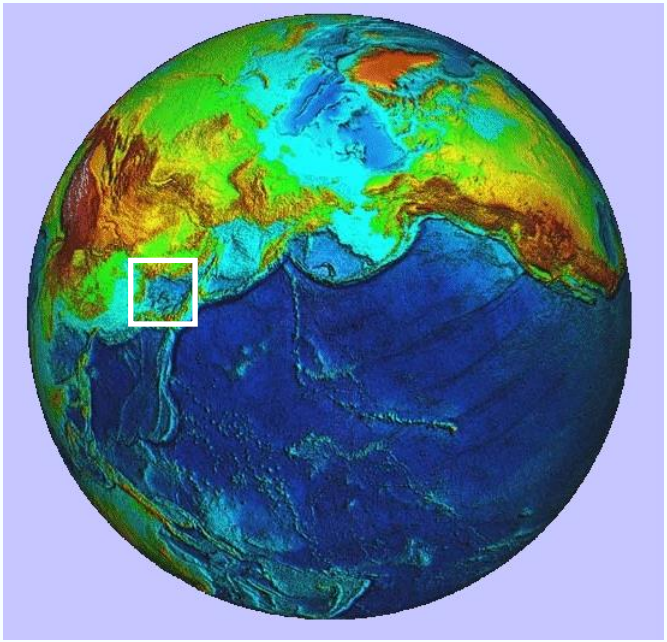
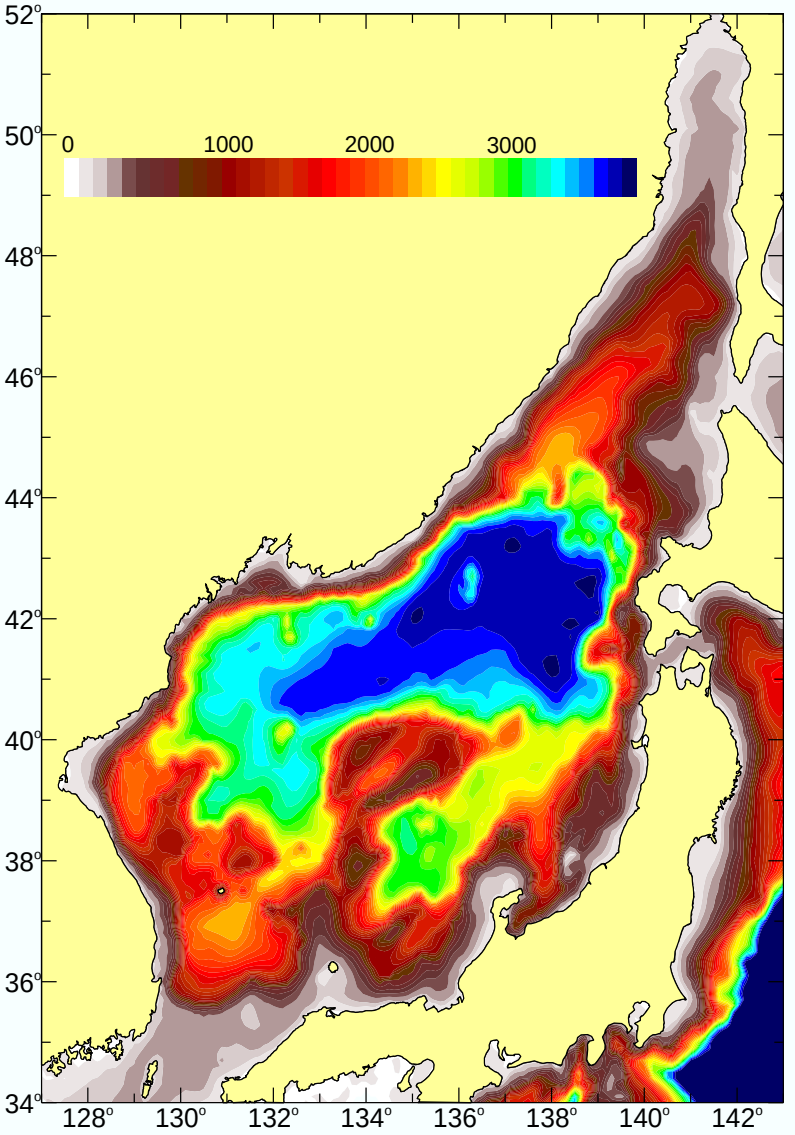
Big Questions in East/Japan Sea Research?

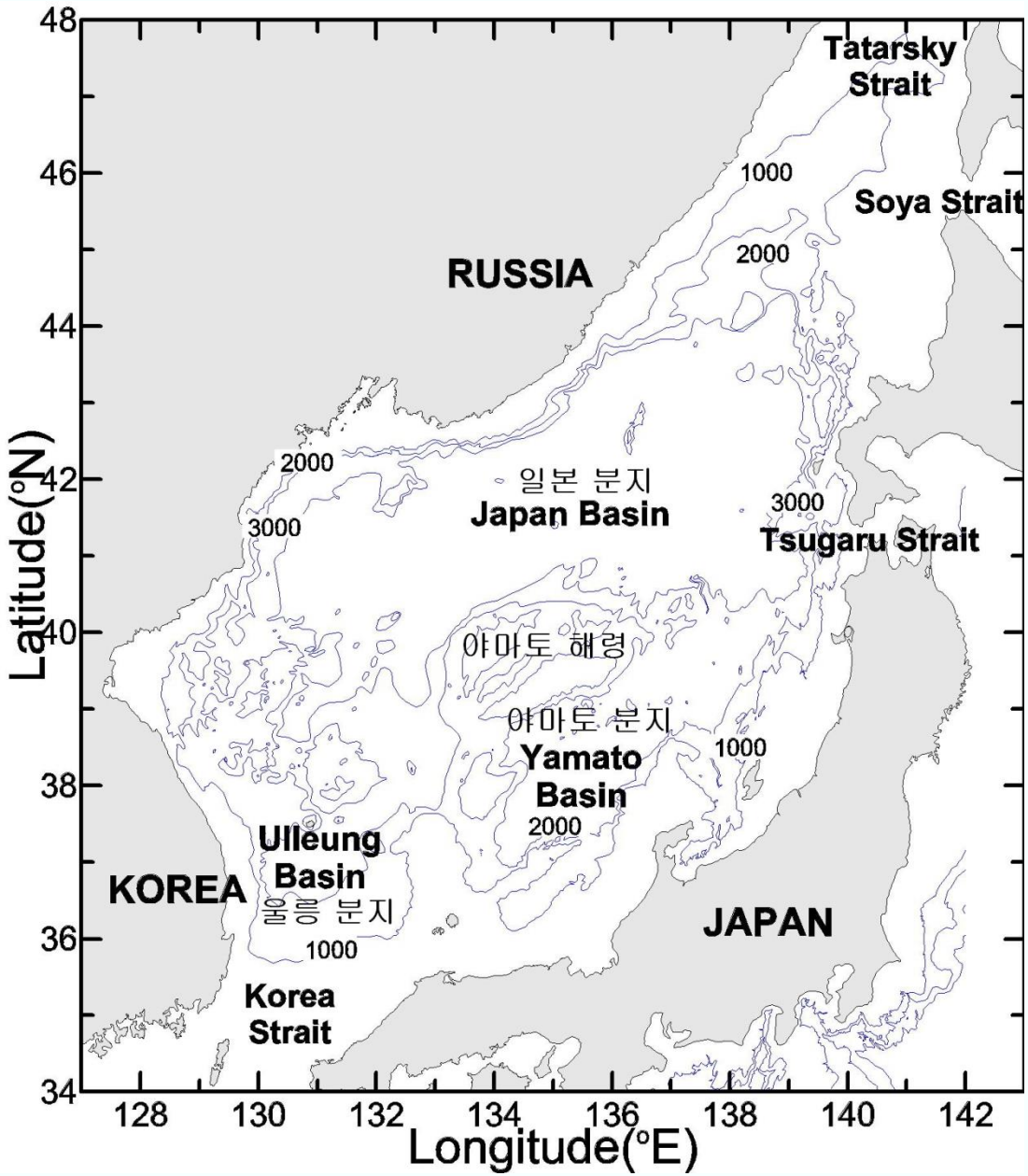
2013. 9. 19.

Kyung-Ryul Kim
Seoul National University, Korea

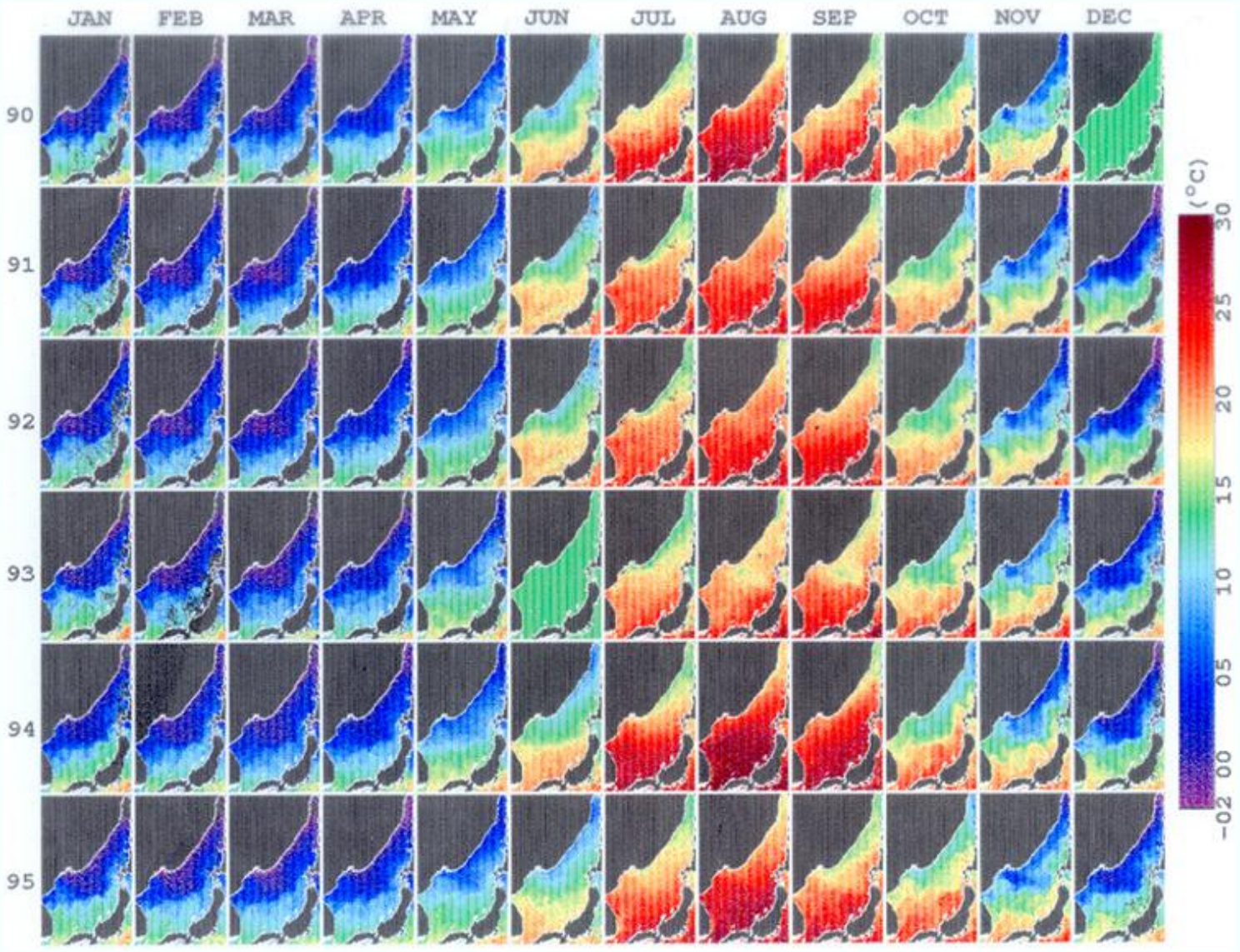
East (Japan) Sea



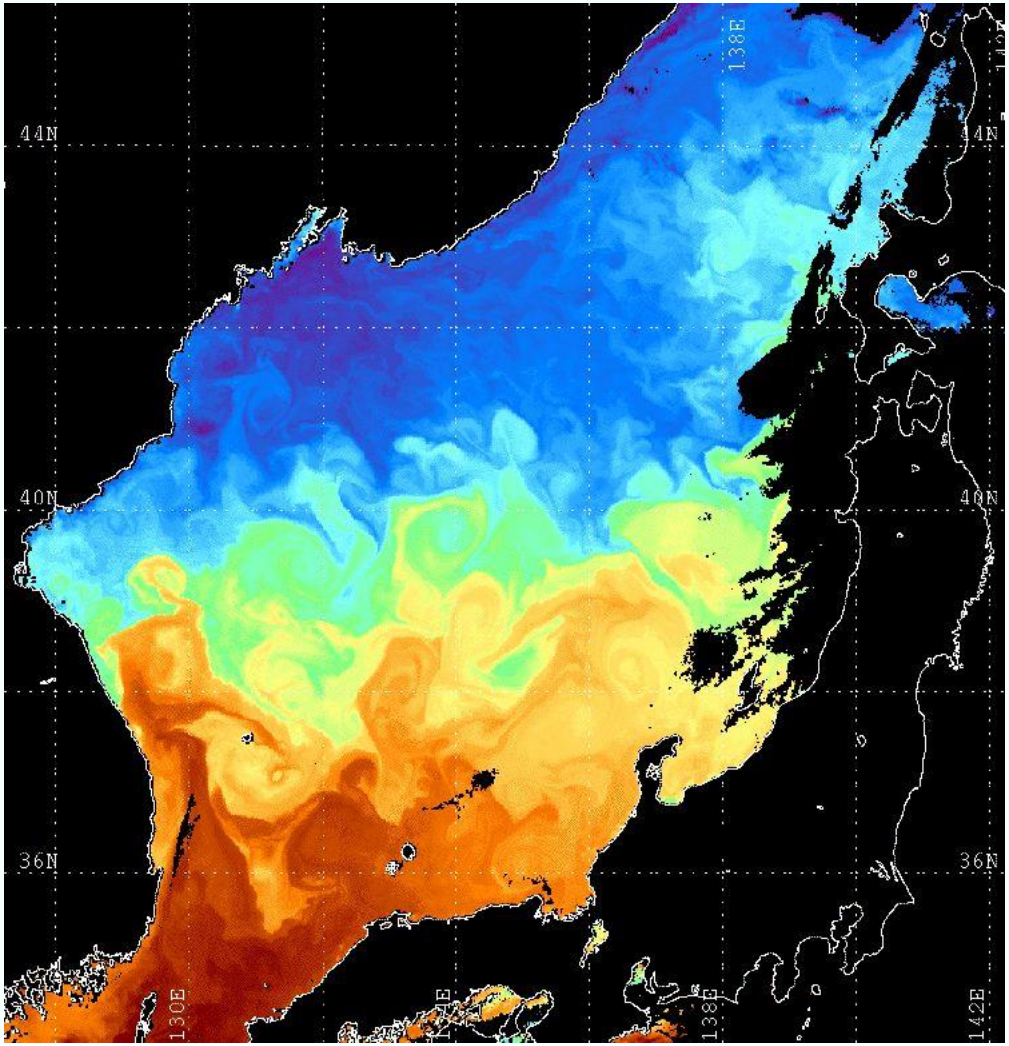



Tatarsky Strait
Soya Strait
RUSSIA
1000
2000
2000
3000
일본 분지
Japan Basin
3000
Tsugaru Strait
야마토 해령
야마토 분지
Yamato Basin
1000
2000
Ulleung Basin
울릉 분지
KOREA
JAPAN
1000
Korea Strait
Latitude(°N)
Longitude(°E)
48
46
44
42
40
38
36
34
128
130
132
134
136
138
140
142

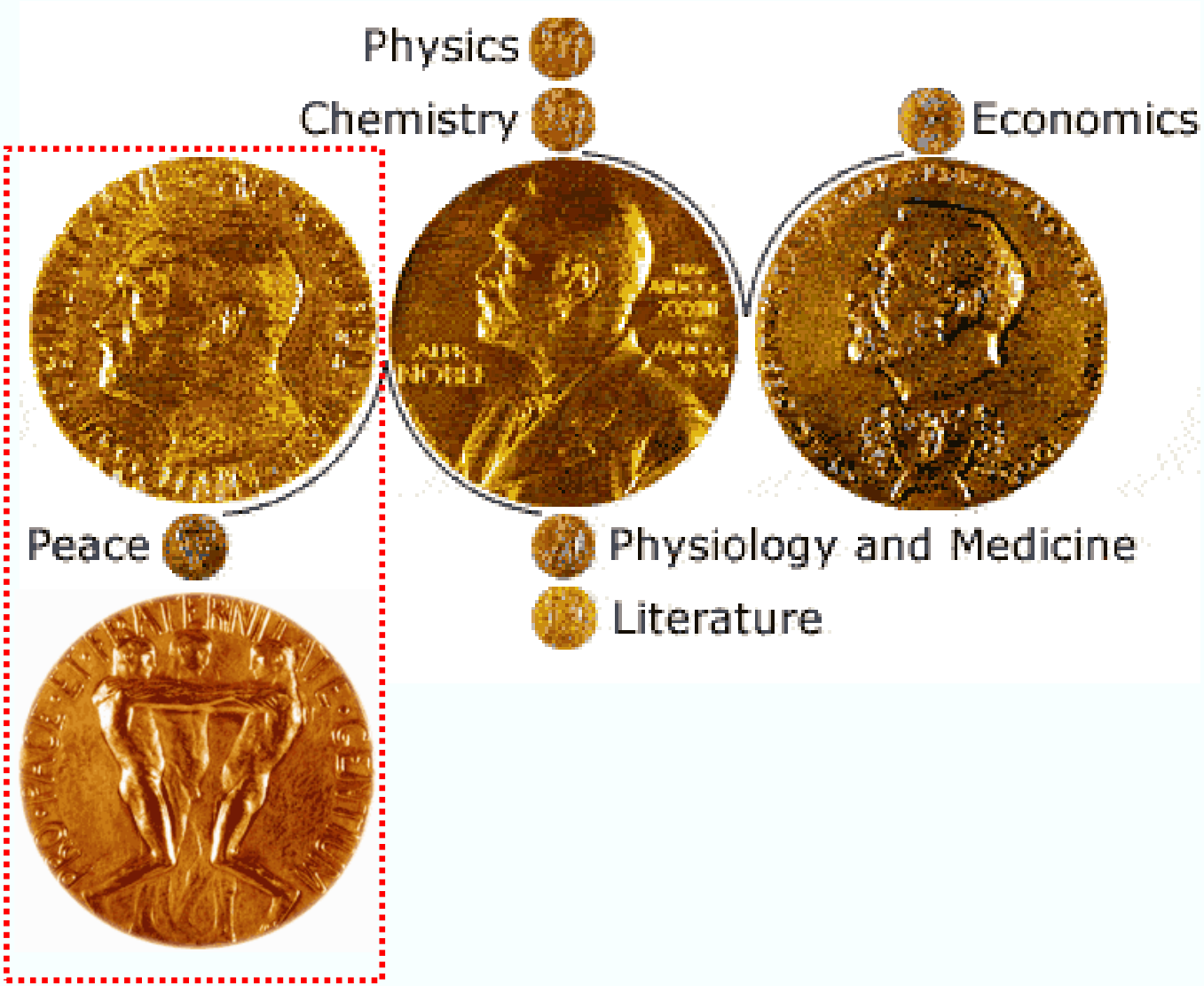
SST in the East Sea



SST in the East Sea

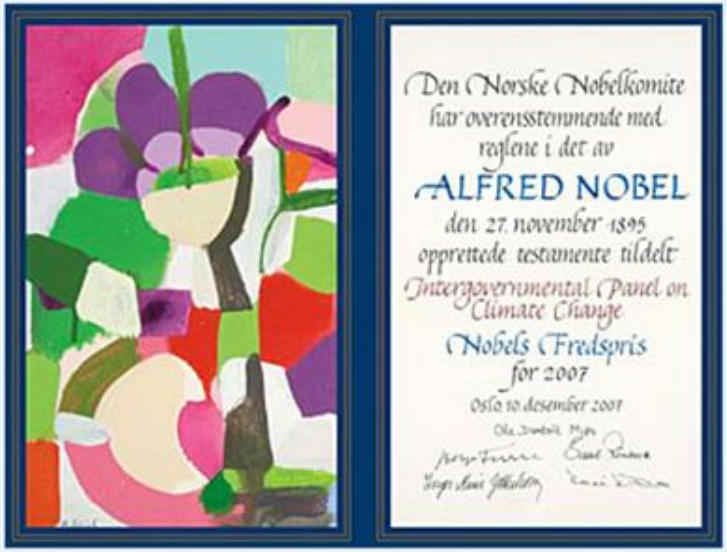


Nobel Peace Prize 2007



El Gore, IPCC Scientists

The IPCC is honored with the Nobel Peace Prize



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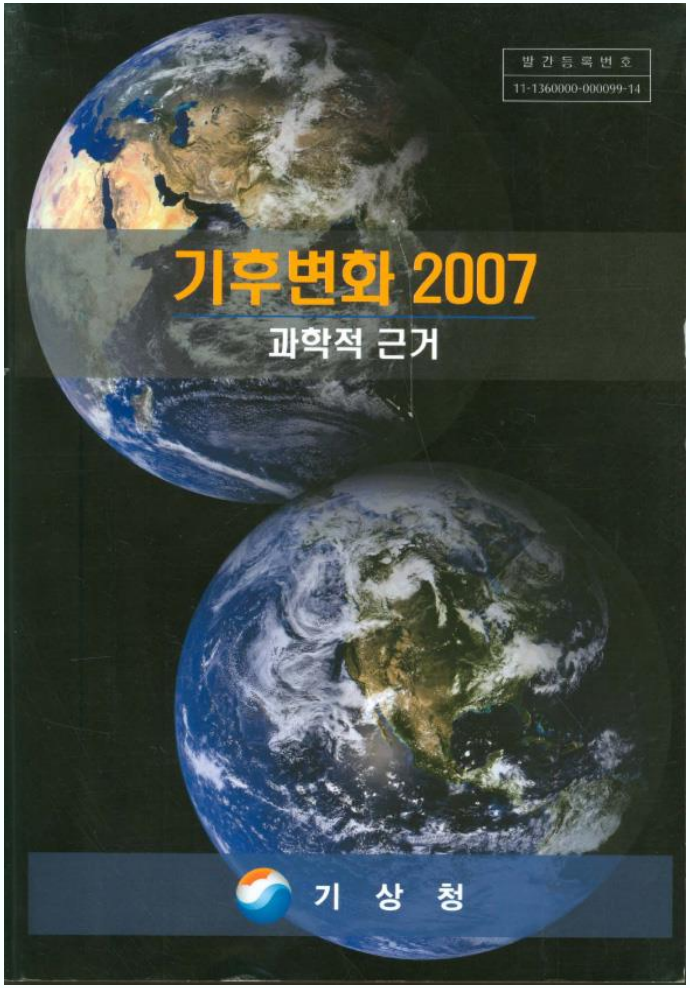
Oslo, 10 December 07 - The Intergovernmental Panel on Climate Change and Albert Arnold (Al) Gore Jr. were awarded of **the Nobel Peace Prize** "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change".

- Speech of the IPCC Chairman at the Award Ceremony
- More information

Fourth Assessment Report
“The Physical Science Basis”



IPCC 4th Report

Summary for Policymakers
Chapter 1 Historical Overview of Climate Change Science
Chapter 2 Changes in Atmospheric Constituents and in Radiative Forcing
Chapter 3 Observations: Surface and Atmospheric Climate Change
Chapter 4 Observations: Changes in Snow, Ice and Frozen Ground

Chapter 5 Observations: Oceanic Climate Change and Sea Level

Chapter 6 Palaeoclimate
Chapter 7 Couplings Between Changes in the Climate System and Biogeochemistry
Chapter 8 Climate Models and their Evaluation
Chapter 9 Understanding and Attributing Climate Change
Chapter 10 Global Climate Projections
Chapter 11 Regional limate Projections

Chapter 5 Observations: Oceanic Climate Change and Sea Level

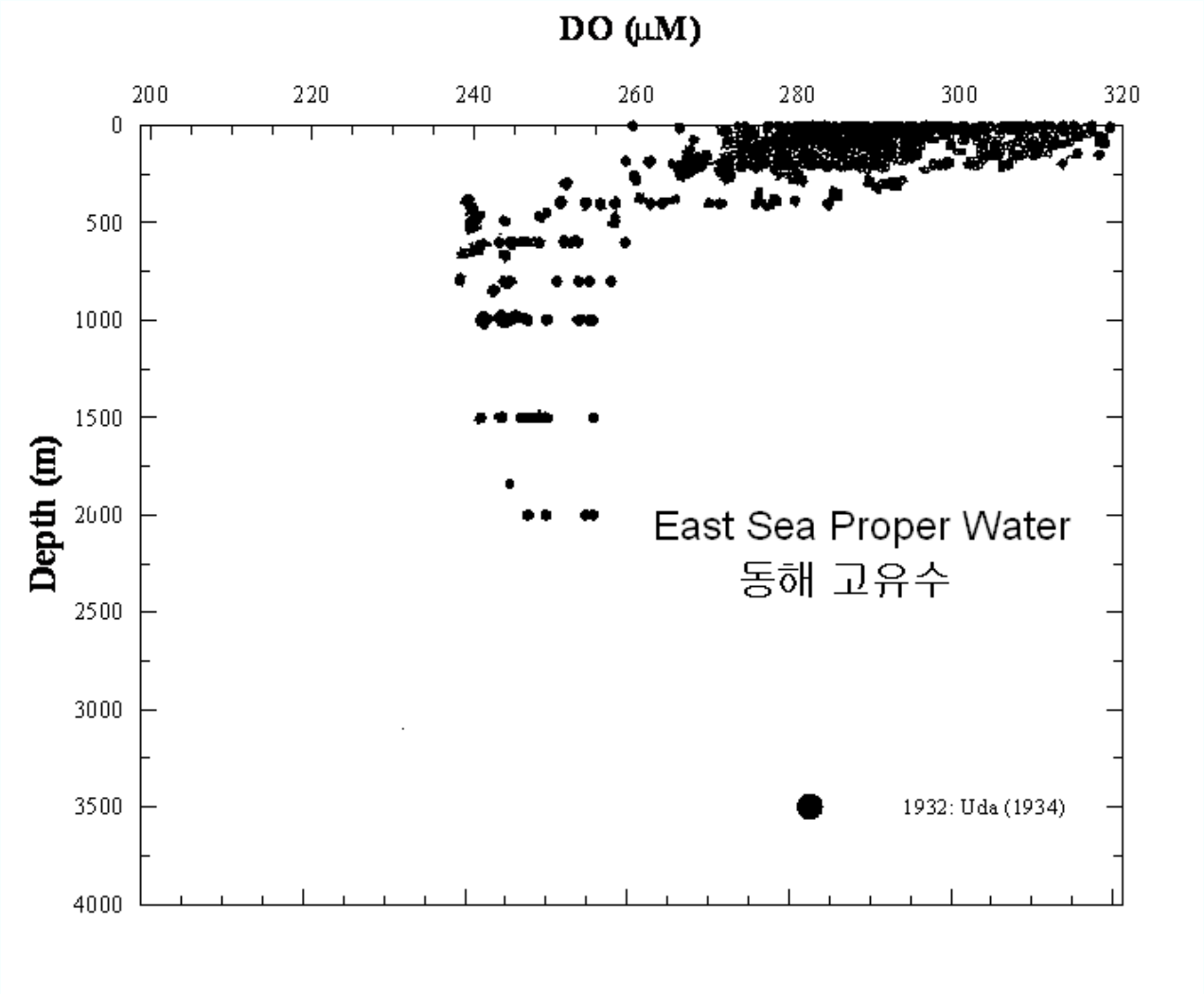
Table of Contents

East/Japan Sea
In Dramatic Changes!!!!

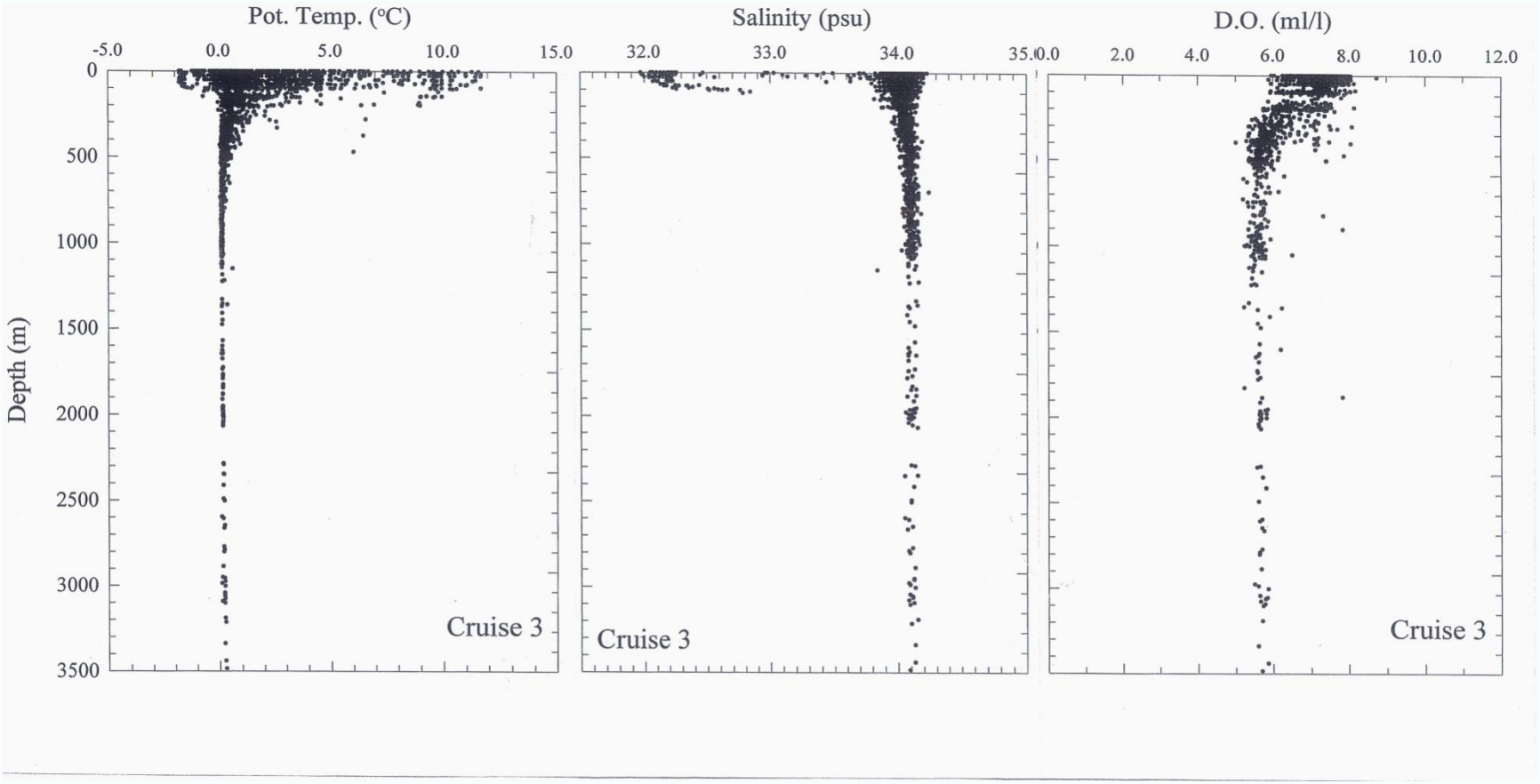
Important studies on the East/Japan Sea

- ’30s : Prof. Uda
- ’50s : Russian Vytias Expedition
- ’70s : Prof. Horibe
- ’80s : Prof. Tsunogai
- ’90s : CREAMS studies
  (Japan-Korea-Russia Co-operative Researches)
- 2000s: EAST(East Asian Sea Time-series)-I studies

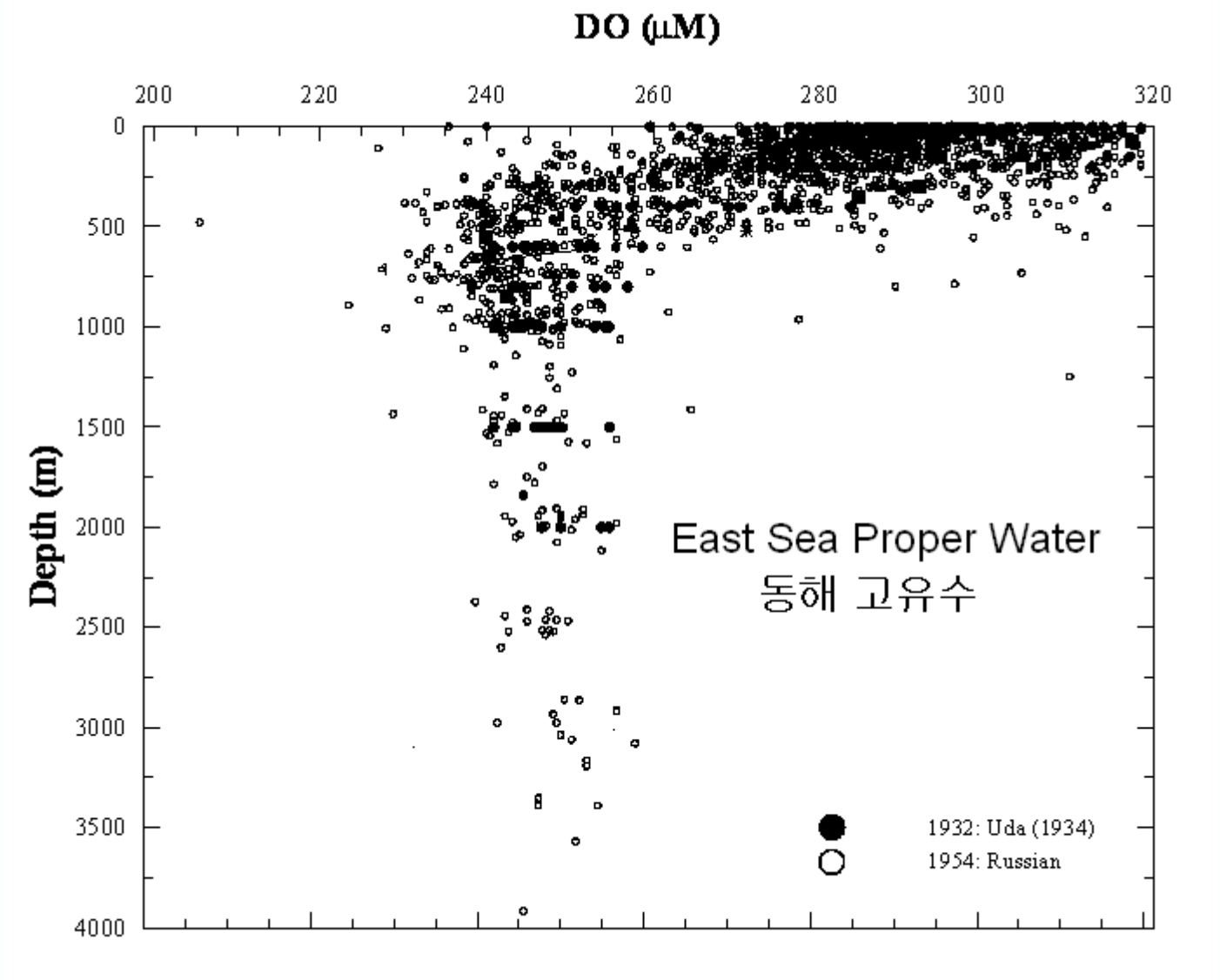
’30s : Prof. Uda
East Sea Proper Water



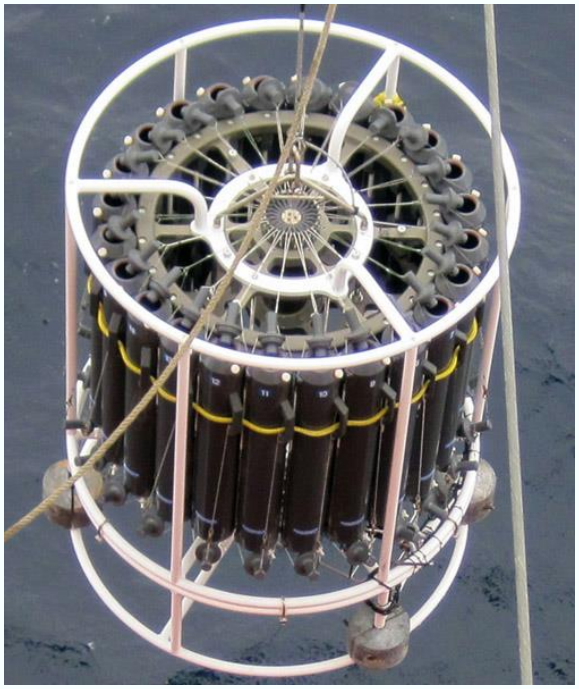
’50s: Russian Vytias Expedition

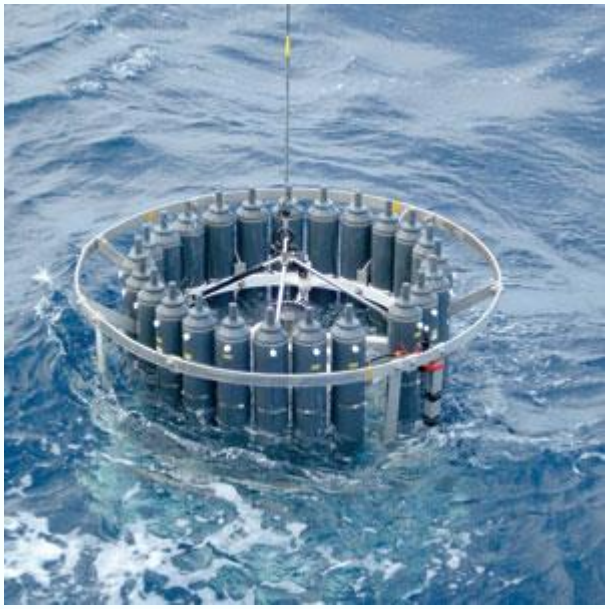

Pot. Temp. (°C)
-5.0
0.0
5.0
10.0
15.0
Salinity (psu)
32.0
33.0
34.0
35.0
D.O. (ml/l)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
Depth (m)
0
500
1000
1500
2000
2500
3000
3500
Cruise 3
Cruise 3
Cruise 3

East Sea Proper Water



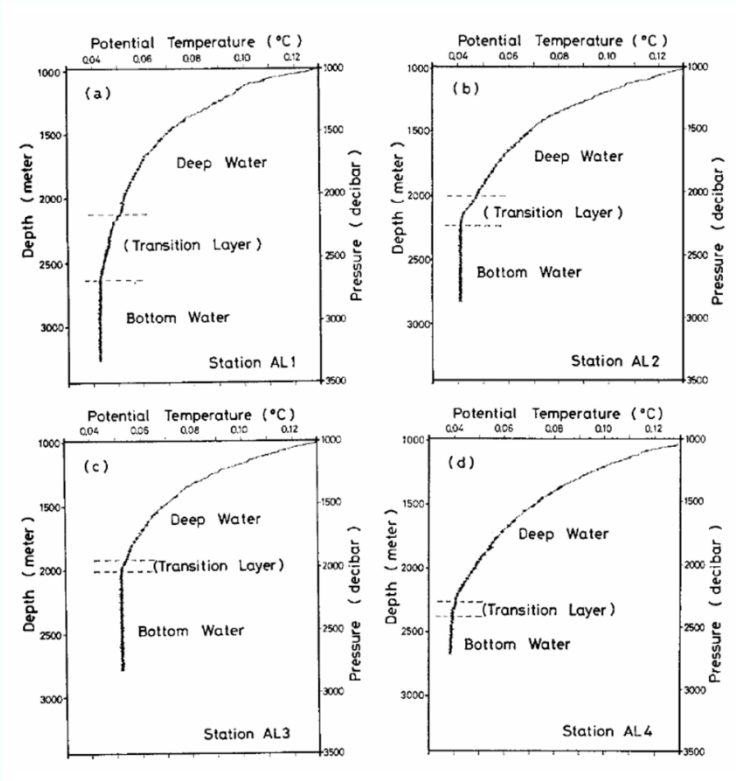
1970's: International Decade of Ocean Exploration

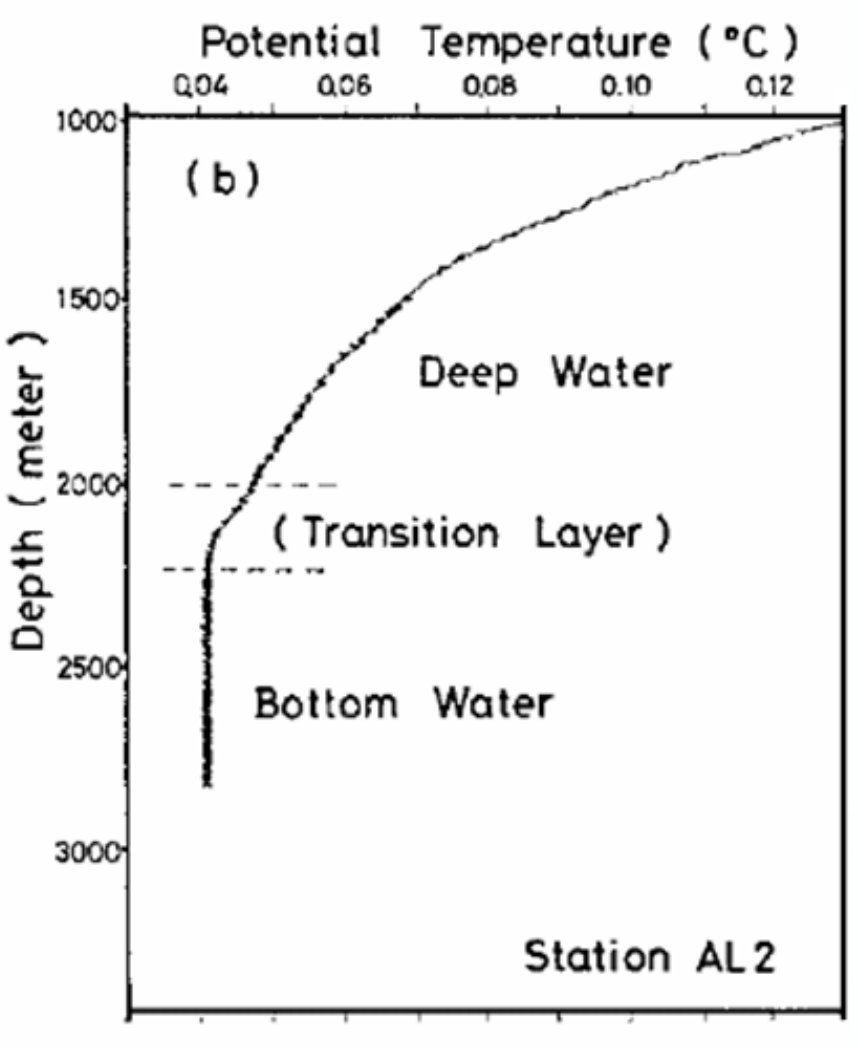




CTD Rosette system

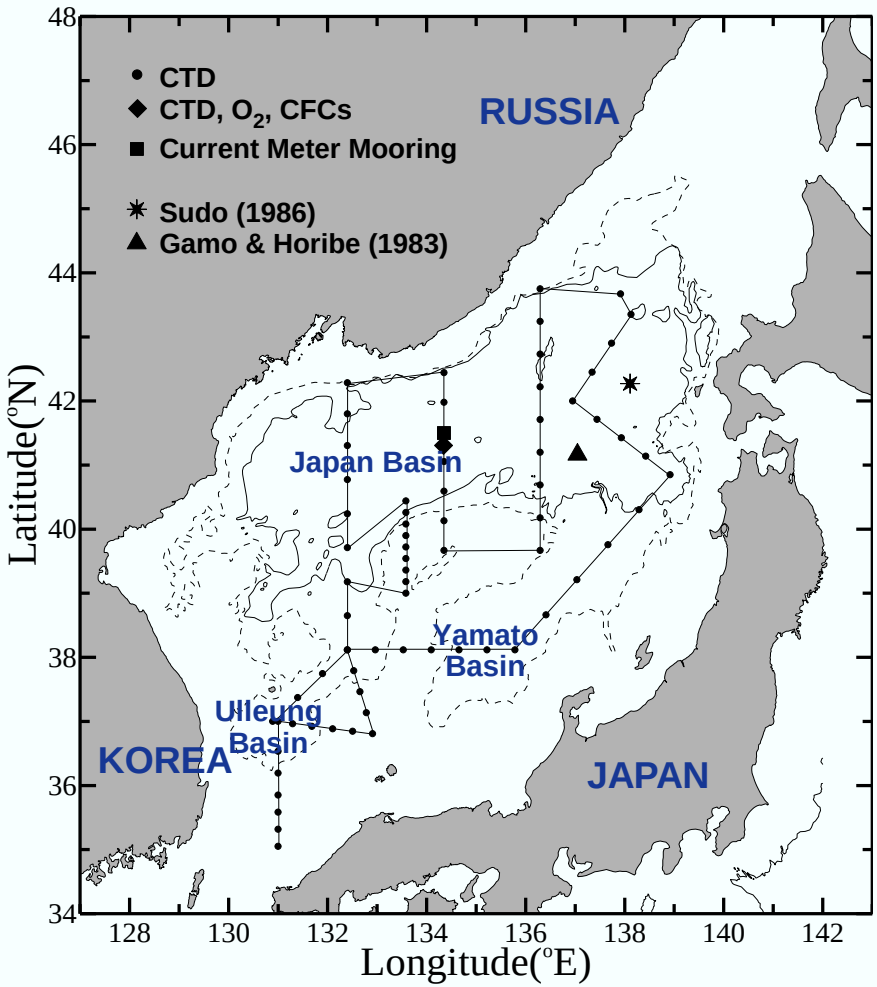
’70s : Prof. Horibe (The first CTD studies)





1993 CREAMS
International (Japan-Korea-Russia)
Co-operative Researches

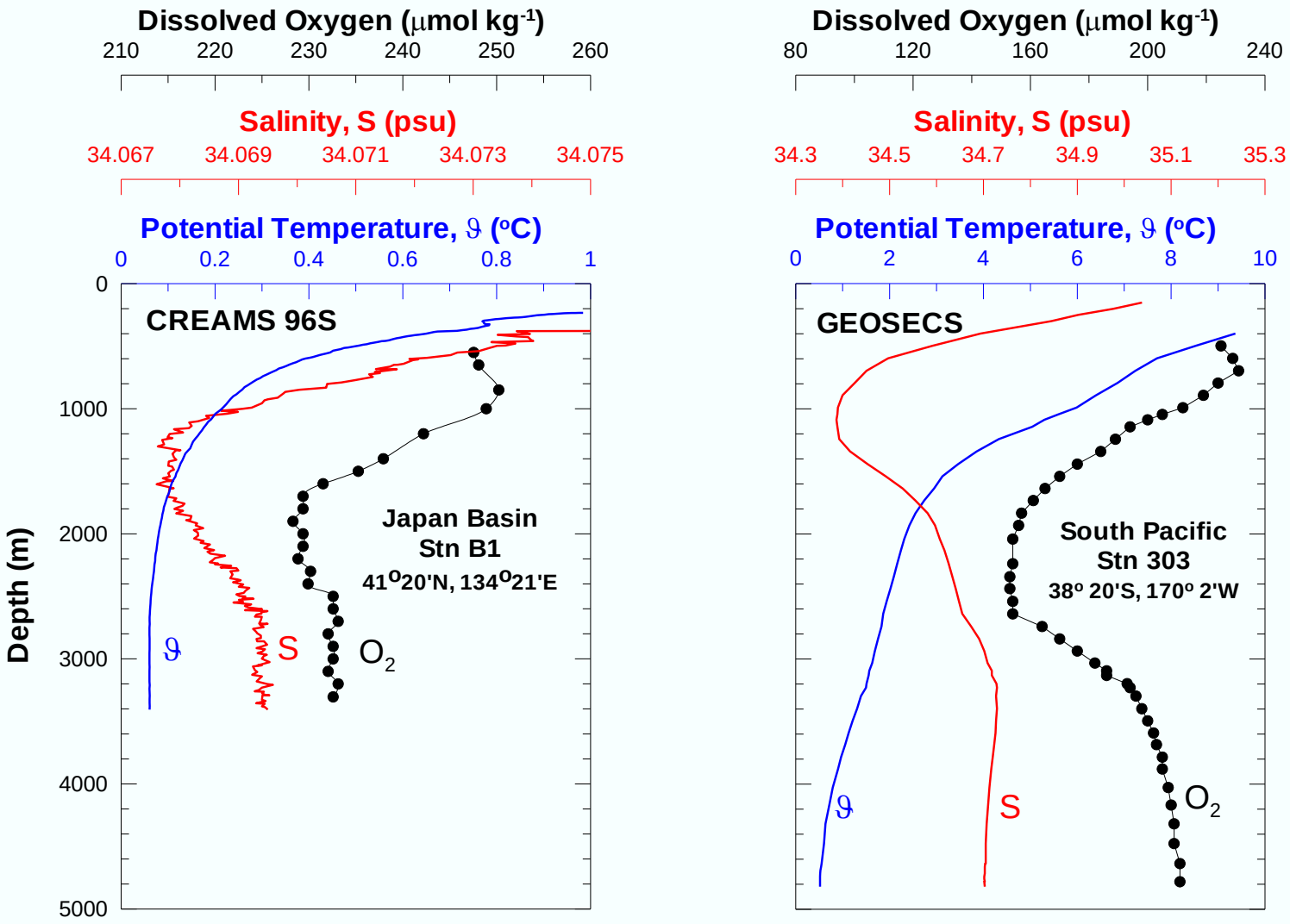
Circulation
Research of
East
Asian
Marginal
Seas



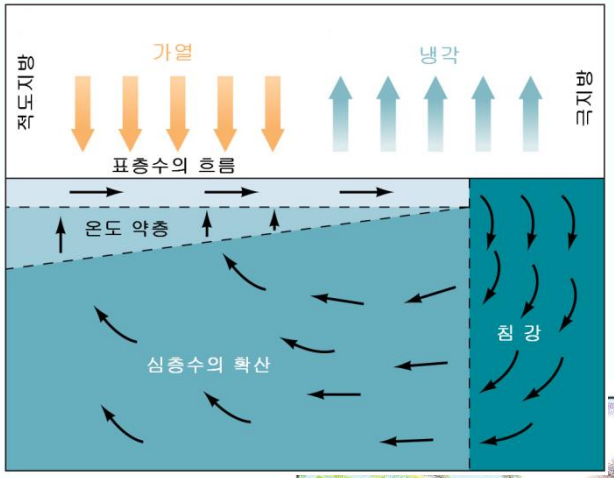
CREAMS Finding: I

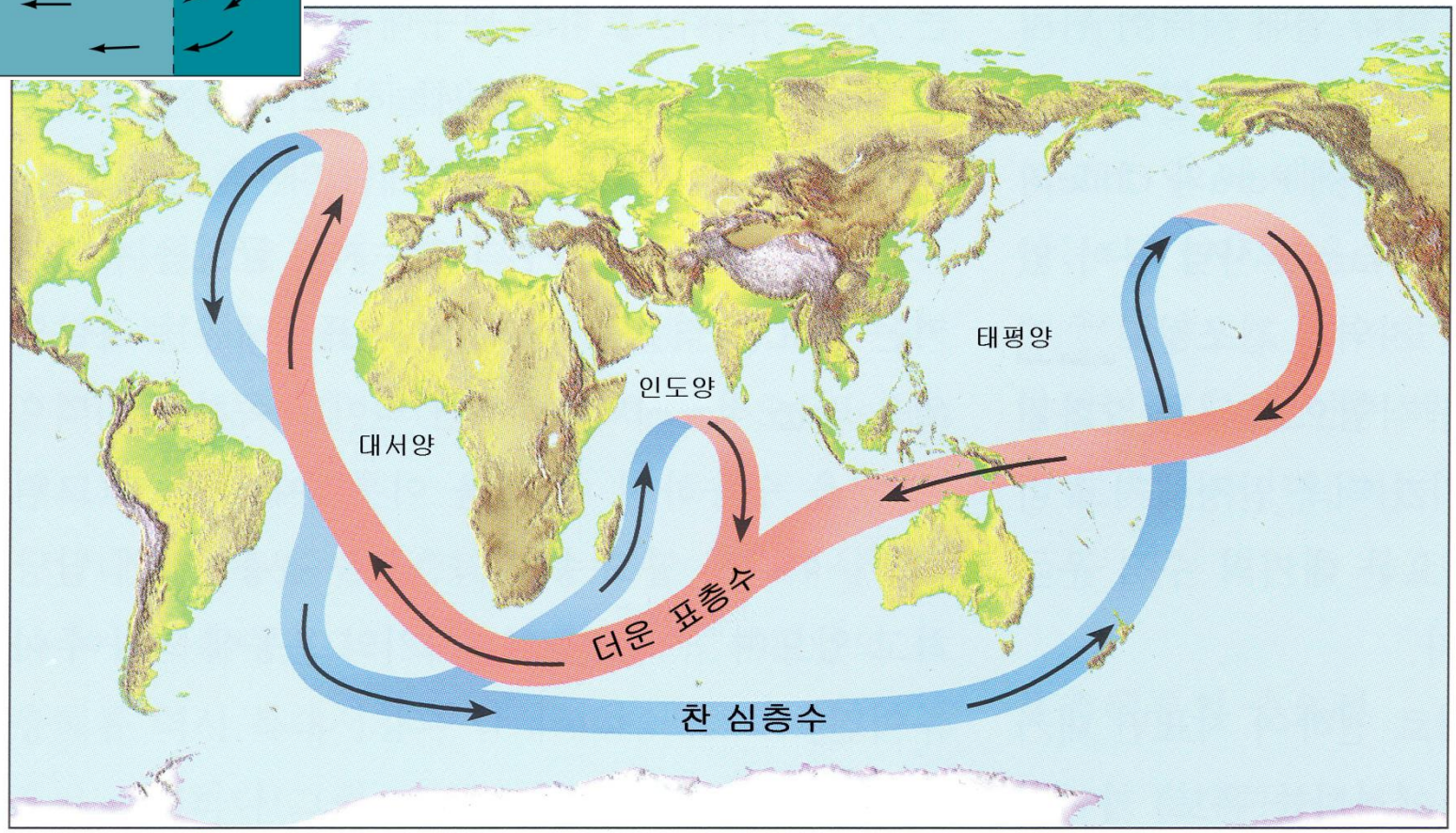
East Sea is a miniature ocean

Vertical profiles : T, S, Dissolved O_2

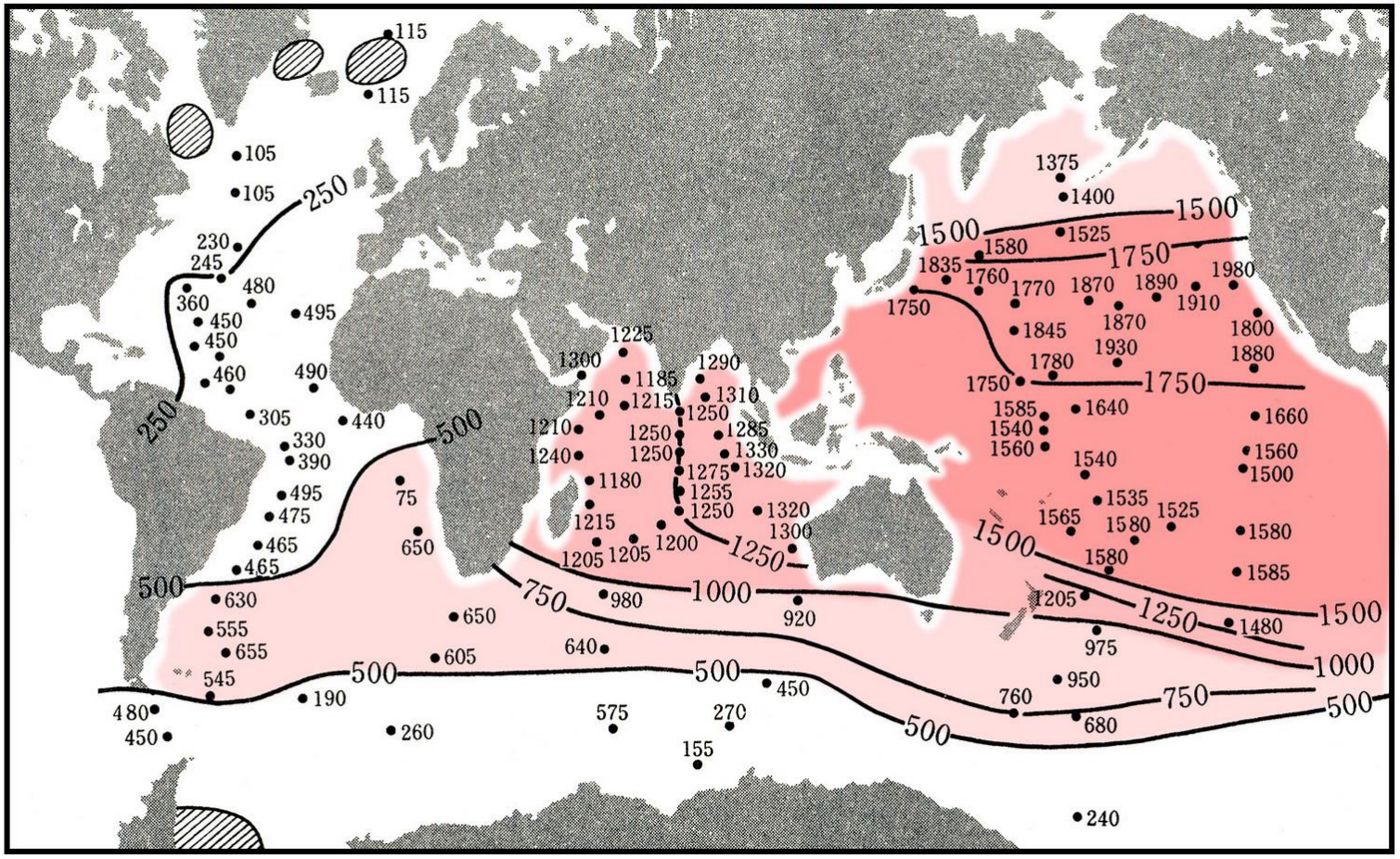


Oceanic Conveyor Belt

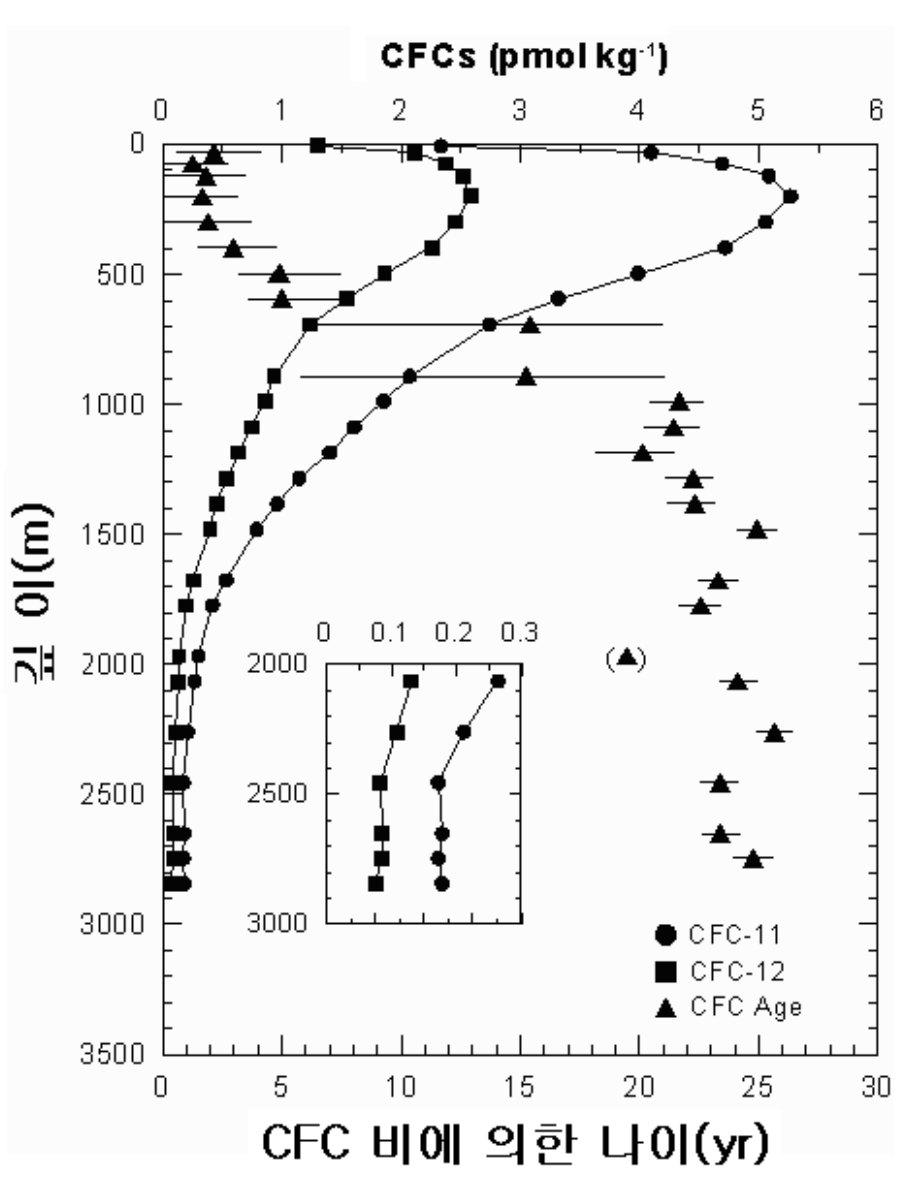




C-14 years of waters at 4000 m depth

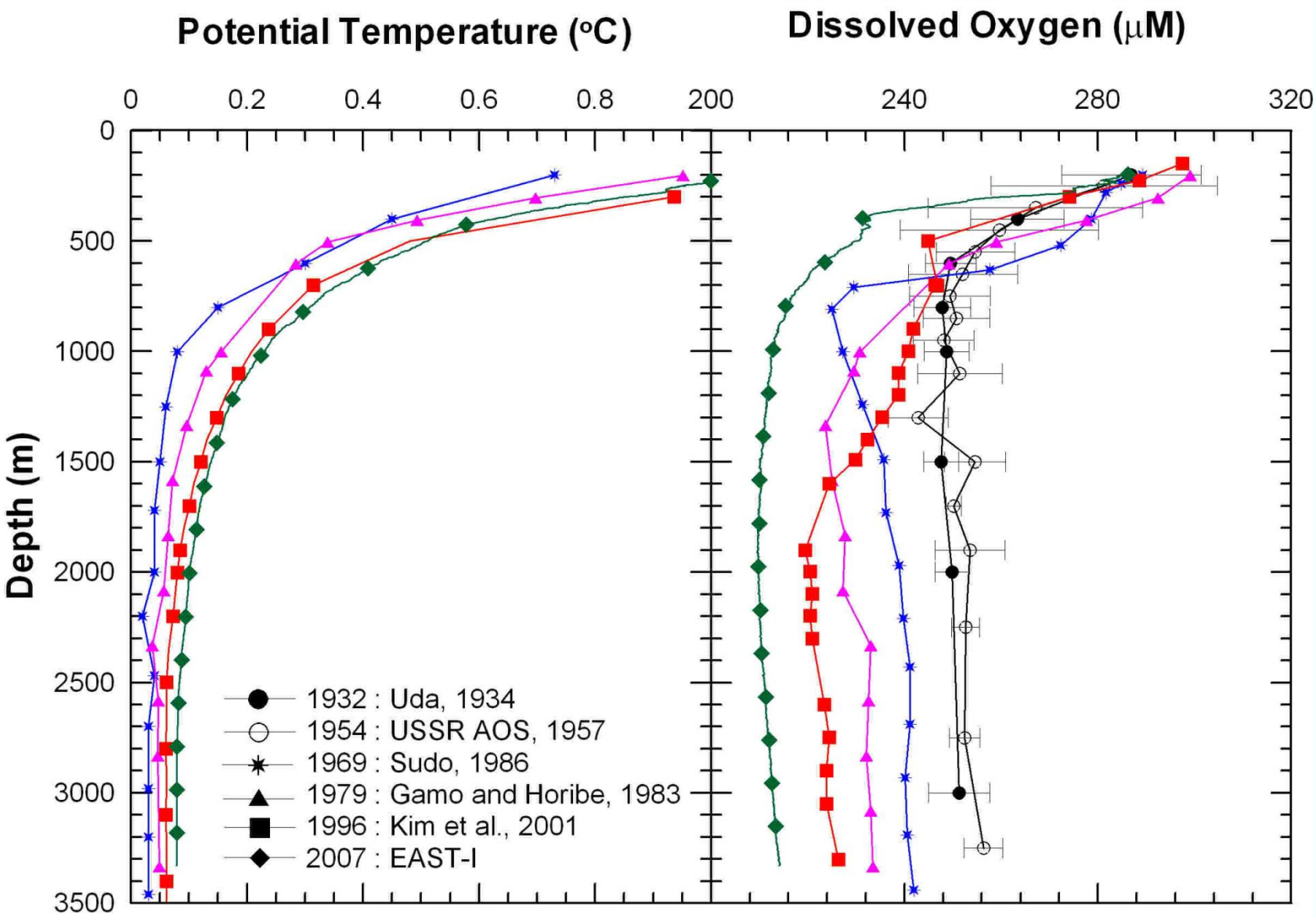


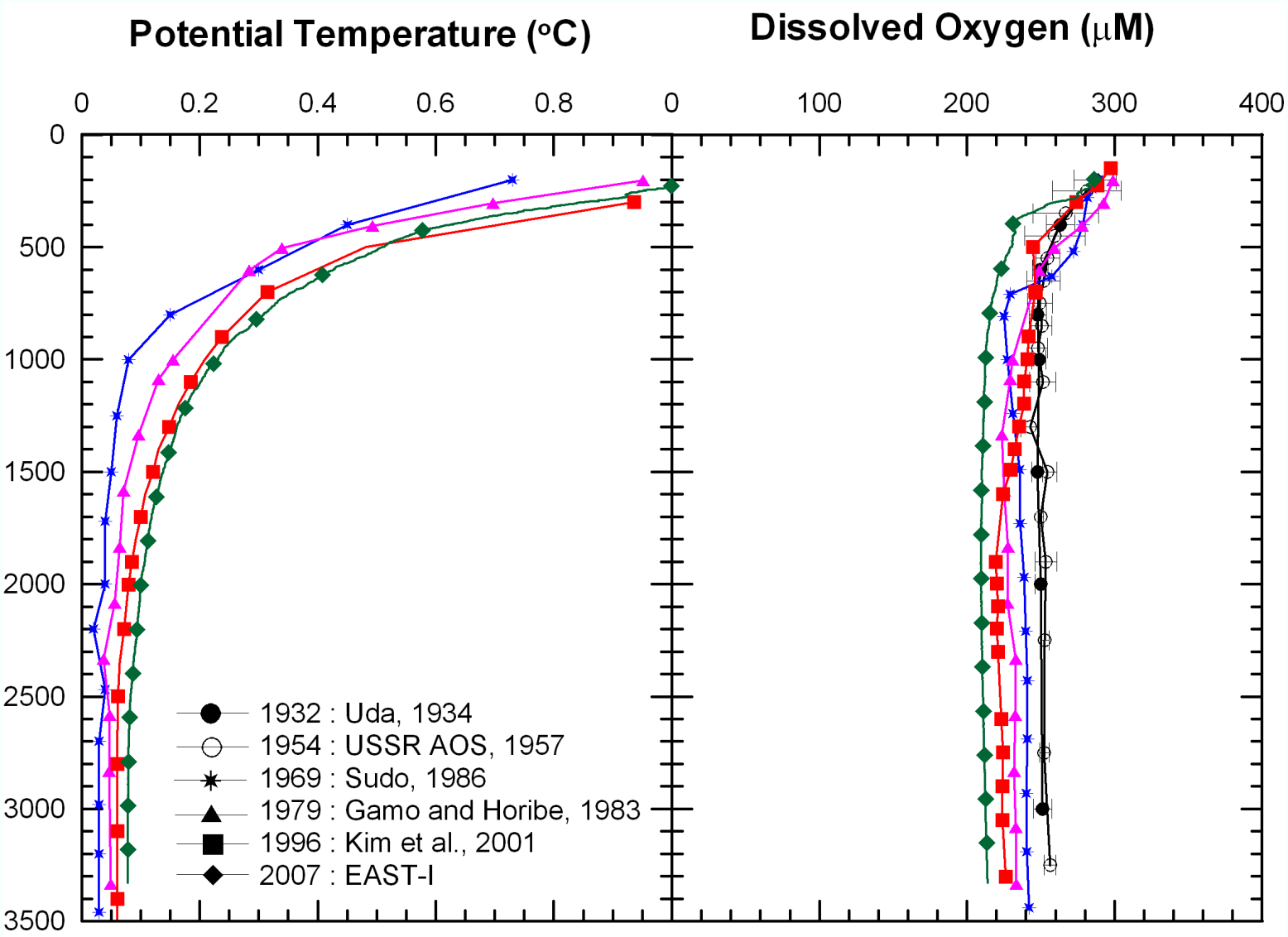
CFCs in the East/Japan Sea



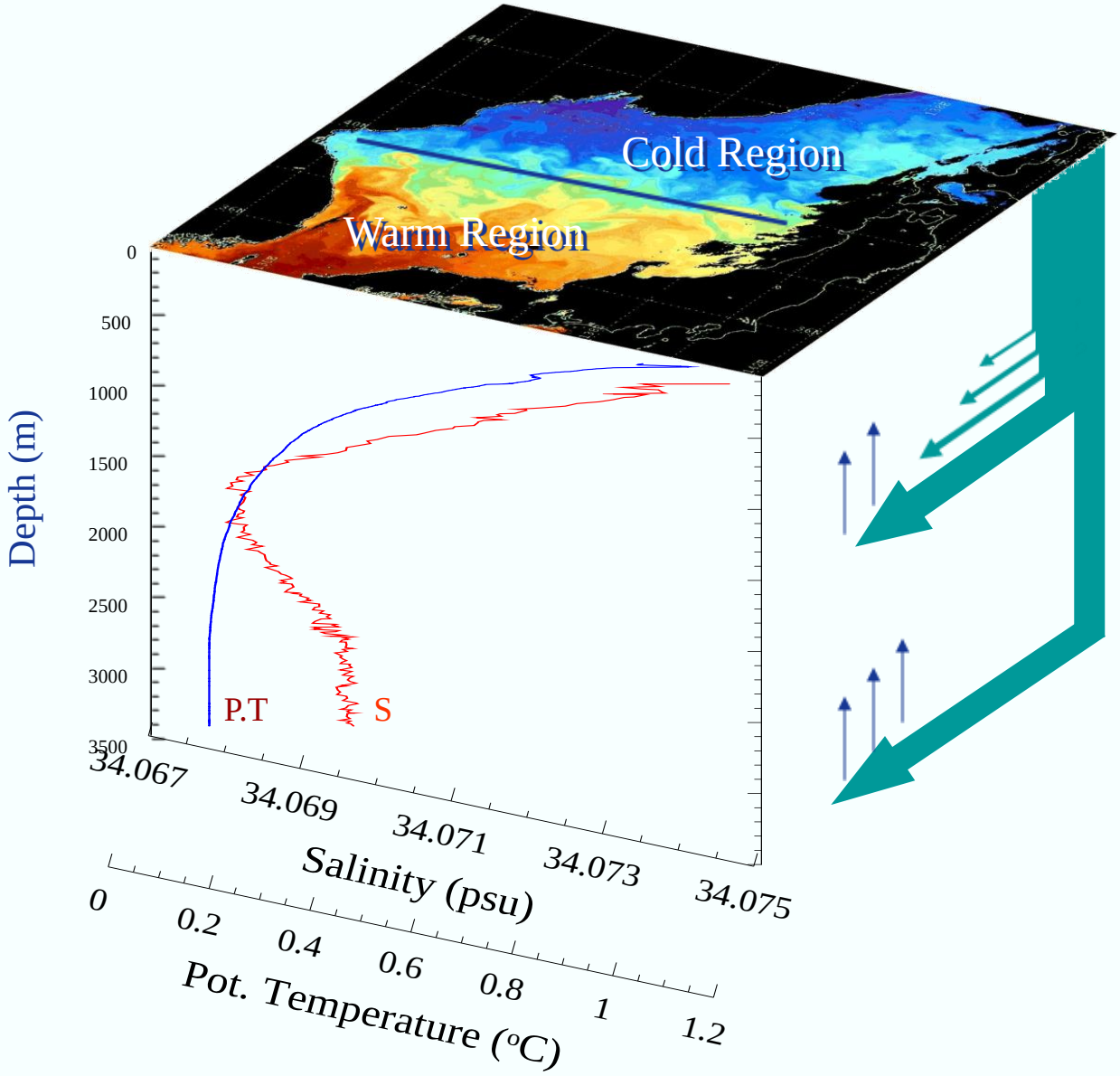
CREAMS Finding: II

East Sea is in Rapid Changes

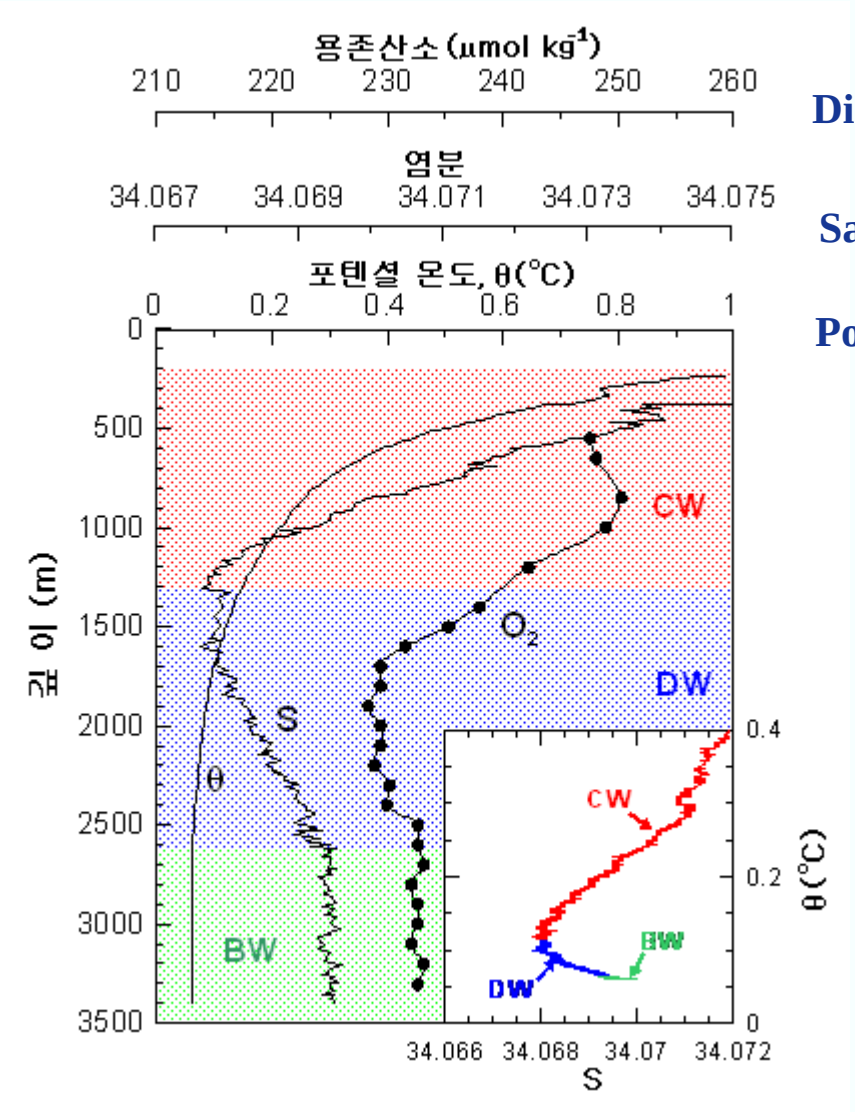

Potential Temperature (°C)
Dissolved Oxygen (μM)
0
0.2
0.4
0.6
0.8
200
240
280
320
Depth (m)
0
500
1000
1500
2000
2500
3000
3500
1932 : Uda, 1934
1954 : USSR AOS, 1957
1969 : Sudo, 1986
1979 : Gamo and Horibe, 1983
1996 : Kim et al., 2001
2007 : EAST-I


Potential Temperature (°C)
Dissolved Oxygen (μM)
0
0.2
0.4
0.6
0.8
0
100
200
300
400
500
1000
1500
2000
2500
3000
3500
1932 : Uda, 1934
1954 : USSR AOS, 1957
1969 : Sudo, 1986
1979 : Gamo and Horibe, 1983
1996 : Kim et al., 2001
2007 : EAST-I

Changes in conveyor belt



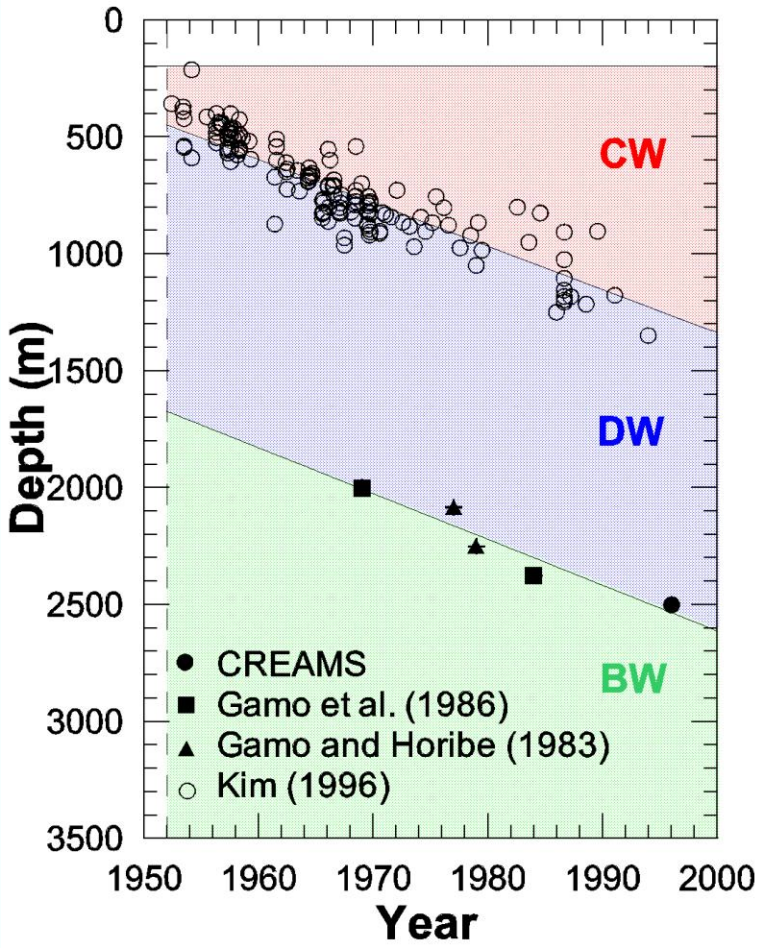
CW(Central), DW(Deep), BW(Bottom)

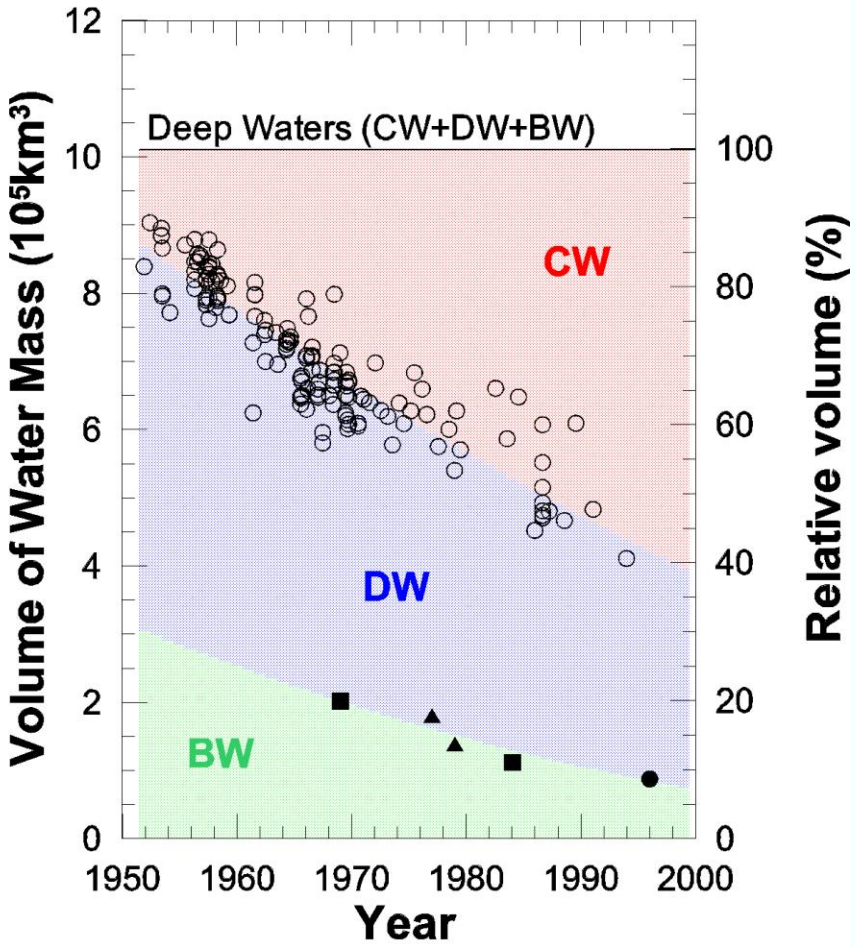


Dissolved Oxygen

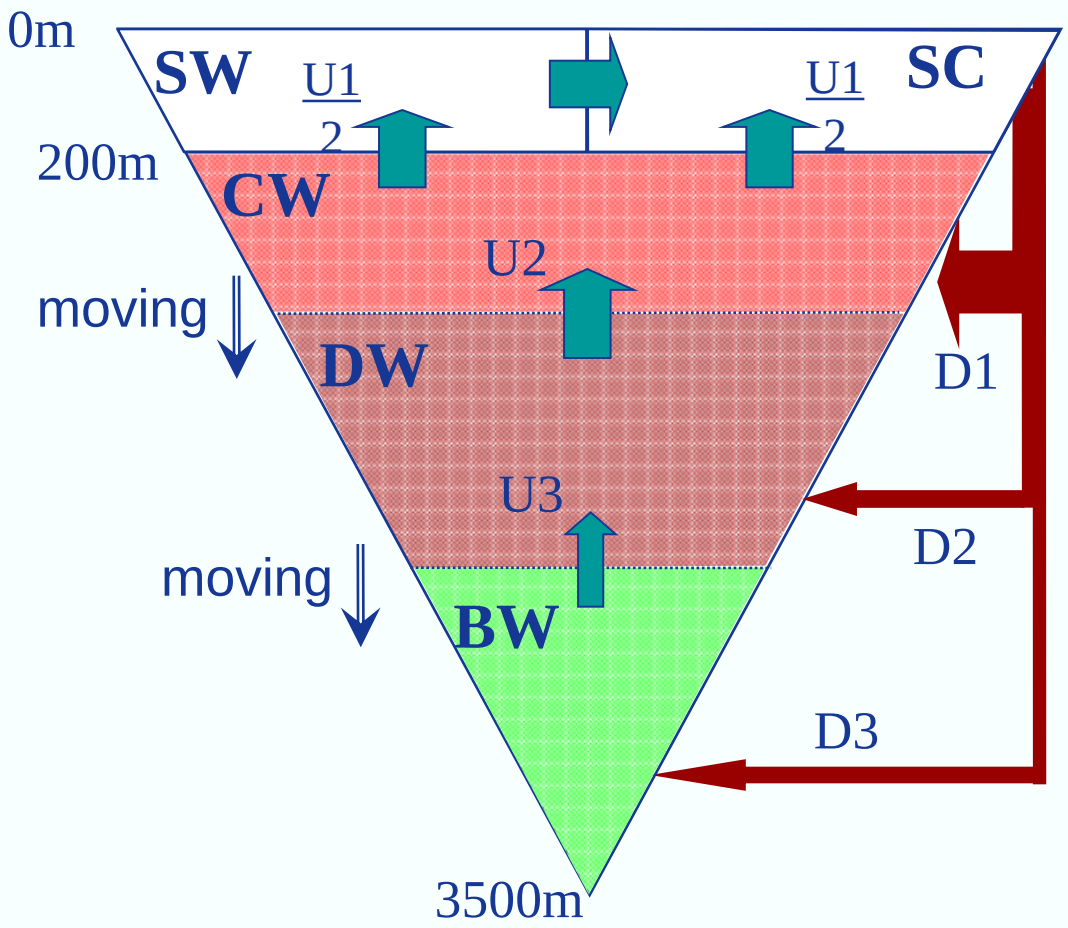
Salinity

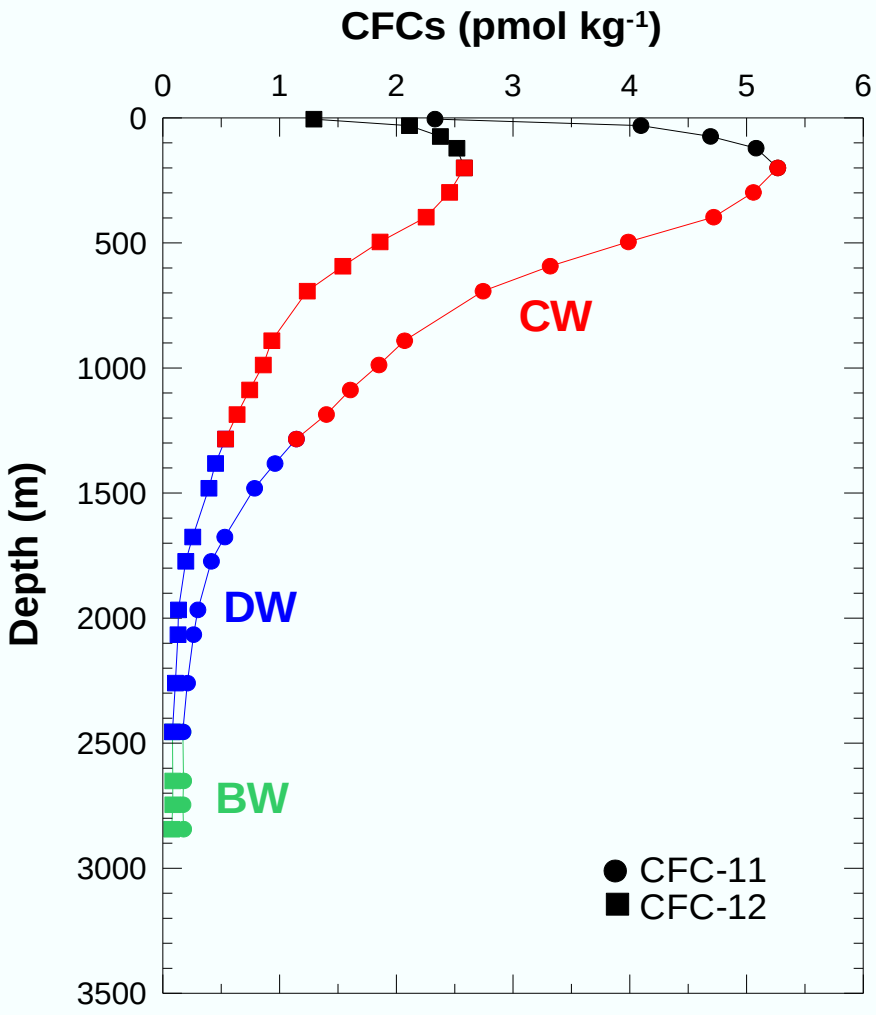
Potential Temperature


Depth (m)
0
500
1000
1500
2000
2500
3000
3500
1950
1960
1970
1980
1990
2000
Year
CW
DW
BW
CREAMS
Gamo et al. (1986)
Gamo and Horibe (1983)
Kim (1996)


Volume of Water Mass (10^5km^3)
Relative volume (%)
Deep Waters (CW+DW+BW)
0
2
4
6
8
10
12
0
20
40
60
80
100
1950
1960
1970
1980
1990
2000
Year
CW
DW
BW

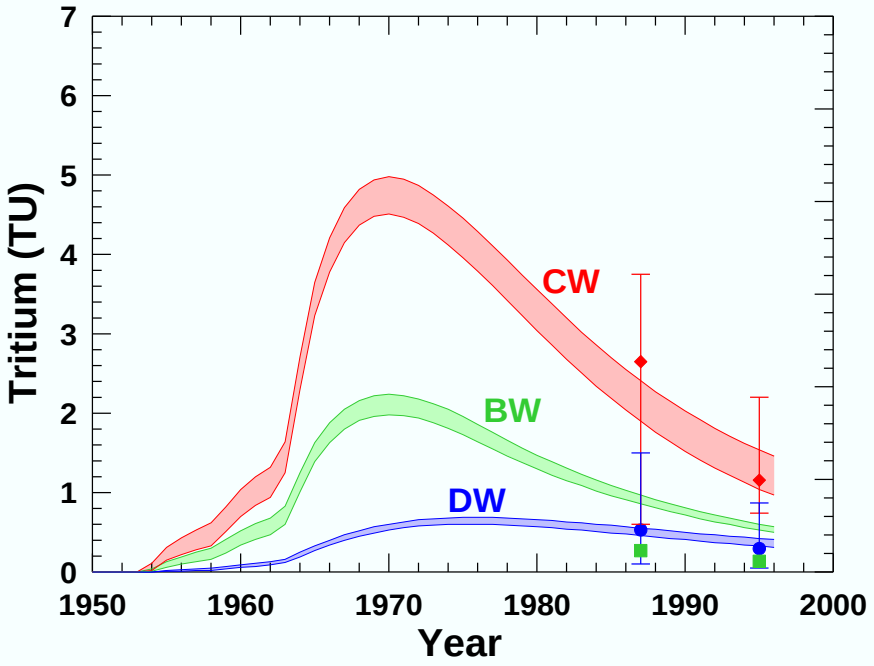
Moving-Boundary Box Model (MBBM)

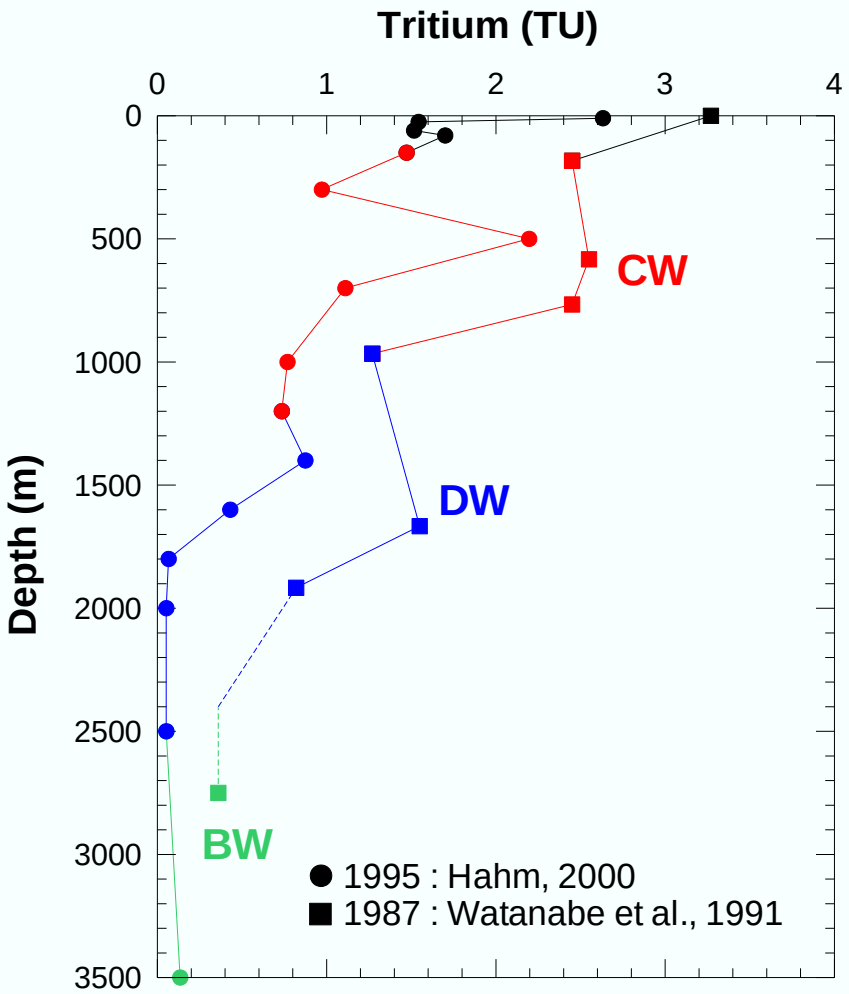


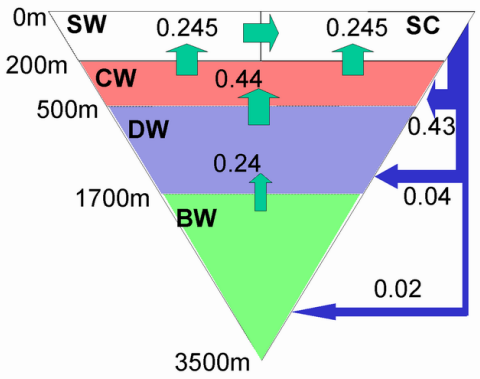


Water Mass	CFC-11 (pmol/kg)	CFC-12 (pmol/kg)
CW	2.551 (0.710–5.375)	1.192 (0.329–2.633)
DW	0.424 (0.150–0.969)	0.202 (0.074–0.454)
BW	0.163 (0.143–0.224)	0.076 (0.052–0.124)

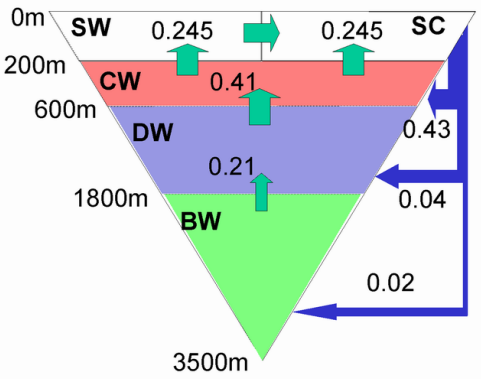
Tritium in the East/Japan Sea



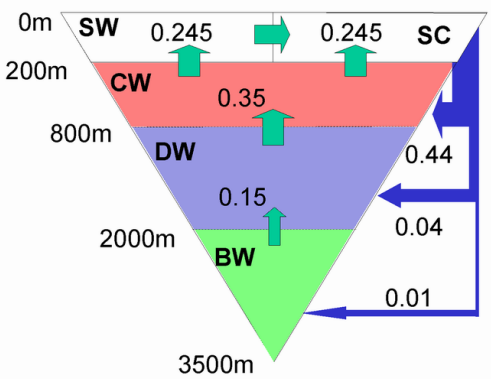




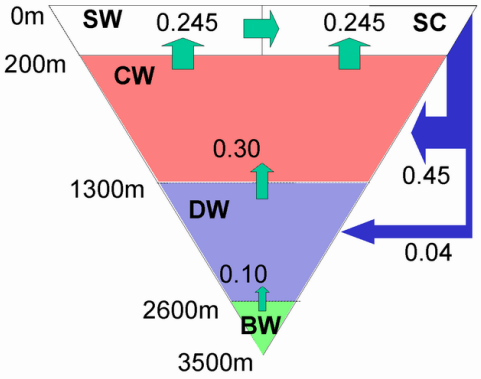
before 1952



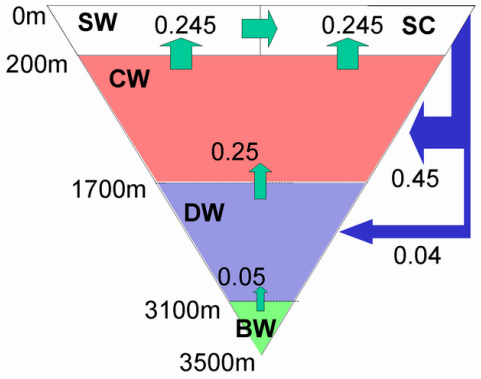
1960



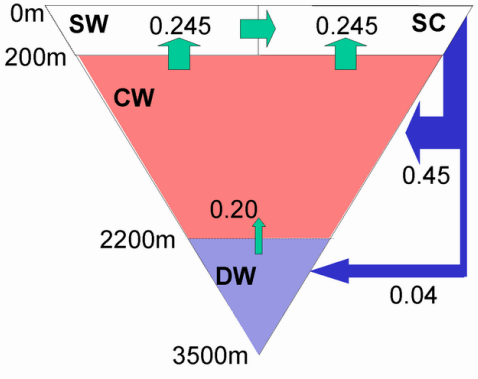
1980



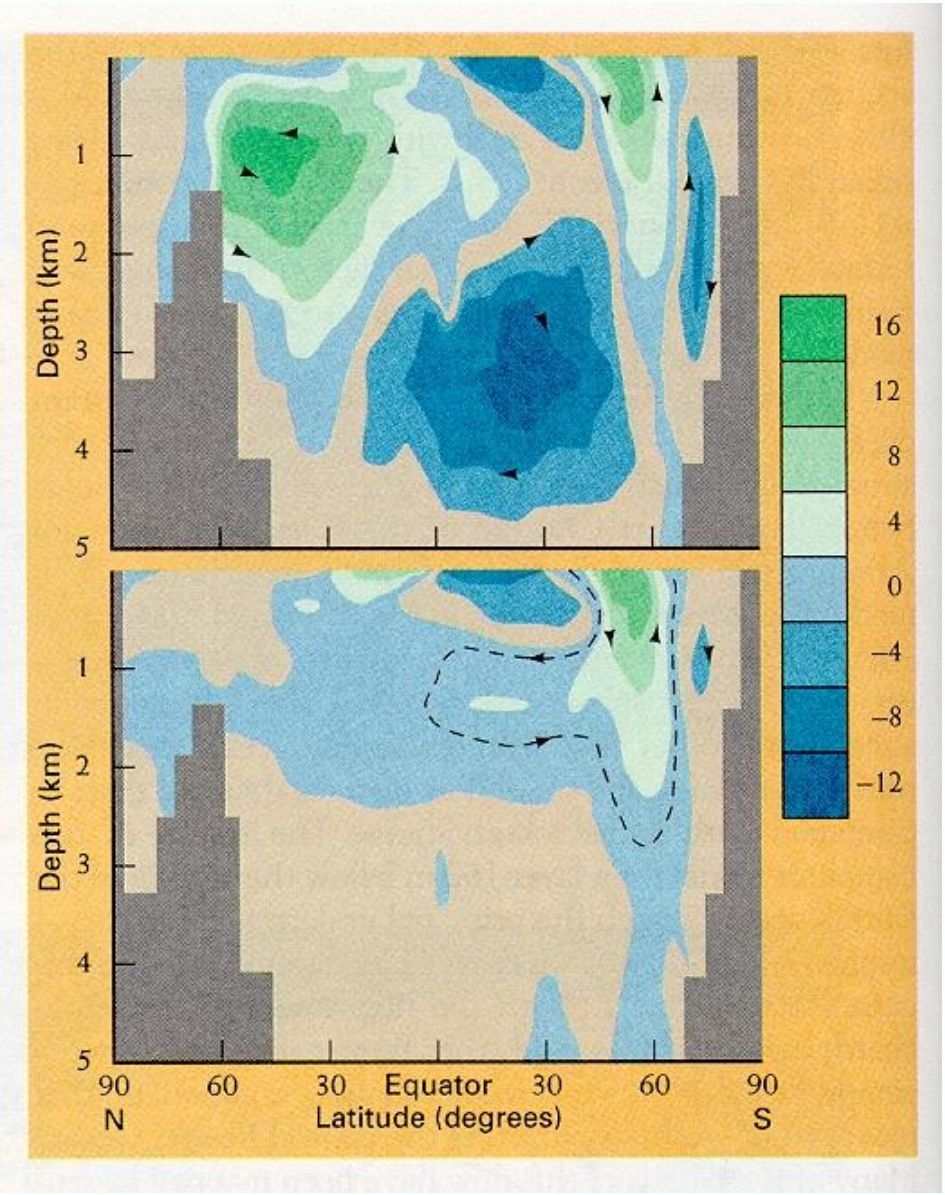
2000



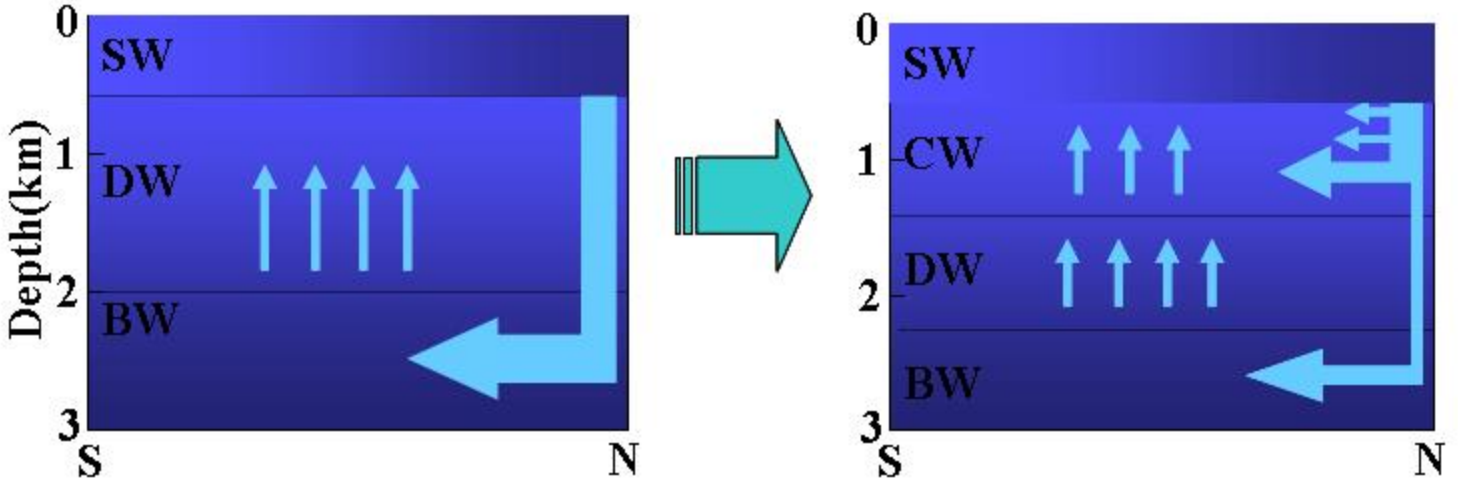
2020



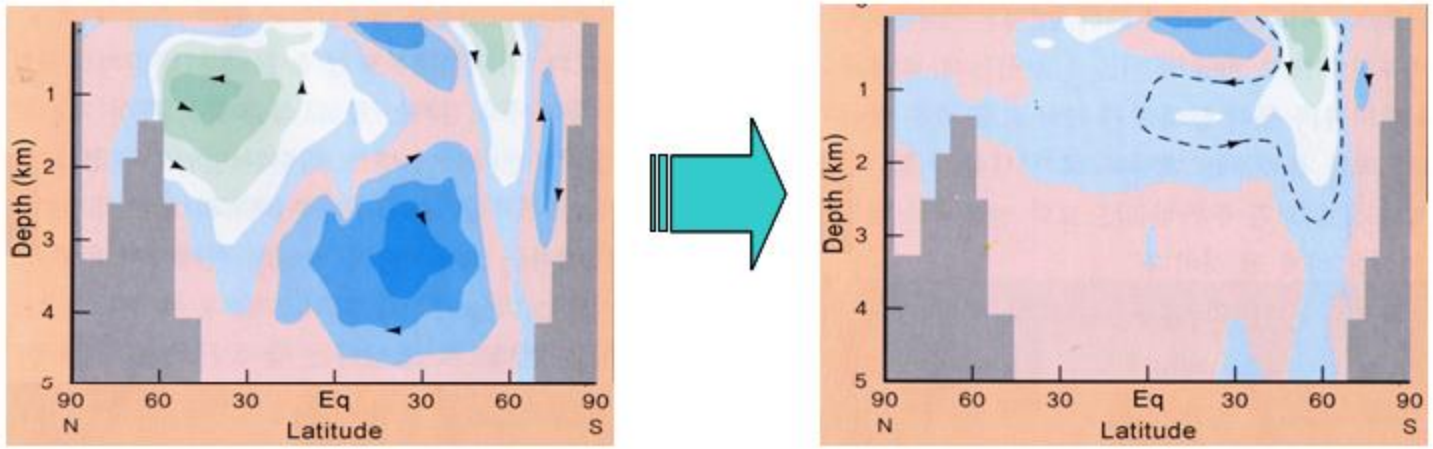
2040


Depth (km)
1
2
3
4
5
Depth (km)
1
2
3
4
5
16
12
8
4
0
−4
−8
−12
90
N
60
30
Equator
30
60
90
S
Latitude (degrees)

동해


0
1
2
3
Depth(km)
SW
DW
BW
S
N
0
1
2
3
SW
CW
DW
BW
S
N

모델 결과 대양


Depth (km)
1
2
3
4
5
90
N
60
30
Eq
30
60
90
S
Latitude
Depth (km)
1
2
3
4
5
90
N
60
30
Eq
30
60
90
S
Latitude

Kim, K., Kim, K.-R., Min, D., Volkov, Y.,
Yoon, J. -H. & Takematsu, M. (2001)

Warming and Structural Changes in the East Sea (Japan Sea): A Clue to the future Changes in Global Oceans?

***Geophys. Res. Lett.*, 28, 3293-3296.**

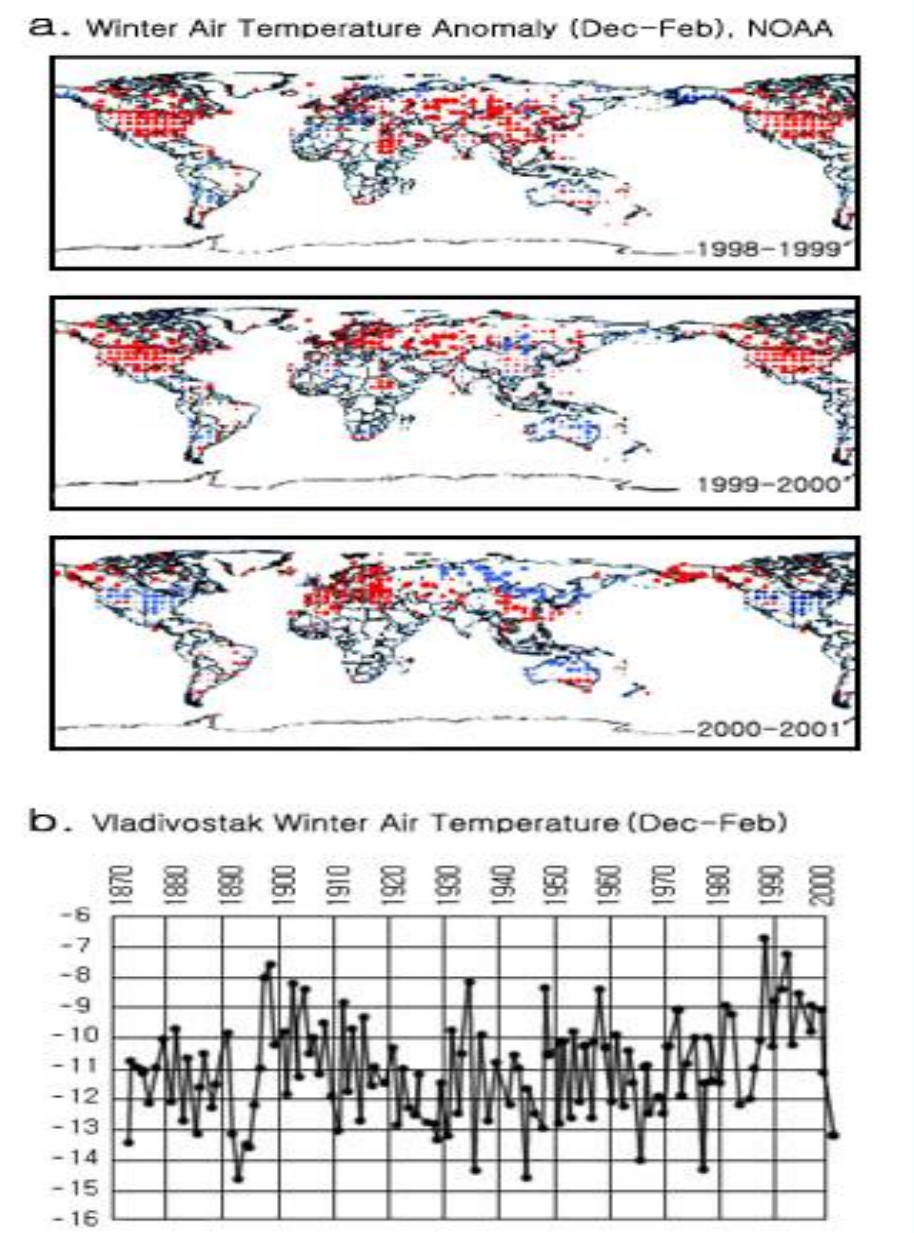
Kang, D.-J., Park. S., Kim, Y.-G., Kim, K.,
Kim K.-R. (2003)

A Moving-Boundary Box Model(MBBM) for oceans in change: An application to the East/Japan Sea

Geophysical Research Letters, 30(6), 1229, doi:10.1029/2002GL016486.

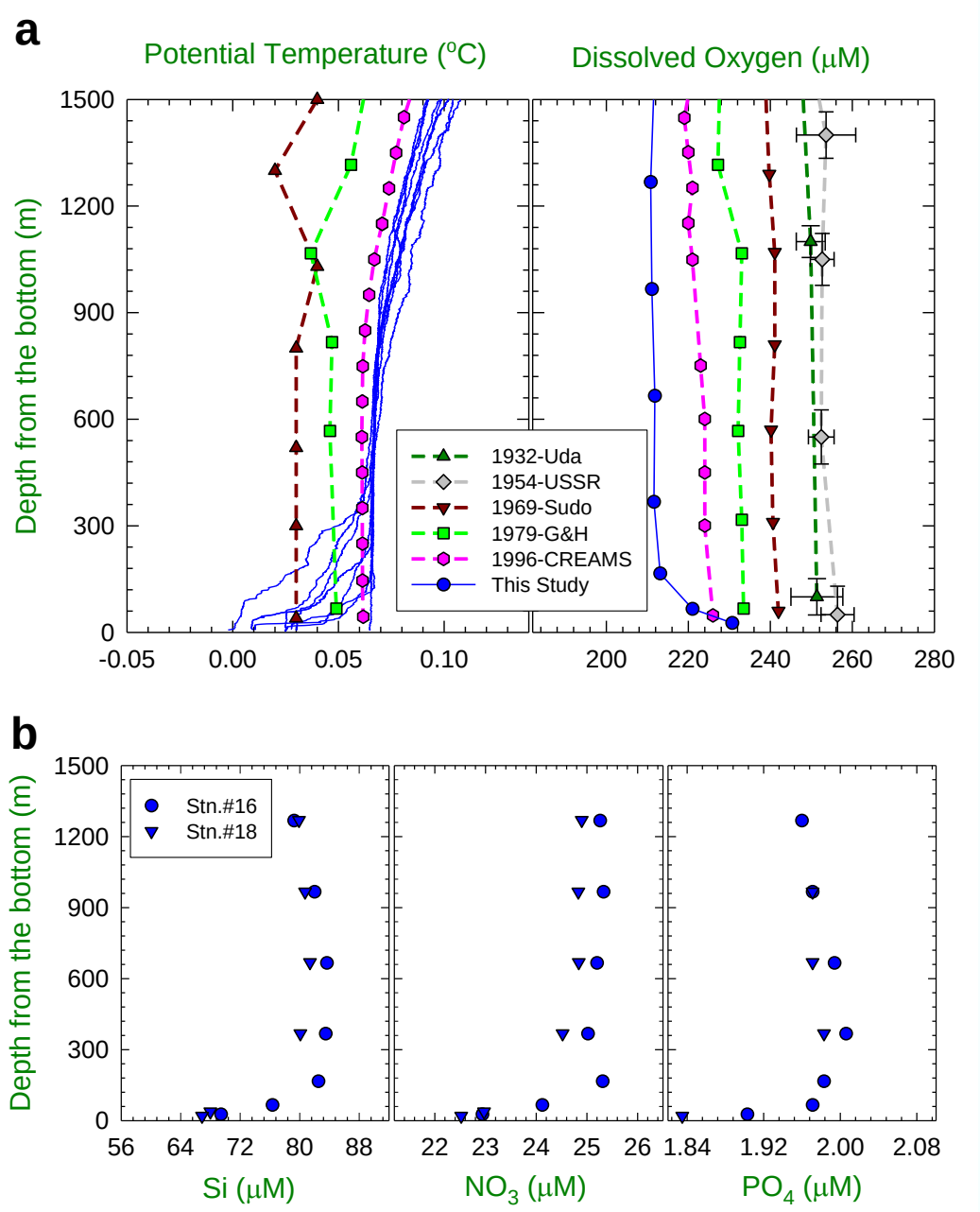
Winter Temperature Anomalies

Winter 2001-2002



A Sudden Bottom Water Formation

Winter 2001–2002



Kim, K.-R., Kim, G., Kim, K.,
Lobanov, V., Ponomarev, V., Salyuk, A.

A sudden bottom-water formation during the severe winter 2000-2001: the case of the East/Japan Sea

Geophys. Res. Lett., 29 (8), 10.1029/2001GL014498, 2002.

IPCC 4th Assessment Report

The marginal seas of the Pacific Ocean are also subject to climate variability and change. Like the Mediterranean in the North Atlantic, the Japan (or East) Sea is nearly completely isolated from the adjacent ocean basin, and forms all of its own waters beneath the shallow pycnocline.

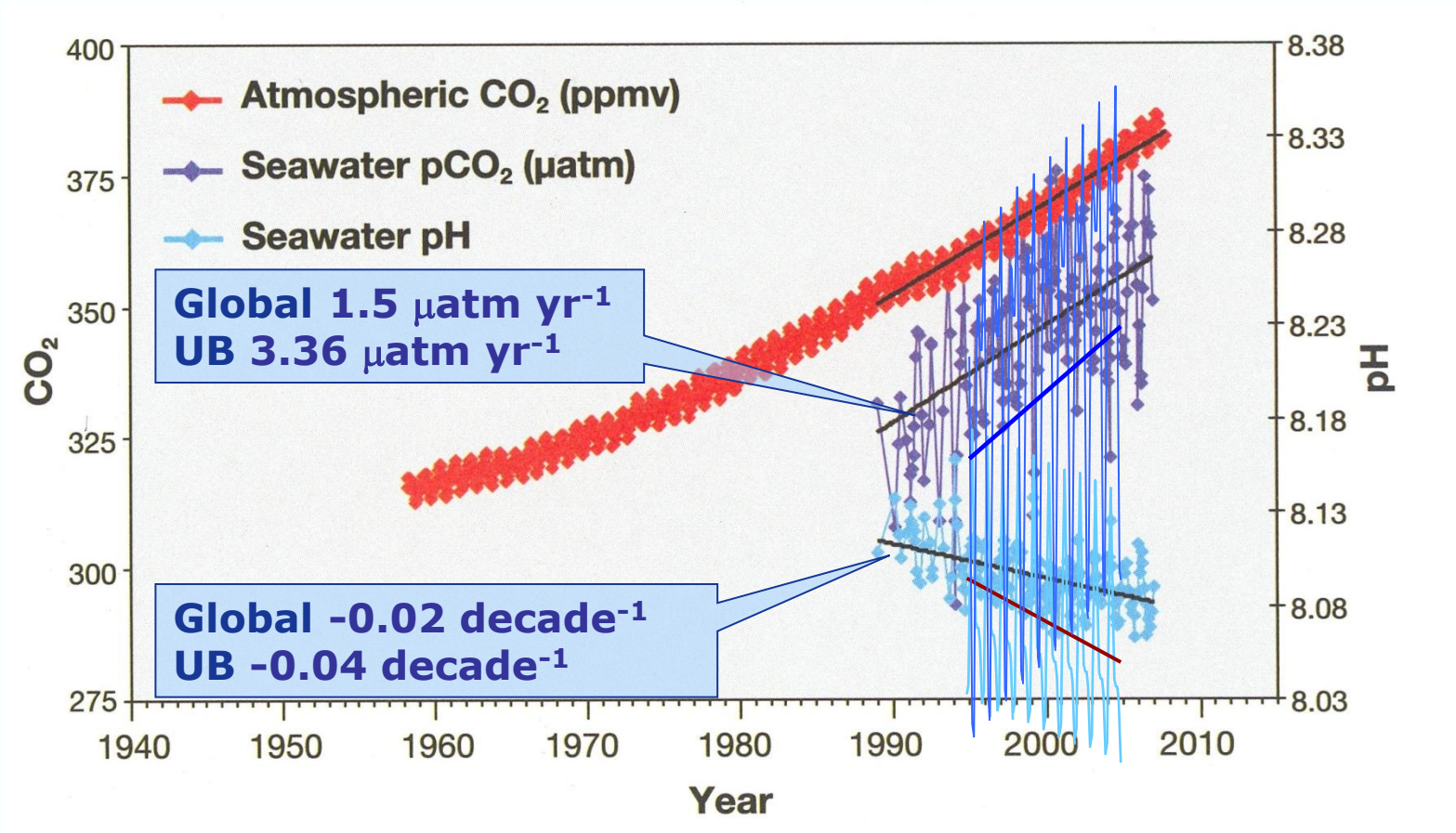
Because of this sea's limited size, it responds quickly through its entire depth to surface forcing changes. The warming evident through the global ocean is clearly apparent in this isolated basin, which warmed by 0.1°C at 1,000 m and 0.05°C below 2,500 m since the 1960s. Salinity at these depths also changed, by 0.06 psu per century for depths of 300 to 1,000 m and by −0.02 psu per century below 1,500 m (Kwon et al., 2004).

These changes have been attributed to reduced surface heat loss and increased surface salinity, which have changed the mode of ventilation (Kim et al., 2004). Deep water production in the Japan (East) Sea slowed for many decades, with a marked decrease in dissolved oxygen from the 1930s to 2000 at a rate of about 0.8 μmol kg−1 yr−1 (Gamo et al., 1986; Minami et al., 1998).

However, possibly because of weakened vertical stratification at mid-depths associated with the decades-long warming, deepwater production reappeared after the 2000–2001 severe winter (e.g., Kim et al., 2002; Senjyu et al., 2002; Talley et al., 2003b).

Nevertheless, the overall trend has continued with lower deepwater production in subsequent years.

Ocean Acidification



CREAMS/PICES Symposium on

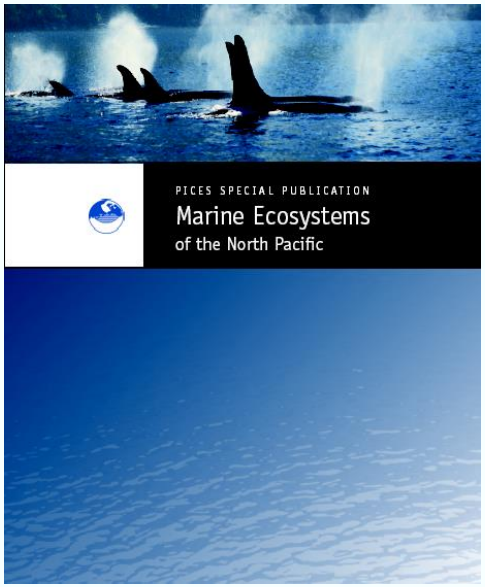
Recent progress in studies of physical and chemical processes in the East/Japan Sea and their impact to its ecosystem

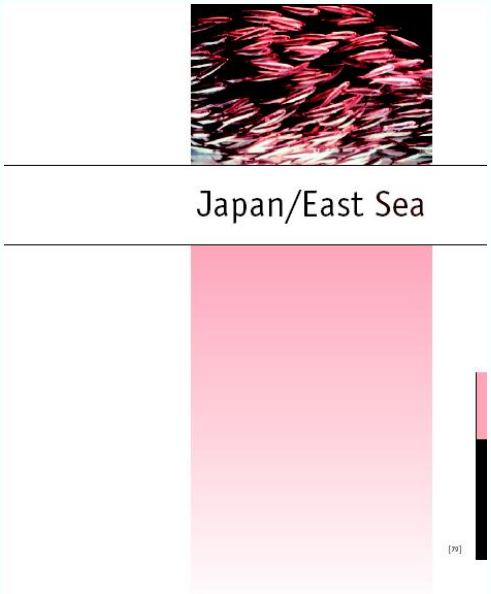
22–23, August 2002
the Hoam Faculty Club
Seoul National University, Seoul, Korea

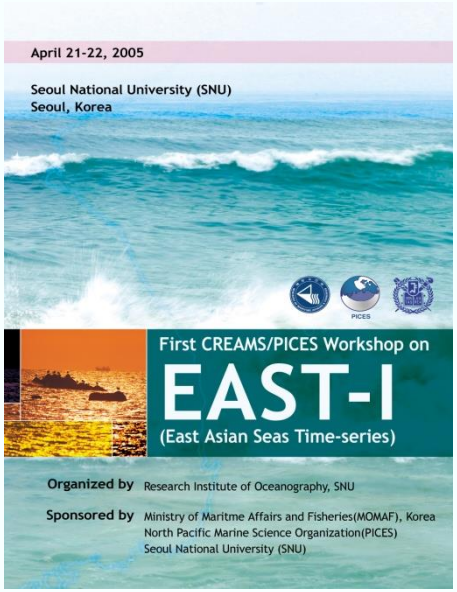
Organized by OCEAN Laboratory, Research Institute of Oceanography,
School of Earth and Environmental Sciences (BK21),
Seoul National University

Sponsored by National Fisheries Research and Development Institute
Korea Ocean Research and Development Institute

EAST-I 추진 경위

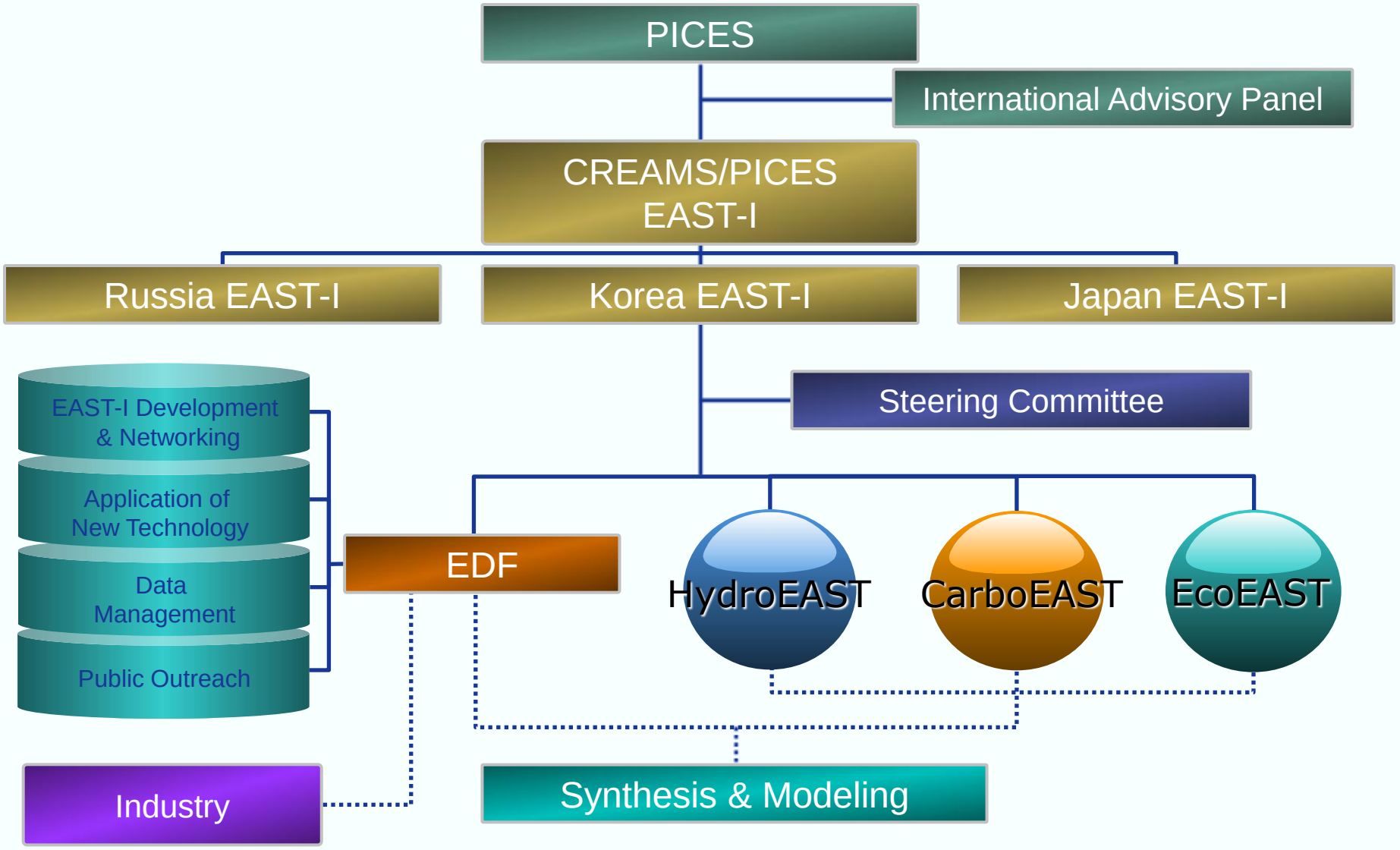




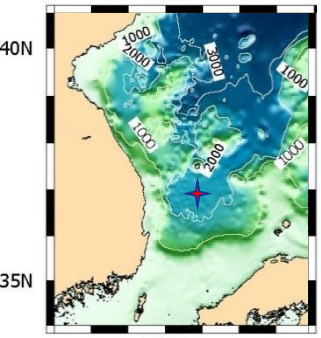


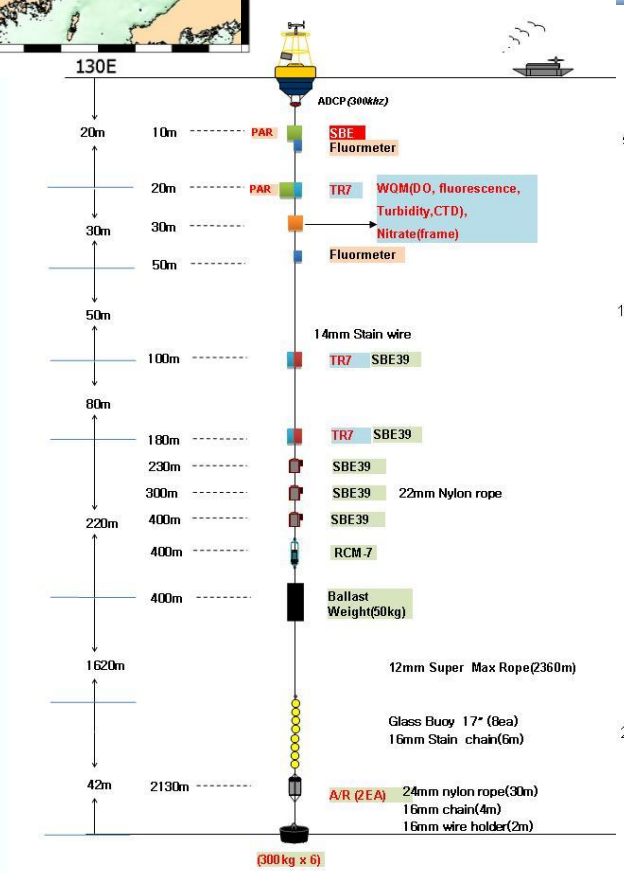
- 2004 PICES Report: Marine Ecosystems of the North Pacific
- 2005 PICES Approved Official CREAMS/PICES program:
  EAST (East Asian Sea Time-series) -I
- 2005 International Conference on EAST-I
- 2006 Korea EAST-I Project initiated.

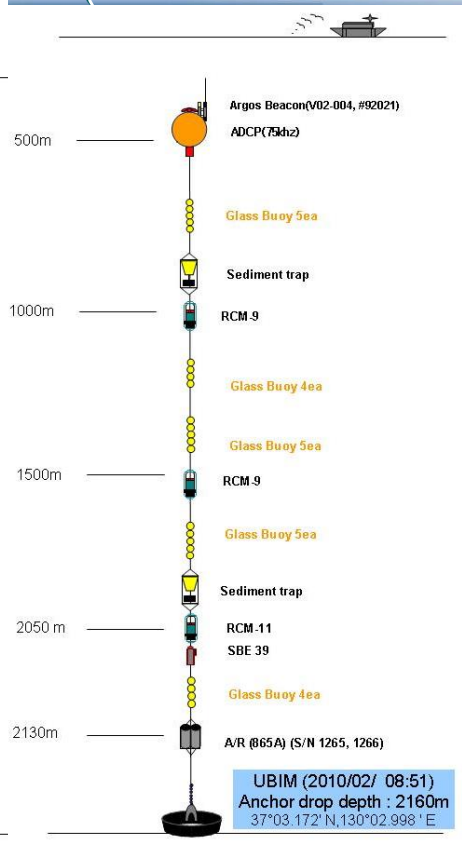
CREAMS/PICES
Korean EAST-I program

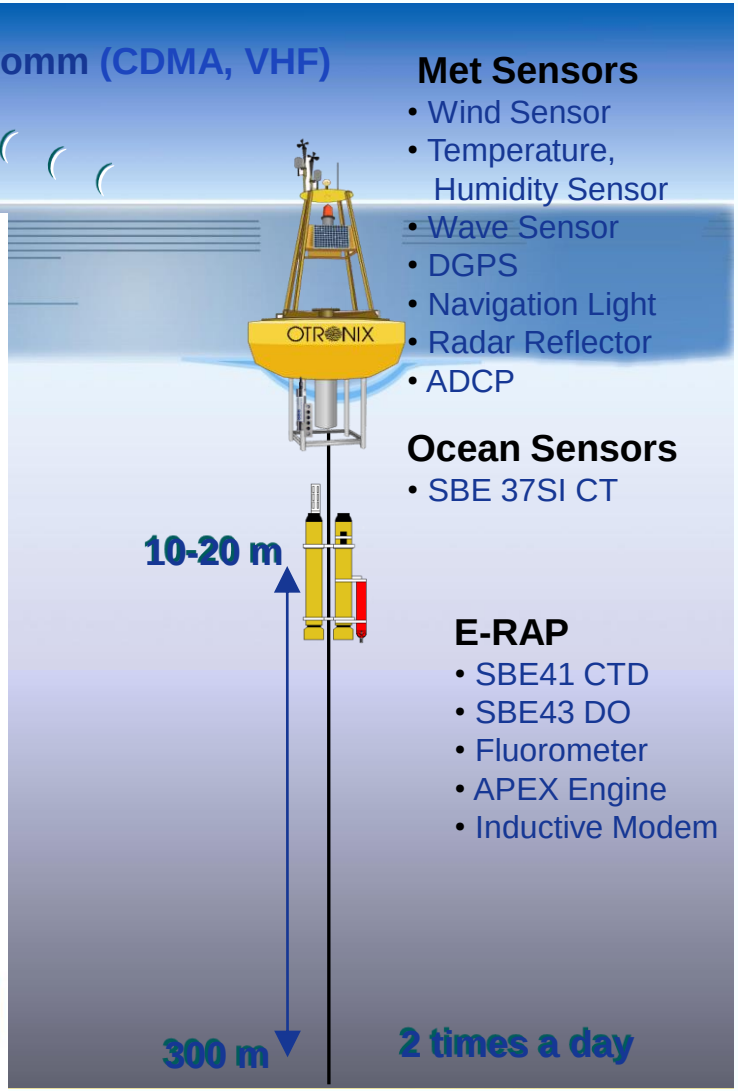


Super Station









Met Sensors
- Wind Sensor
- Temperature, Humidity Sensor
- Wave Sensor
- DGPS
- Navigation Light
- Radar Reflector
- ADCP

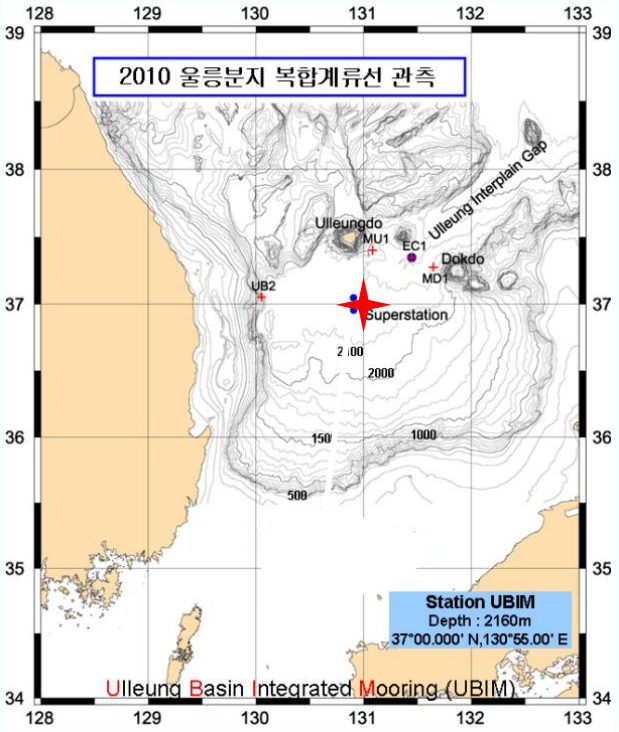
Ocean Sensors
- SBE 37SI CT

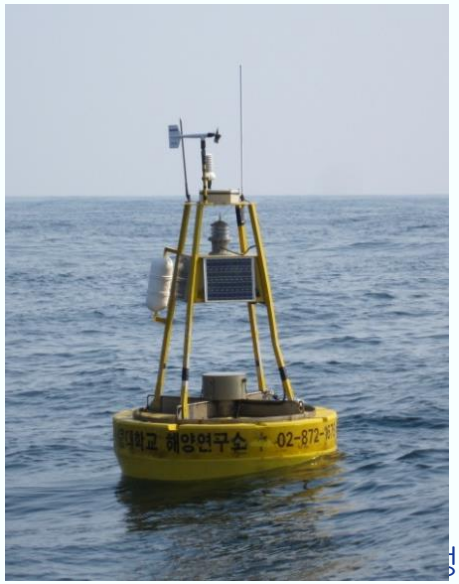
E-RAP
- SBE41 CTD
- SBE43 DO
- Fluorometer
- APEX Engine
- Inductive Modem

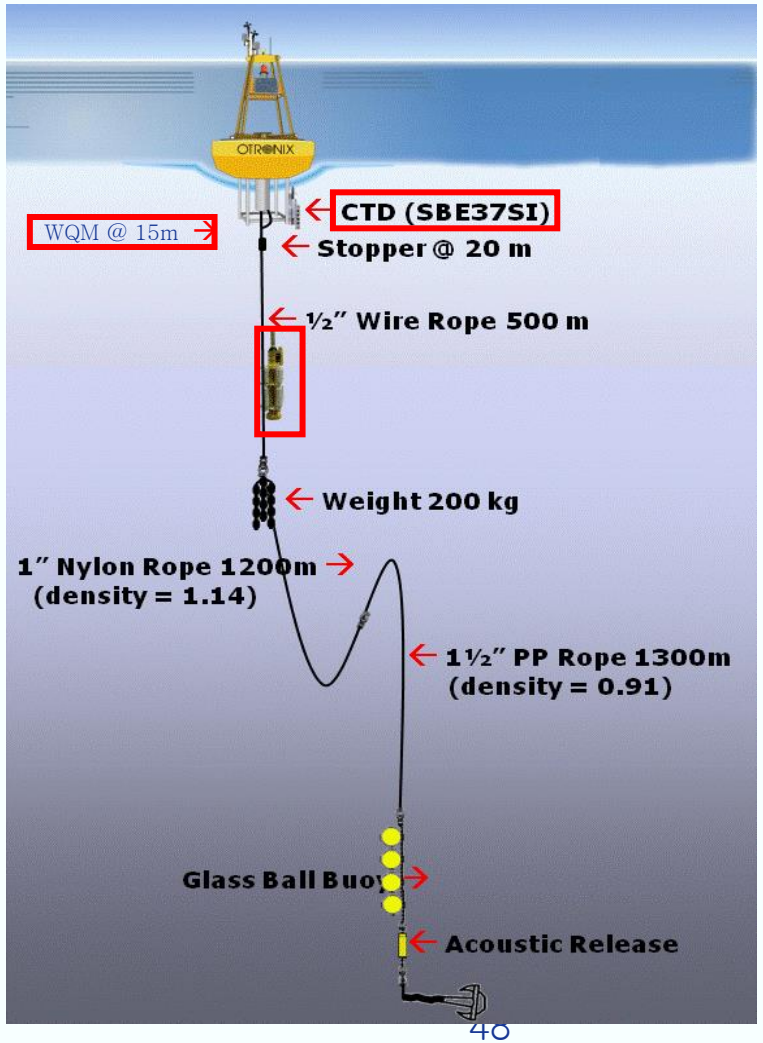
Ulleung Basin Integrated Mooring

E-RAP operation

- Buoy: Deployed 10 Feb, 2012
- Deployed since May 25 – Sep 13, 2012
- Observe T, S, DO, Chl-a
  between 25 and 350 m depth
- Profile twice a day (00:00, 12:00)







(EAST-I)

E-RAP operation

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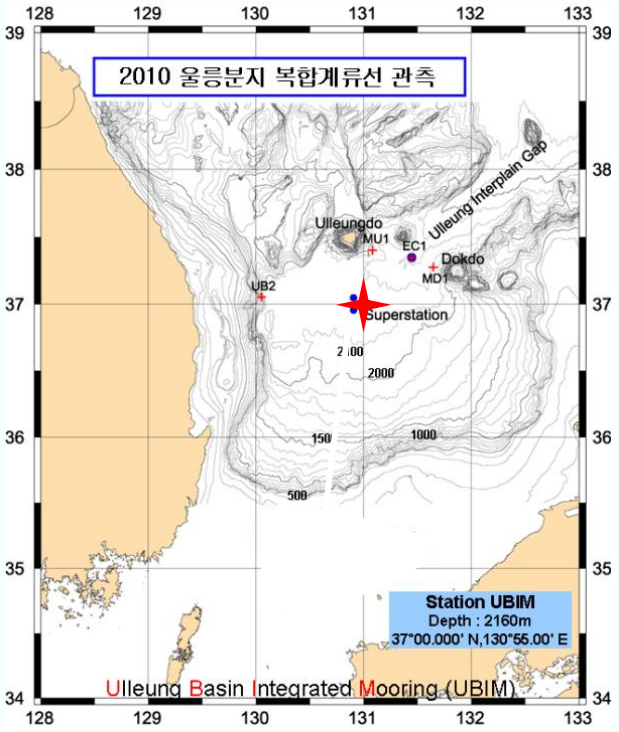
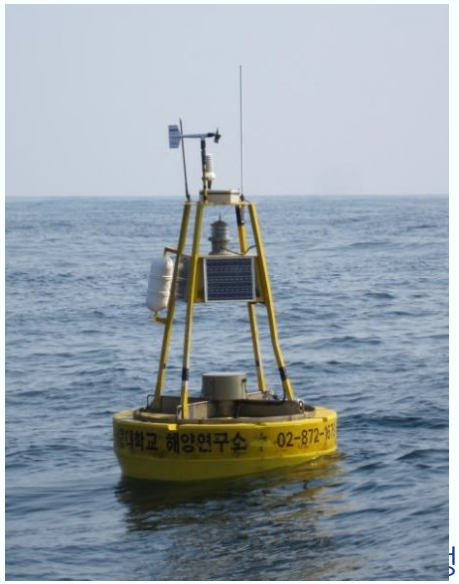
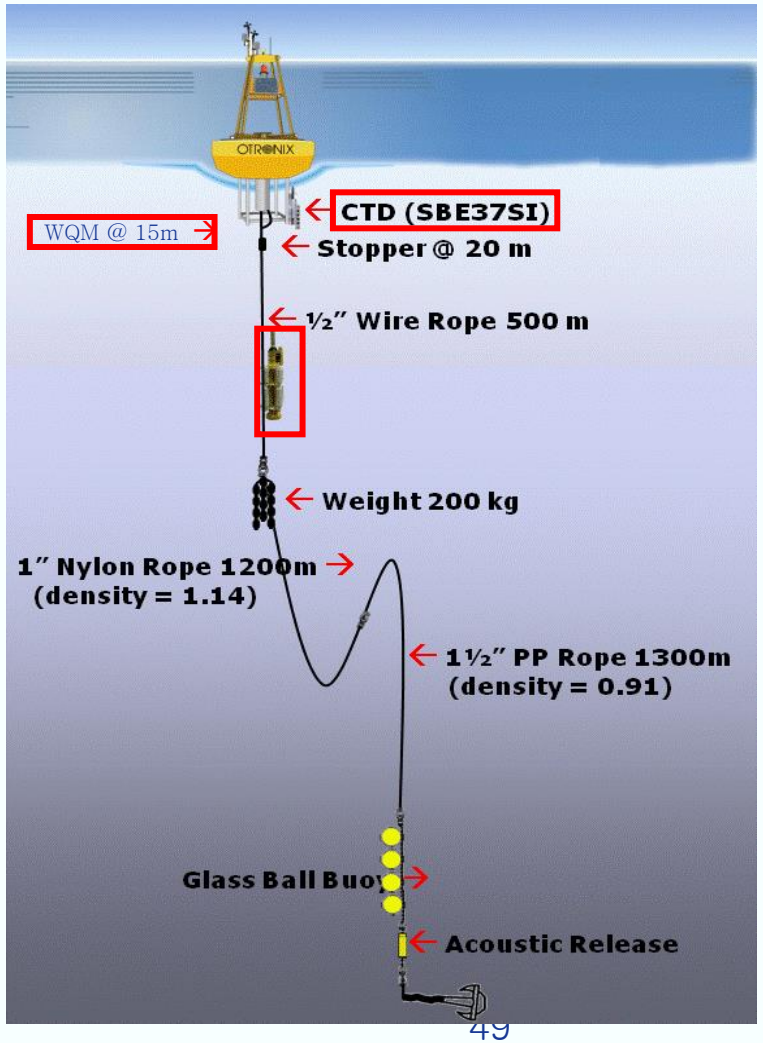
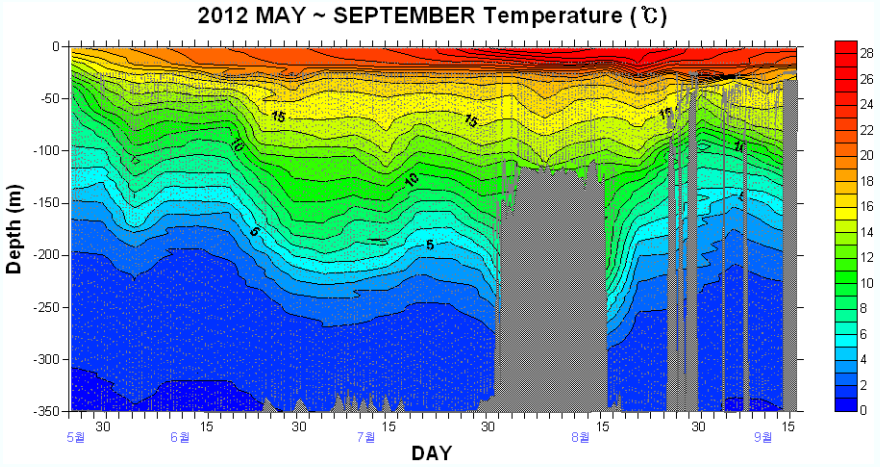
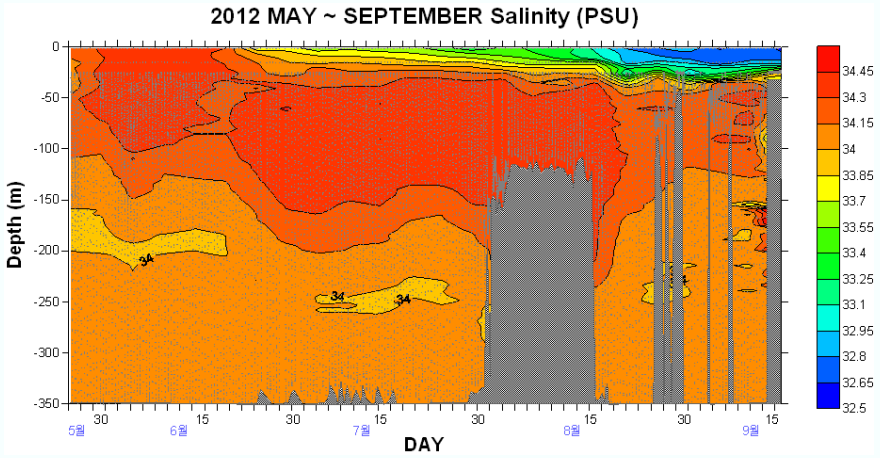


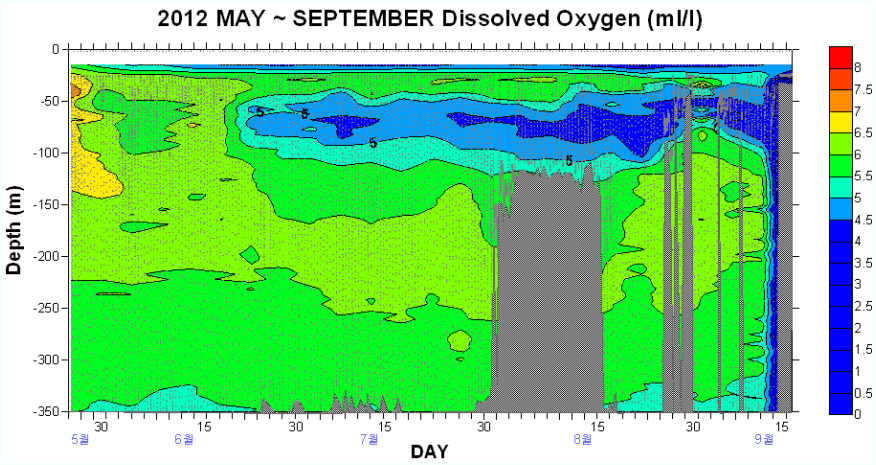


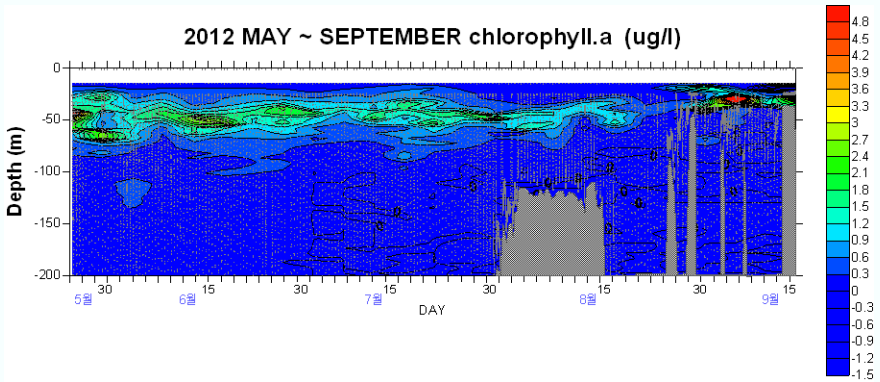


E-RAP data

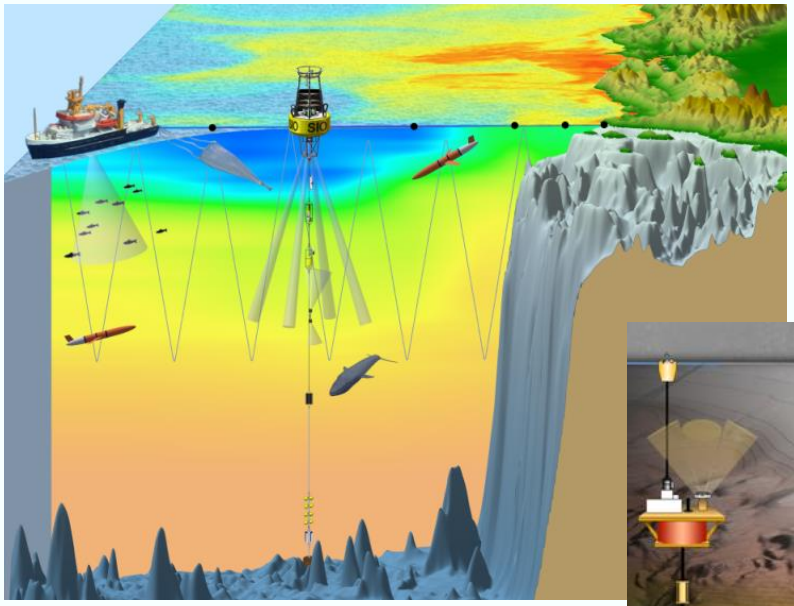

2012 MAY ~ SEPTEMBER Temperature (℃)
Depth (m)
DAY
5월
6월
7월
8월
9월

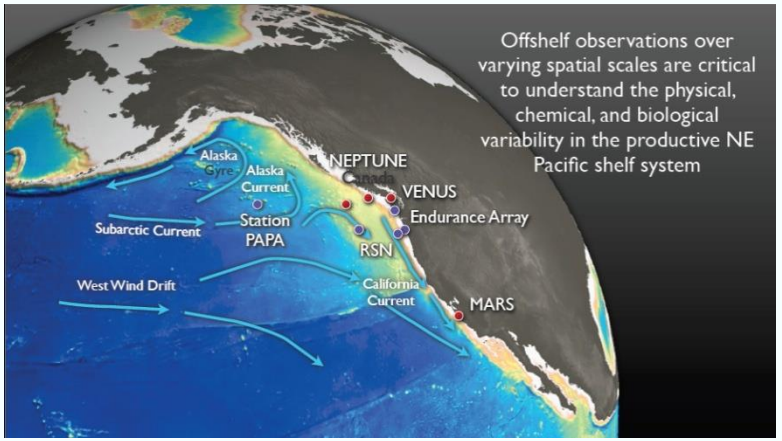

2012 MAY ~ SEPTEMBER Salinity (PSU)
Depth (m)
DAY
5월
6월
7월
8월
9월

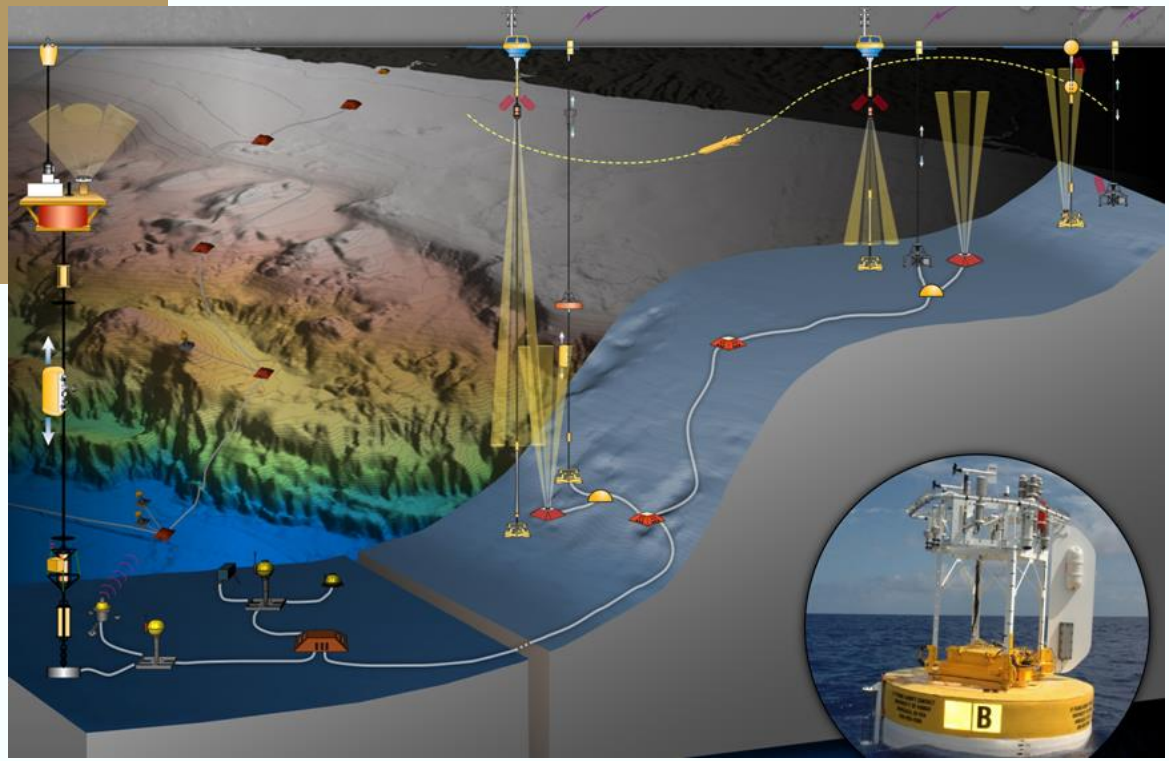

2012 MAY ~ SEPTEMBER Dissolved Oxygen (ml/l)
Depth (m)
DAY
5월
6월
7월
8월
9월


2012 MAY ~ SEPTEMBER chlorophyll.a (ug/l)
Depth (m)
DAY
5월
6월
7월
8월
9월

OceanSITE

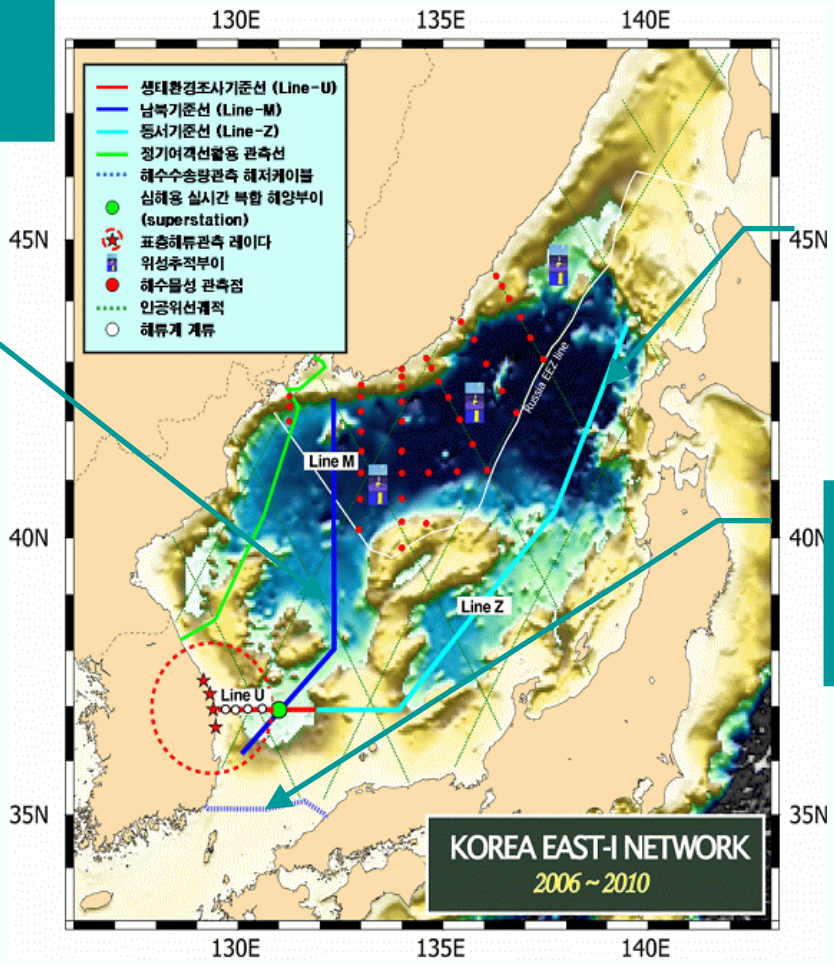



Offshelf observations over varying spatial scales are critical to understand the physical, chemical, and biological variability in the productive NE Pacific shelf system
Alaska Gyre
Alaska Current
NEPTUNE
VENUS
Endurance Array
Subarctic Current
Station PAPA
RSN
West Wind Drift
California Current
MARS


B

International Co-operations

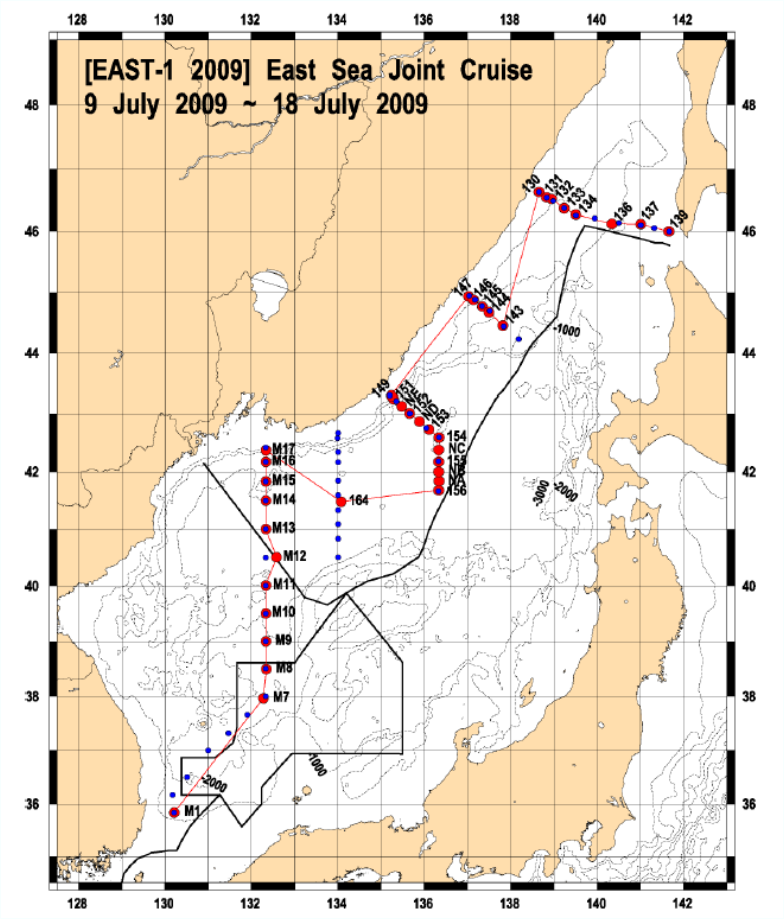
Korea-Russia
N-S Line
'07.5/' 09.7



Korea-Japan E-W Line
'07.9

Korea-Japan Korea Strait Studies
' 06. Oct. Nov. ' 07. May, Sep. Oct.

Korea-Russia Program



Jul. 9- 20 R/V Akademik M. A. Lavrentyev
Korean 15; Russian 18
37 stations 2270 L-km
CTD, chemistry, plankton study, continuous surface measurement

Hakuho Maru
International Researches, 2010

- R/V Hakuho-Maru
  - Length: 100m
  - G/T 3991 ton
  - 35 Berths for scientist
- 2010 Jun. 11 (Tokyo)
  → Jun. 29 (Busan) → Jul. 23 (Tokyo)
  Total 43 days
- Participants
  - Japan: 20
  - Korea: 5-8 (6)
  - Russia: 5-8 (6)
- Works
  - Hydrocast/CTD
    12 liter * 24 bottles
    S, T, D, Nuts, DO, TA, TCO_2
  - Ship Mounted ADCP
  - Large Volume Sample
  - Multiple Core
  - In-situ Filtration
  - Plankton Net Towing

Capacity Building Activities

EAST-II

over Yellow Sea and East China Sea is under discussion

Happy 40th Birthday
to
Prof. Fridtjov Nansen
Institute of Oceanology
BSA

Thank you very much

감사합니다