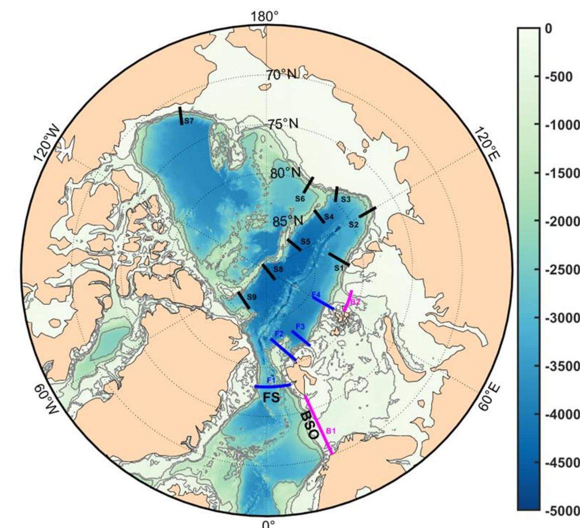
Modelling the Atlantic Water Inflow at the Gateways of the Arctic Ocean with Two Different Simulations

Chuanshuai Fu & Paul G. Myers

Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB, Canada (email: chuanshu@ualberta.ca)

Ⅰ. Introduction

- The encroachment of the warm and saline Atlantic Water (AW) has exerted great influence on the {thermo}dynamics of the Arctic Ocean
- The AW enters the Arctic Ocean through two gateways: Fram Strait and the Barents Sea Opening (BSO)



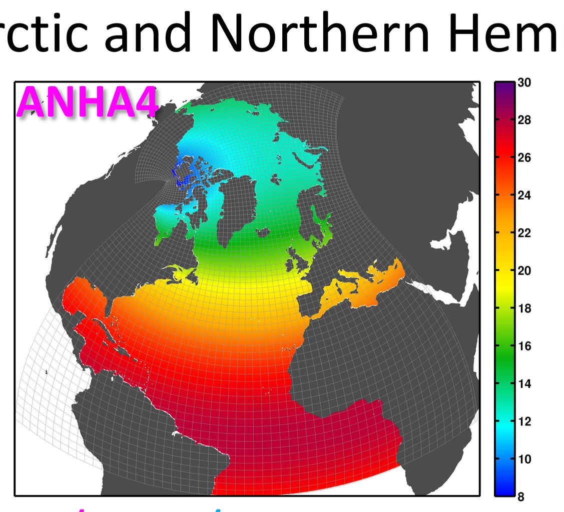
- The relative strength of these two AW branches dominates the oceanic heat contribution to the Arctic Ocean.

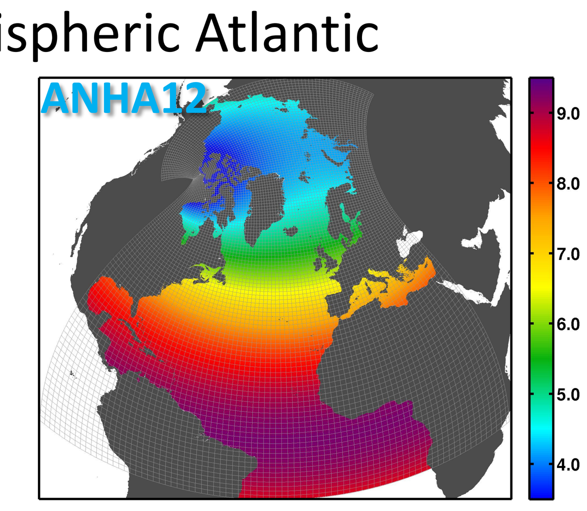
In this study, we

- ➢ Evaluate the interannual variability of the AW hydrographic properties at Fram Strait and Barents Sea Opening
- ➢ Quantify the AW volume and heat contributions to the Arctic Ocean through two gateways
- ➢ Investigate the bifurcation of the AW boundary current when it reaches the Lomonosov Ridge

Ⅱ. Numerical Simulations

ANHA: Arctic and Northern Hemispheric Atlantic





Resolution: 1/4 & 1/12

Mesh: 544*800 & 1632*2400 (50 levels)

Fram Strait: ~13 km & ~4.2 km

Barents Sea Opening: ~ 14 km & ~4.5 km

Time period: 2002-2016 & 2002-2019

Set up:

NEMO v3.4 [ocean] + **LIM2** [sea ice]

Initial & Open Boundary Conditions: GLORYS2v3

(3D: T, S, V 2D: SSH, Sea ice)

No temperature & salinity restoring

Atmospheric forcing: CGRF (33km & hourly)

(10-m wind, 2-m air temperature and humidity, precipitation, radiation)

Calculations:

The volume transport (Sv, $1\ Sv = 10^6\ m^3$):

$$T_{Vol} = \sum_{i=1}^{n} v_i A_i$$

The heat transport (TW, $1\ TW = 10^{12} W$)

$$T_H = \sum_{i=1}^{n} v_i A_i \rho_o C_p (\theta_i - \theta_{ref})$$

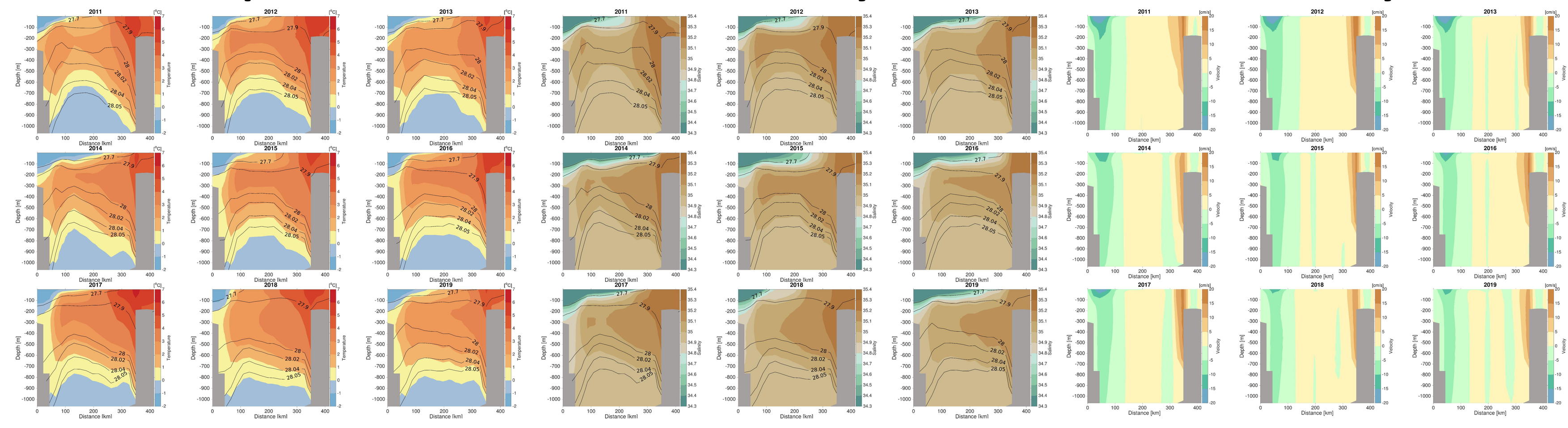
where v_i is the cross-strait velocity (m/s) at each grid cell, A_i is the area of single grid cell (m^2), n is the number of grid cells in the cross section, θ_i is the potential temperature, θ_{ref} is the reference temperature (0 °C), ρ_o is the reference density (1,030 kg/m^3), C_p is the specific heat capacity ($4.0 * 10^3\ J/(kg \cdot °C)$)

Acknowledgements:

Ⅲ. Preliminary Results

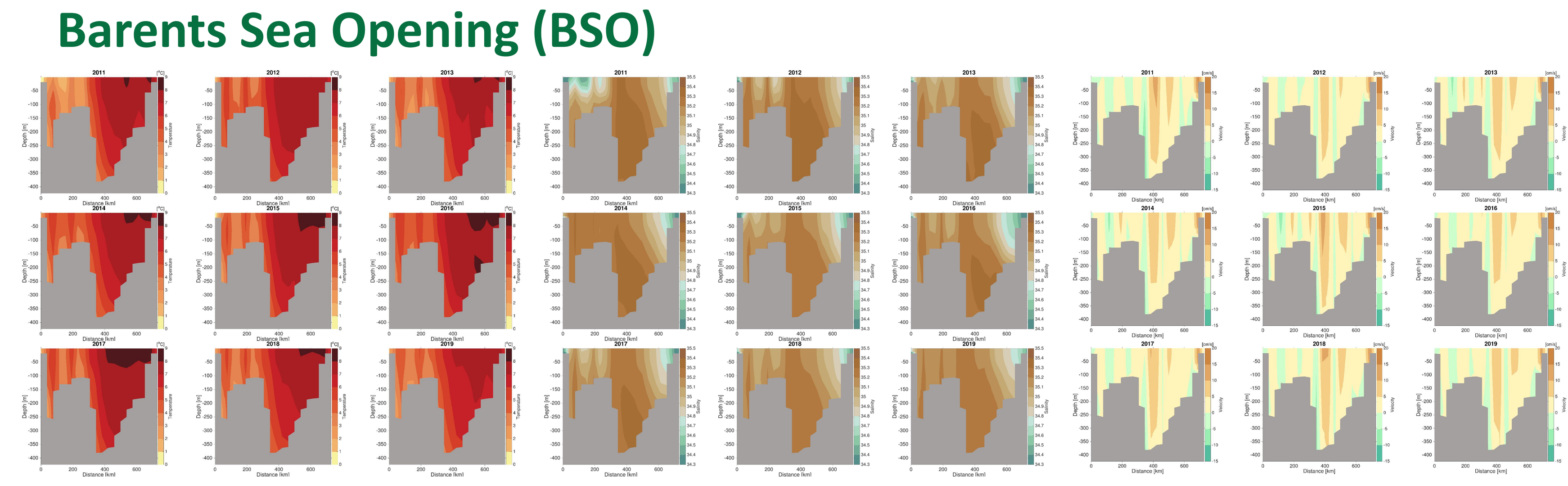
Fram Strait (FS)

Temperature | Salinity | Velocity



Thermohaline structure: the temperature and salinity core along the shelf near the surface and warm and saline AW extension further to the west + recirculating AW branch + maximum temperature in 2017

Barents Sea Opening (BSO)

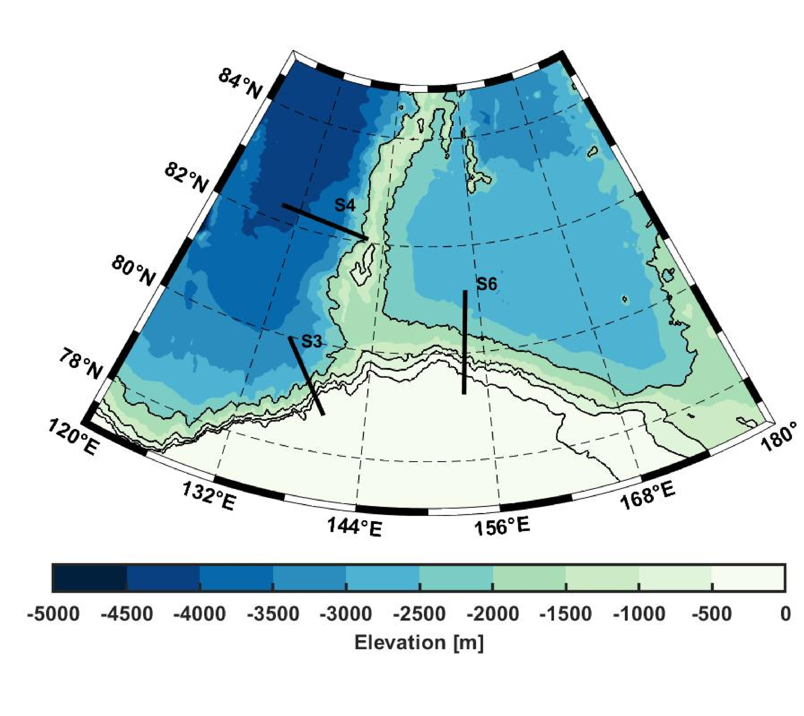


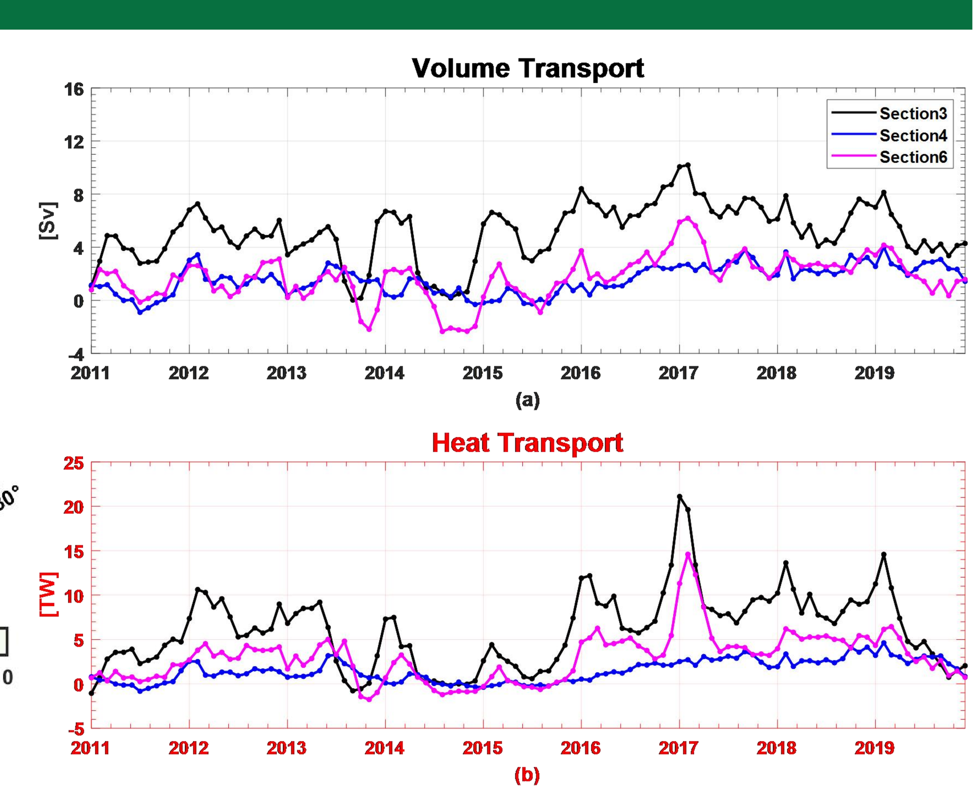
Thermohaline structure: higher temperature core + nonoverlapping temperature and salinity cores + recirculation AW branch + maximum temperature in 2017

Sections		FS	BSO
AW Definitions		T > 2 (Beszczynska-mo, 2012)	T > 3, S > 34.8 (Oziel et al., 2016)
ANHA4	Volume Transport (Sv)	3.2±0.5	2.7±0.3
	Heat Transport (TW)	60.8±3.2	78.3±9.8
	Correlation Coefficient	0.93	0.93
ANHA12	Volume Transport (Sv)	2.4±0.4	2.9±0.3
	Heat Transport (TW)	47.0±8.1	87.3±7.5
	Correlation Coefficient	0.97	0.86

The Barents Sea Branch Water (BSBW) plays a relatively larger role in bringing heat into the Arctic than Fram Strait Branch Water (FSBW). The high correlation coefficients between volume and heat transport indicate that the AW inflow is the principal heat source to the Arctic Ocean.

Ⅳ. Future Work





- The transport variability at S6 shares great similarities with that at S3
- Both the volume and heat transport reach their maximum in 2017
- The volume and heat transport at S4 have been increased since 2015

However, what are the possible physical mechanisms controlling the division of the flows? Mesoscale eddies? Ekman transport?

Next step: Simulate the eddy kinetic energy and potential vorticity in this region to study the properties of the eddies.

References:

Beszczynska-mo, A. (2012). Variability in Atlantic water temperature and transport at the entrance to the Arctic Ocean, 1997–2010. 69, 852–863.

Oziel, L., Sirven, J., & Gascard, J. C. (2016). The Barents Sea frontal zones and water masses variability (1980-2011). Ocean Science, 12(1), 169–184.