Sea Ice and Ocean Evolution of the NORTHERN CANADIAN ARCTIC ARCHIPELAGO SHELF

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BACKGROUND

- The Arctic is warming ***four times*** the global average due to Arctic Amplification driven by ice-albedo feedbacks (Rantanen et al, 2022).
- Sea ice is vital to the Arctic climate system, as well as ice-dependent species and northern communities.
- Summer sea ice is decreasing **12.8%** each decade, with **ice-free** summers expected by the end of the century.
- The Arctic Ocean's mixed layer is warming 0.5°C per decade (IPCC, 2019).
- The north Canadian Arctic Archipelago (CAA) shelf is expected to have the last summer sea ice in the Arctic.
- Observations are difficult to obtain in the remote north, so models must be used to understand the processes driving the rapidly changing Arctic.

MODEL

NEMO
Nucleus for European Modelling of the Ocean

ANHA
Arctic and Northern Hemisphere Atlantic

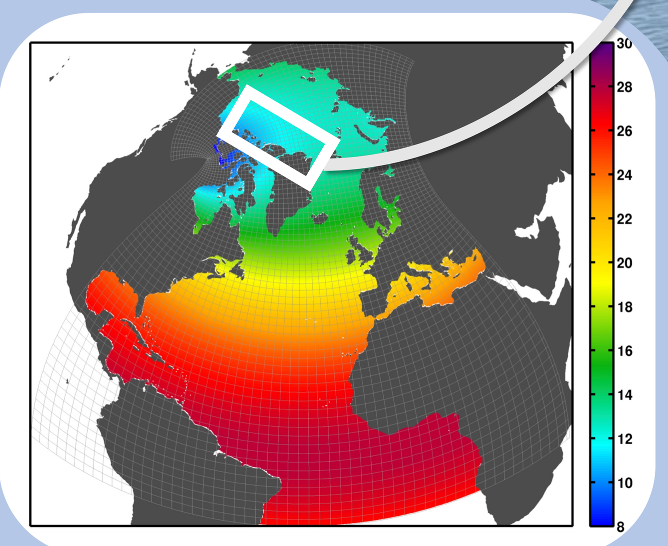
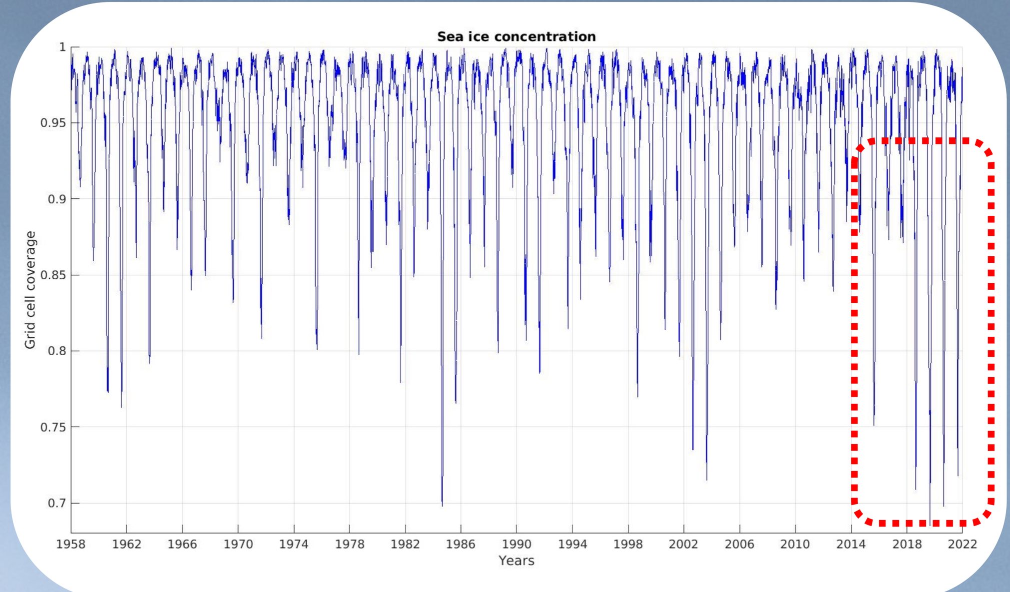


Figure 1: ANHA4 configuration. Coloured to show horizontal resolution (km).

- 3D coupled model
  - Ocean, sea ice, and biogeochemical components
- ¼° resolution
- Atmospheric forcing: interannual reanalysis data
  - CORE and NCEP
- LIM2 sea ice model
- 60 year hindcast 1958-2021

RESULTS



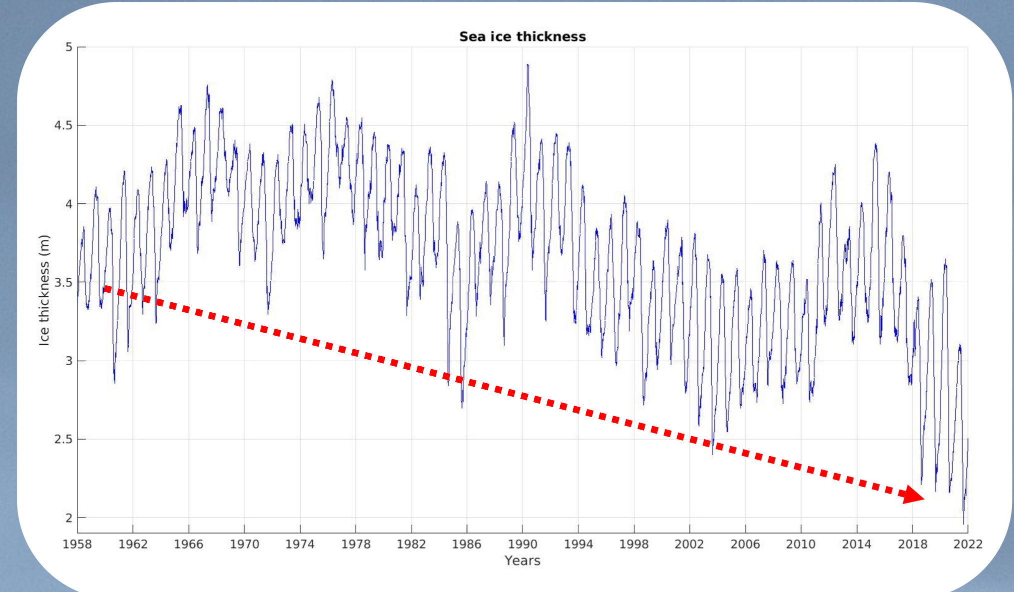


Figure 2a,b: Decreasing sea ice concentration and thickness. Consistent with a warming Arctic. Increasing frequency of anomalies.

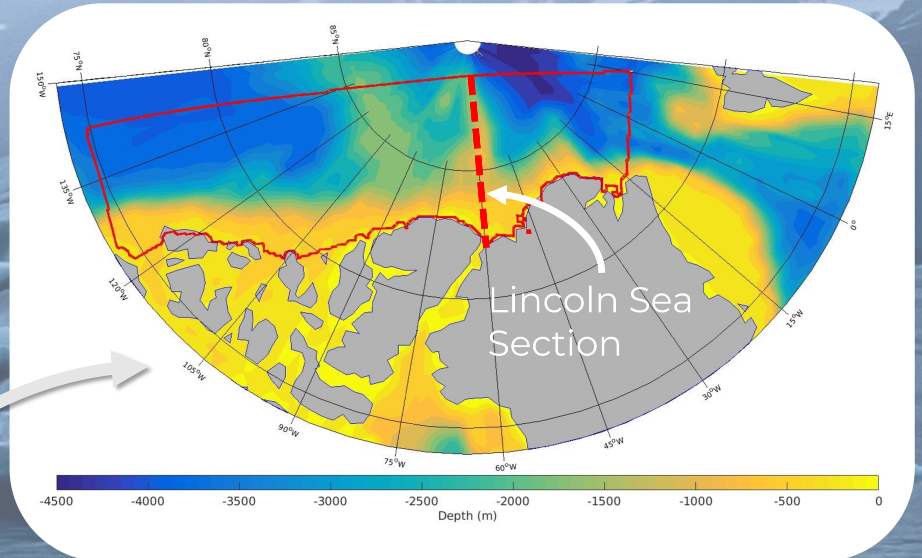
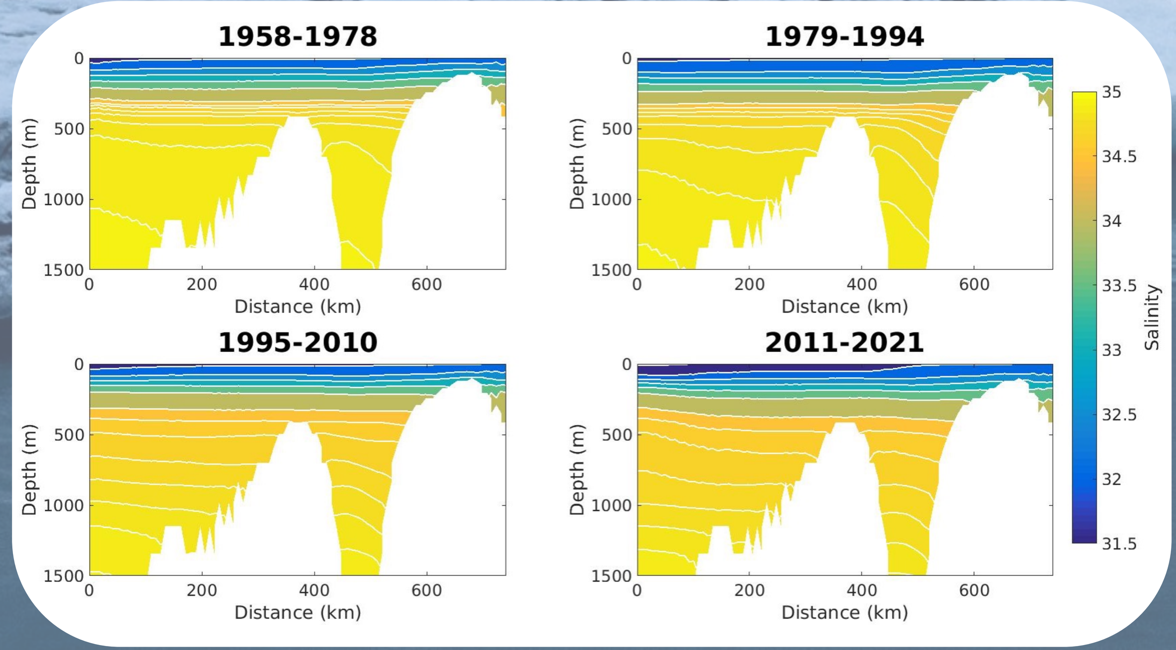


Figure 3: Northern CAA shelf region and bathymetry.

Increased heat
↓
Greater ice melt
↓
More freshwater

Figure 4a: Lincoln Sea cross section salinity.

- Increasing surface freshwater layer – ice melt.
- Salinity contours pushed down by freshwater.
- Decreasing halocline gradient.



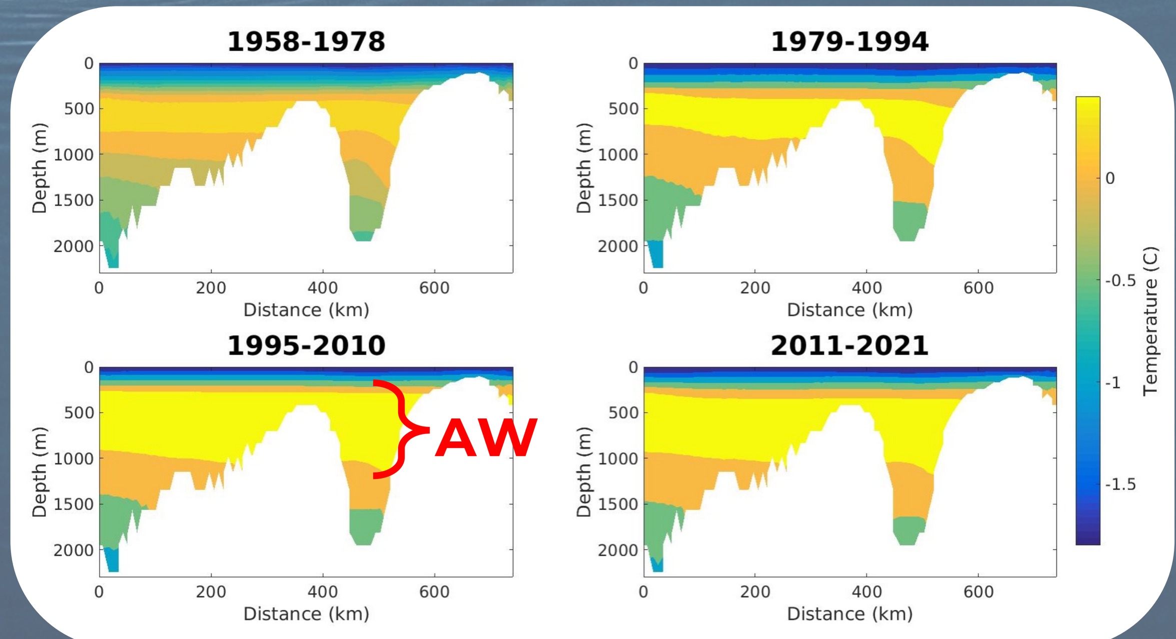
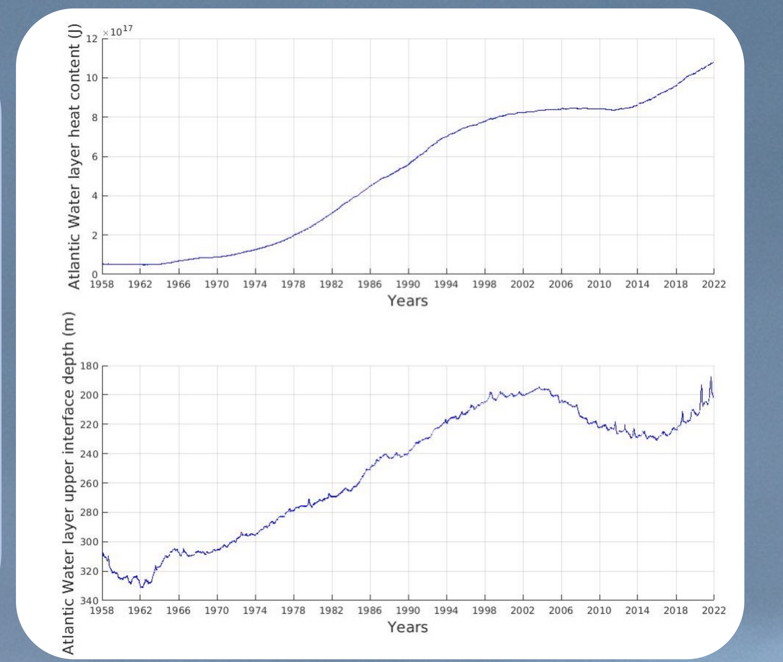


Figure 4b: Lincoln cross section temperature.

- Warming and thickening of the mid-depth **Atlantic Water (AW) layer**.
- Warm AW layer edging closer to cold surface waters.

Figure 5a,b: AW heat content and upper interface depth

- AW is **gaining heat** over the simulation run – more transport?
- AW is getting closer to the surface – might it be getting up on the shelf and melting ice?
- Dip in 2010s – disruption of transport?



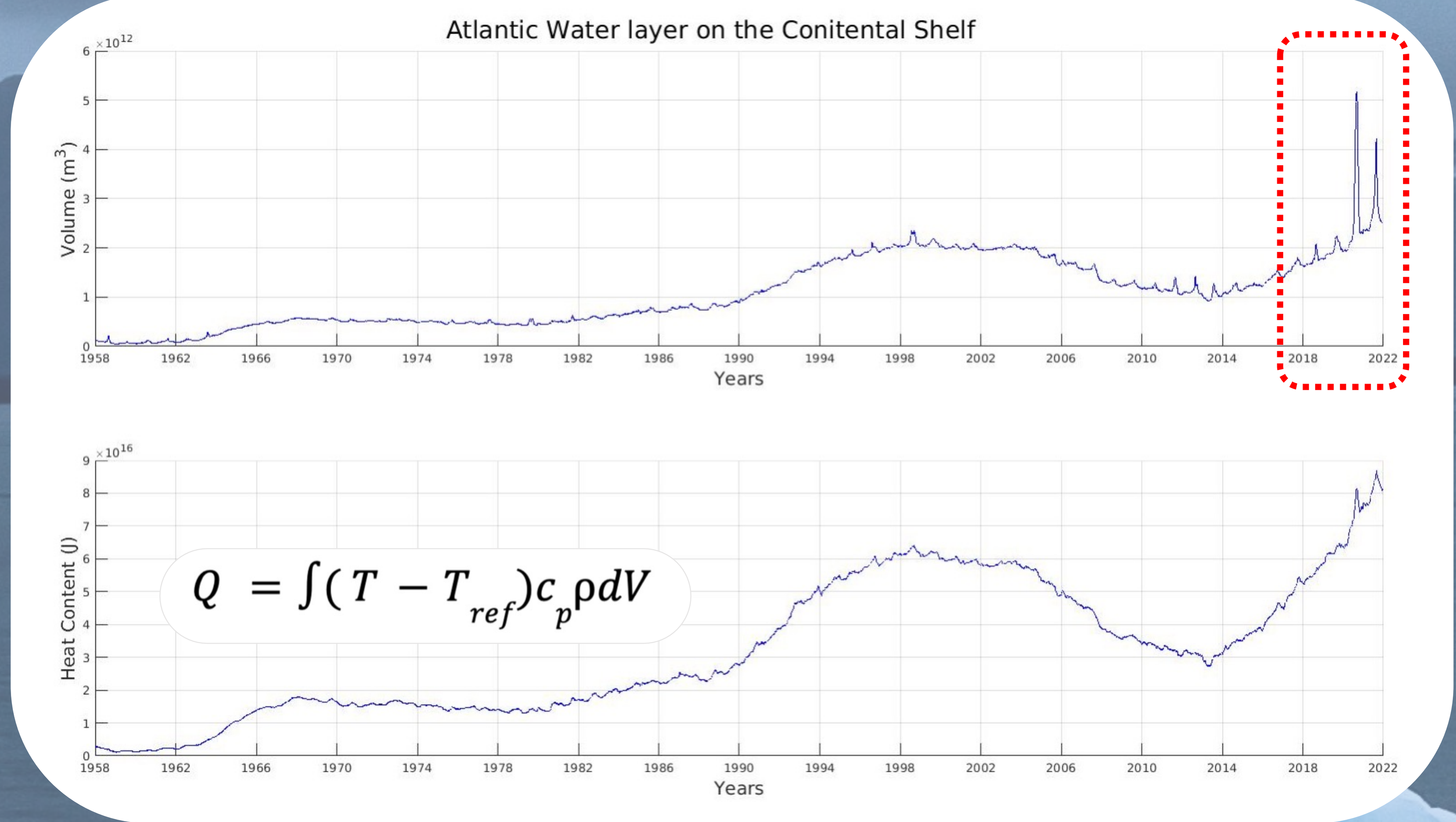


Figure 6a,b: AW volume and heat content on the continental shelf

- Atlantic water is increasing transport onto the shelf over time
  - Large extrusions 2018-2021.
- **AW excursions** onto shelf may relate to **increased sea ice anomalies** after 2018 (Fig 2a,b).

KEY POINTS

- Model demonstrates the expected changes of a warming Arctic … **sparser and thinner sea ice, warmer and fresher ocean**.
- Prominent AW layer in vertical cross sections.
- AW **volume and heat content** is increasing in the Arctic basin and is protruding upwards near the surface and onto the continental shelf.
- Heat from AW may be **contributing to ice melt**, especially in the most recent years.
- Is this reflected in observations?
- What does this mean for *future ice loss and ocean warming*?

References

Rantanen, M. et al. (2022). The Arctic has warmed nearly four times faster than the globe since 1979. *Communications Earth & Environment* 3, 168. doi:10.1038/s43247-022-00498-3

IPCC (Intergovernmental Panel on Climate Change). (2019). *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*, 203-320. doi:10.1017/9781009157964

Background image: https://rare-gallery.com/106253-sea-winter-4k-hd-wallpaper-ice.htm