

# Potential Fram Strait circulation feedback freshens the Arctic Ocean

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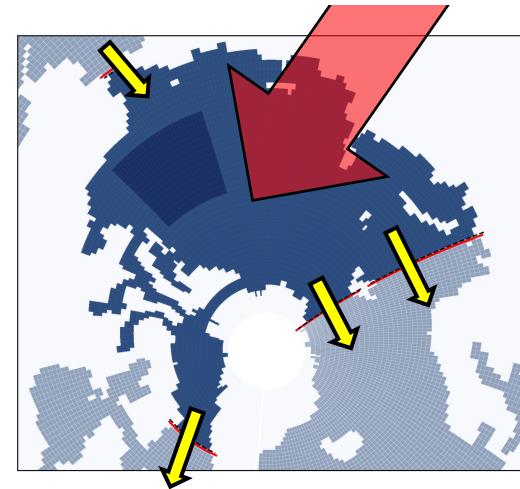
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## a) Using two different kinds of simulations

- **CESM-LE** : ensemble mean of freely running coupled model
- **JRA55 FOSI** : a single realization of forced ocean sea ice simulation

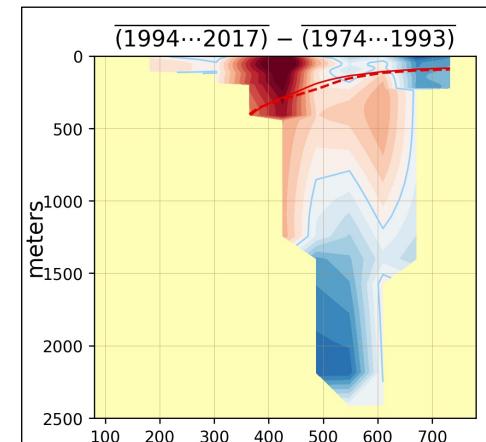
\*CESM @  $\sim 1^\circ$  resolution across components

## b) Comparing changes in freshwater budget



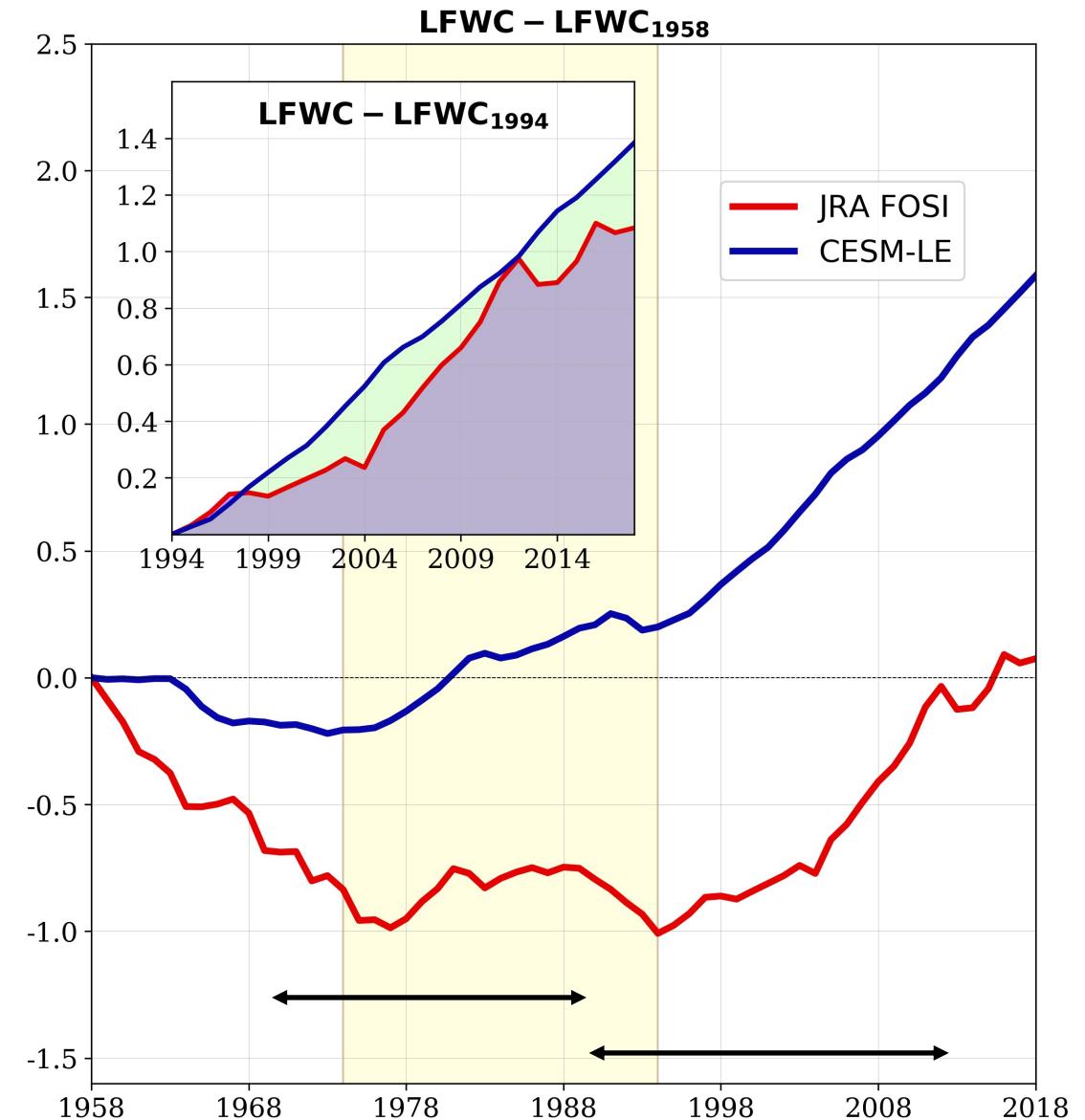
$$\frac{dFWC_{liq}}{dt} = F_{surf} + T_{lat}$$

## c) Investigating Fram Strait circulation changes



# Simulated Increase in Liquid Freshwater Content since 1958 and 1994 (in 1e4 km<sup>3</sup>)

- In order to identify mechanism of the recent build-up (since 1994), freshwater budgets of the two periods are compared,
  - ✓ 1974-1993 (low/no change)
  - ✓ 1994-2017 (rapid increase)



# Liq. FW Budget and changes

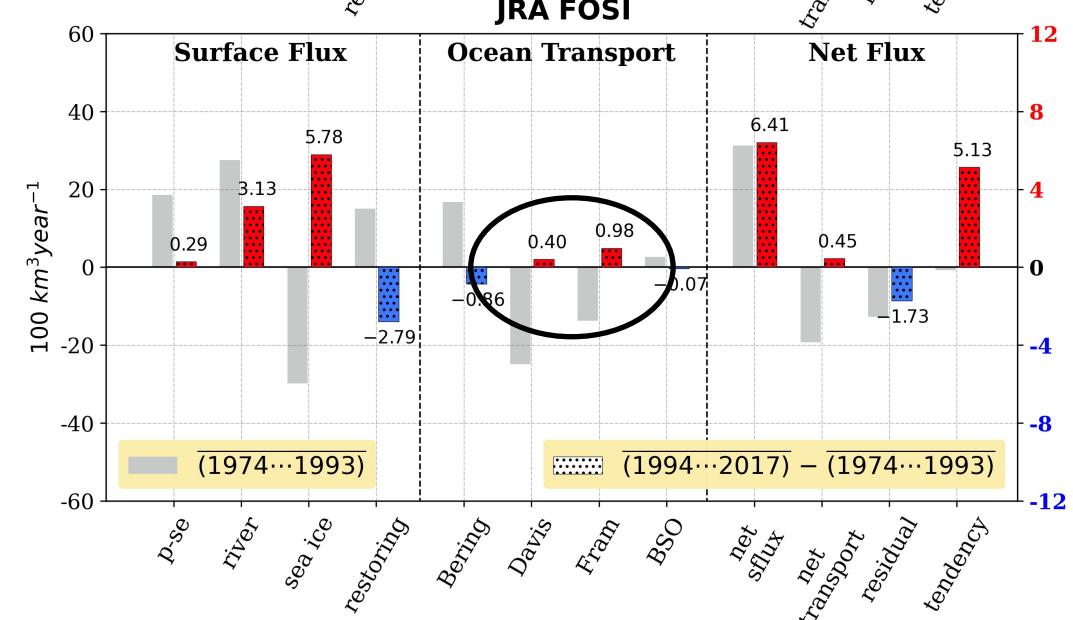
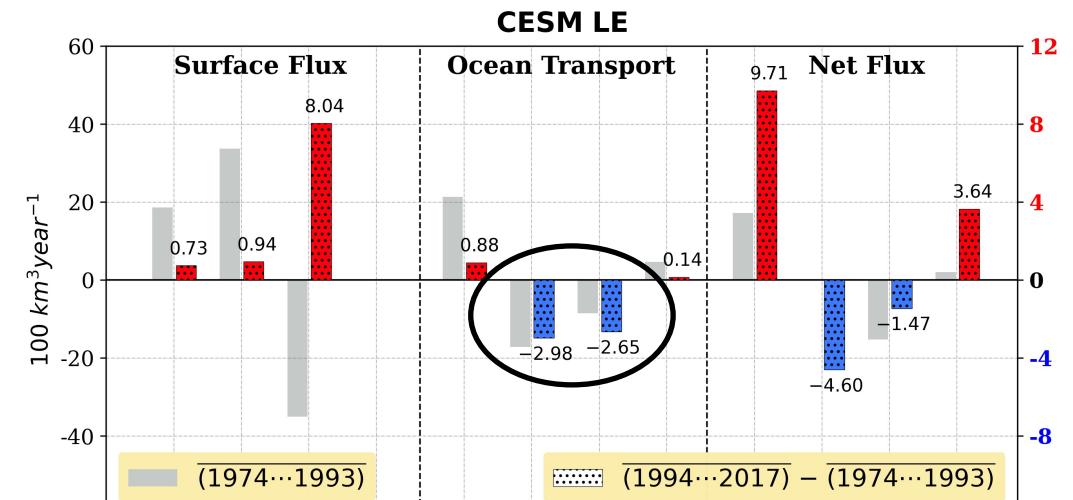


(1974-1993)



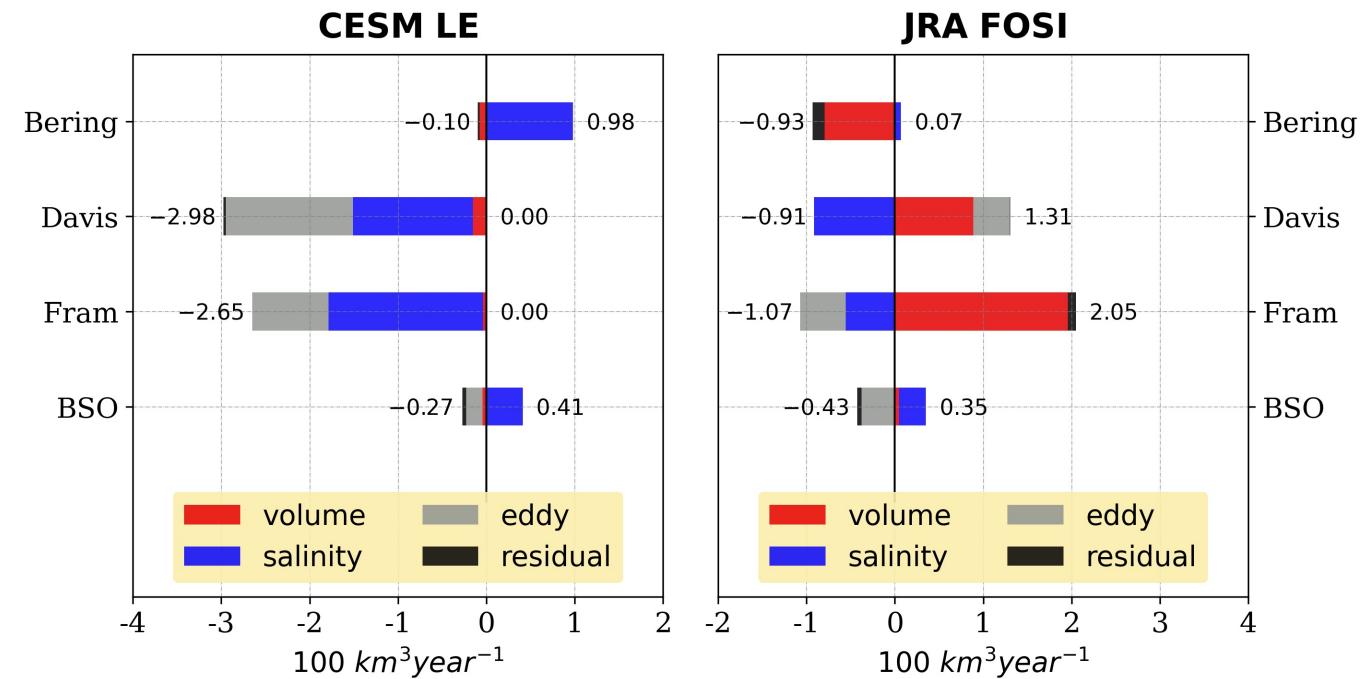
(1994-2017) - (1974-1993)

- Reduction in sea ice volume is the biggest contributor of liquid freshwater increase and it is (mostly) externally forced.
- This externally forced freshening is,
  - **compensated** by increase in FW export out of the Arctic into North Atlantic in CESM-LE.
  - is slightly **enhanced** by net FW import through ocean gateways in FOSI.

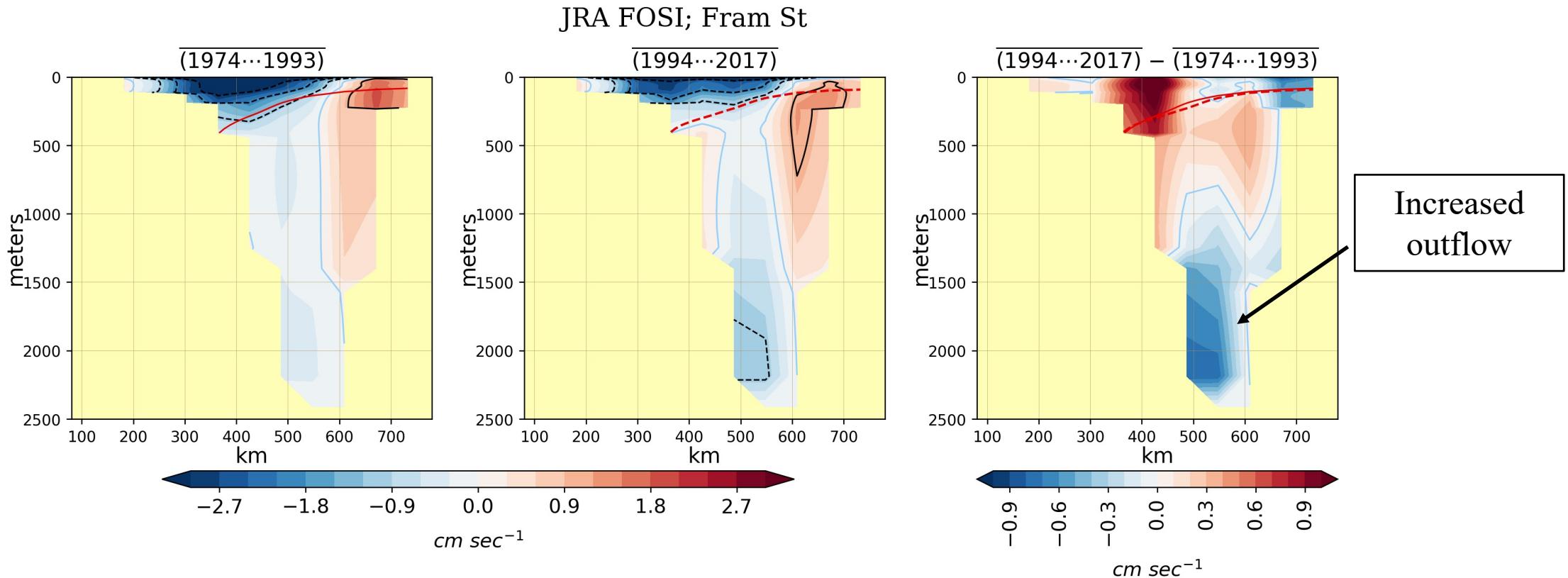


# Decomposition of Delta (FW transports) into volume, salinity and eddy contribution

- In CESM-LE, straits are becoming fresher (salinity driven)
- In JRA FOSI, straits are becoming fresher along with an additional ocean circulation change (primarily volume transport driven)
  - which counteracts salinity driven response and results in larger increase in LFWC and reduced freshwater export.

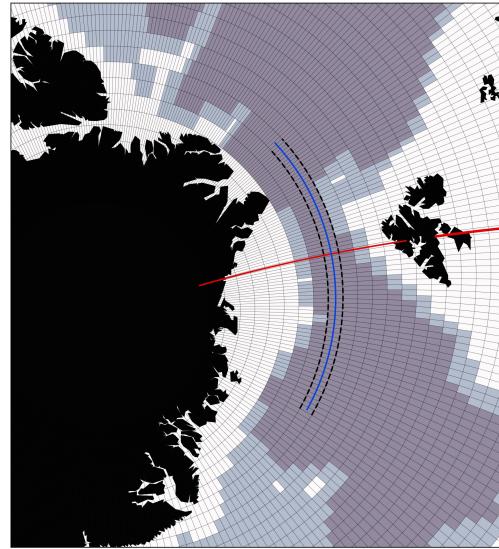


# Fram Strait Circulation Changes



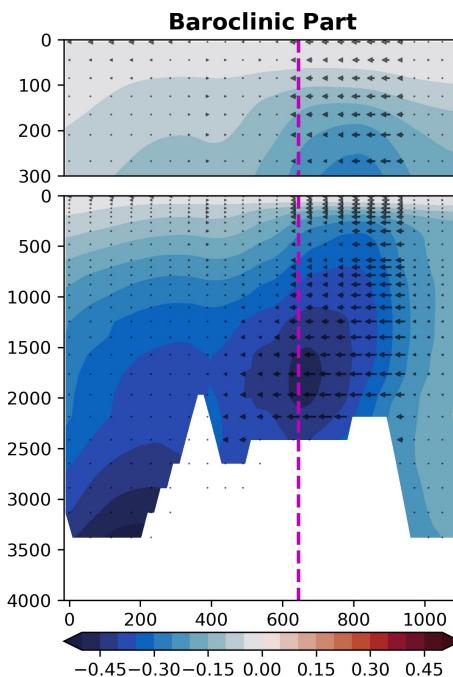
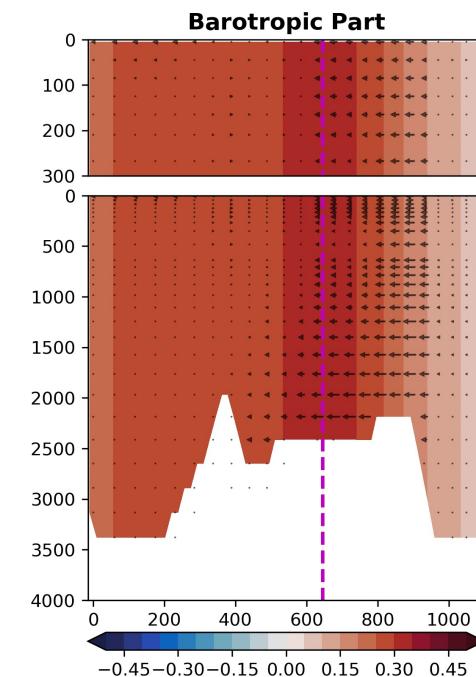
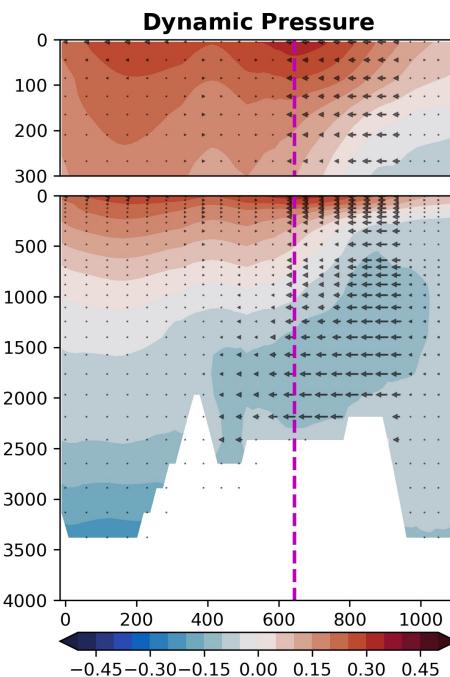
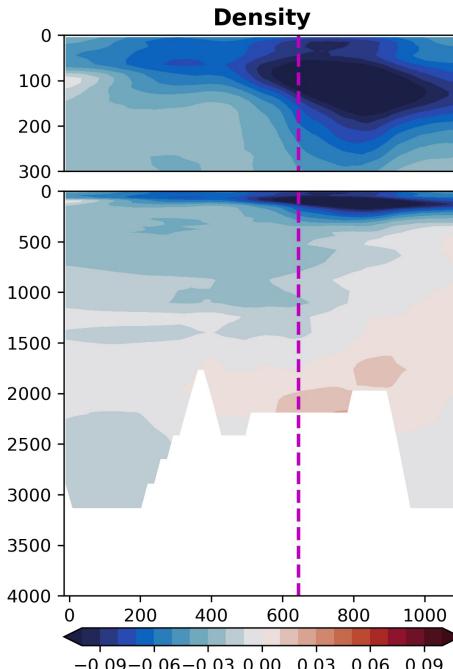
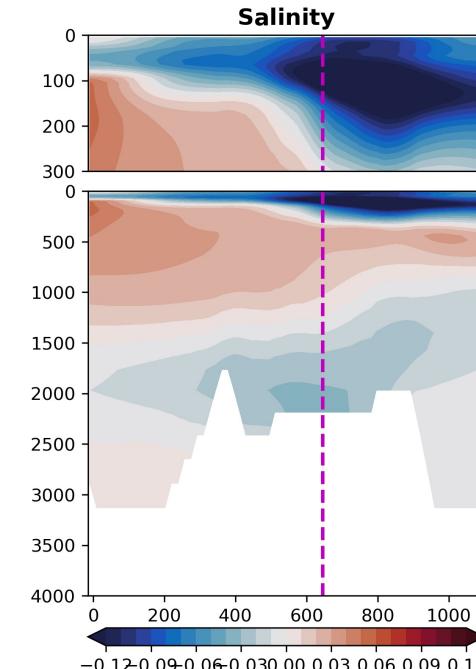
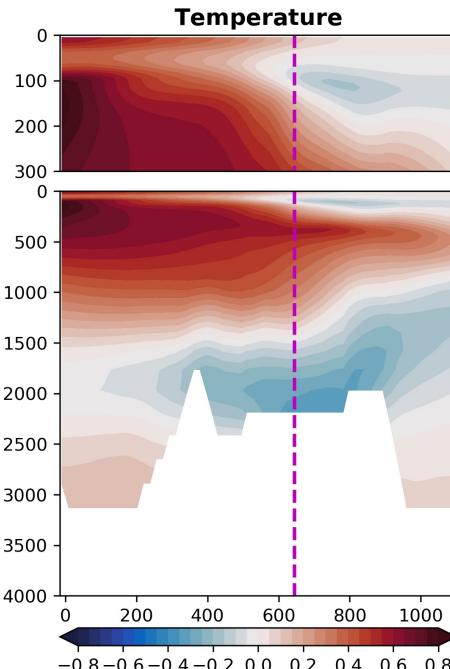
- Similar but weaker response in CESM-LE
- Despite FW transports being controlled by currents and salinity in upper part of the Fram strait, there is an increase in deep outflow in both the simulations
- **What causes the increase in deep outflow?**

# What drives an increased outflow at depth?



Freshening of surface waters (and warming of Atlantic layer) north of the Fram strait reduces the dynamic pressure at depth and drives anomalous southward flow through narrow and deep channel.

(1994…2017) – (1974…1993)



## Conclusions and the potential feedback

- Freshening of surface waters (and warming of Atlantic layer) north of the Fram strait reduces the dynamic pressure at depth and drives anomalous southward flow through narrow and deep channel.
- In JRA FOSI, the increased outflow at depth is compensated by reduction in surface EGC, thereby reinforcing the freshwater accumulation in the Arctic (~ +ve feedback)
- In CESM-LE, the increased outflow at depth is compensated by increased Atlantic inflow at intermediate depth with no effect on FW transports