



Trends in Arctic Shipping

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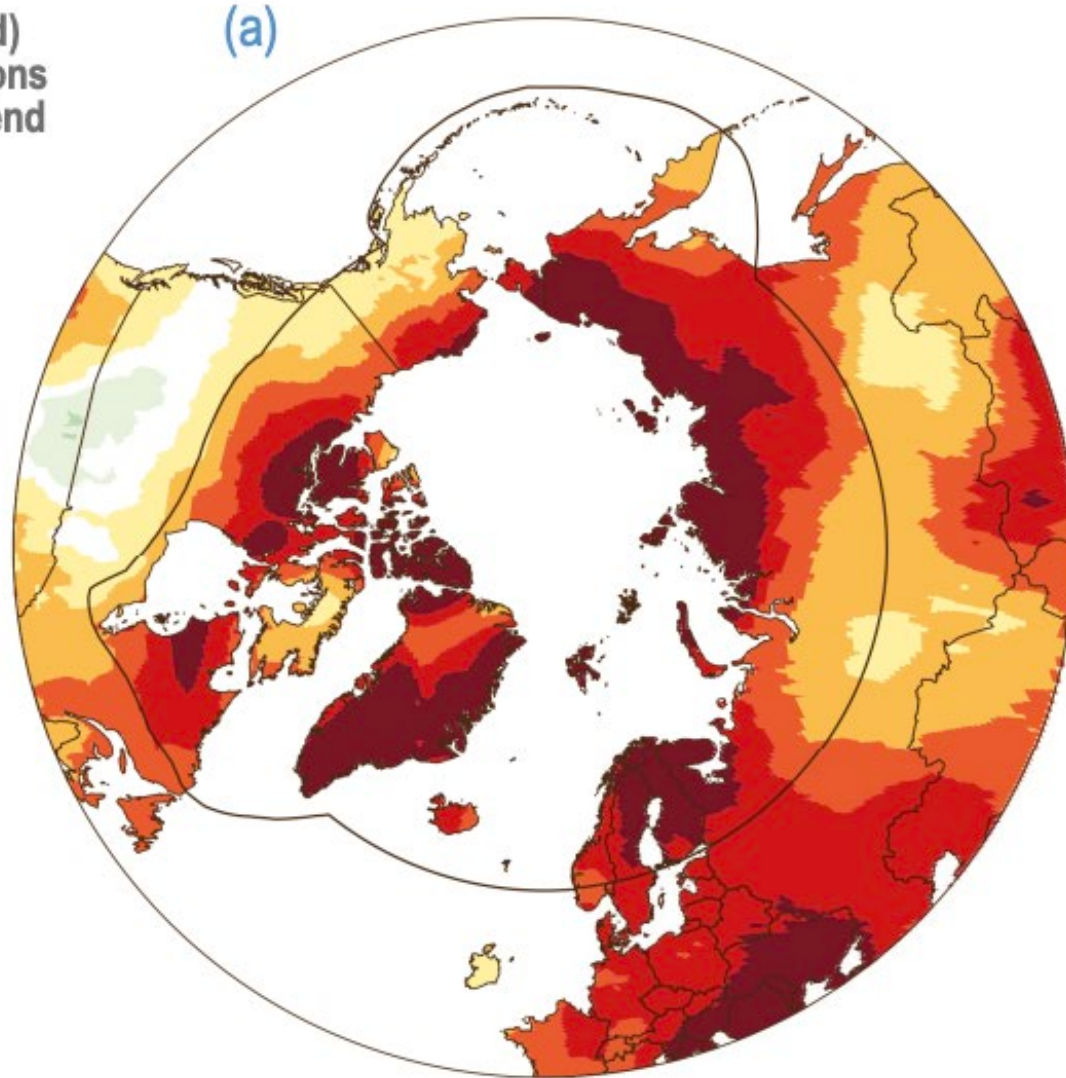
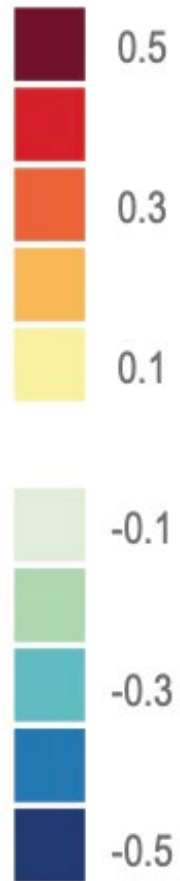
Outline

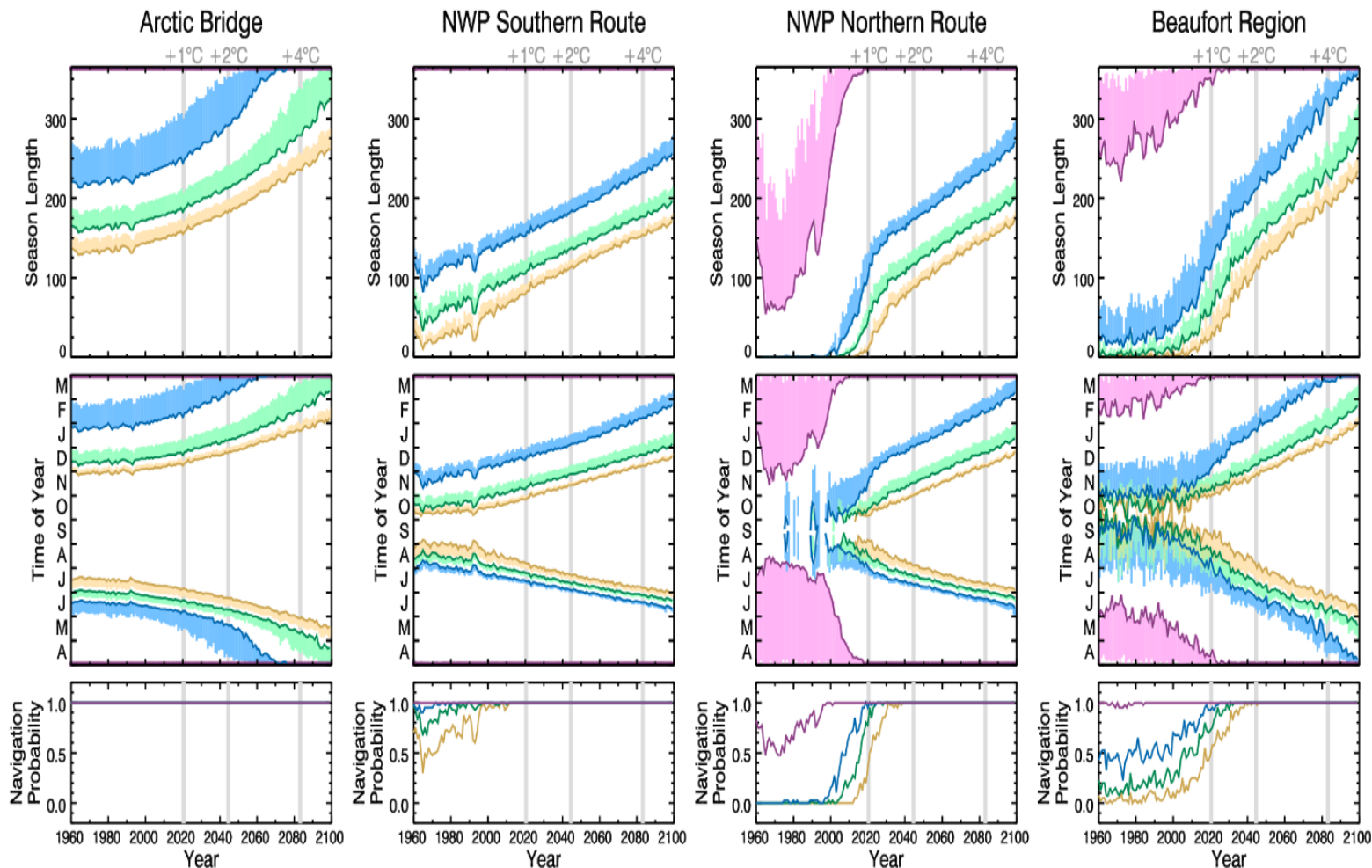
- Climate Change and Future Projections
- Global Arctic Shipping Patterns and Trends
- Ship-Ice Interactions, Accidents and Risk
- Data Challenges



Projected Warming in the Arctic

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





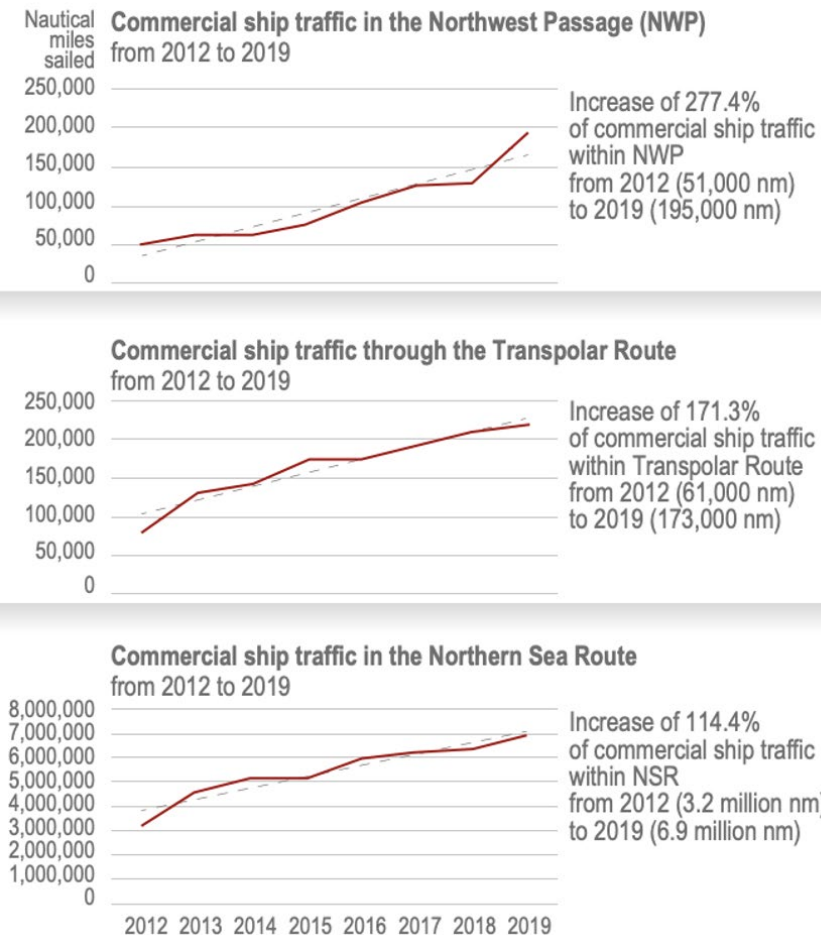
Polar Class 3

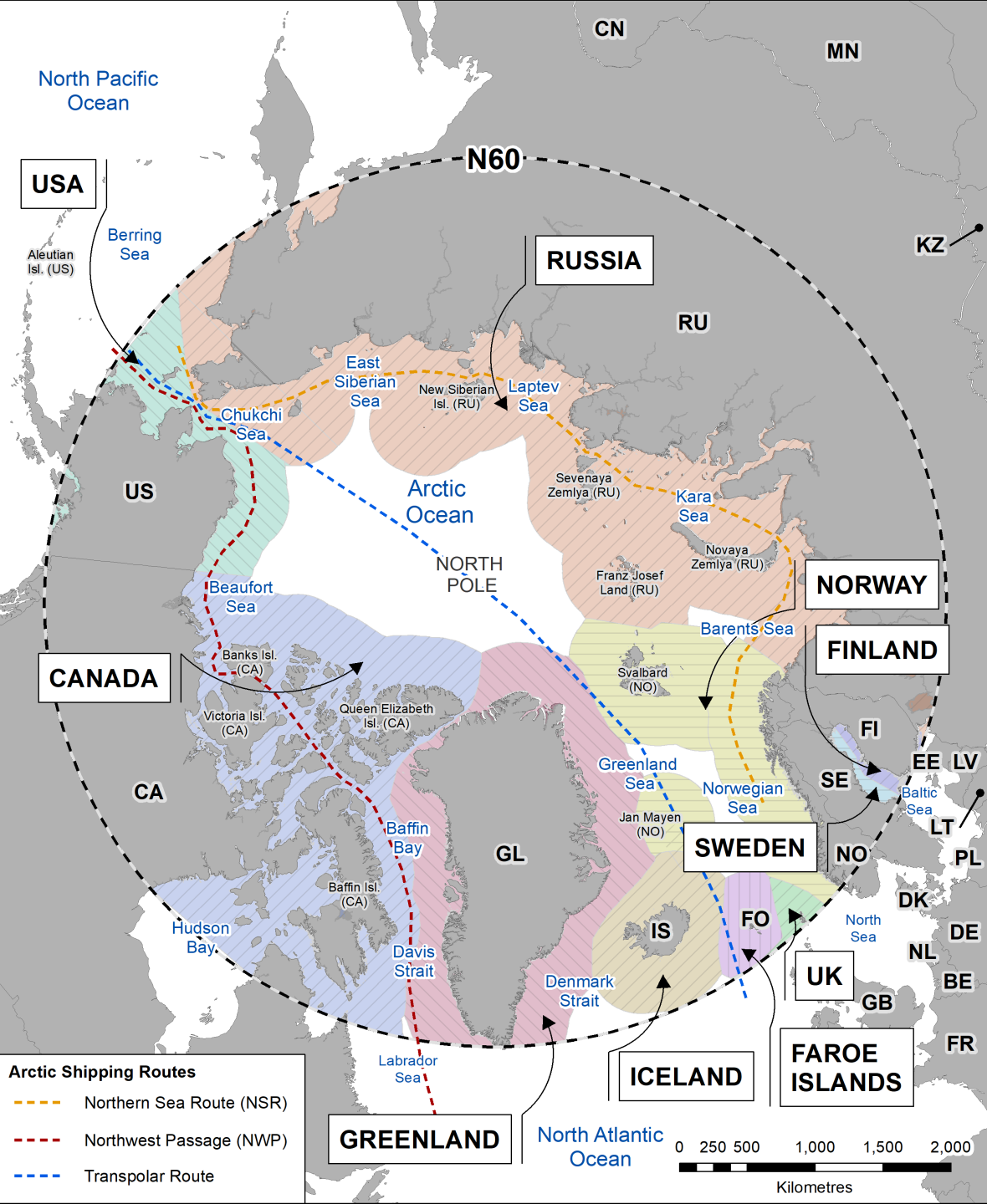
Polar Class 7

Type 1B

No Ice Strength

Northwest Passage: + 14 to 31 days before 4^o C warming
 Northern Sea Route: 101 to 118 days annually by 2050
 Transpolar Route: +56% increase in accessibility by =2050

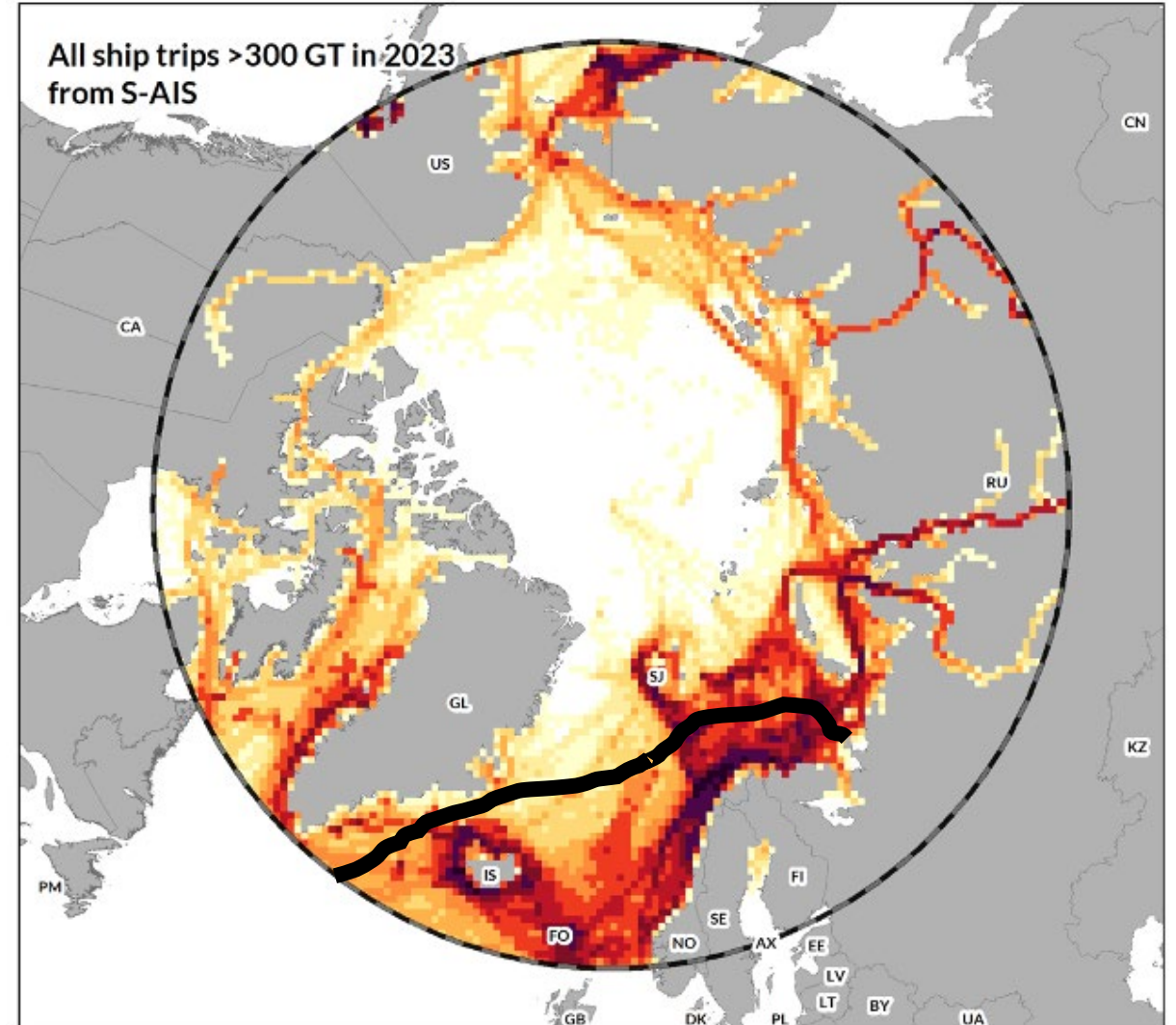
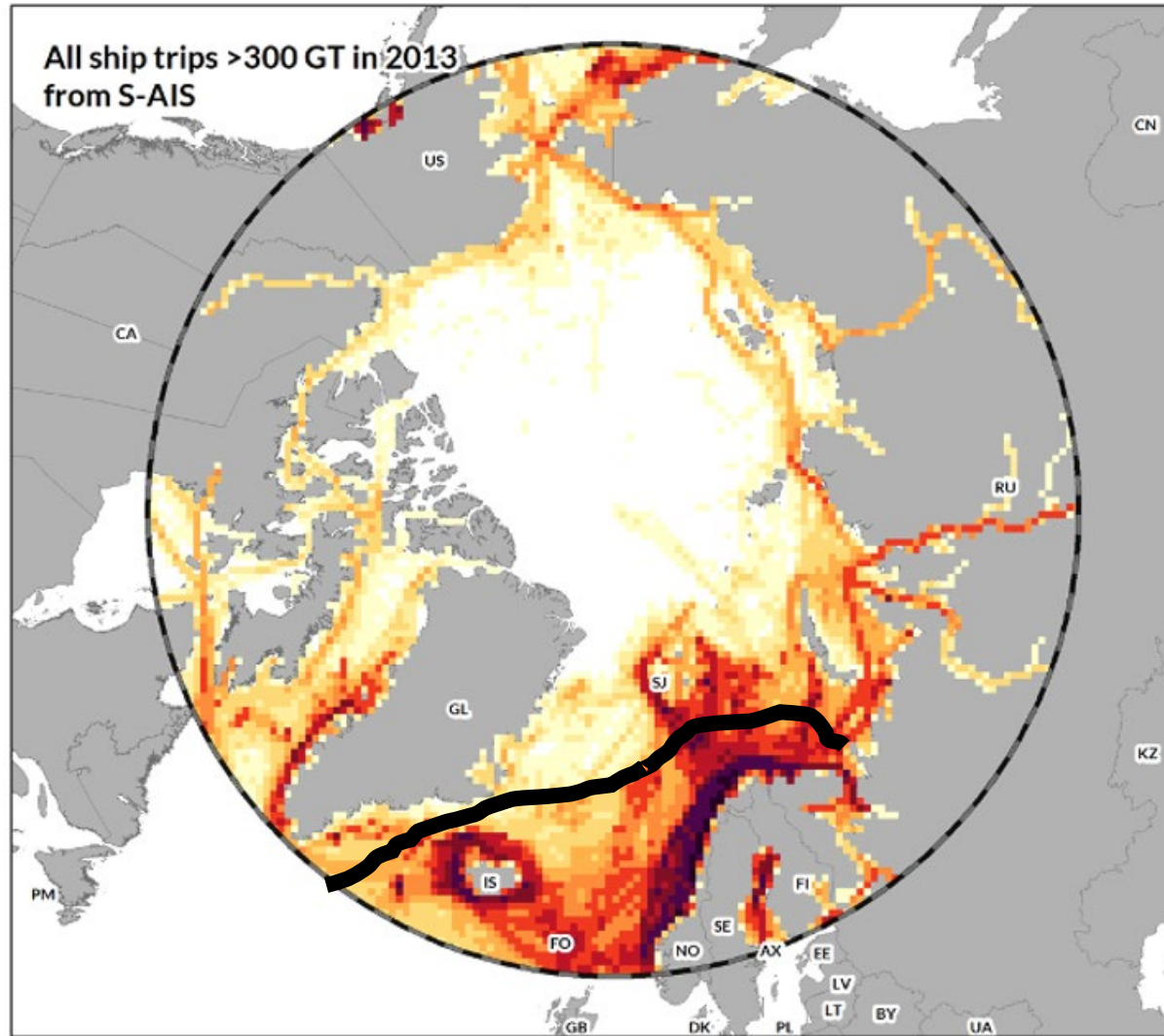




Area of analysis (North of the 60th parallel), with
Exclusive Economic Zones, North of the 60th parallel
Using S-AIS (Spire/Kpler)



Ships Over 300 GT (2013 vs. 2023)



Yearly trips
per 50 km²

< 5
100 to 250

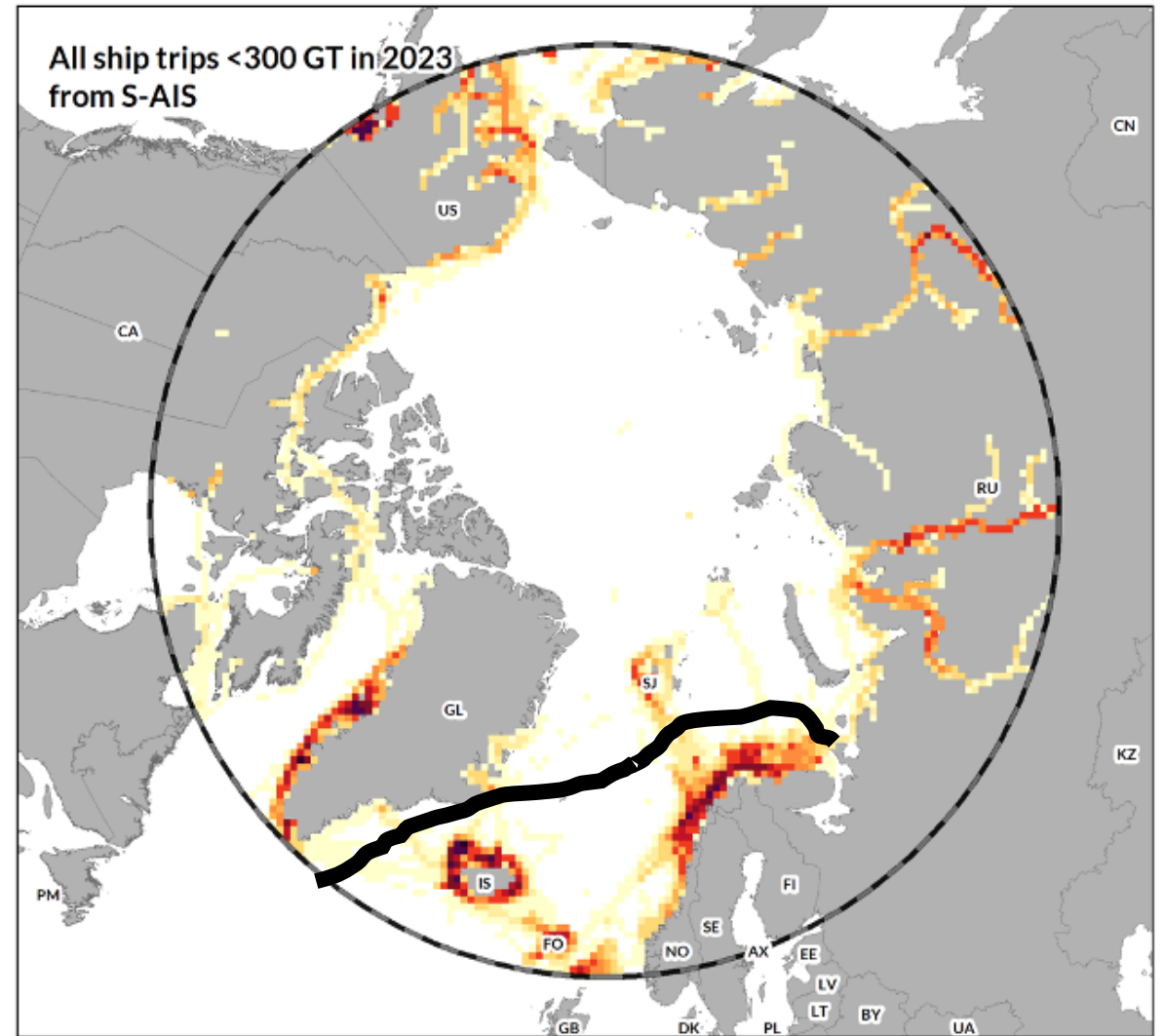
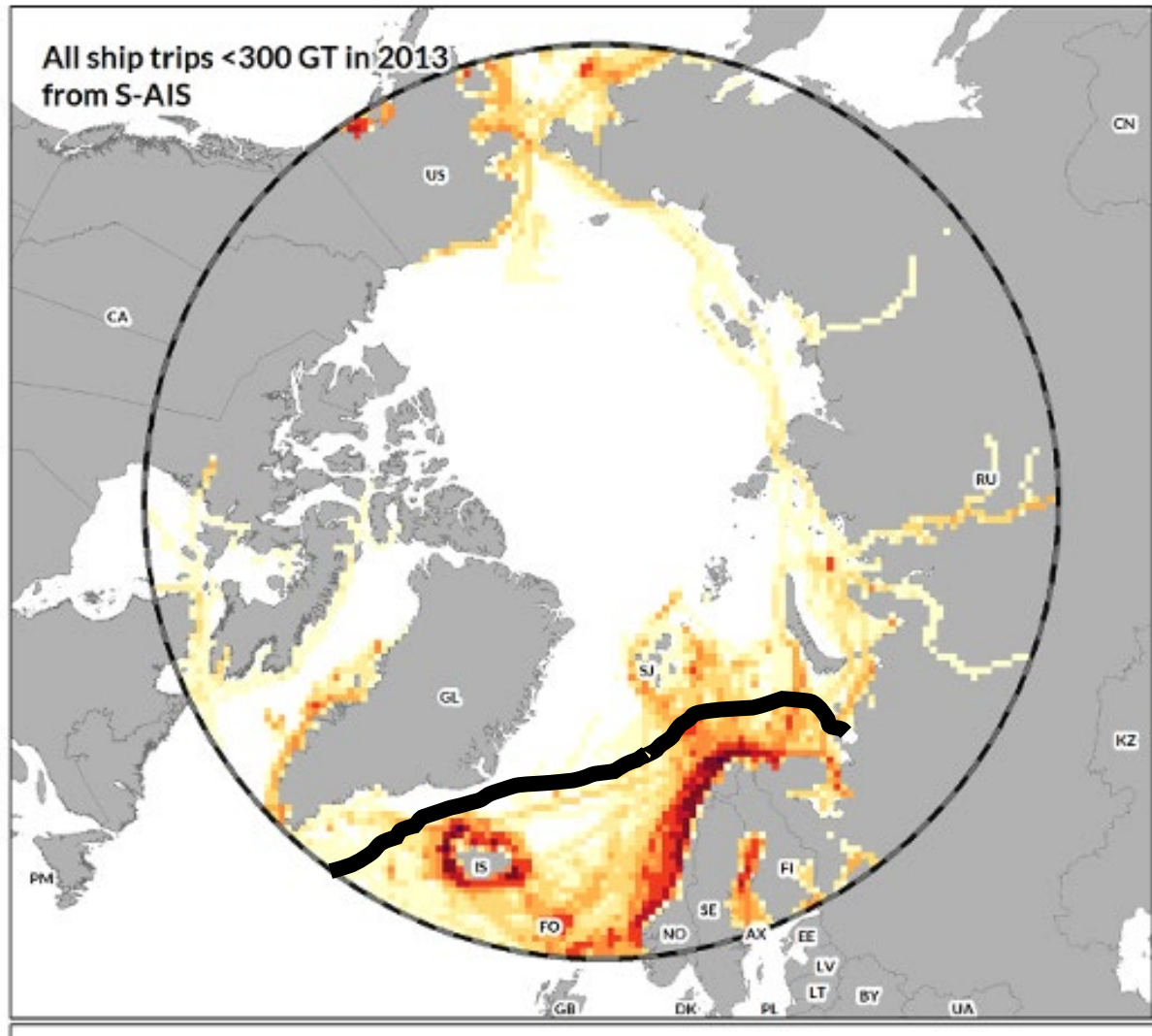
5 to 10
250 to 500

10 to 25
500 to 1,000

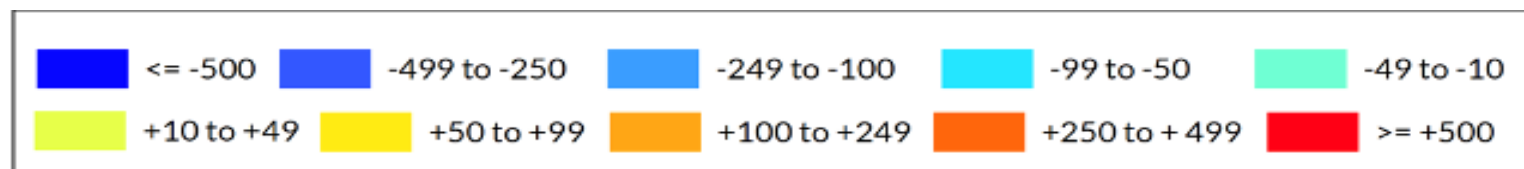
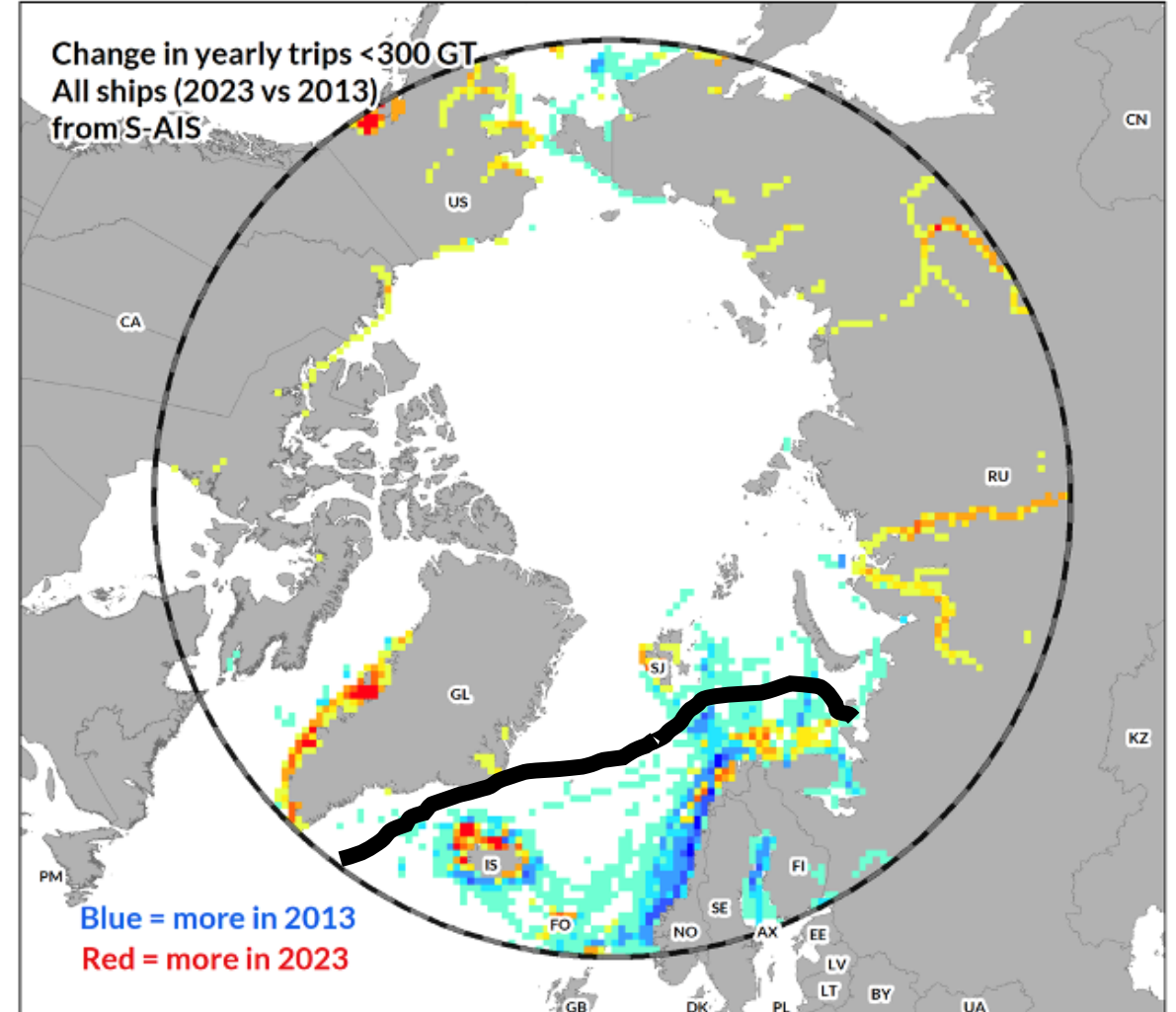
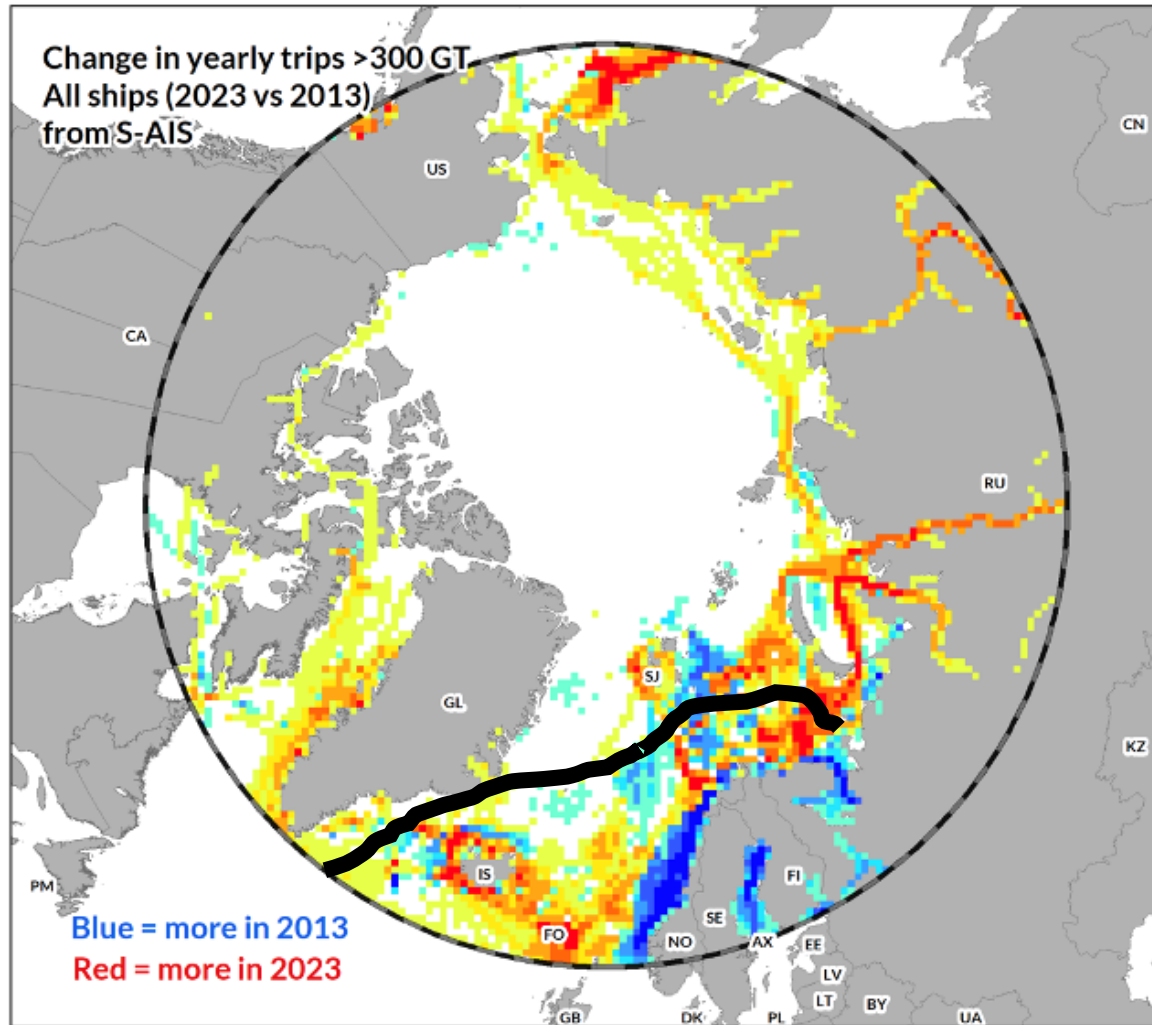
25 to 50
1,000 to 2,500

50 to 100
> 2,500

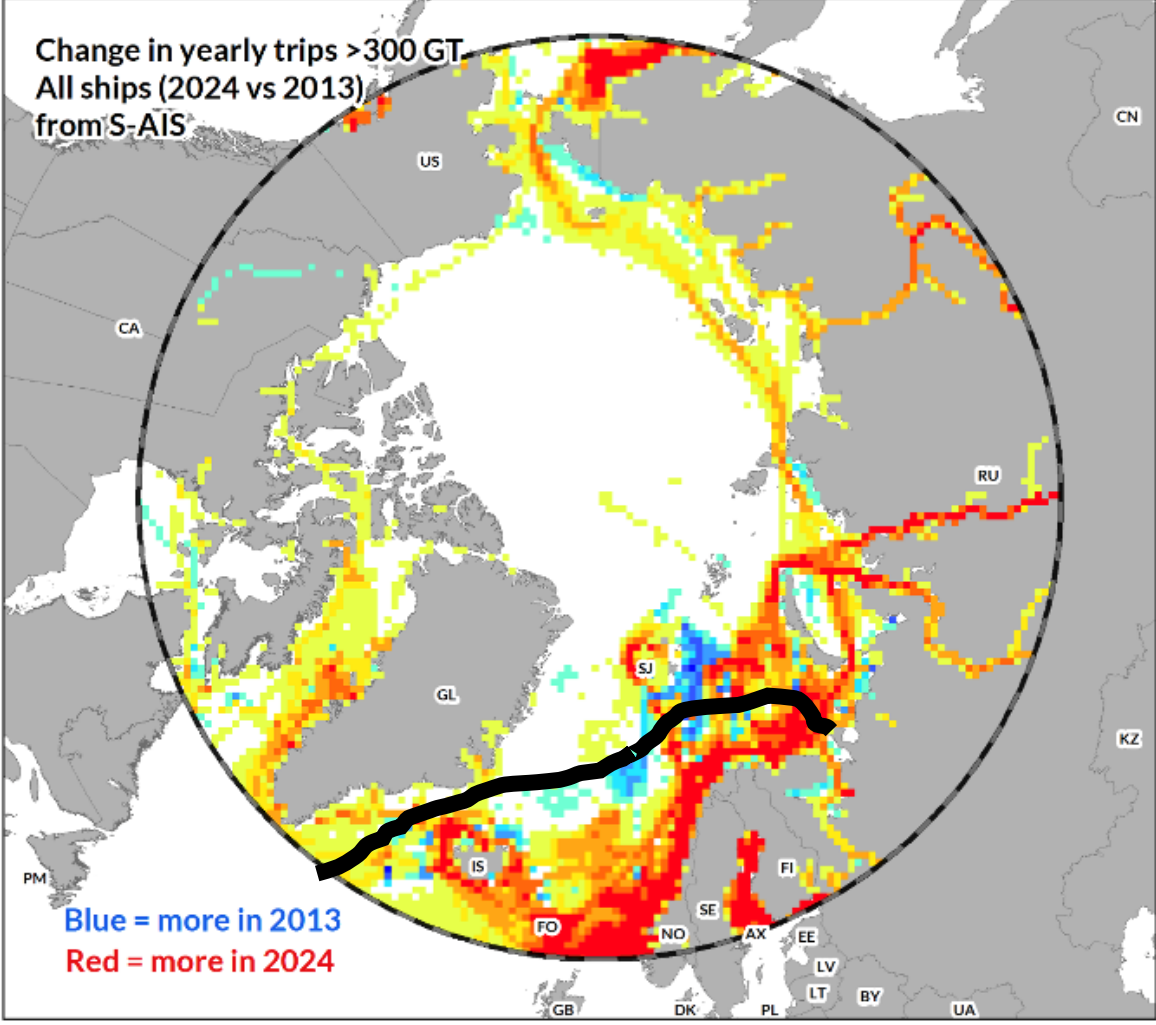
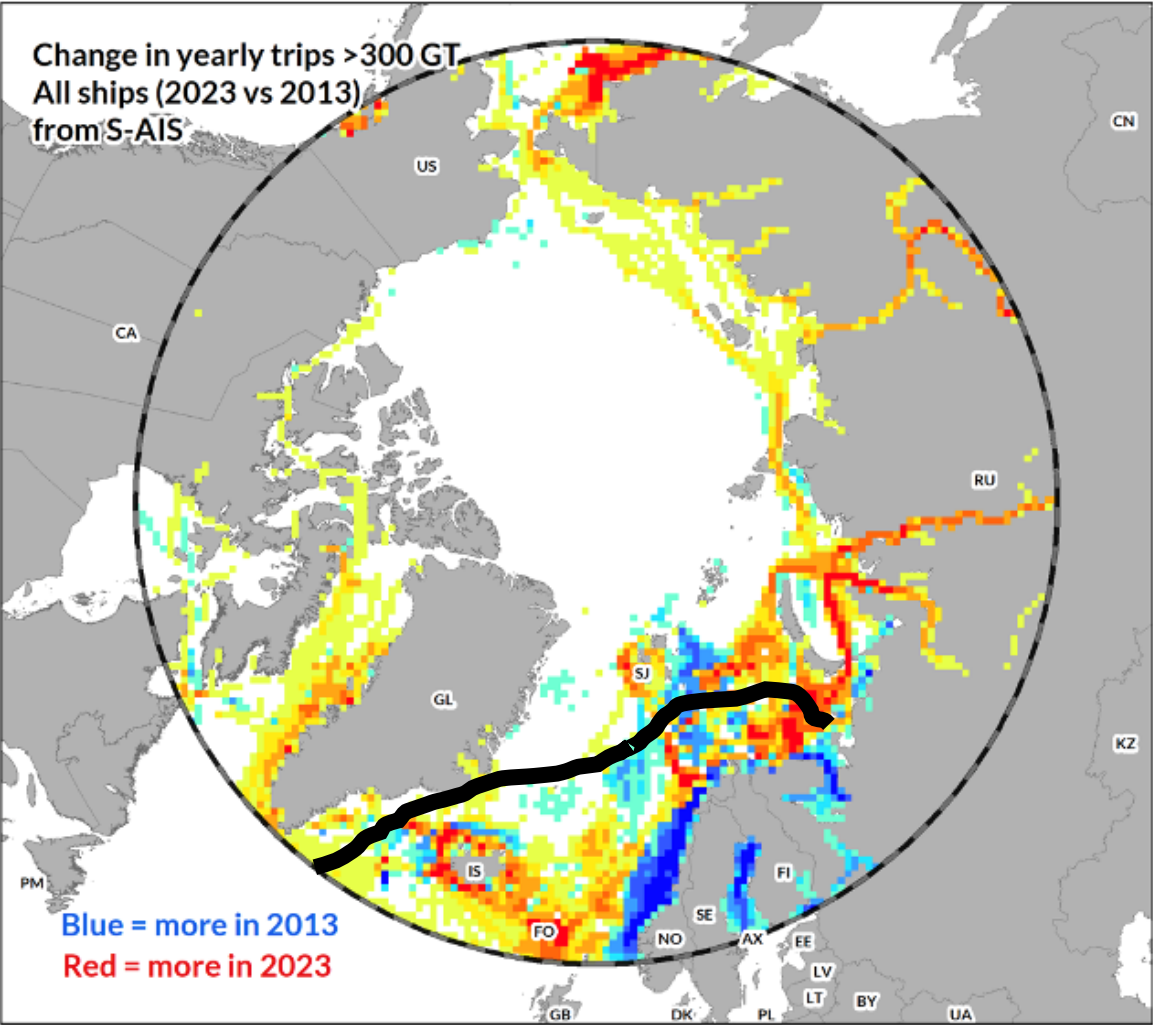
Ships Under 300 GT (2013 vs. 2023)



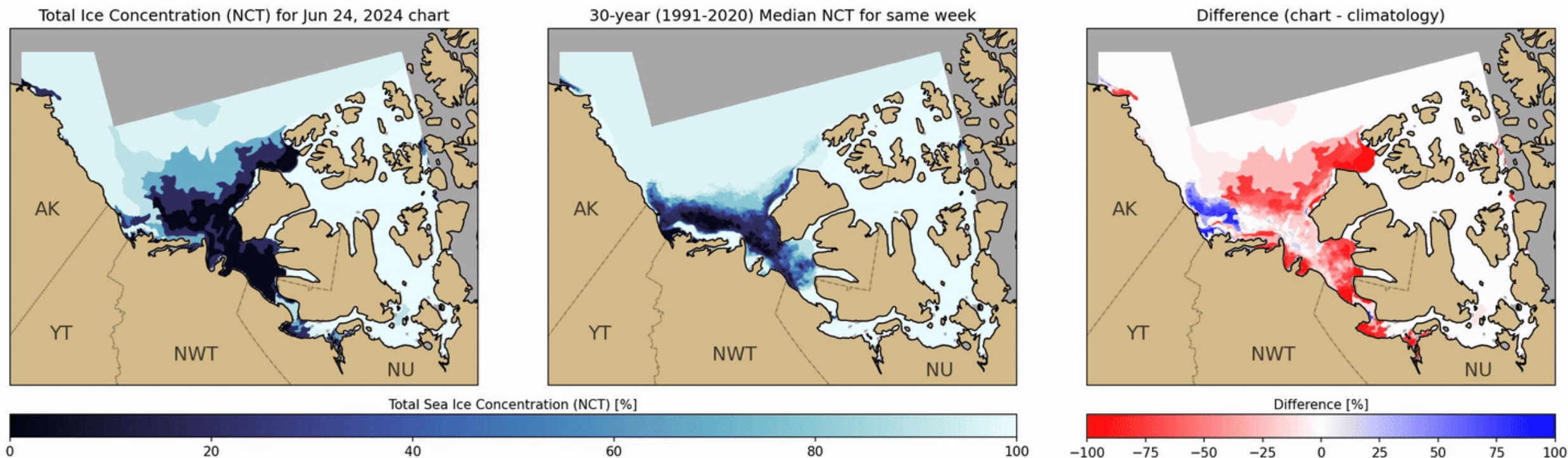
Changes in annual trips 2013 vs. 2023 (>300GT left <300GT right)



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



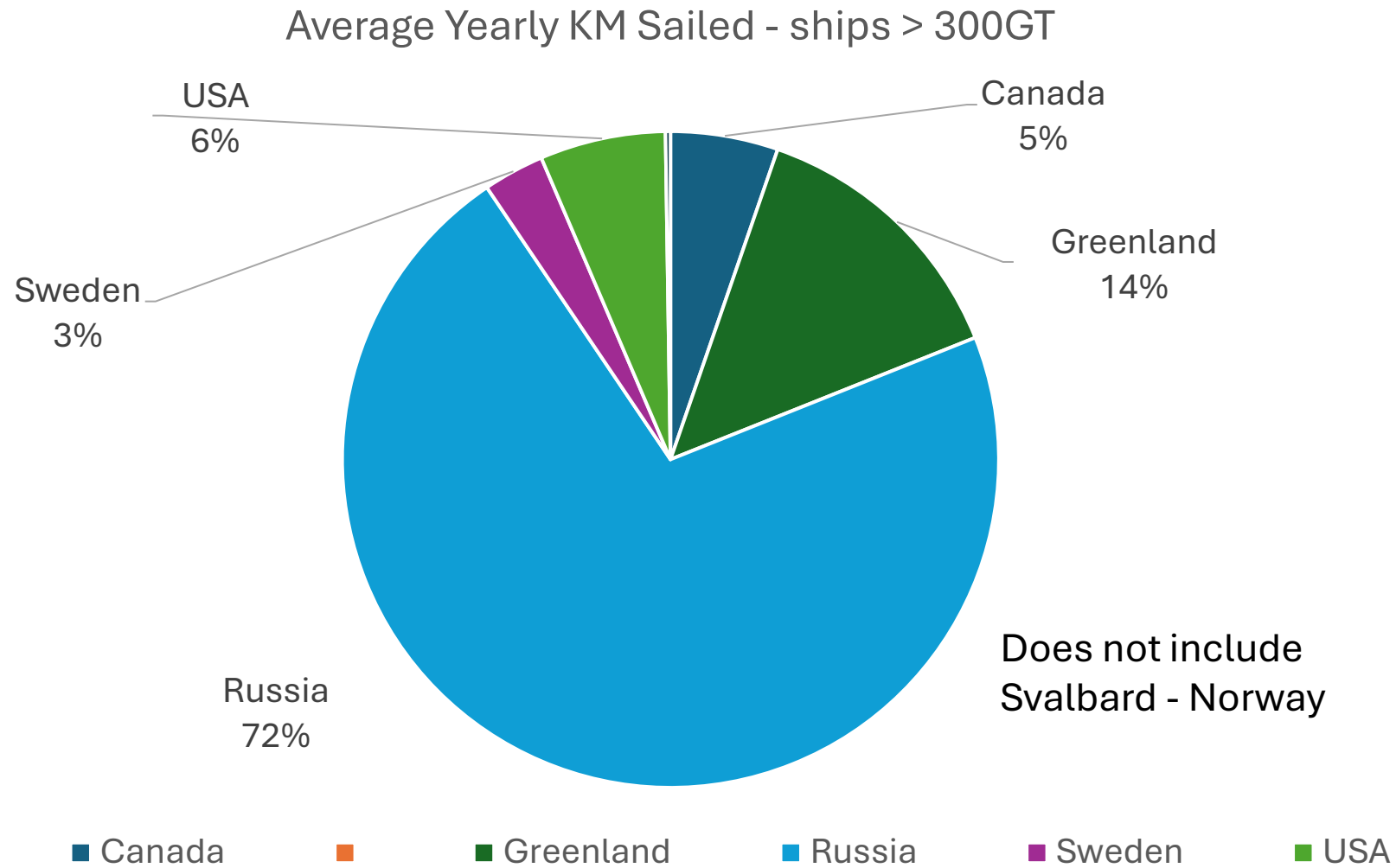
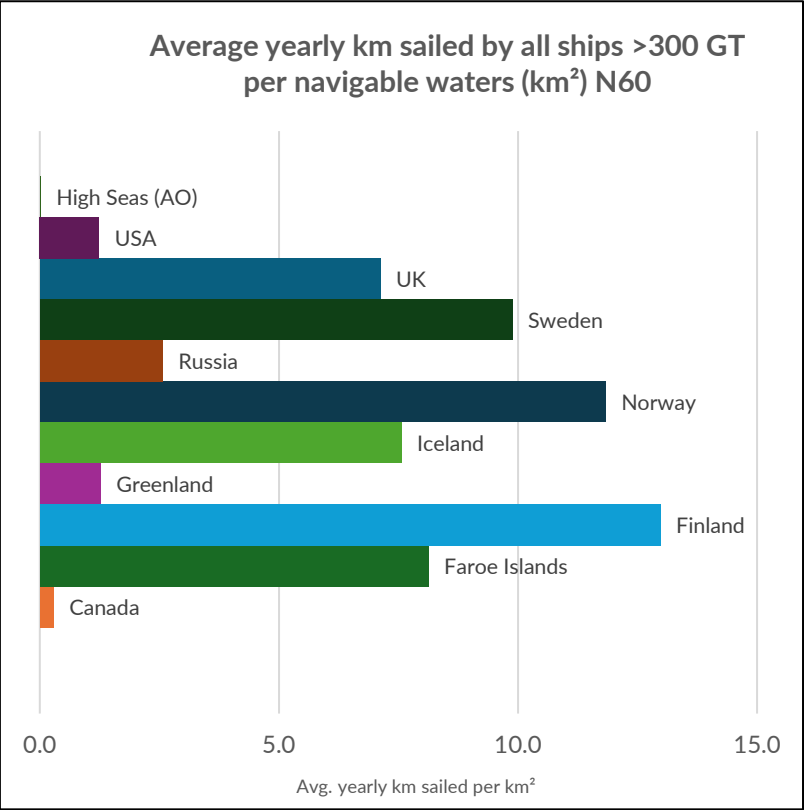
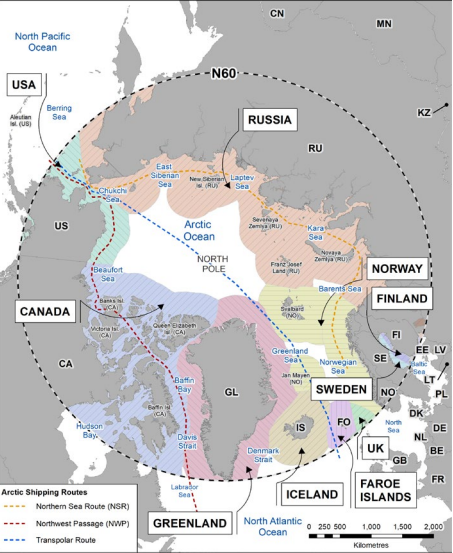
Environment and
Climate Change Canada

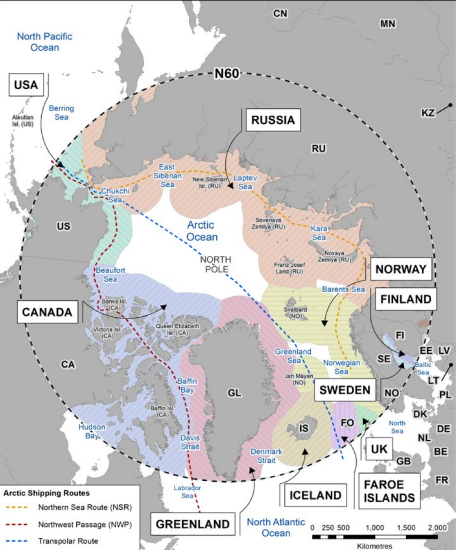
Environnement et
Changement climatique Canada

Acknowledgement - Dr. Stephen Howell

Canada

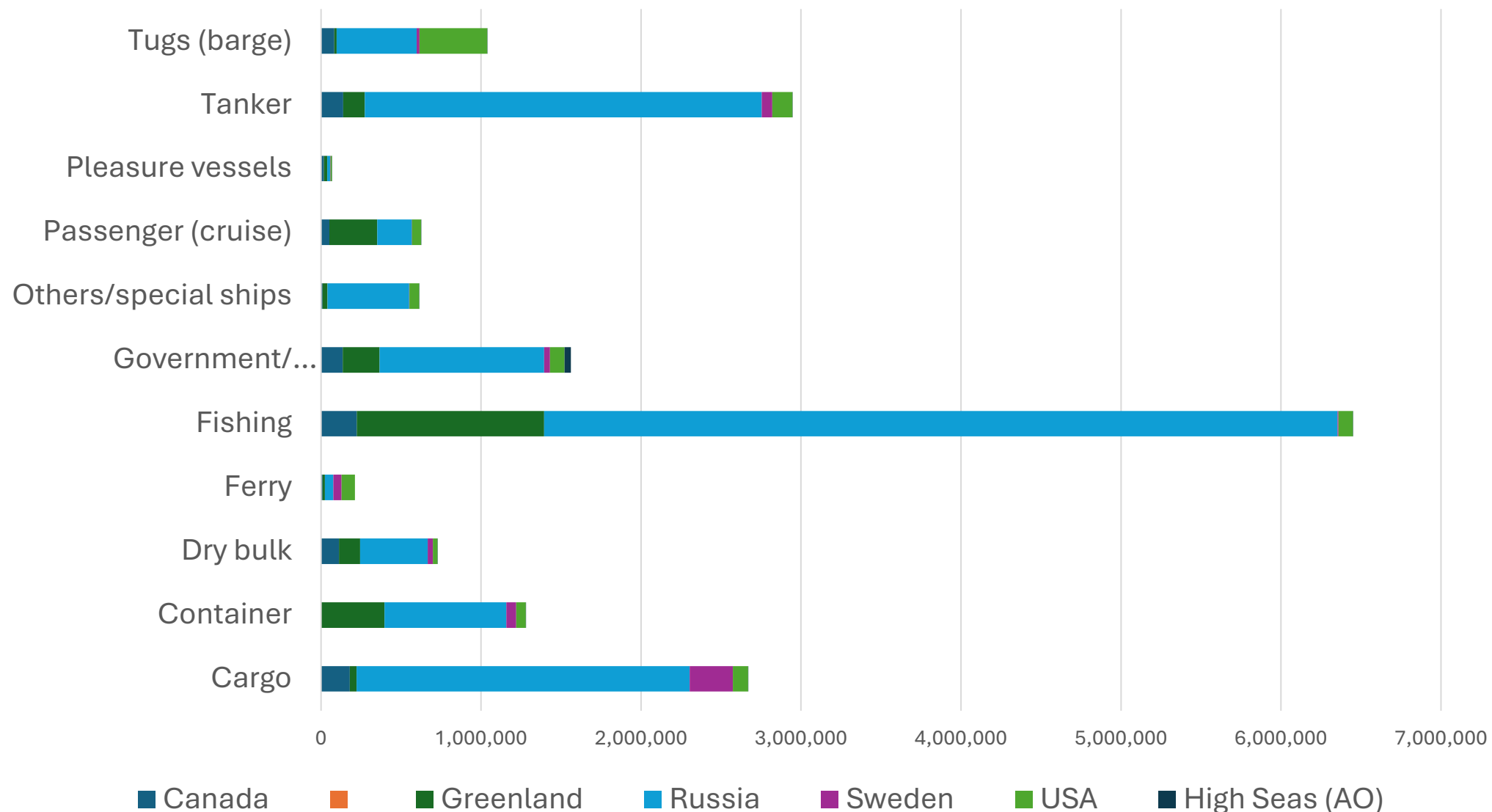
Average Annual KM Sailed (2013-2024) in EEZ of Countries in the Polar Code Area - ships > 300GT

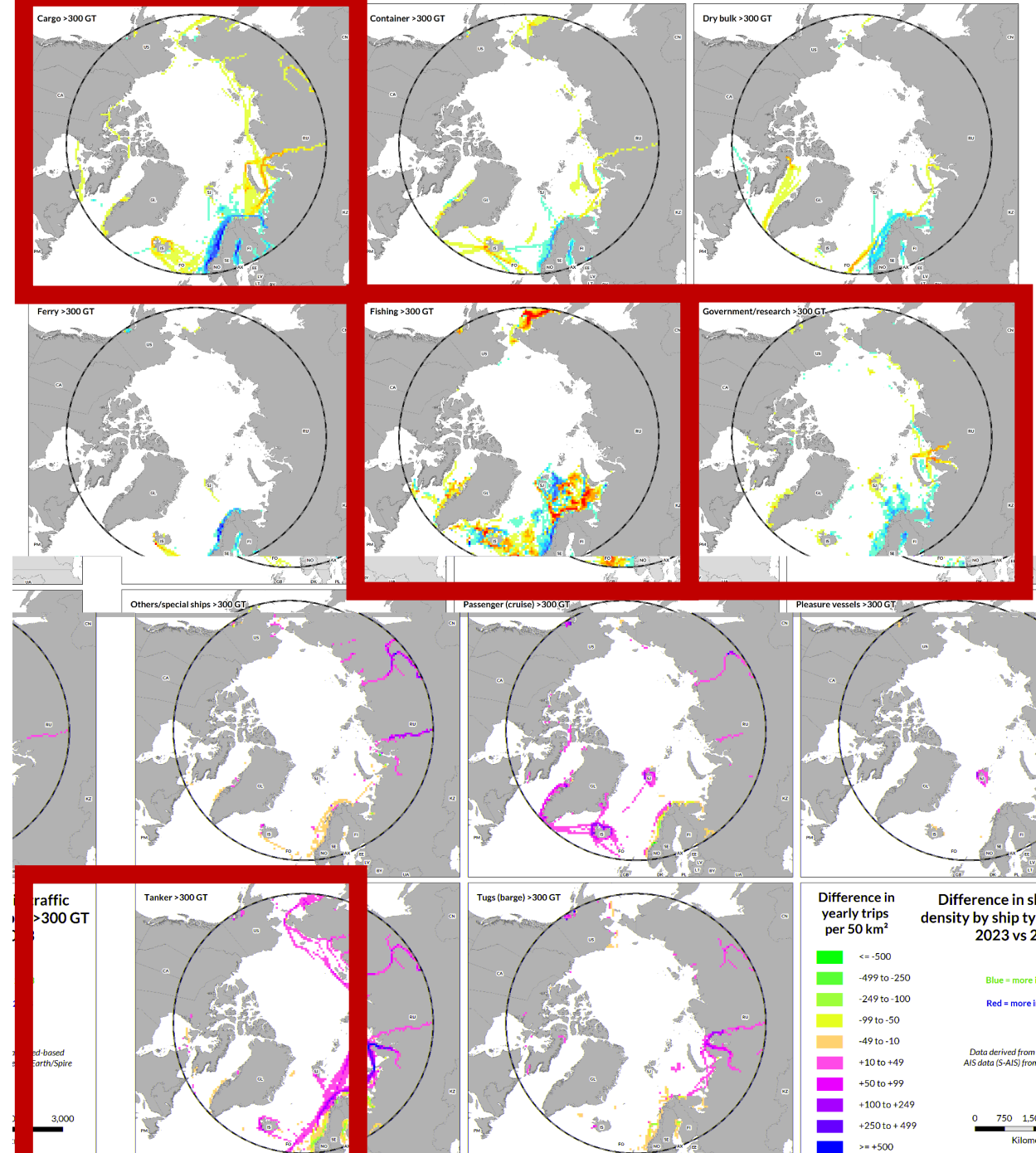
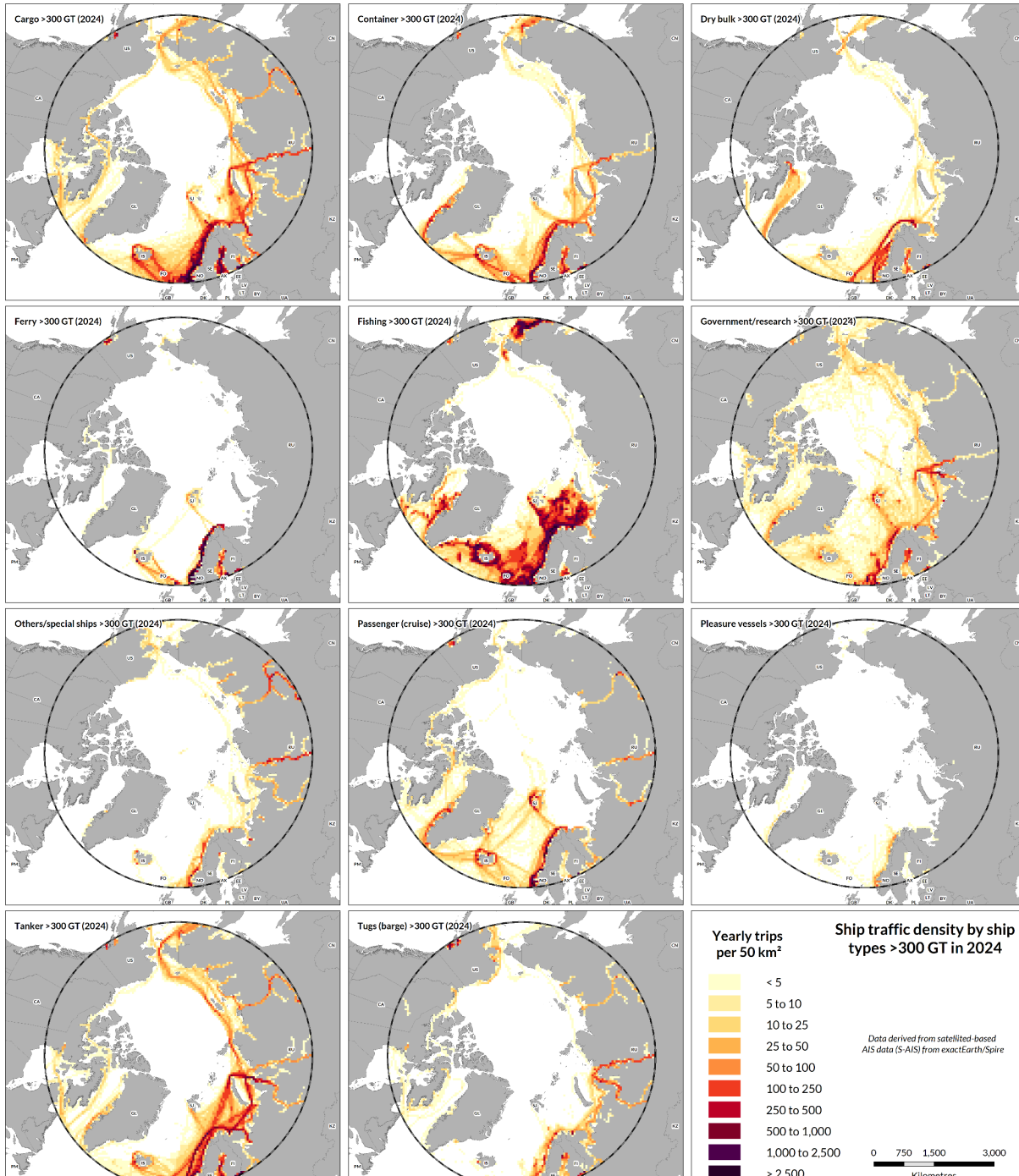




Does not include
Svalbard - Norway

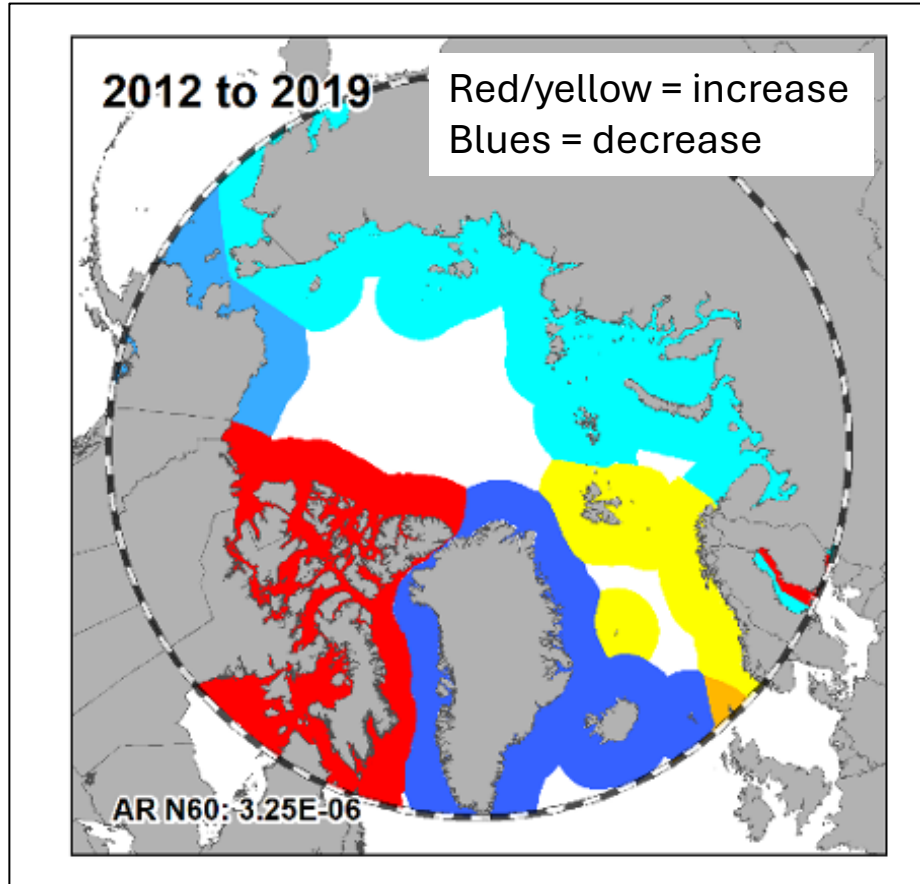
Average Annual KM Sailed (2013-2024) in EEZ of Countries in the Polar Code Area - ships > 300GT – by Vessel Type





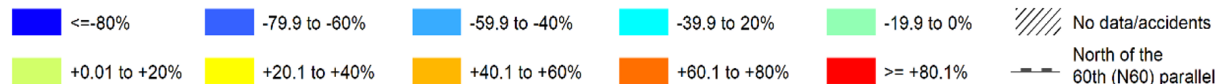
Spatial Shipping Hot Spot Risk Areas

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



High Risk Clusters

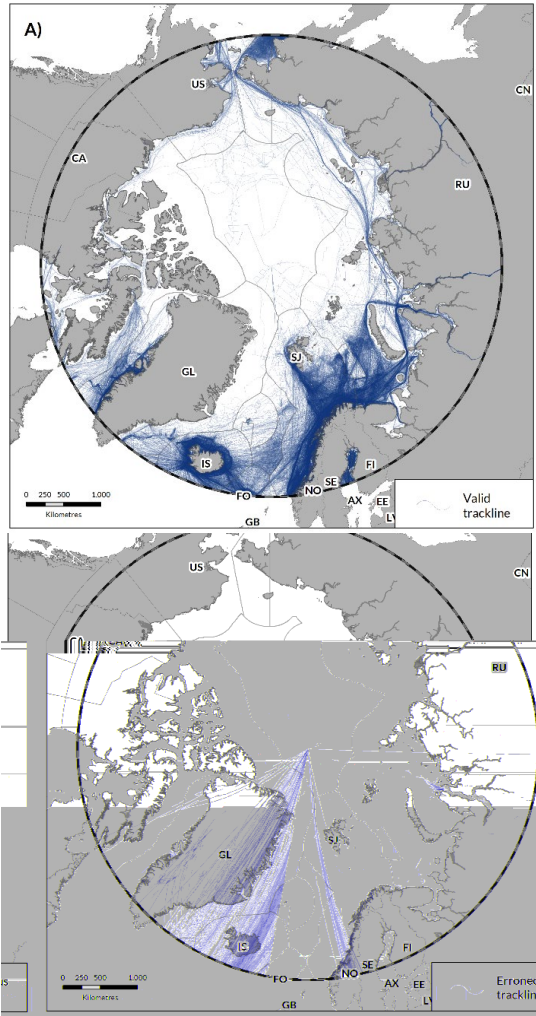
Relative difference from North of 60 2012 to 2019 accident rate for all non-commercial vessels >300 GT



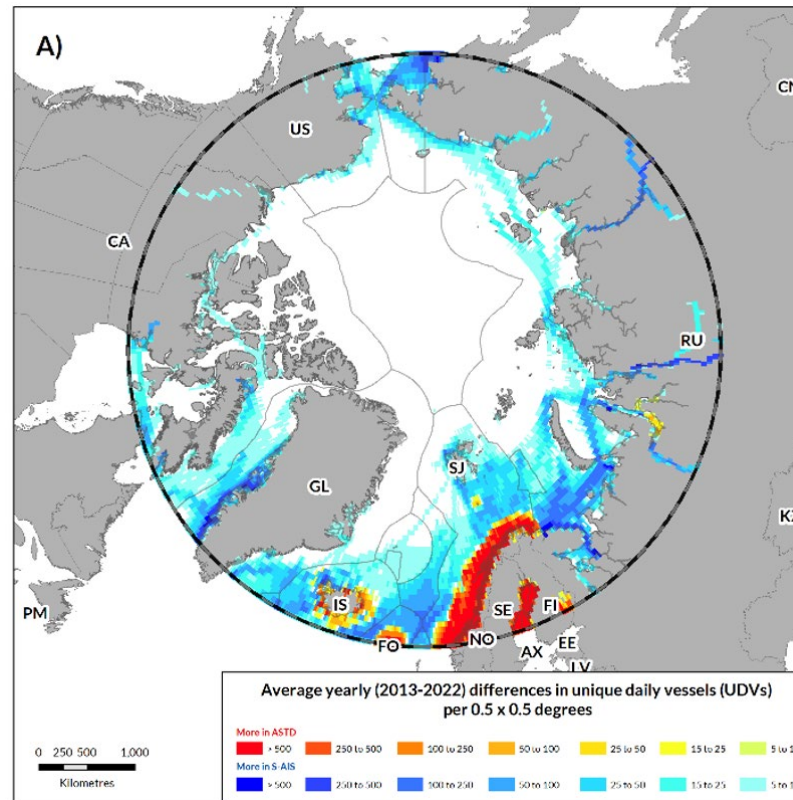
Arctic Shipping Trends

Data Challenges

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

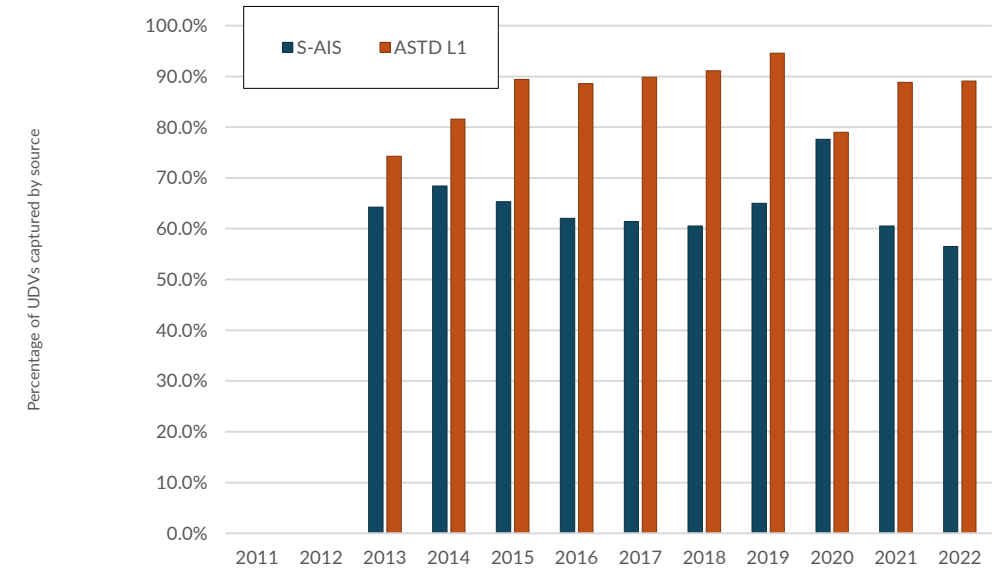


Yearly average (2013-2022) difference in unique daily vessels between ASTD L1 and S-AIS datasets per 0.5 x 0.5-degrees; grid cells in red represent more UDV detected in the ASTD L1 data, while grid cells in blue represent more UDV detected in S-AIS

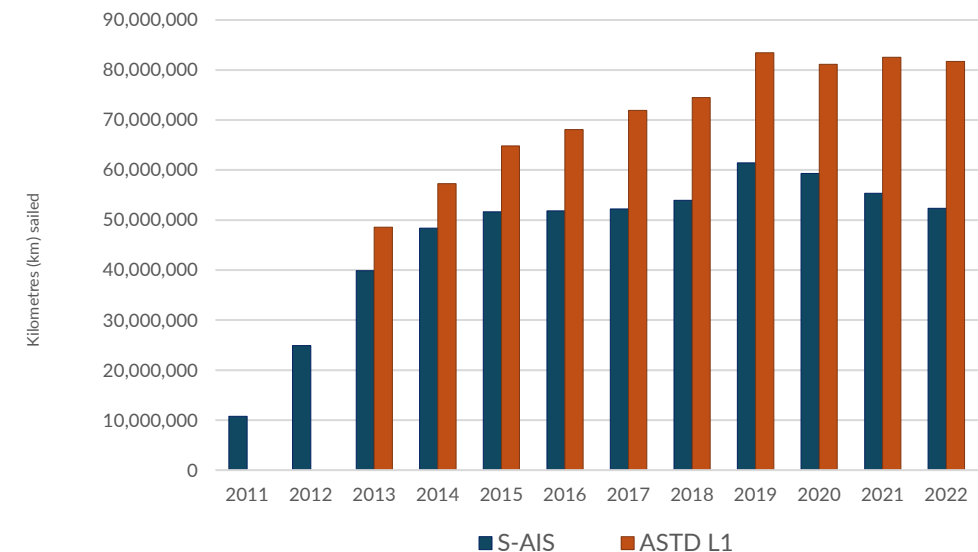


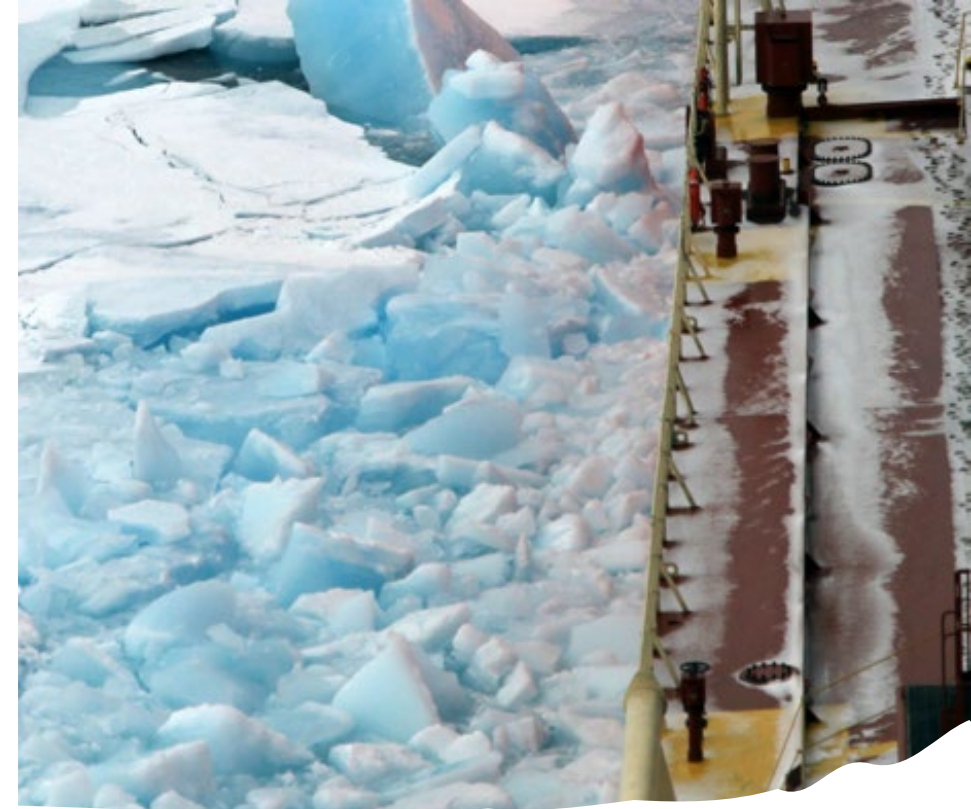
Nicol et al. 2025

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.





Thank you!

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