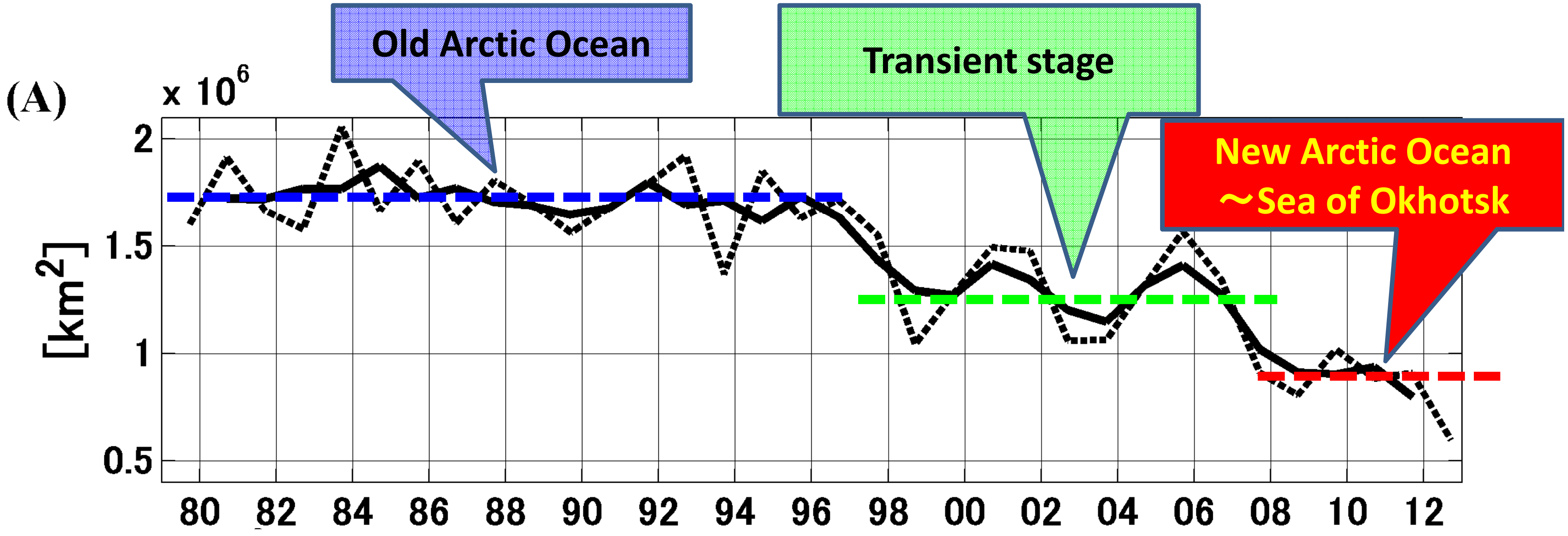
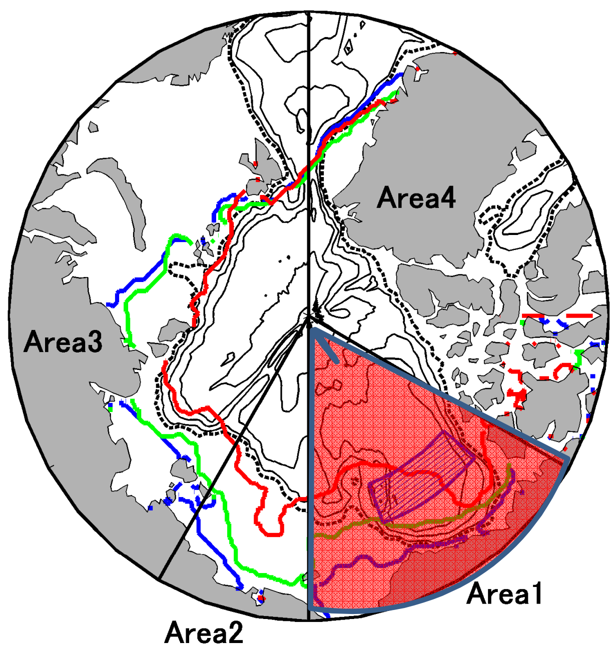
Presentation items for PAG meeting in ASSW2016

Koji Shimada

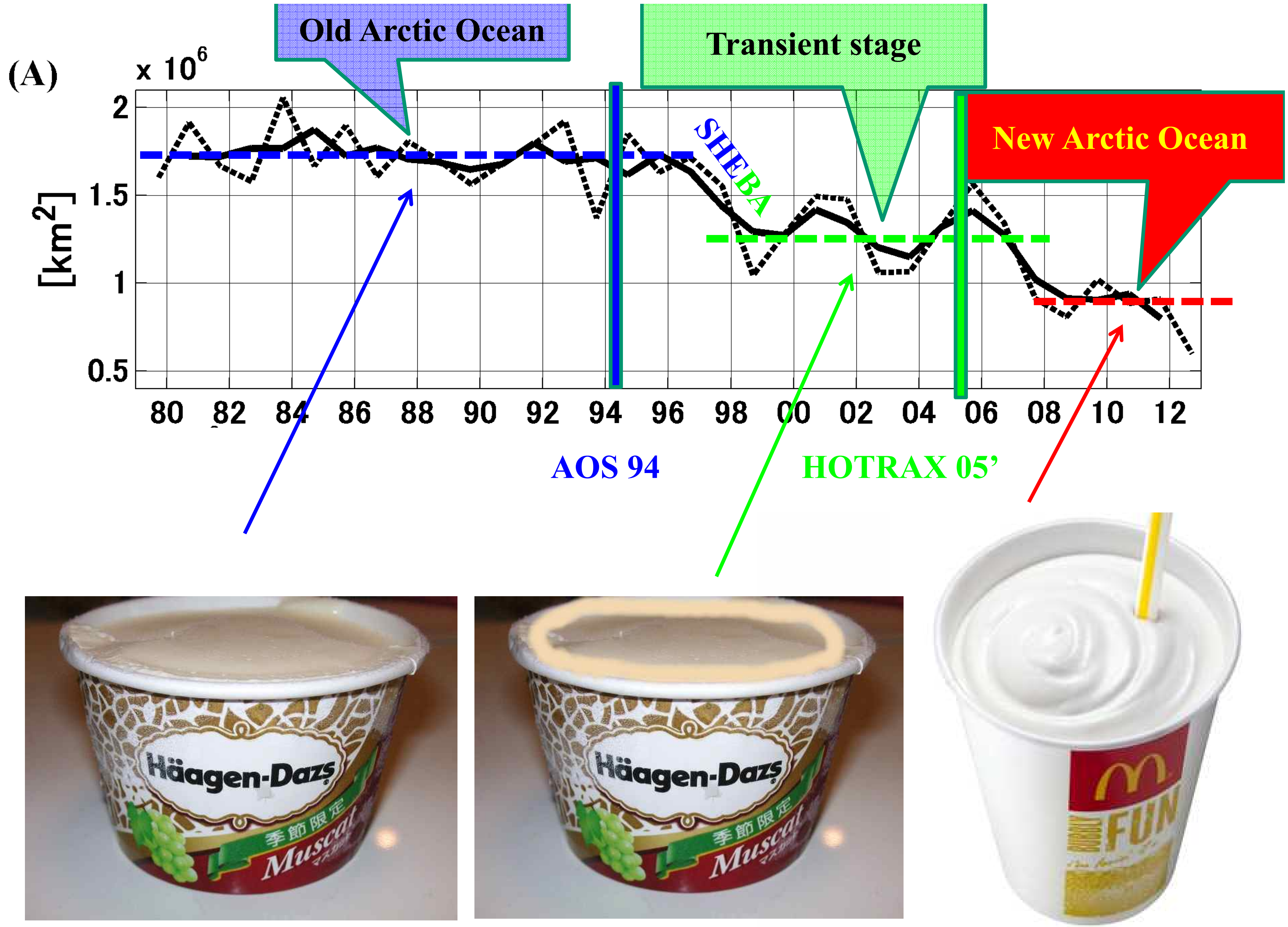
Mar. 13

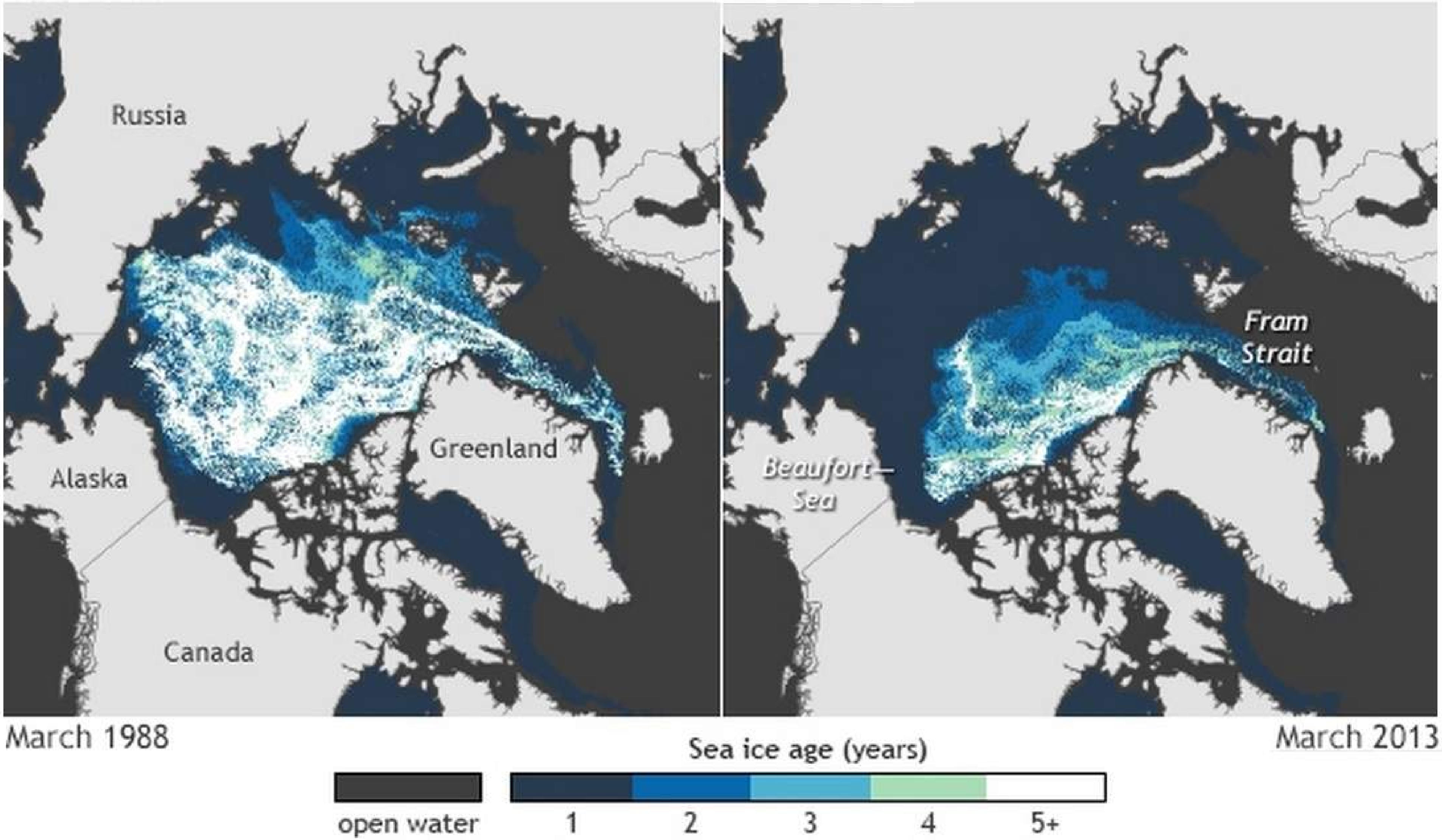


(A)
Old Arctic Ocean
Transient stage
New Arctic Ocean
～Sea of Okhotsk
x 10^6
[km^2]
2
1.5
1
0.5
80
82
84
86
88
90
92
94
96
98
00
02
04
06
08
10
12

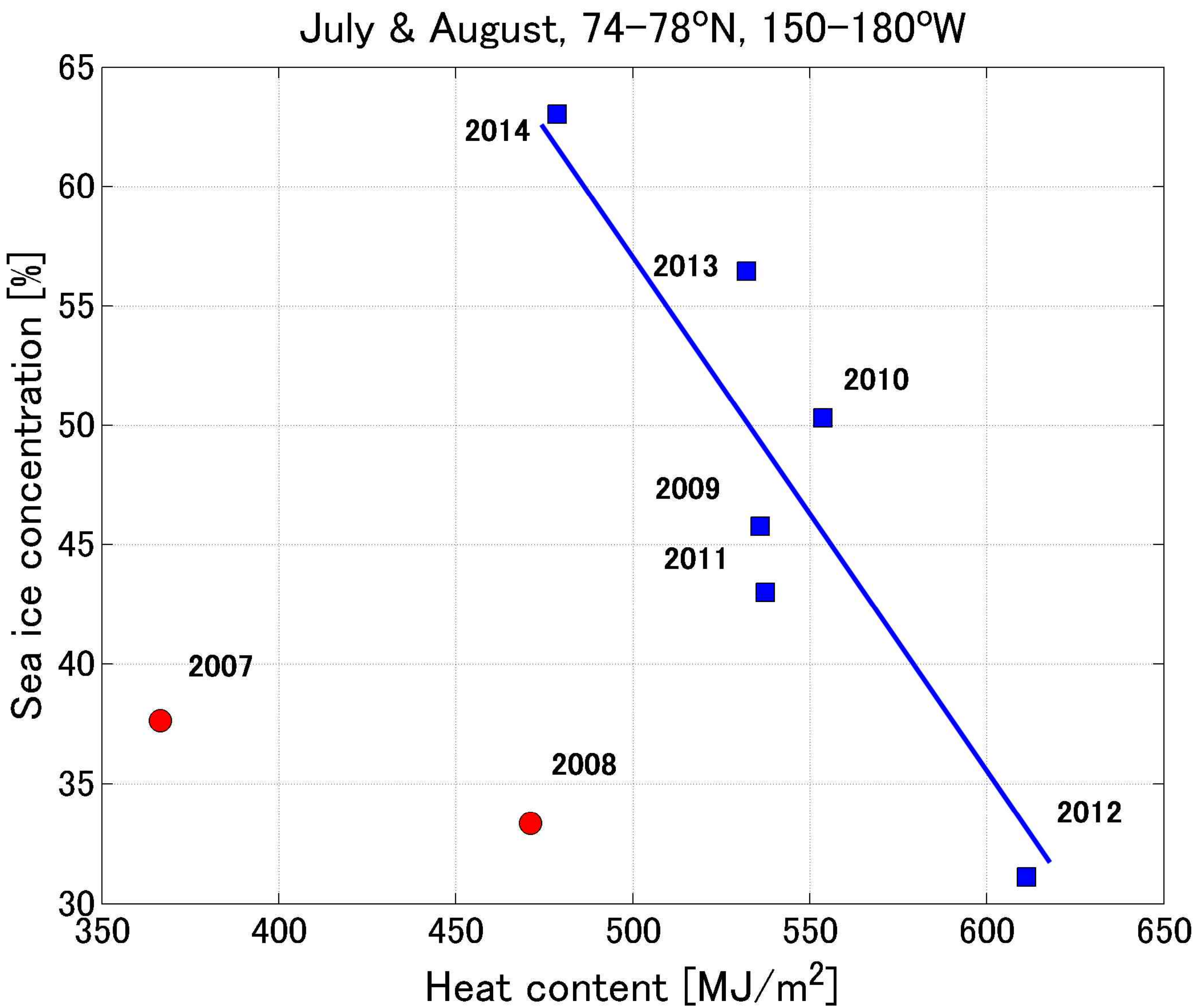


Area4
Area3
Area2
Area1


(A)
Old Arctic Ocean
Transient stage
New Arctic Ocean
SHEBA
x 10^6
[km^2]
2
1.5
1
0.5
80
82
84
86
88
90
92
94
96
98
00
02
04
06
08
10
12
AOS 94
HOTRAX 05'
Häagen-Dazs
季節限定
Muscat
Häagen-Dazs
季節限定
Muscat
FUN



by Mark Tschudi, University of Colorado

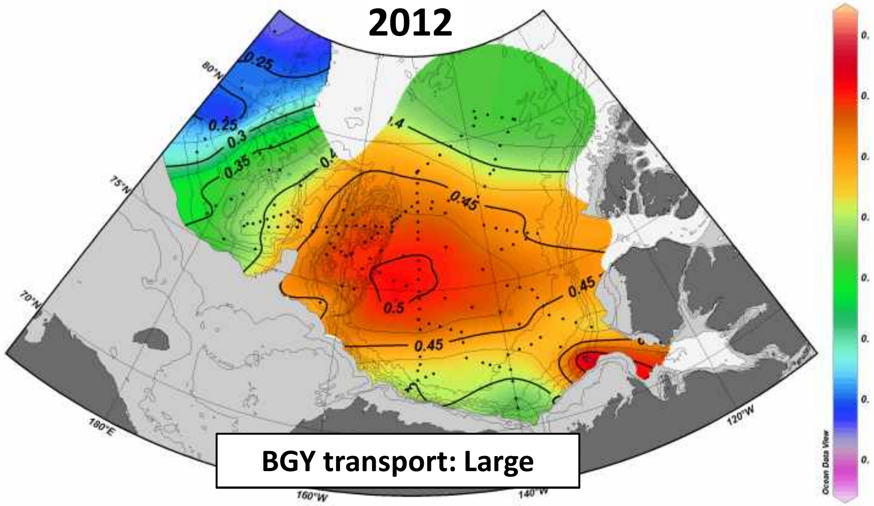


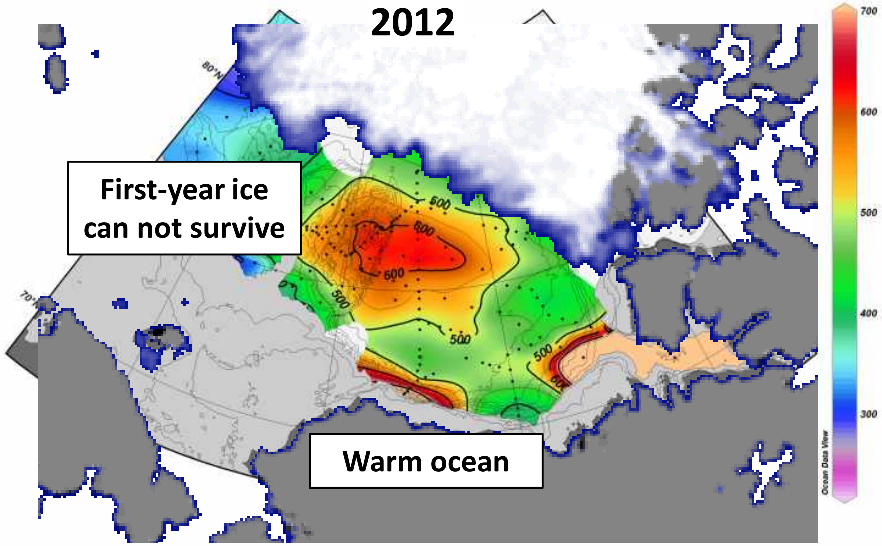
July & August, 74-78°N, 150-180°W
Sea ice concentration [%]
Heat content [MJ/m2]
65
60
55
50
45
40
35
30
350
400
450
500
550
600
650
2014
2013
2010
2009
2011
2007
2008
2012

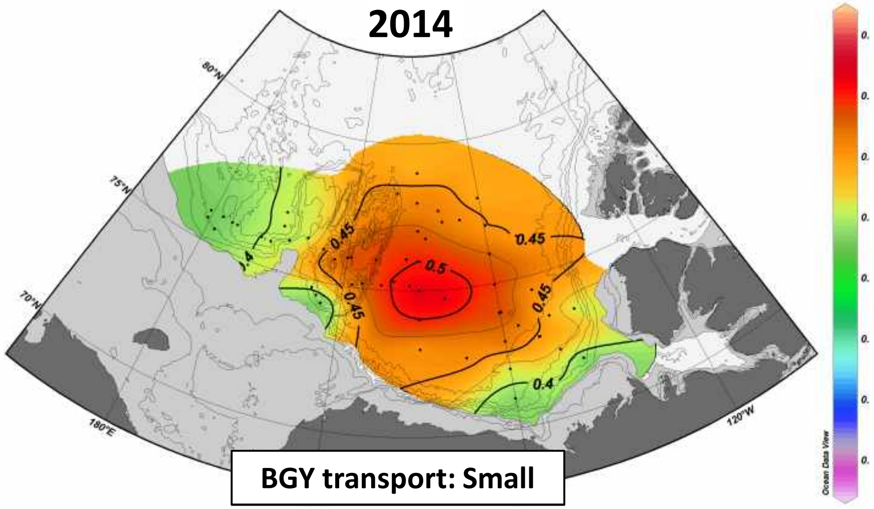
Ocean circulation, heat content, and sea ice distribution in summer

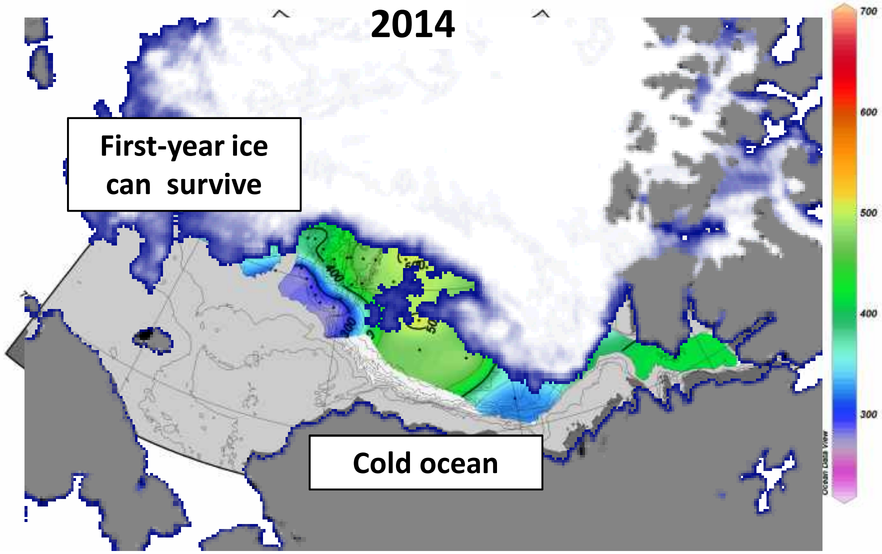
Dynamic height anomaly at 50dbar
(reference 800dbar)

Upper ocean heat content within 20-150m

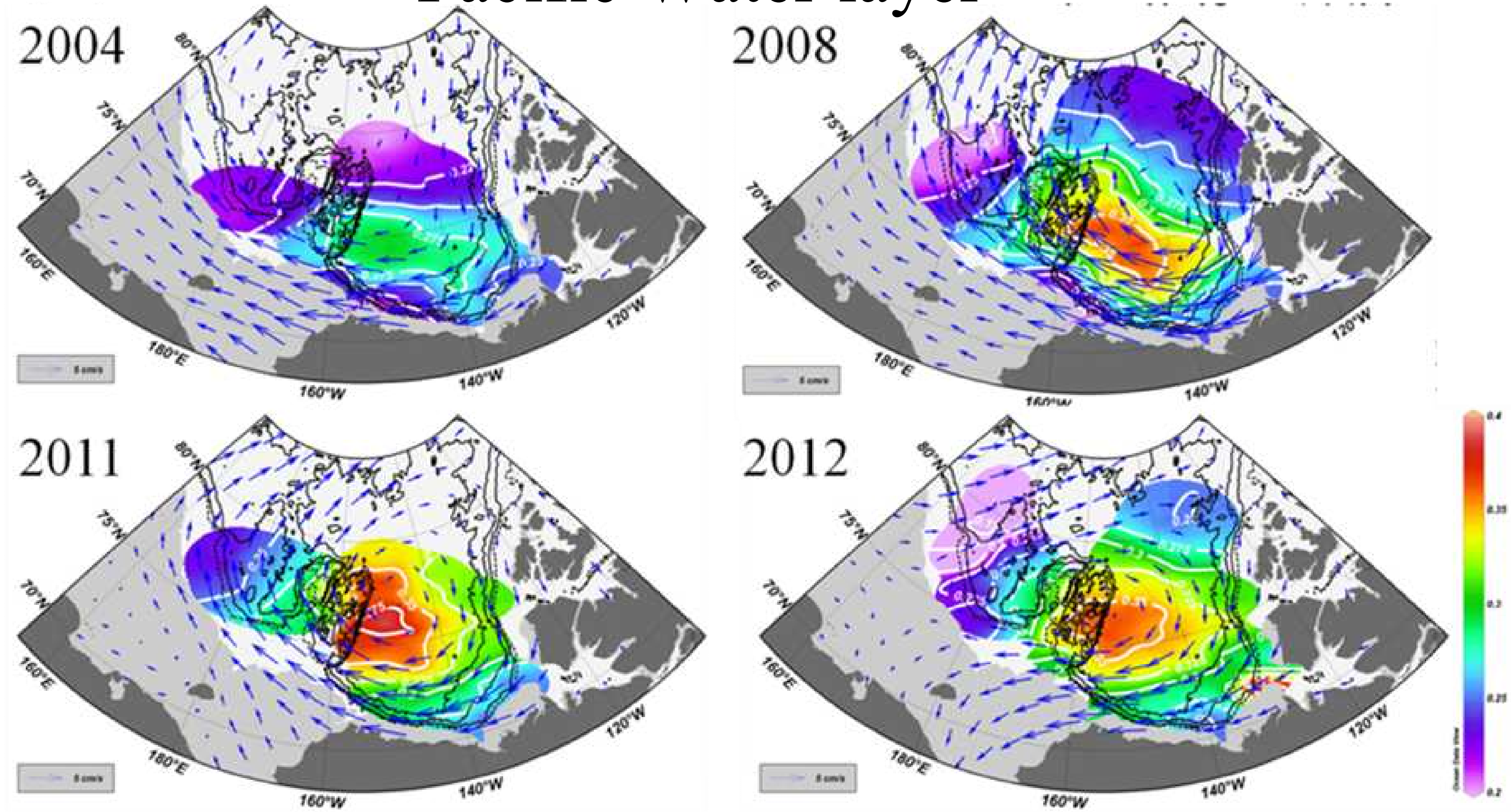








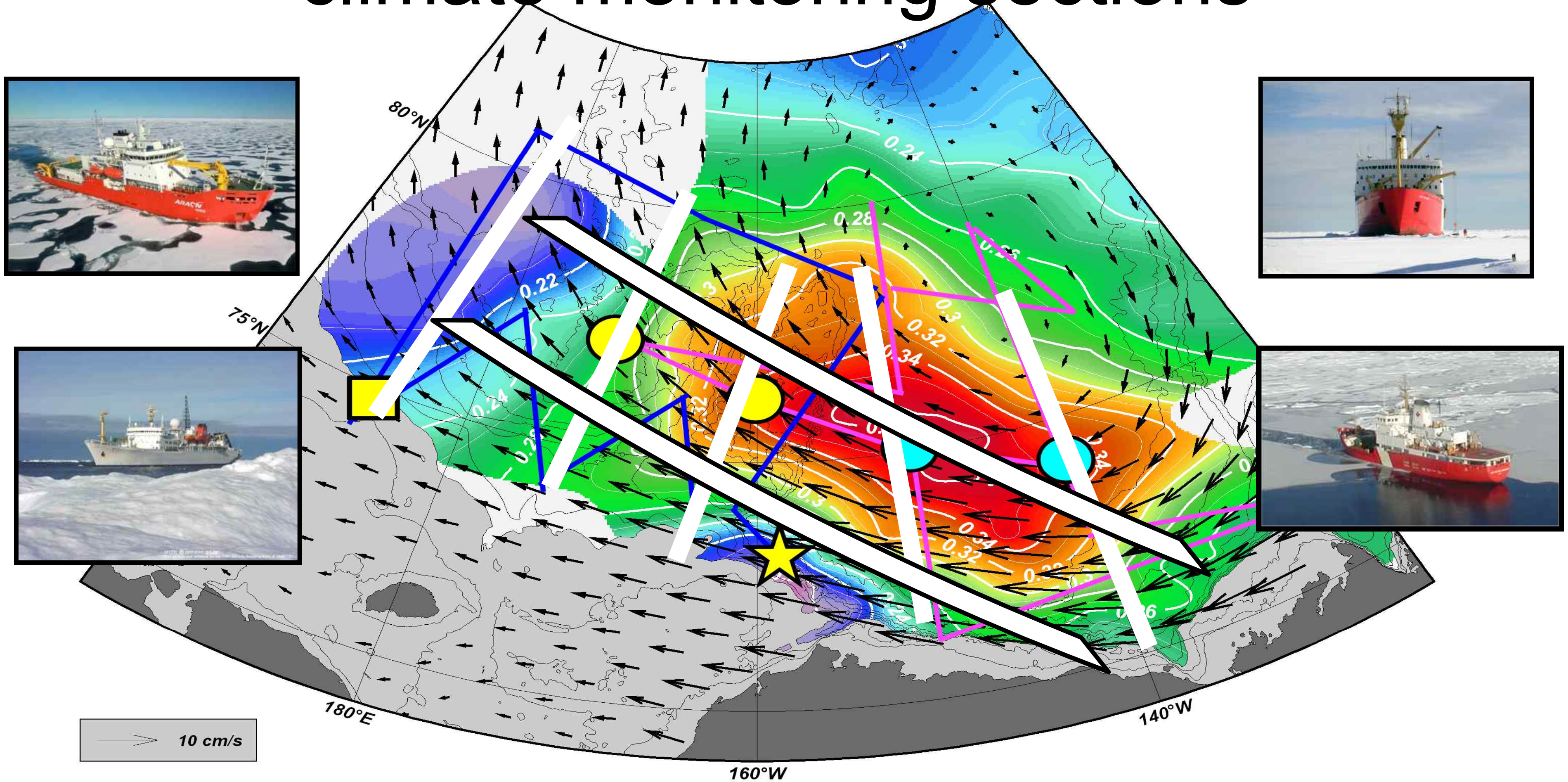
Sea ice motion and ocean circulation of Pacific Water layer



Background color: dynamic height at 100dar relative to 800bdar (Oceanic Beaufort Gyre)
Black vectors: average sea ice motion vectors for November – April.

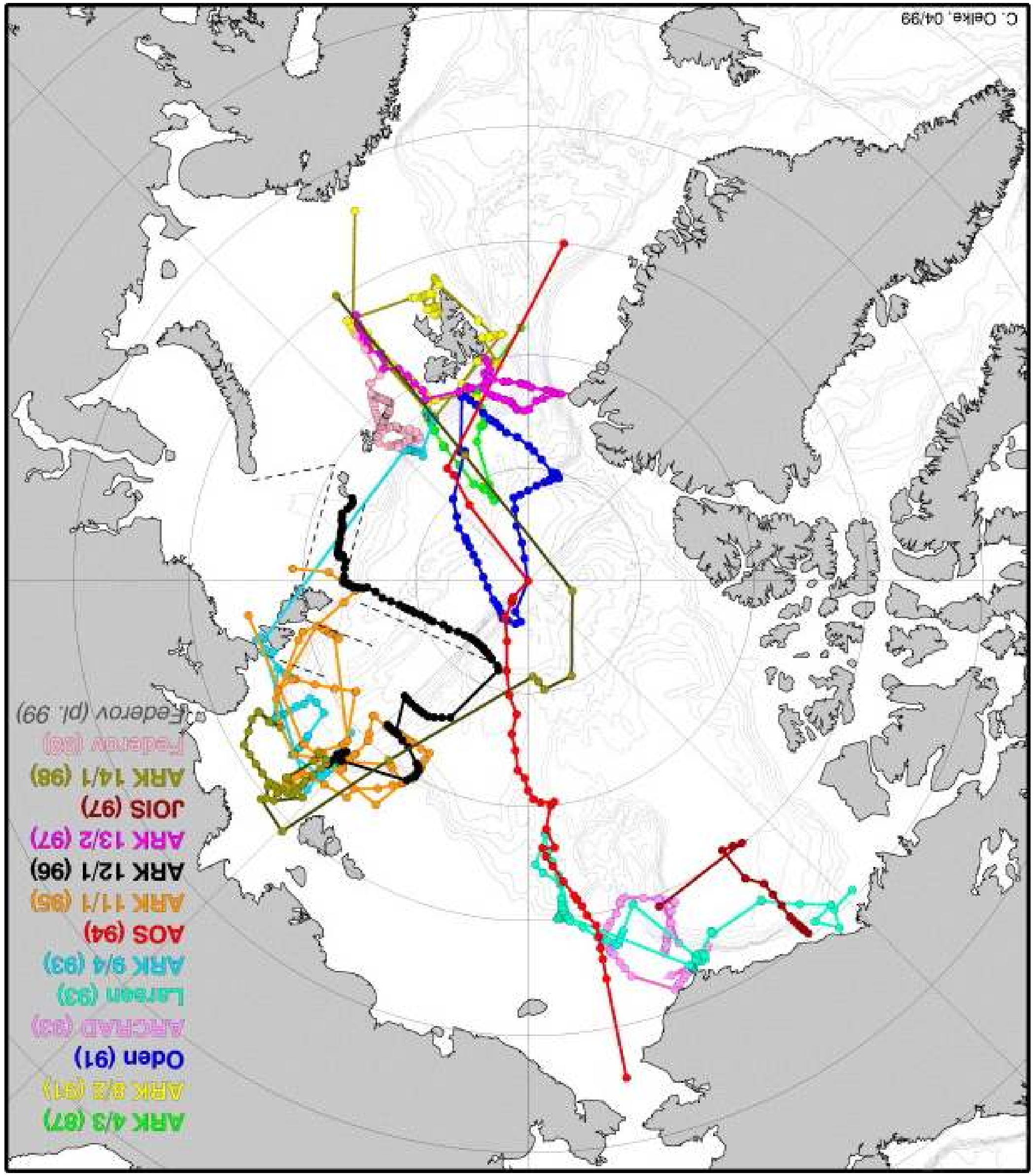
Yoshizawa et al., (2015)

Proposed international Pacific Arctic climate monitoring sections



Background color: dynamic height at 100dar relative to 800bdar from Mirai and Louis S. St-Laurent 2008 cruises (Oceanic Beaufort Gyre)
Black vectors: average sea ice motion vectors for Nov. 2007- Apr. 2008 (Sea Ice Beaufort Gyre)
Simbols: Mooring array in 2012-2013 (TUMSAT/KOPRI/NIPR & WHOI)

Hydrographic stations in 1990s



Synoptic Arctic *Survey*

HOTRAX 05’

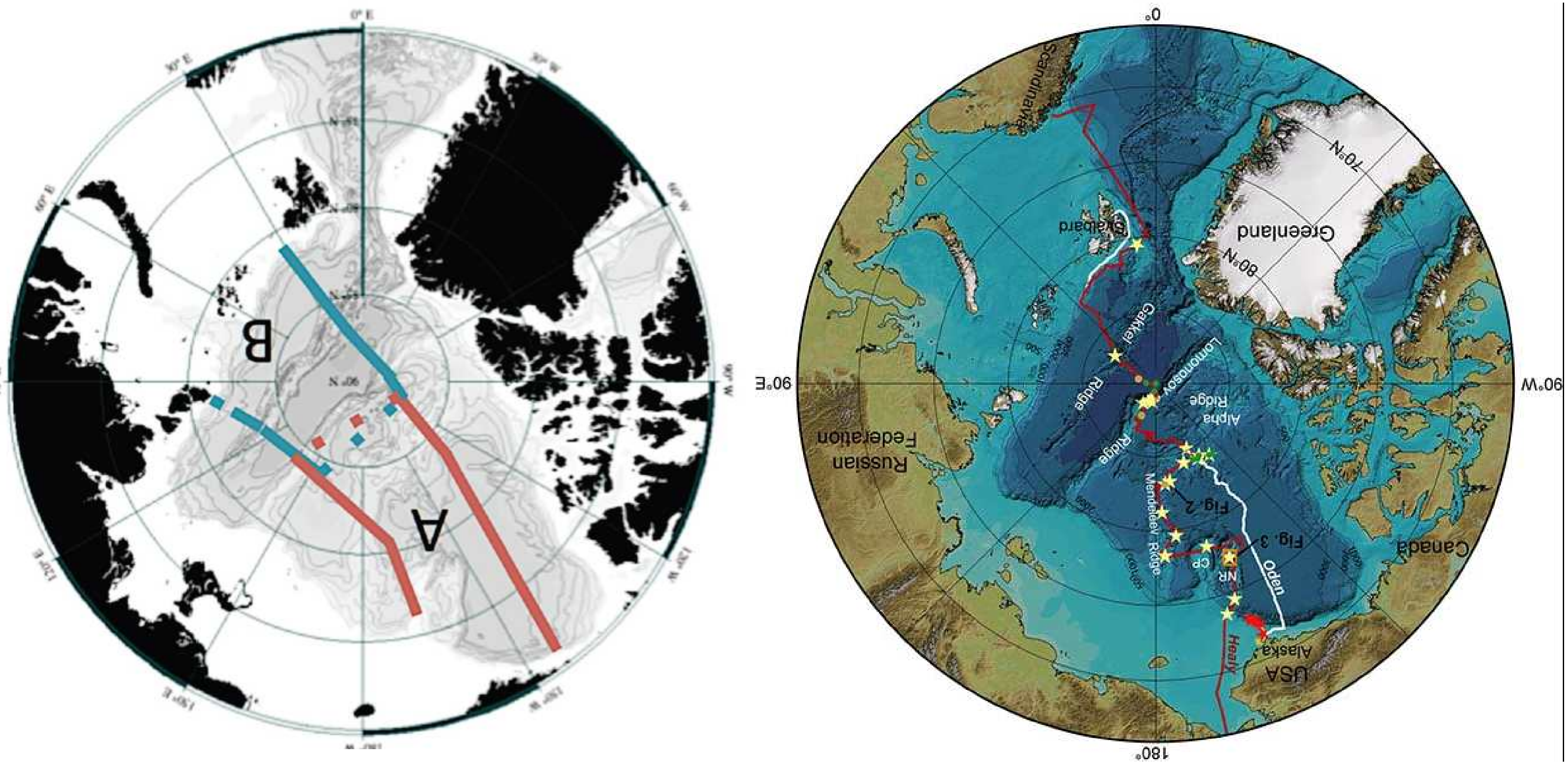
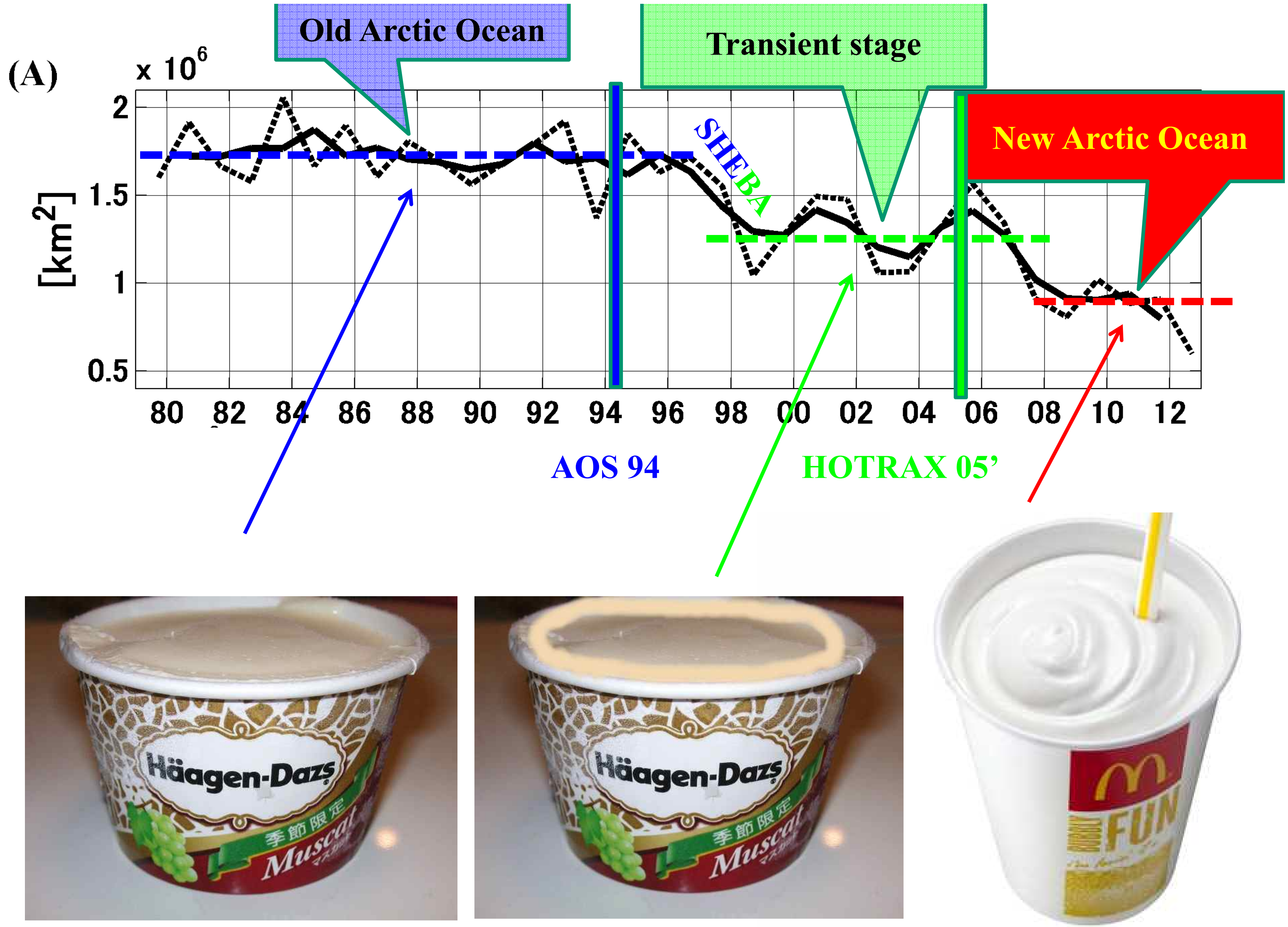


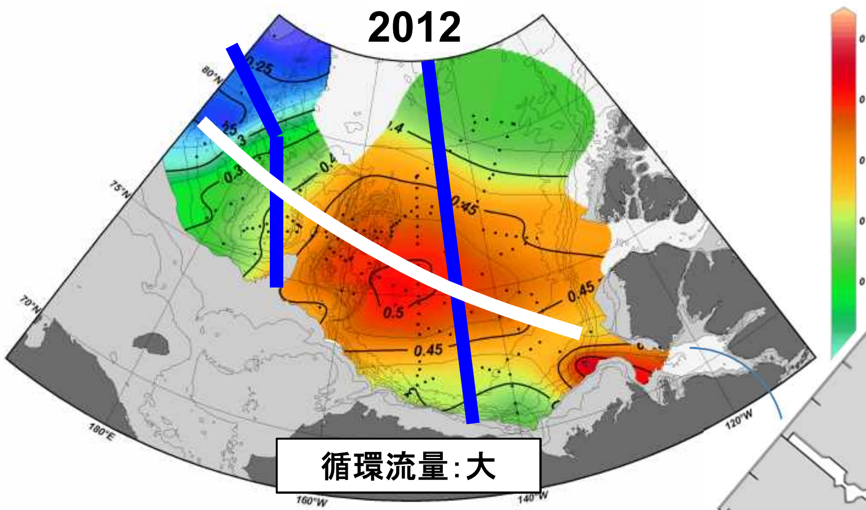
Figure 2: Schematic concept of a pair of one-way trans-Arctic sections in support of global ocean change research. (The dashed line on “B” schematically shows sampling in the Russian EEZ.). The routes in right panel gives the same coverage as those shown in the left, with the added benefit of allowing icebreakers to return to their home port, and also data consistency checks where the two lines meet

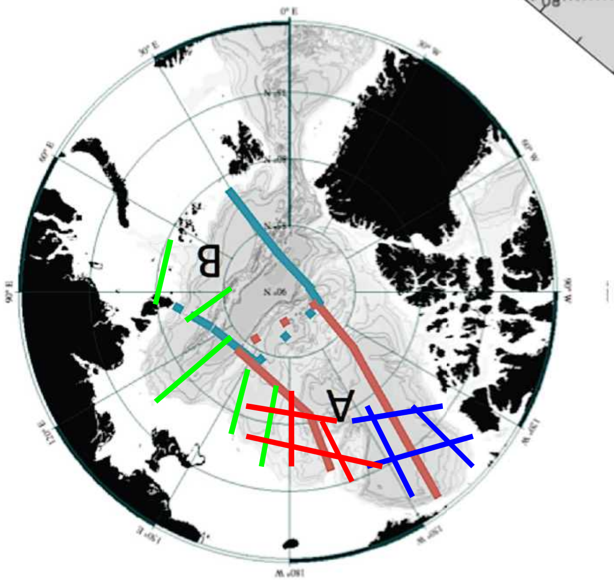


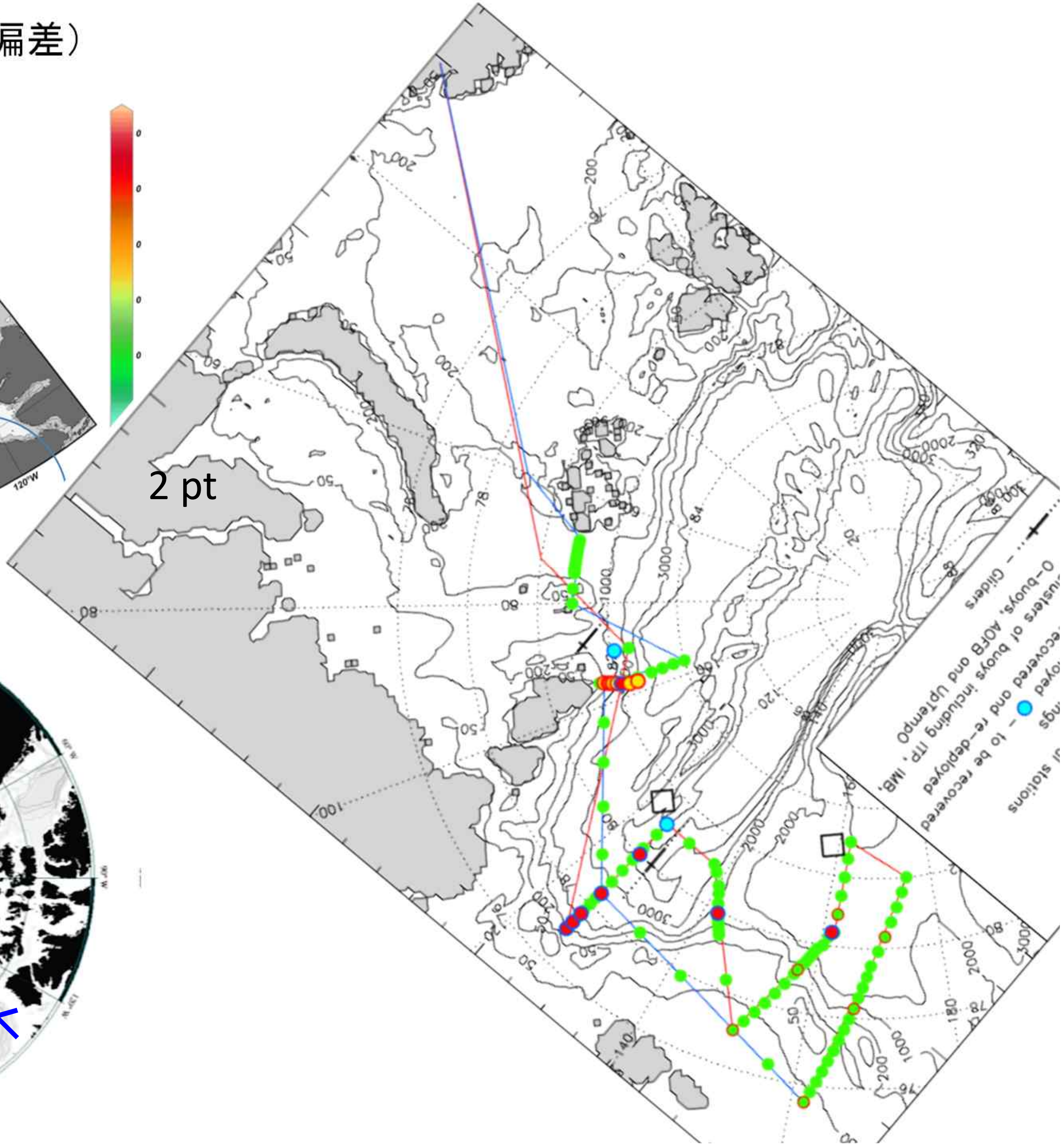
(A)
x 10^6
[km^2]
2
1.5
1
0.5
80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12
Old Arctic Ocean
Transient stage
New Arctic Ocean
SHEBA
AOS 94
HOTRAX 05'
Häagen-Dazs
季節限定
Muscat
Häagen-Dazs
季節限定
Muscat
FUN

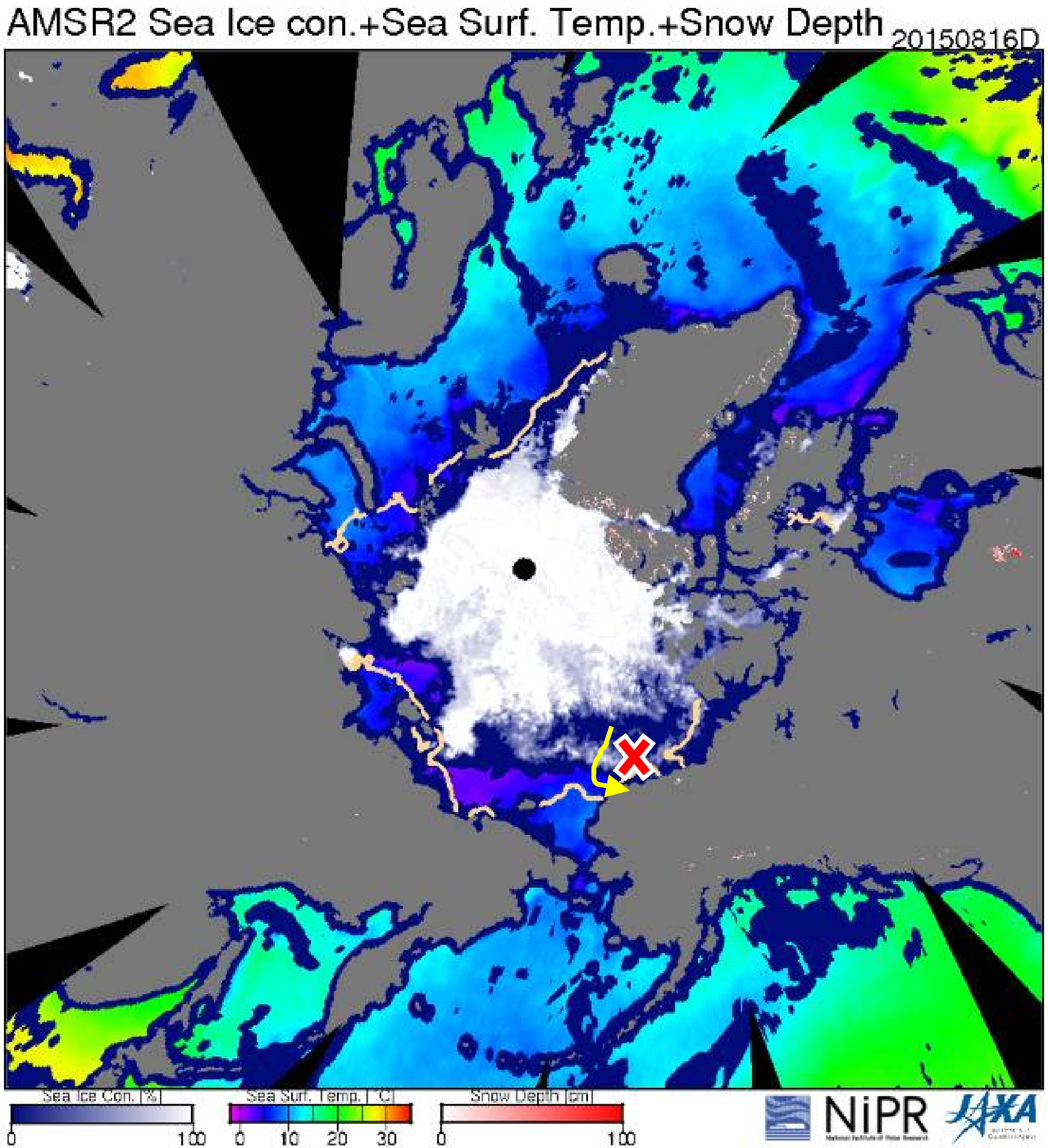
海洋循環・構造変動を海氷変動

海洋循環
（800dbar基準50dbar面の力学高度偏差）



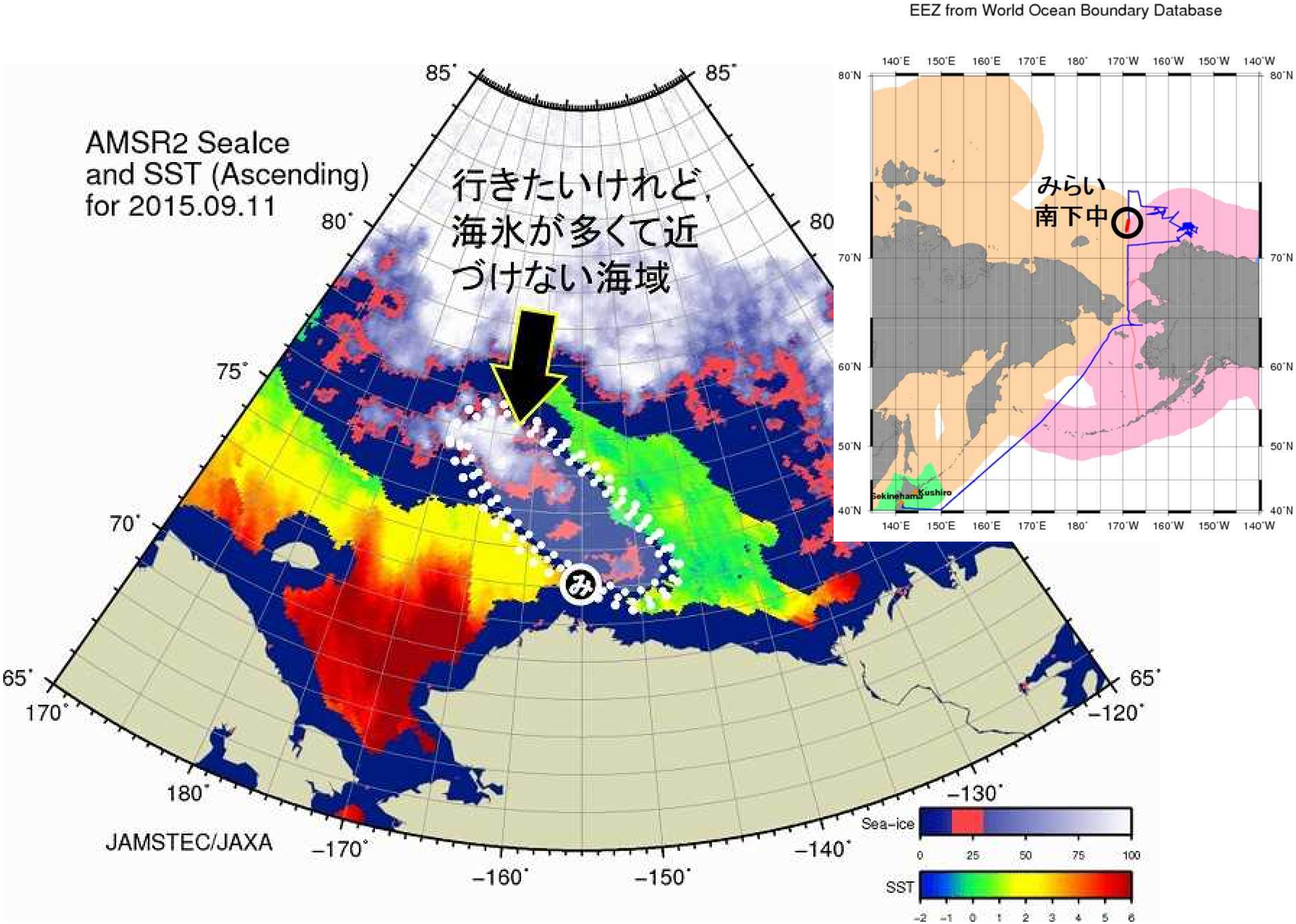






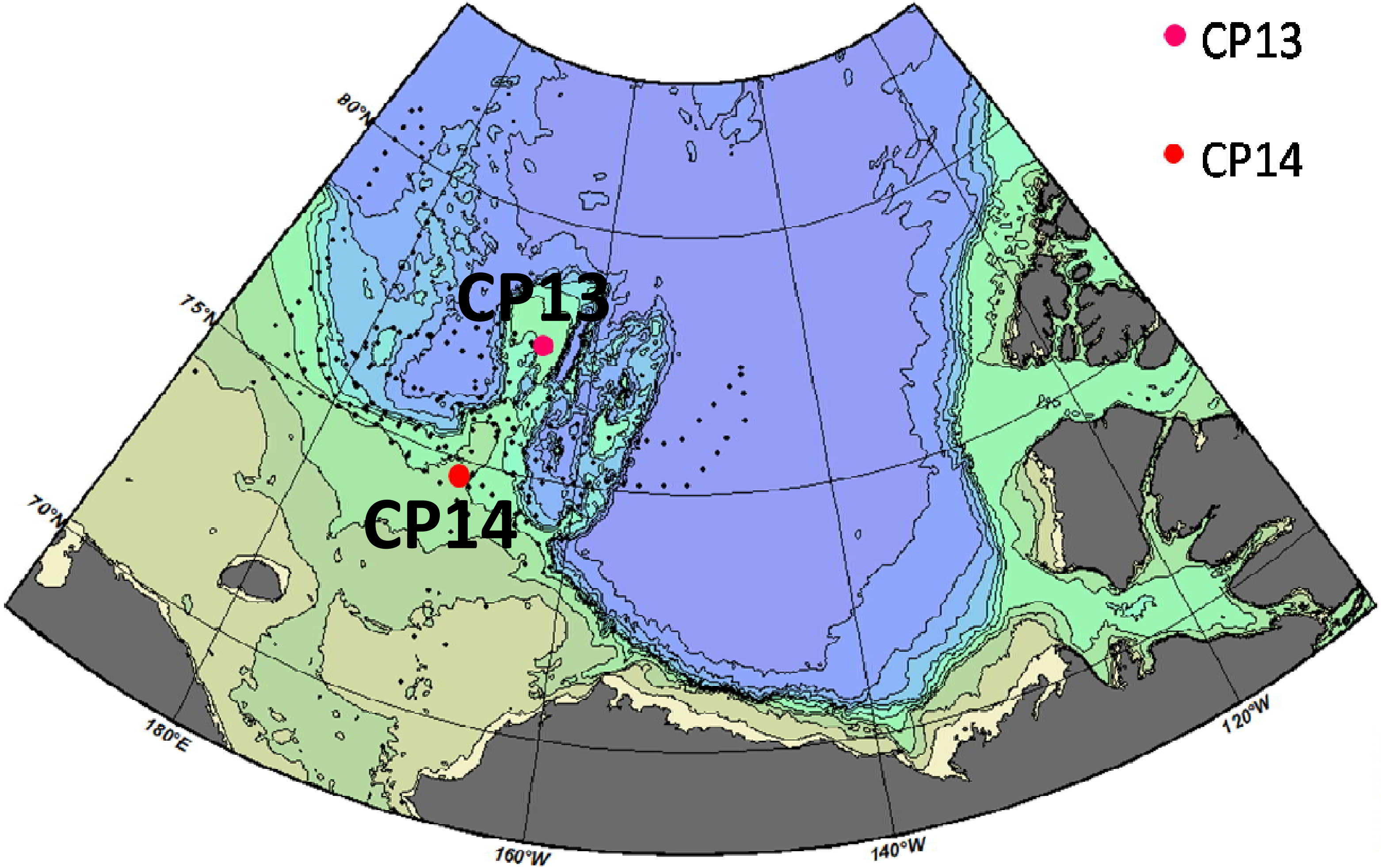
※ change date of image by scrolling mouse-wheel.

※ zoom/move image area by mouse click (left-drag:zoom, right-drag:move, double-click:reset)

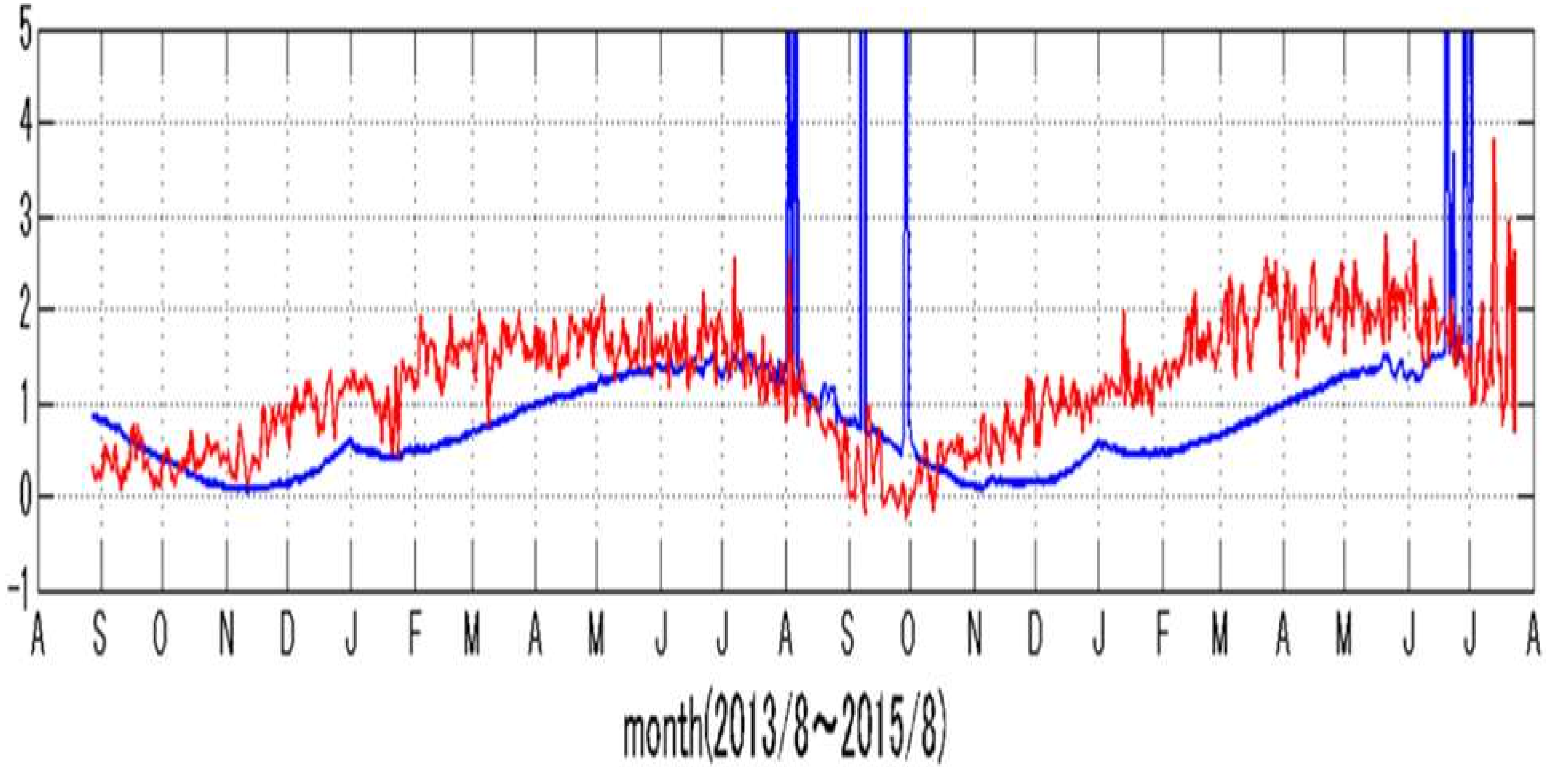


JAMSTEC みらい2015年北極航海ブログ

氷厚観測データは疑わしい



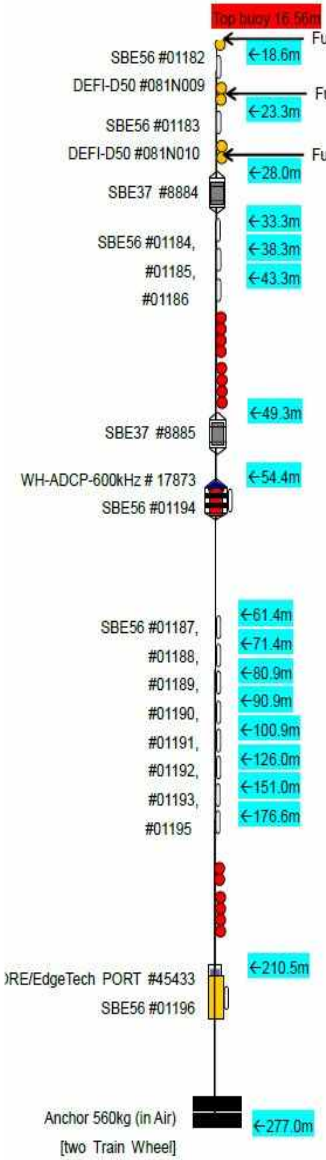
工藤めぐみ（2016）卒業論文



- Blue: Sea ice thickness algorism based on AMSR-2 and WHOI mooring data (IPS).

Krishfield et al. (2014) JGR

- Red: actual sea ice thickness from mooring with variation of sound velocity



Mooring CP13

Position:

(Anchor dropped position near the A frame)

77°28.331'N, 164°07.178'W

(Triangulation result)

77°28.3353'N, 164°07.0789'W

[77.47255°N, 164.11798°W]

Deployment time (Anchor):

August 26, 2013 23:42 (UTC)

Bottom depth: 277m

(272m[Multi beam depth] + 5m)

CTDs:

SBE37-SM S/No. 8884, 8885

Temperature loggers:

SBE56 S/No. 01182, 01183, 01184, 01185, 01186, 01187, 01188, 01189, 01190, 01191, 01192, 01193, 01194, 01195, 01196

Pressure sensors:

DEFI-D50 S/No. 081N009, 081N010

Current Meter:

WH-ADCP-600kHz Sentinel S/No. 17873

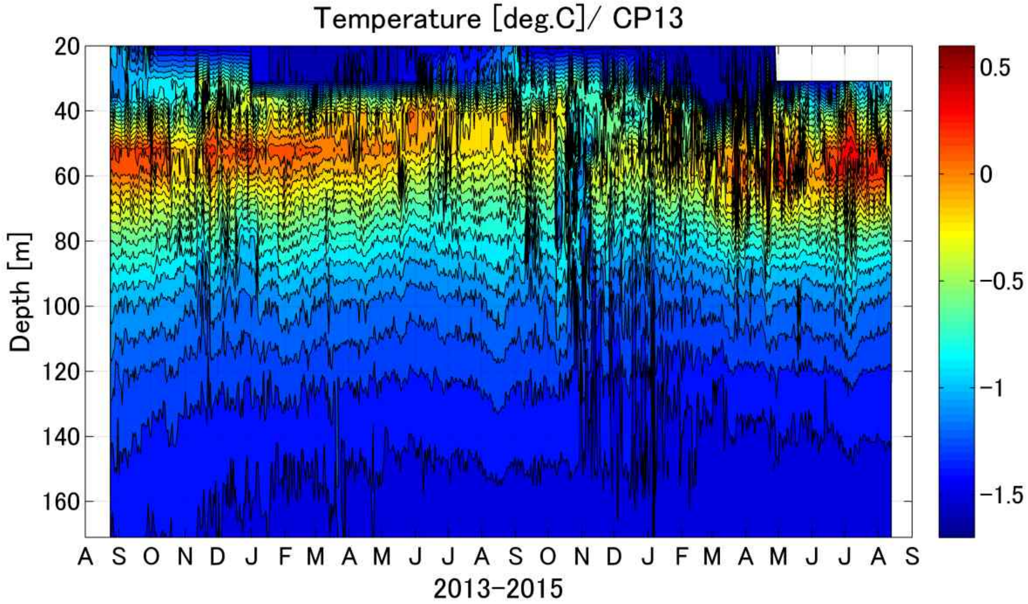
With bottom tracking option

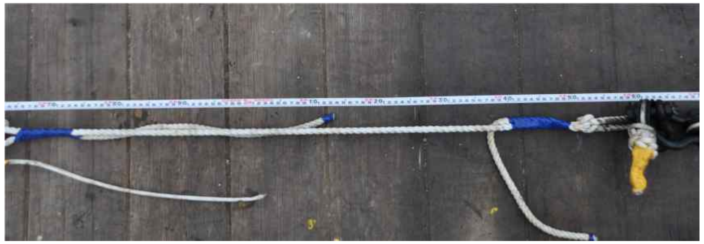
Acoustic Release:

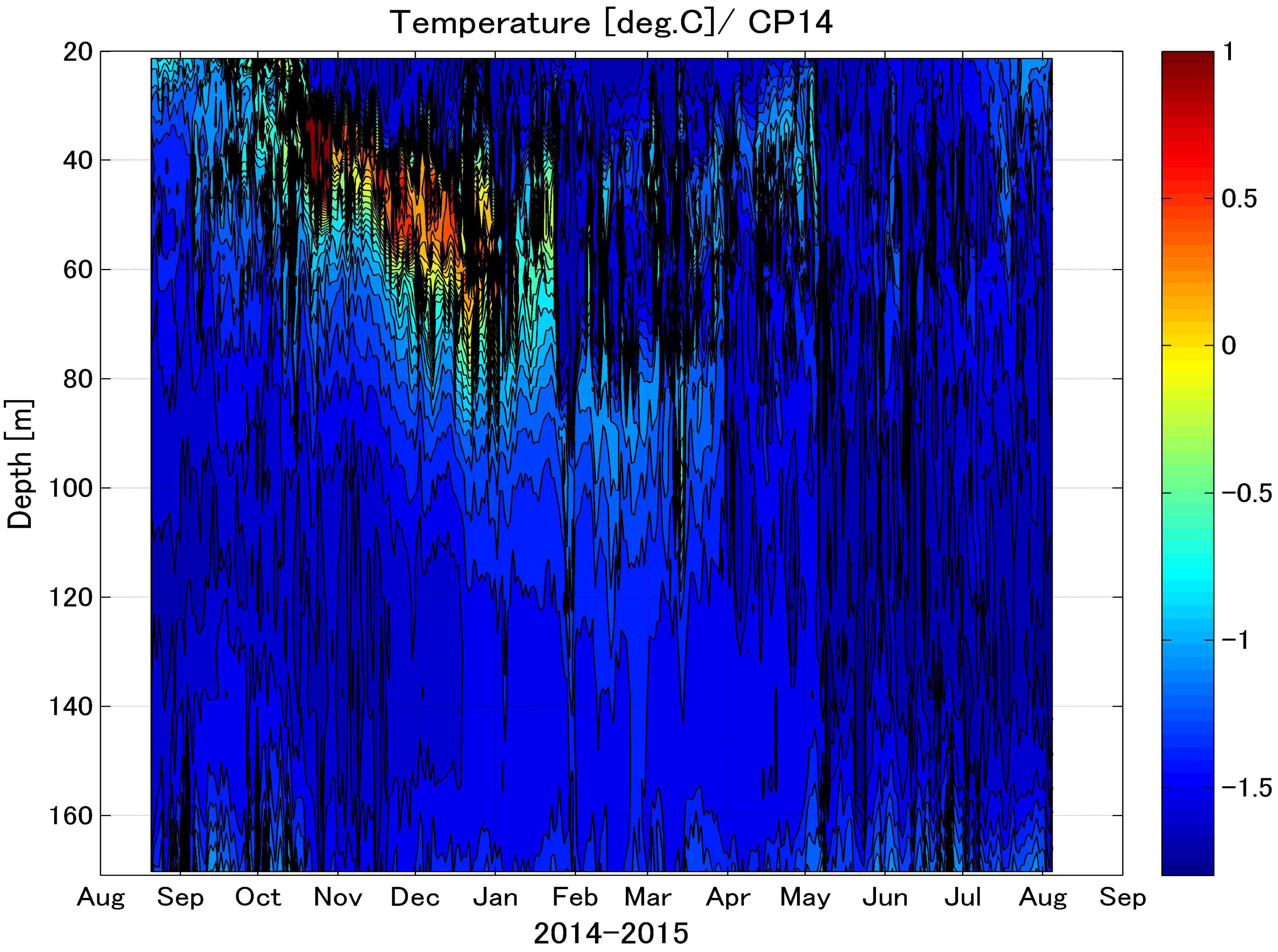
ORE/EdgeTech PORT	S/No. 45433
Int. Frequency:	11.0kHz
Rep. Frequency:	12.0kHz
Pulse Width:	10m/sec.
Release Command:	523635
Enable Command:	501710
Disable Command:	501733

Fuse wires

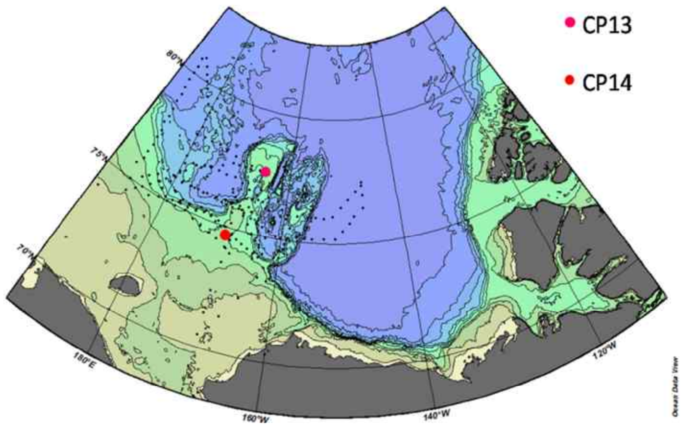
1. Vinylon/polyester mixed fiber φ5mm
2. Vinylon/polyester mixed fiber φ6mm
3. Vinylon/polyester mixed fiber φ8mm

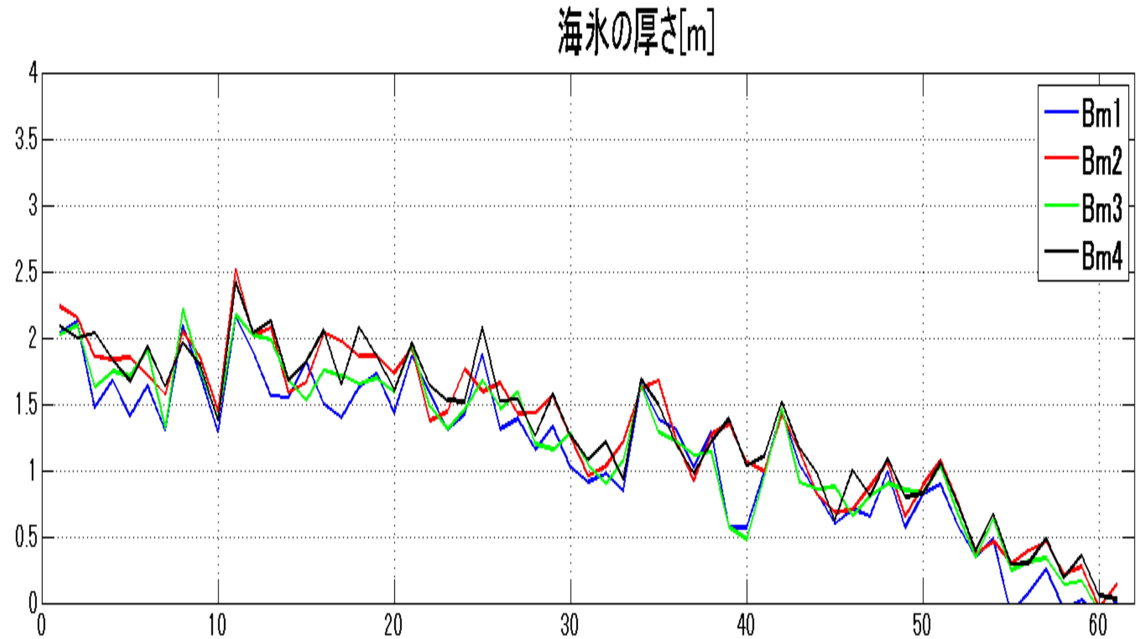


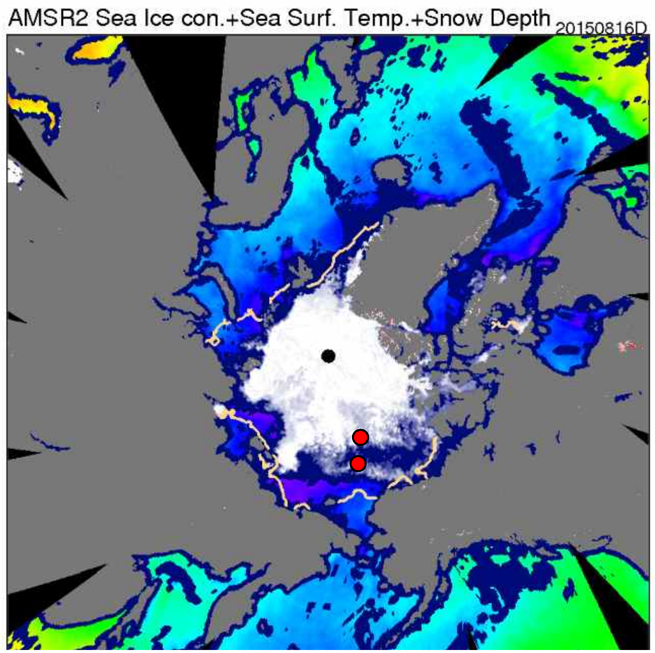


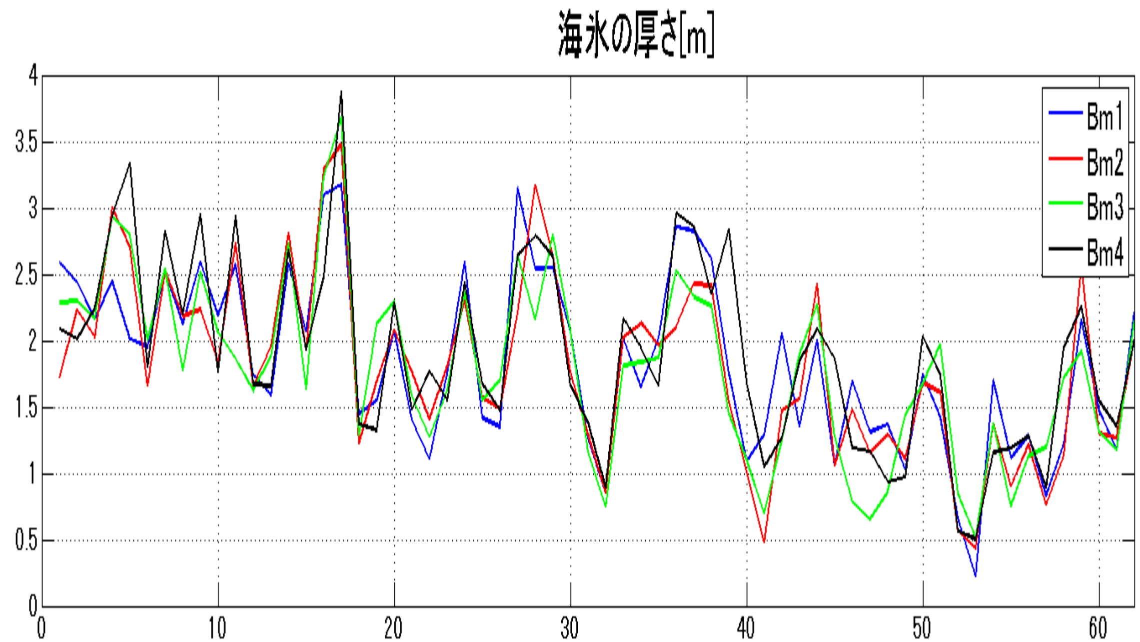


Temperature [deg.C]/ CP14
Depth [m]
20
40
60
80
100
120
140
160
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
2014−2015
1
0.5
0
−0.5
−1
−1.5









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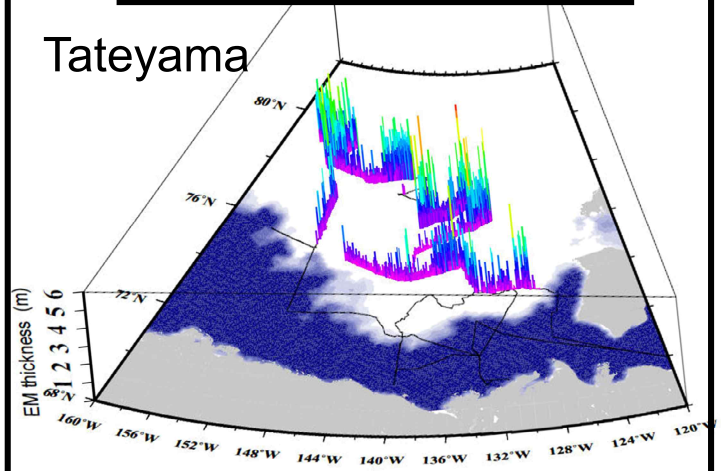
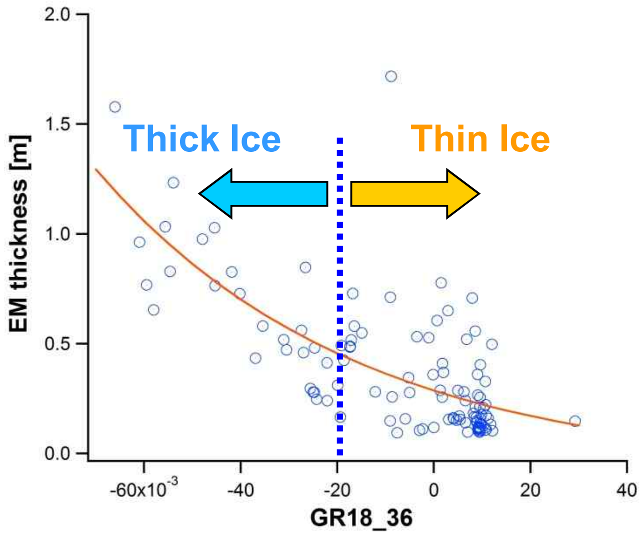
Ice Thickness Group

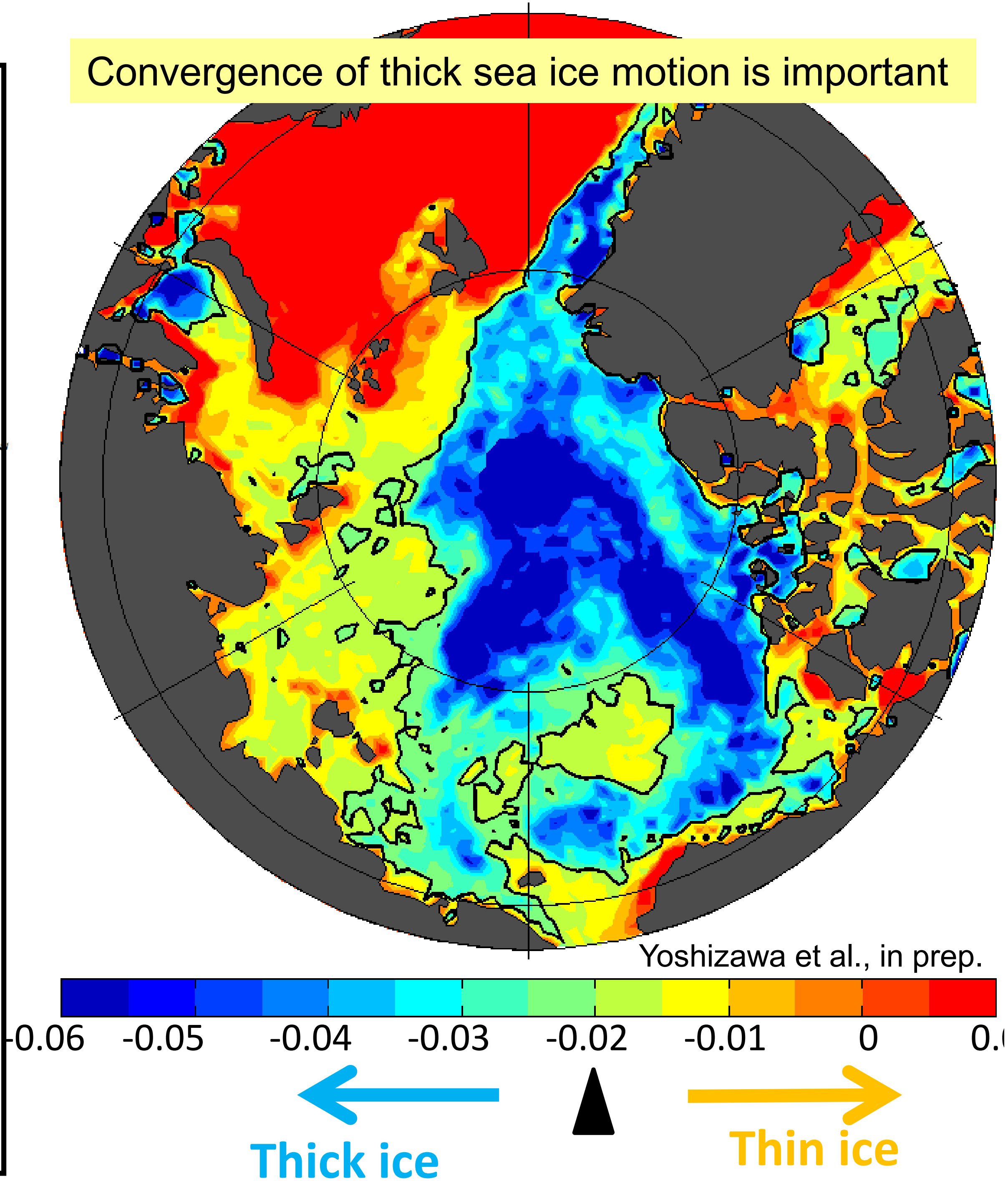
Tateyama

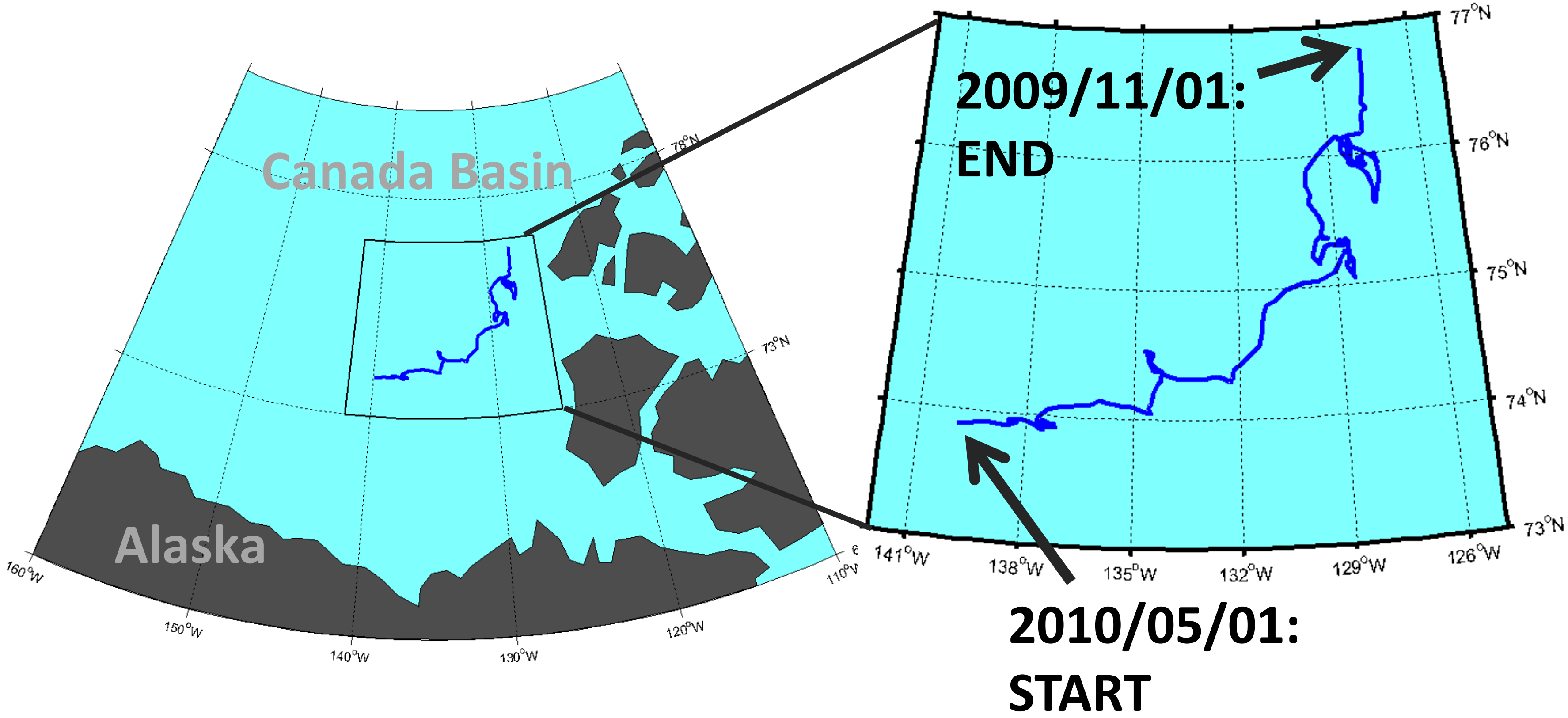




$$GR = \frac{[36V]-[18V]}{[36V]+[18V]}.$$

Convergence of thick sea ice motion is important

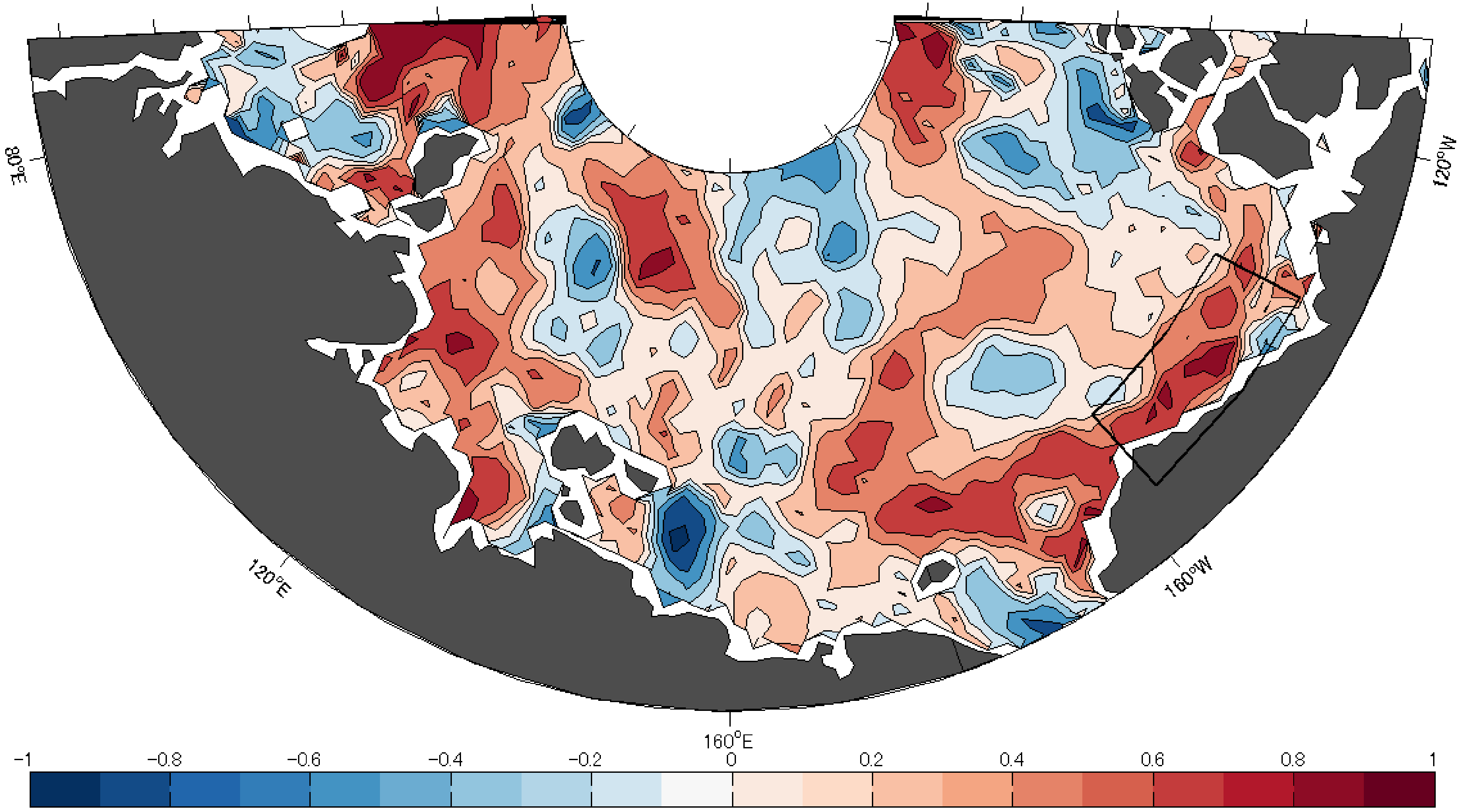




- Calculate convergence if GR is less than critical value (-0.02) and sea ice concentration is greater than 98%.

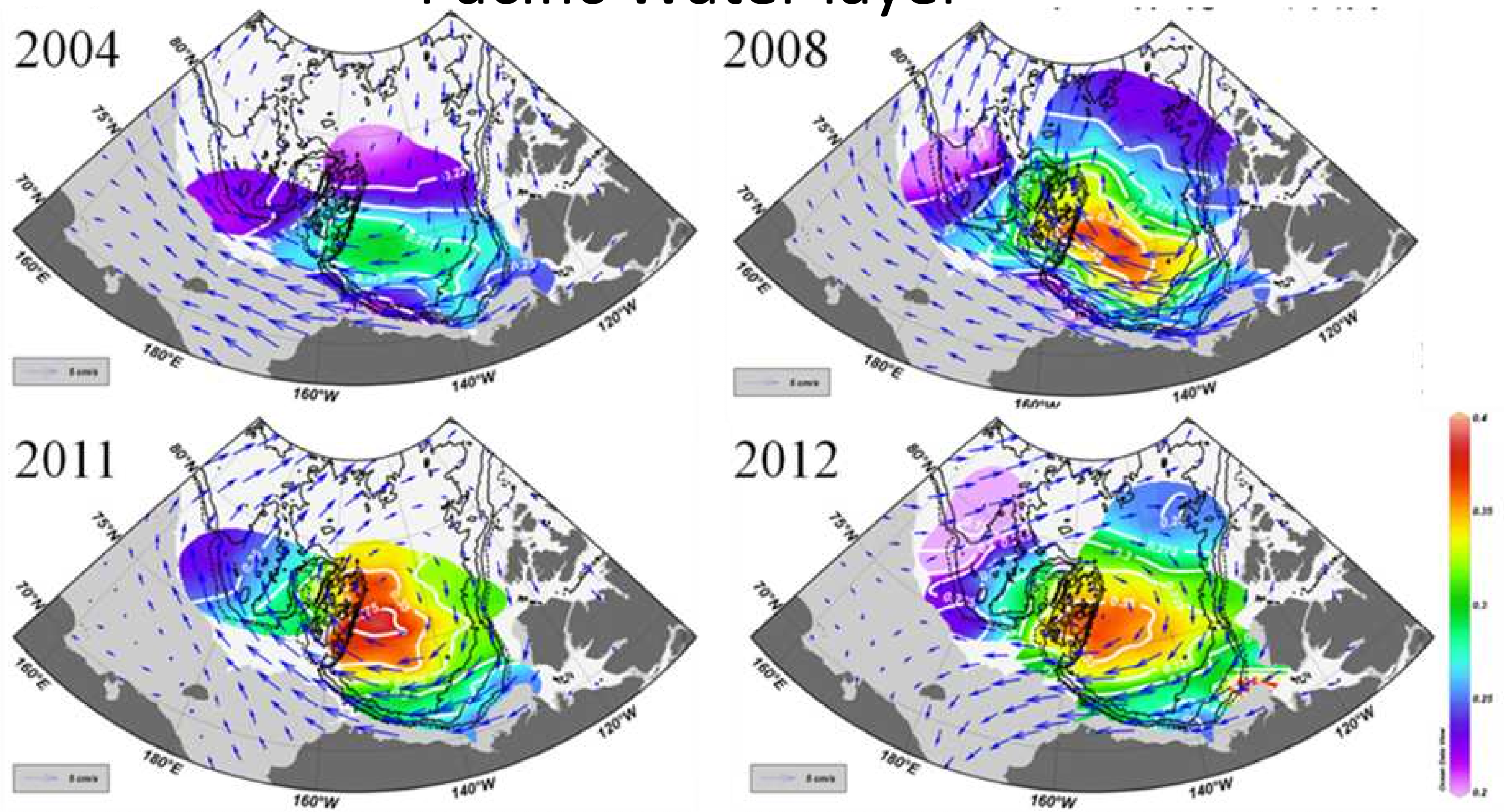
  ⇒ effective convergence for rafting: ECR

- Integrate ECR along drift track of sea ice from November to April.



Correlation between "integrated effective convergence of sea Ice along drift track (Nov.～Apr.)" and "sea ice concentration in the following summer (Jun.～Sep.)". Box shows a key area of the Northwest passage area (70 - 74^{o}N, 135 - 157^{o}W).

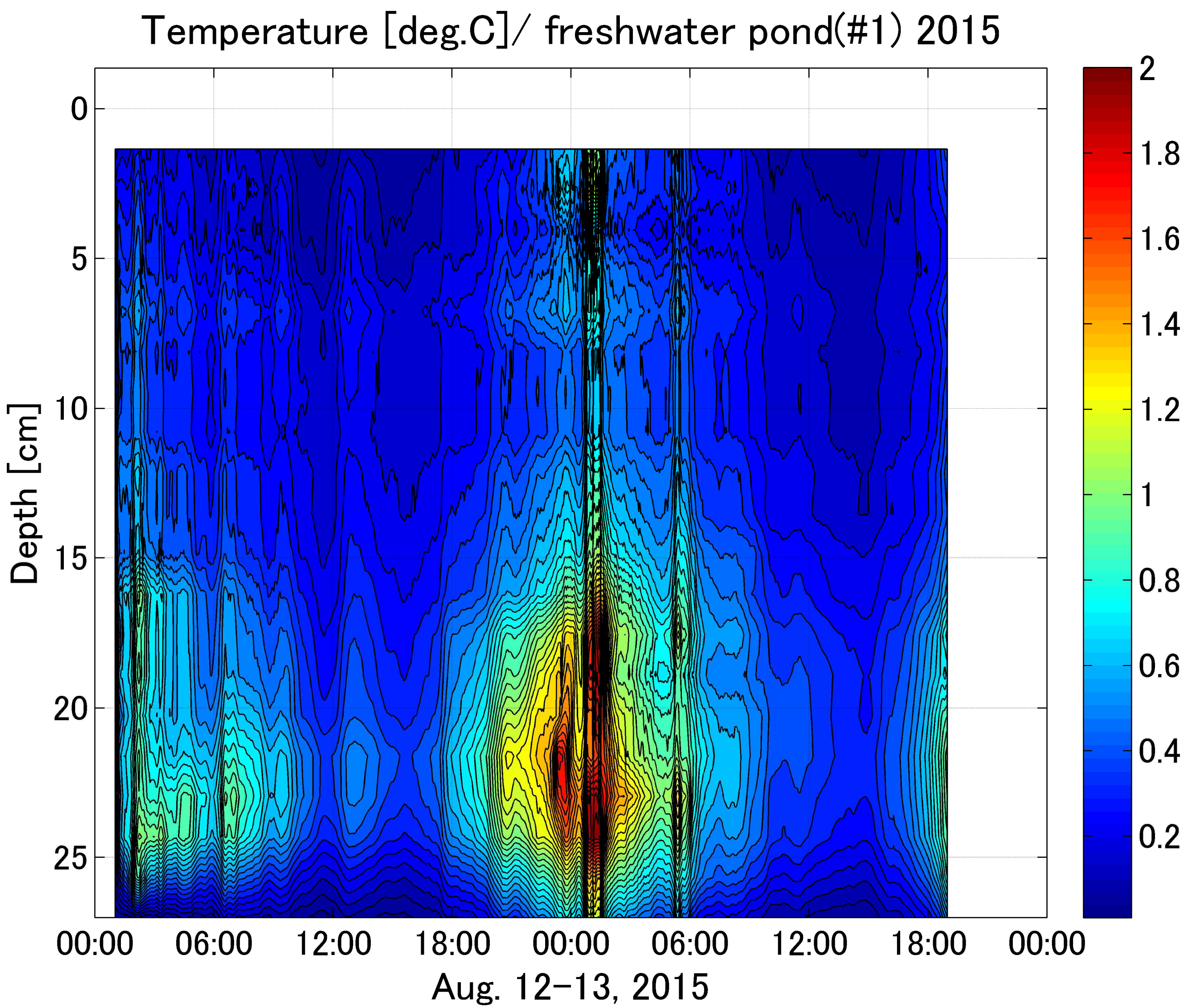
Sea ice motion and ocean circulation of Pacific Water layer



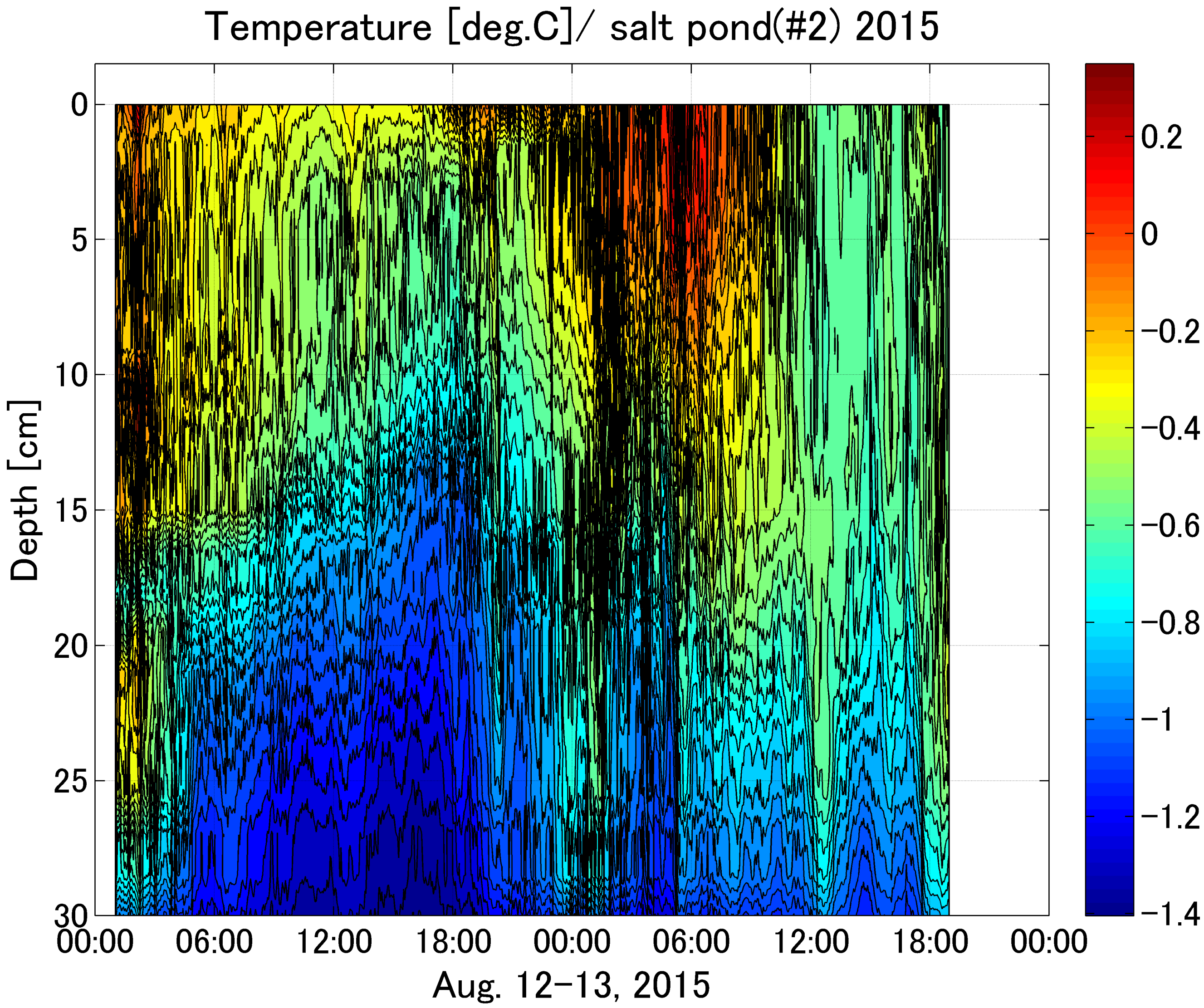
Background color: dynamic height at 100dar relative to 800bdar (Oceanic Beaufort Gyre)
Black vectors: average sea ice motion vectors for November – April.

Yoshizawa et al., (2015)

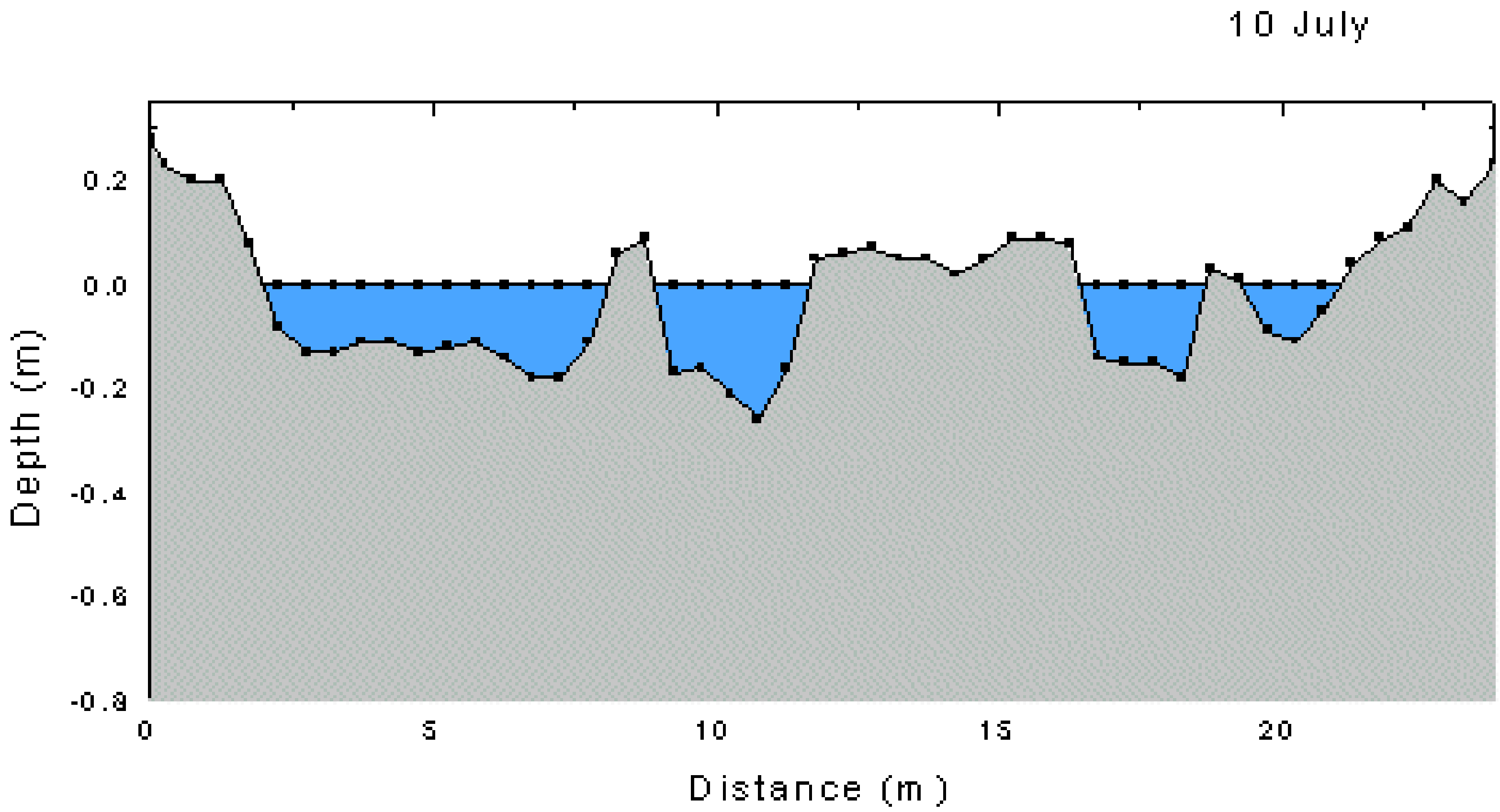

ARAON



Temperature [deg.C]/ freshwater pond(#1) 2015
Depth [cm]
0
5
10
15
20
25
00:00
06:00
12:00
18:00
00:00
06:00
12:00
18:00
00:00
Aug. 12−13, 2015
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2



Temperature [deg.C]/ salt pond(#2) 2015
Depth [cm]
0
5
10
15
20
25
30
00:00
06:00
12:00
18:00
00:00
06:00
12:00
18:00
00:00
Aug. 12−13, 2015
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
−1.2
−1.4



SHEBA 1998
多年氷上のmeltpond の発展

SHEBA HP より

面積変化が無い
⇒ 底融解が卓越

Development of meltpond in the Pacific sector of the Arctic Ocean

Multi year ice
or thick first year ice (rafting/ridging)
Before IPY 2007-2008

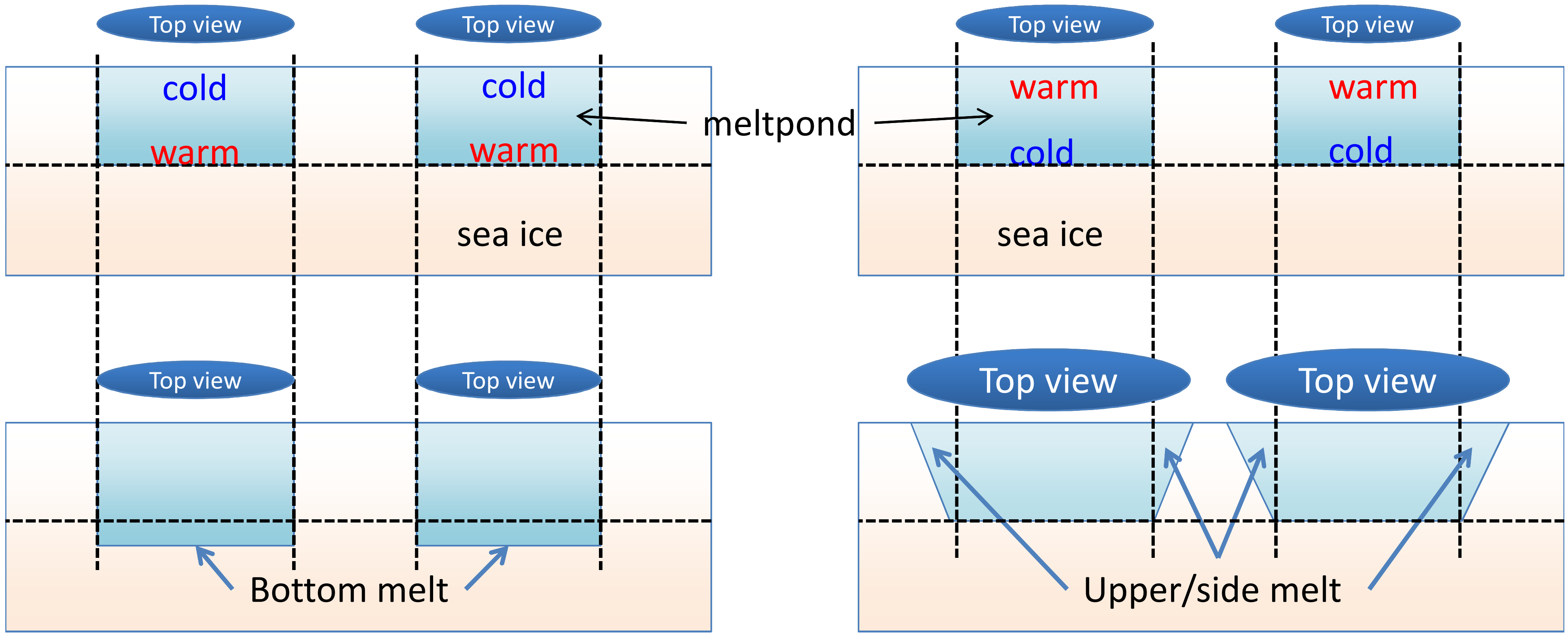
Arctic Change

First year ice

After IPY 2007-2008 (NOW!)

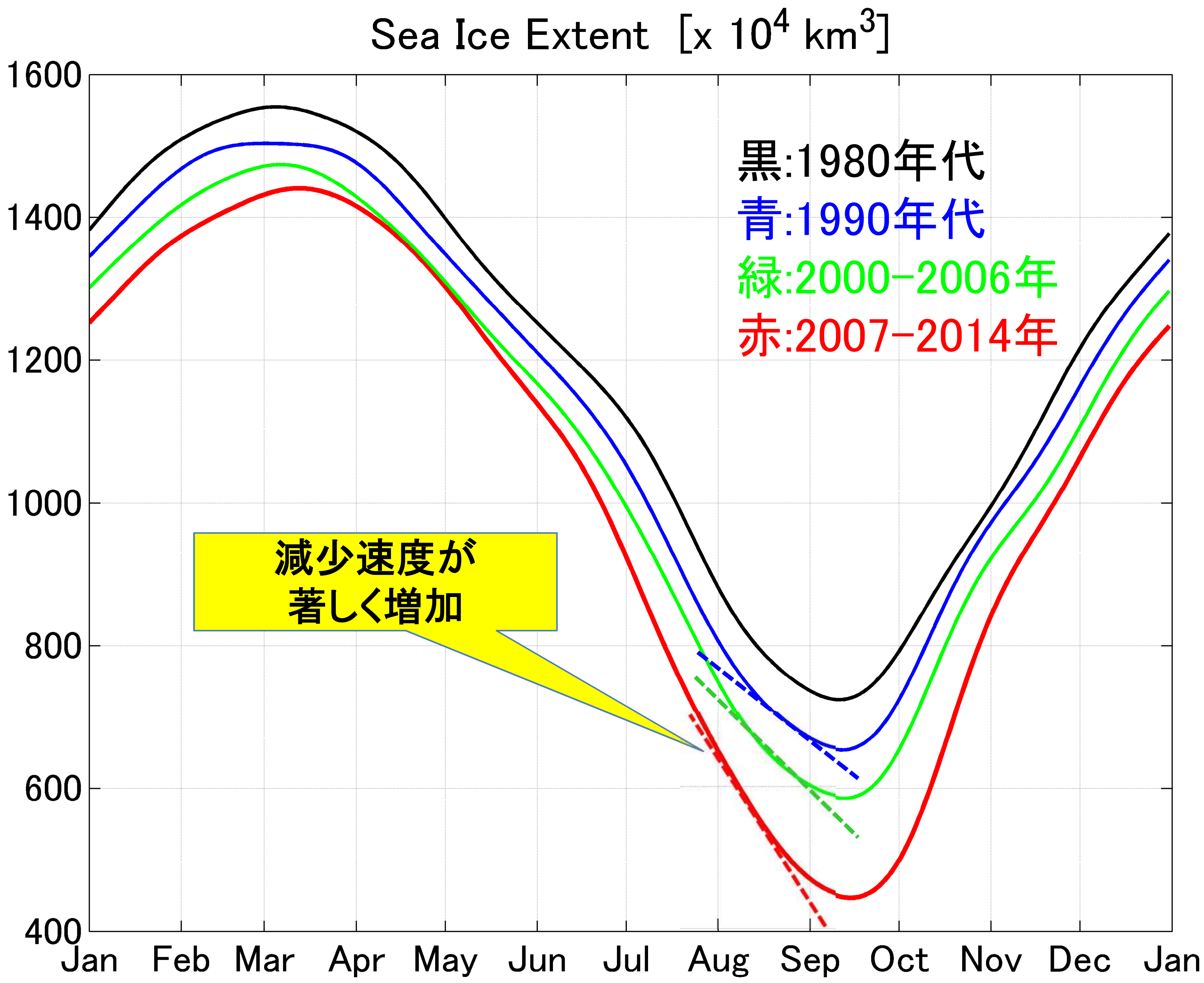
Freshwater pond

Salty pond

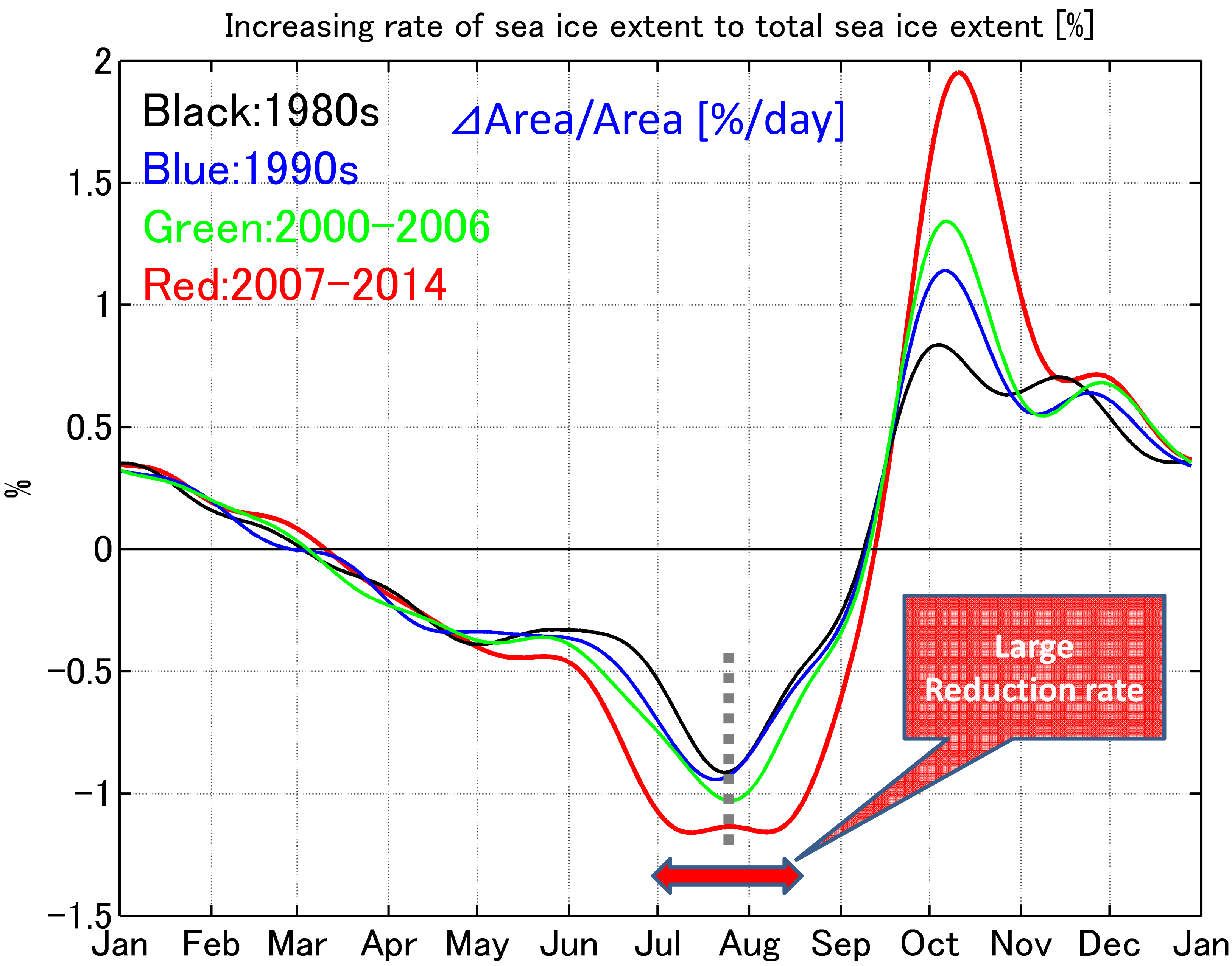


Open water area does not increase

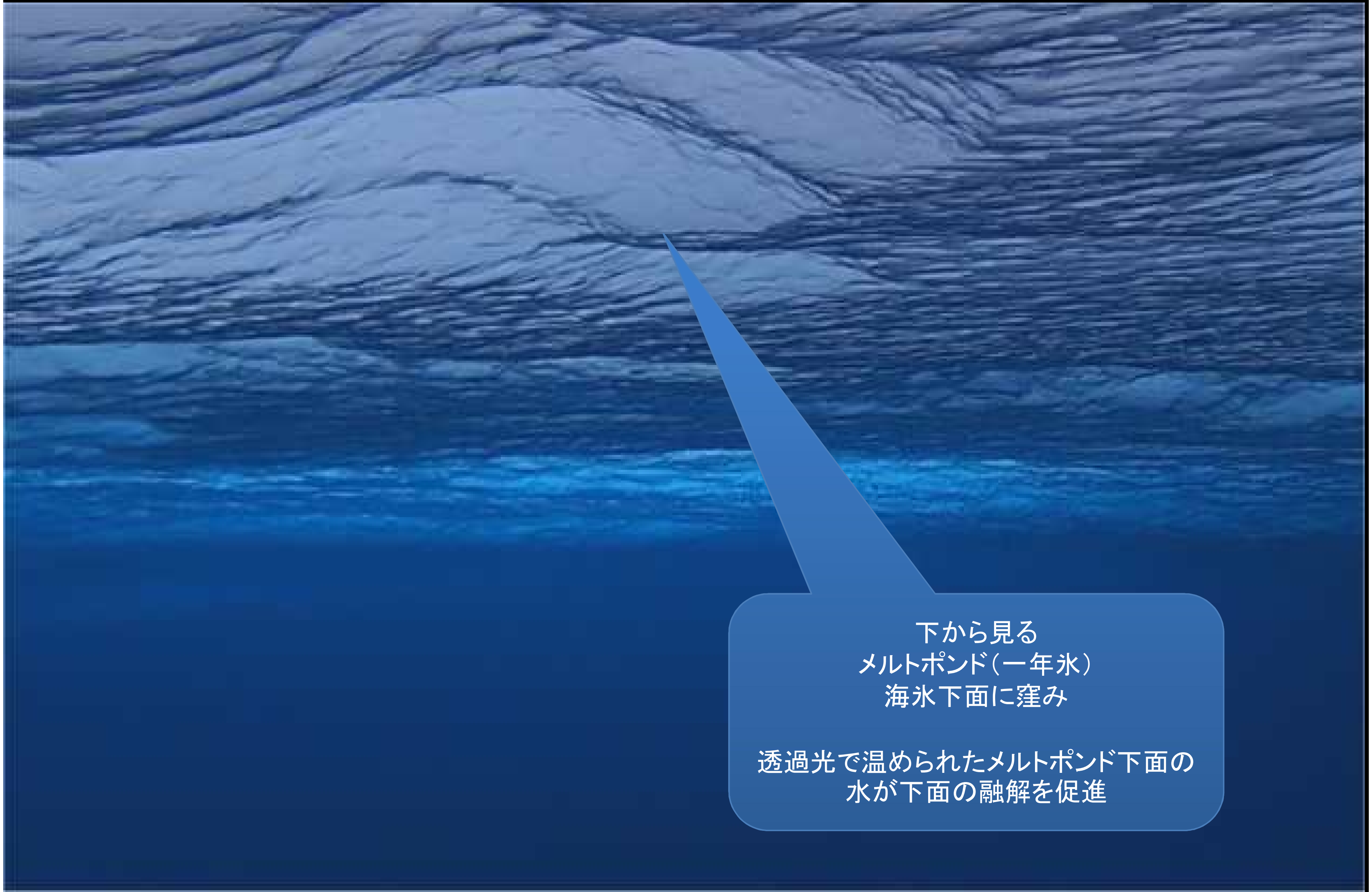
Open water area increases
→Strong positive feedback
for rapid ice reduction



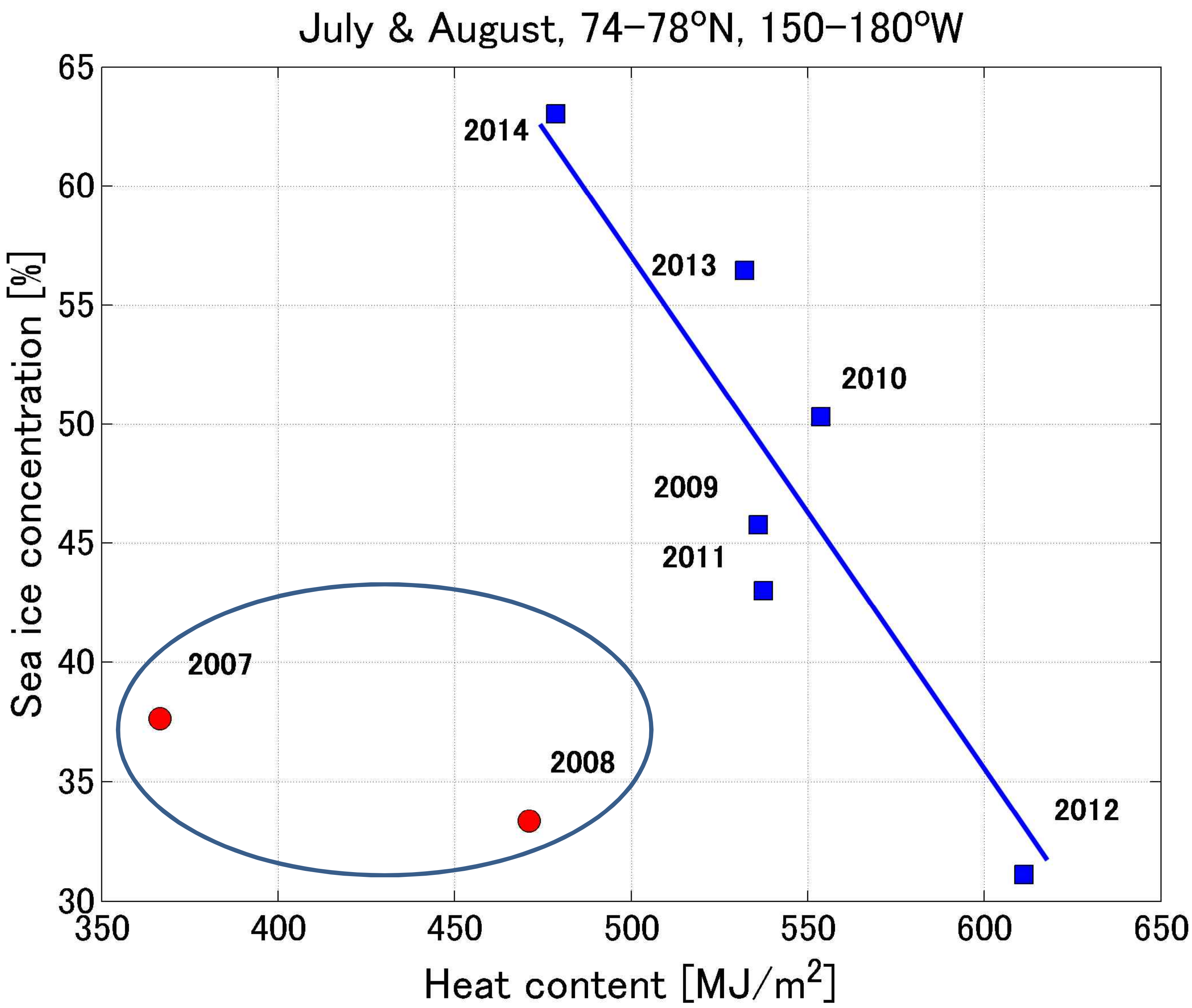
Sea Ice Extent [x 10^4 km^3]
1600
1400
1200
1000
800
600
400
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
黒:1980年代
青:1990年代
緑:2000-2006年
赤:2007-2014年
減少速度が
著しく増加



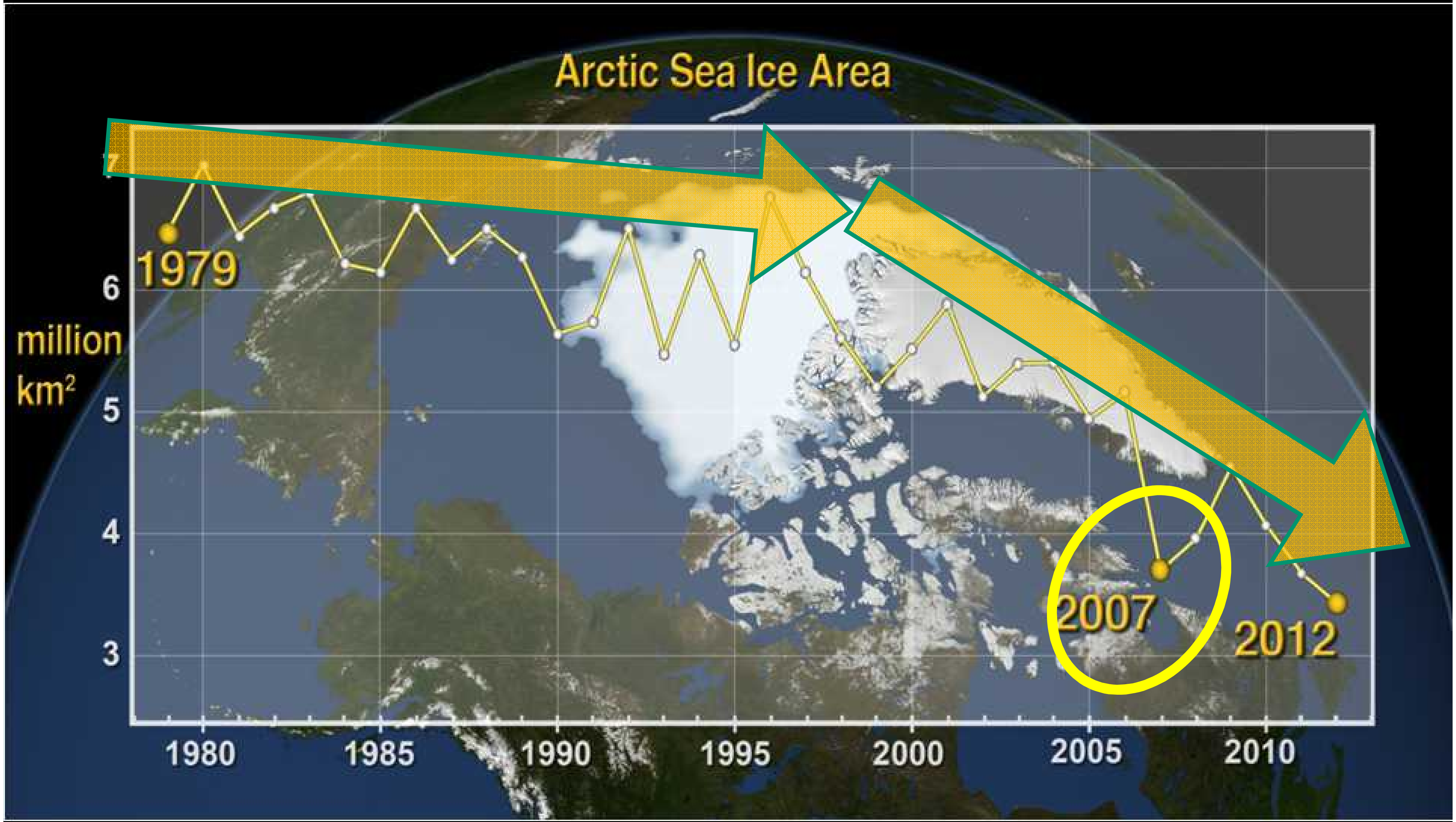
Increasing rate of sea ice extent to total sea ice extent [%]
Black:1980s
Blue:1990s
Green:2000−2006
Red:2007−2014
⊿Area/Area [%/day]
Large
Reduction rate
%
2
1.5
1
0.5
0
−0.5
−1
−1.5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan


下から見る
メルトポンド（一年氷）
海氷下面に窪み

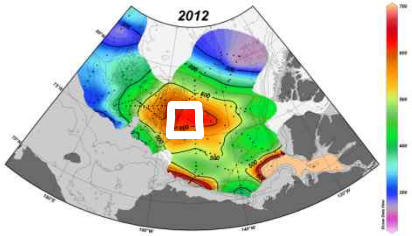
透過光で温められたメルトポンド下面の
水が下面の融解を促進



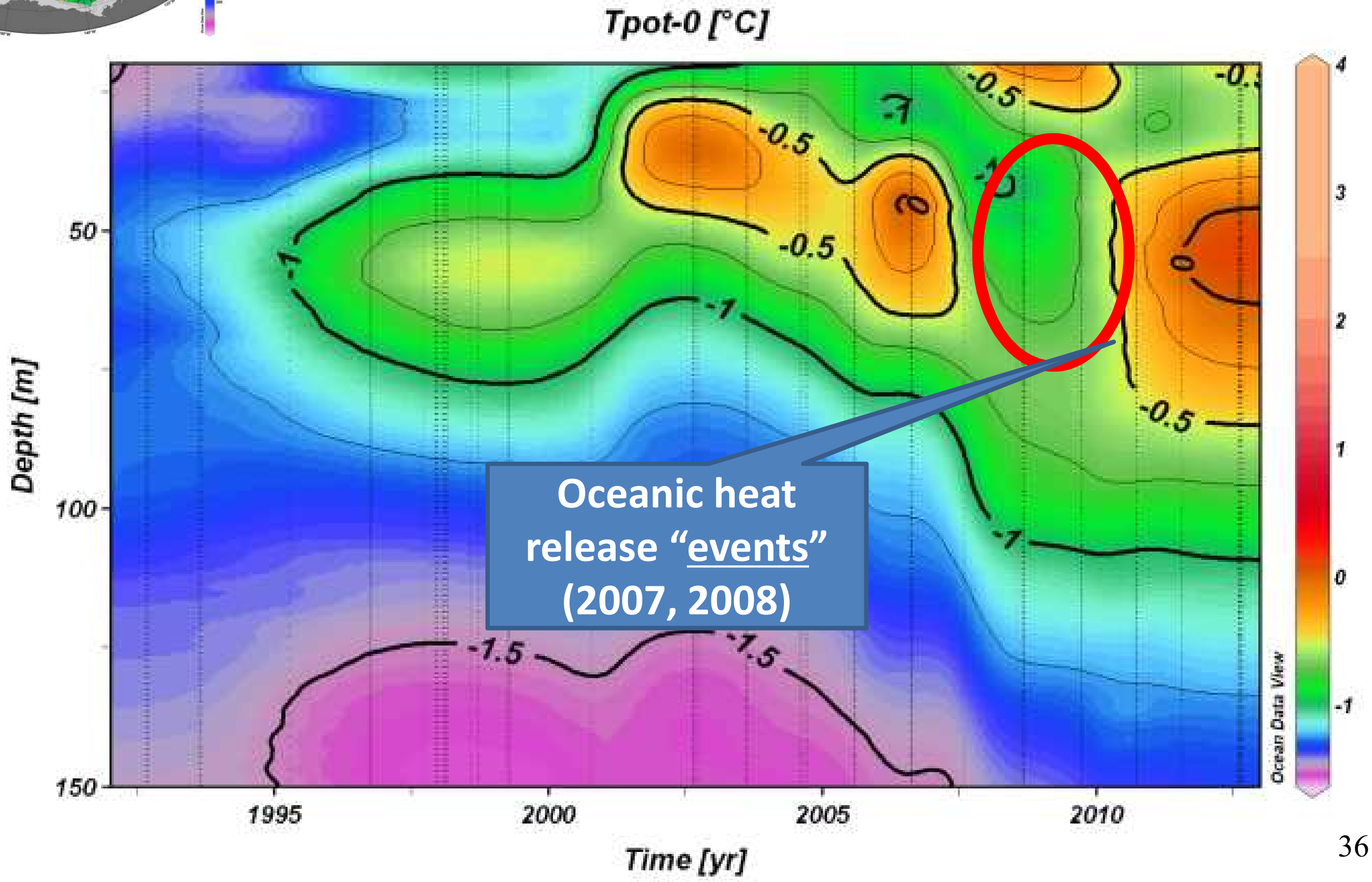
July & August, 74-78°N, 150-180°W
Sea ice concentration [%]
Heat content [MJ/m2]
65
60
55
50
45
40
35
30
350
400
450
500
550
600
650
2014
2013
2010
2009
2011
2007
2008
2012


Arctic Sea Ice Area
million
km²
7
6
5
4
3
1979
2007
2012
1980
1985
1990
1995
2000
2005
2010

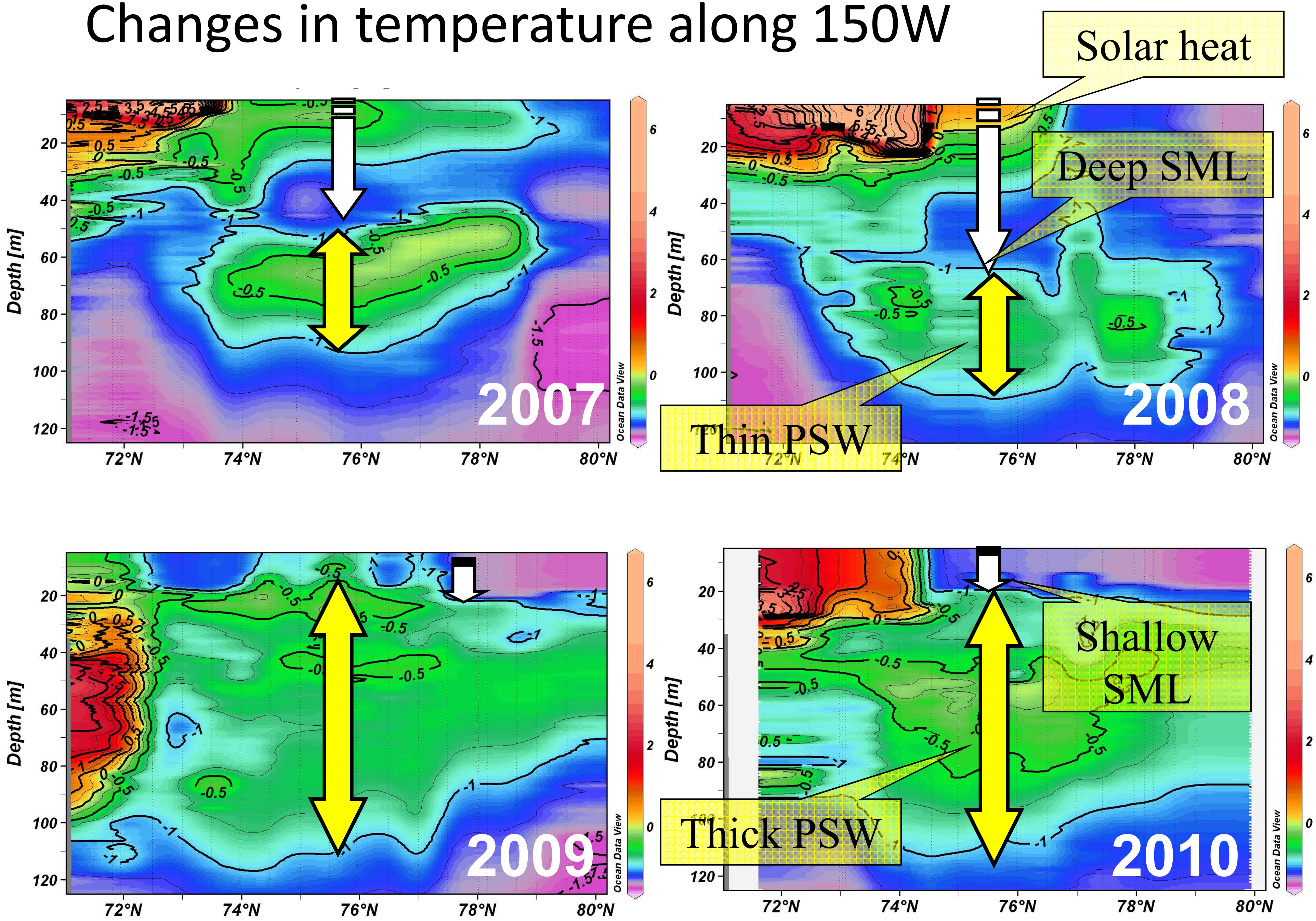
Time series of temperature on the Northwindridge



Heat release “event”.

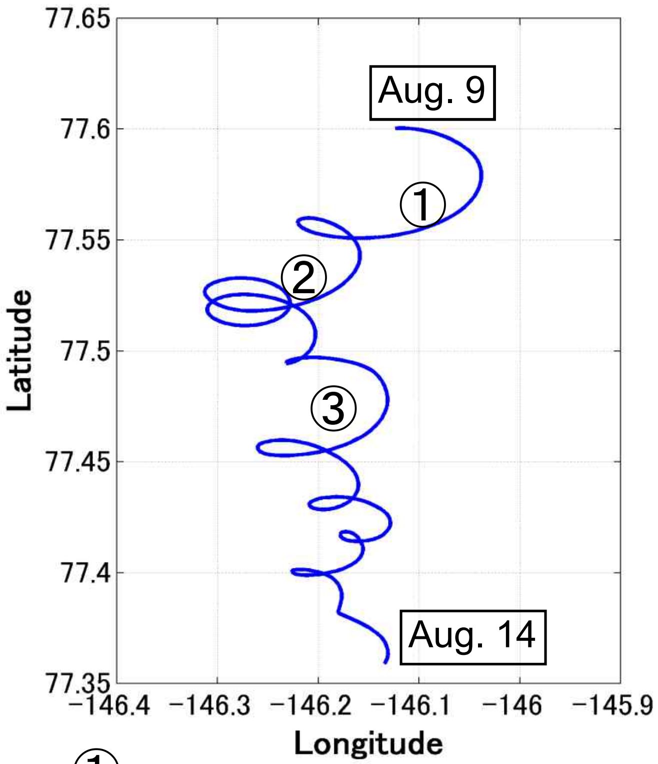


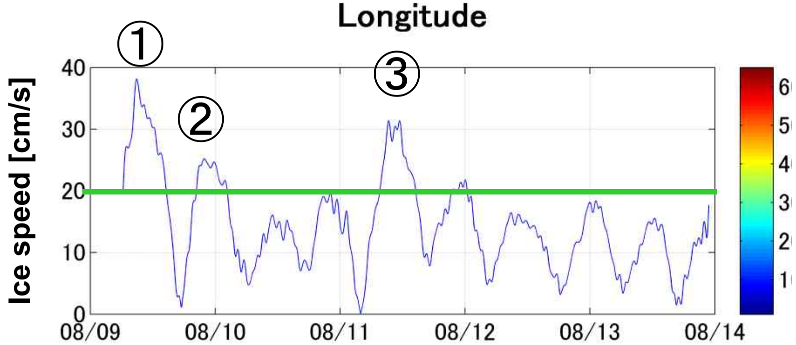
Changes in temperature along 150W

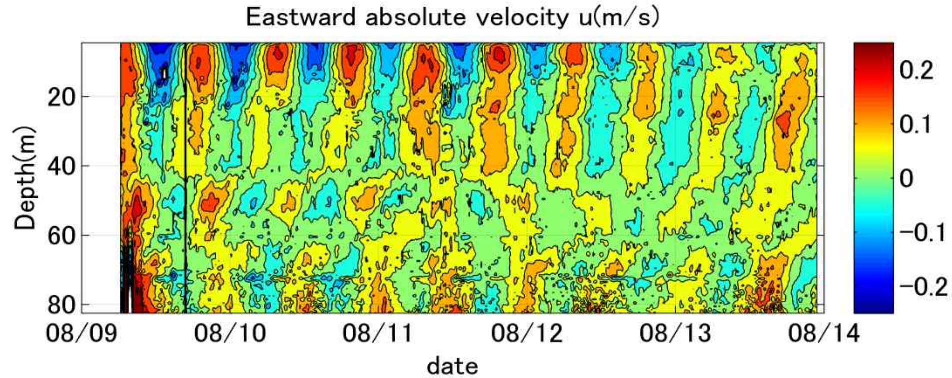


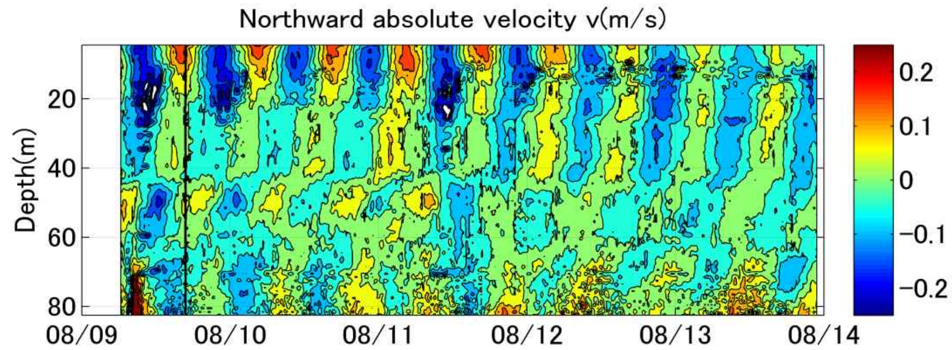
Short time scale sea ice motion and vertical mixing (2014 field experiment)

氷速20cm/s以上で表層混合層と直下の太平洋水層（冬季混合層の名残部分）との間で大きな混合が起こる。
暖かい夏期太平洋水層と直上の太平洋水層（冬季混合層の名残部分）との間の混合は、慣性振動の位相のズレが大事

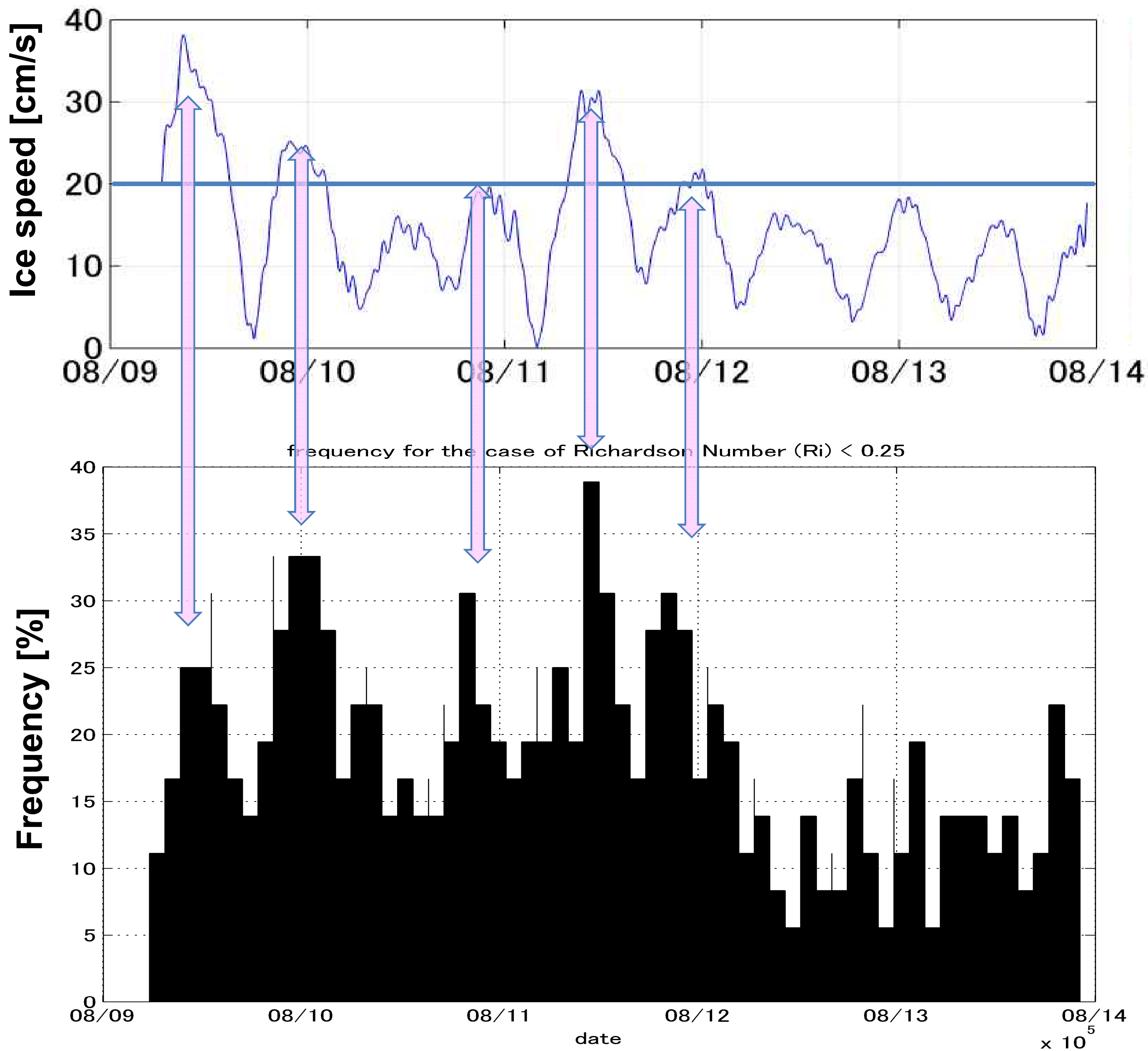








Sea ice speed and Frequency of the case satisfying Ri <0.25 (5-30m)



When sea ice speed is greater than 20cm/s, strong vertical mixing occurred.

The former study by Kawashima (2013) was meaningful.