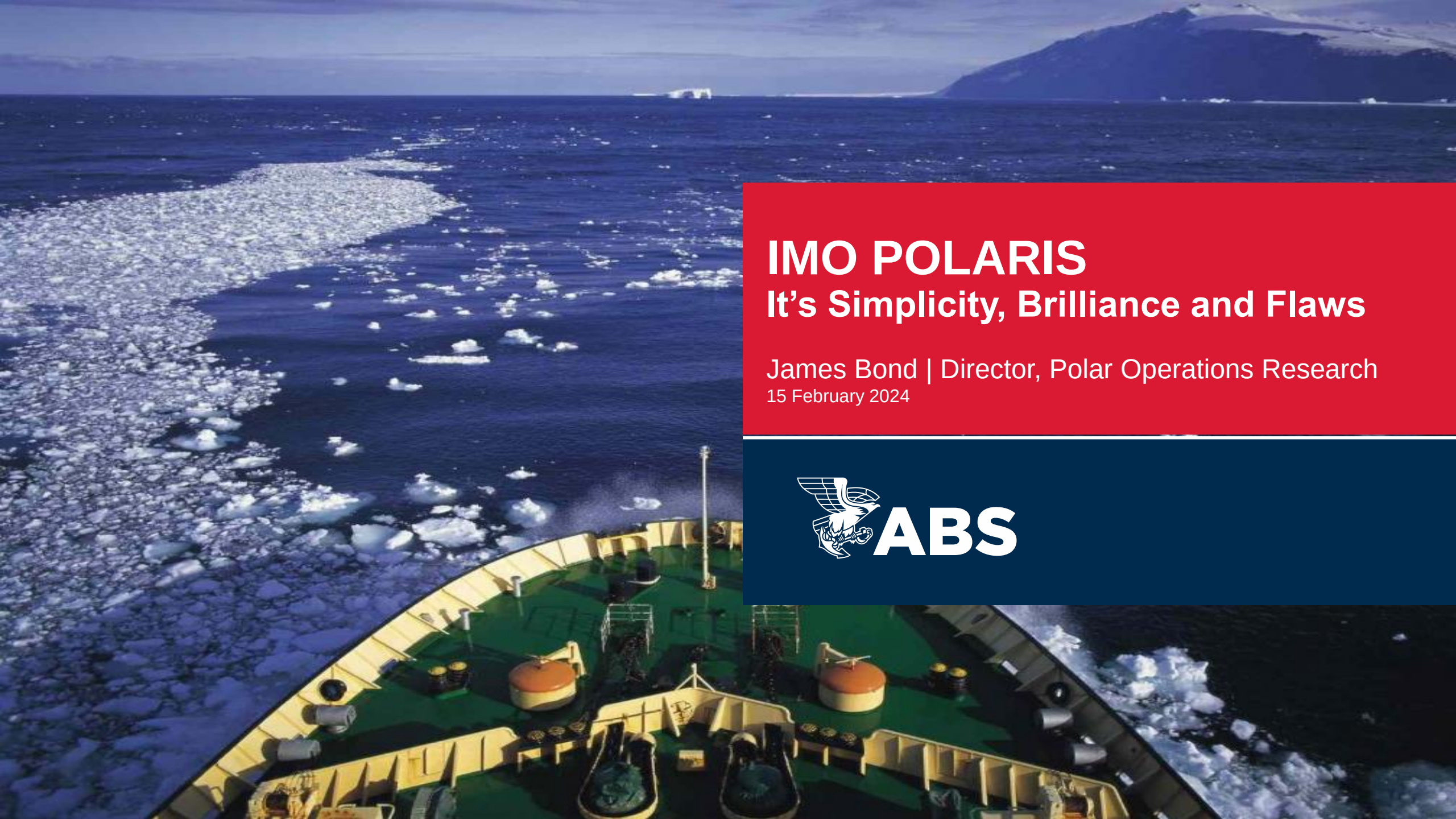


IMO POLARIS
It’s Simplicity, Brilliance and Flaws

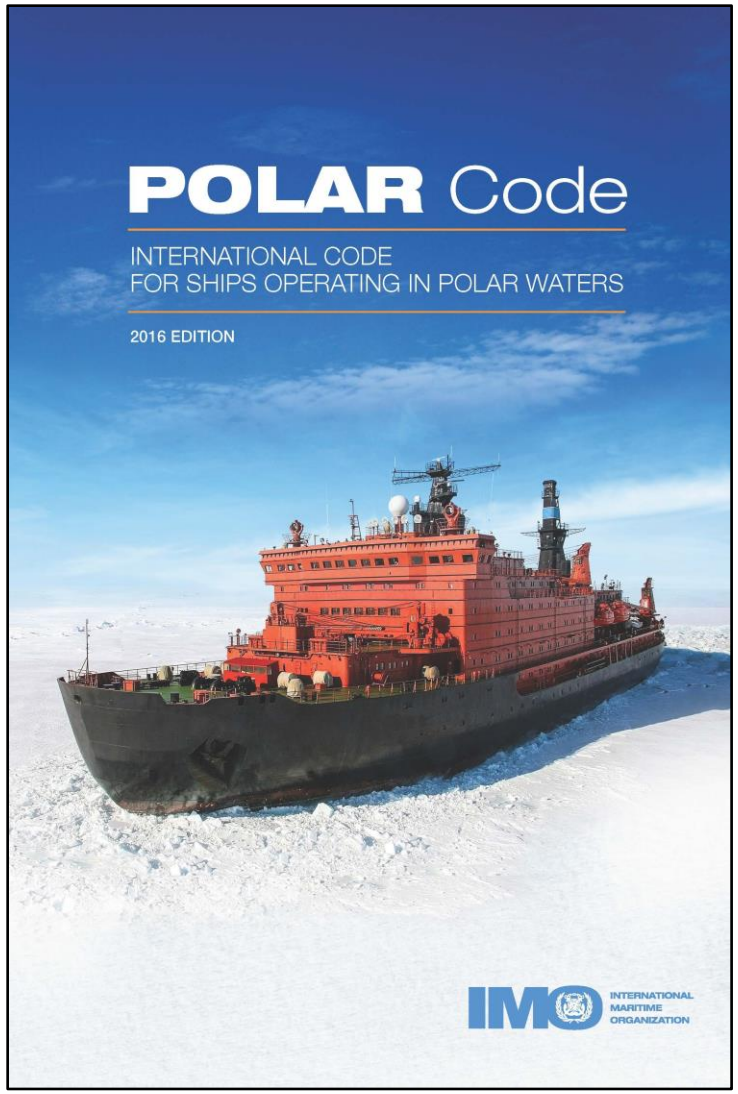
James Bond | Director, Polar Operations Research

15 February 2024

ABS

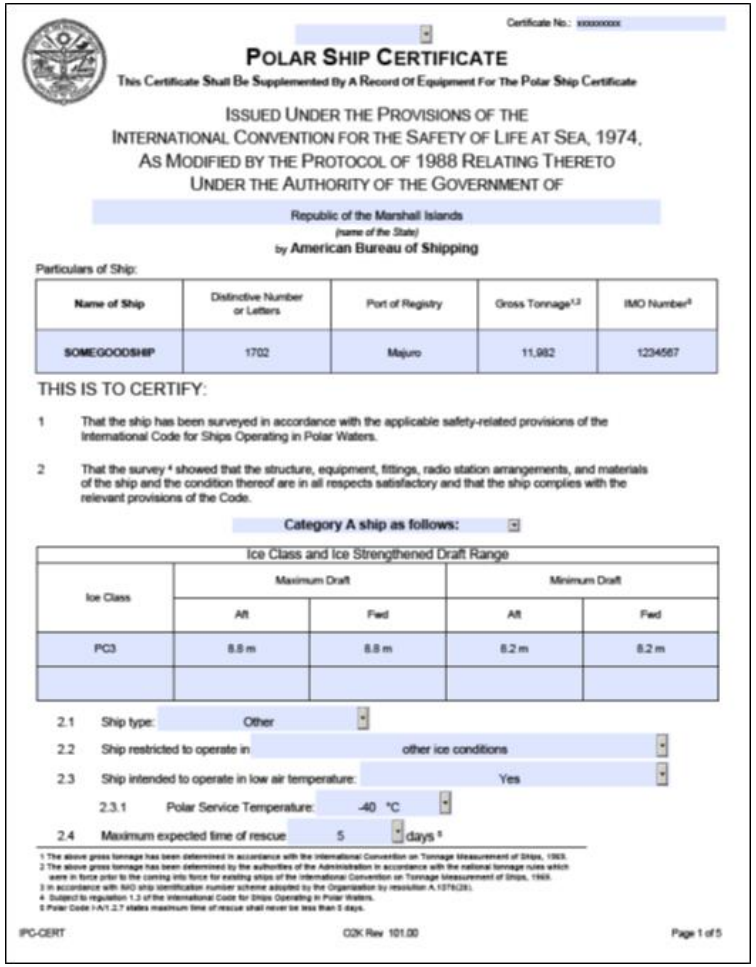
IMO POLAR CODE

- IMO's International Code for Ships Operating in Polar Waters (Polar Code) is mandatory under both SOLAS and MARPOL
- Multi-decade effort
  - 1992: IMO recognition for special safety and environmental protection measures in Polar waters
  - Many steps along the way
- Polar Code entered into force on 1 January 2017
- Phase in period for existing ships has passed
- All SOLAS certificated ships operating in Polar Waters must meet the requirements of the Code



POLAR SHIP CERTIFICATION (11th hour addition)

- The Polar Code require ships intending to operating in the defined waters of the Antarctic and Arctic to have a Polar Ship Certificate
- Ships need to carry a Polar Water Operational Manual, to provide the owner, operator, Master and crew with sufficient information regarding the ship's operational capabilities and limitations to support their decision making



Certificate No.: xxxxxxxxx

POLAR SHIP CERTIFICATE

This Certificate Shall Be Supplemented By A Record Of Equipment For The Polar Ship Certificate

ISSUED UNDER THE PROVISIONS OF THE INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974, AS MODIFIED BY THE PROTOCOL OF 1988 RELATING THERETO UNDER THE AUTHORITY OF THE GOVERNMENT OF

Republic of the Marshall Islands
(name of the State)
by **American Bureau of Shipping**

Particulars of Ship:

Name of Ship	Distinctive Number or Letters	Port of Registry	Gross Tonnage[1,2]	IMO Number[3]
SOMEGOODSHIP	1702	Majuro	11,982	1234567

THIS IS TO CERTIFY:

1 That the ship has been surveyed in accordance with the applicable safety-related provisions of the International Code for Ships Operating in Polar Waters.

2 That the survey [4] showed that the structure, equipment, fittings, radio station arrangements, and materials of the ship and the condition thereof are in all respects satisfactory and that the ship complies with the relevant provisions of the Code.

Category A ship as follows:

Ice Class and Ice Strengthened Draft Range

Ice Class	Maximum Draft		Minimum Draft	
	Aft	Fwd	Aft	Fwd
PC3	8.8 m	8.8 m	8.2 m	8.2 m

2.1 Ship type: Other

2.2 Ship restricted to operate in other ice conditions

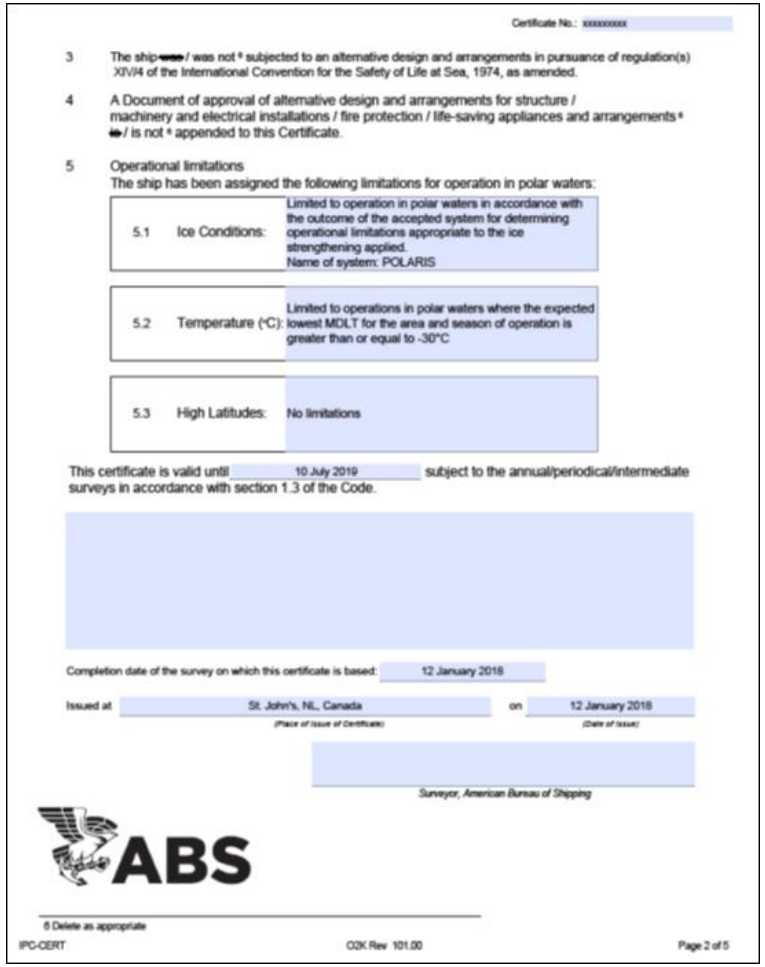
2.3 Ship intended to operate in low air temperature: Yes

2.3.1 Polar Service Temperature: -40 °C

2.4 Maximum expected time of rescue: 5 days [5]

1 The above gross tonnage has been determined in accordance with the International Convention on Tonnage Measurement of Ships, 1969.
2 The above gross tonnage has been determined by the authorities of the Administration in accordance with the national tonnage rules which were in force prior to the coming into force for existing ships of the International Convention on Tonnage Measurement of Ships, 1969.
3 In accordance with IMO ship identification number scheme adopted by the Organization by resolution A.1078(28).
4 Subject to regulation 1.3 of the International Code for Ships Operating in Polar Waters.
5 Polar Code I-A/1.2.7 states maximum time of rescue shall never be less than 5 days.

IPC-CERT C2K Rev 101.00 Page 1 of 5



Certificate No.: xxxxxxxxx

3 The ship ~~was~~ / was not [6] subjected to an alternative design and arrangements in pursuance of regulation(s) XIV/4 of the International Convention for the Safety of Life at Sea, 1974, as amended.

4 A Document of approval of alternative design and arrangements for structure / machinery and electrical installations / fire protection / life-saving appliances and arrangements [6] ~~is~~ / is not [6] appended to this Certificate.

5 Operational limitations
The ship has been assigned the following limitations for operation in polar waters:

5.1	Ice Conditions:	Limited to operation in polar waters in accordance with the outcome of the accepted system for determining operational limitations appropriate to the ice strengthening applied. Name of system: POLARIS
5.2	Temperature (°C):	Limited to operations in polar waters where the expected lowest MDLT for the area and season of operation is greater than or equal to -30°C
5.3	High Latitudes:	No limitations

This certificate is valid until 10 July 2019 subject to the annual/periodical/intermediate surveys in accordance with section 1.3 of the Code.

Completion date of the survey on which this certificate is based: 12 January 2018

Issued at St. John's, NL, Canada (Place of issue of Certificate) on 12 January 2018 (Date of issue)

Surveyor, American Bureau of Shipping

ABS

6 Delete as appropriate

IPC-CERT C2K Rev 101.00 Page 2 of 5

ABS

POLAR SHIP CERTIFICATION

- Certificate contents
  - **Operational limitations**
    - Ice conditions
    - Temperature
    - High Latitudes

5.1 Ice conditions

Limited to operation in polar waters in accordance with the outcome of the accepted system for determining operational limitations appropriate to the ice strengthening applied.
Name of system: POLARIS

POLARIS = Polar Operational Limit Assessment Risk Indexing System

POLAR SHIP CERTIFICA

This Certificate Shall Be Supplemented By A Record Of Equipment

ISSUED UNDER THE PROVISIONS
INTERNATIONAL CONVENTION FOR THE SAFETY
AS MODIFIED BY THE PROTOCOL OF 1988 R
UNDER THE AUTHORITY OF THE GOVE

Republic of the Marshall Islands
(name of the State)
by American Bureau of Shipping

Particulars of Ship:

Name of Ship	Distinctive Number or Letters	Port of Registry
SOMEGOODSHIP	1702	Majuro

THIS IS TO CERTIFY:

1 That the ship has been surveyed in accordance with the applicable safety
International Code for Ships Operating in Polar Waters.

2 That the survey [4] showed that the structure, equipment, fittings, radio stat
of the ship and the condition thereof are in all respects satisfactory and th
relevant provisions of the Code.

Category A ship as follows:

Ice Class	Maximum Draft	
	Aft	Fwd
PC3	8.8 m	8.8 m

2.1 Ship type: Other

2.2 Ship restricted to operate in other ice con

2.3 Ship intended to operate in low air temperature:

2.3.1 Polar Service Temperature: -40 °C

4 Maximum expected time of rescue: 5 days [3]

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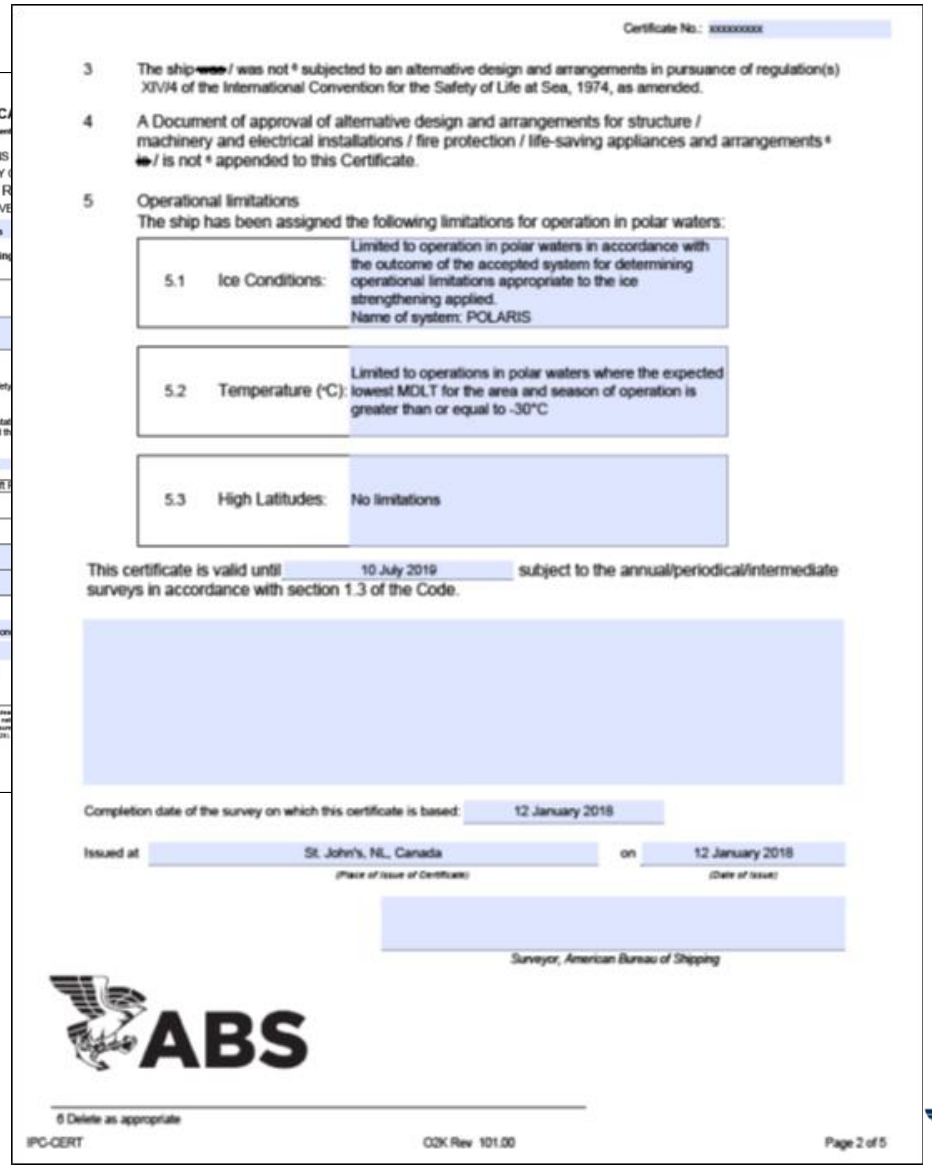
Code I-A/1.2.7 states maximum time of rescue shall never be less than 5 days.

02K Rev 101.00



Certificate No.: xxxxxxxx

3 The ship~~s~~ / was not [6] subjected to an alternative design and arrangements in pursuance of regulation(s) XIV/4 of the International Convention for the Safety of Life at Sea, 1974, as amended.

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Surveyor, American Bureau of Shipping

ABS

6 Delete as appropriate

IPC-CERT 02K Rev 101.00 Page 2 of 5

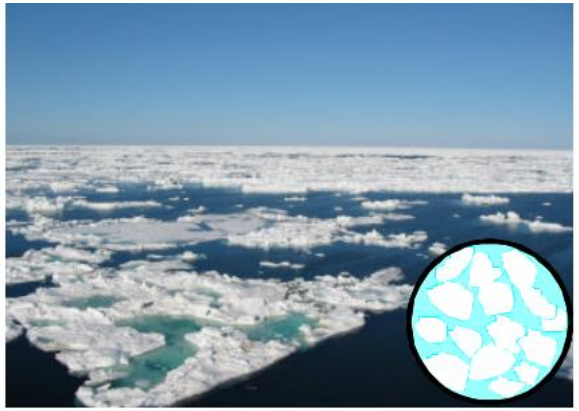
ABS

Sea Ice

- Why doesn't the Certificate simply say, "maximum of 30 cm of ice"? Because:
  - Level ice is rarely found in the Arctic
  - Ice regimes are present, a mixture of different ice type and ice free water
- Different types of ice of varying strength and thickness: New ice, grey ice, first year ice, second year ice, multi-year (old) ice
- Different amounts of ice coverage: 10% = 1/10th ……. 100% = 10/10^{ths}

1 - 3 tenths
very open drift

4 - 6 tenths
open drift



7 - 8 tenths
close pack/drift

10 tenths
compact/consolidated ice

Source: Transport Canada TP 14044E. The reproduction is a copy of an official Transport Canada work and was not produced in affiliation with, or with the endorsement of Transport Canada

IMO POLARIS

- *Decision making:* Risk evaluated based on Ice Class & ice regime encountered
- Outcome is a ***single value*** Risk Index
- RIO = $(C_1 x RV_1)+(C_2 x RV_2)+(C_3 x RV_3)+(C_4 x RV_4)$
  - $C_1 \ldots C_4$ concentrations of ice types within ice regime (mixture of different ice types and ice free water)
  - $RV_1 \ldots RV_4$ Risk Values (RV) for each ice class

RIO_{SHIP}	Ice classes PC1-PC7	Ice classes below PC 7	Color Code
20 ≤ RIO	Normal operation	Normal operation	
10 ≤ RIO < 20			
0 ≤ RIO < 10			
-10 ≤ RIO < 0	Elevated operational risk	Operation subject to special consideration	
-20 ≤ RIO < -10	Operation subject to special consideration	Operation subject to special consideration	
-30 ≤ RIO < -20			

Increasing ice thickness (severity)

Winter Risk Values (RVs)

Polar Ship Category	ICE CLASS	ICE FREE --	NEW ICE 0-10 cm	GREY ICE 10-15 cm	GREY WHITE ICE 15-30 cm	THIN FIRST YEAR 1ST STAGE 30-50 cm	THIN FIRST YEAR 2ND STAGE 50-70 cm	MEDIUM FIRST YEAR 1ST STAGE 70-95 cm	MEDIUM FIRST YEAR 2ND STAGE 95-120 cm	THICK FIRST YEAR 120-200 cm	SECOND YEAR 200-250 cm	LIGHT MULTI YEAR 250-300 cm	HEAVY MULTI YEAR 300+ cm
A	PC1	3	3	3	3	2	2	2	2	2	2	1	1
	PC2	3	3	3	3	2	2	2	2	2	1	1	0
	PC3	3	3	3	3	2	2	2	2	2	1	0	-1
	PC4	3	3	3	3	2	2	2	2	1	0	-1	-2
	PC5	3	3	3	3	2	2	1	1	0	-1	-2	-2
B	PC6	3	2	2	2	2	1	1	0	-1	-2	-3	-3
	PC7	3	2	2	2	1	1	0	-1	-2	-3	-3	-3
C	IAA	3	2	2	2	2	1	0	-1	-2	-3	-4	-4
	IA	3	2	2	2	1	0	-1	-2	-3	-4	-5	-5
	IB	3	2	2	1	0	-1	-2	-3	-4	-5	-6	-6
	IC	3	2	1	0	-1	-2	-3	-4	-5	-6	-7	-8
	No Ice Class	3	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-8

Decreasing ice class

Increased Risk

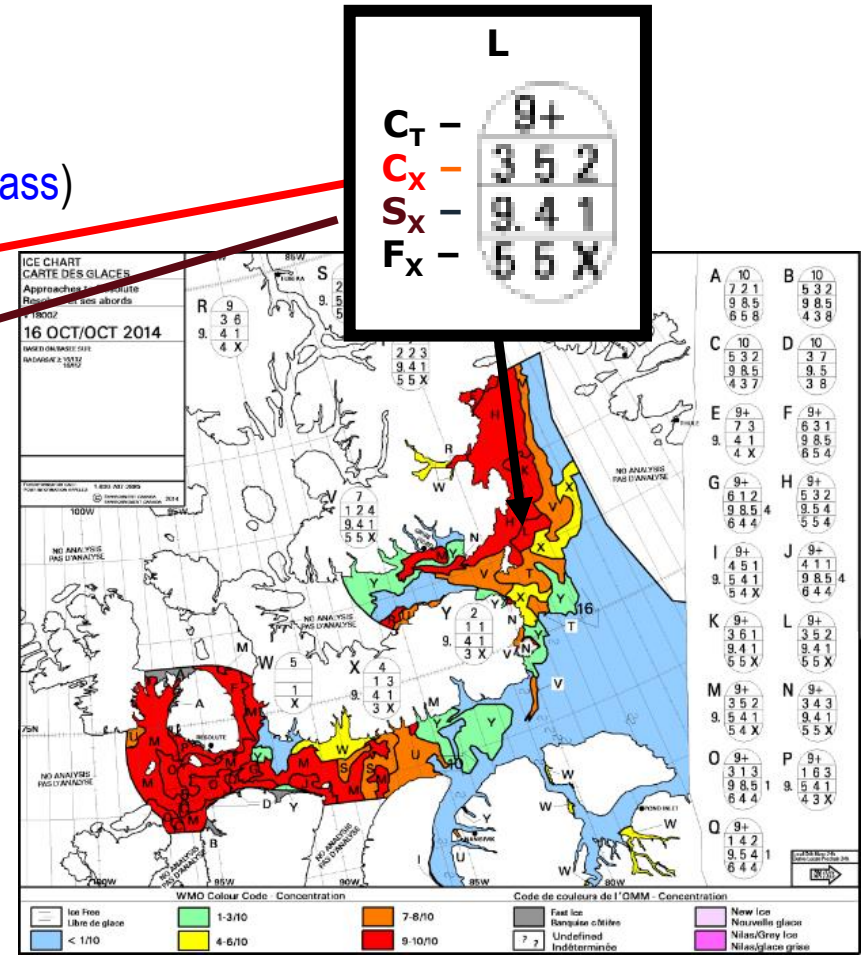
POLARIS Calculation - Simplicity

- Ice Chart data – Egg Code

$$RIO = (C_1 \times RV_1)+(C_2 \times RV_2)+(C_3 \times RV_3)+(C_4 \times RV_4)$$

$$= \sum (\text{Concentration}) \times (\text{Index values for an Ice Thickness \& Ice Class})$$

Concentration, C_X	3	5	2
Thickness, S_X	9. MY Ice	4 Grey Ice	1 New Ice
Risk Value (RV) for PC7	-3	2	2
Risk Value (RV) for 1A	-5	2	2



Ice Class PC7
RIO = (3 x -3) + (5 x 2) + (2 x 2)
RIO = +5 = positive = "Proceed"

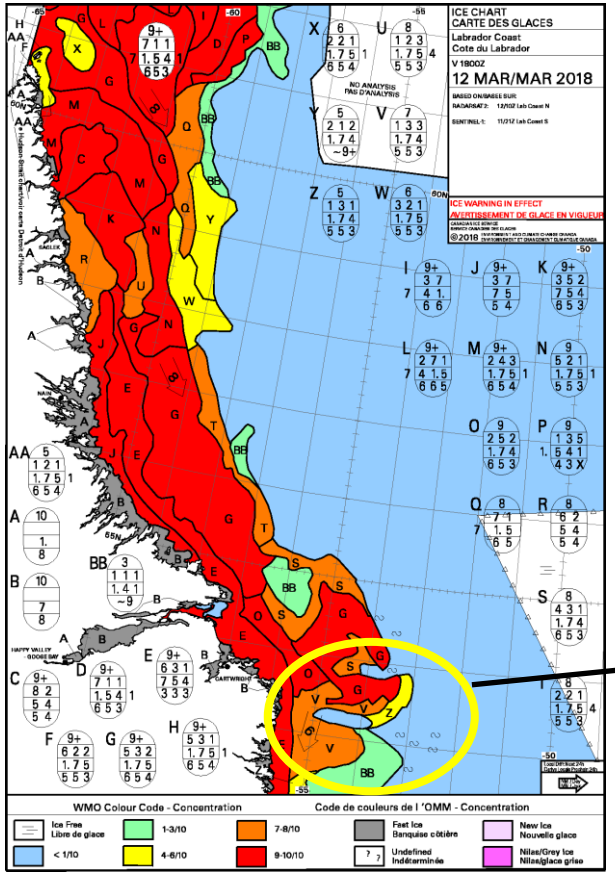
Ice Class 1A
RIO = (3 x -5) + (5 x 2) + (2 x 2)
RIO = -1 = negative = "Stop and Reaccess"

Note: Calculated using Winter RVs, no escort

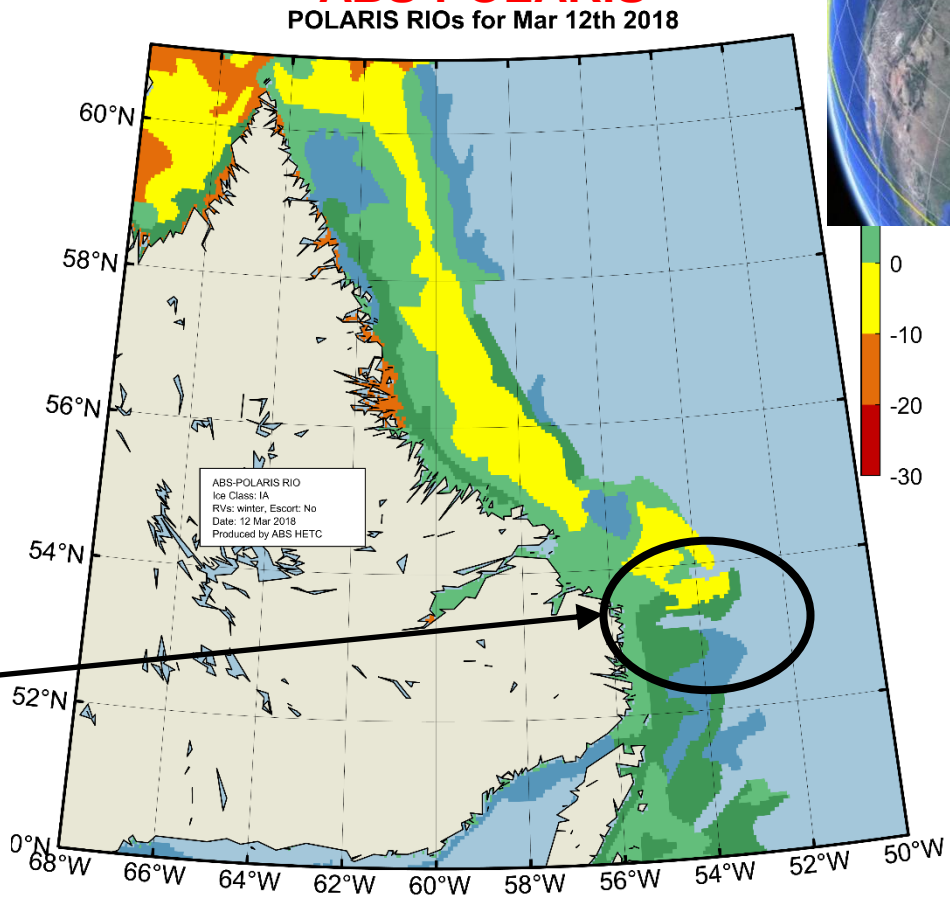
ABS POLARIS

- Based on an IMO POLARIS methodology
- Uses published, publicly available ice charts

Canadian Ice Service



ABS-POLARIS



Brilliance

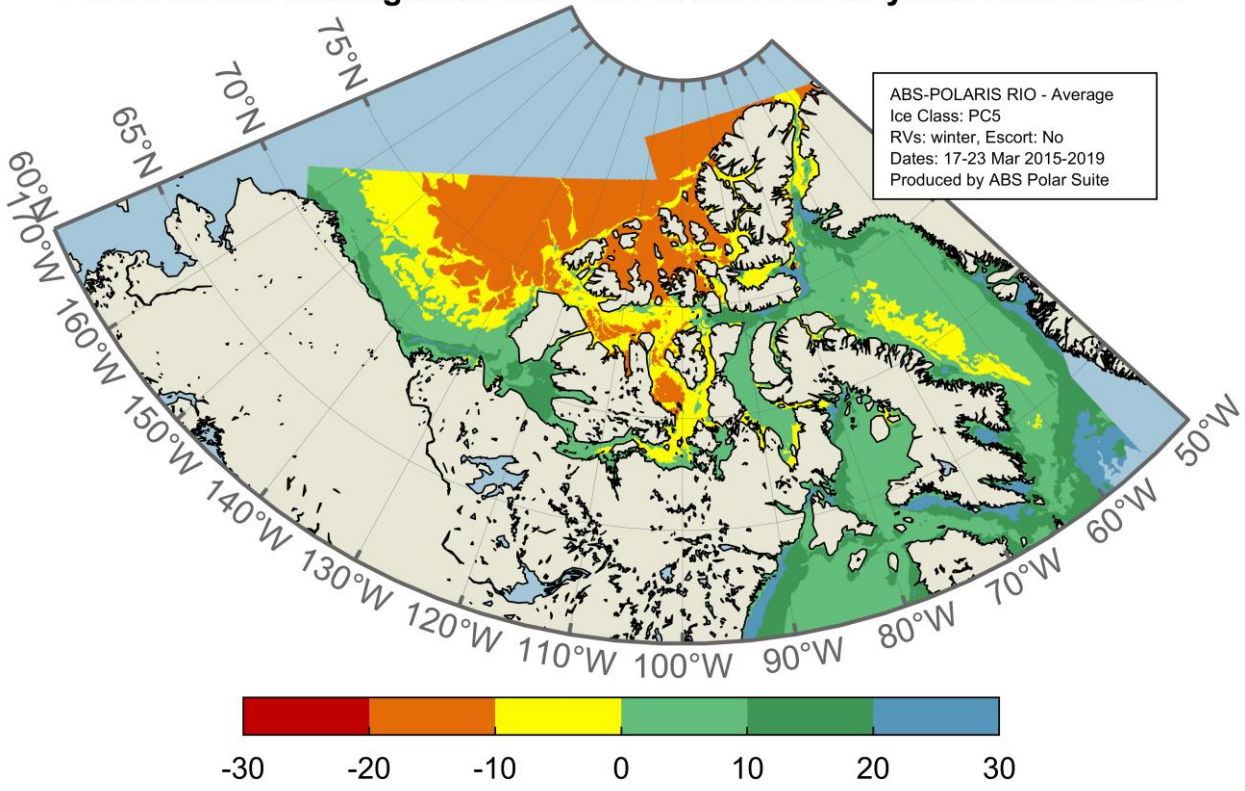
- Brilliant because there are multiple important uses for POLARIS
  - Voyage Planning:
    - Based on historical ice date
    - Where and when can an existing ship safely go
  - Ice Class selection:
    - Based on historical ice date
    - What ice class is needed to confidently go specific places at specific times
  - Governance
    - Coupled with AIS data to provide oversight of Polar shipping safety

Voyage Planning

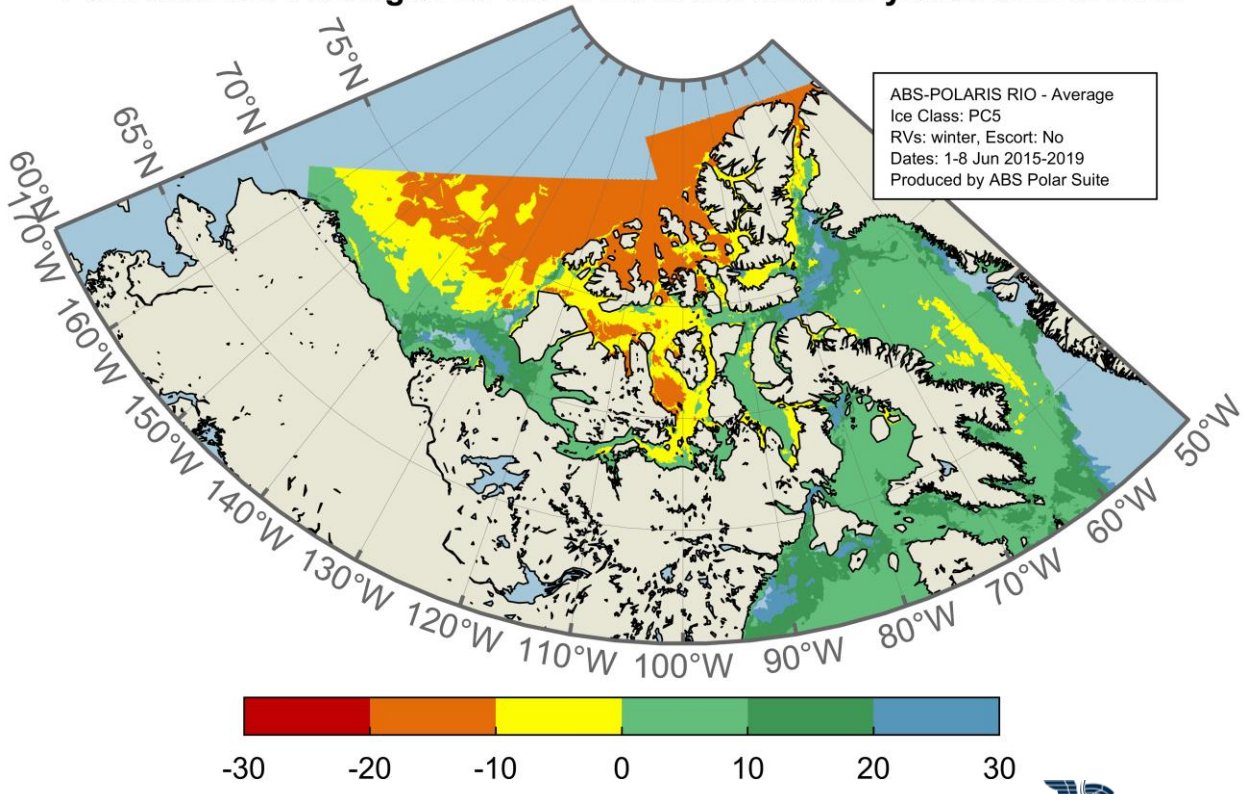
- Consider a PC5 ship

ICE CLASS	ICE FREE	NEW ICE	GREY ICE	GREY WHITE ICE	THIN FIRST YEAR 1ST STAGE	THIN FIRST YEAR 2ND STAGE	MEDIUM FIRST YEAR 1ST STAGE	MEDIUM FIRST YEAR 2ND STAGE	THICK FIRST YEAR	SECOND YEAR	LIGHT MULTI YEAR	HEAVY MULTI YEAR
	--	0-10 cm	10-15 cm	15-30 cm	30-50 cm	50-70 cm	70-95 cm	95-120 cm	120-200 cm	200-250 cm	250-300 cm	300+ cm
PC5	3	3	3	3	2	2	1	1	0	-1	-2	-2

POLARIS RIO-Averages for Mar 17th to the 23rd for years 2015 to 2019



POLARIS RIO-Averages for Jun 01st to the 08th for years 2015 to 2019

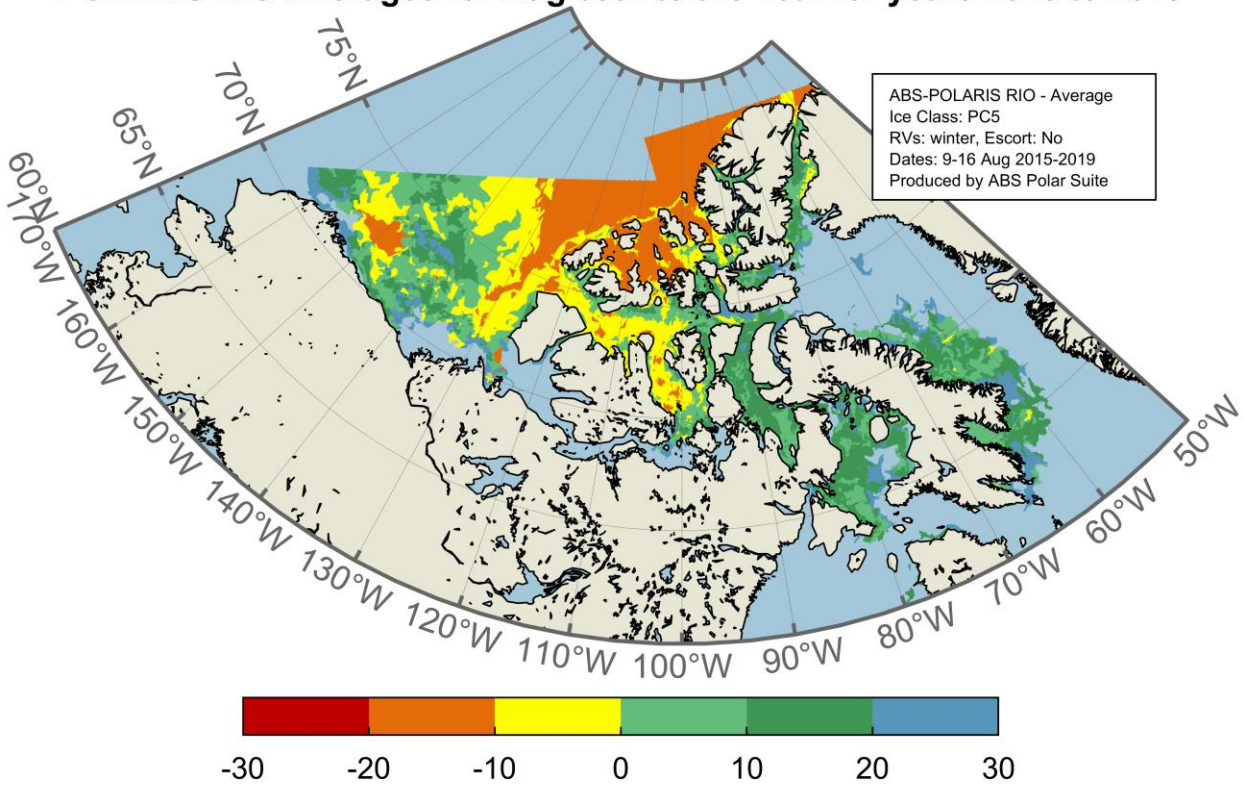


Voyage Planning

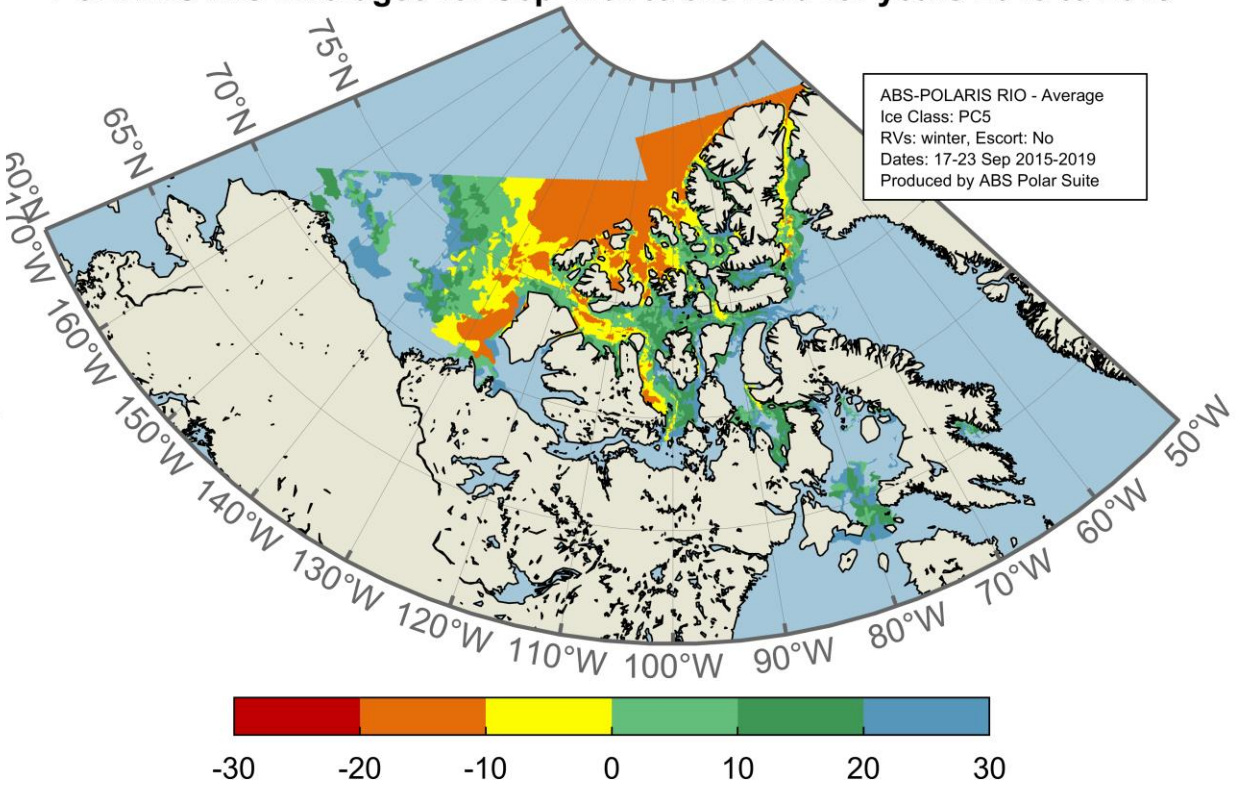
- Consider a PC5 ship

ICE CLASS	ICE FREE	NEW ICE	GREY ICE	GREY WHITE ICE	THIN FIRST YEAR 1ST STAGE	THIN FIRST YEAR 2ND STAGE	MEDIUM FIRST YEAR 1ST STAGE	MEDIUM FIRST YEAR 2ND STAGE	THICK FIRST YEAR	SECOND YEAR	LIGHT MULTI YEAR	HEAVY MULTI YEAR
	--	0-10 cm	10-15 cm	15-30 cm	30-50 cm	50-70 cm	70-95 cm	95-120 cm	120-200 cm	200-250 cm	250-300 cm	300+ cm
PC5	3	3	3	3	2	2	1	1	0	-1	-2	-2

POLARIS RIO-Averages for Aug 09th to the 16th for years 2015 to 2019

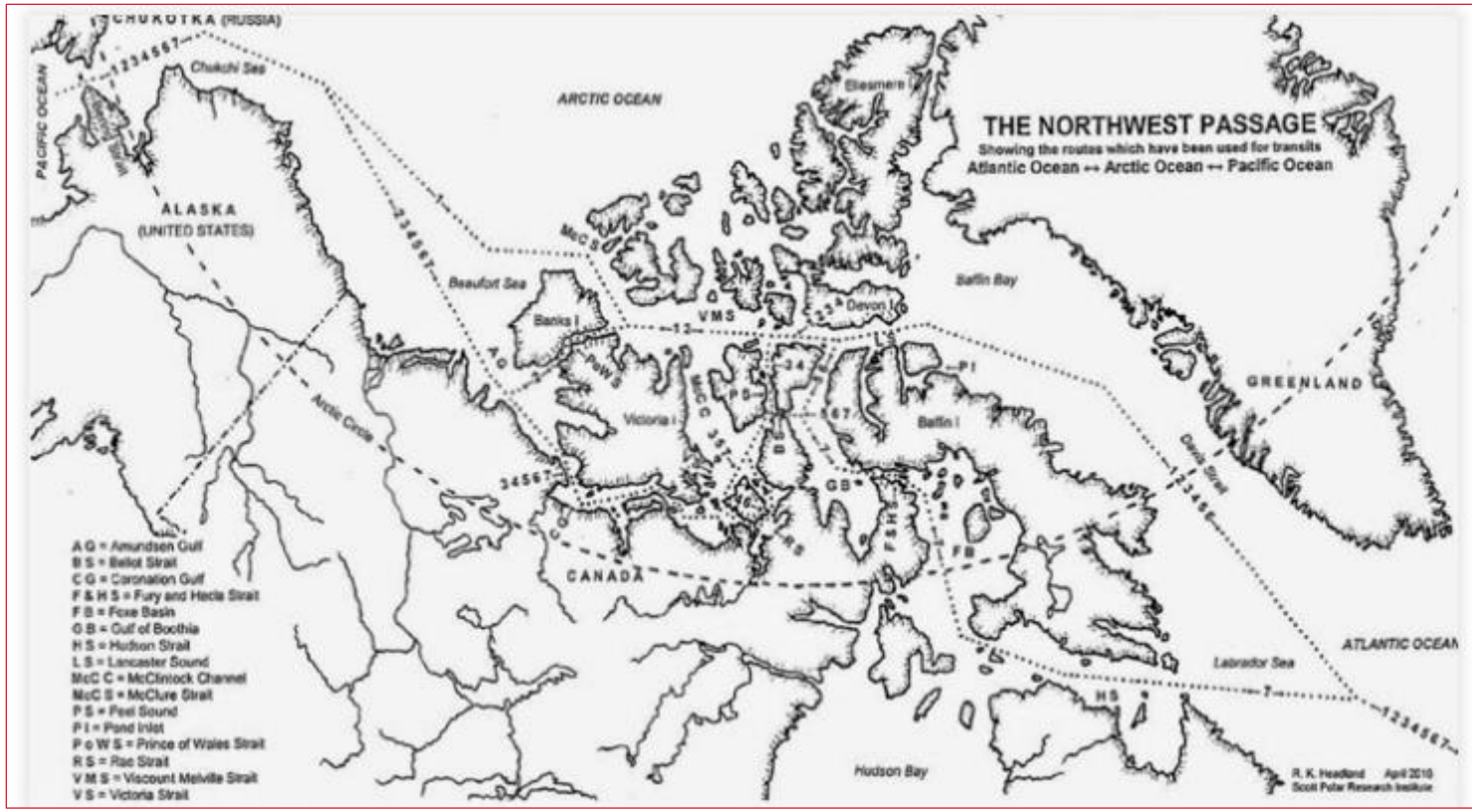


POLARIS RIO-Averages for Sep 17th to the 23rd for years 2015 to 2019



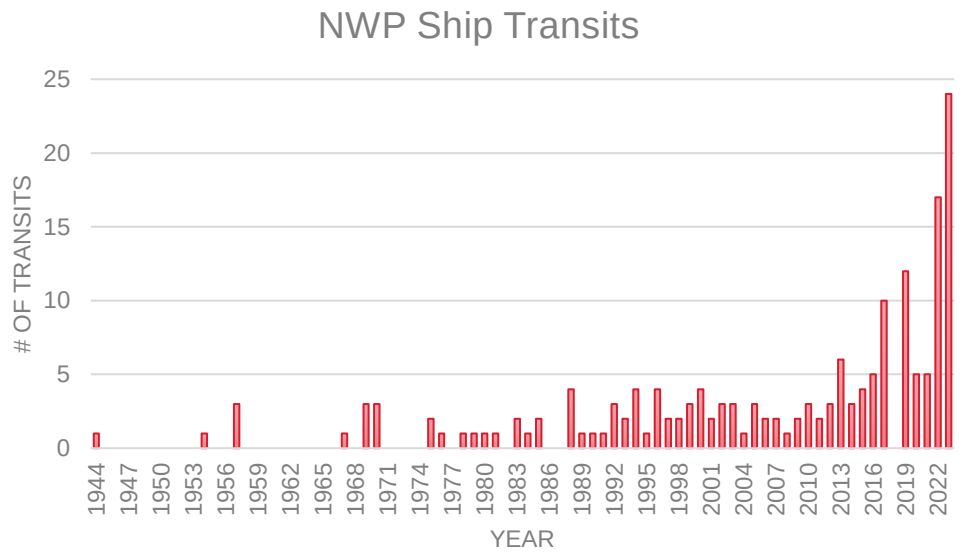
Governance: A Look at the Northwest Passage

- NWP: name given to the multiple marine routes between the Atlantic and Pacific oceans along the northern coast of North America
- Spans the Canadian Arctic Archipelago & the Beaufort Sea
- Of the seven informally recognized routes
  - Routes 1 and 2 (northern routes) have relatively deep water
  - Route 3 and 4 (southern routes) have been used the most but is limited to vessels with a draft of less than 14 meters
  - Route 7 thru Fury & Hecla Strait seeing more use recently
  - Others have draft restrictions to less than 10 meters

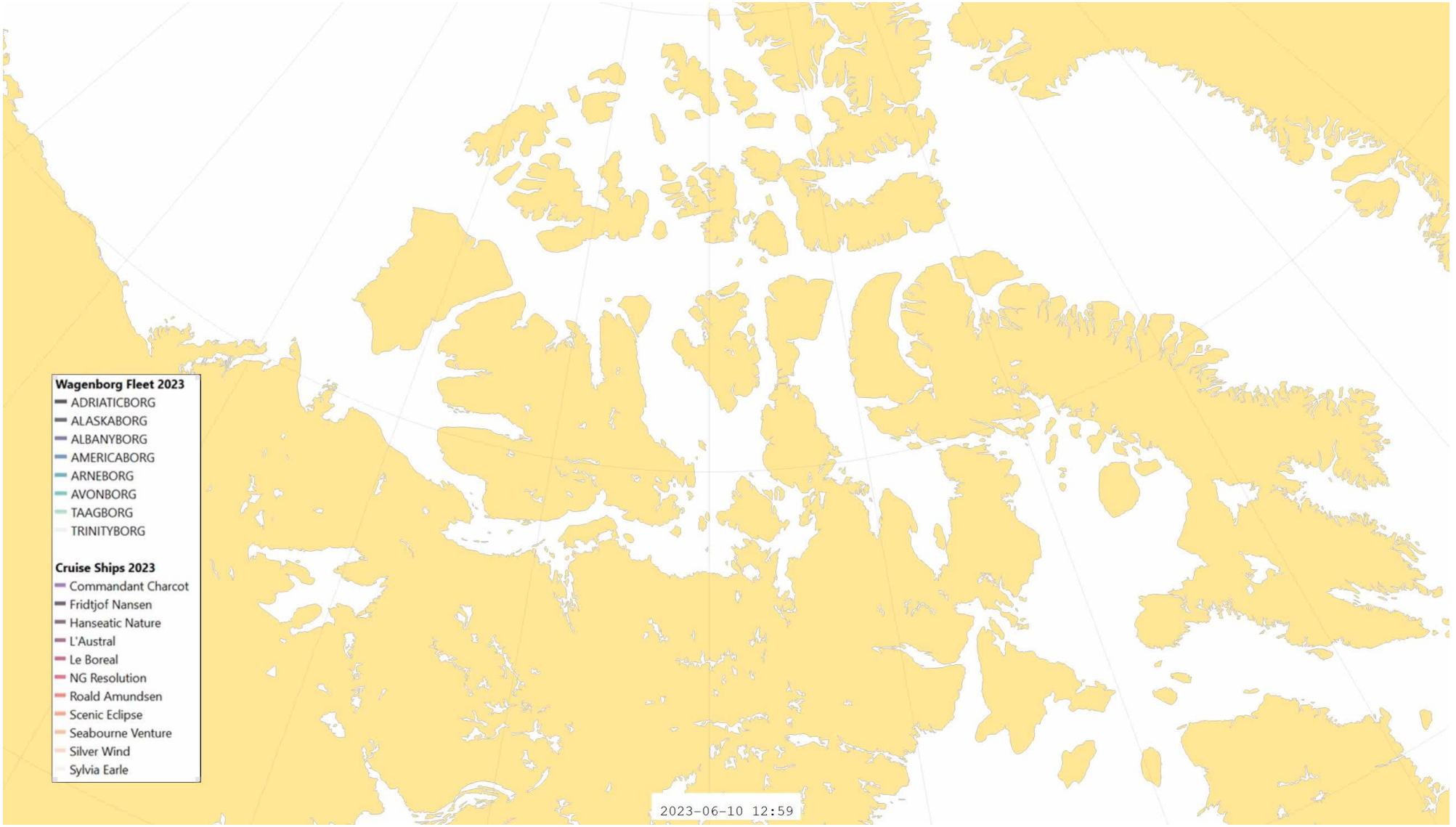


Ships using the NWP for Transit

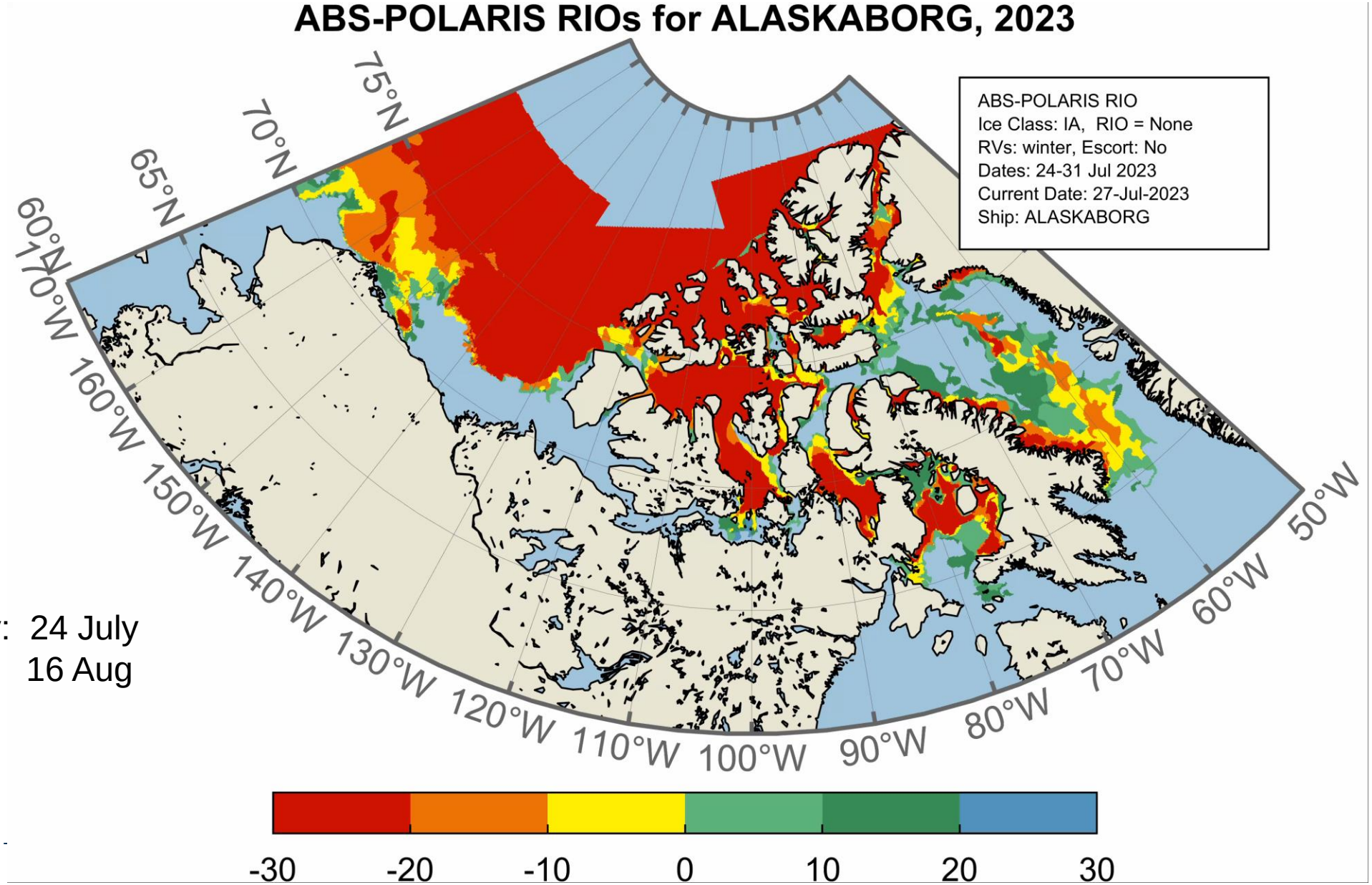
- Number of ships increasing
- Shorter and quicker
- Getting more predictable, while the Suez, Panama and NSR are less predictable



Ships using the NWP for Transit

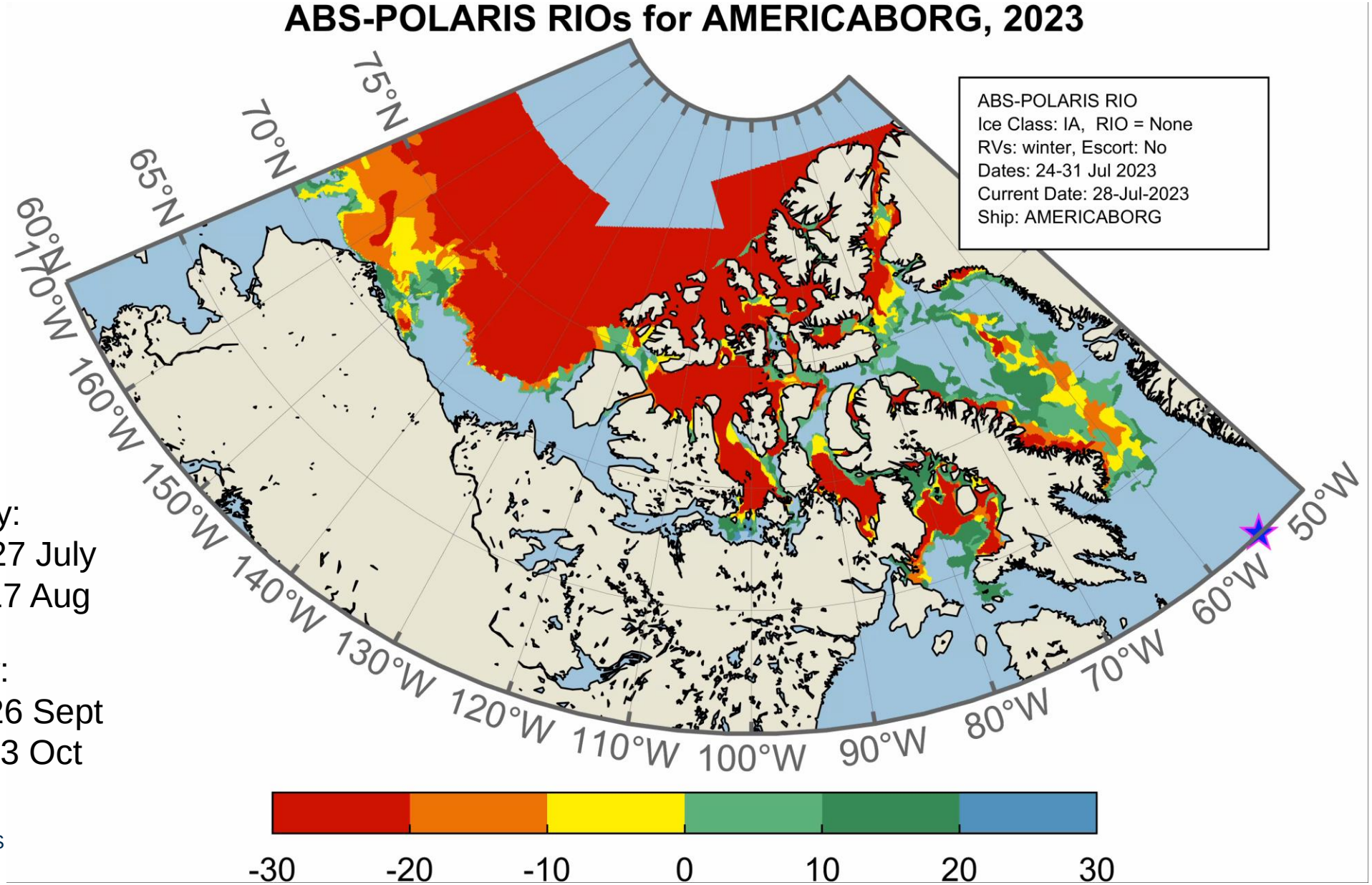


NWP: Some interesting voyages



Entry: 24 July
Exit: 16 Aug

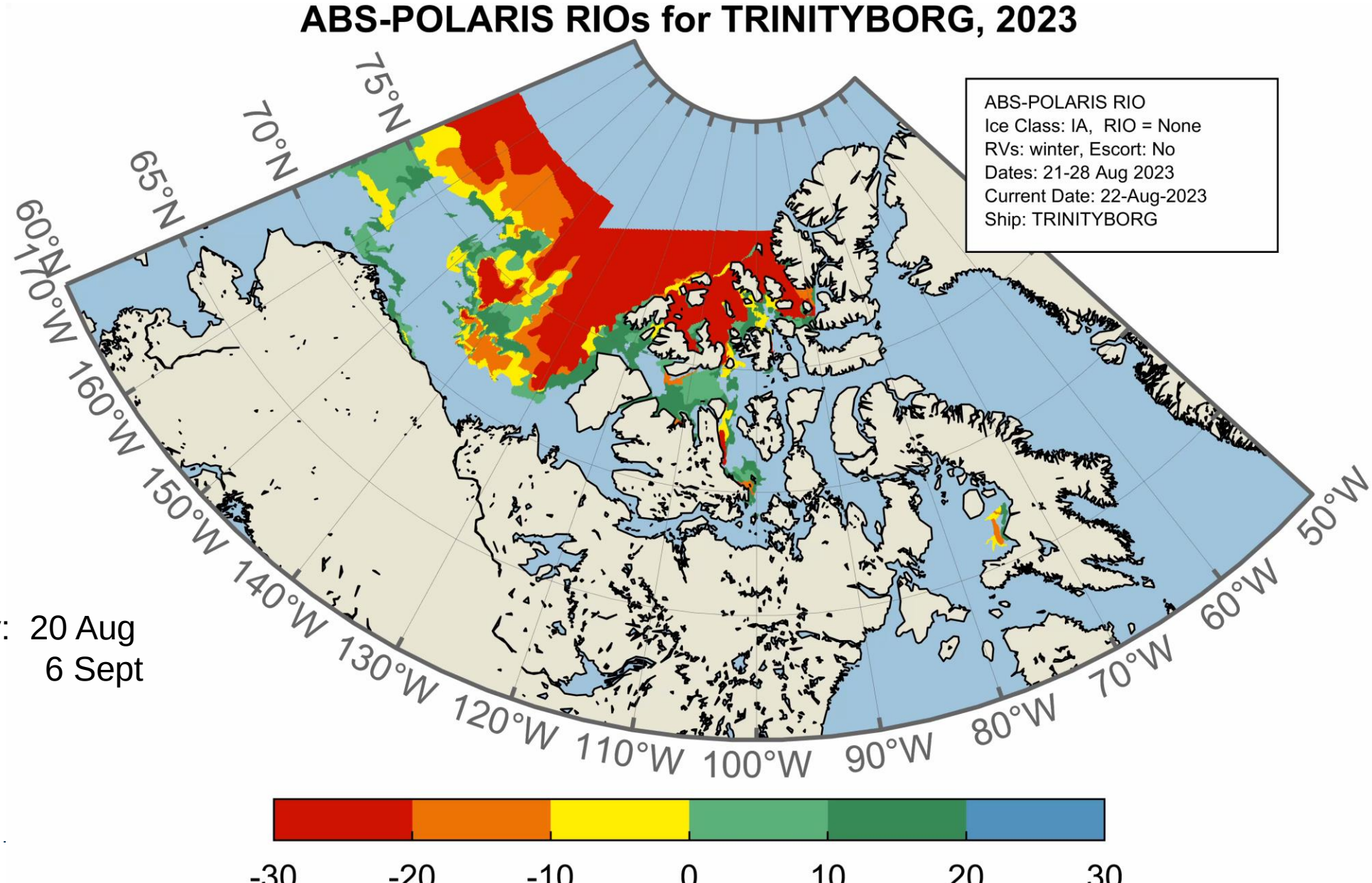
NWP: Some interesting voyages



Westerly:
Entry: 27 July
Exit: 17 Aug

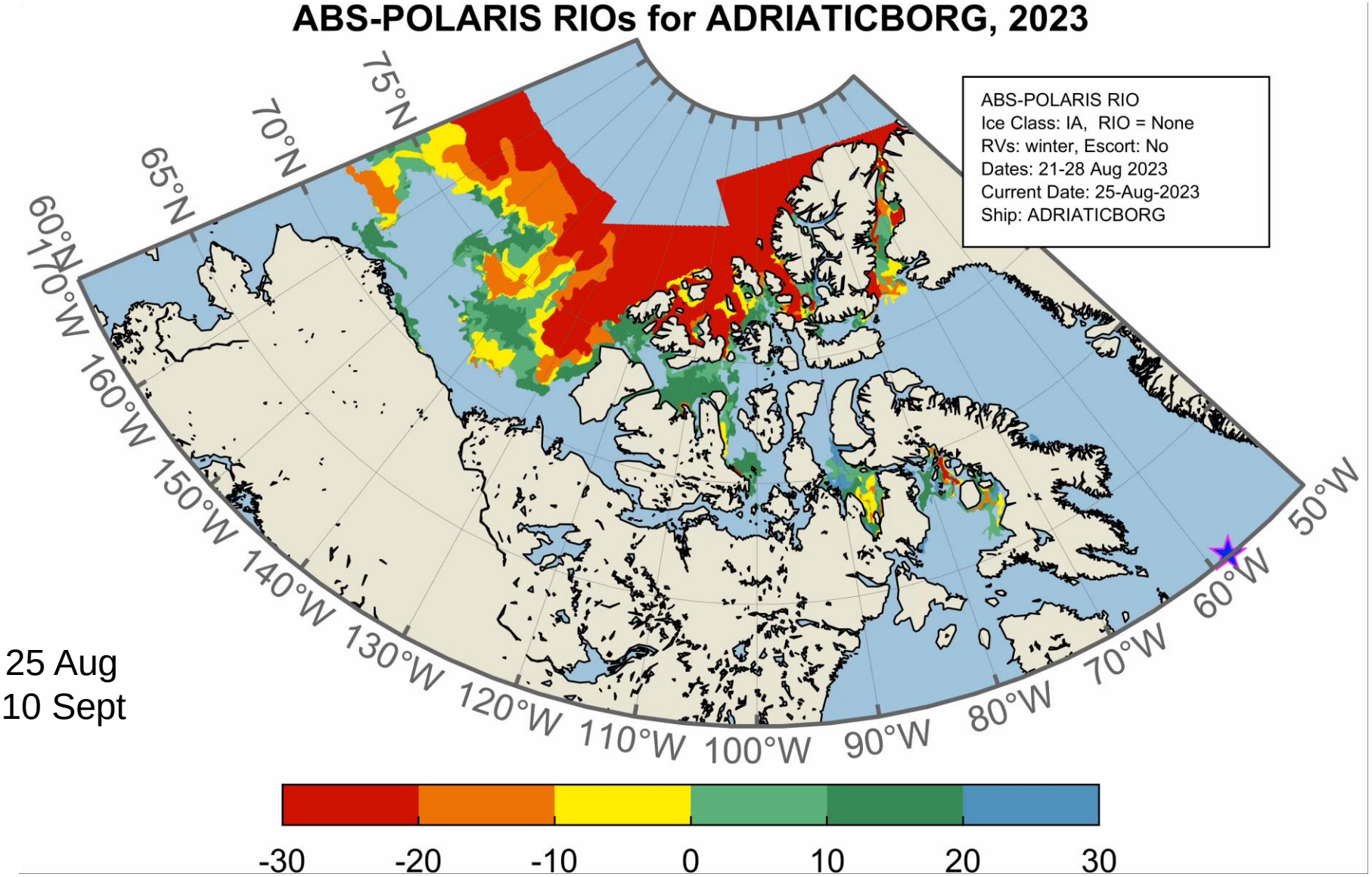
Easterly:
Entry: 26 Sept
Exit: 13 Oct

NWP: Some interesting voyages



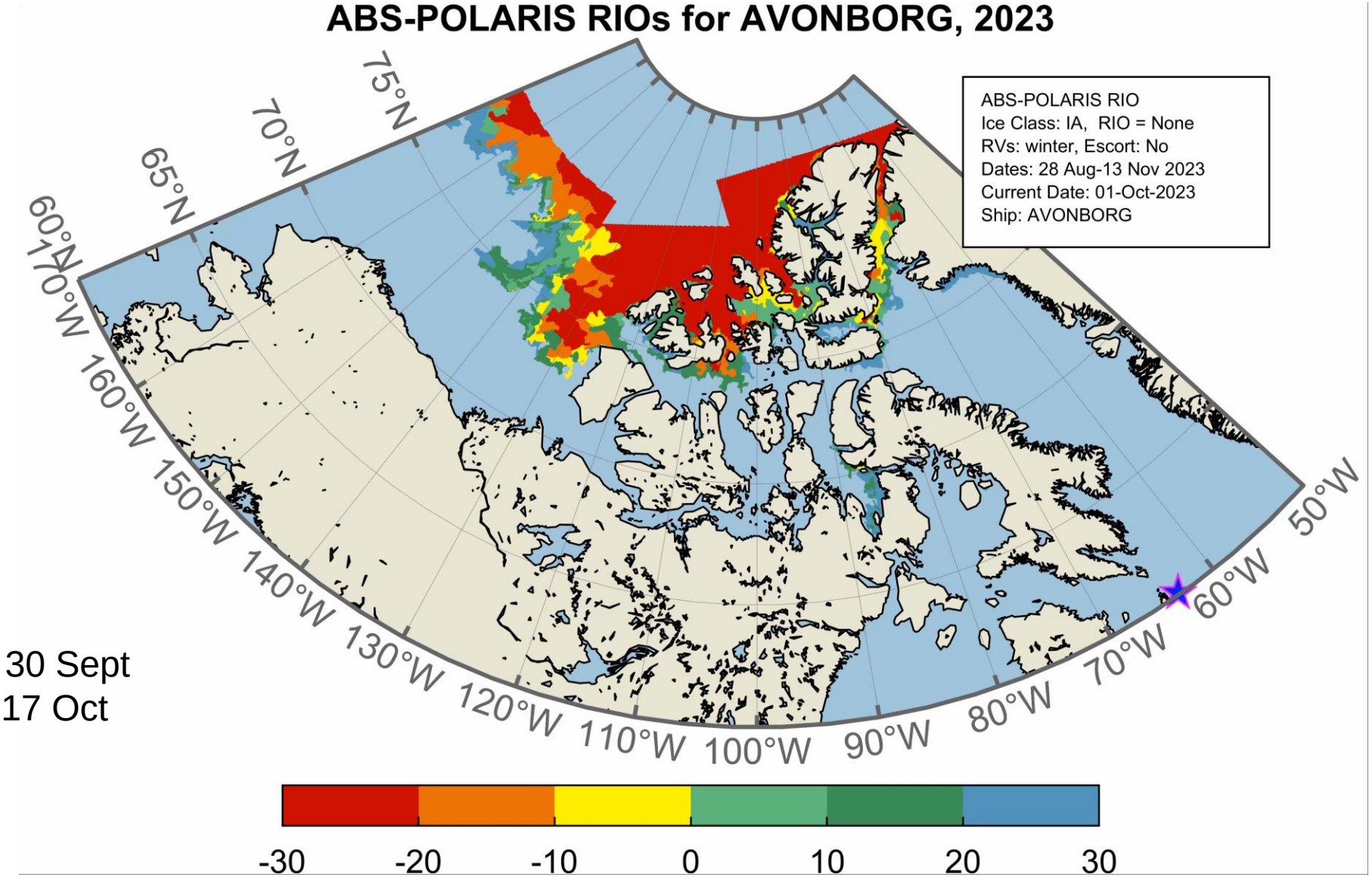
Entry: 20 Aug
Exit: 6 Sept

NWP: Some interesting voyages



Entry: 25 Aug
Exit: 10 Sept

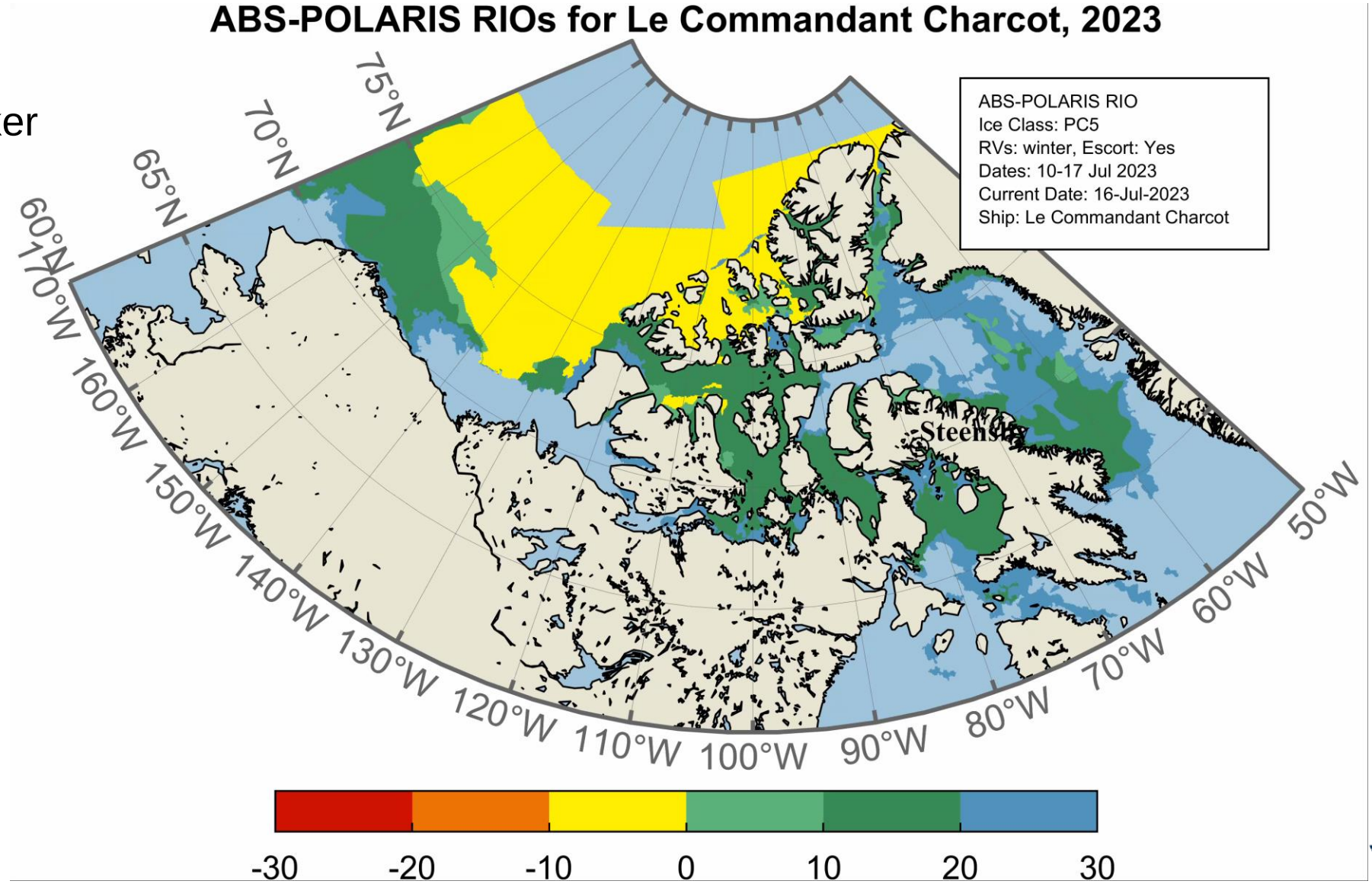
NWP: Some interesting voyages



Entry: 30 Sept
Exit: 17 Oct

NWP: Some interesting voyages

- What if …..
  - A PC2 icebreaker escorted a PC5 ship



POLARIS ~~Flaws~~ Nuances & Issues

- Simplicity? – YES
- Brilliance? – SURE
- ~~Flaws~~ Nuances – SOME
  - Linearity with concentration, there is a point where enough open water to maneuver equals increased safety
  - Icebreaker +10 needs additional analysis / justification
  - Assumes ice class = capability
  - Developed for steel cargo ships (it is seeing broader use)
- Issues – Some
  - Ice charts appear to be conservative (those on board are typically reporting less ice) although there is not enough data available yet to rigorously confirm this
  - Academia are using it for purposes it was never intended for

Thank You

www.eagle.org

James Bond
jbond@eagle.org