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4. China and Arctic science

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4.1. Introduction

As a non-Arctic state, scientific activities have been the foundation for China's polar engagement and, according to China's White Paper on the Arctic, exploring and understanding the Arctic "serves as the priority and focus for China in its Arctic activities" (PRC State Council, 2018). Among its policy goals and basic principles on the Arctic, Chinese authorities declare that:

> To understand the Arctic, China will improve the capacity and capability in scientific research on the Arctic, pursue a deeper understanding and knowledge of the Arctic science, and explore the natural laws behind its changes and development, so as to create favorable conditions for mankind to better protect, develop, and govern the Arctic. (ibid.)

With the above statement and China's rise in terms of its global and polar science position in mind, the aim of this chapter is to cast light on the history, development and current state of China's research engagement in the Arctic.

4.2. Science in the Arctic

Scientific knowledge is critical to the understanding of the Earth's poles and of the drivers and consequences of the rapidly advancing climate change in the Arctic.

Science is also, next to other forms of organized knowledge, a source of key insights to sustainable development of the Arctic as well as of the rest of the planet. We know today that the Arctic plays a critical role in the Earth's climate system and serves as an indicator of global changes. However, our comprehension of the complex processes that unfold in the region and how they are interconnected with global weather patterns, ocean circulation and carbon cycle remains limited. Filling those gaps in our knowledge is essential and even more urgent, considering the pace of change that the Arctic is undergoing.

Yet, gaining scientific knowledge about the polar regions presents great challenges and the scale of operations in the demanding, remote conditions oftentimes exceeds the capacity of any single nation, making international collaboration of paramount importance. In the much distant past, both the Arctic and the Antarctic were first explored by individuals and small groups organized under national flags, and the conduct of research in the two poles was largely dominated by patriotic rivalries and separate competitive national explorations. The major breakthrough to that form of conducting research in the region came with the first International Polar Year (IPY, 1882–1883), which not only collected an enormous amount of material and information but also represented the first successful attempt at collaboration by different countries in the field of scientific research (Barr & Luedecke, 2010; Smieszek, 2017). The second IPY took place fifty years later in 1932–33 and the third, under the banner of International Geophysical Year (IGY), in 1957–1958.[1] Initiatives such as the International Polar Years (IPYs) have served the purpose of facilitating research

[1] The IGY had a strong focus on Antarctica and, as a form of its legacy, the International Council of Scientific Unions (ICSU, today's International Council for Science) established in 1958 the Scientific Committee on Antarctic Research (SCAR), which later came to serve as a model for scientific cooperation in the Arctic (Smieszek, 2015: 2).

cooperation among countries, and the fourth IPY (2007–2009) was the largest, most comprehensive coordinated campaign ever mounted to explore the Earth's polar regions. In general, it could be said that science has been one of the major platforms for collaboration in the Arctic – both during the Cold War and increasingly after its end. Moreover, scientific presence and research have traditionally been the main forms of engagement in the polar regions – both for Arctic and non-Arctic countries alike.

As in the case of the Antarctic, where participation in the decision-making under the Antarctic Treaty is limited to only those countries (aside from the original signatories) that demonstrate their interest in Antarctica "by conducting substantial scientific research activity there" (Article IX.2), so the observer status with the Arctic Council (AC) is open solely to actors that "the Council determines can contribute to its work" and that have demonstrated their Arctic "expertise relevant to the work of the Arctic Council" (Arctic Council, 2013). In practice, that oftentimes requires extensive scientific involvement for a country that intends to apply for the AC observer status, and most Observer states to the AC, including China, seek to maintain and develop their scientific credentials and presence in the Far North.

In exploring China's role in Arctic science, the chapter proceeds as follows. First, it delves into the beginnings of China's interest in the polar regions and the country's gradual development of its scientific capacities up to the present day. Second, seeing the central position of the Arctic Council in discussions pertaining to the region, the chapter concentrates on Chinese involvement within the AC working groups, which conduct most of the work delivered by the Council. In addition, the same section explores China's involvement with the Agreement to prevent unregulated high seas fisheries in the Central Arctic Ocean. Third, in order to provide a broader perspective for China's engagement in polar science, the following section offers a picture at large of research and development in China, including the sector's structural organization and China's unparalleled rise in terms of its global science position. Next, the chapter elaborates on the bilateral linkages that China has been systematically developing with Arctic countries. Finally, the chapter concludes with the most recent political developments on the circumpolar arena, in particular the shift of the United States administration concerning the behavior of China and Russia in the Arctic, which might affect not only the future course of relations between these countries but also the shape of circumpolar collaboration as such, including its scientific dimension.

4.3. History of China's Arctic Science

According to Wang and Zhang, although China did not send any participants to the polar expeditions, it was involved in both the first and second International Polar Years (IPY) in 1882–83 and 1932–33 by providing data for international collaboration from geomagnetic stations located in the country's territory. They note that as the second IPY coincided with a significant buildup of Chinese scientific potential under the new nationalist government, China was able to expand its participation in international efforts by carrying out measurements related to the determination of longitudes and latitudes, as well as conducting meteorological measurements from the newly established stations in Shandong and Sichuan – even if, in general, the scale of those contributions remained marginal (Wang & Zhang, 2010).

In the period between the second and the third IPYs, between the 1930s and 1950s, the world underwent a fundamental transformation and the international environment changed dramatically, also with regard to scientific cooperation. As a result, the third international polar year, the history of China's initial participation and the later withdrawal from it, served perhaps as the most vivid illustration of the intertwined relations between science and politics at that time.

Following the victory of the communists under the leadership of Mao Zedong in the civil war against the nationalist government of Chiang Kai-shek in 1949, the latter, with the support of the United States, retreated to Taiwan, leading ultimately to the country's split into mainland China (i.e. the People's Republic of China, PRC) ruled by the Communist Party of China (CCP), and Taiwan (i.e. the Republic of China, ROC) governed by the Nationalist Party of China (CNP). The situation had obviously far-reaching international consequences as both sides – the PRC and the ROC – claimed rights to legitimate representation of China on international science and began vying for China's seat in international institutions. The situation was further complicated by the position of the United States which, in armed conflict with China in Korea, actively backed the ROC in the United Nations and other international fora, including scientific international bodies.

Consequently, in 1951-52, when the International Council of Scientific Unions (ICSU) approved the proposal for the IGY, China's participation in the next international polar year came to be considered not only in terms of its scientific merits, but it turned into a contentious and sensitive political issue. Whereas any investigation of the Earth's geophysics would not be comprehensive without the inclusion of China's vast territory and Chinese scientists were eager to join the major international scientific endeavor, China's involvement in the IGY depended in the first place on the decision of the Soviet Union to access the IGY, and second, on the resolution of the situation with Taiwan – more precisely, on the exclusion of Taiwan from the IGY (Wang & Zhang, 2010). The events of 1953-1955 – the end of the Korean War and the death of Stalin – seemed to serve a relaxation of Cold War tension, and in 1955 the Soviet Union decided to join the IGY, paving the way for a similar decision of the Chinese Academy of Sciences (CAS) and a consequent buildup over the following two years of scientific capacities and infrastructure that China aimed to contribute within the IGY. The PRC and CAS behaved as they did in the belief that the matter of Taiwan's participation in the IGY was resolved in their favor when Taiwan failed to respond to the invitation from ICSU in 1955. It proved, however, not to be the case, as, with the backing of the U.S. State Department, Taiwan applied late for participation in the IGY, and its application was accepted. The situation was ultimately unacceptable to the PRC, which informed the ICSU accordingly that "China will join [the] IGY only on [the] condition Taiwan should not be admitted. Otherwise China will withdraw from [the] IGY" (Sullivan, fn. 36 in: Wang & Zhang, 2010: 150). Despite the ICSU's continuous reassurances of the unpolitical nature of the entire collaborative scientific endeavor and the efforts of the Council's Special Committee to keep both China and Taiwan onboard, the PRC held its promise – when it was confirmed that the Taiwanese delegation would take part in the science meetings of the international polar year, China withdrew from the IGY.

Nevertheless, the withdrawal of China from the IGY did not result in the complete abandonment of the planned IGY activities, and the collection of data continued, albeit in a much less coordinated and urgent manner as would have likely been the case under the aegis of the IGY. The situation illustrated as well the ultimately political nature of the international scientific interactions at the height of the Cold War, even when it concerned the furthermost regions of the world (Wang & Zhang, 2010; Barr & Luedecke, 2010).

With respect to more focused institutional developments oriented toward the Earth's poles, China's involvement in polar science originated in Antarctica and only later moved into the Arctic. The State Oceanic Administration (SOA) was established in 1964 under a mission that included to "engage in polar expeditions in the future" and in 1985 the SOA purchased the first ice-capable vessel from Finland to launch China's annual Antarctic expeditions. The ship *Jidi*(极地), or *Polar*, ferried supplies for China's Antarctic mission from 1986 to 1994, when it was replaced by an icebreaker research vessel *Xuelong*(雪龙), or *Snow Dragon* (Nong, 2014), a Ukraine-built cargo vessel converted into a polar research and re-supply vessel. *Xuelong*was dispatched for its first Arctic voyage to the Bering and Chukchi seas in 1999 and later in 2003, and since then has been regularly operating in the North as well as in the waters off Antarctica.

To date, *Xuelong* has completed nine Arctic expeditions (named CHINARE), with the most recent operating from July until September 2018. In addition to the scientific studies carried out during the expeditions, each departure and return of *Xuelong* has served to popularize China's polar activities and has received some coverage in the Chinese media.[2] In a similar vein, the operations of the *Xuelong* also served as a platform for tightening bonds between Chinese and Arctic states. In 2012, during its first visit to an Arctic country on the 5th Chinese National Arctic Research Expedition, the *Xuelong* anchored in Iceland to enhance the cooperation of Chinese and Icelandic scientists on polar and marine sciences. At the occasion of CHINARE5 in 2012, *Xuelong* also became the first Chinese-flagged vessel to transit the North-east passage on its way between Qingdao and Reykjavik and then the first vessel to transit the Arctic Ocean from Akureyri to Shanghai, drawing attention to the possibilities of operating outside the exclusive economic zones of the Arctic littoral states in the conditions of the rapidly warming Arctic and decreasing Arctic sea ice. Five years later, in 2017, *Xuelong* undertook a voyage through the North-west Passage and consequently

[2] In general, the popularization of science among the Chinese public has been a notable feature of the country's Arctic profile. To that end, China has been investing in the development of education centers as well as in the publication of cultural and educational material for a broader audience.

became the first vessel to transit all three Arctic passages. In 2018, the 9th CHINARE expedition showcased China's increasing level of scientific and technological potential when, for the first time, Chinese scientists on the Arctic drift ice floes deployed two newfangled Atmosphere-Sea-Ice-Ocean (ASO) unmanned stations developed by the Polar Research Institute of China (*Zhongguo Jidi Yanjiu Zhongxin* 中国极地研究中心) (INTAROS, 2018).

In order to expand its potential for operating in both polar regions, a second icebreaker, *Xuelong 2* (雪龙2), was constructed in partnership with the Finnish ship-building firm Aker Arctic to commence operations in 2019, with its first voyage planned for the occasion of the 36th Chinese national Antarctic Research Expedition in the latter part of 2019.[3] Moreover, Beijing has also expressed interest in constructing a nuclear-powered icebreaker, using either domestic technology or pursuing a project in cooperation with Russia. Currently, Russia is the only country that operates nuclear-powered icebreakers, while other countries are in the planning stages (Eiterjord, 2018). China's Arctic research expeditions were further expanded in 2019 with the oceanographic research vessel *Xiangyanghong 01* departing for the 10th Arctic expedition in August 2019, covering areas of the Bering Sea and the Bering Strait, as well as the Chukchi Sea and other seasonally open waters in the Arctic Ocean during a 50-day mission.

In parallel to its logistics capacities, China has been building institutional infrastructure necessary to organize and support the country's growing polar interests and expertise. In 1989, China established the Polar Research Institute of China (PRIC) in Shanghai under the SOA, which marked the country's rising interest in polar affairs

3 Practically, the vessel was given a 'soft launch' in September 2018 (Straits Times/Xinhua, 11 September 2018).

beyond Antarctica. In 1990, Chinese scientists visited the North Pole for the first time and planted a flag there, and in 1996 the National Antarctic Expedition Committee Office was renamed to the Chinese Arctic and Antarctic Administration (CAA). Also in 1996, China joined the International Arctic Science Committee (IASC), a leading non-governmental international organization supporting scientific research and collaboration in the Arctic, and in 2005, it hosted the Arctic Science Summit Week (ASSW) in the city of Kunming, becoming the first Asian country to host the event. In 2007-2008 it participated in the fourth International Polar Year (IPY).

In 2004, China built its first Arctic research station, the Arctic Yellow River Station (*Huanghe zhan*黄河站), in the research village of Ny-Ålesund in the Spitsbergen Archipelago. In 2012, Iceland and China signed a comprehensive Framework Agreement on Arctic Cooperation for the occasion of an official visit of then-Premier Wen Jiabao to Iceland, and in 2013 the Polar Research Institute of China and the Icelandic Centre for Research (RANNIS) agreed to build a joint aurora observatory (CIAO) at Kárhóll in northern Iceland (Karholl.is). In 2017, the PRIC and RANNIS decided to expand the scope of cooperation, which would consequently enable observations of not only auroras but also research on atmosphere, oceanography, glaciers, geophysics, remote sensing and biology. This new mandate was confirmed when the facility was officially renamed into the China-Iceland Arctic Science Observatory during its official inauguration in October 2018 (*Xinhua*, 19 October 2018). The CIAO is now the second science station, after Ny-Ålesund, administered by China in the Arctic. More recently, there has been some discussion about a third Chinese research station in the Arctic, to be located in Greenland, but that project remains in the early planning stages.

As outlined in the White Paper, “the availability of technical equipment is essential to understanding, utilizing and protecting the Arctic” (PRC State Council, 2018). Consequently, China both “actively participates in the building of infrastructure for Arctic development” while also encouraging the development of environment-friendly polar technical equipment. As listed in the White Paper, it also “pushes for the upgrade of equipment in the fields of deep sea exploration, ice zone prospecting, (...) atmosphere and biology observation, (...) promotes technology innovation in Arctic oil and gas drilling and exploitation, renewable energy development, navigation and monitoring in ice zones, and construction of new-type icebreakers” (*ibid.*). Simultaneously, all these areas of interest should be read – next to their scientific relevance – within the broader setting of China’s policies and in conjunction with the prioritized aspects of China’s Arctic policy, which include both protecting the environment and utilizing Arctic resources (see Chapters 5 and 6).

4.4. China’s scientific engagement with the Arctic Council

China participated for the first time in the meetings of the Arctic Council in 2007 and it was officially admitted as a formal Observer to the Council in 2013. As the Arctic Council Rules of Procedure stipulate, the Observers’ primary role is to observe the work of the Arctic Council and to contribute to it primarily at the level of working groups. Whereas the six working groups of the Council vary in their areas of focus, most of them have a strong science focus and serve to inform decision-making with the best available scientific knowledge. Up to now, it appears fair to say that Chinese involvement with the AC’s working groups has been fairly limited, while most attention has concentrated on the political level of the Senior Arctic Officials (SAO). Part of the reason behind this situation might be the learning curve that all new Observers to the Council face in a novel organizational environment, norms and procedures. As most of the WGs are attended by experts in their respective fields, the identification of the appropriate representatives – both on the side of Member States as well as Observers – is critical to the provision of meaningful input to the working group projects and discussions.

After the initial period of little visibility, inconsistent attendance and a high rotation among its representatives, China has begun to slowly mark its areas of interest and engage in selected activities of the AC working groups. The projects that it has been most invested in have included the Arctic Migratory Birds Initiative (AMBI) of the Conservation of Arctic Flora and Fauna (CAFF) working group of the AC. The project aims at improving the status and securing the long-term sustainability of declining Arctic migratory bird populations and, since many species of Arctic birds move from Arctic breeding grounds to overwintering or stopover sites at lower latitudes, the cooperation between countries along their flyways is vital to any conservation efforts.

The AMBI has been very successful in terms of bringing together the Observers and Member States of the Council. Whereas two previous workshops were held in the Netherlands (April 2016) and in Singapore (January 2017), the third took place in Hainan, China, in December 2018 (CAFF, 2018a). China is a critical partner when it comes to the East Asian-Australasian Flyway, where much of the cause for concern lies in the migration bottleneck of the Yellow Sea region, where birds rest and feed in this densely populated region on the coasts of China, North Korea and South Korea. Over the past fifty years, half of those vital intertidal areas have disappeared and today they are shrinking faster than tropical forests due to the pursued land reclamation policy. To address this issue, in early 2018 the Chinese government announced dramatic changes to their land reclamation policy, stating much enhanced conservation measures in relation to its coastal development and cooperation with the Arctic Council

CAFF on that matter (CAFF, 2018b).

Regarding other working groups, at the meeting of the Protection of Arctic Marine Environment (PAME) in Malmö, Sweden in February 2019, China gave a presentation on its areas of interest in the work of PAME as well as its capacities and potential contributions to them. The presentation is a part of efforts undertaken by all the AC working groups to engage more closely with the Council's Observers. Apart from those, China has previously attended some meetings of the other working groups too: Emergency Preparation, Preparedness and Response (EPPR); the Arctic Contaminants Action Program (ACAP); and the Arctic Monitoring and Assessment Program (AMAP) but so far has not been actively engaged in their projects. It has also not engaged up to now with the Sustainable Development Working Group (SDWG).

From a broader perspective, Chinese engagement with the Arctic Council's working groups reflects a more general pattern of the gradual development of Chinese scientific presence in the polar regions (Lasserre, Alexeeva and Huang, 2017). Both in the Antarctic and the Arctic, Chinese presence was marked first by a strong focus on the foundational construction and set-up of infrastructure and only in the second phase by shifting priorities to formulating a meaningful polar scientific research program. This situation is not surprising, seeing that China, as a developing country that went through long periods of international isolation, needed time to build its capacities and expertise in those areas, also through international collaborations and partnerships. One of the most recent examples of China's involvement with Arctic governance initiatives has been its participation in the negotiations and the signing of the 2018 Agreement on unregulated fishing in the Central Arctic Ocean (CAO) adopted in the so-called 'A5 + 5' format: the "Arctic Five" – Canada, Denmark (Greenland and the Faroe Islands), Norway, Russia, the United States – and five major distant fishing powers – China, Iceland[4], Japan, South Korea and the European Union (EU) (Arctic Fisheries Agreement, 2018). Among others, the agreement provides for the creation of the Joint Program of Scientific Research and Monitoring, in which China intends to actively participate and which would allow it, along with the other parties, to keep track of changes in the range and distribution of fish stocks in the Central Arctic Ocean area over the coming decades. Beyond that, however, it is too early to speak about the details or a specific format of the scientific collaboration under the CAOF Agreement – in order for it to enter into force, all ten parties must first ratify it and so far, at the moment of this writing, Canada, the EU, the Russian Federation and the United States have done so (…). Furthermore, the Agreement does not require its parties to establish the Joint Program until two years after the entry into force.[5]

In discussing China's increasing polar science capacities and potential, it is still important to note a larger picture of the Chinese approach to research and

[4] Iceland as a coastal Arctic state but not an Arctic Ocean coastal state was not invited to the initial talks in 2013, but later joined the negotiations with the European Union and the Asian stakeholders.

[5] The Agreement on unregulated fishing in the Central Arctic Ocean stands among other recently-signed, legally-binding agreements pertaining to the Arctic – the Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic (Arctic SAR Agreement) signed in 2011, the Agreement on Cooperation on Marine Oil Pollution, Preparedness and Response in the Arctic (Arctic MOSPA) signed in 2013, and the Agreement on Enhancing International Arctic Scientific Cooperation signed in 2017 – as the first circumpolar treaty concluded not exclusively among Arctic states, but with non-Arctic states and entities as parties to the Agreement. Under the terms of the Agreement on Enhancing International Arctic Scientific Cooperation, the cooperation of its parties – eight Arctic states – with non-Arctic states such as China is regulated by Article 17, which stipulates that the "Parties may continue to enhance and facilitate cooperation with non-Parties with regard to Arctic science (…), [and] Parties may in their discretion undertake with non-Parties cooperation described in this Agreement and apply measures consistent with those described in this Agreement in cooperation with non-Parties" ("Agreement on Enhancing International Arctic Scientific Cooperation," 2017). Both the realization of the Agreement and its effects in practice are yet to transpire.

development (R&D) and, in particular, its unprecedented leap forward in the last decade.

4.5. China's science at large

In keeping with Chinese President Xi Jinping's motto of the 'Chinese Dream', China has set a goal of becoming a world-class innovator by 2050, further confirmed by the Minister of Science and Technology, Wan Gang, in 2017 (Han and Appelbaum, 2018; Reuters, 2018, February 27). Toward that goal over the past decades, China's spending on research and development has been steadily growing, with annual increases of three or more times compared to the rest of the world, including the United States (Global R&D Funding Forecast, 2018). In comparison, even if China's spending on science in 2017 amounted to around 2.1 percent of the total gross domestic product (compared with around 2.8 percent in the United States, 2.9 percent in Germany and 3.3 percent in Japan), between 2000 and 2015, R&D investments in China have soared annually by an average of 18%, whereas U.S. spending rose in the same period by about 4% annually. China's annual R&D spending has risen 70.9 percent from 2012 and, based on data from 2015, China's R&D investments have now surpassed those of the European Union with its US$386 billion expenditure on research and development and remain second only to the United States (Showstack, 2018; "China spends $279 bln on R&D in 2017: science minister," 2018).

Science has also been considered by President Xi Jinping as one of the central pillars of the Belt and Road Initiative (BRI), China's mega-plan for global infrastructure announced in 2013. Whereas most of the BRI has been centered around industrial developments aimed at increasing trade through transforming global trade networks that both supply China and provide a market for its products, science, technology and innovation play an extremely important, if sometimes overlooked, role in the BRI and are viewed as amongst the key driving forces behind its development (Masood, 2019). In particular, when it comes to cooperation with developing countries, China views science as a central element in building bridges with them through offering scientific assistance and signing collaborative agreements. To provide a scale of this assistance "not seen since the United States and the former Soviet Union vied with each other to fund researchers in allied nations during the Cold War" (*ibid.*, 21), in April 2019 the Chinese Academy of Sciences (CAS) announced that up to now it has invested nearly US$268 million in the science and technology parts of the BRI, involving tens of thousands of researchers and students, and hundreds of universities. Viewed from a science perspective, next to its infrastructure dimension, the goal of the BRI appears to be the restoration of "China's place as one of the world's great civilizations, and that includes being seen by all other nations as a source of scientific power, too" (*ibid.).*

Science in China is conducted in five main institutional sectors. The first comprises around 120 institutes overseen by the Chinese Academy of Sciences (*Zhongguo Kexueyuan*中国科学院), or CAS. They include "big science" facilities, and today many of their labs engage in word-class research across a wide range of disciplines, including quantum physics, mathematics and neuroscience. The second is universities, which have emerged as important centers of basic and applied research, and which also serve to support high-tech entrepreneurship. Government research institutes under civilian ministries – among them public health, environmental protection and natural resources – are the third system, whereas R&D dedicated to serving military needs is the fourth.

Finally, China's industrial enterprises constitute the last system. It is in this sector that the most significant changes have taken place over the past two decades, with an emergence of market-owned, non-state-owned high-tech firms and a surge of company-based research and development, especially in the fields of information and communication technology. For instance, Alibaba, China's leading e-commerce company, has recently announced plans to invest US$15 billion in new R&D projects, including the opening of seven new research labs in such locations as Moscow and Silicon Valley, amongst others. The research in those labs will be focused on foundational and disruptive technologies such as the Internet of Things, data analysis, artificial intelligence, and quantum computing. In general, expenditures for research and development in the enterprise sector now amount to approximately 80% of the nation's total (Suttmeier, 2018).

China's continued emphasis on, and investments in, research and development have brought outstanding results and have placed China among the world's leading science powers. China has completed numerous large-scale science projects (Bloomberg, 2018, June 19) and has risen to the forefront of science at a global scale with an improved scholarly rating impact, manpower (it has more scientists and engineers than any other country), a dynamic space program, and also an increasing share of the world's research articles (even if their quality, judged by the number of citations, still remains below average) (Global R&D Funding Forecast, 2018). Whereas some of the Chinese accomplishments and progress in the fields of research and technology have been disputed as results of violation of intellectual property rights and forced technology transfers (Office of the United States Trade Representative, 2018), as well as of misconduct in research publishing (Cyranoski, 2018), and there still remain structural challenges in the country's education and research environment that might interfere with its aim of successfully transforming into a knowledge-based economy (Han and Appelbaum, 2018), the country's improvement in its science and innovation capacities have been dramatic and unprecedented.

This emphasis has also been reflected in Chinese investments into, and development of, its polar capacities. Since 2003, China has been building new infrastructure and refurbishing older assets (among others, it has twice refitted *Xuelong* and constructed a dedicated berth and warehouse space in Shanghai) and has also been increasing its budget for polar research. While the economic crisis in 2008 forced other countries to cut or suspend their spending on R&D, and institutions in the United States and in the European Union saw decreasing budgets to support their research infrastructure, China has been advancing its polar capacities, even if at a slower pace because of its own recent economic slowdown. Chinese Arctic research funders include: the Ministry of Science and Technology (*Kexue Jishubu*科学技术部), or MOST; the Ministry of Natural Resources (*Ziran Ziyuanbu*自然资源部), or MNR, and its subordinate agency, the State Oceanic Administration (SOA); the National Natural Science Foundation of China (*Guojia Ziran Kexue Jijin Weiyuanhui*国家自然科学基金委员会); the Ministry of Education (*Jiaoyubu*教育部); and the China Meteorological Administration (*Zhongguo Qixiangju*中国气象局) (2nd Arctic Science Ministerial, 2018).

Whereas providing exact numbers for China's spending on polar research is very difficult because spending is allocated via those various ministries and agencies, it can be assessed that most of the budget is spent on investments in the infrastructure and on annual expeditions to the Antarctic and the Arctic under the SOA; much less, however, is spent on scientific research itself. According to a statement provided by China to the second Arctic Science Ministerial Meeting in Berlin in October 2018, "NSF funds about 40 Arctic research projects per year, at a level of up to 18 million RMB (~$2.7 million US) in 2015)" (2nd Arctic Science Ministerial, 2018). Together with Russia, China will also provide fuel and key logistical support to *R/V Polarstern* during

MOSAiC (The International Multidisciplinary drifting Observatory for the study of the Arctic Climate), the largest international Arctic cooperation project ever funded and the first year-around expedition in the central Arctic Ocean planned from September 2019 until September 2020 (*ibid.*).

4.6. Bilateral Arctic science collaboration

Next to involvement in multilateral bodies such as the IASC[6] or major projects such as MOSAiC, China has also been seeking to enhance its bilateral scientific cooperation with Arctic states. In light of the costs of operating and conducting scientific research in the North – a recent study found them eight times more expensive than similar studies in southern locations, and with Svalbard and Nunavut in Canada being on the top of the list (Hoag, 2018) – the interest for scientific partnerships with China has been increasing on their side, even if Arctic countries have taken a varied stance on this cooperation. Concurrently, polar scientific collaborations can be seen as part of broader and more strategic bilateral relationships between China and the Arctic countries.

Among them, Iceland has been the most proactive and, as mentioned earlier, has been consequently developing its closer relations with China for around a decade, including a bilateral Arctic science exchange that commenced in 2011. In the case of Norway, following the restoration of relations between the two countries in December 2016, in April 2018 Norway's Minister of Research and Education led a delegation of 250 of the country's heads of universities and scientists to strengthen Chinese-

[6] At present, Chinese representative, Dr. Yang Huigen, Director-General of PRIC, serves as IASC's Vice-President and a member of IASC 6-person Executive Committee.

Norwegian research collaboration (Myklebust, 2018).[7] The program of the visit, hosted by China's Minister of Science and Technology, was organized by the Norwegian Centre for International Cooperation in Education (SIU)[8] and the Research Council of Norway on behalf of the Ministry of Education and Research, and included such topics for cooperation as digitalization, climate, environmental and polar research. It was also accompanied by a roadmap for cooperation on research and education with China 2018–2020, drawing attention to the fact that at present China has the world's largest education system with a stated goal to increase both incoming and outgoing student mobility (Forskningsrådet, 2018). With respect to polar science, Chinese scientists are likewise encouraged to conduct international academic exchanges and the involvement with the University of the Arctic – whose international secretariat is located at the University of Lapland in Rovaniemi, Finland – is strongly promoted among Chinese higher education and research institutions (PRC State Council, 2018). Given Finland's expertise and focus on meteorological cooperation and icebreaking capabilities, Chinese partners cooperate with the Finnish Meteorological Institute's Arctic Space Centre in Sodankylä on meteorological data and, as mentioned earlier, it contracted the concept and basic design of its second research icebreaker from the Finnish company Aker Arctic. Finally, a new series of collaboration agreements between the two countries were signed during President Xi's visit to Finland in April 2017, including the memorandum of understanding between Universities Finland (UNIFI) and the Chinese Academy of Social Sciences.

Beyond strictly bilateral relations, in order to facilitate and provide a platform

[7] Following the awarding of the Nobel Peace Prize to Chinese dissident Liu Xiaobo in 2010, diplomatic relations between China and Norway were frozen for six years and fully restored only since 2017 (Watts and Weaver, 2011).

[8] In October 2018, following its organizational changes, SIU was renamed to the Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (Diku).

for academic cooperation with the Nordic states on the Arctic, in December 2013 four Chinese and six Nordic institutions established the China-Nordic Arctic Research Centre (CNARC), located in Shanghai and dedicated to Arctic research. Since its inception, the CNARC has convened the annual China-Nordic Arctic Cooperation Symposia that rotate between Chinese and Nordic members of the network and attract an increasing number of attendees and participants.[9] In accordance with the adopted formula, CNARC symposia consist of two parts: an academic conference and a business roundtable, which is open only to invited participants and brings together relevant partners from China and Nordic countries (in the case of conferences held in the Nordics, invited guests come from China and the organizing country). In this model, CNARC conferences serve not only as academic exchanges but also aim to enhance bilateral linkages between the involved countries.[10]

In the case of the United States, science and technology have been primary vehicles for enhancing the bilateral relationship with China since the opening of relations between the two countries in the late 1970s. At present, however, this trend

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[9] Up to now, seven symposia have taken place: "Sustainable Development in the Arctic: Human Activity and Environmental Change" in June 2013 in Shanghai; "North meets East" in June 2014 in Akureyri, Iceland; "Arctic Synergies: Policies and Best Practices" in May 2015 in Shanghai; "The Sustainable Arctic - Opportunities and Challenges of Globalization" in June 2016 in Rovaniemi, Finland; "Towards the Future: Transregional Cooperation in the Arctic Development and Protection" in May 2017 in Dalian, China; "Integrated Ocean Management in the Arctic" in May 2018 in Tromsø, Norway; and "Arctic Fisheries, Polar Silk Road, and Sustainable Development Practices" again in Shanghai, China, in May 2019.

[10] Speaking of multilateral fora for collaboration on Arctic matters, among other recent developments has been the emergence of the trilateral high-level dialog on the Arctic formed by China, Japan, and South Korea to discuss their engagement in the region and engage in polar science diplomacy. The first dialog took place in Seoul in April 2016, the second in June 2017, and the third one in Shanghai in June 2018. As noted by Lanteigne, "[t]hus far, these meetings have produced little in terms of concrete regional initiatives beyond pledges for future cooperation" (Lanteigne, 2018).

appears to be heading towards the reverse. Among other measures, as early as 2011, Congress prohibited the White House Office of Science and Technology Policy (OSTP) and the National Aeronautics and Space Administration (NASA) from coordinating any joint scientific activity with China.[11] Recently, the U.S. began expressing its wariness of China's rise to the position of global research power more explicitly, as reported in January 2018 by the U.S. National Science Board to Congress, where it announced the possibility that Chinese R&D investments might soon catch up with those of the U.S. (Showstack, 2018). The change of tone in relation to increasing Chinese engagement in the global arena in general, and to China's increasing scientific potential and capacities, did not omit the Arctic either, despite the invitation issued for scientists from the U.S. to join the 9th expedition of the *Xuelong* into the Arctic in 2018. Amid rapidly escalating tensions between the two countries, the Trump administration used the occasion of the Arctic Council Ministerial Meeting in May 2019 in Rovaniemi, Finland to manifest not only its hardline opposition to include any reference to climate change in the Arctic ministerial statement, but also to unilaterally single out and criticize, in an unprecedented manner, China and Russia for their activities in the region, marking a sharp contrast with the culture of dialog and cooperative spirit, which have characterized circumpolar Arctic affairs since their institutionalized beginnings in the early 1990s. In his statement delivered on the day preceding the actual Ministerial gathering, Secretary of State Pompeo denounced China for its aggressive behavior in other parts of the world and accused it of repeating the same expansion patterns in the Arctic. Moreover, in direct reference to China's scientific engagement in the North, Pompeo recalled the annual report of the Pentagon to

[11] There has been, however, some cooperation between the two countries in areas such as aeronautics and Earth science (Foust, 2018).

Congress on military developments in China, which in April 2019 included for the first time a section about the Arctic and stated that China's "[c]ivilian research could support a strengthened Chinese military presence in the Arctic Ocean, which could include deploying submarines to the region as a deterrent against nuclear attacks" (Office of the Secretary of Defense, 2019: 114). The report noted as well that "outside potential friction over the Northern Sea Route" (*ibid.),* the Arctic represents an area of opportunity for Sino-Russian commercial cooperation (see Chapter 6), the advancements of which were also criticized by Secretary Pompeo (U.S. Department of State, 2019).

Next to enhanced cooperation between China and Russia in the development of Russian energy resources and the Northern Sea Route, two countries have been increasingly working together, also in the research domain. Among others, in 2016, the Far Eastern Federal University in Russia and the Harbin Polytechnic University in China established the Russian-Chinese Polar Engineering and Research Center, dedicated to developing engineering capabilities for polar conditions, such as ice-resistant platforms and more efficient and durable icebreakers (Devyatkin, 2019). More recently, in April 2019 – the same month in which Pentagon issued its report to the U.S. Congress – two major oceanology institutes from both countries, China's Pilot National Laboratory for Marine Science and Technology (QNLM) and the P.P. Shirshov Institute of Oceanology of Russian Academy of Sciences (IO RAS) signed an agreement to form the Chinese-Russian Arctic Research Center to conduct joint research projects in the Arctic (*ibid.*). The new center is aimed to study the Far North's mineral and biological resources, deepen the comprehension of the changing northern ecosystems, and enable the forecasting of ice conditions along the Northern Sea Route. As proclaimed by two founding institutes, the results obtained from conducted research will provide for recommendations for the environmentally-sound economic development of the Arctic region. In August 2019, scientists involved with the newly established Center announced that the goal of their first joint expedition will be a broad study of Russia's Siberian Arctic shelf and of the European part of the Laptev Sea (Quinn, 2019).

4.7. Conclusions

In light of the unprecedented scale and pace of changes unfolding in the socio-ecological systems of the Arctic, their deepened scientific understanding is a matter of primary importance. In addition to the regional consequences of Arctic climate change are its global impacts, which through altering weather patterns, rising sea levels and effects on the ocean circulation matter to countries located in the southern latitudes, among them China. Whereas China's interest and capacities to operate in the polar regions and Earth's poles date back to the middle of the twentieth century, it is over the past decade that the country has exponentially developed its polar expertise, infrastructure and logistics capabilities. This growth in polar domain paralleled China's unprecedented leap forward in research and development in general, reflecting not only country's scientific ambitions, but most of all China's steady rise to the position of a global power capable of operating in all parts of the world and developing its competitive advantage across the whole spectrum of activities, from trade and business to science.

With the launch of its second icebreaker in 2019, China joined the ranks of a handful of countries able to simultaneously operate at both of Earth's poles. Until very recently, the country's scientific engagement has been largely welcomed among Arctic nations, none of which possesses sufficient resources and capacities to conduct research in the North correspondent in its scale and pace to the magnitude of changes observed in the Arctic ocean, climate and biodiversity. At the same time, from the outset, China's involvement in the Arctic has generated unparalleled attention and has been viewed with caution by some Arctic observers, wary of the country's economic interests, potential, and possibly also military motives, even if none of the latter have ever come to the surface. It appears fair to say that the speech of U.S. State Secretary Pompeo, delivered in May 2019 in Rovaniemi, Finland, opened a new chapter in relations between the United States, China and Russia in the Arctic, and in circumpolar collaboration more broadly. In his adopted rhetoric, Secretary Pompeo showcased the Arctic not only as a region of grand economic potential but also an arena for power and competition, where the United States is ready to fortify its strategic and diplomatic actions to secure its interests from Arctic and non-Arctic states alike. Therefore, many multilateral and bilateral projects including Chinese scientists are ongoing, and even intensifying, as in the case of collaboration with Russia, and the extent to which the stance of the United States will affect the shape of relations in the Arctic remains to be seen.

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