Understanding the Behavior of the Pacific-origin Waters from the Ocean Mooring Data observed on the Chukchi Plateau

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Abstract: In summer 2015, two ocean mooring systems were recovered in the Chukchi Plateau (CP), which had been deployed over the northern CP in 2013 (nCP13) and the southern CP in 2014 (sCP14), respectively. Yearlong temperature and water velocity data show spatial and temporal variations of the Pacific summer water (PSW) over the CP. During the autumn 2014, especially, the period that PSW was weakened in nCP13 coincides with the period that PSW appeared in sCP14. Northeasterly winds and sea ice covering appear to play an important role in initiating substantial heat release/storage within the PSW layer from October and mid-winter of 2014. This study will focus on understanding how the distribution of PSW over the CP is related with other parameters (winds, sea ice, SST, etc.) through the further analysis of the mooring data.

1 INTRODUCTION

◆ Environmental Change in the Arctic Ocean (Fig.1)
- 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

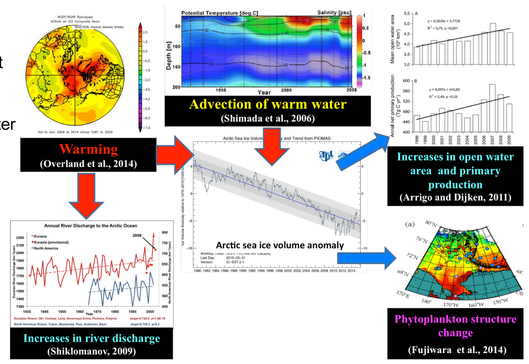

Figure 1. Recent decadal studies on the environmental changes in the Arctic Ocean.

◆ 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.2)

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.

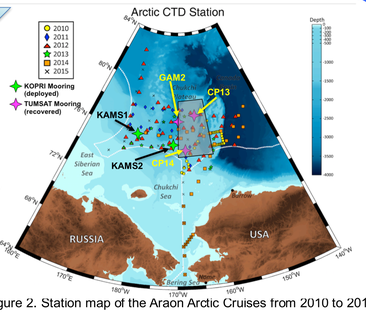

Figure 2. Station map of the Araon Arctic Cruises from 2010 to 2015.

Table 1. Information on 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

◆ Ocean Mooring Systems

1) Three mooring systems were recovered from the ice breaker R/V ARAON (Figs. 2&3)
- ADCPs, microCATs, temperature loggers, etc.

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

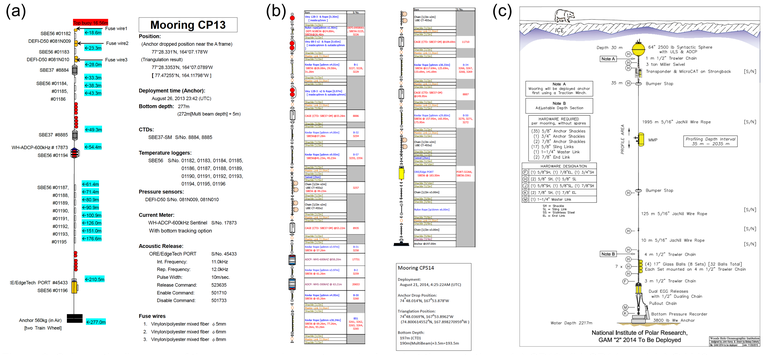

Figure 3. Schematic diagrams of the ocean mooring systems deployed at three stations, (a) CP13, (b) CP14, and (c) GAM2.

3-1 RESULTS: Hydrographic

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

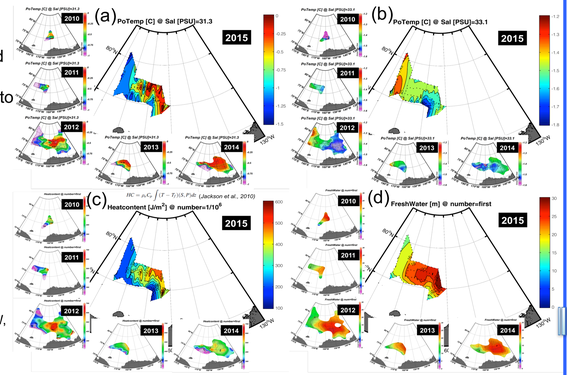

Figure 4. Horizontal distributions of (a) PSW, (b) PWW, (c) heat contents, and (d) freshwater contents over 6 years.

◆ Variability of the Pacific-origin waters
: Vertical structures of T, S averaged over the selected region in Fig.2 (Fig.4)
- 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
- S in SML vs. sea ice extent: positive

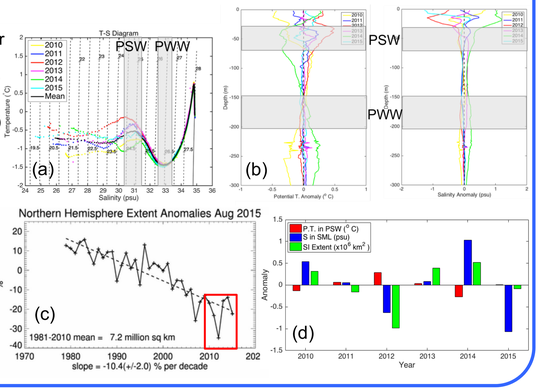

Figure 5. Variability of the physical parameters observed from 2010 to 2015: (a) domain-averaged T-S profiles, (b) vertical profiles of T and S anomalies, (c) anomaly of sea ice extent for August in the Arctic Ocean, and (d) comparison between sea ice extent anomaly, T anomaly in PSW and S anomaly in SML.

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.

3-2 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

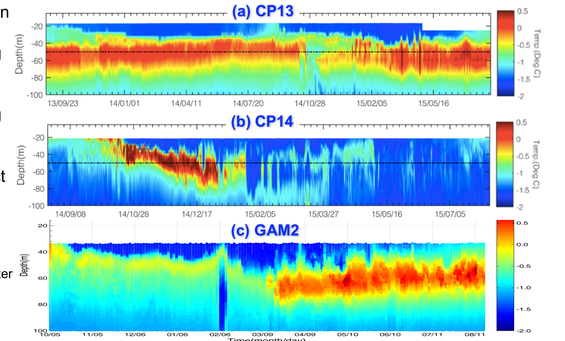

Figure 6. Time series of observed water temperature at (a) CP13 and (b) CP14, and (c) GAM2.

◆ Temporal variation of potential temperature
- 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)

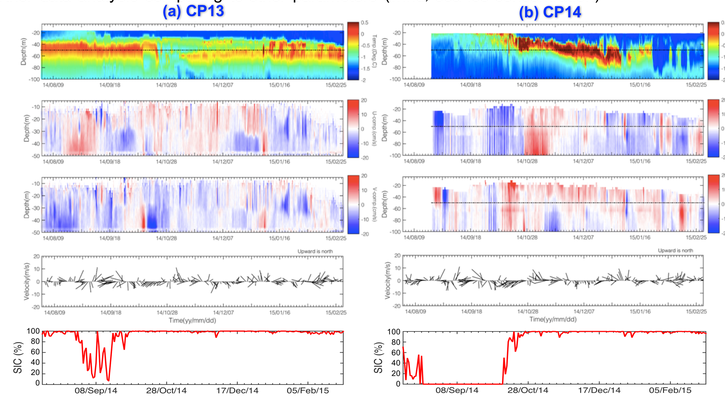

Figure 7. Time series of observed water temperature, u & v water velocities, reanalyzed NCEP wind vectors, and sea ice concentration at (a) CP13 and (b) CP14.

◆ Variability of spatial distribution of monthly parameters from satellite observation

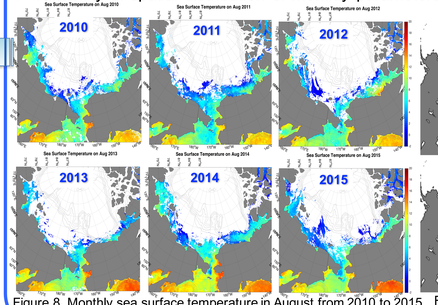

Figure 8. Monthly sea surface temperature in August from 2010 to 2015. Data are available at *http://oceandata.sci.gsfc.nasa.gov.*

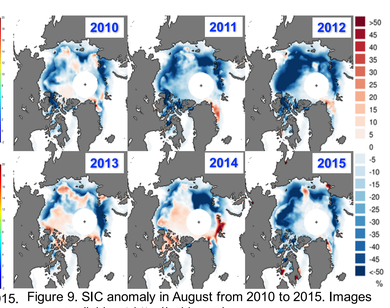

Figure 9. SIC anomaly in August from 2010 to 2015. Images are available at *http://nsidc.org/.*