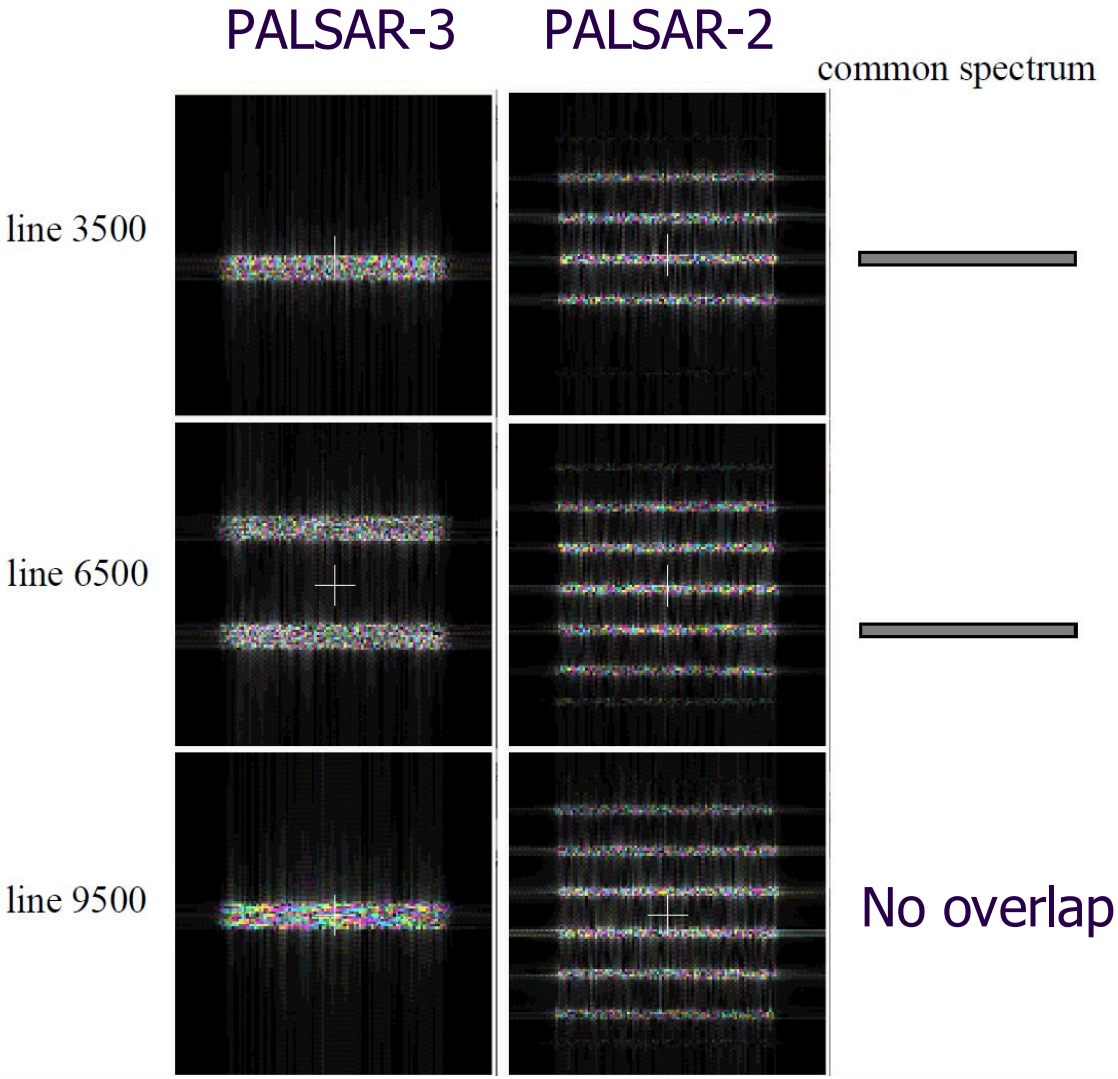
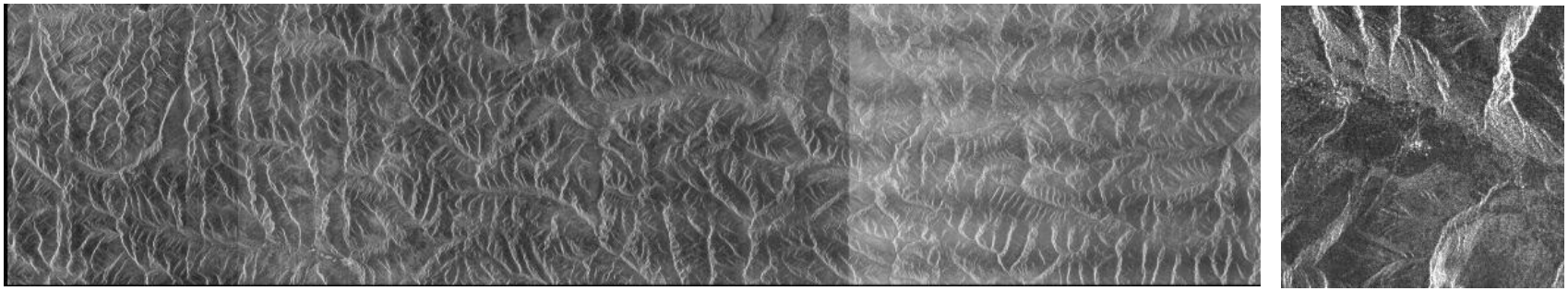
PALSAR-2 PALSAR-3 ScanSAR interferometry (1)

Spectra after co-registration.

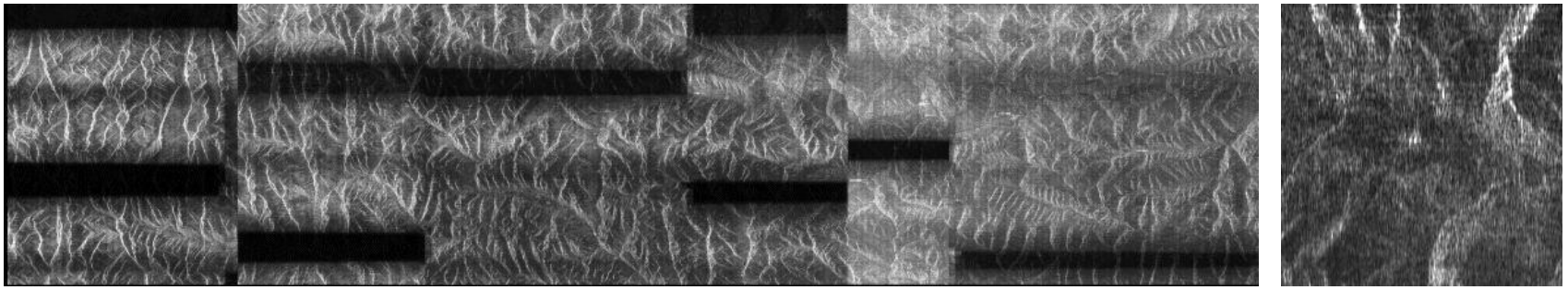


PALSAR-2 PALSAR-3 ScanSAR interferometry (2)

PALSAR-3 ScanSAR data on 6-May-2025 over the Alps

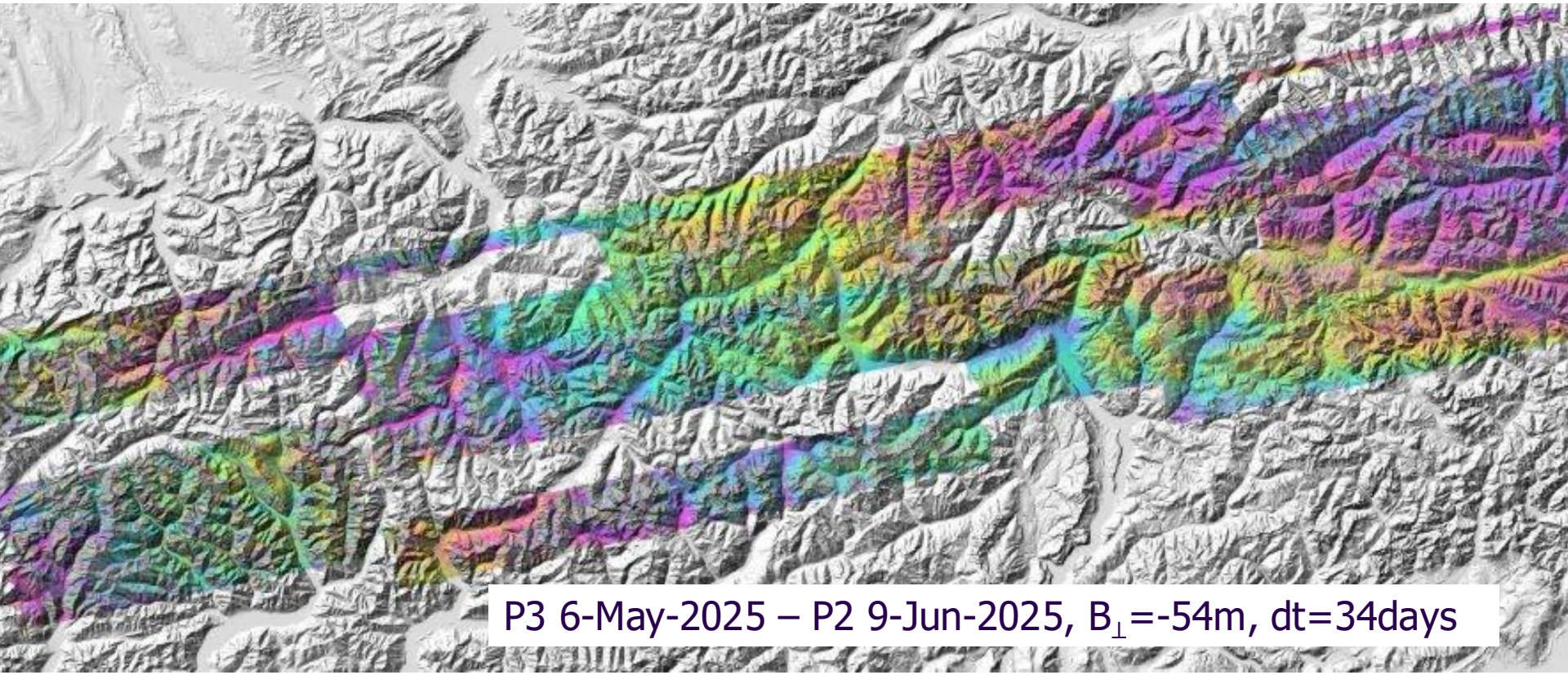


Same data after spatially adaptive common band filtering



PALSAR-2 PALSAR-3 ScanSAR interferometry (3)

PALSAR-3 ScanSAR – PALSAR-2 ScanSAR differential interferogram over the Alps.

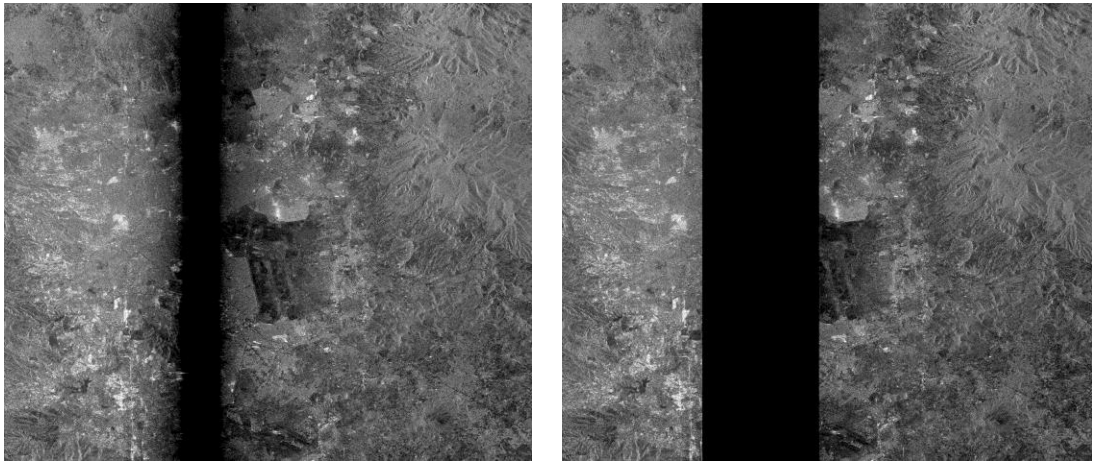


Persistent Scatterer Interferometry (1)

Two PALSAR-2 Stripmap Scenes (20241218, 20250226) and five PALSAR-3 Stripmap Scenes (20250403, 20250626, 20250807, 20260219, 20260514) over Mexico City were used.

One of the PALSAR-3 scenes, acquired in fixed PRF mode, has a spatial data gap. To avoid anomalies in the PSI analysis by using lower quality data we enhance this gap, so that the full spectrum is available in the unmasked data.

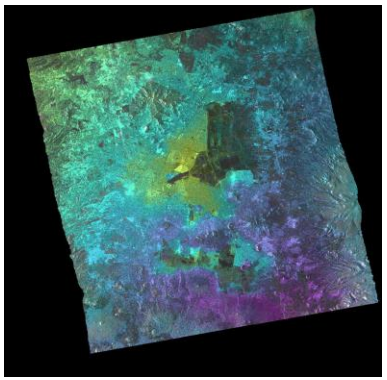
P3 SLC with gap, before (left) and after (right masking



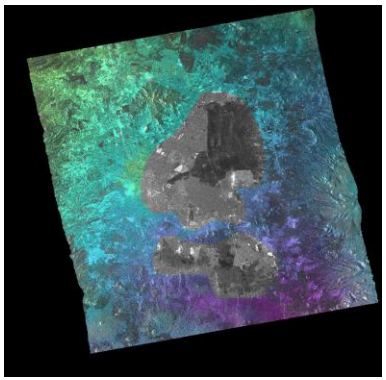
Persistent Scatterer Interferometry (2)

Persistent Scatterer Candidates were identified based on a high spectral coherence (= "point scatterer characteristics").

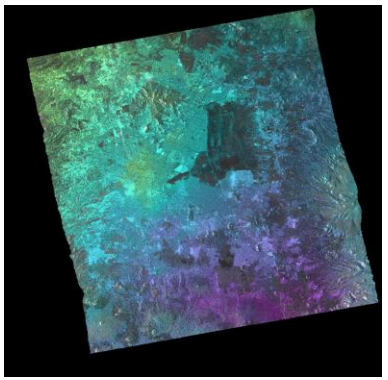
To achieve a cm/year accuracy for this small and short stack we first estimated and subtracted a low frequency (atmospheric, ionospheric and orbital phase) phase term. To avoid shifting displacement phase into this term the known large subsidence areas were masked in this step.



diff phase



masked



interpolated

Persistent Scatterer Interferometry (3)

A single reference stack was used.

A one dimensional regression (versus time) was used for this L-band stack with short spatial baselines (< 350m). No point height corrections were determined.

One iteration (updating the atmospheric phase estimate based on the residual phase relative to the linear regression) was used.

The main result is the average line-of-sight deformation rate for the considered time interval.

The estimated precision is better than 1cm/year.

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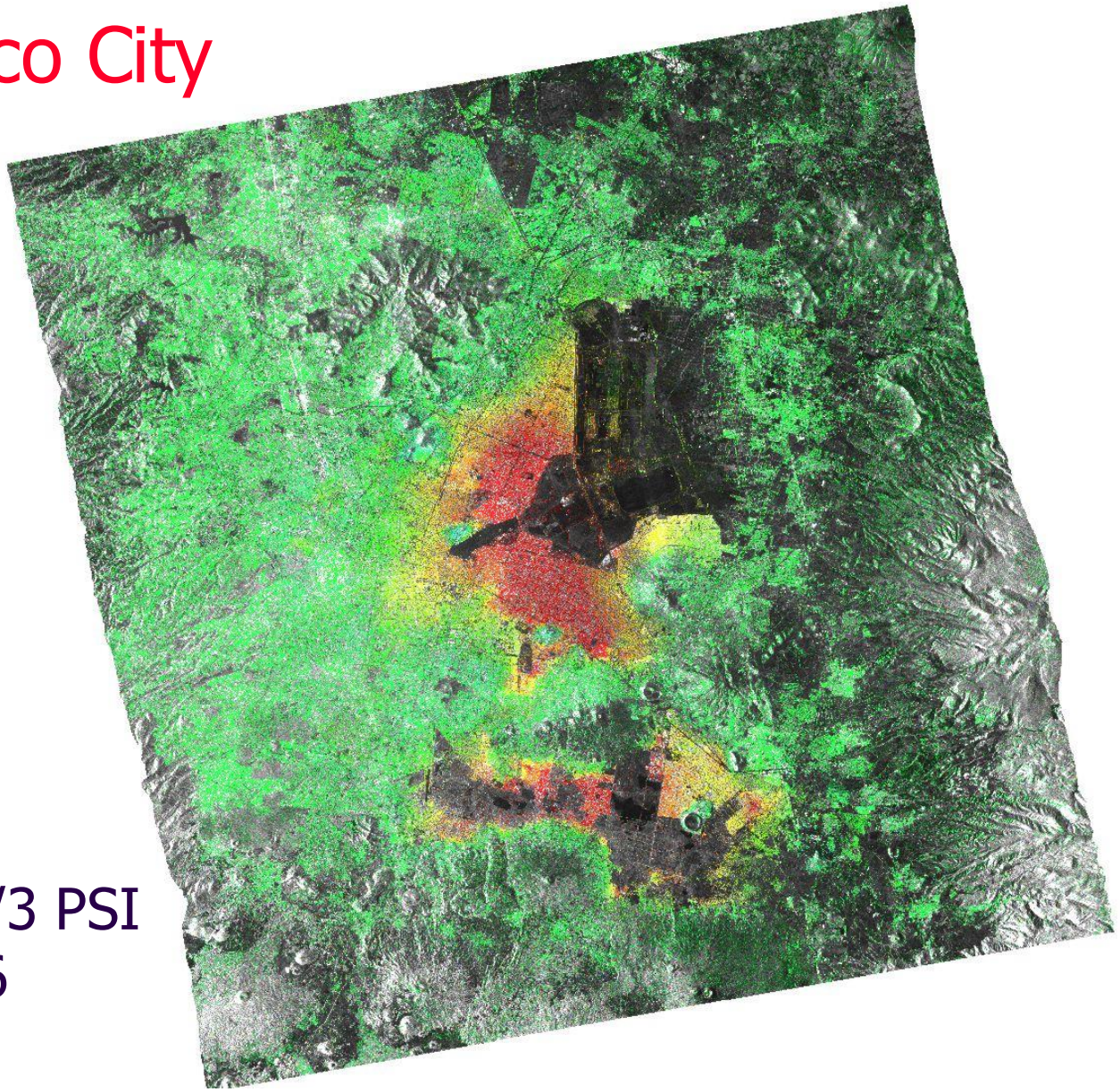
Mexico City



PALSAR-2/3 PSI
2025/2026

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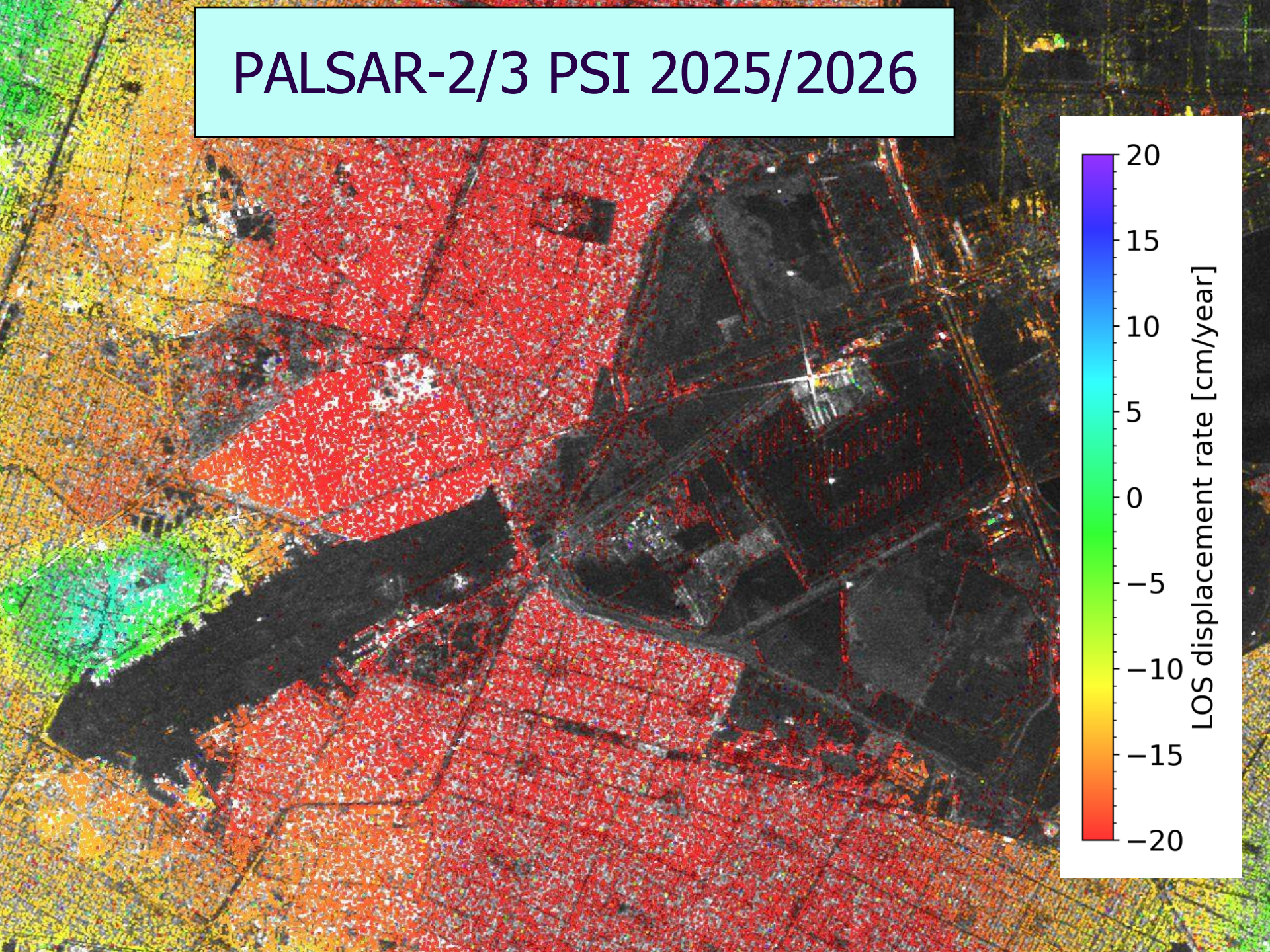
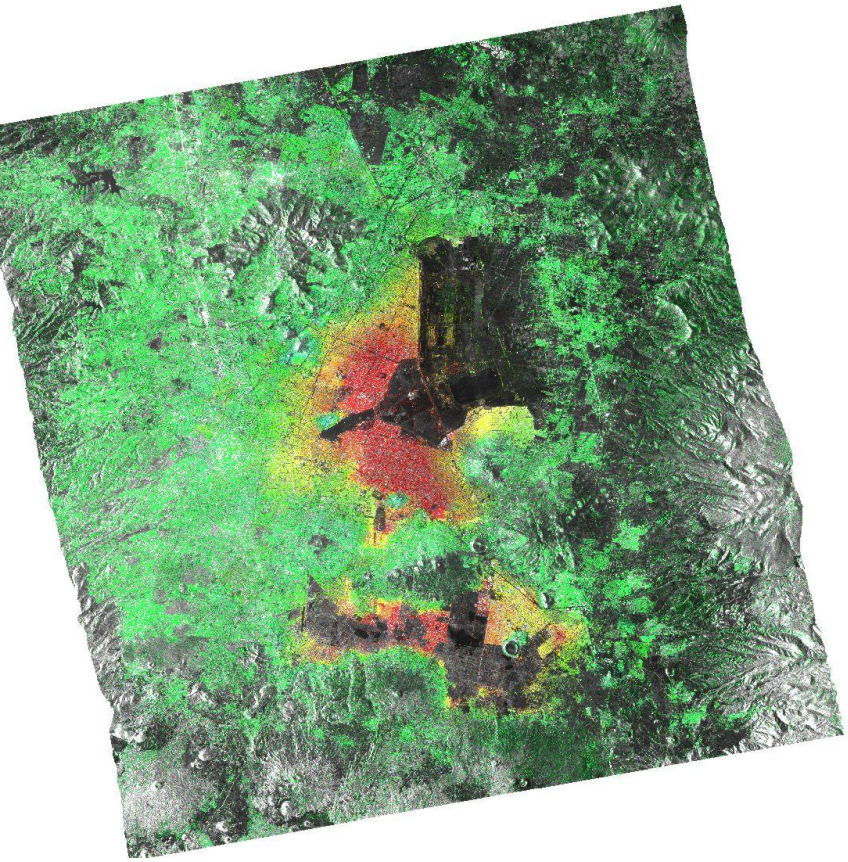
PALSAR-2/3 PSI 2025/2026

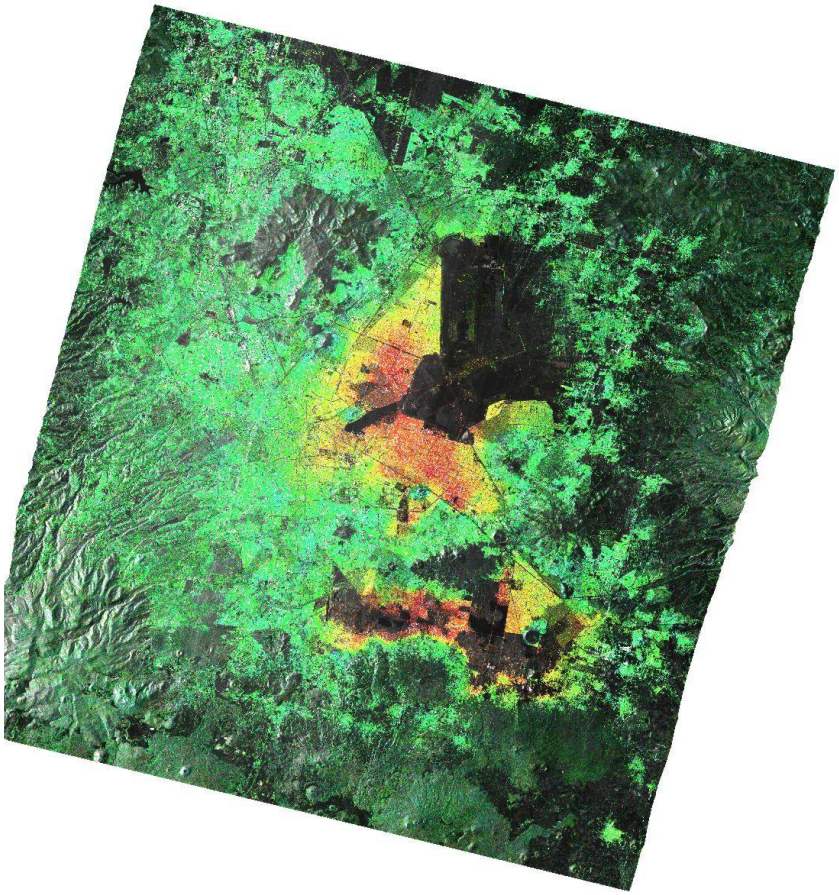


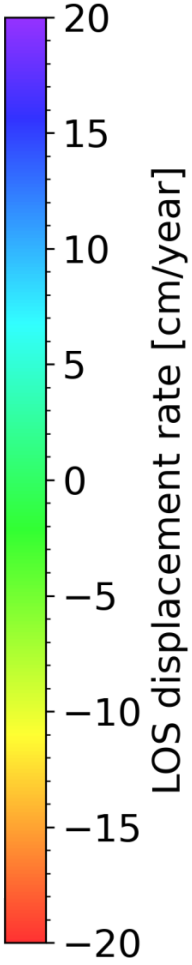
Conclusions

- ✓ PALSAR-2/3 cross-interferometry works well.
- ✓ DInSAR was tested for Stripmap and ScanSAR data, incl. pairs with 6 and 8 day intervals.
- ✓ PSI was successful for combined stacks.
- ○ There are some PALSAR-3 data quality issues:
  - higher NESZ
  - azimuth ambiguities
  - data gaps for some fixed prf acquisitions
  - Palsar-3 Scansar issues (files, quality)

Cross-comparison with NISAR-L PSI result







PALSAR-2/3 2025/2026

NISAR-L 2025/2026

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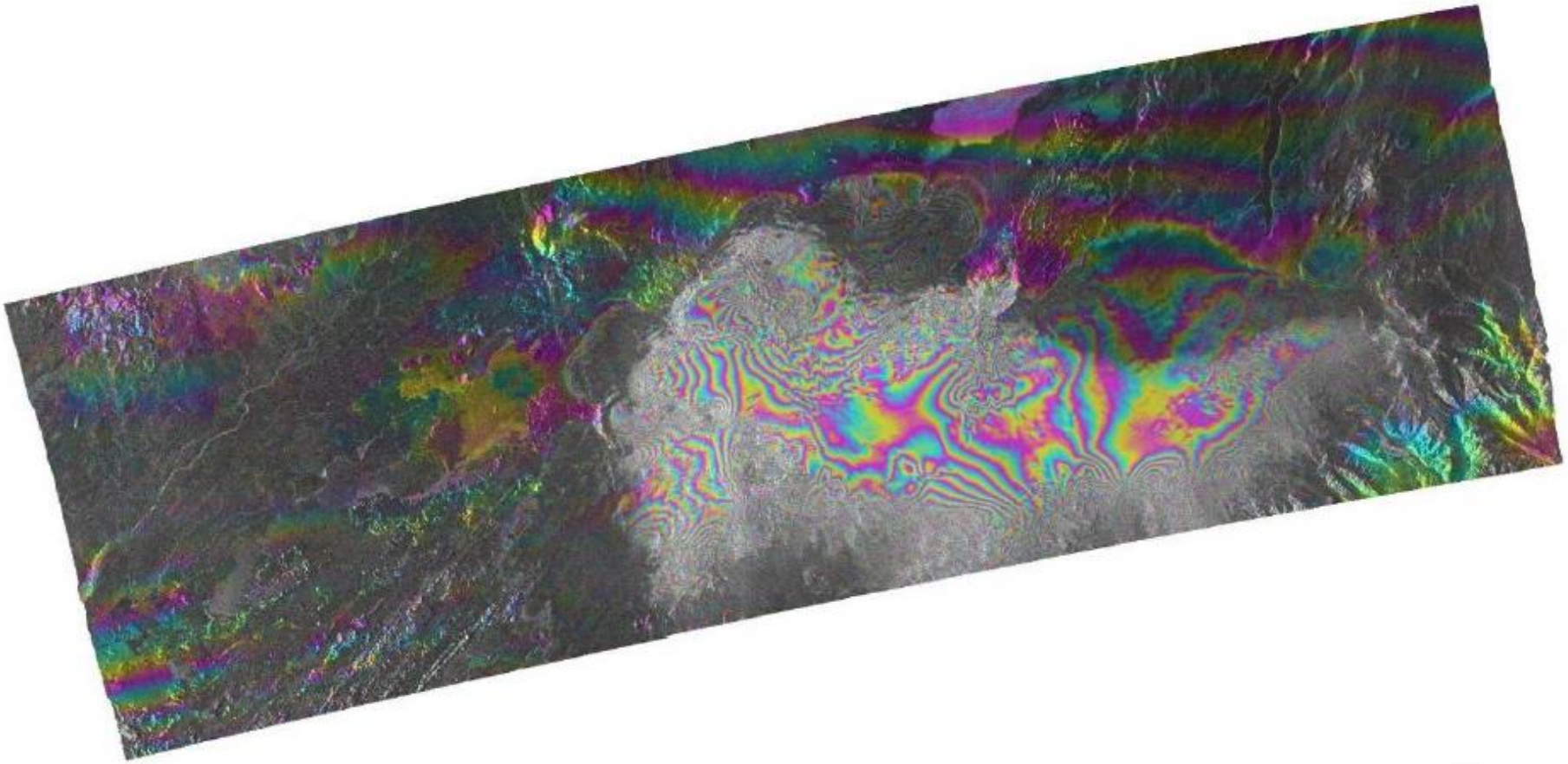
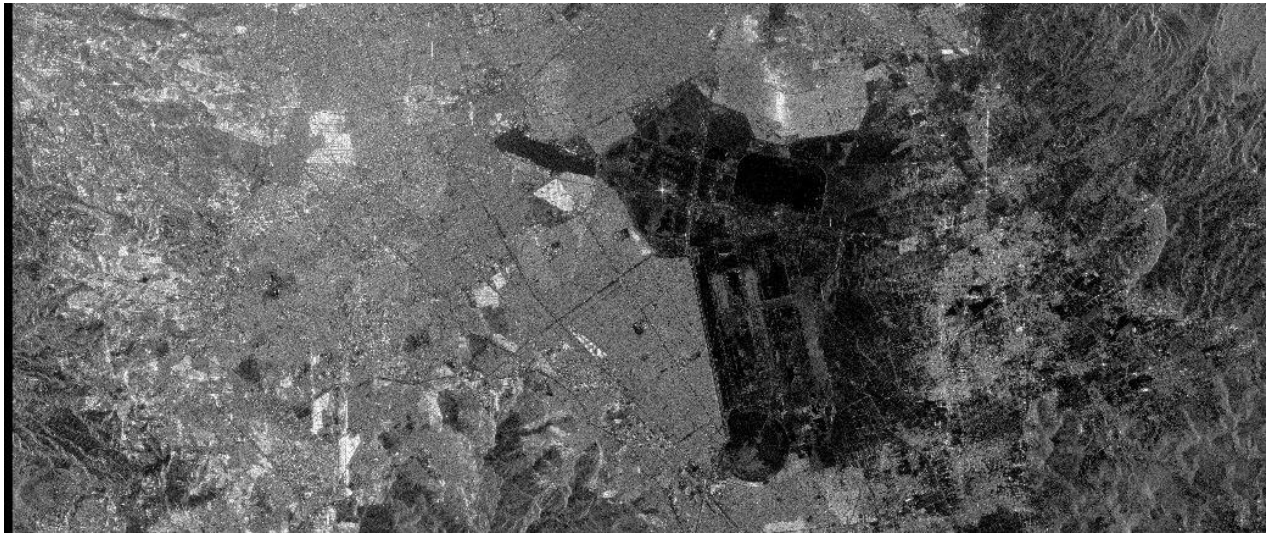
P3/P3 DInSAR with full beam-width

(no phase jumps observed between sub-swaths)



Stripmap data quality comparison

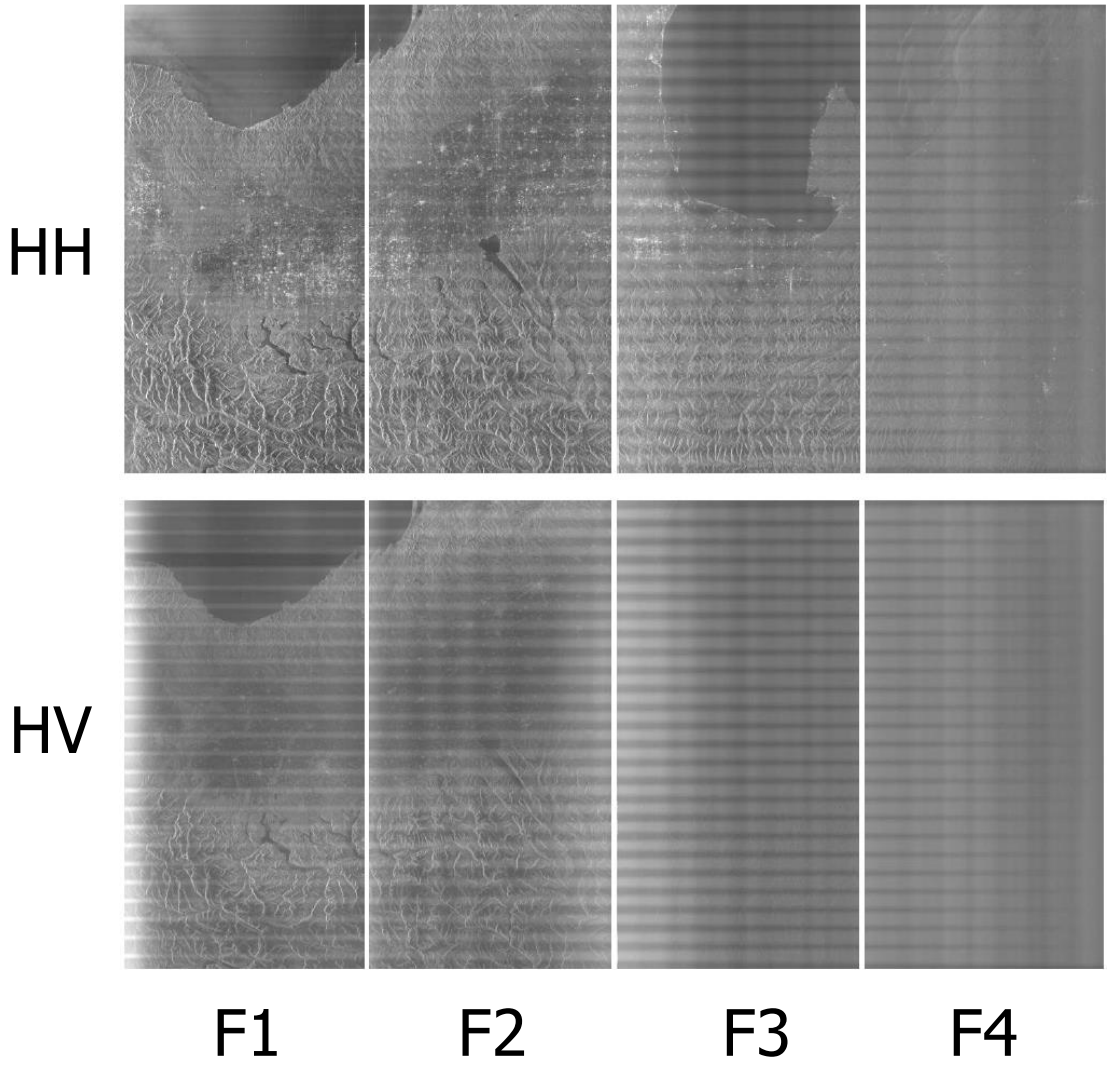
PALSAR-2, 25MHz
HH, 20250226



PALSAR-3, 27MHz
HH, 20250403

PALSAR-3 ScanSAR data A198, 6-May-2025

Quick-look images of the sub-swath SLC data (F1-F4, HH, and HV pol.)



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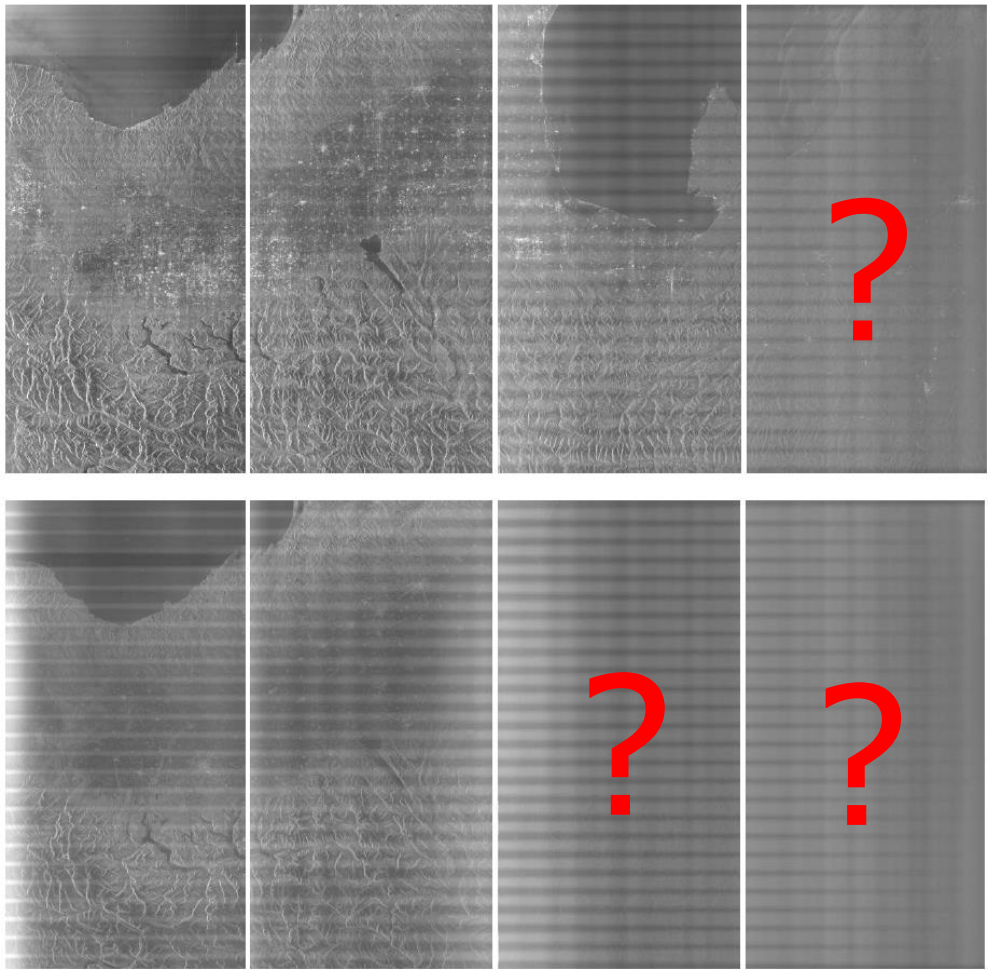
PALSAR-3 ScanSAR data A198, 6-May-2025

Quick-look images of the sub-swath SLC data (F1-F4, HH, and HV pol.)



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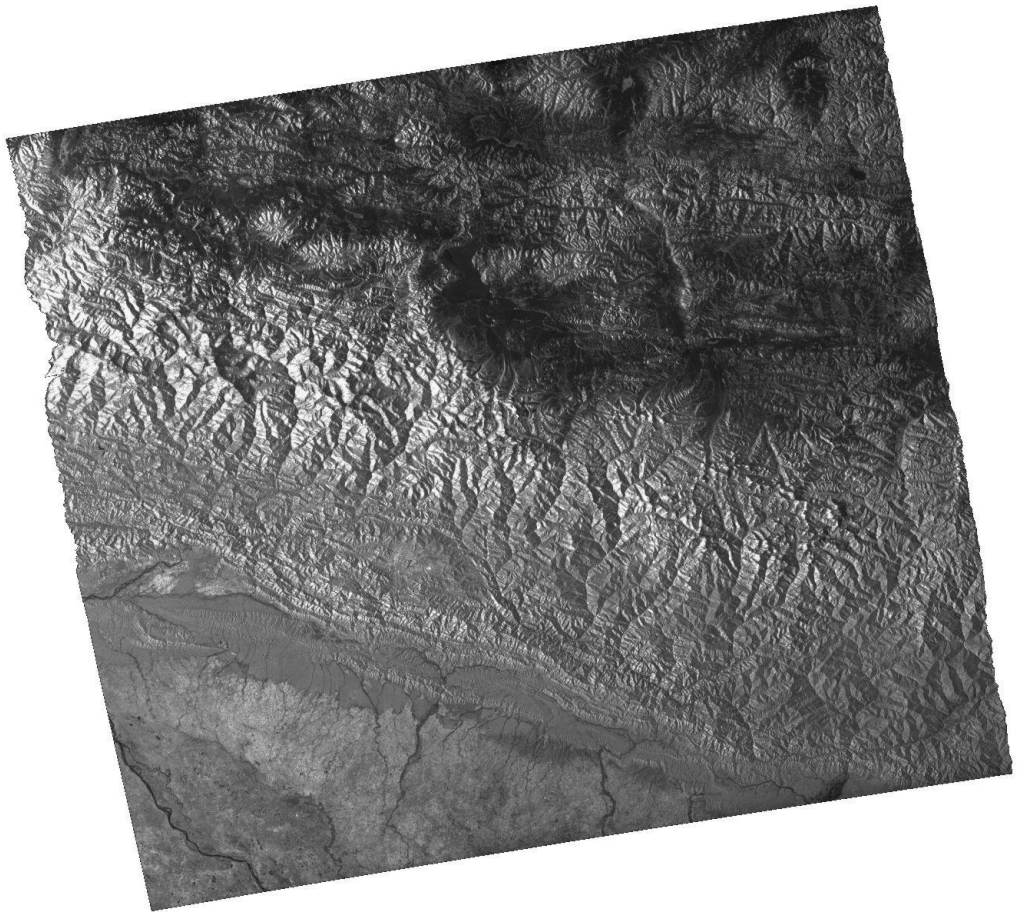
Comparison of PALSAR-3 stripmap and PALSAR-2 ScanSAR data

PALSAR-3 stripmap (28MHz, provided in 4 sections).

Comparison of PALSAR-3 stripmap and PALSAR-2 ScanSAR data



PALSAR-2 ScanSAR (provided in 5 sub-swaths).

PALSAR-3 ScanSAR data provision

One PALSAR-3 dual-pol. ScanSAR acquisition → 403 Gbyte.
Provided at present as 403 zip file fractions.

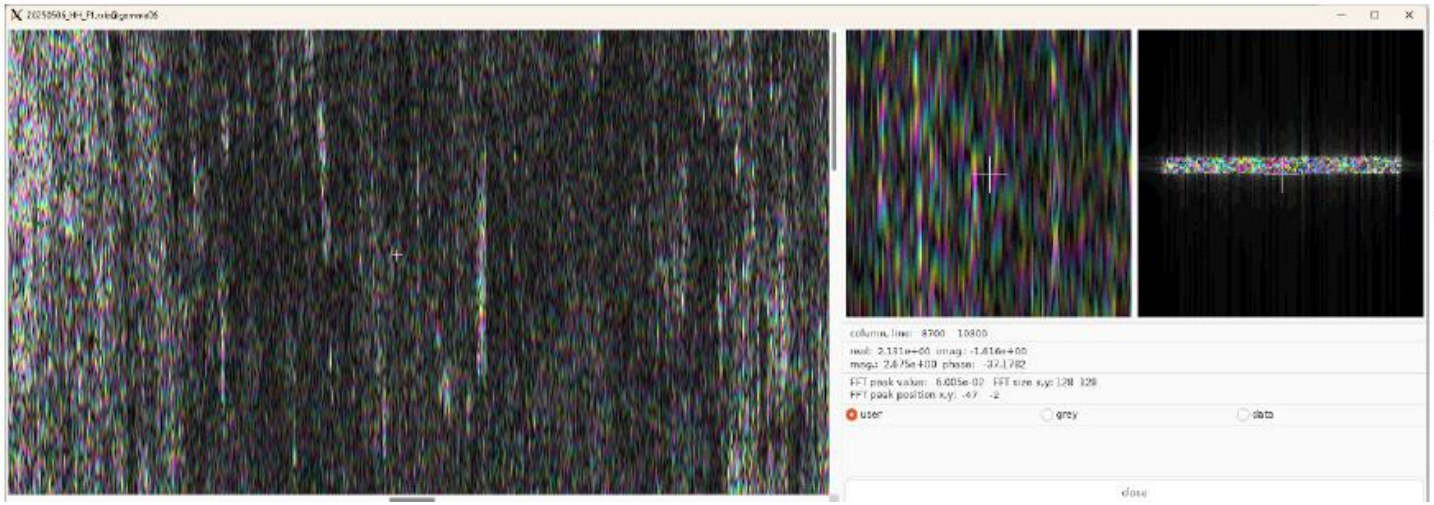
Suggestions:

1) Checking the spectrum shows that < 50% of the azimuth spectrum is used.
→ azimuth sampling bandwidth could be reduced to 50%

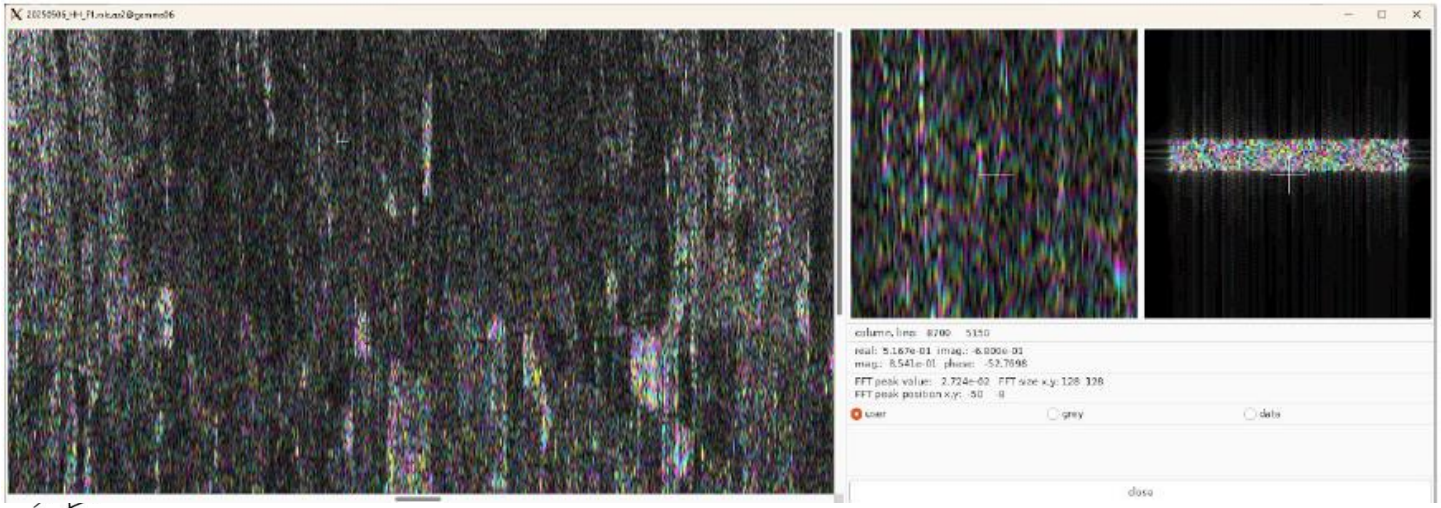
2) The access could be to the individual files (this also allows only downloading one polarization and/or selected sub-swaths).
→ may significantly reduce data volume downloaded.
→ splitting up zip files not necessary for the smaller files.

3) SCOMPLEX (instead of FCOMPLEX) format could be used.
→ reduces data volume to 50%.

Reducing PALSAR-3 ScanSAR azimuth sampling band-width



original



reduced