Studies to support the European Green Deal
Lot 2- Vessel density

Interim Presentation- Overview/ Current Status

Presenter: Dimitris Zissis (dzissis@marinetraffic.com)

MarineTraffic

UBITECH ubiquitous solutions

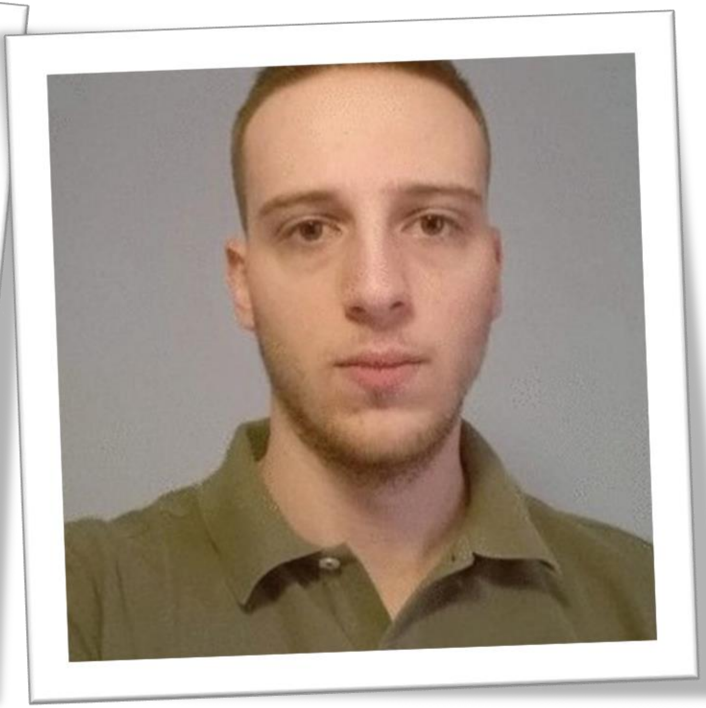
The team

MarineTraffic

UBITECH
ubiquitous solutions

MarineTraffic

UBITECH
ubiquitous solutions

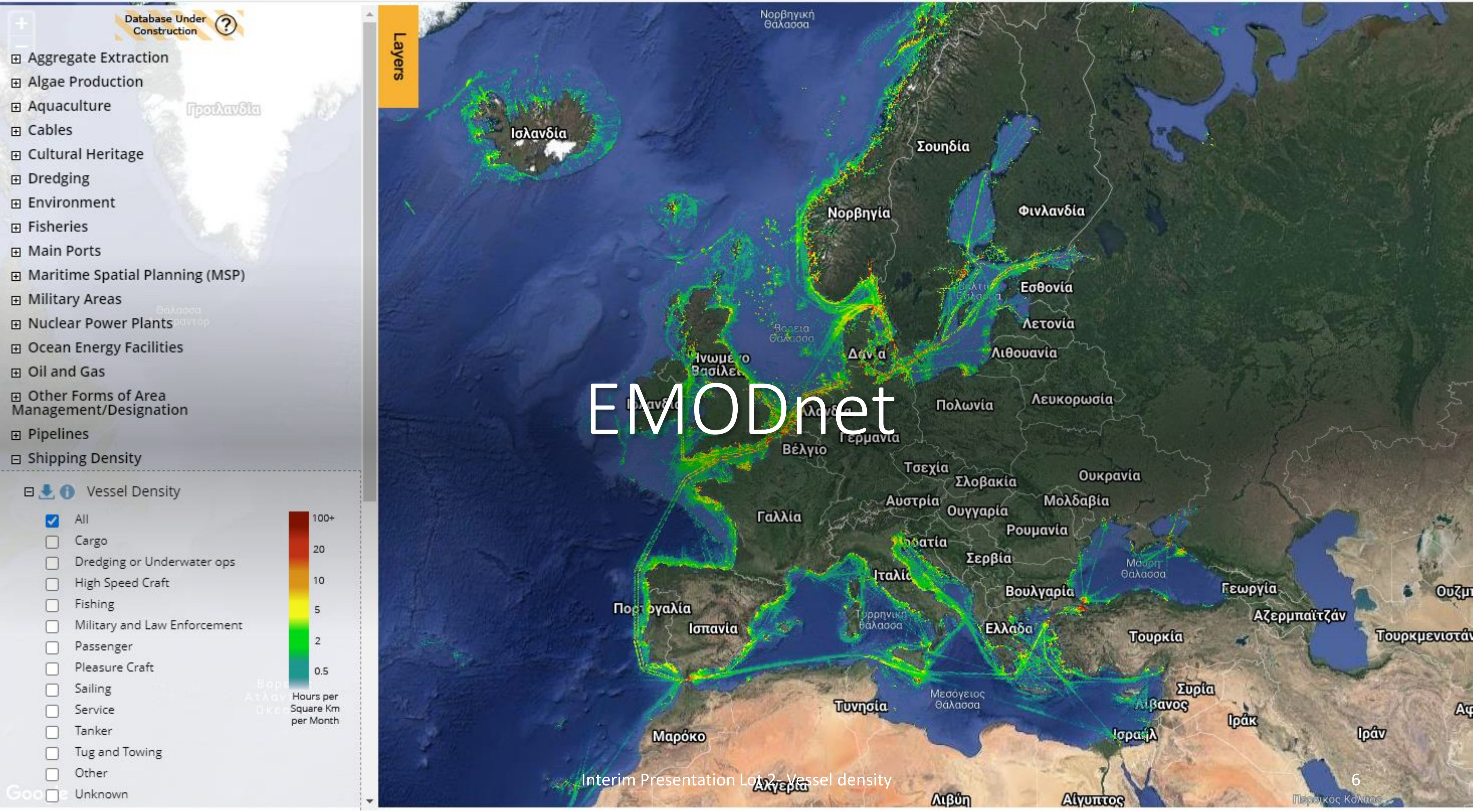


Studies to support the European Green Deal

- The European Commission’s proposal for a Green Deal resets the Commission’s commitment to achieving zero emissions of greenhouse gases in 2050 with economic growth decoupled from resource use.
- Scenarios explored in the preparation of the EU’s Clean Planet communication suggested that achieving this will require doubling electricity production with about a quarter of it produced offshore
- This will mean enormous changes to European waters. Up to a quarter of certain countries’ waters could be devoted to wind farms. Aquaculture production could be much greater than it is today. This will inevitably affect other marine activities – fishing, shipping etc. The aim of this call for tender is to add to the evidence base that will underpin planning for this transition. It will look at two particular aspects:

(1) assessing the potential of shellfish and algae to recycle nutrients and the greenhouse gas emissions from their production;

(2) improving knowledge of vessel density in European waters.

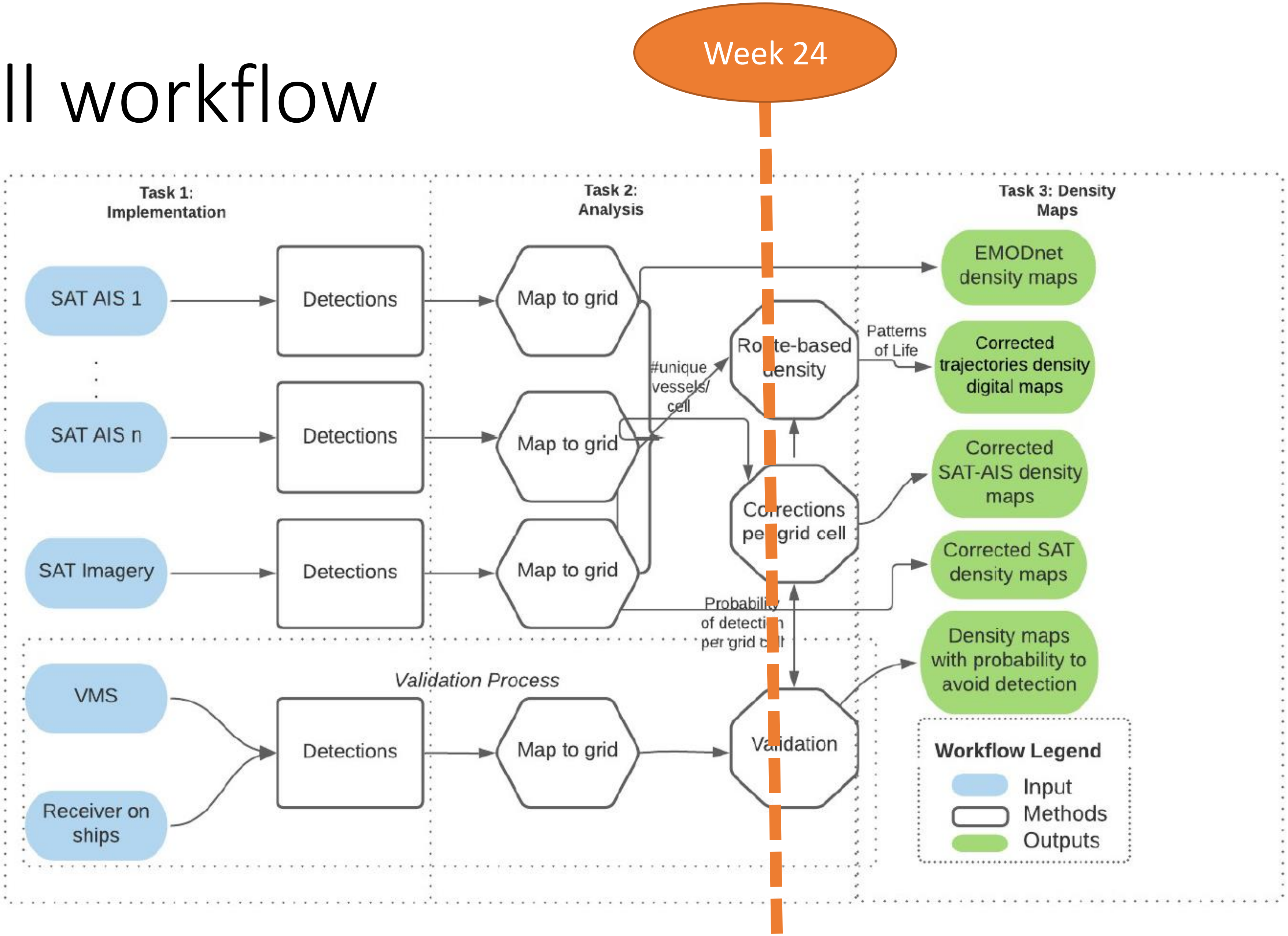

Database Under Construction
Layers
Aggregate Extraction
Algae Production
Aquaculture
Cables
Cultural Heritage
Dredging
Environment
Fisheries
Main Ports
Maritime Spatial Planning (MSP)
Military Areas
Nuclear Power Plants
Ocean Energy Facilities
Oil and Gas
Other Forms of Area Management/Designation
Pipelines
Shipping Density
Vessel Density
All
Cargo
Dredging or Underwater ops
High Speed Craft
Fishing
Military and Law Enforcement
Passenger
Pleasure Craft
Sailing
Service
Tanker
Tug and Towing
Other
Unknown
100+
20
10
5
2
0.5
Hours per Square Km per Month
Γροιλανδία
Νορβηγική Θάλασσα
Ισλανδία
Σουηδία
Νορβηγία
Φινλανδία
Εσθονία
Λετονία
Λιθουανία
Λευκορωσία
Πολωνία
Βέλγιο
Τσεχία
Σλοβακία
Ουκρανία
Αυστρία
Ουγγαρία
Μολδαβία
Γαλλία
Ρουμανία
Σερβία
Βουλγαρία
Γεωργία
Αζερμπαϊτζάν
Ελλάδα
Τουρκία
Ισπανία
Τυνησία
Μεσόγειος Θάλασσα
Συρία
Ιράκ
Ιράν
Μαρόκο
Λιβύη
Αίγυπτος

EMODnet

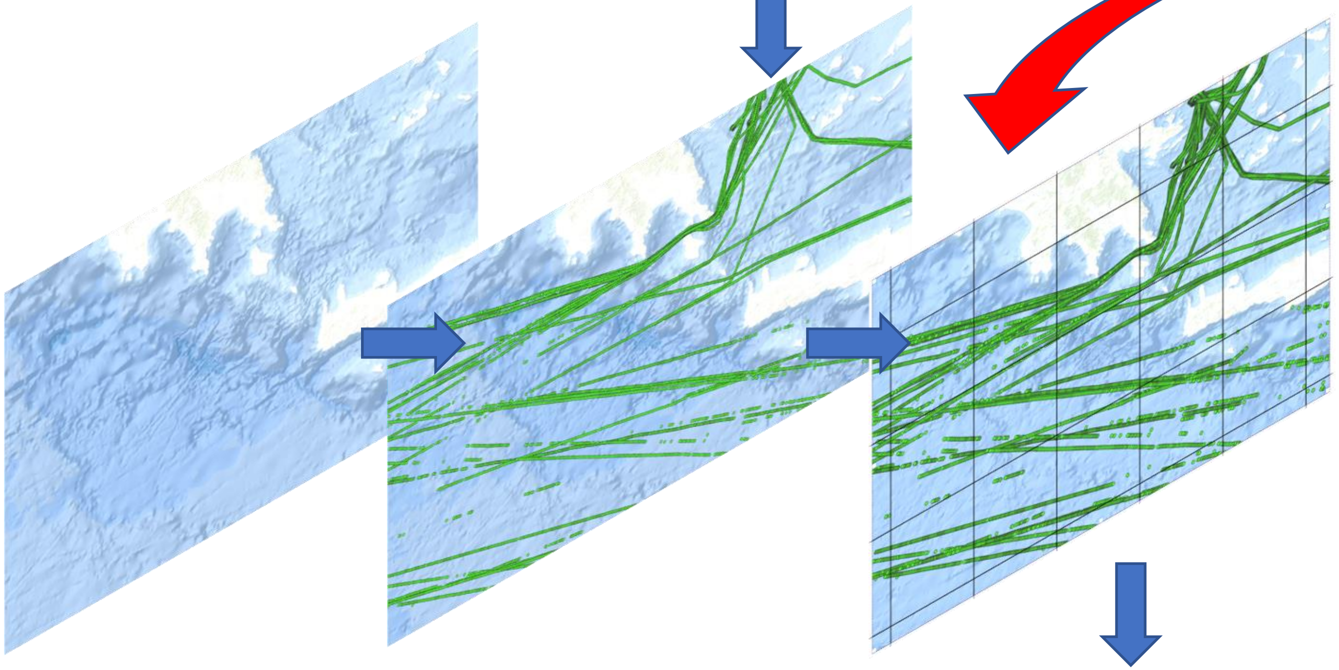
Partial Truth

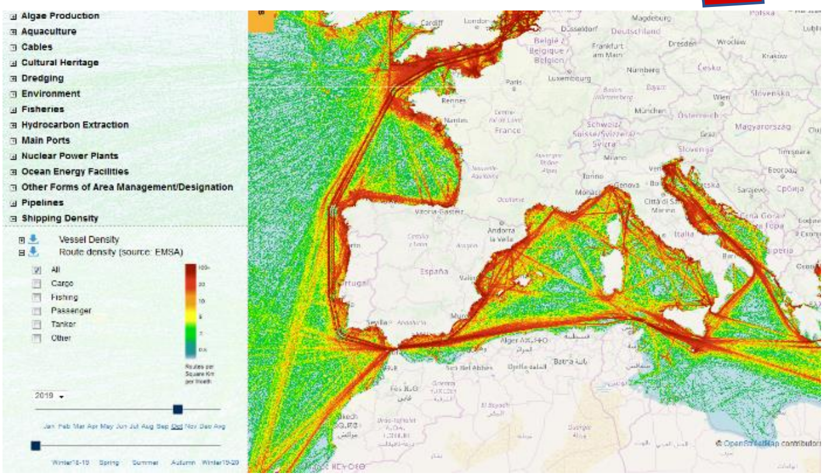
- Spatial trajectories are never perfectly accurate, due to sensor noise, measurement errors, physical limitations or other factors.
- Analyze the corrections necessary to vessel density maps to take into account those missed by AIS receivers mounted on satellites
    - Check against synthetic aperture radar image
    - Check through comparison between different AIS receivers on satellites
    - Check through comparison with VMS records
    - Check through messages from receivers on board ships

Overall workflow



Data from all sources





Cell ID	Number of Detections (points)	Unique Number of Vessels Detected	Number of Crossings (trajectories)	Total Vessel Presence Times (hours)

Evaluation Tables

Cell ID	N1	N2	N	PoD

Task 1: Software development and evaluation for assessment of marine waters

[T1.1] Acquisition and processing of AIS data (Lead: MT)

[T1.2] Vessel detection from spaceborne optical and SAR images (Lead: MT)

[T1.3] Enrichment and reconstruction of vessel trajectories based on vessel routes (Lead: MT)

Task 2: Analysis
The objective of this task is to use the outputs of Task 1 and perform an analysis in order to compare the
computed vessel density per grid cell for each data source used in Task 1.

[T2.1] Comparison between vessel density results from SAT-AIS and SAT imagery processing (Lead: MT)

[T2.2] Comparison between different AIS Receivers on satellites (Lead: MT)

[T2.3] Comparison with VMS records (Lead: UBI)

[T2.4] Comparison with receivers mounted on board vessels and other offshore facilities (Lead: MT)

Task 3: Creating new sets of digital density maps

[T3.1] Creating density maps used in EMODnet

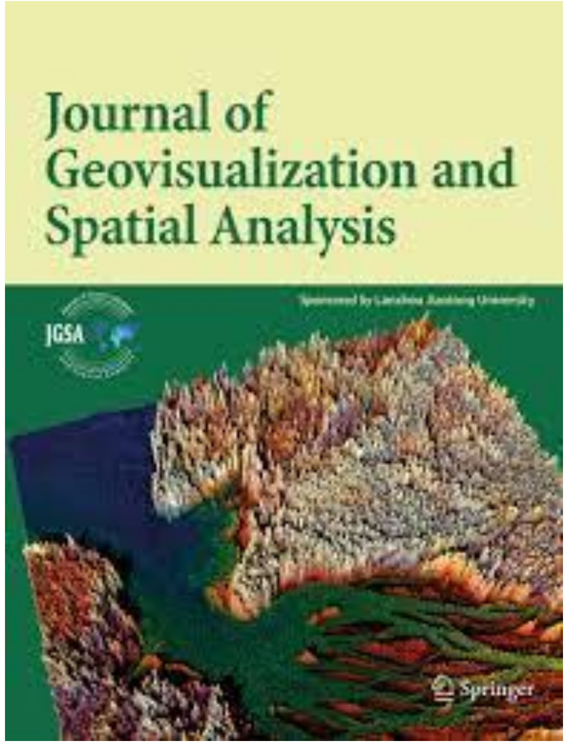
[T3.2] Vessel density maps using vessel density information acquired from satellite image processing

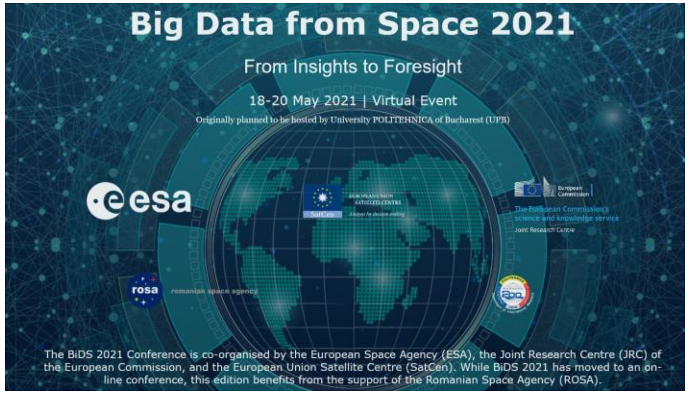
[T3.3] Corrected density maps with SAT-AIS message collision elimination (Lead: MT)

[T3.4] Density maps showing the probability to avoid detection of a vessel (Lead: UBI)

[T3.5] Corrected trajectories density digital maps (Lead: MT)

Task 4: Preparation of results for peer-reviewed journal





Konstantina Bereta, Ioannis Karantaidis, Dimitris Zissis. Vessel Traffic Density Maps based on Vessel Detection in Satellite Imagery. Submitted to IGARSS 2022.

Task 5: Transition and Handover details at the end of the contract

[T5.1] State of Play, Handover and Business continuity for products and services (Lead: UBI)

[T5.2] Legacy Strategy (Lead: UBI)

Objectives (1/2)

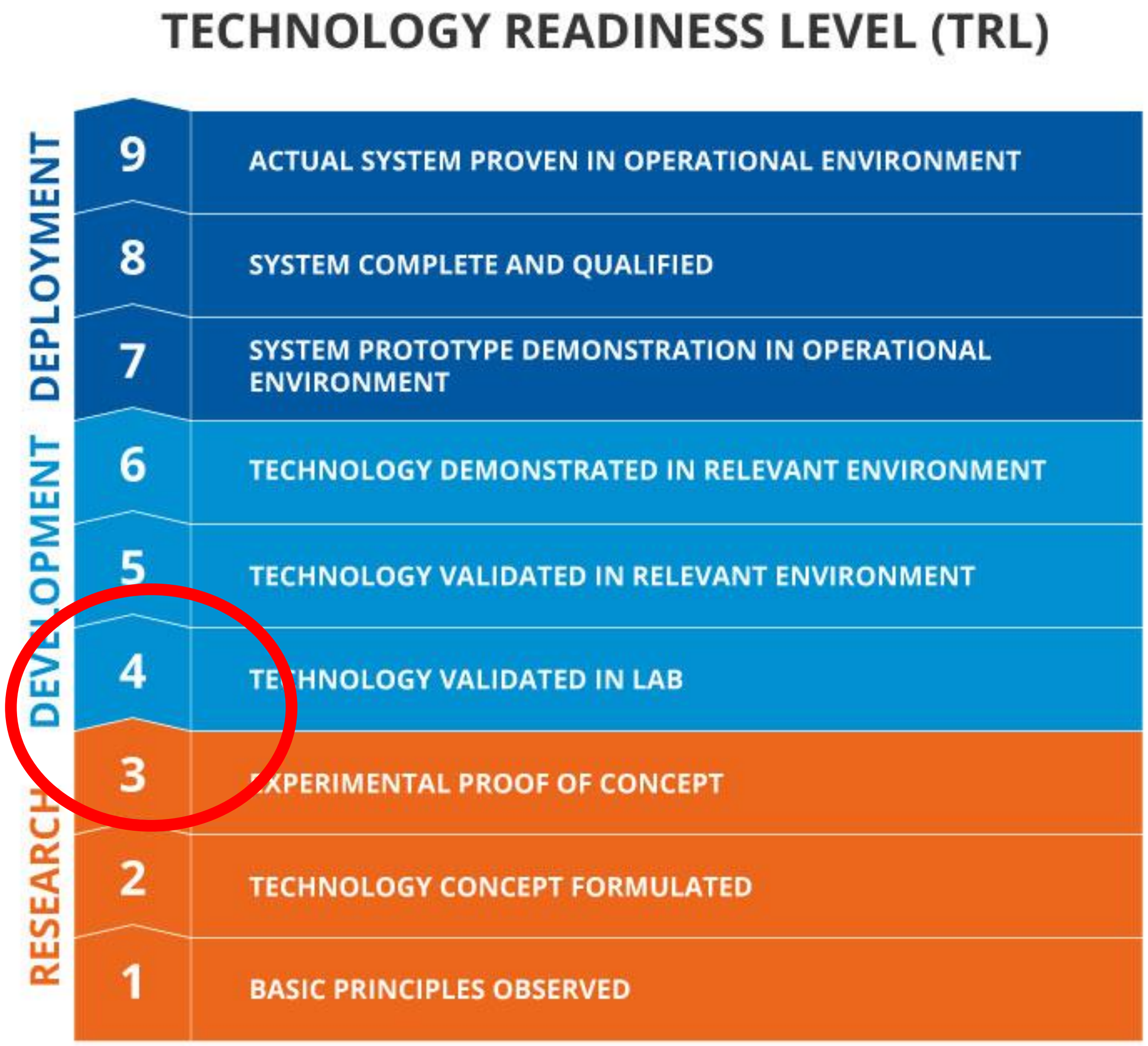
	Objective	Means of Achievement	Measures
O1	Construction of a new set of vessel-based and trajectory-based density maps.	“detectability maps” that indicate the probability of a vessel crossing an area without being detected by a satellite passing overhead	Produce a vessel-based and trajectory based density map for every vessel category mentioned in EMODnet for the following areas: Baltic, Black, Irish, Mediterranean, North East Atlantic and North Seas.
O2	Construction of “detectability maps” that indicate the probability of a vessel crossing an area without being detected by a satellite passing overhead.	Produce detectability maps for the following areas: Baltic, Black, Irish, Mediterranean, North East Atlantic and North Seas. The formula used to estimate detectability should be documented and explained.	Soundness of the used formula should be proved. Every vessel/grid cell in the detectability map should be associated with the respective detectability indicator.

Objectives (2/2)

	Objective	Means of Achievement	Measures
O3	Design and implement the software that produces the maps and include detailed documentation.	The implemented workflow should be automatic and full documentation should be provided, including also test cases. Every step of the workflow should be explained.	End-to-end workflow documentation and scenario description. The workflow should be able to be executed in stand-alone mode producing the results described in the test cases.
O4	Preparation of an article that describes the methodology and the results.	The methodology, data sources, and results should be reported in at least one scientific publication. The document should be formatted as a journal article and it should be submission-ready by the end of the project.	The article should be ready for submission.

Technology Readiness Level

studies →



Milestones Description

MS1 (W2) Initial software requirements (Task 1)
MS2 (W22) First draft version of deliverables for Tasks 1,2,3,5 and interim progress presentation submitted to EASME for feedback.
MS3 (W22) Final version of interim report and deliverables submitted to EASME
MS4 (W32) Draft version of deliverables for Tasks 1-5 and presentation
MS5 (W34) Final version of deliverable and presentation of results to the steering committee
MS6 (W36) Final analysis report and final version of handover guidelines, including software manual

Overall Technical Approach

Interim Presentation

Presenter: Dimitris Zissis (dzissis@marinetraffic.com)

MarineTraffic

UBITECH ubiquitous solutions

Vessel density

- The term “vessel density” has several co-notations and thus is used with several meanings in this domain. Therefore, vessel density can refer to

1. the average number of vessels detected within a defined geographical area (spatial grid) in a given timeframe;
2. the average number of crossings within a defined geographical area (spatial grid) in a given timeframe (often also referred to as “vessel traffic density”);
3. the total vessel presence times within a defined geographical area (spatial grid) in a given timeframe;

The common dominator between all approaches is the dataset (AIS)

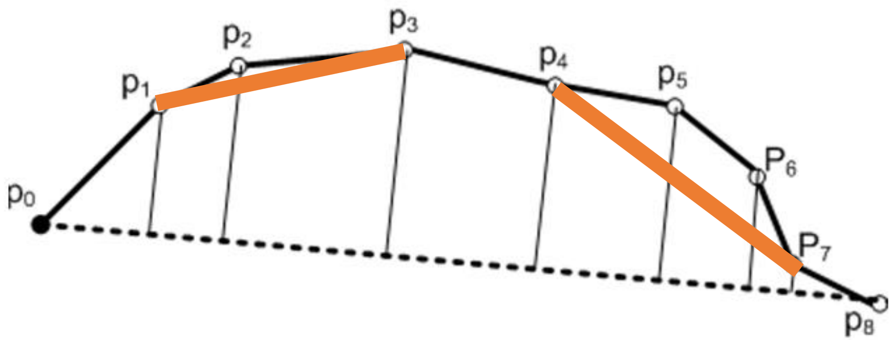
It is impossible to capture a lossless trajectory

- To capture though the accurate and complete trajectory of a moving object, is almost impossible in real conditions, due to the inherent limitations of data acquisition and storage mechanisms.
- Thus it can be captured as a time stamped series of location points denoted as $p_0(x_0,y_0,t_0)$, $p_0(x_1,y_1,t_1)$, …, $p_n(x_n,y_n,t_n)$, where $x_{i,}y_i$ represents geographic coordinates of the moving object at time t_i and N is the total number of elements in the series. To generate the trajectory, a sensor needs to acquire its coordinates x,y at time t.

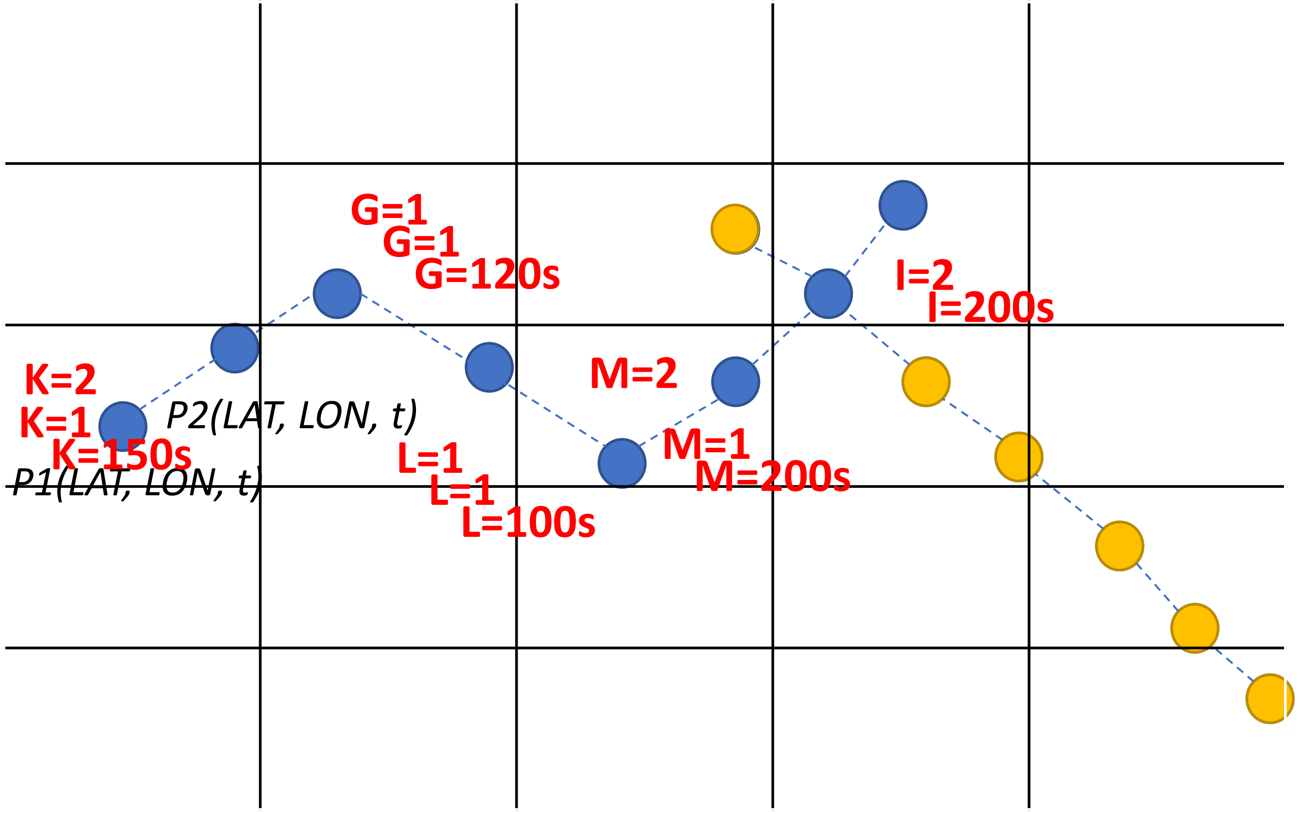
$$\sum traj_1 = \overline{p_0p_1}, \overline{p_1p_2}, \overline{p_2p_3}, \overline{p_3p_4}, \overline{p_4p_5}, \overline{p_5p_6}, \overline{p_6p_7}, \overline{p_7p_8}$$

$$\sum traj_2 = \overline{p_0p_1}, \overline{p_1p_3}, \overline{p_3p_4}, \overline{p_4p_7}, \overline{p_7p_8}$$

$$\sum traj_1 \mathrel{!=} \sum traj_2$$



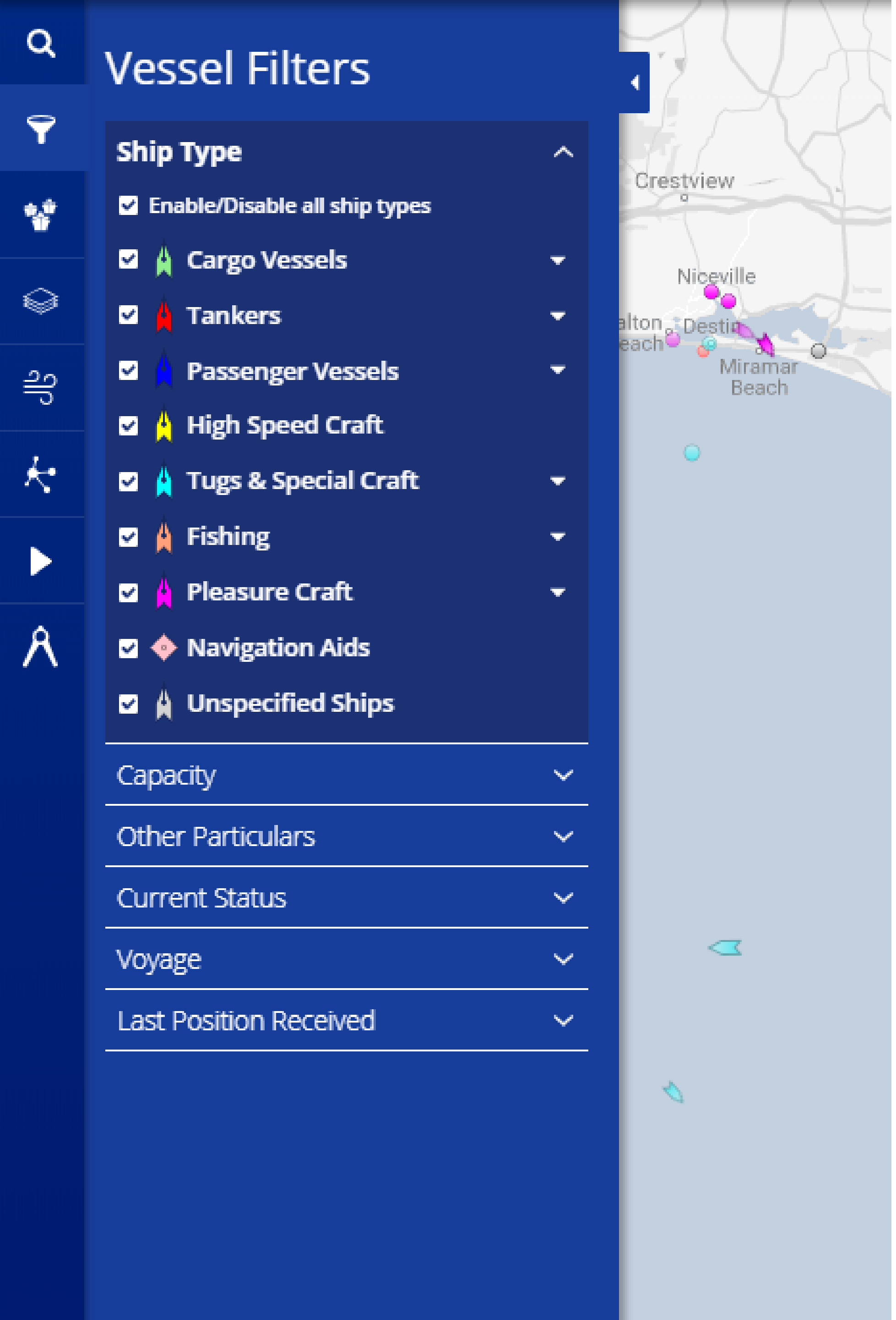
Spatial Trajectories & Density Maps



1. the average number of vessels or positions detected within a defined geographical area (spatial grid) in a given timeframe;

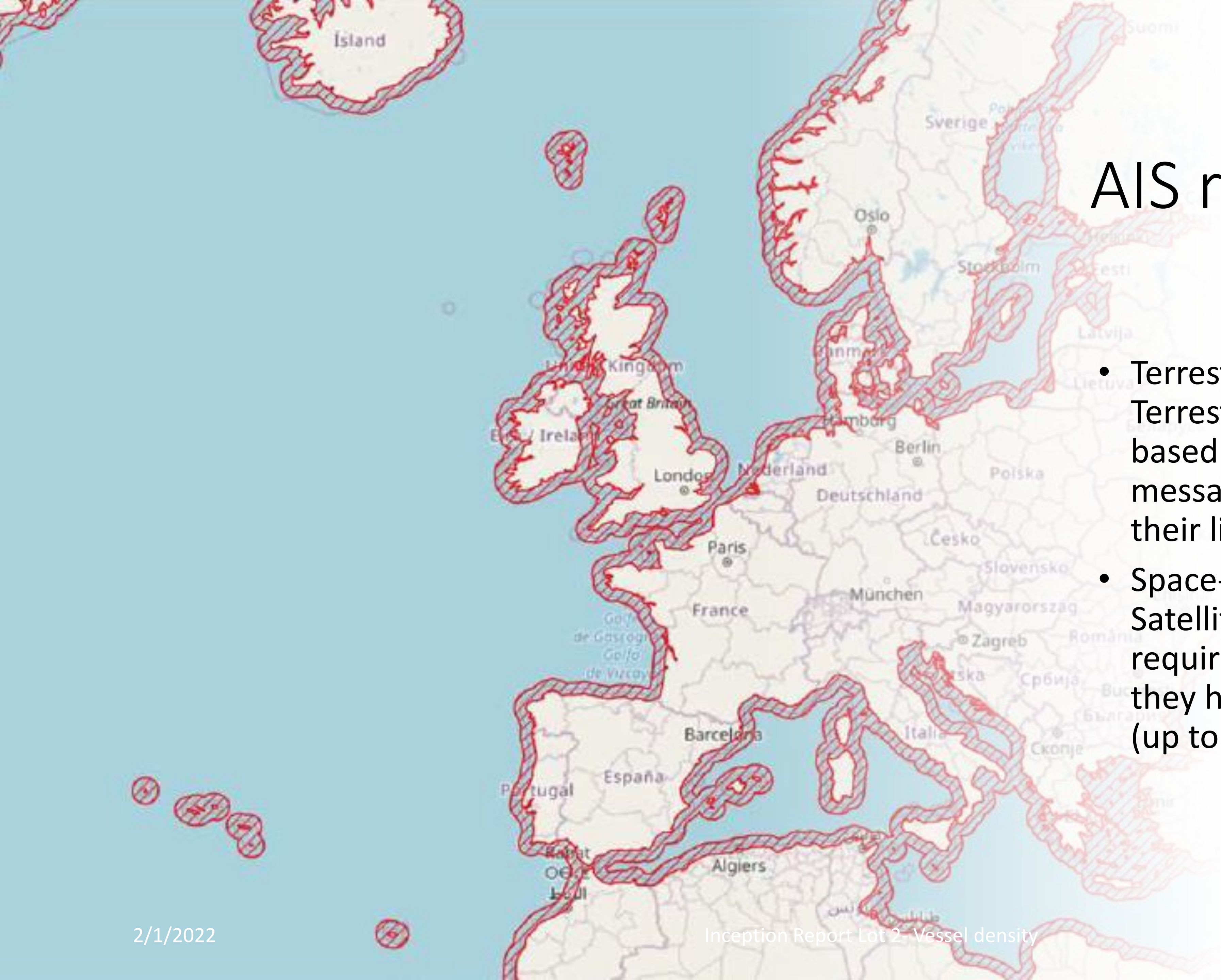
2. the average number of crossings within a defined geographical area (spatial grid) in a given timeframe (often also referred to as "vessel traffic density");

3. the total vessel presence times within a defined geographical area (spatial grid) in a given timeframe;



Automatic Identification System

- The most commonly used dataset for tracking vessel activities at sea is the Automatic Identification System (AIS), a collaborative, self-reporting system that allows vessels to broadcast their identification information, characteristics and destination, along with other information originating from on-board devices and sensors, such as location, speed and heading.
- AIS messages are broadcast periodically and can be received by other vessels equipped with AIS transceivers, as well as by on the ground or satellite-based sensors.
- This information is transmitted at regular intervals ranging anywhere from 2 seconds to 3 minutes, according to the vessels behaviour.
- Since 31 December 2004, AIS must be fitted aboard all vessels of 300 gross tonnage and upwards engaged on international voyages, cargo vessels of 500 gross tonnage and upwards not engaged on international voyages and all passenger vessels irrespective of size.



AIS receivers

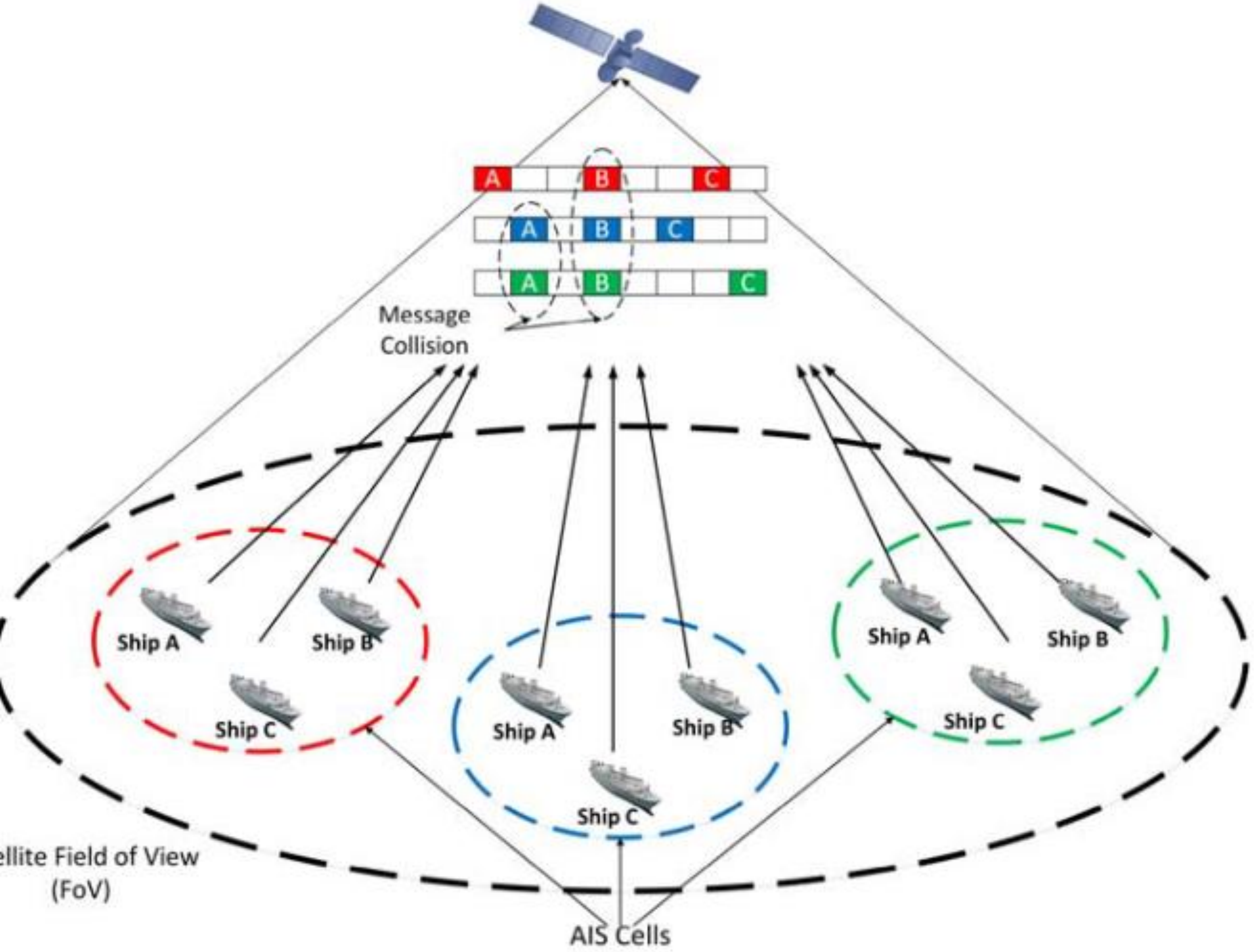
- Terrestrial-based AIS (TER-AIS): Terrestrial receivers are coastal based stations which receive messages from vessels within their line of sight.
- Space-based AIS (SAT-AIS): Satellite receivers do not require line of sight; therefore, they have a large field of view (up to 5,000 km)

Data fitness for purpose

- Spatial trajectories are never perfectly accurate, due to sensor noise, measurement errors, physical limitations or other factors.
- Sometimes the error is acceptable for a given use case while in other occasions it may lead to erroneous interpretations.
- The resolution of the initial rasterisation is the major factor effecting the data error or uncertainty propogation in the resulting grids.

Data Products

Density maps parameters	
Input	• Points • Detections • Lines
Count	•the average number of vessels detected within a defined geographical area (spatial grid) in a given timeframe; •the average number of crossings within a defined geographical area (spatial grid) in a given timeframe (often also referred to as "vessel traffic density"); •the total vessel presence times within a defined geographical area (spatial grid) in a given timeframe;
Output Cell Size	•Density per square kilometers •10x10 •100x100



Packet Collisions and phantom ships

- in large coverage areas there is no guarantee that another vessel is not transmitting at the same time

Priority to class A

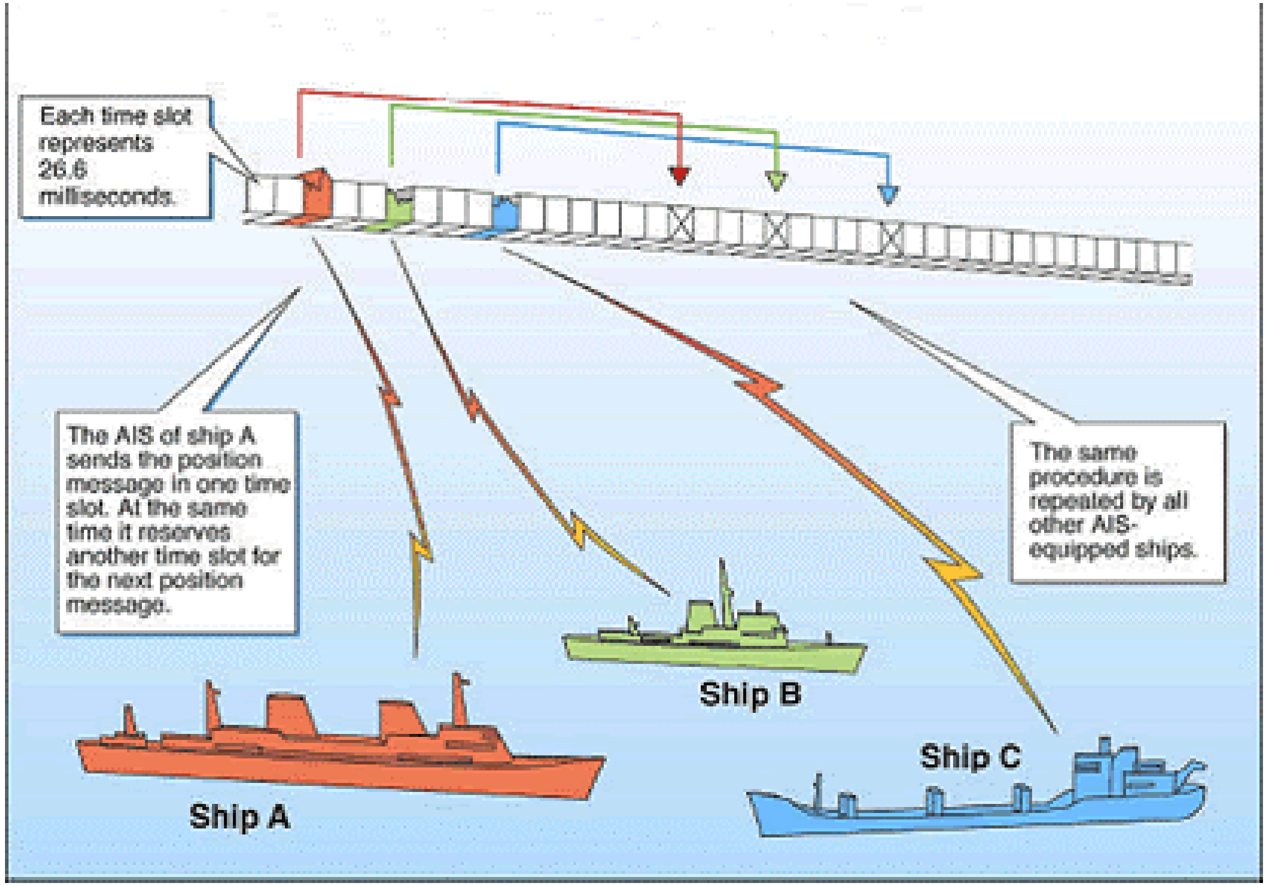
- Class A transceivers reserve their time slots for transmission via Self Organized Time Division Multiple Access (SOTDMA).

1. After performing a scan to ascertain which slots have already been reserved by other vessels, they reserve an empty slot.
2. The device makes know to nearby AIS devices that it intends to use this slot for future broadcasts.

Class B transceivers are permitted to transmit via Carrier Sense Time Division Multiple Access (CSTDMA).

- Unlike SOTDMA, slots are not reserved. They instead simply scan for available space and transmit when a free one is determined to be available.

Transmission priority is given to Class A transceivers which use SOTDMA since they reserve time slots



Weaker transmission

- According to the ITU specifications Provision should be made for two levels of nominal power (high power, low power) as required by some applications. The default operation of the AIS station should be on the high nominal power level. The two power settings should be 1 W and 12.5 W or 1 W and 5 W for Class B “SO”.
- Evidently the weaker signal of Class B devices means it is more difficult to receive these signals from space.

CLASS A		CLASS B
12.5W	DEFAULT	5W
1 W		1W

The data

- CLASS B
- Lower temporal resolution by design

Class A systems

Ships Dynamic Conditions	Reporting rate
At anchor or moored	3 Minutes
0-14 knots	10 Seconds
0-14 knots and changing course	$3\frac{1}{3}$ Seconds
14-23 knots	6 Seconds
14-23 knots and changing course	2 seconds
Faster than 23 knots	2 seconds
Faster than 23 knots and changing course	2 seconds

Class B systems

Ships Dynamic Conditions	Reporting rate
0 to 2 knots	3 Minutes
Above 2 knots	30 Seconds

Other AIS sources

Source	Reporting rate
Search and Rescue (SAR) aircraft	10 seconds
Aids to navigation	3 minutes
AIS base station	10 seconds or 3.33 seconds, depending on operating parameters

Data Issues

Data fitness for purpose (SAT AIS)

Class A

1. large coverage areas affect Class A reception

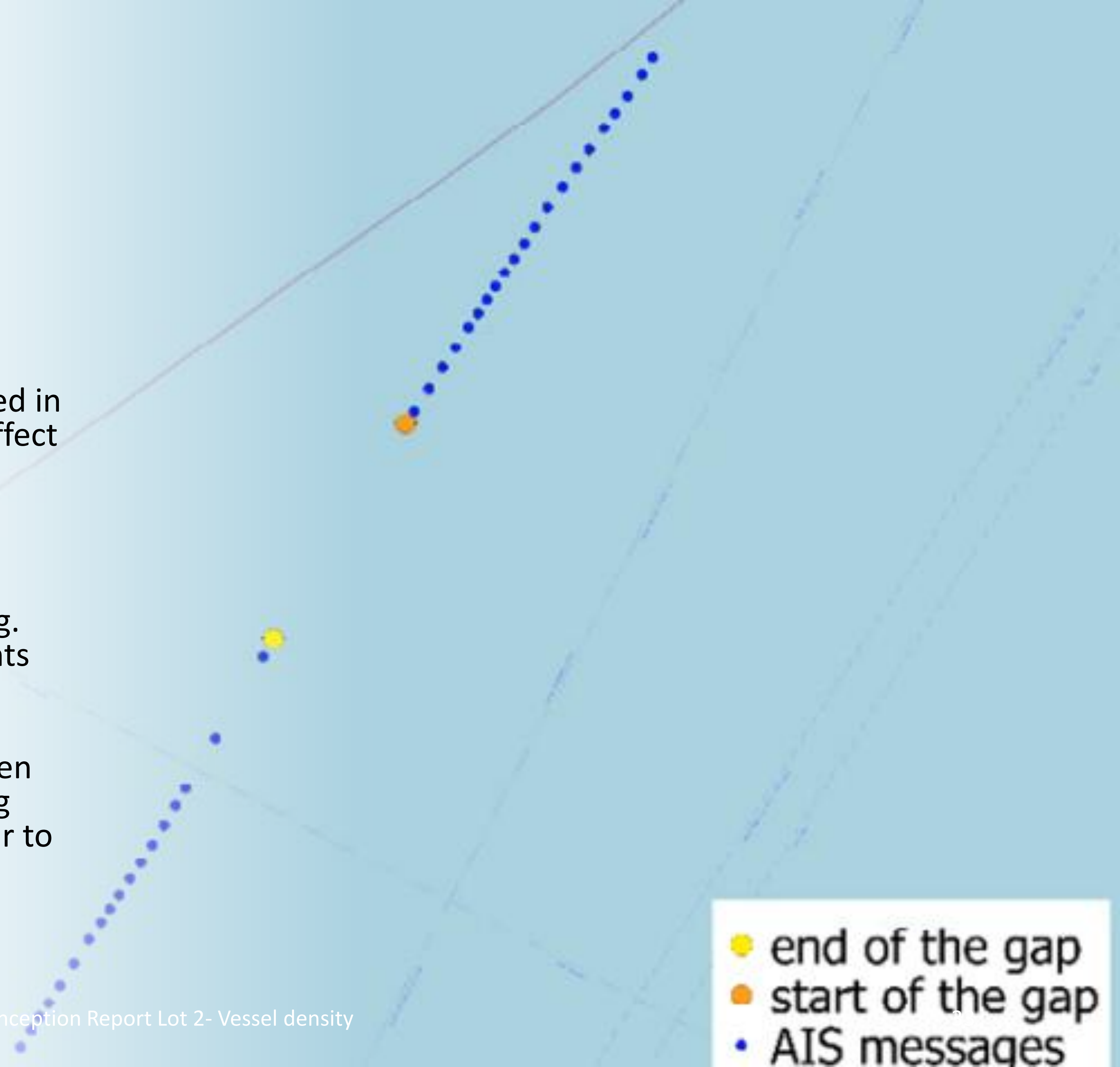
Class B

1. Congestion heavily affects Class B
2. Class A is given priority over Class B (CSTDMA)
3. Weaker Signal
4. Lower temporal/spatial resolution by design

Packet Collisions and phantom ships

Overall, two main types of issues can be identified in respect to package collisions in SAT-AIS, which affect density map generation,

1. Fewer vessels detected in a given region
2. Incomplete trajectories are received
    - Due to the lower temporal resolution (e.g. track difference between connected points could be 6-12 hours apart), vessel tracks cannot be reconstructed accurately.
    - Therefore, a track could be drawn between two points quite a long way apart, cutting through landmasses and making it appear to be more dense.



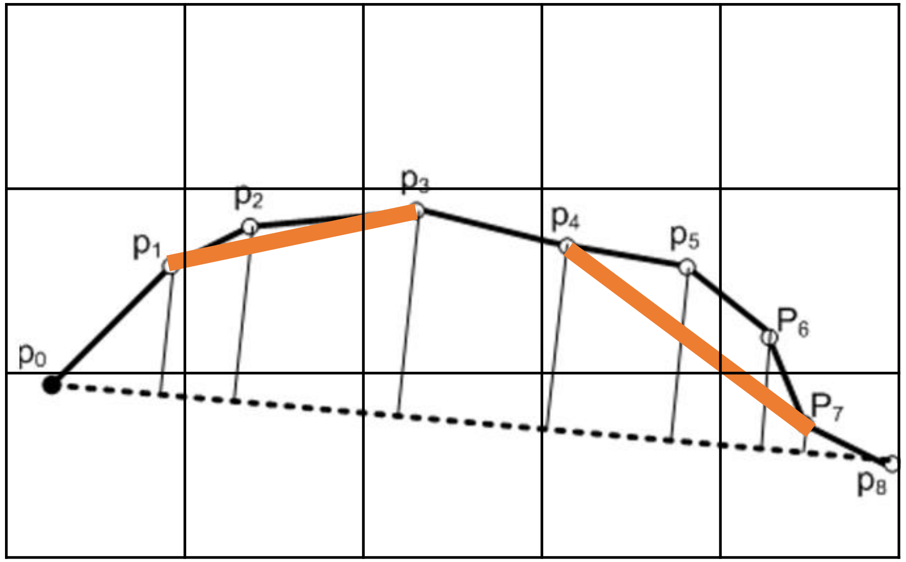
Differences in density maps

$$\sum traj_1 = \overline{p_0p_1}, \overline{p_1p_2}, \overline{p_2p_3}, \overline{p_3p_4}, \overline{p_4p_5}, \overline{p_5p_6}, \overline{p_6p_7}, \overline{p_7p_8}$$

$$\sum traj_2 = \overline{p_0p_1}, \overline{p_1p_3}, \overline{p_3p_4}, \overline{p_4p_7}, \overline{p_7p_8}$$

$\sum traj_1$!= $\sum traj_2$

Different Results in the Density maps



Data Pre-processing & Area Definition

Interim Presentation

Presenter: Dimitris Zissis (dzissis@marinetraffic.com)

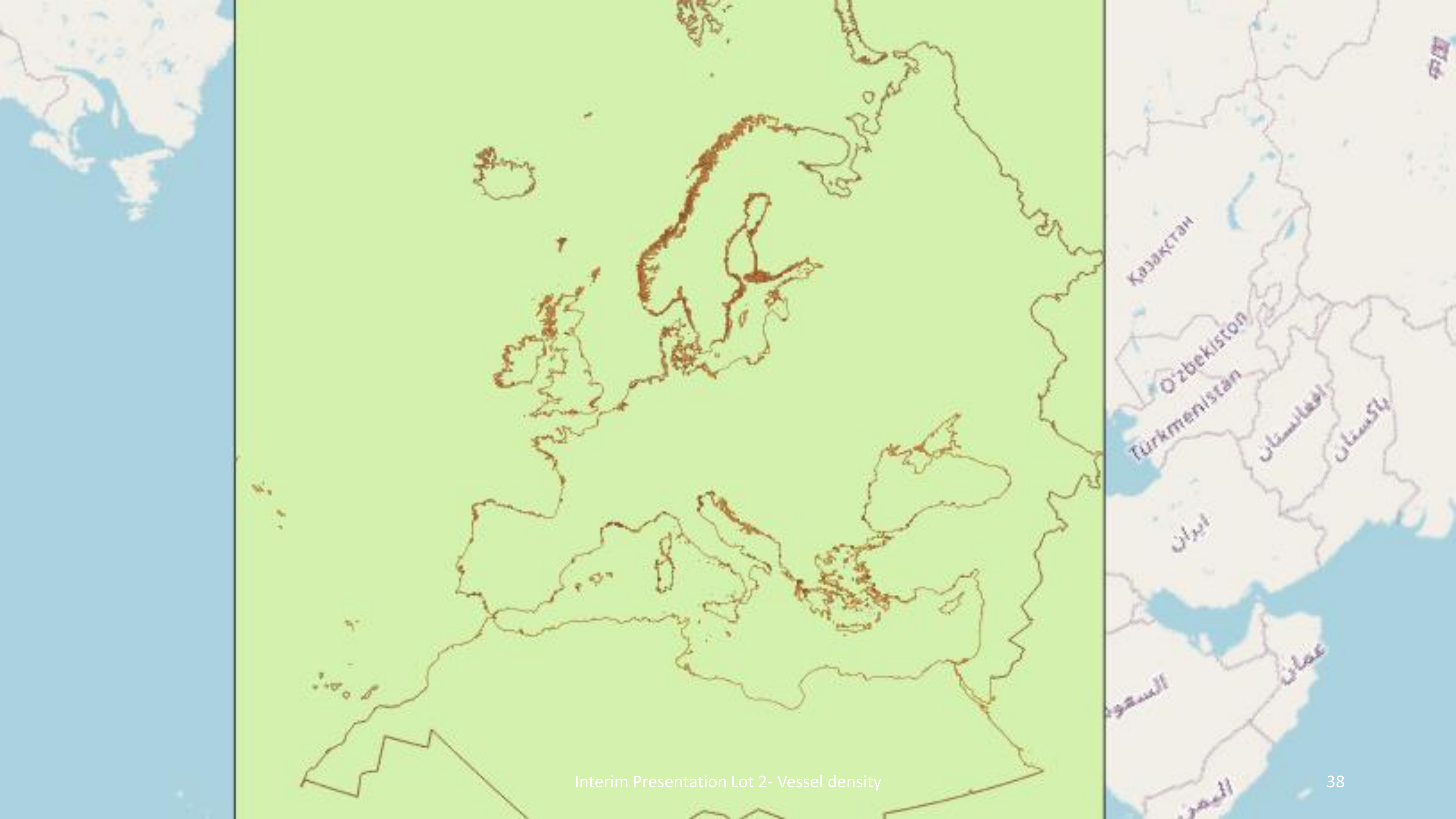
MarineTraffic

UBITECH ubiquitous solutions

DATA SOURCES USED

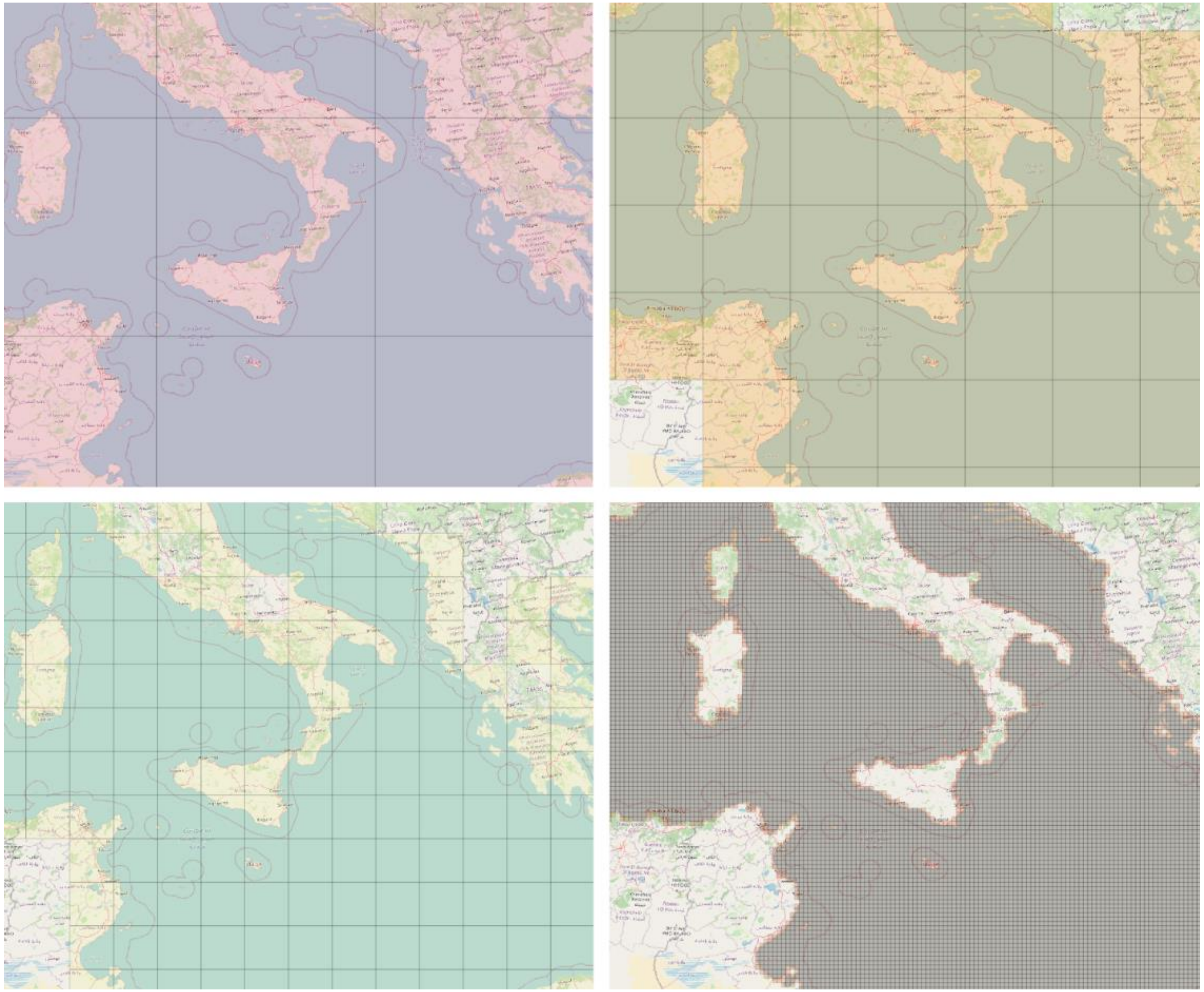
for the period 5 Oct 2021 – 31 Oct 2021

- Terrestrial AIS from MarineTraffic own coastal Network
- S-AIS from 3 major providers
- Copernicus Sentinel-1 (SAR) and Sentinel-2 (Optical) imagery


Казахстан
O'zbekiston
Türkmenistan
افغانستان
پاکستان
ایران
عمان

Grid

- 500km (pink)
- 200km (yellow)
- 100km (orange)
- 10km (brown)
- 1 Km



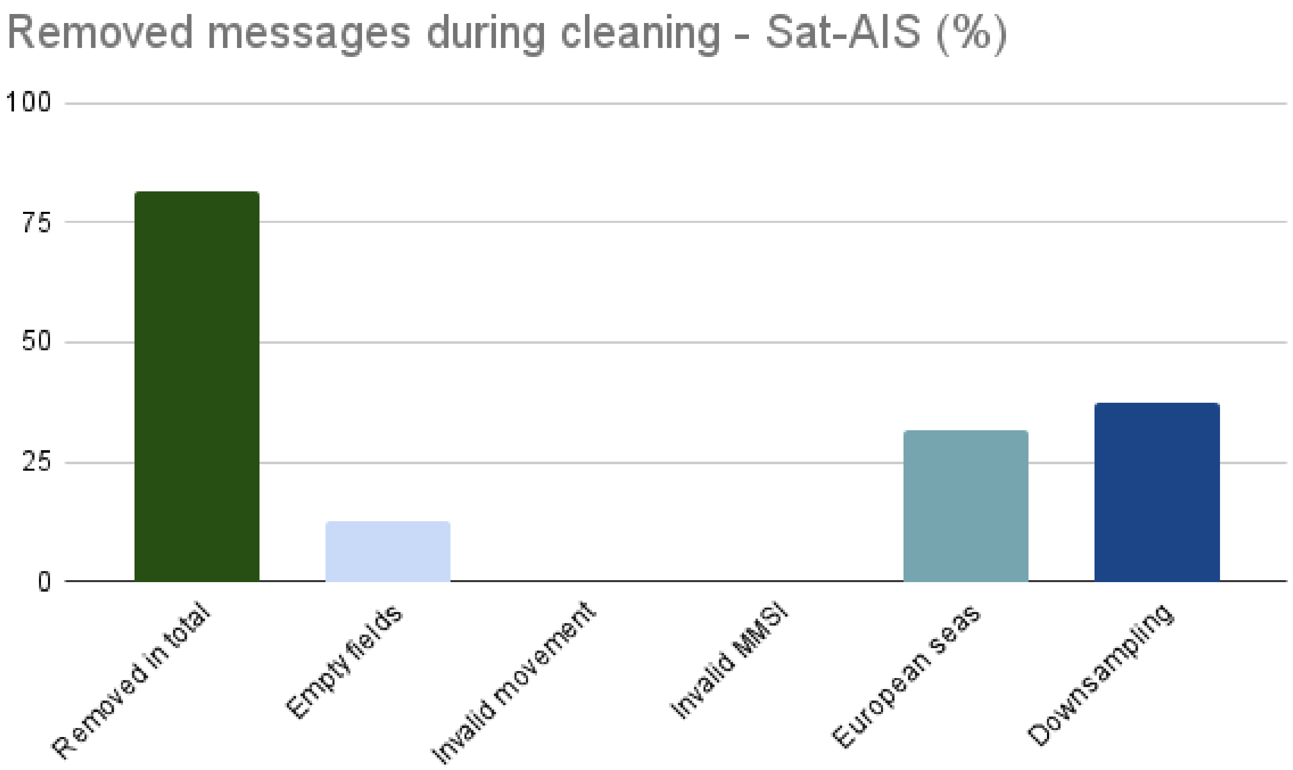
Cleaning & Pre-processing

- trajectories are never perfectly accurate due to sensor noise and other factors.
- In most situations it is necessary to apply algorithmic techniques to the data to smooth the noise and potentially decrease the error in the measurements.

Open Source Release

Cleaning & Preprocessing the data

- More precisely the filters applied to each input message are the following:
- Removing data with empty fields
- Invalid movement fields
- Invalid vessel ID
- Special characters
- Downsampling (min 3 minutes)

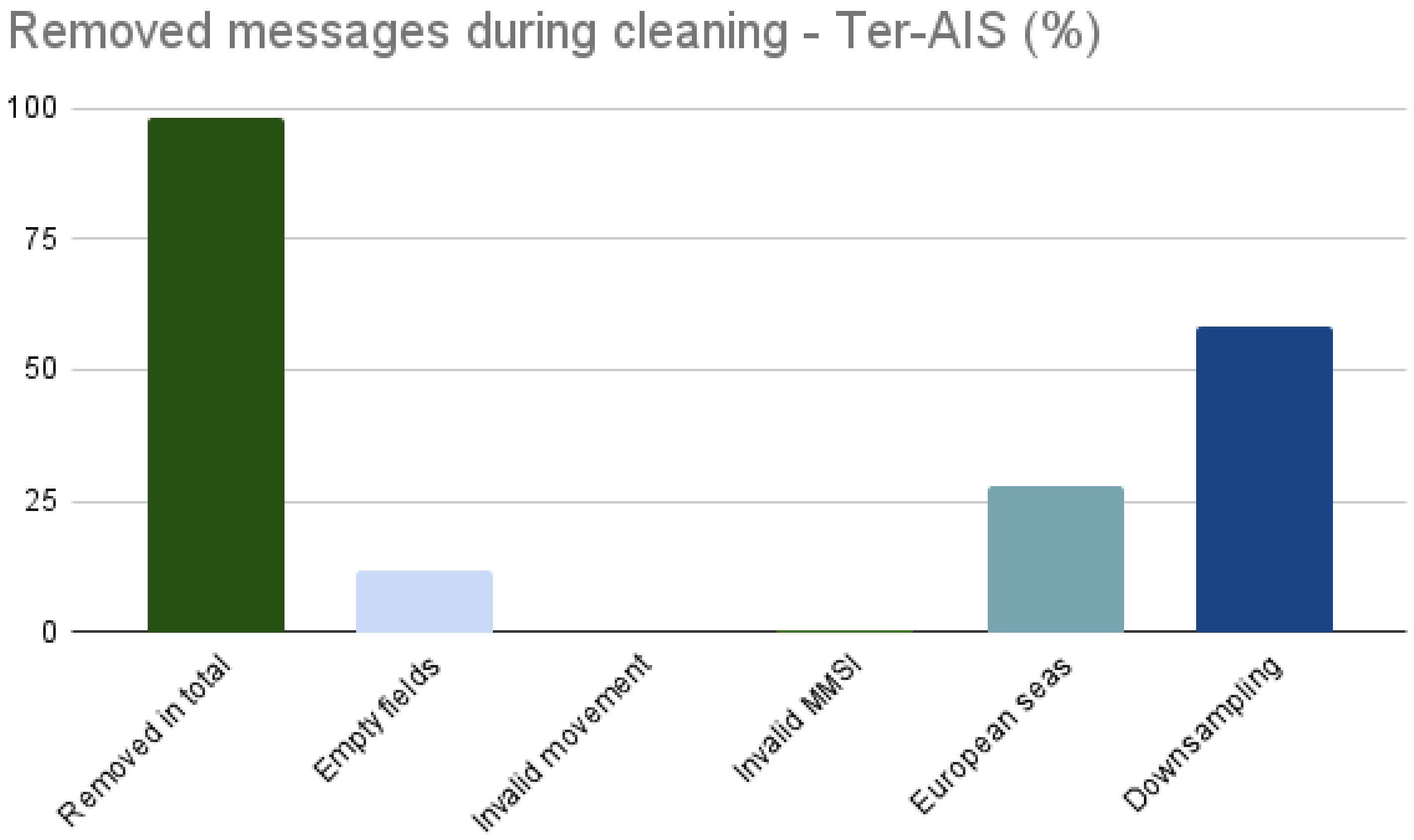


20 GB→ 2.8GB

Open Source Release

Cleaning & Preprocessing the data

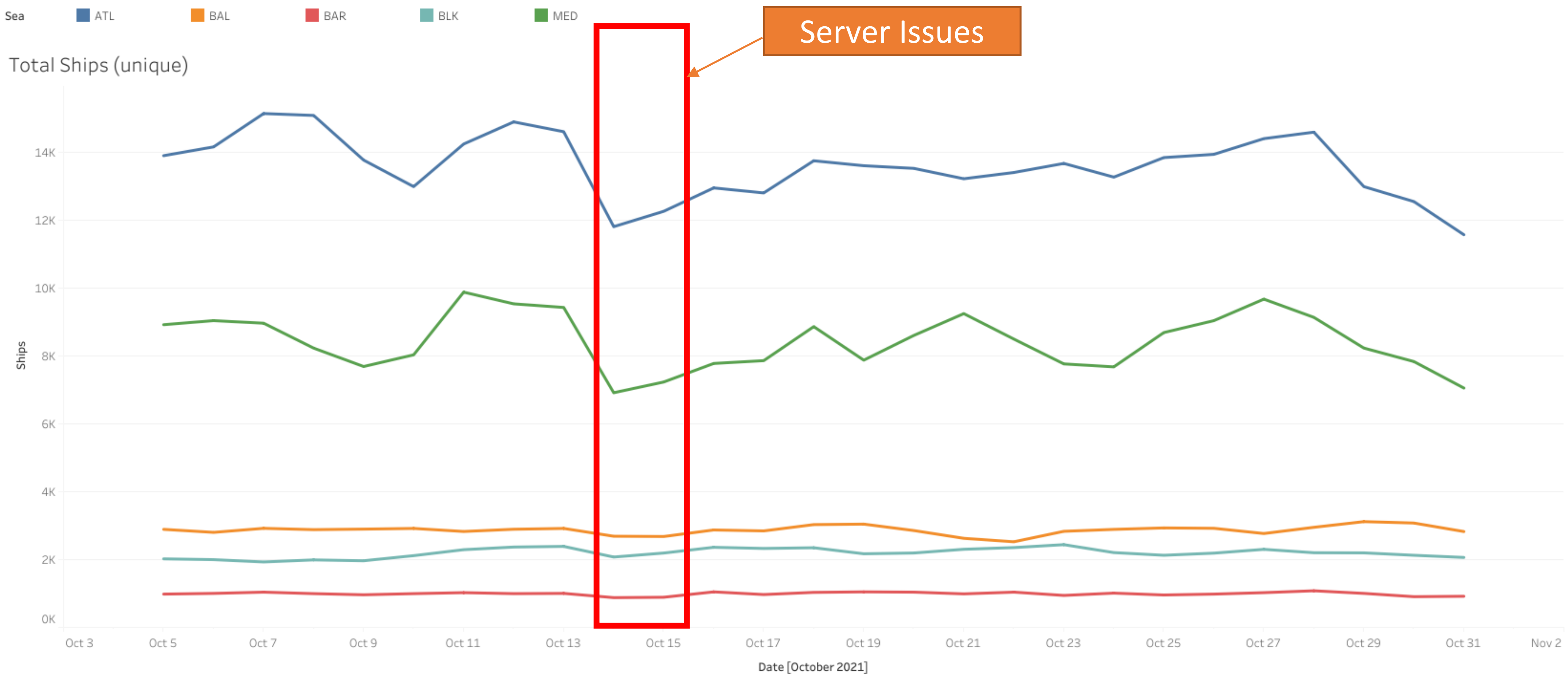
- More precisely the filters applied to each input message are the following:
- Removing data with empty fields
- Invalid movement fields
- Invalid vessel ID
- Special characters
- Downsampling (min 3 minutes)



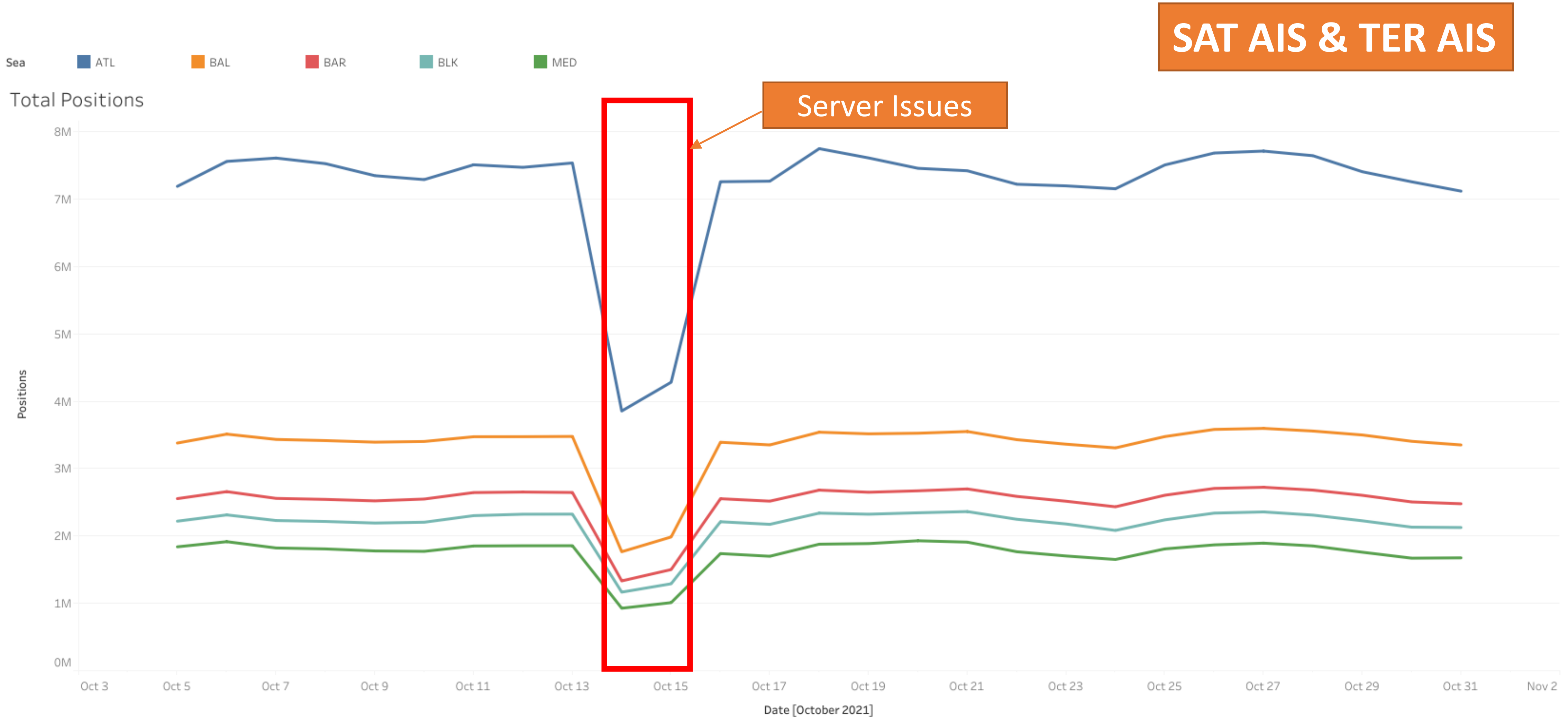
676 GB→ 20GB

Number of unique ships detected daily for each sea

SAT AIS & TER AIS



Number of positions received per day



CLASS A / CLASS B fitness

AIS Class Distribution

		SEA									
		ATL		BAL		BAR		BLK		MED	
Datasource	CLASS	% of Total Positions a..	% of Total Ships alon..	% of Total Positions a..	% of Total Ships alon..	% of Total Positions a..	% of Total Ships alon..	% of Total Positions a..	% of Total Ships alon..	% of Total Positions a..	% of Total Ships alon..
sat-ais-all-merged	A	98.03%	76.54%	100.00%	99.17%	96.69%	60.95%	99.81%	99.51%	99.79%	95.38%
	B	1.97%	23.46%	0.00%	0.83%	3.31%	39.05%	0.19%	0.49%	0.21%	4.62%
ter-ais-merged	A	76.14%	61.71%	82.14%	59.26%	53.87%	60.62%	63.75%	65.91%	76.37%	62.94%
	B	23.86%	38.29%	17.86%	40.74%	46.13%	39.38%	36.25%	34.09%	23.63%	37.06%

Our focus is on CLASS A

The tools are released open source

MarineTraffic Research

ABOUT PUBLICATIONS PARTNERSHIPS OUTREACH TOOLS & DOWNLOADS NEWS CAREERS

The MarineTraffic AIS toolbox

An open-source tool developed from Marinetraffic Reseach

The MarineTraffic AIS toolbox provides a number of modules to support handling AIS data while improving their transformation into actionable visualisations such as density maps. The code is written in python for simplicity, readability and overall ease of use. We look forward to seeing what people do with the MarineTraffic Toolobox and would like to hear your comments.

We will be releasing the software as a beta version over the next few weeks because we wanted to get feedback as soon as possible.

Tutorial Repository

Acknowledgement:

This work has been partially funded by the *European Maritime and Fisheries Fund (EMFF)* through service contract *No. CINEA/EMFF/2020/3.1.16/Lot2/SI2.850940*. The following people helped make the open source release possible: *Alexandros Troupiotis, Marios Vodas, Nikolaos Zugouras, Giannis Spiliopoulos*

AIS Cleaning Module

Trajectories are never perfectly accurate due to sensor noise and other factors. In most situations it is necessary to apply algorithmic techniques to the data to smooth the noise and potentially decrease the error in the measurements.

This module also includes a number of simple data reduction techniques. The main objective of such trajectory reduction techniques is to reduce the size of the dataset so as to make it operable without compromising too much of its precision.

This module reads data as csv, it applies filters and delivers the cleaned data-set into the same csv format. The filters applied include removing empty fields, invalid movement data, invalid vessel details, special characters and downsampling the data according to user defined parameters.

Tutorial

Density Maps Module

Density Maps support the improved understanding of vessel traffic, through providing a bird's eye view of vessel behavior either at a regional or global scale.

The term "vessel density" has several co-notations and thus is used with several meanings in this domain. Therefore, vessel density can refer to

1. *the average number of vessels detected within a defined geographical area (spatial grid) in a given timeframe;*
2. *the average number of crossings within a defined geographical area (spatial grid) in a given timeframe (often also referred to as "vessel traffic density");*
3. *the total vessel presence times within a defined geographical area (spatial grid) in a given timeframe;*

Here we refer to vessel density as total presence time.AIS is the most commonly used dataset for the generation of density maps. This module provides a number of functions for the conversion of AIS data into density maps.

The input is AIS csv while the output is geotiff in 1 km^2,10 km^2, 100 km^2 or any other km2^2 resolution defined in the configuration.

Tutorial

https://www.marinetraffic.com/research/the-marinetraffic-ais-toolbox/

Vessel detection from space

Interim Presentation

Presenter: Konstantina Bereta

Analysis & Preliminary Results

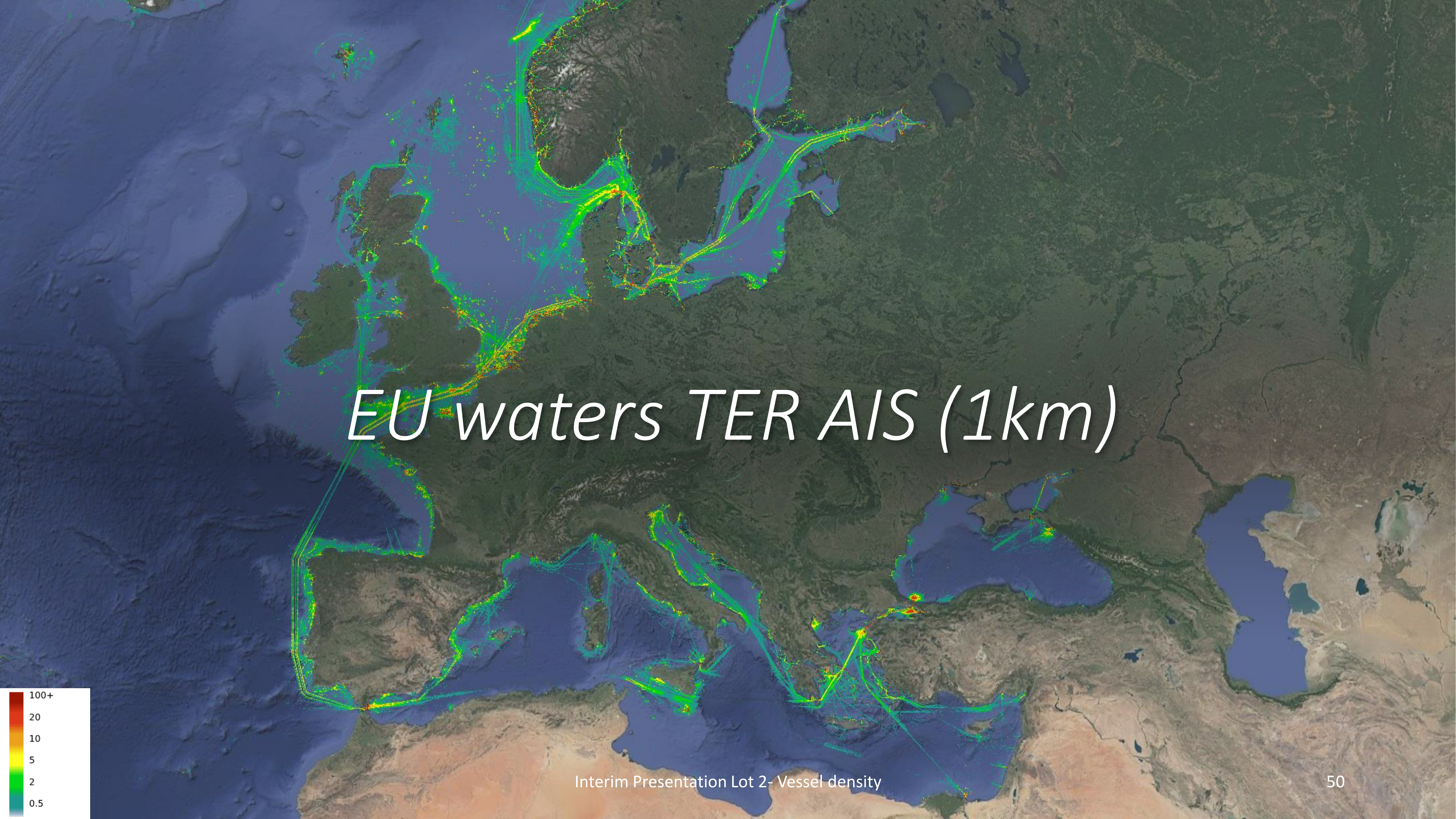
Interim Presentation

Presenter: Dimitris Zissis (dzissis@marinetraffic.com)

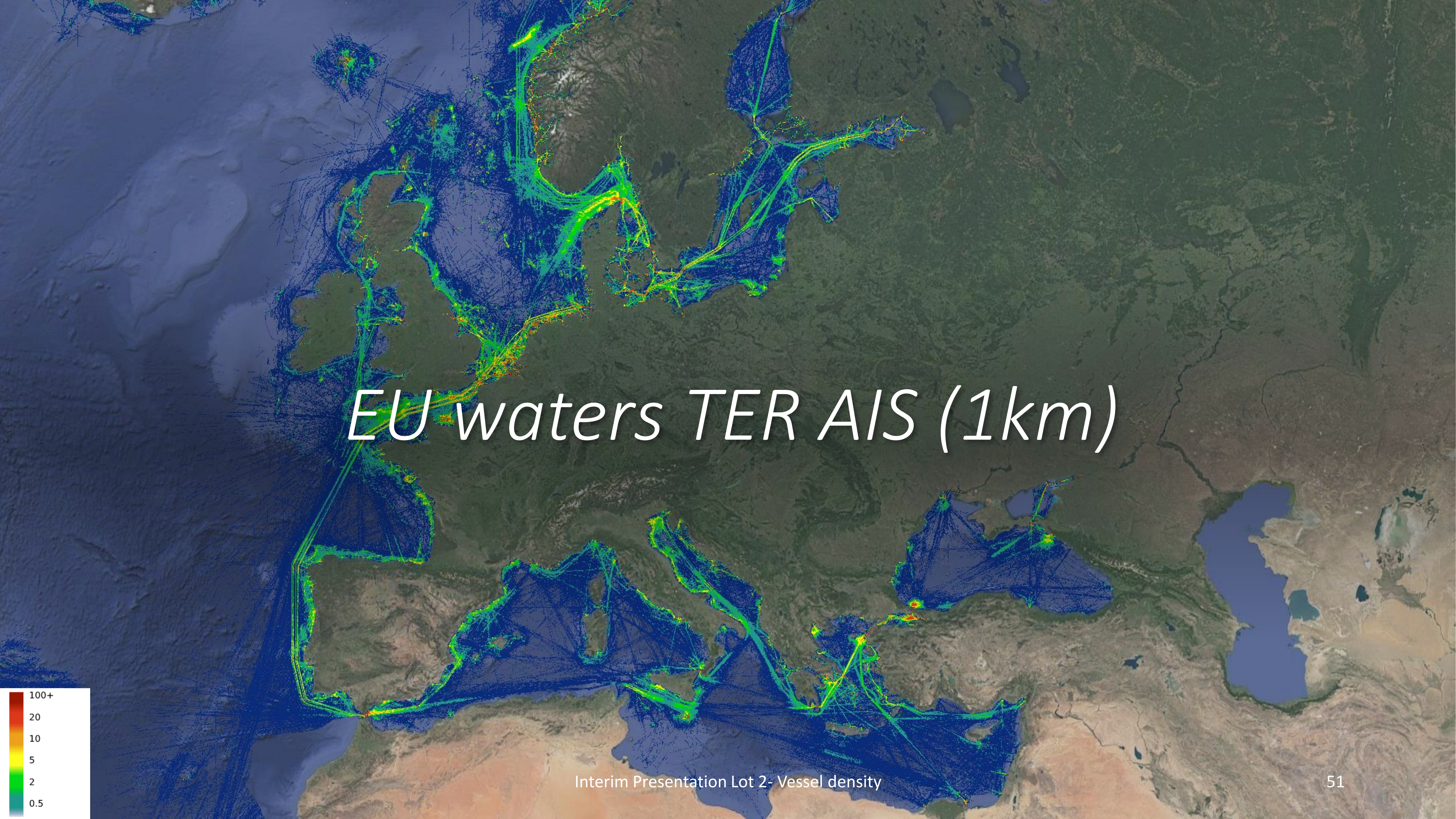
MarineTraffic

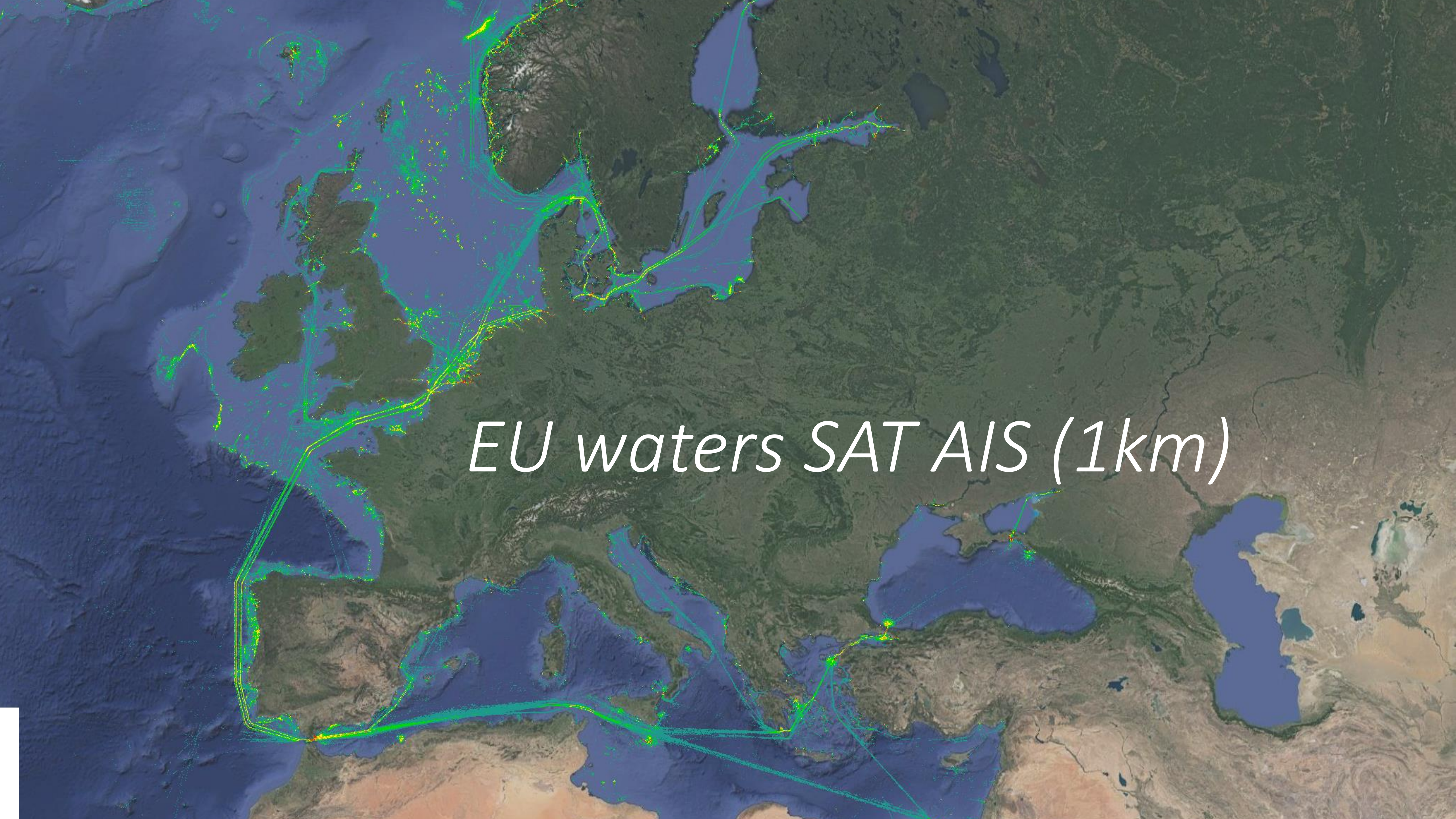
UBITECH ubiquitous solutions

EU waters TER AIS (1km)

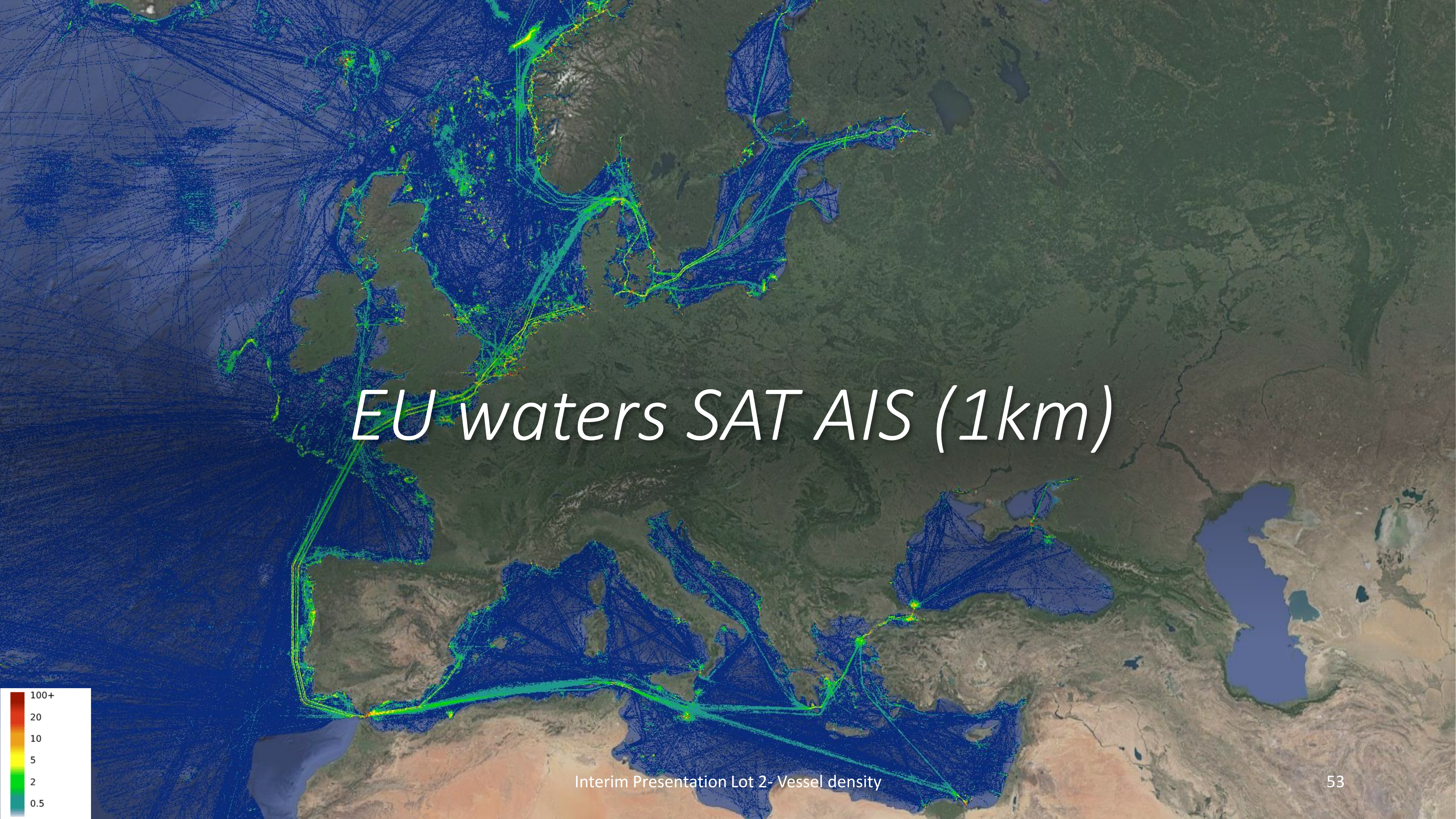


EU waters TER AIS (1km)

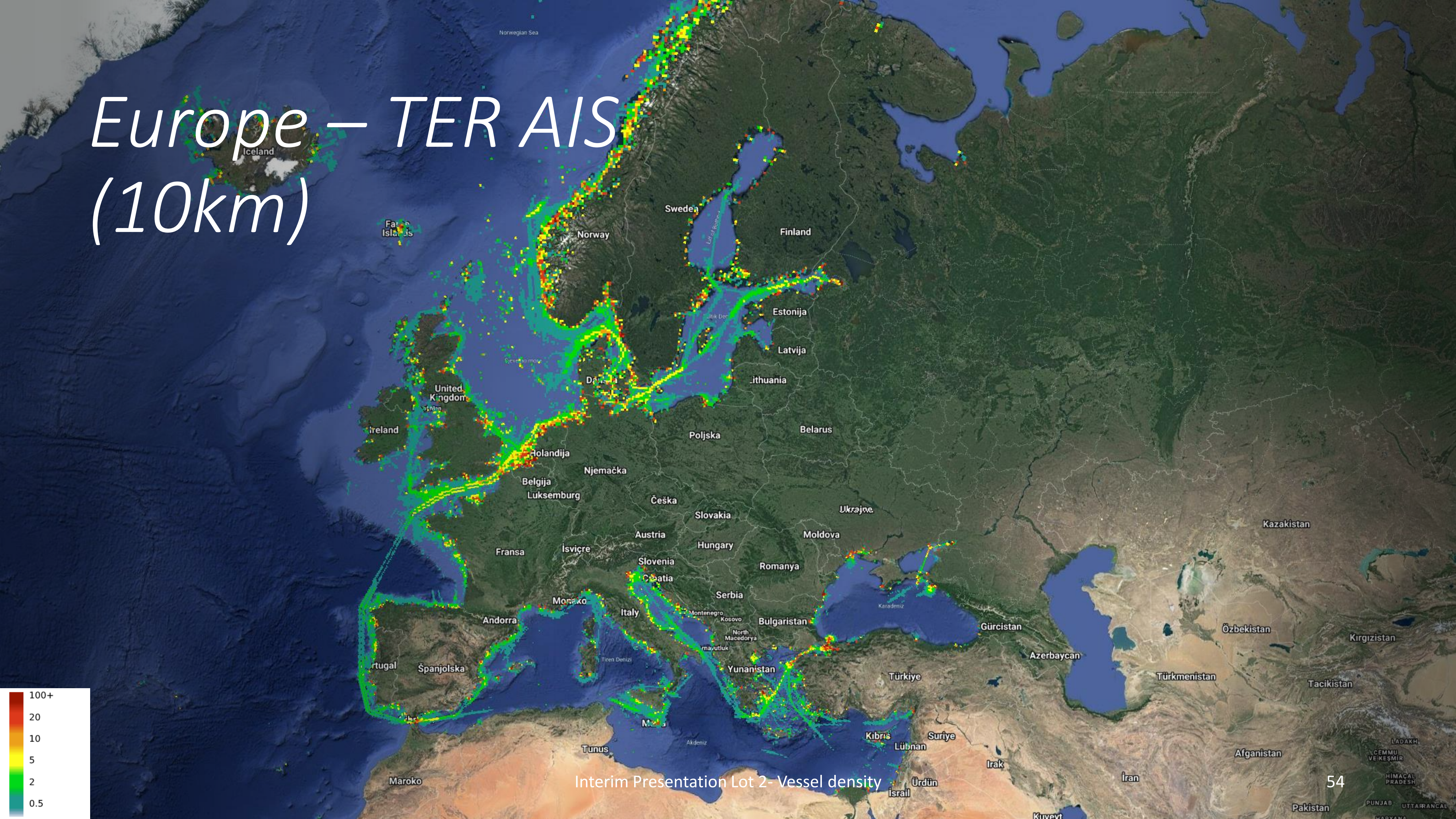



EU waters SAT AIS (1km)

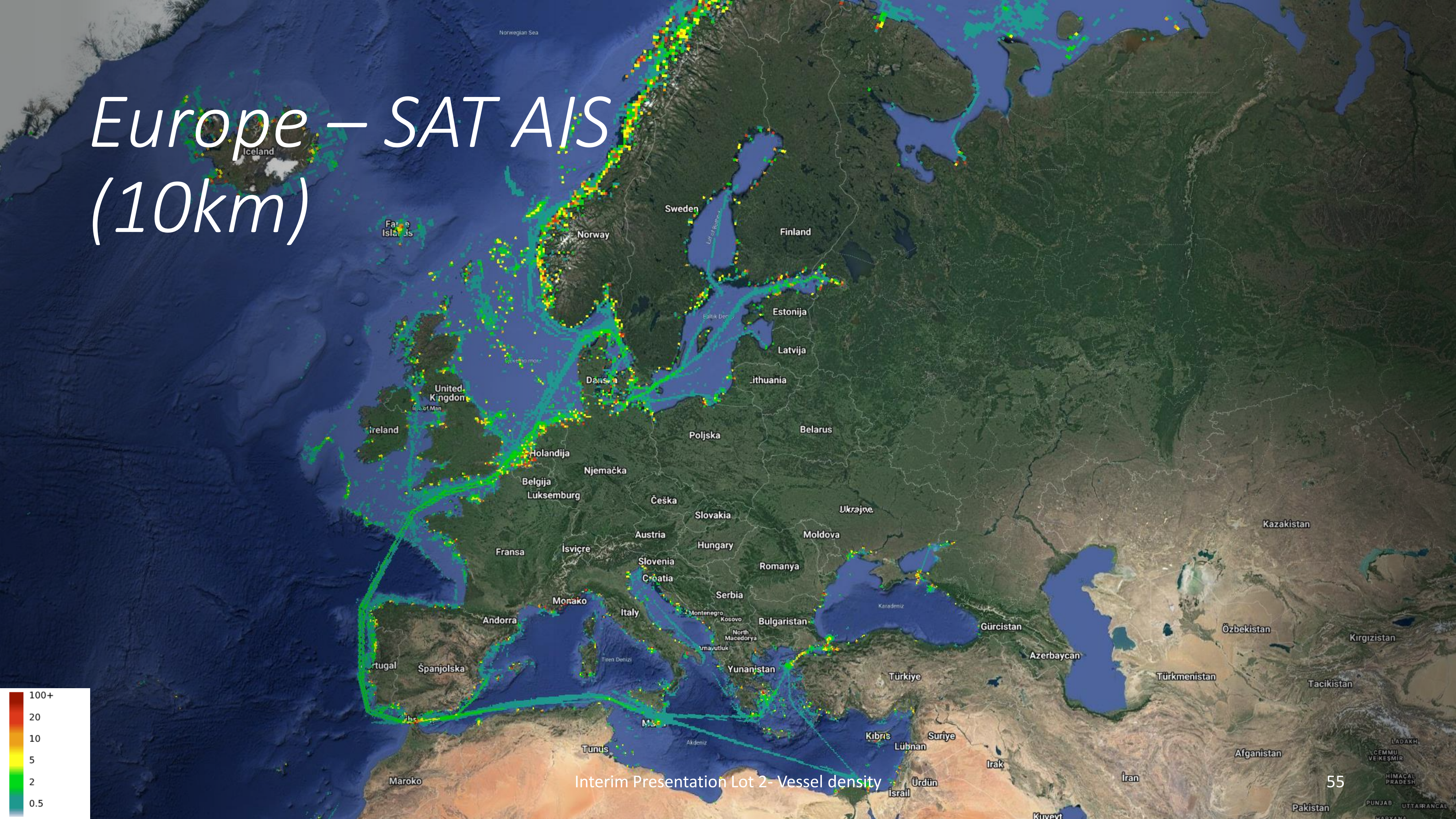
EU waters SAT AIS (1km)



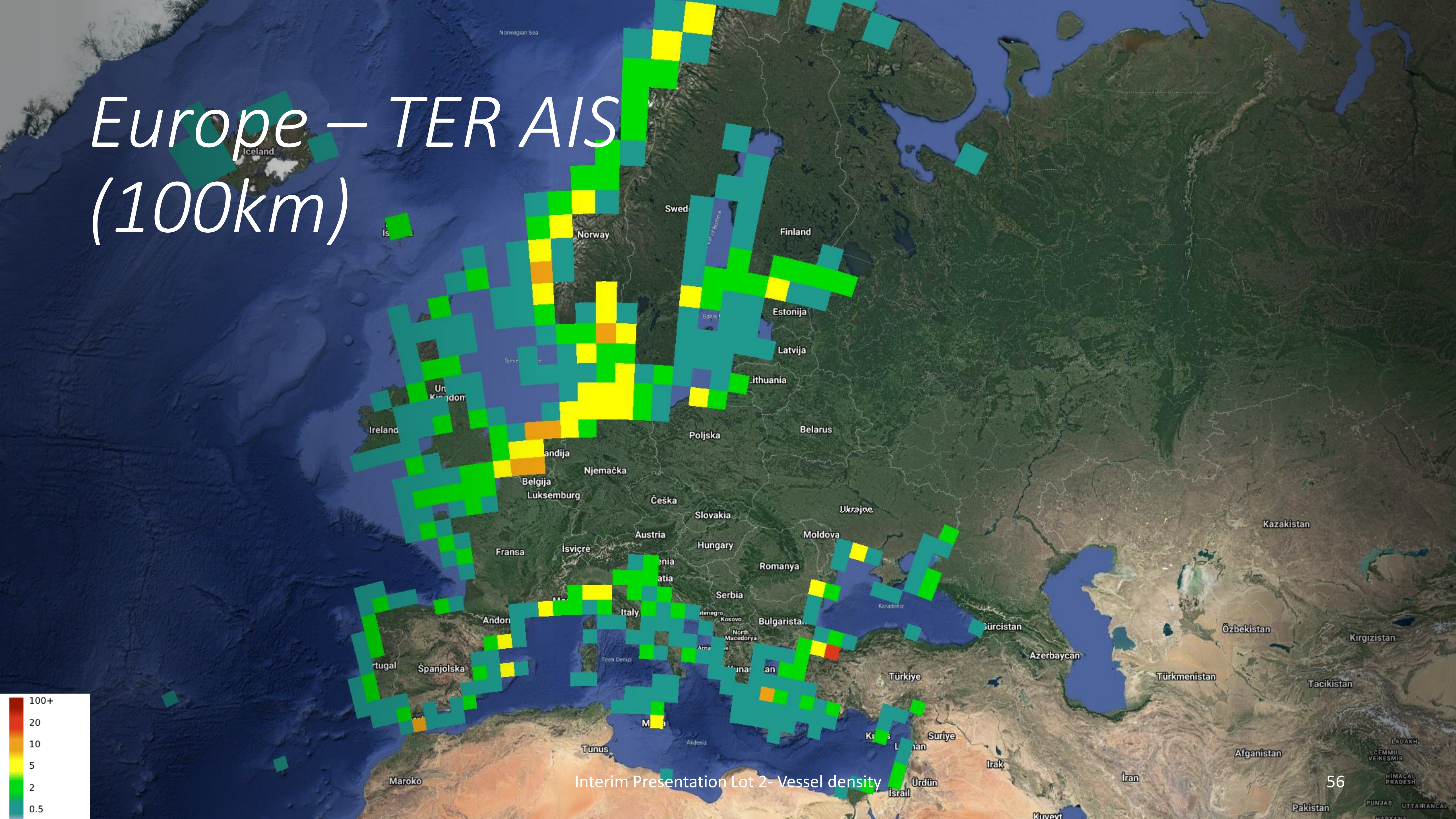
Europe – TER AIS (10km)



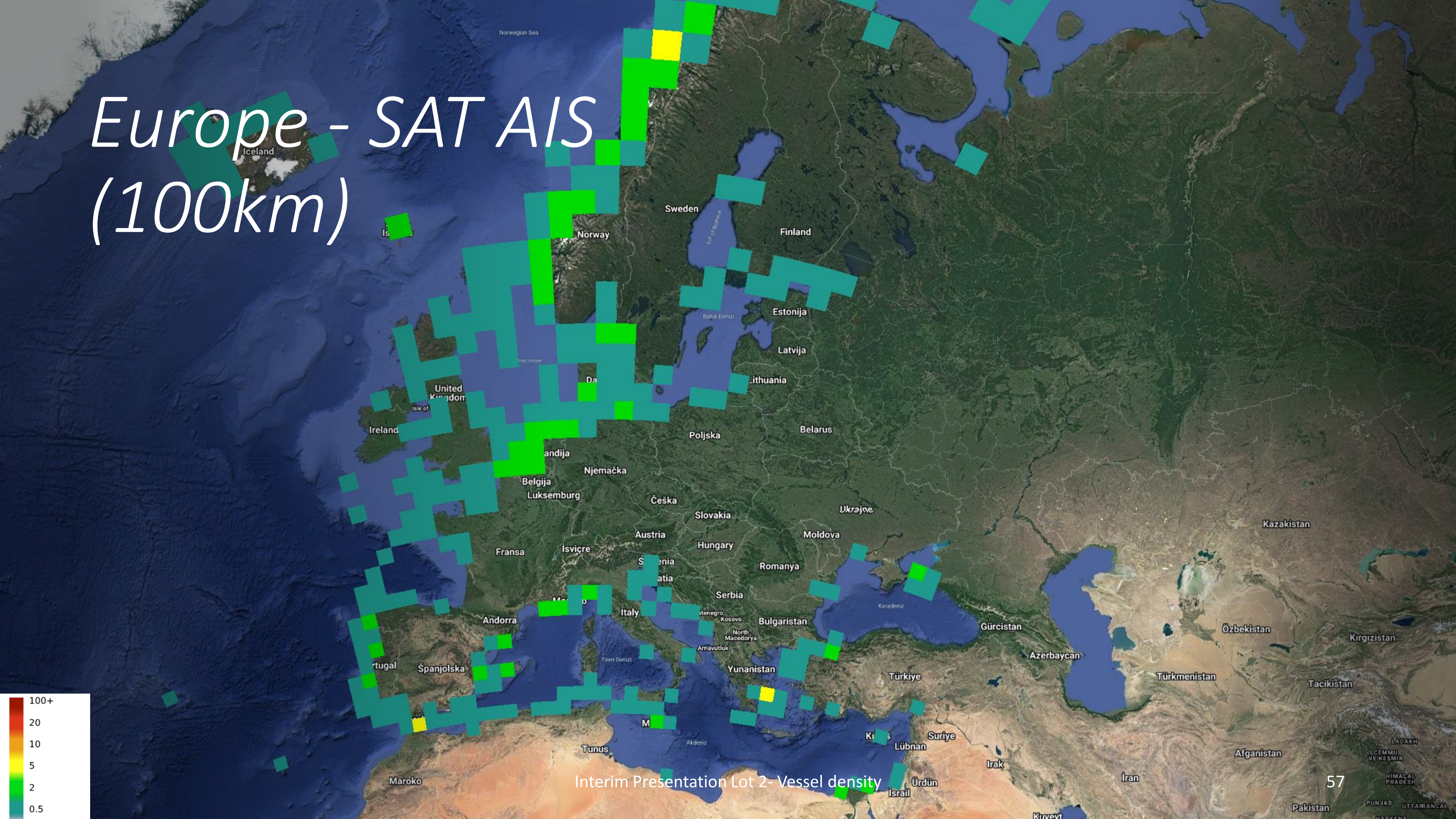
Europe – SAT AIS (10km)



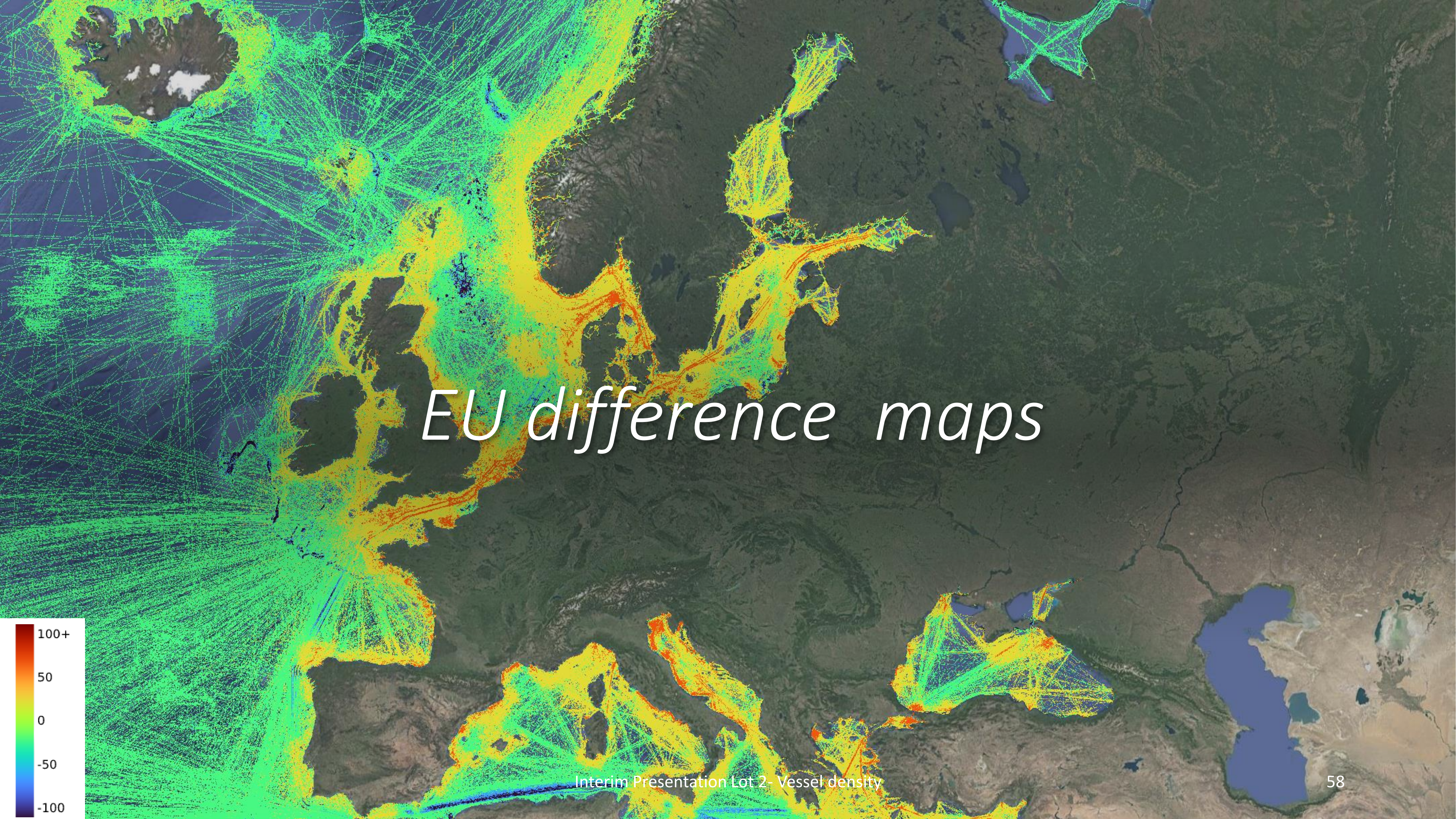
Europe – TER AIS (100km)



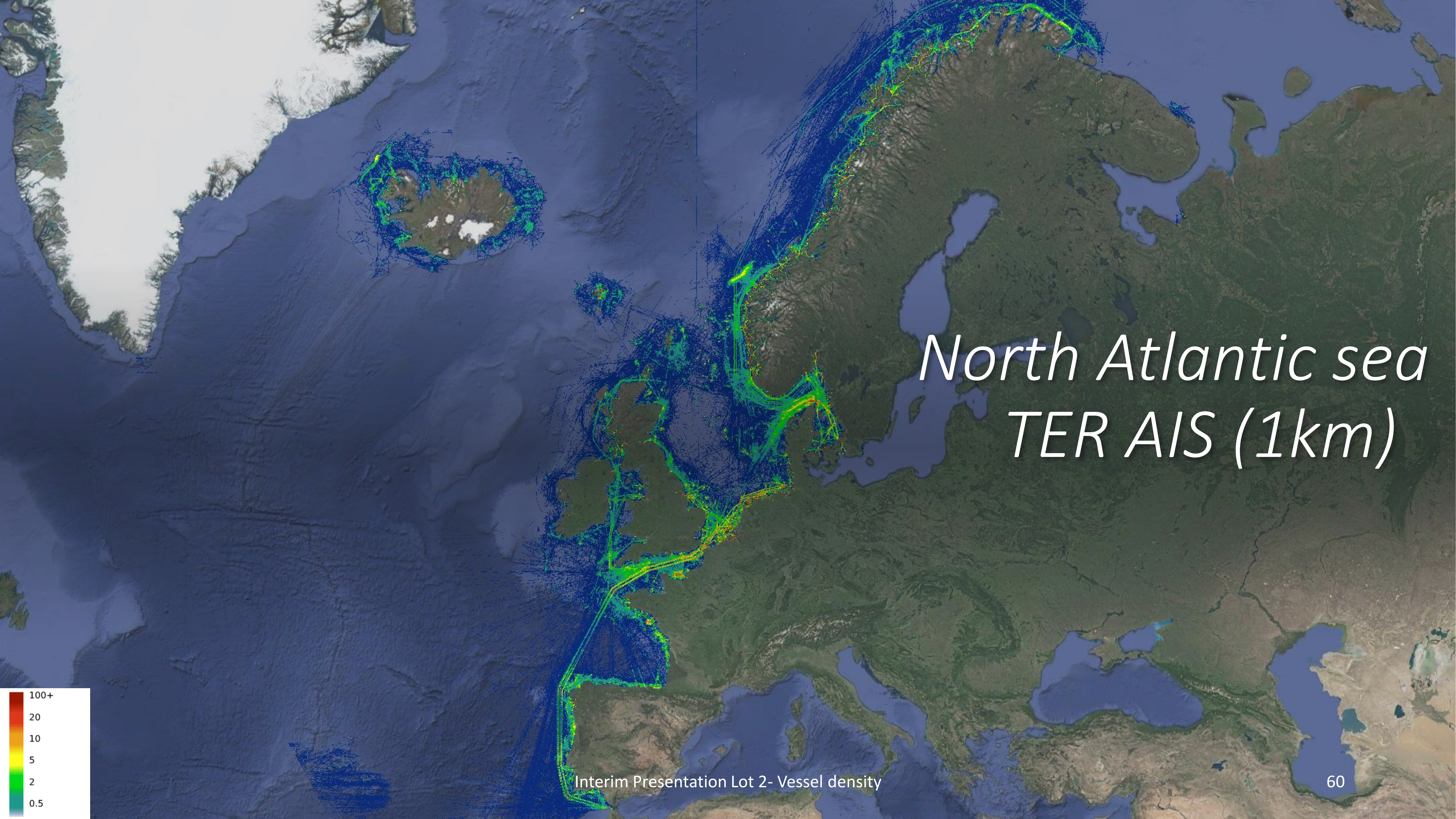
Europe - SAT AIS (100km)



EU difference maps

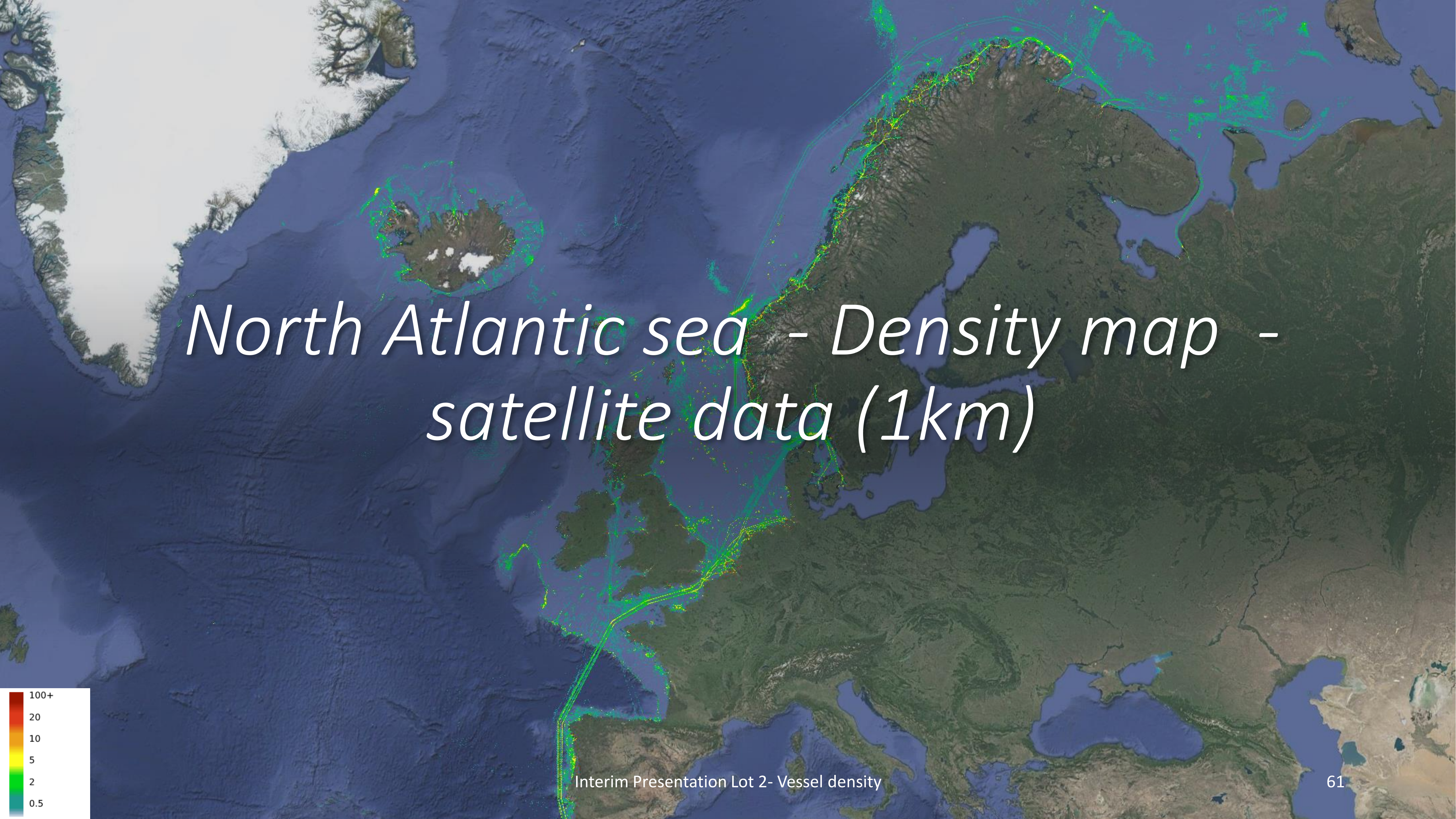


North Atlantic sea TER AIS (1km)



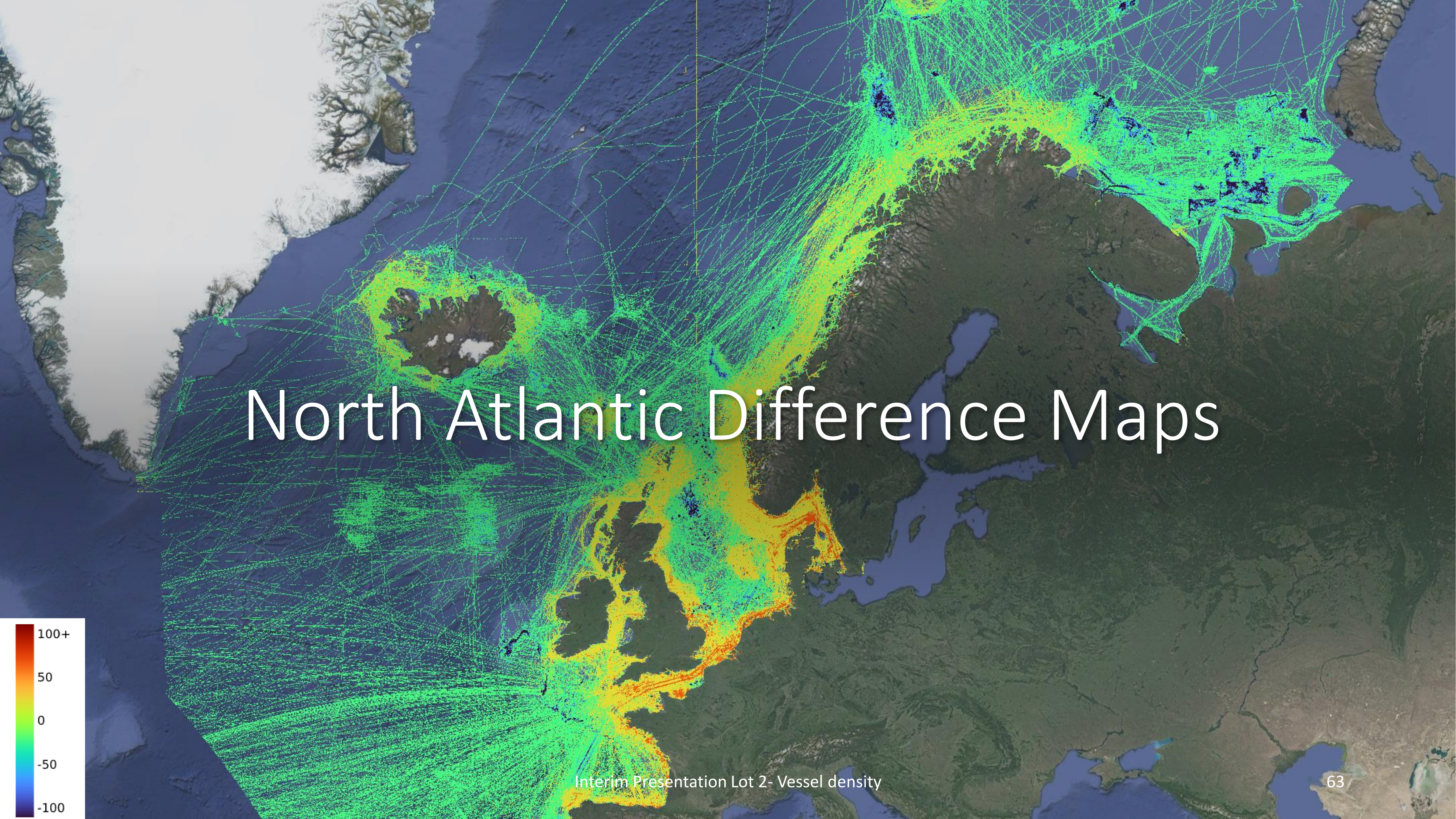
North Atlantic sea TER AIS (1km)

North Atlantic sea - Density map - satellite data (1km)




North Atlantic sea - SAT AIS(1km)
100+
20
10
5
2
0.5

North Atlantic Difference Maps



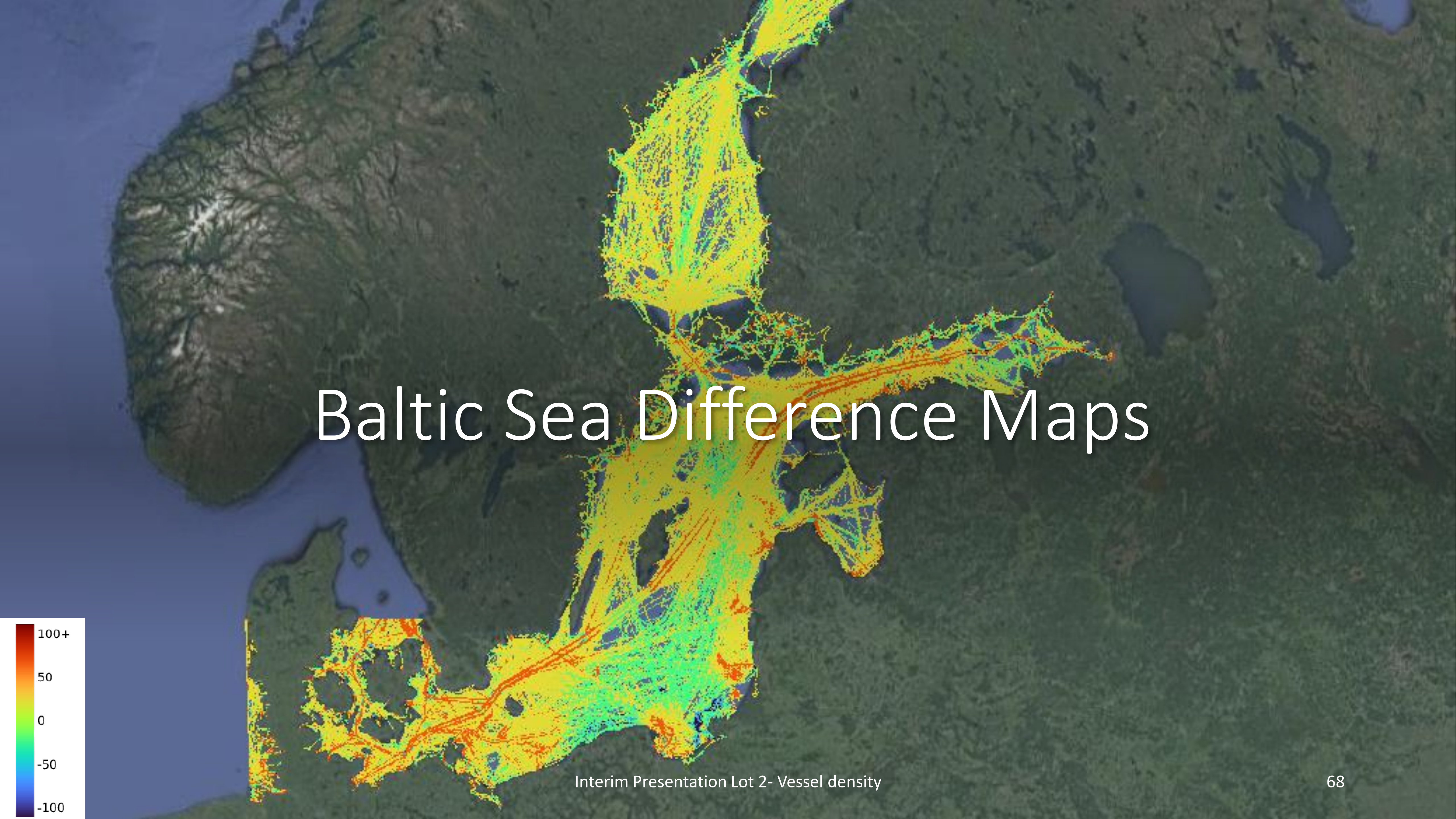
Baltic sea - *TER AIS(1km)*

Baltic sea - *TER AIS(1km)*

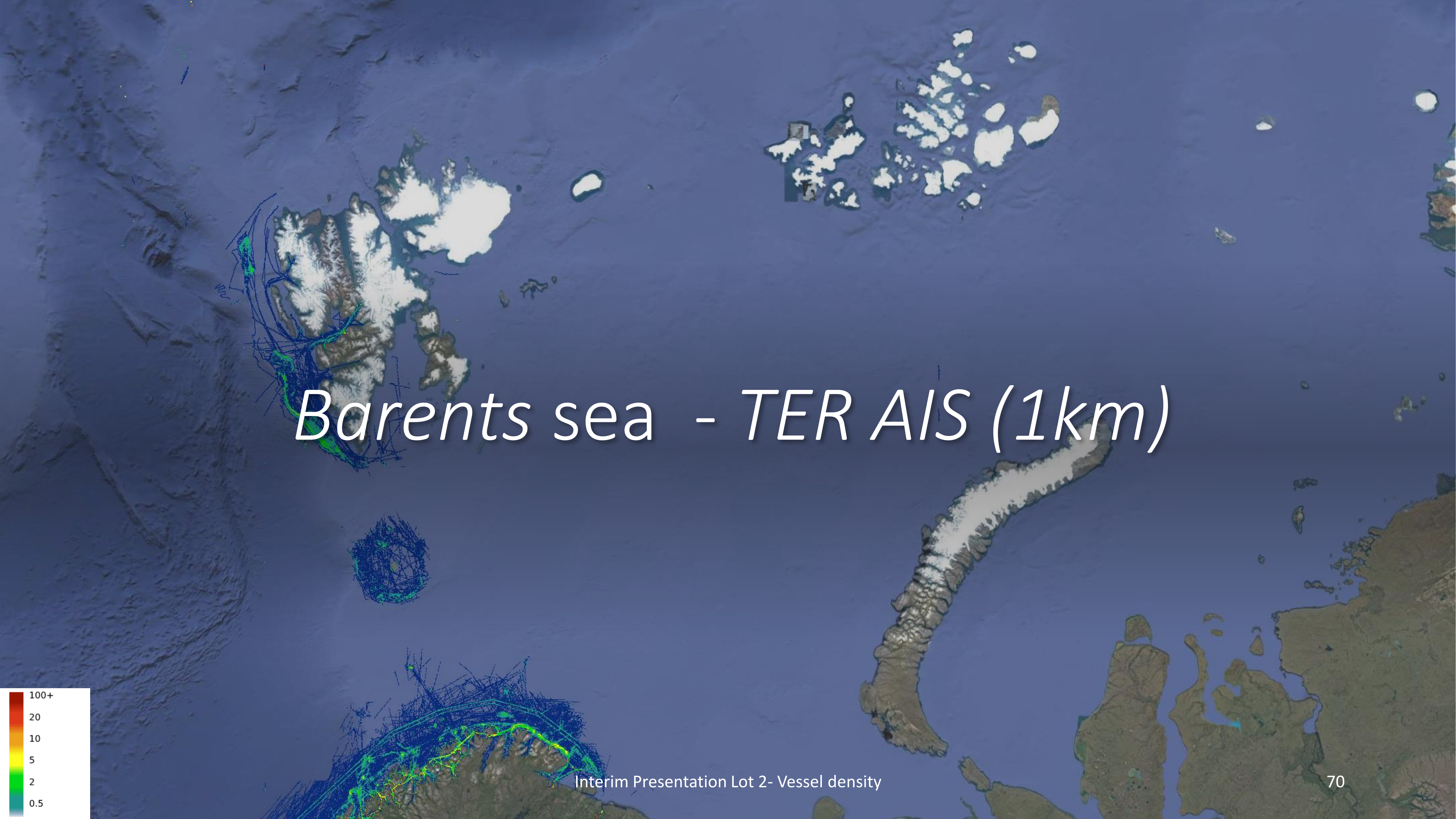
Baltic sea - *SAT AIS (1km)*

Baltic sea - *SAT AIS(1km)*

Baltic Sea Difference Maps

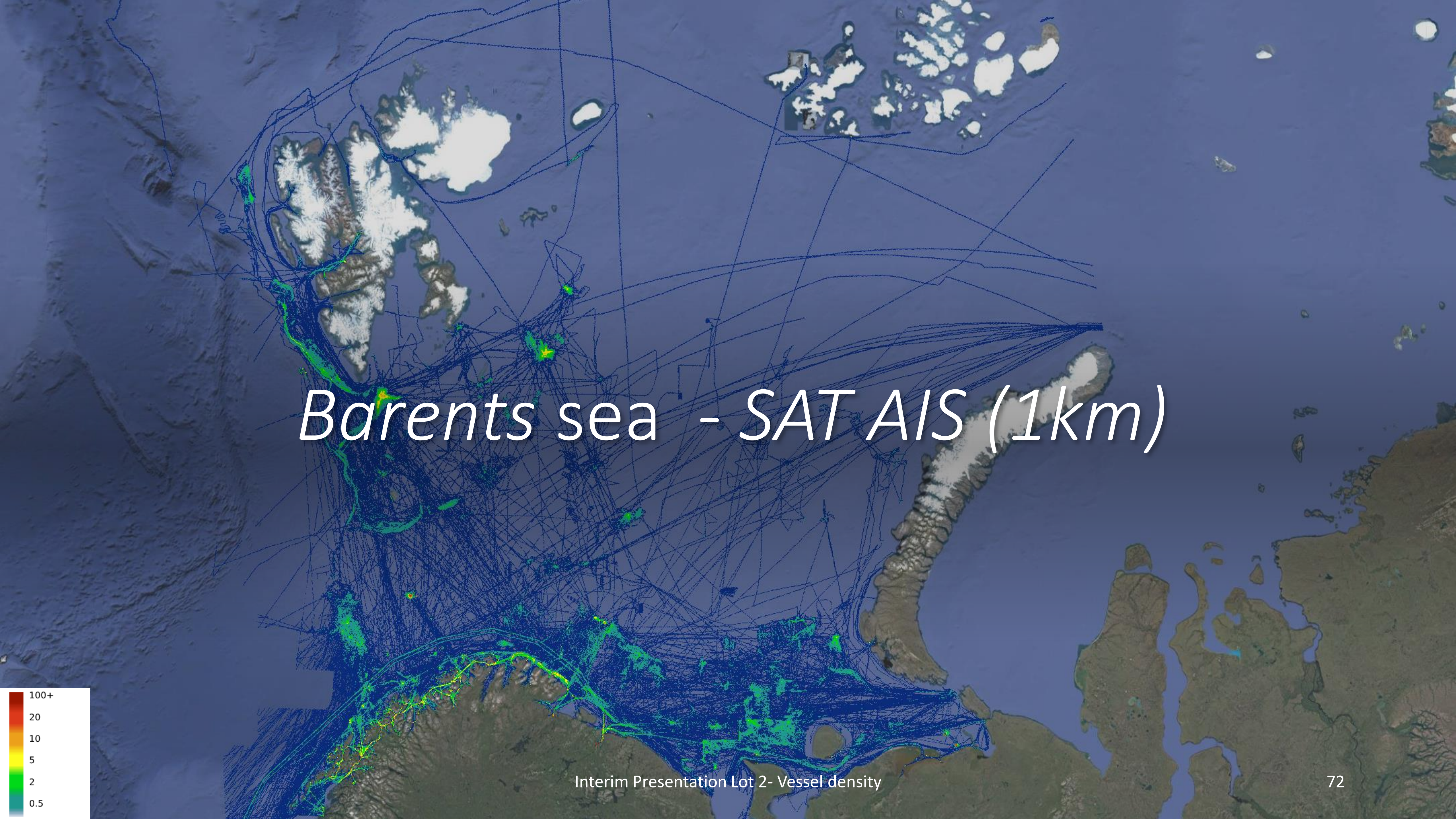


Barents sea - *TER AIS (1km)*

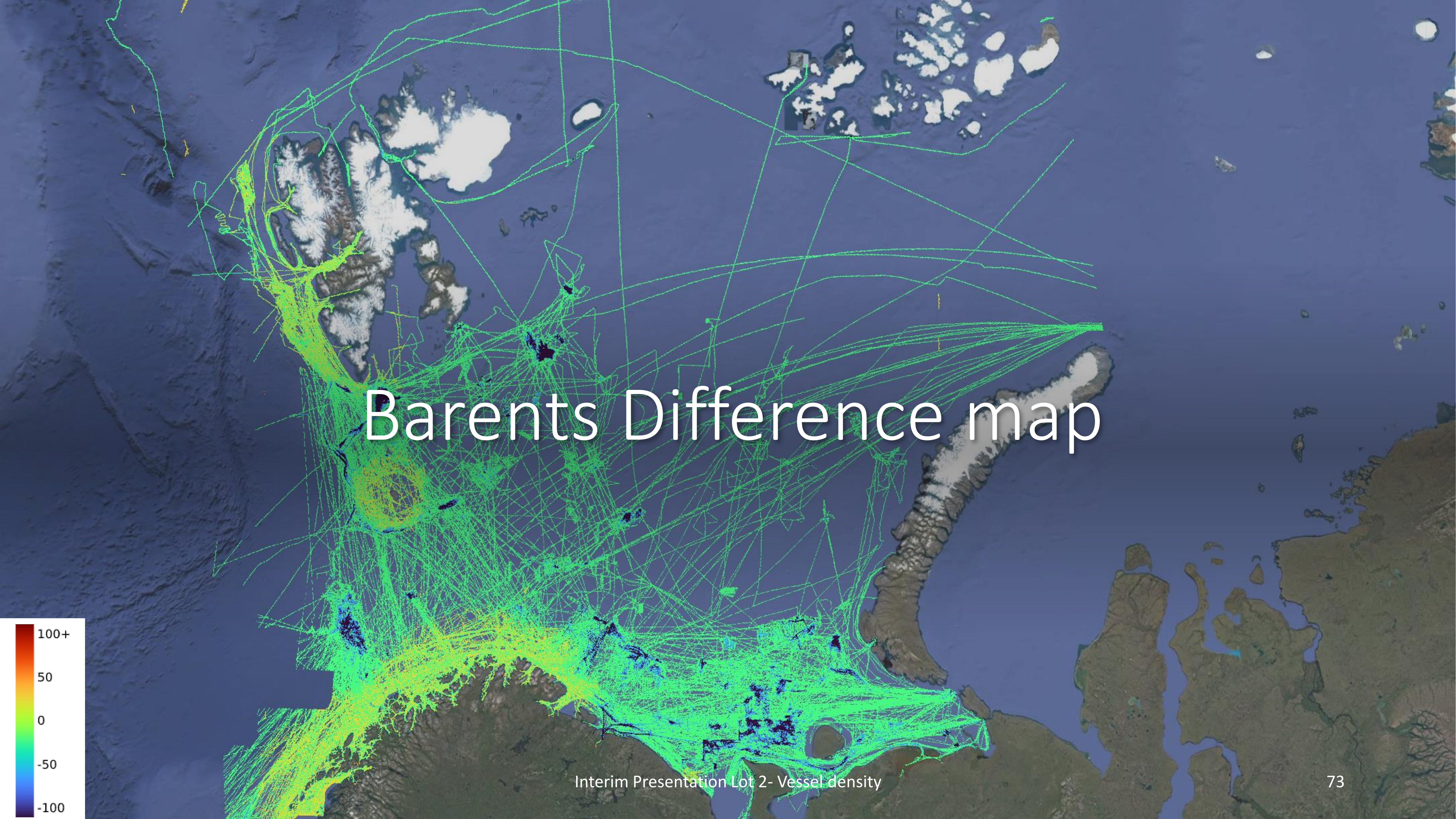

Barents sea - TER AIS (1km)
100+
20
10
5
2
0.5

Barents sea - SAT AIS (1km)

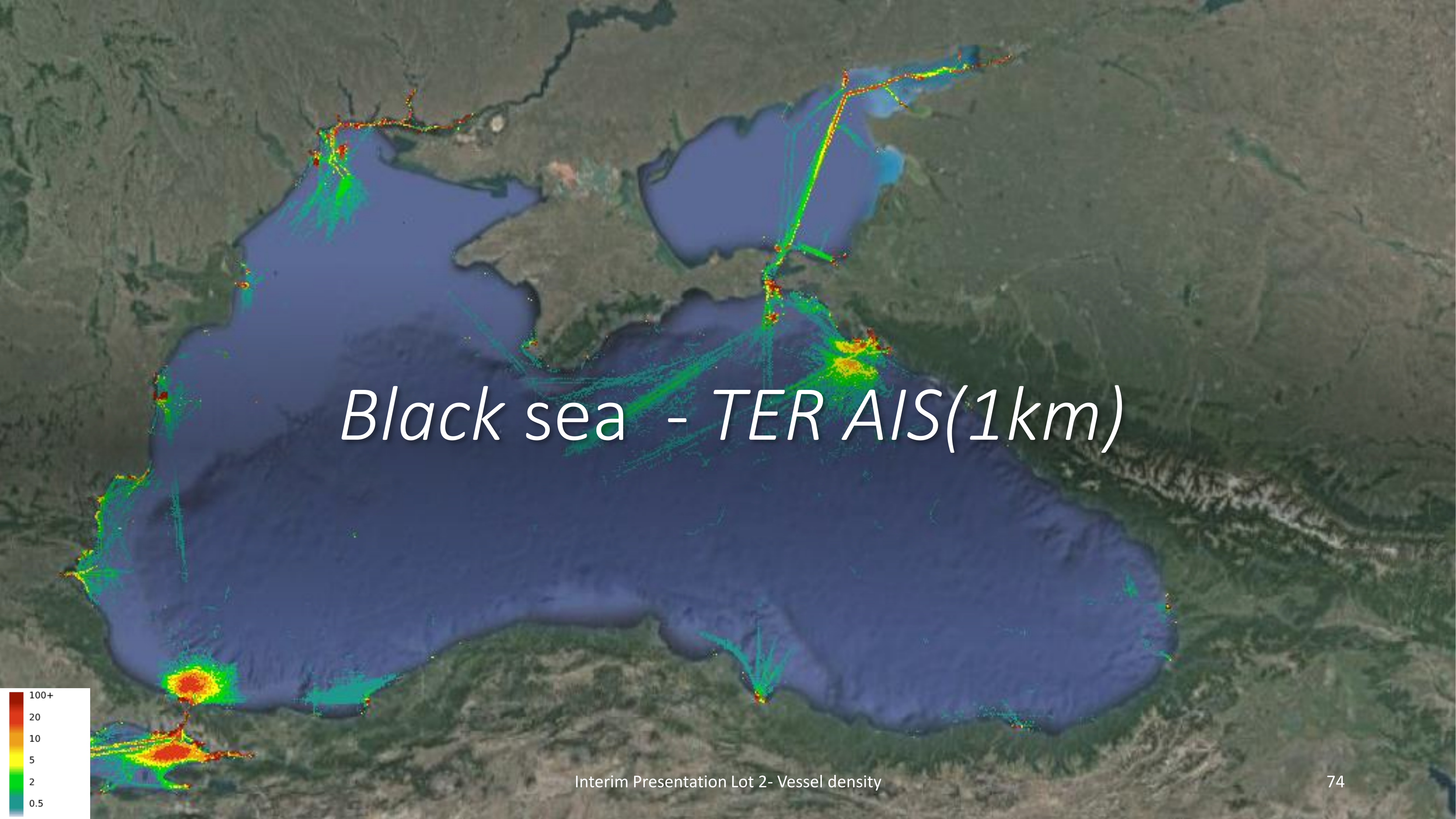
Barents sea - SAT AIS (1km)



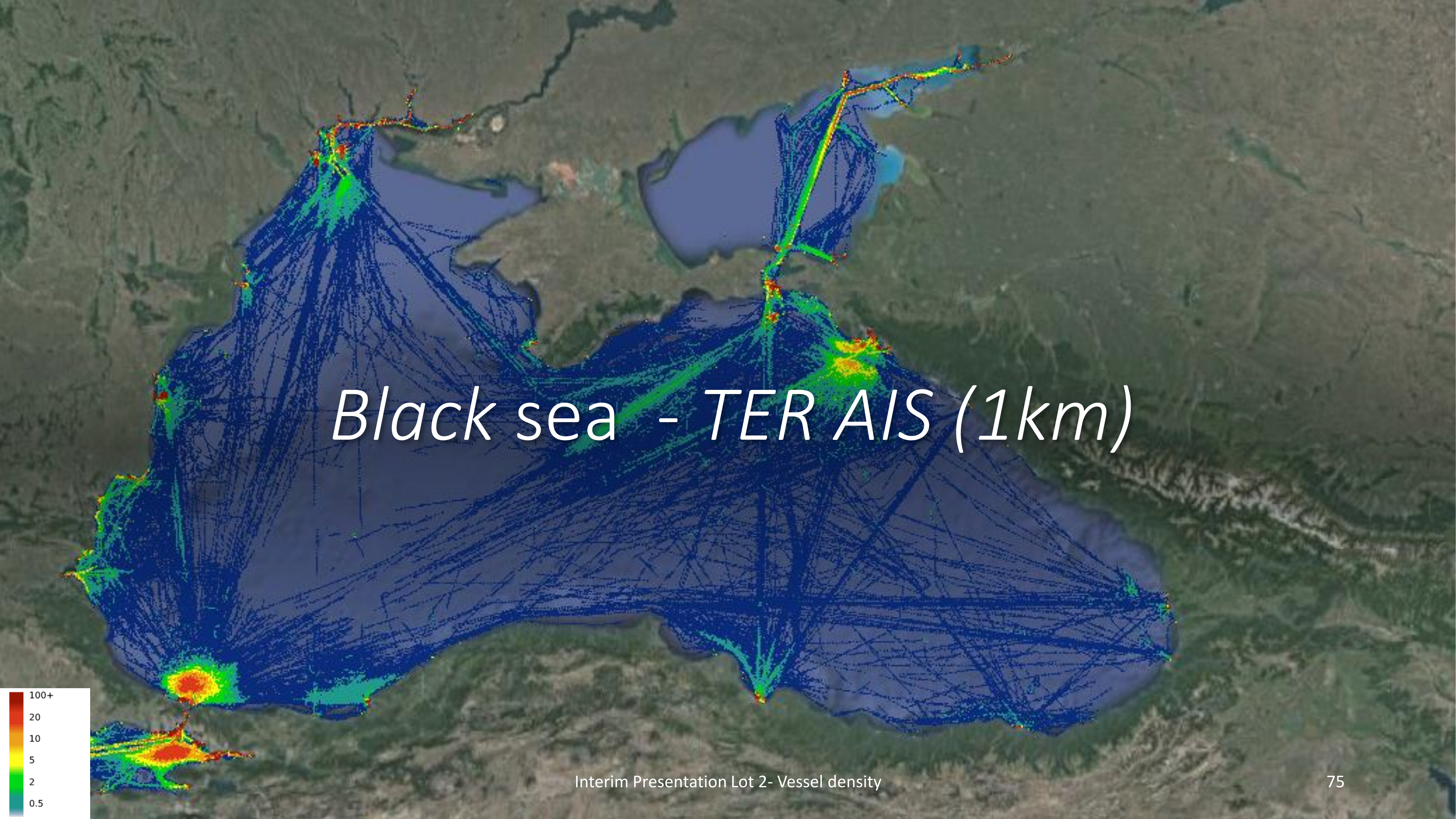
Barents Difference map



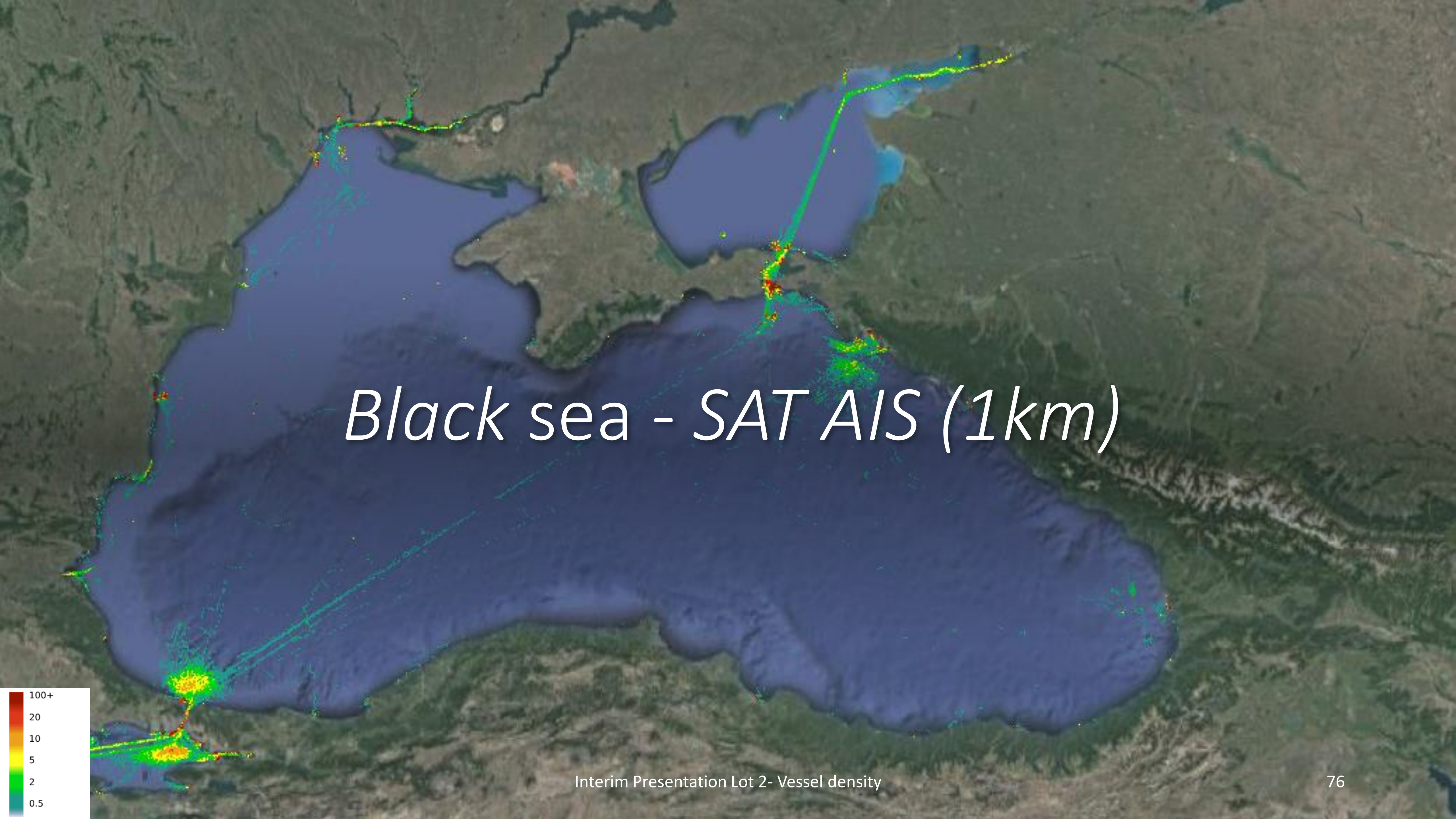
Black sea - TER AIS(1km)

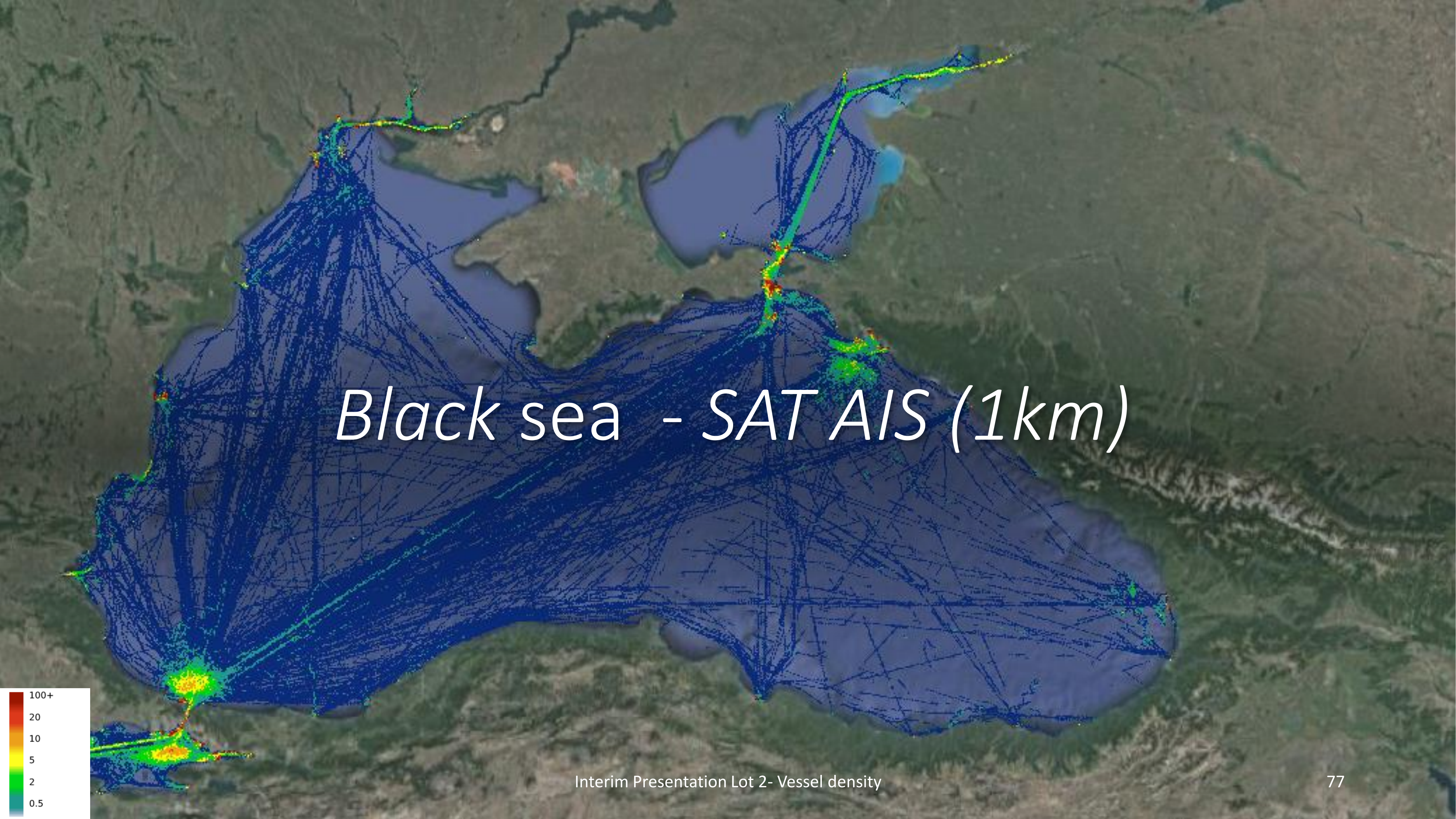


Black sea - TER AIS (1km)

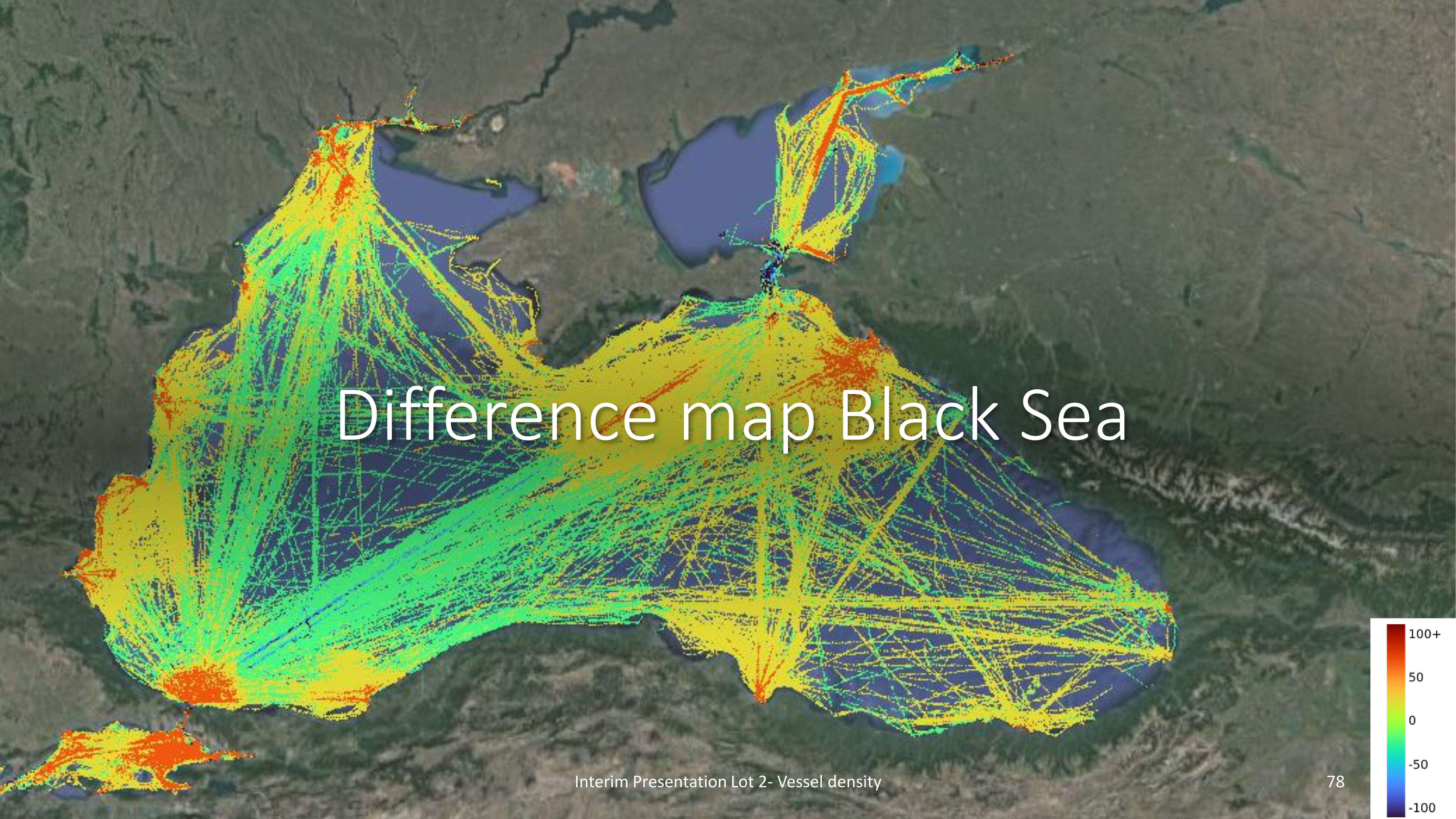


Black sea - *SAT AIS (1km)*

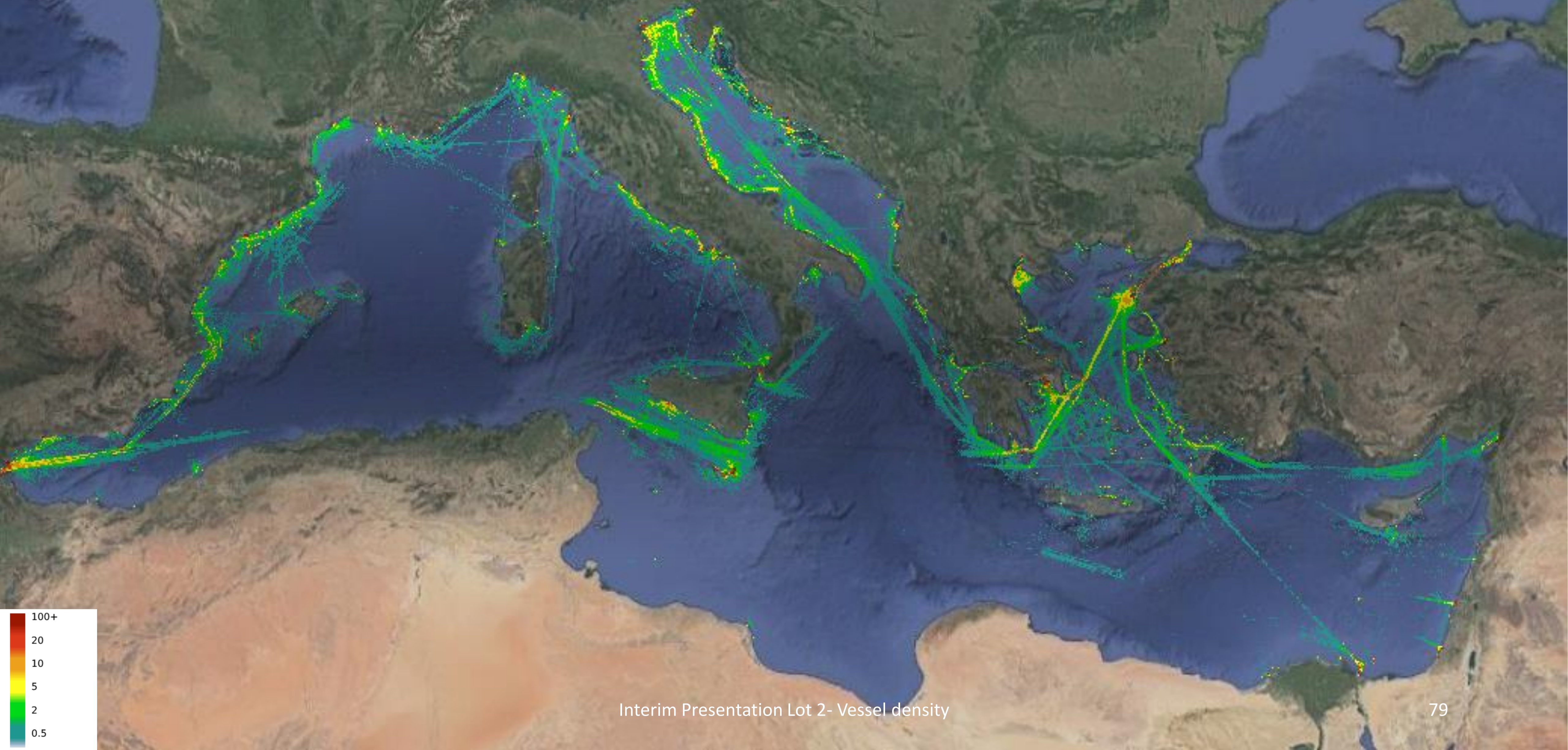



Black sea - SAT AIS (1km)
100+
20
10
5
2
0.5

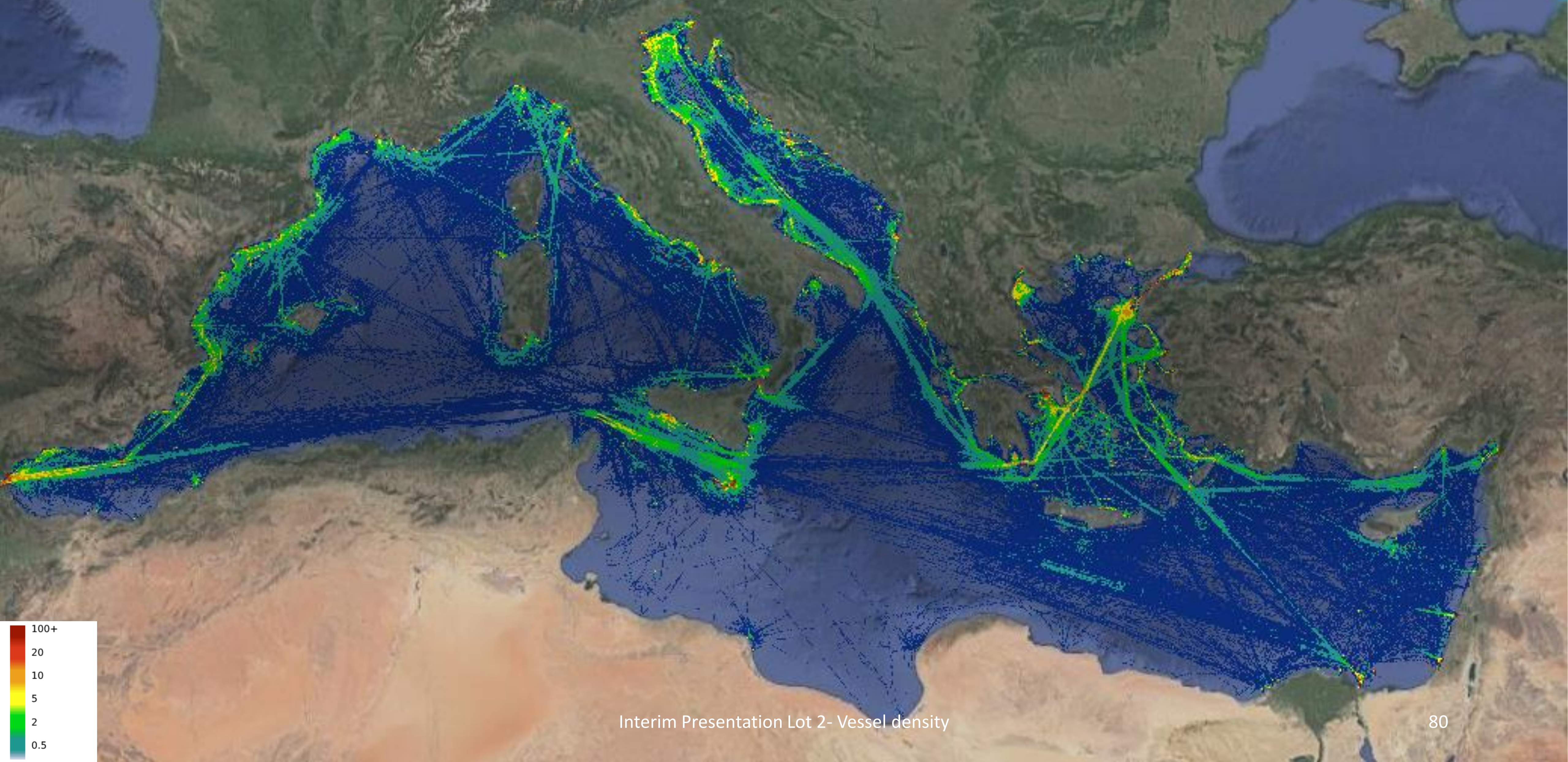
Difference map Black Sea



Mediterranean sea - TER AIS (1km)

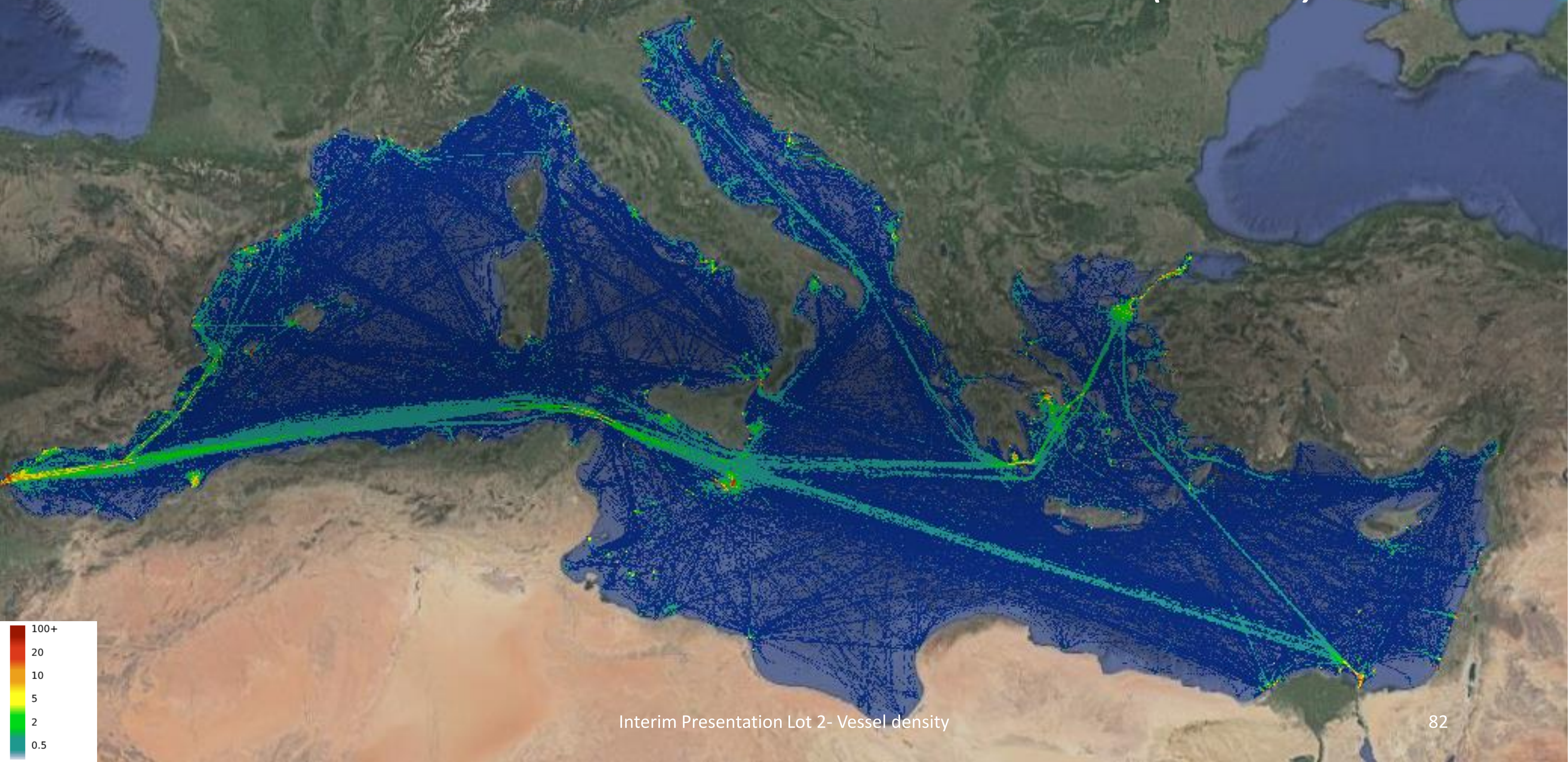


Mediterranean sea - TER AIS (1km)

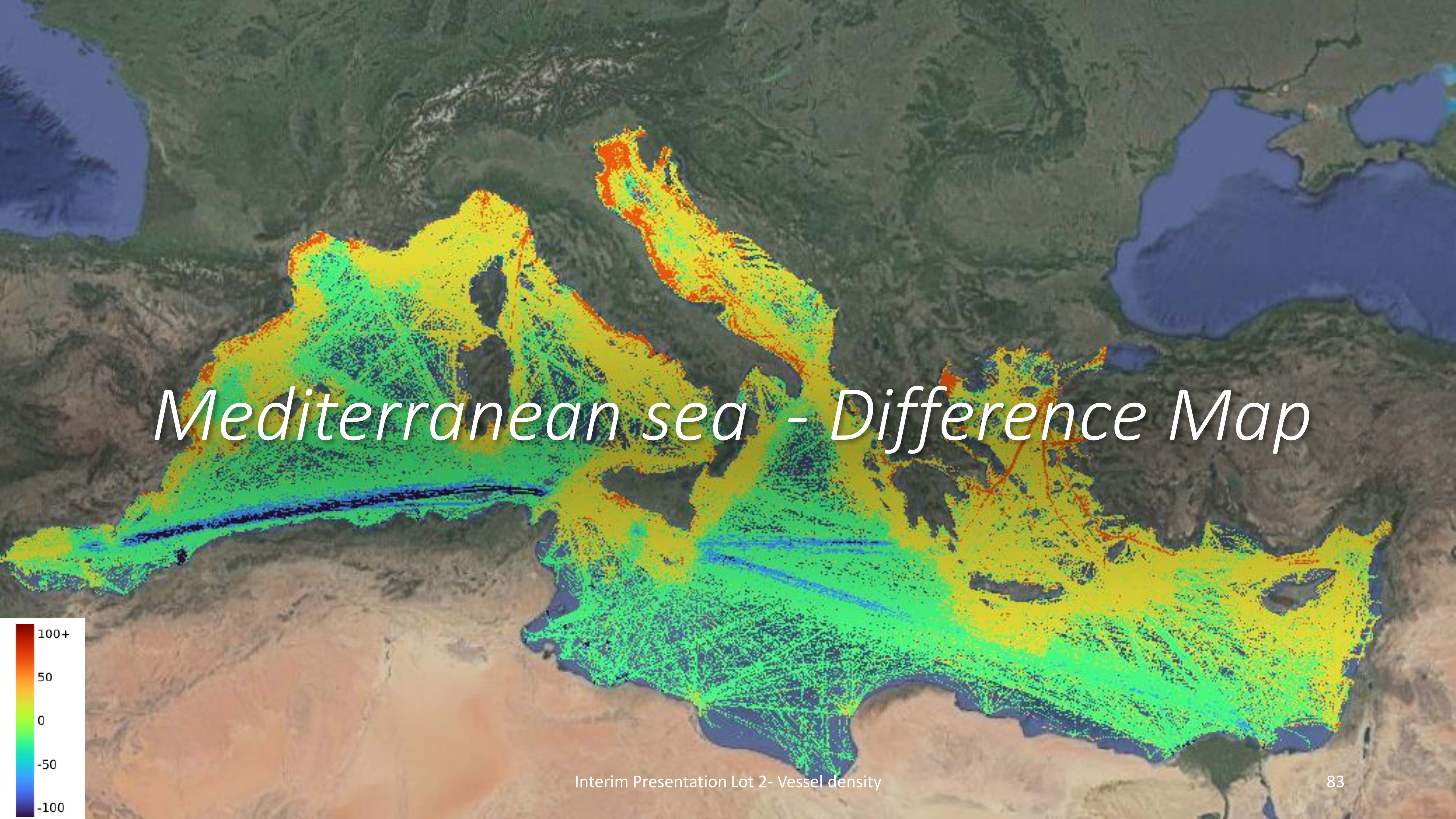


Mediterranean sea - SAT AIS (1km)

Mediterranean sea - SAT AIS (1km)



Mediterranean sea - Difference Map



Some important findings

EU Waters

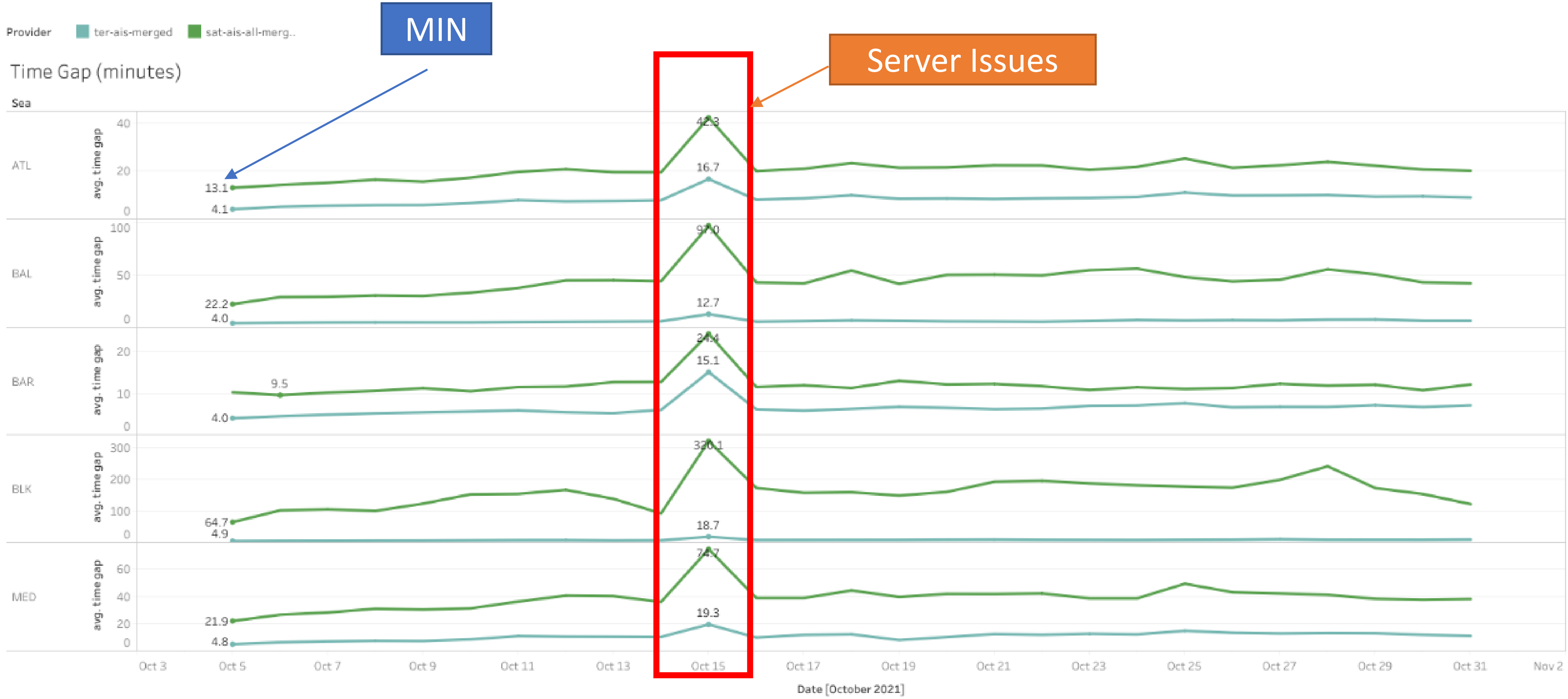
- >45% geographically covered by TER AIS
- >80% SAT AIS

Some important findings

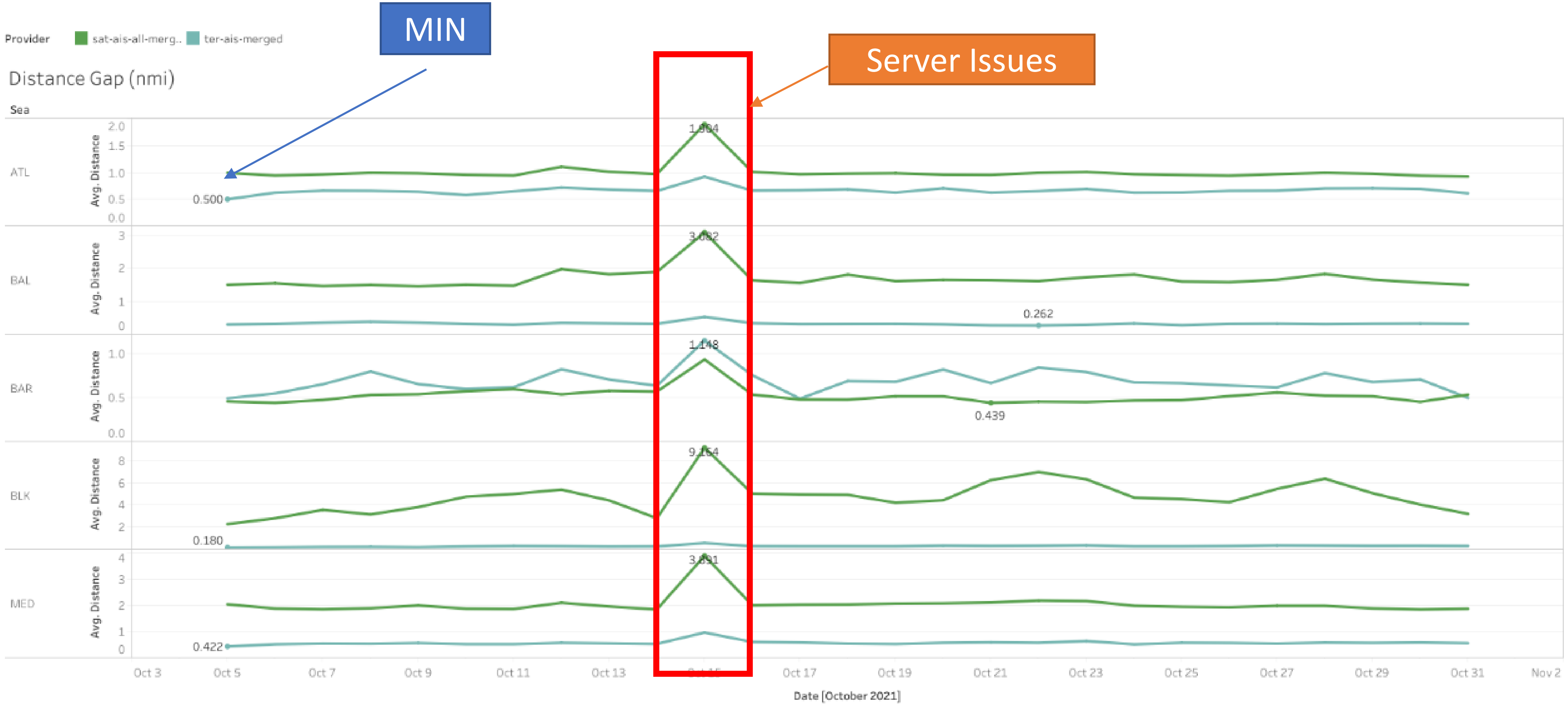
EU Waters

- No single data source can be used
- Each source complements the other

Average time gap between two sequential AIS messages of a vessel for Sat-AIS and TER-AIS per day.

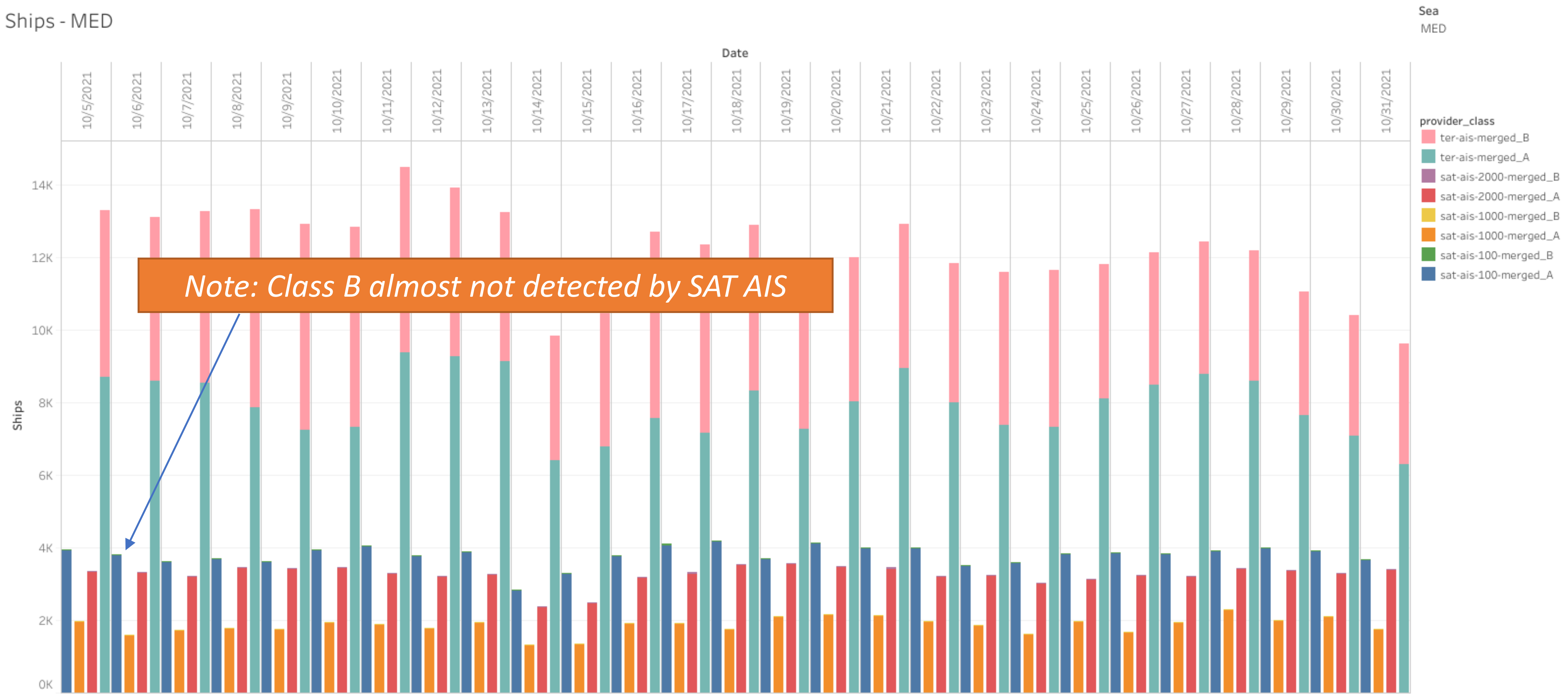


Average distance between two sequential AIS messages of a vessel for Sat-AIS and TER-AIS per day.

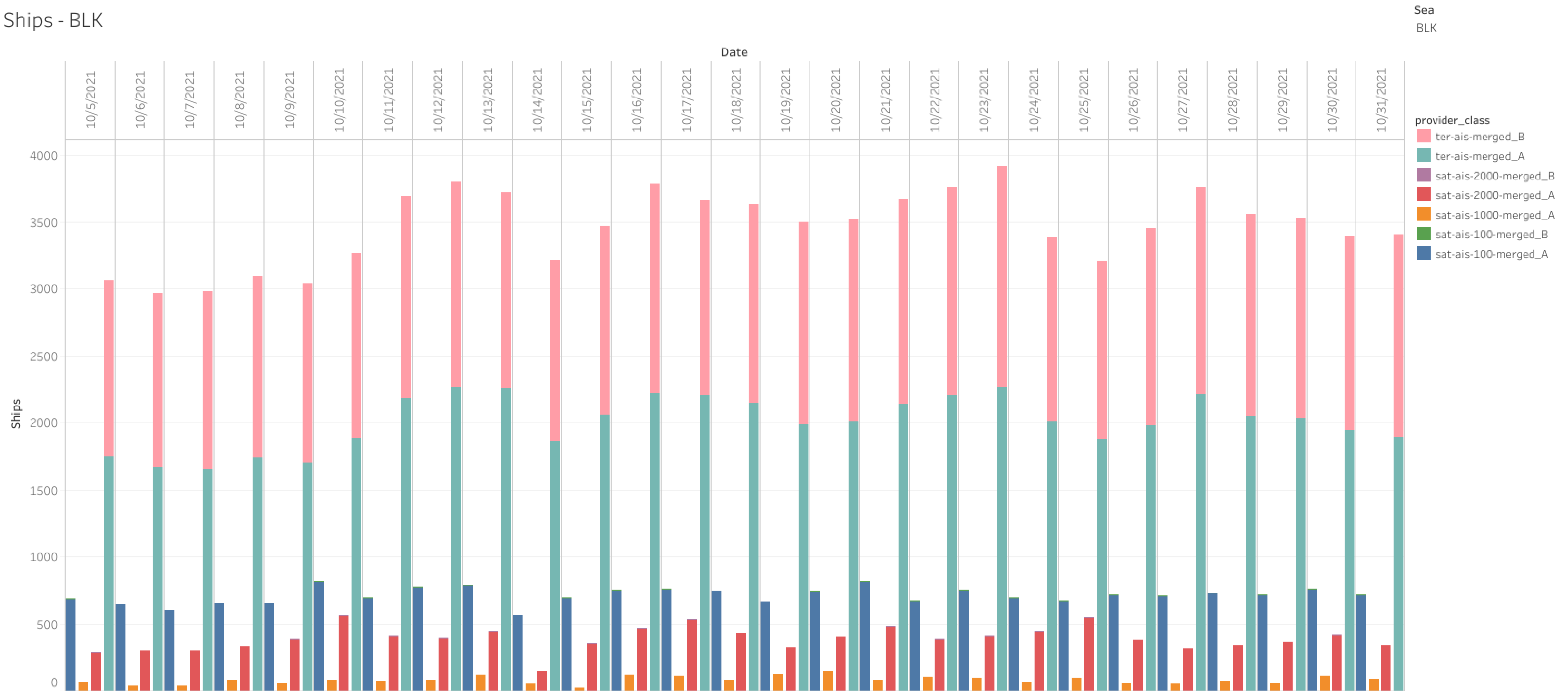


1.0 NM = 1.852 km

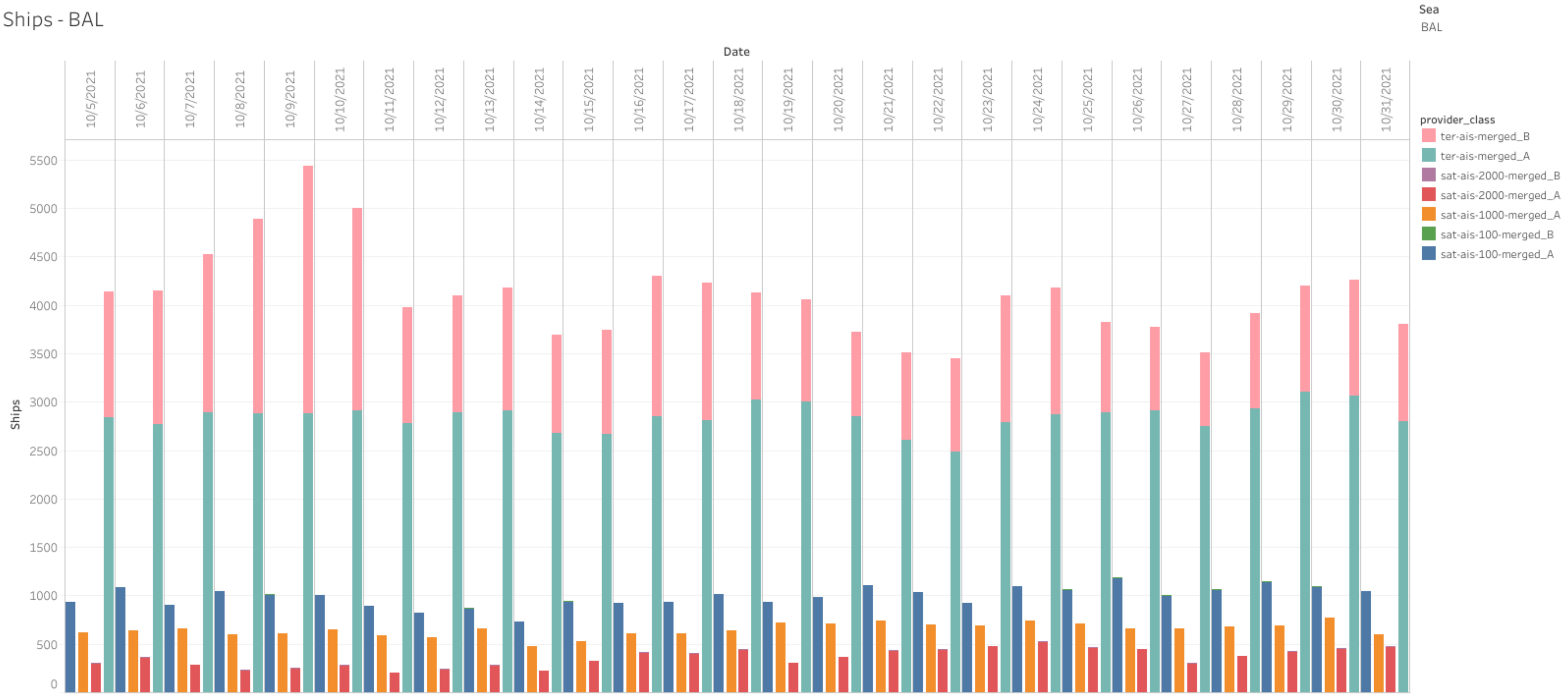
Number of unique ships (Mediterranean Sea)



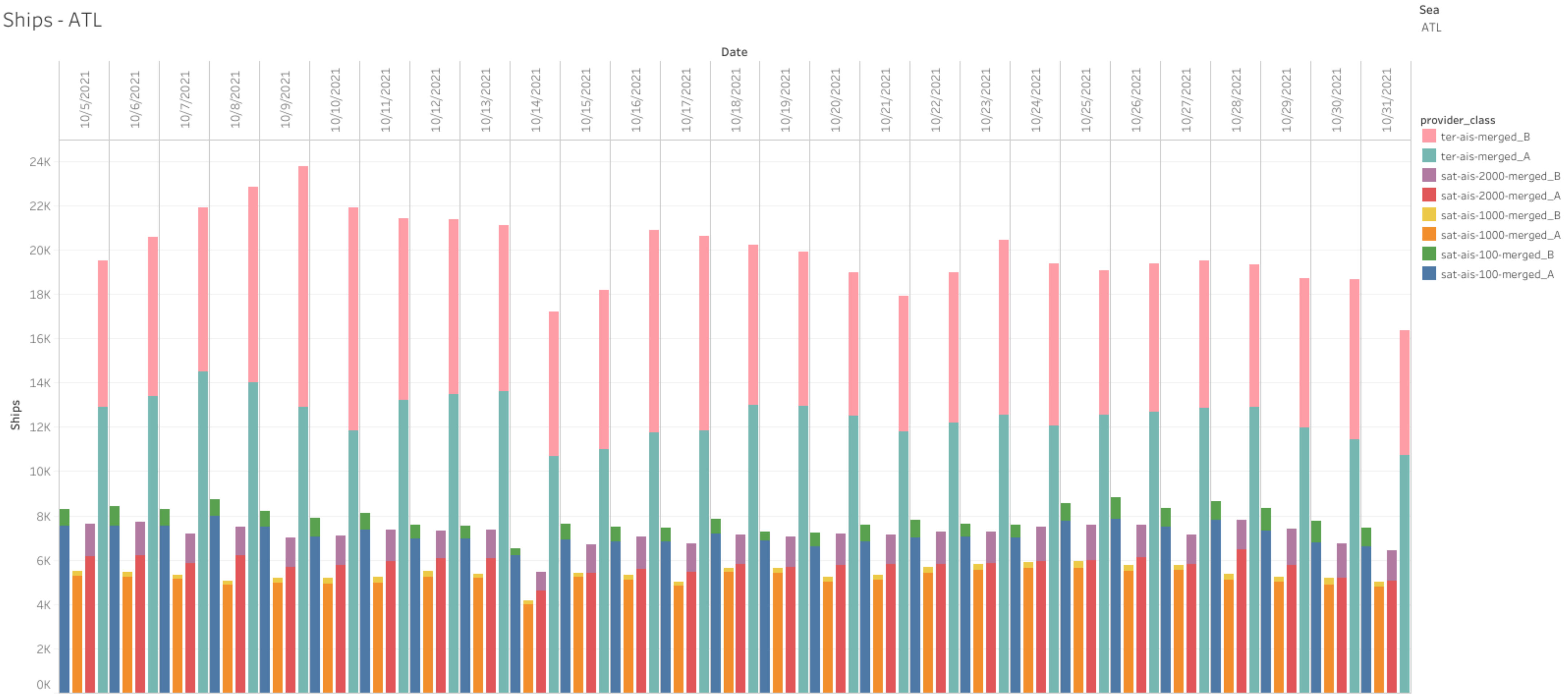
Number of unique ships (Black Sea)



Number of unique ships (Baltic Sea)

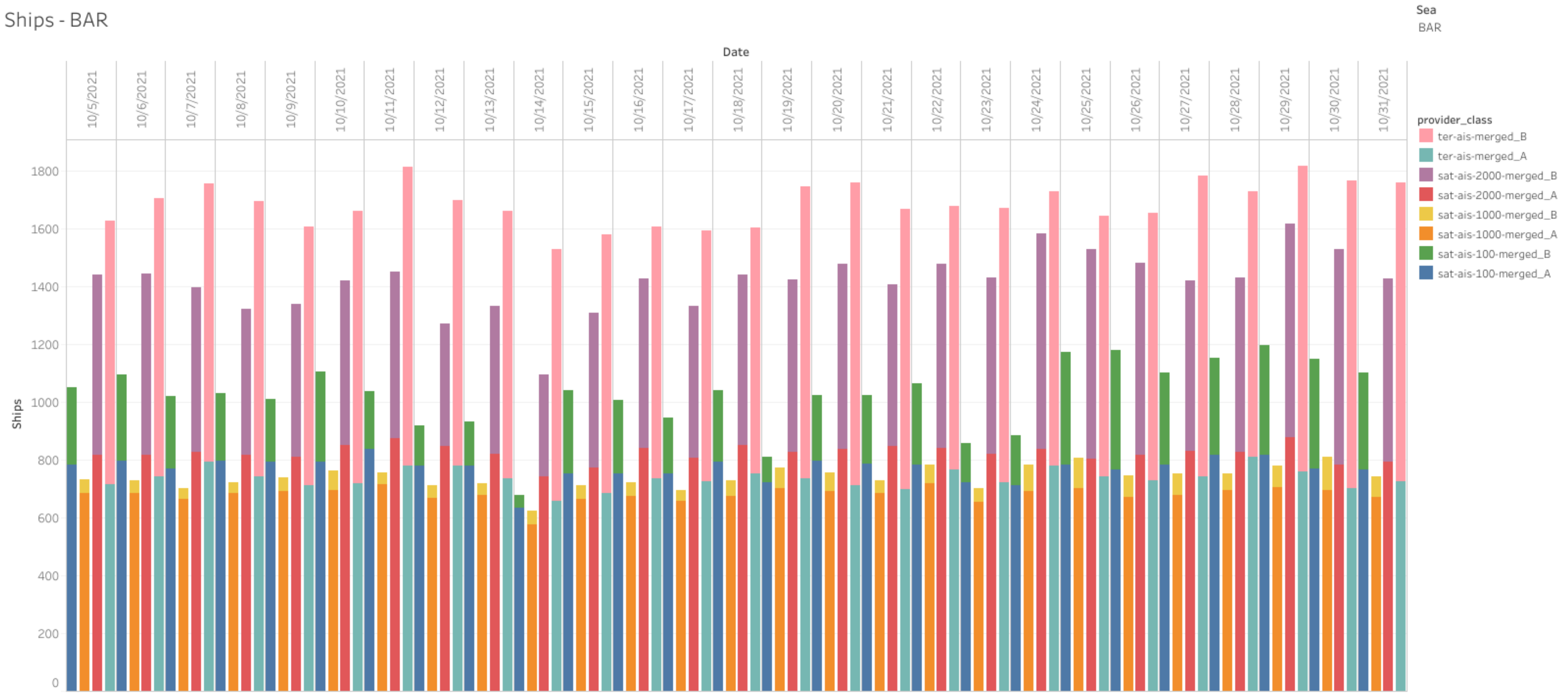


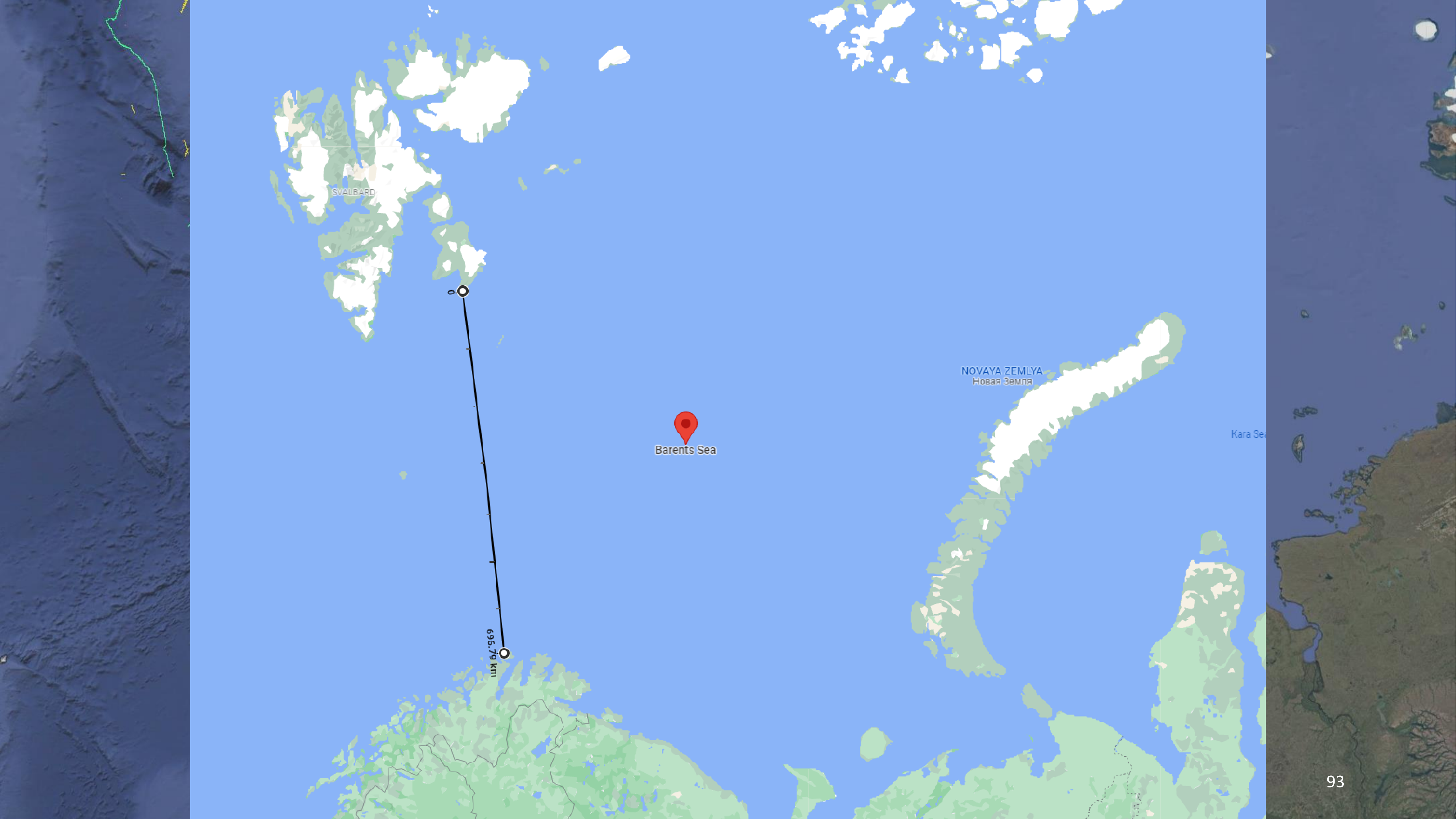
Number of unique ships (North Atlantic)



Number of unique ships (Barents Sea)

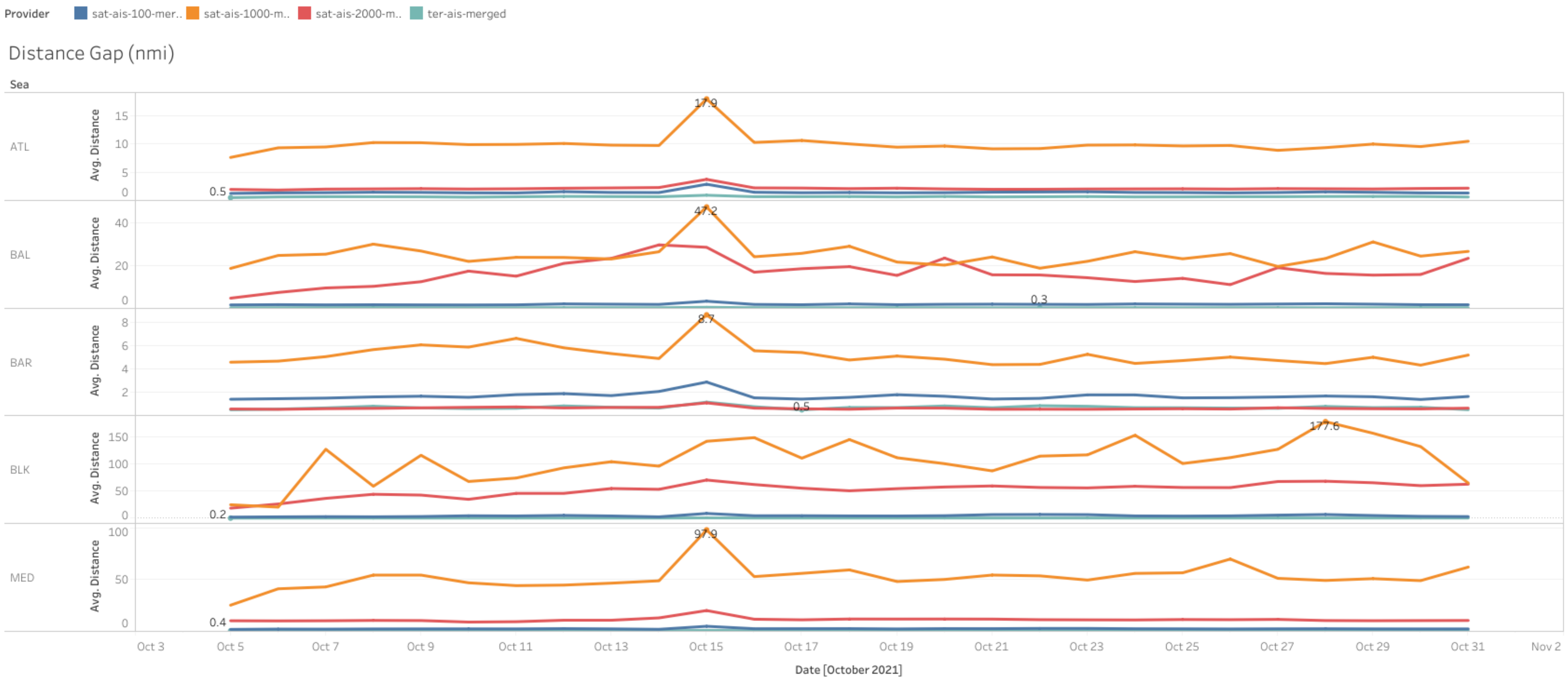
Note: This is the only area where we see SAT AIS detecting more vessels (CLASS A)



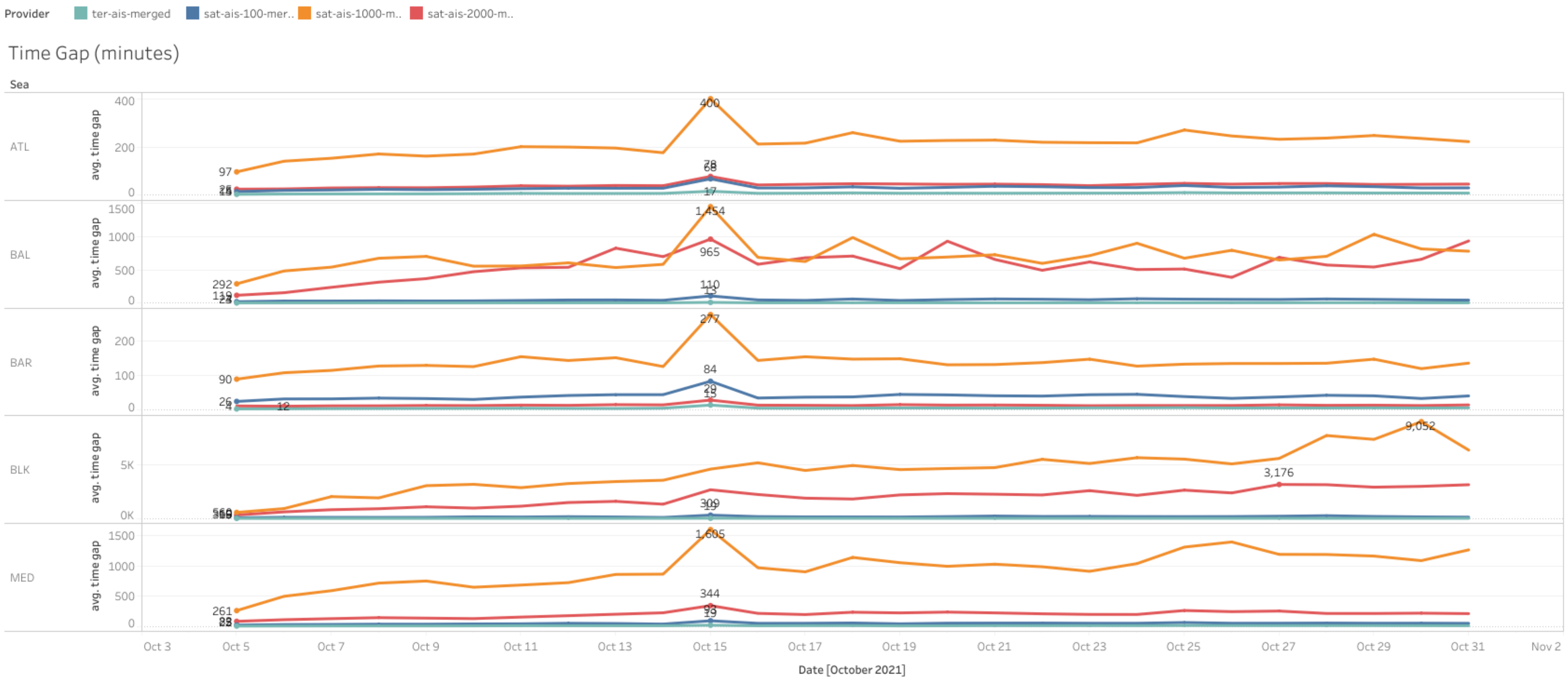


SVALBARD
0
696.79 km
Barents Sea
NOVAYA ZEMLYA
Новая Земля
Kara Se

Average distance between two sequential AIS messages (Sat-AIS providers)



Average time gap between two sequential AIS messages (Sat-AIS) per day

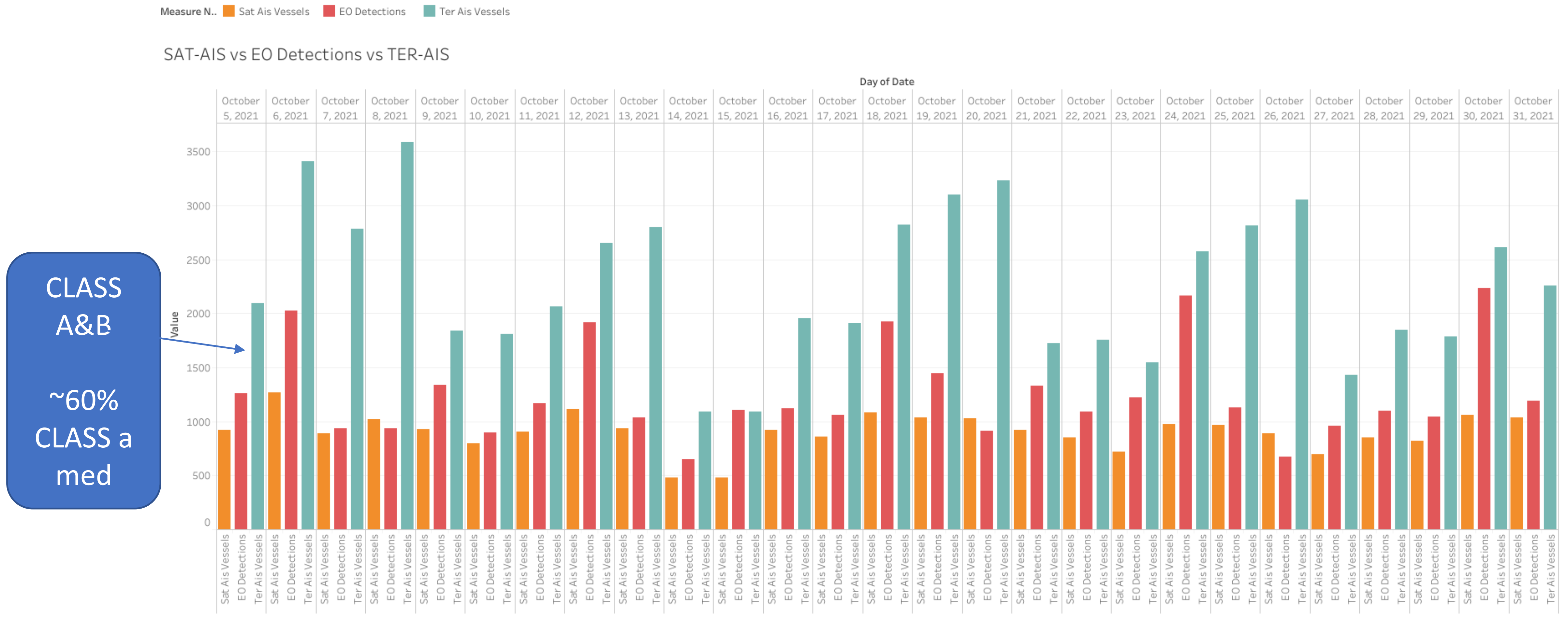


Some important take aways

EU Waters

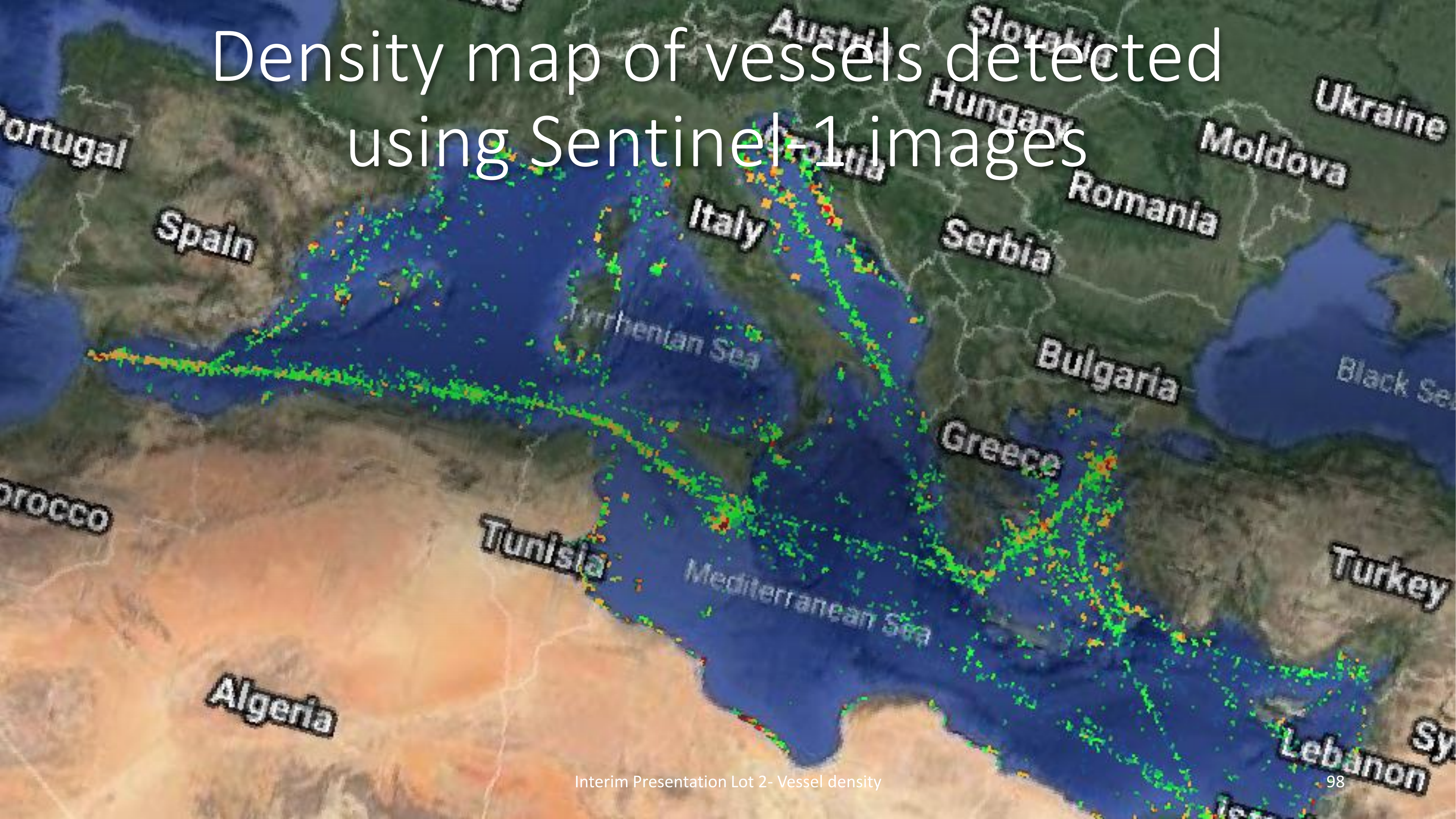
- Only in Barents Sea do we see SAT AIS outperform TER AIS
- Where TER AIS coverage is sufficient, SAT AIS detects approx. 50% less vessels in area
- TER AIS data has much better quality and granularity

Comparison between SAT AIS vs EO Det vs TER AIS (Med)

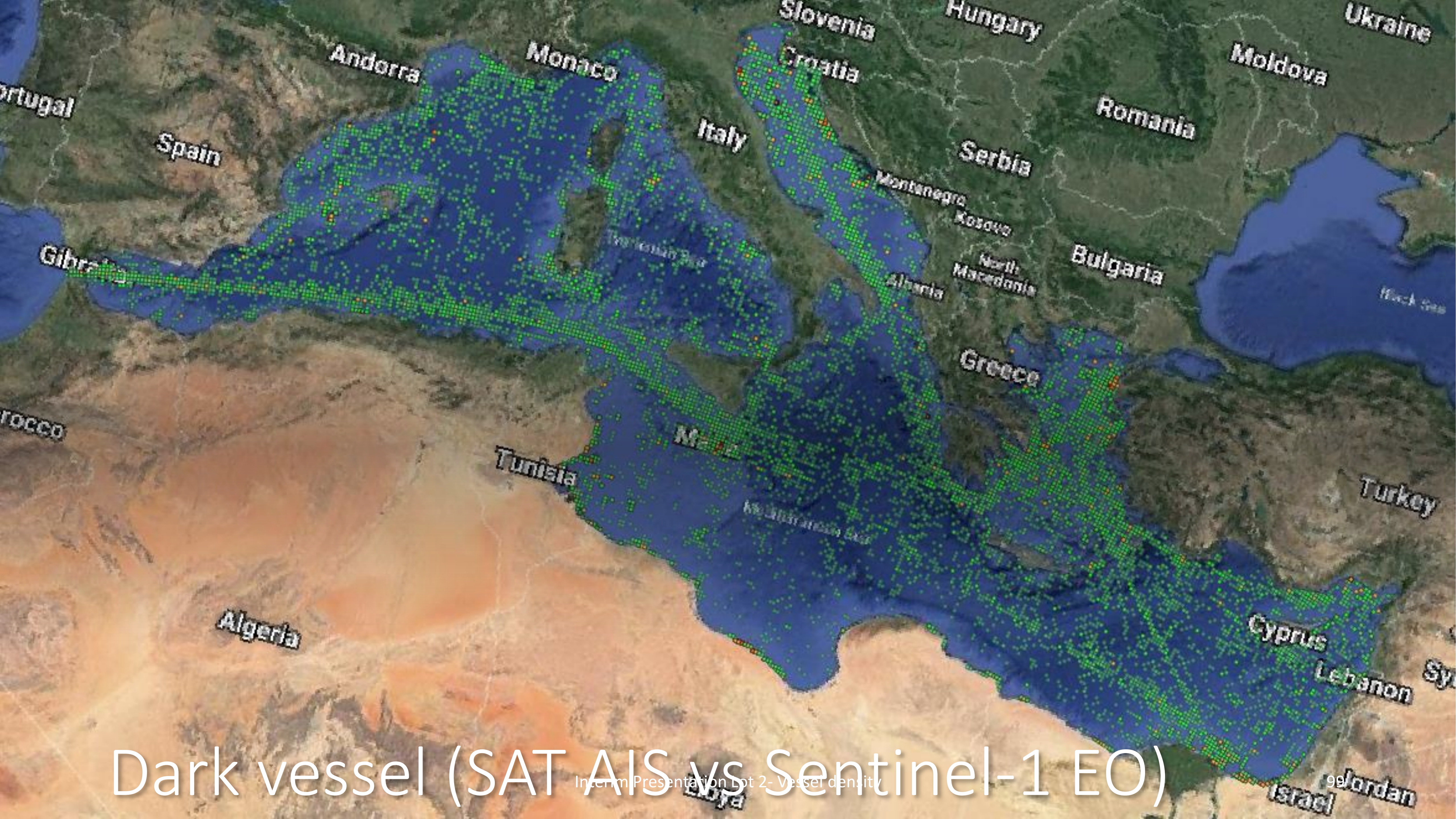


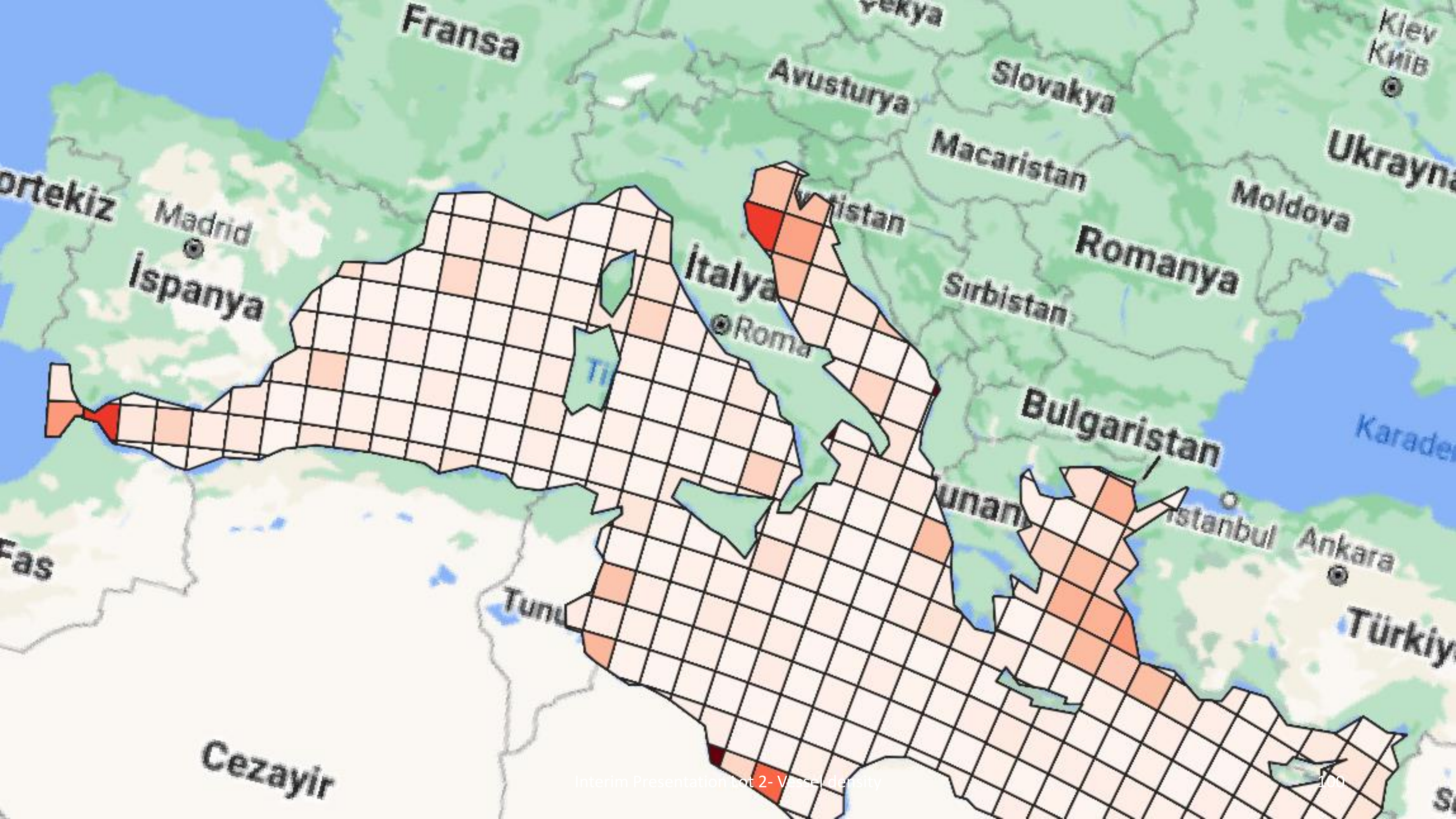
Note: Not entire day but snapshots

Density map of vessels detected using Sentinel-1 images

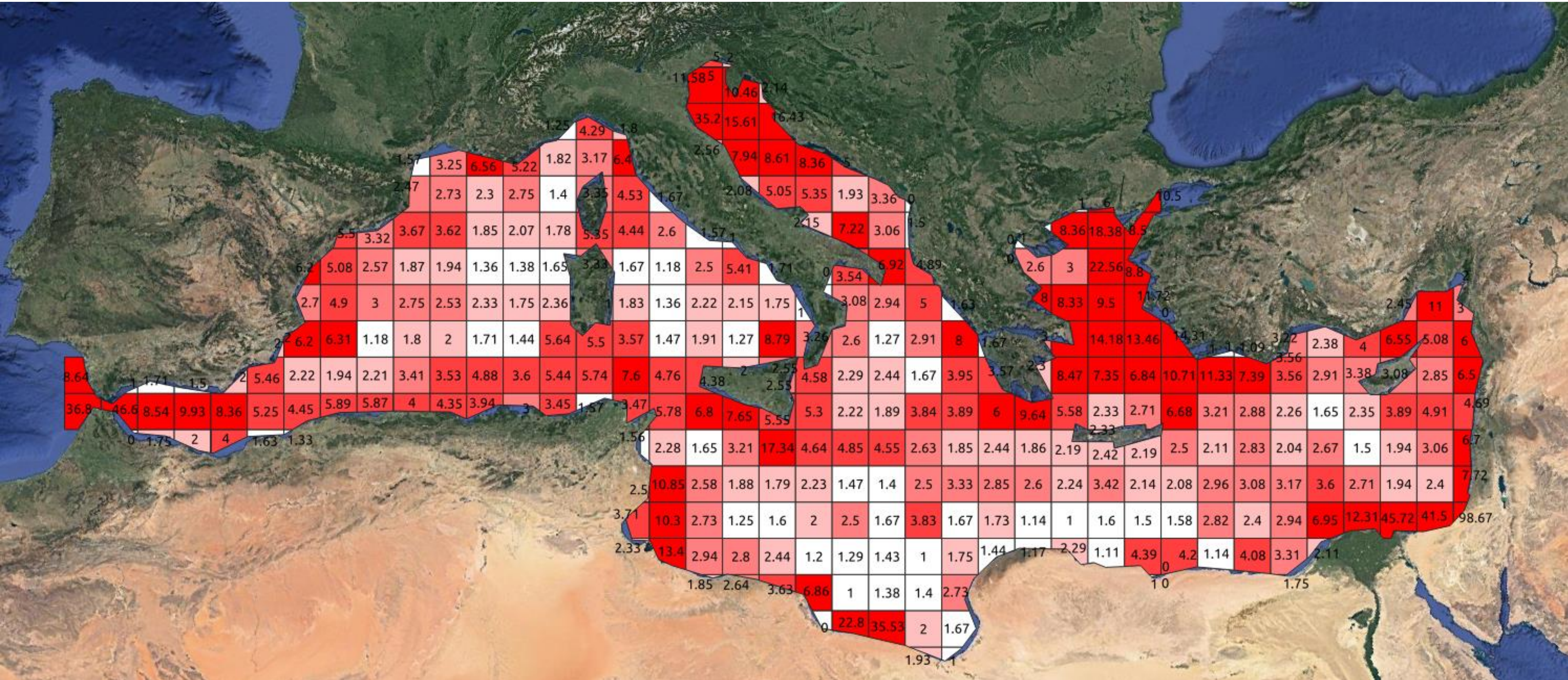


Dark vessel (SAT AIS vs Sentinel-1 EO)

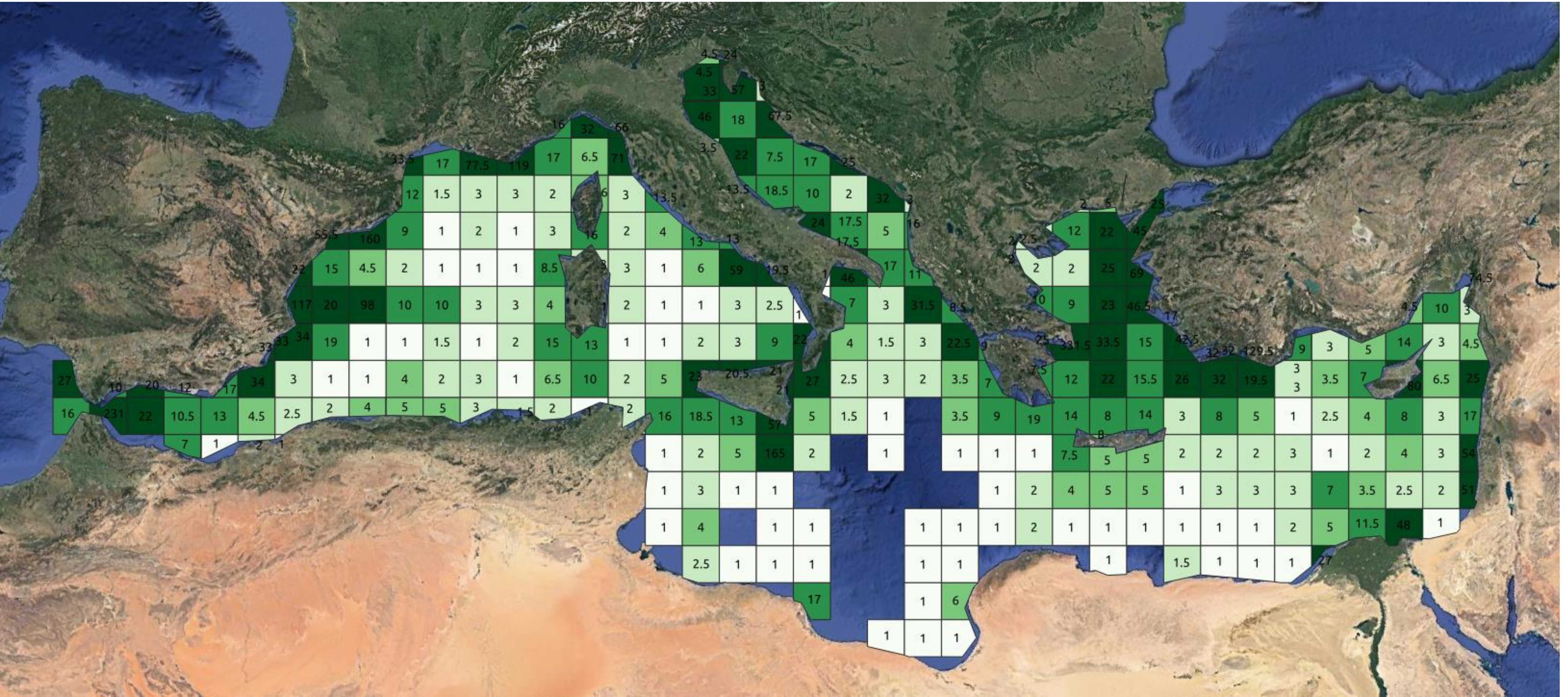



Fransa
Avusturya
Slovakya
Kiev
Київ
Macaristan
Moldova
Romanya
Sırbistan
Bulgaristan
Madrid
İspanya
İtalya
Roma
Ankara
Cezayir
Fas

Not detected from SAT AIS

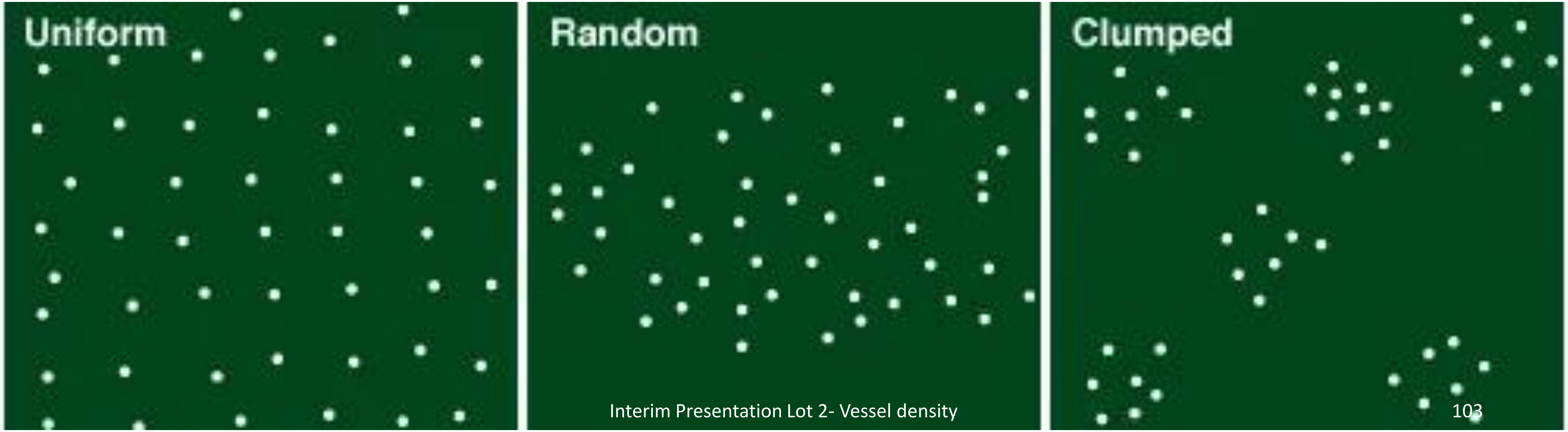


Number of vessels detected (per cell) on average



spatial pattern of objects

- **Clustered**: occurs when objects exist in close proximity to one another.
- **Dispersed**: occurs when objects are spread out from one another.
- **Random**: occurs when objects exist in neither a clustered or dispersed pattern. This is what we also refer to as a "hypothetical" or "normative" pattern



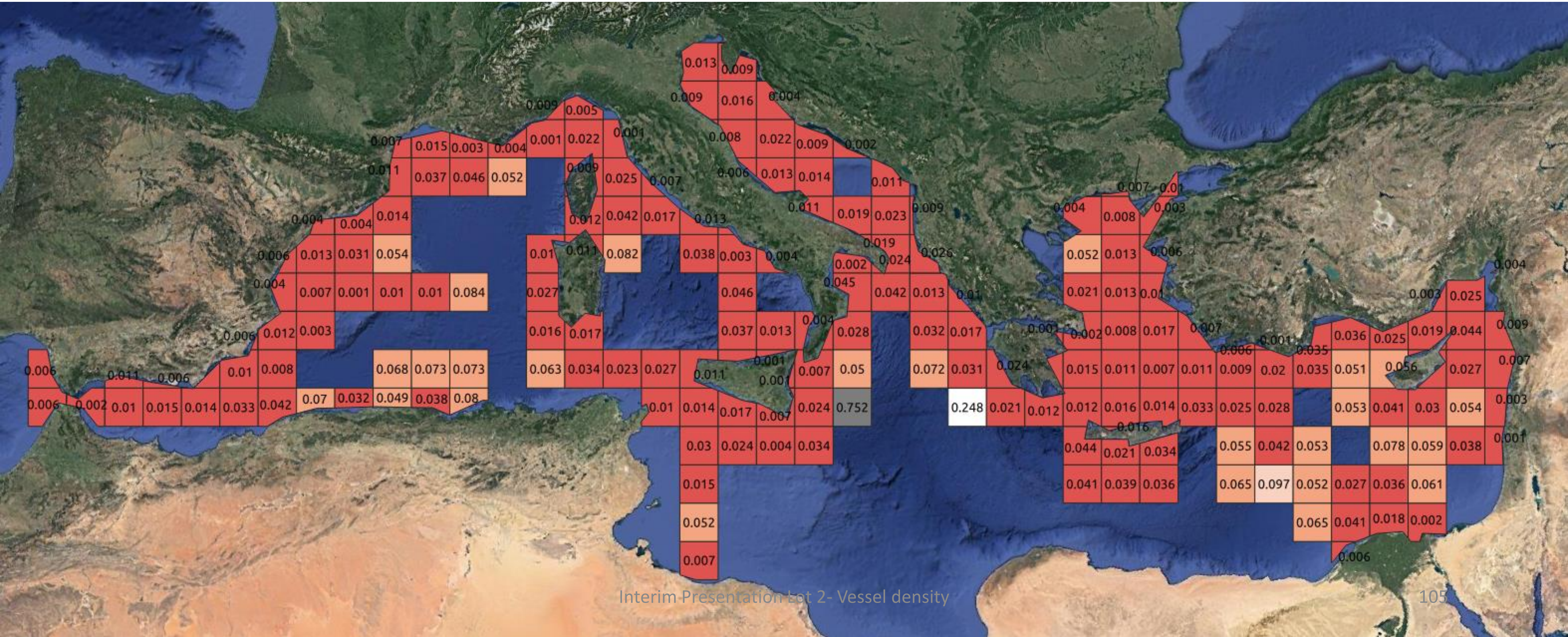
Nearest Neighbour Analysis

1. measure the distance between each point and its nearest neighbor.
2. all the distances are summed together and divided by the number of points in the study area, which gives us a measure called the average nearest neighbor distance. The equation for the mean NND is:

$$\overline{NND} = \frac{\sum NND}{n}$$

Nearest Neighbour Analysis

a perfectly clustered pattern has a NND = 0



Some more important take aways

EU Waters

- Resolution of SENTINEL does not permit the detection of small vessels
- # of vessels and NNA is a good indicator for areas where SAT AIS detection is low

Overall Conclusions

- One single unique data source to compute a vessel density map at global level does not exist.
- SAT AIS only a partial view; missing both ships and positions, with less granularity
- We can calculate areas and conditions where SAT AIS reception is low (detectability maps)

Status Report & Next Steps

Release Open-Source software (v 1.0)

Create density maps for additional months
- Different density maps per type

Quantify previous analysis into detection maps

Sentinel-2 workflow execution in progress

Sentinel-1 execution for the rest of the time period

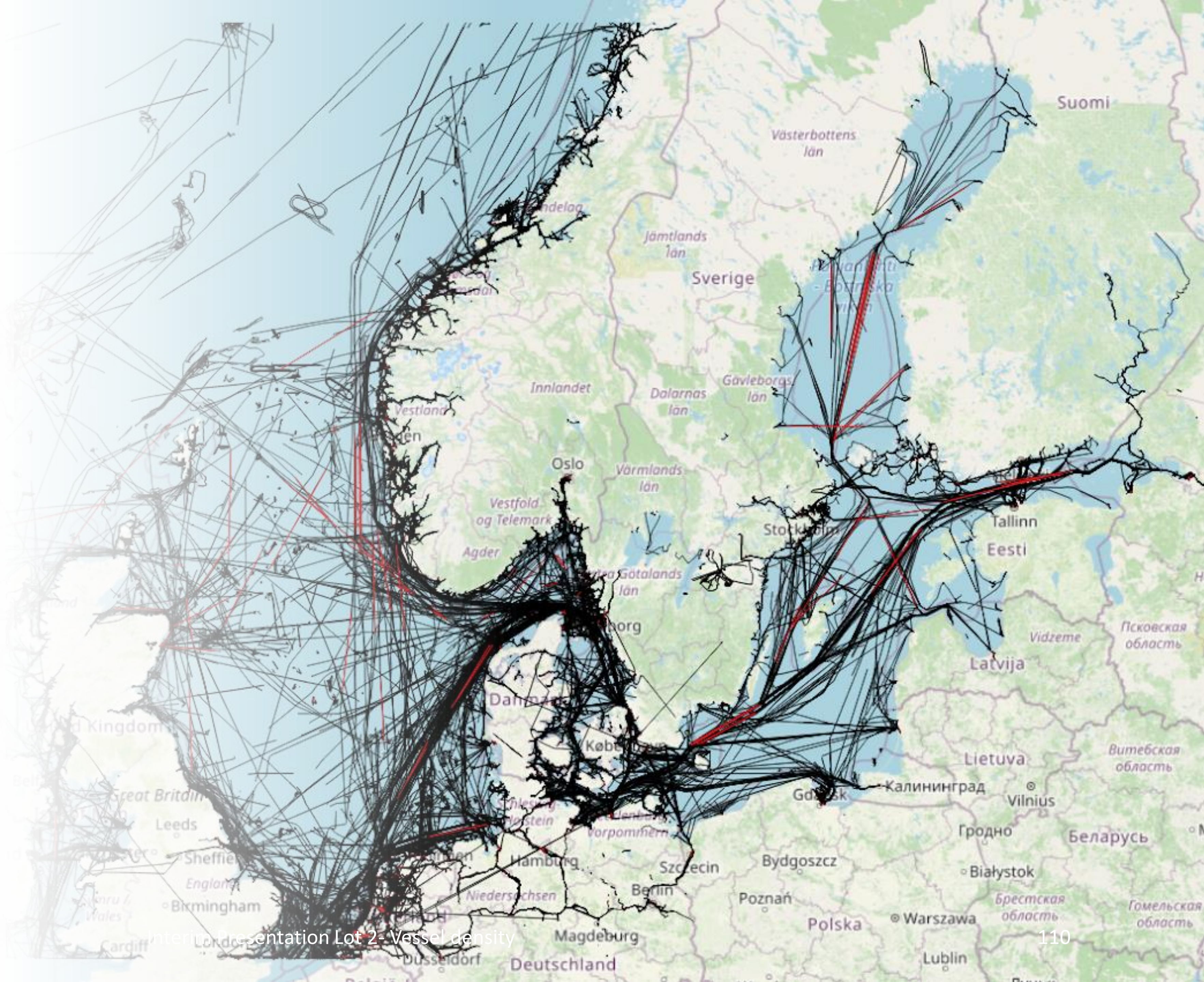
Classification by vessel type

Gap filling

Use transition grid to fill trajectory gaps

Gap filling

Mean temporal gap (mins):	31.2
Mean spatial gap (km)	2.5
Temporal Max	41990
Temporal Min	3
Spatial Max	6549.5
Spatial Min	0



Transition and Handover details at the end of the contract

Interim Presentation

Presenter: Sofia Karagiorgou

State of Play

- Best practices
  - PM²: effort needed, planning, etc.
  - ITIL: services for handover + business continuity w.r.t. lessons learnt and knowledge transfer
- Method Review, Liaison and Landscape set up
  - Focus on EMODnet method compatibility (i.e., 3rd method in EU Vessel density map; Detailed method; v1.5; 03/19 with current stack: PostgreSQL & PostGIS, QGIS)
  - Vessel detection from spaceborne optical and SAR images
  - Early publications w.r.t. 1st half of the project results
  - In progress: discussions/interactions with EMODnet team to:
    - Share & use common Med. Area
    - Share, use & compare GeoTIFF files

Handover and Business Continuity

Handover team already set: follows up & monitors progress

Regular & Digital communication channels for feedback & sync

Define objectives and KPIs; suggest plans:

Establish a pipeline/method to assess/compare density maps

Inform/Train interested stakeholders on the outcomes and their production

Collect lessons learnt & provide recommendations based on the findings

Extend and transfer insights to similar tasks/initiatives, i.e., maps on shipping emissions and noise maps

Contribute/assist in developing an adaptive legacy strategy on maritime/specific ecosystems

Thank you for your attention!