



Trends in Arctic Shipping

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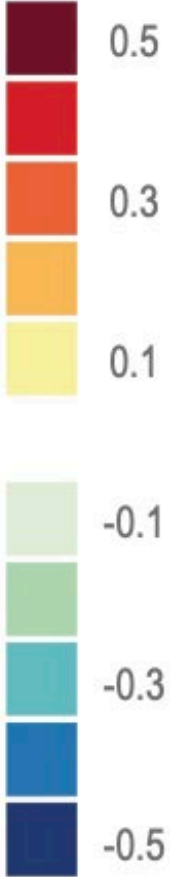
Outline

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

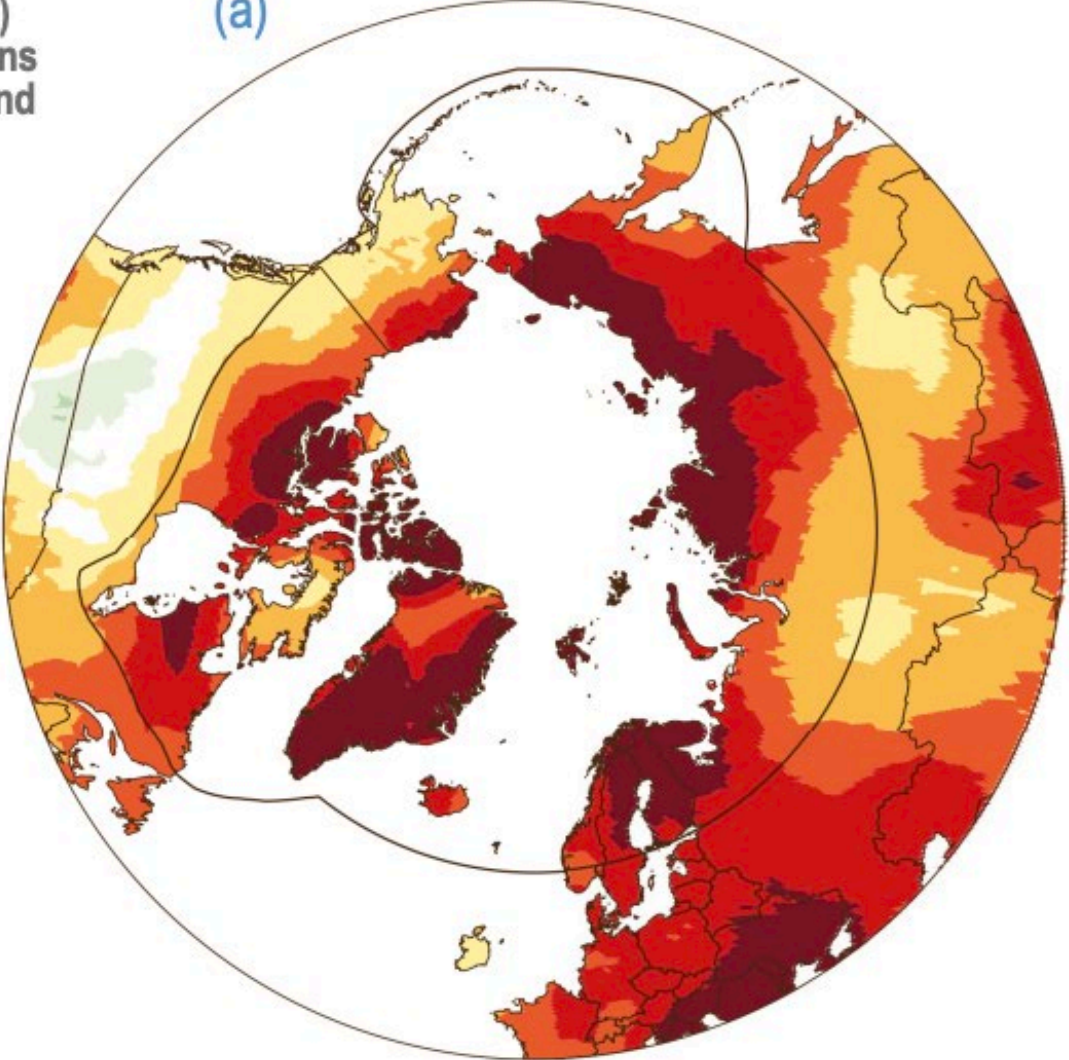


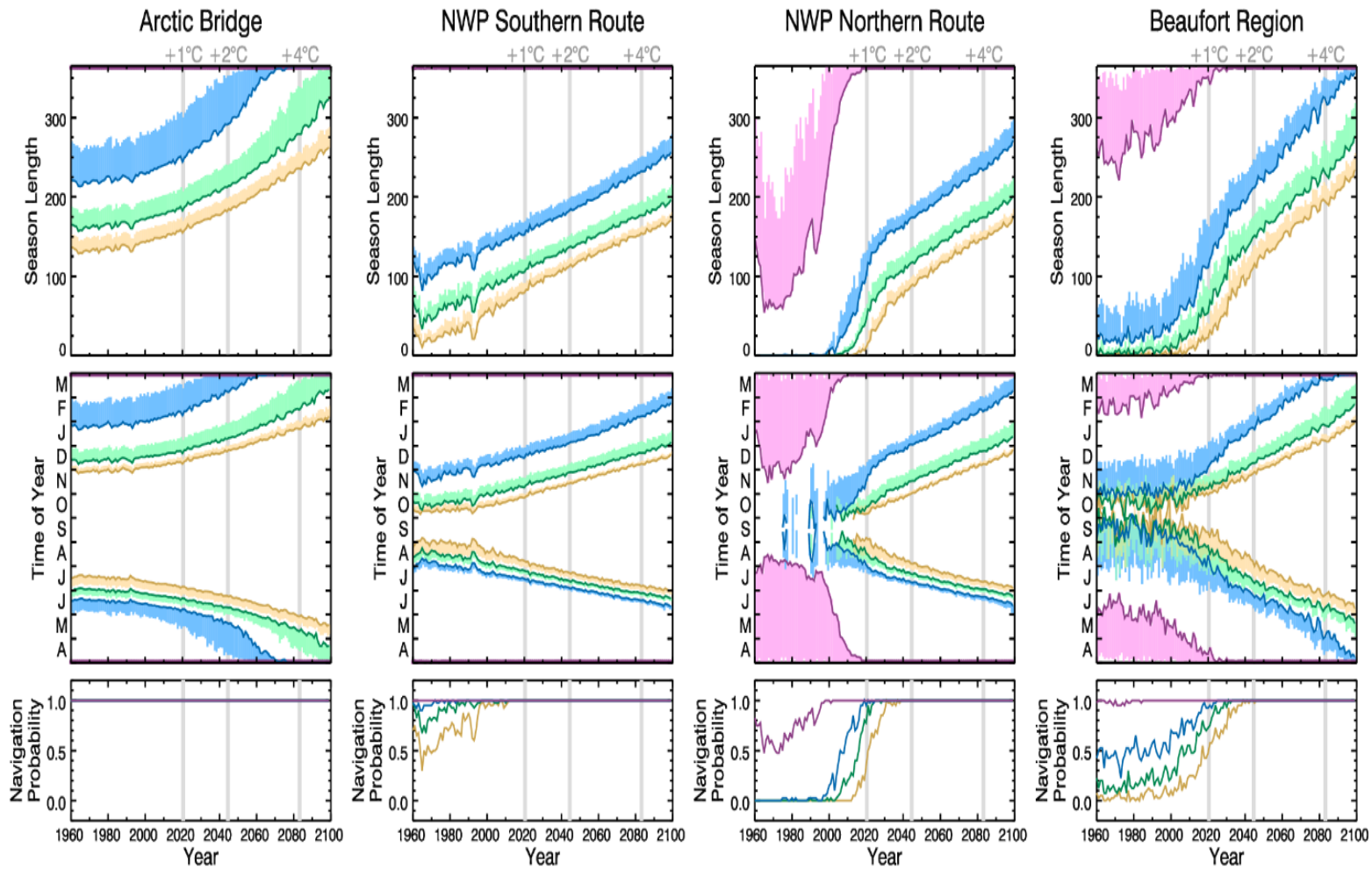
Projected Warming in the Arctic

W5E5 (ERA5 adjusted)
1980–2015 observations
mean temperature trend
(°C decade⁻¹)



(a)





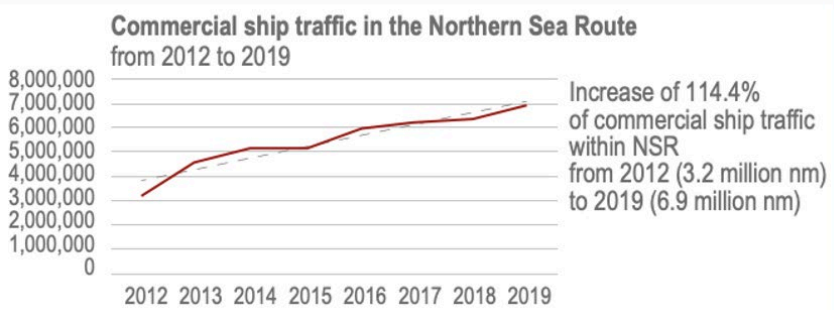
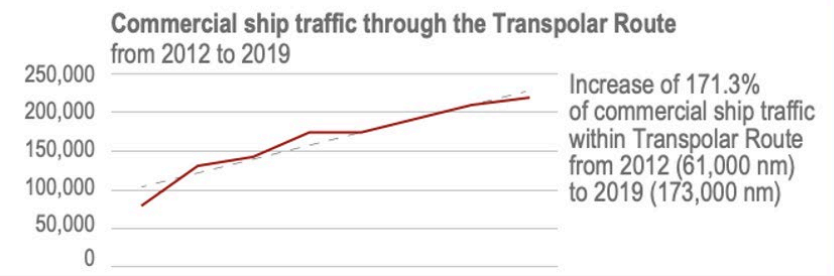
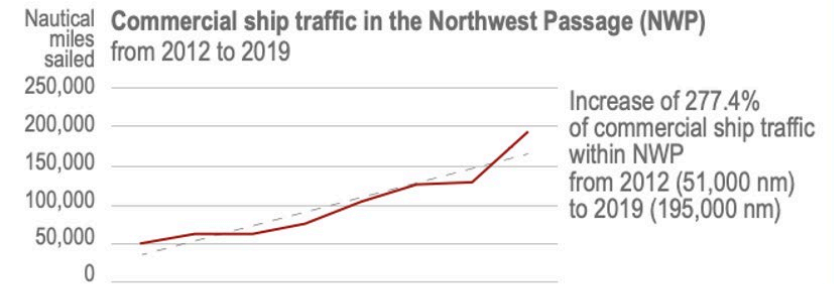
Polar Class 3

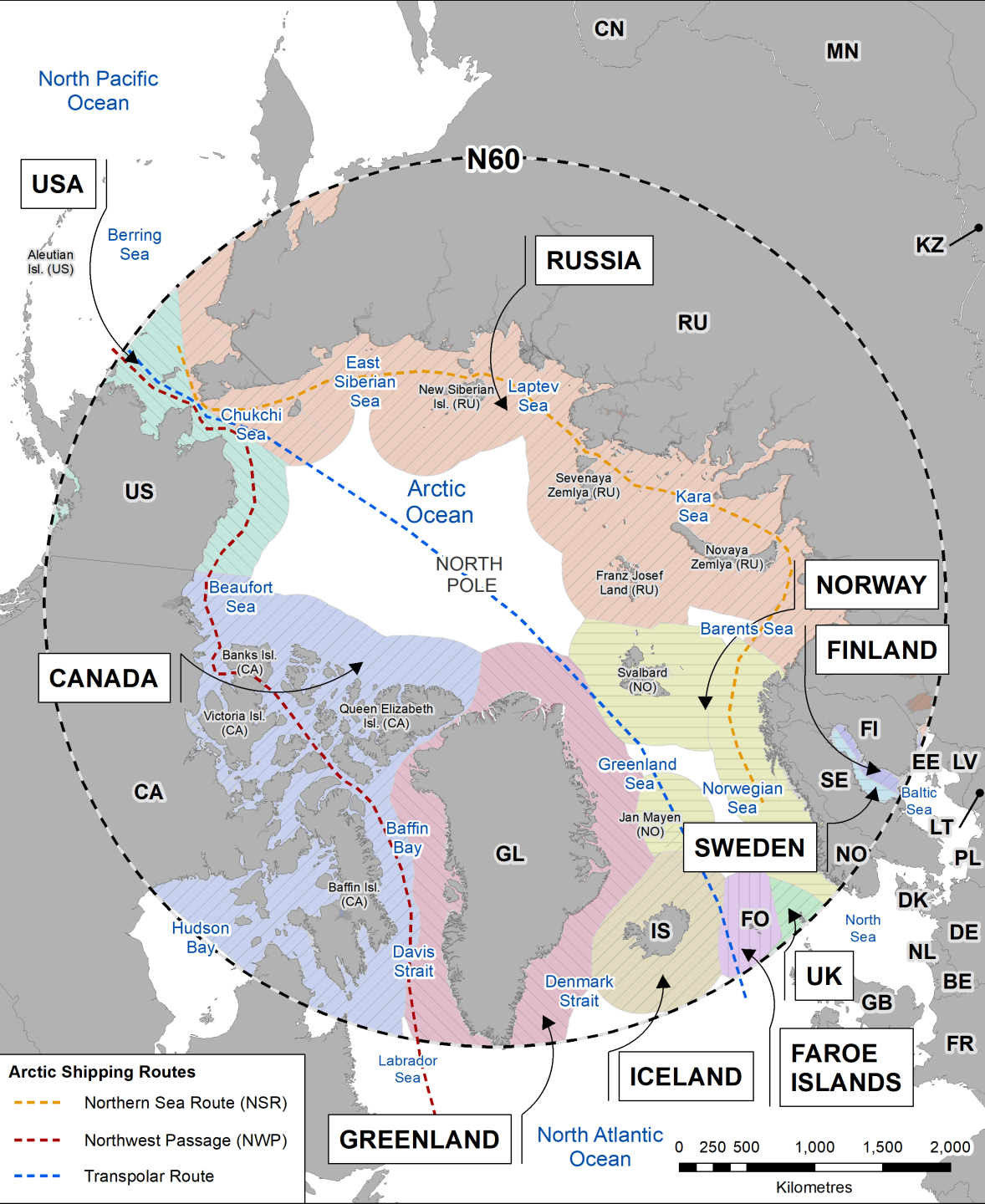
Polar Class 7

Type 1B

No Ice Strength

Northwest Passage: + 14 to 31 days before 4⁰ C warming
 Northern Sea Route: 101 to 118 days annually by 2050
 Transpolar Route: +56% increase in accessibility by =2050

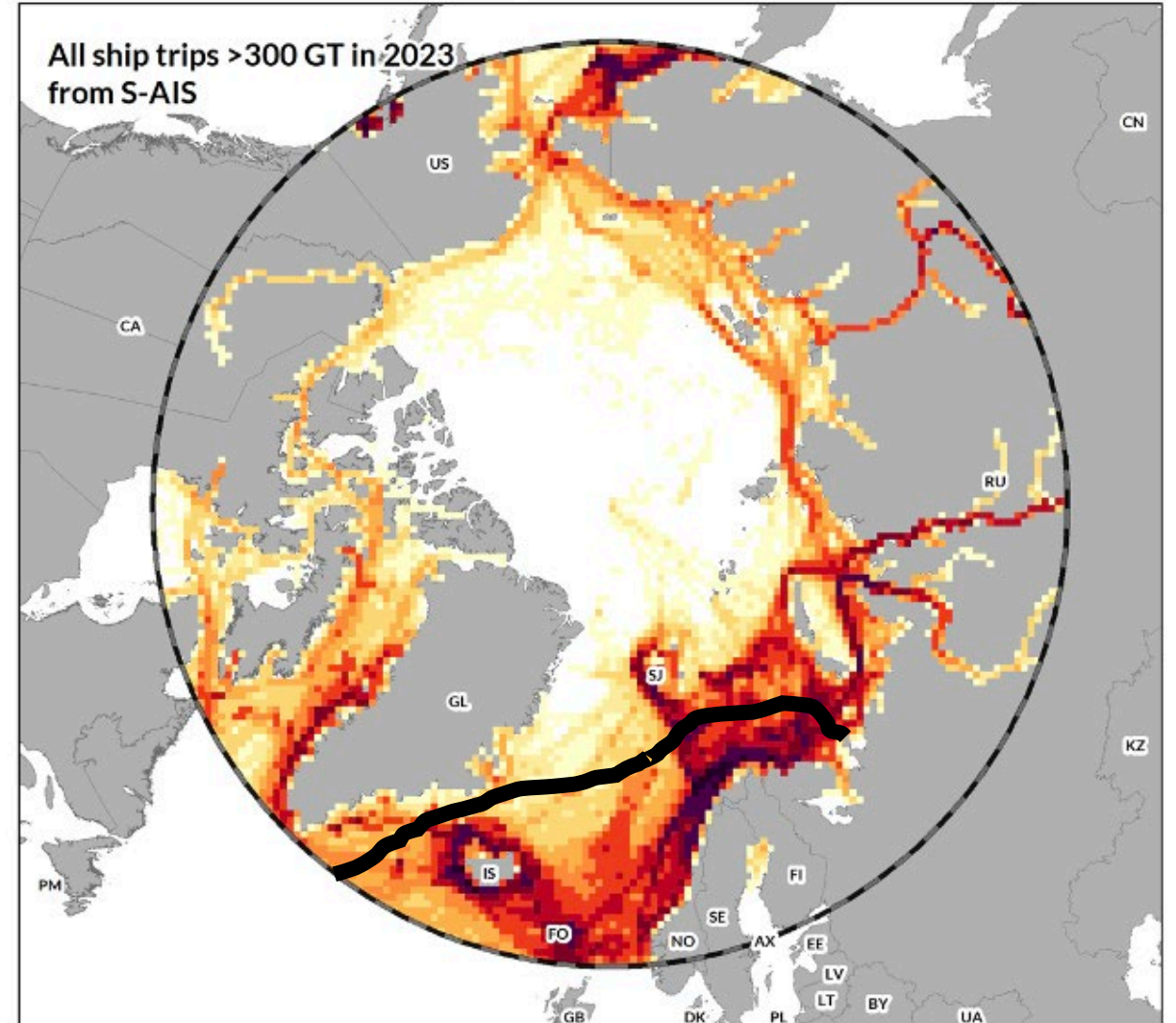
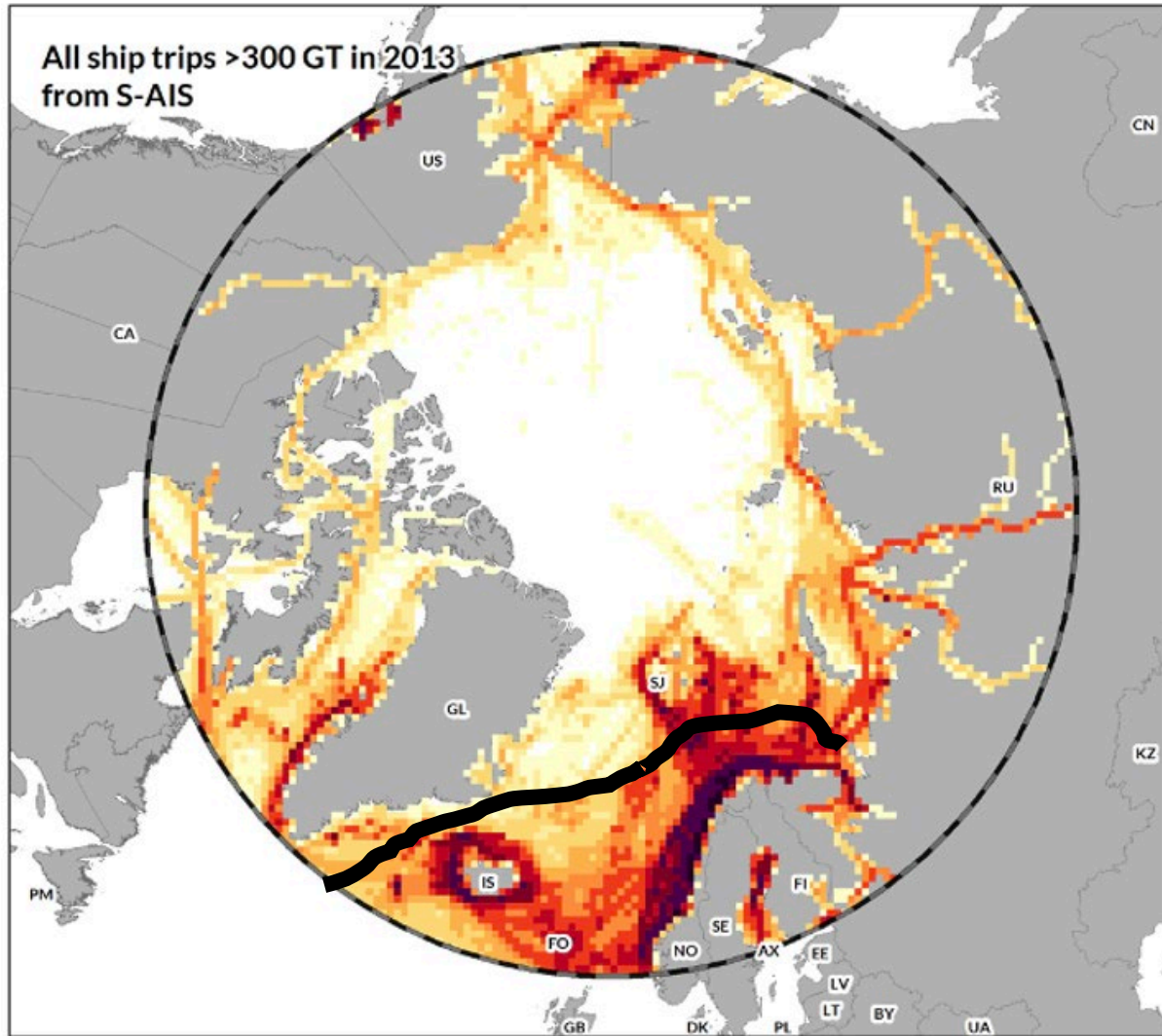




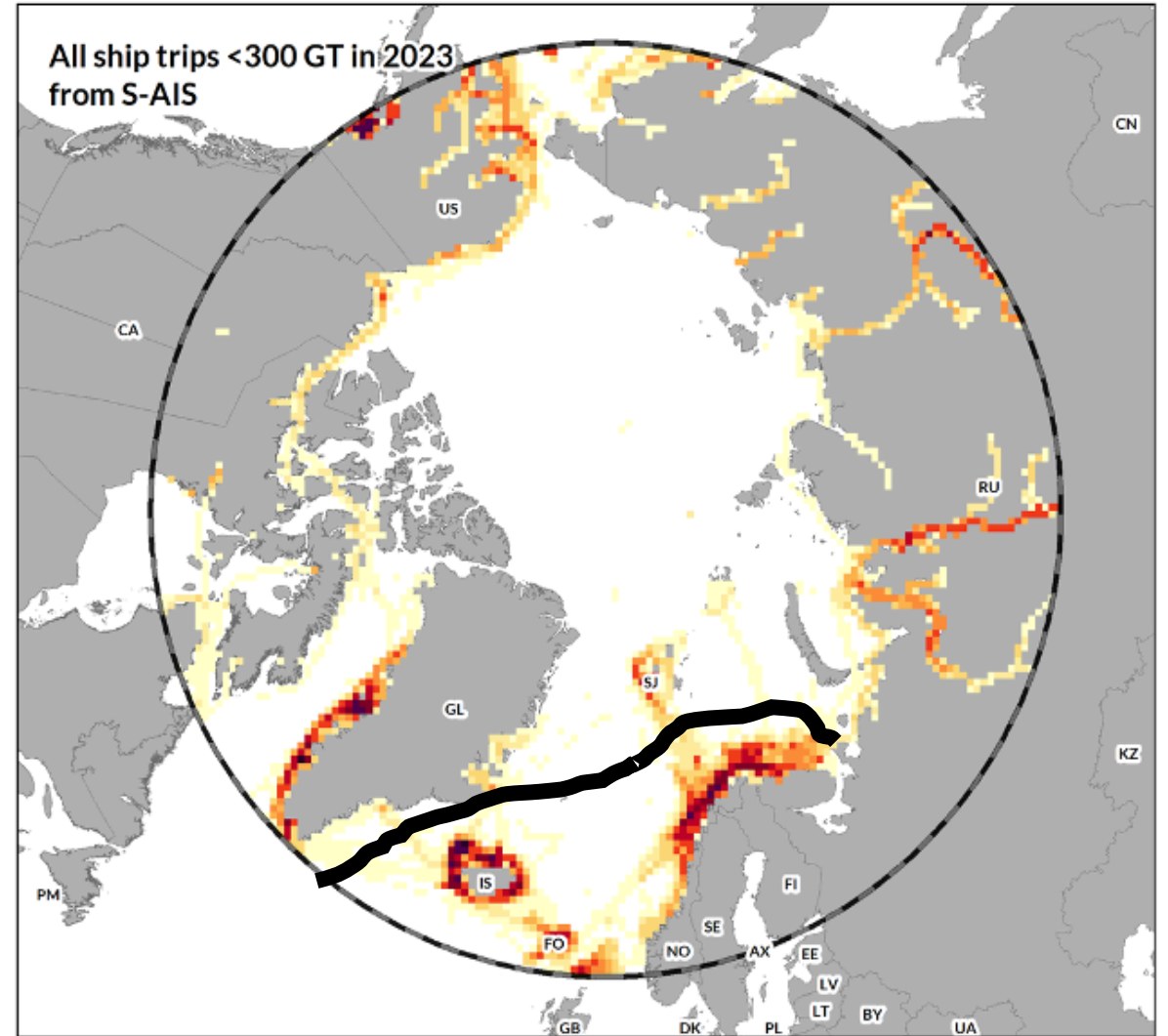
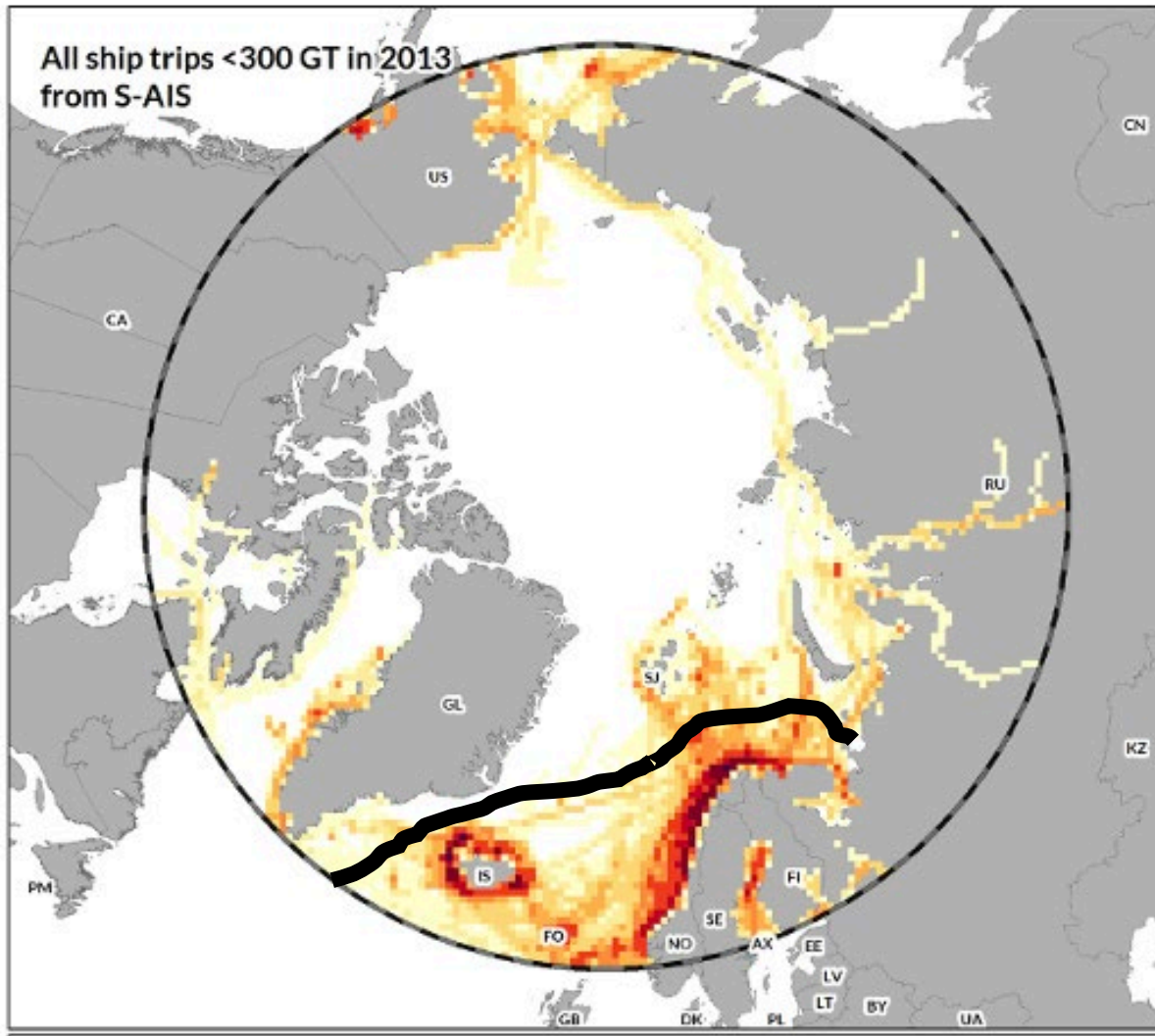
Area of analysis (North of the 60th parallel), with Exclusive Economic Zones, North of the 60th parallel Using S-AIS (Spire/Kpler)



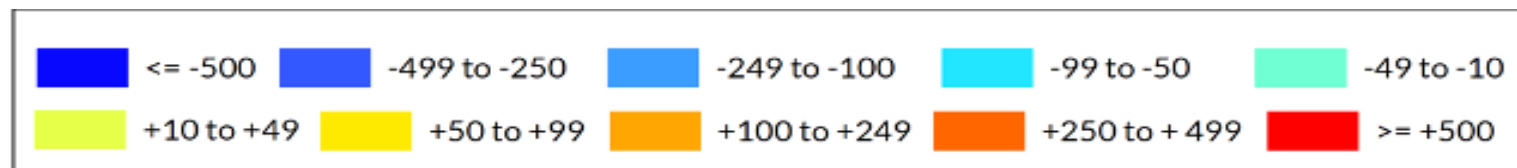
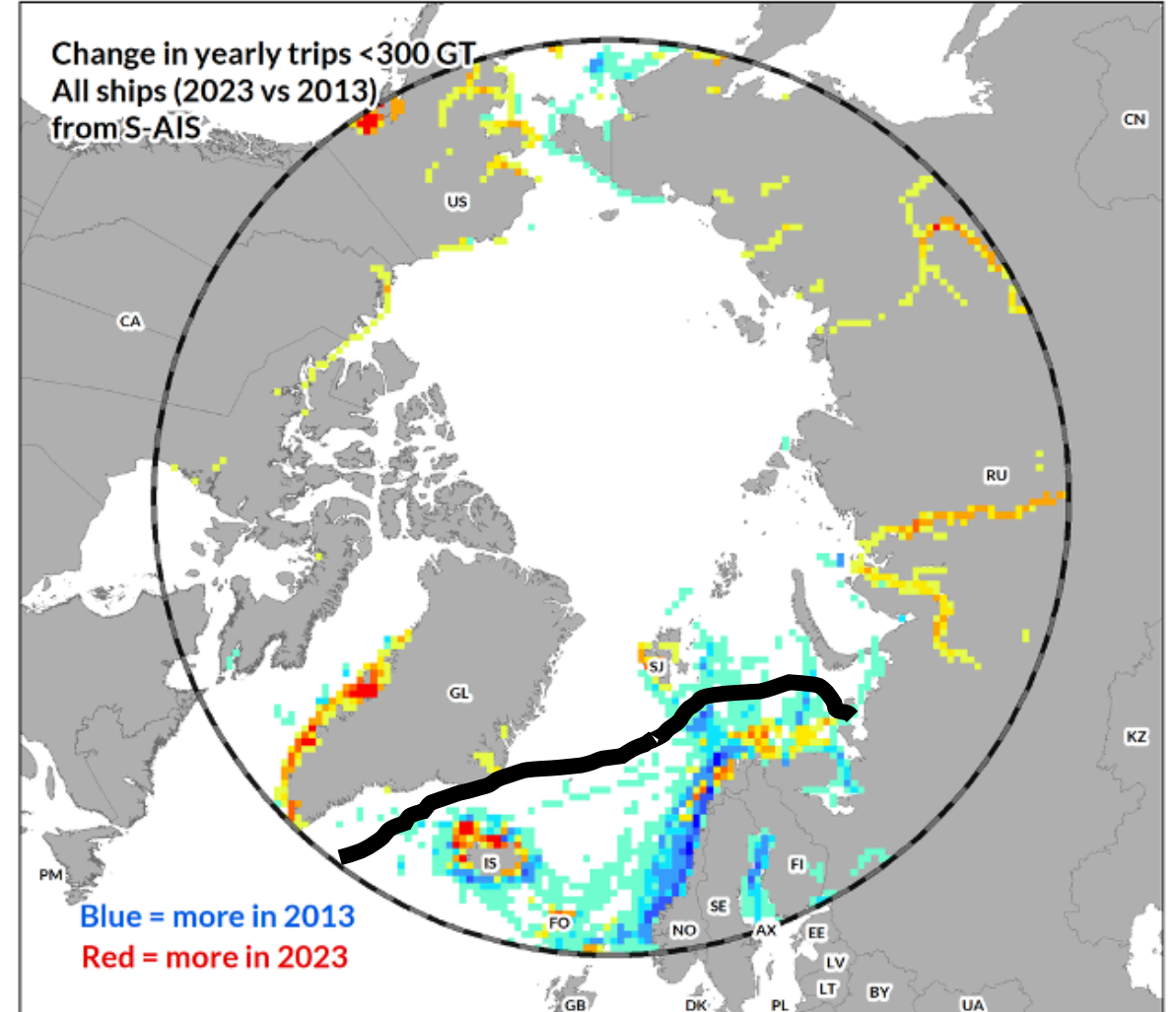
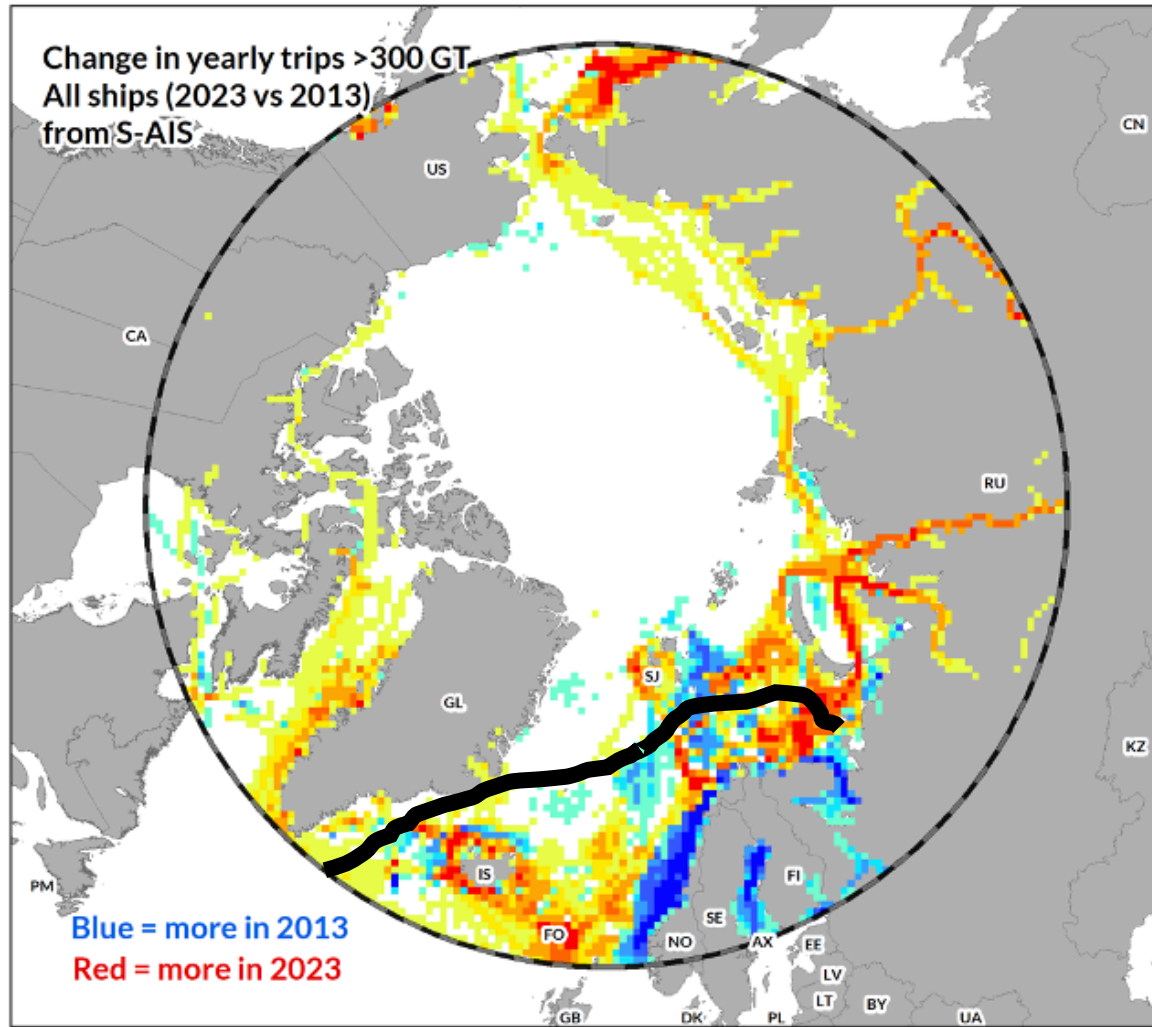
Ships Over 300 GT (2013 vs. 2023)



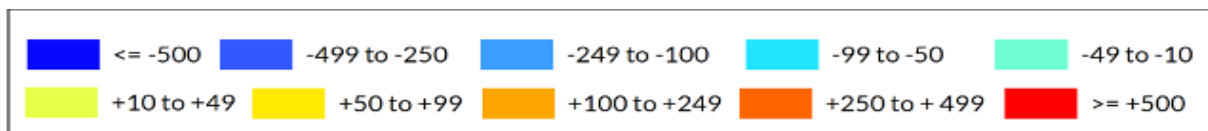
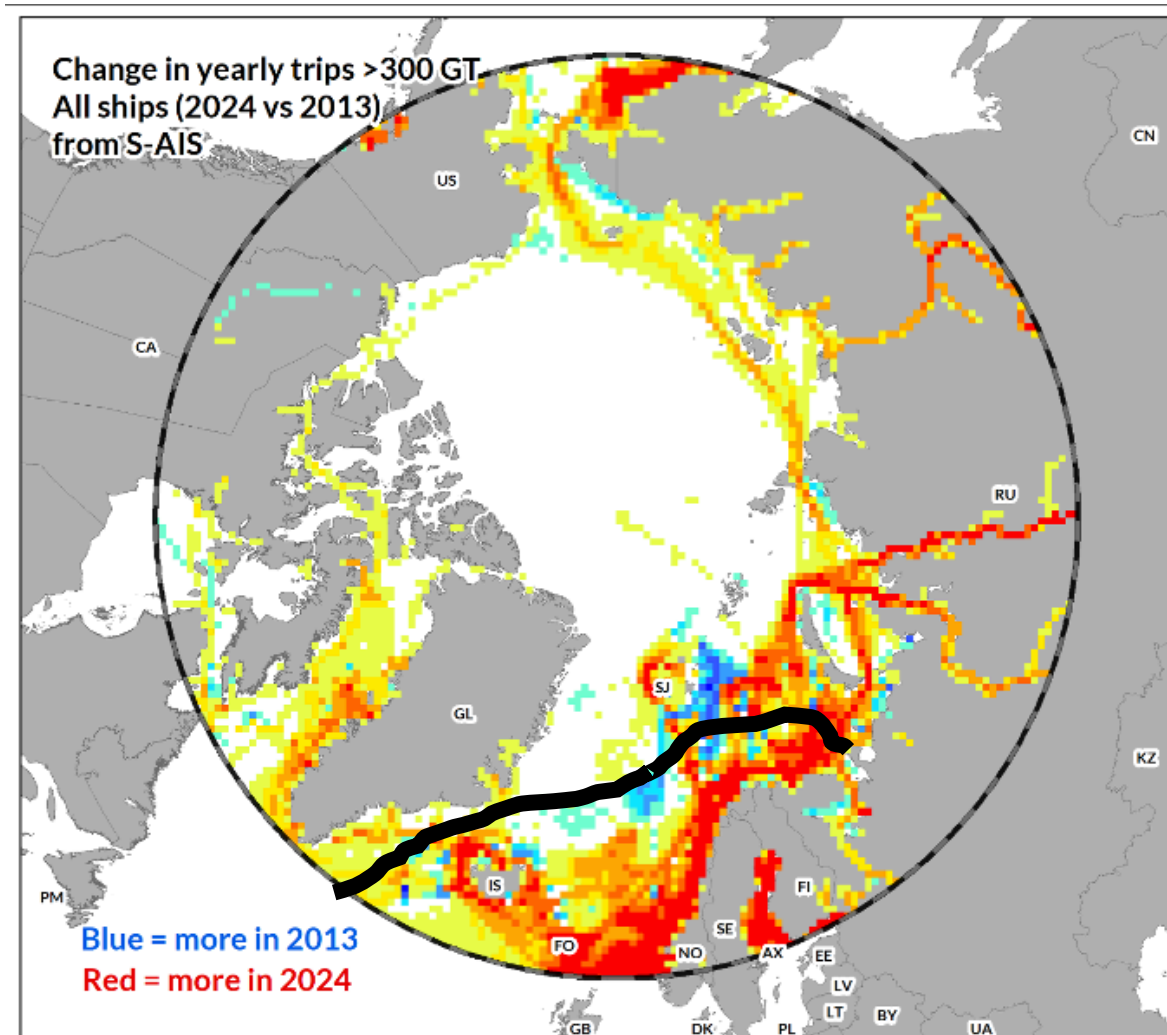
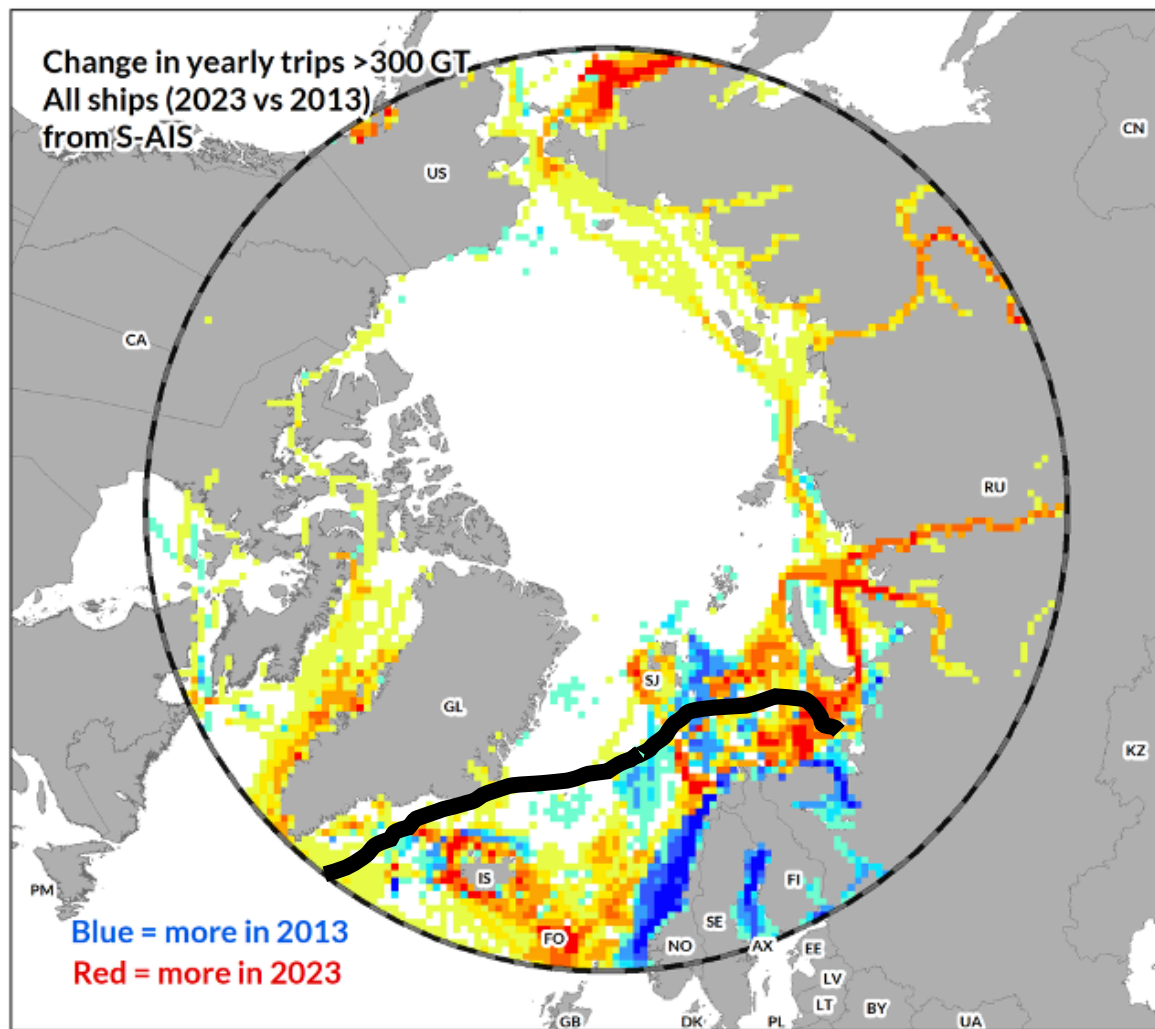
Ships Under 300 GT (2013 vs. 2023)



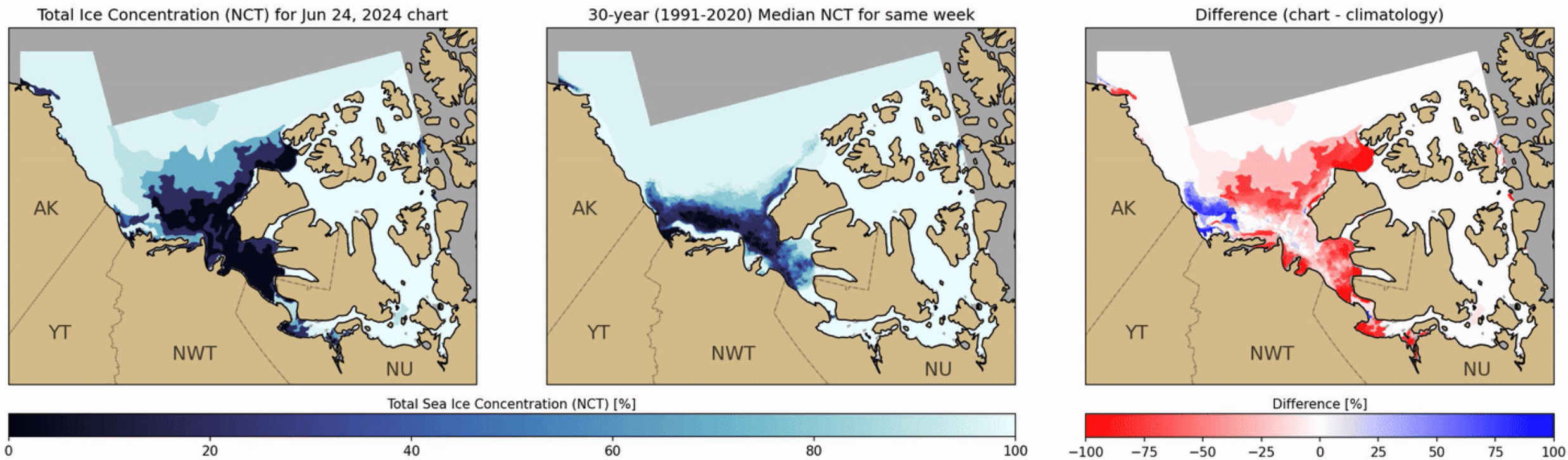
Changes in annual trips 2013 vs. 2023 (>300GT left <300GT right)



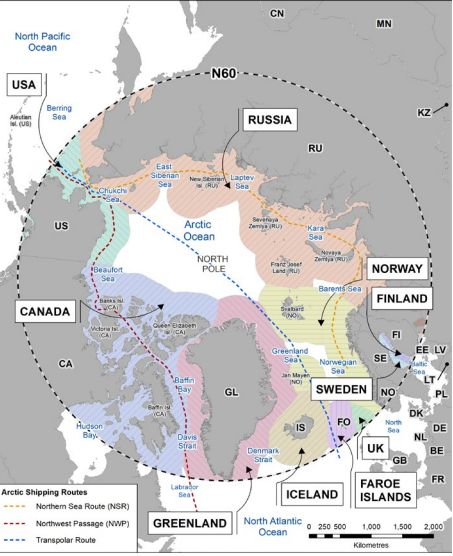
Changes in annual trips >300GT 2013 vs. 2023 (left) and 2013 vs. 2024 (right)



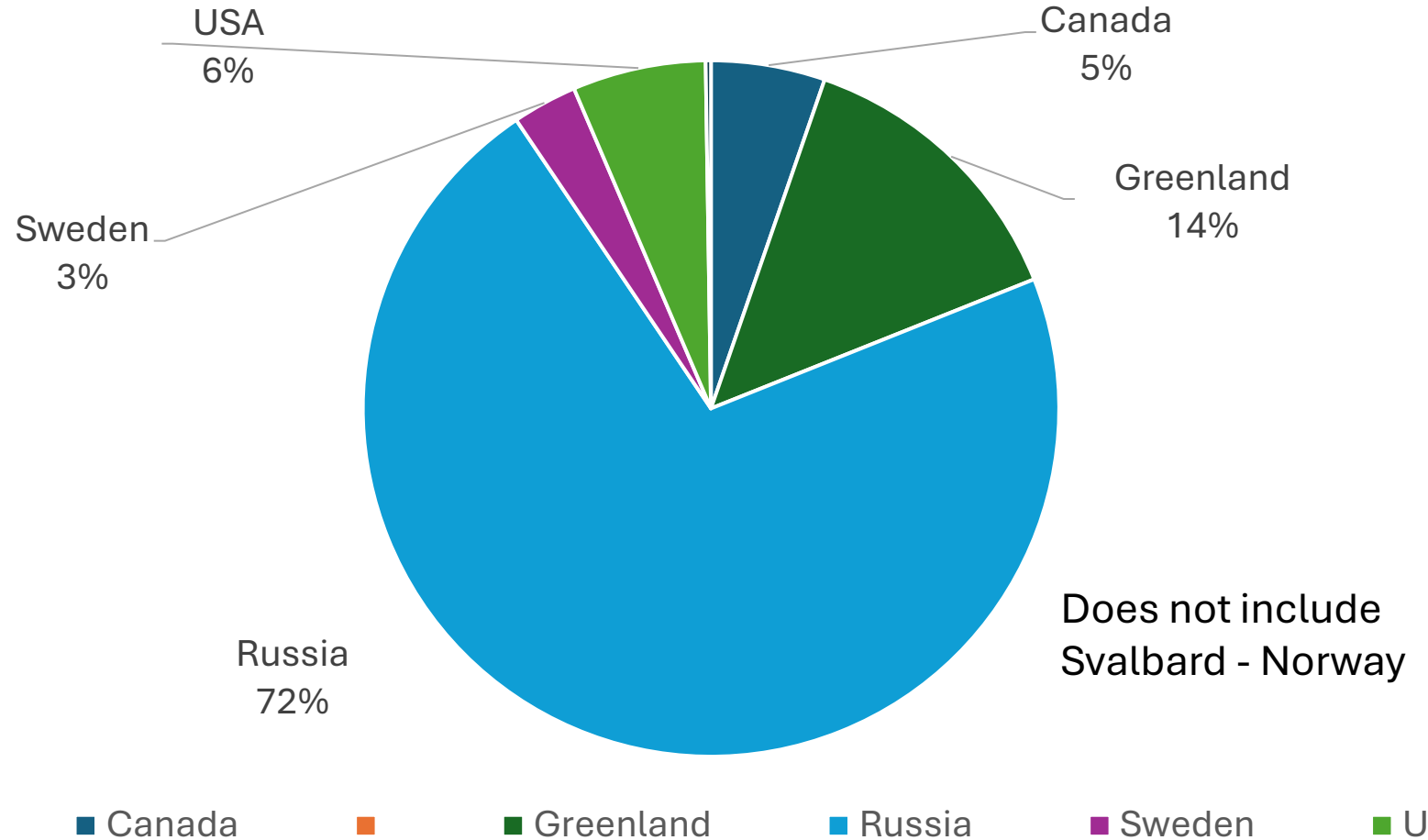
Animation of record low (2024) sea ice conditions in the Northern Route of the Northwest Passage



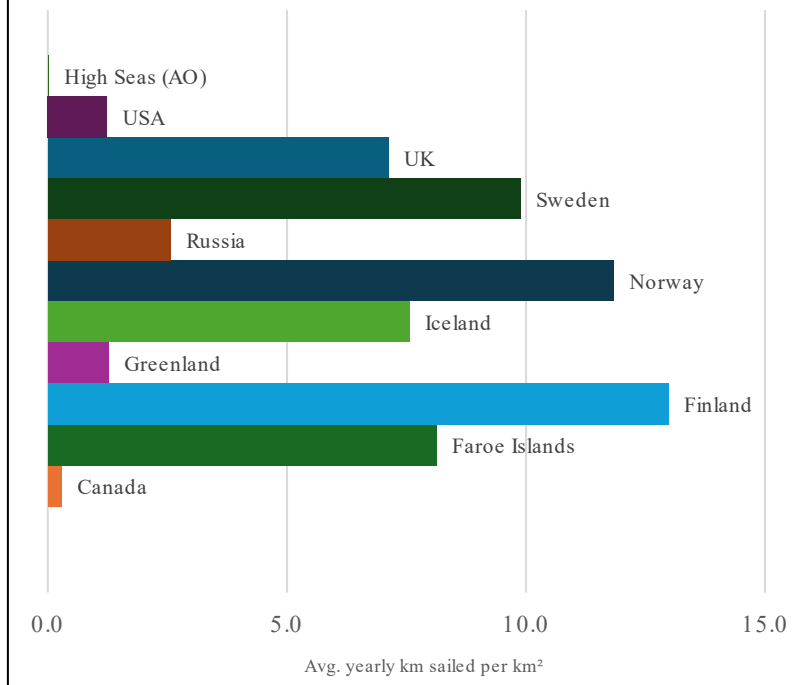
Average Annual KM Sailed (2013-2024) in EEZ of Countries in the Polar Code Area - ships > 300GT



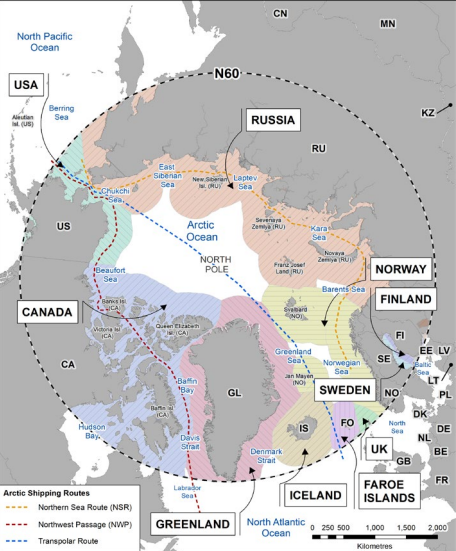
Average Yearly KM Sailed - ships > 300GT



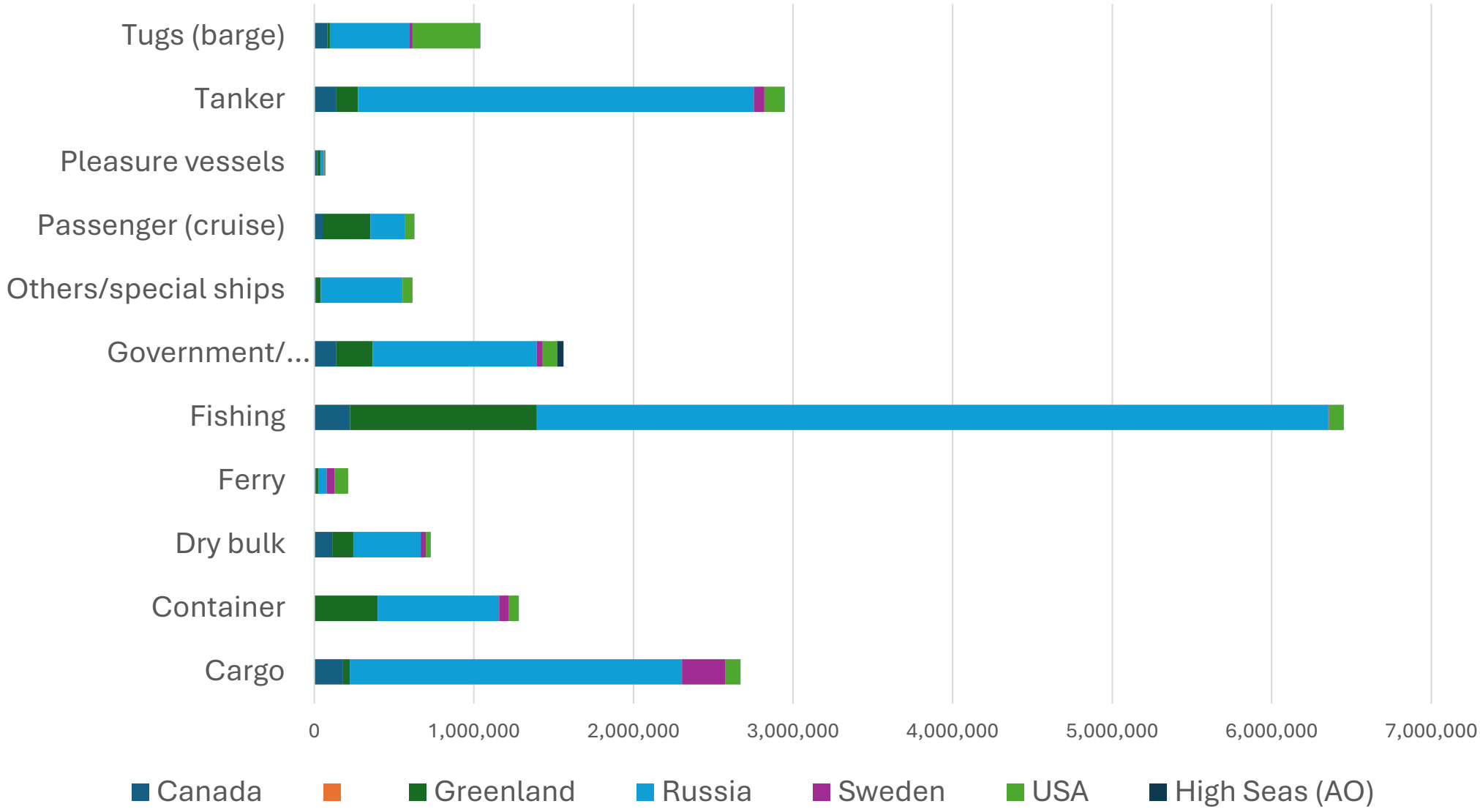
Average yearly km sailed by all ships >300 GT per navigable waters (km²) N60

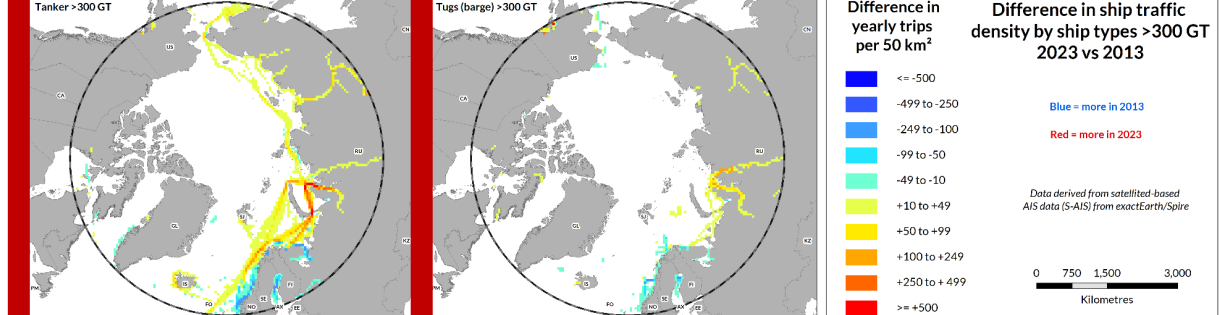
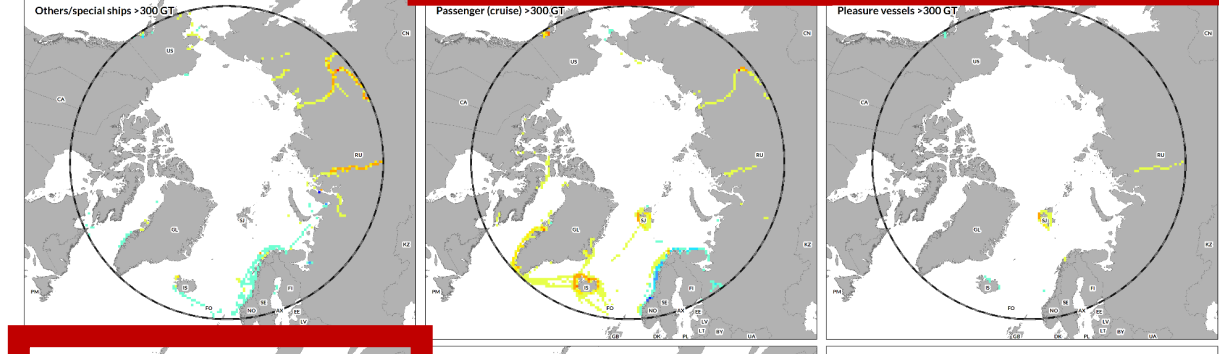
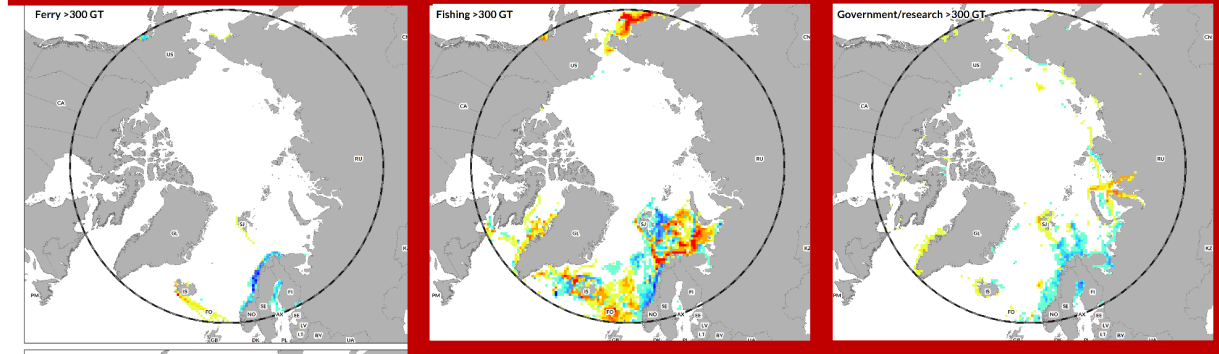
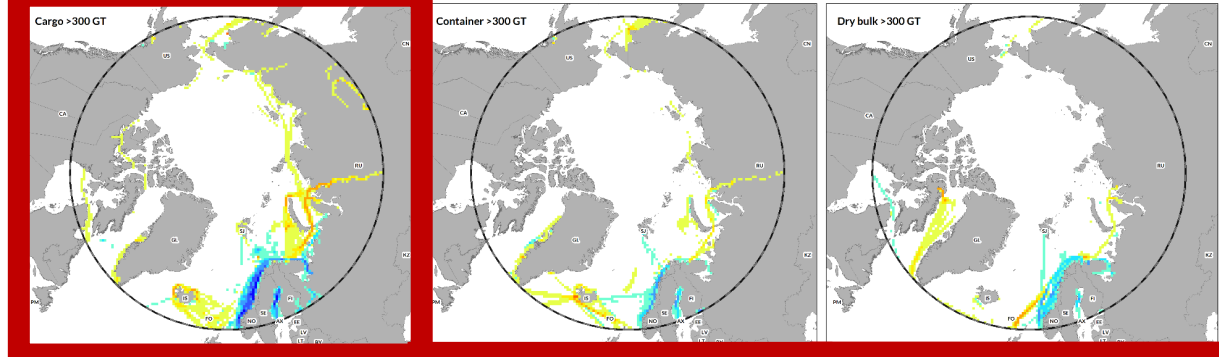
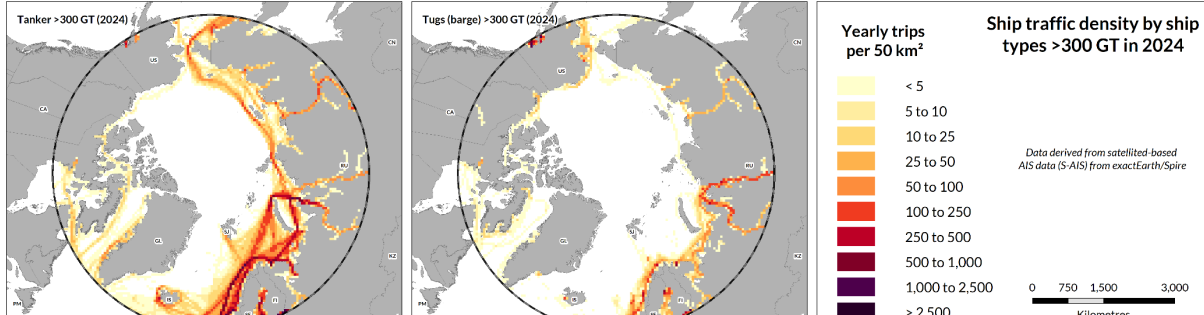
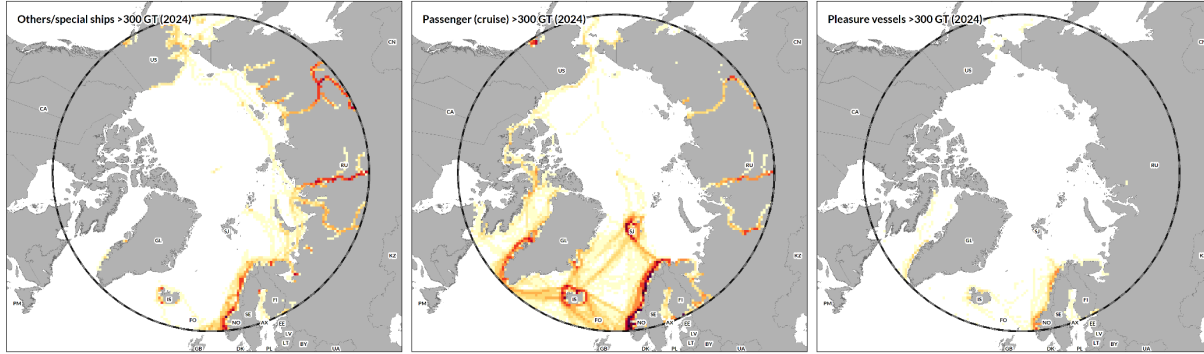
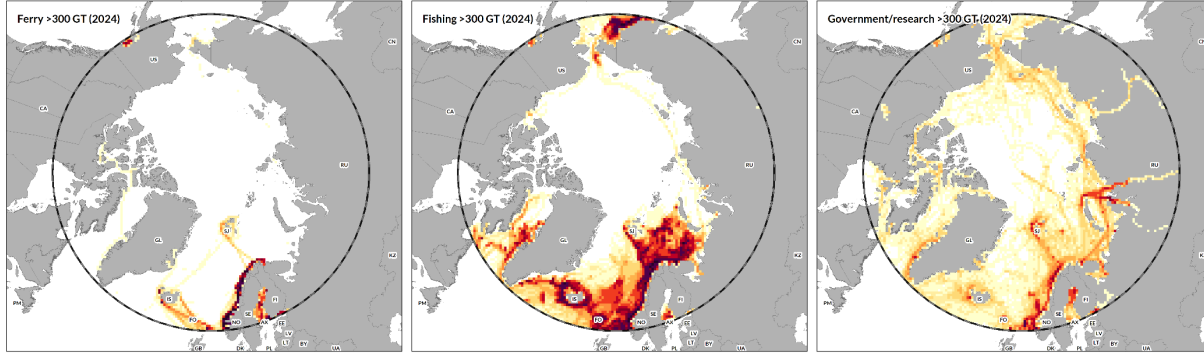
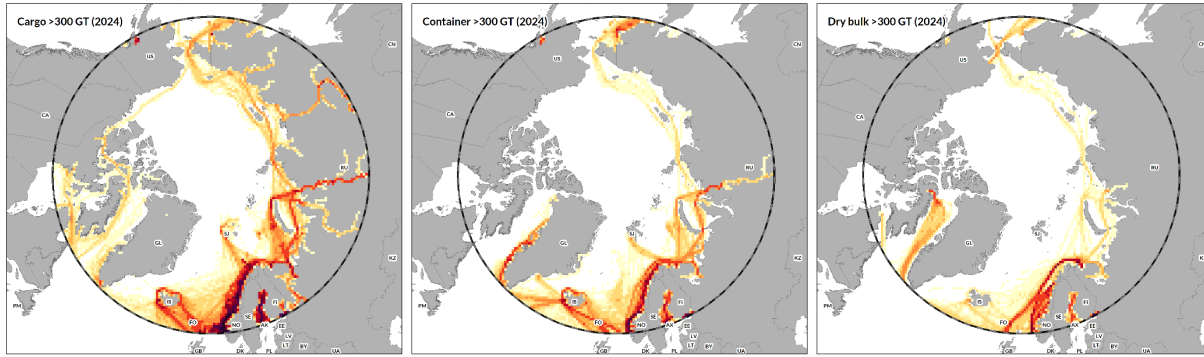


Average Annual KM Sailed (2013-2024) in EEZ of Countries in the Polar Code Area - ships > 300GT – by Vessel Type



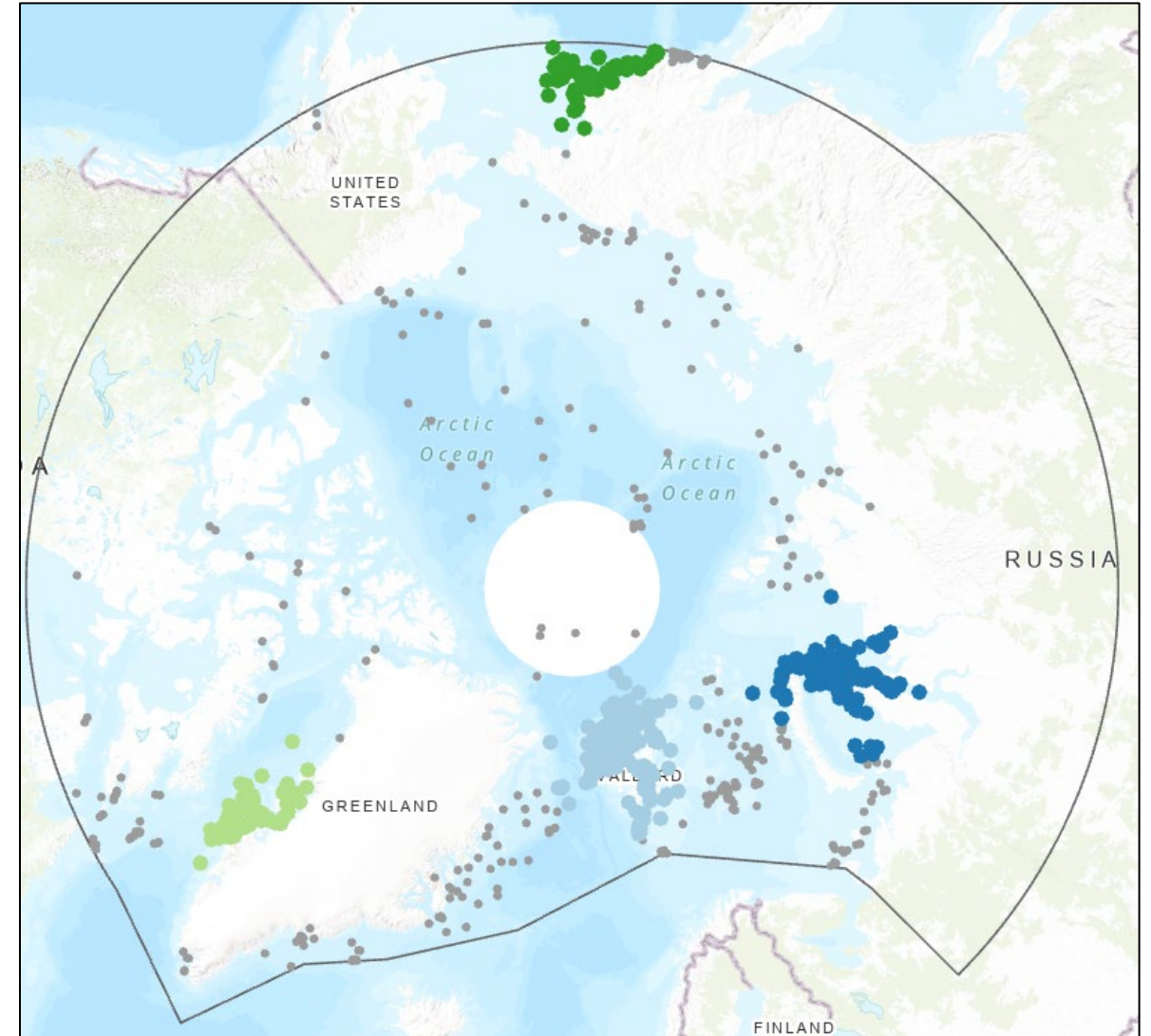
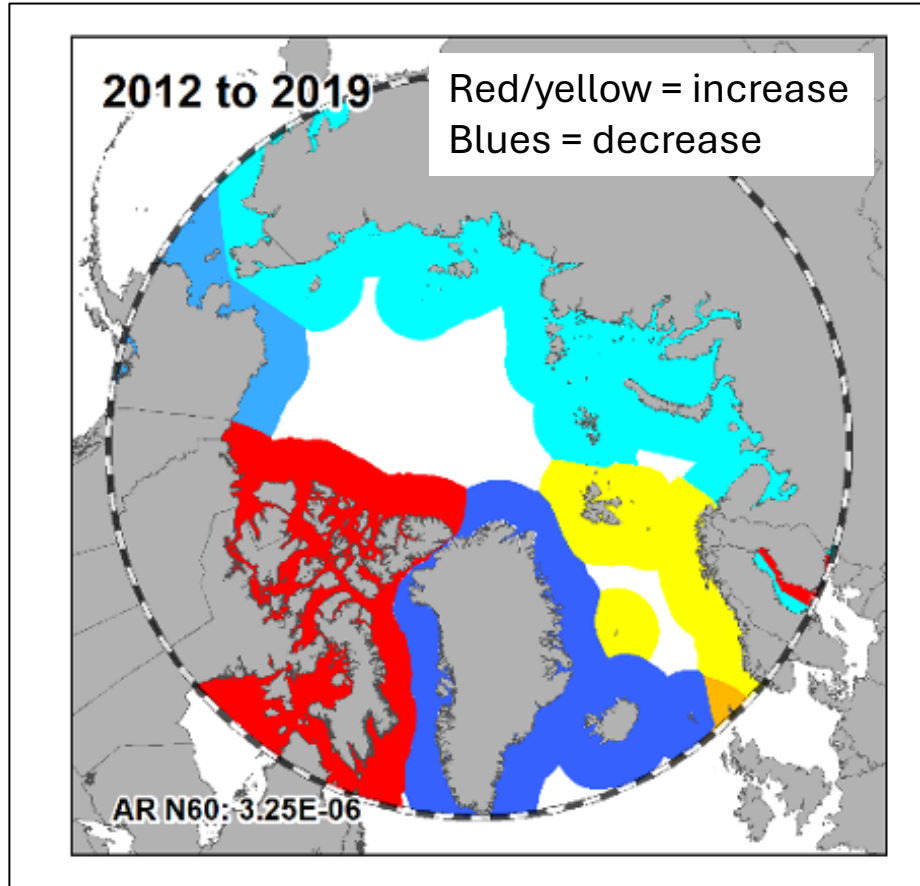
Does not include Svalbard - Norway



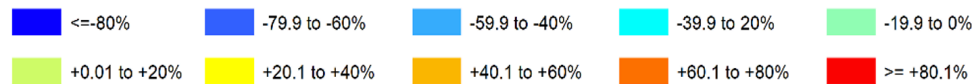


Spatial Shipping Hot Spot Risk Areas

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

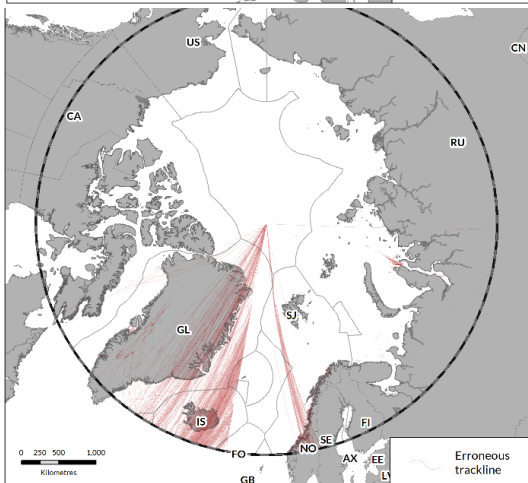
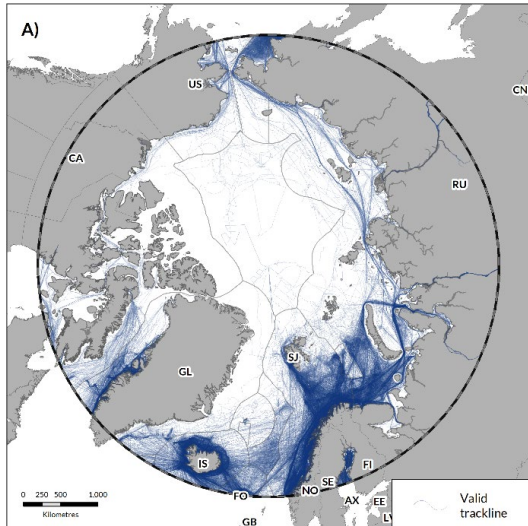
0 362.5725 1,450
 Kilometres

High Risk Clusters

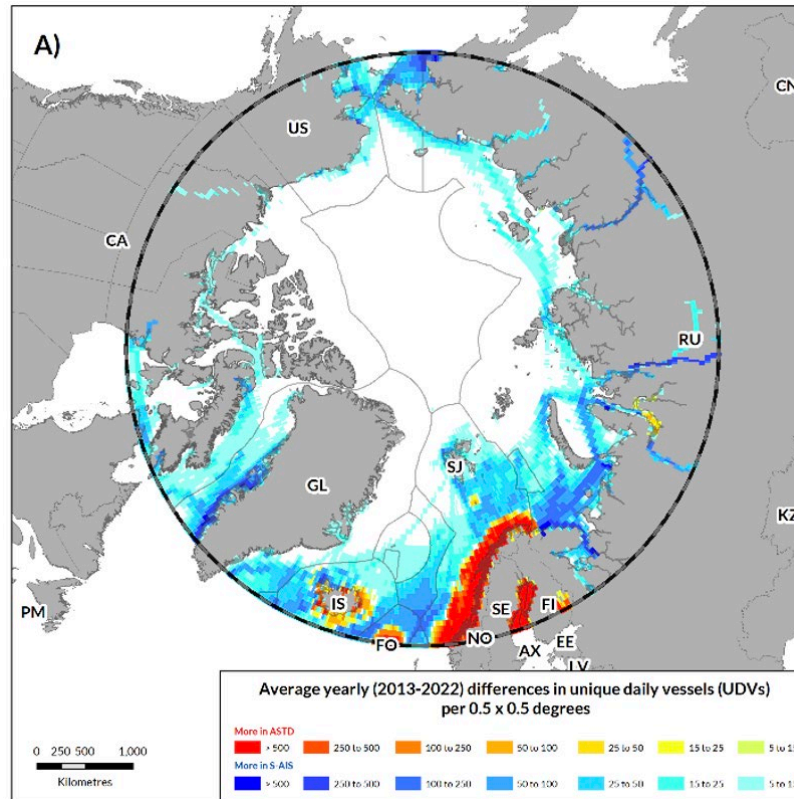
Arctic Shipping Trends

Data Challenges

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

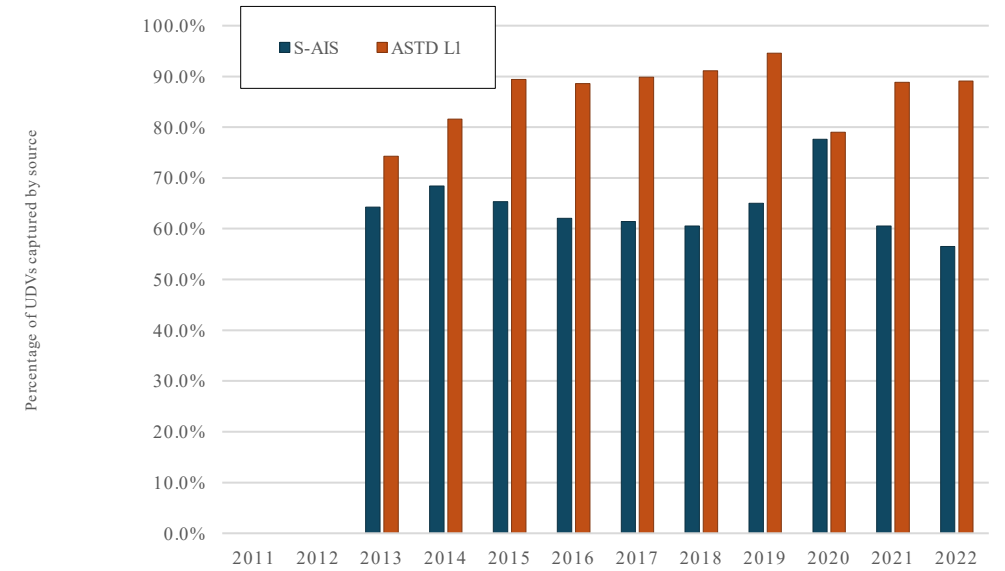


Yearly average (2013-2022) difference in unique daily vessels between ASTD L1 and S-AIS datasets per 0.5 x 0.5-degrees; grid cells in red represent more UDV detected in the ASTD L1 data, while grid cells in blue represent more UDV detected in S-AIS

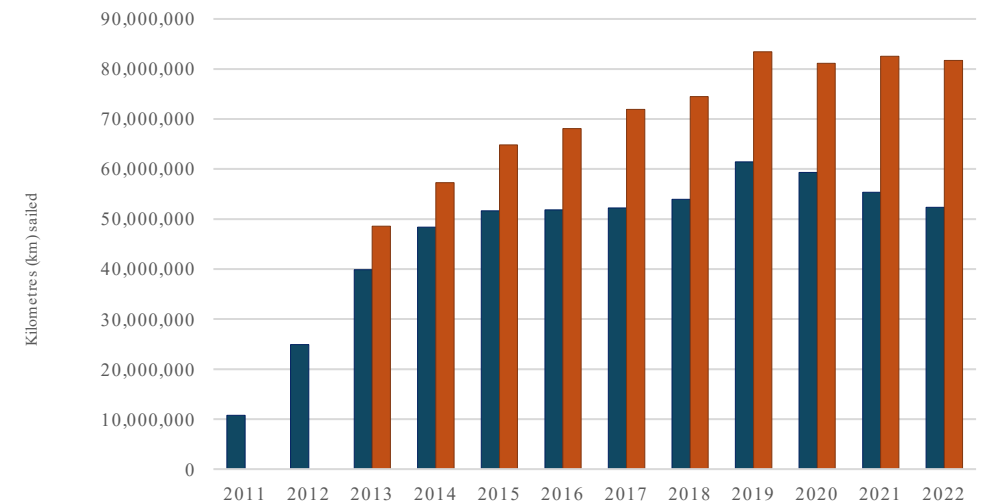


Nicol et al. 2025

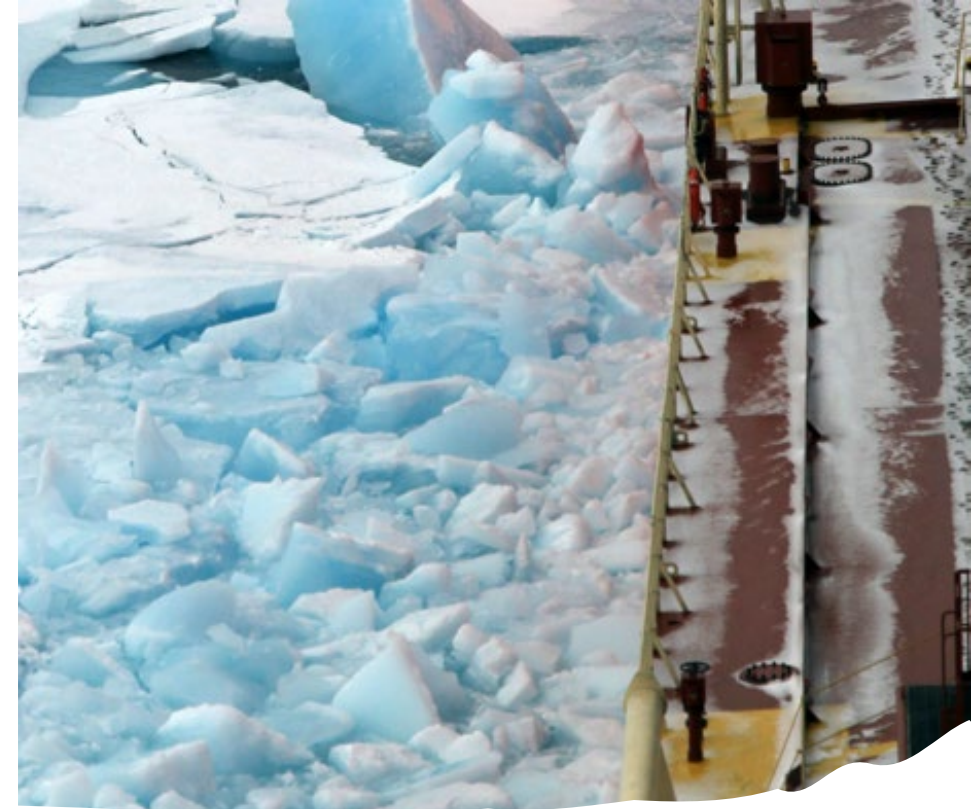
Percentage (%) of unique daily vessels captured by S-AIS and ASTD L1 North of the 62nd parallel from 2011 to 2022.



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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