Sea Ice — Climate Interactions

AOS 801 - Lecture 12

Till Wagner, Oct 17 2022

Last Lecture

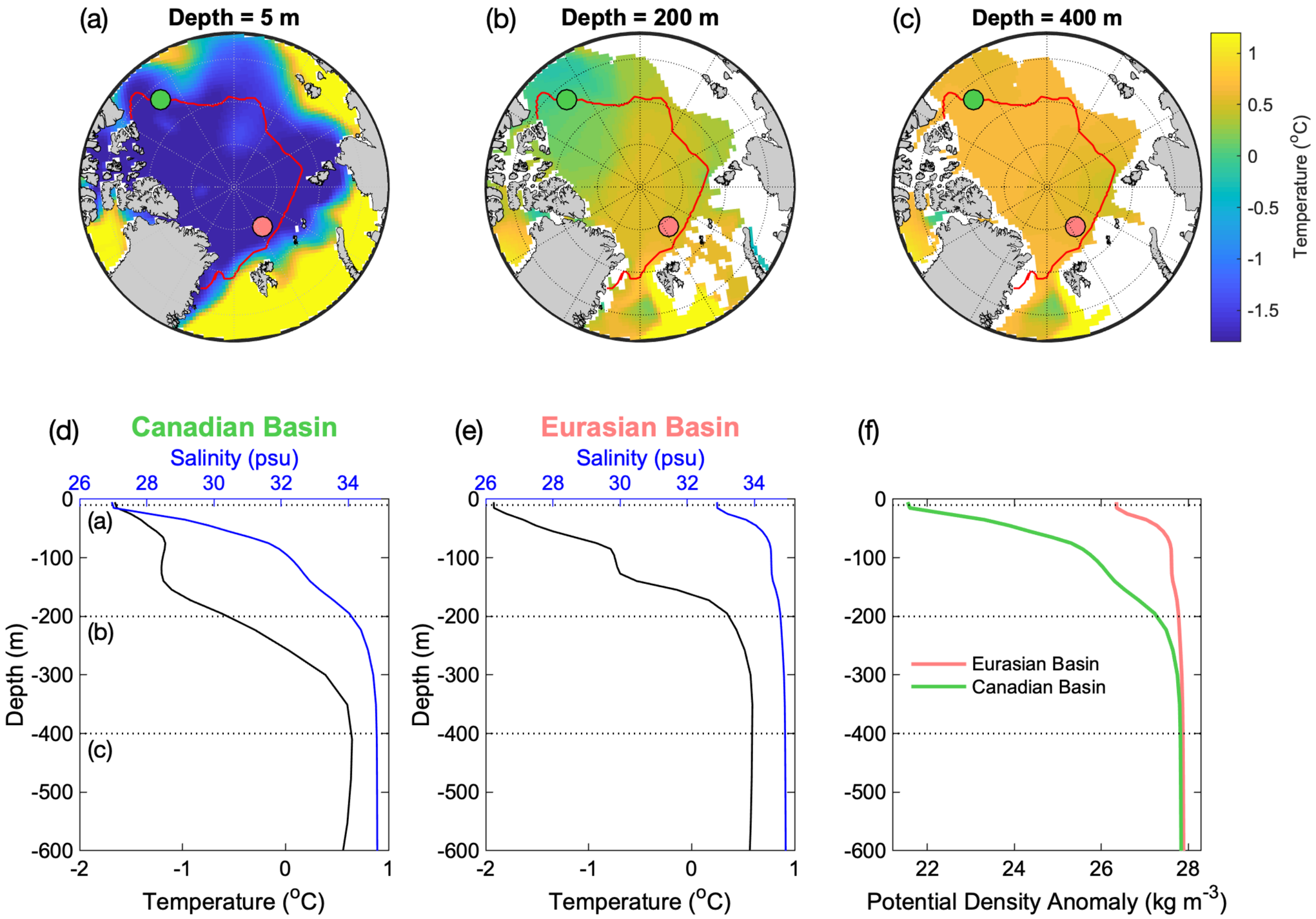
Attribution and Drivers of Sea Ice Loss

- Attribution of sea ice loss
- Forced retreat vs internal variability
- Role of atmosphere

Today

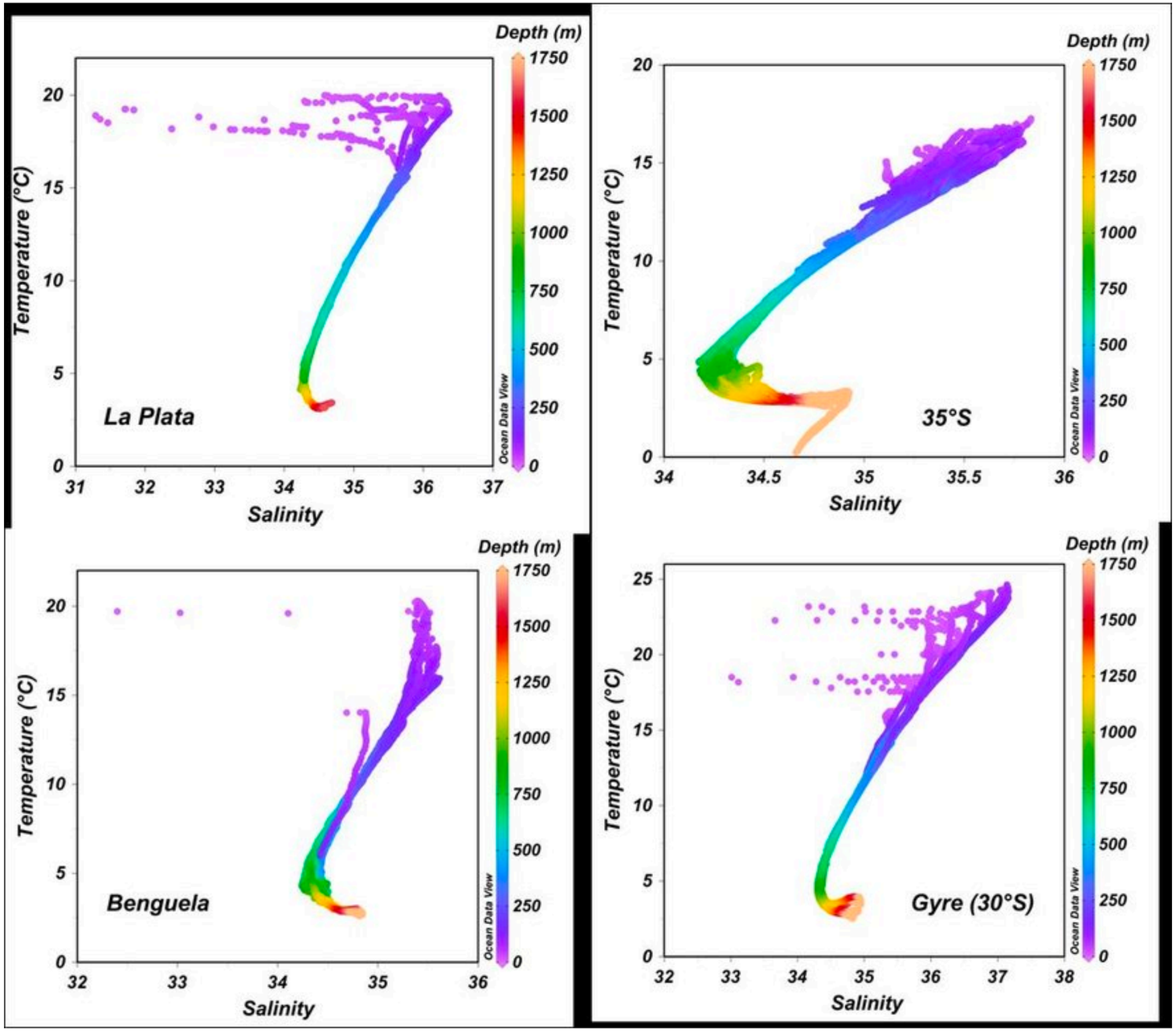
- Role of ocean / Atlantification
- Arctic Amplification
- Teleconnections

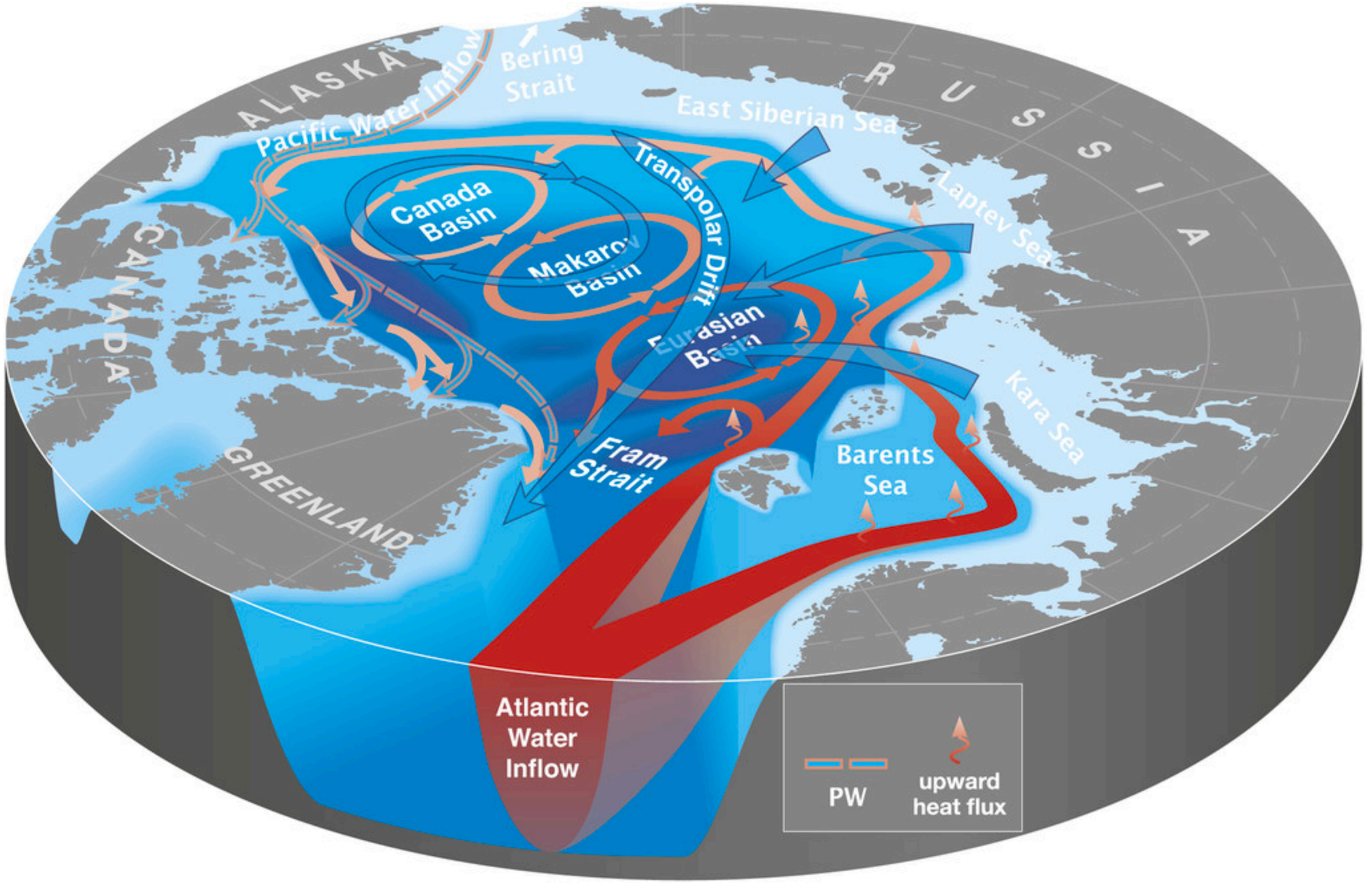
Atlantification - a driver of sea ice loss?


(a) Depth = 5 m
(b) Depth = 200 m
(c) Depth = 400 m
1
0.5
0
-0.5
-1
-1.5
Temperature (°C)
(d) Canadian Basin
Salinity (psu)
26 28 30 32 34
(a)
(b)
(c)
Depth (m)
0 -100 -200 -300 -400 -500 -600
-2 -1 0 1
Temperature (°C)
(e) Eurasian Basin
Salinity (psu)
26 28 30 32 34
Depth (m)
0 -100 -200 -300 -400 -500 -600
-2 -1 0 1
Temperature (°C)
(f)
Eurasian Basin
Canadian Basin
0 -100 -200 -300 -400 -500 -600
22 24 26 28
Potential Density Anomaly (kg m-3)

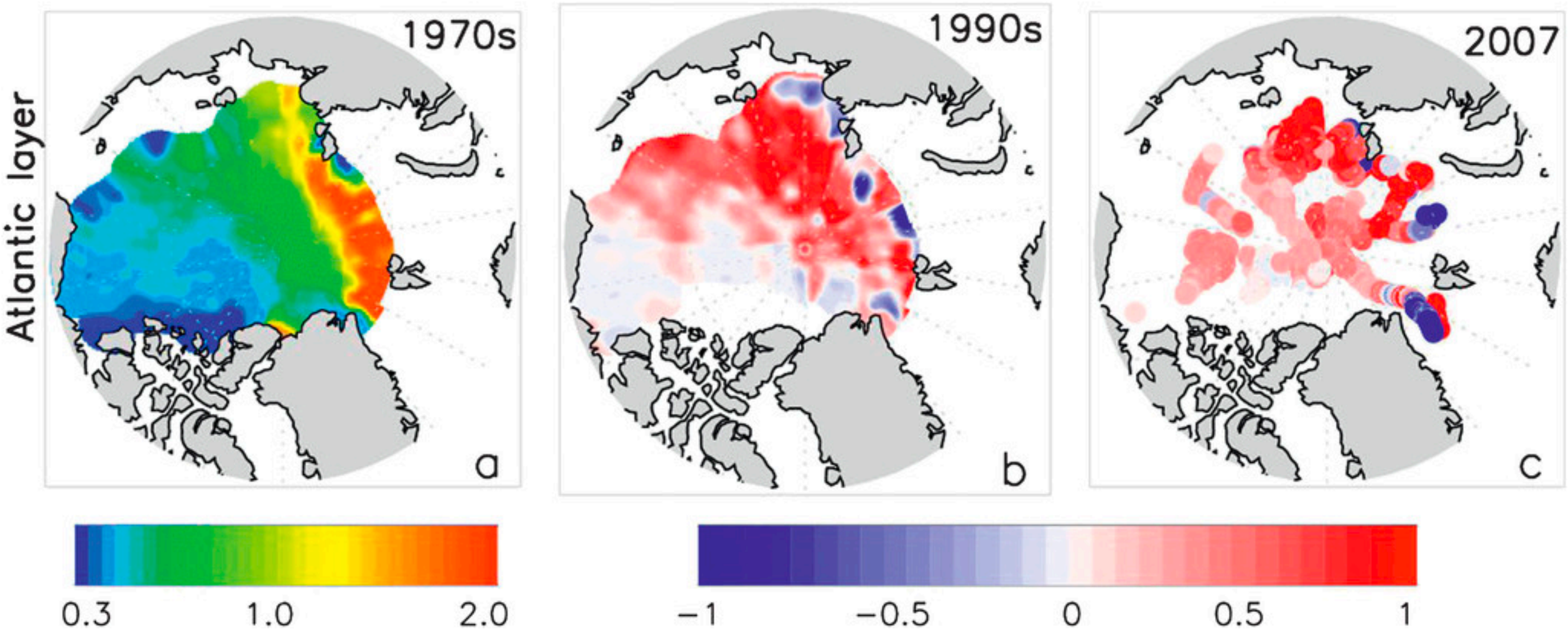
ECCOv5

Random T-S Diagram:

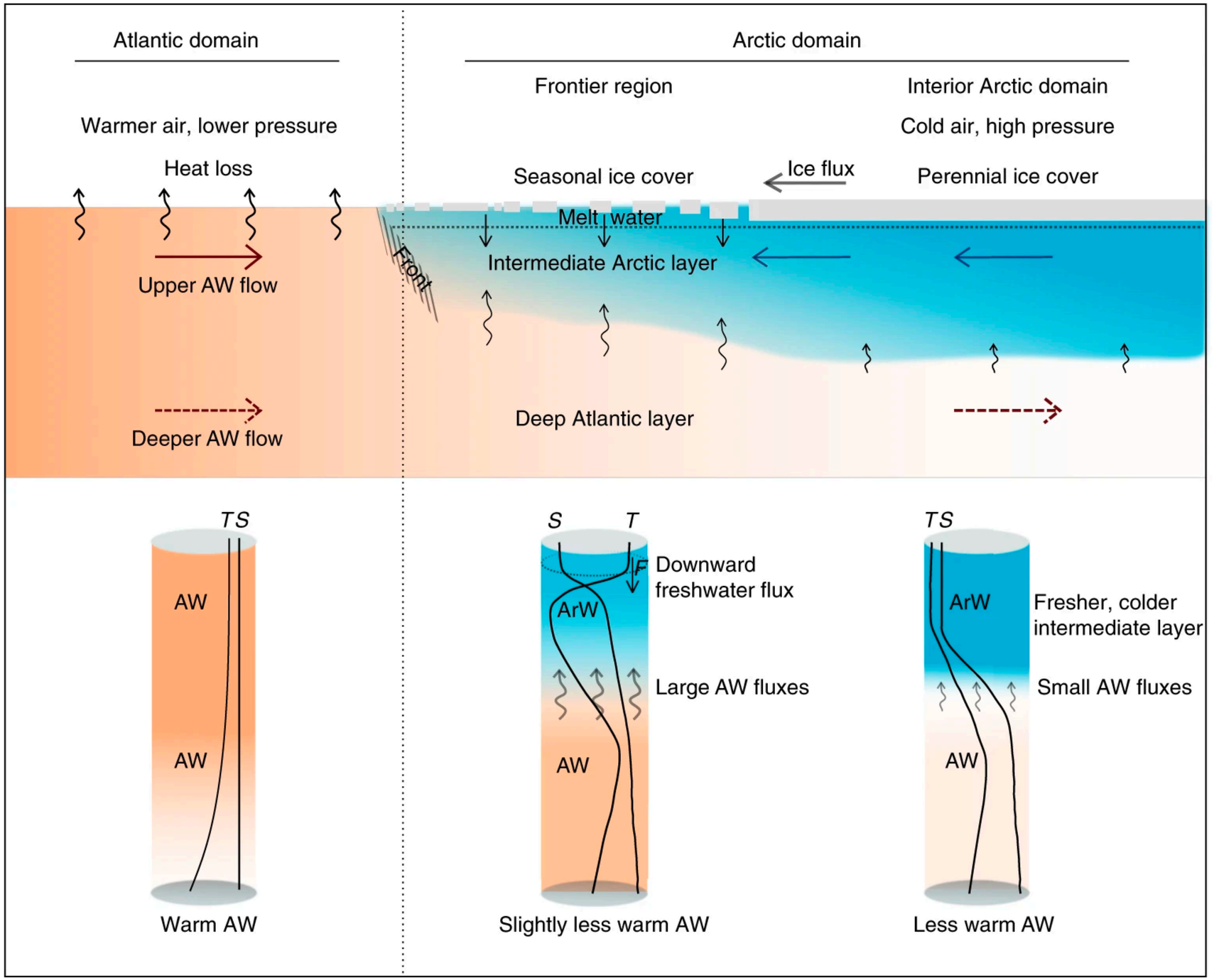




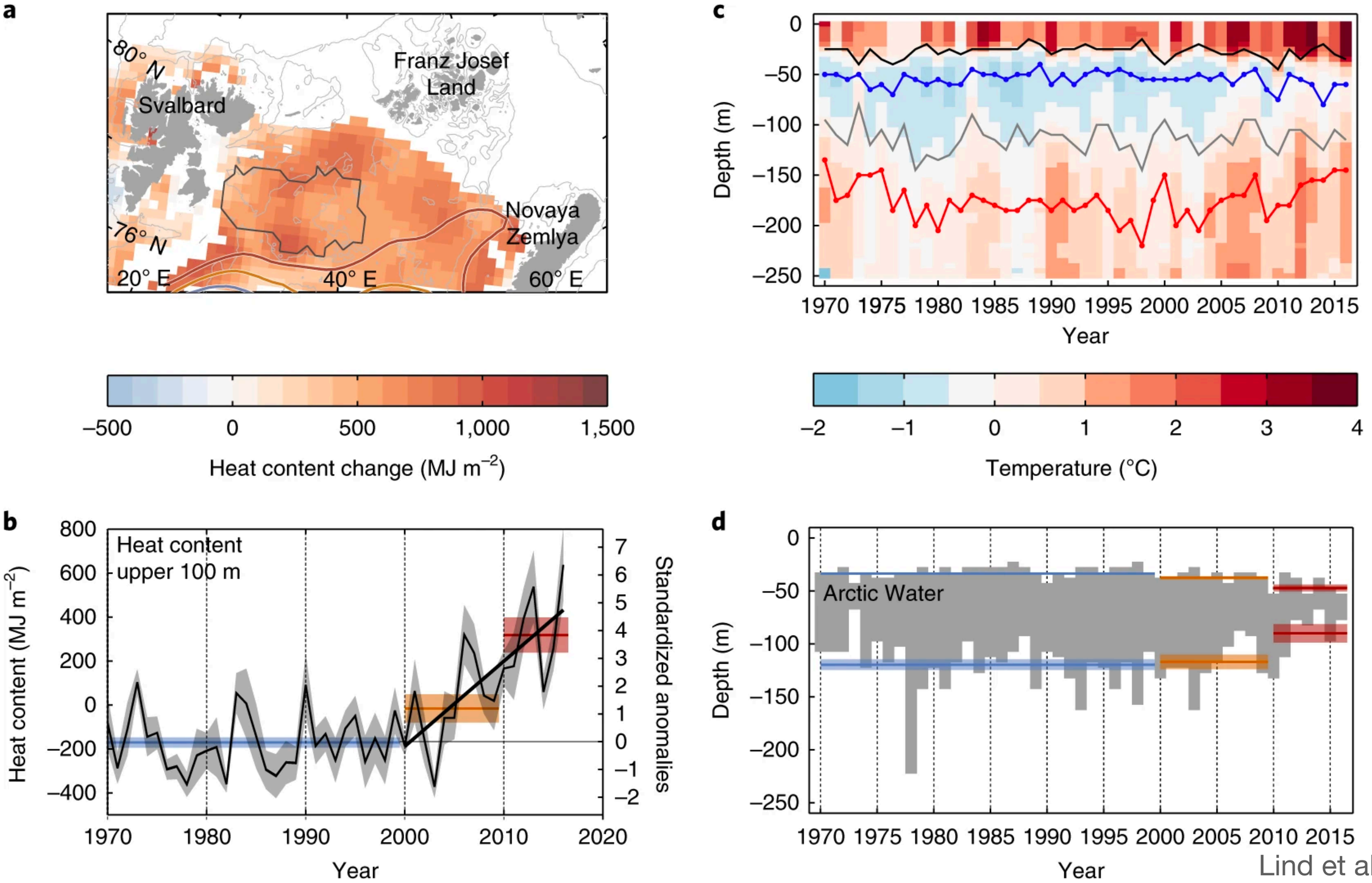
Carmack et al (2015)



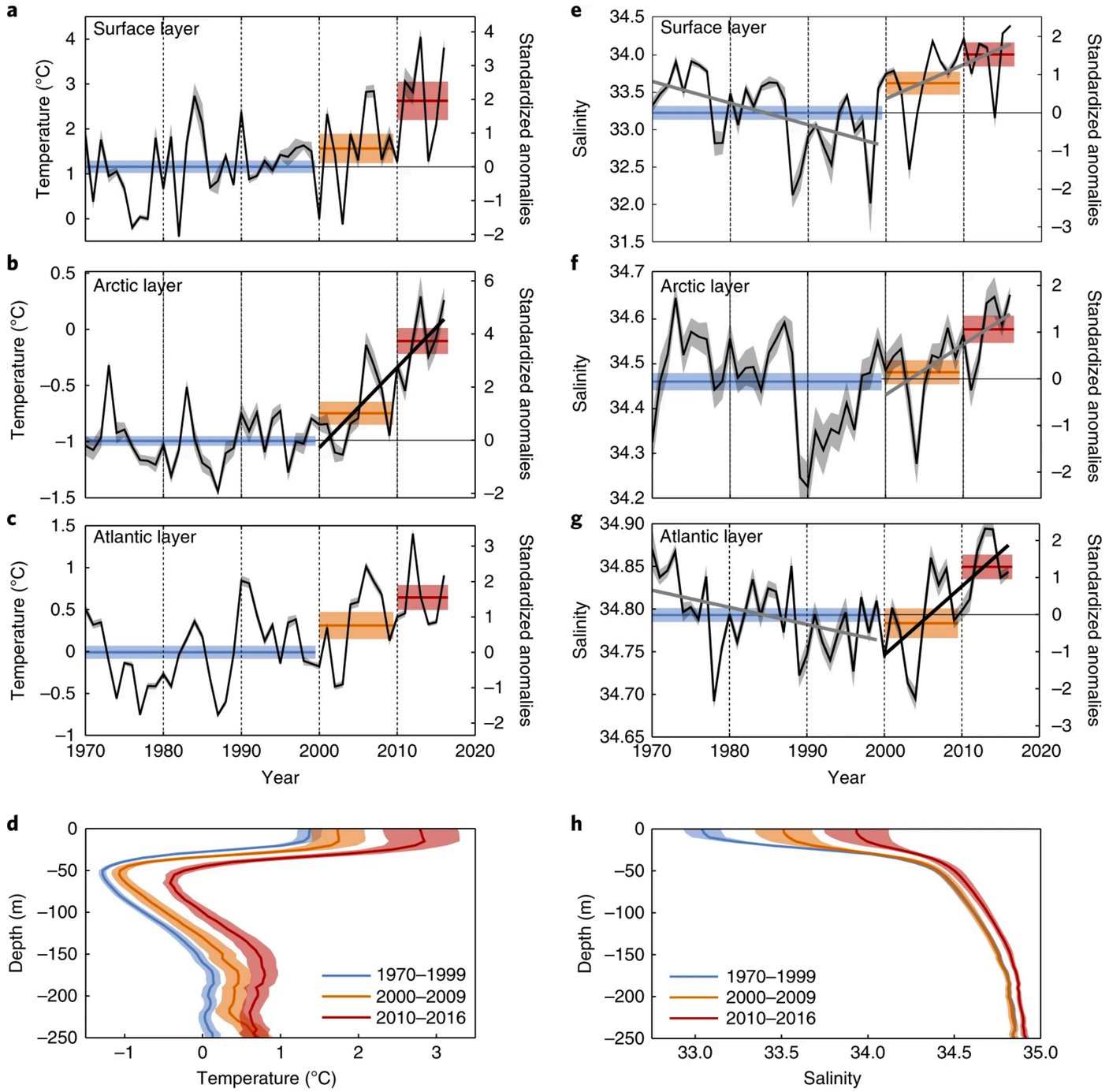
Polyakov et al (2010)



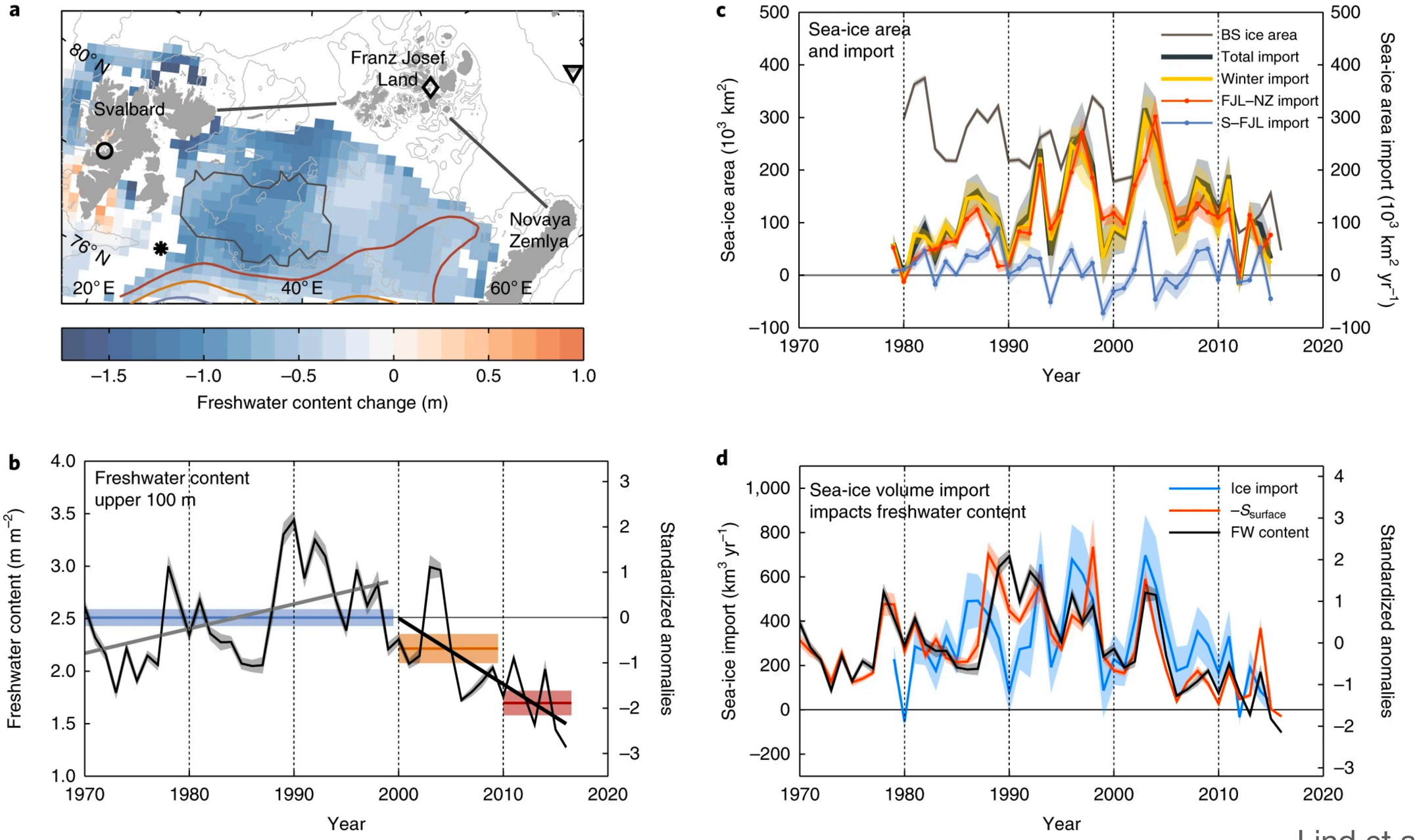
Lind et al (2018)



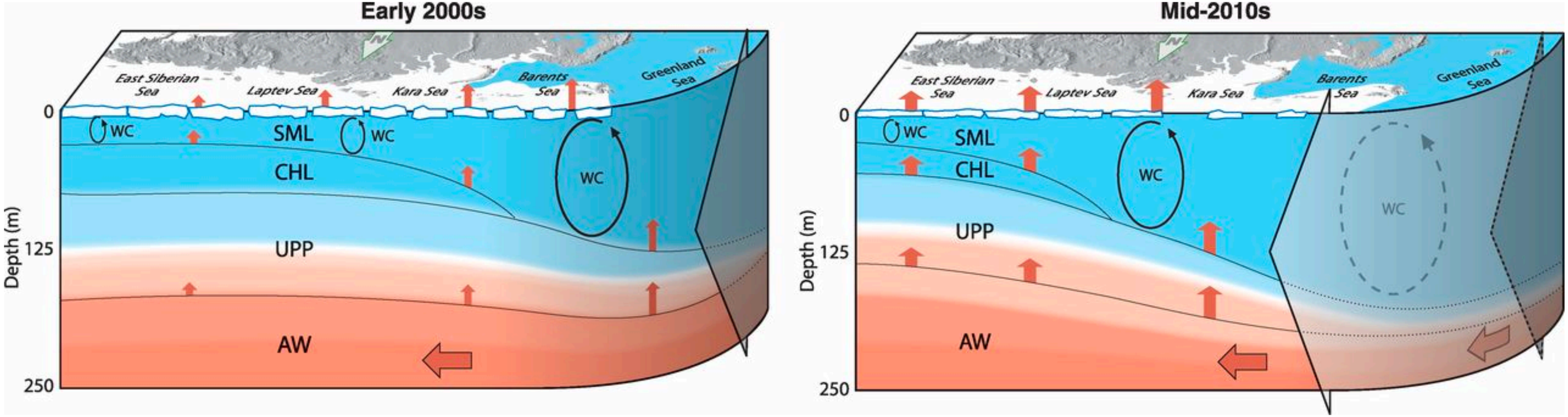
Lind et al (2018)



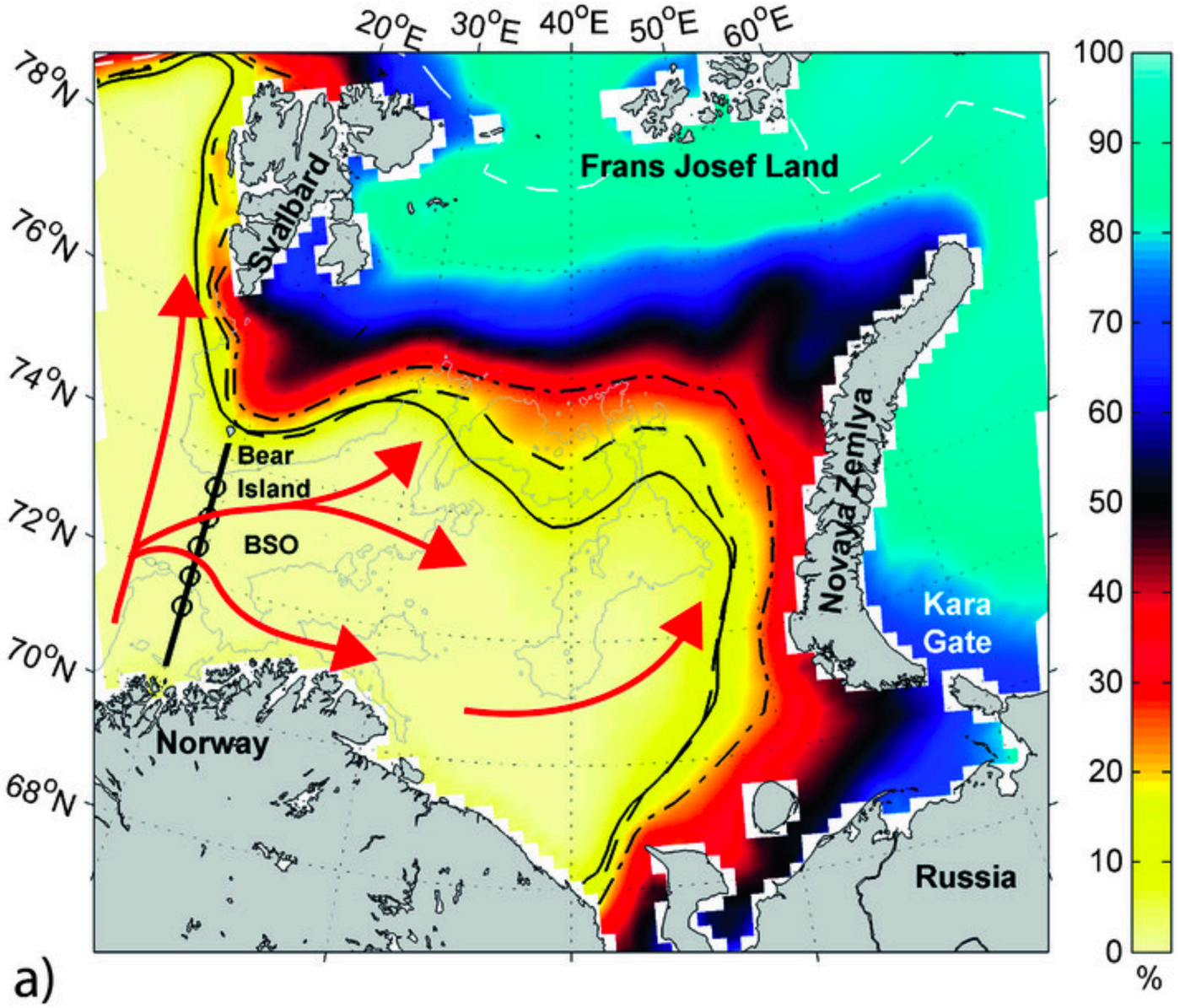
Lind et al (2018)

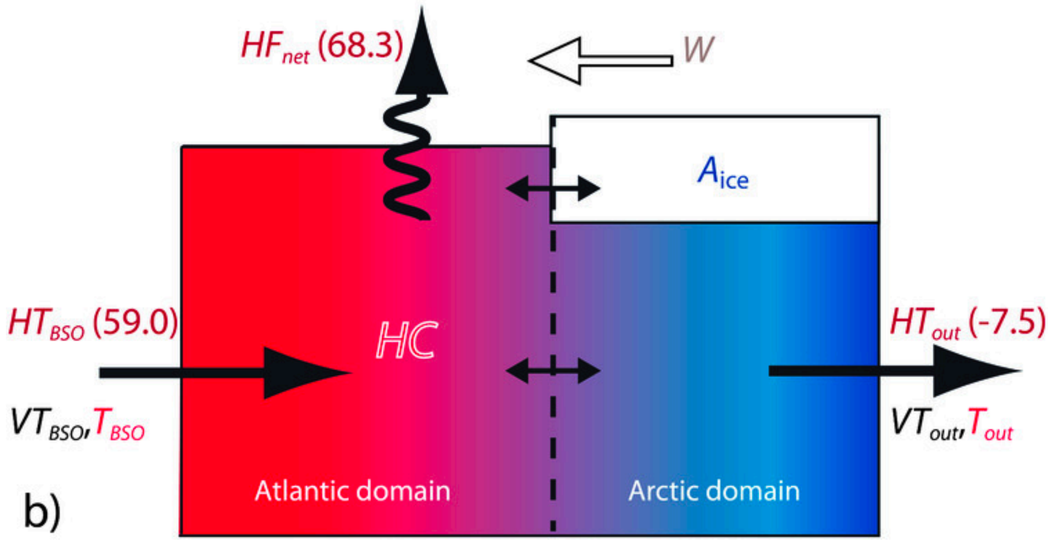


Lind et al (2018)



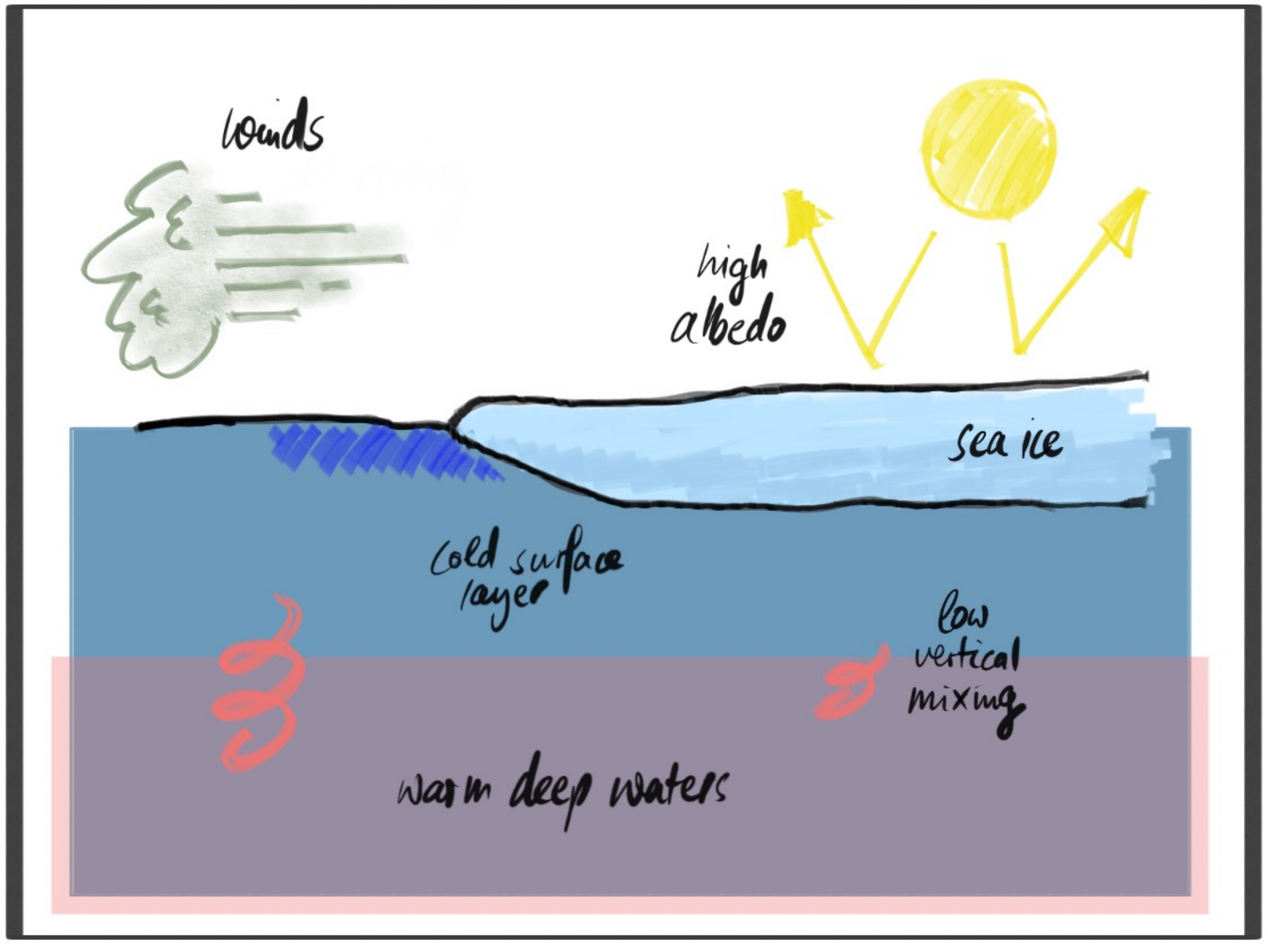
Polyakov et al (2010)

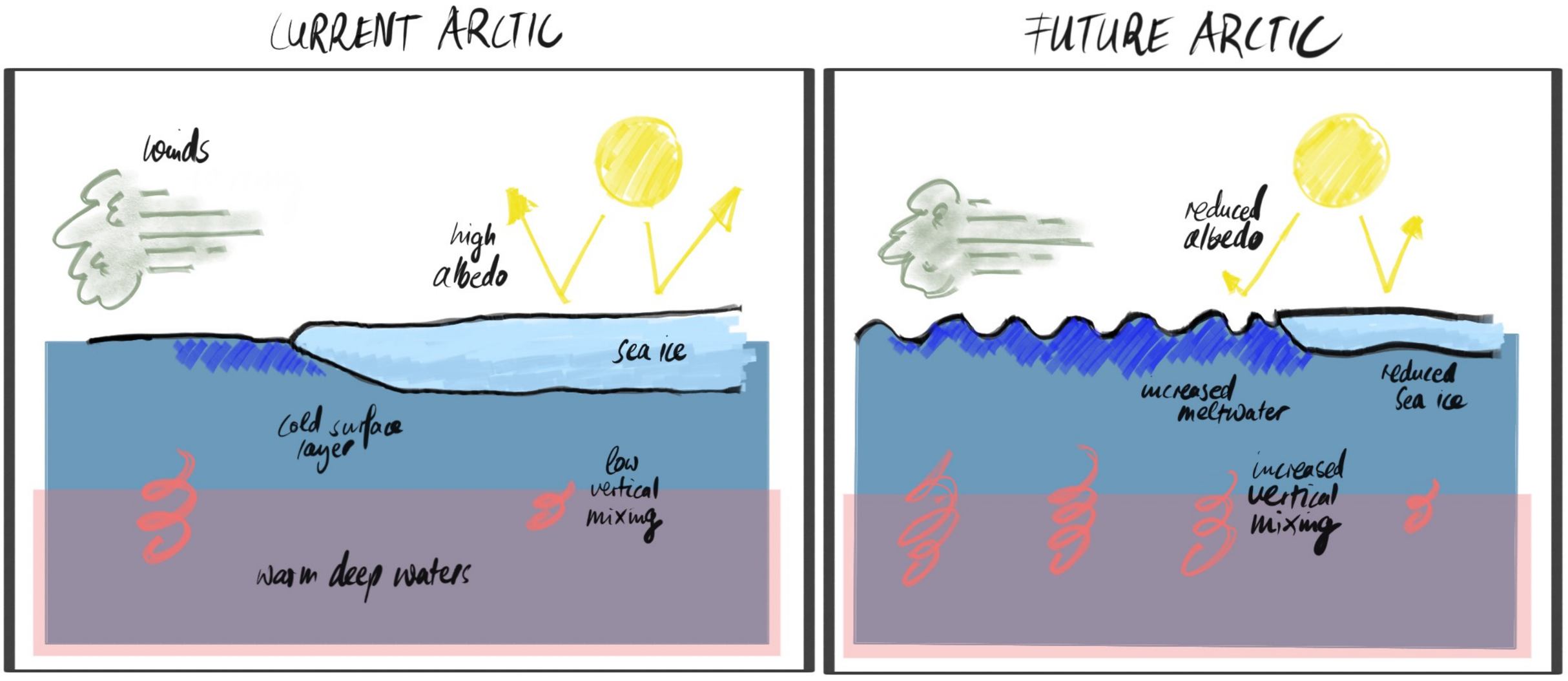


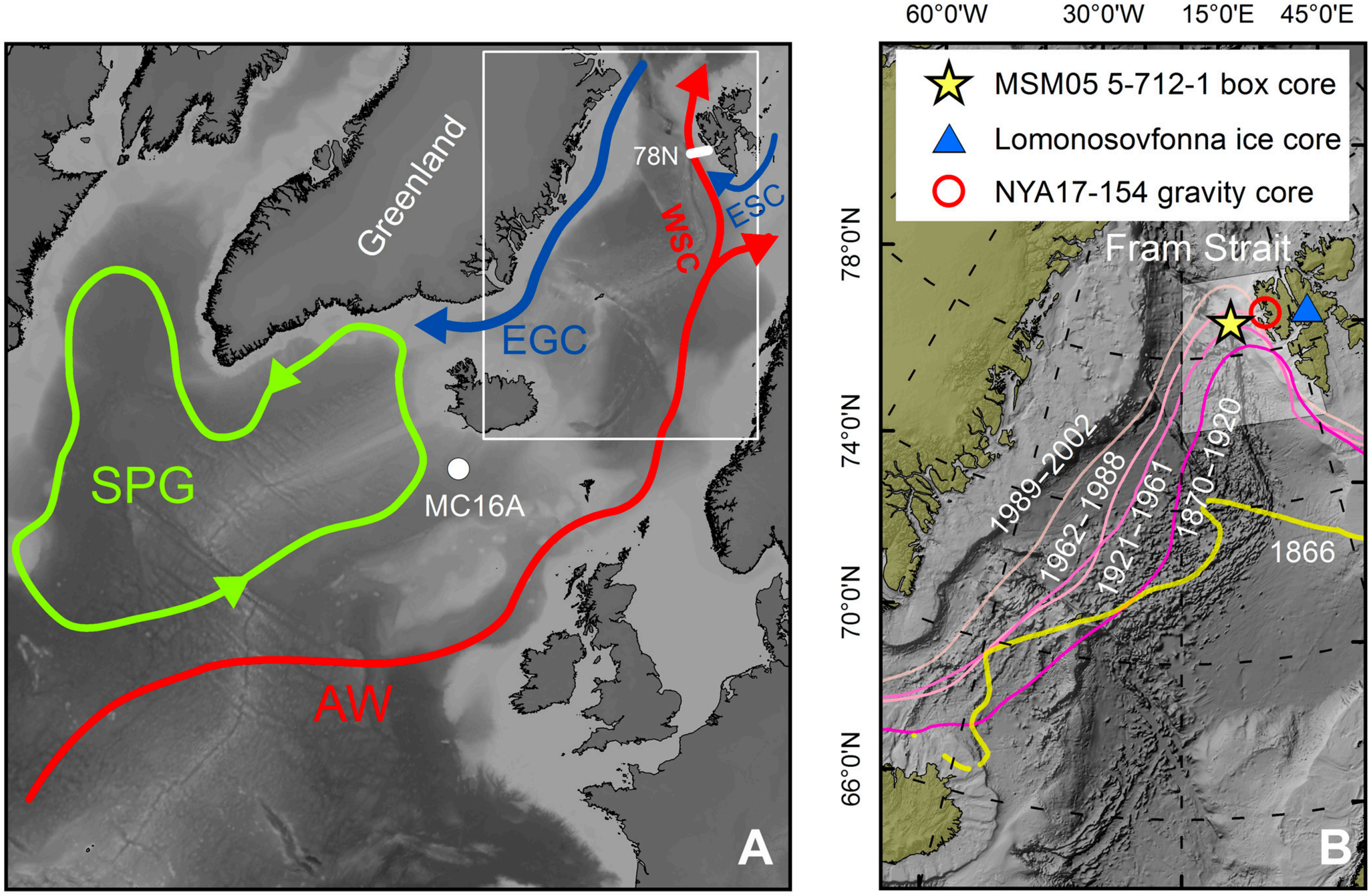


Årthun et al (2012)

CURRENT ARCTIC



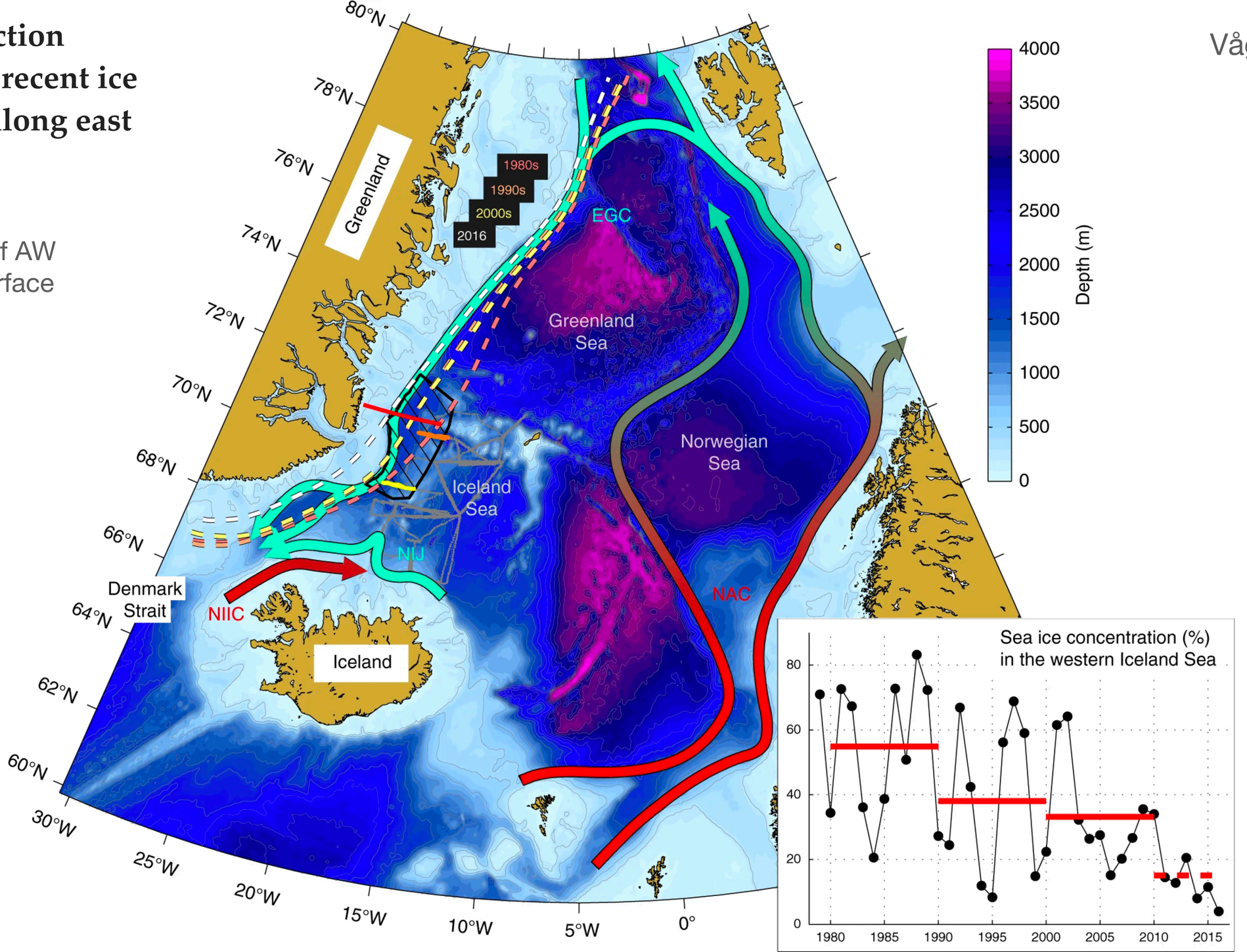

CURRENT ARCTIC
winds
high albedo
sea ice
cold surface layer
low vertical mixing
warm deep waters
FUTURE ARCTIC
reduced albedo
increased meltwater
reduced sea ice
increased vertical mixing


Greenland
78N
WSC
ESC
EGC
SPG
MC16A
AW
A
60°0'W
30°0'W
15°0'E
45°0'E
78°0'N
74°0'N
70°0'N
66°0'N
MSM05 5-712-1 box core
Lomonosovfonna ice core
NYA17-154 gravity core
Fram Strait
1989–2002
1962–1988
1921–1961
1870–1920
1866
B

Ocean convection linked to the recent ice edge retreat along east Greenland

(Re-ventilation of AW water due to Surface Layer Ekman Transport)

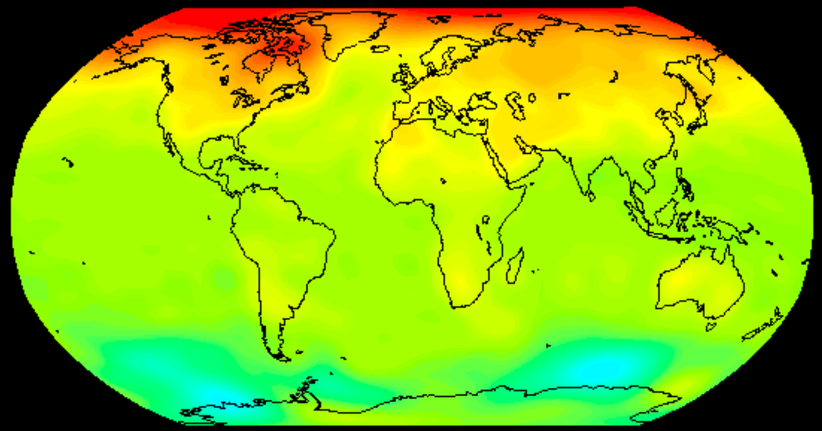
Våge et al (2018)



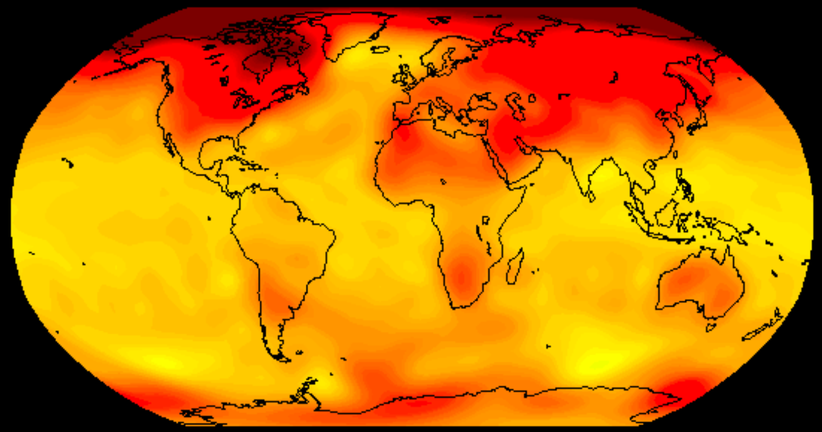
Impacts of Sea Ice Loss: Arctic Amplification

Surface Air Warming (deg F)

$2\times CO_2$

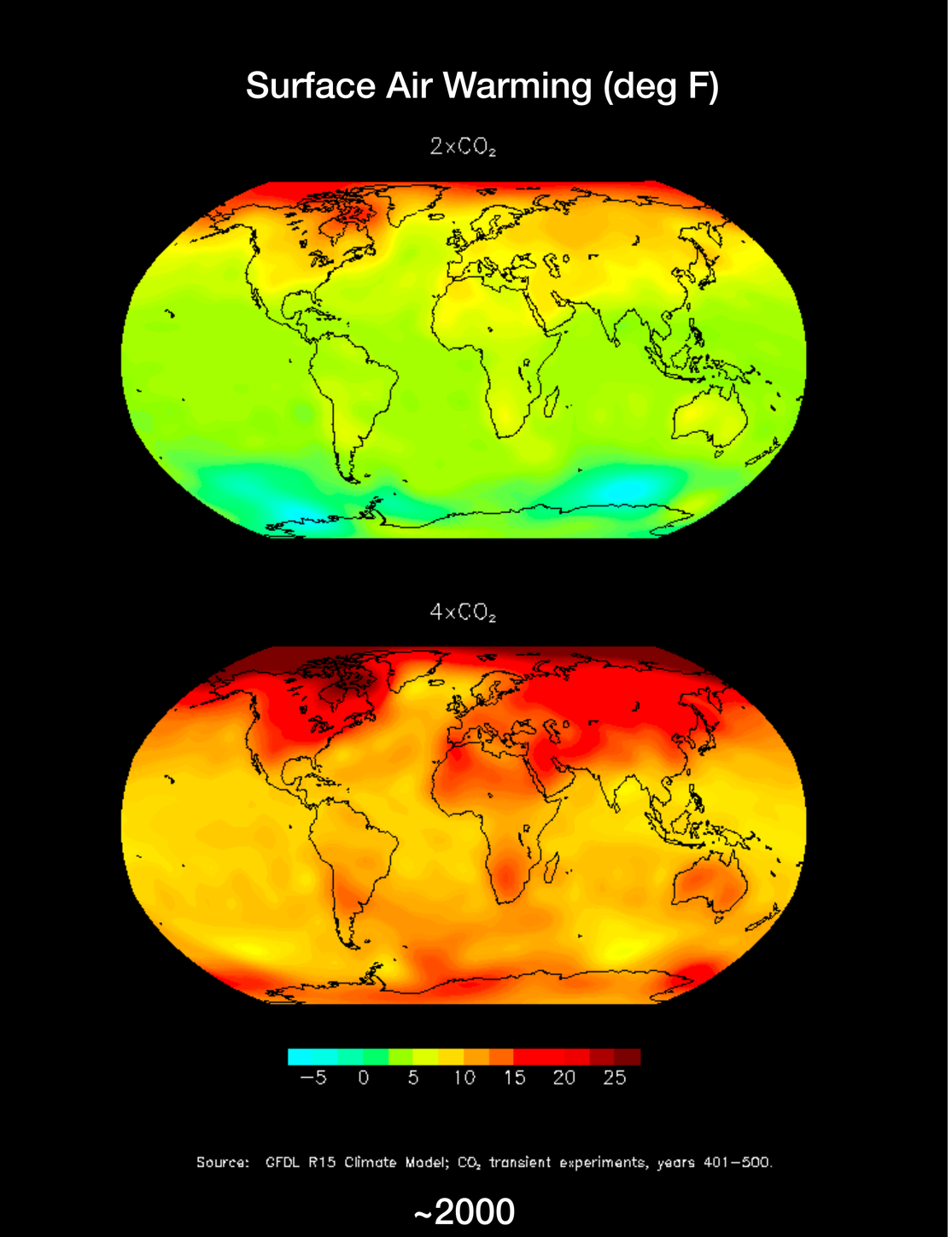


$4\times CO_2$

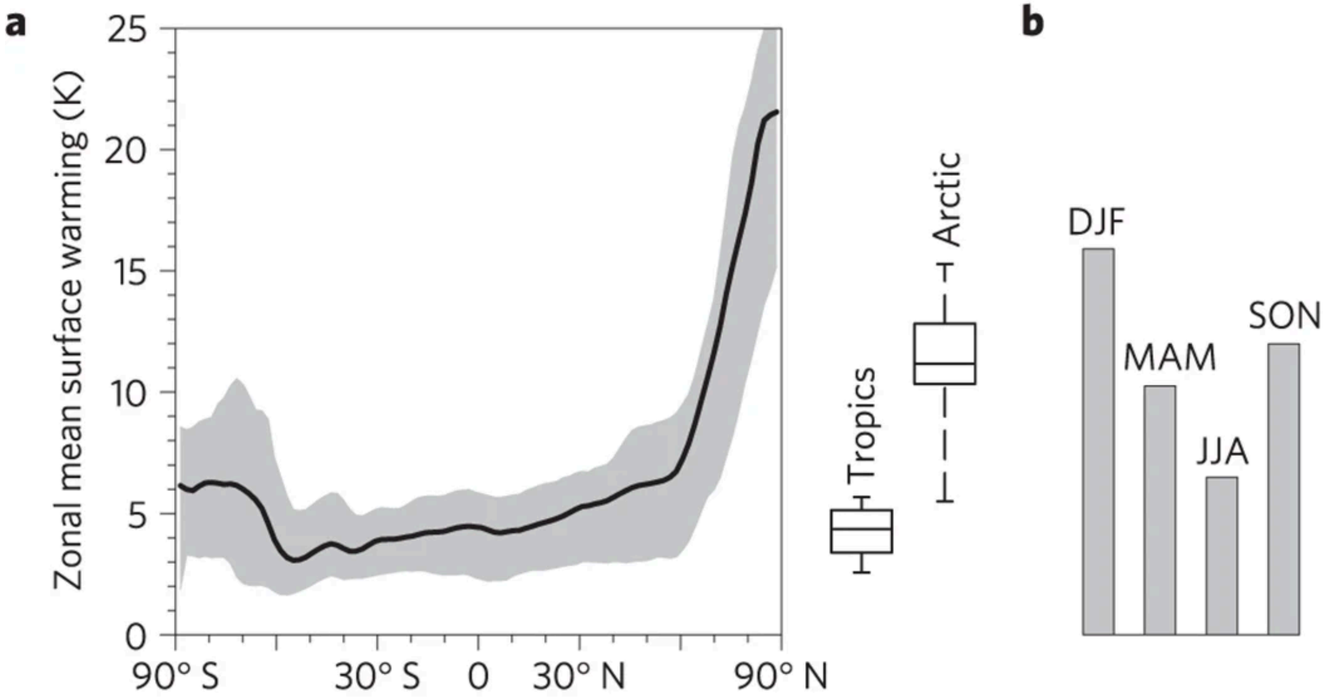


Source: GFDL R15 Climate Model; CO_2 transient experiments, years 401–500.

~2000

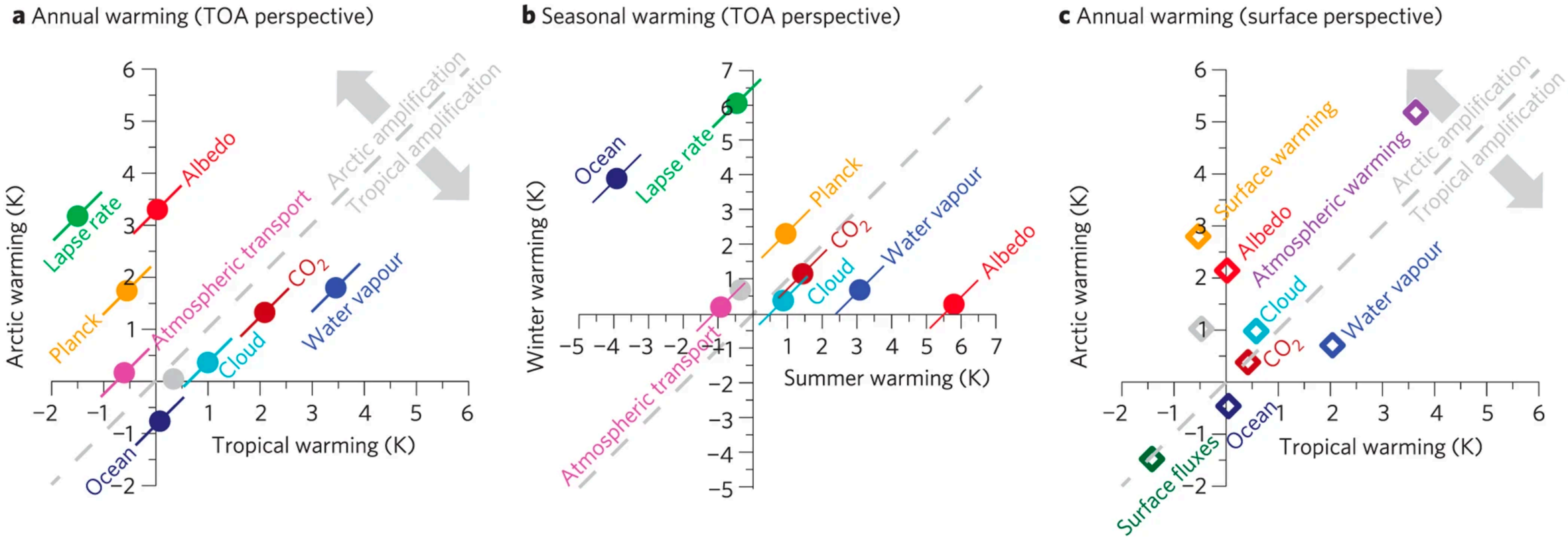


Arctic amplification in CMIP5 models (4 × CO_2)



Pithan and Mauritsen (2014)

Warming contributions of individual feedback mechanisms



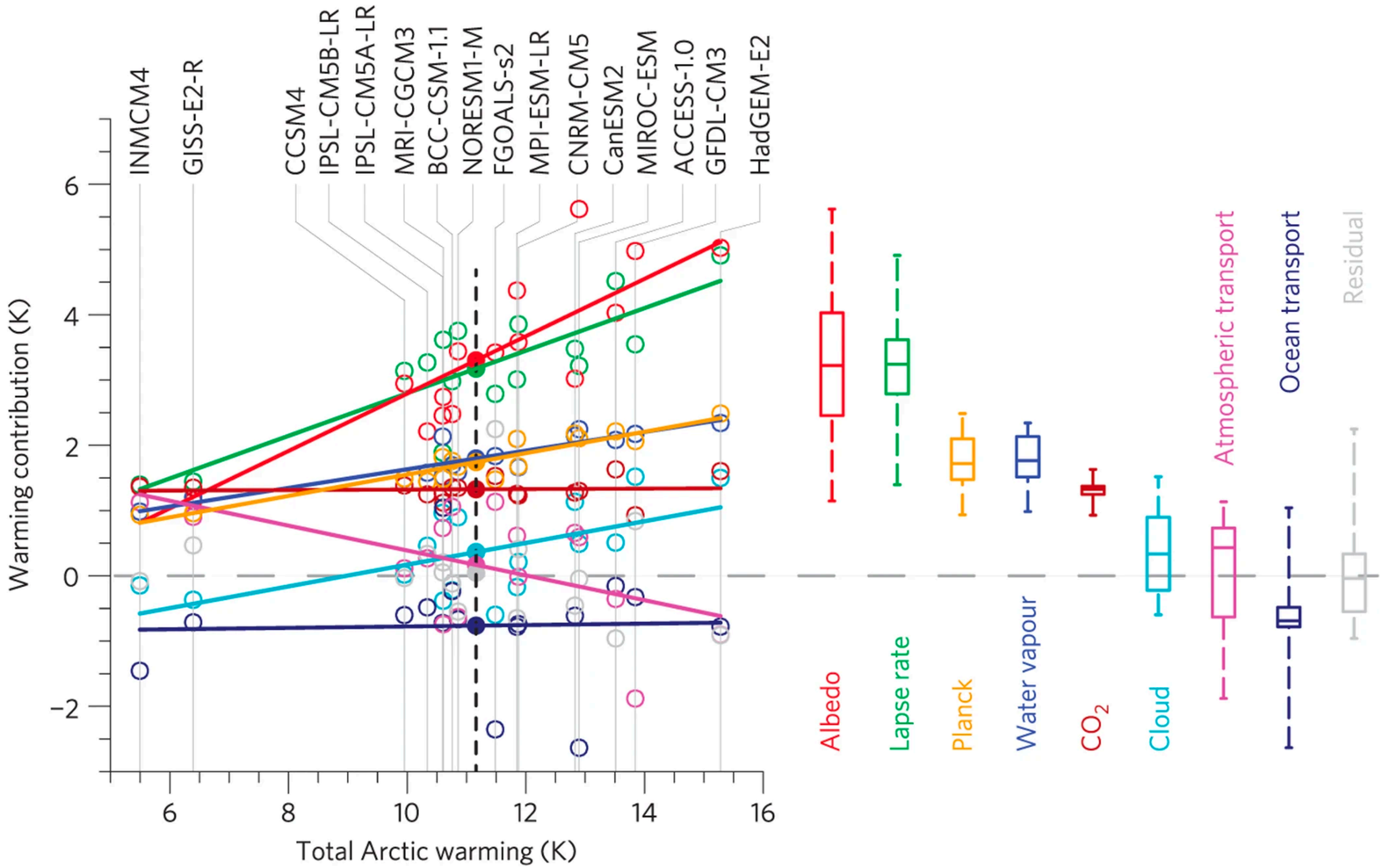
- Planck feedback: from vertically uniform warming

("For example, at 30C, an external forcing of 1W/m² can be balanced by a 0.16 C warming, whereas at -30C a 0.31C warming is required to balance the same forcing.")

- Lapse-rate feedback: from deviation of vertically uniform warming

Pithan and Mauritsen (2014)

Intermodel spread of Arctic warming contributions of feedbacks versus total Arctic warming in individual models.



Pithan and Mauritsen (2014)