북극해의 장기관측 자료를 이용한 태평양기원 해수의 변동성 이해

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요약: *최근 북극 척치고원 해역에서 해빙의 급속한 후퇴가 관측되었고, 대기외력의 열역학적인 역할, 고위도 해역에서의 온난화로 인한 융빙, 해수 표층의 태양복사열 증대 및 태평양과 대서양으로부터 유입된 해양열에너지의 영향 등이 주된 원인으로 파악되고 있다 (Polyakov et al., 2012). 본 연구에서는 해빙면적 감소에 의한 북극 척치보더랜드 해역의 해수의 변동성을 파악하기 위하여 2010년부터 2015년까지 관측한 정점자료와 장기계류관측시스템에서 얻은 자료를 를 분석하였다. 해빙면적과 수온의 아노말리 분석에서 태평양기원 여름수의 수온 증대는 해빙면적 감소와 밀접한 상관관계를 가졌으며, 해빙면적과 염분의 아노말리 분석에서는 해빙면적 감소는 표층혼합층의 염분 감소와 밀접한 상관관계를 나타내었다. 척치고원 남쪽과 북쪽 해역에서 얻은 장기 수온 및 해류 자료를 분석해 본 결과, 수평적인 융빙해역 분포는 태평양기원 여름수의 경로 분포와 유사성을 가졌으며 기상외력과 지형적인 효과가 태평양기원 여름수 경로의 변동성에 영향을 미치고 있음을 파악하였다.*

1 INTRODUCTION

◆ Environmental Change in the Arctic Ocean
- Mean air temperature in recent 5 years warmer than that in 1981~2000
- Extension of warm Pacific Water to the Arctic Ocean
- Sea ice extent drastically diminished
- Increase of annual river discharge to the Arctic Ocean
- Consequent Arctic sea ice volume diminution
- Increase of net primary production corresponds to increase of open water area
  -> change ecosystem in the Arctic

◆ Research Objective

This study aims to investigate recent behaviors of the Pacific-origin waters around the Chukchi Plateau area using hydrographic and yearlong ocean mooring data obtained from 2010 to 2015.

2 Methods & Data

◆ Hydrographic Surveys from 2010 to 2015 (Fig.1)

1) Equipment used on the ice breaker R/V ARAON
- CTD, lowered ADCP, XCTD (Table 1)
- Bio/Geo/Chemical equipment

2) Items observed from the Araon
- Temperature, salinity, water velocity,
- DO, fluorescence, PAR, transmission, backscatter,
- Atmospheric components,
- Primary production and new production,
- Chlorophyll-a and HPLC,
- Phytoplankton, Zooplankton compositions,
- Nutrients, POC, PON, DOC, DON, DOP,
- N_2O gas, pCO_2, DIC, pH, SS, TA,
- etc.

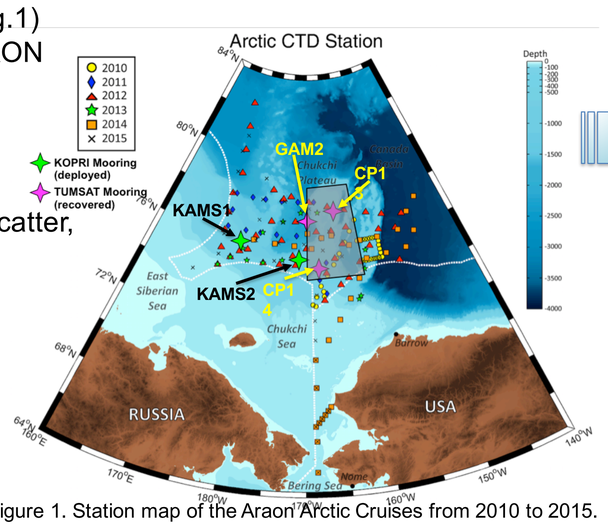

Figure 1. Station map of the Araon Arctic Cruises from 2010 to 2015.

	2010	2011	2012	2013	2014	2015
CTD	38	18	44	16	32	42
XCTD	*	33	48	36	51	61
Period	07/20~08/10	08/02~08/16	08/04~09/06	08/24~09/01	08/01~08/23	08/01~08/21

Table 1. Information on the Araon Arctic Cruises from 2010 to 2015.

◆ Ocean Mooring Systems

1) Three mooring systems were recovered from the ice breaker R/V ARAON (Figs. 1&2)
- ADCPs, microCATs, temperature loggers, etc.

2) Items measured from the mooring systems
- Temperature, salinity, water velocity, ice speed, pressure, etc.

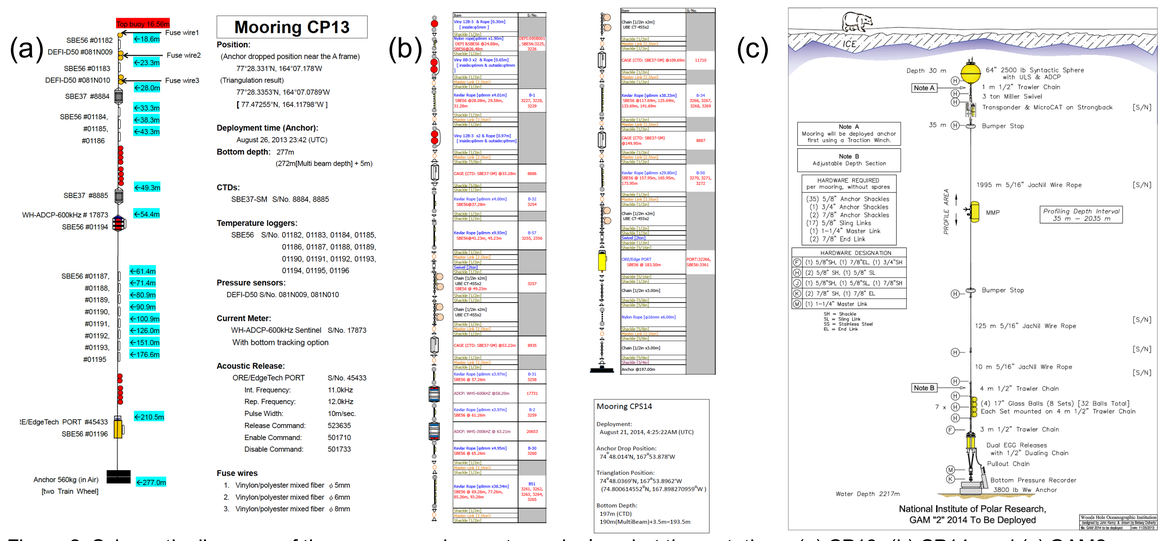

Figure 2. Schematic diagrams of the ocean mooring systems deployed at three stations, (a) CP13, (b) CP14, and (c) GAM2.

4 SUMMARY

◆ The 6-year hydrographic survey data and yearlong mooring data were collected and analyzed to investigate recent behaviors of the Pacific-origin waters around the Chukchi Plateau (CP). Ocean mooring data are available at three stations, CP13, CP14, and GAM2 where is southern, northern, and eastern parts of CP, respectively.

◆ In August, anomaly of PSW temperature has a negative correlation with that of sea ice extent (SIE) whereas anomaly of SML salinity has a positive correlation with that of sea ice extent. This implies that interannual variation of PSW temperature plays an important role on the trend of sea ice melting and consequent ice melting has an influence on salinity reduction in the surface mixed layer.

◆ The mooring data showed that the PSW layer at the northern CP remained over the 2013 winter but during 2014 winter some heat is possibly released to the southern CP or its pathway may change to the south. At GAM2, the PSW layer appeared distinctly from the mid of March 2015 and its depth gradually became shallower during spring/summer.

◆ Further analyses of sea ice concentration, NCEP wind, and other satellite data are ongoing to understand the their relations with the behavior of the Pacific–origin waters around the Chukchi Plateau.

Acknowledgement

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Data availability
- Satellite SST: http://oceandata.sci.gsfc.nasa.gov/MODIS-Aqua/Monthly/4km/sst/.
- Sea Ice Index: http://nsidc.org/data/seaice_index/archives.html.

3-1 RESULTS: Hydrographic

◆ Horizontal distributions of physical parameters (Fig. 3)
: PSW, PWW, heat content (HC), and freshwater content (FWC)
- PSW and HC patterns are similar to ice melt region

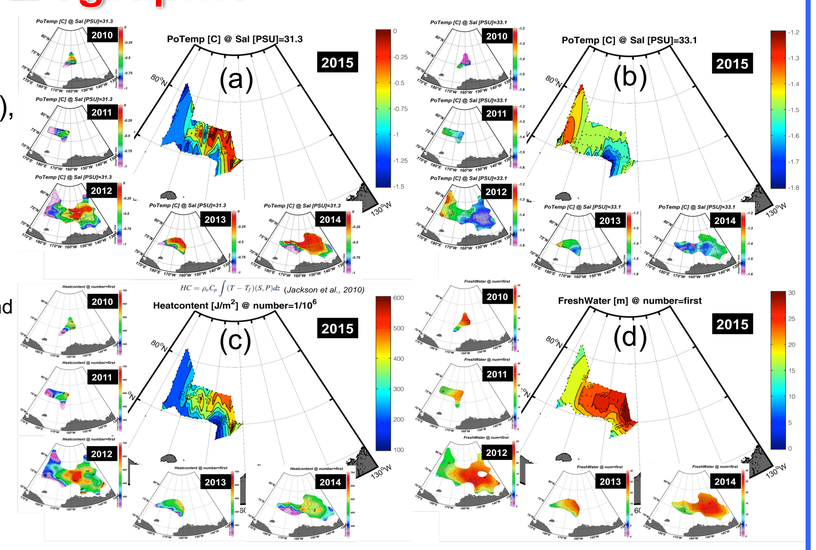

Figure 3. Horizontal distributions of (a) PSW, (b) PWW, (c) heat contents, and (d) freshwater contents over 6 years.

◆ Variability of the Pacific-origin waters
: Vertical structures of T, S averaged over the selected region in Fig.1 (Fig.3)
- Anomaly of T, S in the Pacific summer water (PSW) layer, Pacific winter water (PWW) layer, surface mixed layer (SML)
- T in PSW vs. sea ice extent: negative (Fig. 4d)
- S in SML vs. sea ice extent: positive (Fig. 4d)

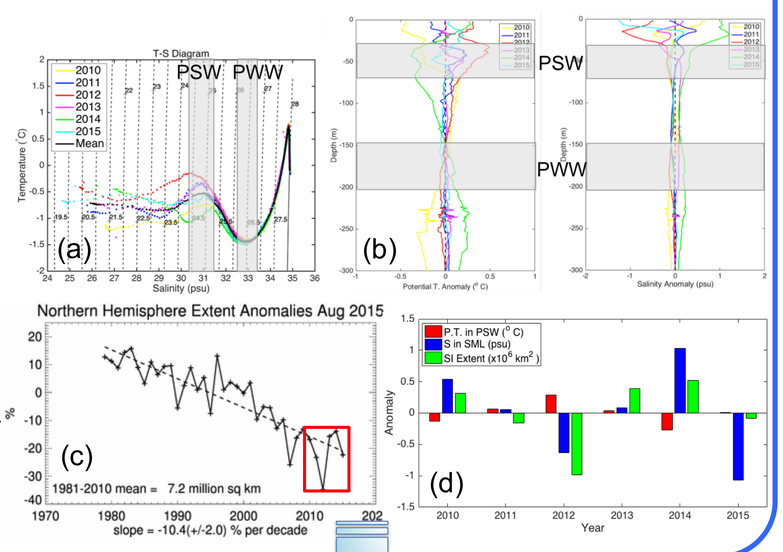

Figure 4. Variability of the physical parameters observed from 2010 to 2015: (a) domain-averaged T-S profiles, (b) vertical profiles of T and S anomalies, (c) anomaly of sea ice extent for August in the Arctic Ocean, and (d) comparison between sea ice extent anomaly, T anomaly in PSW and S anomaly in SML.

3-2 RESULTS: Yearlong ocean mooring

◆ Ocean mooring systems on the Chukchi Plateau (CP)
- CP13: deployed from Aug 2013 to Aug 2015 at northern CP
- CP14: deployed from Aug 2014 to Aug 2015 at southern CP
- GAM2: deployed from Oct 2014 to Aug 2015 at the western CP

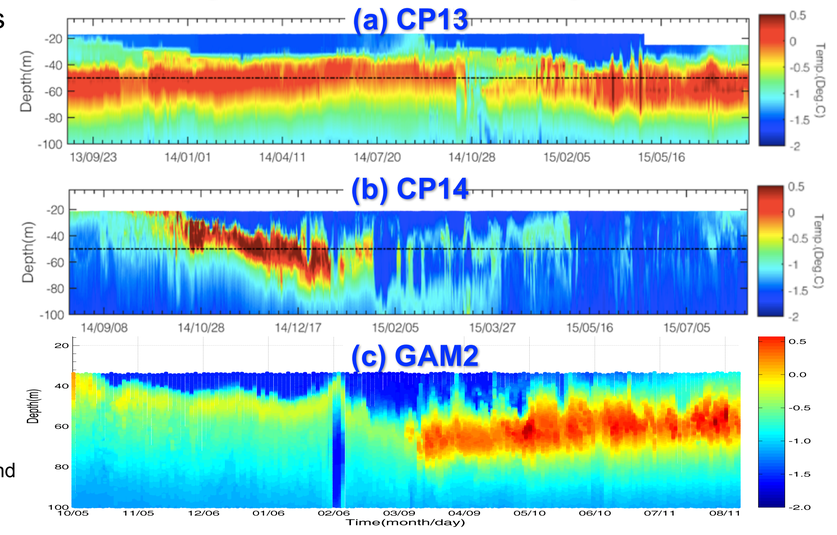

Figure 5. Time series of observed water temperature at (a) CP13 and (b) CP14, and (c) GAM2.

◆ Temporal variation of potential temperature (Fig. 5)
- PSW remains over the winter of 2013 at CP13 (northern CP).
- PSW heat was released to CP14 (southern CP) from Oct to mid-winter of 2014, implying that it may influence on ice formation/melting along the PSW pathways.
- From the mid-March of 2015, PSW at GAM2 appeared and became shallower over time.

3-3 RESULTS: Ongoing Work

◆ Further data analysis comparing to other parameters (wind, sea ice concentration)

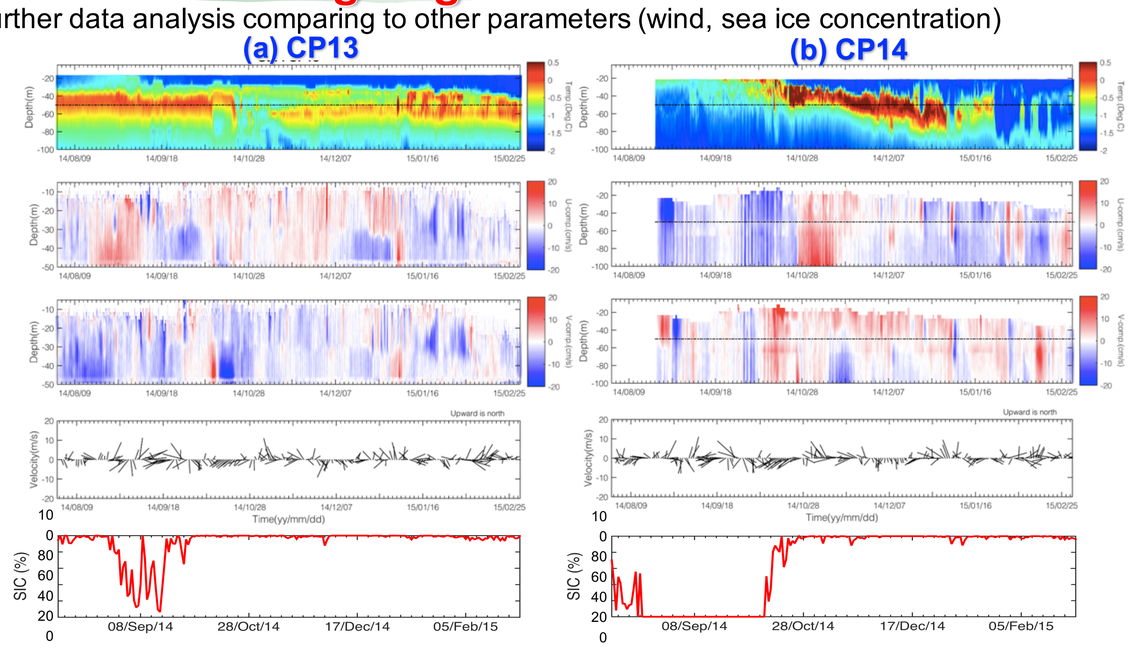

Figure 6. Time series of observed water temperature, u & v water velocities, reanalyzed NCEP wind vectors, and sea ice concentration at (a) CP13 and (b) CP14.