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CMSN

REPORTS

CHINA'S ARCTIC TOOLKIT

Icebreakers, Drones, and Polar Capabilities

Cover Image: Xue Long 2 (photo: Nigel Greenwood); Page 3 image: Timo Palo, Drift ice camp in the middle of the Arctic Ocean as seen from the Xue Long" (2010), wikimedia commons

About This Report

This report is an overview of China's Arctic capabilities. Derived from English- and Chinese-language sources, it provides basic specifications and capabilities of China's icebreaker fleet and its Arctic drones, robots, and other tools. It also provides an overview of China's Arctic expeditions, examining both the intent of the operations and the evolving capabilities being displayed. This document is by no means a comprehensive survey. A great deal of information on China's Arctic technology is not in the public domain and is therefore absent from this overview. As such, this is intended to be a living document, with future editions planned to improve its scope and accuracy.

This report is produced in two versions. Version Two is not for general distribution while Version One is designed for public consumption.

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China's Arctic Toolkit: Icebreakers, Drones, and Polar Capabilities
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Contents

Acronyms

Organizations, Institutions, and Programs

CAA	Chinese Arctic and Antarctic Administration
CAAA	Chinese Arctic and Antarctic Administration
CAS	Chinese Academy of Sciences
CCS	China Classification Society
CHINARE	Chinese National Arctic Research Expedition
CMSN	Canadian Maritime Security Network
CMSS	Canadian Maritime Security Studies
CPRC	China Polar Research Center
CSSC	China State Shipbuilding Corporation
CSIC	China Shipbuilding Industry Corporation
EEZ	Exclusive Economic Zone
IDSSE	Institute of Deep-Sea Science and Engineering
MLR	Ministry of Land and Resources
MNR	Ministry of Natural Resources
MSR	Maritime Scientific Research
ORF	Observer Research Foundation
PLAN	People's Liberation Army Navy
PRC	People's Republic of China
PRIC	Polar Research Institute of China
SOA	State Oceanic Administration
SYSU	Sun Yat-sen University
US	United States
WMO	World Meteorological Organization

Vessels, Platforms, and Ship Classes

PC	Polar Class
RV	Research Vessel

Vehicles, Systems, and Technologies

ADCP	Acoustic Doppler Current Profiler
AI	Artificial Intelligence
ARGO	Array for Real-time Geostrophic Oceanography
ARV	Autonomous / Remotely Operated Vehicle
AUV	Autonomous Underwater Vehicle
BGAN	Broadband Global Area Network
BSSS	Bathymetry / Side-Scan Sonar
CAD	Canadian Dollar
CASPPR	Chinese Arctic and Antarctic Polar Platform Rating
CTD	Conductivity, Temperature, Depth (sensor/system)
DP	Dynamic Positioning
ECS	Extended Continental Shelf

EK-500	Echo Sounder Model 500
GPS	Global Positioning System
HAMC	Harbin Aircraft Manufacturing Corporation
MOSAiC	Multidisciplinary drifting Observatory for the Study of Arctic Climate
nm	Nautical Mile
NSR	Northern Sea Route
ROV	Remotely Operated Vehicle
UAV	Uncrewed Aerial Vehicle
Wi-Fi	Wireless Fidelity
XBT	Expendable Bathythermograph
XCTD	Expendable Conductivity-Temperature-Depth profiler
YOPP	Year of Polar Prediction

Measurement & Scientific Terms

CO_2	Carbon Dioxide
GB	Gigabyte
kW	Kilowatt
m	Metre

Introduction

In the Summer of 2024 three Chinese icebreakers deployed simultaneously to the Arctic. It was the first multi-vessel Arctic operation and demonstrated significant capability not only in polar science but in Chinese icebreaker design, specialized tools, and technology. Since the first Chinese icebreaker arrived in the Arctic in 1999, there have been 15 such expeditions to the region (as well as 41 to the Antarctic). Each demonstrated an iterative improvement in capability and technology as missions became more complex and the technology more refined and specialized.

The rationale for this sustained presence varies depending on who one asks. There are clear scientific objectives behind China's presence, with climate change a central motivating factor. Most of China's maritime scientific research (MSR) has been specifically geared towards understanding the changing climate and northern environment. The region has been called the canary in the climate coal mine and environmental research has obvious applicability to China.[1] This represents the official Chinese government narrative; namely, that its Arctic research activities are geared towards scientific inquiry, not only for China's benefit but for the common good.[2]

Politically, China's Arctic presence also enables it to substantiate its broader claims to be a 'Near Arctic State.' Namely, a non-Arctic state with capabilities and interests that justify its role in regional governance.[3] Chinese sources regularly argue that a country's level of scientific research activity in the Arctic "directly determines its "right to speak" in regional affairs."[4] This right to speak provides influence but it also serves to normalize a broader presence – something which may also serve as an access point for influence over future resources and shipping routes.[5]

Indeed, MSR directly supports China's long-term interest in Arctic shipping. The country's 14th Five-Year

Plan for National Meteorological Development (2021) highlighted the need to monitor "important marine areas and shipping routes" in the Arctic.[6] The official report of the Fifth Arctic Expedition (2012) emphasised how it set various new records, representing the first Chinese scientific expedition to transit the Arctic Ocean as an "Arctic seaway" and thus opening a "new chapter in China's maritime history" and "laying a material foundation" for "China's Arctic sea-related assessment work."[7] The report on the 8th Expedition (2017) is more sparse, but takes pride in the icebreaker *Xue Long*'s "crossing the Arctic Central Channel and the Northwest Passage for the first time" and how "the regional scope and content of China's Arctic marine environmental operational surveys have made positive contributions to building China's Arctic operational survey system, Arctic environmental assessment and resource utilization, and Arctic frontier scientific research."[8] The country's 2018 Arctic Policy also clearly lays out China's desire to develop new Arctic shipping routes and to leverage its polar research to those ends. Arctic Expeditions in 2012 and 2017 involved transits through the Northwest Passage and the Northern Sea Route to examine their possible future use.[9] Thus, while future shipping operations are rarely as central to Chinese messaging as science, it is clearly an important consideration.

More alarming than shipping and science, many security scholars – and some Western governments – point to the military applications of Chinese MSR. This 'dual purpose' research combines legitimate scientific work with military objectives. The connectivity between the Chinese civilian agencies undertaking Arctic science, and the Chinese military, makes these suggestions all the more plausible. In 2019, the US Department of Defence's report on China's military power was open in its assessment that "civilian research could support a strengthened Chinese military presence in the Arctic Ocean."[10] The 2022 US Arctic Strategy reemphasised this point, asserting that China has used its scientific engagements "to conduct dual-use research with intelligence or military applications."[11] Since that time, Western accusations of dual purpose research have become common place.

More recent Chinese MSR and doctrine seems to lend support to these assertions. The 2020 edition of *Science of Military Strategy* – an overview document on military strategy – states that "military-civilian mixing is the main way for great powers to achieve a Polar military presence." It adds that China should "give full play to the role of military forces in supporting polar scientific research and other operations."[12] This integration is the foundation of China's Military Civil Fusion strategy, which emphasizes the complementarity, integration, and transfer of resources, capabilities, and technologies between military and civilian actors. This strategy facilitates the adaptation of civilian technologies for military use while also driving the commercialization and widespread adoption of military technologies for civilian consumption.[13]

China's Arctic MSR has grown more sophisticated in recent years, including the testing of technologies with a clear military nexus. Of some concern, China's activities frequently include extensive oceanographic surveys and acoustic modeling, which mirror some of its activities in the South China Sea, where a thorough understanding of the region's waters is essential for the Chinese Navy to operate submarines.[14] In the Arctic, these surveys have become more frequent and comprehensive and China's monitoring capabilities have grown apace. In 2014, Chinese researchers introduced the country's first ice-tethered buoys in the Arctic Ocean in a move toward autonomous monitoring. Although designed for civilian oceanographic research, underwater sensors can also provide surveillance capabilities.[15] In July 2023, China announced that scientists from the Polar Research Institute of China (PRIC) had successfully tested a listening device under Arctic conditions and are planning to deploy these devices "on a large scale in the Arctic Ocean.[16] Recent research indicates that this acoustic technology could help detect underwater vessels with near-perfect accuracy in the Beaufort Sea.[17] This capability was apparently developed from China's 2020 Arctic Expedition studying ocean acoustic layers.[18]

Undertaking this research has required China to develop a host of specialized Arctic-capable drones, robots, gliders and other tools. These systems have become more capable and complex over successive Arctic expeditions and now offer a capability similar to that employed by most Arctic states. Like Chinese MSR more generally, these tools may have dual-purpose applications – where separating the civilian scientific tasks and military utility is difficult.

For over 25 years, this research was undertaken by civilian agencies, though the organizing framework has evolved. Beginning in the 1980s, polar research was the responsibility of the State Oceanic Administration (SOA). Operating under the Ministry of Land and Resources (MLR), the SOA served as the primary body for Arctic engagement until 2018 when a governmental reorganisation led to the Ministry of Natural Resources (MNR) absorbing the MLR. Following that reorganization, the SOA functioned as an entity within the MNR, with its director serving as Deputy Minister.[19]

For its scientific work, the SOA coordinates with the China Academy of Sciences (CAS), which oversees several institutions engaged in Arctic research, notably the Sanya-based Institute of Deep-Sea Science and Engineering (IDSSE). Within the SOA, the Polar Research Institute of China (PRIC) is principally responsible for Arctic affairs. Established in 1981 as the Office of the National Antarctic Expedition Committee, it initially focused solely on Antarctic research. China's official Arctic research programme began in 1989, prompting the Chinese Arctic and Antarctic Administration (CAA) to adopt its present name. Today, the PRIC is the principal institute responsible for polar research in China and for executing the five-year plans drawn up by the CAA. [20]

Over time, China's research activities have continued to expand. After nearly two decades, the pattern of expeditions shifted in 2016 – moving from a biennial to annual event. And, in 2020, China launched its first domestically built polar icebreaker, the *Xue Long 2*. In the years that followed, that ship was joined by several others either built in China or purchased abroad and refitted in China. By the 2024, Chinese deployments shifted again, to include multiple vessels, with up to five simultaneous deployments in recent years.

Along with icebreaker capabilities China has also rapidly iterated its Arctic deep-dive capabilities. In 2025, China completed a landmark series of 43 manned submersible dives beneath the Arctic ice cap, deploying its advanced human-occupied vehicles *Fendouzhe* ("Striver") and *Shenhai Yongshi* ("Deep Sea Warrior"). The dives explored seabed formations and marine ecosystems on the Gakkel Ridge – within the Russian claimed extended continental shelf and an area of growing interest for its resource potential. These expeditions signal China's growing technological independence and operational reach and underscore an expanding interest in Arctic seabed resources.

This report is an overview of this extensive and growing Arctic MSR, its history and China's capabilities. It is not an in-depth examination of the politics or strategic intent of this activity, but rather an overview of the platforms and tools used to undertake this work. It is also an incomplete and imperfect assessment. Some elements of Chinese MSR remains classified. The analysis and coverage of this report is also biased by its source base. Almost all of the information contained herein comes from Chinese sources, primarily scientific work and media reporting. These sources have a strong incentive to celebrate Chinese success; to report triumph and progress and ignore failure. Chinese research organizations seeking a continuation of their work consistently emphasise the amount and value of data collected. Chinese state media, meanwhile, tends to portray these voyages as a demonstration of national prowess, from which the public can draw pride. Indeed, in no document did the author uncover a story of failure – by either the icebreakers or the embarked scientific teams.

What this report offers is an overview and key data, which paint a general picture of China's Arctic maritime capabilities, operational patterns, and technologies. From this, readers can derive patterns and priorities. In the years to come, there will be more such activity. How that activity differs from the baseline and how it evolves will therefore be telling.

Icebreakers

Definitions of the term icebreaker can vary. Different regional ice conditions and requirements have led to the label being applied to very different types of ships with different capabilities. According to the International Maritime Organization, an icebreaker is any vessel "whose operational profile may include escort or ice management functions, whose powering and dimensions allow it to undertake aggressive operations in ice-covered waters."[21] China now has several such vessels as well as several that are better understood as ice-strengthened ships. These are ships capable of operating in ice-covered areas, though without sufficient hull strength and engine power to navigate through thick, often multi-year sea ice, and clear channels for other ships.[22]

There are multiple rating systems to measure a ship's icebreaking capabilities. This report will use the International Association of Classification Societies' (ICAS) polar class ratings which applies to a wide array of vessels, ranging from those built for operating year-round in all polar sea-ice conditions (Polar Class 1) to ships only cleared for summer and autumn operations in light ice conditions (Polar Class 7).[23] While ships with PC ratings higher than 4 are generally not considered icebreakers, they are included in this report since these lighter vessels have undertaken most of China's Arctic MSR over the past 25 years, and still make up most of its 'icebreaker' fleet. For simplicity's sake, all Chinese ice-strengthened ships will be lumped into a single category of 'icebreakers.'

Chinese Icebreakers

Name	Polar Class	Length	Beam	Draft	Speed	Displacement (tonnes)	Range	Crew	Launched	Owner	Shipyard
Xue Long	PC6	167m	22.6m	9m	18kn	21,025	20,000nm	34 + 128 Passengers	1993 (2007 refit)	PRIC	Kherson Shipyard, Ukraine
Xue Long 2	PC3	122.5m	22.3m	7.85m	12kn	14,300	20,000 nm	30 + 60 Passengers	2019	PRIC	JNCX, Shanghai
Zhang Shan Da Xue Ji Di	PC4	78.95m	17.22m	18.1m	15.5kn	5,852	15,000nm	20 + 40 Researchers	1982 (current owner: 2021)	Sun Yat-sen University	Icebreaker conversion undertaken by Guangzhou Wenchong Shipyard, Guangzhou
Ji Di	PC6	89m	17.8m	5.5m	15kn	5,600	14,000nm	60 (Total)	2023	State Oceanic Administration	GSI, Guangzhou
Tan Suo San Hao	PC4	104m	19.7m	6.7m	16kn	9,200	15,000nm	32 + 48 Researchers	2024	Institute of Deep-sea Science and Engineering	GSI, Guangzhou
Hai Bing 722 *Hai Bing 723*	PC5	103m	18.4m	uncertain	18kn	4,860	7,000nm	uncertain	2015 & 2016	PLAN	Dalian Shipbuilding Industry Company and Southern Liaoning Shipyard

Chart data primarily from Monty Khanna, "China and the Arctic: An Overview," ORF, [*https://www.orfonline.org/research/china-and-the-arctic-an-overview*](https://www.orfonline.org/research/china-and-the-arctic-an-overview).[24]

Xue Long (Snow Dragon)

Specifications

- Polar class: CCS B1 (PC6)
- Operator: PRIC
- Ship size:
  - Length: 167 metres
  - Width: 22.6 metres
  - Beam 22.6 metres
  - Draft: 9 metres
- Launched: 1993
- Range: 20,000 nautical miles
-
- Speed: 18 knots
- Displacement: 21,025 tonnes
- Ice Capability: Vessels can continuously break through a 1.2 meter thick ice layer (including 0.2 meters of snow) at a continuous speed of 1.5 knots.[25]

Xue Long is a Ukrainian built ice-strengthened cargo carrier, originally designed as a multi-purpose transport vessel for the Arctic region. The ship was purchased by China and underwent extensive modification. During a mid-life refit, the ship received a new superstructure that considerably changed its external appearance, as well as another overhaul in 2013 which included replacing the main engine.[26]

The ship is equipped with advanced systems for self-contained navigation and weather observation, as well as extensive lab space for scientific research.[27] The ship also doubles as a resupply vessel to support China's research presence in Antarctica. The vessel has a Chinese ice rating of CCS B1, which has a rough equivalency to PC6. These conversions are not perfect, however, and *Xue Long* is likely more capable than that rating would suggest.[28] While not designed to break through heavy ice, *Xue Long* has still been China's workhorse in the Arctic since the beginning of the Arctic Expeditions in 1999. Notably, it has transited both the Northwest Passage and the Northern Sea Route and undertaken the lion's share of China's Antarctic resupply missions.

The ship was subject to several upgrades over its live. Over its first decade in operation, China's Arctic Expeditions showed the need for more space and improved technology. The ship's laboratory space expanded from 200 to 580 square meters and had CTD winches and a stern-mounted 10,000-meter geological winch installed, the latter being some the most advanced marine survey equipment in the world. The vessel now has seven labs – including a low temperature cultivation room, a clean laboratory, a marine biological laboratory, a marine chemical laboratory, a geological laboratory, and geological laboratory.[29]

During its modernization, Xue Long was also outfitted with state-of-the-art communication and navigation systems, including laser path guidance, a first among global research vessels. It is also the world's first research ship equipped with the Broadband Global Area Network (BGAN) system.

The upgraded vessel also features the world's most advanced cabin automation control system, enabling unmanned operation and centralized cockpit control of its main and auxiliary engines, boilers, and related equipment. Additionally, its marine research instruments have been comprehensively modernized, including the installation of the world's leading surface seawater collection and analysis system. This marks the system's debut on a Chinese vessel, placing Xue Long among an elite group of ships operated by the U.S. and a select few other nations.[30]

From previous page: Chinese icebreaker Xue Long in 2024 (source: Wikimedia)

Above: Xue Long berthed at Victoria Quay in the inner harbour of Fremantle Harbour, Western Australia. (Source Wikimedia):

Xue Long 2 (Snow Dragon 2)

Specifications

- Polar Class: PC3
- Operator: PRIC
- Ship size:
  - Length: 122.5 metres
  - Width: 22.3 metres
  - Draft: 7.85 metres
- Launched: 2019
- Displacement: 13,990 tons
- Owner:
- Speed: 22 km/h maximum or 12-knots
- Range: 20,000 nautical miles
- Ice Capability: Vessel can continuously break ice and navigate at a speed of 2 to 3 knots in conditions with 1.5 meters of ice thickness and 0.2 meters of snow.

Xue Long 2 is China's first purpose-build icebreaker. A PC3 ship, it was built in 2019, designed by 708 Research Institute of China State Shipbuilding Corporation (CSSC) with the support of Aker Arctic of Finland. Boasting bi-directional azipod icebreaking technology, it is the first ship in the world able to break ice at either its bow or stern. The ship is China's most capable icebreaker and had become the PRIC's primary tool for Arctic research, supplementing the less capable *Xue Long*. While rated to transit 1.5 metres of ice, *Xue Long 2* is likely more capable, with Chinese news reports indicating that the vessel has transited dense fields of ice two to five metres thick, with large multi-year ice inclusions and significant ridging.[31]

Specifically designed for scientific research, the ship features extensive laboratory workspace and a moon pool workshop that covers approximately 160 square meters. This feature allows the crew to lower instruments and drones into the Arctic waters without having to break through the Arctic ice.[32] To support this work, the ship is also equipped with 2 deck cranes, a core sampler, a survey station, and facilities for an embarked helicopter. Purpose built for extended operations in the High Arctic, all the vessel's facilities and equipment were designed to be work continuously in air temperatures as low as to -30 degrees Celsius.[33] Critically, *Xue Long 2* is also built with a helicopter hanger, allowing it to repair and maintain aircraft and sustain flight operations far better than *Xue Long*. Since being delivered, *Xue Long 2* has become China's primary Arctic research platform.

From previous page: Chinese icebreaker Xue Long in 2024 (source: Wikimedia)

Above: Xuelong-2 at Hong Kong in 2024 (Source Wikimedia)

Ji Di (Polar)

Specifications

- Polar Class: PC6
- Operator: Ministry of Natural Resources
- Ship size:
  - Length: 89.95 metres
  - Width: 17.8 metres
  - Draft: 5.5 metres
- Launched: 2024
- Range: 14,000 nautical miles
- Speed: 15 knots
- Crew: 60
- Displacement: 5,700 tons
- Ice Capability: Vessel can continuously break ice and navigate at a speed of 2 knots in areas with 1-metre-thick first-year ice.

Ji Di was launched from Guangzhou Shipyard in 2024, having been constructed in only two years. This ship represents a significant leap in Chinese design capabilities, as it was the first icebreaker to be domestically designed. A PC6 vessel, it is capable of operating in ice-covered waters but is not able to move through dense multi-year ice. Designed for summer operations in the Arctic, it was China's first vessel earmarked for hydrographic surveying in the region.

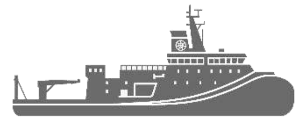
Ji Di in the Western Arctic (Source: US Coast Guard)

When in the Arctic, it often operates in proximity to a more powerful vessel, such as *Xue Long 2*.[34] In the winter, it can effectively operate in the Yellow and Bohai Seas.

Building on China's long track record of developing Arctic-capable autonomous systems, *Ji Di* is equipped to carry domestically produced drones, uncrewed surface vessels, and autonomous underwater robots.[35] The vessel also carries advanced marine survey equipment and can undertake atmospheric and maritime observations and survey tasks.[36] Of significance, the ship is equipped with a multibeam bathymetry system and shallow stratigraphic profiler to study seafloor geomorphology and undertake hydrographic surveys.[37] While equipped with a helicopter deck, *Ji Di* lacks a hangar, a serious limiting factor for Arctic operations since hanger space is critical to repairing and maintaining aircraft for sustained operations.

Designated as China's first "ice-going" or polar scientific research vessel, *Ji Di* was designed from the prototype of a cargo ship that was fitted with 1A icebreaking capability.[38] Its comprehensive marine sampling and observation abilities make it a useful tool for observation, investigation, and research taskings related to sea ice, the polar atmosphere, and the polar oceans.[39]

Tan Suo San Hao (Explorer 3)



Specifications

- Polar Class: PC4
- Operator: Institute of Deep-Sea Science and Engineering (IDSSE) of the Chinese Academy of Sciences
- Ship size:
  - Length: 104 metres
  - Width: 19.7 metres
  - Draft: 6.7 metres
  - Beam: 19.7 metres
- Launched: 2024
- Range: 15,000 nautical miles
- Speed: 16 knots
- Displacement: 9,300 tons
- Ice Capability: Vessel can break 1.2 metres of ice with 20 centimetres of snow at a continuous speed of 2 knots.

Tan Suo San Hao – alternatively known as Explorer 3, Discovery 3, or Tansuo San – was constructed in June 2023 by Guangzhou Shipyard International (GSI).[40] Designed to be the nation's "first comprehensive scientific research vessel,"[41] the ship belongs to the Ministry of Natural Resources. Its development and construction was reported to have been a remarkably collaborative venture involving over 100 domestic enterprises, universities, and institutes. It's design also reportedly led to the creation "of numerous new technologies."[42]

The speed of its construction was remarkable, with the vessel launched a mere ten months after the first steel was cut. More broadly, this pace demonstrated China's rapid improvement in icebreaker design and shipbuilding. *Tan Suo San Hao* is not a minor vessel; with a 10,000-tonne displacement it is the largest icebreaker to be designed and constructed in China, and as a PC4, it is classified as a medium icebreaker, able to operate in polar waters with multi-year ice inclusions.

Operating with the call sign BPPW8, *Tan Suo San Hao* boasts a cruising distance of more than 15,000 nautical miles, self-endurance of over 75 days, and personnel capacity of 80, including 32 crew and 48 passengers.[43] With four 3,000-kilowatt generators and a propulsion system comprised of two ABB azimuthing podded thrusters, the vessel can attain a maximum speed of 30 kilometres per hour, or 16 knots.[44] Equipped with cabins, laboratories, a moon pool to enable robot and drone access, and an A-frame deck to facilitate the operations of larger crewed submersibles like the Jialong, Deep Sea Warrior, or Striver, it represents a uniquely capable research vessel.[45] It boasts a bidirectional icebreaking capability, facilitating summertime polar operations,[46] and is equipped for archaeological research and deep-sea exploration. In particular, it has been geared towards supporting deep-diving missions. This capability has been demonstrated in the Arctic where it has carried, deployed, and recovered small crewed submersibles,[47] remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs), even in areas covered in ice.[48]

In October 2024, *Tan Suo San Hao* underwent an eight-day sea trial. This comprised 30 test categories – evaluating speed, underwater radiated noise, and manoeuvrability. Media reported that its results in all categories either met or surpassed the vessel's initial design parameters.[49] The vessel has also been tested for low-temperature operations and underwater docking, but the details of those tests are scarce.[50] In the summer of 2025 it operated in the north Bering Sea and Arctic waters as part of a larger Chinese fleet.[51]

During the 2025 operations, the vessel supported deep sea dives and AUV operations, in conjunction with other Chinese icebreakers. These operations made China the first country since the 2007 Russian Arktika mission (and the second country overall) to deploy a crewed vessel to the Arctic seabed.[52] Beyond the scientific importance of these operations, the *Tan Suo San Hao* represents an important symbolic capability, showing Chinese capacity and presence in the Arctic.[53]

Above: Tan Suo San Hao in the Western Arctic (Source: US Coast Guard)

Zhong Shan Da Xue Ji Di (Sun Yat-sen University Polar)

Specifications

- Polar Class: CASPPR Arctic Class 4 (PC3)
- Operator: SYSU
- Ship size:
  - Length: 78.95 metres
  - Width: 17.22 metres
  - Draft: 8.16 metres
- Launched: 1982 (donated to Sun Yat-sen University in 2021)
- Displacement: 5,852 tons
- Range: 15,000 nm
- Speed: 15.5 knots
- Ice Capability: Vessel's maximum ice-breaking capacity is 2.2 meters.[54]

The *Zhong Shan Da Xue Ji Di* was originally built in 1983 as an icebreaking anchor-handling tug named *Ikaluk* for Beau Drill, a drilling subsidiary of Gulf Canada Resources. In 1998, the vessel was purchased by Smit International and renamed *Smit Sibu*. It was then deployed to the Sakhalin oil fields in eastern Russia along. *Ikaluk* was purchased in 2018 by Chinese reality TV hosts Zhang Xinyu and Liang Hong and refitted as research vessel, renamed *Beijing Ocean Leader*, which was used for a scientific mission to Antarctica in 2020. The vessel was acquired

by Sun Yat-sen University in 2021 and sent to Guangzhou Wenchong Shipyard for a $100 million yuan ($20 million CAD) refurbishment before being delivered to the university as a scientific research vessel.[55] While smaller than *Xue Long* and *Xue Long 2*, the ship is highly capable, having been designed for heavy ice conditions in the Beaufort Sea.[56]

To convert the ship into a functional research vessel, a suite of critical equipment was added, including a full-depth multi-beam echo sounding system.[57] *Zhong Shan Da Xue Ji Di* now includes multiple laboratories, meteorological stations, and the ability to deploy drone systems. It can also carry out offshore, ocean, and polar marine physics, biology, chemistry, and meteorology surveys.[58]

Above: Zhong Shan Da Xue Ji Di in the Western Arctic (Source: US Coast Guard)

Previous page: Zhong Shan Da Xue Ji Di in the Western Arctic (Source: US Coast Guard)

Other Relevant Ships

While China's dedicated research icebreakers form the backbone of its polar fleet, a growing number of ice-strengthened vessels contribute to its Arctic presence. This includes ships not designed for polar operations but deployed into the region. These ice-strengthened ships can access the Arctic but have limited capabilities in waters with multi-year ice.

Deploying the ice camp on sea ice during Chinese CHINARE expedition to the central Arctic in summer 2010 on board of icebreaker Xue Long (Timo Palo)

Yanrao-class[59] Icebreakers [Type 272]

Specifications

- Polar Class: PC5
- Operator: People's Liberation Army Navy (PLAN)
- Ship size:
  - Length: 103 metres
  - Width: 18.4 metres
- Launched: 2015
- Displacement: 4,860 tons
- Range: 7,000 nautical miles
- Speed: 18 knots
- Ice Capability: Vessel's maximum ice-breaking capacity is one metre of new ice.

The Type 272 icebreaker is the third-generation light icebreaker indigenously developed by China for the People's Liberation Army Navy (PLAN). They are the namesakes of their predecessors built in 1969 – the Haibing 722s. Two vessels are currently in service with the North Sea Fleet, *Hai Bing* (Sea Ice) 722 and 723. The first was launched in 2015 and the second one year later. While naval vessels they remain unarmed.

These vessels have never entered the Arctic, designed instead for survey work, icebreaking, and search and rescue missions in the Yellow and Bohai Seas.[60] Despite this, they have (on paper) roughly comparable ice capability to the Canadian Arctic Offshore and Patrol Vessels and could operate in the Arctic if required. These are not research vessels like China's other Arctic platforms, thought they do possess a crane specially installed to carry out ice layer sampling and other tasks.

RV Kexue

Specifications

- Polar Class: CCS AUT-0, Ice Class B3, DP-1, OMBO (PC7)
- Operator: Institute of Oceanology, Chinese Academy of Sciences
- Ship size:
  - Length: 99.8 metres
  - Width: 17.8 metres
  - Draft: 8.9 metres
- Launched: 2012
- Displacement: 4,981 tons
- Range: 15,000 nautical miles
- Speed: 15.8 knots
- Ice Capability: Limited

Designed by the Marine Design and Research Institute of China, and constructed by Wuchang Shipbuilding Industry Co. Ltd., RV *Kexue* was delivered in 2012 and successfully passed its national acceptance trials three years later, in 2015.[61] The vessel is equipped with an electric propulsion system, two sets of bow thrusters, and 80 berths, for permanent crew, technicians, and scientists.[62]

RV *Kexue* was designed and constructed in response to China's growing global marine scientific research program. Equipped a host of MSR instruments, it is capable of performing a variety of research tasks in deep ocean environments, specifically marine environment detection, observation, and "in situ fidelity sampling and analysis." Furthermore, the vessel is intended to offer "technical support" for addressing issues related to energy, marine sources, natural disasters, and national security and defence.[63]

The research vessel has been active in recent years. In 2023 it undertook five cruises involving 261 days at sea across 34,293 nautical miles. The voyage was said to have generated a wealth of experimental samples.[64] The vessel's 2024 operations saw it operating in the North Pacific for three weeks before entering the Bering Sea on August 9 – where it remained for roughly one week. While in the central Bering Sea, the ship collected of data and samples while deploying submersibles and moored instruments.[65]

Kexue was not designed for the Arctic and its presence in the region demonstrates the connection between China's Arctic operations and is global MSR program. Of note, the ship has also been witnessed operating in sensitive regions of the Indo-Pacific, notably near Guam.[66]

Xiang Yang Hong 01

- Polar Class: Ice Class B (PC7)
- Operator: First Institute of Oceanography, Ministry of Natural Resources
- Ship size:
  - Length: 112 metres
  - Width: 17.89 metres
- Launched: 2016
- Displacement: 5,180 tonnes
- Range: 15,000 nautical miles
- Speed: 15.8 knots
- Ice Capability: Limited

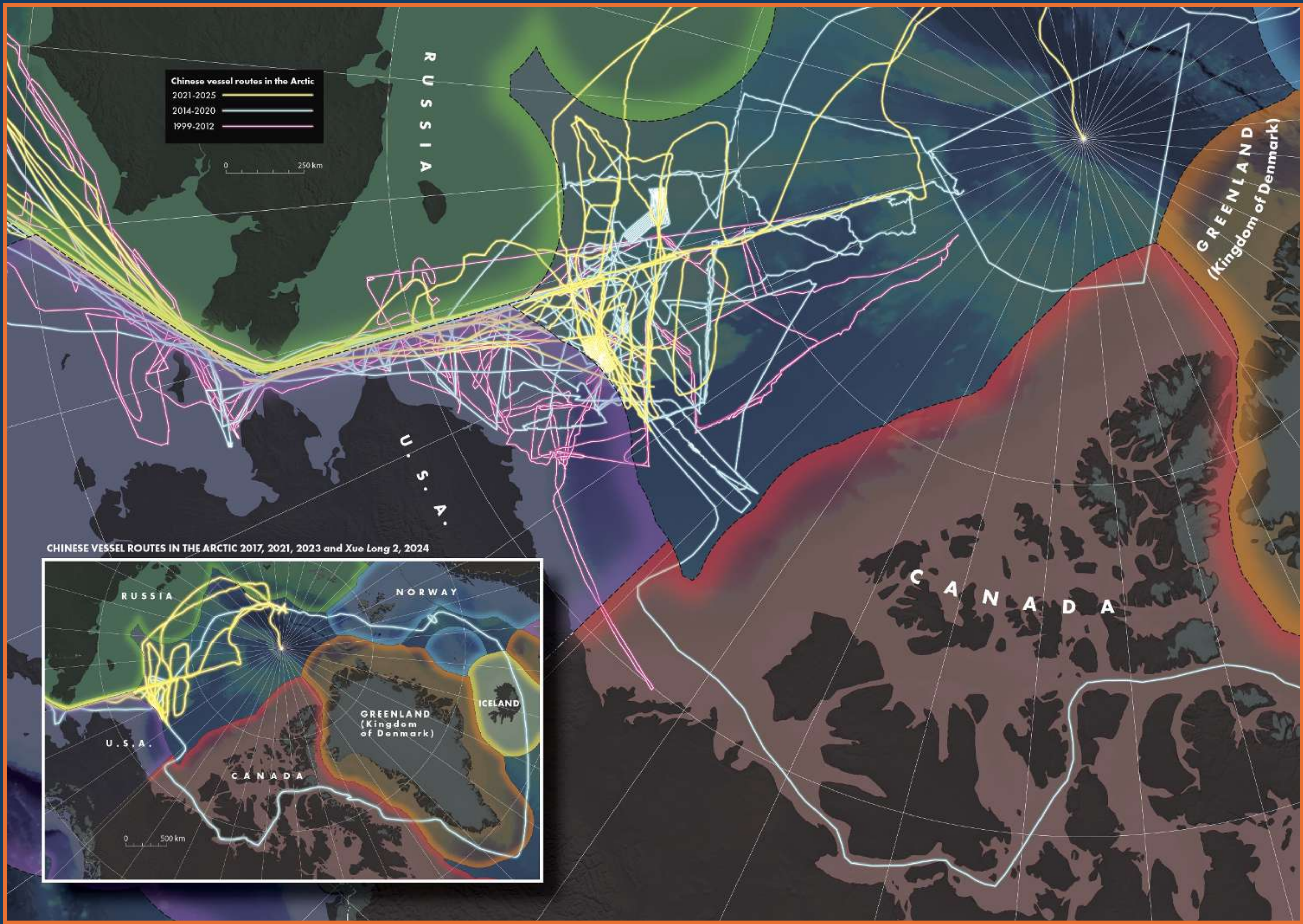
Xiang Yang Hong 01 is a research vessel built to support multidisciplinary research in deep-sea and open-ocean environments, it brings together a wide range of scientific capabilities and technical systems to function as a mobile marine laboratory and testing platform, supporting both fundamental ocean science and the development of advanced marine technologies.[67]

The vessel's onboard systems support both continuous fixed-point and underway measurements of marine environmental ecosystems, including routine sea-surface meteorological observations, air–sea interface flux measurements, seafloor topography and geomorphology surveys, seabed characteristic sampling, geophysical exploration, cable-controlled deep-diving operations, and visual sampling. Together, these capabilities enable comprehensive three-dimensional surveys of the marine environment and resources across the atmosphere, sea surface, water column, seafloor, and deep-sea extreme environments.[68]

Xiang Yang Hong 01 undertook its first Arctic mission in August 2019 as part of China's 10th Arctic scientific expedition [69] During this trip, the vessel visited a Russian military port and operated within Russia's exclusive economic zone, activity that a US Naval War College research note interpreted as evidence of "a high degree of Russian support of PRC activities in the region."[70] The ship concluded its survey, on September 2, travelling to Russia's Avacha Bay, which houses the Russian Navy's Pacific Fleet. It remained for a day there before retracing its route back home to China.[71] The vessel did not enter the Arctic Ocean, however its mission was one of the earlier Chinese efforts to undertake symbolic cooperation with the Russians in the region.

Operational Patterns

The operational patterns of China's icebreakers – principally *Xue Long* and *Xue Long 2* – indicate a clear interest in the Arctic areas north of the Bering Strait. Nearly every Chinese Arctic Expedition has placed considerable emphasis on surveying and studying the continental shelf north of Alaska. In particular, the focus has been on the Chukchi Plateau and Northwind Ridge. The fifth expedition in 2012 and the eighth in 2017 represent notable exceptions to China's concentrated activity. Both of these expeditions circumnavigated the Arctic, but with different return routes, with the ship returning via the Transpolar Route in 2012 and through the Northwest Passage in 2017.


Chinese vessel routes in the Arctic
2021-2025
2014-2020
1999-2012
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RUSSIA
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GREENLAND
(Kingdom of Denmark)
CANADA
CHINESE VESSEL ROUTES IN THE ARCTIC 2017, 2021, 2023 and *Xue Long 2*, 2024
RUSSIA
NORWAY
ICELAND
GREENLAND
(Kingdom
of Denmark)
U.S.A.
CANADA
0
500 km

1st Arctic Expedition (1999)

- Ship: *Xue Long*
    - Map drawn from media release (imprecise)

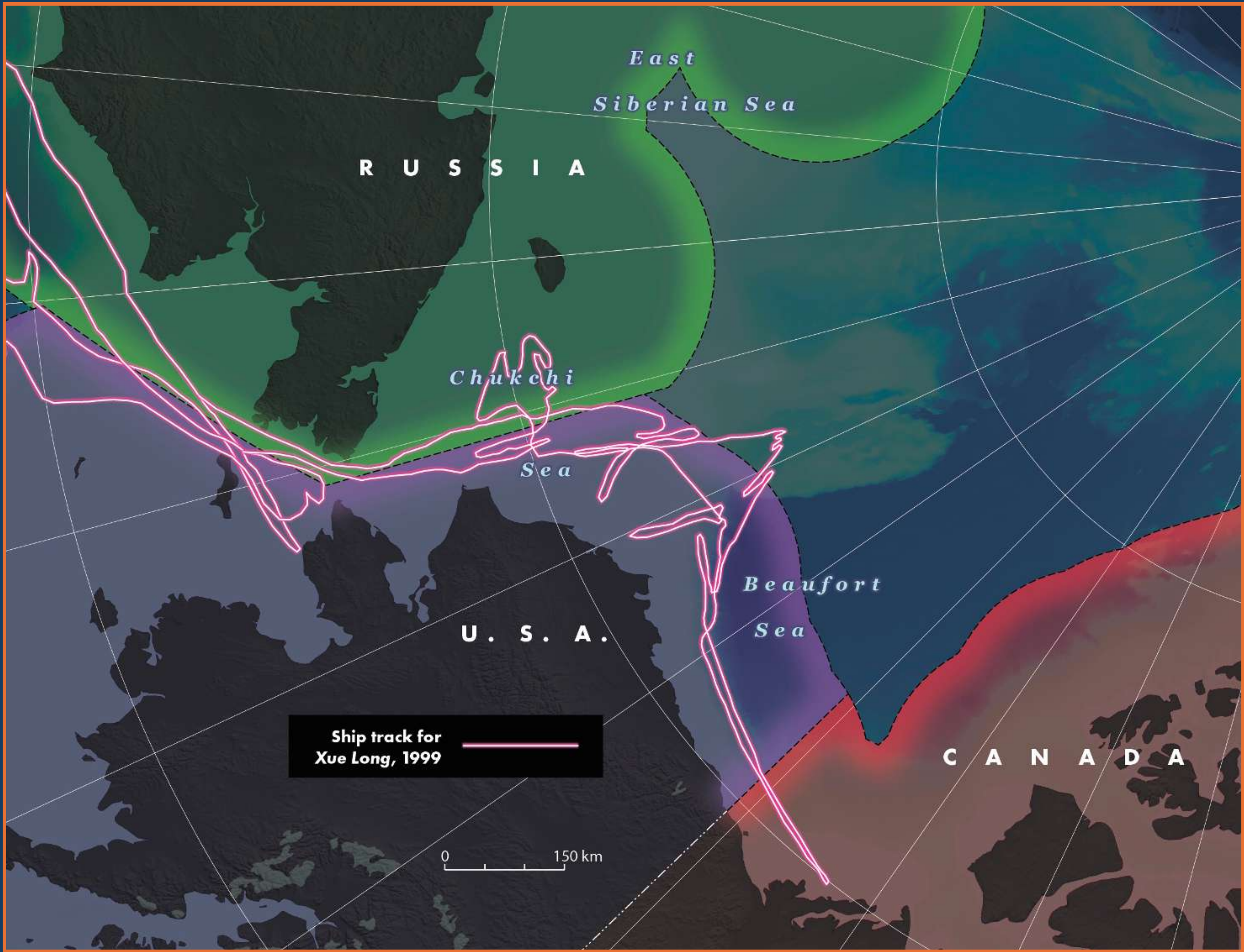
China's inaugural Arctic research voyage took place in the summer of 1999. *Xue Long* departed Shanghai in July, carrying a scientific team. Dubbed the Chinese National Arctic Research Expedition (CHINARE), the vessel travelled though the Bering Strait and into the Chukchi Sea, Canada Basin, and Bering Sea, where it undertook a series of sea-ice and atmospheric surveys. Researchers sampled seawater chemistry, measured marine greenhouse gases (such as methane and nitrous oxide), and analyzed suspended particulates to map their distribution in Arctic waters. The overarching objective of the mission was to study the impacts of climate change on the Arctic, and to determine how this may impact Chinese weather patterns. The surveys were also designed to better understand the impacts of climate change on the local ecosystem, with specific attention paid to Arctic biology, and potential ramifications for Chinese fisheries.[72]

> *"[Arctic presence] "raised China's prestige and influence in the international Arctic research."*
> *- PRIC researcher Minghong Cai*

The expedition obtained valuable oceanographic samples and data, including the first Chinese sediment core sampling of the Arctic Ocean (at a depth of 3,000 meters) as well as hydrological composite data at a maximum water depth of 3,950 meters. The ship also took several ice cores, surface snow samples, plankton, seawater samples, and atmospheric readings.[73] The pattern of research indicated a clear interest in obtaining a baseline understanding of the Arctic environment.

Xue Long also began to test scientific equipment in the region. It ran a multibeam bathymetric system and a proton magnetometer to measure the strength of the polar magnetic field and deployed biological and ecological survey equipment and aircraft, including the HAMC Z-9/Harbin Z-9 helicopter and experimental fixed wing drone aircraft with a range of 10 km.

Politically, the voyage also demonstrated an increasingly capable China, moving beyond its near seas and undertaking scientific work on a global scale. In describing the voyage, PRIC researcher Minghong Cai explained that it also "raised China's prestige and influence in the international Arctic research."[74] The icebreaker also paid the first visit to the Canadian Arctic, arriving in the hamlet of Tuktoyaktuk. The visit caused a political problem for the Canadian government as the hamlet had not been notified in advance. A myth surrounding the voyage grew up that the ship arrived without permission and without Canada being able to track it. In reality, Canadian officials were notified and a breakdown in internal communications led to the failure to notify.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CANADA
Ship track for
Xue Long, 1999
0
150 km

2nd Arctic Expedition (2003)

- Ship: *Xue Long*
    - Map drawn from media release (imprecise)

China's second Arctic Expedition took place in July 2003, expanding both the geographic and scientific scope of its Arctic work. During this voyage, *Xue Long* became the first Chinese vessel to venture beyond 80°N, reaching 80°15′N. State media reporting on the expedition focused on the crew's progress in "using the Arctic region to better understand global climatic changes" and, in particular, the impact of those changes on Chinese weather.[75] This work included studies of the ocean column, atmospheric sampling, sea ice, biology, geology, fisheries, and ecological conditions.[76]

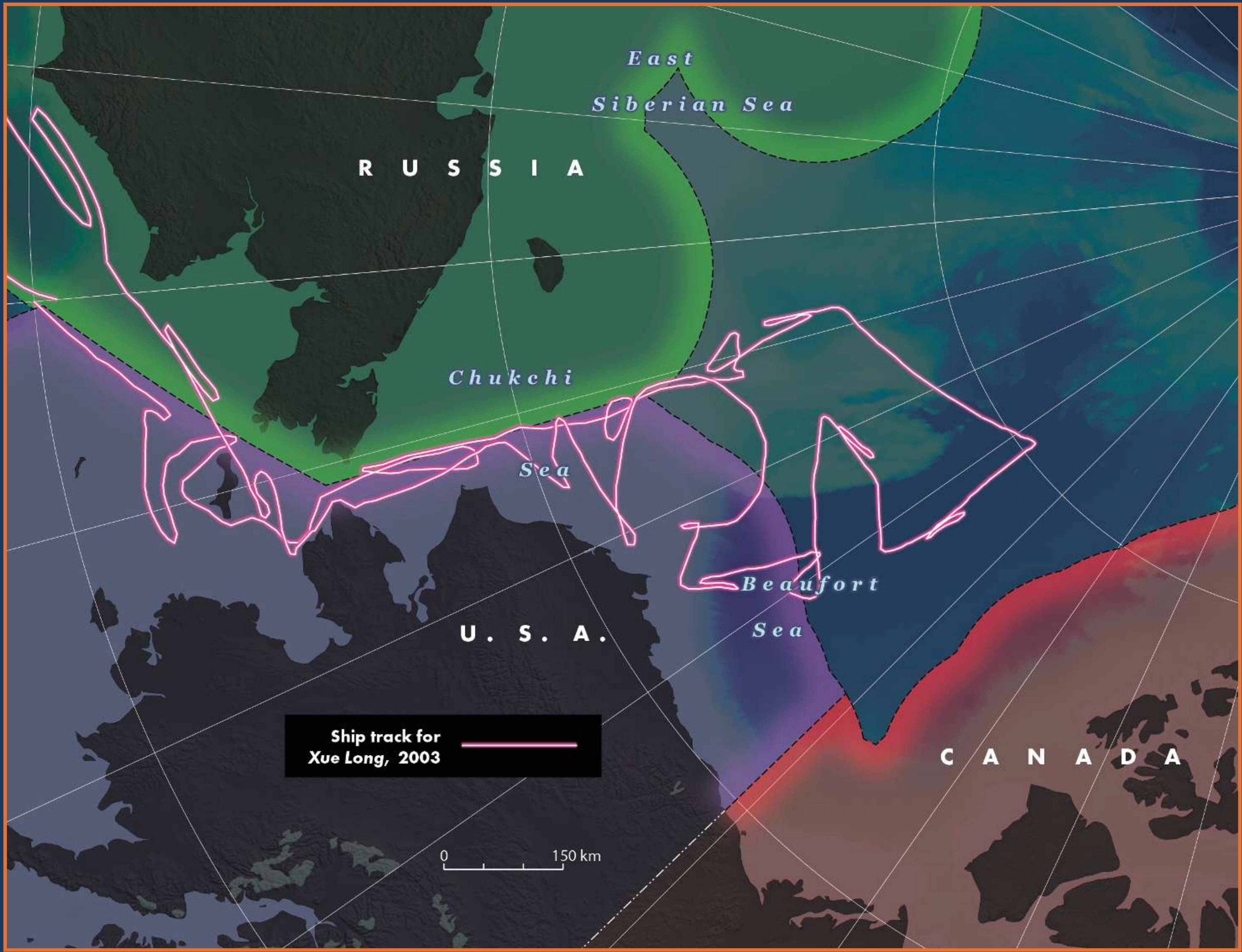
During this expedition, two polar satellite tracking buoys were successfully deployed for the first time, and an independently developed remote-controlled underwater robot (ROV) was also launched on a test mission. The ROV completed a continuous measurement of sea ice thickness, sea ice bottom morphology, temperature and salinity, providing China's "first glimpse of the under-ice Arctic Ocean."[77] The icebreaker also brought helicopters which deployed GPS arrays on Arctic sea ice to continuously monitor ice trajectory. Helicopter operations reached as far north as 81° degrees north latitude, which "created a new milestone in China's polar expedition."[78] The shipborne automatic weather station also acquired meteorological data north of 80° for the first time, filling a gap of China's meteorological data.

Developing a longer-term monitoring system, the ship deployed stations on an ice floe at 78° north latitude. Over 15 days, the expedition's scientists conducted continuous tracking of the region's meteorological conditions, sea-air exchange, ice thickness, temperature, and salinity. The icebreaker also deployed two indigenously produced polar buoys on the ice floe which Chinese publications suggest were left in place to gather data over the next two years.[79]

These new tools were used to analyze and study the variations of Arctic ocean-atmosphere and sea ice systems[80] by studying the interplay between the ice, atmosphere, sea, biology, and geology in the Bering and Chukchi Sea, and the Canadian Basin. This work completed a comprehensive large-scale field study of the ocean area and atmosphere.[81]

Politically, an important feature of the expedition was the participation of 13 foreign expedition members from eight foreign research institutes in six countries: the United States, Canada, Japan, Finland, South Korea, and Russia. This was the most significant cooperation with the international scientific community and showcased China's ability to support and facilitate Arctic work.[82]

Compared to the First Arctic Expedition, Chinese publications boast that this voyage saw a substantial improvement in the "technical level" of its research. *Xue Long* was equipped with a "variety of advanced instruments and equipment, basically reaching the level of today's foreign expeditions." The voyage also covered more area owing to easier ice conditions.[83]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Ship track for
Xue Long, 2003
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150 km

3rd Arctic Expedition (2008)

- Ship: *Xue Long*
    - Map drawn from AIS tracks

China's Third Arctic Expedition took place in 2008 and centred on the Bering Sea. Like previous missions, its program of work revolved around oceanographic, sea ice, and atmospheric research. The stated rationale for this work continued to be climate change research and the need to better understand the changing Arctic and its impact on China. Despite the continuity, this voyage was both more complex and expanded its objectives in new directions, adding an emphasis on the region's unique biological resources, Arctic geology, and geophysics.[84]

In support of this work, *Xue Long* took over 4,000 diverse samples, yielding "extensive high-precision data." This included seawater samples at a depth of 2,110 meters at the Alpha Ridge, and hydrological data to track the temperature and salinity of seawater.[85] Chinese reports indicate that studying the hydrological parameters between the Canadian and Markov Basin, helped them understand the "seawater flow conditions and water mass structure differences" between the two basins.[86] Finally, a geophysical survey was conducted for the first time, covering 870 km of magnetic measurements and 7,340 km of gravity surveys, filling a critical gap in China's research capabilities in this field.[87] On its return to China, *Xue Long* established two short-term ice stations in the Arctic Ocean to conduct surveys of Arctic sea ice, before undertaking comprehensive ocean surveys along 164 degrees west longitude.[88]

This work required an expansion of the team's technology and Arctic-capable tools. The voyage included the first airdrop of and Expendable conductivity-temperature-depth profiler (XCTD) in the Arctic, the first optical experiment on sea ice with an artificial light source, and the adoption of a wide range of new observation technologies.[89] *Xue Long's* research team also used its Z-9 helicopter to extend the ships' operational range, landing on ice floes up to 89 km away. This set a Chinese record for polar flight, with aircraft arriving on station at 85°25′N and 87°N.[90]

> *"China advocates peaceful development of the Arctic together with the international community, and the [Arctic] expedition will mainly focus on the climate and environment, biological resources, geology and geography." He continued to say that the "'International Polar Year' is an international event for cooperation in polar scientific research [and] as a big country, China arranged an Arctic expedition during the 'Polar Year' to reflect the responsible attitude of a big country towards the survival and development of mankind, and to dedicate wisdom to international polar research."*
>
> - *Wu Jinyou, secretary of the party committee of the China Polar Research Center (2008)*

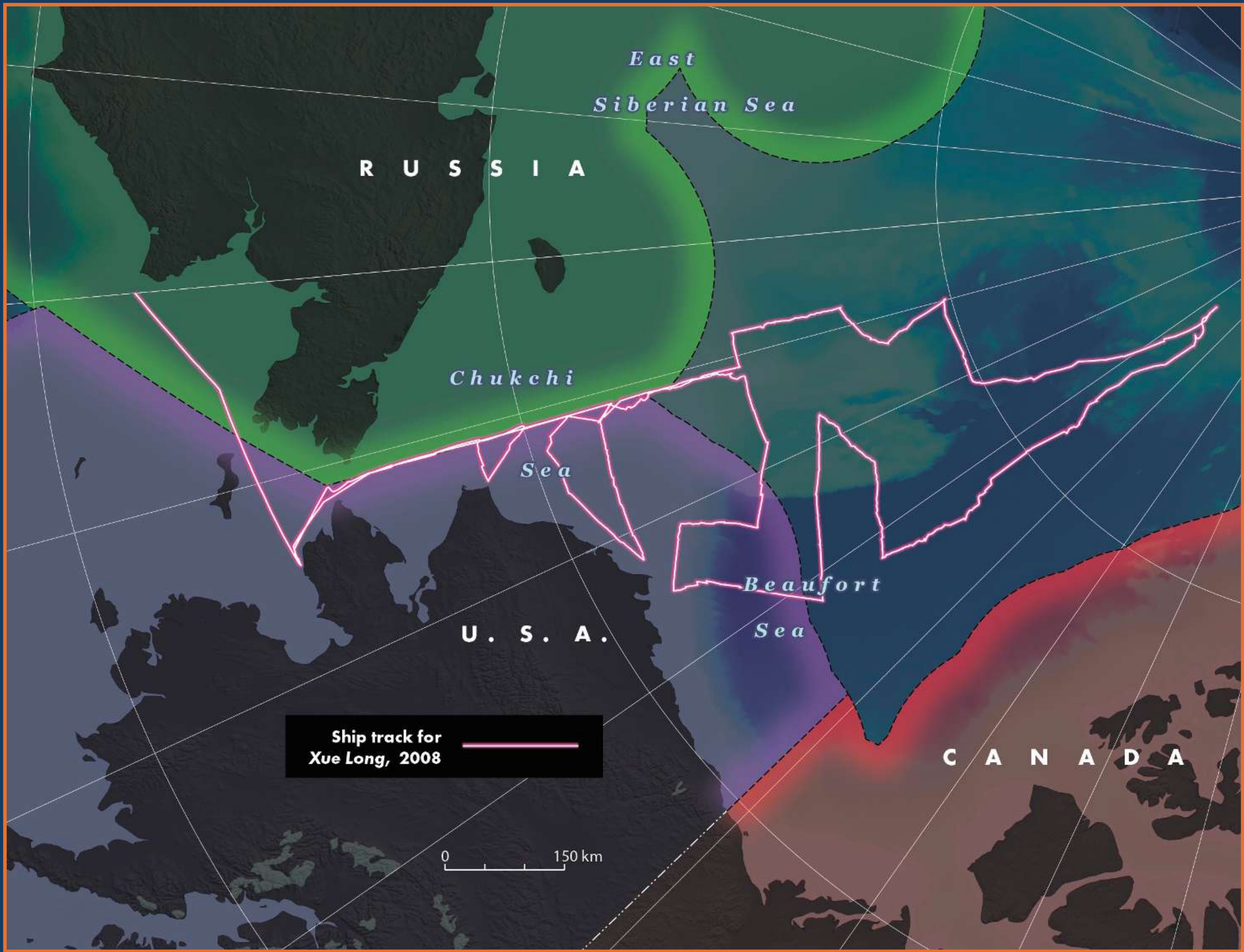
During the voyage, the Shenyang Institute of Automation of the Chinese Academy of Sciences (CAS), deployed its independently developed Arctic Autonomous/Remote-Controlled Marine Environment Monitoring System ("Arctic ARV"). This marked the second deployment of the Institute's underwater robotics in Arctic research, following the "Sea Pole" ROV in 2003. The

"Arctic ARV" was a newly developed underwater robot designed specifically for polar under-ice marine environments. Part of the national "863" Program, under the marine technology initiative, this mission marked the first use of a hybrid autonomous/remote-controlled underwater robot in China's polar scientific research for marine environment monitoring.[91] On August 23, the ARV captured under-ice video footage and mapped sub-ice morphology using onboard measurement instruments. It also collected data on ice floe thickness, under-ice temperature, salinity, depth, and optical parameters. According to the CAS, its successful deployment "significantly enhance[ed] China's ability to conduct wide-area, continuous, and real-time under-ice observations, providing an effective supplement to existing Arctic monitoring systems."[92]

Of political importance, the voyage also continued the previous expedition's pattern of opening research facilities to foreign partners. Twelve foreign scientists took part this year.[93]

The Third Expedition represented a clear iterative improvement over the previous two. Yuan Shaohong, leader of China's third Arctic scientific expedition and deputy director of the China Polar Research Center (CPRC) explained his view of this progress, stating:

> The first Chinese Arctic expedition served as a pioneering effort. Prior to this initiative, Chinese scientists' Arctic research was confined to international collaborations or reliance on foreign research vessels. Consequently, the inaugural expedition provided critical foundational data that informed subsequent scientific strategies. The Second Expedition represented a more comprehensive Arctic survey, though it faced constraints due to limitations in equipment, safety protocols, and funding. In contrast, the Third Expedition was conducted under a more robust logistical and scientific framework, with clearly defined research objectives and rigorous organizational planning. As a result, this expedition yielded more substantial and meaningful data than its predecessors, offering deeper insights into key research areas. The subsequent analysis and findings from this mission are expected to significantly advance China's polar research agenda."[94]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Ship track for
Xue Long, 2008
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4th Arctic Expedition (2010)

- Ship: *Xue Long*
    - Map drawn from AIS tracks

China conducted its Fourth Arctic Expedition in 2010, reducing the gap between its voyages to two years. This operation saw *Xue Long* travel to the North Pole, conducting a comprehensive marine and sea ice survey. The work encompassed an area extending approximately 2,300 nm from north to south and 1,100 nm from east to west, encompassing the Bering Sea and Strait, the Chukchi Sea, the Canadian Basin, the Mendeleev Ridge, and Fletcher Plateau. Compared to previous expeditions, the fourth marked a clear expansion in both geographic scope and scientific ambition, yielding a substantially larger volume of observational data and physical samples.[95]

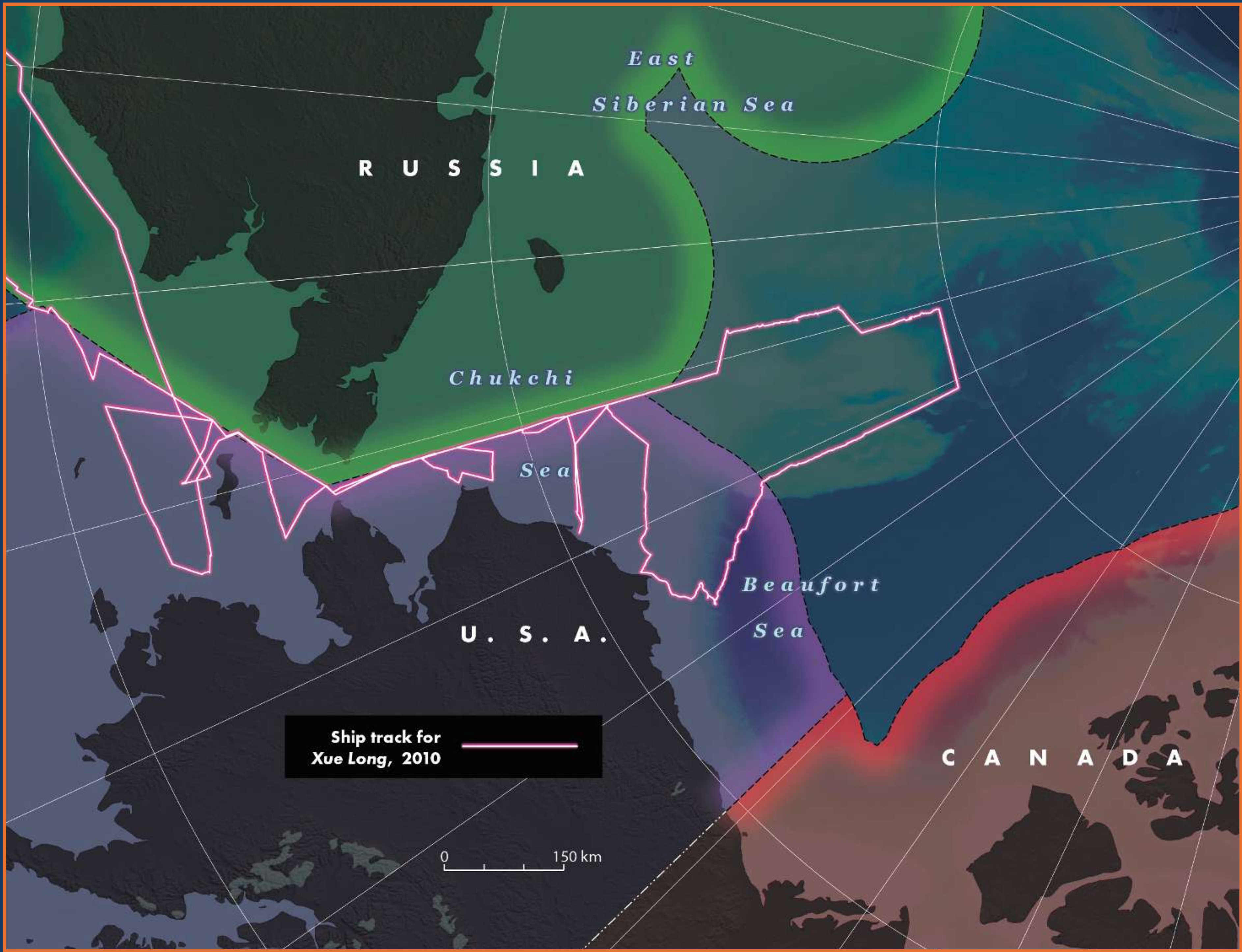
Of political significance, *Xue Long* reached the North Pole for the first time; there it deployed ice buoys and expendable conductivity-temperature-depth probes while conducting ecological studies and collecting sea ice and seawater samples. In another first, the team extracted an ice core from the pole. The expedition also undertook the first work on the deep-sea plains of the Arctic Ocean, where valuable data was collected on atmospheric physics and atmospheric chemistry.[96]

A more robust scientific program is discernable from the expedition's reports. This showed an ability to sustain ahigh tempo of operations, completing continuous 24-hour oceanographic observations. In total, the expedition completed 135 oceanographic survey stations, established one long-term integrated observation station for sea ice and atmospheric studies, eight short-term ice stations, and one dedicated research site at the North Pole. Both the number of stations and their geographic spread exceeded the team's initial projections.[97]

This expedition also deployed new scientific instruments. These included a multi-channel plankton sampler – to conduct precise, stratified deep-water sampling down to 3,000 meters. Demonstrating a new continuity between expeditions, *Xue Long* also recovered the integrated moored observation system deployed during the Third Expedition.[98]

As had been the case in 2008, the team made good use of the ship's helicopter.[99] In 2010 it was the Dolphin aircraft. Operated by CITIC Offshore Helicopter Co., Ltd., the Dolphin has a maximum range of 860 kilometers, and an endurance of 3.5 hours.[100] It also performed well in Arctic conditions, even landing expedition leader Wu Jun and Chief Scientist Yu Xingguang and their 12-member team at the North Pole (in two separate groups).[101]

The expedition also continued to evolve its Arctic ARV. This underwater robot was deployed for the first time through an ice hole and successfully conducted under-ice surveys, setting a new record for China's underwater robotic operations at high latitudes. During the survey, the robot conducted continuous repeat observations of horizontal transects over multiple days. Equipped with a CTD (Conductivity, Temperature, Depth) profiler, an upward-looking sonar, a light flux sensor, and two underwater cameras.[102]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Ship track for
Xue Long, 2010
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5th Arctic Expedition (2012)

- Ship: *Xue Long*
    - Map drawn from AIS tracks

The Fifth Arctic Expedition was jointly organized by the Chinese Arctic and Antarctic Administration (CAA) and the State Oceanic Administration of China (SOA). The Polar Research Institution of China (PRIC) took the operational lead as the research body of CAA. The expedition was led by Dr. Huigen Yang, Director of the Polar Research Institute of China, while the chief scientist was Dr. Deyi Ma, Director of the First Institute of Oceanography SOA.

The mission confirmed the PRIC's new operational tempo, with a voyage now taking place every other year. There was also an emerging multi-year program being executed. *Xue Long* revised several research points from previous expeditions to confirm data and examine changes in the environment. Most of these points were located in the Bering and Chukchi seas, and in the Canada Basin.

The ship also travelled to the Norwegian Sea for the first time, merging marine scientific research with work undertaken at China's ground station at Svalbard. The principal research subjects for the voyage were divided into four fields: physical oceanography and sea ice, meteorology, geology, chemistry biology, and ecosystem studies.[103] This work focused on ice sciences and interaction with air systems, the geologic record, local biology, and the impacts of climate change on the marine environment. Research questions centred on identifying key factors driving ocean changes and sea-ice-atmospheric systems. The ship's surveys analyzed structural characteristics of key geophysical parameters in the regions, focusing on baseline data such as water depth, gravity, magnetic field, and stratigraphic profiles within the study area.[104]

As with previous voyages, these reports indicate that the primary objective of the expedition was to study the impact of Arctic changes on Chinese climate.[105] Despite that, there are clear indications that this voyage took China's Arctic operations beyond science into areas of greater geostrategic importance. In August, *Xue Long* visited Iceland in an effort to "strengthen the two countries Arctic research cooperation." The ship was also opened to public tours.[106] This visit followed the April 2012 signing of the Iceland-China Memorandum of Understanding on Marine and Polar Science and Technology Cooperation which, according to Chinese media held "significant importance for enhancing China's scientific investigation and research capabilities in the Arctic region, as well as elevating bilateral Arctic cooperation to a higher level."[107] China was also negotiating a free trade agreement with Iceland at this time (signed in 2013). Of great significance, this visit also coincided with China's lobbying campaign to join the Arctic Council as an Observer – a campaign in which one of its principal supporters was Iceland.

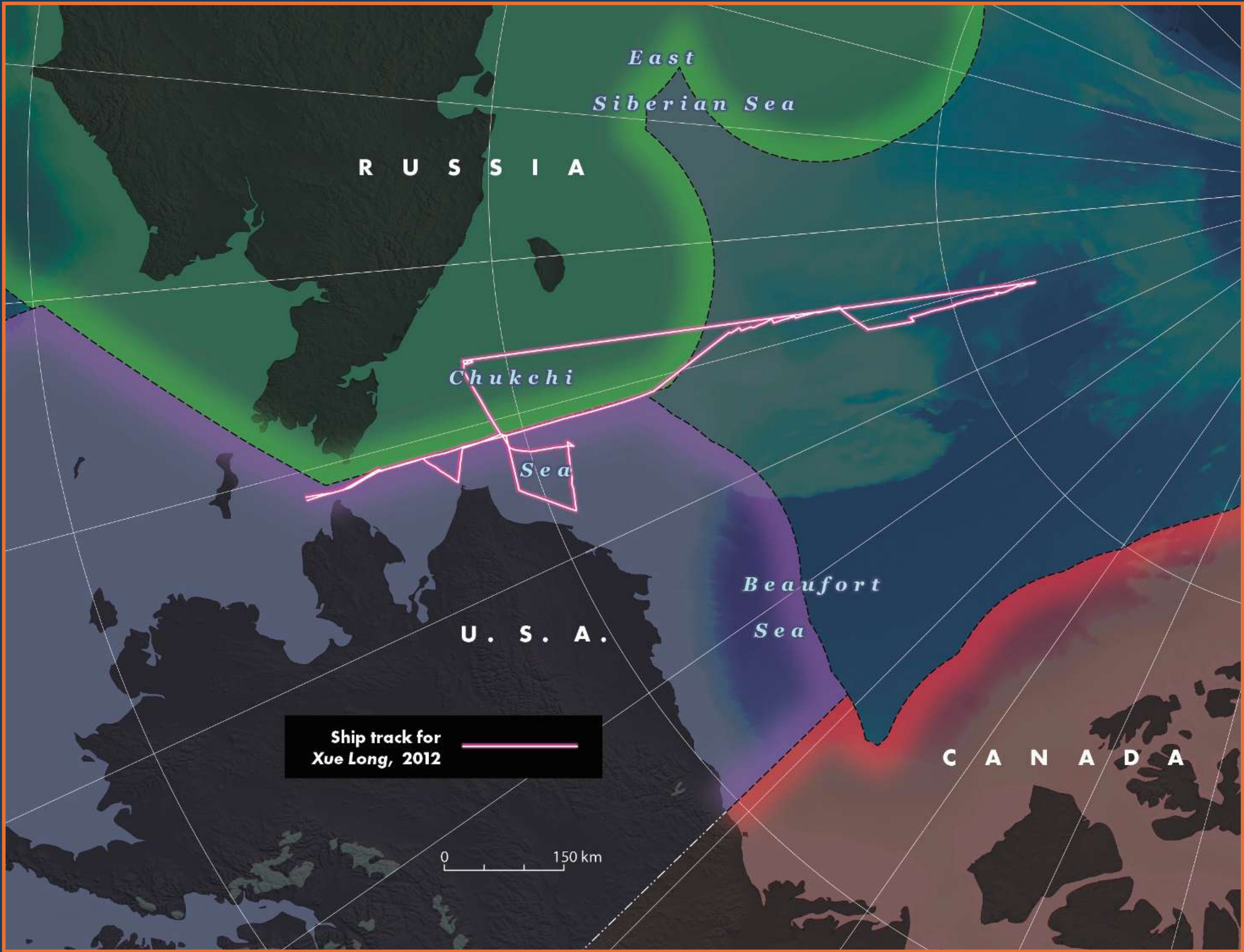
The voyage also fit into China's growing public interest in Arctic shipping. As part of its operations, *Xue Long* transited the Northern Sea Route. From July 22 to 30 the ship was escorted by a Russian icebreaker and operated in convoy through the Chukchi, East Siberian, and Laptev Seas. [108] From July 30 to August 2, 2012, *Xue Long* operated independently, passing through the Kara and Barents Sea. The voyage through the passage covered 2,894 nautical miles and took approximately 11 days.[109]

Of note, the Chinese authorities were willing to comply with Russian regulations governing Arctic shipping. Captain Wang Jianzhong, one of the expedition's route planners, told Chinese media that, because the eastern NSR lies within Russia's exclusive economic zone (EEZ) the ship had to sign a pilotage contract with Rosatom and equip itself with 'safety devices' required by Russian regulations.[110] This compliance is noteworthy since China's legal position on navigation rights in the Arctic was (and remains) ambiguous.

For its return, it navigated the Arctic 'High-Latitude Route,' returning from the Atlantic sector to the Pacific sector, marking its first successful high-latitude crossing of the Arctic Ocean. Xue Long reached its northernmost point at 87°40′N.[111] Chinese media rejoiced in the ship's charting "a course for future Chinese merchant shipping through the NSR."[112] In a later interview, SOA Deputy Director Lin Shanqing noted that this voyage allowed China to not only obtain "a large amount of first-hand information for my country to understand Arctic climate change, but also laid the foundation for my country to explore and utilize Arctic waterways and participate in the sustainable development of the Arctic economy."[113]

Attention to Arctic resources also seemed to expand with this voyage. The mission saw the first investigation of the bathymetry, gravity, magnetism and tectonics of mid-ocean ridges – suspected to be mineral rich areas. *Xue Long* also studied the crustal thickness and fault morphology of the area, including core sampling of the sea floor. While this work may have had pure scientific motivations, it is easy to draw connections to China's interest in Arctic resource, which was clearly growing.[114]

This expedition also saw an expansion of China's use of Arctic scientific tools across a wide geographic area. There were comprehensive oceanographic surveys at 128 stations and multidisciplinary observations at six short-term ice stations. These included the deployment of one large air-sea coupled buoy, five ice mass balance buoys, eight ice drift buoys, and a polar long-term automatic meteorological observation system. Additionally, one subsurface mooring was deployed and successfully recovered.[115] The team also deployed buoys in the Norwegian Sea for the first time.[116] Some of these tools were far more sophisticated than in years past. The buoy deployed in the Norwegian Sea had over 40 types of observational instruments and data sensors as well as a "dynamic communication system." The buoy enabled long-term, unmanned, automated observations, giving China a "distant eye" in the North Atlantic to study the mechanisms of ocean-atmosphere interactions.[117]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Ship track for
Xue Long, 2012
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6th Arctic Expedition (2014)

- Ship: *Xue Long*
  - Map drawn from AIS tracks

In 2014 *Xue Long* redeployed along familiar routes: the Bering Strait, Chukchi Sea, and the Canada Basin. As in 2012, the ship retraced some lines to compare research results against previous expeditions. Broadly speaking, this research continued to focus on climate change and the impact on China. More specifically, *Xue Long's* research team continued and expanded its work on marine hydrology and meteorology, geology, and biology.[118]

The voyage saw several firsts. The ship deployed a set of air-sea interface moored buoys in the North Pacific Ocean and near-seafloor magnetic surveys – collecting high-resolution geomagnetic data – along two tracks totaling 592 kilometers in the Arctic. Working with US scientists, the research team also deployed three deepwater drifting buoys in Canada Basin to study the Beaufort gyre. This mission was also the first time the Chinese deployed an array of sea ice buoys.[119]

Researchers also pioneered new technology in their efforts. In the Bering Sea the ship deployed the Conductivity, Temperature, and Depth (CTD) system. Weighing over 200 kilograms, the CTD is a large-scale automatic recording instrument which measures seawater temperature, salinity, pressure, and dissolved oxygen. As it descends, it automatically collects seawater samples, which are transmitted to the onboard laboratory for analysis.[120]

During transit operations, the team also carried out a series of underway observations, including multi-parameter atmospheric and oceanographic measurements, gravity measurements, and salinity structure observations. A total of 12 radiosondes, 213 XBT (Expendable Bathythermograph) probes, and seven ARGO floats were deployed, yielding a large volume of observational data.[121]

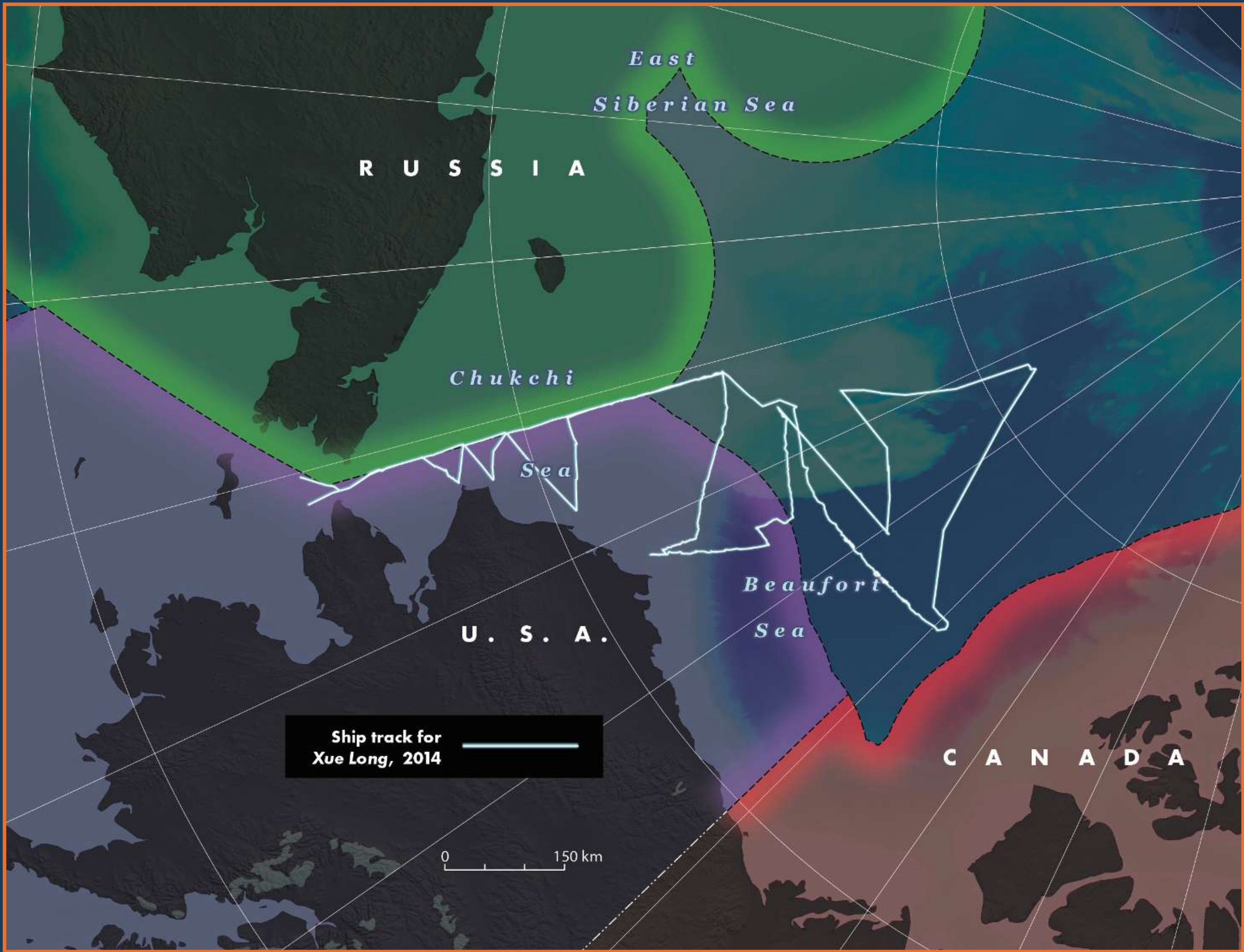
The crew continued to rely on the Arctic ARV, which completed three autonomous missions to measure ice thickness, underside ice morphology, and marine environmental conditions. At the a long-term ice station at 81°N latitude, the robot sustained operations over five days, accumulating nearly ten hours of under-ice data over eight kilometers. Reports indicated that the operations validated the Arctic ARV's capabilities in field operations, specifically around maneuverability, hybrid autonomous/remote control, and high-latitude navigation accuracy.[122] These trials also had larger implications for China's technology sector. According to Lin Yang, Director of the Autonomous Underwater Vehicle (AUV) Technology Research Division at the Shenyang Institute, China was still trying to build a mature AUV industry and their systems' operation at the operational level "remains noticeably limited."[123] As such, Arctic tests likely had value for China beyond the polar regions.

In the Canada Basin, the ship located a floe at 76.42°N, 151.04°W, where it established the first of several short-term ice stations. A total of 28 expedition members from five research groups (focusing on atmospheric science, sea ice physics, hydro-optics, marine biology, and marine chemistry) went ashore to carry out scientific operations. There, the team undertook greenhouse gas sampling, deployed temperature measuring buoys, measured sea ice thickness, and collected ice cores.[124]

In addition to studying the region's impact on climate change, there was also growing interest in the Arctic's natural resources. In its reporting on the expedition, Chinese state media referred to the US Geological Survey's estimate that the Arctic contained up to 30% of the world's undiscovered gas deposits and 13% of its undiscovered oil resources.[125] These "riches" were described as increasingly accessible and in the process of being claimed by the Arctic countries.

In a similar vein, China's interest in shipping was also highlighted by Wang Yong, the Science Program's division head at the Chinese Arctic and Antarctic Administration (CAAA). "Like other countries, China is also interested in the resources and the Northern Sea Route," Wang told media; "during the expedition, Chinese scientists will collect information on climate change, consider future uses of the Northern Sea Route and explore the region's resources."[126]

The voyage likely had political motivations as well. Following China's 2013 success in joining the Arctic Council as an Observer state, the country was interested in demonstrating support for international research. As such, this voyage also brought along three American scientists and one each from Germany, Russia, and France.[127]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Ship track for
Xue Long, 2014
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7th Arctic Expedition (2016)

- Ship: *Xue Long*
    - Map drawn from AIS tracks

The Seventh Arctic Expedition continued work in the Beaufort Sea and Arctic Ocean areas north of Alaska. There, research team leader Xia Limin of the State Oceanic Administration reported that scientists studied marine chemistry, ecology, geology, geophysics, and sea ice dynamics.[128] Chinese scientists worked at several ice stations and 38 deep-water stations examining CO_2 uptake in the Arctic Ocean and acidification in the region.[129] The expedition conducted 35 large-scale benthic trawls, collecting valuable samples and data that provided "key insights" into marine life in the Arctic, including species' northward migration.[130]

This expedition was described by the team as more systematic than previous ones, with more advanced equipment and a broader scope. In addition to multidisciplinary observations in marine biology, chemistry, sea ice, atmosphere, and geophysics, researchers recovered a sediment trap deployed during China's 6th Arctic expedition near 75°N, 156°W, obtaining two years worth of sediment samples and key data on sedimentation rates.[131] By this point Chinese operations were clearly working on multi-year timelines.

In addition to areas covered by *Xue Long*'s previous Arctic expeditions, the ship also visited the Mendeleyev Ridge in the Arctic Ocean and completed China's first oceanographic observations in the East Siberian Sea and Western Chukchi Sea.[132] For the first time, an air gun was used to generate artificial seismic waves to explore the geological structure beneath the Arctic seabed.[133] Some of this work had tangential links to long-term deep-sea mining opportunities – a subject of increasing importance as perceptions of Arctic resource accessibility were growing.[134]

This link was demonstrated by marine geologist and assistant leader of the Expedition Wang Weiguo's report of metallic nodules on the continental shelf of the Chukchi Sea. Wang described this discovery as a "world first." Chinese media noted that future Arctic expeditions will conduct more in-depth research on this metallic nodule area.[135]

China also continued to experiment with new Arctic-capable technology. It tested the Xueying-601, a fixed-wing aircraft designed specifically for polar conditions (it had also been tested in Antarctica).[136] *Xue Long* also carried two French-made "Dolphin" helicopters for personnel transport, cargo lifting, and emergency rescue. During long-term ice station operations, the crew conducted its first polar emergency rescue drill using its Dolphins.[137]

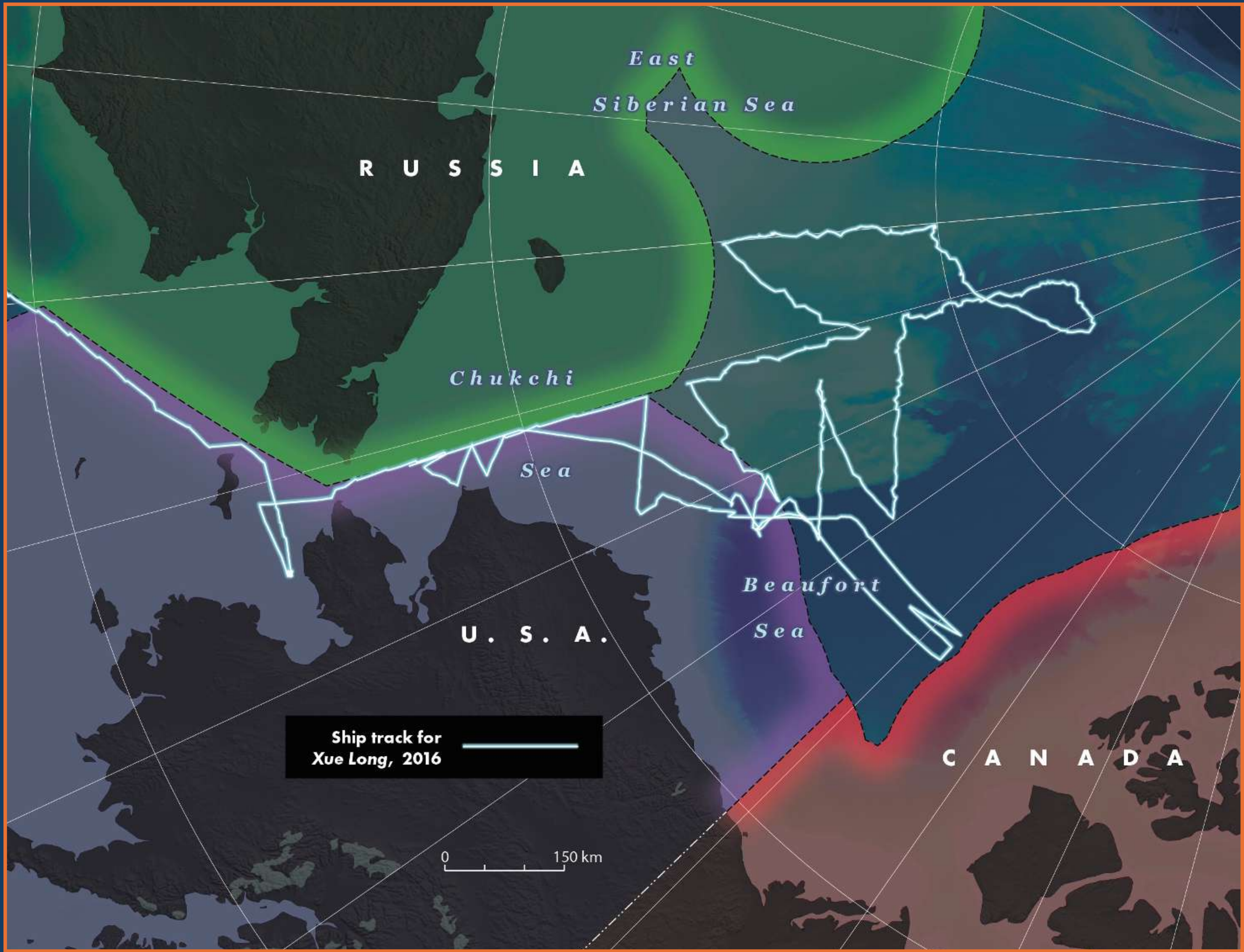
The expedition also continued to experiment with Arctic buoys. In total, the ship deployed 40 ice-based buoys, including an array of 13 in the Canada Basin by helicopter. This represented the most systematic such deployment from any of China's expeditions.[138] Lei Ruibo, assistant to the chief scientist of the expedition team, stated that that the buoys would drift with the sea ice into the central Arctic, thereby expanding China's research coverage. The continuous data transmitted by these buoys provided "critical scientific support" for studying shifts in the sea ice and "enhances China's ability to predict future changes in the Arctic climate, sea ice, and marine environment."[139]

Research was also continued into future shipping routes. This expedition saw the first deep-water mooring of instruments in the Bering Sea. Assistant Chief Scientist Liu Na noted that three sets of instruments and buoys were deployed to monitor long-term oceanic environmental changes and collect data for environmental forecasting of the Northeast and Northwest Passage.[140]

On July 18, expedition members also deployed a CTD observation system into the North Pacific Ocean. Alongside it, an Acoustic Doppler Current Profiler (ADCP) was deployed to measure ocean current velocity, chlorophyll concentration, and dissolved oxygen.[141] Along with its maritime research, the crew launched two to three weather balloons each day to study the upper atmosphere and track the movement of polar weather systems – research ultimately intended to improve the accuracy of polar weather forecasts.[142]

This expedition also saw some of the first clear efforts to understand the region's acoustic properties, a critical step to any future submarine operations. The ship conducted two underwater acoustic experiments in ice-covered areas to study how sound travels long distances in Arctic waters. "This was China's first such experiment in the Arctic Ocean," said Wei Chonghua, associate researcher at the Chinese Academy of Sciences. "The data will help support future research and improve underwater communication in icy conditions." He added that current technology can reduce the impact of sea ice on underwater sound transmission, which is important for designing communication and navigation tools used in polar missions.[143]

Continuing its trend of welcoming foreign scientist, several American and French scientists were invited to join the 128-member research team in an effort to "promote peace, stability and sustainable development in the Arctic region." The SOA also sought to formalize a joint Arctic Ocean expedition with Russia.[144] This was the first expedition organized after Russia's 2014 invasion of Crimea and demonstrated the emergence of closer Sino-Russian ties as Western sanctions forced Moscow to pivot East. Chinese Foreign Ministry Spokesperson Hong Lei told state media that "China-Russia Arctic cooperation enjoys sound basis. We stand ready to strengthen our exchanges and cooperation on Arctic affairs with the Russian side."[145]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Ship track for
Xue Long, 2016
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8th Arctic Expedition (2017)

- Ship: *Xue Long*
    - Map drawn from media release (imprecise)

The Nineth Arctic Expedition marked a shift in operational tempo as China moved from biannual to annual Arctic operations. He Jianfeng, deputy leader of China's 8th Arctic expedition and a researcher at the PRIC, explained that the Arctic environment has been changing rapidly in recent years, and infrequent observations can no longer keep pace. Implementing regular operational observations will strengthen China's voice on critical issues such as global climate change and environmental pollution control.[146]

Xue Long undertook the usual studies surrounding sea-ice thickness, meteorology, astrophysics, geophysical and ecosystem surveys, while also undertaking the first studies of microplastics, ocean acidification, and artificial radionuclides. [147] Chinese scientists also established several short- and long-term observation posts on the Arctic ice cap, demonstrating a steadily improving ability to manage autonomous data collection sites.

This expedition was also the first to place Arctic shipping front and centre as the ship completed a "historic transit" of the Central Arctic Ocean,[148] as well as its first transit of the Canadian Northwest Passage. The voyage through the Northwest Passage was described as a "trial voyage," filling survey gaps in the Labrador Sea and Baffin Bay regions.[149] Three Canadian scientists participated in a joint seafloor topography and geomorphology survey during *Xue Long's* trial voyage, "fostering mutual understanding, strengthening friendship, and establishing channels of communication – laying a solid foundation for future cooperation."[150] This mission – along with similar voyages through the central Arctic route and the NSR, was described by media as advancing "the commercial utilization of Arctic passages by Chinese vessels and provided valuable experience for future navigation through the Northwest Passage"[151] For a complete Canadian account, the reader should consult Nigel Greenwood's account in the *Canadian Naval Review*.[152]

In the Central Arctic, the research team drilled ice cores to observe and analyze the sea ice and seawater in an effort to better understand the physical and chemical properties of sea ice "thereby providing essential data support for the development and utilization of the passage."[153] Through the Arctic Ocean circumnavigation expedition, the ship collected six million data entries and over 5,000 biological and chemical analysis samples. This effort was described as significantly advancing the development of China's operational Arctic research system while providing valuable information for the "systematic analysis and assessment of Arctic shipping routes, ecosystems, and environmental pollution."[154]

To conduct long-term monitoring of the sea ice the ship established seven ice stations in the area between 79°N and 81°N. During this mission, three sea ice mass balance buoys, five temperature chain buoys, and one ice-based drifting automatic weather station were deployed into the ocean.[155] These balance buoys are capable of real-time monitoring of snow and ice temperature, snow and ice thickness, air temperature at the ice surface, chlorophyll and dissolved oxygen beneath the ice, as well as the real-time GPS position of the sea ice. The ice-based drifting automatic weather station can monitor, in real time, temperature, humidity, and wind speed as well as surface air pressure and radiation flux.[156]

> *"The Arctic has been recognized as the region most profoundly affected by global warming. The rapid changes taking place in the Arctic are bound to have far-reaching impacts that extend to China. Now, more than ever, there is an urgent need to quantitatively assess the magnitude of these impacts.*
>
> *- Qin Weijia, Director of the Polar Research Office of the State Oceanic Administration*

Since August 2017, the National Marine Environmental Forecasting Center had been providing sea ice thickness forecast and, in recent years, the Center developed an Arctic sea ice data assimilation technology based on the Ensemble Kalman Filter. For the first time it was incorporating two internationally available datasets (CryoSat-2 and SMOS) into operational forecast trials. This effort led to the establishment of what Chinese media called an "ensemble forecasting system" for Arctic sea ice and ocean conditions.[157]

Research work on the seafloor also expanded from previous missions. The ship undertook multibeam seabed topography and geomorphology surveys were conducted in the Chukchi Plateau area and a basic environmental survey in the Chukchi Sea.[158]


RUSSIA
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Greenland Sea
Chukchi Sea
ICELAND
GREENLAND (Kingdom of Denmark)
Beaufort Sea
U.S.A.
Baffin Bay
CANADA
Ship track for Xue Long, 2017

9th Arctic Expedition (2018)

- Ship: *Xue Long*
    - Map drawn from AIS tracks

China's Ninth Arctic Expedition marked a new phase in the country's polar research program. It was the first expedition undertaken following the establishment of the Ministry of Natural Resources and the release of China's Arctic Policy earlier that year. As such, it represented both the consolidation of national polar research capabilities and the practical implementation of consolidated policy directives.[159]

The expedition operated across the Arctic Ocean, the Canadian Basin, the Chukchi Sea, the Mendeleev Ridge, the Beaufort Sea, and the Bering Sea. Over the course of the voyage, the research team conducted extensive temperature and salinity measurements, sound velocity profiling, and ocean surface hydrological observations. The scientific program encompassed investigations in marine chemistry, biology, atmospheric science, sea-ice dynamics, and geology.

Across the Arctic Ocean and Bering Sea, 88 stations were completed for CTD and current profile observations. In total, 251 expendable bathythermographs and 51 expendable CTD probes were released. Twelve surface drifting buoys were deployed, and three sets of Ocean Bottom Seismograph systems were positioned and recovered on the Chukchi Sea shelf. Sixteen acoustic experiments were conducted in ice-covered waters, and 13 mooring platforms were deployed and recovered, establishing new records for Chinese Arctic operations. The atmospheric component of the mission included the launch of 89 GPS radiosondes and 35 radiation sondes, reaching average altitudes of 31,000 meters. These data were shared globally in near real time to improve Arctic atmospheric forecasting.[160]

Ice-based operations were similarly intensive. Ten ice stations and four helicopter-supported surveys were established, focusing on under-ice hydrography, surface meteorology, and sea-ice properties. Forty-eight unmanned observational instruments were deployed, including sea-ice mass balance buoys, ocean profiling buoys, automatic weather stations, and visual monitoring systems. A total of 63 ice cores were collected and a 32-day underway sea-ice observation program tracked variability along the Arctic shipping route – providing critical baseline data for future navigation assessments.[161]

Hydrographic mapping was also undertaken with multibeam acoustic sounding and submarine topographic surveys.[162] For the first time among the Chinese cruises, multibeam acoustic sounding was performed in the abyssal plain region of the Northwind Ridge in the Chukchi Sea, and rock trawling was undertaken in the region.

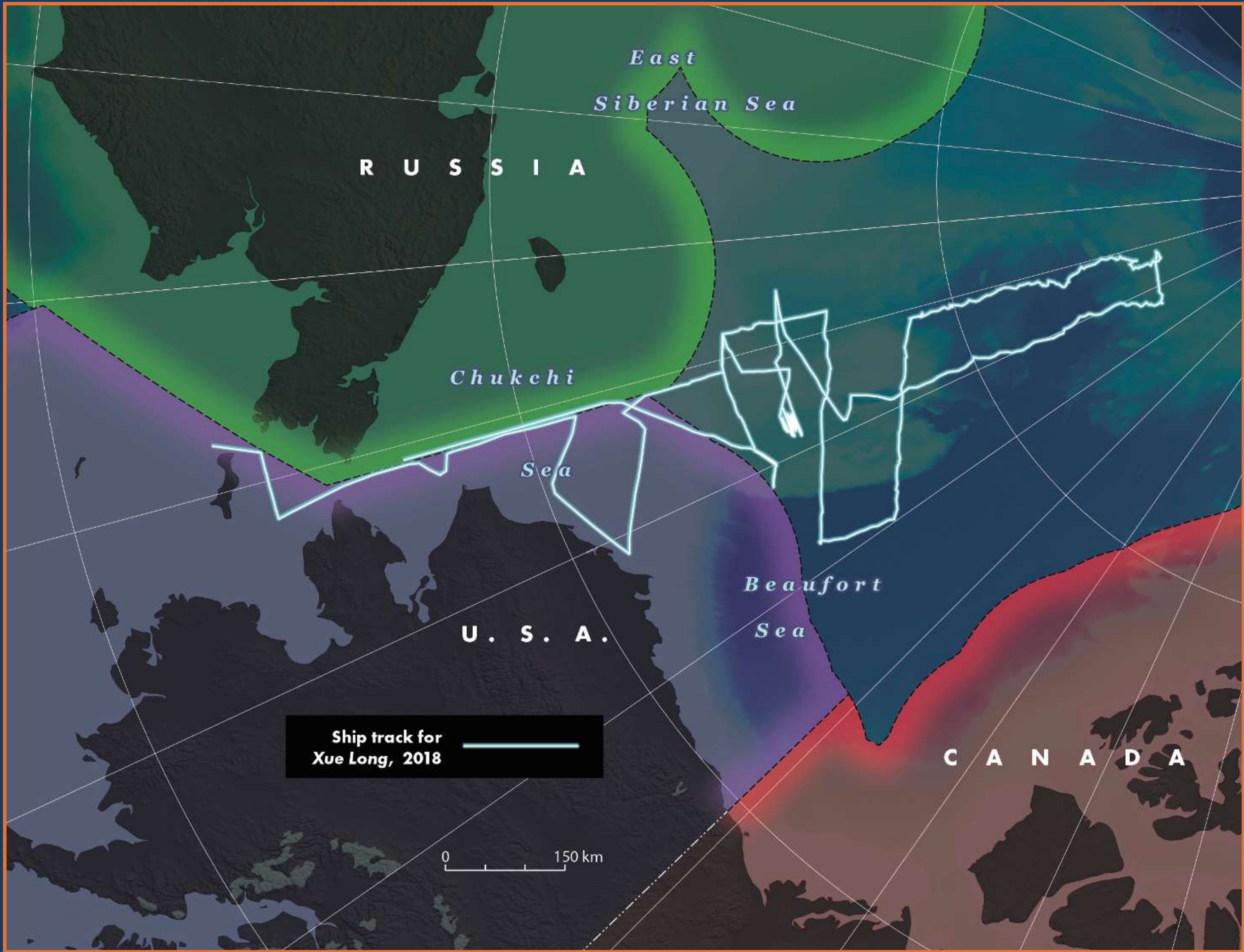
The expedition saw a significant expansion in the use of uncrewed systems. The Ocean University of China deployed two autonomous ice stations to monitor sea-ice temperature, salinity, dissolved oxygen, and chlorophyll. These systems observed the interactions between sea ice and the upper ocean during the freezing period as well as the role of solar radiation in melting processes. Critically, these experiments saw real-time transmission of data back to China – an important consideration for dual purpose military applications.[163]

Of note as well, the Shenyang Institute of Automation's "Haiyi" underwater glider was deployed in the Bering Sea, marking its first use in polar research. Over a 45-day operational period, the glider traveled 930 kilometers and collected 229 profiles of water temperature and salinity, demonstrating China's ability to sustain autonomous hydrographic observations in Arctic waters. A fully unmanned ice station was also successfully deployed to collect data autonomously over an extended period. This included ice stations and profiling floats that extended China's Arctic observations beyond the summer season into winter.[164]

The mission's geological and geophysical program involved sediment sampling at multiple stations, gravity coring (to depths of over four meters), and extensive multibeam bathymetric surveys covering 4,100 kilometers. These surveys produced 640 GB of data and included China's first multibeam acoustic sounding in the abyssal plain of the Northwind Ridge. A concurrent towed magnetometer survey extended over 1,100 kilometers, and heat flow measurements were conducted at 14 stations.[165]

This expedition also saw increased interest in the seafloor, with seabed rock dredges and geological surveys collecting sediment samples of potentially valuable polymetallic nodules.[166] Specifically, the expedition's operations on the Chukchi Plateau identified iron-manganese nodules – the second time that these potentially harvestable resources had been detected in the CHINARE cruises (the first being the 7th cruise in 2016).[167]

By integrating operational surveys with scientific investigations and adopting a multidisciplinary approach, this program laid the groundwork for sustained, year-round Arctic observation. It also positioned China to contribute to major international research initiatives such as MOSAiC and YOPP, with atmospheric sounding and sea-ice data shared in near real time through the WMO's Global Telecommunication System. This cooperative posture strengthened China's role within the international Arctic research community.[168]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Ship track for
Xue Long, 2018
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10th Arctic Expedition (2019)

- *Ship: Xue Long*
    - *Map drawn from media release (imprecise)*

The 10th Arctic Expedition focused on the American EEZ in the Bering and Chukchi Seas. This voyage focused on sea ice changes, ocean-ice-atmosphere interactions, and their impact on the environment and ecosystem. Research work included meteorological work, water profiling for temperature and salinity, water nutrient concentrations, marine biology, and microplastics analysis. A total of over 6,640 samples of various types were collected.[169]

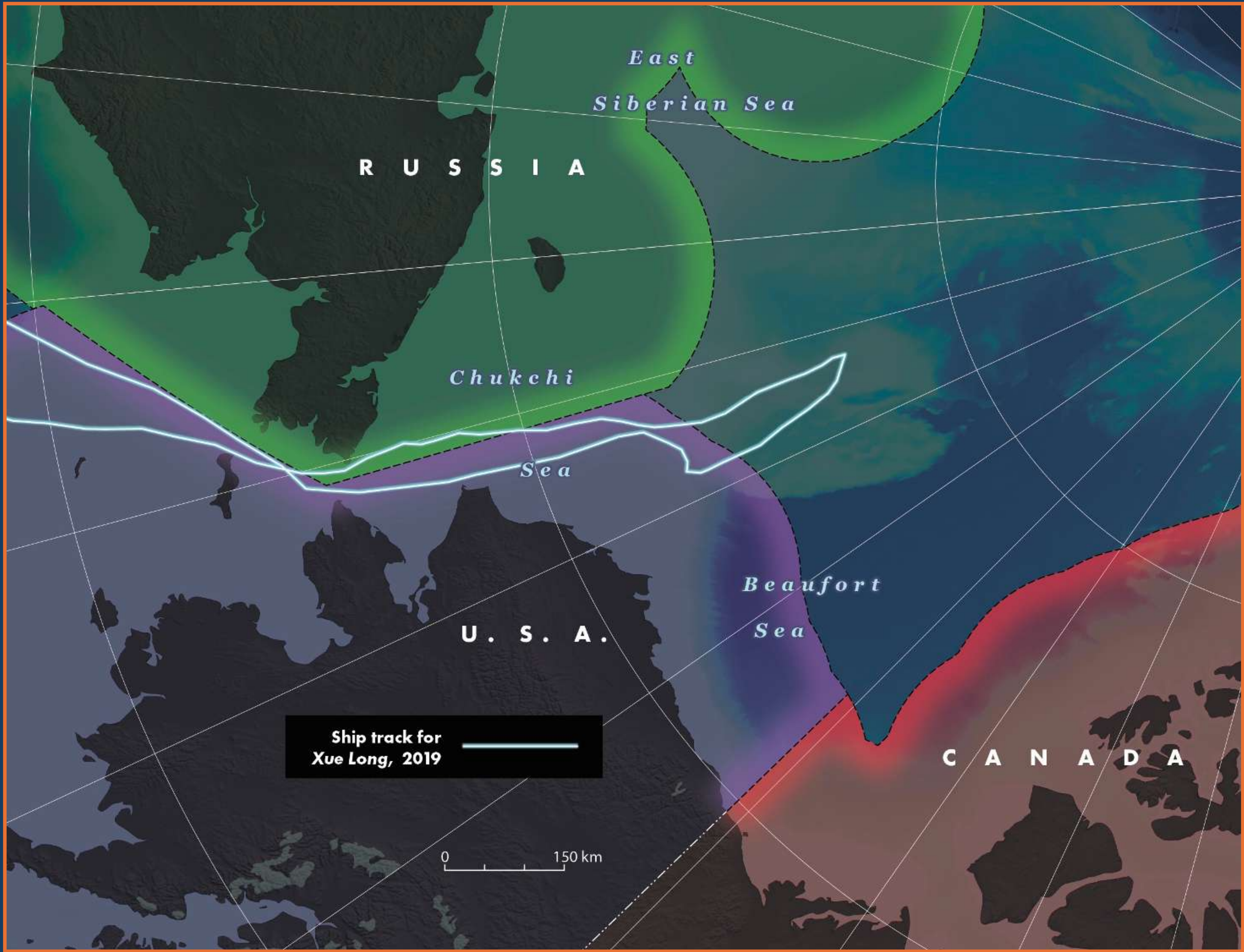
Studies on ocean acidification, microplastics, and anthropogenic radionuclides were described as offering "crucial data on potential ecological risks" while research on species composition, community structure, and ecosystems allowed Chinese scientists to track biological responses to rapid environmental change and the region's role in "global climate feedback systems."[170]

The research teams also undertook water sound speed analysis, building on work from the previous year. This was a research field destined to grow in importance in following expeditions as Chinese expeditions increased their attention to regional acoustics and detection.[171]

Research on potential future resource development also expanded. Continuing the geological work undertaken in 2016 and 2018, *Xue Long* sampled seabed sediment[172] and undertook integrated trawl sampling to investigate the formation of polymetallic nodules, providing "key insights" into the evolution of the Chukchi Margin and polar mineral genesis.[173]

The expedition also saw a continued evolution of the ship's Arctic uncrewed systems and buoys. *Xue Long* deployed two sets of moored subsurface buoys, ice-ocean buoys, and three underwater gliders. Chinese literature suggests that these tests "significantly advanced China's operational monitoring capabilities in the region."[174]

In particular, the Haiyan glider proved its value. This tool was equipped with CTD and dissolved oxygen sensors to conduct a "systematic networked observation" of the Arctic Ocean. This initiative marked the first successful deployment of a networked glider observation system on an Arctic expedition. Three such gliders were deployed in the Bering Sea to carry out zonal transect observations. Over 22 days the gliders collected continuous high-resolution hydrographic and biogeochemical data, extending the icebreaker's scientific and survey range.[175] This success was described as offering "a new model for China's polar exploration and research."[176]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CANADA
Ship track for
Xue Long, 2019
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150 km

11th Arctic Expedition (2020)

- Ship: *Xue Long 2*
    - Map drawn from AIS tracks

In 2020 the PRIC deployed *Xue Long 2* on its maiden voyage. A smaller but far more capable icebreaker than *Xue Long,* this was China's first domestically produced icebreaker. From 2020 onwards, this new ship became China's Arctic workhorse, undertaking most of Beijing's scientific and survey work in the region.

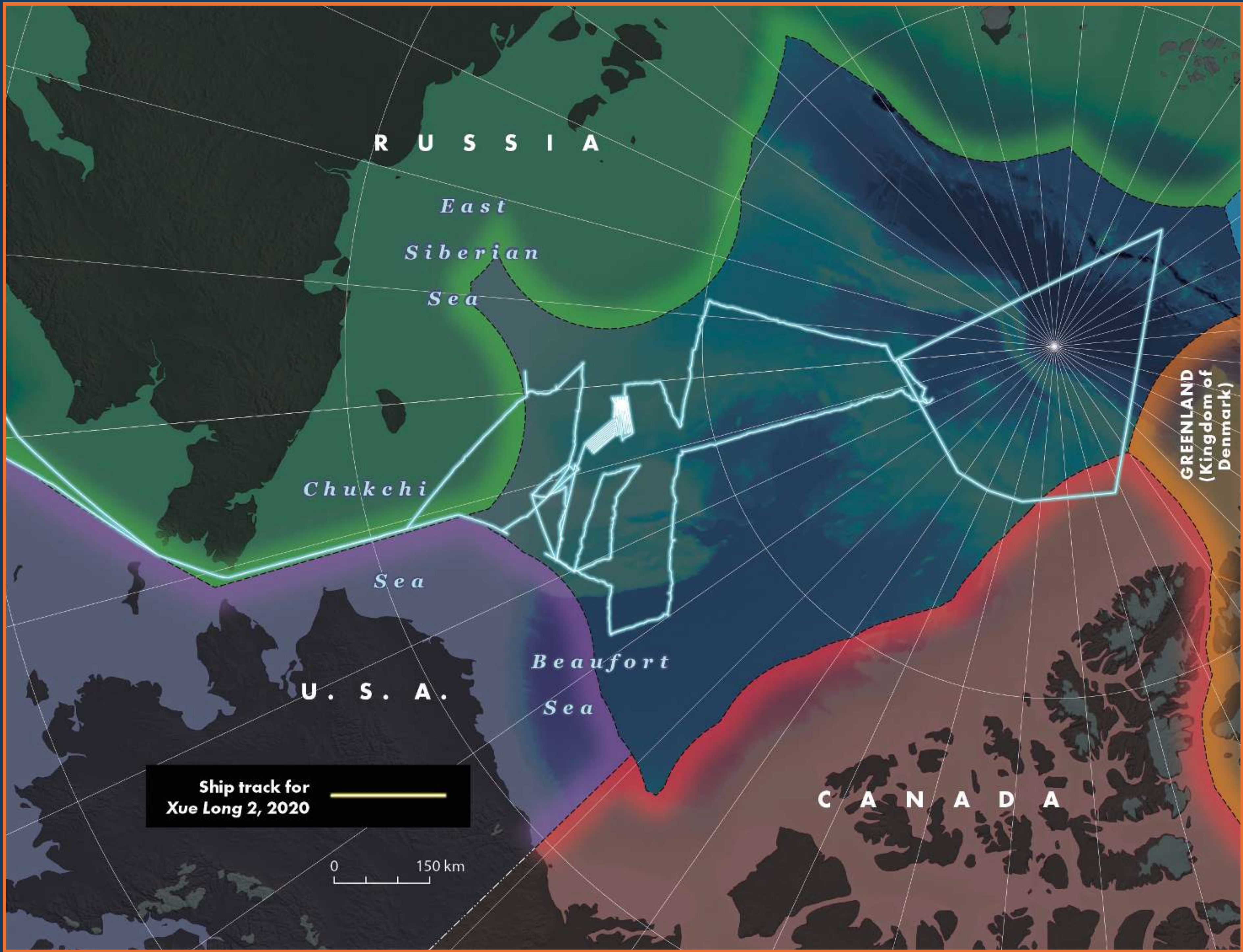
With its new icebreaker, the PRIC announced that its key tasks included a comprehensive survey of the central Arctic Ocean, biodiversity and ecosystem studies, monitoring of ocean acidification and chemical environments, detection of emerging pollutants, and observations on ocean-ice-atmosphere interactions. This expedition was also intended to enhance China's climate science and support ongoing research in oceanography and meteorology, marine and atmospheric chemistry, marine biology and ecology, as well as marine geology and geophysics.[177]

Researchers expanded their attention to the Arctic seafloor on this trip, including the use of a gravity piston to collect a 20-meter core sample of the seafloor at Northwind Basin. This core was said to have supported an "in-depth study of the process and mechanism of Arctic sea ice and ice cover changes."[178] It may also have been useful in resource exploration. The research team attributed this success to the new icebreaker's advanced scientific equipment and superior maneuverability.[179] In the Chukchi Sea, the geophysical team carried out full-coverage multibeam bathymetric surveys, providing "detailed fundamental data for studying the geological evolution of the Chukchi Sea."[180]

Critically, this kind of data would also be useful for both shipping and future naval deployments – giving rise to growing concern in the US that such research may have dual purpose civilian/military implications.

This expedition also moved beyond its traditional operating areas and ventured into the Russian extended continental shelf area. Here, *Xue Long 2* undertook research on Gakkel Ridge, an area thought to be rich in seabed resources. This operation marked the first seafloor and resource study undertaken in areas of (claimed) Russian jurisdiction. While Moscow did not object, it did provoke the government to extend its extended continental shelf to cover the ridge.

With a more advanced icebreaker, Chinese teams also increased their use of Arctic tools. In addition to the new ice-based ocean profiling buoys, the ship deployed polar sea fog optical sounding instrument to monitor fog in what was described as a future shipping route.[181] This instrument employs a novel independent-channel filtering technology, enabling simultaneous acquisition of solar shortwave radiation intensities across five spectral bands and one total band. Compared with the first-generation model used in 2018-2019, the new instrument significantly improved data accuracy and stability. Its successful application was said to mark a notable advancement in meteorological observation capabilities in the Arctic Ocean.[182]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Chukchi Sea
Beaufort Sea
U.S.A.
CANADA
GREENLAND (Kingdom of Denmark)
Ship track for Xue Long 2, 2020
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150 km

12th Arctic Expedition (2021)

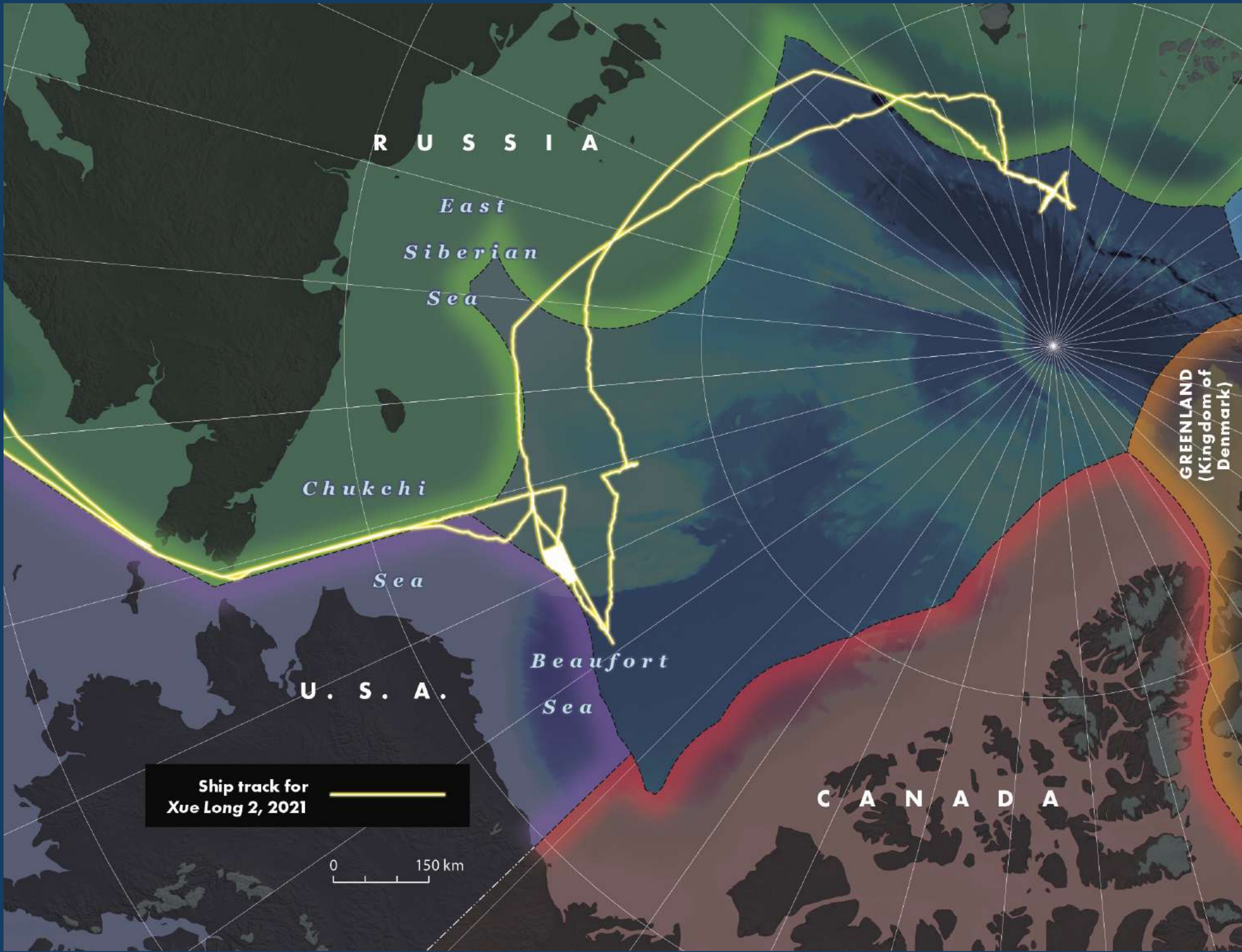
- Ship: *Xue Long 2*
    - Map drawn from AIS tracks

The 12th Arctic Expedition continued the standard Chinese research in sea ice, atmospheric studies, microplastics, and ocean acidification, collecting data on Arctic marine hydrology, meteorology, and biology. Despite this, the 12th expedition also marked a shift in Chinese priorities, with a much greater focus on the seabed.

This expedition also saw the program's first successfully Arctic deployment of an AUV, which took place on the Russian Extended Continental Shelf near Gakkel Ridge between Greenland and Siberia in the Central Arctic Ocean.[183] This AUV, dubbed the Tansuo 4500, was developed by the Chinese Academy of Sciences' Strategic Pilot Science and Technology Project and operated by Shao Gang and three other scientific expedition members.[184] The vehicle was deployed to measure sea ice and undertake "near-seabed scientific research."[185] Its successful deployment was said to have provided "valuable data for advancing understanding of multi-sphere material and energy exchanges and geological processes along the Arctic mid-ocean ridge."[186] In the Gakkel Ridge, this allowed for detailed studies of the regional geomorphology, magmatism, and hydrothermal activity of the ridge. More broadly, the AUV provided high-resolution multibeam bathymetric, hydrographic, and magnetic data, offering a new and seemingly capable took for deep-sea Arctic research.[187]

Li Yang, an associate research fellow at the Shenyang Institute of Automation, stated that AUVs of this sort were designed to undertake three tasks. The first is observing and detected sea ice, gathering information on its thickness, condition, and movement. The second is measuring water column parameters, including depth, temperature, and salinity. The third was conducting detailed surveys of seafloor topography and geomorphology, which Chinese state media claimed "aided in the discovery of submarine mineral resources."[188]

This voyage also saw *Xue Long 2* deploy three sets of acoustic detection buoys designed by the Taiyuan University of Technology. These detection buoys represent another potential dual-purpose technology, given the technology's theoretical capacity to detect and track submarine activity. Further, the icebreaker deployed three sets of Ice Mass Balance (IMB) buoys, an Arctic melt pond observation buoy, and four ice temperature chain buoys. All these tools possessed the ability to collect data and transmit it back to the university in real time. Of note, a post-expedition university press release celebrated this "unmanned detection of the Arctic underwater acoustic environment and long-term autonomous observation.[189]



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Ship track for Xue Long 2, 2021
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13th Arctic Expedition (2023)

- Ship: *Xue Long 2*
    - Map drawn from AIS tracks

China's 13th Arctic expedition focused on the Chukchi Sea, Central Arctic Ocean, and Gakkel Ridge, with four overarching research tasks: environmental monitoring; geological and geophysical studies of the mid-ocean ridge; atmospheric, sea ice, marine and subsurface environmental surveys, biome and resource research, and pollutant monitoring; and sea ice research.

In keeping with themes dating back to 1999, the environmental research was officially tied to the impacts of climate change on China and, in particular, its "economic interests in agriculture, forestry, fishery, marine industry and other sectors."[190] A total of 49 oceanographic survey stations were established over the duration of the voyage where the ship took 142 atmospheric sounding operations alongside the establishment of six short-term and one long-term ice stations.[191]

Sea ice studies were an important component of this voyage. Professor Chen Xiaodong from Dalian University of Technology played a key role in underway sea ice observations and the testing of sea ice mechanical properties. His work included in-situ testing and sampling of sea ice mechanical properties, automated underway observation of sea ice parameters, and UAV-based monitoring. The operations also included sea ice mass balance buoys, sea ice core sampling, and optical observations of sea ice using unmanned aerial vehicles.[192] These efforts reportedly "filled a critical data gap in China's research on the physical and mechanical properties of sea ice in this region."[193]

Lin Long, Associate Researcher at the Chinese Polar Research Center and Head of the Sea Ice Environment Team stated that the comprehensive sea ice survey was one of the key components of the expedition. The main tasks included buoy deployment on ice, sea ice sampling, and on-ice experiments. In addition, the expedition used "unattended" equipment to conduct long-term monitoring.[194]

This expedition saw a continuation of work on the Russian ECS. There, the *Xue Long 2* undertook geological and geophysical surveys of Gakkel Ridge.[195] This work included geomagnetic instruments and submarine seismometers to investigate geological and tectonic features of the ridge. This work was intended to provide "a better understanding of its unique geological structure and magmatic movement."[196] On Gakkel ridge, the research team also demonstrated an ability to recover tools deployed under the ice as seven undersea geomagnetic instruments and five undersea seismometers were deployed with all the seismometers recovered.[197]

While in the region, *Xue Long 2* also undertook a "comprehensive survey" at the North Pole. This included ice station surveys and marine surveys focused on atmospheric, hydrological, biological, and sea-ice conditions. To do so, the ship deployed buoys and undertook ice core collection, as well as under-ice observations.[198] In total, the work involved 26 sets of disposable buoys[199] as well as autonomous robot deployments under the ice.[200] This work also included seafloor seismic and magnetotelluric measurements, geological sampling, and mooring deployments. marked the first implementation of unmanned intelligent observation of sea ice thickness. [201] These devices provided data on meteorology, atmospheric composition, aerosols, sea debris, gravity, sea surface temperature, profiling of currents, ship stress and related parameters.[202]

In addition to the seafloor and ice studies, Chen Chao, PRIC Engineer and leader of the Ocean Expedition Team, noted that this was also the first deployment of a sub-grid scale buoy array in the Arctic and the first use of longline fishing methods in the Arctic Ocean to investigate under-ice fish species.[203]

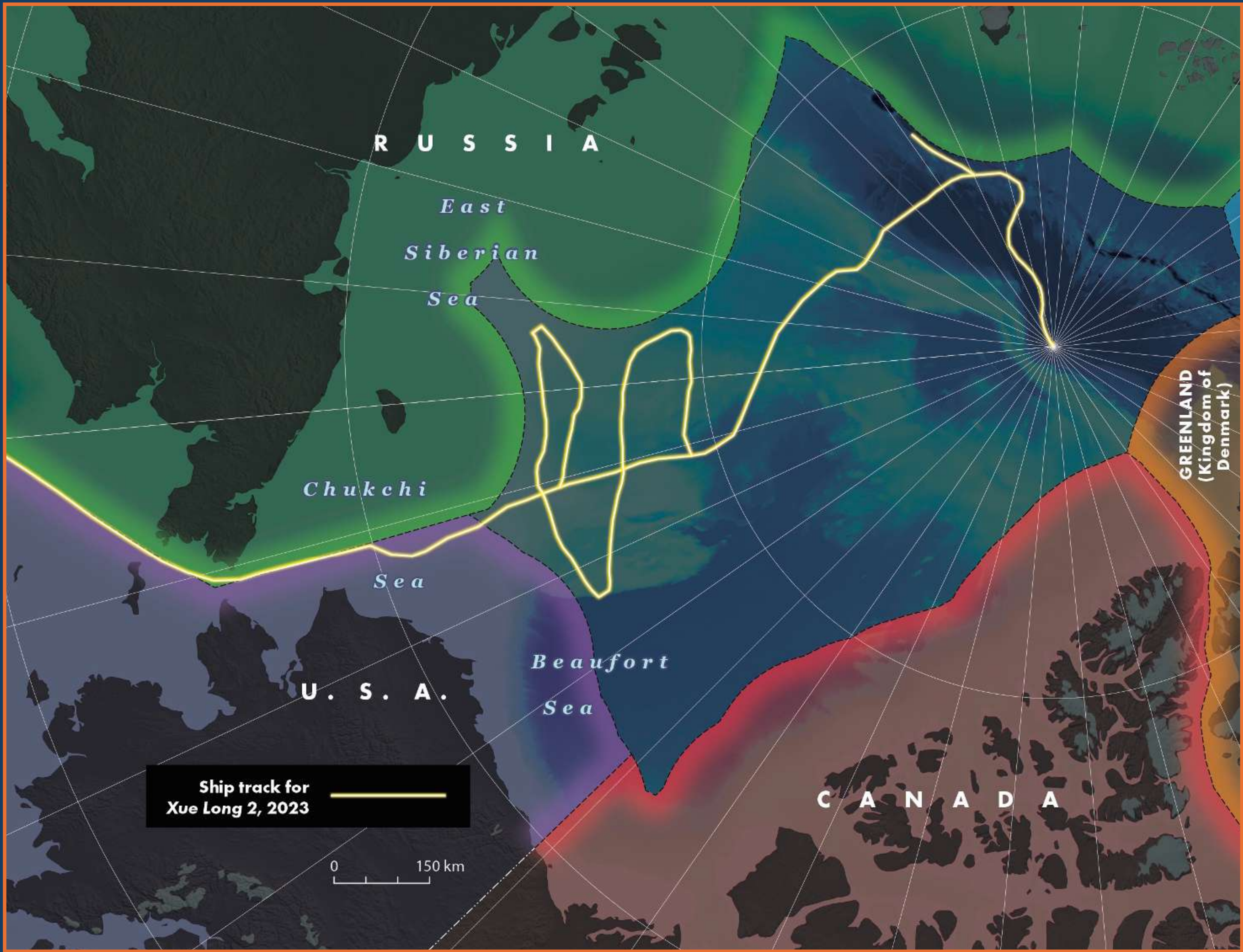
To undertake this work, the ship deployed a number of new tools and technologies. Chen Zhi, Chief Scientist of China's 13th Arctic Ocean Scientific Expedition, explained that several instruments, including internal sea ice stress buoys, profiling buoys for sea ice optics, and subgrid-scale buoy arrays, were deployed in the Arctic Ocean for the first time. These experimental deployments contribute to a more refined understanding of the dynamic and thermodynamic processes of sea ice, providing valuable data for the further improvement and optimization of China's sea ice modeling capabilities.

Most significantly, Harbin Engineering University deployed the Xinghai 1000, an AUV designed for polar exploration. This AUV conducted the country's first under-ice topography observation in the Arctic, surveying an area of 7,000 square meters and collecting key oceanographic data. Equipped with a multibeam under-ice sonar system and high-latitude navigation technology, it successfully demonstrated core capabilities including autonomous navigation and under-ice communication in polar conditions. It successfully completed autonomous under-ice exploration and sea ice underside topography observations in the Arctic. It acquired key oceanographic parameters—such as seawater temperature, salinity, chlorophyll, dissolved oxygen, turbidity, and pH—across five under-ice profiles in the waters near the Chukchi Sea, significantly enriching the Arctic Ocean data repository.[204]

China also made its first Arctic use of Synthetic Aperture Radars (SARs). These systems can be mounted on satellites or aircraft and use microwave signals to penetrate dust, darkness, clouds and rain to create high-resolution images. During the expedition, Chinese scientists used five different frequency bands of SAR to build an integrated testing platform, for conducting sea ice observation by microwave remote sensing.[205]

Chinese scientists were joined on this expedition by colleagues from Thailand for a joint investigation of microplastics in the atmosphere, surface seawater, and sediments, "contributing valuable insight for global microplastic pollution research and mitigation." In addition, geophysical cooperation was undertaken with Russia on joint surveys of Gakkel Ridge.

Upon the ship's return home, Chinese state media announced that "this expedition "represents a concrete step toward advancing China's maritime power strategy. It significantly enhances understanding of the rapid changes in the Arctic Ocean and their ecological impacts, providing critical data to support national responses to global climate change. The mission also highlights China's role and responsibility in Arctic governance on the international stage."[206]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Ship track for Xue Long 2, 2023
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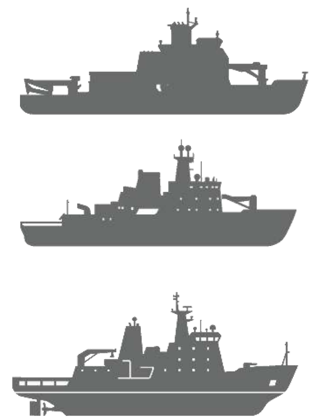
14th Arctic Expedition (2024)



- Ships: *Xue Long 2, Ji Di, and Zhong Shan Da Xue Ji Di*
    - Map drawn from AIS tracks of Xue Long 2; other maps drawn from media release (imprecise)

China's 2024 Arctic operations marked a significant break from past patterns. Rather than deploying one icebreaker into the region, the 14th Expedition saw three Chinese agencies operating three separate ships during the same season. These vessels pursued their own research agendas though there may have been a degree of coordination. This pattern was continued in 2025 and now likely represent the standard for Chinese Arctic expeditions.

During this expedition, *Xue Long 2* travelled through the Bering Sea in July and, in an indication of tenser relations, was shadowed by the Canadian frigate HMCS *Regina*. While in the region it completed temperature, salinity, depth and current velocity studies.[207] Professor Li Tao from Ocean University of China carried out CTD/LADCP observations at 42 stations, deployed 43 sea fog visibility profilers and 160 expendable CTD probes (XCTDs), recorded weather conditions and fog droplet spectra continuously over 92 days of navigation, and installed two ice-based ocean profiling buoys at ice stations to enable real-time, long-term, all-weather monitoring of hydrological changes in the upper ocean beneath the ice. [208]

The second vessel was the *Zhong Shan Da Xue Ji Di*, which undertook its maiden Arctic journey – travelling approximately 11,500 nautical miles, including 1,473 nautical miles in ice-covered water. Aboard, researchers conducted a series of "multidisciplinary" studies in the Arctic Ocean, focusing on sea-ice-atmosphere interactions and the retreat of the marginal ice zone. Their work spanned fields including remote sensing, oceanography, sea ice analysis, atmospheric studies, and geophysics.[209] The ship left China's port of Nansha on July 16th, passing through the Bering Strait and entering the Arctic Ocean west of Alaska.[210]

Led by Zhongshan University and the Polar Expedition Office of the State Oceanic Administration, this was the first Chinese expedition not managed and organized by the government and the first independently organized by a Chinese university. The research team was drawn from the humanities, sciences, medicine, and engineering with dedicated educational programing aboard where graduate students received interdisciplinary instruction and mentorship directly from experts in the field.[211]

The Laboratory of Ocean University of China played a key role in this expedition by participating in a multidisciplinary hydrological–chemical–ecological survey which yielded "a range of important findings," including insights into the variation of Arctic water masses and circulation structures, the response and adaptation of Arctic ecosystems to sub-Arctic influences and changes in atmosphere–ice–ocean coupling processes, as well as preliminary technical assessments for the feasibility of a pan-Arctic real-time observation system.[212]

In the Canadian Basin, the ship undertook hydrographic profiles included measurements of depth, temperature, salinity, density, chlorophyll-a fluorescence, dissolved oxygen, pH, turbidity, and ocean optical properties. Two radial hydrographic transects across the Basin were conducted along the 155°W and 177°W meridians, including the Chukchi Sea shelf, Chukchi Plateau, Canadian Basin, Alpha Ridge, Mendeleev Ridge, and the Chukchi Abyssal Plain.[213]

At 84.75°N, near the high-latitude marginal ice zone, an intensive hydrographic survey was carried out along the ice edge. This enabled high-resolution mapping of the hydrographic structure, effectively filling a significant data gap in detailed hydrographic profiles of the region.[214]

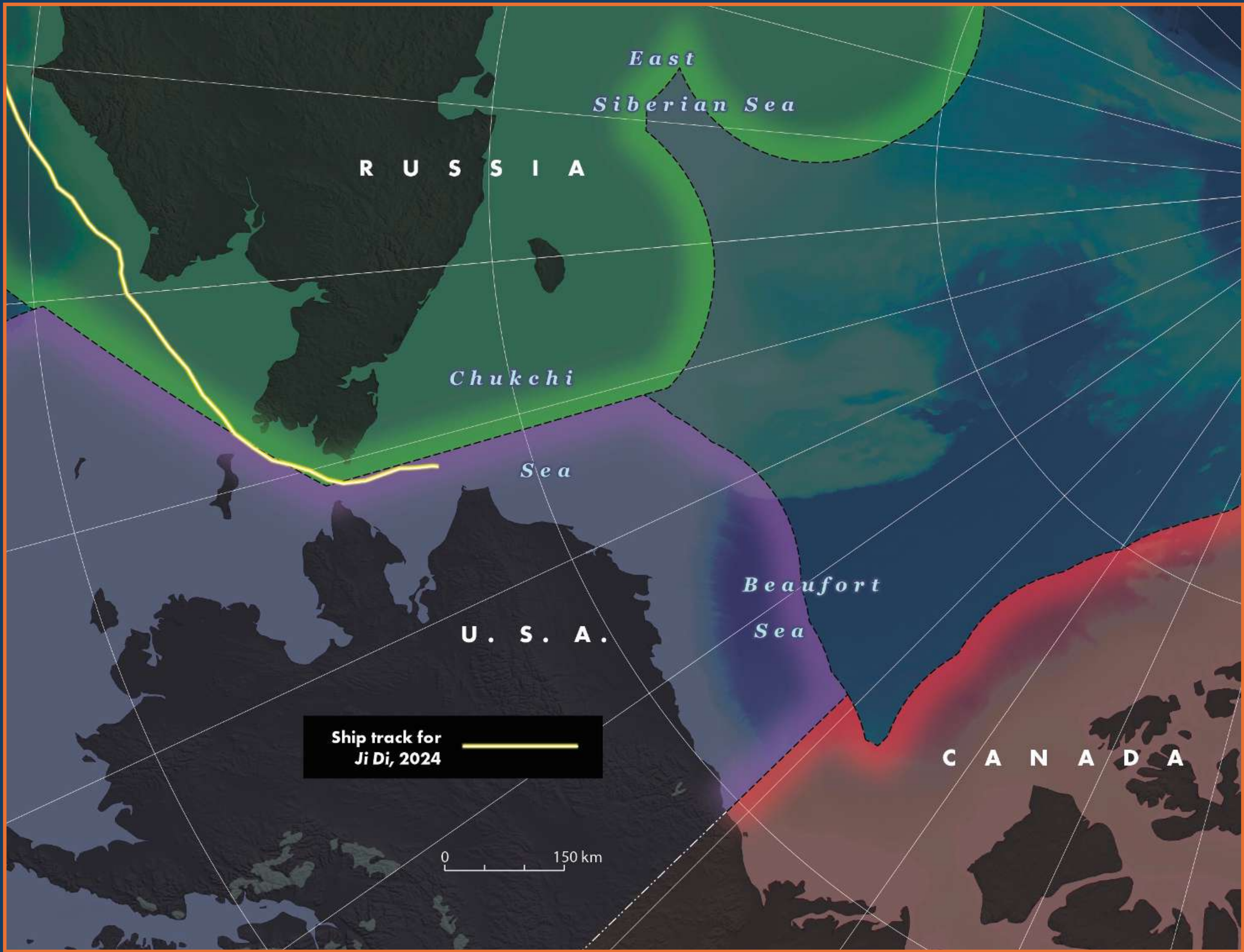
During ice station operations in the Arctic Ocean, three prototype dual-mode drifting buoys (for both ice and open water deployment) were successfully deployed by the research team. Additionally, two prototype ice-based ocean temperature and salinity chain buoys were installed, capable of conducting high-frequency, multi-layer continuous observations of the subsurface ocean beneath sea ice. These instruments also support networked deployment in both open water and thin-ice zones along the ice edge.[215]

The third vessel, *Ji Di*, operated in the region for 53 days on its own maiden test voyage, covering roughly 10,000 miles. Managed by the North Sea Bureau of the Ministry of Natural Resources, the ship carried out ice-breaking tests and obtained sea fog visibility profilers from 40 stations. It also deployed and recovered Arctic buoys providing data on air-ice-sea interactions in the Northwest Arctic Ocean sector. *Ji Di* also trialed unmanned aerial vehicles and other specialized Arctic equipment, including Arctic subsurface moorings. Public statements indicate that this domestically produced icebreaker met or exceeded design expectations.[216]

> *"The ability to conduct polar expeditions has become the embodiment of national scientific research capabilities."*
> - *Wu Gang, Ship design master*

Ji Di also trialed the Pin Bo hovercraft, which was advertised as completing vital "transport missions."[217] *Ji Di* was also equipped with the MK-400BH heavy-lift unmanned helicopter and the DB-400 manned/unmanned helicopter, both developed with Beihang University. This series of aircraft is powered by a new turboshaft engine developed under the guidance of Liu Daxiang of Beihang. Equipped with various mission payloads, a remote technical support team was also established at the National Key Laboratory of Integrated Aircraft Control to ensure effective operation and real-time data processing. The ability to conduct polar expeditions has become the embodiment of national scientific research capabilities.[218]

At sites near 80°N latitude, the ship successfully conducted multiple tests, including a low-temperature cold start of the turboshaft engine, flight operations over water and ice, navigation in weak geomagnetic conditions, and rotor de-icing system evaluation. Missions such as polar bear patrols, supply delivery, casualty evacuation, stretcher towing on ice, and ice surface mapping were also carried out "with great success." The equipment was advertised as having operated "reliably and stably, providing new aerial capabilities for detection, early warning, rescue, and transportation in polar regions, significantly enhancing the efficiency and capability of scientific expeditions in extreme environments."[219]



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CANADA
Ship track for
Ji Di, 2024
0
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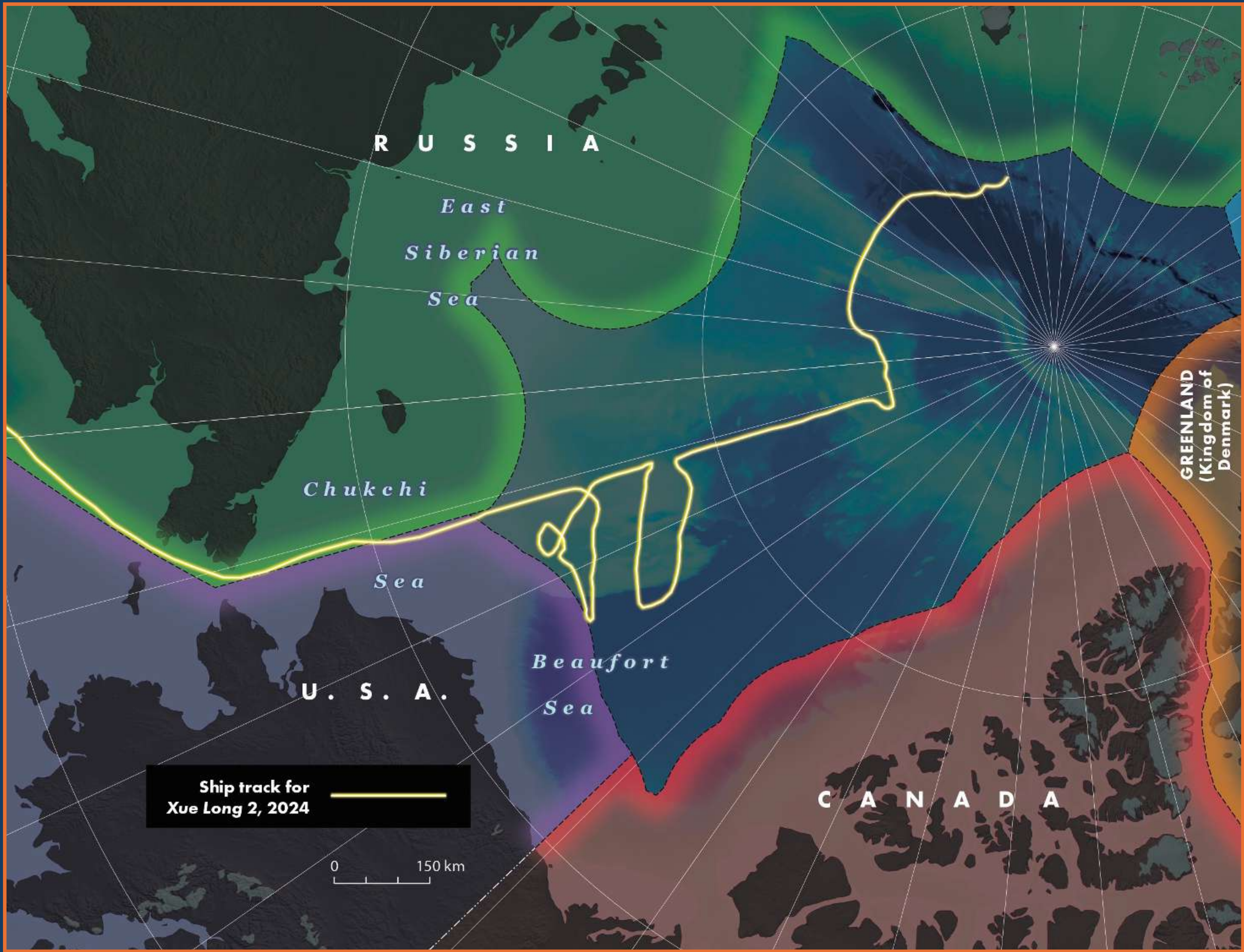
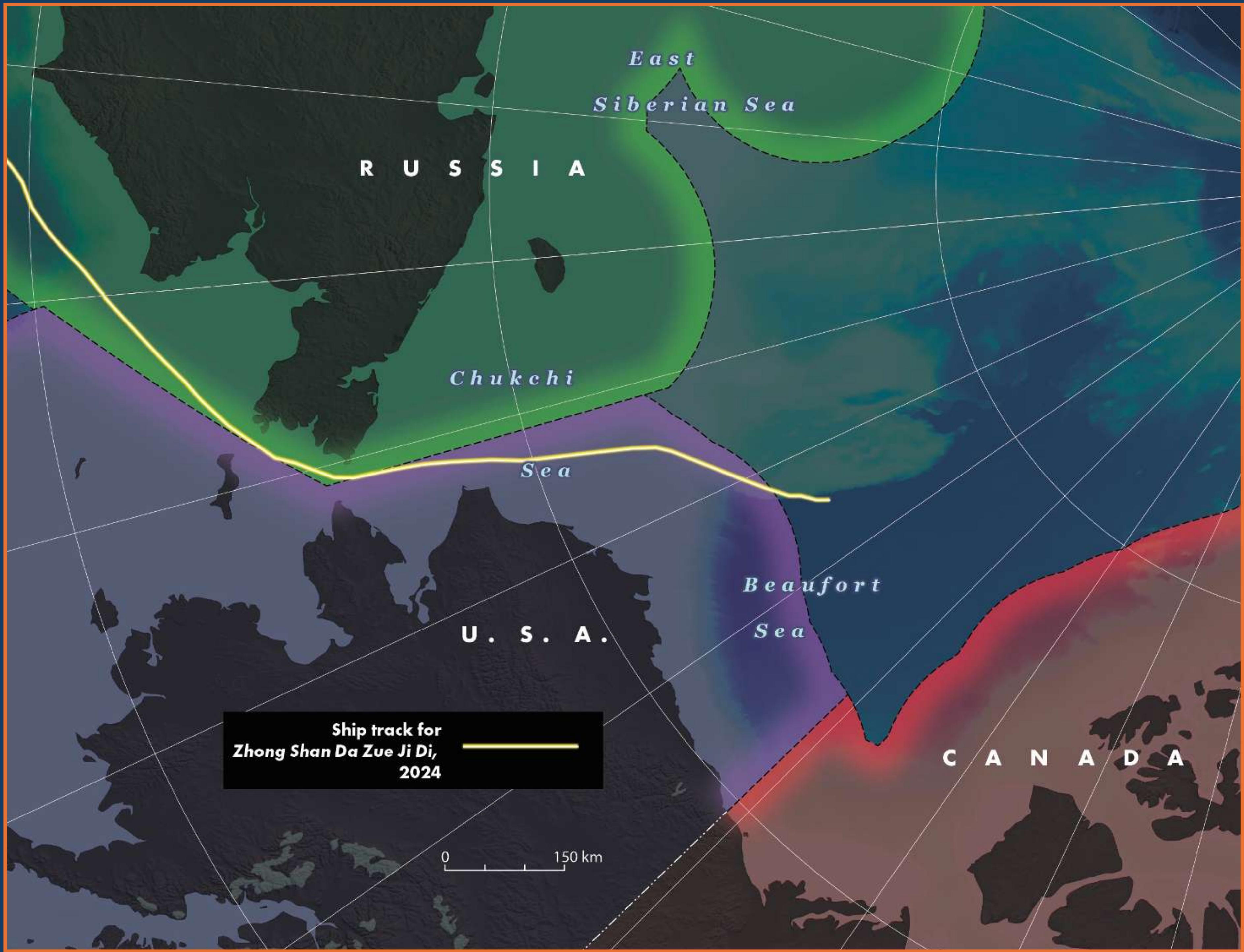
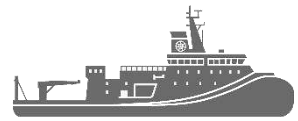

R U S S I A
East Siberian Sea
Chukchi Sea
Beaufort Sea
U. S. A.
C A N A D A
GREENLAND (Kingdom of Denmark)
Ship track for Xue Long 2, 2024
0
150 km


East Siberian Sea
RUSSIA
Chukchi Sea
U.S.A.
Beaufort Sea
CANADA
Ship track for
Zhong Shan Da Zue Ji Di,
2024
0
150 km

15th Arctic Expedition (2025)

- Ships: *Xue Long 2, Ji Di, Zhong Shan Da Xue Ji Di, Tan Suo San Hao, Shenhai-1*
  - Map drawn from media release (imprecise / tracks combined)



China's 15th Arctic expedition took place in the summer of 2025 under the direction of the Ministry of Natural Resources and included a fleet of five vessels – making this the largest of China's Arctic expeditions. Notable achievements included Chinas first crewed deep dive below the polar ice and the world's first coordinated crewed-uncrewed submersible operation in the Arctic.[220]

During the expedition, elements of this fleet voyaged as far as 77.5 degrees north, conducting comprehensive marine environmental surveys and deep-sea dives, according to CCTV.[221] Researchers collected hundreds of deep-sea samples as well as data on biodiversity, ocean hydrology, sea ice conditions and water chemistry, including with the help of artificial intelligence.[222] In a statement from China's Ministry of National Resources, the findings of the Arctic "significantly improved its understanding of the changing Arctic climate and environmental conditions."[223]

The flagship for the operation was *Xue Long 2*, which sailed 20,000 nautical miles with a crew of 101.[224] The icebreaker carried out comprehensive maritime environmental surveys and crewed deep-sea diving support tasks in the Chukchi Sea Plateau, the Canada Basin, and the central region of the Arctic Ocean.[225] The ship was also the main platform for deploying ice-tethered buoys, benthic landers, and CTD probes to monitor ocean temperature, salinity, and current dynamics.[226] The State Council of the PRC stated that these studies included coordinated observations of the air, ice, and sea – filling "existing scientific knowledge gap in this area."[227] According to Chinese and Russian state media, Russian scientists also participated in the expedition and were brought aboard *Xue Long 2*.[228]

Thee other ships – *Tan Suo San Hao, Zhong Shan Da Xue Ji Di,* and *Shenhai-1* - accompanied *Xue Long 2* and supported in a variety of scientific tasks. *Shenhai-1* carried the Jiaolong manned submersible, which carried out a joint underwater operation in the Arctic Ocean consisting of synchronized dives with HOVs.[229] The Jiaolong had recently received an upgrade to its battery and propulsion systems and was used to conduct China's first crewed deep-sea dives in ice-covered Arctic waters.[230] The joint dives took place in August, during which the submersible sampled underwater organisms and sediment materials, and the two vehicles filmed each other.[231]

China also deployed the brand-new *Tan Suo San Hao*. This vessel had completed its sea trials in October 2024 and was quickly deployed on quasi-political missions. In May 2025 it made an appearance in the EEZ of the Philippines, prompting the dispatch of the BRP *Teresa Magbanua* to intercept.[232]

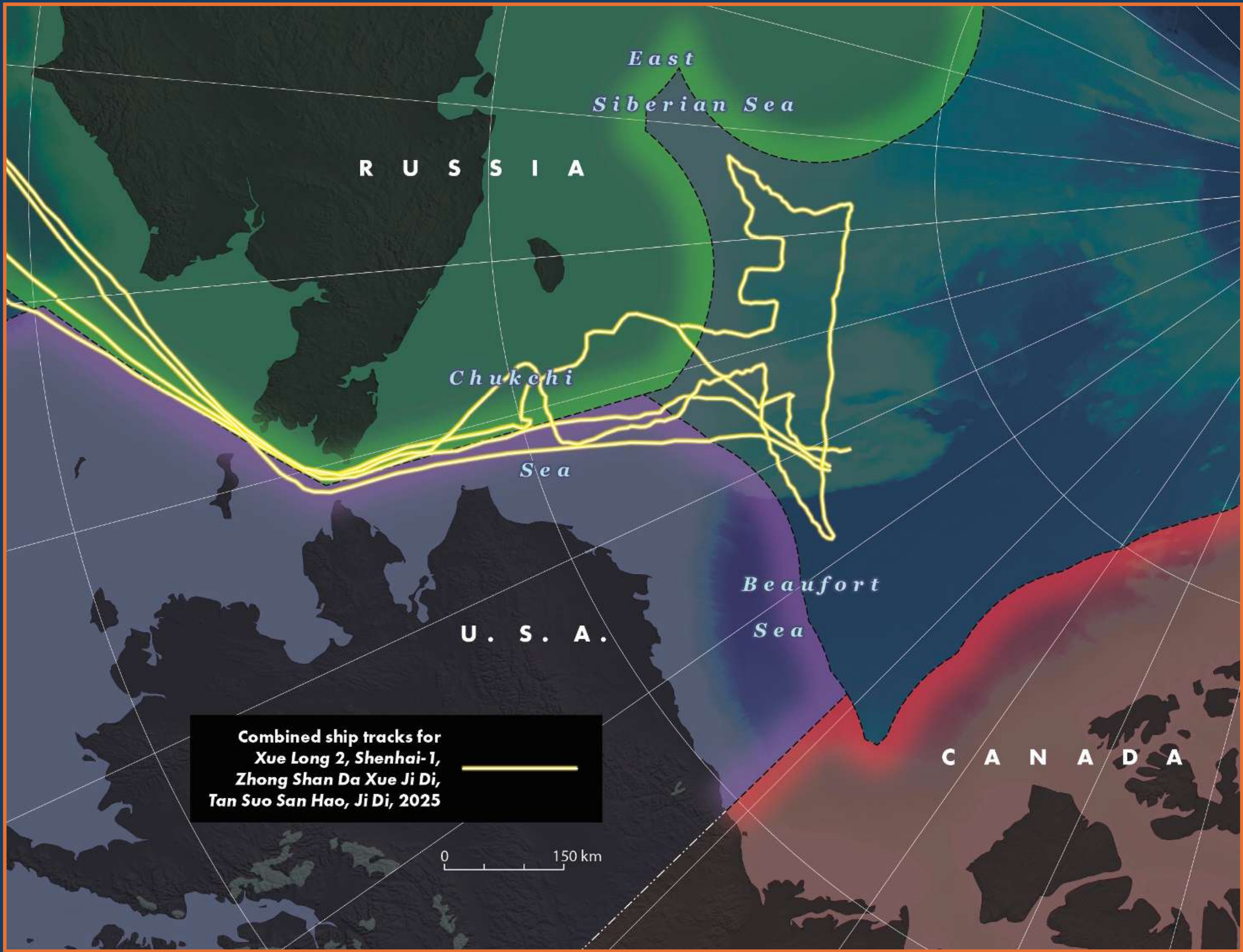
In the Arctic, *Tan Suo San Hao* acted as the fleet's deep-ocean exploration platform, complementing *Shenhai-1* by supporting submersible operations in heavier ice and deeper waters. Equipped with state-of-the-art sonar, sampling booms, and dynamic positioning systems, *Tan Suo San Hao* hosted the Fendouzhe ("Striver") submersible for dual-submersible missions, a first for China's polar research program. At the Gakkel Ridge, the Fendouzhe and Jiaolong performed alternating deep dives exceeding 5,000 meters, capturing seafloor imagery, mineral samples, and hydrothermal vent observations. Over a 56-day period, *Tan Suo San Hao* executed coordinated underwater navigation, deploying sensor arrays and monitored mid-depth water masses to track how Arctic warming influences ocean circulation. The vessel's mission underscored China's drive to merge polar and abyssal research, expanding the scope of its blue-water scientific capacity beyond traditional surface-based expeditions.[233]

The Jiaolong – which conducted over 10 dives in total – collected 183 biological samples, including shrimp, sea spiders and sea anemones, as well as samples of sediment, rock and seawater. [234] Chinese scientists on the expedition noted that they "tried a collaborative operation between the Jiaolong and a remotely operated vehicle, which required solving challenges such as communication and positioning before moving on to the next step of joint operations." [235] AI was also incorporated into polar surveys studying organism biomass and biodiversity, which can be used to examine the potential connection between species in different survey regions.[236]

The *Ji Di* operated along the marginal ice zones, where the frozen pack meets open water, to gather physical and chemical ocean data, focusing on sea-ice mechanics, salinity gradients, and thermodynamic processes. The ship carried teams specializing in ice-sheet dynamics, surface-ice observation, and ship-ice maneuvering tests, contributing vital data to models predicting Arctic melt patterns. Mid-voyage, *Ji Di* was observed entering waters north of Alaska, near the U.S. Extended Continental Shelf (ECS), confirming survey activities far into the western Arctic Basin.[237]

The 2025 voyages involved China's most impressive dive operations, showcasing advanced crewed and uncrewed under-ice capability. Minister of Science and Technology Wang Zhigang celebrated the successful development of the Fendouzhe submersible and its 10,000-meter sea trials as having demonstrated the effectiveness of China's whole-of-nation innovation system and the development of its high-tech industries in deep-sea energy and advanced materials.[238] The Chinese Academy of Sciences echoed that assessment, stating that these scientific results will help reveal the deep ocean's mysteries and accelerate advances in deep-sea components, high-performance batteries, precision sensors, and specialized materials.[239] Ye Cong, Deputy Director of the 702nd Research Institute of China State Shipbuilding Corporation and Chief Designer of the Fendouzhe submersible, described this success as "overcoming key technical challenges in full-ocean-depth exploration equipment, thereby driving leapfrog development in deep-sea science and deep-sea engineering technologies."[240]

This framing shows a clear pattern of China using Arctic capabilities to stress test its most advanced marine technologies while capitalizing on successes to amplify a broader narrative of technological progress and indigenous development that matches or surpasses Western capabilities.



East
Siberian Sea
RUSSIA
Chukchi
Sea
Beaufort
Sea
U. S. A.
CANADA
Combined ship tracks for
Xue Long 2, Shenhai-1,
Zhong Shan Da Xue Ji Di,
Tan Suo San Hao, Ji Di, 2025
0
150 km

Chinese Arctic Technology

This section is an (alphabetical) overview of Chinese Arctic research tools, with a focus on technology used in more recent expeditions. The intent is to provide a general overview of these systems to better understand their capabilities and uses. Of note, this list is based on open-source media reporting and is almost certainly incomplete.

The deployment of Chinese technology into the Arctic Ocean and surrounding seas is nothing fundamentally new. Working in ice-covered waters requires a unique set of tools and skills, and China's scientists have been developing them for well over two decades. As early as 2008, the Polar Research Institute of China began deploying what it described as "underwater robots," designed to help track and predict sea ice changes.[241] Four years later, *Xue Long*'s crew advertised the first successful deployment of buoys in the region. The mission was to observe air-sea interactions in the Norwegian Sea.[242] By 2018, that program of work had expanded considerably, and, as part of the country's 9th Arctic Expedition, *Xue Long* deployed an unmanned ice station on an Arctic ice floe.[243] The PRIC also boasted of its success in testing underwater gliders, observation platforms, and sediment traps.[244] As part of a large scientific program, including five ice stations and 43 different buoys, the Chinese icebreaker also trialed submersible devices able to "record the temperature, salinity, current speed and flow data" of the ocean.[245]

In recent years, the use of AUVs and buoys has grown considerably. These tools are now regularly used to map sea ice, collect samples, study the water column, and undertake a myriad of different studies. Just how threatening these tools are remains the subject of debate. These systems are widely used by other Arctic states and have legitimate scientific uses and capabilities. Still, the military applications of many are also obvious.

China's gliders, for instance, have no propulsion systems, maintaining momentum by relying on small changes in buoyancy; as such, the acoustic signature is extremely low, making them ideally suited to undersea warfare.[246] The mapping of the region's seafloor, salinity levels, and water temperature are also all perfectly legitimate scientific pursuits; and indeed, this work is framed in English and Chinese language discussions as important civilian environmental research, designed to better understand the Arctic region and a changing global climate.[247] Still, this is also the prerequisite work to understanding submarine and anti-submarine warfare operations in Arctic waters. Indeed, these were the same preparatory studies undertaken by the US and Canadian navies and defence research agencies in the early Cold War.

China's buoys have also gained increasingly sophisticated sensor systems. Official statements highlight how they can transmit data back to China in real time – making them useful tools for monitoring more than environmental data. There is also a clear trend to developing autonomous systems with long range and sustainability, all of which would provide a host of military uses for both intelligence gathering or even a longer-term development of strike capability. This is all speculation since China has not advanced any such agenda and there is no formal security mission for any of its tools. The broader decline of Sino-Western relations does, however, create the need to view Chinese tools with some suspicion.

CR-01 Autonomous Underwater Vehicle

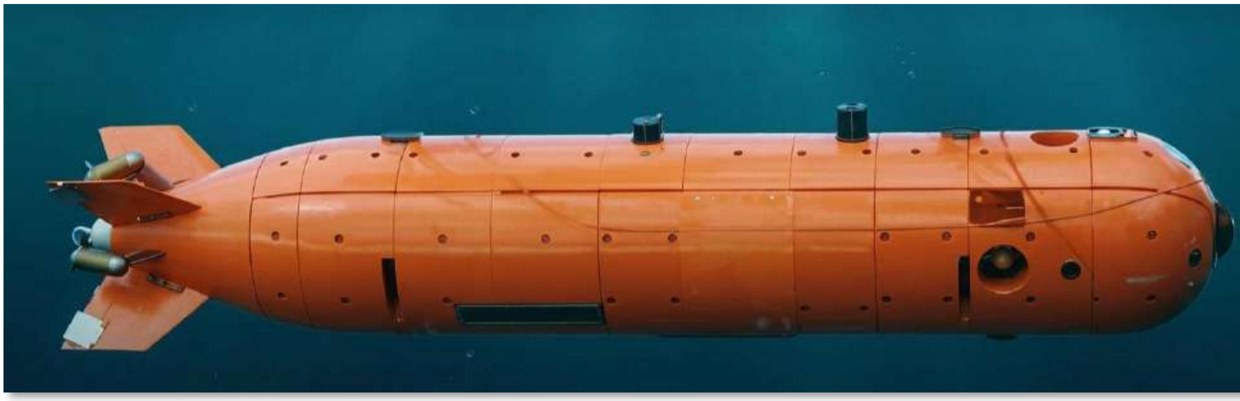
The CR-01 is a 4.5-metre-long and 0.8-metre-wide autonomous underwater vehicle (AUV), with a draft of 0.93 metres and weight of 1,305.15 kilograms. It can operate at depths of up to 6,000 metres (granting it access to 98% of the world's seabed). Its top speed is 2 knots and it has a maximum endurance of 10 hours. Developed collaboratively by Russian and Chinese educational and research institutions, including the Shenyang Institute of Automation of the Chinese Academy of Science and the 702nd Research Institute of the China Shipbuilding Industry Corporation (CSIC), the platform was initially launched in 1995.[248]

The CR-01's primary mission is to conduct shallow stratum profiling and seafloor topographic surveys, including in the deep sea, often alongside the CR-02 AUV. As a self-propelled robotic platform, it can follow a pre-programmed trajectory to capture photographs and videos, collect physical and hydrological measurements of salinity and temperature, map seabed profiles and terrain, measure the proliferation of polymetallic nodules, locate and observe objects on the seafloor, and autonomically record data and the associated coordinates.[249] It also has utility for radio signal and light processing. The modified version of the platform, the CR-01A AUV, can penetrate mud layers, offering an even greater detection capability.[250] While cannot perform more complex tasks like the collection of samples, the CR-01 allows China to perform detailed surveys of vast stretches of the ocean floor. [251]

Structurally, the CR-01 is equipped with lateral and vertical thrusters at the bow. These offer it high manoeuvrability, as well as careful auto-direction and auto-depth control, all of which are crucial for stable visual and acoustic detection and observations in deep waters. Its GPS and long-baseline acoustic positioning system enable operators to precisely monitor and follow its progression in deep waters. The platform is also equipped with an extensive array of sensors for depth, salinity, and temperature. Its multi-CPU and hierarchical control structure simplify programming and allow for the compilation of real-time "black box" operational data records. If the robot's navigation fails or a malfunction occurs, it can automatically jettison weights and rise to the surface to dispatch a rescue light and emergency radio antenna. The CR-01 moreover has a dedicated deployment and recovery system to facilitate its use.[252]

The CR-01 made critical advancements in the early stages of China's deep-sea research and exploration program. It completed its deep-sea functions tests in August 1995 and the summer of 1997 and supported by *Da Yang 1*, completed 39 days of engineering sea trials in the Pacific Ocean, surveying polymetallic nodules, collecting salinity and temperature measurements, taking photographs, and successfully attaining a depth of 5,179 metres.[253] In the course of this trial, on June 10, it remained underwater for almost 10 hours, six of which involved work on the seabed taking photographs and side-scans, collecting salinity and temperature measurements, and performing shadow profiling and remote-control operations. [254] These operations illustrated that the CR-01's long-baseline sonar system can accurately report depth, altitude, and heading and confirmed its ability to respond to acoustic control commands to dive, surface, turn, or terminate its mission.[255]

The CR-01's success directly supported China's obligations, following the UN's 1991 approval of China's Deep-Sea Mining Association as the fifth pioneer investor in seabed mining, to survey 300,000 square kilometres of ocean floor. The consequent success of its 1997 surveys was crucial to China's 1999 acquisition of prospecting rights for 75,000 square kilometres of seabed, as well as priority development rights.[256] The platform's accomplishments were widely celebrated in China, with the platform receiving China's First Prize for National Science and Technology Progress, while Deputy Chief Engineer Feng Xisheng, its chief technical leader, was elected an academician in 1999 of the Chinese Academy of Engineering.[257]



CR-01 (AI generated from media images)

CR-02 Autonomous Underwater Vehicle

The CR-02 AUV is a survey vehicle 4.5 metres in length, 0.8 metres in width, and 1.5 metres in height. With a draft of 0.93 metres, weight of 1.5 tonnes, and speed of 2.3 knots, it has a working depth of 6,000 metres[258] and 25-hour endurance capability. Its survey sonars have a range of 12 kilometres and accuracy of better than 20 metres, and it boasts an obstacle avoidance sonar accuracy of 1% and obstacle avoidance sonar range of 60 metres. The CR-02 has a bottom penetration of 50 metres, in soft mud. Powered by a silver-zinc battery, it has a recording capability of over four continuous hours and photographic capability of 3,000 photos. The CR-02 AUV is an advanced variant of the CR-01, equipped with superior obstacle-avoidance systems and capabilities.[259]

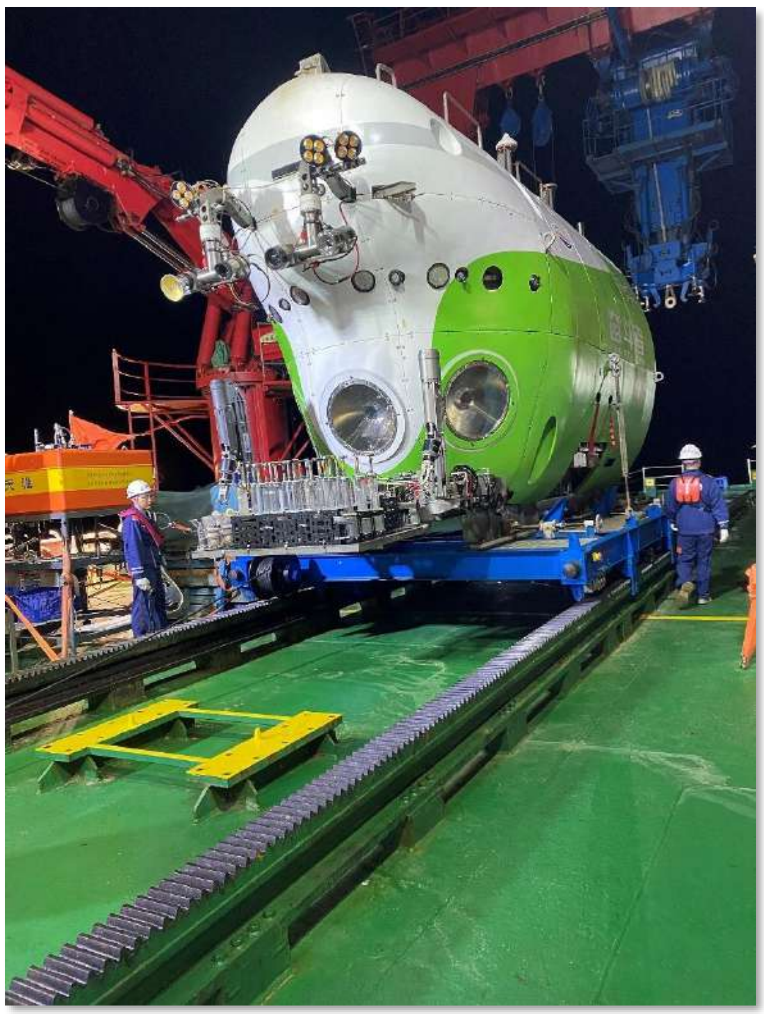
CR-02 (AI generated from media images)

Fendouzhe ("Striver")

The Fendouzhe is an independently developed, deep-dive Chinese submersible capable of operating at 10,000 meters below the surface. Initiated in 2016, the project was undertaken by a research team largely composed of developers from the earlier Jiaolong and Shenhai Yongshi submersible programs. On June 19, 2020, China officially launched and named the submersible "Fendouzhe" – or Striver.

On March 16, 2021, the Institute of Deep-Sea Science and Engineering (IDSSE), part of the Chinese Academy of Sciences, took the lead in establishing the 'User Scientific Steering Committee' for the deep-dive Shenhai, Yongshi, and Fendouzhe systems. According to Hu Zhen, Deputy Chief Designer of the Fendouzhe, this committee served, and still serves, as the user and "expert communities" for these systems and will play a "positive role in advancing technological upgrades and operational capabilities, expanding their application potential in deep-sea and hadal frontier scientific research, and promoting international cooperation."[260]

The Fendouzhe is an extremely capable dive system. It can carry three crew members and conduct continuous operations for more than six hours at depths reaching 10,000 meters. The system features three observation ports and two robotic arms, supported by seven cameras and seven sonar systems. The vessel also carries specialized scientific equipment, including a columnar sediment corer and a hydraulic drilling-cutting integrated system.[261] To address the extremely high-pressure and complex deep-sea environment, the design team adopted a multi-system integrated approach that significantly improved the submersible's diving and surfacing speed and the efficiency of internal cabin space, while enabling real-time monitoring and assessment of the crewed pressure hull.



Fendouzhe, IDSSE, China (Source: wikmedia)

Central to this integrated design was the development of the spherical crewed pressure hull, which required years of dedicated research to create a special titanium alloy capable of withstanding immense pressures at extreme depths. Complementing the structural innovations, the team achieved a breakthrough in buoyancy materials, successfully developing a high-strength hollow glass microsphere material that balances low density with high strength – essential for descending and ascending efficiently. Connecting these systems to the surface is a new system of underwater acoustic communication, which serves as the sole link between Fendouzhe and its support vessel. This system enables real-time text, voice, and image transfer from depths up to 10,000 meters.

The system was trialed in the Mariana Trench in 2020, where it deployed a full ocean depth hydraulic manipulator system, showcasing its exceptional ability to complete complex tasks at extreme depth.[262] Following a series of polar upgrades, Fendouzhe gained the ability to conduct precise operations under low-temperature conditions and in environments without satellite signal coverage. This upgrade process fell within China's 14th Five-Year Plan goals of enhancing deep-sea scientific and technological capability and evidence suggests that these have developed rapidly.

In 2025. the scientific expedition team established operational procedures for manned deep-sea dives under extreme polar conditions, pioneering a new mobile ice-diving model based on "ship-submersible coordination" in densely ice-covered waters. This innovation was praised in the *Beijing Daily Client* as providing "precise guidance and safe surfacing," making China the only country in the world to have conducted continuous manned deep-sea dives in the densely ice-covered regions of the Arctic.[263]

In 2025, the Fendouzhe was deployed from the *Tan Suo San Hao* for multiple Arctic deep-dive operations. At the Gakkel Ridge, the Fendouzhe and Jiaolong submersible performed alternating deep dives exceeding 5,000 meters, capturing seafloor imagery, mineral samples, and hydrothermal vent observations. Over a 56-day period, *Tan Suo San Hao* executed coordinated underwater navigation, deploying sensor arrays and monitored mid-depth water masses to track how Arctic warming influences ocean circulation.[264]

After the mission, Minister of Science and Technology Wang Zhigang celebrated the successful development of the Fendouzhe as having demonstrated the effectiveness of China's whole-of-nation innovation system and the development of its high-tech industries in deep-sea energy and advanced materials.[265] The Chinese Academy of Sciences echoed that assessment, stating that these scientific results will help reveal the deep ocean's mysteries and accelerate advances in deep-sea components, high-performance batteries, precision sensors, and specialized materials.[266] Ye Cong, Deputy Director of the 702nd Research Institute of China State Shipbuilding Corporation and Chief Designer of the Fendouzhe submersible, described this success as "overcoming key technical challenges in full-ocean-depth exploration equipment, thereby driving leapfrog development in deep-sea science and deep-sea engineering technologies."[267]

These dives caught Western attention and generated fresh concern over their dual use. While there is no clear connection between the Fendouzhe program and the Chinese military, its deep-sea operations have raised concerns that this system could be used as a deep-sea cable-cutting platform, which could significantly increase the hybrid warfare capabilities of the PRC, and impact both regional and global power dynamics.[268]

Haidou-1 Uncrewed Submersible ("Hadal-1 ARV")

The Haidou-1 – also referred to as the Hadal-1 or North Pole ARV, and the successor of the Hadal ARV and Arctic ARV[269] – is an autonomous and remotely operated underwater vehicle constructed by the Shenyang Institute of Automation (SIA) between 2016 and 2019 and used by the People's Liberation Army Navy (PLAN). Powered by battery and measuring 3.8 metres in length and 350 kilograms in weight, it can attain a maximum depth of 10,908 metres, operate for over eight hours on the seafloor, and travel over 14 kilometres.[270] The result of China's "863 Plan" in the marine technological field, it was the first ARV to be independently developed by Chinese Academy of Sciences.[271]

Equipped with a high-definition camera, electric manipulator arm with full ocean depth, and advanced communication and sensors systems, including optical flux metres, profiling sonar, and salinity and temperature sensors,[272] the Haidou-1 boasts the able to collect data beneath the ice, mapping hydrographic characteristics, sea ice thickness, and ice-bottom morphology.[273] It has set numerous international records, including those related to high-precision depth exploration, near-seafloor working time, acoustic communication range,

Haidou-1 (AI generated from media images)

manipulator arm operations, acoustic positioning and detection, and real-time high-definition video transmission.[274]

It is particularly proficient at identifying and locating target objects, conducting real-time and live video broadcasts, and reading seabed terrain.[275] As the product of SIA scientists in China to combine the functions of a remotely operated vehicles (ROV) and autonomous underwater vehicles (AUV), the vehicle can operate either in AUV mode, for large-scale underwater explorations, or in ROV mode, for more accurate investigations of smaller sea areas. The Haidou-1 therefore has many of the advantages of both platforms, enabling the real-time transmission of data, performing light tasks underwater, and using long-distance fibre-optic micro-cables that serve to reduce the weight and size of its surface equipment, minimizing its reliance on support vessels and extending range.[276]

The Haidou-1 has completed several landmark expeditions. In August 2008 it was launched from *Xue Long* as part of the 3rd Chinese Arctic scientific expedition. There, it collected data on the physical characteristics of ice and "other ocean elements." It mapped sub-ice morphology, collected under-ice video, and gathered data on optical parameters, depth, salinity, under-ice temperature, and ice flow thickness, all the while maintaining autonomy in its position control and successfully performing both vertical and horizontal profiling beneath the ice.[277] This represented the first Chinese deployment of a domestically engineered robot on one of its Arctic expeditions.[278]

In May 2020, the system successfully completed its initial 10,000-metre trial in the Mariana Trench, placing markers with its robotic arms, collecting sediment, and gathering water samples.[279] During this expedition, it descended 10,908 metres to the Challenger Deep seabed in the Mariana Trench and remained on the seabed for 10 hours – surpassing its prior longest operations on the ocean floor by two hours.[280]

Haiyan Autonomous Underwater Glider

Also called the Petrel II HUG or Haiyi underwater glider, the Haiyan autonomous underwater glider (AUG) was developed by Tianjin University/Shenyang Institute of Autonomation of the Chinese Academy of Sciences.[281] Torpedo-like in shape, the Haiyan is notably thin and light compared to traditional AUVs, measuring around 70 kilograms in weight, 0.3 metres in diameter, and 1.8 metres in length.[282] It has a range of between 1,200 and 1,500 kilometres, a maximum propeller speed of three knots, a maximum gliding speed of 0.08 knots, and a maximum depth of 1,500 metres.[283] By 2019, China had developed Haiyan glider variants with ranges of 200, 1,000, 1,500, 4,000, and 10,000 metres.[284] Its primary use is in the monitoring of deep-sea environments in expansive regions, courtesy of its real-time salinity, dissolved oxygen, temperature, and depth sensors.[285]

Its advanced hybrid propulsion system, which combines propeller propulsion technology with buoyancy drive, enables it to replicate the

Haiyan AUG (AI generated from media images) horizontal and turning movement capacities of the AUV while also possessing the ability to undertake the zig-zag movements typical of glider.[286] The Haiyan is able to switch automatically between these two modes of operation – between flying (thanks to its propeller) and gliding (thanks to its buoyancy) – depending upon the environmental circumstances or commands.[287] Its vertical thrusters, combined with its bow-mounted side-shift thrusters, enhance its manoeuvrability and ensure its ability to accurately and stably perform observations and detections in deep waters.[288]

Mechanically, the Haiyan is comprised of five subsystems, the pressure hull, attitude regulating unit, emergency unit, buoyancy regulating unit, and propeller unit with wings, tail, and antenna.[289] Its electrical control systems are also divided into subsystems, including the processing unit, energy unit, scientific sensor suites, communication and position unit (comprised of GPS, Iridium, and wireless modules), and navigation unit.[290] With its multi-CPU and multi-level control structure, it can pre-program its navigation and record its functions, movements, and image parameters. It has a distinct system for recovering and releasing the glider and, in the event of a capability loss or mechanical failure, it can dispatch its loads to the surface and deploy a first aid light and emergency radio transmitting antennas.[291]

It is able to operate for around 30 consecutive days[292] and carry a variety of scientific payloads – depending on mission needs.[293] The platform is also notable for being highly transportable. Since its antenna mast and wings can be removed the entire glider can be loaded into a box for easy shipping.[294]

The glider is not an Arctic-specific system. Rather, the Chinese have deployed it around the world, including in extensive cluster operations in the Indian and Pacific Oceans.[295] In 2019, for instance, the Haiyan operated continuously for a 550-day period in the East Indian Ocean.[296] However, the it has also been used extensively in the polar region, demonstrating China's efforts – and, in some cases, success – in the adaptation of pre-existing systems for operations in ice.[297] The system underwent testing in the Bering Sea in 2019,[298] in an expedition that saw the it left in the area to travel independently and autonomously for over 1,111 kilometres, before being retrieved by an icebreaker on its return journey.[299] The following year, the Haiyan was again used to acquire biochemical and hydrographic data in the Bering Sea.[300]

In the Arctic, the glider was also successful in performing continuous high-frequency observations on the Bering Sea's continental slope and basin. Its 44 or 45 (depending on the source) days of operations during this expedition resulted in it sailing 843 kilometres performing profile observations and gathering 229 salinity, depth, and temperature profiles. This represented the first use of a glider during an Arctic cruise to undertake hydrographic investigations,[301] as well as the first use of an underwater glider in China's broader polar research program.[302]

In 2019, 11 gliders were deployed in the Northwest Pacific to observe mesoscale/cold eddies,[303] and these performed network observations for 22 days, gathering high-density – and continuous – biochemical and hydrological data near the Bering Sea.[304] Following this deployment, the Ministry of Natural Resources' First Marine Research Institute used the Haiyan glider as part of its "Ten North" underwater glider observation project.[305]

Innovation UAV

The "Innovation" UAV is a heavy-duty, uncrewed aerial vehicle. It boasts a substantial payload capacity – able to carry 250 kilograms of cargo in one trip – allowing it to perform challenging, dangerous, and time-sensitive tasks repeatedly. This system has been deployed by *Ji Di* in polar waters, supporting the icebreaker through aerial remote sensing, rapid material transport, ice surveys, and emergency transport missions.[306]

Jiaolong (Submerged Dragon-1)

The Jiaolong (Submerged Dragon-1) is a modified version of the CR-02 AUV system,[307] designed as one of a series of advanced autonomous underwater robots.[308] Initially developed as a crewed submersible, the Jiaolong is a deep-sea drone and undersea explorer that operates alongside autonomous systems to expand the reach of Chinese research capabilities into hadal regions. Capable of diving to 7,000 metres, it has been used to study deep-ocean ecosystems, geology, and microbial life while facilitating mapping, imaging, and sampling missions, especially when deployed alongside the Fendouzhe submersible. The Jiaolong and Fendouzhe, together, are indicative of China's progress toward the regular and routine conduct of deep-sea operations that blend both robotic and human capabilities for deep-sea resource examinations and scientific analyses.

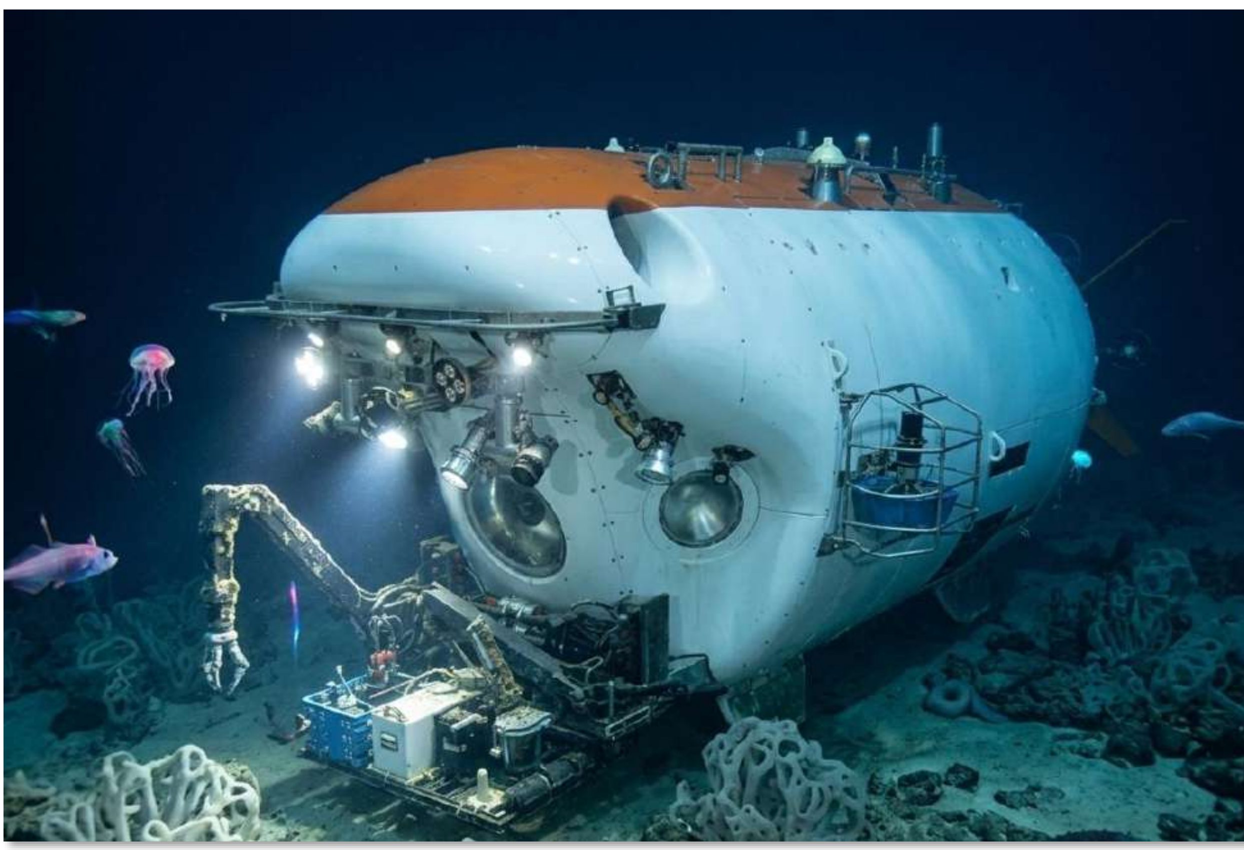
The Jiaolong was developed to "advance China's deep-sea deployment technology and to provide critical high-tech equipment for the China Ocean Mineral Resources Research and Development Association's international seafloor resource surveys and scientific research, and to contribute technology for China's deep-sea exploration and subsea operations."[309] It is managed by the China Ocean Association, under the organization and direction of the State Oceanic Administration, which acts as the project owner and led in the development of the manned submersible program.[310]

The Jiaolong can be fitted with specialized drilling systems that allow deep-sea bedrock coring and sampling of cobalt-rich crust deposits, providing geological samples for ocean mineral exploration.[311] According to the China Ocean Mineral Resources Association, it is also capable of deep-sea mineral exploration, high-precision seafloor topographic mapping, detection and retrieval of objects of interest, and deep-sea biological surveys. These capabilities allow it to undertake the exploration of polymetallic nodule resources; fine mapping of local seabed morphology; targeted sampling of nodules, water, sediments, and biological specimens; and assessment of nodule coverage and abundance through video and photographic data. It can measure temperatures at polymetallic sulfide hydrothermal vents, collect surrounding water samples, and reliably preserve hydrothermal fluid samples. It can also perform precision deployments of underwater equipment, inspection of subsea cables and pipelines, and other complex deep-sea exploration and recovery operations.[312]

The Jiaolong successfully completed its diving trials in December 2014, reaching depths of 7,000 metres in the southwest Indian Ocean's mid-ocean ridge. Xiao Xiang, a marine biologist, described the mission's objectives as studying the biodiversity of the region to compare it to the Pacific and the Atlantic."[313]

The operational pattern of the submersible reveals a systematic and progressively ambitious approach to deep-sea exploration that aligns closely with China's strategic interests in marine resource assessment and scientific research. Geographically, Jiaolong's operations have encompassed three major oceanic domains: the South China Sea, the Indian Ocean, and the Pacific Ocean, with targeted descents into several of the world's deepest trenches including the Mariana, Yap, and Challenger Deep. This geographic scope reflects both scientific ambition and resource-oriented objectives. The South China Sea operations, for instance, have focused heavily on polymetallic sulfide deposits and hydrothermal vent systems, areas of significant economic interest given their proximity to Chinese territorial waters.[314] Meanwhile, Pacific expeditions have targeted polymetallic nodule fields and cobalt-rich crust formations, resources critical to emerging technologies and industrial applications.[315]

The submersible's mission portfolio has been multifaceted, encompassing sea trials, systematic resource surveys, biological sample collection, hydrothermal vent characterization, and fundamental oceanographic research. Notably, the transition from initial sea trials (2009-2012), which established depth capabilities and operational protocols, to trial application phases (2013 onwards) marked a shift toward mission-driven deployments with tangible scientific and economic outputs. By the mid-2010s, Jiaolong had transitioned into routine scientific expeditions, indicating operational maturity and institutional confidence in the platform's reliability.

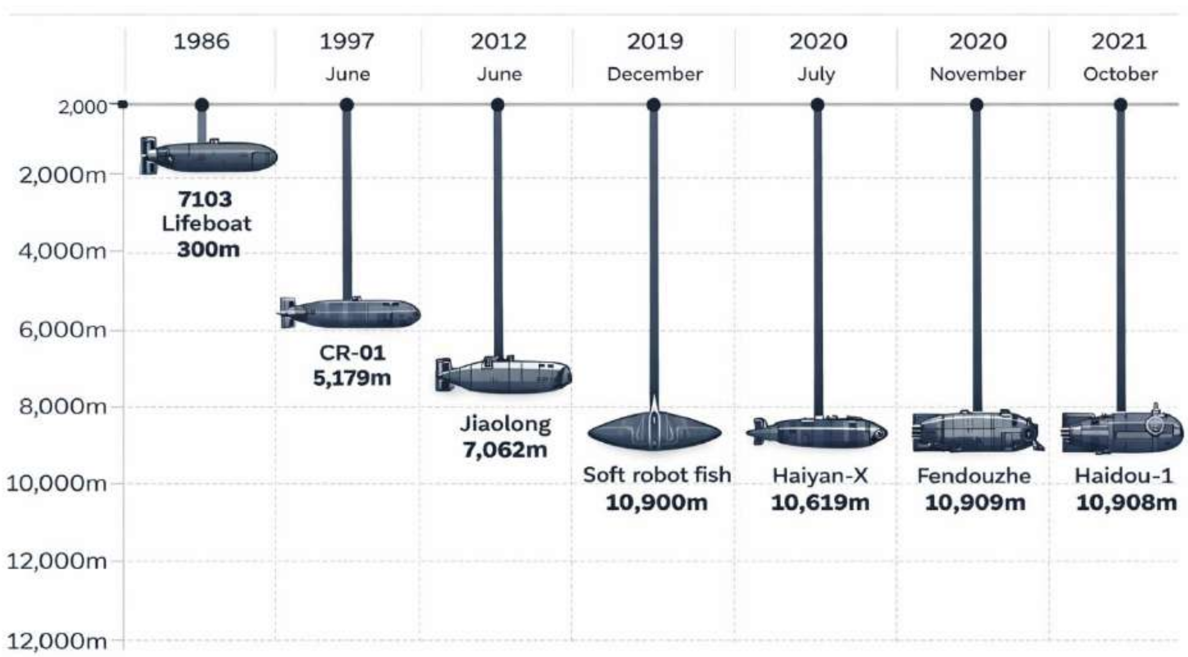


Jiaolong (AI generated from media images)

The Jiaolong was deployed into the Arctic aboard *Shenhai-1* which undertook a program of deep-sea dives in 2025.[316] *Shenhai-1* was accompanied and supported on this voyage by the *Tan Suo San Hao*, which acted as the fleet's deep-ocean exploration platform and supported submersible operations in heavier ice and deeper waters. At Gakkel Ridge, the Jiaolong and Fendouzhe submersibles performed alternating deep dives exceeding 5,000 meters, capturing seafloor imagery, mineral samples, and hydrothermal vent observations. Over a 56-day period, *Tan Suo San Hao* executed coordinated underwater navigation, deploying sensor arrays and monitored mid-depth water masses to track how Arctic warming influences ocean circulation.[317]

The Jiaolong – which conducted over 10 dives in total – collected 183 biological samples, including shrimp, sea spiders and sea anemones, as well as samples of sediment, rock and seawater.[318] Chinese scientists noted that they "tried a collaborative operation between the Jiaolong and a remotely operated vehicle, which required solving challenges such as communication and positioning." [319] AI was also incorporated into polar surveys studying organism biomass and biodiversity, which can be used to examine the potential connection between species in different survey regions.[320]

These capabilities point to dual purpose uses. Some Western media outlets have claimed that the submersible "possesses significant military potential." China has been clear that the system was developed for scientific research, however, its technological breakthroughs in communication and remote control, electronics, and mechanical systems could easily be applied to military fields, particularly to the development of deep-sea submarines. Commentary on Sina Military (the military news section of the Chinese online media portal Sina) pointed out a clear military application for the technology, with the system highlighted as a tool for "safeguarding the vast maritime borders of the motherland, especially in protecting underwater security."[321]

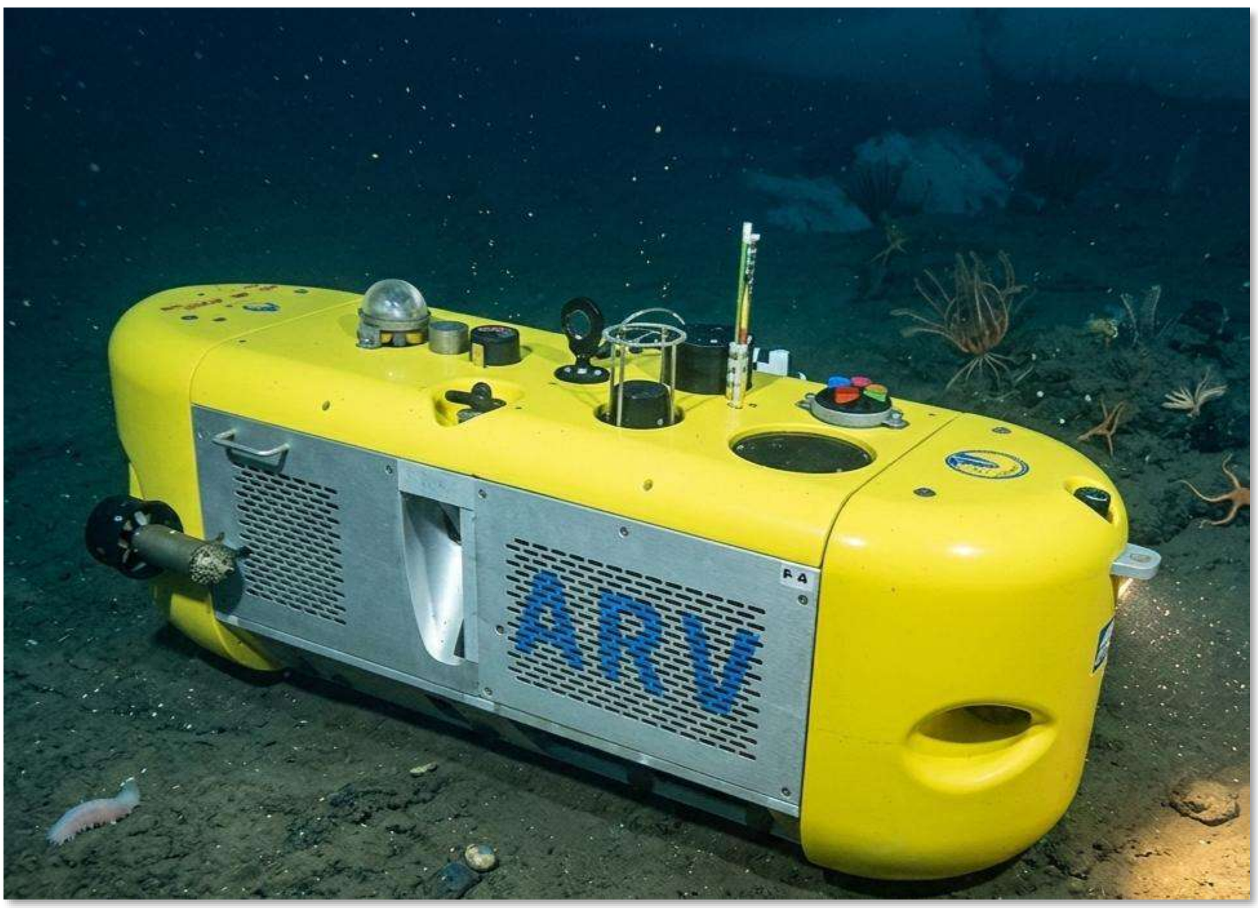


Data from: Huang, L. (2022, October 17). How will China's submersibles help us explore the ocean depths? [News]. Dialogue Earth.

Polar/Arctic Autonomous and Remotely Operated Underwater Vehicle

The Polar/Arctic autonomous remotely operated underwater vehicle (ARV) was developed by the Chinese Academy of Sciences' Shenyang Institute of Automation and constructed between 2007 and 2008. Engineered to operate to depths of up to 300 metres, it is equipped with an altimeter, radiometer, pressure sensor, two cameras, and suite of conductivity, temperature, and depth (CTD) sensors, which enable it to measure temperature, ice draft, spectral irradiance, and conductivity while capturing videos and images beneath the ice. Inherently versatile, it can function either fully autonomously or remotely through an optical fibre link.[322]

A particularly notable feature of the Polar ARV is its navigation and positioning system. While the ARV is beneath the ice, it offers highly accurate, stable, real-time data, relative to the sea ice. By compensating for the motion of the sea ice, the system expands the application value of the data collected as well as the operational security and safety of the ARV.[323] The Polar/Arctic ARV has deployed beneath the Arctic sea ice as part of the 2008, 2010, and 2014 Arctic Research Expeditions.[324]



Polar ARV (AI generated from media images)

Polar Subglacial Shallow Surface Acoustic Monitoring Buoy System

Chinese engineers and scientists installed the Polar subglacial shallow surface acoustic monitoring buoy system on a remote ice floe in the Arctic Ocean on August 9, 2021.[325] Broadly speaking, the unit is comprised of five components: the main control module, data acquisition module, power supply module, data remote transmission module, and remote monitoring centre.[326] In addition to the microcontroller-based main control unit, the buoy system also includes an atmospheric pressure sensor, CTD sensor, humidity and air temperature sensor, GPS module, sea ice temperature chain, vector hydrophone, and remote communication system.[327] While some sensors, like the vector hydrophone, gather acoustic data every two hours, other sensors measure parameters every hour.[328] The platform uses the Sailor Cobham 4300 and Iridium 9523 for stable communications relays even in severe environmental conditions. The reliability of these satellite communications systems was demonstrated during China's 12th Arctic expedition, during which they provided significant – and novel – acoustic data from the Arctic waters.[329]

The buoy system was designed to monitor environmental parameters present at the air-ice-sea interface and the physical processes of their interactions. It can, in real time, transmit sensor data, as well as shallow subglacial surface acoustic data. The sensors' transmission frequencies can be adjusted in accordance with the prevailing environmental conditions and the system's operational status, allowing the platform to extend its operating time. Overall, the Polar subglacial shallow surface acoustic monitoring buoy system has been useful in enabling China to close the gaps in its Arctic acoustic data and progress toward the automatic, uncrewed monitoring of polar conditions and the polar environment.[330]

Qiushi Autonomous Underwater Robot

The "Qiushi" autonomous underwater robot has been deployed in the Arctic from the icebreaker *Ji Di*. It is designed to independently perform topographic examinations and marine environmental surveys beneath the ice surface, providing a bottom-up examination and observation of sea ice structure and morphology.[331]

Tansuo 100

The Tansuo 100 was developed by the Shenyang Institute of Automation at the Chinese Academy of Sciences. Weighing 50 kilograms, and measuring 1.7 metres in length and 0.2 metres in diameter, the Tansuo 100 can attain depths of 100 metres and travel at a normal operational speed of three knots and maximum speed of five knots. Its maximum range is 70 kilometres, at three knots.[332] This system is part of the Tansuo series of autonomous underwater vehicles, which was designed for scientific research functions, including collaborative surveys by multiple AUVs and hydrothermal vent studies.

The Tansuo 100 combines both optical observation and acoustic detection abilities.[333] Its core observation sensors include a CTD module and bathymetry/side-scan sonar (BSSS), with optional sensor payloads including video cameras, Acoustic Doppler Current Profilers (ADCPs), turbidity sensors, and various other modular instruments. It has a "distributed structure," comprised of two segments that communicate with each other: its control computer, which governs its motion control, and its payload computer, responsible for data collection. Communication is a key feature of the Tansuo 100. It can connect to a mobile control console through an umbilical cable, Wi-Fi, radio, or Iridium satellite. Iridium satellite connectivity is used solely to pass along navigation data during emergencies or at the completion of the mission, while radio can be used to operate the AUV via remote control when it is in the vicinity of the control console. Meanwhile, mission files are uploaded and the collected data downloaded via Wi-Fi.[334] These acoustic communication capabilities are critical in allowing the Tansuo 100 to participate in multi-AUV networked observation missions.[335]

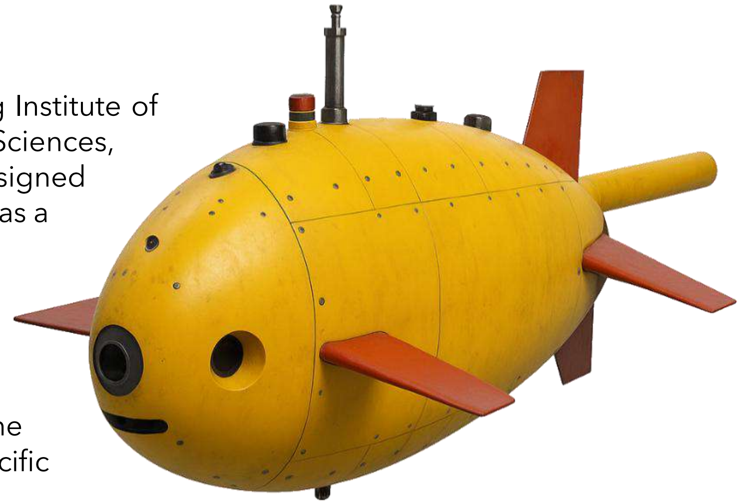
The Tansuo has successfully undergone several marine observation sea trials and demonstration missions, and it is frequently employed as part of multi-AUV teams to undertake collaborative investigations, including formation navigation, hotspot searches, thermocline-coordinated examinations, and adaptive marine environmental observation demonstrations.[336]

Tansuo 1000

The Tansuo 1000, also known as the Explorer, is an autonomous underwater vehicle developed by the Shenyang Institute of Automation, the China Ship Scientific Research Center, and the Institute of Acoustics of the Chinese Academy of Sciences.[337] Constructed between 1991 and 1994, it weighs 1,200 kilograms, operates at depths of up to 100 metres, and can travel at speeds of between two and five knots.[338] Its endurance capability is particularly notable, as it is able to travel over 300 kilometres, remain at sea for more than 30 days, and cover distances, under the water, of over 1,000 kilometres over 30-plus-day durations.[339] This endurance – as well as its variable ballast system, which permits it to move vertically over a fixed location – makes the Tansuo 1000 especially proficient at long-term and fixed-point profile observations.[340]

The Tansuo 1000 marked a milestone for China. On one deployment, after descending 5,179 metres to the Pacific Ocean seafloor, scientists deployed a Chinese flag from its compartment. The Tansuo 1000 was thus described as China's first "return-type seabed satellite" and was indicative of China's emergence as a world leader in AUV development.[341] Since then, the vehicle has been modified for Antarctic conditions and deployed in the Ross Sea in 2019 and 2020, gathering biological and hydrographic data as part of the 35th and 36th Chinese National Antarctic Research Expeditions. These deployments also demonstrated the feasibility of AUVs in even severe polar environments.[342]

Tansuo 4500



Tansuo 4500 (AI generated from media images)

The Tansuo 4500, developed by the Shenyang Institute of Automation (SIA) of the Chinese Academy of Sciences, can reach a working depth of 4,500 metres. Designed to perform scientific missions in polar areas, it has a speed of two knots, endurance capability of 20 hours, and weighs 15,000 kilograms.[343] It was initially designed under a pilot project revolving around strategic science and technology, the objective of which was to analyze energy–substance exchanges and the influence of those exchanges in the West Pacific tropical belt.[344]

The robot is equipped with a suite of sensors enabling micro-topography measurement, hydrothermal anomaly detection, seabed photography, fine acoustic detection, and near-bottom optical observations in cold seep and deep-sea hydrothermal activity regions.[345] As an untethered AUV, it requires no cable connection to its mother ship, and thus the Explorer 4500 can navigate, detect, and collect data autonomously, without requiring human intervention.[346] It is, therefore, able to independently assess its condition and consequently make decisions on how and whether to proceed, although it is equipped with an emergency beacon that enables operators to precisely locate it in the event that it becomes trapped beneath the ice. Its scope of activities and operational range are widened by its longer battery lifespan and greater endurance, enabling the AUV to more precisely and flexibly collect sea samples, as well as observe the undersea polar environment through its cameras and imaging sonar.[347]

Since 2017, the Explorer 4500 has embarked on numerous offshore operations, including surveys of hydrothermal fields and cold seeps.[348] It has conducted joint operations with the Haima ROV on the South China Sea's northern continental slope, performing optical surveys and water body observation missions that captured high-definition seabed photographs, including of seabed organisms associated with cold seep environments. The wealth of data collected helped establish the foundation for the discovery of new cold-seep seabed systems and determination of their fluid activities, biological communities, and distribution.[349]

In 2021, while deployed for scientific survey operations in the 12th Arctic Expedition, it became the first autonomous underwater robot used by China for near-seafloor scientific investigations and explorations in ice-covered regions.[350] While researchers studied the Arctic shelf from *Xue Long 2*, the Explorer 4500 gathered data from the ice-covered waters, even completing a successful dive under Arctic ice to compile in-depth seabed mapping data.[351] Challenged by dense ice conditions, researchers used an innovative combination of acoustic remote control and automated guidance to collect soil samples from beneath the ice, enabling the AUV to contend with ice floe movements and the limited periods and sections of open water in which it could connect with the icebreaker. Consequently, the robot was able to gather volumes of high-resolution and multi-directional aero-magnetic and hydro-dynamic data that were essential for the study of the geological, geo-morphological, and topographical data, including magma flows, hydrothermal activity, and energy–substance exchange cycles. The 13th Chinese Arctic Expedition (in 2023) saw the vehicle return to the region.[352]

Viking Dragon

The Viking Dragon is China's first semi-submersible drilling platform suited for operations in the Arctic. CIMC Raffles Offshoring Engineering Co. Ltd. initially constructed the platform for Norway. China deployed the Viking Dragon in November 2015.[353]

Xueying 102 (Snow Eagle 102 Helicopter)

The Snow Eagle 102, also known as the Xueying 102 or Kamov 32, is a helicopter operated by the Polar Research Institute of China. China purchased the aircraft from Russia in December 2008, and it formally joined China's Antarctic scientific expedition program in 2009,[354] offering vital transportation support for polar research missions. Powered by twin gas-turbine engines, the helicopter is fitted with a GPS locator as well as life-saving equipment.[355]

Xueying 301 (Snow Eagle 301 Helicopter)

The Snow Eagle 301, alternatively known as the Xueying 301, is an AW169 helicopter that, since 2019, has been deployed as part of China's polar scientific research missions. It is equipped with an automatic speed-changing rotor system, integrated digital touchscreen glass cockpit, and left-engine auxiliary power unit (APU) mode. Its strong wind mooring and rotor folding systems enhance its utility in rough seas, and its pontoons, life rafts, and main landing gear anti-trap sled are integral for polar operations. A powerful and wind resistant helicopter, it can deploy on a variety of missions, from air commuting to iceberg identification, from search and rescue operations to cargo transportation and lifting.[356]

Xueying 601 (Snow Eagle 601 Aircraft)

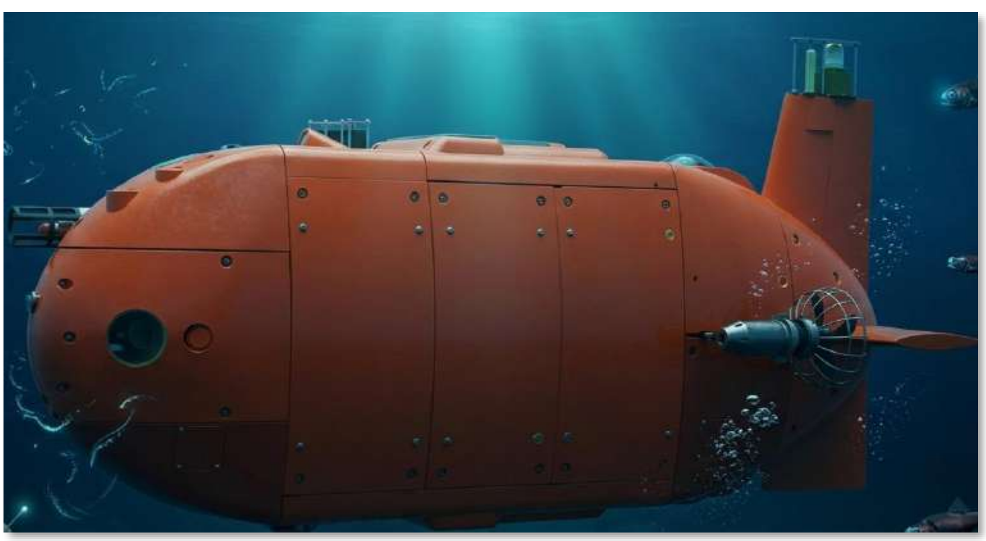
The Snow Eagle 601, known also as the Xueying 601, is China's first fixed-wing aircraft for use in polar operations and investigations.[357] A modified Basler BT-67, it has a wingspan of 29.16 metres, fuselage length of 20.45 metres, maximum range of approximately 3,440 kilometres, and cruising speed of 380 kilometres per hour.[358] It has a maximum takeoff weight of 13.6 tons, passenger capacity of up to 18 people, and can carry a maximum payload of 5,900 kilograms.[359] Designed for emergency rescue and rapid transport it is also useful for research purposes.[360]

Equipped with advanced control, electronics, and power systems, including an ice radar, onboard laser radar system, airborne gravimeter, and airborne magnetometer, its modifications for polar conditions have also seen it being fitted with air conditioning, an oxygen supply system, an automatic de-icing system, and dual wheel-and-ski landing gear.[361] Its state-of-the-art avionics system and dual HP PT6A-67R turboprop engines ensure its ability to safely take off and land in severe environments and temperatures as low as -50°C.[362]

The Snow Eagle 601 entered service following extensive testing. Its first successful trial flight occurred in 2015 and saw it departing Canada on November 15 and arriving at the British Rothera Research Station in Antarctica eight days later, subsequently reaching Zhongshan Station on November 26, 2015. In early January 2017, it reached another milestone when it completed its first landing at Antarctica's Kunlun Station.[363] Now, the aircraft is an important element in logistics missions like supply runs in support of expedition teams within an approximate 1,300-kilometre radius around the Zhongshan Station in Antarctica.[364]

XH1000 (Xinghai 1000)

The XH1000 or Xinghai 1000 is an autonomous underwater vehicle developed by Harbin Engineering University researchers for polar observations. Equipped with Chinese-developed detection sonar, the XH1000 demonstrated its utility during China's 13th Arctic Expedition, (2023). During this expedition, it explored a 7,000-square-metre region underneath the Arctic ice, gathering and relaying a wealth of data, including pH levels, salinity, and ocean water temperature, and uncovering distinct features beneath the North Pole. Zhu Zhongben, Associate Professor at Harbin Engineering University and the expedition team leader, noted that the data collected will improve scientists' comprehension of changes in regional ocean currents and sea ice, facilitating understandings of the ramifications of global warming on China. The expedition also served to confirm the utility of various technologies such as underwater navigation at high polar latitudes, in addition to providing crucial operational experience in the use of robotic submersibles in harsh environments and extreme polar regions.[365]



Tansuo 4500 (AI generated from media images)

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