NARAS – EO AND GNSS DATA TO IMPROVE NAVIGATION RISK ASSESSMENT

– FINAL PRESENTATION–

ESTEC

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Systems & Advanced Technologies Engineering S.r.l.

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State of the art and NARAS objectives

SoA on GNSS and EO technologies

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GNSS + AIS

Global Navigation Satellite System: Provides signals from space that transmit **positioning and timing** data to GNSS receivers, which use this to determine location.

Problems:

1. GNSS visibility
2. Multipath errors
3. Interferences
4. Satellite errors
5. Atmosphere errors
6. Receiver errors
7. Coastal areas errors

Automatic Identification Systems: automatically **shares vessel information** with other vessels and coastal authorities, helping to prevent collisions and illegal operations at sea.

Problems:

1. Human errors
   - Wrong MMSI
   - Incorrect ship's information
   - Wrong destination and time of arrival to destination
   - Lack of classification categories
   - Wrong navigational status
2. Technical errors
   - No transmission
   - No information on position
   - No speed/course over ground
   - No information on the rate of turn-ROT

SoA on GNSS and EO technologies

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EO

Synthetic Aperture Radar:

- High-resolution
- Ability to penetrate darkness, clouds and rain

Optical satellites:

- From 30 cm to 80 cm spatial resolution (best EO image quality currently available)
- Inability to acquire during night or bad weather condition

EO is a powerful source of information, it allows to:

- Monitor areas in the sea
- See objects in the sea not transmitting AIS
- Verify quality of the AIS

NARAS objectives

1. Utilization of the information of the features identified to **improve navigation risk assessment models and to enable near real-time applications, including the modification of the planned or preferred routes** (described by space-time waypoints and tolerances) set for either the shore assisted navigation or, in the future, for the autonomous ships navigation. This will exploit the previous technology developed by SATE and MARIN under a preceding ESA contract.

2. The suitability of the approach defined to **the combination of AIS/VTS data and SAR images with optical images** to improve, when the latter are available, the **detection of unreported features** in the AIS system and the statistical **evaluation of the accuracy** of current positions data available through the AIS system or **their alignment with EO extracted positions**.

3. The **assessment of the benefits using MARIN risk model to quantify the collision risk** with and without EO information.

Selection of the areas of interest

Criteria for the use cases selection

1. **Accessibility** to the area information and availability of AIS/EO raw data

2. Importance of the area in terms of **traffic**

3. Number of **accidents per year** and number of inhabitants in the coastal area

4. Transport of goods or people, and which kind of goods

5. **Complexity** of the coastal area

6. Multiple accesses

7. **Weather** (atmospheric agents)

Area north of the Wadden Islands

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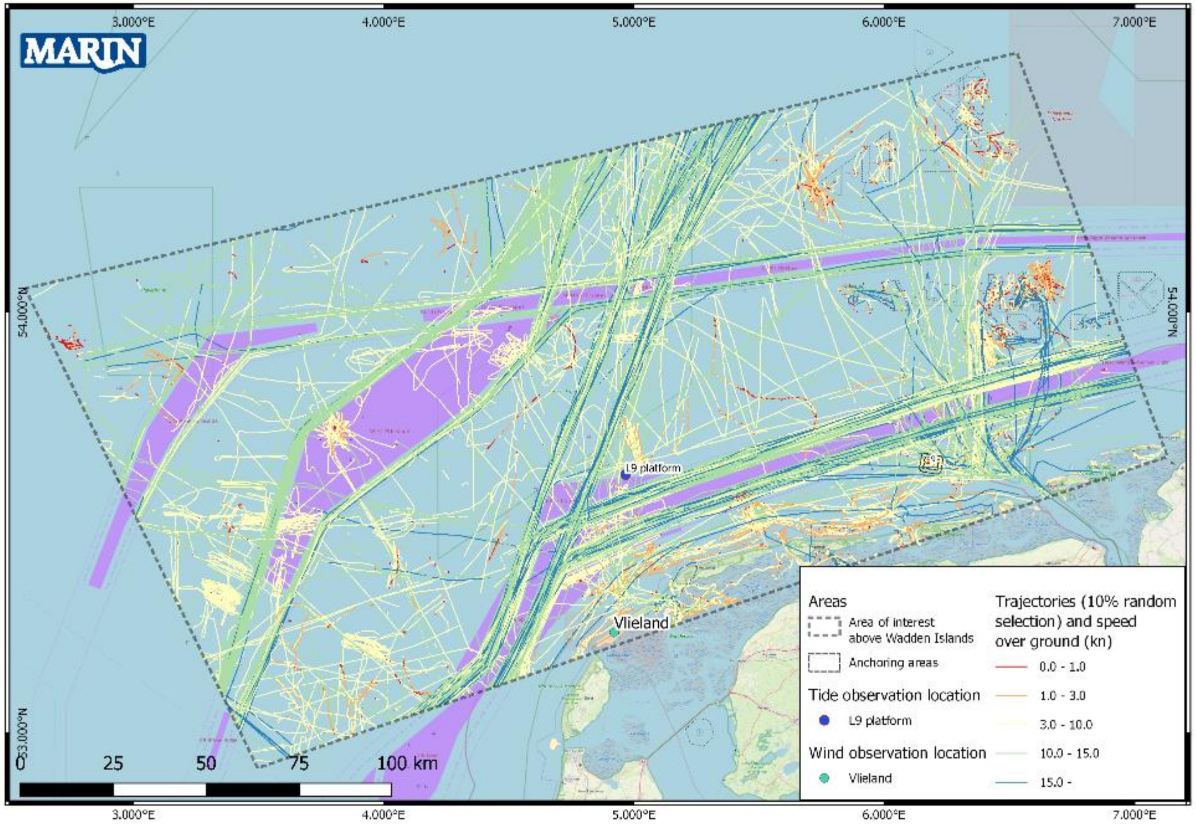
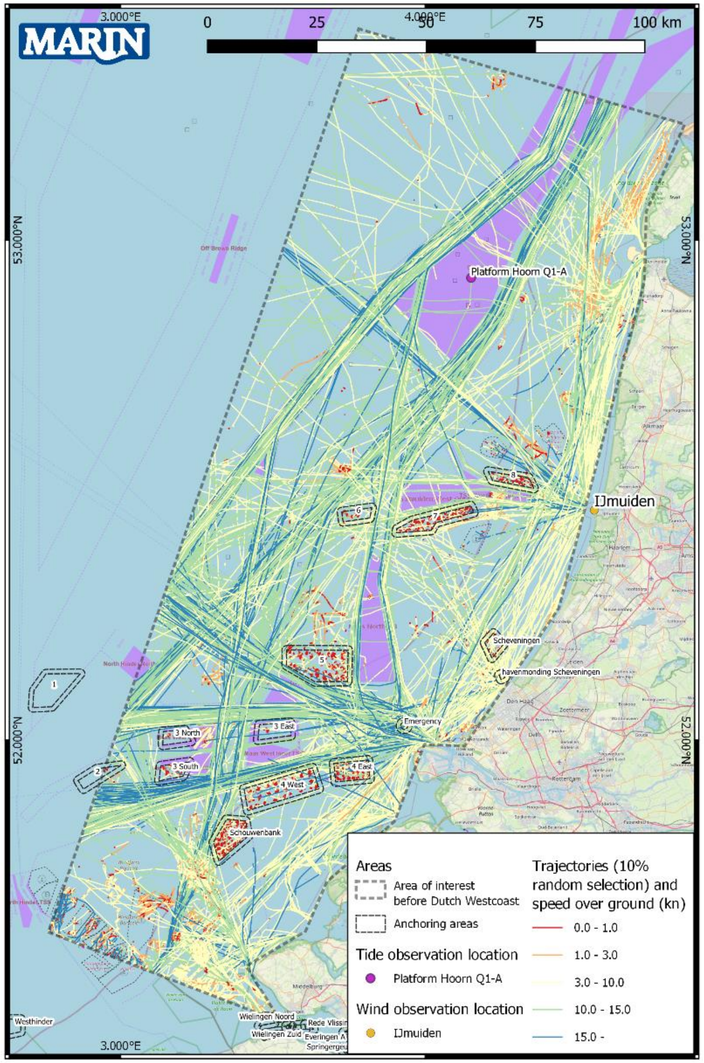
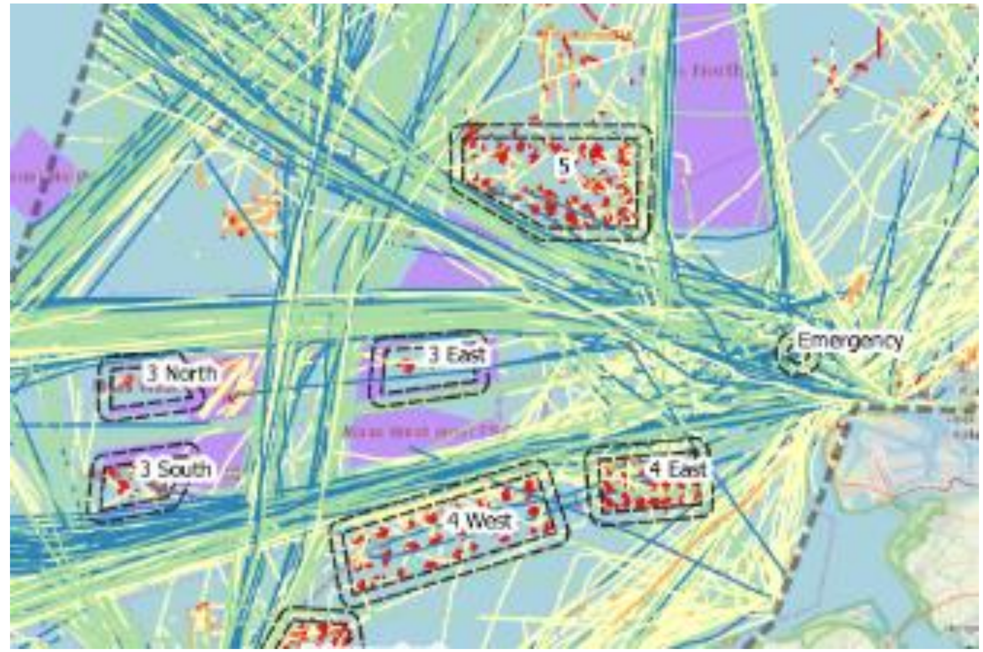


14 months of data:

- 454.687 journeys
- 58.994 (13.0%) assigned to routes
- 114.626 (25.2%) journeys of merchant vessels
- 47.4% of these assigned to routes

Area of the Dutch Westcoast





14 months of data:

- 653.499 journeys
- 205.470 (31.4%) assigned to routes
- 439.259 (67.2%) journeys of merchant vessels
- 37.4% of these assigned to routes

Area North Adriatic Sea

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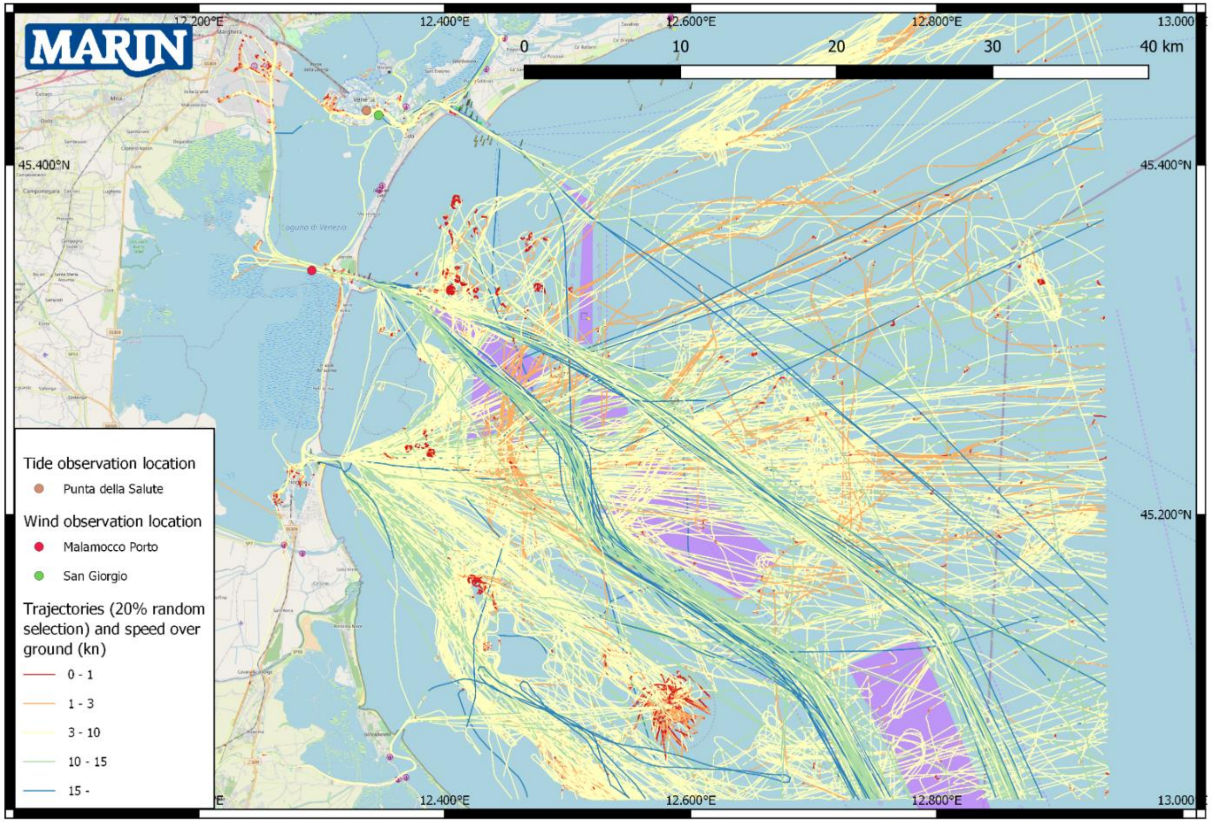


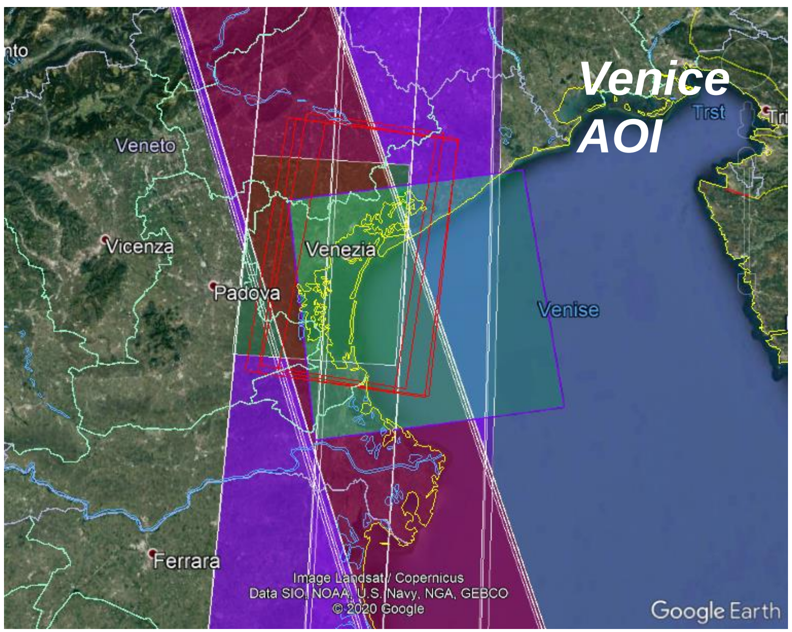
5 months of data:

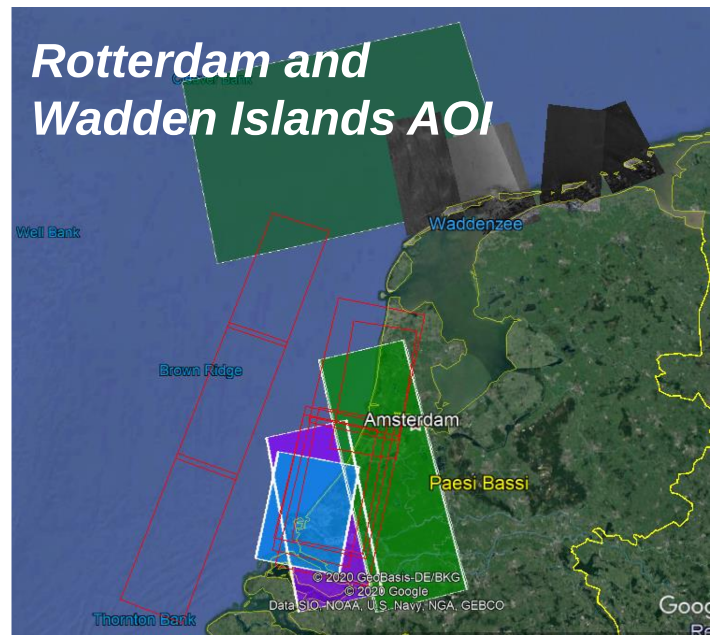
- 66.568 journeys
- 11.247 (16.9%) assigned to routes
- 23.839 (35.8%) journeys of merchant vessels
- 15.0% of these assigned to routes

Selection and processing of the EO data

Collection of EO data for the selected areas and time periods

- 44 EO products collected over 3 Areas-of-Interest
  - – 24 Cosmo Sky-Med (Level-1C GEC, .he5 format)
  - – 15 Iceye (Level-1 GRD, GeoTIFF format)
  - – 5 TerraSAR (Level-1 GEC, GeoTIFF format)





Analysis AIS data and Preferred routes extraction

Area North Adriatic Sea

SATE
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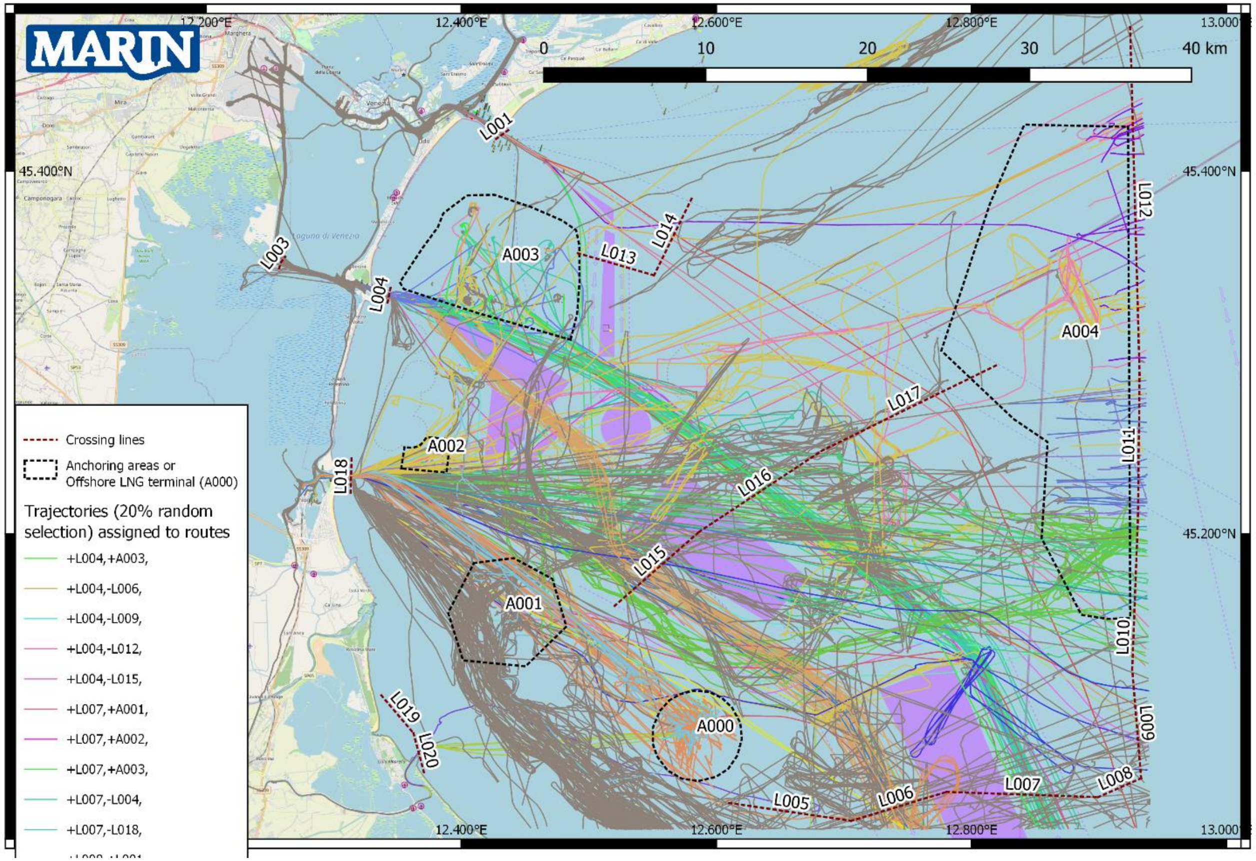

5 months of data:

- 66.568 journeys
- 11.247 (16.9%) assigned to routes
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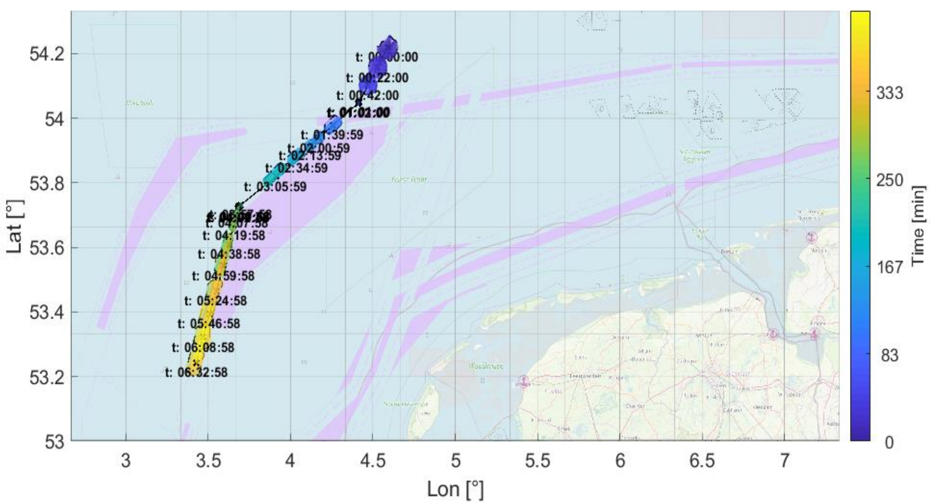
Preferred routes extraction

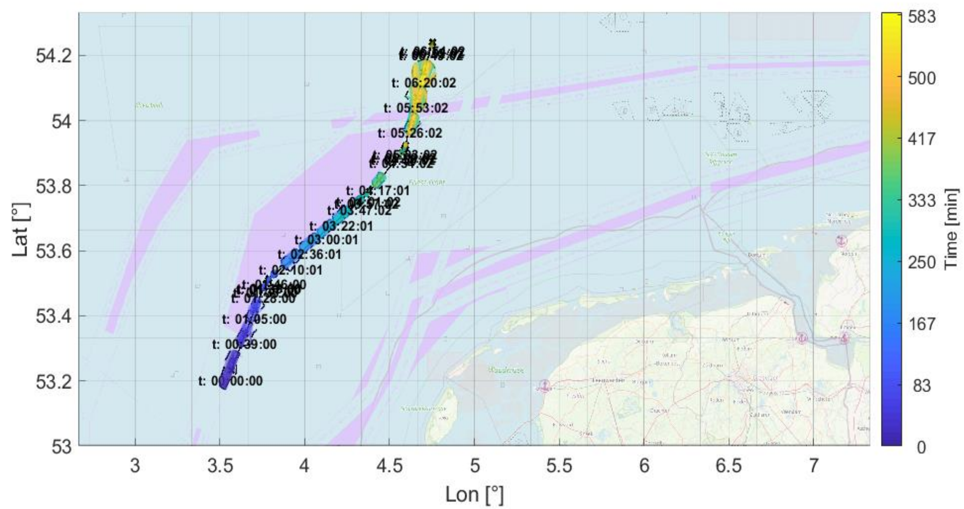
Wadden Islands - Tankers

Cluster ID 1



Tracks: 271
Ships: 233
Ship type: Tanker (100%)
Ship length: > 200 m (73%)
Wind dir: E (24%) [BF: 3-5]

Cluster ID 2



Tracks: 247
Ships: 208
Ship type: Tanker (100%)
Ship length: > 200 m (72%)
Wind dir: E (26%) [BF: 3-5]

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Data fusion (EO and GNSS) and generation of the derived information

Workflow

- Given an EO acquisition, **discriminate** the collaborative from the non-collaborative objects.
- **Estimate trajectory** of the non-collaborative objects.
- In case of **risk of collision**, suggest **modification** of preferred route.

Recommended routes adaptation

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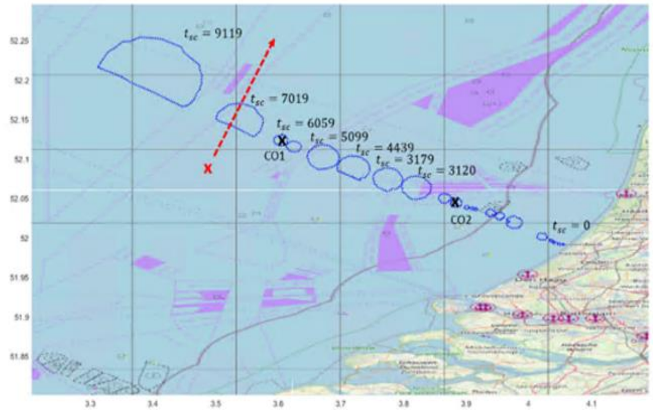
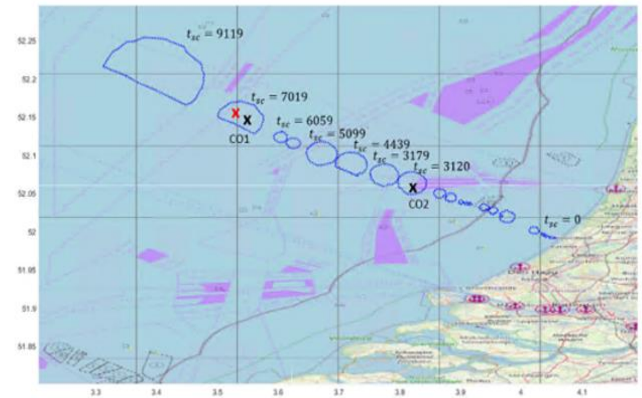
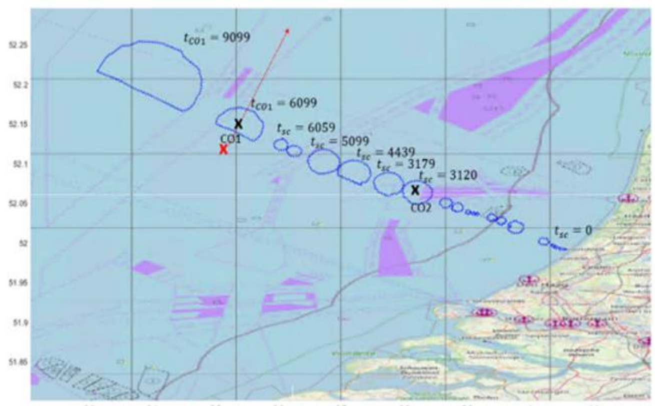
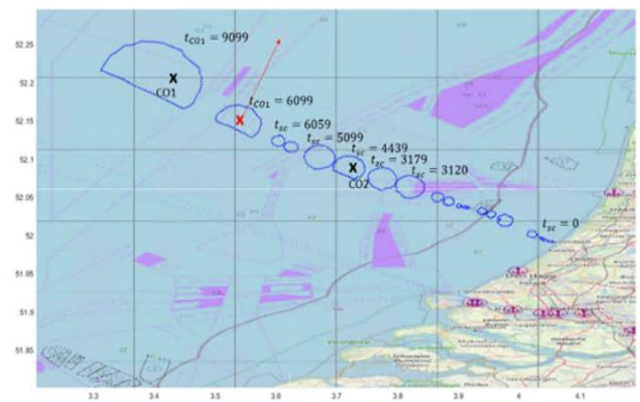
Risk of collision





Collision avoided





Benefits of exploiting EO data

EO objects in risk evaluation models

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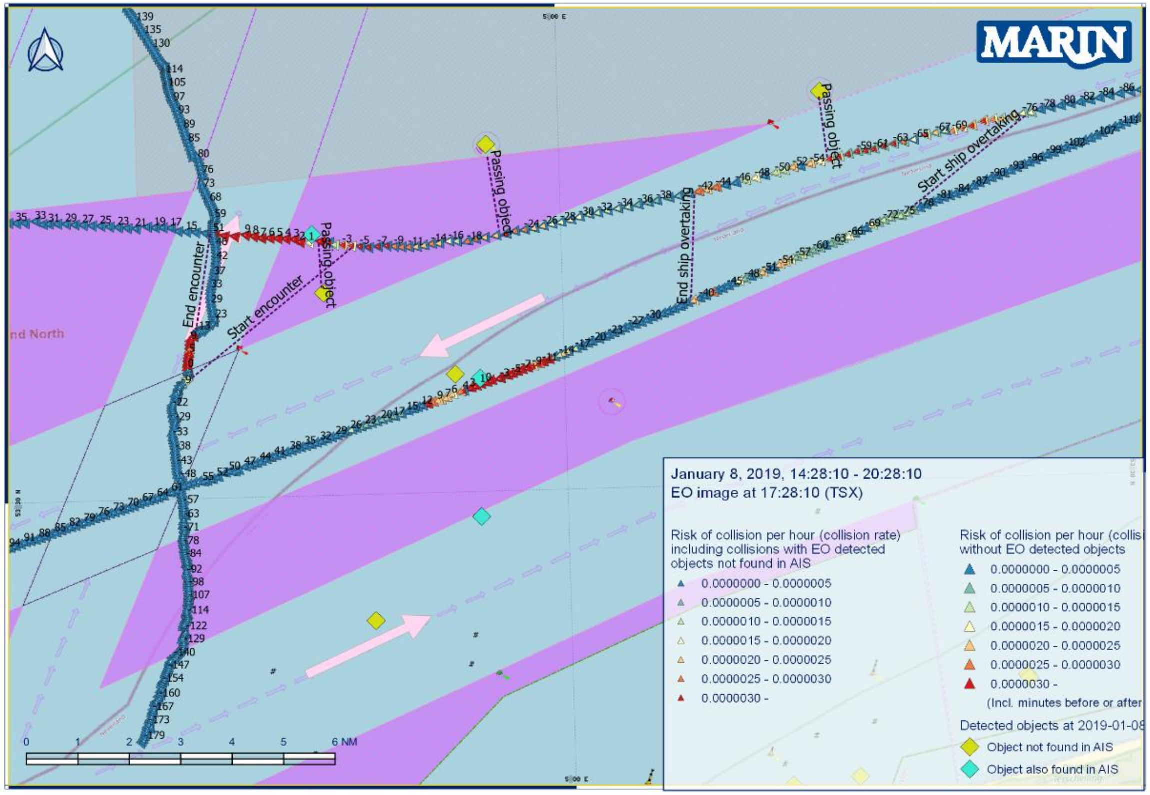
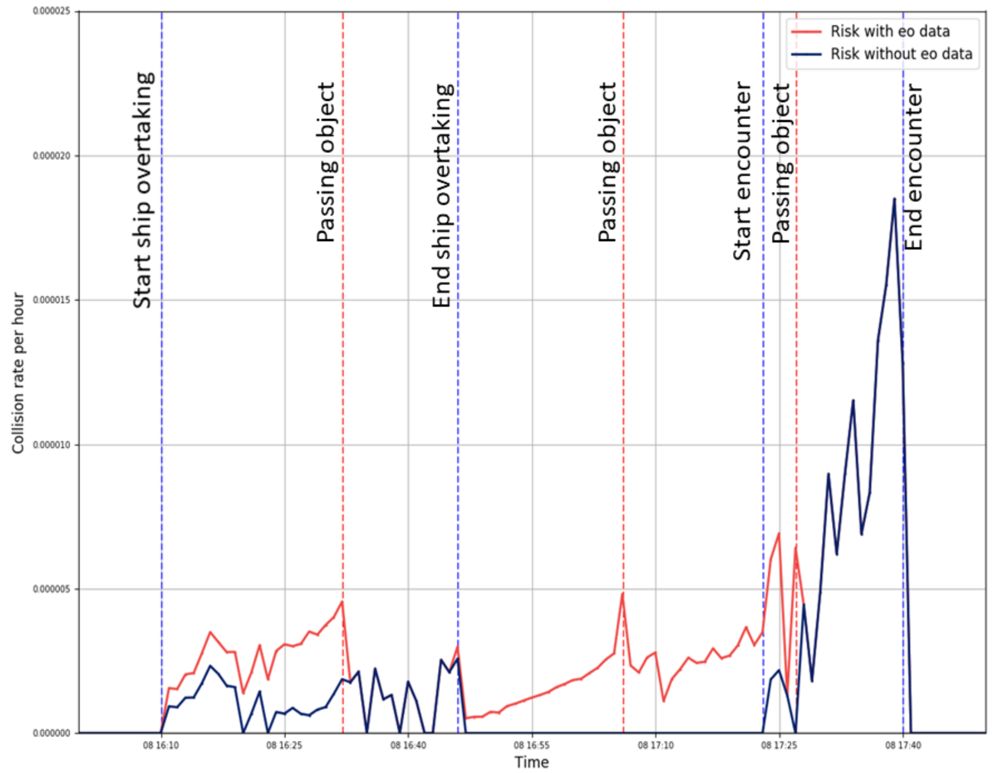
One of the interesting case considered to investigate the effect of EO object on the risk index calculated by the MarinRisk model.

The value of risk index changes when computed with or without the knowledge of EO



Risk index

The behavior of the risk index computed knowing or ingoring the presence of the EO-detected object.



Conclusions

Conclusions

The project **demonstrated** the capabilities of the algorithms for:

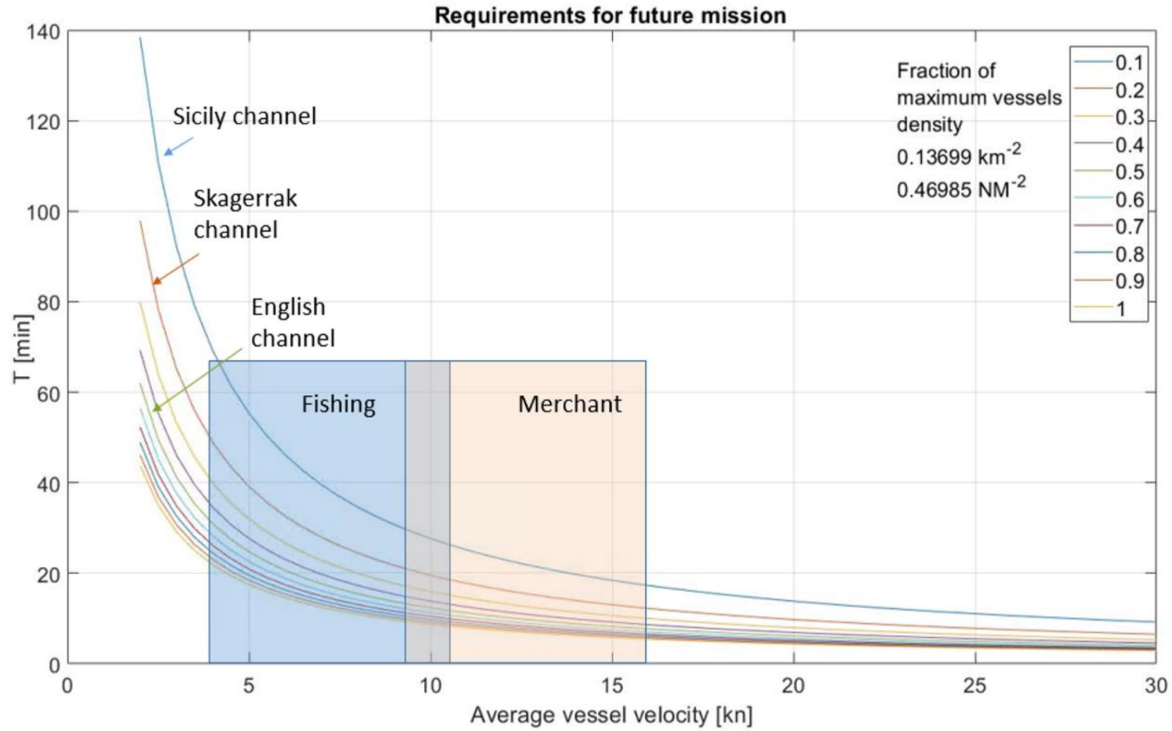
- **Object detection**
- **Object classification**
- **Preferred routes extraction**
- **Estimate of the risk of collision**
- **Adaptation of the route to mitigate the risk**

While the algorithms for **object tracking** and preferred **routes adaptation** have been defined, **more data** are necessary to validate their methods.

The fusion of optical and SAR data is an active area of research, facing challenges both on the algorithm definition and the large asynchrony of SAR and optical acquisitions in real life missions.

Conclusions

For future missions, the sum of revisit time and latency should by lower than the time *T* shown in the plot, which is the average collision time between ships as a function of the velocity for different vessel densities.



The results suggest a reference value of the time *T* in the 20 - 40 minutes range.

THANK YOU