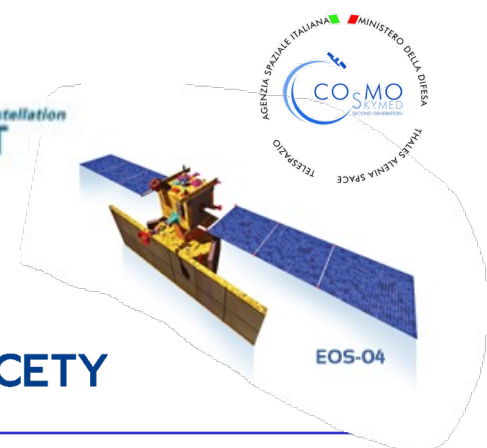
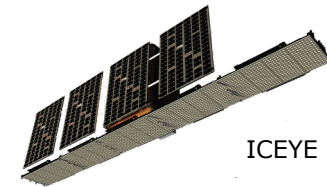


Wide-area, Hierarchical and Activity-based Structured Observation with satellite SAR technologies

Dr Paolo Pasquali

Co-founder, President and Technical Director

How not to be optimistic...



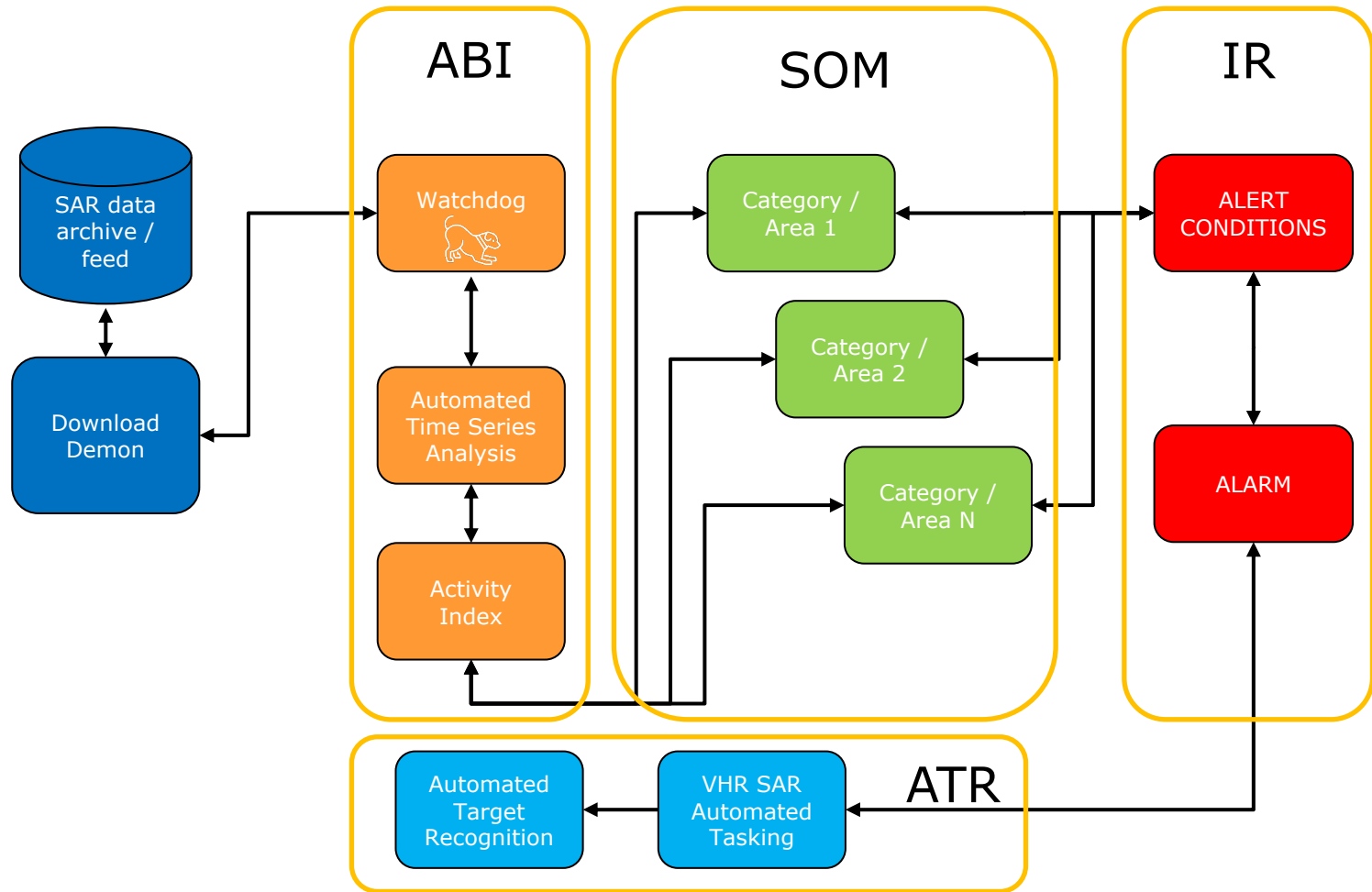
How to better build a bridge between Earth Observation and D&I / GEOINT

- Better understand
 - Requirements
 - Processes
- Focus on
 - Easier access to SAR technology
 - Higher level of information extraction and synthesis
 - Standardisation (STANAGs, ATPs)
 - Automation
 - Scalability

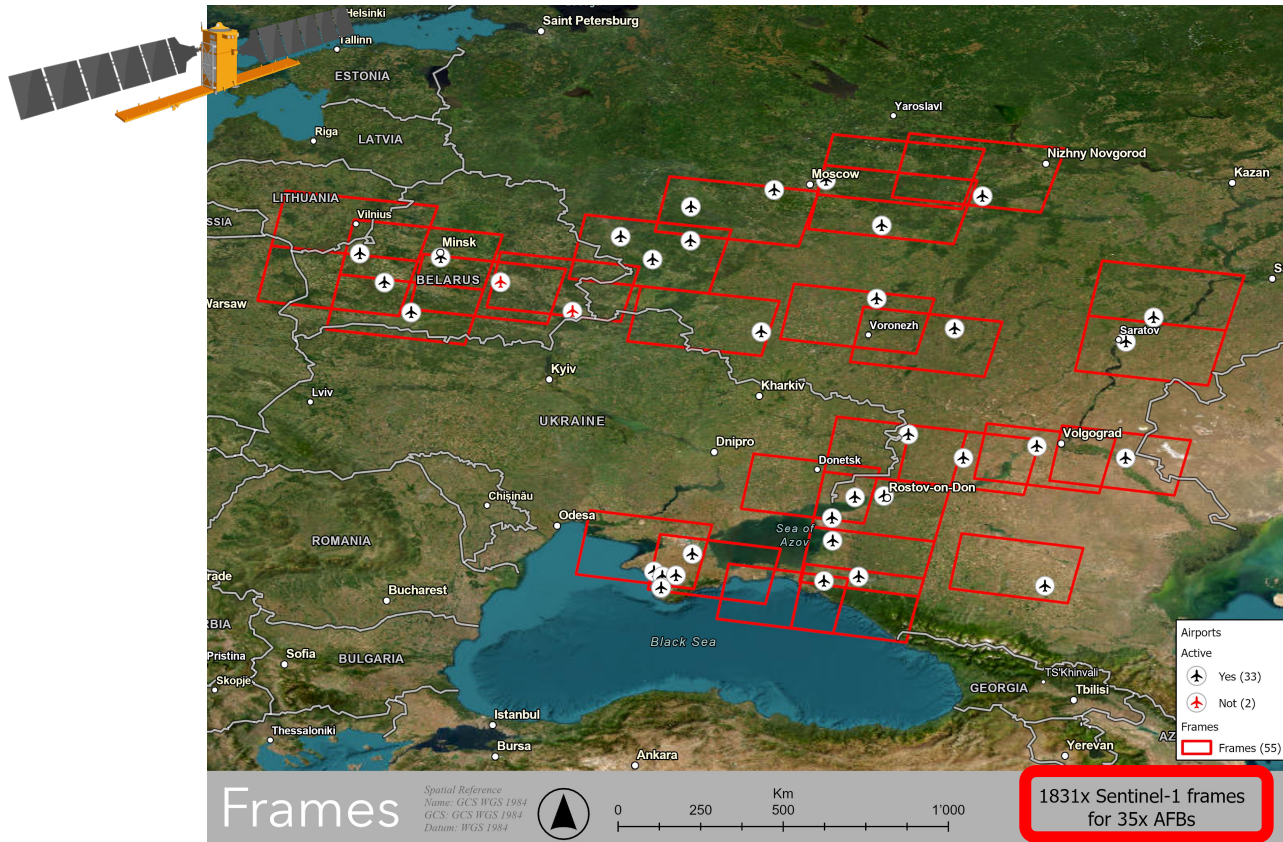
One concrete example of a possible bridge

- | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <ul style="list-style-type: none"> Monitoring of 35 Air Force Bases distributed over a territory of more than 1 million km², AFBs with anomalous activity (e.g., sudden activity after long quiet periods) have been identified (assumed as Information Requirement of potential end users) Time interval between August 2021 and February 2023 | IR |
| <ul style="list-style-type: none"> Each AFB has been divided in areas with different level of interest and results have been structured according to SOM | SOM |
| <ul style="list-style-type: none"> Areal statistics of changes detected in HR Sentinel-1 data have been converted into "Activity Index" (ABI) | ABI |
| <ul style="list-style-type: none"> VHR images have been obtained for anomalous activity periods and analyzed with ATR | ATR |
| <ul style="list-style-type: none"> More than 1'800 images, Sentinel-1 (Change Detection, ABI) and Capella Space (ATR), have been automatically processed | |

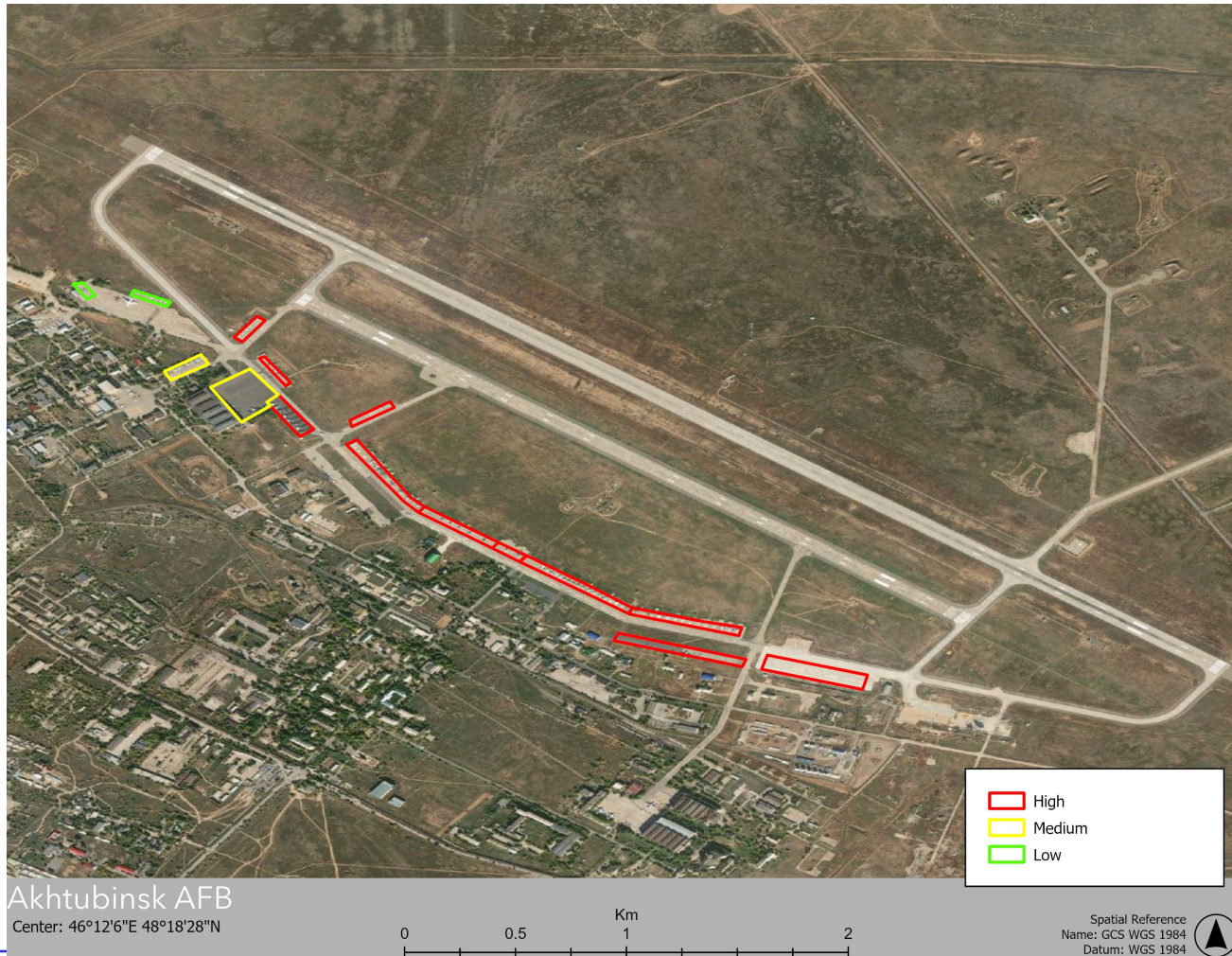
The implementation



The area and the data: Copernicus Sentinel-1

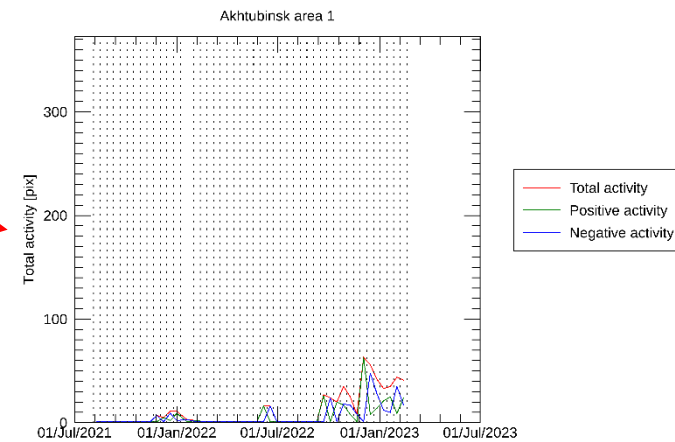
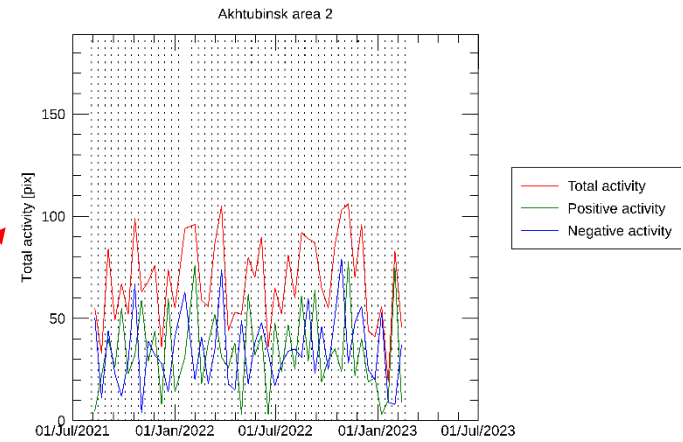
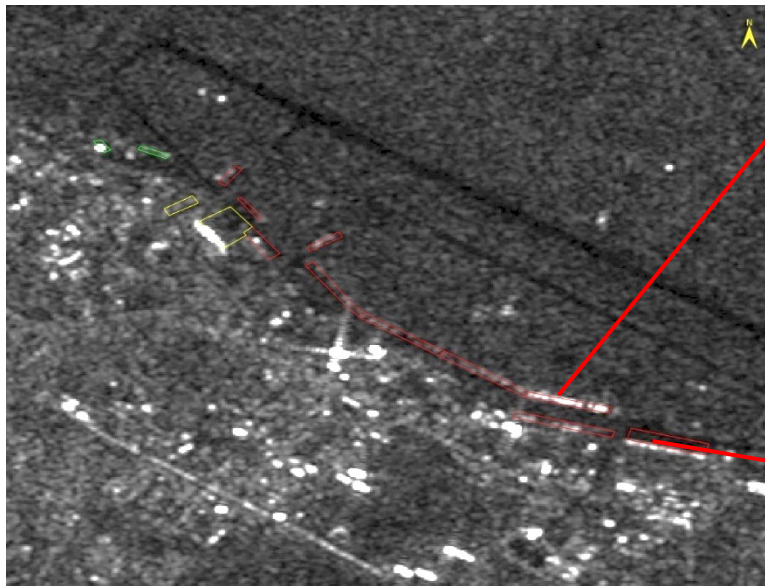


Structured Observation Management analysis of one AFB

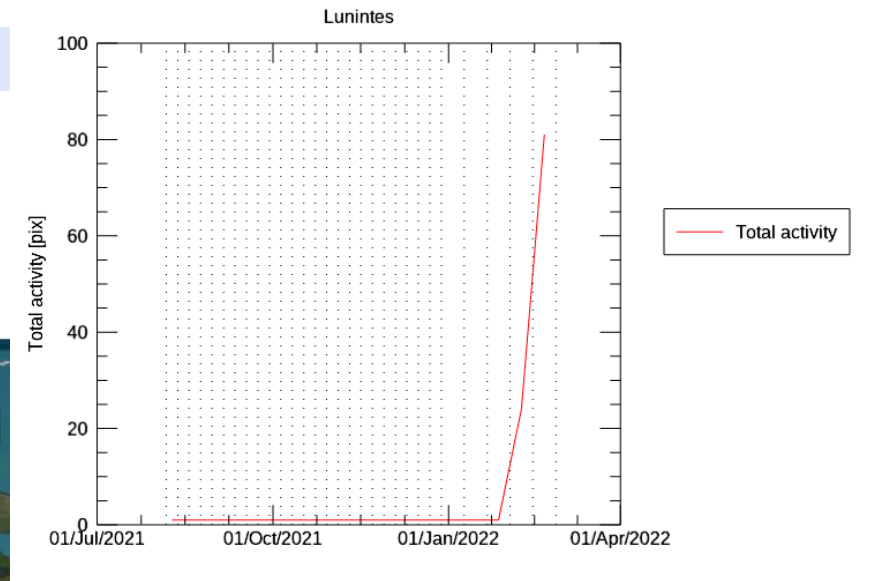
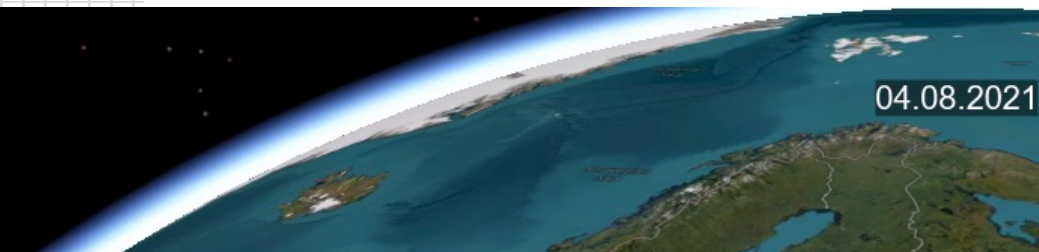


This has been repeated for each of the 35 AFBs

ABI: Activity Index



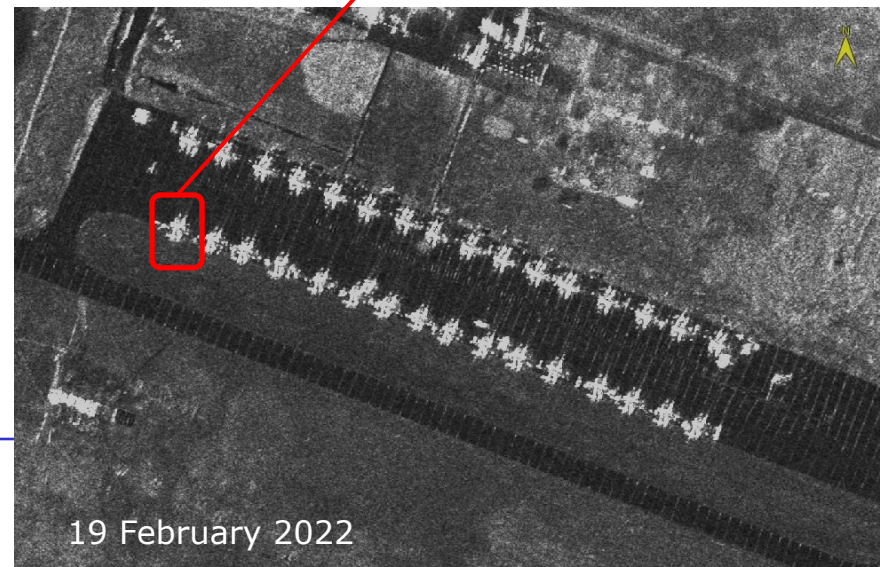
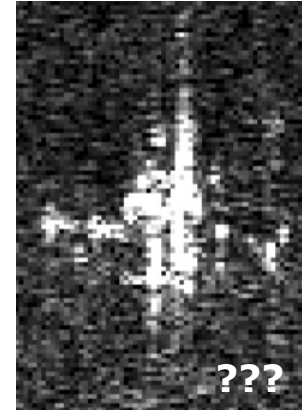
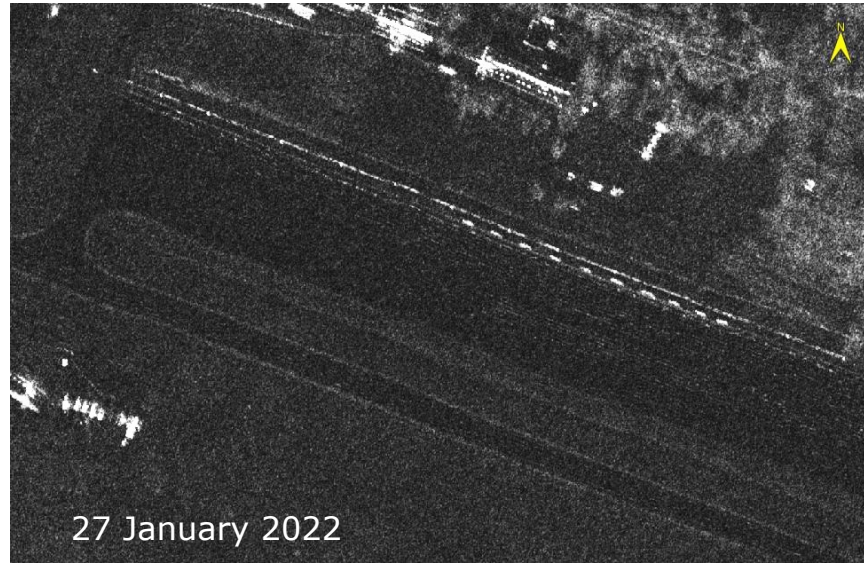
Animation of the activity for the whole area



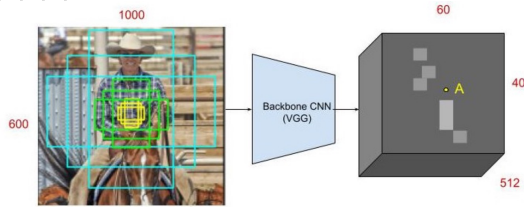
The position of the AFBs of interest is indicated by the red circles. The size of the circles correspond to the amount of activity. Luninets, Belarus, became active in February 2022

Capella images of Luninets AFB, Belarus

VHR Capella images acquired just before and across the period of start of activity. Airplanes arrive there in the period: which type? ATR needed.



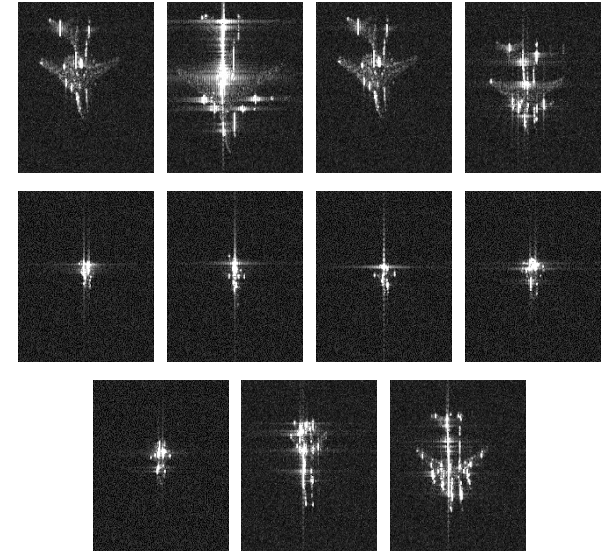
ATR: detection and classification



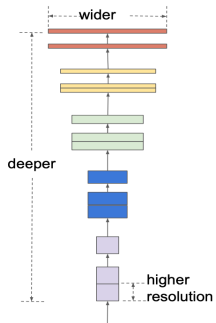
Deep Learning component 1: detection



The targets



The simulated training data



Deep Learning component 2: classification

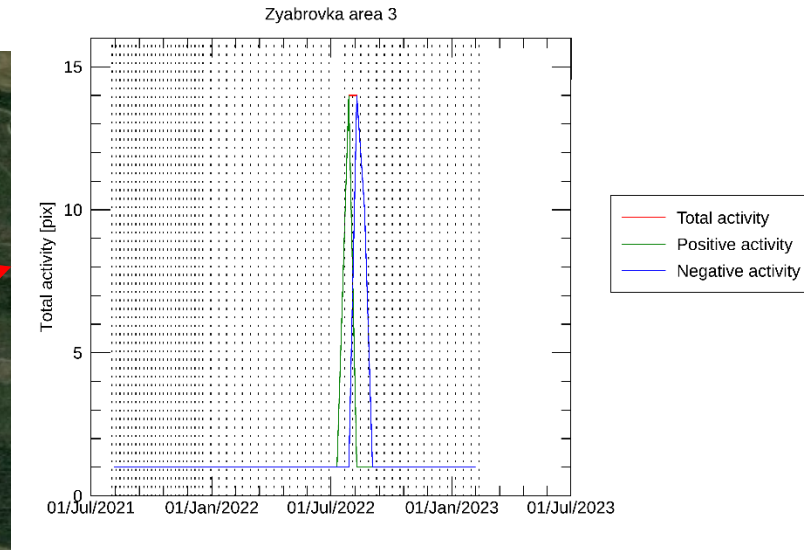
ATR on Capella Space images of Luninets AFB



32
Sukhoi
SU-25
ground
attack
airplanes

19 February 2022

Another AFB that showed anomalous activity: Zyabrovka (Pribytki), Belarus, as visible in the animation



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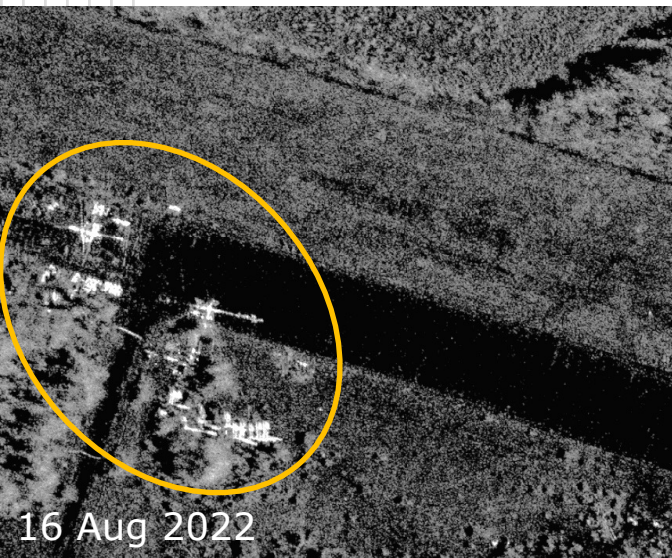
3315

Capella Space images of Zyabrovka (Pribytki) AFB

VHR Capella images acquired just before and across the period of activity show that it corresponds to the deployment of an Air Defense System.



6 Jul 2022



16 Aug 2022

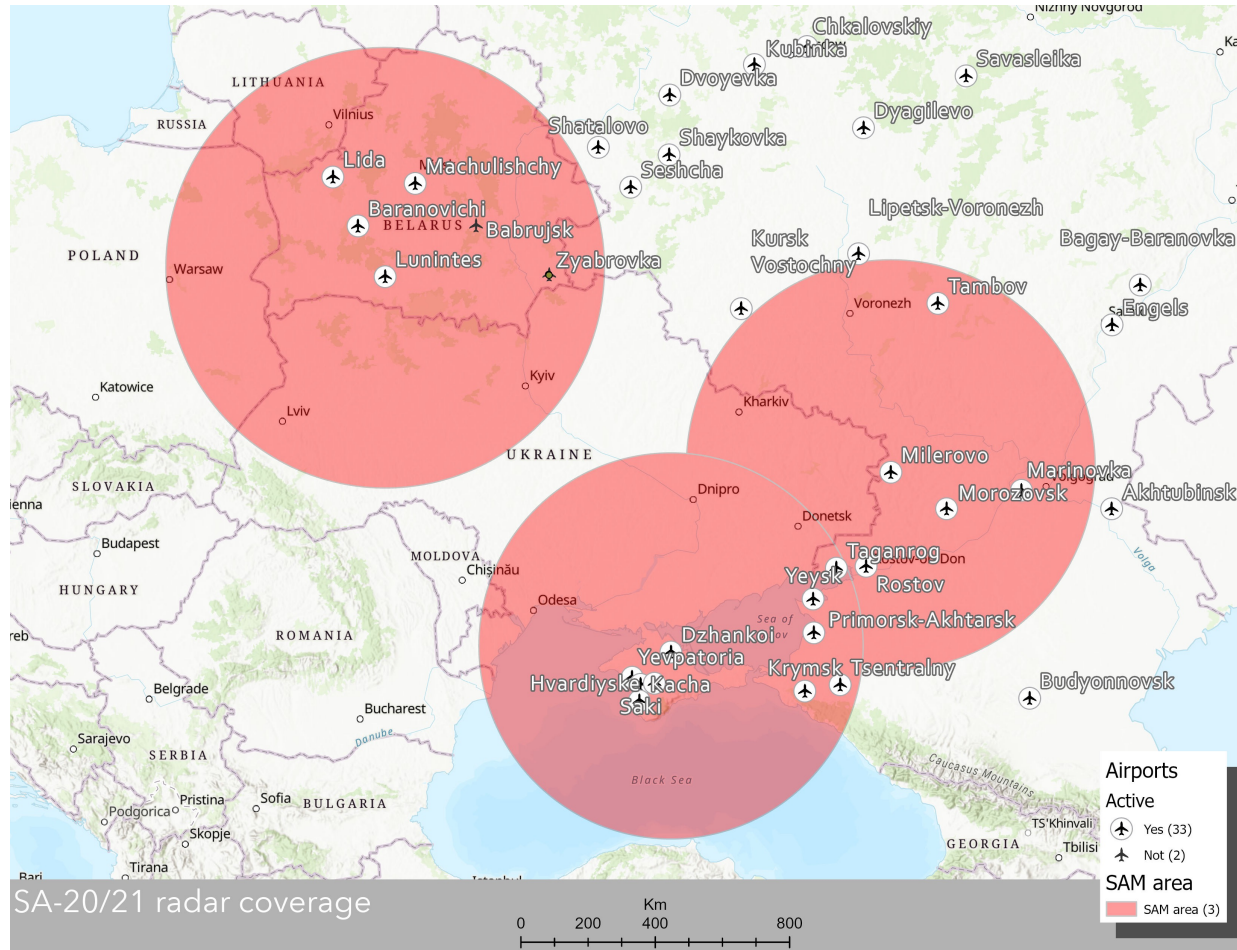
Deployment of a
SA-20/21 Air
Defense System

STANAG 3596 Category 2



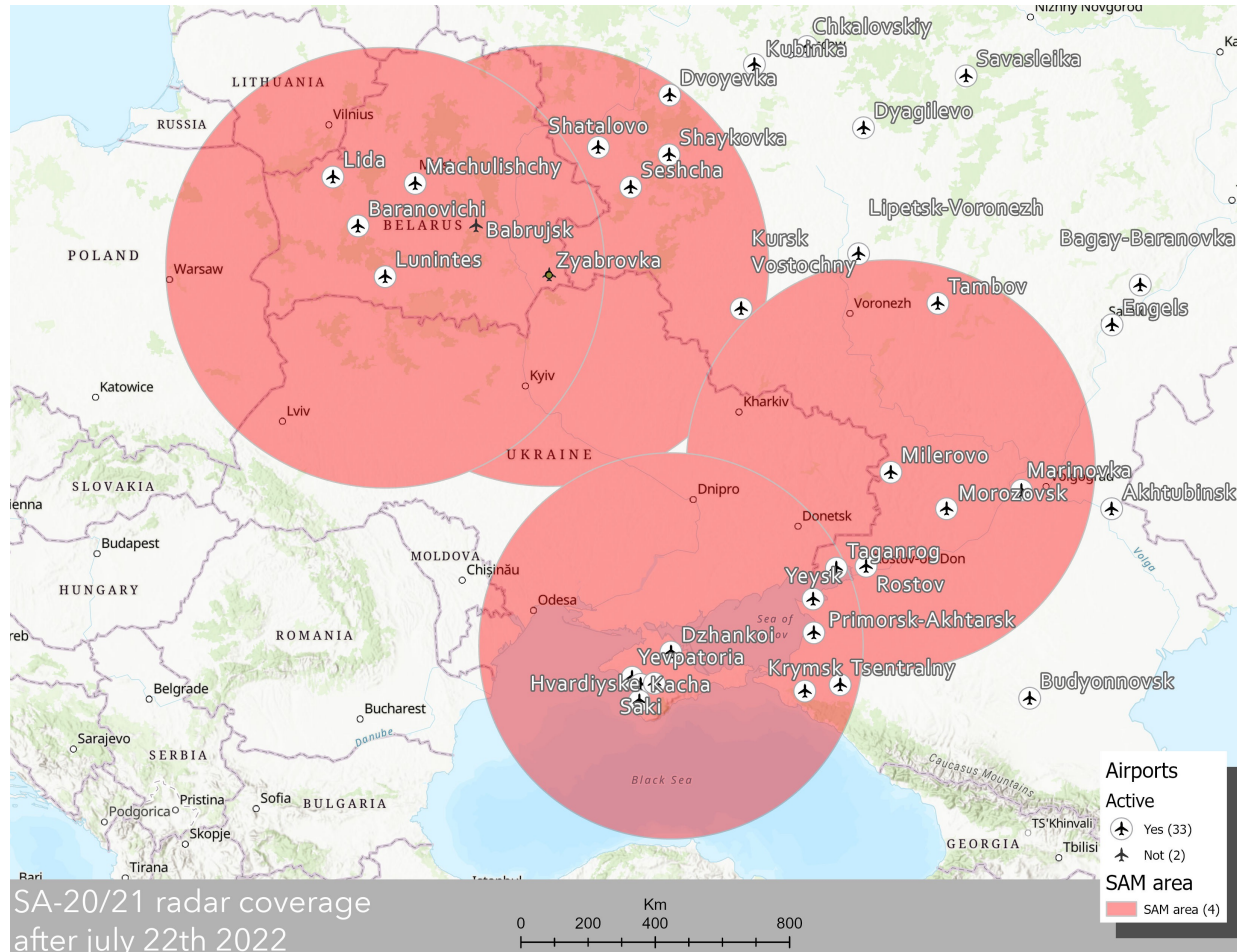
21 Feb 2023

Air Defense Systems coverage before new deployment in Zyabrovka (Pribytki) AFB



The red circles correspond to the radius of coverage of the radars of the SA-20/21 Air Defense Systems, respect of known locations of deployment before July 2022. The central area seems not adequately covered.

Air Defense Systems coverage after deployment in Zyabrovka (Pribytki) AFB



The whole area is adequately covered after the deployment in Zyabrovka.

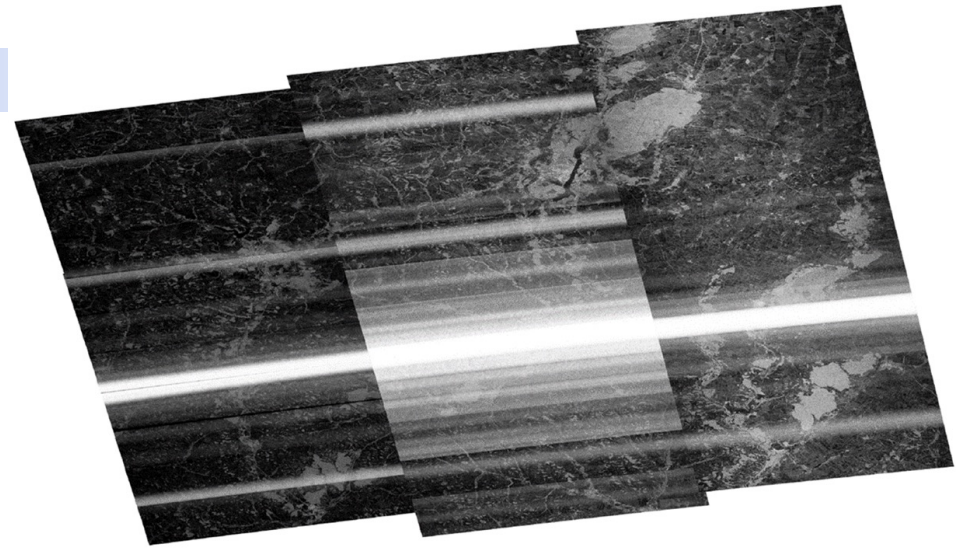
By the way..



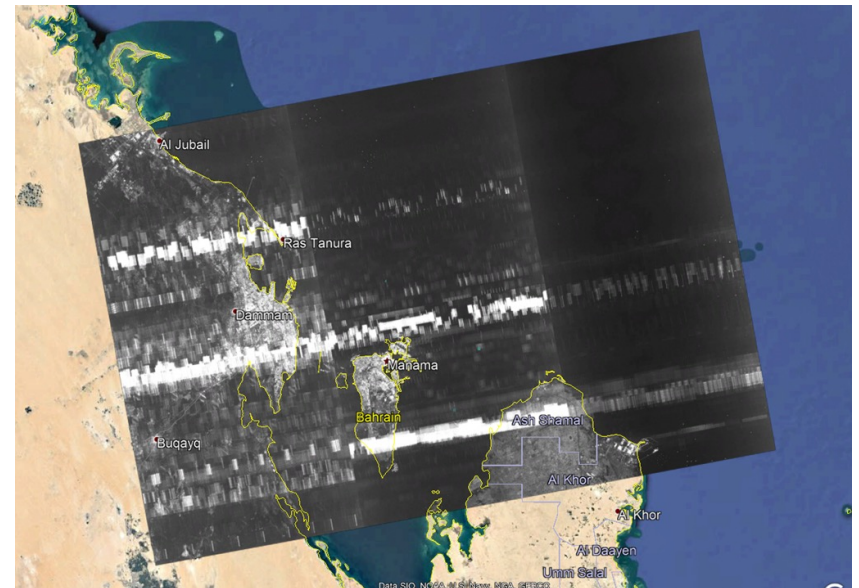
MeteoSwiss Weather RADAR

Analysis of SAR raw data permits detection and parametrisation of ground transmitters operating in the same frequency spectrum of the SAR instruments.

RF Activity Index can also be derived (as well as identification of the transmitters parameters and working mechanism).



Jammer, Russia / Ukraine border



Patriot batteries, Qatar

Summarising a few ideas

- GEOINT concepts and doctrine can be fruitfully used to structure and connect SAR analysis with D&I requirements.
- Quantitative metrics shall be identified (e.g., activity indexes).
- Quantitative (vectorial) results are fundamental to compare SAR (EO), normally raster, results with other sources of intelligence (e.g., OSINT, SOSINT, SIGINT).
- Standardization and automatization of processes and analyses are of extreme importance.
- Structured analyses can be fruitfully carried out on large areas.
- Advanced results can also be obtained (e.g., classification of active targets (ATR), parametrization of activities (e.g., underground nuclear tests, RFIs)).

Thanks a lot for your attention!

...and for your patience!