

Example Use Cases of Historical Satellite AIS data for the Analysis of Maritime Activity in Polar Waters

Mr. Mark A. Stoddard, Dalhousie University, Canada

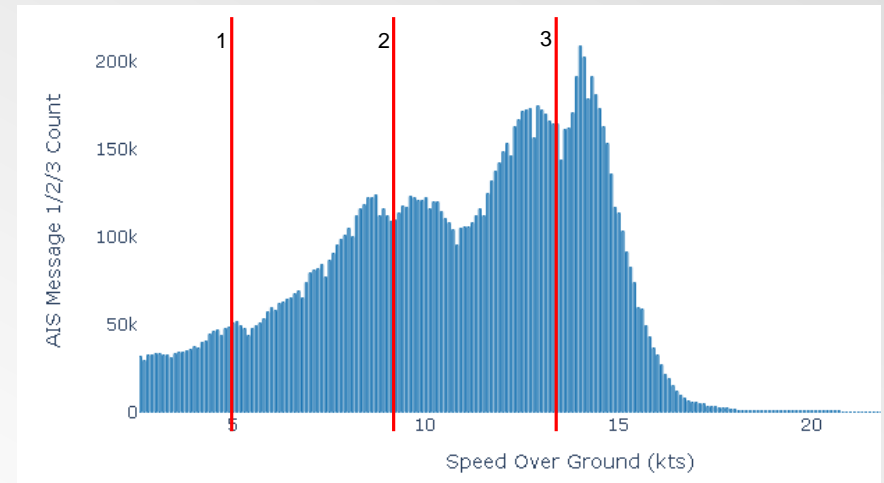
Dr. Ronald Pelot, Dalhousie University, Canada

Mr. Casey Hilliard, Dalhousie University, Canada

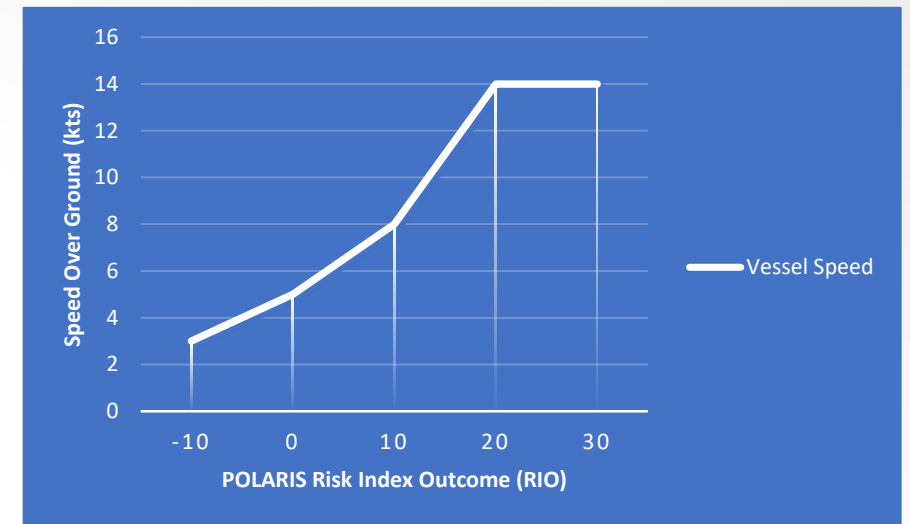


PhD Research Overview

- Research aims to develop a year-round measure of maritime remoteness and accessibility for coastal communities in the Canadian arctic
- Quantitative methods are focused arctic navigation risk assessment and transit time estimation
- Primary use of AIS data is to characterize polar vessel speeds in different ice regimes and associated navigational risk levels

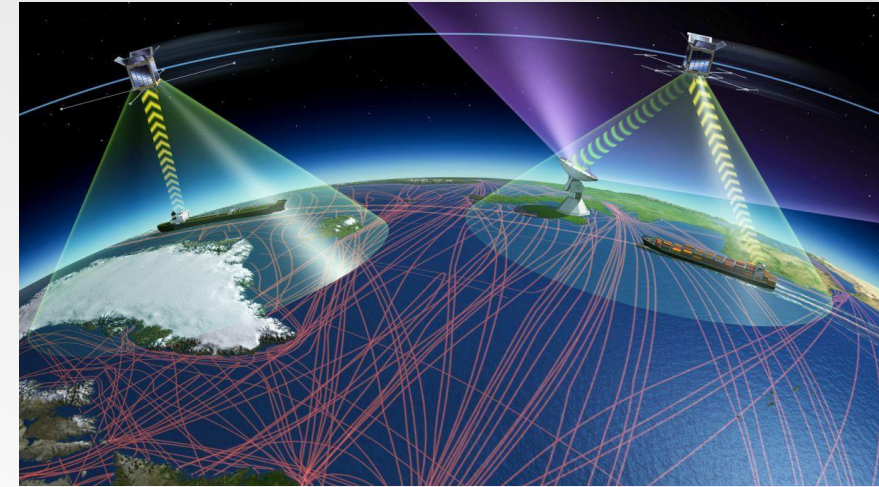


Vessel Speed Histogram for study area of interest

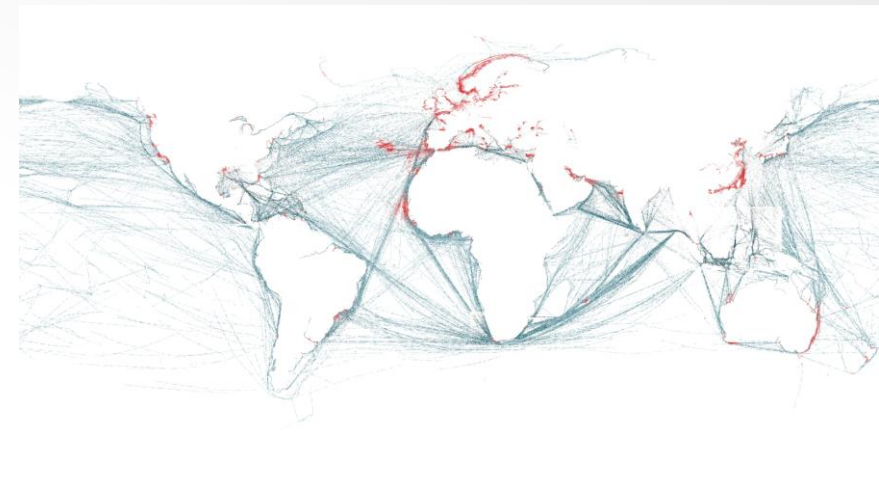


Automatic Identification System

- Automatic identification systems (AIS) transponders are designed to be capable of providing position, identification and other information about the ship to other ships, coastal authorities, ... and academic researchers, automatically.
- Since 2004, SOLAS regulation V/19 - "Carriage requirements for shipborne navigational systems and equipment" has required all ships of 300 gross tonnage to carry AIS.
- Early days of AIS vessel tracking dependent on network of shore-based AIS receivers. The advent of satellite-based AIS receivers, and rapid commercialization, has led to an explosion of global vessel tracking and related research.



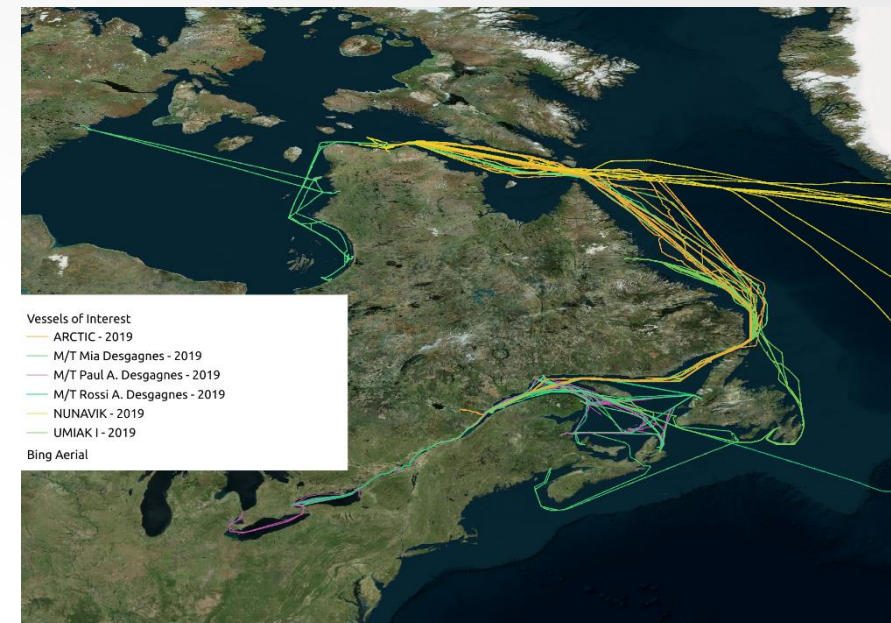
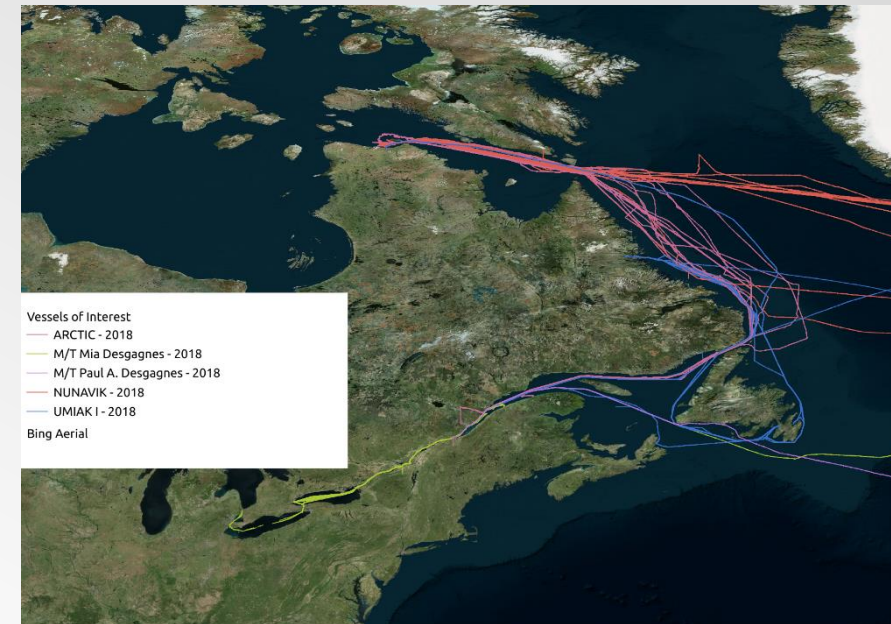
Source: Marine Industry News



Source: Spire Global Ltd.

AIS Data Set

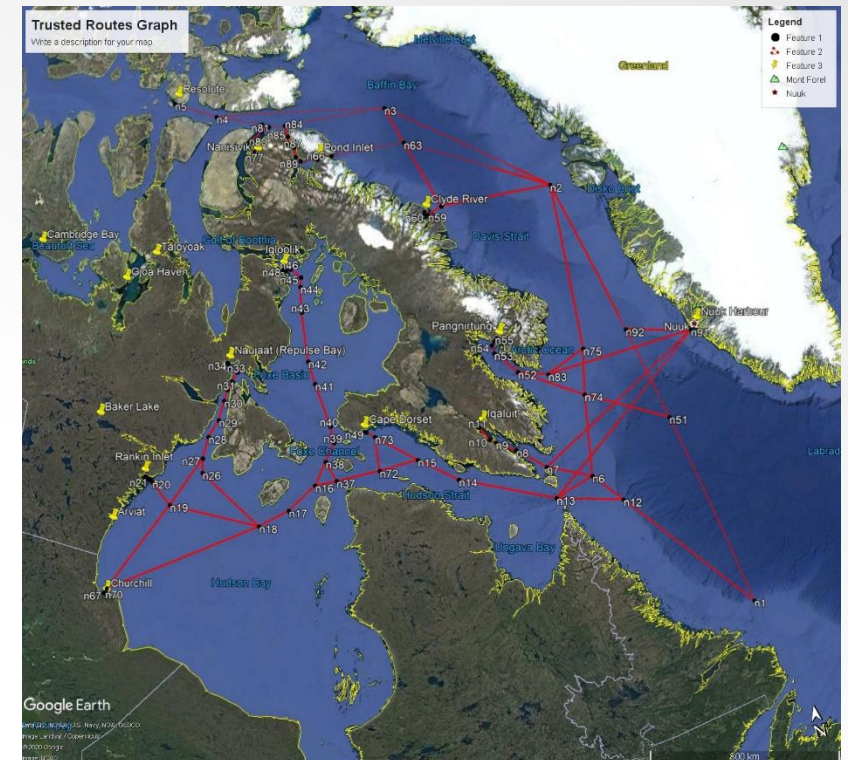
- AIS data set provided by Dalhousie University Institute for Big Data Analytics
 - Total AIS 1/2/3 Messages: ~20M
 - Temporal extent: 2018 to 2019
 - Spatial extent: 60N to 90N, circumpolar
 - Focus on AIS data from experience polar ship operator fleets on established routes (~100 polar class vessels)
 - Fednav Ltd. (65 vessels)
 - Degagnes (16 vessels)
 - Coastal Shipping Limited (3 vessels)
 - Neas (5 vessels)



Eastern Arctic Trusted Routes Graph

- The greatest challenge of including maritime transportation in quantitative studies of remoteness is the relatively unconstrained nature of navigation at sea.
- To overcome this challenge, Dalhousie University worked with expert navigators from the CCG and RCN to compile a list of trusted routes connecting several communities of interest in the eastern arctic.
- The routes were used to create a trusted routes graph, effectively constraining the feasible paths between origin and destination

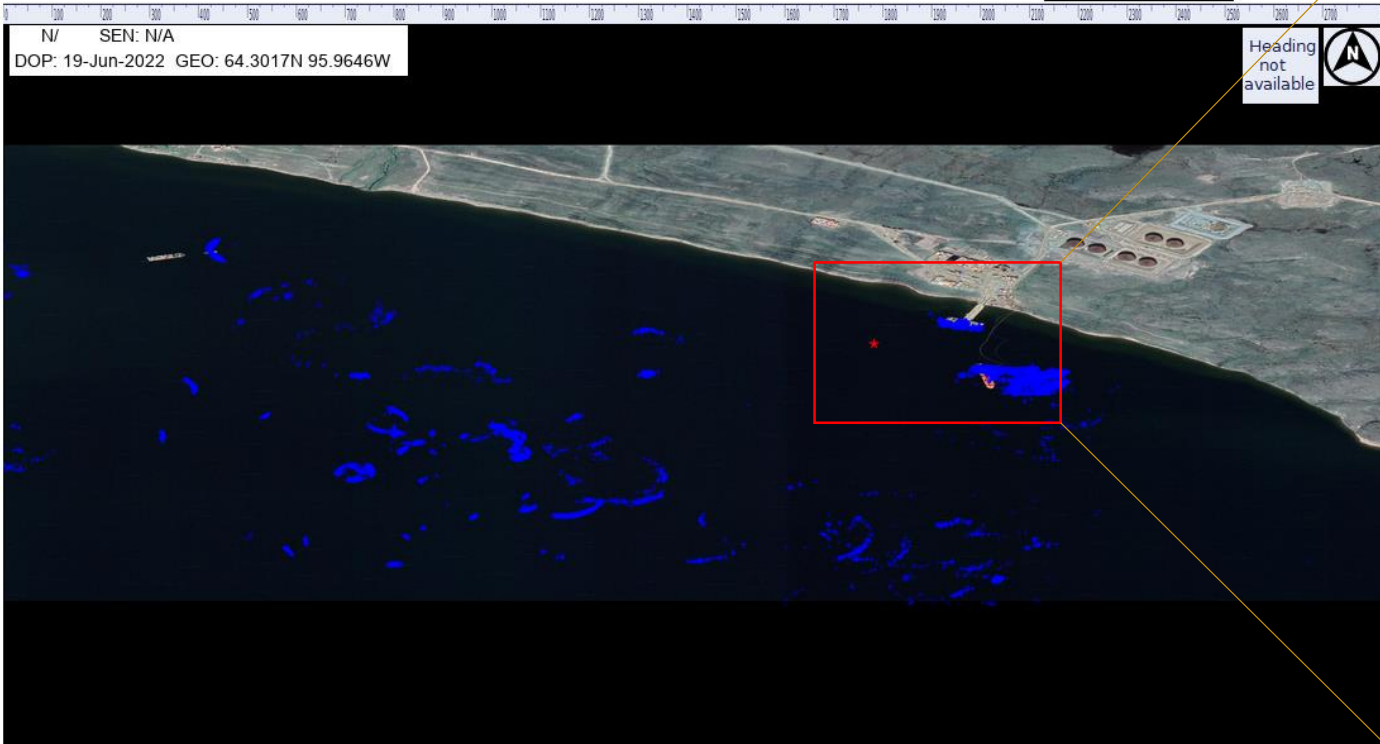
TO/FROM	Resolute	Pond Inlet	Clyde River	Pangnirtung	Iqaluit	Cape Dorset	Igloolik	Repulse Bay	Rankin Inlet
Reference Point	R1	R2	R3	R4	R5	R6	R7	R8	R9
Nuuk	R10	R11	R12	R13	R14	R15	R16	R17	R18
Nanisivik	R19	R20	R21	R22	R23	R24	R25	R26	R27
Churchill	R28	R29	R30	R31	R32	R33	R34	R35	36



Maritime Node Location – Baker Lake

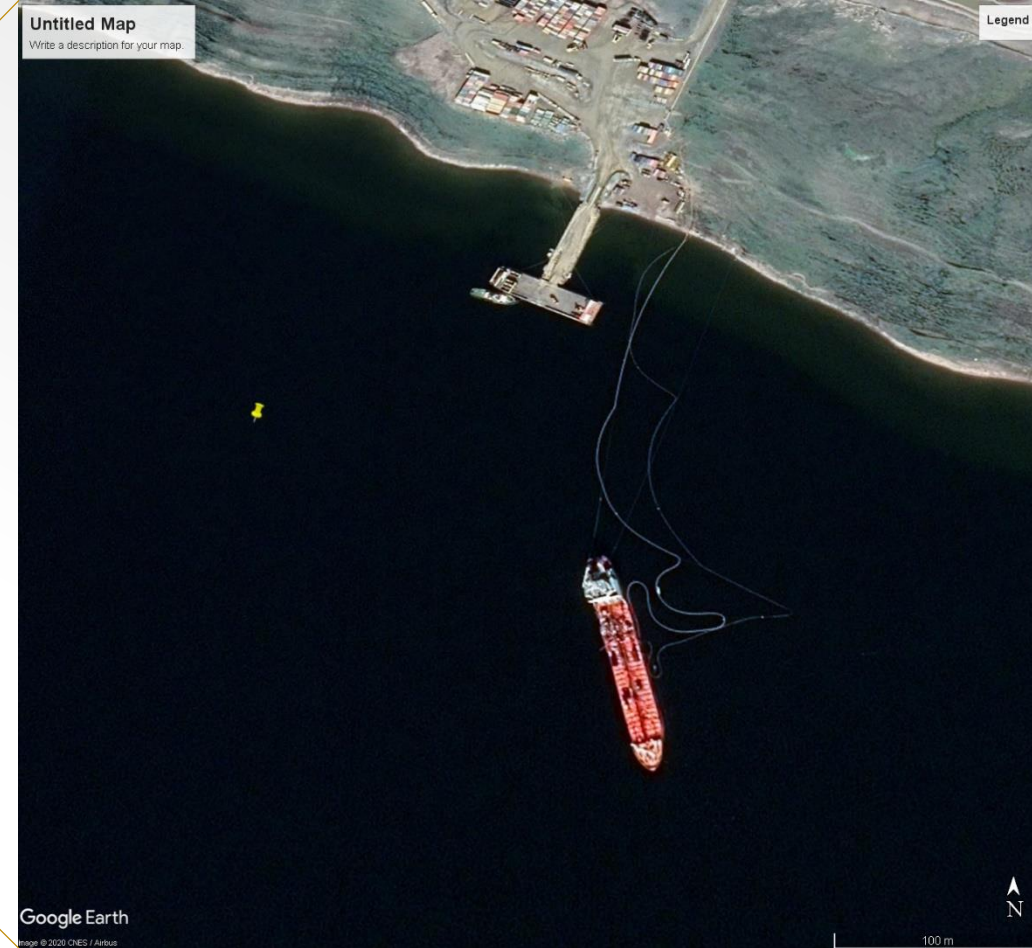
DRDC | RDDC

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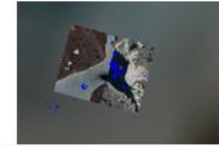
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Canada

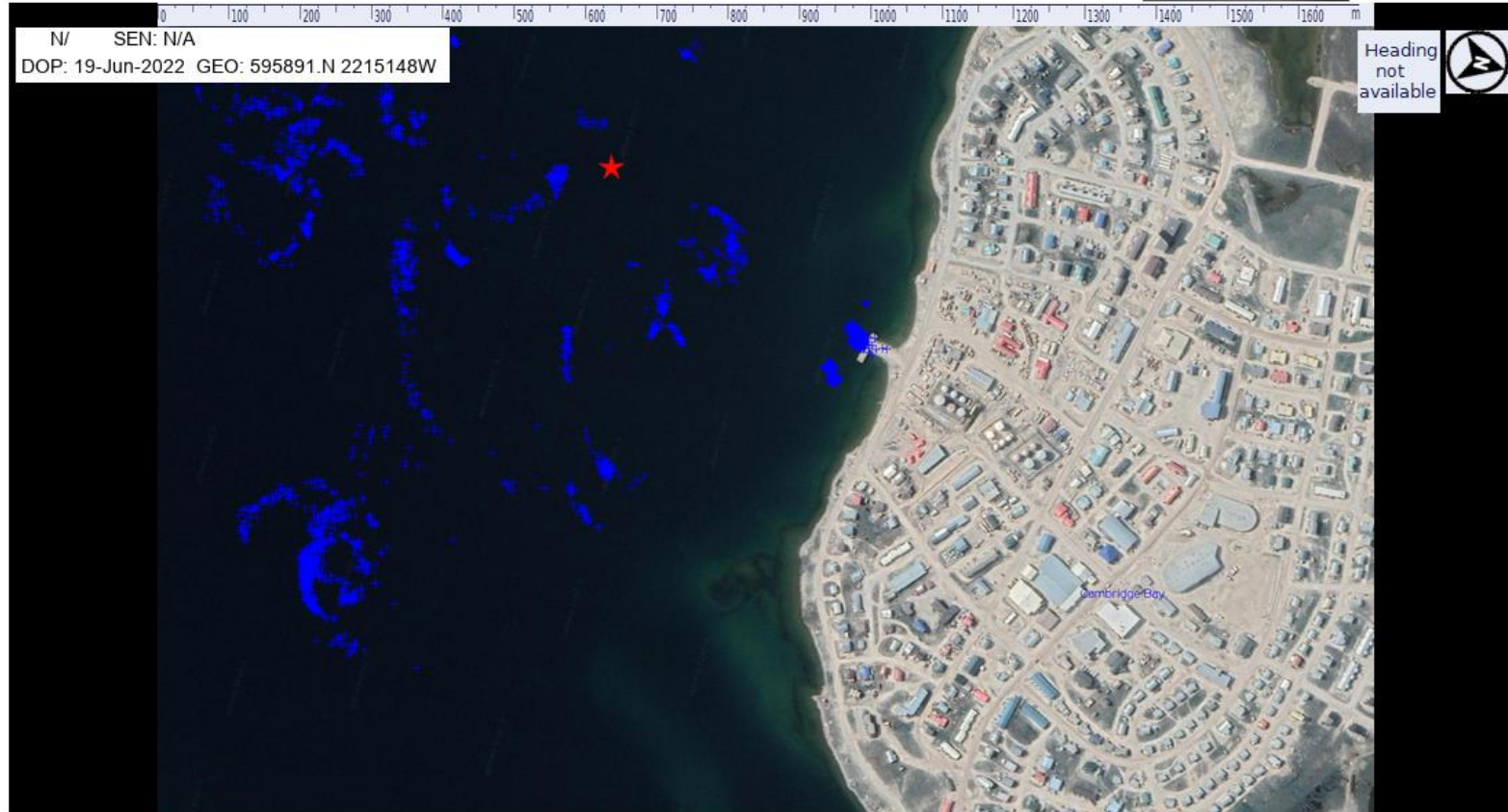


Maritime Node Location – Cambridge Bay

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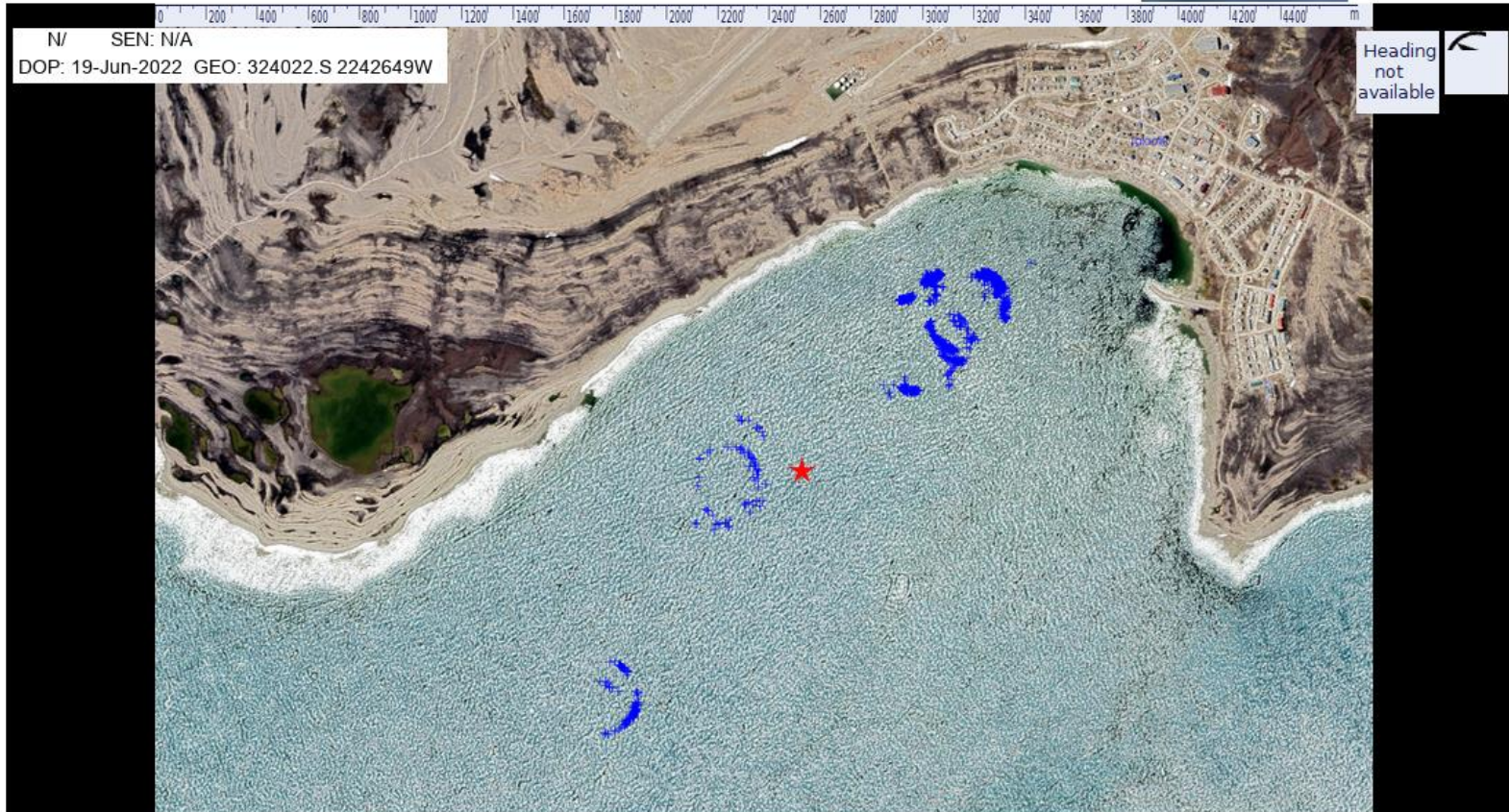
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Maritime Node Location - Igloolik

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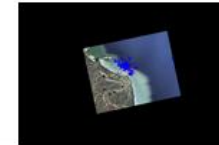


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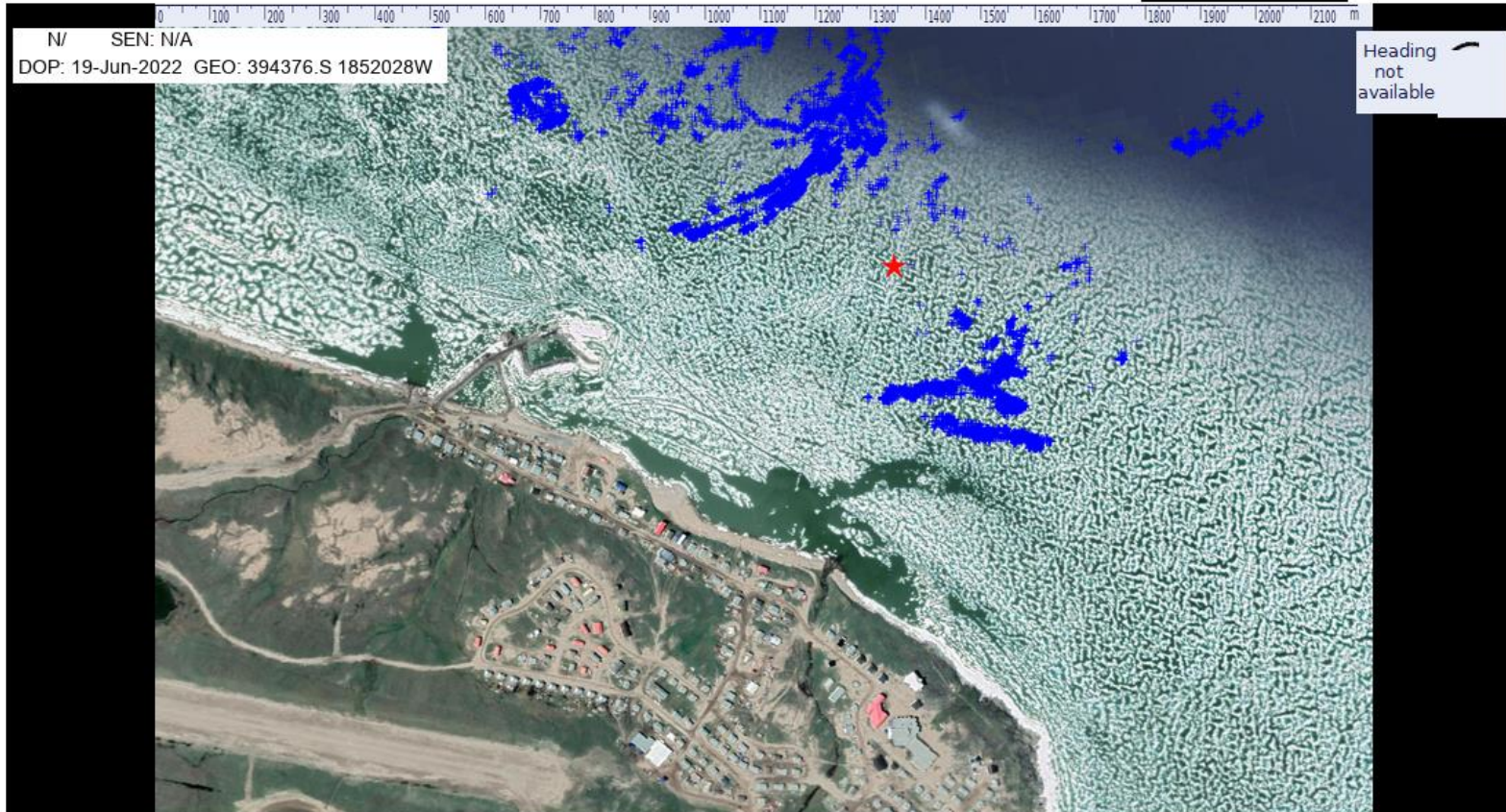
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Maritime Node Location – Pond Inlet

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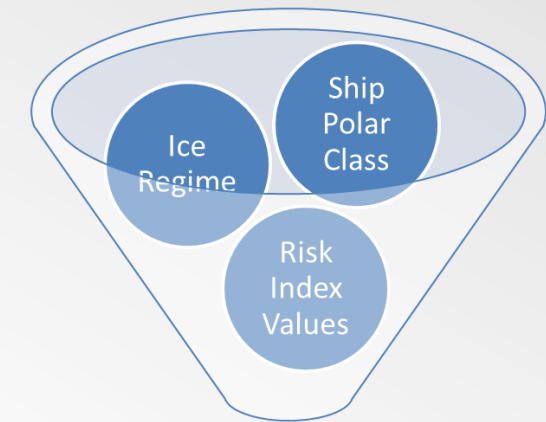
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The Polar Operational Limits Assessment Risk Indexing System (POLARIS)

POLARIS provides a risk assessment framework for determining ship operational limits in ice

Its use is recommended as part of the International Maritime Organization (IMO) POLAR CODE

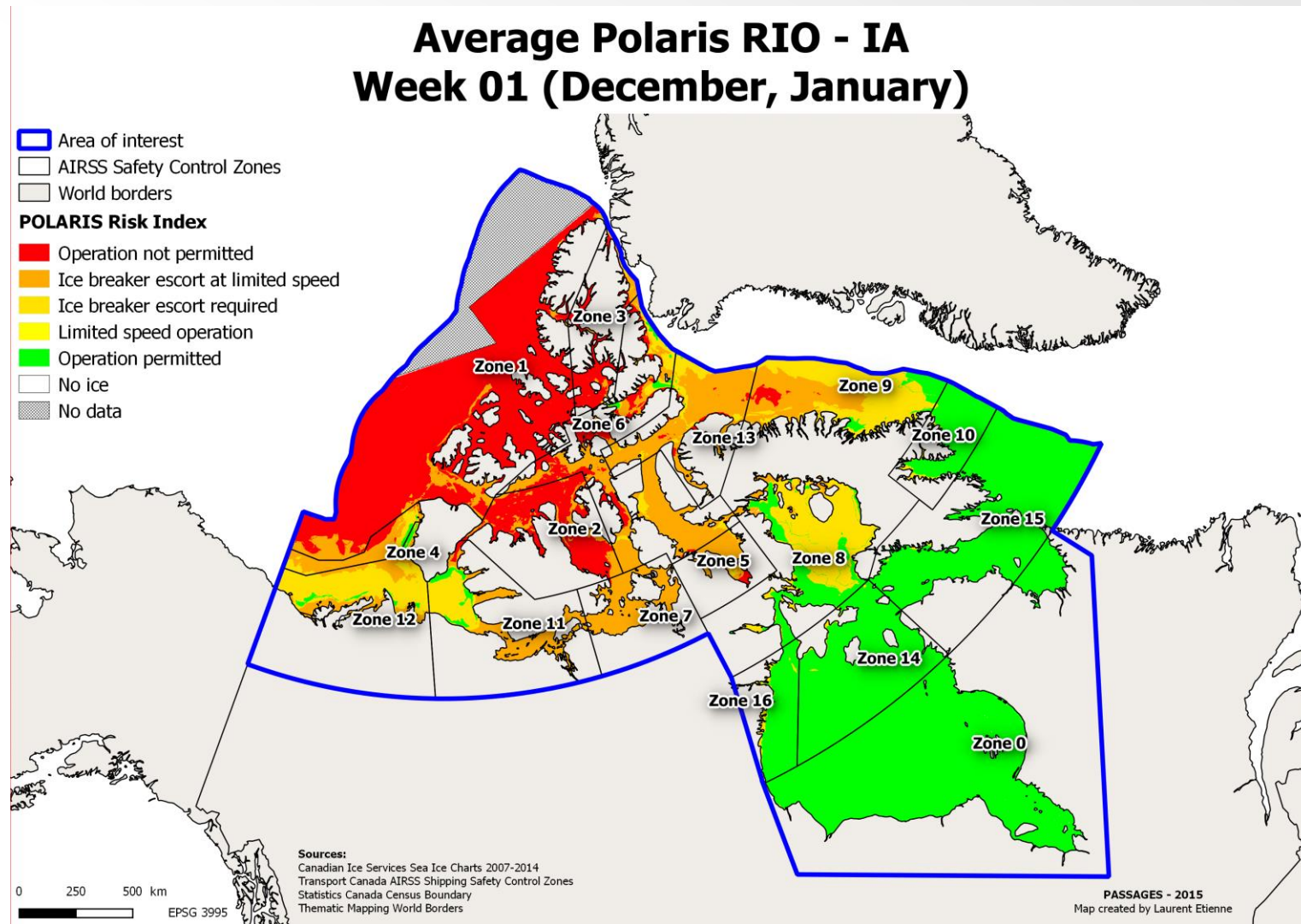
The output of POLARIS is referred to as the Risk Index Outcome (RIO)



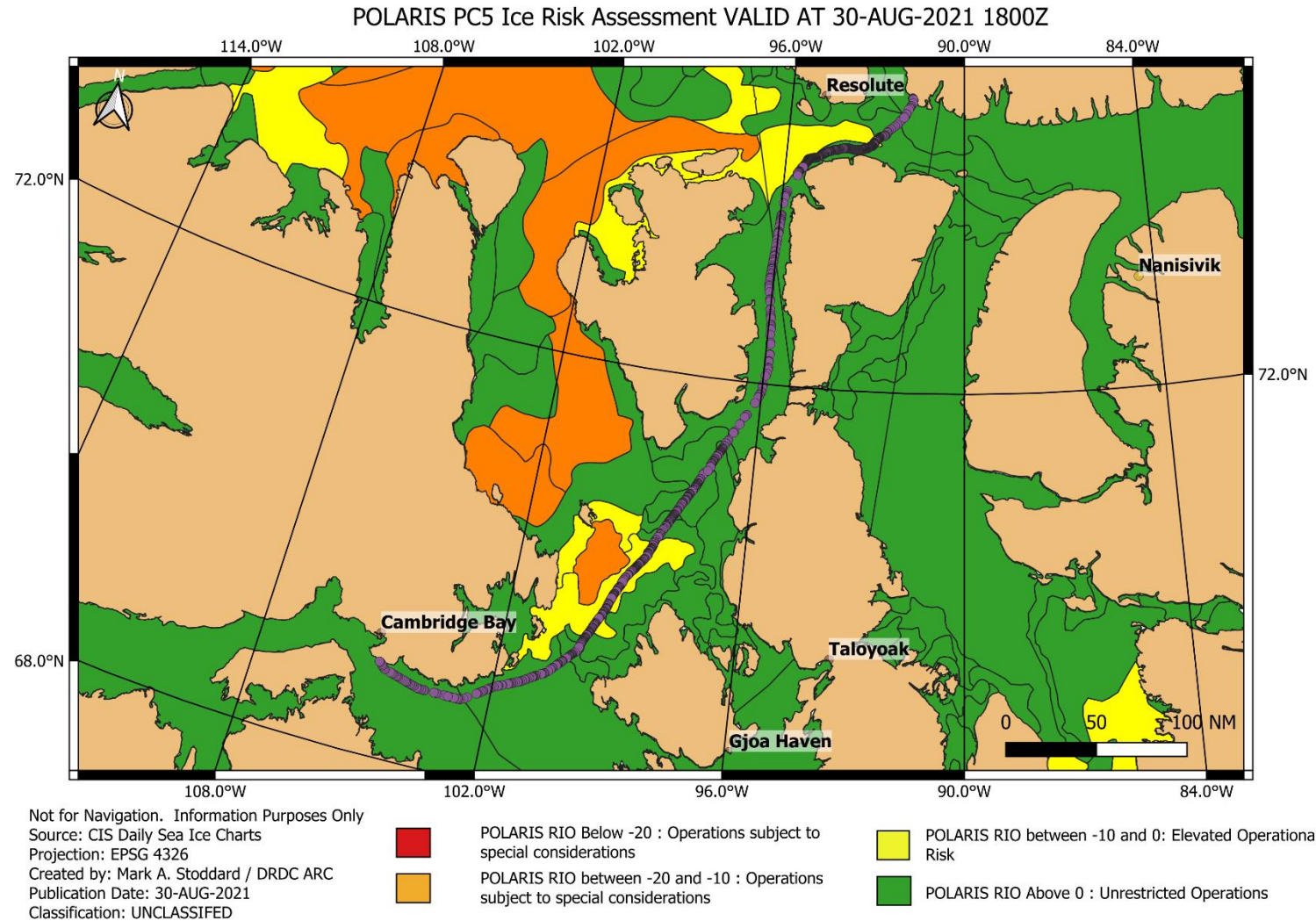
$$RIO = C_1RV_1 + C_2RV_2 + \dots + C_nRV_n$$



POLARIS using Wide-area Sea Ice Analysis

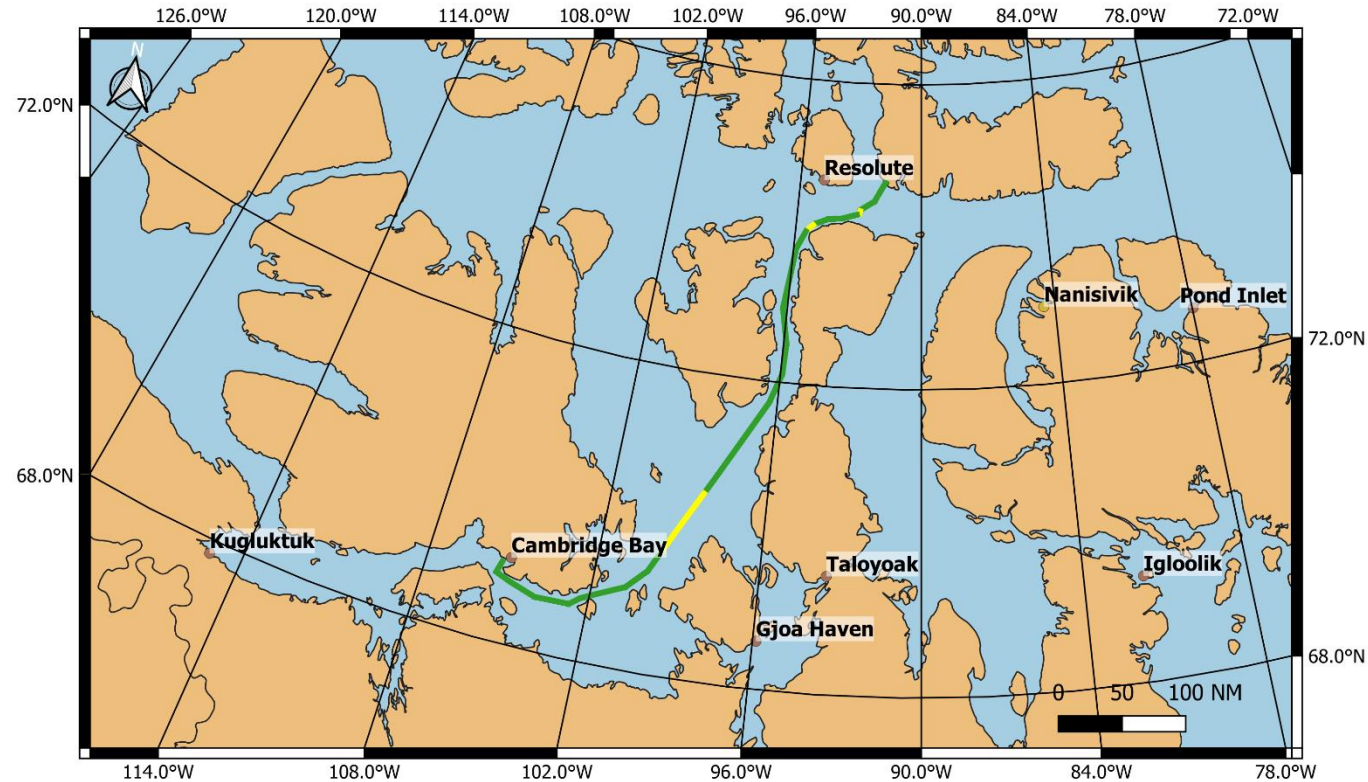


Ice Risk Adjusted Transit Time Estimation



Ice Risk Adjusted Transit Time Estimation

DRDC Gascoyne Inlet Camp to Cambridge Bay, NWT
 POLAR CLASS: PC5
 ETA @ 8kts = 65.4 hrs
 Transit Distance (nm): 523nm
 Ice-Risk Adjusted ETA = 93.6 hrs



Not for Navigation. Information Purposes Only
 Source: CIS Daily Sea Ice Charts
 Projection: EPSG 4326
 Created by: Mark A. Stoddard / DRDC ARC
 Publication Date: 19-JUNE-2022
 Classification: UNCLASSIFIED

- | | |
|---|--|
| <ul style="list-style-type: none"> POLARIS RIO Below -20 : Operations subject to special considerations POLARIS RIO between -20 and -10 : Operations subject to special considerations | <ul style="list-style-type: none"> POLARIS RIO between -10 and 0: Elevated Operational Risk POLARIS RIO Above 0 : Unrestricted Operations |
|---|--|

Conclusion

- AIS data continues to play an important role in the development and testing of the quantitative methods being developed for this PhD.
- Clustering of historical AIS data in the waters off arctic coastal communities is a useful technique to generate graph node locations near communities for maritime transportation studies.
- The use of historical AIS data to characterize polar class ship speeds in varying ice regimes is a useful application of AIS data

