SAR for Defense and Security Applications

Paolo Pasquali

Technical Director and President, sarmap SA

paolo.pasquali@sarmap.ch

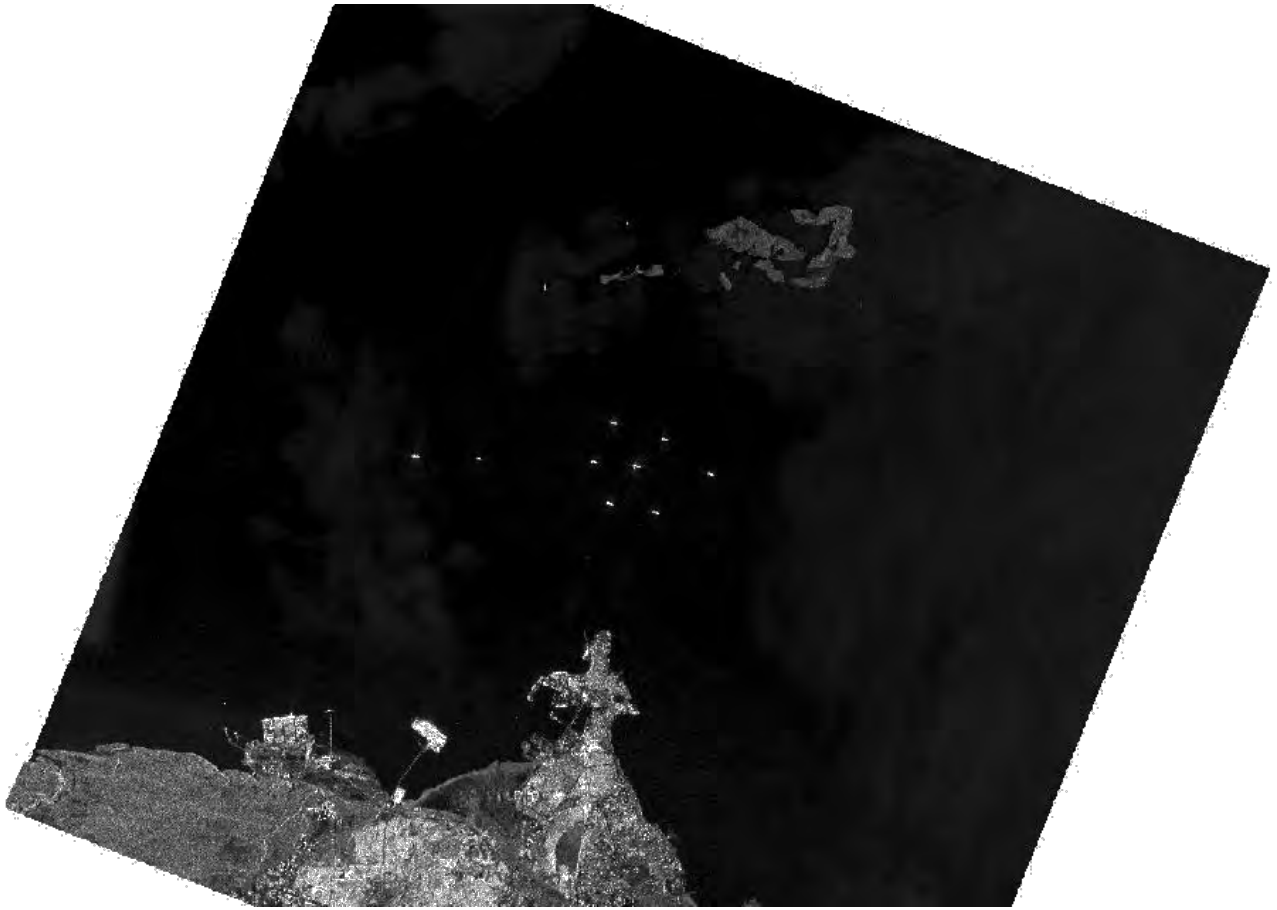
SAR SESSIONS

sarmap
your information gateway

Looking at a single SAR image

- Basic
  - Coherence Workflows
    - Coherence ILU-RGB Workflow
    - Coherence CCD Workflow
    - Coherence MTC RGB Workflow
    - Coherence MICCD RGB Workflow
    - Coherence COV-PWR-CC RGB Workflow
    - Coherence CCD Time Line Workflow
  - Intensity Time Series Workflow
  - Moving Target Detection Workflow
  - Intensity Processing
    - Multilooking
    - Coregistration
    - Filtering
    - Geocoding
    - Post Calibration
  - Feature Extraction
    - Coherence
    - Multi Temporal Coherence
    - Coefficient of Variation
    - Ratio
    - Multi Temporal Features
    - Moving Target Detection
  - Ship Features
    - Ship Detection
    - SAR AIS Matching
    - Ship Statistics
- Gamma and Gaussian Filtering

SARscape



SAR SESSIONS

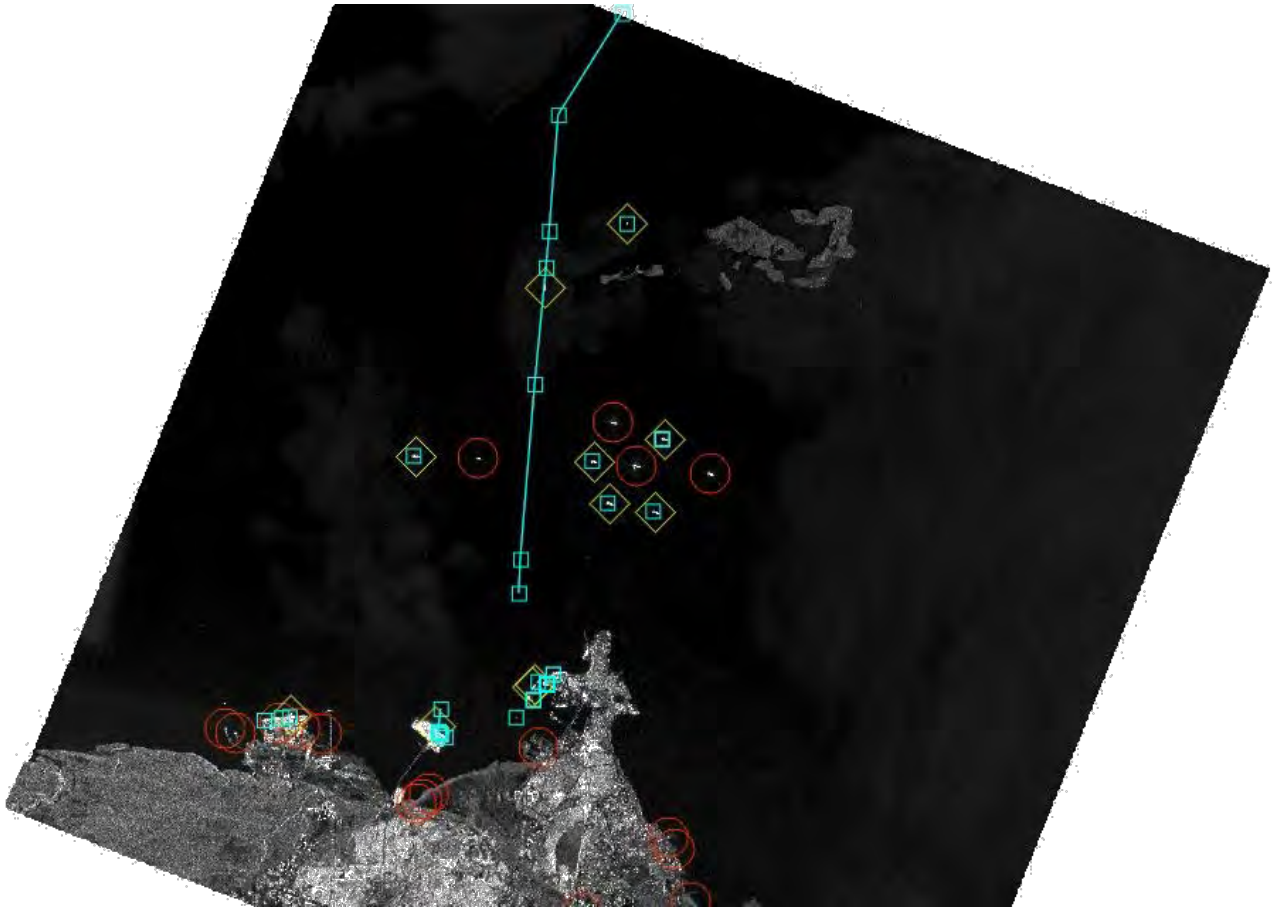
sarmap
your information gateway

Ship detection and matching with AIS

AIS Track

AIS & SAR

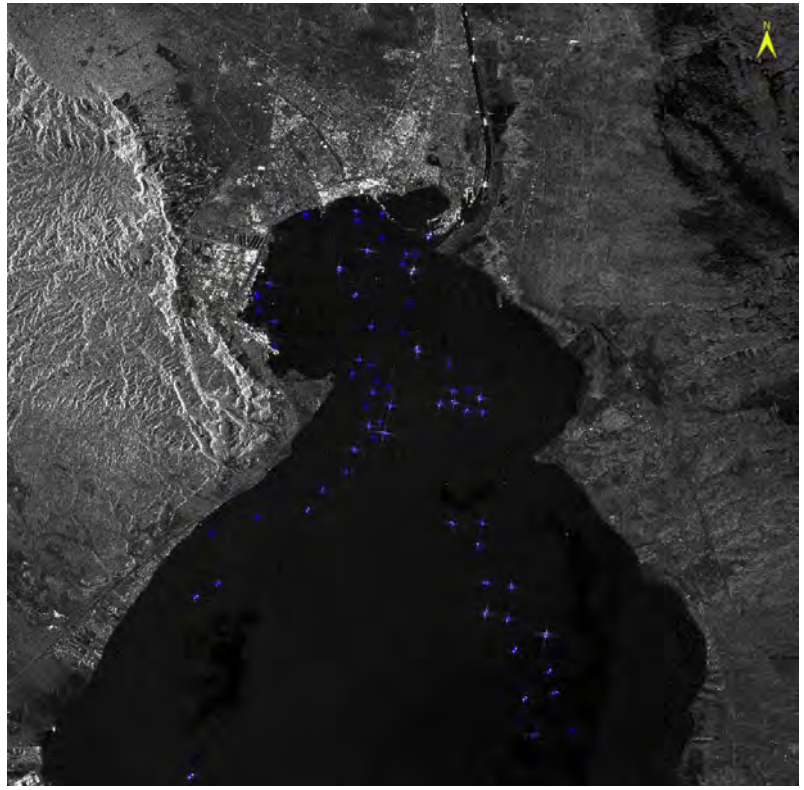
SAR only



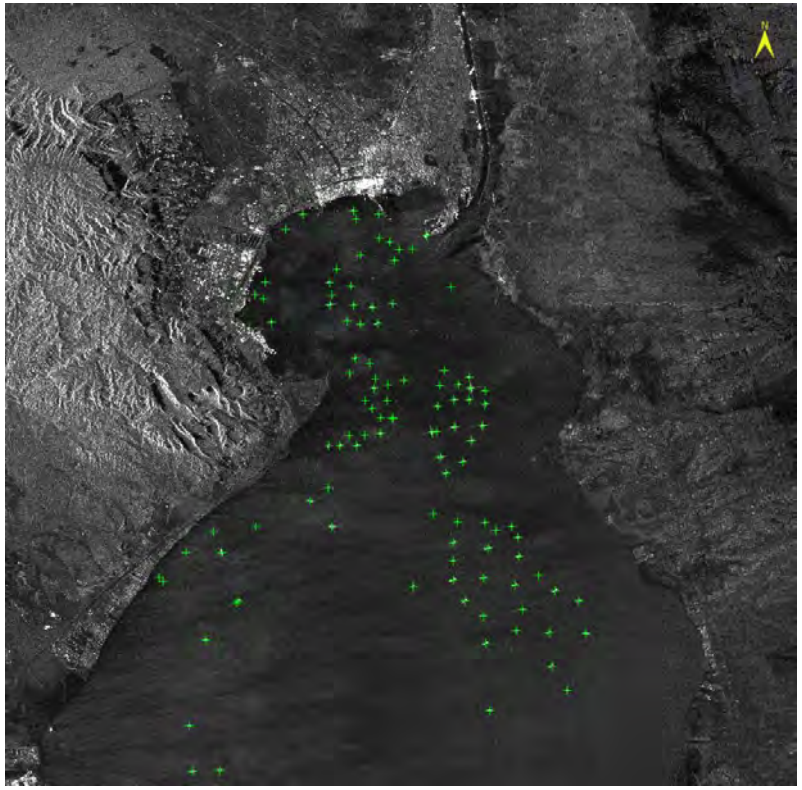
SAR SESSIONS

sarmap
your information gateway

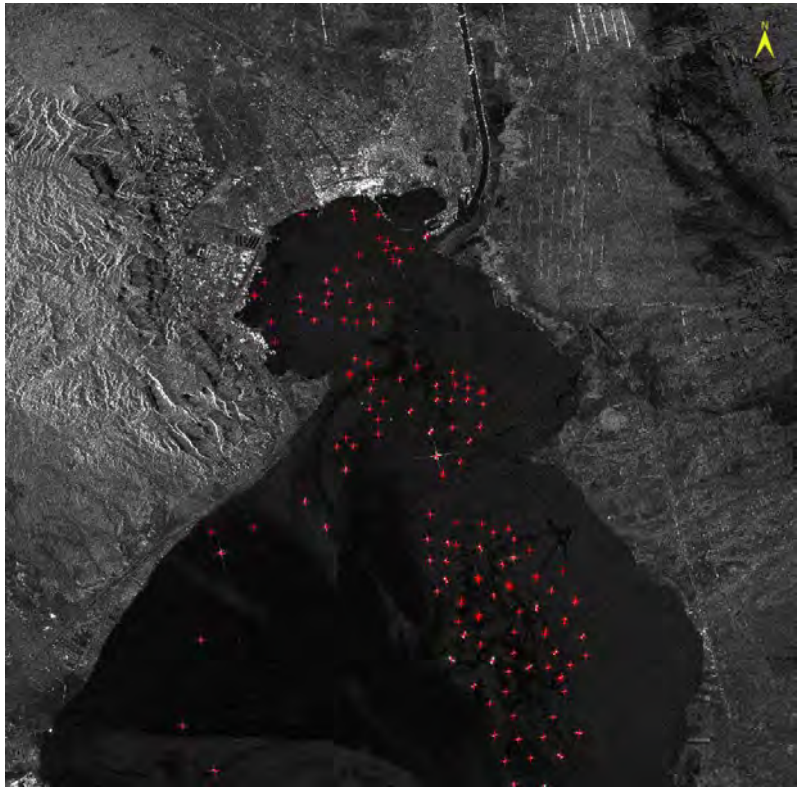
SAR is an ideal instrument for regular monitoring



67 ships on 21st March 2021



108 ships on 24th March 2021



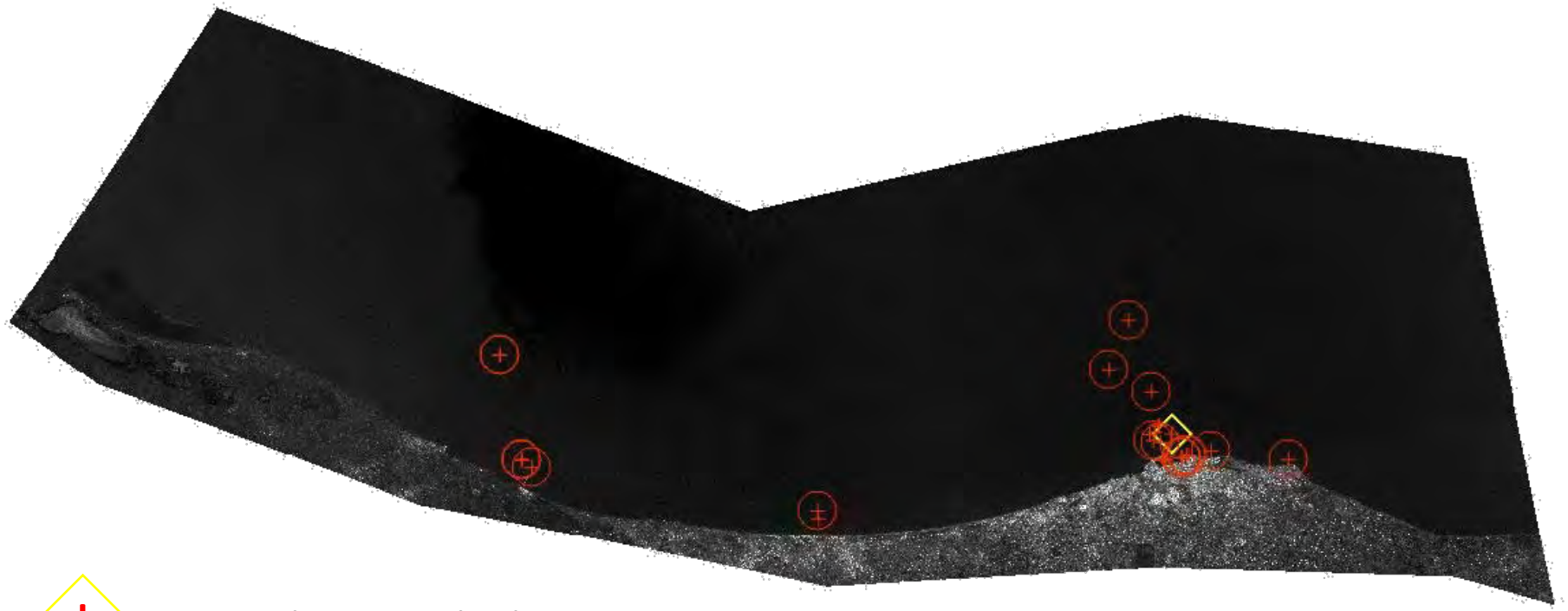
151 ships on 25th March 2021

SAR SESSIONS

Southern entry of the Suez channel

sarmap
your information gateway

Monitoring the coast west of Tripoli



SAR and AIS matched

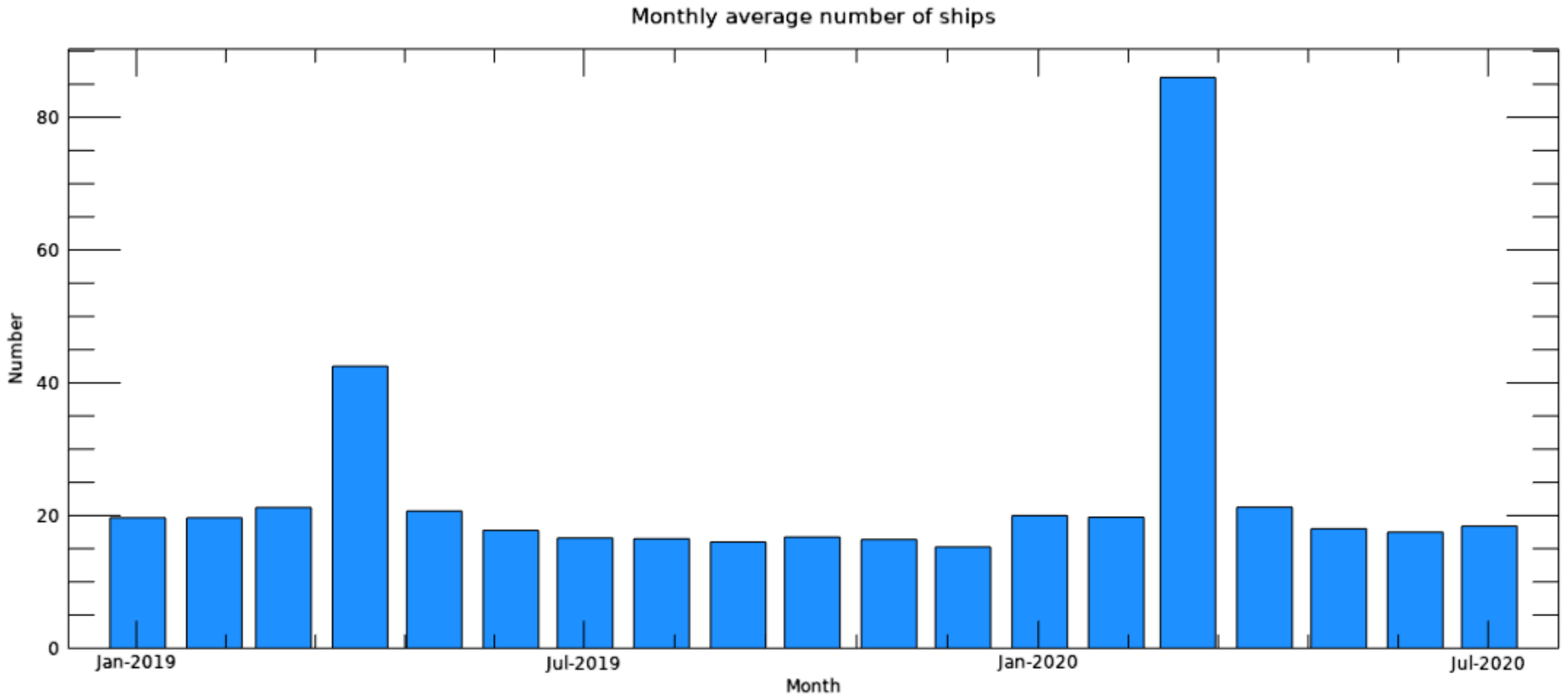
Only SAR detection

19 May 2020

SAR SESSIONS

sarmap
your information gateway

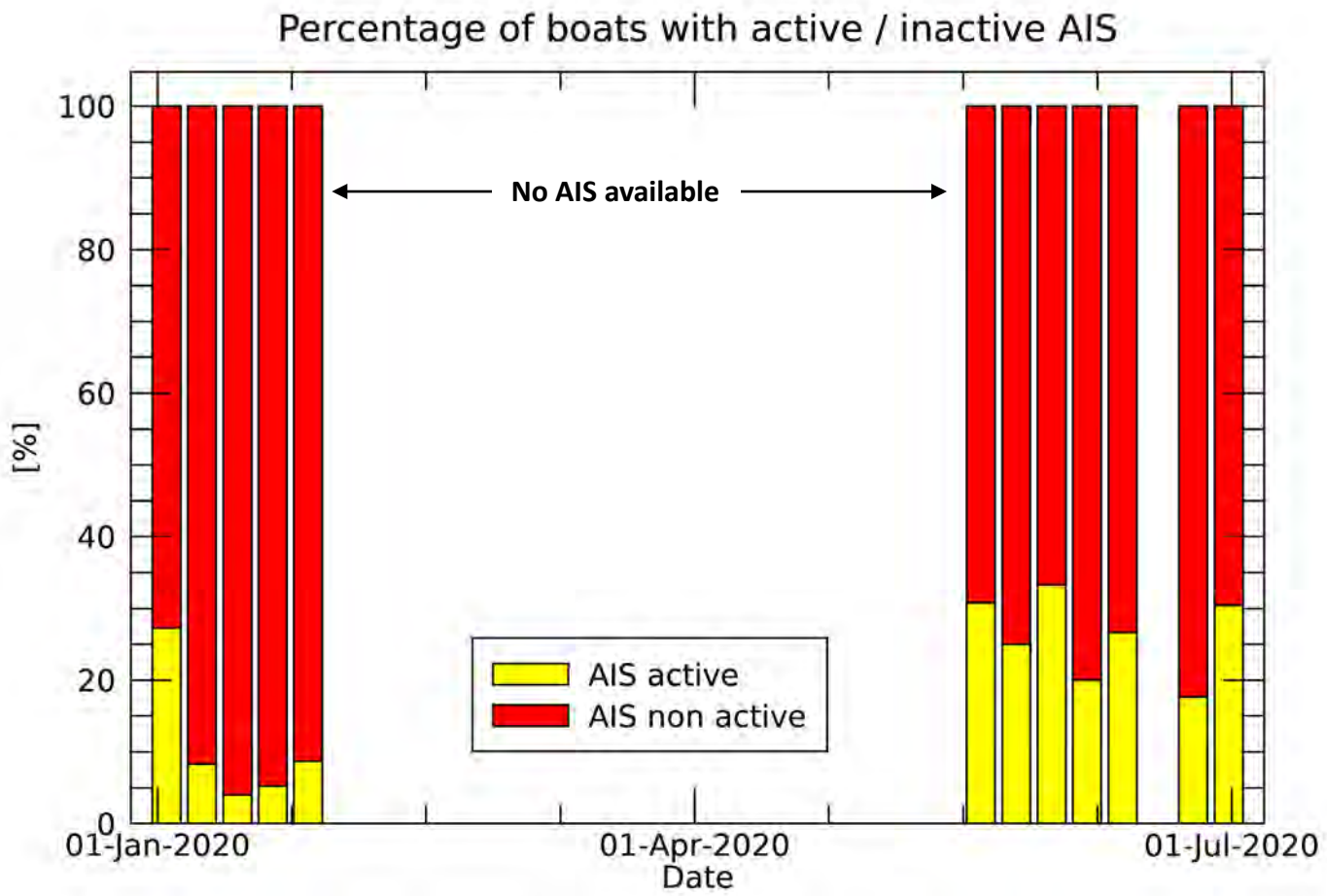
Statistics of ships detected from Sentinel-1 images



SAR SESSIONS

sarmap
your information gateway

Ships detected from Sentinel-1 images and AIS data



SAR SESSIONS

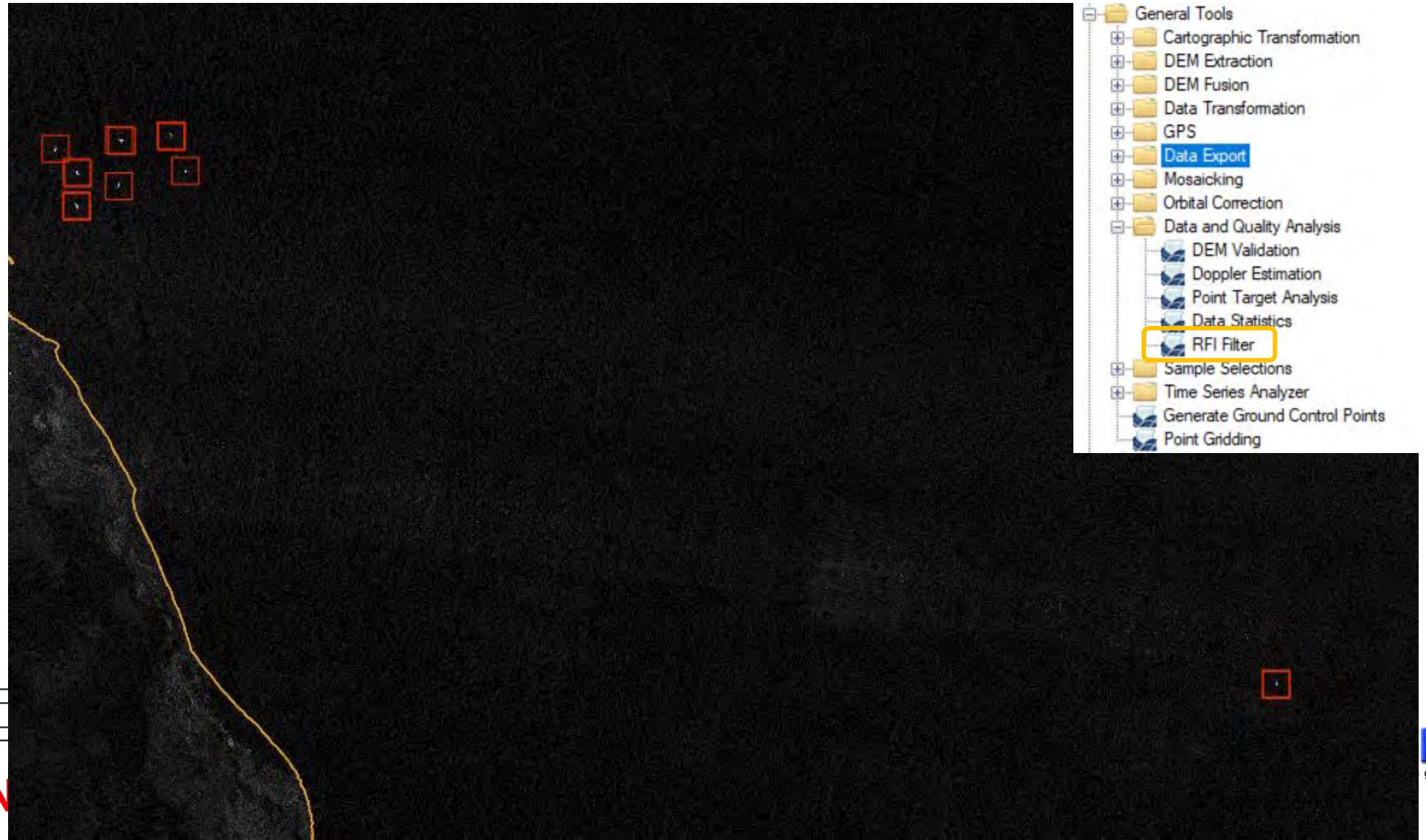
sarmap
your information gateway

Ship detection on RFI-affected data

SAF
SESSION

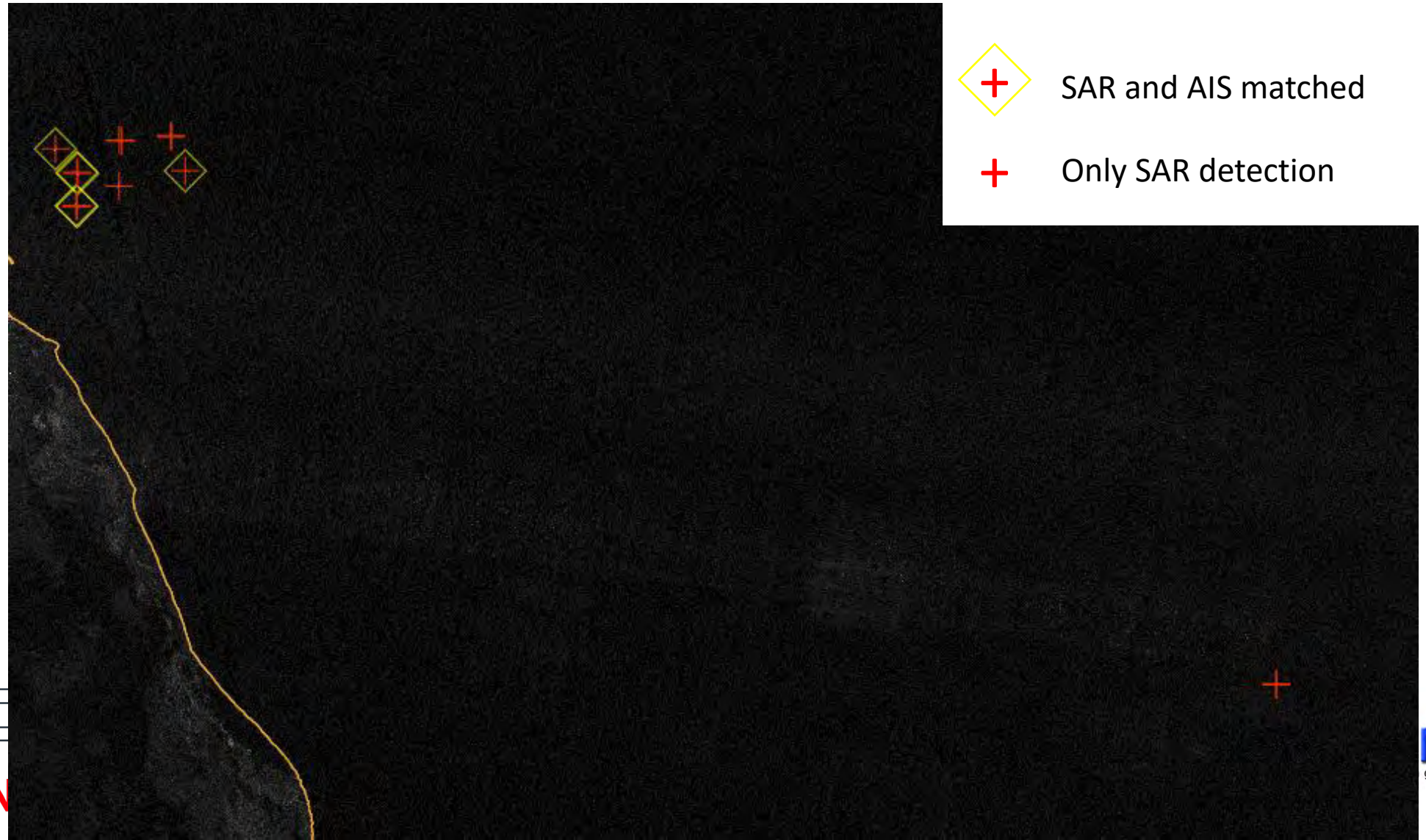
map
gateway

Ship detection on RFI-filtered data



SAF
SESSION
map
gateway

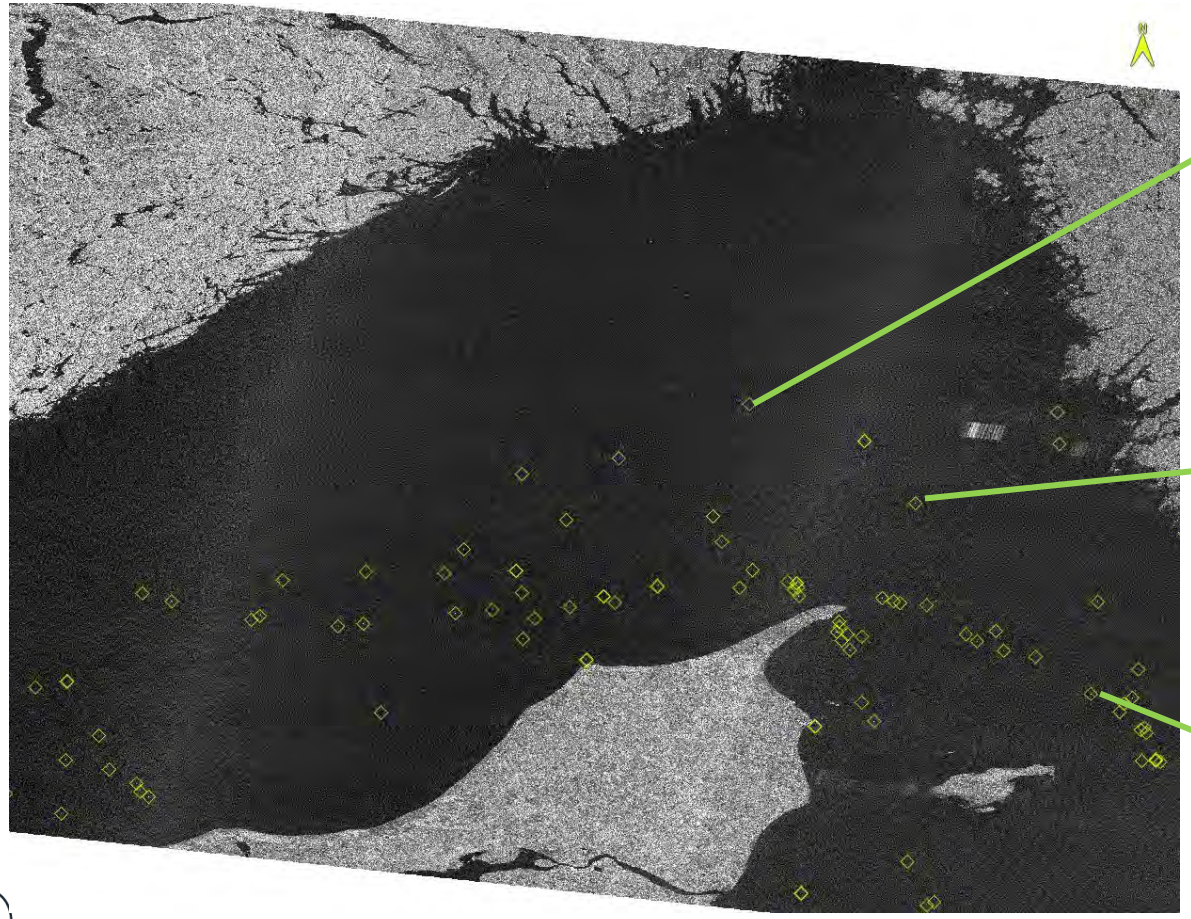
Ships detected from Sentinel-1 images and AIS data

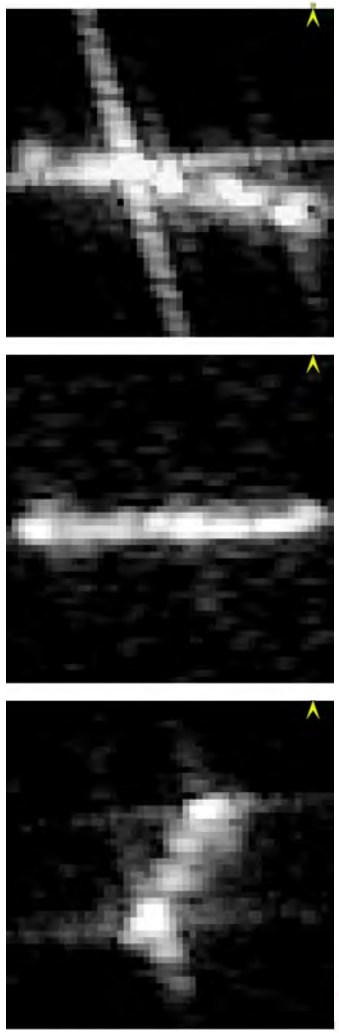


SAR SESSION

map gateway

SAR + AIS can help Automated Target Recognition



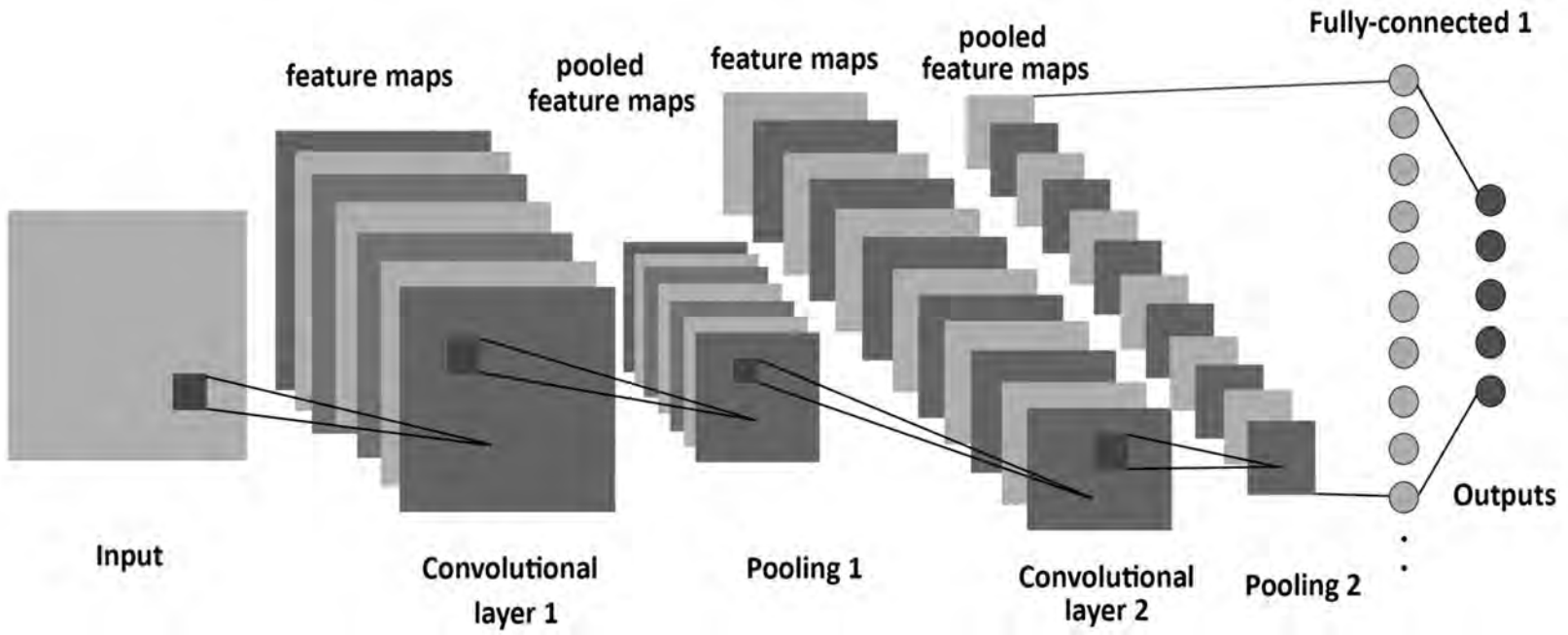


-> Deep Learning training based on automatically extracted datasets for ships classification

SAR SESSIONS

armap information gateway

Convolutional Neural Network

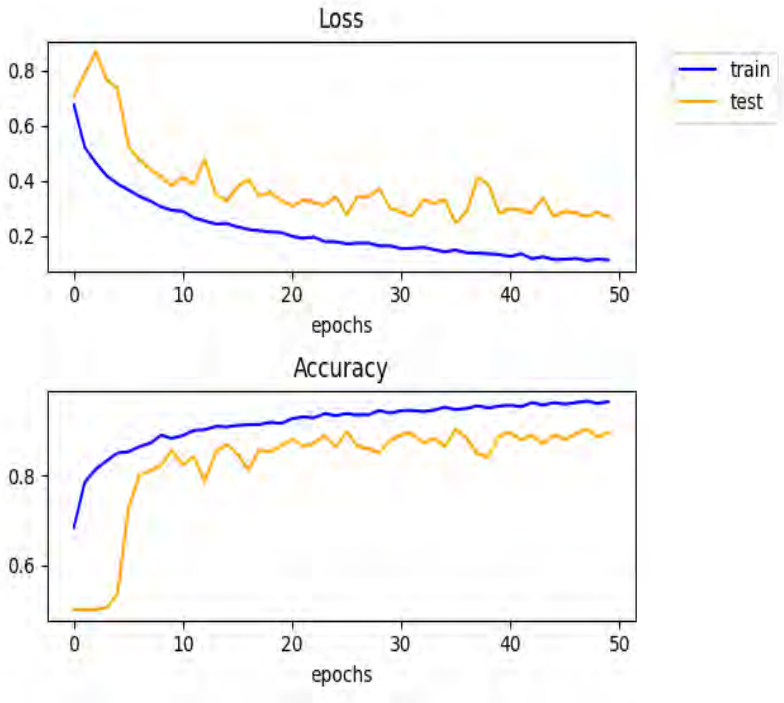


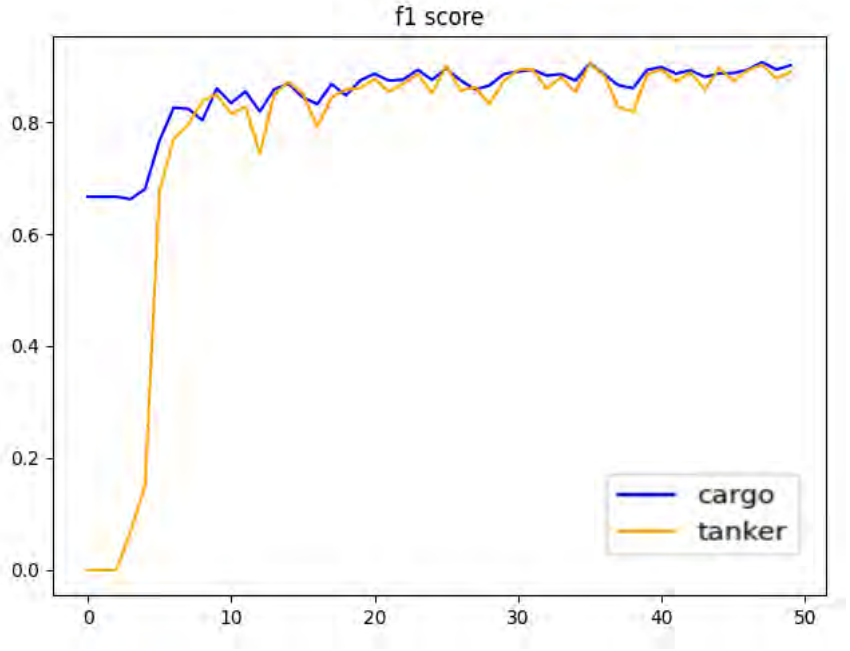
SAR SESSIONS

sarmap your information gateway

Binary Classification Accuracy

	Cargo	Tanker
Cargo	439	23
Tanker	73	389



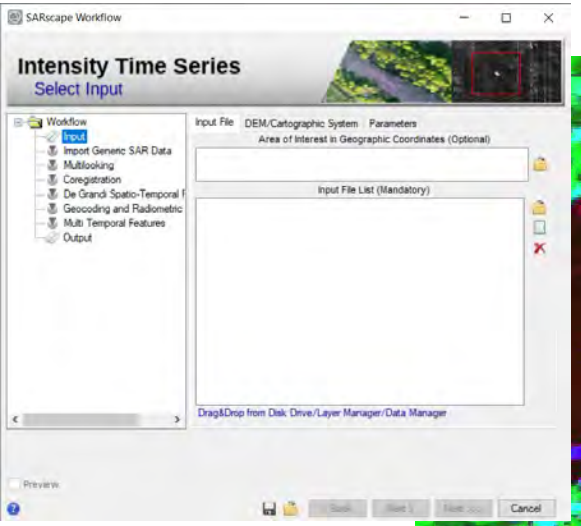


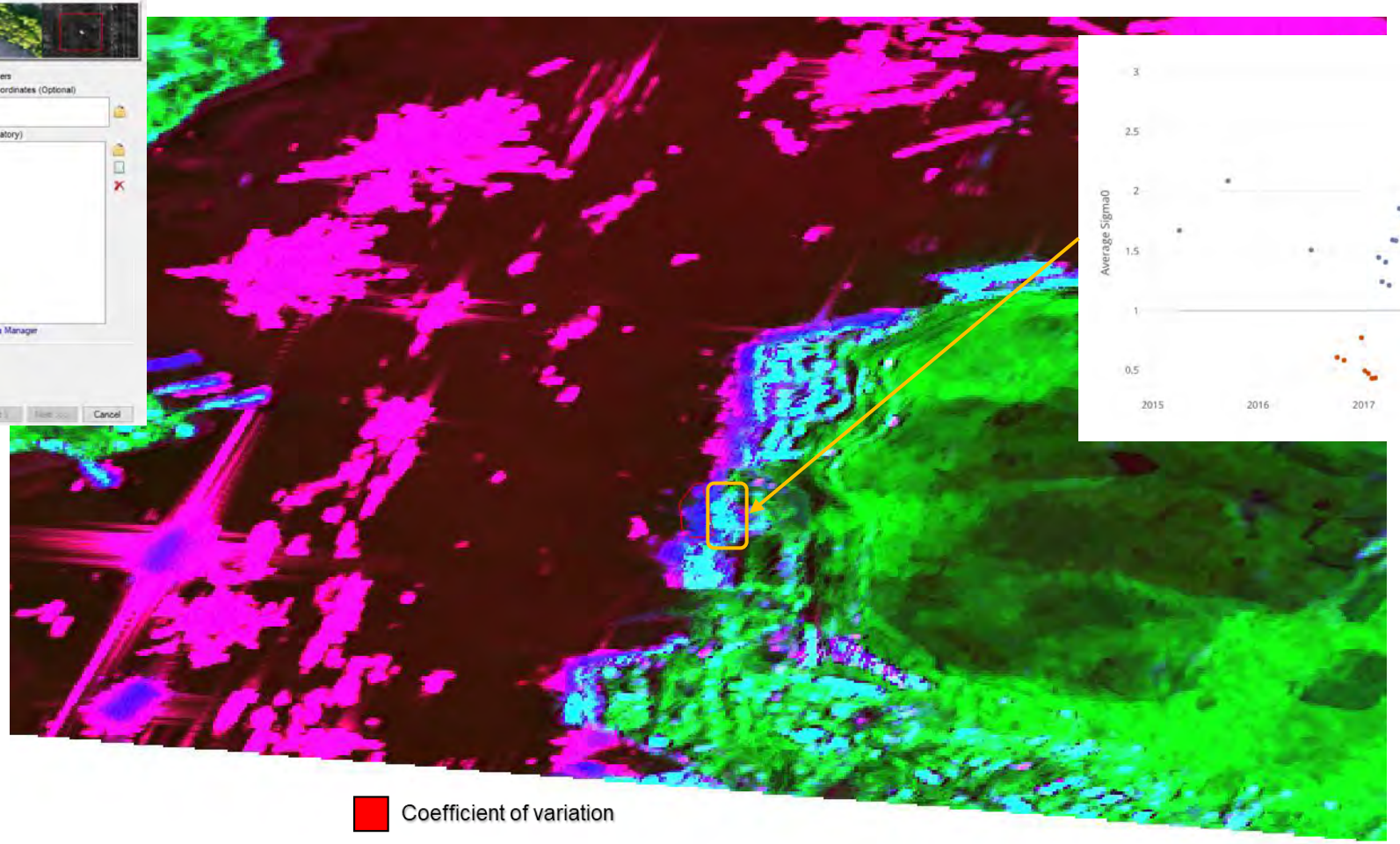
$$\text{f1 score} = \frac{TP}{TP+\frac{1}{2}(FP+FN)}$$

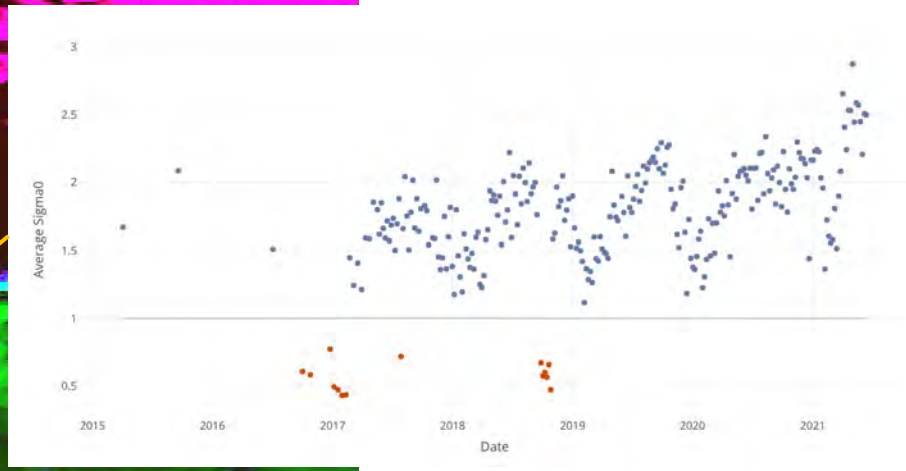
SAR SESSIONS

sarmap
your information gateway

Permanent monitoring of harbours







Coefficient of variation

Mean

Gradient

SAR SESSIONS

sarmap
your information gateway

Modern SAR systems allow frequent monitoring

Syrian refugees camp at the Jordan border

3 images in 1 day

SAR SESSIONS

e-geos AN ASI / TELESPAZIO COMPANY

sarmap your information gateway

STANAG Terminology

SAR image analysis can provide answers to code B requests (Change Detection / Surveillance) made according to the STANAG 3596 standard for the category 14, Port Installations.

SAR SESSIONS

sarmap your information gateway

Airport monitoring

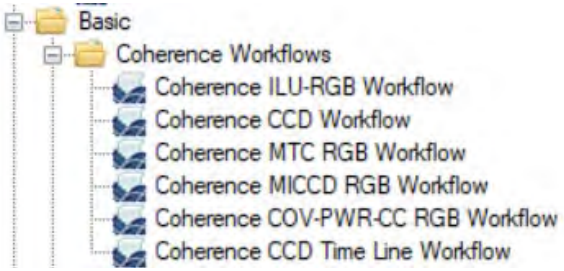
Aircraft stands

Google Earth

SAR SESSIONS

sarmap
your information gateway

Airport monitoring: ACD - CCD



- InSAR Coherence
- Mean Backscatter
- Backscatter Change

Aircraft stands

SAR SESSIONS

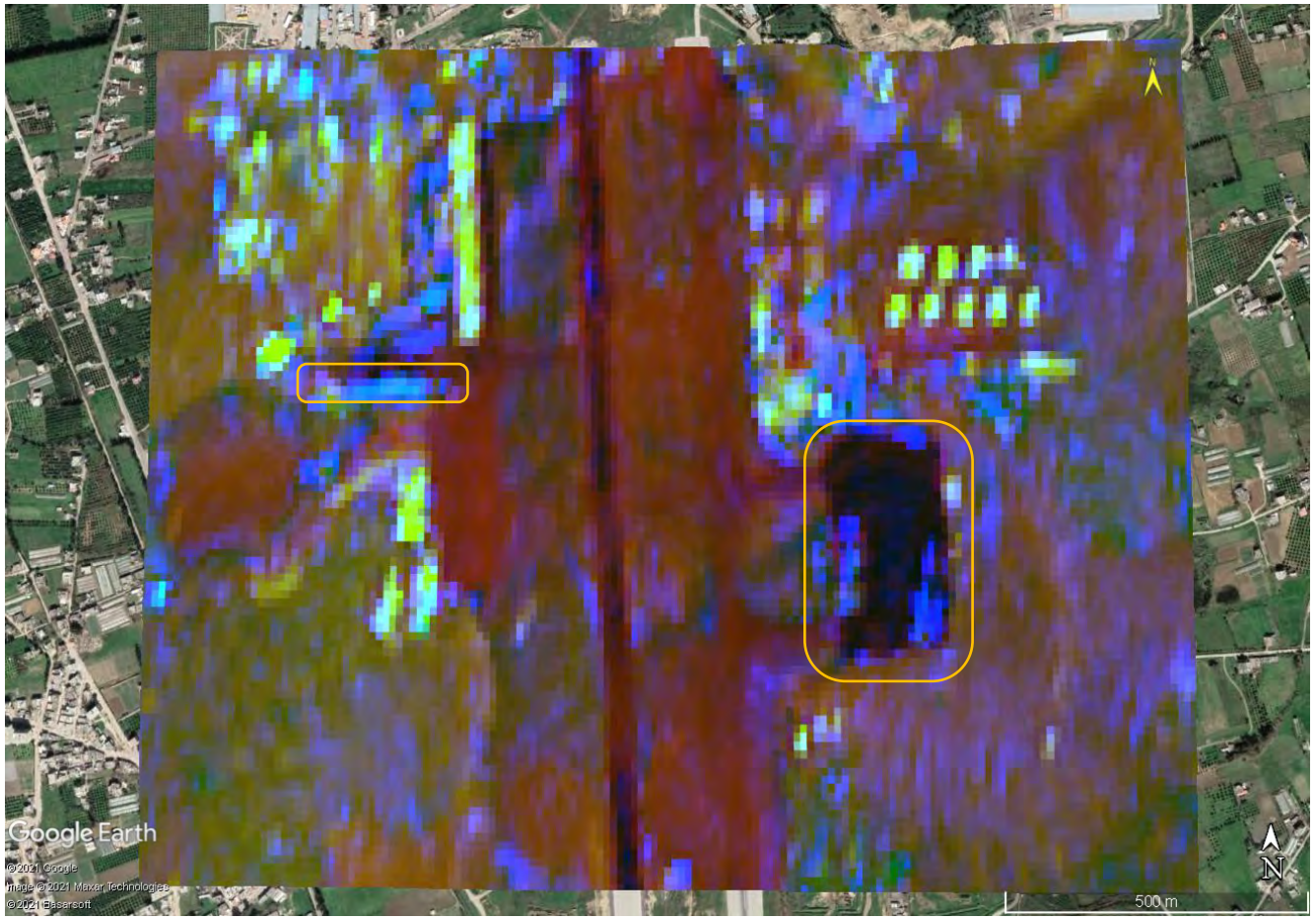
Capella-2 3 and 9 January 2021

Data courtesy Capella Space

sarmap
your information gateway

Airport monitoring: ACD - CCD

- InSAR Coherence
- Mean Backscatter
- Backscatter Change



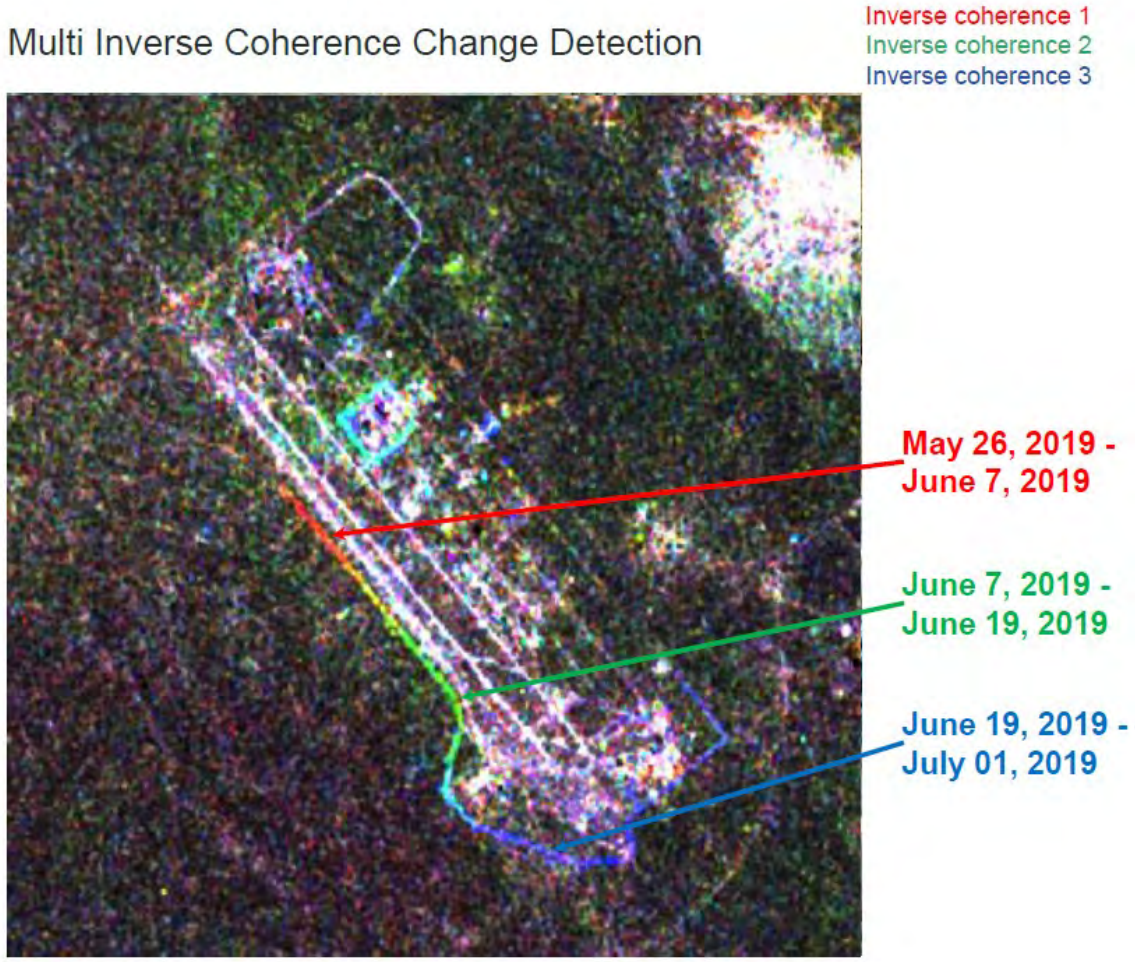
Aircraft stands

Sentinel-1 3 and 9 January 2021

SAR SESSIONS

sarmap your information gateway

Airport monitoring: CCD

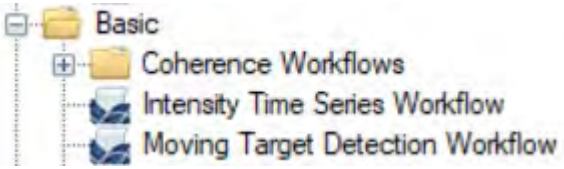


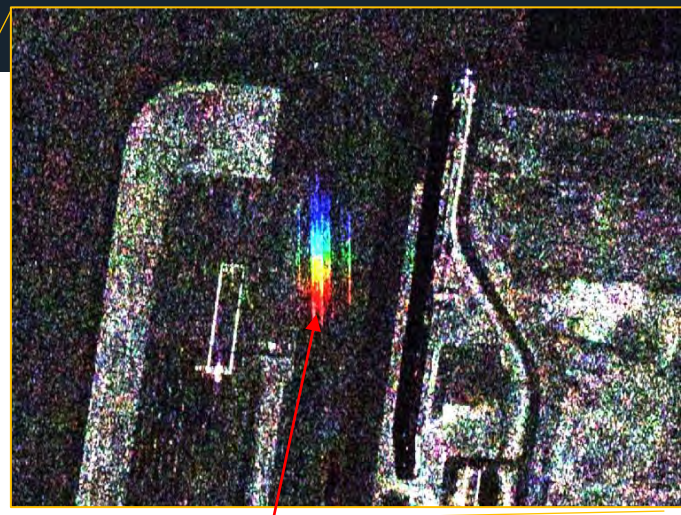
SAR SESSIONS

sarmap
your information gateway

Airport monitoring: Moving Target Detection

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





Moving objects can be automatically highlighted

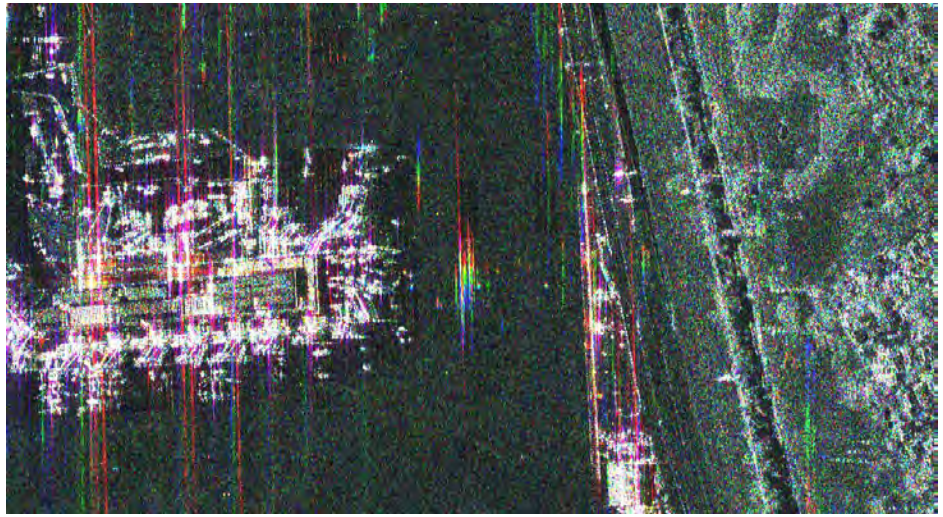
SAR SESSIONS

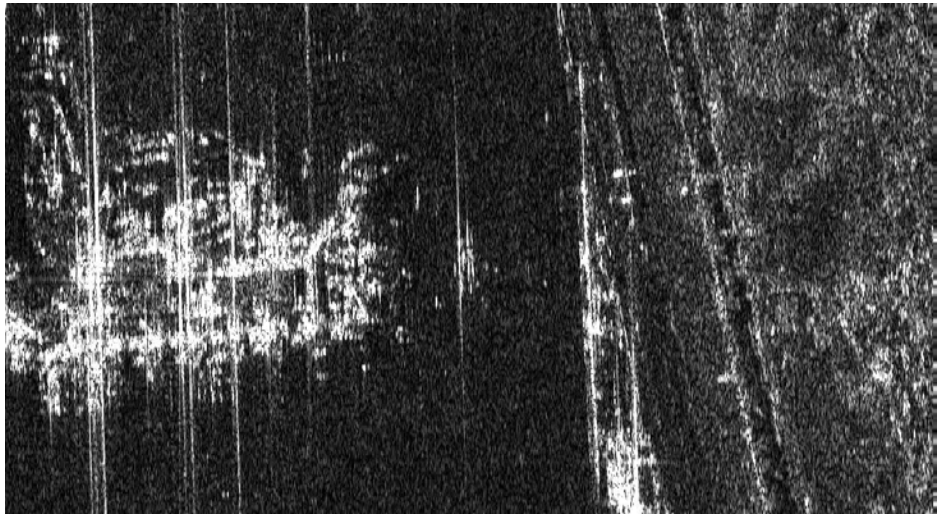
sarmap your information gateway

Data courtesy ASI / eGeos

Airport monitoring: Moving Target Detection

Exploiting the time of acquisition of a full Synthetic Aperture





Data courtesy Capella Space

SAR SESSIONS

sarmap your information gateway

STANAG Terminology

SAR image analysis can provide answers to code B requests (Change Detection / Surveillance) made according to the STANAG 3596 standard for the category 1, Airfields.

SAR SESSIONS

sarmap your information gateway

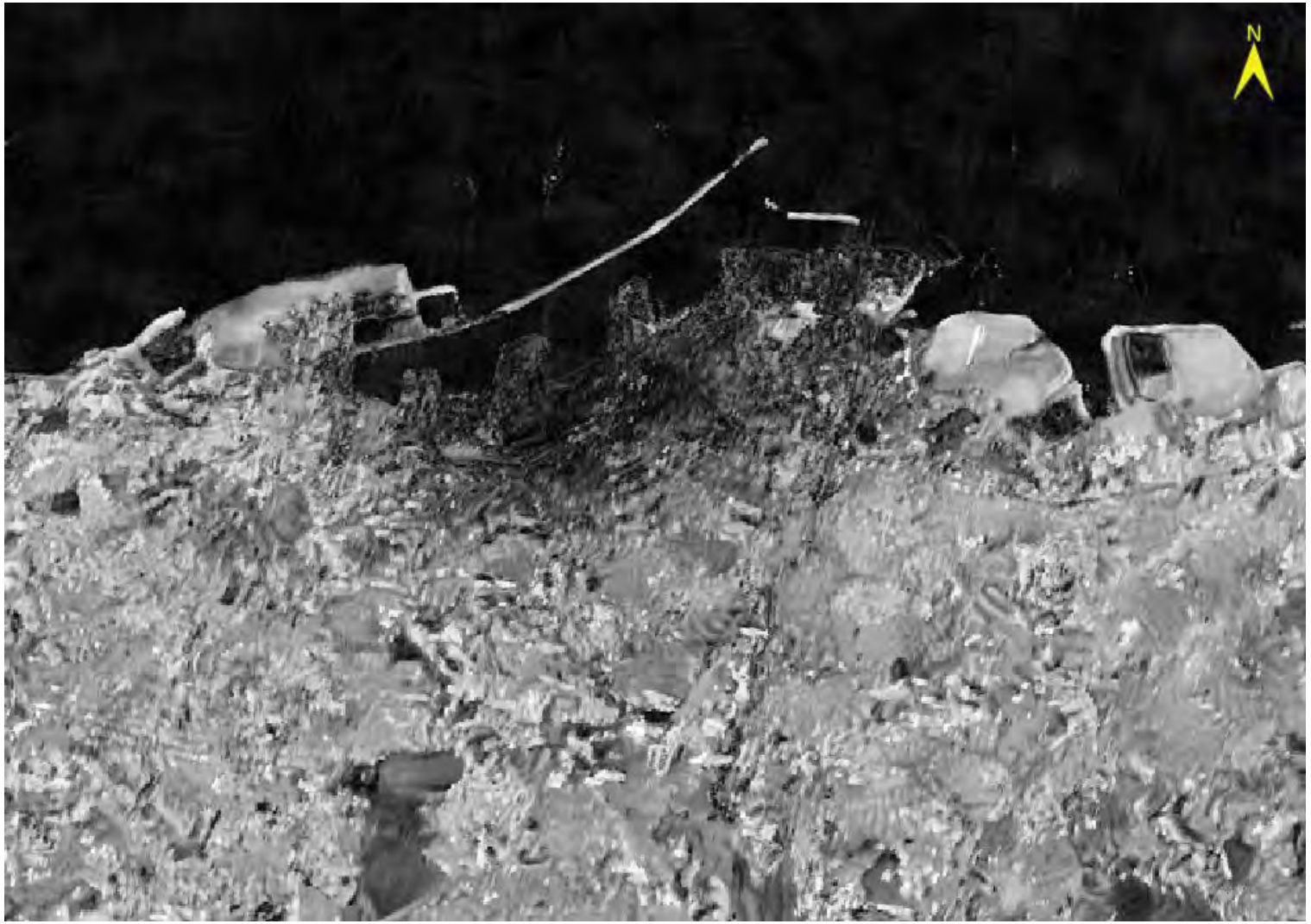
Coherent Change Detection: 2020 Beirut port explosion

Pre-event coherence

SAR SESSIONS

sarmap
your information gateway

Coherent Change Detection: 2020 Beirut port explosion



Cross-event coherence

SAR SESSIONS

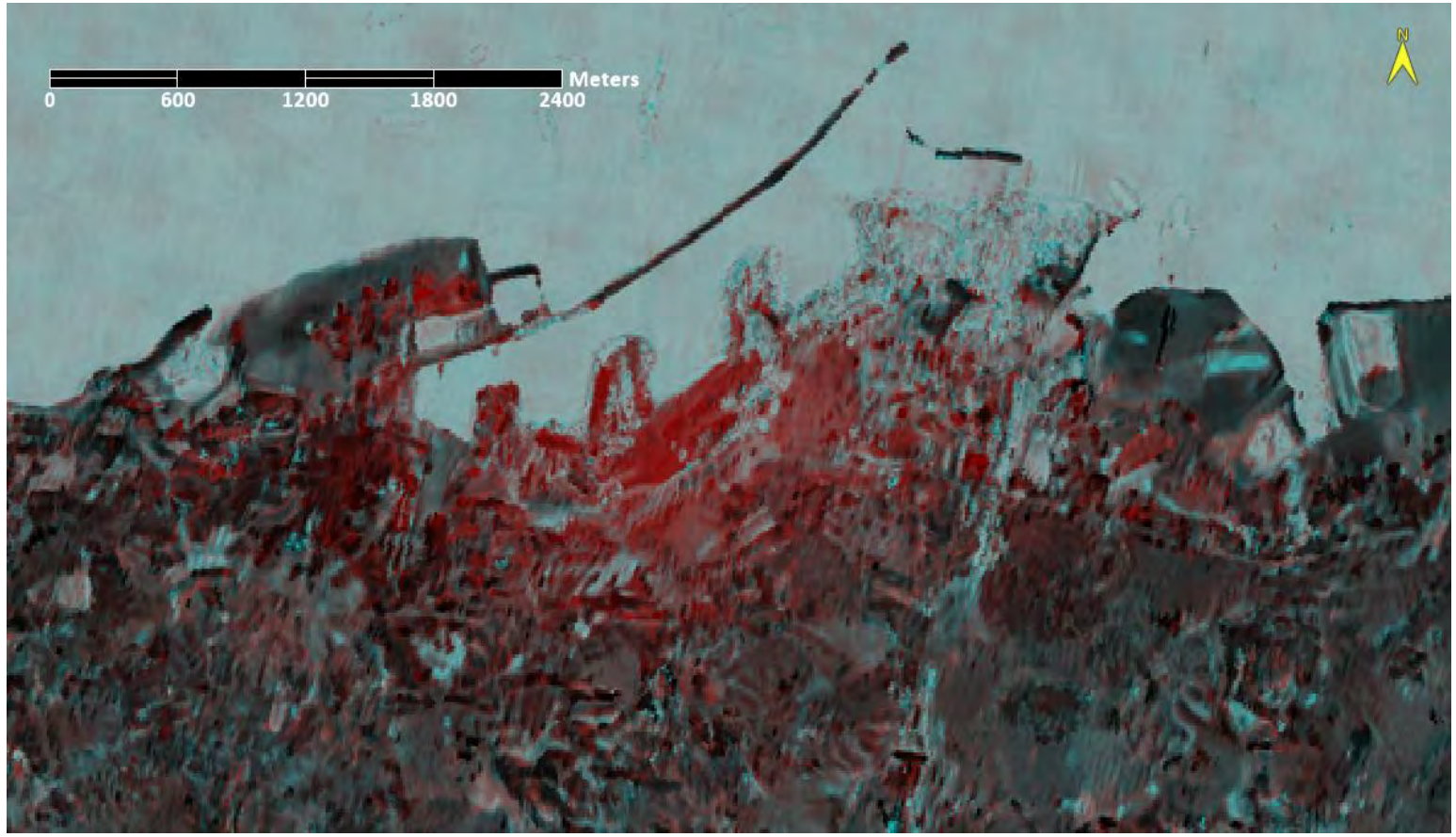
sarmap
your information gateway

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



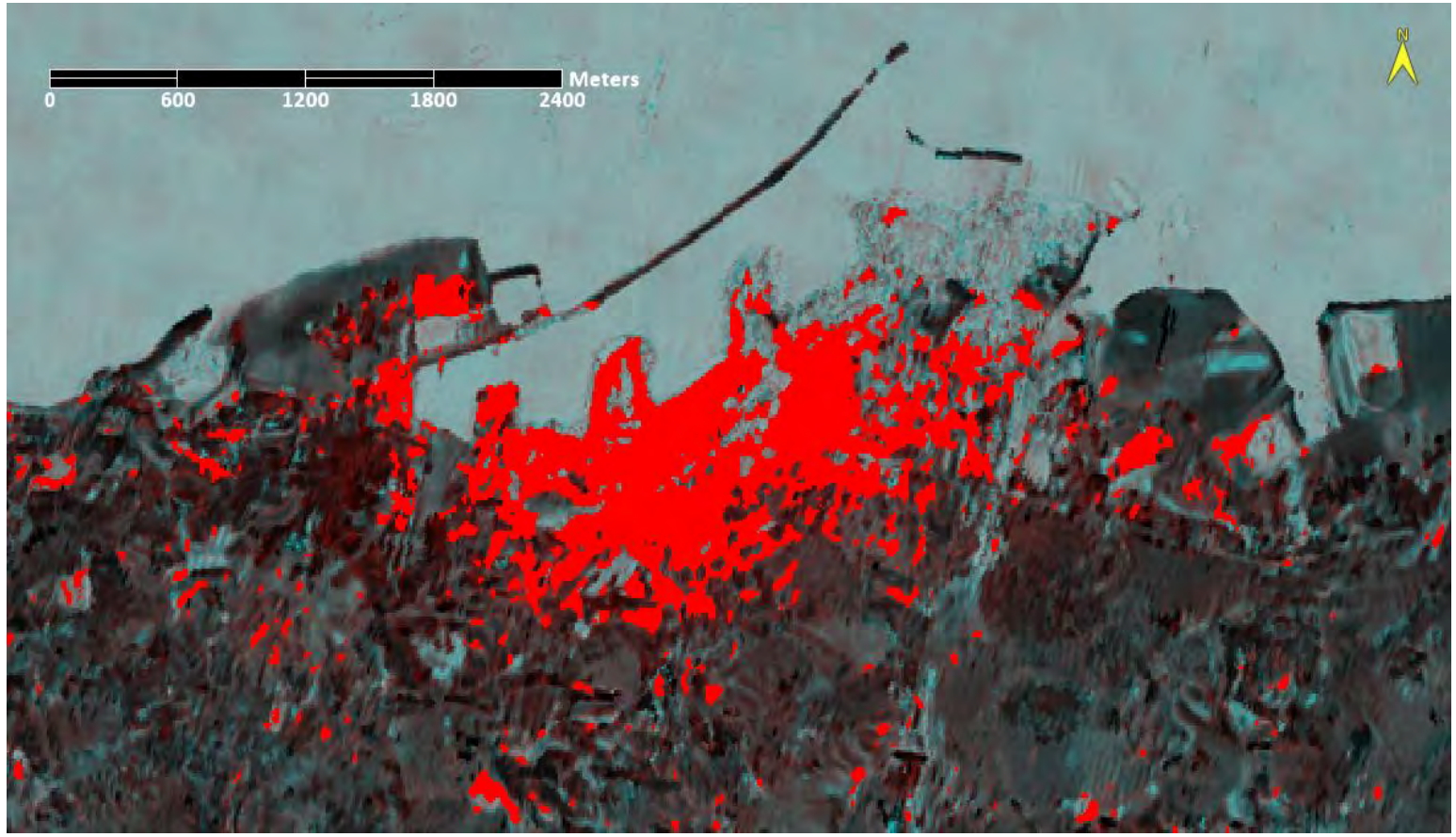
SAR SESSIONS

sarmap
your information gateway

Coherent Change Detection Classification

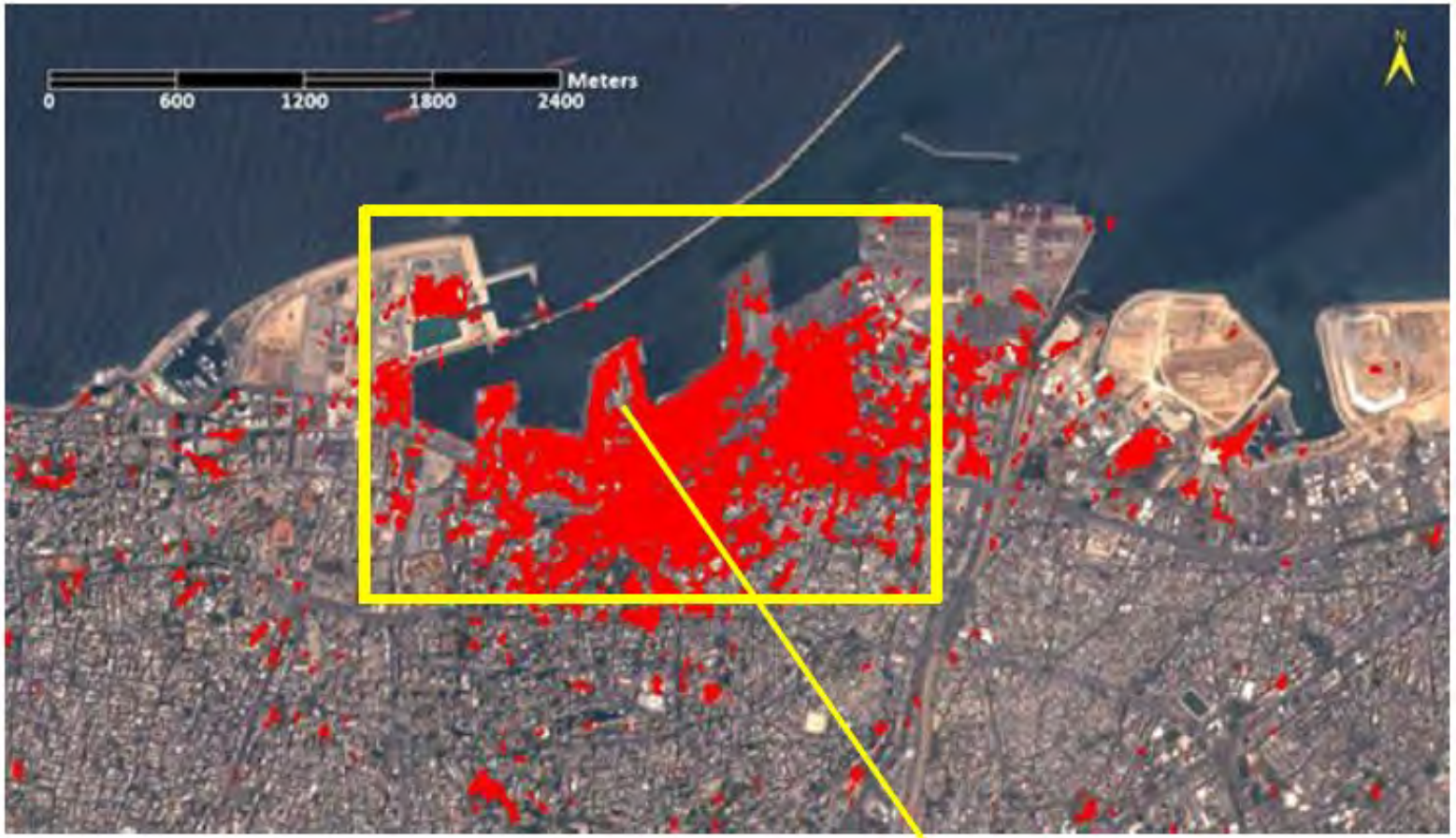
Sentinel-1 data:
- 24 July
- 30 July
- 5 August

Severely damaged areas appear in red polygons



SAR SESSIONS

sarmap
your information gateway

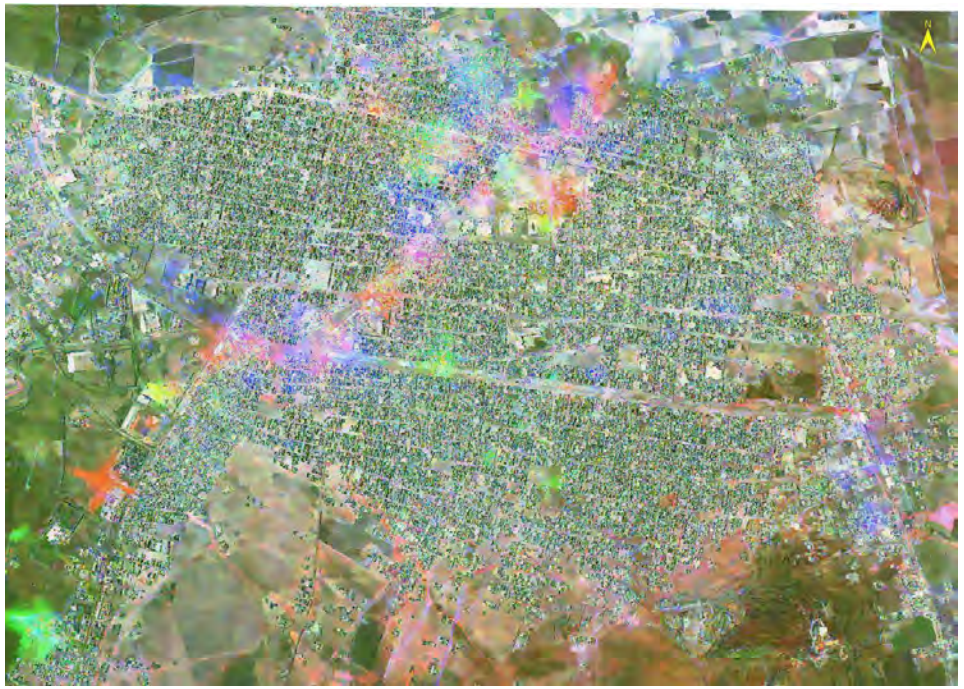


SAR SESSIONS

sarmap
your information gateway

Amplitude vs. Coherent Change Detection

15/10/2014
19/10/2014
23/10/2014



15/10/2014 - 19/10/2014
19/10/2014 - 23/10/2014
23/10/2014 - 08/11/2014

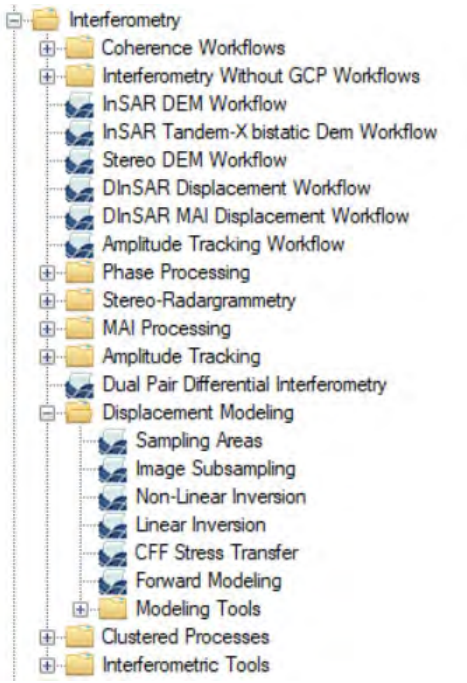
SAR SESSIONS

Data courtesy ASI / eGeos

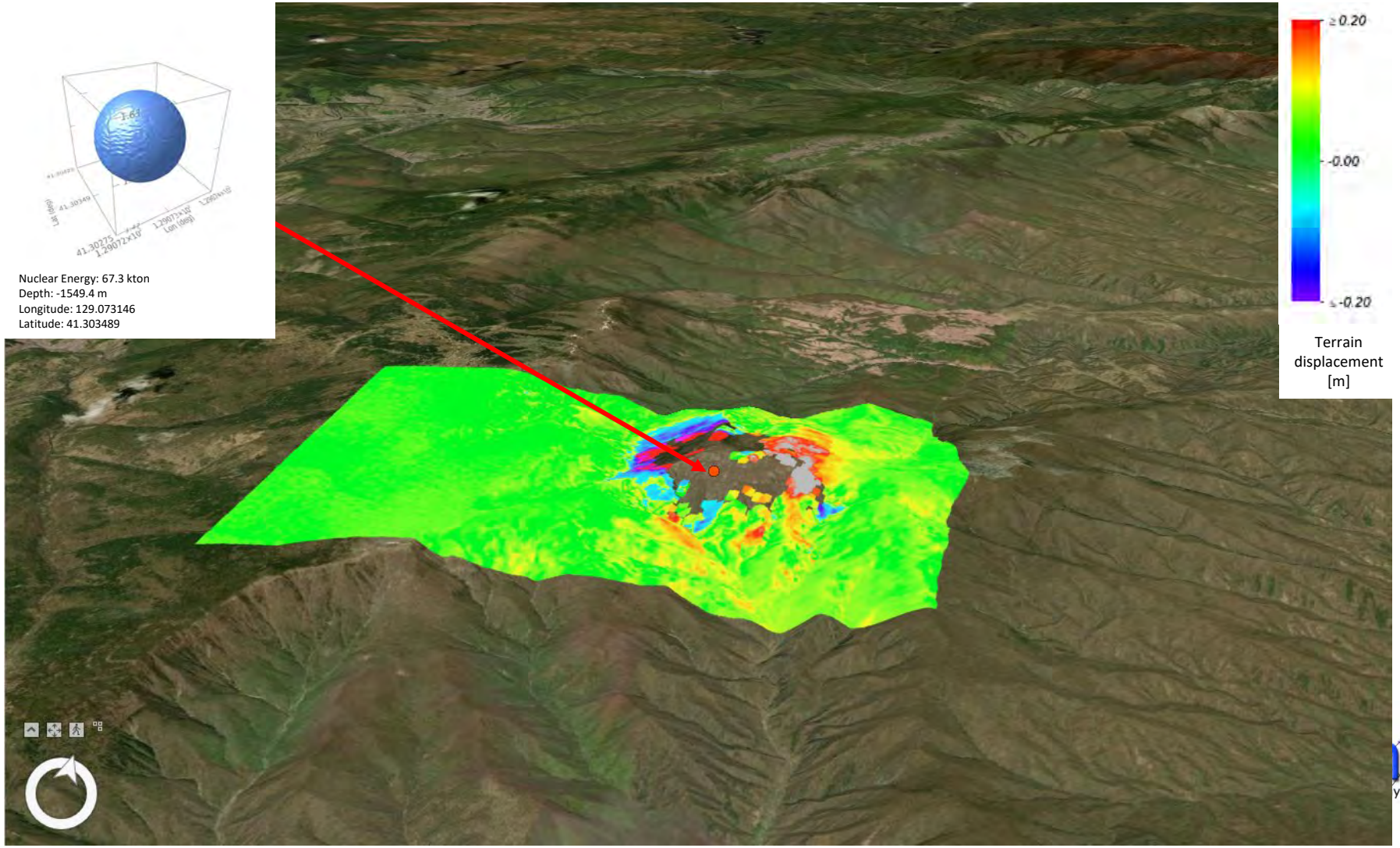
sarmap
your information gateway

Terrain displacement from underground nuclear experiments

Source model

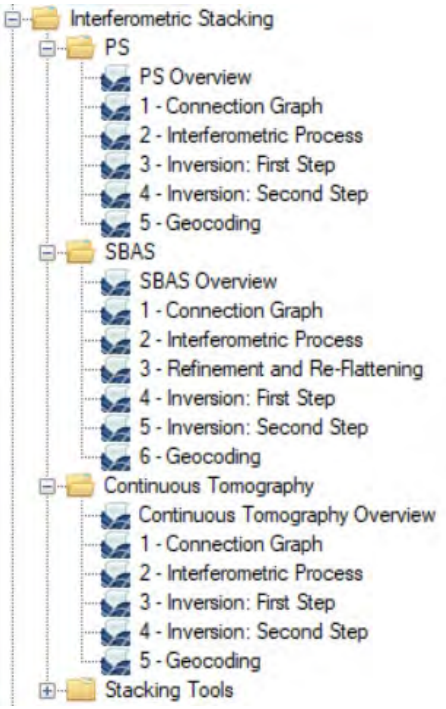


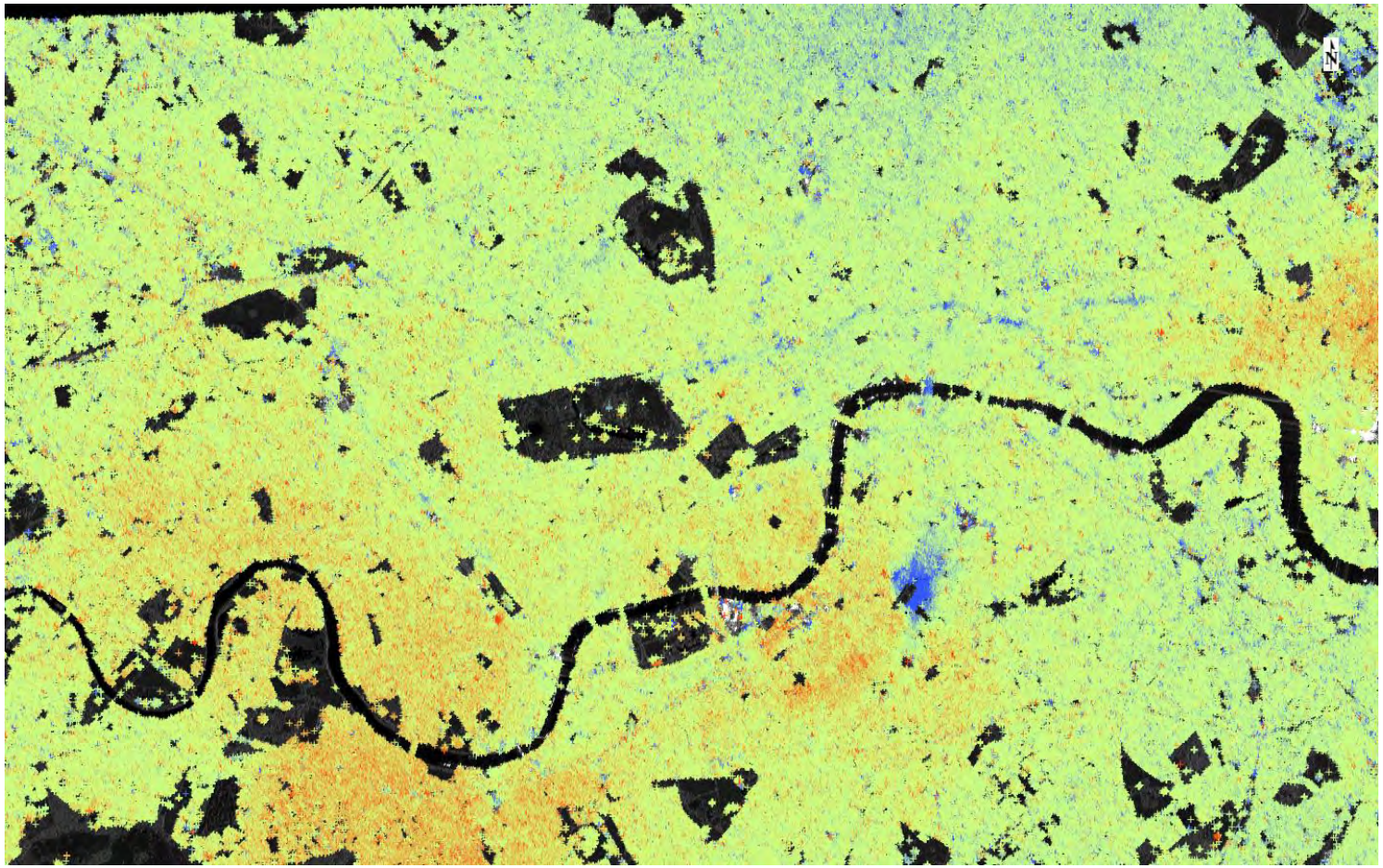
Nuclear Energy: 67.3 kton
Depth: -1549.4 m
Longitude: 129.073146
Latitude: 41.303489



SAR SESSIONS

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





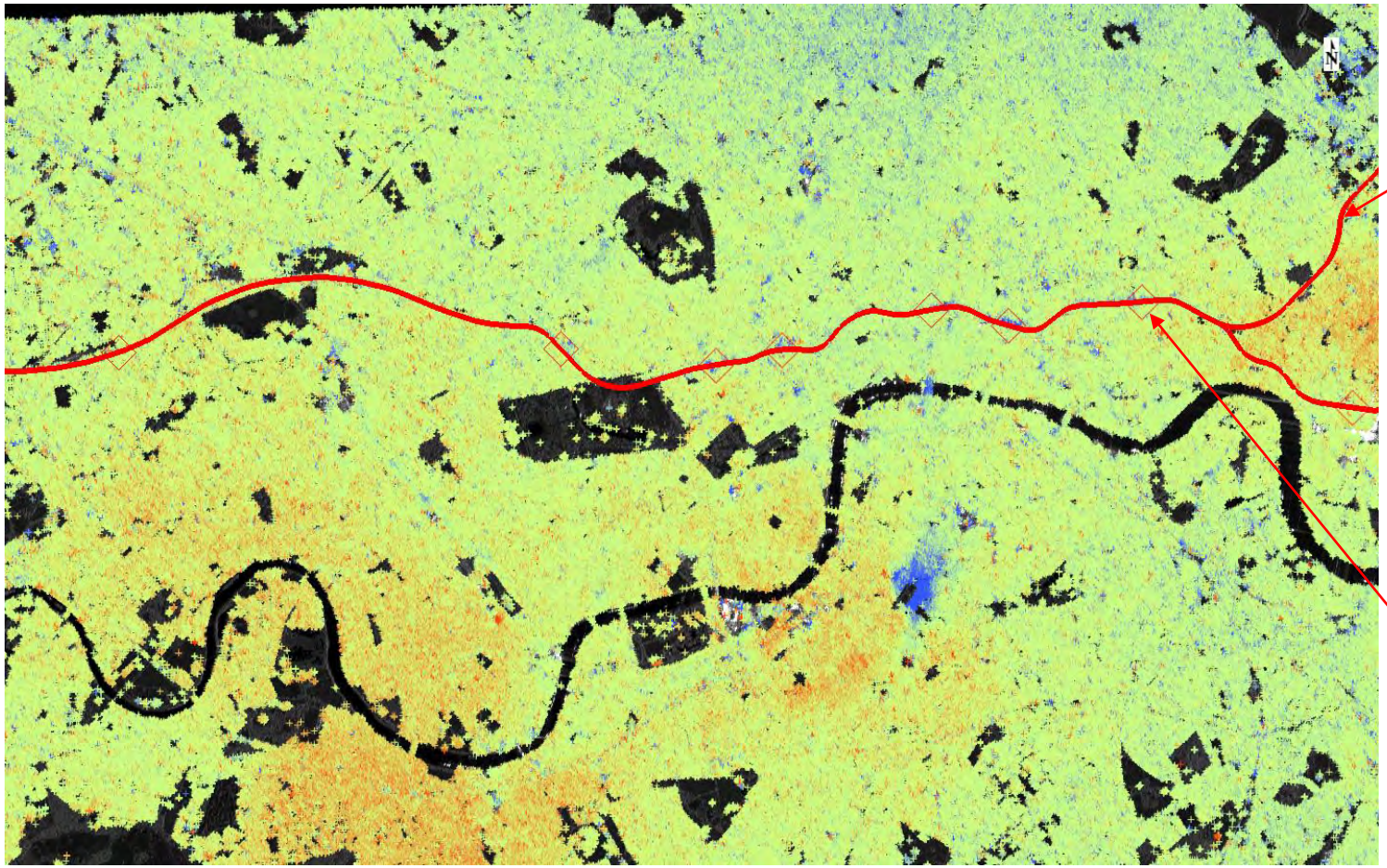
London

-5 mm/y +5 mm/y

SAR SESSIONS

sarmap your information gateway

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



SAR SESSIONS

sarmap your information gateway

Paks nuclear plant

SAF
SESSION

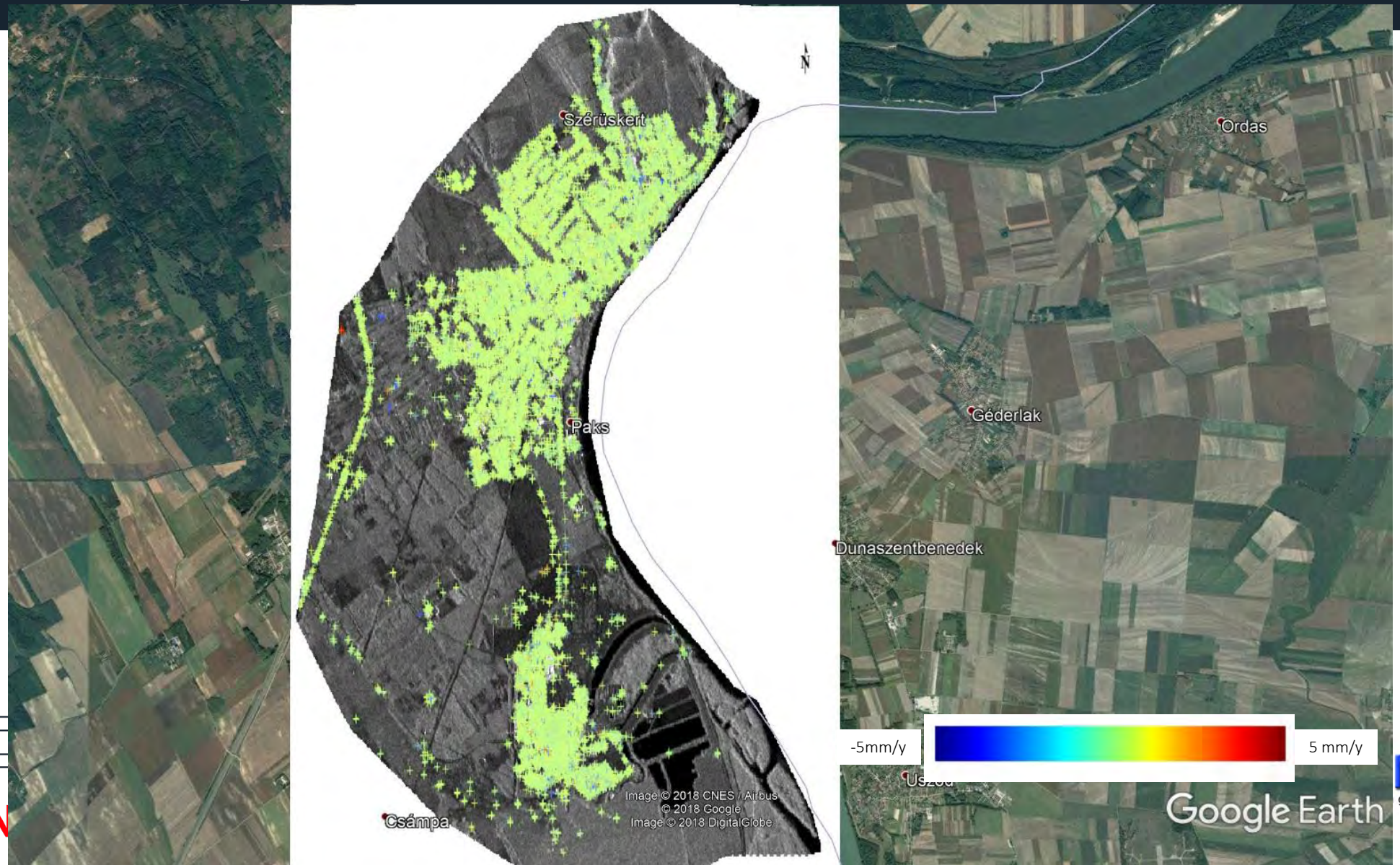
map
gateway

Paks nuclear plant

SAF
SESSION

map gateway

Paks nuclear plant

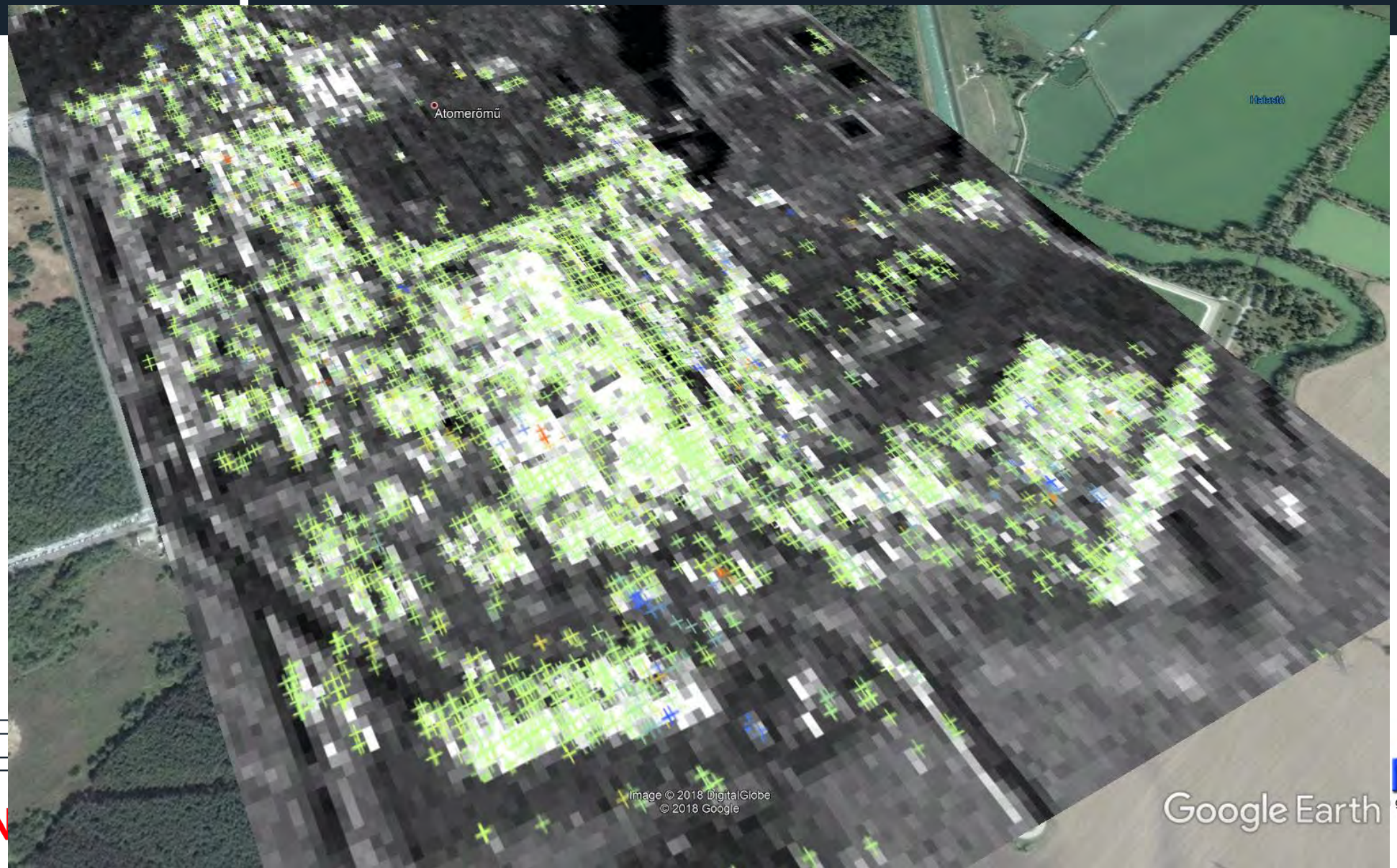


SAR SESSION

map gateway

Paks nuclear plant

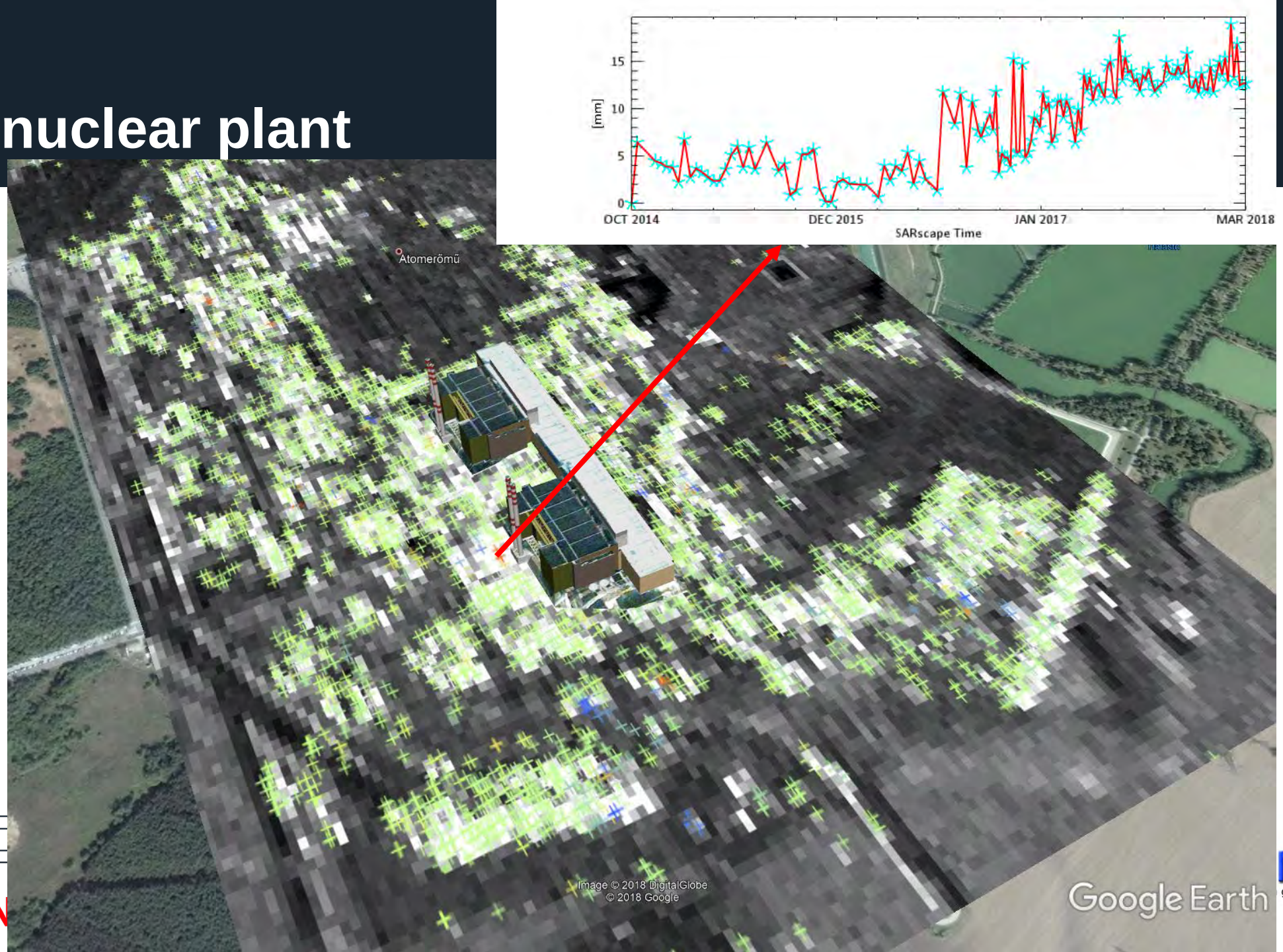
Paks nuclear plant



SAF
SESSION

map
gateway

Paks nuclear plant



SAR
SESSION

map
gateway

STANAG Terminology

SAR image analysis can provide answers to code B requests (Change Detection / Surveillance) made according to the STANAG 3596 standard for the category 6, Ground Activity.

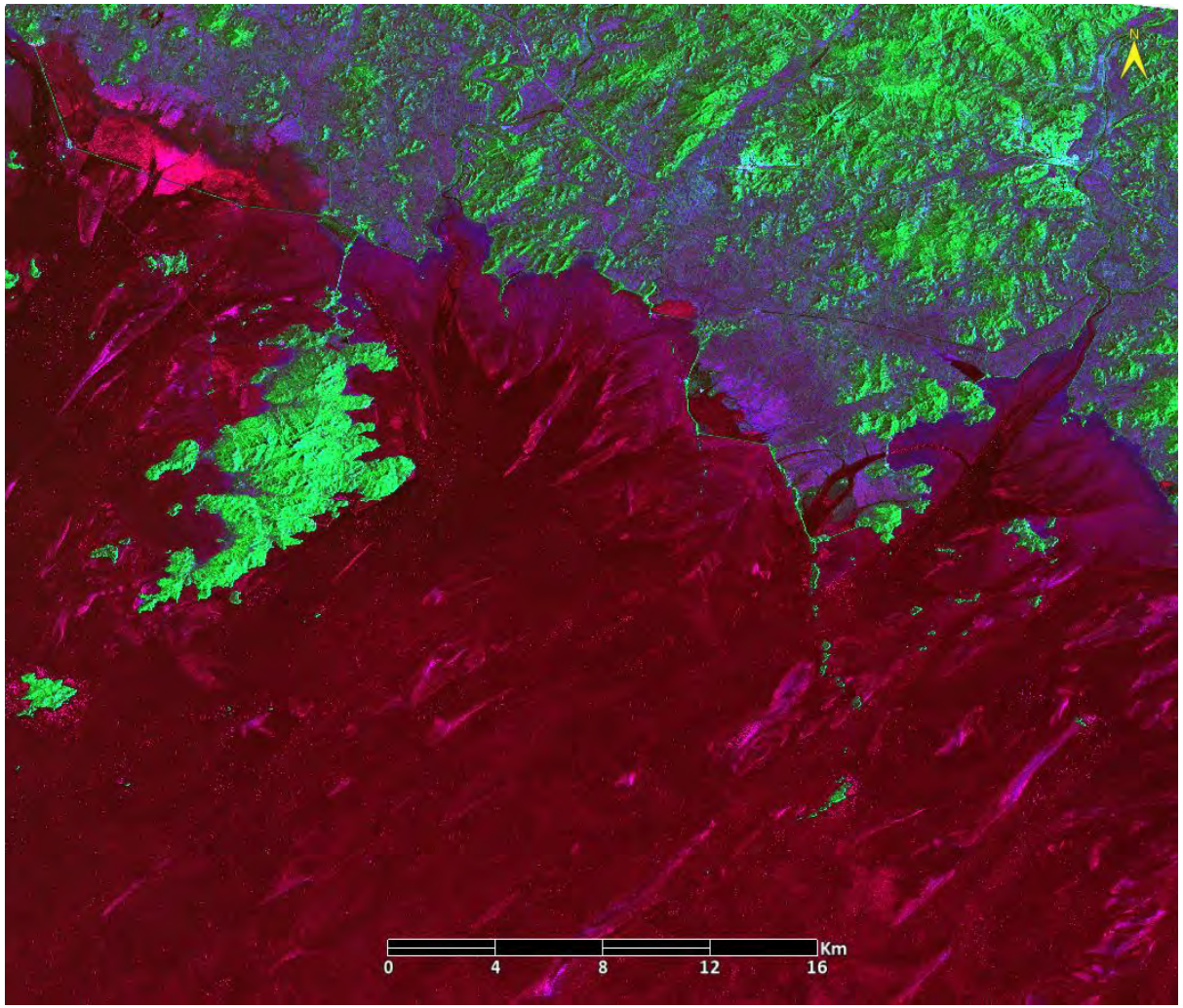
SAR SESSIONS

sarmap your information gateway

Coastal activity

2015 - 2019

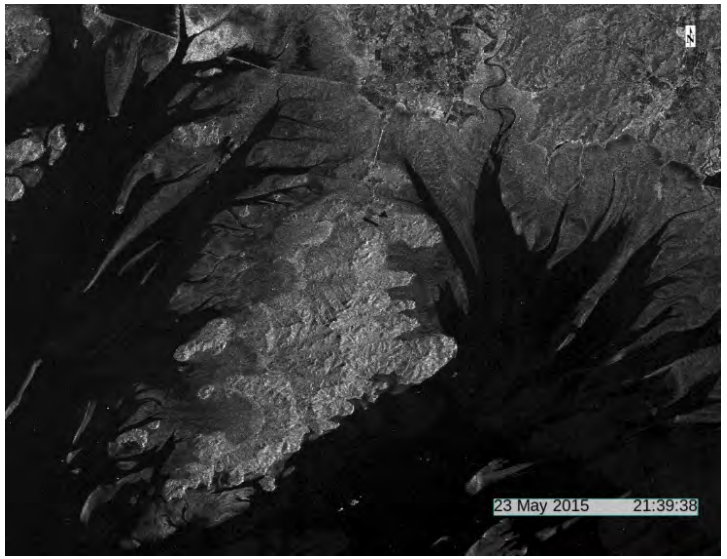
- Coefficient of variation
- Mean
- Gradient

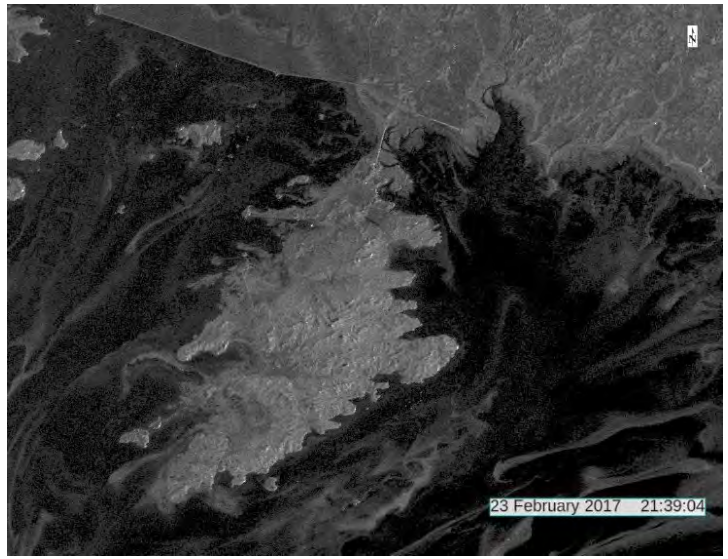


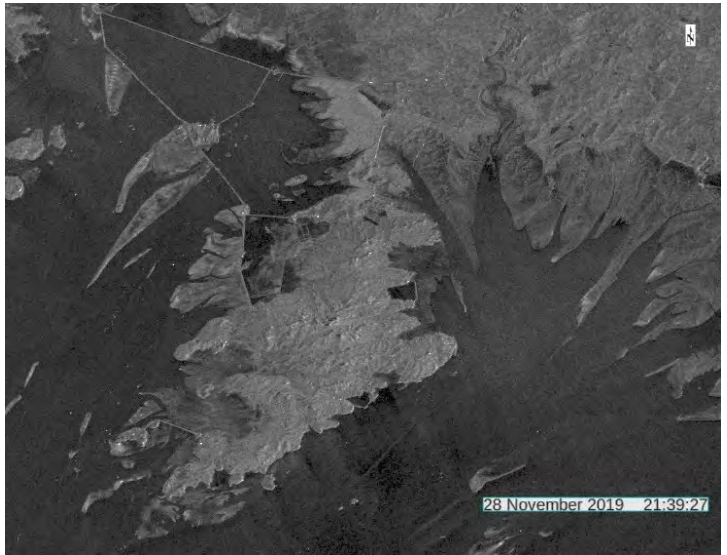
SAR SESSIONS

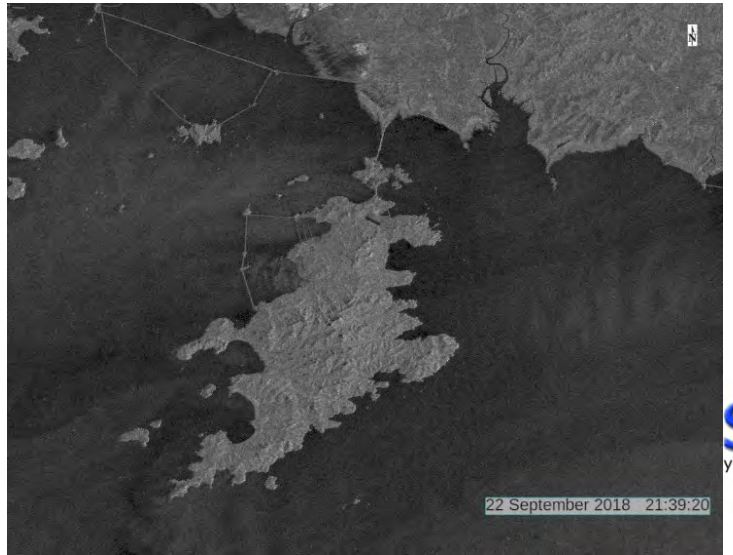
sarmap
your information gateway

Coastal activity





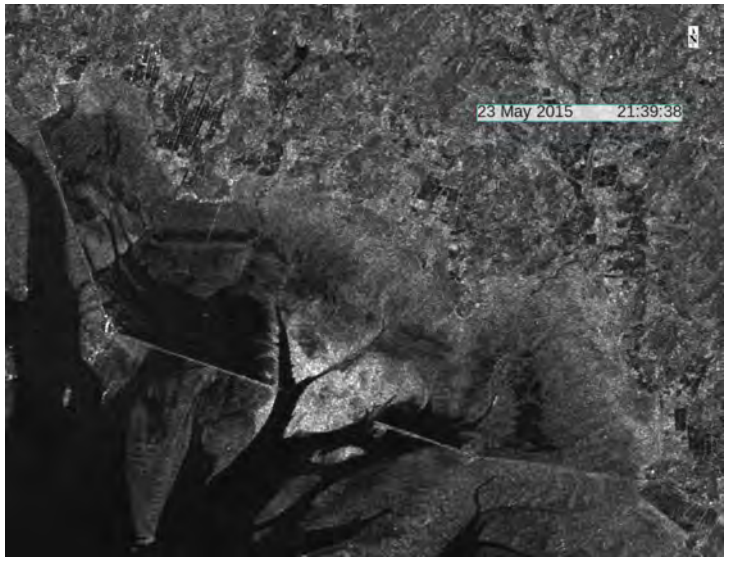




SAR SESSIONS

sarmap your information gateway

Coastal activity



SAR SESSIONS

sarmap your information gateway

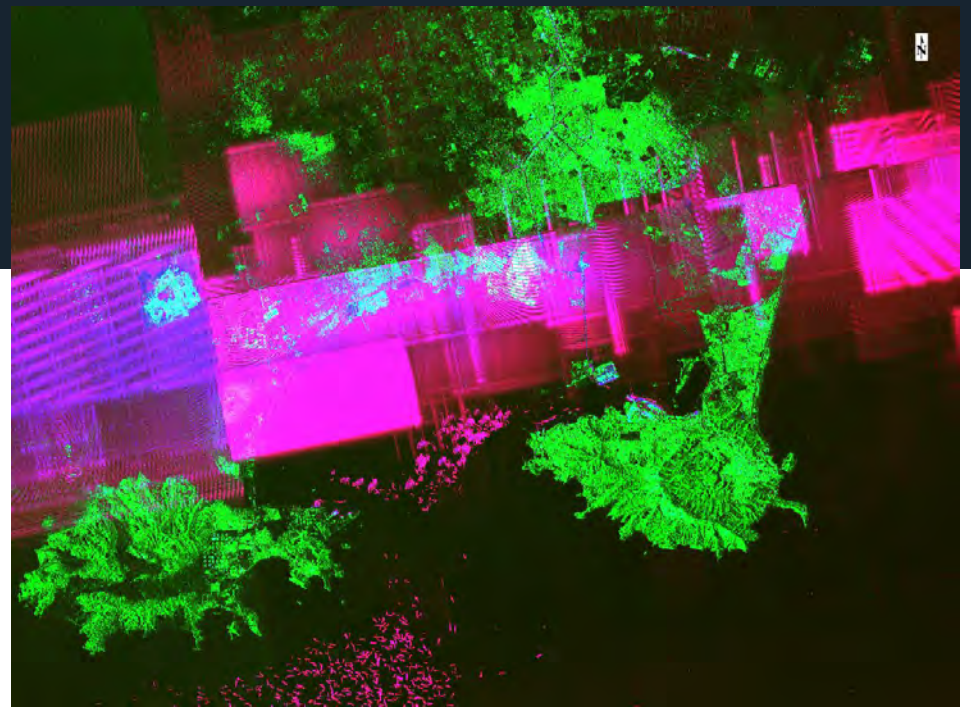
STANAG Terminology

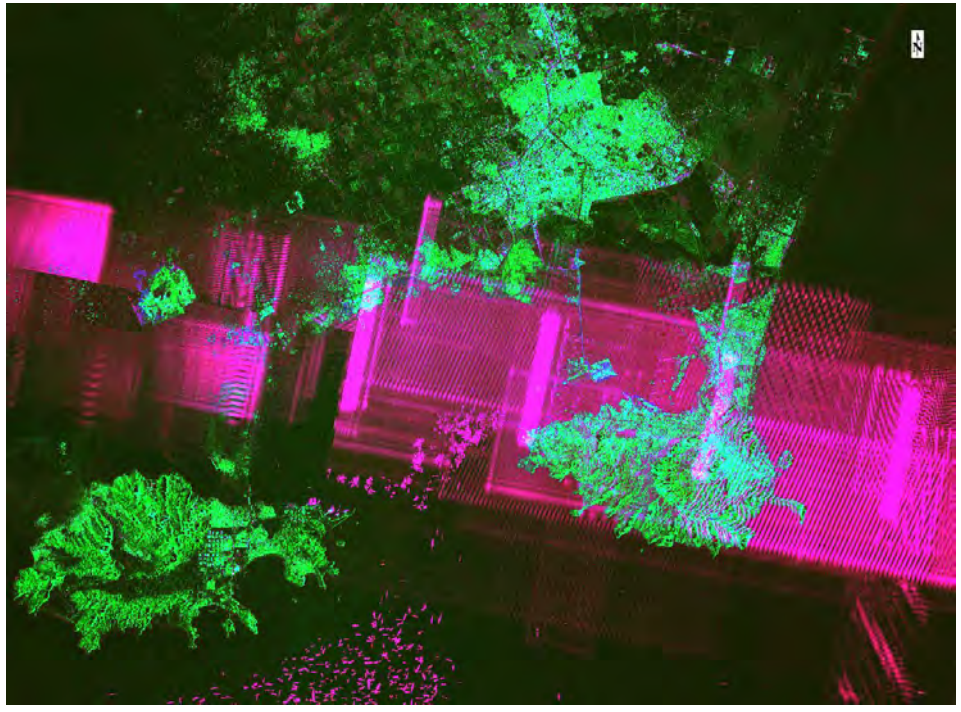
SAR image analysis can provide answers to code B requests (Change Detection / Surveillance) made according to the STANAG 3596 standard for the category 11, Coastal Reconnaissance.

Radio Frequency Interferences

Amplitude Change Detection

- Coefficient of variation
- Mean
- Gradient





2017-2019

SAR SESSIONS

sarmap
your information gateway

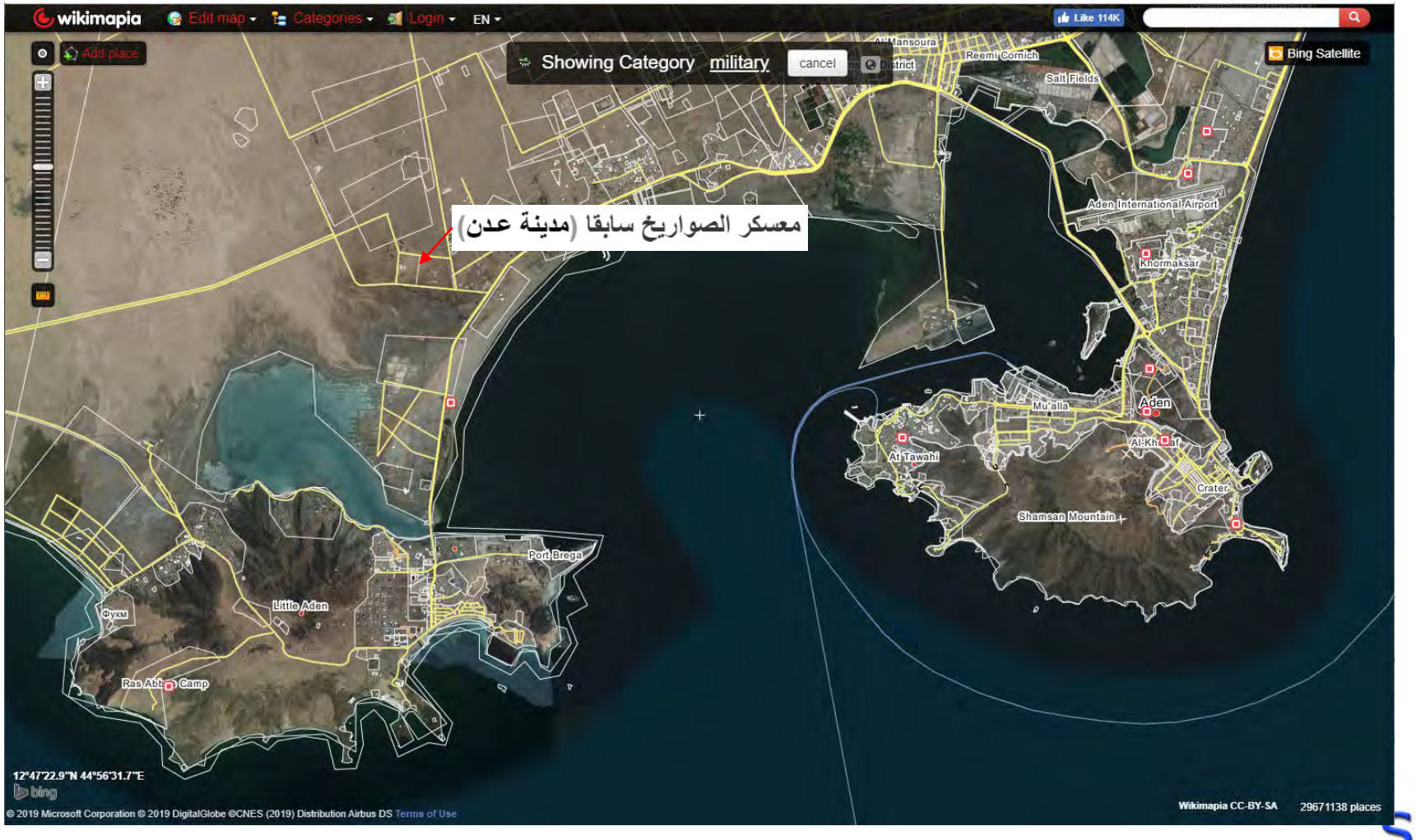
Radio Frequency Interferences

2017-2019

SAR SESSIONS

sarmap
your information gateway

Radio Frequency Interferences



معسكر الصواريخ سابقا (مدينة عدن) : *Former missile camp (Aden)* according to Google Translate

SAR SESSIONS

sarmap your information gateway

STANAG Terminology

SAR image analysis can provide some answers to code B requests (Change Detection / Surveillance) made according to the STANAG 3596 standard for the category 3, Missile Systems / Electronic installations.

Thanks a lot for your attention!

SAR SESSIONS

sarmap
your information gateway