Canadian Marine Shipping Risk Forum

Improving AIS Analysis for Vessel Tracking

September 24, 2025

ClearSeas

MEOPAR
MARINE ENVIRONMENTAL OBSERVATION PREDICTION & RESPONSE NETWORK

ABOUT THIS REPORT

This report summarizes highlights of the online workshop, “Improving AIS Analysis for Vessel Tracking”, convened by the Canadian Marine Shipping Risk Forum (CMSRF) on September 24, 2025. The workshop aimed to engage a broad community of practitioners in shipping research and application. The CMSRF is a MEOPAR-funded Community of Practice providing an ongoing forum for communicating about and identifying potential collaborations on shipping risk in Canada.

The goal of this workshop was to gather representatives of government agencies, Indigenous groups, researchers, industry and other relevant organizations from across Canada whose work focuses on maritime shipping in a collaborative workshop where they can share their experience using the Automatic Identification System (AIS) for vessel tracking.

The workshop offered participants the opportunity to hear from leading experts, share novel techniques, and suggest improvements or best practices to overcome common challenges when working with AIS data in a Canadian marine shipping context.

Four priority issues (handling data errors and data gaps in AIS data; tracking MMSI and IMO numbers over time; generating vessel track lines from AIS data; & using “navigational status” data in analysis) were identified by registrants through a survey submitted prior to the workshop. Interest was demonstrated by the engaged participation of over 30 registrants from academia, industry, government, and non-governmental organizations from across Canada.

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WORKSHOP OVERVIEW

The CMSRF community of practice hosted an interactive online workshop on September 24, 2025 on Improving AIS Analysis for Vessel Tracking. This workshop was part of a planned series of workshops and webinars to explore related topics in shipping risk and provide a recurring forum for knowledge exchange.

Recently, the need for focused research and standardized approaches to handling AIS data was identified as a topic of interest to members of the Canadian Marine Shipping Risk Forum (CMSRF). Because AIS-sourced data comes with significant and unique challenges, there is a need to catalog and share resources, and identify and fill gaps. This workshop gathered stakeholders—including providers of AIS data and AIS infrastructure, researchers, government, industry, and interested members of the public—to confer on shared challenges in processing AIS and vessel attributes.

A pre-workshop survey was sent out to identify specific challenges or gaps of relevance. The four priority issues identified by registrants were:

- Handling data errors and data gaps in AIS data
- Tracking MMSI and IMO numbers over time
- Generating vessel track lines from AIS data
- Using “navigational status” data in analysis

The workshop began with short presentations on each topic by subject-matter experts, after which participants self-selected into breakout rooms to discuss one of the topics in greater detail. Breakout groups then presented a summary of their discussions and highlighted key insights and knowledge gaps.

Across the discussions, several common themes emerged. Participants emphasized the value of transparent, documented parameters for building and breaking vessel tracks (including dynamic time–distance thresholds and anomaly checks), and noted that navigational status is best used as supplementary information, with behaviour more reliably inferred from speed and context. The need to anchor vessel identity on IMO numbers was underscored, as MMSI numbers are transient and liable to change frequently. Interest in a shared, open metadata resource linking IMO and MMSI over time was expressed. Participants also pointed to practical considerations for fusing terrestrial and satellite feeds, sequencing by transmit timestamps, and using context-specific speed bins (e.g., open ocean vs. port environments).

The workshop provided opportunities for sharing tools and resources, illustrating potential approaches and use cases, and strengthening connections among practitioners. Input from the plenary and breakout discussions will be collated by the Community of Practice with the purpose to help guide researchers, government, and industry using AIS data. Follow-up sessions and further discussions will be scheduled with the goal of further developing standard practices for working with AIS data and facilitating conversations between multiple stakeholders. This report will be made public on the CMSRF webpage and circulated to the participants.

ABOUT THE CMSRF COMMUNITY OF PRACTICE

This Community of Practice was formed in response to an identified need in Canada for an on-going forum to discuss developments in marine shipping modelling and risk assessment. The MEOPAR Research Network, in collaboration with Clear Seas, launched this Community of Practice to be open to, and supportive of, people and organizations working and doing research in these fields, and to network and share knowledge on these topics.

This Community of Practice – focused on modelling and risk assessment for marine shipping – is one of eight such communities supported by MEOPAR to:

- Help to mobilize knowledge, enrich research and identify knowledge gaps, and encourage collaboration between academics, practitioners, policy-makers and community groups.
- Provide a way for practitioners to share best practices, ask questions of their colleagues, and provide support for each other.

The Canadian Marine Shipping Risk Forum Community of Practice focuses on the exploration of risks from – and to – shipping within Canadian waters, with three primary interest areas:

- Shipping movement data
- Shipping traffic modeling
- Shipping risk quantification and assessment

The objectives of this Community of Practice and its activities include:

- Identifying best practices for shipping modeling and shipping risk analysis
- Maintaining active discussion on new developments in marine shipping data sources
- Identifying gaps in marine shipping risk assessment and sharing knowledge to address them
- Engaging with stakeholders and highly qualified personnel to develop further knowledge on approaches for considering shipping risk as well as techniques on shipping data handling through the inclusion of training components within each of the workshops.

Ultimately, this Community of Practice provides a focal event for identifying, discussing and furthering application of best practices for shipping modelling and shipping risk analysis, topics inherently interdisciplinary in nature.

WORKSHOP HIGHLIGHTS

Workshop Objectives

The focus of this workshop was to begin developing standard practices and sharing resources for improving AIS analysis for vessel tracking, through a facilitated set of presentations and breakout discussions with the broader CMSRF community. Workshop attendees were solicited through the CMSRF Community of Practice network, with the aim of gathering a diverse group of participants who could both provide input on what should be included in a common approach and offer representative perspectives from intended users of AIS-sourced data.

The purpose of this workshop was to introduce key AIS analysis concepts and provide opportunities for participants to share and comment on their experience using AIS data in a marine shipping vessel tracking context. The workshop was intended to help identify and address challenges in AIS data analysis and communication by:

- Outlining a common workflow for AIS data (ingest, quality control, source fusion, sequencing, track construction, and behavior classification),
- Mapping challenges, methods, and resources to that framework to support consistent, transparent practice, and
- Identifying specific areas in need of greater research and investigation.

Workshop Approach

Experts on each of the four priority issues to be discussed in the workshop were invited to give a short (5 minute) presentation introducing the topic. After this, participants self-selected into one of four breakout rooms, each discussing one of the priority issues in greater detail, before reporting back to the plenary session and sharing key points and summaries of their discussion.

Key findings

Best Practices

- **Vessel identity:** Use **IMO** number as the primary identifier for all vessels. **MMSI** numbers are more likely to change between sailings.
- **Timestamp handling:** Sequence AIS by **transmission time**; distinguish and document `transmitted_at` vs `created_at` and note feed-specific latency/clock-skew.
- **Multi-feed fusion & "zig-zag" artifacts:** Zig-zagging is often caused by fusing data from land-based and satellite transmissions. Apply explicit de-duplication and conflict-resolution rules, preferring terrestrial sources when duplicates exist. Handle satellite-fed data with extra care due to higher duplication and latency.
- **Track construction:** Use **adaptive** time–distance gates (port vs open ocean) with anomaly detection / predicted-next-point checks. Keep break/reconnect parameters transparent and documented.
- **"Navigational status":** Treat navigational status as **supplementary only**; infer behavior

primarily from speed, course, and geography. AIS navigational status can be used for coarse filtering/QA, but should not be used as the sole classifier.

- **Speed metrics & visualization:** Prefer **speed over ground (SOG) from vessel GPS**. Define context-specific speed bins (e.g., maneuvering vs underway; ports vs open ocean) and adopt consistent symbology; for large vessels, typical underway thresholds of $\sim$6–8 kt were noted.
- **Coverage documentation:** Note Arctic/remote gaps and, where feasible, fuse adjunct sources (e.g., AIS Hub, EMSA receivers) when AIS is intermittent. Note that limited coverage and data fusion is more likely to cause artifacts in the AIS trace line, i.e., unrealistic track segments like zig-zags, jumps, or gaps that arise from data errors or processing rather than the vessel's true movement.

Future Work

- **Open identifiers registry:** Develop and maintain an open **IMO$\leftrightarrow$MMSI** mapping with change history and provenance.
- **Timestamp standards:** Providers to publish unambiguous timestamp semantics and latency guidance (e.g., `transmitted_at` vs `created_at`); consumers to align pipelines accordingly.
- **Fusion specification:** Create a community specification for de-duplication and conflict resolution across terrestrial/satellite feeds to minimize zig-zag artifacts.
- **Reference parameters & benchmarks:** Publish example $\Delta t/\Delta d$ ranges by environment/vessel class; release a small open benchmark dataset and a reference implementation for track-building.
- **Visualization guidance:** Standardize speed-bin thresholds and symbology for common applications (e.g., ports, emissions, underwater noise, strike risk).
- **Provider corrections:** Request corrective re-releases for 2024 Canadian Coast Guard datasets affected by transient MMSI numbers, and an authoritative MMSI-change history service.
- **Arctic/remote infrastructure:** Explore expansion of terrestrial receivers and integrate community stations. Improve discoverability and integration of existing feeds with more official sources.

APPENDIX A -- WORKSHOP PROGRAM

Time (PT)	Topic / Activity	Speaker
10:00	Roundtable Introductions	All Participants
10:10	Topic Presentation: Handling AIS data errors and data gaps	Norma Serra Sogas (Transport Canada)
10:15	Topic Presentation: Generating vessel track lines from AIS data	Tessa Coulthard (Clear Seas)
10:20	Topic Presentation: Tracking MMSI and IMO number changes over time	Ben Friedrich (GSTS)
10:25	Breakout Group Discussion	—
11:00	Break	—
11:05	Breakout Groups Report Back	—
11:20	General Discussion	—
11:25	Closing Statements	Meghan Mathieson (Clear Seas)

APPENDIX B -- SPEAKER BIOS

Norma Serra Sogas (Transport Canada): Environmental Analyst Norma is an environmental analyst with Transport Canada under the Oceans Protection Plan. Among other tasks, her work involves developing systems and methods for collecting and analyzing vessel information to inform the assessment of vessel activities and their potential impacts to marine and coastal environments, including vessels that do not use AIS. Her interests include coastal conservation planning and management, and environmental impact assessments. Norma holds an MSc from the University of Victoria and previously was a Research Associate for over 10 years with the CORAL Research Group there.

Tessa Coulthard (Clear Seas): Research Lead As a Research Lead, Tessa brings skills and experience in spatial analysis and data visualization to the Clear Seas team. Making information about marine shipping clear and accessible by developing GIS mapping tools that allow users to learn about shipping in a fun, interactive way is a key part of her work. She enjoys learning about the interconnectedness of people and the environment and has a B.Sc. in Geography and Environmental Studies from the University of Victoria.

Benjamin Friedrich (GSTS): GIS Data Scientist Ben has been working on spatial problem solving and algorithms for AI based maritime domain awareness with GSTS for over 6 years. His work includes developing toolsets for maritime users to manage port logistics for shipping efficiency and planning. Ben has a Master of Science in Geomatics from Wilfrid Laurier University.

APPENDIX C -- WORKSHOP PARTICIPANTS

This workshop was attended by 34 of 52 registrants. This number excludes the workshop moderator. Of all registrants, 30 were on the CMSRF mailing list prior to the workshop, and 22 were not.

Attendees' names and organizations, and a breakdown by organization type, are provided below. This attendance summary was compiled from three information sources: the CMSRF subscribers list (people who signed up to receive notifications from CMSRF); the registration tracking list (used to track registrations and communication and which reflects the Eventbrite registration reports and manual registrations (people who emailed the organizers directly or who replied to Steering Committee member calendar invitations that were shared)); and the Zoom Meeting breakout room poll.

Room	Breakout topic
1	Using "navigational status" data in analysis
2	Tracking MMSI and IMO numbers over time
3	Handling data errors and data gaps
4	Generating vessel track lines from AIS data

Rm #	Name	Affiliation	Sector
1	Meghan Mathieson	Clear Seas	NGO
1	Cameron Duval	Datifex	Industry
1	Cihad Celik	Liverpool John Moores Univ.	Academic
1	Diane Wilson	Nature Way	NGO
1	Jasmine Sharifi	UBC	Academic
1	Rob Marshy	GSTS	Industry
1	Sidhant Bansal	WA Dept of Ecology	Government
1	Xinrui Liang	Dalhousie University	Academic
2	Paul Blomerus	Clear Seas	NGO
2	Adam Byrd	WA Dept of Ecology	Government
2	Benjamin Friedrich	GSTS	Industry
2	Deborah Sharpe	University of Victoria	Academic
2	Vaishnav Vaidheeswaran	Dalhousie University	Academic
3	Hugo Dignoes Ricart	Clear Seas	NGO
3	Adrian Nicoll	Transport Canada	Government
3	Alex Suchar	WA Dept of Ecology	Government
3	Amanda Belanger	DFO	Government
3	Jonathan Duguay	LPA	Industry
3	Lynne Hodge	UCAR CPAESS / NOAA SEFS	Government
3	Ruixin Song	Dalhousie University	Academic
3	Sierra Beacher	University of Ottawa	Academic

Rm #	Name	Affiliation	Sector
3	Zachary Klass	Transport Canada	Government
4	Tessa Coulthard	Clear Seas	NGO
4	Alexandra Mayette	Canadian Wildlife Federation	ENGO
4	Alison Cook	Scottish Association for Marine Science	Academic
4	Bretwood Higson	Nuka Research	Industry
4	Derek Eden	DHI	Industry
4	Stephanie Woodend	Transport Canada	Government
4	Zhewen Luo	University of Ottawa	Academic


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