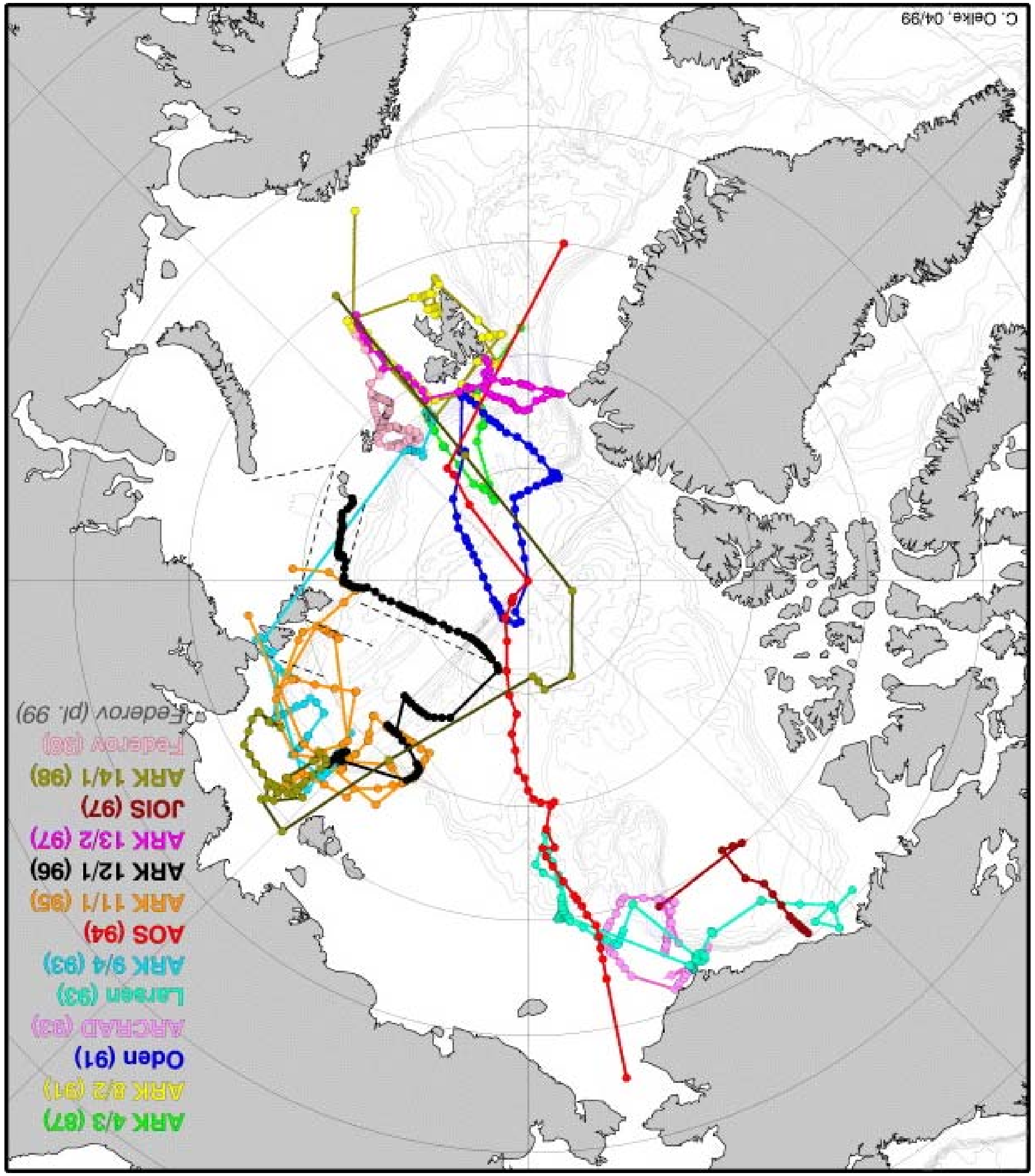
Climate Line

Arctic WOCE section

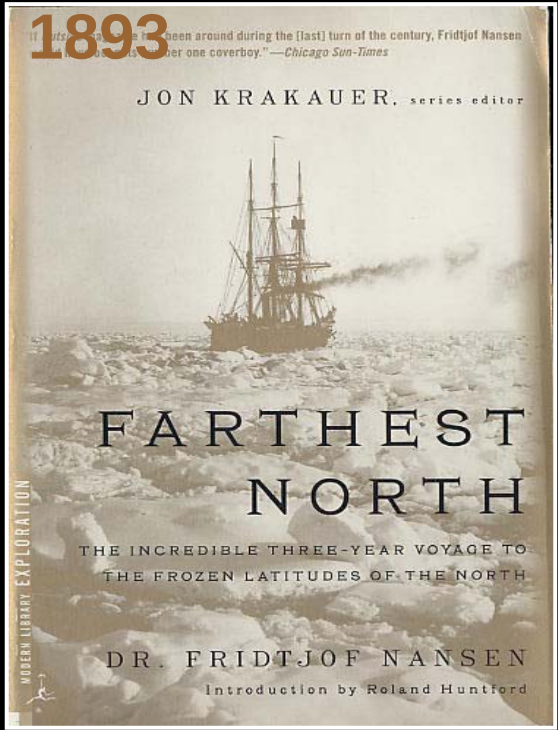
Koji Shimada

TUMSAT

CTD stations in 1990s from ACSYS HP

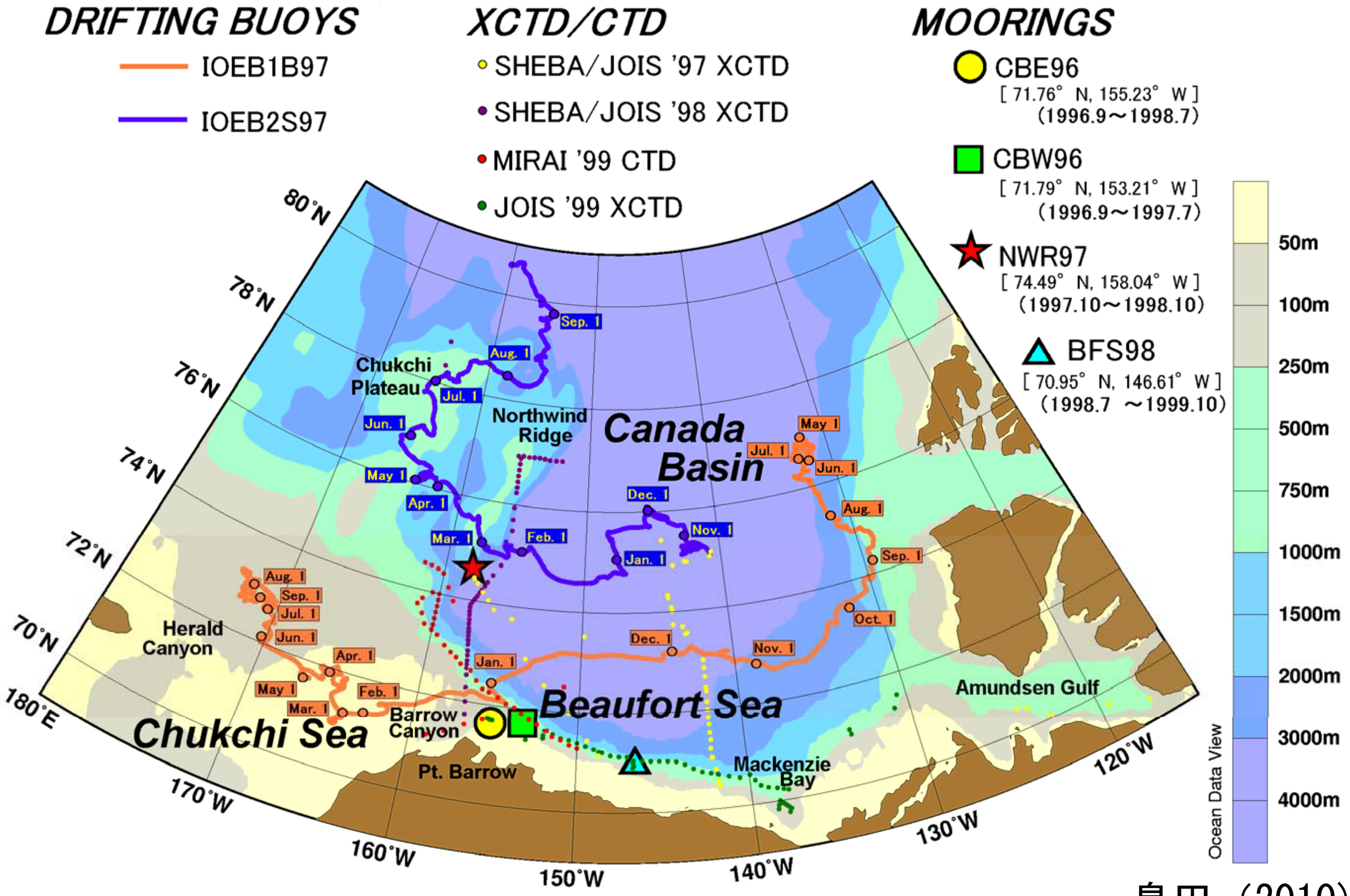


Changes in the Arctic Ocean



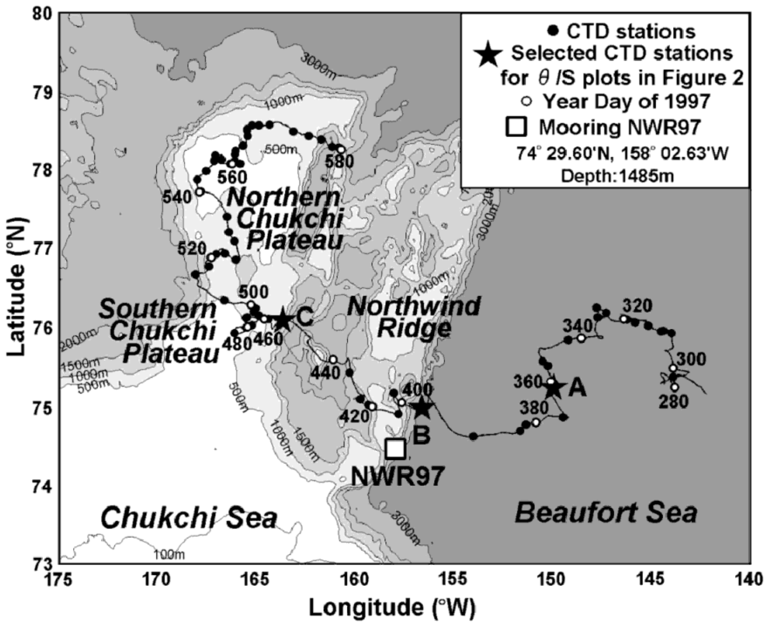

Canadä
SHEBA 1997-1998

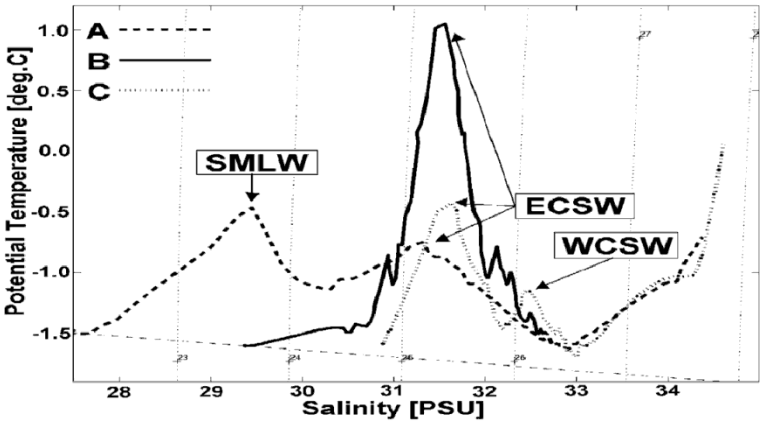
SHEBA／ARM 1997-1998

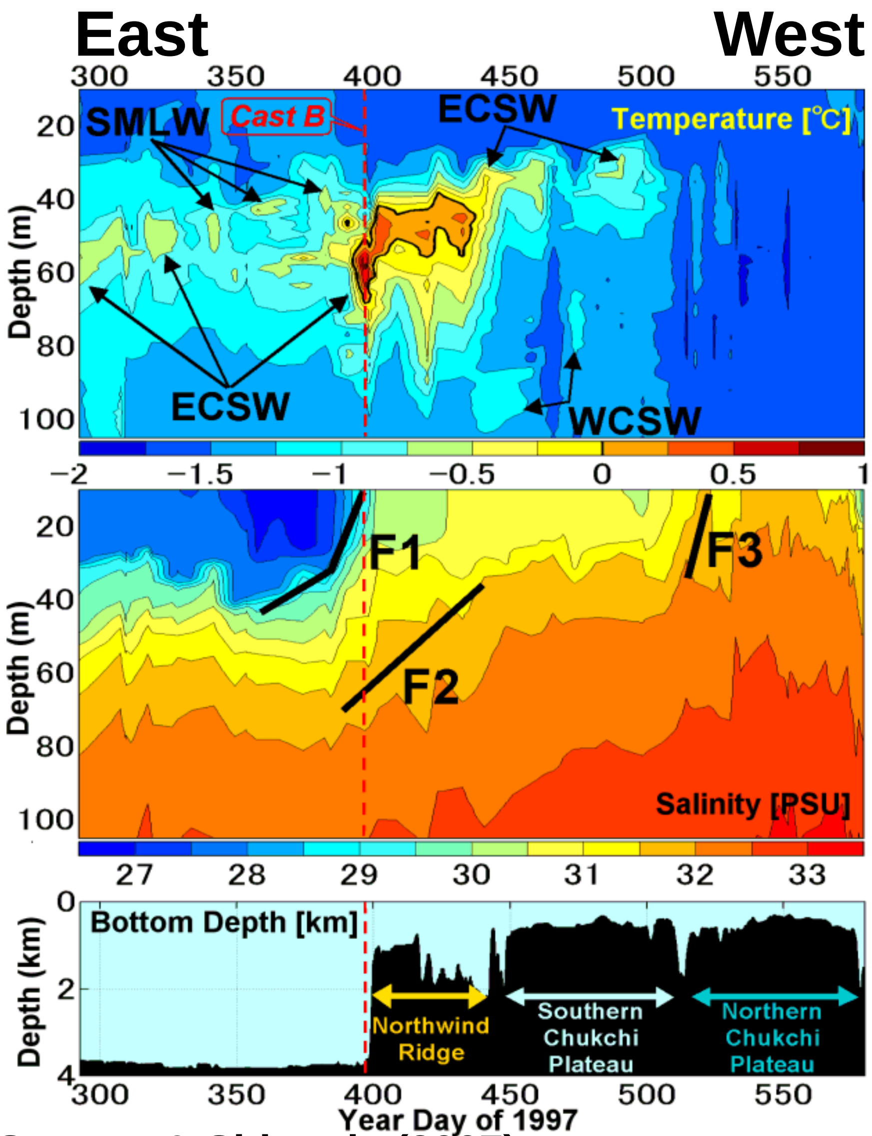


島田 （2010）

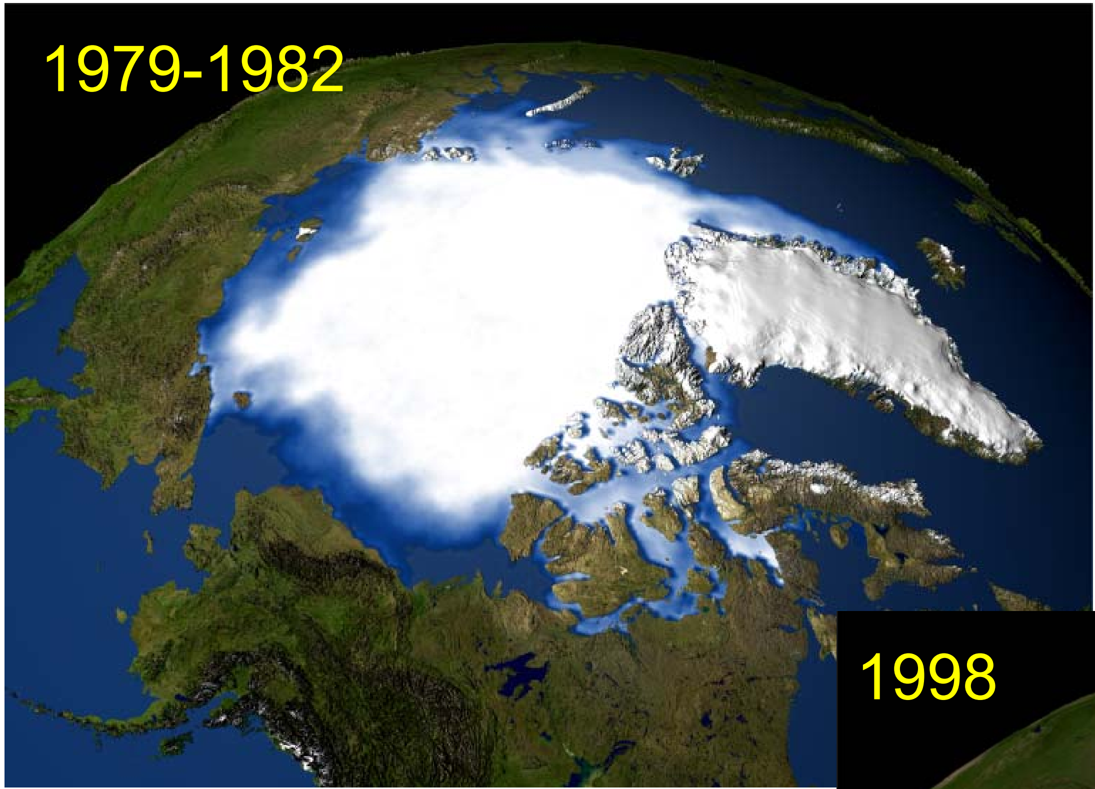
Major pathways of Pacific Summer Waters were identified.



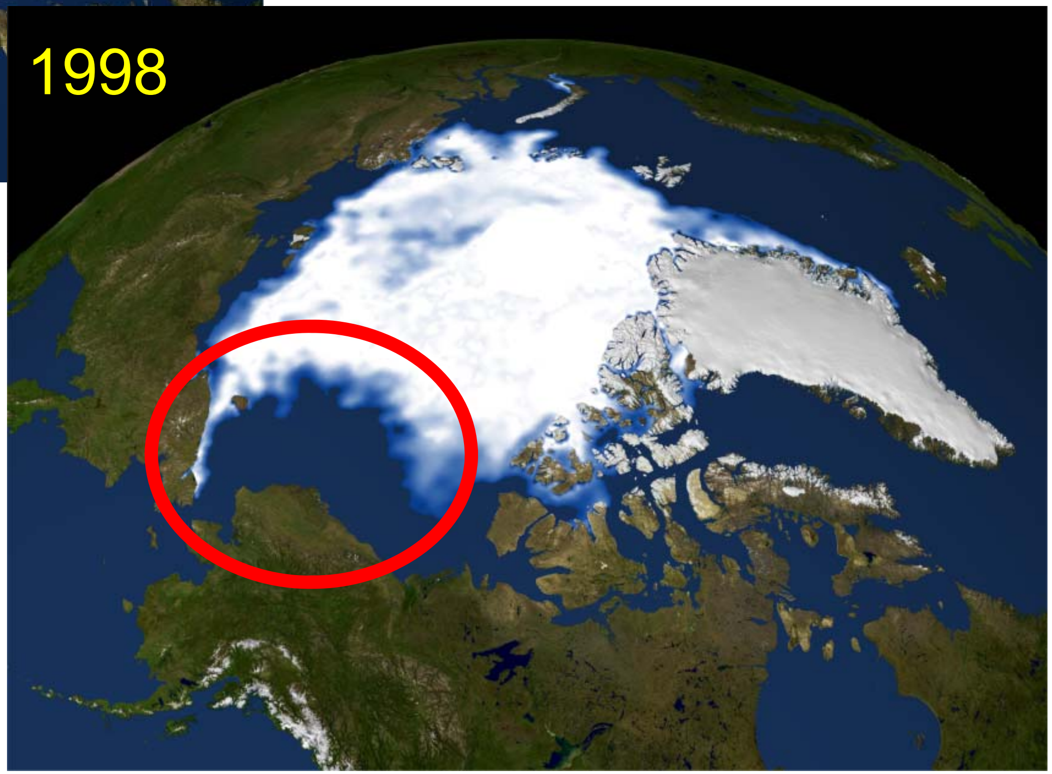




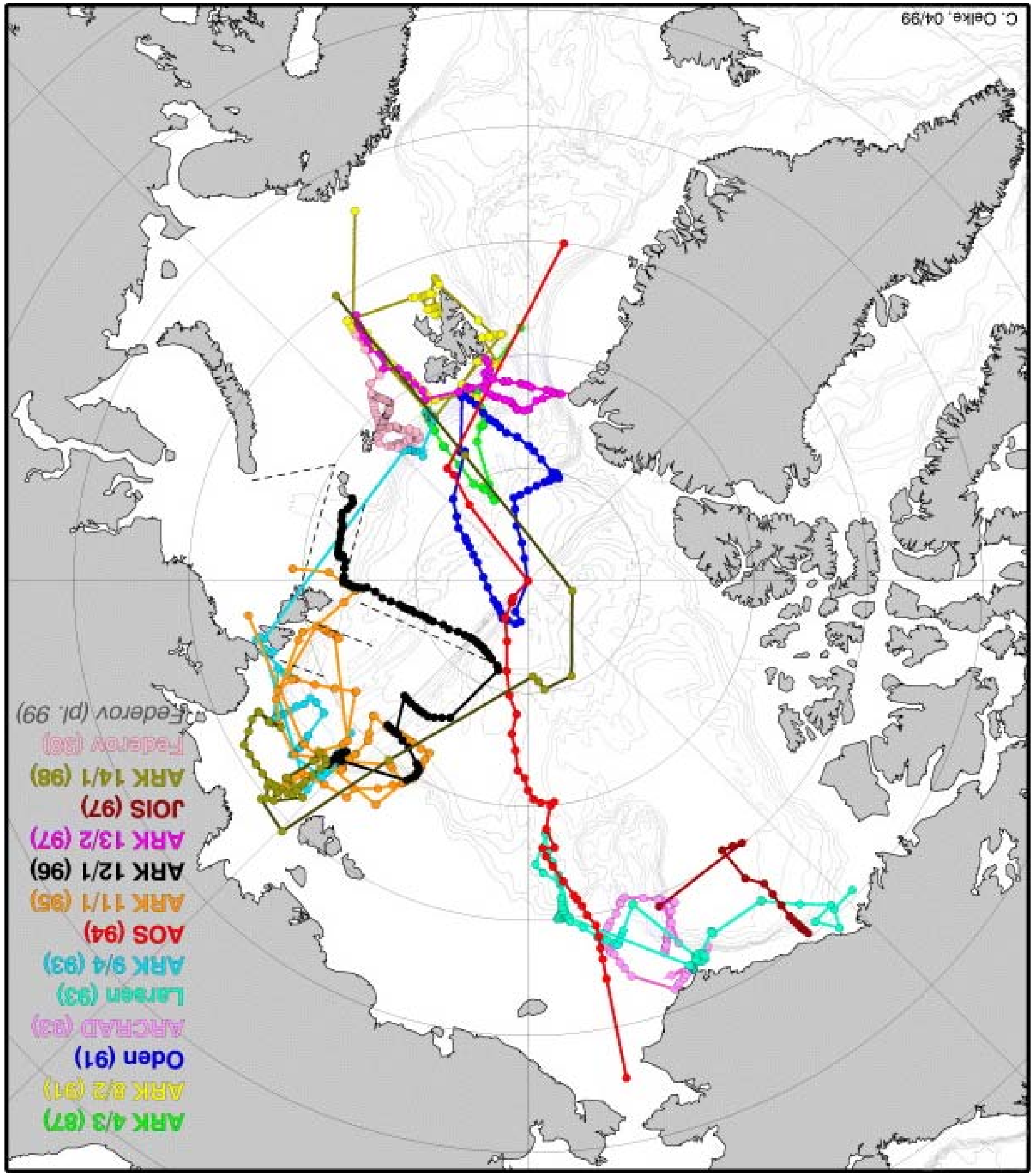
Shimada et al. (2001)、Sumata & Shimada (2007)



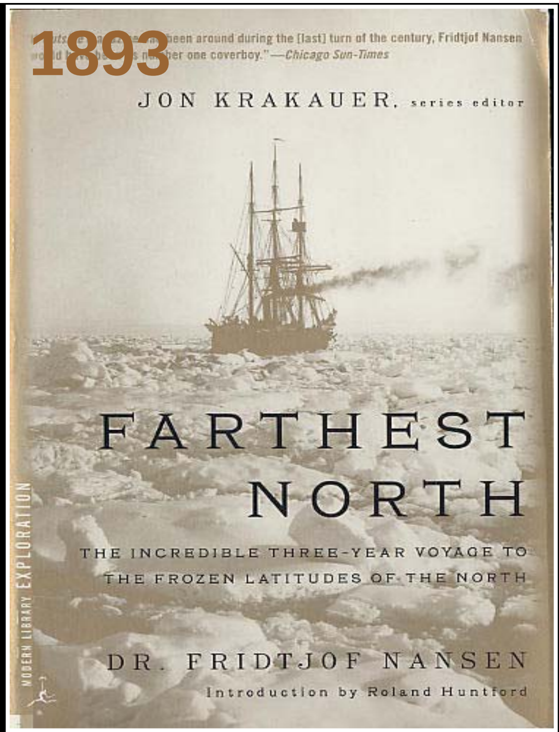
Ocean controled the sea ice reduction in the Pacific Sector



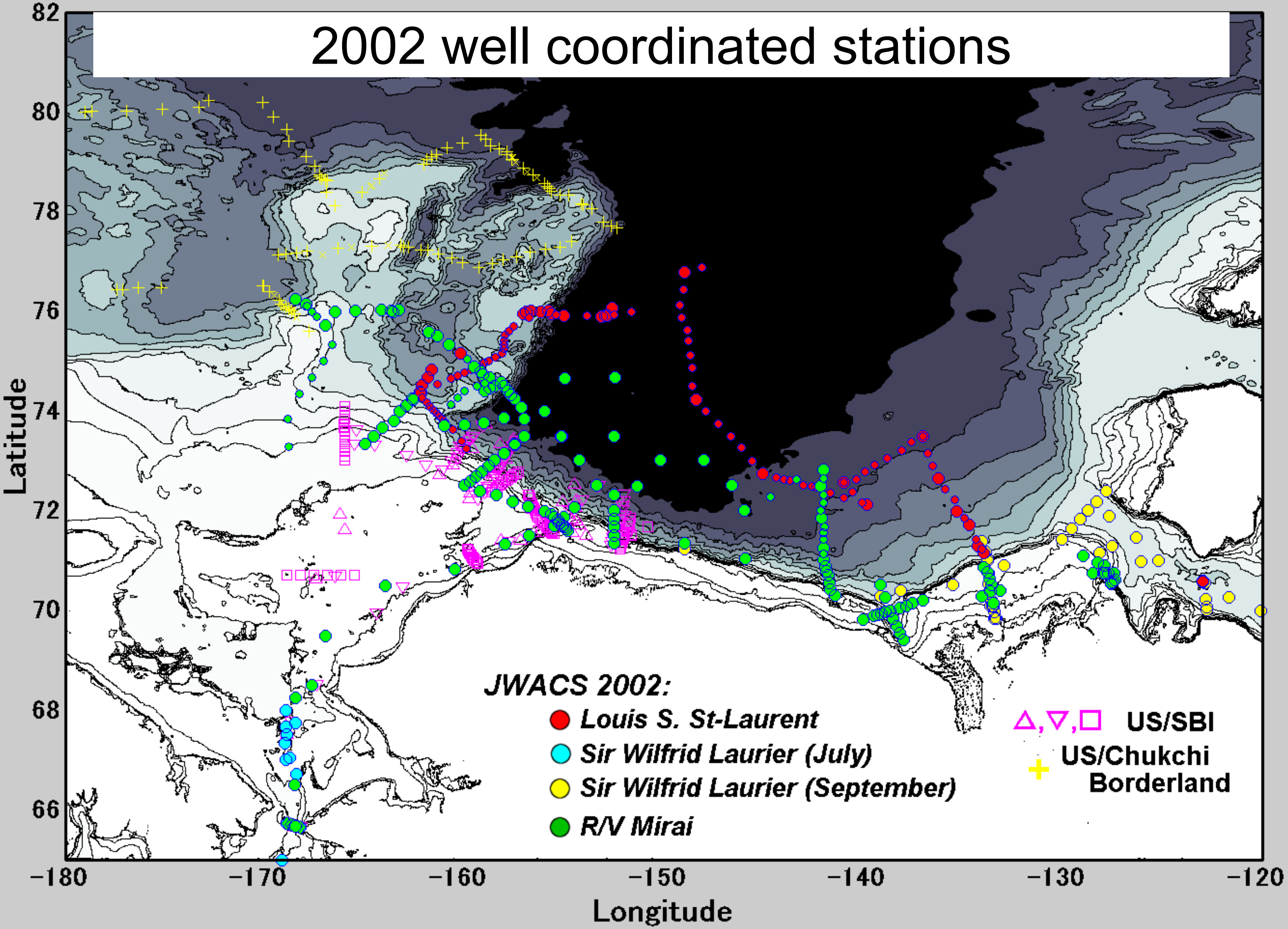
CTD stations in 1990s
from ACSYS HP



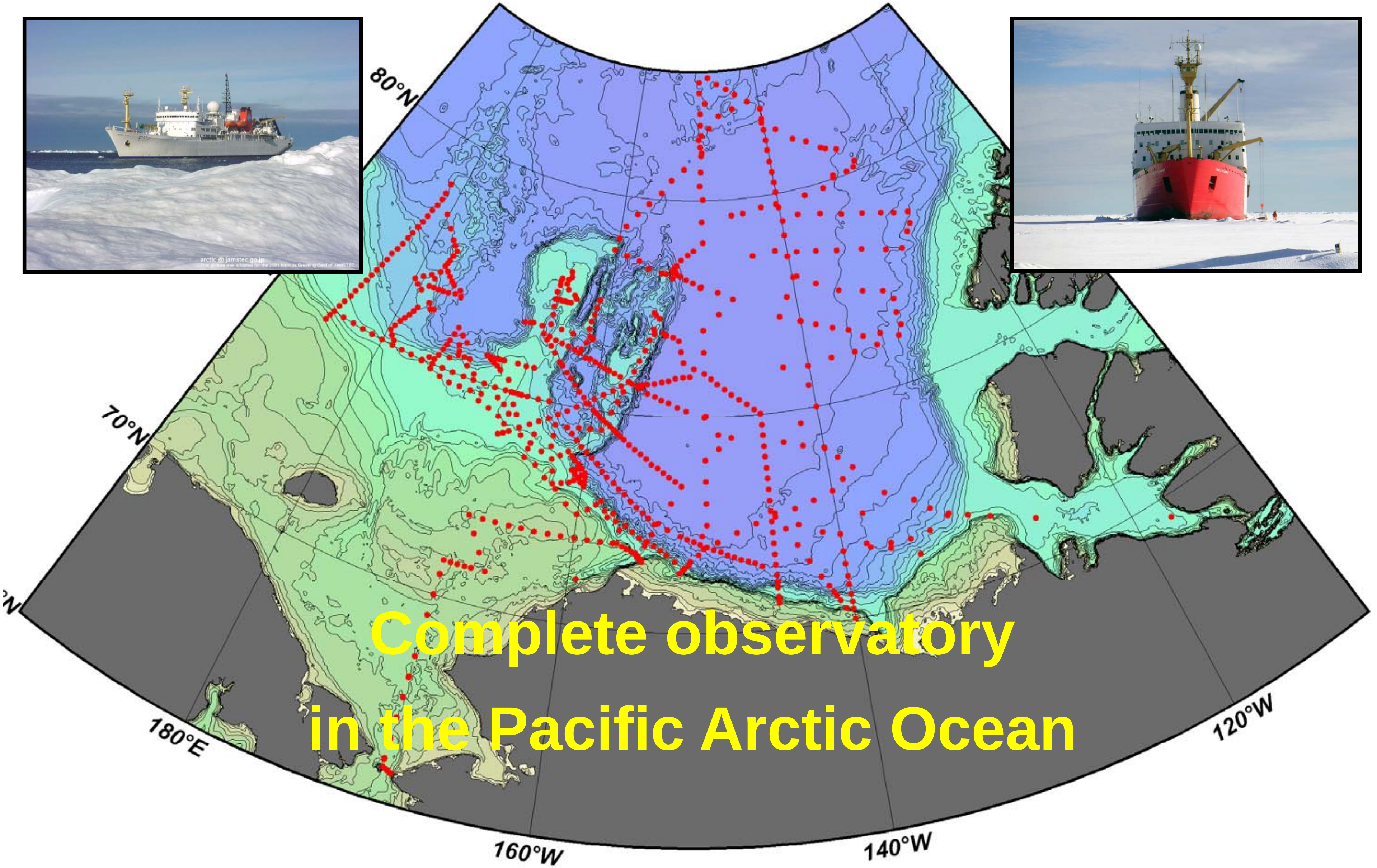
Changes in the Arctic Ocean



2002 well coordinated stations

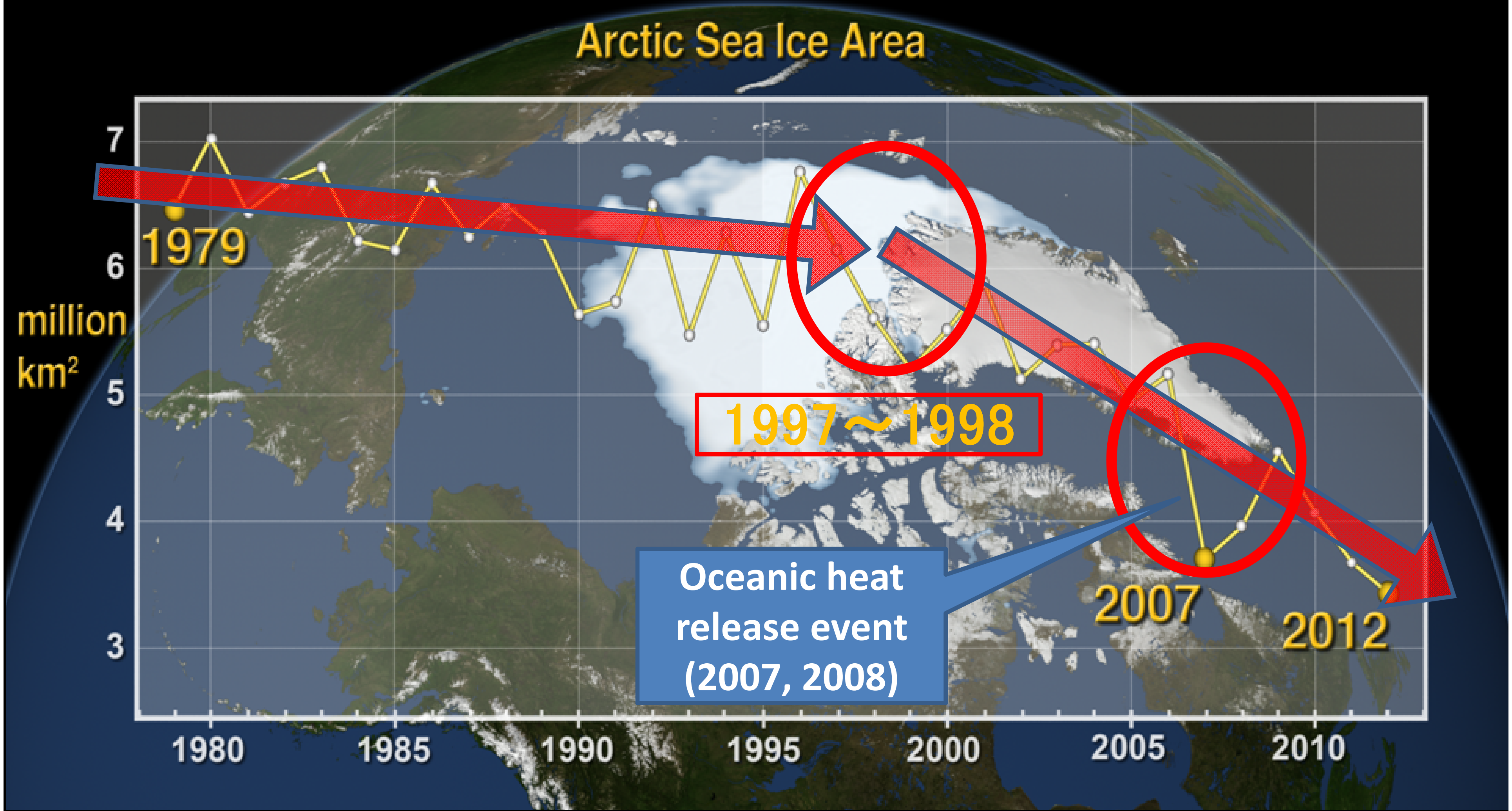


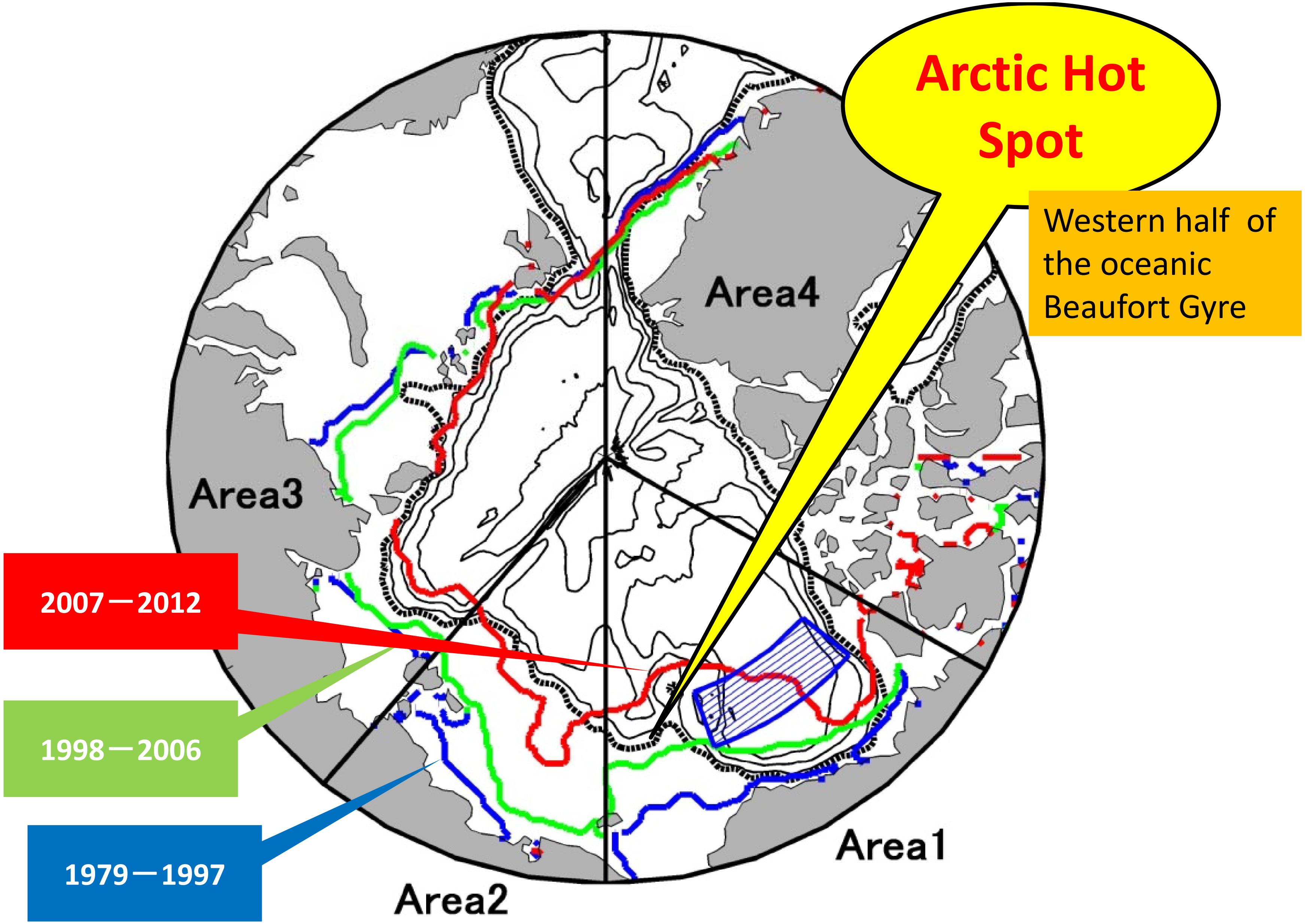
IPY2007-2008



Complete observatory in the Pacific Arctic Ocean

Sea ice extent : 1979～2012

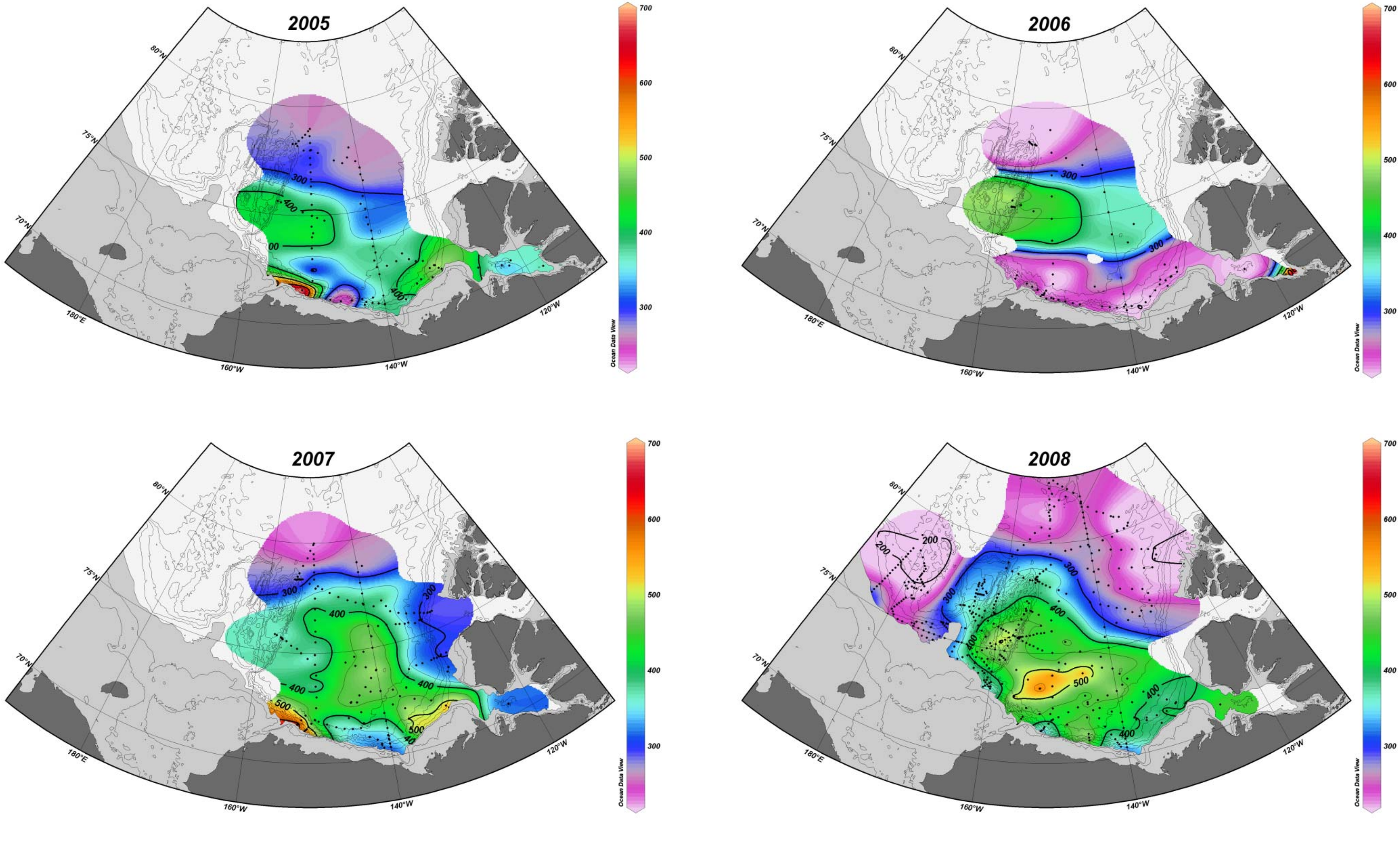




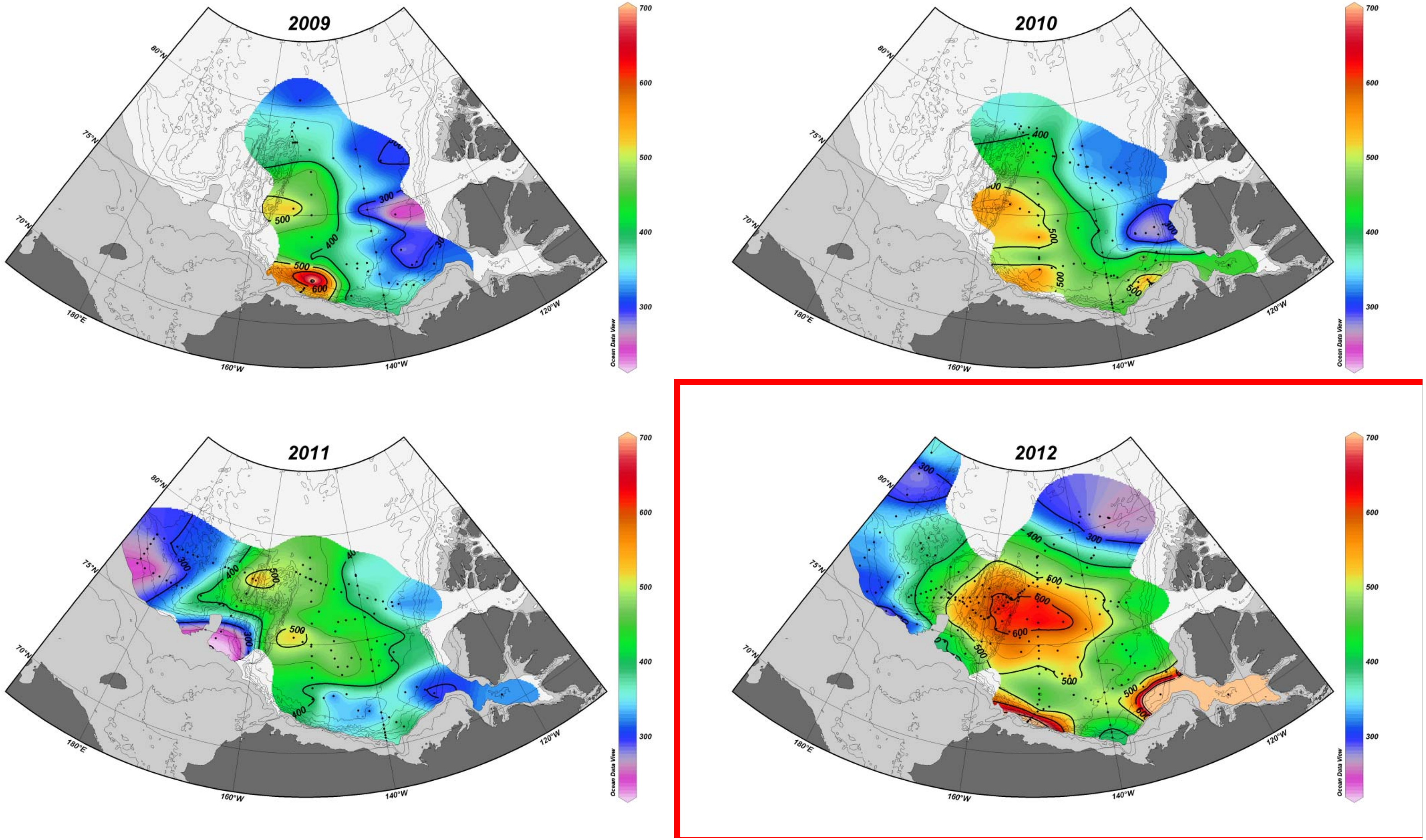
Ice edge in September

Yoshizawa et al., (2014)

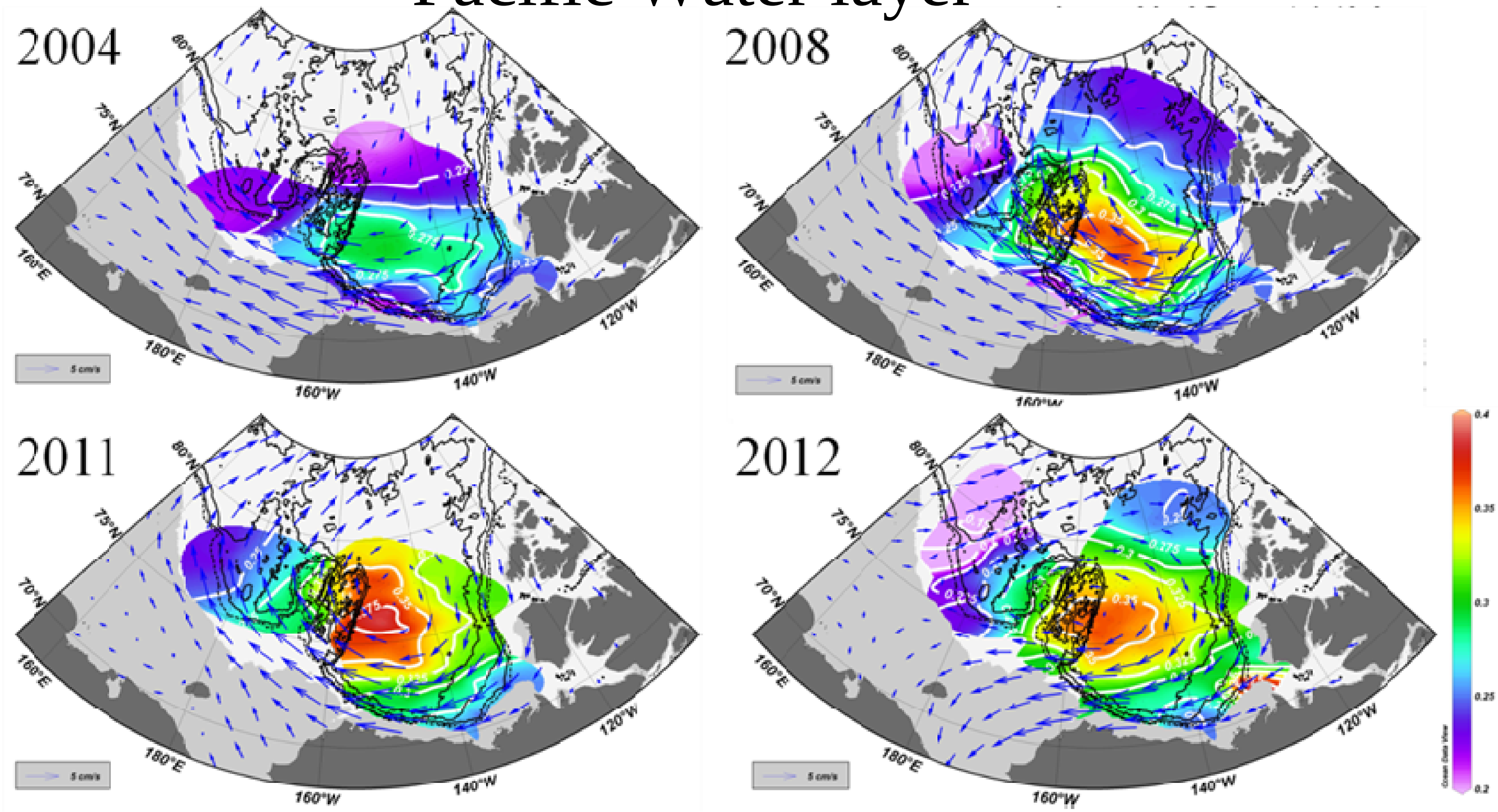
Heat content (20-150m)



Heat content (20-150m)



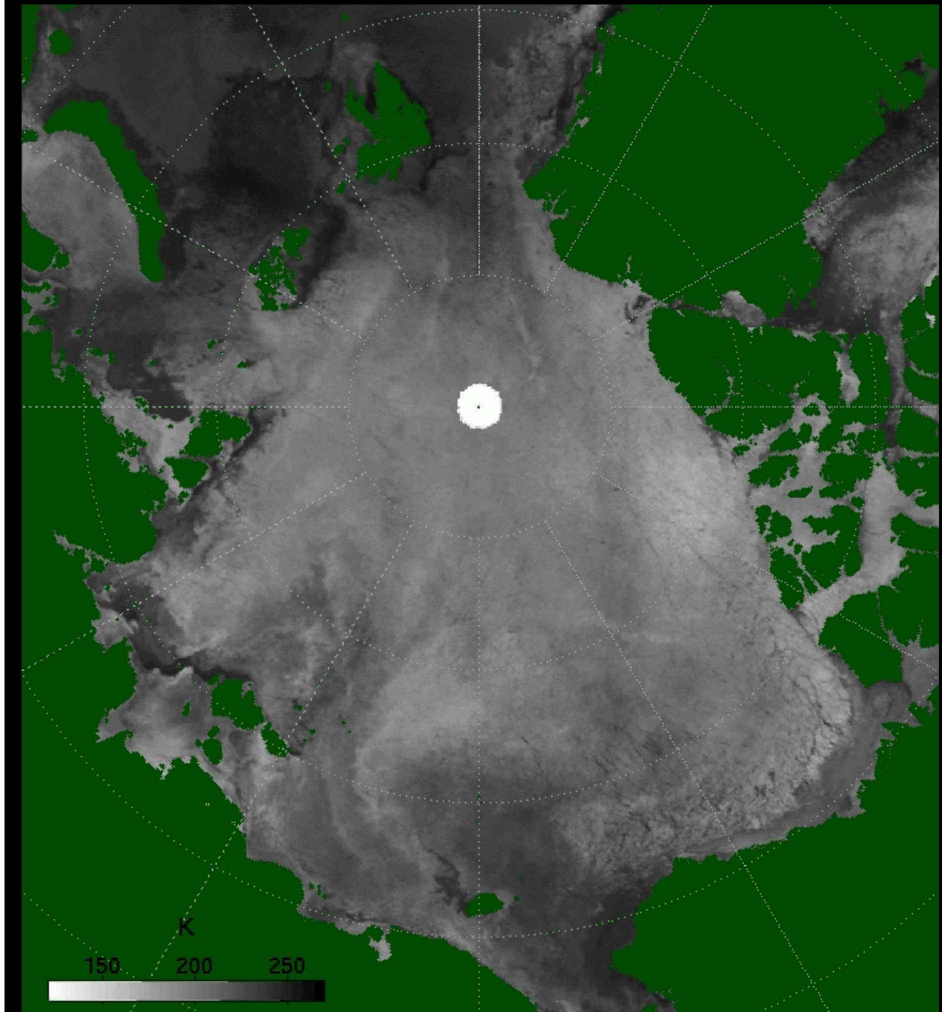
Sea ice motion and ocean circulation of Pacific Water layer



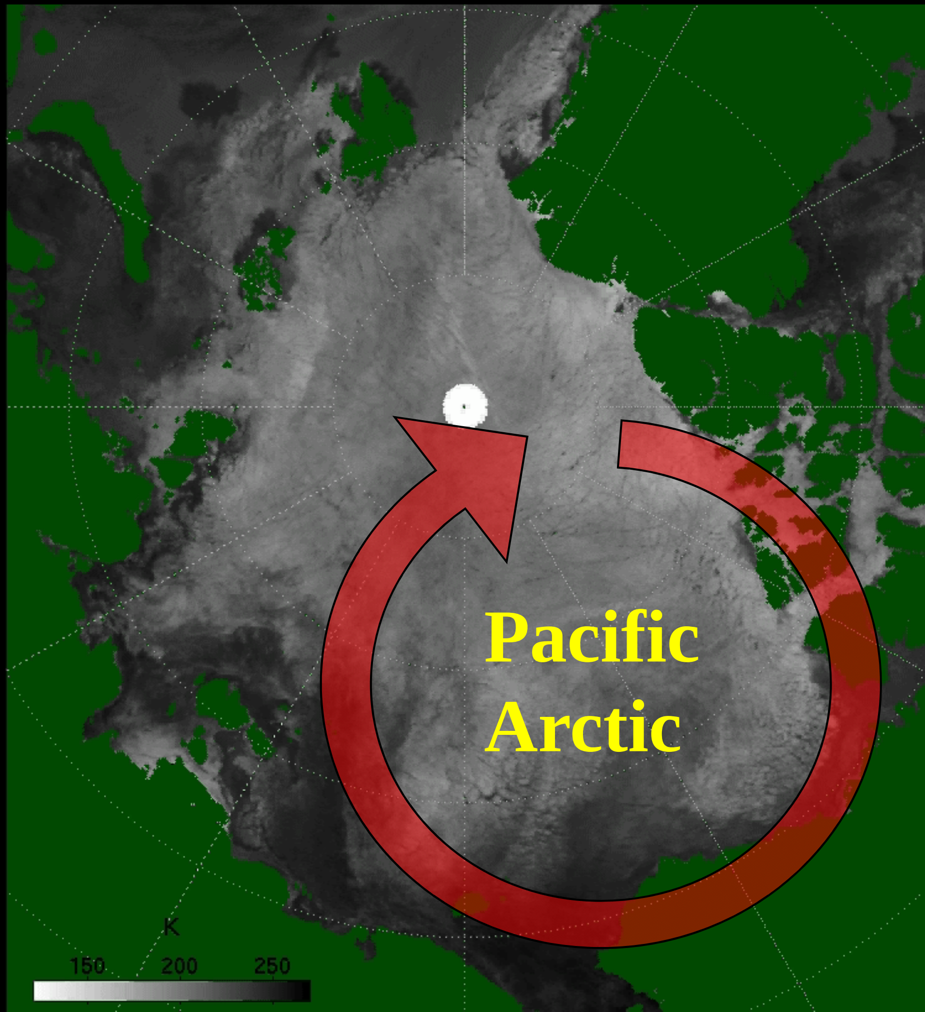
Background color: dynamic height at 100dar relative to 800bdar (Oceanic Beaufort Gyre)
Black vectors: average sea ice motion vectors for November – April.

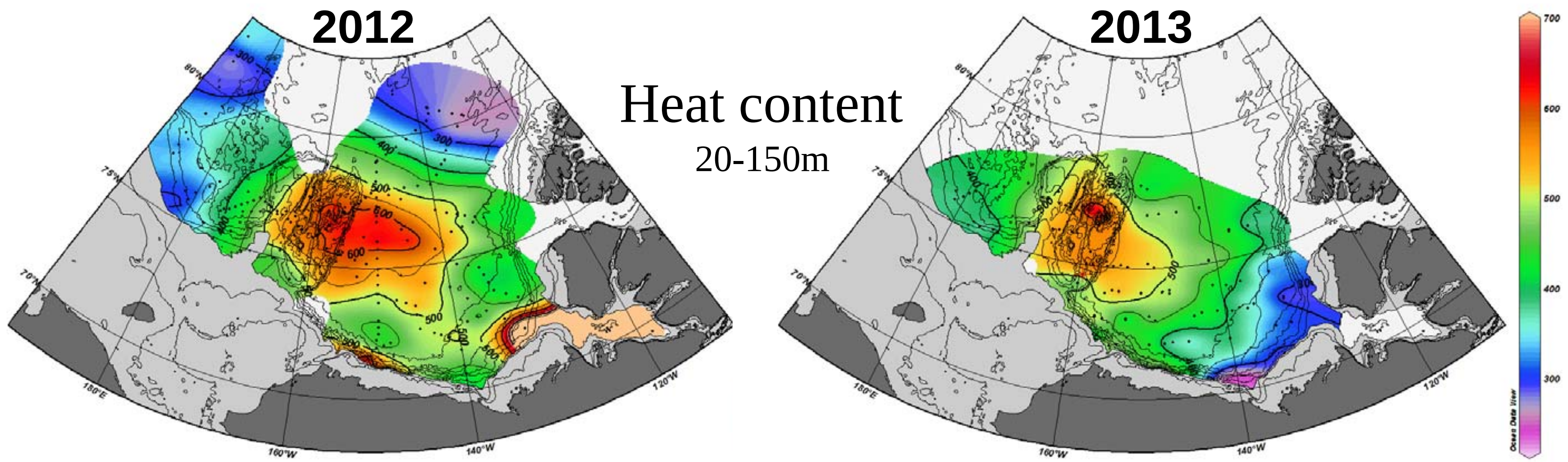
Yoshizawa et al., (2015)

Heavy Ice



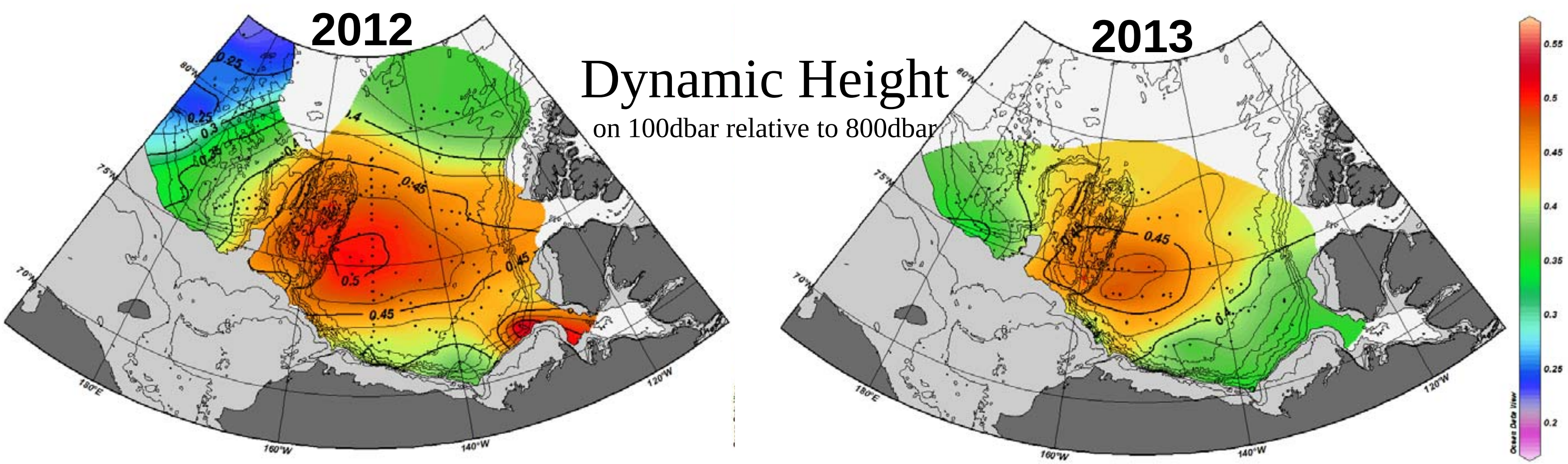
Less Ice



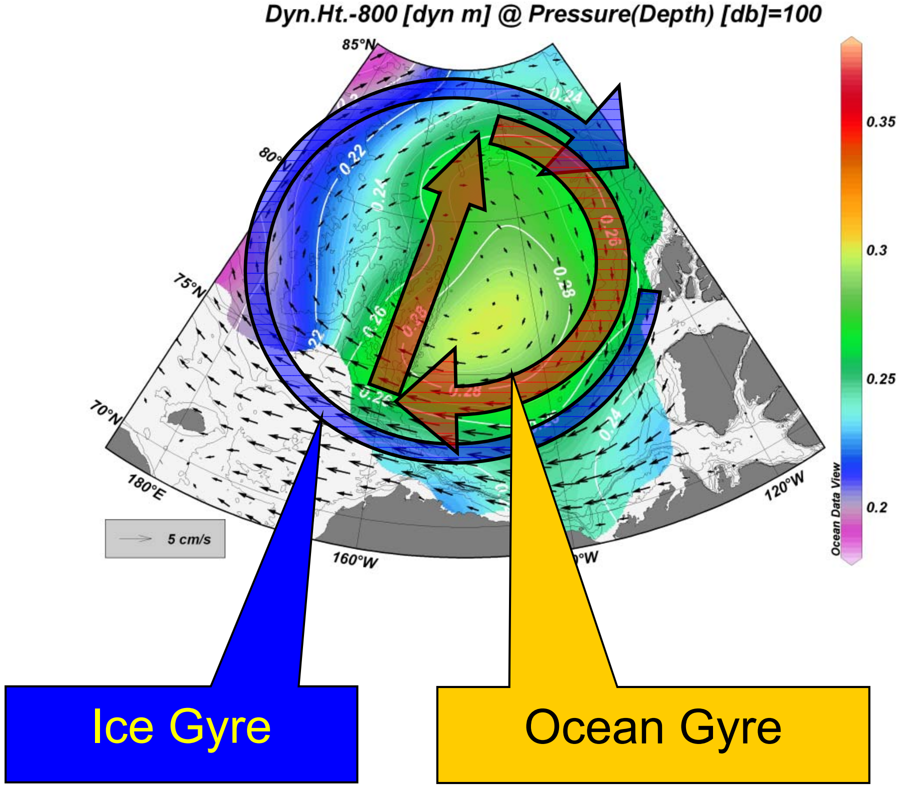


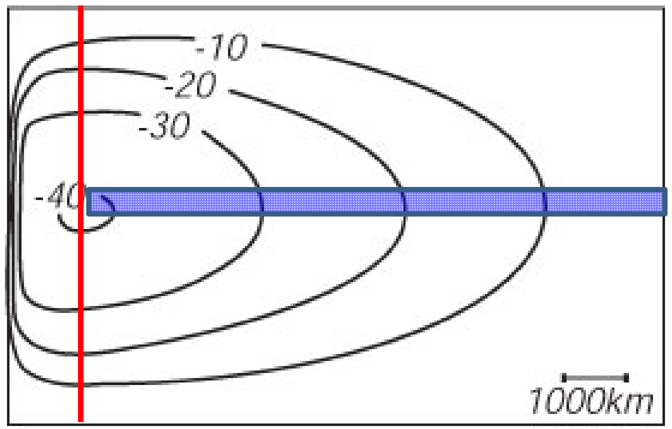
2013:

upper ocean heat decrease→ formation of sea ice enhanced
→thickness of first year ice increase→sea ice survive by the end of summer



Upper ocean circulation was weakened in 2013





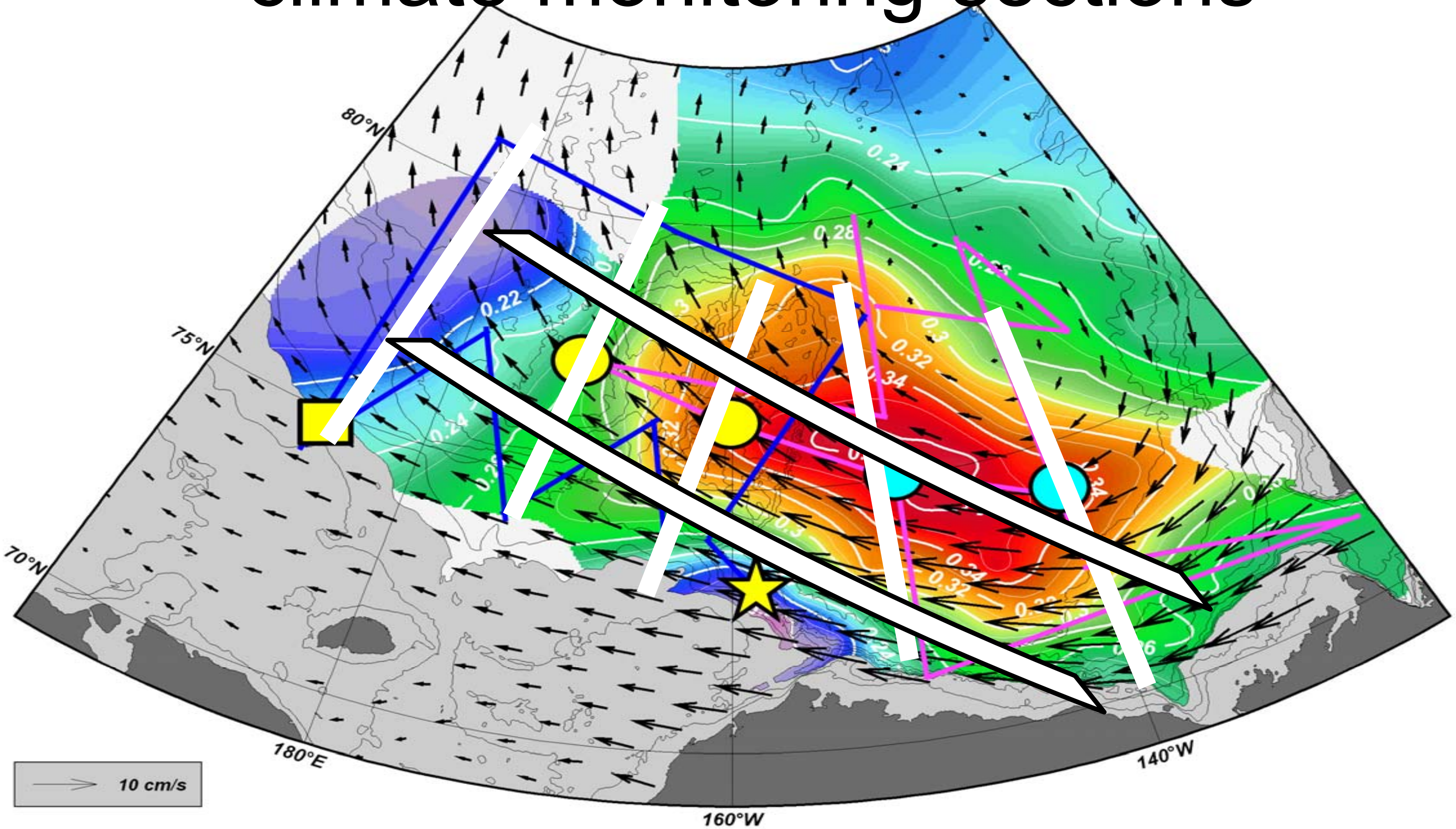
β-plane

スベルトラップ輸送を計算

This is principal "Oceanic Beaufort Gyre" established by surface forcing and wave dynamics.
It is different from Beaufort High and Beaufort Ice Gyre.

Sumata & Shimada (2007)

Proposed international Pacific Arctic climate monitoring sections



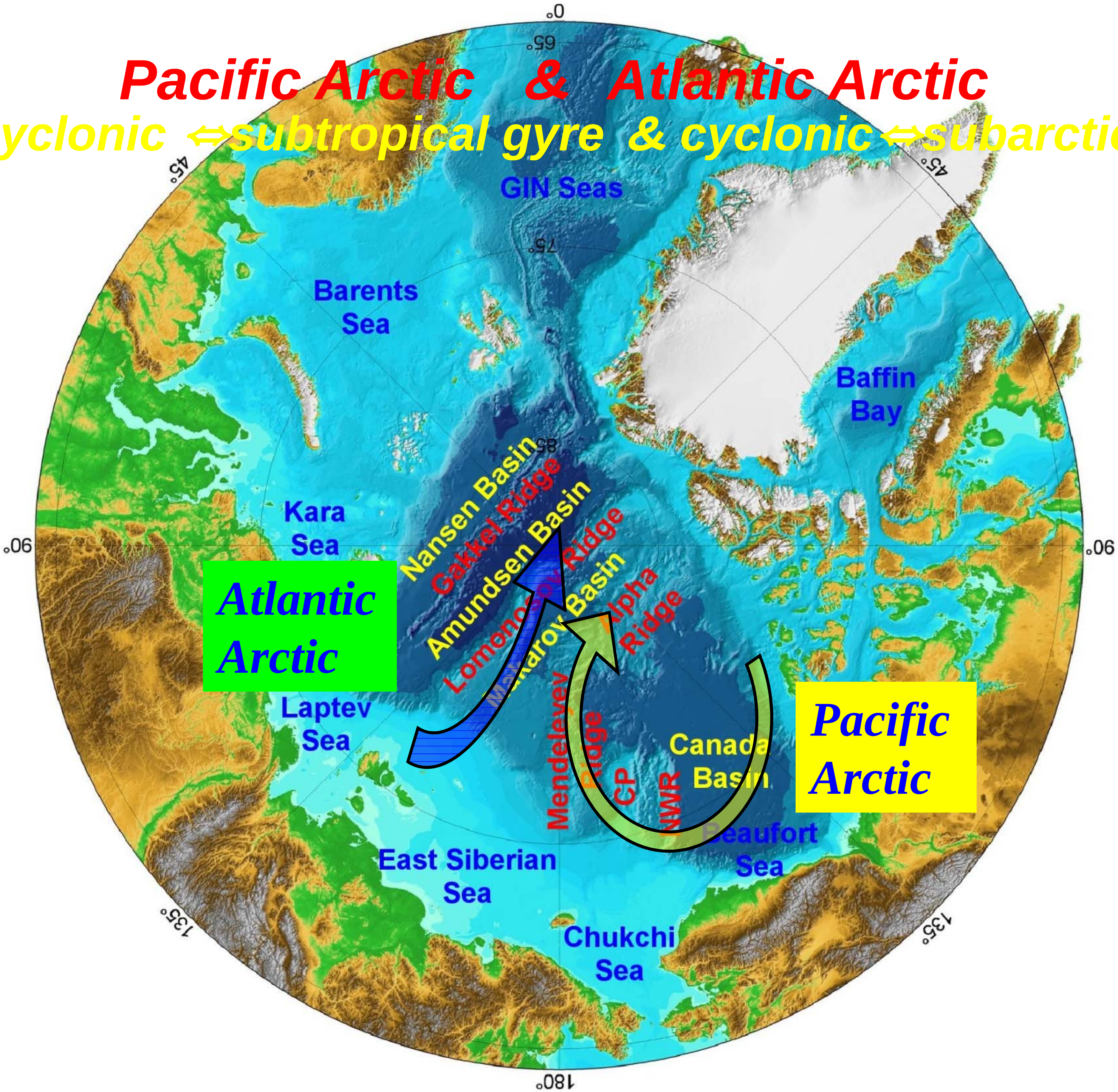
Background color: dynamic height at 100dar relative to 800bdar from Mirai and Louis S. St-Laurent 2008 cruises (Oceanic Beaufort Gyre)

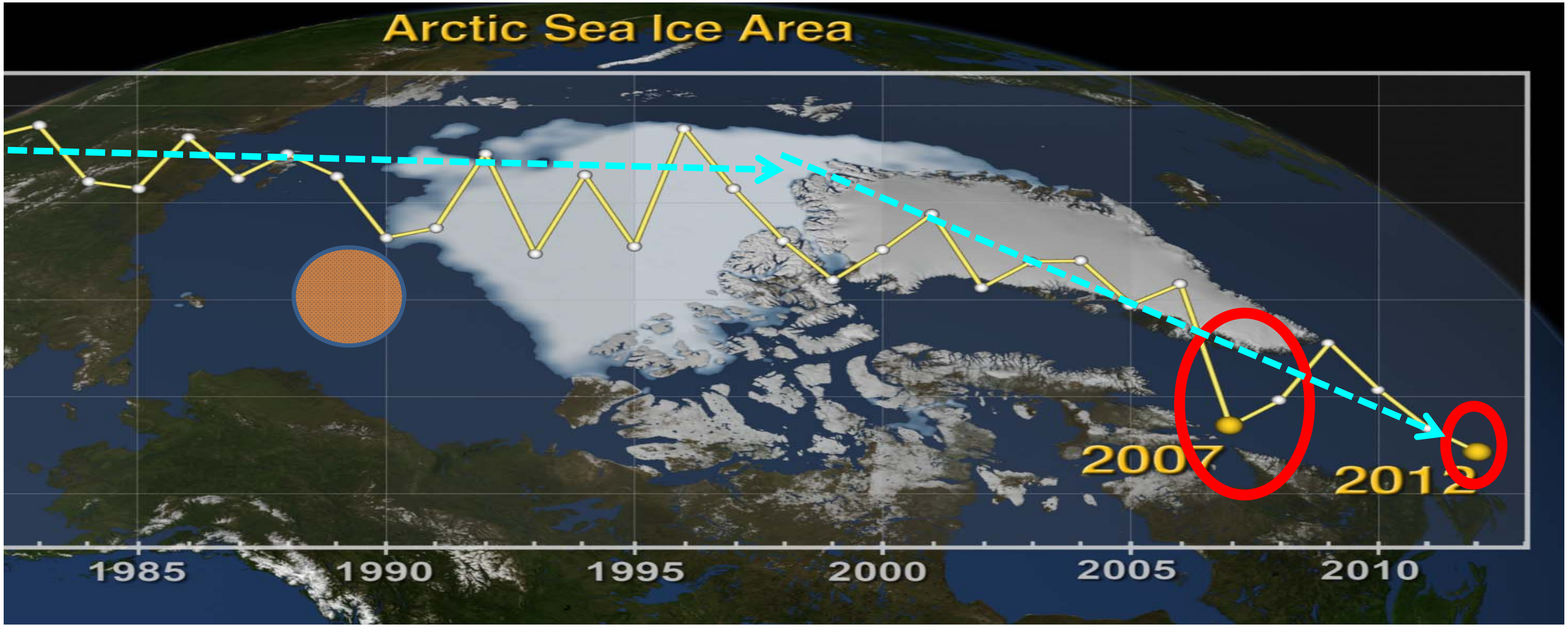
Black vectors: average sea ice motion vectors for Nov. 2007- Apr. 2008 (Sea Ice Beaufort Gyre)

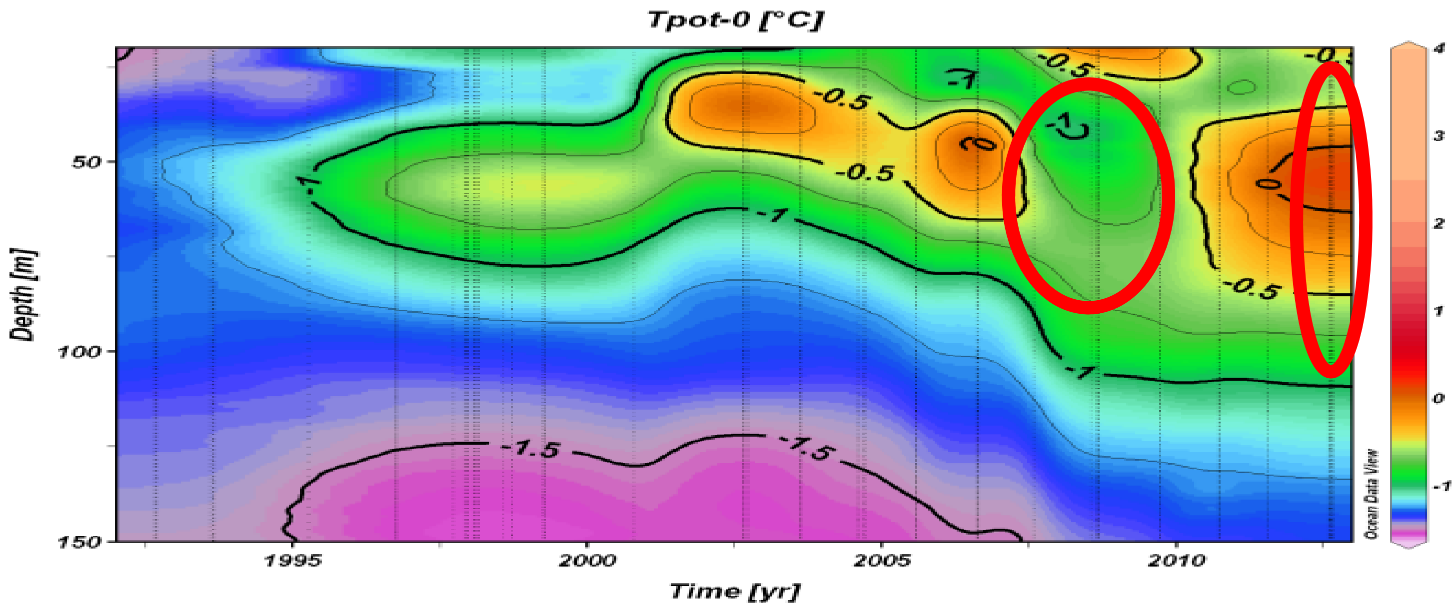
Simbols: Mooring array in 2012-2013 (TUMSAT/KOPRI/NIPR & WHOI)

Pacific Arctic & Atlantic Arctic

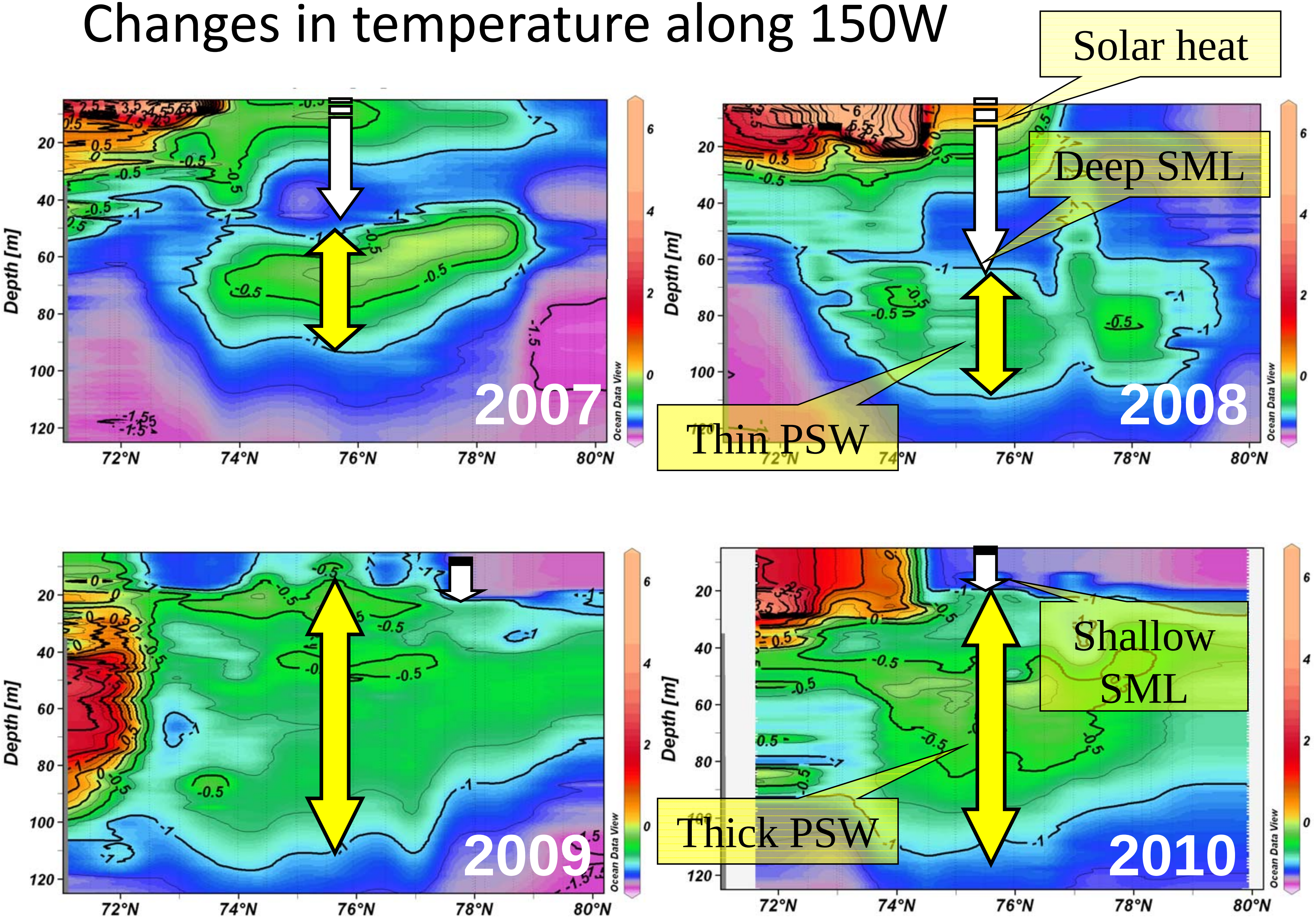
anticyclonic ⇔subtropical gyre & cyclonic⇔subarctic gyre




Arctic Sea Ice Area
2007
2012
1985
1990
1995
2000
2005
2010

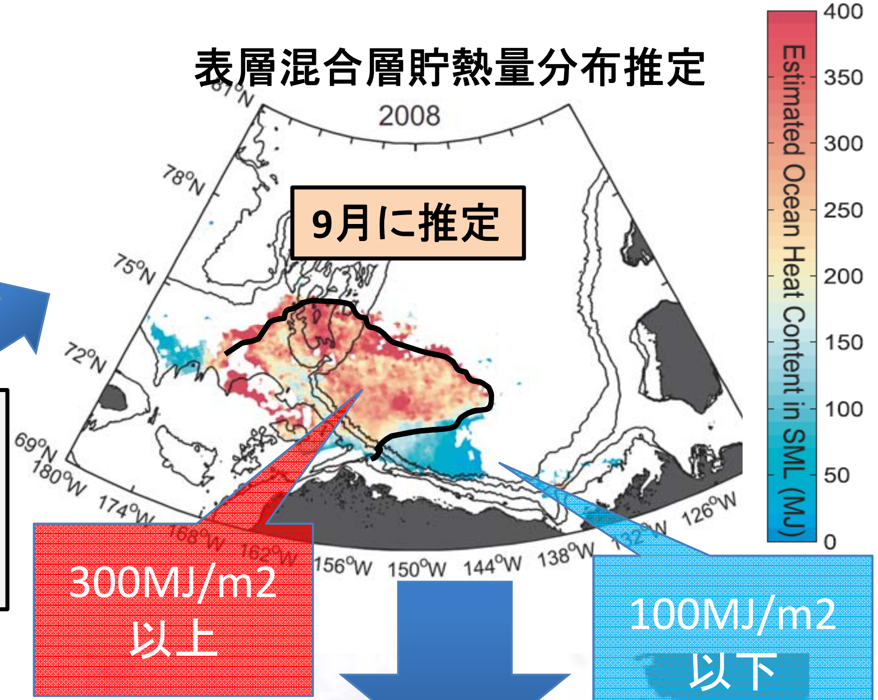

Tpot-0 [°C]
Depth [m]
50
100
150
1995
2000
2005
2010
Time [yr]
-0.5
-1
-1.5
Ocean Data View
4
3
2
1
0
-1

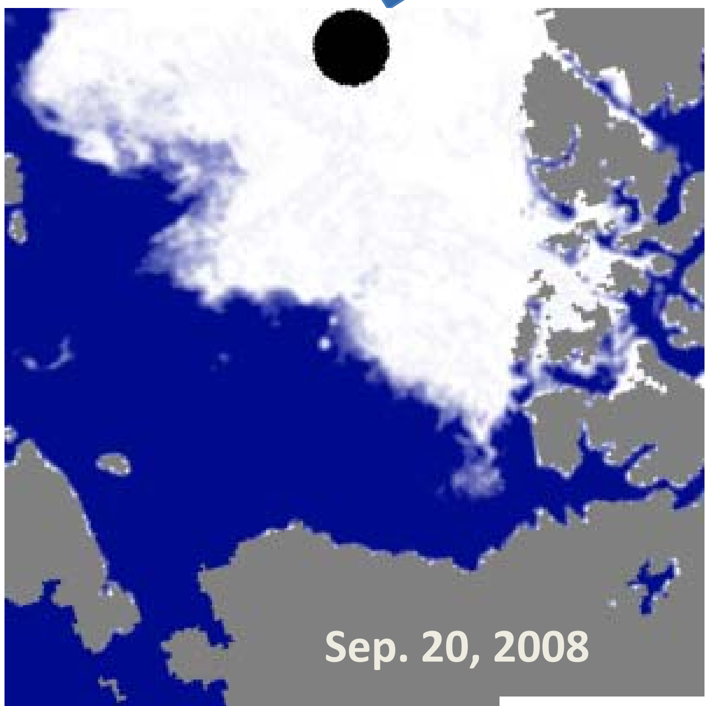
Changes in temperature along 150W



小規模海氷運動の強化
鉛直熱輸送の増大(観測)
海氷にいつ覆われるのか？
北極海航路が閉じる
タイミングの予測

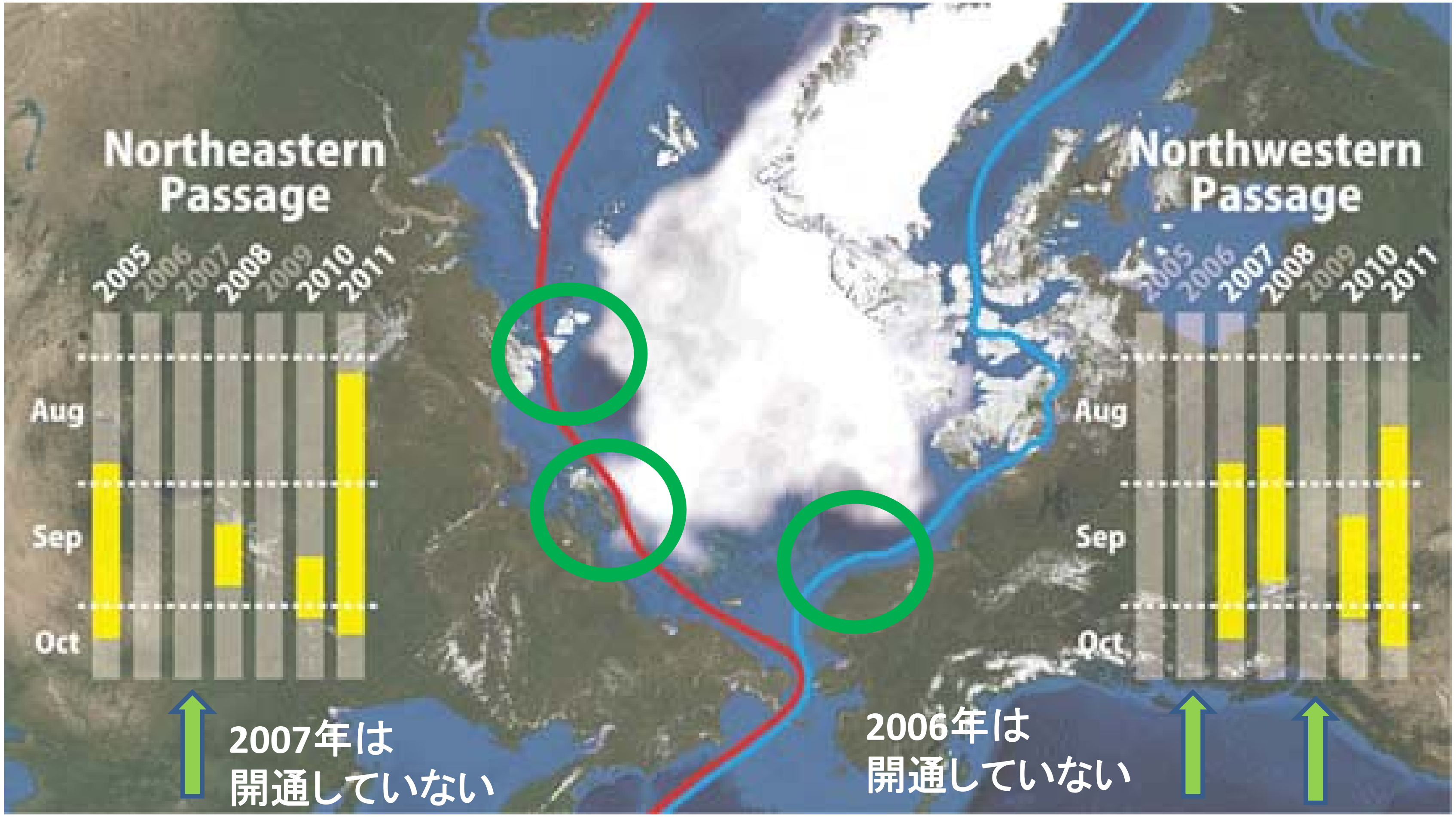
- 海氷面積最小直後(冷却開始時)に表層混合層厚、表層混合層貯熱量を衛星データ(AMSR-E)から推定。
- 検証実データはみらい2008年国際極年北極航海





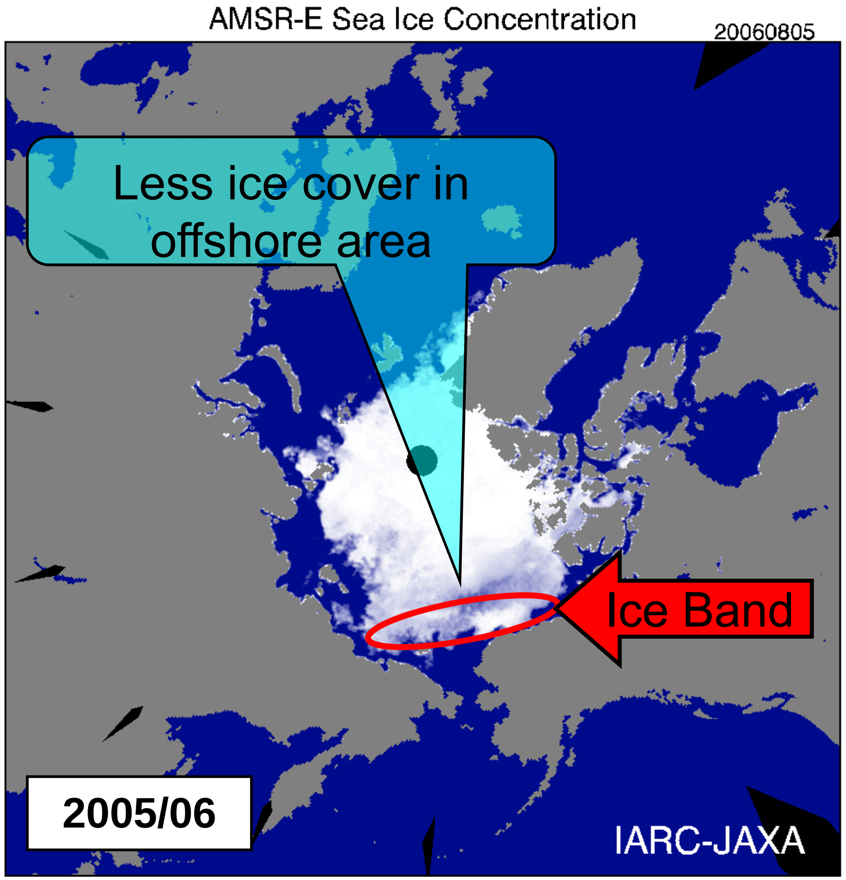
K. Mizobata, K. Shimada / Deep-Sea Research II 77–80 (2012) 62–69

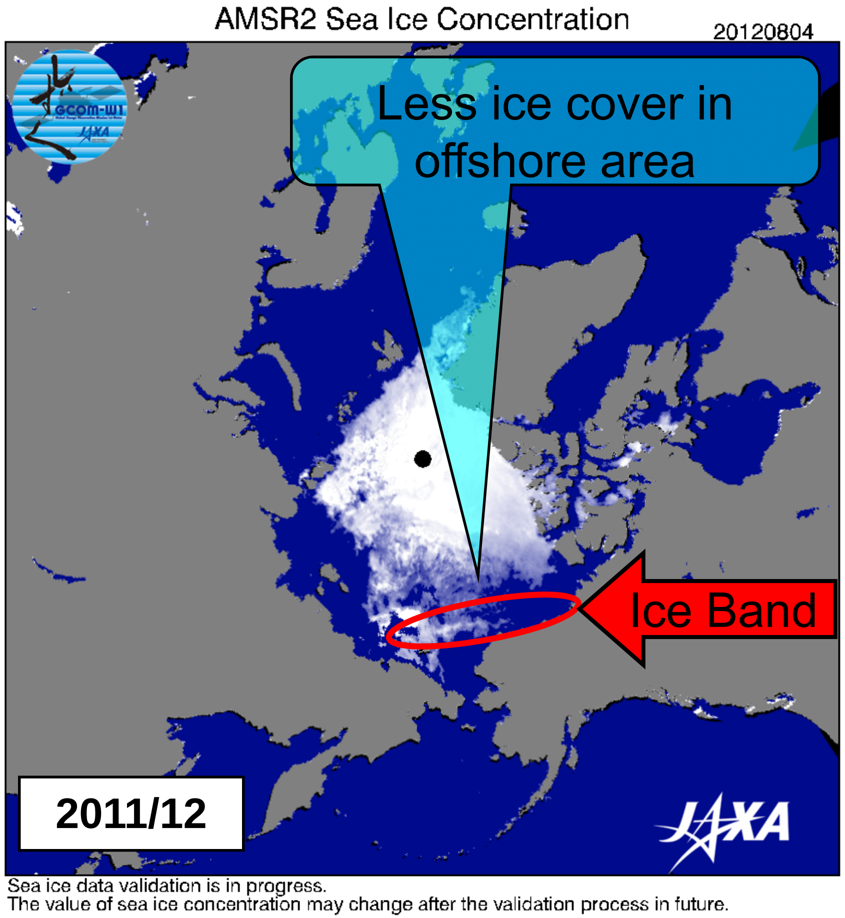
Application for Arctic Sea Routes



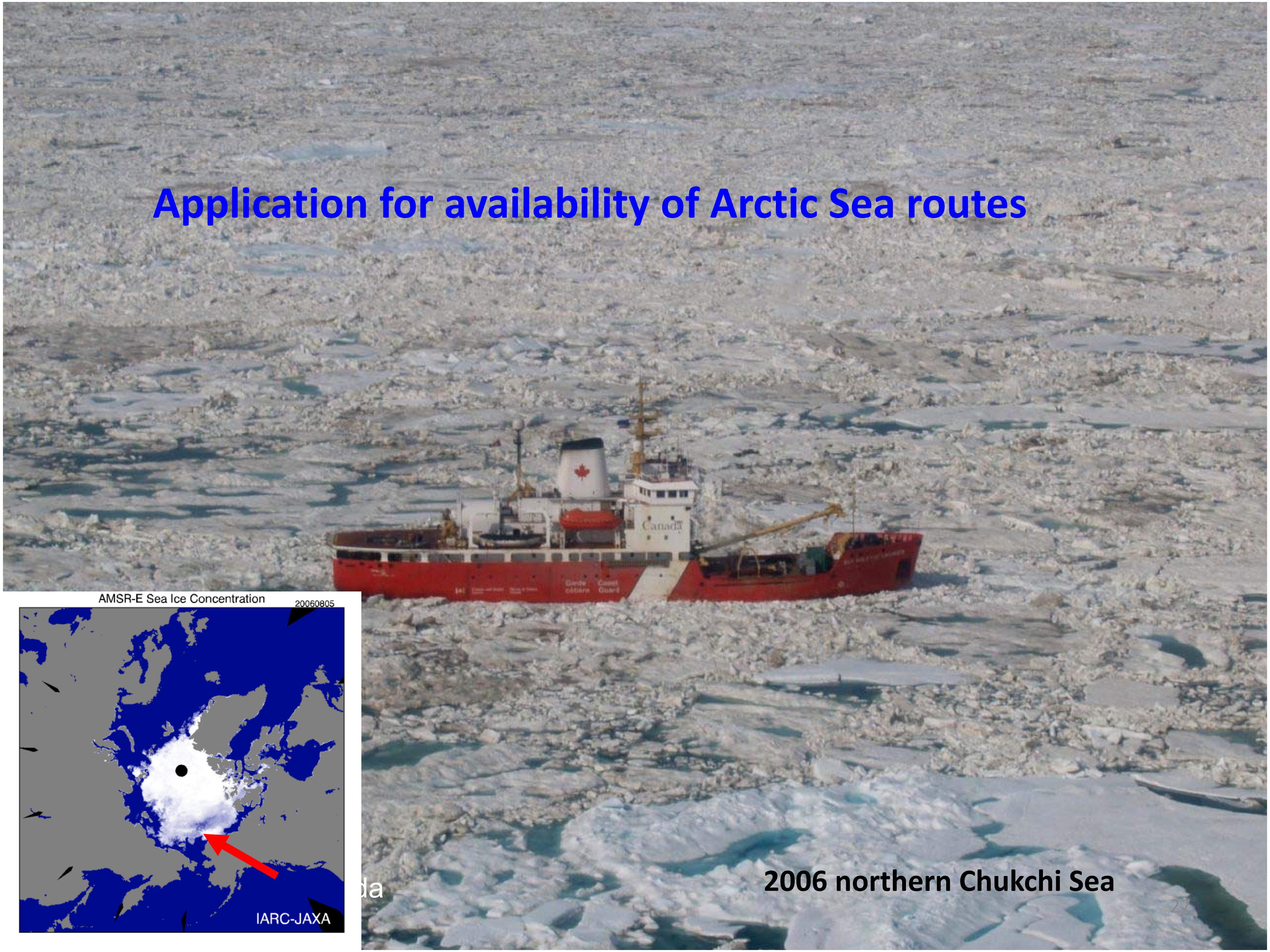
Weather　News社

- As the results, heavy ice bands were formed Alaskan coast and northern Chukchi area.
- Presence of this ice bands is important for Arctic Sea routes.

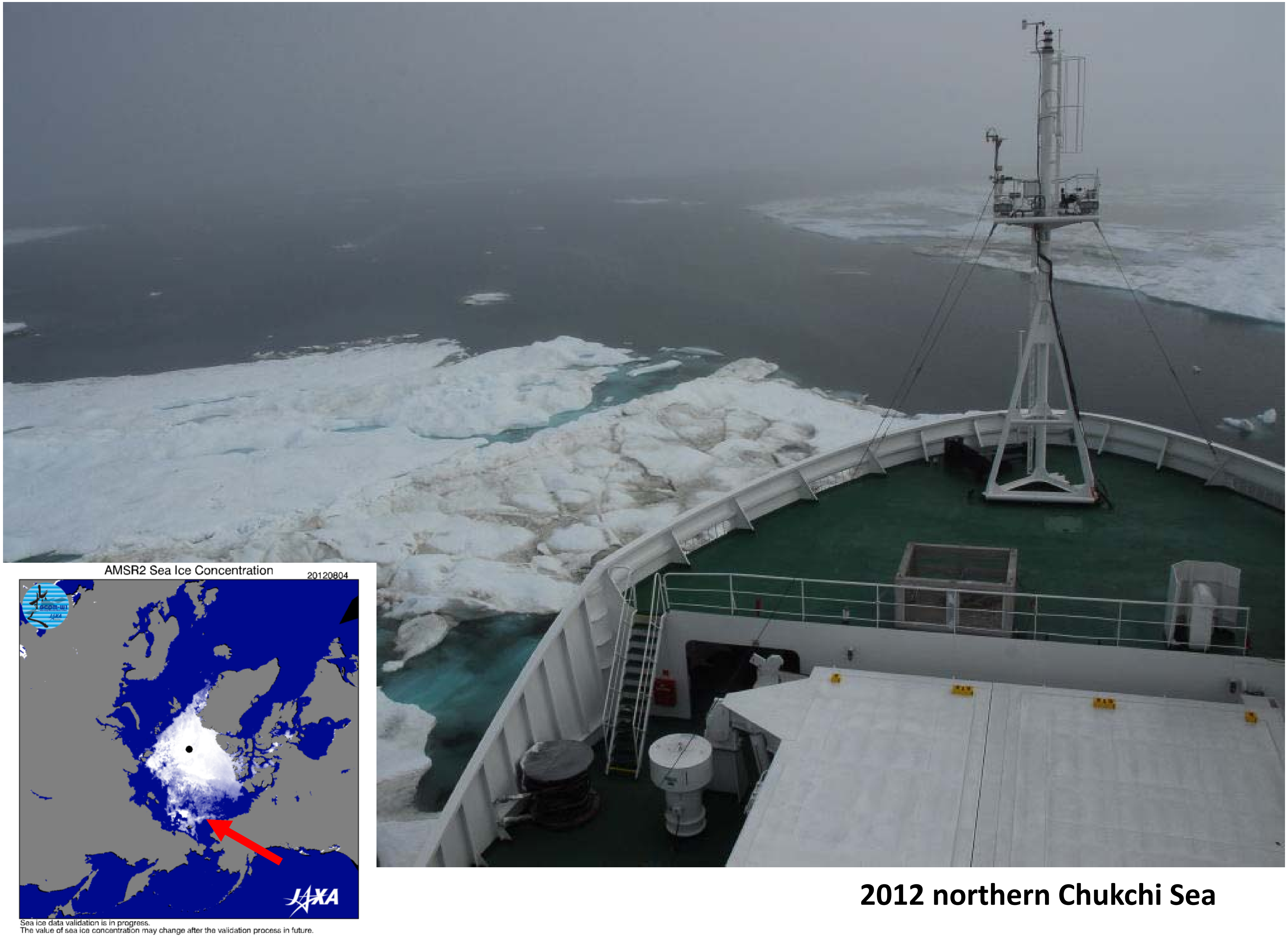




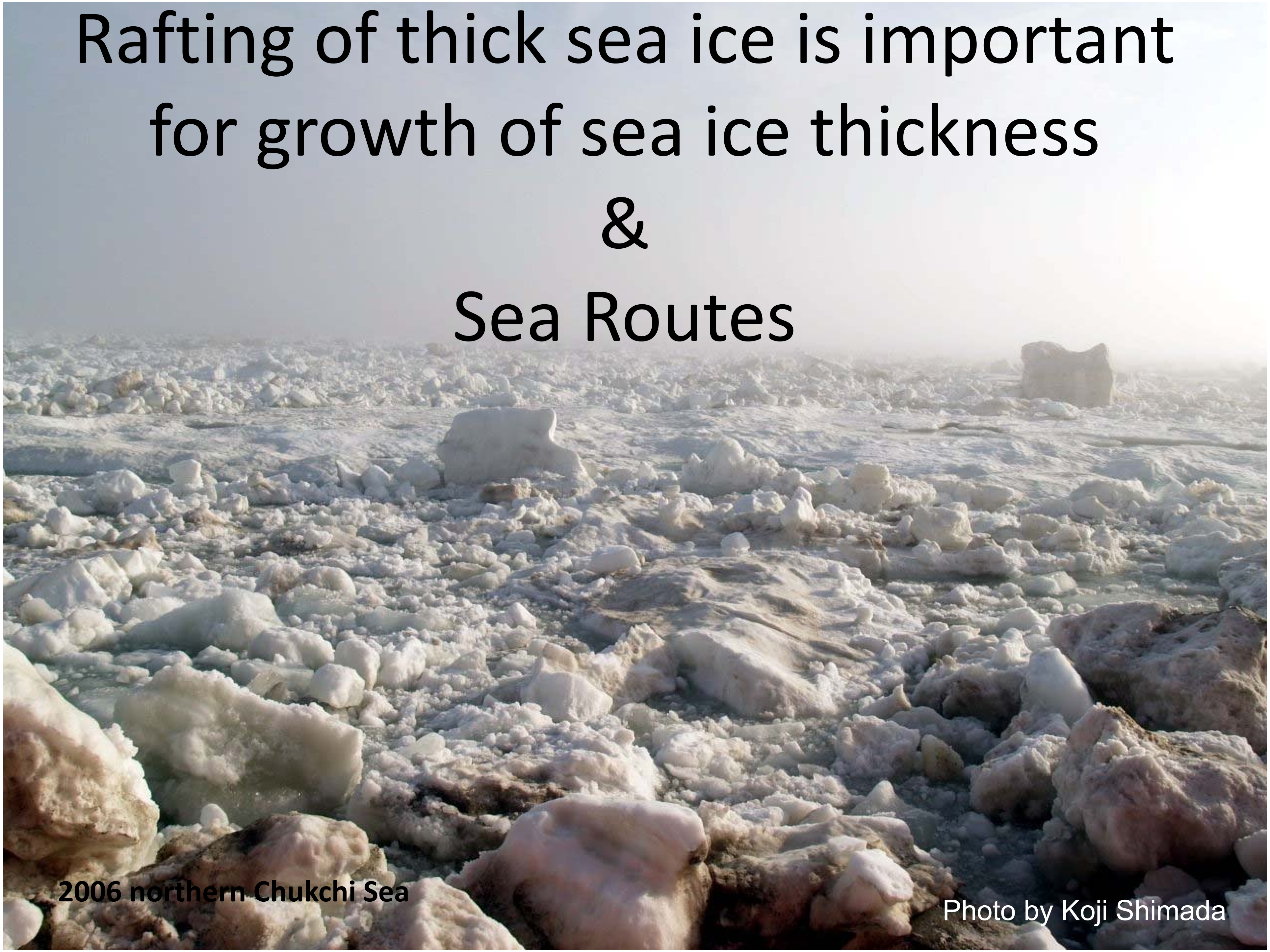
Application for availability of Arctic Sea routes

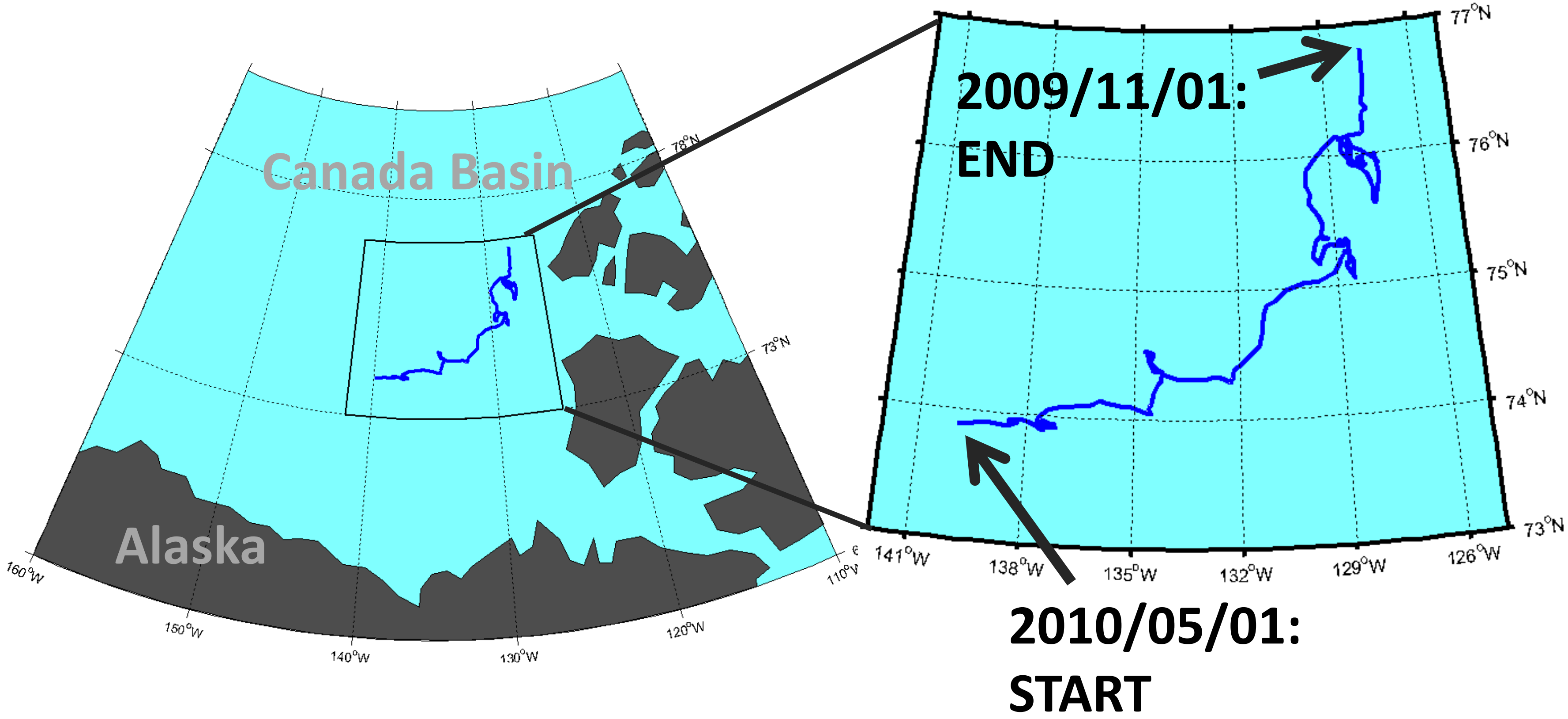


2006 northern Chukchi Sea



2012 northern Chukchi Sea

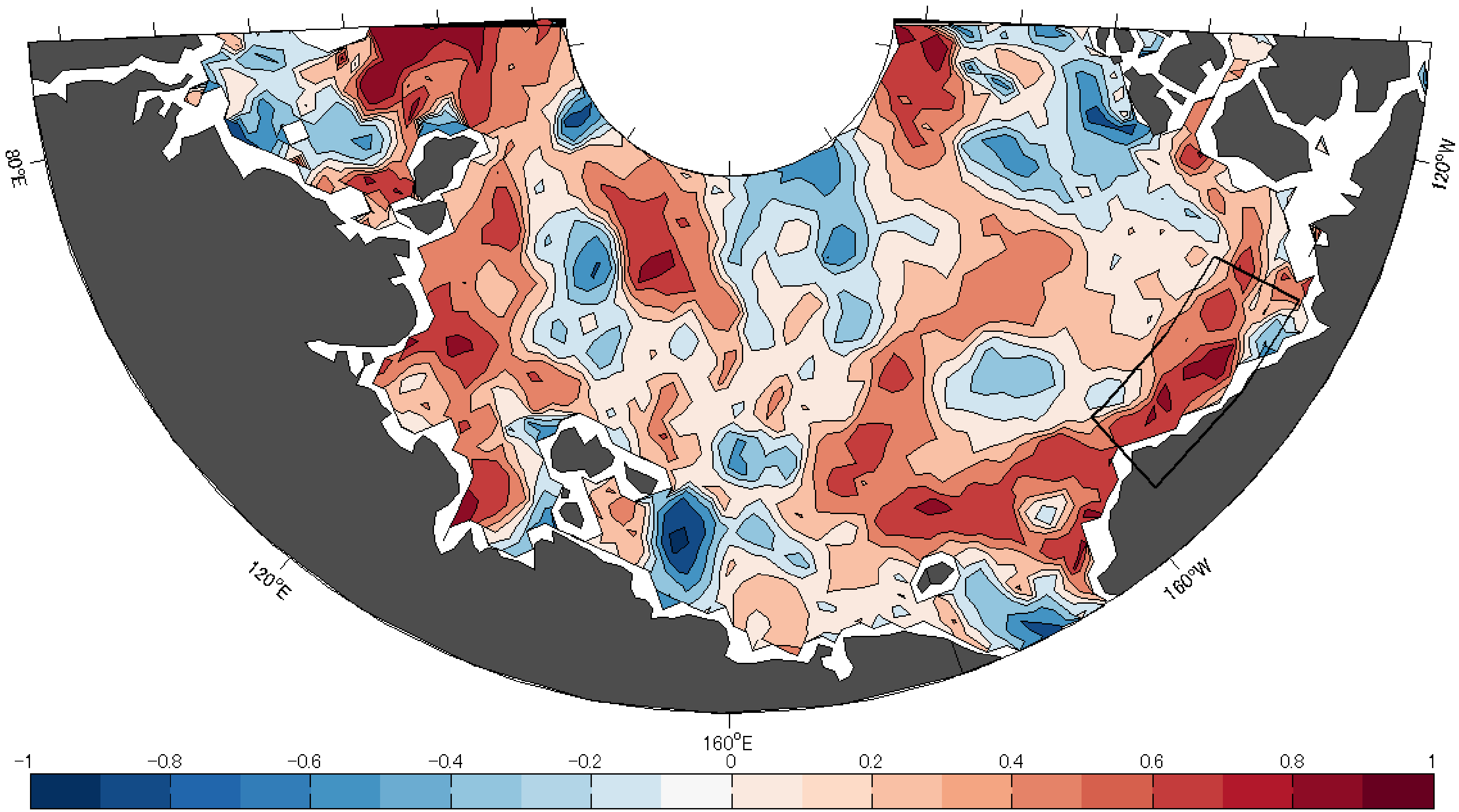

Rafting of thick sea ice is important
for growth of sea ice thickness
&
Sea Routes
2006 northern Chukchi Sea
Photo by Koji Shimada



- 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°N, 135 - 157°W).

regression

Spring GR only (using just thickness in spring, without sea ice motion)

$$SIC_{GR} = 4.3542 \times \mathrm{GR} + 0.2556. \quad (r = 0.2717)$$

GR and integration of effective convergence for rafting (iECR)

$$SIC_{Yoshi} = 0.6924 \times \mathrm{iECR} + 0.1547 \quad (r = 0.6924)$$

forecast