Image-based change detection to reduce false alarms in the Vision1200 synthetic aperture sonar

Dr. C. Erdmann and Dr. J. Groen

… a sound decision

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Image-based Change Detection

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Image-based Change Detection

Basic processing chain

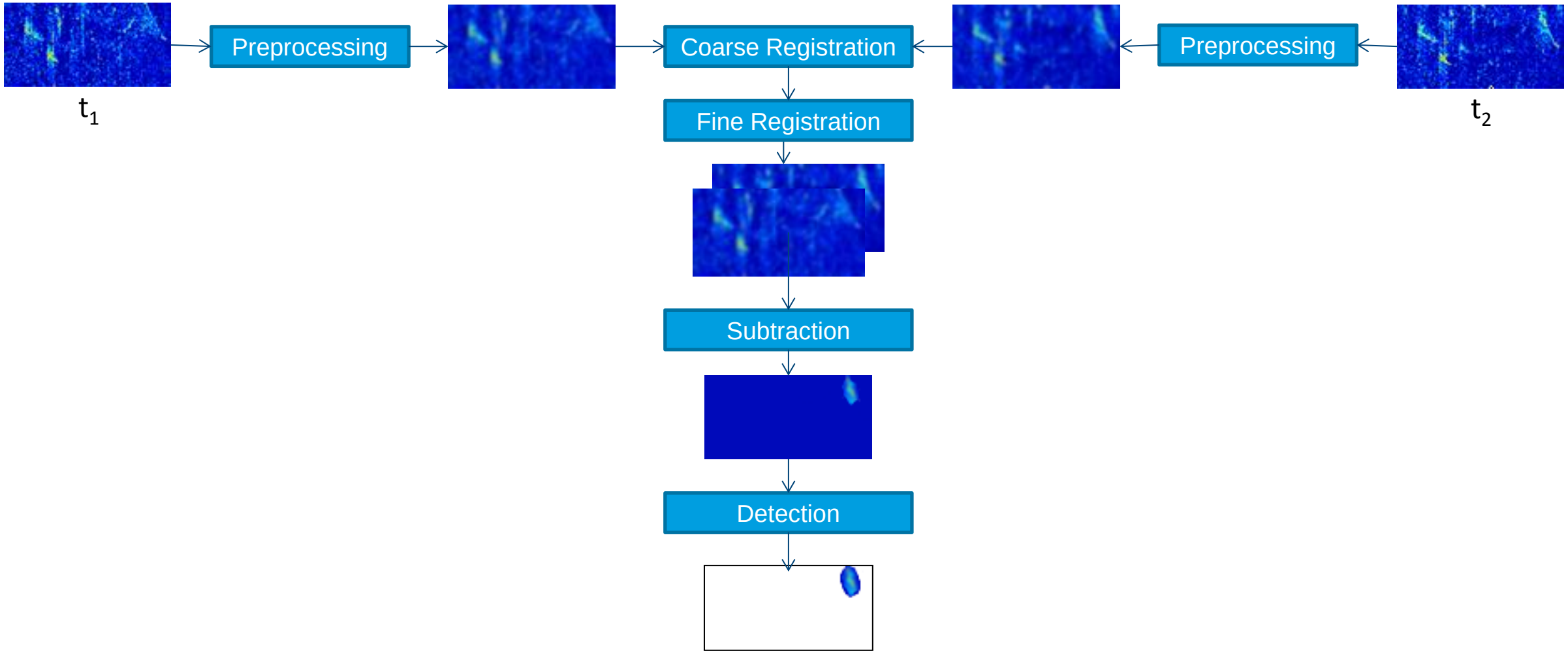

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Image-based Change Detection

Survey

- ITMINEX NATO Trial 2014
  - Study commissioned by WTD 71
  - Provision of RV „Alliance“ and trial organization by CMRE
- 3 identical missions
- 2 different sets of 7 objects
- 34 usable legs with total of 116 MLO images
- Sea Otter AUV
- ATLAS ELEKTRONIK UK „Vision MK1 1200“ SAS System

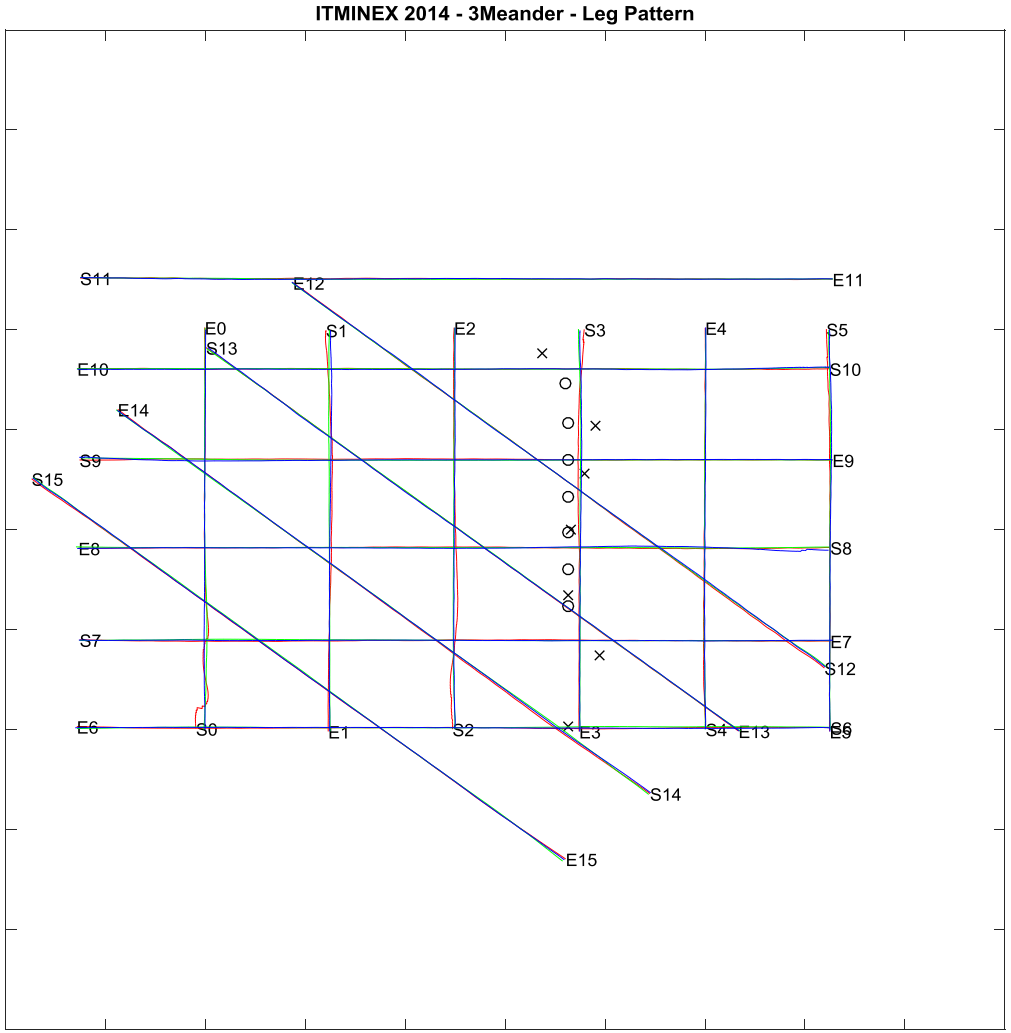
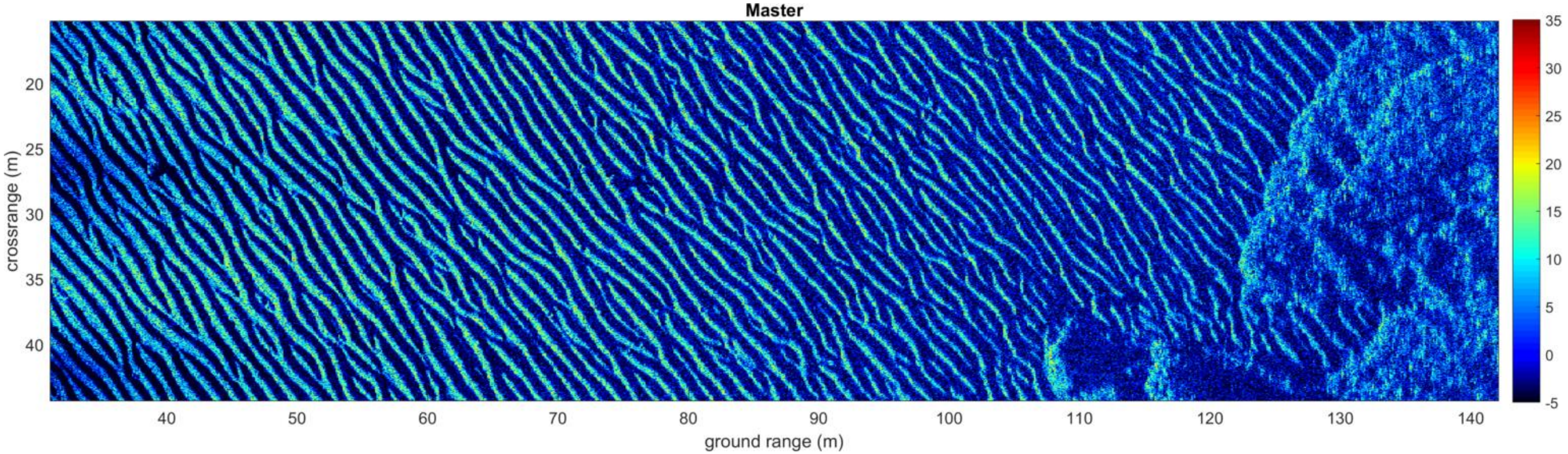


Image-based Change Detection

Data: typical example



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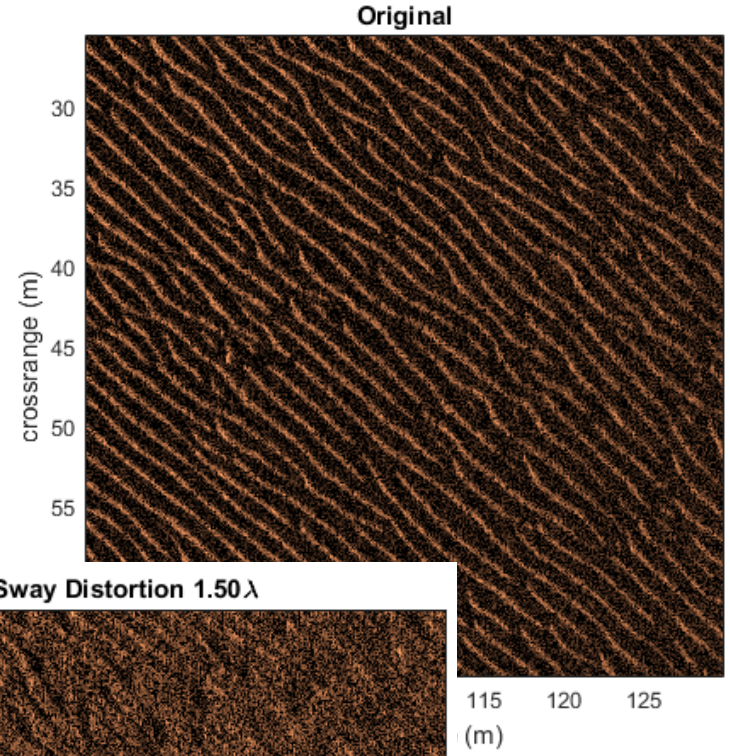
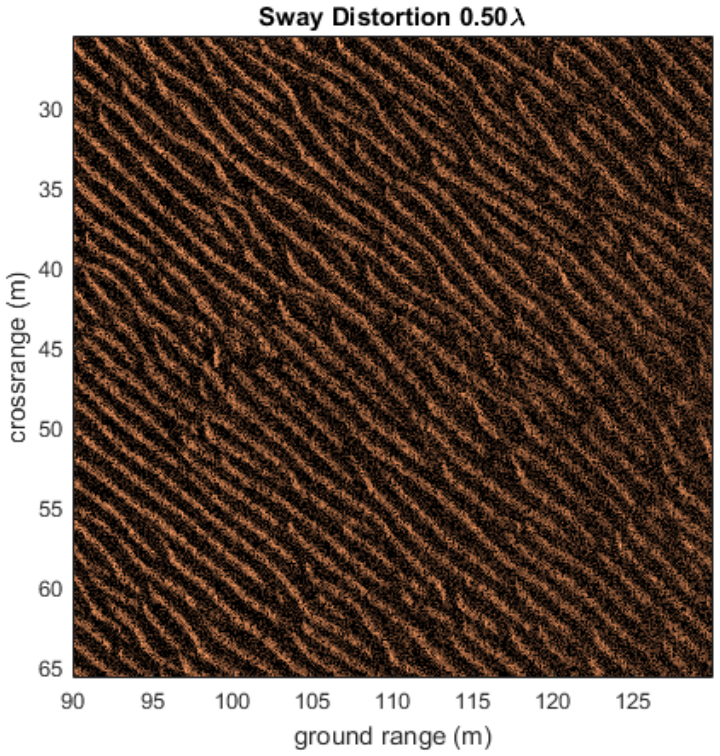
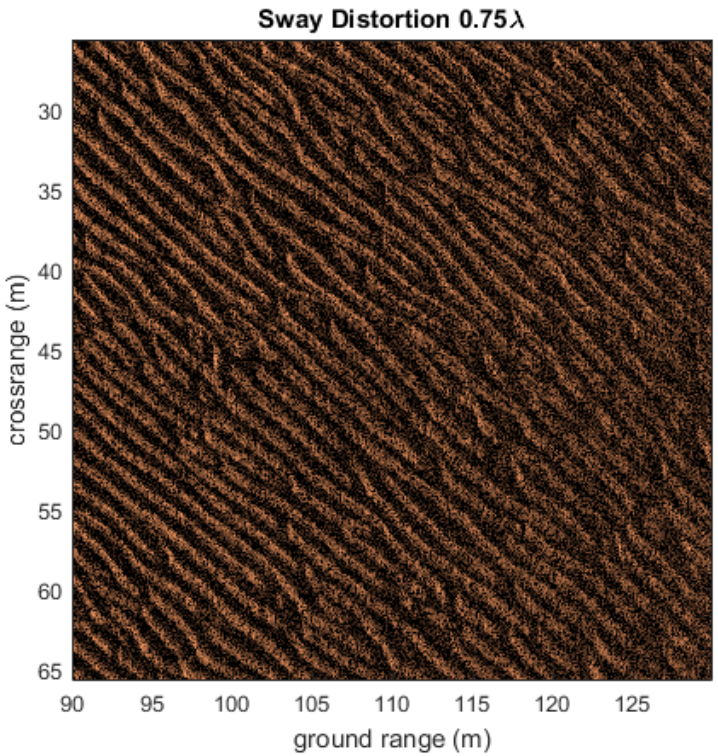
Data processing

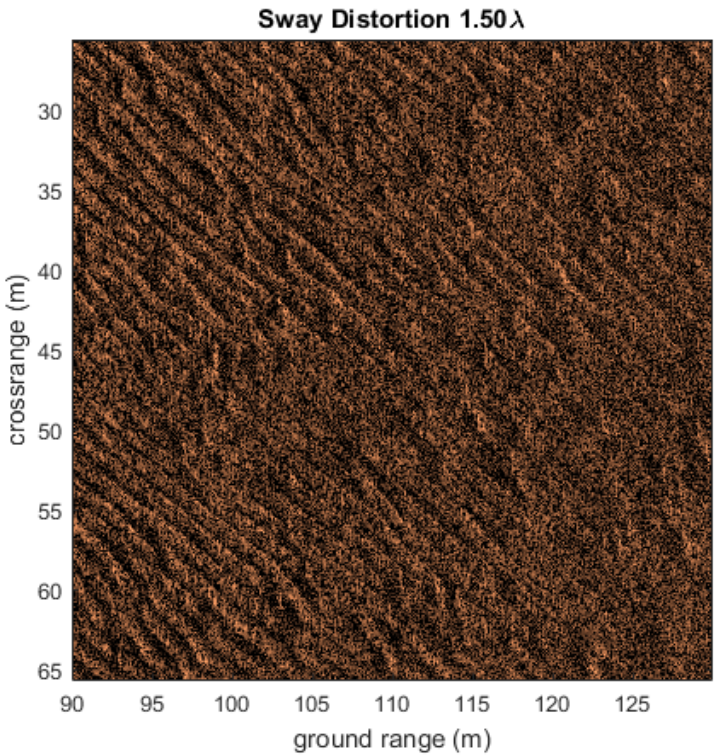
SAS processing

- ATLAS ELEKTRONIK SAS processing chain
- Artificial defocusing by sway data distortion









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Data Processing

Normalization and Filtering

- Normalization
  - Based on along-track mean
  - Based on roll data (eliminate roll effect)
  - Based on combined along-track and range median
- Filtering
  - No filtering
  - Lee-filter: speckle-reducing
  - Anisotropic diffusion filter: edge-preserving

Image Registration

Coarse registration

- Rigid registration
- Maximize correlation coefficient of whole image
- Rotation correction
- Δx, Δy: 2cm, Δφ: 0.1°

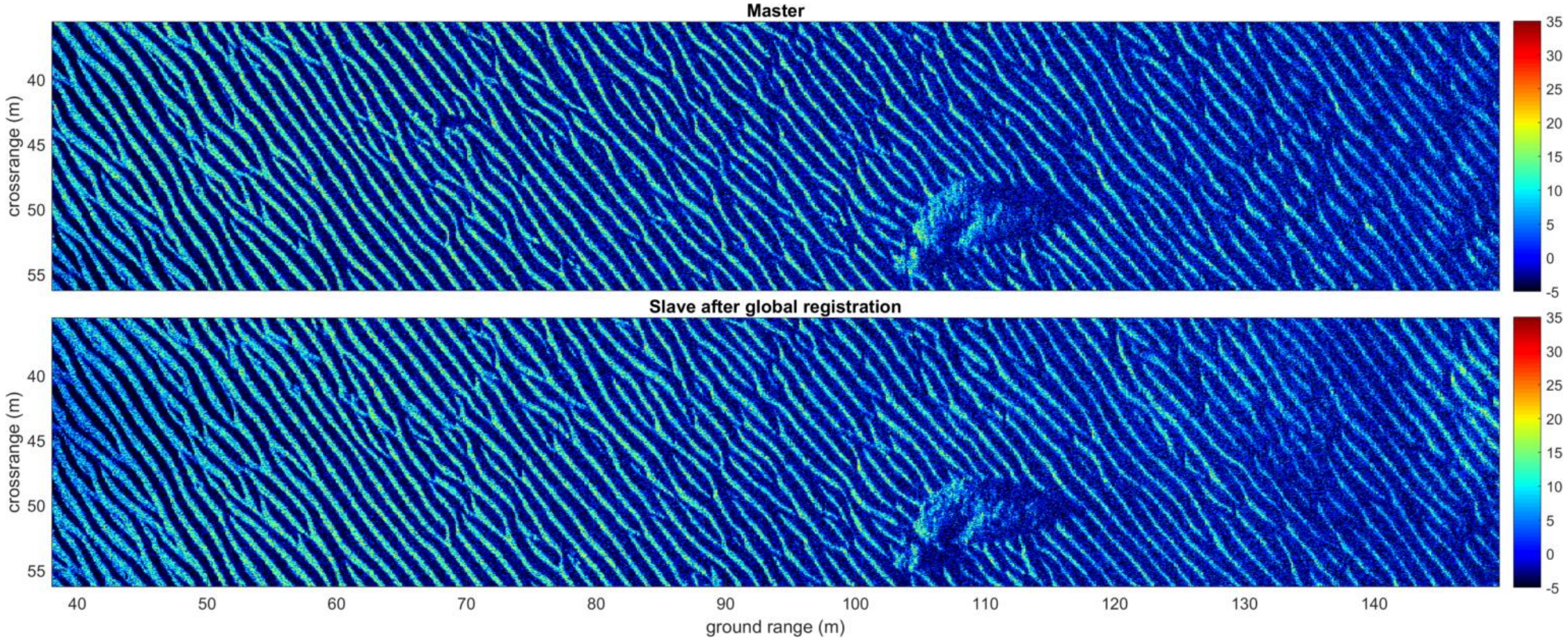

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Image Registration

Fine Registration

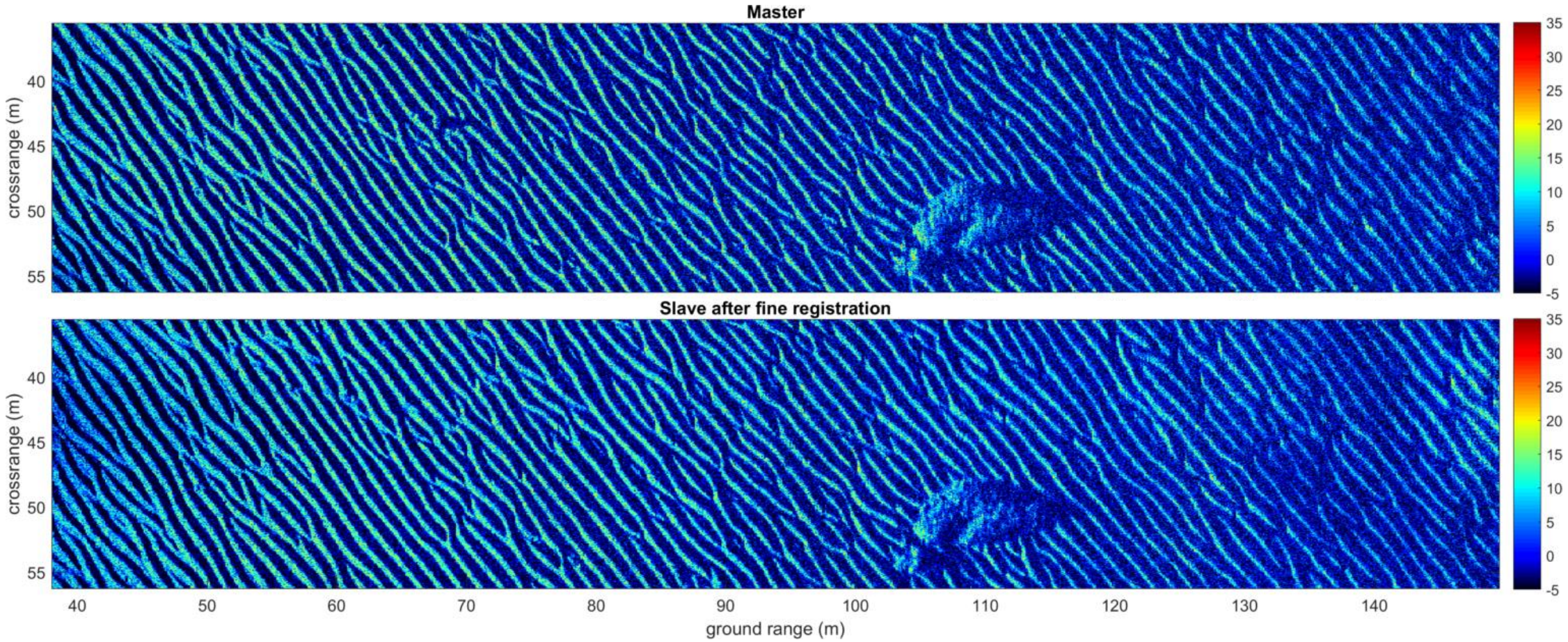

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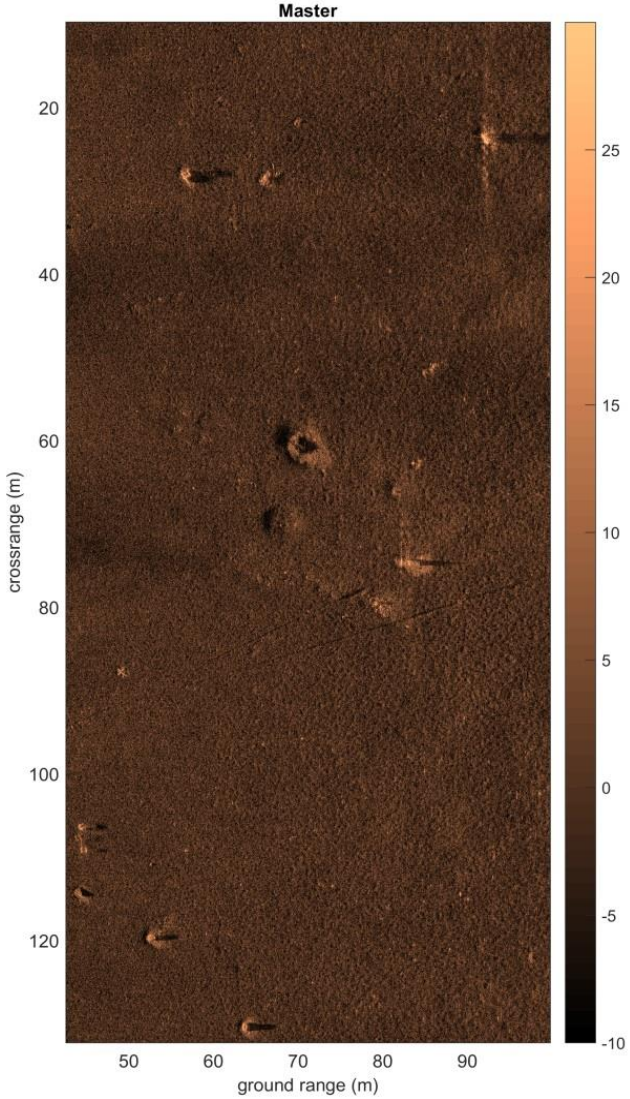
Image Registration

Coherent Fine Registration



Δt = 3 h

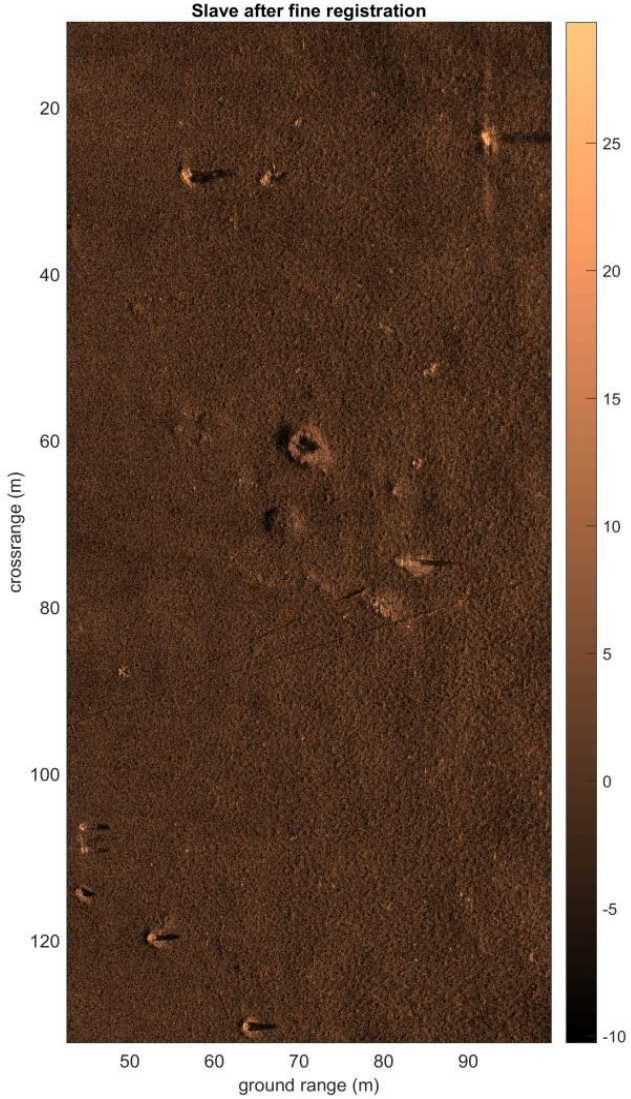


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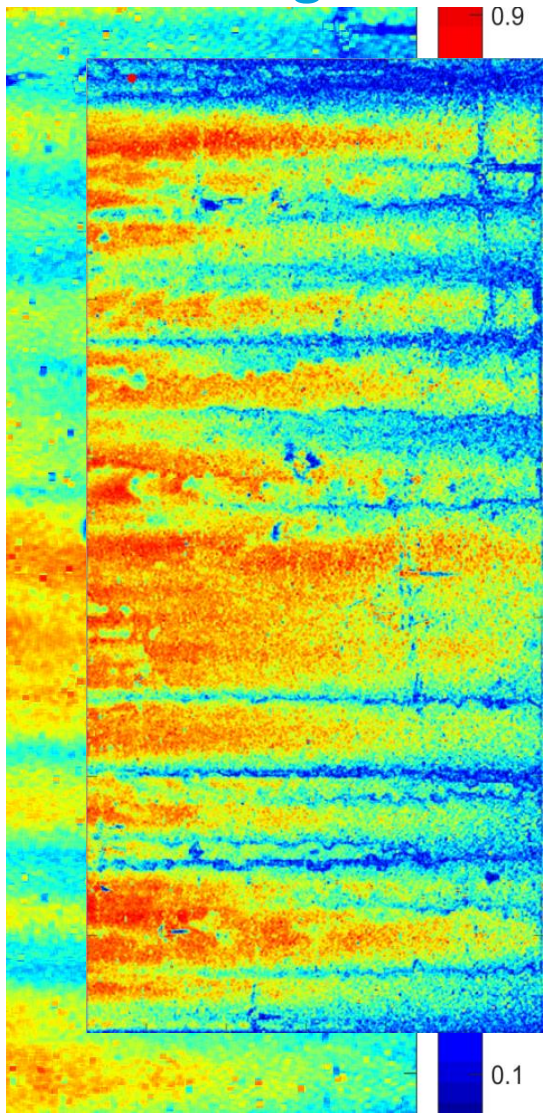
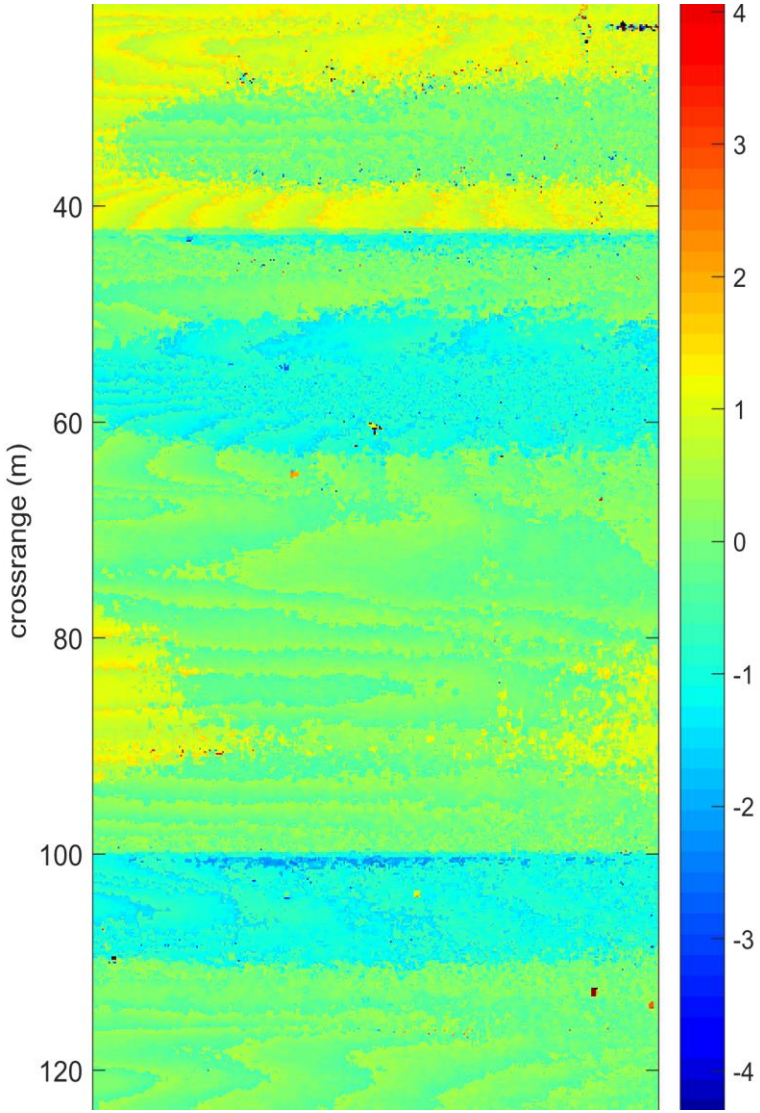
Image Registration

Coherent Fine Registration





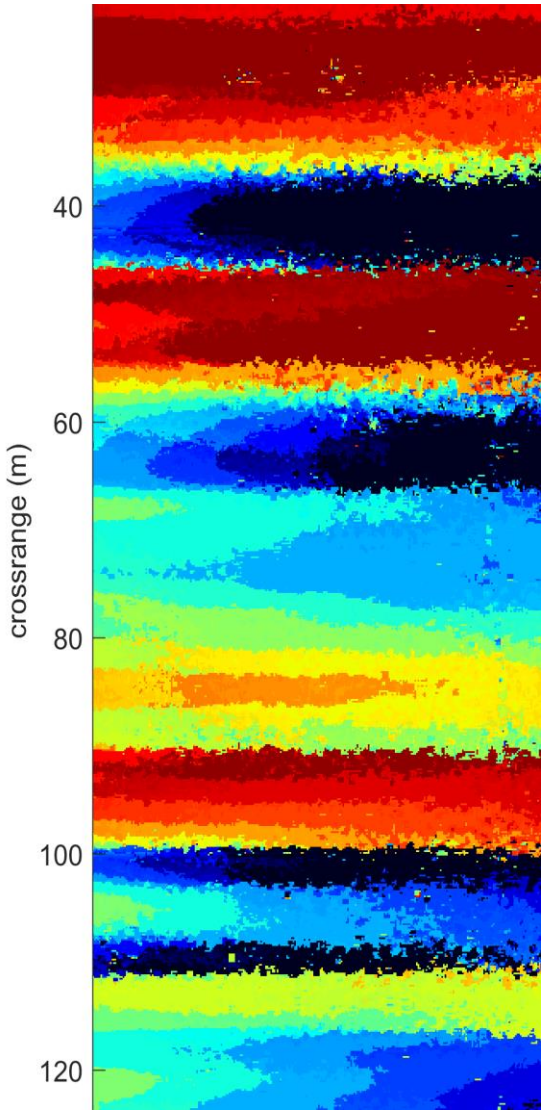


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Image Registration

Coherent vs. Incoherent Fine Registration

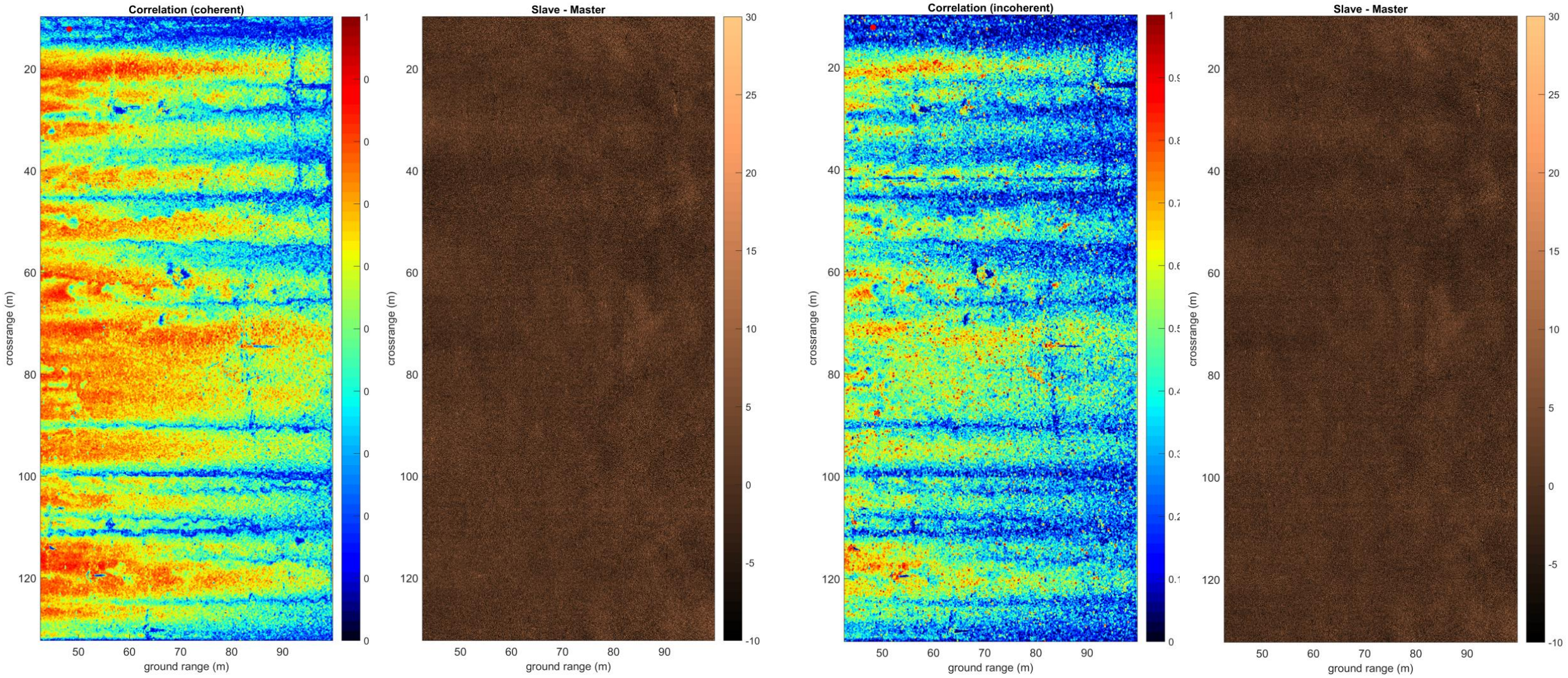

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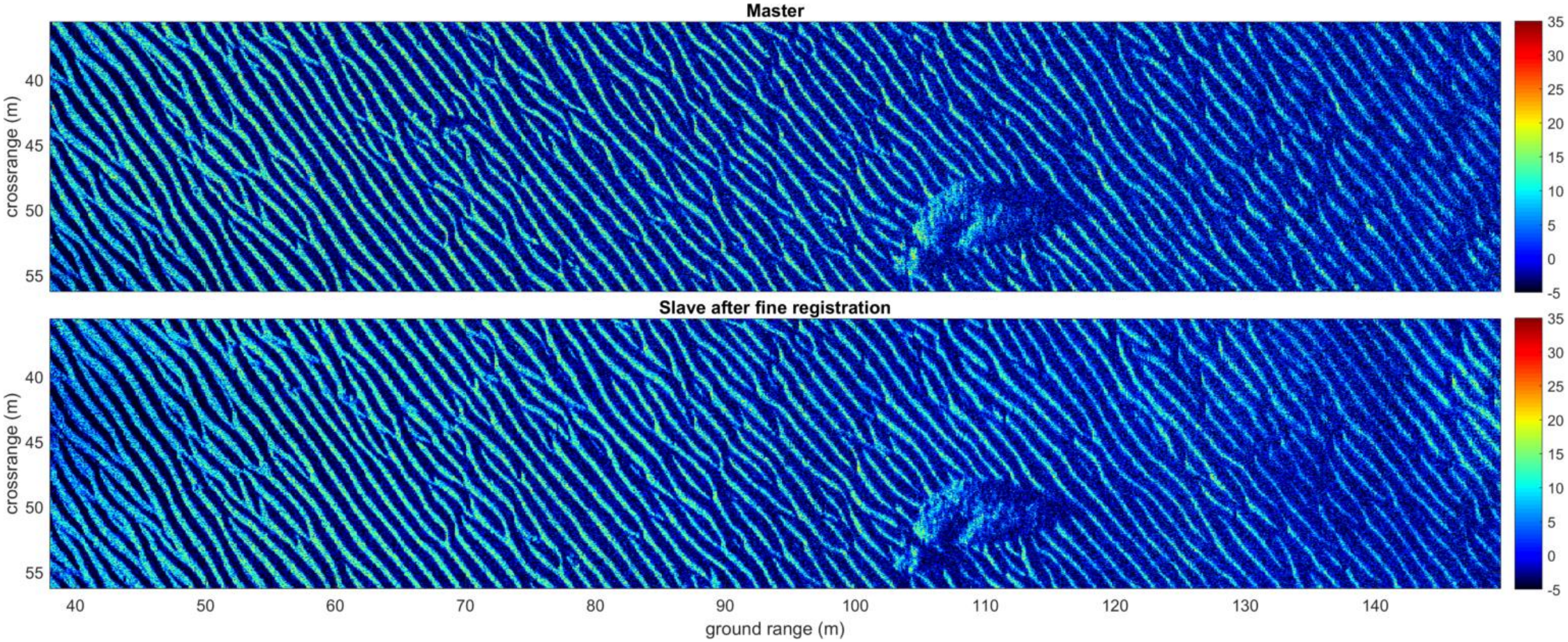
Image Preparation

Subtraction



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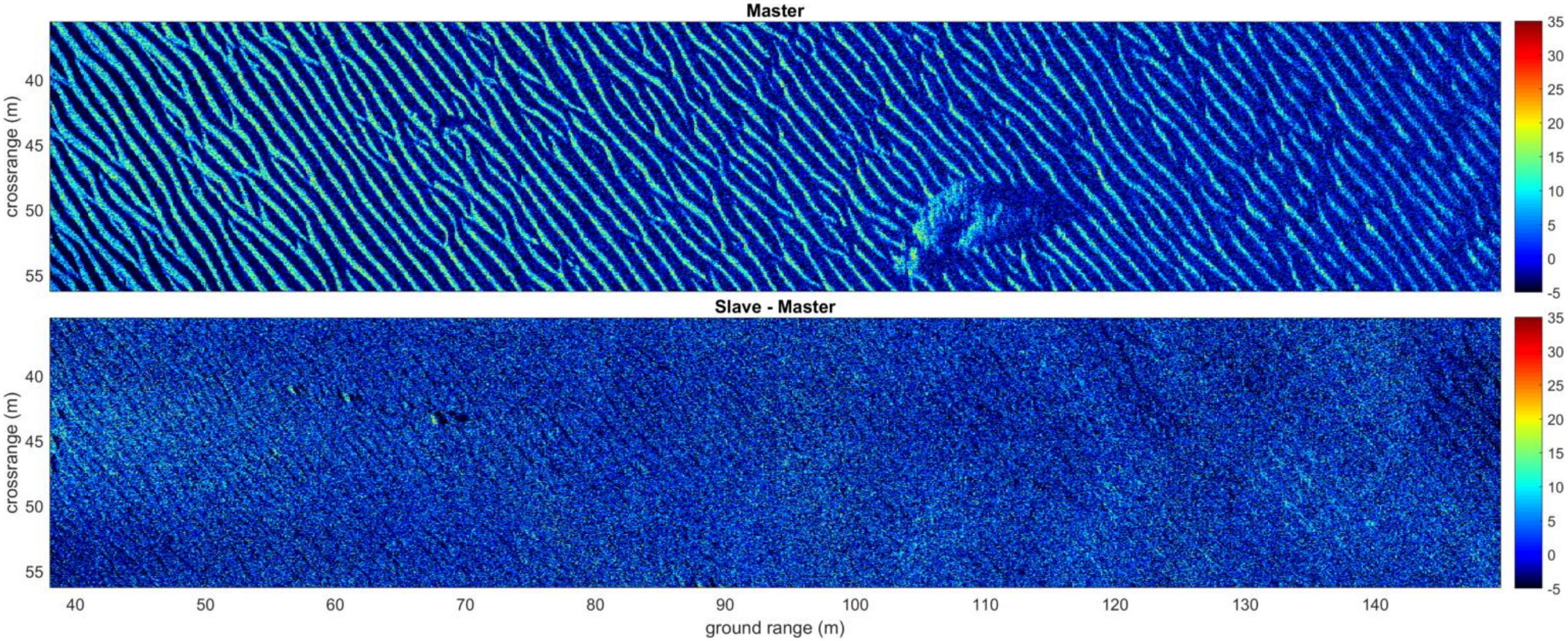
Subtraction



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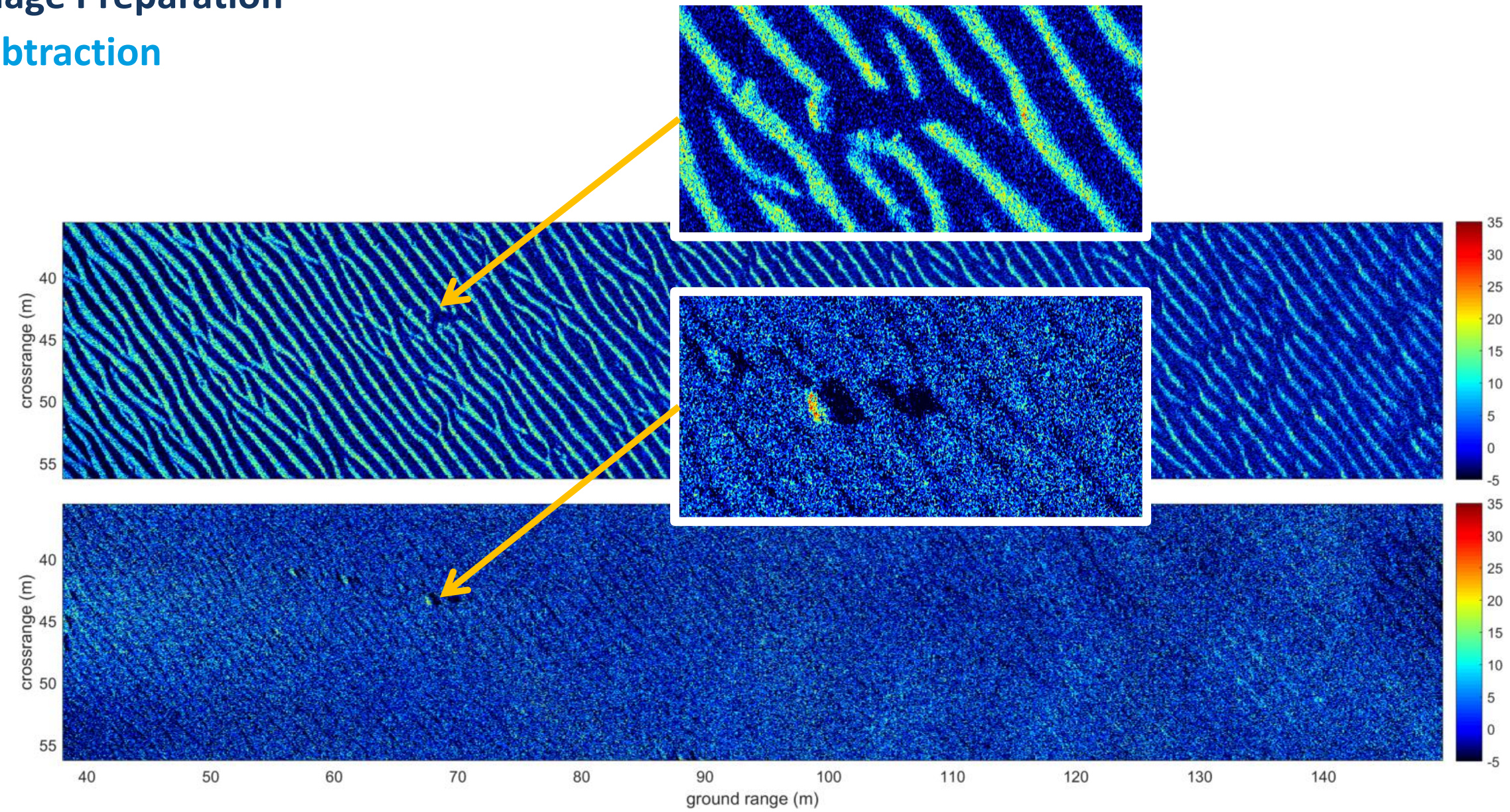
Subtraction



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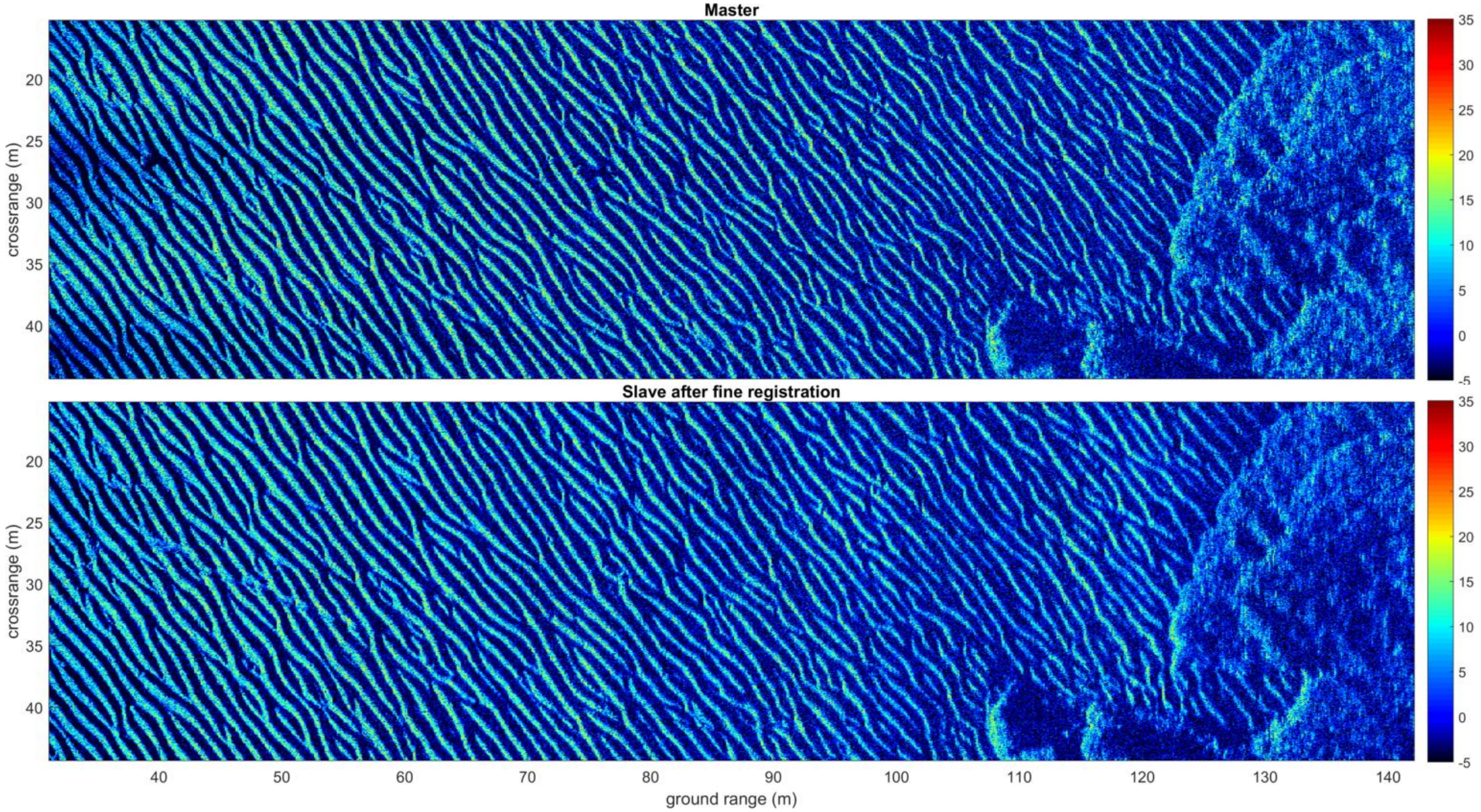
Example 2



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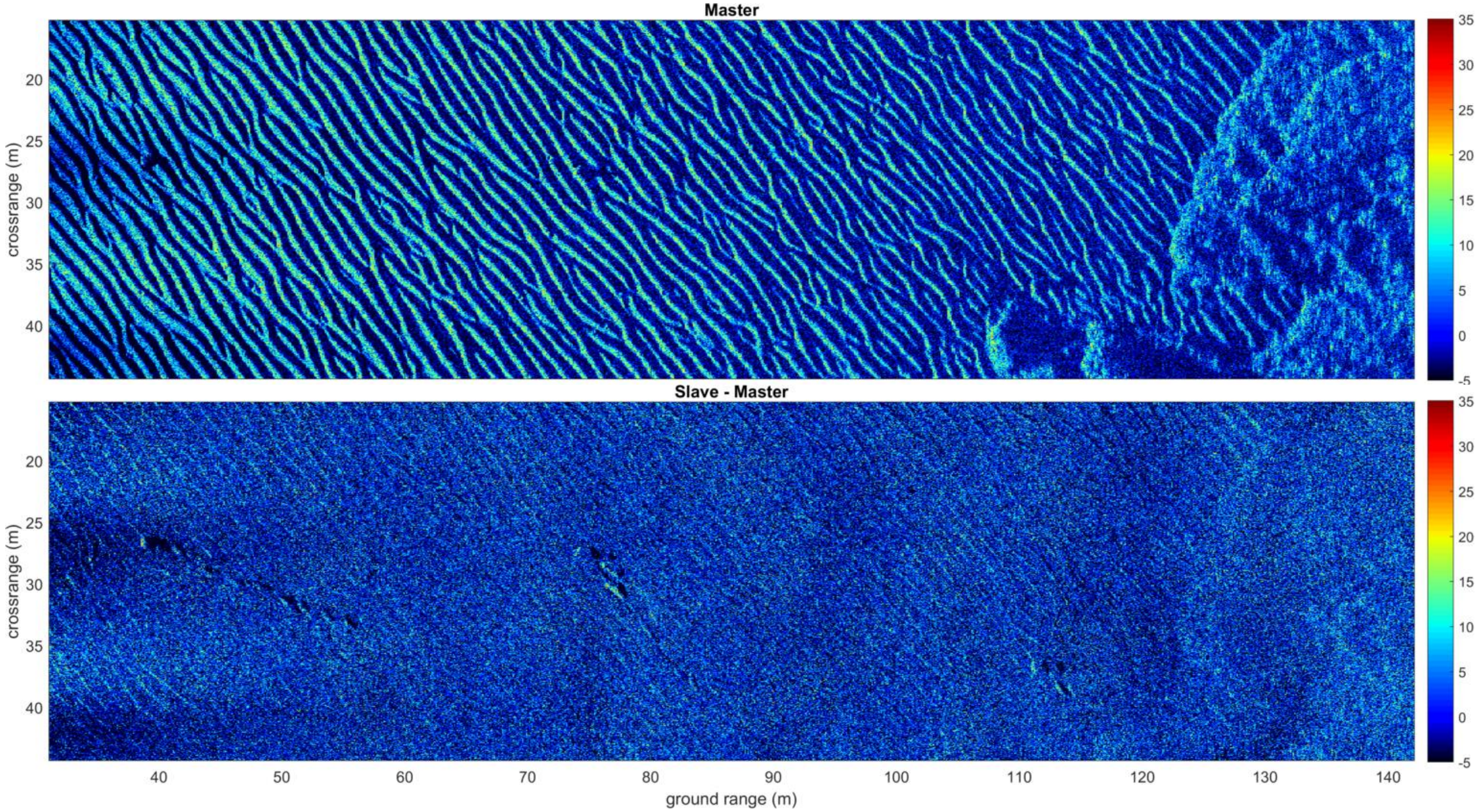
Example 2



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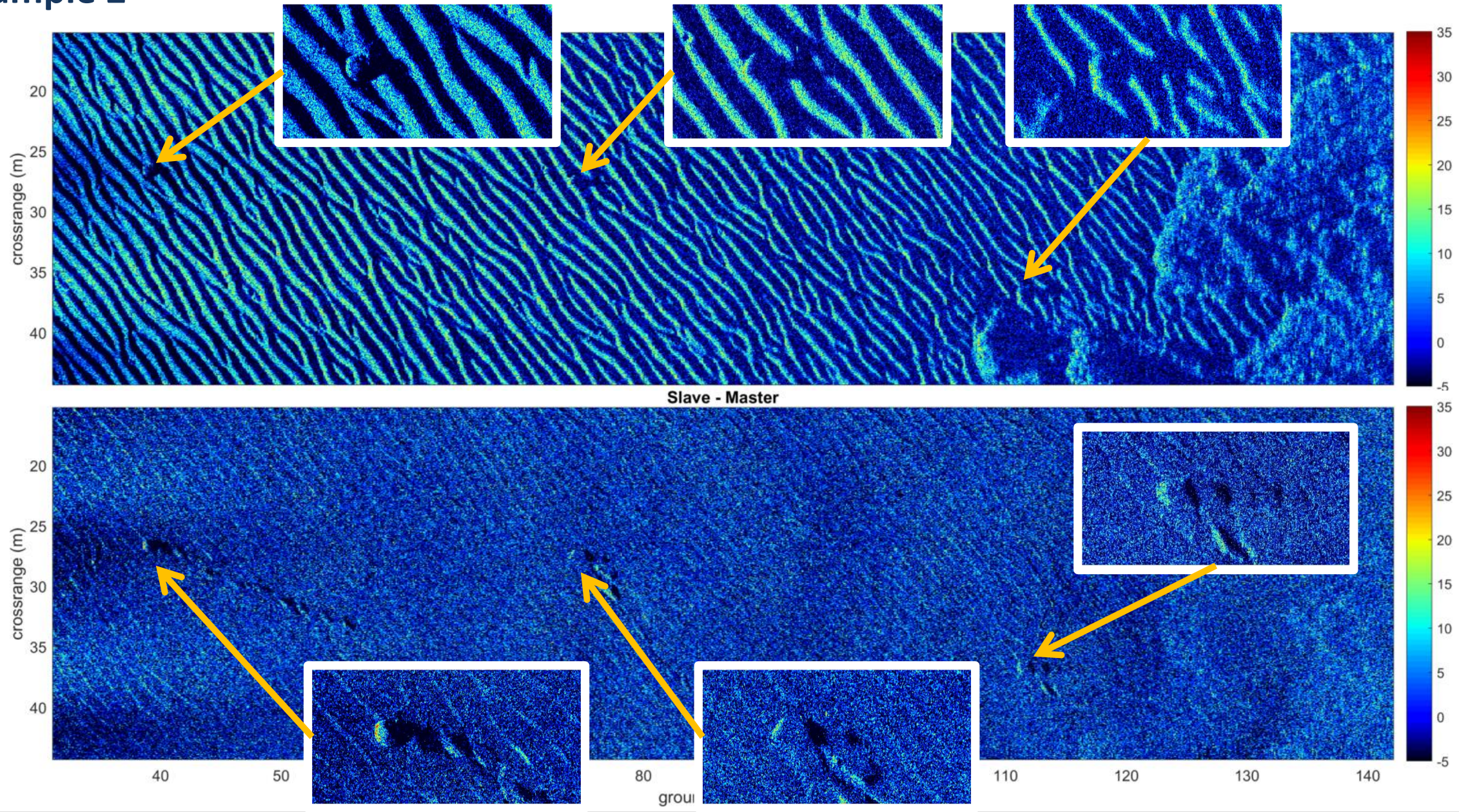
Example 2



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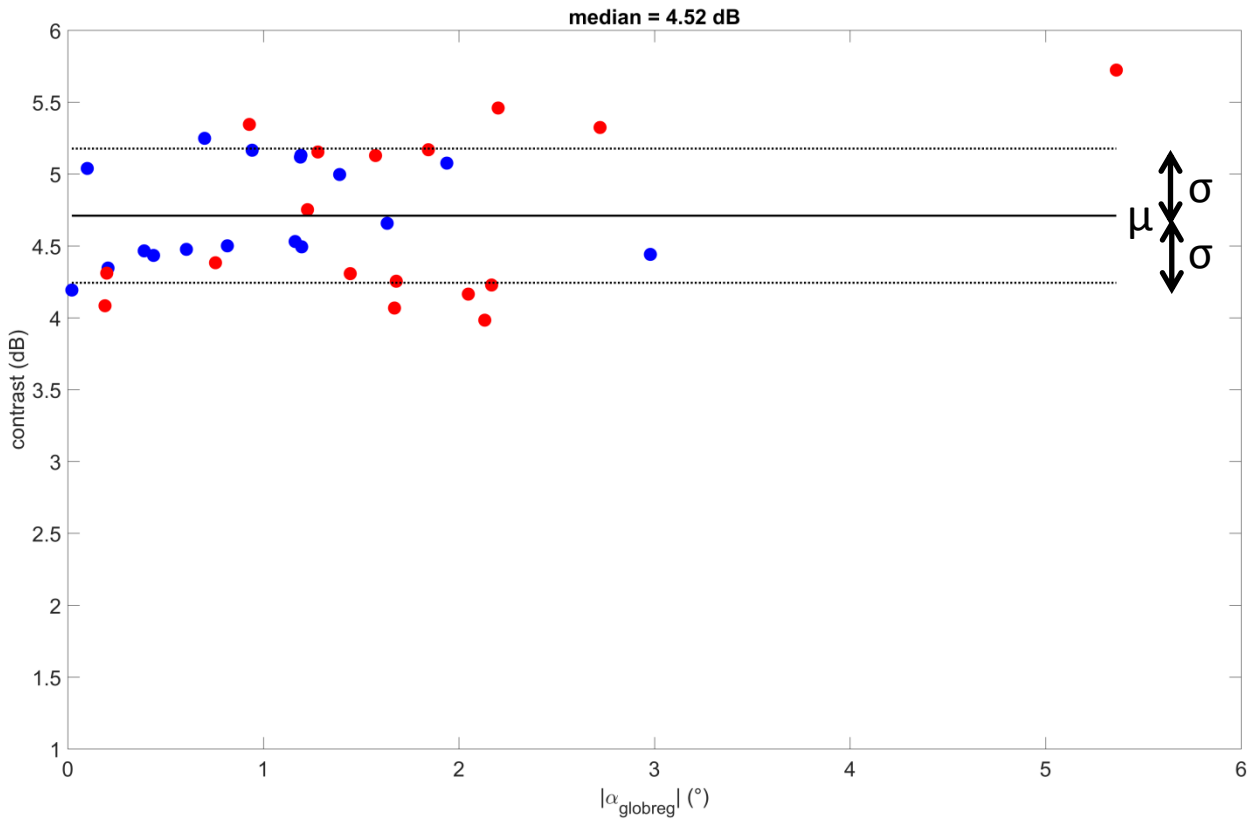
Performance Analysis

Performance Analysis: Overall Image Contrast



Blue: Δt = 26 h
Red: Δt = 56 h

Coherent, 32x32 px

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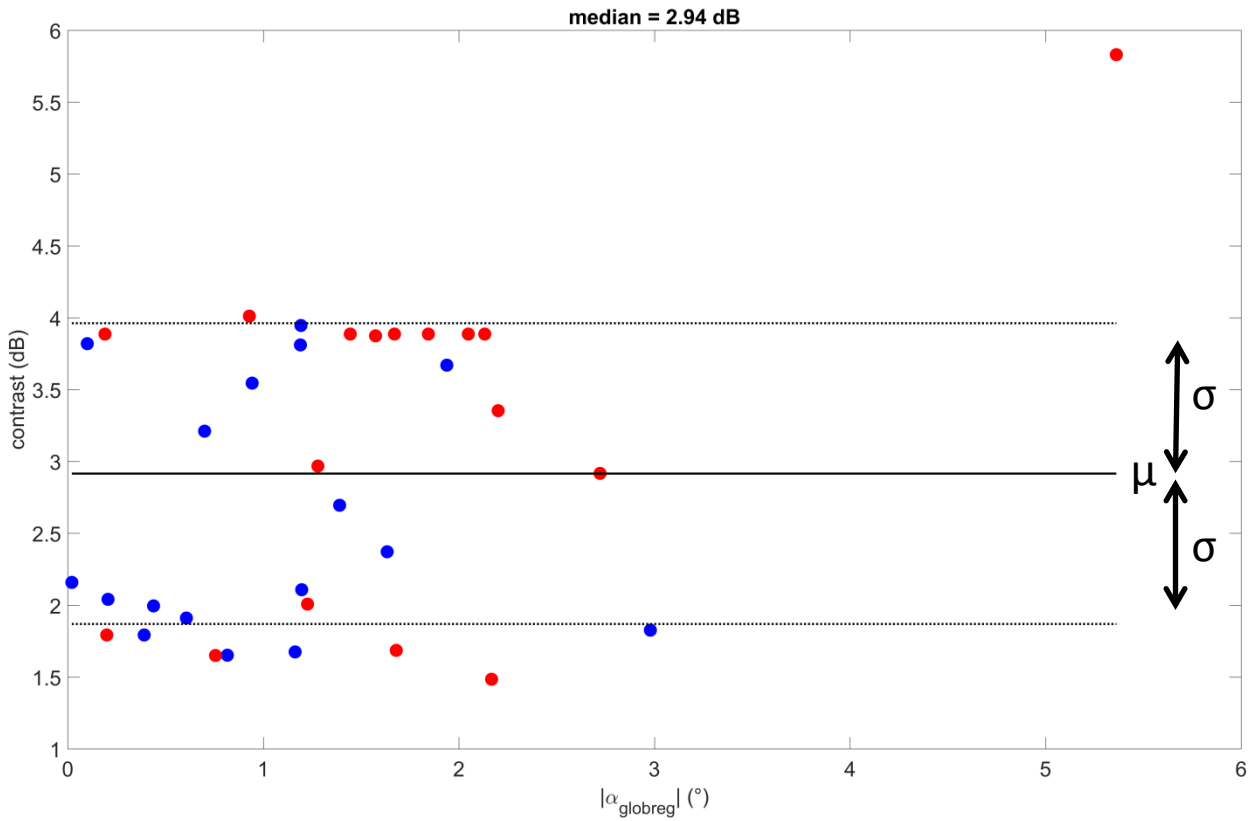
Performance Analysis

Performance Analysis: Overall Image Contrast

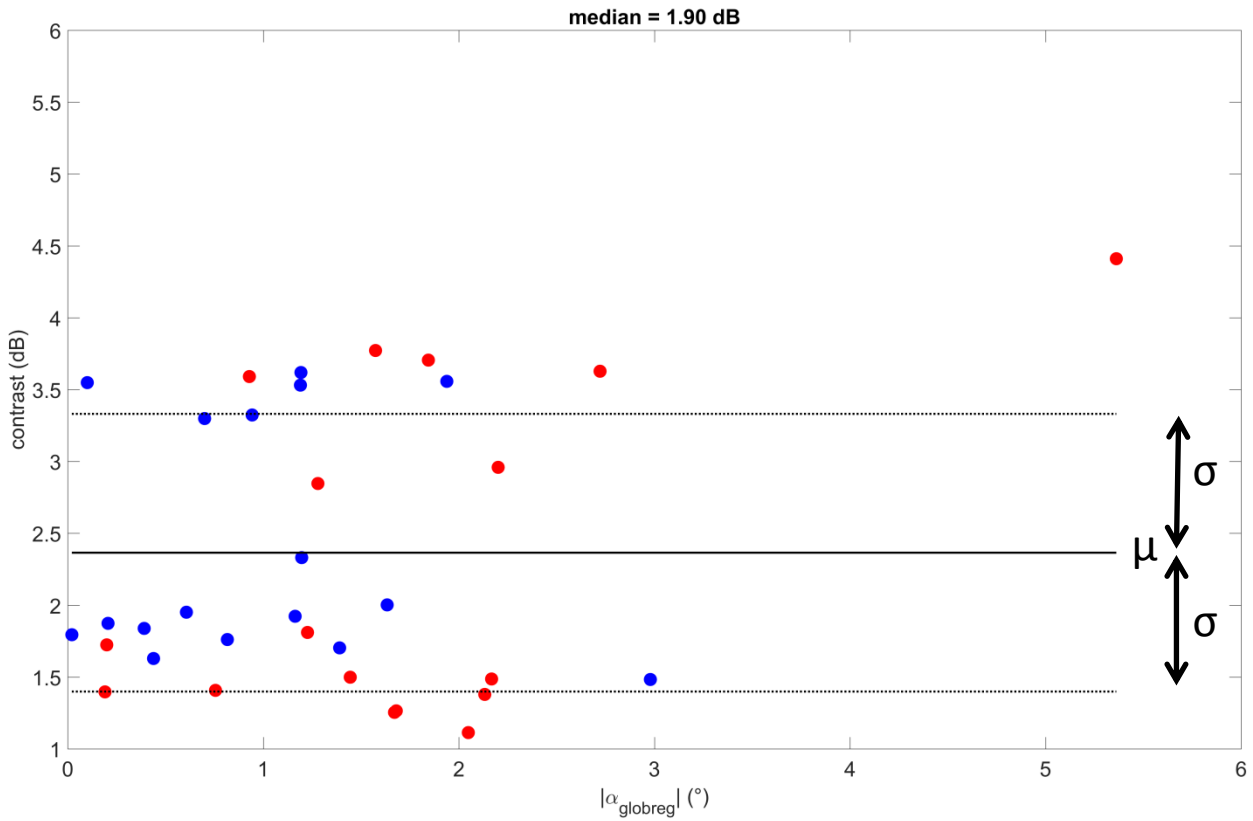


Blue: Δt = 26 h
Red: Δt = 56 h

Incoherent, 64x64 px

Performance Analysis

Performance Analysis: Overall Image Contrast



Blue: Δt = 26 h
Red: Δt = 56 h

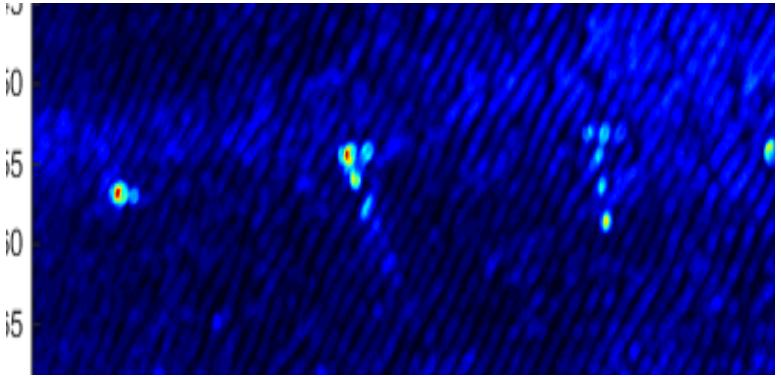
Incoherent, 512x512 px

Detectors

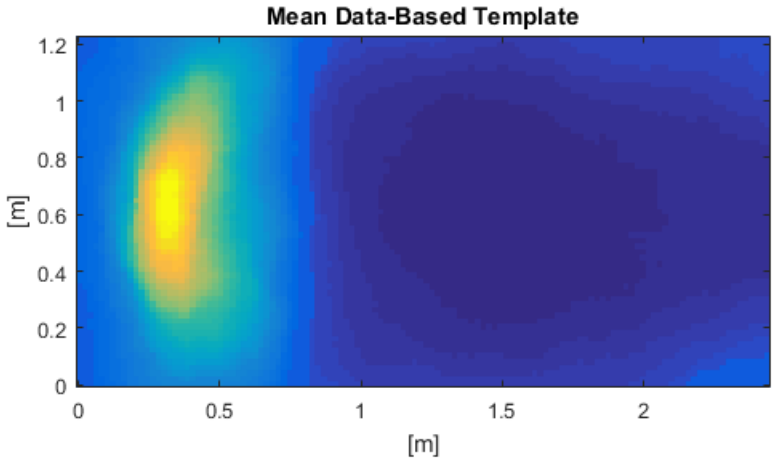
ROC curves

Two simple detectors (single score for comparability)

1. Variance detector
   - Threshold in difference image variance



2. Template matching detector
   - Template: mean of all MLO signatures



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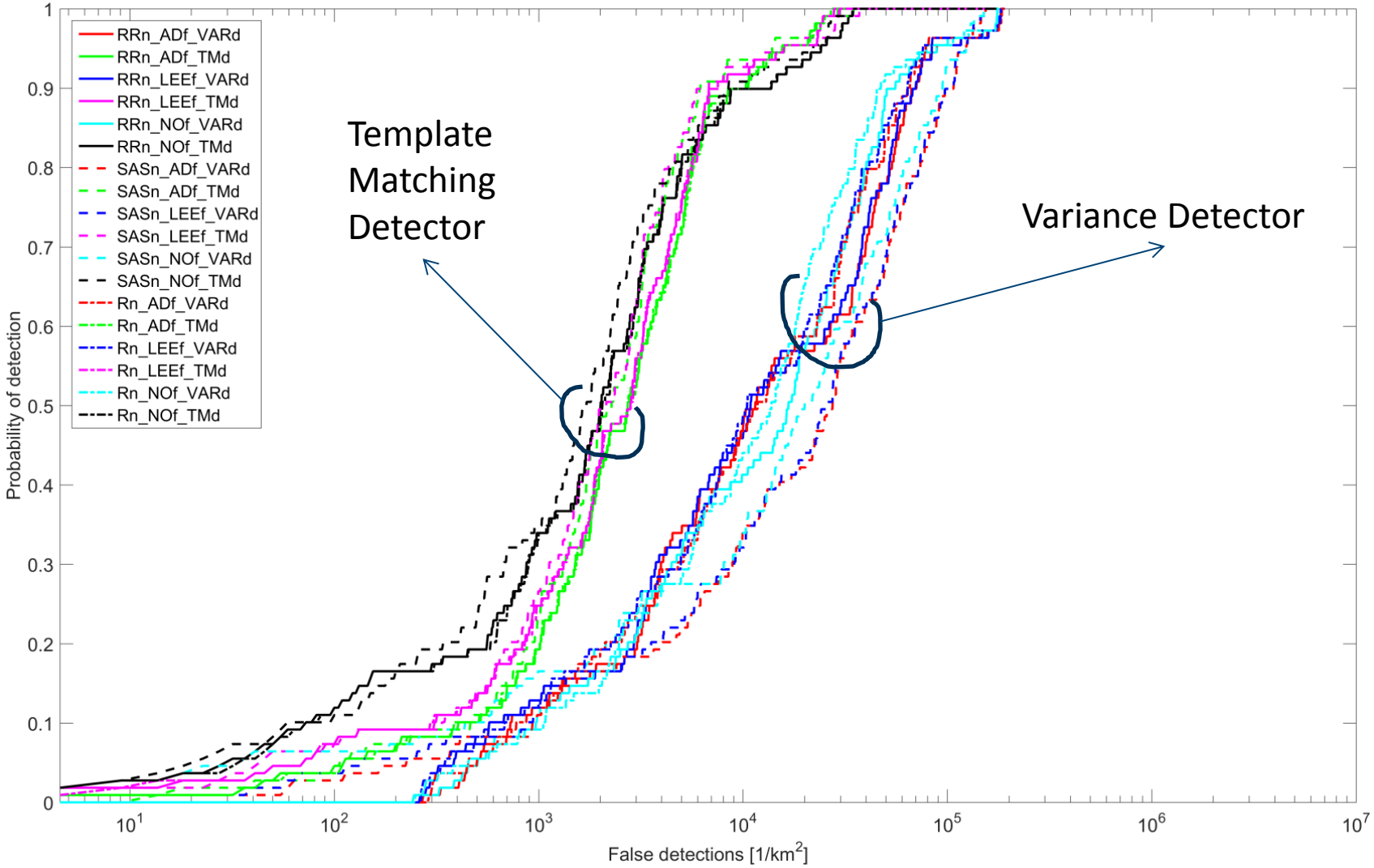
Results

Tested Combinations

Normalization		Filter		Detector	
RRn	Range-Roll-normalization	**ADf**	Anisotropic Diffusion Filter	**VARd**	Variance detector
SASn	Median-based normalization	**LEEf**	Lee-Filter	**TMd**	Template matching detector
Rn	Range normalization	**NOf**	No Filter	-	-

ROC Curves

No Change Detection



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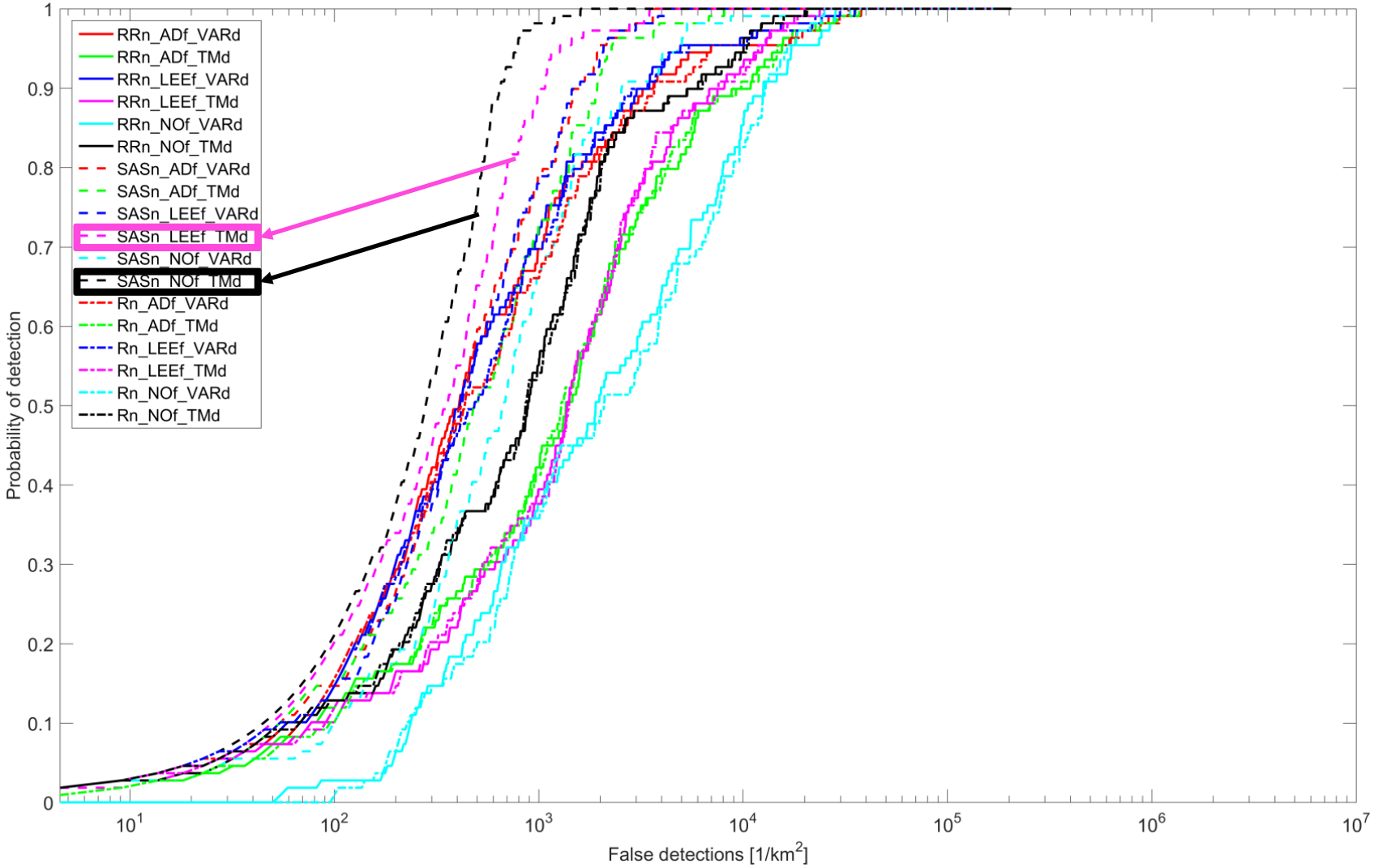
ROC Curves

Incoherent Change Detection



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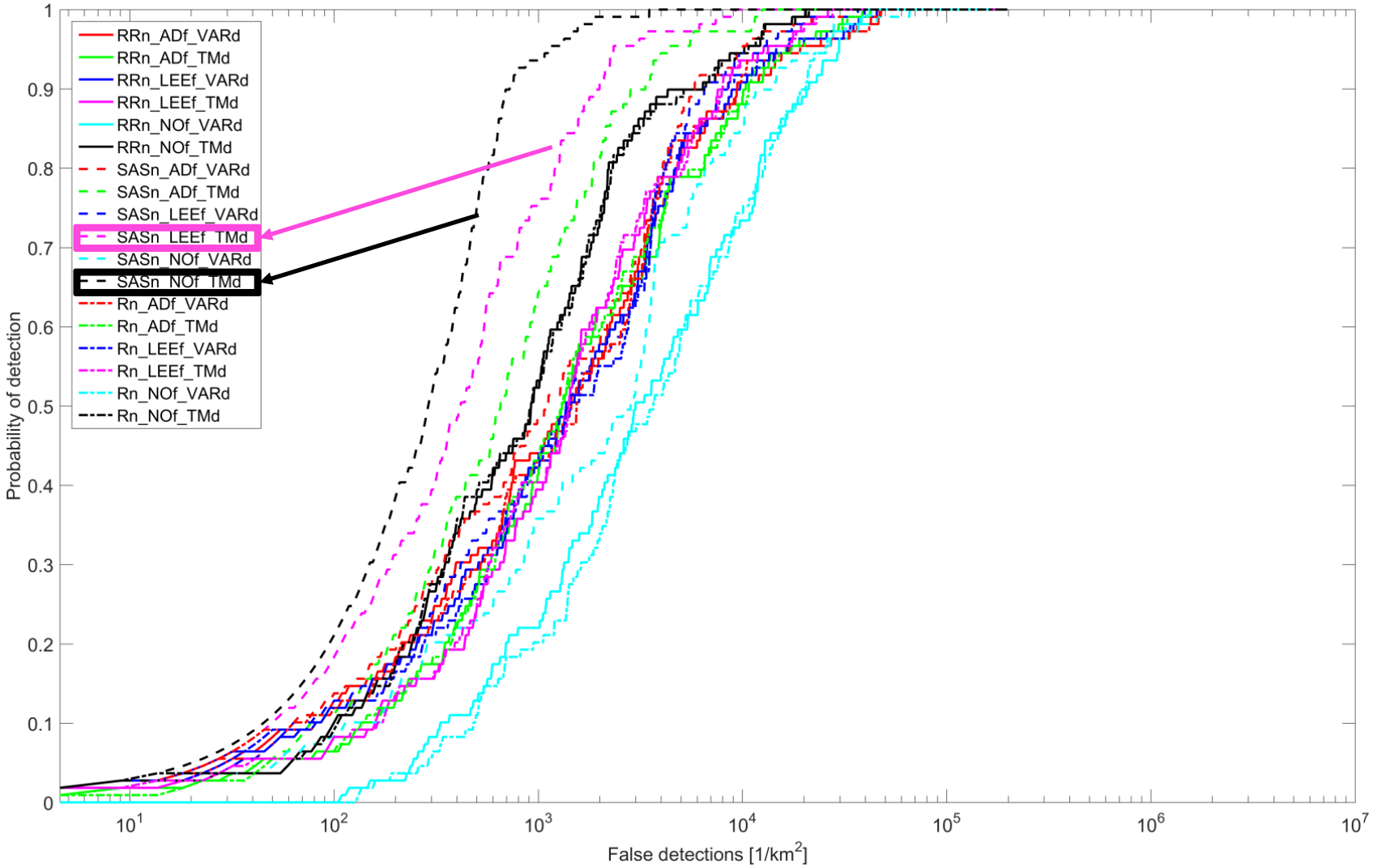
ROC Curves

Coherent Change Detection



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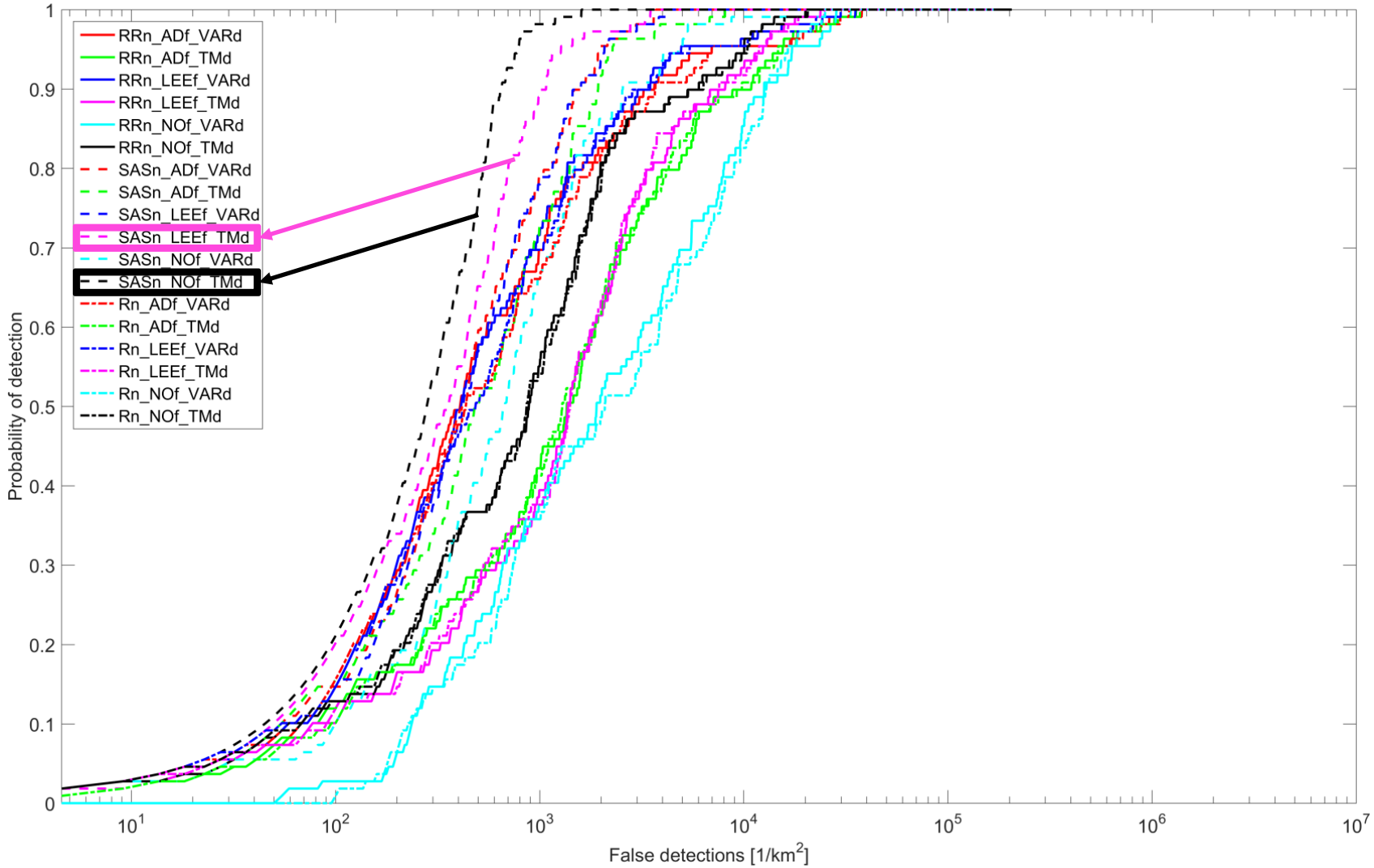
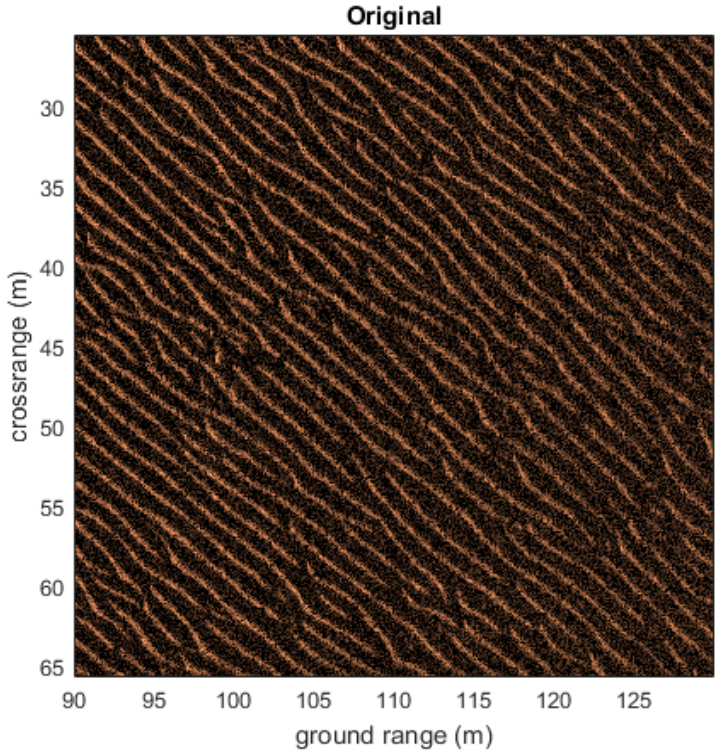
ROC Curves

Robustness: Best Change Detection (Incoherent)





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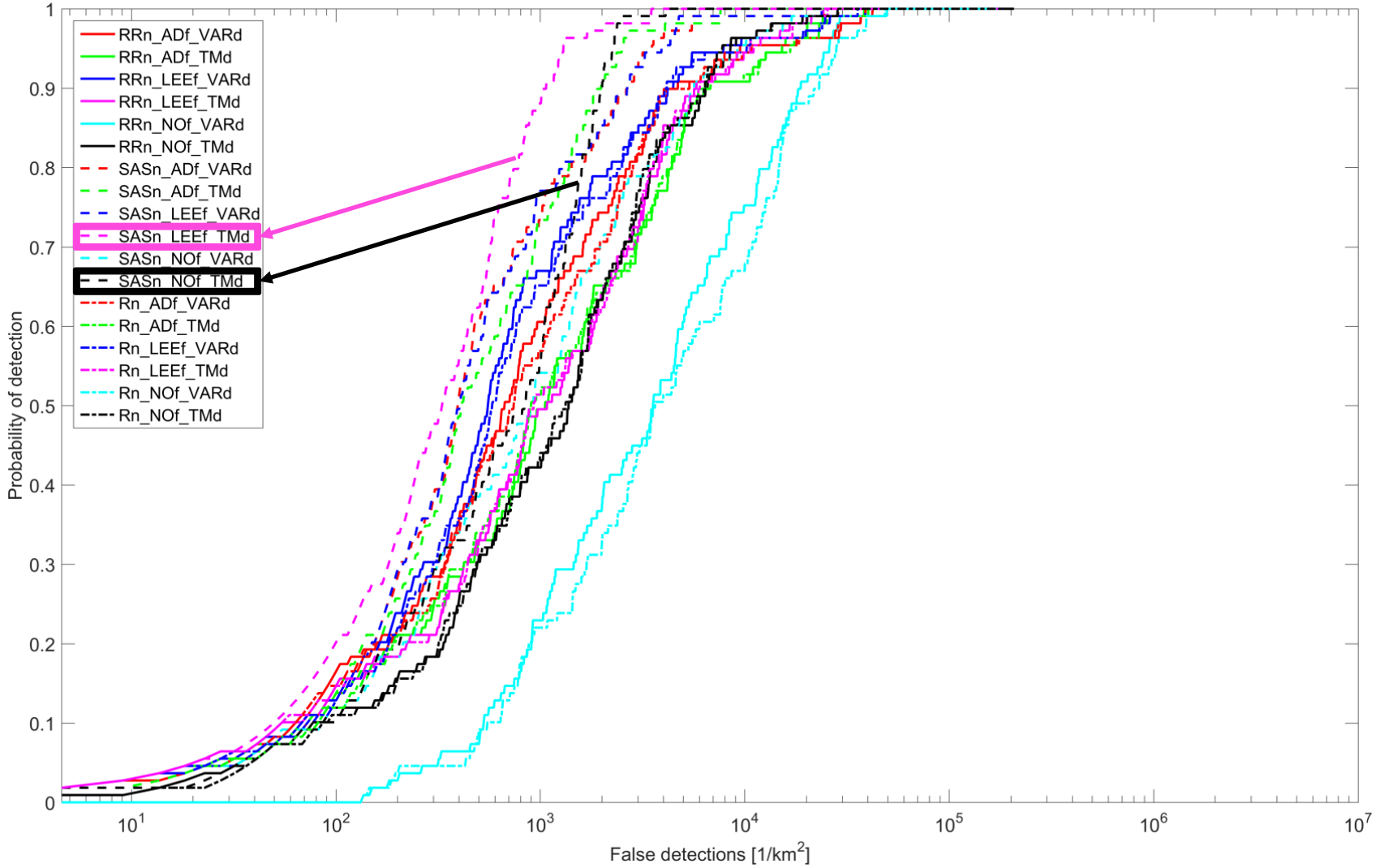
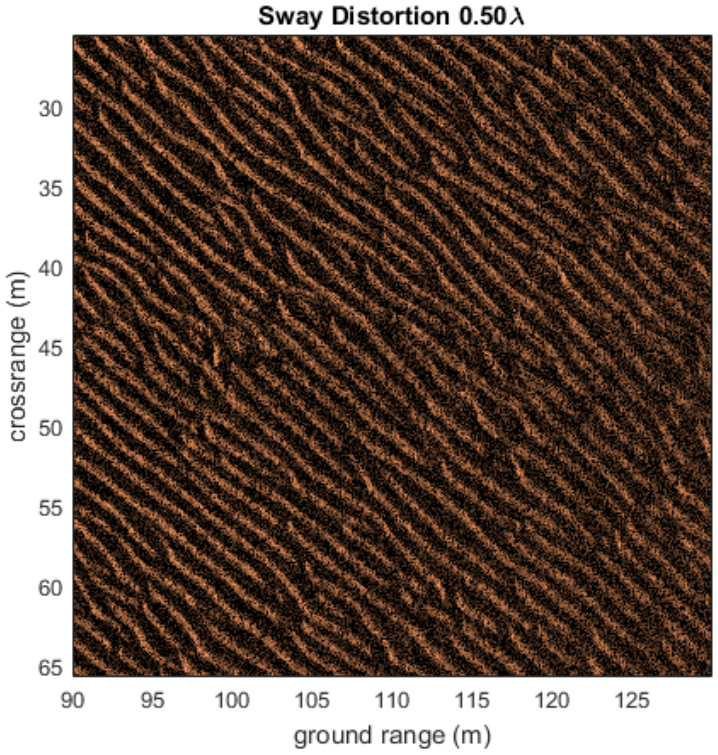
ROC Curves

Robustness: 0.5λ





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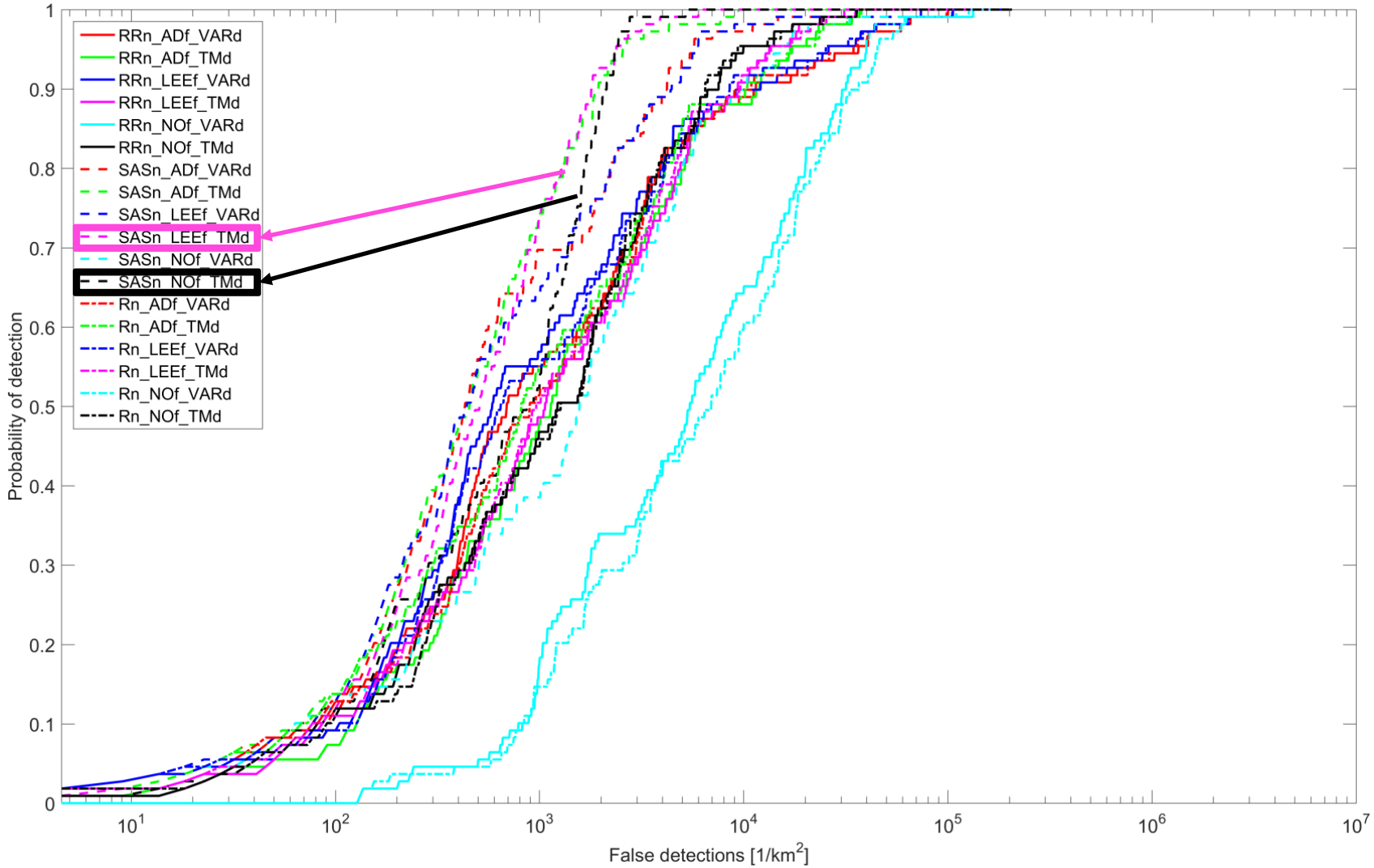
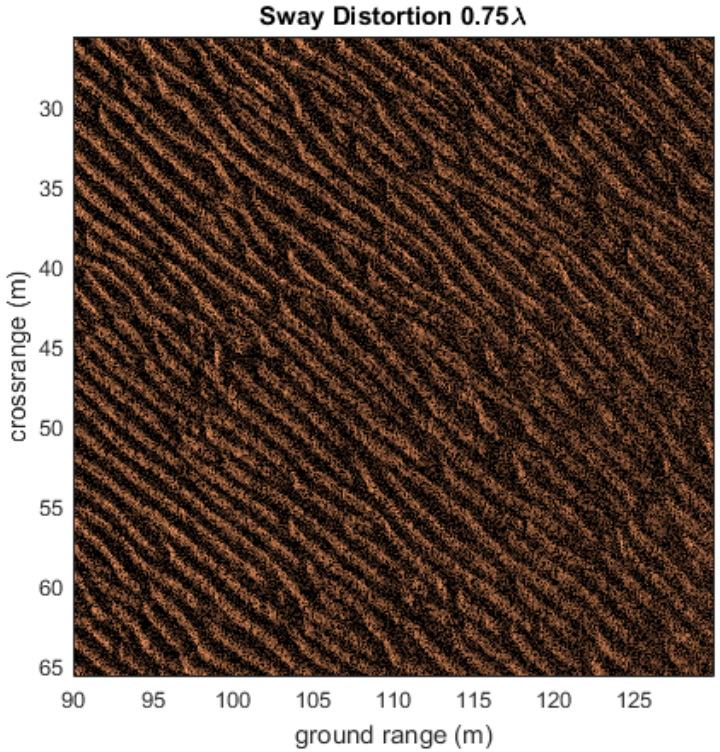
ROC Curves

Robustness: 0.75λ





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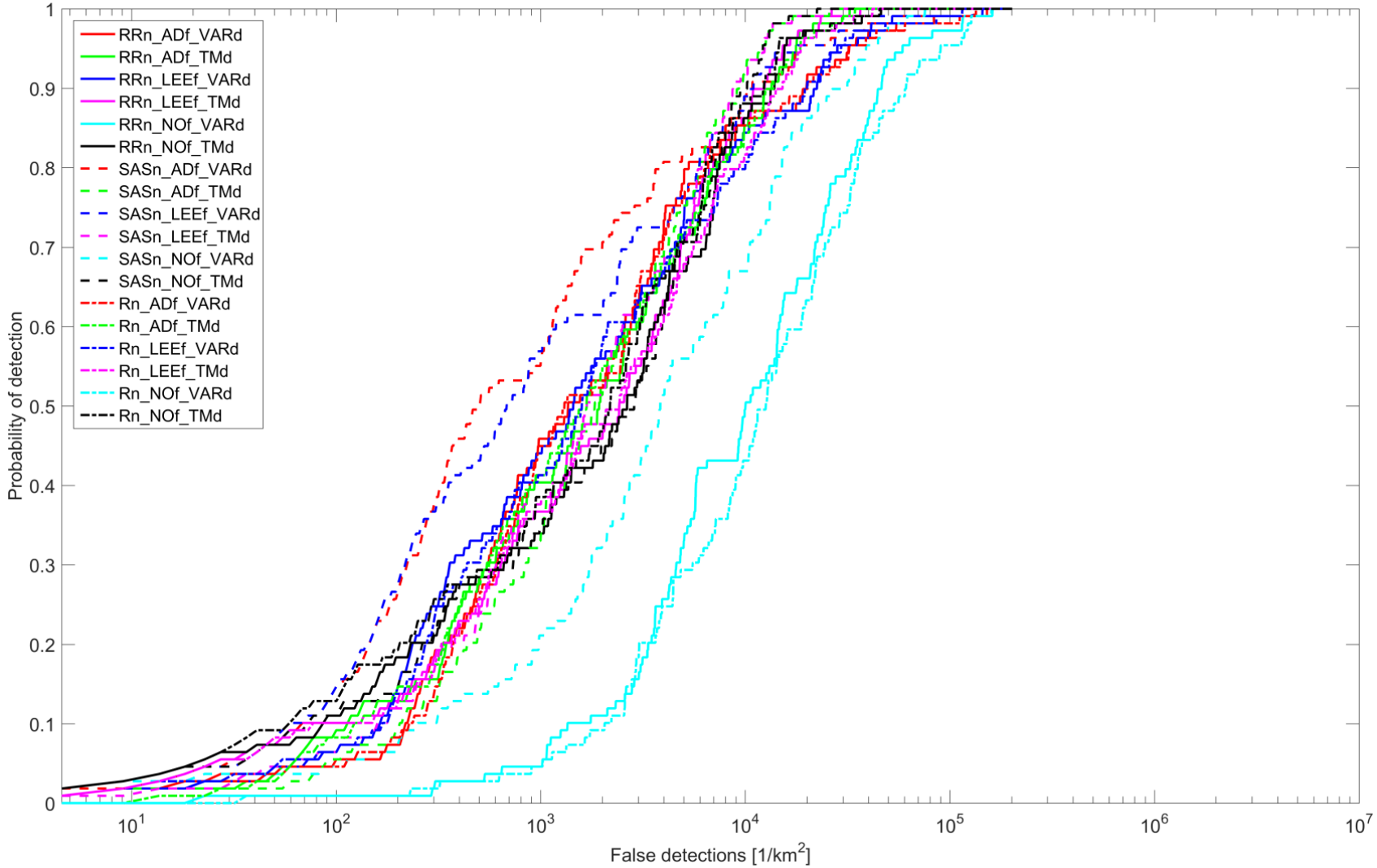
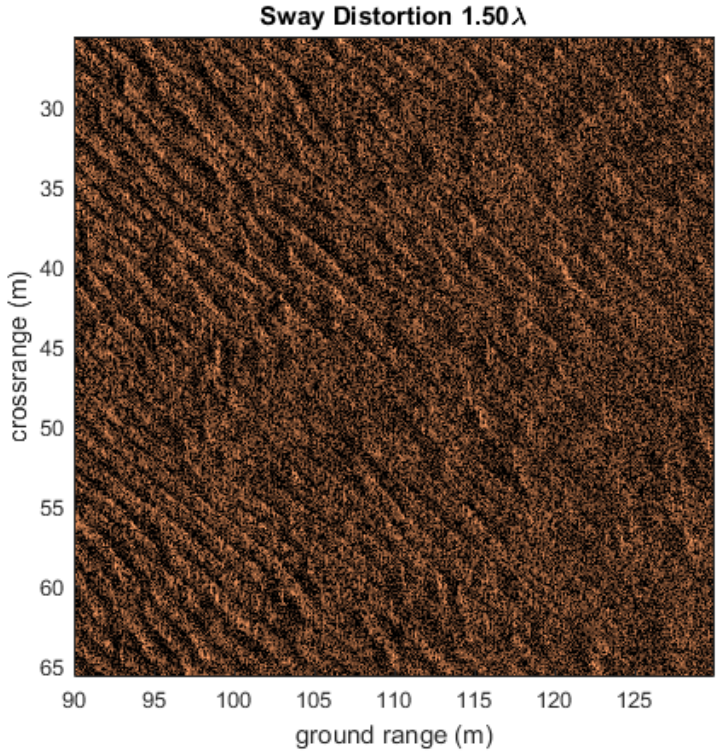
ROC Curves

Robustness: 1.5λ





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Results

Summary

	No CD	CCD	ICD	ICD-DPCA ½λ	ICD-DPCA ¾λ	ICD-DPCA 1½λ
TM 90%	6200	720	**650**	1100	1800	8700
TM 95%	14000	1100	**780**	1300	2400	12000
Var 90%	47000	5800	1600	2700	4200	11000
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- The different normalization schemes and filters have a noticeable impact on performance. The median-based normalization method without filtering performs best on well focused imagery. Lee-filtering becomes beneficial when dealing with defocused SAS imagery.
- Future work aims at connecting change detection to the automatic target recognition (ATR) for which the target shadow needs be treated such that its information is preserved.

Contact

ATLAS ELEKTRONIK GmbH
Sebaldsbruecker Heerstrasse 235
28309 Bremen | Germany
Phone: +49 421 457-02
Telefax: +49 421 457-3699

www.atlas-elektronik.com

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