2016 PACIFIC ARCTIC GROUP (PAG) FALL MEETING MINUTES

Ocean University of China,
Qingdao, China

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Welcome and Introduction

1. Welcoming Remarks

Huajun Li, the Vice President of Ocean University of China (OUC), expressed his congratulations and warm welcome to all meeting participants. Noting the significance of Arctic research, he encouraged more synergic cooperation in Arctic research to effectively address challenges of global environmental change.

2. Introduction by the Chair

[PPT 1] Sung-Ho Kang, PAG Chair, welcomed participants to the meeting, giving an introduction of PAG and an overview of the meeting agenda. Outlining PAG's history, mission, on-going research programs and activities, Sung-Ho highlighted the group's growth and development from its beginnings as an informal forum under IASC to an autonomous global network facilitating scientific cooperation for large-scale, multidisciplinary research and synthesis.

I. Country Reports for 2016 Field Season & Updates for 2017 Preliminary Plans

1.1 Canada

[PPT 2] Jackie Grebmeier, on behalf of **Bill Williams**, presented Canadian activities in the Pacific Arctic region in 2016, as well as plans for 2017. From July 10 to 22, 2016, aboard CCGS *Sir Wilfred Laurier*, Canada's Three Oceans (C3O) and the Distributed Biological Observatory (DBO) carried out sampling along latitudinal transect lines, specifically, DBO lines 1-4 for long-term monitoring of biophysical responses to changing environmental conditions. This year, sampling along DBO-lines 1 to 4 included the adding of 7 new stations along DBO line 2. From September 22 to October 18^{th,} 2016, Joint Ocean Ice Study (JOIS) was carried out aboard the CCGS *Louis S. St. Laurent*. Through this cruise, a new maximum of 23, 600 km^3 for Beaufort Gyre freshwater content was found. The center of the Beaufort Gyre was also found to have shifted towards the east. From August 7 to September 18, 2016, the UNCLOS cruise was carried out from Tromsø, Norway to Kugluktuk, Nunavut, Canada. This DFO cruise took place in collaboration with Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Trent University, Vancouver Aquarium and University of Laval.

1.2 China

[PPT 3] Jin Bo, on behalf of **Jianfeng He**, presented on the 2016 Chinese Arctic research expedition. From July 11 to September 26, 2016, the 7th Chinese National Arctic Research Expedition (CHINARE) took place on Chinese R/V *Xuelong*. Investigation regions included the Bering Sea, Chukchi Sea, Chukchi Plateau, Mendeleev Ridge, Canadian Basin, and Alfa Ridge. The research survey was multidisciplinary, encompassing physical oceanography, meteorology, sea ice, marine chemistry, marine biology, geology, geophysics alongside many other fields of study. During the cruise, 83 oceanographic stations were carried out and 4 anchor mooring buoys were deployed in the Bering Sea, Chukchi Sea and Canadian Basin. In addition, 6 short-term ice station and one long-term (8 days) ice camp were set-up to conduct snow, ice, and water sampling for physical,

biological and chemical studies. 40 ice-tethered buoys were also deployed: namely, 1 for the weather station, 1 for oceanography profiling, 20 ice mass balance buoys, and 18 GPS buoys. International cooperation involved the joining of 3 foreign scientists from the U.S and France, focusing on ocean acidification studies in the Arctic Ocean. In the same summer of 2016, the first Sino-Russian Artic research voyage took place in the Pacific sector of the Arctic Ocean from Chukchi Sea to Laptev Sea from August 19 to September 18, covering 43 oceanographic stations for sampling including marine geology, physical oceanography, marine chemistry, and marine biology. The cruise was carried out on a Russian vessel, *Akademik M.A. Lavrentyev*, involving 11 Chinese scientists.

1.3 Japan

[PPT4] Shigeto Nishino presented highlights from the 2016 Japanese field activities as well as preliminary 2017 plans. The Japanese R/V *Mirai* 2016 Arctic Ocean cruise was carried out from August 22 to October 5 to visit the North Pacific Ocean, Bering Sea, and Arctic Ocean. Activities included the recovery and re-deployment of JAMSTEC moorings off Pt. Barrow and Pt. Hope, CTD/XCTD, plankton nets, S& M grabs, bio-optics observations, and sediment traps in the Bering Strait and Canada Bain. Based on mooring observations from July 2012 to July 2014 off of Pt. Hope, turbid and low DO (high nutrient) water in September and October was shown to give rise to fall blooms each year, while spring blooms could be found around May each year. Sediment trap moorings were deployed to study the difference of particles between upstream and downstream eddy passage. The 2017 Arctic Cruises are planned to be carried out from 6th July to 2nd August on T/S *Oshoro-maru* and from 23rd August to 6th October on R/V *Mirai*.

1.4 Korea

[PPT 5] Eun Jin Yang presented an update of 2016 Korean Arctic research activities, as well as preliminary plans for 2017 field season. The 2016 Arctic cruise aboard ice breaker R/V *Araon* took place from August 5th to September 10th, consisting of 2 legs. Typically, *Araon's* annual visit to the Pacific Arctic Ocean conducts sampling in the Bering Strait, Chukchi Sea, East Siberian Sea (ESS) and Beaufort Sea. However, this year, it covered only the Chukchi Sea and ESS due to sea ice conditions. The first leg aimed to identify key environmental parameters (physical and biogeochemical) in rapid transition due to the sea-ice decrease in the western Arctic Ocean, to predict environmental change patterns, and to understand sea ice dynamics and sea ice ecosystem. It was an international collaboration involving scientists from 18 different research organizations and universities from a total of 8 different countries, including China, Japan, France, Spain, UK, and the U.S.

The second leg aimed to map geological features/structures in the Arctic continental margin, to understand geological processes related to melting subsea permafrost and gas hydrate in the Arctic, and to evaluate the interactions and linkages in terms of methane cycle. A research highlight is that extremely high dissolved methane concentration and gas hydrate and manganese nodules were found in the ESS shelf.

1.5 United States

[PPT 6] Jackie Grebmeier presented an outline of 2016 US research activities in the Arctic Ocean. This year in 2016, the joint cruise between Canada's Three Oceans (C30) and the Distributed Biological Observatory (DBO) aboard CCGS *Sir Wilfrid Laurier* conducted sampling across DBO lines 1-4; unfortunately, DBO line 5 could not be reached due to heavy sea ice conditions. DBO data collections include seawater temperature and salinity, velocity measurements, nutrients, chlorophyll, carbon products, CDOM, phytoplankton, zooplankton and macrobenthic abundance, biomass, community structure, as well as marine mammal and seabird surveys. From September 19th to October 15th, a joint cruise between Canada, US and Japan, the Joint Ocean-Ice Study (JOIS)/Arctic Observing Network (AON)/Beaufort Gyre Observing System (BGOS) took place.

As part of the new Arctic program under the North Pacific Research Board (NPRB), the Arctic Shelf Growth, Advection, Respiration and Deposition Rate Experiment (ASGARD) will have a cruise on the RV *Sikuliaq* in June 2017 and 2018. The Arctic Marine Bioodiversity Observing Network (AMBON) will have a cruise in August 2017 on either *Sikuliaq* or *Norseman II* and will occupy DBO-3 and 4. Another program funded by the NPRB is the Arctic Ecosystem Integrated Survey (Artic EIS2) which will have a cruise in August to September in 2017 and 2019, occupying DBO lines 3, 4 and 5.

Jackie showed the preliminary 2017 PAG and DBO cruise map, which will be uploaded on the PAG and DBO websites with updated finalized cruise dates. Jackie also reminded all PAG members that as April-May and September-October are seasons coastal communities carry out subsistence whaling activities, early communication of cruise plans with the Alaska Eskimo Whaling Commission (AEWC) is necessary. Jackie noted that just as it was done last year, one page reports outlining period and basic activities of the cruise will be put together and presented at the AEWC meeting in December 2016.

II. Updates and Planning of Joint Field and Modelling Activities

2.1 Update on RUSALCA & Plans for NOAA DBO Cruise

[PPT 7] Jackie noted that the Russian-American Long-term Census of the Arctic (RUSALCA) program has been suspended. A shorter cruise is planned to take place in September 2017 on the *Healy*, carrying out standard DBO measurements and process studies. Takashi noted that as the R/V *Mirai* cruise will take place around a similar time, collaboration can be a possibility to consider. Jackie responded that a collaboration can certainly be discussed once plans become more concrete in the coming weeks.

[PPT 7] Bob Pickart presented on the Marine Arctic Ecosystem Study (MARES) program. The overall goal of the MARES program aims to better understand the relationship between the physical forcing (ocean, ice, atmosphere) and the trophic structure and function of the marine ecosystem in the Canadian Beaufort Sea. In October, 2016 on the CCGC *Laurier,* gliders deployed in Prudhoe Bay were recovered, and moorings were deployed alongside hydrographic and benthic sampling. Bob also introduced an AON mooring program for the monitoring of the western Arctic boundary current in a warming climate. In early September, a mooring deployed near DBO line 6 was turned

around on the *Sikuliaq*. The mooring will be serviced in 2018, with an extended hydrographic survey of the boundary current system.

2.2 Nansen and Amundsen Basins Observational System II (NABOS-II) program

On behalf of **Igor Polyakov**, **Kyoung-Ho Cho** presented on recent research findings from the NABOS program. Recently, shoaling of the Atlantic Water layer in the eastern Eurasian Basin has provided means for unprecedented winter ventilation of the ocean interior, making this region similar to the western Eurasian Basin. An associated enhanced release of oceanic heat has reduced winter sea-ice formation at a rate comparable to sea-ice loss due to local atmospheric thermodynamic forcing, explaining the observed recent reduction in sea-ice cover in the eastern Arctic. This "atlantification" of the eastern Arctic Ocean may represent a fundamental step toward a new Arctic climate state.

2.3 Chukchi Borderland/Arctic Basin Joint Activities

[PPT 8] Jackie presented on joint research activities in the Chukchi Borderland and Arctic Basin. From July 2nd to August 10th, 2016, the Hidden Ocean cruise, a NOAA Ocean exploration expedition, took place in the Chukchi Borderlands, employing an ecosystem perspective to investigate microbial communities in sea ice, water and seafloor environments; water column (planktonic) organisms, invertebrate and fish sea floor (benthic) communities, as well as conducting observations of marine mammals and seabirds. Jackie also introduced the Synoptic Arctic Survey (SAS), an international initiative for a coordinated multi-ship operation in the Arctic Ocean in the course of one summer season in one year. By obtaining synoptic view of the ecosystem, hydrography, biogeochemistry including carbon storage, the SAS aims to remedy the spotty data coverage in the Arctic, pave the way for large-scale assessments, create the observational fundamental for future observing programs and leave a legacy for future generations.

2.4 Satellite Remote Sensing

[PPT 9] Hyun-Cheol Kim gave a presentation on sea ice observations through a Korean satellite system by the name, KOrea Multi-Purpose SATellite-5 (KOMPSAT-5). Launched on August 22nd, 2013, KOMPSAT-5 is the first Korean satellite to be equipped with SAR (X-band), capable of providing high resolution images with various observation modes (various observing swaths) with the capability of imaging twice a day. During the 2016 Arctic expedition on *Araon*, satellite data collected consisted of AMSR2 (passive microwave) sea ice concentration, Terra/Aqua MODIS RGB True and False color images, and KOMPSAT-5 EW SAR images. In contrast to the first two types of data, KOMPSAT-5 provided data that was of very high spatial resolution (i.e. 6.25 m/100km swath), providing important information on sea ice (i.e. ice size, shape, etc.), uninfluenced by clouds and sun altitudes. Indeed, the pros of using KOMPSAT-5 for sea ice include fine discrimination of features (i.e. sea vs. open water) with its high resolution SAR with X-band, as well as its capability of imaging twice a day, which is good for change detection in Polar Regions. The only weak point at this stage of development is that post-launch radiometric calibration is incomplete, meaning radar backscattering coefficients from wide swath images cannot be provided.

Xiangdong Zhang noted that the sea ice concentration captured through KOMPSAT-5 is very different from the concentration observed at the National Ice Center (NIC) in Washington D.C and asked Hyun-Cheol for a possible reason for the difference. When Hyun-Cheol responded explaining that the reason may be due to the fact that the NIC does not have high-resolution data on sea ice, Xiangdong recommended that it will be good if the KOMPSAT-5 high-resolution data be used to calibrate and improve NIC data.

2.5 Sea Ice and Atmosphere

[PPT 10] Joo Hong Kim presented on observations of atmosphere and sea ice on the IB/RV *Araon* Arctic cruises. Just as much as the Polar Regions represent a sparsely observed region in comparison to other parts of the globe, the Polar Oceans are sparsely observed by the Argo array of automated profiling floats, implying challenges in coupled model initialization. In recognition of this sparsity of data, or to "fill in the gaps," field activities through the IB/RV *Araon* have been carried out each year observing the Bering Sea, Chukchi Sea and East Siberian Seas. During the first leg of the cruise, buoy deployments during sea ice camp and ship-borne meteorological observations measuring air temperature, humidity, winds, SW/LW radiations for surface and radiosonde launch for upper-atmospheric sounding were conducted. During the second leg, ship-borne meteorological observations consisted of surface measurements and upper-atmospheric sounding. Notably, in 2016, all meteorological instruments have been replaced. The radar mast now includes a 2-d sonic anemometer, downward SW and LW, T/RH, all-sky images, windmill anemometer, pressure and precipitation gauge while the foremast includes windmill anemometer, 4-component radiation*2, T/RH and pressure.

2.6 Modelling Activities

Atmospheric and Modelling Studies at IARC/UAF

[PPT 11] Xiangdong Zhang introduced atmospheric research and modeling studies at International Arctic Research Center (IARC), University of Alaska Fairbanks (UAF).

Recently, a group led by NOAA and NASA published a white paper on the "Systematic Improvements of Reanalyses in the Arctic (SIRTA)," wherein global reanalysis products were summarized and compared. Among the products, only 4 were regional reanalysis products, while the Chukchi-Beaufort Seas High Resolution Atmospheric Reanalysis (CBHAR) displayed the highest horizontal resolution. Using observational data collected from MODIS satellite, buoy deployments on cruises, as well as surface/ground measurements, CBHAR has 31-year high-resolution data, from 1979 to 2009. When comparing four other global and regional reanalyses with observations, CBHAR showed an improved representation of surface wind and 2m air temperature in the reanalysis domain.

In addition, the data was used for climatological storms studies. In recent years, the occurrence of storms has been more frequent in the Arctic. Notably, when a super storm occurred in early August of 2012, it was coincided by a record low of sea ice cover. Storms can enhance ocean mixing, change ocean circulation, as well as sea ice distribution and motion.

Based on the CBHAR high-resolution data in Beaufort Sea and Chukchi Sea from 1979 to 2009, it was found that more storms occurred in the summer season with a minimum count of storms found in March, and stronger storms occurred in winter with weaker storms in March and May. An integrated storm index combining storm intensity, frequency/number, and lifetime showed a general trend of stronger storm activity in the second half of the year. Long-term variability of storm intensity showed enhanced storm intensity and activity generally in January and March,

A modelling study was also carried out on a long-lasting Arctic storm, which occurred from September 23rd to 30th in 2010 near the region of Beaufort Sea. The model proved to realistically capture the spatial and temporal structures of storm parameters measured through radiosonde observation aboard R/V *Mirai*. In addition, a study was carried out on the storm's physical mechanism and processes. Through the study, a distinct feature from regular, baroclinically driven storms was observed: a barotropical structure dominated throughout the storm's lifetime. From a composite analysis on the climatological impacts of intense storms on sea ice and ocean, intense storms were found to cause a decrease in sea ice concentration and thickness, and an increase in SST.

Bob asked whether there were any plans to continue the CBHAR for data beyond 2009. Xiangdong responded that while no concrete plans are in place, although extension of the CBHAR data may be possible with multiple funding agencies and international cooperation. He noted that the prospect of extension may occur as CBHAR data has attracted interest to be one among the core datasets presented at the Year of Polar Prediction (YOPP) planning conference.

2.7 Update on 2016 Mooring Activities

[PPT 12] On behalf of **Phyllis Stabeno**, Jackie gave an overview of Arctic Ocean moorings and their locations in 2016. In 2016, a total of about 80 moorings were deployed/redeployed in the Arctic Ocean by PAG members. Jackie showed the standardized form that will be made and filled out to be put on the PAG and NOAA DBO website.

2.8 Update on Joint Scientific Research and Monitoring Planning for the Central Arctic Ocean and Adjacent Seas (JSRMP)

[PPT 13] On behalf of **Phil Mundy,** Jackie gave an update on activities of Fish Stocks in the Central Arctic Ocean (FiSAO), especially on the JSRMP. Since 2011, FiSCAO has been holding a series of scientific meetings, gathering scientists from Arctic coastal states (Russia, U.S, Canada, Greenland/Denmark, and Norway) to discuss scientific information that will be provided to international negotiations for control of fishing on the High Seas of the central Arctic. The attendance at the third meeting in 2015 was expanded to include scientists from nine nations, with the addition of China, Iceland, Japan and Korea. The attendance at the fourth meeting (September) 2016 included scientists from the EU in addition to those of the nine nations.

Negotiations require information on fish species identity and biomass, trophic linkages (predator biomass, prey biomass), and physical and chemical drivers of biomass. While diplomatic negotiations and scientific support activities have different geographic reference frames, the focus of

the negotiations for controlling commercial fishing is the High Seas. Nonetheless, the scientific research and monitoring plan is being designed to follow trophic linkages and life cycles of fish wherever they are linked to populations that are now found, or that may be found in the future, in the High Seas area. As the High Seas area is a mixture of fish habitats that coincide with bathymetry, continental shelf, and shelf break, monitoring and research will need to be designed to sample and monitor accordingly.

Tabled at the first meeting of scientists from all Parties, the "strawman" Joint Scientific Research and Monitoring Plan is currently under review by scientists from the Parties. When ready, the draft plan will be widely circulated within the scientific community for review and comment. On implementation, it is likely that all nations conducting scientific research in the Arctic would be invited to participate under an approach similar to that for the Distributed Biological Observatory, since no one nation has the capabilities to conduct quantitative Arctic fish stock biomass estimation.

The Synthesis of Arctic Research supports the negotiations and the planning and implementation. A new version was tabled at 4th FiSCAO September 2016 and currently undergoing review among the Parties. A few highlights from the draft includes: 12 species of fish identified from the High Seas areas; more than 300 fish species are known from Arctic waters nearby the High Seas. In 2017 to 2018, for research and monitoring plan and implementation, opportunities will be sought among existing observation platforms, ships, moorings, satellites, and DBO locations.

III. Status Report on on-going and planned future activities for PAG-endorsed DBO and PACEO

3.1 Distributed Biological Observatory (DBO): Highlights and Updates

[PPT 14] Bob Pickart presented highlights from the physical oceanographic component of the DBO program. With the pilot phase started in 2010, a time-space series could be developed through CTD crossings, the number of which grew steadily each year. Notably, among the CTD crossings conducted for DBO lines 1-5, a total of 41 were carried out for line 5, while 45 were carried out for line 3. Overall mean sections could be drawn-up for temperature and salinity, through which Alaska Coastal Water (ACW) passage could be observed to have the biggest presence in the Barrow Canyon in August and September. Newly Ventilated Winter Water (NVWW) was observed to have the highest presence in August in the western side of the Canyon. Upwelling events could also be observed through seasonal variations to meso-scale variations of mean unforced salinity with mean upwelling sanity.

Jackie continued to note a few other research highlights. Trends in annual sea ice persistence could also be observed. Since 2000, annual sea ice persistence has accelerated, with recent gains in the south (DBO lines 1-2) transitioning to losses in the north (DBO lines 3-8). Based on time series data from 1972 to 2012, northward movement of the centroid benthic biomass at regions near DBO lines 1-3 could be observed, which may be related to changes in advection, production and deposition areas. DBO sampling also allowed the tracking of changing benthic fauna as subset of western SLIP region (DBO line 1). Declining biomass of bivalves and increasing polychaete biomass in the

southern DBO stations could be observed, compared to the increasing benthic biomass in the northern DBO site.

3.2 Results from Pilot PACEO Program in 2016 and Plans for 2017 Field Activities

3.2.1 Physical Oceanography and Sea Ice Dynamics

KOPRI Activities in the Arctic: Physical Oceanography

[PPT 15] Kyoung-Ho Cho presented 2016 KOPRI physical oceanographic research activities in the Arctic. On the 2016 Arctic cruise, 34 CTD stations and 38 XCTD stations were carried out. Unfortunately, two mooring systems deployed in 2015 could not be recovered; recovery will be re-attempted during next year's 2017 cruise. CTD data from 2015 and 2016 showed high sea ice concentration around the ESS in 2015 and high sea ice concentration around the Chukchi Borderland in 2016. In 2016, compared to 2015, less melt water could be observed, the depth of Pacific Winter Water had slightly increased, with the weakening of the Pacific Summer Water. Transect data showed relatively fresh water in the upper layer of Station 4 in 2016, while fresher water had existed nearshore in 2015. In August 2016, cold water (<3° C) was found in the lower layer of Stations 3 to 6 while relatively warm water as found in the upper layer of Station 4. A North-south transect showed deepening of the surface mixed layer, weakening of the surface temperature maximum, and weakening but thickening of the Pacific Summer Water in 2016. An East-west transect showed the Pacific Summer Water weakening but thickening along with a weakening of its expansion to the west in 2016. Future work will include more detailed analyses of the observation data and a more precise identification of the relationship(s) between atmospheric forcing, sea ice motion, and upper ocean circulation. Arctic surveys will continue to be conducted for monitoring of the variations of Pacific-origin waters around the Chukchi Borderland and East Siberian Sea.

Drift-Towing Ocean Profiler (D-Top)

[PPT 16] Jinping Zhao introduced the Drift-Towing Ocean Profiler (D-TOP) instrument. With a 120m long cable, the profiler is deployed beneath sea ice and allowed to go up and down by buoyancy. Built in 2014, 2 were deployed in 2015 and a total of 4 were deployed in 2016 to obtain mixed layer and halocline information. While the spatial resolution depends on ice-drifting velocity, the average resolution is about 5 kilometers. Next year in 2017, two ocean-type sets of D-TOP will be deployed on the NABOS cruise. Furthermore, a new project funded by the Ministry of Science and Technology in China will be launched to develop a new D-TOP that can carry up to 6 additional sensors. The project's 3-year plan includes development of two sets and testing in 2017, deployment of 2 sets in the Arctic in 2018, and deployment of two integrated systems in the Arctic in 2019.

Ocean University of China (OUC) 2016 Field Activities in the Pacific Arctic

[PPT 17] Tao Li presented OUC research activities in the Pacific Arctic region in 2016. During the 2016 Chinese Arctic Expedition (CHINARE 7), ship-based sampling included a total of 83 CTDs and 81 LADCP stations, and 41 Vertical Microstructure Profiler (VMP) stations. Ice-based sampling included 2 deployments of the D-TOP, hydrographic sampling for measurements of temperature, salinity, and current velocity in the upper ocean beneath the sea ice, optical measurements for solar

energy absorbed by sea ice, concentration of melt pond observed by Unmanned Aerial Vehicle (UAV), and sea ice thickness measurements using Ground Penetrating Radar (GPR). During the Korean Arctic expedition on *Araon*, 2 deployments of D-TOP were made in the ESS and Chukchi Sea. During the 2016 Chinese-Russia Joint Expedition, 40 CTD, 40 LADCP, 21 XBT, and 13 XCTD stations were undertaken. In addition, a total of 40 stations were occupied to conduct a hydrographic-optical biological survey to measure CTD, solar radiation and chlorophyll concentration.

Inter-annual variabilities of fluxes in Barrow Canyon from 2010-2014: results from the DBO-5 repeat section

[PPT 18] Motoyoh Itoh presented on observations of inter-annual variabilities of fluxes in Barrow Canyon. Since 2010 to 2014, volume and heat fluxes in the Barrow Canyon were examined through repeat hydrographic section, mooring and wind data collected near the DBO-5 line. As of 2015, a total of 35 occupations along the DBO-5 line were carried out. From 2010 to 2014, repeat hydrography along DBO-5 section included 23 CTD and ADCP sections, which allowed for detailed structures of flow fields and water properties to be captured. Since 2009, through moorings near the DBO-5 line, temperature, salinity and velocity time series were observed, which provided time series measurements between repeat hydrographic observations. Inter-annual variation of flow fields in early September showed that flow fields and water properties in 2013 to completely differ with those in 2010 and 2011, a difference most probably due to wind. Based on the mooring data, a significant correlation between along-coast wind and the transport in Barrow Canyon could be confirmed. Future work includes estimation of heat flux between 2010 and 214 using repeat section occupations of DBO-5, as well as wind and time series of ACW temperature observed with moorings neighboring the section.

3.2.2 Chemical Oceanography

Phytoplankton Communities' Production of Mycosporine-like Amino Acids (MAAs) in the Arctic

[PPT 19] Sun-Yong Ha presented research on phytoplankton communities' production of mycosporine-like Amino Acids (MAAs) in the Arctic. In both the Arctic and Antarctic, ozone depletion has been occurring and continues still. Hence, different sea ice thickness sites have experienced UV-B transmission, wherein UVBR have transmitted deeper into open sea water. Against this rapidly transitioning marine environment, Mycosporine-like amino acids (MAAs) function as versatile elements. To name key functional values, MAAs are anti-oxidants, providing sunscreen protection, proto-protection and have osmotic pressure. Key functions that possess ecological significance include nitrogen storage, photosynthetic efficacy, thermal stress and desiccation stress. Through in-situ incubations using HPLC analyses, the production rate of MAAs by phytoplankton communities on melting ponds in the Arctic were calculated. It was found that the production rate of MAAs in an open melt pond was more than 10 times higher than in the closed melt pond.

3.2.3 Biogeochemical Oceanography

Phytoplankton Physiological Study in the Western Arctic

[PPT 20] Jisoo Park introduced a phytoplankton physiological study that was conducted in the Chukchi and East Siberian Sea. In a preliminary study on long-term variation of surface chlorophyll in the western Arctic, satellite data of the past 17 years showed that as open water period gradually increases in length in most regions (4~6 days per year), summertime phytoplankton biomass tended to increase, except in the Beaufort Sea.

Using Fluorescence Induction and Relaxation system (FIRe), a comprehensive set of physiological characteristics of phytoplankton were examined. This is the first-time study for variable fluorescence of phytoplankton in Arctic at a higher resolution, both spatial and vertical. Results from the 2015 cruise showed that spatial distribution of quantum efficiencies of photosystem II (PSII) values were high when phytoplankton cells were in favourable conditions and low when cells undergo conditions of limited light or nutrients. Quantum efficiencies on the surface were higher in Bering Strait & Chukchi Sea whereas those were lower in East Siberian Sea.

Based on results from the 2015 cruise, a significant relationship could not be found between quantum efficiencies (Fv/Fm) and PAR, temperature and chlorophyll, but could be found with salinity. Intrusion of freshwater (low salinity & nutrient depleted) and/or nutrient supply from the lower water column seems to control not only chlorophyll concentration, but also Fv/Fm in the Arctic Ocean surface.

Impacts of Ice retreat on biological pump and carbon sink in the Western Arctic Ocean based on Chinese Arctic Cruises since 1999

[PPT 21] Haiyan Jin presented research on the impacts of ice retreat on the biological pump and carbon sink in the western Arctic Ocean based on Chinese Arctic cruises. Changes in ice cover in the Arctic Ocean, the duration and extent of the sea ice, the sea ice thickness, and sea water temperature, as well as the water mass characteristics, have a critical influence on the primary production and structure of the phytoplankton community. Indeed, changes in the marine ecosystem would alter the carbon biogeochemical cycles and the carbon flux efficiency. Since 1999, China has been conducting comprehensive research expeditions to the Arctic Ocean on the IB/RV *Xuelong*. Research on nutrient dynamics and “biological pump” response, as well as carbon sink efficiency and ocean acidification have been carried out as part of the Chinese Polar Environmental Comprehensive Investigation and Assessment Program research. In situ monitoring included pCO_2, and Ar/O_2 net productivity observations using sensors for DO, pH, salinity, temperature, SS and nutrients. Haiyan noted that cooperation in co-maintaining of moorings, employment of ecological sensors with higher precision, exchange of knowledge and data is welcome and sought.

3.2.4 Ecosystem

Spatial Patterns in Zooplankton Communities and Stable Isotope Ratios in Relation to Environmental Factors

[PPT 22] Eun Jung Choy presented on her research which investigates zooplankton communities and isotope ratios in relation to environmental factors. With the retreat of sea ice in the Arctic Ocean, multiple environmental stresses can be affected. Indeed, environmental changes are not only impacting the physical structure of the Arctic ecosystem, but give rise to ecological changes, such as in food structure, stability and efficiency. Serving as a link between primary producers and higher trophic level species, zooplankton play a key role in marine food webs. The main question of research aims to understand how structural and functional ecosystem dynamics will respond to multiple stressors in relation to the reduction of sea-ice in the Arctic Ocean. Major observations include zooplankton community structure, carbon and nitrogen stable isotope ratios of potential organic matter sources and dominant zooplankton species for understanding of trophic relations using compound-specific stable isotope analysis. Zooplankton samples were collected at 330 m depth and a total of 27 species were identified across 28 sampling stations. Cluster analysis was conducted for spatial taxonomic patterns for zooplankton communities on Bray-Curtis similarities for species abundance data for 28 sampling stations. Through carbon and nitrogen isotope ratios, dietary or food sources and the trophic levels of animals can be identified, respectively. In combination with environmental parameters, more data interpretation is needed.

KOPRI's Ecosystem Studies for PACEO Program

[PPT 23] Hyoung Sul La presented on plankton dynamics research in the PACEO region. A region of high seasonal and inter-annual sea ice variations with complex water column structure, the PACEO region makes for a good site of marine ecosystem research. A key research objective is to understand how physical and chemical processes influence plankton dynamics (i.e., composition, biomass, trophic interaction). Major observations conducted through the past Arctic cruises include: biomass and diversity of heterotrophic bacteria; phytoplankton community structure, primary production, and physiology; microzooplankton community structure and grazing impact; mesozooplankton population, grazing impact, and vertical habitats. Plans for the 2016 Arctic cruise included measurements of spatial and temporal variation of phyto- and zooplankton composition using net, sediment trap and acoustic system methods. While observations of the spatial distribution of plankton composition were successfully completed, temporal variation data could be not attained due to the failed mooring recovery in this year's cruise. Preliminary plans for the 2017 Arctic cruise include observing mesozooplankton under seasonal varying sea ice using Ice profiling sonar (IPS) and ADCP for sea ice thickness and motion, and an Acoustic Zooplankton Fish Profiler (AZFP) to monitor mesozooplankton vertical behaviour.

3.2.5 Sediment Trap

Sediment Trap Moorings in the Southwestern Canada Basin

[PPT 24] Jonaotaro Onodera presented on sediment trap moorings in the southwestern Canada Basin. A shallow sediment trap was deployed at 180-260m water depth while a deep trap was deployed at 1300-1360m water depth in the southwestern Canada Basin since October 2010 to September 2014. Comparing the settling particle flux at the two stations, westward eddy advection and high settling fluxes of shelf materials in early winter could be observed. In September 2015, JAMSTEC physical oceanographic moorings were deployed near the Hanna Canyon and Barrow Canyon. The objectives behind the mooring experiment were to understand the lateral transportation of heat, materials from shelf to basin, the influences of ocean acidification and warming on the marine ecosystem, and to conduct biological research using e-DNA. One mooring system was located in the Northern Hanna Canyon (NHc15t) and the other in the northern region of Barrow Canyon (NBc15t). The NBc15t mooring was equipped with sensors measuring CTD, pH, chlorophyll, turbidity, ADCP, CT, camera and sediment traps at 2000m water depth. The NHc15t mooring was equipped with CTD, pH, Chl, turbidity, DO sensors, sediment trap, and camera at 425 water depth. They will be recovered by the R/V *Mirai* cruise in September 2017.

CHINARE Mooring Observation in the Pacific Arctic Region

[PPT 25] He Yan presented on CHINARE mooring observations in the Pacific Arctic region. Having participated in all of the 7 CHINARE cruises since 1999, the First Institute of Oceanography of SOA has been accumulating CTD data in the Pacific - Arctic region. The Key Lab of Marine Science and Numerical Modeling (MASNUM) at FIO has been in charge of physical oceanography and meteorology studies, for which long-term mooring observations have represented a crucial aspect of research. Out of a total of 7 buoy deployments thus far in the Pacific Arctic region, 2 were buoys and 5 were moored subsurface buoys. On-going developments are being carried out to further improve design of the buoys for larger measuring capacity and longer time series. The latest buoy could be deployed in the Bering Sea at 3800m depth, carrying 150k ADCP, CTD and TD. Notably, a mooring system deployed in the Chukchi Sea during the 5th CHINARE cruise recorded the entire varying procedure of the changes of water mass and circulation characteristics induced by the Great Arctic Cyclone in August 2012, which was the strongest summer cyclone since the beginning of satellite observations in 1979. Mooring observations will constitute a significant aspect of the 8th CHINARE cruise in 2018. International cooperation through joint cruises, data-sharing and information exchange is always welcome.

Xiangdong asked whether 2012 ocean observation data was available. He Yan answered that the data can be shared under a cooperative arrangement. Upon being asked the period of time moorings are underwater, He Yan explained that they were in the water for only 50 days, deployed and recovered during the cruise.

3.2.6 Atmosphere and Sea Ice

Summer Atmospheric Condition in 2016 & Future Field and Plans for Atmospheric Studies

[PPT 26] Joo Hong Kim presented results from atmospheric studies from 2015 to 2016 along with preliminary plans for 2017. Observations of near surface winds in summer of 2015 and 2016 on the Araon showed an interesting difference: whereas the maximum mean near surface wind speed in 2015 was 15 m/s, the speed was 50 m/s in 2016, much like a tropical cyclone. Using the NCEP/NCAr reanalysis data, the monthly-mean time scale was made for sea level pressure and surface air temperature. In 2015, sea level pressure was much higher than in 2016. In response to such circulation, a southwest shift of surface air temperature could be observed. A preliminary simulation of the great cyclone case was carried out using NCEP GFS forecast for initial and boundary conditions. Plans for 2017 include data assimilation of the WRF model domain with 2016 ARAON radiosonde observations.

Collaborative Atmospheric Studies: Current Activity and Future Work

[PPT 27] Xiangdong Zhang presented on collaborative atmospheric studies that are being carried out. One collaborative project is a modelling study on the great cyclone in August 2016. Two students from IARC/UAF were sent to join the *Araon* cruise. Another area of collaboration was radiosonde observations on IB/RV *Araon*. Since 2009, there has been an increased amount of observation of the Arctic Ocean, especially in the Chukchi Sea and Beaufort Sea regions and intense observations will follow in the coming years as well. In collaboration with YOPP, MOSAiC, Polar Science Center at the University of Washington, KOPRI, JAMSTEC and Chinese institutions, efforts are being made to extend and update the CBHAR data. Notably, CBHAR has been recognized to be one of the core data for the YOPP program. In addition, efforts are being made for a better understanding and improvement of sea ice dynamics in modelling simulations, specifically for forcing data.

Observation of Chemical Oceanographic Components to Understand Ice-Sea-Climate Interaction: R/V *Araon*'s 2016 Arctic Cruise

[PPT 28] Keyhong Park presented on studies of ice-sea-climate interaction through chemical oceanographic observations. The atmosphere, Polar Oceans and sea ice form one interconnected system whereby physical, biological, and chemical processes are linked through complex interaction at the air-sea-ice interface and of the chemical species. Measurements made during the 2016 Arctic cruise included: underway sampling for pCO_2, DO, O_2/Ar (EIMS), O_2/Ar (MIMS), and DMS; in melt ponds for DO, O_2/Ar (MIMS), DMS, and in the atmosphere for CO, O_3, VOCs, and aerosols for microanalysis. On IB/RV *Araon*, air sampling for VOCs analysis, aerosol sampling for microanalysis and ozone and carbon monoxide measurements were carried out. Among these parameters, measurement of dimethyl sulfide (DMS) is essential for understanding the future role of the Arctic Ocean on climate change. Not only does DMS play a pivotal role in the climate change-related biogeochemical cycles, oceanic DMS is the main source of DMS emission and produced by biological processes. Through underway measurements, it was found that DMS concentration in seawater was mostly less than 10 nM with relatively high concentration in Bering Strait and coastal

areas (DBO stations). Melt pond studies included a 2-day station for the observation of salinity and temperature of 10 melt ponds. In general, it was found that DO in the melt ponds were similar or lower than that of the ambient ocean's. Also, oxygen-rich water was observed in the salty ponds. For DMS and net community production (NCP), fresh water ponds' DMS concentration was observed to be low and similar to the ambient ocean, while high DMS concentration was found in salty ponds and O_2/Ar widely distributed across melt ponds. To understand the variations across the ponds, further analysis will be carried out. In terms of atmospheric chemistry studies, short-lived climate forcers and aerosols are being investigated. Air sampling for VOCs measurement have been carried out. As DMS and VOCs have been identified as predominant precursors of cloud condensation nuclei (CCN) in remote areas such as the Arctic region, they will be analyzed in gas chromatography electrospray time of flight mass spectrometer to characterize and quantify existing VOCs.

3.2.7 Modelling Activities

Update on KOPRI Modelling Activities

[PPT 29] On behalf of **Baek-Min Kim,** Joo-Hong presented on KOPRI's modelling activities. KOPRI's modelling activities mainly consist of investigating sea ice, weather and climate. Specifically, sea ice studies include understanding characteristics of a stand-alone sea ice model and preparing seasonal prediction of sea ice extent and concentration for sea ice on a Pan-Arctic scale, with the ultimate goal to develop an ice-ocean coupled sea ice prediction model. Part of the KOPRI Polar Prediction system (KPOPS), studies of weather and climate aim to develop a weather prediction system with *Araon* observations added and a coupled seasonal climate prediction system.

GLERL Coupled Ice-Ocean Modelling and Forecasting

[PPT 30] On behalf of **Jia Wang,** Jackie briefly introduced modelling systems developed for the Arctic Ocean by NOAA Great Lake Environmental Research Laboratory (GLERL). GLERL developed the Regional Coupled Ice-Ocean Model (CIOM) in the Bering Sea (POM-based), and the 3-D NPZD (9-compartment) coupled Physical-Ecosystem (biogeochemical) Models (PhEcoM).

It was found that in providing the initial condition and lateral boundary condition, Ice POM gave the best ocean data for 1-2 km simulations for the Chukchi Sea and ESS, near the DBO 3 line, likely due to the spatial resolution. Other data, such as ECCO-v4 and GLoSea5 will be tested, as will the longer transect (CCL line) since 2011.

It is also planned that Arctic-FVCOM, a high-resolution unstructured-grid, finite-volume coupled ice-ocean model for the Arctic Ocean, will be implemented from 2013 to present. Future efforts will also include validation of Ice POM, FVCOM and ice unstructured variable grid using RUSALCA and other datasets, as well as seasonal forecast and projection of Arctic sea ice using Ice POM and FVCOM.

3.2.7 Satellite Observations

Overview of Polar Web GIS for Data Sharing

[PPT 31] Hyun-Cheol Kim introduced the Polar Web GIS (p-web GIS) system with an update of recent developments. Of similar concept to the DBO meta-data webpage, the p-web GIS system was developed to be an efficient system of sharing data. While 2016 marks the 3rd year of development, the system is undergoing on-going improvements. As of 2016, the system is now equipped with new functions which include ship track, contour graphs, thematic map printing, vertical graphs, personal data upload and satellite data. For the next 5 years, from 2017 to 2021, further plans to upgrade and improve the system are underway. Future improvements for p-Web GIS system include redesigning the system based on function requirements analysis from users, standardization of oceanographic observation database, and splitting the system into analysis/data management system and data access/sharing system.

3.3 Other Activities

Paleoceanography

[PPT 32] Wenshen Xiao introduced the Chinese Arctic paleoceanographic studies. Arctic hydrography studies, as well as studies on glacial-interglacial water structure changes, and coring along the Bering Sea Green Belt were carried out. Through the 5th CHINARE expedition, investigations were also carried out in the Nordic Seas, North Pacific and western Arctic Ocean. Late quaternary sedimentological and paleoceanographic records were collected in the western Arctic Ocean. Based on evidence from fossil ostracods, Atlantic Water shoaling onto Chukchi Plateau after last deglaciation could be confirmed. A radiolarian assemblage in Bering Sea surface sediments was also formed. The productivity structure and terrigenous input could be observed based on Holocene biomarker records from the North Bering Sea slope. High terrigenous input was found during the early Holocene, with a decrease towards the late Holocene in response to sea level rise. Future work will include investigation of Arctic glaciation history, related changes in circulation, water structure, productivity, as well as the connection between Bering Sea and the Arctic Ocean.

IV. Data Sharing Issues

4.1 DBO Data Policy

[PPT 33] Jackie introduced the DBO Data Policy with a few updates. The DBO Data policy formulated on February 20, 2015 will undergo a few modifications once reviewed and approved by the PAG Executive Committee. Notably, one of the modifications include a new location for the submission of DBO parameter files. During November 2016, the DBO parameter files that identify the standard DBO data collections (transects, upper trophic data, satellite, mooring) can be downloaded and completed offline using templates archived at http://dbo.eol.ucar.edu, soon at http://arctic.cbl.umces.edu. Appropriate DBO parameter files for the 2016 field season should be completed and sent to the CBL site; a matrix of data parameter types from the annual cruises will be prepared. A summary matrix of the annual results of the cruise parameter file submissions will be posted on the new CBL site wherein information identifying which DBO parameters were collected

on which cruises or activities, the location of the associated data files, and point of contact will be made accessible.

4.2 Overview of Polar Web GIS (p-web GIS) for Data Sharing

[PPT 34] Hyun-Cheol Kim introduced the Polar Web GIS (p-web GIS) system with an update of recent developments. Of similar concept to the DBO meta-data webpage, the p-web GIS system was developed to be an efficient system of sharing data. While 2016 marks the 3rd year of development, the system is undergoing on-going improvements. As of 2016, the system is now equipped with new functions which include ship track, contour graphs, thematic map printing, vertical graphs, personal data upload and satellite data. For the next 5 years, from 2017 to 2021, further plans to upgrade and improve the system are underway. Future improvements for p-Web GIS system include redesigning the system based on function requirements analysis from users, standardization of oceanographic observation database, and splitting the system into analysis/data management system and data access/sharing system.

V. Status Update on Synthesis and Future Plans:

5.1 DSR II DBO Special Issue

[PPT 35] Jackie Grebmeier gave an update on the status of the DBO Special Issue in Deep Sea Research II journal. 32 papers were brought forward based on DBO data sets. Paper submission is now open for fall 2016. The Special Issue is planned to be published by fall 2017 in possibly 2 volumes.

5.2 Biogeosciences Special Issue

[PPT 36] Takashi gave an update on the status of the Biogeosciences Special Issue. Deadline for paper submission was about 1 year prior. A total of 13 papers were submitted. 12 papers have been already accepted and one paper is being reviewed.

VI. Updates on Interactions with other Organizations and Upcoming Meetings

6.1 Arctic Observing Network (AON)

[PPT 37] William Ambrose introduced the Arctic Observing Network (AON) program at the U.S National Science Foundation (NSF). In support of the overall objective of NSF Arctic science to understand the Arctic on regional scale and its relationship to the global system, the AON aims to observe, understand and predict Arctic environmental change. In particular, AON works to address emerging questions in Arctic science, support new technology, support observing infrastructure and facilitate collaboration with mission agencies. Indeed, notably, the DBO and NABOS projects are among the many projects that receive support from AON for infrastructure.

AON encompasses physical, biological, social, cultural, and economic observations, including indigenous knowledge, of the land, ocean, atmosphere (troposphere and stratosphere) and social systems. AON also supports community-based observation. With Arctic indigenous people possessing both long-term knowledge of the region and intimate relationship to the environment,

spatial and temporal coverage of observations is possible. As such, efforts to involve indigenous people from project inception are being pursued.

6.2 Stratified Ocean Dynamics of the Arctic (SODA): Science and Experiment Plan

[PPT 38] Kyoung-Ho Cho introduced the newly launched Stratified Ocean Dynamics of the Arctic (SODA) program. Involving scientists from 30 organizations, the SODA program is focused on understanding how the upper Beaufort Sea responds to changes in inflow and surface forcing, with specific science questions addressing 3 oceanographic properties: buoyancy, momentum and heat. Examples of the program's primary operational objectives include deployment of acoustic navigation moorings, ice-based clusters, Seagliders and ALAMO floats. A mix of dedicated cruises will be used, including the R/V *Ukpik*, R/V *Sikuliaq*, USCGC *Healy*, and provided that opportunities are available, collaborative operations from CCGS *Louis St. Laurent*, IBRV *Araon* and USCG C-130 Arctic Domain Awareness flights. Kyoung-Ho and Joo Hong Kim are planned to attend the upcoming SODA meeting in Seattle.

6.3 Central Arctic Ocean Synthesis Activity

[PPT 39] Jackie introduced the Central Arctic Ocean (CAO) Synthesis activity of the Working Group on Integrated Ecosystem Assessment for the Central Arctic Ocean (WGICA). Affiliated with the Arctic Council (AC) working group, Protection of the Marine Environment (PAME), and International Council for the Exploration of the Sea (ICES), WGICA' key effort will be to provide an Integrated Ecosystem Assessments (IEA) for the CAO. The first year will involve assemblage of data and information to consider approach and methodology for IEA, as well as monitoring requirements, with the following 2 years for more data assemblage, analyses and final IEA report, consideration of monitoring requirements and priority research issues.

Two assessment teams were established to initiate work on the development of integrated assessments on a subregional basis in 2016. Aside from the Eurasian Basin/Atlantic gateway team, Jackie will be leading the Amerasian Basin/Pacific gateway team.

A request was made for this WGIA assessment to be endorsed by PAG. If PAG agrees to facilitate this effort, further discussion with the PAG Executive Committee will follow for country suggestions for participants for this synthesis activity. Jackie, chairing the Pacific side of the WGICA synthesis activity, will be developing a work plan, building off the recent Pacific Arctic Marine Regional Synthesis (PacMARS) 2-year activity.

6.4 Synoptic Arctic Survey (SAS)

[PPT 40] Takashi introduced the Synoptic Arctic Survey (SAS), an initiative for a coordinated multi-national, multi-ship survey of the Arctic Ocean's ecosystems, carbon cycle, and associated hydrography using a fleet of international icebreakers and research vessels. The goal is to generate a comprehensive data set that will allow for unprecedented assessments of the state of the Arctic Ocean, detection of the impact of climate change on these systems, and provide a baseline to track future climate change. From participating in the SAS workshop this past September, Takashi shared

that a new version of the Science Plan is currently being drafted and the updated version will be presented at the 2017 ASSW in Prague.

6.5 North Pacific Research Board (NPRB): Arctic Call

[PPT 41] Jackie Grebmeier, on behalf of Danielle Dickson, gave an update on the funding decisions for the NPRB integrated Arctic observational research program. With $16 million funding, the 5-year research program aims to address the following overarching question: how will reductions in Arctic sea ice and the associated changes in the physical environment influence the flow of energy through the ecosystem in the Chukchi Sea? The program consists of 4 core programs: 1) UAF cruises aboard R/V *Sikuliaq* in the northern Bering and southern Chukchi Seas in June 2017 and 2018; 2) NOAA cruises aboard chartered fishing vessels in Beaufort and Chukchi Seas in August to early October in 2017 and 2019; 3) acoustic recorders on moorings in Bering Strait and southern Chukchi Sea; and 4) a Social science study on Chukchi coastal communities' understanding of and responses to environmental change. An integrated Work Plan outlining the program's scope, including specific hypotheses and cruise plans, will be made publically available on the NPRB website soon. As NPRB will invest in synthesis beginning in 2021, it is seeking partners to co-fund the synthesis effort and interested in modelling projects that build from the field program.

6.6 White House Arctic Science Ministerial Meeting

[PPT 42] Jackie Grebmeier gave an overview of the White House Arctic Science Ministerial meeting on behalf of **Jeremy Mathis** (NOAA Arctic Program manager). Hosted by the White House administration on September 28-29, 2016, the Ministerial gathered more than 29 ministers from Artic and non-Arctic states to expand joint collaborations focused on Arctic science, research, observations, monitoring and data-sharing. The Ministerial had four themes: 1) Arctic science challenges and their regional and global implication; 2) Strengthening and Integrating Arctic observations and data-sharing; 3) Applying expanded scientific understanding of the Arctic to build regional resilience and to shape global responses; and 4) Empowering citizens through Science Technology, Engineering, and Mathematics (STEM) Education leveraging Arctic Science. A White House Fact sheet was drawn up and a Joint Statement of Minsters was signed.

Jinping noted that as a follow-up to the meeting, the next step that will be taken is establishment of a committee. Takashi noted that DBO was referenced in the White House Fact sheet.

6.7 Asian Forum for Polar Sciences (AFoPS)

[PPT 43] Sung-Ho Kang introduced the Asian Forum for Polar Sciences (AFoPS), a non-governmental organization established to encourage and facilitate cooperation and partnership in Polar research among countries in the Asian region. Established in 2004, the Forum consists of representatives from national polar research institutions from 5 member states, namely from China, Japan, South Korea, India and Malaysia with 4 observer states, Thailand, Indonesia, Philippines and Vietnam. While in the past decade, AFoPS has been more active in Antarctic research, a number of advances in Arctic research cooperation have come underway in recent years. At the 2016 AFoPS

Annual General Meeting hosted by KOPRI in October, Sung-Ho introduced PAG to AFoPS members and encouraged exploring areas of future cooperation.

6.8 Polar Gordon Research Conference

[PPT 44] Jackie gave updated information on the upcoming Polar Gordon Research Conference (GRC). To be held from March 26-31, 2017 in Ventura, California, U.S, the GRC Polar Marine Science will bring together investigators in Arctic and Antarctic marine research across all career levels to discuss new findings and uncertainties associated with marine time series data, use of developing technology for collecting those observations, and to identify successes and challenges emerging from time series observations and biophysical modeling that can be used to accurately forecast future ecosystem response. The central theme is “Understanding Ecosystem Change through Time Series Observations, Technological Advances, and Biophysical Coupled Modeling.” The weekend before the Conference, from March 25-26, a research seminar will also take place to serve as a forum for early career scientists to present and exchange new data and cutting-edge ideas with experts in different fields of polar science. The seminar will be held with the theme” Advancing the Physical-Biological Understanding of Polar Marine Ecosystems through innovative technology.”

7. PAG Structure

Transfer of new chairmanship of PAG from Korea to Japan took place. The incoming PAG Chair, Takashi Kikuchi, commended the excellent work of leadership the outgoing Chair, Sung-Ho Kang, undertook for the past 2 years.

8. Future Meetings

The next PAG meeting will be held on April 2nd, during the 2017 Arctic Science Summit Week (ASSW) in Prague, Czech Republic (March 31-April 2). Following the series of business meetings, the Science Symposium will take place from April 4 to 7. The symposium will consist of 25 science sessions. Takashi encouraged PAG members to submit abstracts for the 5th science session entitled “Arctic Ocean dynamics, transformations and ecosystem response” by the deadline, December 16, 2016.

9. Appendix

9.1 List of Participants

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9.2 Acronym List

AARI (Arctic and Antarctic Research Institution of Russia)

ABL (Alaska Fisheries Science Center's Auke Bay Laboratories)

ADCP (Acoustic Doppler Current Profiler)

AICC (Arctic Icebreaker Coordinating Committee)

AMBON (Arctic Marine Biodiversity Monitoring Network)

AON (Arctic Observing Network)

AOOS (Alaska Ocean Observing System)

ART (Arctic in Rapid Transition)

ASCOS (Arctic Summer Cloud Ocean Study)

ASR (Arctic Sea Route)

BAS (British Antarctic Survey)

BGOS (Beaufort Gyre Observing System)

CAA (Chinese Arctic & Antarctic Administration)

CAFF (Conservation of Arctic Flora and Fauna),

CBL (Chesapeake Biological Laboratory)

CBMP (Circumpolar Biodiversity Monitoring Program)

CS (Chukchi Sea)

DBO (Distributed Biological Observatory)

DFO (Department of Fisheries and Ocean Canada)

DSR II (Deep Sea Research II)

ECS (Early Career Scientists)

EEZ (Exclusive Economic Zone)

EPB (European Polar Board)

ESS (East Siberian Sea)

FARO (Forum of Arctic Research Operators)

FIO (First Institute of Oceanography)

IACE (Institute of Arctic Climate and Environment Research)

IARC (International Arctic Research Center, UAF)

IARPC (Interagency Arctic Research and Policy Committee)

IASC (International Arctic Science Committee)

IASOA (International Arctic Systems for Observing the Atmosphere)

ICARP III (Third International Conference on Arctic Research Planning)

INSROP (International Northern Sea Route Programme)

ISTAS (Integrating Spatial and Temporal scales in the changing Arctic System)

ITP (Ice Tethered Profiler)

JAMSTEC (Japan Marine Science and Technology Center)

JOIS (Joint Ocean Ice Studies)

KOPRI (Korea Polar Research Institute)

MIZ (Marginal Ice Zone)

MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate)

NMEMC (National Marine Environmental Monitoring Center, China)

NOAA (National Oceanic and Atmospheric Administration)

NPRB (North Pacific Research Board)

NSF (National Science Foundation)

NUIST (Nanjing University of Information Science and Technology)

OUC (Ocean University of China)

PACEO (Pacific Arctic Climate Ecosystem Observatory)

PPP (Polar Prediction Project)

PRB (Polar Research Board)

PRIC (Polar Research Institute of China)

RUSALCA (Russian American Long-term Census of the Arctic)

SAMS (The Scottish Association for Marine Science)

SAON (Sustaining Arctic Observing Network)

SIO (Second Institute of Oceanography)

SOA (State Oceanic Administration)

TRANSSIZ (Transitions in the Arctic Seasonal Sea Ice Zone)

TOA (Third Institute of Oceanography)

TUMSAT (Tokyo University of Marine and Science Technology)

UAF (University of Alaska Fairbanks)

UMCES (University of Maryland Center for Environment Sciences)

USCG (US Coast Guard)

UW (University of Washington)

WHOI (Woods Hole Oceanography Institute)

YOPP (Year of Polar Prediction)