

**2011**

# **PAG MEETING**



**INSTITUTE OF OCEAN SCIENCES  
SIDNEY, BRITISH COLUMBIA,  
CANADA  
16-17 NOVEMBER 2011**

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## Marty Bergmann



*Friends of the Pacific Arctic Group (PAG) and the International Arctic Science Committee (IASC) Marine Working Group: On Saturday, August 20, 2011 in Resolute Bay, Nunavut we lost a dear friend and colleague Martin “Marty” Bergmann in a tragic plane crash.*

*Marty Bergmann championed Arctic science both in Canada and within the international community. During his impressive career with the Canadian Government, most recently as Director of the Polar Continental Shelf Program, he worked tirelessly to support researchers in Canada’s vast and remote north and was a leader in rejuvenating Canada’s Arctic research infrastructure. Marty was a passionate advocate for research in Canada’s north and encouraged others to work beyond departmental, governmental, and international borders to achieve a better understanding of the Arctic.*

*Many of you also knew Marty as a strong supporter of IASC initiatives. He was instrumental in helping to establish and build the PAG and was the Canadian representative to PAG (2001-08). He Chaired the PAG in 2007-08 and was a strong advocate for numerous PAG initiatives that promoted international research collaboration with a focus in the Pacific-Arctic Region. At the time of his passing, Marty had moved to spearhead new initiatives as the Chair of the Forum of Arctic Research Operators (FARO).*

*We will also remember Marty as a passionate man who loved talking to others, asking them about their lives, and through these conversations developing lifelong friendships.*

*Our thoughts and prayers go out to his wife Sheila and his four children during this very difficult time. Marty's legacy will live on within the science community and the research he supported in the Arctic. He is greatly missed.*

**GIVING:**

*The Martin Bergmann Fund for Arctic Research was established through the Winnipeg Foundation in his memory by his family and friends. Gifts to this fund are invested and the income generated will support Marty's passion for advancing scientific research in the Arctic.*

*Donations can be made in honor of Marty to The Martin Bergmann Fund for Arctic Research at The Winnipeg Foundation, 1350 One Lombard Place, Winnipeg, MB, R3B 0X3, or by phoning (204) 944-9474 or Toll Free 1-877-974-3631 or online at [www.wpgfdn.org](http://www.wpgfdn.org).*

*Direct Link: <https://wpgfdn.tng-secure.com/?pageId=donation-edit&categoryId=3531>*

## Table of Contents

<b>1.0 WELCOME &amp; INTRODUCTION</b> .....	5
<b>2.0 THE FUTURE OF THE DISTRIBUTED BIOLOGICAL OBSERVATORY (DBO)</b> .....	5
<b>3.0 THE 2011 &amp; 2012 PAG NATION CRUISES OPERATIONS</b> .....	5
3.1 Canada .....	5
3.1.1 <i>Canada's Three Oceans (C3O)</i> .....	6
3.1.2 <i>Joint Ocean Ice Study (JOIS)</i> .....	8
3.1.3 <i>Arctic Ice Monitoring (AIM)</i> .....	9
3.1.4 <i>UNCLOS – Continental Shelf Seabed Mapping</i> .....	9
3.1.5 <i>ArcticNet</i> .....	10
3.1.6 <i>Barrow Strait Project</i> .....	11
3.1.7 <i>Canadian Arctic Marine Programs 2012</i> .....	12
3.2 China .....	13
3.3 Japan .....	13
3.4 Korea .....	14
3.5 The Russia Federation .....	18
3.6 The United States .....	20
3.6.1 <i>U.S. Pacific Arctic oceanographic research programs</i> .....	20
3.6.2 <i>Pacific Arctic Region (PAR) Synthesis: An update</i> .....	27
3.6.3 <i>Arctic Climate System Network (ACSNet) report</i> .....	29
3.6.4 <i>The Circumpolar Marine Biodiversity Monitoring Plan (CMBMP): An update</i> .....	31
<b>4.0 PAG BUSINESS</b> .....	32
4.1 Upcoming PAG related meetings .....	32
4.1.1 <i>Ecosystem Studies of Sub-Arctic Seas (ESSAS)</i> .....	32
4.1.2 <i>PAG Spring Meeting 2012</i> .....	34
4.1.3 <i>Arctic Science Summit Week (ASSW) 2012</i> .....	34
4.1.4 <i>International Polar Year (IPY) 2012 Conference</i> .....	34
4.1.5 <i>Arctic Science Summit Week (ASSW) 2013</i> .....	34
4.2 PAG executive secretariat .....	35
4.3 2013 & beyond .....	35
<b>5.0 APPENDIX A</b> .....	35
5.1 <i>Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System</i> .....	35
<b>6.0 PAG MEETING PARTICIPANT LIST</b> .....	36

## 1.0 WELCOME & INTRODUCTION

The Pacific Arctic Group (PAG) Meeting was organized by the PAG Executive Secretariat and the Institute of Ocean Sciences (IOS) of the Department of Fisheries and Oceans (DFO) Canada. Over 40 participants were involved in the meeting discussions. The goal of the PAG Meeting was to:

- 1) Review the outcomes of the Distributed Biological Observatory (DBO) Workshop and discuss the future of the DBO
- 2) Review 2011 and 2012 PAG nation Arctic science activities and cruise operations
- 3) Review PAG business

The DBO Workshop began with opening remarks by Dr. Jackie Grebmeier from the Chesapeake Biological Laboratory at the University of Maryland Center for Environmental Science (UMCES), where she linked biology to physics in an Arctic Ocean observing system.

Dr. Grebmeier welcomed PAG participants to the meeting and introduced the Acting PAG Chair, Dr. Kathy Crane from the National Oceanic and Atmospheric Administration (NOAA)'s Arctic Research Program (standing in for Dr. John Calder, the current Chair of PAG), and the Canadian PAG Host, Dr. Bill Williams, from IOS.

## 2.0 THE FUTURE OF THE DISTRIBUTED BIOLOGICAL OBSERVATORY (DBO)

Dr. Grebmeier spent the opening session of the PAG Meeting reviewing presentations and action items from the DBO Workshop that was held on November 15<sup>th</sup>, 2011 at IOS. *Please refer to Appendix A “**Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System**” for summary information regarding presentations and workshop outcomes. Also refer to the PAG website for a detailed review of presentations made during the DBO Workshop: ([www.paq.arcticportal.org](http://www.paq.arcticportal.org)).*

## 3.0 THE 2011 & 2012 PAG NATION CRUISE OPERATIONS

### 3.1 Canada

Dr. Robert Fudge, Director of the National Centre for Arctic Aquatic Research Excellence (NCAARE) of DFO Canada gave an insightful overview of Canada's marine science programs in the Arctic.

The main priorities that drive the Canadian Arctic marine program in the PAG region are:

- Understanding ecosystem science and climate change
- Marine Protected Areas (MPA), specifically the Beaufort Sea
- Oil and gas industry exploration and development

- United Nations Convention on the Law of the Sea (UNCLOS)

In 2011, Canadian Arctic marine programs included Canada's Three Oceans (C3O) (Bill Williams, Svein Vagle), the Joint Ocean-Ice Study (JOIS) (Svein Vagle, Bill Williams, Jane Eert), Arctic Ice Monitoring (AIM) (Humphrey Melling), UNCLOS, ArcticNet (Martin Fortier), and the Barrow Strait Program (Jim Hamilton).

The 2011 field year represented a return to pre International Polar Year (IPY) levels of vessel programming. Researchers that are continuing with work are examining more efficient ways of conducting research, which may include alternating field years, investigating alternate platform options, moving to opportunistic ship time options or relying more heavily on national, international and industry partners.

### **3.1.1 Canada's Three Oceans (C3O)**

The goal of the C3O program is to study the impacts of climate variability on the sub-arctic and arctic water circulation and on the associated marine ecosystems. As part of Canada's contribution, and now a continuation of, the IPY research effort, two Canadian research vessels, the *CCGS Louis S. St-Laurent (LSSL)* (St. John's – Resolute; July 02-21, 2011) and the *CCGS Sir Wilfrid Laurier (SWL)* (Victoria – Barrow; July 08-20, 2011) were employed in nearly synchronous data collection along the east and west coasts of Canada.

#### CCGS LSSL 2011 program components:

- Underway collection of meteorological and near-surface seawater
- 49 XCTD (expendable temperature, salinity and depth profiler) casts to 1100m depth
- 48 drift bottles launched at 2 sites
- 1 CTD/rosette cast with 11 samples for hydrograph and geochemistry (nutrients, salinity,  $\delta^{18}\text{O}$ , and barium)
- Seabird surveys using 5-minute observation periods while the ship was underway
- Ice observations through regular visual observations from bridge and automated fixed-camera photos.

#### CCGS SWL 2011 program components (including DBO stations):

*CCGS SWL* data were collected on the physical, biological and geochemical properties of ocean waters across the North Pacific Ocean, and the shelf regions of the Bering and Chukchi Seas. Data were also collected on the benthic ecosystems in the Bering and Chukchi Seas.

The shipboard data collection included physical, biological, geochemical and benthic sampling. Profiles of water temperature and salinity were obtained with CTD, and an underway CTD system. Additional sensors on the CTD profiler collected in situ data on phytoplankton concentrations (fluorometer), optical clarity (transmissometer), dissolved

oxygen and photoactive radiation. A rosette sampler was used with the CTD to obtain water samples from discrete depths for a broad suite of biological and geochemical parameters, some for onboard analysis, others to be stored for later analysis in shore-based laboratories. Benthic sampling was conducted using Van Veen grabs. Both bio-acoustic backscatter data and depth-varying current information were collected using a RDI Longranger 150 kHz Acoustic Doppler Current Profiler (ADCP) deployed over the port side of the ship at most of the science stations. Data were also collected from the ship-mounted 12 kHz transducer along the ship track to evaluate the possibility of using these data for bottom classification purposes. Zooplankton samples were obtained in vertical hauls by bongo-nets lowered to 100 m or from bottom depth minus 10 m in waters shallower than 110 m. Continuous underway sampling of near-surface seawater temperature, salinity, fluorescence, oxygen, nitrogen, CO<sub>2</sub>, and methane (CH<sub>4</sub>). Samples were collected for analysis of chlorophyll. Onboard laboratory primary productivity experiments were performed in incubators located on the helicopter deck. Bird and marine mammal observations were also conducted, as well as drift-bottle deployments.

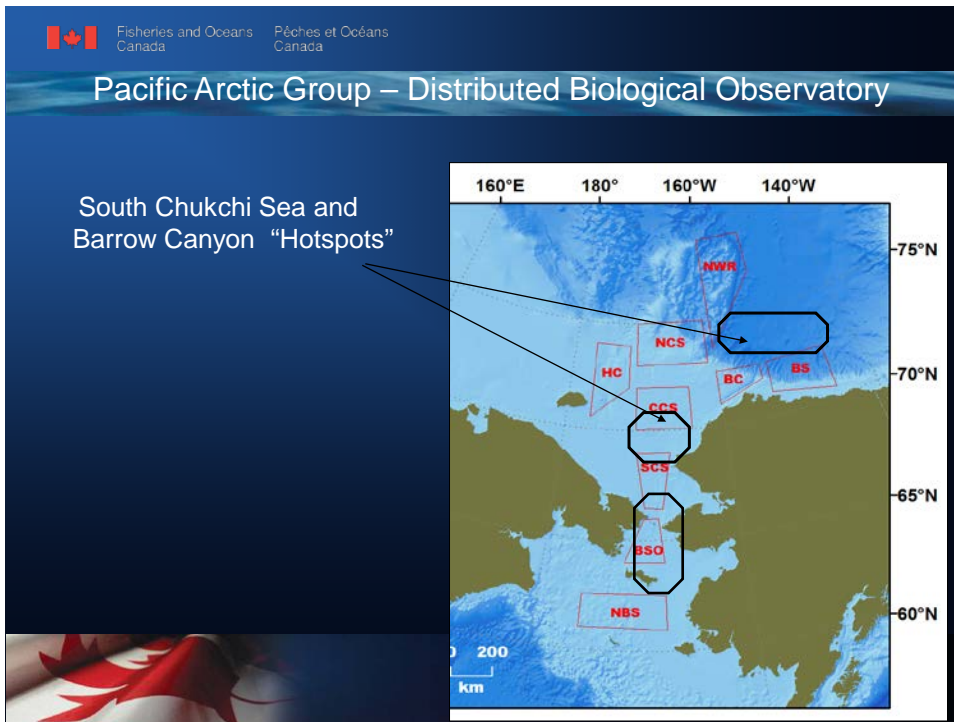
Areas: North Pacific Ocean, the Bering and Chukchi Seas

- 37 science stations completed
- 37 CTD/rosette casts
- 37 150 kHz ADCP deployments
- 29 bongo plankton net hauls
- 33 benthic sampling station

Underway data collection included:

- 32 XCTD profiles
- Surface water properties using the seawater loop
- Bird and mammal observations during daylight hours
- Meteorological data from ship sensors

C3O and the DBO programs combine efforts by researchers from government institutes and universities to monitor physical, biological and geochemical factors affecting changes in climate. There are 9 zones established for standardized and seasonal observations in the DBO. The Canadian program contributed in the 3 zones (South Chukchi Sea and Barrow Canyon ‘Hotspots’) indicated in black (Figure 3.1.1-1):



(Figure 3.1.1-1): C3O standardized zones ( 3 zones in the South Chukchi Sea and Barrow Canyon ‘Hotspot’ regions as indicated in black) and seasonal observations in the DBO. Courtesy of Dr. Robert Fudge from NCAARE.

### 3.1.2 Joint Ocean Ice Study (JOIS)

The Beaufort Gyre in the Canadian Basin is the largest freshwater storage reservoir of the Arctic, however its variability and influence on circulation and the export of freshwater to the global ocean is still poorly understood. JOIS aims to study the effects of climate variability and the changing properties and distributions of the Pacific and Atlantic waters within the Arctic. During 2010 – 2014 JOIS is continuing the Beaufort Gyre Observing Program, which is a collaboration between DFO, the U.S. National Science Foundation (NSF), Woods Hole Oceanographic Institute (WHOI), and The Japanese Agency for Marine-Earth Science and Technology (JAMSTEC).

#### CCGS SWL 2011 program components (CCGS LSL, Jul 21-Aug 18):

CTD/Rosette Stations:

- 52 CTD/rosette casts at 48 Stations with 997 water samples collected
- 78 vertical net casts at 37 select rosette stations (100m to 500m deep)
- 49 XCTD casts (~ 1100m depth)
- WHOI - mooring and buoy operations
- Ice observations

### 3.1.3 Arctic Ice Monitoring (AIM)

The objective of the AIM expedition is to recover, service, and re-deploy internal recording instruments on sub-sea moorings. As well, AIM aspires to map selected properties of seawater (temperature, salinity, chlorophyll fluorescence, dissolved O<sub>2</sub>, CO<sub>2</sub>, and CH<sub>4</sub>), as well as monitor sea ice thickness (hazard assessment).

#### CCGS SWL 2011 program components (September 20 – October 9, 2011):

- Recover 5 short oceanographic moorings; and redeployed 5 replacement moorings
- Recover 1 deep-sea mooring with sediment traps
- Deploy 1 prototype satellite reporting drifting buoy (UpTempO) (for the University of Washington)
- Deploy 3 ocean-to-ice drifting buoys (for Environment Canada)
- 7 CTD casts and 3 CTD/rosette casts at mooring sites
- 48 XCTD drops along the Beaufort slope
- On-shore calibration of instrument compasses

### 3.1.4 UNCLOS – Continental Shelf Seabed Mapping

UNCLOS governs the delineation of the continental shelf where it extends beyond the 200-nautical-mile Exclusive Economic Zone (EEZ). A coastal state with a continental shelf extending beyond 200 nautical miles has 10 years from its ratification of UNCLOS to make a submission to the United Nations Commission for the Limits of the Continental Shelf (the Commission). Canada ratified UNCLOS in 2003 and has until 2013 to present a submission to the Commission. In 2011 Canada successfully completed its mission. Figure 3.1.4-1 illustrates the UNCLOS survey area for 2011.

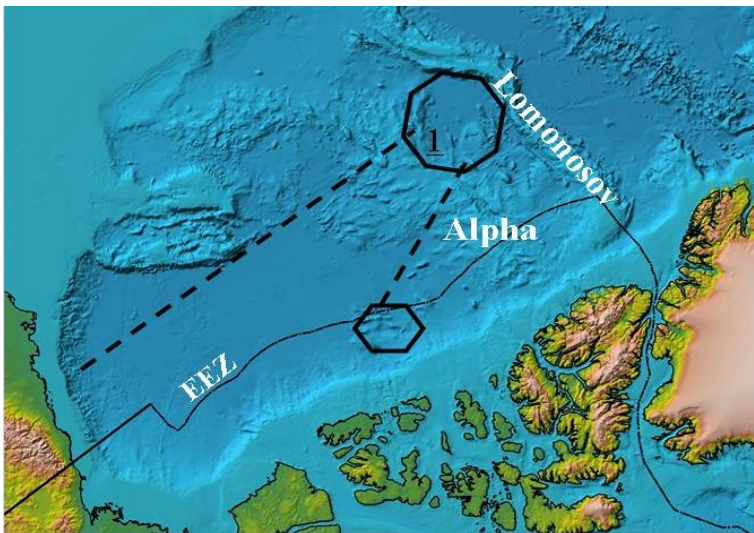


Figure 3.1.4-1: UNCLOS survey area for 2011. Courtesy of Dr. Robert Fudge from NCAARE.

The CCGS LSL and the USCG Cutter Healy (August 18 – September 29, 2011) program components:

- Successful seismic surveys
  - Collected 13,500 km of seismic data (very good quality)
  - Covered most of the extended area
- Joint operations with U.S. in 2008, 2009, 2010 and 2011
  - Able to collect seismic under heavy ice conditions (up to 84)
  - First seismic data in northern Beaufort Sea
  - Large quantities of sediments in entire Beaufort Sea
  - Fourth joint survey with U.S. planned for 2011
  - Extensive use of Autonomous Underwater Vehicles (AUV)'s

### **3.1.5 ArcticNet**

ArcticNet is a Network of Centres of Excellence of Canada that brings together scientists and managers in the natural, human health and social sciences with their partners from Inuit organizations, northern communities, federal and provincial agencies and the private sector to study the impacts of climate change in the coastal Canadian Arctic. Over 145 ArcticNet researchers from 30 Canadian Universities, 8 federal and 11 provincial agencies and departments collaborate with research teams in Denmark, Finland, France, Greenland, Japan, Norway, Poland, Russia, Spain, Sweden, the U.K. and the U.S..

In 2011 the ArcticNet expedition commenced on board the *CCGS Amundsen* (July 17 – November 3, 2011; see Figure 3.1.5-1). More specifically, the overarching goal of the ArcticNet marine-based research program is to study on a long-term basis how climate induced changes are impacting the marine ecosystem, contaminant transport, biogeochemical fluxes, and exchange processes across the ocean-sea ice-atmosphere interface in the Canadian Arctic Ocean. Ultimately, the knowledge generated from this multi-year program will be integrated into regional impact studies to help decision makers develop effective adaptation strategies for the changing coastal Canadian Arctic.

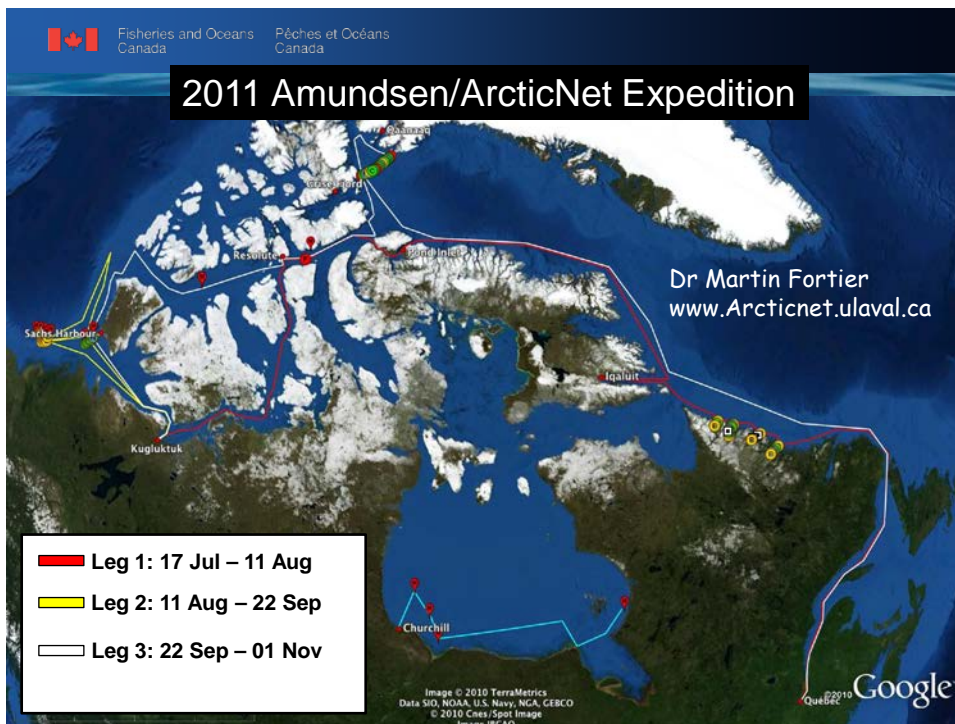


Figure 3.1.5-1: 2011 CCGS Amundsen ArcticNet expedition. Courtesy of Dr. Robert Fudge from NCAARE.

CCGS Amundsen 2011 program components:

- Mooring deployments
- Oceanographic and biological sampling

ArcticNet has been approved for another 7 years of study.

**3.1.6 Barrow Strait Project**

The Barrow Strait Project commenced on board the *CCGS Des Groseilliers* (August 02 – 11, 2011) in the Barrow Strait.

CCGS Des Groseilliers 2011 program components:

- Recover 5 moorings at 091° W in Barrow Strait.
- Deploy 3 moorings at the Southerly site at 091° W.
- Along the eastern Barrow Strait line at ~091° W
  - 17 CTD stations
  - Water sample collection for biological and chemical analysis
  - Zooplankton sample collection with ring nets

In 2009, a 3km cable was successfully routed through a pipe across the Bering Strait. In 2010, a 2-way Iridium satellite communications system was developed for the project and was successfully tested. In 2011, a 5km extension was deployed to the underwater cable

at Gascoyne Inlet. An instrumented mooring was also deployed near the offshore end of the cable. Figure 3.1.6-1 provides an illustration of 2011 Barrow Strait science activities.



Figure 3.1.6-1: Barrow Strait Project 2011 science activities. Courtesy of Dr. Robert Fudge from NCAARE.

### 3.1.7 Canadian Arctic Marine Programs 2012

In 2012, Canadian Arctic marine programs will include:

- **C30** (July, 2012 – CCGS LSSL St-John’s – Kugluktuk (Leg 1); July, 2012 – CCGS SWL Victoria – Barrow (Leg1)) – Bill Williams, Svein Vagle
- **JOIS** (July – August 2012 – CCGS LSSL Kugluktuk – Beaufort Sea and Canada Basin) – Svein Vagle, Bill Williams, Jane Eert
- **AIM** (September 25, 2012 – CCGS SWL homebound transit (Leg3)) – Humfrey Melling
- **ArcticNet** – Martin Fortier
- **Canadian Arctic Through-flow Study** (*NEW INITIATIVE, initiated during IPY*) (Tentatively August 2012 – CCGS Henry Larsen Nares Strait (Smith Sound-Hall Basin and Petermann Fjord)) – Humfrey Melling
  - This scientific study is directed towards measuring the flow of seawater from the Arctic cross the Canadian polar shelf. By closing gaps in our knowledge of this flow we will better understand the impacts of Arctic climate change. The study is based on long-term observations by autonomous instruments on sub-sea moorings.
    - Recover 7 deep-water moorings
    - Recover 1 shallow-water mooring
    - Deploy a smaller array of 3 deep-sea moorings
    - Service automatic weather stations at Brevoort Island, Hans Island (Canada and Denmark) and Cape Baird

- Retrieve robot cameras from Petermann Fjord (Canada and U.S. (NSF))
  - CTD profiles
- **Barrow Strait Program** (Tentatively August 27 – September 02, 2012 – *CCGS Henry Larsen* Eastern Barrow Strait Area – Gasycoyne Inlet) – Jim Hamilton

*Suggestion:* Add acoustic sensors to the Barrow Strait Program cables to monitor for marine mammals.

### 3.2 China

Participants from China were unable to attend the PAG meeting to report on Arctic cruise operational activities. China had no Arctic research activities in 2011.

### 3.3 Japan

Dr. Takashi Kikuchi from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) in Yokosuka, Japan gave a presentation on Japanese science activities in the Arctic. Though Japan had no Arctic cruise operational activities to report on for 2011, Dr. Kikuchi did present on a new Japanese multidisciplinary initiative, Ecosystem Studies on the Arctic Ocean Declining Sea Ice (ECOARCS), that focuses on sea ice reduction and its impact to the Arctic marine ecosystem from 2011-2015.

Due to the very rapid reduction in sea ice, the project will focus on three main areas that are closely related together:

- 1) Changes in hydrographic and geochemical conditions
- 2) Impacts on the distribution, production, size, and delivery of microbe, phytoplankton and zooplankton
- 3) Changes in marine mammals and seabird dynamics in the Arctic Ocean

Under ECOARCS project, they will have observational cruises by *R/V Mirai* (JAMSTEC) and *T/S Oshoro-maru* (Faculty of Fisheries, Hokkaido University), moorings, bio-logging, satellite-monitoring and model investigations.

In 2012 there is a tentative *R/V Mirai* Arctic Ocean cruise plan scheduled for early September-late October. The main target will be the Chukchi shelf and shelf slope areas. Tentative activities will include:

- CTD/LADCP/water sampling and XCTD
- Mooring recovery/deployment
- Plankton net sampling
- Bio-geochemical measurements
- Multiple corer sampling
- General meteorological monitoring

- Surface water sampling/monitoring
- Shipboard ADCP monitoring

Moorings will be deployed around two areas of the DBO ‘hotspots’. One is at the southern Chukchi ‘hotspot’, and another is at the Barrow Canyon. For those moorings, Acoustic Water Column Profilers (ASL Environmental Science) will be used for detecting dynamics of marine zooplankton in addition to hydrographic sensors and acoustic receivers. The first (short-term) mooring will be deployed by the *CCGS Laurier* cruise in July 2012. After the recoveries, year-round mooring observations will start from September 2012 (*R/V Mirai* cruise). Figure 3.3-1 provides an overview of the 2011-2015 ECOARCS science activities planned.



New Japanese project (2011-2015):

DBO workshop/PAG meeting  
@ Sydney, Canada  
November 15-17, 2011

### Sea ice reduction and its impact to Arctic marine ecosystem

Table 1 Yearly Plan of the project







	2011	2012	2013	2014	2015
1) Ship-based Observation	Preparation	R/V Mirai Arctic Ocean cruise 	Oshoro-Marui Cruise R/V Mirai Arctic Ocean Cruise 	Oshoro-Marui Cruise 	
2) Mooring	Preparation 	Jul. Deployment by SWL Sept. Recoveries & Deployments by Mirai	Sept. Recoveries & Deployments by Mirai	Sept-Oct. Recoveries & Deployments by SWL(?)	Sept-Oct. Recoveries by Mirai
3) Bio-Logging	Preparation	Bio-Logging 	Oshoro-Marui Cruise	Oshoro-Marui Cruise	
4) Satellite	(GCOM-W)	Collaboration with ship-based observations	Satellite monitoring Collaboration with ship-based observations	Collaboration with ship-based observations	
5) Numerical simulation			Model development & simulation		

Figure 3.3-1: Yearly plan of the new Japanese project ECOARCS from 2011-2015. Courtesy of Dr. Takashi Kikuchi from JAMSTEC.

### 3.4 Korea

Dr. Kyung Ho Chung from the Korean Polar Research Institute (KOPRI) in Seoul, Korea, gave a presentation on Korea’s 2011 and 2012 research activities in the Arctic.

The main purpose of Korea’s 2011 research activities in the Arctic was to monitor marine ecosystem response to ongoing environmental changes in the Western Arctic Ocean. The cruise commenced from July 31 – August 20, 2011 (Nome-Nome) with a total of 40 participants from Korea, the U.K., Spain, Russia, Japan and China. Figure 3.4-1 depicts the 2011 study area. Areas of research interest included atmospheric observations, satellite remote sensing, PCO<sub>2</sub> measurements, hydrographic surveys, microbes and plankton ecology, sea ice studies, melt pond (ice algae) studies and paleoceanographic changes.

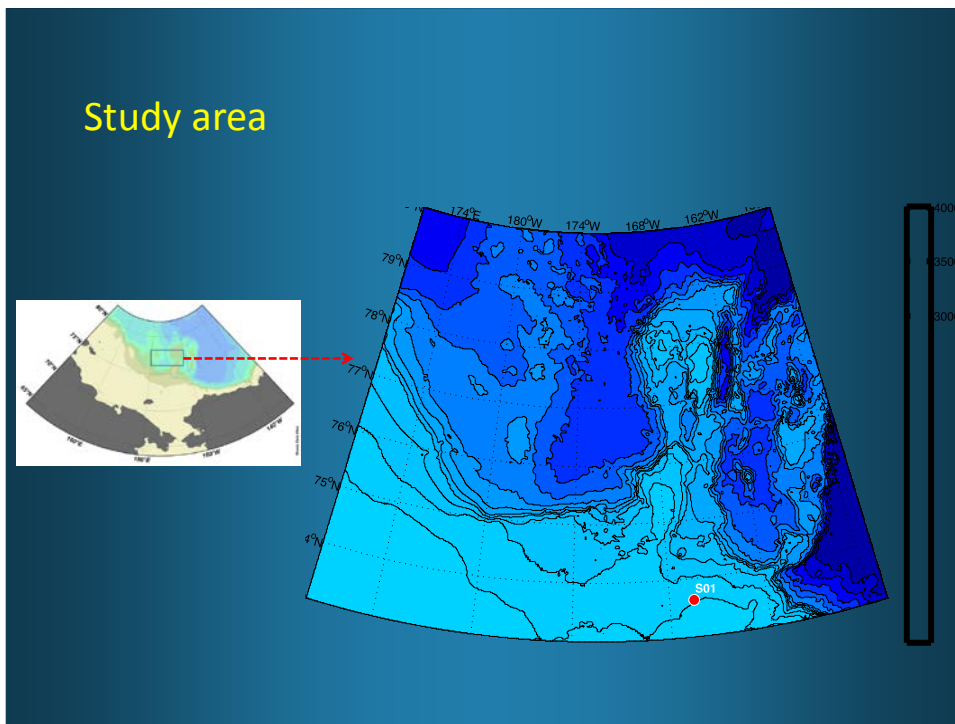


Figure 3.4-1: The 2011 Korean study area in the Arctic Ocean. Courtesy of Dr. Kyung Ho Chung from KOPRI.

### Atmospheric Observations

The atmospheric observation objectives for 2011 included greenhouse gases ( $\text{CO}_2$ ,  $\text{CH}_4$ ) and aerosol measurements (in situ) to better understand the effect of decreased sea ice on the atmosphere and to test on board atmospheric instruments to improve them for in-situ measurements.

### Satellite Remote Sensing

The satellite remote sensing objectives for 2011 focused on ocean color, specifically absorption by phytoplankton, suspected sediments and colored dissolved organic matter.

### PCO<sub>2</sub> Measurements

The  $\text{pCO}_2$  measurement objectives for 2011 included continuous concentration measurements in the surface mixed layer along the cruise track of *RV/ARAON* from Incheon–Chukchi Sea–Incheon.

Figure 3.4-2 shows the saturation anomaly of dissolved  $\text{CO}_2$  along the cruise track. The Chukchi Sea appeared to be under-saturated with atmospheric  $\text{CO}_2$  during the cruise season. The Bering Strait shows much larger under-saturation than the area over the Chukchi Plateau. Dr. Chung surmises that this is likely due to strong biological activities supplying nutrients from the Pacific Ocean.

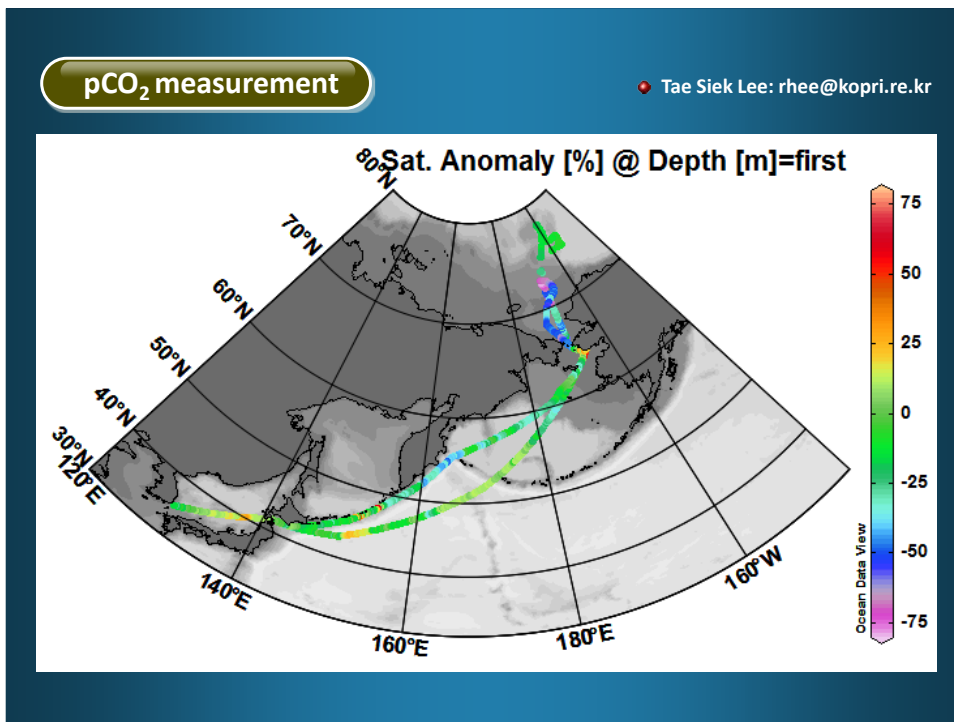


Figure 3.4-2: Saturation anomaly of dissolved CO<sub>2</sub> along the RV/ARAON cruise track from Incheon–Chukchi Sea–Incheon. Courtesy of Dr. Chung from KOPRI.

### Hydrographic Surveys

The objectives for the hydrographic and water mass studies for 2011 were to study water mass distribution and characteristics in the Chukchi Boderland/Mendelev Ridge. Variability in spatial and temporal distribution of water masses was examined. This included 1) the examination of temperature and salinity structure; 2) the origin of Pacific warm water; 3) the correlation between water intrusion and sea ice distribution; 4) current velocity fields; and 5) eddy structure.

### Microbial Ecology

The objective for the 2011 microbial ecology study was to examine distributions and diversities of bacteria and viruses in the open ocean (links between bacterial and viral communities), deep-sea sediments (bacterial diversity and biogeography), and sea ice (isolations and characterizations of psychrophilic bacteria and cold active viruses).

### Plankton Ecology

The objectives for the 2011 phytoplankton ecology studies were to 1) understand temporal and spatial fluctuations of environmental factors affecting on physiological/ecological mechanisms of phytoplankton in the Marginal Ice Zone (MIZ); 2) measure the relative importance of the environmental factors affecting phytoplankton in the MIZ; 3) understand changing patterns of phytoplankton community structures at the species-specific level (composition and dominance); 4) find key indicator species to detect

the environmental changes; and 5) use the indicators as biological parameters on the environmental changes.

The objectives for the 2011 zooplankton ecology studies were to 1) understand temporal and spatial distributions; 2) investigate changing patterns of zooplankton community structures at the species-specific level (composition and dominance); 3) find key indicator species to detect the environmental changes; and 4) study feeding rates of abundant copepods and the impact of copepod grazing on phytoplankton biomass.

### Underway Measurements

In 2011, continuous sampling along the Incheon–Chukchi Sea–Incheon cruise track, except in the U.S. EEZ, commenced in order to examine *in vivo* chlorophyll *a*, temperature, salinity, nutrients ( $\text{SiO}_2$ ,  $\text{NO}_3+\text{NO}_2$ ,  $\text{NH}_4$ ,  $\text{PO}_4$ ), and physiological parameters ( $F_v/F_m$ ,  $\sigma_{\text{PSII}}$ ,  $1/\tau_{\text{PSII}}$ ). Pigment and nutrient measurements took place every 4 hours.

### Sea Ice Studies

The objective of the 2011 sea ice study was to capture sea ice patterns, perform airborne (helicopter) SAR surveys and buoy deployment.

Sea ice pattern studies involved 1) real time mapping using icebreaker navigation; 2) satellite sea ice data CAL/VAL to improve accuracy of sea ice data from microwave satellite; and 3) sea ice pattern grouping to find correlations between ocean environmental conditions (temperature, salinity, wind and air temperature).

Airborne (helicopter) SAR surveys were performed to acquire ground-truth data for the calibration and validation of the satellite observations. They were also performed to test the feasibility of helicopter-based airborne SAR system for the future measurements.

Buoy deployments (SATICE Buoy, SAMS Ice Mass Balance Buoy (SIMAB), and UpTempO#9 Buoy) were performed to obtain accurate and continuous measurements of sea ice dynamics and upper-ocean properties in the Arctic Ocean. These findings are crucial for improved understanding of the mechanisms behind recent abrupt changes, as well as to identify/improve the shortcomings of climate models.

The SATICE Buoy can provide high precision position, snow depth, free-board and meteorological variables. The SATICE Buoy measures sea ice/ocean dynamics to within a few centimeters precision. It was used to study tides, ocean circulation, ocean dynamic topography, sea-ice free-board heights, ice thickness and sea ice mass balance in the Arctic Ocean.

The SIMAB can provide GPS locations, temperature profiles (air, ice and water), and ice growth/melt using a 'hot wire' technique. The SIMAB consists of a thermistor string (about 5-m long), a GPS and Iridium transmitter/receiver. The thermistors of the string are spaced

every 2 cm with 'hot-wire' capability, which is used to delineate the surrounded media (air, snow, ice and water) based on different thermal conductivity of the media.

The UpTempO#9 Buoy measures the upper layer temperature of the polar oceans at nominal depths down to 60m.

### Melt Pond (Ice Algae) Studies

The melt pond study objective for 2011 was to investigate the production and macromolecular composition of ice algae to 1) examine the controlling factors for ice algal C/N production; 2) compare macromolecular compositions of different size fractionated ice algae; and 3) study the effect of light intensity under different sea ice thicknesses on primary productions.

### Paleoceanography

The paleoceanography objectives for 2011 included measurements (seismic surveys, sediment and box cores) to better understand recent oceanographic and environmental changes closely related to global warming in the western Arctic, and to reconstruct paleoceanographic changes (sea-ice coverage, brine formation, paleoproductivity, and the origin of organic matter) in the western Arctic Ocean during the late Quaternary glacial-interglacial cycles.

Dr. Chung spoke briefly about Korea's tentative 2012 cruise operation plans in the Arctic. Currently Korea is expecting to conduct a result study (Nome-Nome) during the period of July 31-September 8, 2012. Participants are not fixed at this time. The area of study is expected to mirror that of 2011 and include atmospheric observations, satellite remote sensing, pCO<sub>2</sub> measurements, hydrographic surveys, microbes and plankton ecology, sea ice studies, melt pond (ice algae) studies and paleoceanographic studies.

In 2012 Korea is expecting to examine protozoan community structure, diversity and production. They plan to investigate the ecological characteristic of protozoa in relation to physical environmental conditions (water mass and sea ice). This would include distribution and community structure, protozoan indicator species to detect environmental variation, and herbivory of protozoan grazers.

## **3.5 The Russian Federation**

Dr. Igor Semiletov from the International Arctic Research Center (IARC) at the University of Alaska Fairbanks (UAF), and the Far Eastern Branch of Russian Academy of Sciences (FEBRAS) gave an overview of Russian activities in 2011 and 2012 in the Arctic. He presented on Russian-U.S. joint field activities in the Laptev, East Siberian, Chukchi, and Bering Seas in 2011. Dr. Semiletov discussed 1) how the East Siberian Arctic Shelf (ESAS) is a unique environment hosting shallow shelf hydrates; 2) what was known before the cruise in 2011; 3) cruise findings; and 4) future plans.

The ESAS is a unique natural laboratory comprising most of the accessible Arctic Shelf. The total area is  $2.1 \times 10^6 \text{ km}^2$  (~25% of the Arctic Shelf and ~8% of the world ocean's continental shelf). Approximately 75% of the ESAS is shallower than 50m (mean depth of the continental shelf is 130m); this provides very short conduit for Green House Gases (GHGs) to escape to the atmosphere. The shallowness determines alteration of dry position (cold epochs)/submerged position (warm epochs), which occurs due to sea level fluctuation.

The Arctic sub-sea permafrost is the most fragile component of the modern cryosphere. The state of the sub-sea permafrost is a key geological factor controlling gas emission from the seabed. Approximately 80% of the total area of sub-sea permafrost is in the ESAS. Shallow hydrates underlay more than 80% of the ESAS area. Release of approximately 1% of the expected hydrate deposits from this shallow seafloor into the atmosphere can greatly increase the amount of methane in the atmosphere.

The Holocene transgression warmed up the flooded onshore/sub-sea permafrost  $> 15^\circ\text{C}$ .

Land-shelf export of terrestrial organic carbon plays a dominant role in the regional carbon cycle. The ESAS represents the broadest and shallowest shelf of the world's oceans, which accumulates fresh water and carbon signals from the Eurasian continent via the Great Siberian Rivers Lena, Indigirka and Kolyma. Those rivers integrate 21 geochemical signals from their vast watersheds located in changing permafrost zones. The huge pool of vulnerable carbon in the ESAS is comparable to the carbon pool contained in the upper 3m of shore permafrost. Increasing land-shelf transport of carbon is expected. One consequence could be enhanced acidification of the ocean in this region.

The highest rates of coastal erosion were found in the ESAS, with rates that can be as high as 30m over a two week period.

In general, the western ESAS has low-productivity, is turbid, and is a source of  $\text{CO}_2$ . Conversely, the eastern ESAS has high-productivity and is a  $\text{CO}_2$  sink.

The ESAS is a strong source of  $\text{CH}_4$  in the atmosphere.

Dr. Semiletov illustrated the location of oceanographic stations accomplished with NOAA, FEBRAS, and the Office of Polar Programs (OPP) at the NSF support in 2003-2010.

Complex oceanographic stations, including ~ 10,000 miles of continuous  $\text{CH}_4$  and  $\text{CO}_2$  air/surface water measurements, 3 echo-sounding stations, ~1,500 miles of high resolution seismoprofiling, and 115 biogeochemical stations, were accomplished in September-October of 2011 during the 8<sup>th</sup> Russian-American joint cruise onboard the *RV/Academician Lavrentiev*.

Dr. Semiletov showed images of seafloor features produced using side-looking sonar and seismoprofilers, and mentioned the new discovery of a massive methane seepage field in the ESAS that is currently being investigated.

The first Russian-U.S. drilling and methane study transpired in April 2011 in the Laptev Sea. An abundance of methane and hydrogen was discovered. No permafrost was detected at the drilling site.

Dr. John Holdren, advisor to President Barack Obama for Science and Technology, and Russian Minister Andrey Fursenko co-chaired the second official meeting of the Science and Technology Working Group (S&T WG) of the Bilateral Presidential Commission (BPC) on March 2, 2011 in Moscow, Russia. The S&T WG identified climate science as 1 of 4 critical areas to embark upon immediately. Degradation of subsea permafrost and associated methane emissions in the Arctic was deemed urgent and to receive immediate attention.

#### 2012 and beyond:

- 1) 9<sup>th</sup> Russia-U.S. (NOAA-IARC/FEBRAS based) joint cruise in the ESAS (August-September, 2012)
- 2) 2<sup>nd</sup> Russia-U.S. drilling campaign in the Laptev Sea (March-April, 2012)
- 3) Involve more U.S. and Japanese scientists in the South Siberian Sea project
- 4) Contribute to DBO in frame of new joint projects

### **3.6 The United States**

#### ***3.6.1 U.S. Pacific Arctic oceanographic research programs***

Dr. Kathleen Crane from NOAA's Arctic Research Program gave a presentation on the U.S. Pacific Arctic oceanographic research programs, specifically the Russian American Long-Term Census of the Arctic (RUSALCA), the Ice Edges Project, and the Alaska Monitoring and Assessment Program (AKMAP) Chukchi Sea 2011 Coastal Impact Assistance Program Assessment. Additionally Dr. Grebmeier spoke briefly about a few more endeavors, specifically the Impacts of Climate on Ecosystems and Chemistry of the Arctic Pacific Environment (ICESCAPE), the Chukchi Acoustics, Oceanography, and Zooplankton (CHAOZ) Study, the Bowhead Whale Feeding Ecological Study (BOWFEST), the Arctic Observing Network (AON), the Early Winter Oceanography in the Bering and Chukchi Seas Project, the Bureau of Ocean Energy Management (BOEM) Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA) Hanna Shoal Ecosystem Study, and Industry Partnerships – Shell-Conoco Phillips-StatOil.

## RUSALCA

The RUSALCA program is an excellent example of NOAA's international efforts and of integrated physical-ecosystem science. Dr. Crane began her presentation with an overview of the RUSALCA program main goals followed by a historical overview. The main goals of the RUSALCA program are to:

- 1) Take observations where the Arctic sea ice is reducing rapidly
- 2) Study Bering Strait fresh water and nutrient fluxes
- 3) Understand regional physics and ecosystem response to change
- 4) Improve international Arctic science collaboration
- 5) Explore the unknown Arctic
- 6) Link RUSALCA with PAG vessels and programs.

Twelve research proposals have been funded from 2004-2013 to support these goals in the Chukchi and Bering Sea's. As well, funds have gone toward The Bering Strait Mooring Observatory:

- Physical and chemical oceanography
- Observations of Seafloor fluxes, carbon, CH<sub>4</sub> observations of atmospheric fluxes and contaminants
- Seafloor mapping and paleoceanography
- Benthic ecosystems observations
- Water column observations of biota
- Nutrients and productivity
- Fish ecosystems
- Ice biology

July 23, 2004 marked an historic day in Arctic research and exploration as well as Russian-U.S. Relations. On this date the Russian research ship, the Professor Khromov, left Vladivostok, Russia packed with U.S. and Russian funded scientists to begin a 45-day collaborative journey of exploration and research in the Arctic.

Stemming from a 2003 Memorandum of Understanding (MOU) for World Ocean and Polar Regions Studies between NOAA and the Russian Academy of Sciences, this cruise was the first activity under the RUSALCA program. In November 2003, a RUSALCA planning workshop was held in Moscow, Russia to outline the biological, geological, chemical and physical oceanographic sampling strategies to be pursued in the Bering Strait and the Chukchi Sea.

The Initial Expedition to the Bering and Chukchi Seas was conducted in 2004. This initial cruise was a collaborative U.S. – Russian Federation oceanographic expedition to the Arctic seas regions shared by both countries: the Bering and Chukchi Seas. A census of marine life and exploration of the Chukchi Sea commenced. Also, monitoring of fresh and salt water fluxes through the Bering Strait and Herald Canyon took place. These seas and

the life within are thought to be particularly sensitive to global climate change because they are centers where steep thermohaline and nutrient gradients in the ocean coincide with steep thermal gradients in the atmosphere. The Bering Strait acts as the only Pacific gateway into and out of the Arctic Ocean and as such is critical for the flux of heat between the Arctic and the rest of the world. Monitoring the flux of fresh and salt water as well as establishing benchmark information about the distribution and migration patterns of the life in these seas are also critical pieces of information needed prior to the placement of a climate-monitoring network in this region.

The RUSALCA program is an example of the value of both interagency and international partnerships. It was designed so that annual cruises would take place, with a major interdisciplinary ocean exploration effort, every 4 years. RUSALCA cruises in 2005 and 2007 were smaller-scale efforts to retrieve mooring data. In 2007, the RUSALCA program installed 7 moorings from the U.S. to Russia. NOAA and the NSF co-funded the Bering Strait Gateway Mooring Observatory in 2007 with collaboration from the Russian Academy of Sciences, Roshydromet and the Russian Federation Navy. Moorings were also placed from Alaska to Chutkotka in 2007. Other moorings across the Bering Strait were serviced and data was removed.

The Bering Strait Mooring Observatory is one of the most difficult programs to carry out due to political restraints between governments. Currently 8 moorings exist, with upper and lower sensors. They are also equipped with whale recorders, as well as pH and pCO<sub>2</sub> sensors.

These moorings help the scientific community better understand how the melt back of sea ice in the Pacific Arctic reflects flow pathways of different water masses, such as that observed in the Harold Canyon.

As well, these moorings have been used to link ice cover to ecosystem structure of benthic and pelagic species. In the Northern Bering and Chukchi Seas there is an abundance of sea ice, with a greater abundance of ice algae and less phyto- and zoo-plankton in the water column. Hence there is greater abundance of benthos to support demersal fish, diving ducks, walrus, gray whales and bearded seals. Conversely, in the Southern Bering Sea there is limited sea ice, with a greater abundance of pelagic species and more phyto and zooplankton in the water column. Therefore there is greater abundance of pelagic species to support sea birds, pelagic fish, as well as bowhead and gray whales.

Physical and chemical changes in the ocean will have ecosystem consequences of importance, such as species migration and transport to new locations north.

In 2011 the RUSALCA program faced a confluence of permission issues regarding border guard requirements. The expedition was prohibited access into Russian waters. Only moorings on the U.S. side of the Bering Strait were retrieved, serviced and redeployed. As of 2011, the U.S. solved all previous U.S. Coast Guard related issues.

Dr. Crane briefly described the proposed 2012 RUSALCA expedition (Figure 3.6.1-1), and well as proposed RUSALCA program observing 2012-2020 (Figure 3.6.1-2).

## Proposed RUSALCA 2012 Leg 1 & 2

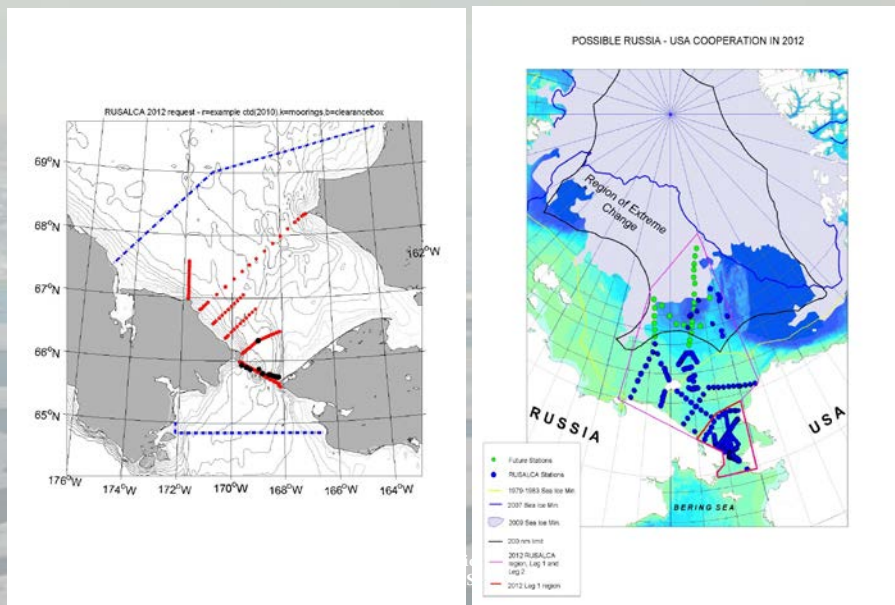


Figure 3.6.1-1: Proposed RUSALCA 2012 Leg 1 and 2. Courtesy of Dr. Crane, NOAA Arctic Research Program.

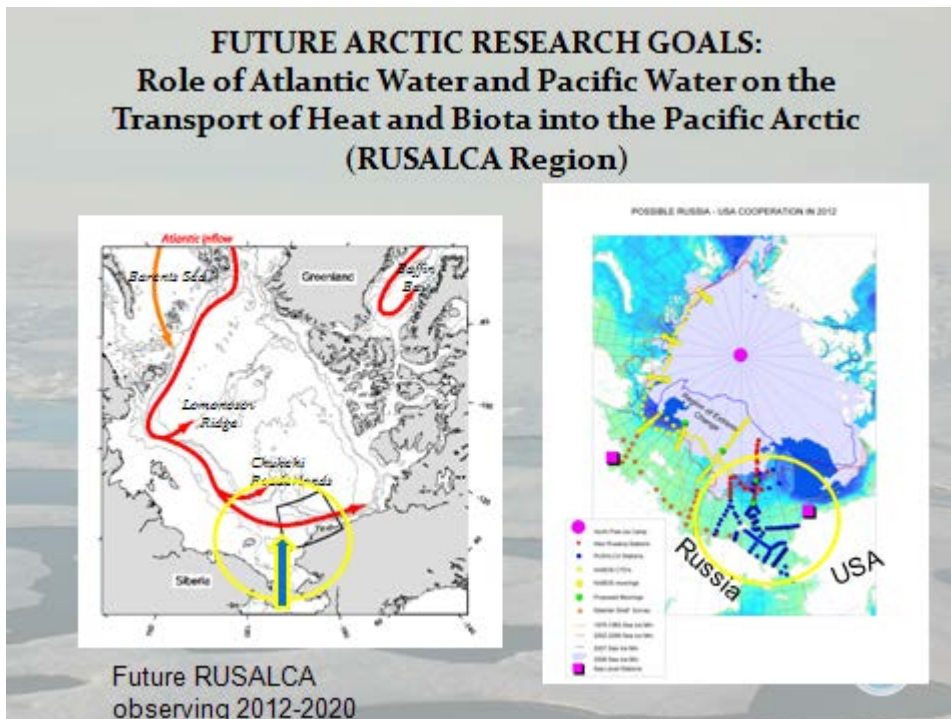


Figure 3.6.1-2: Proposed 2012-2020 RUSALCA program observing. Courtesy of Dr. Crane, NOAA Arctic Research Program.

In 2012, 11 mooring will need to be retrieved from the Bering Strait. All PAG members should possess coordinate information for the 11 moorings currently remaining at sea. Please contact Dr. Rebecca Woodgate ([woodgate@apl.washington.edu](mailto:woodgate@apl.washington.edu)) for that information so that submerged instruments are not damaged during CTD casts.

The U.S.-Russian MOU agreement is due to expire at the end of 2012. A new U.S.-Russian MOU agreement needs to be signed. Additionally, NOAA's Arctic Research Program is set to have a review of its program. Results from that program review will dictate NOAA's future participation in and commitment to the RUSALCA program.

### Ice Edges Project

Dr. Crane went on to discuss another U.S. Pacific Arctic oceanographic research program, the Chukchi Edges Project. The Chukchi Edges Project aims to collect Multi-Channel Seismic Reflection (MCS) data across the transition from the Chukchi Shelf to the Chukchi Borderland. These data will serve two purposes:

- 1) By imaging the transition between the two continental blocks, the history and timing of relative motion between them can be constrained
- 2) By collecting continuous MCS data from exploration wells drilled by Shell on the Chukchi shelf in the late 80's, following the thickest sediment section, time stratigraphy along existing profiles and other profiles crossed can be established

This project is supported by the Arctic Natural Sciences program at NSF with funding granted to the Geophysical Institute of the University of Alaska. Cruise participants are from Korea, Germany, Turkey, the U.S. and the U.K., representing seven different universities and research organizations.

The Chief Scientist and Principle Investigator for this project is Dr. Bernard Coakley ([bernard.coakley@gi.alaska.edu](mailto:bernard.coakley@gi.alaska.edu)) from the Geophysical Institute of the University of Alaska Fairbanks.

### Alaska Monitoring and Assessment Program (AKMAP)

Another noteworthy U.S. Pacific Arctic oceanographic research program briefly described by Dr. Crane was the Alaska Monitoring and Assessment Program (AKMAP) Chukchi Sea 2011 Coastal Impact Assistance Program Assessment. The Alaska Department of Environmental Conservation (DEC) with its University of Alaska partner established an AKMAP focused on conducting aquatic resource surveys of Alaska's waters. Research cruises were held in 2010 and 2011 to survey the Chukchi Sea coastal environment. In 2011, NOAA's National Status and Trends Program joined this effort. Figure 3.6.1-3 depicts the 2010 and 2011 survey stations in the Chukchi Sea.

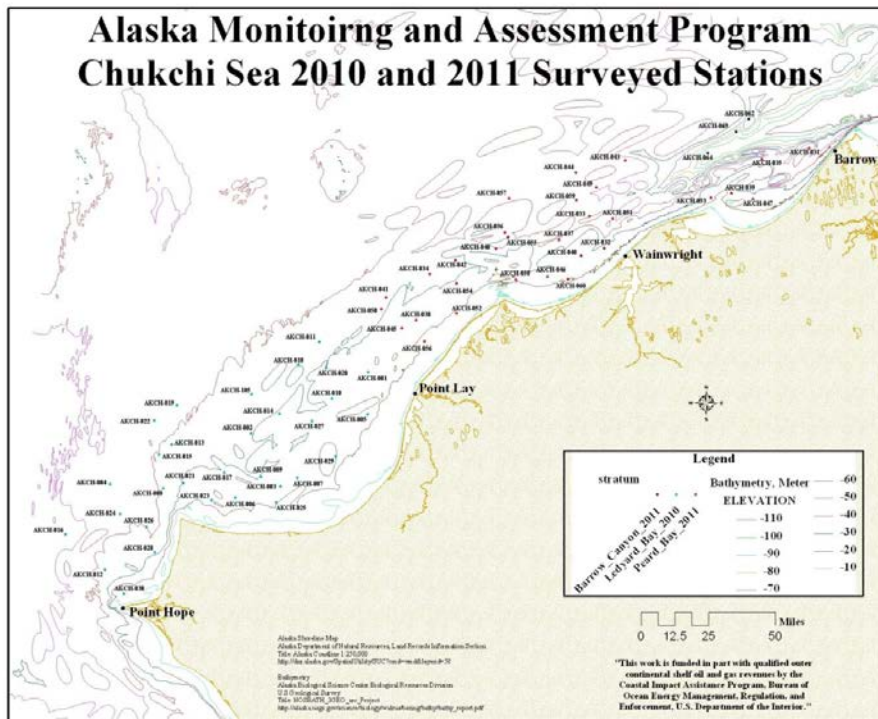


Figure 3.6.1-3: AKMAP Chukchi Sea 2010 and 2011 survey stations. Courtesy of Dr. Crane, NOAA Arctic Research Program.

*Impacts of Climate on Ecosystems and Chemistry of the Arctic Pacific Environment (ICESCAPE)*

The ICESCAPE examines the impacts of climate on ecosystems and chemistry of the Arctic Pacific environment. Please refer to Appendix A (5.1 *Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System*) for additional details.

*Chukchi Acoustics, Oceanography, and Zooplankton (CHAOZ) Study (September-October 2012)*

The CHAOZ study aims to documents the distribution and relative abundance of whales in areas of potential oil and gas exploration and to relative changes in those variables to oceanographic conditions, indices of prey density, and level of anthropogenic activity. Please refer to Appendix A (5.1 *Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System*) for additional details.

### *The Bowhead Whale Feeding Ecological Study (BOWFEST) (2012-2013)*

BOWFEST examines the relationship between bowhead whales and their environment in an area northeast of Point Barrow. This study involves a coalition of scientific parties gathering data from oceanographic samples, boat-based observations, tagging operations, acoustic monitoring, and aerial surveys. The aerial survey component of BOWFEST is designed to document patterns and variability in the timing and locations of bowhead whales in order to provide information on temporal and spatial habitat use. Residence times, feeding ecology, and sizes of individual whales are also examined. Please refer to Appendix A (5.1 *Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System*) for additional details.

### *Arctic Observing Network (AON) (2012-2013)*

AON aims to assess the Western Arctic boundary current and its role in the Arctic ecosystem and climate change. Please refer to Appendix A (5.1 *Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System*) for additional details.

### *Early Winter Oceanography in the Bering and Chukchi Seas*

The goal of this endeavor (November 7-December 2011) was to collect some of the first information on early winter biology and physics in the Bering and Chukchi Seas. The cruise worked along a set of key cross-shelf-slope transects and will conduct physical (water temperature, salinity, and circulation), chemical (nutrients) and biological (phytoplankton, zooplankton) sampling. The cruise took place primarily in the Bering and Chukchi Seas but the goal is to eventually sample in the Western Beaufort Sea as well (depending on ice conditions).

### *Bureau of Ocean Energy Management (BOEM) Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA) Hanna Shoal Ecosystem Study (2011-2016)*

The BOEM COMIDA Hanna Shoal Ecosystem Study conducts open-water baseline measurements of benthic chemical and biological resources, with specific focus on trophic structure and the potential for bio-accumulation of anthropogenic chemicals into food webs. The current spatial structure of the ecosystem is examined to better understand the seasonal, inter-annual, and long-term climate change impacts on the ecosystem. Please refer to Appendix A (5.1 *Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System*) for additional details.

### *Industry partnerships – Shell-Conoco Phillips-StatOil*

In 2008 and 2009, Conoco-Phillips and Shell began the Chukchi Sea Environmental Studies Program (CSESP) examining ocean physics, nutrients, plankton, benthos, fish, birds, and mammals in their designated study area. In 2010, Statoil joined this effort with a nearby

survey, AKMAP began in the coastal zone, and Shell began work near Camden Bay in the western Beaufort Sea. In 2011, industry greatly expanded their survey area, AKMAP's coastal studies moved northward and BeauFISH covered much of the Beaufort shelf also joined the group of industries examining various sites in these areas. Please refer to Appendix A (5.1 *Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System*) for more details.

### **3.6.2 Pacific Arctic Region (PAR) Synthesis: An update**

Dr. Grebmeier provided an update on the Pacific Arctic Region (PAR) Synthesis book with a brief review of the definition and objectives of the endeavor.

PAG defines the "Pacific Sector" of the Arctic as the marine area from the Northern Bering Sea into the Chukchi Sea and adjacent Seas, and extending into the deep basins of the Arctic Ocean, with model boundaries from Aleutian Island and deep Bering Sea northward to Arctic Basin.

The objectives of the PAR Synthesis are to:

1. Present results from research, observation, and modeling activities related to the PAG area, both retrospective and IPY efforts;
2. Share information on current modeling activities covering the PAG synthesis area; work toward a shared modeling system;
3. Identify status, trends, and major new findings and understanding of state and processes in the PAG area;
4. Using best available model projections, prepare hypotheses regarding the future evolution of the physics and biology of the region;
5. Prepare scientific conclusions and recommendations to guide future PAG science activities; and
6. Specifically for the PAG region, identify critical marine components of a future Arctic Observing Network

While presenting the overview of the PAR Synthesis effort and objectives, Dr. Grebmeier also discussed elements of the PAR Syntheses that are important components for consideration. These include:

- The geographic area over which data is to be considered: Upstream (Bering Sea) to downstream (the Chukchi Sea, portions of the East Siberian and Beaufort Seas, the Canadian Arctic Archipelago, and the Arctic Ocean)
- The time period to be considered: Decades leading up to the International Polar Year (IPY), IPY, and build scenarios decades past IPY
- Science questions to be addressed by the synthesis and types of data to be included in the synthesis: Pacific-influenced Arctic system status and trends in atmosphere, sea ice, physical forcing, and biogeochemical/biological ecosystem response

- Linkage between observational data and modeling: Results from PAG Modeling/data fusion workshop and other chapters
- The products: Special book volume confirmed by Springer for PAG synthesis chapters; special science volumes
- The scope: Synthesis through workshops and invited participants
- Who the synthesis is endorsed by: International Arctic Science Committee (IASC), Arctic Ocean Science Board (AOSB), and the International Council for Science (ICSU) IPY project office as an IPY legacy effort

Many successes have come out of the PAR Synthesis workshops to date. A PAR Modeling Workshop held in Sanya, China, in January 2008 resulted in a special issue of Chinese Journal of Polar Science, Vol.9, 2008. Additionally, a PAR Biology Workshop held in May 2009 in Seattle, WA, USA resulted in a feature article for EOS (May 4 2010) and 2 chapters for the Springer book in progress). Furthermore, a PAR Marine Carbon Cycling Workshop held in June 2009 in Xiamen, China resulted in development of a special issue *Deep Sea Research* (in progress, Wei-Jun Cai *et al.*). In 2010, two oral sessions focusing on ecosystem change in the Pacific Arctic in relation to the Pan-Arctic system took place, one at the AGU Ocean Sciences Meeting in February and the other at the International Polar Year Conference in Oslo in June. The anticipated target groups were disciplinary and interdisciplinary Arctic marine scientists, from physical, biogeochemical and biological oceanographers to higher trophic organism specialists, as well as climate and ecosystem modelers. In both sessions the rooms were filled to over capacity. In September of 2010 (to the present) chapters continue to arrive for peer-review, revision, and final form (in anticipation of volume submission to Springer in late 2011). The plan is to release the Springer book at the 2012 ASSW and IPY Conference in Montreal, Canada in 2012.

Dr. Grebmeier outlined the PAR Synthesis, with special emphasis on Chapter 2, 6, 7, 8, 9, 10, 11, 12, and 13, which have been completed and peer reviewed. Constructive comments include the following:

- The book is too heavy on physical oceanography. More biology should be added
- Modification to the title should be considered.
- There is a need for decadal scale change forecast in modeling chapters

Dr. Grebmeier is working to address these comments.

An executive summary (white paper) will be completed in early 2012, followed by a publication (Springer PAG Synthesis Special Issue).

### **3.6.3 Arctic Climate System Network (ACSNet) report**

Dr. Mary-Louise Timmermans, Assistant Professor at the Department of Geology and Geophysics at Yale University provided a brief overview of the Arctic Climate System Network (ACSNet) as well as an insightful overview of the Ice-Tethered Profiler (ITP), an autonomous instrument for sustained observation of the Arctic Ocean, useful for marginal ice-zone studies within the context of the DBO.

The ACSNet, an International Arctic Science Committee (IASC) cross-cutting initiative established in June 2011, aims through the coordination and networking of existing or emerging fieldwork to implement an intensive cross-disciplinary study of the role of the polar seas in climate. In particular special reference is made to the Western Arctic as a site of demonstrable global importance.

The goal is to devise a common space-time framework for individual research projects arguing for the combining of disparate efforts to form an intensive, international and multidisciplinary research effort initially with its focus on the Greater Canada Basin and its marginal ice zone, later on a pan-Arctic scale. If this is effective, the combined effect could approach the intensity of the IPY itself in these sea areas. It will be of mutual benefit by adding a worthwhile depth and context to the original programs while generating the intensity and variety of coverage needed to understand the complex workings of the ocean-cryosphere-atmosphere system and its role in climate.

Coordinators of the ACSNet are:

- Mary-Louise Timmermans (Marine Working Group; [mary-louise.timmermans@yale.edu](mailto:mary-louise.timmermans@yale.edu))
- John Cassano (Atmosphere Working Group; [john.cassano@colorado.edu](mailto:john.cassano@colorado.edu))
- Pedro Elosegui (Cryosphere Working Group; [p.elosegui@csic.es](mailto:p.elosegui@csic.es))
- Jeremy Wilkinson (Marine Working Group; [jeremy.wilkinson@sams.ac.uk](mailto:jeremy.wilkinson@sams.ac.uk))

An Inaugural ACSNet Meeting will commence on April 23, 2012, from 5:30-7:30 pm, during the IPY2012 Conference, in Montreal, Canada. PAG members are encouraged to register. Future ACSNet activities will also include initial workshops (2011-13), field operations (2013-15), and a synthesis effort (2015-16).

Please see the web for more information:

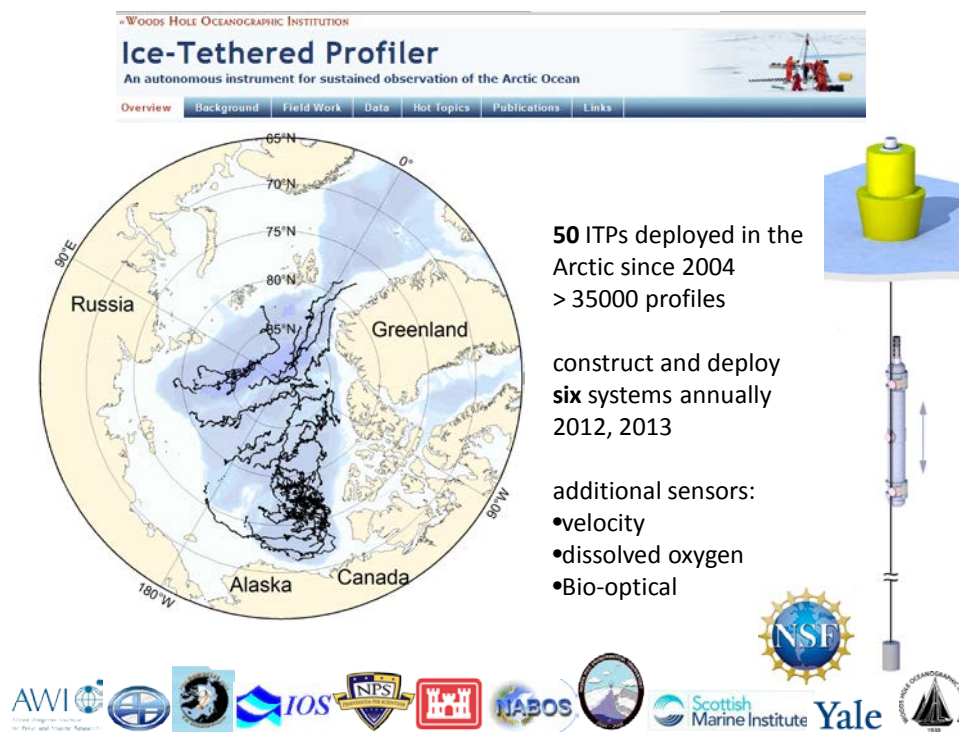
<http://iasc.arcticportal.org/index.php/home/networks/arctic-climate-system-network-acsnet>

The ACSNet plans to use ITPs to gather data about the marginal ice-zone in the Arctic Ocean.

Recent studies indicate that the Arctic may be both a sensitive indicator and an active agent of climate variability and change. While progress has been made in understanding

the Arctic's coupled atmosphere-ice-ocean system, documentation of its evolution has been hindered by a sparse data archive. This observational gap represents a critical shortcoming of the 'global' ocean observing system. To address this gap, the ITP was conceived to repeatedly sample the properties of the ice-covered Arctic Ocean at high vertical resolution over time periods of up to three years. Analogous to the international Argo float program that is employing autonomous profiling floats to return real-time seawater property data from the temperate oceans, scientists from Woods Hole Oceanographic Institute (WHOI) are working together with fellow North American, European and Asian investigators to maintain a loose array of ITPs and other similar instruments throughout the ice-covered Arctic. They hope that the analysis of data from these instruments will lead to better understanding of the Arctic Ocean's response and role in global climate change.

The ITP system (Figure 3.6.3-1) consists of a small surface capsule that sits atop an ice flow and supports a plastic-jacketed wire rope tether that extends through the ice and down into the ocean, ending with a weight (intended to keep the wire vertical). A cylindrical underwater instrument (in shape and size much like an Argo float) mounts on this tether and cycles vertically along it, carrying oceanographic sensors through the water column. Water property data are telemetered from the ITP to shore in near-real time.



3.6.3-1: ITP system. Courtesy of Dr. Timmermans, Yale University.

Future modification could include the addition of sensors to monitor biogeochemically-relevant ocean properties such as dissolved oxygen levels, phytoplankton biomass, and dissolved organic matter concentrations.

Two bio-ITPs were deployed in the Fall of 2011. Future deployments of bio-optical ITPs include 3 in 2012 and 3 in 2013, as part of the NSF AON project.

Data from the ITP field (including publications and further information) is available in real time from [www.whoi.edu/itp](http://www.whoi.edu/itp). As much as 17 months of data can be collected from one ITP. Deployment of ITP's can be done with relative ease. Scientists can be trained for deployment, making this technology cost-effective.

#### ***3.6.4 The Circumpolar Marine Biodiversity Monitoring Plan (CMBMP): An update***

Dr. Crane provided an overview of how the Circumpolar Biodiversity Monitoring Program (CBMP) incorporates the DBO into its Arctic Marine Plan.

Dr. Crane started with an overview of the different Expert Monitoring Groups (EMG), one of which includes the Marine (M) component. Dr. Crane recognized the participating institutions in the MEMG as well as its representatives from the six Arctic countries (Canada, United States, Russia, Greenland/Denmark, Iceland, and Norway). An overview of the process and timeline of the marine implementation plan was also given.

In January 2011 a final draft of the Arctic Marine Biodiversity Monitoring Plan (AMBMP) was submitted to the Arctic Council for acceptance. The AMBMP was officially accepted in March 2011 to move forward into an implementation phase, now currently underway.

An overview map of the Arctic Marine Areas, as well as the parameters by which they are defined, was reviewed by Dr. Crane. She pointed out that the most important drivers of the AMBMP are environmental contamination (i.e., long range transport of contaminants), invasive species (non-native), increasing ship and air traffic, harvest of natural resources, oil and gas exploration, and climate change (perhaps the most pervasive threat).

Dr. Crane reviewed various maps that identified sentinel region stations and transects. Following this she provided a brief overview of the AMBMP data management approach. A CBMP web-based portal and data nodes sponsored by nations (agencies) will be made available. These data nodes still need to be determined. The data formats will be agreed upon by data managers appointed by nations. Current data (status) is to be compared to historical baselines to get a better understanding of trends.

Implementation of the AMBMP commenced in 2011. Marine Expert Networks (MEN's) will be supported by the nations and established by the Marine Expert Monitoring Advisory Committee (MEMAC) (also supported by nations). The task will be for expert networks to establish "baselines" from historical data (funding will come from individual nations). As well, expert networks will aggregate existing Pan Arctic data sets.

The reporting timeline for the first phase of the AMBMP will be from 2012-2015. In 2012 reports will be published on the status of indicators. Performance reports and work-plans

will be produced. In 2013 scientific publications and papers will be produced as well as various summaries and other communications material. In 2015 the State of the Arctic Marine Biodiversity report will be produced. As well an independent review of parameters, sampling approaches, data management approaches, analysis, and reporting will take place.

The AMBMP takes a phased approach to planning and implementation:

Phase 1 (2008-2011):

- ✓ Arctic Nations – Russia, U.S., Canada, Greenland/Denmark, Iceland, & Norway  
(Possible addition of other Arctic Countries (such as Sweden and Finland))

Phase 2 (2015 - TBD):

- ✓ Integration of Observer Countries into Phase 2 of implementation (e.g., PAG Member Nations: Japan, China, and Korea)

The AMBMP feeds directly into the purpose, vision, and goals of the Sustained Arctic Observing Network (SAON).

## **4.0 PAG BUSINESS**

### **4.1 Upcoming PAG related meetings**

#### ***4.1.1 Ecosystem Studies of Sub-Arctic Seas (ESSAS)***

Dr. George Hunt from the School of Aquatic and Fishery Science at the University of Washington gave a brief overview of the Ecosystem Studies of Sub-Arctic Seas (ESSAS) program and planned activities for 2012.

The ESSAS program addresses the need to understand how climate change will affect the marine ecosystems of the Sub-Arctic Seas and their sustainability. The Sub-Arctic Seas support stocks of commercial fish that generate a major portion of the fish landings of the nations bordering them. They also support subsistence fishers along their coasts, and vast numbers of marine birds and mammals. Climate-forced changes in these systems will have major economic and societal impact.

ESSAS conducts research to compare, quantify, and predict the impact of climate variability and global change on the productivity and sustainability of Sub-Arctic marine ecosystems.

### ESSAS Planned Activities for 2012

- American Geophysical Union (AGU)/Association for the Science of Limnology and Oceanography (ASLO) Ocean Sciences Meeting: Session 180: *Arctic-Subarctic Interactions*
  - Date: 19-24 February 2012
  - Place: Salt lake City, Utah, U.S.
  - Conveners: Ken Drinkwater, Tom Haine
  - Sponsors: ESSAS, Arctic/Subarctic Ocean Fluxes (ASOF)
  
- International Council for the Exploration of the Sea (ICES)/The North Pacific Marine Science Organization (PICES) Symposium on the *Effects of the Climate Change on the World's Oceans: Workshop: The Effects of Climate Change on Advective Fluxes in High Latitude Regions*
  - Date: 15-19 May 2012
  - Place: Yeosu, South Korea
  - Conveners: Ken Drinkwater, George Hunt, Eugene Murphy, Jim Overland, Jinping Zhao
  - Sponsors: ESSAS, ICES, PICES
  
- ICES Arctic System Modeling (ASM): Theme Session: *Subarctic-Arctic Interactions: Ecological consequences*
  - Date: September 2012
  - Place: Bergen, Norway
  - Conveners: Ken Drinkwater, Olafur Astthorsson, George Hunt, Anne Hollowed
  - Sponsors: ESSAS, ICES, PICES, Arctic Ocean Science Board (AOSB)
  
- PICES Workshop: *Subarctic-Arctic Interactions*
  - Date: October 2012
  - Place: Hiroshima, Japan
  - Conveners: Ken Drinkwater, Jackie Grebmeier, Jim Overland, Sei-ichi Saitoh
  - Sponsors: ESSAS, PICES, ICES

Dr. Hunt invited the PAG to join all 2012 ESSAS planned activities and requested that the PAG consider becoming a sponsor of future activities. Sponsorship is free. In turn ESSAS will advertise the PAG logo and PAG activities at all events. The PAG would receive reports. ESSAS would also help pay for speakers and early career scientists to attend ESSAS events.

#### **4.1.2 PAG Spring Meeting 2012**

The annual PAG Spring meeting will be held on the afternoon of Saturday April 21 and the morning of Sunday April 22, 2012 prior to the start of the IPY 2012 Conference in Montreal, Quebec, Canada at the Palais des congrès. More details will follow.

#### **4.1.3 Arctic Science Summit Week (ASSW) 2012**

The ASSW 2012 will be held on April 19-22, 2012 in Montreal, Quebec, Canada, at the Palais des congrès. For more information, please see the website:

[www.assw2012.org](http://www.assw2012.org)

#### **4.1.4 International Polar Year (IPY) 2012 Conference**

The IPY 2012 Conference will be held on April 22-27, 2012 in Montreal, Quebec, Canada, at the Palais des congrès. For more information, please see the website:

[www.ipy2012montreal.ca](http://www.ipy2012montreal.ca)

#### **4.1.5 Arctic Science Summit Week (ASSW) 2013**

Dr. Bill Williams provided a brief update on the status of ASSW 2013. The ASSW 2013 will be held on April 14-20, 2013 in Krakow, Poland.

Recently the Scientific Steering Committee (SSC) met by teleconference. Members of the SSC include:

Jacek Jania (Chair), Antoni Lewkowicz (International Permafrost Association (IPA)), Naja Mikkelsen (International Arctic Science Committee (IASC)), Lillian Magelund Jensen (for Morten Rasch, Forum for Arctic Research Operators (FARO)), Julia Schmale (Association of Polar Early Career Scientists (APECS)), Bill Williams (PAG), Paul Egerton (European Polar Board (EPB)), Gail Fondahl (International Arctic Social Science Association (IASSA)), Sara Bowden, Mare Pit, Volker Rachold (IASC Secretariat).

Though the SSC is still in the early planning phase there has been agreement on the science symposium: *THE ARCTIC HUB - Importance of the High North for lower latitudes*.

In 2013 there will be 5 thematic sessions and 3 cross-cutting sessions with a greater focus on posters than in the past. The SSC would like to employ the "Frostbyte" approach for viewing posters, which enables those interested to view a 30 second on-line informational review by the presenter of what the poster will discuss.

The SSC is considering a PAG/DBO/Synthesis of Arctic Research (SOAR) session titled *'Ecology of Advection and Arctic Amplification on the Pacific Arctic Highway: 5 unique 'hotspots' from the Northern Bering to the Chukchi Sea'*.

PAG participants were in favor of the proposal to have a special PAG/DBO/SOAR session during the ASSW 2013.

#### **4.2 PAG executive secretariat**

Starting March 31, 2012, Gillian Lichota, the current Executive Secretary for the PAG will no longer be performing PAG Secretariat duties. A new PAG Executive Secretary will need to resume duties, particularly with regard to communications, coordination, and planning activities. PAG member nations interested in volunteering a candidate to fill Gillian Lichota's role as the Executive Secretary should contact the PAG Executive Secretariat prior to the end of February 2012.

A new PAG Chair will be elected during the PAG Spring 2012 meeting.

#### **4.3 2013 & beyond**

*Note: Please see APPENDIX A **Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System** for specific "Action Item" details related to the DBO.*

The PAG Spring 2012 meeting in Montreal, Quebec, Canada will be the time to make some very important decisions regarding the future direction of the PAG.

During the PAG Spring 2012 meeting DBO subgroups will meet for the first time.

Dr. Grebmeier will produce a 2012 cruise operations document. It will be forwarded to PAG members for completion. Each country will return the completed document to Gillian Lichota ([gillian.lichota@noaa.gov](mailto:gillian.lichota@noaa.gov)). The document will provide details regarding coordinates (time and space) and anticipated science activities at sampling station (including metadata, mooring positions and deployment). Once all information is collected, Dr. Crane will assimilate the information into a map for distribution among PAG members.

## **5.0 APPENDIX A**

### **5.1 *Distributed Biological Observatory (DBO) Workshop Linking Biology to Physics in an Arctic Ocean Observing System***

## 6.0 PAG MEETING PARTICIPANT LIST

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