

IMMINGHAM EASTERN RO-RO TERMINAL



Change 4 – Navigational Simulations

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Report from HR Wallingford: Navigation study considering revised flows and impact protection

Immingham Eastern Ro Ro Terminal

Navigation study considering
revised flows and impact
protection

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Executive summary

Associated British Ports (ABP) Humber is considering the development of additional RoRo berth capacity to the east of the Immingham dock, which will be known as the Immingham East RoRo Terminal (IERRT).

ABP has commissioned HR Wallingford to undertake a series of desk studies and real-time navigation simulation studies to assess the feasibility of the design for the IERRT.

Context

The new facility is currently being subjected to a Development Consent Order Process. As part of that process, the Examining Authority encouraged ABP and Stakeholders to consider whether some further simulation work would enable them to come to a closer level of agreement on some of the contentious navigational issues.

Assessment of Changes

To support ABP's proposed Application for Changes to the IERRT facility dated 19 October 2023 [AS-026 to AS-035], HR Wallingford was instructed to undertake navigational simulations to understand and test the validity of the navigational effects associated with Change 4 – enhanced management controls and options for the potential provision of additional impact protection measures to the IOT finger pier.

In doing so, HR Wallingford updated the IERRT flow model to take account of a pre-application amendment to the IERRT design, in particular the increased dimensions of the southern pontoon at the rear of the IERRT infrastructure.

Flow Modelling

The increased dimensions of the southern pontoon was incorporated into the EIA assessments and the flows were modelled by ABPmer as part of the EIA (Environmental Statement Volume 2, Document Reference 8.3.7) at the time of the DCO application. The set-up and validation of the flow model used by HR Wallingford in the simulations conducted up to 8 November 2023 has previously been described in HR Wallingford reporting but is covered in detail within Report DJR6612-RT005-R02.

For the simulations undertaken on 15 November, the flow model for a peak spring tide condition has been rerun to take account of the larger southern pontoon and the new results provided to the Navigation Simulation.

It was expected that APT and their representatives would attend the simulations, but were unable to.

This short study has been undertaken to:

- Review any changes to the flow with respect to previously observed accelerations around the pontoon structures during lower water levels when they present a significant blockage.
- Review whether the additional structures proposed affect operations at IOT 6/8 finger pier.

Key conclusions

Flow Modelling

- The remodelled flows based on the larger pontoons indicate a subtle additional acceleration around the northern pontoon between the IERRT and IOT; this is apparent between LW and one hour after low water. The effect is to change a flow previously 310 T at 1.3 knots to 315 T at 1.5 knots.

- The Applicant has instructed HR Wallingford to undertake further flow modelling across a mean spring tidal cycle and at the time of writing, the assessment is being undertaken.
- An initial sensitivity analysis for manoeuvres at IOT 8 shows that this change does not affect departing vessels. When the most challenging operating parameters are applied to the berth, specifically a strong flood tide and with 26 knots (or 30 mph) SW wind conditions, approaching vessels are more challenging to operate. The effect is limited in duration, for the first hour of strong flood tides and only in conditions which would already be deemed close to marginal for operations at the berth.

Effects of Proposed Change 4

- Work undertaken to consider the proposed impact protection demonstrates that the new geometry does not affect operations to and from IOT 8.
- The detailed design for impact protection will need to accommodate the vessels sliding along the face of the berth before departure, and it would be sensible also to ensure that any fendering could withstand an approaching vessel landing on the impact protection.
- The detailed design will need further simulation studies in due course.

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1 Introduction

Associated British Ports (ABP) Humber is considering the development of additional RoRo berth capacity to the east of the Immingham dock, which will be known as the Immingham East RoRo Terminal (IERRT).

ABP has commissioned HR Wallingford to undertake a series of desk studies and real-time navigation simulation studies to assess the feasibility of the design for the IERRT.

1.1 Context for this study

The new facility is currently being subjected to a Development Consent Order Process. As part of that process, the Examining Authority encouraged ABP and Stakeholders to consider whether some further simulation work would enable them to come to a closer level of agreement on some of the contentious navigational issues.

Assessment of Changes

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Flow Modelling

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For the simulations undertaken on 15 November, the flow model for a peak spring tide condition has been rerun to take account of the larger southern pontoon and the new results provided to the Navigation Simulation.

It was expected that APT and their representatives would attend the simulations, but were unable to.

This short study has been undertaken to:

- Review any changes to the flow with respect to previously observed accelerations around the pontoon structures during lower water levels when they present a significant blockage.
- Review whether the additional structures proposed affect operations at IOT 6/8 finger pier.

2 Simulation configuration

2.1 General

The simulator setup was undertaken in accordance with HR Wallingford's normal procedures; the layout, environmental models and ship manoeuvring models were tested beforehand.

2.2 Environment

2.2.1 Wind

IOT operates a policy the vessels arriving at IOT 6 and 8 are limited to 30 mph when the wind sets off the berth. This is equivalent to 26 knots.

During previous work, it has been determined that with the wind varying between 25 and 30 knots based on a mean strength of 27.5 knots, vessels can still operate at the IOT6/8, noting that this exceeds the current operational limit.

The new layout removes a piled obstruction between IOT and IERRT, which provides more space.

This study focussed on SW wind conditions, which were previously shown to be the most challenging.

Sensitivity was considered for the north east wind condition with winds setting off the berth at 25 to 30 knots.

2.2.2 Waves

As with the previous studies, no significant wave penetration is expected in normal operating conditions, at least not of the nature which would lead to any significant degradation.

2.2.3 Flow

The flows used as the basis for this study were the peak spring flow associated with the layout described in Figure 2.3. These flows are considered to be the most conservative as they represent the strongest tidal currents expected and the maximum blockage that can be expected due to the combined effect of the floating pontoons.

The effect of the blockage at low water flood was previously noted by HR Wallingford, and sensitivity cases run in previous simulation studies, the deviation and acceleration was deemed then to have negligible effect on the outcome.

HR Wallingford has analysed the peak spring tidal cycle associated with the increased blockage. The only significant difference noted between flows previously used for simulations and the new understanding is a minor increase in deviation and acceleration of flow between IERRT and IOT.

HR Wallingford has completed a review of the models 'Original' based on the 2022 layout and 'Revised' based on the 2023 layout for flows on a peak spring tidal range. A time series for flows at a point between IOT 8 and IERRT is shown in Figure 2.1. It can be seen that the duration where there is any appreciable difference is short, within the hour immediately after the low water. Further analysis is now being undertaken to advise the effect of the blockage on more moderate tides, but the deviation and acceleration are expected to be lower.

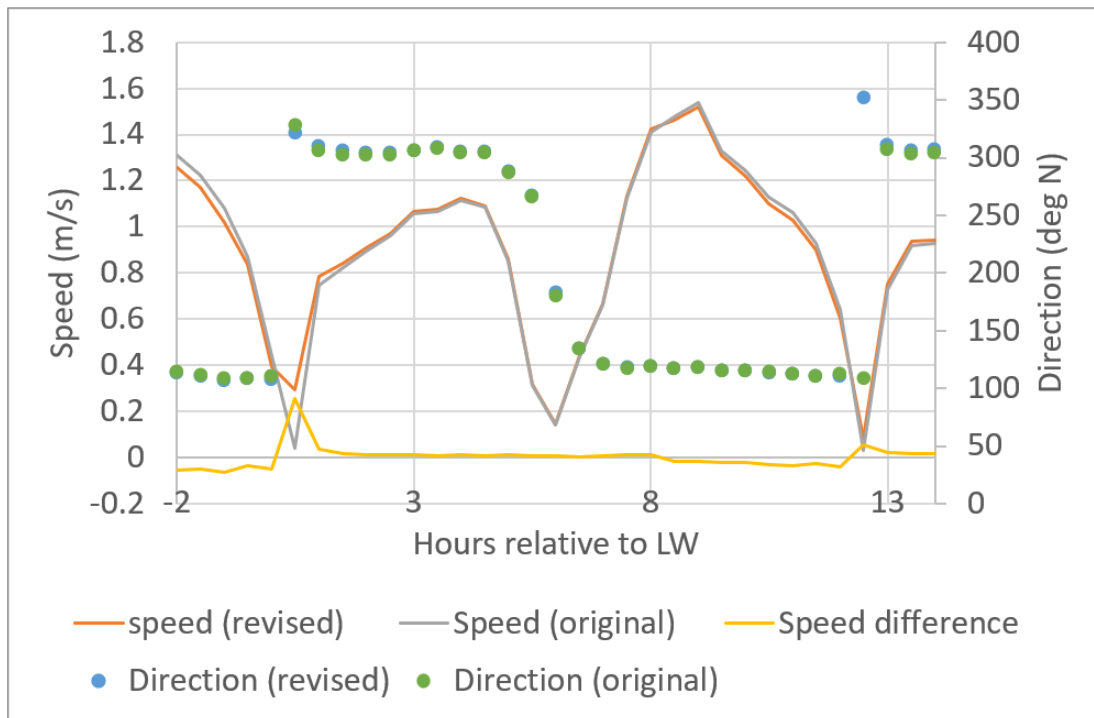


Figure 2.1: Time series comparing flow rates and directions between IOT and IERRT using original peak spring flow cycle and a revised model

2.3 Port layout

3 layouts were used in this study:

- May 22, a layout based on Jacobs drawings provided to HRW in May and used in simulations completed prior to this set (Figure 2.2);
- Feb 23, a layout based on design drawings submitted to the DCO process in February 23, incorporating a larger southern pontoon (Figure 2.3);
- Nov 23, a layout incorporating proposed impact protection at the north western end of the IOT 6/8 finger pier (Figure 2.4).

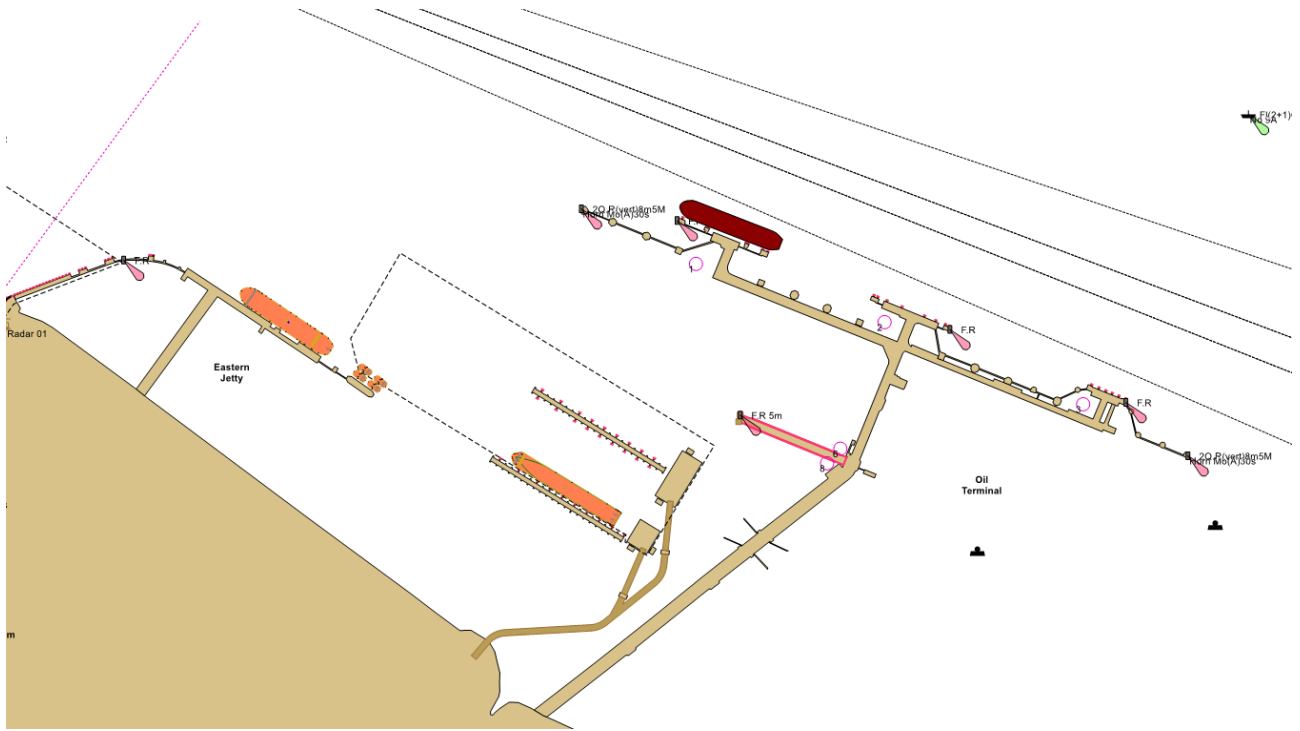


Figure 2.2: Port layout as simulated including tugs and vessels moored on eastern jetty

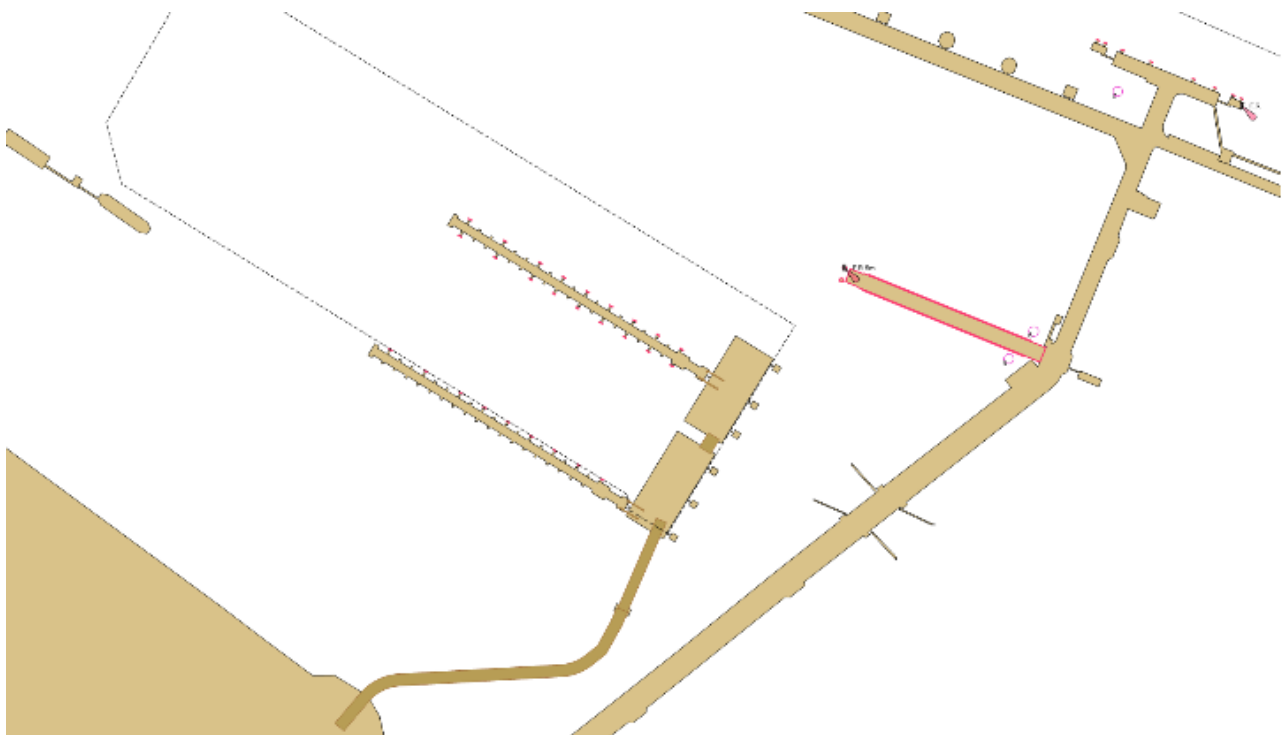


Figure 2.3: Port layout including larger southern pontoon

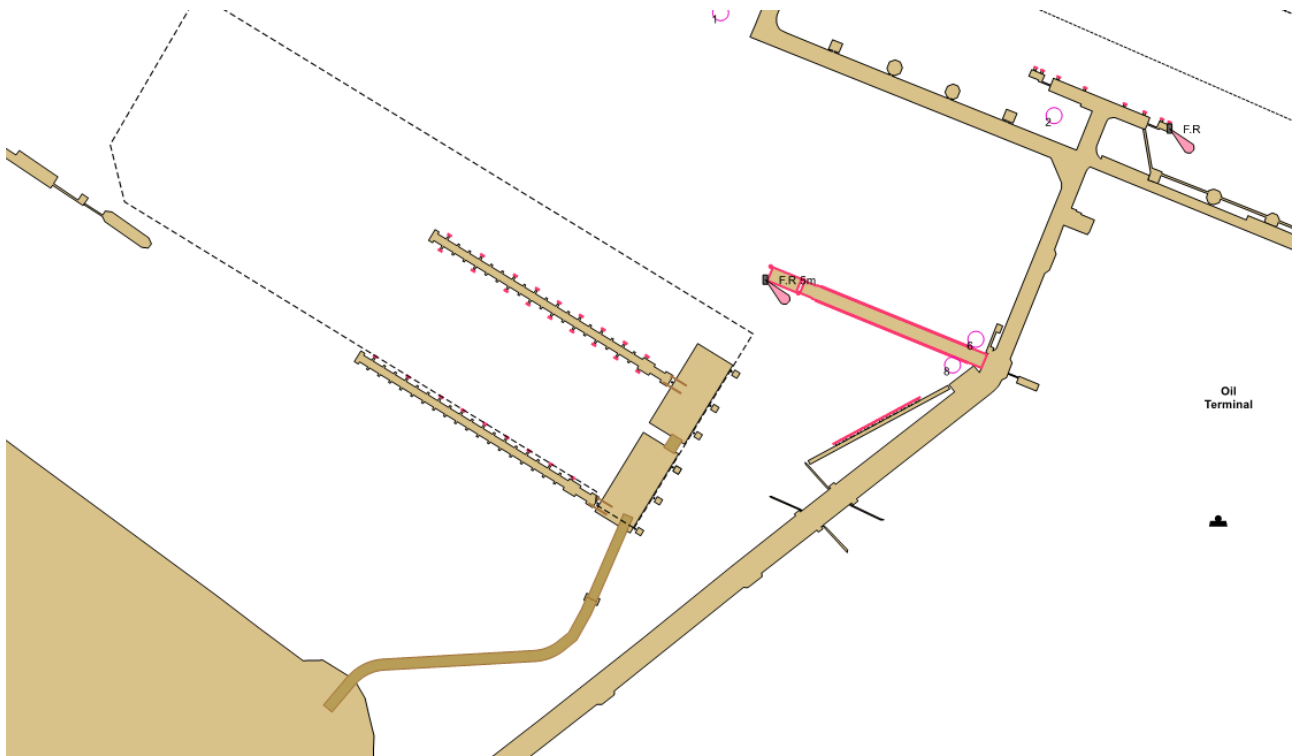


Figure 2.4: Port Layout incorporating impact protection at the north western end of IOT 6/8 finger pier

2.4 Design vessel

2.4.1 Wisby Teak

The design vessel for the study was the Wisby Teak, previously used in November 2022 simulations on the Humber to present to stakeholders. The manoeuvring characteristics are shown in Table 2.1.

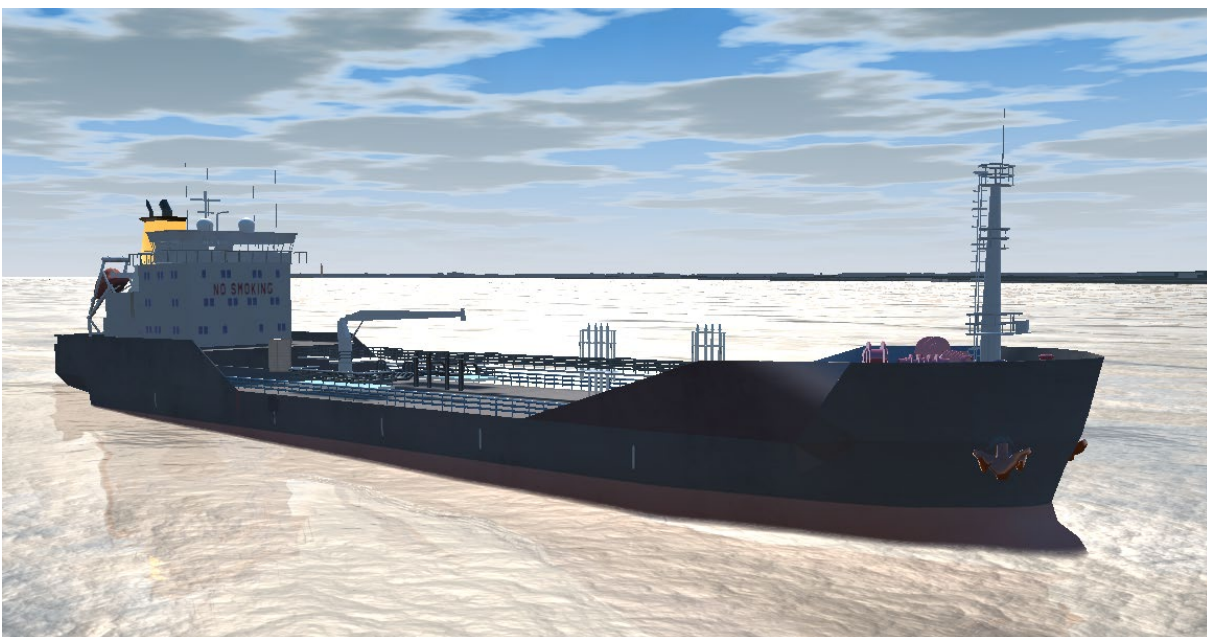


Figure 2.5: Wisby Teak

Table 2.1: Whisby Teak manoeuvring characteristics

Characteristic	Unit	100m x 18m Product Tanker Laden	100m x 18m Product Tanker Ballast		
Ship type		Product Tanker	Product Tanker		
Length overall	m	99.9	99.9		
Length between perpendiculars	m	95	95		
Beam overall	m	18.25	18.25		
Distance bridge to stern	m	19.4	19.4		
Modelled conditions					
Draught forward	m	6	3.73		
Draught aft	m	6.1	5.83		
Block coefficient		0.744	0.706		
Displacement	t	8000	6000		
Propulsion					
Main engine type		Wartsila 9L26	Wartsila 9L26		
Engine power (total)	kW	2925	2925		
No. of propellers, type		1 x CPP	1 x CPP		
Bow thrusters	t	7	7		
Stern thrusters	t	none	none		
Rudder type		Spade	Spade		
Max rudder angle	°	70	70		
Manoeuvring engine order		RPM	Speed (knots)	RPM	Speed (knots)
Full Ahead		100	13.0	100	13.1
STOP		0	0	0	0
Full Astern		85	- 7.8	85	- 7.8
Windage					
Windage lateral	m ²	1006		1133	
Windage frontal	m ²	315.4		320.3	
Wind speed (knots)		Beam wind force (t)		Beam wind force (t)	
15		4		4	
20		7		7	
25		10		11	
30		15		17	
45		33		37	

2.5 Tug models

HR Wallingford provided a 50t BP ASD tug model and a 16m workboat used in previous studies to represent the ‘Spurn Sands’ which supports operations at IOT.

HR Wallingford’s navigation simulation system supports two types of tug models:

- Centrally controlled tugs:** The tug(s) assisting the vessel are controlled by the Simulator Operator following the Pilot’s commands, and in a manner similar to that which would be expected in practice, with realistic delays applied. The response of each centrally-controlled tug is governed by a tug performance model that ensures the response times and maximum force deliverable by each tug varies with tug type, winch type, vessel water speed and assist mode (push, direct pull, powered indirect, indirect pull and transverse arrest) as well as the local wave conditions and any hull sheltering effects.
- Independently controlled tugs:** The independently controlled tugs are operated by a tug master from separate, but linked simulator bridge(s) configured as a tug. The behaviour and performance of each independent tug model, in terms of the response to any helm, engine and towline/fender forces, along with the effects of the local wind, wave and current conditions, is governed by a full mathematical tug manoeuvring model. The tug model represents motions in all six degrees of freedom (6DOF), i.e. surge, sway, heave, roll, pitch and yaw motions, and includes tug interactions with waves, the tow line, winches and fenders. Independent tugs can be used in conjunction with centrally controlled tugs to complete the full tug complement required for a manoeuvre.

Throughout all simulations tug models were operated in the centrally controlled mode.

With the independently controlled tug models, the operating delays and performance degradation are automatically taken into account. The centrally controlled tugs are subject to operating delays as shown in Table 2.2, and tug performance curves as shown in Figure 2.6 and Figure 2.7.

Table 2.2: Centrally controlled tug response settings

Tug response delay			Delay
Time to attach and secure			5 minutes (+ 3 minutes line pay-out)
Time to react to new thrust level command			1 minute
Time to react to change in thrust level			20 seconds
Time to change thrust direction	Direct	Up to 90°	Up to 1 minute
		90 to 180°	Up to 2 minutes
	Indirect	Roll into assist	Up to 30 seconds
		Quarter to quarter	Up to 1 minute
Time to detach	Push/pull mode		1 minute

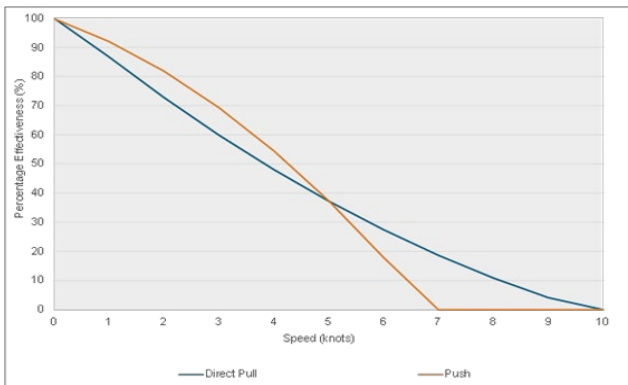


Figure 2.6: Effectiveness of centrally controlled tugs with water speed

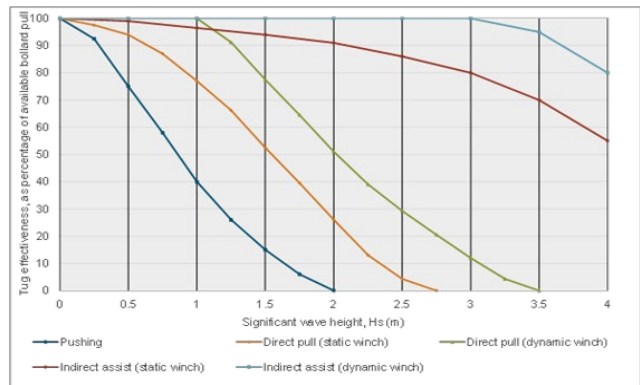


Figure 2.7: Effectiveness of centrally controlled tugs with wave height

3 Navigation simulation session

3.1 Simulation session

The real time navigation simulation session was conducted at HR Wallingford's UK Ship Simulation Centre on 13 and 14 November 2023 using a full mission ship bridge simulator. The demonstrations were facilitated by HR Wallingford staff with significant input from all stakeholders and suitably qualified pilots and masters controlled the ship manoeuvring models.

The attendees are detailed in Table 3.1.

Table 3.1: Attendance list

Attendees	Role	Organisation
Mike Parr	Project Lead	HR Wallingford
Liam Monahan-Smith	Simulator Operator	HR Wallingford
Fred Firman	Harbour Master	ABP Humber
Daniel Landi	Project Manager	ABP Project Team
Sophie Young	Consents Lead	ABP Project Team
Joe Smith	Pilot Operations	ABP Humber
Jason Melles-Sawyers	VLS pilot	VLS pilot (ABP)
Brian Greenwood	Lawyer	ABP Legal Team (C&C)

3.2 Grading of results

Each simulation run was graded by the simulation participants as Successful, Marginal or Fail, according to the following evaluation criteria:

Successful Standard manoeuvres:

- The ship remains under full control at all times without resorting to aggressive manoeuvring techniques;
- The ship stays within safe water areas with acceptable clearances to all port and other structures, and other berthed ships;
- Tugs are operating safely and within sustainable limits;
- For berthing manoeuvres, the ship ends the run alongside, or in such a position that lines would be ashore without appreciable difficulty, at zero speed, with an acceptable sway velocity and no appreciable yaw rate;

- For departure manoeuvres the ship exits smoothly, without risk of drifting onto port structures or other ships.

Emergency/failure situations:

- The ship is brought back under full control without encountering significant hazards, with the risk of only minor damage;
- The ship may leave the designated manoeuvring area boundaries, but still has acceptable under keel clearance and maintains acceptable clearances to other ships/structures throughout the recovery;
- Tugs are neither endangered nor asked to operate in an unsafe manner;
- The ship can be moved into safe, deep water or to a position suitable to anchor safely, where the equipment failure can be investigated/resolved.

Marginal

Standard manoeuvres:

- The Pilot considers the ship is at the limit of control during standard manoeuvres;
- The ship stays within the safe water area boundaries, but with unacceptable clearances;
- The ship clears all port structures, and other berthed ships, but with unacceptable clearances;
- Tugs are operating safely, but approaching their sustainable operating limits (e.g. being used at 100% power for more than 15 minutes);
- For approach manoeuvres, the ship ends up alongside, but may have a high approach velocity. The manoeuvre can be concluded, but minor damage may occur;
- On departure, the ship is manoeuvred off the berth but with some difficulty. The manoeuvre is completed with the potential for minor damage only.

Emergency/failure situations:

- The ship is at the limits of control during the recovery from the failure;
- The ship has marginal under keel clearance or marginal clearances to other ships/structures during the recovery;
- Tugs operate at the limits of safety;
- The ship is at the limits of controllability as it is moved into safe, deep water or to a position suitable to anchor safely, where the equipment failure can be investigated/resolved.

Fail

Standard manoeuvres:

- The Pilot loses control of the ship;
- The ship strays outside the safe water area boundaries and/or grounds;
- The ship either contacts, or has a near-miss with port structures and/or other berth ships;
- Tugs are required to operate in an unsafe manner, or exceed sustainable operating limits (e.g. being used at 100% power for more than 30 minutes);
- For approach manoeuvres, the ship cannot get alongside at all, or contacts the berth with sufficient force that severe damage may have occurred;
- On departure, the ship either cannot be manoeuvred off the berth, or encounters significant difficulty in manoeuvring, such that severe damage may have occurred.

Emergency/failure situations:

- The Pilot cannot regain control of the ship before the ship is endangered;
- The ship cannot be prevented from entering dangerously shallow water and/or grounds;
- The ship either contacts or has a near-miss with a known hazard, port structures, and/or other berth ships;
- Tugs are endangered or are asked to operate in an unsafe manner;
- The ship cannot be moved into safe, deep water or to a position suitable to anchor safely.

- Aborted The run was aborted for efficiency reasons, to save wasting any time, due to either:
- The initial manoeuvring strategy or approach/departure manoeuvre was deemed to be inappropriate right at the start, so the run would be bound to fail if continued; or
 - Because of the need to test aspects of the ship manoeuvring model.

3.3 Simulation run summary

The simulation run summary is shown in Table 3.2.

Table 3.2: Run summary table

Run ID	Pilot	Manoeuvre	Layout	Vessel	Tugs	Tide (to) (time, state)	Flow at midpoint between IOT and IERRT	Wind (from) (dir, speed)	Assessment
01	JM	Approach IOT 8	Original	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 17.5 knots ± 2.5 knots	Success
02	JM	Approach IOT 8	Original	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat + 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 27.5 knots ± 2.5 knots	Success
02A	JM	Approach IOT 8	Original	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 27.5 knots ± 2.5 knots	Marginal
02B	JM	Approach IOT 8	Original	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 27.5 knots ± 2.5 knots	Success
03	JM	Approach IOT 8	Original	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Peak Flood High Water - 2.5 hours	2.2 knots 304°T	SW (225°) 27.5 knots ± 2.5 knots	Success
04	JM	Departure IOT 8	Original	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Quarter (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 27.5 knots ± 2.5 knots	Success
05	JM	Approach IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Peak Flood High Water - 2.5 hours	2.2 knots 304°T	SW (225°) 27.5 knots ± 2.5 knots	Success
06	JM	Approach IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 27.5 knots ± 2.5 knots	Marginal

Run ID	Pilot	Manoeuvre	Layout	Vessel	Tugs	Tide (to) (time, state)	Flow at midpoint between IOT and IERRT	Wind (from) (dir, speed)	Assessment
07	JM	Departure IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 25 knots	Success
08	JM	Arrival IOT 8	May 22 Layout, with associated flow	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.3 knots 310°T	SW (225°) 25 knots	Success
09	JM	Arrival IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 27.5 knots ± 2.5 knots	Success
10	JM	Arrival IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 22.5 knots ± 2.5 knots	Success
10A	JM	Arrival IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Port Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Low Water + 1 hour	1.5 knots 315°T	SW (225°) 22.5 knots ± 2.5 knots	Success
11	JM	Departure IOT8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat Tug 1: 16m Port Shoulder (CCT)	Low water + 1 hour	1.5 knots 315°T	SW (225°) 27.5 knots ± 2.5 knots	Success
12	JM	Arrival IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat Tug 1: 16m Port Shoulder (CCT)	Low water + 1 hour	1.5 knots 315°T	SW (225°) 17.5 knots ± 2.5 knots	Success
13	JM	Arrival IOT 8	With Protection	Whisby Teak 100m x 18m Laden	1 x 16m Workboat Tug 1: 16m Port Shoulder (CCT)	Low water + 1 hour	1.5 knots 315°T	N (000°) 0 knots	Success
14	JM	Arrival IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat Tug 1: 16m Port Shoulder (CCT)	Low water + 1 hour	1.5 knots 315°T	SW (225°) 27.5 knots ± 2.5 knots (Sheltering)	Success

Run ID	Pilot	Manoeuvre	Layout	Vessel	Tugs	Tide (to) (time, state)	Flow at midpoint between IOT and IERRT	Wind (from) (dir, speed)	Assessment
15	JM	Approach IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Starboard Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Peak Flood High water -2.5 hours	2.2 knots 304°T	NE (045°) 27.5 knots ± 2.5 knots	Success
16	JM	Departure IOT 8	With Protection	Whisby Teak 100m x 18m Ballast	1 x 16m Workboat 1 x 45t BP ASD Tug 1: 16m Starboard Shoulder (CCT) Tug 2: 45t ASD tug Centre- lead Aft (CCT)	Peak Flood High water -2.5 hours	2.2 knots 304°T	NE (045°) 27.5 knots ± 2.5 knots	Success

Notes:

The vessel was under the command of a trained Pilot from the Humber, Jason Melles -Sawyers (JM), mentioned on the attendee list.

All tugs were labelled Centrally Controlled Tug (CCT) were controlled by the Simulator Operator.

Tugs were Azimuth Stern Drive (ASD).

Wind directions were aligned with predominant wind conditions at the site: South Westerly (SW), North Easterly (NE).

3.4 Simulation track and data plots

The results of each navigation simulation run are available in the form of plots of the vessel tracks and graphs of key data parameters recorded during the run. These data are presented in Appendix A.

The vessel data and track plots show:

- The position of the ship and the tugs at one minute intervals is indicated by a succession of black and blue vessel outlines. Red vessel outlines indicate the vessel's position every 10 minutes from the start of the run;
- The positions of port structures and aids to navigation;
- A north arrow;
- A scale bar;
- Seabed contours (bed levels in mCD).

The data graphs plot the variation of various key parameters against elapsed simulation time and graphs have been included for all vessels in all of the runs. These graphs are presented by vessel, starting with the ship, and then the independent tug (where applicable). The vessel ID is identified in the text block on the bottom right of each page.

The ship graphs comprise:

- Ship's under keel clearance(s) in metres and speed over the ground (knots). The data plotted in these UKC graphs does not take account of wave-induced ship motions;
- Speed (knots) and direction (°N) of the wind acting on the ship;
- Lateral wind force acting on the ship (tonnes);
- Ship's rate of turn (°/min) and heading in °N;
- Ship's course over the ground and drift angle in degrees;
- Ship's speed (over the ground and through the water) in knots, expressed in terms of longitudinal and lateral components relative to the ship's head;
- Ship's rate of turn (°/min);
- Ship's rudder angle (degrees);
- Ship's bow and/or stern thruster power (%);
- Number of ship's engine restarts.

Where there are no plots for a particular parameter, for example for bow thruster power, this indicates that the particular parameter was not relevant for the particular run or no bow thruster was available.

4 Conclusions

Flow Modelling:

- The remodelled flows based on the larger pontoons indicate a subtle additional acceleration around the northern pontoon between the IERRT and IOT; this is apparent between LW and one hour after low water. The effect is to change a flow previously 310 T at 1.3 knots to 315 T at 1.5 knots.
- The Applicant has instructed HR Wallingford to undertake further flow modelling across a mean spring tidal cycle and at the time of writing, the assessment is being undertaken.
- An initial sensitivity analysis for manoeuvres at IOT 8 shows that this change does not affect departing vessels. When the most challenging operating parameters are applied to the berth, specifically a strong flood tide and with 26 knots (or 30 mph) SW wind conditions, approaching vessels are more challenging to operate. The effect is limited in duration, for the first hour of

strong flood tides and only in conditions which would already be deemed close to marginal for operations at the berth.

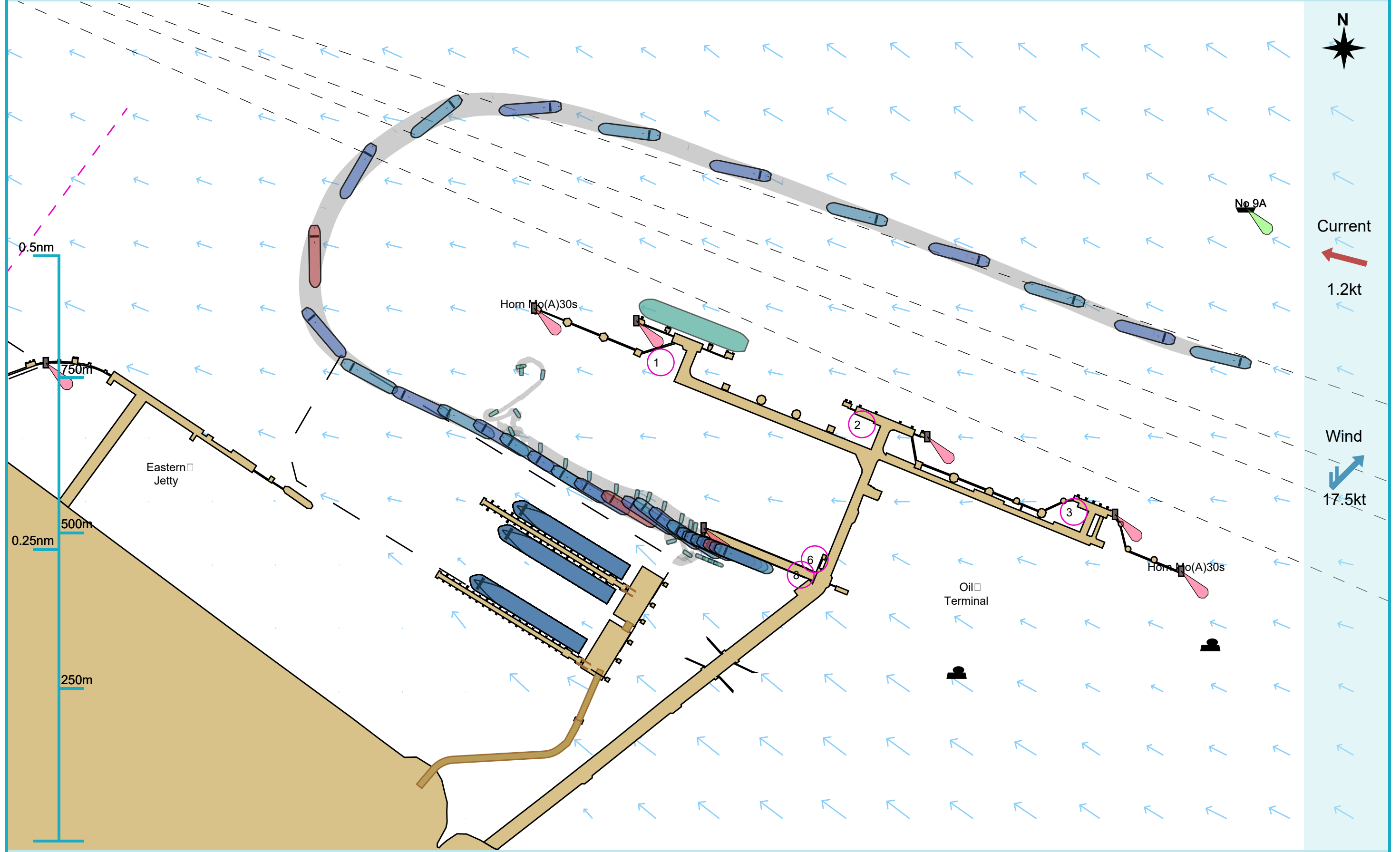
Effects of Proposed Change 4:

- Work undertaken to consider the proposed impact protection demonstrates that the new geometry does not affect operations to and from IOT 8.
- The detailed design for impact protection will need to accommodate the vessels sliding along the face of the berth before departure, and it would be sensible also to ensure that any fendering could withstand an approaching vessel landing on the impact protection.
- The detailed design will need further simulation studies in due course.

Appendices

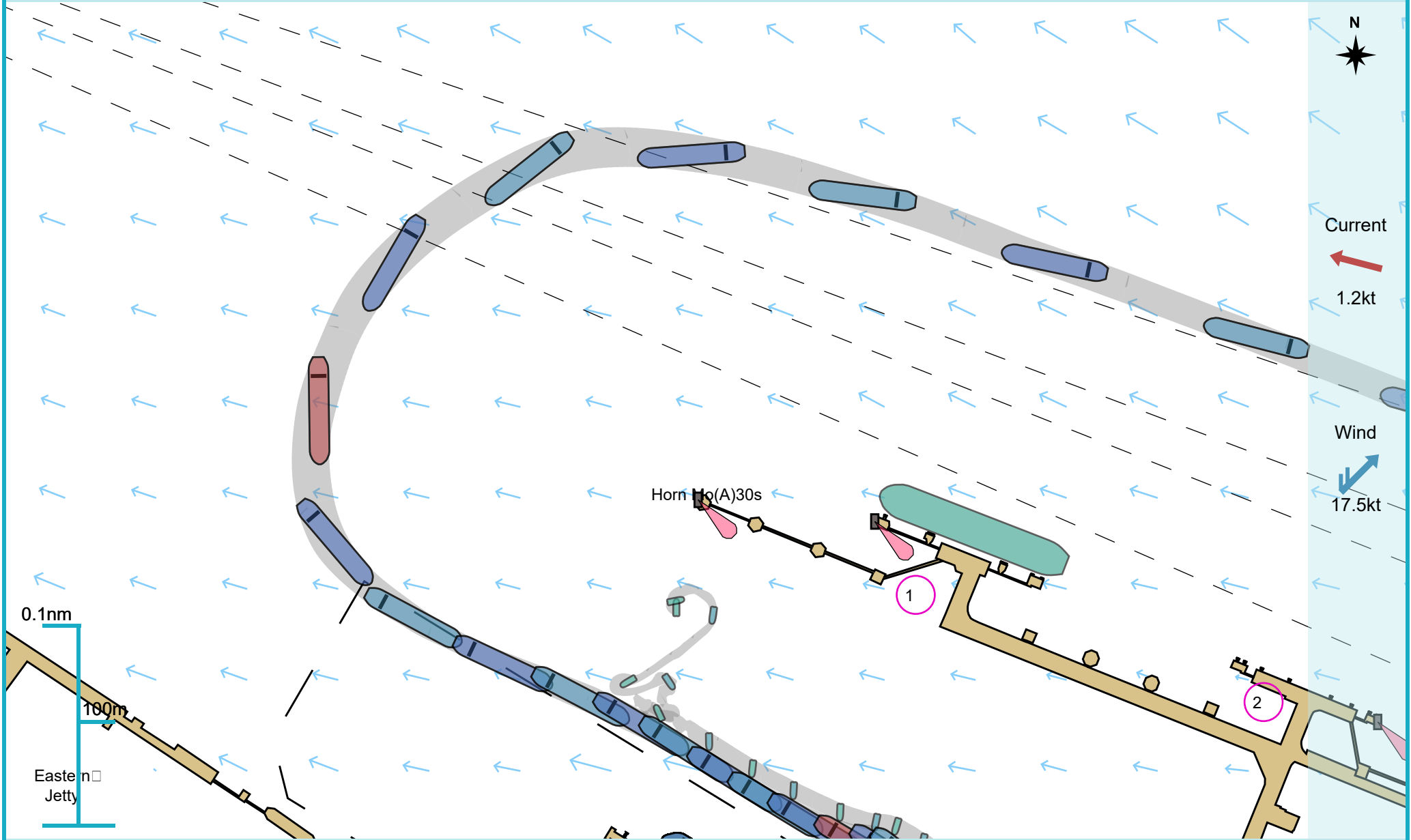
A Track plots

Manoeuvre track plot



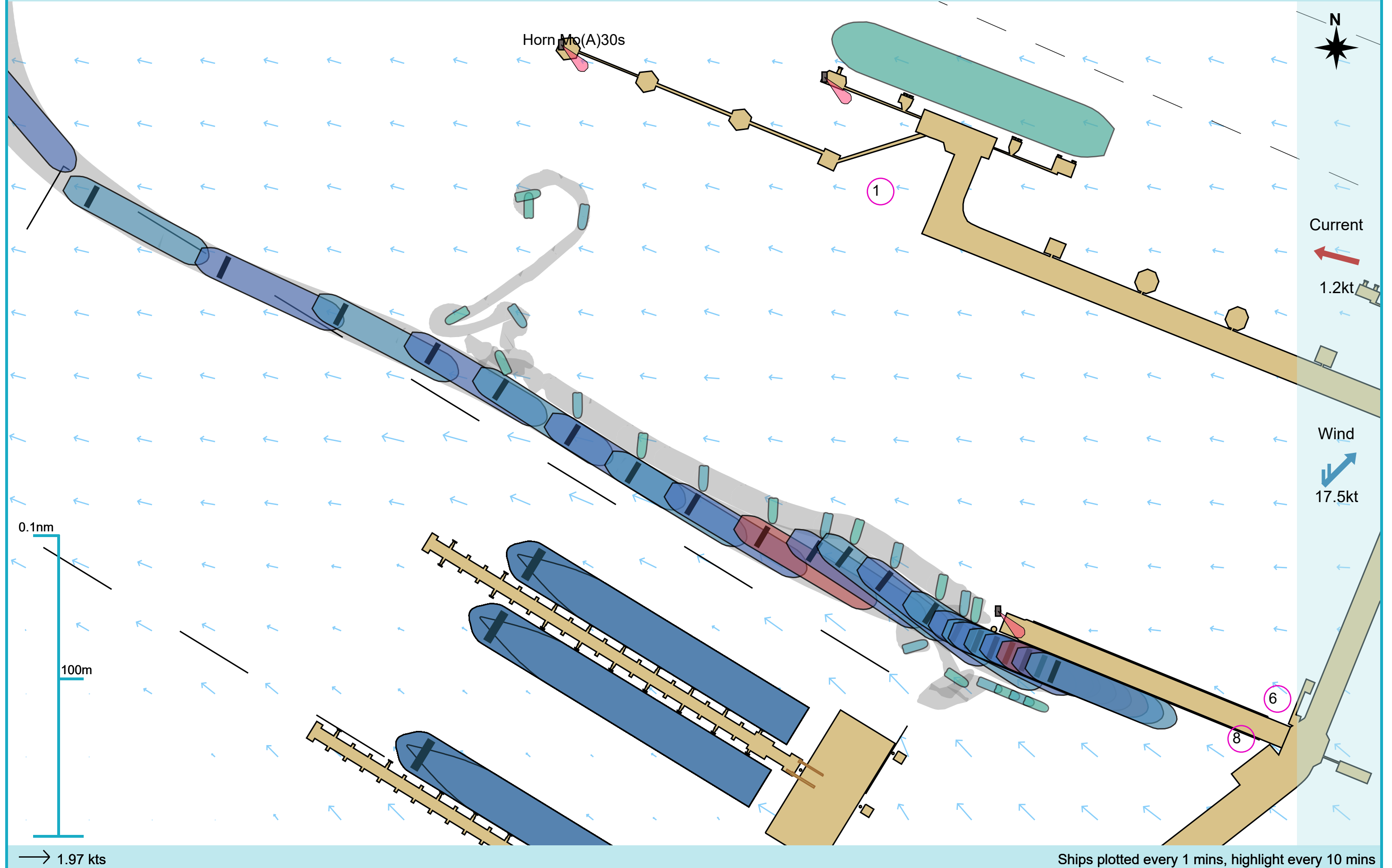
Ships plotted every 1 mins, highlight every 10 mins

Manoeuvre track plot



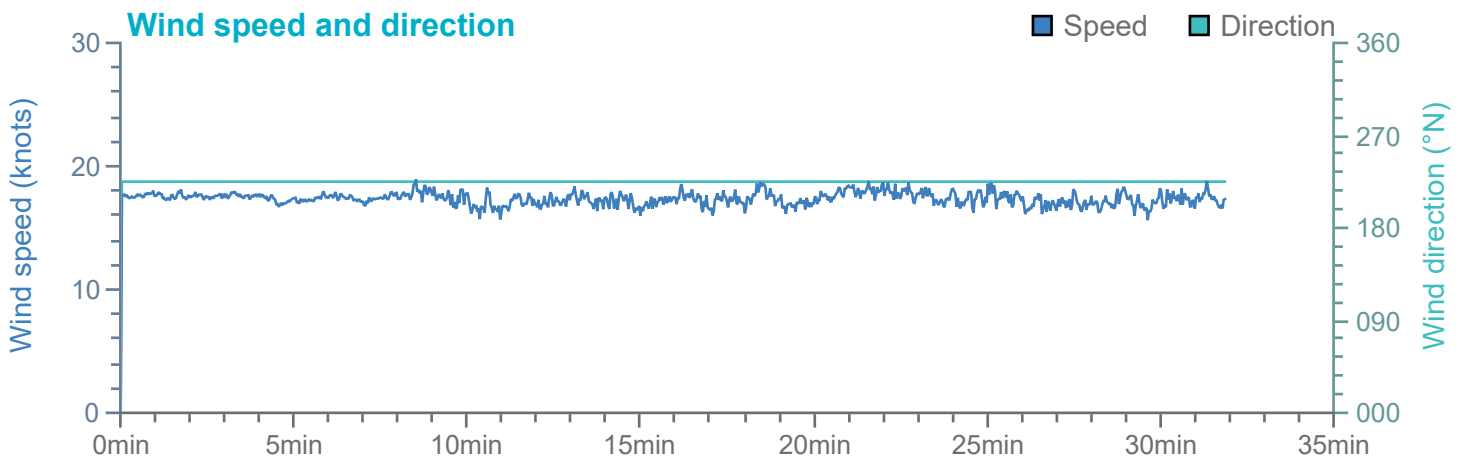
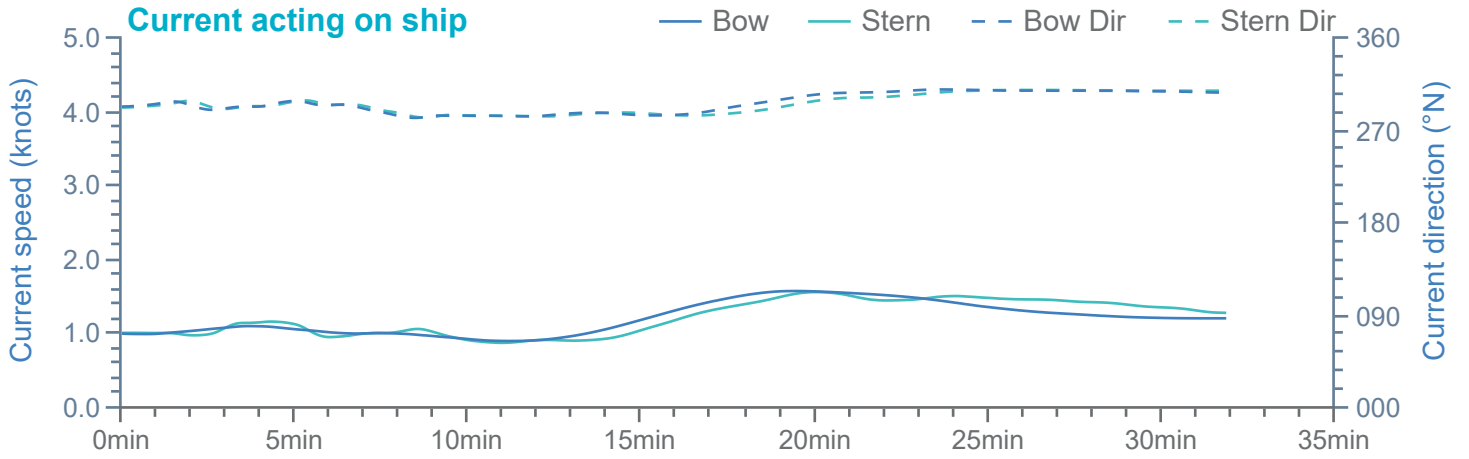
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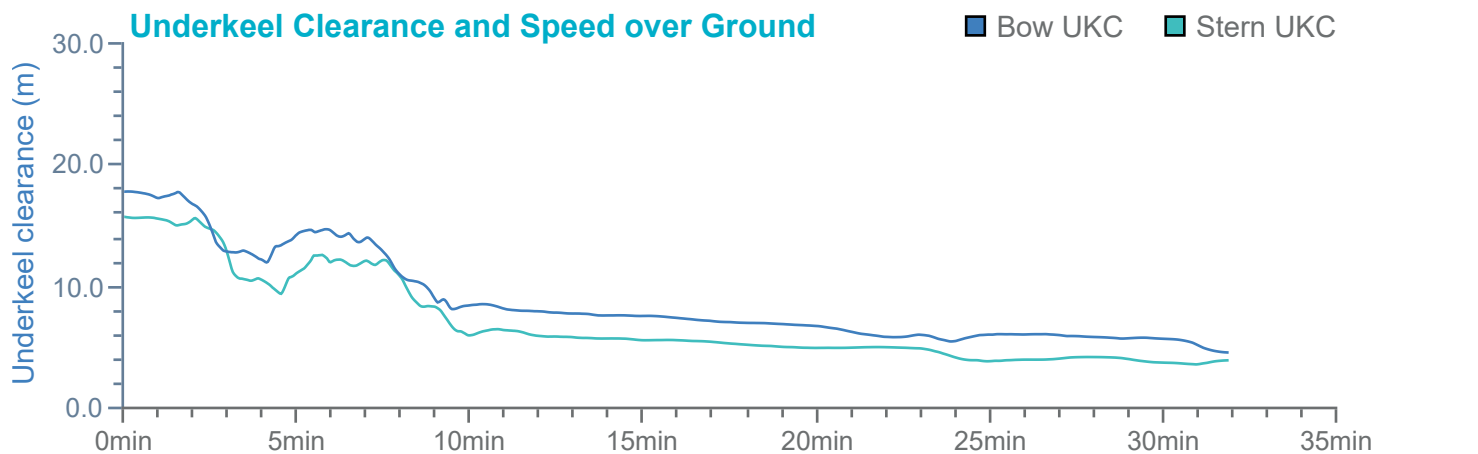
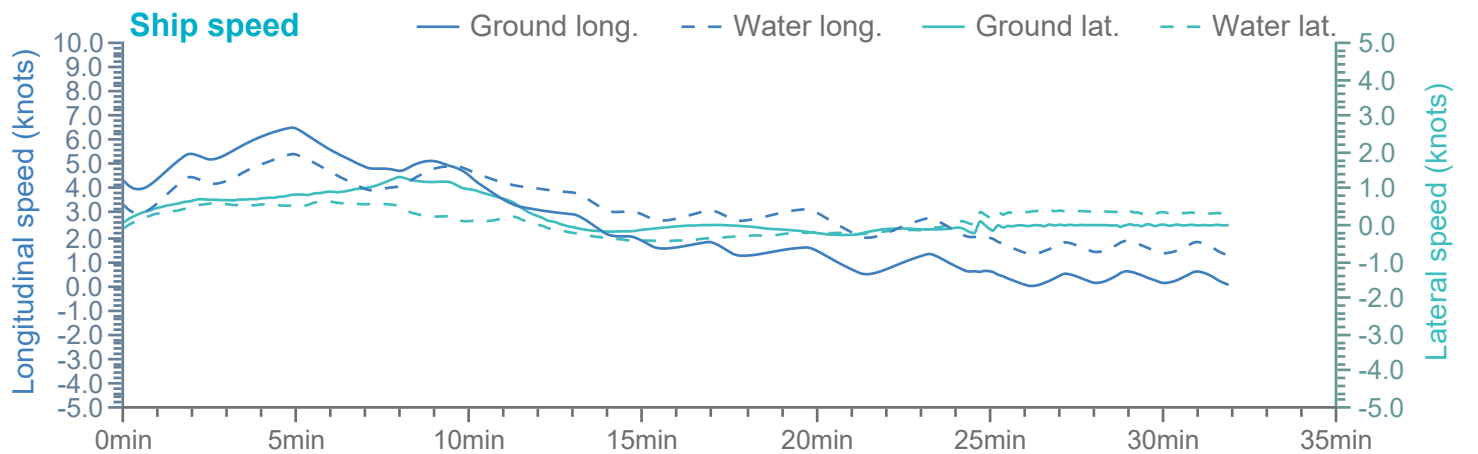
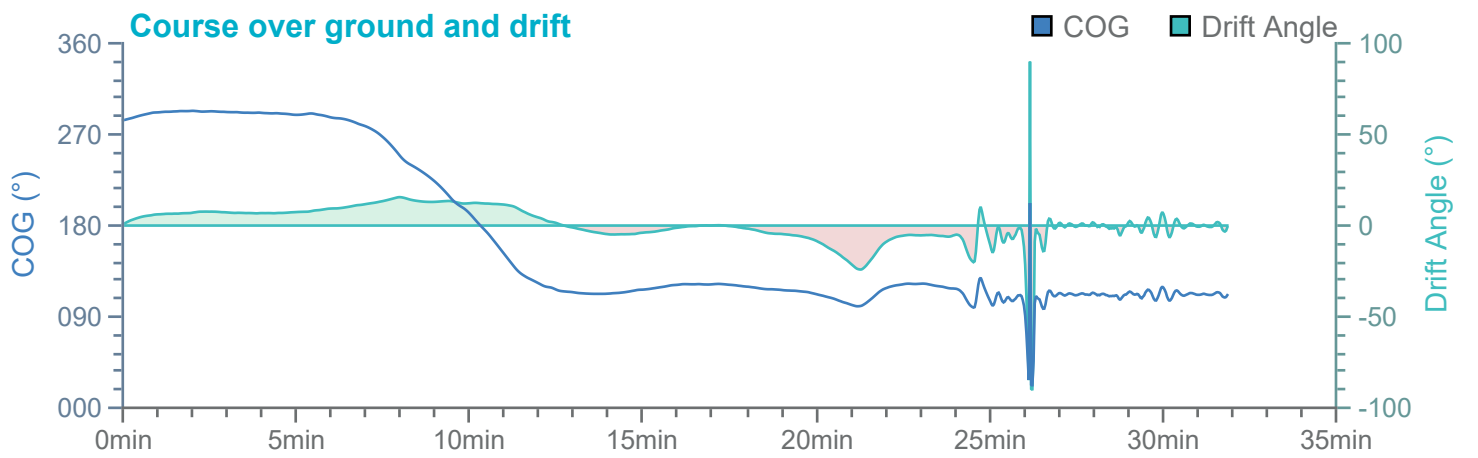
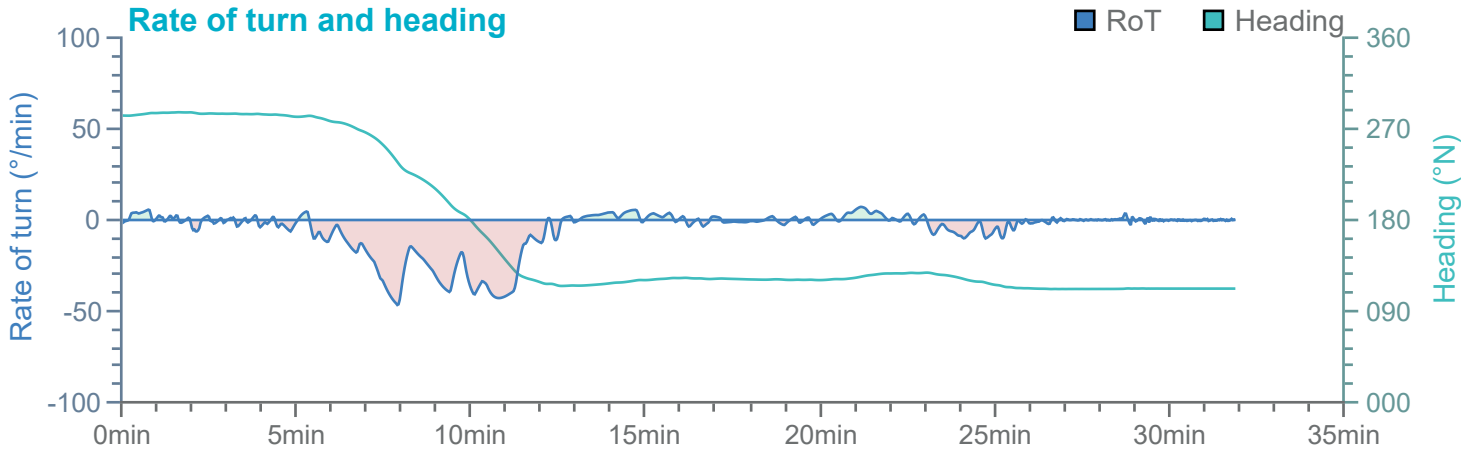
Manoeuvre track plot



→ 1.97 kts

Ships plotted every 1 mins, highlight every 10 mins



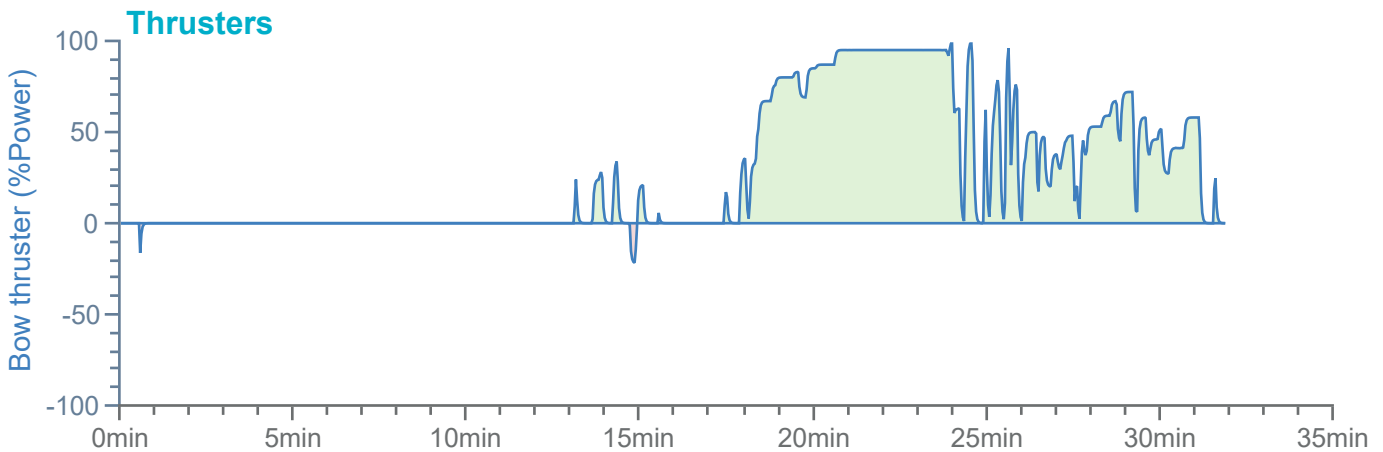
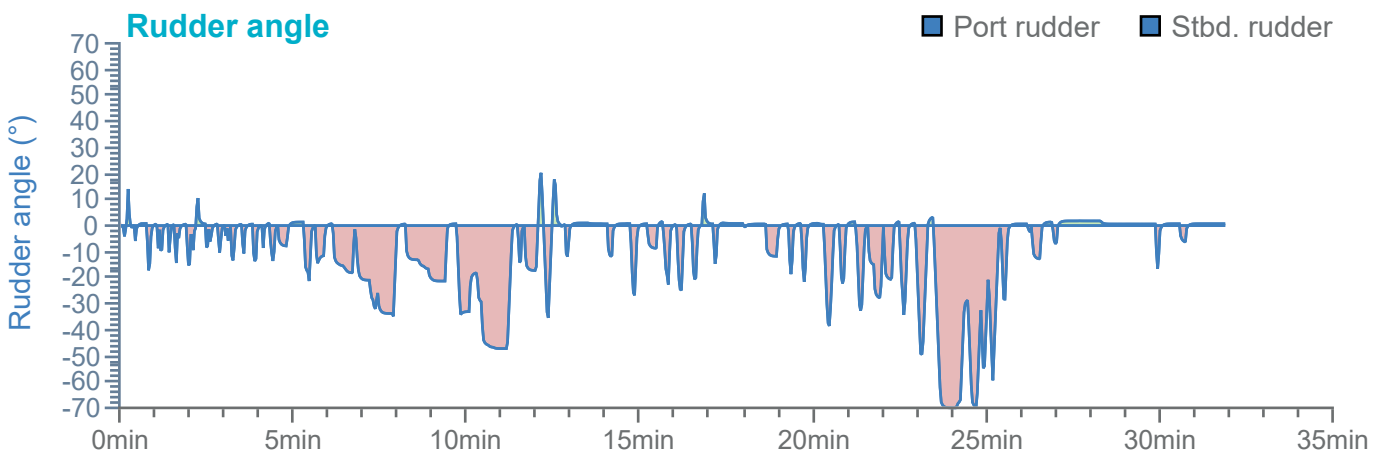
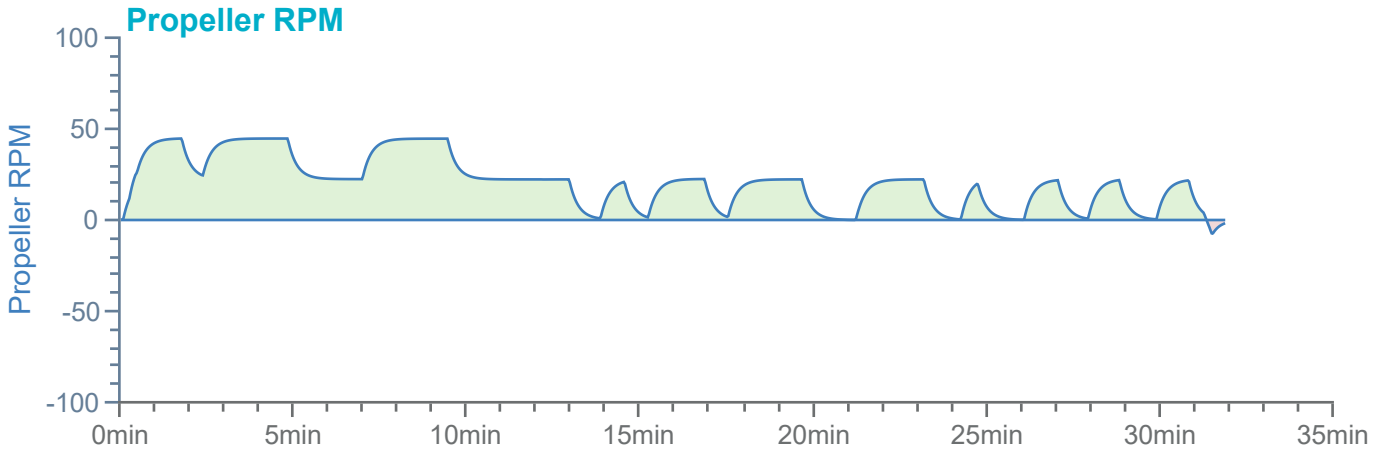


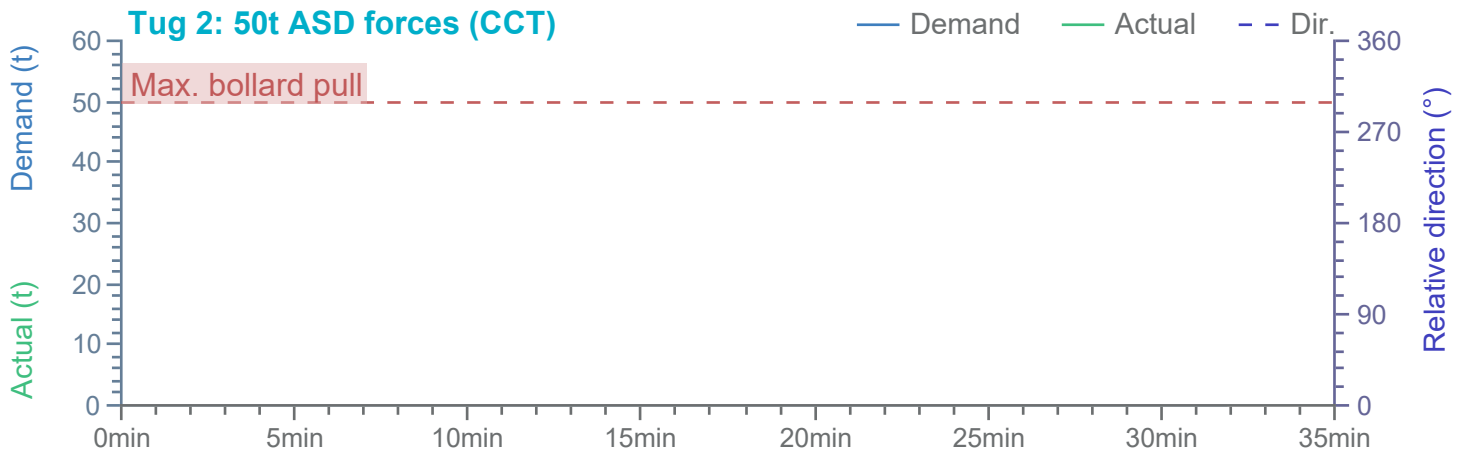
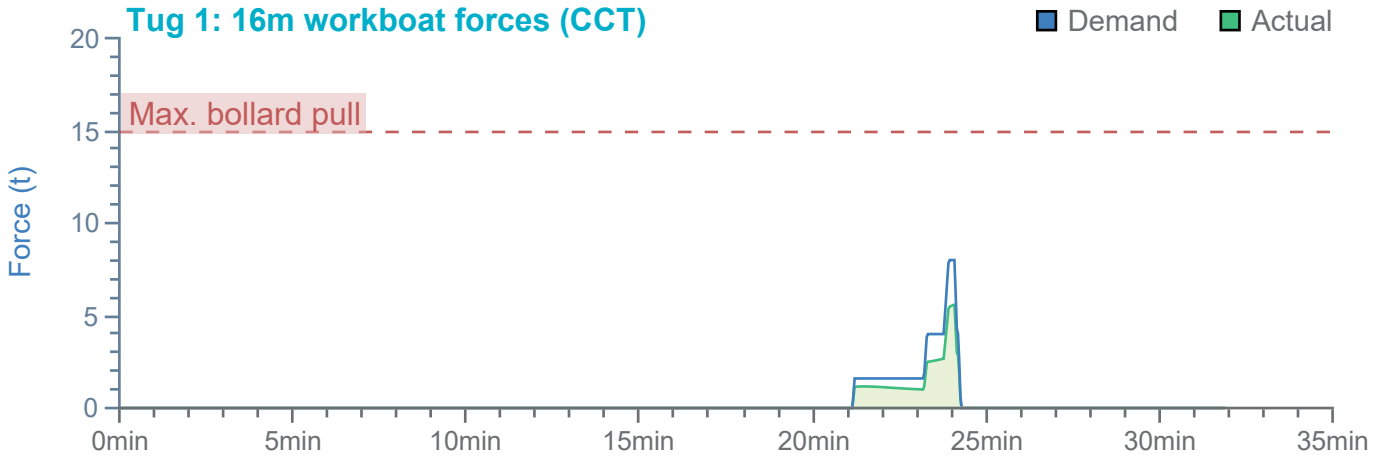
Overview

Environment

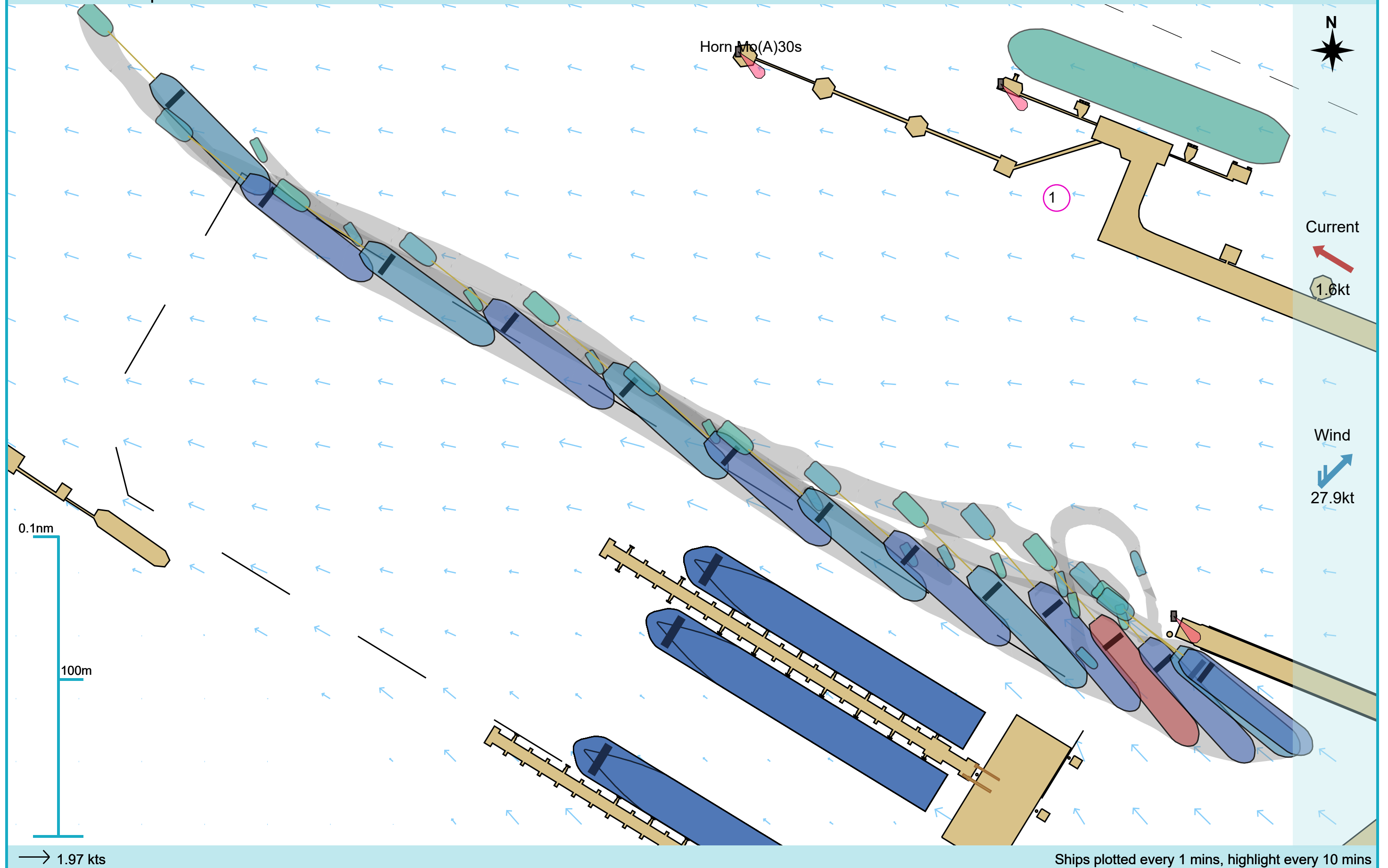
100m x 18m Product Tanker

Tugs



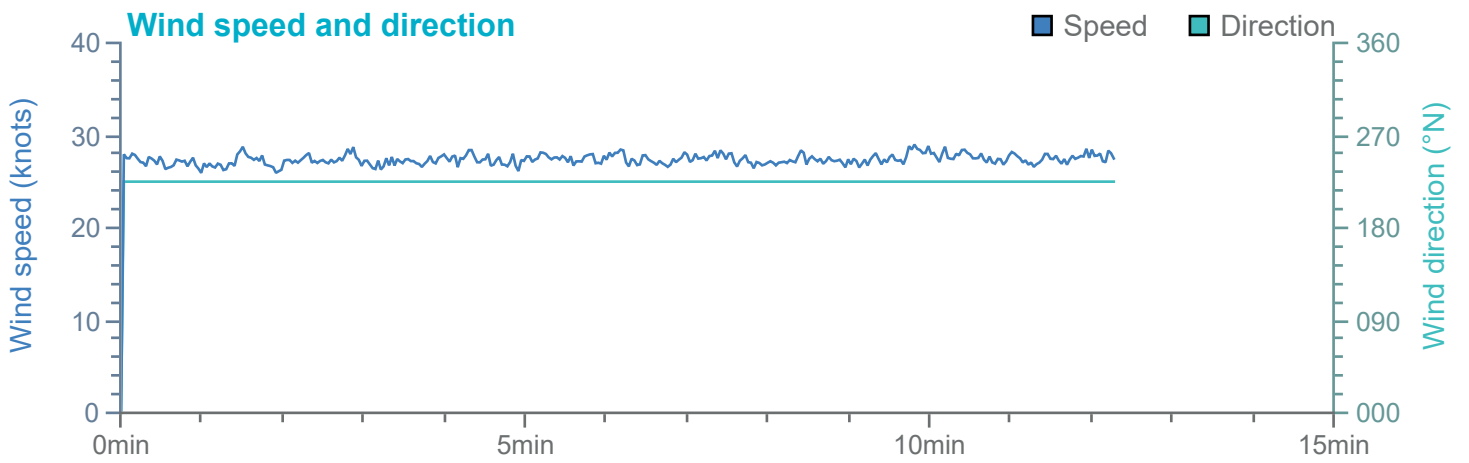
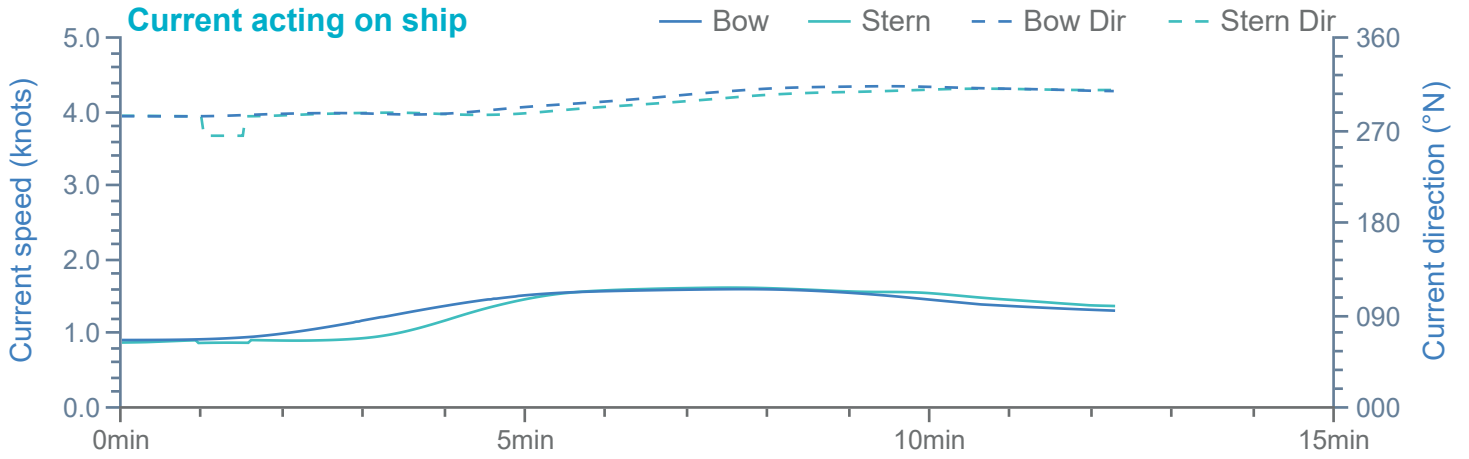


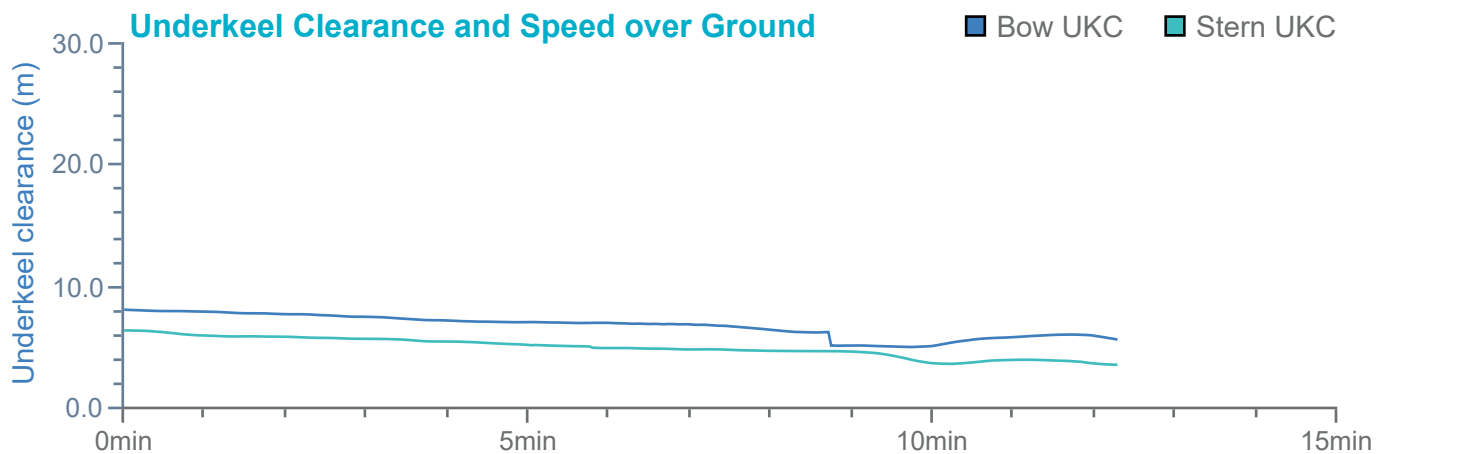
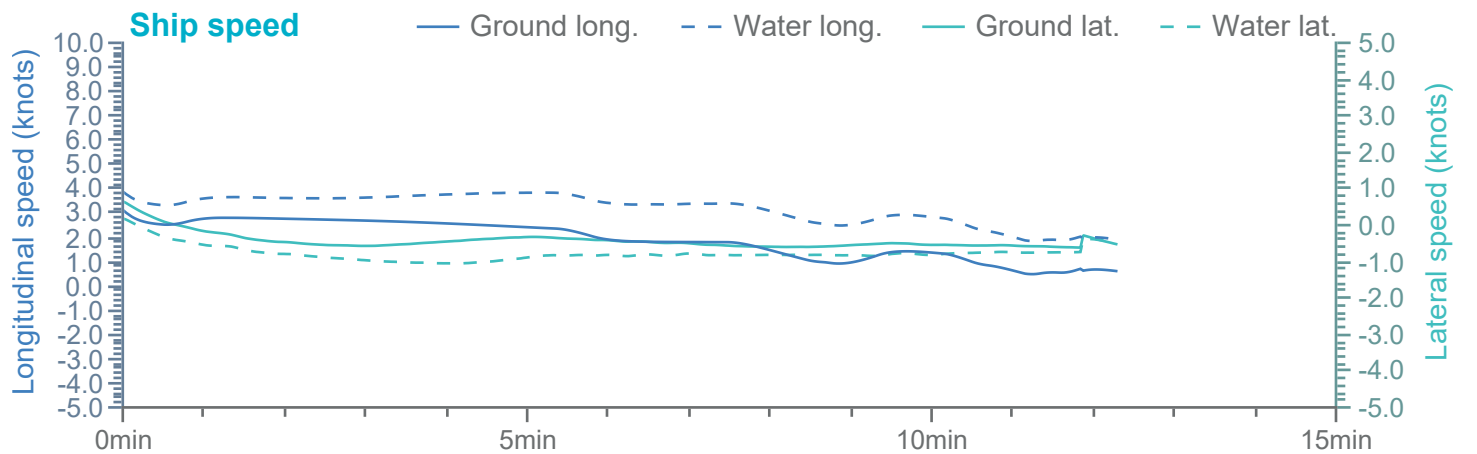
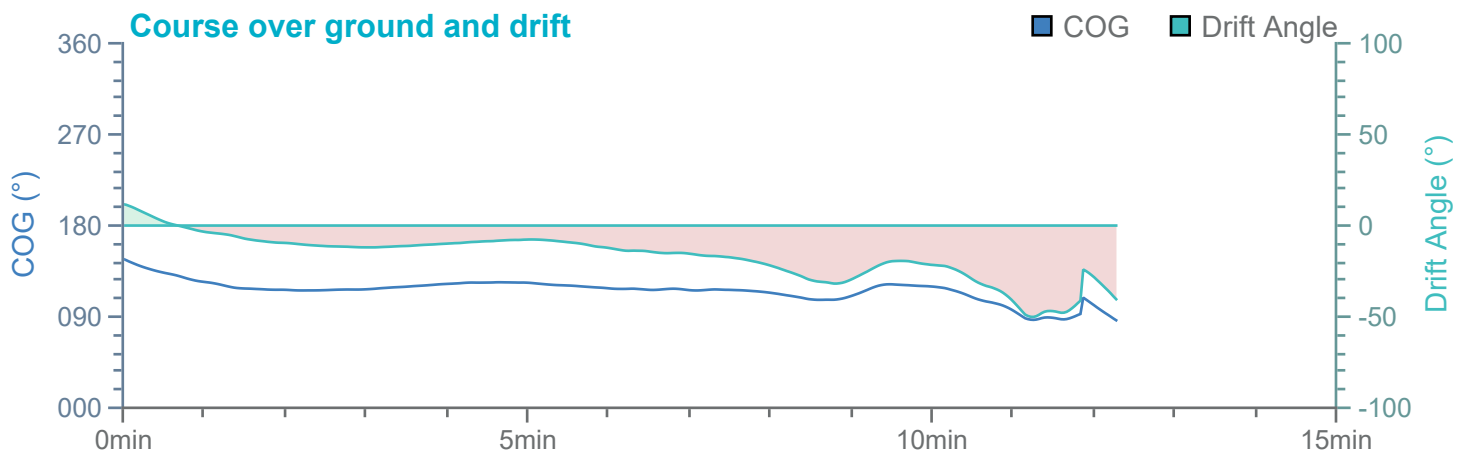
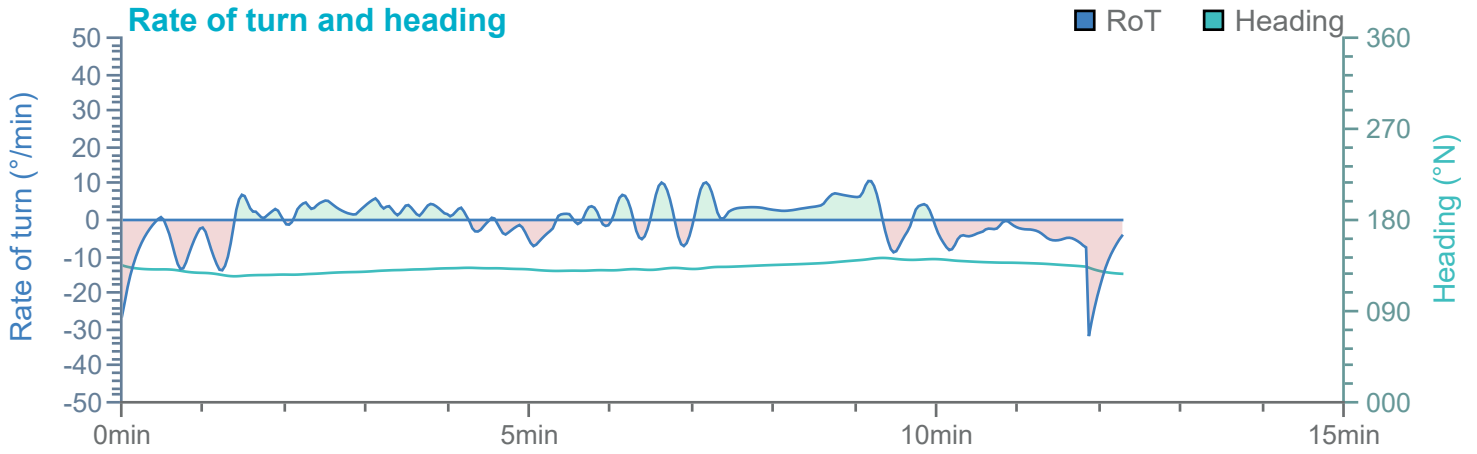
Manoeuvre track plot

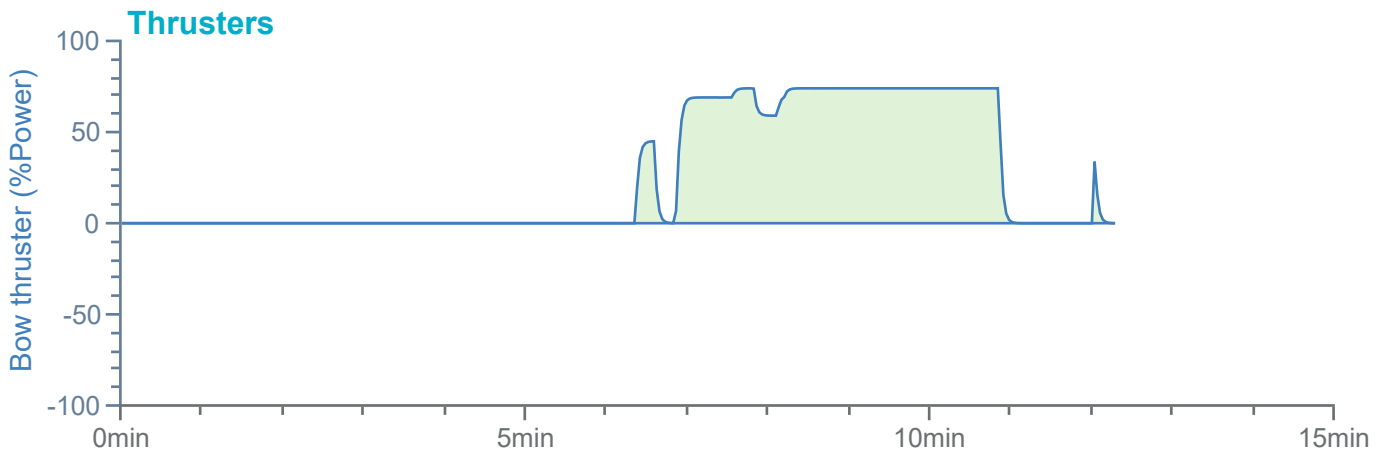
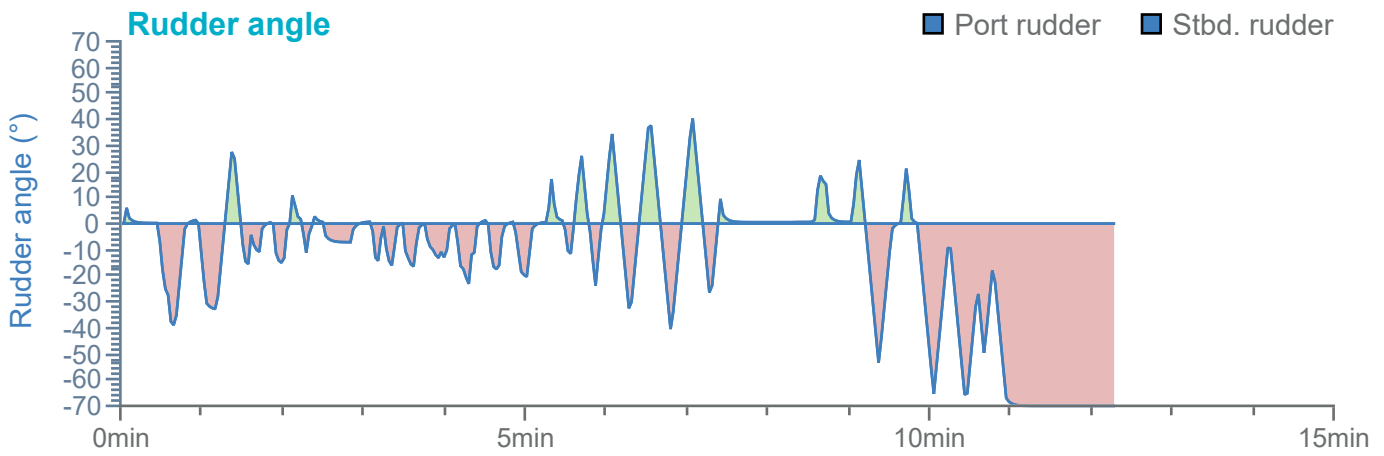
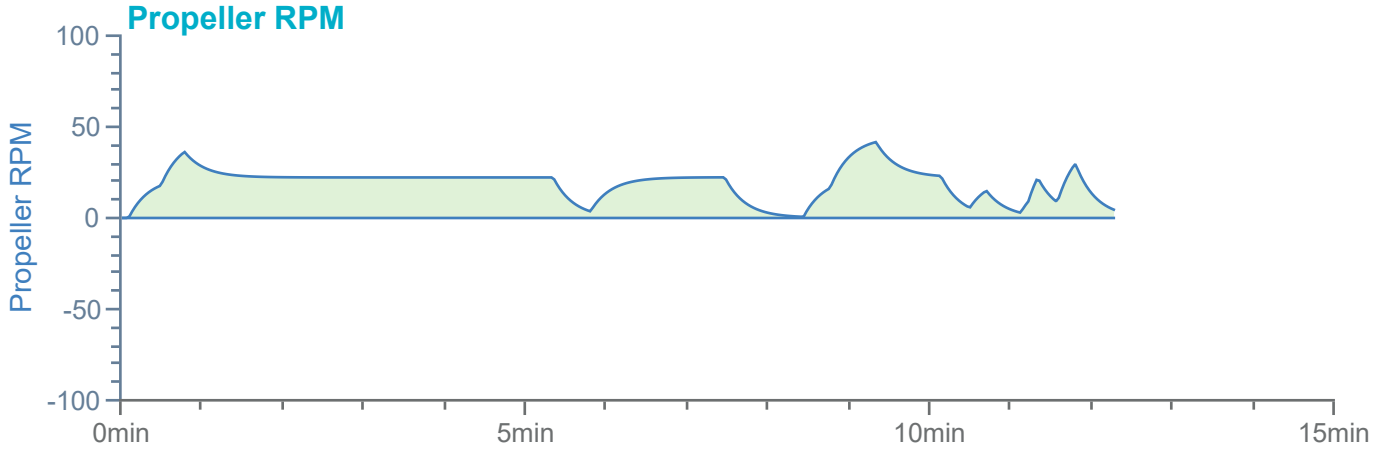


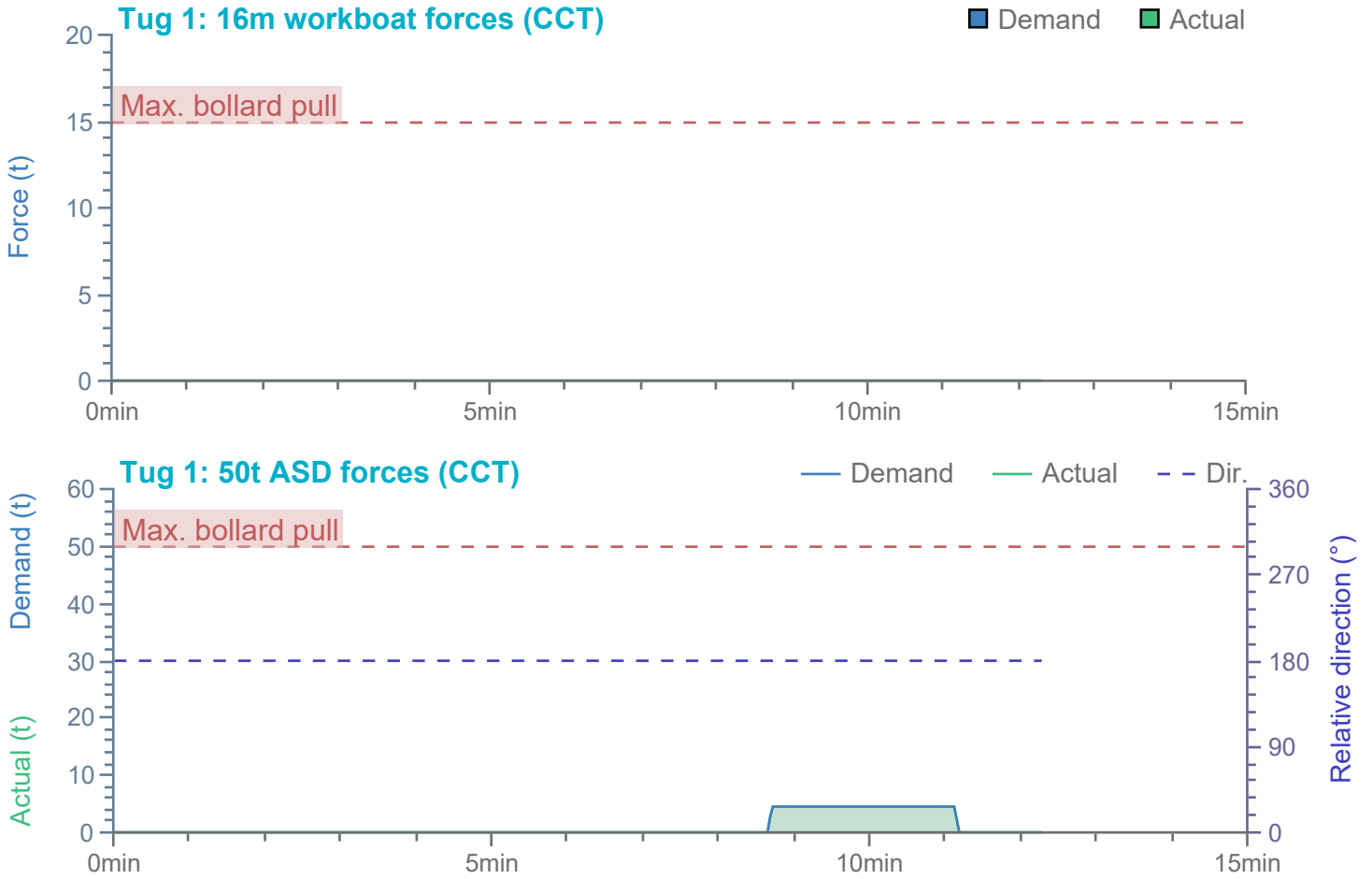
→ 1.97 kts

Ships plotted every 1 mins, highlight every 10 mins

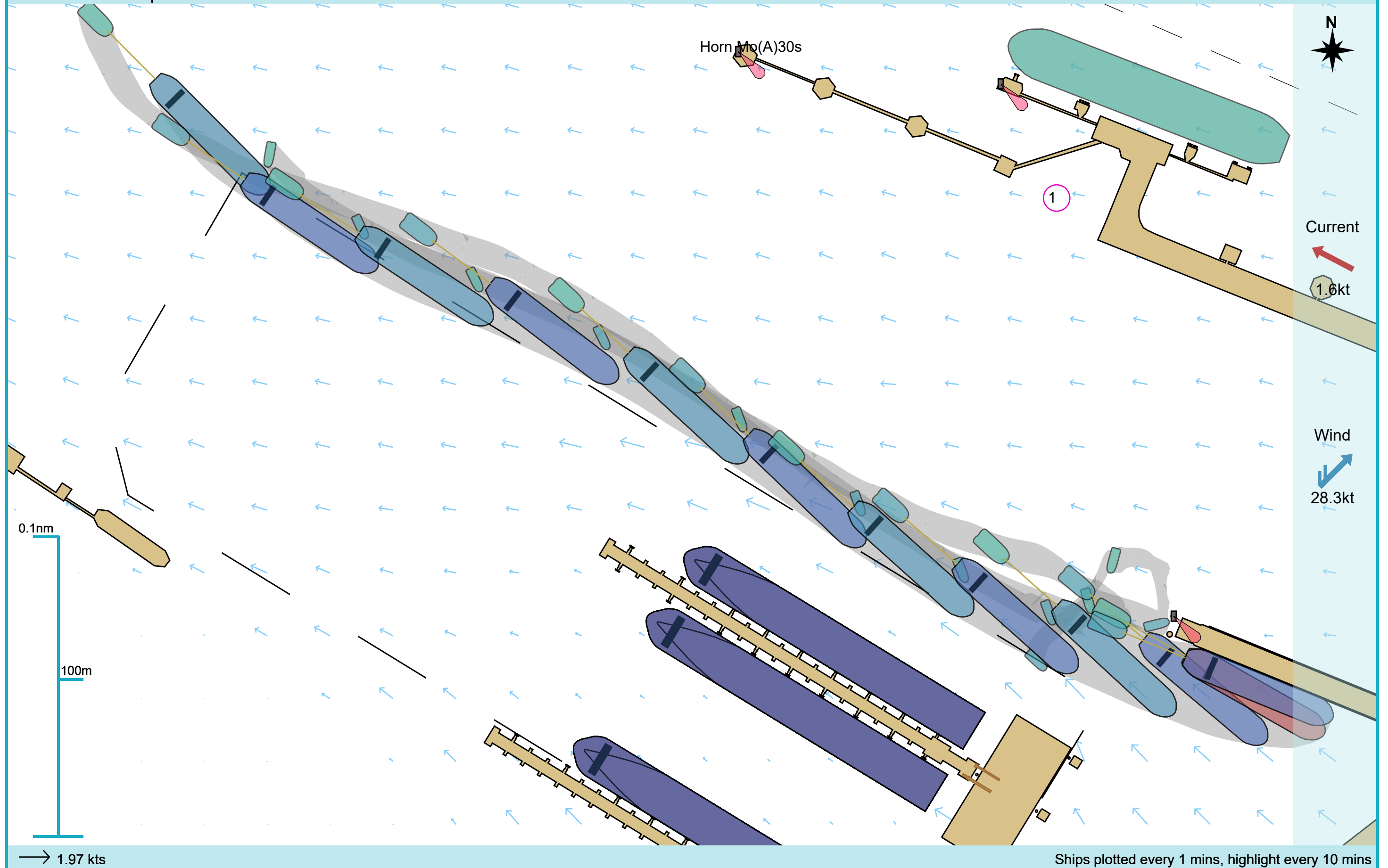






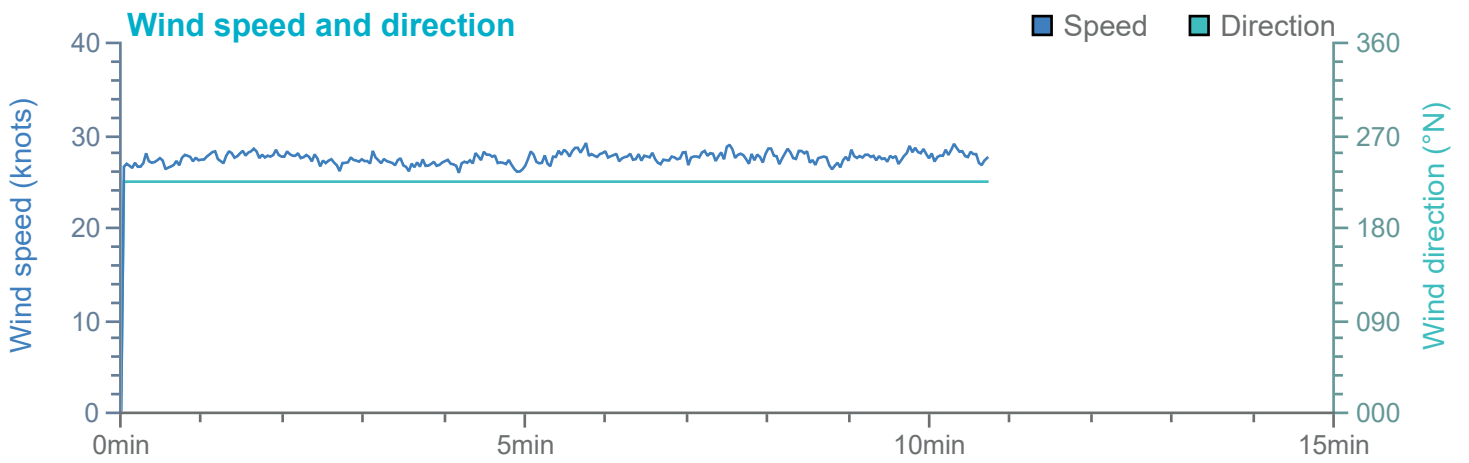
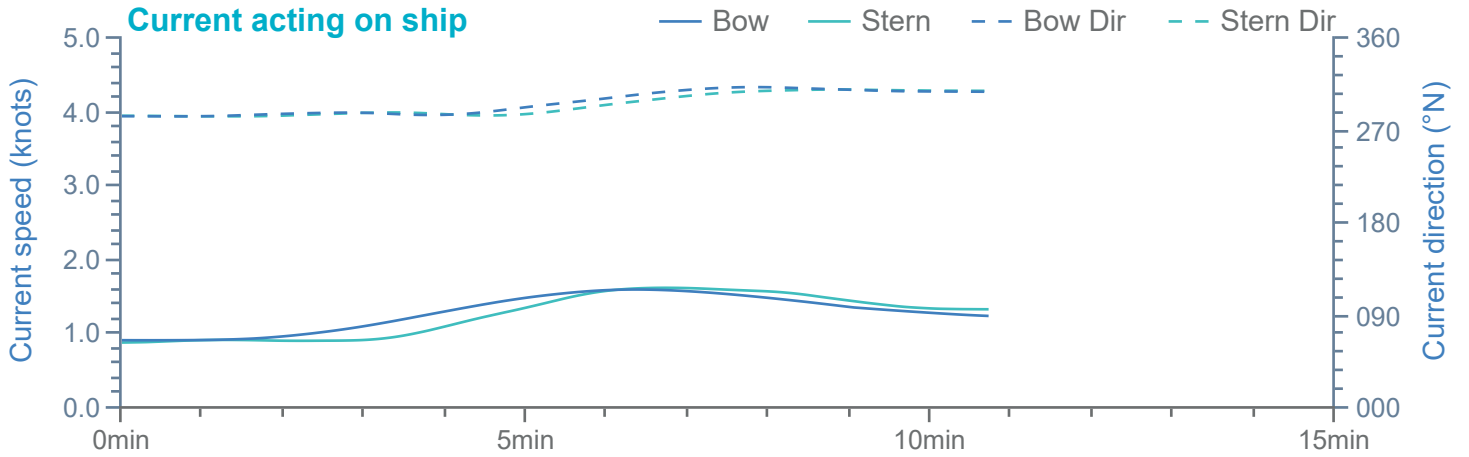


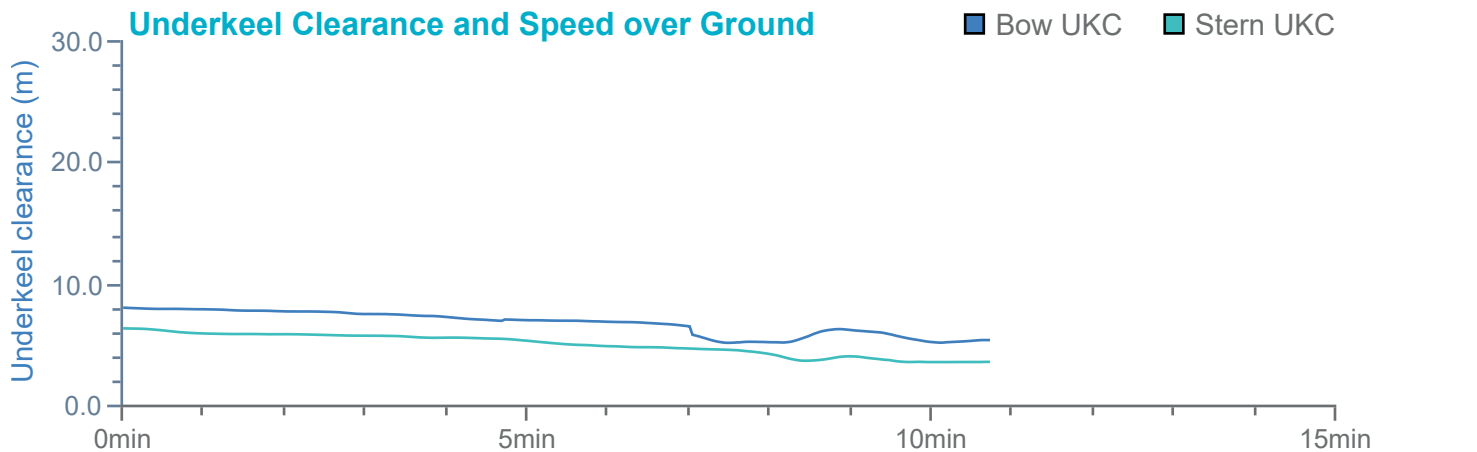
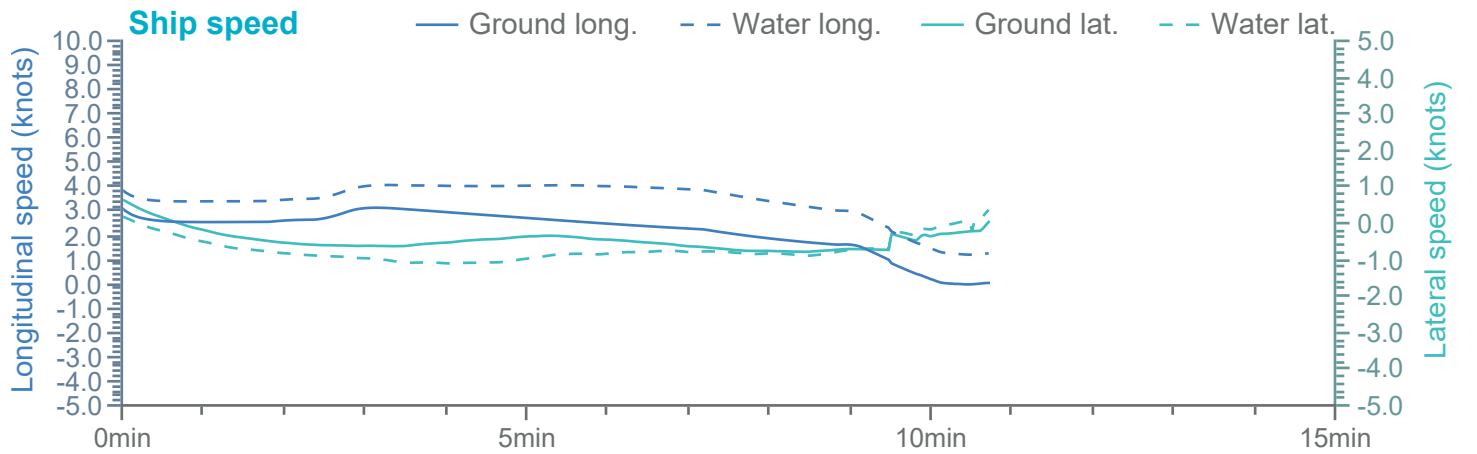
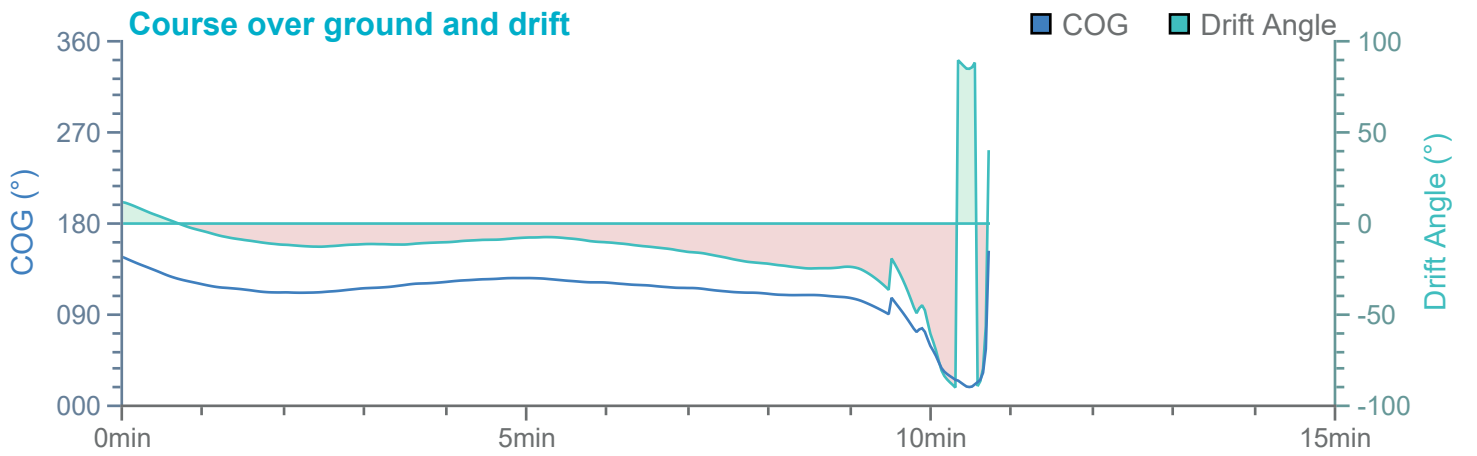
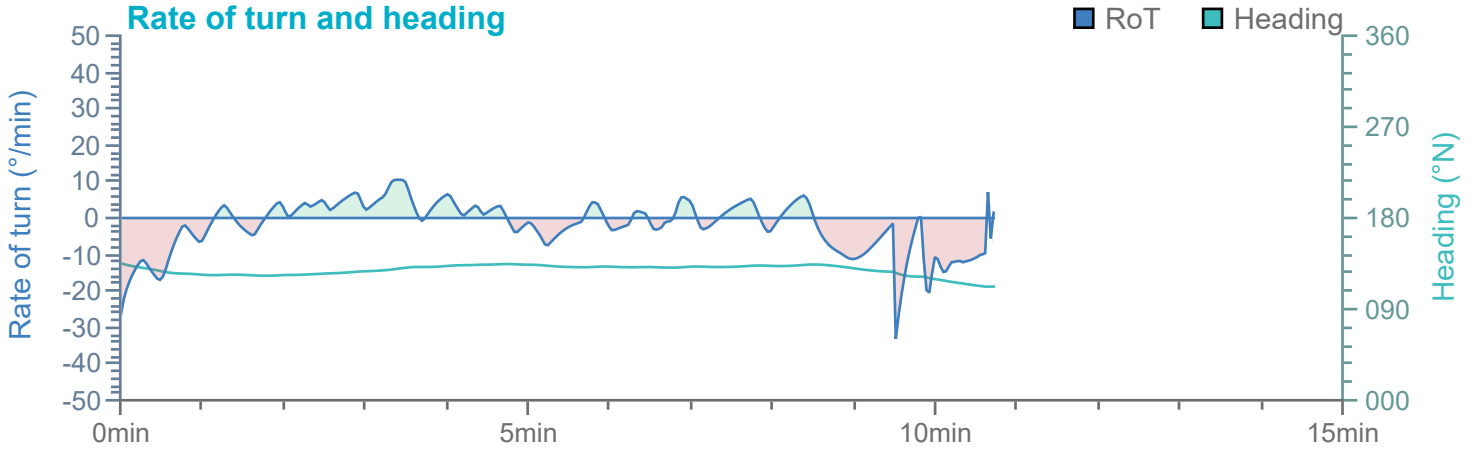
Manoeuvre track plot



→ 1.97 kts

Ships plotted every 1 mins, highlight every 10 mins



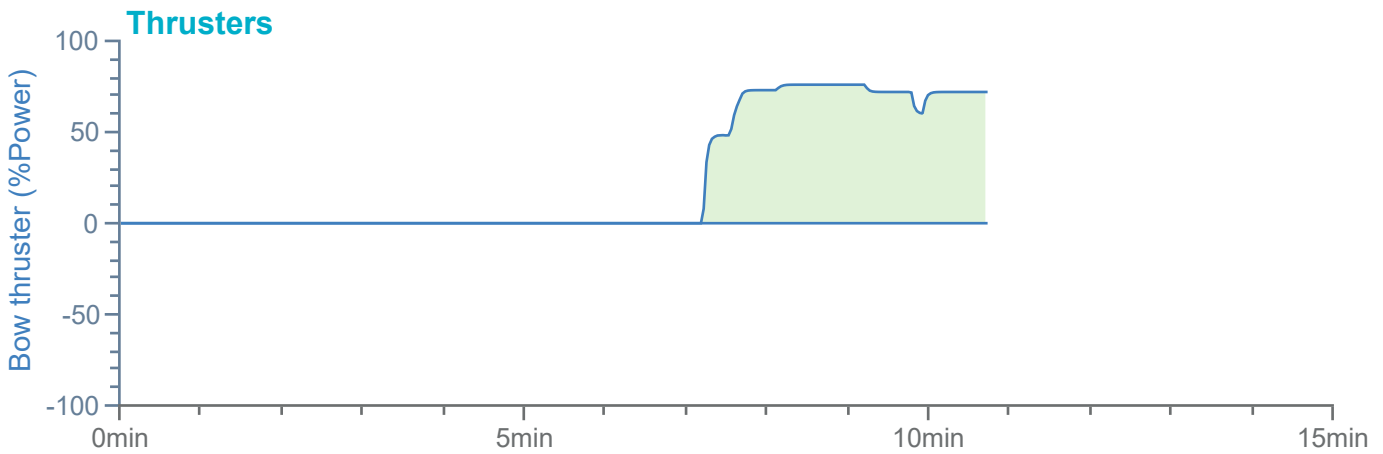
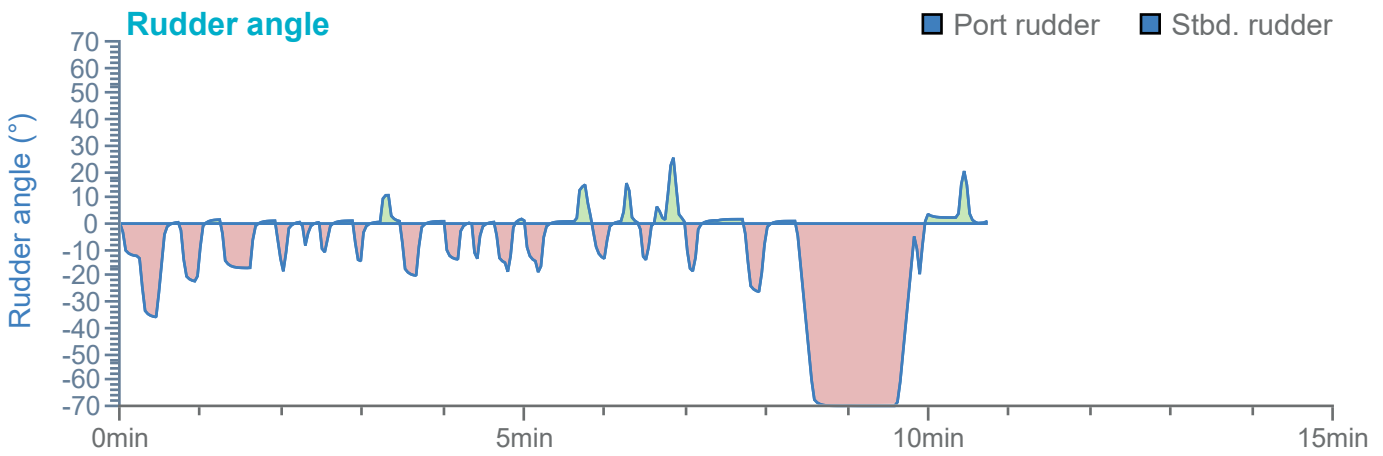
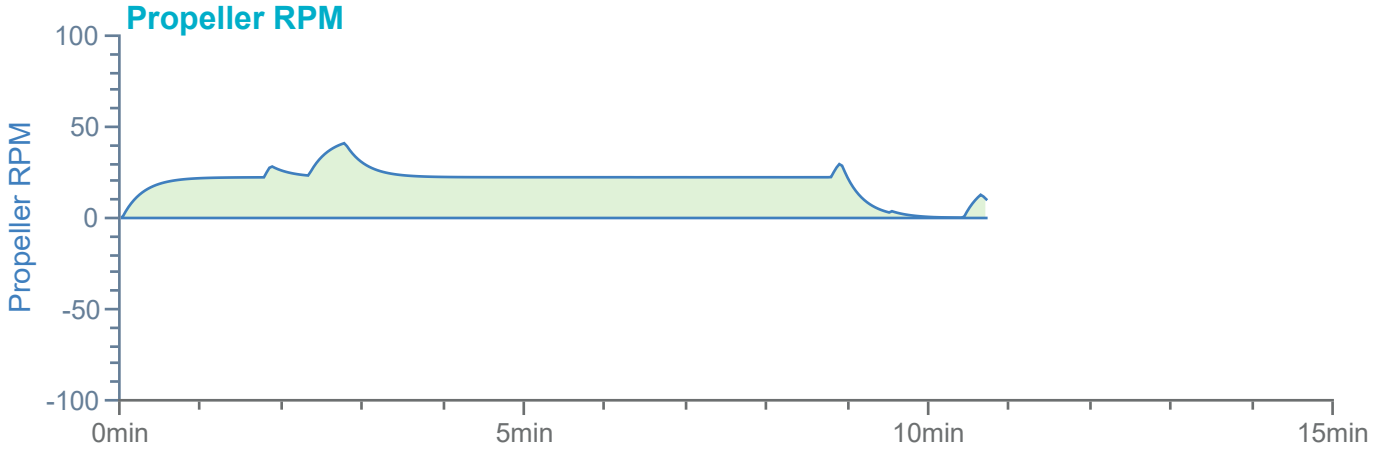


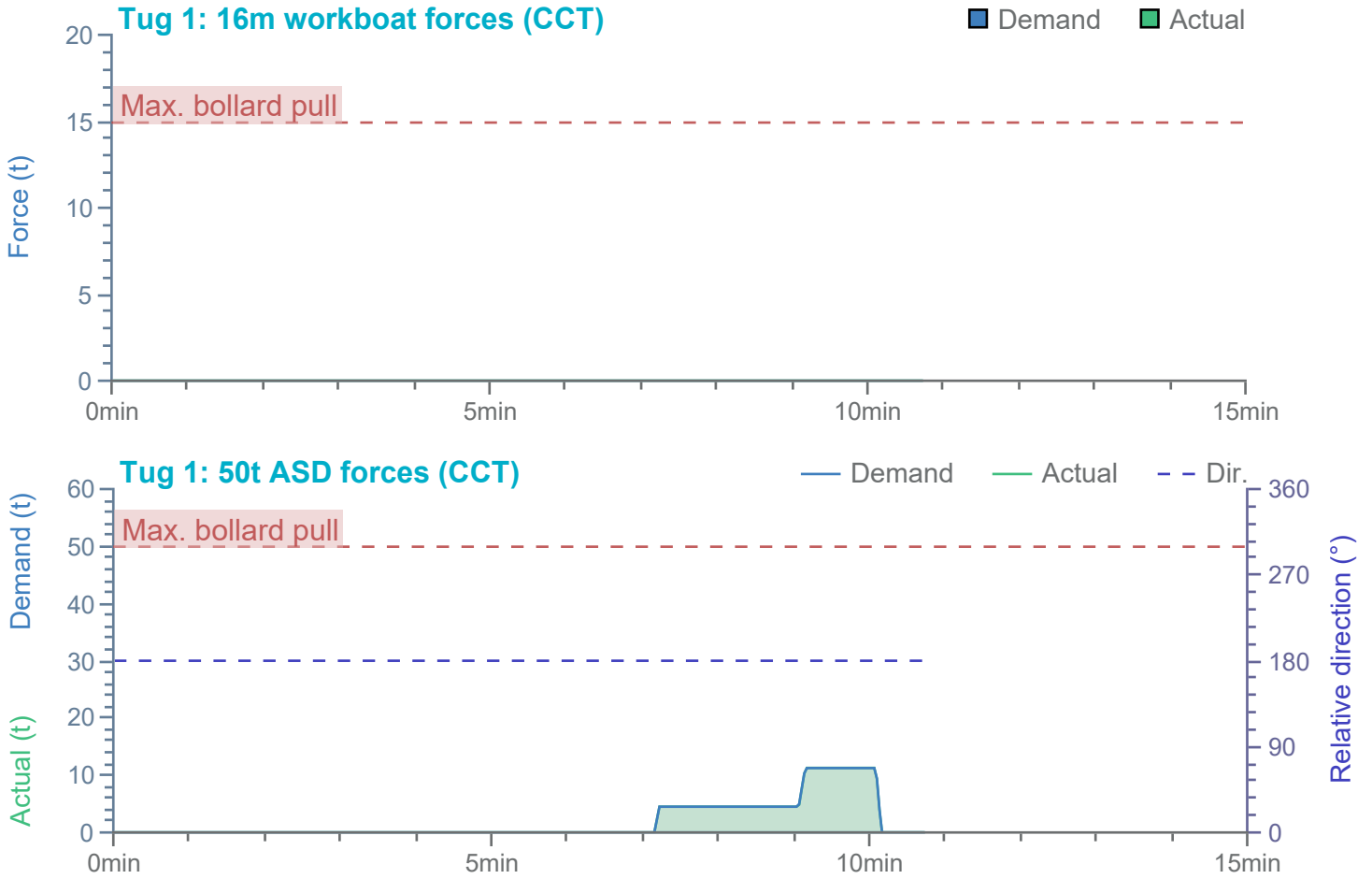
Overview

Environment

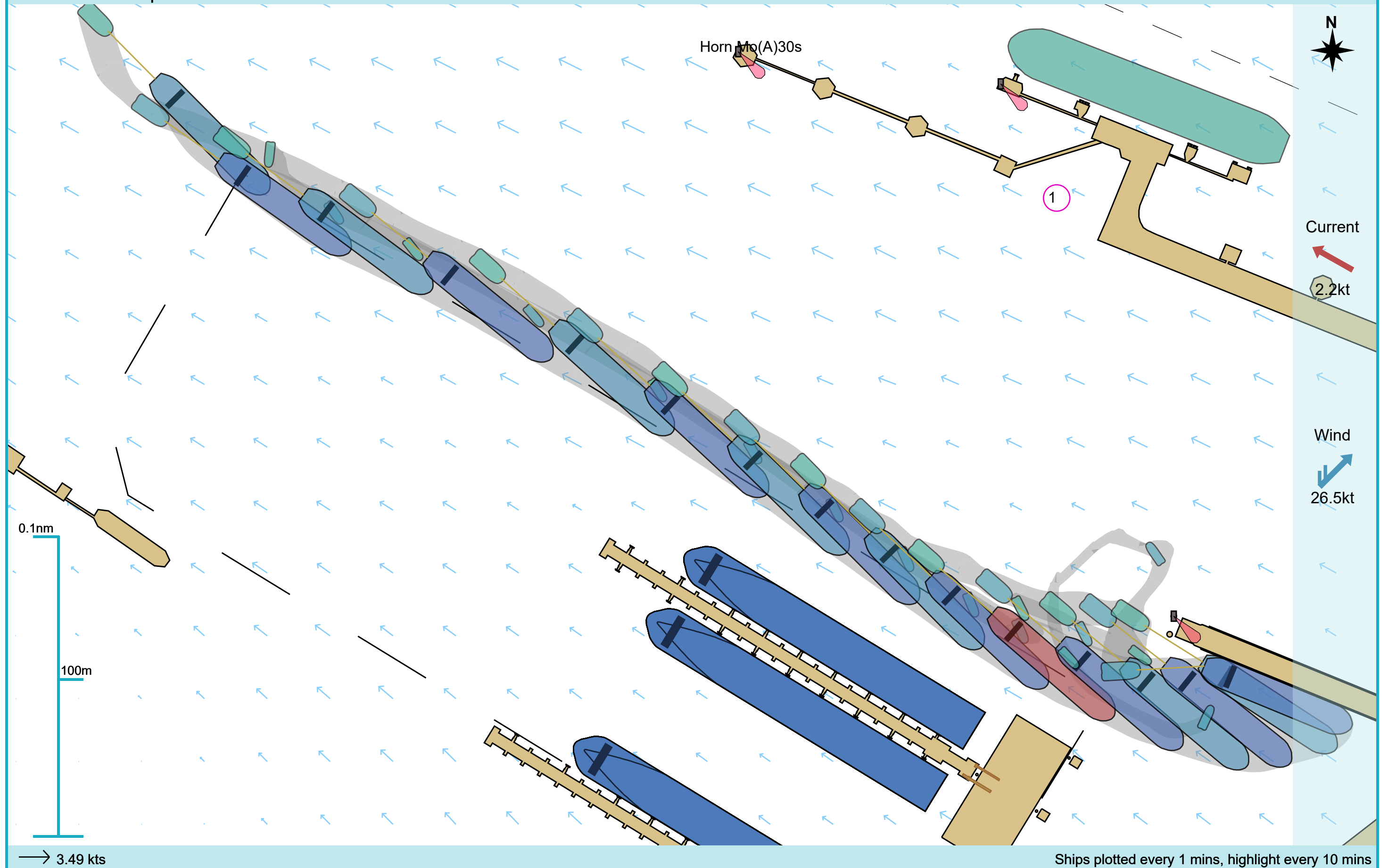
100m x 18m Product Tanker

Tugs



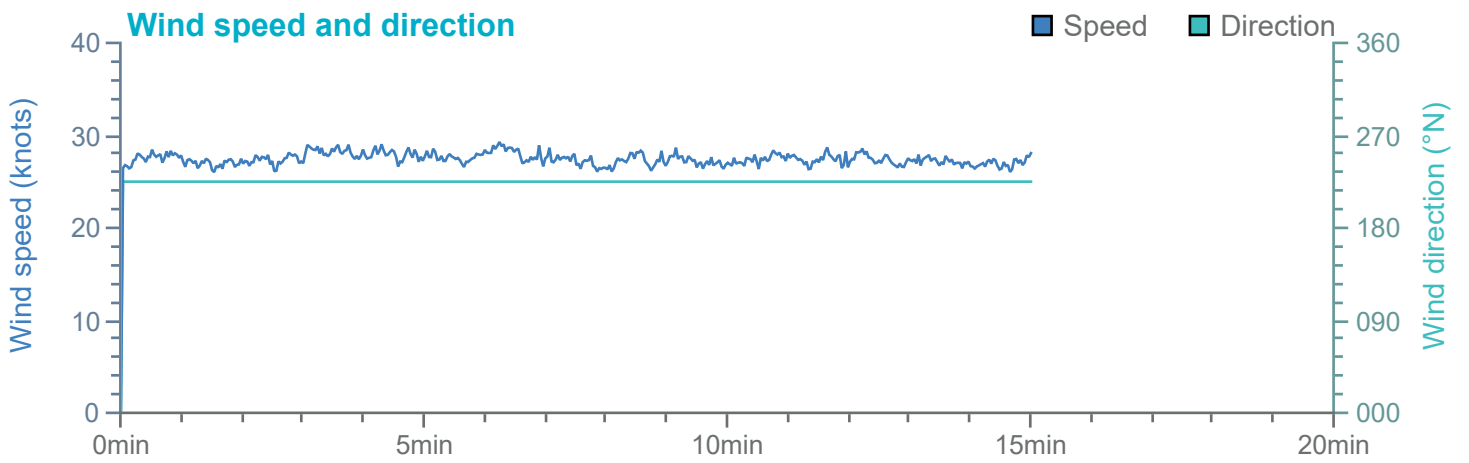
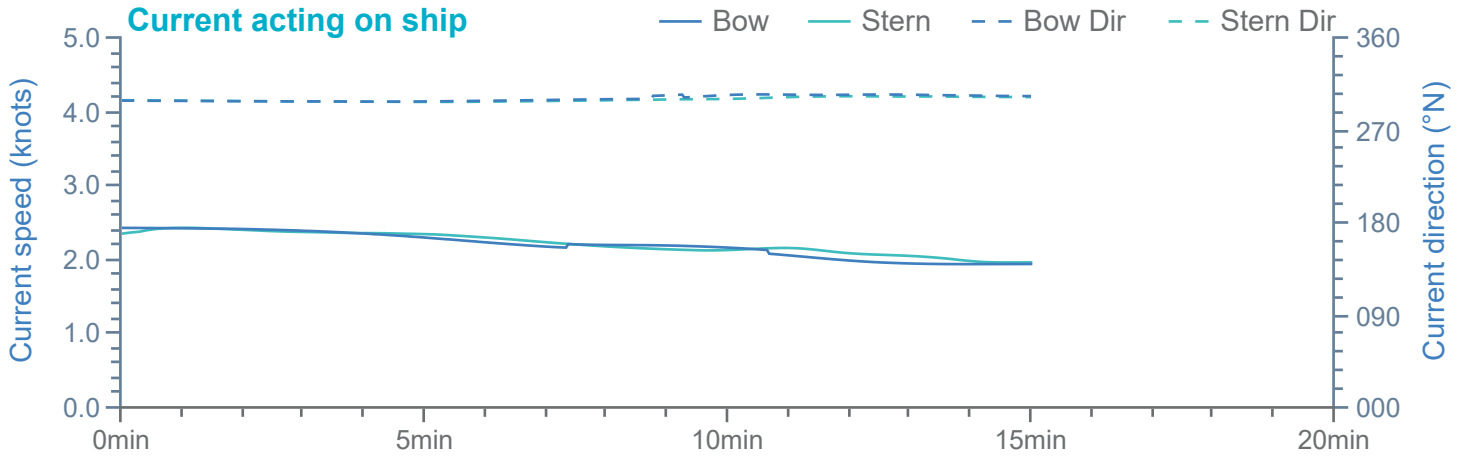


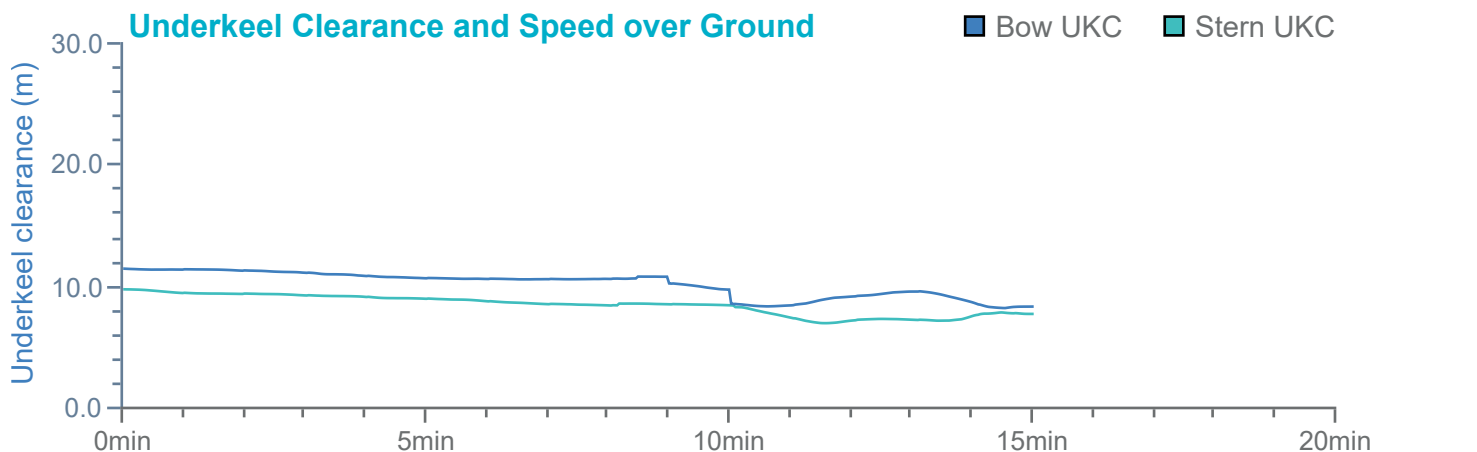
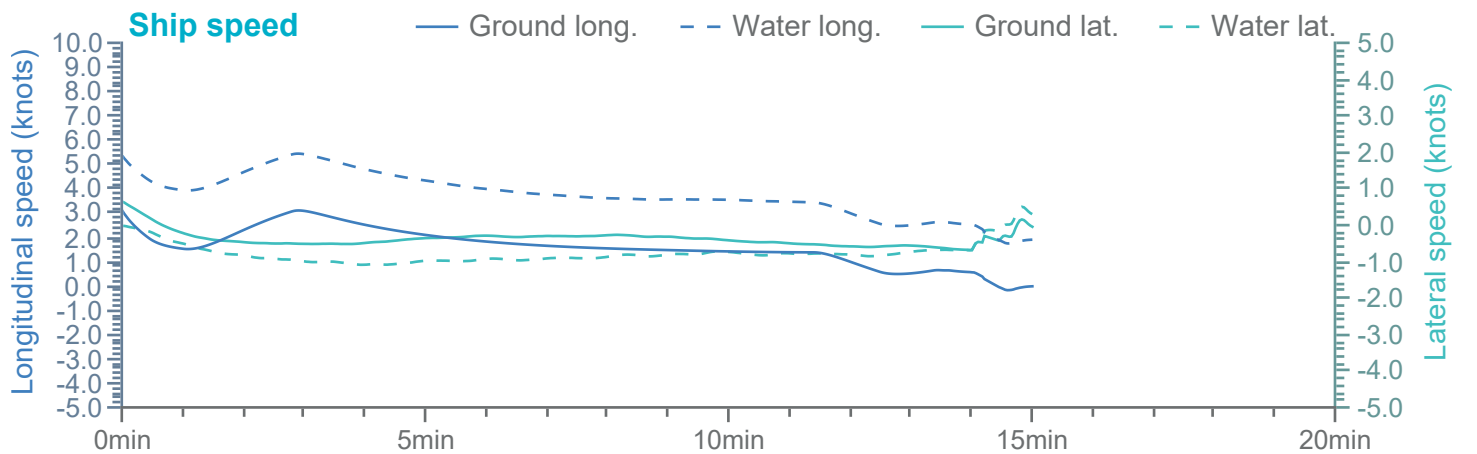
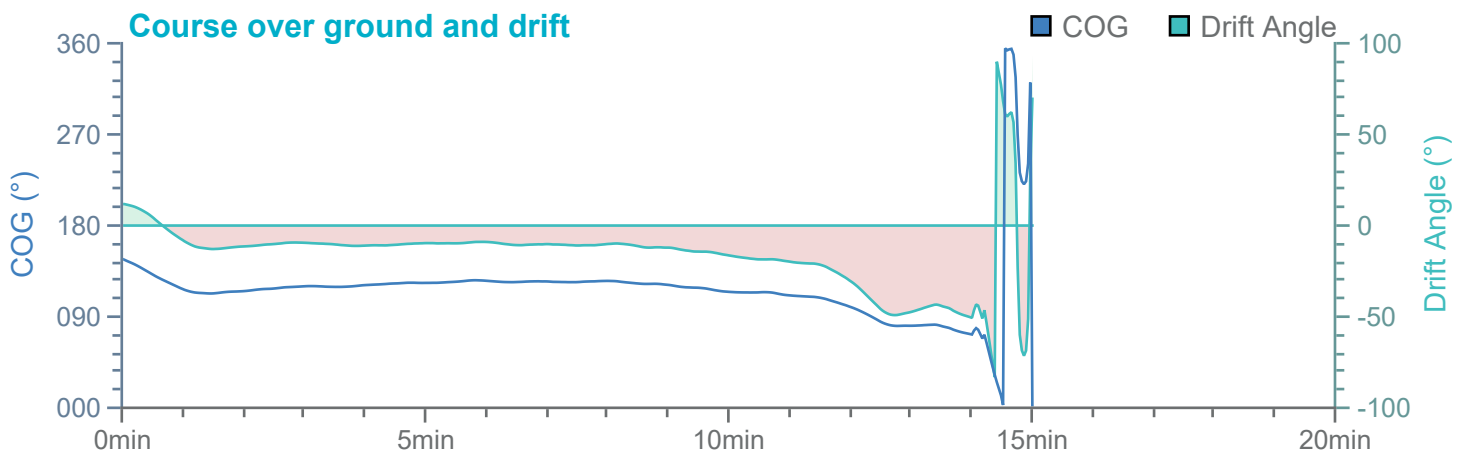
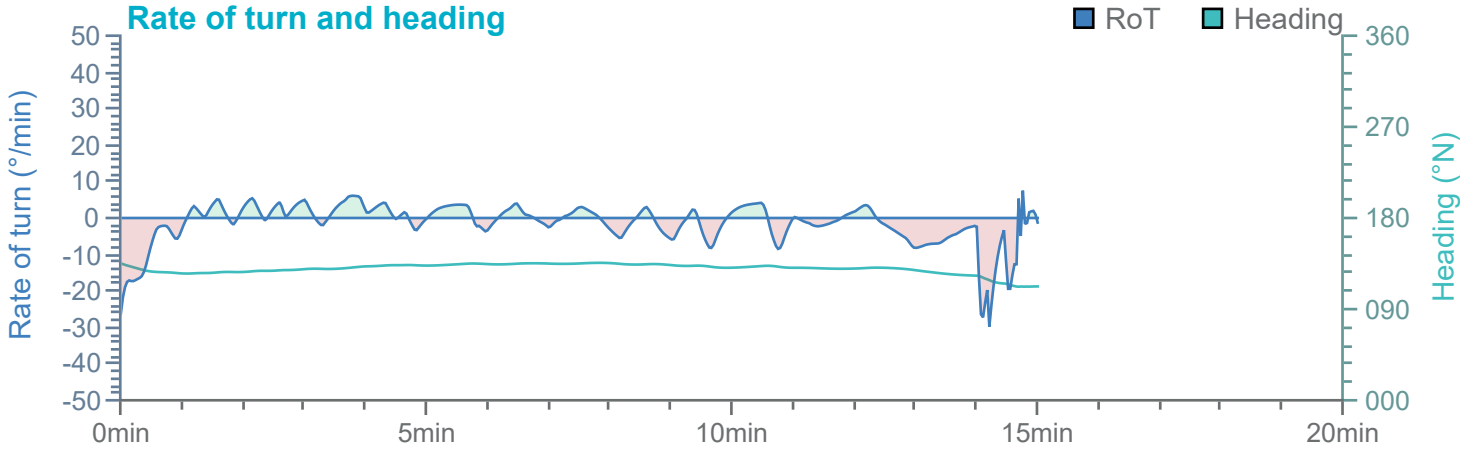
Manoeuvre track plot



→ 3.49 kts

Ships plotted every 1 mins, highlight every 10 mins



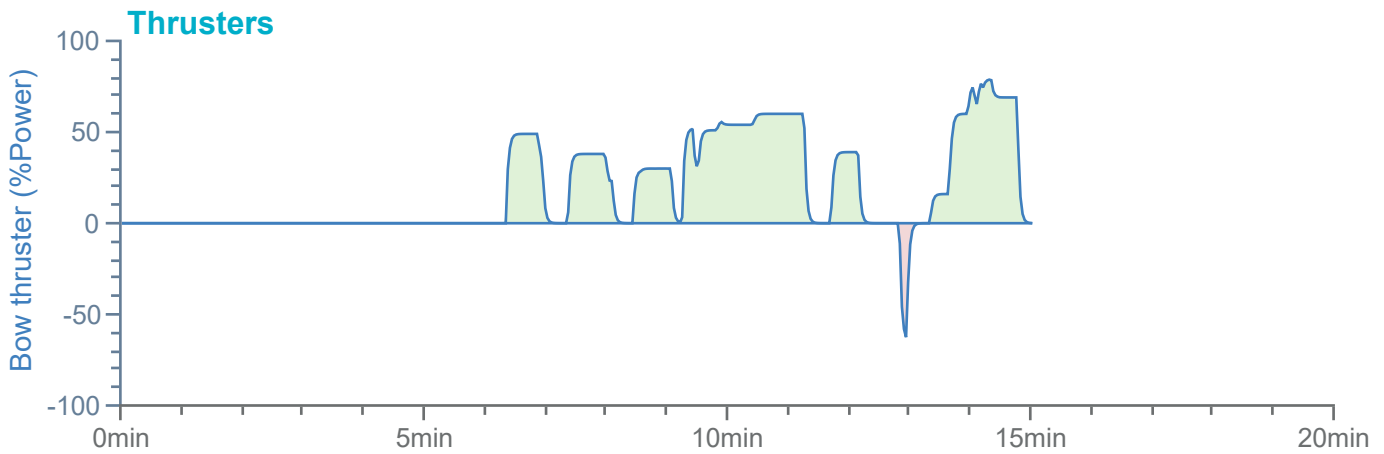
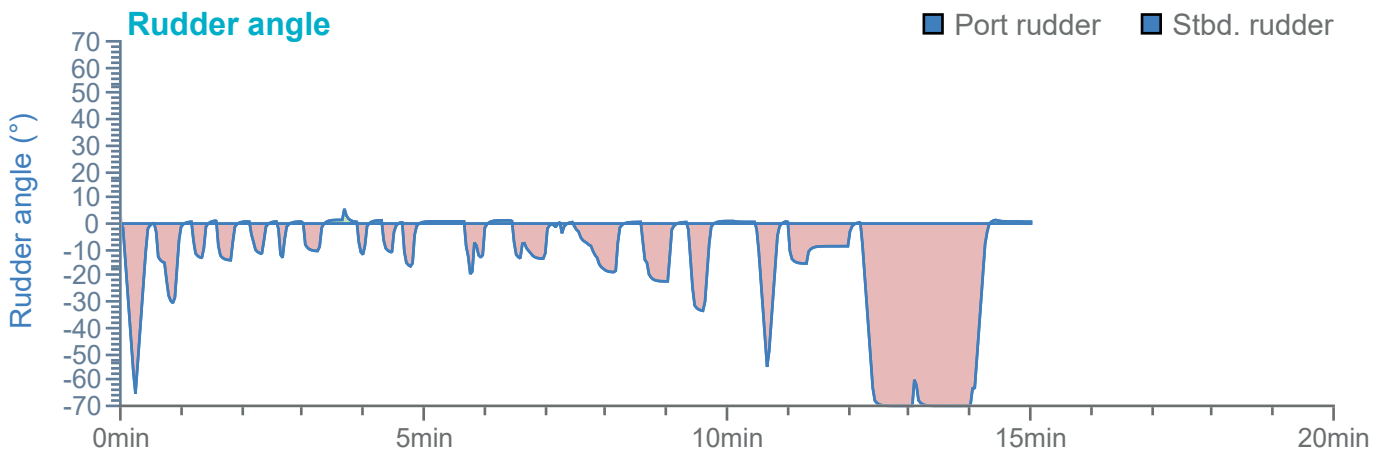
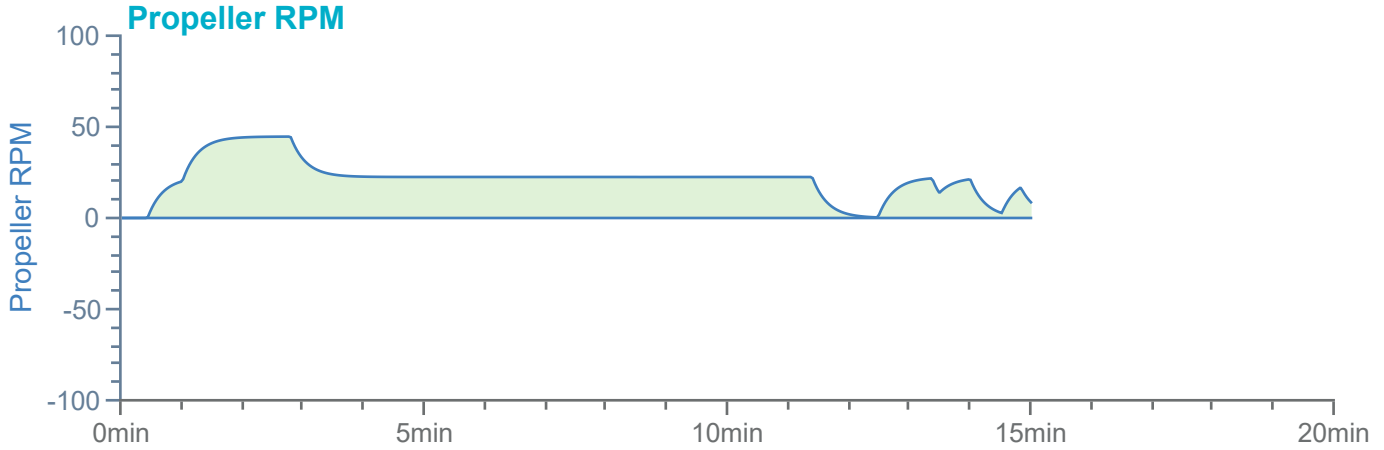


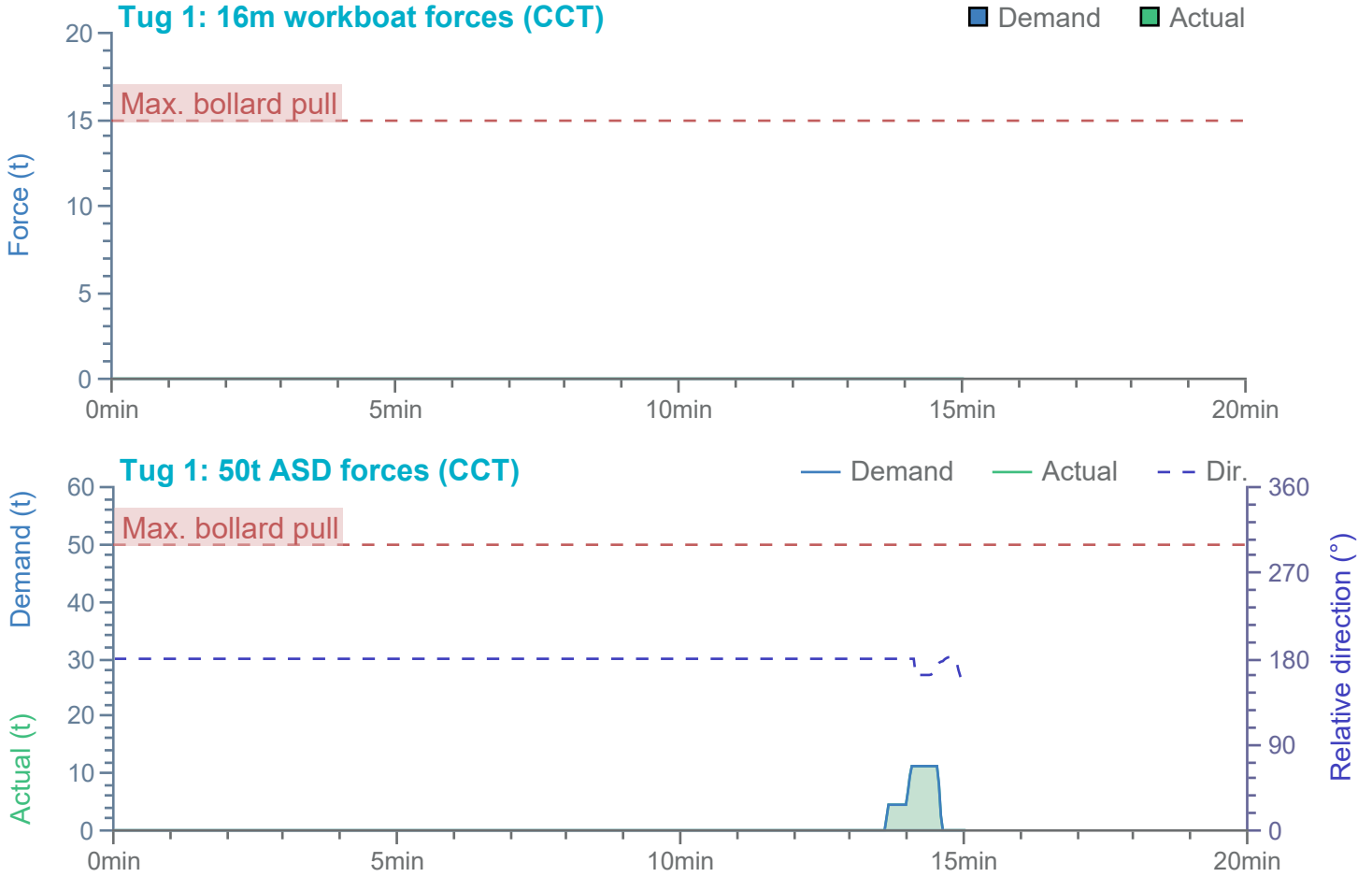
Overview

Environment

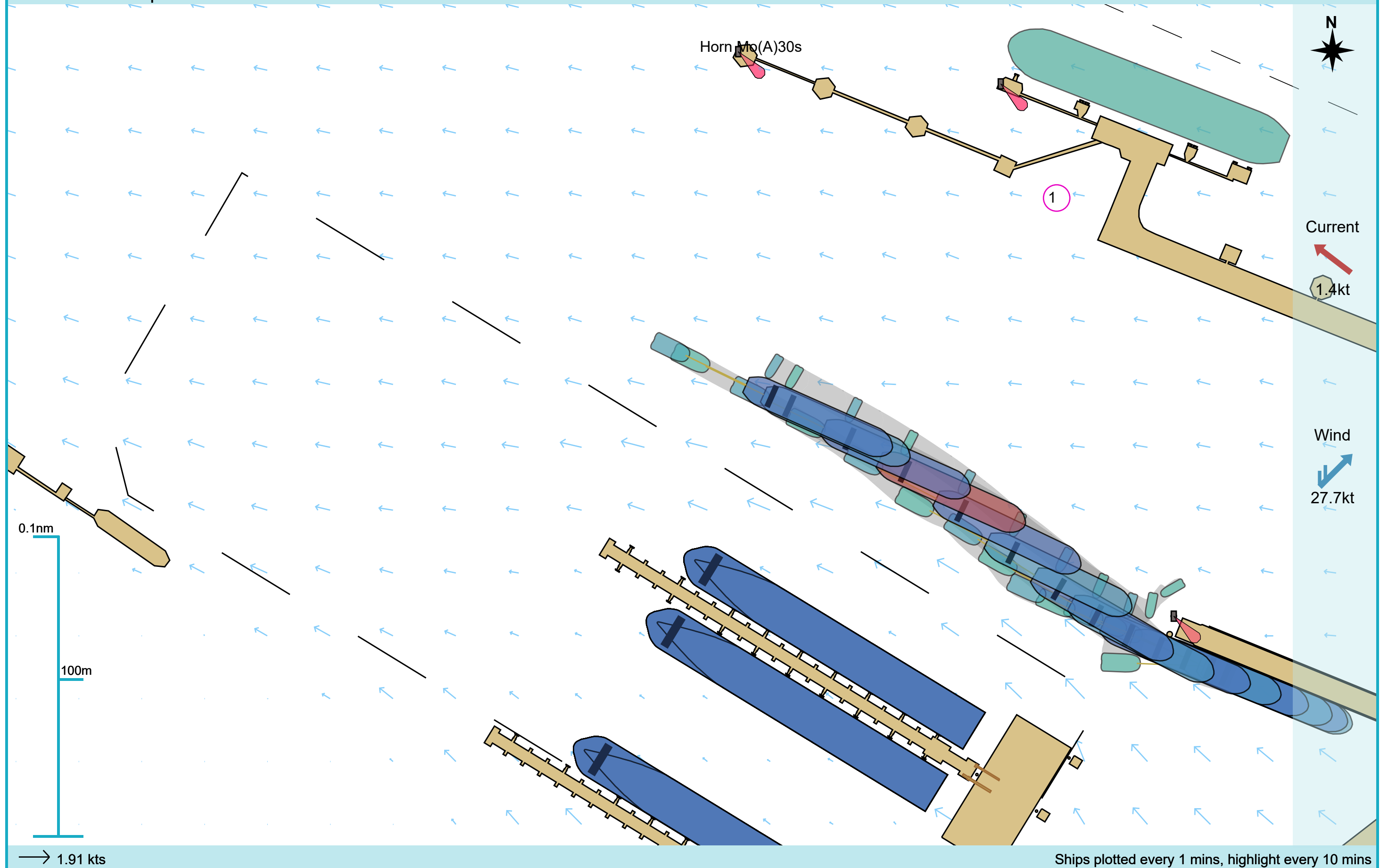
100m x 18m Product Tanker

Tugs

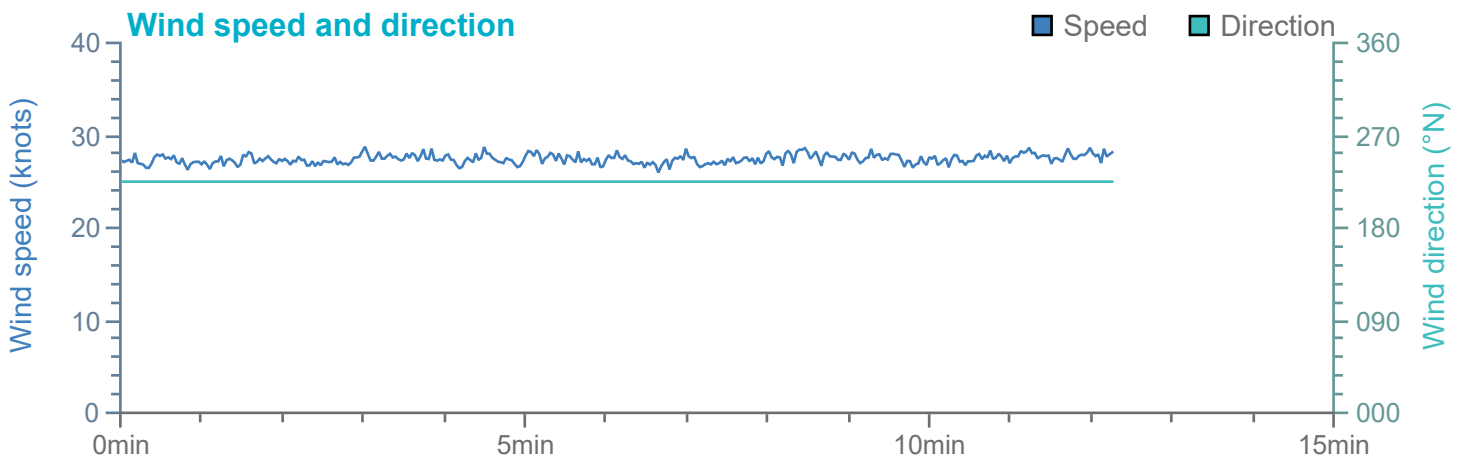
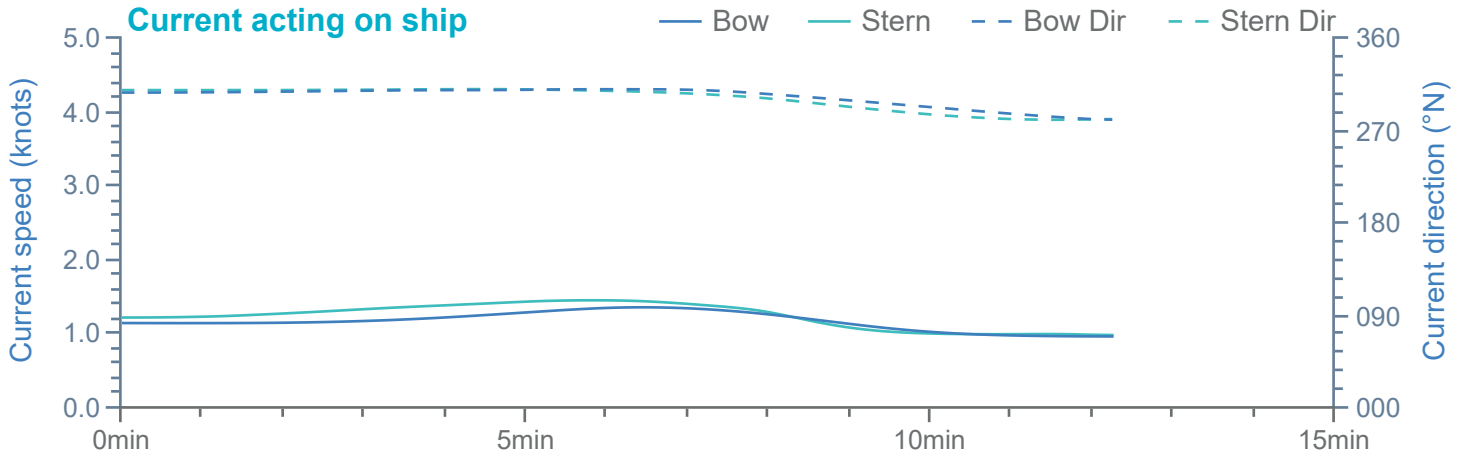


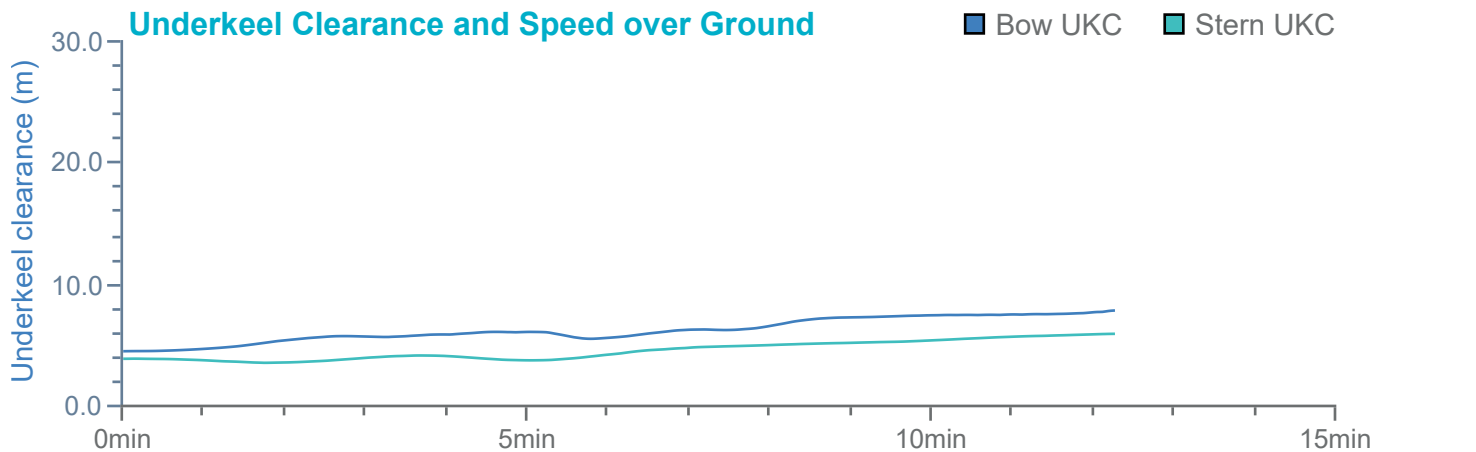
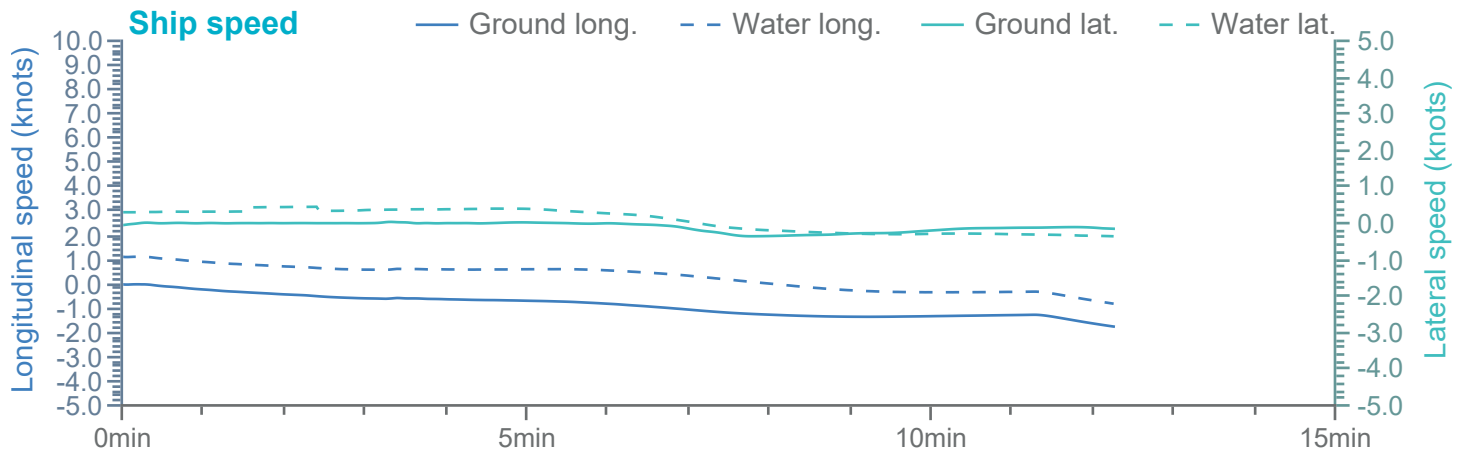
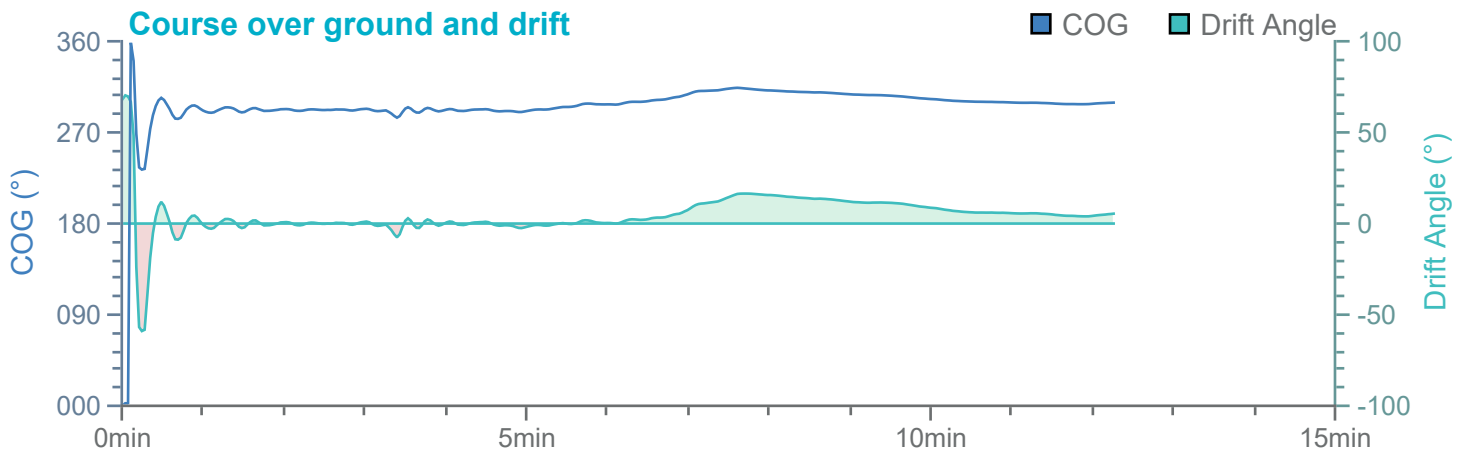
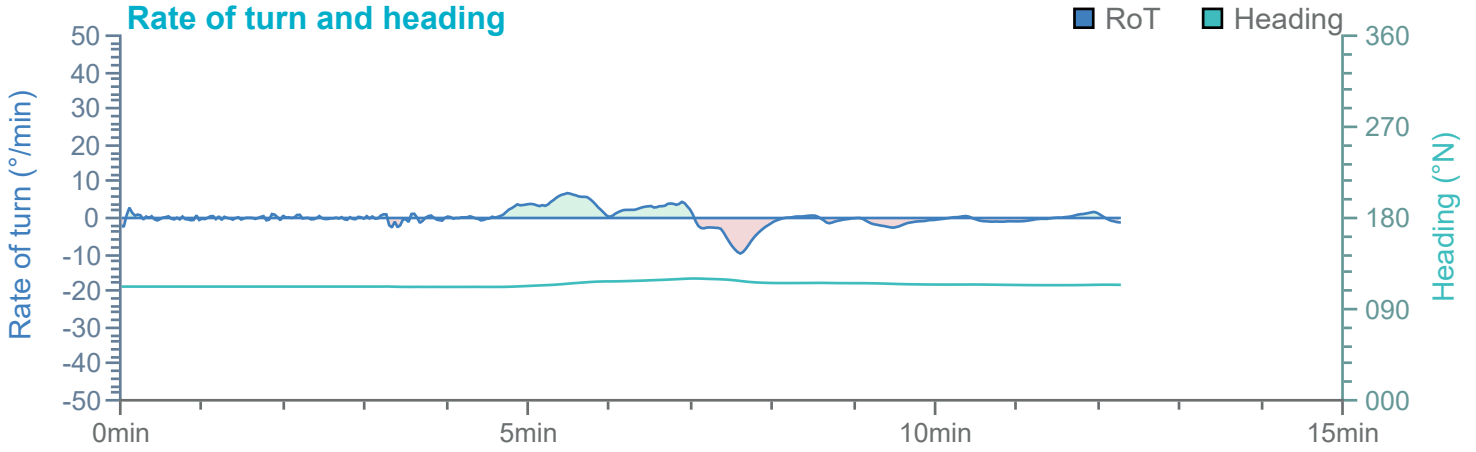


Manoeuvre track plot



Ships plotted every 1 mins, highlight every 10 mins



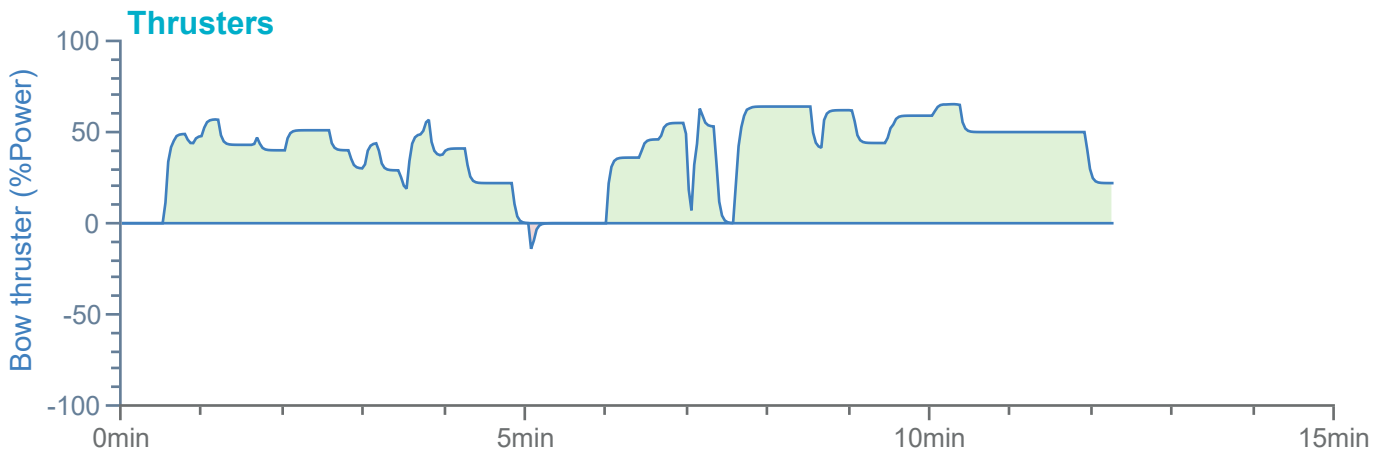
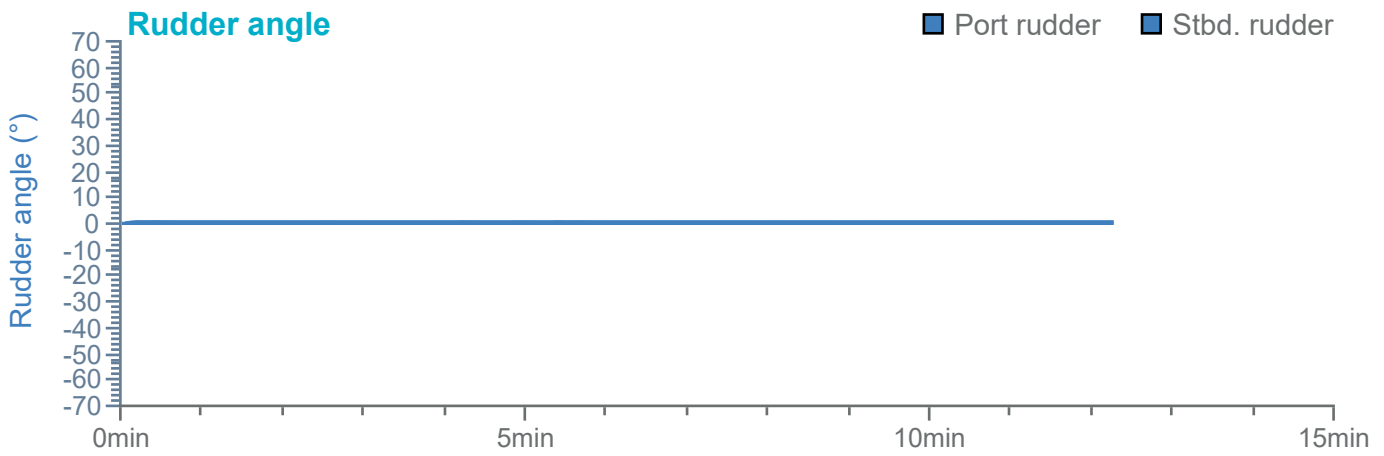
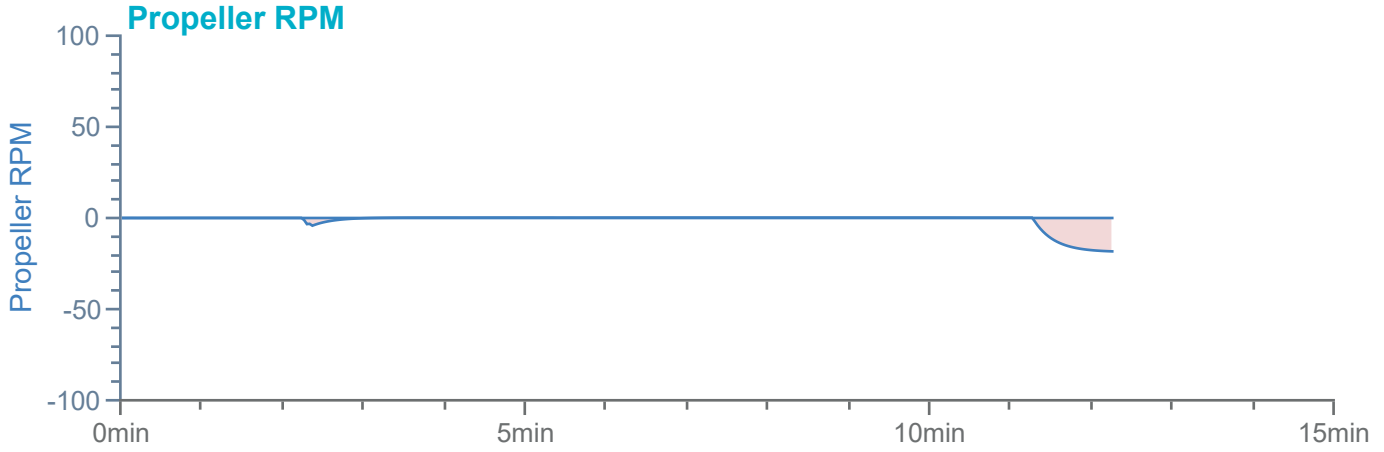


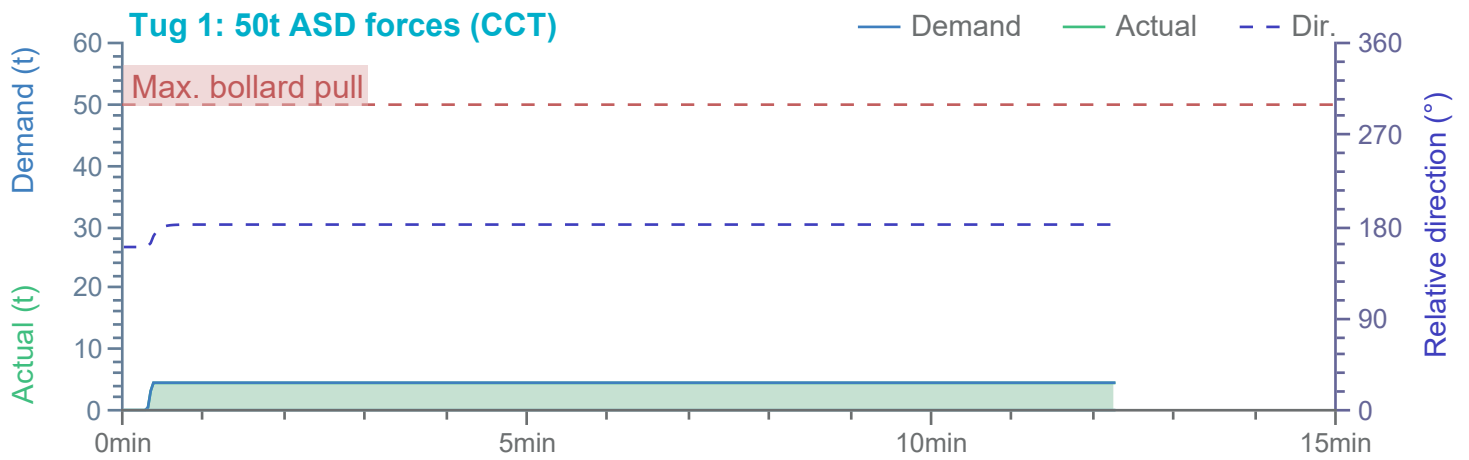
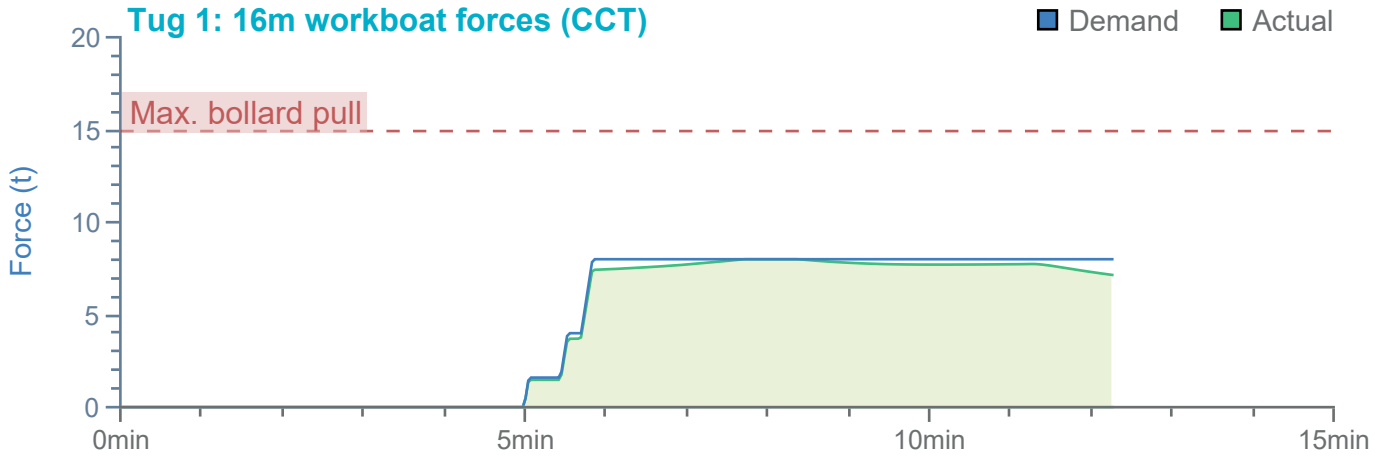
Overview

Environment

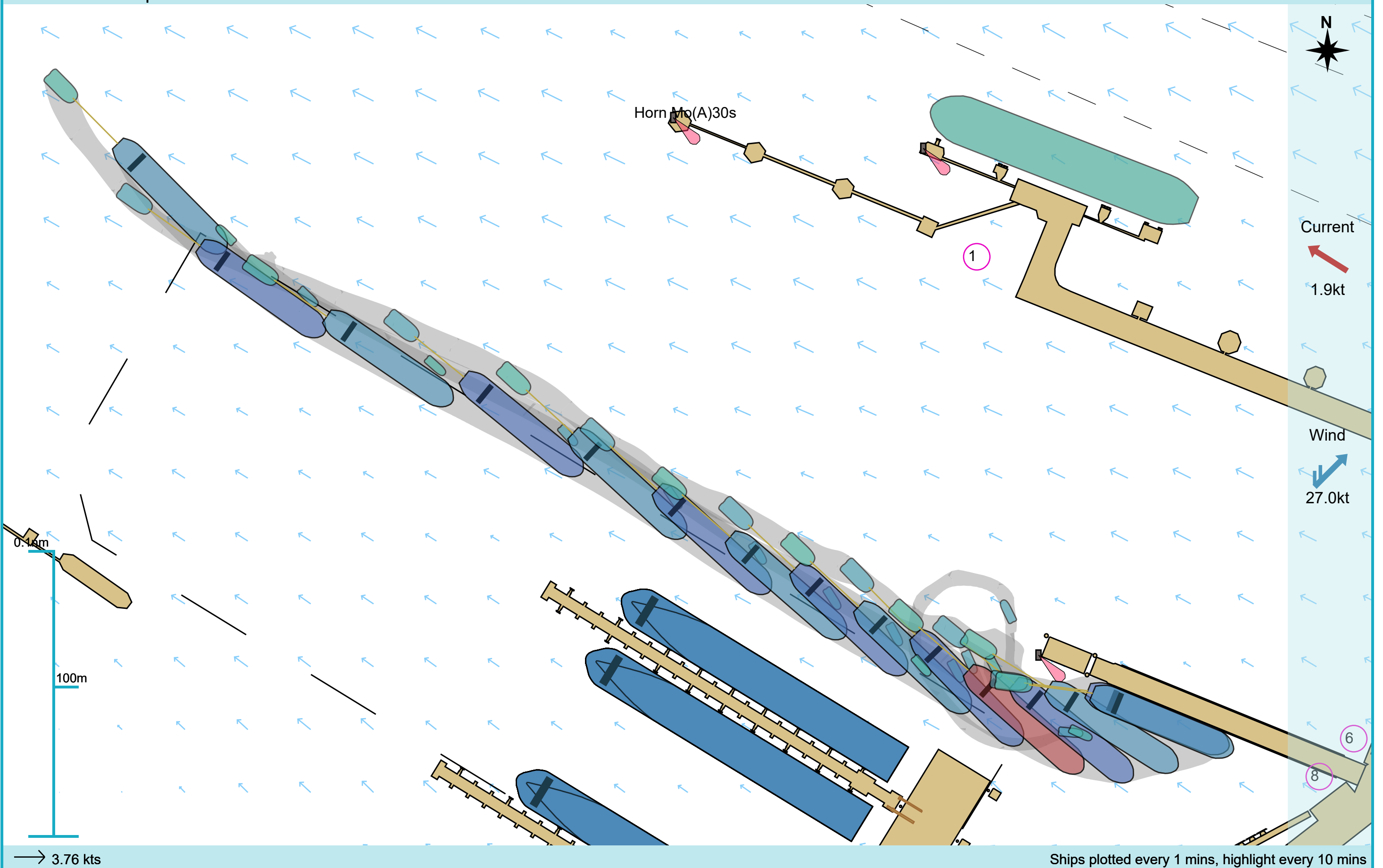
100m x 18m Product Tanker

Tugs



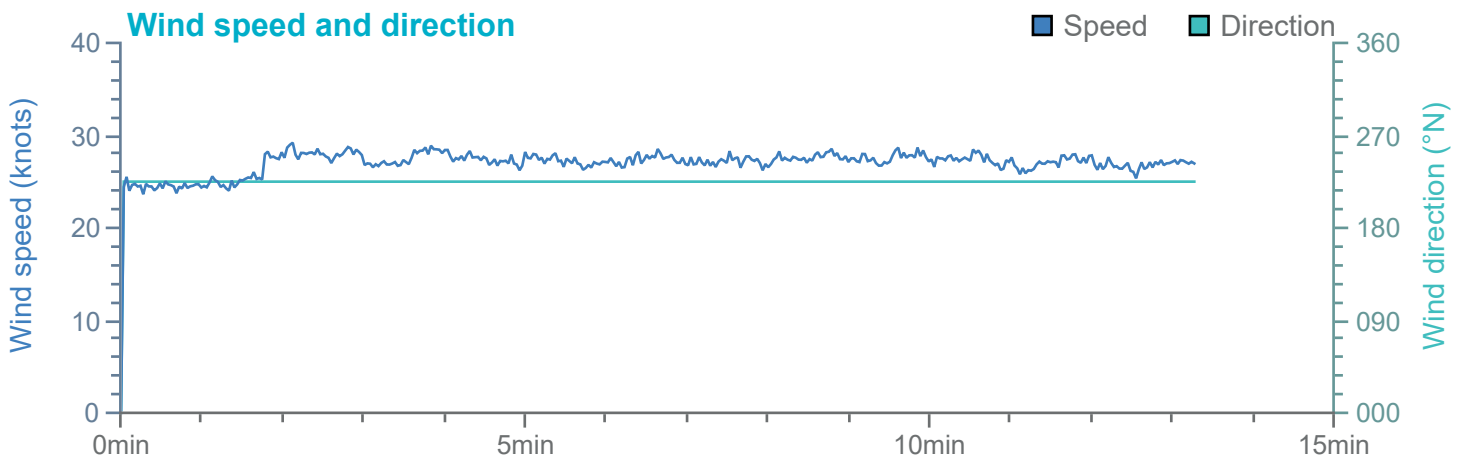
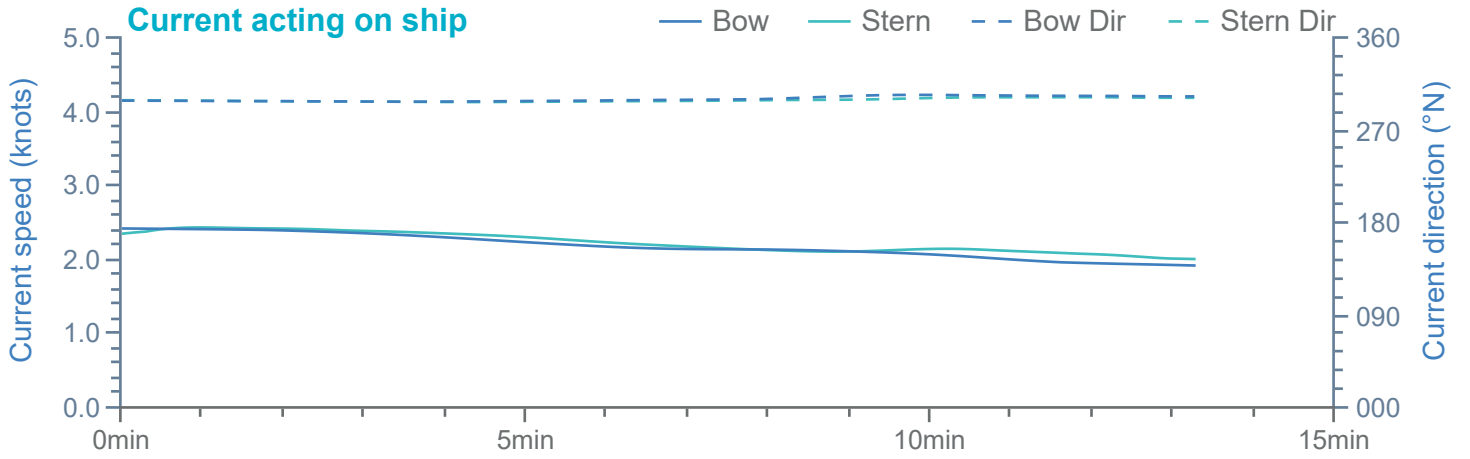


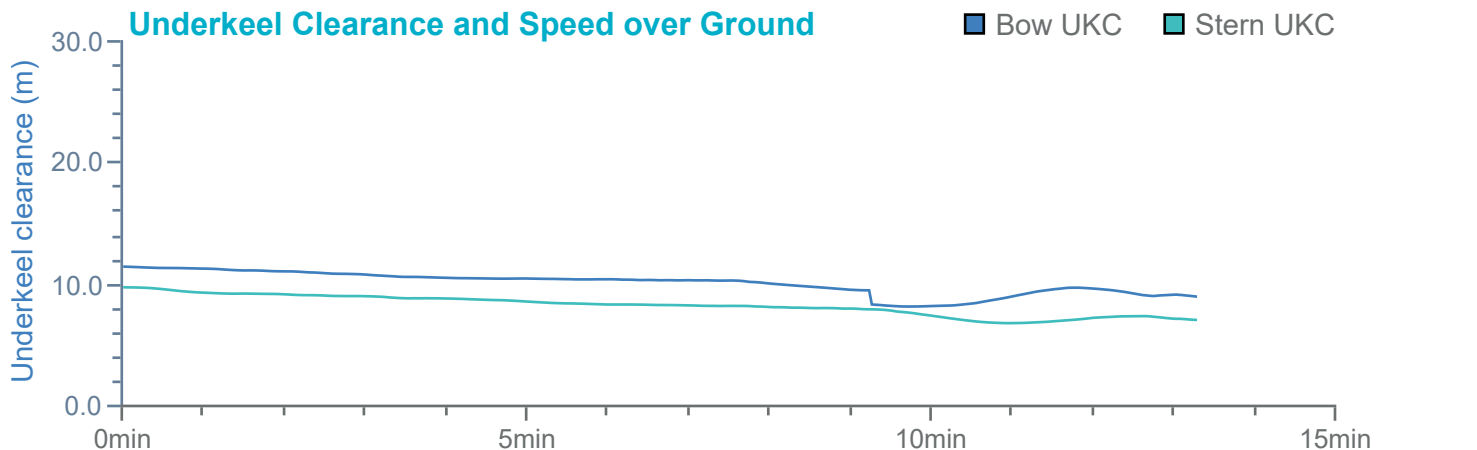
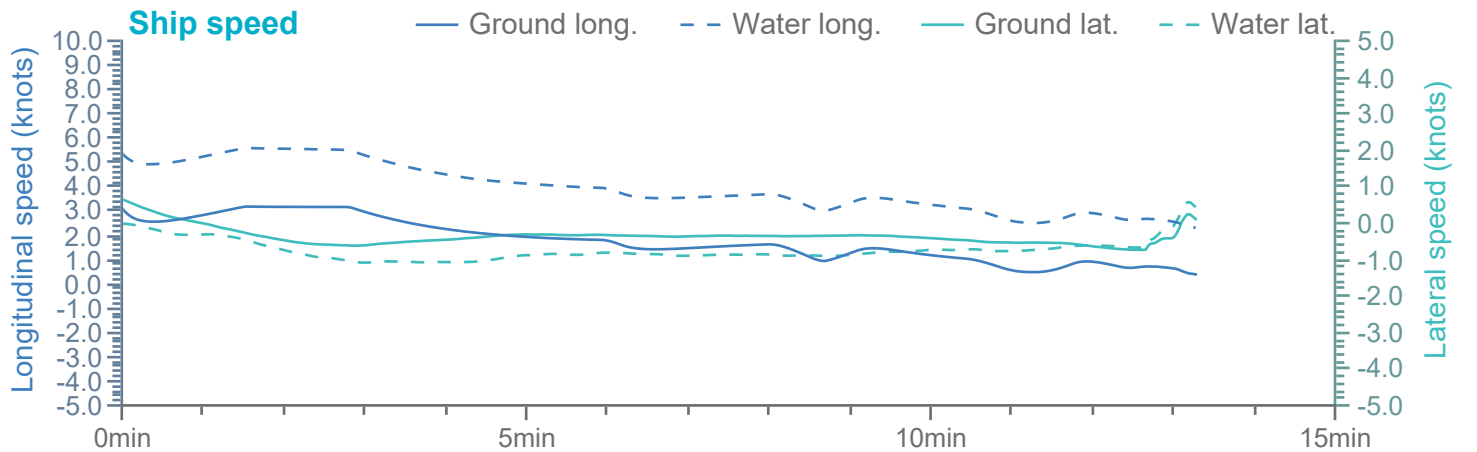
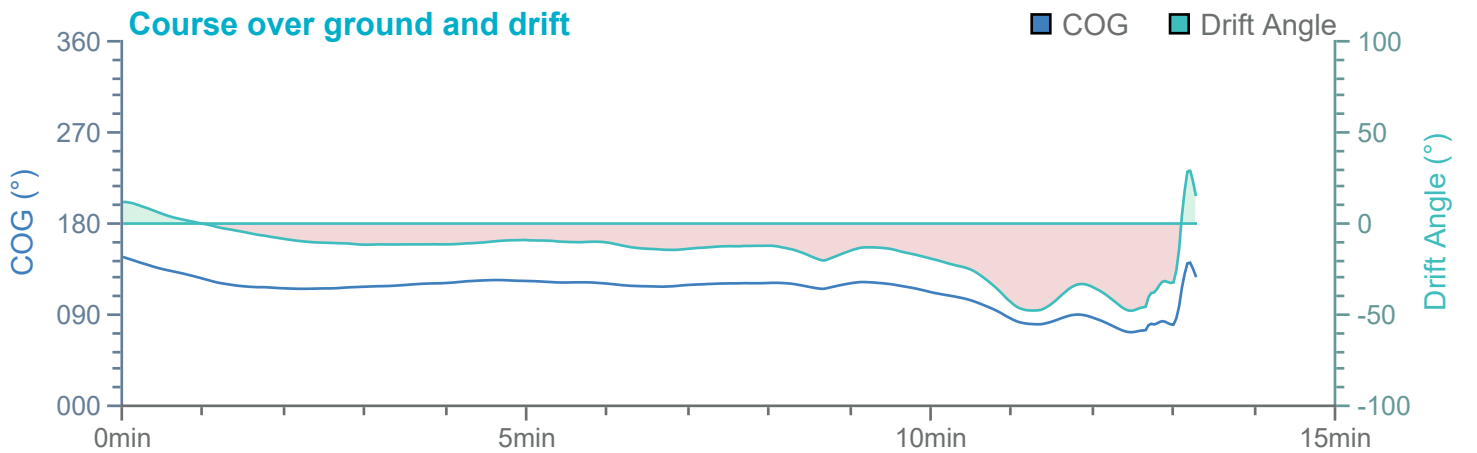
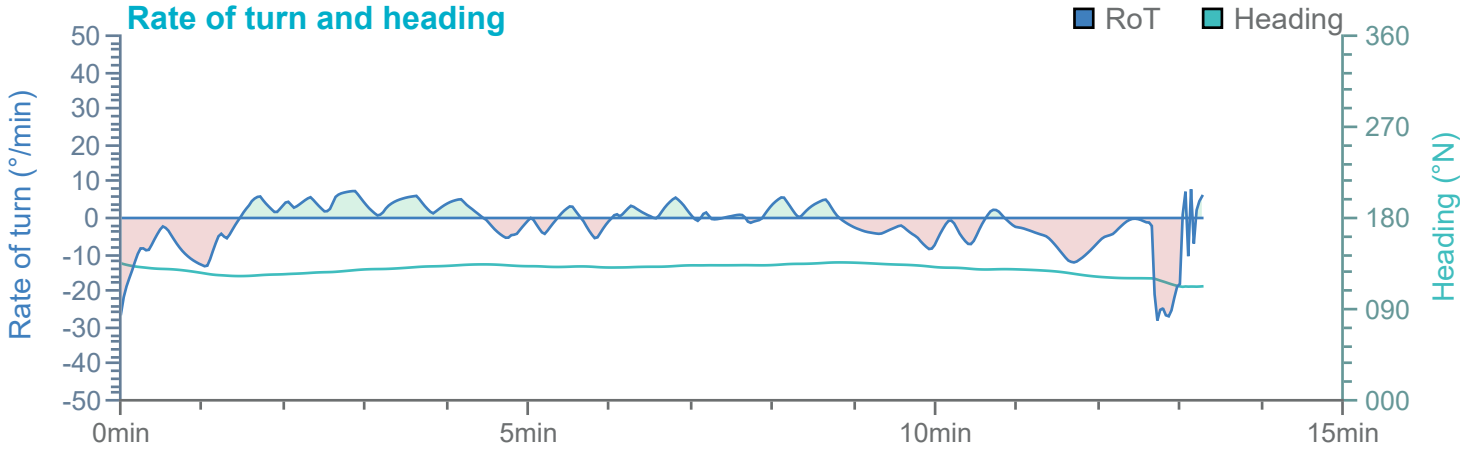
Manoeuvre track plot

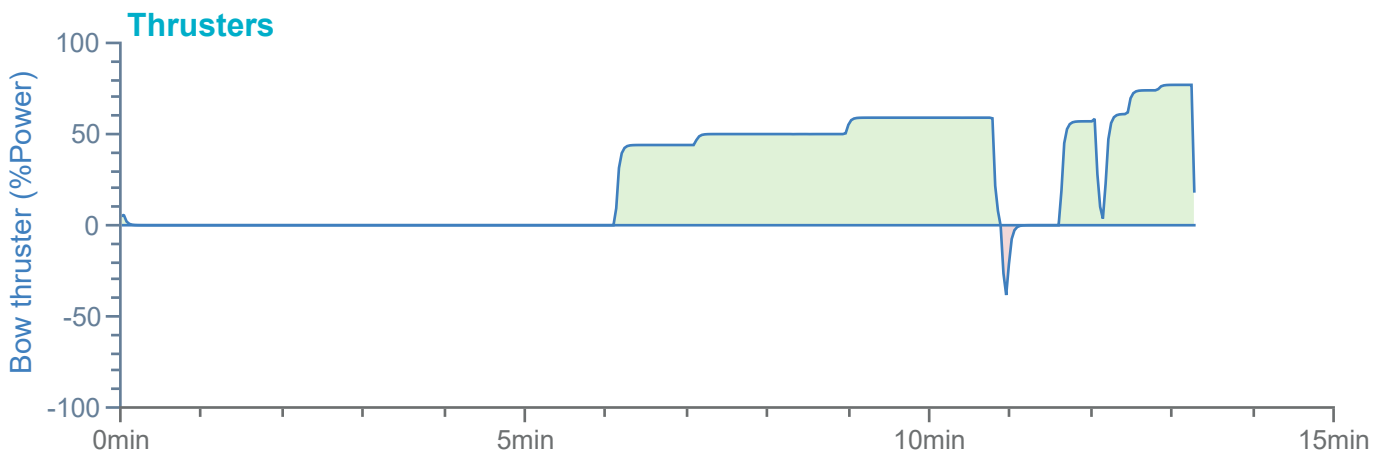
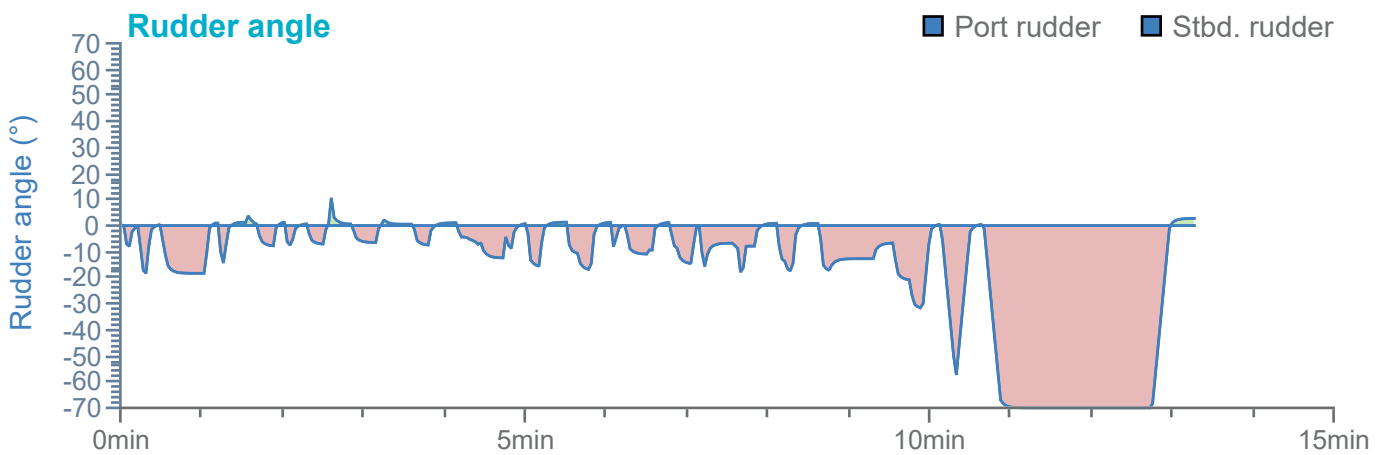
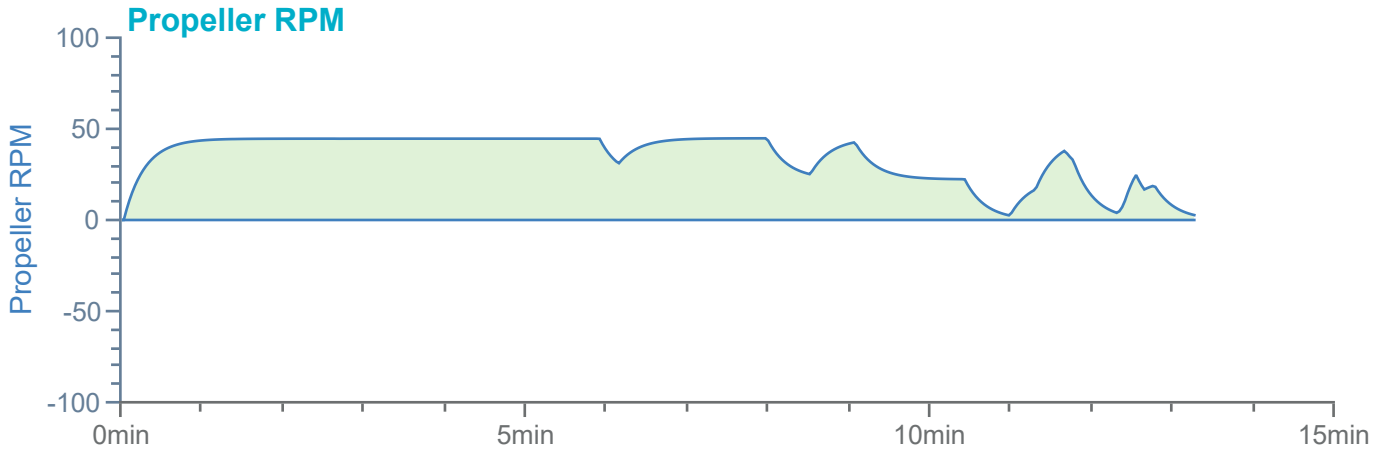


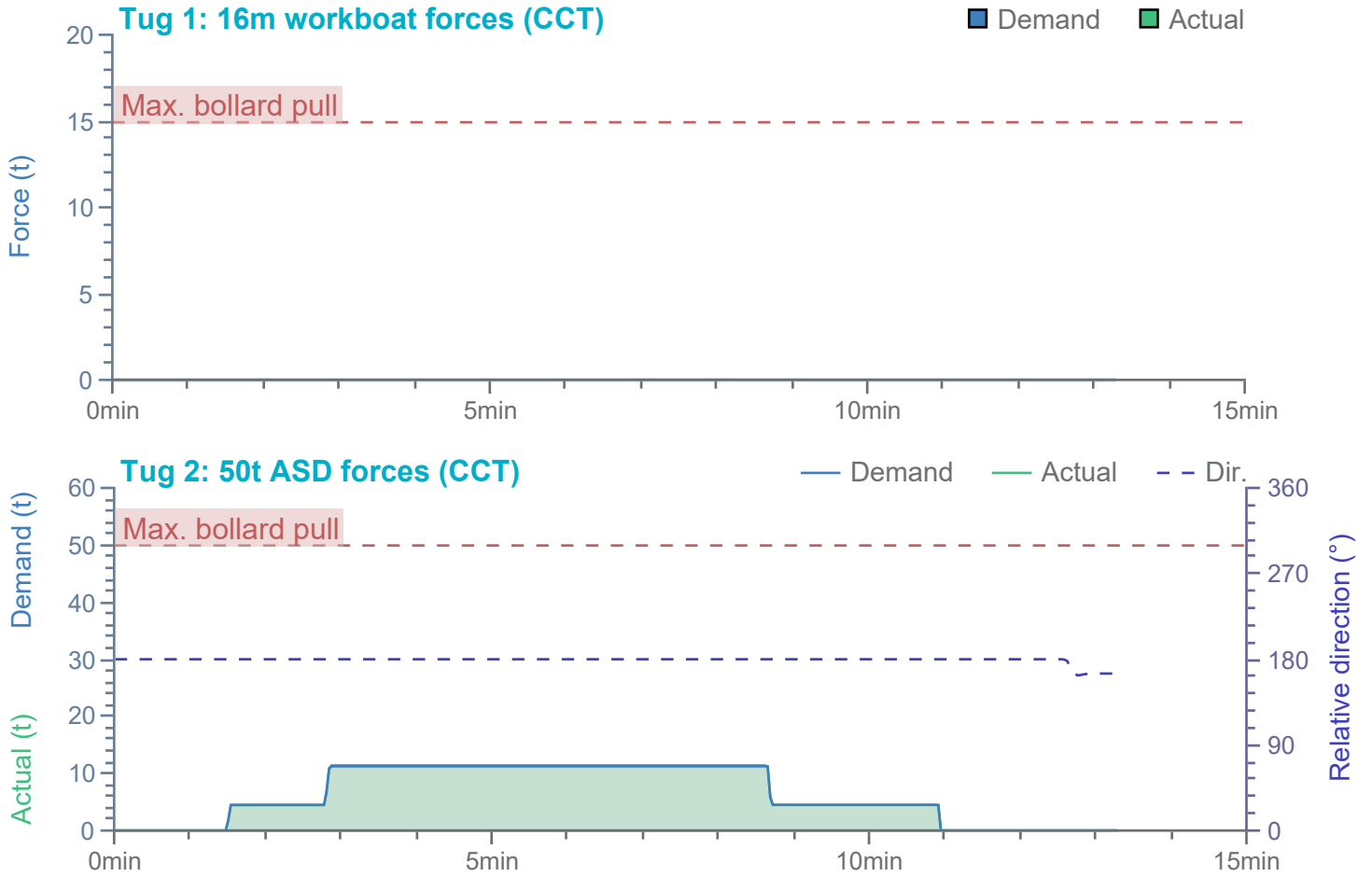
→ 3.76 kts

Ships plotted every 1 mins, highlight every 10 mins

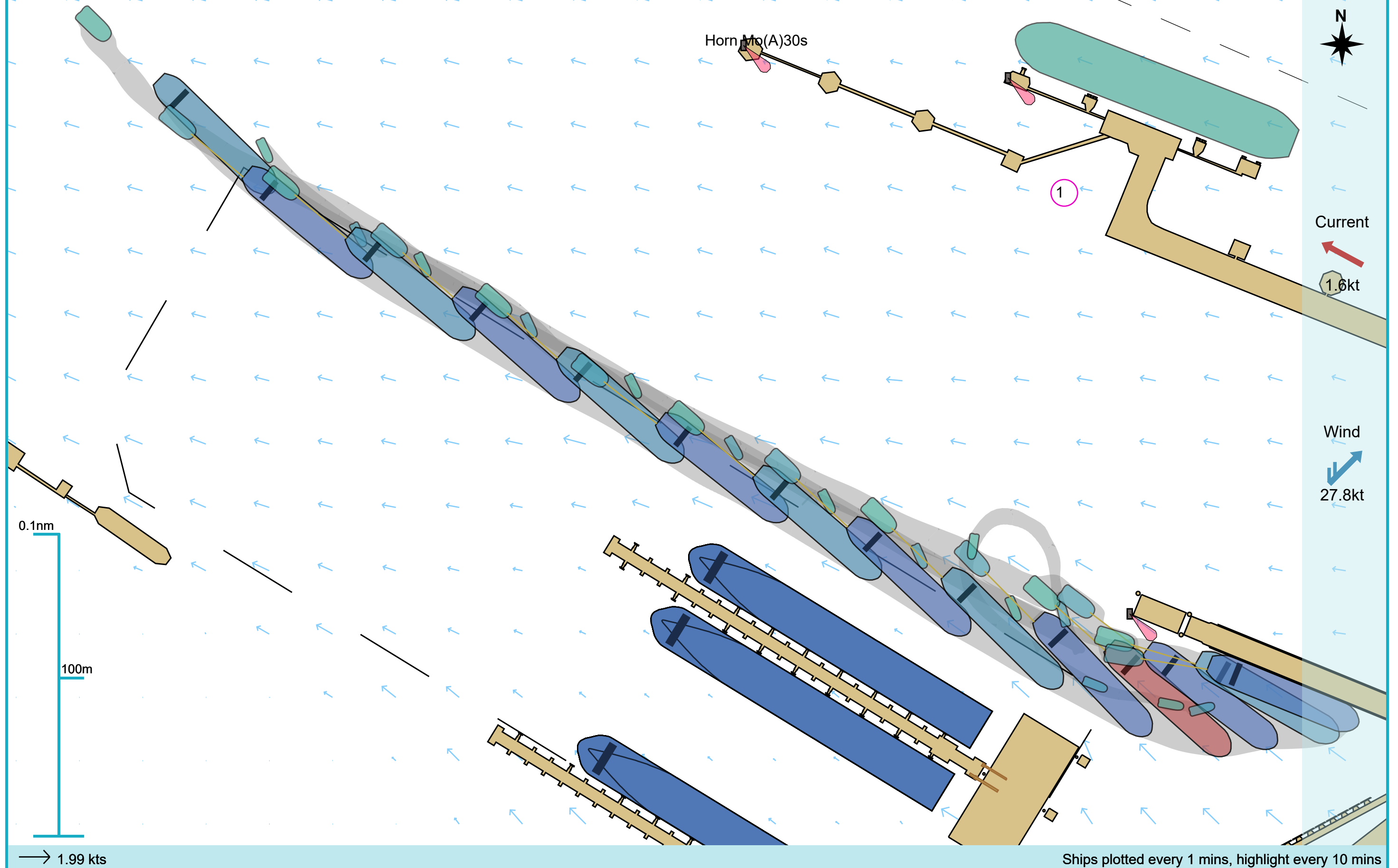


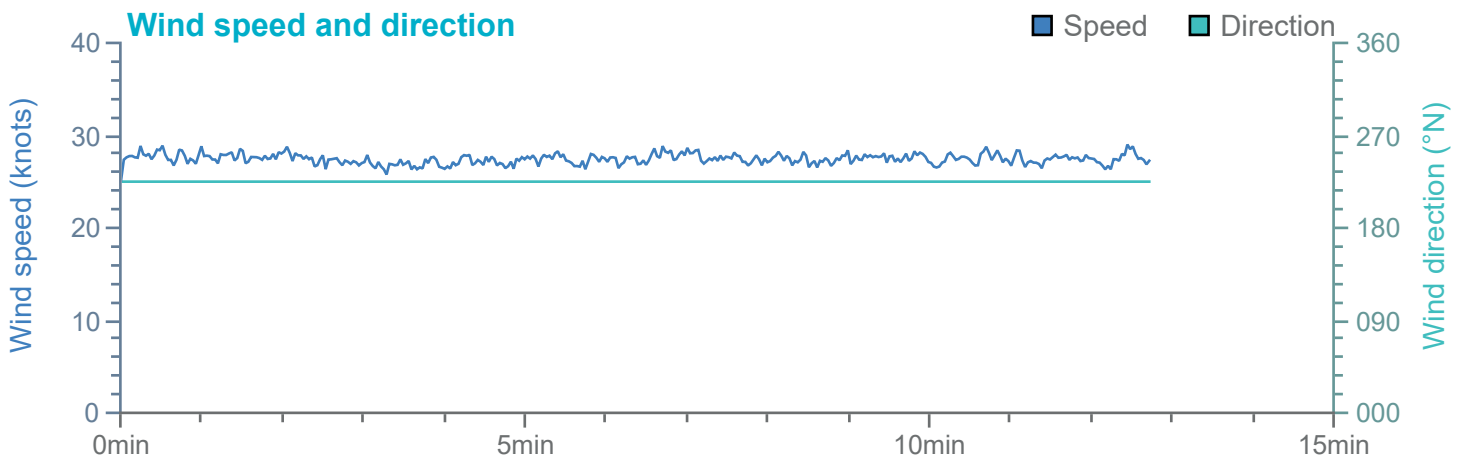
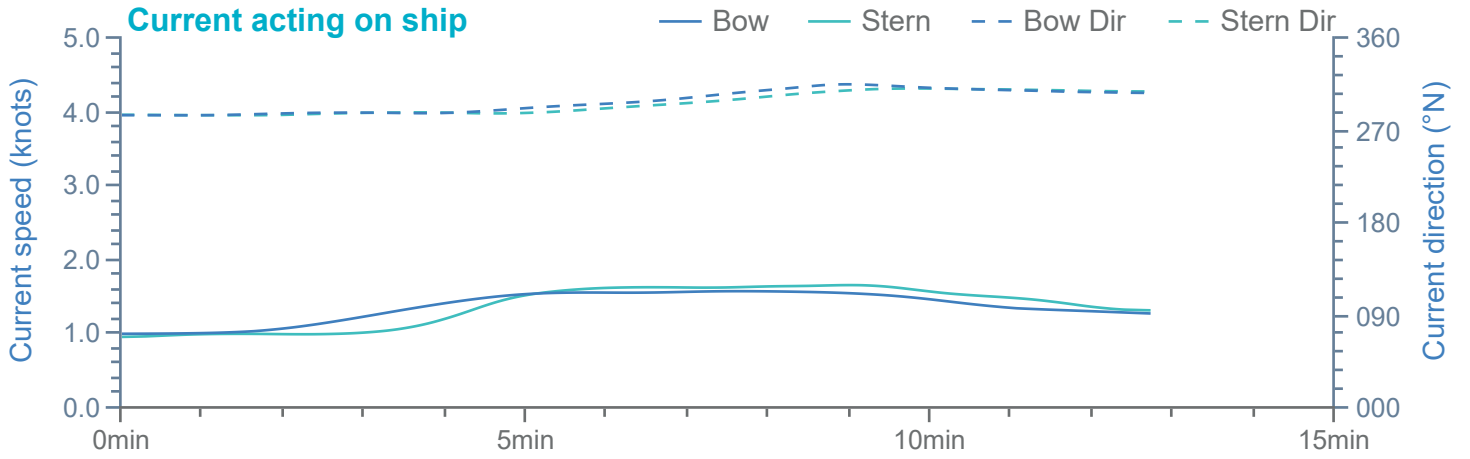


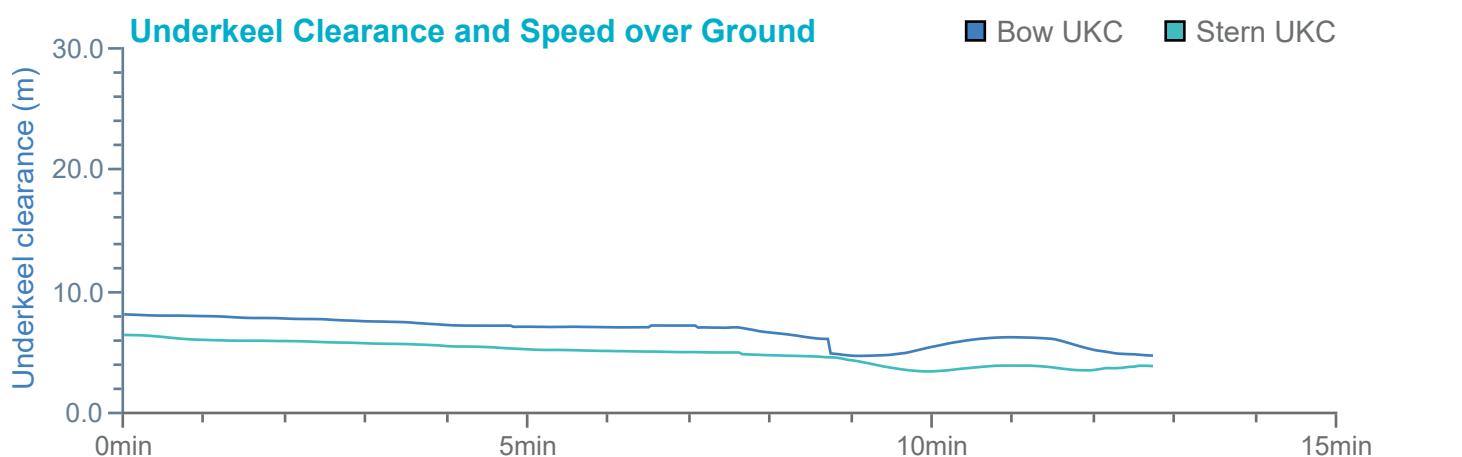
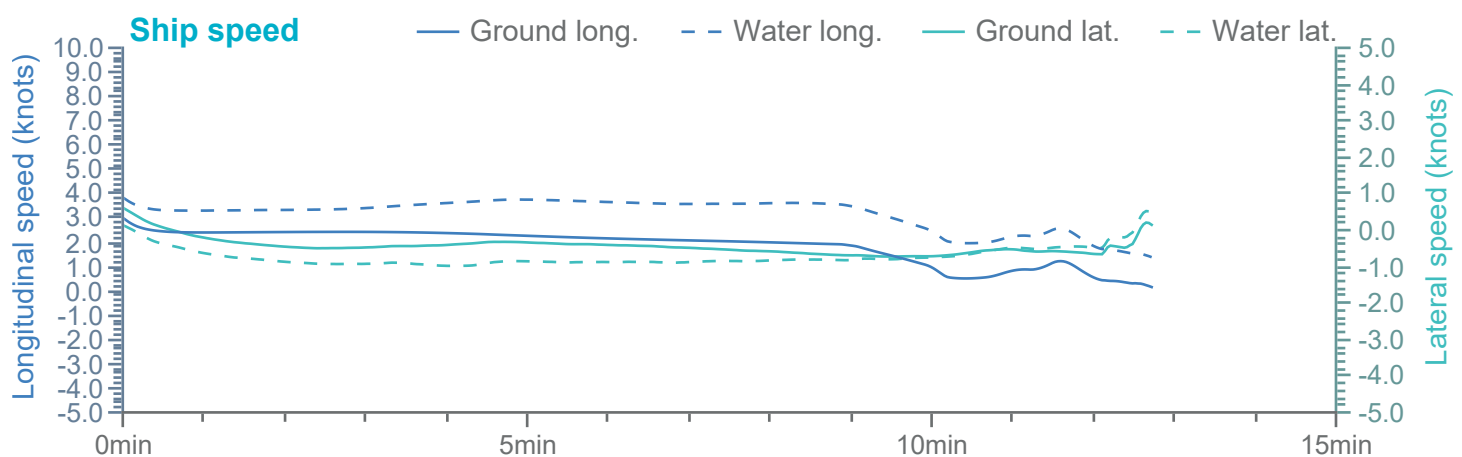
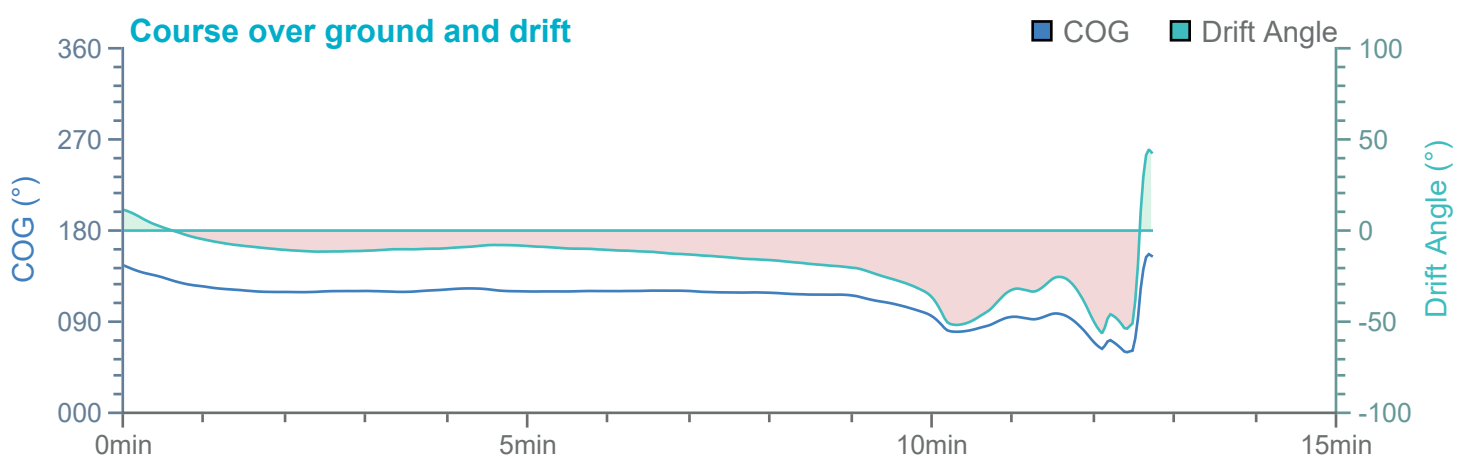
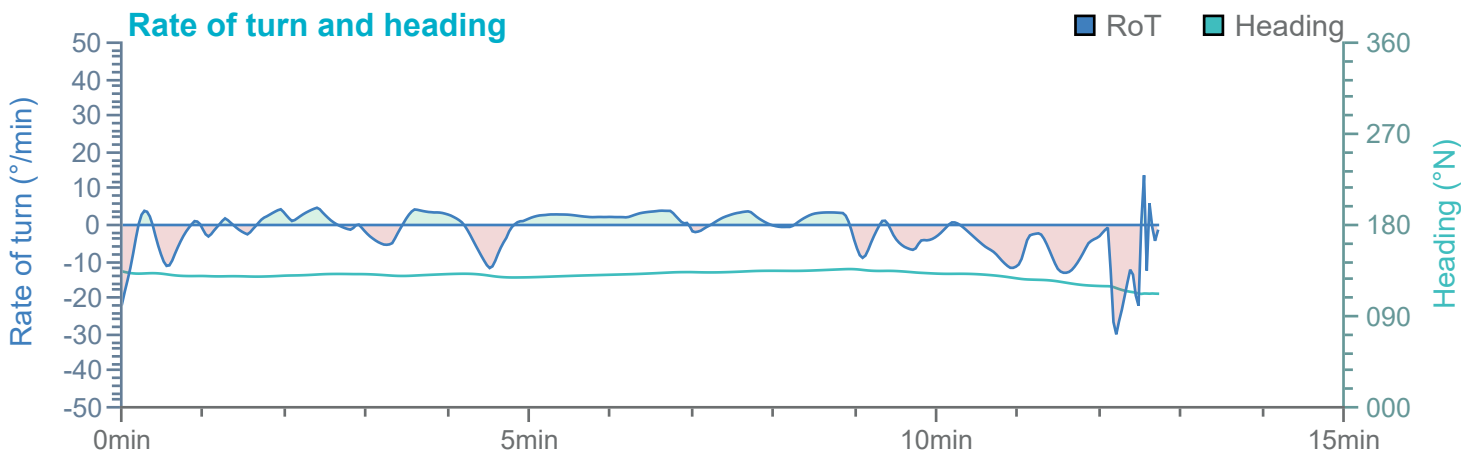


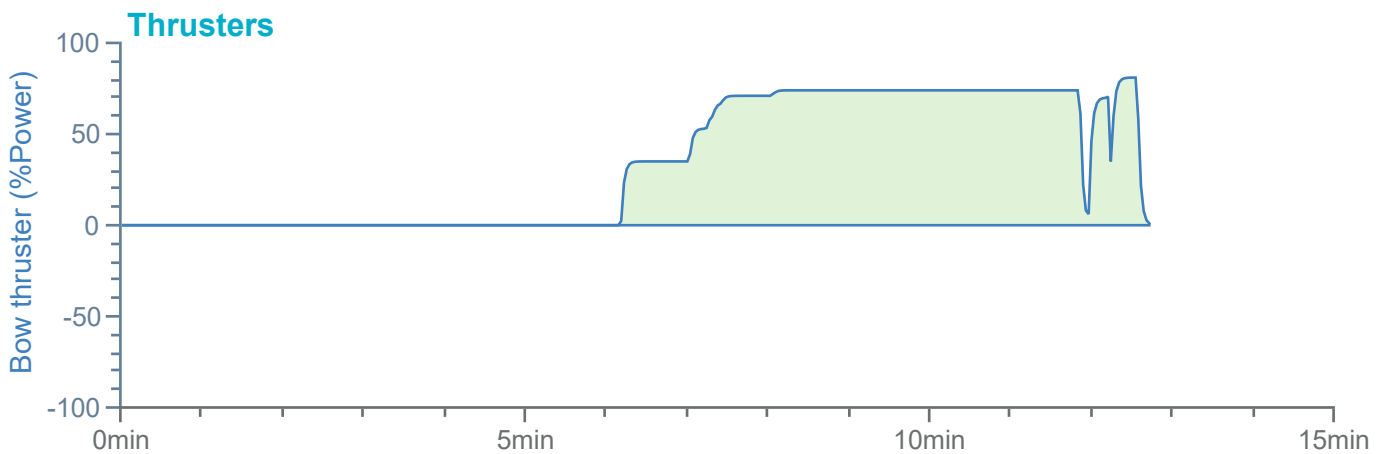
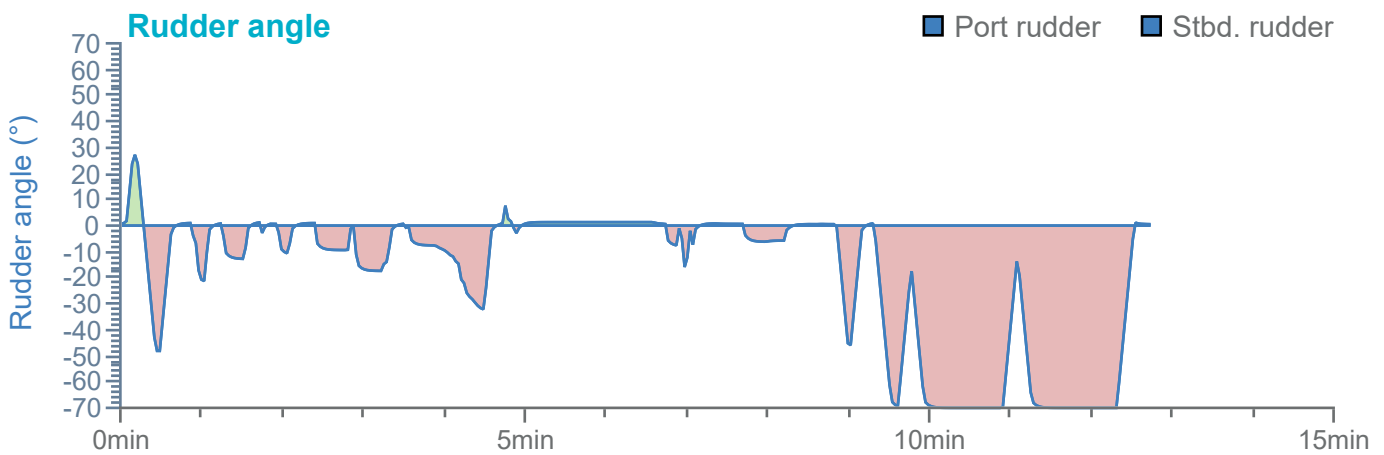
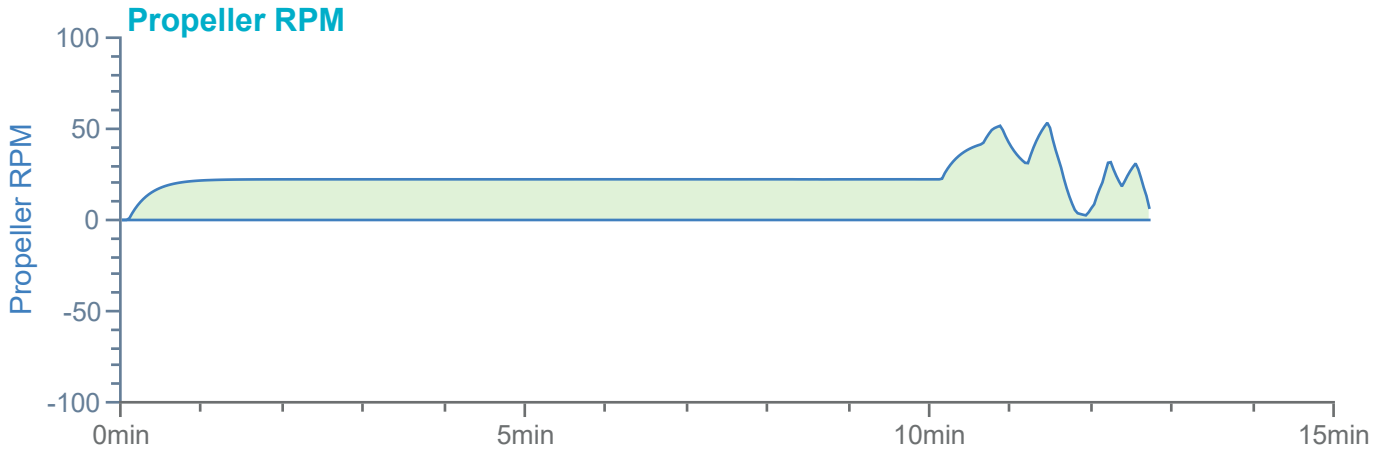


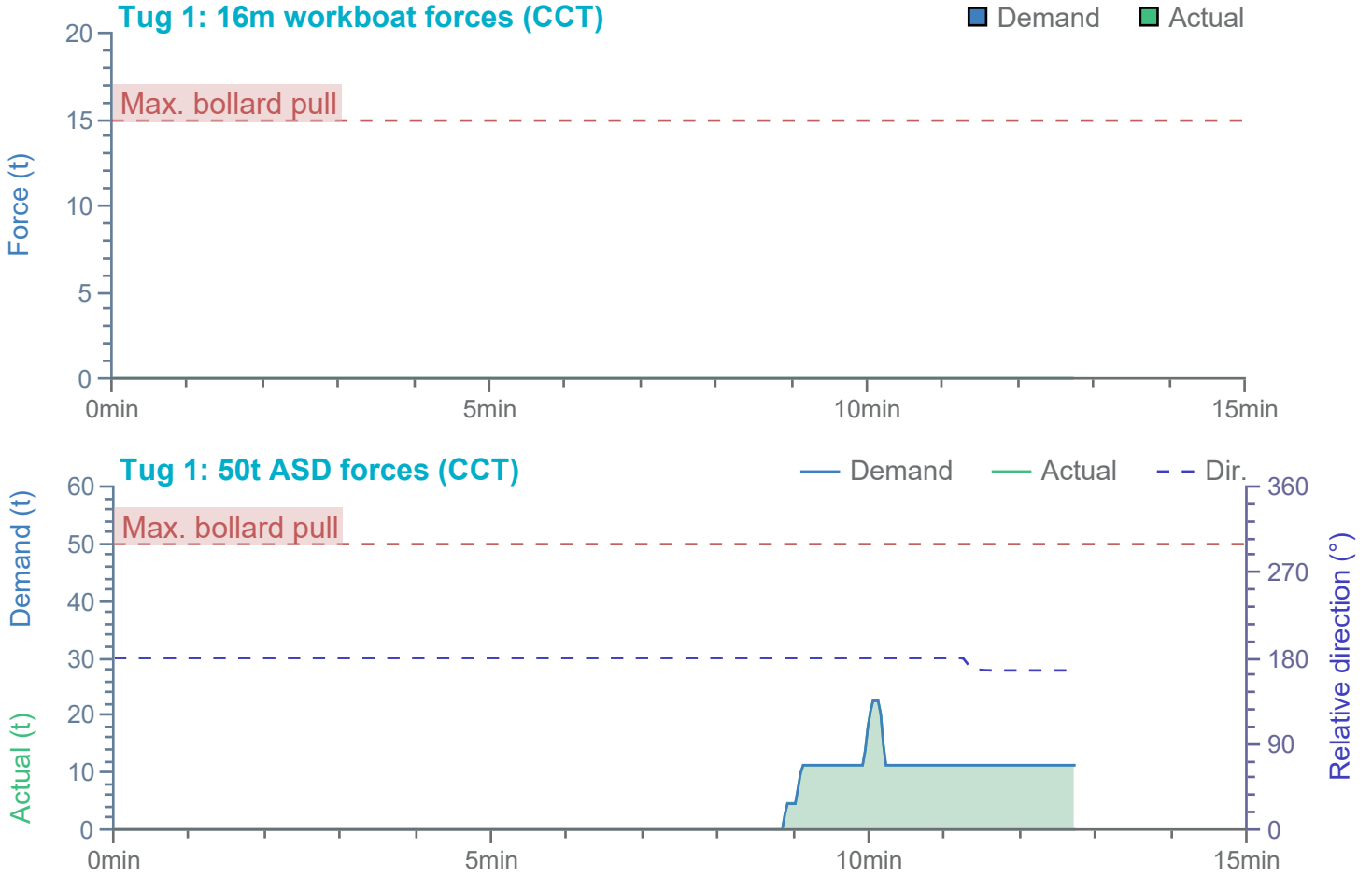
Manoeuvre track plot



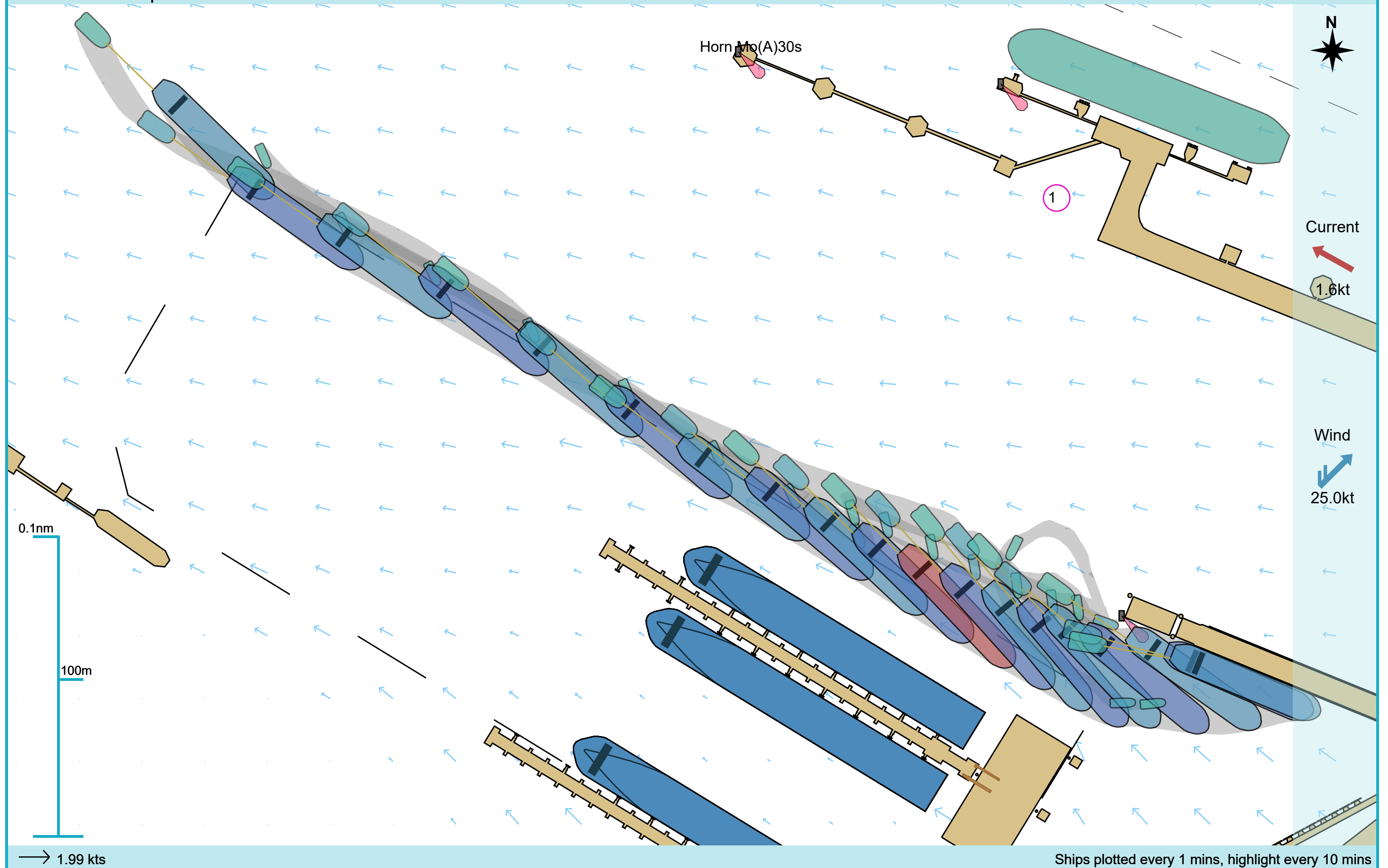






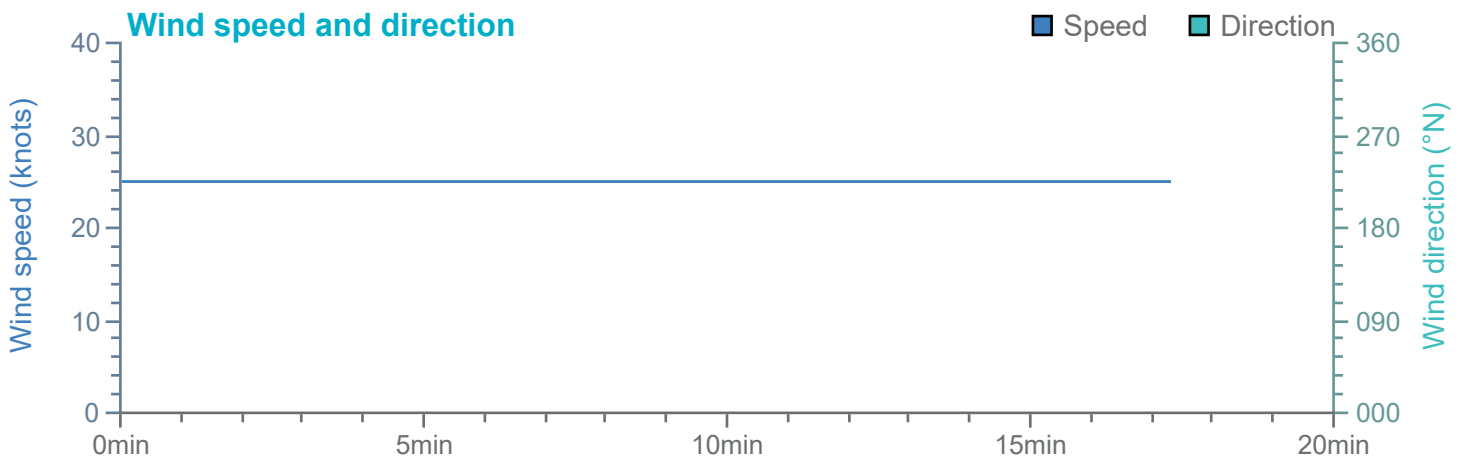
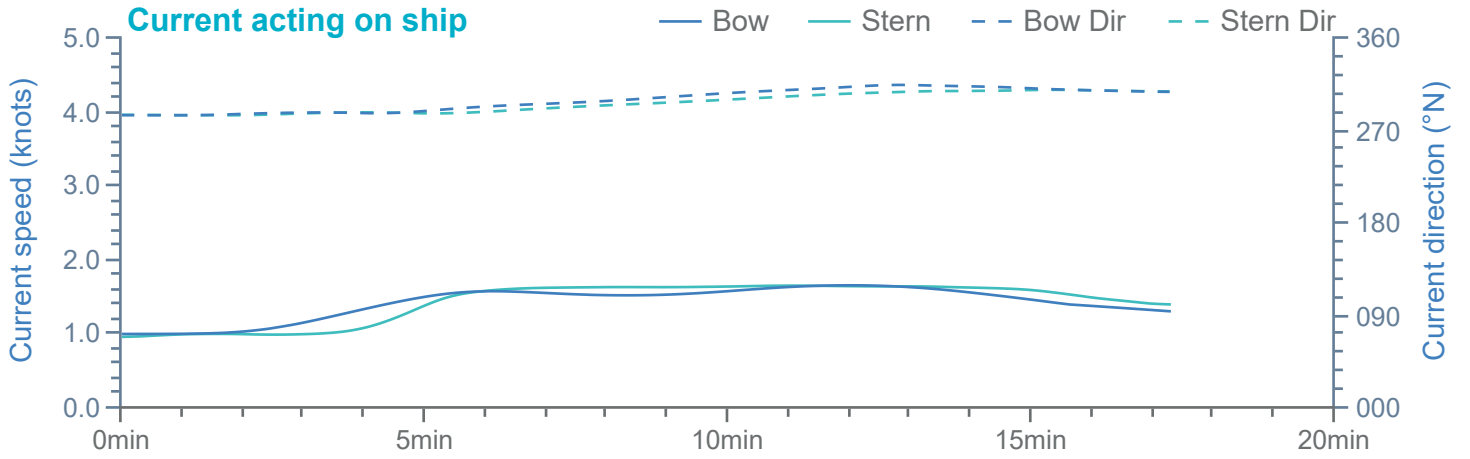


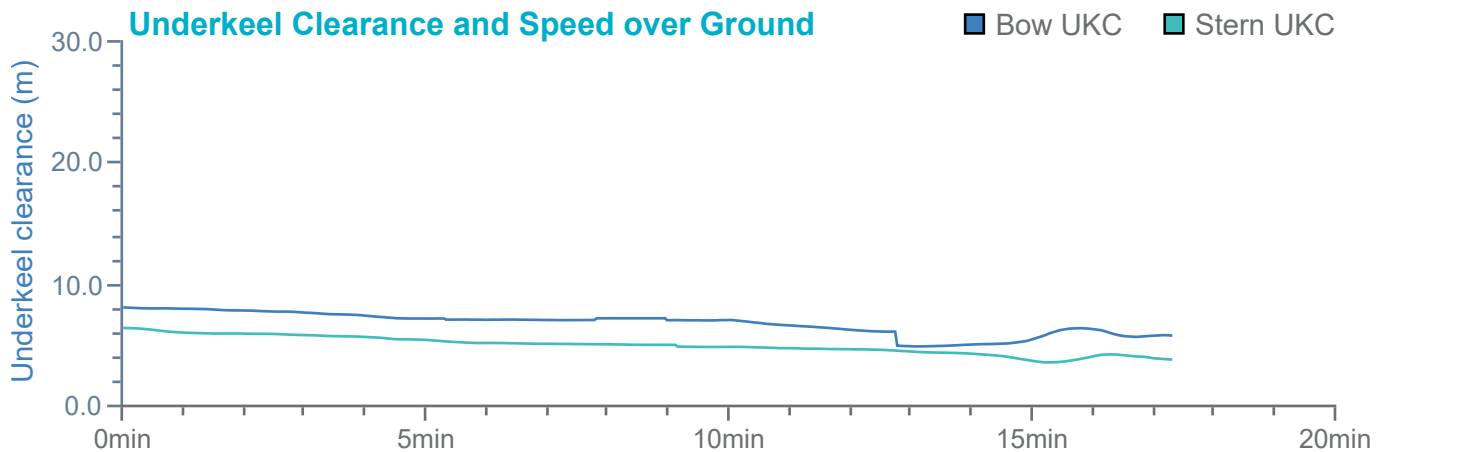
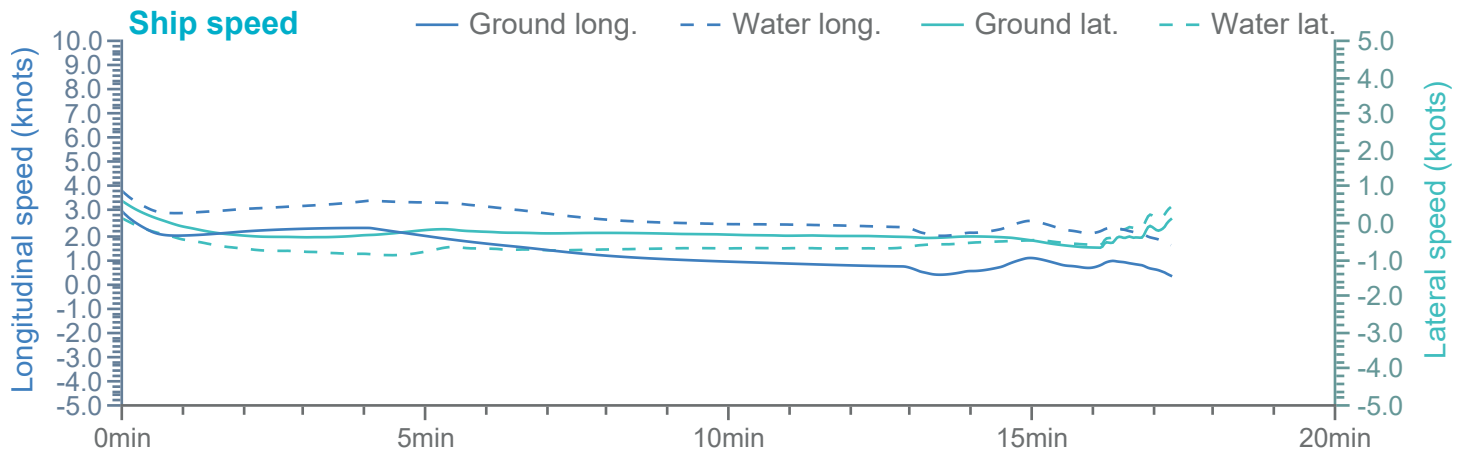
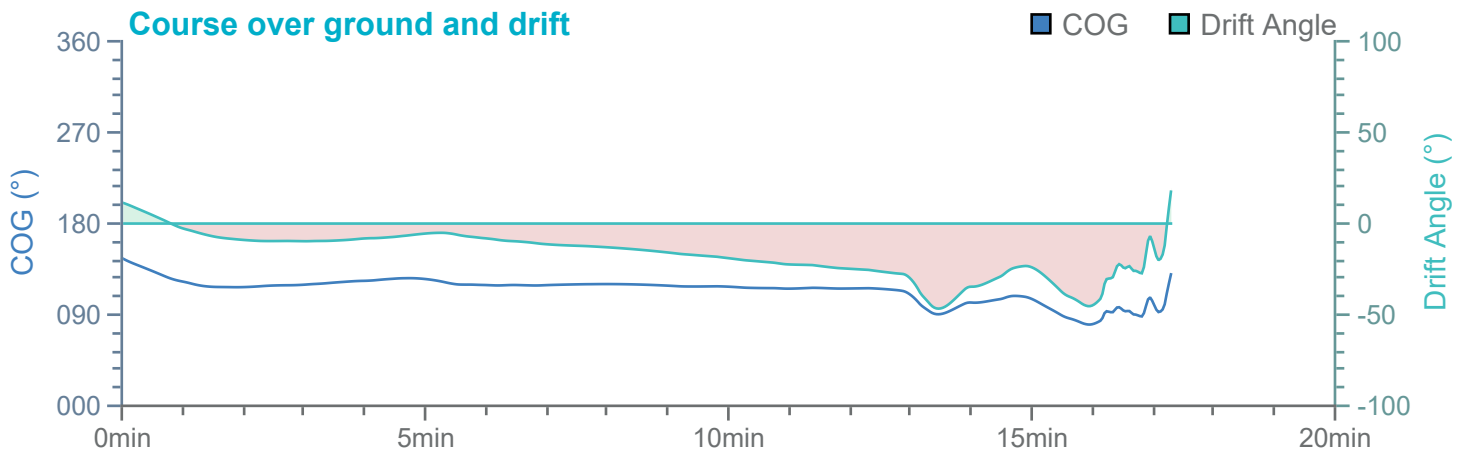
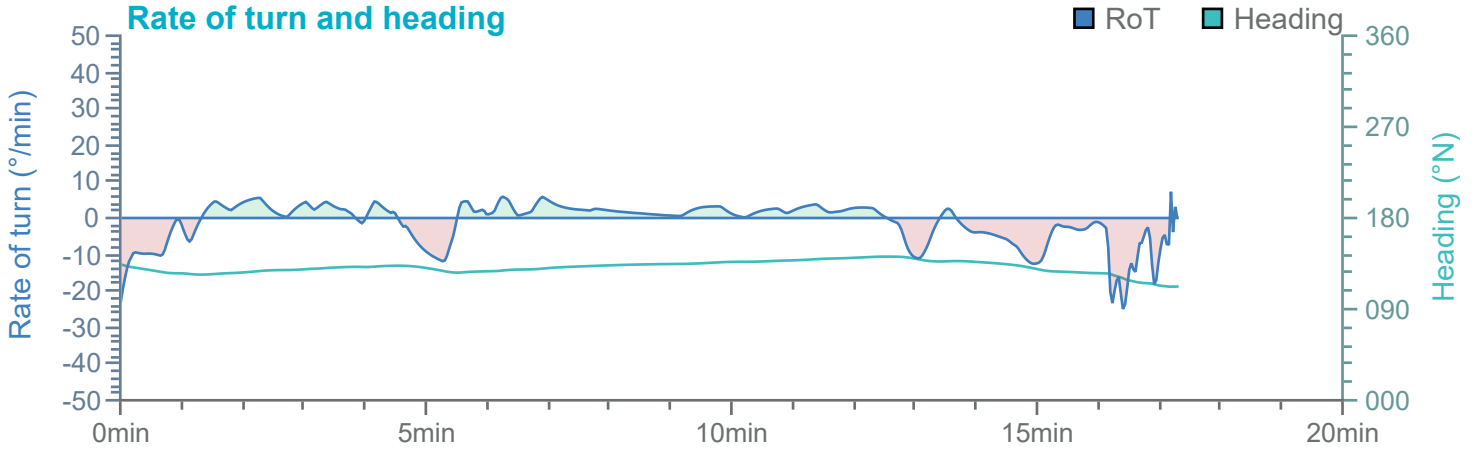
Manoeuvre track plot



→ 1.99 kts

Ships plotted every 1 mins, highlight every 10 mins



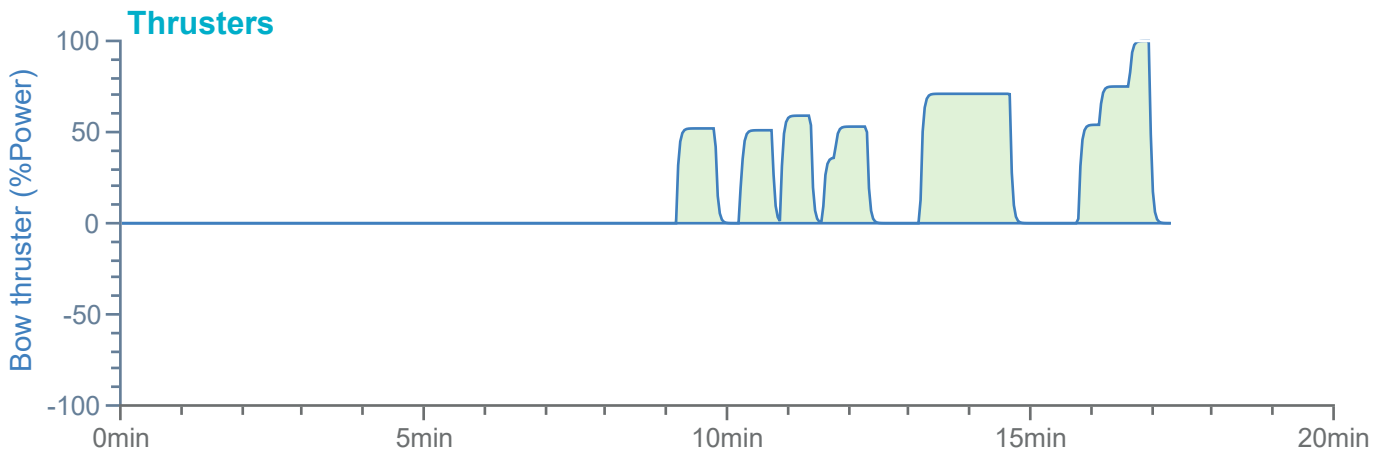
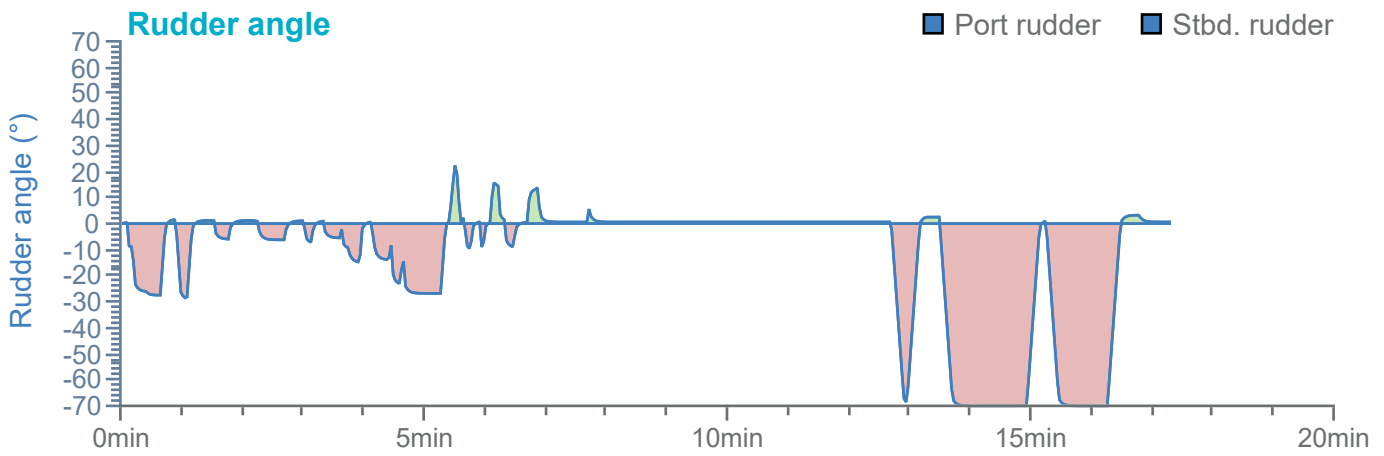
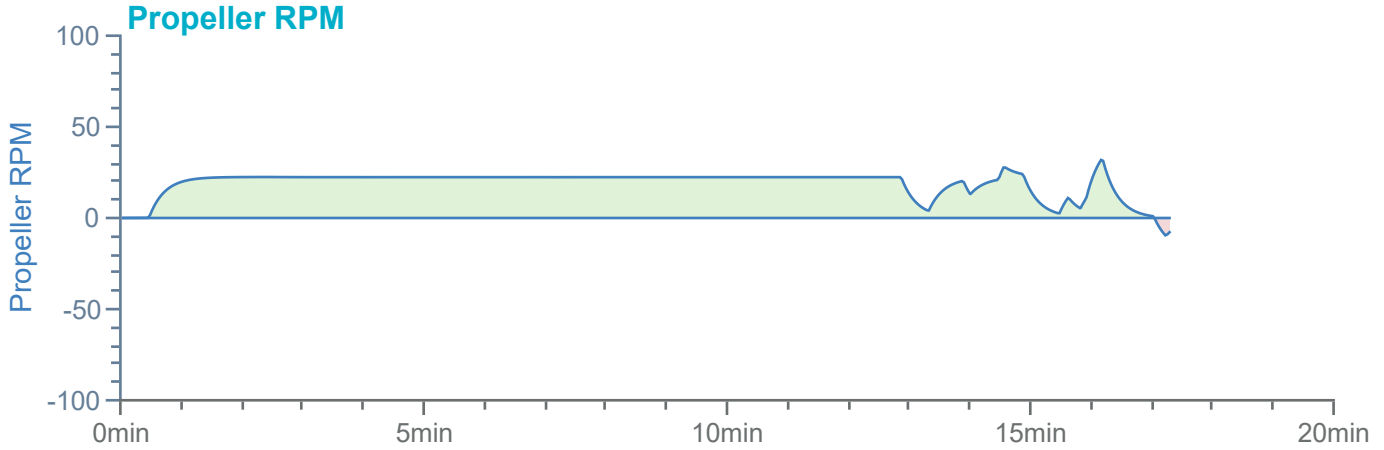


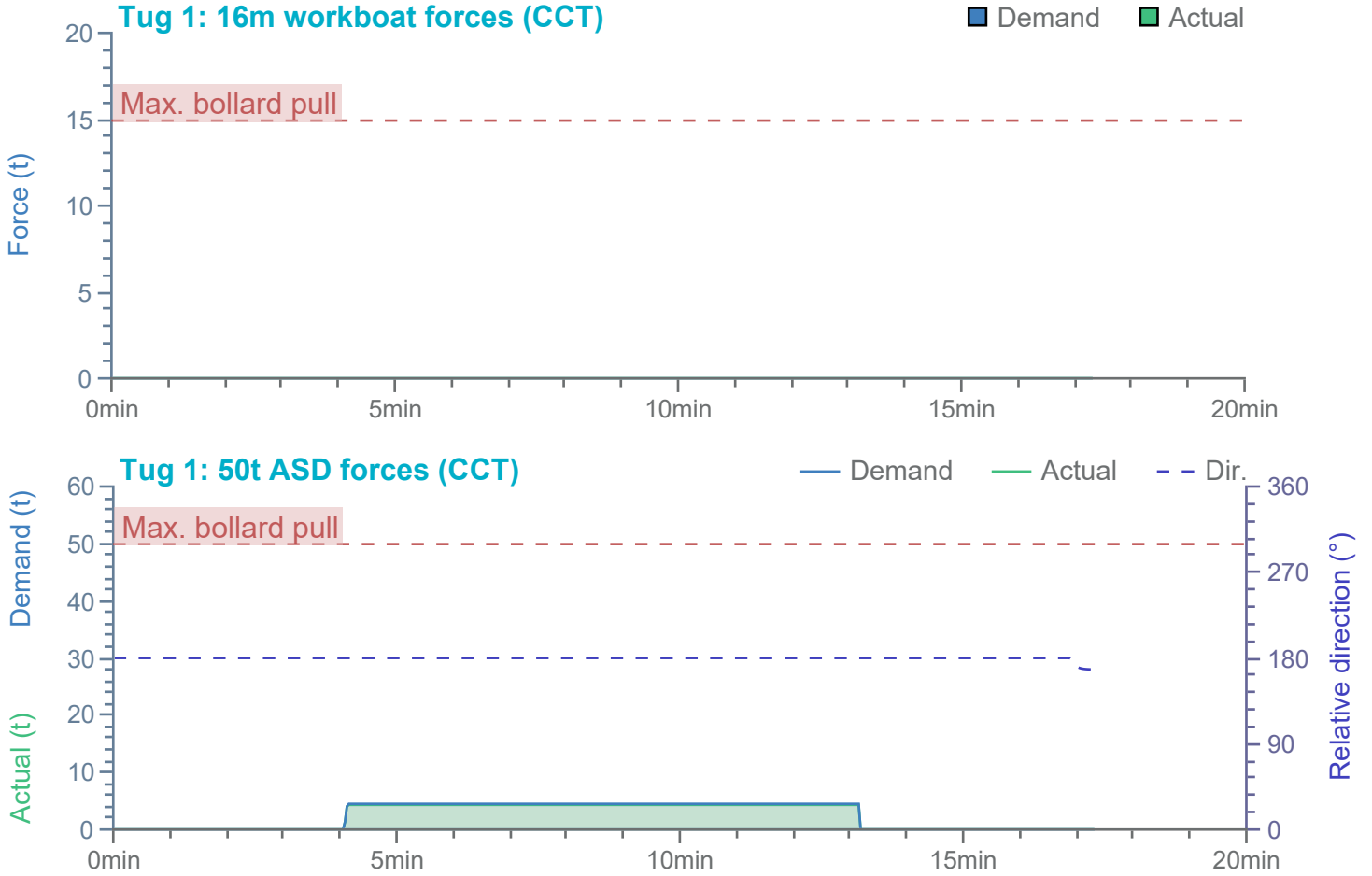
Overview

Environment

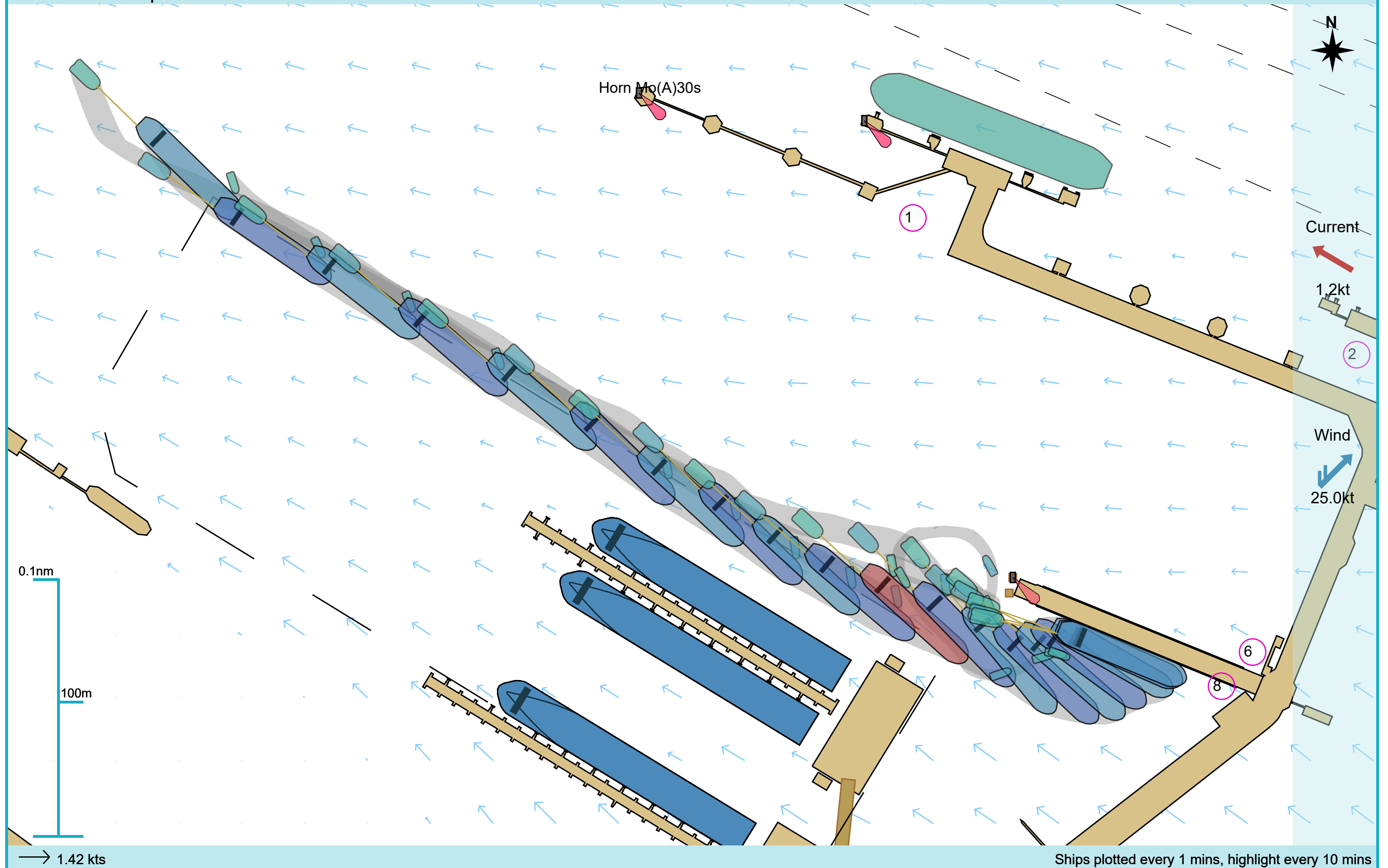
100m x 18m Product Tanker

Tugs



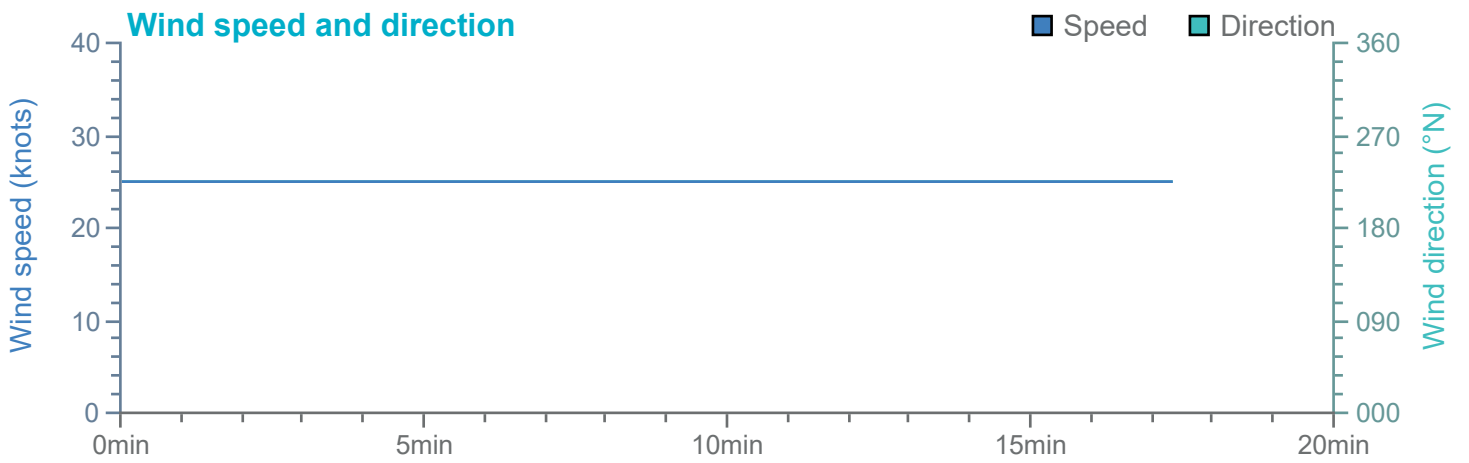
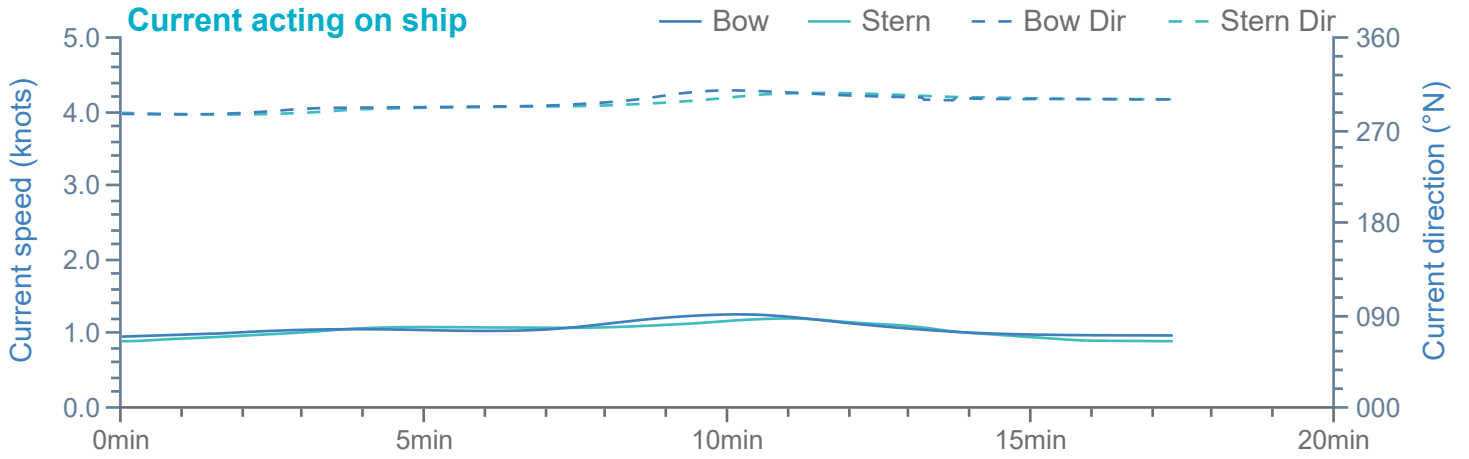


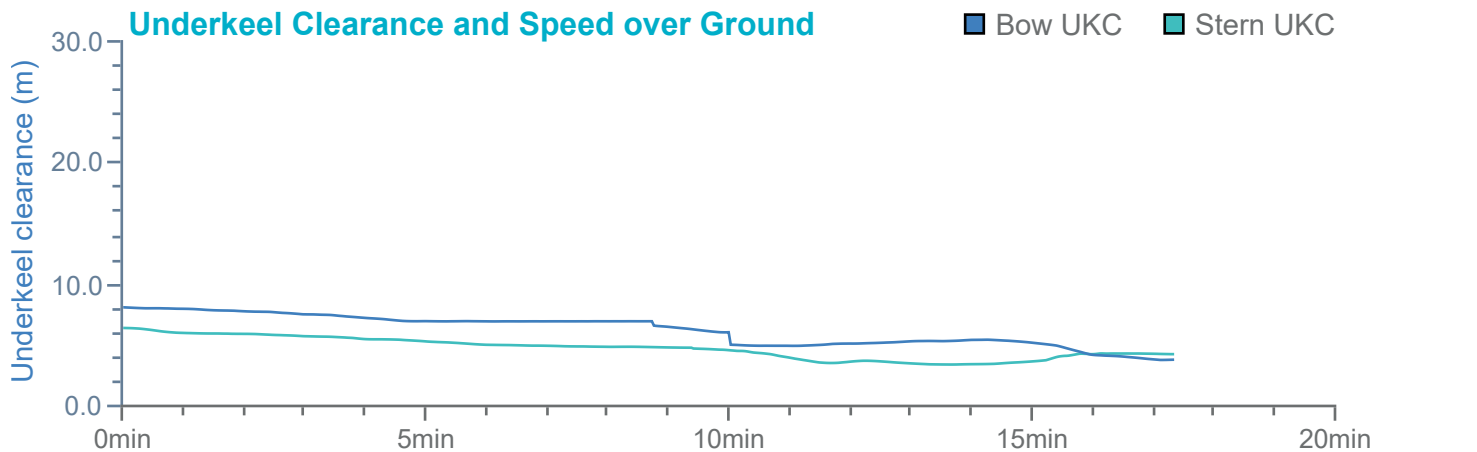
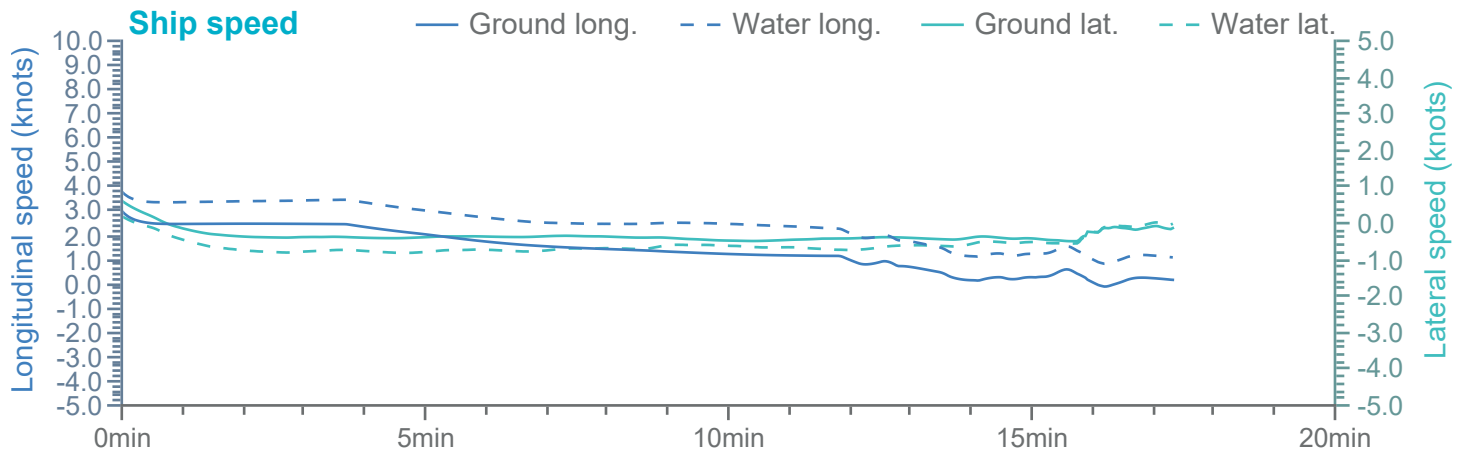
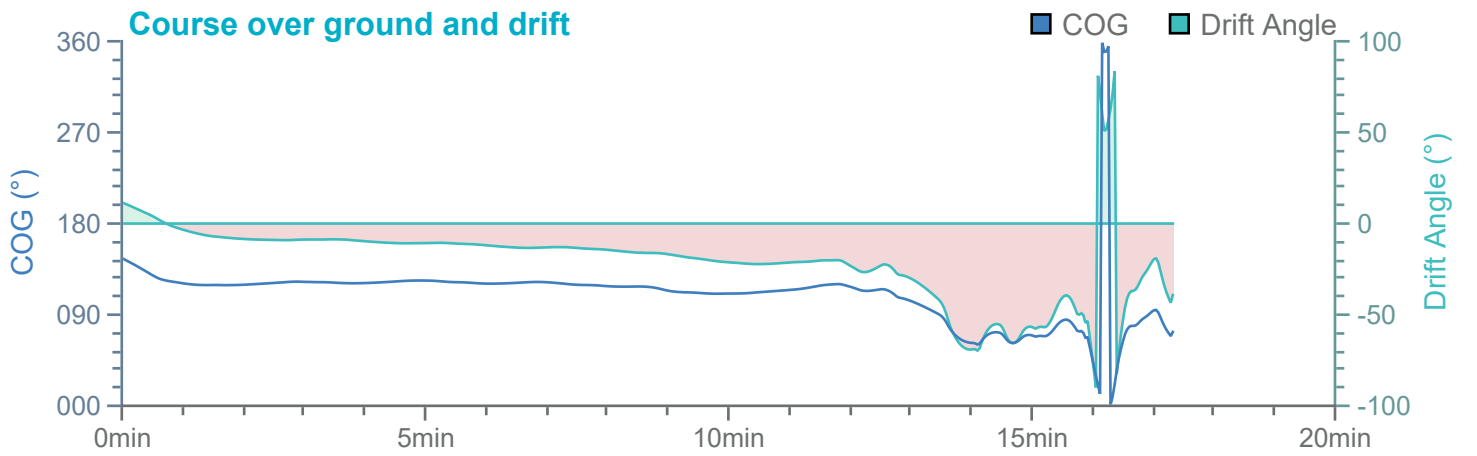
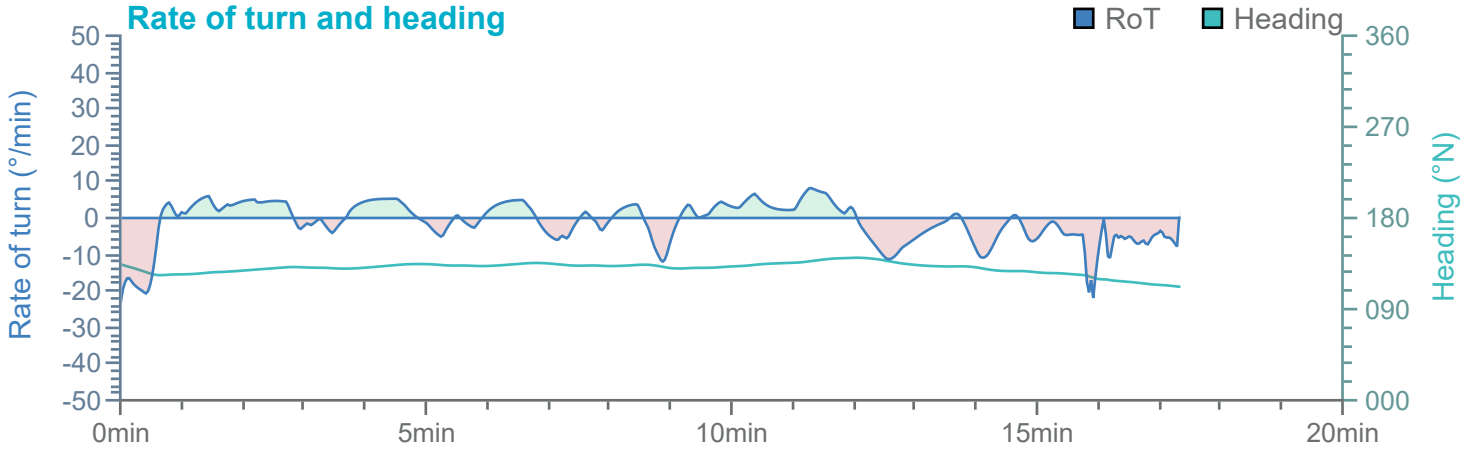
Manoeuvre track plot



→ 1.42 kts

Ships plotted every 1 mins, highlight every 10 mins



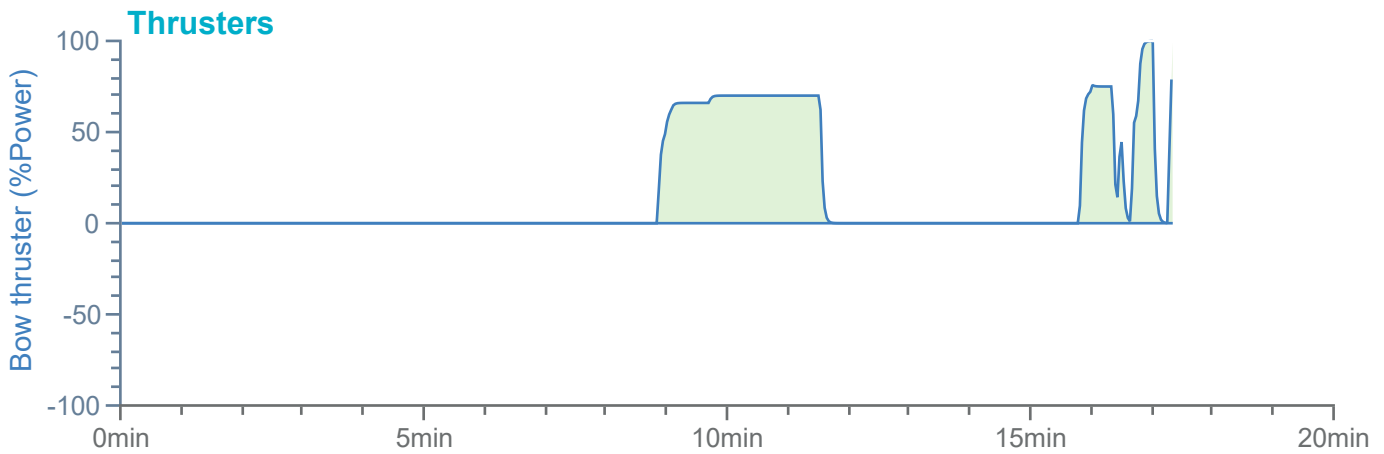
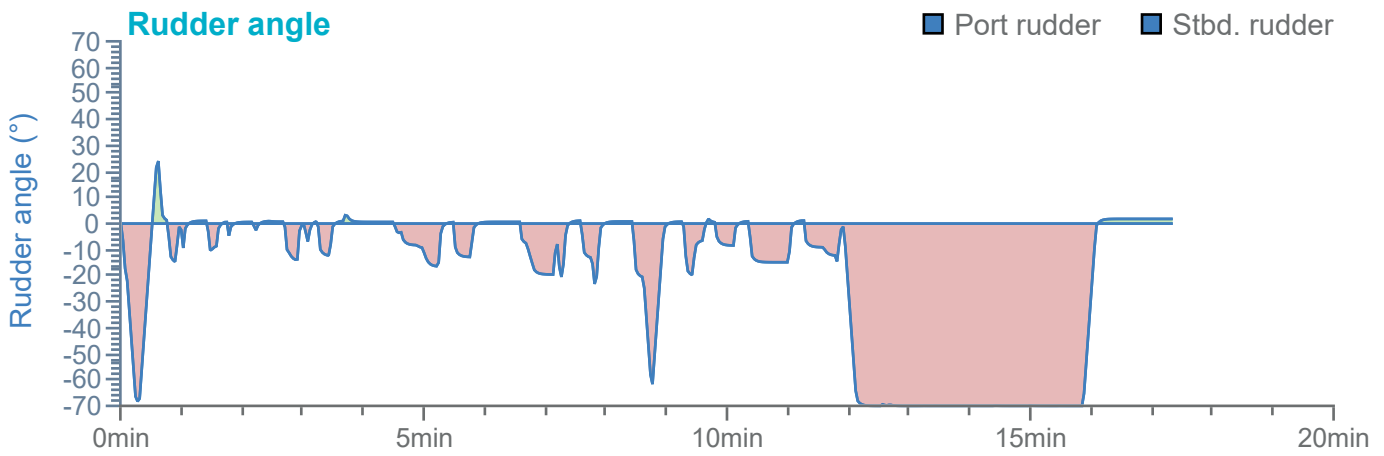
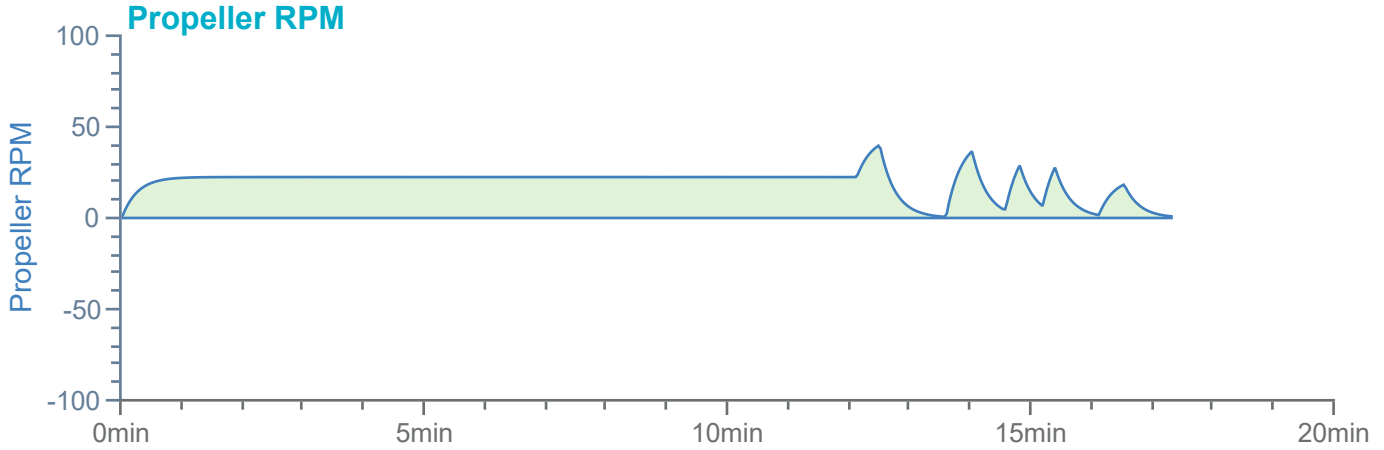


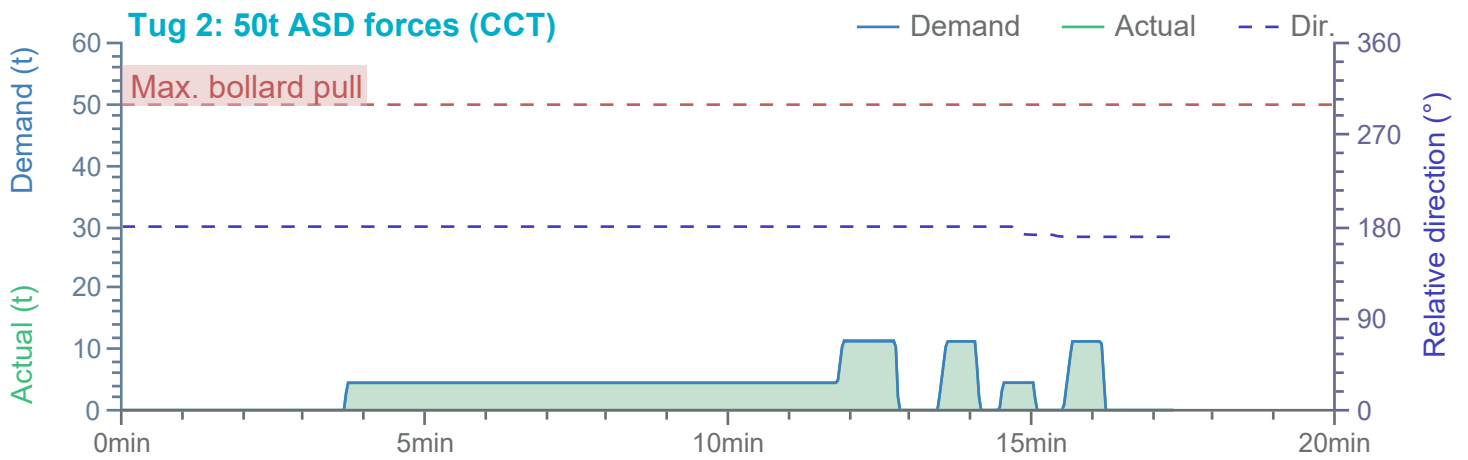
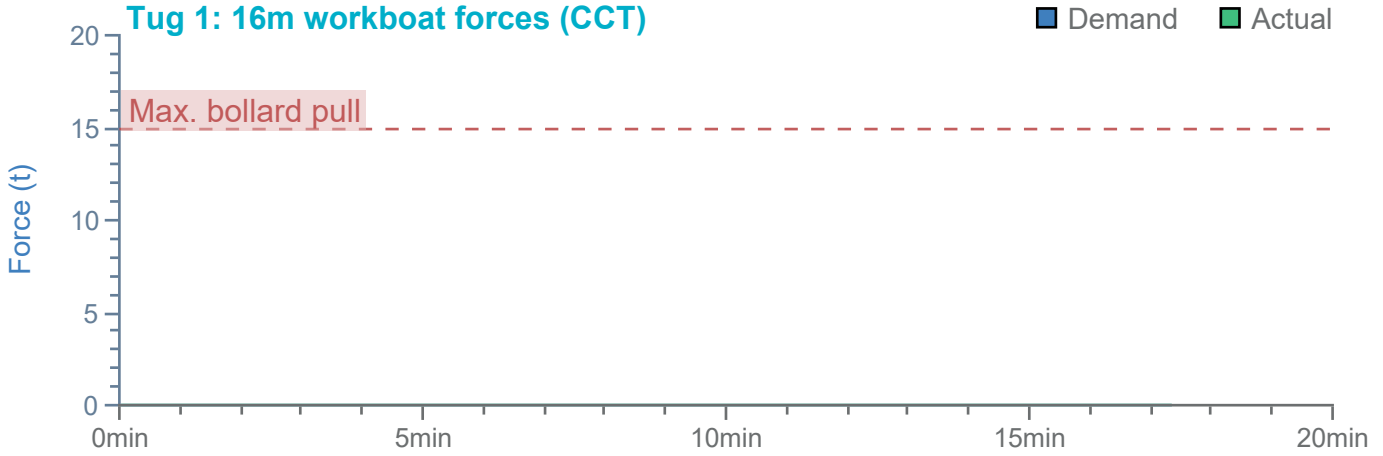
Overview

Environment

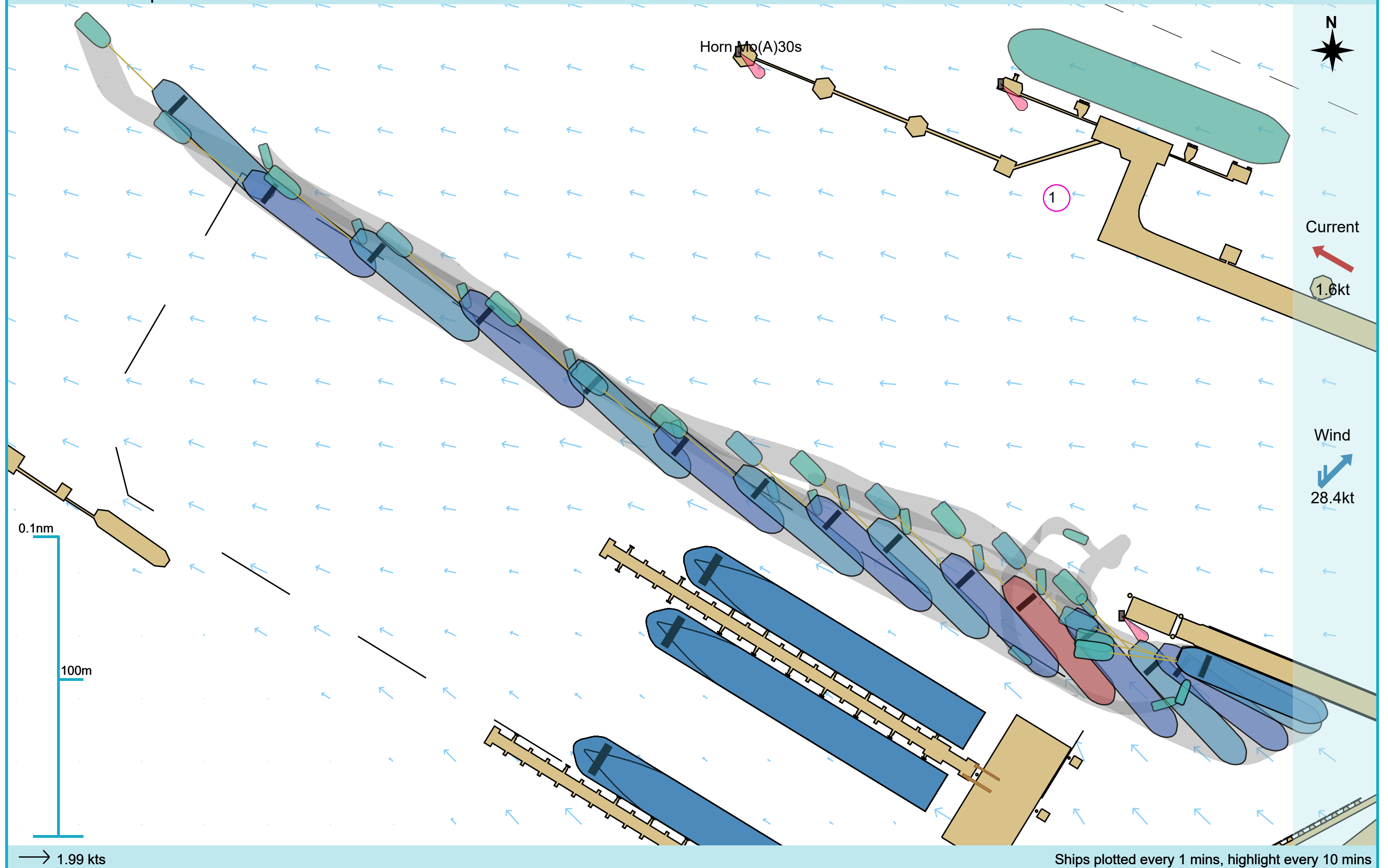
100m x 18m Product Tanker

Tugs



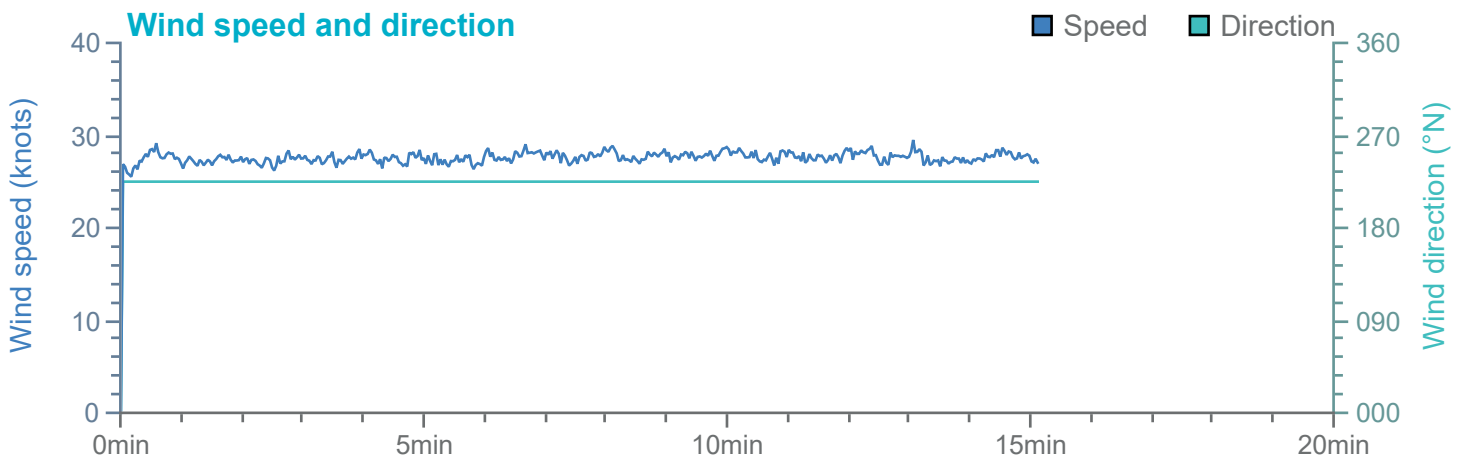
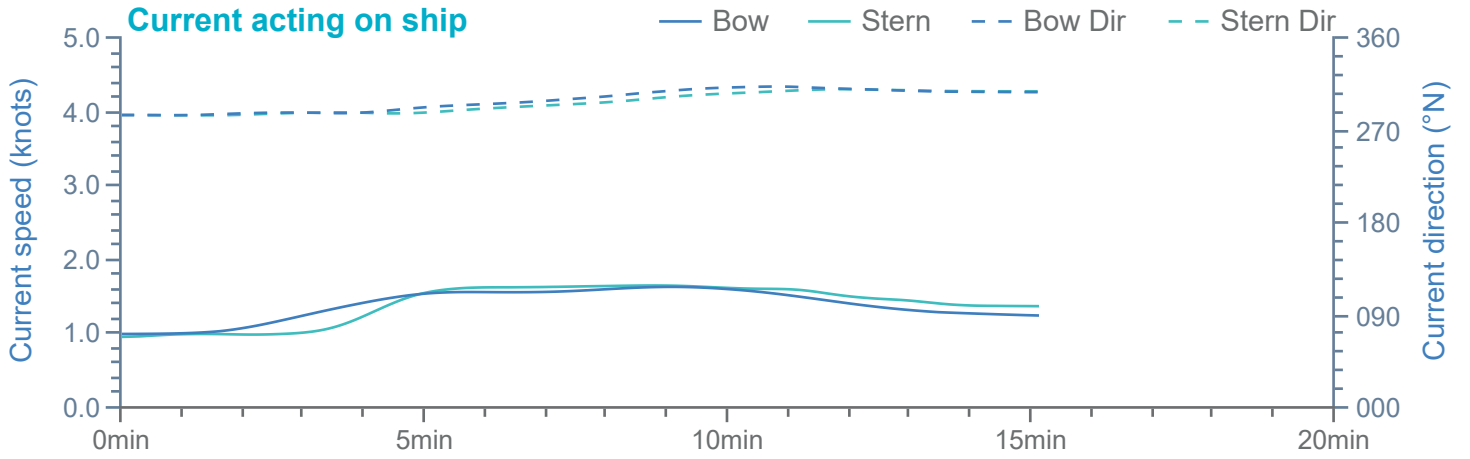


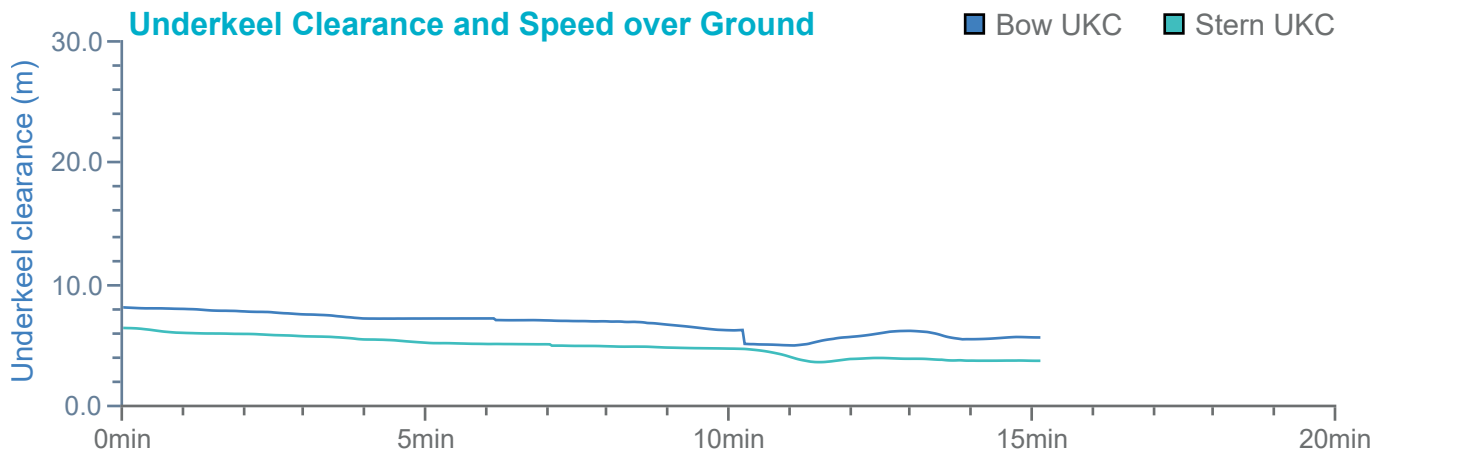
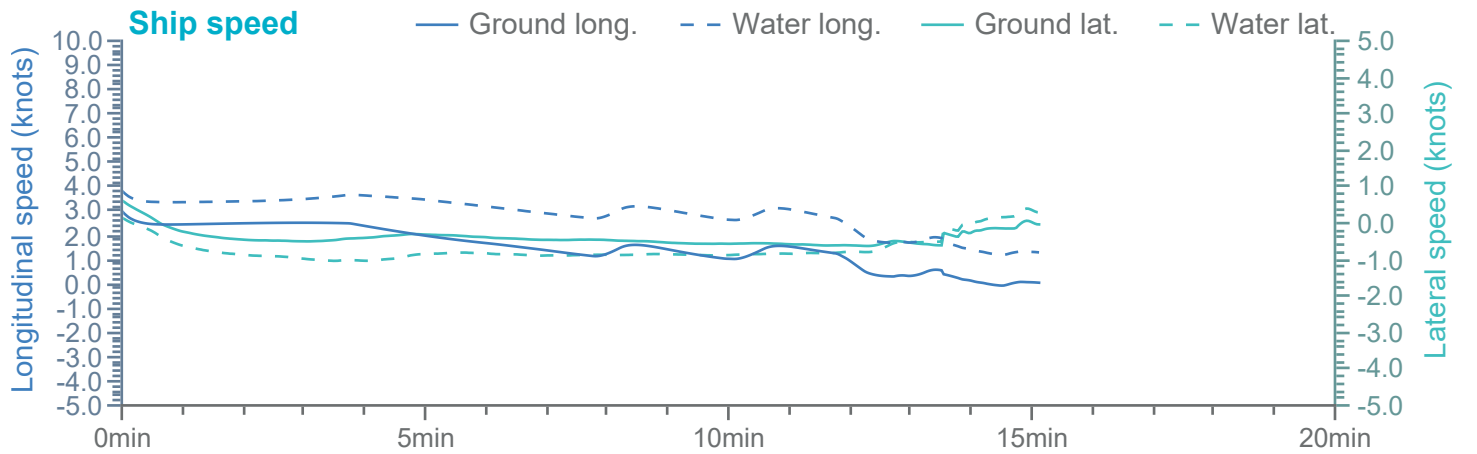
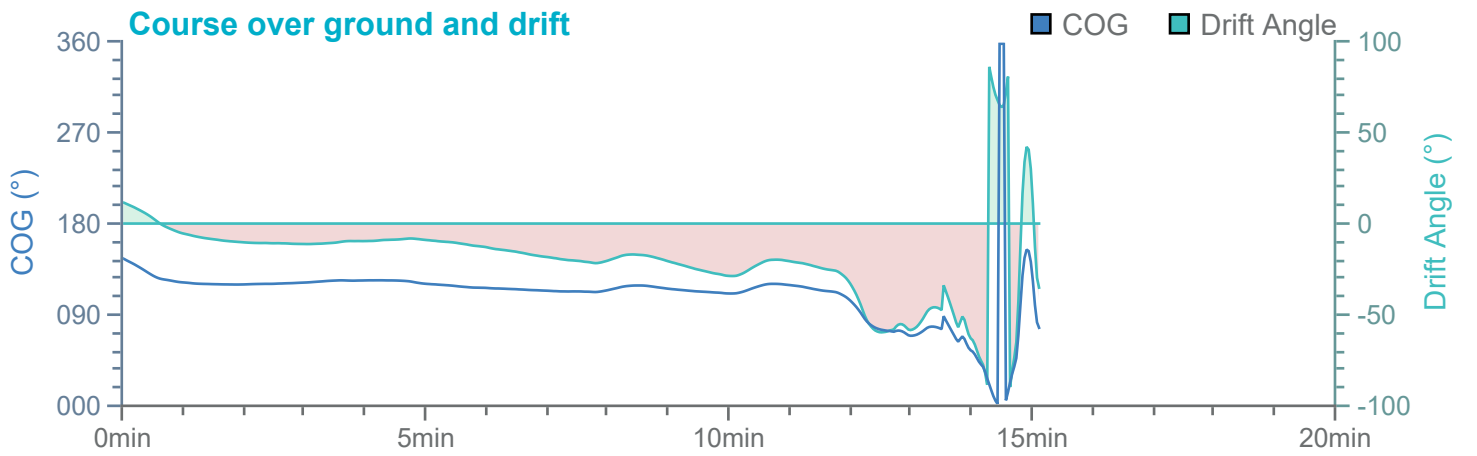
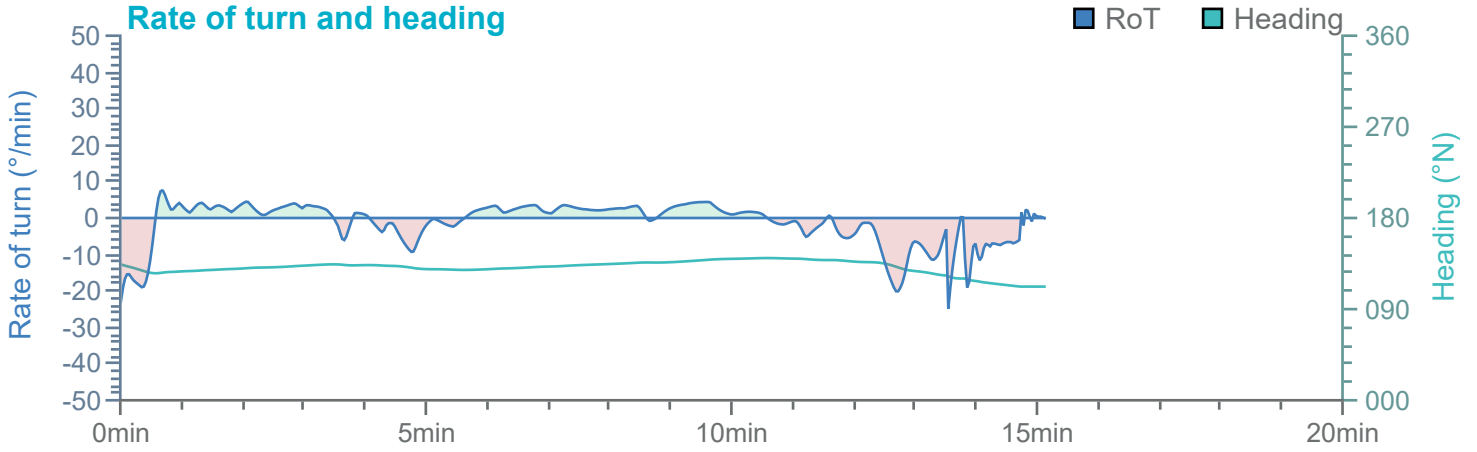
Manoeuvre track plot

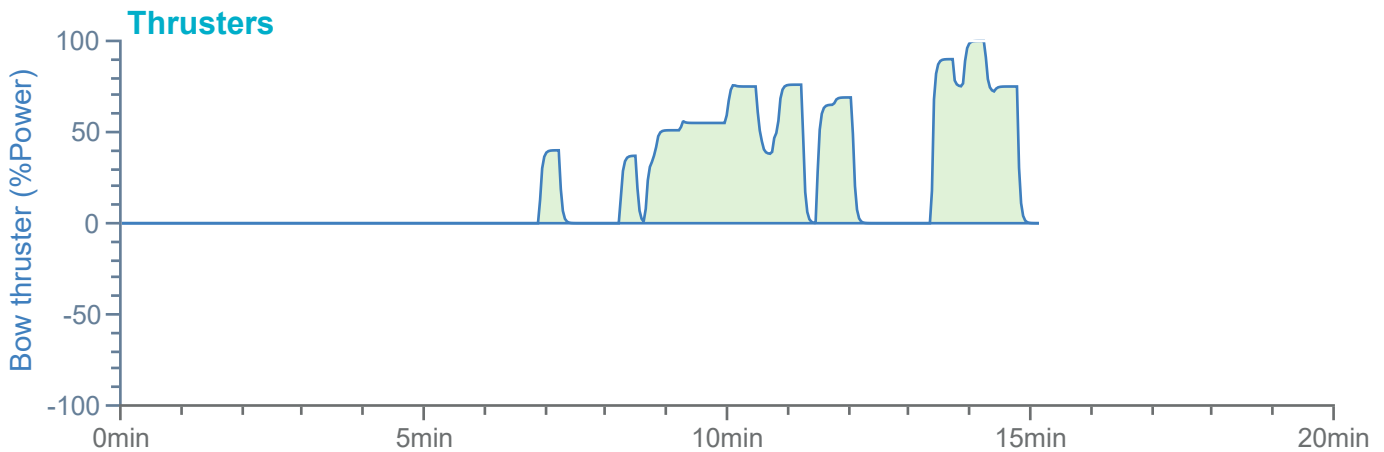
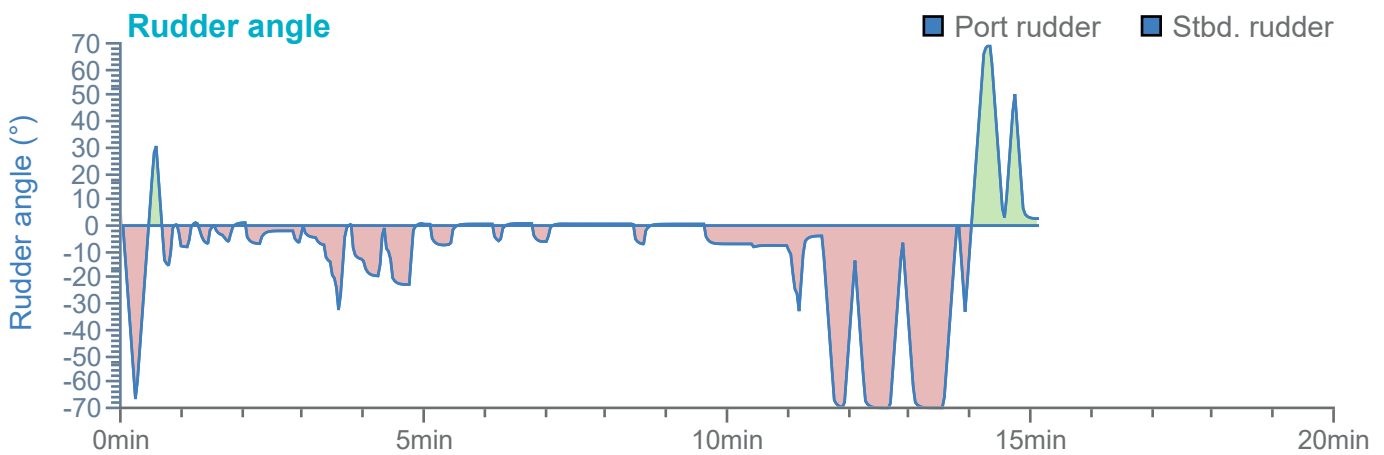
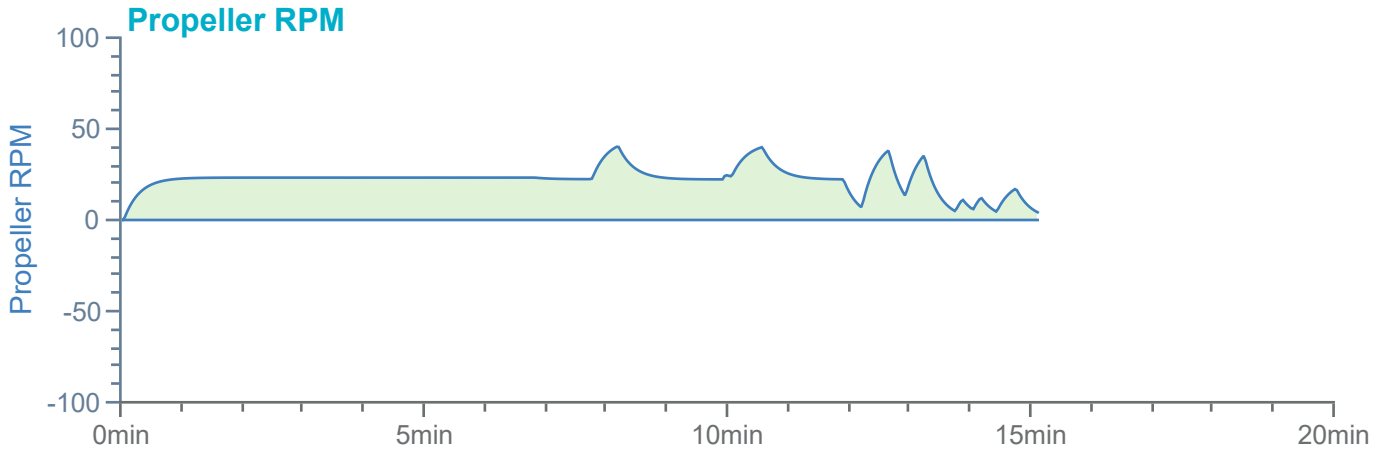


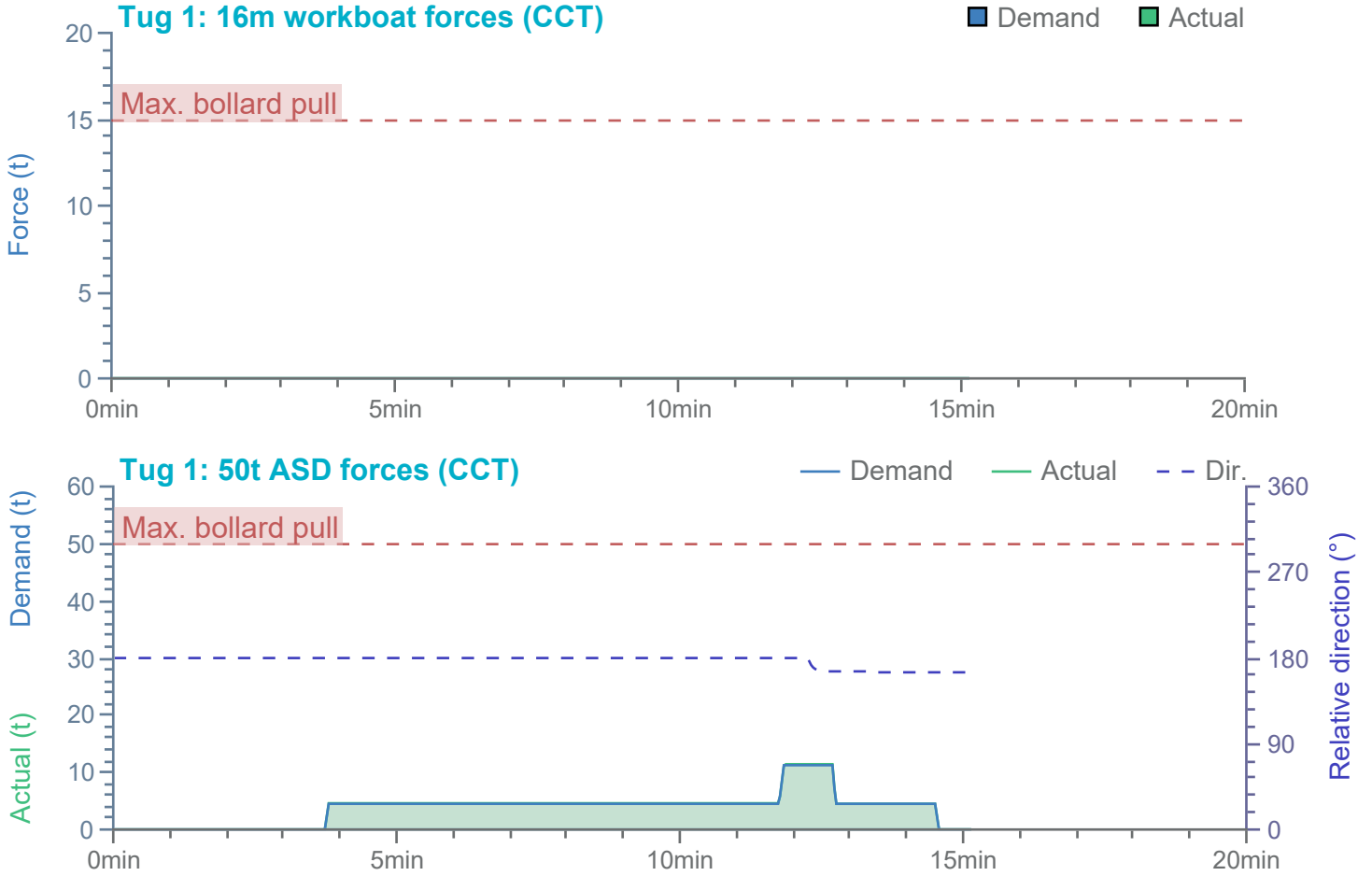
→ 1.99 kts

Ships plotted every 1 mins, highlight every 10 mins

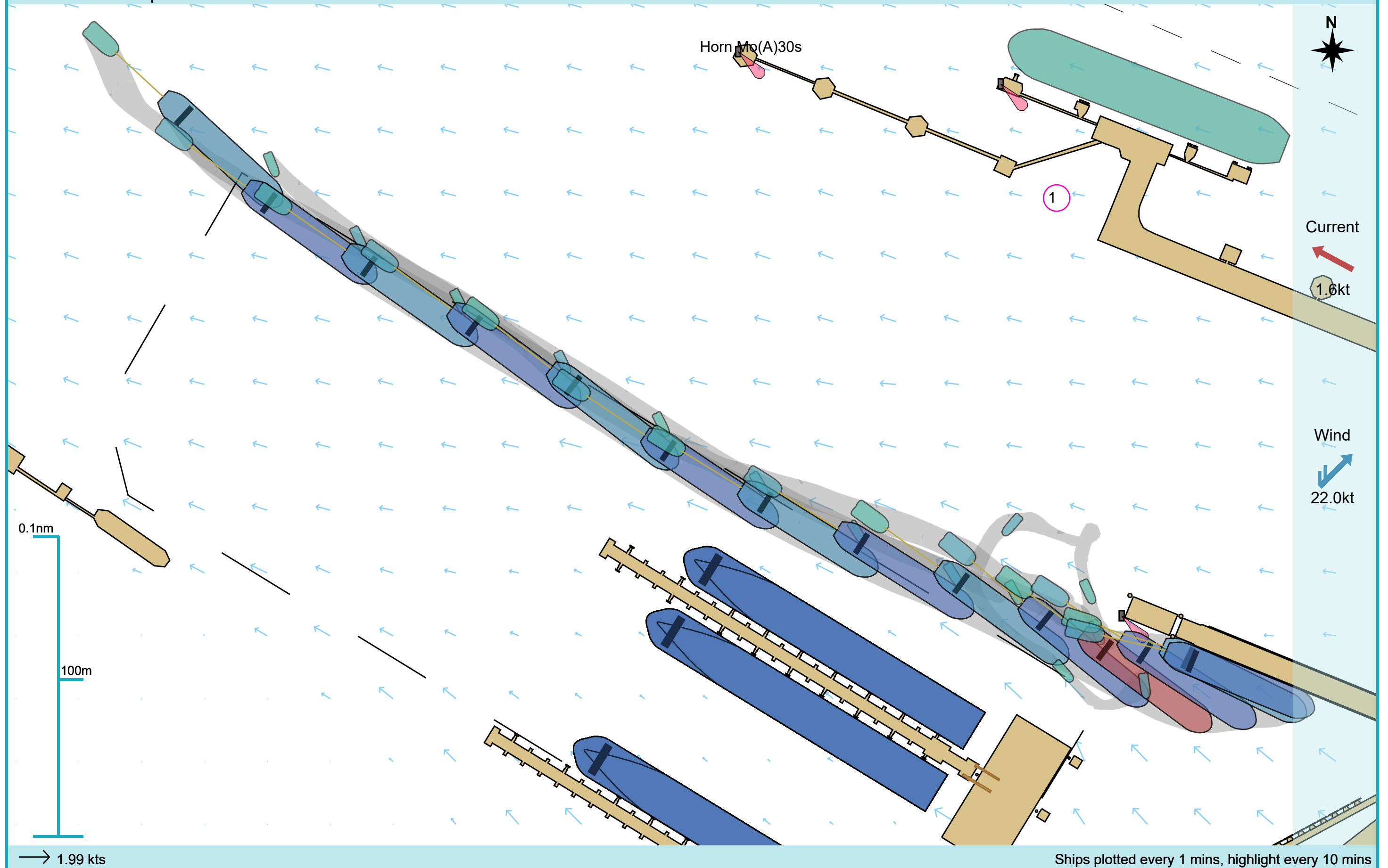


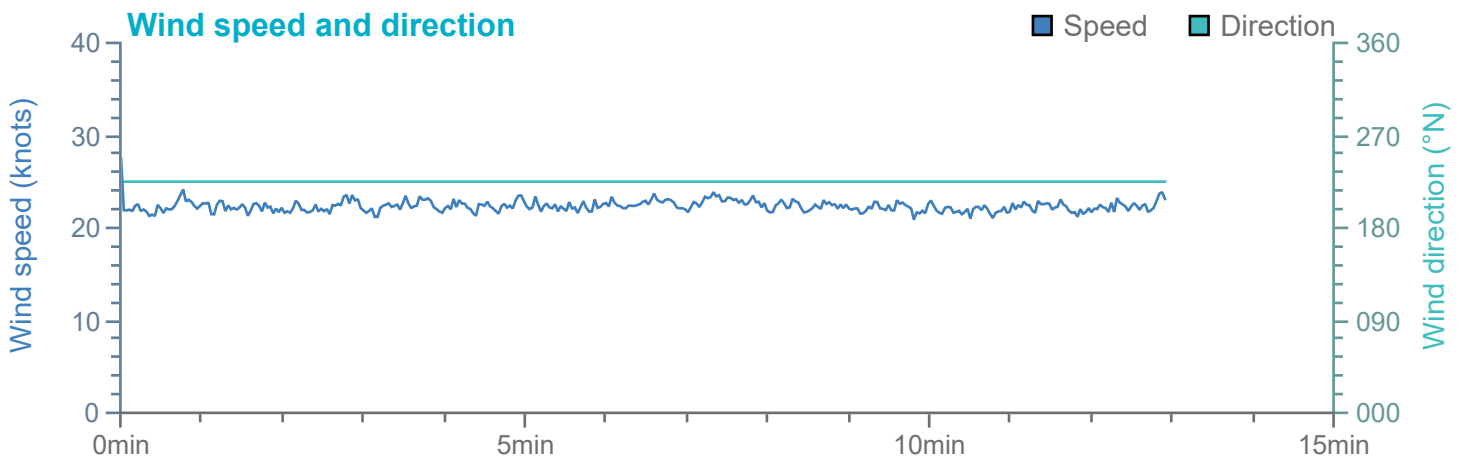
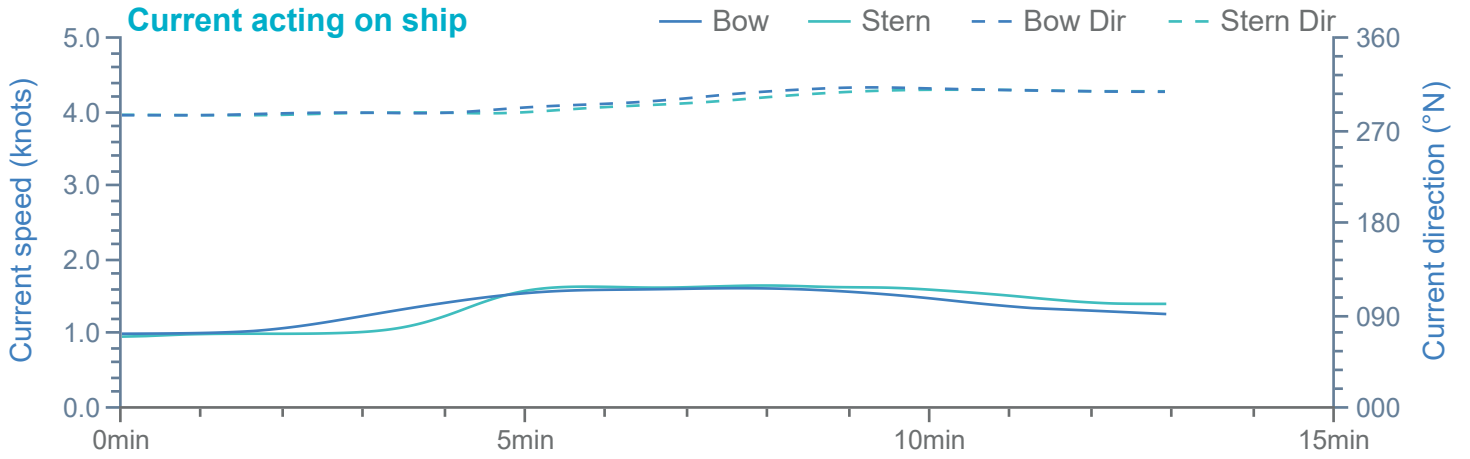


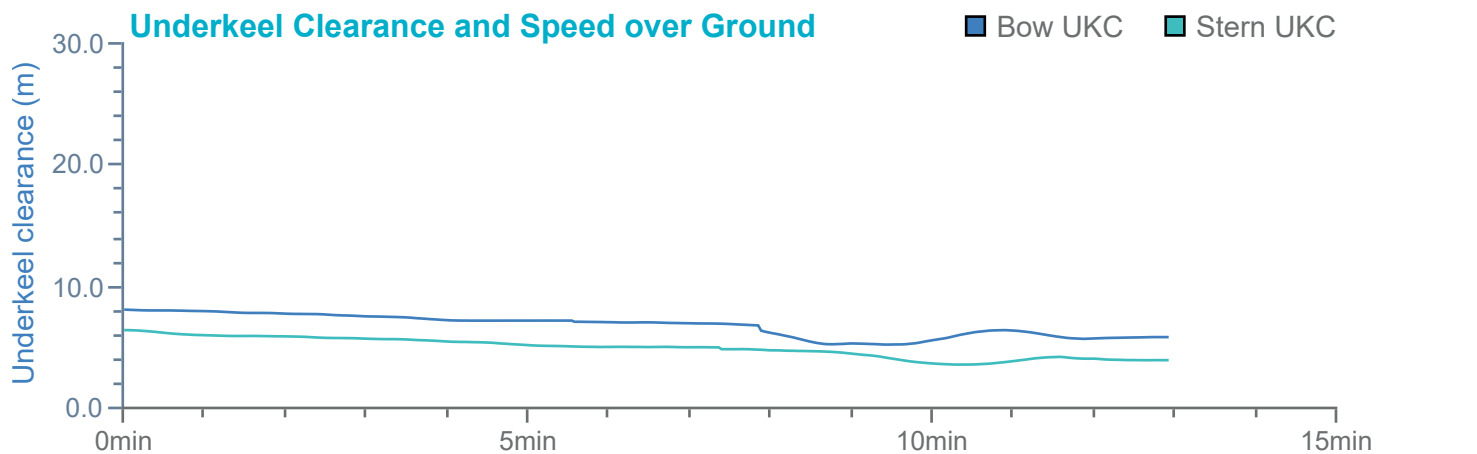
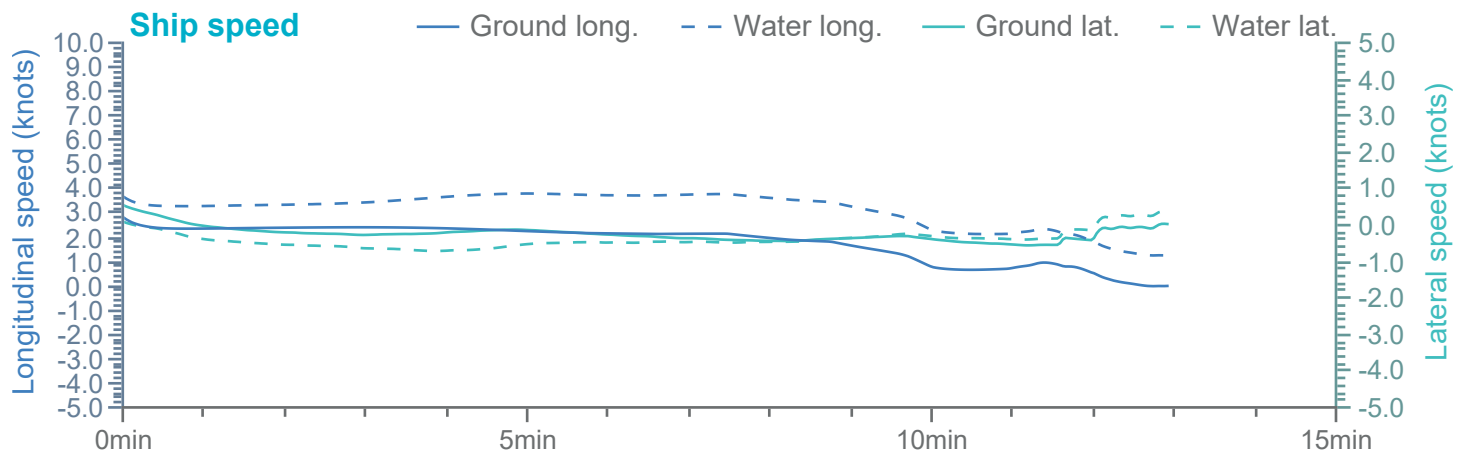
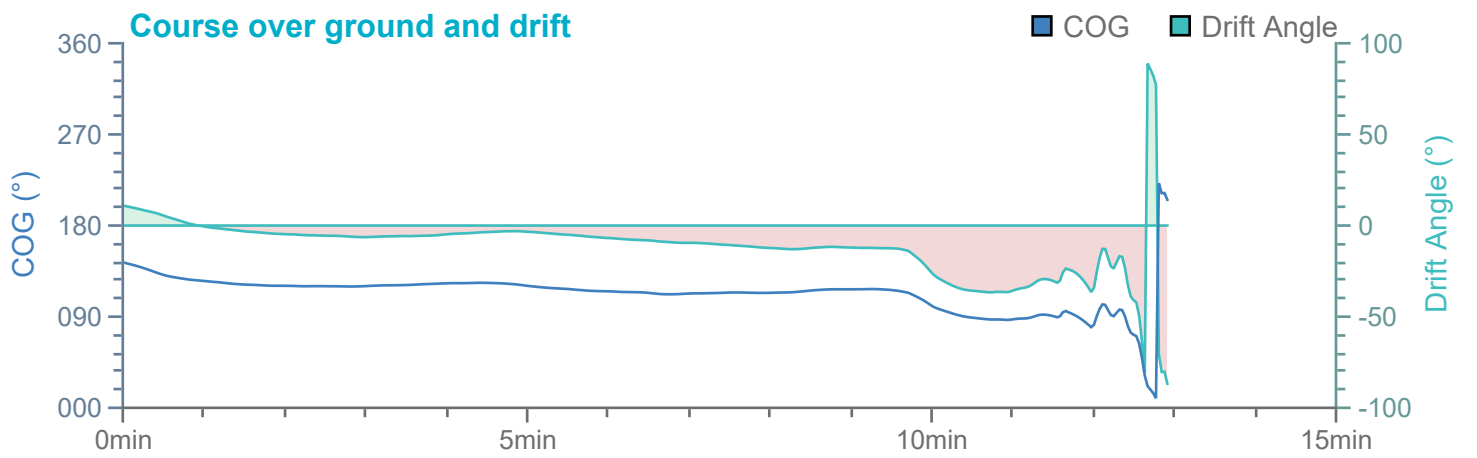
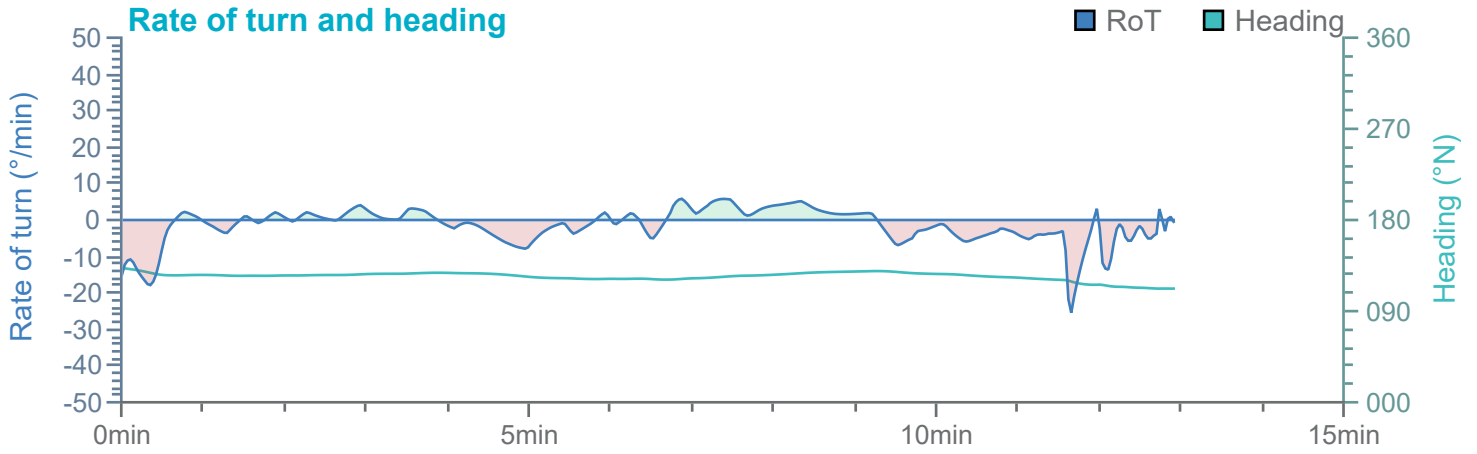


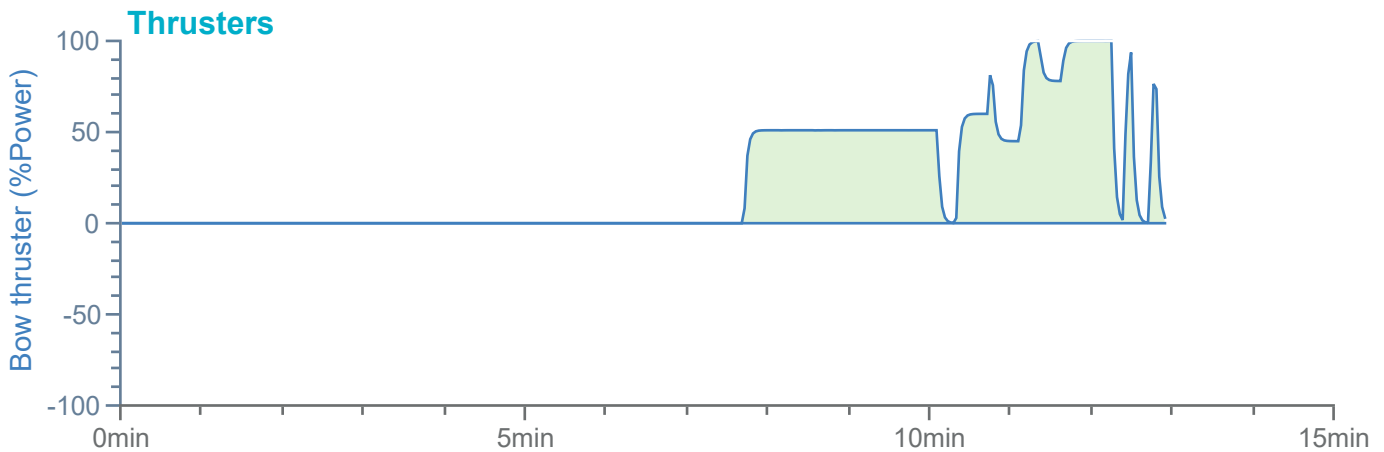
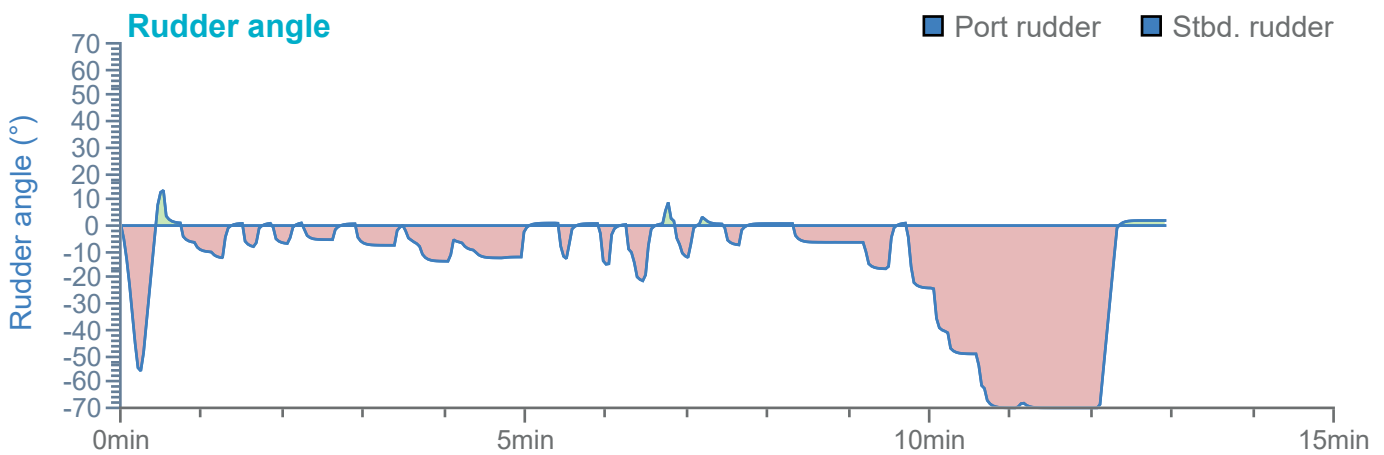
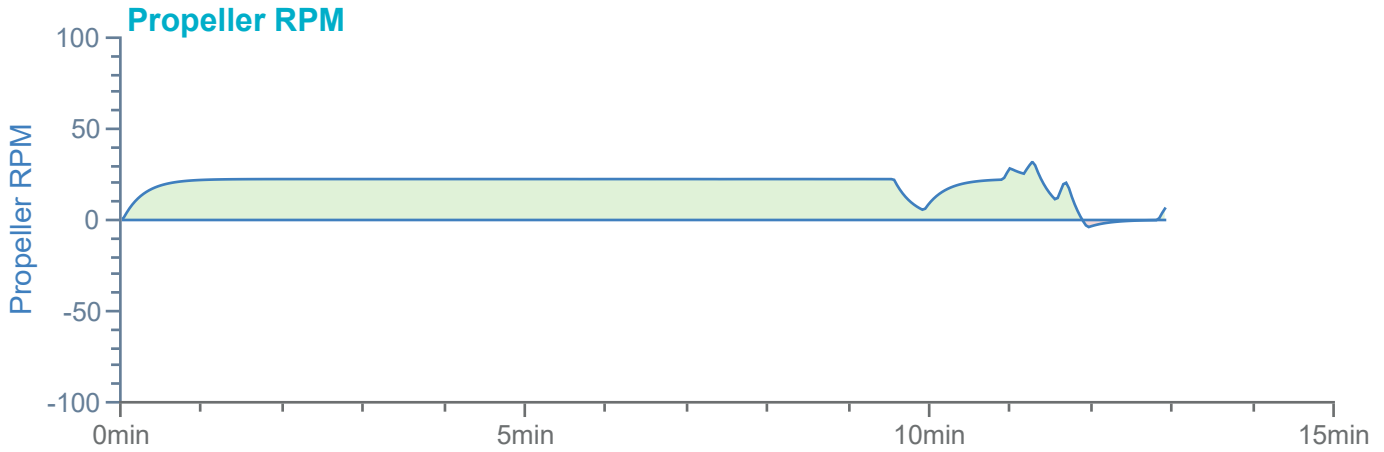


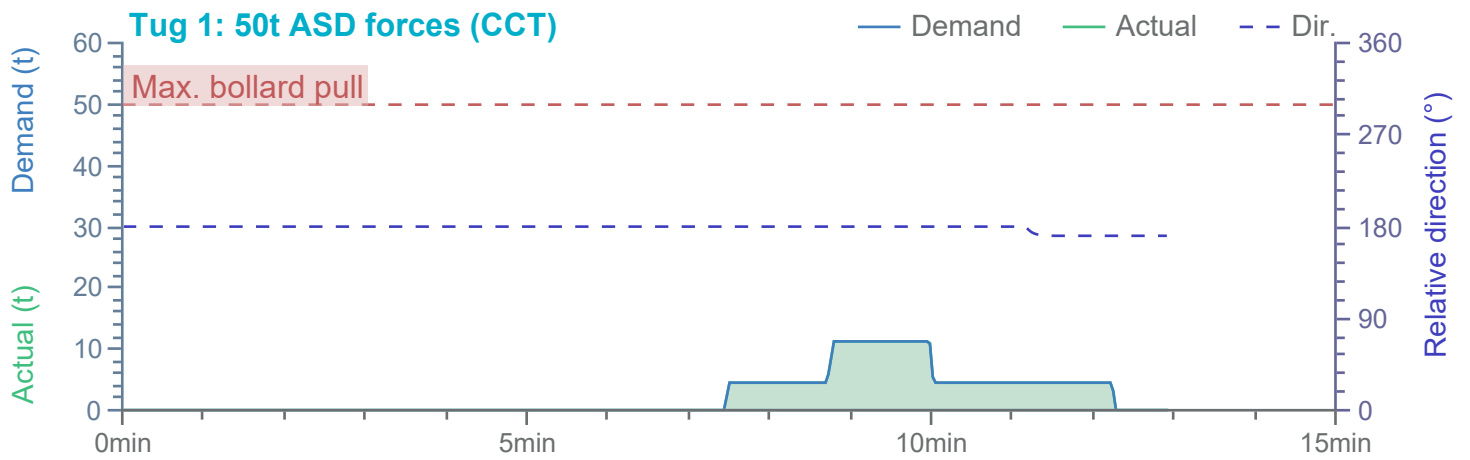
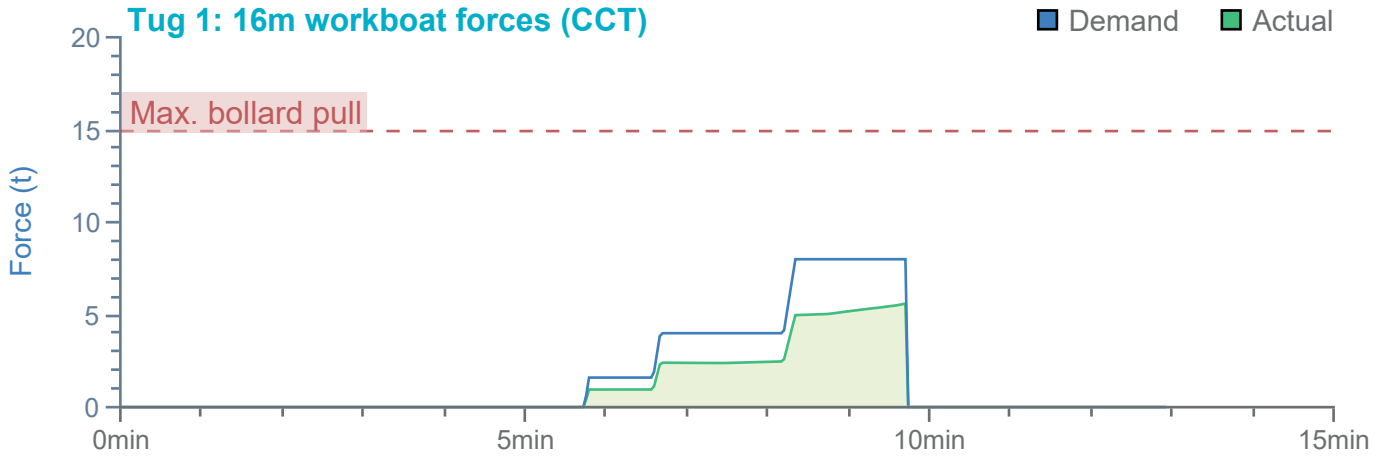
Manoeuvre track plot



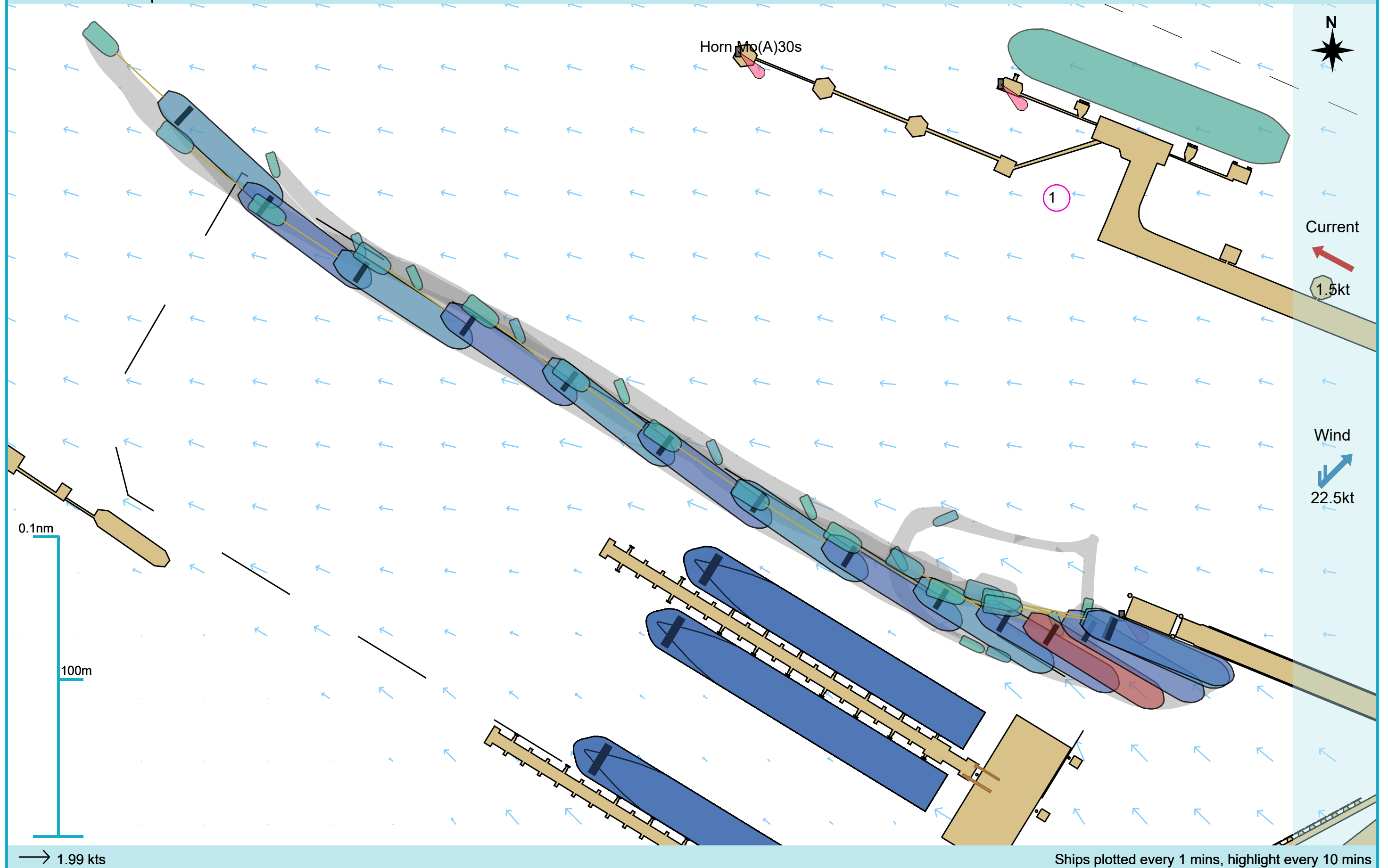






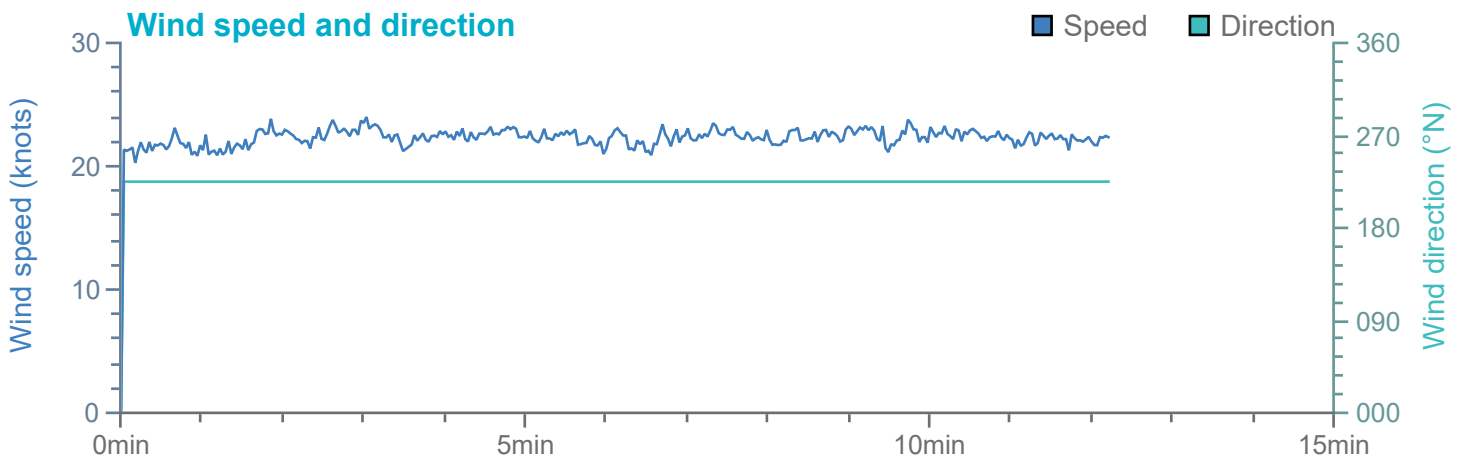
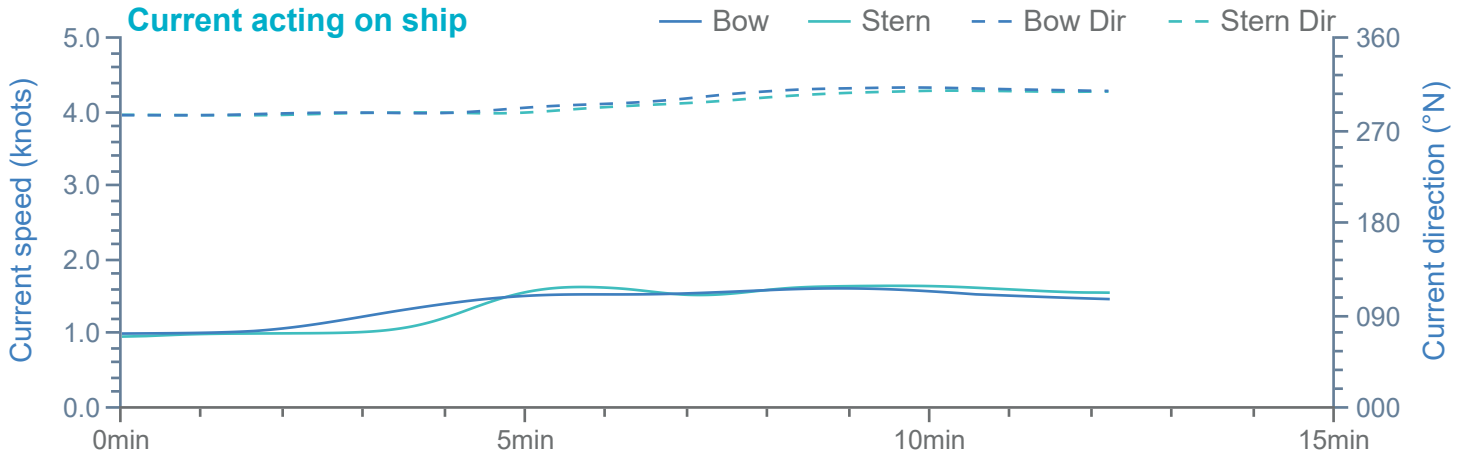


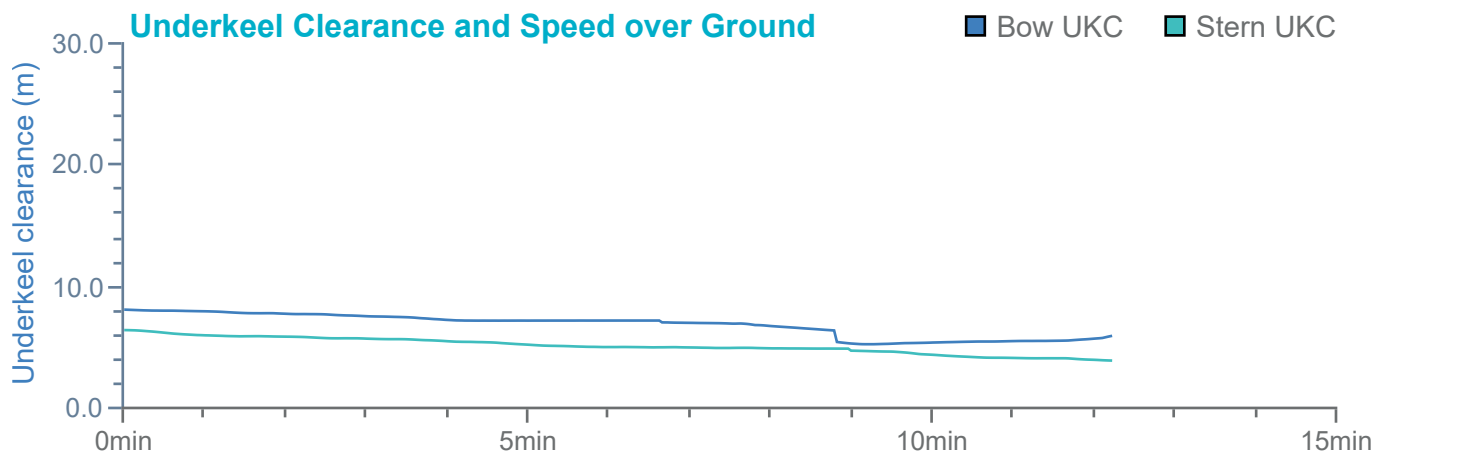
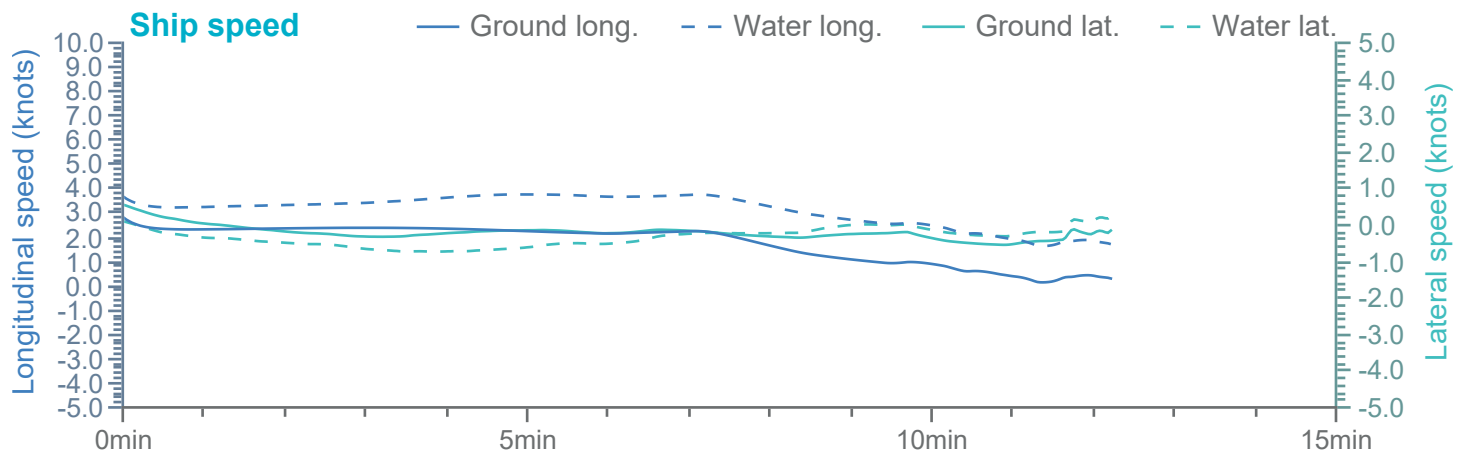
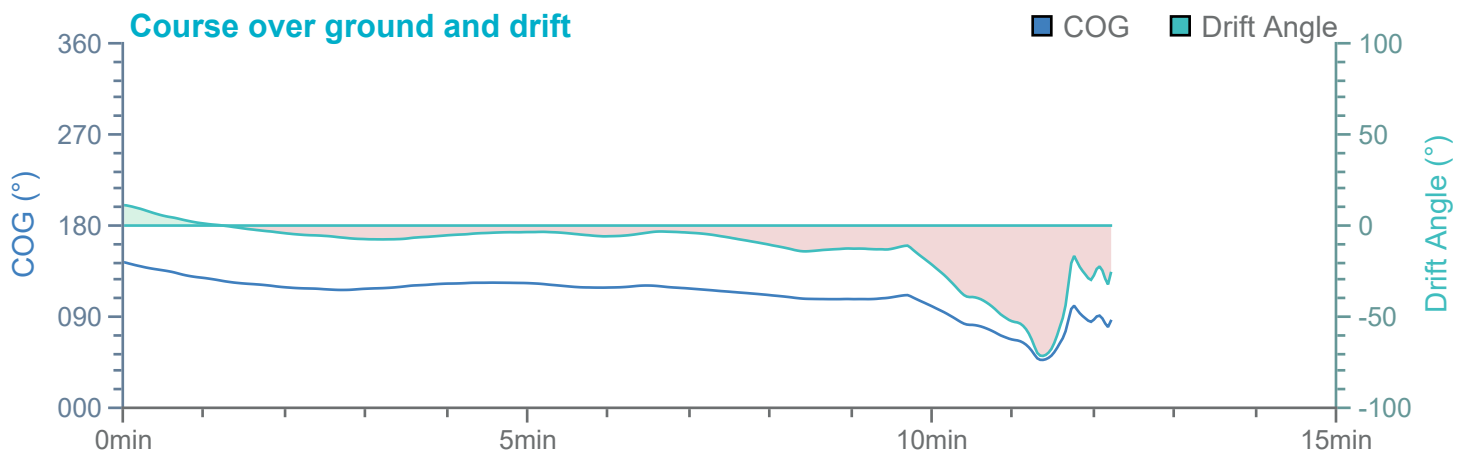
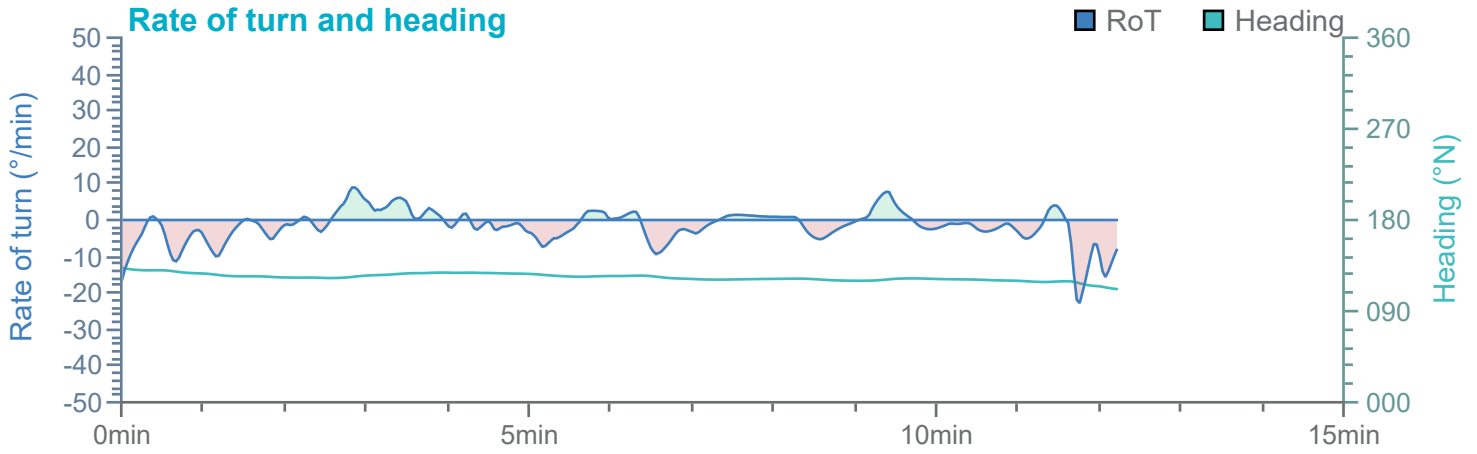
Manoeuvre track plot



→ 1.99 kts

Ships plotted every 1 mins, highlight every 10 mins



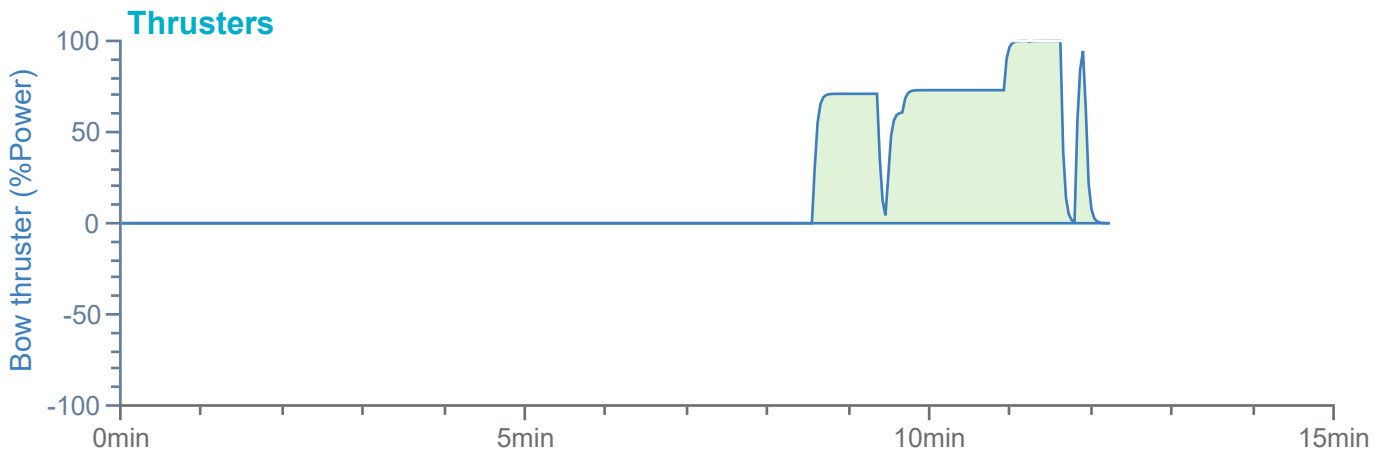
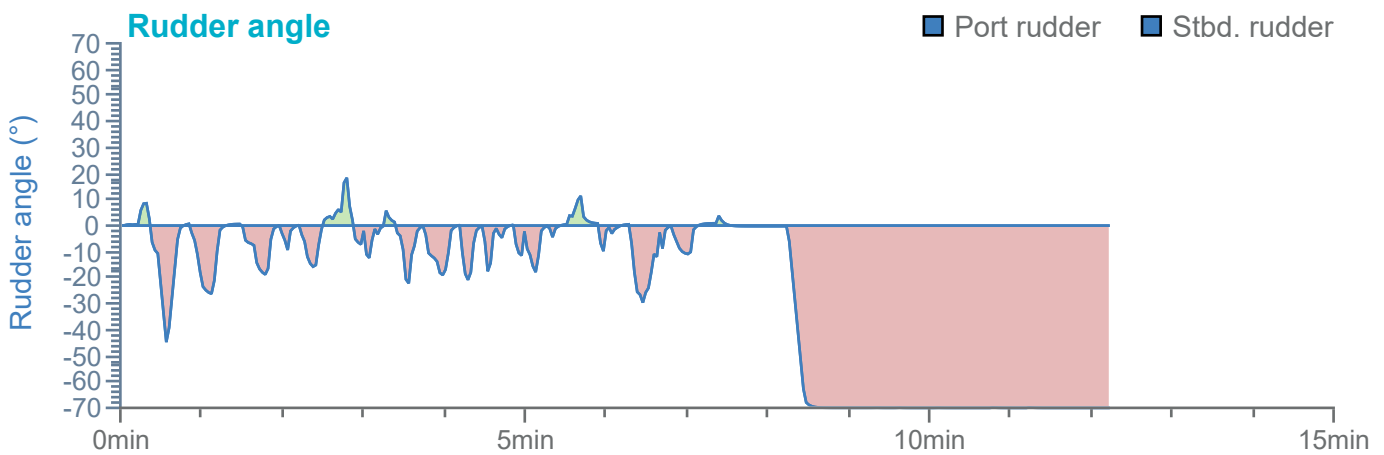
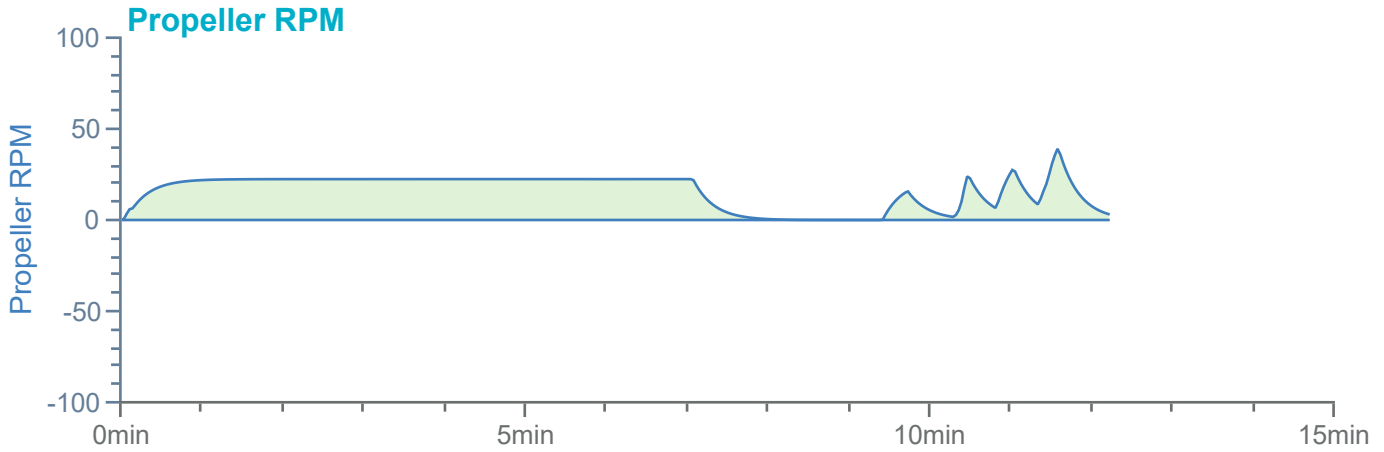


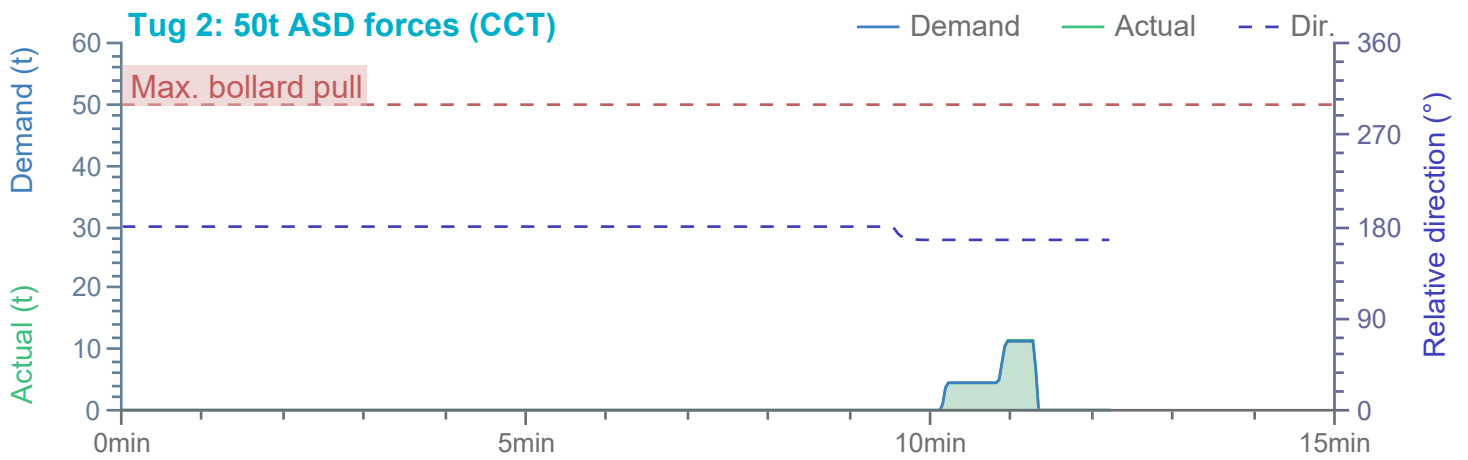
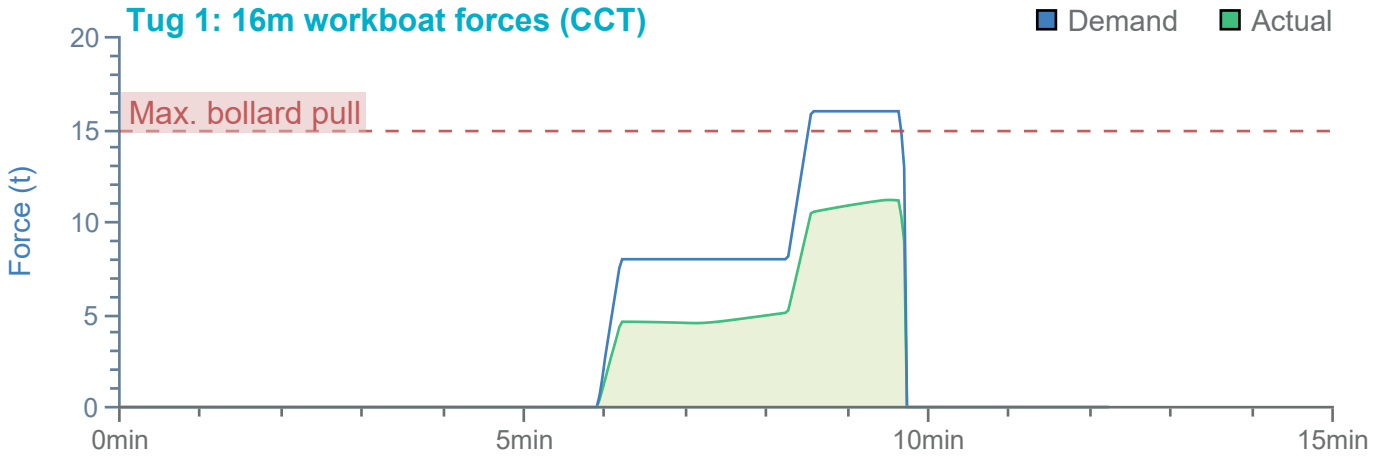
Overview

Environment

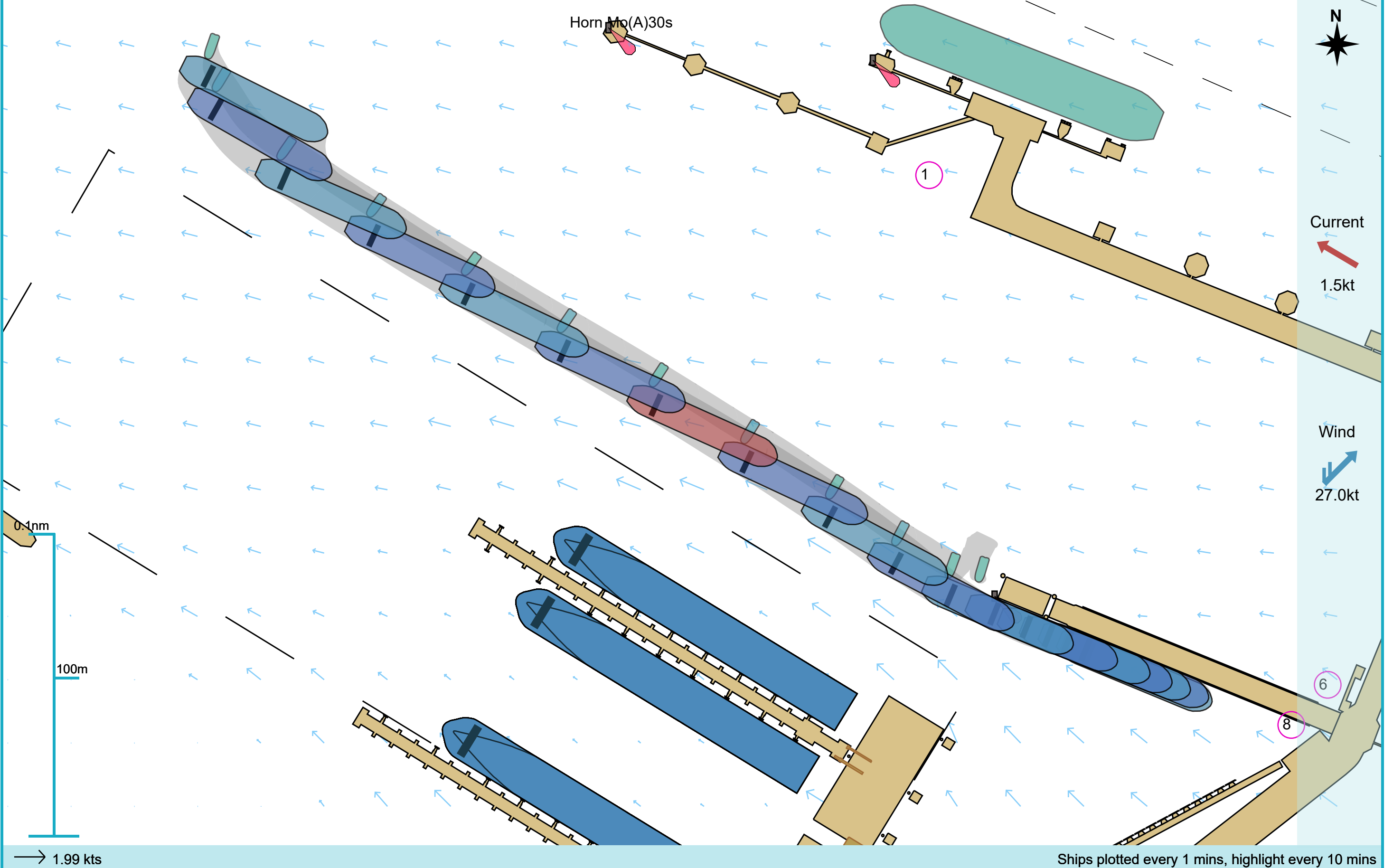
100m x 18m Product Tanker

Tugs

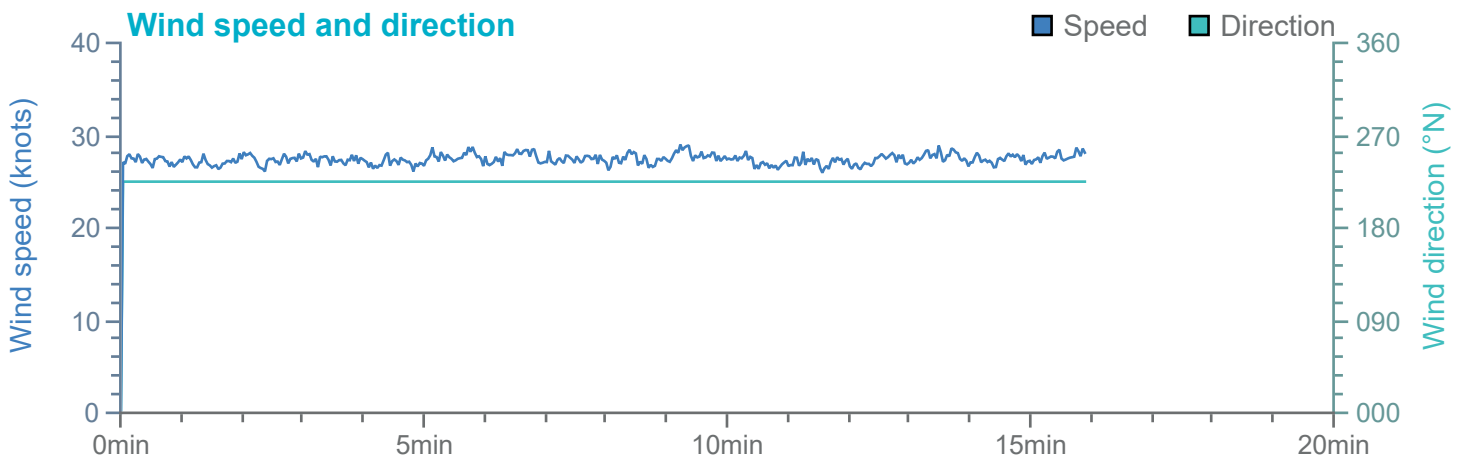
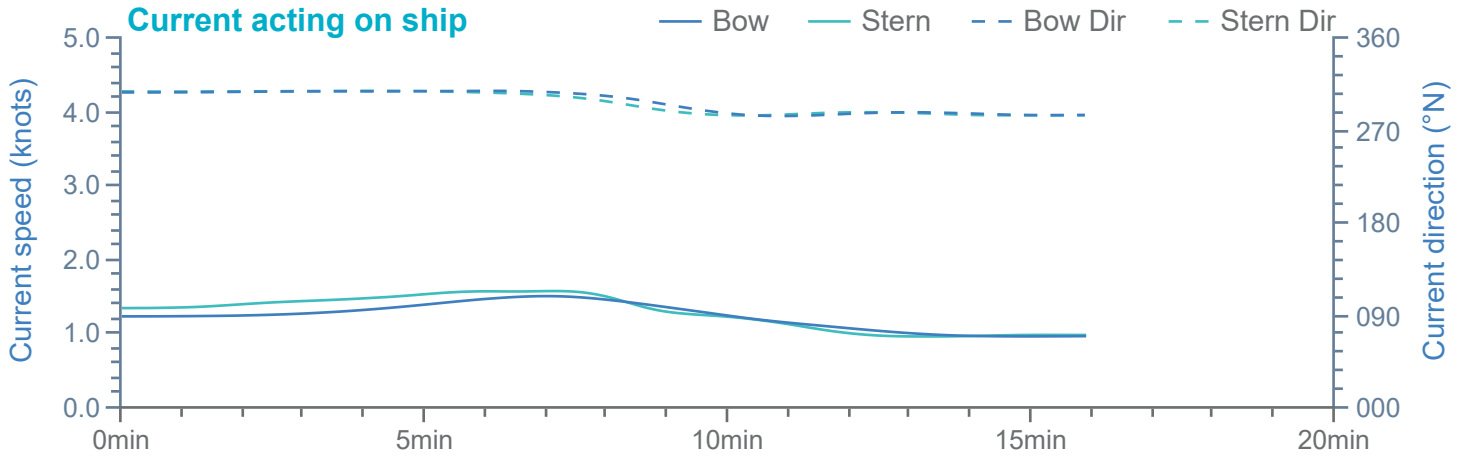




Manoeuvre track plot



Ships plotted every 1 mins, highlight every 10 mins

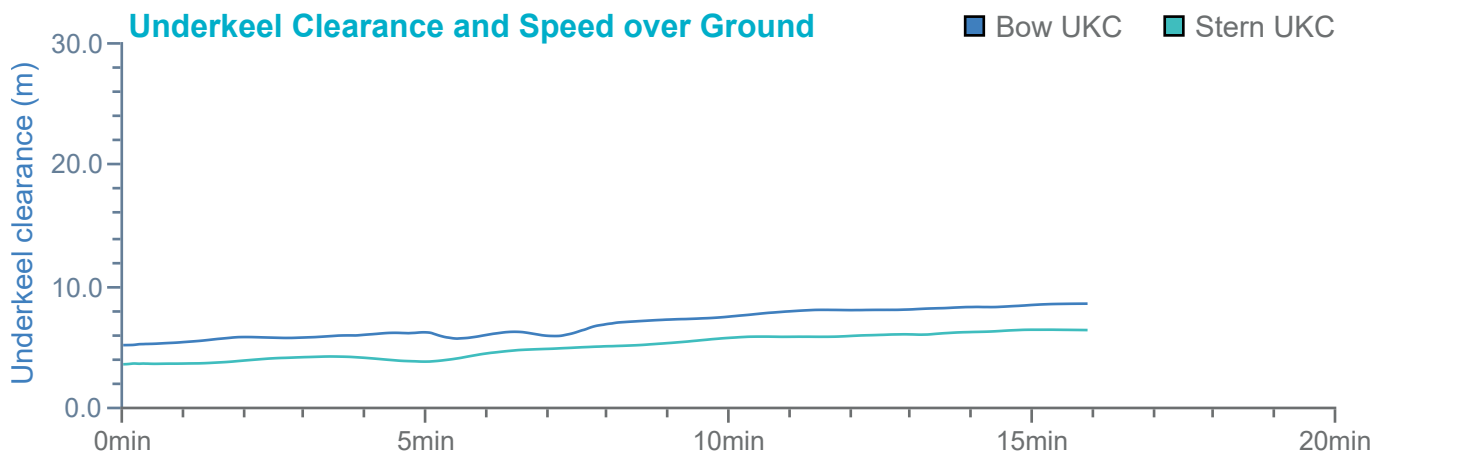
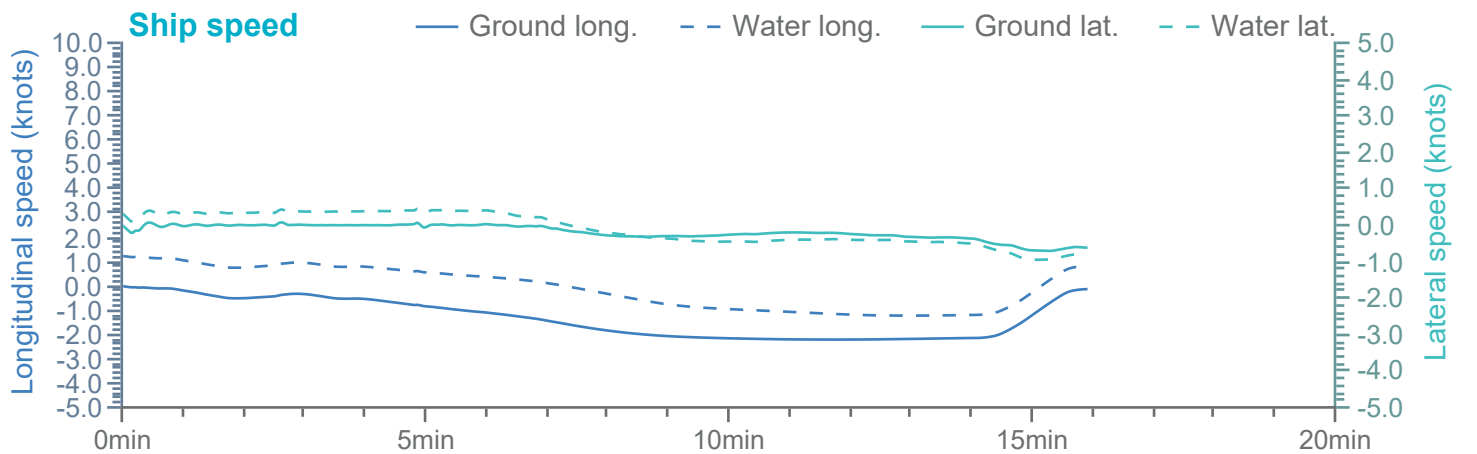
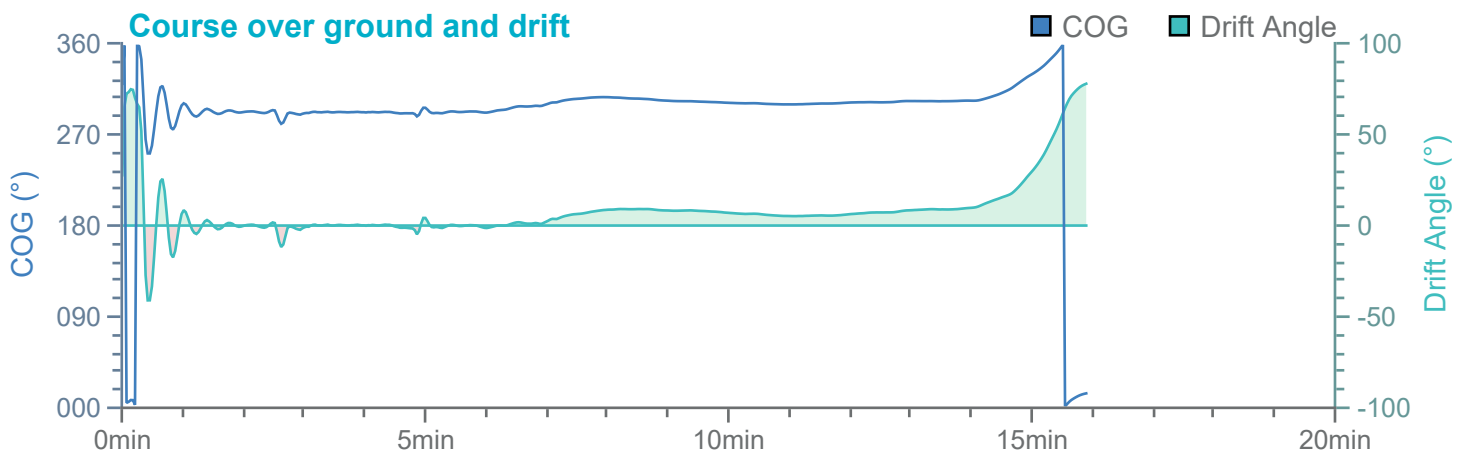
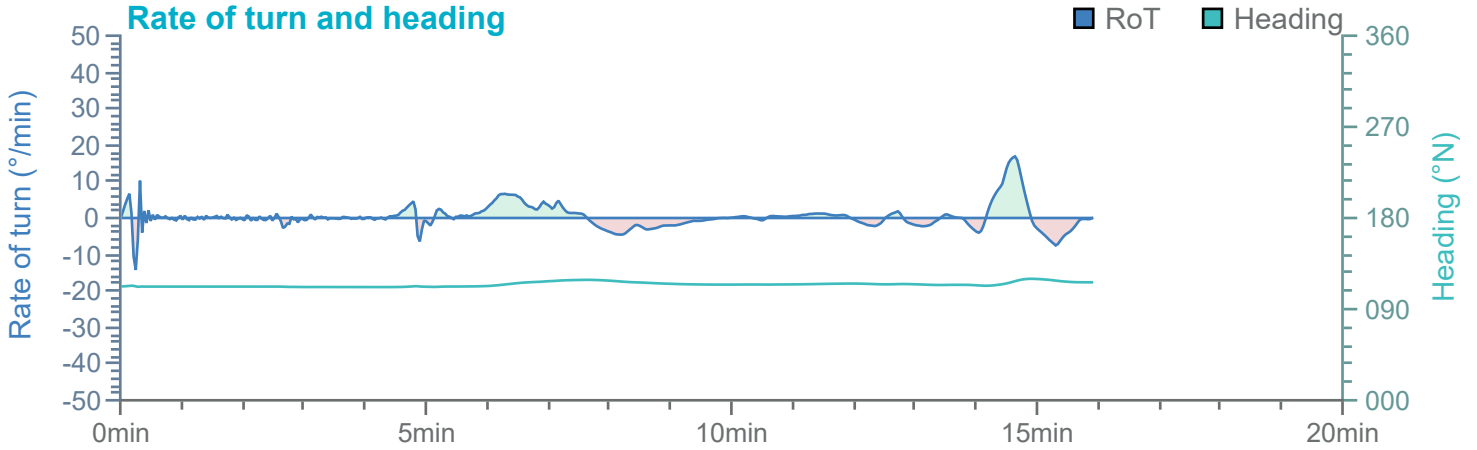


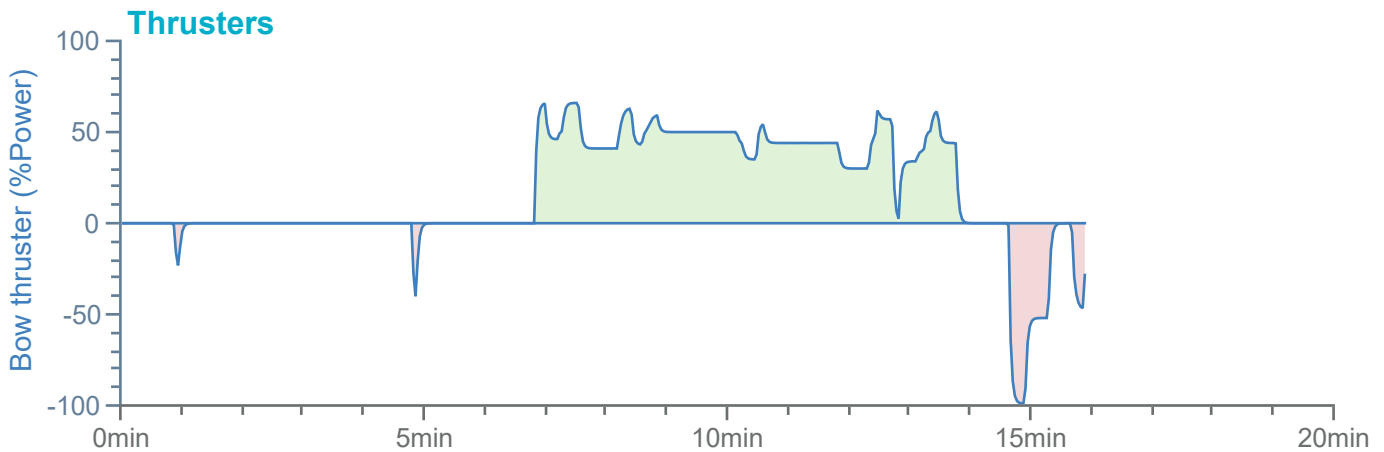
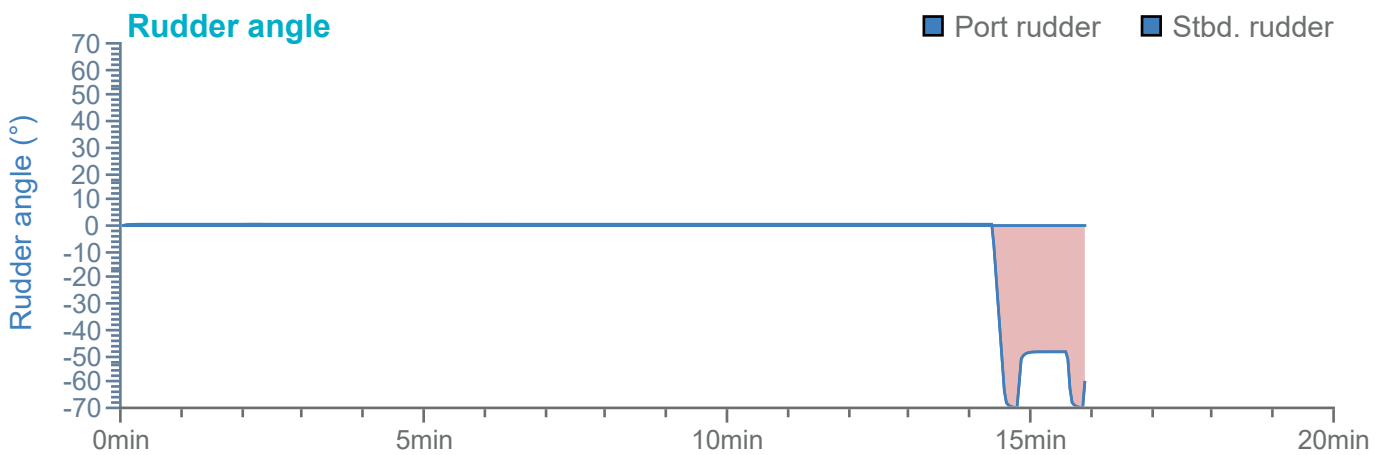
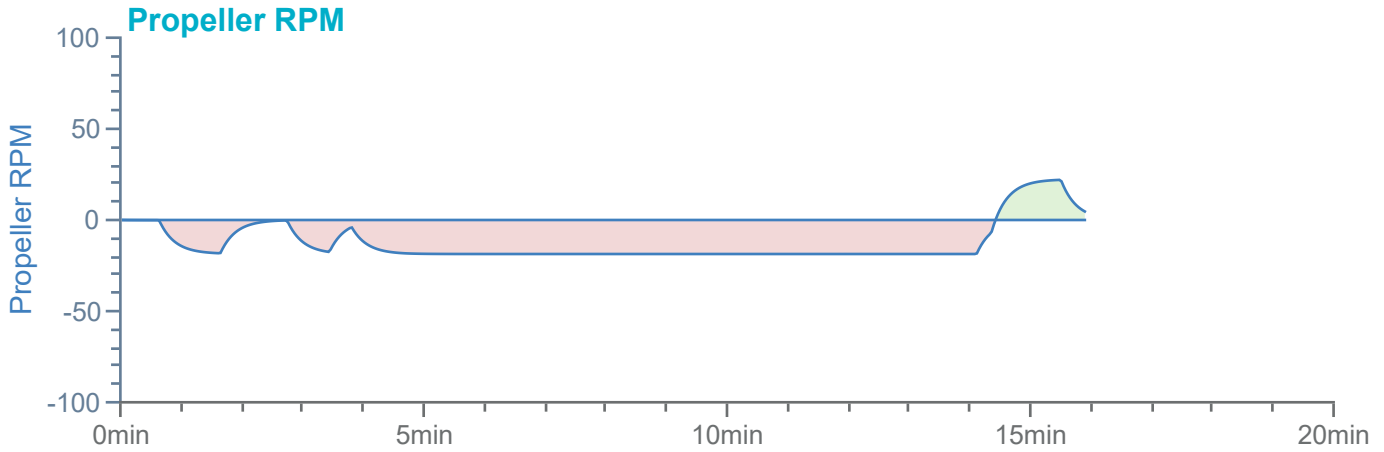
Overview

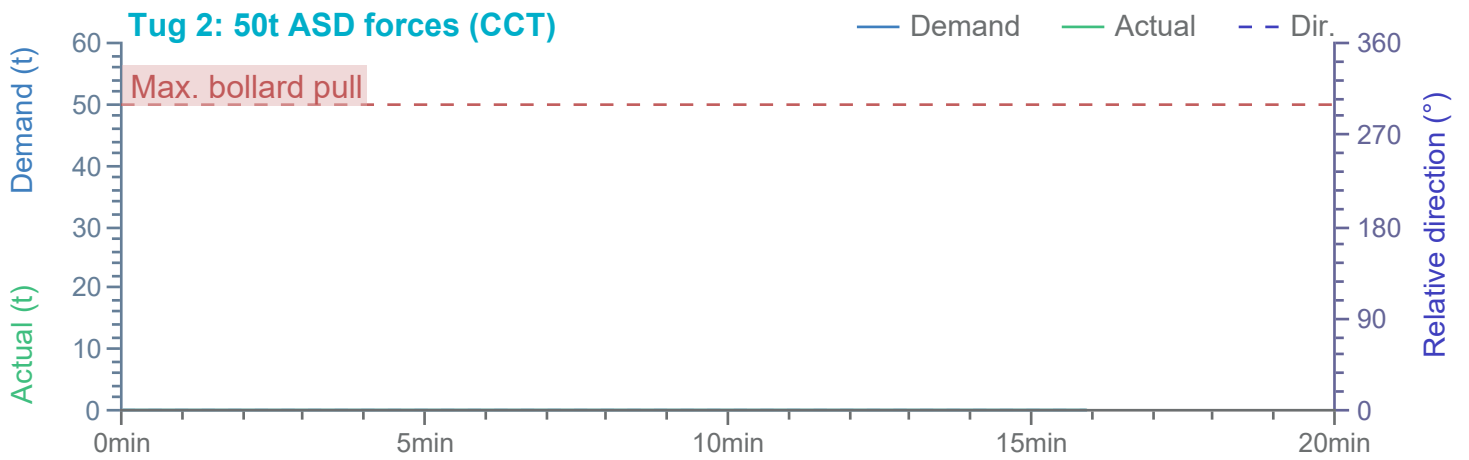
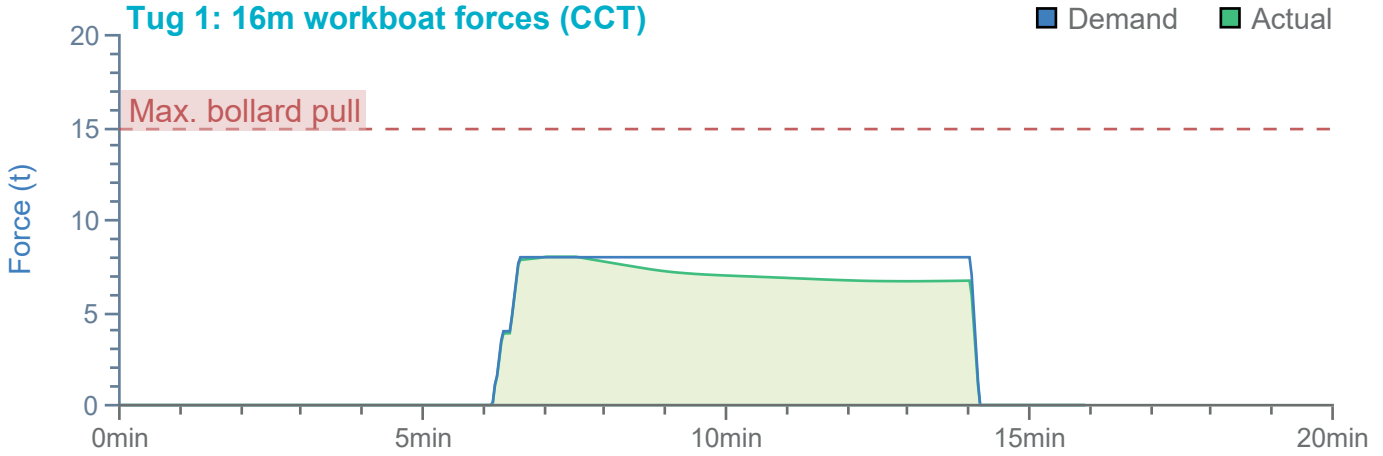
Environment

100m x 18m Product Tanker

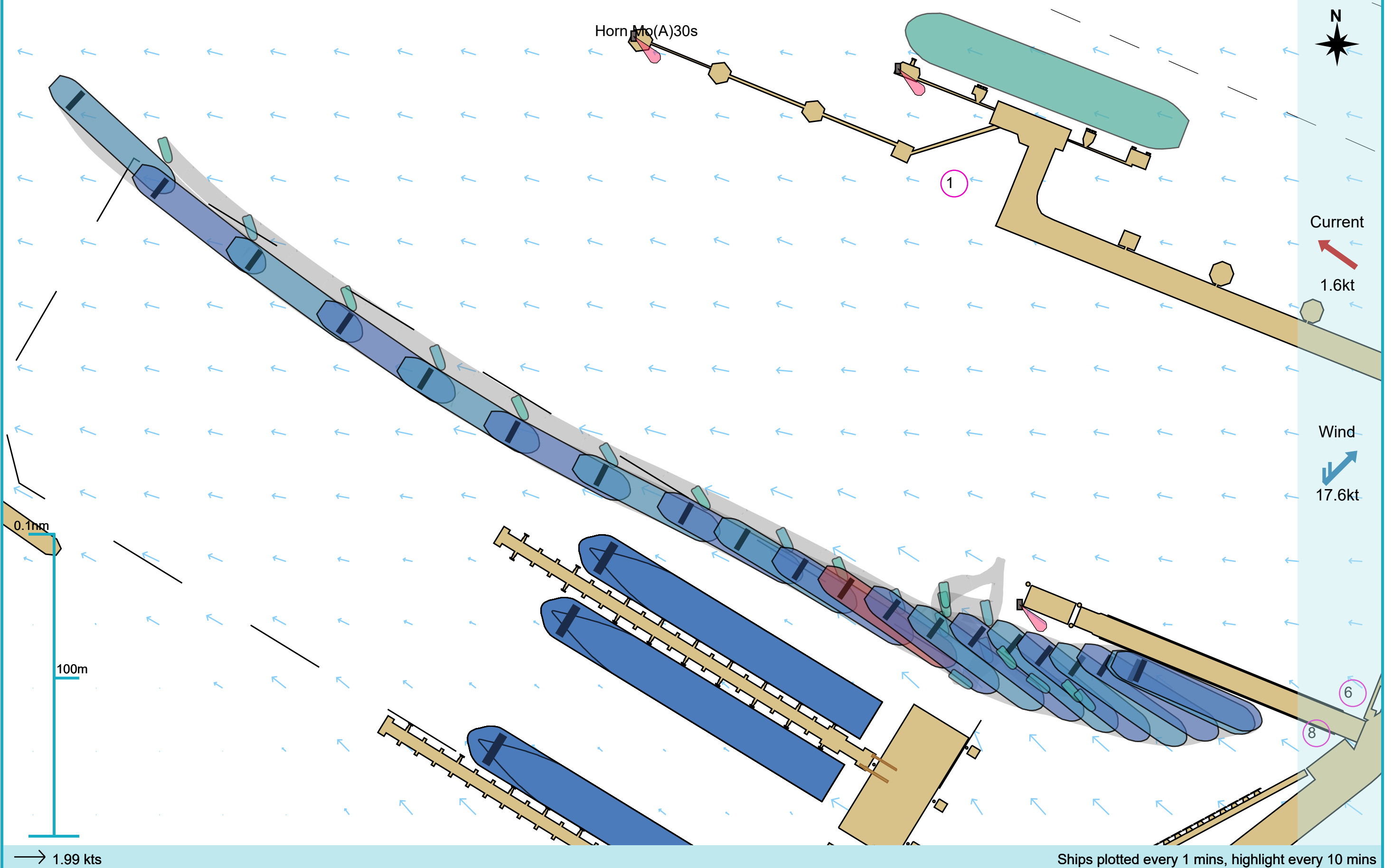
Tugs





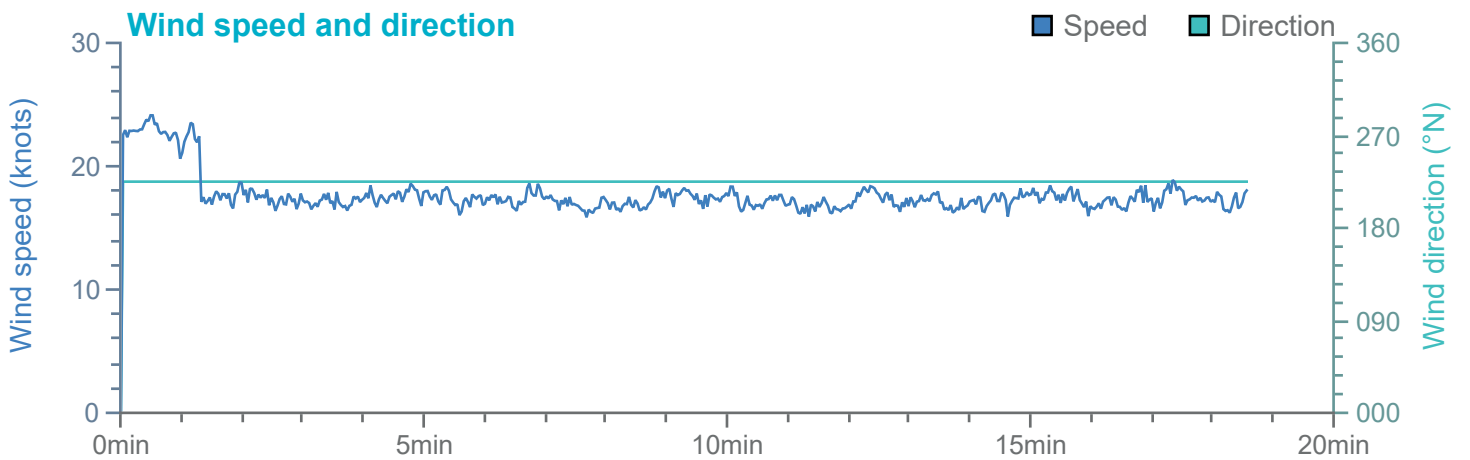
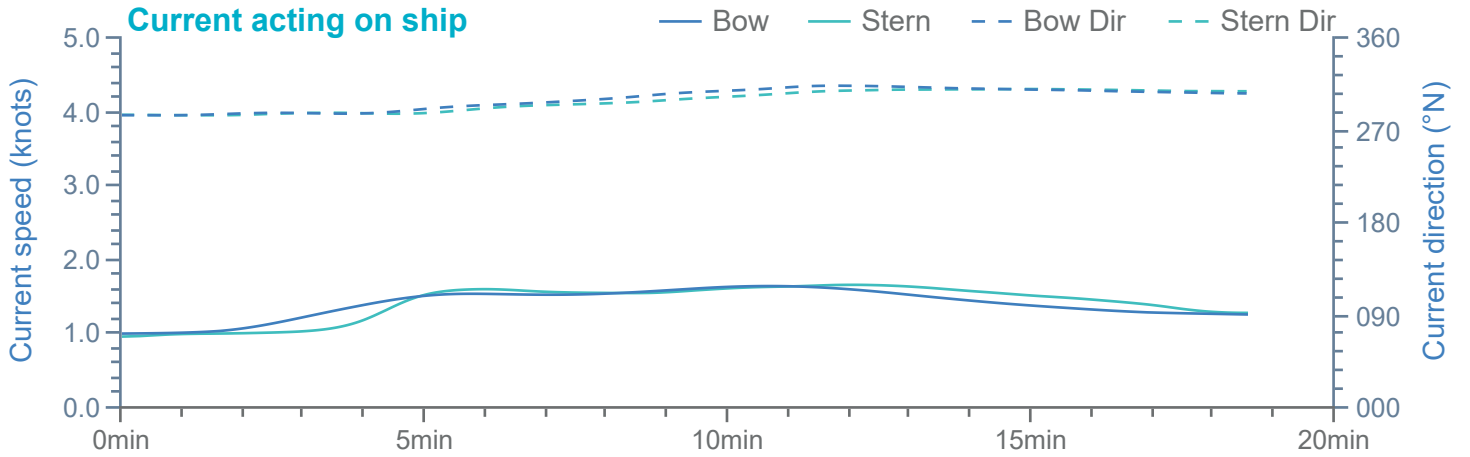


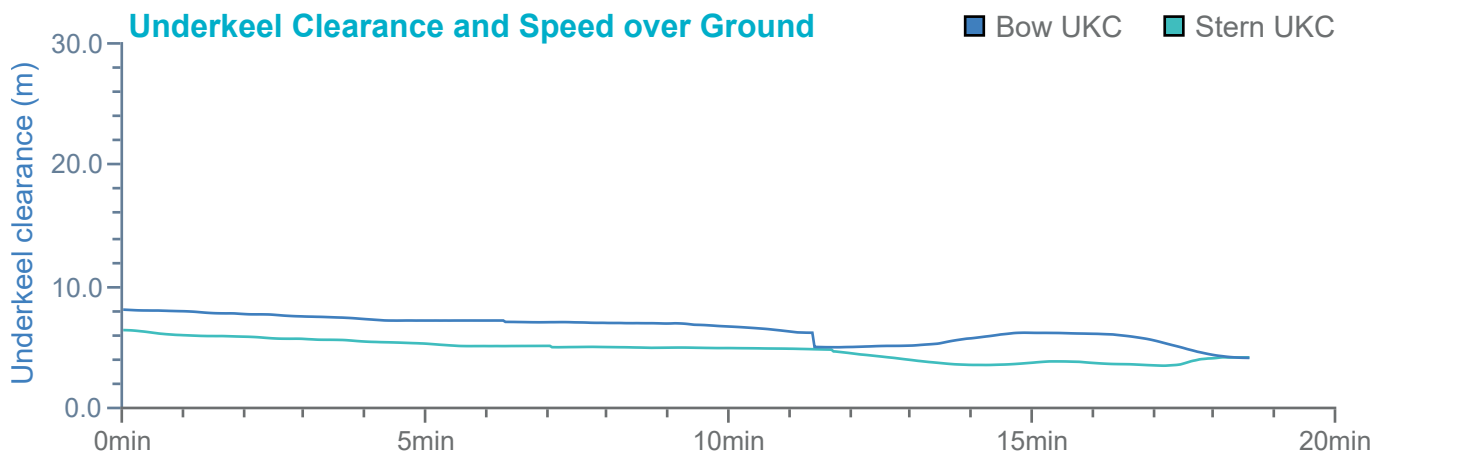
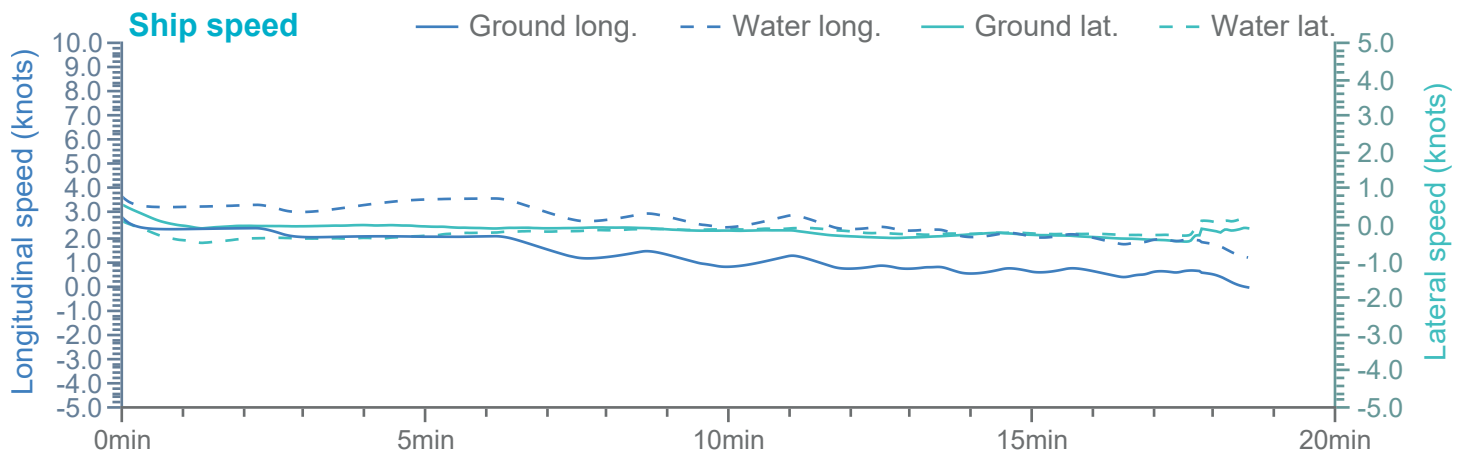
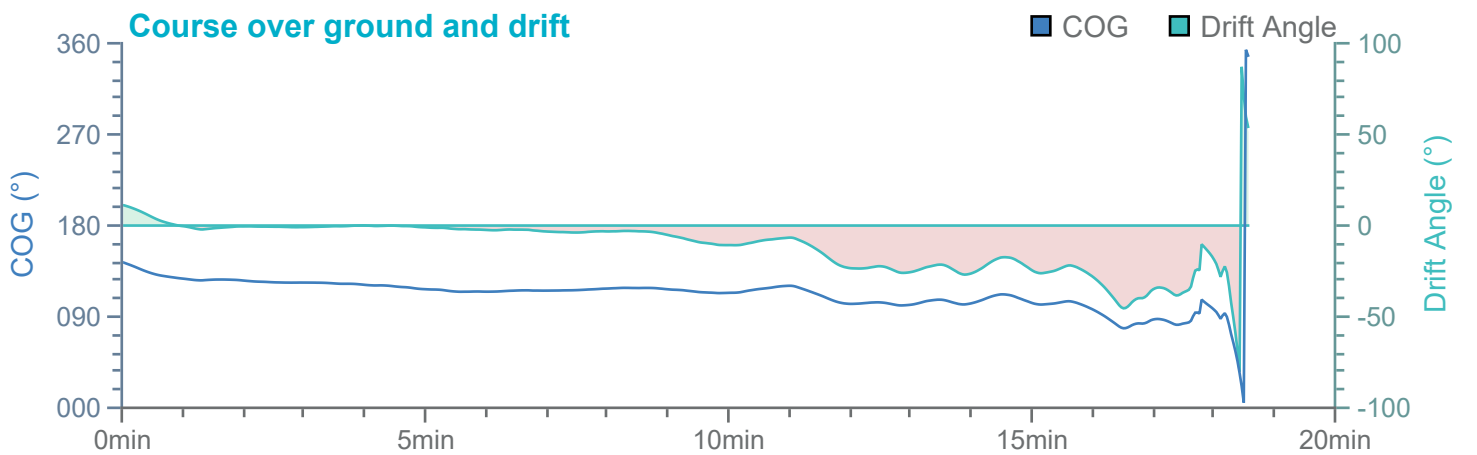
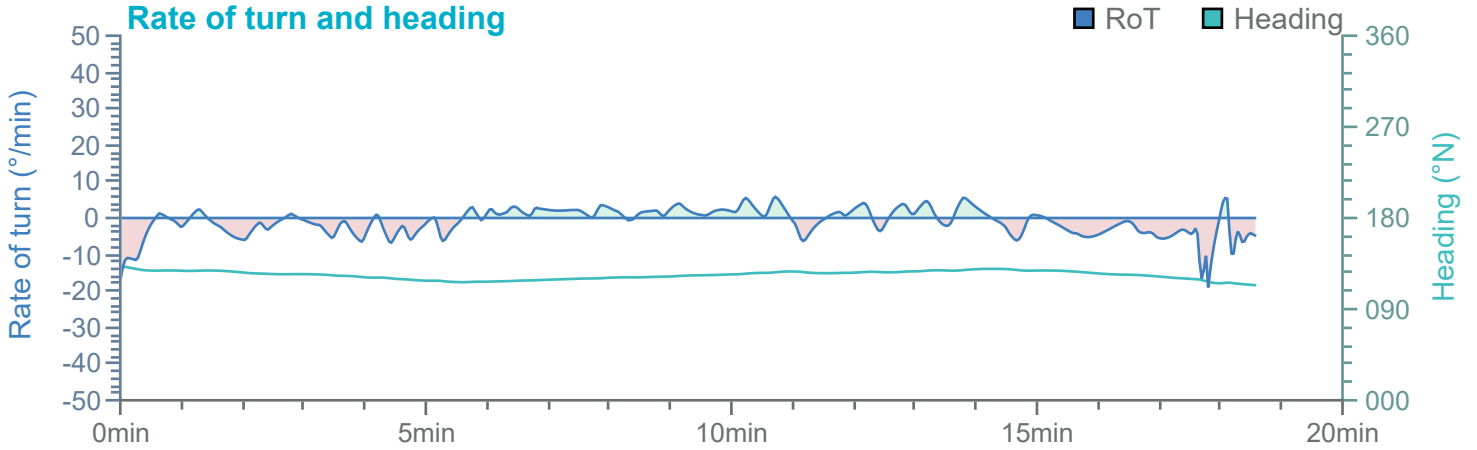
Manoeuvre track plot



→ 1.99 kts

Ships plotted every 1 mins, highlight every 10 mins



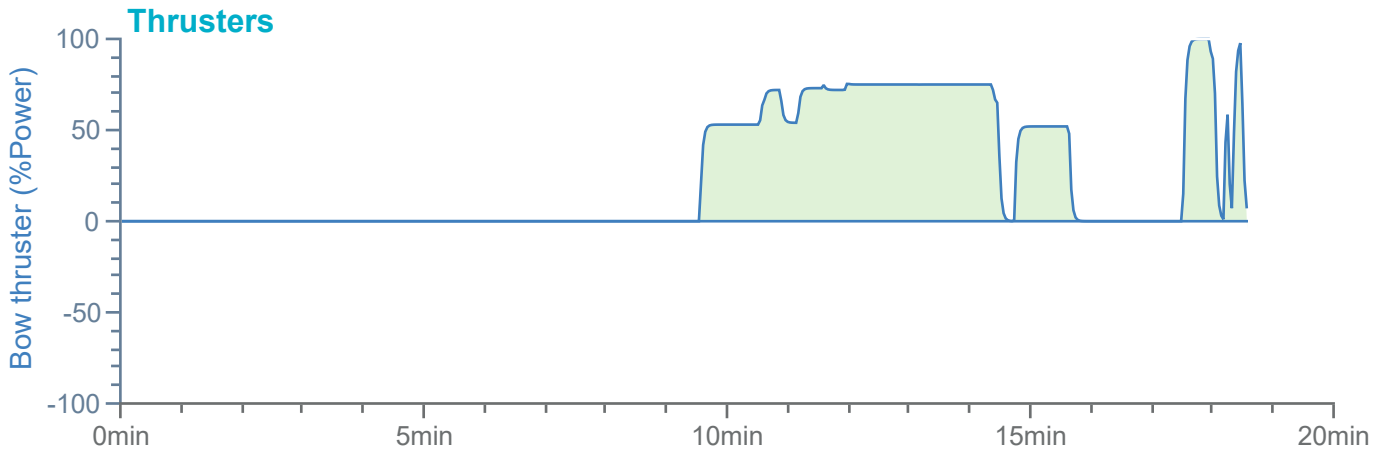
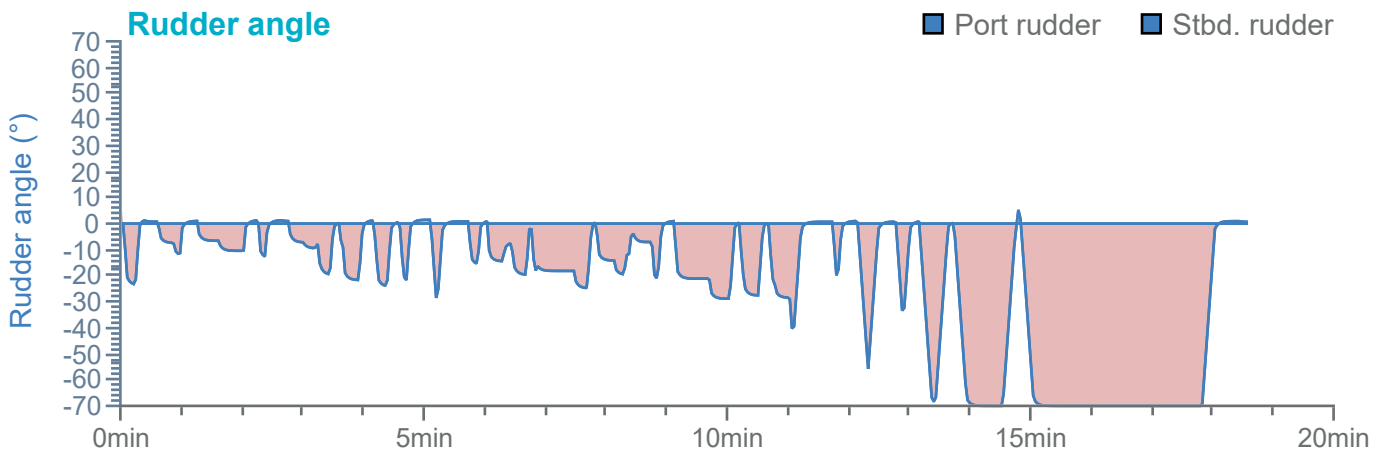
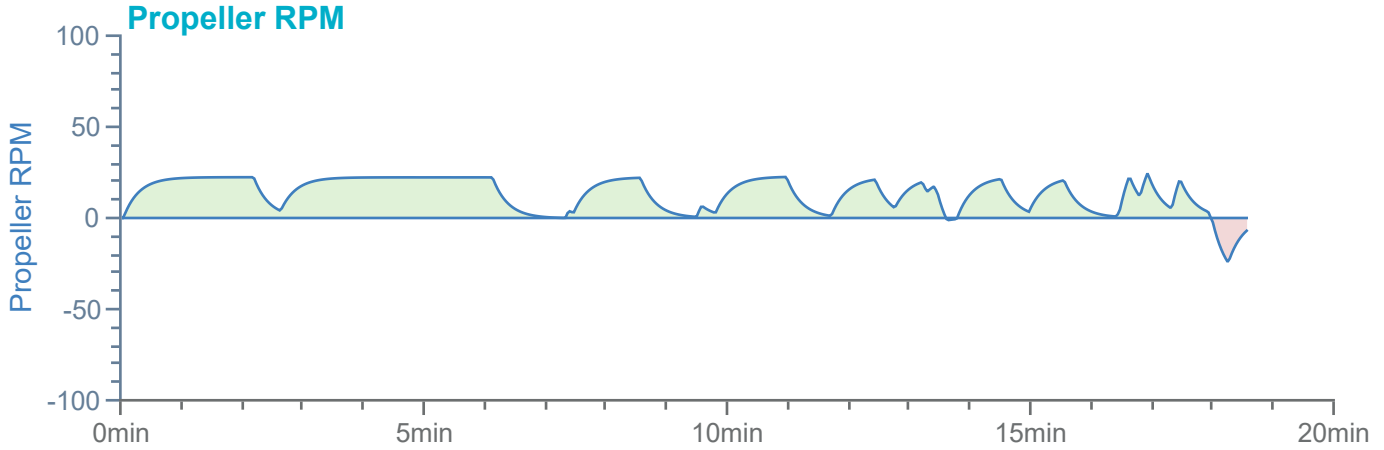


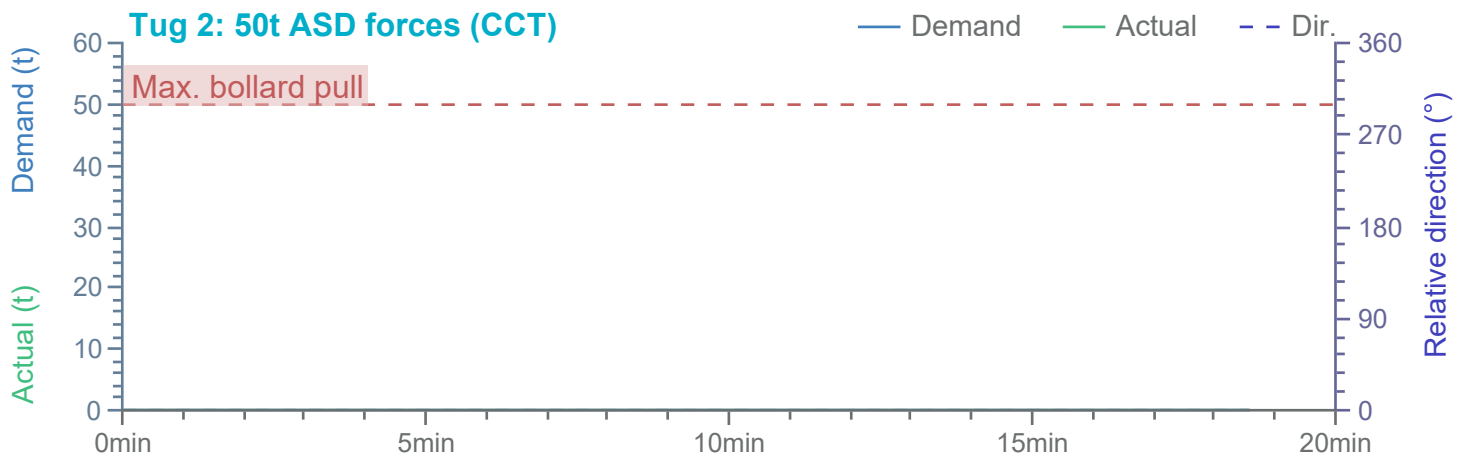
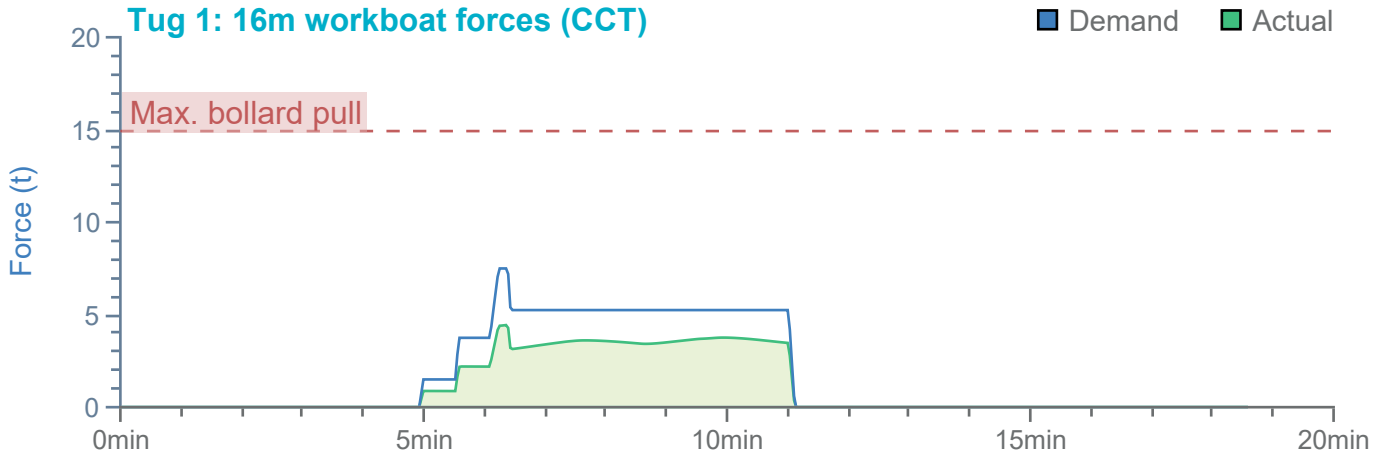
Overview

Environment

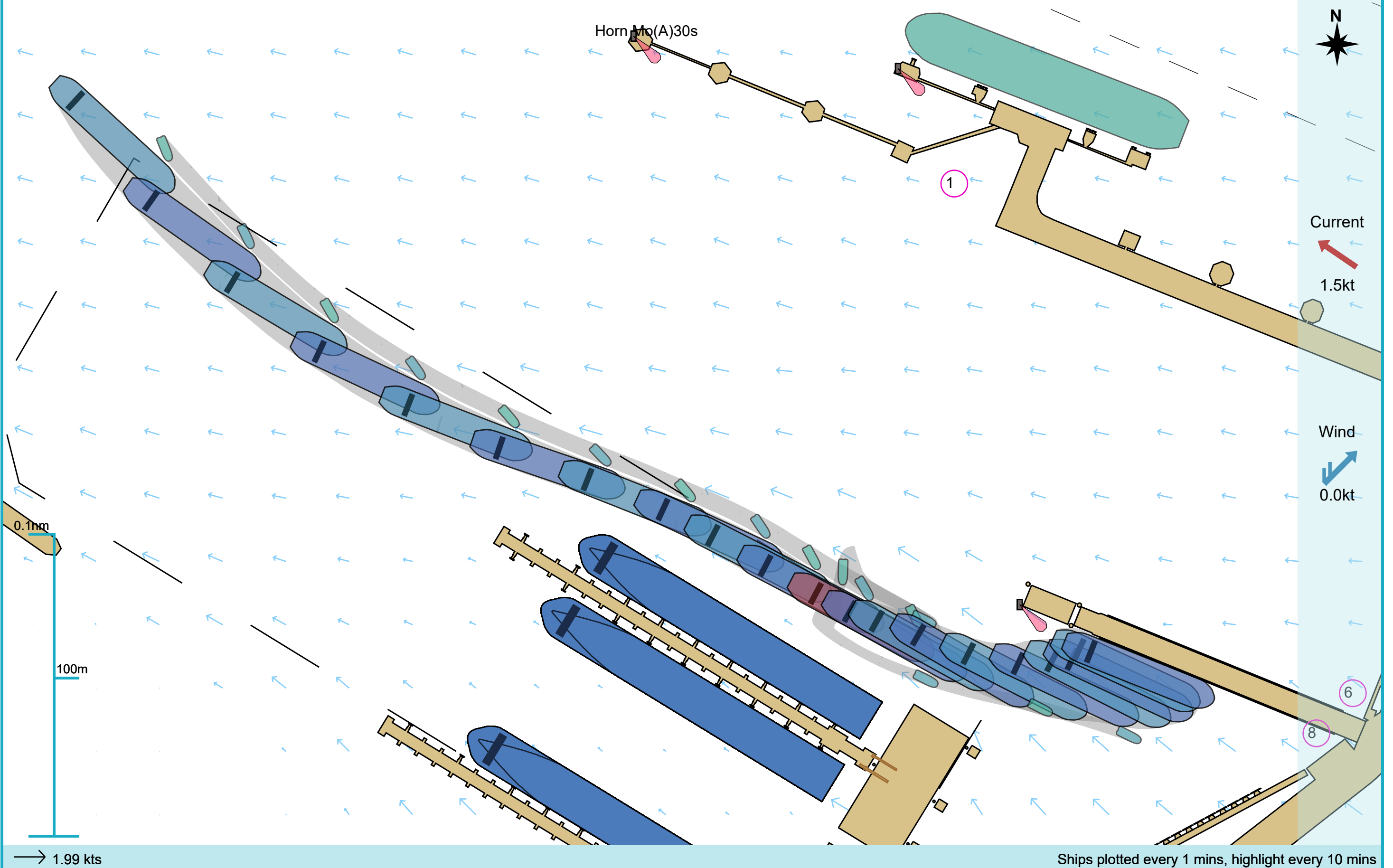
100m x 18m Product Tanker

Tugs



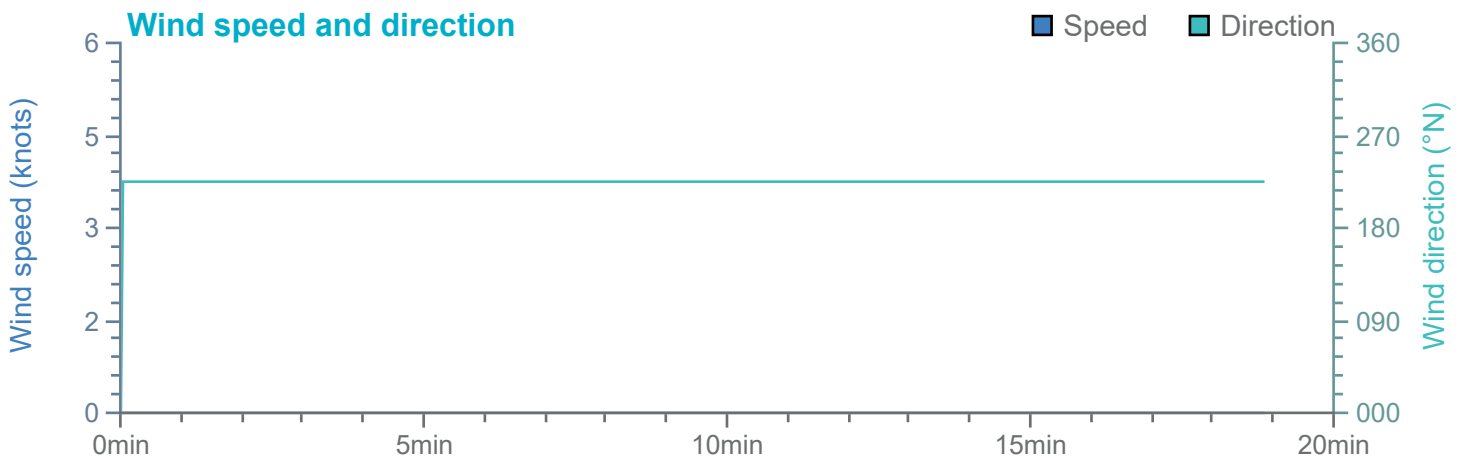
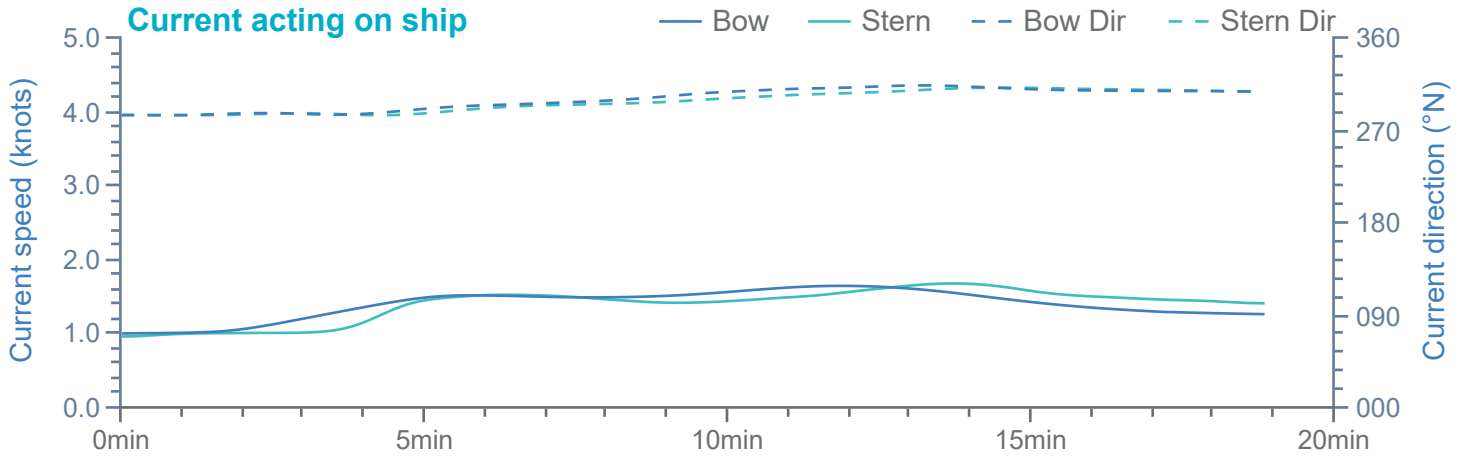


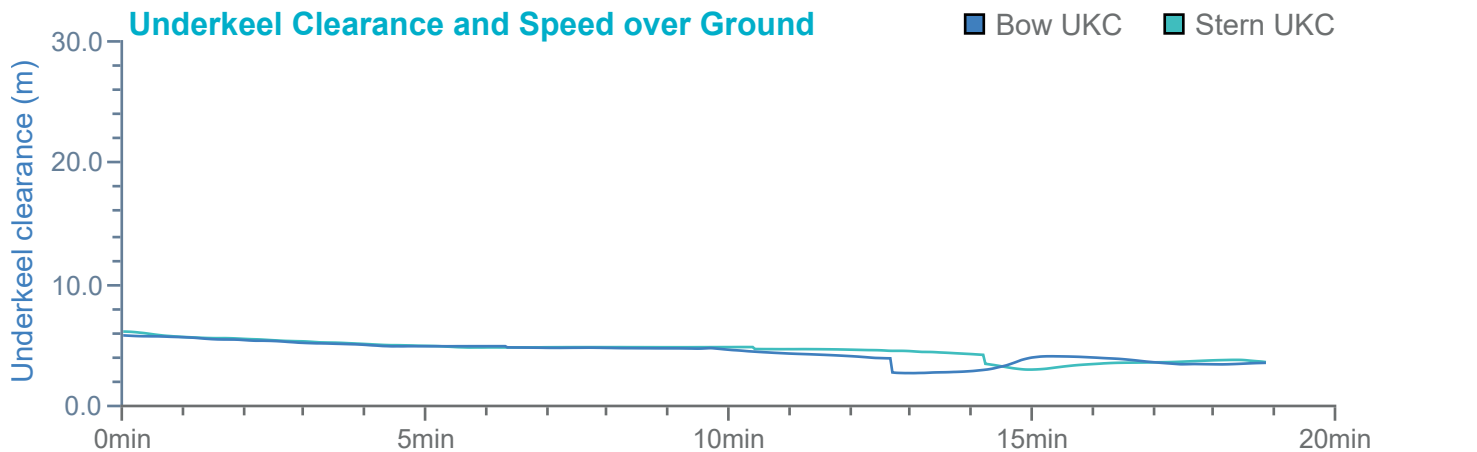
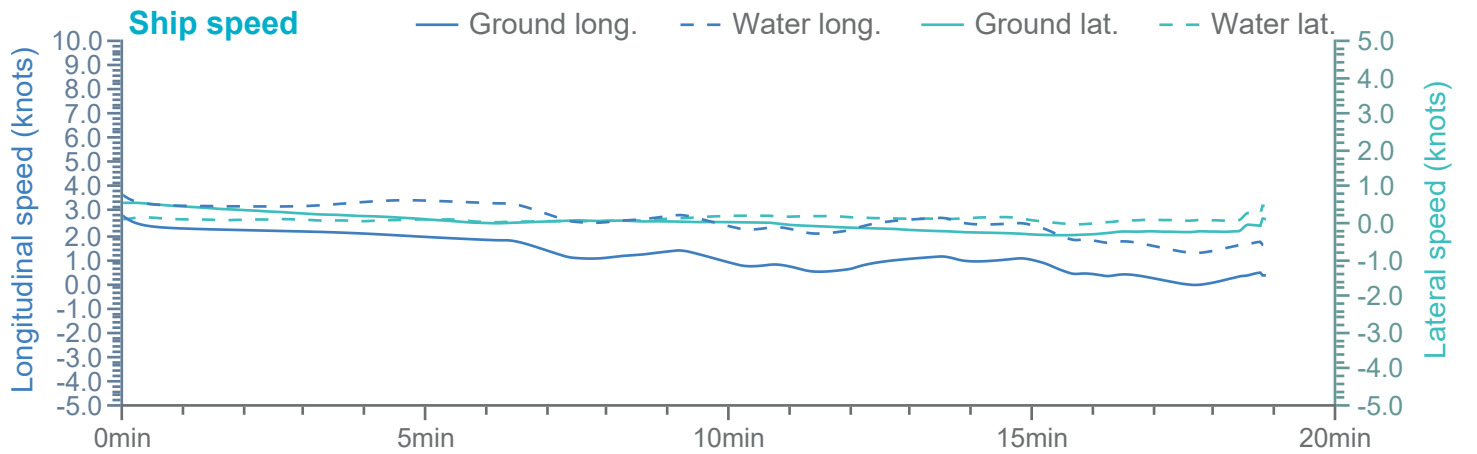
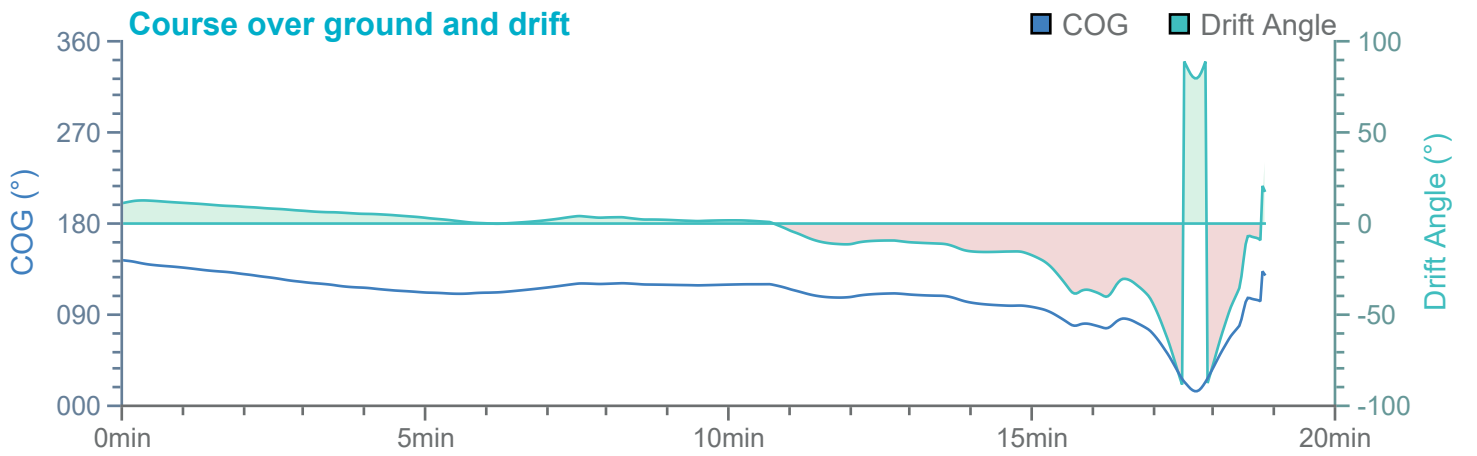
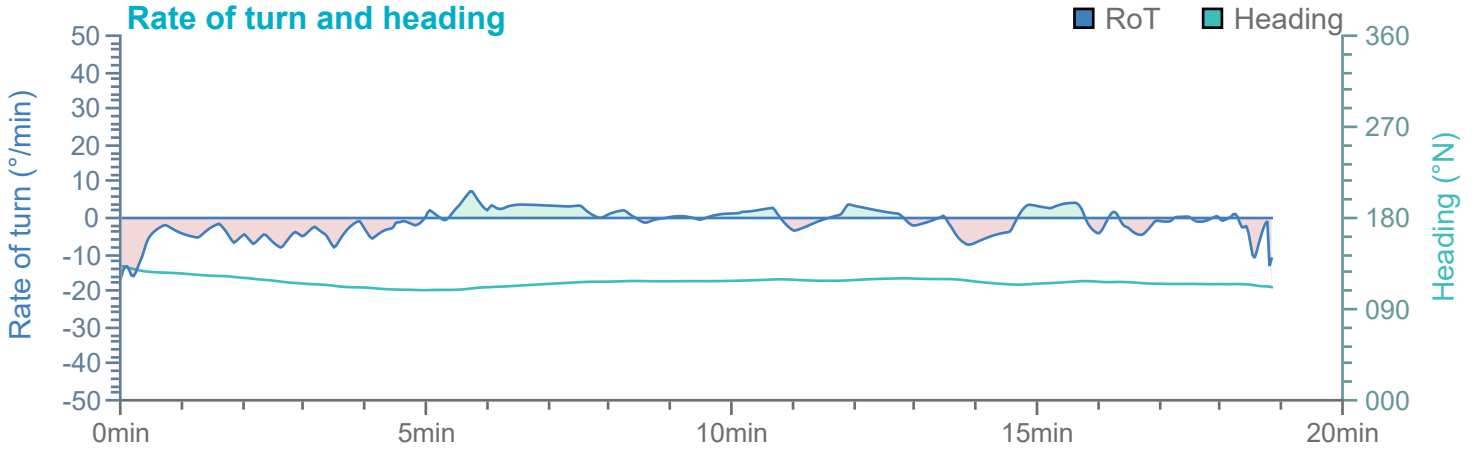
Manoeuvre track plot

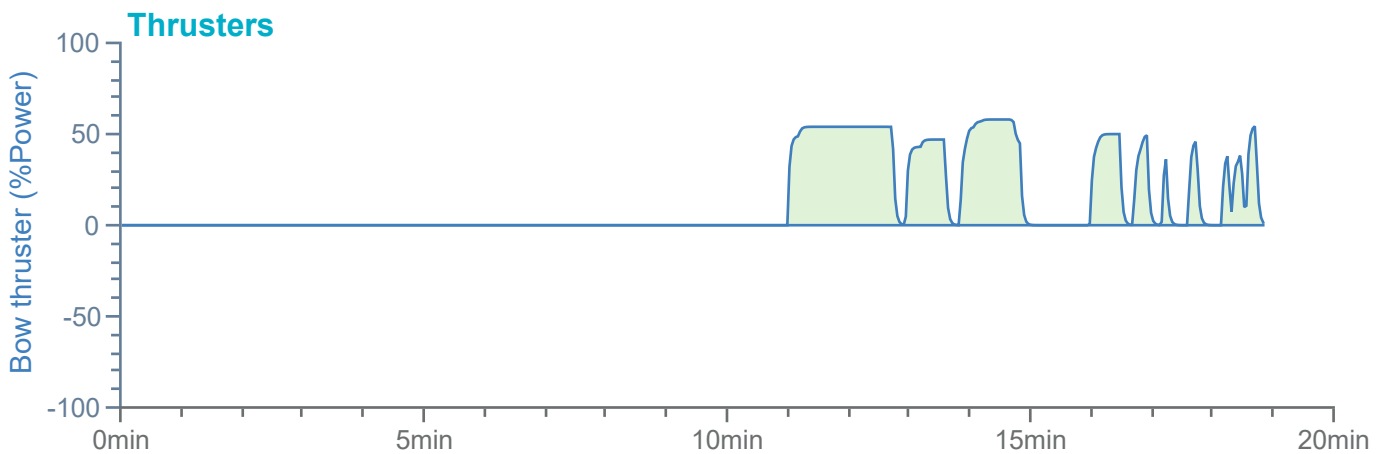
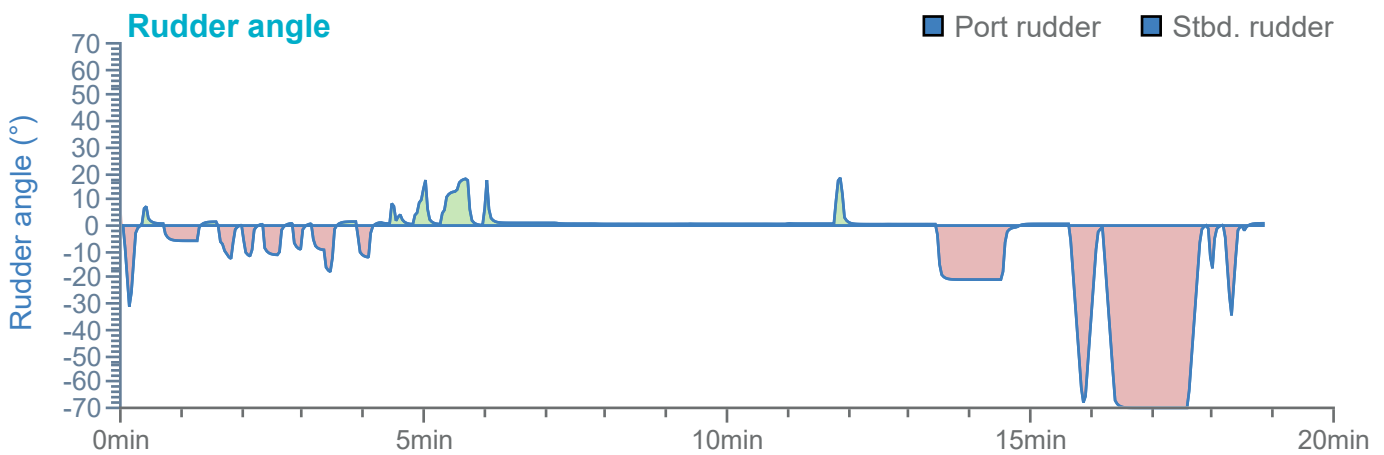
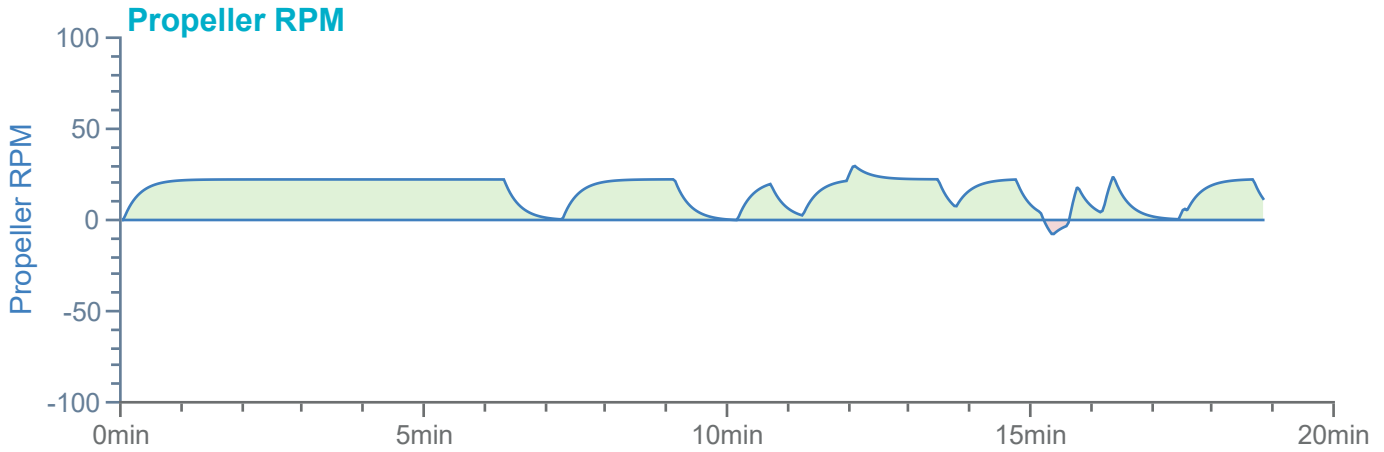


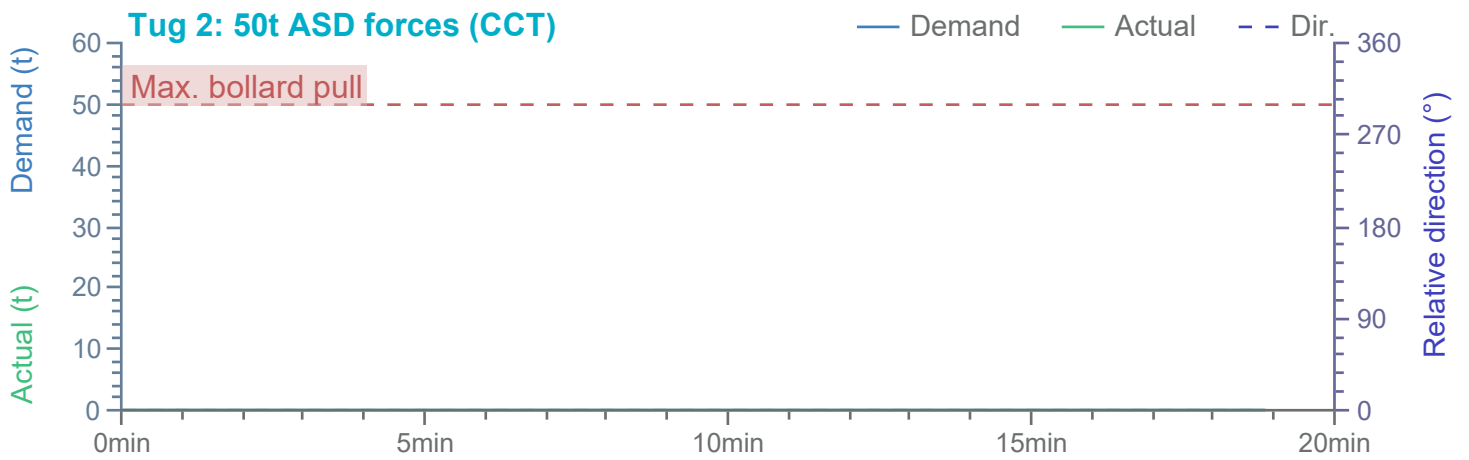
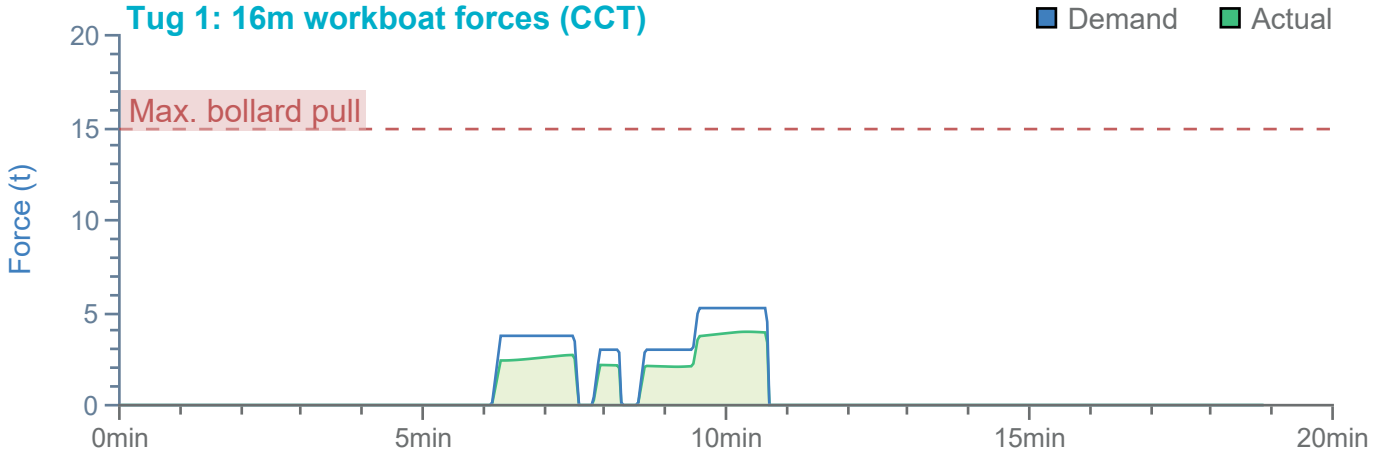
→ 1.99 kts

Ships plotted every 1 mins, highlight every 10 mins

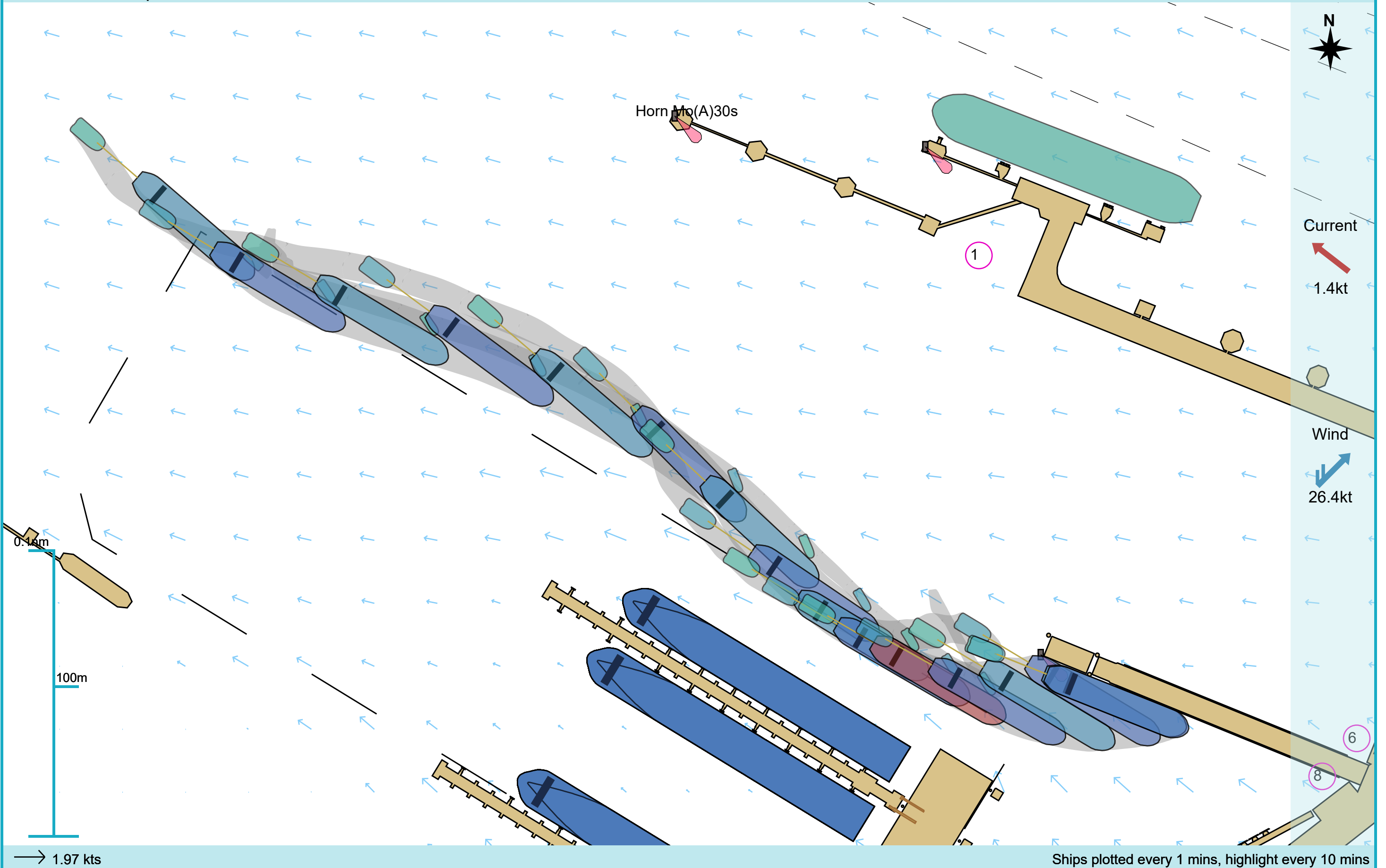






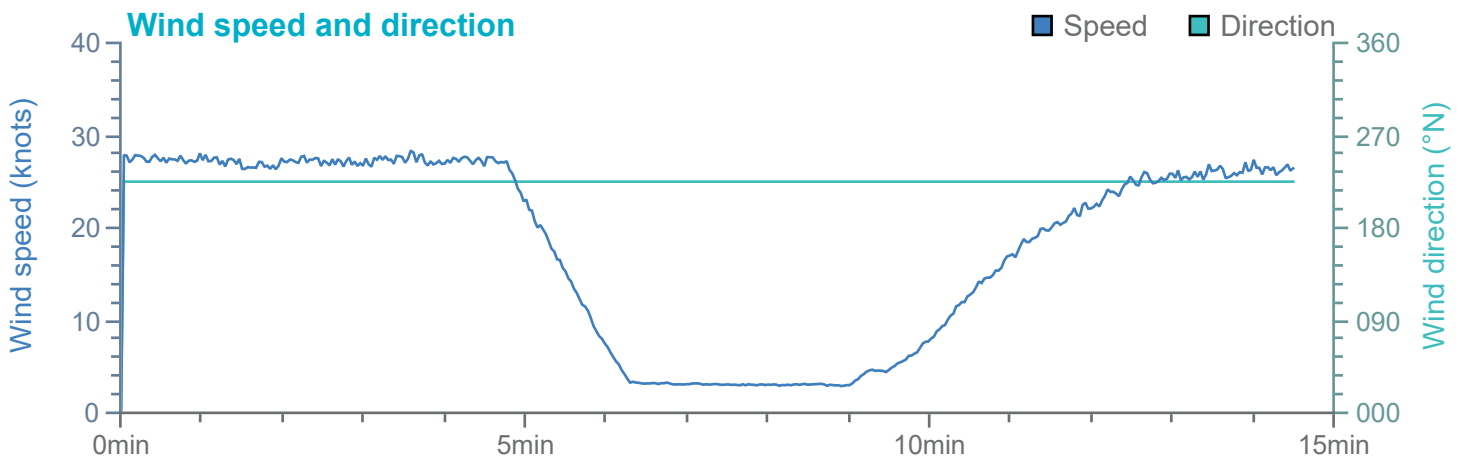
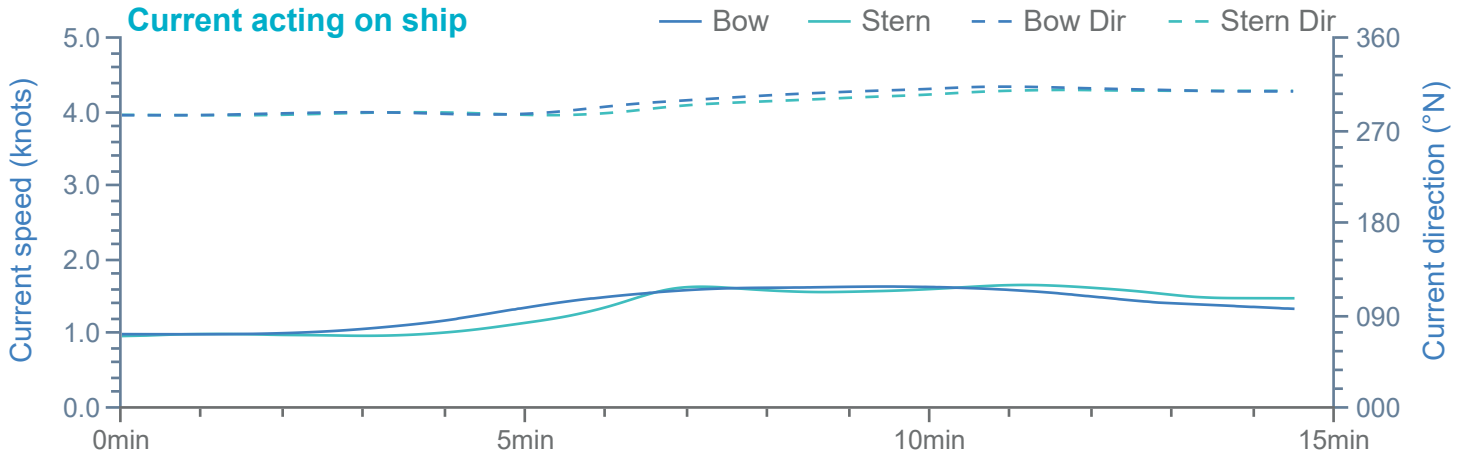


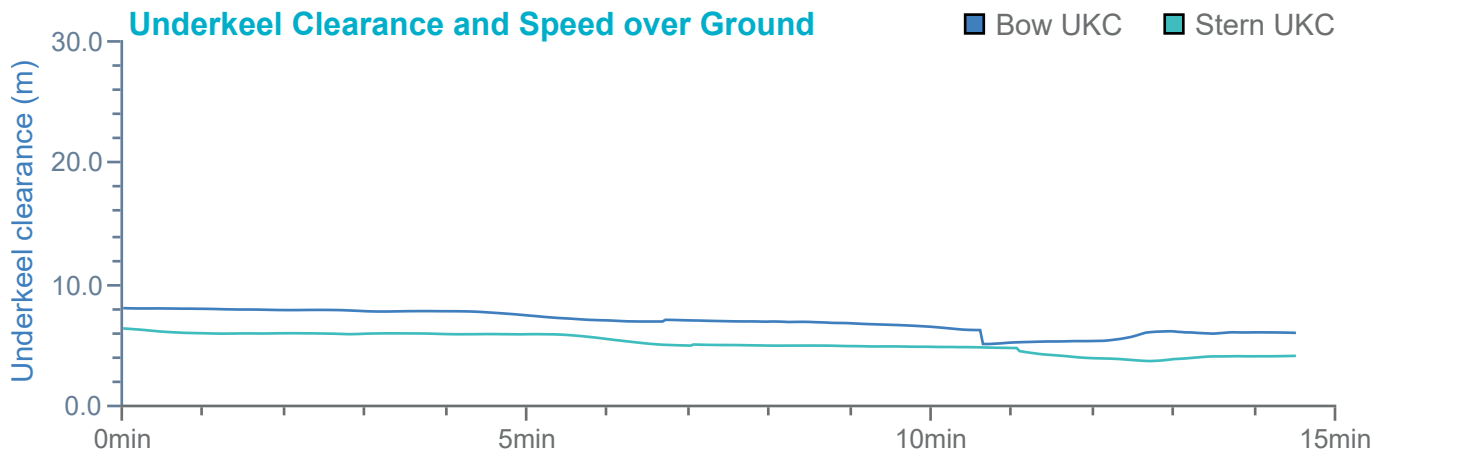
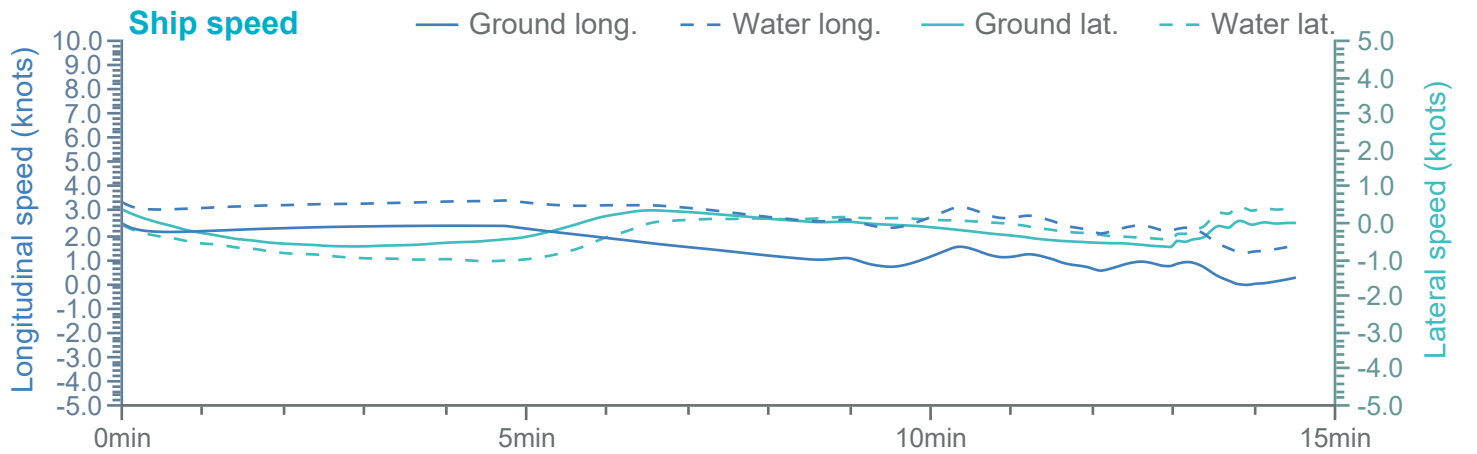
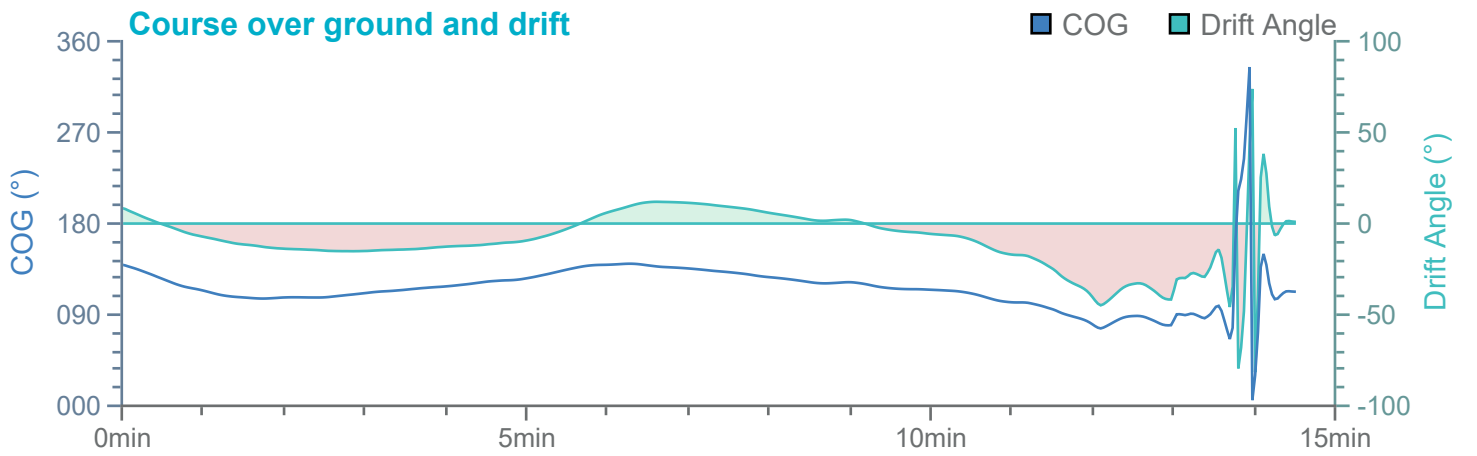
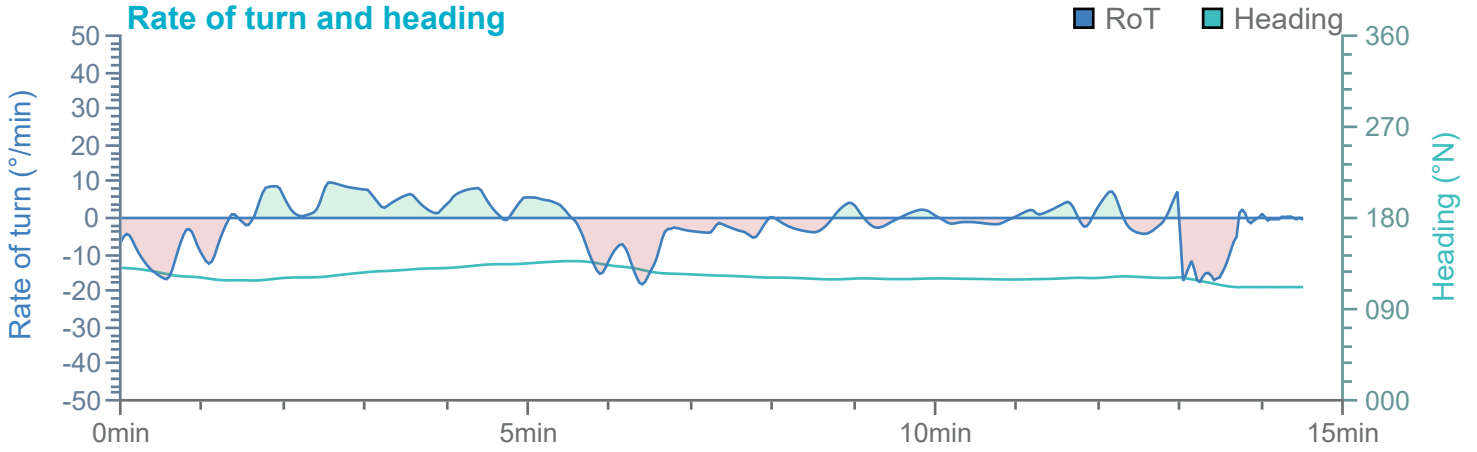
Manoeuvre track plot



→ 1.97 kts

Ships plotted every 1 mins, highlight every 10 mins



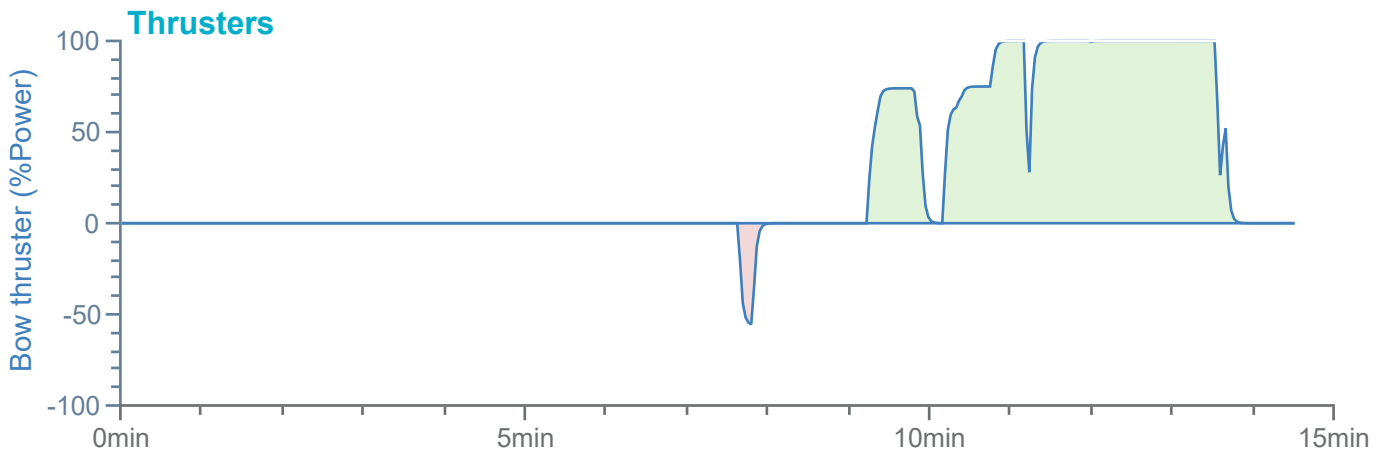
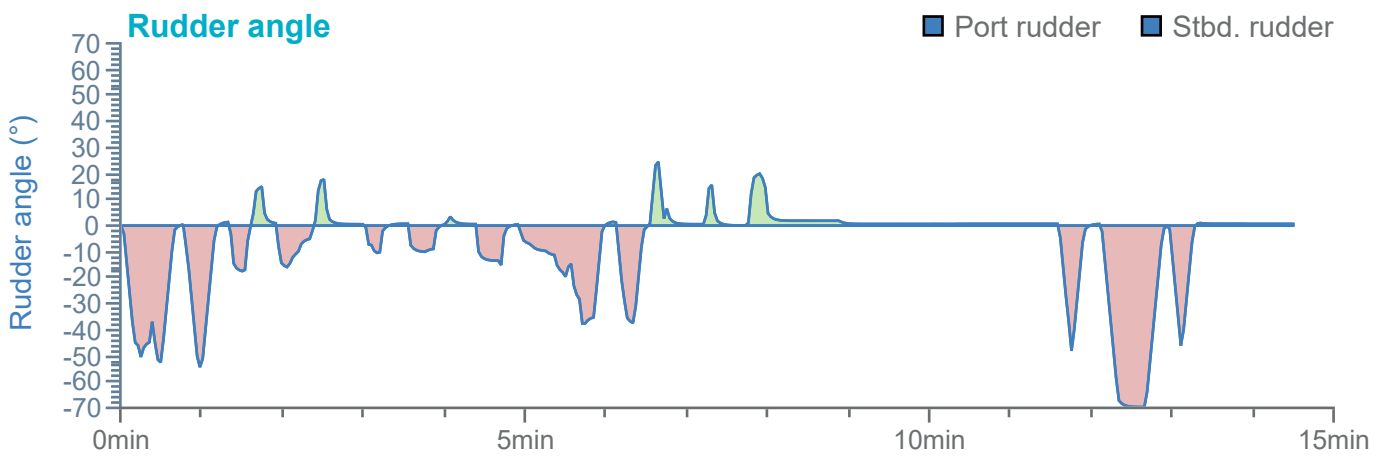
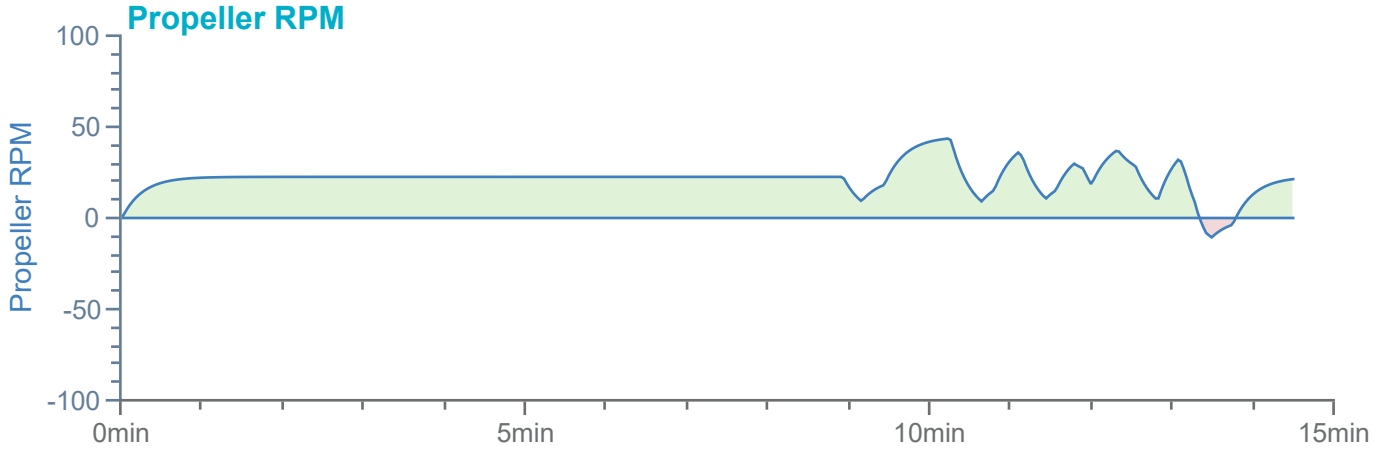


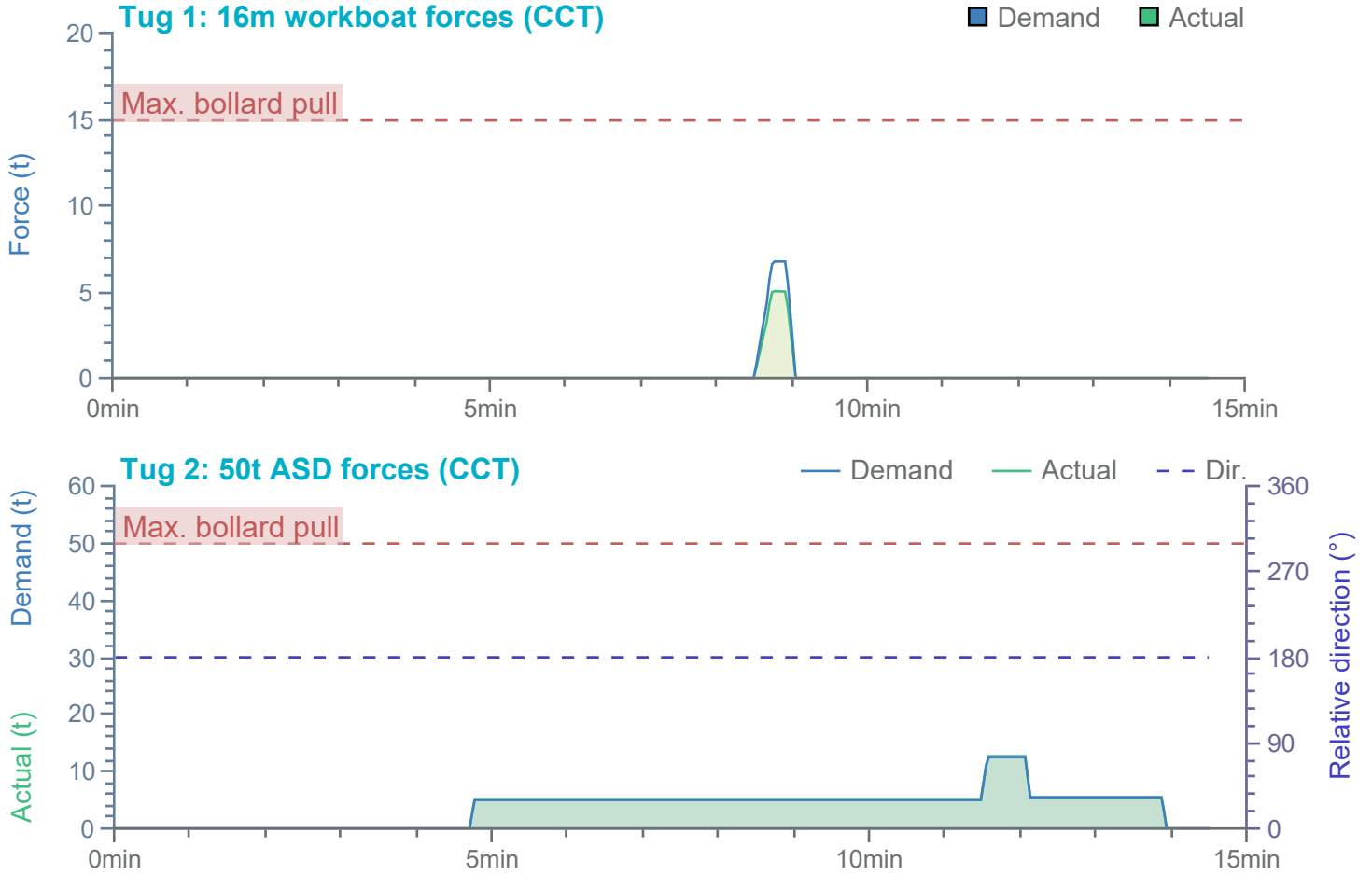
Overview

Environment

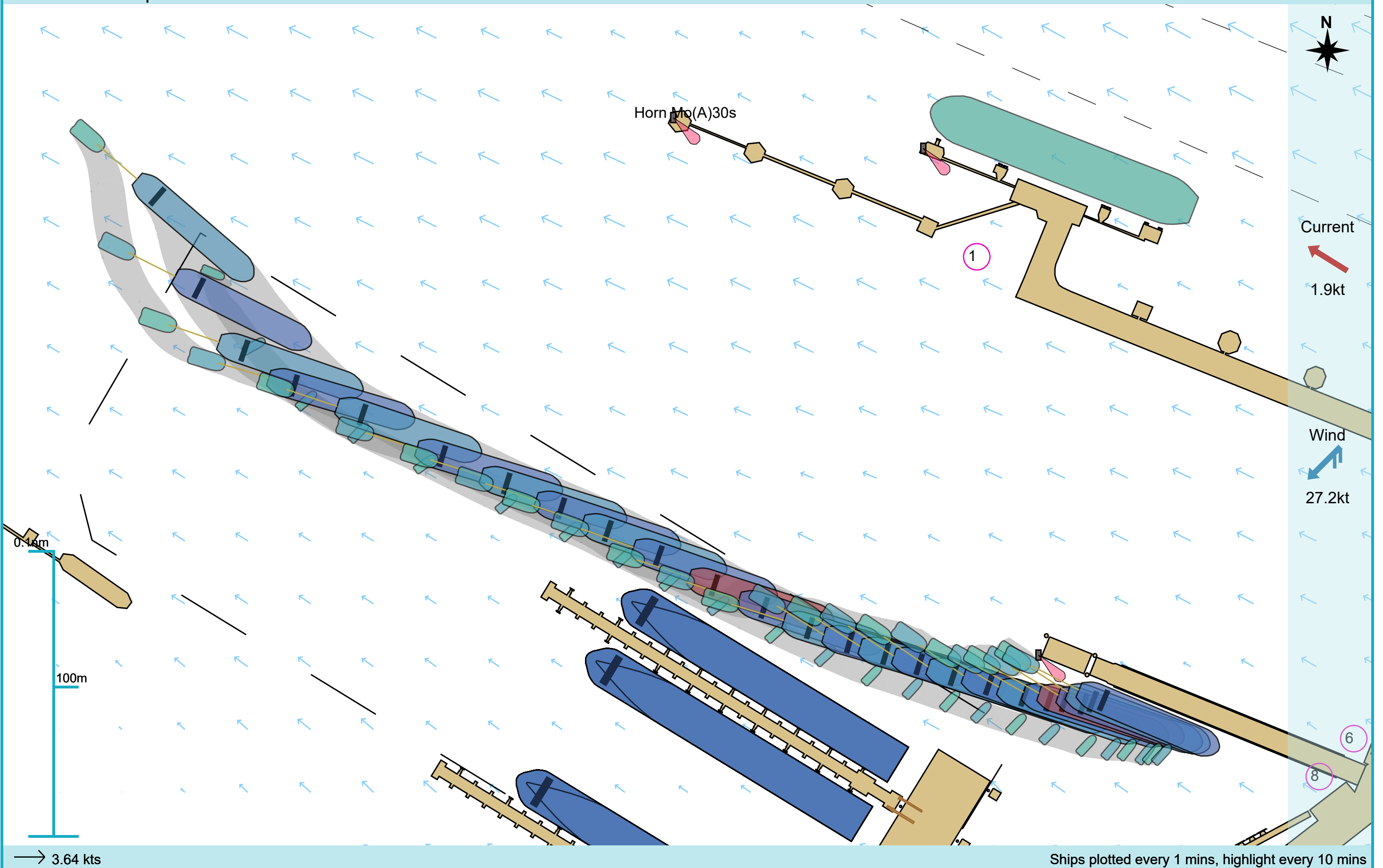
100m x 18m Product Tanker

Tugs



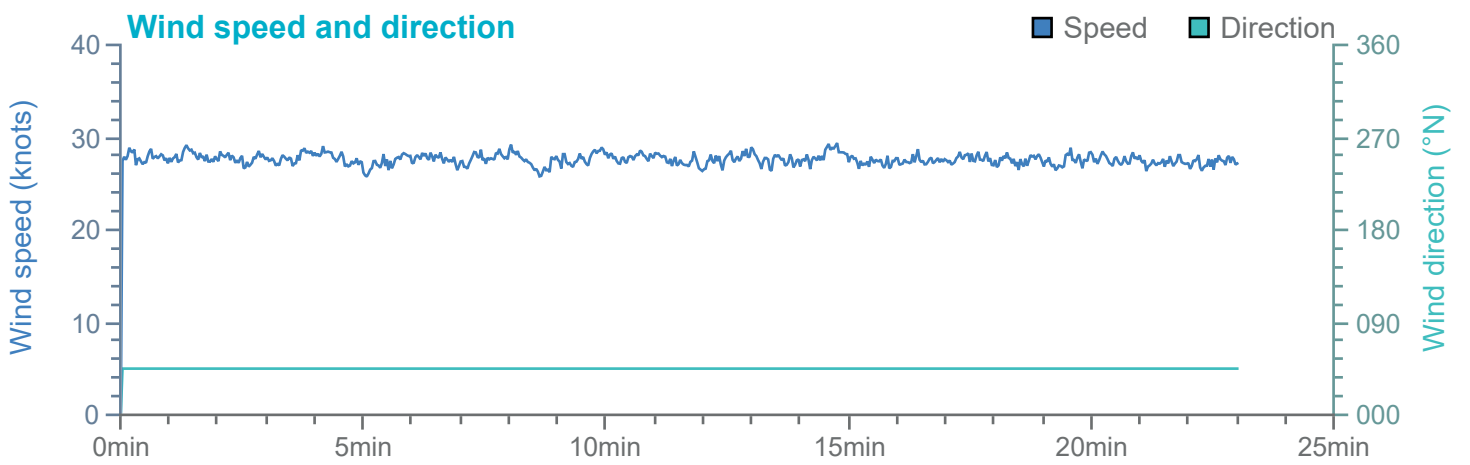
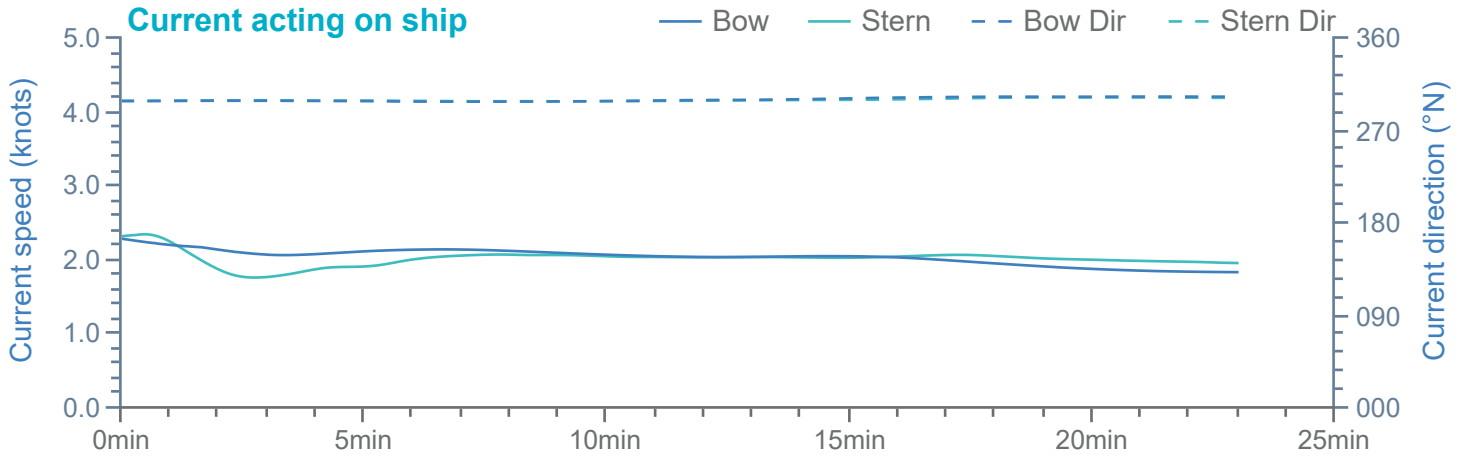


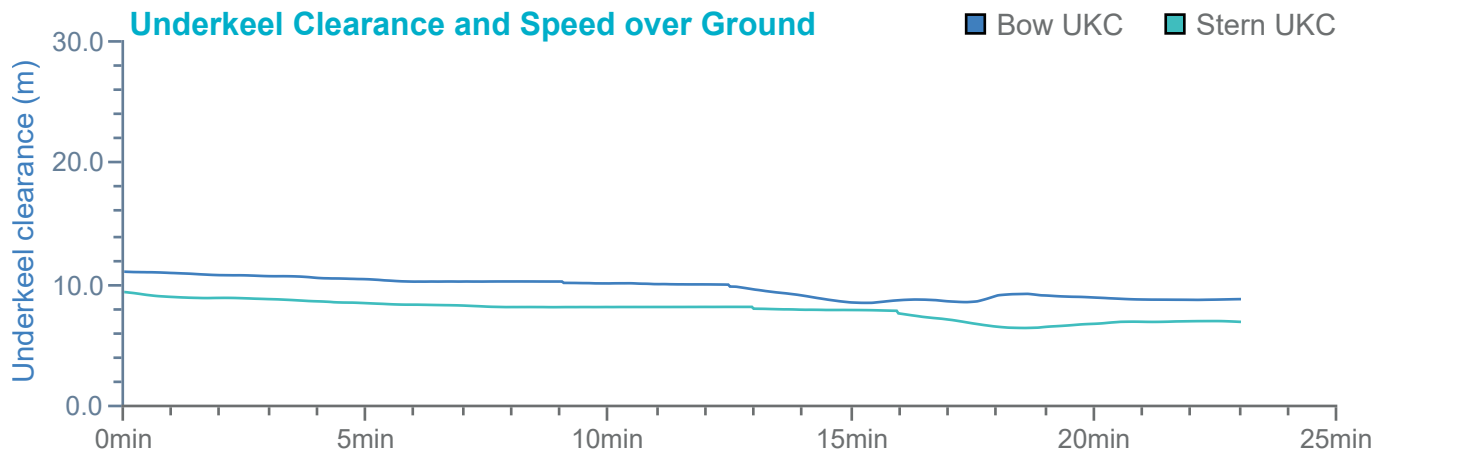
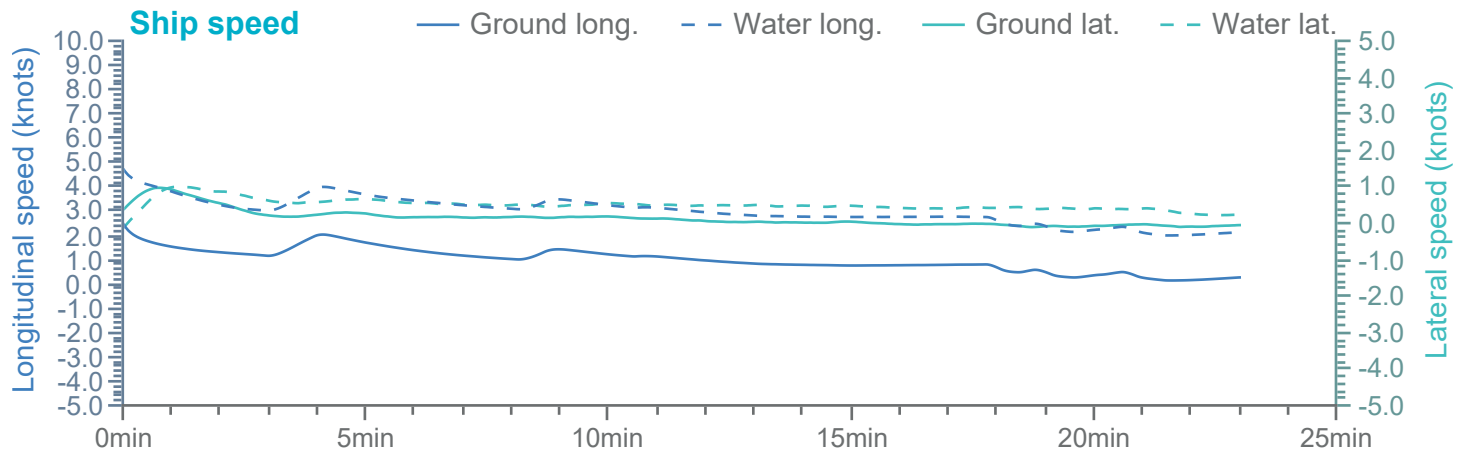
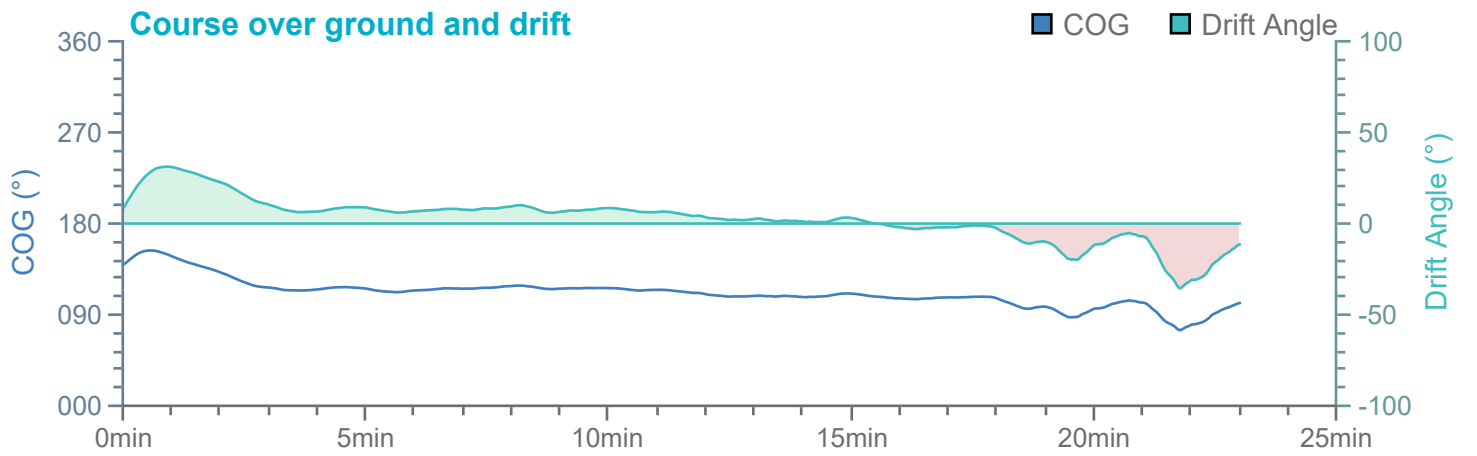
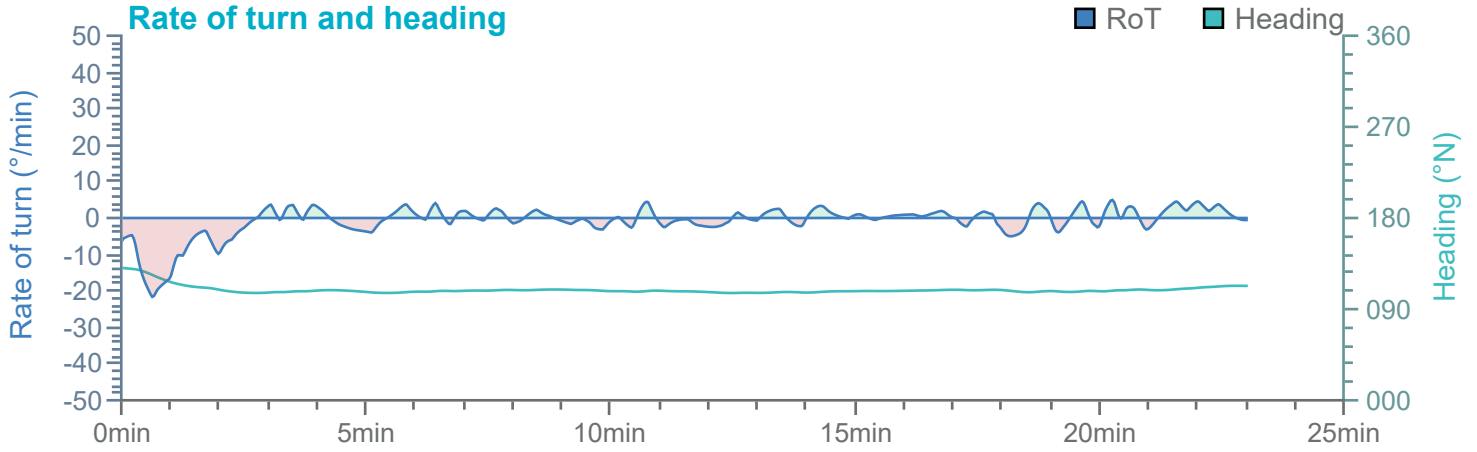
Manoeuvre track plot

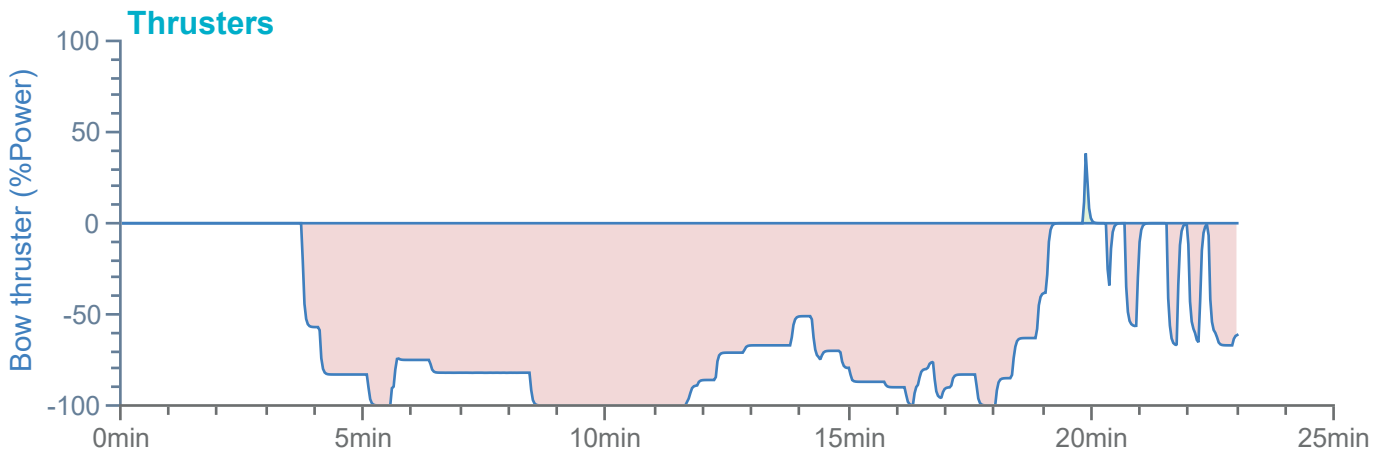
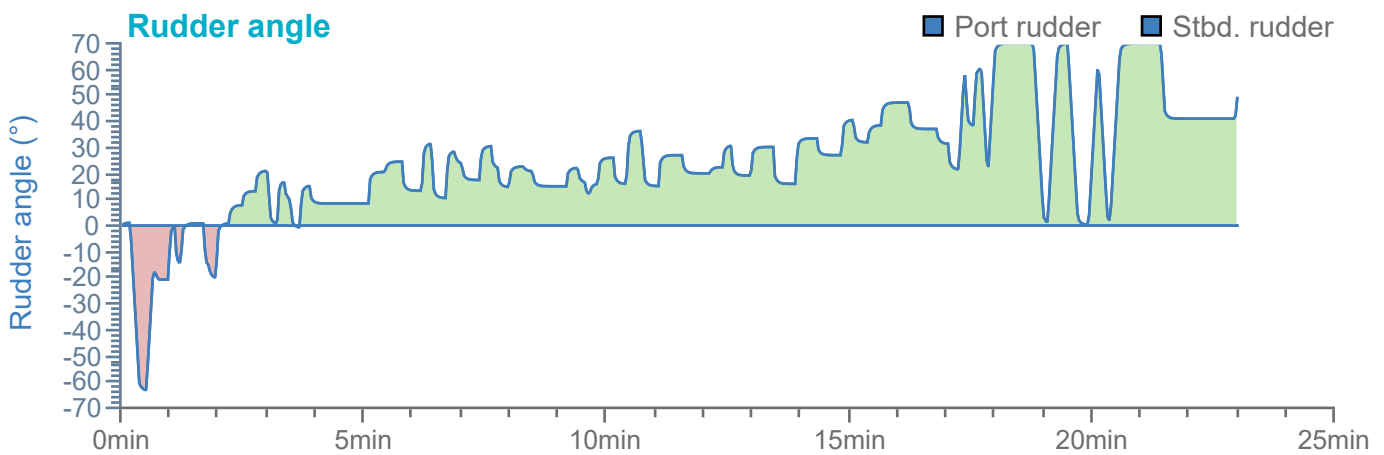
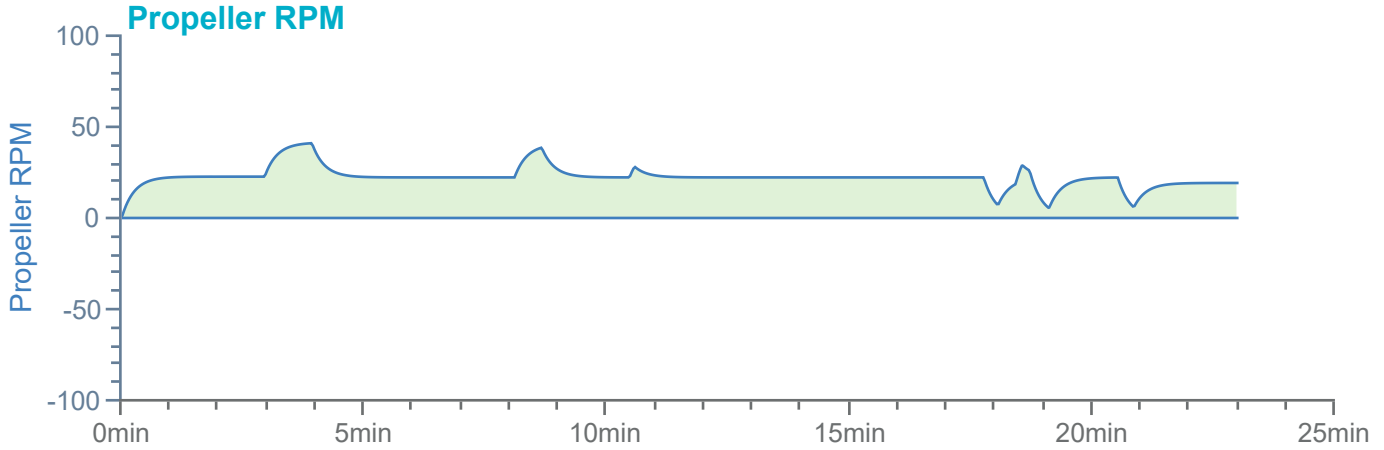


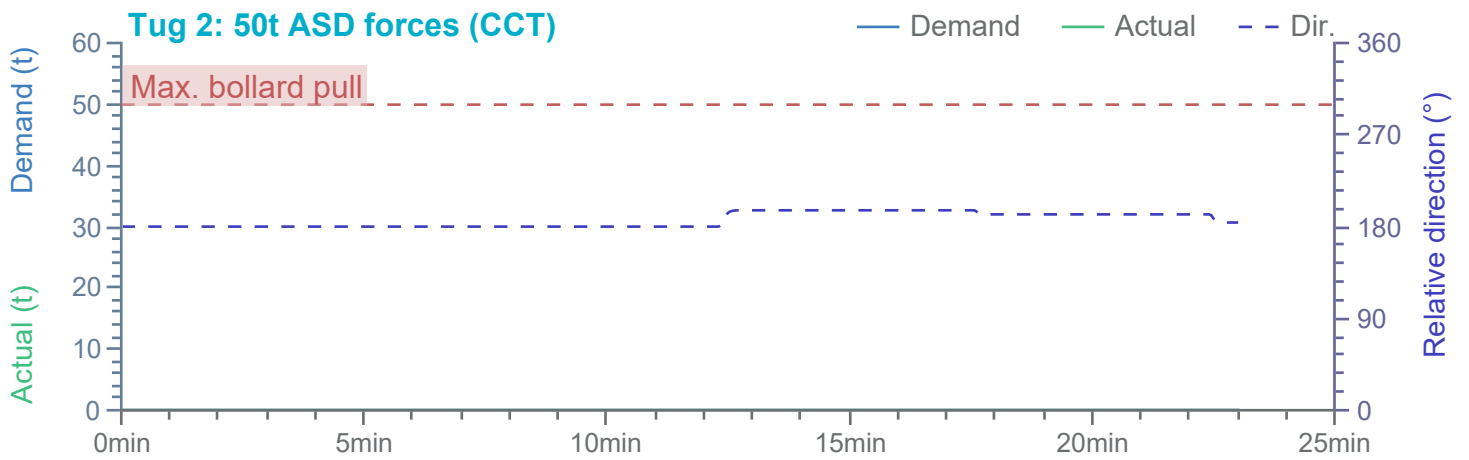
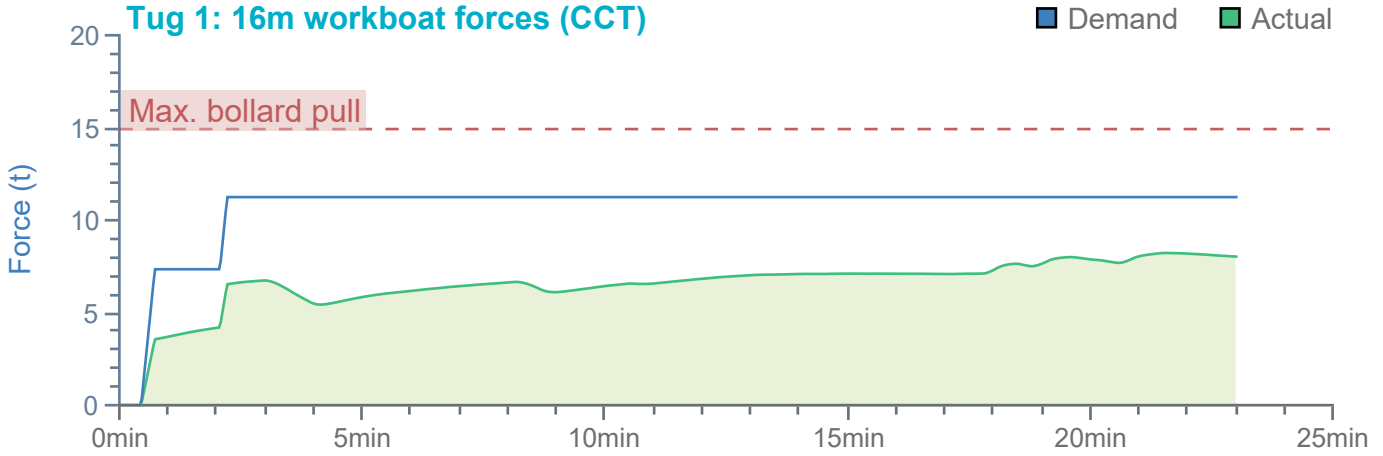
→ 3.64 kts

Ships plotted every 1 mins, highlight every 10 mins

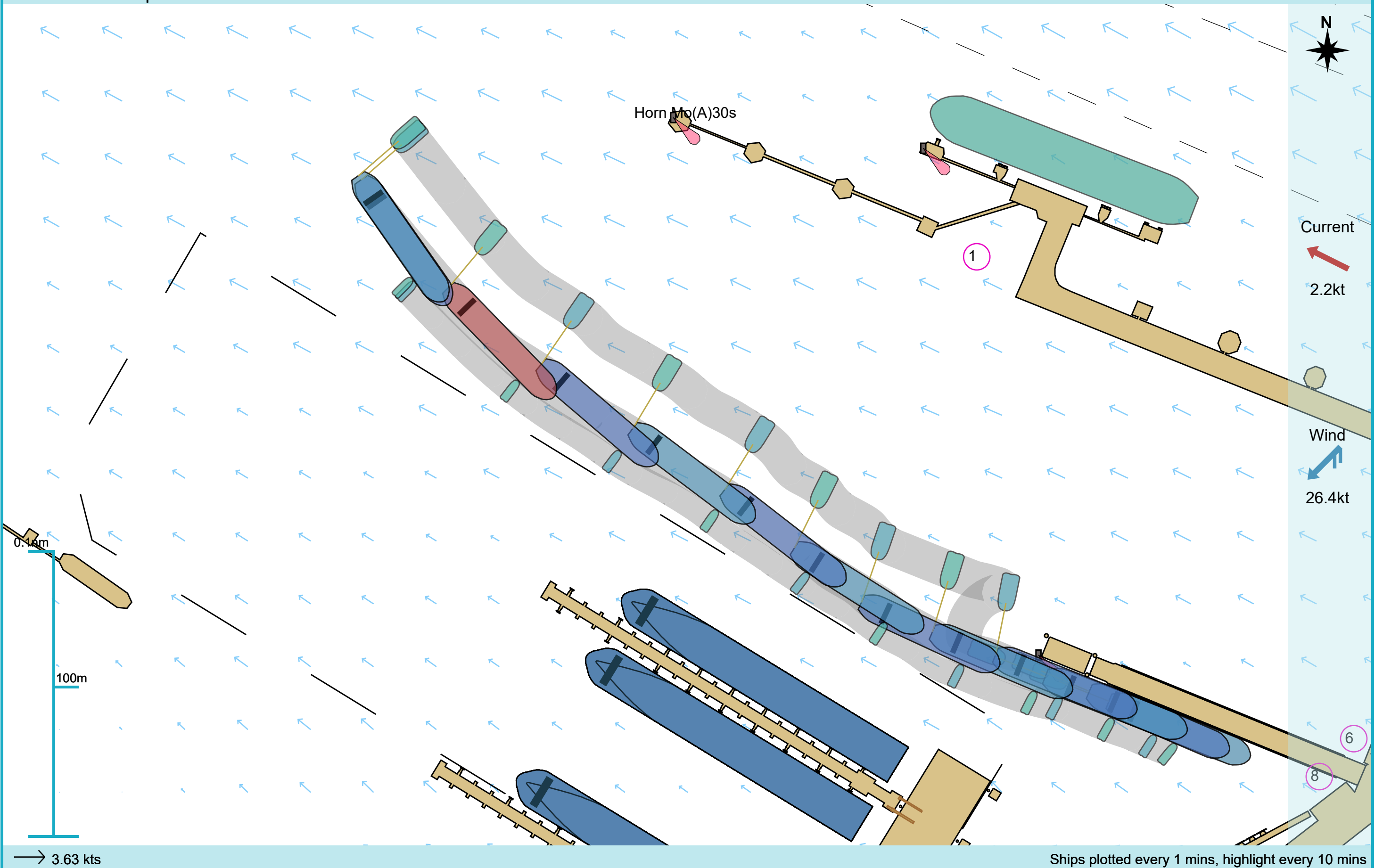






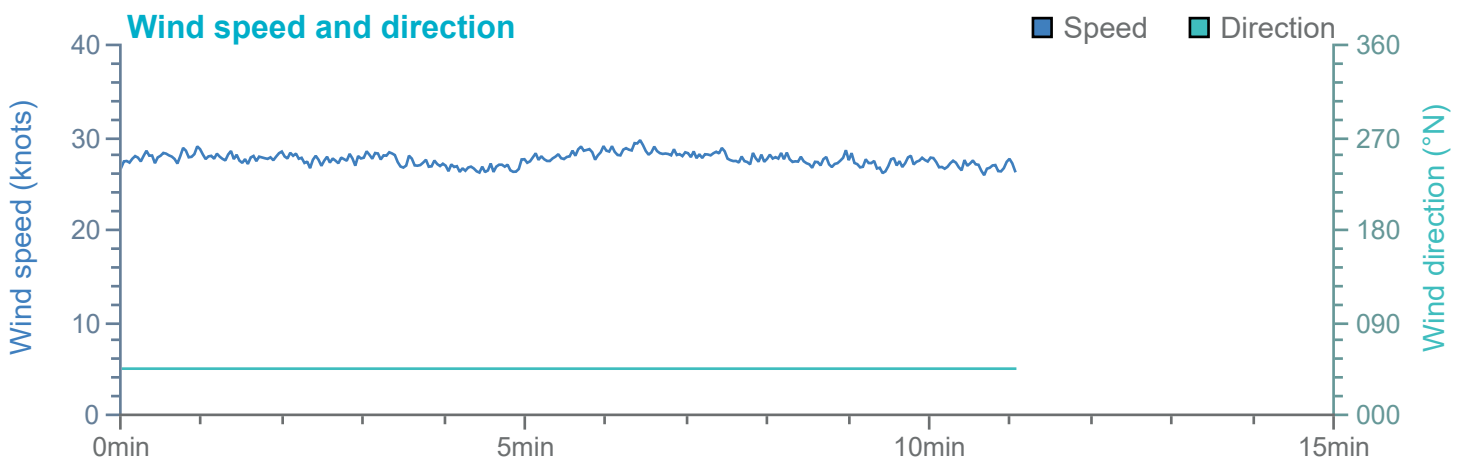
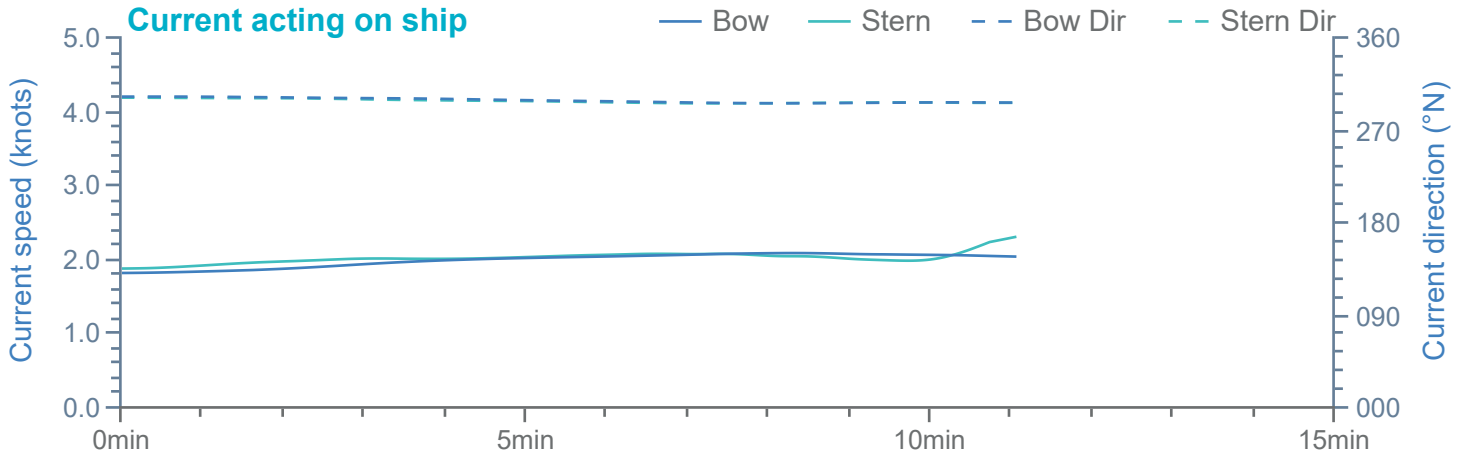


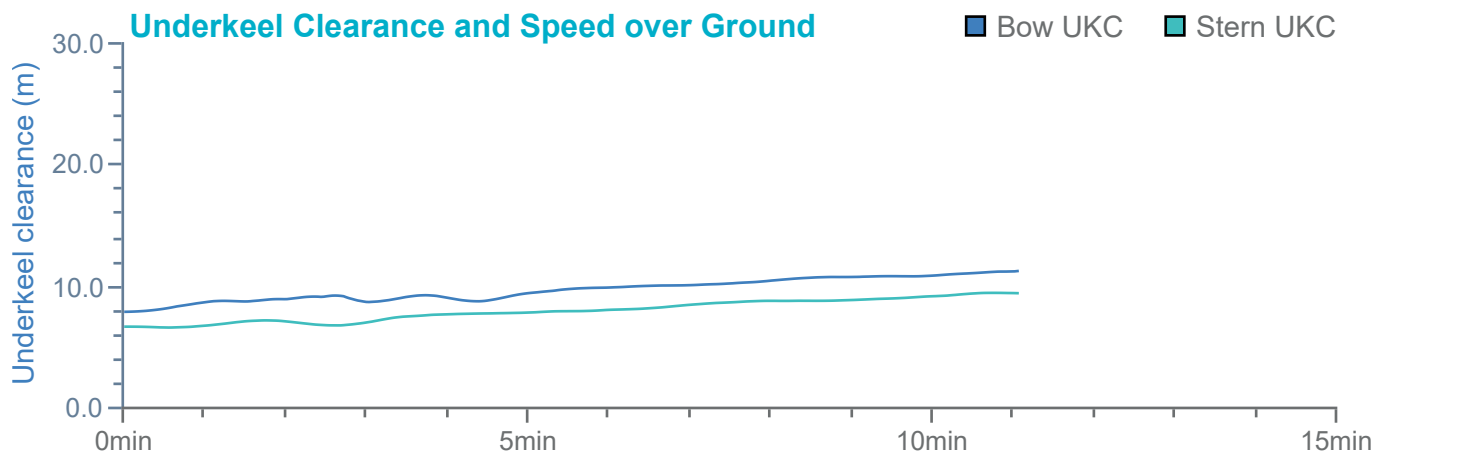
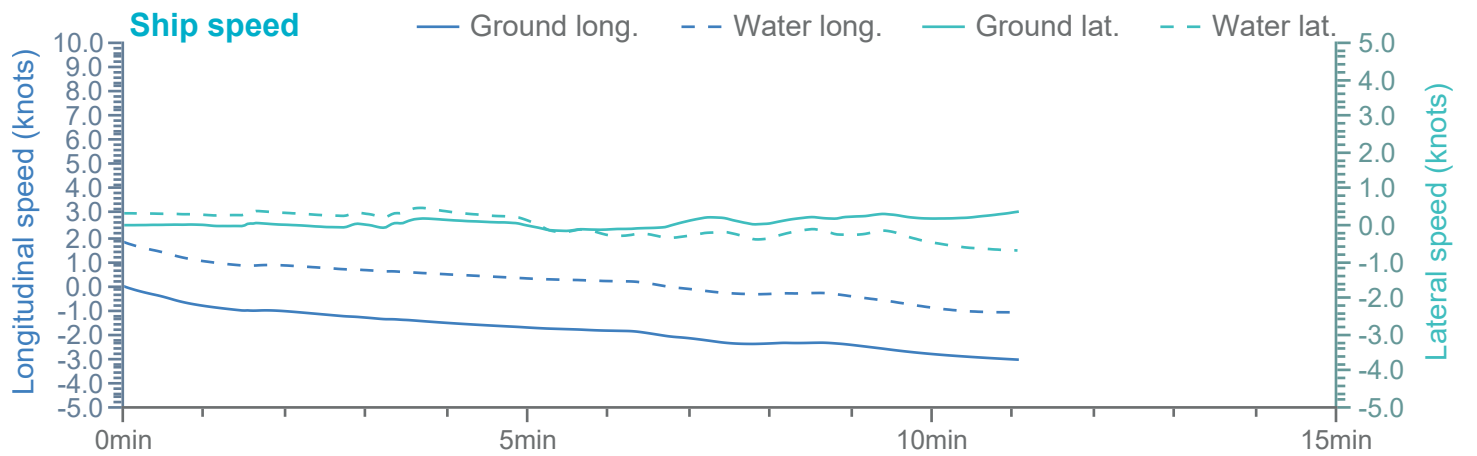
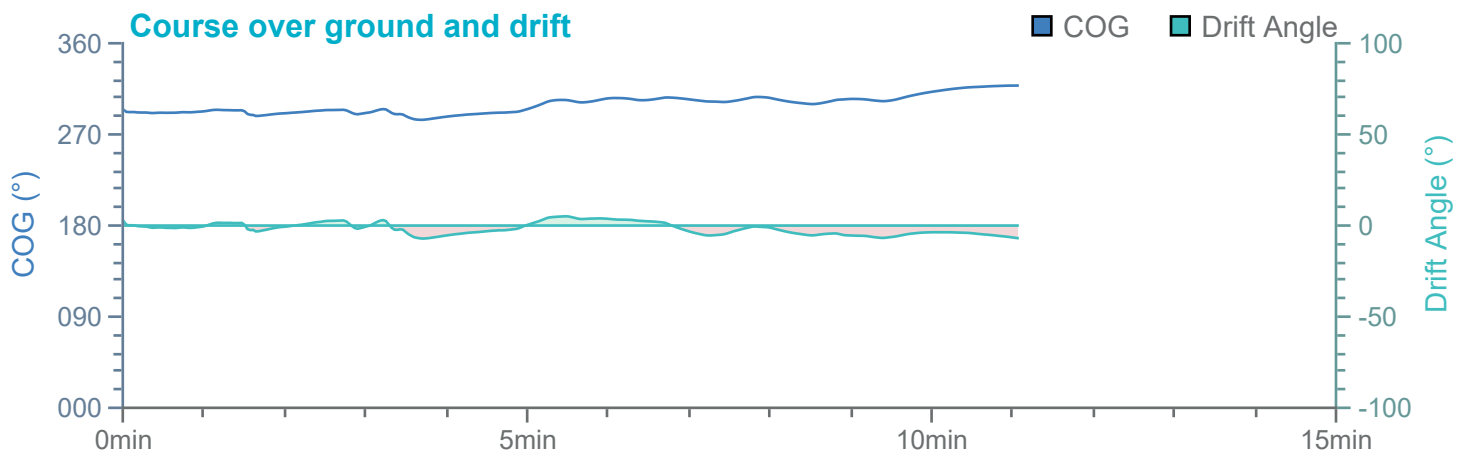
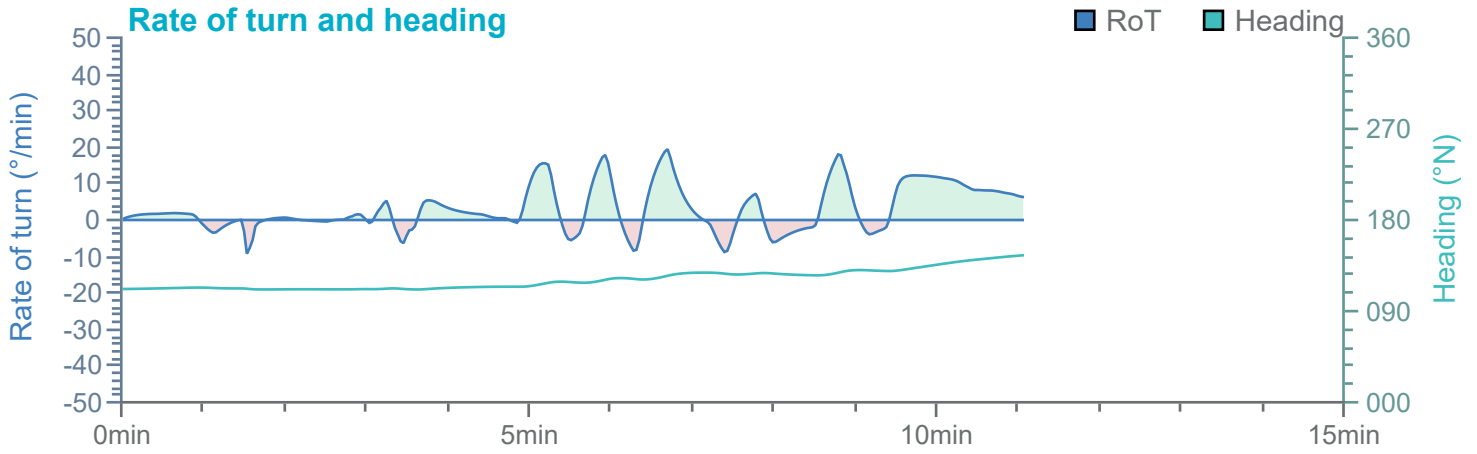
Manoeuvre track plot



→ 3.63 kts

Ships plotted every 1 mins, highlight every 10 mins



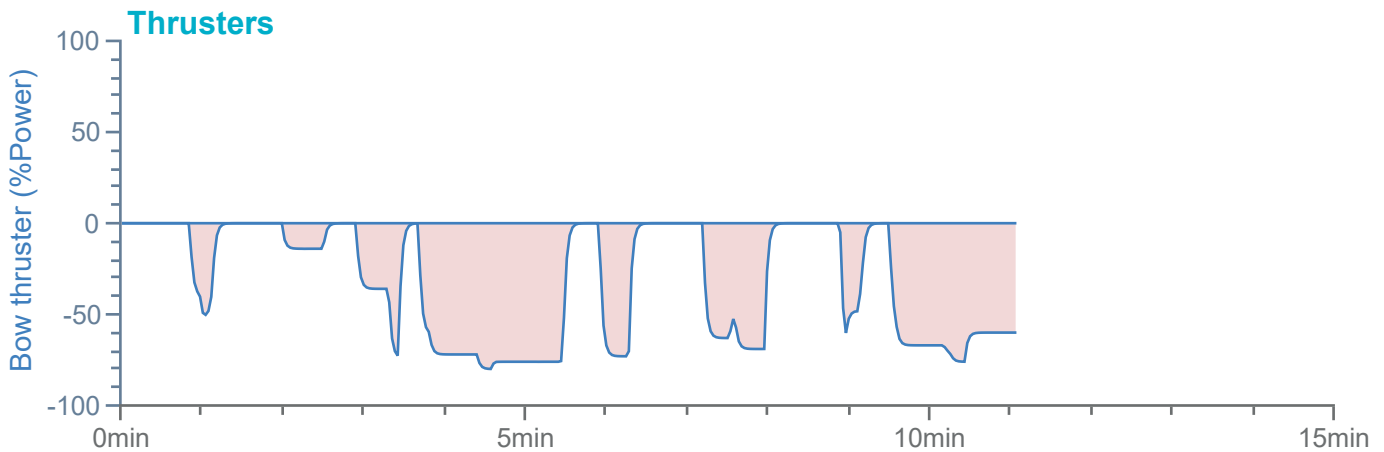
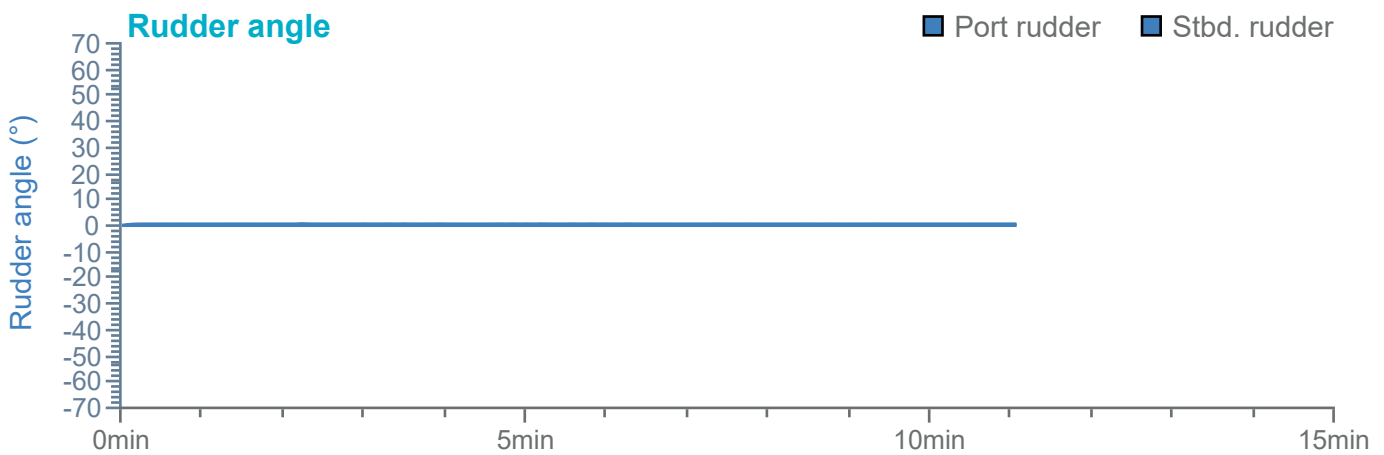
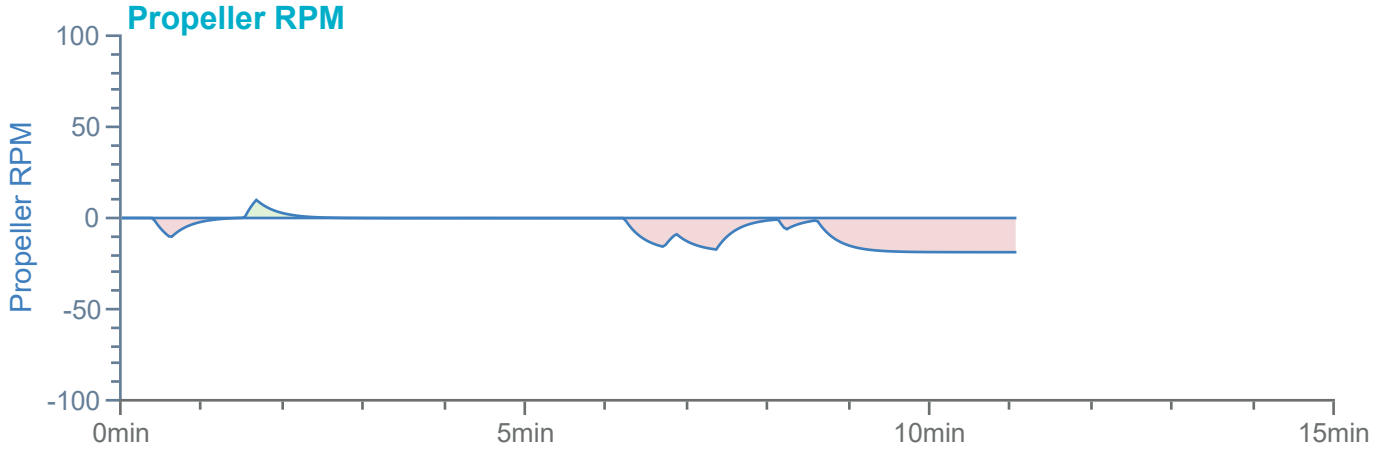


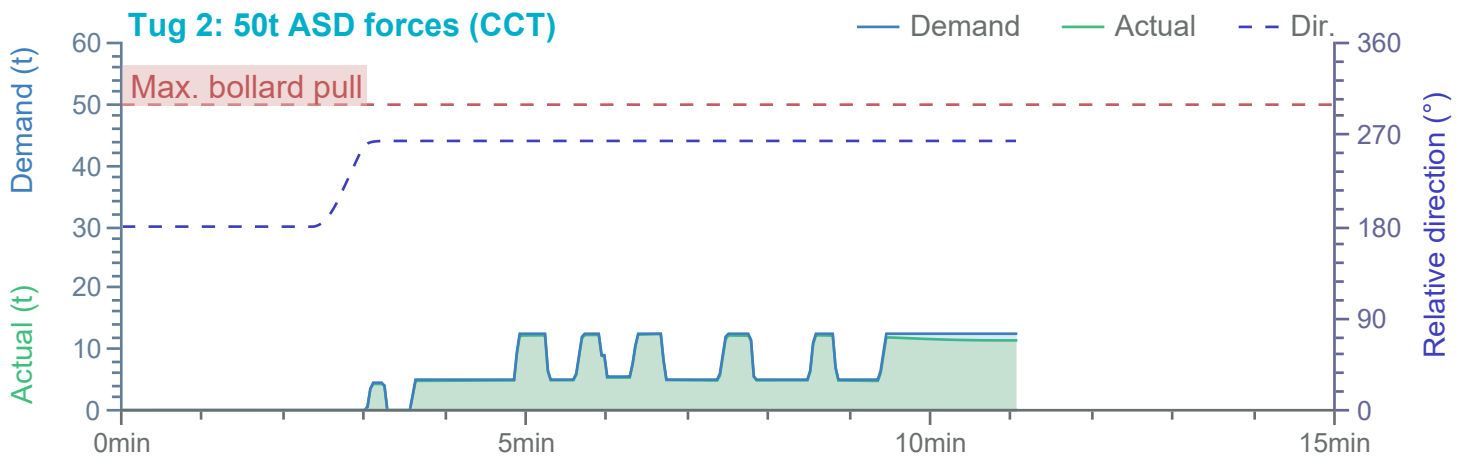
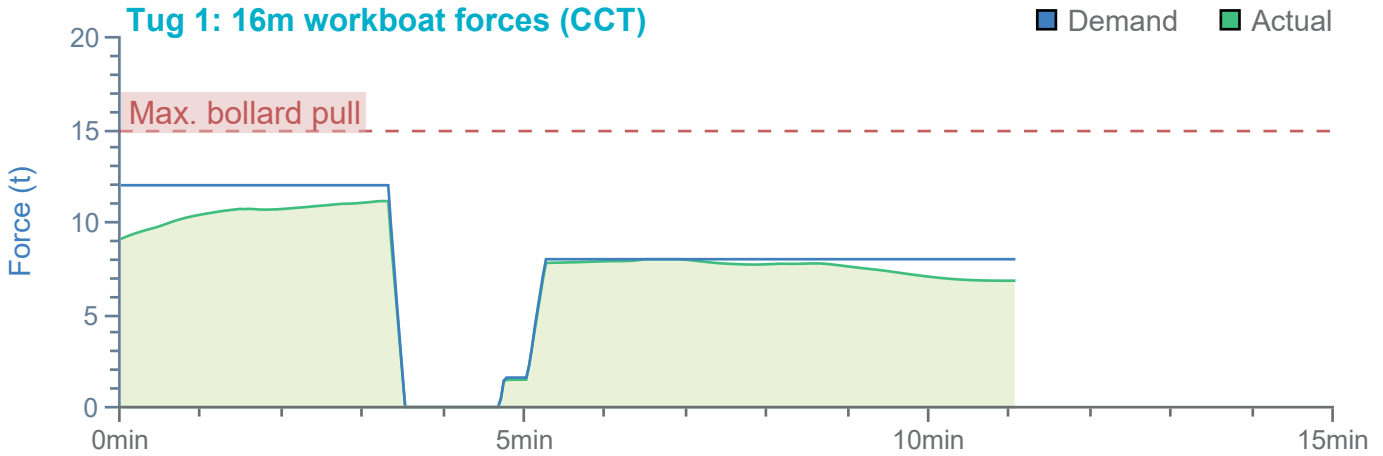
Overview

Environment

100m x 18m Product Tanker

Tugs





B Construction Design and Management Regulations (CDM, 2015)

The Construction (Design and Management) Regulations 2015 (CDM 2015) require a designer to avoid foreseeable risks to those involved in construction and future use of the structure, and in doing so, they should eliminate hazards (so far as is reasonably practicable, taking into account other design considerations) and reduce and control risks associated with those hazards which remain. It is essential that, where required to do so, a principal designer and principal contractor are appointed to fulfil their respective duties under the CDM 2015. It is also essential to highlight and record the impacts of the works on health, safety and welfare which should feed into the Health and Safety File (if required). Further details of the requirements of CDM 2015 can be found on:

<http://www.hse.gov.uk/construction/cdm/2015/index.htm>.

This project consists of desk assessments, numerical and physical modelling work and/or simulation work which may be used by others in the design process. No design work, as defined in the CDM 2015, has been undertaken by HR Wallingford. If during the navigation simulation process we identify any particular issues that should be drawn to the attention of the principal designer and principal contractor in any ultimate construction work which may be undertaken, we will do so in our client discussions and reports. It is assumed that the appointed principal designer will review the information produced in this study when discharging their duties under the CDM 2015.

We design smarter, more resilient solutions across both the natural and built environment to help everyone live and work more sustainably with water.

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IMR 719286



FS 516431



OHS 595357



EMS 558310

Letter from HR Wallingford: Enhanced operational controls

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29 November 2023

Our ref: DJR6612

Dear Ben

Enhanced operational controls

HR Wallingford undertook a short simulation study on 15 November to assist ABP in understanding the effectiveness of the use of tugs as an enhanced operational control with respect to the proposed IERRT infrastructure.

The work was informed by previous work undertaken to support your team's work on impact protection, work we undertook with Humber Estuary Services and correspondence you provided between yourselves and APT.

This letter is in lieu of a full report and is produced to support your ongoing Navigational Risk Assessment review and presentation of that by you to your board. The information is also expected to be shared with interested parties and the Examining Authority for the ongoing Development Consent Order being sought for IERRT. At the time of writing HR Wallingford has been asked to repeat this work with stakeholders and advise that you consider the results indicative until the completion of that process, following which a formal report will be produced.

It has been demonstrated that a single 50t BP ASD tug will be an appropriate enhanced control measure to mitigate the risk of an allision with IOT infrastructure in the event of a Stena Transit Class vessel operating at IERRT berth 1 in peak ebb flows with winds up to a mean 27.5 knots. It should be noted that this assumes the vessel is also following the approach guidelines provided by Humber Estuary Services.

A sensitivity test using a vessel with a displacement of 46,000t indicates that 2x 50tBP tugs would be required in similar conditions. It would be inappropriate to attempt to draw specific conclusions from this test. Although it provides confidence that:

- A similar process can, in due course, be used for larger vessels that may be considered for operation at the berth.
- Enhanced control measures incorporating tugs that can be shown to be effective mitigations to protect IOT infrastructure.

Partial controls failures were not considered in this study, based on the assumption that the enhanced measures will need to account for a total control failure. We would emphasise that technical documentation or other evidence might be available in the future that shows a full controls failure is impossible or explains the extremely low level of risk anticipated during operations at IERRT. In this case, the enhanced control measures could be reviewed and amended to ensure safe operations in the event of a partial failure.

We were also asked to consider poor visibility and night time scenarios. We advise that enhanced control measures being considered that are effective in daylight and good visibility will be effective in poor visibility and at nighttime, with respect to tug power and control, particularly in

this case where the distance to objects is short. It should be assumed that the masters/PECS are suitably qualified to operate in the prevailing conditions and that other controls prevent vessel operations near the berths where situational awareness is reduced to the extent that proper control cannot be affected. The simulator is appropriate for training in night conditions or poor visibility; it does not usefully support the design for lights and other aids considered helpful in these scenarios. Any lighting or navigational aids proposed as part of a risk assessment should meet the requirements of British Standards or IALA codes as appropriate.

Operations at IERRT are similar concerning the risk to IOT as all other movements on the river until approaching vessels enter the area indicated in red in Figure 1.

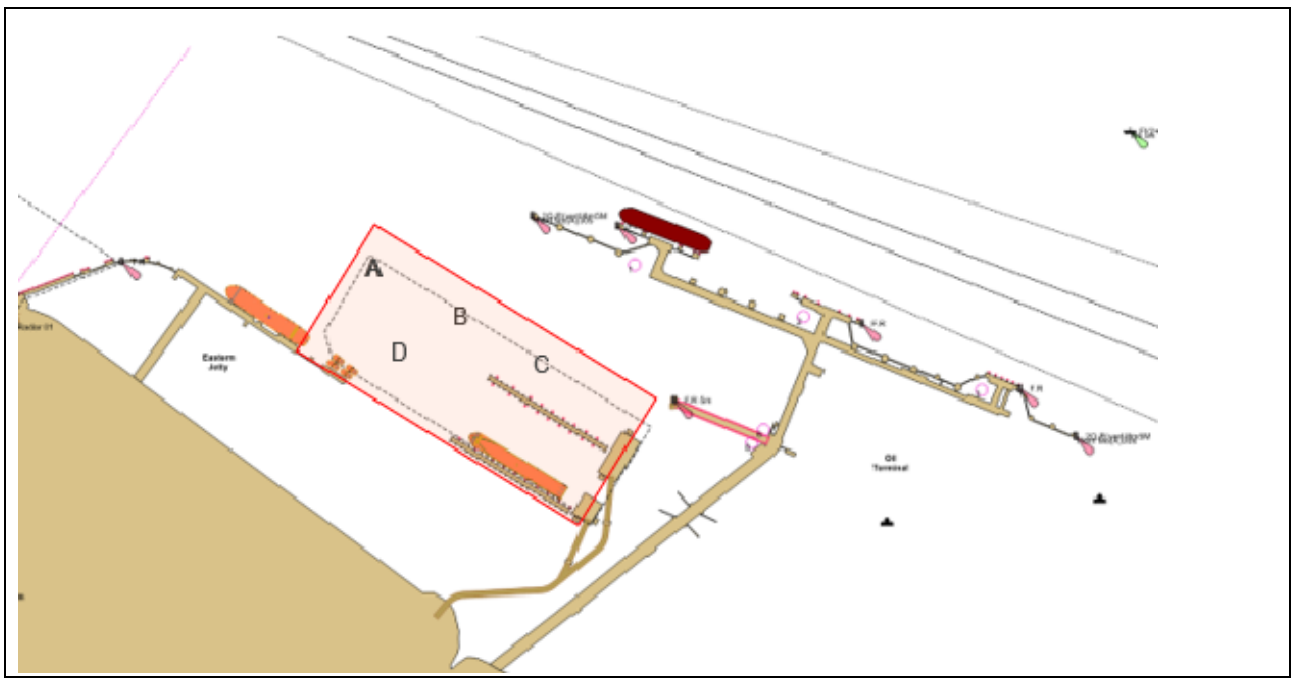


Figure 1: Diagram indicating area where enhanced operational controls are being considered, and locations referred to in the run summary.

Consideration was also given to bridge team errors. It is not feasible to test speculative human errors in the simulator. If in due course a specific scenario can be identified, then a simulation to understand that could be developed.

We look forward to taking this work forward with stakeholders in due course.

Yours sincerely

Mike Parr
Principle Scientist

Enclosures:
1. Run Summary
2. Track plots

Simulation run summary

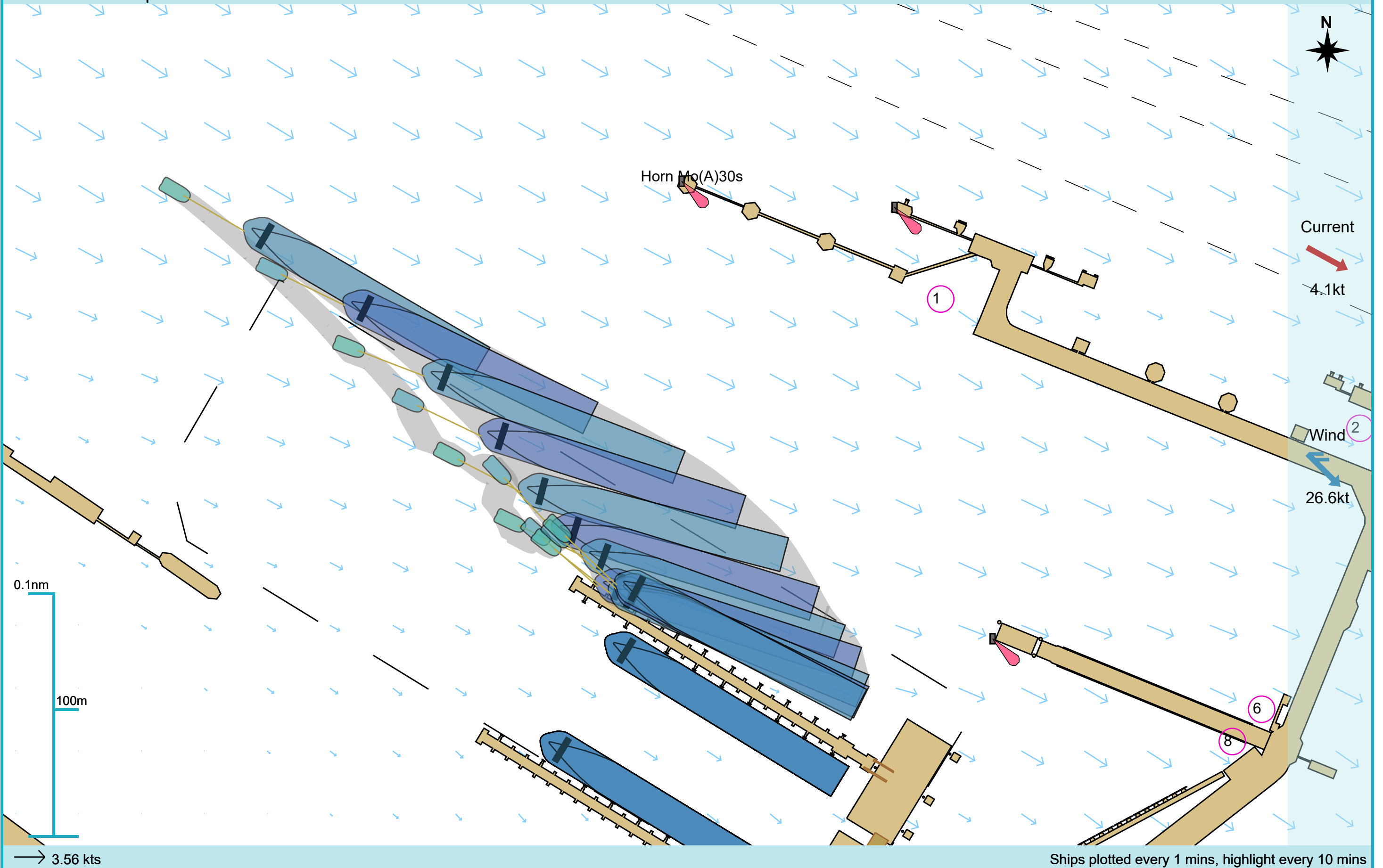
The simulation run summary is shown in Table 4.2. The following abbreviations are used in the table:

Table Error! No text of specified style in document..1: Run summary of loss of control at RoRo terminal

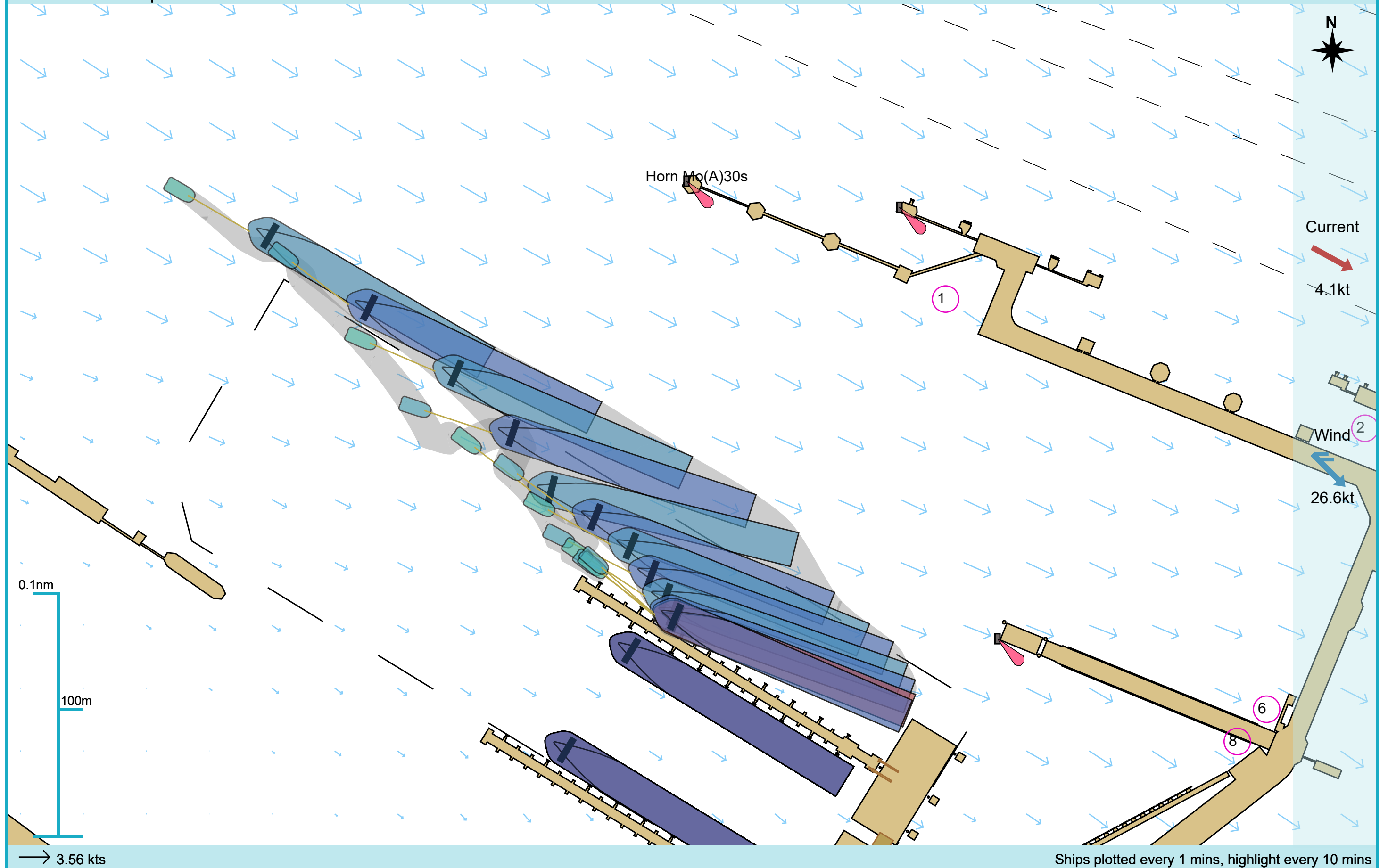
Run ID	Starting site	Starting SOG Astern (knots)	Layout	Vessel	Tugs	Tide (to) (time, state)	Flow at pt A	Wind (from) (dir, speed)	Time (minutes)
1	A	2.5	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward No movement	Peak Spring Ebb HW + 3 hours Scale: 1.2	4.4 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	08:30
2	A	2.5	Without protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward No movement	Peak Spring Ebb HW + 3 hours Scale: 1.2	4.4 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	06:30
3	A	0.0	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward No movement	Peak Spring Ebb HW + 3 hours Scale: 0.75	2.6 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	1:30
4	A	0.5	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward No movement	Peak Spring Ebb HW + 3 hours Scale: 0.75	2.6 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	2:00
5	A	1.5	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward	Peak Spring Ebb HW + 3 hours Scale: 0.75	2.6 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	
6	B	0.5	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward	Peak Spring Ebb HW + 3 hours Scale: 1.2	4.4 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	
7	B	1.1	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward	Peak Spring Ebb HW + 3 hours Scale: 1.2	4.4 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	5:00
8	B	1.1	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward	Peak Spring Ebb HW + 3 hours Scale: 1	3.5 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	
8A	B	1.1	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward	Peak Spring Ebb HW + 3 hours Scale: 1	3.5 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	07:15
9	B	0.5	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward	Peak Spring Ebb HW + 3 hours Scale: 1.2	4.4 knots 119°T	NW (315°) 27.5 knots ± 2.5 knots	10:00 +
10	B	1.5	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward	Peak Spring Ebb HW + 3 hours Scale: 1.2	4.4 knots 119°T	NE (045°) 27.5 knots ± 2.5 knots	04:00
11	B	1.5	With protection	Stena Transit	1 x 50t ASD Tug Tug 1: Centre-lead Forward	Peak Spring Ebb HW + 3 hours Scale: 1.2	4.4 knots 119°T	SW (225°) 27.5 knots ± 2.5 knots	04:00

Run ID	Starting site	Starting SOG Astern (knots)	Layout	Vessel	Tugs	Tide (to) (time, state)	Flow at pt A	Wind (from) (dir, speed)	Time (minutes)
12	B	1.0	With protection	MV Celine	2 x 50t ASD Tug Tug 1: Centre-lead Forward	Peak Spring Ebb HW + 3 hours Scale: 1.2	4.4 knots 119°T	NE (045°) 27.5 knots ± 2.5 knots	07:30

Manoeuvre track plot



Manoeuvre track plot



0.1nm
100m

→ 3.56 kts



Current
4.1kt

Wind
26.6kt

1

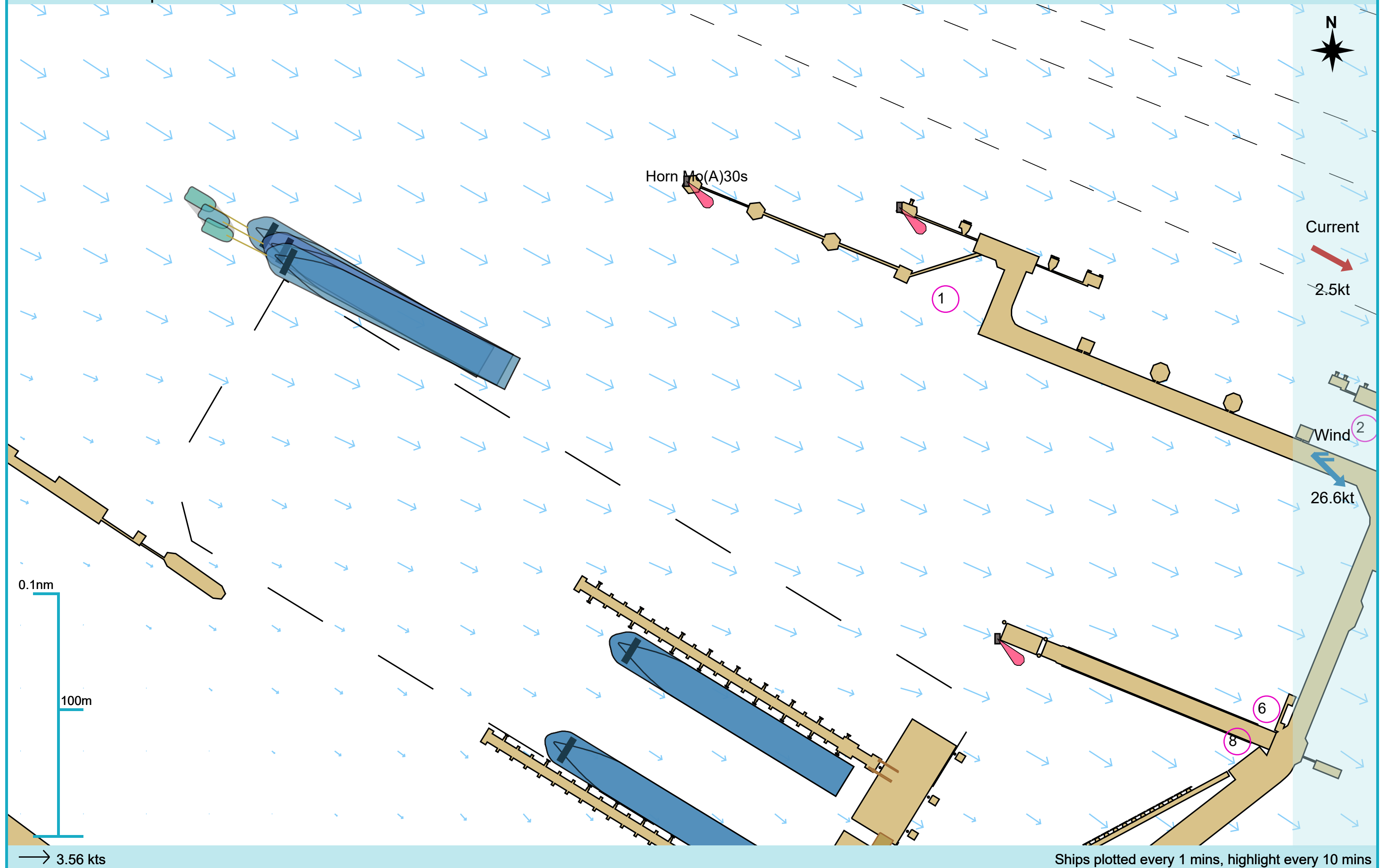
2

6

8

Ships plotted every 1 mins, highlight every 10 mins

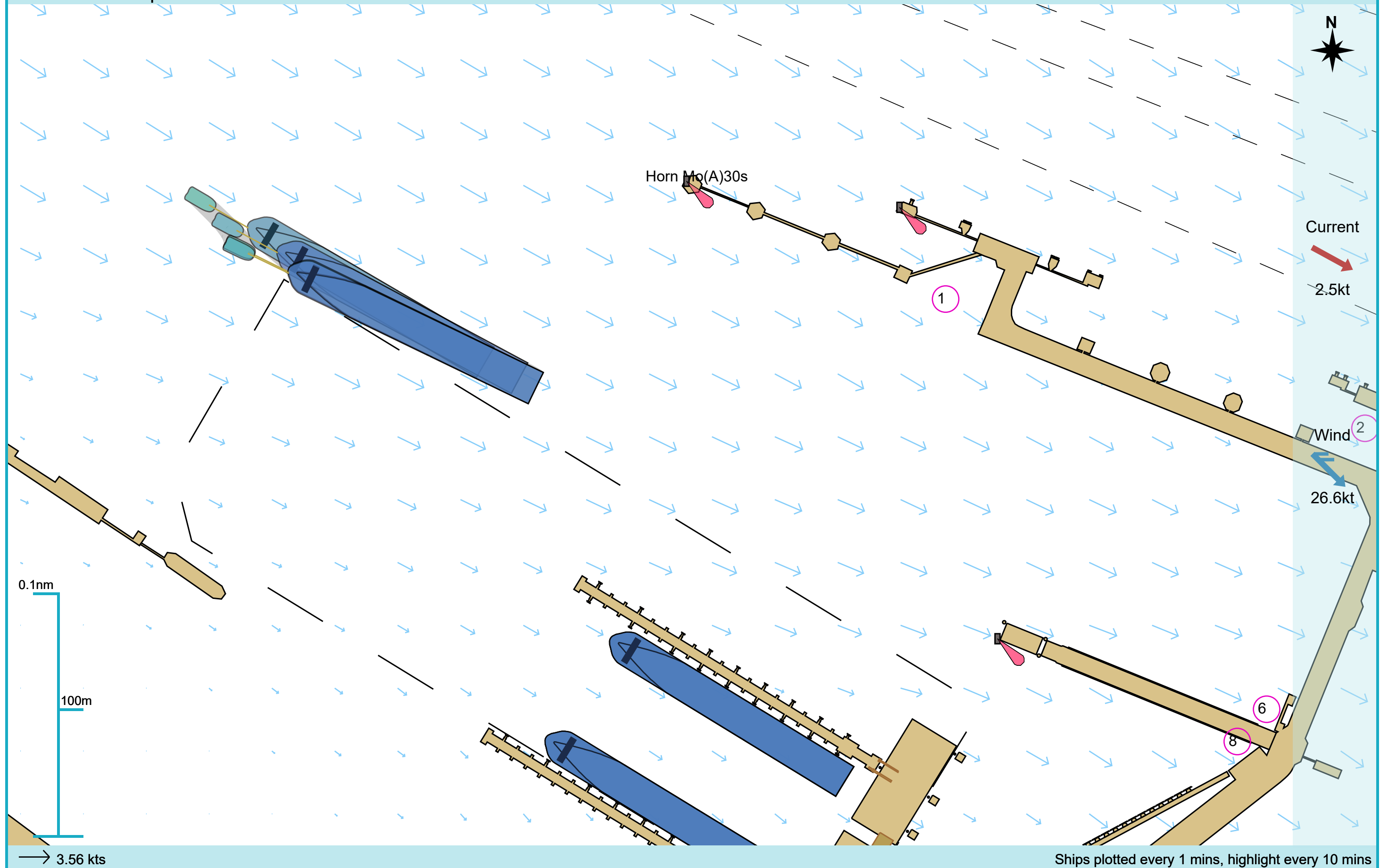
Manoeuvre track plot



→ 3.56 kts

Ships plotted every 1 mins, highlight every 10 mins

Manoeuvre track plot



0.1nm

100m

→ 3.56 kts



Current

2.5kt

Wind

26.6kt

1

2

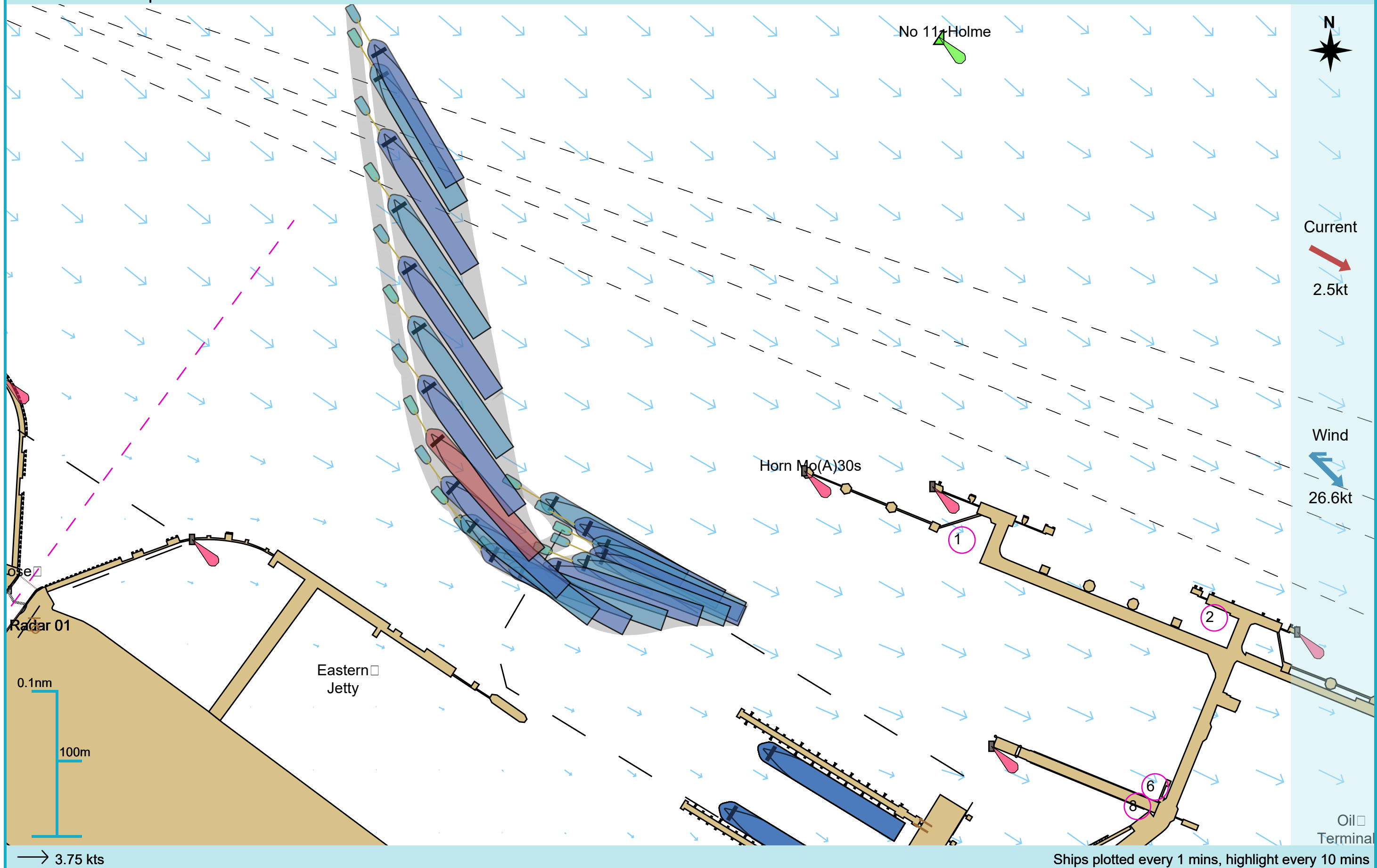
6

8

Horn Mo(A)30s

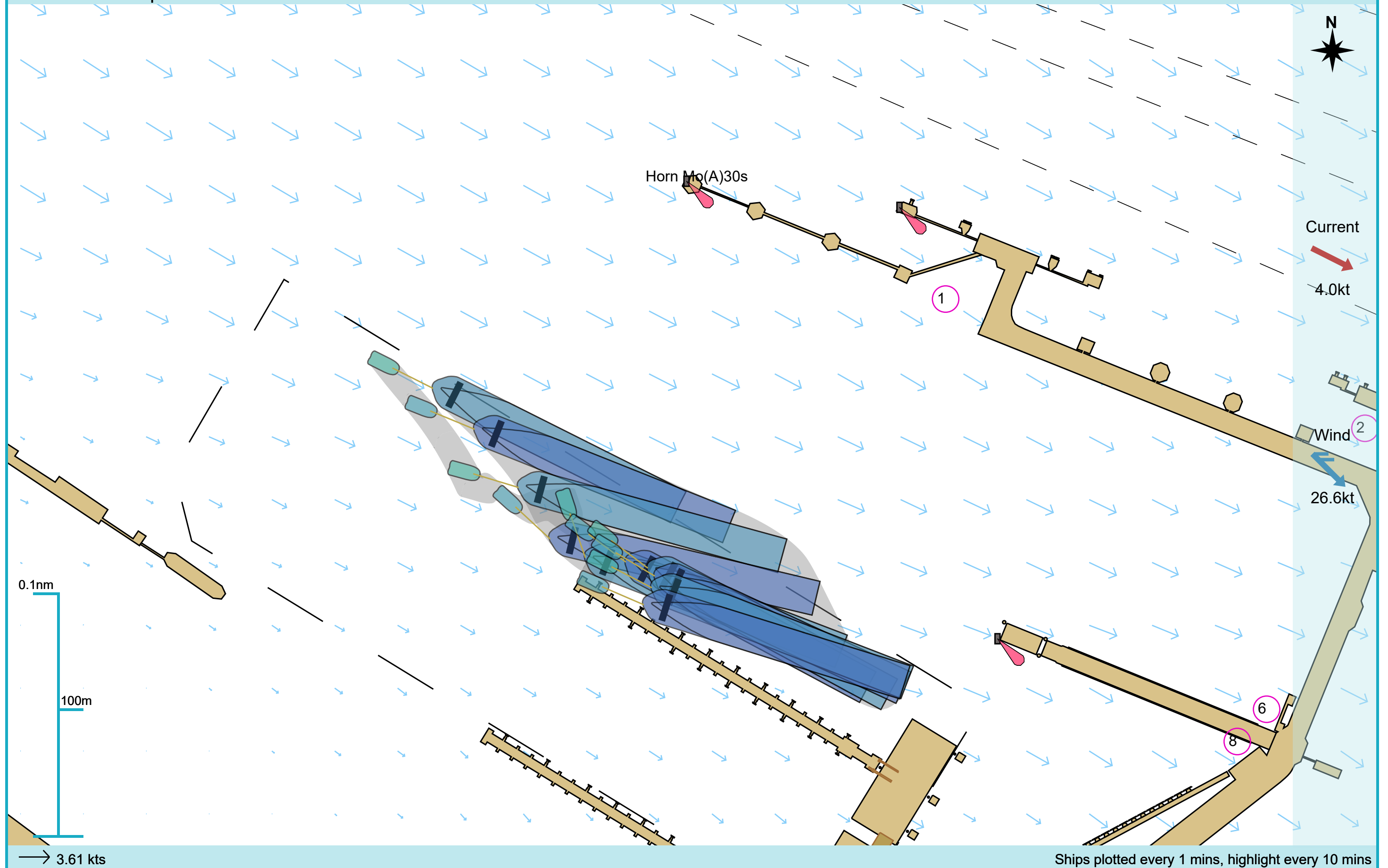
Ships plotted every 1 mins, highlight every 10 mins

Manoeuvre track plot

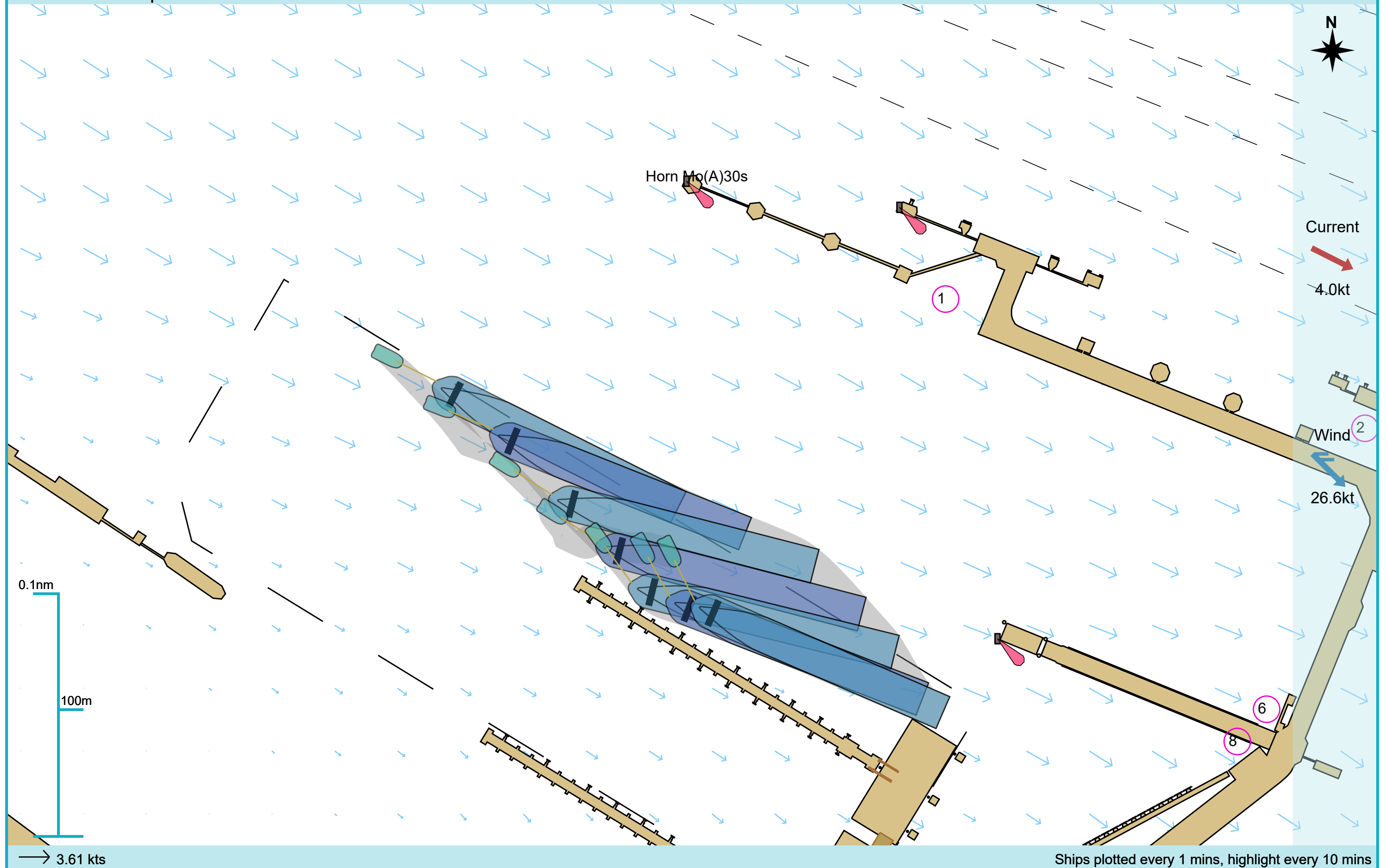


Ships plotted every 1 mins, highlight every 10 mins

Manoeuvre track plot

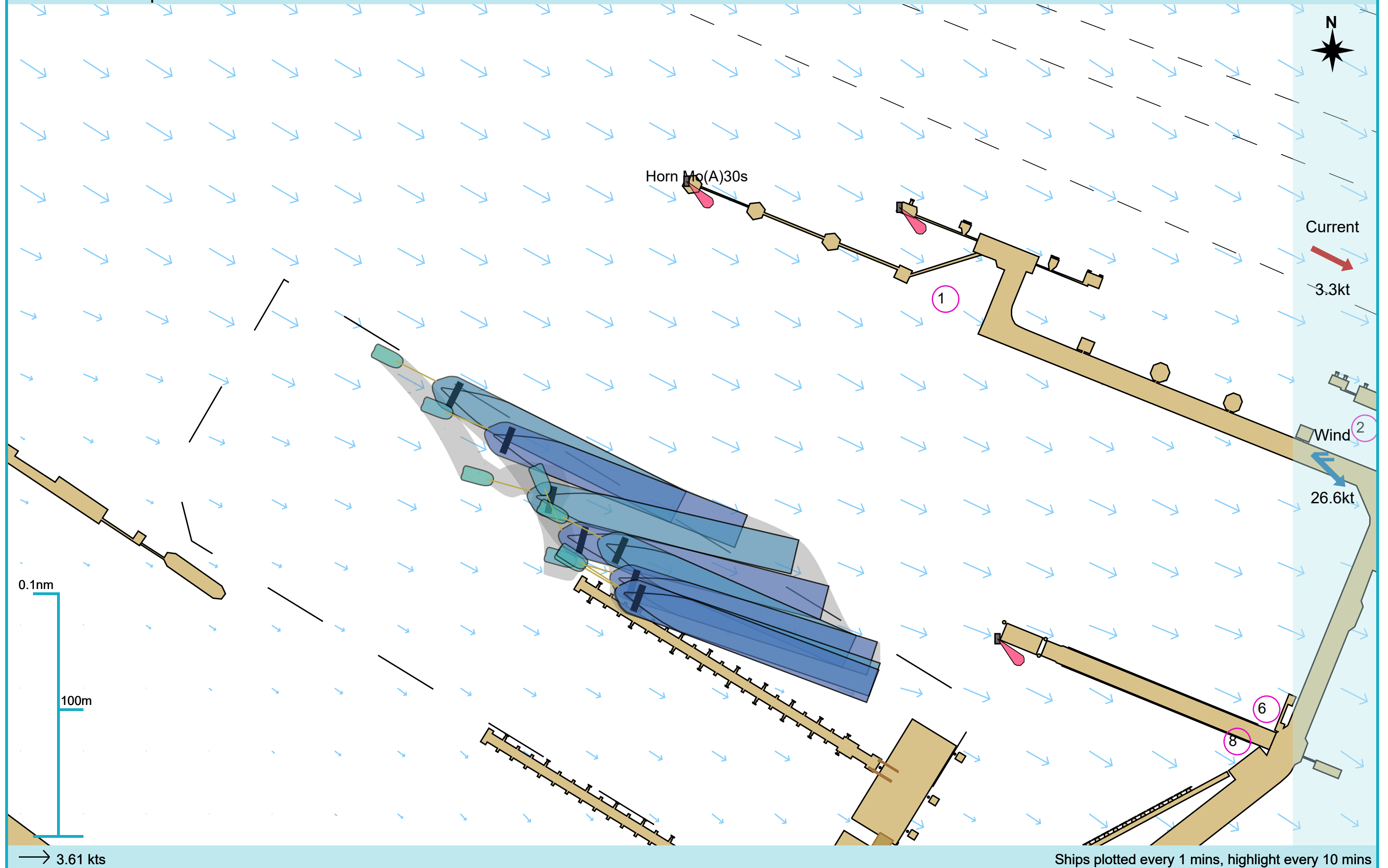


Manoeuvre track plot



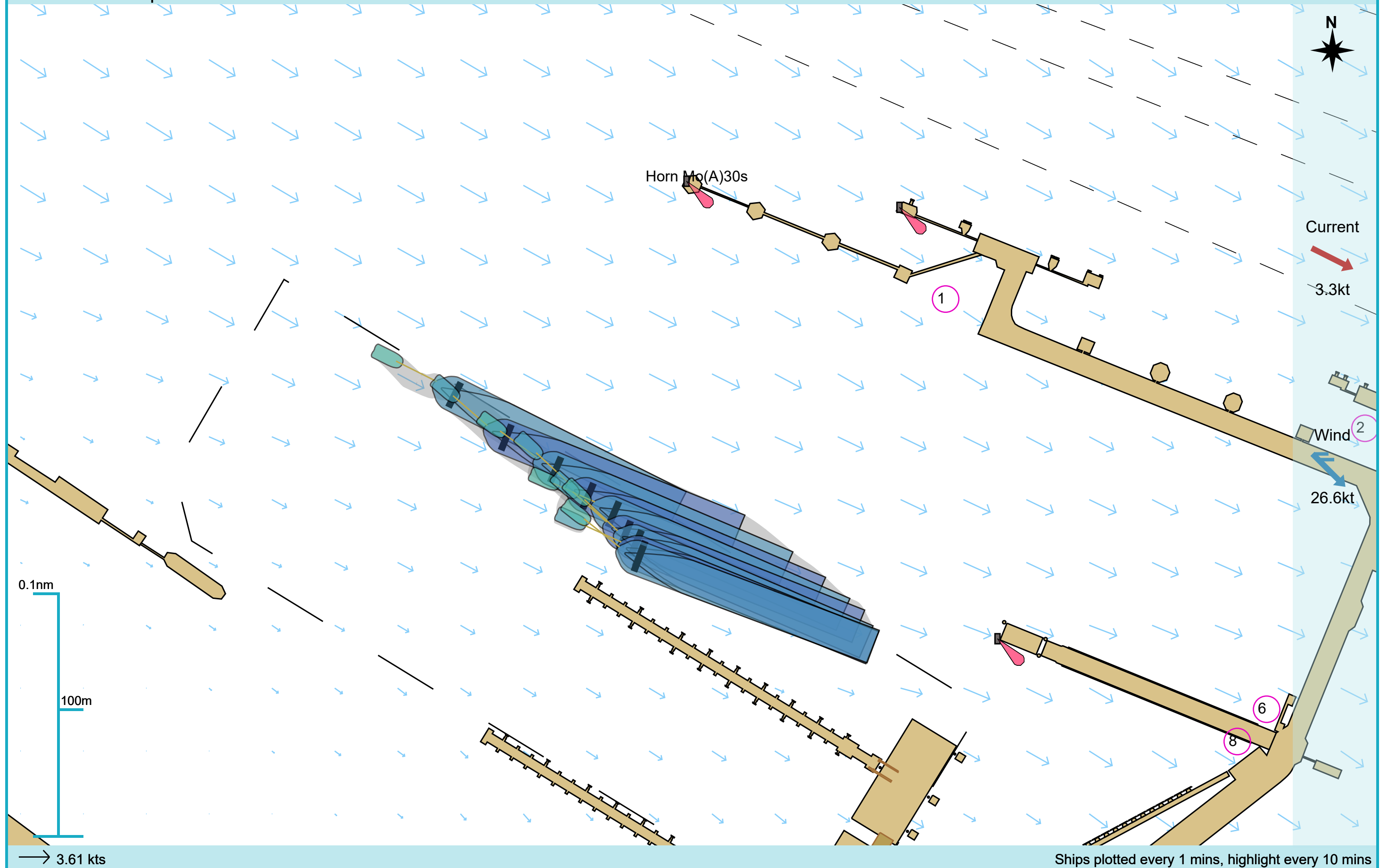
Ships plotted every 1 mins, highlight every 10 mins

Manoeuvre track plot



Ships plotted every 1 mins, highlight every 10 mins

Manoeuvre track plot



0.1nm
100m

→ 3.61 kts



Current
3.3kt

Wind
26.6kt

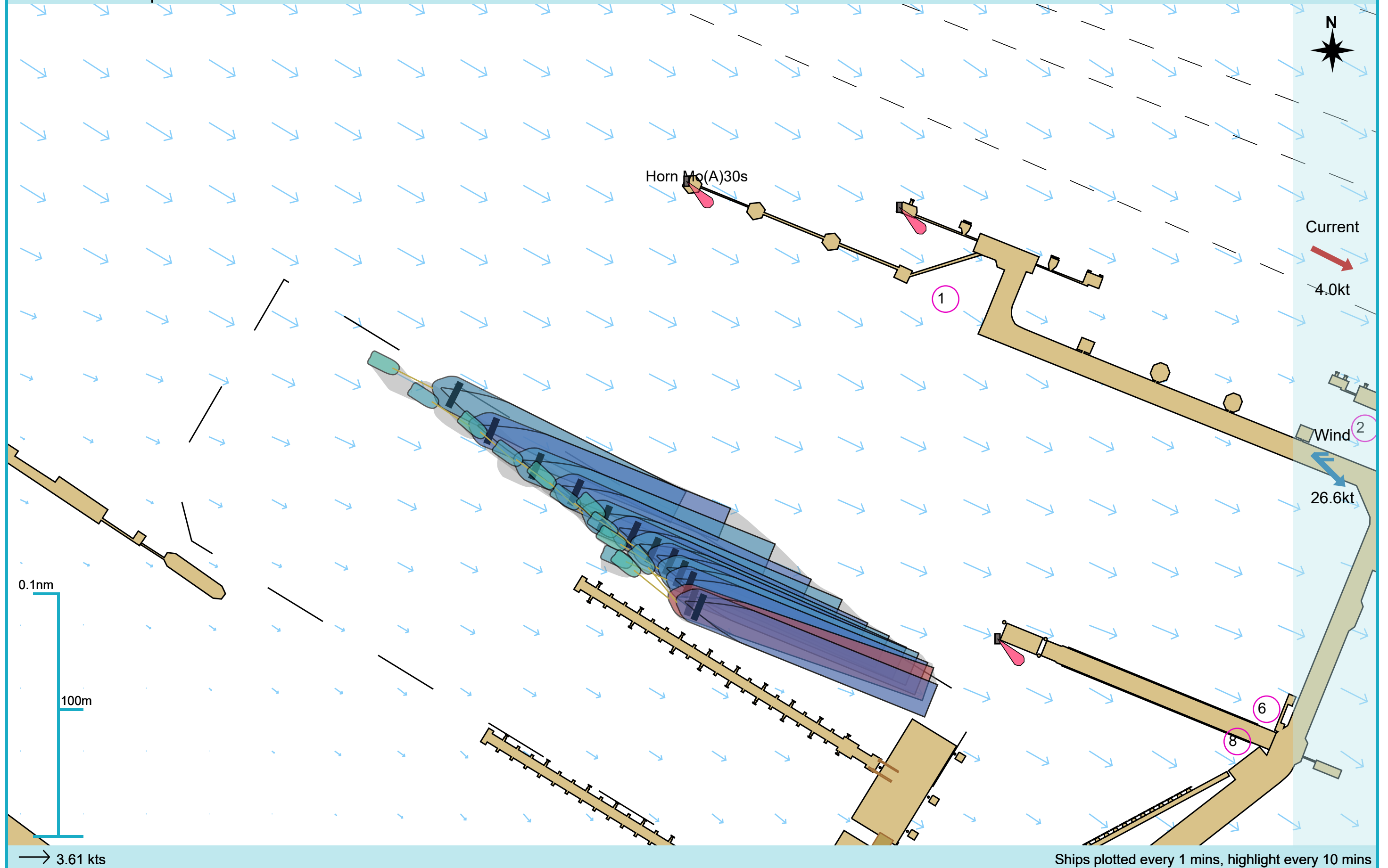
1

2

6

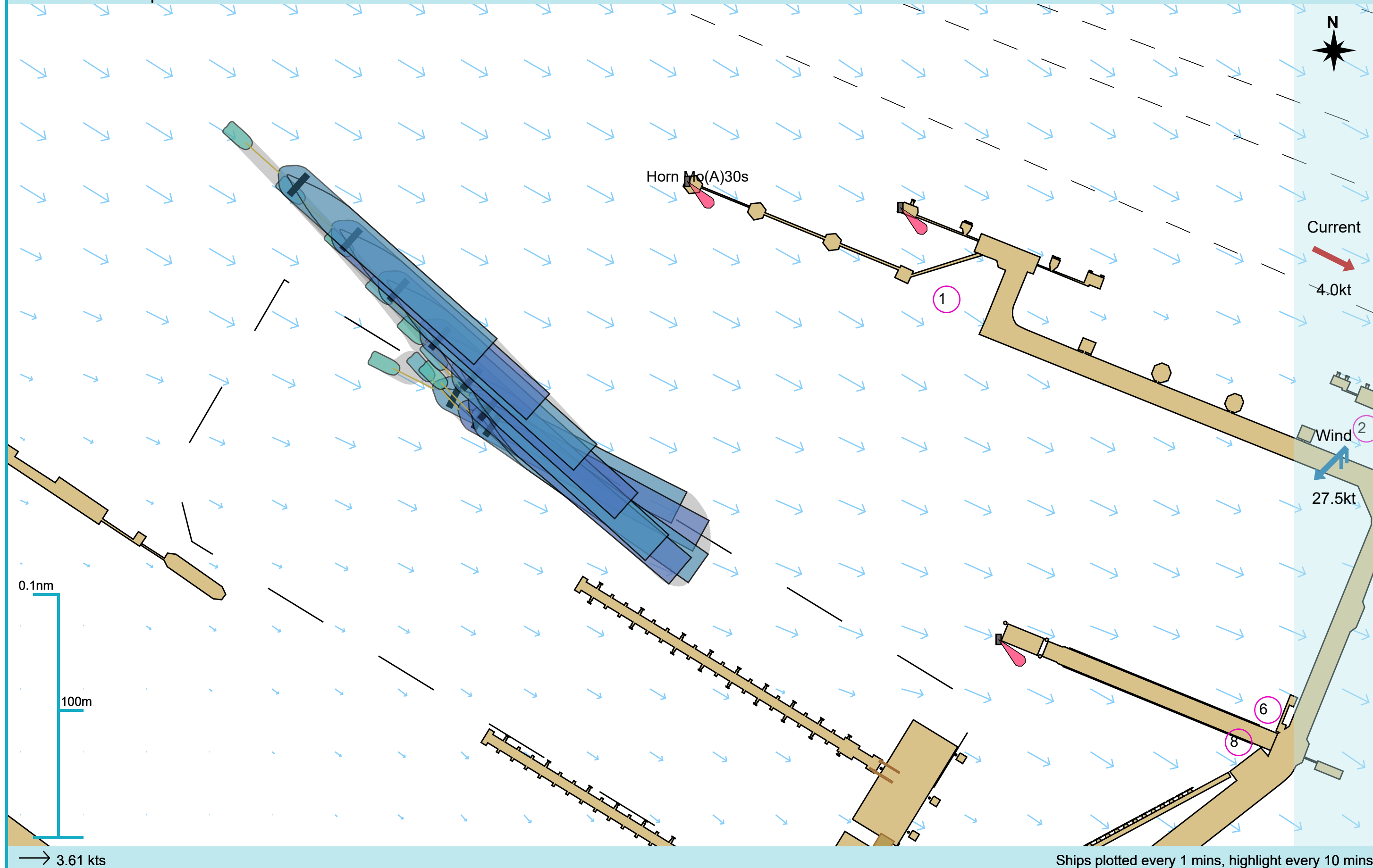
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Manoeuvre track plot

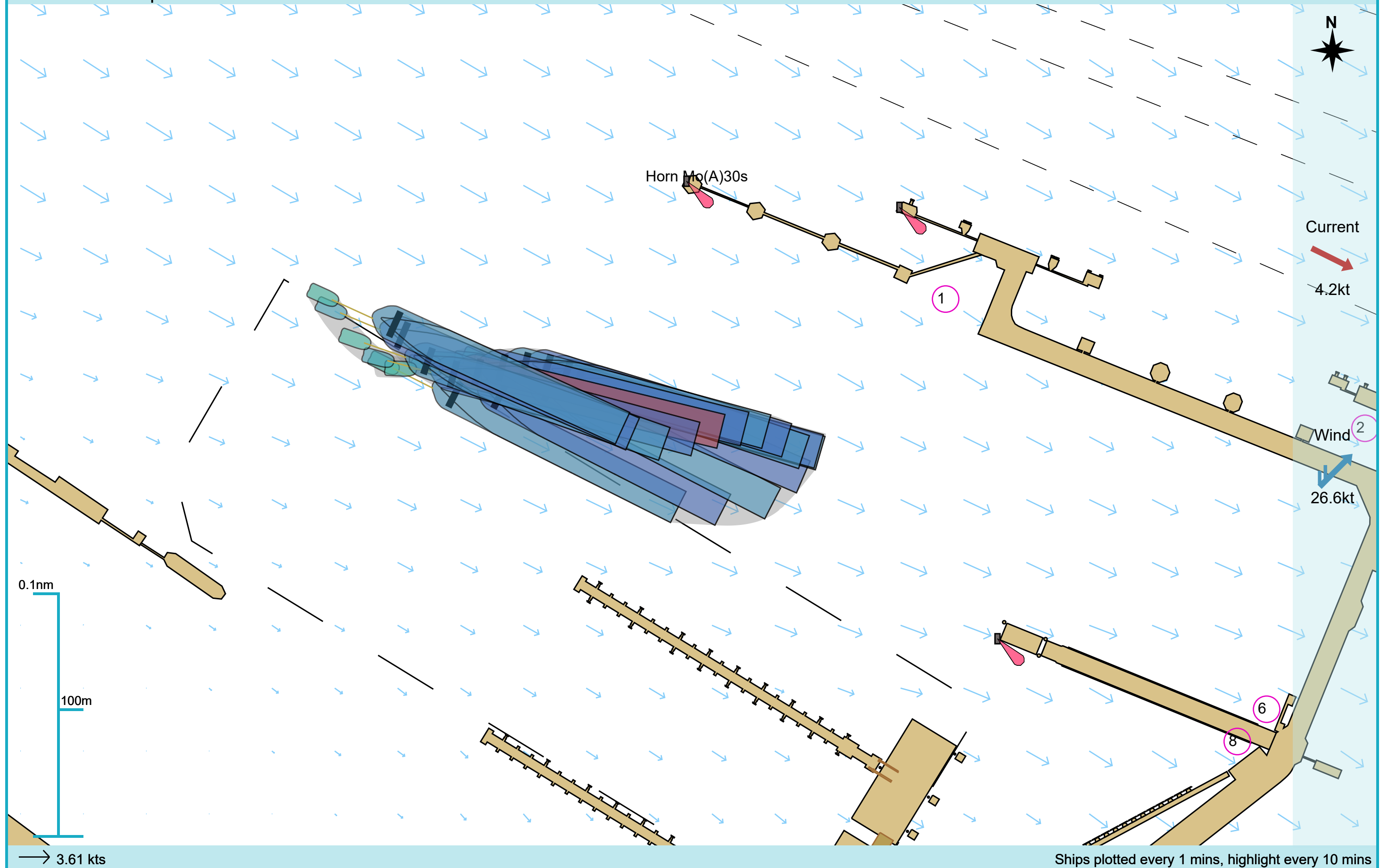


Ships plotted every 1 mins, highlight every 10 mins

Manoeuvre track plot



Manoeuvre track plot



0.1nm
100m

→ 3.61 kts



Current
4.2kt

Wind
26.6kt

Horn Mo(A)30s

1

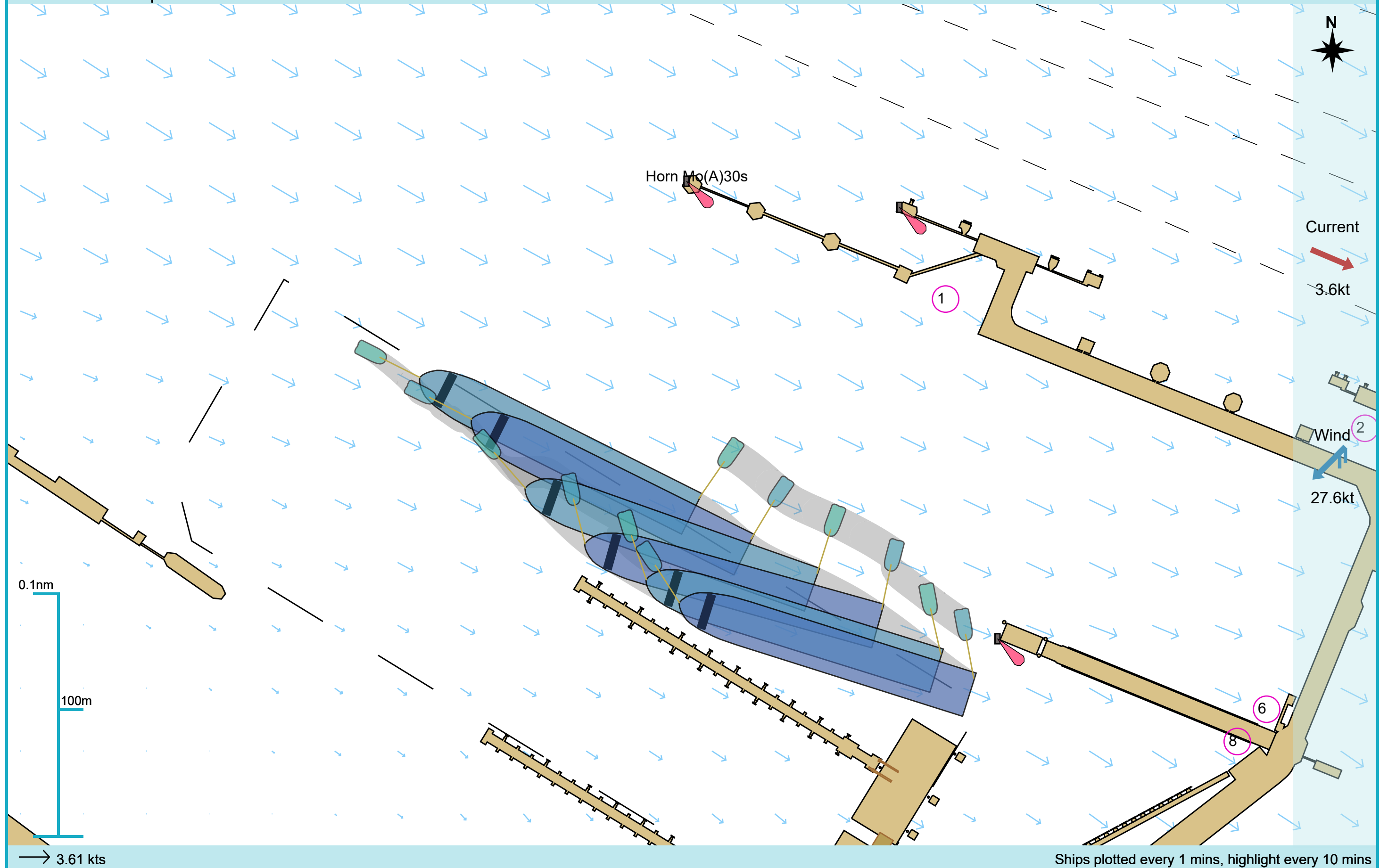
2

6

8

Ships plotted every 1 mins, highlight every 10 mins

Manoeuvre track plot



0.1nm
100m

→ 3.61 kts

Ships plotted every 1 mins, highlight every 10 mins