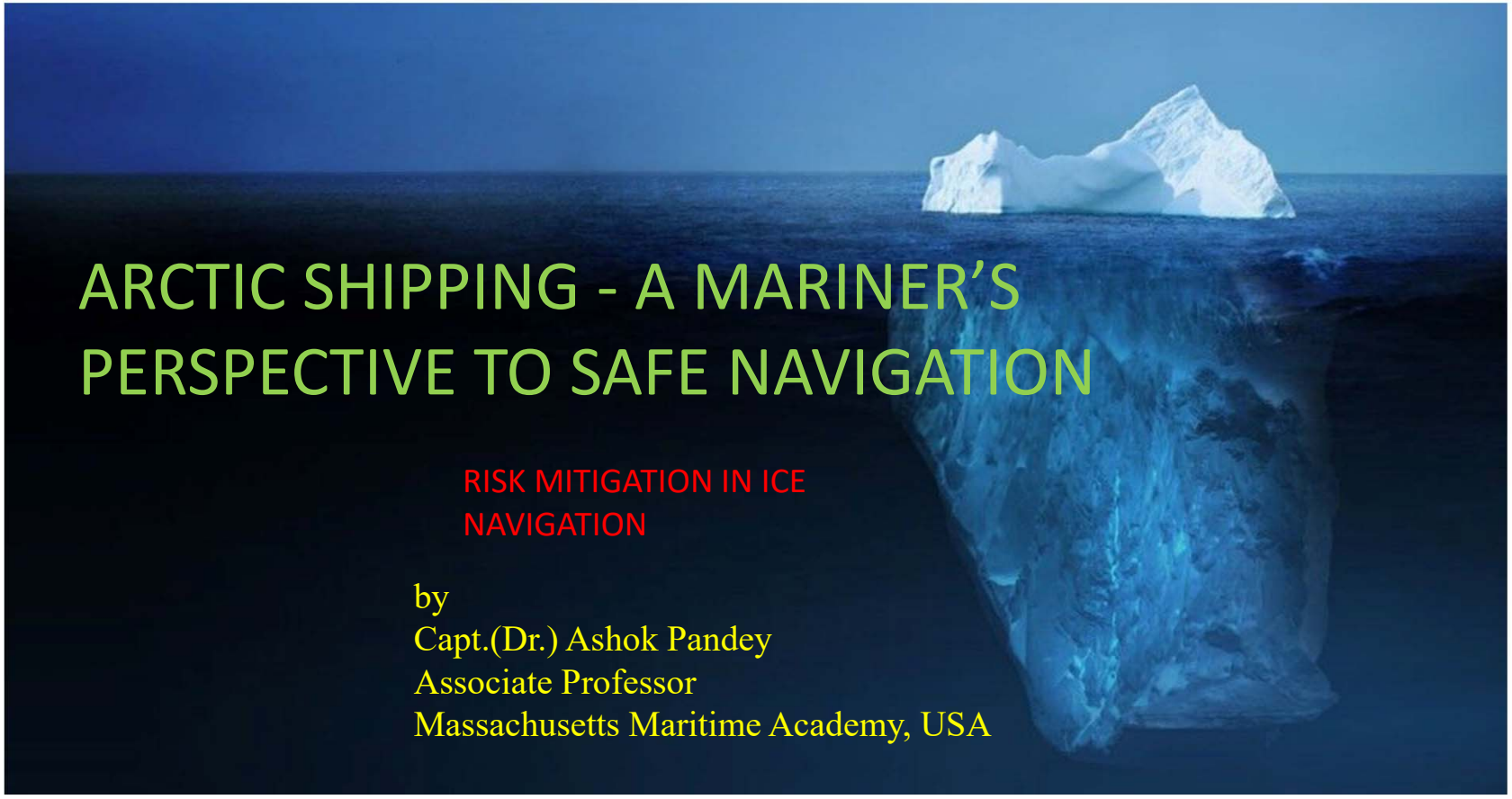

ARCTIC SHIPPING - A MARINER'S PERSPECTIVE TO SAFE NAVIGATION

RISK MITIGATION IN ICE NAVIGATION

by
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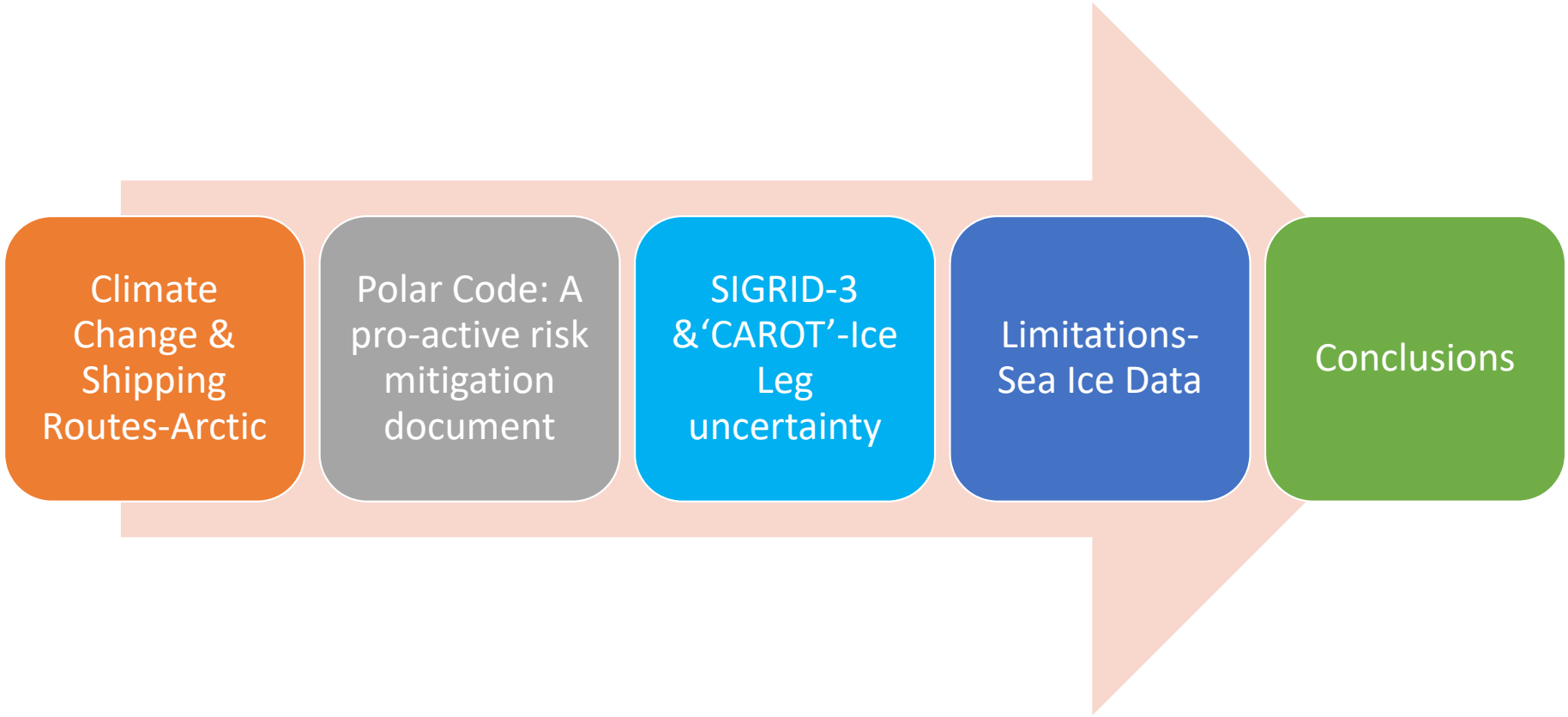
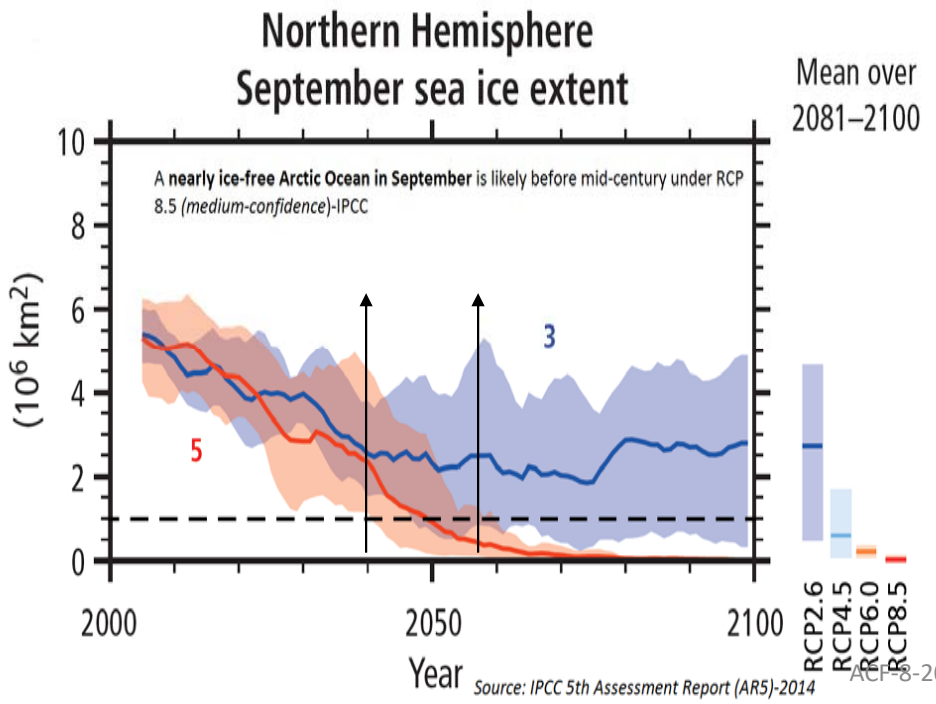
AGENDA


Climate Change & Shipping Routes-Arctic
Polar Code: A pro-active risk mitigation document
SIGRID-3 &'CAROT'-Ice Leg uncertainty
Limitations- Sea Ice Data
Conclusions

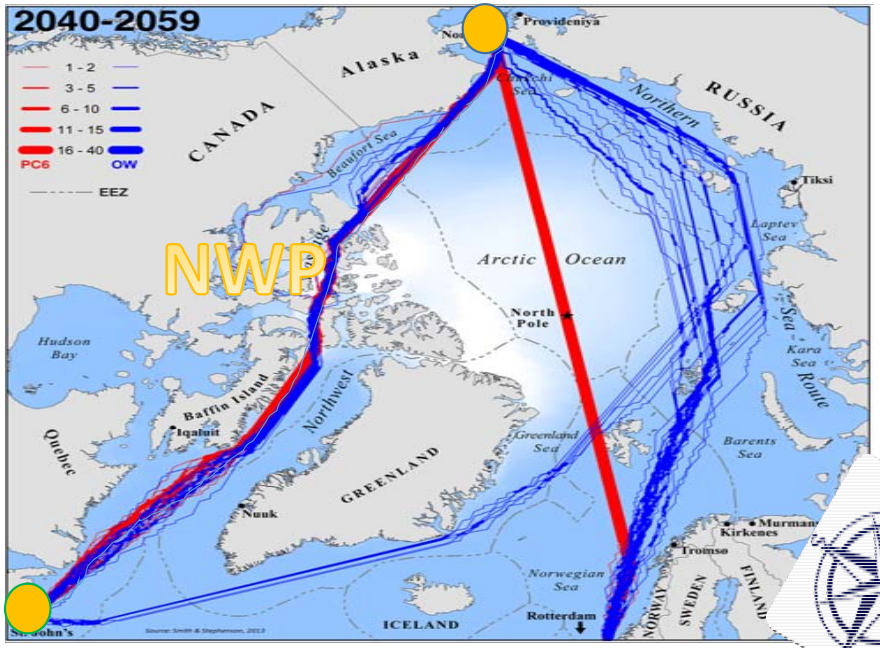
ARCTIC SHIPPING ROUTES- TRIGGER & CONSEQUENCE

THE TRIGGER:DECLINE IN SEA-ICE



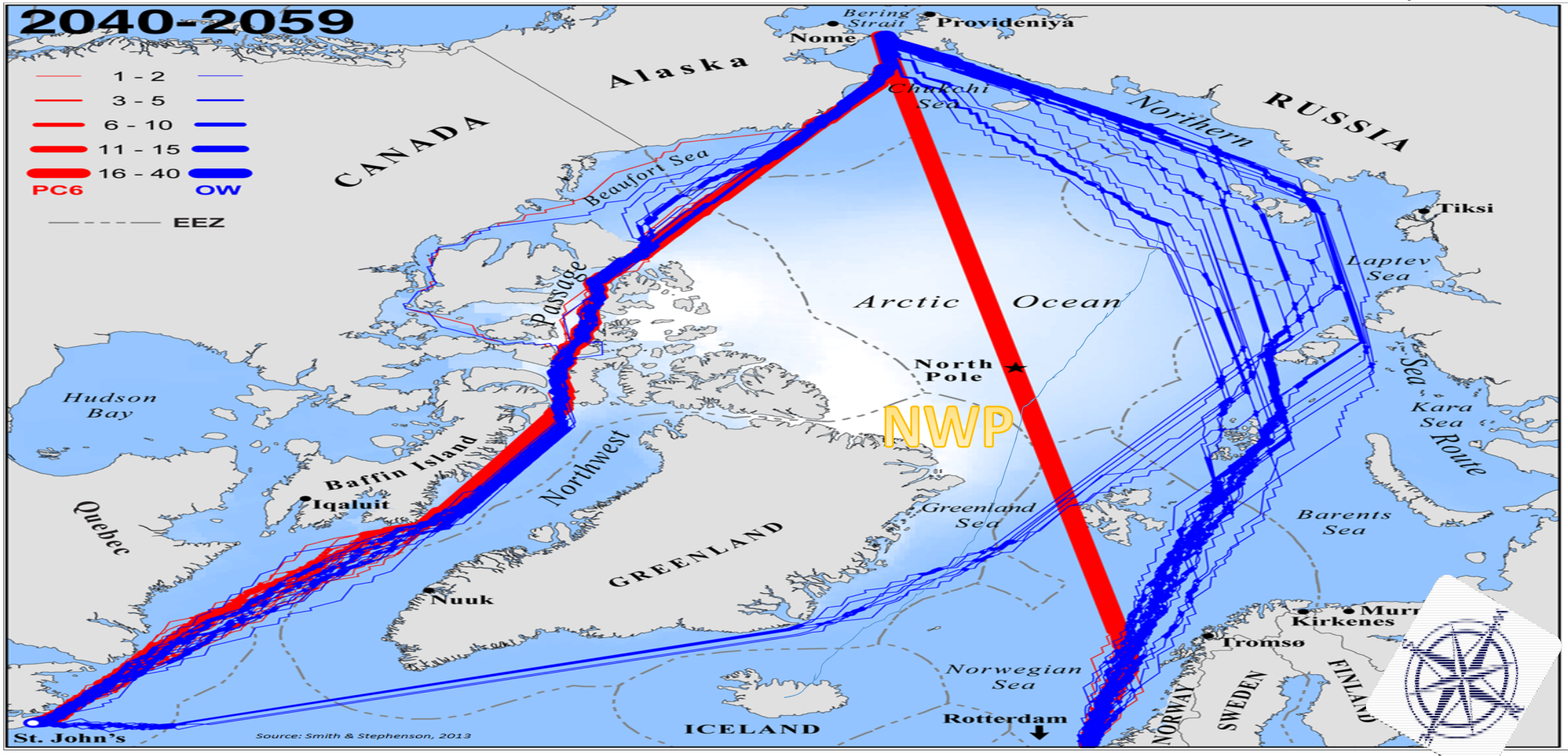
Source: IPCC 5th Assessment Report (AR5)-2014

EMERGENCE OF TRANS-ARCTIC SHIPPING ROUTES: THE CONSEQUENCE



Source: Smith & Stephenson (2013)

ARCTIC TRANSPORT ACCESSIBILITY-MODEL(2040-2059)

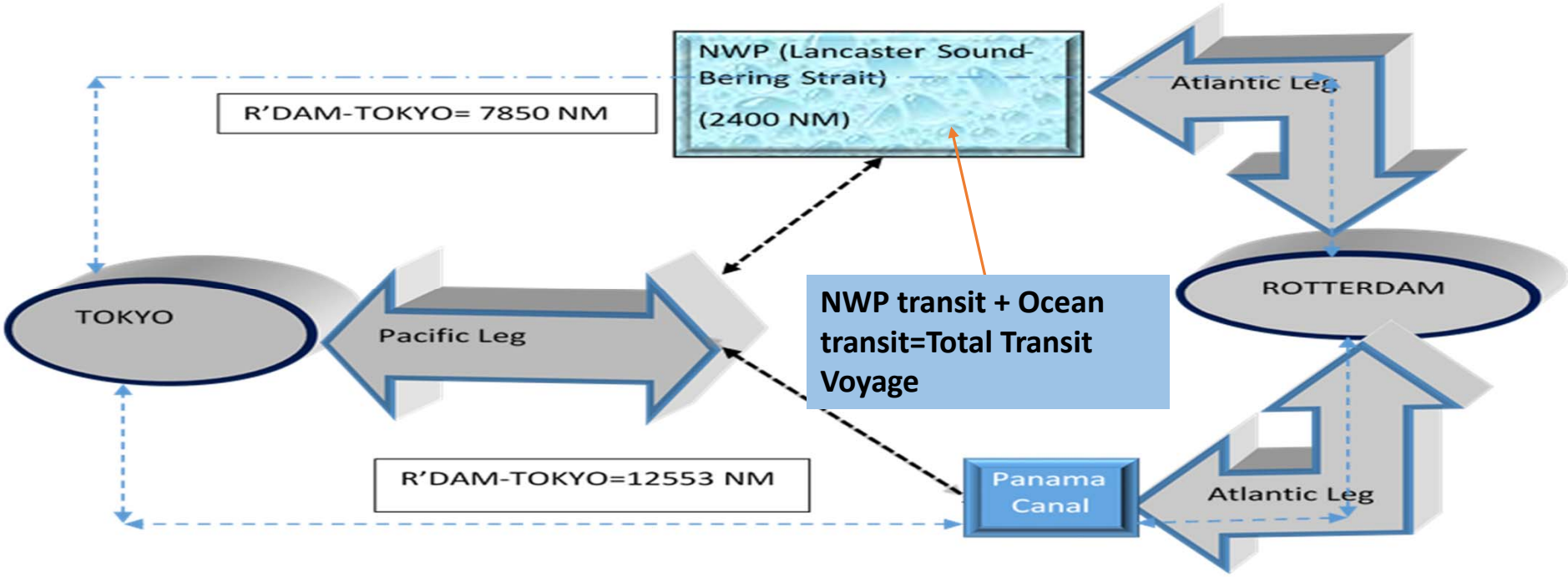


Source: Smith & Stephenson (2013)

DIGITAL ICE CHARTS-'SIGRID'-3

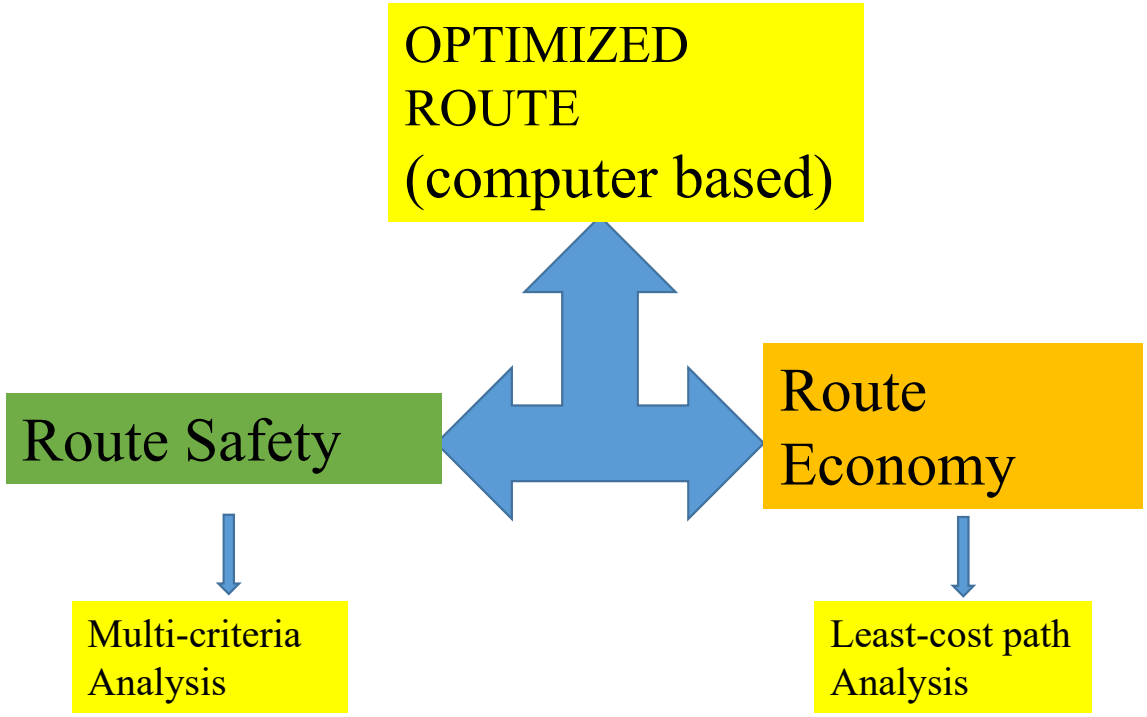
- Adhering to the Polar Code (a pro-active document)- Risk mitigation and voyage planning remains the best option to conduct safe navigation.
- The erstwhile frozen sea ice is also breaking into pieces and each piece can repeat the TITANIC story if not identified and avoided.
- Sea ice forecasts are even more important in ice bound regions than ever before- growlers difficult to detect-experienced ice navigators!
- The SIGRID-3 (WMO,2010) format is a powerful tool in understanding the parameters (CT,CA,SA,FA…CN,CD..)

THE ‘ICE’ LEG-AN UNCERTAIN FACTOR IN ARCTIC NAVIGATION



‘CAROT’ & SIGRID-3

- The route optimization tool seeks the least cost path in an ice regime
- SIGRID-3 data quality is a concern that will get better over time.



INCONSISTENCIES-SEA ICE DATA

- It is hard to estimate the average sea-ice thickness with a 'dummy variable' (-9) present in the mix that introduces an uncertainty in averaging ice thickness.
- Information on floe size that is critical to voyage planning becomes unreliable with missing values and 'unknown parameters' (99).
- An accurate estimation of ice concentration is also not precise with so many missing variables.

SELECTED SEA ICE CHART DATA-29th SEPT'14

OBJECTID *	Shape *	CT	CA	SA	CB	SB	CC	FC
		Total Conc	Partial Conc	Stage Of Dev	Partial Conc	Stage Of Dev	Partial Conc	Ice Form
1	Polygon	92	-9	95	-9	-9	-9	-9
3	Polygon	91	90	95	10	84	-9	-9
4	Polygon	91	90	95	10	93	-9	-9
10	Polygon	1	-9	99	-9	-9	-9	3
66	Polygon	60	20	95	40	81	-9	99
95	Polygon	2	-9	98	-9	-9	-9	-9
96	Polygon	91	-9	84	-9	-9	-9	8
102	Polygon	90	70	95	10	93	10	4
103	Polygon	80	-9	81	-9	-9	-9	8
120	Polygon	92	-9	93	-9	-9	-9	4
173	Polygon	91	10	95	10	93	10	4
178	Polygon	1	-9	99	-9	-9	-9	4
180	Polygon	20	-9	81	-9	-9	-9	4
263	Polygon	60	10	95	50	81	-9	8

OBSERVATIONS-SEA ICE DATA

- The daily ice charts (CIS) represent the best estimate of ice conditions at the time of image acquisition (4 hours before transmission), based on an integration of data from a variety of sources, such as satellite observation, ship, and aircraft-based visual observations.
- Ice concentration data collected from passive microwave radiation techniques may not be as reliable as SAR (active microwave) telemetry data. Passive microwave radiation data is known to underestimate sea ice concentration
- Ice berg charts of the Arctic on similar lines as the IIP charts off Grand banks is necessary.

Route Optimization & Sea Ice Data

- Decision making in ice -timely and accurate
- Passage planning –a powerful tool that assists the ice navigator in judging the dangers involved and arrive at a better route selection.
- A host of measures to improve safety and reduce risk are currently under development- Model embraces AIRSS methodology & and a risk indexing system for Polar operations (POLARIS) .
- A dynamic/tactical route optimization tool 'on-the-fly' will immensely assist in better decision making on the safest route to follow in ice.
- All of the above may not be possible without an accurate Ice Chart!
- Deploying more space assets & better ship-shore data connectivity in Arctic

NWP- NAVIGATION SEASON (2011-2099)

PROJECTED-NAVIGATION DAYS-SUMMER (JULY-OCTOBER)						
	NORTH WEST PASSAGE					
	PC3		PC6		Non-Ice Class/OW	
RCP4.5	Navigable Days /SD					
	Days	*SD*	Days	*SD*	Days	*SD*
2011-2030	89	*19*	79	*19*	69	*19*
2045-2065	109	*13*	96	*18*	83	*18*
2080-2099	114	*17*	94	*18*	84	*17*
RCP6.0						
2011-2030	86	*15*	76	*16*	67	*15*
2045-2065	96	*16*	85	*17*	74	*15*
2080-2099	116	*10*	107	*15*	95	*16*
RCP8.5						
2011-2030	84	*16*	75	*15*	66	*13*
2045-2065	121	*4*	115	*8*	105	*12*
2080-2099	122	*1*	120	*4*	116	*6*
RCP	Representative Concentration Pathway- Climate forcing scenario					
SD	Standard	Deviation				
PC-3	Polar Class 3		Year-round operation 2nd year ice			
PC-4	Polar Class 4		Year-round operation Thick 1st year ice			
PC-6	Polar Class 6		Summer/Autumn ops-Thick 1st Year			
OW	Open Water		Ice free			

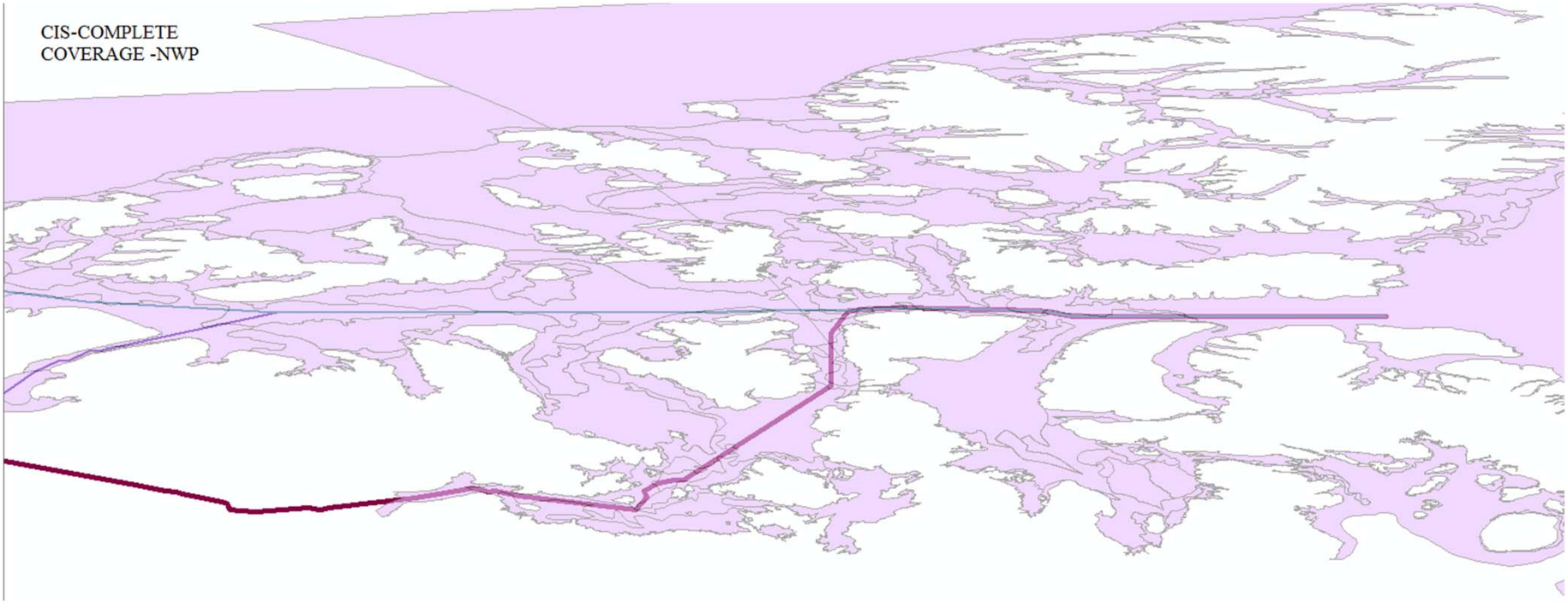
Source: Projected 21st century changes to Arctic Marine Access (Stephenson et. al,2013)

EVIDENCE OF:

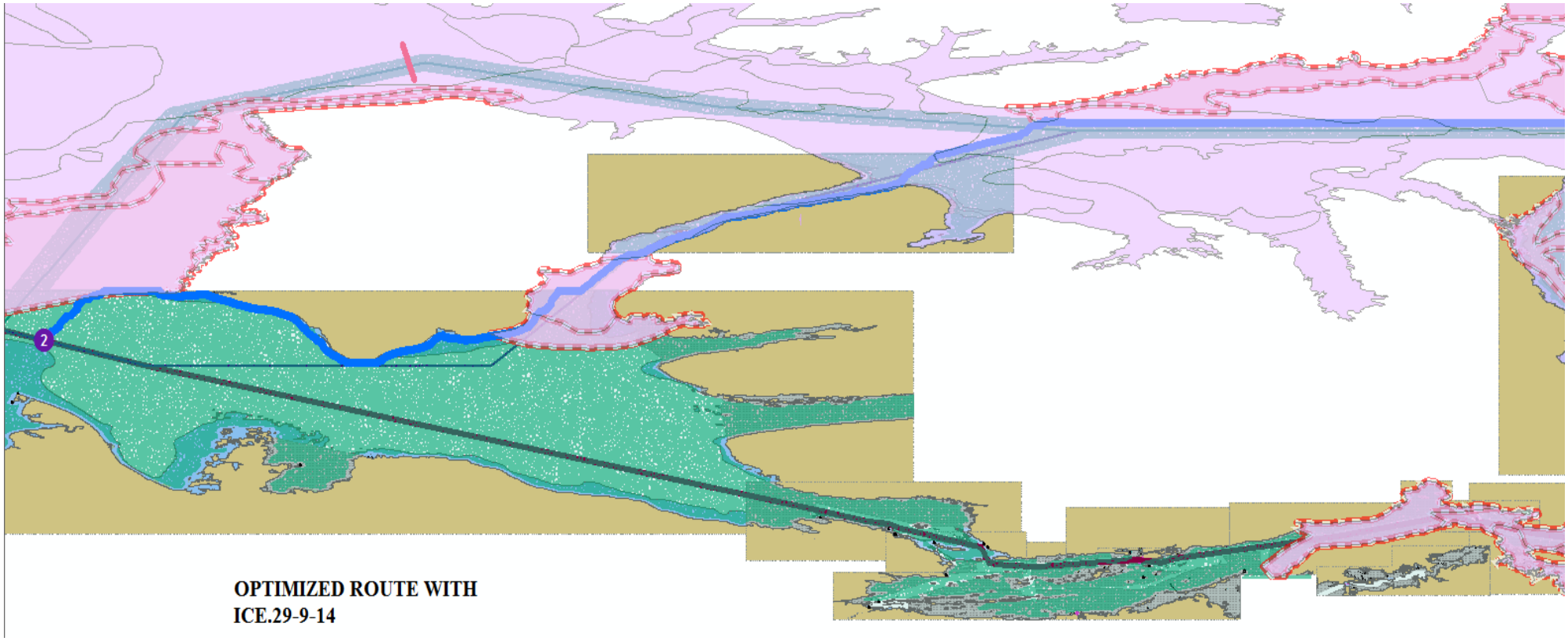
- MEDIAN ICE THICKNESS REDUCING PER AGE CLASS
- INTER-ANNUAL VARIABILITY IN SEA-ICE THICKNESS(2yr& MYI)

Navigable days-getting longer ‘OW’ ships

CIS COVERAGE-NWP



OPTIMIZED ROUTE-NWP



OPTIMIZED ROUTE WITH ICE.29-9-14

CARPE DIEM

- Navigation In Ice-infested Waters Remains an Existential Threat to Shipping despite sea-ice receding.
- Let's Eliminate It!
- The role of weatherpersons is seminal in this effort!

We Have Come A Long Way…….Let's Sail-on-the Wire

Captain J-E Bernier looking for ice….