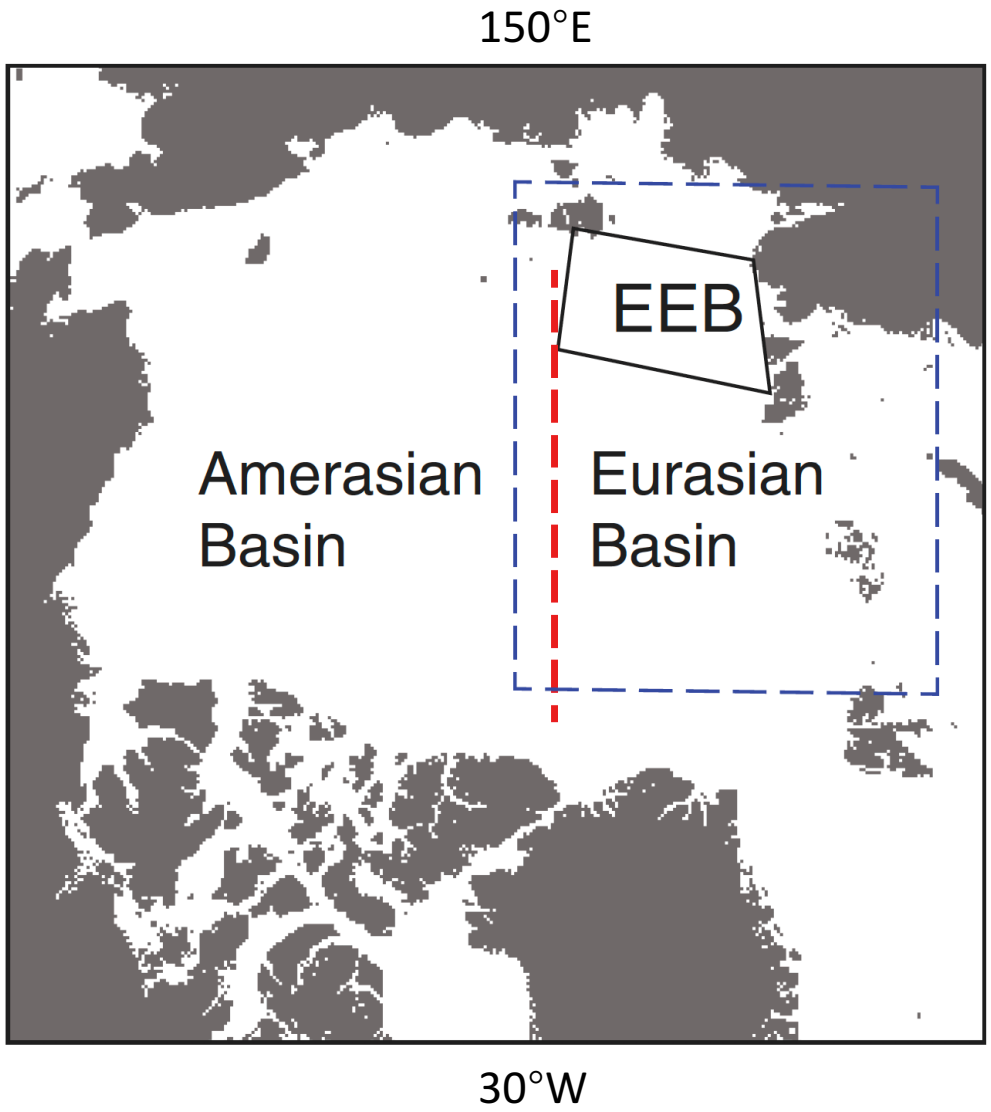
Greater role for Atlantic Inflows on sea-ice loss in the Eurasian Basin of the Arctic Ocean

Science, 2017



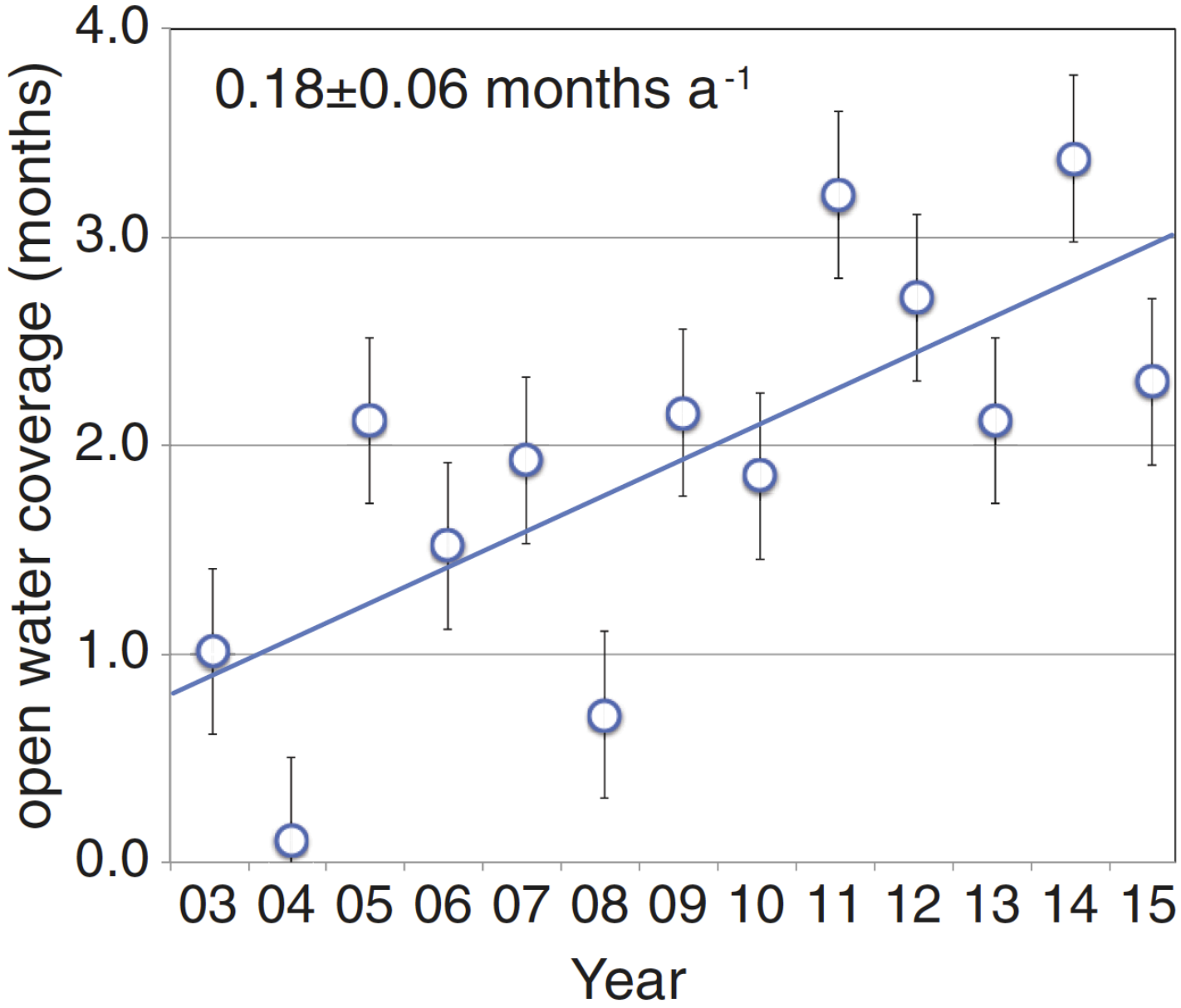
- Ice reduction
- Halocline weakening
- Atlantic Water shoaling

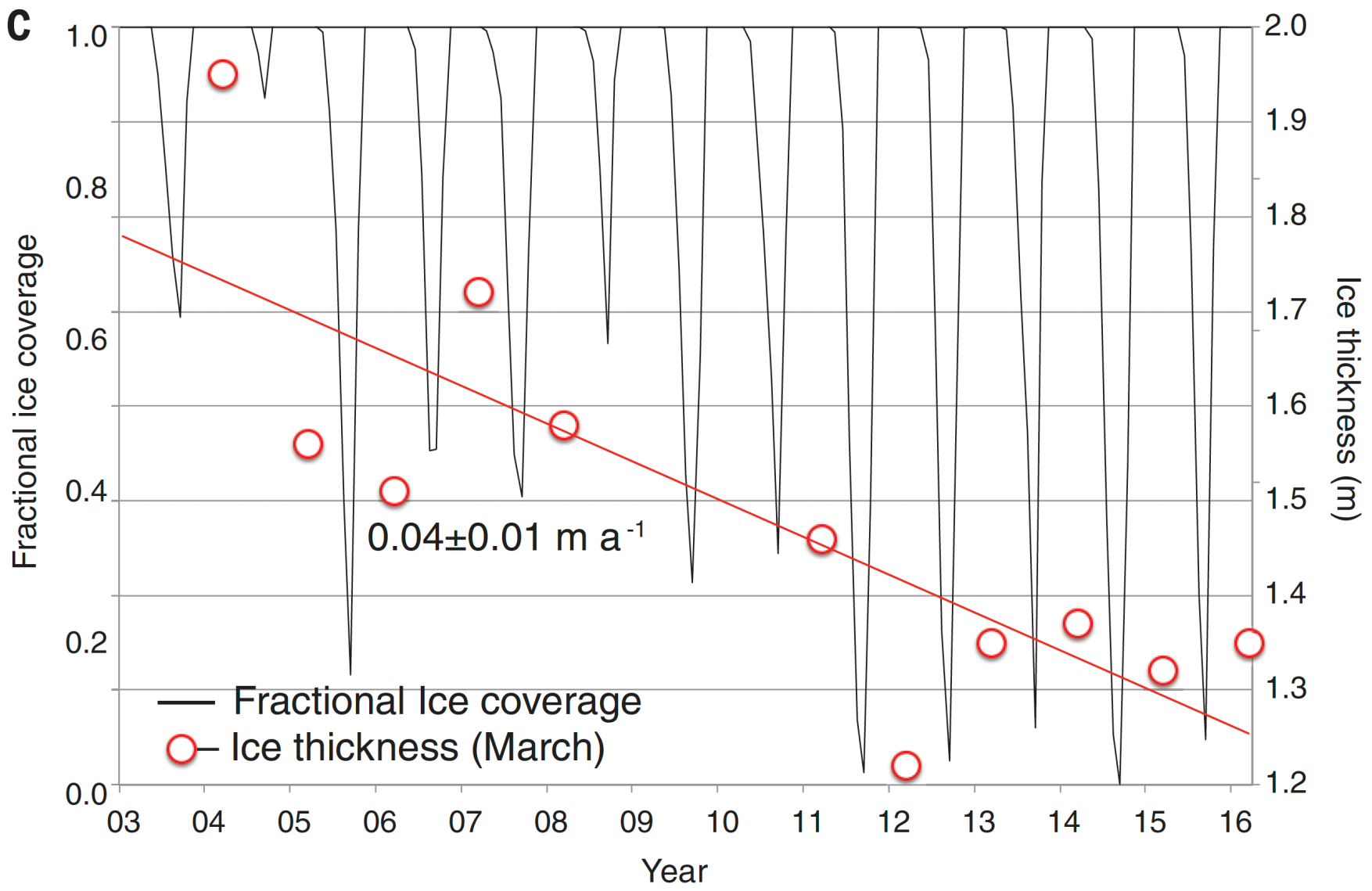
→ Winter ventilation increasing

↓

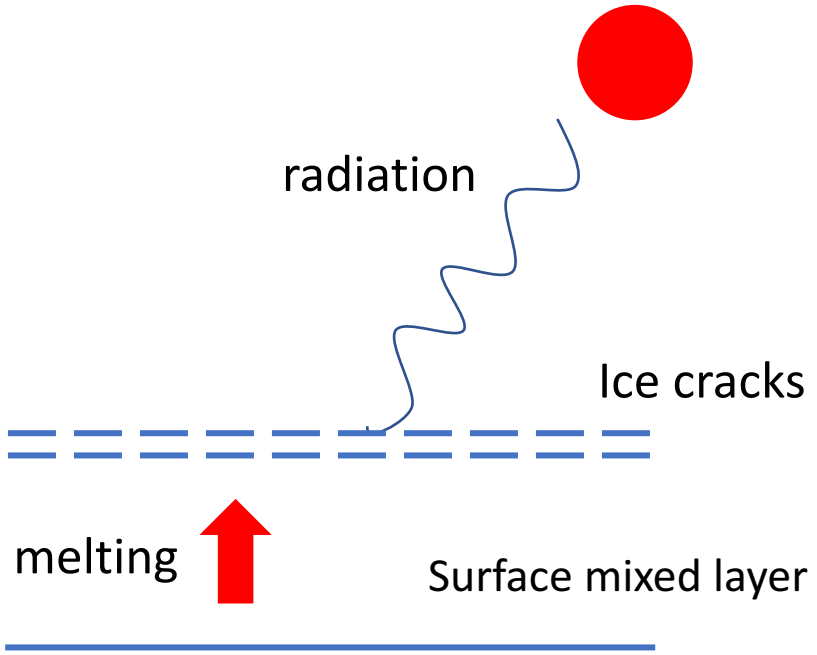
Enhanced oceanic heat releasing

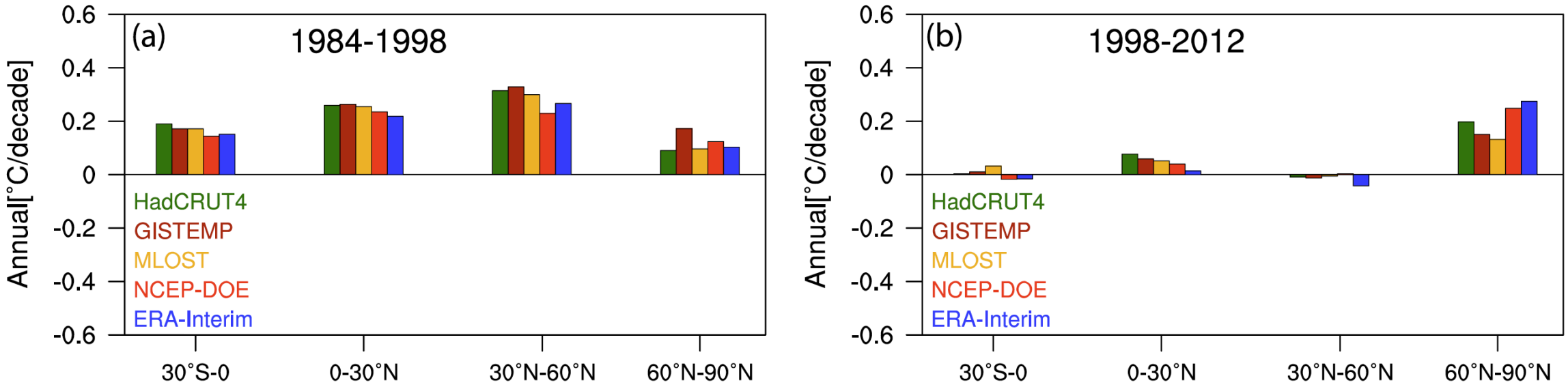
← Reduction of sea-ice cover

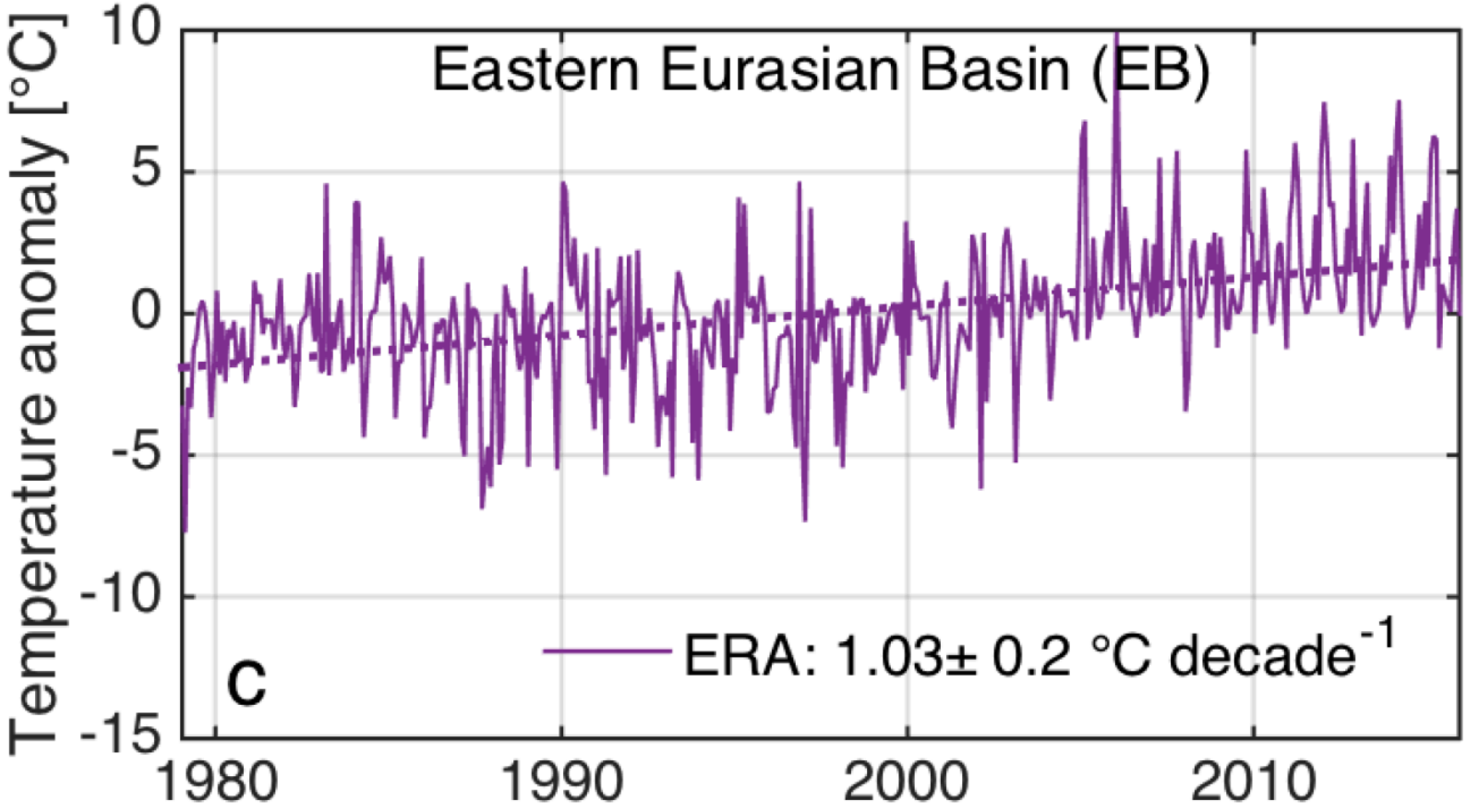

0.18±0.06 months a-1
open water coverage (months)
4.0
3.0
2.0
1.0
0.0
03 04 05 06 07 08 09 10 11 12 13 14 15
Year

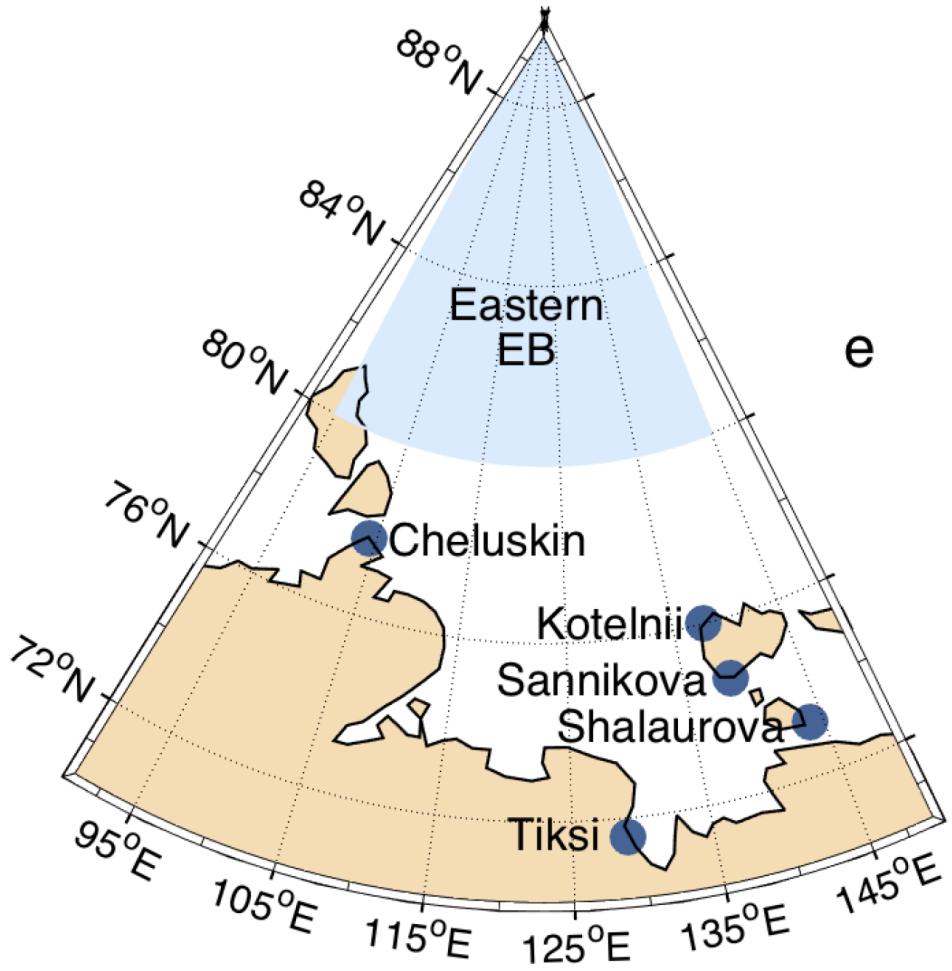

c
1.0
0.8
0.6
0.4
0.2
0.0
Fractional ice coverage
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
Ice thickness (m)
0.04±0.01 m a-1
Fractional Ice coverage
Ice thickness (March)
03
04
05
06
07
08
09
10
11
12
13
14
15
16
Year

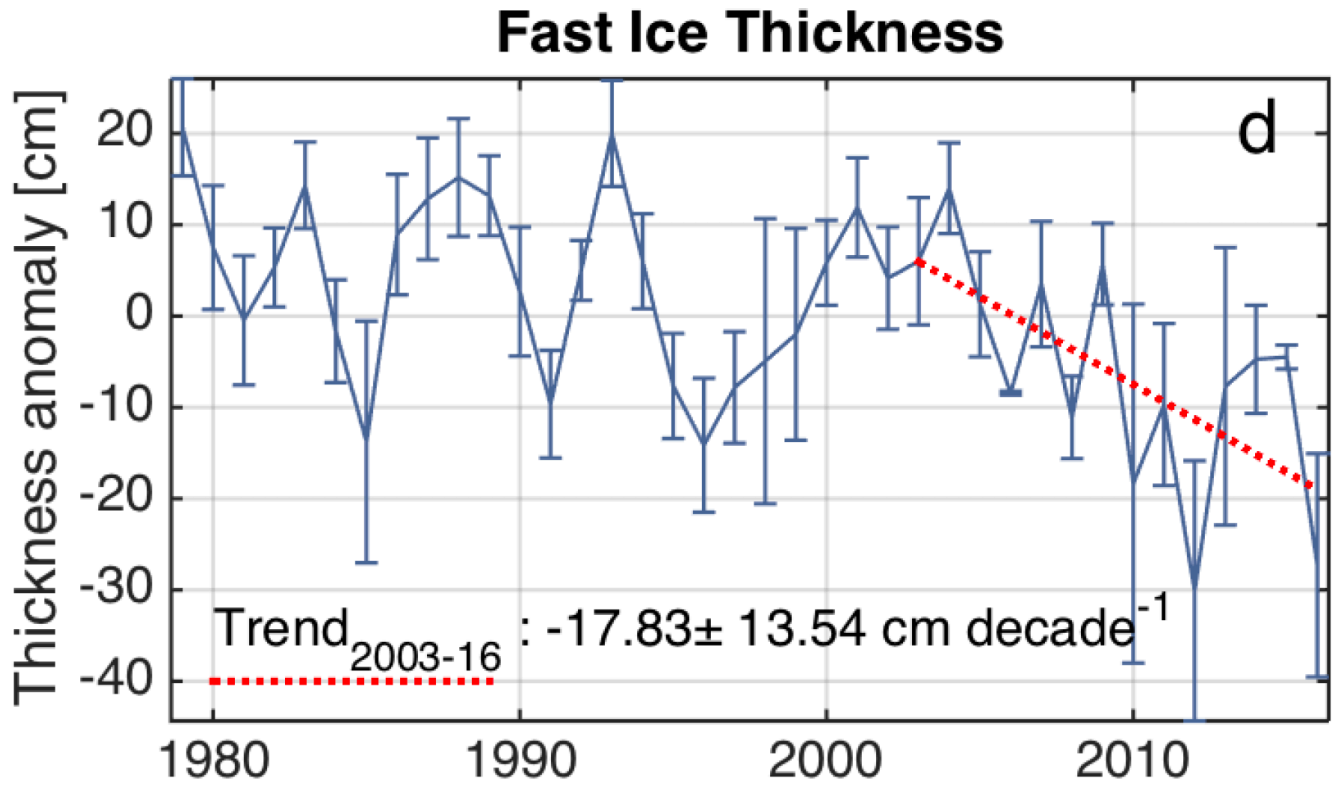
Ice cracks

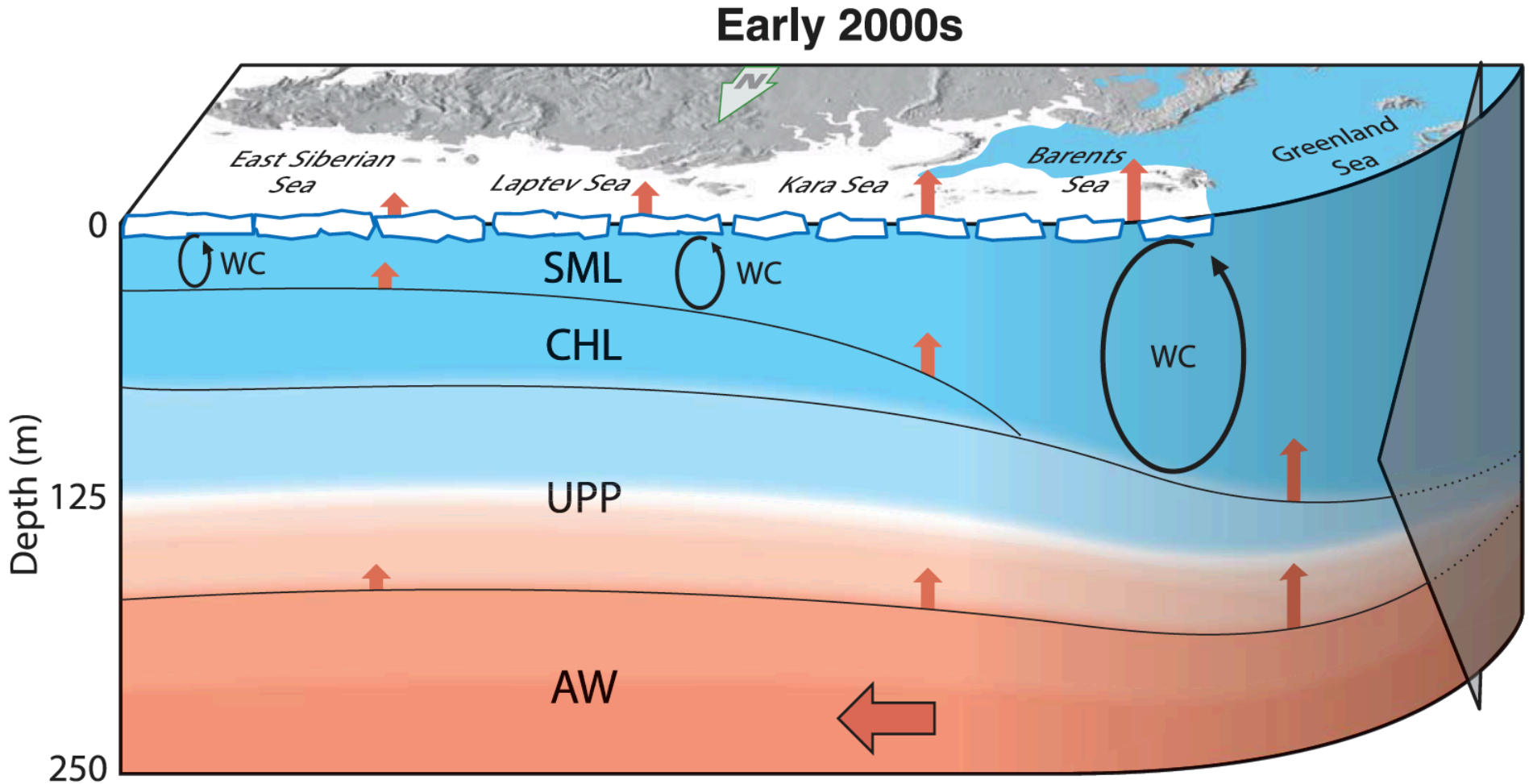

radiation
Ice cracks
melting
Surface mixed layer

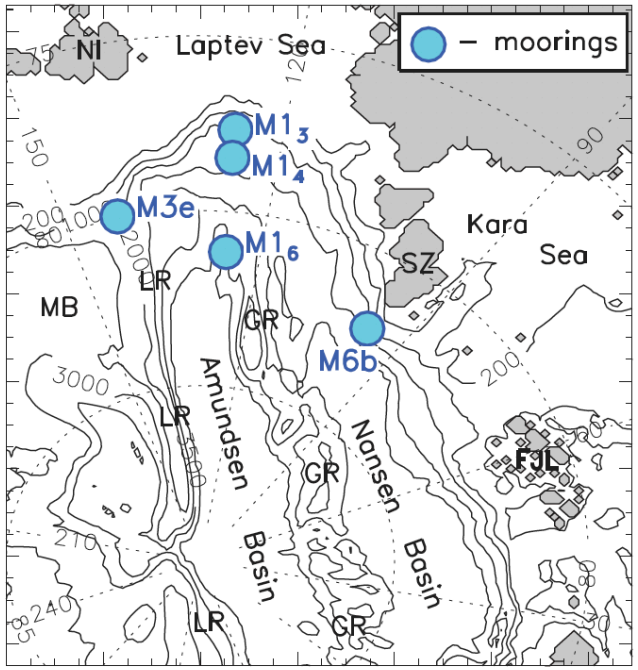

(a)
1984-1998
(b)
1998-2012
Annual[˚C/decade]
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
HadCRUT4
GISTEMP
MLOST
NCEP-DOE
ERA-Interim
30˚S-0
0-30˚N
30˚N-60˚N
60˚N-90˚N

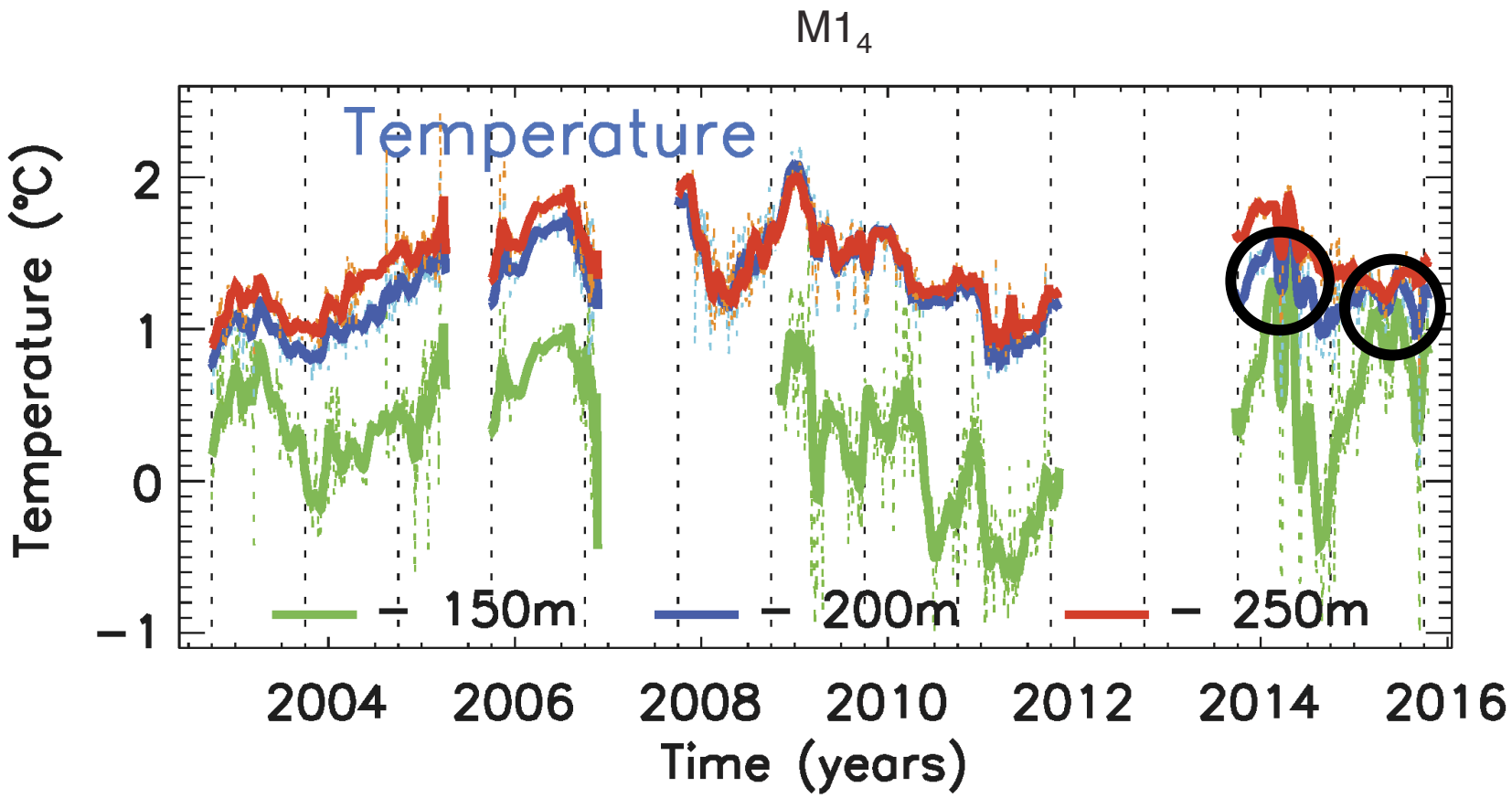

Eastern Eurasian Basin (EB)
Temperature anomaly [°C]
10
5
0
-5
-10
-15
1980
1990
2000
2010
c
ERA: 1.03± 0.2 °C decade-1


88°N
84°N
80°N
76°N
72°N
95°E
105°E
115°E
125°E
135°E
145°E
Eastern
EB
e
Cheluskin
Kotelnii
Sannikova
Shalaurova
Tiksi

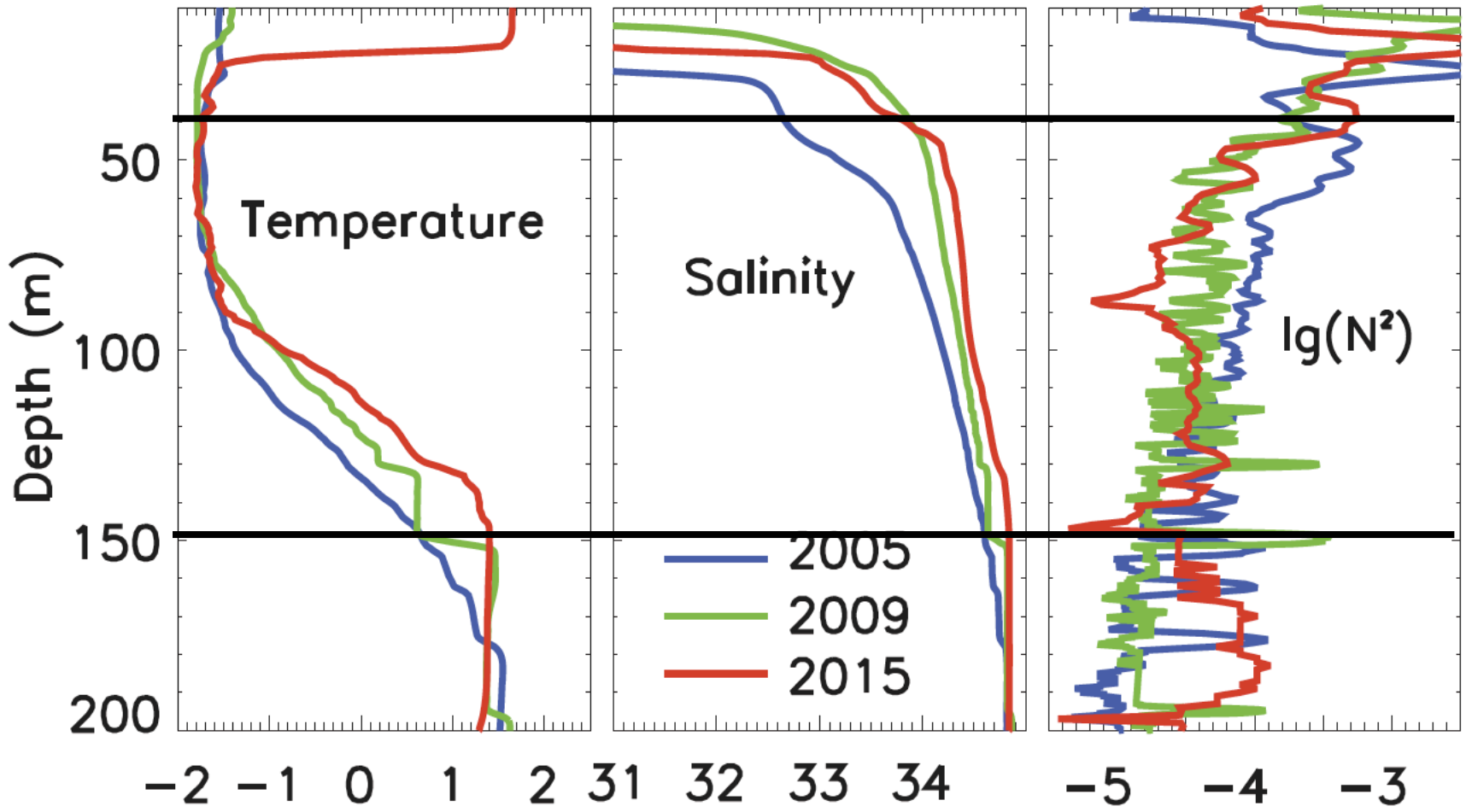

Fast Ice Thickness
d
Thickness anomaly [cm]
20
10
0
-10
-20
-30
-40
1980
1990
2000
2010
Trend2003-16 : -17.83± 13.54 cm decade-1

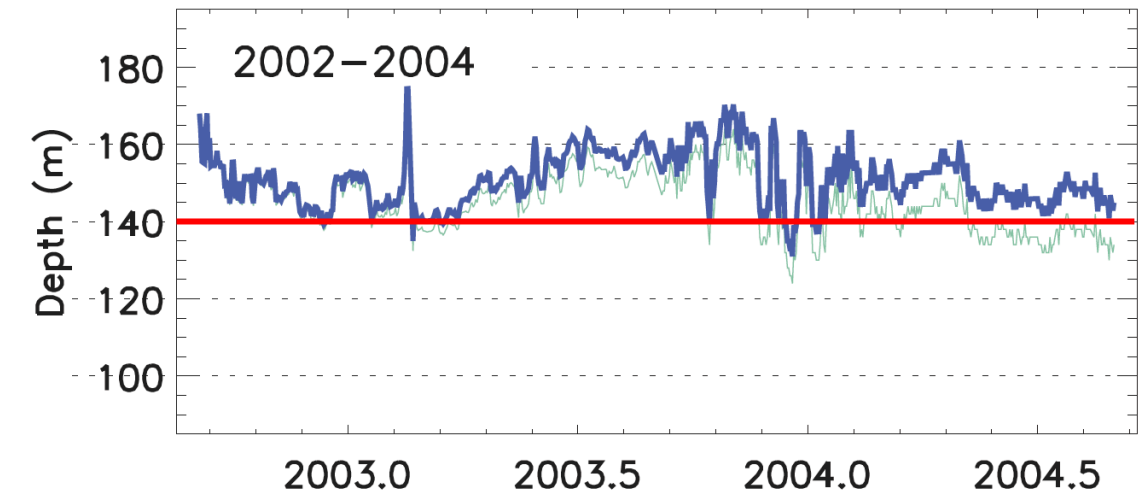

Early 2000s
East Siberian Sea
Laptev Sea
Kara Sea
Barents Sea
Greenland Sea
0
125
250
Depth (m)
WC
WC
WC
SML
CHL
UPP
AW

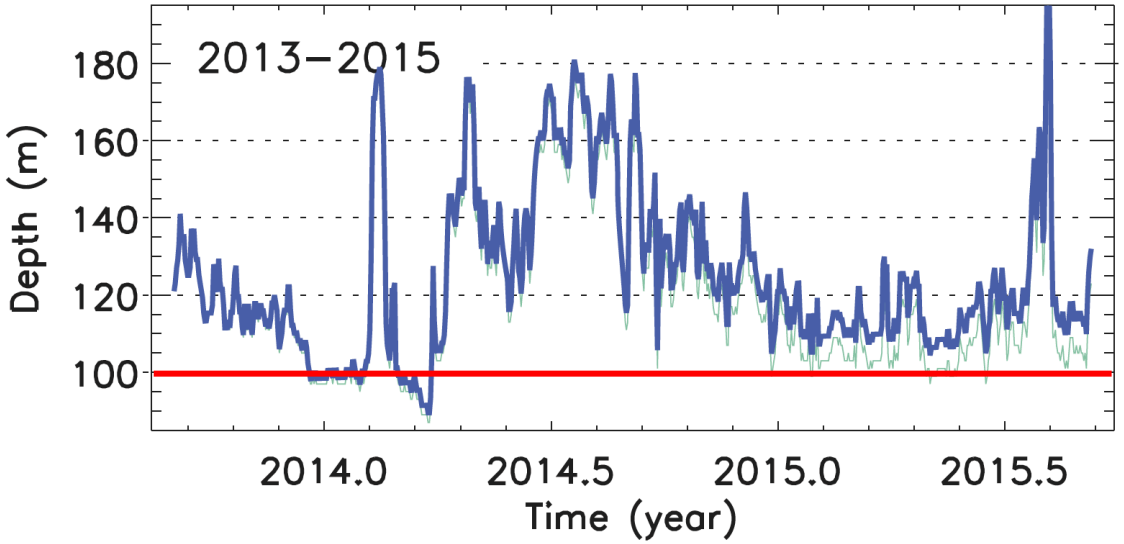

NI
Laptev Sea
– moorings
M1 3
M1 4
M3e
M1 6
M6b
Kara
Sea
SZ
LR
MB
GR
Amundsen
Basin
Nansen
Basin
FJL
LR
GR
LR
GR

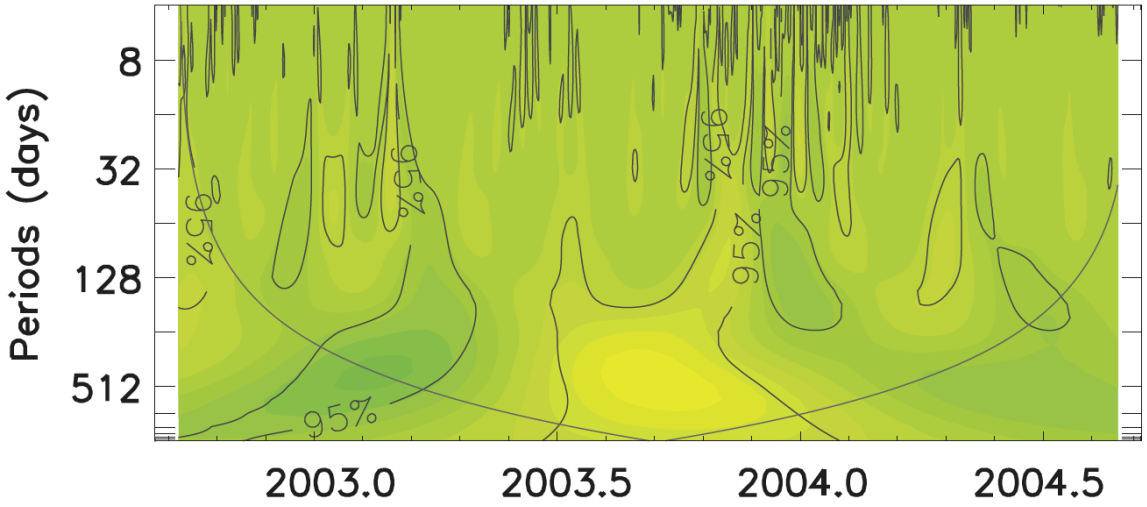

M1 4
Temperature
Temperature (°C)
2
1
0
–1
– 150m
– 200m
– 250m
2004
2006
2008
2010
2012
2014
2016
Time (years)

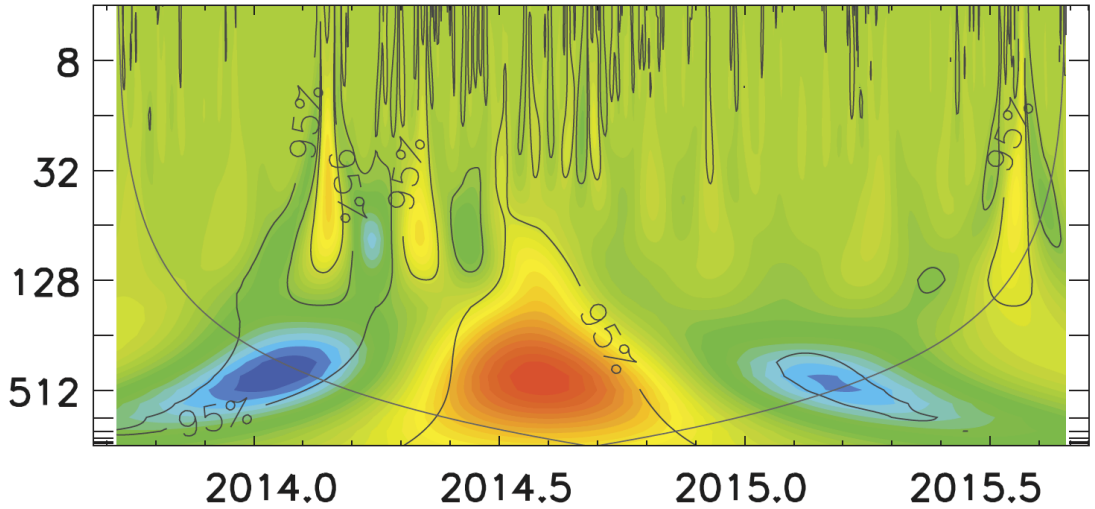
CTD profiles

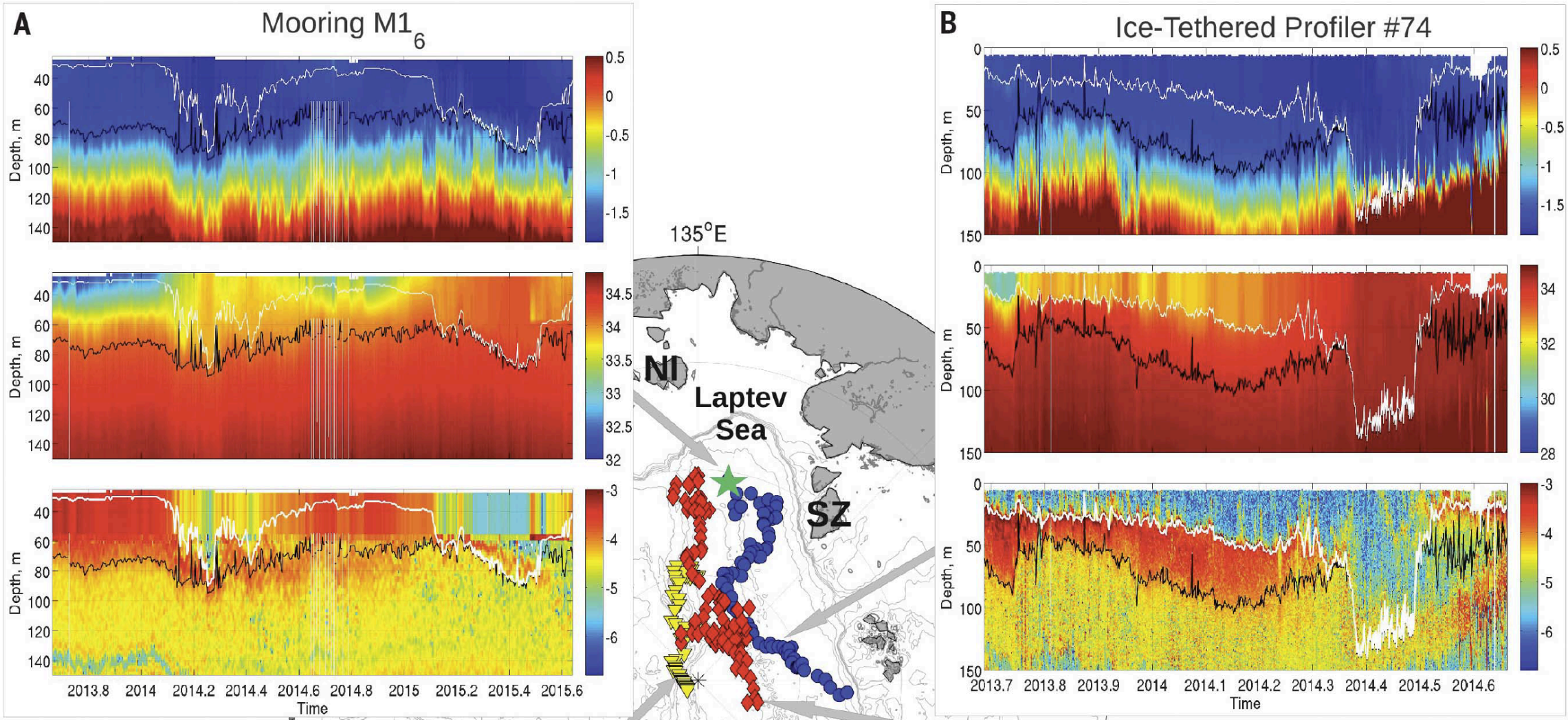


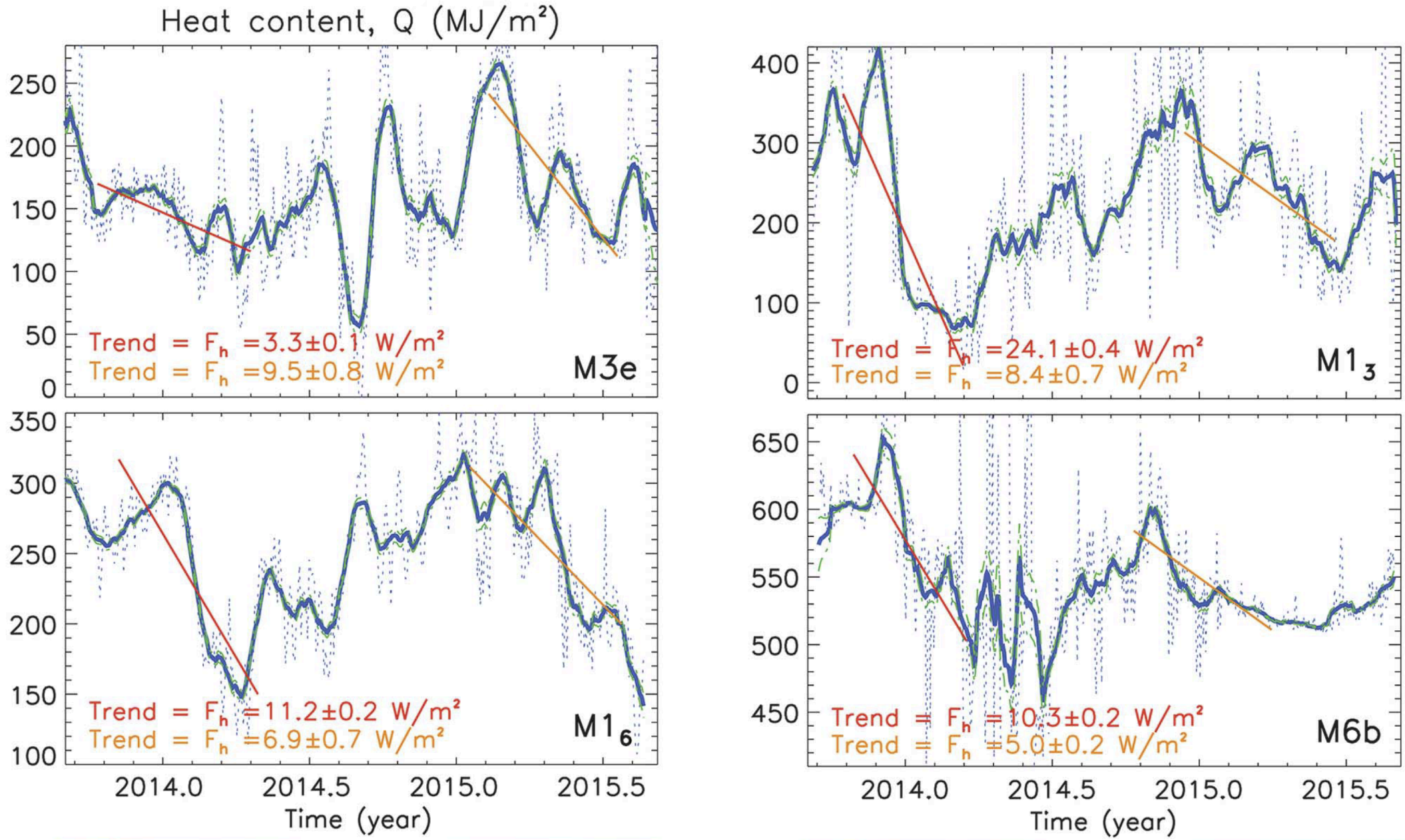

2002–2004
Depth (m)
180
160
140
120
100
2003.0
2003.5
2004.0
2004.5

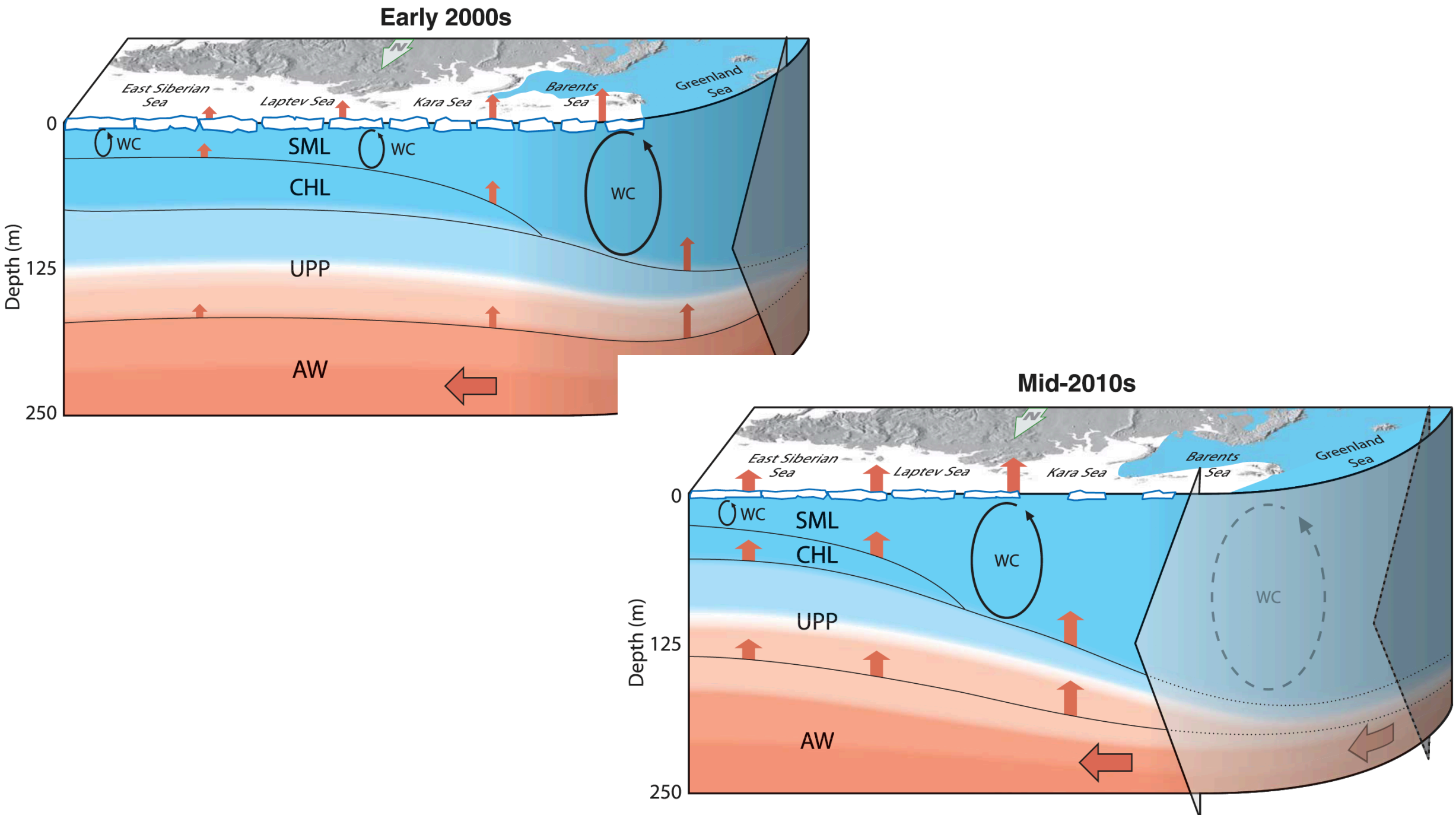

2013–2015
Depth (m)
180
160
140
120
100
2014.0
2014.5
2015.0
2015.5
Time (year)

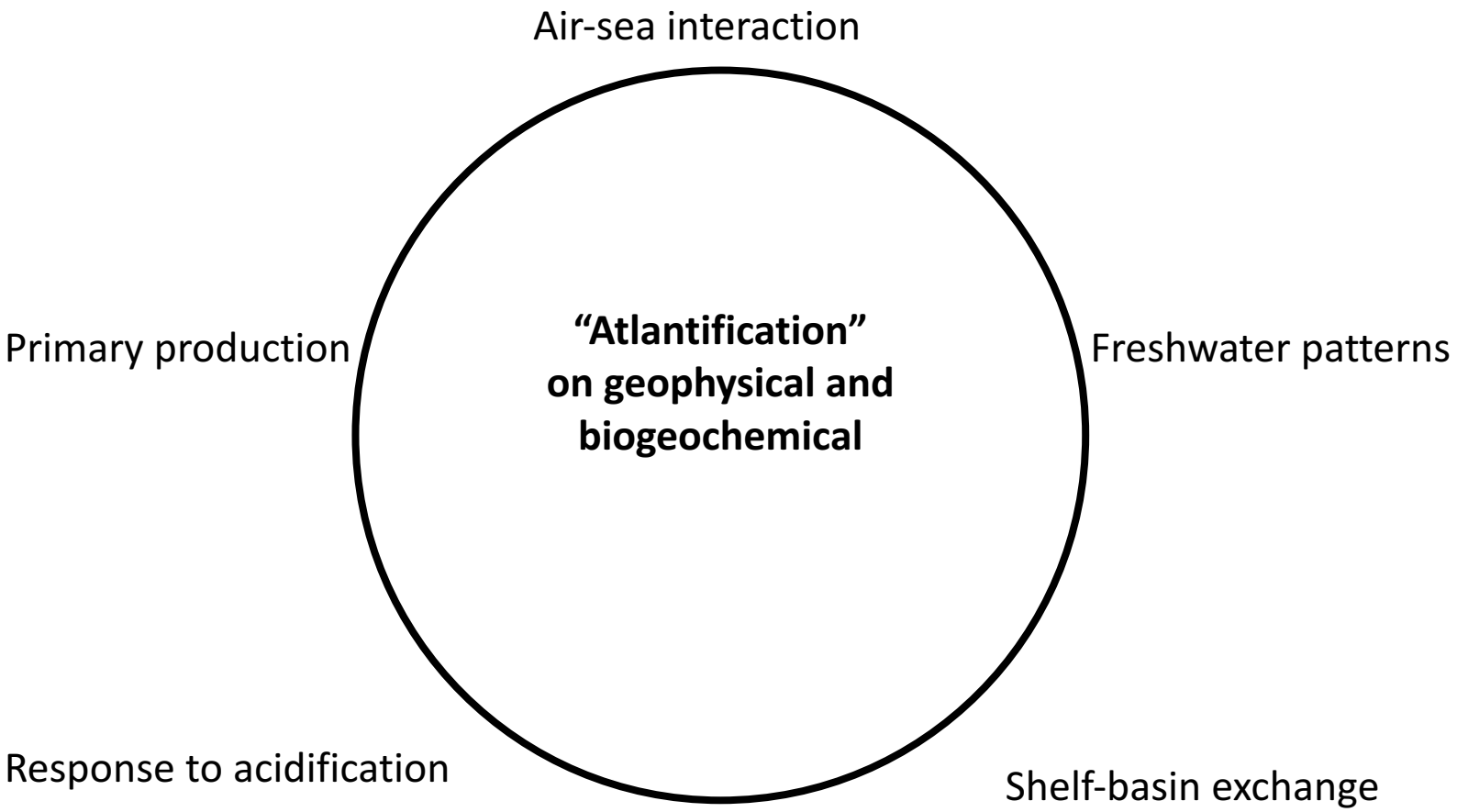

Periods (days)
8
32
128
512
95%
2003.0
2003.5
2004.0
2004.5


8
32
128
512
95%
2014.0
2014.5
2015.0
2015.5


A
Mooring M1
6
Depth, m
Time
2013.8
2014
2014.2
2014.4
2014.6
2014.8
2015
2015.2
2015.4
2015.6
135°E
NI
Laptev
Sea
SZ
B
Ice-Tethered Profiler #74
2013.7
2013.8
2013.9
2014
2014.1
2014.2
2014.3
2014.4
2014.5
2014.6


Heat content, Q (MJ/m²)
Trend = F_h =3.3±0.1 W/m²
Trend = F_h =9.5±0.8 W/m²
M3e
Trend = F_h =24.1±0.4 W/m²
Trend = F_h =8.4±0.7 W/m²
M1_3
Trend = F_h =11.2±0.2 W/m²
Trend = F_h =6.9±0.7 W/m²
M1_6
Trend = F_h =10.3±0.2 W/m²
Trend = F_h =5.0±0.2 W/m²
M6b
2014.0
2014.5
2015.0
2015.5
Time (year)


Early 2000s
East Siberian Sea
Laptev Sea
Kara Sea
Barents Sea
Greenland Sea
0
125
250
Depth (m)
WC
SML
CHL
UPP
AW
Mid-2010s


Air-sea interaction
Primary production
“Atlantification” on geophysical and biogeochemical
Freshwater patterns
Response to acidification
Shelf-basin exchange