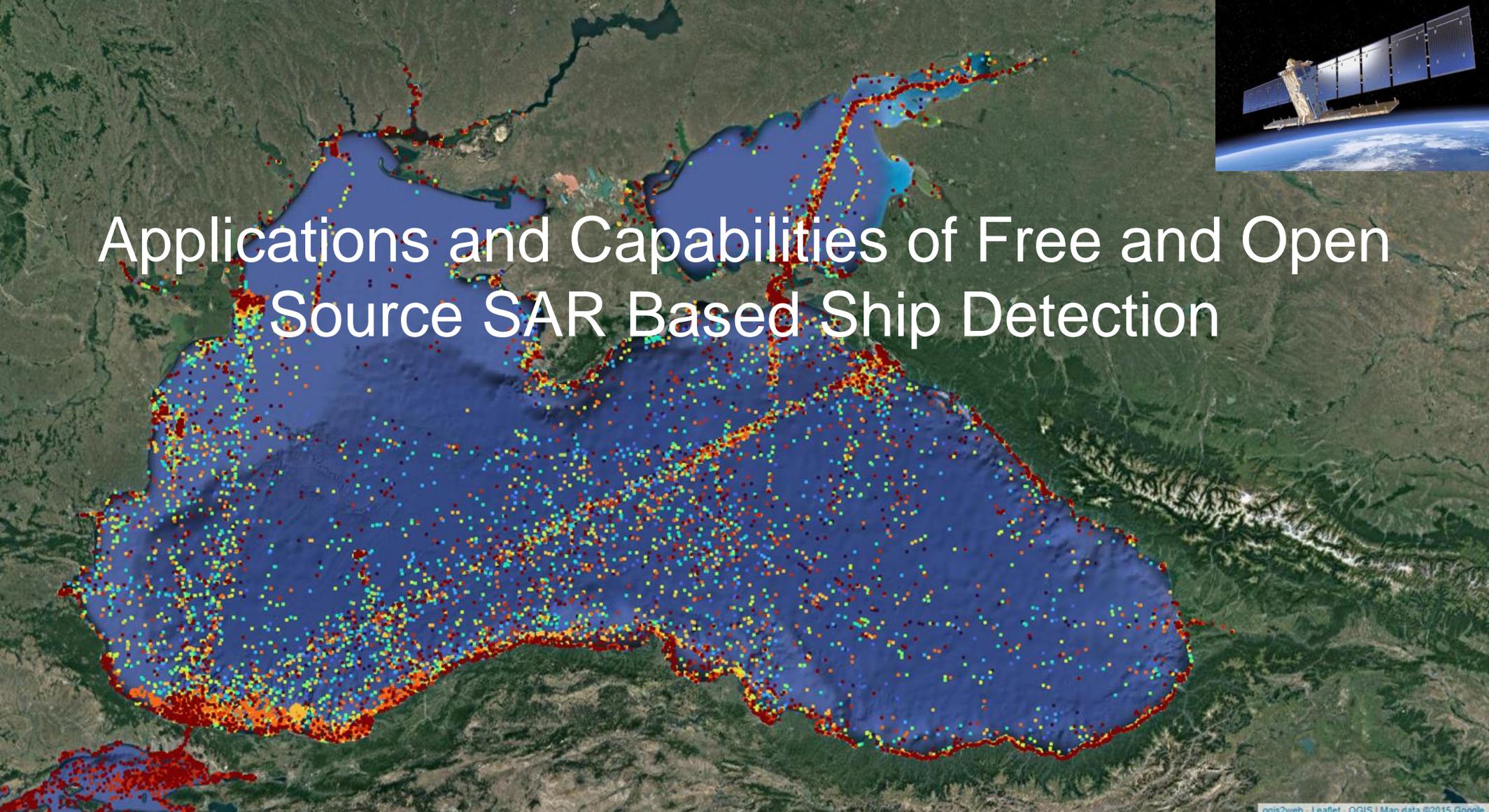




Applications and Capabilities of Free and Open Source SAR Based Ship Detection



Overview



Motivation



Methodology



Results and
Applications



Next Steps

Motivation

- All current ship tracking information is based on voluntarily broadcast AIS signals
- Issues with locating ships without transmitting transponders
- Illegal fishing
- Military operations
- Piracy
- Human trafficking



Current Applications



Most applications in the motivation would require the integration and correlation of AIS data which is not currently implemented.

Expected applications in its current state include:

Monitoring shipping lanes, port backlogs and other bottlenecks

Observing fisheries

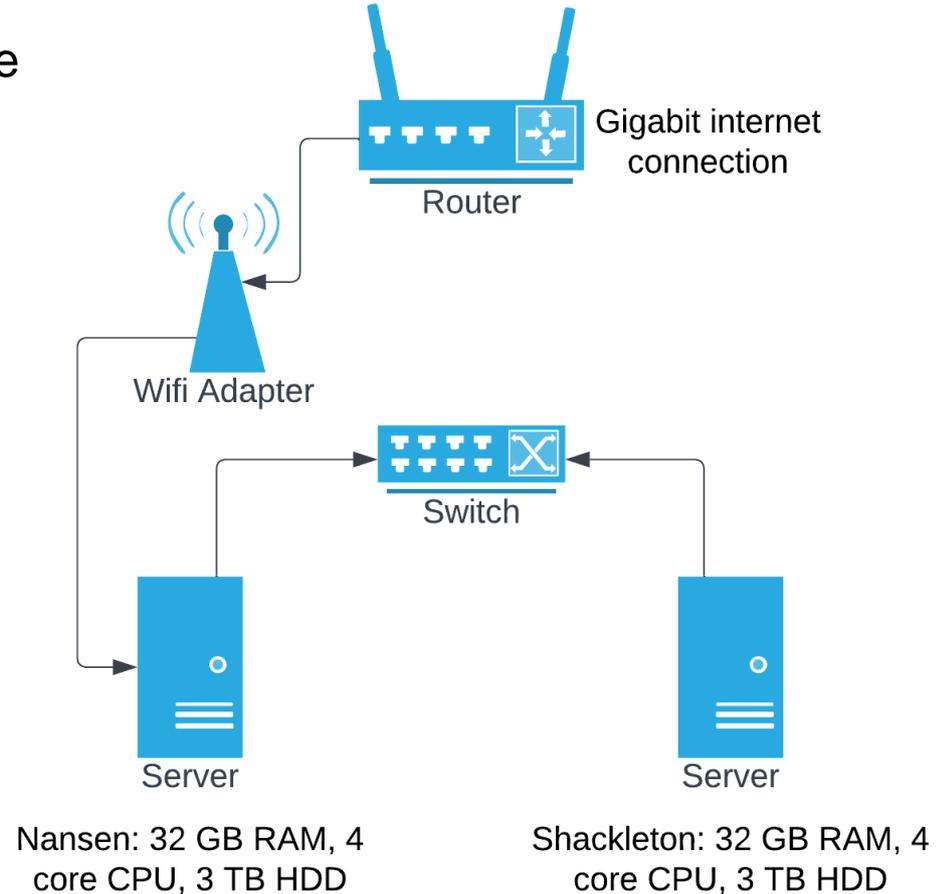
Unanticipated applications include:

Monitoring offshore wind farm construction

Detecting Offshore oil operations

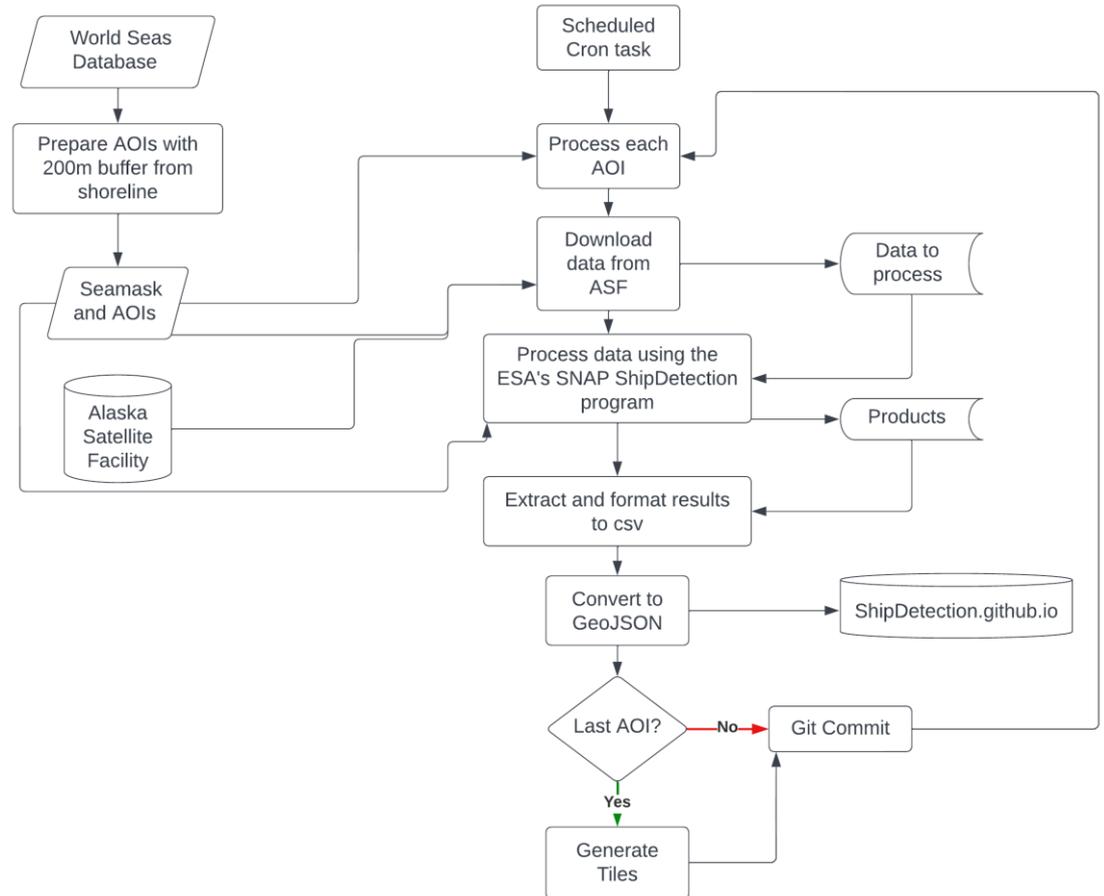
Processing Resources

- All processing occurs using 2 Lenovo Thinkcentre M910s.
- Processing AOIs split between them and results output over the network to a single github repository to reduce risk of conflicts.
- Each with:
 - 32 GB RAM
 - 3TB HDD Storage
 - 4 core I5 CPU
 - Gigabit internet over a shared wifi adapter through a switch
- Currently takes 6-12 hrs a day for the processing to complete. Highly dependent on internet speed.



Processing Workflow

- Download data from the ASF (Alaska Satellite Facility)
- Run Shipdetection algorithm using ESA SNAP with a landmask with a 200 m buffer
- Extract the results from output directory
- Convert results into leaflet compatible json
- Generate vector tiles
- Commit to webpage
- Delete unneeded data (most important step, requires experience to optimize and avoid system failures)

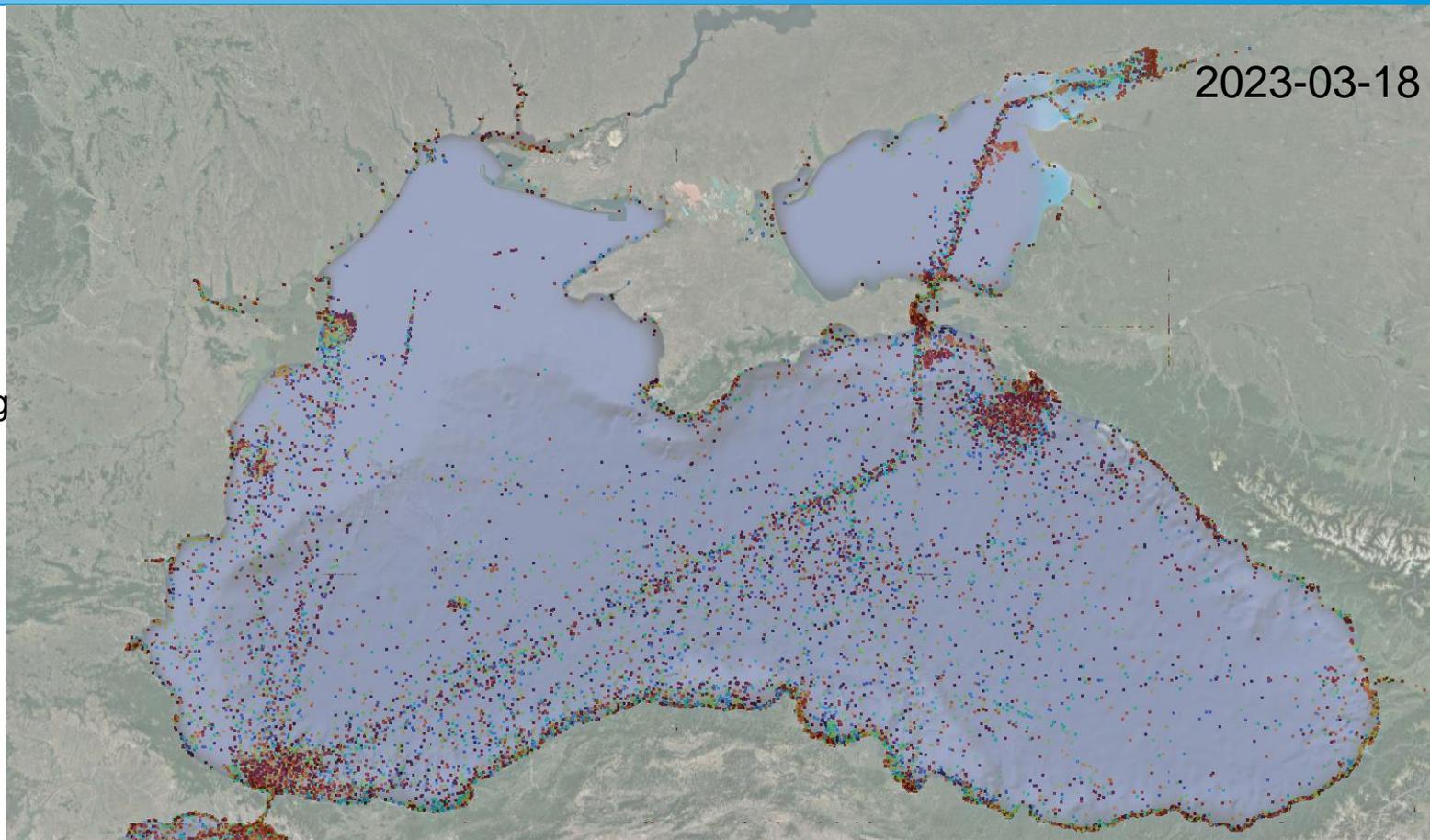


Results – Black Sea

> Colour scale based on age of the detection (Red to blue with 12 day increments up to 120 days. Based on up to 10 revisits of SNT

Notable observations:

- > Reduction in shipping backlog around the Danube Delta originally caused due to the blockade of Odesa
- > Reopening of shipping lanes to the port of Odesa following the grain deal



Results - Mediterranean Sea

Manually digitized the Suez canal
to observe ships in transit

2023-03-18

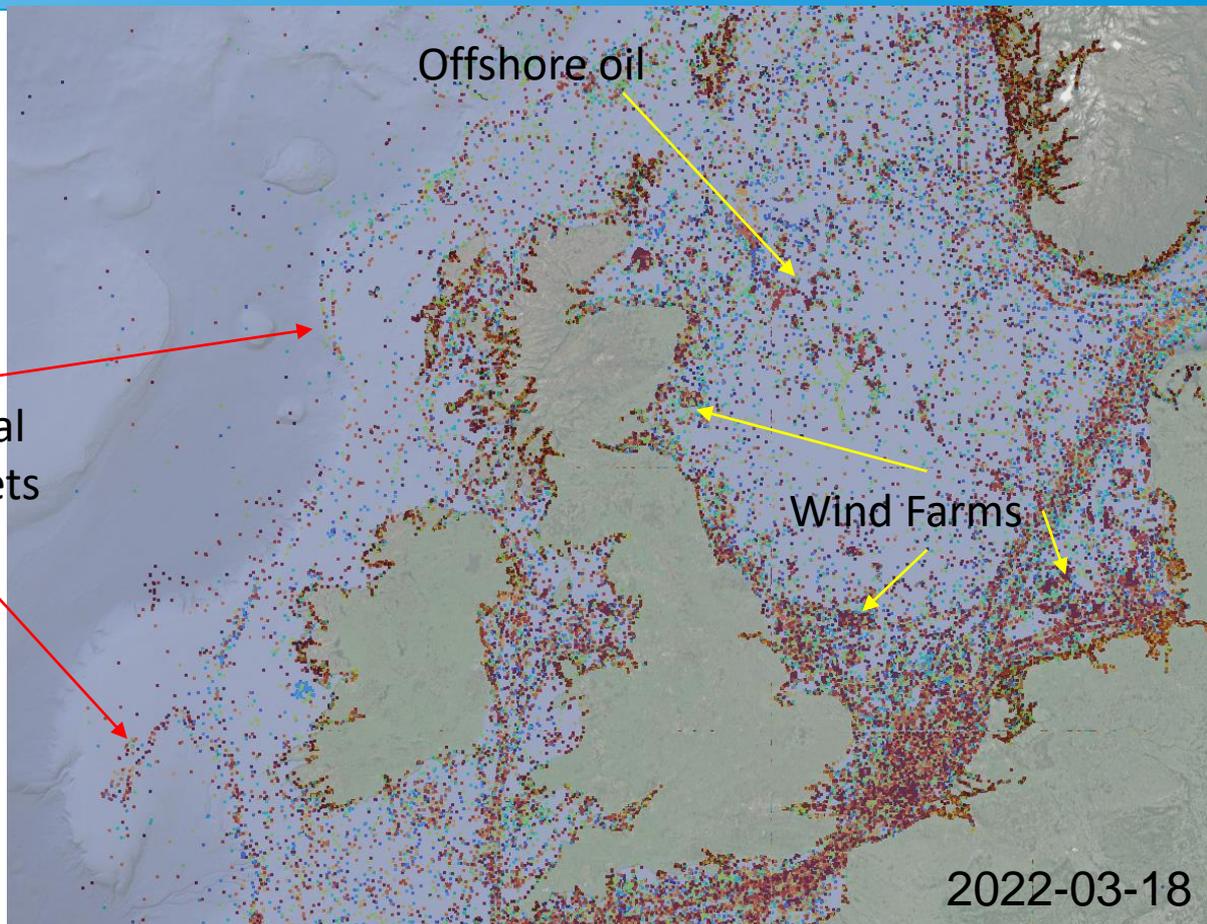
> Can clearly see the shipping lanes from the Suez Canal,
Turkish Straits and the Adriatic Sea.

3/26/2023

Results – North Sea

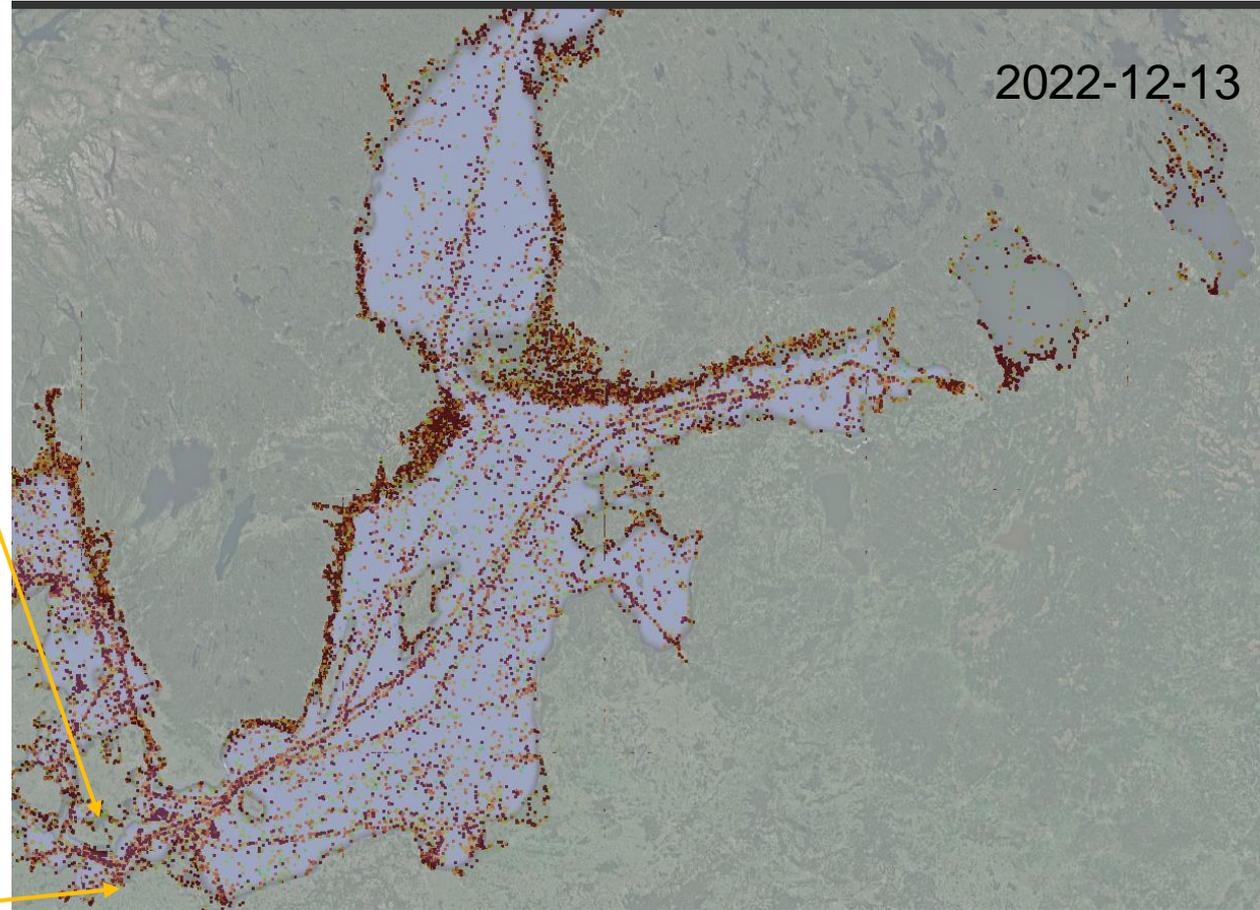
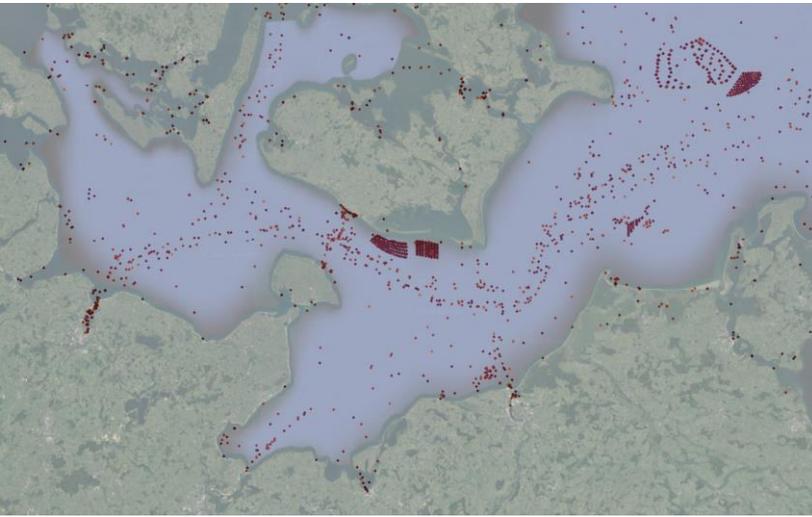
- Wind farms show up very well
- North Sea oil production highlighted
- Location of commercial fishing fleets

Commercial
fishing fleets



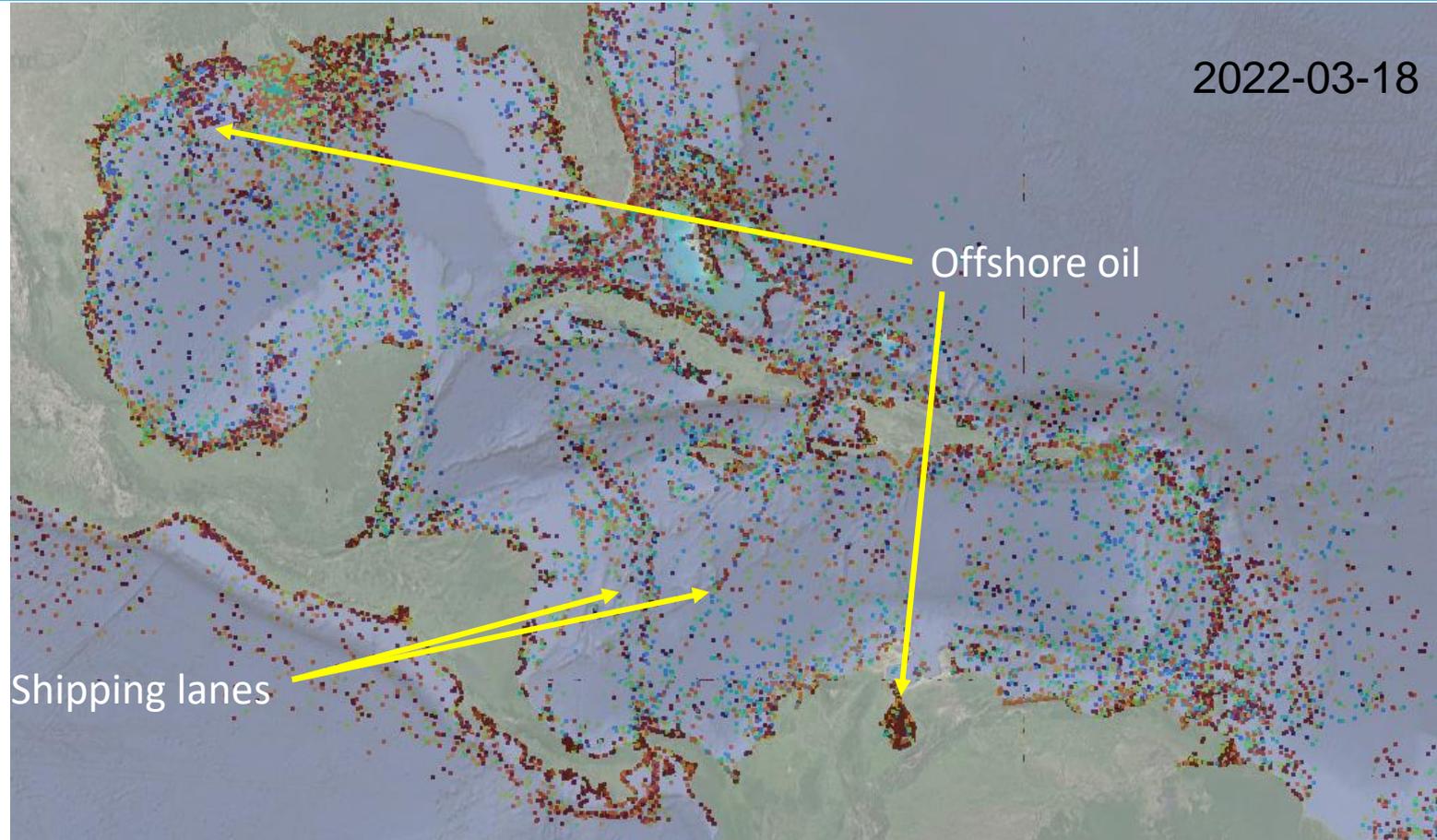
Results – Baltic Sea

- Shows main shipping lanes
- Ferry routes and wind farms are apparent
- Lot of false positives off the coast of Sweden and Finland due to small rocky islands not included in the seamask



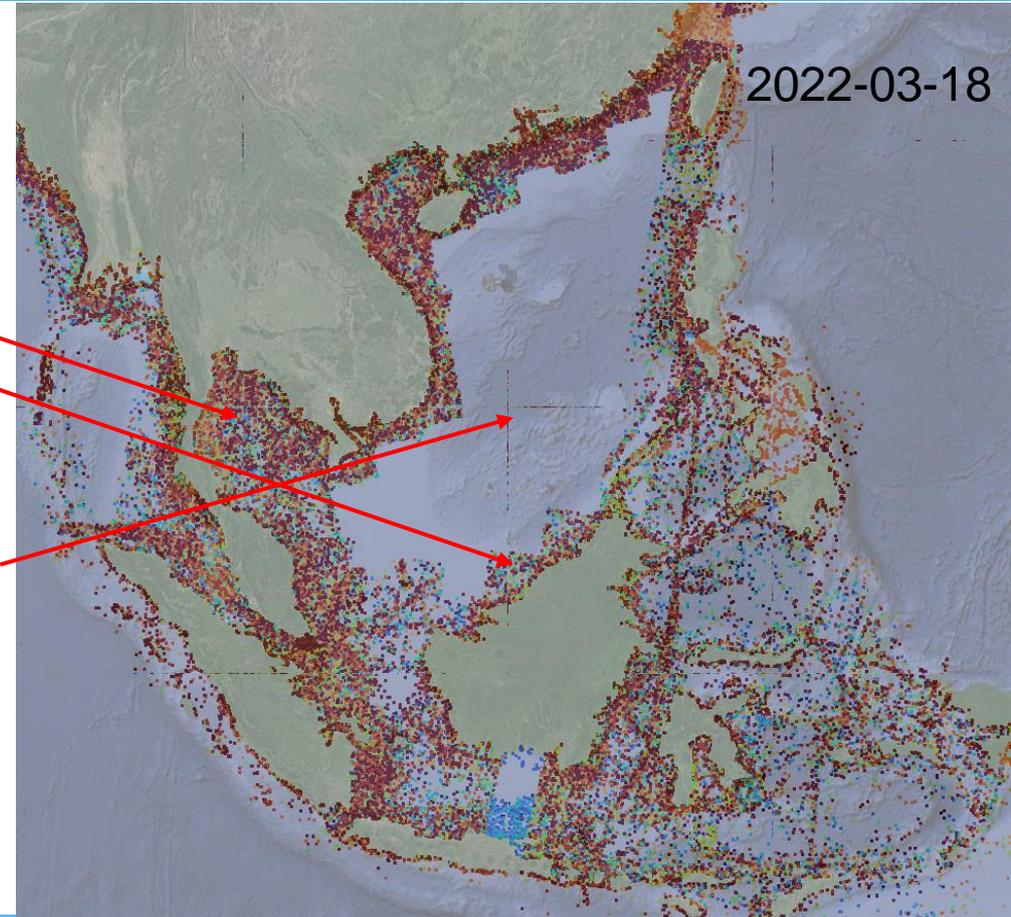
Results - Caribbean

- Offshore oil operations highlighted
- Shipping lanes to the Panama canal



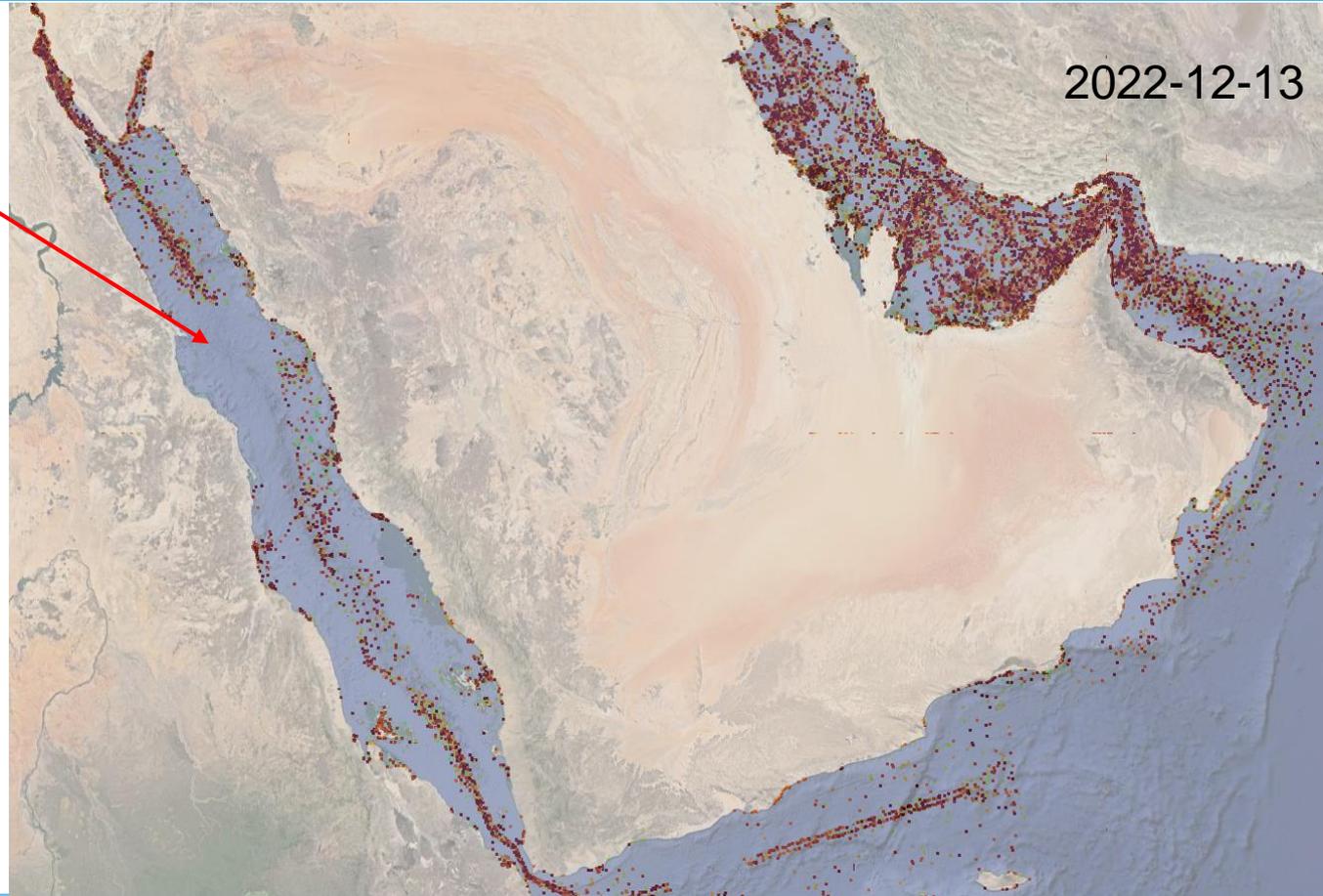
Results – Southeast Asia

- Main Shipping lanes are highlighted.
- Offshore oil in the Gulf of Thailand and off the north coast of Borneo
- SNT is not acquired over a most of the South China Sea
- An issue is apparent here with edge effects on the borders of the tiles



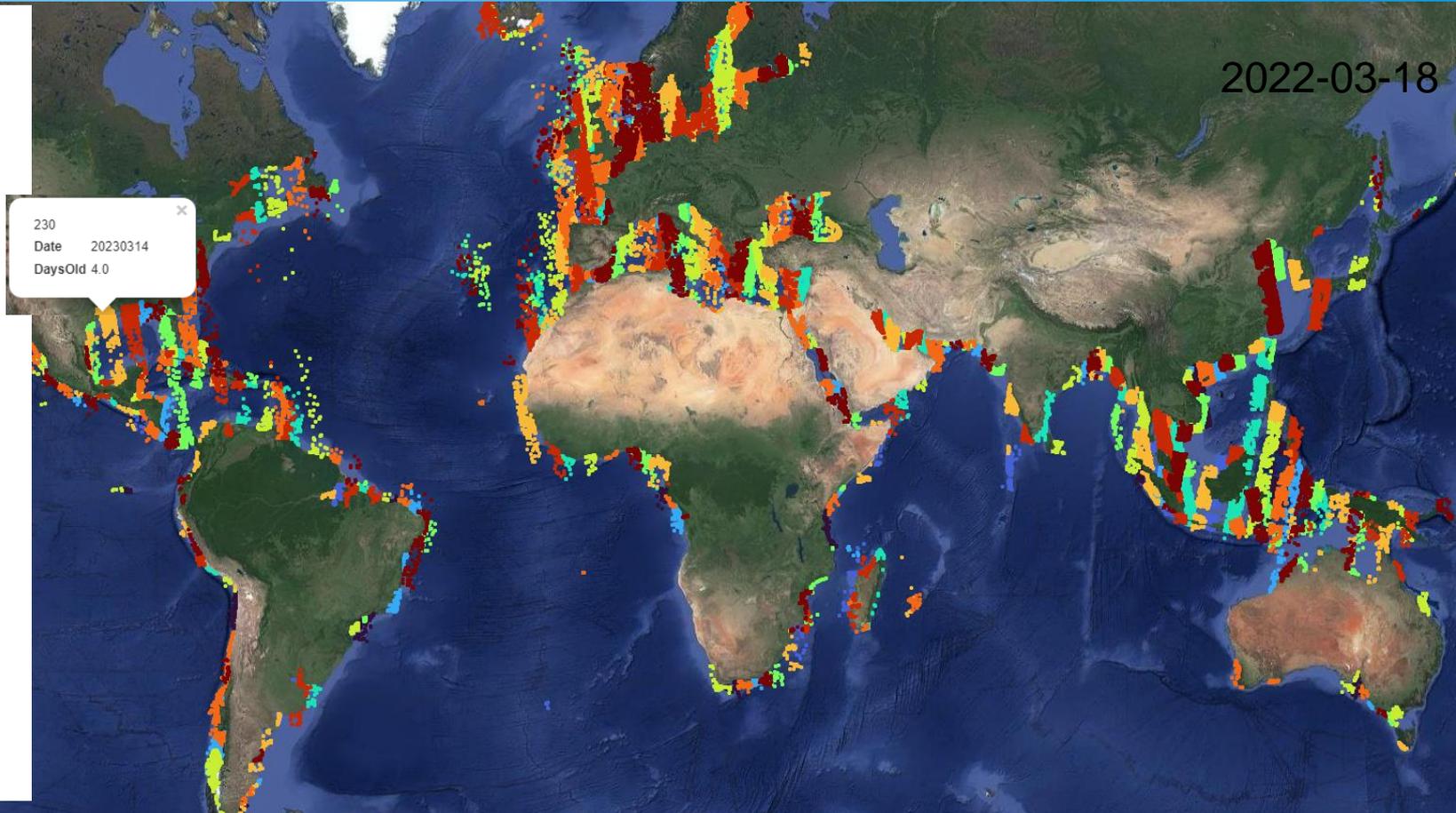
Results – Arabian Peninsula

- SNT does not acquire over a portion of the Red Sea
- Shipping lanes from the Suez canal highlighted.
- Offshore oil in the Persian Gulf highlighted



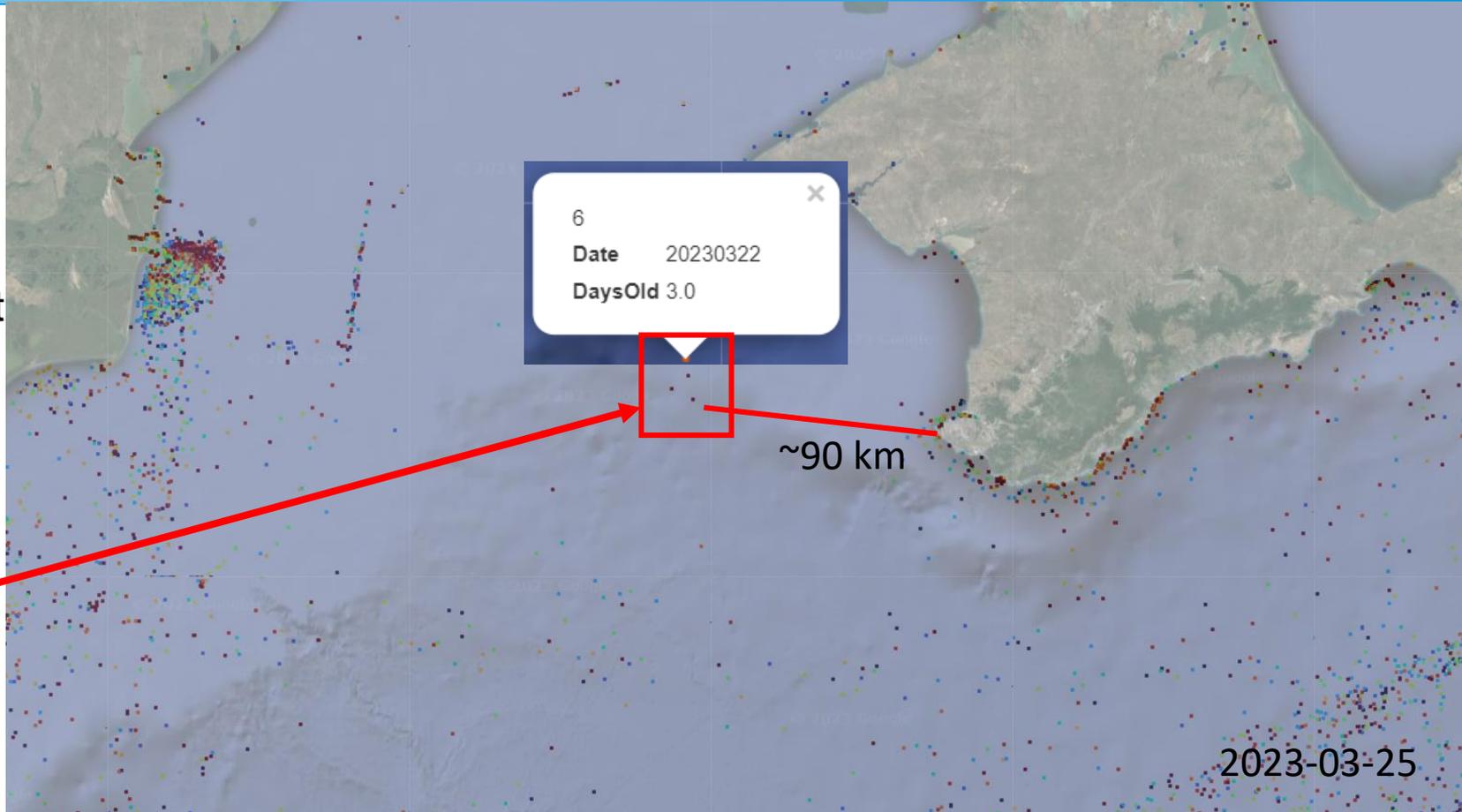
Results – Live Results Page

- Meant for up to date tracking of shipping activities with queryable metadata
- Provides information on only the most recent detections (1-12 days old (revisit period of SNT))
- Poor performance, needs optimization



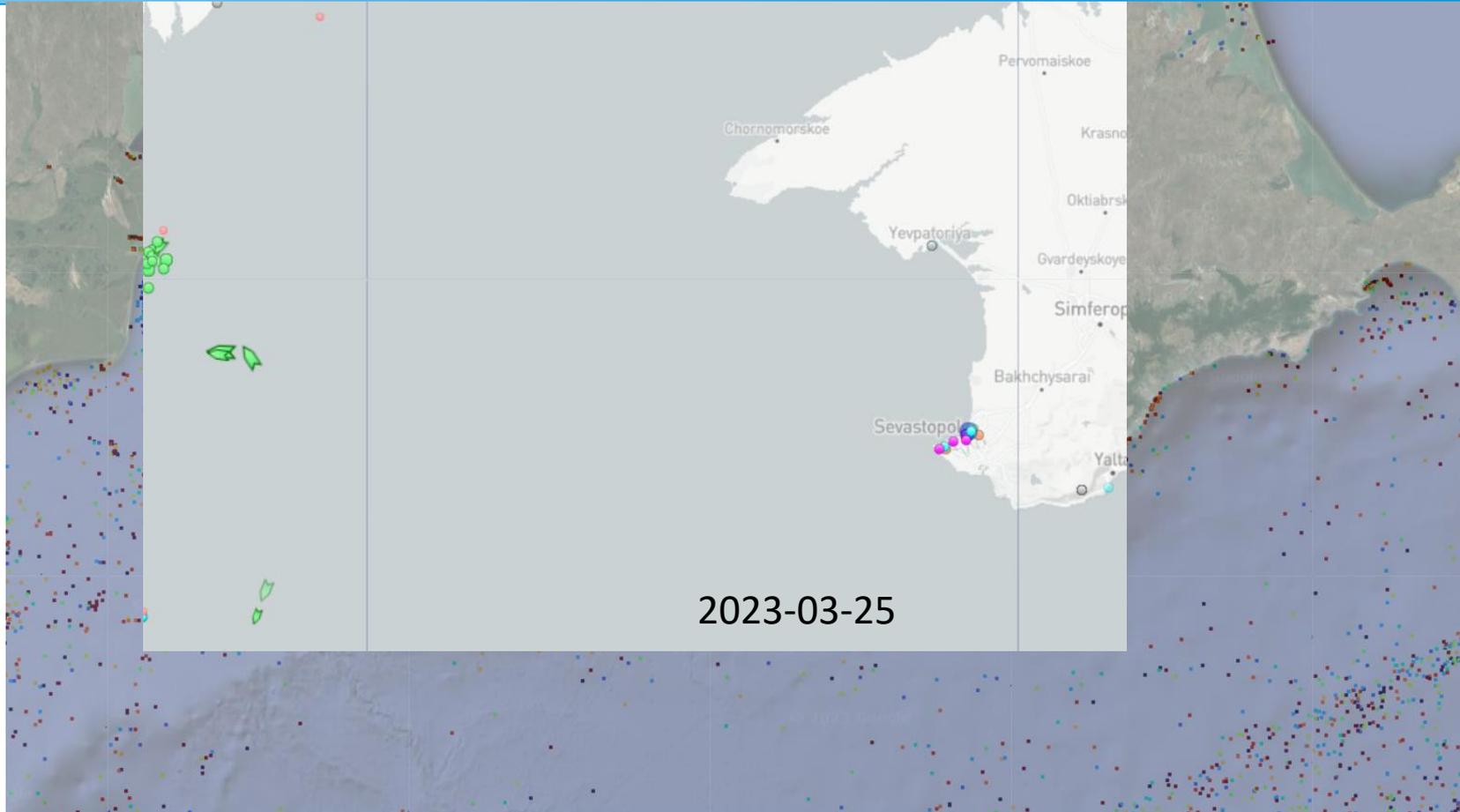
Applications – Naval Intelligence

- Three objects located near the suspected crash site of the American MQ-9 Reaper drone lost over the Black Sea on March 14th, 2023.
- No history of ships in this area since the beginning of the war.



Applications – Naval Intelligence

- No AIS transmissions from the area on marinetraffic
- One point is a repeat detection. Probably not a ship
- Likely two ships of the Russian black sea fleet sent to recover the drone

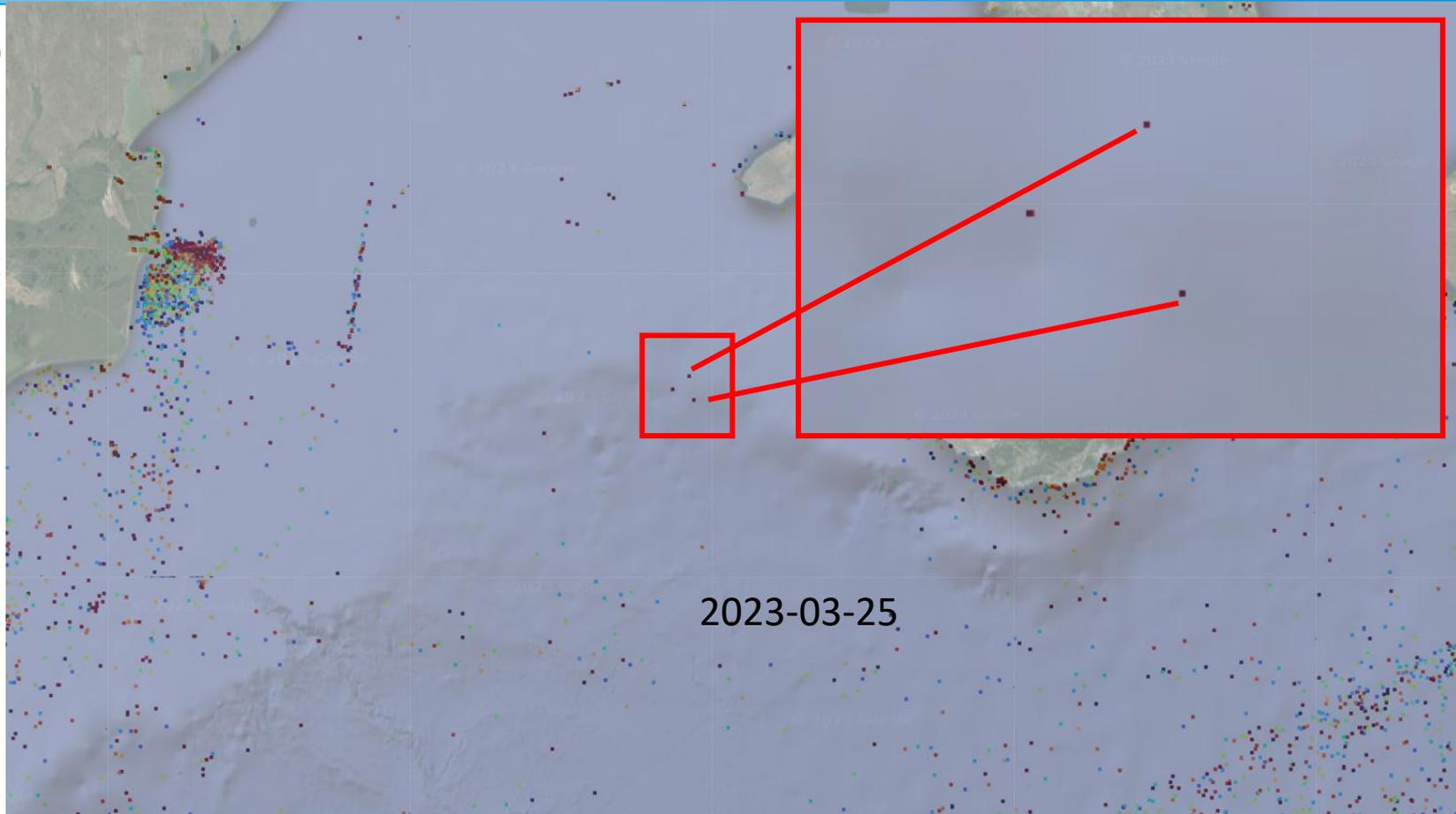


Applications – Naval Intelligence

- BBC reported two Russian ships sent to the crash site

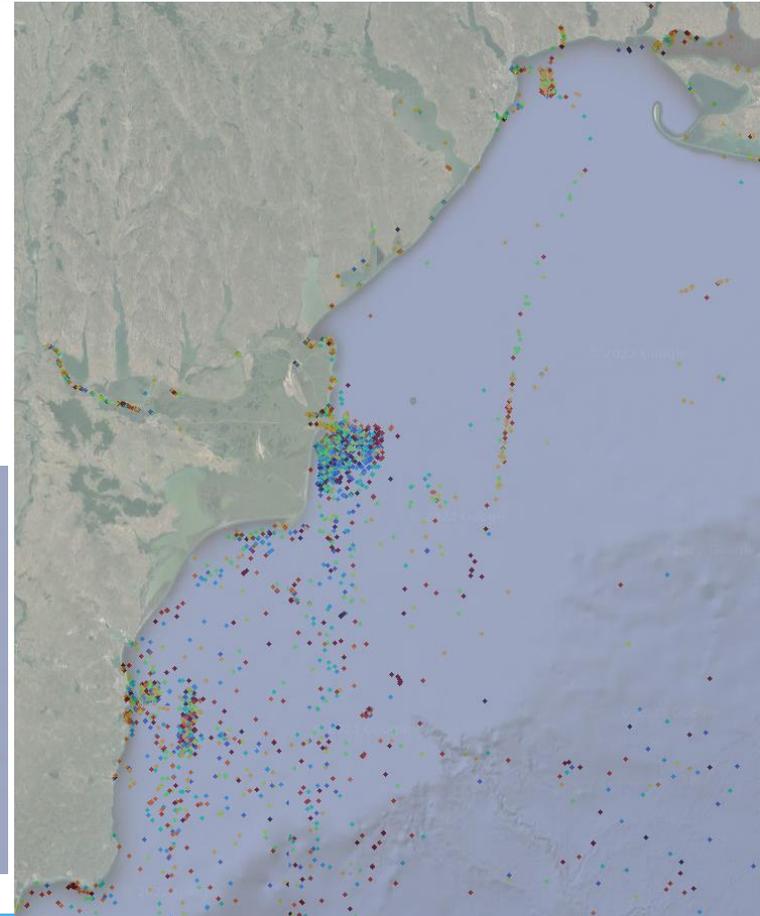
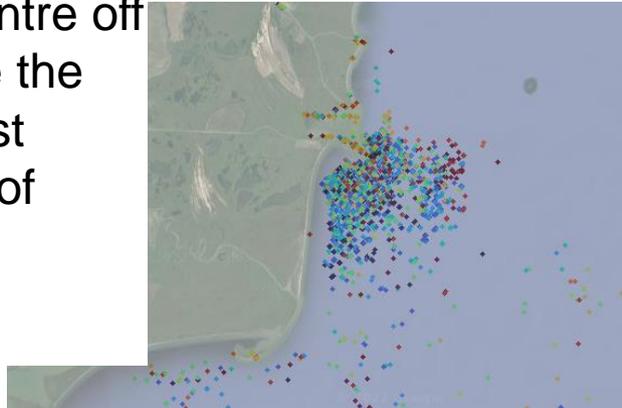
(<https://www.bbc.com/news/world-us-canada-64972002>)

- These are likely those ships



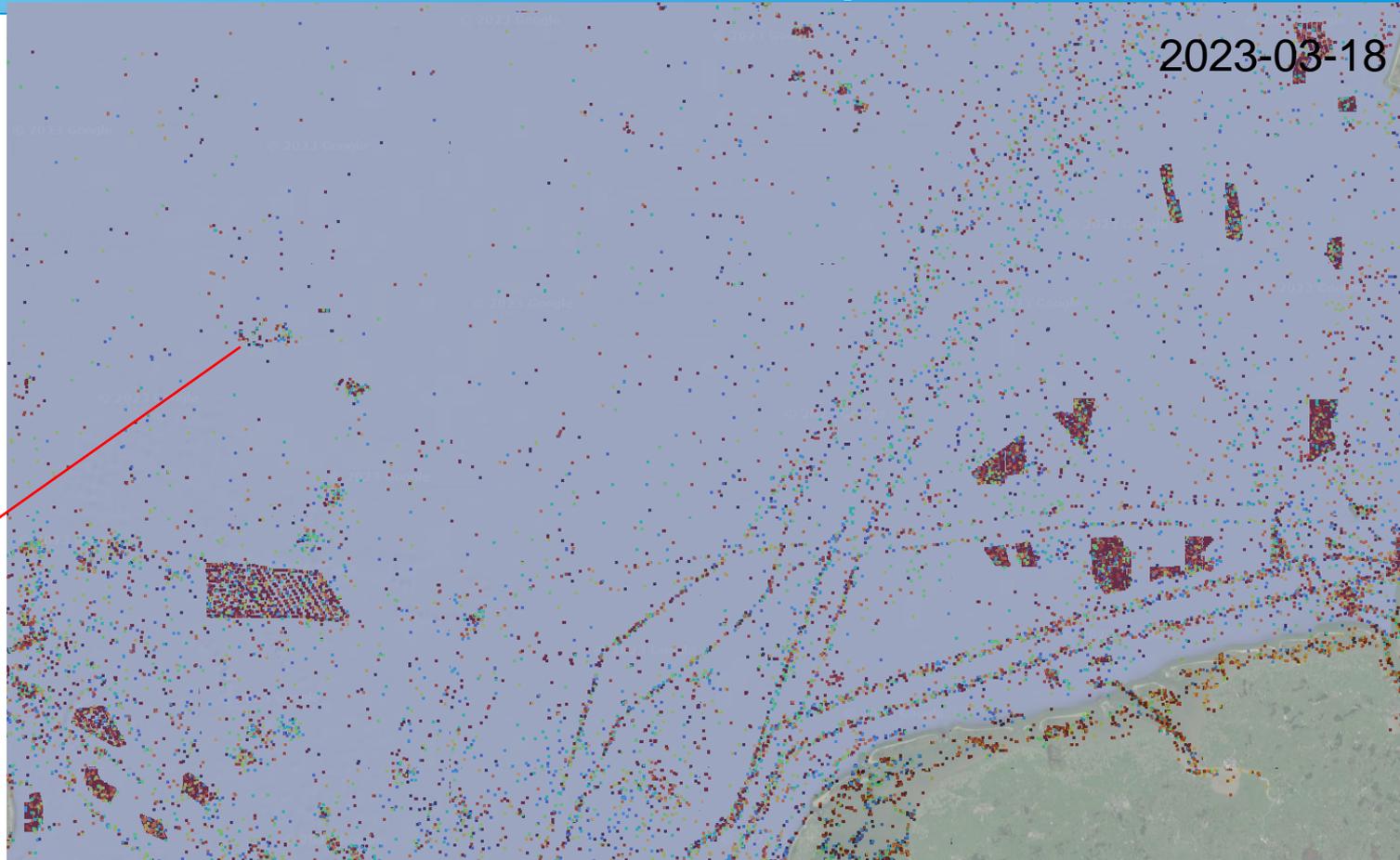
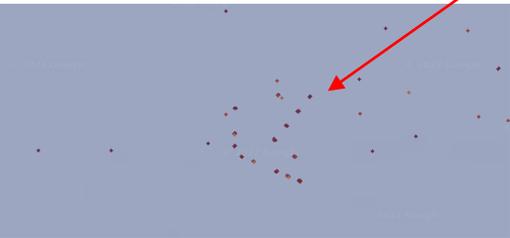
Applications – Changes to shipping routes

- Highlights changes to shipping activity
 - Good at indicating sudden backlogs, clearing of backlogs, increases and decreases in shipping lane usage
- Large area showing blue ships with a cluster of red ships in the centre off the coast of Romania, indicate the clearing of a backlog which first began with Russian blockage of Odesa



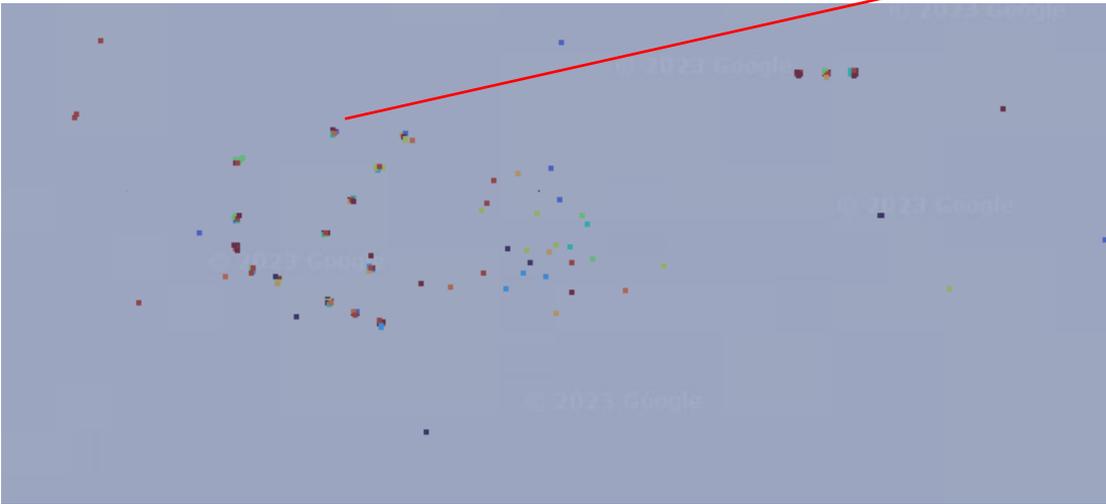
Applications – Offshore wind power

- Wind farms appear as regular grids of objects detected that never move
- Monitoring wind farm construction
- Currently under construction
- Can see construction ships at the locations indicated in the notice to mariners issued

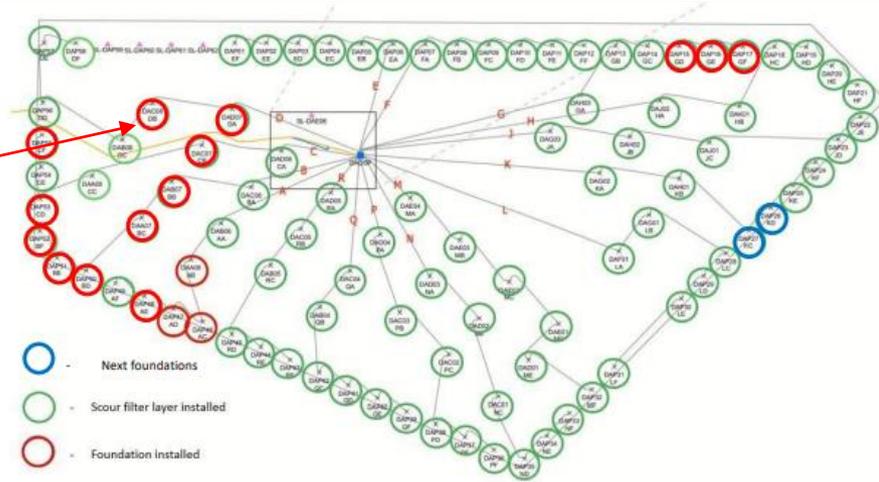


Applications – Offshore wind power

Monitoring wind farm construction

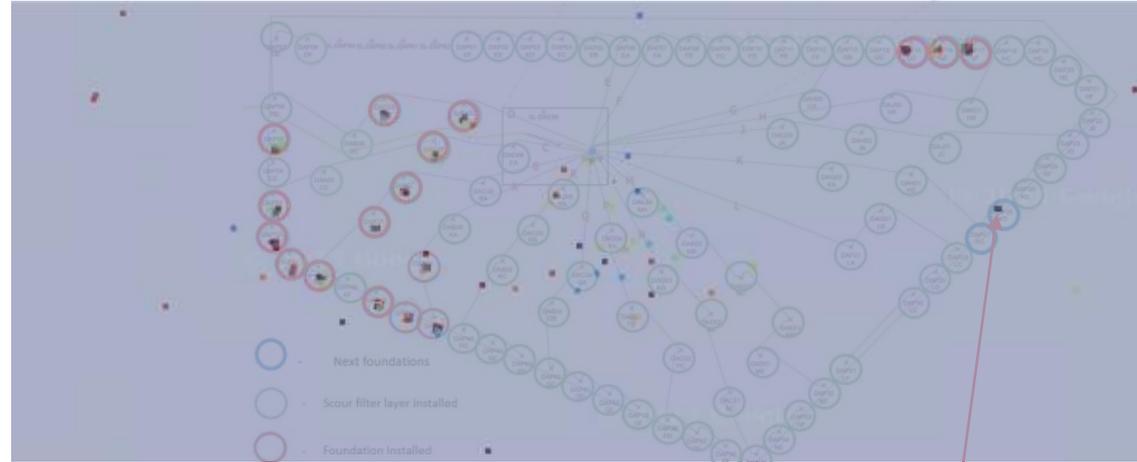


2023-03-18



Applications – Offshore wind power

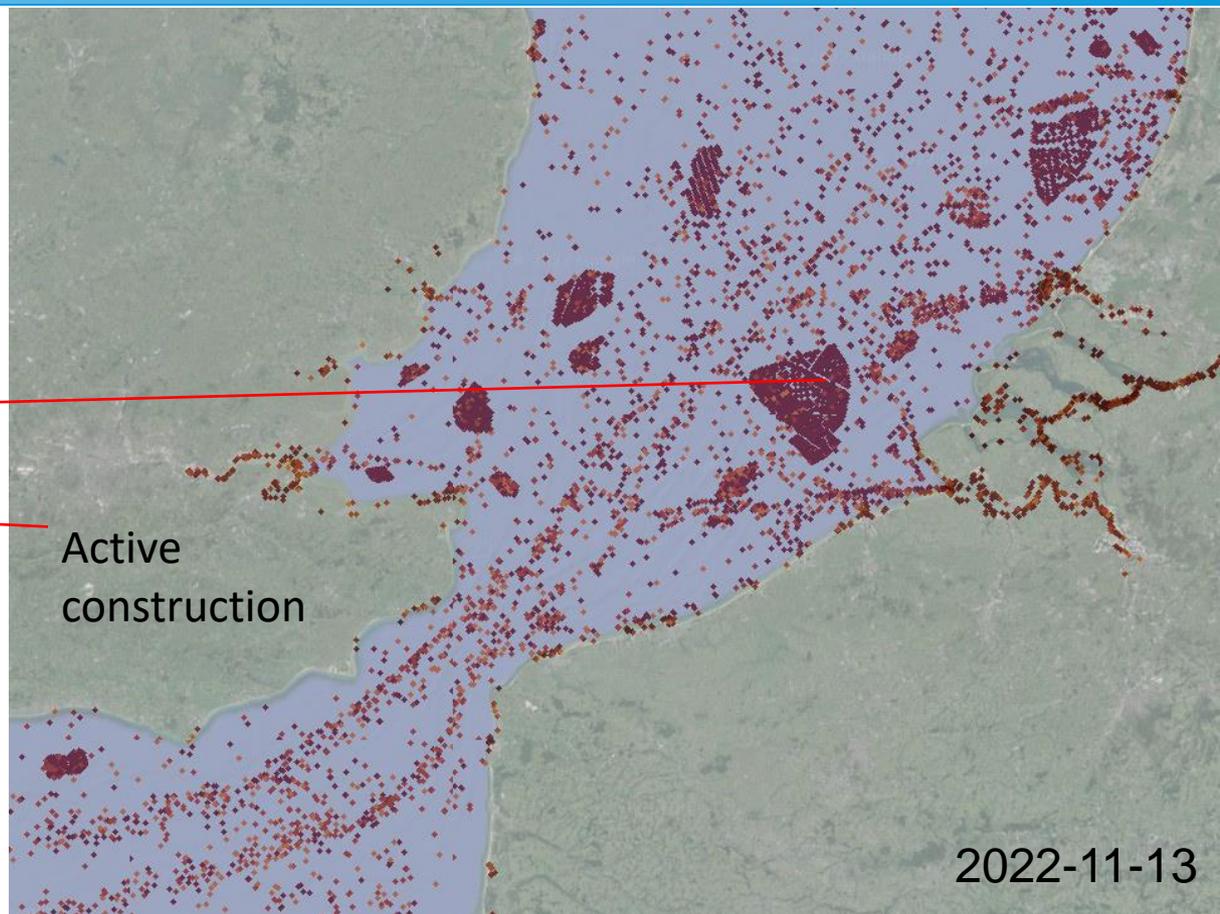
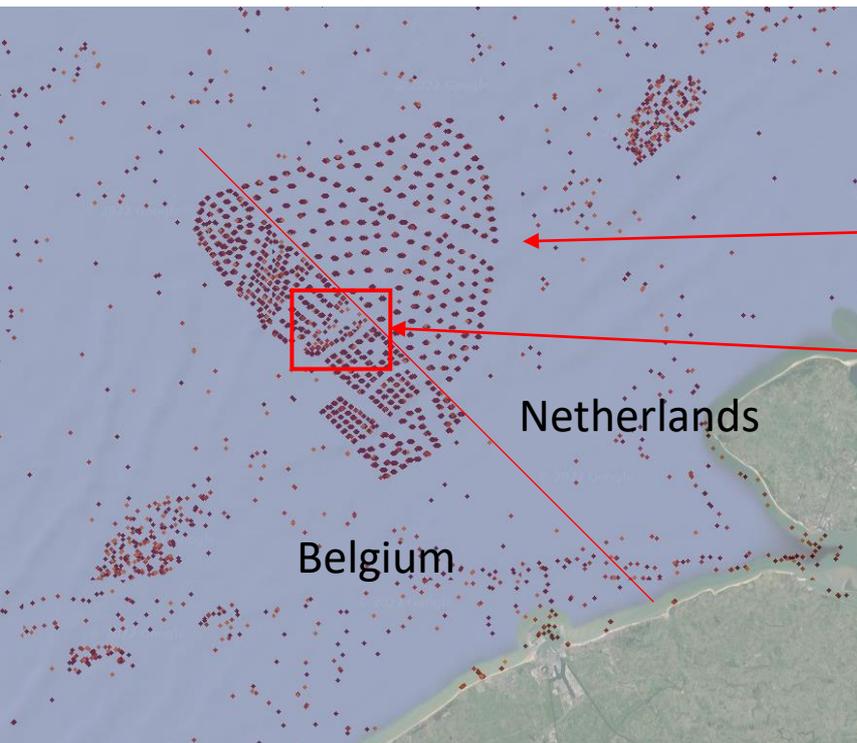
- Monitoring wind farm construction



Ship located over a “Next Foundation” location which was only present for 1 image. Coincidence? Site investigation?

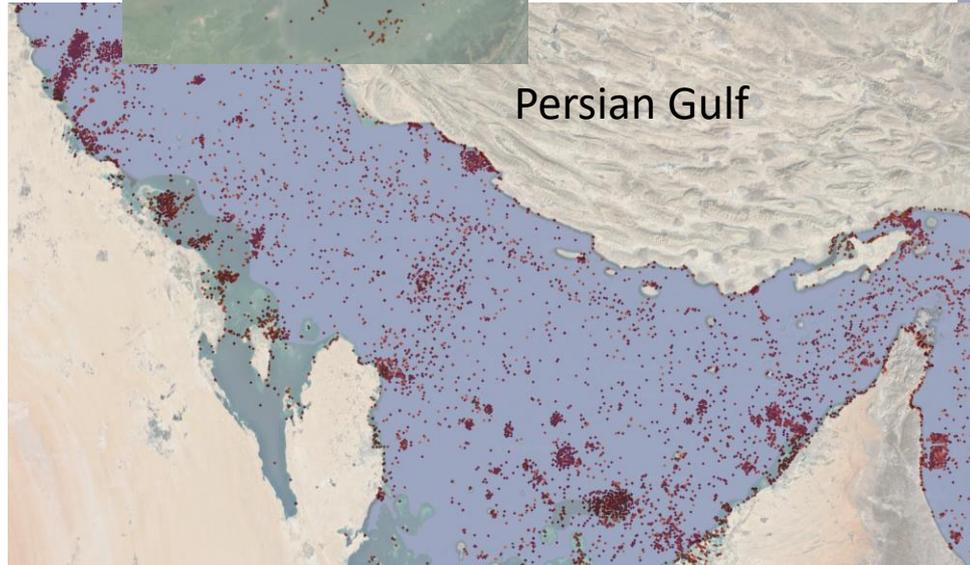
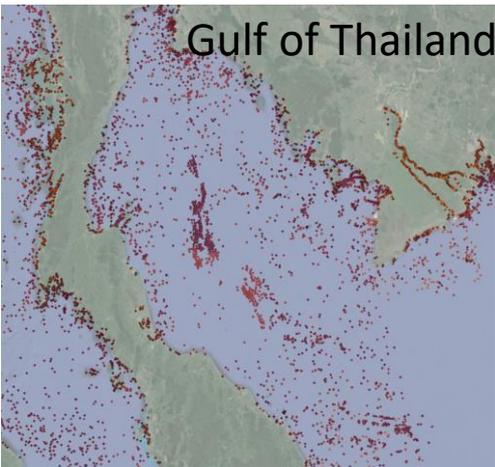
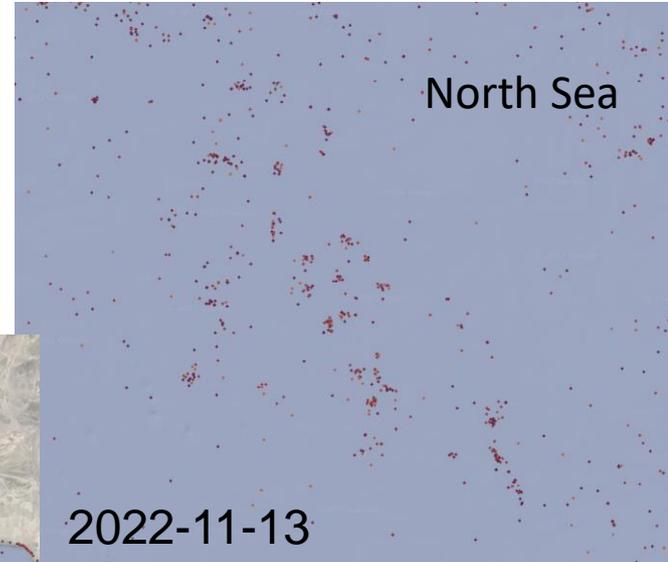
Applications – Offshore wind power

- Design differences between Belgian and Dutch wind projects



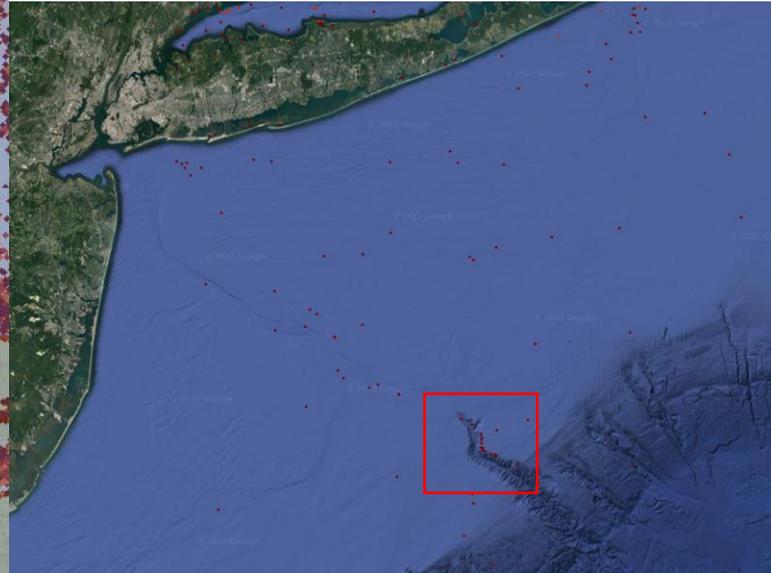
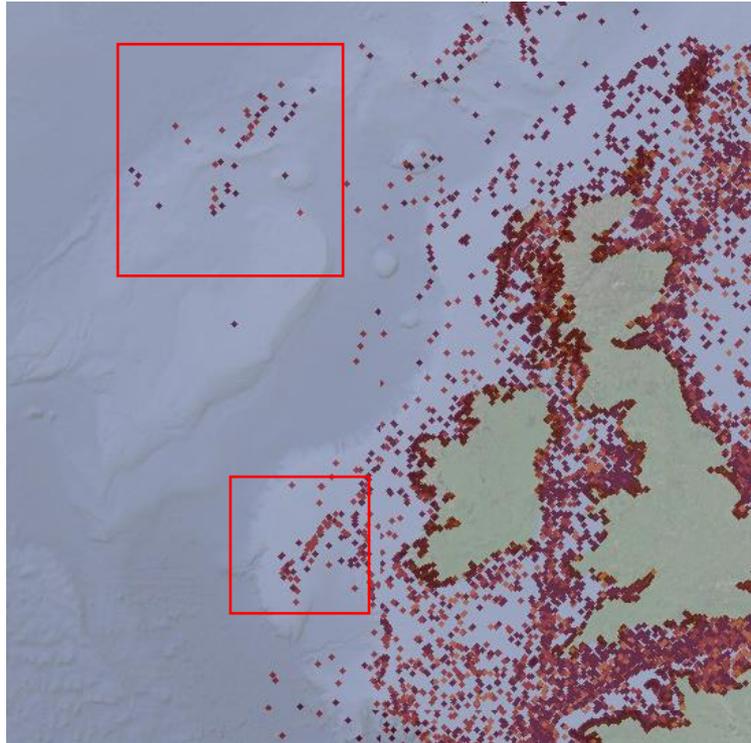
Applications – Offshore Oil Production

- Appear as irregular clusters of points around a static object
- Ships come and go around a static platform



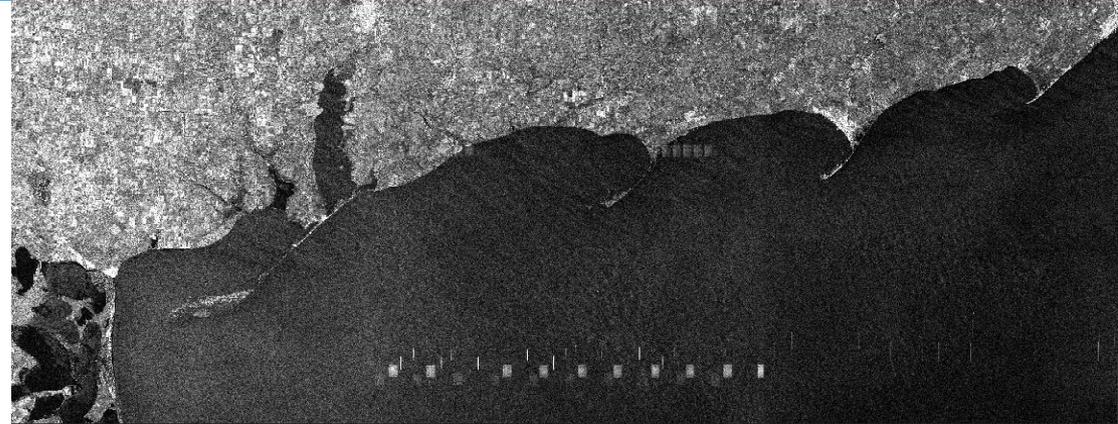
Applications – Fisheries

- Appear as clusters of ships, typically around a bank, always move between images



Applications – Active Radar Systems

- Active radar systems are known to cause interference in SAR imagery and since 2018 have been correlated with Air Defense systems according to a Bellingcat report.
- Appears in results as a distinct pattern of false detections



Next Steps



Include information on where SNT imagery is acquired

- The user will see where no ships are located vs where no imagery is acquired.
- This is already partially covered by the “Live Results” map



Include inland Seas and Large lakes (ie. Great Lakes and the Caspian Sea)

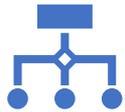
- Waiting for ice melt over the great lakes



Integrate other data sources to improve coverage and sampling

- ie RCM, if possible to download by API
- Coverage isn't ideal and SNT-1C should go up this summer, so data will double in the next year anyways. Not really worth the effort to include other sources.

Acknowledgements



Barry Carter, a Perl dev amongst men. Created the tiling script which makes the website usable. Without his help, it would have taken months more to get to where it is now.



My friends and family who thought that this project was interesting enough to motivate me to not just give up when I ran into my first bug.



My master's supervisors
Dr. Braun and Dr.
Fotopoulos.



My colleagues at TRE
Altamira who also thought
this project was cool and
gave me a platform to share
it.



OpenAI and ChatGPT who
cut months out of the
learning process on how to
build a website.