

# THE ATLANTIC WATER LAYER IN THE ARCTIC

AN OBSERVATIONALIST'S INTRODUCTION TO STATE ESTIMATE MODELING

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A presentation based on Grabon, Toole, Nguyen and Krishfield, 2021. An analysis of Atlantic Water in the Arctic Ocean using the Arctic Subpolar Gyre State Estimate and observations.  
Progress in Oceanography, <https://doi.org/10.1016/j.pocean.2021.102685>

Research supported by:



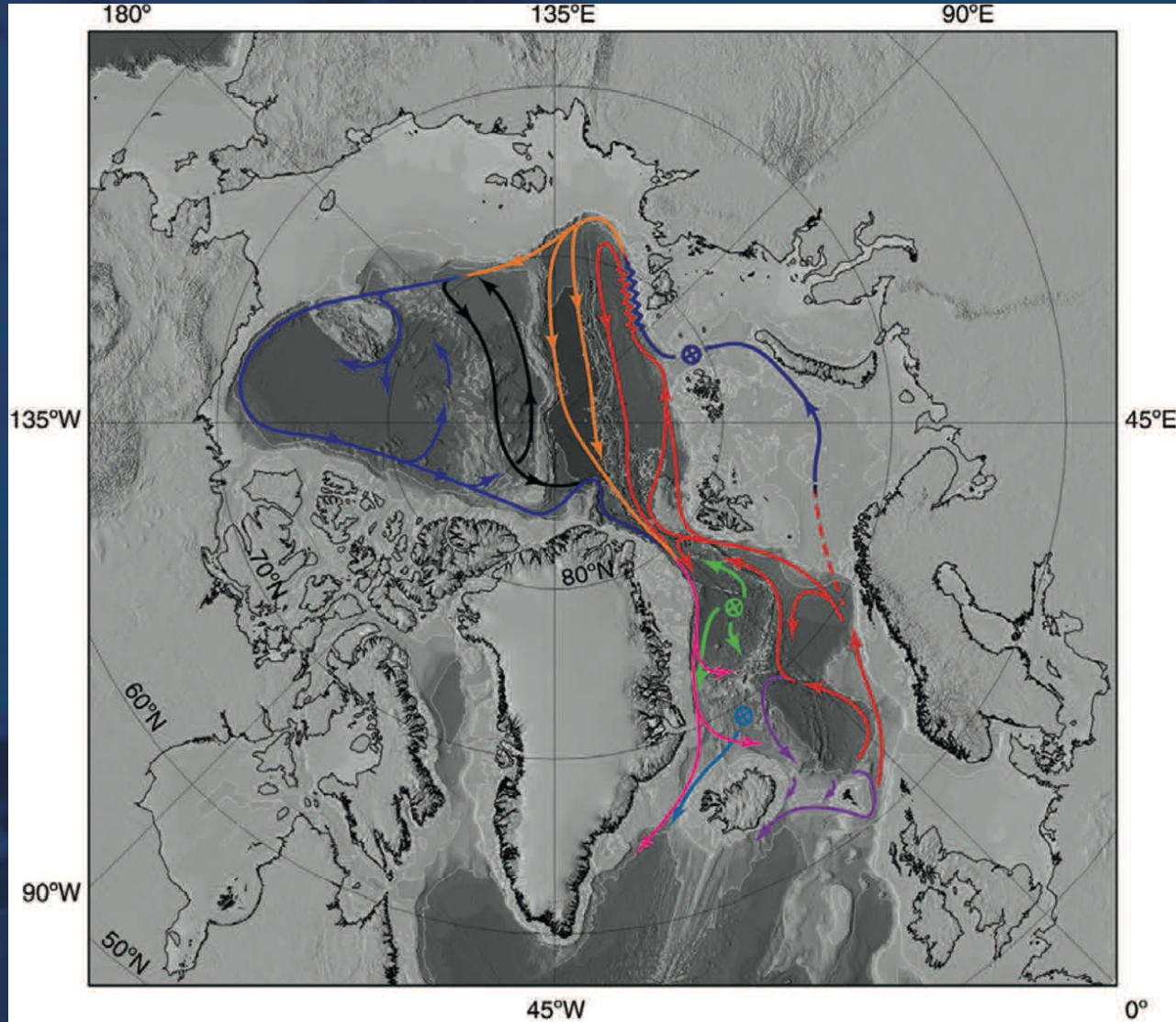
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Existence of a relatively warm, subsurface layer of water extending throughout the Arctic Ocean has been known since Nansen's polar expedition aboard the *Fram*: 1893-96







## Questions:

- Why does AW flow into the Arctic?
- What dictates the sense of the horizontal circulation (cyclonic or anticyclonic)?
- Is this circulation schematic representative of the real flow?
- What is the intensity of the watermass transformations and associated overturning circulation?
- How does the circulation and water properties vary in time?
- What are the relationships between AW in the Arctic and the climate state (locally and beyond)?

Adapted from Rudels et al. (2012).

Too many questions for a 20-minute overview (20 hours probably not enough)

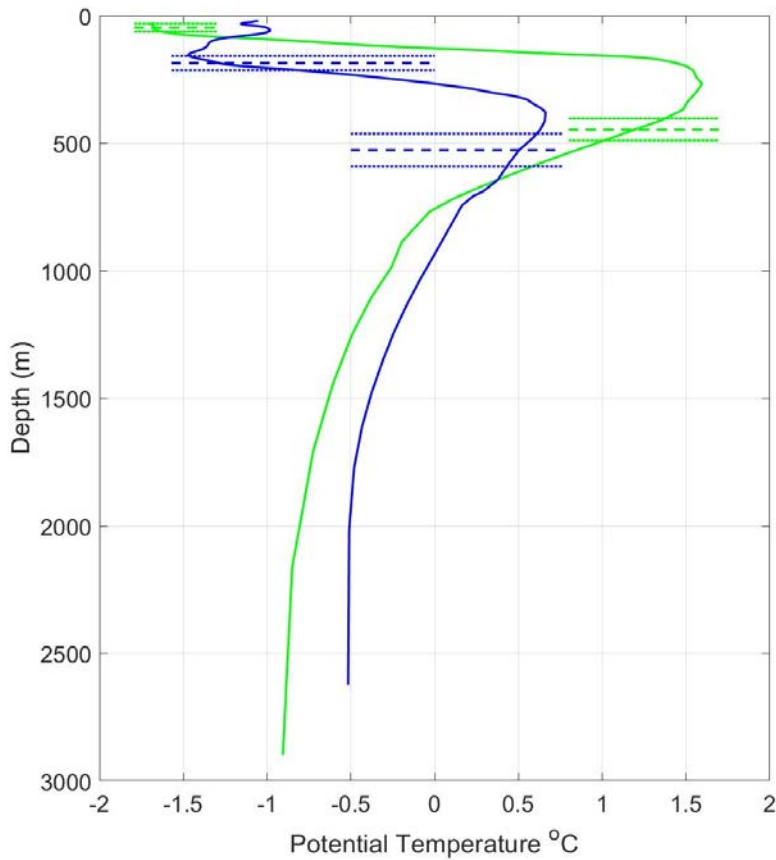
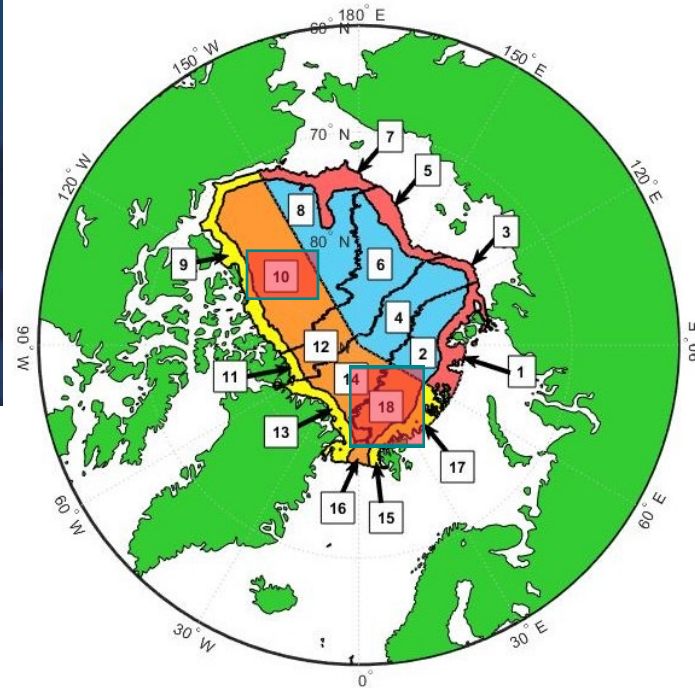
Rather, I will discuss some findings from Grabon et al. (2021) that make a start exploring some of these questions by analyzing monthly output from Nguyen et al.'s (2021) Arctic Subpolar gyre sTate Estimate Release 1 (ASTE) for the period 2002-2017.

Nguyen, A. T., H. Pillar, V. Ocaña, A. Bigdeli, T.A. Smith and P. Heimbach, 2021. The Arctic Subpolar gyre sTate Estimate (ASTE): Description and assessment of a data-constrained, dynamically consistent ocean-sea ice estimate for 2002-2017.

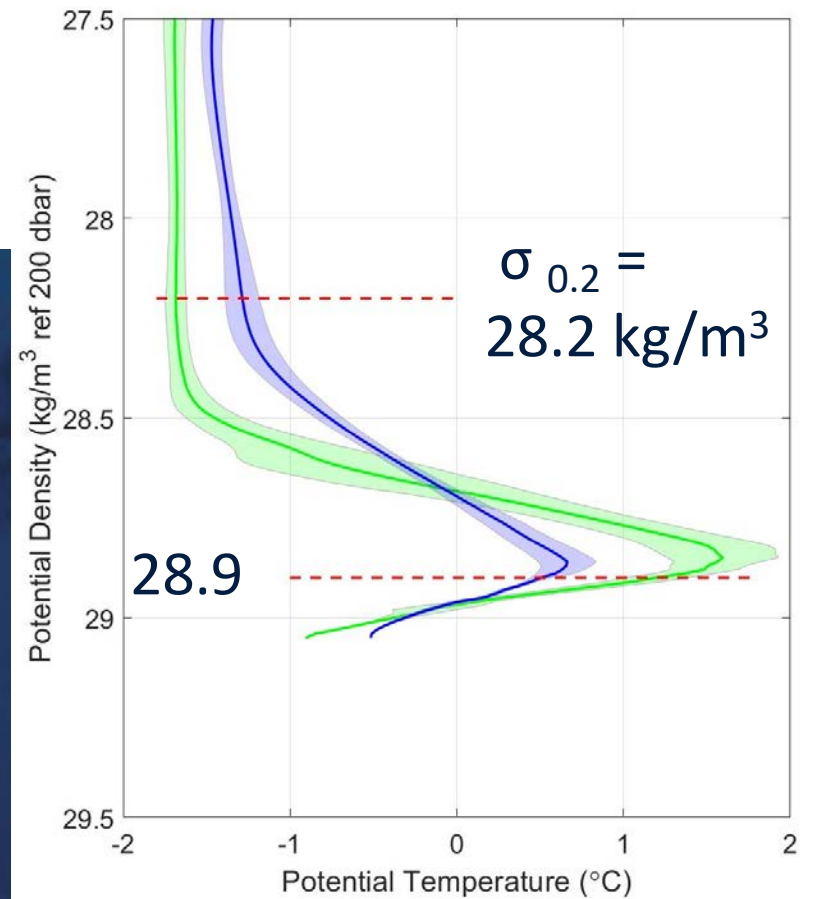
doi:10.1002/essoar.10504669.1



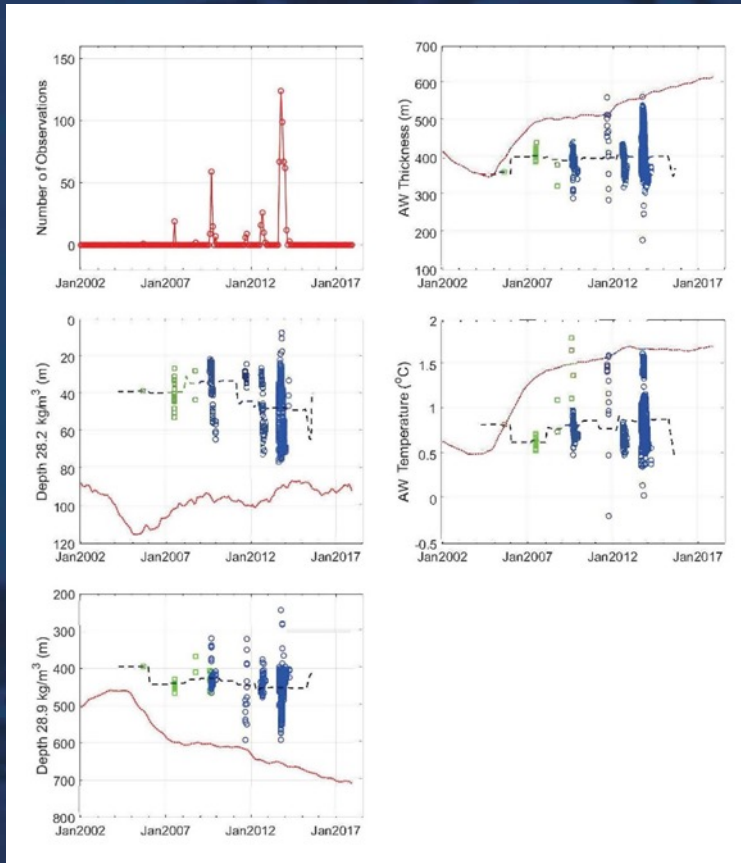
2002 - 2017



Contrasting  
temperature profiles  
from the Nansen Basin  
and Canada Basin



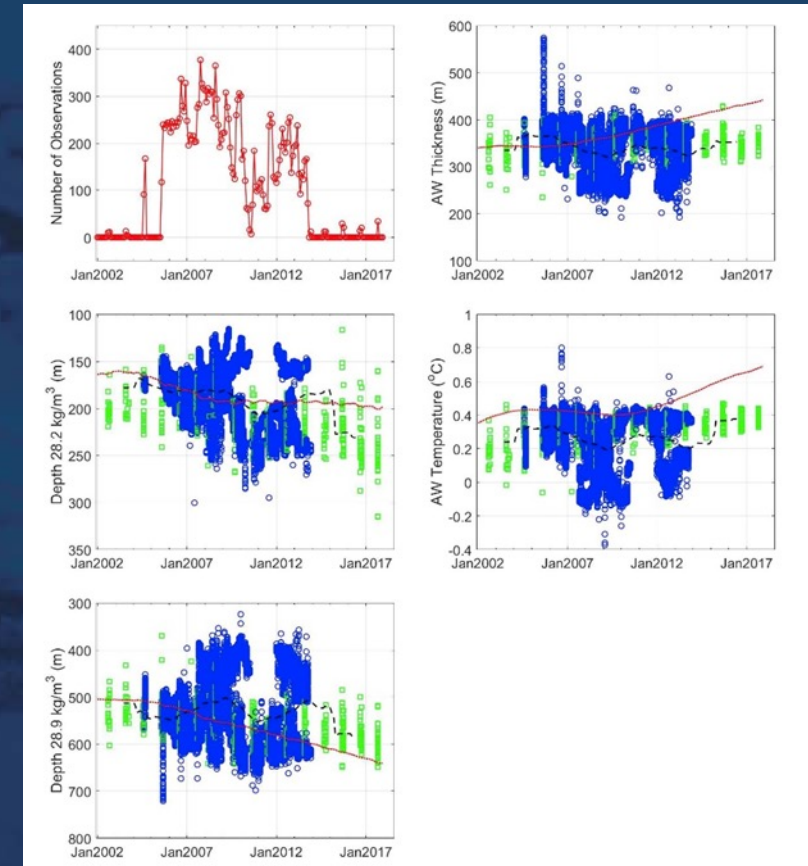
## Nansen Basin



How well does  
ASTE replicate the  
observations?

Comparisons of  
observed and ASTE  
estimates of AW  
properties in  
subsectors of the  
Arctic

## Canada Basin

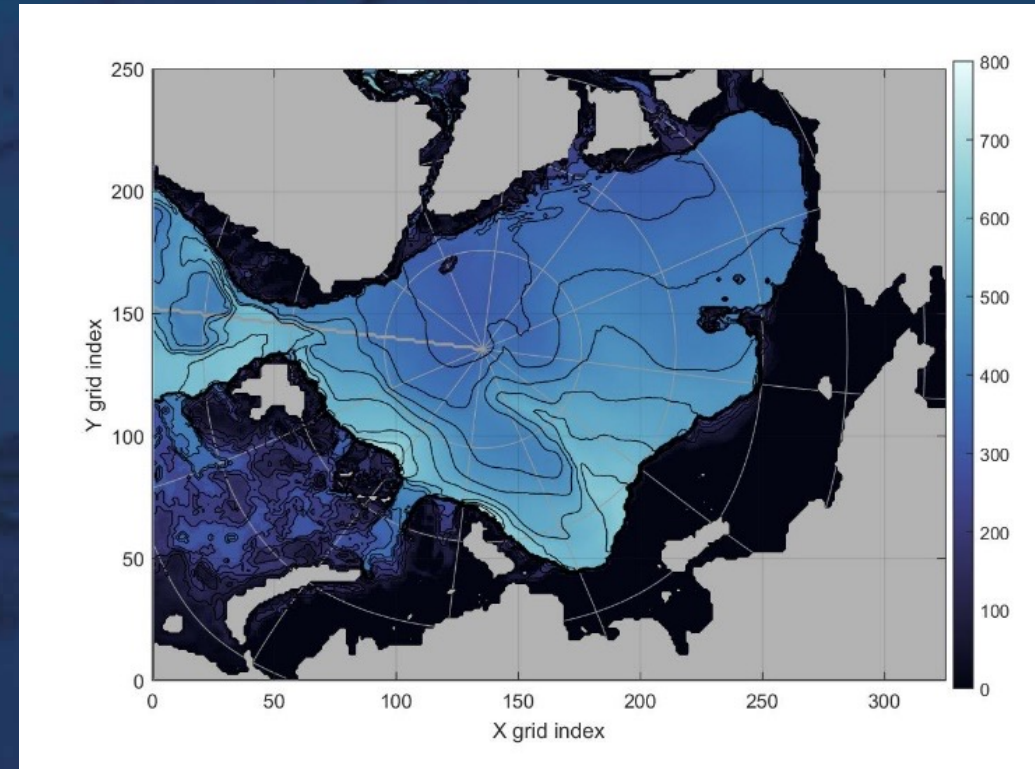
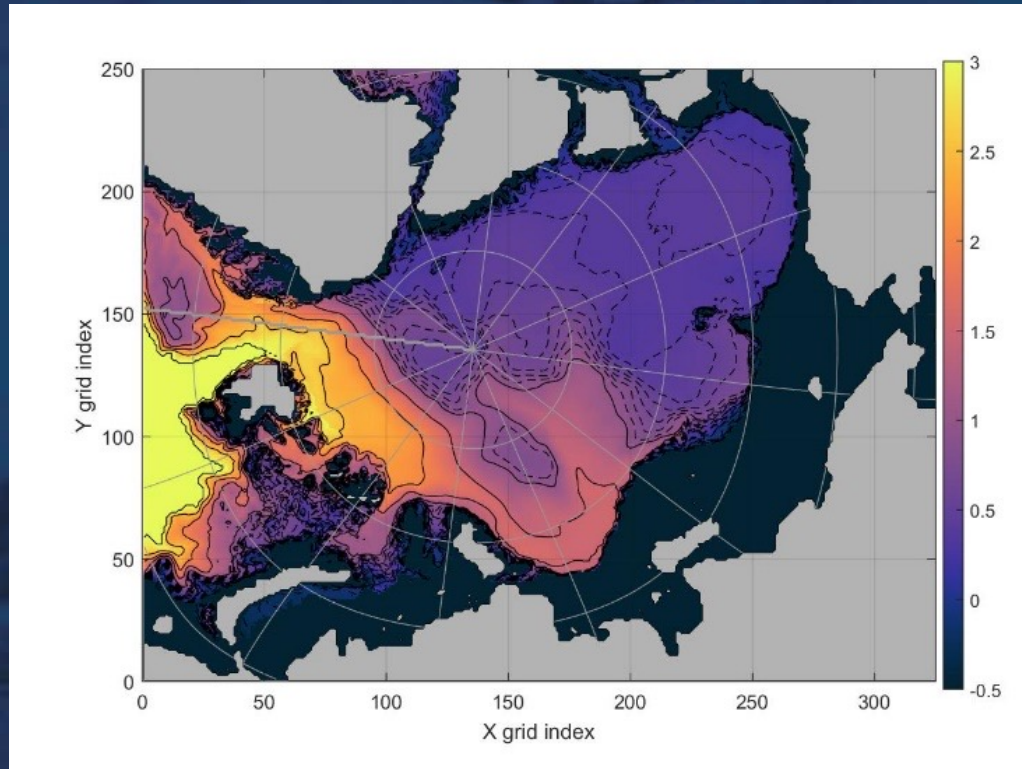


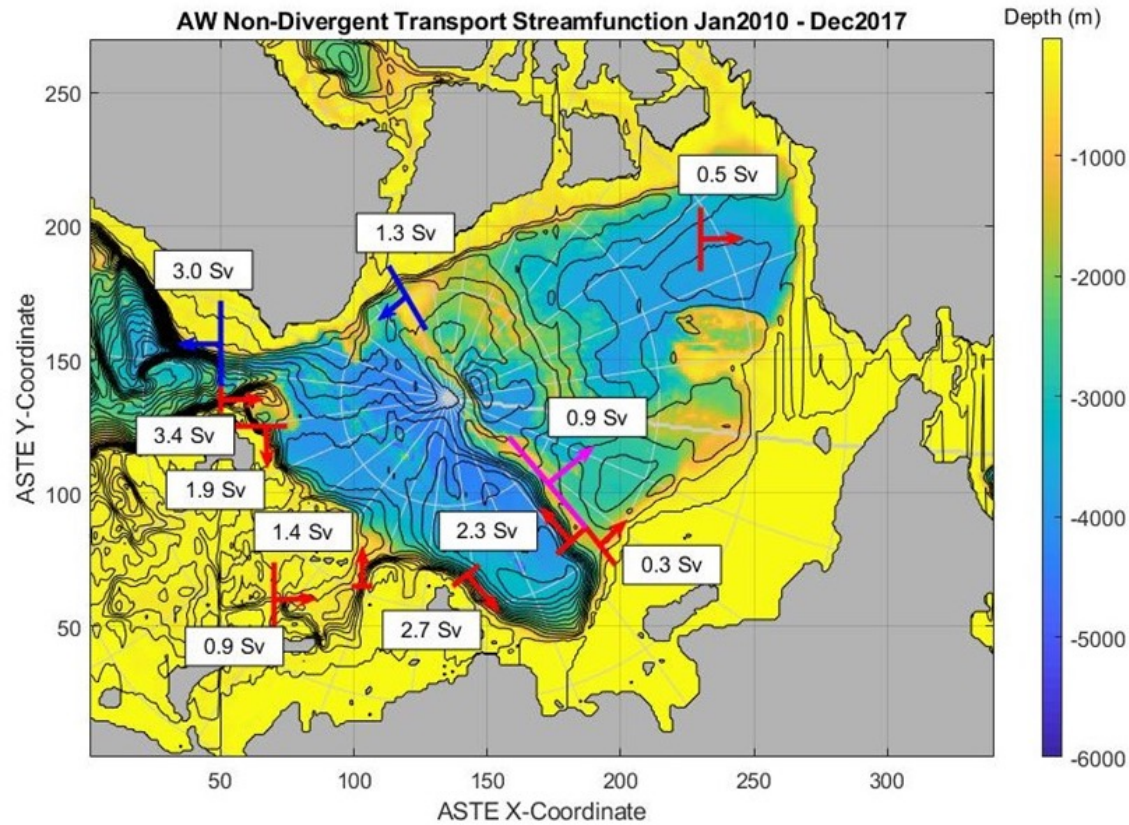


Time-average fields, Jan 2010-Dec 2017

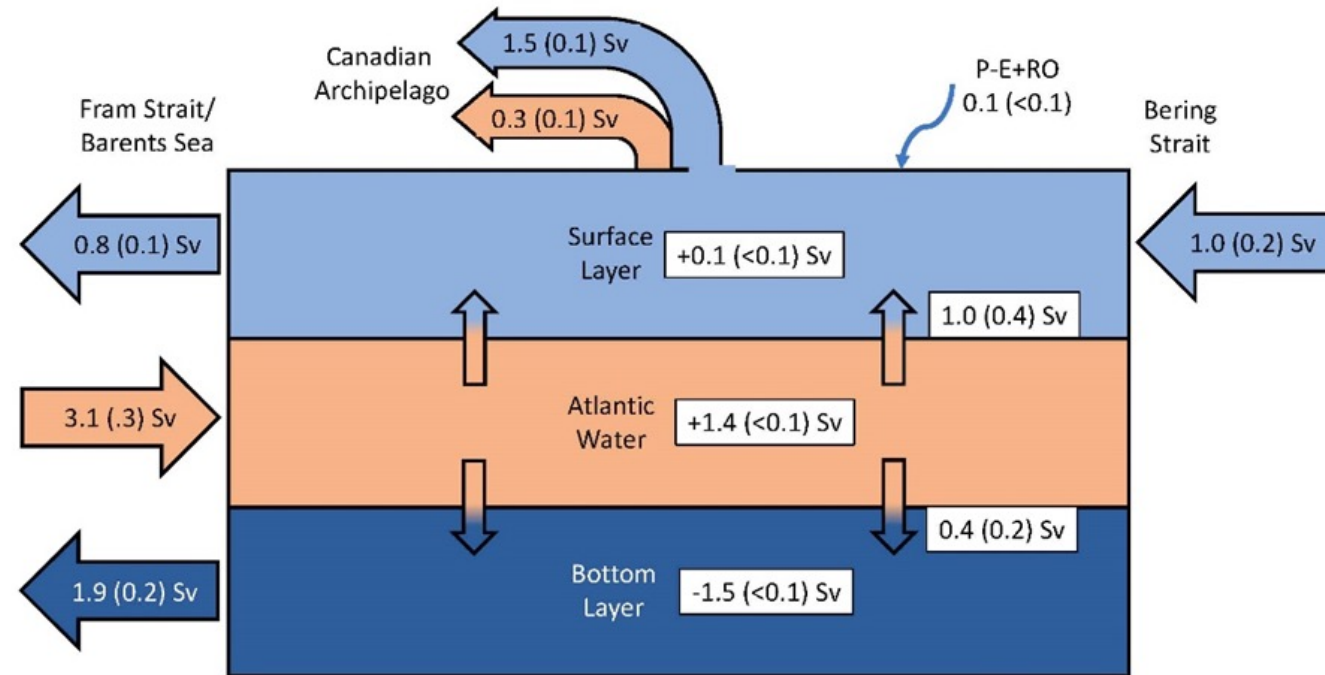
AW Layer-averaged Potential Temperature ( $^{\circ}\text{C}$ )

Thickness (m)





## Arctic Ocean Mean Overturning Circulation

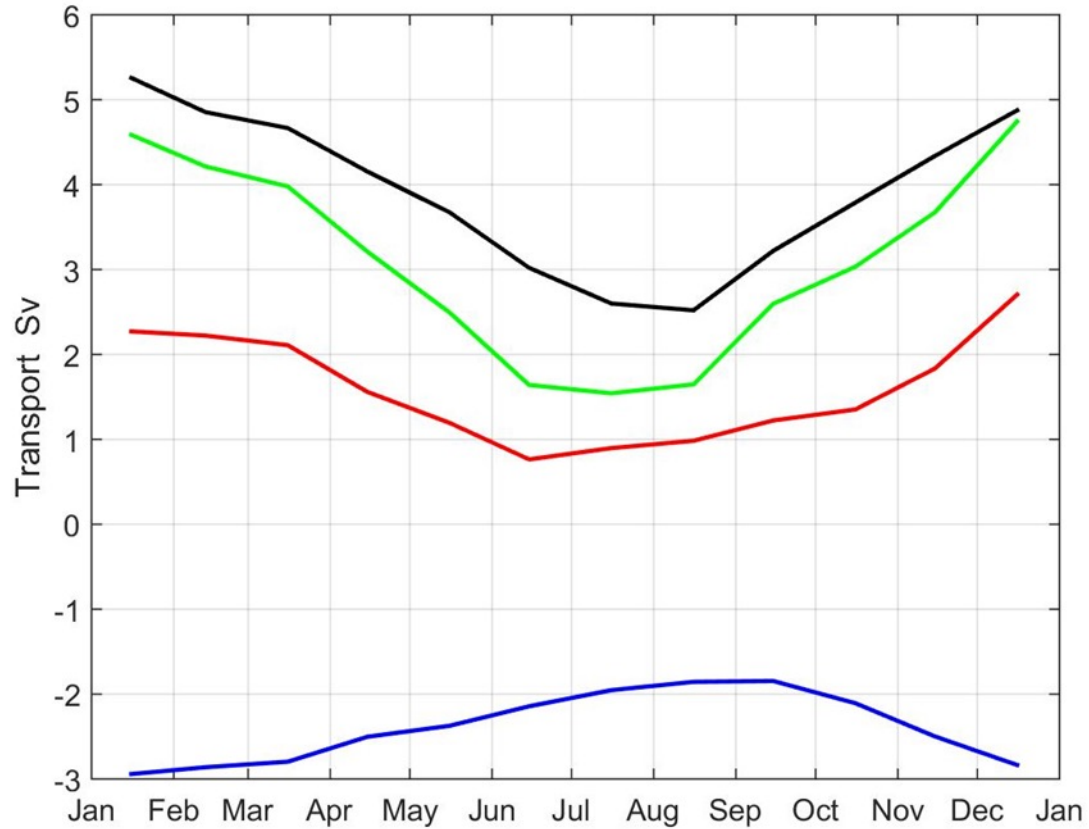


c.i. = 0.25 Sv

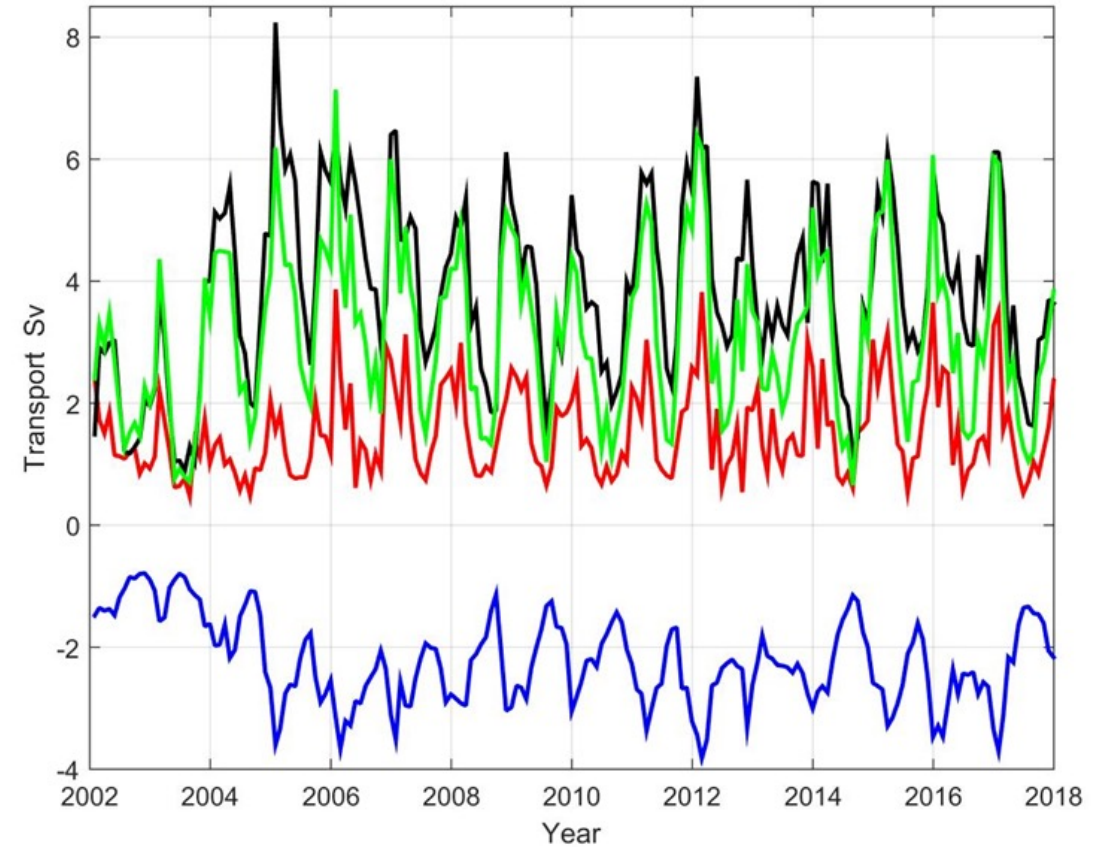


## Temporal variability

### Fram Strait and Barents Sea AW Transports Mean Seasonal Cycle

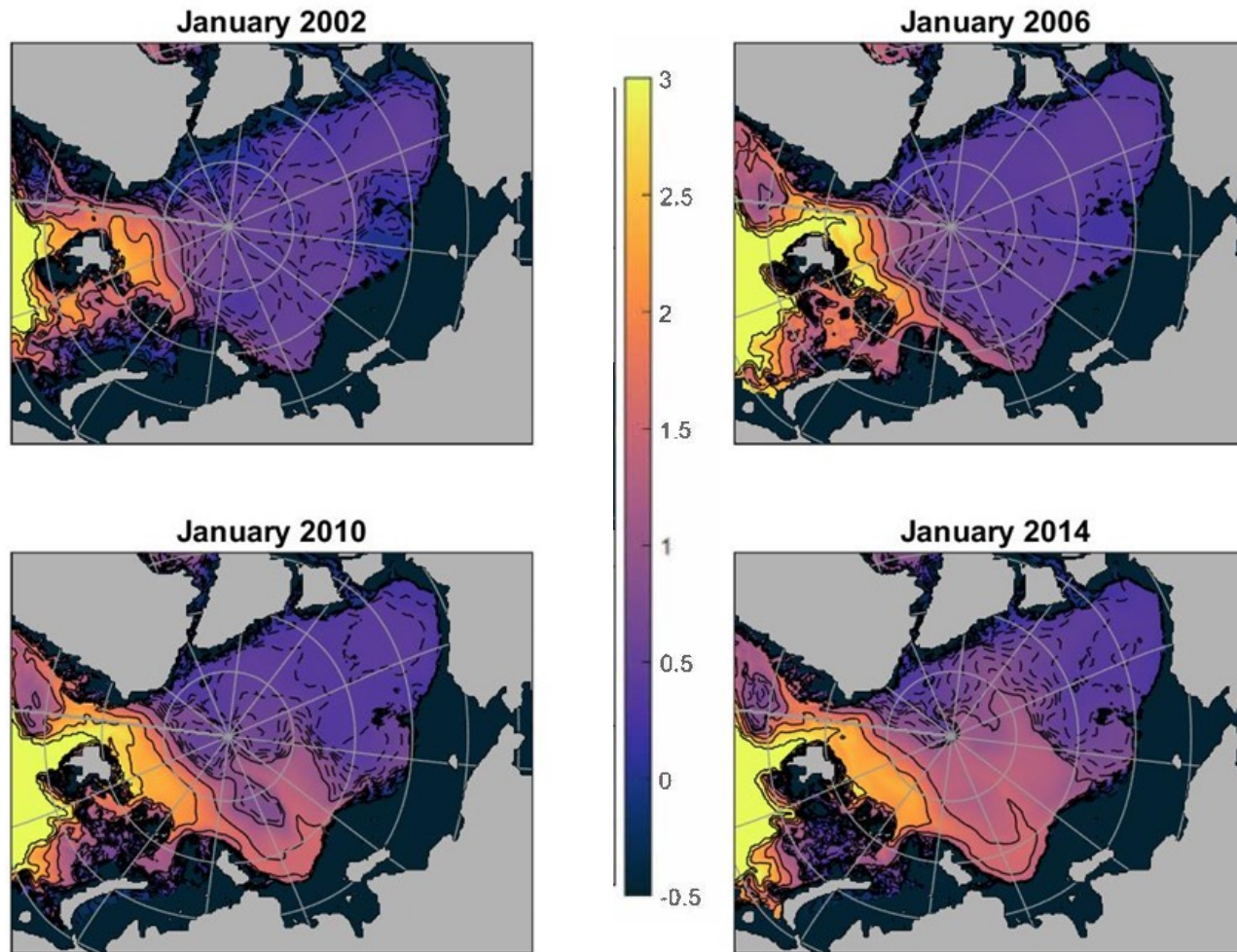


### Interannual Variability



FS inflow (black), FS outflow (blue), BS inflow (red), net inflow (green)

# Interannual warming of the AW Layer



Temperatures in each panel range between -0.5 and 3.0 °C with solid contours at 0.5 °C increment drawn between 1 and 3 °C and dashed contours at 0.1 °C increment between -0.5 and 1.0 °C.





Why does AW flow into the Arctic?

What dictates the sense of the horizontal circulation (cyclonic or anticyclonic)?

Are circulation schematics based on inferences and state estimates representative of the real flow?

What is the intensity of the watermass transformations and associated overturning circulation in the Arctic? What are the mechanisms?

How does the circulation and water properties vary in time? Why does it vary?

What are the relationships between AW in the Arctic and the climate state (locally and beyond)?

What observations are needed to better constrain state estimate models?





Velocity (m/s) parallel to circuit shown below

