GLOBAL FISHERIES ENFORCEMENT TRAINING WORKSHOP
HALIFAX, 2 AUGUST 2023

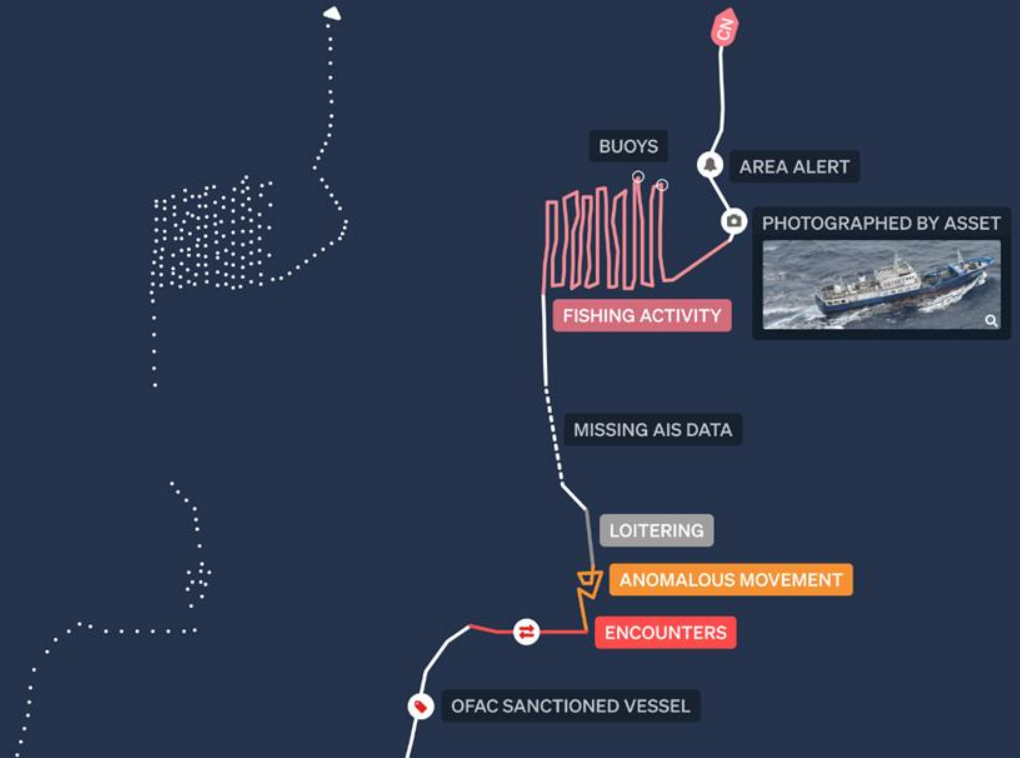
From detection to action: Fresh techniques to harness AIS and satellite data for fisheries MCS

Andrew Middleditch
Moritz Lehmann
Starboard Maritime Intelligence
Aotearoa New Zealand

Starboard Maritime Intelligence

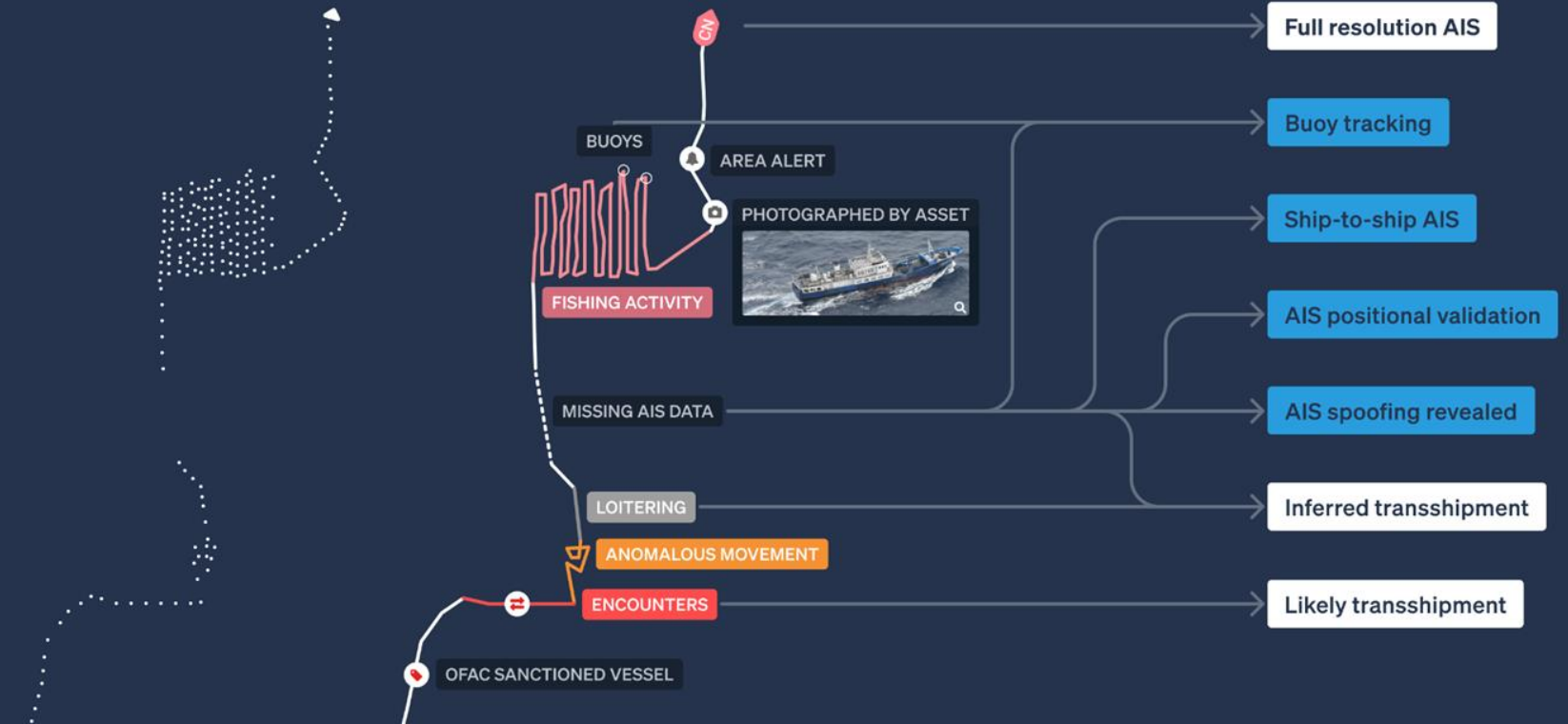
Self reported positions are a cornerstone of MCS

Raw position data → Behavioural insights



Self reported positions are a cornerstone of MCS

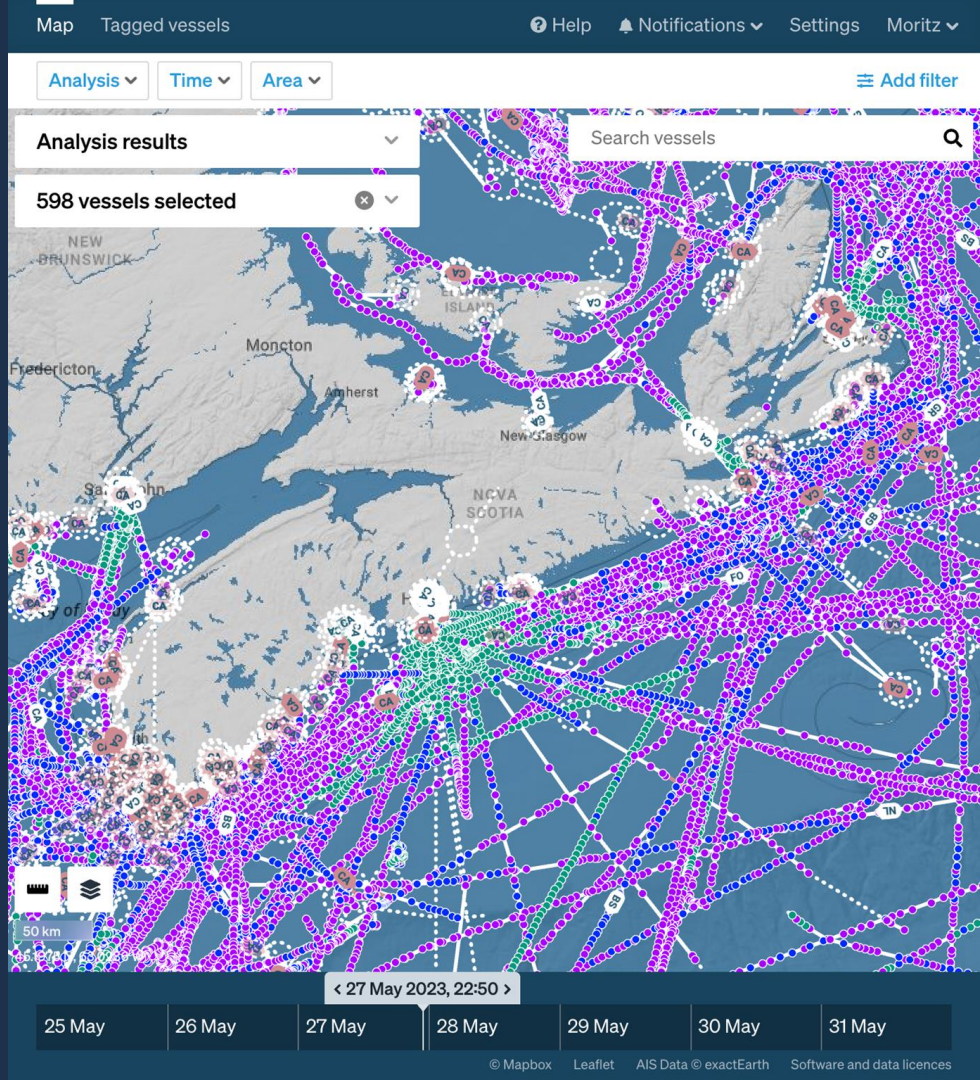
Raw position data → Behavioural insights → Topics, this presentation

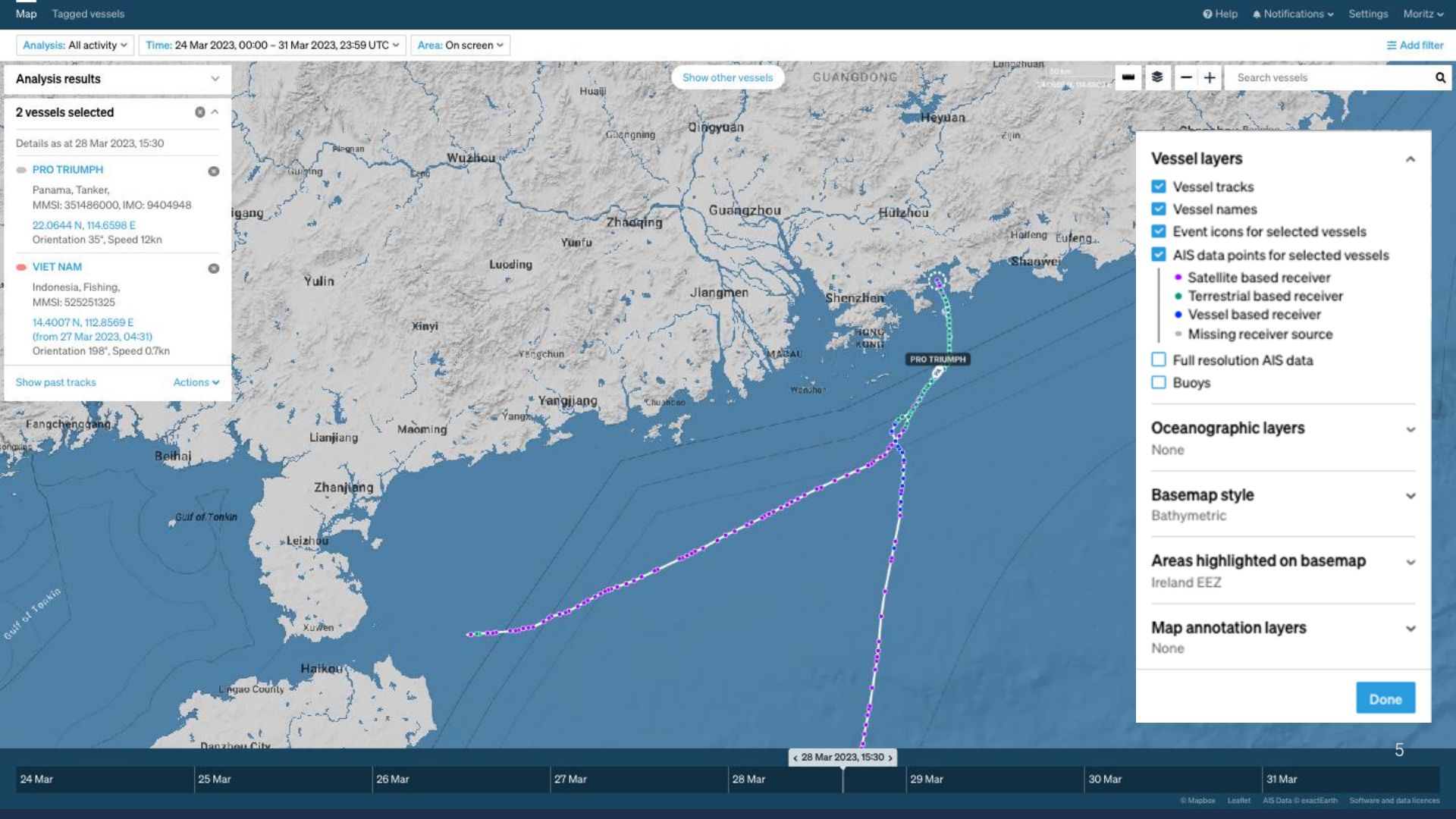


SHIP-TO-SHIP AIS

A new set of eyes for vessel activity

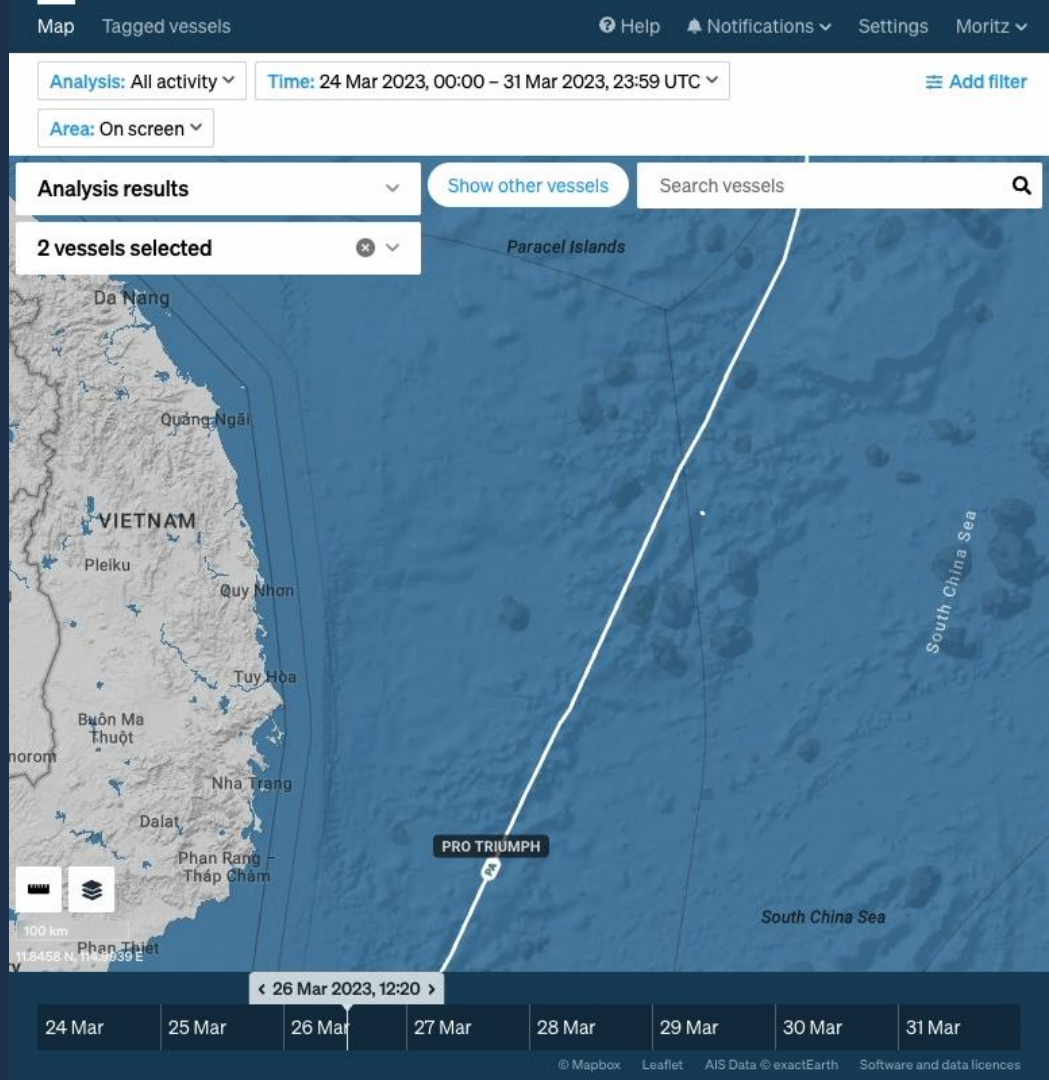
- Ship to shore
- Ship to satellite
- Ship-to-ship

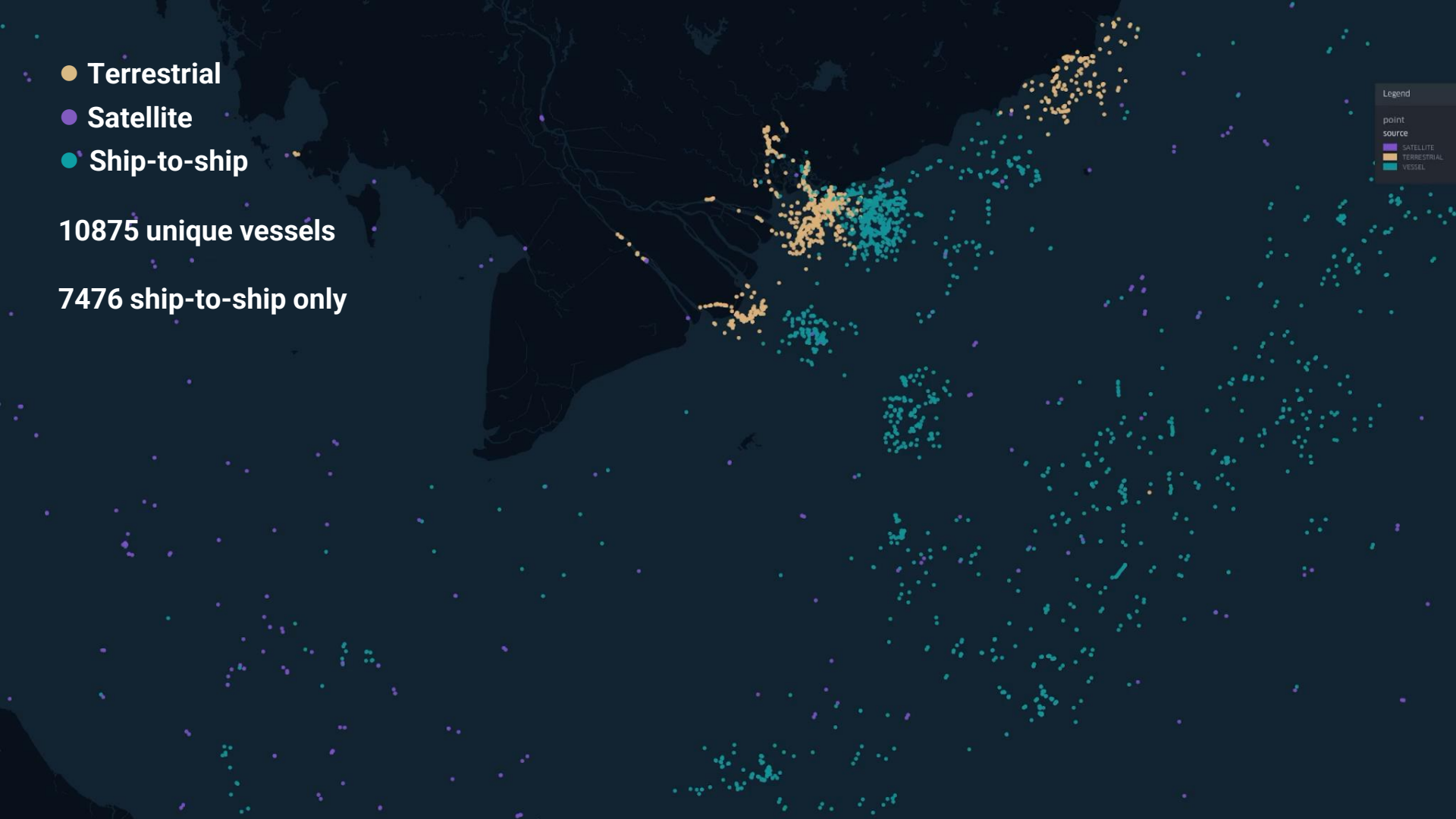



Map
Tagged vessels
Help
Notifications
Settings
Moritz
Analysis: All activity
Time: 24 Mar 2023, 00:00 – 31 Mar 2023, 23:59 UTC
Area: On screen
Add filter
Analysis results
2 vessels selected
Details as at 28 Mar 2023, 15:30
PRO TRIUMPH
Panama, Tanker,
MMSI: 351486000, IMO: 9404948
22.0644 N, 114.6598 E
Orientation 35°, Speed 12kn
VIET NAM
Indonesia, Fishing,
MMSI: 525251325
14.4007 N, 112.8569 E
(from 27 Mar 2023, 04:31)
Orientation 198°, Speed 0.7kn
Show past tracks
Actions
Show other vessels
GUANGDONG
Search vessels
Vessel layers
Vessel tracks
Vessel names
Event icons for selected vessels
AIS data points for selected vessels
Satellite based receiver
Terrestrial based receiver
Vessel based receiver
Missing receiver source
Full resolution AIS data
Buoys
Oceanographic layers
None
Basemap style
Bathymetric
Areas highlighted on basemap
Ireland EEZ
Map annotation layers
None
Done
PRO TRIUMPH
Huaiji
Qingyuan
Heyuan
Wuzhou
Zhaoqing
Guangzhou
Huizhou
Yunfu
Luoding
Yulin
Jiangmen
Shenzhen
Shanwei
Xinyi
Yangchun
MACAU
Yangjiang
Fangchenggang
Lianjiang
Maoming
Beihai
Zhanjiang
Gulf of Tonkin
Leizhou
Haikou
Lingao County
Danzhou City
‹ 28 Mar 2023, 15:30 ›
24 Mar
25 Mar
26 Mar
27 Mar
28 Mar
29 Mar
30 Mar
31 Mar
© Mapbox
Leaflet
AIS Data © exactEarth
Software and data licences

SHIP-TO-SHIP AIS

Ships appear and disappear on passing of a participating vessel.



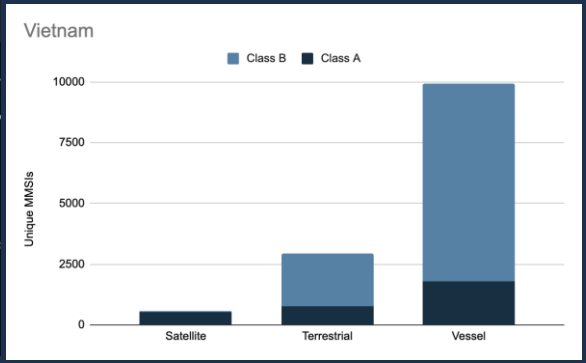

Terrestrial
Satellite
Ship-to-ship
10875 unique vessels
7476 ship-to-ship only
Legend
point
source
SATELLITE
TERRESTRIAL
VESSEL

SHIP-TO-SHIP AIS

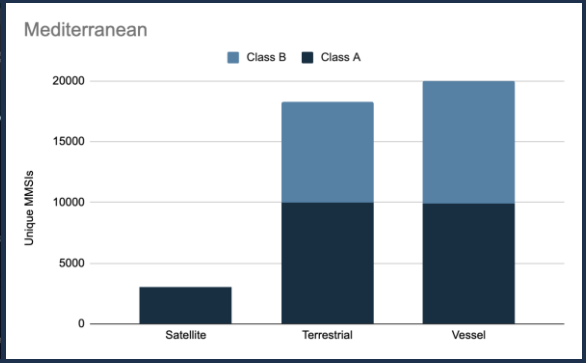
Large portion of Class B AIS transceivers

More small vessels observed than by satellite.

Vietnam: 69% of vessels only ship-to-ship



Mediterranean: 23% of vessels only ship-to-ship



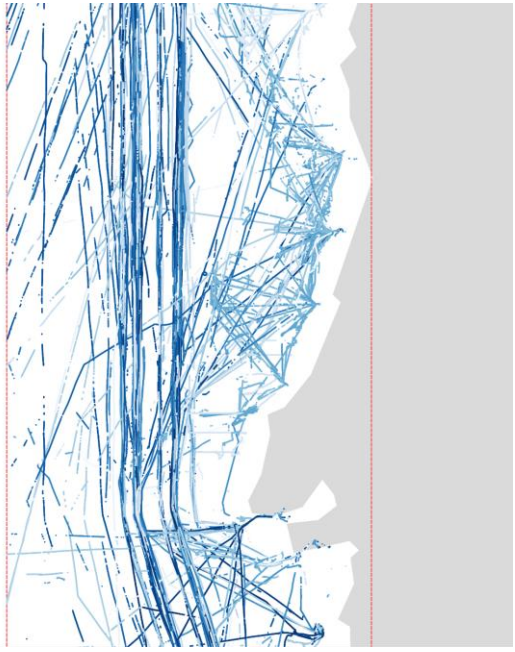
CSIRO

Voyage Data Recorder

- Low cost (~USD 800)
- Receives data from ship GPS and AIS receiver;
- Compressed data pushed to a secure server via ship's WiFi or 4G;
- Can be installed by the ship's engineer or technician.

Additional functionality:

- Ingest ship's navigation radar to merge targets with AIS.



AIS targets received by a small yacht over 28 days

Data logger is built from a Raspberry Pi microcomputer and Actisense NDC-5 Multiplexer.

SHIP-TO-SHIP AIS

Small craft (Class B) transmissions are often not picked up by satellites.

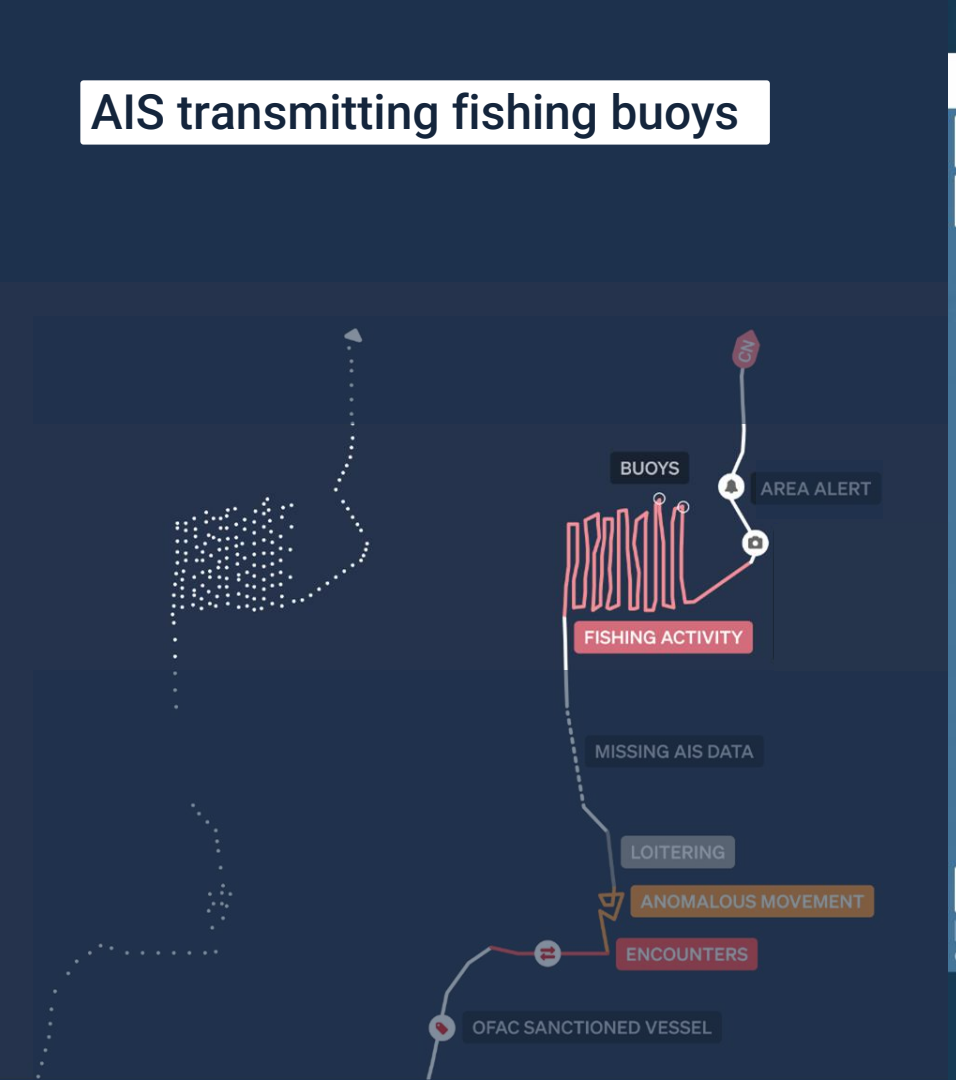
Up to 70% vessels only detected by ship-to-ship AIS in some areas.

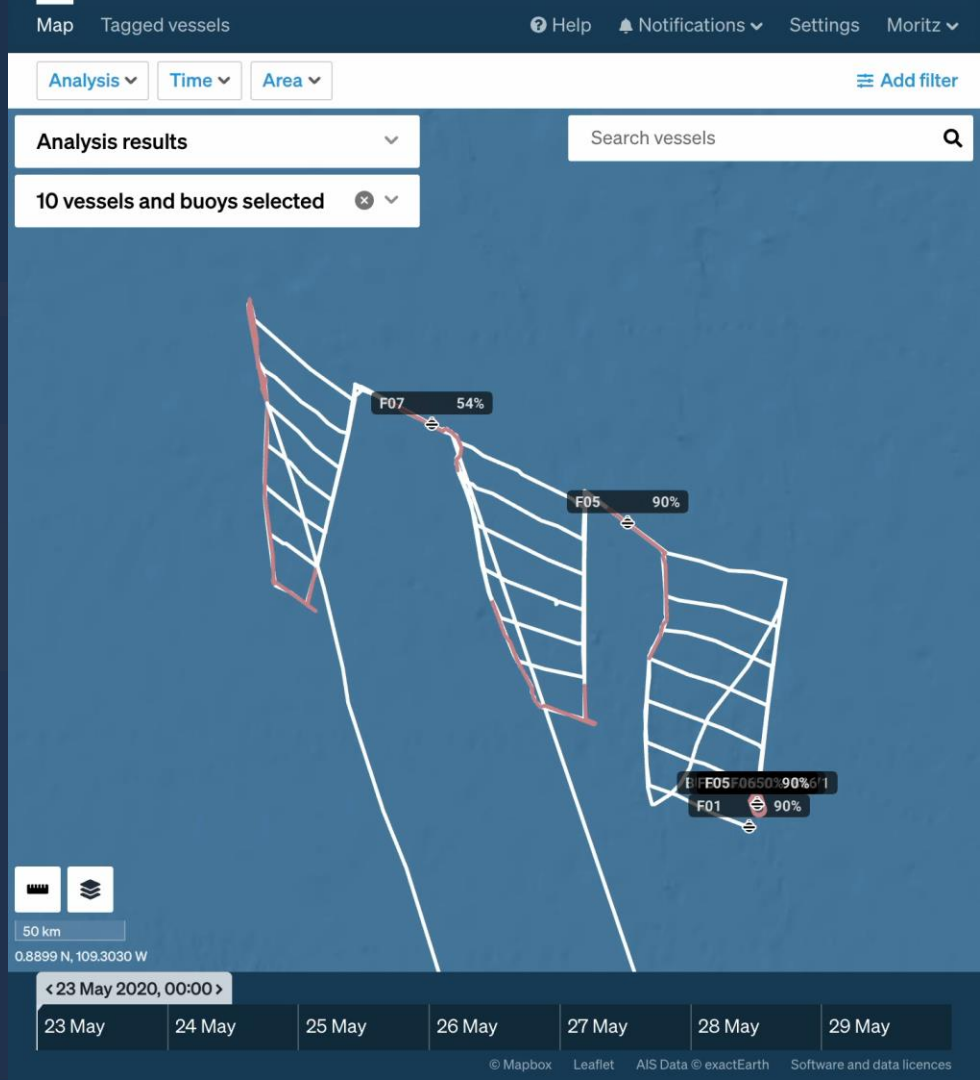
CSIRO’s system can increase AIS harvest in areas not regularly traversed by global shipping vessels.

Provides previously unseen activity, allowing updates of estimates of fishing effort and carbon footprint.

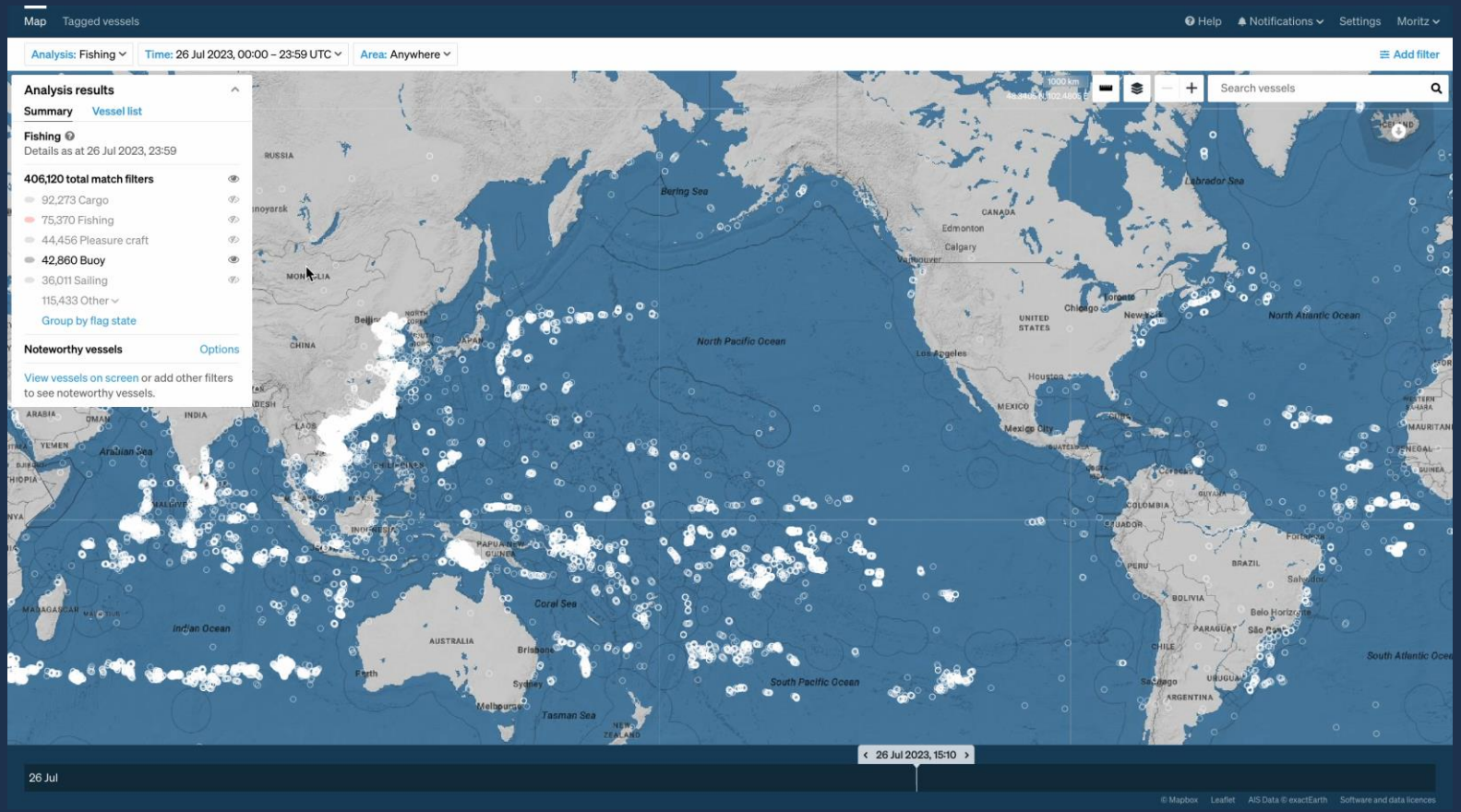
Need a way to deal with ephemeral detections: E.g., how to count them for fishing effort and carbon footprint estimation

AIS transmitting fishing buoys



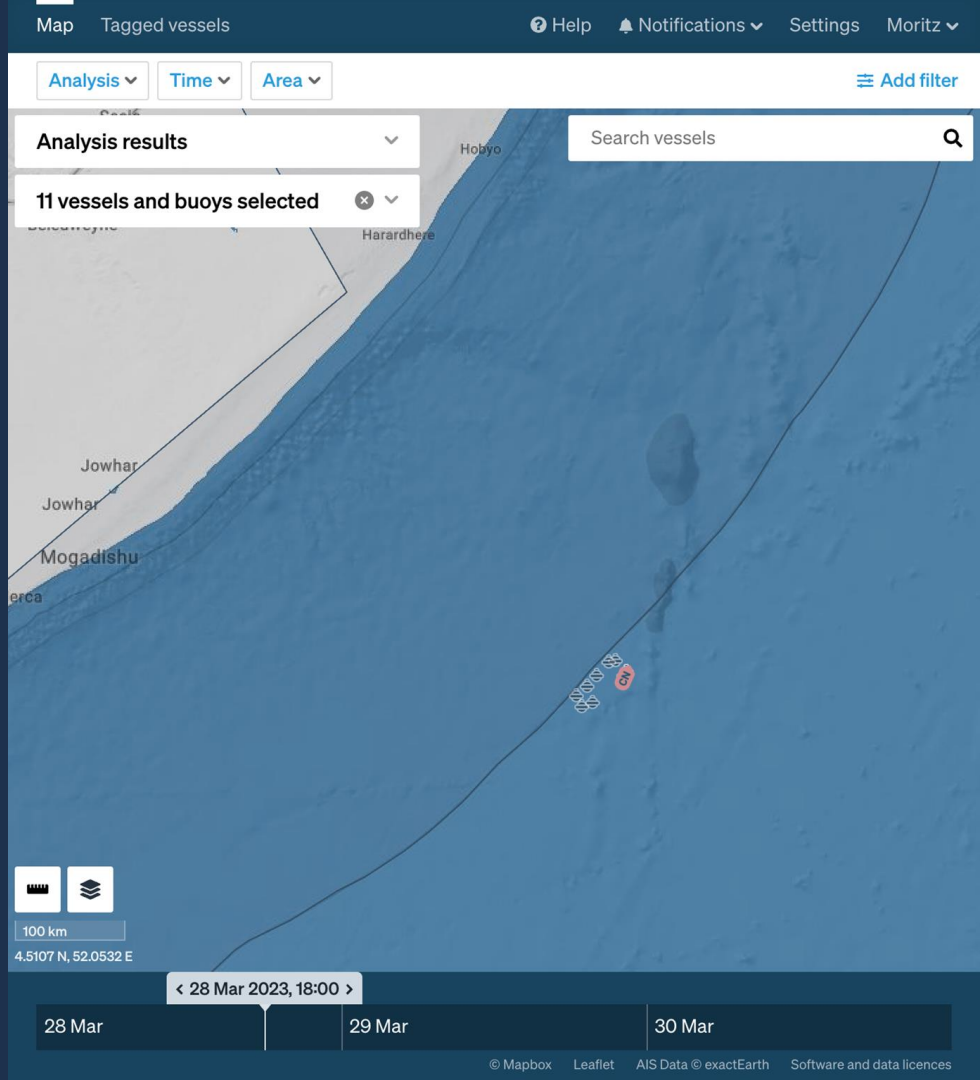


AIS transmitting fishing buoys



AIS transmitting fishing buoys

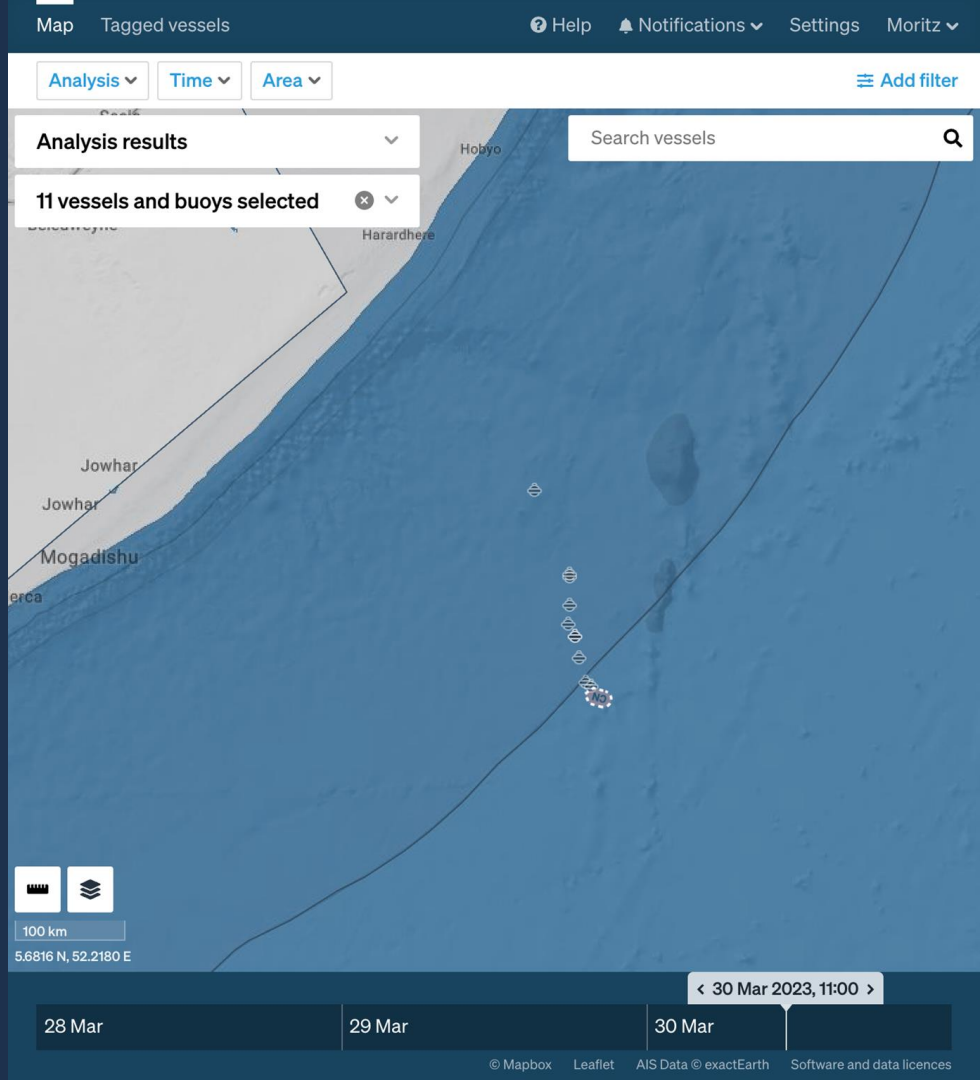
Longlining hugging the Somalia EEZ



AIS transmitting fishing buoys

Longlining hugging the Somalia EEZ

Vessel stops AIS, but buoys deployed inside EEZ



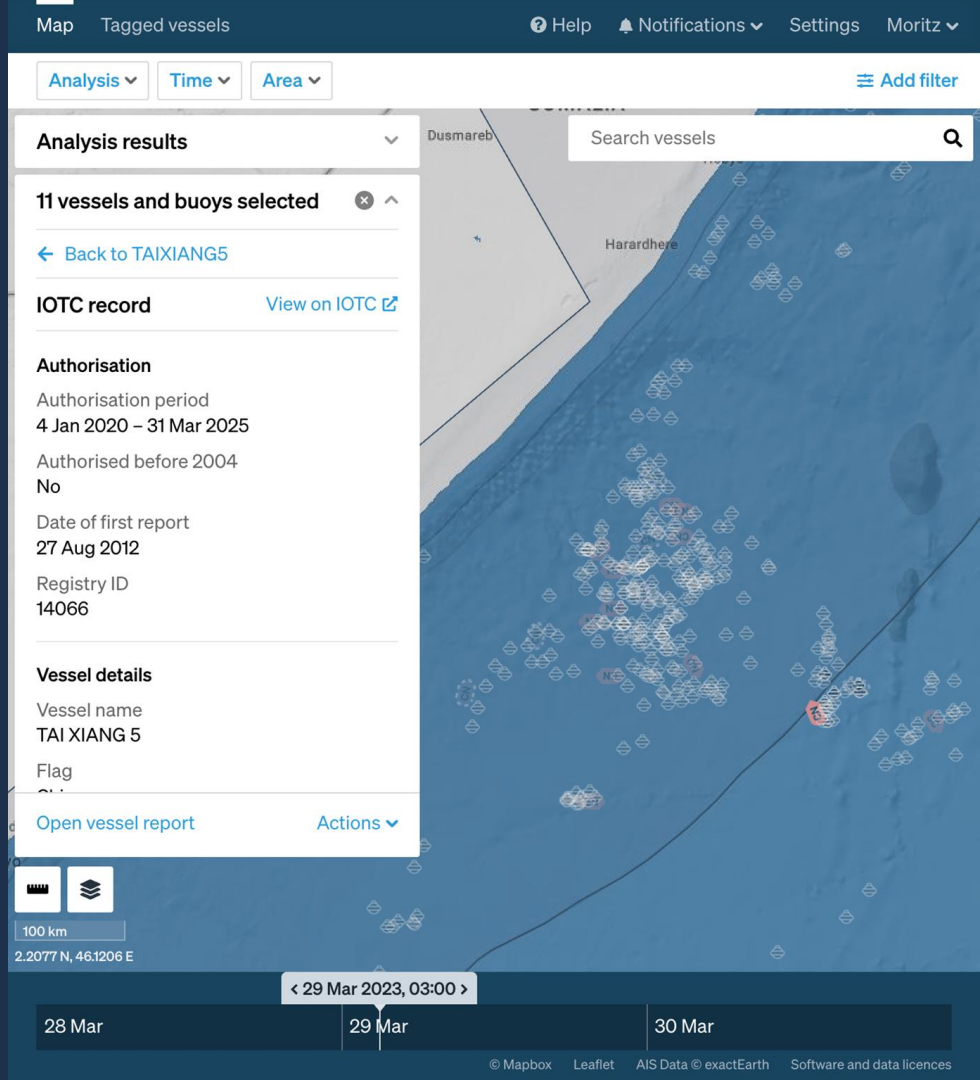
AIS transmitting fishing buoys

Longlining hugging the Somalia EEZ

Vessel stops AIS, but buoys deployed inside EEZ

AIS outage is suspicious, but no proof for illegal activity.

- Fleet of related ships in EEZ
- IOTC registered



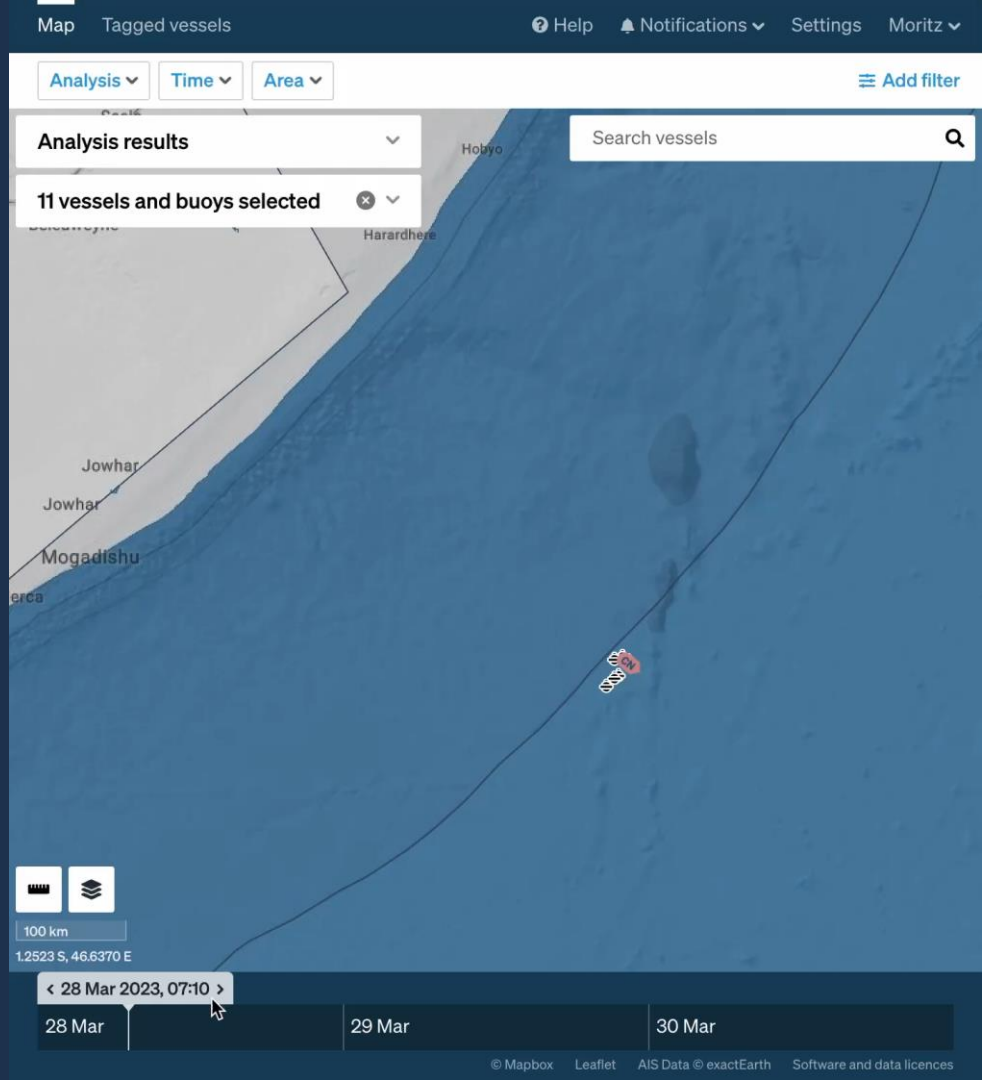
AIS transmitting fishing buoys

Longlining hugging the Somalia EEZ

Vessel stops AIS, but buoys deployed inside EEZ

AIS outage is suspicious, but no proof for illegal activity.

- Fleet of related ships in EEZ
- IOTC registered



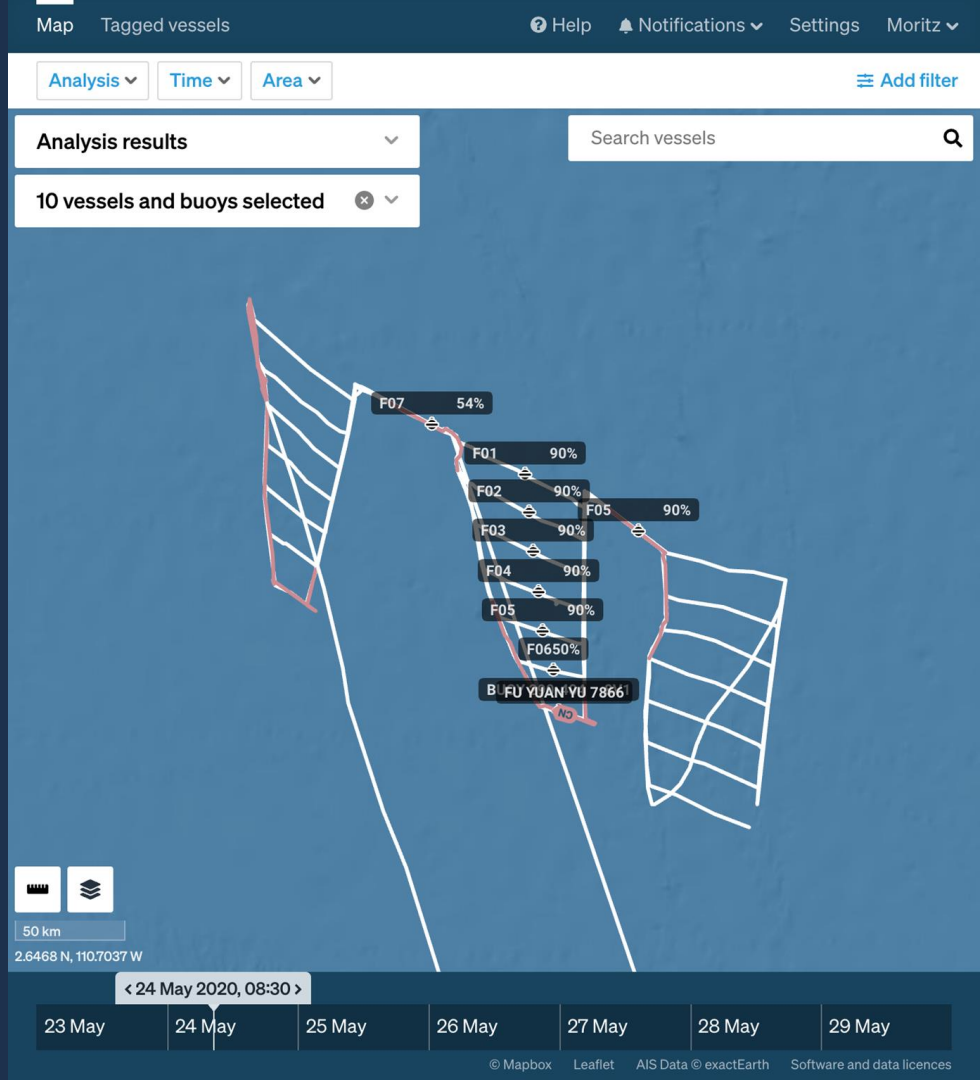
AIS transmitting fishing buoys

Summary:

Advanced buoy classification algorithm declutters AIS data, streamlines other analytics.

Additional tool for ‘dark vessel’ detection.

Full resolution AIS data for legal evidence.



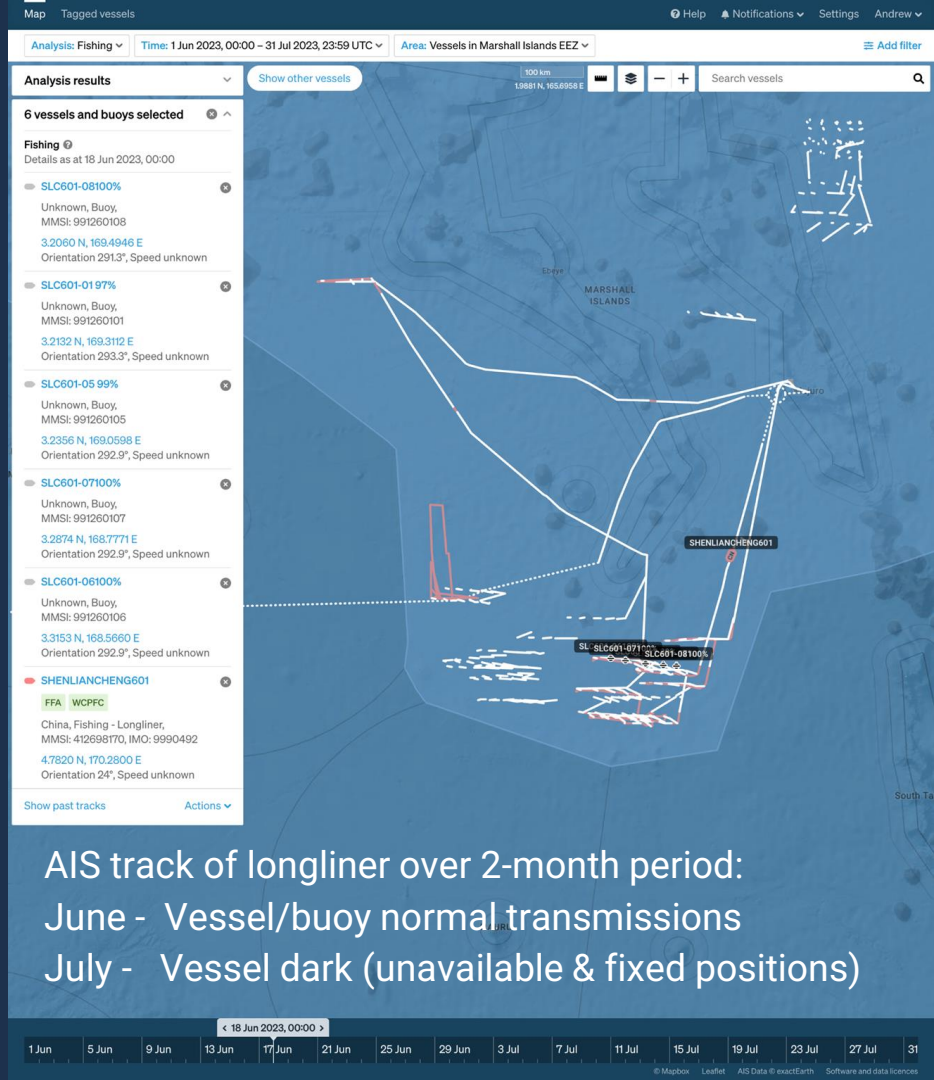
Tracking non-reporting AIS vessels

Vessels often transmit on AIS without providing valid location data.

Common scenarios:

1. Unavailable GPS - 181/91
2. Fixed positions - null island 0/0
3. Spoofed positions

How can we calculate where the vessel is actually located when the AIS messages don’t contain valid positions?



AIS track of longliner over 2-month period:

June - Vessel/buoy normal transmissions

July - Vessel dark (unavailable & fixed positions)

Starboard
Maritime
Intelligence

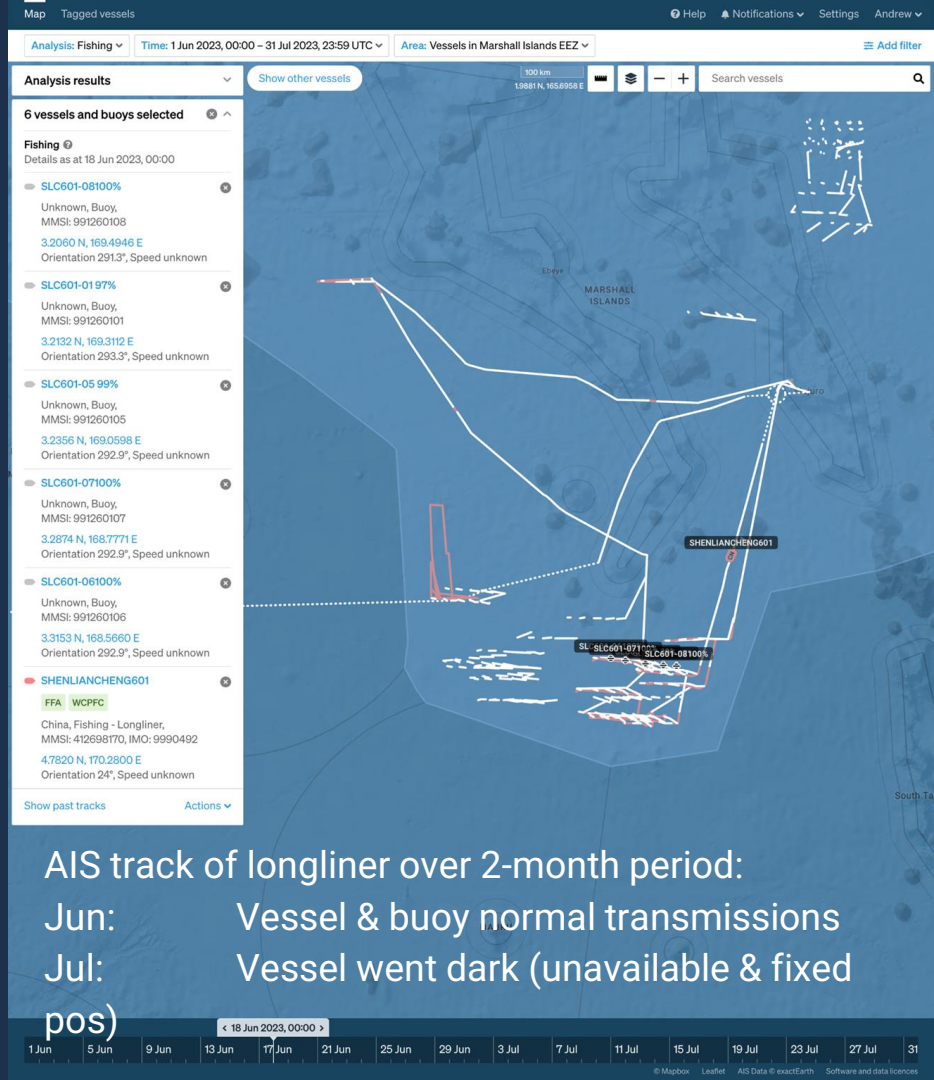
Tracking non-reporting AIS vessels

Vessels often transmit on AIS without providing valid location data

Common scenarios:

1. *Unavailable* positions (GPS 181/91)
2. *Fixed* positions (null island 0/0)
3. *Spoofed* positions

How can we calculate where the vessel is actually located when the AIS messages don't contain valid positions?



AIS track of longliner over 2-month period:

Jun: Vessel & buoy normal transmissions

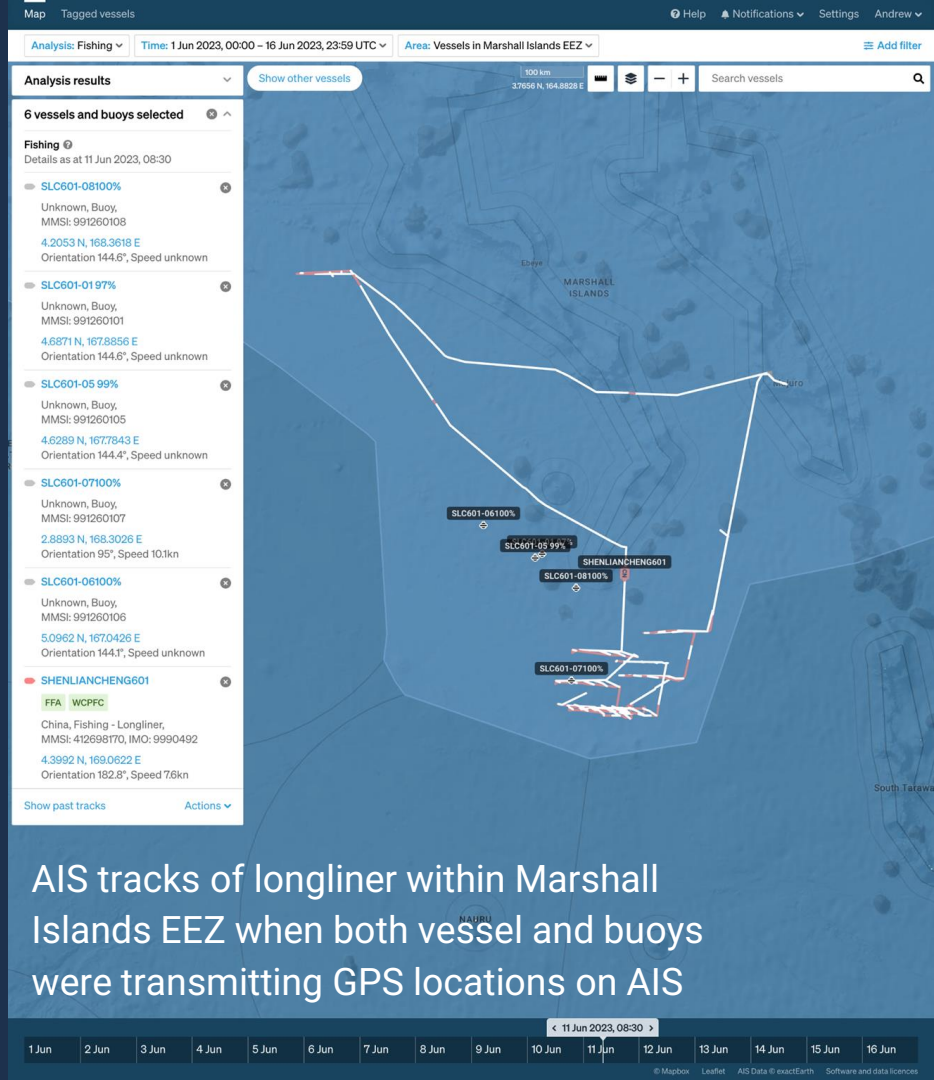
Jul: Vessel went dark (unavailable & fixed pos)

Spire Position Validation (PV)

PV geolocates the source of an AIS signal by analysing the doppler shifts measured at the satellite receivers

PV measurement is independent of the contents of the AIS message

In order to work it needs to receive the same AIS message at 5 separate satellites in the Spire constellation



AIS tracks of longliner within Marshall Islands EEZ when both vessel and buoys were transmitting GPS locations on AIS

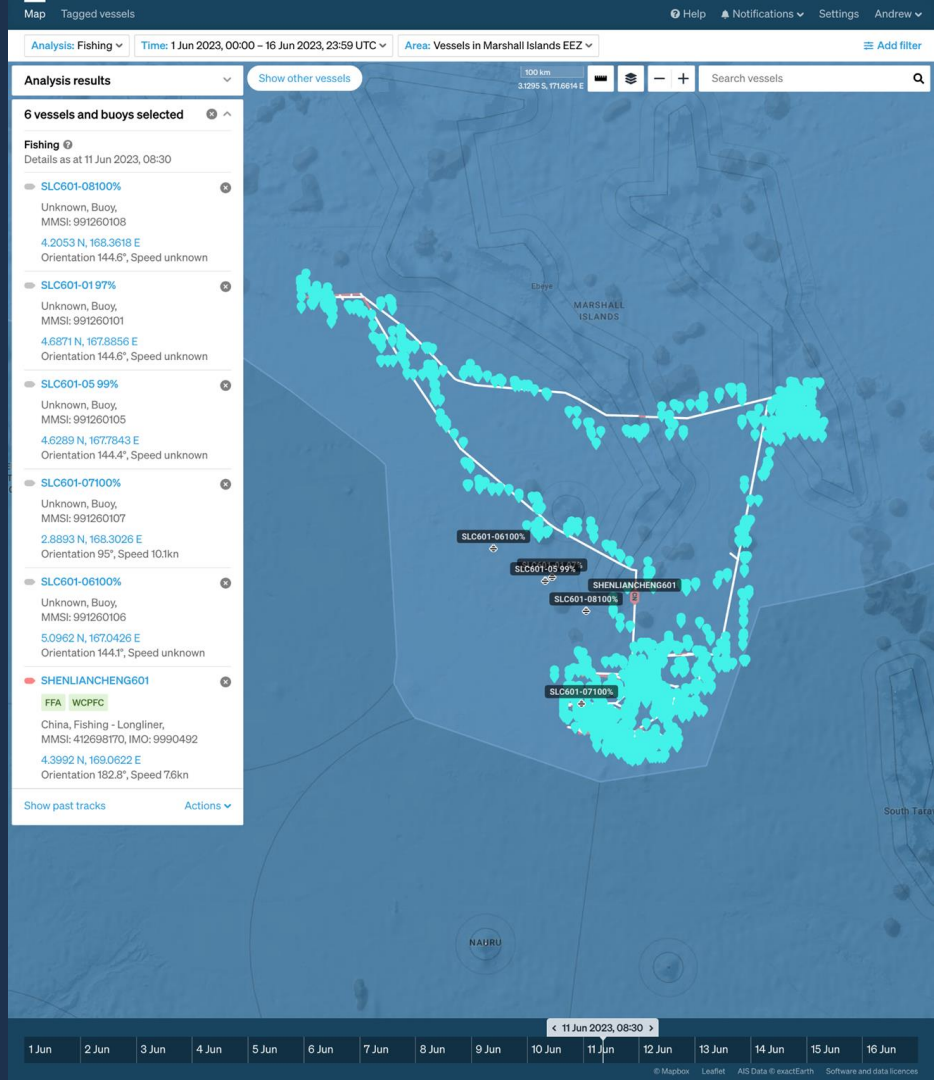
Spire Position Validation (PV)

Case 1: Valid AIS transmissions

Spire PV estimates of the signal source match closely with the coordinates provided in the AIS messages

~2,000 PV measurements collected over a 16-day period in June 2023

Results provide confidence in the accuracy of the PV product



Spire Position Validation (PV)

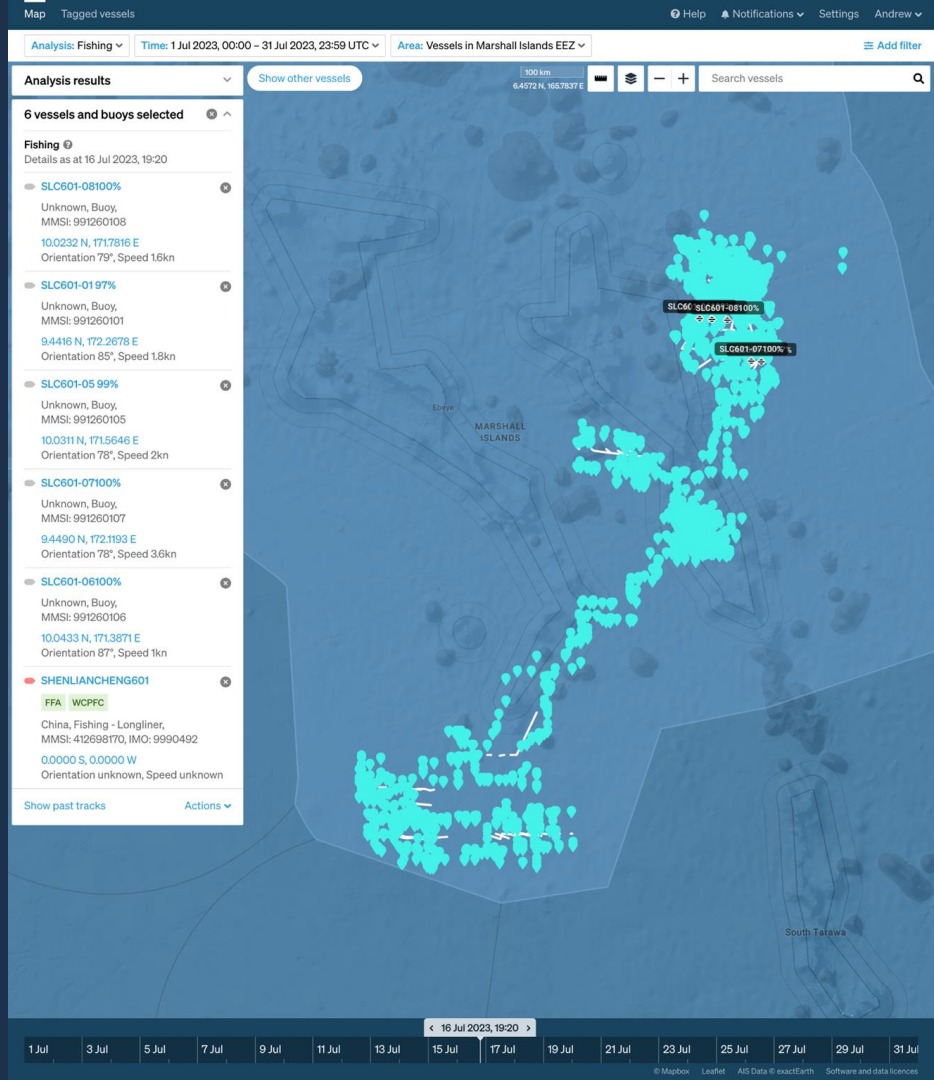
Case 2: AIS data with incorrect locations

Vessel is dark on AIS, sending unavailable (181/91) or fixed (0/0) coordinates

~2,500 PV measurements collected

PV results correlate with buoys and VMS

Vessel can still be detected and tracked from space despite not transmitting its location on AIS



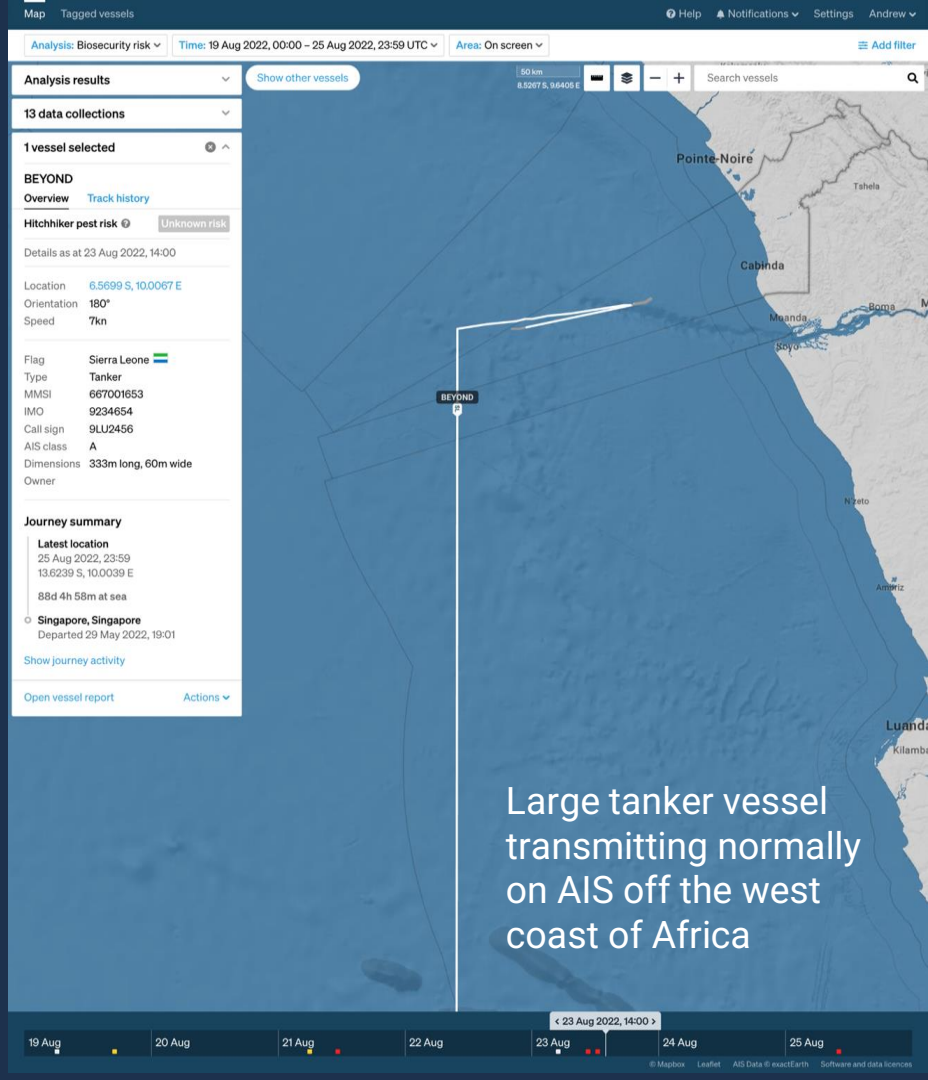
AIS spoofing

Dark vessel detection is the search for vessels that are not reporting on AIS/VMS

We find dark vessels using SAR, RF & optical satellite sensors

Spoofing vessels intentionally transmit false AIS coordinates to hide their location

For our spoofing approach we use “*inverse dark vessel detection*” to find vessels that are on AIS but are not in satellite data



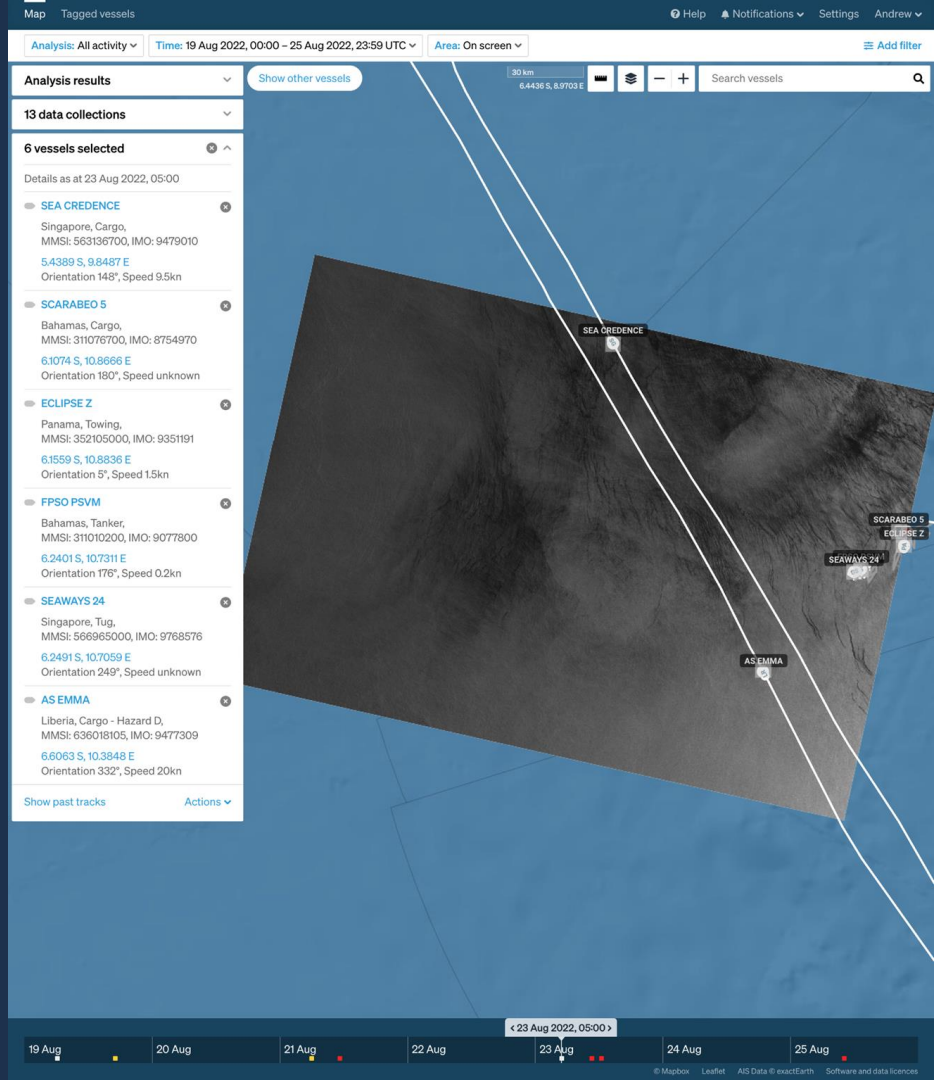
AIS spoofing

We analysed a SAR image that intersects with the AIS track of the tanker vessel

SAR image contains:

- 6 Total detections
- 6 Matched AIS vessels
- 0 Dark vessels

But the BEYOND tanker vessel is not one of the 6 detections



AIS spoofing

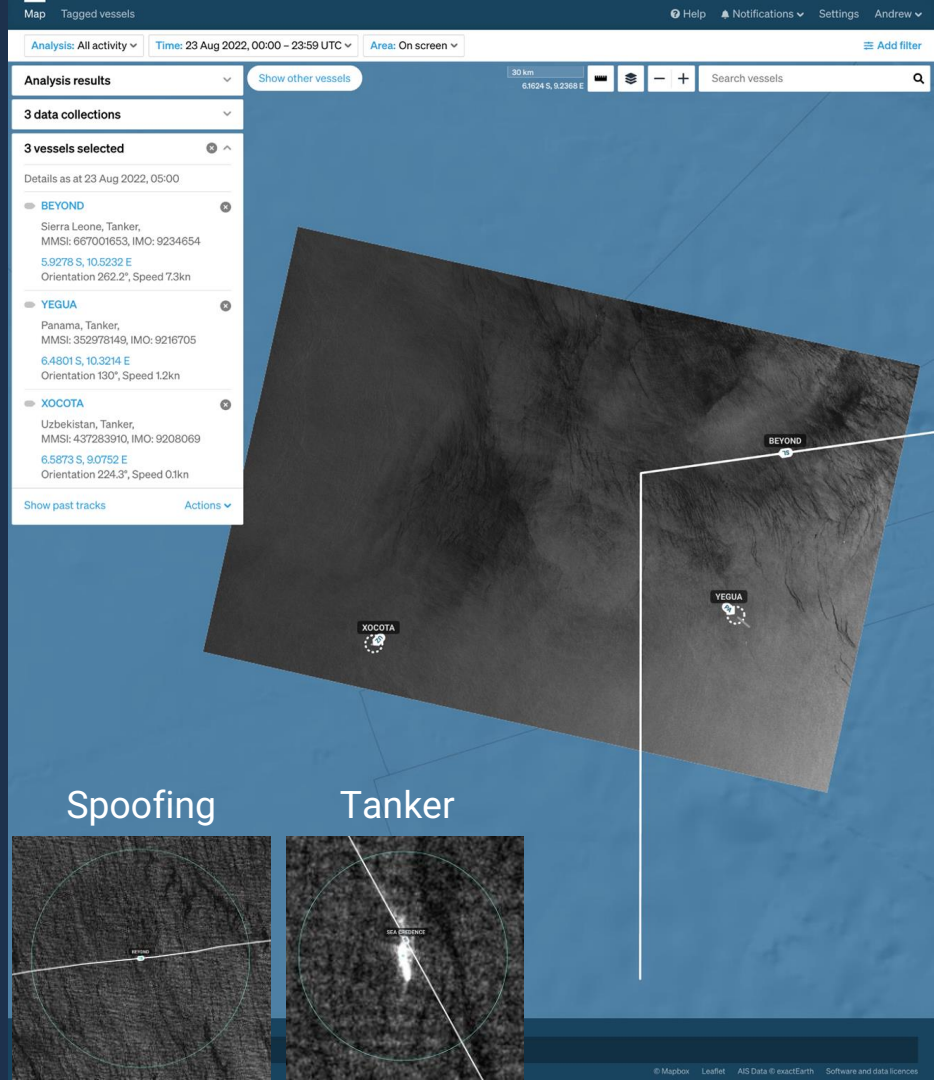
3 vessels transmitting on AIS within the SAR footprint do not appear in the image

All are large >300m tanker vessels that would generate a large radar reflection

Vessels must be spoofing their location

Future plans:

- Extend approach to fishing vessels
- Use Spire PV to find spoofing vessels



Summary

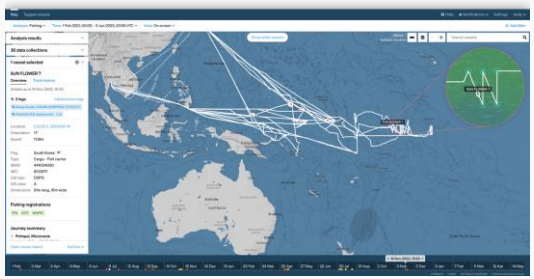
Advanced AIS data and analytics are a powerful component of comprehensive MCS

Incoming data sources

Automated analysis and expert insights

- COLLABORATIVE SHARING
- AI BEHAVIOUR DETECTION
- DATA CLEANING & INTEGRITY
- SATELLITE VESSEL DETECTIONS
- RISK ANALYSIS
- OWNERSHIP ANALYSIS
- NETWORK ANALYSIS

Identify vessels of interest



See us at the table outside for further discussion.

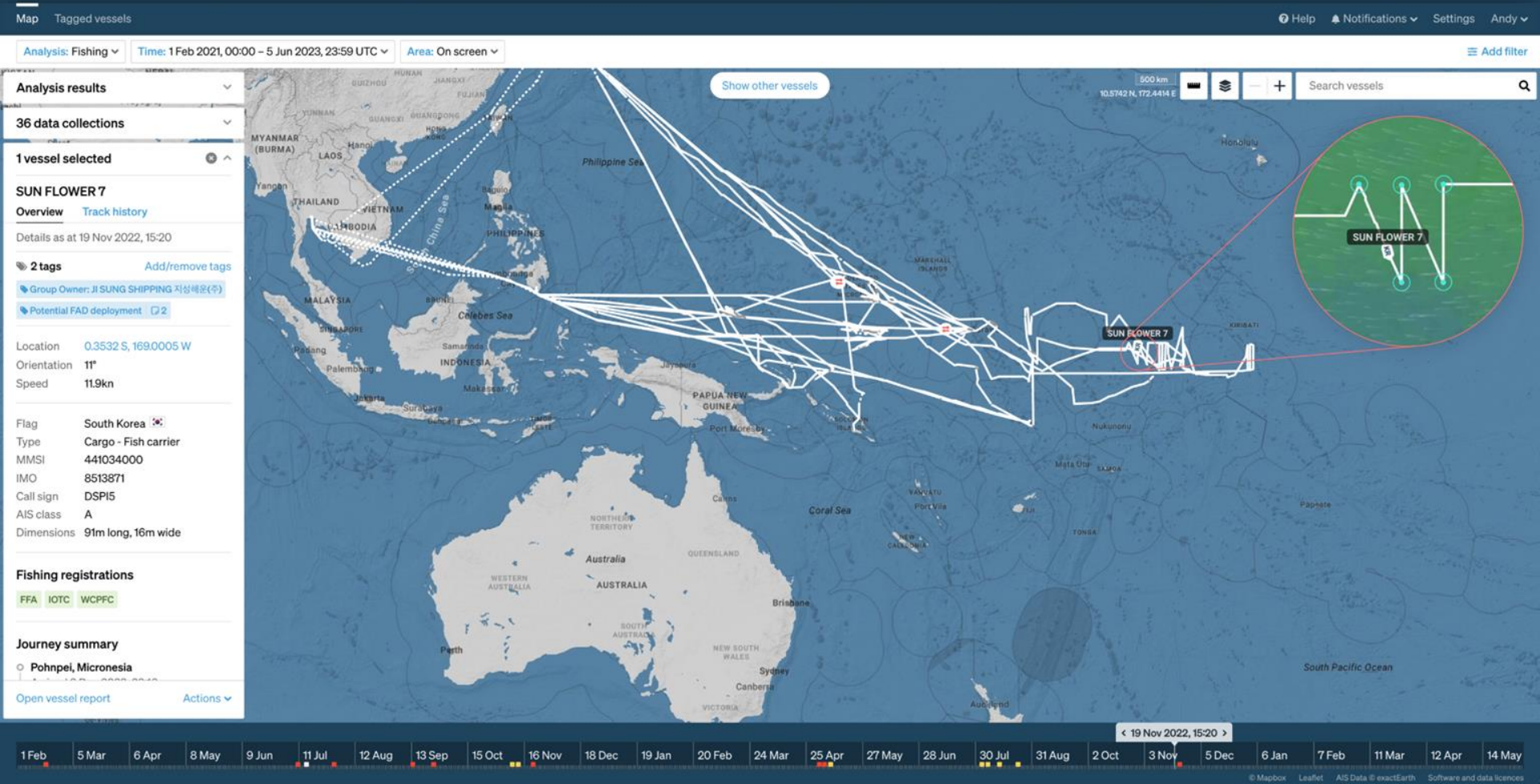
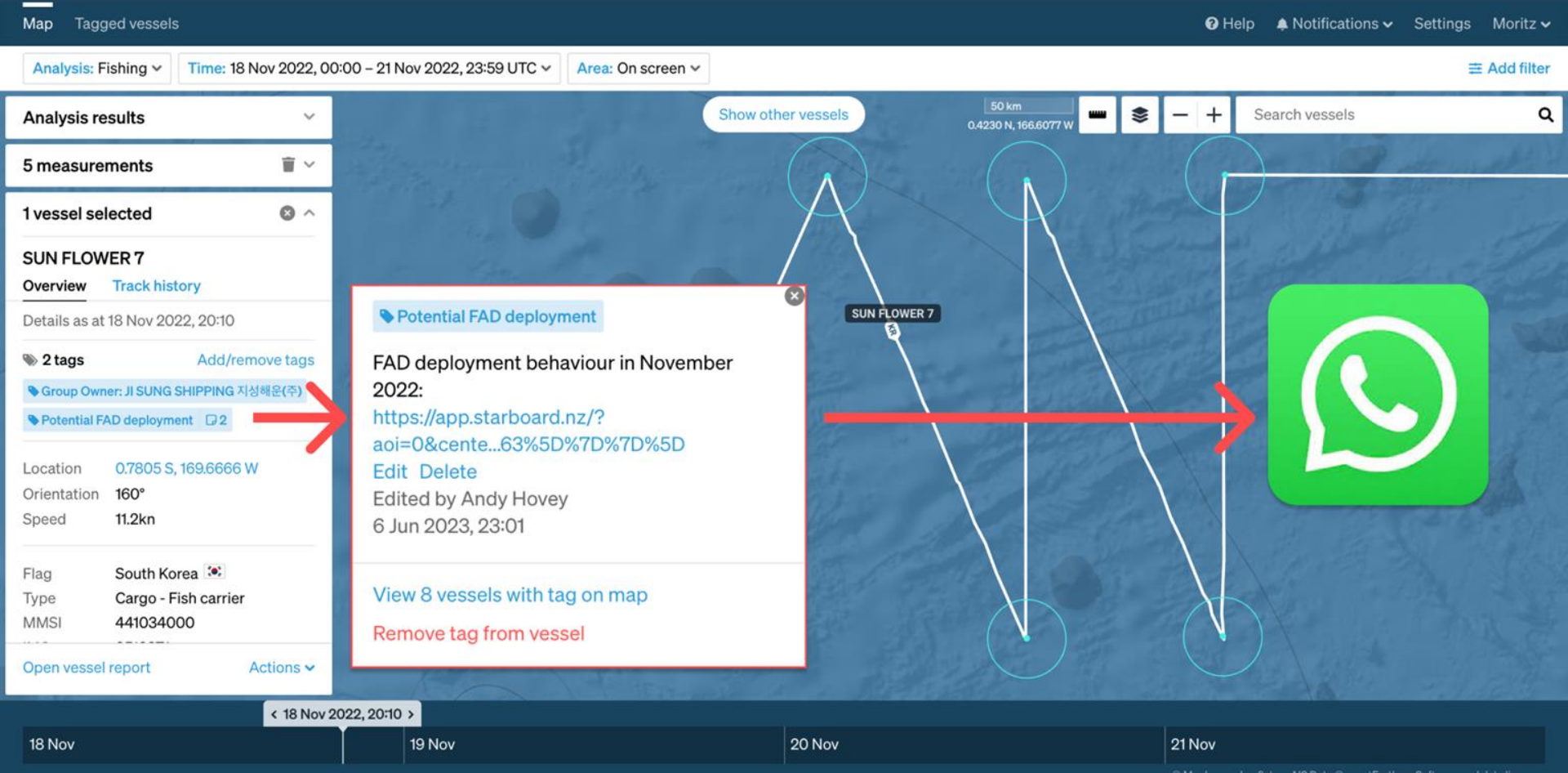
Moritz Lehmann
moritz@starboard.nz

Andrew Middleditch
andrew@starboard.nz

Starboard Maritime Intelligence

www.starboard.nz

Finding a vessel of interest ...



... and telling someone about it.