→ FRINGE 2015 WORKSHOP

Advances in the Science and Applications of SAR Interferometry and Sentinel-1 InSAR Workshop

Ice Velocity Mapping Using TOPS SAR Data and Offset Tracking

Jørgen Dall[1], Anders Kusk[1], Ulrik Nielsen[1], John Peter Merryman Boncori[2]
[1] Technical University of Denmark, [2] Instituto Nazionale di Geofisica e Vulcanologia, Italy

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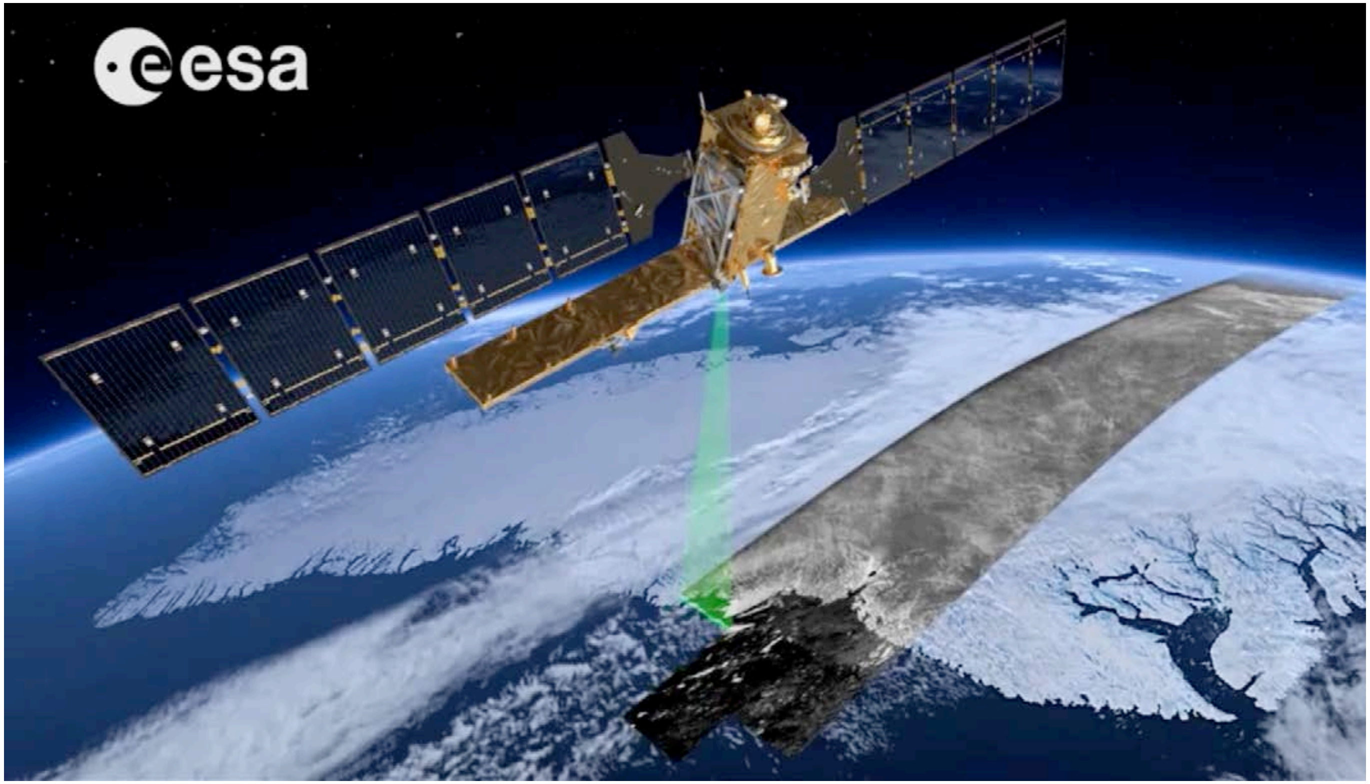
Outline

- Introduction
- Problem (TOPS + large displacements)
- Method
- Results
- Conclusions

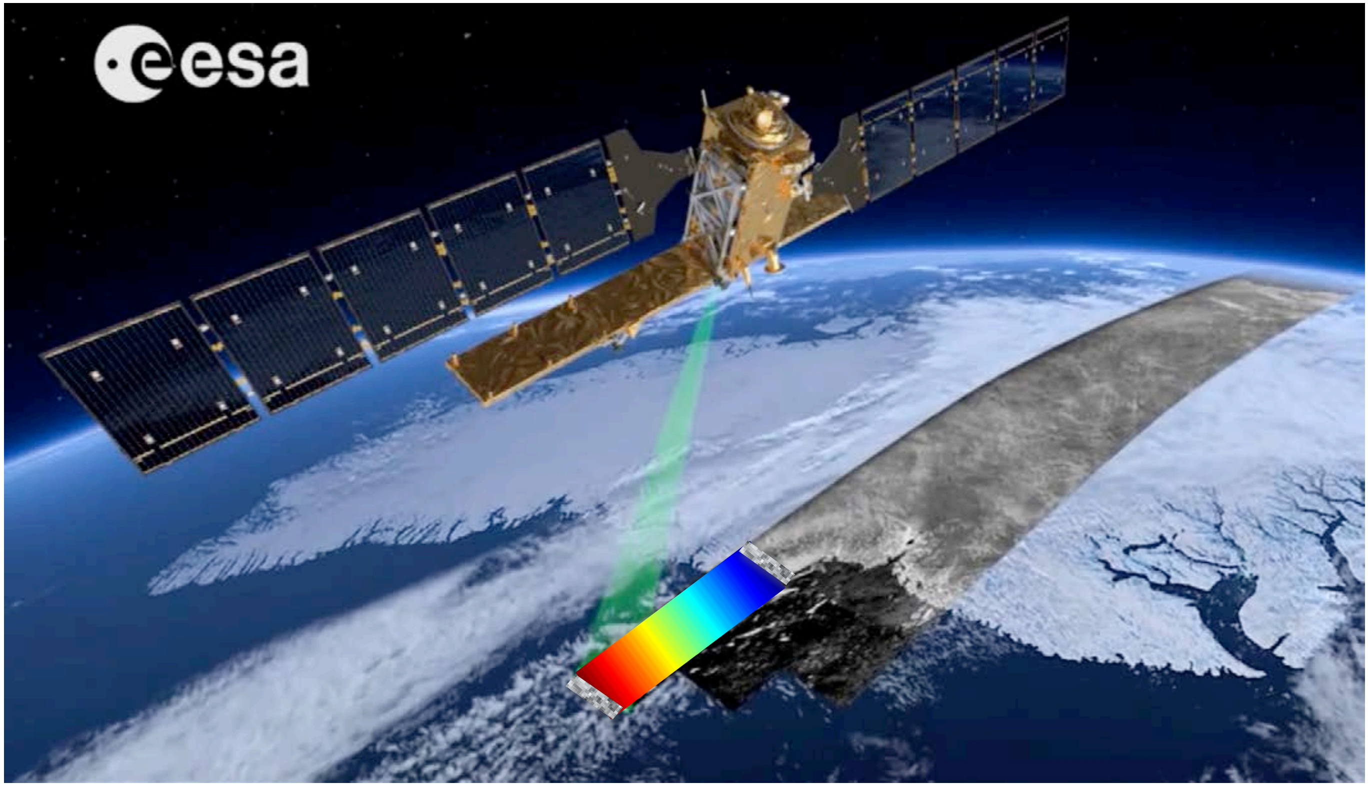
Offset tracking

	Feature tracking	Speckle tracking
Method	Cross-correlation	Cross-correlation
Data type	Detected	Detected or complex
Features	Required	Not required
Coherence	Not required	Required
Patch size	Larger	Smaller
Accuracy	Coarser	Finer

TOPS

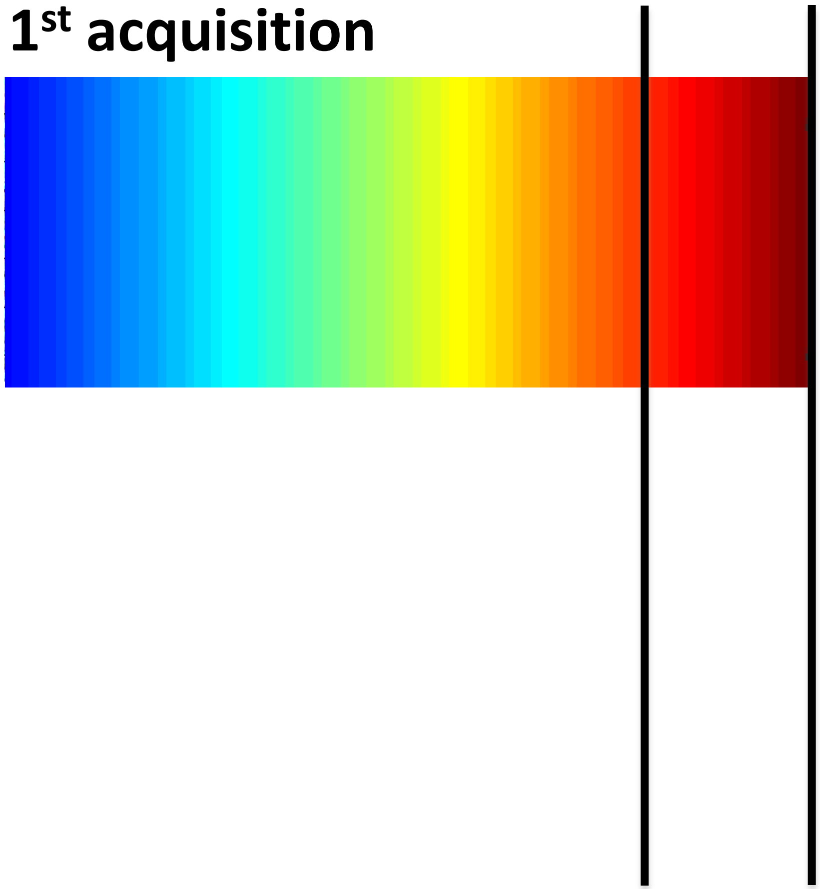


TOPS



Offset tracking with TOPS data

1st acquisition



Offset tracking with TOPS data

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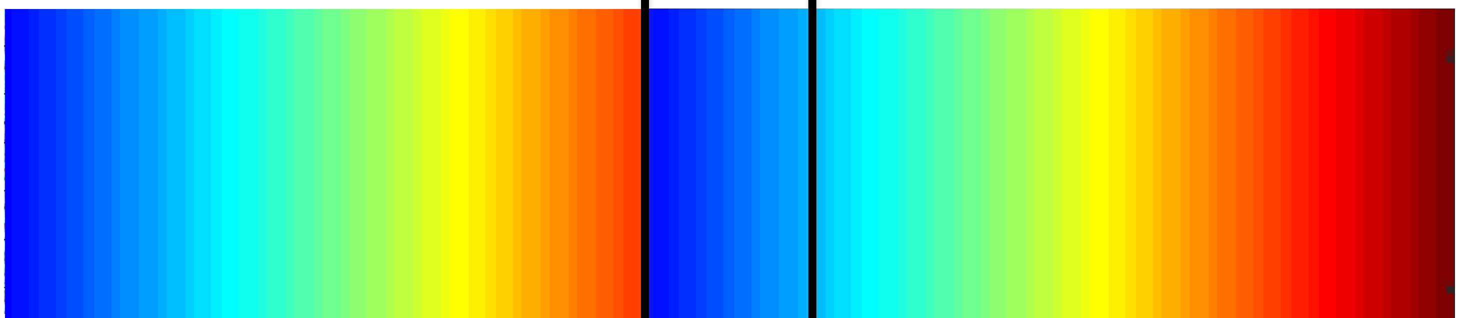
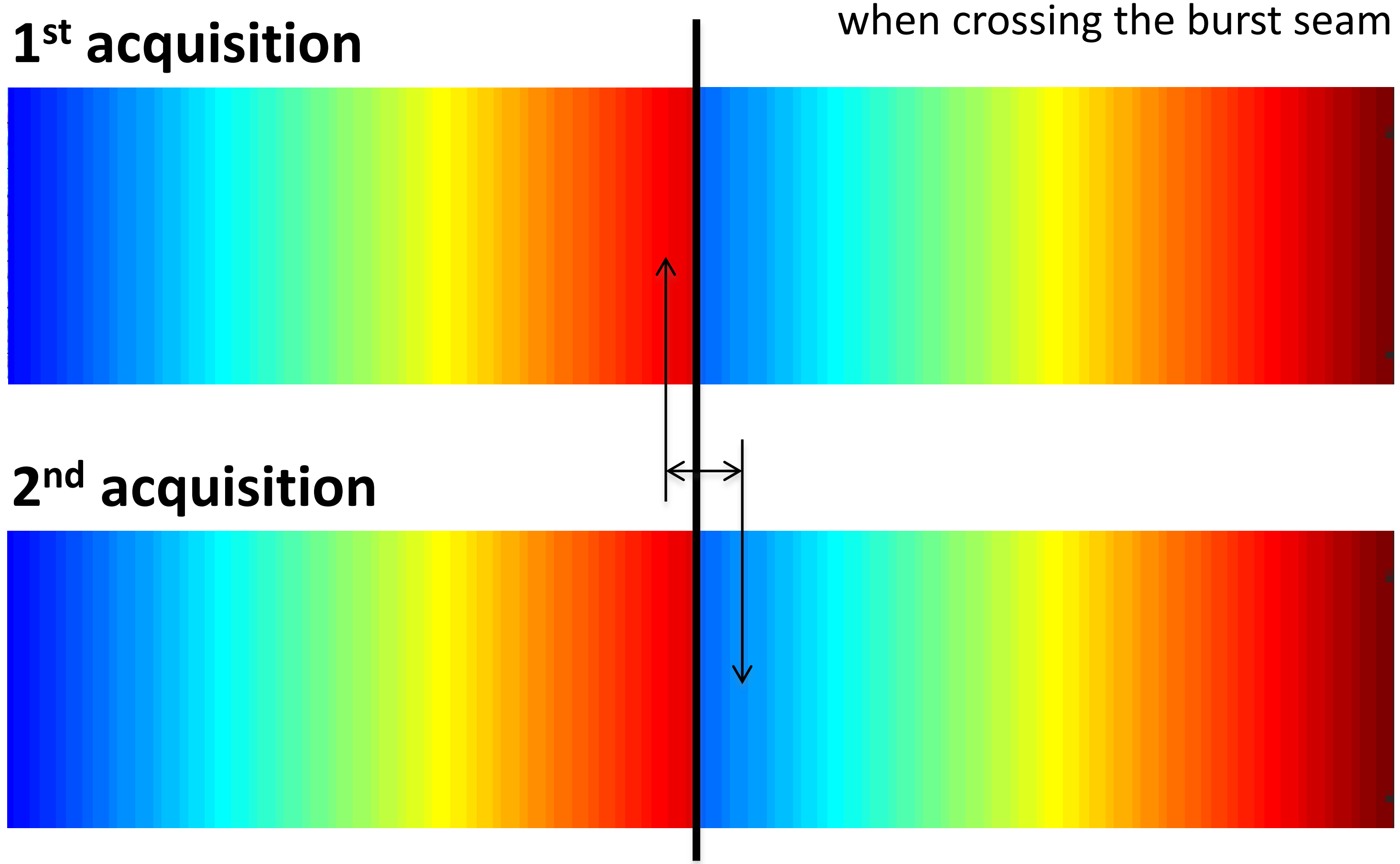


IW SLC product:

- Spatial overlap
- No spectral overlap => speckle pattern differs

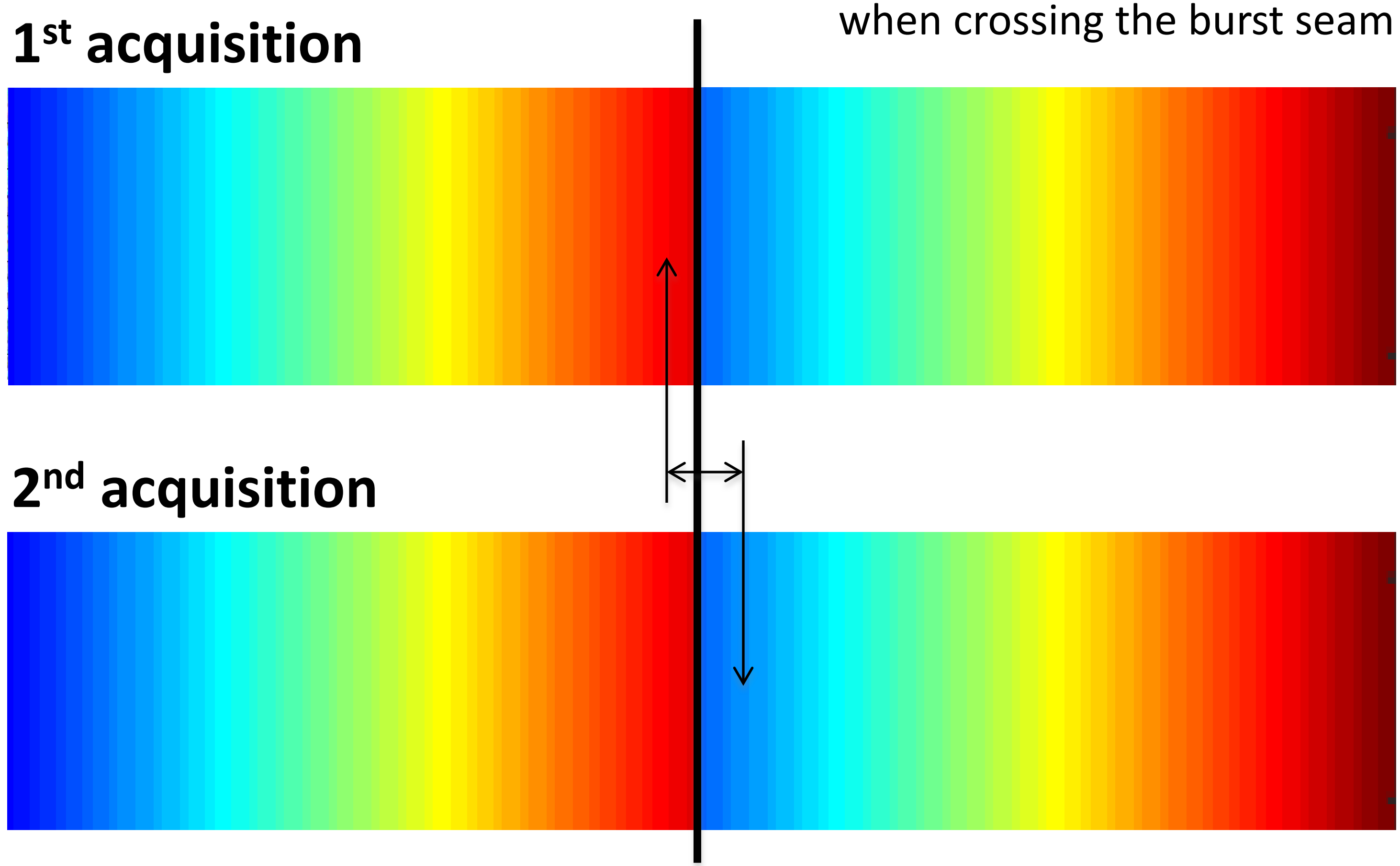
Offset tracking with TOPS data

GRD product: features are preserved when crossing the burst seam

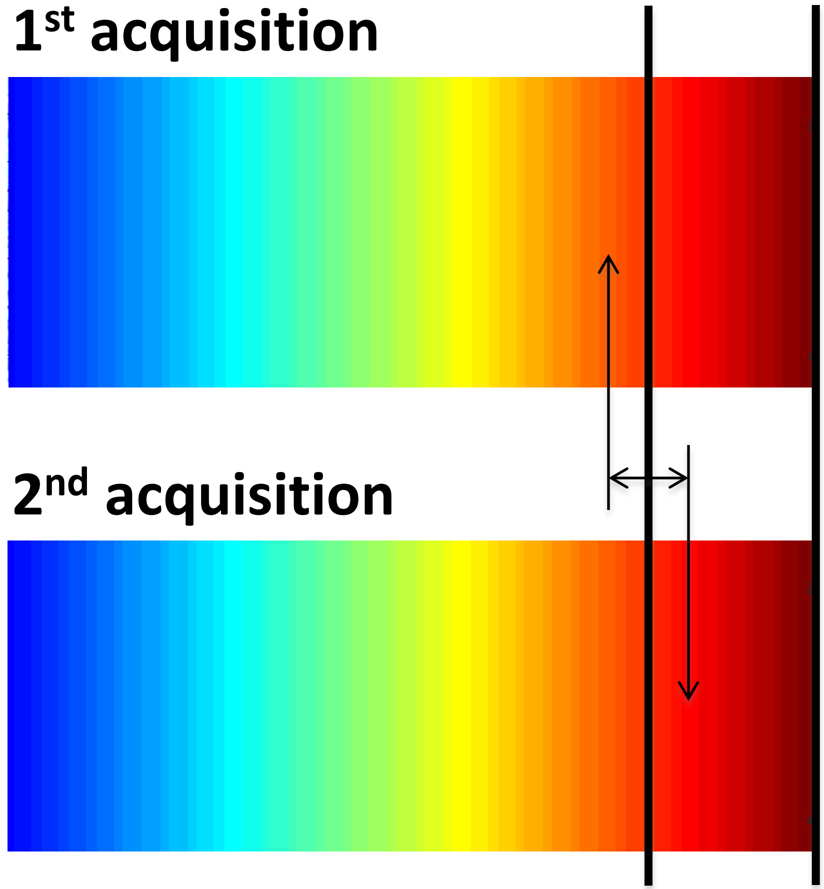


Offset tracking with TOPS data

GRD product: Speckle changes when crossing the burst seam => gap

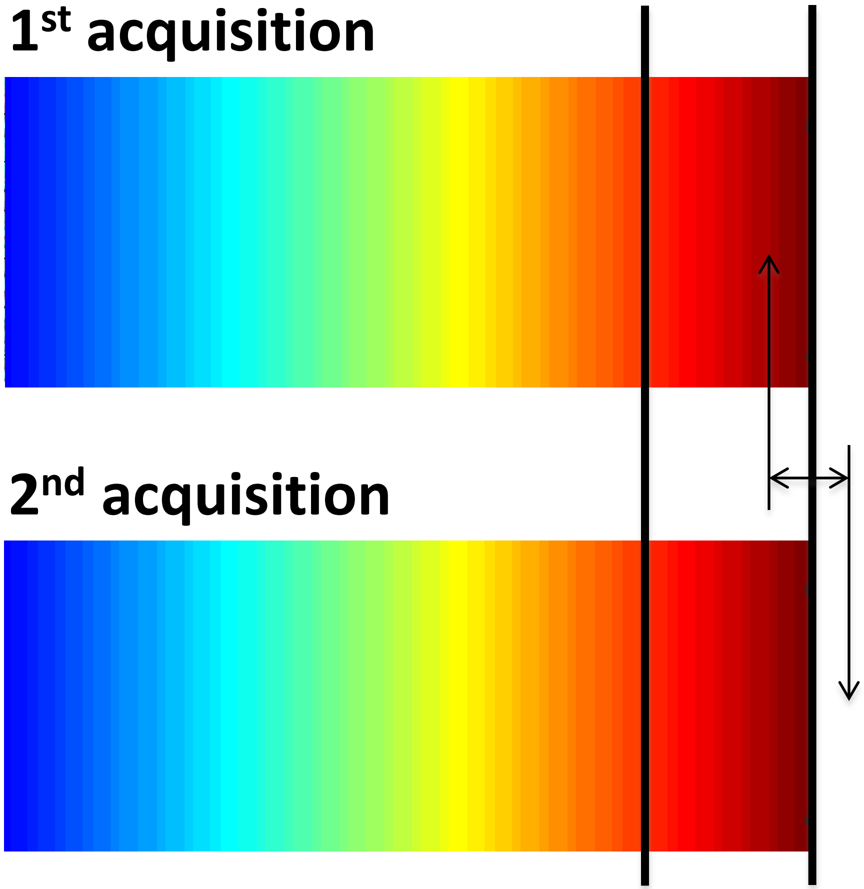


Offset tracking with TOPS data



SLC product: gaps can also be avoided with speckle tracking if ice displacement + patch size < overlap

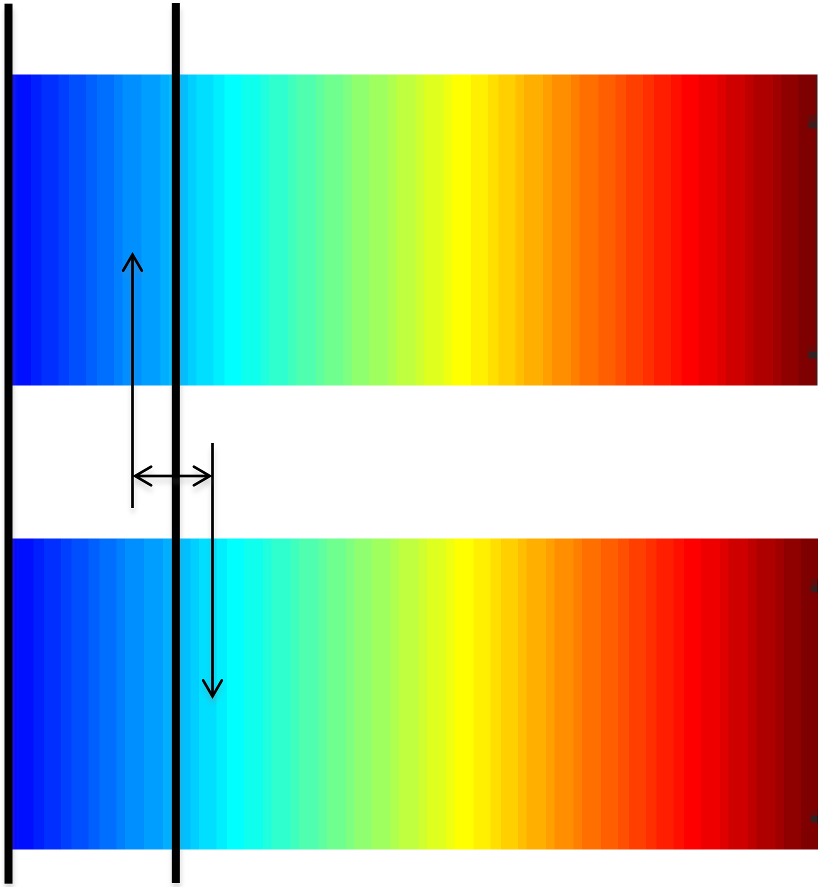
Offset tracking with TOPS data



SLC product: gaps can also be avoided with speckle tracking if ice displacement + patch size < overlap

Offset tracking with TOPS data

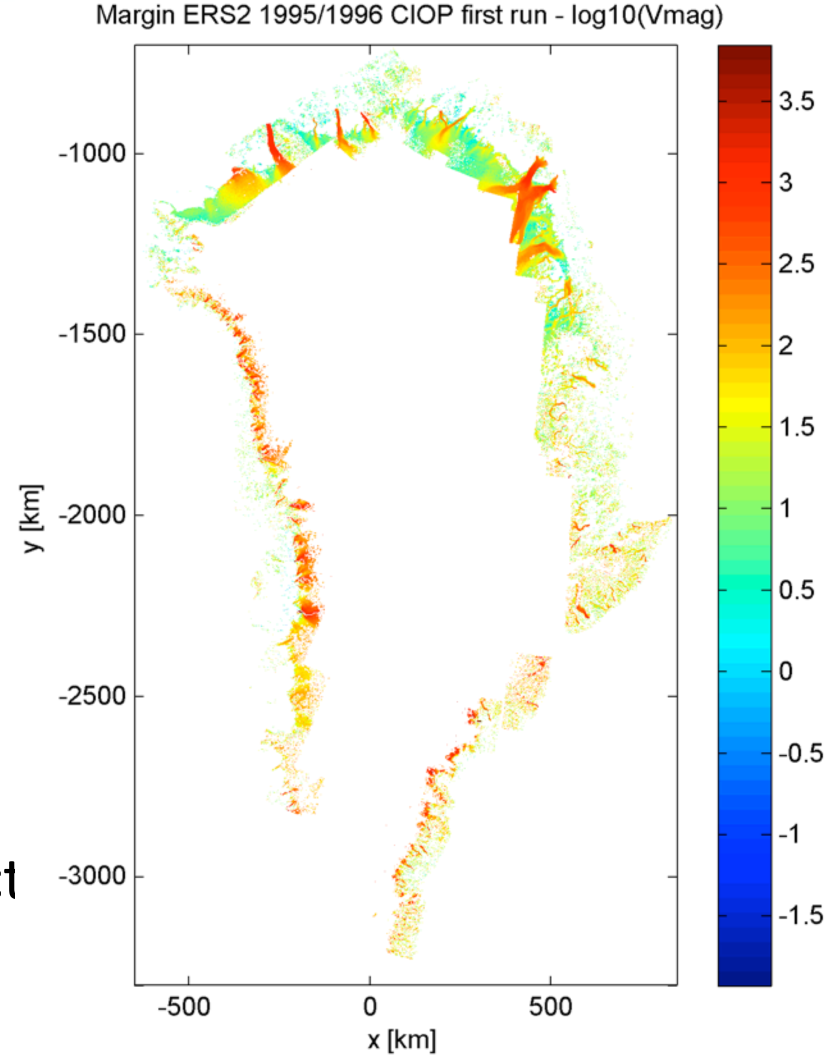
SLC product: gaps can also be avoided with speckle tracking if ice displacement + patch size < overlap



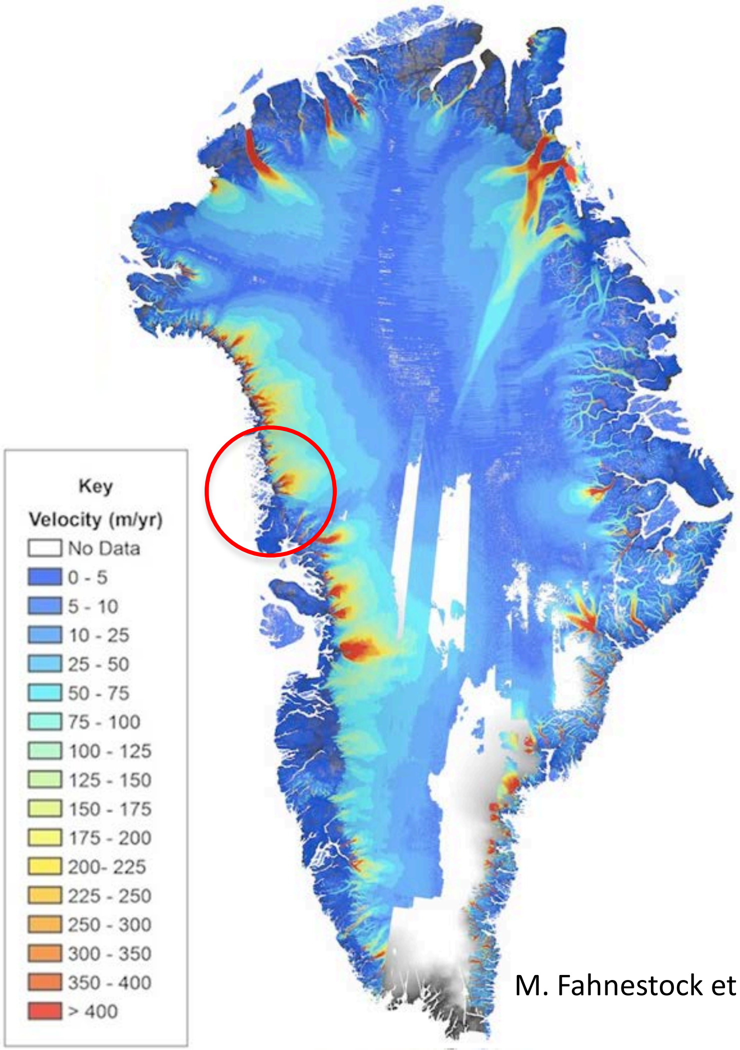
IPP processor

- Intended for DInSAR
  (DEM elimination &
  Double Difference)

- Upgraded for ESA's
  Climate Change Initiative
  (GrIS CCI, AIS CCI):
  - Offset Tracking
  - Bulk processing
    (cloud computing)
  - Sentinel-1 IW SLC product

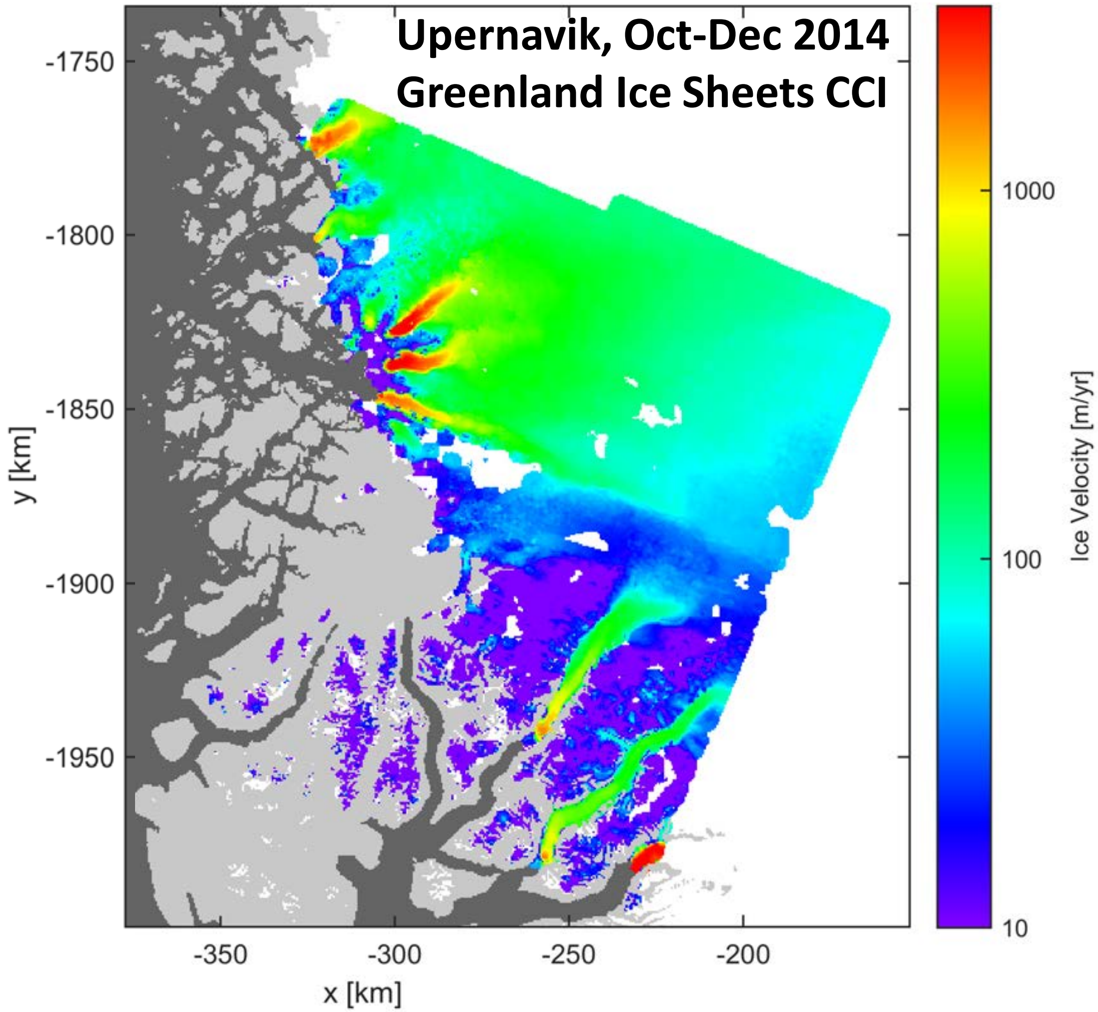


Upernavik glaciers



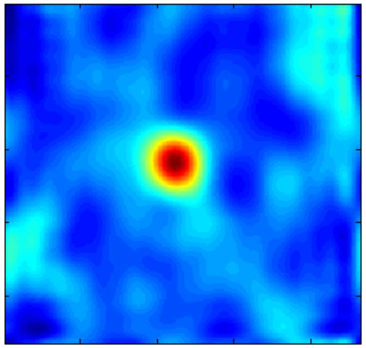
M. Fahnestock et al., 1992

Ice velocity (Sentinel-1 IW SLC)



Normalized cross-correlation:

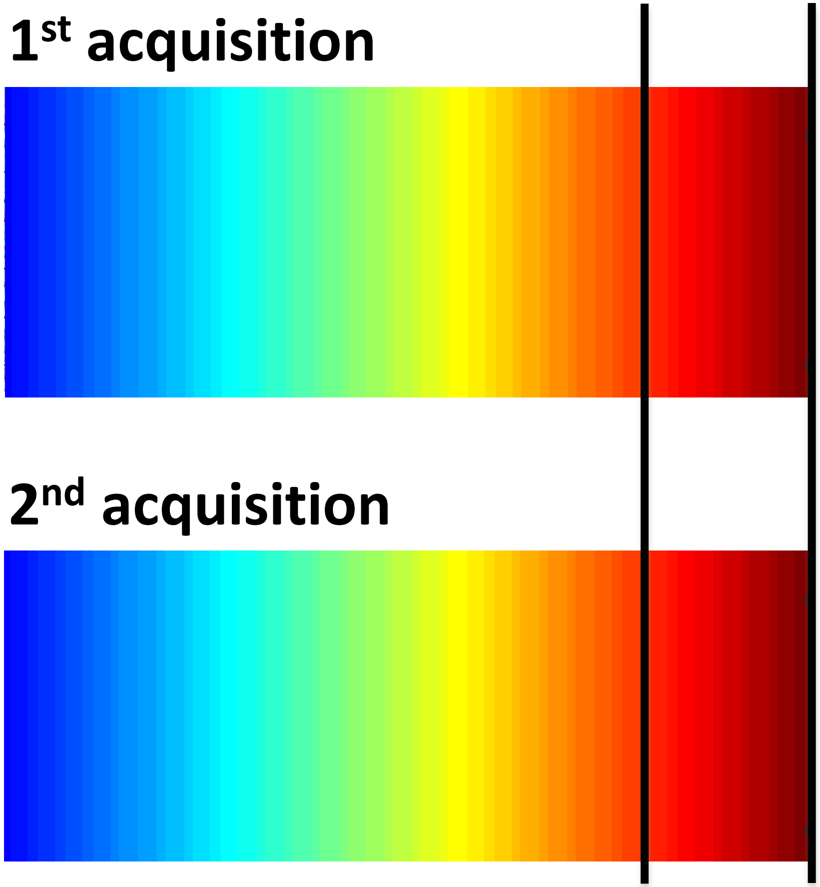
$$NCC(i,j)=\frac{\sum_{k,l}\left(s(i+k,j+l)-\mu_S\right)\left(r(k,l)-\mu_r\right)}{\sqrt{\sum_{k,l}\left|s(i+k,j+l)-\mu_S\right|^2\sum_{k,l}\left|r(k,l)-\mu_r\right|^2}}$$



Figures of merit:

- max(NCC)
- 'signal-to-noise ratio' (SNR)

Approach



Corresponding bursts
(exploited by IPP)

Approach

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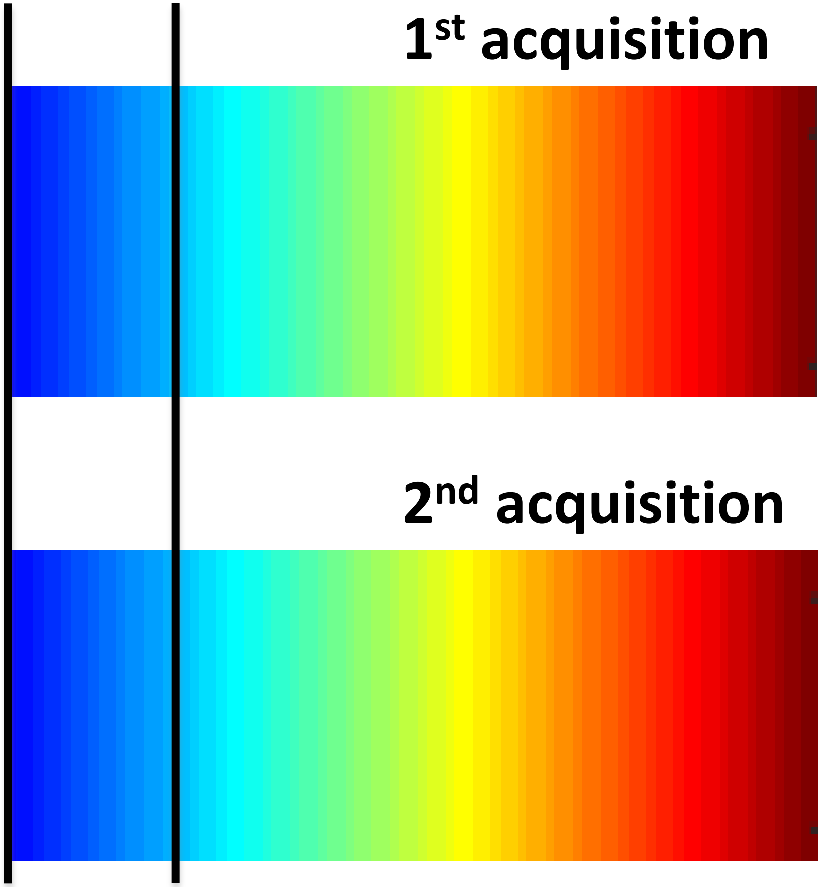
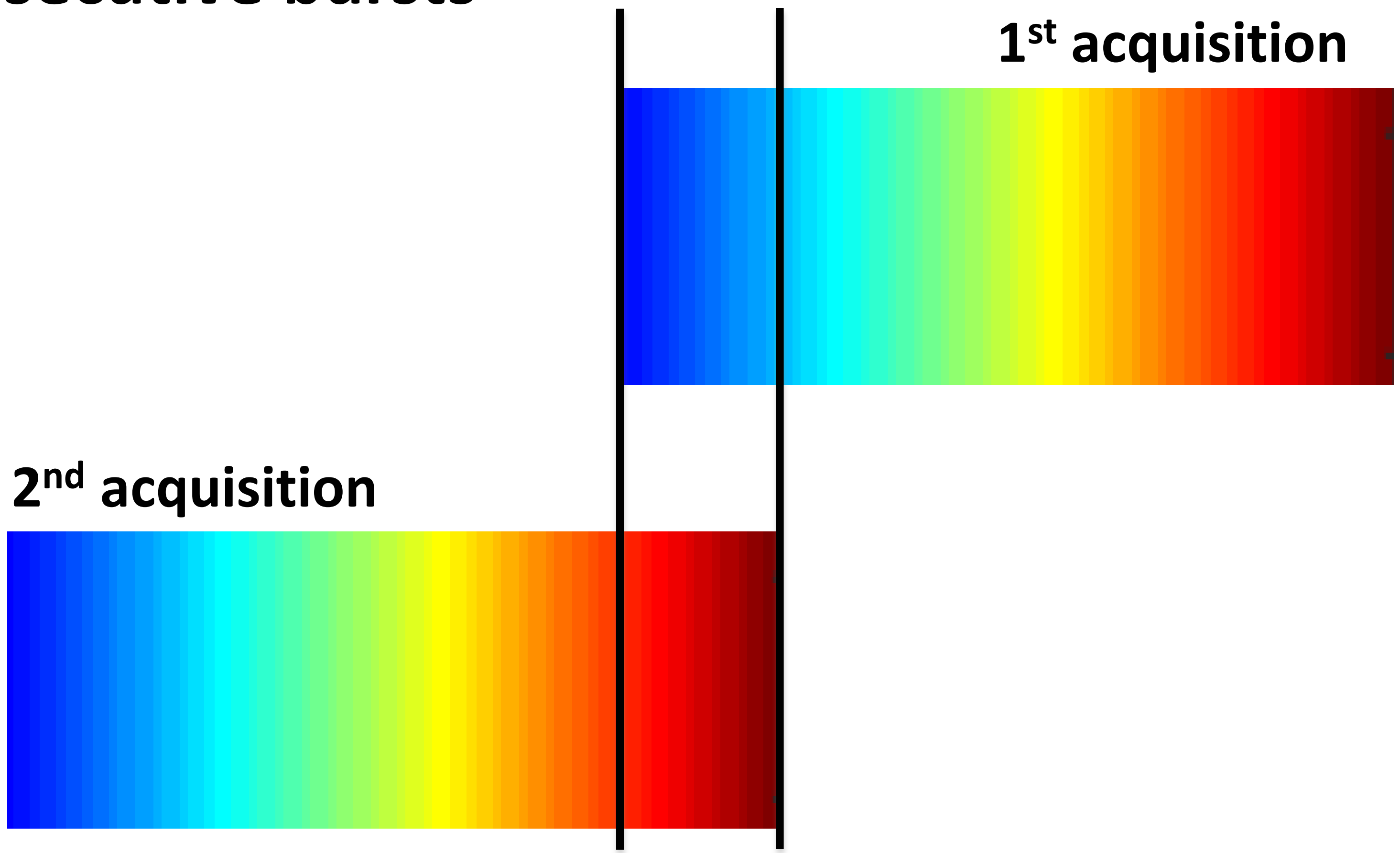
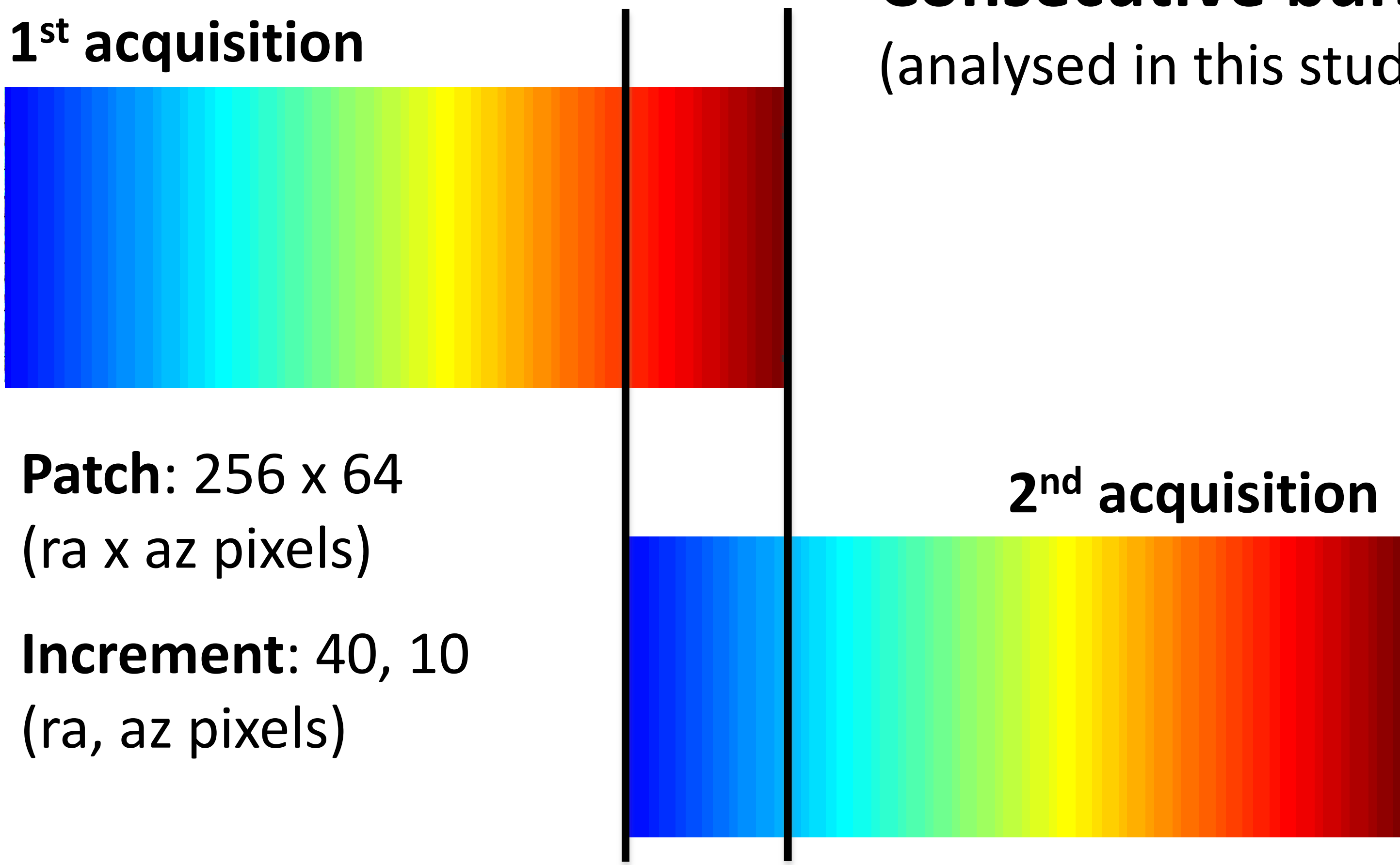


Approach

Consecutive bursts



Approach



Consecutive bursts
(analysed in this study)

1st acquisition

2nd acquisition

Patch: 256 x 64
(ra x az pixels)

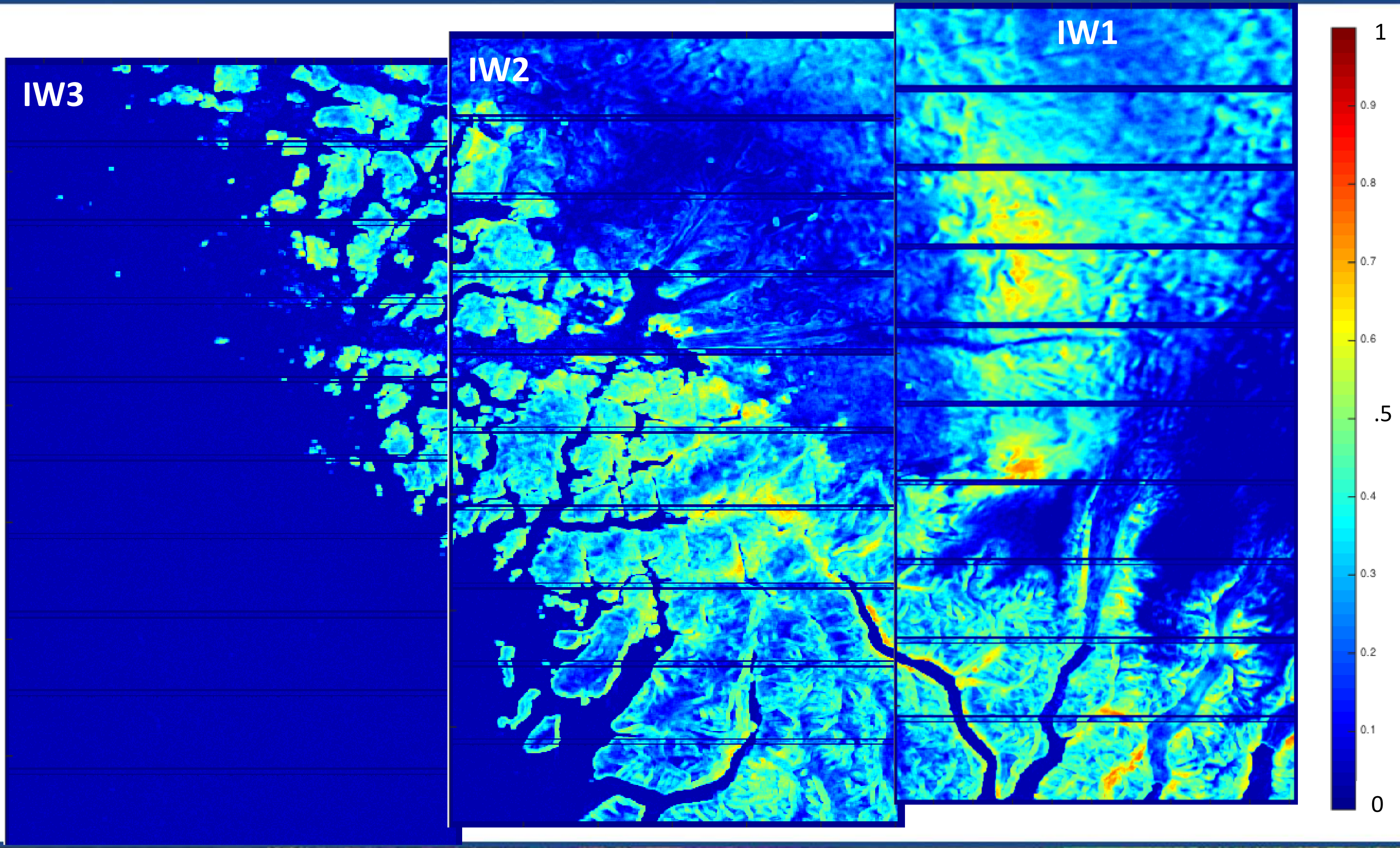
Increment: 40, 10
(ra, az pixels)

Questions addressed

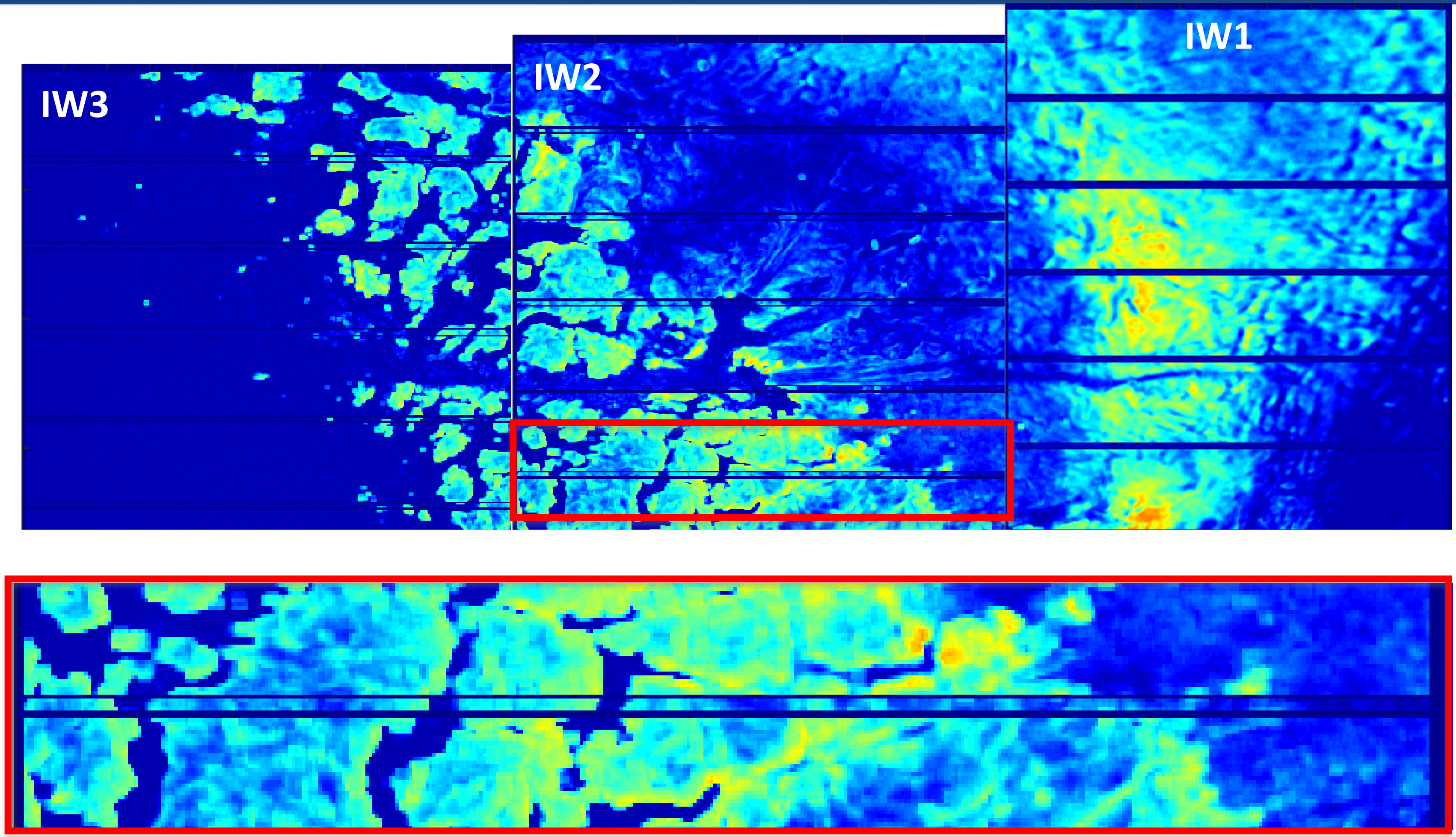
Questions:

- In the overlap area four multi-temporal cross-correlations can be computed. Which ones are useful?
- Where do consecutive (multi-temporal) bursts decorrelate?
- Does the GRD product lead to more velocity gaps?
- Do the dual squint angles within the burst overlap provide valuable glaciological information?

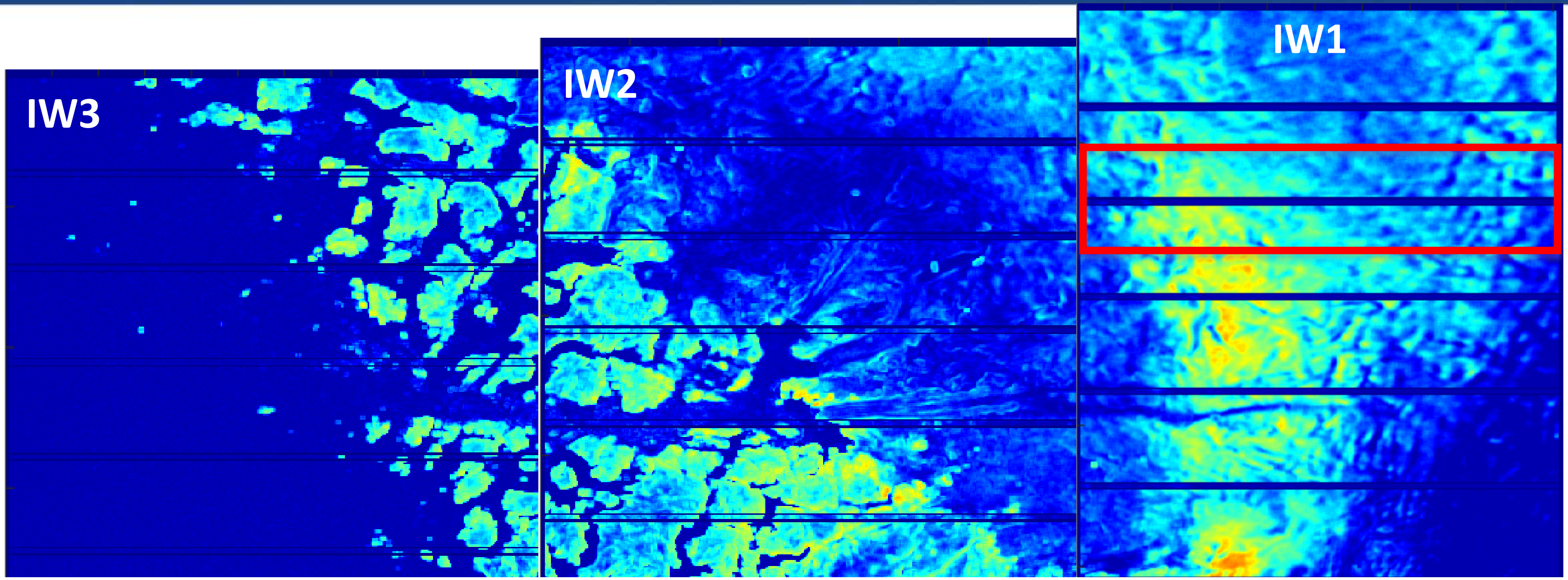
Results: NCC

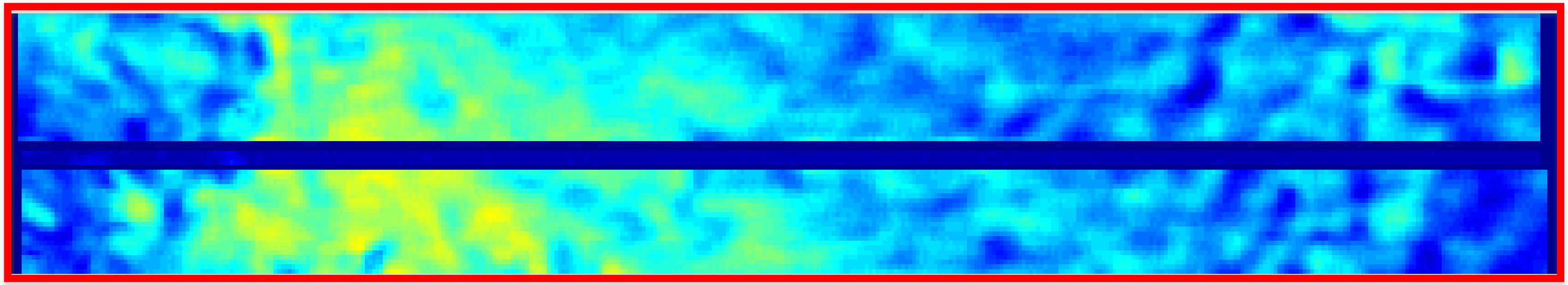


Results: NCC

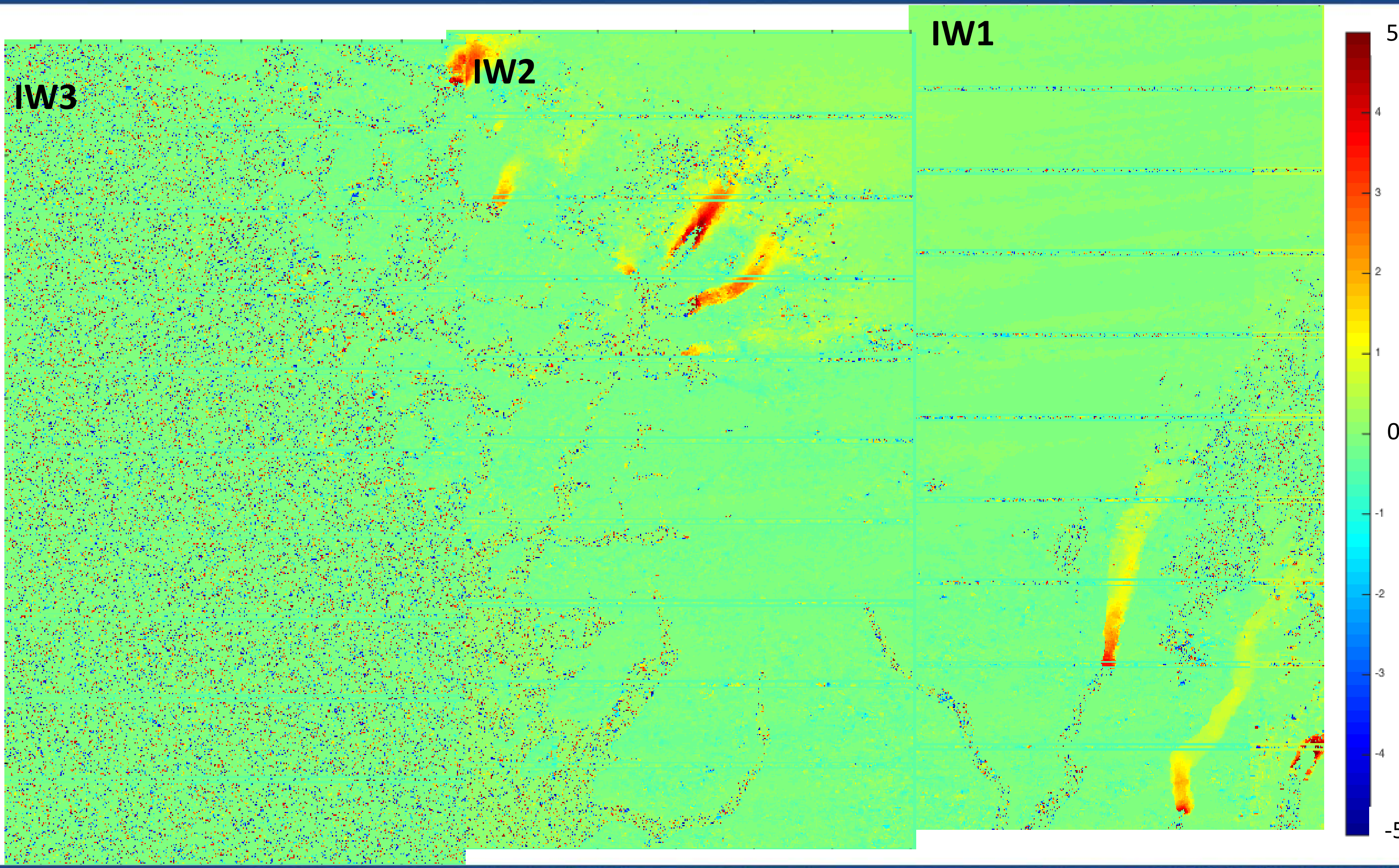


Results: NCC

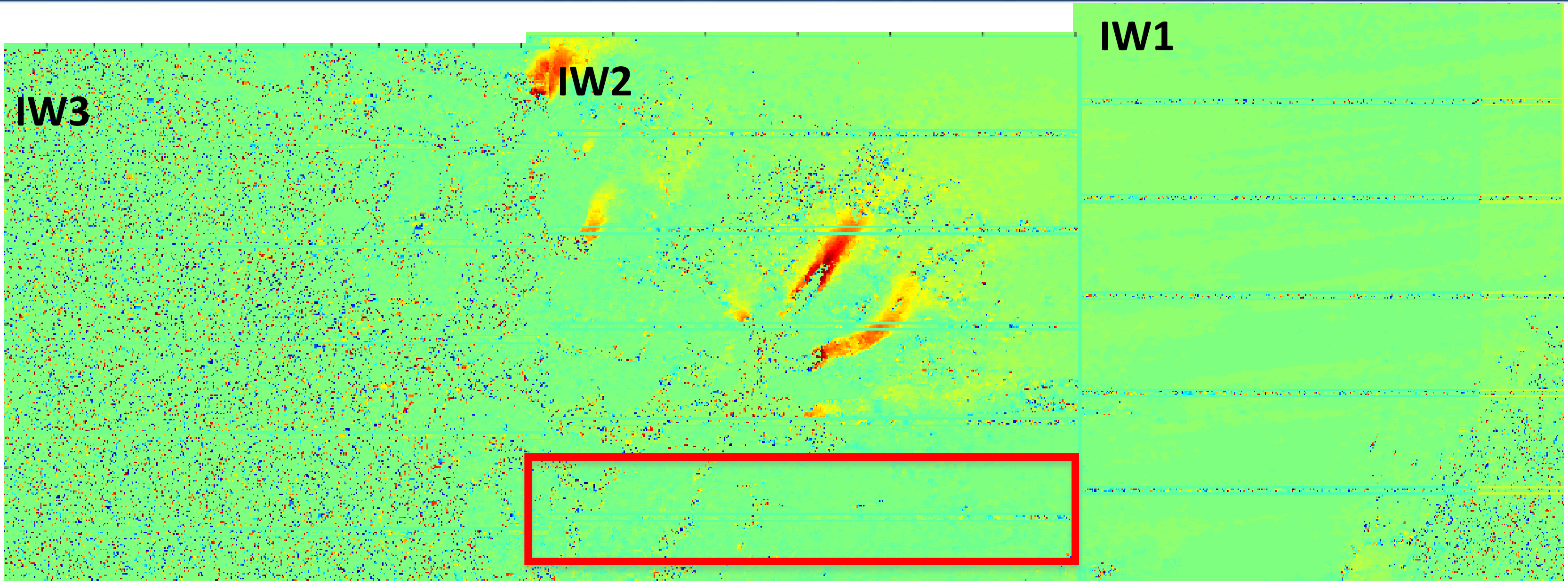


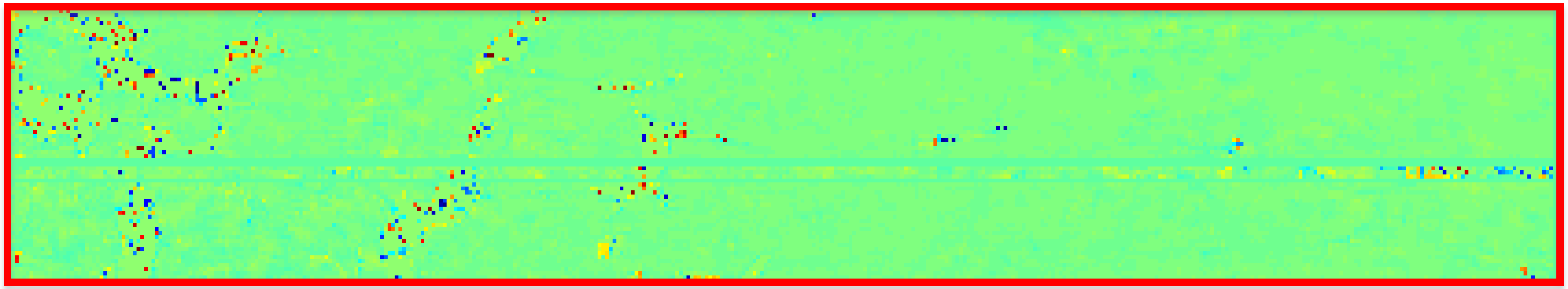


Results: azimuth displacement

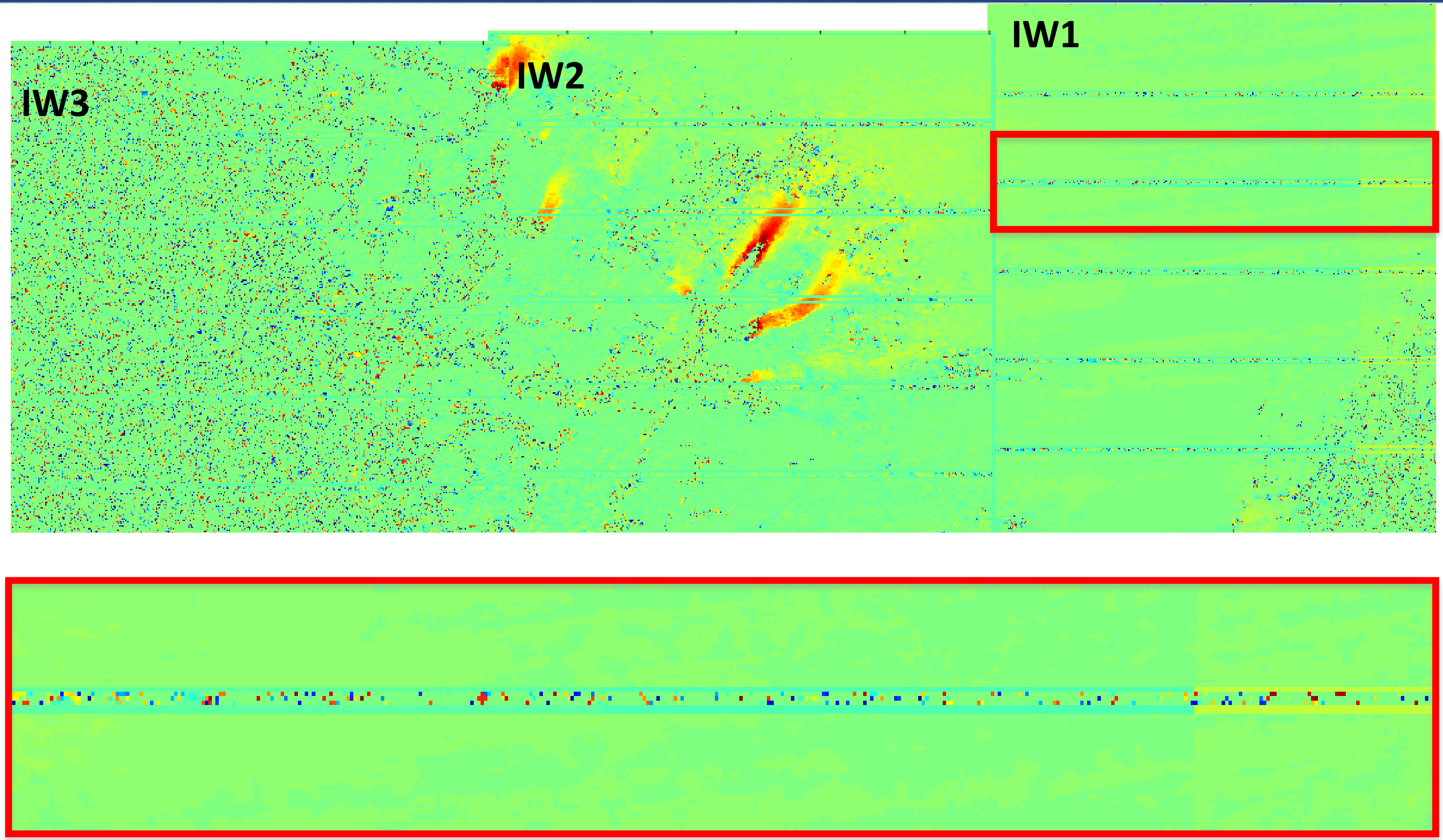


Results: azimuth displacement

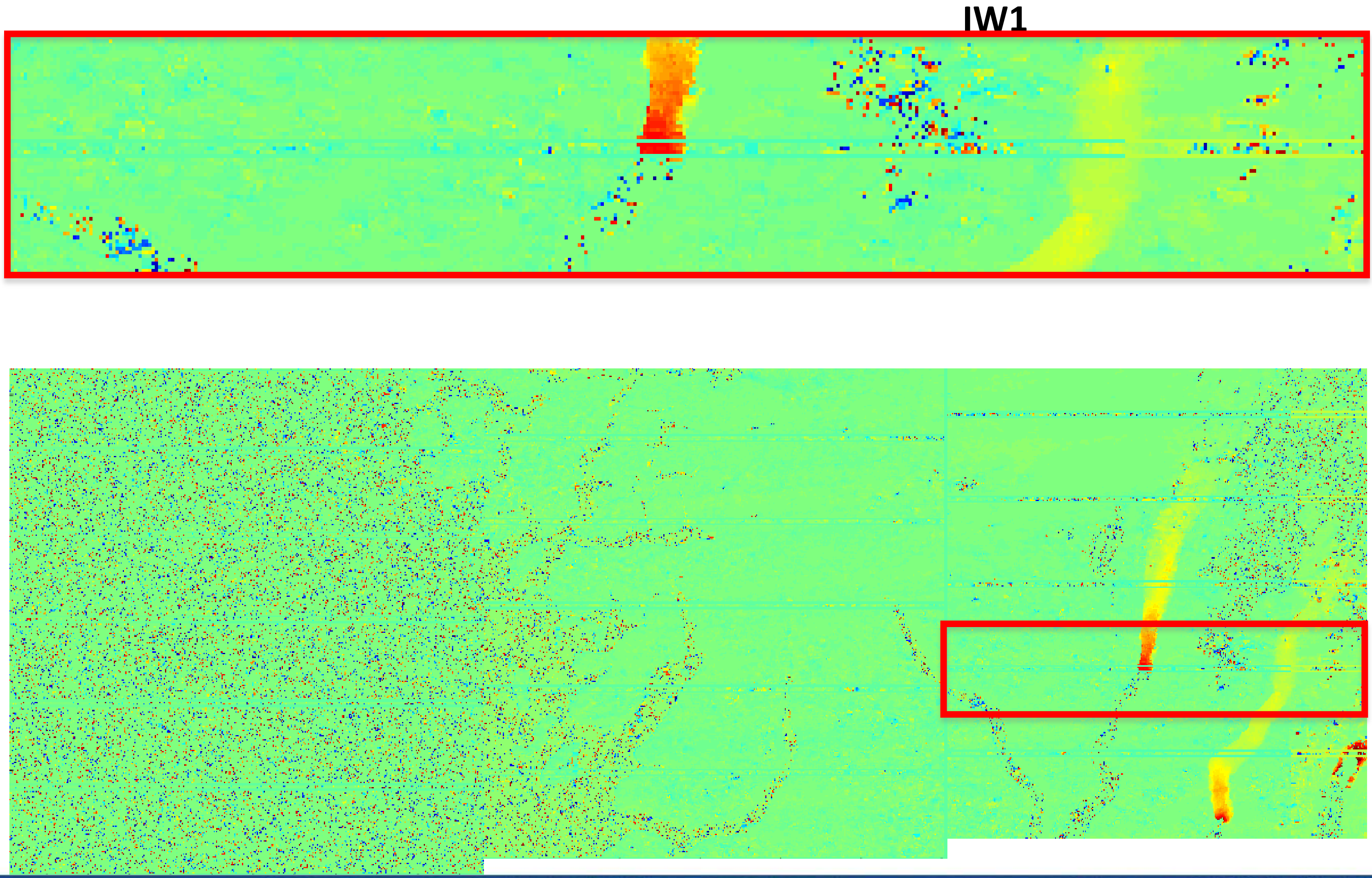




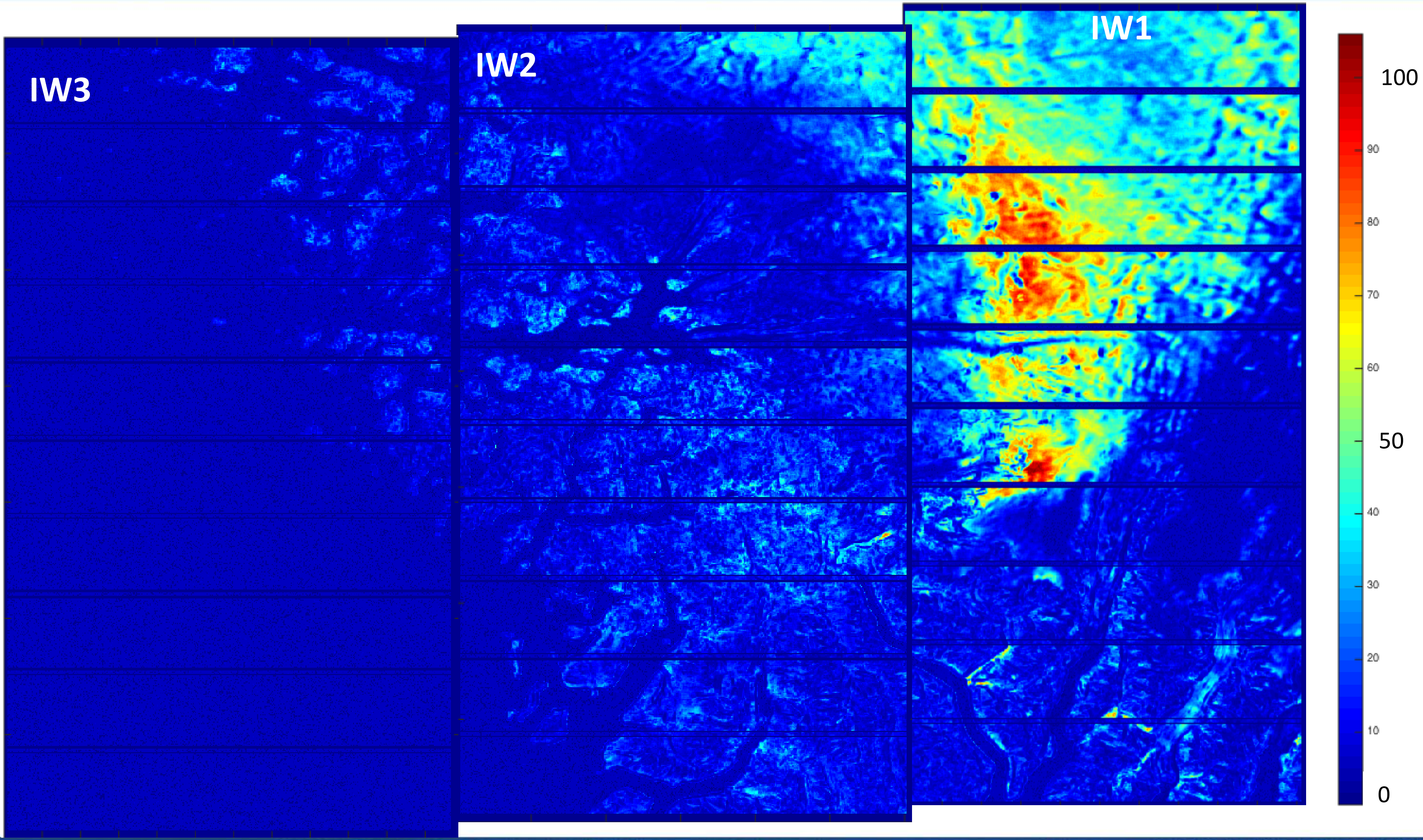
Results: azimuth displacement



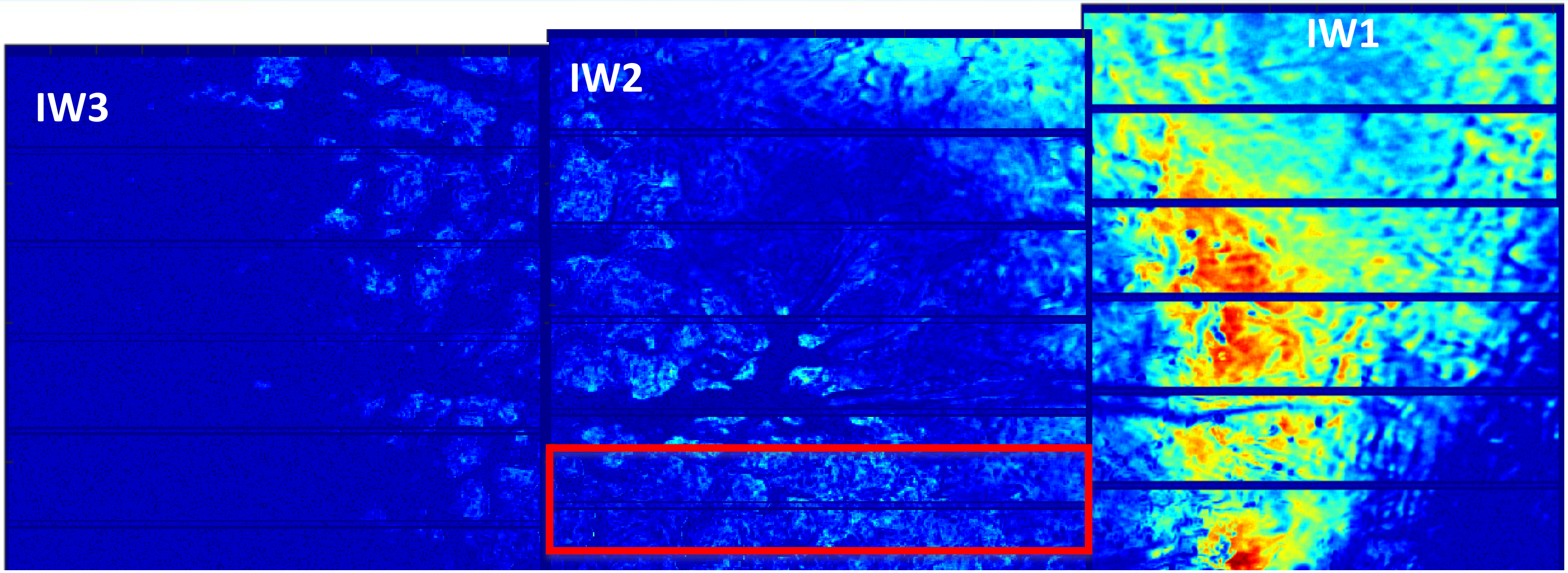
Results: azimuth displacement

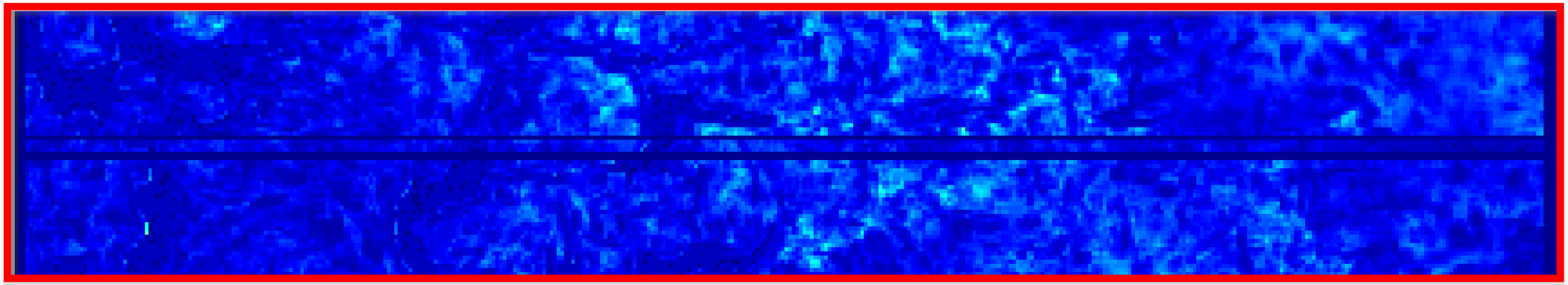


Results: SNR

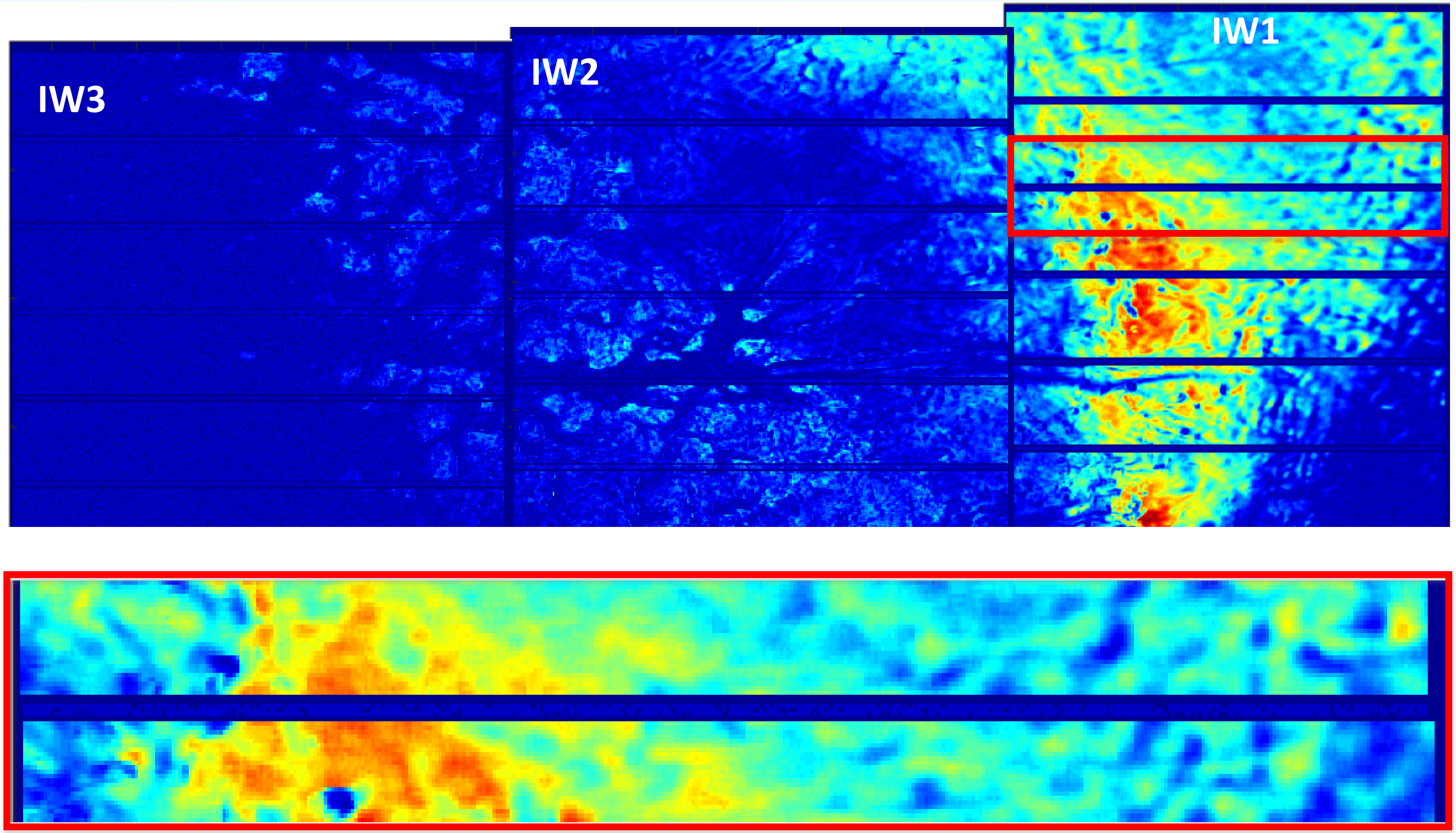


Results: SNR

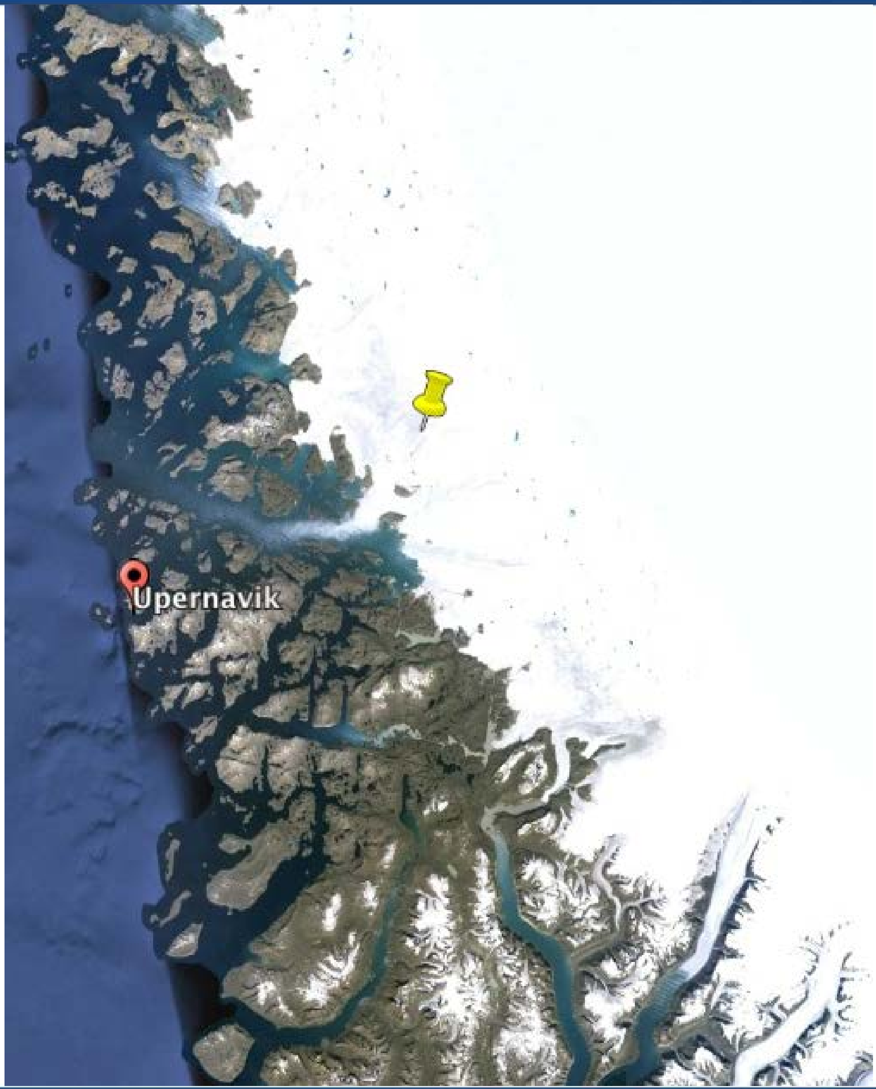




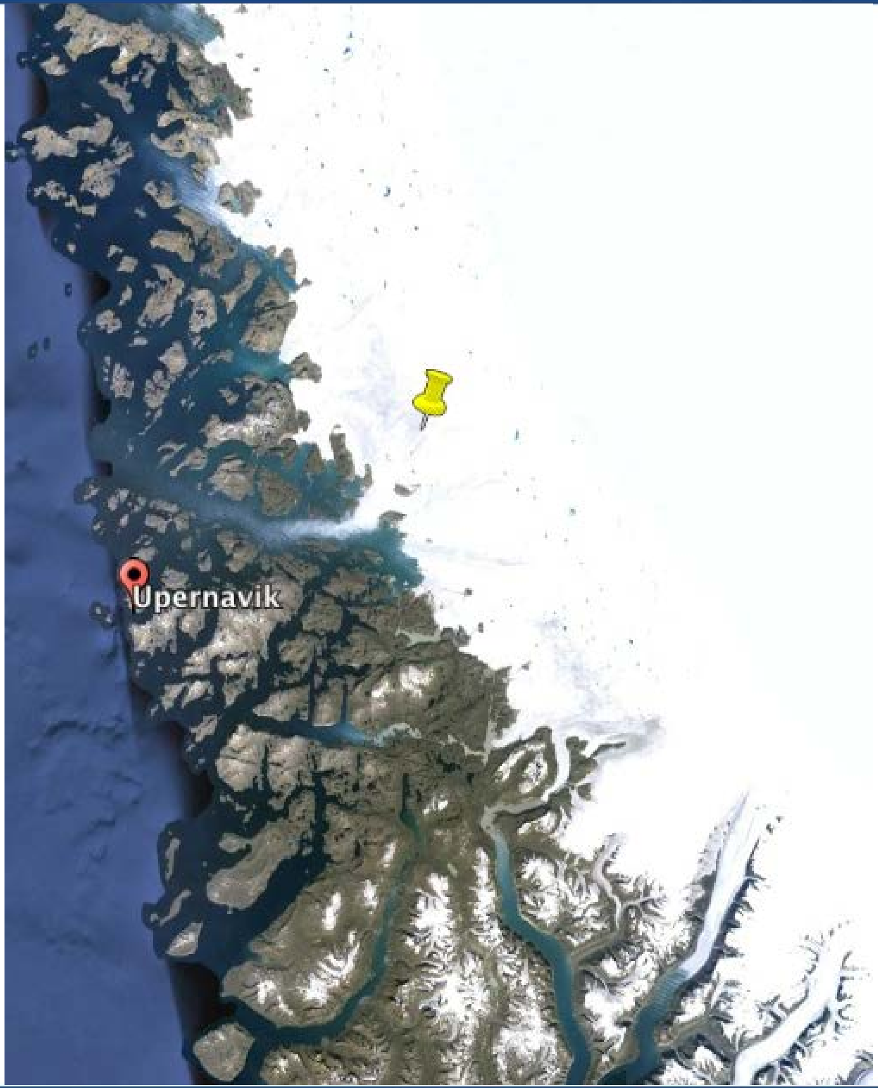
Results: SNR



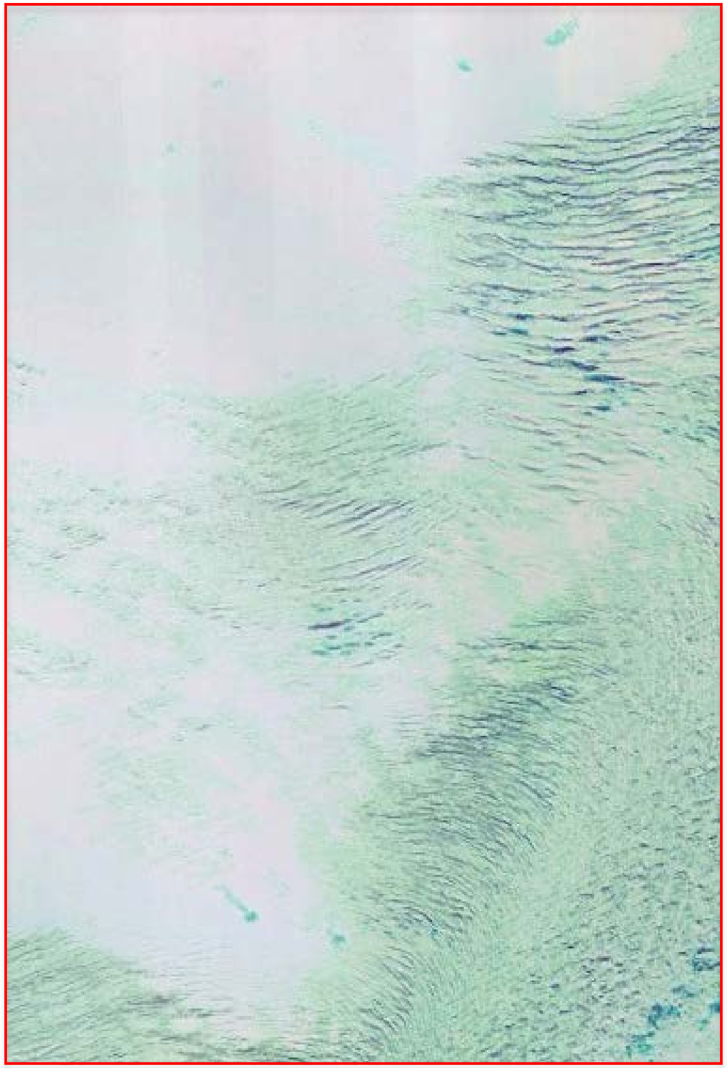
Landsat imagery



Landsat imagery



Landsat imagery



Conclusions

- Velocity map successfully generated from Sentinel-1 IW SLC data in areas with and without features
- At high elevations, two corresponding (multi-temporal) bursts can be successfully cross-correlated, but two consecutive bursts cannot (presumably due to a lack of ice features)
- At low elevations (where ice features are often abundant) also consecutive (multi-temporal) bursts can often be successfully cross-correlated
- The IW GRD product may be applicable for (gap-free) feature tracking
- The IW SLC product is required for (gap-free) speckle tracking