Print

Beaufort Gyre Exploration Project: Modern Scientific Expeditions (1970s-2000s)

AIDJEX 1970-1976

In 1993, The USS Pargo made the first civilian oceanographic submarine cruise in the Arctic Ocean.
(Image courtesy SCICEX)

In the early 1970s, the University of Washington Polar Science Center organized the Arctic Ice Dynamics Joint Experiment (AIDJEX). The objective was to determine the mechanisms of ice deformation and relationship to the external stress fields, and to model these from a few fundamentally derived and easily obtainable parameters. In preparation for the main experiment, the science team established a series of small pilot ice camp studies off the coast of Alaska in 1970 and 1971 and a larger pilot consisting of three manned camps. Several automated buoys were also deployed in March and April 1972. An additional AIDJEX lead experiment north of Barrow utilized Cessnas and helicopters for rapid logistics in 1974.

The main AIDJEX experiment began in March 1975 with selection of the ice floe for the main camp, named Big Bear after its radio call sign. Supplied by a Twin Otter and R4D aircraft landing on a frozen lead, the main camp expanded from a few tents to 25 buildings, two Weatherports, five Parcolls, and three longhouse tents. In the next month and a half, three satellite camps, named Blue Fox, Caribou, and Snowbird, were each built with four buildings, one Parcoll, and one longhouse tent. Initially, more personnel were accommodated at the main camp than expected, as the population was reported to be as many as 60 for several weeks. The four camps were circled by eight data buoys forming an array that took measurements for a full year until May 1976. For the first time, helicopters supported operations throughout the year.

The Healy at work in the Beaufort Sea in 2002 as part of SBI. (Chris Linder, WHOI)

The AIJDEX scientific program established the scales of motion of the ice and upper ocean, examined the mechanisms of sea ice mechanics and heat balance, acquired data on external stresses, and provided evidence of subsurface eddies below the sea ice. Remotely sensed data were provided by Landsat satellite imagery.

References:

Bjornert, R., Field Operations for the AIDJEX main experiment, *AIDJEX Bulletin*, 29, 173-180, 1975.

Heiberg, A., AIDJEX Lead Experiment, Spring 1974 field operations report, *AIDJEX Bulletin*, 26, 23-31, 1974.

Untersteiner, N., AIDJEX Review, in Sea Ice Processes and Models, Pritchard, ed., University of Washington, Seattle, 3-11, 1980.

LOREX 1979

The Lomonosov Ridge Experiment (LOREX) was undertaken by the Canadian Department of Energy, Mines and Resources to study the nature and origin of the submarine mountain range in the Arctic Ocean. Logistic support was provided by the Polar Continental Shelf Project from Resolute, Alert, and Thule. This consisted of paradropping the bulk supplies for the main camp from Hercules C-130s and using a Dash-7 aircraft to move the balance of freight, instrumentation, and personnel. The main camp was located on a thick multi-year ice floe at 88°38'N, 172°18'W in March 1979. Two satellite camps, SNOWSNAKE and ICEMAN, were located approximately 60 km from the LOREX main camp. The scientific program was primarily Canadian with some US scientists and covered April and MayThe main camp drifted 160 km, approaching within 35 km of the Pole on May 17. The fields of study were bathymetry, gravity, plumbline deflection measurements, sub-bottom profiling, shallow (air gun), intermediate (reflection), and deep crsutal (refraction) seismic, coring and dredging, bottom photography, heat flow measurements, and geomagnetic and magnetotelluric soundings.

Reference:

Hobson, G.D., The Lomonosov Ridge Experiment: "LOREX '79", *Musk-Ox*, 26, 51-58, 1980.

FRAM I 1979

In 1976, a plan was devised to repeat the drift of Nansen's research vessel with the US Coast Guard icebreaker Burton Island. While support for the full program was not provided, the FRAM drifting ice station was established in March 1979 in the Eurasian basin at 84°24'N, 06°00'W to study the geophysical and oceanographic conditions over the Nansen-Gakkel Ridge. The program was staged out of Station Nord, on the northeast corner of Greenland, and included US, Danish, Norwegian, and Canadian participation. The University of Washington Polar Science Center was responsible for the logistic support and coordinated the delivery of approximately 80,000 lbs of cargo to the drifting station in about 10 days, using a total of 22 Twin Otter and 5 Tri-Turbo 3 flights. For the oceanographic program, a helicopter was used to acquire hydrographic profiles in the upper ocean in a 150 km radius around the camp. Nearly two months of data were collected as the ice station drifted southward, before ice cracking and ridging forced the station to be abandoned in May.

Reference:

Hunkins, K., Y. Kristoffersen, G.L. Johnson, and A. Heiberg, The Fram I Expedition, *EOS Trans. AGU*, 60 (52), 1043-1044, 1979.

FRAM II 1980

With funding provided by the US Office of Naval Research, three ice camps were established in the Eurasian basin north of Fram Strait from March to May in 1980. The research concentrated on underwater acoustics, marine geophysics, and physical oceanography. The first FRAM II site was established as far north as possible (86°51'N) to maximize the drift, but after only two buildings were constructed, ice ridging forced the camp to be moved to another site, slightly farther south. In order to perform specialized acoustic transmission experiments, sound sources were established at two remote camps. As the ice pack converges and exits Fram Strait between Greenland and Spitsbergen, significant deformation occurs. During FRAM II, the original 3 km x 3 km icefloe that supported the main camp was reduced to 800 m by 1200 m by the end of the drift.

Reference:

Baggeroer, A.B., and I. Dyer, Fram 2 in the Eastern Arctic, *EOS Trans. AGU*, 63 (14), 217-219, 1982.

YMER 1980

In commemoration of Nordenskjöld's voyage through the Northeast Passage, a Swedish-led international expedition was organized in 1977. However, since Soviet participation was not forthcoming, the investigation instead focused on the regions between Franz Josef Land and Greenland. The vessel chosen for the expedition was the Baltic icebreaker *Ymer*, which had never been exposed to multiyear Arctic ice before. The first leg of the voyage obtained oceanographic and biological data between Tromso, Norway and north of Spitsbergen as far as latitude 82°22'N. Landing parties were also installed on the Nordaustlandet for the summer. The following month, the second leg of the voyage went north again with physical and chemical oceanographers, a group of marine geologists, and a reduced biological team. Between August and September, in addition to the oceanographic and meteorological measurements, deep ocean cores were taken throughout the Fram Strait region, but not in Soviet waters. The Ymer returned to Stockholm in October after 100 days, having accommodated a total of 119 scientists and technicians.

Reference:

Schytt, V., Ymer-80: A Swedish expedition to the Arctic Ocean, *The Geographical Journal*, 149 (1), 22-28, 1982.

FRAM III 1981

The third in the series of FRAM ice camps was established at 84.32°N, 20.07°E in March 1981, farther east and south of the previous two camps. The investigators studied the polar front between water masses, wave propagation experiments in the sea ice, underwater acoustics, and geophysical properties of the Nansen basin and Yermak Plateau. Scientists from the US, Canada and England participated. FRAM III was evacuated in May, around the same time as previous FRAM camps. Due to the proximity to the strait between Greenland and Spitsbergen, FRAM III drifted further than previous FRAM camps, covering a larger geographic area and a wider range of ocean depths.

Reference:

Manley, T.O., L.A. Codispoti, K.L. Hunkins, H.R. Jacksin, E.P. Jones, V. Lee, S. Moore, J. Morison, T.T. Packard, and P. Wadhams, The Fram 3 Expedition, *EOS Trans. AGU*, 63 (35), 627-636, 1982.

EUBEX 1981

The Eurasian Basin Experiment (EUBEX) was a Canadian expedition in 1981.

FRAM IV 1982

The fourth and final in the series of FRAM drifting ice camps, FRAM IV, was installed in the Nansen basin north of Spitsbergen from March to May 1982, and included studies of hydroacoustics, geophysics, and physical oceanography. In addition, cooperation with the Soviets enabled a visit to the North Pole 22 drifting station by members of FRAM IV. A typical FRAM ice camp would consist of approximately 20 scientists and support personnel, and the buildings consisted of prefabricated Manigan huts and Jamesway insulated tents (Parcolls), and later Weatherport buildings.

Reference:

Johnson, G.L., The Fram Expeditions:Arctic Ocean studies from floating ice, 1979-82, *Polar Record*, 21 (135), 583-589, 1983.

CESAR 1983

In the spring of 1983 a Canadian polar expedition was conducted under the auspices of Energy, Mines and Resources Canada (EMR): The Canadian Expedition to Study the Alpha Ridge or CESAR. On an ice floe 600 km from the tip of Ellsmere Island, the basic tent camp was constructed in March. The camp housed more than 3 dozen scientists for two months. Canadian Armed Forces Airborne Engineers parachuted onto the ice with a bulldozer, grader and snowmobiles and built a 1600 by 30 m runway to accommodate resupply using Hercules (C-130) military aircraft. The scientific activities that CESAR fostered on the polar ice encompassed marine geology, chemical oceanography, heat flow investigations, satellite navigation, gravity and seismic studies

Reference:

Giuliani, M., Only in Canada? - CESAR 83, *North*, 4-8, 1983.

MIZEX 1983 & 1984

The Marginal Ice Zone Experiments (MIZEX) were formed to understand the processes that determine the Marginal Ice Zone. MIZEX West was conducted in February 1983 in the Bering Sea, while MIZEX East experiments were conducted in the northern Greenland Sea in summer 1983 using the Polarbjorn, and in summer 1984 using the Haakon Mosby, Polar Queen, Polar Stern, Valdivia. Scientists, equipment, and support came from Canada, Denmark, West Germany, Finland, France, Ireland, Norway, Sweden, Switzerland, Britain, and the US. The primary focus of MIZEX East were the complex oceanographic and atmospheric structures associated with the East Greenland Polar Front between warm Atlantic and cold Arctic waters. In addition, there were extensive sea ice, acoustic, and remote sensing research programs.

Reference:

Horn, D.A., and G.L. Johnson, MIZEX East: Past Operations and Future Plans, *Oceanus*, 29 (1), 66-72, 1986.

Canadian Ice Island 1984-93

An approximately 3000 year old tabular glacier fragment measuring 8 km x 3 km x 45 m thick broke from Ellsmere Islands's Ward Hunt Ice Shelf in 1982, and was occupied two years later by the Canadian Polar Continental Shelf Project. For nine years scientists carried out seismic experiments, ice coring, and heat flow measurements to determine the structure of the ice island and seafloor, and physical and bigeochemical oceanography. Each summer the runway would melt and be rebuilt at the start of each spring season. At its peak, the field camp supported 35 people in 14 prefabricated huts and 6 Parcolls tents. The research station was decommissioned in 1993 after drifting southward among the Arctic Islands and breaking up.

Reference:

Hobson, G., Ice Island Field Station, *EOS, Trans. AGU*, September 12, 833-839, 1989.

ARKTIS Polarstern cruises 1984, 87

German icebreaker penetrates deep into the Eurasian Basin with a full complement of physical, chemical, biological, and geological research.

MIZEX 1987

In 1987, MIZEX experiments were conducted in winter in the north Greenland Sea using the Haakon Mosby, Polar Circle, Valdivia.

CEAREX 1987-88

The Coordinated Eastern Arctic Experiment (CEAREX) field program was conducted to study the processes regulating exchange of momentum, heat, and biomass in the Norwegian and Greenland Seas north to Svalbard. CEAREX began with the drift of the R/V Polarbjorn on September 17, 1988 and ended on May 19, 1989 when the Polarbjorn docked in Longyearbyen, Spitsbergen. Canada, Denmark, France, Norway and the United States participated in the experiment. In addition, the R/V Haakon Mosby and two ice camps collected bathymetry, biophysical, hydrography, meteorology, noise, sample position, and sea ice data. CEAREX drift operations used the ship Polarbjorn as a scientific base. During early September 1988, the Polarbjorn made its way into a region of multiyear pack ice north of Svalbard with icebreaker support from the U.S. Coast Guard Northwind. The Polarbjorn was allowed to freeze into the ice on September 16 at 82°41' N, 32°26' E. The ship was relatively immobile and drifted slowly southeastward with the ice pack toward Viktoriya Island, then southwestward past Kvitoya Island, and finally into the Barents Sea. The large ice floe ("Alpha" Floe) to which the Polarbjorn was moored was used as a drifting data collection platform until November 15, when strong northwesterly winds destroyed the ice floe just northwest of Kvitoya. At this time, equipment was brought aboard and an attempt was made to return to Tromso, Norway. After several days of limited progress, 16 of the 20 scientists were airlifted to Spitsbergen on December 12. A strong storm in early January allowed the Polarbjorn to break free and return to Tromso on January 9, 1989. All drift operations were completed by mid-January 1989, and the ship operated in

the Fram Strait and Barents Sea areas from late January until May 1989. The Seasonal Ice Zone Experiment (SIZEX) phase began on January 13, 1989, when the Polarbjorn sailed from Tromso en route to operations in Fram Strait. This phase of CEAREX consisted of two separate cruises. The first cruise lasted from February 9 until March 5, 1989, and the second one from March 8 until April 2, 1989. Biophysical oceanographic operations commenced April 4 and concluded May 17, 1989. The first SIZEX cruise concentrated on conditions in the vicinity of Bjornoya, south of Svalbard; all subsequent cruises were located in the Fram Strait region west of Svalbard. The Haakon Mosby's (University of Bergen, Norway) participation in the SIZEX phase began on February 25, 1989, when the ship left Tromso, Norway, bound for regions in the Barents Sea. From February 26 to March 7, 1989, the ship operated in the general area between the Svalbard and the northern coast of Norway. On March 7, the Haakon Mosby headed northwest toward regions in the Fram Strait west and southwest of Svalbard, where the ship cruised seaward of the pack ice edge from March 11 to March 19, 1989. The Haakon Mosby then headed southeast into the Barents Sea, finally returning to port on March 23, 1989. Johannessen and Sandven (1989) describe SIZEX in more detail and provide a list of participants in the experiment. The oceanography ice camp (O-Camp) and acoustic ice camp (A-Camp) operations were located on the pack ice in the Fram Strait. Most of the studies conducted at O-Camp were related to processes in the upper boundary layer of the ocean. The A-Camp focus was acoustics in the ocean. The O-Camp was active from March 30 until April 24, 1989. The A-Camp operated from March 30 until April 20, 1989.

References:

On the web: CEAREX - Project Guide Document

Pritchard, R. S. et al. 1990. CEAREX Drift Experiment. EOS, Transactions of the American Geophysical Union, 71(40):1115-1118.

Oden 1991

Swedish icebreaker transects the Eurasian Basin in the summer of 1991.

LEADEX 1992

The Leads Experiment (LEADEX) was a drifting ice camp deployed from March to April 1992 in the Beaufort Sea, north of Prudhoe Bay, sponsored by the US Office of Naval Research.

Laptev Sea System 1992-1996

Joint Russian and German expedition between 1992 and 1996 to study mechanisms involved in past and ongoing climatic variation in the Laptev Sea, with emphasis on the interaction between the sea and the Lena River.

Reference:

Kassens, H., I. Dmitrenko, V. Rachold, J. Thiede, and L. Timokhov, Russian and German scientists explore the Arctic's Laptec Sea and its climate system, EOS, Trans. AGU, 79 (27), 317-,1998.

SIMI 1993 & 1994

ONR sea ice mechanics ice camps.

Polar Star 1993

A research cruise was conducted by US and Canadian scientists on the Polar Star to the Northwind Ridge and Canada Basin of the western Arctic in August and September 1993. Major objectives of the cruise were: survey the geology of the Northwind Ridge and Canada Basin, determine whether radionuclide contamination from nuclear waste by the former Soviet Union in the Kara and Barents Seas had penetrated the North American Arctic, acquire sediment cores in support of research on the history of glaciation in the region, and gain a better understanding of water structure and currents, sea-ice physics, and sediment and nutrient transport.

Reference:

Grantz, A., P.E. Hart, R.L. Phillips, M. McCormick, R.G. Perkin, R. Jackson, A. Gagnon, S. Li, C. Byers, and K.R. Schwartz, Preliminary results of a binational research cruise in the western Arctic Ocean, *Polar geography and geology*, 18 (3), 187-210, 1994.

AOS 1994

Two icebreakers, the Canadian Louis St. Laurent and the US Polar Sea, crossed the Arctic Ocean in tandem on the Arctic Ocean Section (AOS) from July to September in 1994, while investigations in biological, chemical, and physical oceanography were conducted. The route of the section is remarkable because it traces a relatively straight path across the Arctic Ocean, beginning at Bering Strait and ending by Spitsbergen. Multiple warm cores in the Atlantic layer were observed, and biogeochemical measurements were obtained.

Reference:

Aagaard, K., L.A. Barrie, E.C. Carmack, C. Garrity, E.P. Jones, D. Lubin, R.W. Macdonald, J.H. Swift, W.B. Tucker, P.A. Wheeler, and R.H. Whritner, U.S., Canadian researchers Explore Arctic Ocean, *EOS, Trans. AGU*, 77 (22), 209-213, 1996.

SHEBA 1997-98

SHEBA is an acronym for The Surface Heat Budget of the Arctic Ocean. In one of the larger and more complex operations ever supported in the Arctic by the National Science Foundation (NSF), an icebreaker was frozen into the perennial pack ice and left to drift for a full year. From October 1997 to October 1998 the ship served as a floating scientific research station.

Reference:

On the web: SHEBA website

AREA Ice Camps 1960s-1990s

In addition to the true scientific expeditions, the US Space and Naval Warfare Command annually conducted Arctic Regional Exercise Activity (AREA) ice camp operations out of Thule Air Base between the 1960s and 1990s. These operations were primarily training for potential rescue of submarine crews that could be stranded in the Arctic. Simultaneously, classified acoustic research was performed by the Navy, but in later years, the AREA operations also provided logistic support for some non-classified scientific programs.

SCICEX Transects 1993, 1995 to 1998

The first scientific trip by a nuclear powered submarine to the Arctic was made by Pargo in the summer of 1993. During the cruise, underway data (bathymetry, gravity anomaly, temperature, salinity, ice draft, and images of the underside of the ice) were collected in the deep Arctic. The data indicated that the influence of the inflowing Atlantic water had increased relative previous measurements. Due to the utility of the data, the Scientific Ice Expeditions (or SCICEX) cruises were continued between 1995 and 1998 using the submarines Cavalla, Pogy, Archerfish, and Hawkbill. For 3 to 6 weeks, each of these cruises collected data within boxes that fall within the central Arctic basins.

References:

On the web: SCICEX website

SCICEX 2000 Workshop Organizing Committee, Arctic Ocean Science from Submarines: A Report Based on the SCICEX 2000 Workshop, APL, University of Washington, 1999.

Western Arctic Shelf-Basin Interactions (SBI), 2002-2004

SBI was a multi-year, multi-disciplinary program sponsored jointly by the National Science Foundation's Office of Polar Programs and the High-latitude branch of the Office of Naval Research. The overall goal was to understand how the Arctic shelves communicate with the interior basin from a coupled physical--biogeochemical standpoint. The premise was that this system is in a delicate balance that could be upset by global change, which in turn could have important ramifications. These include possible melting of portions of the polar ice cover, changes in export of water to the global ocean, and alteration of the food web with significant consequences for native populations. From the physical oceanographic perspective the goal was straightforward: understand how shelf water is transferred, at the continental shelfbreak, to the interior basin in order to help maintain the "cold halocline" of the Arctic Ocean. This is the salty layer at mid-depth which shields the surface ice cover from the warm deep water. If this shield is weakened, there is more than enough heat contained in the underlying Atlantic-origin water to start melting the ice from below.

References:

On the web: WHOI Edge of the Arctic Shelf virtual cruise website
On the web: University of Tennessee SBI website

Arctic/Subarctic Ocean Fluxes Programme (ASOF), 2000-2008

The Arctic and Subarctic Ocean Flux (ASOF) programme aimed to monitor and understand the oceanic fluxes of heat, salt and freshwater at high northern latitudes and their effect on global ocean circulation and climate. ASOF constructed a coordinated, circum-Arctic ocean flux monitoring system. The system provided long-term measurements critical to understanding the factors that control the global thermohaline circulation and its influence on global climate.

Reference:

On the web: ASOF website

Joint Western Arctic Climate Study (JWACS), 2002-2008

The Joint Western Arctic Climate Study (JWACS) was a scientific collaboration of more than 130 researchers from Canada, the United States, Japan and China. 2002 was the first of a six-year program, and was one of the most diverse and complicated international Arctic research initiatives ever undertaken by Canada. The JWACS program spans the Canadian Basin and the Mackenzie Shelf examining the impacts of climate variability on living and physical ocean processes. Research topics included atmospheric science, oceanography, climate change, potential effects of oil and gas exploitation and marine mammal observations.

Reference:

On the web: JWACS website

International Polar Year 2007-2008

The International Polar Year was a large scientific programme focused on the Arctic and the Antarctic from March 2007 to March 2009. IPY, organized through the International Council for Science (ICSU) and the World Meteorological Organization (WMO), was actually the fourth polar year, following those in 1882-3, 1932-3, and 1957-8. In order to have full and equal coverage of both the Arctic and the Antarctic, IPY 2007-8 covered two full annual cycles from March 2007 to March 2009 and involved over 200 projects, with thousands of scientists from over 60 nations examining a wide range of physical, biological and social research topics. It is also an unprecedented opportunity to demonstrate, follow, and get involved with, cutting edge science in real-time.

Reference:

On the web: IPY 2007-2008 website

Arctic Gakkel Vents Expedition (AGAVE), 2007

At the top of the world, the Arctic Ocean is cold, remote, and covered in darkness for half the year. It's hard enough to get onto the ice-covered ocean. It's even harder to get under it and down to its seafloor. For this 40-day cruise to the Gakkel Ridge in the eastern Arctic Ocean, science team wanted to see if active hydrothermal vents were there, to find them, and to learn if they, and the communities of life around them, are different. Engineers built two new robotic autonomous underwater vehicles (AUVs), called PUMA and Jaguar, and a tethered Camera-Sampler (CAMPER) to explore the deep reaches of the Arctic Ocean.

Reference:

On the web: Polar Discovery education website

Bering Strait for IPY, 2007-2009

The Bering Strait is the only Pacific Entrance into the Arctic Ocean. It is a ~ 50m deep, ~ 85km wide channel, divided in two by the two Diomede Islands. Waters flowing through the Bering Strait are a major source of nutrients for Arctic ecosystems, and an important source of freshwater both for the Arctic and (after some years) the North Atlantic. The Bering Strait throughflow is believed to influence the Atlantic Overturning Circulation and thus, even though the Bering Strait throughflow is small, changes in its volume or properties may have impacts on world climate. In this 2-year IPY project, Russian and US scientists worked together to get the best ever resolution of the physical and biological features of the Bering Strait.

Reference:

On the web: Bering Strait for IPY website

DAMOCLES: Understanding Climate Change in the Arctic, 2007-2010

DAMOCLES (Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies) was an integrated ice-atmosphere-ocean monitoring and forecasting system designed for observing, understanding and quantifying climate changes in the Arctic. DAMOCLES was specifically concerned with the potential for a significantly reduced sea ice cover, and the impacts this might have on the environment and on human activities, both regionally and globally. DAMOCLES was a European integrated project.

Reference:

On the web: DAMOCLES website

Vanishing Arctic expedition, 2010

This expedition, led by Dr. Bob Pickart from WHOI, was to the Beaufort Sea north of Alaska's North Slope. The team's goal was to continue measuring the circulation and water characteristics of the continental shelf and deep ocean. The science party included an eclectic team of scientists and technicians—marine-mammal and plankton experts, ocean chemists and ecologists, an ornithologist—to conduct their own experiments, as well as an Inupiat observer. The environmental, holistic approach to climate change studies in the Western Arctic: that's what makes this cruise special.

Reference:

On the web: Vanishing Arctic public outreach website

Last updated: October 7, 2015

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