



# Trends in Arctic Shipping

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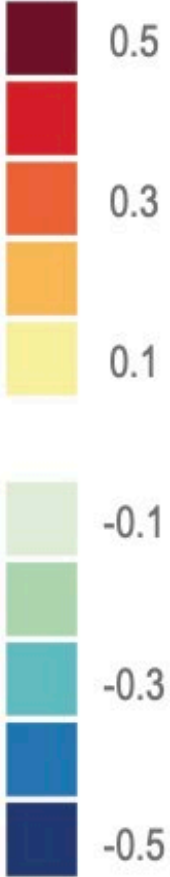
# Outline

- Climate Change and Future Projections
- Global Arctic Shipping Patterns and Trends
- Ship-Ice Interactions, Accidents and Risk
- Data Challenges

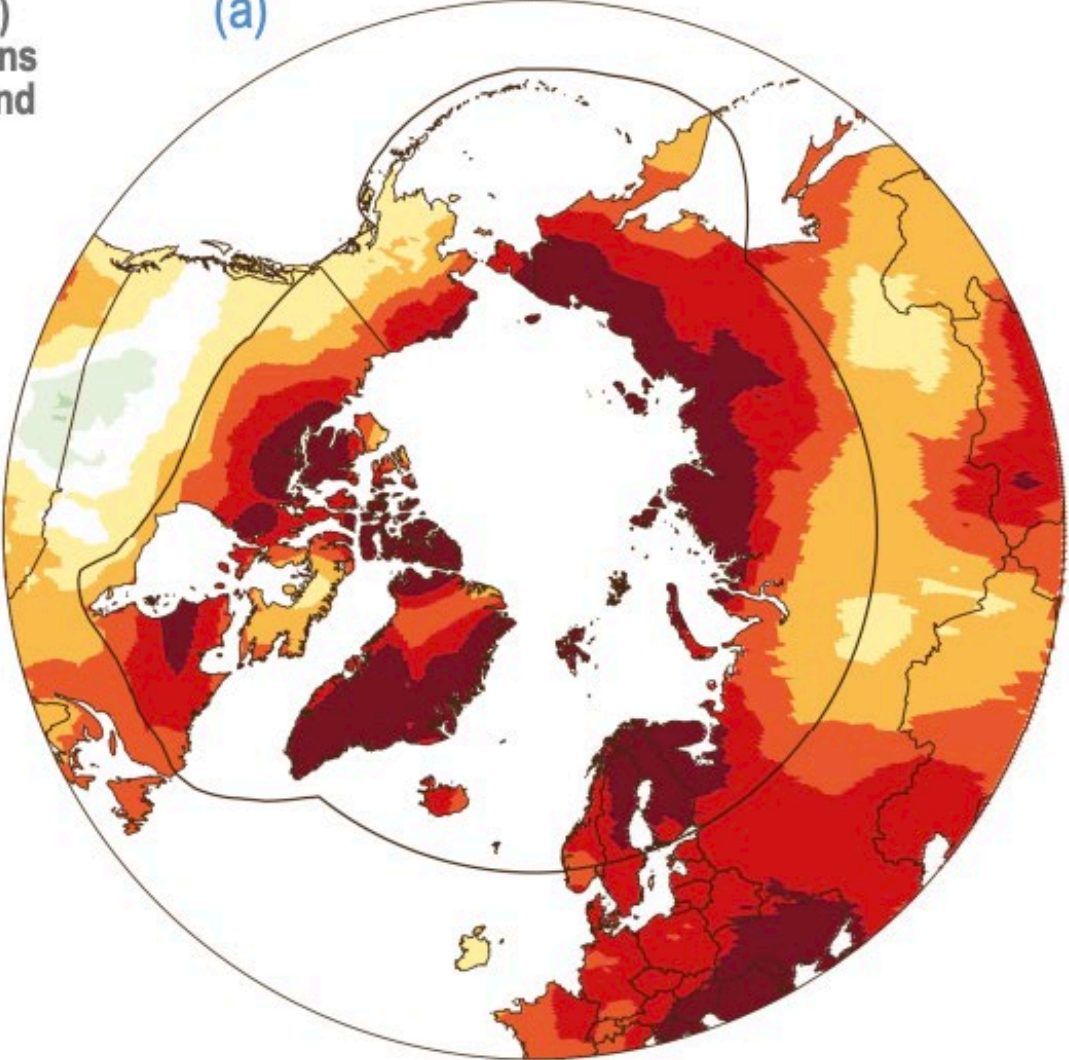


# Projected Warming in the Arctic

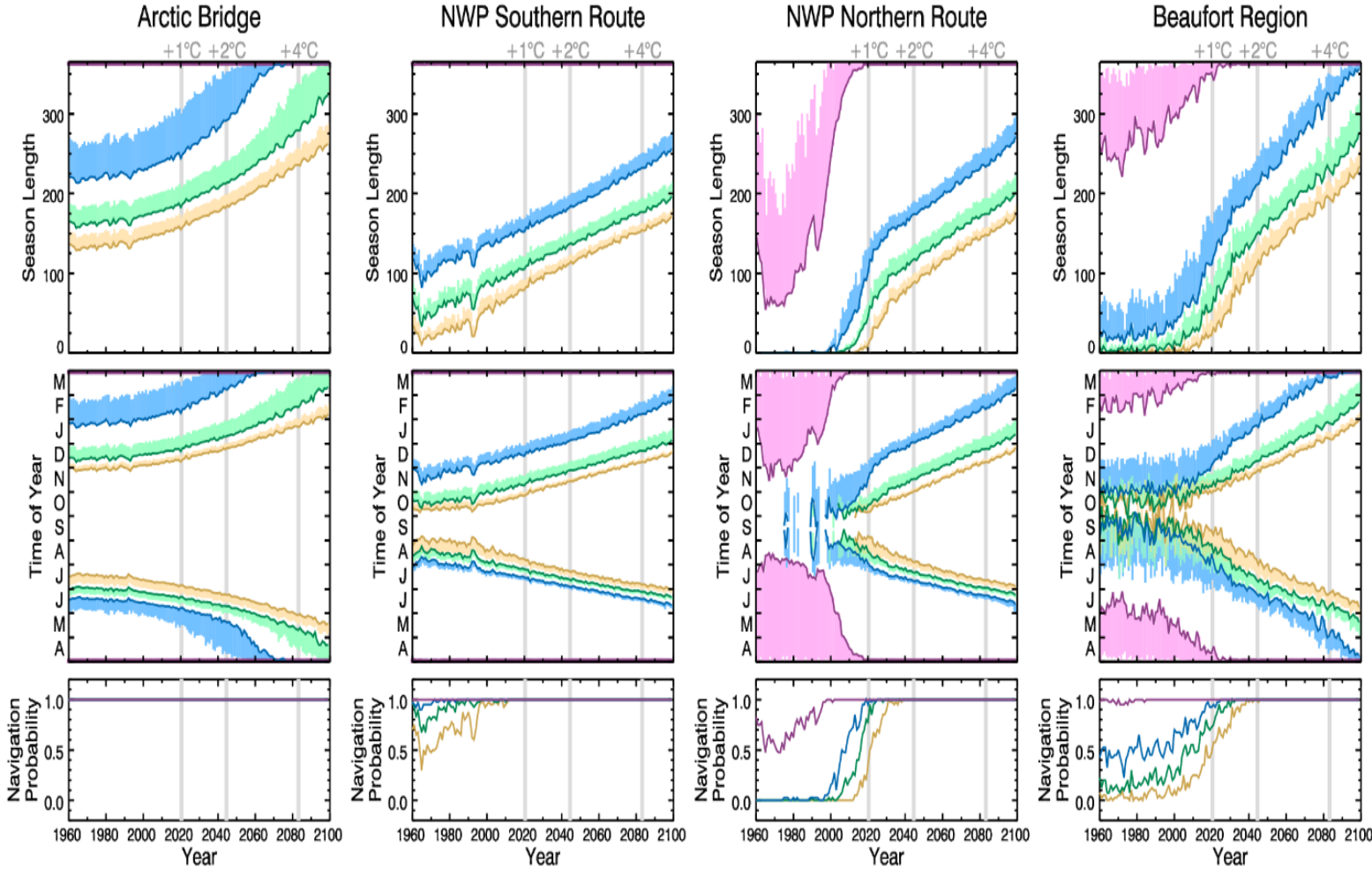
W5E5 (ERA5 adjusted)  
1980–2015 observations  
mean temperature trend  
(°C decade<sup>-1</sup>)



(a)







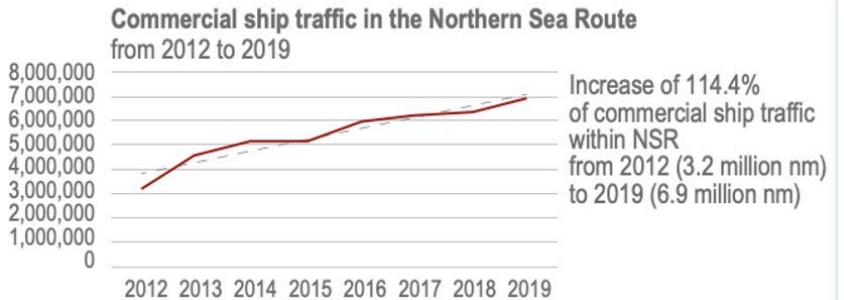
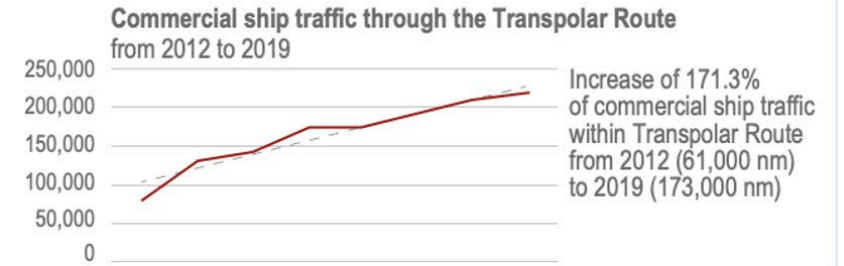
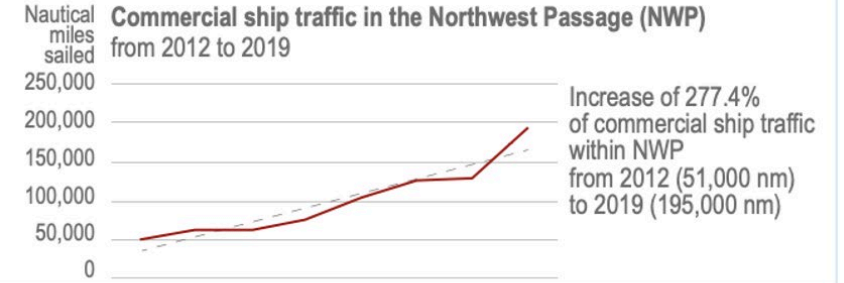
Polar Class 3

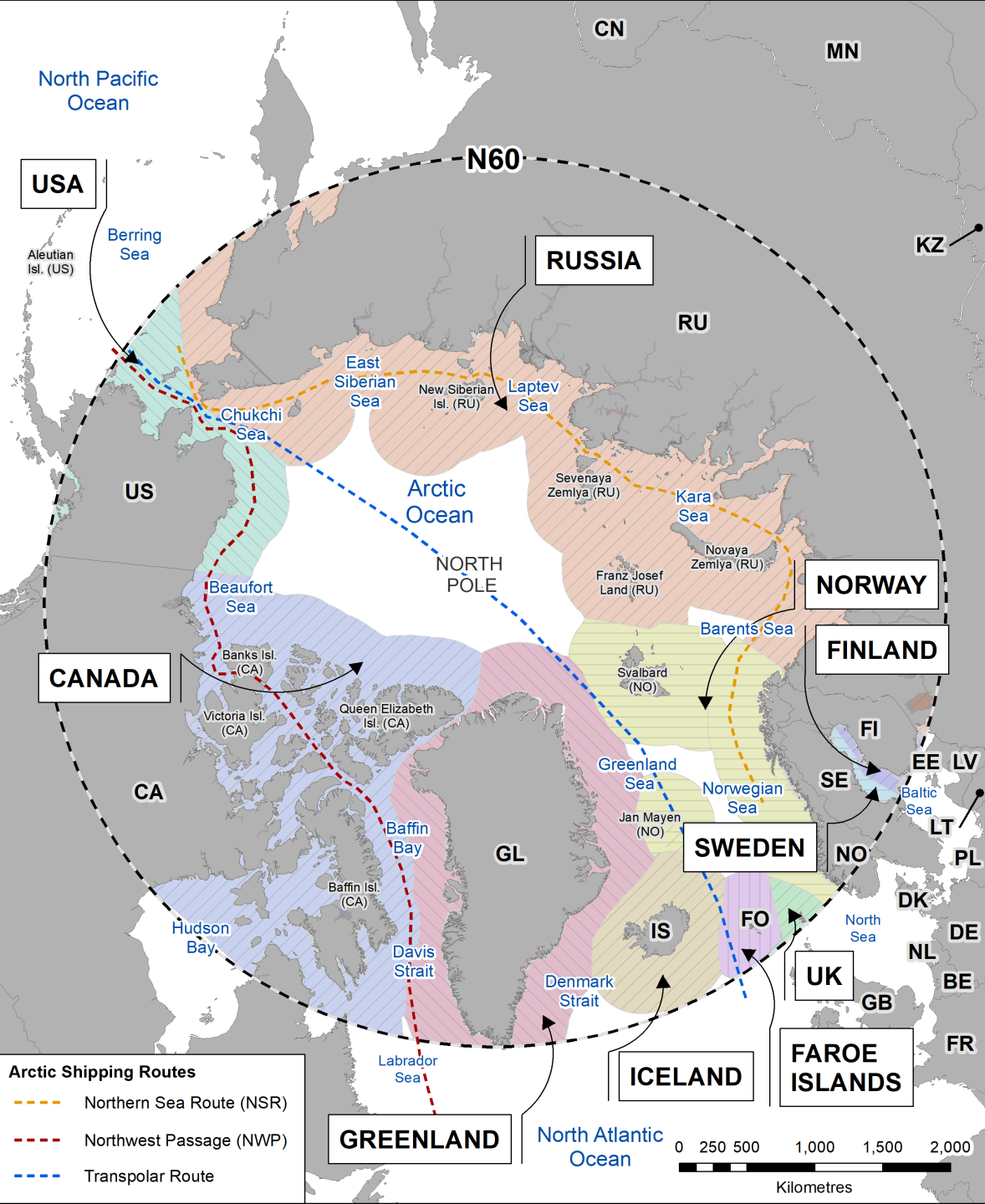
Polar Class 7

Type 1B

No Ice Strength

Northwest Passage: + 14 to 31 days before 4<sup>0</sup> C warming  
 Northern Sea Route: 101 to 118 days annually by 2050  
 Transpolar Route: +56% increase in accessibility by =2050



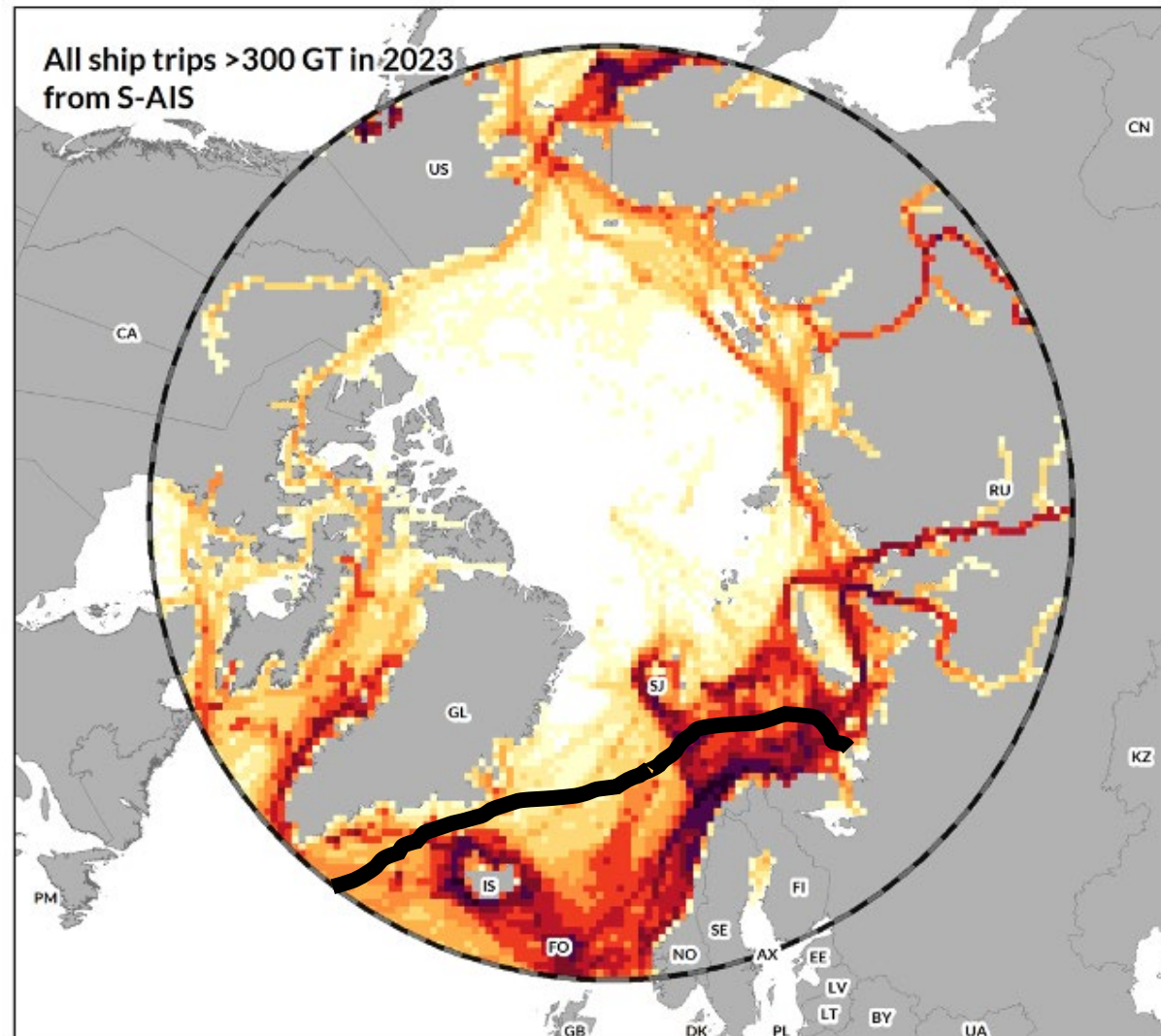
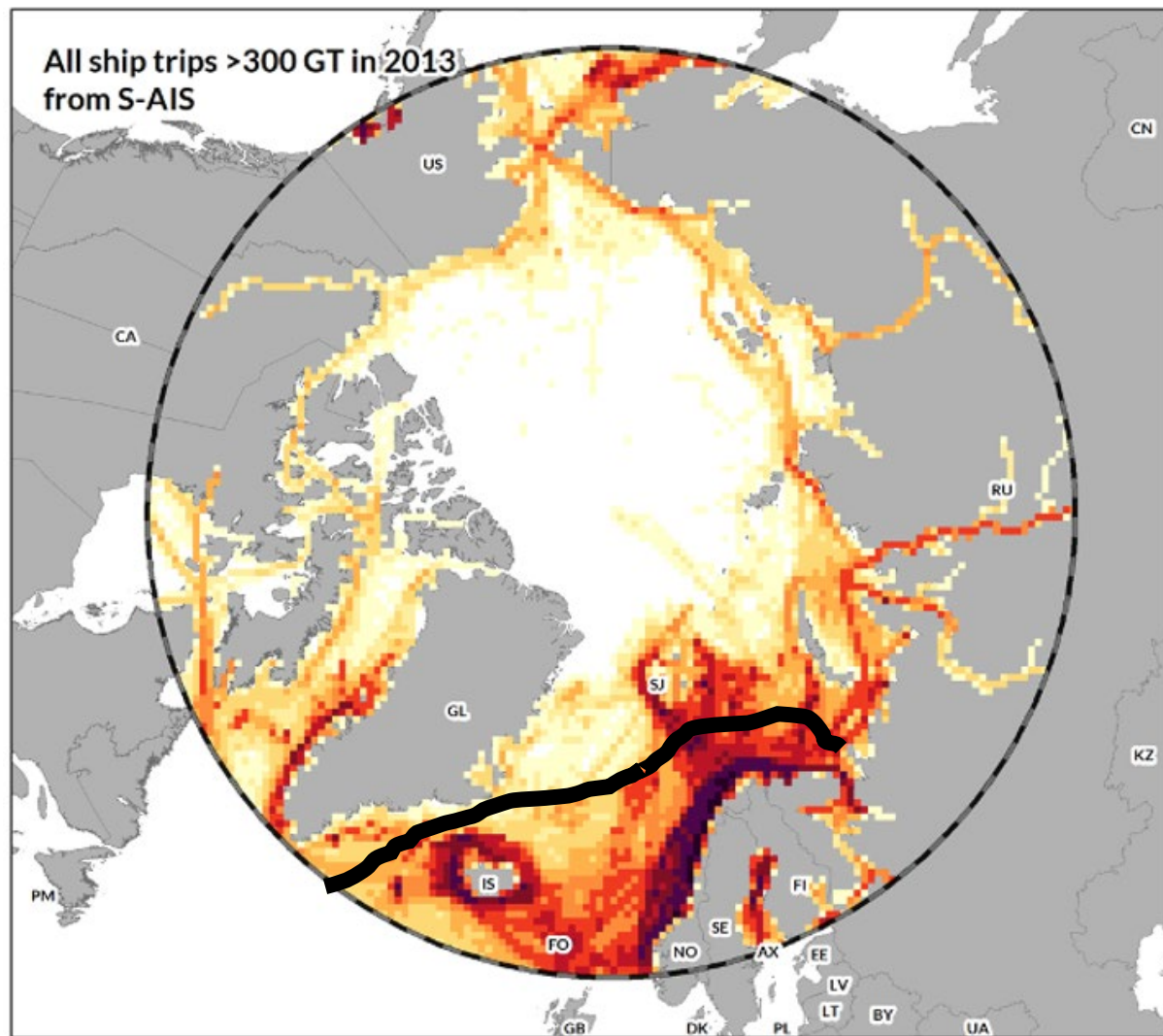


Area of analysis (North of the 60<sup>th</sup> parallel), with Exclusive Economic Zones, North of the 60<sup>th</sup> parallel Using S-AIS (Spire/Kpler)

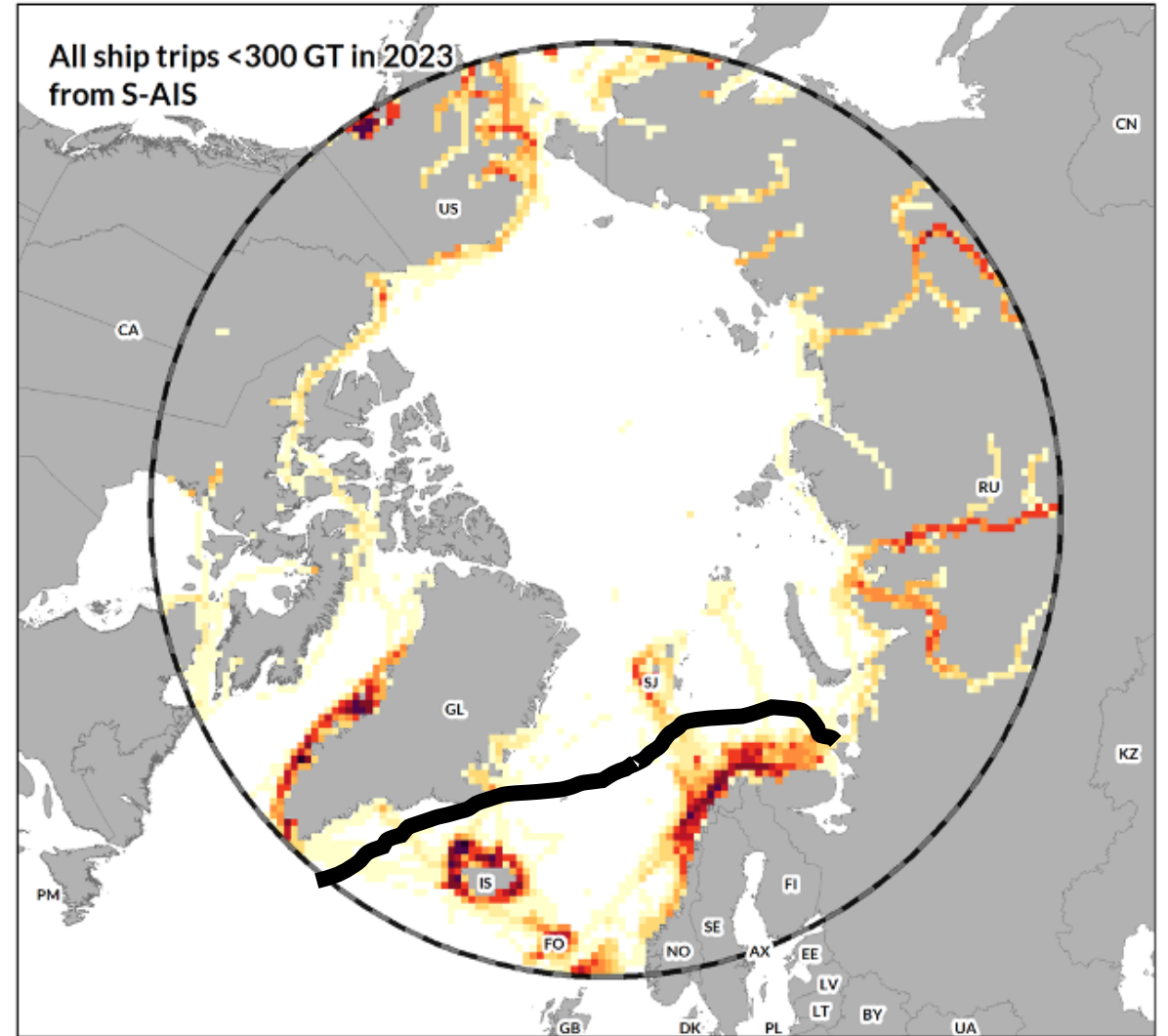
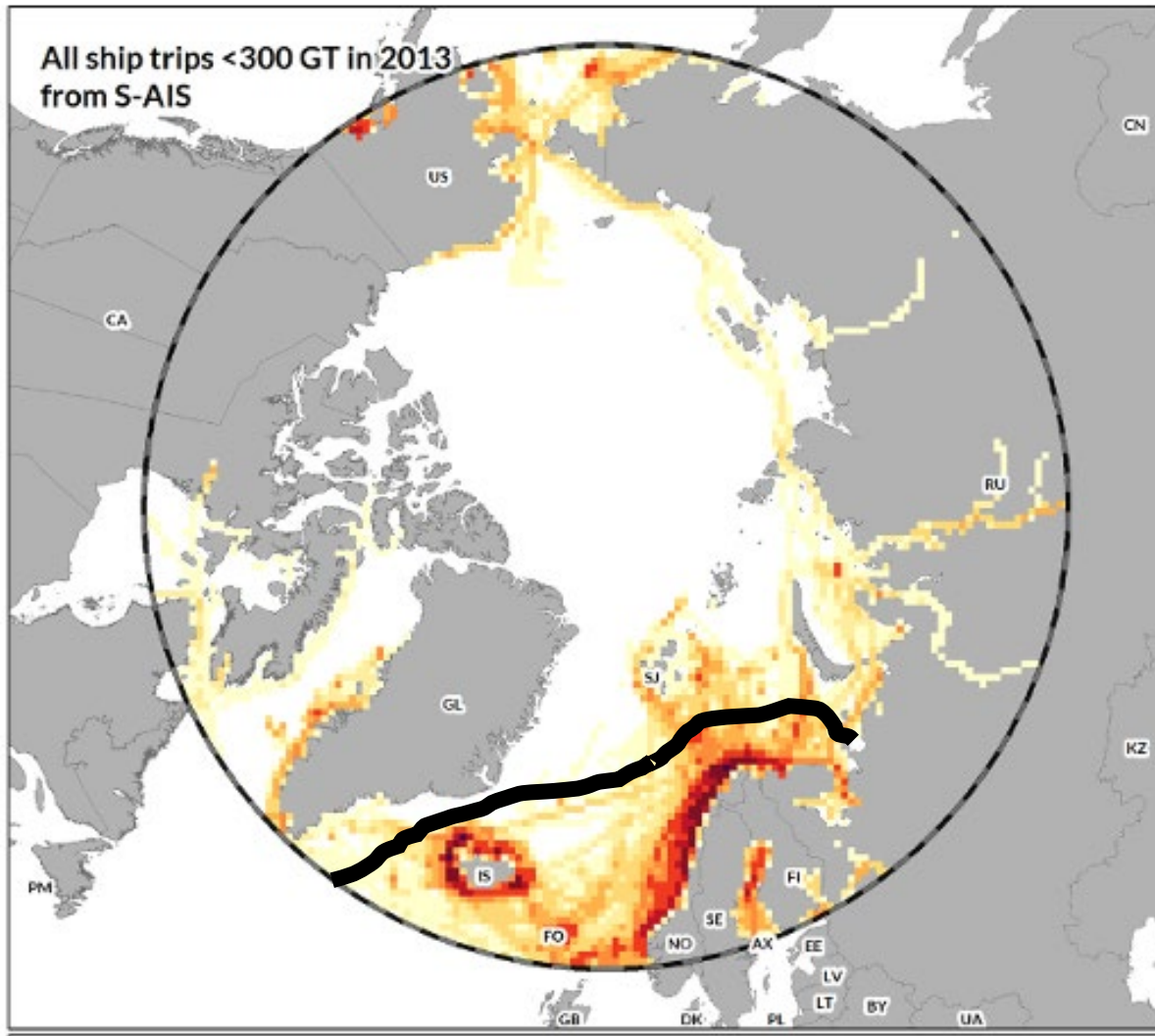




# Ships Over 300 GT (2013 vs. 2023)

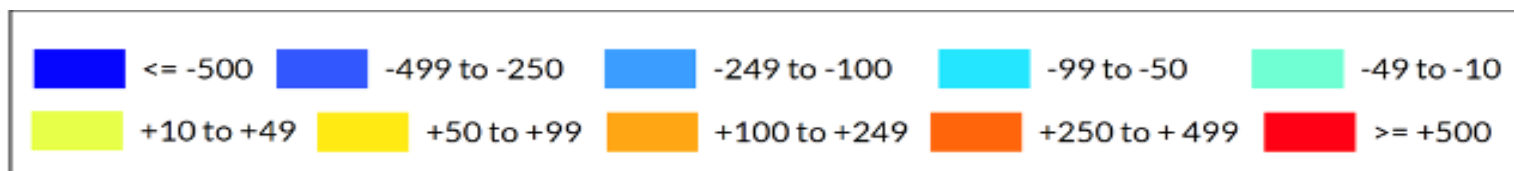
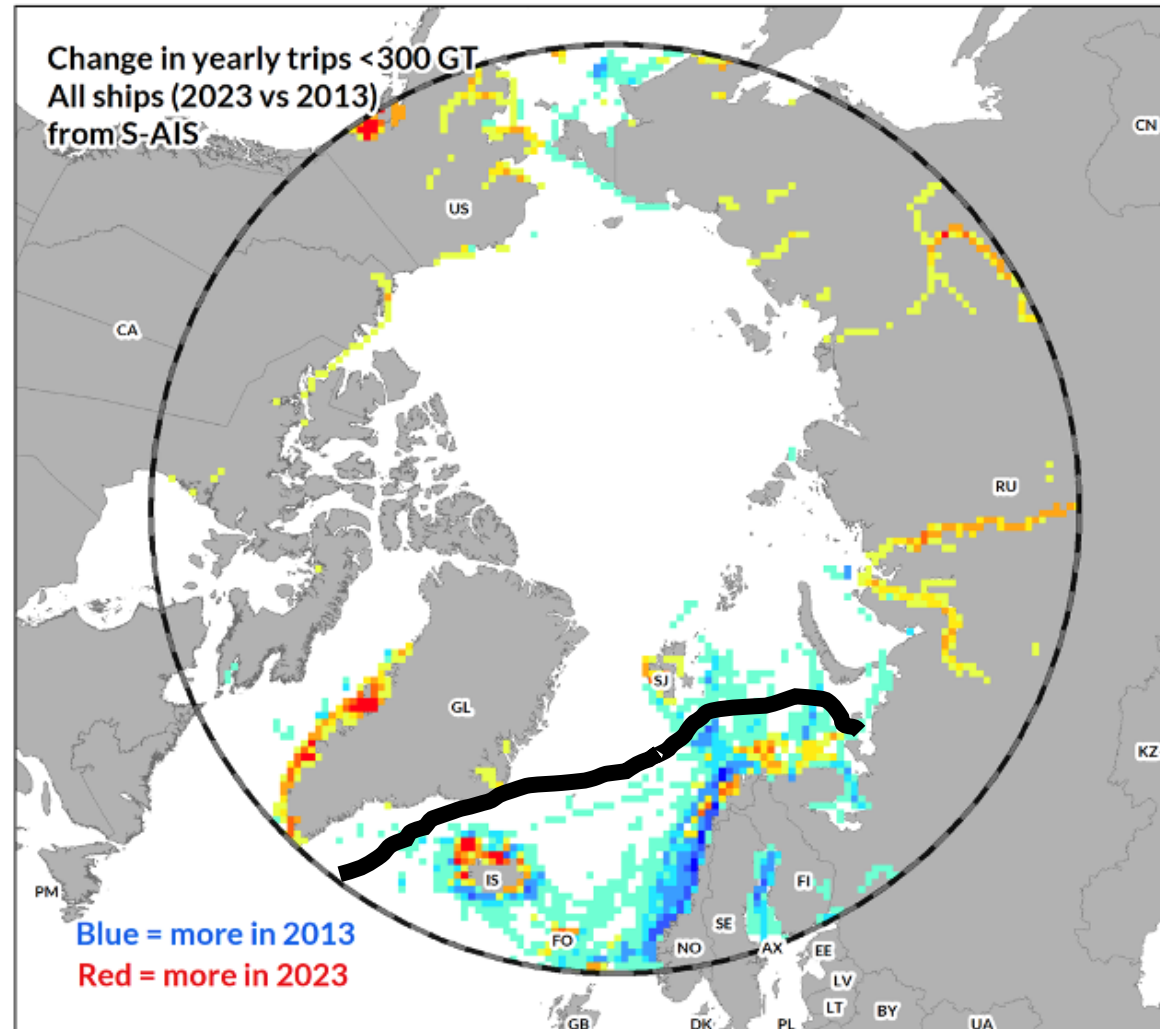
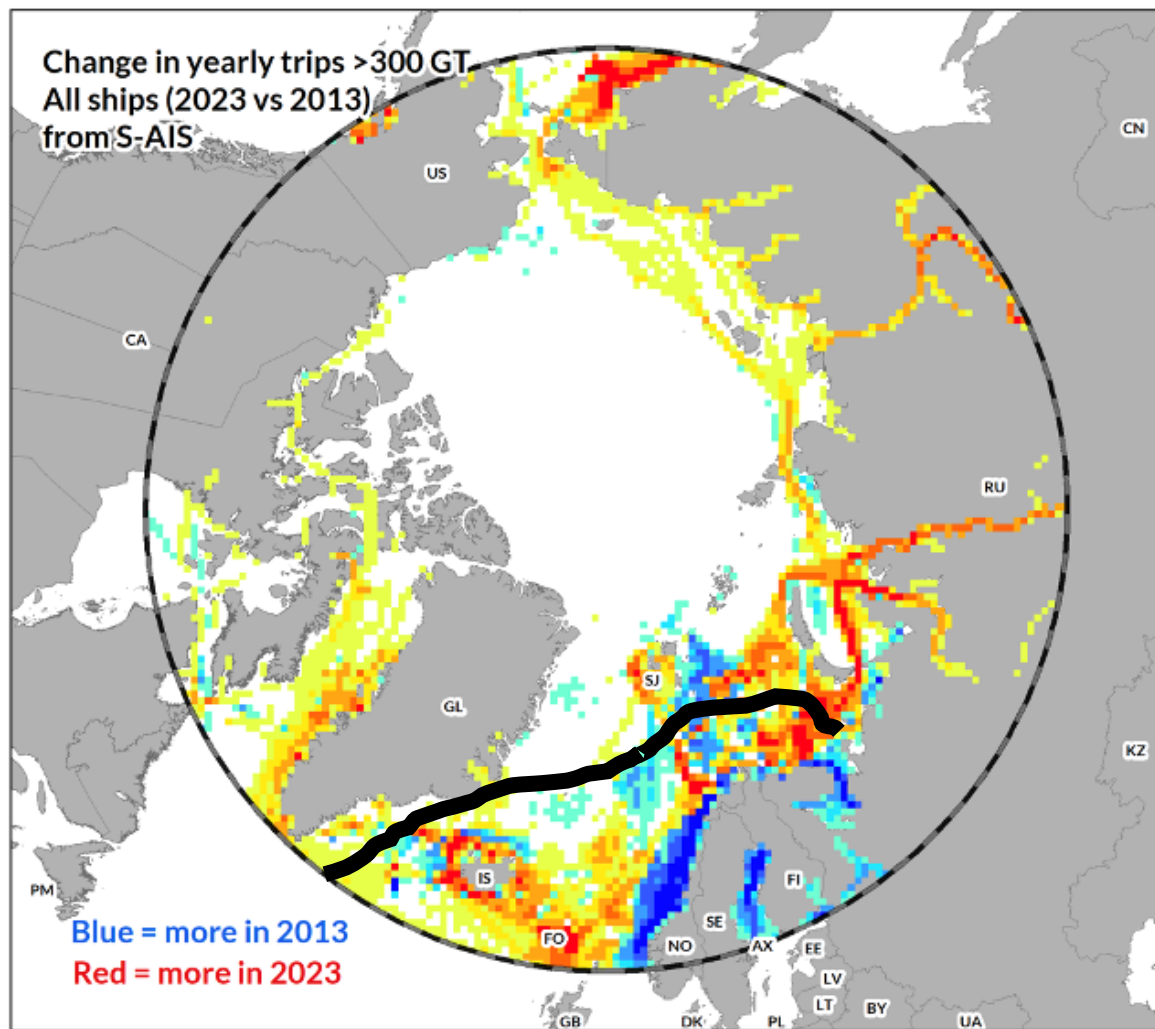


# Ships Under 300 GT (2013 vs. 2023)



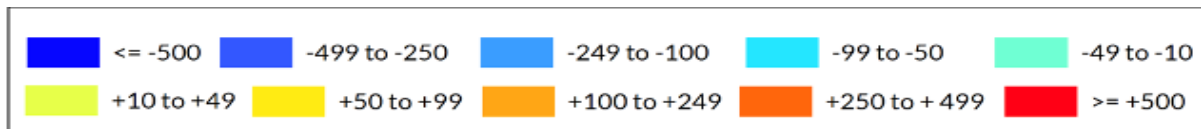
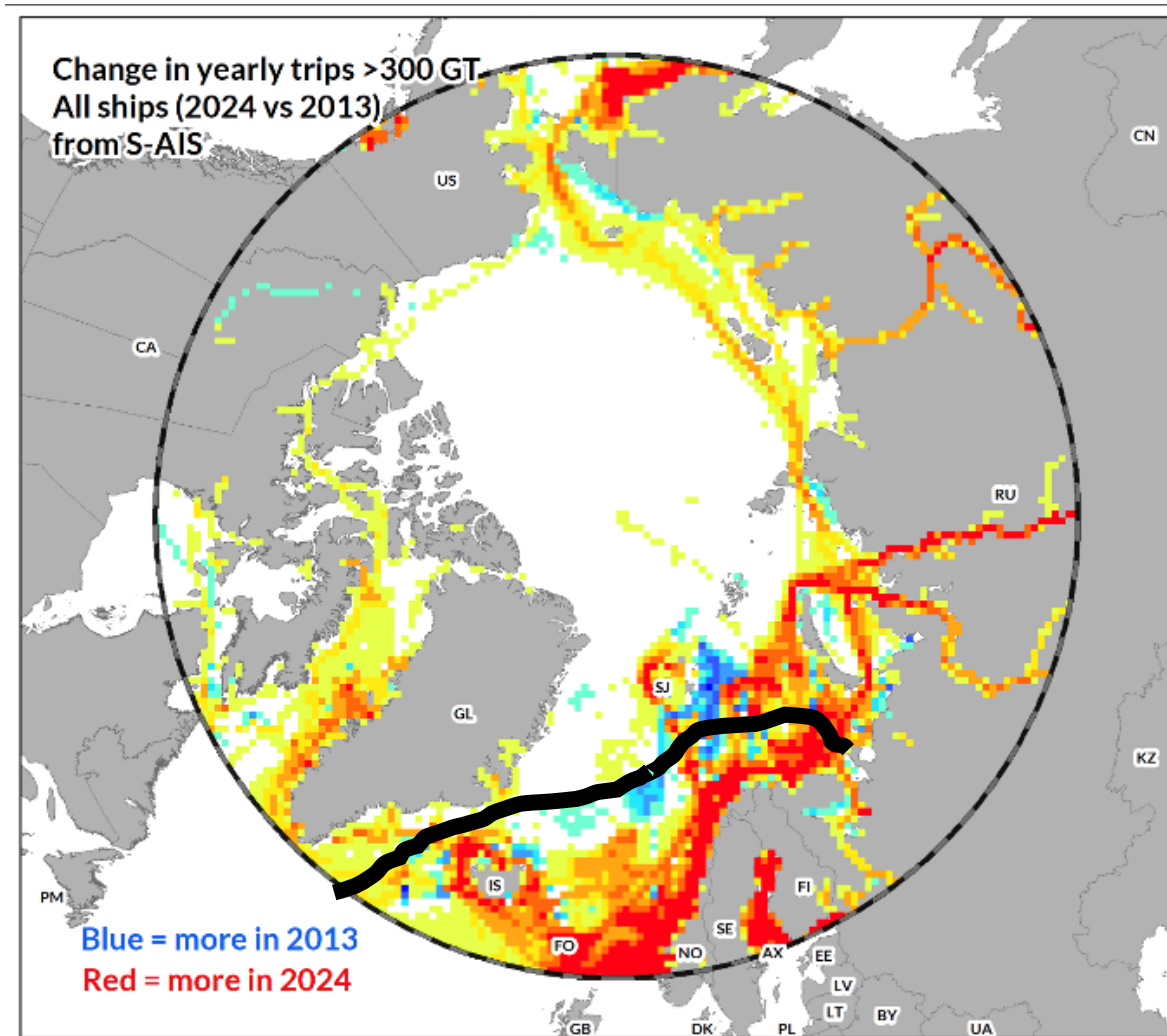
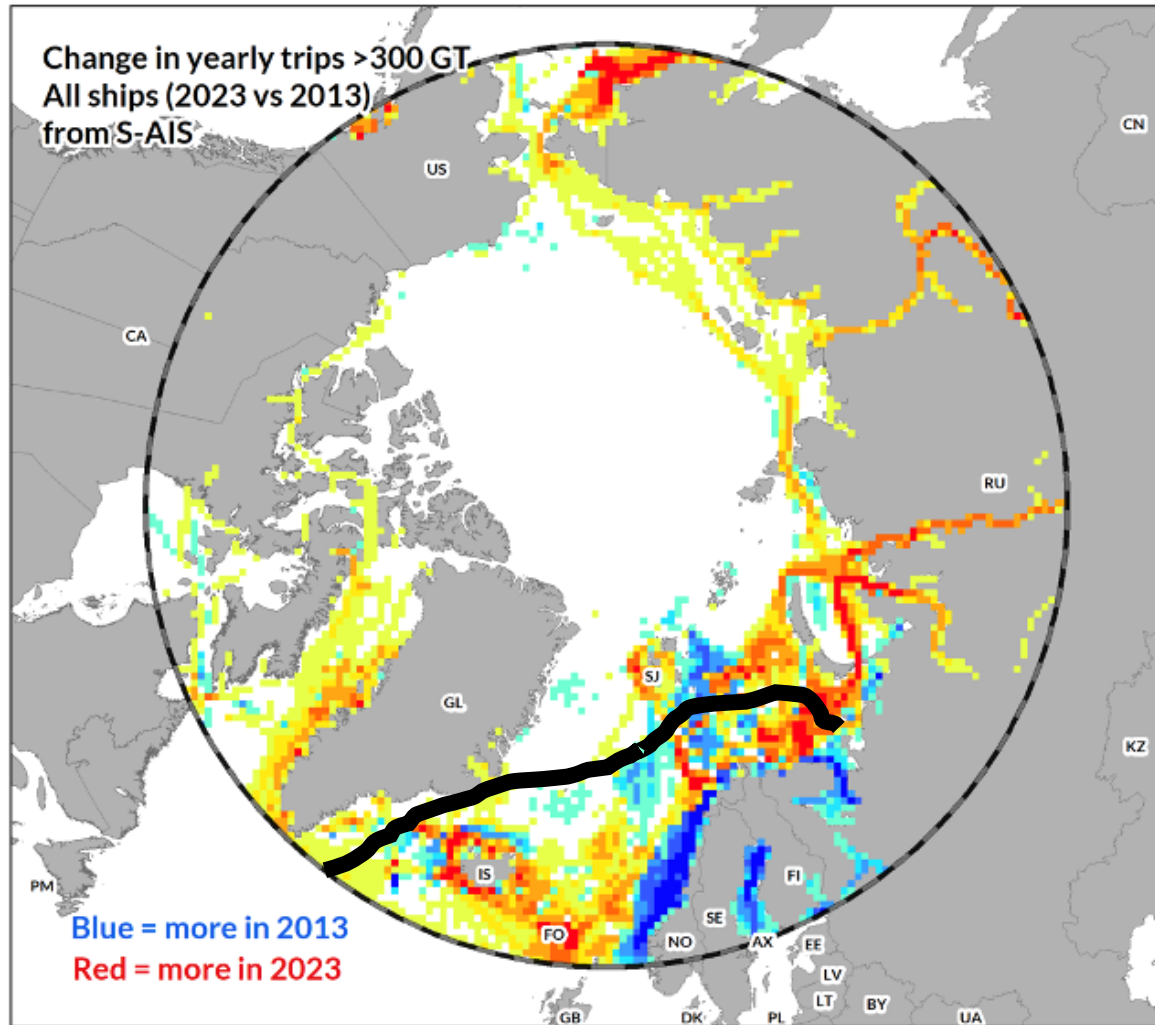


# Changes in annual trips 2013 vs. 2023 (>300GT left <300GT right)

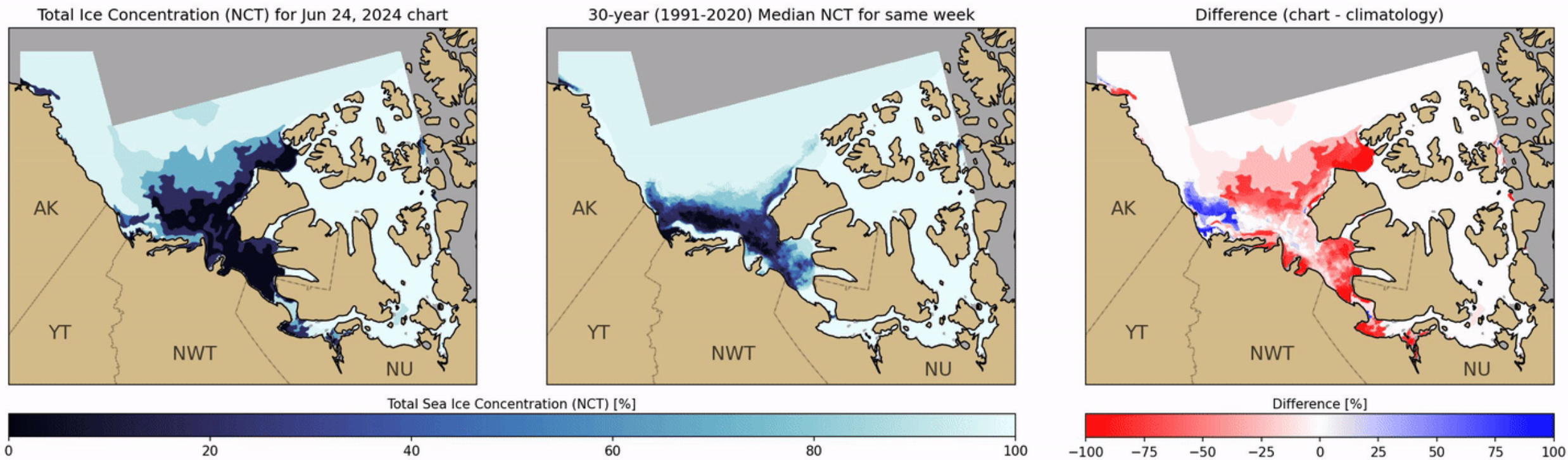




# Changes in annual trips >300GT 2013 vs. 2023 (left) and 2013 vs. 2024 (right)

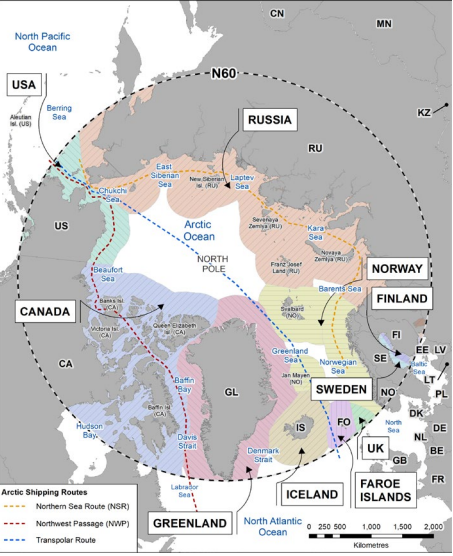


# Animation of record low (2024) sea ice conditions in the Northern Route of the Northwest Passage

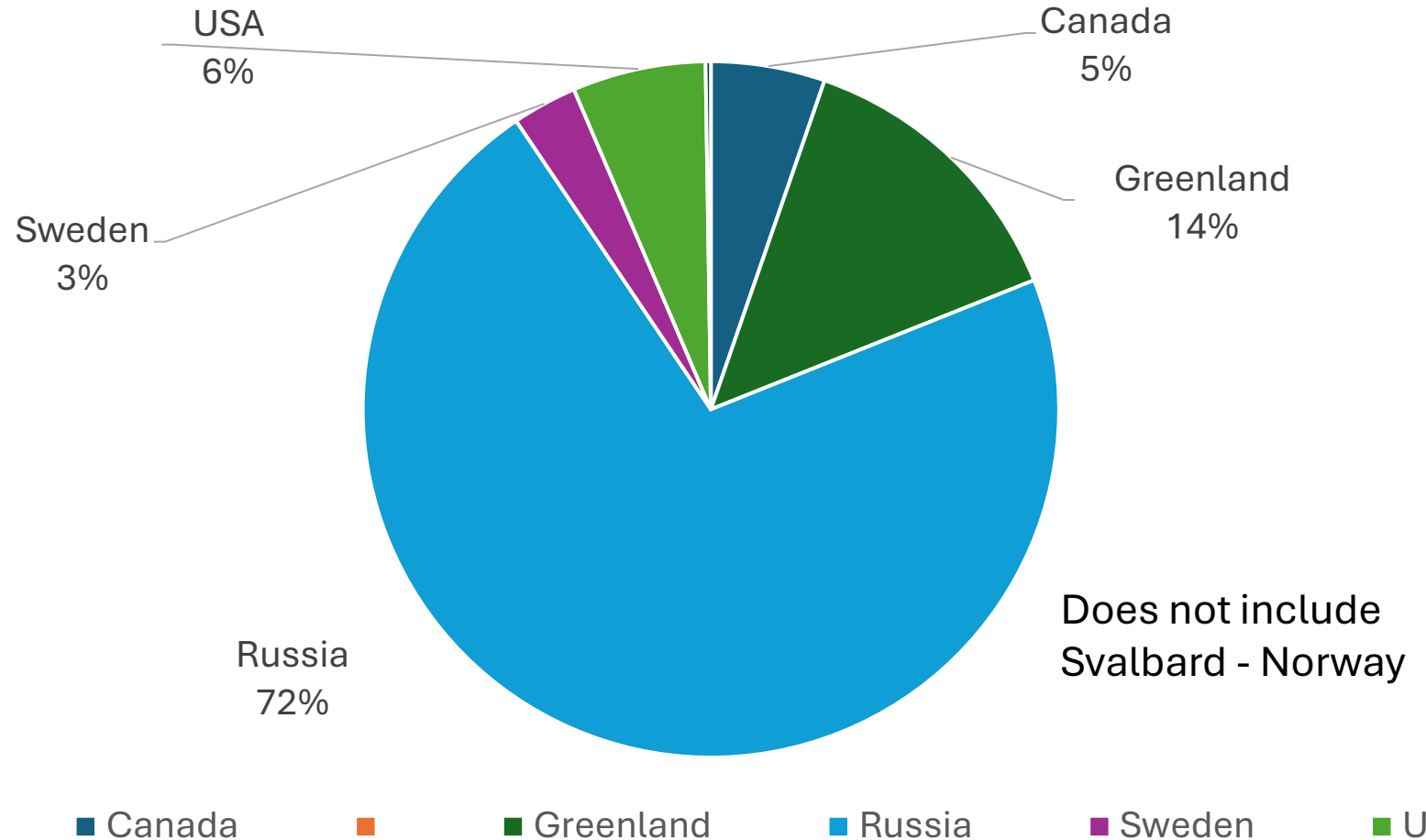




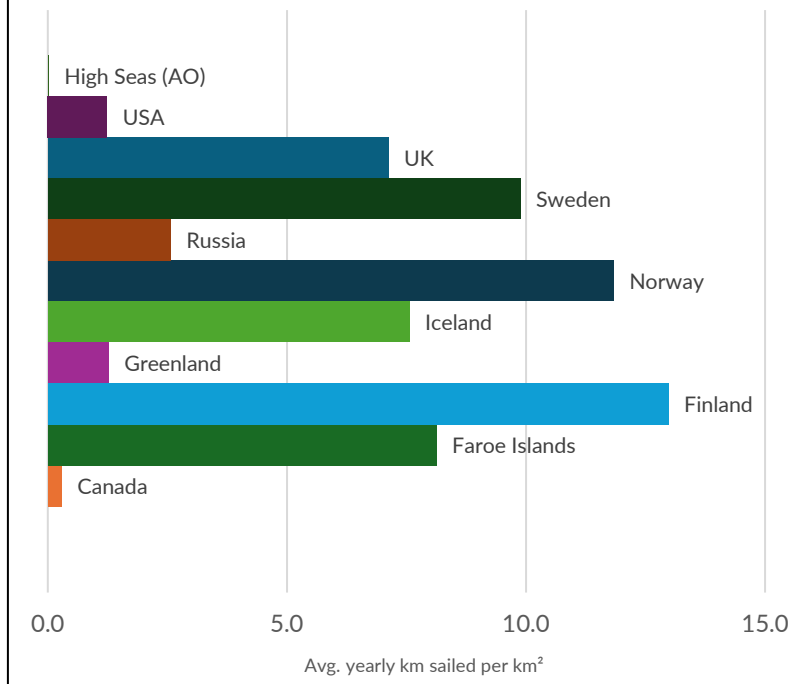
# Average Annual KM Sailed (2013-2024) in EEZ of Countries in the Polar Code Area - ships > 300GT



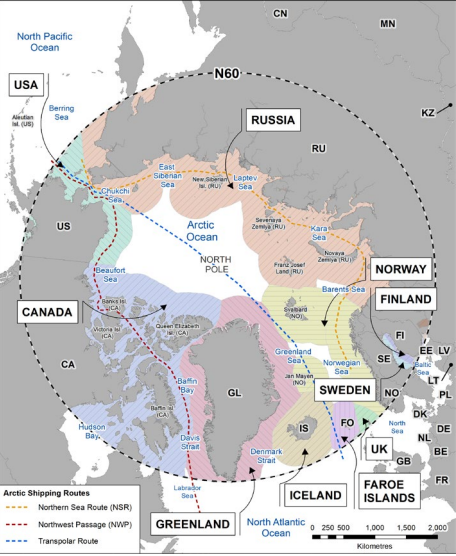
Average Yearly KM Sailed - ships > 300GT



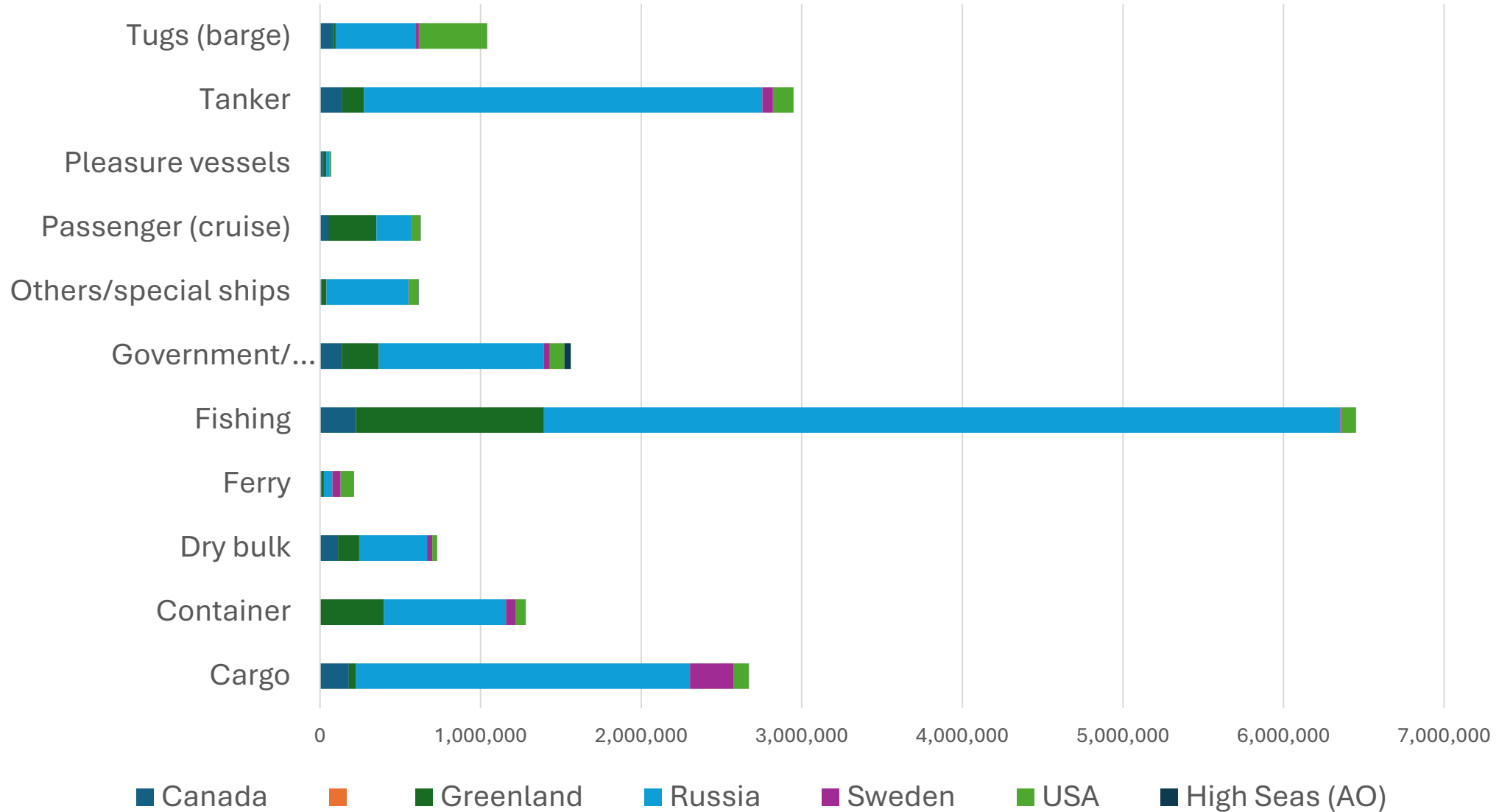
Average yearly km sailed by all ships >300 GT per navigable waters (km<sup>2</sup>) N60



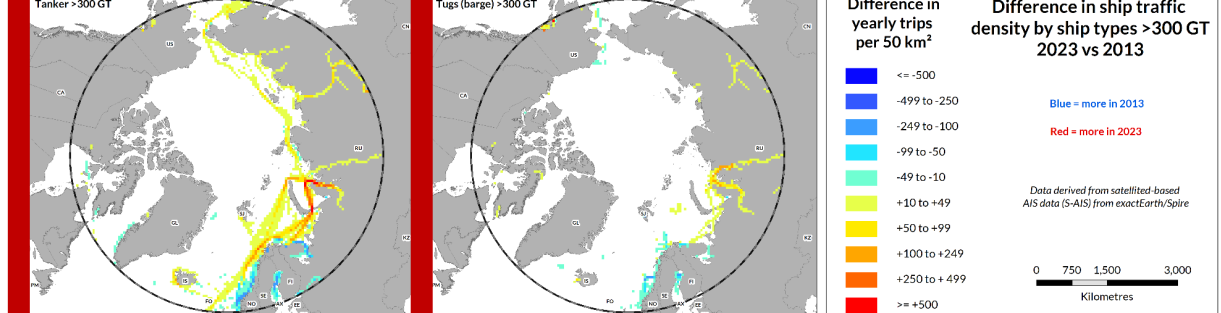
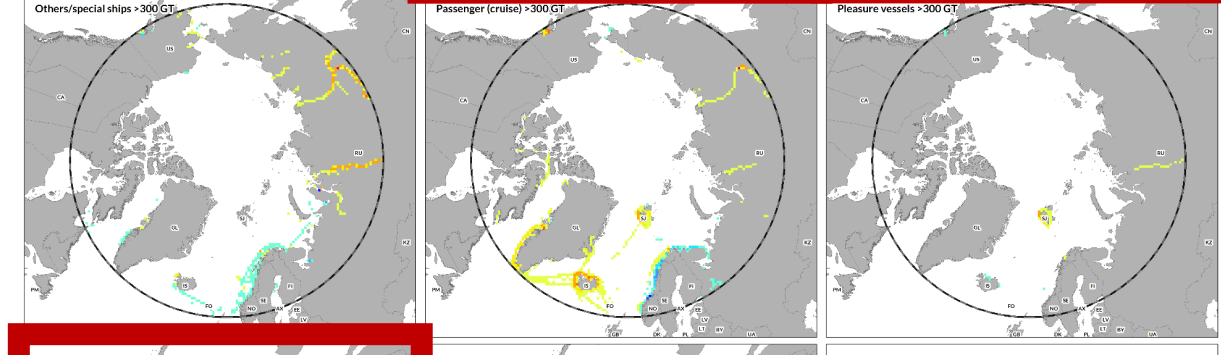
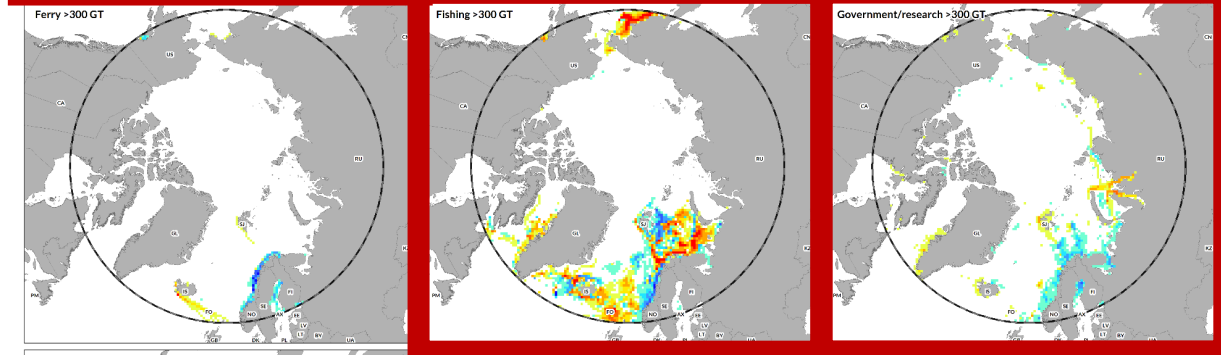
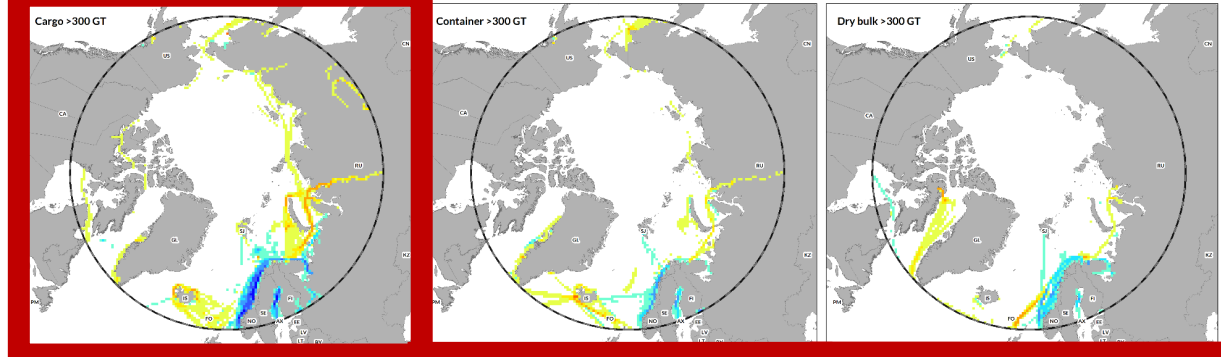
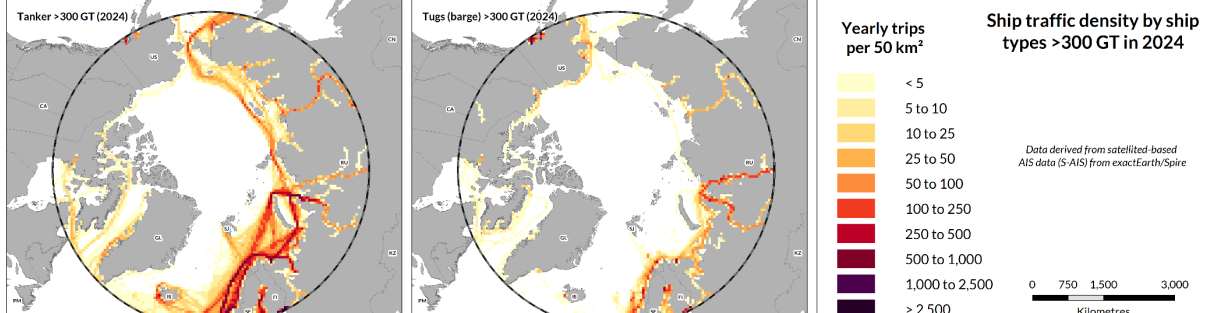
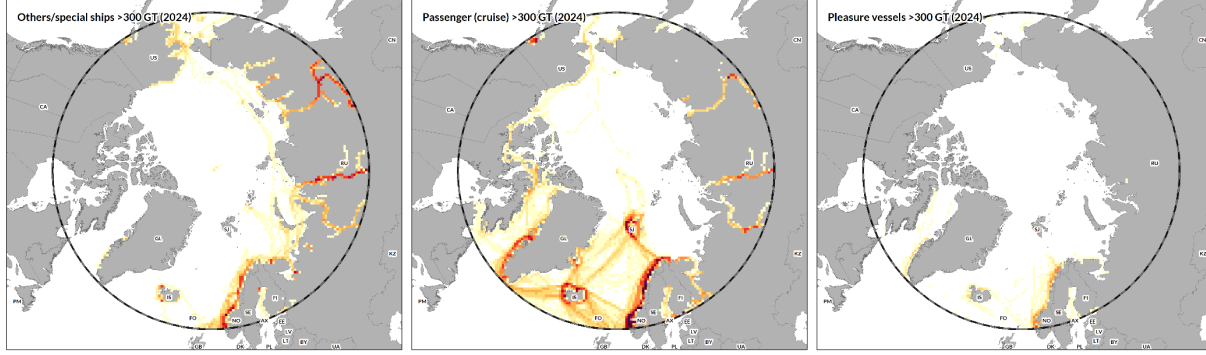
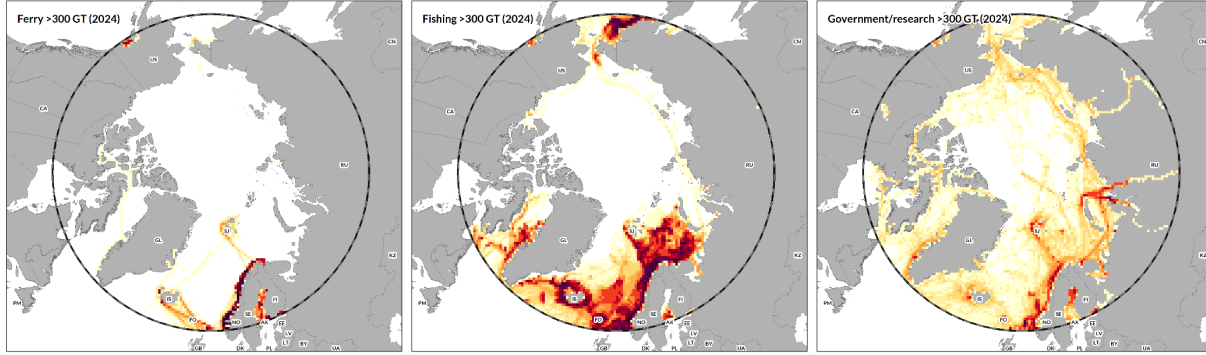
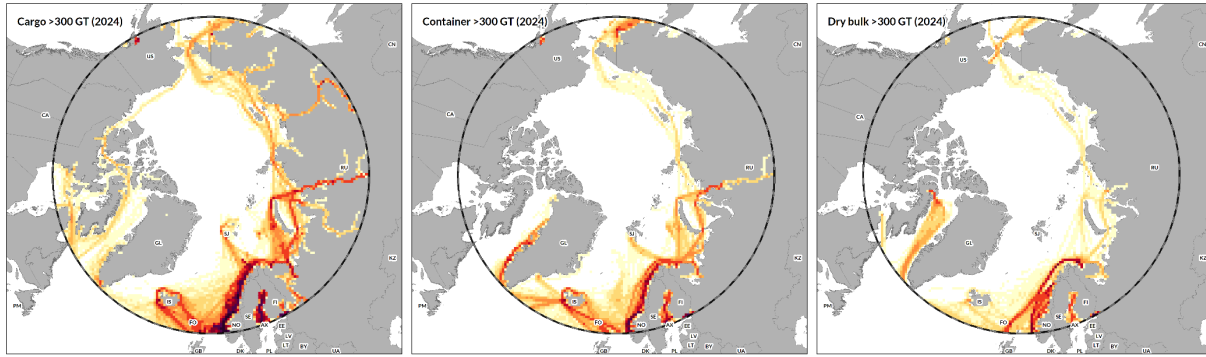
# Average Annual KM Sailed (2013-2024) in EEZ of Countries in the Polar Code Area - ships > 300GT – by Vessel Type



Does not include Svalbard - Norway

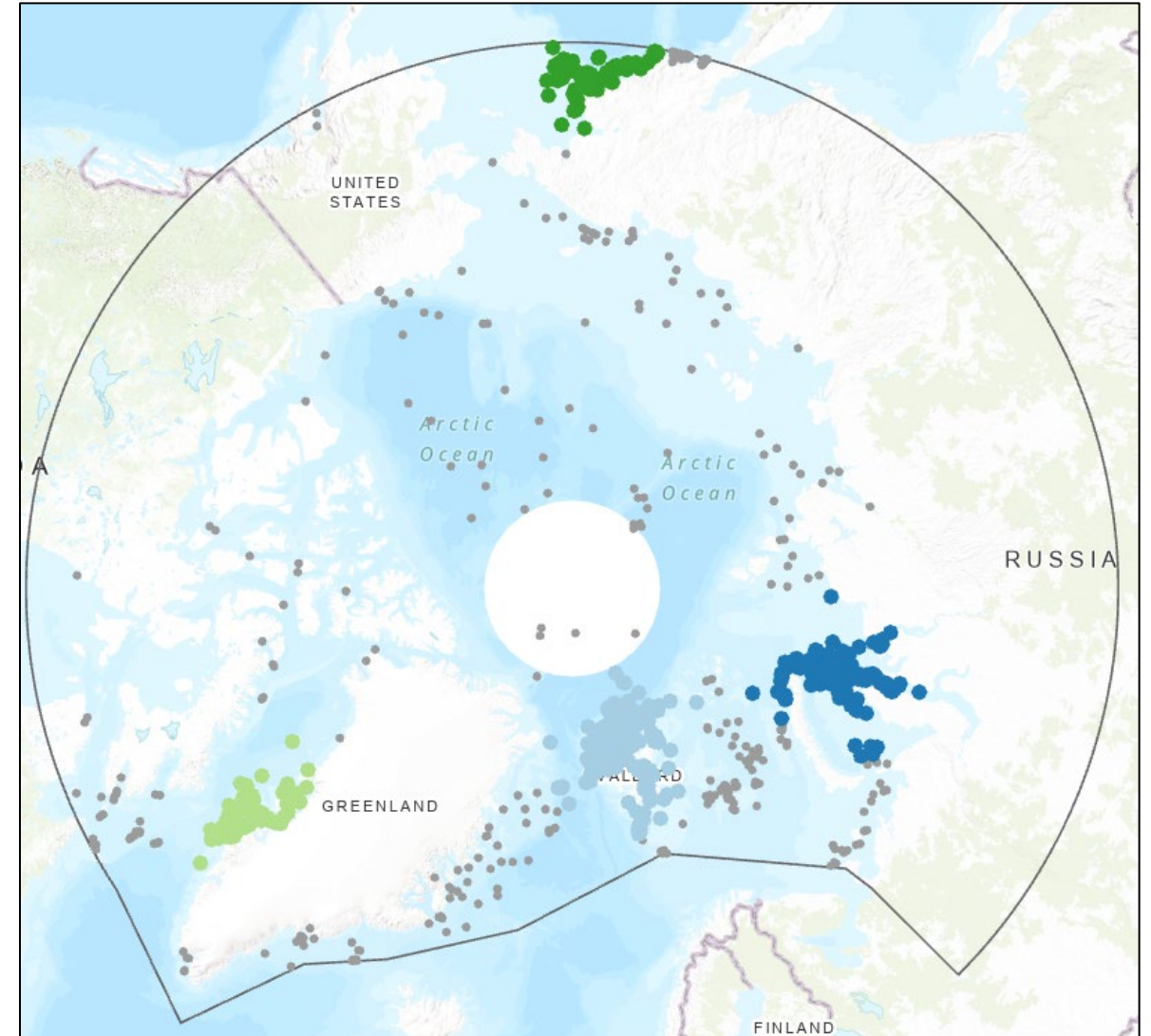
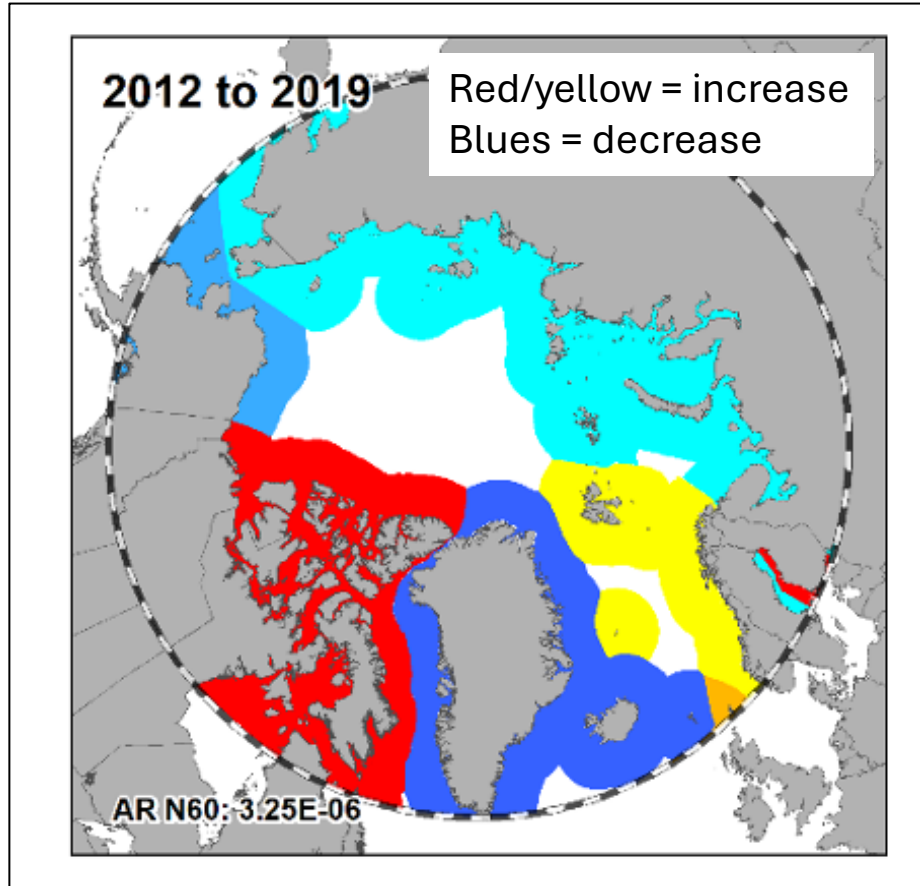




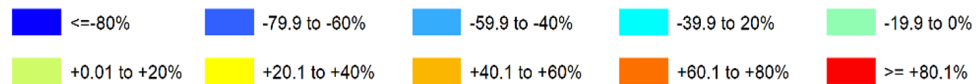


# Spatial Shipping Hot Spot Risk Areas

Total unique vessels = increasing  
 Total kilometers travelled = increasing  
 Accident rate = decreasing (varies regionally)



Relative difference from North of 60 2012 to 2019 accident rate for all non-commercial vessels >300 GT



/// No data/accidents  
 - - - North of the 60th (N60) parallel

0 362.5725 1,450  
 Kilometres

High Risk Clusters

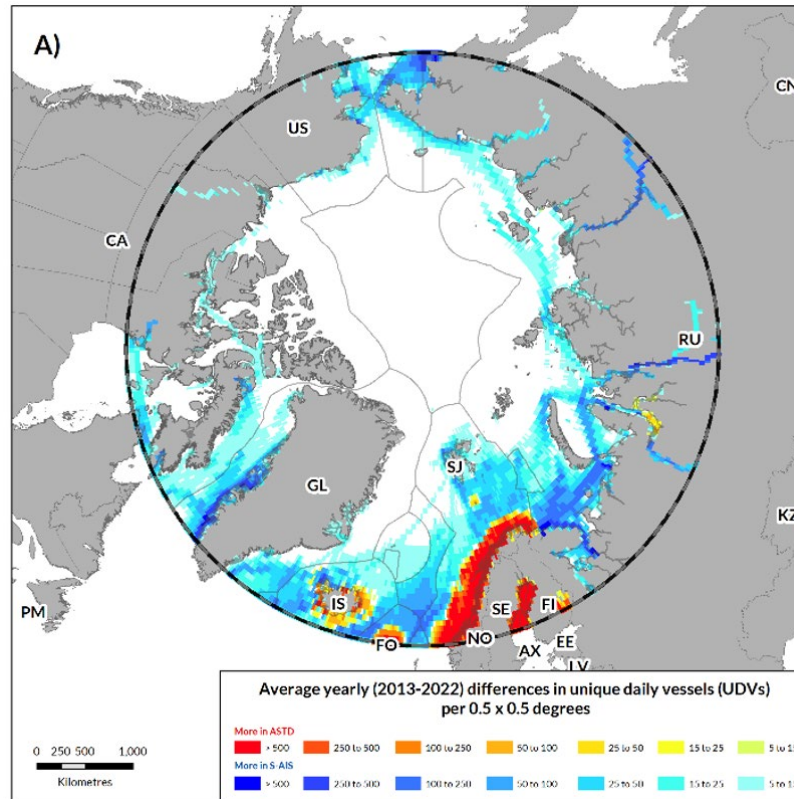
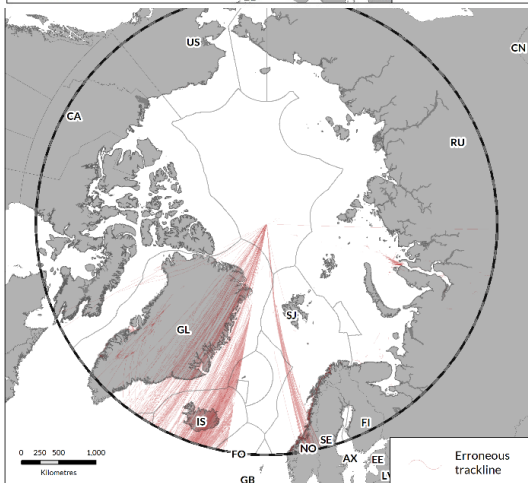
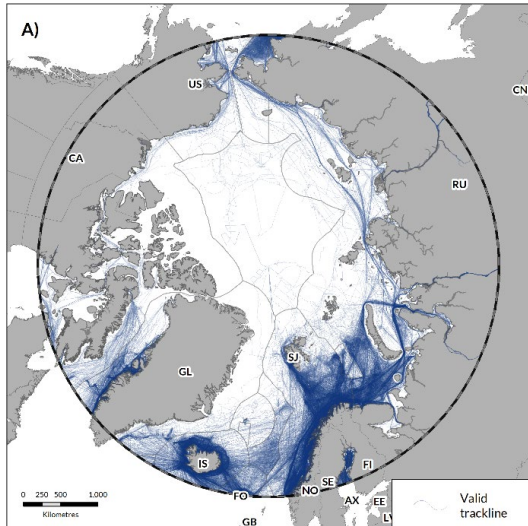


# Arctic Shipping Trends

## Data Challenges

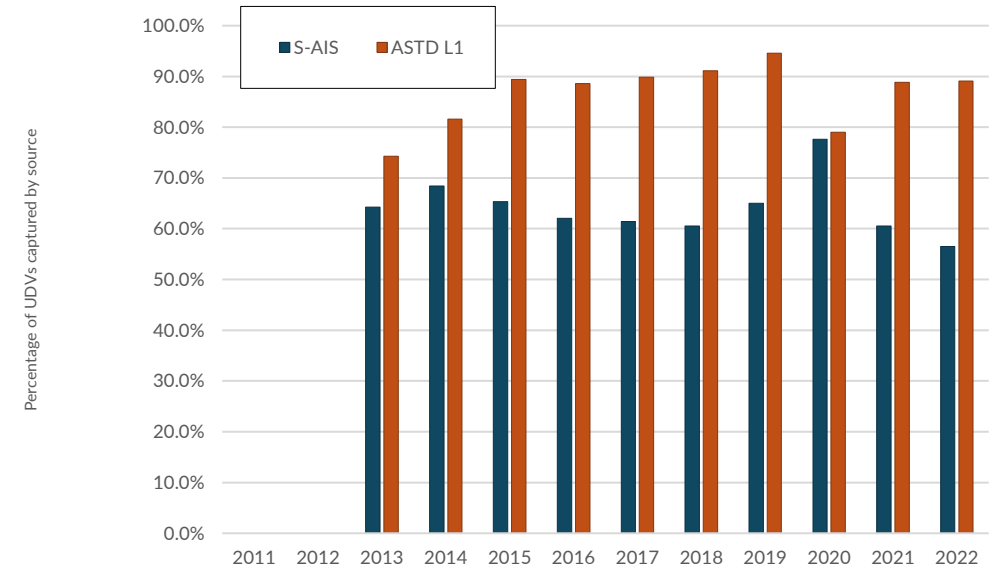
- A) cleaned S-AIS tracklines in N62 for the year 2020 as an example.
- B) S-AIS tracklines identified as spoofing vessels

Yearly average (2013-2022) difference in unique daily vessels between ASTD L1 and S-AIS datasets per 0.5 x 0.5-degrees; grid cells in red represent more UDV detected in the ASTD L1 data, while grid cells in blue represent more UDV detected in S-AIS

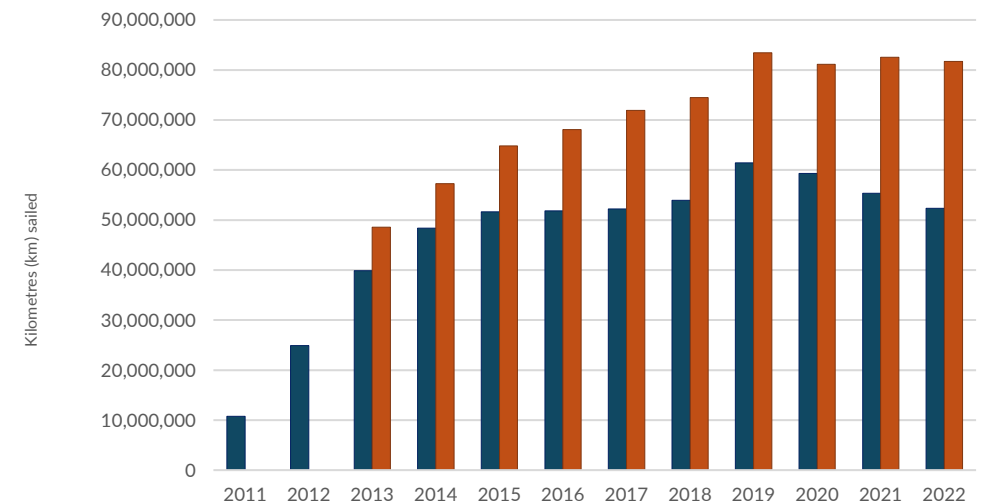


Nicol et al. 2025

Percentage (%) of unique daily vessels captured by S-AIS and ASTD L1 North of the 62nd parallel from 2011 to 2022.



Derived kilometres (km) sailed by S-AIS and ASTD L1 North of the 62nd parallel from 2011 to 2022.



■ S-AIS ■ ASTD L1





# Thank you!

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