Supplement of Nat. Hazards Earth Syst. Sci., 24, 2115–2132, 2024
https://doi.org/10.5194/nhess-24-2115-2024-supplement


Natural Hazards and Earth System Sciences
Open Access
EGU

*Supplement of*

# The risk of synoptic-scale Arctic cyclones to shipping

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**Table S1.** Summary of all reported incidents following an intersection between a ship track and an Arctic cyclone's track, where a ship's longitude and latitude coordinate are within 6° (approximately 666 km) of the longitude and latitude coordinate of the cyclone's maximum significant wave height at the same time step, and the significant wave height at the ship tracks coordinates is greater than 2.5m, between 2010 and 2016. Shipping incident data from PAME (2023).

| **Time of Incident (YYYY/MM/DD)** | **Vessel Name** | **Type of Incident** | **Vessel Lost or Damaged** | **Vessel Tonnage (Tonnes)** | **Consequences** |
|---|---|---|---|---|---|
| 30/06/2011 | AP1-88-8701 | Flooding | Damaged | 18 | Marine Casualty |
| 04/07/2011 | Arctic Hawk | Fire | Damaged | 17 | Marine Casualty |
| 22/07/2011 | Barge 210 | Allision | Damaged | 1255 | Marine Casualty |
| 11/09/2011 | Barge 211 | Equipment failure | Damaged | 1016 | Marine Casualty |
| 28/07/2013 | Tony Saganna | Set Adrift | Damaged | 40 | Marine Casualty |
| 12/10/2013 | Beauty Bay | Fire | Damaged | 196 | Marine Casualty |
| 17/11/2013 | AP 1-88-8701 | Equipment failure | Damaged | 18 | Marine Casualty |
| 15/11/2013 | AP 1-88-8701 | Equipment failure | Damaged | 18 | Marine Casualty |
| 23/08/2015 | Capt Frank Moody | Collision | Damaged | 166 | Marine Casualty |
| 02/01/2016 | Arctic Hawk | Loss of electrical power | Damaged | 17 | Marine Casualty |

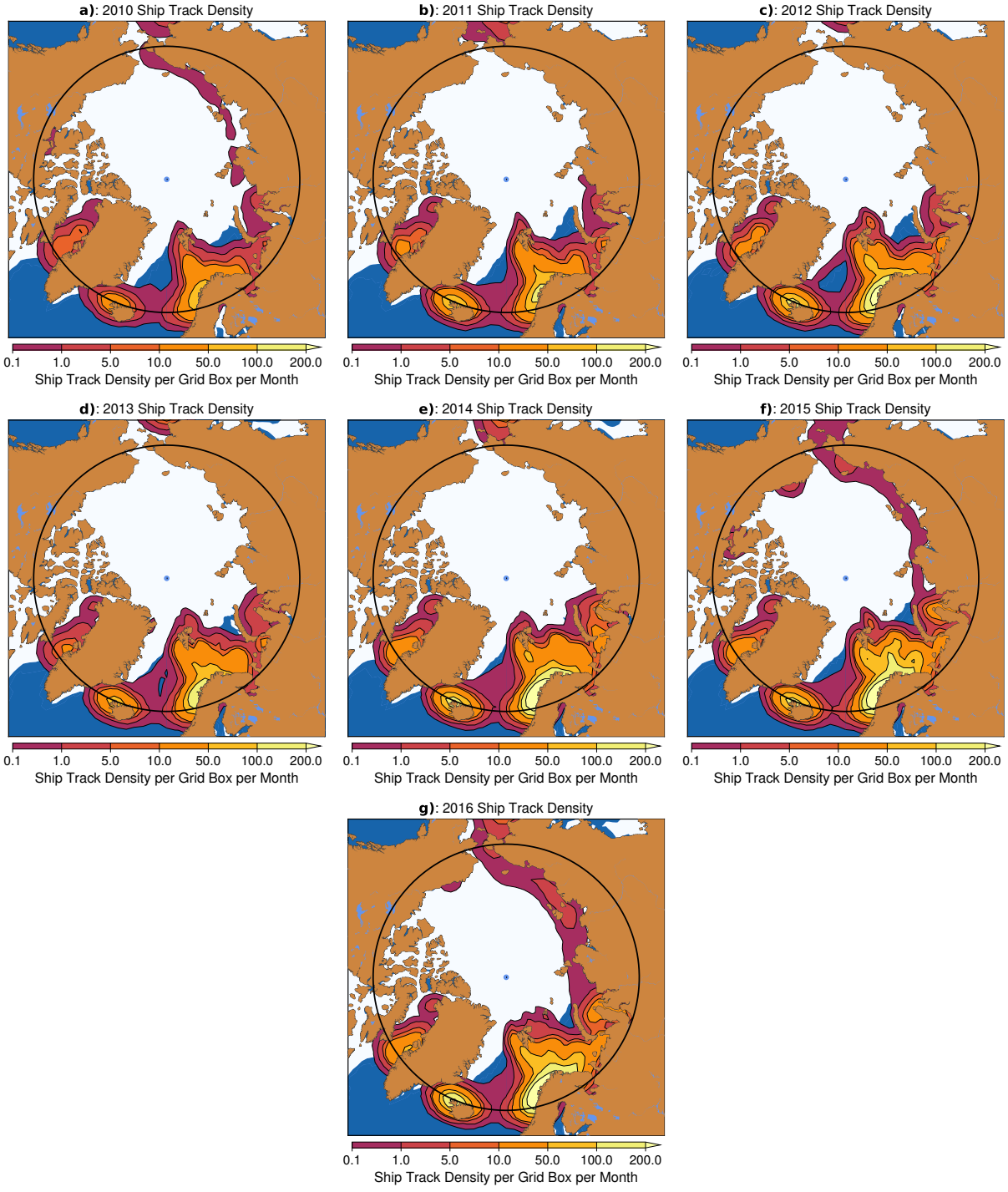


**Figure S1.** Ship track density per year from 2010 to 2016 from the Berkman et al. (2020) Arctic shipping dataset. **(a)** 2010, **(b)** 2011, **(c)** 2012, **(d)** 2013, **(d)** 2014, **(f)** 2015, **(g)** 2016. Mean HadISST Arctic sea ice concentration is also shown in white, where sea ice concentration is greater than 15%. The solid black line indicates the Arctic Circle (66.5°N).

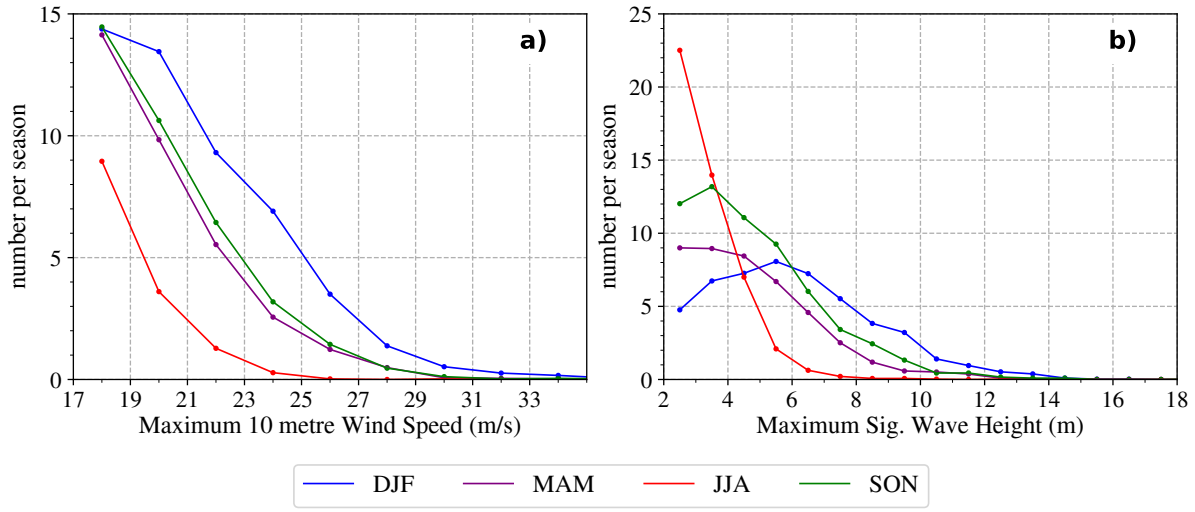


**Figure S2.** The distribution of maximum **a)** 10 metre (m) wind speed and b) significant wave height of Arctic cyclones when they are located in the Arctic. Based on the ERA-5 reanalysis dataset between 1979-2021 in spring (MAM), summer (JJA) and autumn (SON), and 1979/80-2020/21 in winter (DJF). Bin widths are **a)** 2 $ms^{-1}$ for 10 m wind speed and **b)** 1 m for significant wave height. Note the difference in y-axis scales in **a)** and **b)**.

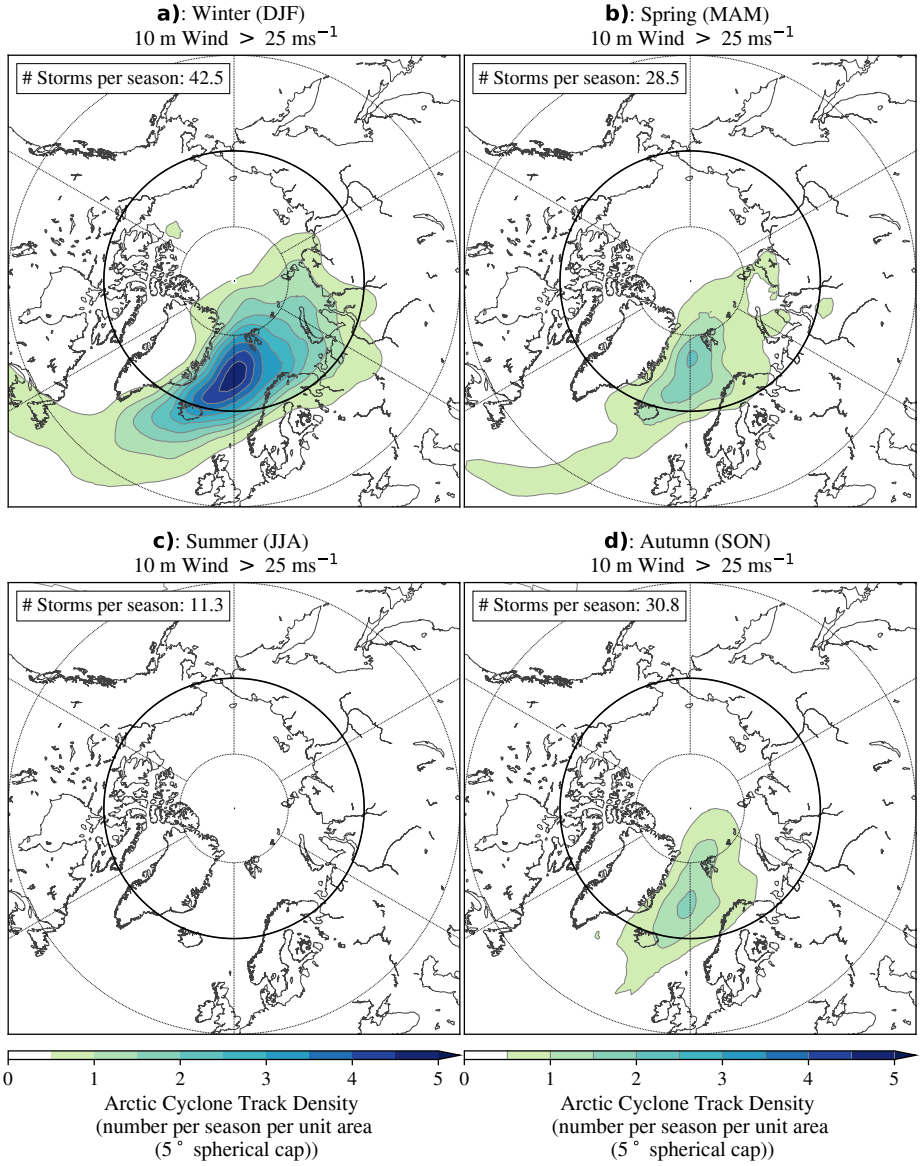


**Figure S3.** Track density per season of **a)** winter (DJF), **b)** spring (MAM), **c)** summer (JJA) and **d)** autumn (SON) Arctic cyclones that have maximum 10 metre (m) wind speeds in the Arctic (66.5°N) greater than 25 ms$^{-1}$. Based on the ERA-5 reanalysis dataset between 1979-2021 in spring (MAM), summer (JJA) and autumn (SON), and 1979/80-2020/21 in winter (DJF). Track density indicates the number of cyclones that travel over a grid point and has units of number per season per unit area (5° spherical cap, approximately $10^6$ km$^2$). Longitudes are shown every 60°E, and latitudes are shown at 80°N, 66.5°N (bold) and 50°N.

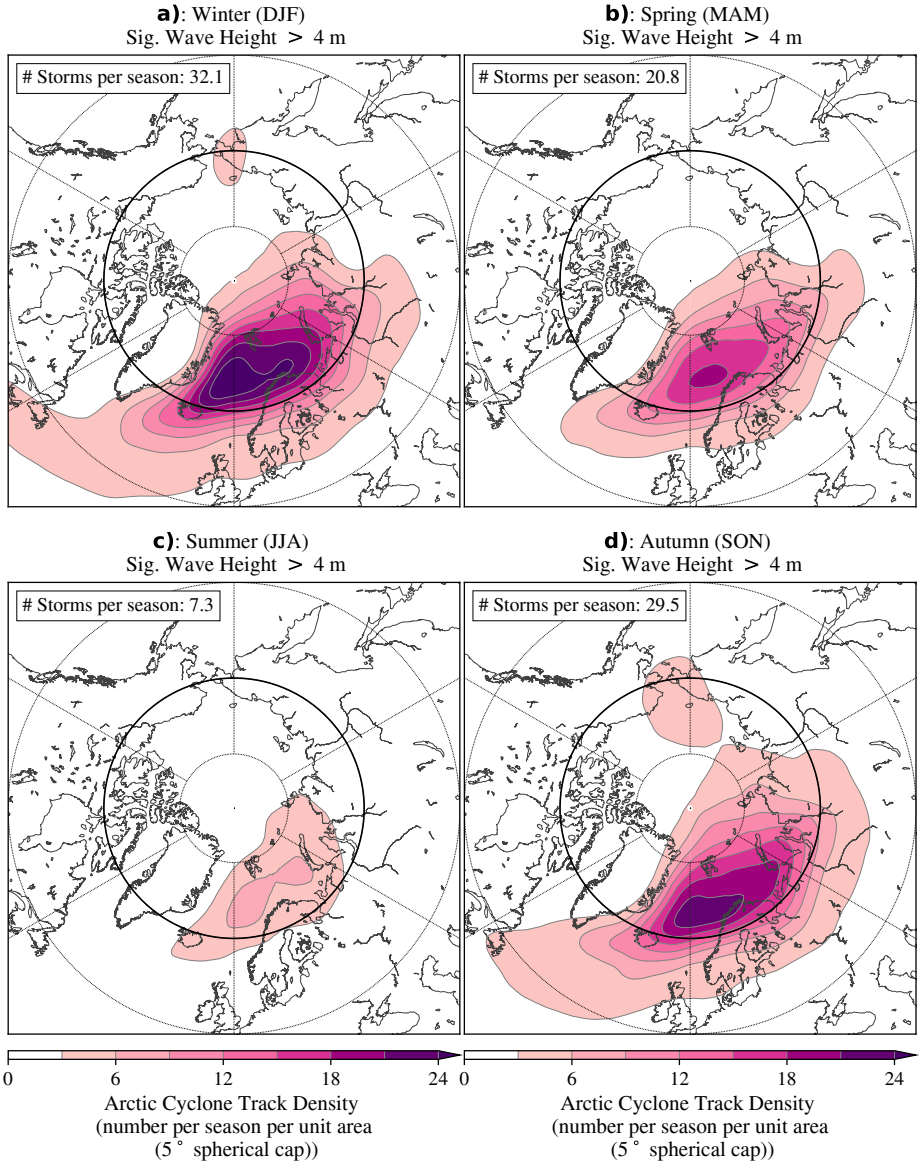


**Figure S4.** Track density per season of **a)** winter (DJF), **b)** spring (MAM), **c)** summer (JJA) and **d)** autumn (SON) Arctic cyclones that have maximum significant wave height including tide and swell in the Arctic (66.5°N) greater than 4 m. Based on the ERA-5 reanalysis dataset between 1979-2021 in spring (MAM), summer (JJA) and autumn (SON), and 1979/80-2020/21 in winter (DJF). Track density indicates the number of cyclones that travel over a grid point and has units of number per season per unit area (5° spherical cap, $\approx 10^6$ km$^2$). Longitudes are shown every 60°E, and latitudes are shown at 80°N, 66.5°N (bold) and 50°N.

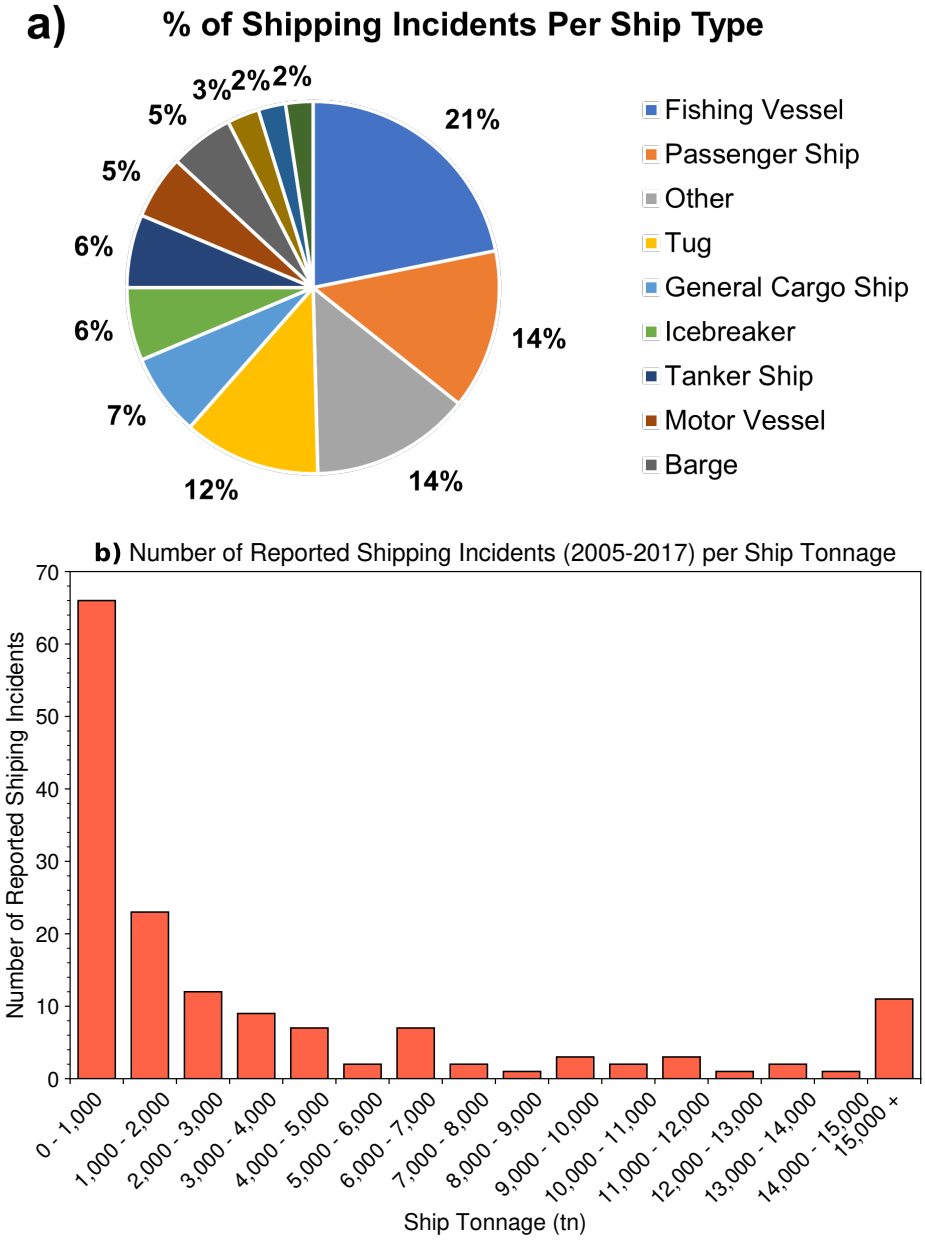


**Figure S5.** Summary of Arctic shipping incidents between 2005 and 2017. **a)** Percentage of reported shipping incidents per ship type. **b)** Number of reported shipping incidents per ship tonnage.

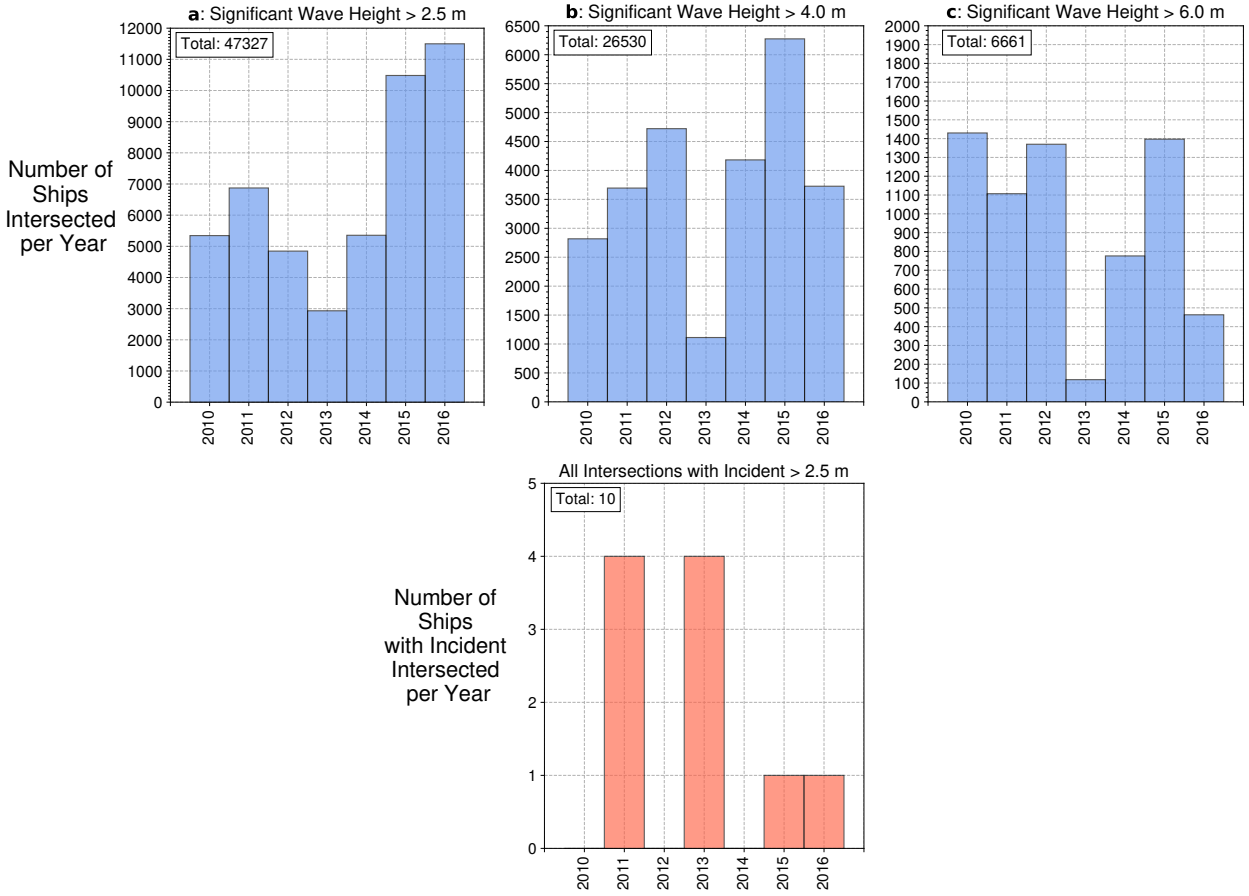


**Figure S6.** The annual number of Arctic ship and cyclone intersections from 2010 to 2016, where a ship's longitude and latitude coordinate are within 6° (approximately 666 km) of the longitude and latitude coordinate of the cyclone's maximum significant wave height at the same time step, and the significant wave height at the ship tracks coordinates is greater than **a)** 2.5m, **b)** 4.0m and **c)** 6.0m. **d)** Shows how many intersections led to a reported shipping incident within 48 hours of an Arctic ship and cyclone intersection. Note: multiple intersections between a cyclone and the same ship track are not double counted.

## References

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