

# Submersible Mooring Hydrographic Observation Data in the Chukchi Sea

He, Y.<sup>1</sup> Chen, H. X.<sup>1\*</sup> Zhang, J.<sup>2</sup> Lin, L. N.<sup>1</sup> Kong, B.<sup>3</sup> Wang, Y. J.<sup>1</sup>

1. The First Institute of Oceanography, State Oceanic Administration, P. R. China, Qingdao 266061, China;

2. Polar Research Institute of China, Shanghai 200129;

3. School of Ocean and Earth Science, Tongji University, Shanghai 200092

**Abstract:** The dataset of temperature, salinity and current in the central Chukchi Sea (2012) was collected by the 5th CHINARE Arctic Exploration from 21 July to 8 September 2012. The dataset is consisted of two types data, one is the geolocation GIS data where the data collected, and another one is the tables, they are: (1) Aquad\_14.mat data is the collected using the Nortek Aquad in the 14 m depth, 2431 rows and 17 columns in both u and v factors; (2) CT\_18.mat data is collected using RBR CT in 18 m depth, 69740 rows and 17 column, including time, temperature and salt data; (3) TD\_19.mat is collected by the ALEC TD in 19 m depth, 139000 rows on time and temperature; (4) CT\_25.mat is collected by the ALEC CT in 25 m depth, 139575 rows on time, temperature and salt; (5) CT\_35.mat is collected by the ALEC CT in 35 m, 139575 rows on temperature and salt; (6) CTD\_40.mat is collected by the RBR CTD in 40 m depth, 279140 rows on temperature and salt; and (7) ADCP\_41.mat is collected by the TRDI ADCP from 17 levels, 3499 rows for each levels, and 59483 rows total. The dataset is archived in .kmz, .shp and .xlsx data formats with the data size of 28.6MB.

**Keywords:** Submersible mooring; the Chukchi Sea; the fifth Chinese Arctic Research Expedition; ocean current; temperature and salinity

## 1 Introduction

The Chukchi Sea is an important marginal sea of the Arctic Ocean. It is adjacent to Chukchi Plateau to the north and joins the Pacific via the Bering Strait to the south, a significant passageway for the Arctic Ocean-Pacific hydrothermal exchange and a main source of heat and fresh water of the Arctic Ocean<sup>[1,2]</sup>, as well as an important source of nutrient substance for Arctic ecosystem<sup>[3]</sup>. With global warming, water temperature of the Chukchi Sea also raises<sup>[4]</sup> and the exchange of water and heat with the Pacific changes accordingly<sup>[5]</sup>, thus influencing the production and melting process of Arctic ice and interaction between atmosphere, ocean and ocean ice, resulting in changes in ecosystem and environment of the Arctic Ocean.

Submersible mooring hydrographic observation data in the Chukchi Sea (SMHOD\_ChukchiSea\_2012)<sup>[6]</sup> obtained during the fifth Arctic research expedition with the support of special topic one named “Arctic Ocean Physical Oceanography and Marine Meteorology Investigation” of the special program three “comprehensive survey and assessment of the

**Received:** 16-07-2016; **Accepted:** 16-08-2016; **Published:** 25-06-2017

**Corresponding author:** Chen H. X. A-4871-2017, the First Institute of Oceanography, SOA, chenhx@fio.org.cn

**Article Citation:** He Y., Chen H. X., Zhang J., et al. Submersible mooring hydrographic observation data in the Chukchi Sea [J]. *Journal of Global Change Data & Discovery*, 2017, 1(2): 177-182. DOI:10.3974/geodp.2017.02.07.

**Dataset Citation:** He Y., Chen H. X., Zhang J., et al. In Situ Dataset of Temperature, Salinity and Current in the Central Chukchi Sea (2012) [DB]. *Global Change Research Data Publishing & Repository*, DOI:10.3974/geodb.2016.05.09.V1.

environment of the south and north poles” of State Oceanic Administration. This dataset provides a significant research basis for strengthening the knowledge of long-term change features of water mass and currents of the Chukchi Sea and deepening the understanding of the exchange of matter and energy between the Arctic Ocean and the Pacific and arctic climate change. Based on this dataset, the authors published a paper titled *Observed features of temperature, salinity and current in central Chukchi Sea during the summer of 2012* [7]. To enable the sharing of scientific data, this dataset now is published. This dataset contains data on seawater temperature, salinity, current velocity, and flow direction.

2 Metadata

The metadata of submersible mooring hydrographic observation data in the Chukchi Sea (SMHOD\_ChukchiSea\_2012) is summarized in Table 1. It includes the dataset full name, short name, authors, year of the dataset, temporal resolution, spatial resolution, data format, data size, data files, data publisher, and data sharing policy, et al.

Table 1 Metadata of submersible mooring hydrographic observation data in the Chukchi Sea

Items	Description
Dataset full name	In Situ Dataset of Temperature, Salinity and Current in the Central Chukchi Sea (2012)
Dataset short name	ChukchiSea2012
Authors	He, Y. A-3216-2017, The First Institute of Oceanography, SOA, <a href="mailto:heyang@fio.org.cn">heyang@fio.org.cn</a> Chen, H. X. A-4871-2017, The First Institute of Oceanography, SOA, <a href="mailto:chenhx@fio.org.cn">chenhx@fio.org.cn</a> Zhang, J. L-4784-2016, Polar Research Institute of China, <a href="mailto:zhangjie@pric.org.cn">zhangjie@pric.org.cn</a> Lin, L. N. L-6637-2016, The First Institute of Oceanography, SOA, <a href="mailto:linln@fio.org.cn">linln@fio.org.cn</a> Kong, B. A-3202-2017, Tongji University, <a href="mailto:kongbin@fio.org.cn">kongbin@fio.org.cn</a> Wang, Y. J. A-3180-2017, The First Institute of Oceanography, SOA, <a href="mailto:wangyj@fio.org.cn">wangyj@fio.org.cn</a>
Geographic region	69°30.9'N, 169°00.39'W. Chukchi Sea, Arctic Ocean
Year	2012
Temporal resolution	15s, 30s, 10mins, 20mins and 30mins(See Table 2 for details)
Spatial resolution	Fixed-point anchorage data
Data format	.xls and .xlsx
Data size	36.0MB
Data files	Temperature data, salinity data and ocean current data(see 3.2 data collection for details)
Foundation(s)	National Natural Science Foundation of China(41606221), Ministry of Science and Technology of P. R. China (2016YFC1402702, 2016YFC1400303); State Oceanic Administration of P.R. China (CHINARE2016-03-01, CHINARE2016-04-03, 201405031, 2014G02, 2014T02)
Data publisher	Global Change Research Data Publishing & Repository, <a href="http://www.geodoi.ac.cn">http://www.geodoi.ac.cn</a> .
Address	No. 11A, Datun Road, Chaoyang District, Beijing, 100101, China.
Data sharing policy	<b>Data</b> from the Global Change Research Data Publishing & Repository includes metadata, datasets (data products), and publications (in this case, in the <i>Journal of Global Change Data &amp; Discovery</i> ). <b>Data</b> sharing policy includes: (1) <b>Data</b> are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use <b>Data</b> subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute <b>Data</b> subject to written permission from the GCdataPR Editorial Office and the issuance of a <b>Data</b> redistribution license, and; (4) If <b>Data</b> are used to compile new datasets, the ‘ten per cent principal’ should be followed such that <b>Data</b> records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset [8].

3 Methods

3.1 Study area

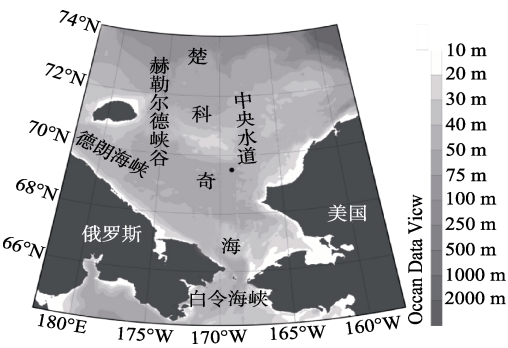
The Chukchi Sea has been a key investigated area in Chinese Arctic Research Expedition.

Pacific water flows into the Chukchi Sea via Bering Strait and flows into the Arctic Ocean along four main thoroughfares: the Barrow Canyon, the Central Channel, the Herald Valley, and the De Long Strait from east to west. The investigated area is located in the central Chukchi Sea, coordinates is 69°30.155'N, 169°00.654'W, two east tributaries and ring currents near Herald shoal can influence environmental changes in that area (Figure 1).

3.2 Data collection

The instruments carried by the submersible mooring observing system mainly include one TRDI 300 KHz ADCP, two ALEC CTs, one ALEC TD, one RBR CT, one RBR CTD and one Nortek “Aquadopp” current meter, which obtained long-term in-depth profile data about hydrologic features such as temperature, salinity, and ocean current, of this station

This set of mooring entered the water at 3:00 pm on July 21, 2012 and were collected at 6:00 am in September 8, obtaining data of about 50 days (Table 2).



**Figure 1** Topographic map of the Chukchi Sea (Black spot is the station where the fifth Chinese Arctic Research Expedition anchorage observing system was placed)

**Table 2** Synopsis of data acquired by moorings

Instrument	Depth(M)	Start time	End time	Observing elements	Sampling period
Aquad	14	2012-07-21 12:31:00	2012-09-08 06:31:00	Ocean current	30mins
RBR CT	18	2012-07-21 05:00:00	2012-09-07 15:19:00	Temperature & salinity	1mins
ALEC TD	19	2012-07-21 17:00	2012-09-08 06:06	Temperature & depth	30s
ALEC CT	25	2012-07-21 16:54:30	2012-09-08 04:01:30	Temperature & salinity	30s
ALEC CT	35	2012-07-21 16:49:30	2012-09-08 03:56:30	Temperature & salinity	30s
RBR CTD	40	2012-07-21 17:00:00	2012-09-08 04:01:30	Temperature, salinity & depth	15s
TRDI ADCP	41	2012-07-21 13:40:00	2012-09-08 03:40:00	Currents	20mins

A total of nearly 830,000 sets of data on temperature and salinity were obtained: temperature data recorded temperature changes at 18, 19, 25, 35, 40 meters (unit: °C); Salinity data were collected at 18, 25, 35, and 40 meters (unit: PSU). There are over 60,000 current datasets: “Aquadopp” observed current at the 14m layer, the unit is mm/s; ADCP was at the depth of 41 meters, and current data (unit: mm/s) of 17 layers were acquired. It is worth mentioning that ADCP was at the depth of 41 meters, data interval is 2m, except blind zone (about 4m), current data over 37 meters can be obtained. Since the observation of surface velocity was affected by bubbles in the seawater, observation data on current more than 5m deep can be used for scientific research. Hence, ADCP data are for 17 layers.

3.3 Data processing

3.3.1 Data on temperature and salinity

CTD is an abbreviation of a depth profile instrument used to measure conductivity (salinity), temperature and depth, and is one of the most common instruments in physical oceanographical observation. Mooring system has two instruments produced by a Canadian company named RBR, and they are CTD and CT respectively. Data processing software is Ruskin built in the instruments. Importing original data into processing software can directly display temperature, conductivity, depth, salinity, density anomaly, sound velocity and other time series curves (Fig-

ure 2). Abnormal data caused by entering in and out of the water at start time and end time were removed. These curves contain a lot of noises, but unnecessary information like burrs and singular value can be removed through low-pass filtering, moving average and other methods. The corrections of temperature and salinity need to calibrate files. The rest of CT and TD are products of a Japanese company named AL-EC, and original data can be translated into readable ASCII-format data for follow-up research through Compact-CT software.

3.3.2 Ocean current data

(1) Explanation on “Aquadopp” single-point current meter data

“Aquadopp” single-point current meter’s sensors mainly are three acoustic transducers, gradient sensor, temperature sensor and pressure sensor, which can obtain data on temperature, pressure and current. Original data were read and processed through Strom software produced by Nortek. The interface after data were imported into Strom software is as shown in Figure 3.

Strom software can exercise quality control over data and output velocity component or speed mode and direction and other current parameters of different directions as

needed. The quality control over ocean current data mainly includes number of beams selected by data, SNR threshold setting, and posture calibration (Figure 4).

(2) Explanation on data from Acoustic Doppler current profiler (ADCP)

ADCP uses the Doppler effect to send sonic wave at a fixed frequency in the water, and determine the velocity and direction of ocean current of different layers according to echo returned by scatterer. In the mooring system, ADCP was placed at 41 meters (bottom) and sent sonic wave to sea surface, acquiring current information between sea surface to where the instrument is. Original data was imported into WinADCP produced by TRDI, data’s header file was displayed at the window on top left corner (Figure 5).

Blind zone for the observation is 4.19 meters. As surface velocity observation was affected by bubbles in the seawater, data of less than 5 meters are mostly blank and ocean current data only between 5m-37m can be obtained eventually. To acquire information about actual current (residual current), the influences of tide and high-frequency noise need to be removed.

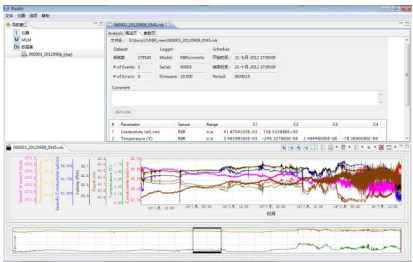


Figure 2 Ruskin software interface

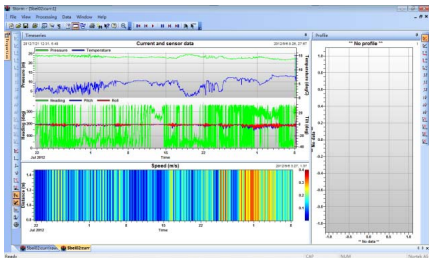


Figure 3 Strom software interface

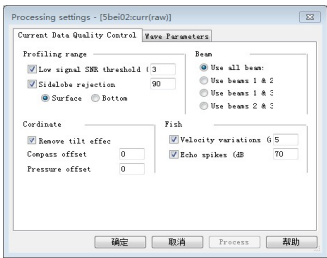


Figure 4 Quality control interface of Storm

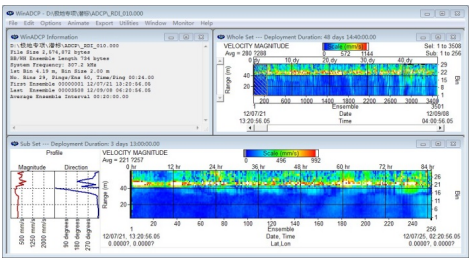


Figure 5 Interface of WinADCP

4 Results and validation

4.1 Comparison of data on temperature and salinity

SR07 station (Observation time is 18:23:00 on September 7, 2012) which is the nearest to the place where moorings were placed was selected to conduct a comparison between moorings and Sea Bird 911 CTD in the results of the observation of temperature, salinity at the same time and at the same layer. The distance between the two points is about 15km. The comparison of observation results is shown in Table 3. Preliminary analysis of the comparison shows that temperature measured by SR07 station is higher than that measured by submersible mooring observation station at different depths and the salinity it measured is lower. According to previous sectional temperature and salinity profile, the trends of changes in sectional temperature and salinity are consistent with the above-mentioned comparative results. Therefore, we believe that the data from CTD and CT are reliable.

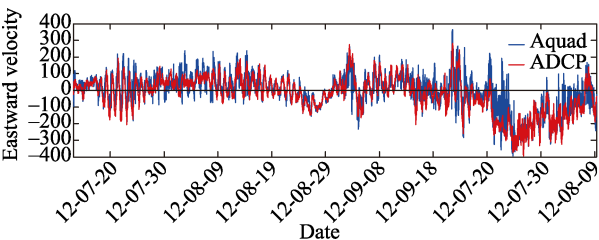
**Table 3** Comparison between moorings and Sea Bird 911 CTD in the observed temperature and salinity

	Mooring (18m)	911 SBE (18m)	Mooring (25m)	911 SBE (25m)	Mooring (35m)	911 SBE (35m)	Mooring (40m)	911SBE (40m)
Salinity,PSU	29.8380	28.5964	31.2710	31.0307	32.1630	31.5033	32.4520	31.9269
Temp., °C	7.2189	7.5938	5.4030	6.3888	3.0690	5.6657	1.6375	4.1654

In addition, the synchronic comparison between temperature, salinity sensor of moorings (Fig. 2 and Fig. 3 in [7]) also indicate that temperature and salinity data have good quality.

4.2 Comparison of data from “Aquadopp” and ADCP

Data on velocity at depth of water of 14m obtained from ADCP were extracted to compare with velocity time series at the same depth observed by current meter “Aquadopp”. As shown in Figure 6 and Figure 7, both the observation and ADCP are fairly consistent at most of times. Thus, we think these Aquadopp and ADCP observation data have good quality.

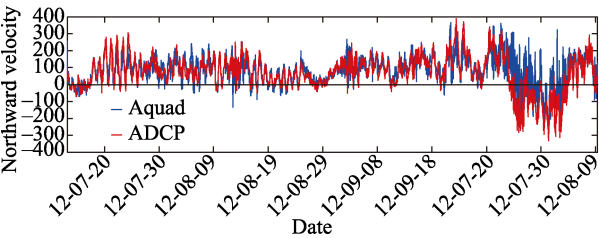


**Figure 6** Comparison of Aquadopp and ADCP in data on east component

5 Discussion and summary

Submersible mooring hydrographic observation data in the Chukchi Sea consist of seven Excel files. Since the depth of each sensor carried by moorings remains basically unchanged, dataset does not contain depth variable. This dataset contains the following data:

1. Tab1.xls is ocean current data obtained by Nortek “Aquadopp” current meter at 14m. There are a total of 2,431 datasets, and each set of data contain two variables-u and v, which denote data on east and north components respectively.
2. Tab2.xlsx is data on temperature and salinity acquired by RBR CT at 18m. There are a total of 69740 data, each dataset contains three variables-data\_time, temp and salt.



**Figure 7** Comparison of Aquadopp and ADCP in data on north component

Date\_time's first to sixth columns are year, month, day, hour, minute and second; temp is temperature data; salt is salinity data.

3. Tab3.xlsx is temperature and depth data acquired by ALEC TD at 19m. There are 139,000 datasets in total and each dataset contains two variables-xtime and temp, which stand for observation time and temperature data. Xtime's first to sixth columns are year, month, day, hour, minute and second, respectively.

4. Tab4.xlsx is temperature and salinity data acquired by ALEC CT at 25m. There are a total of 139,575 datasets and each dataset includes four variables-CT\_date, CT\_time, temp and salt, which are date, time, temperature and salinity data through data collection, respectively.

5. Tab5.xlsx is temperature and salinity data obtained by ALEC CT at 35m. Data size and variable name are the same with Tab4. xlsx.

6. Tab6.xlsx is temperature and salinity data obtained by RBR CTD at 40m. There are a total of 279,140 datasets, whose variable names are the same as Tab2. xlsx.

7. Tab7.xls is current profile data obtained by TRDI ADCP at 41st layer upward. It was divided into 17 layers, each layer has 3,499 sets, so there are a total of 59,483 sets of data. Each dataset contains two variables- u (Tab7\_1.xls) and v (Tab7\_2.xls), which denote data on east and north current components, respectively.

### Author contributions

Chen Hongxia designed the algorithms of dataset. Chen Hongxia and Lin Lina contributed to collect mooring data. He Yan contributed to the data processing and analysis. Kong Bin and Wang Yingjie conducted data validation. He Yan wrote the data paper.

### Acknowledgements

Thank all co-workers who have engaged in organizing and coordination, assembling, deploying and recovering for mooring observation system and other tasks in the fifth Chinese Arctic Research Expedition team. Thank Liu, N., Research Associate in laboratory of marine environment and numerical simulation of the First Institute of Oceanography, SOA, for offering guidance for the data processing.

### References

- [1] Serreze, M., Barrett, A., Slater, A., *et al.* The large-scale freshwater cycle of the Arctic [J]. *Journal of Geophysical Research: Oceans* (1978-2012), 2006, 111(C11): 63-79
- [2] Woodgate, R., Aagaard, K., Weingartner, T. A year in the physical oceanography of the Chukchi Sea: Moored measurements from autumn1990-1991 [J]. *Deep Sea Research Part II: Topical Studies in Oceanography*, 2005, 52(24): 3116-3149
- [3] Walsh, J., Mcroy, C., Coachman, L., *et al.* Carbon and nitrogen cycling within the Bering/Chukchi Seas: Source regions for organic matter effecting AOU demands of the Arctic Ocean [J]. *Progress in Oceanography*, 1989, 22(4): 277-359.
- [4] Zhao, J. P., Gao, G. P., Jiao, Y. T. Warming in Arctic intermediate and deep waters around Chukchi Plateau and its adjacent regions in 1999 [J]. *Science in China*, 2004, 34(2), 188-194. (In Chinese)
- [5] Luchin, V., Panteleev, G. Thermal regimes in the Chukchi Sea from 1941 to 2008 [J]. *Deep-Sea Res. II*, 2014, 109: 14-26.
- [6] He Y., Chen H. X., Zhang J., *et al.* Submersible mooring hydrographic observation data in the Chukchi Sea [DB], *Global Change Research Data Publishing & Repository*, DOI: 10.3974/ geodb.2015.01.17.V1.
- [7] He, Y., Liu, N., Chen, H. X., *et al.* Observed features of temperature, salinity and current in central Chukchi Sea during the summer of 2012 [J], *Acta Oceanologica Sinica*. 2015, 34(5): 51-59.
- [8] GCdataPR Editorial Office. GCdataPR Data Sharing Policy. DOI: 10.3974/dp.policy.2014.05.