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REMOTE SENSING FOR NATIONAL SECURITY

Obtain Rapid, Actionable Intelligence with Hyperspectral Imagery and Synthetic Aperture Radar

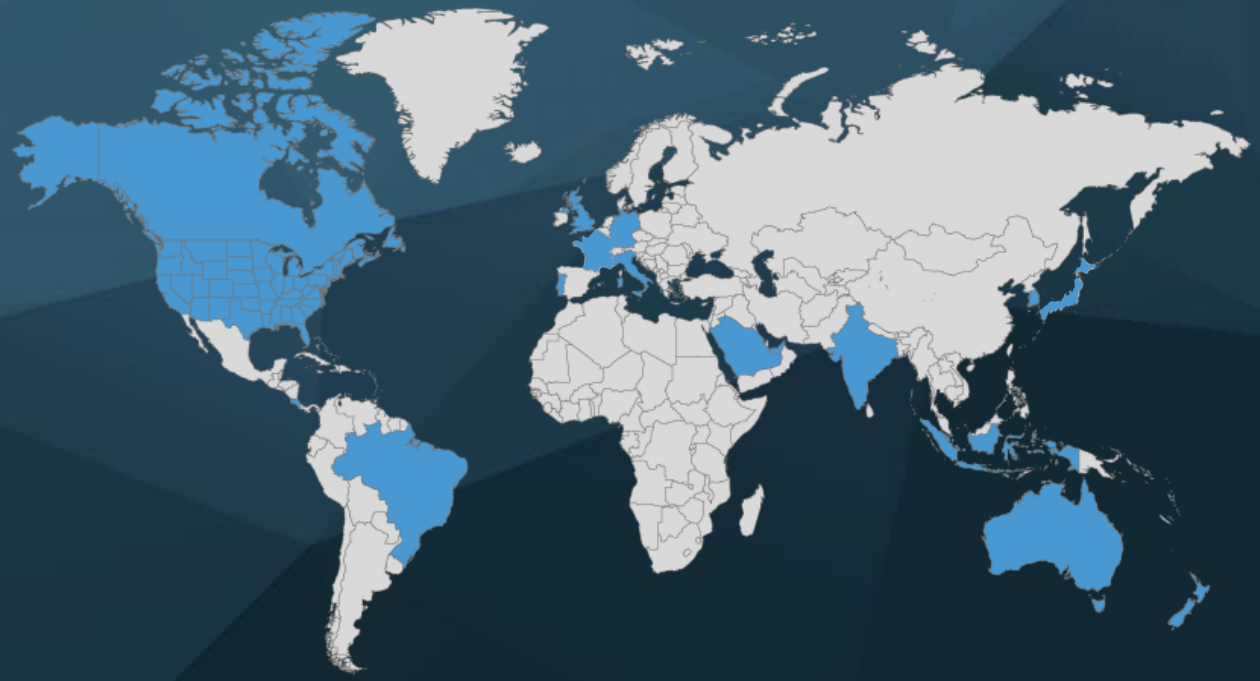
April 29th, 2021

JAMES SLATER | L3HARRIS GEOSPATIAL | CHANNEL MANAGER EMEA
PAOLO PASQUALI | SARMAP | TECHNICAL DIRECTOR AND PRESIDENT
NICOLAI HOLZER | L3HARRIS GEOSPATIAL | SALES ENGINEER EMEA

PROPRIETARY INFORMATION

L3HARRIS

L3Harris Technologies is an agile global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers' mission-critical needs.



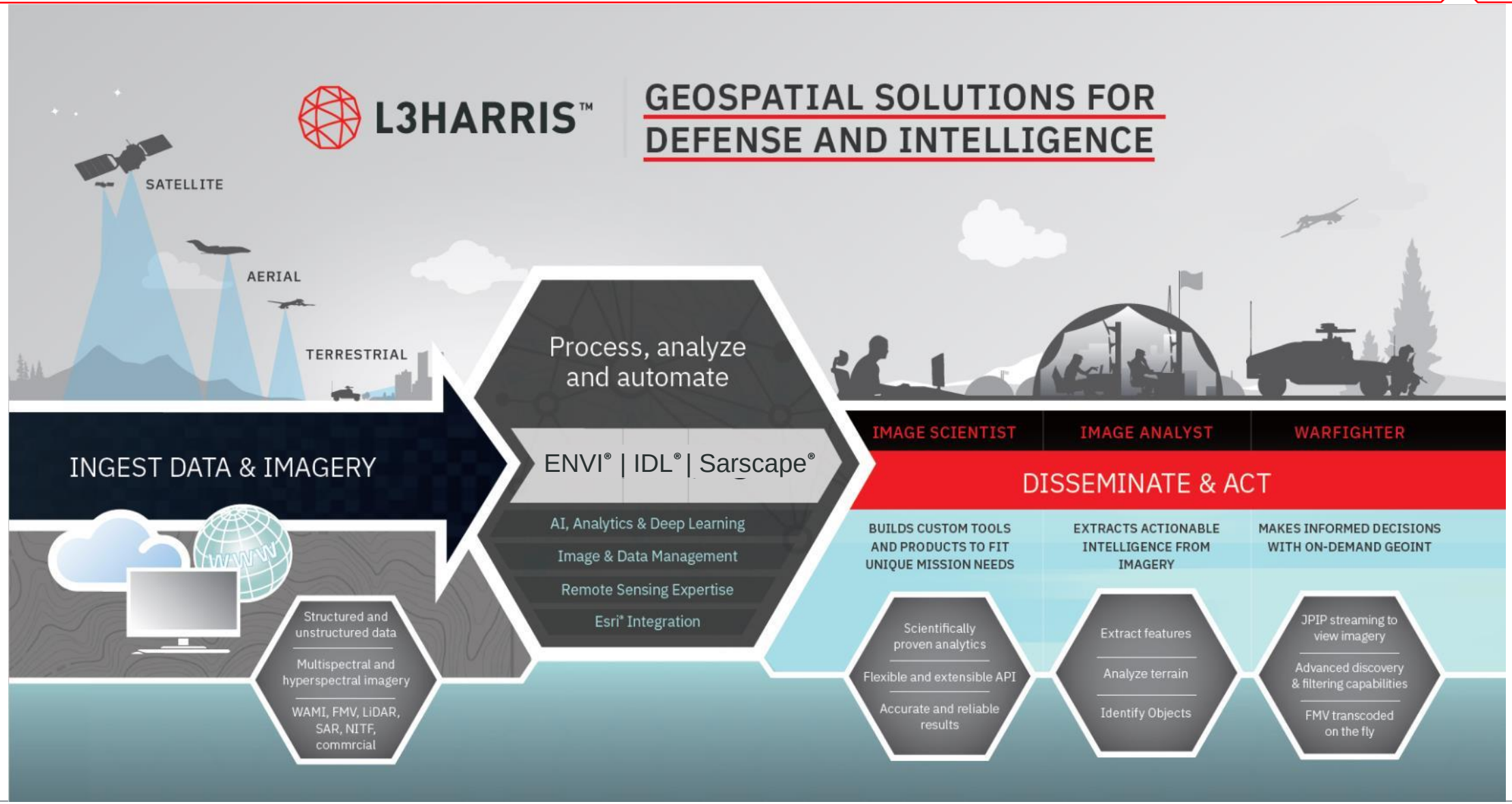
+350
LOCATIONS

CUSTOMERS IN
+100
COUNTRIES

~20k
ENGINEERS

~48K
EMPLOYEES

L3Harris Geospatial Defence & Intel at a Glance

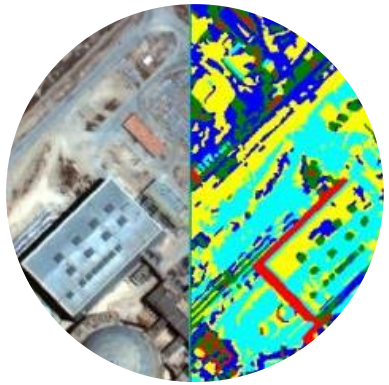


Scenarios on Security & Intelligence

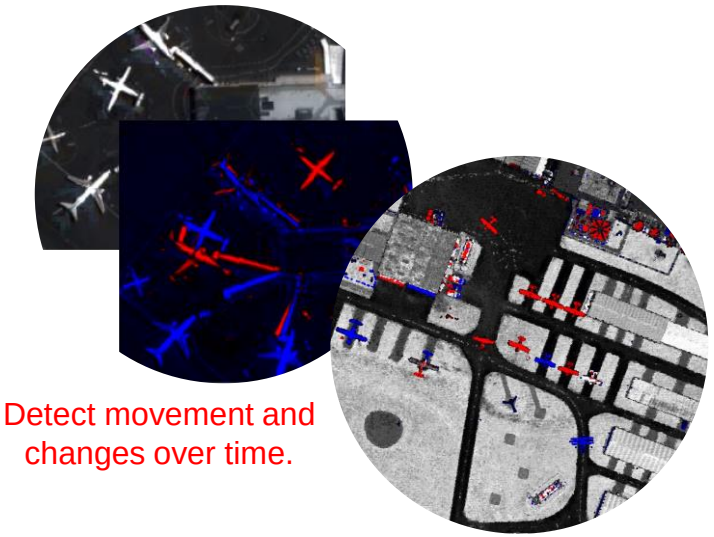
Multispectral / Hyperspectral, Deep Learning – L3Harris

Technical Brief ENVI

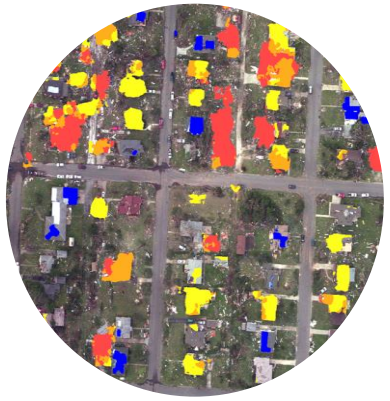
Using Imagery for Security and Intelligence Applications



Categorize terrain to understand land use.

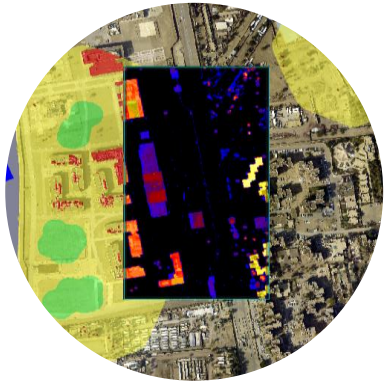


Detect movement and changes over time.

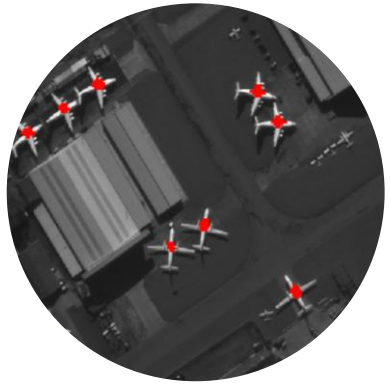


Map damage for disaster assessment and response.

Detect anomalies to uncover hidden targets.



Fuse Imagery & SAR for multi-INT products.



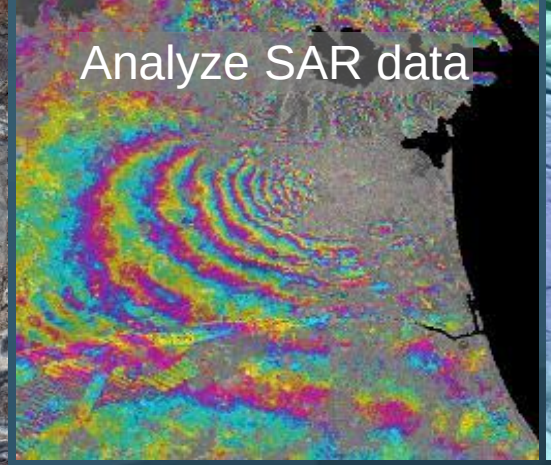
Extract features of interest and save directly to a GIS.

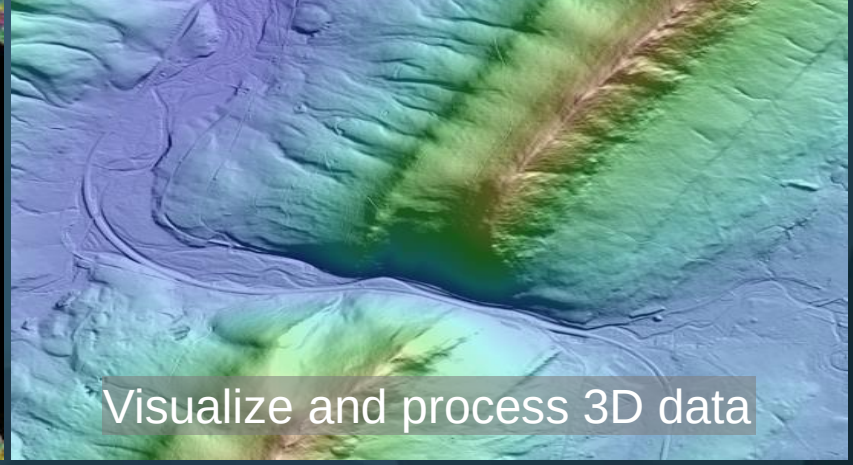
What is ENVI?

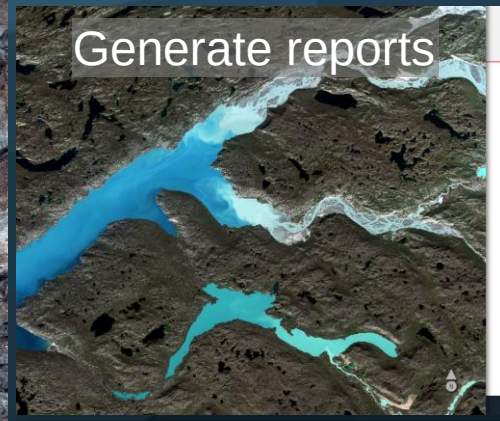
The industry standard for image processing and analysis, used to extract accurate and timely information from remotely-sensed data

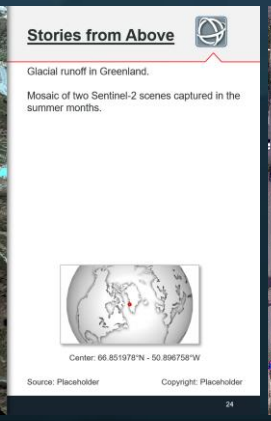
ENVI has remained on the cutting edge of innovation for more than three decades

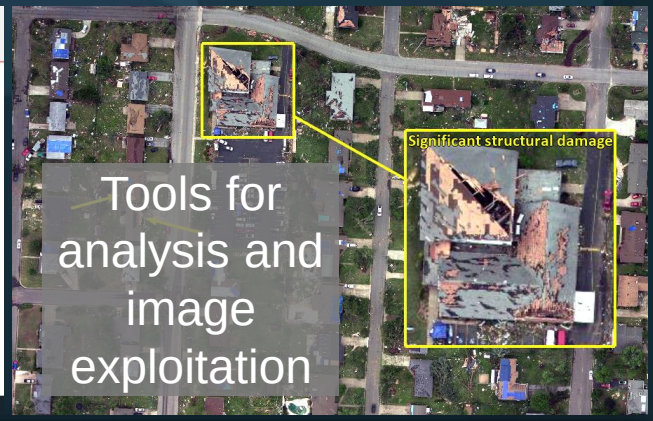
ENVI makes image analysis accessible and requires no prior experience or programming

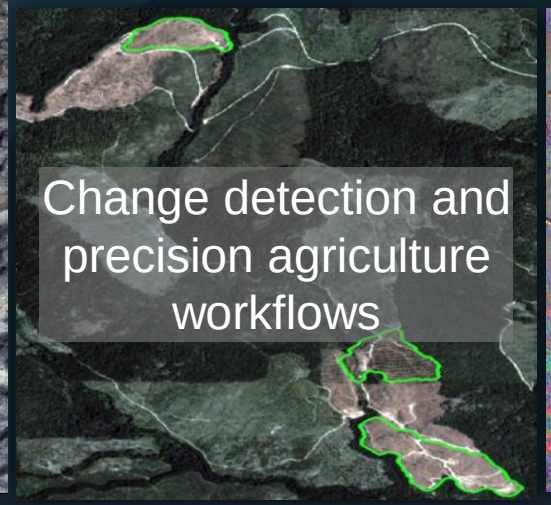


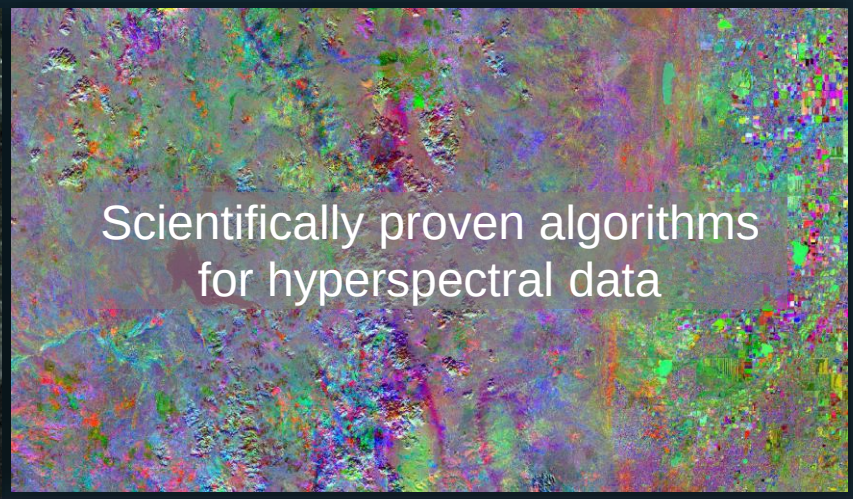




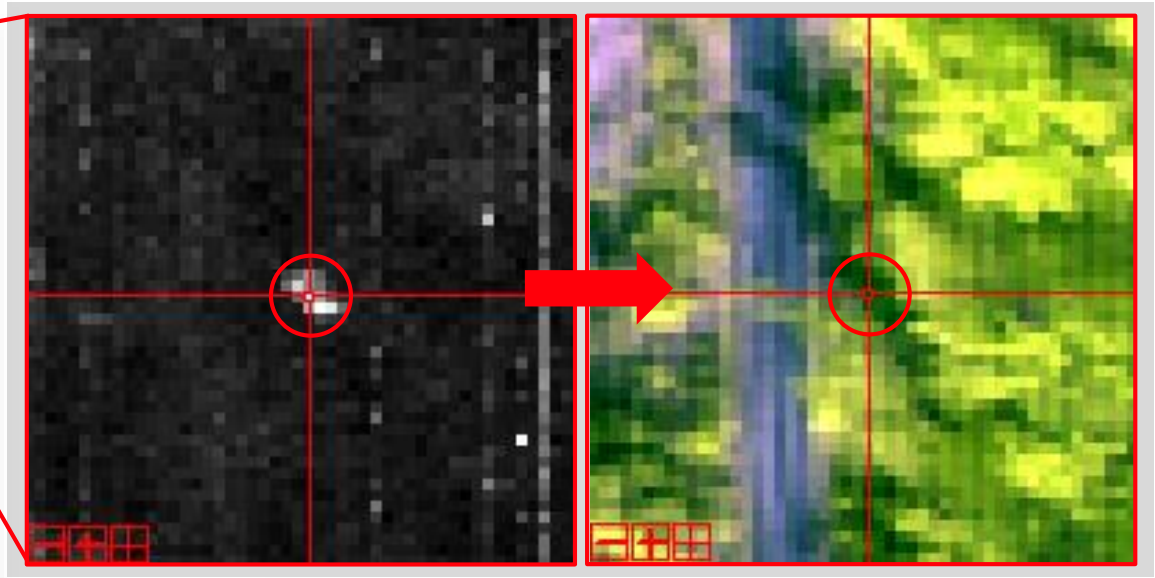




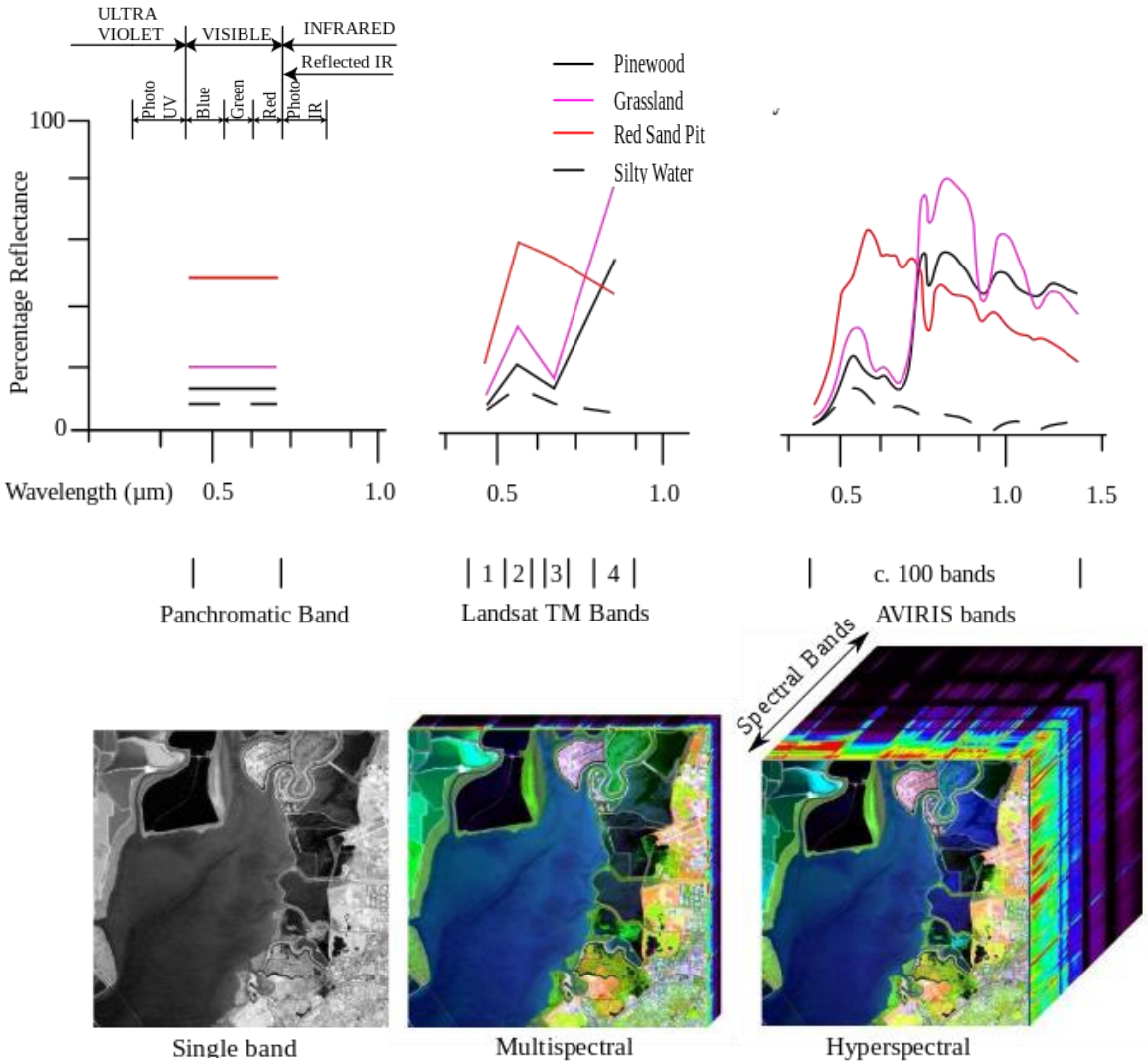


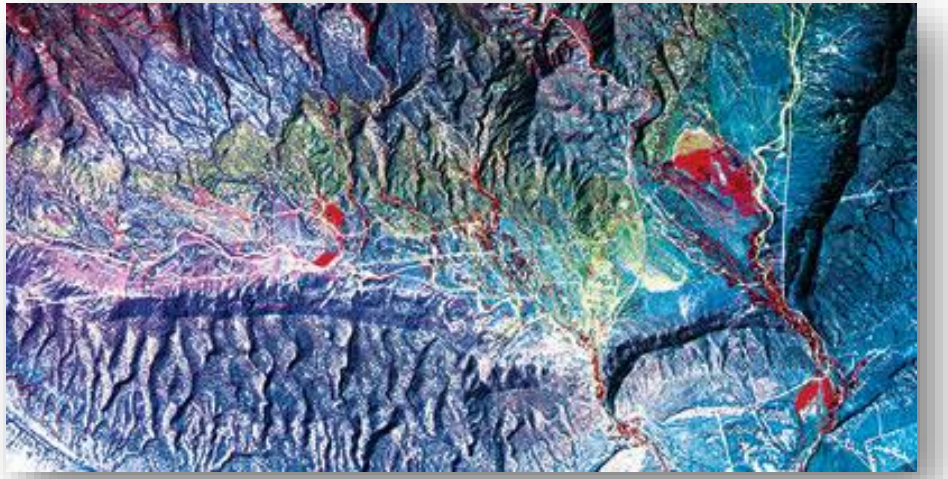


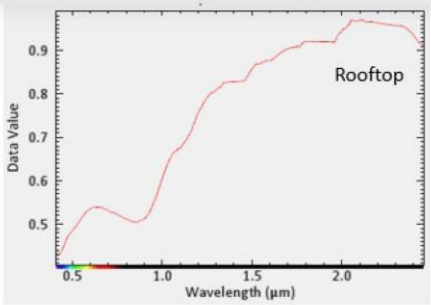
Detect Anomalies to uncover Hidden Targets

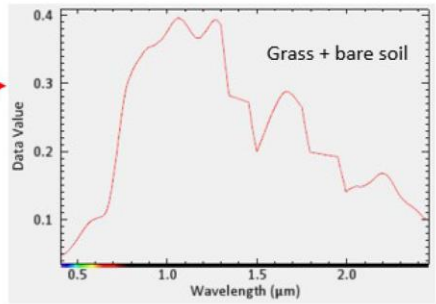


Spectral Resolution

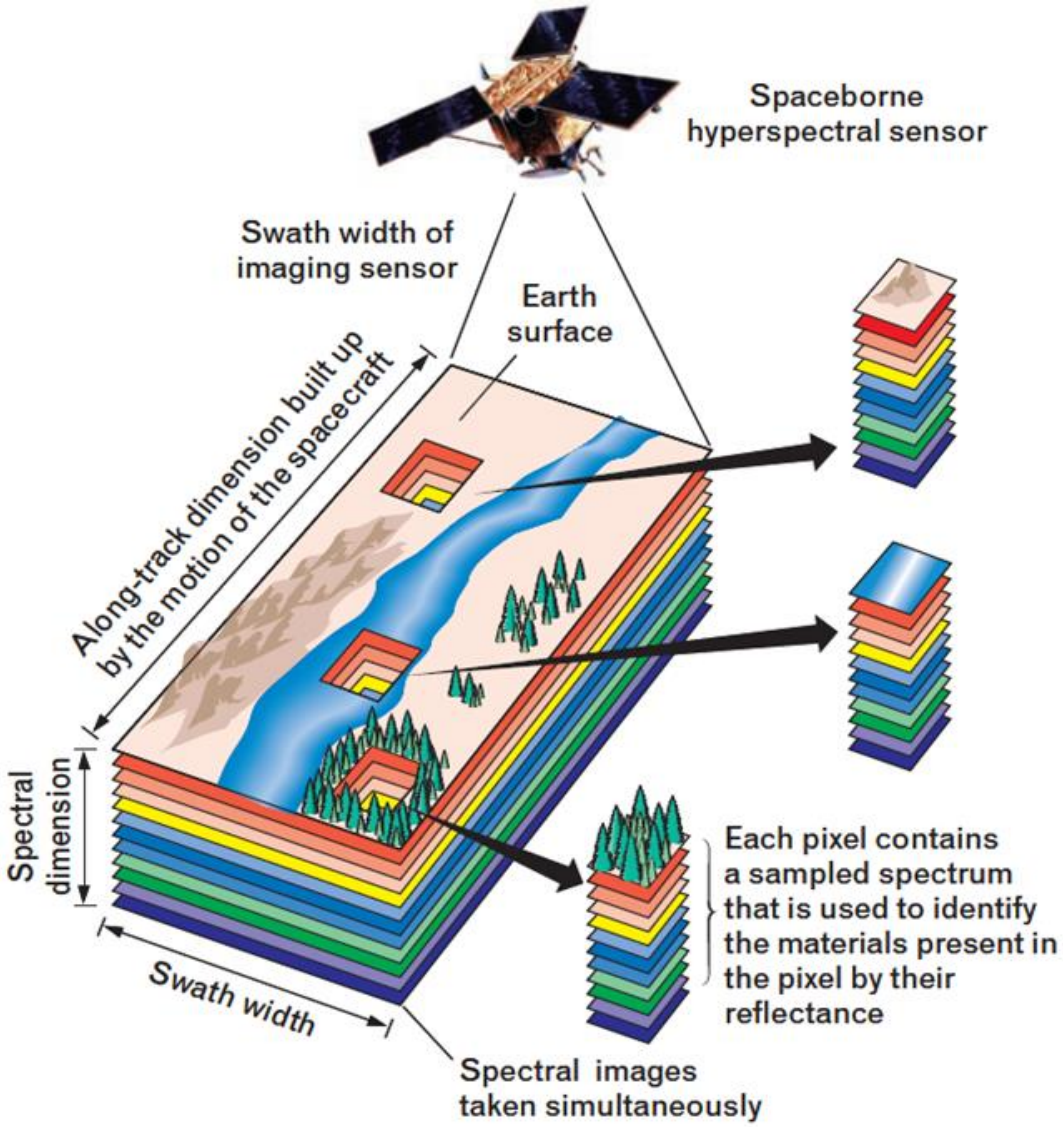


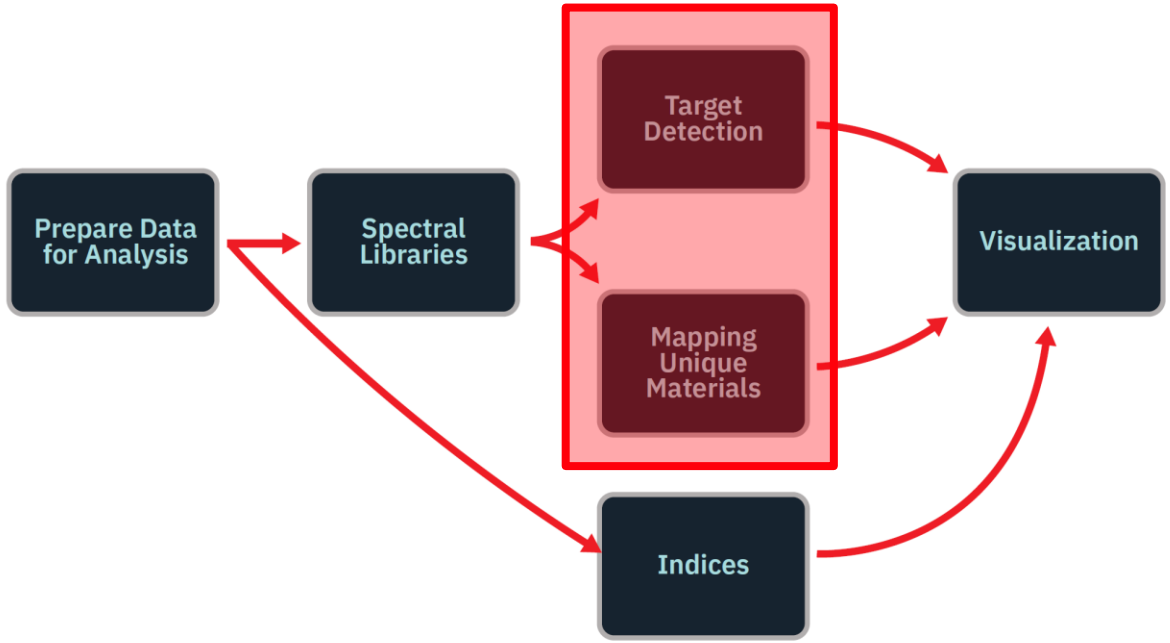


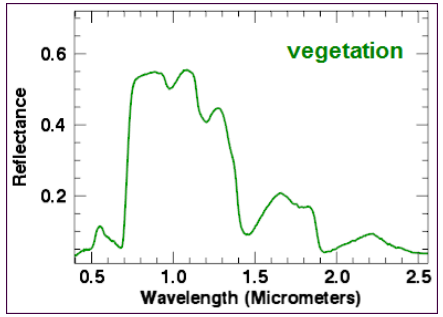


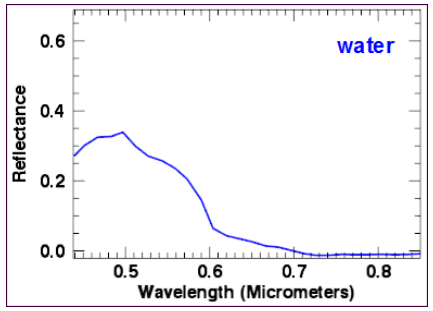


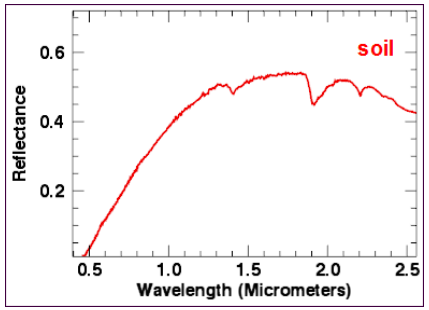
Spectral Image Concept



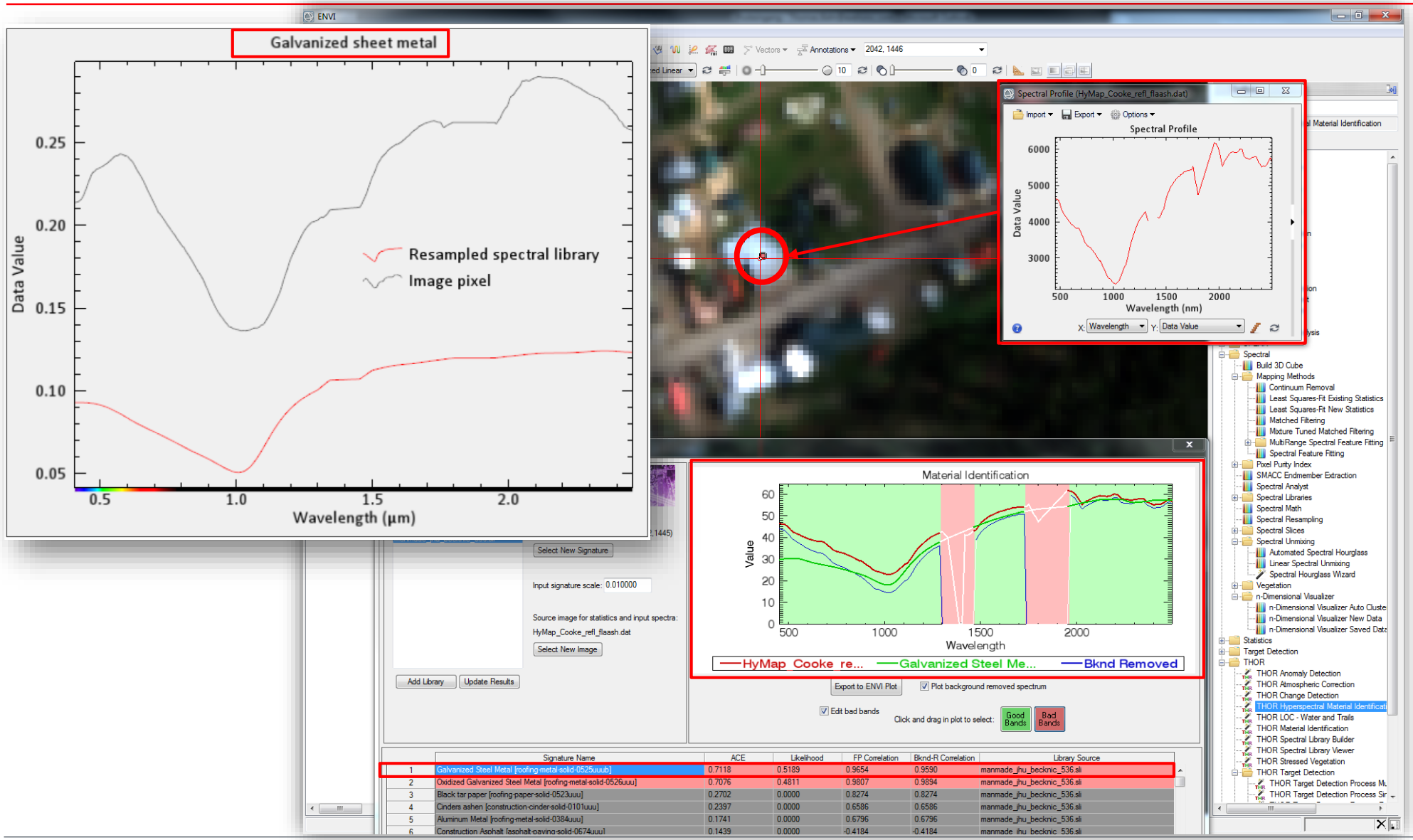






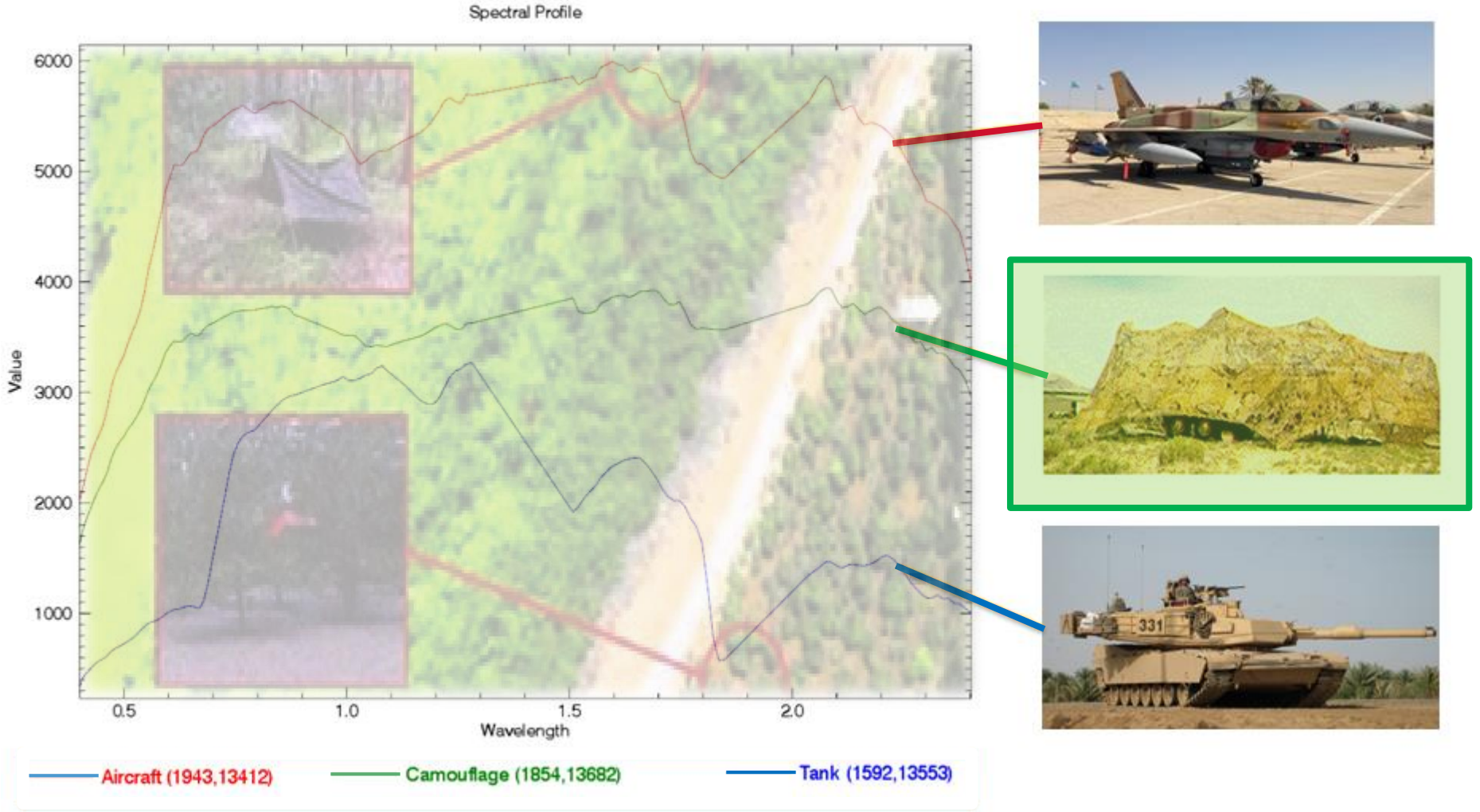


Spectral Material Identification

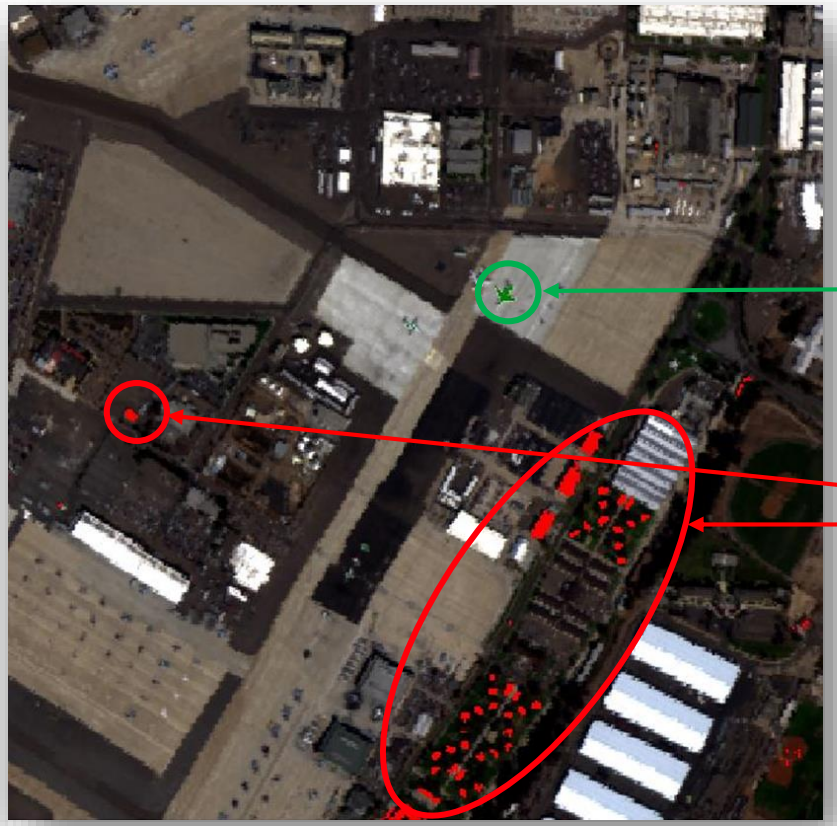


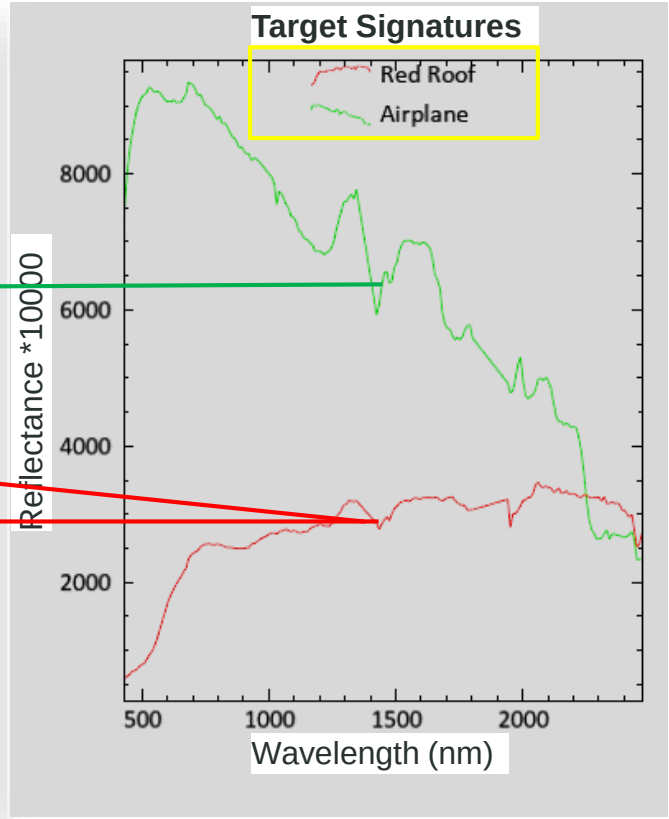
Spectral Target / Object Identification

Finding targets at the sub-pixel level using spectral signatures



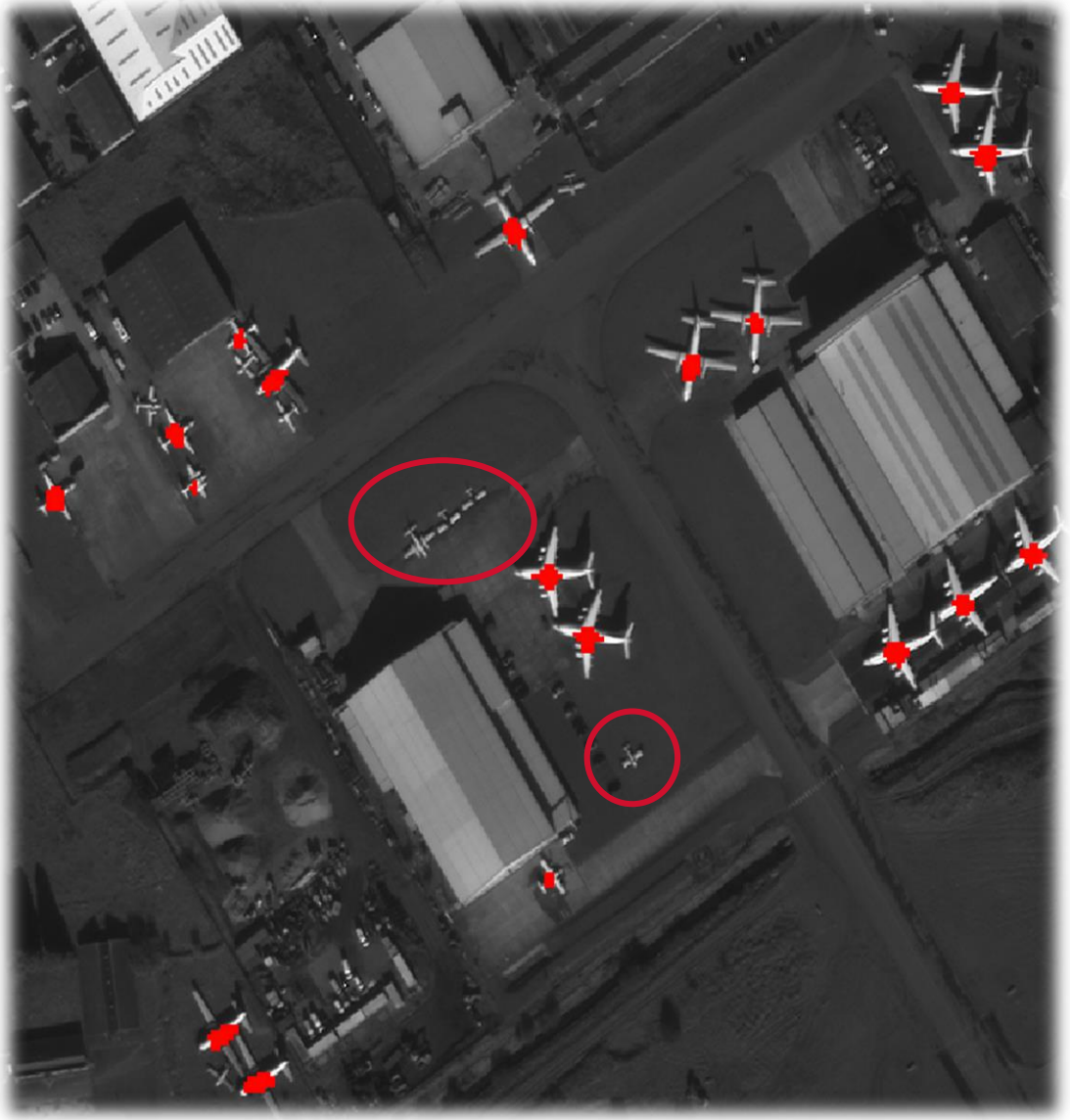
Hyperspectral Object / Target Detection





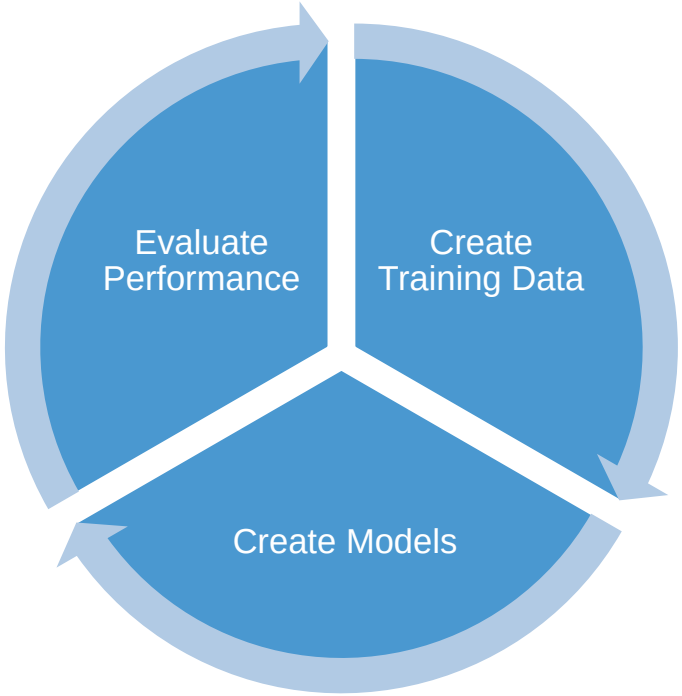
Atmospheric Correction → Adaptive Coherent Estimator → Threshold → Export to Vector

Deep Learning Target Detection



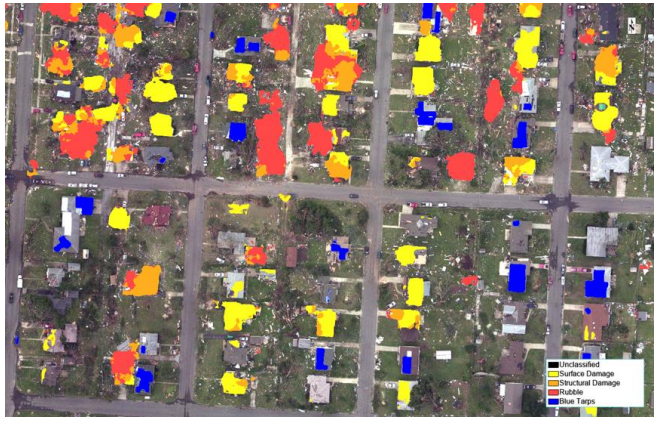
ENVI Deep Learning

- Applied Deep Learning for geospatial imagery in ENVI, the leading remote sensing and image analysis software

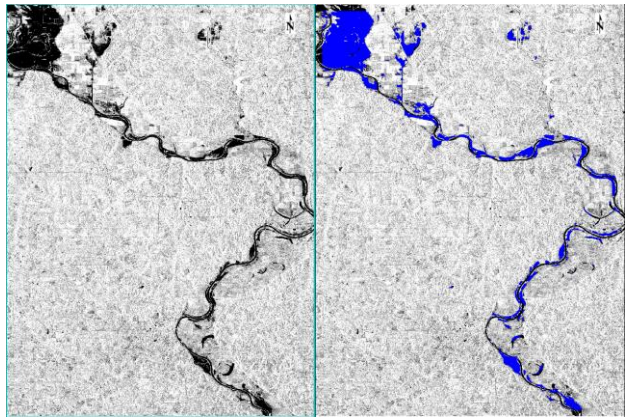


Deep Learning workflow in ENVI, built on TensorFlow and Keras

- Without needing to program, the capabilities include:
  - Object detection (e.g. cars or ships)
  - Linear feature extraction (e.g. roads)
  - Segmentation (e.g. buildings)
- Support for nearly any image format and data modality
  - Works with point, polyline, and polygon types of geometry
- Complete access to ENVI's suite of postprocessing tools
  - Easily create customized workflows



Assess building damage after hurricanes and tornadoes



Automated flood detection using SAR

Deep Learning Target Detection

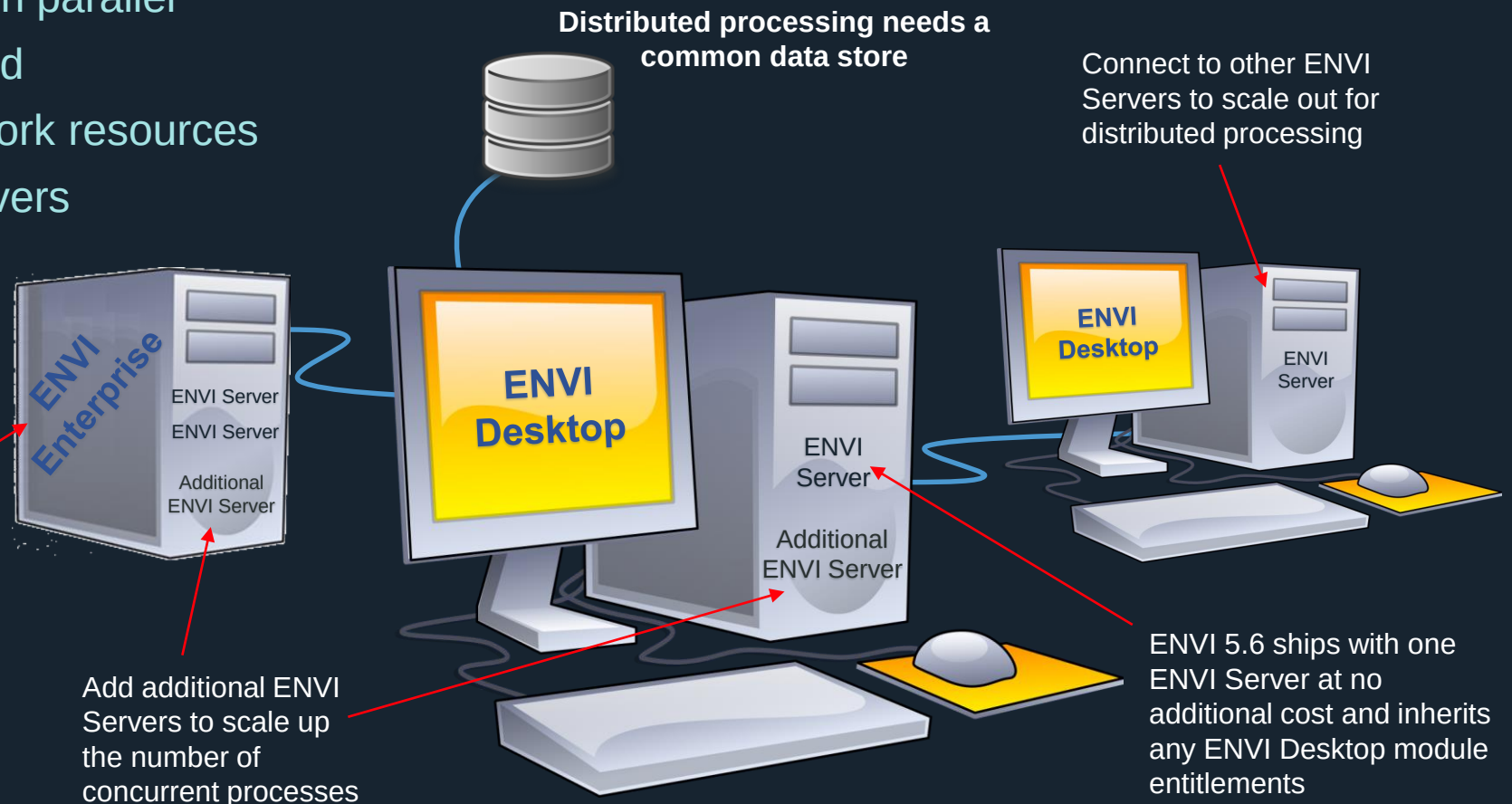
Extracted road network

Berms:
Potential Surface-to-Air Missile (SAM) sites

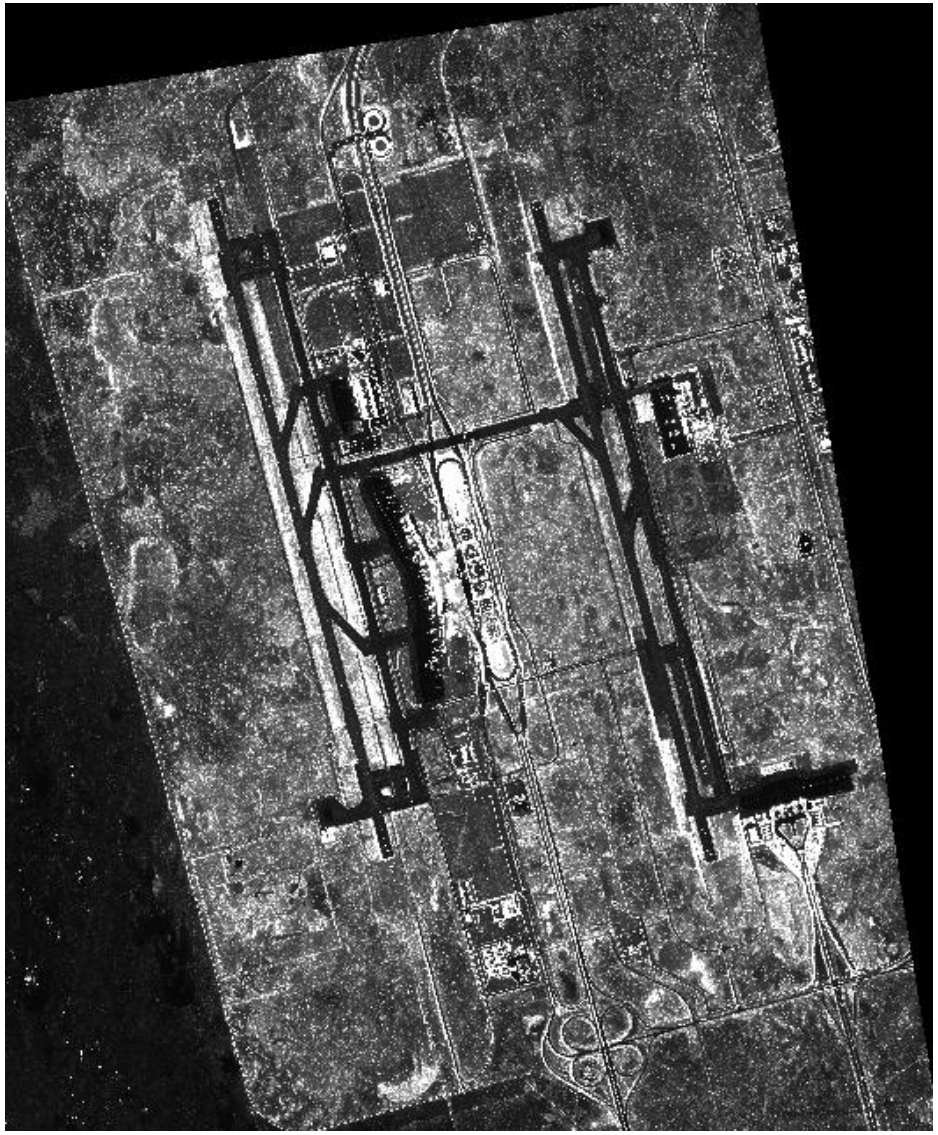
Operational Processing with ENVI Server and ENVI Enterprise

ENVI Server lets you run multiple, concurrent ENVI processes in the background, in parallel, or distributed among different computers

- Save time by running processes in parallel
- Bulk processing in the background
- Take advantage of powerful network resources
- Distribute processing to local servers with common data access
- No programming required!



SAR & Literal Image Analysis



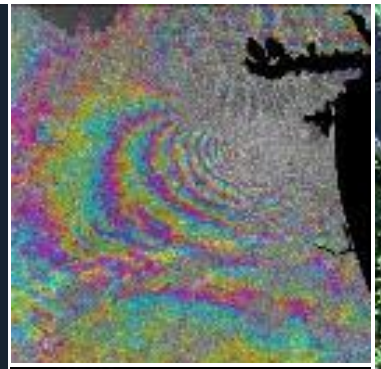
ENVI SARscape

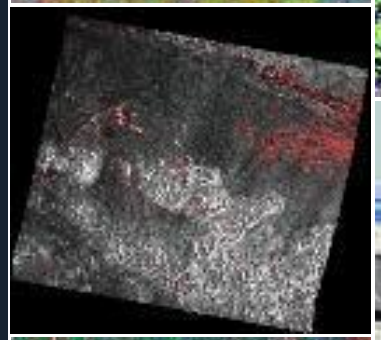
Easily process and analyze SAR data

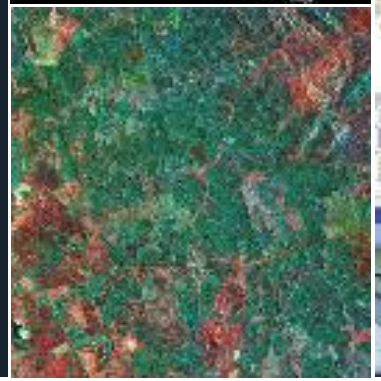
ENVI integration brings advanced image processing and analysis together with SAR processing in one package

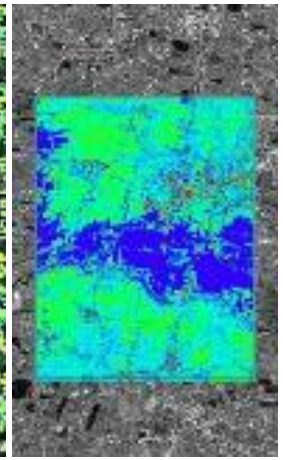
Generate products (like DEMs or surface deformation maps) that can be integrated with other geospatial products

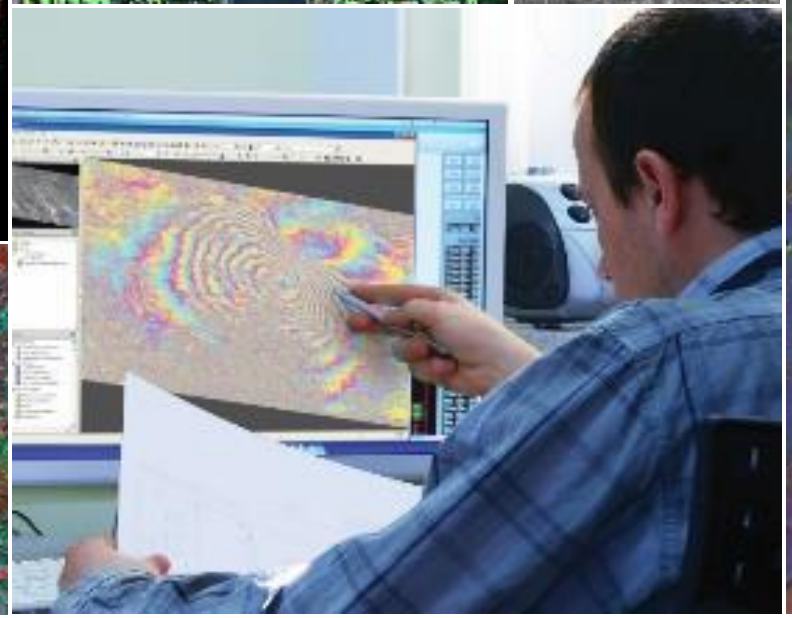
Built-in workflows and modules simplify processing and can be customized











Scenarios on Security & Intelligence

Synthetic Aperture Radar (SAR) – Sarmap

Technical Brief SARscape

Remote Sensing for National Security – Obtain Rapid, Actionable Intelligence with Hyperspectral Imagery and SAR

Dr. Paolo Pasquali

co-founder, president & CTO

paolo.pasquali@sarmap.ch

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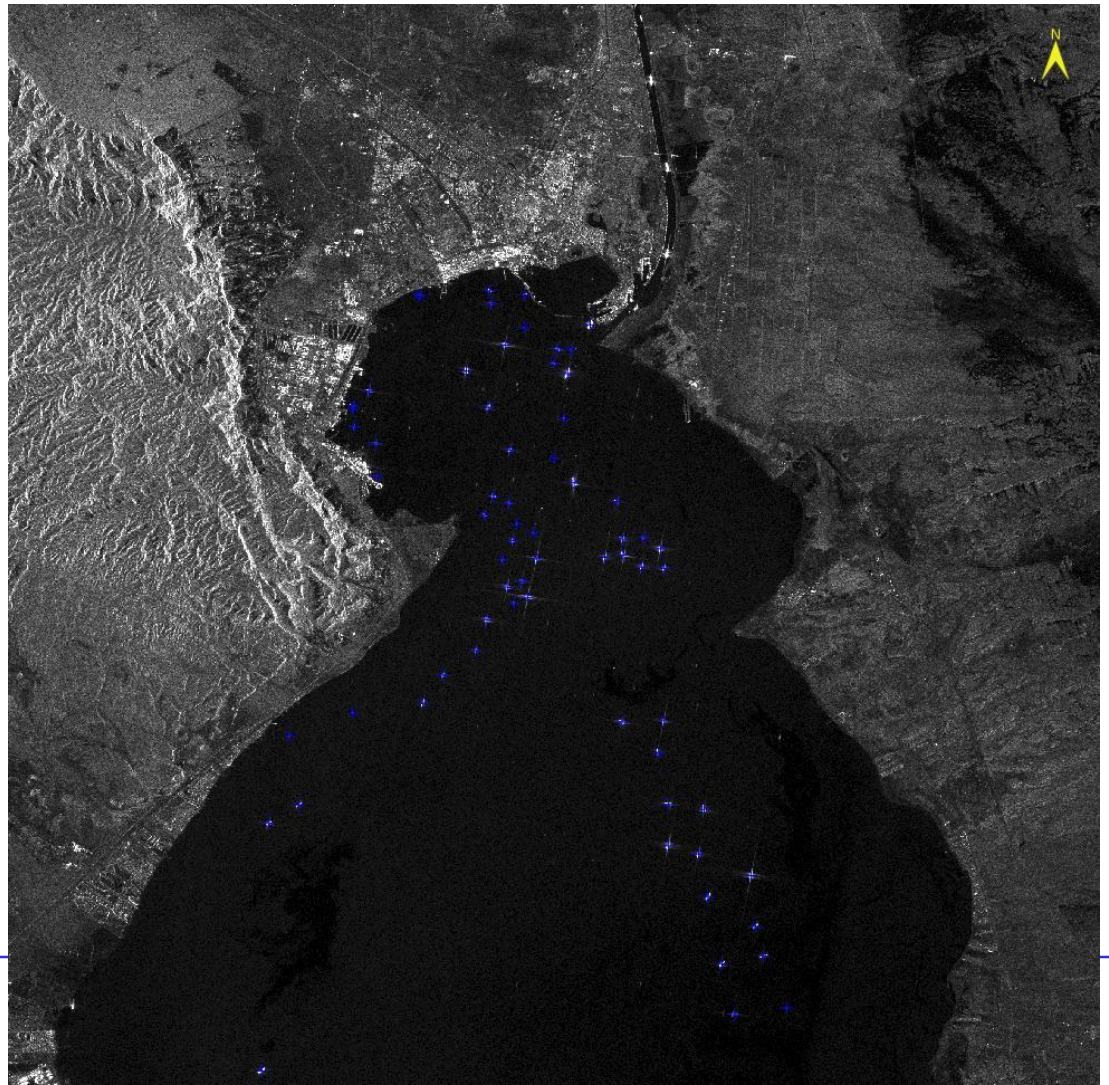
SAR is an ideal instrument for regular monitoring



67 ships detected from Sentinel-1 data

21st March 2021

Southern entry of the Suez channel

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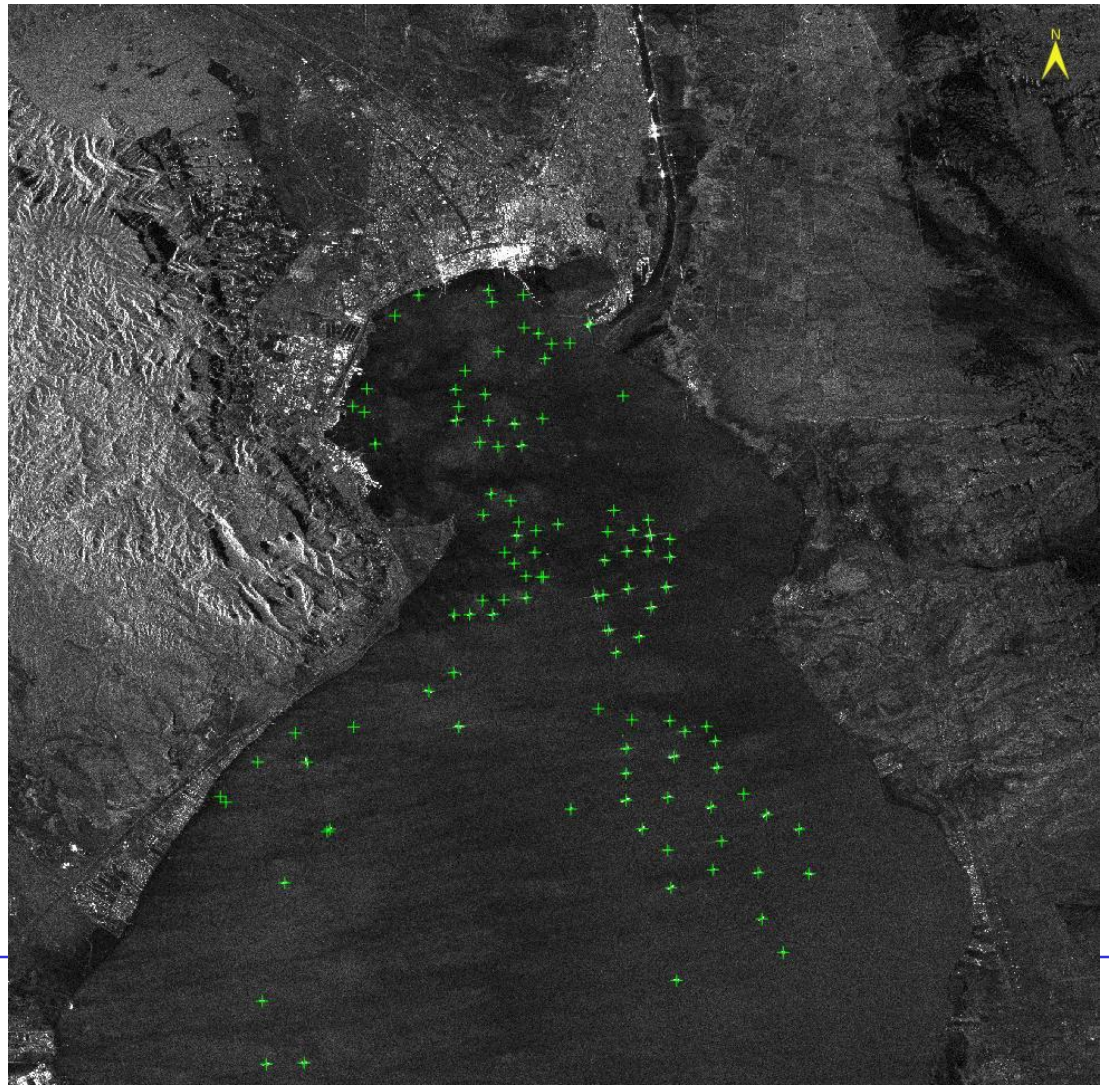
SAR is an ideal instrument for regular monitoring



108 ships detected from Sentinel-1 data

24th March 2021

Southern entry of the Suez channel

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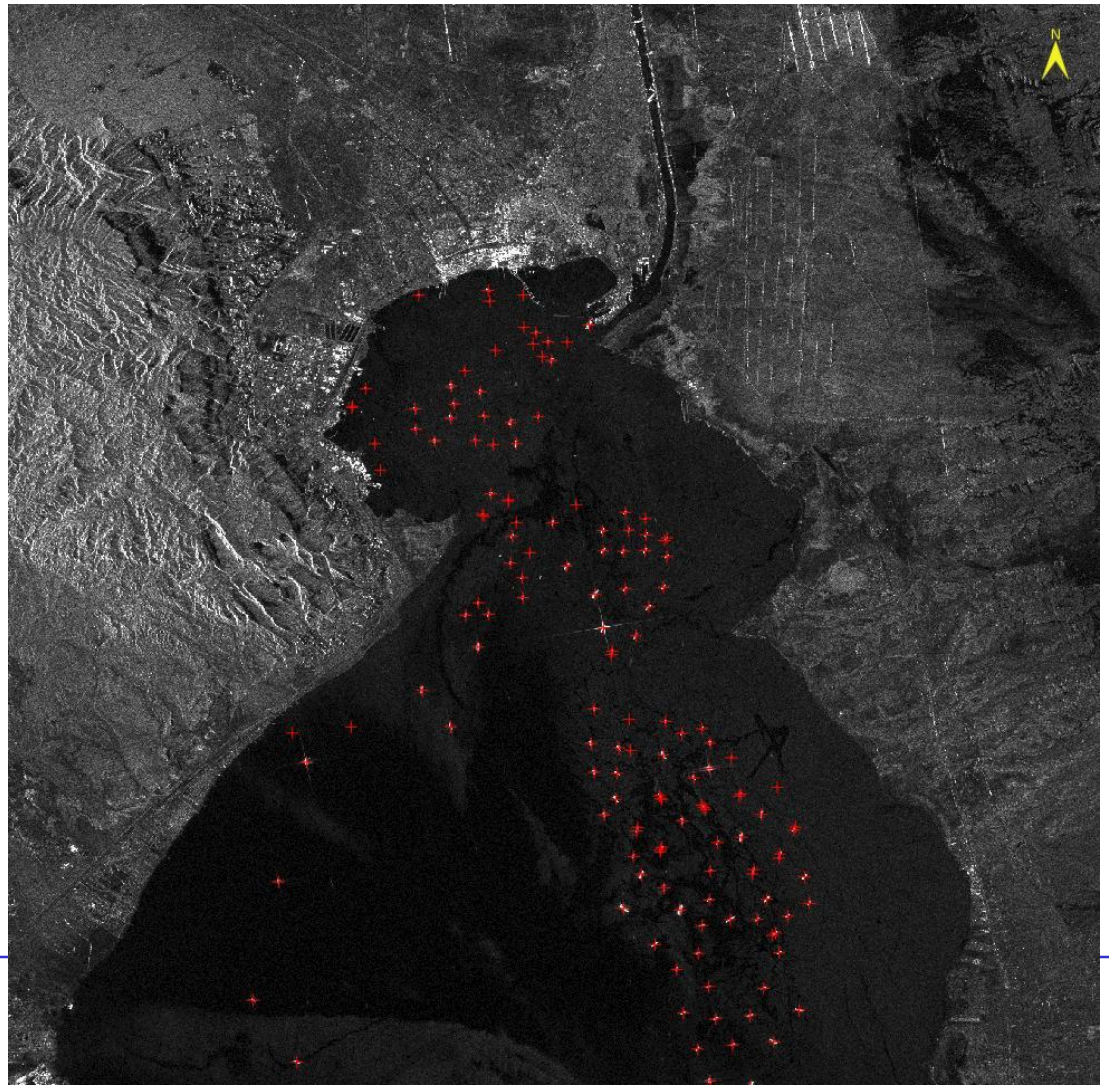
SAR is an ideal instrument for regular monitoring



151 ships detected from Sentinel-1 data

25th March 2021

Southern entry of the Suez channel

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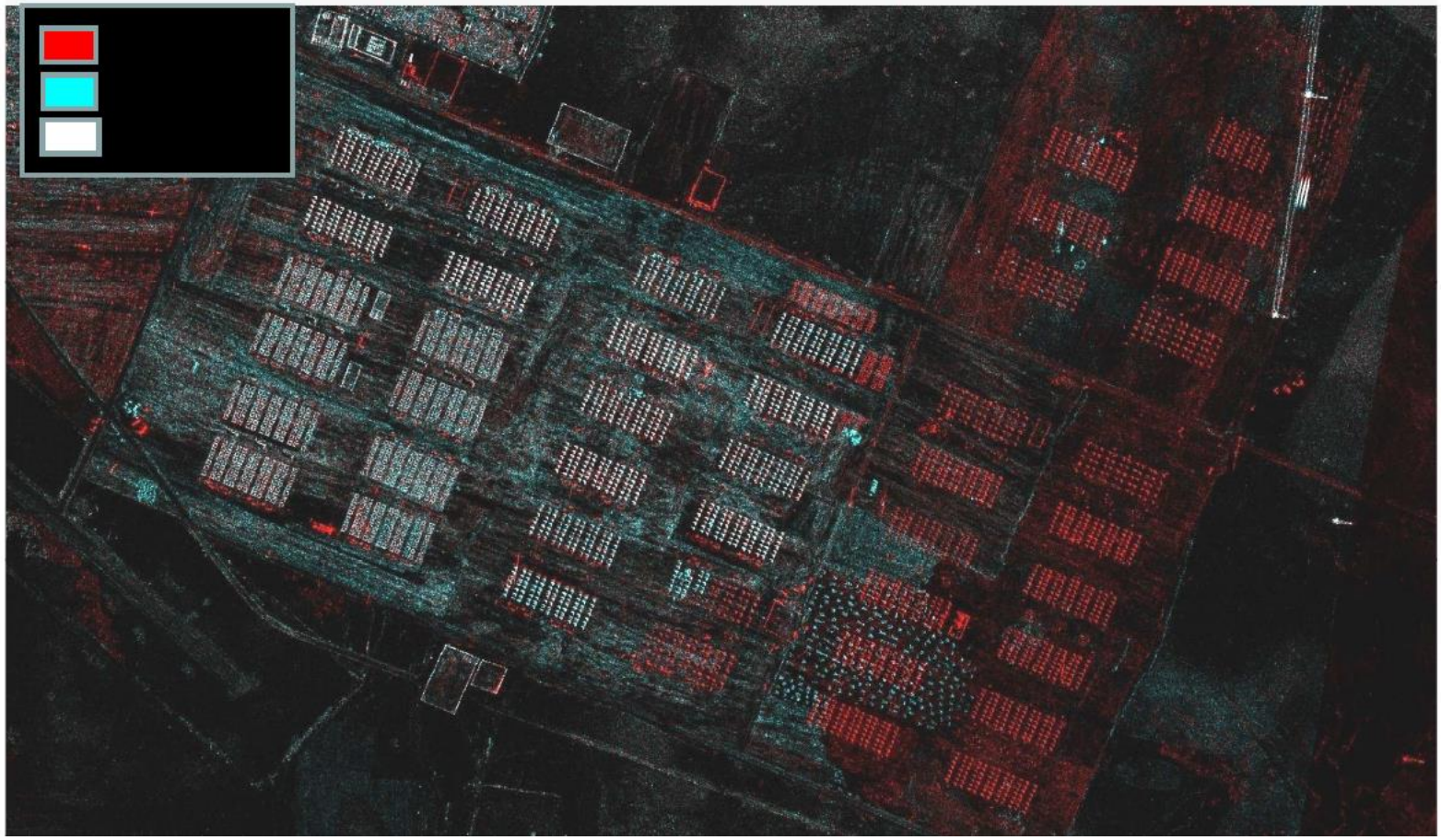
Modern SAR systems allow frequent monitoring



e-geos
AN ASI / TELESPAZIO COMPANY

Syrian refugees camp at the Jordan border

3 images in 1 day

SAR is an ideal instrument for regular monitoring

Doraleh container terminal, Djibouti

Detected ships

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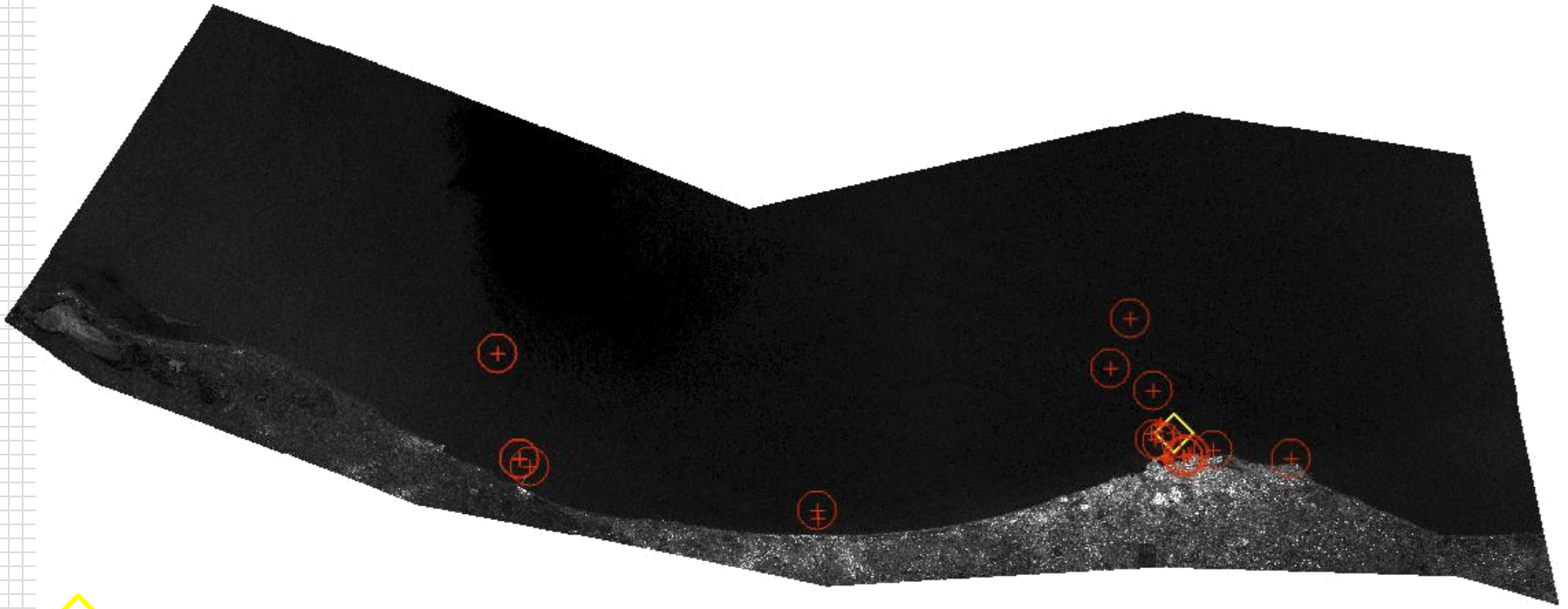
SAR can enhance what AIS data do not see

AIS Track

AIS & SAR

SAR only

Monitoring the coast west of Tripoli



SAR and AIS matched

Only SAR detection

19 May 2020

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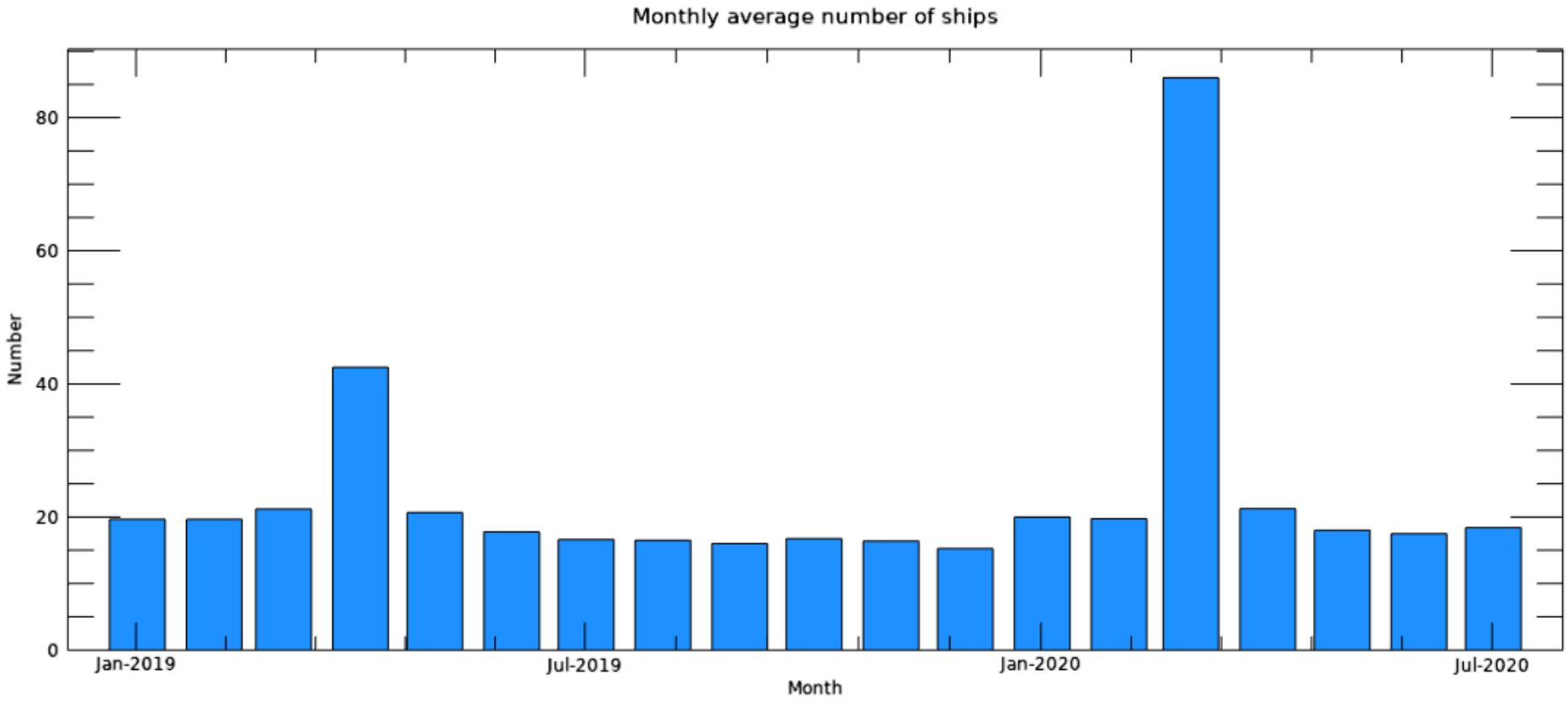
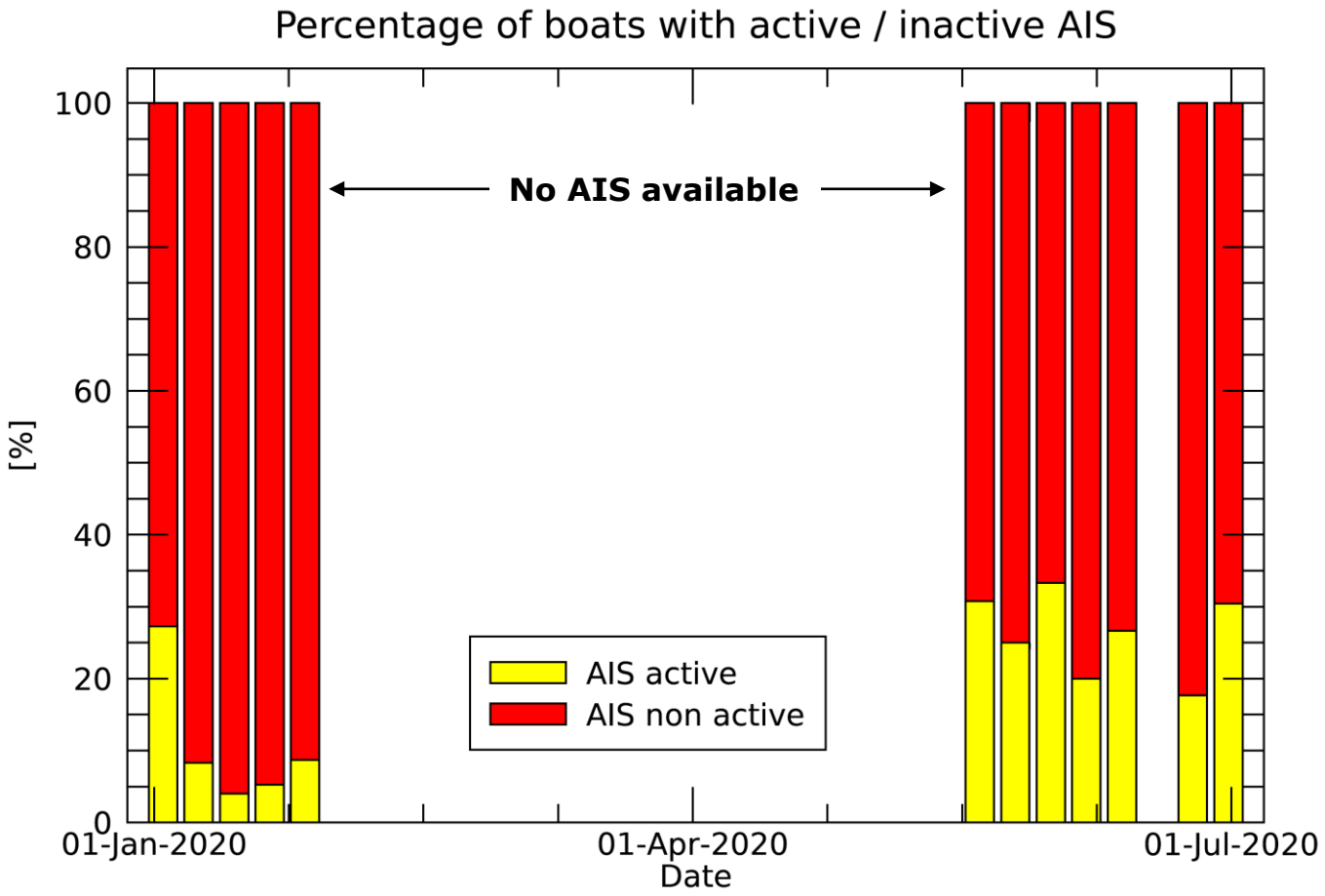
Statistics of ships detected from Sentinel-1 images



Ships detected from Sentinel-1 images and AIS data



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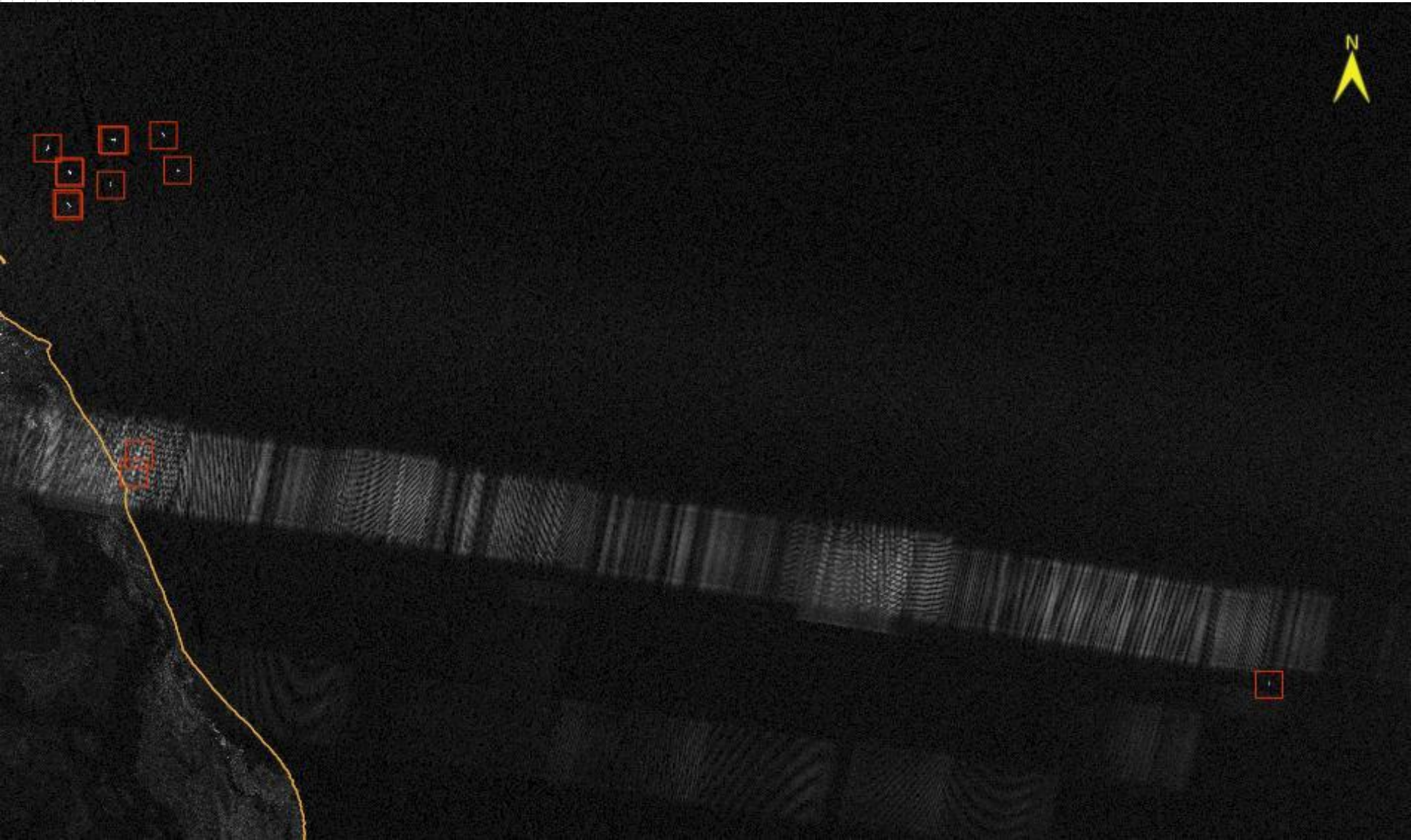
Ship detection on RFI-affected data



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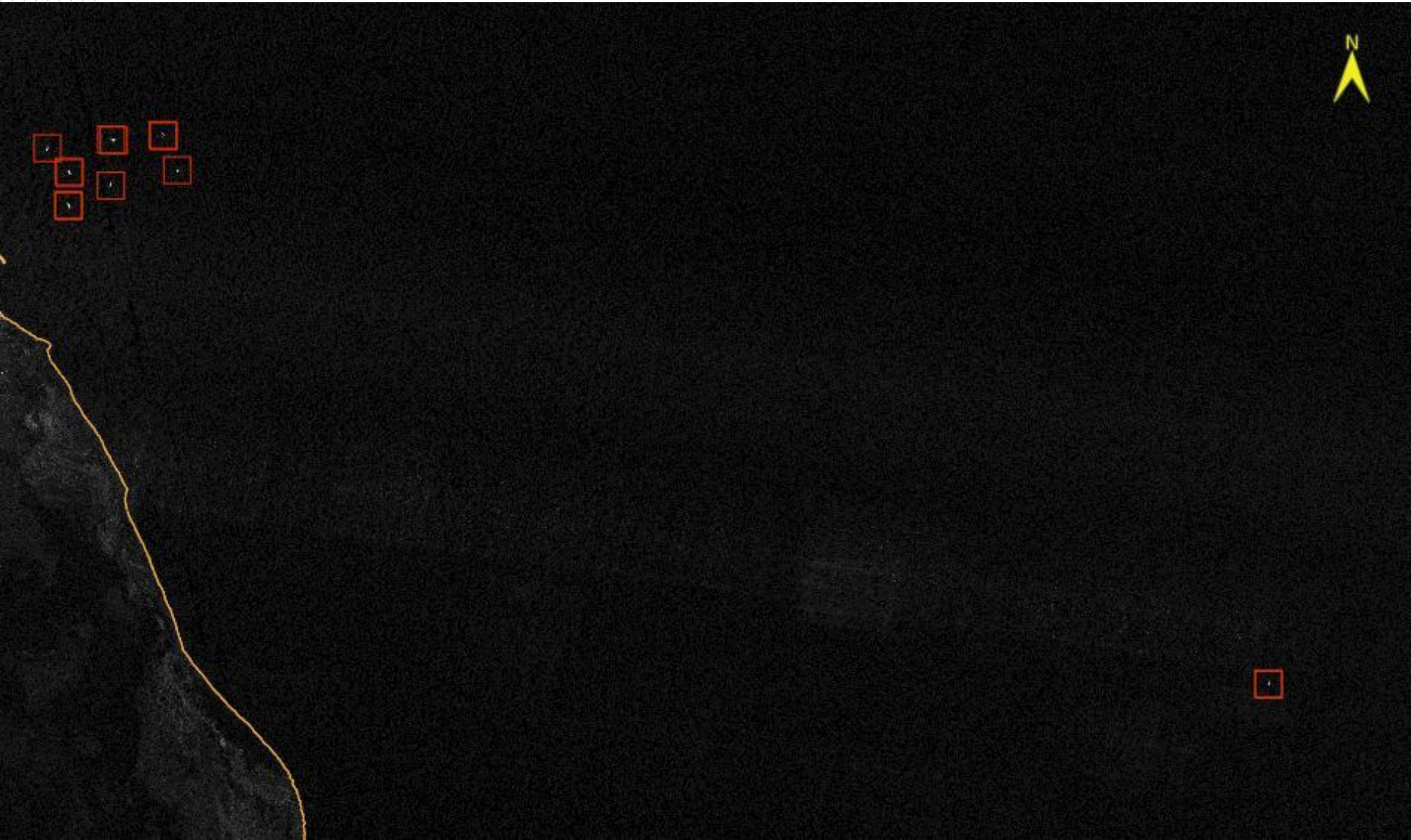
Ship detection on RFI-filtered data



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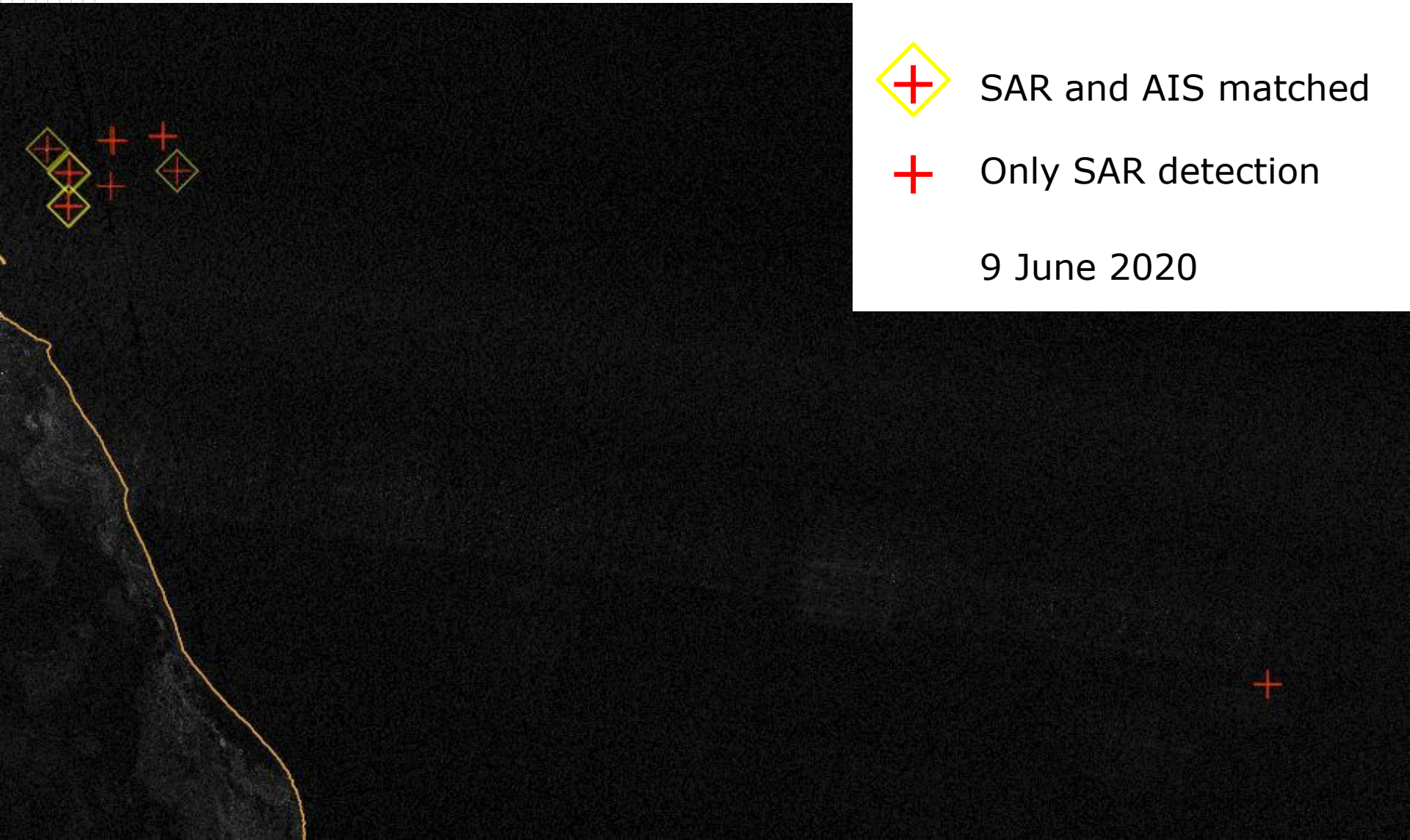
Ships detected from Sentinel-1 images and AIS data



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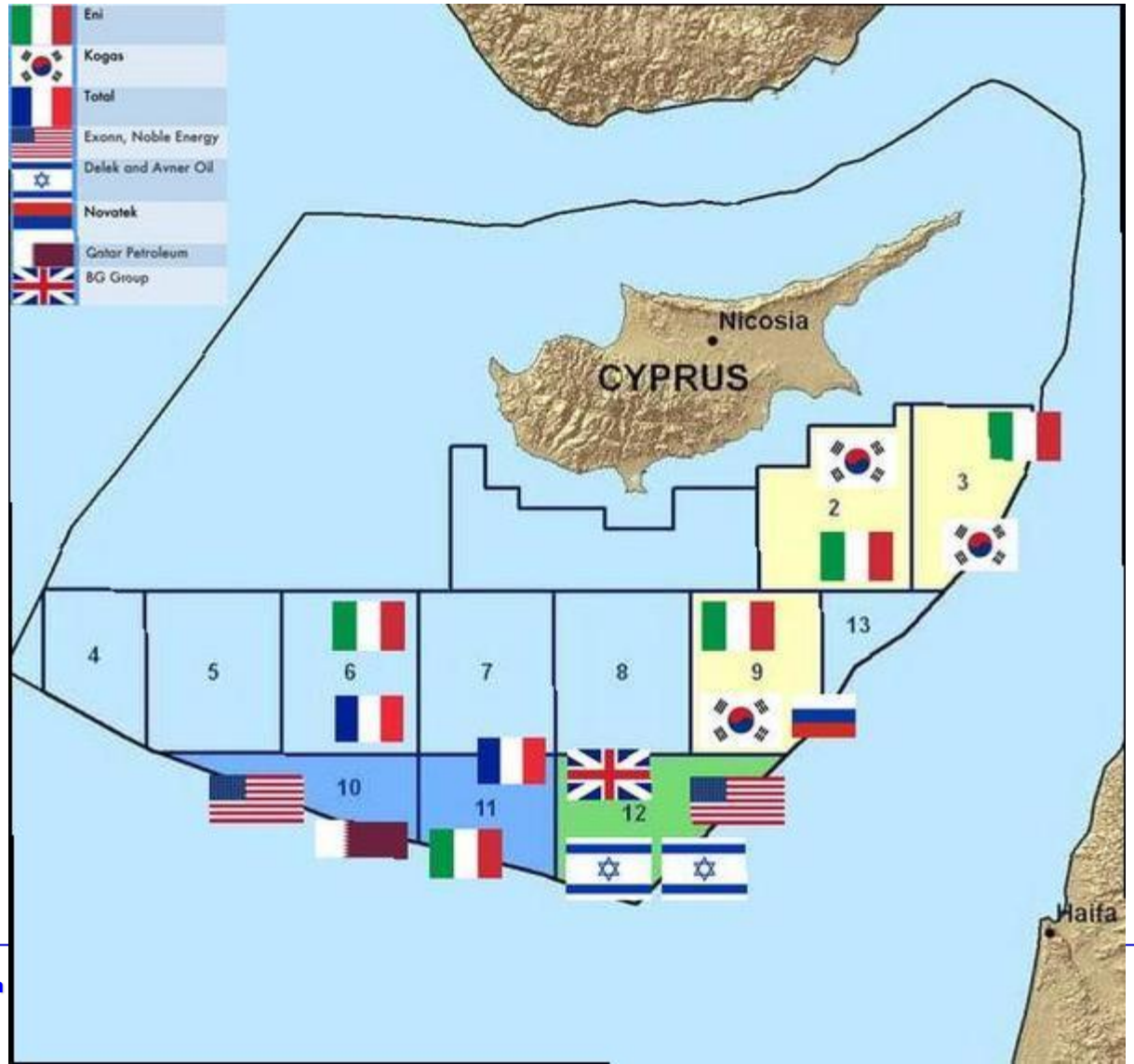
Oil & gas concessions off-shore of Cyprus



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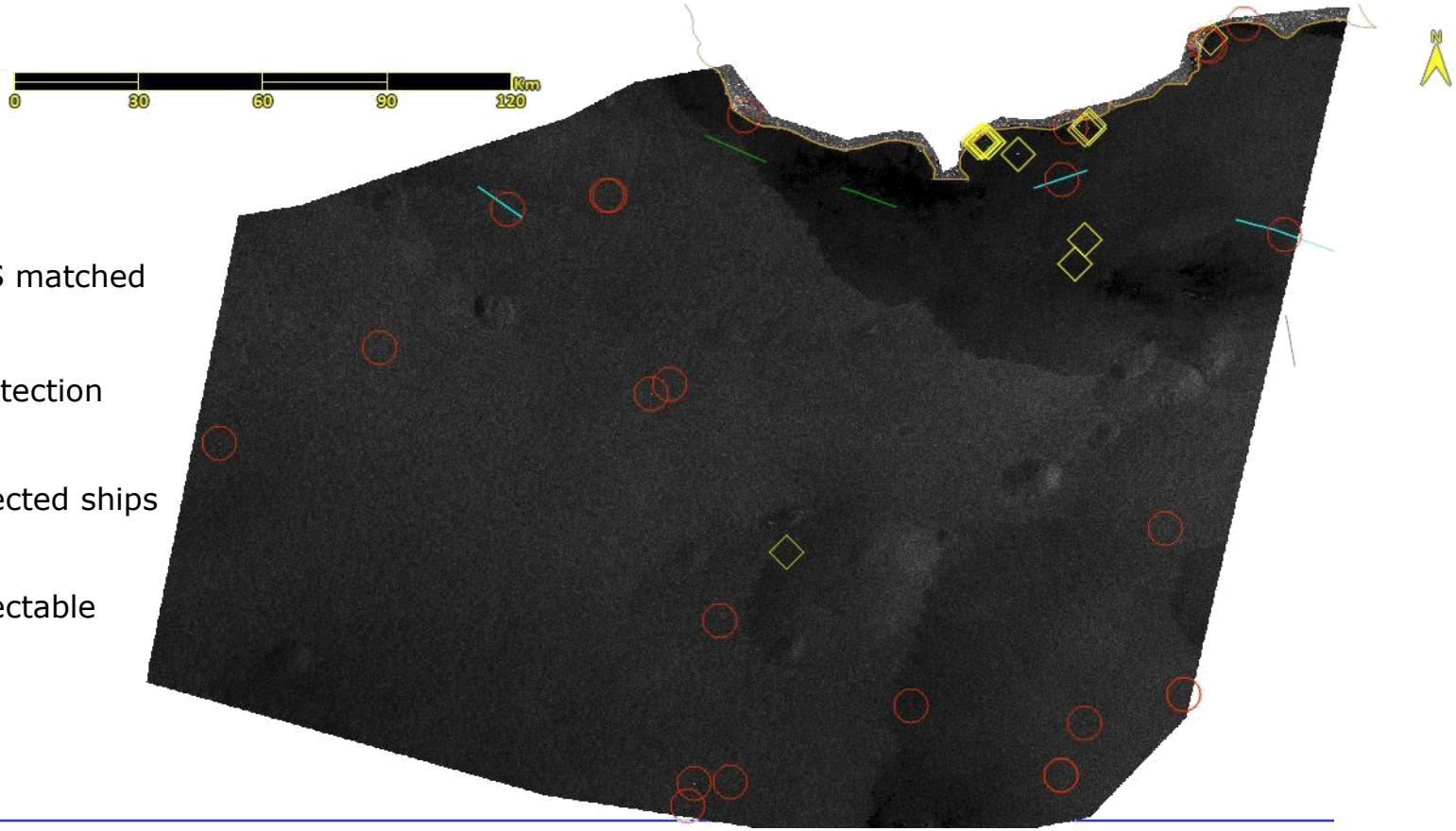
Cyprus: ships detected from Sentinel-1 images and AIS data



SAR and AIS matched

Only SAR detection

AIS close to detected ships

AIS close to detectable ships

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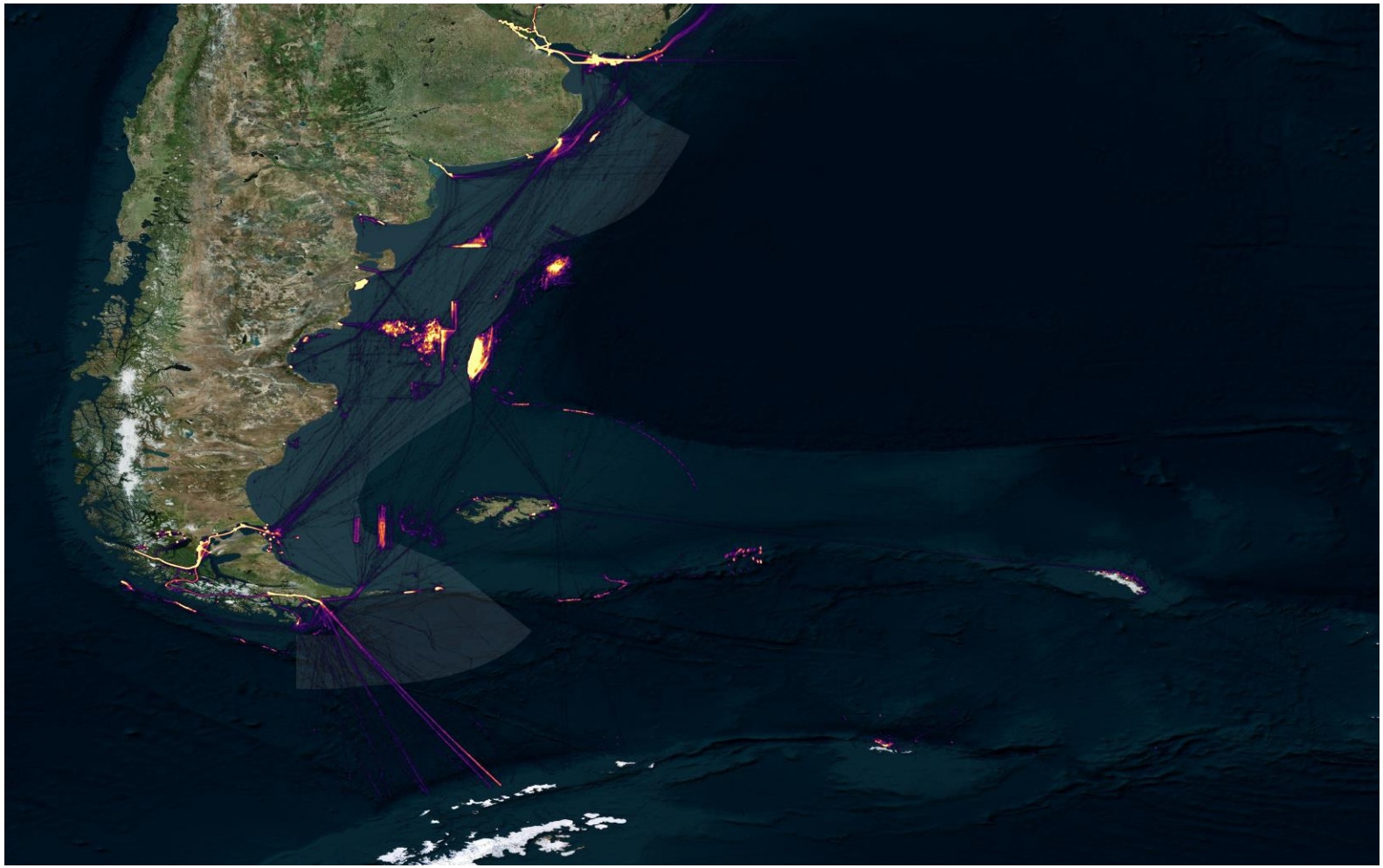
Heat map of ships offshore the Argentinean coast



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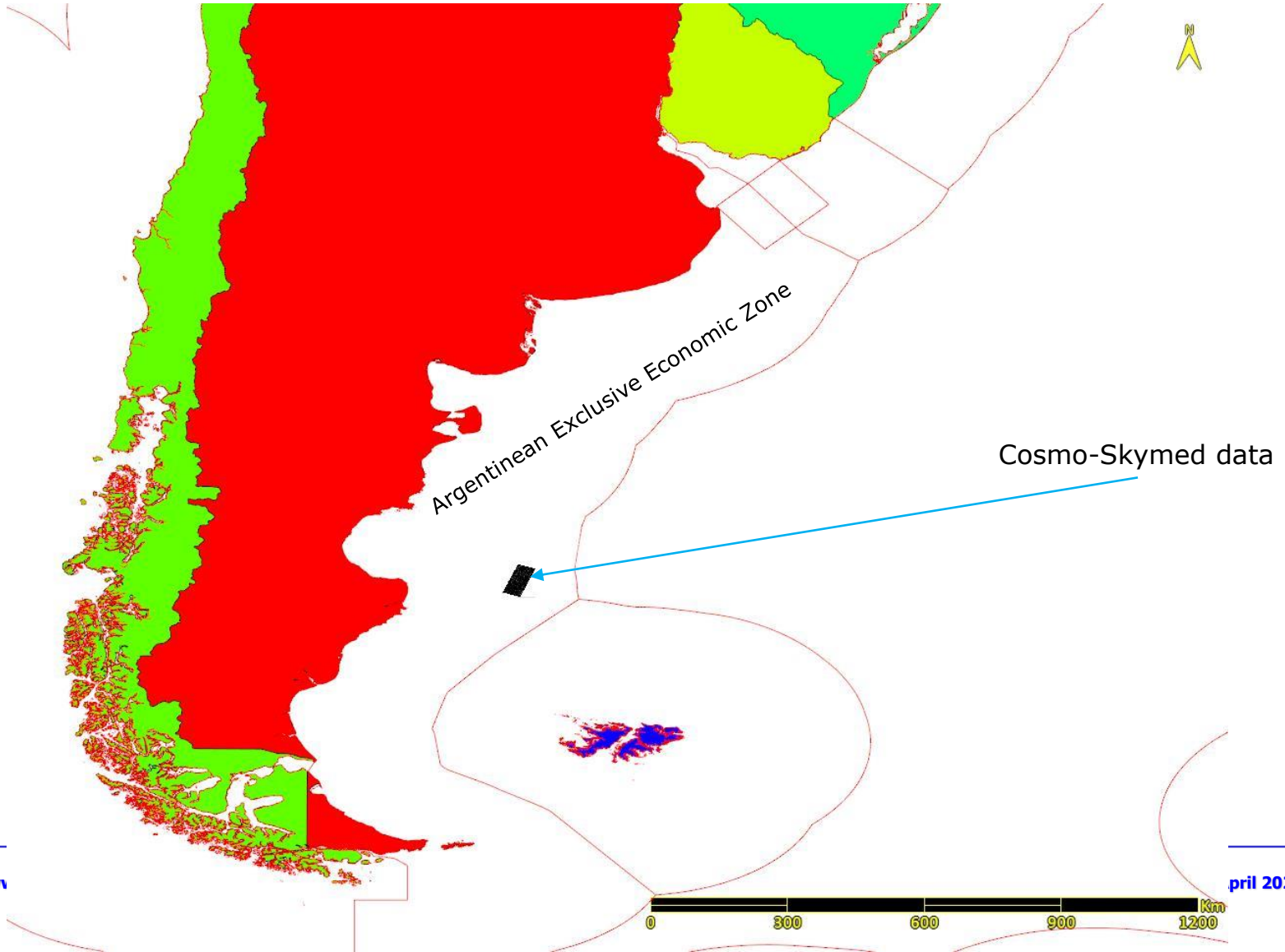
Ship detection in Argentinean Exclusive Economic Zone



Ship detection in Argentinean Exclusive Economic Zone

Cosmo-Skymed data
Courtesy of ASI - eGeos

Ship detection in Argentinean Exclusive Economic Zone

Attribute Viewer: ua9QjwIBSYycB14BYD-YIA_1Jan2020_to_1Feb2020_results_120_tracks_edit.shp

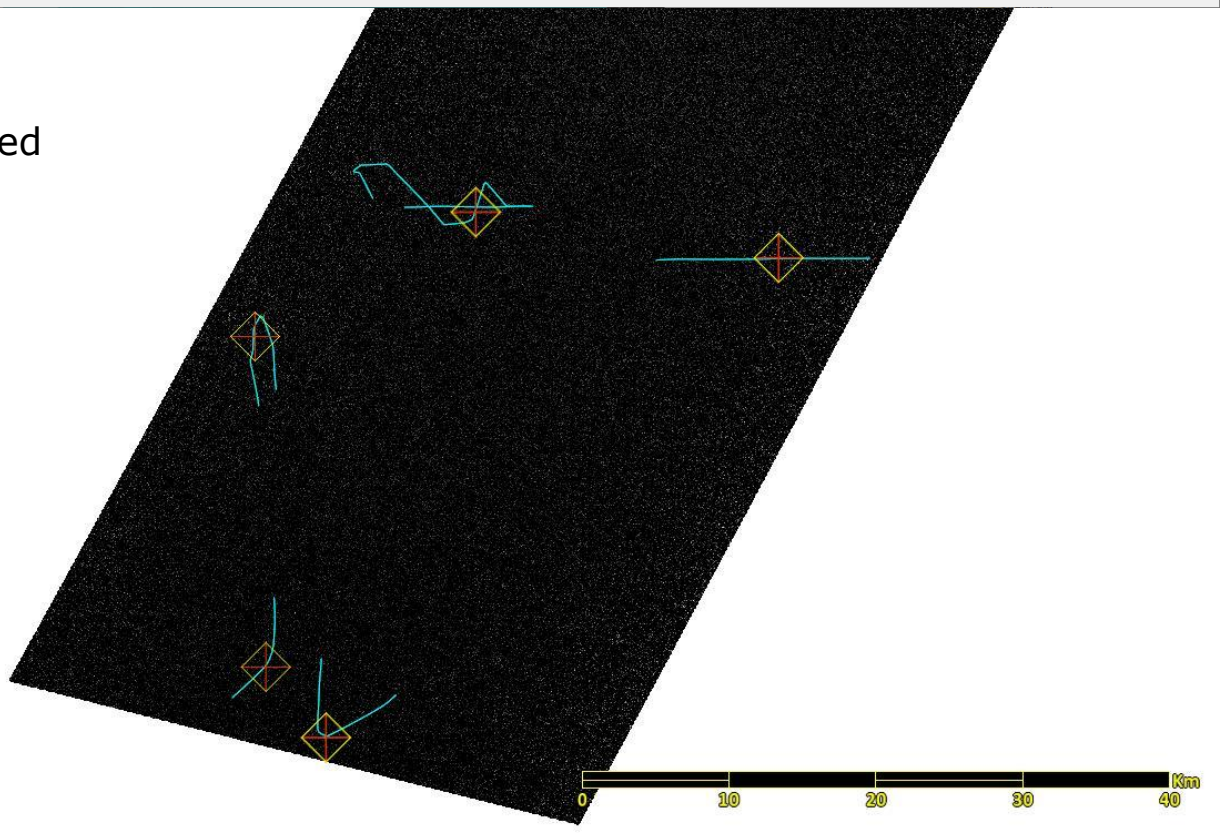
File Options Help

	MMSI	Provider	Class	Time	IMONumber	CallSign	VesselName	ShipType	EPFDFixTyp	DimToBow	DimToStern	DimToPort	DimToStarb	ETA	Draught	Destinatio	Coord	Lenght	Width	Country
1	701000834	IntelliEar	A	2020-01-31 19:48:18.000	7406423	LW9165	ANDRES JORGE	Fishing	Undefined	21.000000	32.000000	5.000000	5.000000	12-01 10:00	4.300000	PTO MDP	Ok	53.000000	10.000000	Argentine Republic
2	701000786	IntelliEar	A	2020-01-31 19:48:58.000	8606525	LW9105	ITXAS LUR	Sailing	GPS	13.000000	50.000000	5.000000	5.000000	01-15 09:00	4.700000	ZONA DE PESCA	Ok	63.000000	10.000000	Argentine Republic
3	701006044	IntelliEar	A	2020-01-31 19:56:38.000	8709509	LW9882	GEMINIS	Not available	GPS	16.000000	44.000000	8.000000	4.000000	05-16 17:00	0.000000	ZONA DE PESCA	Ok	60.000000	12.000000	Argentine Republic
4	701006445	IntelliEar	A	2020-01-31 20:01:28.000	7336484	LW2678	API V	Fishing	GPS	27.000000	53.000000	5.000000	8.000000	01-14 12:00	6.600000	ZONA DE PESCA	Ok	80.000000	13.000000	Argentine Republic
5	701006046	IntelliEar	A	2020-01-31 20:16:28.000	8812150	8366	VENTARRON	Fishing	GPS	18.000000	48.000000	6.000000	5.000000	11-15 15:00	5.100000	ZONA DE PESCA	Ok	66.000000	11.000000	Argentine Republic

1 0 of 5 records selected

SAR and AIS matched

Only SAR detection



Cosmo-Skymed data
Courtesy of ASI - eGeos

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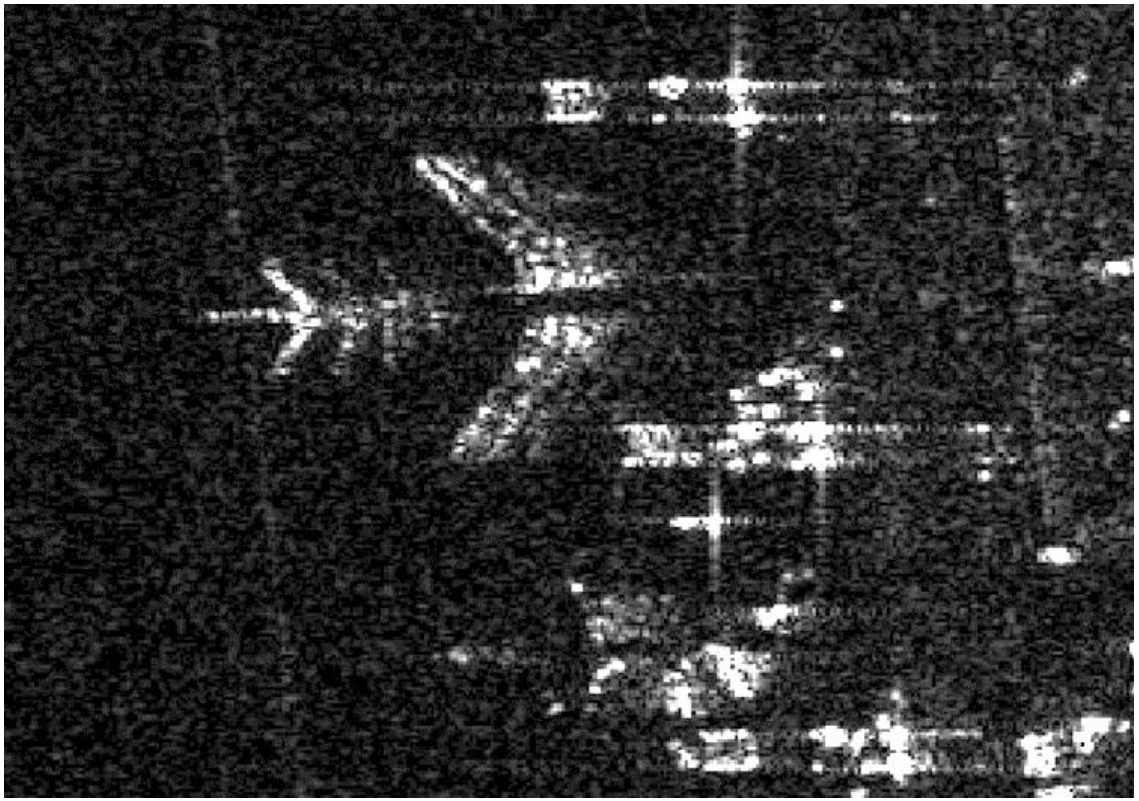
Interpretation and Automatic Target Recognition on SAR imagery are neither simple nor intuitive



Full resolution COSMO-Skymed spotlight image of an airplane in an airport area

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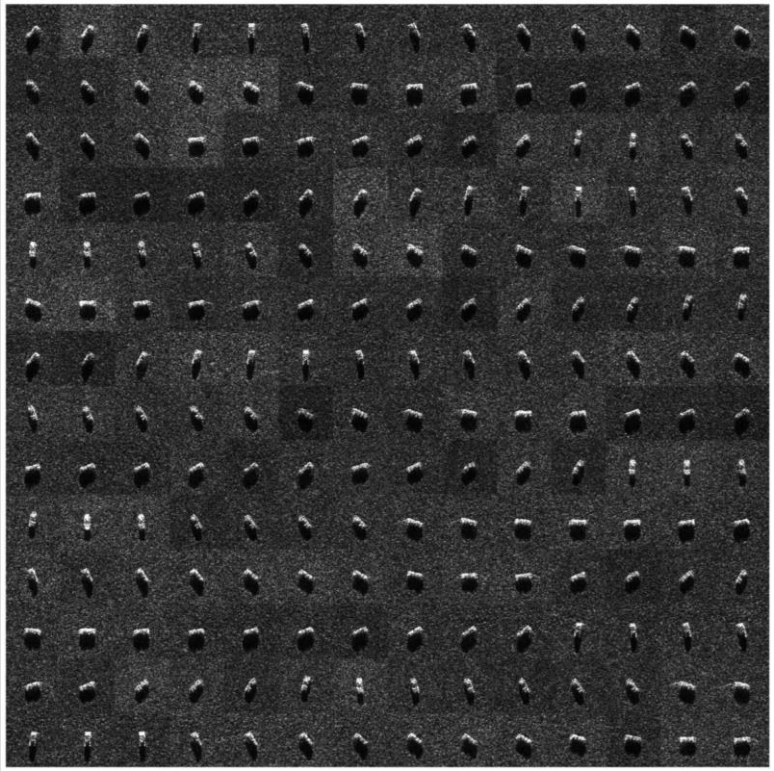
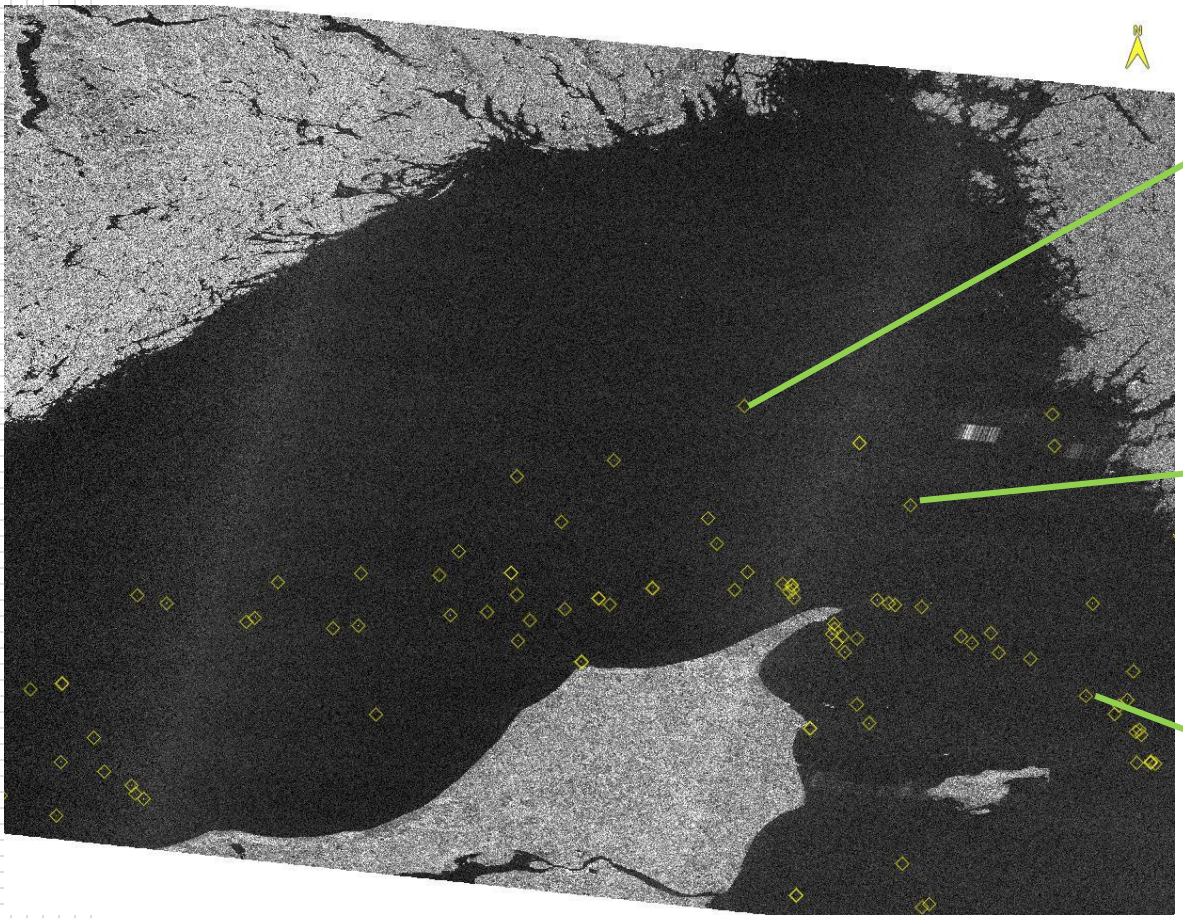
«Brute force» approaches to support this are very expensive



Sample dataset taken from the MSTAR database

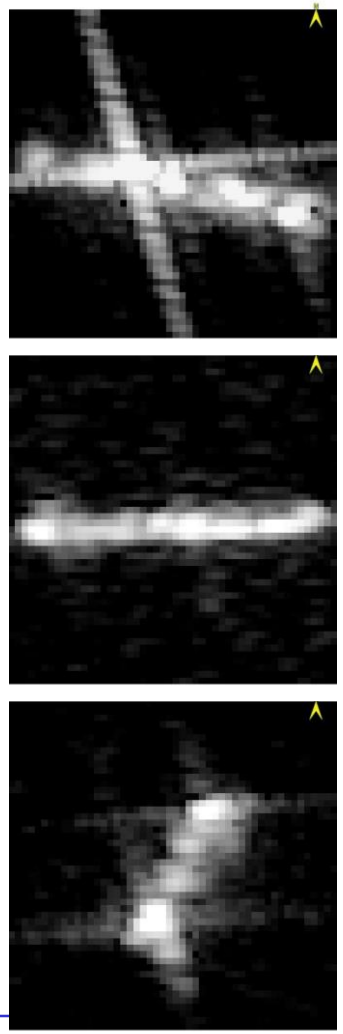
SAR + AIS can help Automated Target Recognition



Cargo

Passenger

Tanker



-> Deep Learning training based on automatically extracted datasets for ships classification

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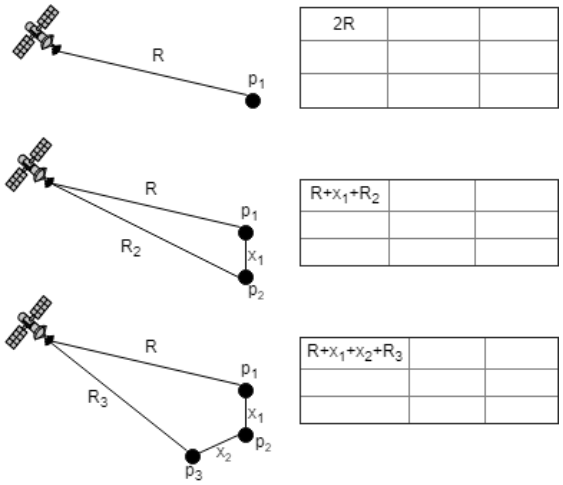
Under development: a CAD-based software simulator

- Ray tracer for simulating **RAW** and SLC Synthetic Aperture Radar satellite images.

- Tech used:
  - GPU
  - OverVision
  - Compute shaders



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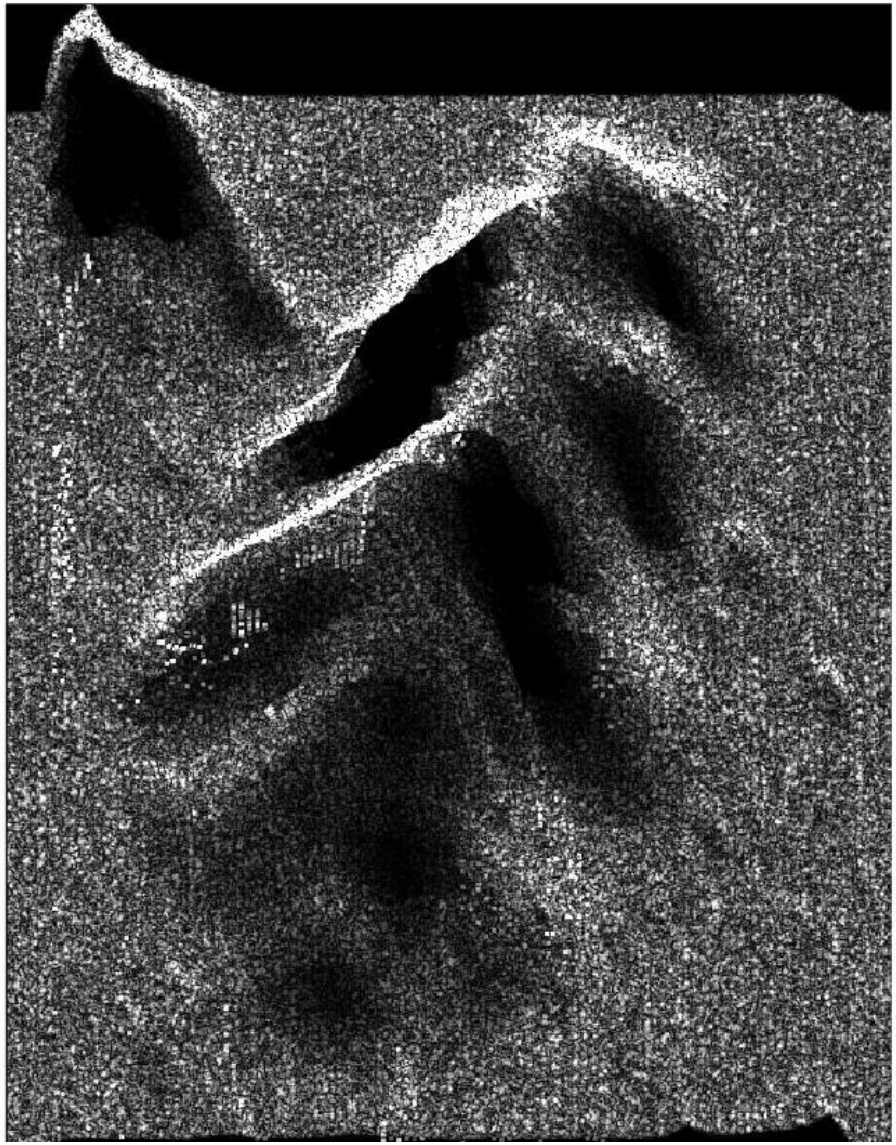
For natural...



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… as well as for man-made features

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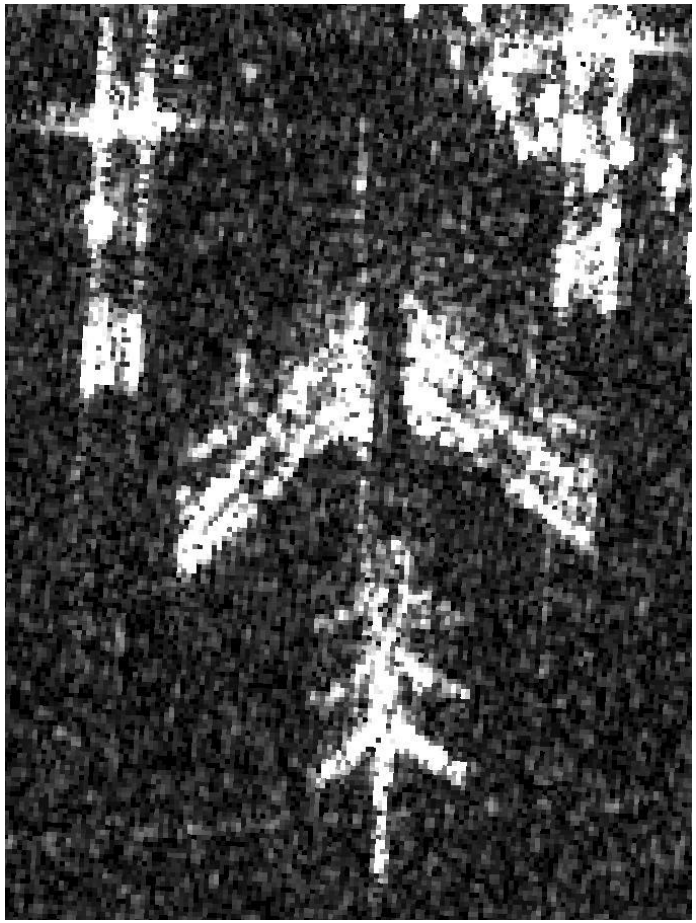
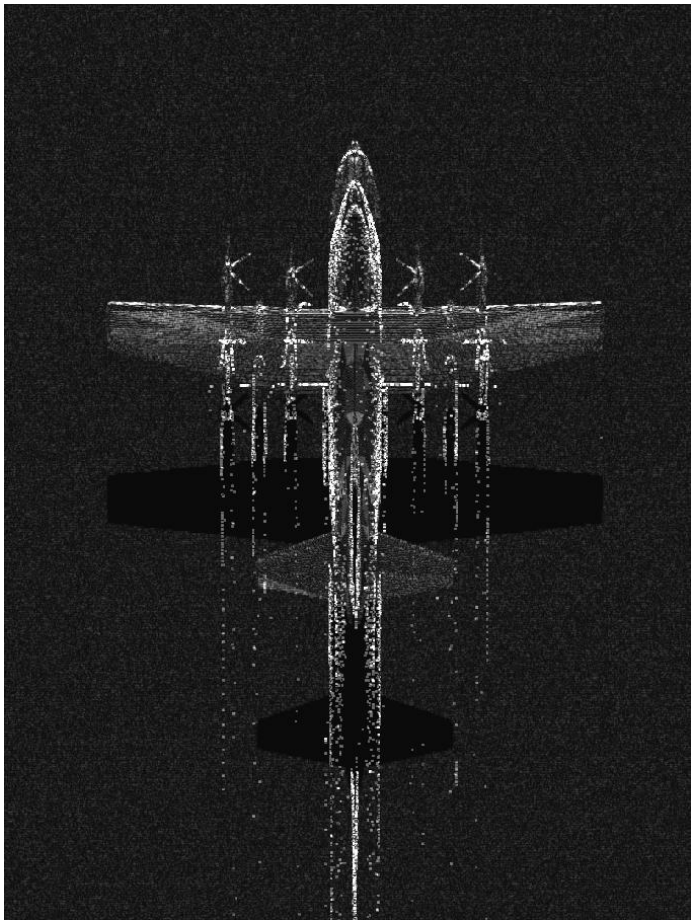


Cosmo-Skymed



SARscape

-> Deep Learning training based on SAR imagery simulated from CAD models of the targets of interest

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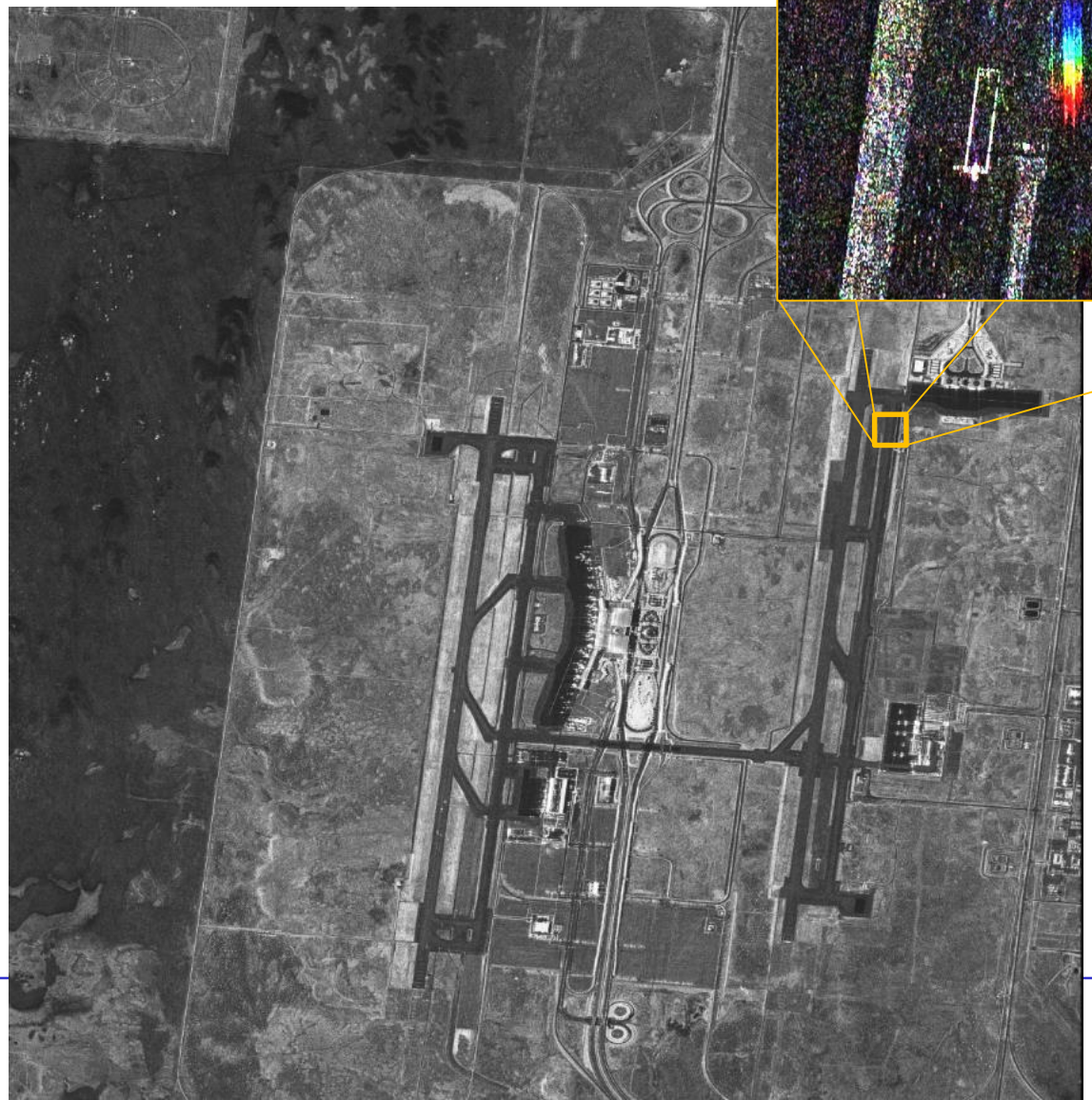
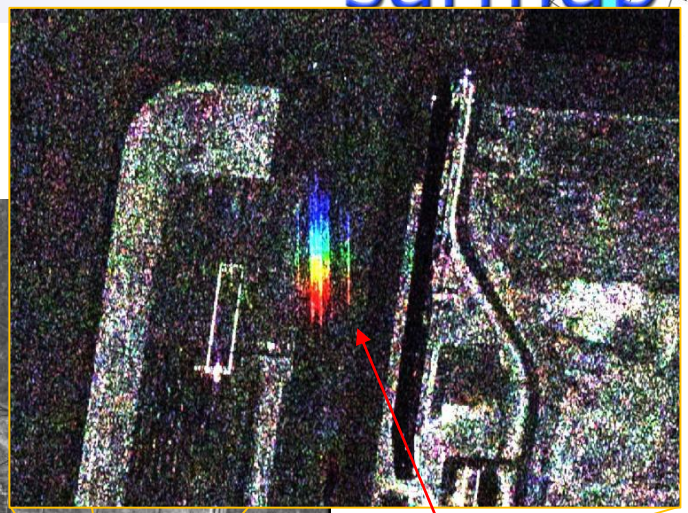
Moving Target Detection

Exploiting the time necessary to acquire data to form the Synthetic Aperture





Moving objects can be automatically highlighted

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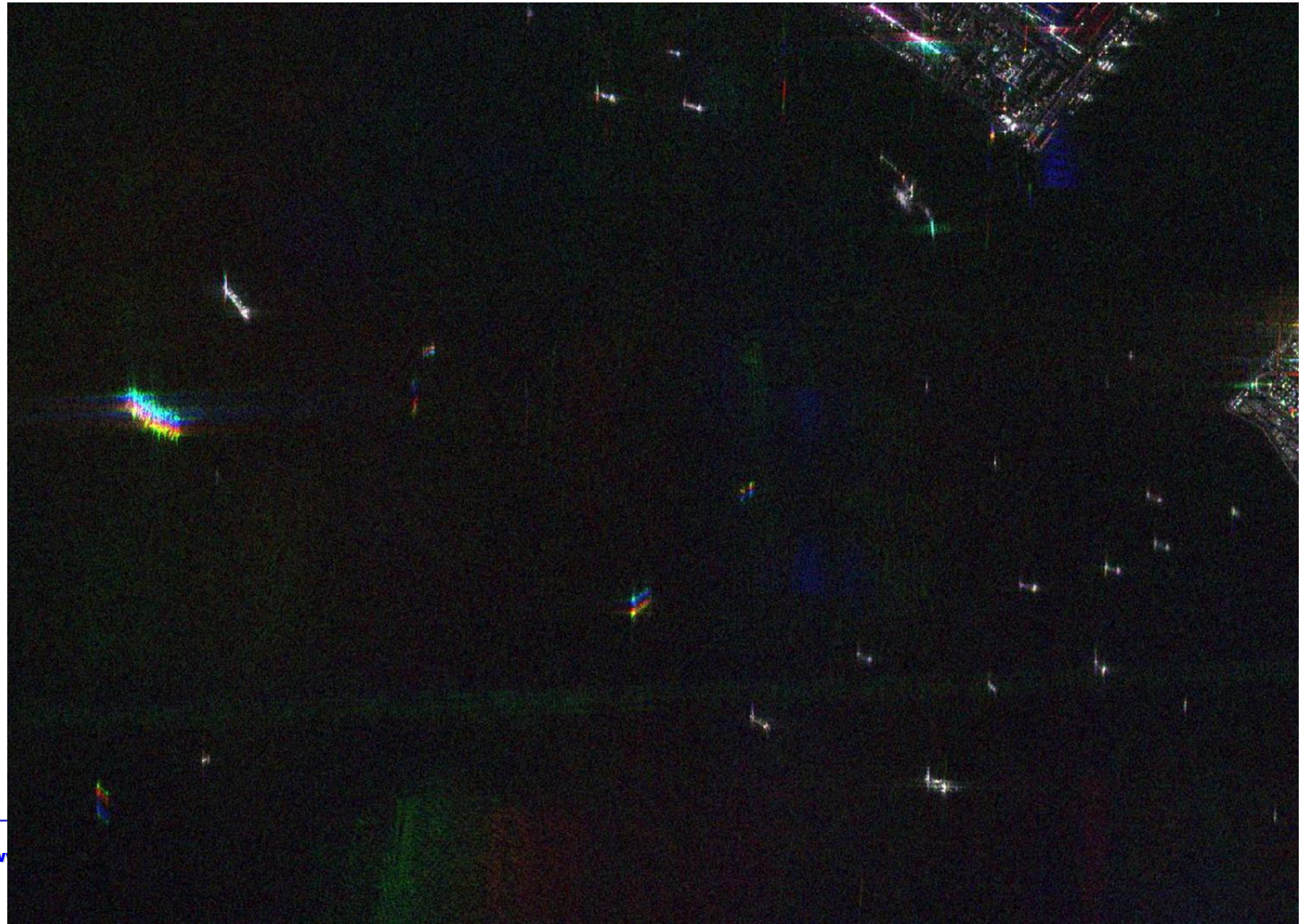
Moving Target Detection



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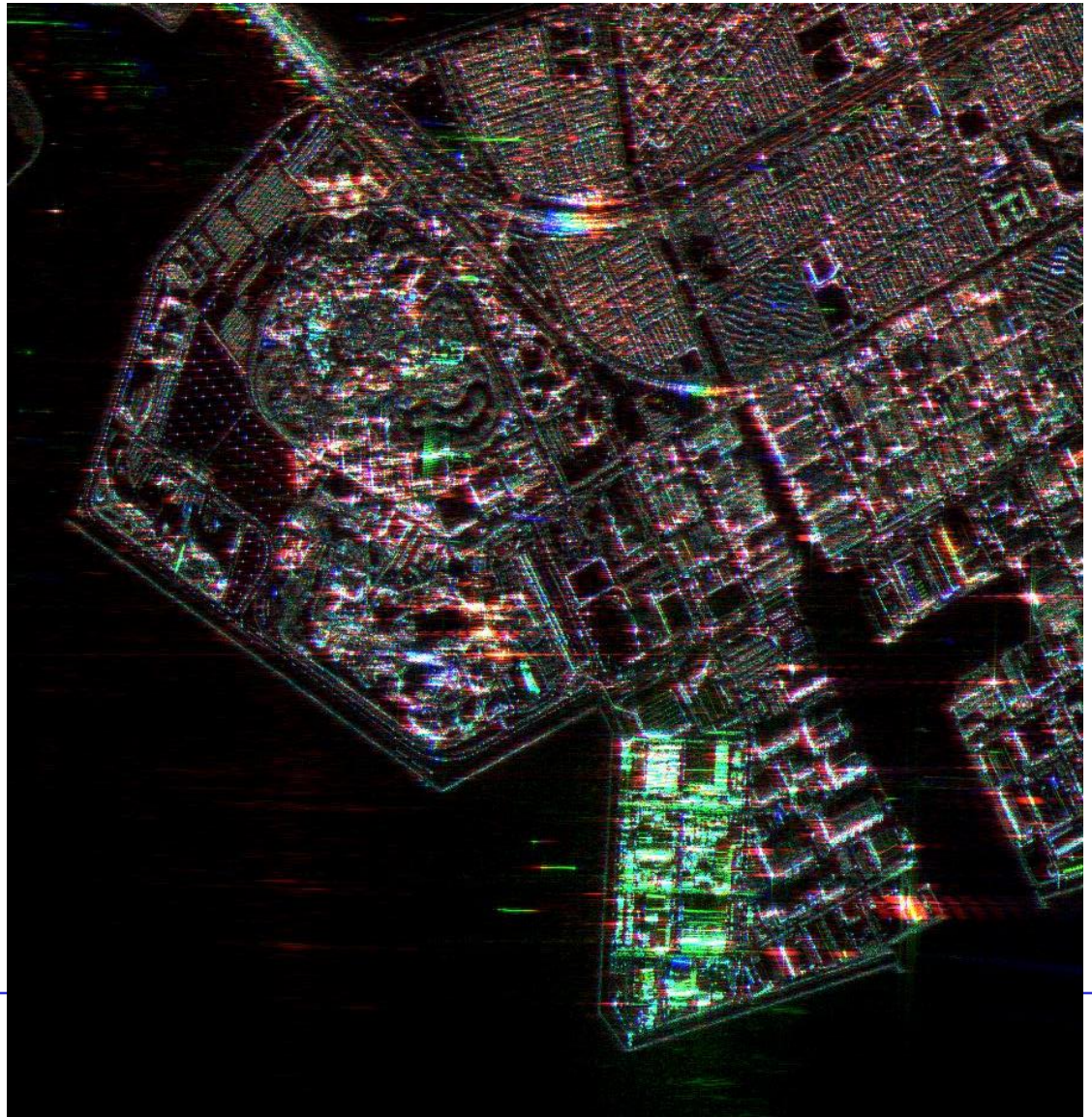
Moving Target Detection



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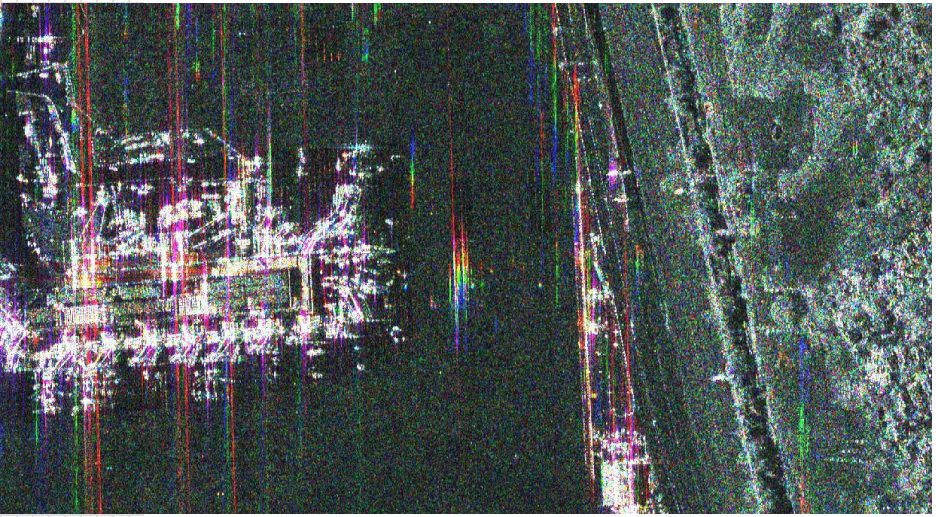
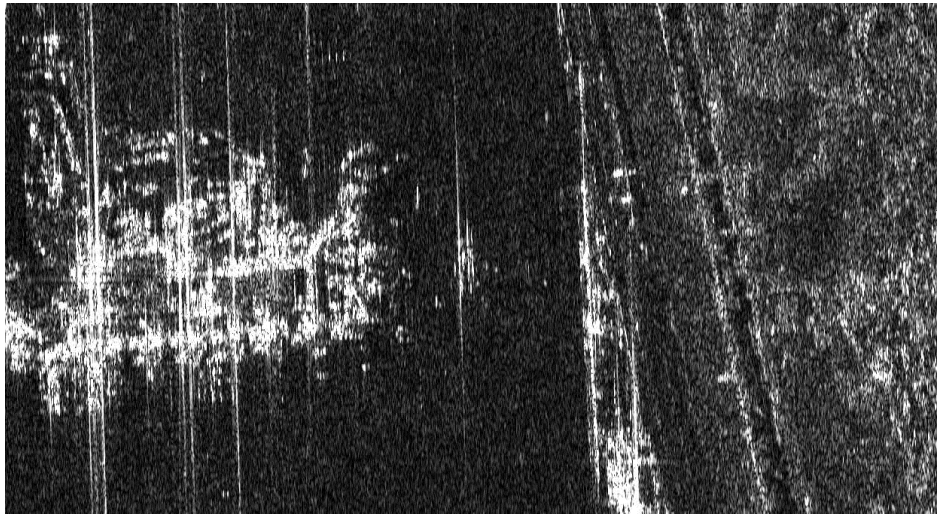
Moving Target Detection

Exploiting the time of acquisition of a full Synthetic Aperture





Data courtesy Capella Space

…and acquisition of such data can be personally tasked!

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Coherent Change Detection: 2020 Beirut port explosion

Pre-event coherence

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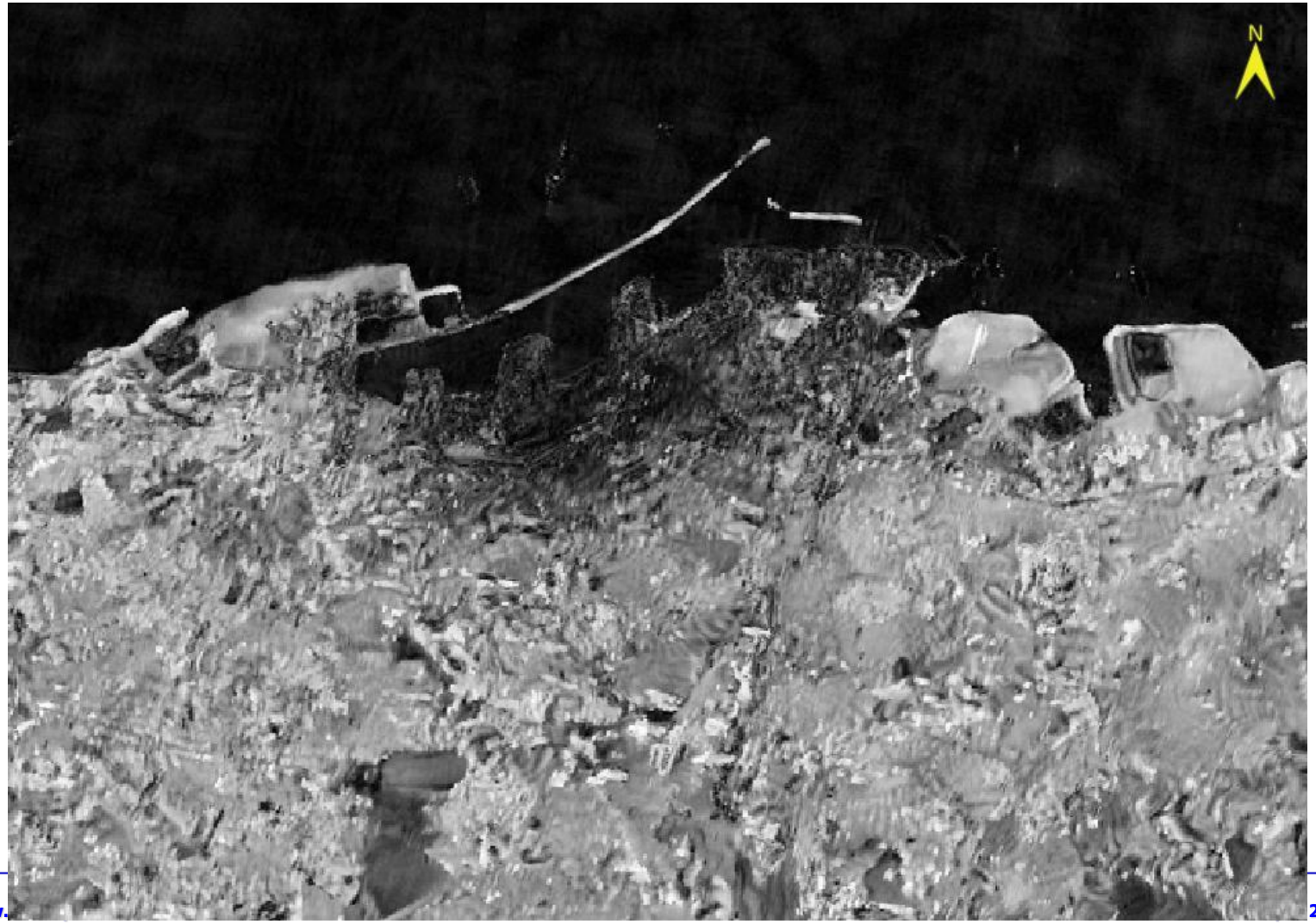
Coherent Change Detection: 2020 Beirut port explosion



Cross-event coherence

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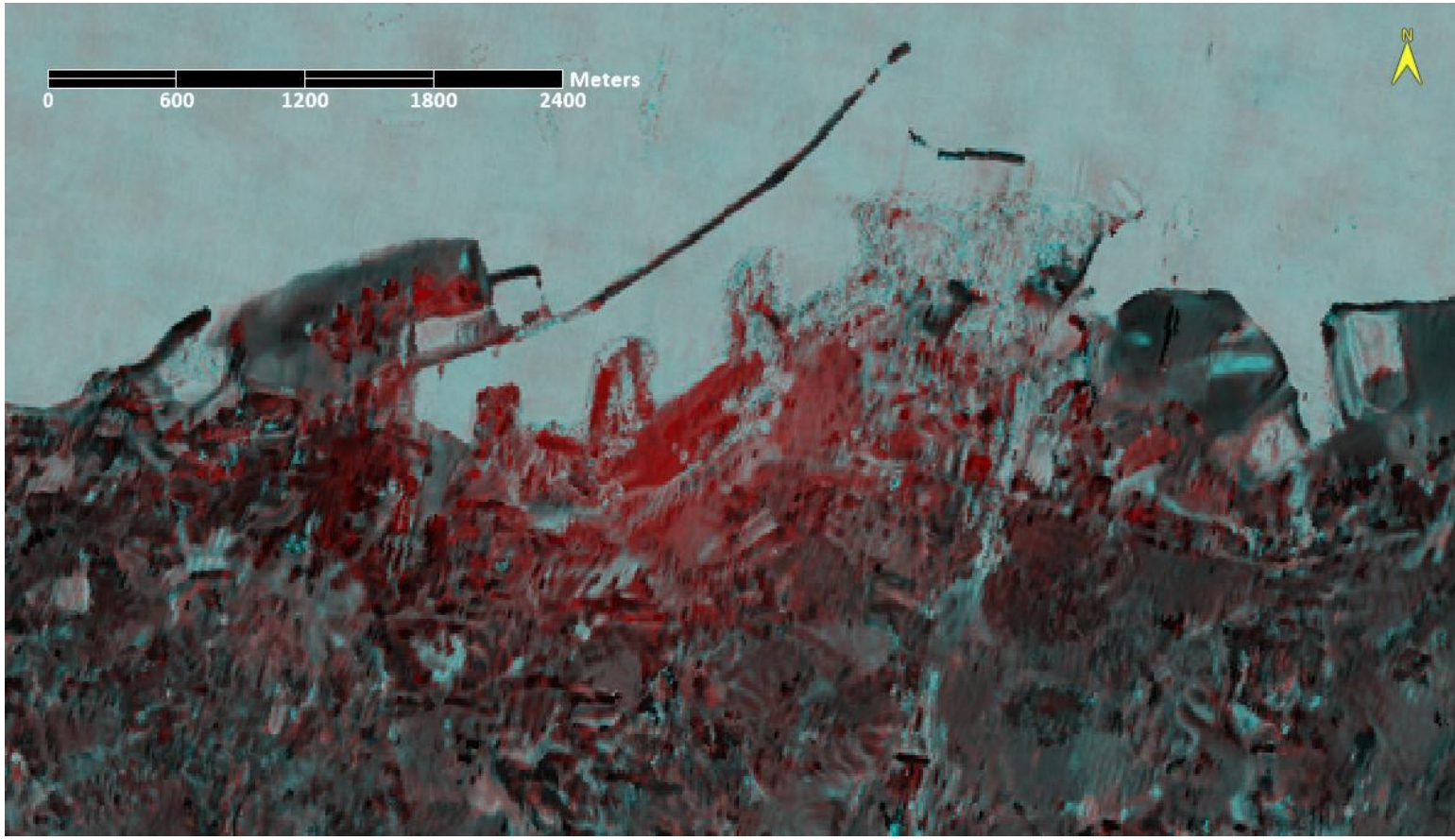
Coherent Change Detection

Sentinel-1 Coherent Change Detection

Red: Pre-event
Green: Across the event
Blue: Across the event

Sentinel-1 data:
- 24 July
- 30 July
- 5 August

Severely damaged areas appear in red shades



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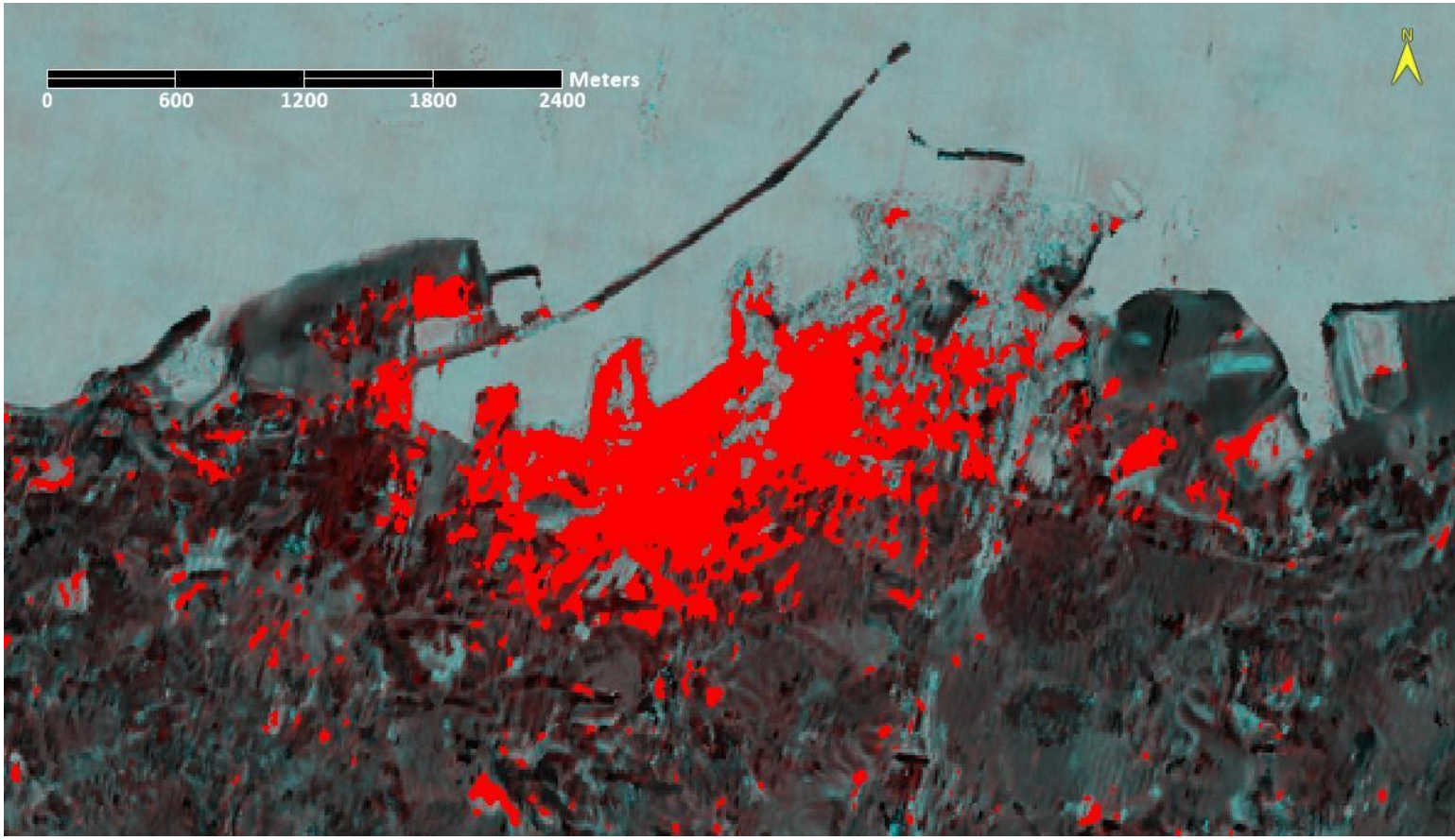
Coherent Change Detection Classification



Sentinel-1 data:
- 24 July
- 30 July
- 5 August

Severely damaged areas appear in red polygons

Meters
0
600
1200
1800
2400
N

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SAR can detect and measure small terrain displacement, to relate with underground activities (e.g. excavation)

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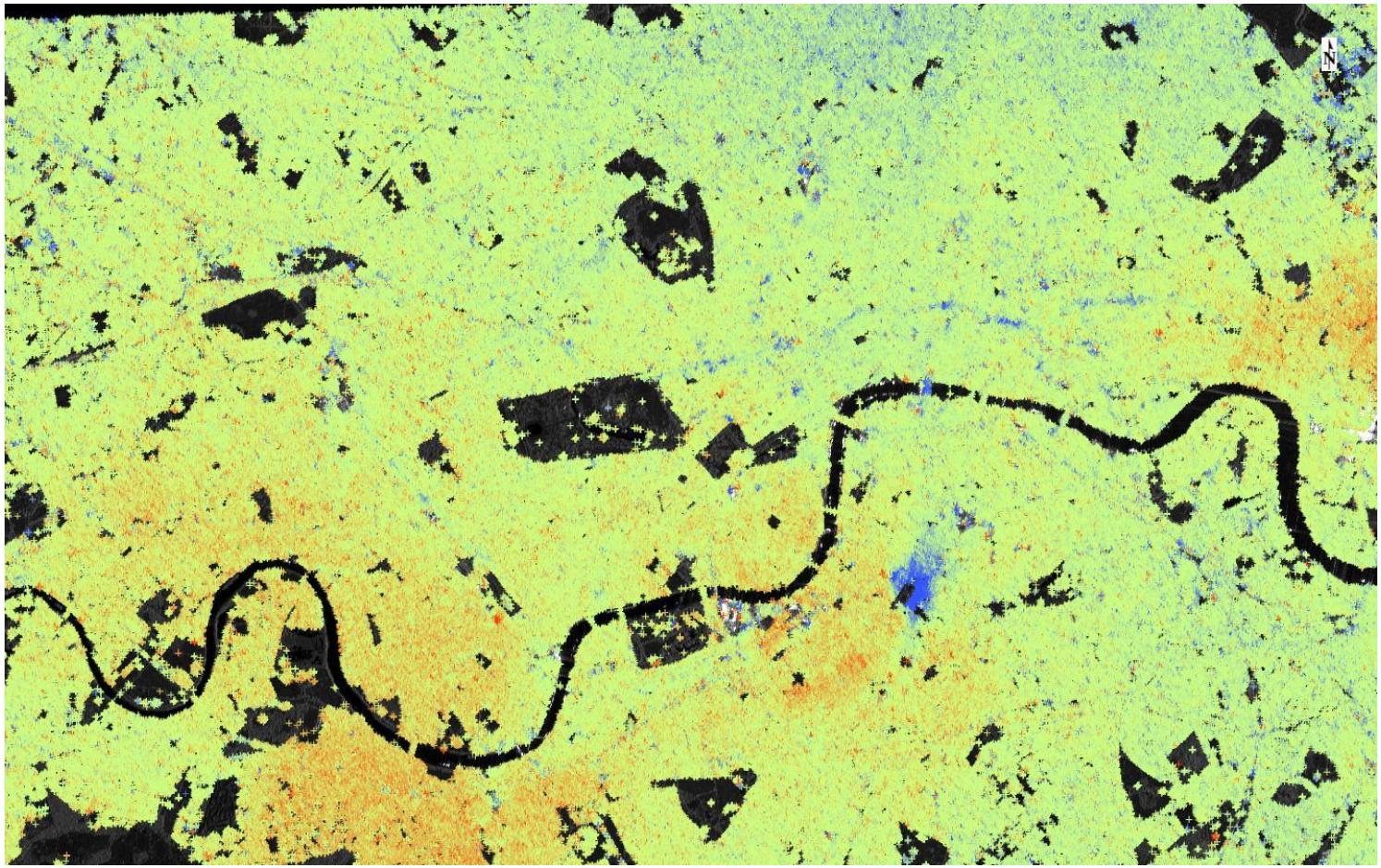

London

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SAR can detect and measure small terrain displacement, to relate with underground activities (e.g. excavation)

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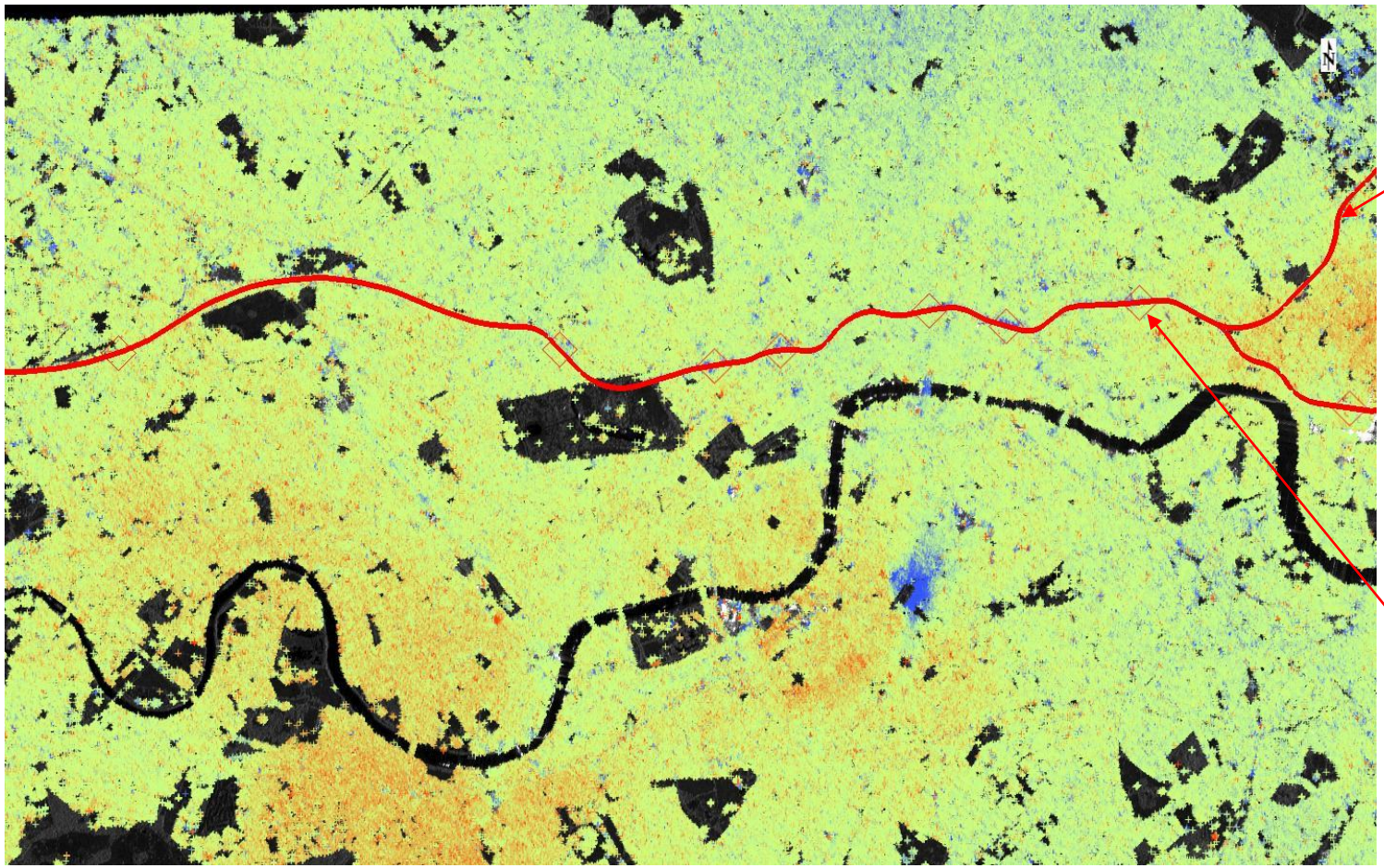
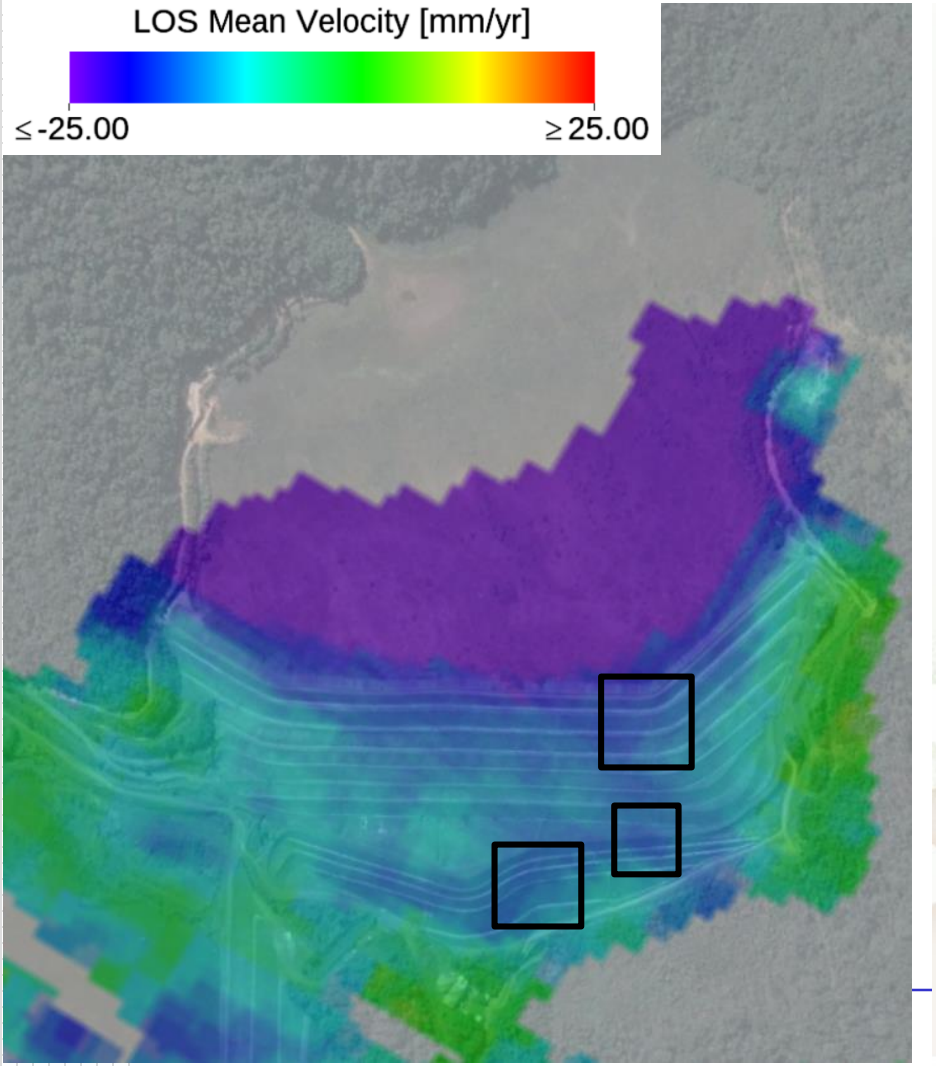
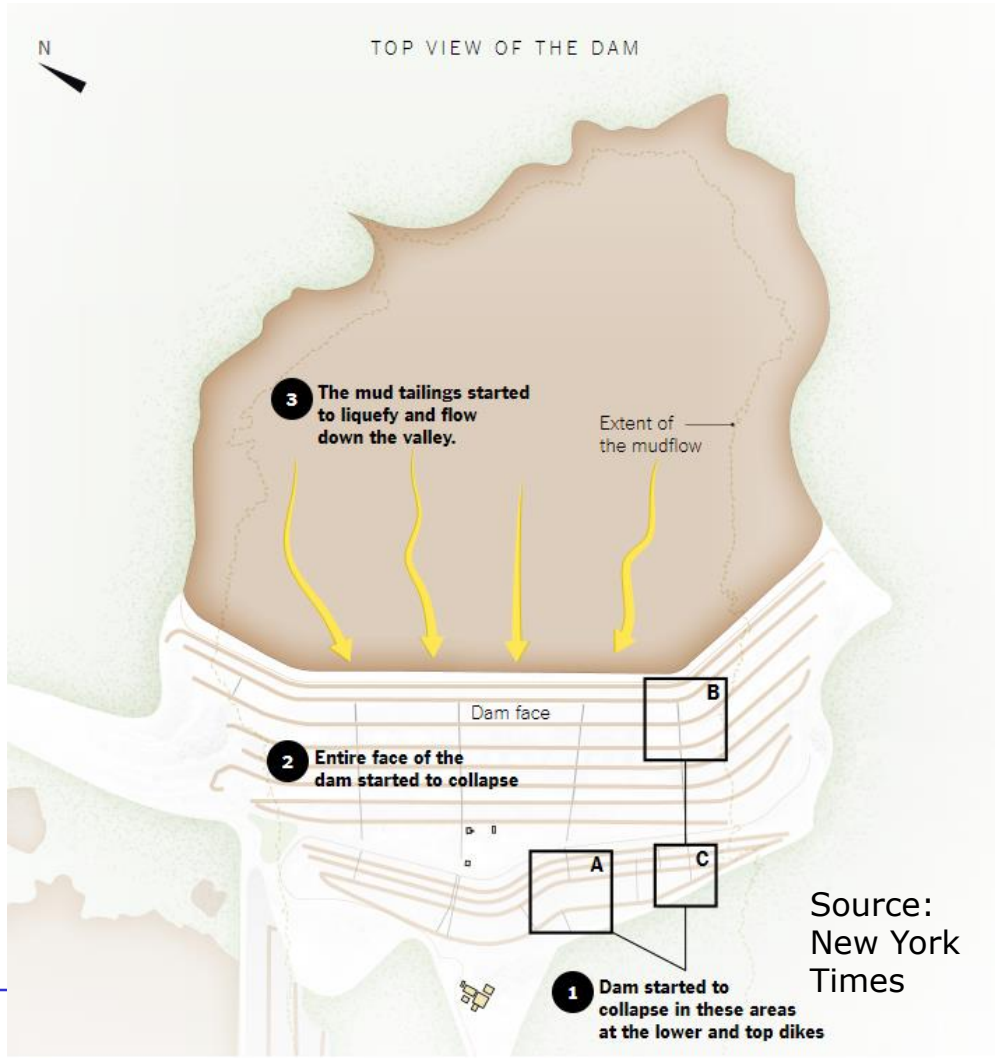


SAR can help monitoring structural stability of infrastructures
Brumadinho tailing dam collapse – Mean Velocity

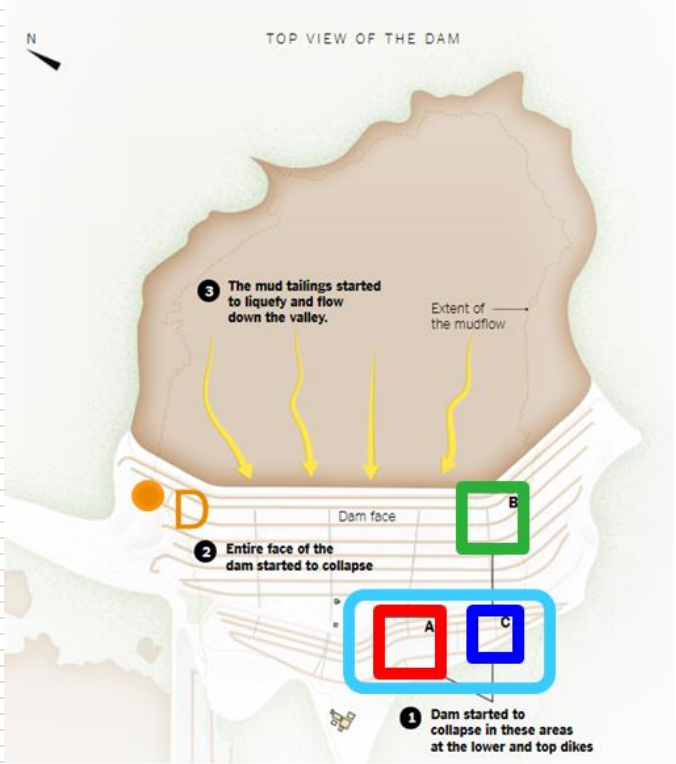


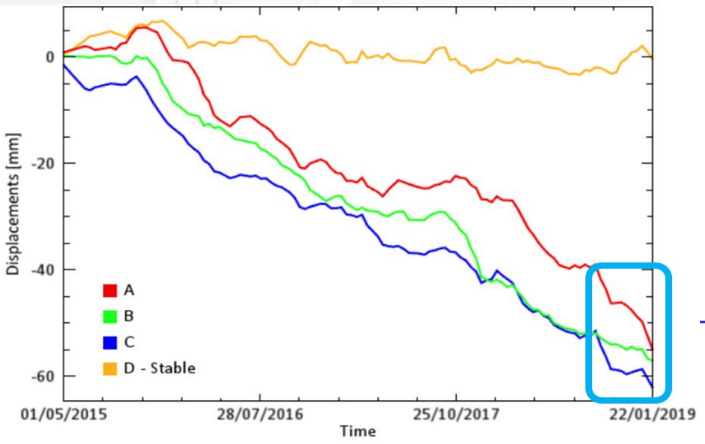


Source: New York Times

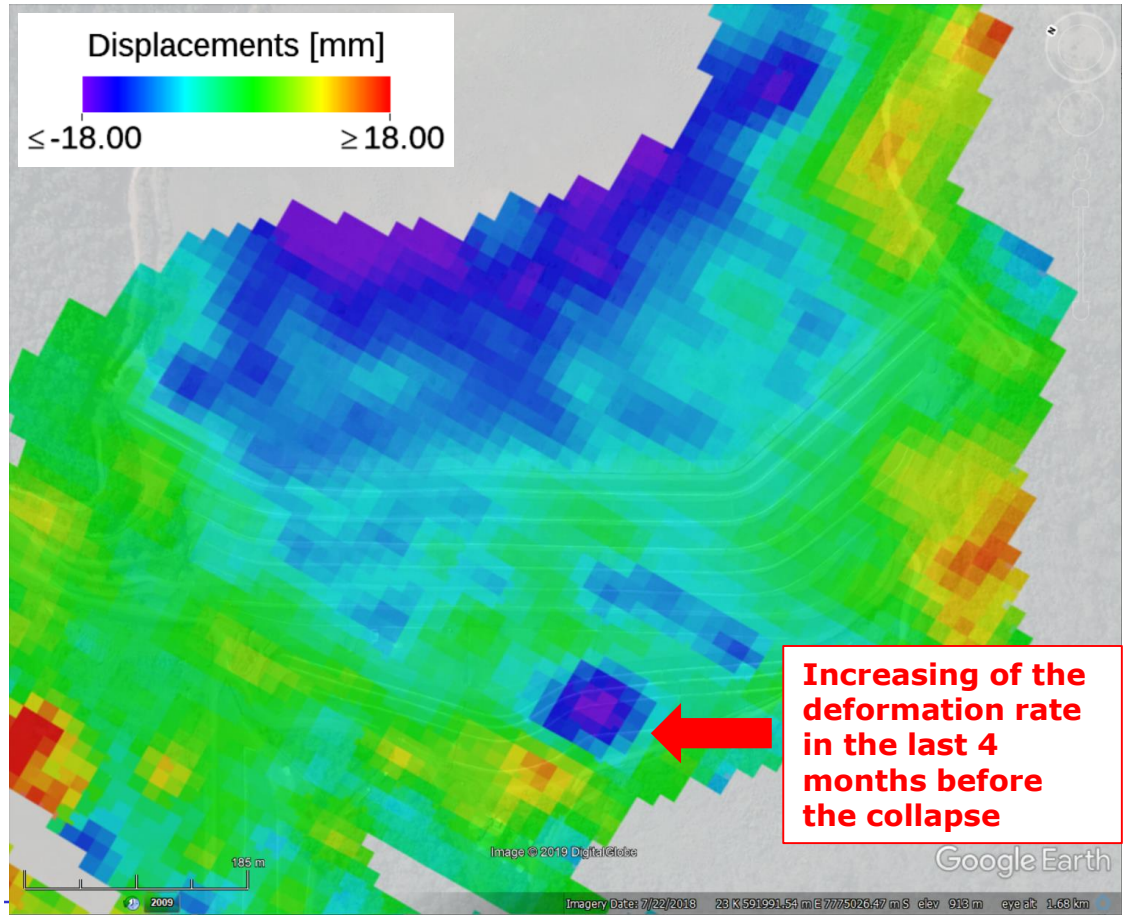
The New York Times | Note: Diagram is based on a 2010 master's thesis by Washington Pirete and a 2018 report by Tüv Süd.

Cumulative deformations between 24/9/2018 and 22/1/2019





The ongoing deformations showed an acceleration in between September 2018 and January 2019, particularly in points A and C.



29 April 2021

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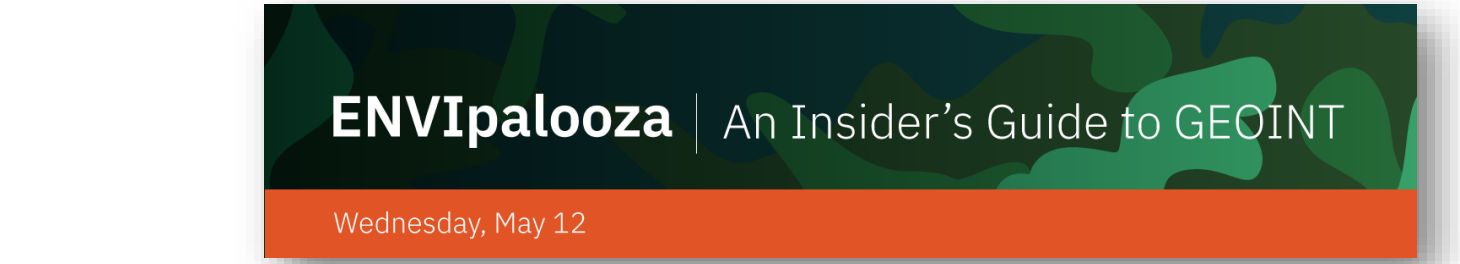
Thanks a lot for your attention!



Wednesday, May 12, 3pm – 6pm CEST → Register on our website at

https://www.l3harrisgeospatial.com/Company/Events/Tradeshows/Tradeshows-Details/ArtMID/18447/ArticleID/24027/ENVIpalooza

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