Exchanges of volume, heat and freshwater through the Canadian Arctic Archipelago: A numerical study

Nathan Grivault, Xianmin Hu and Paul G. Myers
Earth and Atmospheric Sciences, University of Alberta, Canada
(grivault@ualberta.ca)

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Introduction

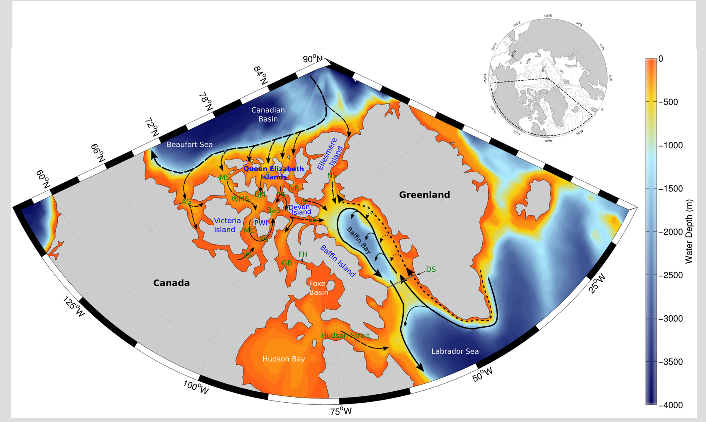

Fig. 1: Schematic representation of the circulation in the Canadian Arctic

The Canadian Arctic Archipelago (CAA) is a tangle of shallow basins interlinked by narrows straits. It is the main pathway of liquid freshwater from the Arctic Ocean to the North Atlantic. The mean through flow is controlled by the geostrophic gradient between the Beaufort Gyre and Baffin Bay. It also receives runoff from several rivers and snowmelt from the different islands that composes the archipelago.

The aims of this study are:

- Evaluate the flow pathways through the CAA for the recent past and over the second part of the 20th century.
- Evaluate the volume, heat and freshwater transports across the CAA's majors straits.

Method

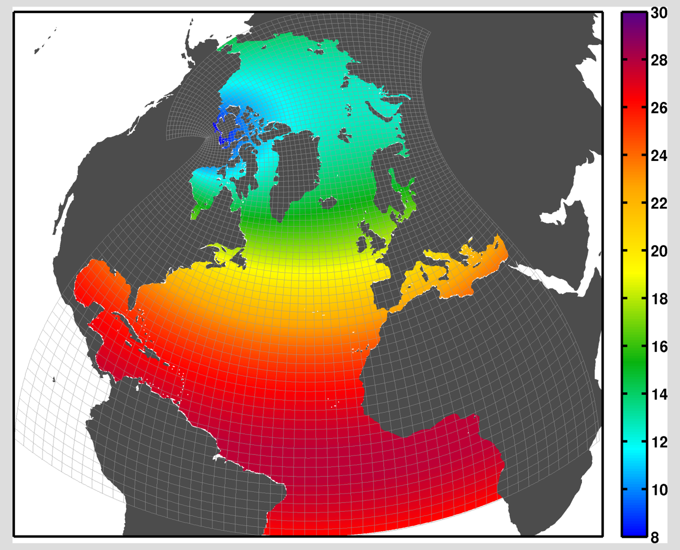

Fig. 2: Representation of the domain used with horizontal resolution (in km)

For this study we used a regional configuration (1/4°) of the coupled ice-ocean numerical model NEMO. We consider a short term hindcast experiment (2002-2014) driven by the latest version of the high temporal and spatial resolution inter-annual atmospheric forcing from Environment Canada and a long-term hindcast experiment (1958-2008) based upon the CORE-II atmospheric forcing.

Experiment	Integration Period	Radiation fluxes	Turbulent Fluxes	Precipitation	Restoring	Data Assimilation
Recent past	2004-2014	CGRF[1]	CGRF[1]	CGRF[1]	No	No
Long term	1958-2008	CORE-II[2]	CORE-II[2]	CORE-II[2]	No	No

1: Canadian Meteorological Centre's (CMC) global deterministic prediction system (GDPS) Reforcasts (CGRF).
2: Coordinated Ocean-ice Reference Experiments II.

Recent evolution (2002-2014)

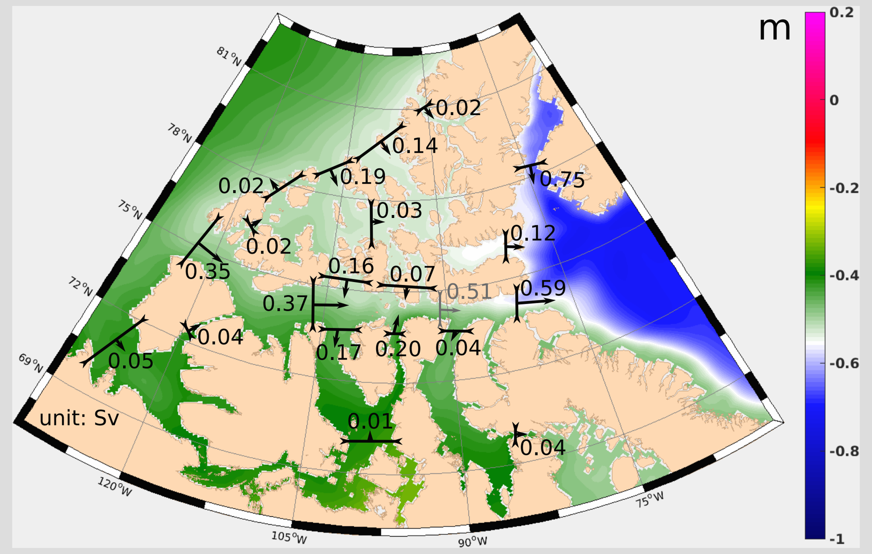

Fig. 3: SSH (colour) and volume transport averaged over the 2002-2014 period. Grey arrow represents the observed mean transport over 1999-2010.

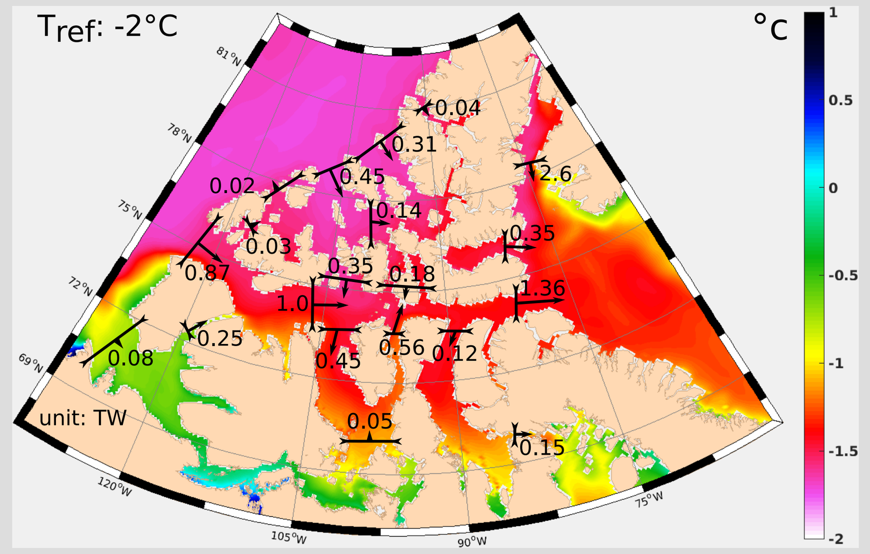

Fig. 4: Top 50m averaged temperature (colour) and heat transport averaged over the 2002-2014 period.

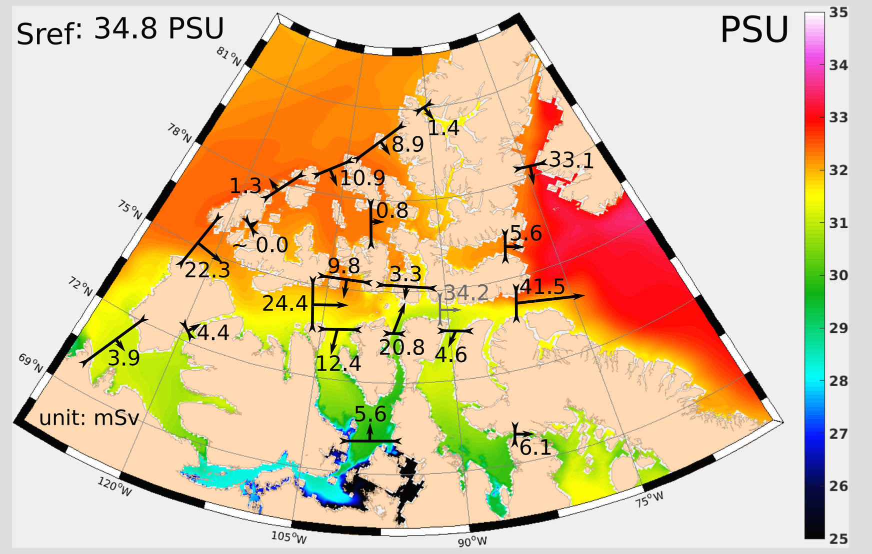

Fig. 5: Top 50m averaged salinity (colour) and freshwater transport averaged over the 2002-2014 period. Grey arrow represents the observed mean transport over 1999-2010.

Long term evolution (1958-2008)

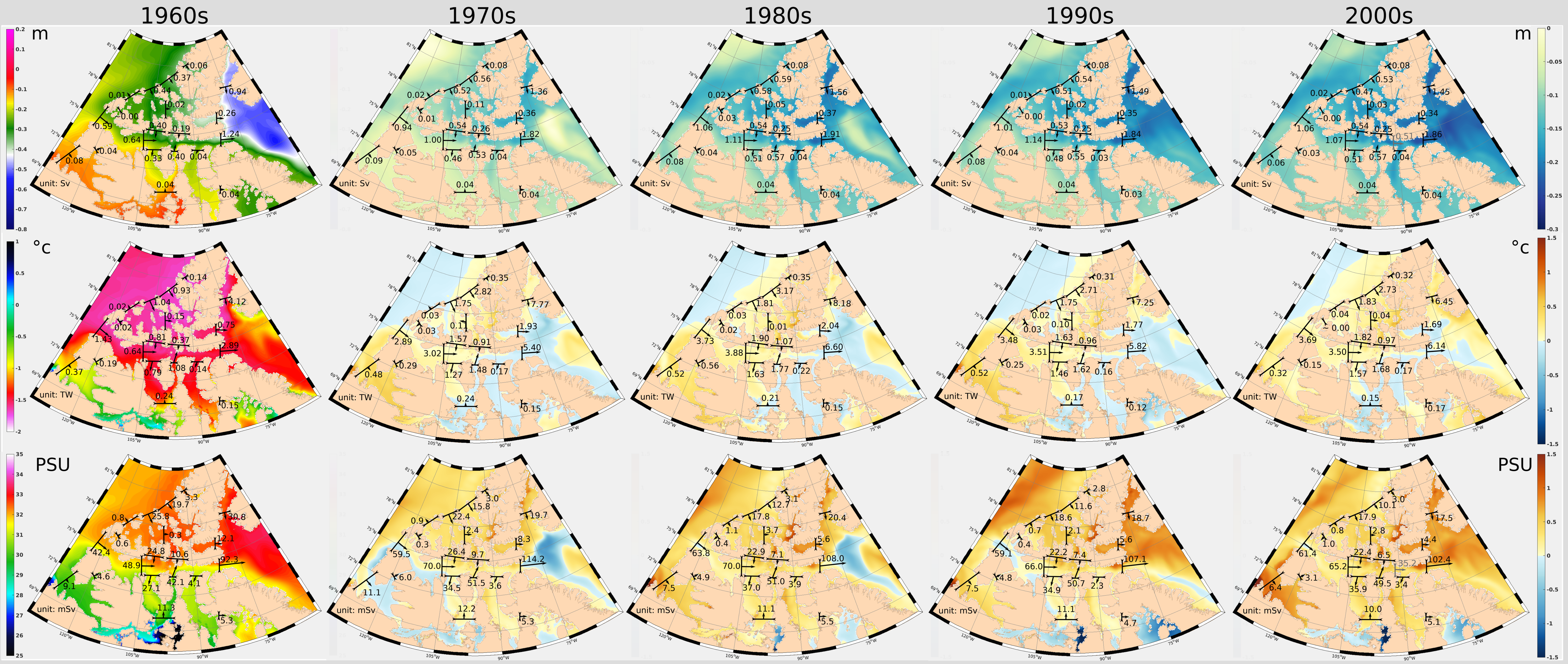

Fig. 6: SSH (top), top 50m averaged temperature (middle) and top 50m averaged salinity (bottom) average during the 1960s (first column) and the anomaly from the 1960s (others columns). The arrows represent respectively the volume, heat and freshwater transports averaged over the decade. The grey arrows represent the observed mean transport over 2000-2009.

Model evaluation

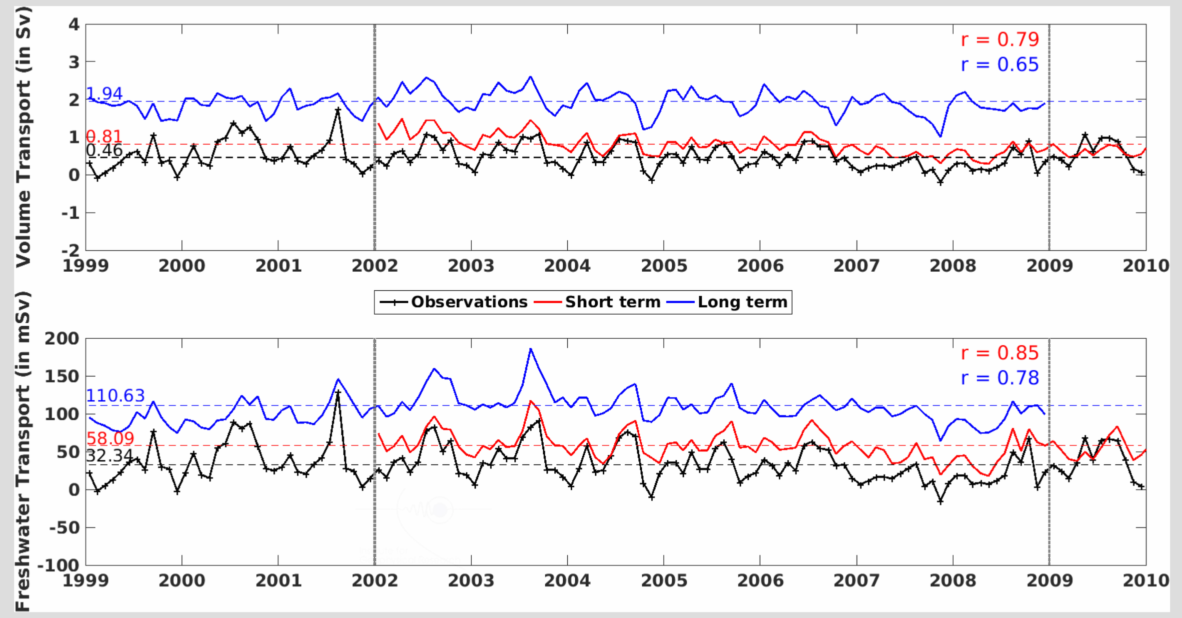

Fig. 8: Volume and freshwater transport at Barrow Strait (grey lines on Fig. 3). Dashed lines represent the averaged transport between 2002 and 2009 for observations (black), short term (red) and long term (blue) experiment. The correlation functions are computed between 2002 and 2009.

Conclusions

- The transport variability is well correlated with observations at Barrow Strait.
- About half of the transport goes through the Queen Elizabeth Islands (QEI), about 2/3 flows to the Parry Channel, 1/3 flows directly to Baffin Bay. Amundsen Gulf inflow represents less than 1/10 of the total inflow.
- The volume and heat transports through the CAA increase significantly between the 1960s and 1970s while the freshwater decreases because of the higher salinity.
- The transport through the QEI might be controlled by the evolution of the salinity at the Norwegian Bay and Jones Sound.

Acknowledgements

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