Beach erosion in warmer and stormier Arctic

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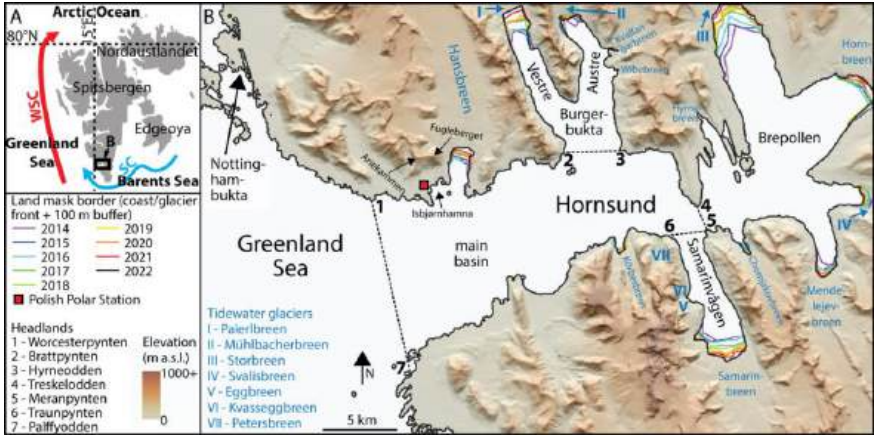
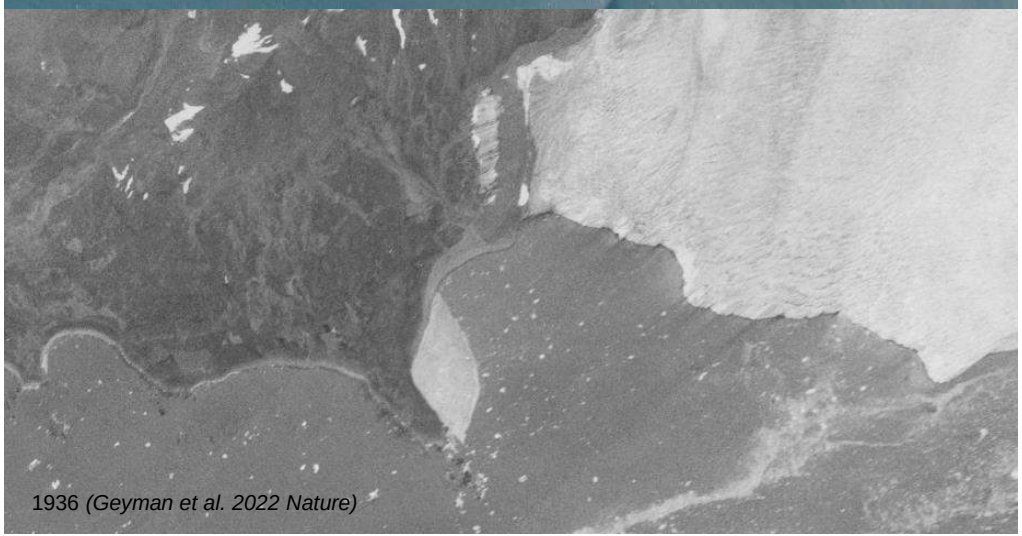
PPS 2018

↓ sea ice + ↑ waves = ↑ coastal hazards

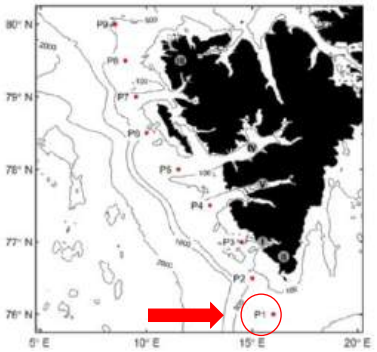
Isbjornhamna (Hornsund, Svalbard)



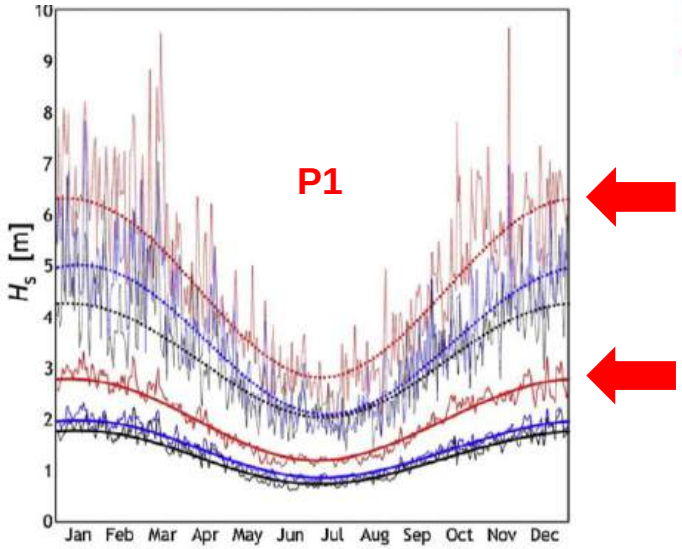
Swirad et al., 2024 The Cryosphere
WCS = West Spitsbergen Current; SC = Sørkapp Current

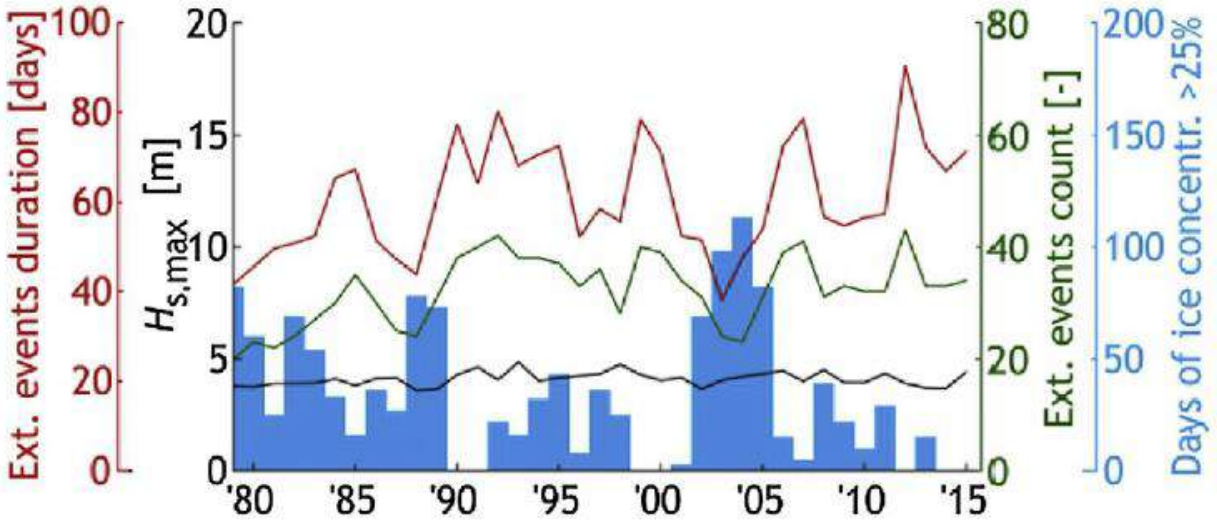


Long-term: waves



ERA Interim
1979-2015



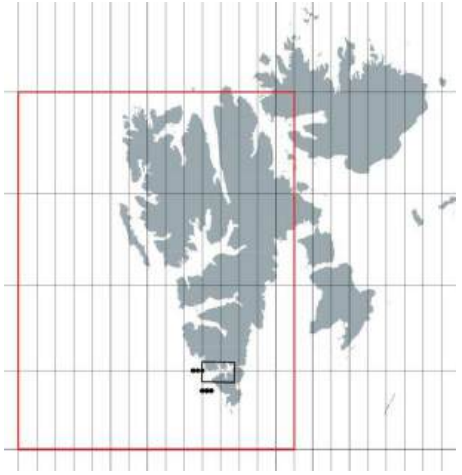


Increasing storm

- Frequency by 0.2 storms/yr (average 35 storms)
- Duration by 0.4 days/yr (average 60 days)

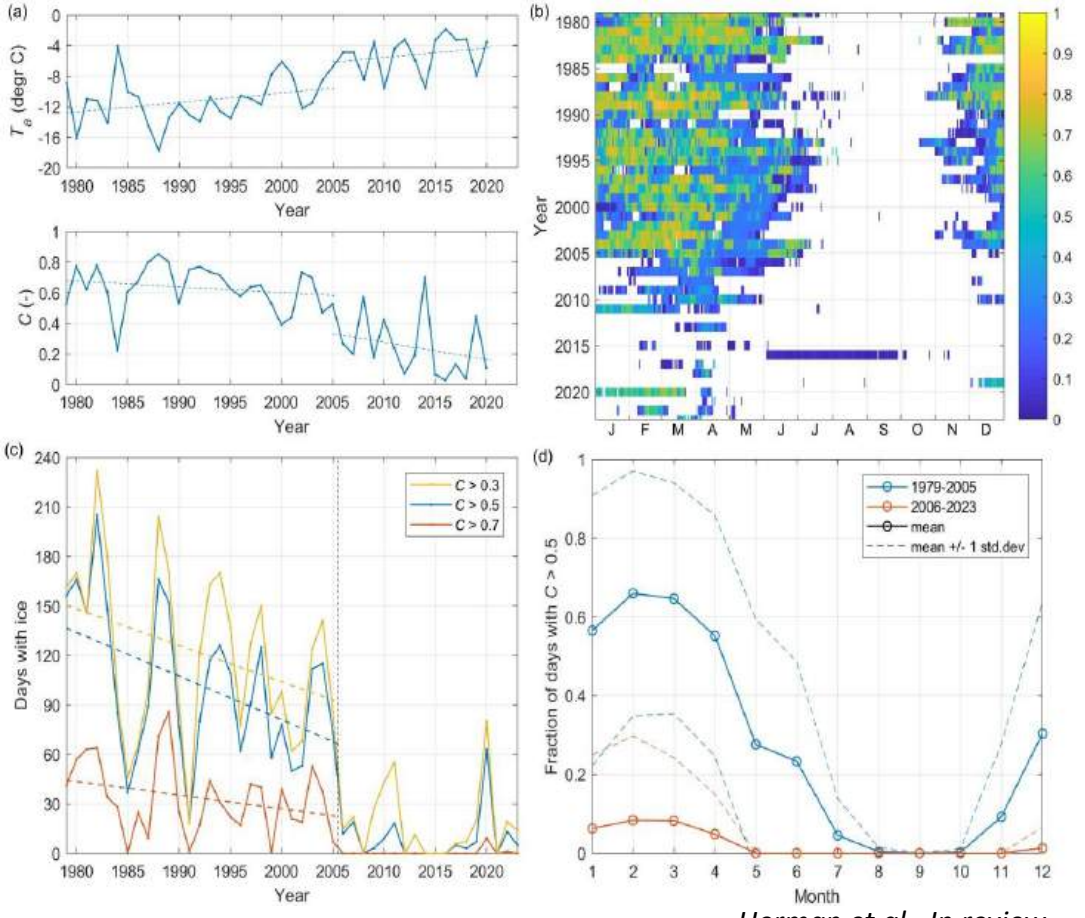
Wojtysiak et al., 2018 Oceanologia

Long-term: sea ice



ERA-5
1979-2023

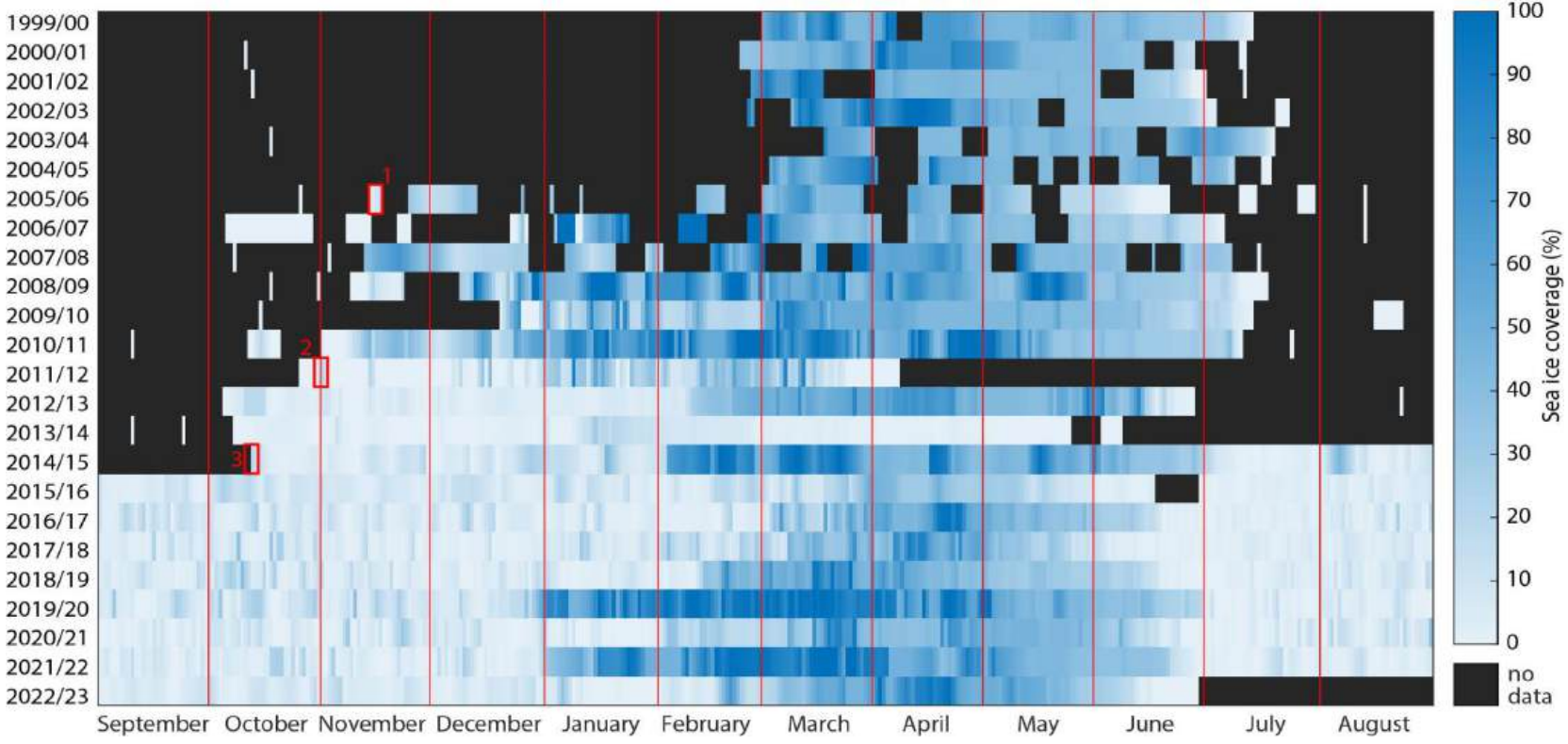
C = sea ice concentration



Herman et al., In review

Long-term: fjord ice

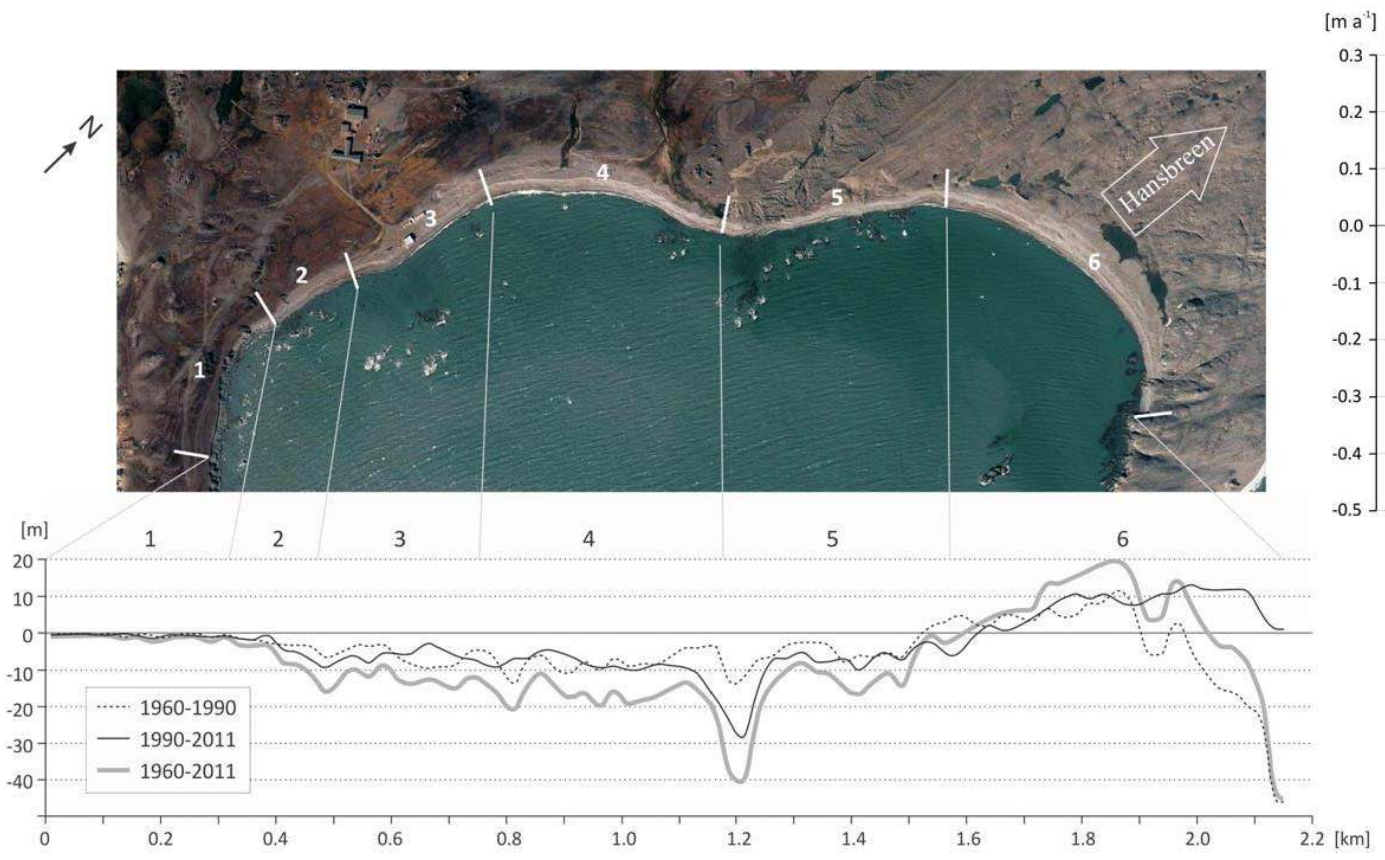
Sentinel 2, 2020-04-26

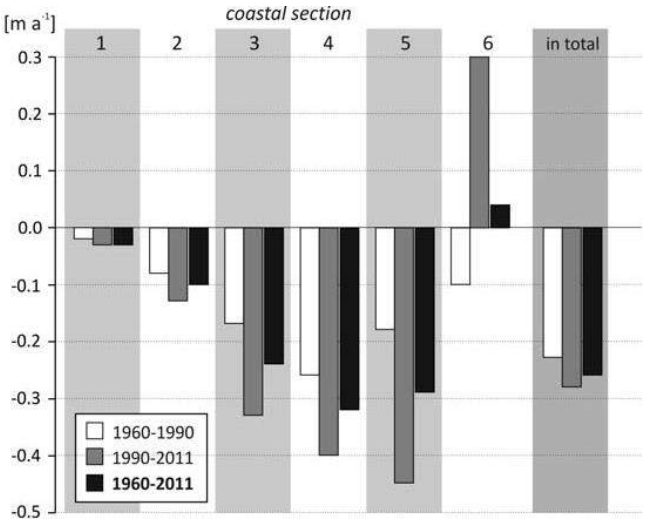


1: Envisat ASAR, 2- RADARSAT-2, 3: Sentinel-1

Muckenhuber et al., 2016 The Cryosphere
Swirad et al., 2024 The Cryosphere

Long-term: coastal change



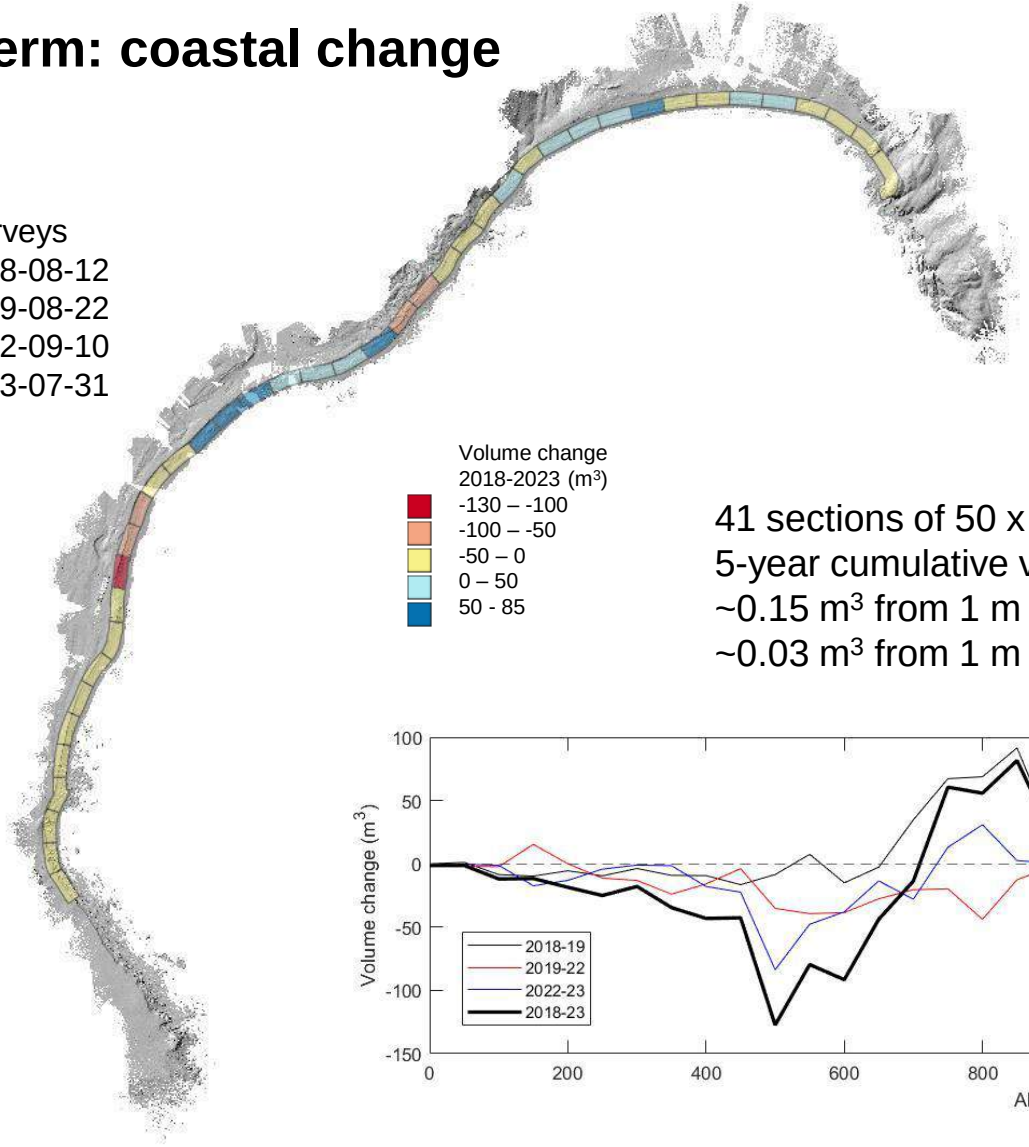


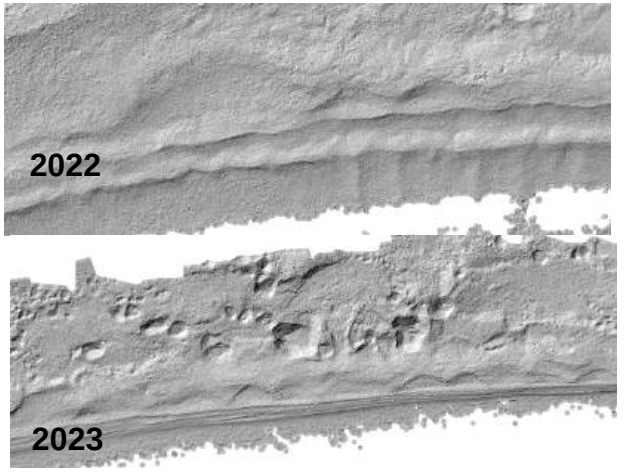
51-year
shoreline retreat 13.1 m
rate 0.26 m/yr

Zagórski et al., 2015 Polish Polar Res.

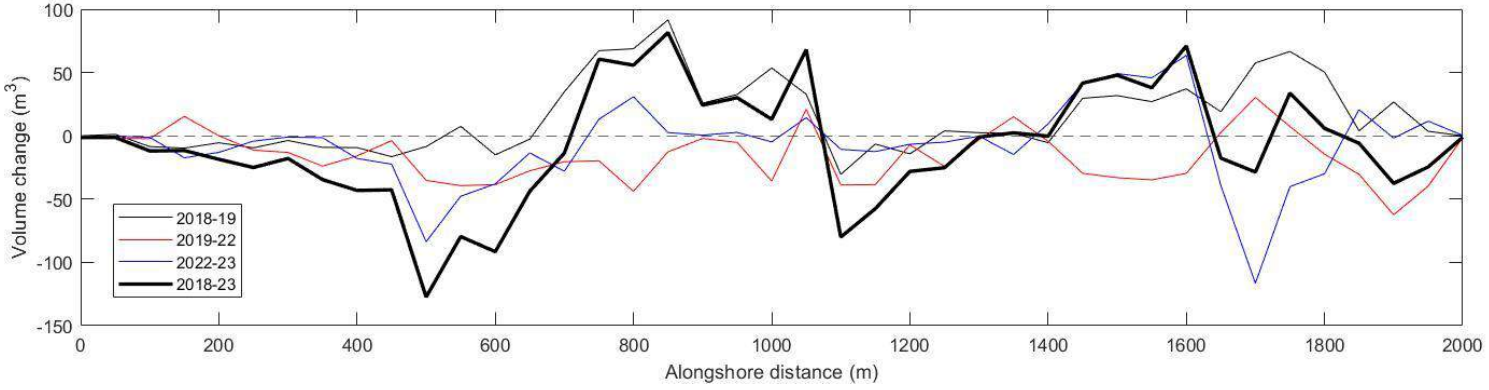
Short-term: coastal change

UAV surveys
- 2018-08-12
- 2019-08-22
- 2022-09-10
- 2023-07-31

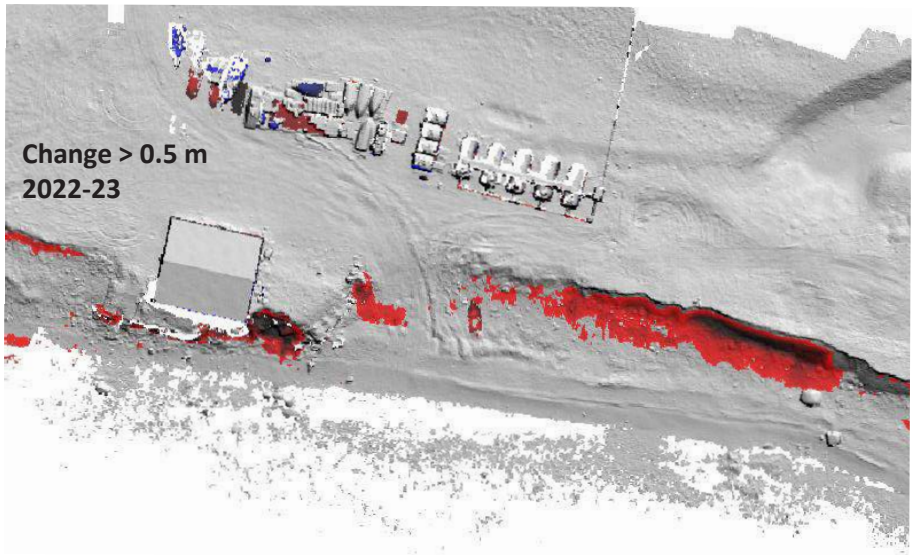




41 sections of 50 x 20 m
5-year cumulative volume loss of ~300 m^3
~0.15 m^3 from 1 m alongshore
~0.03 m^3 from 1 m alongshore per year



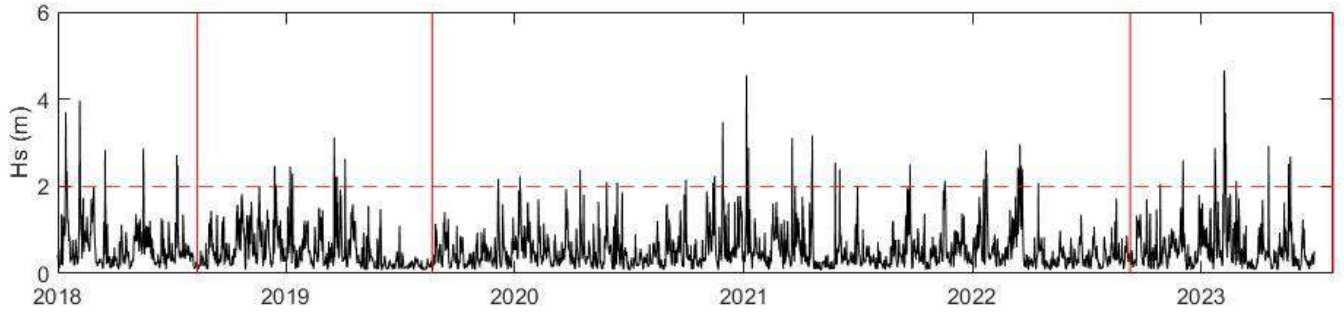
Short-term: coastal change

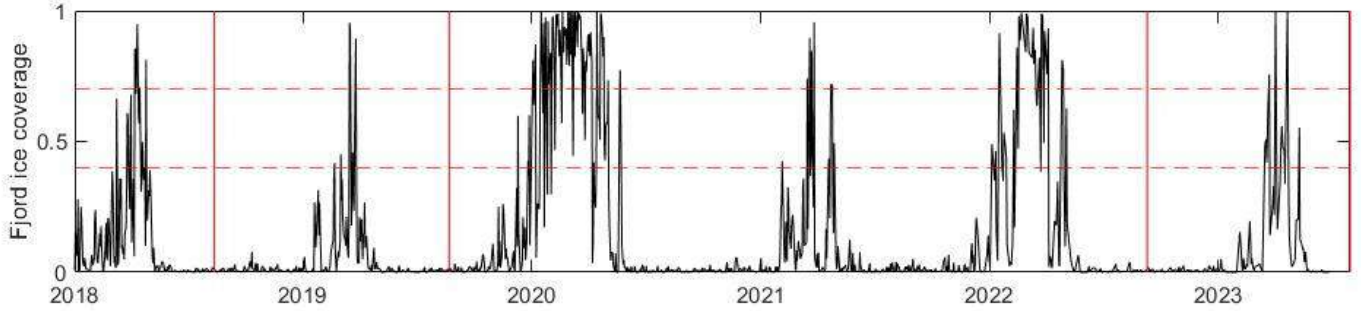


Facebook 16.08.2023

„Every year the sea takes away a bit of the shore from us, so there is a risk that Banachowka, the hall where all the floating equipment is stored, will collapse. Therefore, with the entire team and additional help from the scientists present at the Station, we carried out an action to strengthen the shore."

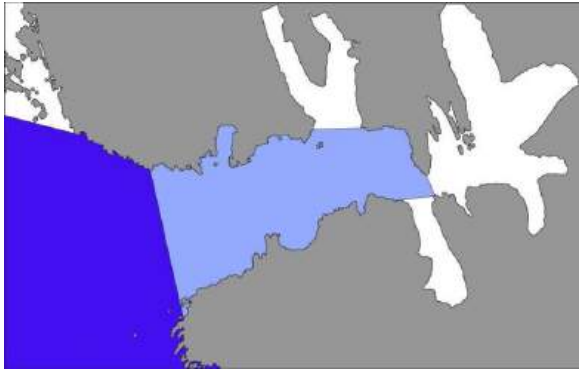
Short-term: waves & fjord ice





METNO: 40-70% open drift ice, >70% close drift ice + fast ice

Herman et al., 2019 Estuar. Coast. Shelf Sci.
Swirad et al., 2023 ESSD



Swirad et al., 2024 The Cryosphere

Short-term: summary

	Length (yr)	Volume change (m^3/yr)	Volume change @PPS (m^3/yr)	Mean Hs (m)	% year with Hs > 2 m	Months with fjord ice cover > 40% per year	Months with fjord ice cover > 70% per year
2018-2019	1.03	605	-8.2	0.54	0.9	0.3	0.2
2019-2022	3.05	-214	-11.5	0.53	1.2	2.2	1.5
2022-2023	0.89	-301	-94.0	0.59	2.2	1.0	0.2

Take-home messages

Decreasing **sea ice** extent and duration and increasing **storminess** contribute to increasing **coastal hazards**. In Hornsund we observe:

- Increasing storminess at the decadal-scale
- Regime shift in sea ice conditions after 2005
- Great inter-annual variability in fjord ice conditions
- Acceleration in beach erosion, focused in hotspots

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Hornsund nearshore and coastal references

- **Herman et al. 2019**. Wind wave variability in Hornsund fjord, west Spitsbergen. Estuarine, Coastal and Shelf Sciences 217: 96-109. https://doi.org/10.1016/j.ecss.2018.11.001
- **Herman et al. In review**. Increased exposure of the shores of Hornsund (Svalbard) to wave action due to a rapid shift in sea ice conditions. Elementa: Science of the Anthropocene. http://dx.doi.org/10.13140/RG.2.2.13028.39046
- **Muckenhuber et al. 2016**. Sea ice cover in Isfjorden and Hornsund, Svalbard (2000–2014) from remote sensing data. The Cryosphere 10: 149-158. https://doi.org/10.5194/tc-10-149-2016
- **Swirad et al. 2023**. Wind wave and water level dataset for Hornsund, Svalbard (2013–2021). Earth System Science Data 15, 2623-2633. https://doi.org/10.5194/essd-15-2623-2023
- **Swirad et al. 2024**. Extent, duration and timing of the sea ice cover in Hornsund, Svalbard, from 2014-2023. The Cryosphere. https://doi.org/10.5194/tc-18-895-2024
- **Wojtysiak et al. 2018**. Wind wave climate of west Spitsbergen: seasonal variability and extreme events. Oceanologia 60(3): 331-343. https://doi.org/10.1016/j.oceano.2018.01.002
- **Zagórski et al. 2015**. Multidecadal (1960-2011) shoreline changes in Isbjornhamna (Hornsund, Svalbard). Polish Polar Research 36(4): 369-390.

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